出國報告（出國類別：開會）

出席「第 36 屆歐洲核醫學國際會議」及實地參訪國際鉿室原廠、INFN LNL 研究機構出國報告

服務機關： 核能研究所
姓名職稱： 翁茂琦 聘用助理工程師
樊修秀 研究員
派赴國家/地區：奧地利及義大利
出國期間：112 年 9 月 8 日~112 年 9 月 17 日
報告日期：112 年 12 月 11 日

摘　　要

歐洲核醫學會 (European Association of Nuclear Medicine；簡稱 EANM) 每年舉辦國際性「歐洲核醫學會年會」，為全球核醫學創新研究與新技術發展之指標會議之一，邀集產、官、學、研界提出相關論文，以促進核醫藥物與技術創新研發發展。基於本國六大核心戰略產業之「臺灣精準健康戰略產業」國家政策，已朝向發展精準預防、診斷與治療照護系統之全方位個人化精準健康概念與策略方向前進，本次由樊副所長與翁茂琦博士出席參與 2023 第 36 屆歐洲核醫學會年會 (36th Annual Congress of the European Association of Nuclear Medicine, 簡稱 36th EANM)，並發表研究論文四篇，會議會期於 2023 年 09 月 09 日起至 09 月 17 日止，為期五天。以及於會議結束後，趕赴義大利實地參訪「COMECER」與「TEMA」鉛室原廠及「INFN-LNL」研究機構，實地參訪期於 2023 年 09 月 14 日起至 09 月 15 日止。

由於全球疫情趨緩，本次第 36 屆歐洲核醫學會年會 (36th EANM) 註冊人數打破歷年紀錄，成為歷史上參與人數最多的一屆歐洲核醫年會，大會講座主題領域相當廣，包含 AI、腦神經退化、癌症、心血管、分子影像、新診療用放射性同位素開發等核子醫學基礎研究以及各新藥在臨床技術與案例分析討論及新藥臨床試驗研究現況，包括胃腸道、甲狀腺、心血管及攝護腺之 FAPI、PSMA、CXCR4、CAIX 與腦神經退化新藥臨床應用結果，觀察到許多核醫新藥得以快速地進入人體臨床試驗，可快速獲得臨床驗證以搶得先機與提早佈局，是因為歐洲醫藥管理局 (European Medicine Agency, 簡稱 EMA) 考量核醫藥物屬於特殊類型的醫藥產品。本次聆聽各專業講座以及赴展場與廠商洽談同位素與核醫藥物發展、鉛室與機械手臂規劃等，此外，實地參訪國際鉛室原廠與 INFN-LNL 實驗室，深入瞭解迴旋加速器建置、鉛室設計與製藥法規規範，行程相當緊湊與收穫豐富。

綜合本次會議與實地參訪的內容，瞭解國際核子醫學研究發展現況與趨勢，相信對於本所未來核醫藥物研究規劃與推動應有相當大的助益，可準確掌握科學研究的趨勢。建議未來能持續派有經驗之研究人員參加國際研討會以及跨國際的合作洽談與資訊交流，收集新知及學習技術，以持續提升本所之新診療放射性同位素與新診療核醫藥物研究發展能力，以及能與世界同步與接軌。

目　　次

一、目　的

本次派員出國公差目的有二。第一為出席第 36 屆歐洲核醫學國際會議 (36th EANM)，代表國原院同位素應用研究所 (以下簡稱本所) 發表核醫相關研究壁報論文，共計 4 篇，提升本所國際能見度，以及學習最新核醫發展新知，探知合作對象，並同步參觀廠商展場，瞭解全球核醫藥物發展趨勢。第 36 屆歐洲核醫學會年會 (36th EANM) 由歐洲核醫學會主辦，於奧地利維也納會展中心 ACV (Austria Center Vienna) 舉行，會期為 2023 年 09 月 09 日起至 09 月 17 日止，為期五天。會議主席由維日內瓦大學和日內瓦大學醫院 (Geneva University and Geneva University Hospital) 的部門負責人兼副教授 Valentina Garibotto 教授擔任，該研討會為世界核子醫學藥物開發與技術創新研發會議之一，邀集全球學者專家提出數以千計的核醫領域相關論文。本所致力於核醫藥物開發相關技術研究，藉由參加該國際研討會議可快速獲得該領域最新研究發展方向與技術應用趨勢，有助於本所掌握技術應用與學術發展現況。

第二為配合 70MeV 加速器建置計畫之鉛室建置規劃，赴義大利博洛涅塞堡實地參訪「COMECER」鉛室原廠、法恩紮實地參訪「TEMA」鉛室原廠以及實地參訪萊尼亞羅「INFN-LNL」研究機構。實地參訪期於 2023 年 09 月 14 日起至 09 月 15 日止。主要目的是與實務經驗豐富的原廠或研究人員交流，探討放射性同位素發展趨勢、鉛室製作之法規要求面與製藥工業面的考量以及觀摩 Best 公司執行 INFN-LNL 研究機構之 70MeV 迴旋加速器建置現況，並詢問行前蒐集各單位關於 INFN-LNL 研究方向與建置方面的提問解答。

二、過　程

赴奧地利維也納出席第 36 屆歐洲核醫學會年會 (36th EANM)，代表本所發表壁報論文。此外，並於會議結束當日，趕赴義大利波隆那，於隔日赴博洛涅塞堡參訪「COMECER」鉛室原廠，同日前往法恩紮參訪「TEMA」鉛室原廠；最後一日，前往萊尼亞羅參訪「INFN-LNL」研究機構。出國公差行程與工作紀要，請參見表一。

表一、國原院出國公差行程

月	日	星期	地點	工作紀要
9	8	五	台北	(去程) 台北至奧地利維也納
	9	六	維也納	參加第 36 屆歐洲核醫學會年會 (36th EANM) 開幕典禮
	10	日		參加第 36 屆歐洲核醫學會年會 (36th EANM)，代表本所張貼及解說壁報論文
	11	一		
	12	二		
	13	三		參加第 36 屆歐洲核醫學會年會 (36th EANM) 閉幕典禮
			波隆那	(路程) 奧地利維也納至義大利波隆那
	14	四	博洛涅塞堡 & 法恩紮	實地參訪「COMECER」及「TEMA」鉛室原廠
	15	五	萊尼亞羅	實地參訪「INFN-LNL」研究機構
	16	六	米蘭	(回程) 義大利米蘭至台北
	17	日	台北	

三、心　得

（一）本國參與第 36 屆歐洲核醫學會年會 (36th EANM)

第 36 屆歐洲核醫學會年會 (36th EANM)，會議議程及主題，如附錄(一)。36th EANM 論文發表總共約 1,991 篇，其中口頭論文約 934 篇，壁報論文約 1,057 篇；壁報論文又分為口頭展示壁報 (EPS)、技術人員壁報 (TEPS) 及數位壁報 (EP) 等類別。台灣共發表 18 篇，其中口頭論文為 6 篇，壁報論文為 12 篇。國原院於本次會議發表總共 5 篇，如表二。國內產、學、研單位發表情形，如表三：臺灣大學/醫院有 6 篇，慈濟大學/醫院有 5 篇，長庚大學/醫院 2 篇，高雄榮總 1 篇，和信醫院 1 篇。鄰近國家發表情形：今年除了韓國 13 篇 (口頭 7 壁報 6) 略低於去年數目，中國有 266 篇 (口頭 84 壁報 182)，日本有 56 篇 (口頭 17 壁報 46)，包含台灣的發表數量均大幅增加，已回復至疫情前的水準；其中，中國的發表數量超過大會總數的十分之一，在各個領域都有發表，可謂是聲勢浩大。

台灣各產、學、研單位皆指派多人參加，本單位與會人員有同位素應用所樊修秀副所長、翁茂琦博士及倪于晴博士，所外與會人員包括：高雄榮總諶鴻遠主任、臺大醫院路景竹醫師、黃潔宜醫師以及莊佩儒醫師等，與會廠商包括：臺灣新吉美碩公司、吉晟公司、普瑞默公司、泰歷公司及恩典公司等，此外臺大醫院核醫部亦有多位職員參與盛會。

表二、國原院發表論文明細

序號	作者	論著名稱	口頭或壁報
1	翁茂琦、樊修秀	In vivo evaluation of luteinizing hormone-releasing hormone antagonists in triple negative breast tumor-bearing model by using SPECT/CT imaging	壁報 (編號：EP-0036)
2	羅瑋霖、黃永睿、陳明偉、盧安祺、王世民、陳亮丞、樊修秀	Evaluation of a Long-circulating PSMA-targeting Peptide in a Xenograft Model of Bone Metastatic Prostate Cancer.	壁報 (編號：EP-0029)
3	張博智、樊修秀	Method development for the analysis of14C-acetaminophen by HPLC-MS	壁報 (編號：EP-0858)

4	張明誠、陳俊堂、江秉芳、彭正良	Development ofINER-PP-F11N as the Radionuclide Theragnostics Agent against Cholecystokinin B Receptor-overexpressed Tumors	壁報 (編號：EP-0055)
5	倪于晴等	Differential Diagnosis of Lewy Body Dementia and Alzheimer's Disease in ECD SPECT Images Using 2D and 3D CNN Methods	口頭 (編號：OP-180)

大會手冊節錄本所發表研究論文摘要如附錄(一)。

表三、國內產、學、研單位參與發表情形

發表單位	篇數*	發表單位	篇數	發表單位	篇數
國原院	5 (5)	臺灣大學/醫院	6 (6)	高雄榮總	1 (1)
慈濟大學/醫院	5 (5)	基隆長庚醫院	3 (0)	和信醫院	1 (1)
長庚大學/醫院	2 (2)	亞東醫院	2 (0)	高雄長庚醫院	1 (0)
成功大學/醫院	1 (0)	三軍總醫院	2 (0)	恩典公司	1 (0)
輔仁大學/醫院	1 (0)	秀傳醫院	1 (0)	奇異公司	1 (0)

*註：篇數欄位表示方式為：總發表篇數（第一作者篇數），含口頭與海報發表。

（二）第 36 屆歐洲核醫學會年會 (36th EANM) 簡介

歐洲核醫學會 (EANM) 是歐洲最大的核醫學組織團體，並發行期刊。EANM 的願景是在個人化醫療理念下，優化和推進核醫學科學和教育，造福公眾健康和人類，促進疾病診斷、治療和預防有關的知識間相互交流，擁有 80 個國家超過 2,900 名的會員，每年可吸引 7,000 名與會者參加年會，探索核醫學上的最新進展、創新及突破；該學會並發行核醫學及分子影像領域卓著的 SCI 期刊：歐洲核醫分子影像期刊 (European Journal of Nuclear Medicine and Molecular Imaging，EJNMMI)。1988 年第一屆的年會於義大利米蘭舉辦，1991、2002、2010 及 2017 年亦曾於奧地利維也納會展中心 (ACV) 舉辦年會。近年因 COVID-19 疫情，EANM 曾停辦 2020 年與 2021 年實體年會，改成線上虛擬會議，至 2022 年才再次於西班牙巴塞隆納舉辦實體暨線上會議，同位素所亦有三位同仁報名線上會議 (未出國)；今年 36th EANM 實體會議，看到所有參與人員均無配戴口罩，即使在街道或交通工具上也鮮少人配戴，顯見全球已逐漸度過疫情、再現曙光。根據大會官方統計，36th EANM 註冊人數高達 7,763 人，打破歷年紀錄，成為歷史上參與人數最多的一屆歐洲核醫年會 (圖一)。

圖一、36th EANM 與會者人數統計資料

(摘錄自 EANM 會議簡報)

在 131 個參與國家中，人數最高的前三名，分別為德國、義大利及美國，亞洲國家參與人數最高的是中國 (202 位)，其次為日本、印度及韓國；台灣位居第 45 名，共

29 位參與。在投稿論文的數量上，36th EANM 也達到歷年最高的 2,438 篇 (圖二)；在被接受的 2,132 篇論文中，投稿國家數量以色階表示，主要分布在歐洲 (德國、義大利、西班牙、法國等)、亞洲 (中國、印度、土耳其等)、北美洲 (美國、加拿大等) 等。

圖二、36th EANM 摘要數目(左圖)及投稿國家(右圖)統計資料

(摘錄自 EANM 會議簡報)

為促進研究人員之間的知識交流和擴展，今年 EANM 頒發的獎項如下：(1) 居禮夫人獎 (Marie Curie Award) 鼓勵 EANM 的歐洲成員向年度大會提交其研究，並表彰 EANM 年度大會上在科學品質方面的貢獻，該獎項僅提供給在歐洲有固定居住地的研究人員，並在歐洲完成研究；作為年會最佳貢獻獎，將可獲得 5,000 歐元獎金。(2) 桑吉夫・甘比爾年輕研究人員獎 (Sanjiv Gambhir Young Investigator Award) 是紀念曾於史丹佛大學任教的印度科學家桑吉夫・甘比爾，他終身致力於促進國際合作蓬勃發展，2022 年起該獎項提供 38 歲以下接受訓練的所有初級醫生或其他科學家前往史丹佛大學三個月的訪問機會 (由 Telix 製藥公司贊助)。青年研究員獎 (Young Authors Award) 鼓勵年輕研究人員向 EANM 年度大會提交摘要，該獎項提供 38 歲以下三位優秀研究人員，每位將可獲得 1,000 歐元獎金。技術專家獎 (Technologists' Award) 是為了促進技術人員向 EANM 年度大會提交研究成果，該獎項提供口頭報告前三名的技術人員，分別可獲得 1000、500 及 250 歐元獎金。壁報獲獎第一名可獲得 250 歐元獎金。

36th EANM 最後一日，大會也宣布 2024 年度的 EANM 年會將再次在德國漢堡舉行 (2024 年 10 月 19 日至 23 日)。

36th EANM 的議程分成 12 個主要類別，包括 Plenary Sessions、CME Sessions、Joint Symposia、Cutting Edge Science/M2M Track、Clinical Oncology Track、Special Track、Learn & Improve Professional Skills (LIPS) / Case Reports 、 Other Sciectific (TROP/Featured)、Theranostics Track、Special Sessions、CTE/other Technologists' Track、e-Poster Presentations Session、e-Poster (only) uploaded 等，詳見會議議程，如附錄(二)。各類別場次 (不含 e-Poster) 總數高達 142 場，報告人數約有 891 位，會場內亦規劃有 e-Poster area、Exhibition booth 等區域。

以上會議類別內容相當豐富多元，主題包含：腦神經退化、癌症、發炎、心血管疾病、分子影像、放射核種治療等基礎研究結果。然而，36th EANM 最引人入勝的是各新藥在臨床技術與案例分析討論及新藥臨床試驗研究現況，針對人體內包含胃腸道、甲狀腺、心血管及攝護腺等重要器官，也涵蓋目前 FAPI、PSMA、CXCR4 及 CAIX 等新藥臨床應用結果。

其他特別的主題，如新型同位素開發及應用、小動物研究方法、核醫儀器 (PET、SPECT) 開發、劑量學、輻射防護、AI 應用、Covid-19 相關、放射藥物的法規等。本次會議除了由演講者輪流上台發表外，有一新型研究討論模式，部分主題由大會選派二陣營人馬，讓他們以辯論 (Debate) 方式進行對戰，並開放觀眾發表意見，大大增加互動及趣味性。

本次大會講座內容豐富，主題涵蓋非常廣，講者除了有重量級的教授，也有豐富臨床經驗的醫師，藉由講者們深入淺出的演講，洞見該技術領域的發展，由於會議期間各講座時間緊湊，要聆聽每場講座實則十分困難，故本次人員出國聆聽的重點著重於核醫藥物開發相關技術，以及最新研究發展方向，其餘會議講座之簡報資料下載存查於實驗室電腦中，供相關研究同仁參考與學習，本次會議議程內容與重點主題如下：

（三）36th EANM 居禮夫人獎 (EANM'23 Marie Curie Award)

EANM'23 居禮夫人獎頒給來自比利時自由大學 (Universitélibre de Bruxelles) 的 Magdalena Mileva 醫師暨博士 (圖三)，論文題目是：Molecular imaging predicts response absence to T-DM1 in advanced HER2-positive breast cancer: final results from a prospective phase II ZEPHIR trial。Magdalena Mileva 醫師同時也是今年青年研究員獎得主之一，朱爾斯・博德特研究所 (Institut Jules Bordet) 是布魯塞爾專門從事腫瘤學的綜合性醫院和研究所；2015 年起，ZEPHIR 臨床試驗提供 HER2 表現的轉移乳癌病患給予標靶毒殺治療藥物 trastuzumab emtansine (T-DM1) 前，利用 Zr-89-trastuzumab 進行 HER2 的 PET/CT 造影，有助於了解腫瘤異質性 (Tumour heterogeneity) 表現。

圖三、36th EANM 居禮夫人獎得獎人 Magdalena Mileva 與論文

(摘錄自 EANM 網站)

（四）全體大會 1：亮點講座 (highlight lecture)

全體大會 (Plenary Sessions) 是 EANM 最負盛名的會議，由大會主席所籌辦、規劃，本次大會共有 4 場。列為亮點講座 (highlight lecture) 的主題包含：神經學 (Neurology)、腫瘤學 (Oncology)、劑量學 (Dosimetry)、新造影劑與示蹤劑 (New Radiopharmecuticals and Ligands)、腫瘤造影、技術趨勢 (Technological Trend)、診療學新方法 (New Methodology for theranostics) 等 AI 技術、診斷與治療放射藥物開發與臨床前試驗等，總計神經學有 5 篇，腫瘤學共有 9 篇、劑量學 6 篇、腫瘤造影共 7 篇 (乳癌 3 篇、攝護腺癌 2 篇、胃腸道 2 篇)、技術趨勢 3 篇、診療學新方法 4 篇、攝護腺及

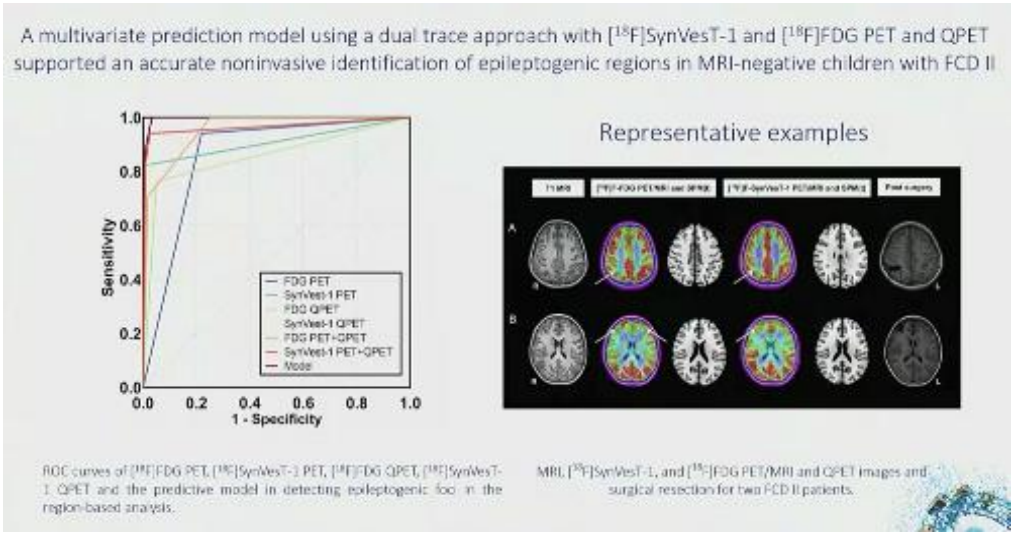
神經內分泌腫瘤治療 2 篇共有 36 篇，主要為 DG、FAPI (Fibroblast Activation Protein Inhibitor)、PSMA (Prostate Specific Membrane Antigen)、DOTATATE 等。亮點講座分別由義大利熱那亞大學 Silvia Morbelli 副教授、荷蘭阿姆斯特丹醫學中心 Sophie Veldhuizen van Zanten 博士、德國埃森大學醫院的 David Kersting 主任及荷蘭阿姆斯特丹醫學中心的 Hein Verberne 博士等進行介紹，如圖四。其中 Silvia Morbelli 教授過去曾協助撰寫 EJNMMI 重要文獻，David Kersting 主任曾獲得 2022 EANM 桑吉夫 • 甘比爾年輕研究人員獎 (Sanjiv Gambhir Young Investigator Award)，Hein Verberne 博士自 2015 年起即擔任 EANM 年度大會科學委員會的成員。

圖四、36th EANM 亮點講座 (highlight lecture) 由四位專家學者共同回顧

(摘錄自 EANM 會議簡報)

1. 義大利熱那亞大學 Silvia Morbelli 副教授回顧神經學、神經腫瘤學與腫瘤學

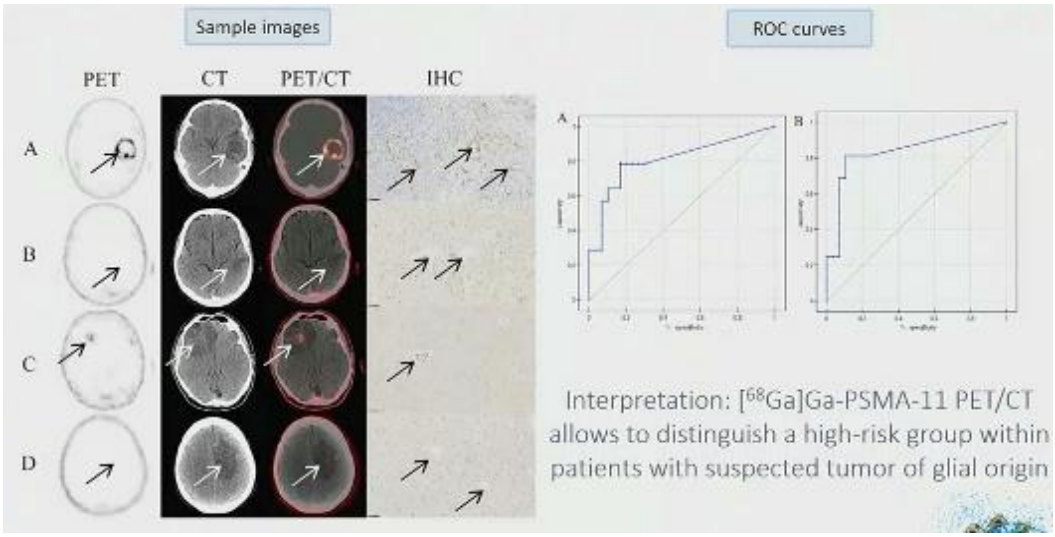
神經學方面，來自中國中南大學湘雅醫院核醫部的 Ling Xiao 團隊，介紹新藥物 F-18-SynVesT-1 與 FDG，用於定量局部皮質發育不良 FCD II 型且 MRI-negative 的癲癇兒童病患之開刀前評估研究 (編號：OP-795)，結果顯示[F-18]F-SynVesT-1 有更佳的定位效果，如圖五。



圖五、癲癇兒童病患之局部皮質發育不良 FCD II 型之多變項檢測方法

(摘錄自 EANM 會議簡報)

神經腫瘤學方面，來自波蘭華沙醫學大學核醫系的 K. Pelka 團隊，介紹 Ga-68-PSMA-11 在臨床神經膠質瘤上的診斷 (編號：OP-587)，顯示顯示可區分疑似神經膠質瘤之高風險病患，預期可增加更多臨床應用，如圖六。

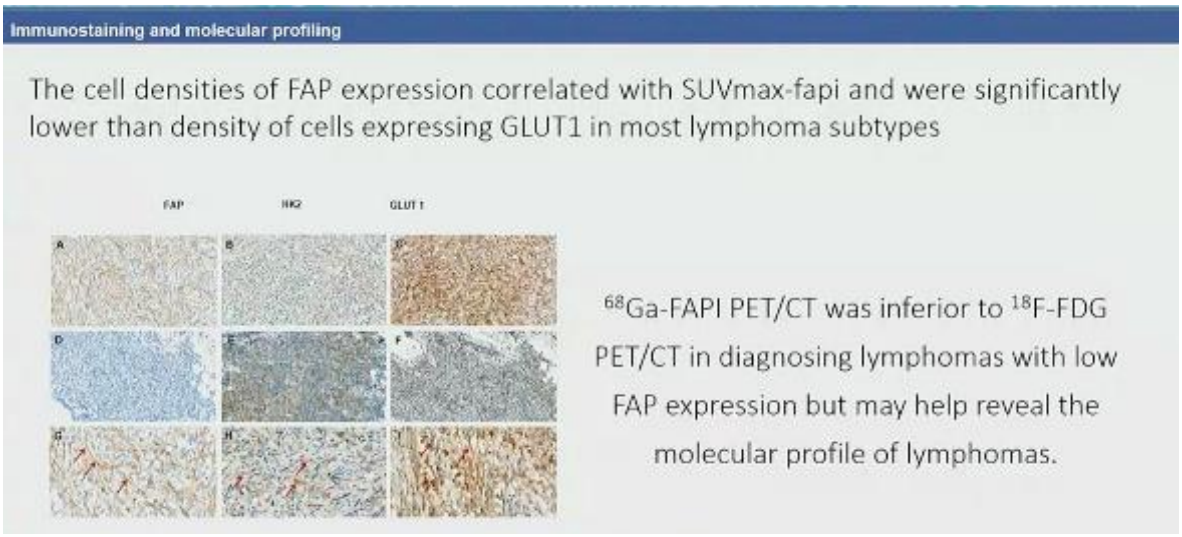


圖六、Ga-68-PSMA-11 可區分疑似神經膠質瘤之高風險病患

(摘錄自 EANM 會議簡報)

腫瘤學研究方面，來自中國北京大學中央醫院核醫科的 Xuetao Chen 團隊，利

用 FDG 及 Ga-68-FAPI 進行淋巴癌臨床診斷比較，然而淋巴癌使用 Ga-68-FAPI 卻比 FDG 較為不靈敏，如圖七，可能由於 FAP 的表現較低導致 (編號：OP-377)。



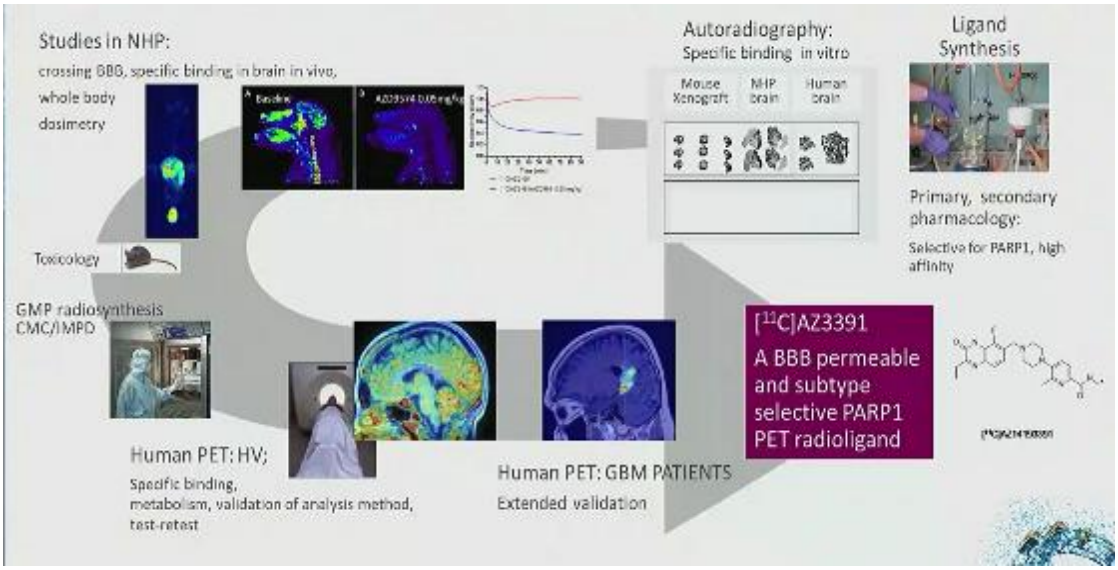
圖七、FDG 及 Ga-68-FAPI 進行淋巴癌臨床診斷比較

(摘錄自 EANM 會議簡報)

2. 荷蘭阿姆斯特丹醫學中心 Sophie Veldhuizen van Zanten 博士回顧新造影劑與示蹤劑與劑量學

新造影劑與示蹤劑研究方面，來自印度古爾岡 Fortis 醫院的 Subha Shankar Das 醫師團隊，進行 Ga-68-Trivehexin 在頭頸癌和胰腺癌的 pilot study，顯示 Ga-68-Trivehexin 正子造影效果，同時與 IHC 染色結果有正相關，具有作為 αvβ6 integrin 表現的分子探針潛力 (編號：OP-786)；來自德國 Essen 大學核醫科的 Masao Watanabe 團隊，進行 Ga-68-FAPI46、FDG 及 CT 在臨床多種實質腫瘤上的比較，可看到 Ga-68-FAPI46 對於原位瘤、淋巴結轉移、肝轉移及內臟轉移偵測率均較佳 (編號：OP-380)；來自德國 Essen 大學核醫科的 H. Lanzafame 團隊，Ga-68-FAPI 被作為肉瘤的臨床診斷探針，無論靈敏度、專一度、準確率均優於 FDG (OP-932)；來自中國上海中央醫院復旦大學核醫科的 Bingxin Gu 團隊，研究 Ga-68-FAPI 用在臨床頭頸部的局部小腫瘤上且與 FDG、CT、MRI 比較診斷效果，可看到 Ga-68-FAPI 無論是靈敏度、準確率等皆較佳 (編號：OP-379)；此外，來自瑞典 AstraZeneca 的卡

羅林斯卡學院正子科學研究所的 Magnus Schou 團隊，介紹 C-11-AZ3391 首次應用在 GBM 活體病患腦部 PARP1 診斷造影轉譯研究，C-11-AZ3391 過去已證明可穿過 BBB，此次，十分關鍵的提出腦部腫瘤的 DNA 損傷及修復與神經退化有關，結果顯示與 MRI 數據相比，均能積聚於腫瘤 (編號：OP-555)，如圖八。



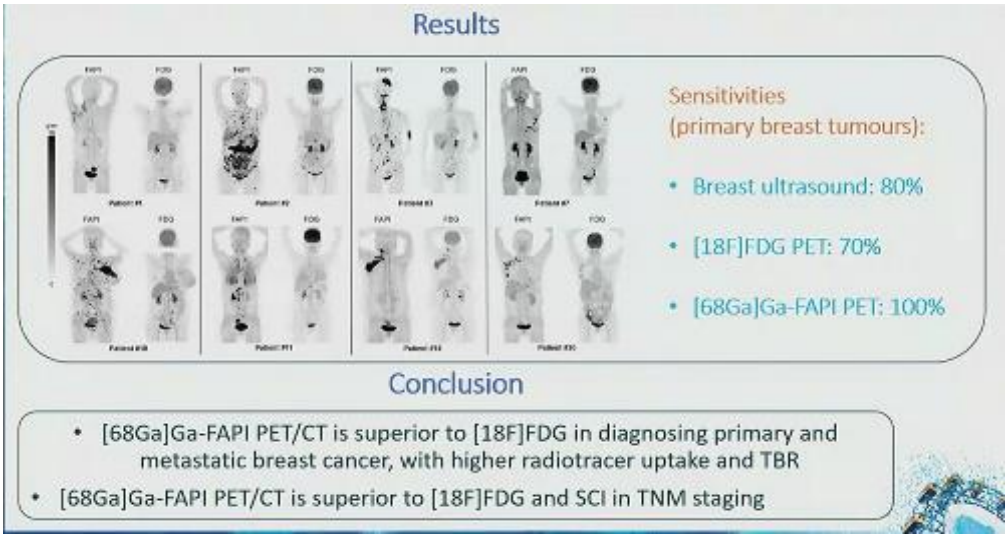
圖八、C-11-AZ3391 首次應用在 GBM 活體病患腦部 PARP1 診斷造影轉譯研究

(摘錄自 EANM 會議簡報)

劑量學研究方面，來自日本量子科學技術研究院 (QST) 的 Chie Toramatsu 團隊，探討未注射放射試劑，大鼠在粒子治療後，利用 PET 收集體內活化反應後物質的影像 (如 C-11、N-13、O-15 等)，並與 DCE-MRI 造影結果比較具正相關，顯示其應用潛力。詳細的介紹可參考本報告後章節 (編號：OP-079)。

3. 德國埃森大學醫院的 David Kersting 主任回顧腫瘤 (乳癌) 造影、腫瘤 (攝護腺癌) 造影與腫瘤 (腸胃道癌) 造影、技術趨勢與診療學新方法

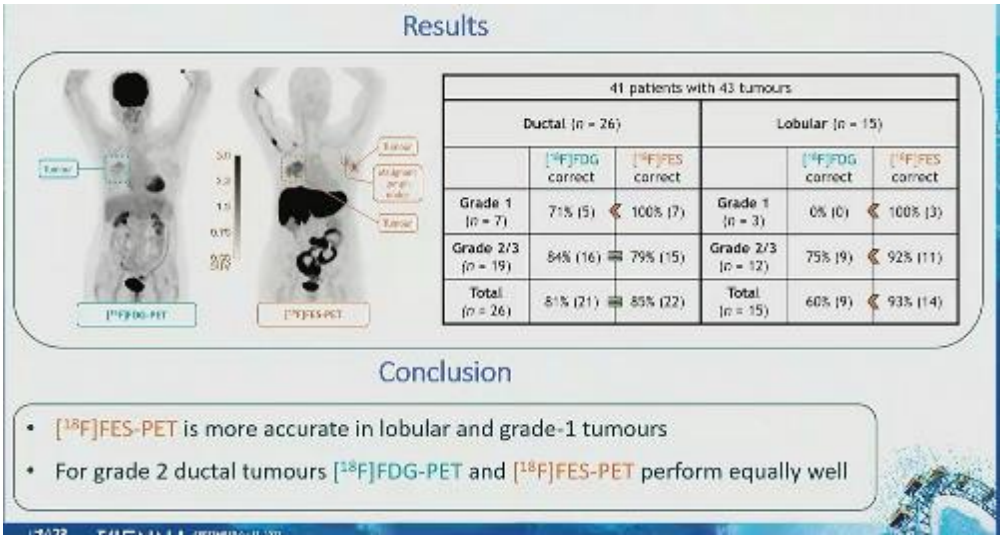
腫瘤 (乳癌) 造影研究方面，來自中國廈門第一醫院核醫科的 Wei Guo 團隊，比較 Ga-68-FAPI、FDG 及超音波在臨床乳癌上影像作為標準化影像或定期的潛力，結果顯示 FAPI 的靈敏度可達到 100%，優於 FDG，如圖九 (編號：OP-374)。



圖九、Ga-68-FAPI 具標準化影像或定期的潛力

(摘錄自 EANM 會議簡報)

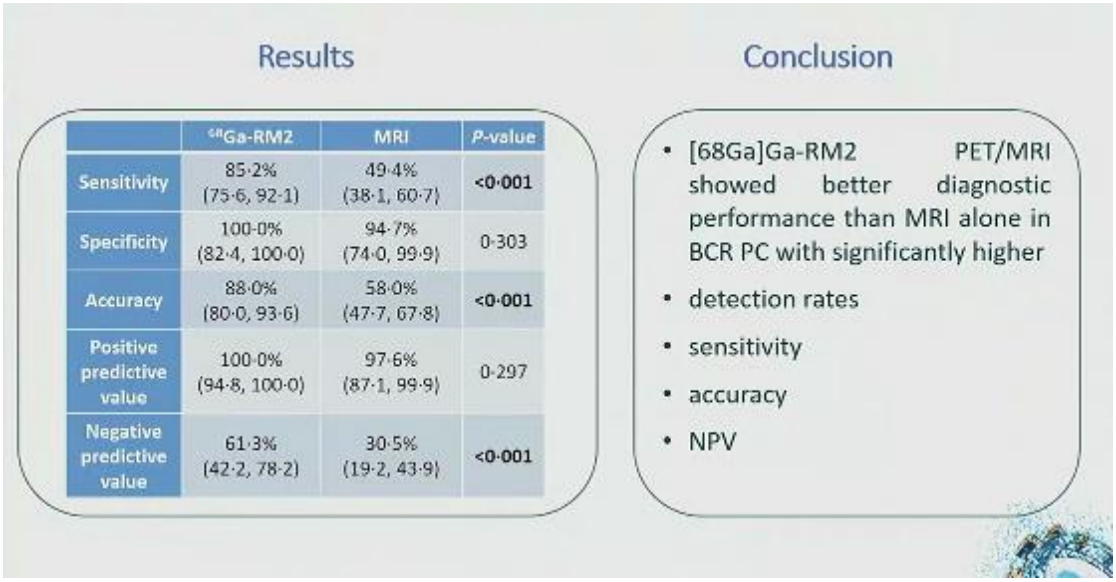
來自荷蘭阿姆斯特丹大學學術醫學中心腫瘤科的 Jelijn J. Knlp 團隊，比較 F-18-FES 及 FDG 作為雌激素表現乳癌病人腫瘤定期的潛力如圖十，結果顯示 FES 在乳葉癌 (lobular) 及臨床 1 期較為準確。於導管癌 (Ductal) 除了臨床 1 期優於 FDG，在臨床 2/3 期或整體期則與 FDG 皆具有高準確率 (編號：EPS-019)。



圖十、F-18-FES 具雌激素表現乳癌病人腫瘤定期的潛力

(摘錄自 EANM 會議簡報)

腫瘤 (攝護腺癌) 造影研究方面，來自澳洲攝護腺診療及影像中心 (ProSTIC) 的 Michael Hofman 教授，研究 PSMA 正子掃描與 CT 或是 bone scan 相比，具有作為未轉移、中-高風險攝護腺癌病患，評估治療風險評估的潛力 (編號：OP-037)。來自美國史丹佛大學放射科的 Duan H 團隊，介紹使用 Ga-68-RM2 PET/MRI 進行臨床 2/3 期造影結果顯示，與 MRI 相比，具有攝護腺癌復發生化檢出潛力，如圖十一，RM2 是蛙皮素 (Bombesin, BBN) 的類似物，可標靶許多癌細胞 (包括前列腺癌) 中過度表現的胃泌素釋放肽受體 (GRPR) (編號：OP-504)。

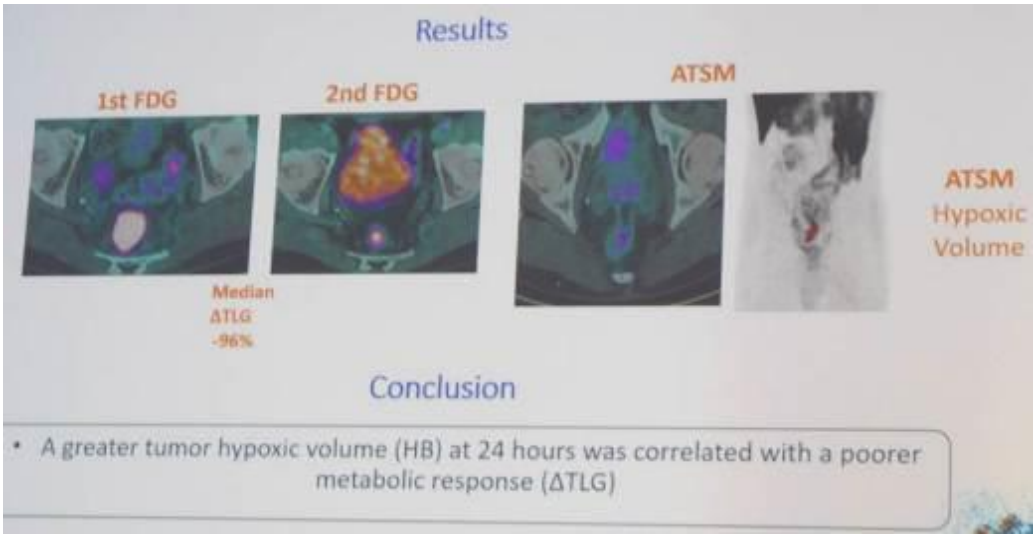


	^{68}Ga-RM2	MRI	*P*-value
Sensitivity	85·2% (75·6, 92·1)	49·4% (38·1, 60·7)	<0·001
Specificity	100·0% (82·4, 100·0)	94·7% (74·0, 99·9)	0·303
Accuracy	88·0% (80·0, 93·6)	58·0% (47·7, 67·8)	<0·001
Positive predictive value	100·0% (94·8, 100·0)	97·6% (87·1, 99·9)	0·297
Negative predictive value	61·3% (42·2, 78·2)	30·5% (19·2, 43·9)	<0·001

圖十一、Ga-68-RM2 具有攝護腺癌復發生化檢出潛力

(摘錄自 EANM 會議簡報)

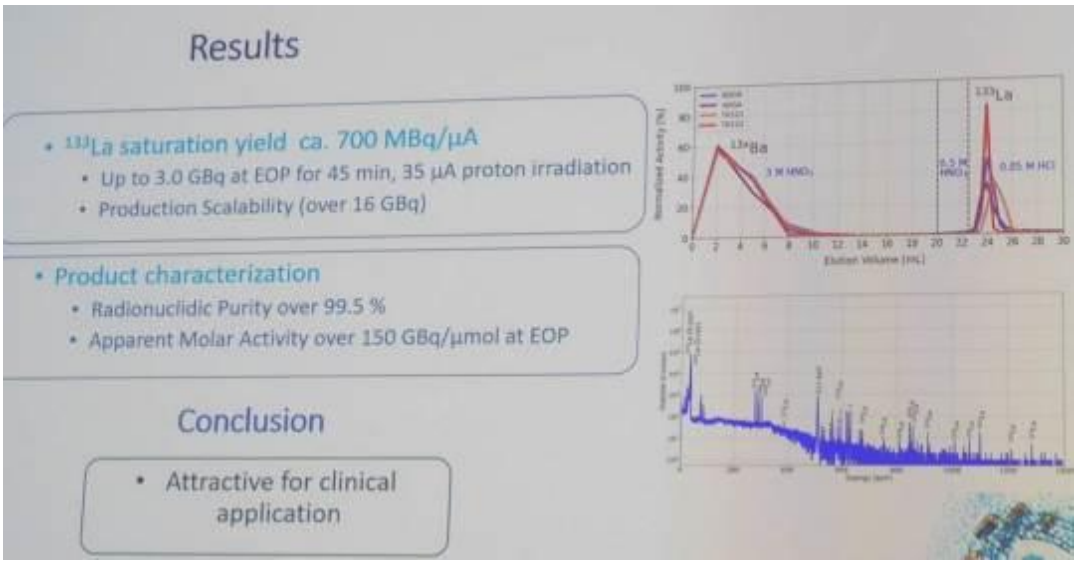
腫瘤 (腸胃道癌) 造影研究方面，來自法國 ICO 中心的 M. Le Thiec 團隊，經評估 24 個直腸癌病患，Cu-64-ATSM 缺氧造影劑與 FDG 造影結果相比可積聚在代謝反應較低的區域，如圖十二，具有作為直腸癌病人術前的預後評估探針的潛力 (編號：OP-155)。



圖十二、[Cu-64]Cu-ATSM 具有作為直腸癌病人術前的預後評估探針的潛力

(摘錄自 EANM 會議簡報)

技術趨勢研究方面，來自德國赫爾曼馮亥姆霍茲聯合會科研中心 Santiago Andres Bruhlmann 團隊，發表透過 Ba-134(p, 2n)La-133 核反應 (產率~700 MBq/μA) 產製鑭-133 (Lanthanum-133)，已知 La-133 與 Ac-225 特性相近，經分析其放射核種純度>99.5%，可用於診療用途 (編號：OP-020)，如圖十三。

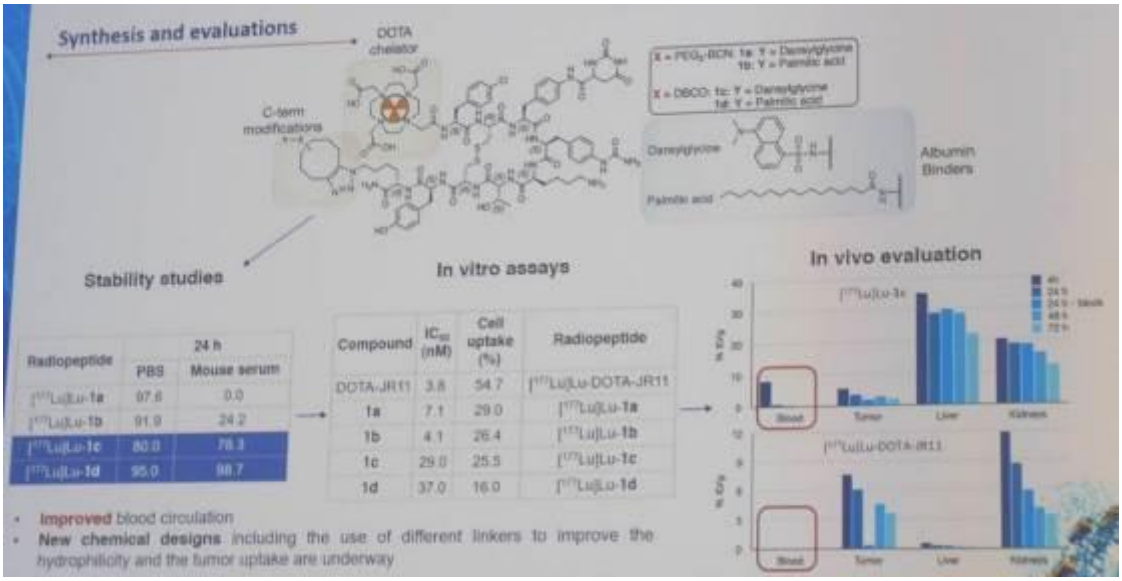


圖十三、透過 Ba-134(p, 2n)La-133 核反應產製鑭-133 (Lanthanum-133)

(摘錄自 EANM 會議簡報)

4. 荷蘭阿姆斯特丹醫學中心的 Hein Verberne 博士回顧診療學新方法與攝護腺及神經內分泌腫瘤治療

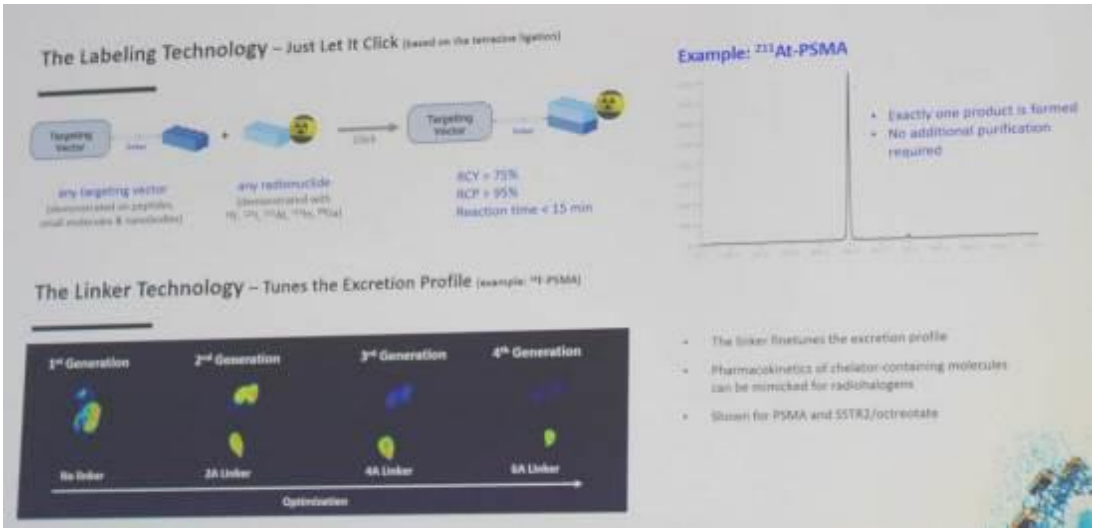
診療學新方法研究方面，來自荷蘭鹿特丹伊拉斯姆大學的 Maryana Handula 團隊，將藥物 (如 peptide) 與白蛋白等進行結構修飾，經標誌 Lu-177 及生物測試，可增加血液內滯留時間並增加水溶性，但觀察腫瘤內積聚效果有下降，如圖十四 (編號：EPS-224)。



圖十四、將藥物 (如 peptide) 與白蛋白等進行結構修飾研究

(摘錄自 EANM 會議簡報)

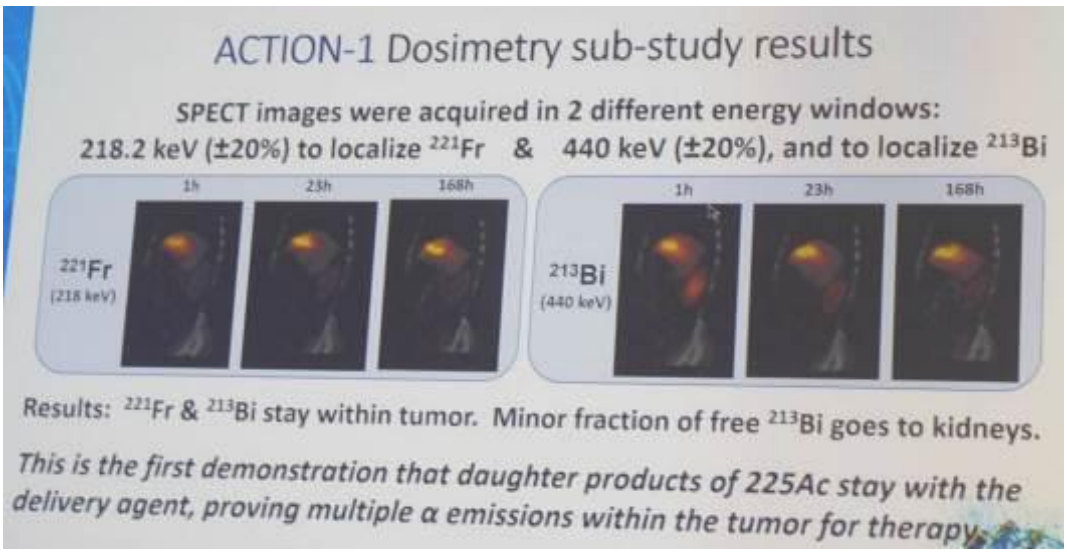
來自丹麥 Tetrakit Technologies APS 公司的 U.M. Battisti 團隊，開發連結子 (linker)，並進行 At-211-PSMA 標誌測試，反應時間<15 min，產率>75%，放射化學純度>95%。不同的 linker 在動物體進行測試，可看到腫瘤積聚優化的效果，如圖十五。



圖十五、開發連結子(linker)並進行 At-211-PSMA 標誌測試

(摘錄自 EANM 會議簡報)

來自美國霍格家族癌症研究所的 Gary Ulaner 團隊，欲觀察 Ac-225-DOTATATE (RZY101) 注射後，如圖十六，透過 SPECT 觀察子核種 Fr-211 (能量：218 keV) 及 Bi-213 (能量：440 keV) 的分布情形，可看到即使經過衰變，仍停留在腫瘤內造成類似的分布結果 (編號：OP-672)。



圖十六、觀察 Ac-225-DOTATATE (RZY101) 子核種的分布情形

(摘錄自 EANM 會議簡報)

攝護腺及神經內分泌腫瘤治療方面，來自澳洲墨爾本彼得麥卡倫研究中心的

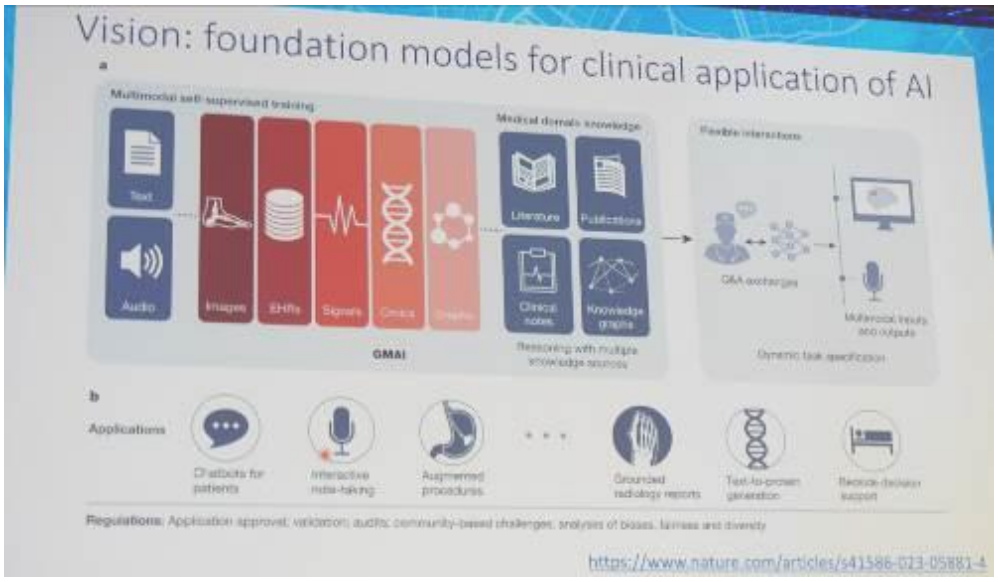
Michael S. Hofman 團隊，將 20 個患者分成 2 組給予不同的劑量 (分別給予一或二個週期) 的 Lu-177-PSMA-617 進行治療，6 週後進行進行臨床達文西手術，顯示 49%的病患可看到 PSA 指數有下降，存活率也提升至 13.8 個月 (80%) (編號：OP-338)。

（五）全體大會 3：新造影技術：跟風或觀望

來自英國劍橋大學癌症醫學系的 Francesca Buffa 教授，介紹 AI 技術目前的應用。自 1975 年美國國家衛生研究院 (NIH) 開始投資 AI 在醫學上的應用，但 AI 不是單純只在專一學門上發展，可以應用在多個領域，如：複雜的計算、資料處理、型態辨認、重複差事、物件追蹤、對弈等。蛋白質的結構決定了他們的功能，英國 AlphaFold Protein Structure Database 發展第一及第二代 AI 並預測蛋白質的結構，在 2020 年 nature 發表的第二代的 AlphaFold2 預測結果幾乎與透過試驗決定的結構相同。

AI 同時也用來加速藥物的研究，2000 年以前的疫苗開發相當耗時，隨著 AI 發展，2020 年 SARS-COV-2 莫德納疫苗僅開發了一年。目前 BioGPT 比起 GPT，更能提供生醫研究的資訊，而 2023 年 nature 發表的 GMAI 透過自我學習、具彈性的交流介面，提供臨床病人對談、互動式病歷紀錄、影像分析報告、藥物研究、床邊病人支持上等應用。

目前 AI 無法協助的包括：無結構的數據、有限數據的學習、可疑及不確定性、上下文文意理解、創造力及直覺、極難解決的問題。而 AI 具有整合多元學科的能力，可整合包含 1. 電腦科學、2. 機器人、3. 認知科學、4. 社會、健康科學、STEM(科學 (Science)、科技 (Technology)、工程 (Engineering)、數學 (Mathematics)、生活等相關政策及邏輯，如圖十七。

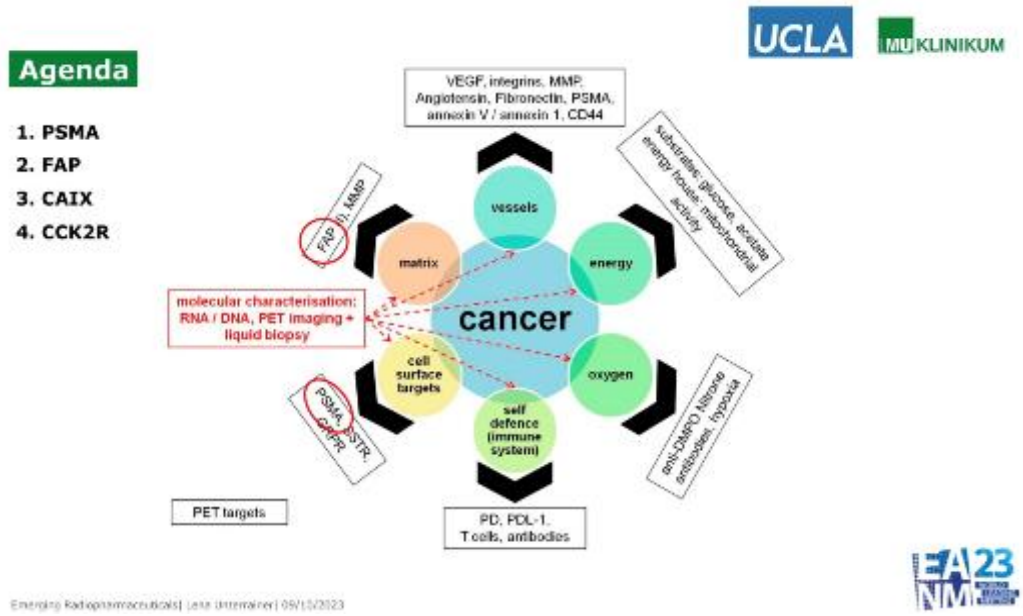


圖十七、AI 應用於多元學科整合能力

(摘錄自 EANM 會議簡報)

（六）LIPS Session：腫瘤學及診療學 — 放射性核種治療的新興放射性藥物

德國慕尼黑大學 Lena Unterrainer 博士報告腫瘤或標靶異質性 (Tumor or Target Heterogeneity, TH) 的存在往往造成「治療抗藥性」，腫瘤或標靶異質性 (TH) 是「治療抗藥性」最常見的原因，腫瘤或標靶異質性 (TH) 是指在同一腫瘤內或同一患者的不同腫瘤部位存在具有不同基因組特徵的可變細胞群，異質性不僅影響治療的決策，也影響治療的結果，由於抗藥性之故，必須從不同的角度看待腫瘤的不同「區域」，如圖十八，包括細胞基質、免疫系統與膜表面標靶等。目前診斷治療和精準醫學的趨勢已朝向發展可診斷與治療的「標靶目標」，即所謂「See what you treat and treat what you seen at a molecular level」，可利用特定的 PET 探針來識別腫瘤細胞的主要路徑，然後使用相同的配體來靶向治療性放射性核素以治療癌症。理想且有效的治療策略，必須同時針對所有元素，並可以於治療期間以 RNA/DNA 分析、正子造影或是液態生物檢體/液態活檢 (Liquid Biopsy) 分析來監測基因突變或標靶特徵的變化，如圖十八。以下分別就 前列腺特異性膜抗原 (prostate-specific membrane antigen, PSMA)、纖維母細胞活化蛋白 (fibroblast-activation-protein, FAP)、碳酸酐酶 IX (Carnonic Anhydrase IX, CAIX) 與膽囊收縮素-2 接受器 (Cholecystokinin-2 Receptor, CCK2R) 進行介紹。



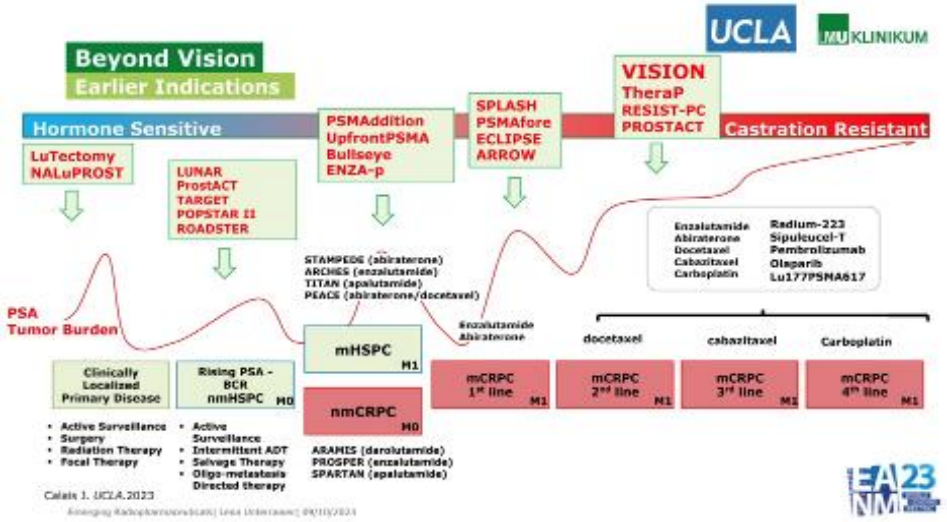
圖十八、腫瘤細胞的主要路徑「區域管理」概念

(摘錄自 EANM 會議簡報)

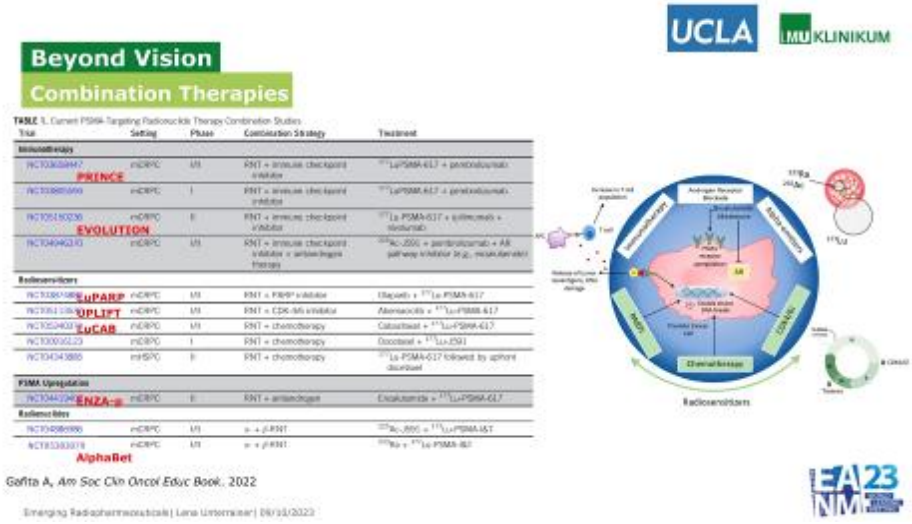
1. 前列腺特異性膜抗原 (PSMA)

治療方法中，新英格蘭雜誌發表 Lu-177-PSMA-617 用來治療轉移性的去勢抗性前列腺癌 (metastatic castration-resistant prostate cancer, mCRPC)，研究顯示 Lu-177-PSMA-617 可提升整體存活率，可提供 mCRPC 治療新選擇。他回顧目前研究方向，一是尋找更早期的指標，如以下幾家廠商進行的 mCRPC 的治療，包括 Point Biopharma 公司 SPLASH (Lu-177-PSMA-I&T)、Novartis 公司 PSMAfore (Lu-177-PSMA-617) 及 Curium 公司 ECLIPSE (Lu-177-PSMA-I&T)，mHSPC 治療方面有 Novartis 公司 PSMAddition (Lu-177-PSMA-617)，目前結果都已發表在期刊上，藥物間亦有互相比較，如圖十九。在 Lu-177-PSMA 治療 mCRPC 前加以 Ac-225-J591 進行治療，並進行劑量分析，可看到 PSMA-617 唾腺及胃腸道毒性較高，J591 則看到骨髓內有毒性。在 2022 年的文獻中，Lu-177-PSMA 已與多個藥物合併進行 mCRPC 臨床試驗 (PRINCE、EVOLUTION、LuPARP、UPLIFT、LuCAB、ENZA-p 及 AlphaBet 等)；2021 年起多篇文章報導 Ac-225-PSMA 藥物用在 mCRPC 的治療，顯示國際上貝他 (Lu-177-PSMA) 至阿伐 (Ac-225-PSMA) 的治療趨勢，而多核種的治療效果也值

得探究，如圖二十。



圖十九、Lu-177-PSMA-617 用來治療轉移性的去勢抗性前列腺癌
(摘錄自 EANM 會議簡報)

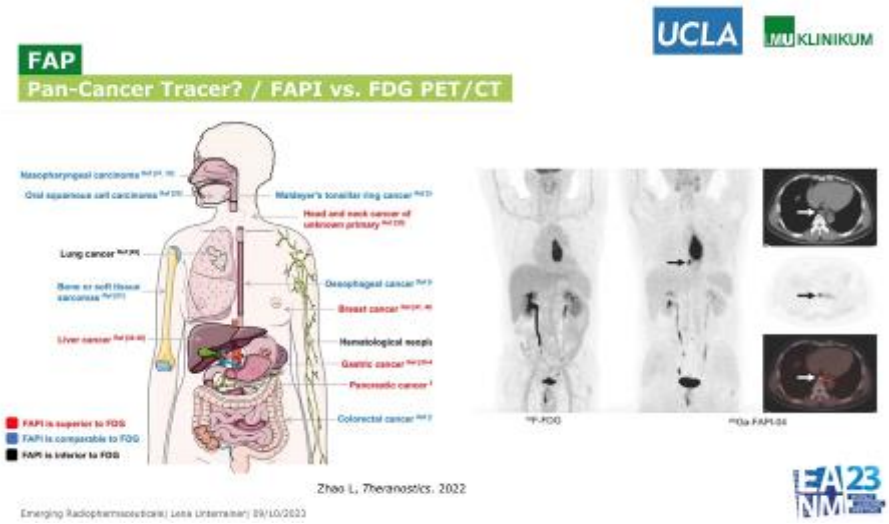


圖二十、Lu-177-PSMA 與多個藥物合併進行 mCRPC 臨床試驗
(摘錄自 EANM 會議簡報)

2. 纖維母細胞活化蛋白 (FAP)

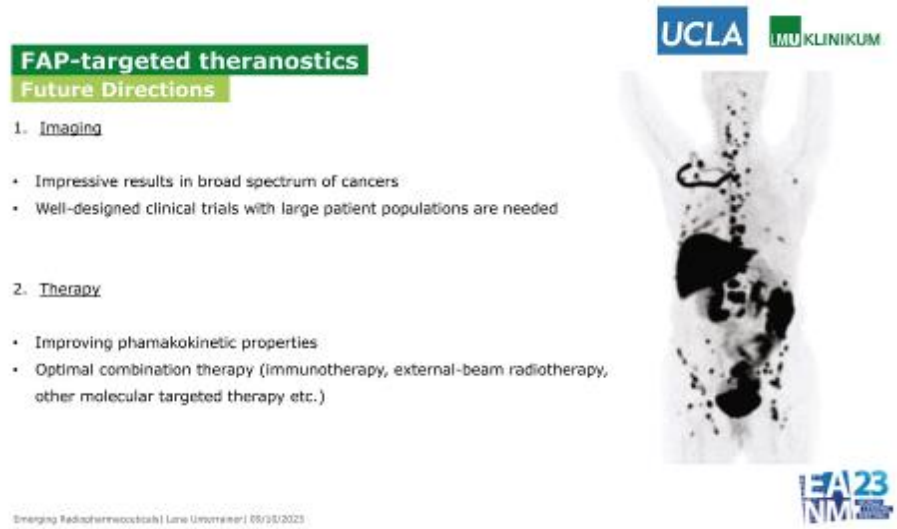
早於 1990 年，已有相關 FAP 發表，如 I-131-Anti-FAP-mAb-F19 造影應用，如圖二十一，截至今年發表文獻的數量不斷增加，其一是在正子造影上的潛力已廣泛應用在腫瘤，其二是在腫瘤診療上的良好成效；如圖二十二，在 FAP 標靶的診療方向上，講者建議須取得多種腫瘤造影的結果，並使用大型臨床試驗的設計，治療方面也須改

進藥物動力學的特性，並找出合適的合併治療策略 (如：免疫治療、射束放射治療及其他分子標靶治療等)。



圖二十一、FAP 在正子造影上已廣泛應用在腫瘤

(摘錄自 EANM 會議簡報)



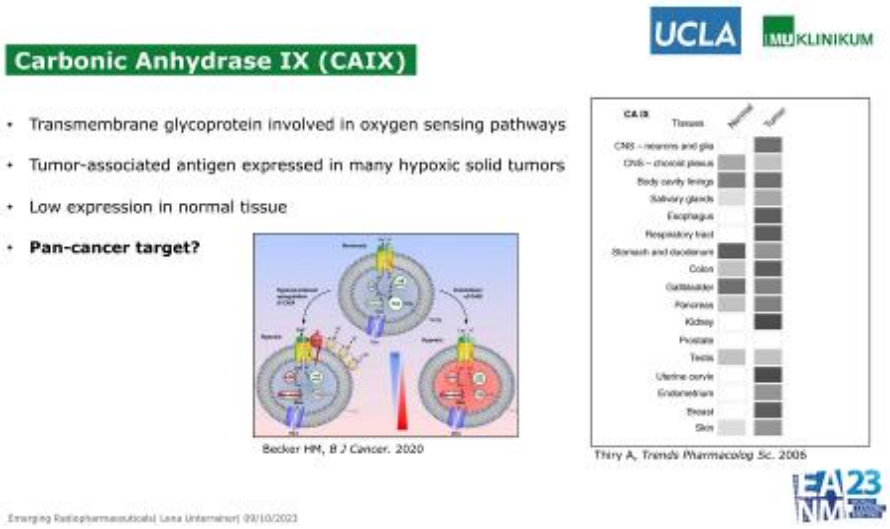
圖二十二、FAP 標靶的診療方向

(摘錄自 EANM 會議簡報)

3. 碳酸酐酶 IX (CAIX)

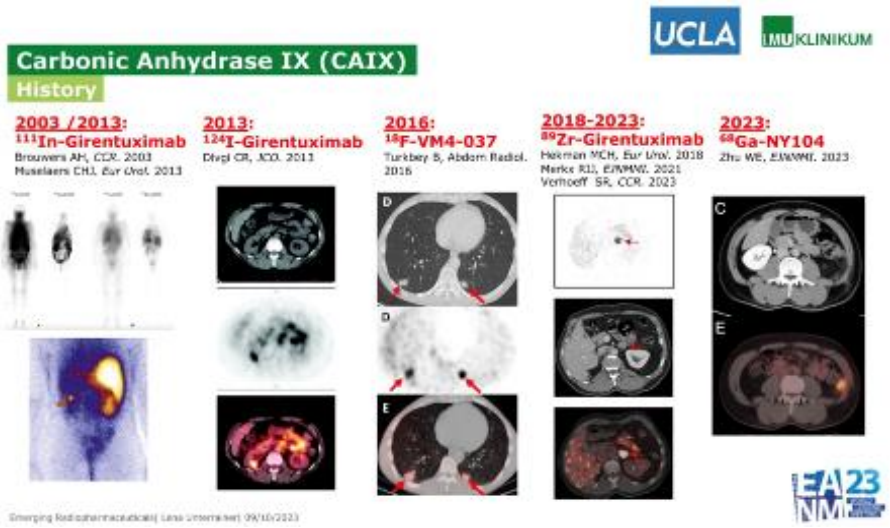
碳酸酐酶 IX (CAIX) 屬於一種參與氧氣偵測的穿膜醣蛋白，在多種缺氧腫瘤內

表現抗原，正常細胞卻不表現；其中透明細胞腎細胞癌 (Clear cell renal cell carcinoma, ccRCC) 中 CAIX 表現>90%。如圖二十三，全球 CAIX 藥物發展歷程：2018-2023 年發展的 Zr-89-Girentuximab (ZIRCON) 及 Ga-68-NY104 都是相當熱門的藥物。其中，ZIRCON 在 CRC 的靈敏度可達 85.5±1.62%，專一性也可達 87.0±2.43%；最新研究中，除了 2023 年在 EJNMMI 發表的 Ga-68-NY104 具有臨床造影潛力，Lu-177-Girentuximab 目前也正在進行臨床 I/II 期腎癌治療試驗，如圖二十四。



圖二十三、碳酸酐酶 IX (CAIX) 在缺氧腫瘤及正常細胞表現情形

(摘錄自 EANM 會議簡報)

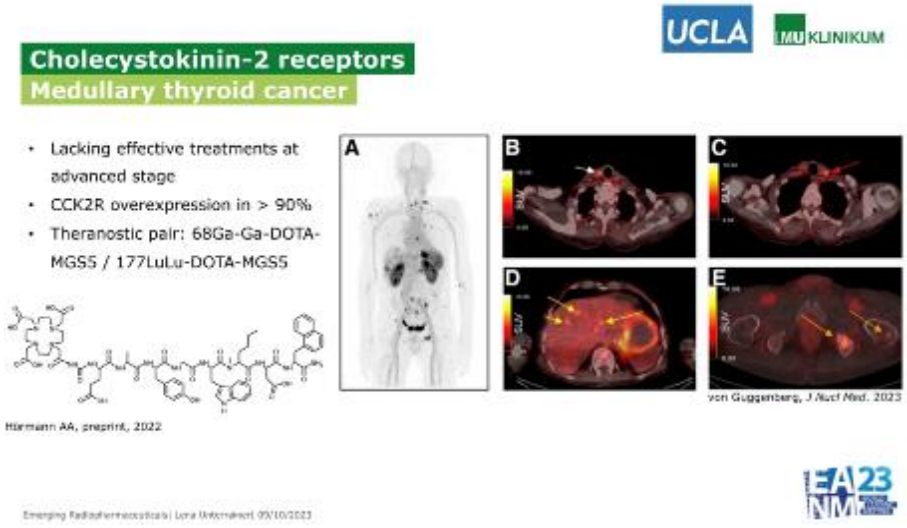


圖二十四、全球 CAIX 藥物發展歷程

(摘錄自 EANM 會議簡報)

4. CCK2 接受器 (Cholecystokinin-2 Receptor, CCK2R)

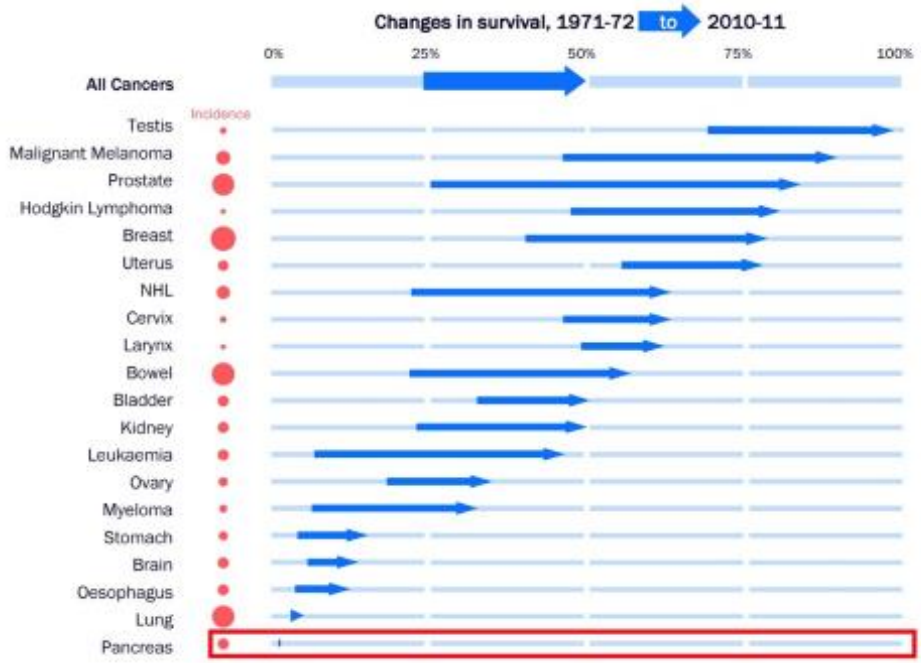
具有 CCK2 接受器 (CCK2R) 相關表現腫瘤 (如：甲狀腺髓質瘤)，目前在嚴重期缺乏治療手段。2023 年報導該組合藥物：Ga-68-DOTA-MGS5 / Lu-177-DOTA-MGS5 (結構如圖二十五)，具有診斷及治療潛力。



圖二十五、Ga-68-DOTA-MGS5 / Lu-177-DOTA-MGS5 結構
(摘錄自 EANM 會議簡報)

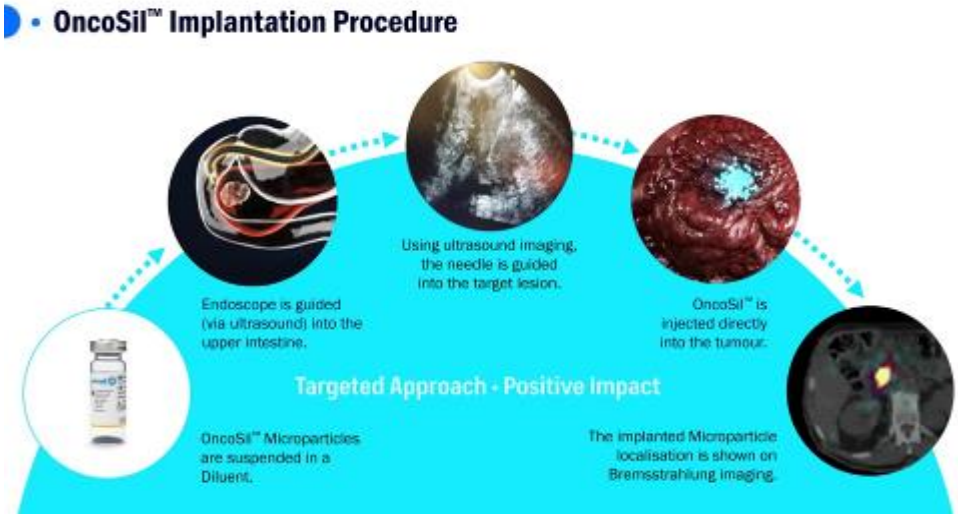
接下來由來自英國倫敦帝國學院 Zami Win 博士介紹透過 P-32 核種治療胰臟癌。過去四十年來，胰臟癌的預後幾乎無改善，5 年的存活率僅提升了 10%，如圖二十六，是所有癌症中最差的。有 79%的病人在第三或第四期才診出，僅有 21%的病人早期診出。15%患部可透過手術切除，中數存活率達到 35.3 個月；局部癌 3-6 個月內有 30%的病患會轉移，若使用化療合併放療，可達到 13 個月的存活率；已轉移的病患僅能使用化療治療，依據藥物其存活率也不同 (<6 個月至 11.1 個月)。P-32 半衰期為 14.27 天，貝他平均能量 0.6950 MeV，平均距離 2.76 mm。如圖二十七，P-32 Oncosil 透過超音波導引內視鏡注射，合併化療藥物 (Gemcitabine) 進行無法局部移除之胰臟癌治療，可提供 100 Gy/tumor 劑量，最後經由 SPECT/CT 制動輻射 (Bremsstrahlung) 造影可觀察及追蹤該核種聚積表現 (4 小時內及第 7 天)。研究顯示，可延長中期存活率 31.6 個月；2022 年在澳洲皇家阿德萊德醫院進行的經驗，12 個病人都成功給予藥物，12 週後平均腫瘤體積減少 8.2 cm^3，有 42%的病人達到可切除的情形，切除情形

顯示 R0 的邊界。P-32 Oncosil 介紹資料已向廠商取得，如附錄(三)(1)。



圖二十六、胰臟癌的預後過去四十年來幾乎無改善

(摘錄自 EANM 會議簡報)

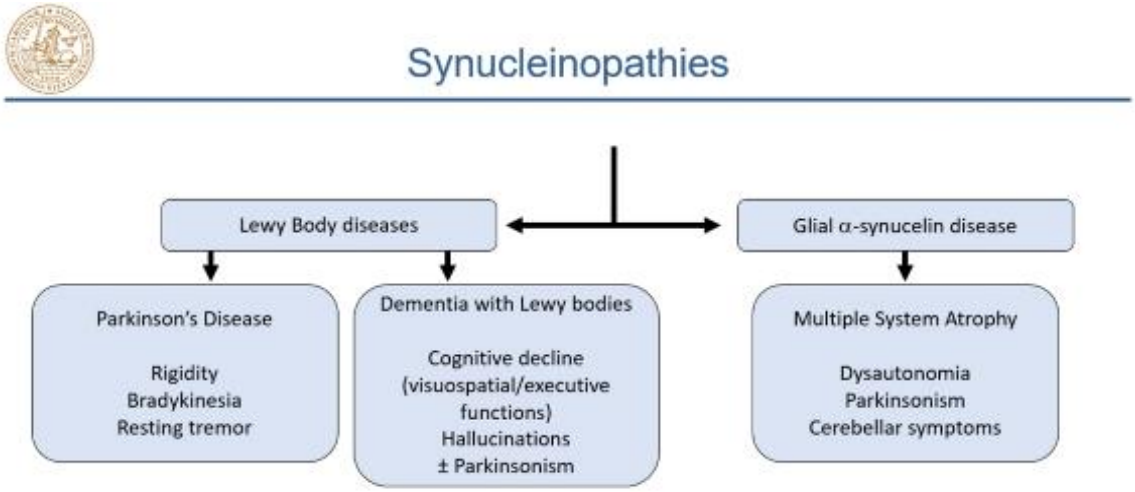


圖二十七、P-32 Oncosil 原位注射治療程序

(摘錄自 EANM 會議簡報)

（七）LIPS Session：神經造影 — 腦部 α-突觸核蛋白體造影之黎明

首先，由瑞典隆德隆德大學醫學院臨床記憶研究室之 Ruben Smith 副教授報告 α-突觸核蛋白 (α-synuclein protein，簡稱 α-syn) 生物標誌的重要性。α-突觸核蛋白病變 (Synucleinopathies) 是一種由 α-突觸核蛋白 (α-syn) 異常聚集在神經元與神經膠質所形成不溶性纖維所引發的神經退化性疾病，包括巴金森氏症 (Parkinson's Disease, PD)、路易氏體失智症 (Dementia with Lewy Bodies, DLB) 與多系統萎縮症 (Multiple System Atrophy, MSA)，如圖二十八。



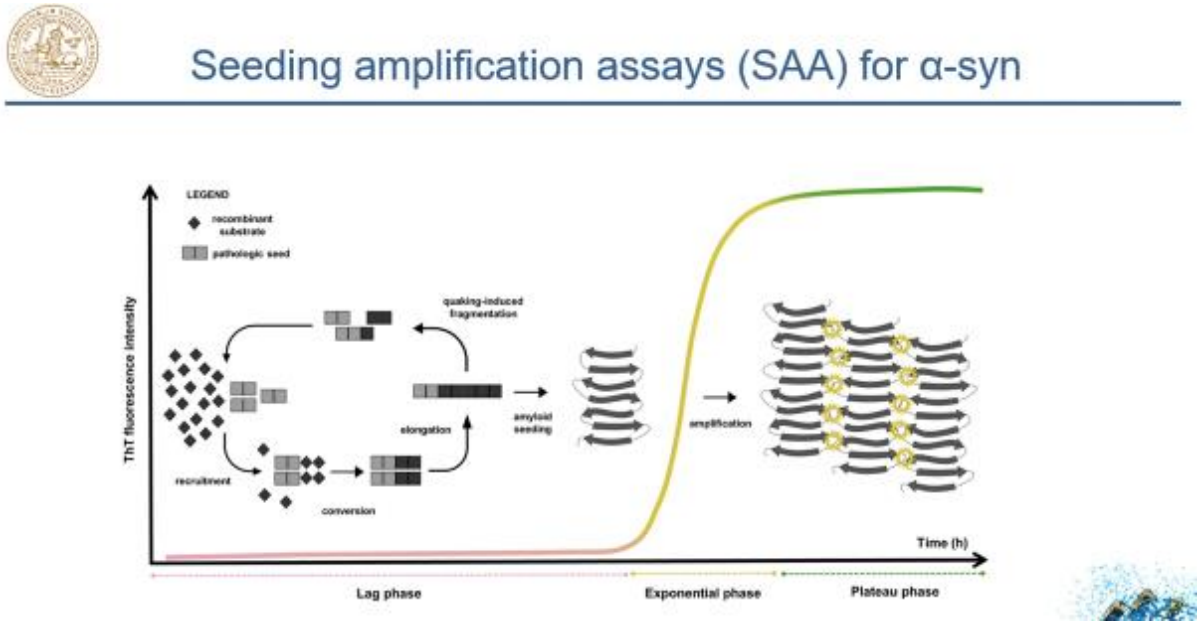
圖二十八、α-突觸核蛋白病 (Synucleinopathies)

(摘錄自 EANM 會議簡報)

神經退化性疾病的最常見的特徵是蛋白質錯誤折疊、聚集以及細胞內外蛋白質澱粉樣蛋白 (amyloidogenic proteins) 的沉積，例如 prion 病毒蛋白、α-突觸核蛋白與 tau 蛋白等。因此，在生物體液和組織中檢測這些異常蛋白質是這些疾病早期鑑定的理想候選者，可作為一種生物標記，可對於疾病臨床診斷產生重大影響，包括早期診斷與確認病患罹病風險。然而，由於不同組織和體液中蛋白質聚集體的濃度存在顯著差異。因此，最近開發的擴增策略之靈敏檢測方法，利用種子聚合傳播機制 (seeded polymerization propagation mechanisms) 概念來高度放大並檢測這些澱粉樣蛋白，例如真實時間震動誘導轉化分析 (real-time quaking-induced conversion assay, RT-QuIC) 方法 - α-突觸核蛋白種子擴增測定法 (seeding amplification assays, SAA)。

近期研究指出，該測定方法可以準確地區分路易氏體疾病 (Lewy body disorders) 和其他形式的帕金森氏症 (parkinsonisms) 或失智症 (dementias)，表明脊髓液的真實時間震動誘導轉化分析 (CSF RT-QuIC) 方法，已可成功應用於突觸核蛋白疾病 (synucleinopathies) 研究。此外，已有令人鼓舞的數據顯示 CSF RT-QuIC 也可能適用於 tau 蛋白，可準確區分 3R 和 4R tau 疾病 (3R- and 4R tauopathies)，包括皮克氏症 (Pick's disease)、進行性核上性麻痺 (progressive supranuclear palsy) 和皮質基底節變性 (corticobasal degeneration)。

RT-QuIC 檢測方法，使用重組蛋白作為基質，藉由間歇性搖晃以促進轉化，並使用硫磺素-T (ThT) 即時監控聚合階段，如圖二十九。反應發展階段有三個階段，包括滯後期 (lag phase)、指數期 (exponential phase) 與平台期 (plateau phase)。滯後期表示醞釀反應發生所需的時間，允許種子接觸基質並觸發結構變化，一旦系統接收到足夠的能量，硫磺素-T (ThT) 敏感低聚物就會出現，將單體合併成小型聚集體則進入指數期最終，當所有物都融入成為纖維時，則可觀察到進入平台期。



圖二十九、α-突觸核蛋白種子擴增測定法 (seeding amplification assays, SAA)

(摘錄自 EANM 會議簡報)

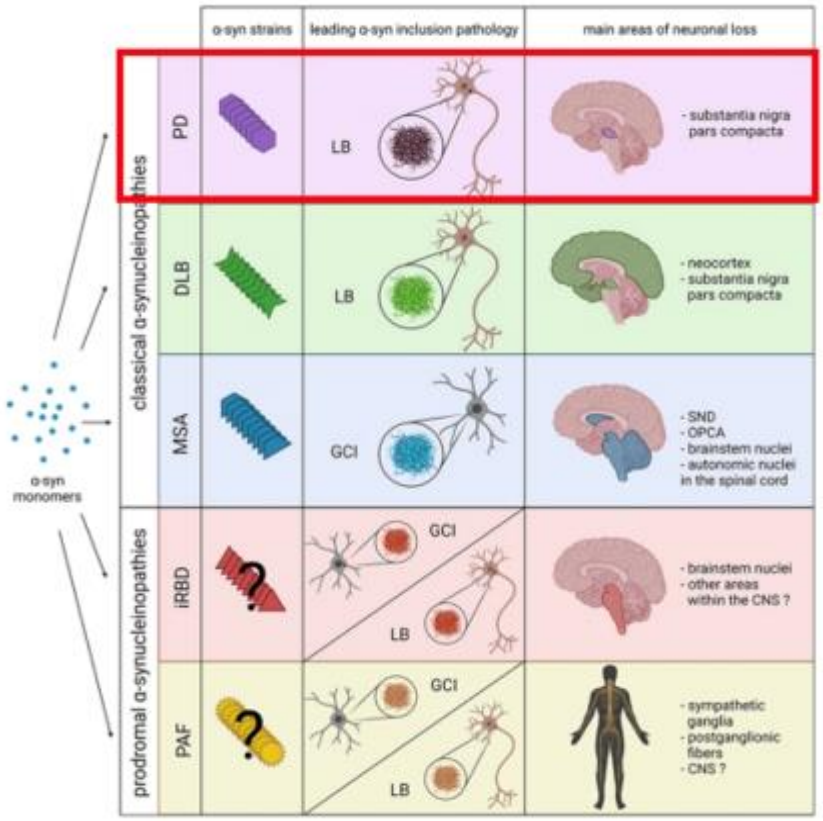
本研究探討利用腦脊髓液 α-突觸核蛋白 (α-syn) 種子擴增方法測定 1,182 名認知

和神經功能未受損的參與者之路易氏體 (Lewy body, LB) 病理學影響研究，由臨床實驗數據結果得知，8%為路易氏體 (LB) 陽性，路易氏體 (LB) 病理對橫向和縱向整體認知和記憶以及縱向注意力/執行功能有獨立的負面影響。同時患有路易氏體 (LB) 和阿茲海默氏症(AD) (Aβ 和 tau) 病理的參與者比僅患有路易氏體 (LB) 或阿茲海默氏症 (AD) 病理的參與者表現出更快的認知衰退。只有路易氏體 (LB) 陽性參與者在 10 年內才進展為臨床路易氏體 (LB) 疾病。

在核醫造影劑開發部分，先前所開發的生物標記是以評估黑質 (substantia nigra) 內多巴胺神經元細胞的喪失情形，包括 I-123 Ioflupan (DaTSCAN)、F-18 DOPA 與 F-18 FE-PE2I/C-11 PE2I 為主。由於 α-突觸核蛋白 (α-syn) 的出現時間早於多巴胺神經元細胞的喪失，因此，α-突觸核蛋白 (α-syn) 可應用於 α-突觸核蛋白病變 (Synucleinopathies) 造影，目前進入人體臨床試驗階段 (in vivo) 的造影劑，計有 F-18 SPAL-T-06 與 F-18 ACI-12589，另外進入人體臨床試驗階段 (in vitro) 的造影劑，計有 F-18 F0502B、F-18 ACI-15916、C-11 MK7337、C-11 MODAG-001、H-3 C05-01-PBB3 衍生物以及 F-18 C05-05 等。

接著由比利時魯汶大學神經病理部門 Donatienne Van Weehaeghe 醫師暨博士介紹 α-突觸核蛋白 (α-syn) 在巴金森氏病 (PD) 之造影研究。早於 1997 年，Polymeropoulos 教授發現特定遺傳畸變是與巴金森氏症 (PD) 有關聯的，在 SNCA 基因 (可轉譯 α-突觸核蛋白 α-syn) 的 G209A 位置發生取代突變，導致 A53T 氨基酸改變。α-突觸核蛋白 (α-syn) 是一種豐富的神經元蛋白，主要存在於突觸前神經末梢，在巴金森氏症 (PD) 和路易氏體失智症 (DLB) 患者所存在的 α-突觸核蛋白包涵體 (α-syn inclusions)，稱為路易氏體 (LB)，主要存在於神經元和神經突，路易氏體 (LB) 的發生與黑質中多巴胺能神經元的喪失有關，可導致普遍的運動症狀，包括運動遲緩、靜止性震顫、肌肉僵硬和姿勢不穩。巴金森氏症 (PD) 是所有 α-突觸核蛋白病變中最常見的疾病，巴金森氏症 (PD) 與路易氏體失智症 (DLB) 兩者都是與年齡相關的疾病，受遺傳和環境因素的影響，巴金森氏症 (PD) 的神經元喪失主要影響腦幹和邊緣區域，但路易氏體失智症 (DLB) 的神經元喪失主要影響新皮質，最常見的症狀包括認知波動、反覆出現幻視

和自發性的錐體外系運動特徵。相較於路易氏體失智症 (DLB) 和巴金森氏症 (PD)，多系統萎縮症 (MSA) 在病理和臨床表現上有著基本差異，最關鍵的是在寡樹突膠質細胞 (oligodendrocytes) 存在 α-突觸核蛋白包涵體 (α-syn inclusions)，稱為神經膠質細胞質包涵體 (glial cytoplasmic inclusions, GCIs) 以及多個大腦區域 (包括黑質、紋狀體、小腦、腦橋核和脊髓) 的選擇性神經變性，巴金森氏症 (PD)、路易氏體失智症 (DLB) 與多系統萎縮症 (MSA) 均屬於典型的 α-突觸核蛋白病變 (Synucleinopathies)，由合併新穎結構以及生化數據來分析，證明巴金森氏症 (PD)、路易氏體失智症 (DLB) 與多系統萎縮症 (MSA) 存在不同的 α-突觸核蛋白株 (α-syn strain)，最近的實驗數據指出，不同的 α-突觸核蛋白株 (α-syn strain) 可能不僅與受影響的細胞類型和 α-突觸核蛋白包涵體 (α-syn inclusions) 類型 (LB, GCIs) 相關，而且還與神經變性模式和疾病嚴重程度相關。近期不同研究將前驅期的純自主神經衰竭 (pure autonomic failure, PAF) 和孤立的快速動眼睡眠行為障礙 (isolated rapid eye movement sleep behavior disorder, iRBD) 也納入 α-突觸核蛋白病變組中。如圖三十。



圖三十、前驅期和典型的 α-突觸核蛋白病變的主要病理特徵

(摘錄自 EANM 會議簡報)

在核醫造影劑開發部分，由於開發正子造影診斷巴金森氏症 (PD) 之優勢在於 α-突觸核蛋白 (α-syn) 的出現時間早於多巴胺神經元細胞的喪失，因此，可提供早期診斷資訊、適當治療方法的選擇、進行疾病病程監測以及病理生理學研究，目前數個已進入動物試驗階段具有發展潛力的 α-突觸核蛋白 (α-syn) 造影劑，計有 F-18 C05-05、F-18 DABTA-7,8,11、F-18 4 Box、F-18 2 Box、F-18 AS69 與 I-124 RAS02-F8D3 等。但開發正子造影診斷巴金森氏症 (PD) 的挑戰在於 α-突觸核蛋白 (α-syn) 聚集濃度相當低，因此需要具高親和性 (< 1 nM)、足夠的選擇性以及必須可區分不同的 α-突觸核蛋白株 (α-syn strain)。

接著由荷蘭烏特勒支大學醫學中心 Tolboom 核醫科醫師暨博士介紹 α-突觸核蛋白 (α-syn) 在路易氏體失智症 (DLB) 之造影研究。α-突觸核蛋白 (α-syn) 是路易氏體疾病 (LBD) 的神經病理學的生物標誌，當 α-突觸核蛋白 (α-syn) 在新皮質中擴散時會導致認知能力下降。DLB 具有神經病理學的異質性，可以共存多達七種病理特徵伴隨產生具有不同臨床徵狀。少數單純的 LB 病理病患通常表現出更典型的 DLB 特徵且常常出現有 RBD、VH 與帕金森氏症候群的核心特徵。然而，絕大多數 DLB 病患是混合型的，最常見的是伴隨阿茲海默症神經病理學變化 (Alzheimer's disease neuropathological changes, ADNC)，其次是伴隨其他共同病理，例如 TDP-43 以及腦血管疾病 (cerebrovascular disease, CVD)，這種情形發生頻率會隨著年齡的增長而增加。DLB 病理變化及其生物標記總結如圖三十一，這些共同病理變化可能具有協同效應，造成更頻繁且更嚴重的疾病。

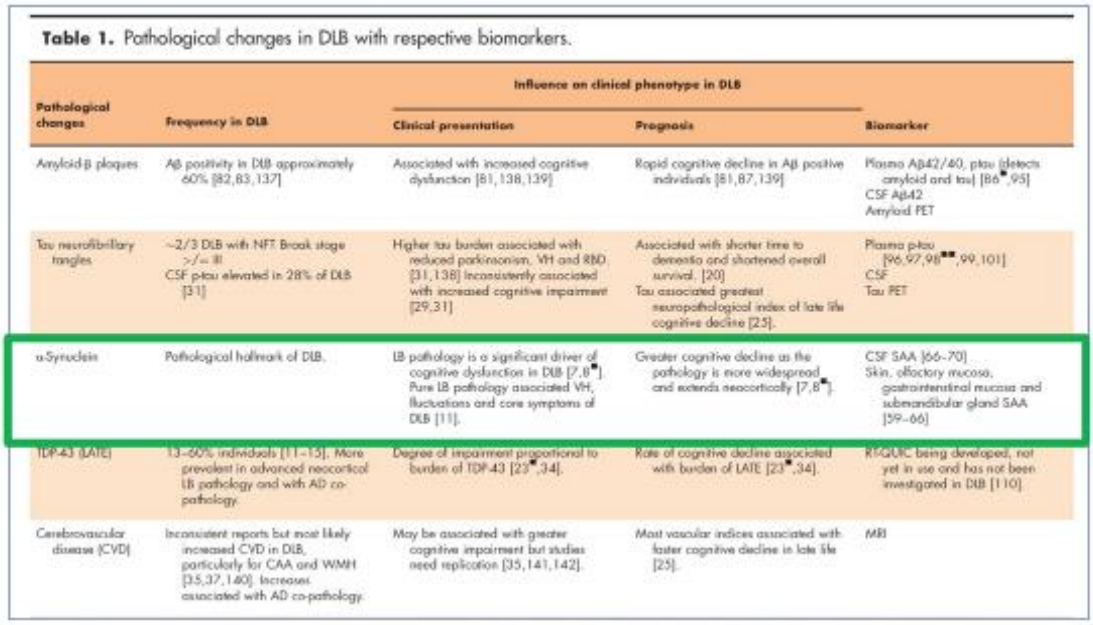


Table 1. Pathological changes in DLB with respective biomarkers.

Pathological changes	Frequency in DLB	Influence on clinical phenotype in DLB: Clinical presentation	Influence on clinical phenotype in DLB: Prognosis	Biomarker
Amyloid-β plaques	Aβ positivity in DLB approximately 60% [82,83,137]	Associated with increased cognitive dysfunction [81,138,139]	Rapid cognitive decline in Aβ positive individuals [81,87,139]	Plasma Aβ42/40, ptau (detects amyloid and tau) [86▪,95] CSF Aβ42 Amyloid PET
Tau neurofibrillary tangles	~2/3 DLB with NFT Braak stage >/= III CSF p-tau elevated in 28% of DLB [31]	Higher tau burden associated with reduced parkinsonism, VH and RBD [31,138] Inconsistently associated with increased cognitive impairment [29,31]	Associated with shorter time to dementia and shortened overall survival. [20] Tau associated greatest neuropathological index of late life cognitive decline [25].	Plasma p-tau [96,97,98▪▪,99,101] CSF Tau PET
α-Synuclein	Pathological hallmark of DLB.	LB pathology is a significant driver of cognitive dysfunction in DLB [7,8▪]. Pure LB pathology associated VH, fluctuations and core symptoms of DLB [11].	Greater cognitive decline as the pathology is more widespread and extends neocortically [7,8▪].	CSF SAA [66–70] Skin, olfactory mucosa, gastrointestinal mucosa and submandibular gland SAA [59–66]
TDP-43 (LATE)	13–60% individuals [11–15]. More prevalent in advanced neocortical LB pathology and with AD co-pathology	Degree of impairment proportional to burden of TDP-43 [23▪▪,34].	Rate of cognitive decline associated with burden of LATE [23▪▪,34].	RT-QUIC being developed, not yet in use and has not been investigated in DLB [110]
Cerebrovascular disease (CVD)	Inconsistent reports but most likely increased CVD in DLB, particularly for CAA and WMH [35,37,140]. Increases associated with AD co-pathology	May be associated with greater cognitive impairment but studies need replication [35,141,142].	Most vascular indices associated with faster cognitive decline in late life [25].	MRI

圖三十一、DLB 病理變化及其生物標記

(摘錄自 EANM 會議簡報)

目前疑似路易氏體失智症 (DLB) 之臨床診斷方式有二種，一為透過出現二種或兩種以上的明顯地臨床徵兆，另一為出現一種明顯的臨床徵兆加上指標性生物標記的檢測判斷。目前指標性生物標記包括 I-123-FP-CIT、I-123-MIBG、整夜睡眠多項生理功能檢查 (Polysomnography, PSG) 以及支持性生物標記包括 MRI 與 F-18-FDG。但開發路易氏體失智症 (DLB) 的挑戰在於 DLB 是混合病理病理特徵的，因此，開發的 α-突觸核蛋白 (α-syn) 必須具有高親和性與高選擇性，例如 C-11-MODAG-001 與 I-125-TZ6184 具有高親和性以及 F-18-FBox、F-18-15a、C-11-MODAG-001 與 F-18-S3-1 具有高選擇性。

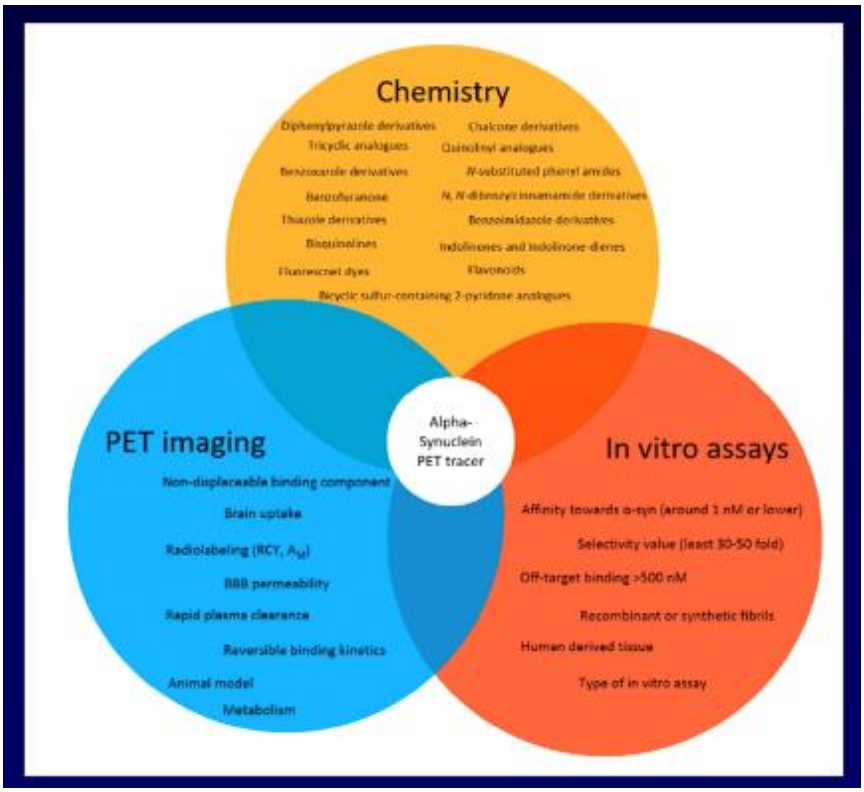
接著由德國萊比錫大學醫學中心 Henryk Barthel 核醫科醫師暨博士介紹 α-突觸核蛋白 (α-syn) 在多系統萎縮症 (MSA) 之造影研究。多系統萎縮症 (MSA) 是一種影響成年男性和女性的進行性神經系統疾病。它是由大腦多個 (或多個) 區域的神經細胞退化或萎縮 (收縮) 引起的。這可能會導致多種身體功能出現問題，例如言語、運動、平衡和血壓控制。多系統萎縮症 (MSA) 是一種罕見疾病，目前尚無治癒方法。

整體來說，隨著老年人口的增加，因此神經退行性疾病的患病率增加，阿茲海默

氏症 (AD) 與帕金森氏症 (PD) 是最普遍的神經退行性疾病。病理學的分子影像生物標記，例如 β-澱粉樣蛋白 (β-amyloid) 與 tau 蛋白影像學檢查；神經退行生物標誌，例如腦葡萄糖代謝減退等，均已被納入新的診斷標準。大多數神經退行性疾病的組織病理學特徵是存在蛋白質的聚集，包括 β-澱粉樣蛋白 (β-amyloid)、tau 蛋白、α-突觸核蛋白 (α-syn)、反式反應 DNA 結合蛋白 43 kDa (TDP-43) 和其他聚集體。疾病診斷的黃金標準是通過死後組織病理學檢測前述病理性蛋白質的沉積。但目前已成功引入放射性示蹤劑，可將準確診斷的時間點從死後轉移到死前，甚至可能轉移到前驅疾病階段，因此，提供重要的訊息來影響病患個體的管理。

現今，除了 β-澱粉樣蛋白 (β-amyloid)、tau 蛋白的示蹤劑正於開發階段外，還越來越多地努力開發用於其他蛋白質聚集體的 PET 示蹤劑。α-突觸核蛋白 (α-syn) 示蹤劑可作為帕金森氏症 (PD)、路易體失智症 (DLB) 和多系統萎縮 (MSA) 的組織病理學的生物標誌。

開發 α-突觸核蛋白 (α-syn) 示蹤劑用於診斷多系統萎縮症 (MSA)，面臨三個挑戰。第一，與β-澱粉樣蛋白 (β-amyloid)、tau 蛋白的示蹤劑或單胺氧化酶 (monoamine oxidases) 相比，α-突觸核蛋白 (α-syn) 目標密度較低。第二，避免交叉選擇性是很複雜的。因為，α-突觸核蛋白 (α-syn) 示蹤劑會在結合在 α-突觸核蛋白 (α-syn) 的 β-sheetsb 摺疊二級結構，這二級結構與β-澱粉樣蛋白 (β-amyloid)、tau 蛋白的二級結構是相同的。第三，缺乏對蛋白質完整晶體結構的瞭解，但低溫電子顯微鏡的進展可能有助於示蹤劑的開發。因此，α-突觸核蛋白 (α-syn) 示蹤劑需要具有極高的結合親和性和選擇性。到目前為止，已開發 37 種不同化學類別的候選分子，並發展到不同的階段，如圖三十二。其中只有 2 種，二苯基吡唑衍生物 C-11-MODAG-001 與 I-125-TZ6184 喹啉類似物顯示出足夠的靶標親和性，其中有 4 種顯示對 β-澱粉樣蛋白 (β-amyloid)、tau 蛋白具有足夠的結合選擇性。



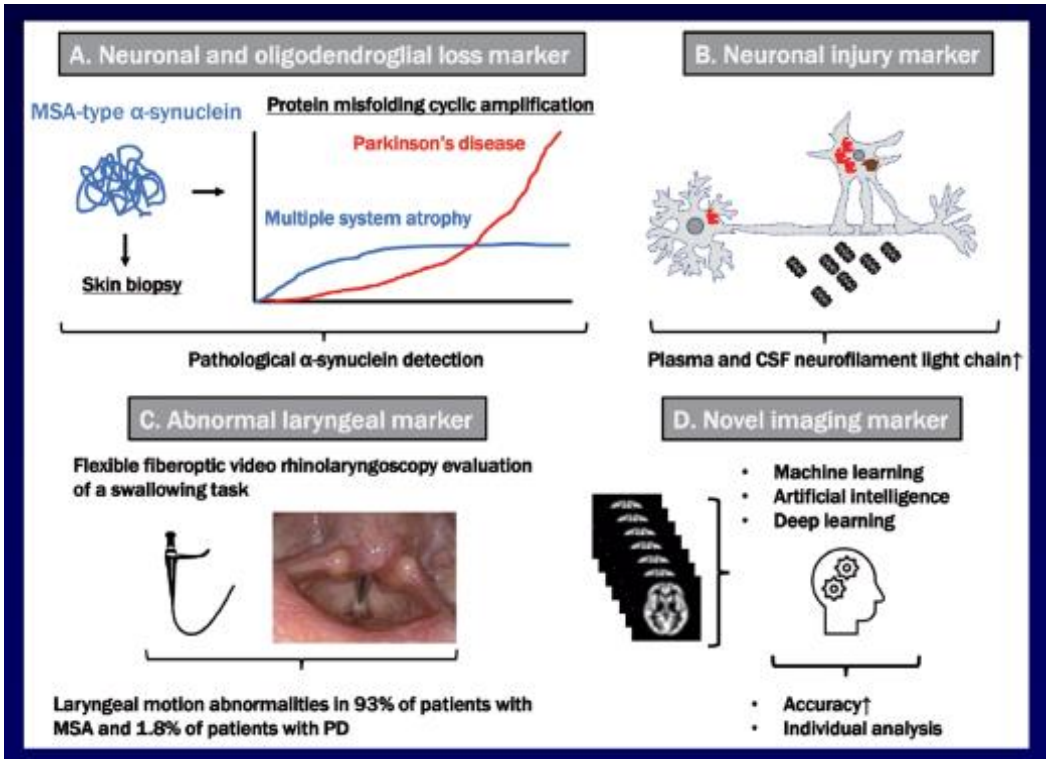
圖三十二、多系統萎縮症 (MSA) 示蹤劑類別與發展階段

(摘錄自 EANM 會議簡報)

目前臨床對於多系統萎縮症 (MSA) 診斷方法，包括 MRI/CT、DAT SPECT 以及 FDG PET 造影，MRI/CT 常出現訊號流失或過度顯影以及 DAT SPECT 以及 FDG PET 造影已無法作為可接受的黃金標準。因此，目前已有多種專注於多系統萎縮 (MSA) 的 α-突觸核蛋白的新診斷方法正在開發中，如圖三十三，包括蛋白質錯誤折疊循環擴增 (Protein Misfolding Cyclic Amplification, PMCA) 和真實時間震動誘導轉化分析 (RT-QuIC) 評估 α-突觸核蛋白 (α-syn) 聚集體、腦脊髓液和血液中的神經絲輕鏈 (NeuroFilament Light chain, NFL) 含量分析評估神經元受損情形、喉部運動的內視鏡觀察以及新型擴散型 MRI 成像生物標記等。

其中，腦脊髓液經過蛋白質錯誤折疊循環擴增 (PMCA) 和真實時間震動誘導轉化分析 (RT-QuIC) 處理後，α-突觸核蛋白 (α-syn) 聚集體的特性可做為多系統萎縮 (MSA) 的早期診斷以及與帕金森氏症 (PD) 的鑑別診斷。蛋白質錯誤折疊循環擴增 (PMCA) 是透過循環超音波處理，將感染樣本與含有細胞朊病毒蛋白 (cellular prion

protein, PrPC) 基質共同培養，再以蛋白酶消化分析蛋白質錯誤折疊循環擴增 (PMCA) 產物，而後以西方墨點試驗 (Western Blotting) 檢測擴增的轉化產物。然而，作為一種，蛋白質錯誤折疊循環擴增 (PMCA) 的限制在於需要長達一週的反應時間，且西方墨點試驗則存在擴增產物可能具有生物危害性感染性的風險。



圖三十三、多系統萎縮症 (MSA) 新型診斷方法

(摘錄自 EANM 會議簡報)

（八）Satellite Symposium：PSMA 放射核種攝護腺癌治療臨床表現

Monrol 公司是世界頗具規模的核子醫學公司，也是 GMP 級放射性同位素及放射性藥物開發製造的領先者，也是本場講座的贊助者。Monrol symposium 的主題是 PSMA 放射核種攝護腺癌治療臨床表現。首先由英國華威大學醫學院 Maria De Santis 教授介紹，PSMA 可增加選擇、也增加複雜程度，根據試驗結果，在治療選擇上，從 HSPC (hormone-sensitive prostate cancer) 轉成 CRPC (castration-resistant prostate cancer) 的第一線治療，僅一部分可選擇 Lu-177-PSMA 或以 ^{223}Ra 進行骨轉移治療，非第一線的選擇則包含 Lu-177-PSMA 或 Ra-223 及其他療法都適合。結論：雖然攝護腺癌治療的選

擇增加，但合適的療法仍然尚未確立，分子層面的訊息 (如：PARP 抑制劑) 反映預後或個人化治療也是關鍵。

接著由來自德國埃森大學醫院核醫部 Ken Herrmann 醫師報告，他同時也是 Aktis Oncology 公司首席外部諮詢員，為大家介紹下一代的攝護腺癌診斷藥物。過去已有發表效果不錯的臨床研究，包括： F-18-DCFBC (JNM 2012)、Ga-68-PSMA-11 (EJNMMI 2013) 、 Ga-68-PSMA-I&T (JNM 2015) 、 F-18-DCFPyL (Mol Im Biol 2015) 、 F-18-PSMA-1007 及 F-18-rh-PSMA7 (EJNMMI 2016) 等，目前已有四項藥物獲得 FDA 或 EMA 核准上市，如表四。與傳統診斷方式相比，PSMA 正子檢查專一性及靈敏度都明顯較為優越。目前的治療方針已將 PSMA 用於疾病分級及病人篩選，下一步將發展 PSMA 正子檢查用來當作治療偵測劑，因此首要的需求包括 PSMA 正子造影的標準化及患病分析，最重要的需求是：腫瘤核醫學 (oncologize nuclear medicine)。

表四、全球 PSMA 診療藥物上市與臨床試驗現況

(摘錄自 EANM 會議簡報，作者再製)

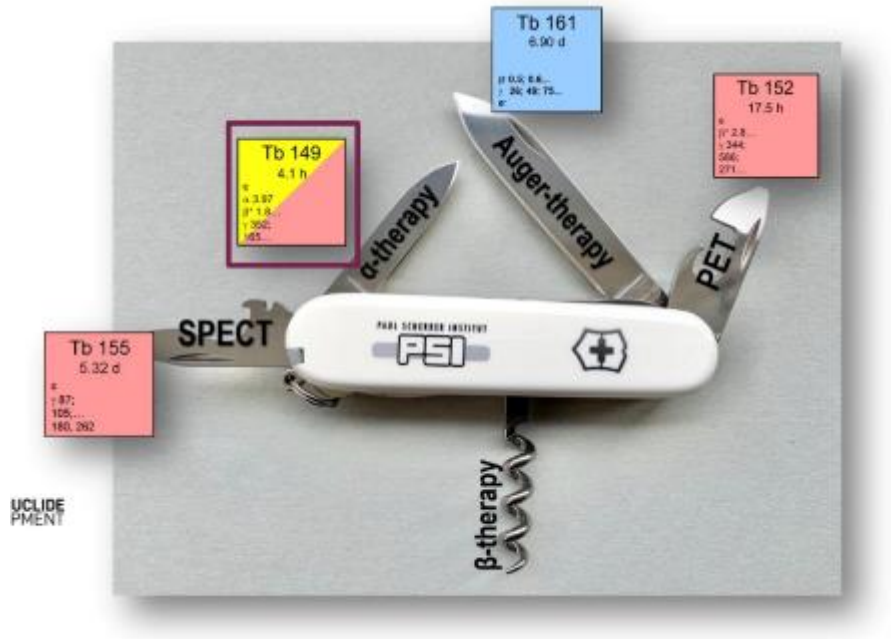
	Probe	IP Protected	Company: Europe	Company: US	Status
	Ga-68-PSMA-11	No	Telix, Isotopia, Novatis, academic centers	Telix, AAA, Novatis, academic centers	FDA approved, EMA approved
	F-18-DCFPyL	Yes	Curium	Progenics	FDA approved, EMA approved
	F-18-PSMA-1007	Yes	ABX	ABX	Phase 3, Marketing authorisation in F, E
	F-18-rh-PSMA-7.3	Yes	BlueEarth Diagnostics	BlueEarth Diagnostics	FDA approved
Ga-68	Ga-68-PSMA-I&T	Yes	N/A	N/A	N/A
	Ga-68-THP-PSMA	Yes	Theragnositcs, GE	Theragnositcs, GE	Phase 3 planned
F-18	F-18-CTT1057	Yes	AAA	AAA	Phase 3 ongoing
other	Tc-99-MIP1404	Yes	ROTOP	Progenics	Phase 3 planned
	Cu-64 PSMA-I&T	Yes	Curium	Curium	Phase 3 planned

接著由來自英國貝爾法斯特女王大學放射腫瘤專業的 Joe M. O'sullivan 教授介紹

在攝護腺癌 PSMA 標靶的診療學進展。PSMA 標靶應用於骨診療 (Bone Theranostics)，是依據骨代謝的核種治療，結合 Tc-99m-MDP 診斷及 Ra-223-$RaCl_2$，然而骨診療只能針對骨內轉移，且並未直接標靶腫瘤，並且受限於骨頭的健康，亦不能治療軟組織及內臟內的轉移。標靶 PSMA 的診療學，結合如 Ga-68-PSMA-11 正子造影及 Lu-177-PSMA-617，應用在臨床試驗 (VISION Trial)，造成降低 38%死亡風險。在攝護腺癌各階段中，Lu-177-PSMA 目前是第二和三線 mCRPC 的新標準，正在進行多個合併治療的臨床試驗都有不錯的結果，如 PSMAfore 和 PSMAaddtion。使用 Lu-177-PSMA-617 結合 cabazitaxel 用在 mCRPC (metastatic castration-resistant prostate cancer) 的治療方法又稱為 TheraP，在 PSMA SUVmean ≧10 預期會有良好生物反應。在 ASCO 2023 年發表，較高的全身 SUVmean 與整體存活率有關。結論：以上研究指出 PSMA 正子造影結果若陽性佳，Lu-177-PSMA-617 在 mCRPC 會有較佳整體存活率。此療法 (TheraP) 有機會往前至第一和二線 mCRPC 治療，較高 SUVmean 預期會有較佳的預後。但此假說目前仍需要評估基因變異效果及劑量學。

（九）M2M：鋱-149 (Tb-149) 生產 — 應用於臨床潛力的務實看法

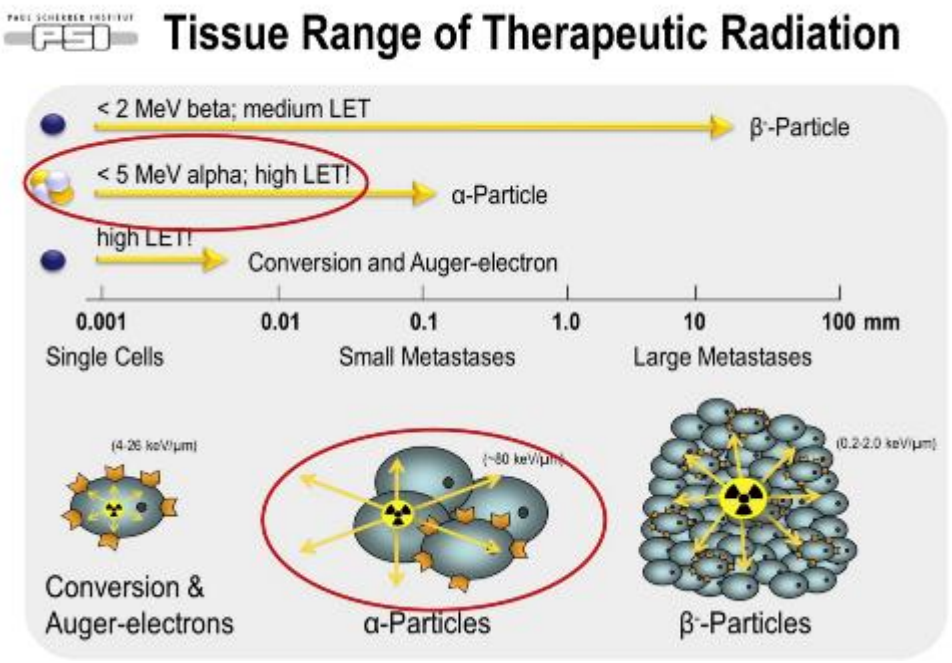
保羅謝勒研究所 (PAUL SCHERRER INSTITUT, PSI) 為屬於瑞士聯邦理工學院，著重在材料科學、生命科學、能源、核能安全、粒子物理與環境等領域的基礎與應用研究。本次由瑞士 PSI 研究所放射核種開發實驗室主持人 Nicholas P. van der Meulen 博士報告鋱-149 (Terbium-161, Tb-149)的生產與其應用於臨床潛力的務實看法。首先，鋱系列核種屬於鑭系元素，包括二種診斷用核種，例如鋱-152 (Tb-152)，半衰期為 17.5 小時，發射 β 粒子 ($E_{\beta+}$平均值 = 1140 keV) 與鋱-155 (Tb-155)，半衰期為 5.32 天，發射 γ 輻射 (87 keV (32%)、105 keV (25%))，以及二種治療用核種，例如鋱-149 (Tb-149)與鋱-161 (Tb-161)等，因此，成為治療診斷學「配對」原則的理想選擇。如圖三十四。



圖三十四、鋱元素系列之診療核種

(摘錄自 EANM 會議簡報)

通常，選擇適當的放射性金屬來改善癌症患者腫瘤靶向放射性同位素治療效果，是需要仔細考慮的。主要是因為放射性金屬的物理衰變特性決定其治療特定腫瘤類型或是不同分級腫瘤的適用性。治療用核種發射 α 粒子，由於其短穿透深度和高線性能量轉移 (LET)，與發射 β 粒子或 γ 輻射相比，在殺死腫瘤細胞方面具有優勢，如圖三十五。因此，放射性金屬結合現有腫瘤靶向治療藥物應用的實用性，使得產製高活度的放射性同位素之潛在生產機會，是可以考慮的。



圖三十五、治療用放射性同位素之能量與組織穿透度

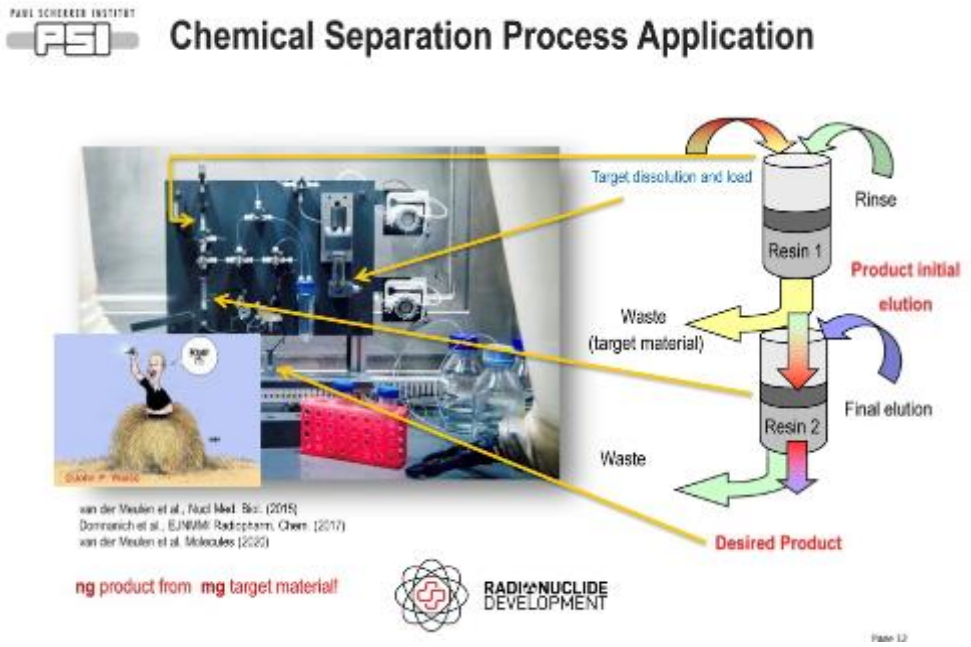
(摘錄自 EANM 會議簡報)

鋱-161 (Tb-161)，半衰期為 6.95 天，發射 β 粒子 ($E_{\beta+}$平均值 = 154 keV) 與 γ 輻射($E\gamma$ = 48.9 keV (17.0%)；74.6 keV (10.2%))，其衰變特性類似鎦-177 (lutetium-177, Lu-177)。由於鋱-161 (Tb-161) 可共同發射與轉換歐傑電子 (Auger electrons)，使得更顯優異。這些短程電子不但可以有效消除在 PET 影像看不見微小轉移，甚至於對復發和轉移擴散的腫瘤也有效。Champion et al.等人發現，與鎦-177 (Lu-177) 相比，使用鋱-161 (Tb-161) 之細胞或亞細胞範圍的球體吸收劑量增加了數倍；因此，因此，得出結論是鋱-161 (Tb-161) 將是可用於臨床研究治療微小殘留疾病的首選候選同位素。

本次主要關注在鋱-149 (Tb-149)，鋱-149 (Tb-149) 半衰期相對較短 ($T_{1/2}$ = 4.1 h)，α 能量低 (3.97 MeV，I_α = 16.7 %)，不會出現 α daughter 粒子且可以透過 chelator (DOTA) 穩定螯合，所以，具有潛在臨床應用價值。此外，鋱-149 (Tb-149) 具有正電子發射 ($E_{\beta+}$平均值= 730 keV，$I_{\beta+}$ = 7.1 %)，可用於 PET 成像以及治療價值。因此，使得鋱-149 (Tb-149) 於未來臨床試驗中的放射治療應用極具吸引力。

建置產製鋱-149 (Tb-149) 的設施是昂貴的且必須是政府強力支持方可進行。現

今，產製鋱-149 (Tb-149)最好的方式是是由 PSI 研究所與 ISOLDE 共同開發之利用高能量質子於 2,200℃ 高溫下撞擊靶材，採用線上同位素分離方式 (Isotope Separation OnLine, ISOL) 的方法，經抽取 (Extraction)、質量分離與收集 (Mass Separation & Collection)以及化學分離 (Chemical Separation) 等步驟，化學分離裝置，如圖三十六，獲得鋱-149 (Tb-149)。目前生產批量為一週 5 批次，產量為 260 MBq、放射化學分離效率大於 90%、核種純度大於 99.9%以及放射標誌可達 20 MBq/nmol。歐盟其他單位發展鋱-149 (Tb-149) 的現況，採取共同開發合作模式，例如 CERN/ISOLDE (生產階段)、CERN/MEDICIS (發展階段)、ISOL@MYRRHA (比利時，建置階段)、IMPACTTATTOOS (荷蘭，等待核准階段)。



圖三十六、鋱-149 (Tb-149) 化學分離裝置

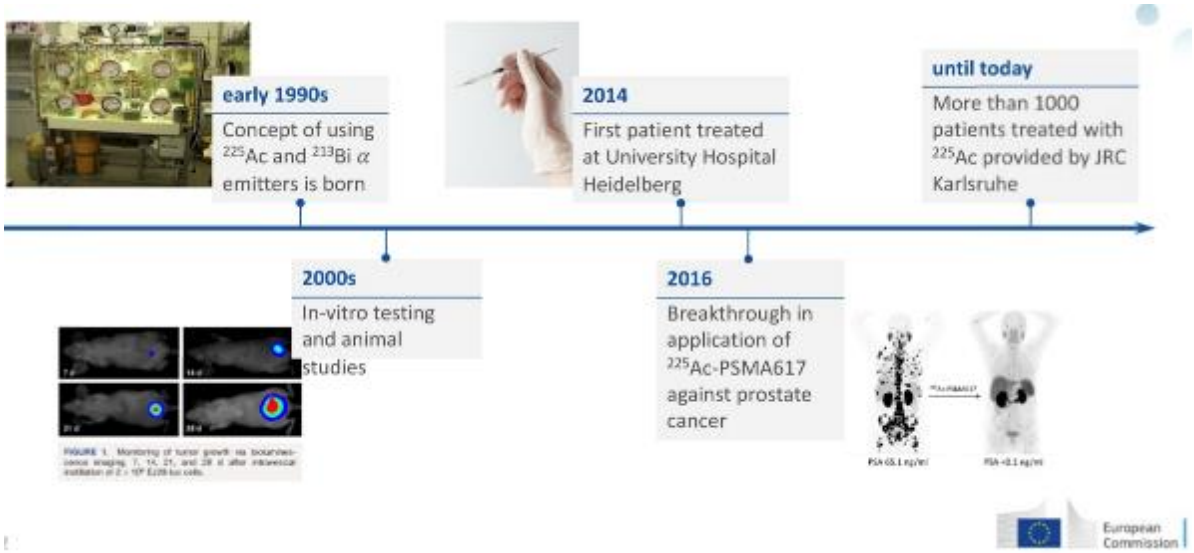
(摘錄自 EANM 會議簡報)

（十）M2M：以迴旋加速器生產錒-225 (Ac-225) 應用於標靶 α 療法

本次由德國卡爾斯魯厄聯合研究中心 (Joint Research Centre, JRC) 歐洲委員會科學 (European Commission) 官員 A. Kellerbauer 教授報告。JRC 聯合研究中心是由五個國家的研究單位共同組成的，包括比利時 (賀爾 Geel)、德國 (卡爾斯魯厄 Karlsruhe)、義大利 (依斯普拉 Ispra)、荷蘭 (Petten) 以及西班牙 (Seville) 等。JRC 聯合研究中心

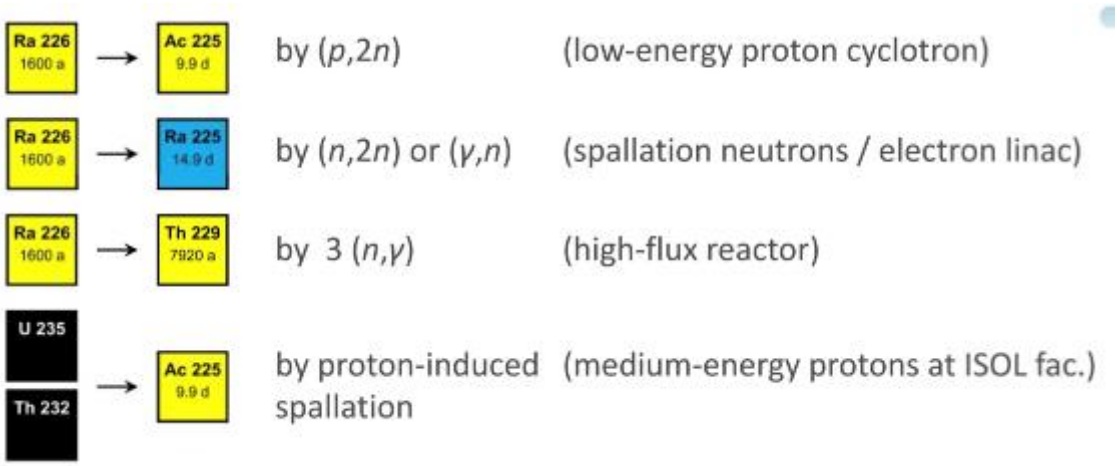
每年研究經費約為 380 百萬歐元加上以及自籌 80 百萬歐元。

首先介紹 JRC 聯合研究中心之錒-225 (Ac-225) 應用於標靶 α 療法歷程：早於 1990 年代，JRC 聯合研究中心已提出利用錒-225 (Ac-225) 與鉍-213 (Bi-213) 應用於標靶 α 療法的概念，於 2000 年代，進行體外試驗與動物試驗，於 2014 年在海德堡大學附設醫院進行第一例人體臨床試驗以及 2016 年突破性進展地將 Ac-225-PSMA-617 應用在攝護腺癌病患治療，迄今，已超過 1,000 病患接受錒-225 (Ac-225) 治療，如圖三十七。



圖三十七、JRC 聯合研究中心之錒-225 (Ac-225) 應用於標靶 α 療法歷程
(摘錄自 EANM 會議簡報)

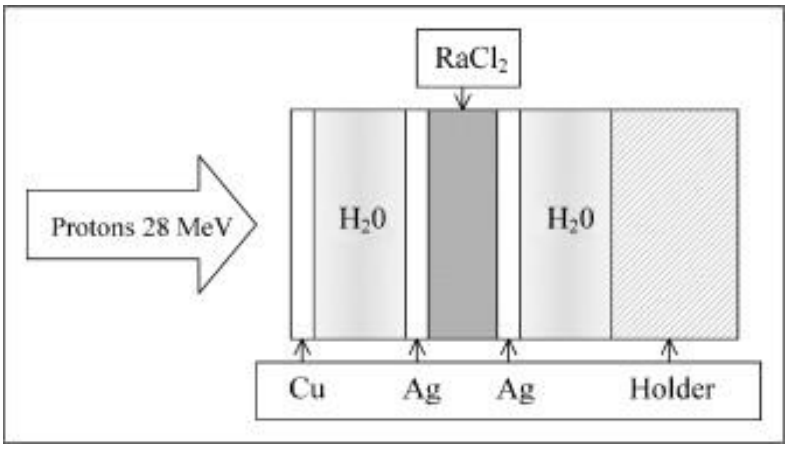
目前錒-225 (Ac-225)產製方式主要為來自釷-229 (Th-229) (為鈾-233 (U-233) 轉變後之核種)，全球主要供應來源有三大實驗室，包括美國橡樹嶺國家實驗室 (Oak Ridge National Laboratory, ORNL)、與俄羅斯奧博寧斯克物理與動力工程研究所 (Institute of Physics and Power Engineering Obninsk, IPPE Obninsk) 以及德國卡爾斯魯厄聯合研究中心 (JRC)，平均供應量分別為 33 GBq、22 GBq 與 8.4 GBq，可足夠供應給 5,000 病患所需劑量。但目前每一藥物開發計畫之錒-225 (Ac-225) 平均需求量為 3-5 TBq，因此急迫需要開發替代的生產方法。創新替代的生產方法 Accelerator-Based Routes，使用中子、質子、氘核或伽馬射線輻照鐳-226 (Ra-226) 靶材以及用高能質子輻照釷-232 (Th-232) 產製錒-225 (Ac-225)，如圖三十八。



圖三十八、以加速器為基礎之 Ac-225 創新替代的生產方法

(摘錄自 EANM 會議簡報)

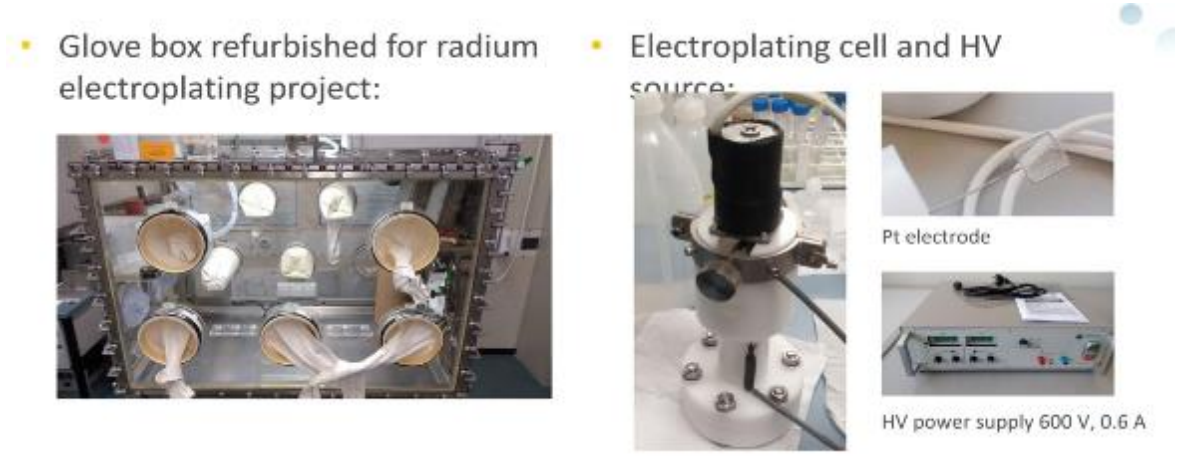
本研究最主要討論 Ra-226(p, 2n)Ac-225 產製方式。早於 2005 年，德國卡爾斯魯厄研究中心 (JRC) 以迴旋加速器 28 MeV 質子束進行照射，質子電流從 10~50 μA 不等，採用水冷方式冷卻，並透過連續偵測冷卻水迴路內的 alpha 粒子活性以監測 online 膠囊密封控制(capsule leak-tightness control)情形，當鐳-226 (Ra-226) 靶材發生異常時則可自動關閉。採用鐳-226 (Ra-226) 水溶液以蒸發方式來製作靶材，以將含有均質恆量的鐳-226 (Ra-226) 靶材 12.5 μg 在 10 μA 的質子電流下照射 7 小時，使用不同厚度的銀箔 (silver foils) 進行能量衰減，入射質子能量在 8.8~24.8 MeV 之間變化，探討研究隨入射質子能量的變化之錒-225 (Ac-225) 的產量。Ra-226 靶材組裝式意圖，如圖三十九。



圖三十九、Ra-226(p, 2n)Ac-225 之 Ra-226 靶材組裝式意圖

(摘錄自 EANM 會議簡報)

於 2007 年，德國卡爾斯魯厄研究中心 (JRC) 採用鐳-226 (Ra-226) 水溶液或水溶液/有機溶液，以電鍍方式 (Electroplating) 來製作靶材。實驗條件如下所述，電鍍場所位於手套箱，如圖四十；電鍍有機溶劑為 Ammonium acetate + nitric acid 或 Isopropanol + nitric acid；鐳-226 (Ra-226) 含量為 1~10 ug；陰極材質為白金(Pt)及其支柱材質為銀(Ag) ，如圖四十；淬滅液為 ammonium solution，其目的避免發生再溶解；電鍍參數為電壓 <32V、電流 0.4~0.6A / 50~80V, <150 mA；電鍍時間為 60~300 分鐘。目視觀察靶材外觀以及利用掃描式電子顯微鏡與 Elysia-Raytest CR-35 測量均勻度。由實驗數據得知，在 60V 電壓以及 90~300 分鐘電鍍時間之電沉積產率為 30%~60%，並獲得均勻電鍍靶材。

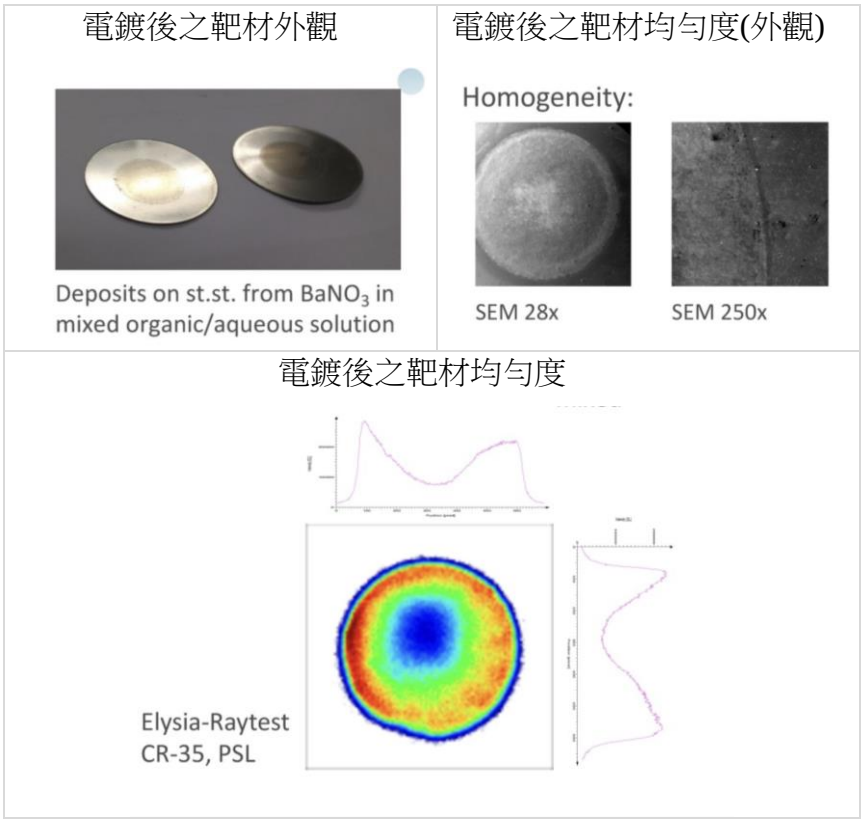


圖四十、電鍍操作手套箱與電鍍裝置

(摘錄自 EANM 會議簡報)

本次研究以前述的實驗條件，但改以高電壓 600V 與電流 0.6A 以及不同支柱材質 - 不鏽鋼銀 (stainless steel, silver，簡稱 st. st. silver) 惰性材質與鋁 (aluminum) 材質，進行測試，以酸度、電壓/電流與電鍍時間進行評估。結果發現，以不鏽鋼銀 (st. st. silver) 惰性材質在約 220V, 100mA 電鍍 110 分鐘、電鍍有機溶劑為 Isopropanol + 0.1M nitric

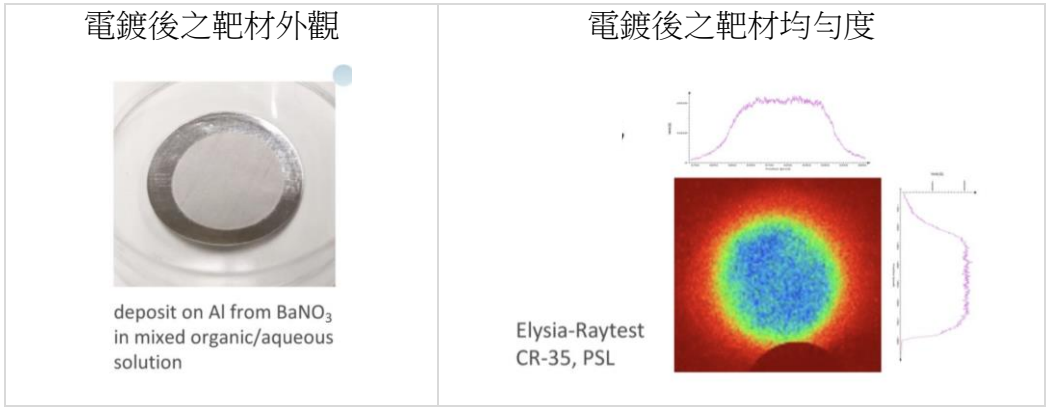
acid 與淬滅液為 ammonium solution。由實驗數據得知，不鏽銀鋼支柱之電鍍後靶材外觀與均勻度，如圖四十一，其最佳產率可達到 97%。



圖四十一、不鏽鋼銀支柱之電鍍後靶材外觀與均勻度

(摘錄自 EANM 會議簡報，作者再製)

以鋁 (aluminum) 材質在約 120V, 30 mA 電鍍僅需 20 分鐘、電鍍有機溶劑為 Isopropanol + 0.1M nitric acid 與淬滅液是不需要的。由實驗數據得知，最佳產率可達到 36%，鋁支柱之電鍍後靶材外觀與均勻度，如圖四十二，雖高電流或是長電鍍時間無法增加產率，但已可達均勻度。



圖四十二、鋁支柱之電鍍後靶材外觀與均勻度

(摘錄自 EANM 會議簡報，作者再製)

（十一）M2M：靶向 α 治療放射性藥物之 Ac-225 的分離和純化

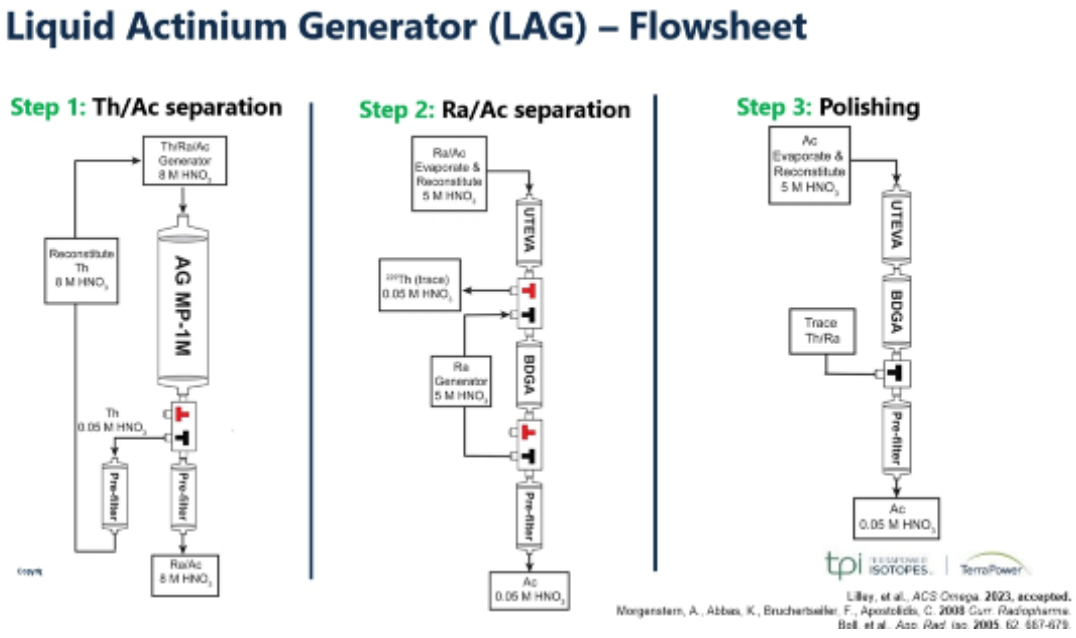
TerraPower Isotopes (TPI) 公司是由比爾蓋茲和一群志同道合的遠見者共同創立的。正在透過開發下一代同位素來改變癌症的治療方法。TPI 團隊正在利用經過驗證的方法提取研究級 Actinium-225 (不含 Actinium 的同位素雜質)，期望應用於新醫療的潛在標靶和癌症治療以及 TPI 公司正在增加同位素起始材料 Actinium-225 的全球稀缺供應以支持製藥公司的癌症研究和開發工作。本次由 TPI 公司 Laura Lilley 博士報告靶向 α 治療放射性藥物之 Ac-225 的分離和純化。

標靶 α 療法 (TAT) 是傳統癌症療法 (例如 γ 射線照射或化療) 的一種有前途的新途徑，並且已經針對致病性疾病進行了初步研究。TAT 通常透過螯合劑 (發展的主要點) 將 α 發射放射性核素偶聯至細胞表面靶向載體，例如抗體或胜肽。在生物組織中，α 粒子只穿過幾個細胞直徑 (<100 μm)，結合高線性能量轉移（102 MeV/μm），TAT 可以選擇性地破壞患病細胞，並且比傳統化療的副作用更少。適合 TAT 的候選 α 發射體以 Ac-225 及其子體 Bi-213 最有希望。Ac-225 半衰期為 9.920 天，主要透過六種子同位素進行，其中最可能的衰變路徑產生四個 α 粒子和兩個 β 粒子。

迄今為止，在美洲、歐洲與澳洲執行的臨床試驗所使用的 Ac-225 有三個供應來源，包括美國橡樹嶺國家實驗室 (ORNL)、與俄羅斯奧博寧斯克物理與動力工程研究所 (IPPE Obninsk) 以及德國卡爾斯魯厄聯合研究中心 (JRC)。目前的世界供應量無法滿足大型臨床試驗或醫院廣泛實施的需求。TerraPower Isotopes (TPI) 正在與橡樹嶺國

家實驗室 (ORNL) 的美國聯邦清理承包商 Isotek Systems LLC 合作回收 Th-229，相對於其他來源，Th-229 沒有被 Th-232 同位素稀釋，因此，透過 Th-229 ($T_{1/2}$ = 7932y) 獲得 Ac-225 的最直接和最乾淨的 (就放射性同位素核種純度而言) 途徑，也是目前最主要的供應生產方式。其他替代方案，例如由美國能源部 (DOE) 領導，通過 Th-232(p,x)Ac-225 以及通過 Ra-226(p,2n)Ac-225 進行的更商業化的迴旋加速器產製方法，亦已獲得良好產率。

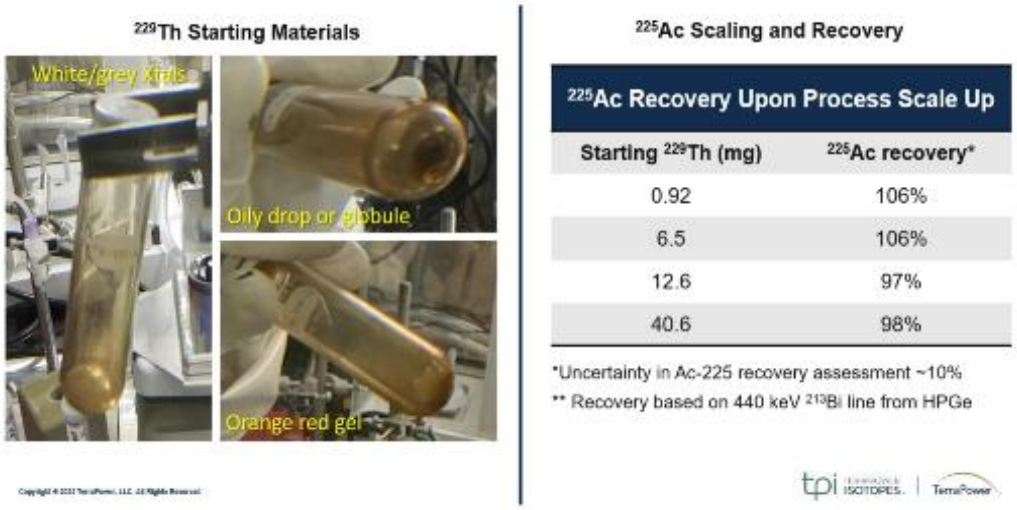
TPI 公司生產的 Ac-225 的分離和純化方法，是以 DOE、JRC 和加拿大核子實驗室 Ac-225 處理方式之陰離子交換樹脂為基礎。主要有三個關鍵分離步驟，步驟(1) Th/Ac 分離：於 8M HNO3 溶液中 $[Th(NO_3)_6]_2^-$ 陰離子，可透過陰離子交換樹脂 AG MP-1M 來將 Th 保留在樹脂上，而 Ra 與 Ac 在此條件下不被吸附，並可通過 IIa 預過濾器樹脂來收集，此外，利用 0.05M HNO_3 溶液洗脫 IIb 預過濾器樹脂以回收 Th。由於製程反應體積的原因，Ac 和 Ra 隨後會變得軟性乾燥狀態，所以，以 5M HNO_3 溶液重新溶解。步驟(2) Ra/Ac 分離：透過 UTEVA 管柱去除任何殘留的 Th。UTEVA 管柱直接連接 BDGA 管柱，5M HNO_3 溶液的 Ac 會保留在 BDGA 上，再以 0.05 M HNO_3 溶液從 BDGA 中洗脫出 Ac，步驟(3) Polishing：透過預先過濾器樹脂去除任何殘留有機物。分離和純化流程，如圖四十三。



圖四十三、TPI 公司開發的 Ac-225 的分離和純化流程

(摘錄自 EANM 會議簡報)

由實驗數據得知，起始原料 Th-229 來源可能為白灰晶體狀、油滴狀或橘紅膠體狀，透過此分離純化步驟後，可獲得 Ac-225 回收率達 97%~106%，如圖四十四。



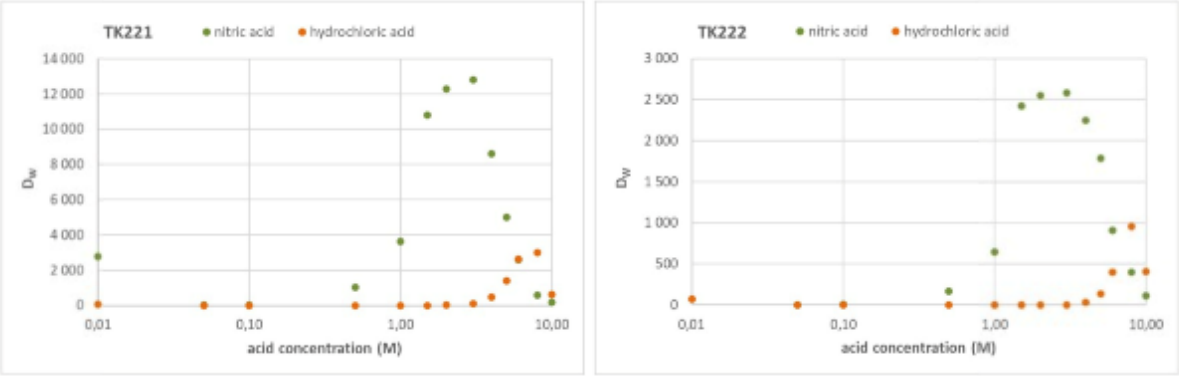
圖四十四、TPI 公司的 Ac-225 回收率

(摘錄自 EANM 會議簡報)

（十二）M2M：使用新樹脂應用於 Ac-225 分離純化

本次由捷克共和國核子物理研究所 (Nuclear Physics Institute CAS public research institution) 核醫藥物發展部門 Ondřej Lebeda 教授報告，採用法國 Triskem International 公司所開發的新樹脂 (TK221 與 TK222) 進行 Ac-225 分離純化測試。TK221 樹脂是二氯醯胺 diglocylamide (TO-DGA) 和氧化膦 phosphine oxide (CMPO) 的混合物，且含有少量的長鏈醇；TK222 樹脂是分支二氯醯胺 diglocylamide (TEH-DGA) 和氧化膦 phosphine oxide (CMPO) 的混合物，且含有少量的長鏈醇。為了提高 TK221 或 TK222 抗輻射分解的穩定性，所以，有機相浸漬在含有芳香族基團的惰性載體上。結果發現，TK221 或 TK222 對於 Ac-225 親和性是相似的 (無論是在鹽酸或硝酸條件下)，但由 Ac-225 在 TK221 分布係數 (Distribution Coefficient, Dw) 數值顯示，於 0.01~1,000M 濃度範圍下，具有較大顯著的分布係數 Dw 差異，如圖四十五。此外，TK221 與 TK222

樹脂都可以在極少量的稀鹽酸中，快速定量地將 Ac-225 從硝酸鹽重新鹽化為氯化物形式。



圖四十五、Ac-225 在 TK221 與 TK222 樹脂分布係數

(摘錄自 EANM 會議簡報)

（十三）M2M：迴旋加速器產製 Cu-64 / Cu-67 診斷和治療診斷核種配對組合

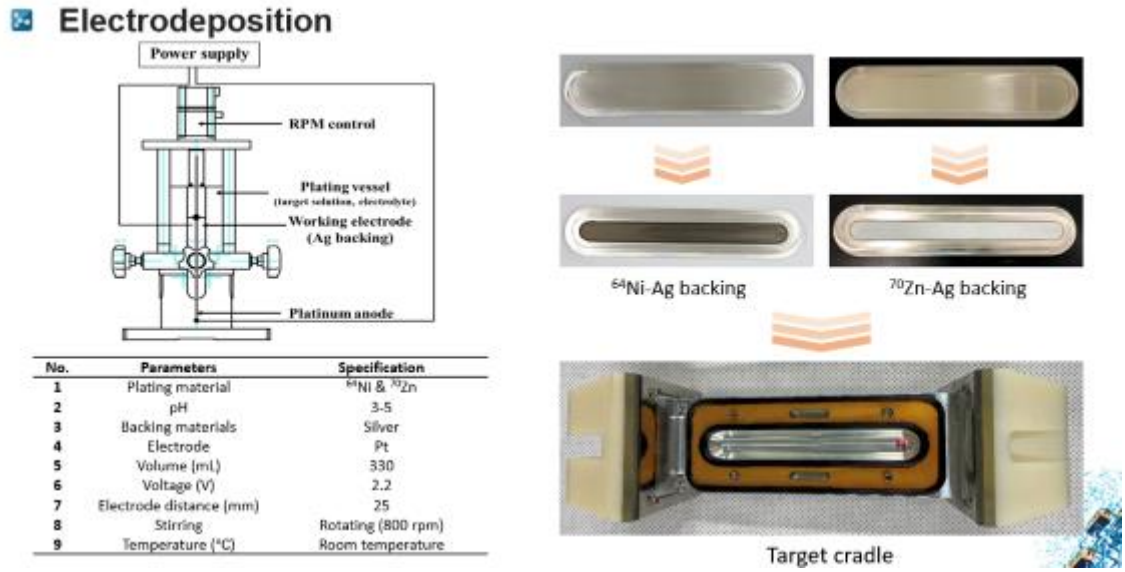
本次由韓國原子能研究所先進輻射技術研究所李俊英高級研究員報告。韓國原子能研究所自主研發設計靶材、電鍍方式與溶解裝置，並利用 RFT-30 迴旋加速器 (30 MeV) 質子束照射靶材以獲得銅-64 (Cu-64) 和銅-67 (Cu-67)。

核醫學領域依賴於將放射性同位素標誌上小分子、核酸、肽、蛋白質、抗體與藥物載體，這些技術對各種疾病具有很高的敏感性，以提供診斷和治療效果。由於化學性質相同，銅-64 (Cu-64) 和銅-67 (Cu-67) 可以使用相同的標誌方法形成化學複合物，並且可以同時進行診斷/治療。銅是所有生物健康必不可少的微量元素。在人類中，銅是器官正常功能和代謝過程所必需的。因此，放射性銅是一種很有前途的候選藥物，可以應用於各種疾病。銅的多用途配位化學允許其與各種螯合劑進行放射性金屬化，例如 DOTA (1,4,7,10-四氮雜環十二烷-四乙酸)、NOTA (1,4,7-三氮雜環壬烷-三乙酸)、TETA (1,4,8,11-四氮雜環十四烷-1,4,8,11-四乙酸) 與 CB-TE2A (4,11-雙(羧甲基)-1,4,8,11-四氮雜雙環[6.6.2]十六烷)，它們可以與各種放射性藥物偶聯。銅-64 (Cu-64) ($t_{1/2}$ = 12.7 h) 是一種有吸引力的放射性同位素，對正電子發射斷層掃描 (PET) 具有重要意義，具有 β^+（E_{max} = 653.03 keV 和 E_{mean} = 278.21 keV）和 EC (電子捕獲 = 1675.03

KeV 與 1345.77 keV)。相較於氟-18 ($T_{1/2}$ = 110 分鐘) 和碳-11 ($T_{1/2}$ = 20.4 分鐘)，對於需要長期追蹤藥物而言，銅-64 (Cu-64)具有足夠長的半衰期。另一銅-67 (Cu-67)(($T_{1/2}$ = 61.83 小時，β^-平均能量 = 141 keV) 是一種放射性同位素，由於其 β 平均能量以及具有與鎦-177 (Lu-177) 相似的 134 keV，因此，在核醫學中具有巨大的治療應用潛力。但幾十年來，因銅-67 (Cu-67)供應有限與比活性低而阻礙銅-67 (Cu-67) 應用在放射性核素治療。

使用 Zn 作為靶材的主要生產途徑，是以迴旋加速器質子束能量 38~50 MeV 照射發生 Zn-68(p,2p)Cu-67 核反應，高豐度鋅-68 (Zn-68) 不僅可以提高銅-67 (Cu-67)產量，並可以減少其他 Cu 放射性核種的產生。另一以 30 MeV 的質子束照射高豐度(95.47%)的鋅-70 (Zn-70)，發生 Zn-70(p,α)Cu-67 核反應，是可行的且不會同時產生 Cu-64，但成本昂貴，並且使得照射靶材料的回收和再利用成為一項至關重要的任務。除此之外，可使用 20~40 MeV 質子束能量以及 24 小時照射鎵-71 (Ga-71)，發生 Ga-71(p,x)Cu-67 核反應來生產銅-67 (Cu-67)，但此反應的缺點是產率低、高銅-64 (Cu-64)污染高。此外，鎵的低熔點使得靶材的製備變得困難。

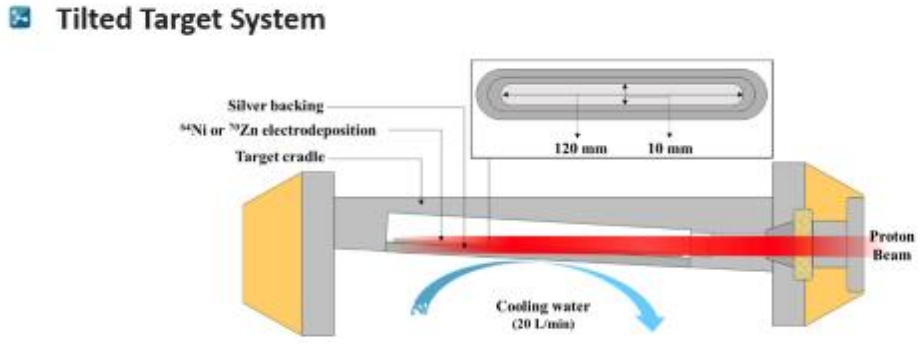
韓國原子能研究所利用電沉積法電鍍製備靶材，以典型的電鍍靶材鎳-64 (Ni-64)或鋅-70 (Zn-70) 金屬溶於 10mL 濃 HCl 溶液中。等到金屬完全溶解後，在真空系統下將目標溶液蒸發至乾燥，將乾燥物重新溶於 600 mL 水中，然後再溶液中加入 2 mL 水合肼(hydrazine hydrate) 作為電解質。接著將最終溶液與基板一起載入到電鍍池內，電鍍優化條件如下：波形 (waveform) – 方波、頻率 (frequency) – 50Hz、振幅 (amplitude) – 2000、tau – 2、相位 (phase) – 10 度、斬波頻率和佔空比 (chopping frequency and duty) – 100 Hz and 84%以及 square duty 60%，如圖四十六。金和銀被用作陰極，鉑棒被用作陽極。將條形基板電沉積鎳-64 (Ni-64) 或鋅-70 (Zn-70)。電鍍後，清洗乾燥後，鎳-64 (Ni-64) 與鋅-70 (Zn-70) 通過測量靶材的厚度以及通過光學顯微鏡確認表面均勻性。



圖四十六、電沉積法電鍍製備鎳-64 (Ni-64) 或鋅-70 (Zn-70) 靶材

(摘錄自 EANM 會議簡報)

將電鍍靶固定在固體靶站，並分別以 11.0 MeV (Cu-64) 或 17.7 MeV (Cu-67) 質子照射來各別發生 Ni-64(p,n)Cu-64 與 Zn-70(p,a)Cu-67 核反應。與質子射束線之固體靶站傾斜 6°角度，並使用相變色膠片 (Gafchromic film) 來調整優化質子射束分佈 90%面積下可達到靶面 1,175 mm^2 照射面積。此外，利用中央冷卻水系統(冷卻水條件：1.1 MPa 水壓與水冷管線 1/4”尺寸)連接到固體靶站，以避免發生靶熱損傷，並分別以電流 30 μA 和 100 μA，持續照射 3 小時和 12 小時來生產銅-64 (Cu-64) 與銅-67 (Cu-67)，圖四十七。



Nuclide	Beam line	Target material	Target weight	Proton beam energy (MeV)	Incident energy (MeV)	Degrader	Wobbler	Current
^{64}Cu	Tilted target system	^{64}Ni	~150 mg	17.7	11	1 mm Al	3 A	30 μA
^{67}Cu		^{70}Zn	~280 mg	17.7	17.7	n/a	3 A	100 μA

圖四十七、鎳-64 (Ni-64) 或鋅-70 (Zn-70) 靶材照射條件

(摘錄自 EANM 會議簡報)

銅-64 (Cu-64) 和銅-67 (Cu-67) 分離純化可分為四步驟，分別為溶解、載入、洗脫與回收等步驟，如圖四十八。

銅-64 (Cu-64)分離純化過程如後所述，使用自動靶運輸系統將照射後的鎳-64 (Ni-64) 靶材 (電鍍靶材重量：130 mg) 直接輸送到熱室，將照射的鎳-64 (Ni-64) 靶材溶解於 90℃ 下，以 7 mL 8M HCl 溶液溶解 1.5 小時後，用 0.45 μm PVDF 注射器過濾器過濾溶解液，並調整溶解液的 pH 到 2，再將溶液蒸發後以水重新溶解後待用，另外準備已事先經 0.01M HCl 前處理的銅選擇性 CU 樹脂管柱。將溶解溶液載入到 CU 樹脂預填充柱，以 20 mL 0.01 M HCl (1.0 mL/min) 洗滌 CU 樹脂以回收並除去鎳-64 (Ni-64) 靶材雜質。最後，以 2 mL 8M HCl 洗脫收集銅-64 (Cu-64) 溶液，在真空系統下蒸發至接近乾燥。

銅-67 (Cu-67) 分離純化過程如後所述，使用自動靶運輸系統將照射後的鋅-70 (Zn-70) 靶材 (電鍍靶材重量：260 mg) 直接輸送到熱室，將照射的鎳-64 (Ni-64) 靶材溶解於 90℃ 下，以 7mL 9M HCl 溶液溶解 10 分鐘後，用 0.45 μm PVDF 注射器過濾器過濾溶解液。接著採用兩步分離程序，先將溶解液載入 ZR 濾芯以去除鎵-66 (Ga-66) 雜質，以 9M HCl 溶液洗脫回收鋅-70 (Zn-70) 靶材，洗脫液再通過濕式填充 AG1X8 離子交換樹脂管柱 (填充高度 7 cm)，並以 2.5 倍管柱體積的 9 M HCl 溶液洗脫以去除其他雜質。最後，以 8 mL 2M HCl 洗脫收集銅-67 (Cu-67) 溶液，在真空系統下蒸發至接近乾燥。

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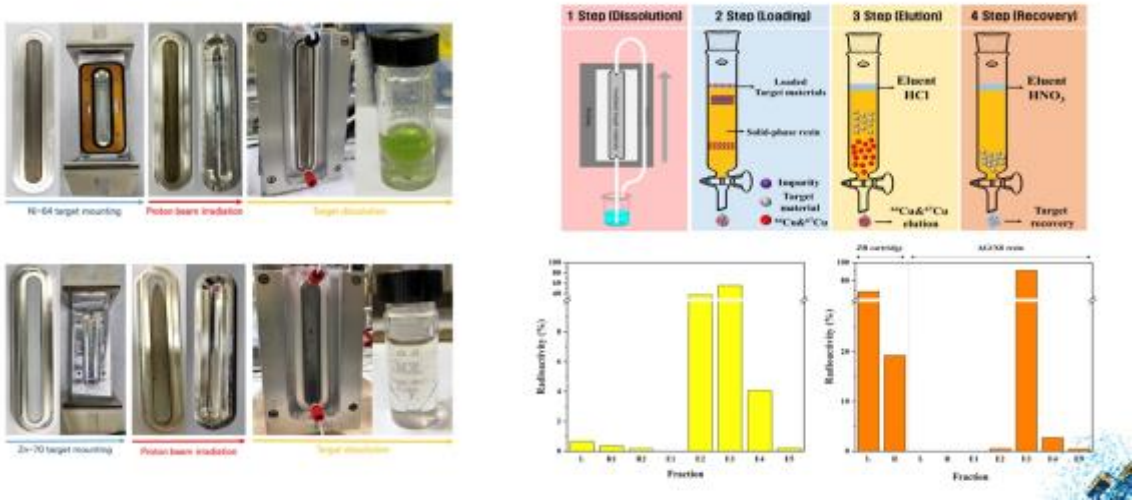
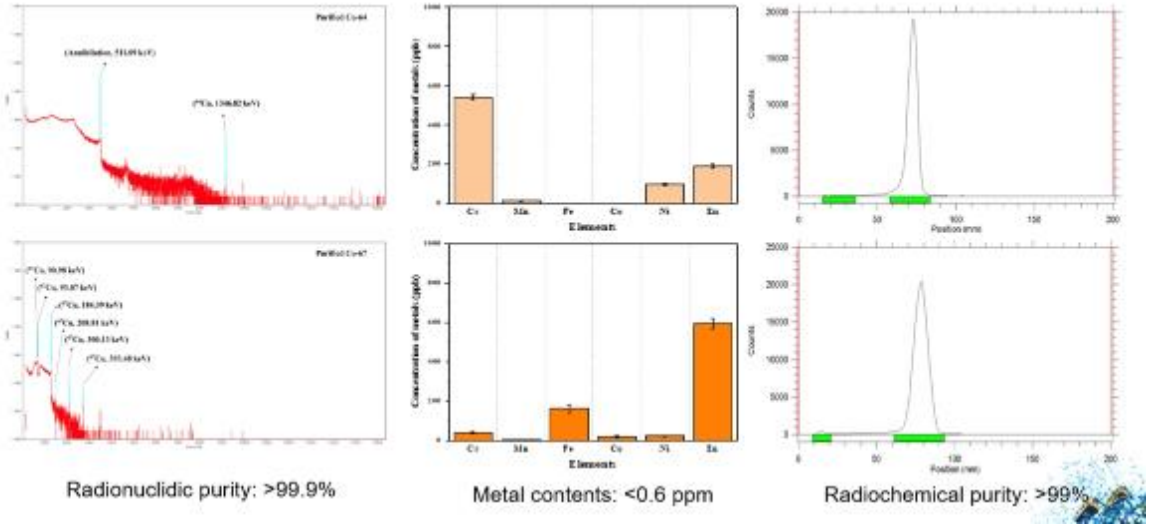


圖四十八、銅-64 (Cu-64) 和銅-67 (Cu-67) 分離純化

(摘錄自 EANM 會議簡報)

優化高豐度靶材電極沉積、質子束照射條件與分離純化過程可增強銅-64 (Cu-64) 和銅-67 (Cu-67) 生產，由品管分析實驗數據得知，銅-64 (Cu-64) 和銅-67 (Cu-67) 放射性核種純度均大於 99.9%，金屬雜質的含量小於 0.6 ppm 以及放射化學純度均大於 99%，如圖四十九。



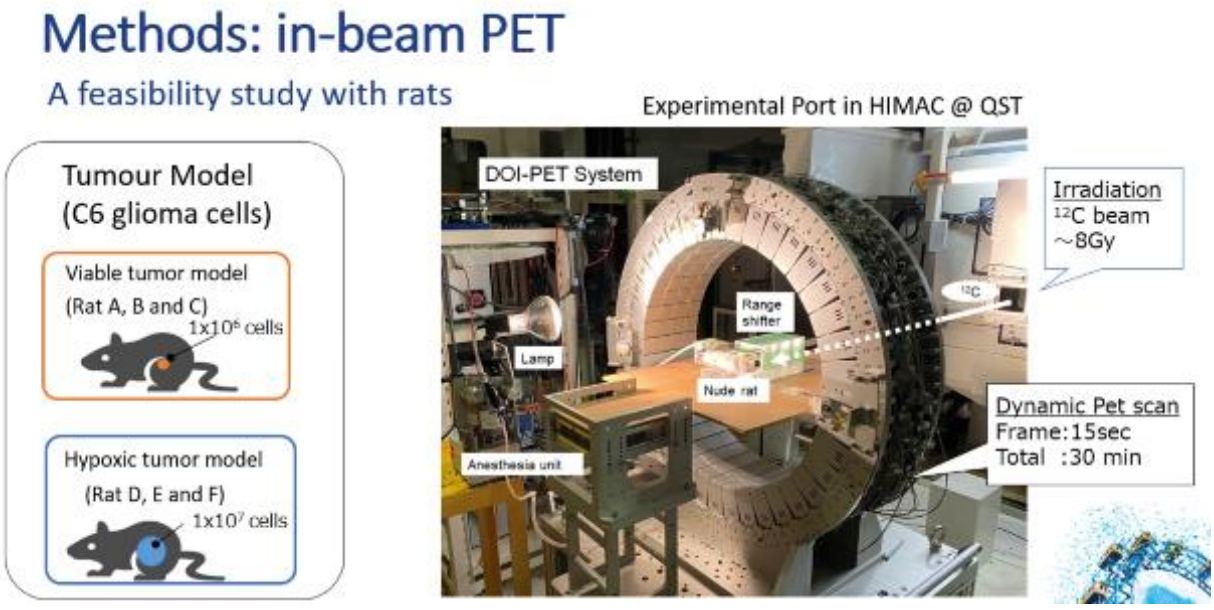
圖四十九、銅-64 (Cu-64) 和銅-67 (Cu-67) 品管分析

(摘錄自 EANM 會議簡報)

（十四）M2M：方法學評價：體外 (In vitro) 及體內 (In vivo) 模型

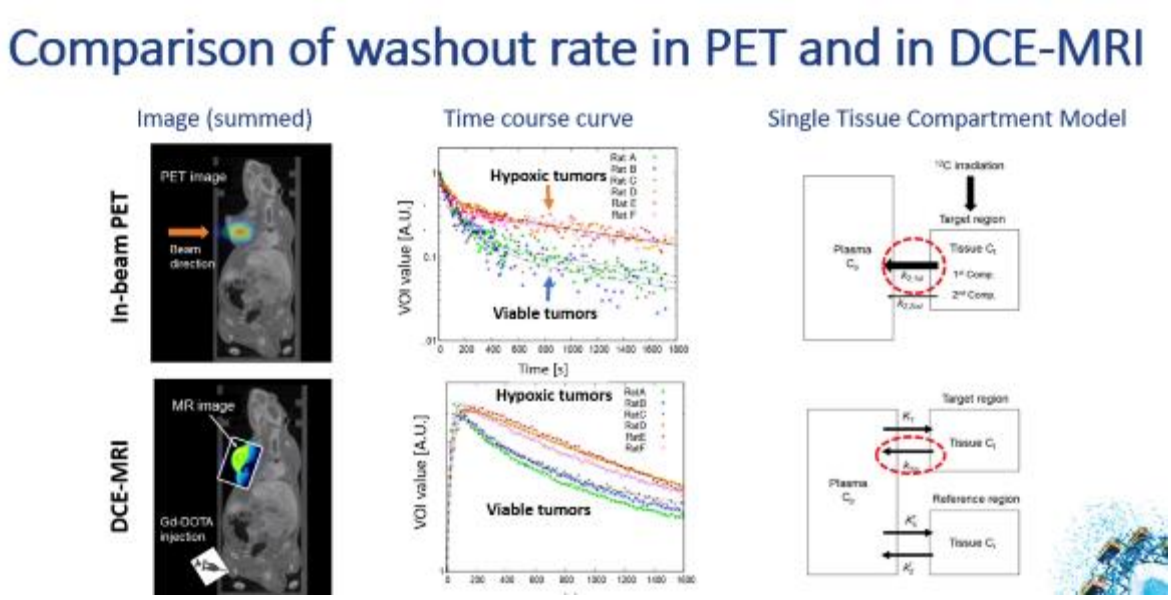
來自南非普勒托利亞大學的 Thomas Ebenhan 助理教授分析目前 PET/CT 上嚙齒類動物麻醉方法，針對 F-18-FDG、Ga-68-DOTA-TATE 及 Ga-68-PSMA-11 藥物，觀察動物的呼吸、體溫、心跳、血糖等，並分析藥物吸收、藥動、代謝等結果。研究結果發現，與 Sevoflurane 相比，Isoflurane 較適合用來進行氣麻；針對 F-18-FDG 動物造影，FCFD (Fentanylcitrate flunisone/Diazepam) 影響最小，使用 Ketamine/Xylazine 則具有高風險，而 Propofol 則會改變 FDG 在腦內的代謝。

來自日本量子科學技術研究開發機構 (QST) 的資深研究員 Chie Toramatsu 提到，目前放射治療欲觀察治療後反應皆透過正子藥物進行追蹤造影，如圖五十，本研究目標：研究大鼠在粒子治療 (給予 C-12 beam ~ 8 Gy) 後，不須注射放射試劑，並利用 DOI-PET 收集體內活化反應後物質的影像 (如 C-11、N-13、O-15 等) (Frame：15 秒，總造影時間：30 分)，並與 DCE-MRI 造影結果比較具正相關，如圖五十一，顯示其應用潛力。



圖五十、粒子治療後利用 DOI-PET 收集體內活化反應後物質的影像

(摘錄自 EANM 會議簡報)



圖五十一、PET 與 DCE-MRI 造影結果比較具正相關

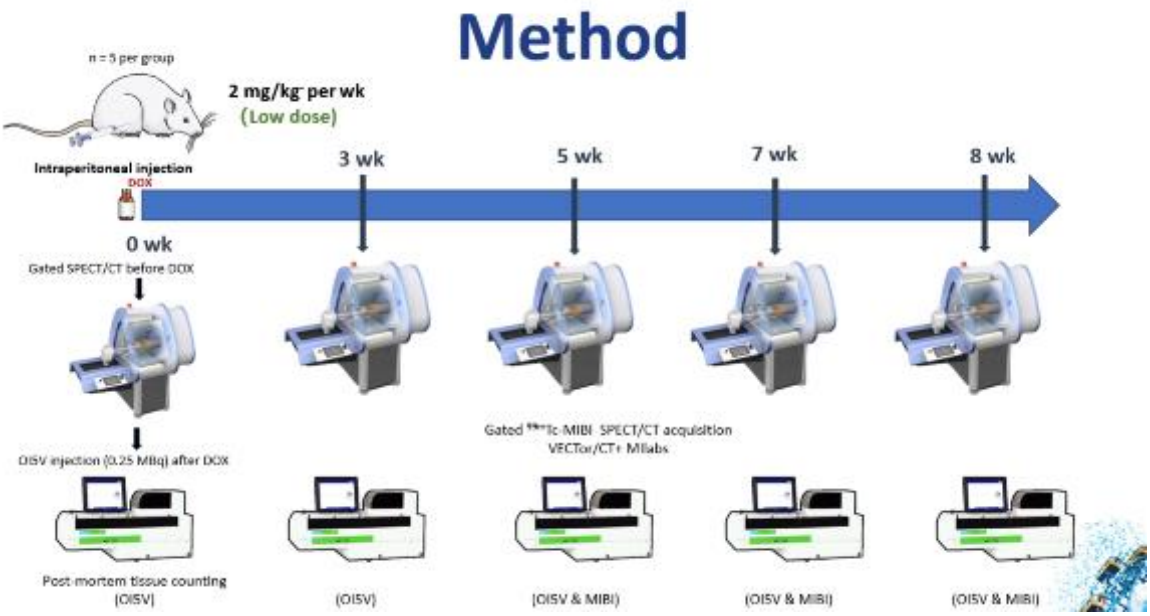
(摘錄自 EANM 會議簡報)

來自瑞典哥德堡大學的 Frida Westerberg 博士生發表，利用 Terbium-161 (Tb-161) 進行標靶核種治療結果。與鎦-177 (Lu-177) 相比，半衰期接近，亦具有 γ，可進行單光子造影研究，但具更高的 Auger electron 比率，將能造成腫瘤更高傷害 (46.3 keV vs 13.8 keV/decay)。本研究利用假體 (Cylinder、Jaszczak 及 MEMA 腎臟假體) 進行造影，並利用 Tb-161-DTPA 作為造影用的射源，使用 ELEGP、LEHR 及 MEGP 等作為準直器，最後利用 OSEM 演算法進行影像重組。結果顯示，SPECT 確實可利用 Tb-161 進行準確度高的造影，使用 LEHR 準直器則可以獲得較佳品質的影像。

（十五）M2M：心血管疾病中的發炎造影

來自日本金澤大學醫院核醫部的 Zhuoqing Chen 團隊，研究艾黴素 (Doxorubicin, DOX)藥物引發的心肌症 (cardiomyopathy)，導致心肌的內質網 (endoplasmic reticulum, ER) 壓力，反映到心肌上的 σ-1 受體 (sigma-1 receptor, σ1R) 攝取活化。本研究使用橫主動脈狹窄 (transverse aortic constriction, TAC) 的小鼠模式，除了會造成心肌萎縮外，也會導致 σ1R 的表現減少。實驗設計如圖五十二，利用 Tc-99m-MIBI (SPECT/CT) 觀

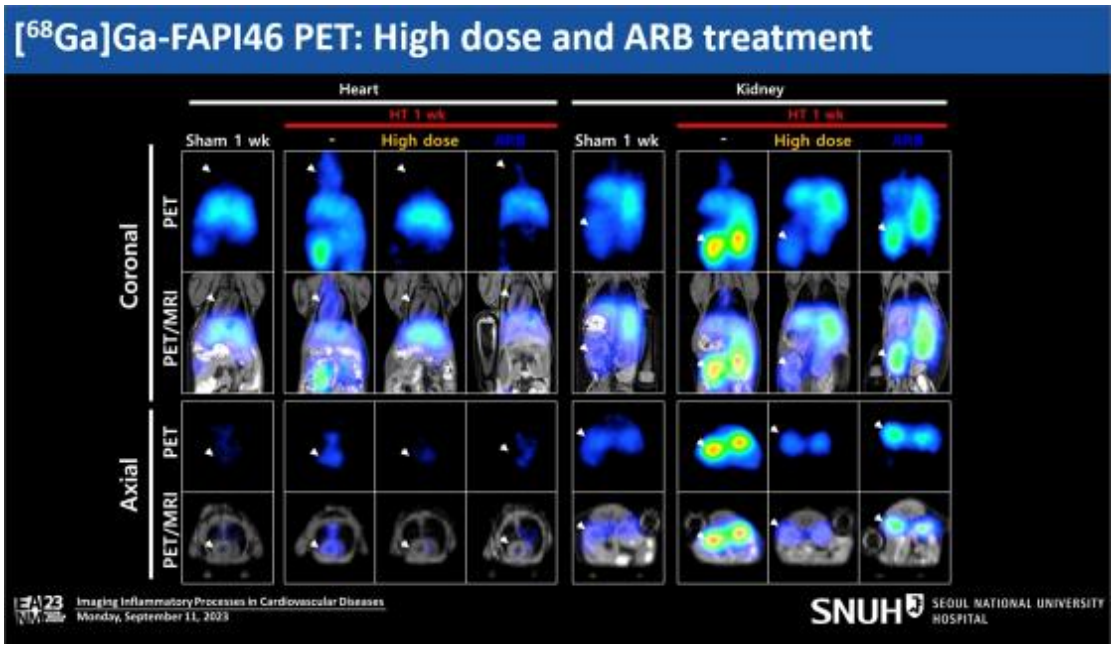
察心肌功能，在給予DOX 7週後會有功能下降的結果；利用I-125-OI5V (gamma counter) 觀察 σ1R 表現，可看到在給予 DOX 5 週後開始表現。本篇結論：除了可看到 DOX 具有心肌毒性外，σ1R 表現可能早於心肌功能下降。



圖五十二、觀察艾黴素於小鼠體內 σ1R 表現實驗設計

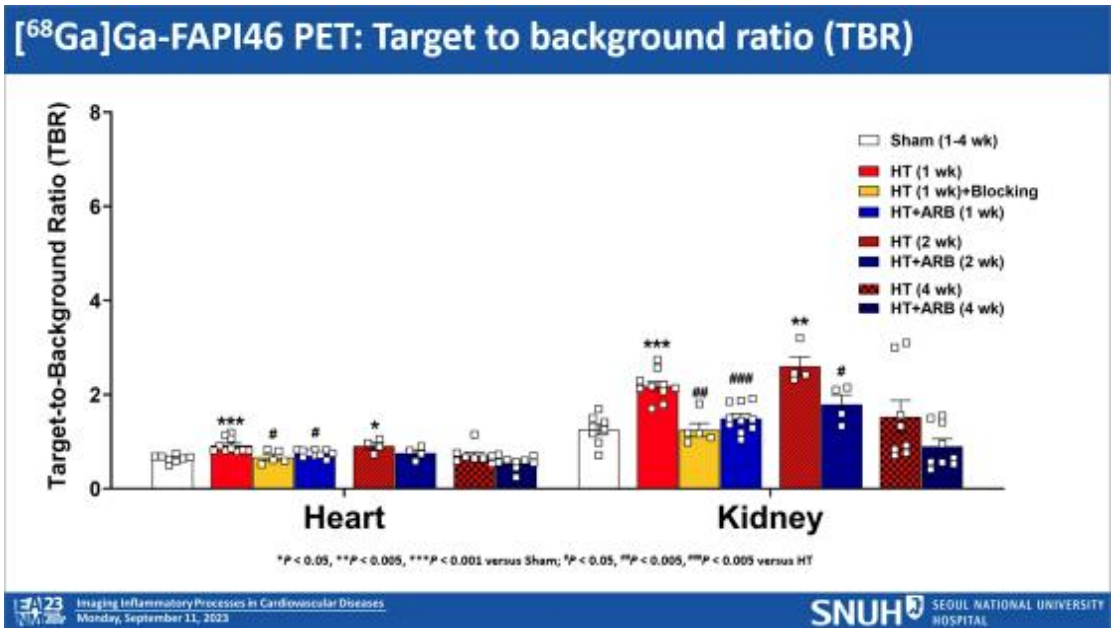
(摘錄自 EANM 會議簡報)

接著由韓國首爾大學醫院核醫科的 Jung Woo Byun 報告，血管收縮素 II (Angiotensin II, Ang II) 誘發的高血壓動物模式，利用 Ga-68-FAPI46 觀察早期器官纖維化的實驗。目前在美國高血壓病患逐年增來到 1.2 億人，造成醫療支出花費也來到 524 億元，而高血壓可能導致中風、心臟病、腎衰竭、周圍血管疾病等。實驗設計將 Ang II 埋於小鼠體內釋放，並給予 Ang II 抑制劑後於第 1, 2, 3 及 4 週後進行 PET/MRI 或生物分布研究。如圖五十三，結果顯示 Ga-68-FAPI46 可積聚在高血壓模式動物的心及腎內，尤其是腎臟內的積聚較高 (FAP 表現高)，如圖五十四；據觀察在誘發高血壓一週後 Ga-68-FAPI46 就有積聚表現，直到 4 週後會下降，可應用於心臟及腎臟的纖維化的早期分析。



圖五十三、Ga-68-FAPI46 可積聚在高血壓模式動物的心及腎內

(摘錄自 EANM 會議簡報)

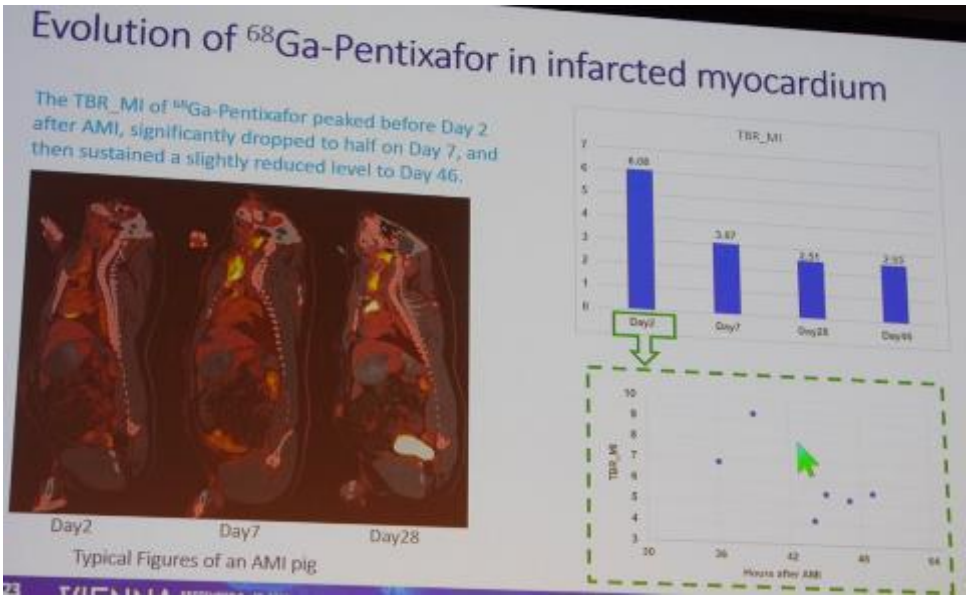


圖五十四、誘發高血壓後 Ga-68-FAPI46 積聚表現

(摘錄自 EANM 會議簡報)

來自中國山西醫學大學第一醫院核醫科的 Ping Wu，報告 Ga-68-Pentixafor 應用於急性心肌梗塞 (AMI) 的造影指標的潛力。趨化因子受體 4 (Chemokine receptor 4,

CXCR4) 會表現在急性心肌梗塞 (AMI) 區域，Ga-68-Pentixafor 過去則報導可應用於抗發炎的造影。本研究目的是研究心肌外的其他梗塞區域，並利用豬動物模式代表人類觀察預後指標。結果如圖五十五，可以看到 AMI 發生後 2 天顯示 Ga-68-Pentixafor 的積聚，7 天後則降為一半，並在 46 天後些微下降；然而早期 ^{68}Ga-Pentixafor 攝取高，後續的心肌功能下降越多。



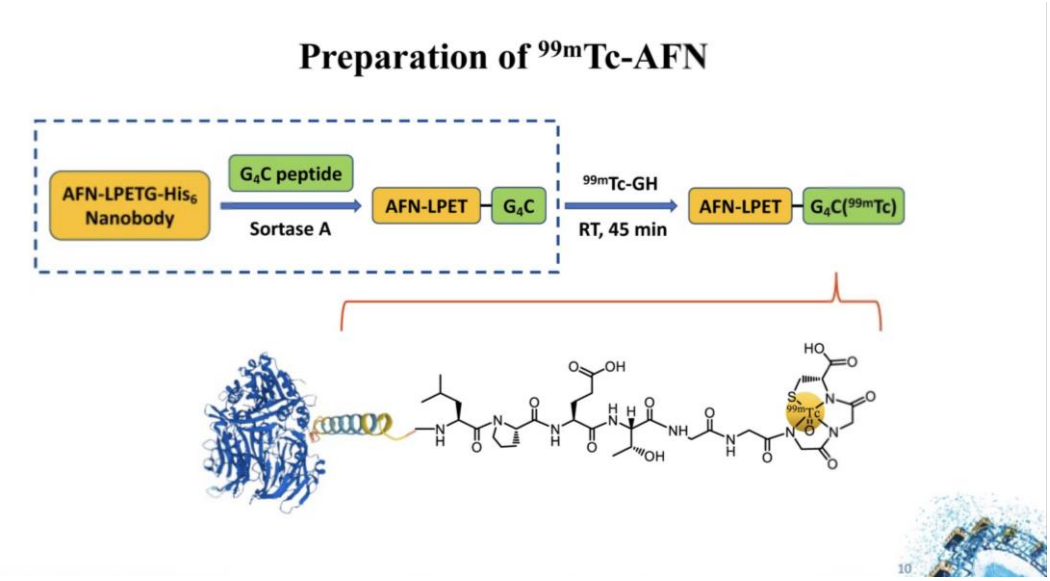
圖五十五、Ga-68-Pentixafor 於急性心肌梗塞的豬動物模式造影

(摘錄自 EANM 會議簡報)

來自北京朝陽醫院的 Xin Zhang，報導 Tc-99m-AFN 在心肌梗塞後作為可偵測纖維化的納體 (Nanobody) 示蹤劑。心肌的重塑期包括發炎期、修復期、治療期，在修復期纖維母細胞增生、疤痕形成且血管新生；目前有許多針對 FAP 的標靶造影劑 (FAPI)，本研究使用的納體是小型的抗原標靶單元，具有高親合性、低免疫反應、血中快速清除、易修飾等優點，結構如圖五十六，透過修飾 Tc99m 可觀察心肌梗塞後 FAP 的表現。

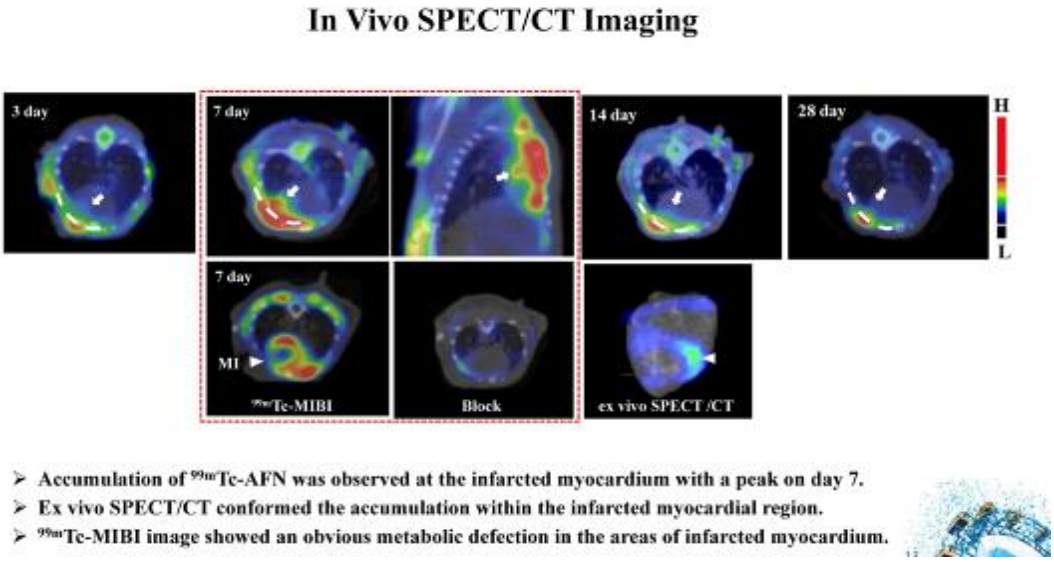
心肌梗塞 7 天後觀察 0.4~4 小時的造影結果，可看到注射 Tc-99m-AFN 後分佈 1 小時有較高的攝取；如圖五十七 ，在心肌梗塞後 3,7,14,28 天進行 Tc-99m-AFN 造影，可看到第 7 天有較高的攝取結果，而與 Tc-99m-MIBI 相比，可看到心肌梗塞的區域相

當吻合。本篇結論，與 FAPI 藥物相比，Tc-99m-AFN 有較低的血液攝取且有梗塞-不梗塞區域(infarct-to-noninfarct) 較高的攝取比率。



圖五十六、^{99m}Tc-AFN 在心肌梗塞後作為可偵測纖維化的納體示蹤劑結構

(摘錄自 EANM 會議簡報)



圖五十七、注射 ^{99m}Tc-AFN 後 SPECT/CT 影像於第 7 天有較高的攝取結果

(摘錄自 EANM 會議簡報)

（十六）Booth：全球核醫領域公司發展趨勢

36th EANM 的廠商攤位，可說冠蓋雲集。會場內並規劃有 Exhibition booth 等，其

中廠商高達 151 家。此外午休時段於各廳內設有 Satellite Symposium (共 12 場)。

本次參與會議的部分時段，皆赴 booth 參觀以瞭解核醫領域公司發展現況與趨勢，參觀主題包括研究用小鼠分子影像儀器、核醫藥物、同位素加速器、機械手臂及鉛室原廠等。

1. 拜訪研究用小動物正子造影儀廠商攤位：本次安排前往 Mediso 廠商攤位進行拜訪。Mediso 是國際最大的小動物分子影像儀器廠商，國內除了核研所外，也有許多學術單位採購，包括長庚醫院、國衛院等，顯示分子影像儀器在藥物開發具有高度應用潛力。

本所於民國 99 年起配合大型計畫，陸續編列預算採購 Mediso 單光子斷層掃描儀 (NanoSPECT/CT)、正子斷層掃描儀 (NanoPET/CT) 等，匯聚本所藥物開發人才，協助各大機構進行藥物於生物體內分析。近年原有的 Mediso 儀器因老舊，已完成更新採購新一代的單光子斷層掃描儀 (NanoScan SPECT/CT)。本所小動物 PET/CT 及 MRI 均已使用多年，亦面臨維修及替換材料停產的重大問題；隨著 MRI 技術的進步，PET/MRI 在各項新型小動物研究中，已取代 PET/CT 成為快速發展、不可或缺的研發用儀器。本次拜訪原廠人員及代理商泰歷公司，聆聽介紹並合影，如圖五十八，並已向攤位取得相關產品型錄，如附錄(三)(2)。該公司推出的 NanoScan PET/MRI 有 3T 及 7T 兩種選擇，能提供較高解析度的造影需求。現場也有提供實機展示，實際占地空間非常小，且提供可一次進行 3 隻小鼠造影動物床，具極方便的應用性，如圖五十九。

目前本所使用的小動物儀器設備中，包括 MR SOLUTIONS 公司的 3T MRI 產品，MR SOLUTIONS 公司由於規模較小，在國內也較少單位採用，該公司亦推出 MRS*PET/MR 的產品，已向攤位取得相關產品型錄，如附錄(三)(3)。與 Mediso 公司的產品相比，可提供 MRI 較多選擇 (3T、4.7T、7.0T 及 9.4T 等)，並依需求可選擇 MRS 功能，且提供可一次進行 3 隻小鼠造影動物床，亦具極方便的應用性。

目前小動物 MRI 造影儀的大廠 Bruker 公司，也是國內多個單位小動物 MRI 的首選，如台北醫學大學、長庚醫院等；攤位上並無展示 PET/MRI 產品，回國後已

向代理商取得 BioSpec Maxwell MRI 產品型錄，如附錄(三)(4)。與前二家相比，可提供 3T、7T、9.4T 等，同時具 3 隻小鼠造影動物床，經詢問目前陽明交通大學已採購使用。

圖五十八、樊副所長及翁博士與小動物分子影像儀器大廠 Mediso 公司歐洲區經理 Tamas Hodosi 醫師 (右一) 及台灣區代理-泰歷公司林宗德總經理 (右二) 於展場會面及交流

圖五十九、Mediso 公司 NanoScan PET/MRI 7T 產品外觀

2. 拜訪放射性同位素與核醫藥物廠商攤位：本所在藥物開發上，使用鎦-177 (Lu-177)

射源多由國外進口，因此本次會議已向多個銷售商了解同位素供應情形，包括 isotopia、SHINE、itm、Eckert & Ziegler 等公司，並取得相關資料如附錄(三)(5-6)，同位素所目前的供應商為泰歷公司，代理的廠商為 Monrol 公司所銷售的鎦-177 (Lu-177) 射源，並整理比較表如表五，各廠牌都有類似的規格，提供本所參考。

表五、全球 Lu-177 射源規格比較

Lu-177 銷售商	**isotopia**	**SHINE**	**Monral**
化學型式(Chemical form)	$LuCl_3$ in 0.04M HCl	$LuCl_3$ in 0.04N HCl	$LuCl_3$ in 0.05M HCl
比活度(Specific activity)	> 3000 Gbq/mg	> 3000 Gbq/mg	> 3000 Gbq/mg
核種純度(Radionuclidic purity)	> 99.9 % ^{177}Lu	≧99% (^{175}Yb<0.1%, total impurities ≦ 0.01%)	≧99.9%
放射化學純度 (Radiochemical purity)	> 99% as $^{177}LuCl_3$	≧99%	≧99%

配合「建置 70 MeV 迴旋加速器計畫」，本所預計開發新型 Ac-225 同位素。Ac-225 具有放射阿伐粒子(能量為 5.9351 MeV)，半衰期為 10 天，本次會議可看到有許多 Ac-225 藥物 (如 Ac-225-PSMA)，均是透過採購射源而非自行生產，已向銷售廠商 Eckert & Ziegler 取得相關資料，如附錄(三)(7)。

Tb-161 為本次會議中介紹的新型同位素，放射 Beta 粒子能量為 154 keV，半衰期為 6.89 天，亦具有 γ (能量分別為 49 及 75 keV)，而目前開發的藥物中也包括 Tb-161-PSMA ； 文 獻 指 出 (EJANMMI 2019) ， Tb-161-PSMA-617 和 Lu-177-PSMA-617 在小鼠中表現出相同的體外特性和組織分佈特徵。在整個研究濃度範圍內，與使用相同活性的 Lu-177-PSMA-617 獲得的效果相比，暴露於 Tb-161-PSMA-617 時，腫瘤細胞的活力和存活率降低更多，可能因為其高電子豐度以及 Auger 電子的同步發射，顯示其極具未來應用潛力。會場中發現 TERTHERA 公司已有販售，已於會場取得相關資料，如附錄(三)(8)。

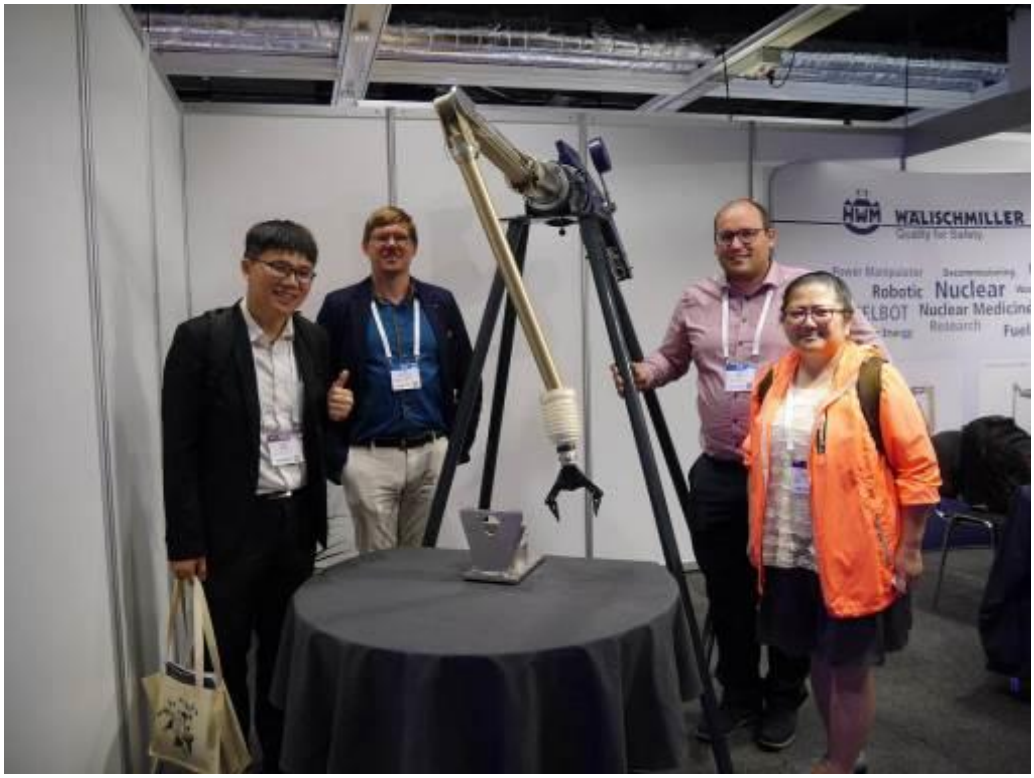
核醫藥物方面，Ga-68-PSMA-11 在本場會議中已有相當多的應用，已向 isotopia 公司取得 PSMA-11 藥物前驅物 (isoPROtrace-11 kit) 相關資料，如附錄(三)(9)。已

知 Ga-68-PentixaFor 可用在原發性高醛固酮症 (Primary Aldosterionism) 引發的高血壓的診斷，其機制可與 CXCR4 接受器表現的腺瘤 (Adenoma) 結合，並提供後續醫師手術的參考。與原先的血管採樣方式相比，具非侵入診斷等多個好處。已向 Eckert & Ziegler 公司取得相關藥物資料，如附錄(三)(10)。

展覽上有多家國外的 CDMO 公司進行宣傳，可協助 API 藥物開發及製造，並具有 cGMP grade 的工廠，如 ROTOP 公司，相關服務介紹資料如附錄(三)(11)。該公司亦有販售許多產品如 I-123-Ioflupane (用於帕金森氏症的診斷)、Tetrofosmin (用於心肌灌注造影)、MAG3、NanoHSA 等藥物。

3. 拜訪迴旋加速器與機械手臂製造商攤位：本次參觀國際最大的迴旋加速器製造商 IBA 攤位現場。IBA 提供從 18 MeV 至 70 MeV 用於放射性藥物生產的 PET (如生產：F-18-FDG 等) 及 SPECT (如生產：Tl-201 等) 迴旋加速器，並可提供液體、氣體、固體靶等產品，目前全球已銷售超過 300 台以上的 PET 加速器及 35 台以上 SPECT 加速器；國內亦有多家醫院及同位素供應商使用該公司的機器，如臺大醫院、新光醫院、新吉美碩公司等。該攤位吸引眾多與會人員，同時該公司亦在會場展示一台小巧型加速器及相關新型設備。

配合「建置 70 MeV 迴旋加速器計畫」，參觀機械手臂及鉛室原廠攤位。本所鉛室目前使用的機械手臂廠牌為：HWM (全名：WALISCHMILLER) 公司，該公司 70 多年來已成為原子研究設施高品質級安全機械的保證，不管是在研究領域、核醫科、核電廠、核廢料處理場都推出適用的產品。本計畫今年規劃鉛室時，已參考 30 MeV 迴旋加速器工作人員的使用經驗，考慮採購該廠牌款的機械手臂，本次參觀已向現場人員取得相關產品型錄，如附錄(三)(12)，並取得相關聯繫方式，未來亦將參考相關資料，並比較其他廠牌作為相關採購規格制訂的重要參考。



圖六十、樊副所長及翁博士與 HWM 公司銷售及 IT 負責人 Jan Hedtstuck (左二) 及產品經理 Mercel Karg (右二) 於展場中會面及交流

4. 拜訪鉛室製造商攤位：本次配合計畫需求，原已排定前往位於義大利的 COMECER 及 TEMA 公司鉛室原廠參觀。不過於行前規劃時，獲知國際鉛室廠商包括 COMECER、TEMA 及 VON GAHLEN 公司等，均會至會場攤位，故本次亦安排時間分別前往攤位詢問相關鉛室需求。

4-1 VON GAHLEN 公司：VON GAHLEN 公司成立於 1973 年，發展鉛室、屏蔽及核醫藥物製造，並提供相關技術服務。該公司鉛室產品過去曾由國內公司代理銷售，並持續擴展，但後來國內自行研發國產鉛室後便停止代理。已於攤位與技術人員及相關銷售業務，詳細討論鉛室建置需求與鉛室內靶材廢棄物處理相關建議，取得相關產品型錄，如附錄(三)(13)，並取得相關聯繫方式。

圖六十一、樊副所長及翁博士與 VON GAHLEN 公司顧問 Henk Duiker (右一)及區域銷售經理 Brenda Bakker (左一) 於展場會面及交流

4-2 COMECER 公司：本計畫與 COMECER 公司區域銷售經理 Fabio Salvini 先生從今年初就已透過電子郵件及視訊會議方式，初步了解 COMECER 公司為國際上極具規模的鉛室製造廠，且在國內也已有多個合作單位 (如：臺灣新吉美碩公司)。於參加會議前，本所已獲邀至攤位參觀，並於攤位與技術人員詳細討論鉛室建置需求與鉛室內靶材廢棄物處理相關建議；會面後也加入彼此聯繫方式，提供後續義大利參訪時方便聯繫。

圖六十二、樊副所長及翁博士與 COMECER 公司區域銷售經理 Fabio Salvini (右一)於展場會面及交流

4-3 TEMA 公司：在計畫討論會議，樊副所長已先透過 Best 公司取得 TEMA 公司遠東區經理 Alessandro Trere 及銷售工程師 Matteo Melandri 的聯繫方式。TEMA 公司亦是國際知名的鉛室製造廠，目前已知國內也有代理商 (恩典公司)，亦已售出產品。本次會議攤位，剛好與兩位專業的技術人員碰面，並取得相關產品型錄，如附錄(三)(4)。

圖六十三、樊副所長及翁博士與 TEMA 公司遠東區經理 Alessandro Trere (左二) 及銷售工程師 Matteo Melandri (右二) 於展場會面及交流

（十七）實地參訪國際鉛室原廠與 INFN-LNL 實驗室

1. 實地參訪「COMECER」鉛室原廠

本次安排前往 COMECER 公司進行參訪，於事前透過 email 與 COMECER 公司區域銷售經理 Fabio Salvini 先生聯繫，並取得邀請函，如附錄(四)(1)。出國期間已於 36th EANM 會場先進行拜會討論，並於 9 月 14 日上午按約前往位於義大利拉韋納省博洛涅塞堡 (Castel Bolognese) 參訪。

COMECER 是一家義大利公司，總部位於博洛涅塞堡，成立於 1970 年代中期，是世界最大的鉛室製造廠之一。COMECER 開發和製造用於製藥和核子醫學行

業無菌處理和密封的高科技系統。自 2019 年起，COMECER 成為 ATS (Automation Tooling Systems Inc.) 的一部分，ATS 是一家在多倫多證券交易所上市的加拿大公司，目前有 300 多名員工，年營業額約為 7,400 萬歐元 (2021 年)。該公司已推出許多的產品，主要有以下三種業務：透過生產用於特殊應用的屏蔽系統和設備，在放射製藥領域開展業務；在製藥領域，生產用於處理無菌和有毒物質的無菌灌裝和/或分配系統的隔離器；在再生醫學領域開展業務用於先進療法產品 (ATMP)。該公司於全球均有設立分公司，亞洲僅有印度設立，如圖六十四。台灣原於台北設有藥品部門，目前已結束相關業務；本次參訪評估項目為放射性用屏蔽鉛室，未來若計畫有訂定採購規格或招標需求，仍需透過總公司業務窗口進行採購。

圖六十四、全球 COMECER 公司分公司分布狀況

(摘錄自 COMECER 公司網站)

本次參訪行程非常豐富。於抵達後，由 Fabio Salvini 先生親自接待，並協助製作參觀證件。首先前往工廠參觀，進入工廠參觀前須套上鞋套，並戴上防爆眼鏡，保護相當充足；一行人接著前往該工廠較高處俯瞰鉛室製作廠房全貌，如圖六十五，

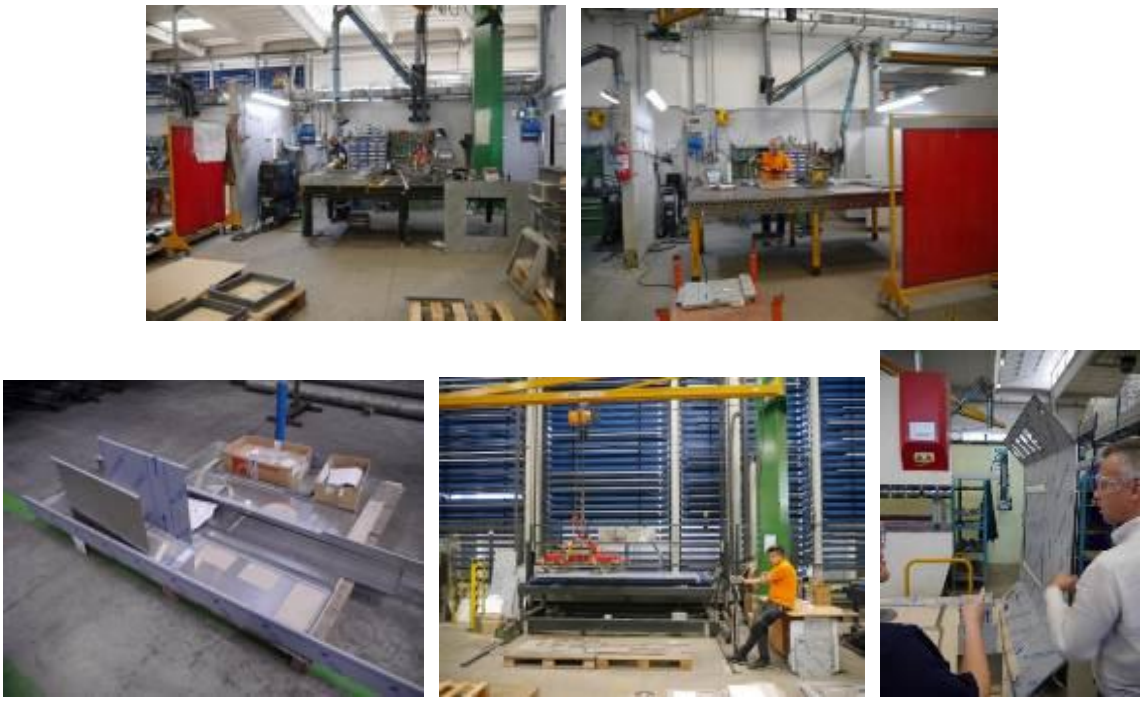
據了解該工廠具備生產鉛室的所有部門，並依照鉛室生產流程安排於工廠內各區，包括：客製化鉛屏蔽製作部門 (圖六十六)、客製化不鏽鋼模具裁切及定型部門 (圖六十七)、鉛玻璃訂製及保存部門 (圖六十八)、鉛室內襯焊接部門 (圖六十九)、鉛室組裝及測試部門 (圖七十) 等，本所人員已於參觀當下就相關疑問提出問題並獲解答 (圖七十一)。

參訪畢，該公司已安排會議室舉行會議，首先由 Fabio Salvini 先生與會說明，接著由本所同仁進行簡報，並討論本所相關需求 (生產射源及活度等) 及該公司設備，同時提出鉛室及鉛室內廢棄物處理相關問題。Fabio Salvini 先生告知目前最需要的是針對新採購 Best 公司 70 MeV 迴旋加速器，同位素鉛室需搭配使用的傳靶動線、以及各靶站的數量、尺寸等，回覆預計與 Best 公司及所內同仁討論後，以 email 提供相關問題回覆，並持續與該公司建立良好的聯繫管道。

為了感謝參訪及相關會議安排舉行，樊副所長於會議後致贈 Fabio Salvini 先生紀念品，並於 COMECER 公司大門合影留念，如圖七十二。

圖六十五、於 COMECER 公司工廠高處俯瞰廠房全貌

圖六十六、參觀客製化鉛屏蔽製作部門



圖六十七、參觀客製化不鏽鋼模具裁切及定型部門

圖六十八、參觀鉛玻璃訂製及保存部門

圖六十九、參觀鉛室內襯焊接部門

圖七十、參觀鉛室組裝及測試部門

圖七十一、樊副所長與翁博士參觀時即時詢問專業問題

圖七十二、樊副所長致贈 Fabio Salvini 先生 (左) 紀念品，並於 COMECER 公司大門合影留念

2. 參訪「TEMA」鉛室原廠

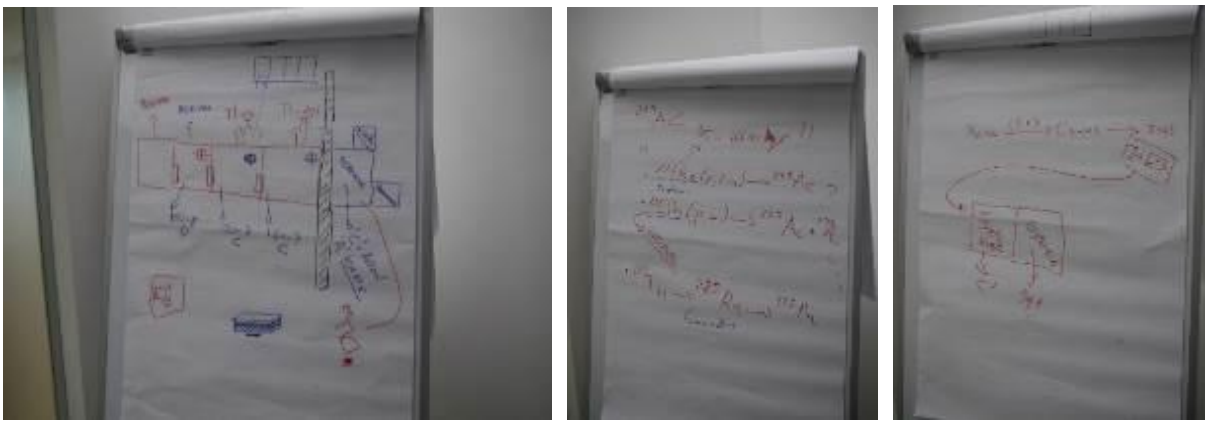
本次安排前往 TEMA 公司進行參訪，已於事前以 email 與 TEMA 公司銷售工程師 Matteo Melandri 先生聯繫，並取得邀請函，如附錄(四)(2)。本次出國期間已於 36th EANM 會場先拜會討論，並交換便捷的手機聯繫方式；此外，同仁於出發前已透過 google 地圖查詢該公司位於義大利 COMECER 公司鄰近的城鎮，經詢問該公司於隔日另有行程，故安排同一天 (9 月 14 日) 下午前往位於義大利拉韋納省法恩紮 (Faenza) 的原廠參訪。

TEMA 公司也是世界最大的鉛室製造廠之一，成立於 1985 年，是個比較年輕的公司，目前有 180 個員工，在不同的專業領域組建了專門的團隊，日常工作密切合作。持續共享內部知識和技能使所有業務部門能夠增強其專業知識。該公司在 2000 年獲得了由 CERMET 公司頒發的 UNI EN ISO 9001 認證。該系統已於 2003 年升級至 ISO 9001:2000，並於 2009 年升級至 ISO 9001:2000。 ISO 9001:2015，於 2018 年 6 月取得。2013 年 1 月，品質系統獲得醫療器材 UNI EN ISO 13485 認證，並於 2018 年 6 月更新為新版 ISO 13485:2016。TEMA 的產品相當多元，據了解除了現有的工廠外，正在原地擴建第二棟工廠，預計於未來可連通空間使用。

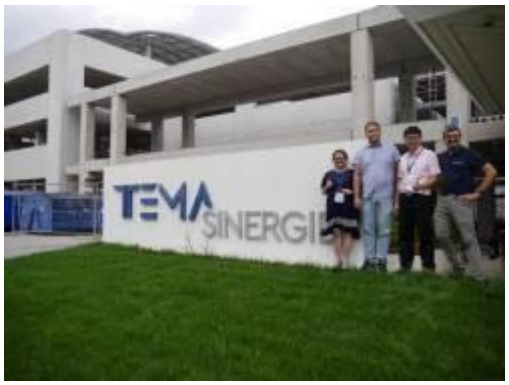
本次參訪行程非常豐富，由 Matteo Melandri 及遠東區經理 Alessandro Trere 先

生進行接待，並協助製作參觀證件；該公司辦公室具有透明的玻璃隔間，光線十分明亮。參訪前，該公司已安排會議室舉行會議，首先由 Alessandro Trere 先生簡報 TEMA 公司的歷史及產品，接著由本所同仁進行簡報，並討論本所相關需求 (生產射源及活度等) 及該公司設備，同時提出鉛室及鉛室內廢棄物處理相關問題，相關討論過程拍攝如圖七十三，會議中就鉛室的設計規劃花了非常多時間討論可行性，並討論 Ac-225 射源製程，獲益良多。為了感謝參訪及相關會議安排舉行，樊副所長於會議後致贈 Matteo Melandri 及 Alessandro Trere 先生紀念品，如圖七十四。

接著前往工廠參觀，進入工廠參觀前須穿上反光背心。據了解該工廠生產除了鉛屏蔽及鉛室等產品，也有生產其他鉛製或醫療設備，如圖七十五，並參觀鉛室製作相關部門，包括：鉛室組裝及測試部門 (圖七十六)、鉛室組裝安裝 HWM 機械手臂及測試部門 (圖七十七) 等，經詢問可配合本所需求安裝不同廠牌的機械手唄。有關鉛室內廢棄物及放射性靶運送方案，本所同仁亦於參觀當下詢問問題 (圖七十八)，評估是否適用本所需求。參訪完畢後，一行人於 TEMA 公司大門合影留念，並預計返國後持續與該公司建立良好的聯繫管道。



圖七十三、相關討論過程



圖七十四、樊副所長致贈 Matteo Melandri (左一) 及 Alessandro Trere (右一) 先生紀念品，並於參訪後於 TEMA 公司大門合影留念


圖七十五、參觀鉛套筒商品陳列及鉛室陳列

圖七十六、參觀鉛室組裝及測試部門

圖七十七、鉛室組裝安裝 HWM 機械手臂及測試部門

圖七十八、樊副所長與翁博士與工作人員討論鉛室內廢棄物及放射性靶運送方案

3. 參訪「INFN-LNL」研究機構

義大利國家核物理研究所 (National Institute for Nuclear Physics, INFN) 於 1951 年 8 月 8 日由羅馬大學、帕多瓦大學、都靈大學和米蘭大學成立，旨在延續和發展 20 世紀 30 年代恩里科•費米先生和他創辦的學院。1950 年代後半葉，INFN 在弗拉斯卡蒂設計並建造了第一台義大利加速器—電同步加速器，該研究所的第一個國家實驗室誕生於此。同一時期，INFN 參與位於日內瓦的歐洲核子研究中心 (CERN) 的研究活動，開始建造和使用日益強大的加速器。如今，該機構擁有約 5000 名科學家，他們的貢獻不僅在各個歐洲實驗室而且在許多世界研究中心得到國際認可。

INFN-LNL (Legnaro National Laboratories) 研究機構位於義大利帕多瓦省萊尼亞羅，入口處如圖七十九，該實驗室的正式員工有 145 名，每天約有 250 人造訪實驗室，平均每年有 700 名外部使用者。該研究機構加速器為核物理和核天文物理研究以及跨學科研究提供離子束，規劃或已建構的設施包括粒子加速器、輻射探測器及其相關技術領域的開發和創新是實驗室的強項。特別相關的是利用實驗室在表面處理技術、薄膜沉積以及未來醫用放射性同位素生產方面的專業知識的技術轉移活動。

圖七十九、INFN LNL 研究機構大門

本次實地參訪義大利萊尼亞羅 INFN-LNL 實驗室，已於事前透過 Best 公司業務經理 David 協助與 Mario Maggiore 博士聯繫，並取得邀請函，如附錄(四)(3)。由 INFN-LNL 70 MeV 迴旋加速器運轉負責人 Mario Maggiore 博士進行介紹。首先參訪機構內部的同步加速器設施，如圖八十，據了解該設施內的加速器建立在不同的研究館內，並規劃將透過地下室將射束連結在一起，可進行更多的應用。

圖八十、參觀機構內部-同步加速器設施

目前 LNL 執行 SPES (Selective Production of Exotic Species) 計畫，可分成 Alpha、Beta、Gamma 與 Delta 四個階段。Alpha 階段計畫主為建置 70 MeV 迴旋加速器本體，自加拿大 BTL 公司於 2010 年簽約購買 70 MeV 迴旋加速器、2012 開始

建造加速器廠館以及於 2018 開始運轉。Beta 階段計畫為研製放射性射束，目前仍為 on-going 狀態，預定 2025 年完成。迴旋加速器館平面圖，如圖八十一，70 MeV 迴旋加速器位於迴旋加速器館一樓中間，並有三條射束通往不同的靶室 (照射室)。

圖八十一、迴旋加速器館平面圖

由 Mario Maggiore 博士帶隊參觀一樓迴旋加速器室外區域及迴旋加速器室迷宮入口，據介紹若以迷宮設計可減少輻射穿出，該區域周圍於照射中會進行管制，迷宮的屏蔽設計是以長方體的混凝土磚層層疊起來，如圖八十二。接著，前往迴旋加速器室參觀，如圖八十三，該迴旋加速器室具挑高、寬敞的空間，燈光明亮，方便加速器開啟維修，混凝土屏蔽約 3 公尺，本所採購的相同廠牌型號的 70 MeV 迴旋加速器 (Best 70p) 位於該室中央，加速器離子源是位於與該室連通的地下室區域內，可透過欄杆觀察離子源外觀；透過該機構過去發表的海報資料，如圖八十四，展示近年加速器建置過程及測試結果，可看到一開始加速器的射束輸出相當不穩定，在驗收期間，經過加速器原廠人員不斷測試、調整後，已可穩定輸出利用。接著參觀圍阻用混凝土屏蔽門及靶室入口，如圖八十五，該屏蔽門位於加速器旁，原為加速器本體送入口，平時可開啟，但在運轉時須關閉避免大量輻射穿出。屏蔽門共二層，混凝土屏蔽達 3 公尺以上，各層的單元均設計為弧狀且交錯，減少輻射穿出。

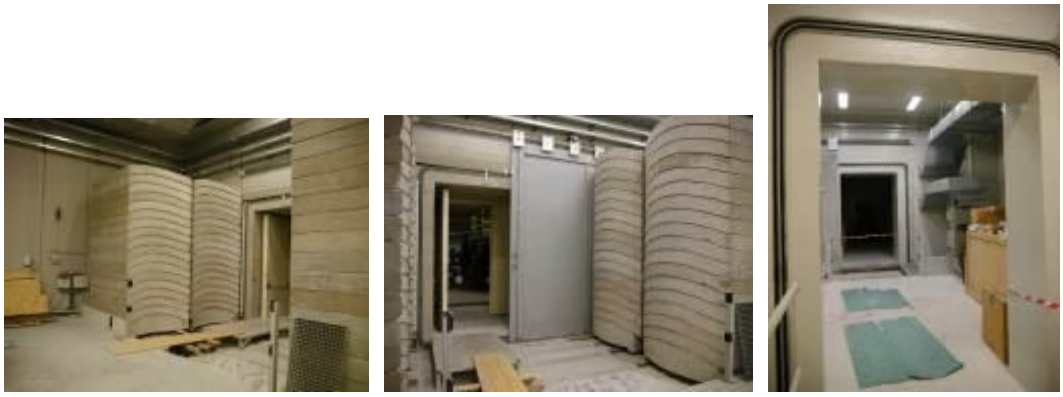
迴旋加速器控制室電腦位於二樓，如圖八十六，主要由電腦主機及二個螢幕控制，該系統由 Best 公司工程師設計，與本所目前使用的系統類似。接著參觀二樓冷卻水設備 (圖八十七) 及加速器電氣室 (圖八十八)，管路及電線等均位於地面下，並有空調循環，同時該電氣室設有 RF 控制箱及 RF 傳送管路 (圖八十九)，該電氣室內二樓高壓變電設備及鐵網，可連接至一樓高壓電及鐵網，提供迴旋加速器使用(圖九十)，二樓具有煙囪排放過濾設備及監測器、控制站 (圖九十一)。

參訪畢，由樊副所長與翁博士介紹目前本所 30 MeV 迴旋加速器設施，以及預計建置的 70 MeV 迴旋加速器廠館設計，並協助計畫同仁詢問中子及質子問題，並獲相關回覆，整理如附錄(五)。Mario Maggiore 博士亦歡迎本所針對其他問題，舉行視訊與該機構進行會議討論。為了感謝參訪及相關會議安排舉行，樊副所長已於會議後致贈 Mario Maggiore 博士及工作人員紀念品，如圖九十二。

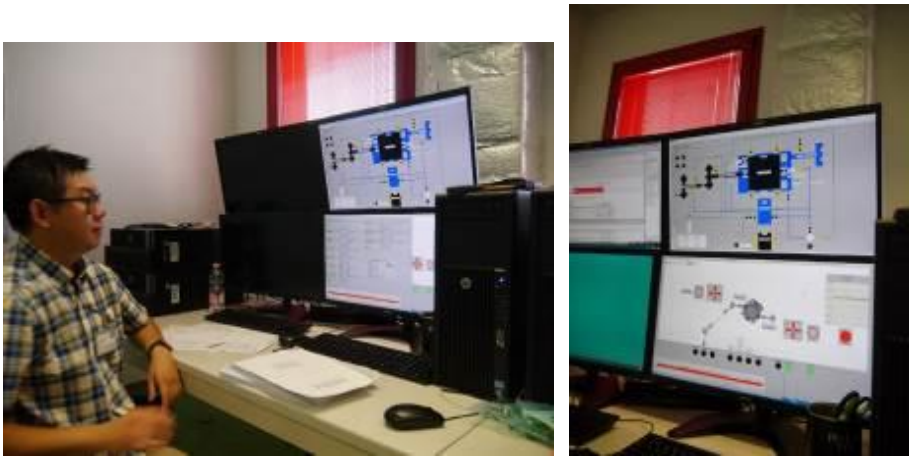
圖八十二、參觀迴旋加速器室外區域及迴旋加速器室迷宮入口

圖八十三、參觀迴旋加速器室、迴旋加速器及離子源外觀

圖八十四、現場海報展示-迴旋加速器建置過程及測試結果



圖八十五、參觀圍阻用混凝土屏蔽門及靶室 (照射室) 入口



圖八十六、迴旋加速器控制室電腦

圖八十七、參觀二樓冷卻水設備

圖八十八、參觀電氣設備室：管路及電線等均位於地面下，並有空調循環

圖八十九、參觀電氣設備室：RF 控制箱及 RF 傳送管路

圖九十、參觀電氣設備室：二樓高壓變電設備及鐵網，連接至一樓高壓電及鐵網

圖九十一、參觀迴旋加速器室上方煙囪排放過濾設備、監測器及控制系統

圖九十二、樊副所長致贈加速器負責人 Mario Maggiore 博士 (右二)
及工作人員 (右一與左一) 紀念品

四、建 議 事 項

本次相當榮幸代表本所前往奧地利出席第 36 屆歐洲核醫學會年會 (36th EANM) 發表論著，並有機會與台灣核醫界頂尖醫師與專家學者，包括高雄榮總核醫部主任諶鴻遠醫師、台大醫院核子醫學部陸景竹醫師、黃潔宜醫師、陳怡潔放射師以及其他關心核醫藥物發展等的產學研專家學者同行與會，除了與臨床醫師建立情誼與合作關係外，重要的是希望未來在於藥物開發的方向能緊密扣合臨床應用端的 unmet medical need，提供極具臨床診斷與治療價值之核醫藥物或放射性同位素於國內產學研醫界應用研究。本次巧遇日本日本金沢大学先進予防医学研究科中嶋憲一教授、南澳分子影像及治療研究中心放射藥物研發負責人 Edward Robins 及資深放化師 Hiu Chun LAM 博士以及德國卡爾斯魯厄聯合研究中心 (JRC) 歐洲委員會科學 (European Commission) 官員 A. Kellerbauer 教授專家學者，透過瞭解其他單位研發現況以及思考本所國際合作的可能性。另外，本次積極與 booth 展場廠商以及實地參訪「COMECER」、「TEMA」與「INFN-LNL」研究機構，與實務經驗豐富的原廠或研究人員交流，探討放射性同位素發展趨勢、鉛室製作之法規要求面與製藥工業面的考量以及 Best 公司 70MeV 迴旋加速器建置環境討論，包括壓差、溫溼度等。

觀察本次第 36 屆歐洲核醫學會年會 (36th EANM) 所有的放射性同位素與核醫藥物的蓬勃發展，因為歐洲醫藥管理局 (European Medicine Agency, EMA) 考量核醫藥物屬於特殊類型的醫藥產品，因此，許多核醫新藥得以快速地進入人體臨床試驗，可快速獲得臨床驗證以搶得先機與提早佈局。本所具有國內最完整生技產業價值鏈，除擁有從藥物探索、先導藥物最佳化、動物實驗等臨床前試驗到臨床試驗藥物 PIC/S GMP 標準化產製作業實作經驗與專業人才外，更具有獨特的放射性同位素開發能力以及具有毒理與放射藥理等分子影像平台以及碳-14 藥物代謝分析平台之服務量能，隨著精準醫療與個人化醫療時代的來臨，分子影像醫學可提供精準治療、智慧醫療與預防醫學訊息，可謂是精準醫療的先驅者，也是生技產業發展之重要一環，因此，核醫藥物與醫材的發展當逢其時，是開創新局的最佳時機以及是值得投入與深耕的領域，這是本所的優勢。

綜合本次會議與實地參訪的內容，具體建議如下：

(一) **發展新診療放射性同位素**：因應未來核醫精準醫療需求，建議可以積極以迴旋加速器

15~30 MeV 或 28~70 MeV 能量範圍所能產製的新診療放射性同位素配對組，例如診斷用放射性同位素 (例如 Zr-89、Ga-68 或 Cu-64)，治療用放射性同位素 (例如 Ac-225 或 Cu-67)，從靶材與支柱選擇設計、電鍍技術精進提升到放射性同位素分離純化技術等研發，以及操作環境之法規面考量，所有環節環環相扣且相當重要。建議可於現況迴旋加速器運轉餘裕下，鼓勵同仁發展新放射性同位素研發相關技術，並可規劃派員赴歐美亞研究機構實習以便並與國際接軌。

(二) **發展新診療核醫藥物**：癌症、心血管及腦神經退化仍是熱門研究的領域，近年來，攝護腺癌 PSMA 診療核醫藥物蓬勃發展，而下一代明星標靶診療核醫藥物，如 FAPI、CAIX、CXCR4 與 CCK2R 等，各以不同腫瘤模式探討治療效果，甚至於已進入臨床驗證階段，但其他如轉甲狀腺素蛋白類澱粉樣心肌病變 (transthyretin amyloid cardiomyopathy, ATTR-CM)、免疫查核點、腦神經退化 (例如：α-synuclein 造影劑) 或是其他代謝性疾病亦是核子醫學研究發展的趨勢，可為本所發展診療核醫新藥開發方向之參考。

(三) **擴大動物造影設備投資：**近一二年，本所所承接的產學研醫界的技服案量，逐年攀升，包括藥物探索或欲進入臨床階段測試，尤其需要以動物試驗進行分子影像驗證或藥物藥物動力學研究。小動物 PET/MRI 動物造影可提供極佳的數值供參，然精準研究數據端賴於高解析的儀器設備，即所謂「工欲善其事，必先利其器」。建議投資更新本所小動物 PET/MRI 動物造影設備，以加強研發量能，可提升服務品質並與國際接軌。

(四) **積極參與國際研討會**：積極參與美國、歐盟與日本等先進國家舉辦之核醫藥物國際研討會及活動，以尋求合作契機與確立研發方向。建議未來能持續派有經驗之研究人員參加國際研討會，收集新知及學習技術，並鼓勵同仁以口頭報告形式發表論文，除可增加國際能見度，並可與國際學者交流討論。

(五) **尋求與歐美亞學術單位合作**：跨國際的合作與資訊交流是相當重要的，透過積極參與國際研討會或其他國際媒合會議，本所具有獨特的技術，之研究分享與交流，才能掌握科學研究的趨勢，哪些課題都是大家感興趣而想研究的方向，以及如何更有效的解決這些課題。建議積極與國內外學者進行合作關係，共同尋求與定調 candidate 新藥物以及新核種發展方向，以及評估技轉的可行性。

五、附　錄

附錄（一）大會手冊節錄本所發表研究論文摘要

EP-0029

Evaluation of a Long-circulating PSMA-targeting Peptide in a Xenograft Model of Bone Metastatic Prostate Cancer.

W. Lo, *Y. Huang, M. Chen, A. Lu, S. Wang, L. Chen, S. Farn;*
Institute of Nuclear Energy Research, Taoyuan, TAIWAN.

EP-0036

In vivo evaluation of luteinizing hormone-releasing hormone antagonists in triple negative breast tumor-bearing model by using SPECT/CT imaging

M. Weng, *S. Farn;*
Institute of Nuclear Energy Research, Taoyuan City, TAIWAN.

EP-0055

Development ofINER-PP-F11N as the Radionuclide Theragnostics Agent against Cholecystokinin B Receptor-overexpressed Tumors

M. Chang, *C. CHEN, P. CHIANG, C. PENG;*
Institute of Nuclear Energy Research, Taipei, TAIWAN.

EP-0858

Method development for the analysis of 14C-acetaminophen by HPLC-MS

P. Chang, *S. Farn;*
Institute of Nuclear Energy Research, Tao-Yuan, TAIWAN.

OP-180

Differential Diagnosis of Lewy Body Dementia andAlzheimer's Disease in ECD SPECT Images Using 2D and 3D CNN Methods

Y. Ni[1], *Z. Lin*[1], *S. Tsen*[1], *M. Pai*[2], *P. Chiu*[3], *G. Hung*[4], *K. Lin*[5], *I. Hsiao*[6], *C. Chang*[7], *Y. Chang*[8];
[1]*Health Physics Division, Institute of Nuclear Energy Research, Atomic Energy Council, Taoyuan, TAIWAN,* [2]*Alzheimer's Disease Research Center, National Cheng Kung University Hospital, Taiwan, TAIWAN,* [3]*Department of Neurology, Show Chwan Memorial Hospital, Changhua, TAIWAN,* [4]*Department of Nuclear Medicine, Chang Bing Show Chwan Memorial Hospital, Changhua, TAIWAN,* [5]*Department of Nuclear Medicine and Molecular Imaging Center, Linkou Chang Gung Memorial Hospi-tal, Taoyuan, TAIWAN,* [6]*Department of Medical Imaging and Radiological Sciences & Healthy Aging Center, Chang Gung University, Taoyuan, TAIWAN,* [7]*Department of Neurology, Kaohsiung Chang Gung Memorial Hospital, Kaohsiung, TAIWAN,* [8]*Department of Neurology, Institute of translational research in biomedicine, Kaohsiung Chang Gung Memorial Hospital, Chang Gung University College of Medicine, Kaohsiung, TAIWAN.*

PROGRAMME OVERVIEW
SATURDAY, SEPTEMBER 9, 2023

Location/ Time	Hall A				Location/ Time
08:00–08:30					08:00–08:30
08:30–09:00					08:30–09:00
09:00–09:30					09:00–09:30
09:30–10:00					09:30–10:00
10:00–10:30					10:00–10:30
10:30–11:00					10:30–11:00
11:00–11:30		**Advisory Council Meeting** (11:00–13:00) Room 1.86			11:00–11:30
11:30–12:00					11:30–12:00
12:00–12:30					12:00–12:30
12:30–13:00					12:30–13:00
13:00–13:30					13:00–13:30
13:30–14:00					13:30–14:00
14:00–14:30			**Delegates' Assembly** (14:00–16:00) Hall F2	**Committee Meetings** (14:00–17:45)	14:00–14:30
14:30–15:00					14:30–15:00
15:00–15:30					15:00–15:30
15:30–16:00					15:30–16:00
16:00–16:30					16:00–16:30
16:30–17:00					16:30–17:00
17:00–17:30					17:00–17:30
17:30–18:00					17:30–18:00
18:00–18:30	**Opening Ceremony including Awards Ceremony** (18:00–18:35)				18:00–18:30
18:30–19:00					19:30–20:30
20:30–21:00	*101* **Plenary 1 Highlights Lecture** (18:35–19:35)				20:30–21:00
21:00–21:30	**Welcome Reception** (19:45–21:45)				21:00–21:30
21:30–22:00					21:30–22:00

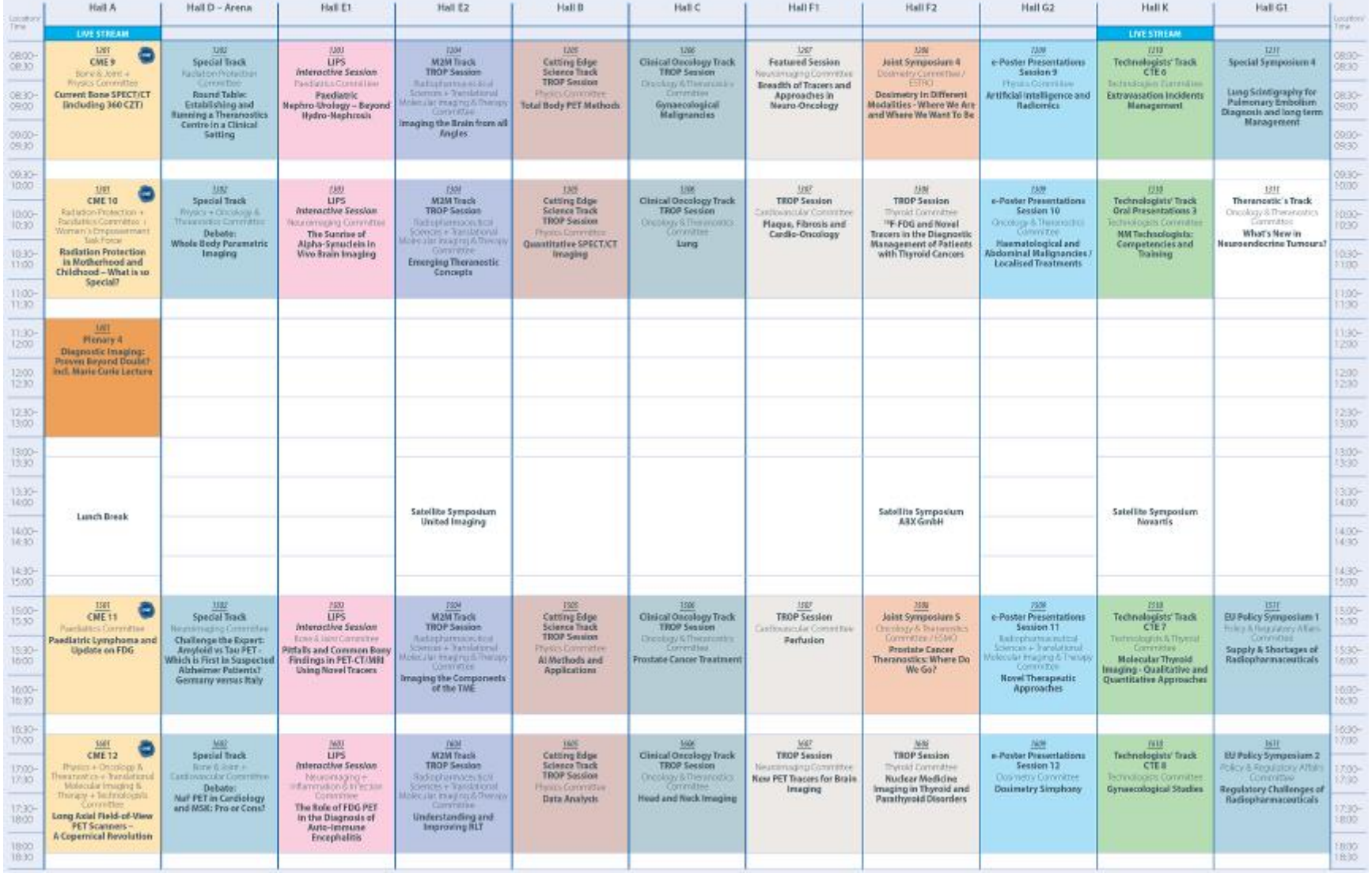
PROGRAMME OVERVIEW
SUNDAY, SEPTEMBER 10, 2023

Location/ Time	Hall A	Hall D – Arena	Hall E1	Hall E2	Hall B	Hall C	Hall F1	Hall F2	Hall G2	Hall K	Hall G1	Location/ Time
	LIVE STREAM									LIVE STREAM		
08:00–08:30	201 CME 1 Inflammation & Infection Committee **Infection and Inflammation – New Guidelines**	202 Special Track Cardiovascular Committee **Debate: Myocardial Perfusion Imaging after ISCHEMIA Trial**	203 LIPS *Interactive Session* Oncology & Theranostics Committee **Novelties in Radionuclide Therapy**	204 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **At the Nucleus: Radionuclide Production**	205 Cutting Edge Science Track TROP Session Physics Committee **Quality Control, Performance, Standardisation**	206 Clinical Oncology Track TROP Session Oncology & Theranostics Committee **Prostate Cancer Staging**	207 Featured Session Neuroimaging Committee **Methods in Neuroimaging: Spotlight on Brain Connectivity**	208 TROP Session Paediatrics Committee **Paediatric PET/CT & PET/MR**	209 e-Poster Presentations Session 1 Oncology & Theranostics Committee **Neuroendocrine Tumours and Gynaecological Malignancies**	210 Technologists' Track Opening CTE 1 Technologists Committee / SNMMI **Technologists' Guide Launch – Gastro Intestinal Molecular Imaging Studies**	**Members' Assembly** (08:00–11:00)	08:00–08:30
08:30–09:00												08:30–09:00
09:00–09:30												09:00–09:30
09:30–10:00	301 CME 2 Translational Molecular Imaging & Therapy + Oncology & Theranostics + Radiopharmaceutical Sciences Committee **FAP – Moving Towards Therapy**	302 Special Track Thyroid Committee **Challenge the Expert: Integrated Diagnostics of Thyroid Disease**	303 LIPS *Interactive Session* Radiation Protection + Physics Committee / EFOMP **Careers in Radiation Protection**	304 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **Validating Methodology: In Vitro and In Vivo Models**	305 Cutting Edge Science Track Featured Session Physics Committee **Radiomics**	306 Clinical Oncology Track Featured Session Oncology & Theranostics Committee **Haematological Disease**	307 TROP Session Neuroimaging Committee **Amyloid, Tau and More in Neurodegenerative Disorders**	308 Joint Symposium 1 Cardiovascular + Inflammation & Infection Committee / EACVI **PET in Valvular Diseases – All in!**	309 e-Poster Presentations Session 2 Paediatrics Committee **Paediatric Nuclear Medicine & Adults General Nuclear Medicine**	310 Technologists' Track CTE 2 Technologists Committee **Head and Neck Molecular Imaging – Updates and Perspectives**		09:30–10:00
10:00–10:30												10:00–10:30
10:30–11:00												10:30–11:00
11:00–11:30												11:00–11:30
11:30–12:00	401 Plenary 2 **New Imaging Techniques – Jump Aboard or Watch and Wait**											11:30–12:00
12:00–12:30												12:00–12:30
12:30–13:00												12:30–13:00
13:00–13:30	Lunch Break			Satellite Symposium Monrol Nuclear Products			Satellite Symposium TELIX	Satellite Symposium Springer Healthcare IME (supported by an educational grant from Lilly)		Satellite Symposium Pfizer	EANM Lunch Break Session **Presentation Skills for Medical Professionals**	13:00–13:30
13:30–14:00												13:30–14:00
14:00–14:30												14:00–14:30
14:30–15:00												14:30–15:00
15:00–15:30	501 CME 3 Cardiovascular Committee **Nuclear Imaging in Cardiac Amyloidosis – What Else?**	502 Special Track Oncology & Theranostics Committee **Challenge the Expert: Risk in Diagnostic and Therapeutic Nuclear Medicine**	503 LIPS *Interactive Session* Thyroid Committee **Rational Use of PET/CT with 18F-FDG in DTC**	504 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **Radioligand Therapy - New and Old Targets**	505 Cutting Edge Science Track TROP Session Dosimetry Committee **From Cells to Human via the Fish**	506 Clinical Oncology Track TROP Session Oncology & Theranostics Committee **Gastrointestinal Malignancies**	507 TROP Session Paediatrics Committee **Adults General Nuclear Medicine**	508 Joint Symposium 2 Oncology & Theranostics Committee / EORTC **Nuclear Medicine Imaging of the Immune System**	509 e-Poster Presentations Session 3 Inflammation & Infection Committee **More on Infection and Inflammation Imaging**	510 Technologists' Track Oral Presentations 1 Technologists Committee **SPECT-CT in Diagnosis and Therapy**	511 Theranostics Track Featured Session Oncology & Theranostics Committee / EARL **Old but Novel Techniques**	15:00–15:30
15:30–16:00												15:30–16:00
16:00–16:30												16:00–16:30
16:30–17:00	601 CME 4 Oncology & Theranostics Committee **Update in Multiple Myeloma**	602 Special Track Dosimetry Committee **Challenge the Expert: Dosimetry Live**	603 LIPS *Interactive Session* Oncology & Theranostics Committee **Residents for Residents**	604 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **Novel Imaging Targets in Oncology**	605 Cutting Edge Science Track TROP Session Physics Committee **Segmentation and Denoising**	606 Clinical Oncology Track TROP Session Oncology & Theranostics Committee **Neuroendocrine tumours Treatment**	607 TROP Session Cardiovascular Committee **Functional Imaging, Plaque and Total-Body PET**	608 TROP Session Inflammation & Infection Committee **Infection and Inflammation Imaging: New Frontiers**	609 e-Poster Presentations Session 4 Thyroid Committee **Thyroid and Parathyroid Disease**	610 Technologists' Track CTE 3 Technologists Committee **Patient Care in Nuclear Medicine**	611 Special Symposium 1 EANM / EARL **Harmonisation and Accreditation Accelerate Research and Clinical Translation**	16:30–17:00
17:00–17:30												17:00–17:30
17:30–18:00												17:30–18:00
18:00–18:30												18:00–18:30

PROGRAMME OVERVIEW
MONDAY, SEPTEMBER 11, 2023

Location/ Time	Hall A	Hall D – Arena	Hall E1	Hall E2	Hall B	Hall C	Hall F1	Hall F2	Hall G2	Hall K	Hall G1	Location/ Time
	LIVE STREAM									LIVE STREAM		
08:00–08:30	701 CME 5 Oncology & Theranostics Committee **Will the Microenvironment Become Even More Important in Nuclear Medicine?**	702 Special Track Neuroimaging Committee **Debate: What is the Best Tracer for Molecular Brain Tumour Imaging?**	703 LIPS Interactive Session Cardiovascular Committee **Challenges in MBF Quantification with PET and SPECT**	704 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **Imaging Inflammatory Processes in Cardiovascular Diseases**	705 Cutting Edge Science Track Featured Session Physics Committee **Imaging Guided Surgery**	706 Clinical Oncology Track TROP Session Oncology & Theranostics Committee **Neuroendocrine Tumours – Diagnosis**	707 TROP Session Paediatrics Committee **Neuroblastoma & Non-PET Paediatric Studies**	708 Special Symposium 2 Inflammation & Infection Committee **Usefulness of PET in the Evaluation of Inflammatory Rheumatisms**	709 e-Poster Presentations Session 5 Physics Committee **SPECT/CT, PET/CT, PET/MR Quantitating Imaging**	710 Technologists' Track Oral Presentations 2 Technologists Committee **All about PET-CT!**	711 Theranostics Track TROP Session Oncology & Theranostics Committee **What's New in Prostate Cancer?**	08:00–08:30
08:30–09:00												08:30–09:00
09:00–09:30												09:00–09:30
09:30–10:00	801 CME 6 Dosimetry Committee **Understanding Radiobiology for Dosimetry-Guided Molecular Radiotherapy**	802 Special Track Translational Molecular Imaging & Therapy + Oncology & Theranostics + Radiopharmaceutical Sciences Committee **Round Table: Dialogue with the Treating Physician**	803 LIPS Interactive Session Neuroimaging + Cardiovascular + Inflammation & Infection Committee **Molecular Imaging to Solve the Problem of Long COVID**	804 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **TME and Therapy: Direct Targeting and Secondary Effects**	805 Cutting Edge Science Track TROP Session Physics Committee **Image Reconstruction and Data Corrections**	806 Clinical Oncology Track Featured Session Oncology & Theranostics Committee **FAP Imaging**	807 TROP Session Cardiovascular Committee **Clinical Perfusion Imaging with PET**	808 Featured Session Thyroid Committee **Iodine-131 Therapy and Beyond in differentiated Thyroid Cancer**	809 e-Poster Presentations Session 6 Oncology & Theranostics Committee **Prostate Cancer**	810 Technologists' Track CTE 4 Technologists Committee **Prostate Cancer Theranostics**	812 Special Symposium 3 EANM / EANMI **You, the EANM and the EJNMMI**	09:30–10:00
10:00–10:30												10:00–10:30
10:30–11:00												10:30–11:00
11:00–11:30												11:00–11:30
11:30–12:00	901 Plenary 3 **Radiotheranostics: What's New?**											11:30–12:00
12:00–12:30												12:00–12:30
12:30–13:00												12:30–13:00
13:00–13:30												13:00–13:30
13:30–14:00	Lunch Break			Satellite Symposium Spectrum Dynamics		Satellite Symposium GE HealthCare	Satellite Symposium Siemens Healthineers	Satellite Symposium Curium		Satellite Symposium Eckert & Ziegler	EANM Lunch Break Session **How to be Upbeat in a Downbeat World**	13:30–14:00
14:00–14:30												14:00–14:30
14:30–15:00												14:30–15:00
15:00–15:30	1001 CME 7 Thyroid + Dosimetry Committee **New NM Guidelines of Benign Thyroid Disease**	1002 Special Track **EANM Sanjiv Sam Gambhir Award – Compete and Win!**	1003 LIPS Interactive Session Inflammation & Infection Committee **Tips and Tricks in the Study of Prosthesis Infection**	1004 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **New Roads Towards FAP-Directed Theranostics**	1005 Cutting Edge Science Track TROP Session Dosimetry Committee **Clinical Dosimetry I ^{177}Lu / ^{225}Ac and ^{161}Tb RLT**	1006 Clinical Oncology Track Featured Session Oncology & Theranostics Committee **Melanoma**	1007 TROP Session Neuroimaging Committee **Imaging Neurotransmission in Movement Disorders**	1008 Joint Symposium 3 Translational Molecular Imaging & Therapy – Oncology & Theranostics + Physics Committee / EAI **Metastases Directed Prostate Cancer Surgery - Translational Challenges and Possibilities**	1009 e-Poster Presentations Session 7 Cardiovascular Committee **Cardiovascular Imaging e-Posters**	1010 Technologists' Track Technologists' e-Poster Presentations Session Technologists Committee **Techs' e-Posters**	1011 TROP Session Case Report Session 1 **Learning from Single Cases in Theranostics**	15:00–15:30
15:30–16:00												15:30–16:00
16:00–16:30												16:00–16:30
16:30–17:00	1101 CME 8 Oncology & Theranostics Committee **Assessing Response to Peptide Receptor Radionuclide Therapy in Patients with Neuroendocrine Tumours**		1102 LIPS Interactive Session Cardiovascular Committee **Stiff to Sweet - Infiltration and Inflammation**	1103 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **Efficient Radiolabelling: Key for Clinical Translation**	1104 Cutting Edge Science Track TROP Session Radiation Protection Committee **Current Issues of Radiation Protection**	1105 Clinical Oncology Track TROP Session Oncology & Theranostics Committee **Prostate Cancer Biochemical Recurrence**	1106 TROP Session Inflammation & Infection Committee **Vasculitis and Endocarditis: Current and New Evidence**	1107 TROP Session Thyroid Committee **Iodine-131 Therapy in Differentiated Thyroid Cancer: Present and Future Perspective**	1108 e-Poster Presentations Session 8 Neuroimaging Committee **E-Poster Neurology: It's in the Brain!**	1109 Technologists' Track CTE 5 Technologists Committee **Cardiac Inflammatory Disease**	1110 TROP Session Case Report Session 2 **Successful Molecular Targeting in Oncology**	16:30–17:00
17:00–17:30		1102 Special Track Physics Committee **Debate: AI in Nuclear Medicine: Fear or Embrace?**										17:00–17:30
17:30–18:00												17:30–18:00
18:00–18:30												18:00–18:30

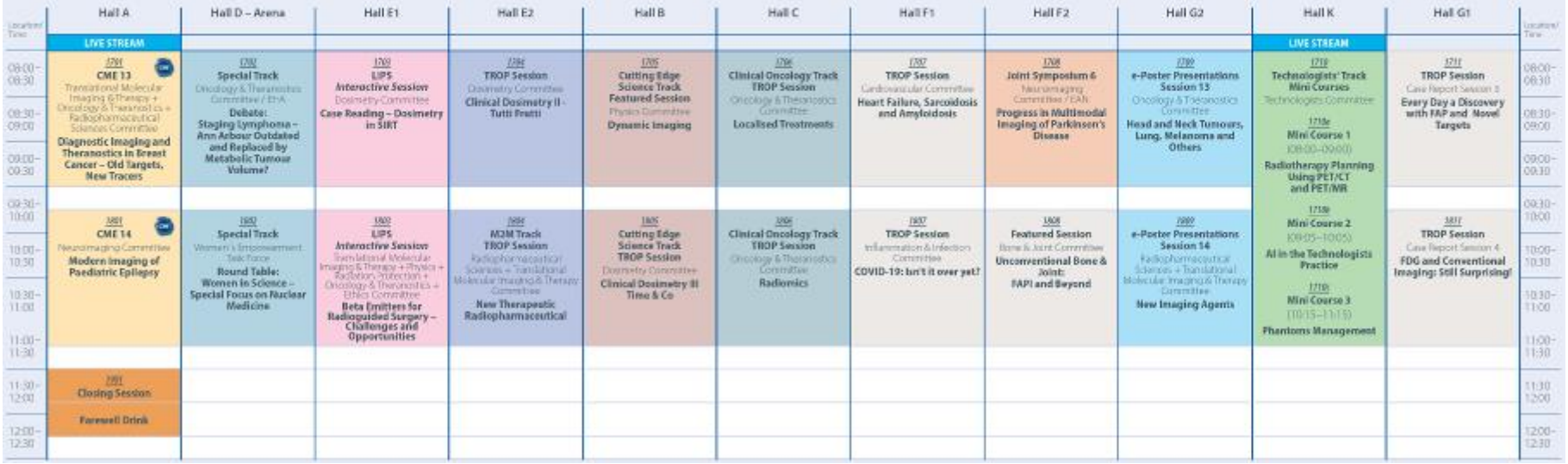
PROGRAMME OVERVIEW
TUESDAY, SEPTEMBER 12, 2023



Location/ Time	Hall A	Hall D – Arena	Hall E1	Hall E2	Hall B	Hall C	Hall F1	Hall F2	Hall G2	Hall K	Hall G1	Location/ Time
	LIVE STREAM									LIVE STREAM		
08:00–08:30	1201 CME 9 Bone & Joint + Physics Committee **Current Bone SPECT/CT (including 360 CZT)**	1202 Special Track Radiation Protection Committee **Round Table: Establishing and Running a Theranostics Centre in a Clinical Setting**	1203 LIPS *Interactive Session* Paediatrics Committee **Paediatric Nephro-Urology – Beyond Hydro-Nephrosis**	1204 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **Imaging the Brain from all Angles**	1205 Cutting Edge Science Track TROP Session Physics Committee **Total Body PET Methods**	1206 Clinical Oncology Track TROP Session Oncology & Theranostics Committee **Gynaecological Malignancies**	1207 Featured Session Neuroimaging Committee **Breadth of Tracers and Approaches in Neuro-Oncology**	1208 Joint Symposium 4 Dosimetry Committee / ESTRO **Dosimetry in Different Modalities - Where We Are and Where We Want To Be**	1209 e-Poster Presentations Session 9 Physics Committee **Artificial Intelligence and Radiomics**	1210 Technologists' Track CTE 6 Technologists Committee **Extravasation Incidents Management**	1211 Special Symposium 4 **Lung Scintigraphy for Pulmonary Embolism Diagnosis and long term Management**	08:00–08:30
08:30–09:00												08:30–09:00
09:00–09:30												09:00–09:30
09:30–10:00	1301 CME 10 Radiation Protection + Paediatrics Committee + Women's Empowerment Task Force **Radiation Protection in Motherhood and Childhood – What is so Special?**	1302 Special Track Physics + Oncology & Theranostics Committee **Debate: Whole Body Parametric Imaging**	1303 LIPS *Interactive Session* Neuroimaging Committee **The Sunrise of Alpha-Synuclein in Vivo Brain Imaging**	1304 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **Emerging Theranostic Concepts**	1305 Cutting Edge Science Track TROP Session Physics Committee **Quantitative SPECT/CT Imaging**	1306 Clinical Oncology Track TROP Session Oncology & Theranostics Committee **Lung**	1307 TROP Session Cardiovascular Committee **Plaque, Fibrosis and Cardio-Oncology**	1308 TROP Session Thyroid Committee **^{18}F-FDG and Novel Tracers in the Diagnostic Management of Patients with Thyroid Cancers**	1309 e-Poster Presentations Session 10 Oncology & Theranostics Committee **Haematological and Abdominal Malignancies / Localised Treatments**	1310 Technologists' Track Oral Presentations 3 Technologists Committee **NM Technologists: Competencies and Training**	1311 Theranostic's Track Oncology & Theranostics Committee **What's New in Neuroendocrine Tumours?**	09:30–10:00
10:00–10:30												10:00–10:30
10:30–11:00												10:30–11:00
11:00–11:30												11:00–11:30
11:30–12:00	1401 Plenary 4 **Diagnostic Imaging: Proven Beyond Doubt? Incl. Marie Curie Lecture**											11:30–12:00
12:00–12:30												12:00–12:30
12:30–13:00												12:30–13:00
13:00–13:30												13:00–13:30
13:30–14:00	Lunch Break			Satellite Symposium United Imaging				Satellite Symposium ABX GmbH		Satellite Symposium Novartis		13:30–14:00
14:00–14:30												14:00–14:30
14:30–15:00												14:30–15:00
15:00–15:30	1501 CME 11 Paediatrics Committee **Paediatric Lymphoma and Update on FDG**	1502 Special Track Neuroimaging Committee **Challenge the Expert: Amyloid vs Tau PET - Which is First in Suspected Alzheimer Patients? Germany versus Italy**	1503 LIPS *Interactive Session* Bone & Joint Committee **Pitfalls and Common Bony Findings in PET-CT/MRI Using Novel Tracers**	1504 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **Imaging the Components of the TME**	1505 Cutting Edge Science Track TROP Session Physics Committee **AI Methods and Applications**	1506 Clinical Oncology Track TROP Session Oncology & Theranostics Committee **Prostate Cancer Treatment**	1507 TROP Session Cardiovascular Committee **Perfusion**	1508 Joint Symposium 5 Oncology & Theranostics Committee / ESMO **Prostate Cancer Theranostics: Where Do We Go?**	1509 e-Poster Presentations Session 11 Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **Novel Therapeutic Approaches**	1510 Technologists' Track CTE 7 Technologists & Thyroid Committee **Molecular Thyroid Imaging - Qualitative and Quantitative Approaches**	1511 EU Policy Symposium 1 Policy & Regulatory Affairs Committee **Supply & Shortages of Radiopharmaceuticals**	15:00–15:30
15:30–16:00												15:30–16:00
16:00–16:30												16:00–16:30
16:30–17:00	1601 CME 12 Physics + Oncology & Theranostics + Translational Molecular Imaging & Therapy + Technologists Committee **Long Axial Field-of-View PET Scanners – A Copernical Revolution**	1602 Special Track Bone & Joint + Cardiovascular Committee **Debate: NaF PET in Cardiology and MSK: Pro or Cons?**	1603 LIPS *Interactive Session* Neuroimaging + Inflammation & Infection Committee **The Role of FDG PET in the Diagnosis of Auto-Immune Encephalitis**	1604 M2M Track TROP Session Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **Understanding and Improving RLT**	1605 Cutting Edge Science Track TROP Session Physics Committee **Data Analysis**	1606 Clinical Oncology Track TROP Session Oncology & Theranostics Committee **Head and Neck Imaging**	1607 TROP Session Neuroimaging Committee **New PET Tracers for Brain Imaging**	1608 TROP Session Thyroid Committee **Nuclear Medicine Imaging in Thyroid and Parathyroid Disorders**	1609 e-Poster Presentations Session 12 Dosimetry Committee **Dosimetry Simphony**	1610 Technologists' Track CTE 8 Technologists Committee **Gynaecological Studies**	1611 EU Policy Symposium 2 Policy & Regulatory Affairs Committee **Regulatory Challenges of Radiopharmaceuticals**	16:30–17:00
17:00–17:30												17:00–17:30
17:30–18:00												17:30–18:00
18:00–18:30												18:00–18:30

PROGRAMME OVERVIEW

WEDNESDAY, SEPTEMBER 13, 2023



Location/ Time	Hall A	Hall D – Arena	Hall E1	Hall E2	Hall B	Hall C	Hall F1	Hall F2	Hall G2	Hall K	Hall G1	Location/ Time
	LIVE STREAM									LIVE STREAM		
08:00–08:30	1701 CME 13 Translational Molecular Imaging & Therapy + Oncology & Theranostics + Radiopharmaceutical Sciences Committee **Diagnostic Imaging and Theranostics in Breast Cancer – Old Targets, New Tracers**	1702 **Special Track** Oncology & Theranostics Committee / EANM **Debate: Staging Lymphoma – Ann Arbour Outdated and Replaced by Metabolic Tumour Volume?**	1703 **LIPS** ***Interactive Session*** Dosimetry Committee **Case Reading – Dosimetry in SIRT**	1704 **TROP Session** Dosimetry Committee **Clinical Dosimetry II - Tutti Frutti**	1705 **Cutting Edge Science Track** **Featured Session** Physics Committee **Dynamic Imaging**	1706 **Clinical Oncology Track** **TROP Session** Oncology & Theranostics Committee **Localised Treatments**	1707 **TROP Session** Cardiovascular Committee **Heart Failure, Sarcoidosis and Amyloidosis**	1708 **Joint Symposium 6** Neuroimaging Committee / EANM **Progress in Multimodal Imaging of Parkinson's Disease**	1709 **e-Poster Presentations Session 13** Oncology & Theranostics Committee **Head and Neck Tumours, Lung, Melanoma and Others**	1710 **Technologists' Track** **Mini Courses** Technologists Committee 1710a **Mini Course 1** (08:00–09:00) **Radiotherapy Planning Using PET/CT and PET/MR**	1711 **TROP Session** Case Report Session 3 **Every Day a Discovery with FAP and Novel Targets**	08:00–08:30
08:30–09:00												08:30–09:00
09:00–09:30												09:00–09:30
09:30–10:00										1710b **Mini Course 2** (09:05–10:05) **AI in the Technologists Practice**		09:30–10:00
10:00–10:30	1801 CME 14 Neuroimaging Committee **Modern Imaging of Paediatric Epilepsy**	1802 **Special Track** Women's Empowerment Task Force **Round Table: Women in Science – Special Focus on Nuclear Medicine**	1803 **LIPS** ***Interactive Session*** Translational Molecular Imaging & Therapy + Physics + Radiation Protection + Oncology & Theranostics + Ethics Committee **Beta Emitters for Radioguided Surgery – Challenges and Opportunities**	1804 **M2M Track** **TROP Session** Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **New Therapeutic Radiopharmaceutical**	1805 **Cutting Edge Science Track** **TROP Session** Dosimetry Committee **Clinical Dosimetry III Time & Co**	1806 **Clinical Oncology Track** **TROP Session** Oncology & Theranostics Committee **Radiomics**	1807 **TROP Session** Inflammation & Infection Committee **COVID-19: Isn't it over yet?**	1808 **Featured Session** Bone & Joint Committee **Unconventional Bone & Joint: FAPI and Beyond**	1809 **e-Poster Presentations Session 14** Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee **New Imaging Agents**	1710c **Mini Course 3** (10:15–11:15) **Phantoms Management**	1811 **TROP Session** Case Report Session 4 **FDG and Conventional Imaging: Still Surprising!**	10:00–10:30
10:30–11:00												10:30–11:00
11:00–11:30												11:00–11:30
11:30–12:00	1901 **Closing Session** **Farewell Drink**											11:30–12:00
12:00–12:30												12:00–12:30

SCIENTIFIC PROGRAMME

INVITED SPEAKER SESSIONS

PLENARY SESSIONS

1
Saturday, September 9, 2023 | 18:35–19:35 | Hall A
Highlights Lecture
Presenters: Silvia Morbelli (Italy), Sophie Veldhuijzen van Zanten (Netherlands), Hein Verberne (Netherlands), David Kersting (Germany)

2
Sunday, September 10, 2023 | 11:30–13:00 | Hall A
New Imaging Techniques – Jump Aboard or Watch and Wait
Chairpersons: Laetitia Imbert (Nancy, France), Dimitris Visvikis (Brest, France)

- Francesca M. Buffa (Milan, Italy): **AI Technology: Living up to Expectations?**
- Laetitia Imbert (Nancy, France): **SPECT/CT CZT based Systems: Jump Aboard**
- John Dickson (London, UK): **SPECT/CT CZT based Systems: Watch and Wait?**
- Antonia Dimitrakopoulou-Strauss (Heidelberg, Germany): **Total Body PET: Opportunities and Challenges**
- Axel Rominger (Bern, Switzerland): **Total Body PET: Jump Aboard**
- Simon Wan (London, UK): **PET/MR: Is it still worth it?**
- May Abdel-Wahab (Vienna, AU): **Innovation and Sustainability in Nuclear Medicine: the IAEA Perspective**

3
Monday, September 11, 2023 | 11:30–13:00 | Hall A
Radiotheranostics: What´s New?
Chairpersons: Cristina Nanni (Bologna, Italy), Ken Herrmann (Essen, Germany)

- Jonathan Strosberg (Tampa, USA): **PRRT in Neuroendocrine Tumours as a Paradigm for Progress in Radiopharmaceuticals: Where are we and where will we be?**
- Michael Hofman (Melbourne, AUS): **2023: PSMA state of the art**
- Sandra Heskamp (Nijmegen, The Netherlands): **PSMA 2.0**
- Andreas Buck (Würzburg, Germany): CXCR4: **Ready for Prime Time!**
- Katharina Lückerath (Essen, Germany): **Targeting the tumour microenvironment: next breakthrough?!**
- Lena Unterrainer (Munich, Germany / Los Angeles, USA): **Dark Horses of Theranostics**

4
Tuesday, September 12, 2023 | 11:30–13:00 | Hall A
Diagnostic Imaging: Proven Beyond Doubt? (incl. Marie Curie Lecture)
Chairpersons: Valentina Garibotto (Geneva, Switzerland), Pedro Fragoso Costa (Essen, Germany)

- Josée Zijlstra (Amsterdam, The Netherlands): **FDG PET imaging and lymphomas: a proven certainty?**
- Sofia Carrilho Vaz (Lisbon, Portugal): **PET imaging in every oncological guideline: what is still missing?**
- Alexander Drzezga (Cologne, Germany): **Marie Curie Lecture: Impact without a cure: prospective evidence for diagnostic neuroimaging**
- Danilo Neglia (Pisa, Italy): **Cardiac imaging: prospective studies and the EURECA registry**
- Mathieu Gaulthé (Grenoble, France): **Cost effectiveness molecular imaging studies**
- Jens Kleesiek (Essen, Germany): **Real world data: an answer to all questions?**

CONTINUING MEDICAL EDUCATION (CME) SESSIONS

1
Sunday, September 10, 2023 | 08:00–09:30 | Hall A
Inflammation & Infection Committee
Infection and Inflammation - New Guidelines

2
Sunday, September 10, 2023 | 09:45–11:15 | Hall A
Translational Molecular Imaging & Therapy + Oncology and Theranostics + Radiopharmaceutical Sciences Committee
FAP - Moving Towards Therapy

3
Sunday, September 10, 2023 | 15:00–16:30 | Hall A
Cardiovascular Committee
Nuclear Imaging in Cardiac Amyloidosis - What Else?

4
Sunday, September 10, 2023 | 16:45–18:15 | Hall A
Oncology and Theranostics Committee
Update in Multiple Myeloma

5
Monday, September 11, 2023 | 08:00–09:30 | Hall A
Oncology & Theranostics Committee
Will the Microenvironment Become Even More Important in Nuclear Medicine?

6
Monday, September 11, 2023 | 09:45–11:15 | Hall A
Dosimetry Committee
Understanding Radiobiology for Dosimetry-Guided Molecular Radiotherapy

7
Monday, September 11, 2023 | 15:00–16:30 | Hall A
Thyroid + Dosimetry Committee
New NM Guidelines of Benign Thyroid Disease

CONTINUING MEDICAL EDUCATION (CME) SESSIONS

8
Monday, September 11, 2023 | 16:45–18:15 | Hall A
Oncology & Theranostics Committee
Assessing Response to Peptide Receptor Radionuclide Therapy in Patients with Neuroendocrine Tumours

9
Tuesday, September 12, 2023 | 08:00–09:30 | Hall A
Bone and Joint + Physics Committee
Current Bone SPECT/CT (including 360 CZT)

10
Tuesday, September 12, 2023 | 09:45–11:15 | Hall A
Radiation Protection + Paediatrics Committee and Women's Empowerment Task Force
Radiation Protection in Motherhood and Childhood - What is so Special?

11
Tuesday, September 12, 2023 | 15:00–16:30 | Hall A
Paediatrics Committee
Pediatric Lymphoma and Update on FDG

12
Tuesday, September 12, 2023 | 16:45–18:15 | Hall A
Translational Molecular Imaging & Therapy + Oncology & Theranostics + Physics + Technologists Committee
Long Axial Field-of-View PET Scanners - A Copernical Revolution

13
Wednesday, September 13, 2023 | 08:00–09:30 | Hall A
Translational Molecular Imaging & Therapy + Oncology & Theranostics + Radiopharmaceutical Sciences Committee
Diagnostic Imaging and Theranostics in Breast Cancer - Old Targets, New Tracers

14
Wednesday, September 13, 2023 | 09:30–11:15 | Hall A
Neuroimaging + Paediatrics Committee
Modern Imaging of Paediatric Epilepsy

TECHNOLOGISTS' TRACK

The Technologists Committee places a massive effort into delivering the most up-to-date and highest-quality educational initiatives. All sessions of this track are aimed specifically at the technologist audience.

PLENARY SESSIONS

1 Saturday, September 9, 2023 | 18:35–19:35 | Hall A
Highlights Lecture

2 Sunday, September 10, 2023 | 11:30–13:00 | Hall A
New Imaging Techniques – Jump Aboard or Watch and Wait

3 Monday, September 11, 2023 | 11:30–13:00 | Hall A
Radiotheranostics: What´s New?

4 Tuesday, September 12, 2023 | 11:30–13:00 | Hall A
Diagnostic Imaging: Proven Beyond Doubt?
(incl. Marie Curie Lecture)

CTE SESSIONS

1 Sunday, September 10, 2023 | 08:00–09:30 | Hall K
Technologists Committee / SNMMI
Technologists' Guide Launch –
Gastro Intestinal Molecular Imaging Studies

2 Sunday, September 10, 2023 | 09:45–11:15 | Hall K
Technologists Committee
Head and Neck Molecular Imaging – Updates and Perspectives

3 Sunday, September 10, 2023 | 16:45–18:15 | Hall K
Technologists Committee
Patient Care in Nuclear Medicine

4 Monday, September 11, 2023 | 09:45–11:15 | Hall K
Technologists Committee
Prostate Cancer Theranostics

5 Monday, September 11, 2023 | 16:45–18:15 | Hall K
Technologists & Thyroid Committee
Cardiac Inflammatory Disease

SPECIAL TRACK

1 Sunday, September 10, 2023 | 08:00–09:30 | Hall D (Arena)
Cardiovascular Committee
Debate: Myocardial Perfusion Imaging after ISCHEMIA Trial

2 Sunday, September 10, 2023 | 09:45–11:15 | Hall D (Arena)
Thyroid Committee
Challenge the Expert: Integrated Diagnostics of Thyroid Disease

3 Sunday, September 10, 2023 | 15:00–16:30 | Hall D (Arena)
Oncology & Theranostics Committee
Challenge the Expert: Risk in Diagnostic and Therapeutic Nuclear Medicine

4 Sunday, September 10, 2023 | 16:45–18:15 | Hall D (Arena)
Dosimetry Committee
Challenge the Expert: Dosimetry Live

5 Monday, September 11, 2023 | 08:00–09:30 | Hall D (Arena)
Neuroimaging Committee
Debate: What is the Best Tracer for Molecular Brain Tumour Imaging?

6 Monday, September 11, 2023 | 09:45–11:15 | Hall D (Arena)
Translational Molecular Imaging & Therapy + Radiopharmaceutical Sciences + Oncology & Theranostics Committee
Round Table: Dialogue with the Treating Physician

7 Monday, September 11, 2023 | 15:00–16:30 | Hall D (Arena)
EANM Sanjiv Sam Gambhir Award – Compete and Win!

8 Monday, September 11, 2023 | 17:15–18:15 | Hall D (Arena)
Physics Committee
Debate: AI in Nuclear Medicine: Fear or Embrace?

9 Tuesday, September 12, 2023 | 08:00–09:30 | Hall D (Arena)
Radiation Protection Committee
Round Table: Establishing and Running a Theranostics Centre in a Clinical Setting

10 Tuesday, September 12, 2023 | 09:45–11:15 | Hall D (Arena)
Physics + Oncology & Theranostics Committee
Debate: Whole Body Parametric Imaging

11 Tuesday, September 12, 2023 | 15:00–16:30 | Hall D (Arena)
Neuroimaging Committee
Challenge the Expert: Amyloid or Tau PET – What First in Alzheimer Dementia Patients? Germany versus Italy

12 Tuesday, September 12, 2023 | 16:45–18:15 | Hall D (Arena)
Bone & Joint + Cardiovascular Committee
Debate: NaF PET in Cardiology and MSK: Pro or Cons?

13 Wednesday, September 13, 2023 | 08:00–09:30 | Hall D (Arena)
Oncology & Theranostics Committee
Debate: Staging Lymphoma – Ann Arbour Outdated and Replaced by Metabolic Tumour Volume?

14 Wednesday, September 13, 2023 | 09:45–11:15 | Hall D (Arena)
EANM Women's Empowerement Initiative
Round Table: Women in Science – Special Focus on Nuclear Medicine

6 Tuesday, September 12, 2023 | 08:00–09:30 | Hall K
Technologists Committee
Extravasation Incidents Management

7 Tuesday, September 12, 2023 | 15:00–16:30 | Hall K
Technologists Committee
Molecular Thyroid Imaging - Qualitative and Quantitative Approaches

8 Tuesday, September 12, 2023 | 16:45–18:15 | Hall K
Technologists & Thyroid Committee
Gynaecological Studies

IN ADDITION TO THE CTE SESSIONS THE TECHNOLOGISTS' TRACK INCLUDES 3 MINI COURSES:

1 Wednesday, September 13, 2023 | 08:00–09:00 | Hall K
Technologists Committee
Radiotherapy Planning Using PET/CT and PET/MR

2 Wednesday, September 13, 2023 | 09:05–10:05 | Hall K
Technologists Committee
AI in the Technologists Practice

3 Wednesday, September 13, 2023 | 10:15–11:15 | Hall K
Technologists Committee
Phantoms Management

TECHNOLOGISTS' ORAL PRESENTATIONS

1 Sunday, September 10, 2023 | 15:00–16:30 | Hall K
Technologists Committee
SPECT-CT in Diagnosis and Therapy

2 Monday, September 11, 2023 | 08:00–09:30 | Hall K
Technologists Committee
All about PET-CT!

3 Tuesday, September 12, 2023 | 09:45–11:15 | Hall K
Technologists Committee
NM Technologists: Competencies and Training

TECHNOLOGISTS' e-POSTER PRESENTATIONS

1 Monday, September 11, 2023 | 15:00–16:30 | Hall K
Technologists Committee
Technologists' e-Poster Presentations Session

JOINT SYMPOSIA

1 Sunday, September 10, 2023 | 09:45–11:15 | Hall F2
Cardiovascular + Inflammation & Infection Committee + EACVI
PET in Valvular Diseases – All In!

2 Sunday, September 10, 2023 | 15:00–16:30 | Hall F2
Oncology & Theranostics Committee / EORTC
Nuclear Medicine Imaging of the Immune System

3 Monday, September 11, 2023 | 15:00–16:30 | Hall F2
Translational Molecular Imaging & Therapy + Oncology & Theranostics + Physics Committee / EAU
Metastases Directed Prostate Cancer Surgery – Translational Challenges and Possibilities

4 Tuesday, September 12, 2023 | 08:00–09:30 | Hall F2
Dosimetry Committee + ESTRO
Dosimetry in Different Modalities – Where We Are and Where We Want to Be

5 Tuesday, September 12, 2023 | 15:00–16:30 | Hall F2
Oncology & Theranostics Committee + ESMO
Prostate Cancer Theranostics: Were Do We Go?

6 Wednesday, September 13, 2023 | 08:00–09:30 | Hall F2
Neuroimaging Committee + EAN
Progress in Multimodal Imaging of Parkinson's Disease

SPECIAL SYMPOSIA

1 Sunday, September 10, 2023 | 16:45–18:15 | Hall G1
EANM/EARL
Harmonisation and Accreditation Accelerate Research and Clinical Translation

2 Monday, September 11, 2023 | 08:00–09:30 | Hall F2
Inflammation & Infection Committee
Usefullness of PET in the Evaluation of Inflammatory Rheumatisms

3 Tuesday, September 12, 2023 | 09:45–11:15 | Hall G1
EANM / EJNMMI
You, the EANM and the EJNMMI

4 Tuesday, September 12, 2023 | 08:00–09:30 | Hall G1
Lung Scintigraphy for Pulmonary Embolism Diagnosis and Long-Term Management

EU POLICY SYMPOSIA

1 Tuesday, September 12, 2023 | 15:00–16:30 | Hall G1
Policy & Regulatory Affairs Committee
Supply & Shortages of Radiopharmaceuticals

2 Tuesday, September 12, 2023 | 16:45–18:15 | Hall G1
Policy & Regulatory Affairs Committee
Regulatory Challenges of Radiopharmaceuticals

LEARN & IMPROVE PROFESSIONAL SKILLS (LIPS) TRACK

1 Sunday, September 10, 2023 | 08:00–09:30 | Hall E1
Oncology & Theranostics Committee
Novelties in Radionuclide Therapy

2 Sunday, September 10, 2023 | 09:45–11:15 | Hall E1
Radiation Protection + Physics Committee / EFOMP
Careers in Radiation Protection

3 Sunday, September 10, 2023 | 15:00–16:30 | Hall E1
Thyroid Committee
Rational Use of PET/CT with 18F-FDG in DTC

4 Sunday, September 10, 2023 | 16:45–18:15 | Hall E1
Oncology & Theranostics Committee
Residents for Residents

5 Monday, September 11, 2023 | 08:00–09:30 | Hall E1
Cardiovascular Committee
Challenges in MBF Quantification with PET and SPECT

6 Monday, September 11, 2023 | 09:45–11:15 | Hall E1
Neuroimaging + Cardiovascular + Inflammation & Infection Committee
Molecular Imaging to Solve the Problem of Long COVID

7 Monday, September 11, 2023 | 15:00–16:30 | Hall E1
Inflammation & Infection Committee
Tips and Tricks in the Study of Prosthesis Infection

8 Monday, September 11, 2023 | 16:45–18:15 | Hall E1
Cardiovascular Committee
Stiff to Sweet – Infiltration and Inflammation

9 Tuesday, September 12, 2023 | 08:00–09:30 | Hall E1
Paediatrics Committee
Paediatric Nephro-Urology – Beyond Hydro-Nephrosis

10 Tuesday, September 12, 2023 | 09:45–11:15 | Hall E1
NeuroimagingCommittee
The Sunrise of Alpha-Synuclein in Vivo Brain Imaging

11 Tuesday, September 12, 2023 | 15:00–16:30 | Hall E1
Bone & Joint Committee
Pitfalls and Common Bony Findings in PET-CT/MRI using Novel Tracers

12 Tuesday, September 12, 2023 | 16:45–18:15 | Hall E1
Neuroimaging + Inflammation & Infection Committee
The Role of FDG PET in the Diagnosis of Auto-Immune Encephalitis

13 Wednesday, September 13, 2023 | 08:00–09:30 | Hall E1
Case Reading - Dosimetry in SIRT

14 Wednesday, September 13, 2023 | 09:45–11:15 | Hall E1
Beta Emitters for Radioguided Surgery - Challenges and Opportunities

CUTTING EDGE SCIENCE TRACK – TROP & FEATURED SESSIONS

205 Sunday, September 10, 2023 | 08:00 – 09:30 | Hall B
Physics Committee – TROP Session
Quality Control, Performance, Standardisation

305 Sunday, September 10, 2023 | 09:45 – 11:15 | Hall B
Physics Committee – FEATURED Session
Radiomics

505 Sunday, September 10, 2023 | 15:00 – 16:30 | Hall B
Dosimetry Committee – TROP Session
From Cells to Human via the Fish

605 Sunday, September 10, 2023 | 16:45 – 18:15 | Hall B
Physics Committee – TROP Session
Segmentation and Denoising

705 Monday, September 11, 2023 | 08:00 – 09:30 | Hall B
Physics Committee – FEATURED Session
Imaging Guided Surgery

805 Monday, September 11, 2023 | 09:45 – 11:15 | Hall B
Physics Committee – TROP Session
Image Reconstruction and Data Corrections

1005 Monday, September 11, 2023 | 15:00 – 16:30 | Hall B
Dosimetry Committee – TROP Session
^{177}Lu / ^{225}Ac and ^{161}Tb RLT

1105 Monday, September 11, 2023 | 16:45 – 18:15 | Hall B
Radiation Protection Committee – TROP Session
Current Issues of Radiation Protection

1205 Tuesday, September 12, 2023 | 08:00 – 09:30 | Hall B
Physics Committee – TROP Session
Total Body PET Methods

1305 Tuesday, September 12, 2023 | 09:45 – 11:15 | Hall B
Physics Committee – TROP Session
Quantitative SPECT/CT Imaging

1505 Tuesday, September 12, 2023 | 15:00 – 16:30 | Hall B
Physics Committee – TROP Session
AI Methods and Applications

1605 Tuesday, September 12, 2023 | 16:45 – 18:15 | Hall B
Physics Committee – TROP Session
Data Analysis

1705 Wednesday, September 13, 2023 | 08:00 – 09:30 | Hall B
Physics Committee – FEATURED Session
Dynamic Imaging

1805 Wednesday, September 13, 2023 | 09:45 – 11:15 | Hall B
Dosimetry Committee – TROP Session
Clinical Dosimetry III-Time & Co

CLINICAL ONCOLOGY TRACK – TROP & FEATURED SESSIONS:

206 Sunday, September 10, 2023 | 08:00 – 09:30 | Hall C
Oncology & Theranostics Committee – TROP Session
Prostate Cancer Staging

306 Sunday, September 10, 2023 | 09:45 – 11:15 | Hall C
Oncology & Theranostics Committee – FEATURED Session
Haematological Disease

506 Sunday, September 10, 2023 | 15:00 – 16:30 | Hall C
Oncology & Theranostics Committee – TROP Session
Gastrointestinal Malignancies

606 Sunday, September 10, 2023 | 16:45 – 18:15 | Hall C
Oncology & Theranostics Committee – TROP Session
Neuroendocrine Tumours Treatment

706 Monday, September 11, 2023 | 08:00 – 09:30 | Hall C
Oncology & Theranostics Committee – TROP Session
Neuroendocrine Tumours – Diagnosis

806 Monday, September 11, 2023 | 09:45 – 11:15 | Hall C
Oncology & Theranostics Committee – FEATURED Session
FAP Imaging

1006 Monday, September 11, 2023 | 15:00 – 16:30 | Hall C
Oncology & Theranostics Committee – FEATURED Session
Melanoma

1106 Monday, September 11, 2023 | 16:45 – 18:15 | Hall C
Oncology & Theranostics Committee – TROP Session
Prostate Cancer Biochemical Recurrence

1206 Tuesday, September 12, 2023 | 08:00 – 09:30 | Hall C
Oncology & Theranostics Committee – TROP Session
Gynaecological Malignancies

1306 Tuesday, September 12, 2023 | 09:45 – 11:15 | Hall C
Oncology & Theranostics Committee – TROP Session
Lung

1506 Tuesday, September 12, 2023 | 15:00 – 16:30 | Hall C
Oncology & Theranostics Committee – TROP Session
Prostate Cancer Treatment

1606 Tuesday, September 12, 2023 | 16:45 – 18:15 | Hall C
Oncology & Theranostics Committee – TROP Session
Head and Neck Imaging

1706 Wednesday, September 13, 2023 | 08:00 – 09:30 | Hall C
Oncology & Theranostics Committee – TROP Session
Localised Treatments

1806 Wednesday, September 13, 2023 | 09:45 – 11:15 | Hall C
Oncology & Theranostics Committee – TROP Session
Radiomics

M2M TRACK – TROP & FEATURED SESSIONS

204 Sunday, September 10, 2023 | 08:00 – 09:30 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
At the Nucleus: Radionuclide Production

304 Sunday, September 10, 2023 | 09:45 – 11:15 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
Validating Methodology: In Vitro and in Vivo Models

504 Sunday, September 10, 2023 | 15:00 – 16:30 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
Radioligand Therapy – New and Old Targets

604 Sunday, September 10, 2023 | 16:45 – 18:15 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
Novel Imaging Targets in Oncology

704 Monday, September 11, 2023 | 08:00 – 09:30 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
Imaging Inflammatory Processes in Cardiovascular Disease

804 Monday, September 11, 2023 | 09:45 – 11:15 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
TME and Therapy: Direct Targeting and Secondary Effects

1004 Monday, September 11, 2023 | 15:00 – 16:30 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
New Roads Towards FAP-Directed Theranostics

1104 Monday, September 11, 2023 | 16:45 – 18:15 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee Committee – TROP Session
Efficient Radiolabelling: Key for Clinical Translation

1204 Tuesday, September 12, 2023 | 08:00 – 09:30 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
Imaging the Brain from all Angles

1304 Tuesday, September 12, 2023 | 09:45 – 11:15 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
Emerging Theranostic Concepts

1504 Tuesday, September 12, 2023 | 15:00 – 16:30 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
Imaging the Components of the TME

1604 Tuesday, September 12, 2023 | 16:45 – 18:15 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
Understanding and Improving RLT

1704 Wednesday, September 13, 2023 | 08:00 – 09:30 | Hall E2
Dosimetry Committee – TROP Session
Clinical Dosimetry II – Tutti Frutti

1804 Wednesday, September 13, 2023 | 09:45 – 11:15 | Hall E2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee – TROP Session
New Therapeutic Radiopharmaceuticals

FURTHER ORAL PRESENTATIONS – TROP & FEATURED SESSIONS

207 Sunday, September 10, 2023 | 08:00 – 09:30 | Hall F1
Neuroimaging Committee – FEATURED Session
Methods in NeuroImaging: Spotlight on Brain Connectivity

208 Sunday, September 10, 2023 | 08:00 – 09:30 | Hall F2
Paediatrics Committee – TROP Session
Paediatric PET/CT & PET/MR

307 Sunday, September 10, 2023 | 09:45 – 11:15 | Hall F1
Neuroimaging Committee – TROP Session
Amyloid, Tau and More in Neurodegenerative Disorders

507 Sunday, September 10, 2023 | 15:00 – 16:30 | Hall F1
Paediatrics Committee – TROP Session
Adults General Nuclear Medicine

607 Sunday, September 10, 2023 | 16:45 – 18:15 | Hall F1
Cardiovascular Committee- TROP Session
Functional Imaging, Plaque and Total-Body PET

608 Sunday, September 10, 2023 | 16:45 – 18:15 | Hall F2
Inflammation & Infection Committee – TROP Session
Infection and Inflammation Imaging: New Frontiers

707 Monday, September 11, 2023 | 08:00 – 09:30 | Hall F1
Paediatrics Committee – TROP Session
Neuroblastoma & Non-PET Paediatric Studies

807 Monday, September 11, 2023 | 09:45 – 11:15 | Hall F1
Cardiovascular Committee – TROP Session
Clinical Perfusion Imaging with PET

808 Monday, September 11, 2023 | 09:45 – 11:15 | Hall F2
Thyroid Committee – FEATURED Session
Iodine-131 Therapy and Beyond in Differentiated Thyroid Cancer

1007 Monday, September 11, 2023 | 15:00 – 16:30 | Hall F1
Neuroimaging Committee – TROP Session
Imaging Neurotransmission in Movement Disorders

1107 Monday, September 11, 2023 | 16:45 – 18:15 | Hall F1
Inflammation & Infection Committee – TROP Session
Vasculitis and Endocarditis: Current and New Evidence

E-POSTER PRESENTATIONS

209 Sunday, September 10, 2023 | 08:00 – 09:30 | Hall G2
Oncology & Theranostics Committee
Neuroendocrine Tumours and Gynaecological Malignancies

309 Sunday, September 10, 2023 | 09:45 – 11:15 | Hall G2
Paediatrics Committee
Paediatric Nuclear Medicine & Adults General Nuclear Medicine

509 Sunday, September 10, 2023 | 15:00 – 16:30 | Hall G2
Inflammation & Infection Committee
More on Infection and Inflammation Imaging

609 Sunday, September 10, 2023 | 16:45 – 18:15 | Hall G2
Thyroid Committee
Thyroid and Parathyroid Disease

709 Monday, September 11, 2023 | 08:00 – 09:30 | Hall G2
Physics Committee
SPECT/CT, PET/CT, PET/MR Quantitating Imaging

809 Monday, September 11, 2023 | 09:45 – 11:15 | Hall G2
Oncology & Theranostics Committee
Prostate Cancer

1009 Monday, September 11, 2023 | 15:00 – 16:30 | Hall G2
Cardiovascular Committee
Cardiovascular Imaging e-Posters

1109 Monday, September 11, 2023 | 16:45 – 18:15 | Hall G2
Neuroimaging Committee
E-Poster Neurology: It's in the Brain!

1209 Tuesday, September 12, 2023 | 08:00 – 09:30 | Hall G2
Physics Committee
Artificial Intelligence and Radiomics

1309 Tuesday, September 12, 2023 | 09:45 – 11:15 | Hall G2
Oncology & Theranostics Committee
Haematological and Abdominal Malignancies / localised Treatments

1509 Tuesday, September 12, 2023 | 15:00 – 16:30 | Hall G2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee
Novel Therapeutic Approaches

1609 Tuesday, September 12, 2023 | 16:45 – 18:15 | Hall G2
Dosimetry Committee
Dosimetry Symphony

1709 Wednesday, September 13, 2023 | 08:00 – 09:30 | Hall G2
Oncology & Theranostics Committee
Head and Neck Tumours, Lung, Melanoma and Others

1809 Wednesday, September 13, 2023 | 09:45 – 11:15 | Hall G2
Radiopharmaceutical Sciences + Translational Molecular Imaging & Therapy Committee
New Imaging Agents

FURTHER ORAL PRESENTATIONS – TROP & FEATURED SESSIONS

1108 Monday, September 11, 2023 | 16:45 – 18:15 | Hall F2
Thyroid Committee – TROP Session
Iodine-131 Therapy in Differentiated Thyroid Cancer: Present and Future Perspective

1207 Tuesday, September 12, 2023 | 08:00 – 09:30 | Hall F1
Neuroimaging Committee – FEATURED Session
Breadth of Tracers and Approaches in Neuro-Oncology

1307 Tuesday, September 12, 2023 | 09:45 – 11:15 | Hall F1
Cardiovascular Committee – TROP Session
Plaque, Fibrosis and Cardio-Oncology

1308 Tuesday, September 12, 2023 | 09:45 – 11:15 | Hall F2
Thyroid Committee – TROP Session
^{18}F-FDG and Novel Tracers in the Diagnostic Management of Patients with Thyroid Cancers

1507 Tuesday, September 12, 2023 | 15:00 – 16:30 | Hall F1
Cardiovascular Committee – TROP Session
Perfusion

1607 Tuesday, September 12, 2023 | 16:45 – 18:15 | Hall F1
Neuroimaging Committee – TROP Session
New PET Tracers for Brain Imaging

1608 Tuesday, September 12, 2023 | 16:45 – 18:15 | Hall F2
Thyroid Committee – TROP Session
Nuclear Medicine Imaging in Thyroid and Parathyroid Disorders

1707 Wednesday, September 12, 2023 | 08:00 – 09:30 | Hall F1
Cardiovascular Committee – TROP Session
Heart Failure, Sarcoidosis and Amyloidosis

1807 Wednesday, September 12, 2023 | 09:45 – 11:15 | Hall F1
Inflammation & Infection Committee – TROP Session
COVID-19: Isn't it over yet?

1808 Wednesday, September 12, 2023 | 09:45 – 11:15 | Hall F2
Bone & Joint Committee – FEATURED Session
COVID-19: Isn't it over yet?

CASE REPORT SESSIONS

1 Monday, September 11, 2023 | 15:00–16:30 | Hall G1
Learning from Single Cases in Theranostics

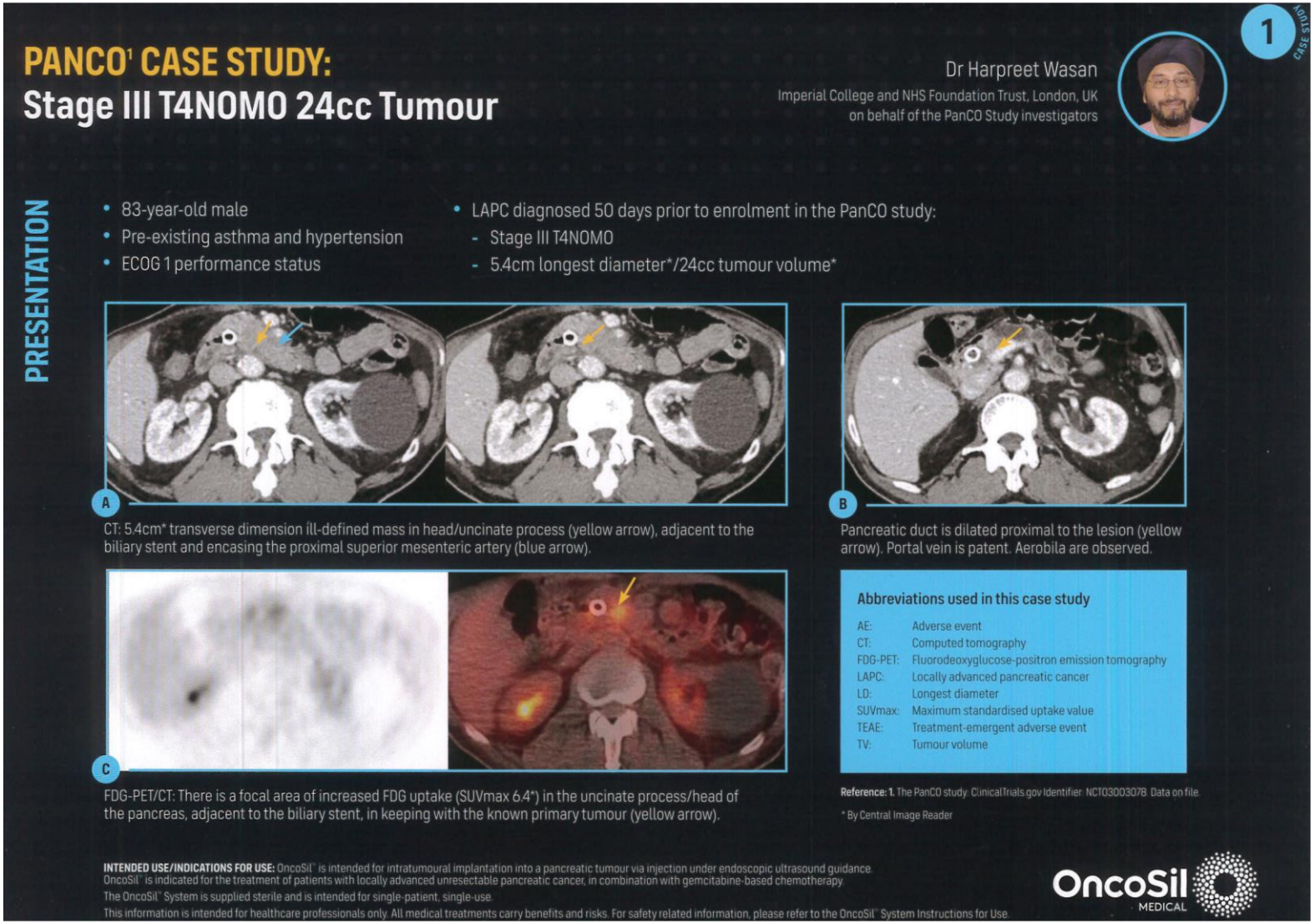
2 Monday, September 11, 2023 | 16:45–18:15 | Hall G1
Successful Molecular Targeting in Oncology

3 Wednesday, September 13, 2023 | 08:00–09:30 | Hall G1
Every Day a Discovery with FAP and Novel Targets

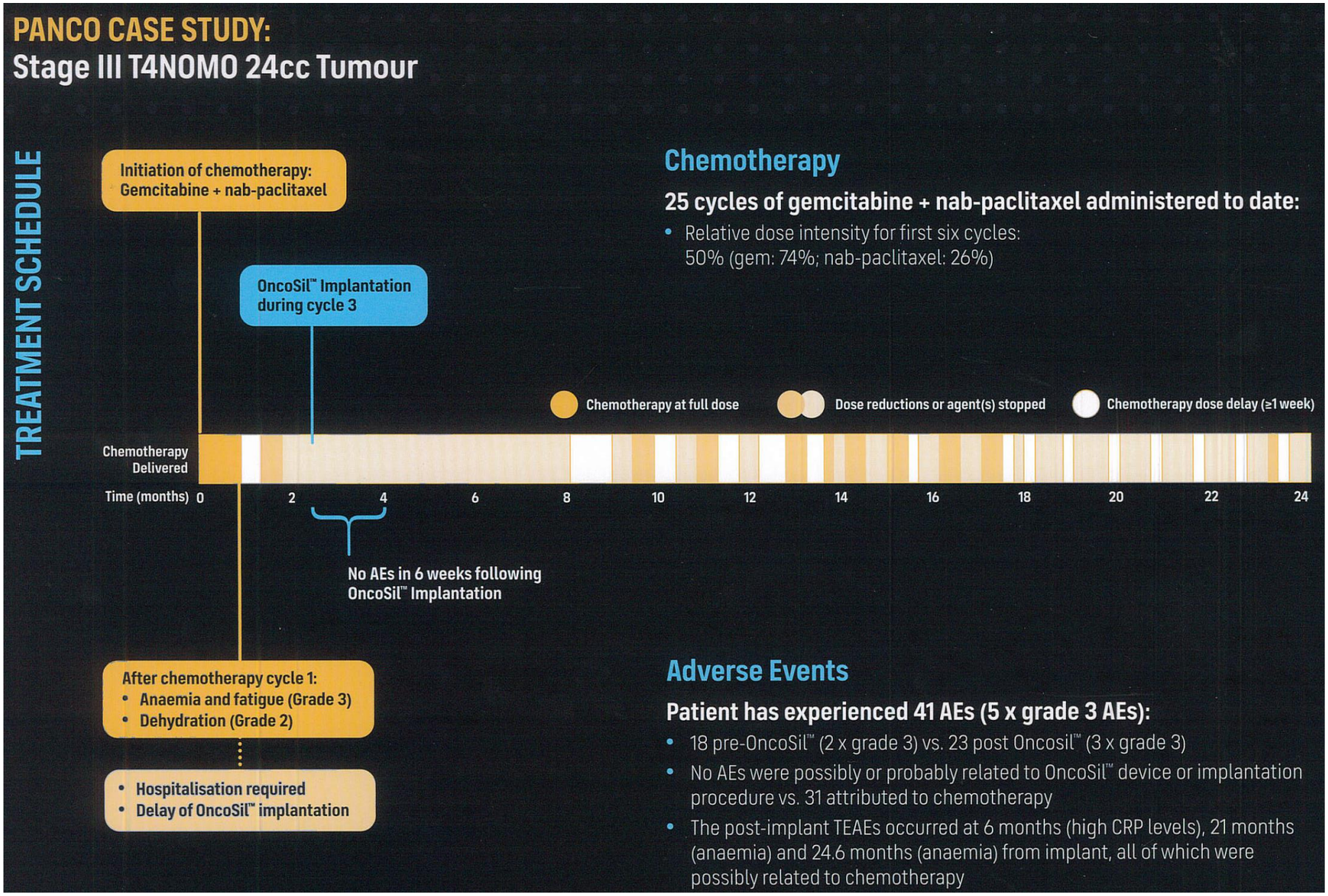
4 Wednesday, September 13, 2023 | 09:45–11:15 | Hall G1
FDG and Conventional Imaging: Still Surprising!

附錄（三）儀器/藥物/同位素產品目錄

(1) P-32 Oncosil 藥物介紹資料



PANCO CASE STUDY:
Stage III T4N0M0 24cc Tumour



Chemotherapy

25 cycles of gemcitabine + nab-paclitaxel administered to date:

- Relative dose intensity for first six cycles: 50% (gem: 74%; nab-paclitaxel: 26%)

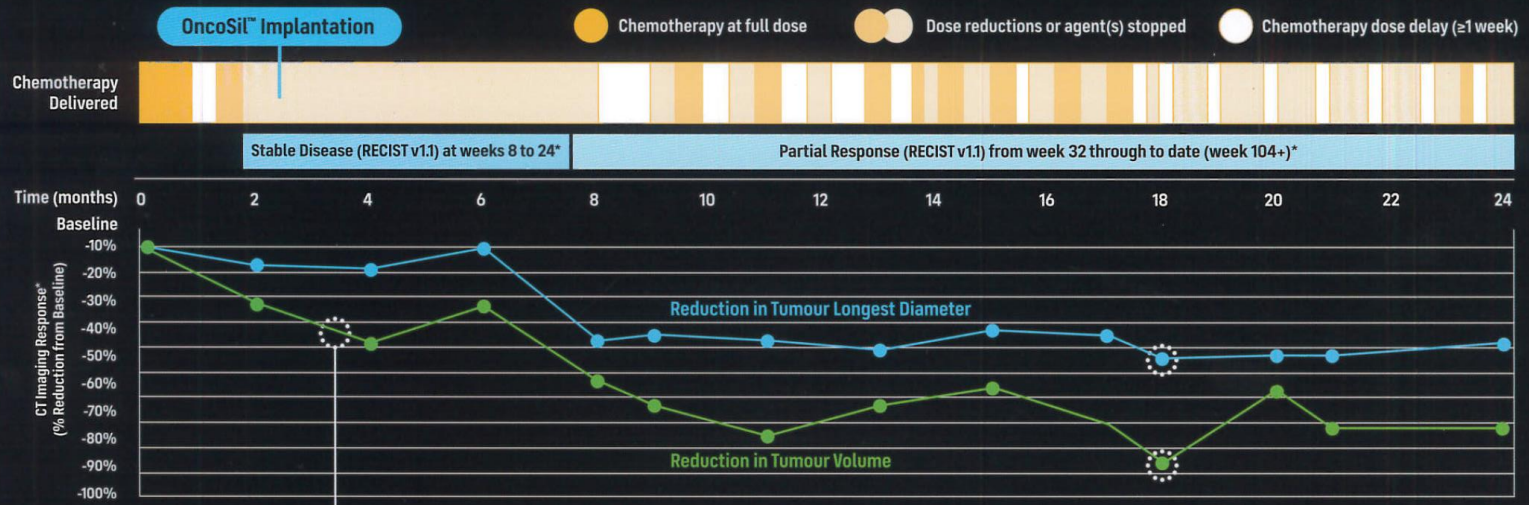
Adverse Events

Patient has experienced 41 AEs (5 x grade 3 AEs):

- 18 pre-OncoSil™ (2 x grade 3) vs. 23 post Oncosil™ (3 x grade 3)
- No AEs were possibly or probably related to OncoSil™ device or implantation procedure vs. 31 attributed to chemotherapy
- The post-implant TEAEs occurred at 6 months (high CRP levels), 21 months (anaemia) and 24.6 months (anaemia) from implant, all of which were possibly related to chemotherapy

Dr Harpreet Wasan
Imperial College and NHS Foundation Trust, London, UK
on behalf of the PanCO Study investigators

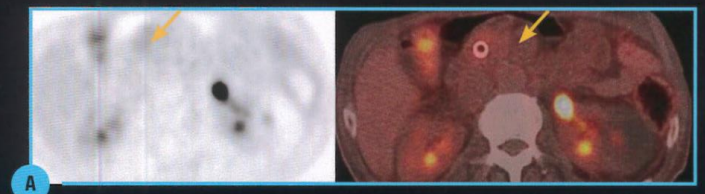
TUMOUR RESPONSE



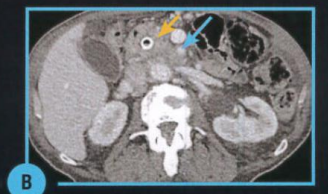
37% reduction in the FDG avidity of the primary pancreatic tumour by SUVmax* [6.4 to 4.07] (yellow arrow), indicating a favourable response to treatment.

-44% LD reduction

-86% TV reduction (3cc vs 24cc at baseline)



FDG-PET/CT Imaging at 12 weeks



CT Imaging at 80 weeks

Notes

- CA 19-9 response not applicable – patient had CA 19-9 <ULN at baseline
- Patient unsuitable for surgical resection due to age, co-morbidities etc

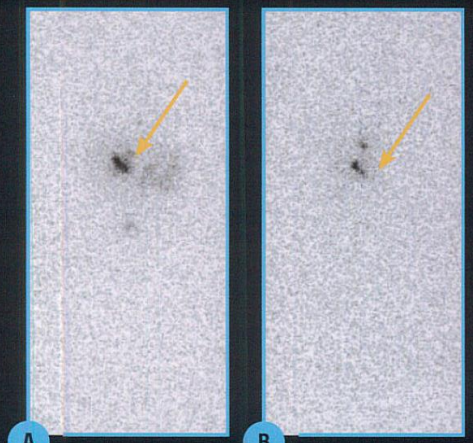
oncosil.com

OncoSil MEDICAL

Dr Harpreet Wasan
Imperial College and NHS Foundation Trust, London, UK
on behalf of the PanCO Study investigators

TUMOUR RESPONSE

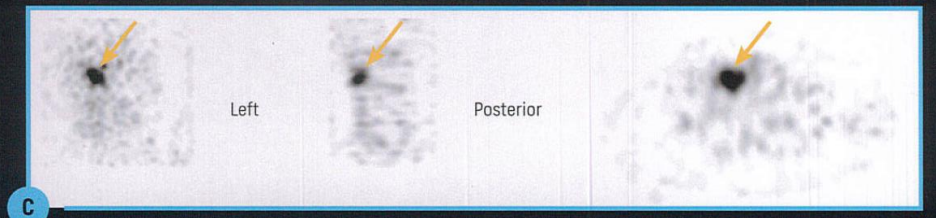
Bremsstrahlung



A 4 hours post OncoSil™ implantation

B 7 days post OncoSil™ implantation

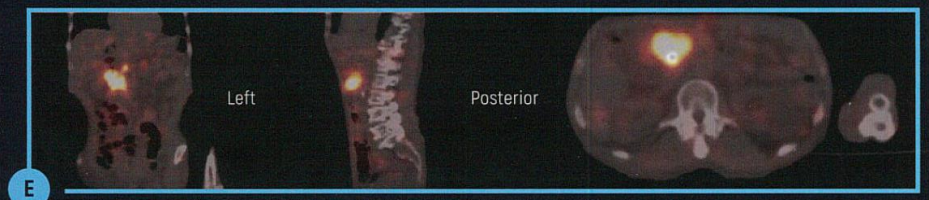
SPECT/CT Imaging



C 4 hours post OncoSil™ implantation

D 7 days post OncoSil™ implantation

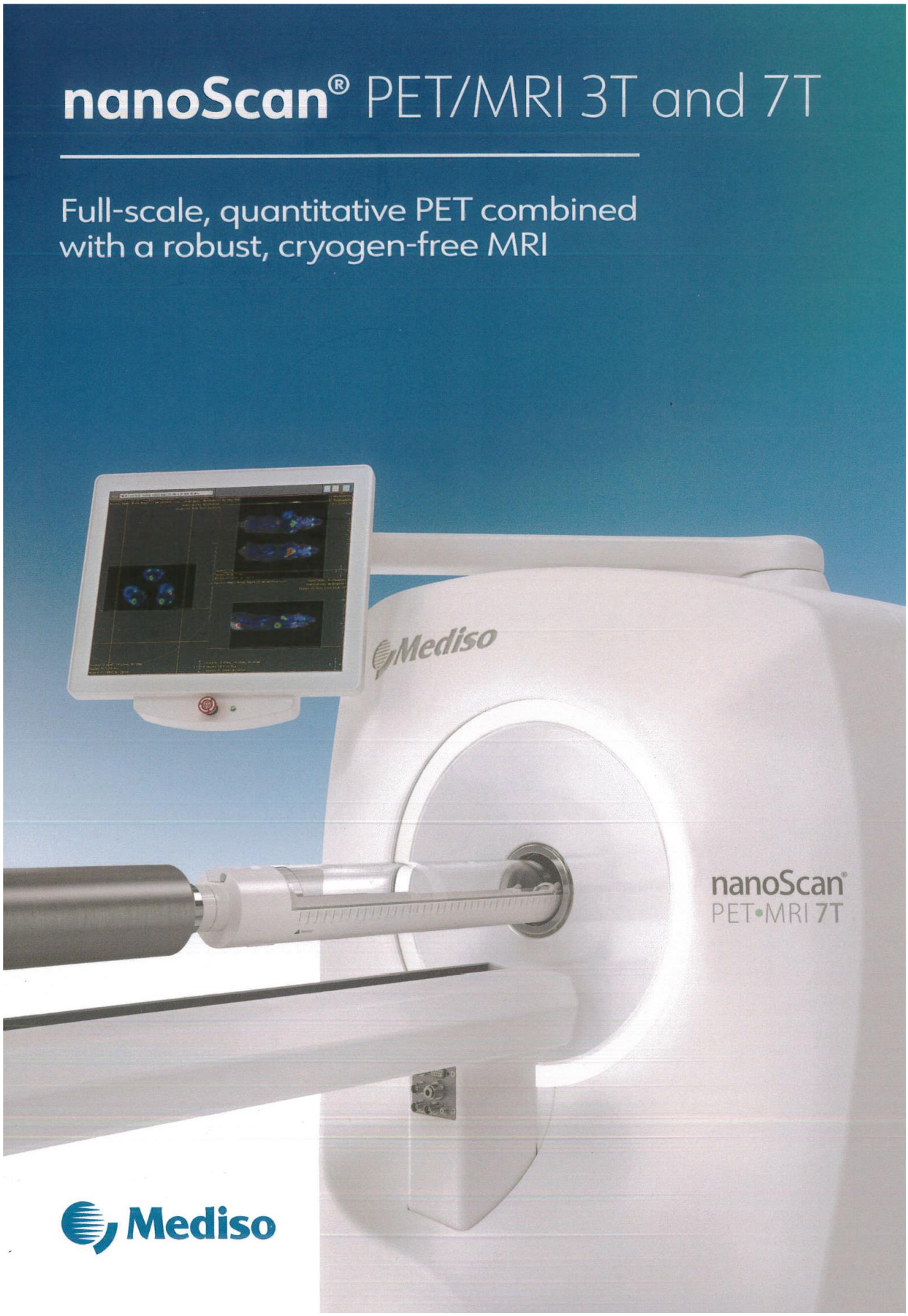
On post-implantation Bremsstrahlung planar and SPECT/CT images, the highest activity is localised to the head of the pancreas, anterior to the biliary stent (yellow arrow). There is contiguous activity in the uncinate process medially. There is much lower activity in the proximal small bowel loops.



E 4 hours post OncoSil™ implantation

F 7 days post OncoSil™ implantation

(2) Mediso 公司 NanoScan PET/MRI 產品型錄



Key features

PET systems

FULL SCALE IN-LINE PET

Highest resolution:
<0.7 mm

Largest transaxial Field-of-View
12 cm

Highest count rate performance
850 kcps @ 60 MBq / 1.62 mCi
- **Multiple animal** imaging
- Imaging of **short half-life isotopes**

Optimized sensitivity and best Minimal Detectable Activity
>8%

Largest installation base
>150 systems

SIPM-BASED PET INSERT

Highest resolution:
<0.7 mm

Optimized Sensitivity
>10%

Removable RF coils:
- **Mouse** WB
- **Rat** brain

Fast setup time
<2 min

Dual layer **DOI** crystal blocks for **homogeneous resolution**

DESIGNED FOR DYNAMIC STUDIES

Freely accessible animal during the scan

Minimized dead space for dynamic imaging

Start dynamic acquisitions from touch screen (e.g dynamic PET or DCE MRI),

Animal monitoring up to 3 animals

MRI systems

3T AND 7T FIELD STRENGTH

100% Cryogen-free magnet

- No liquid helium or nitrogen
- Closed loop – no need to top-up helium

Wide-range of

- RF Coils
- Sequences

Compact design:

- **Small** footprint
- **Marginal** fringe field
- 480 / 970 kg (3T / 7T)

Powerful gradient

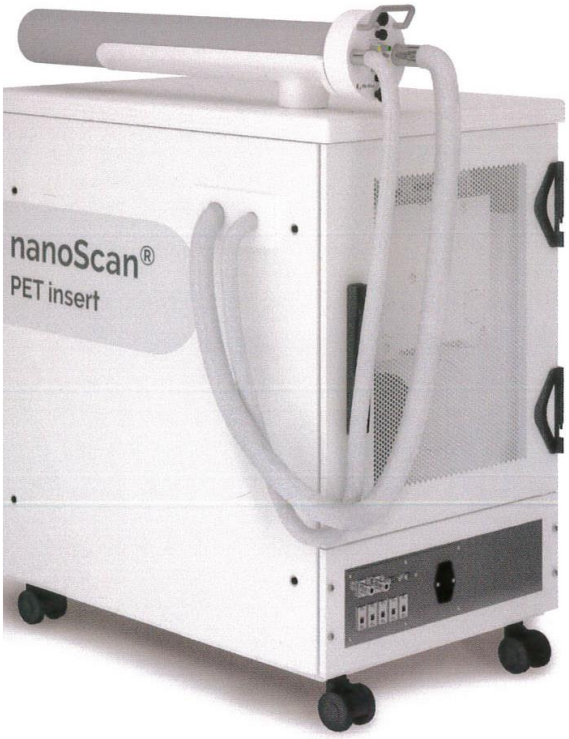
for DWI applications (up to 1050 mT/m)

Low-vibration, **rear mounted**

PulseTube Cryocooler for artefact free DWI-EPI

SmartMagnet™

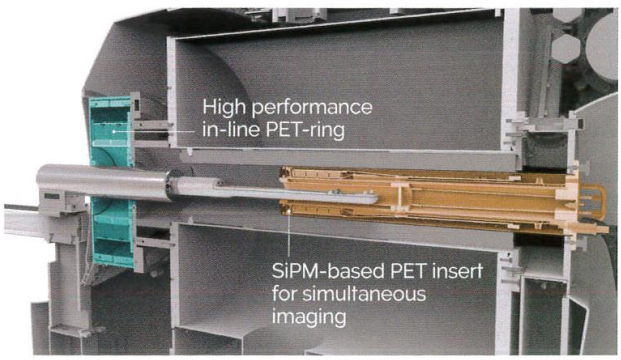
- **Eco-friendly Idle Mode**
- **Active Quench Protection**



DUAL PET CONFIGURATION

Full-scale PET-ring with large field-of-view on the front

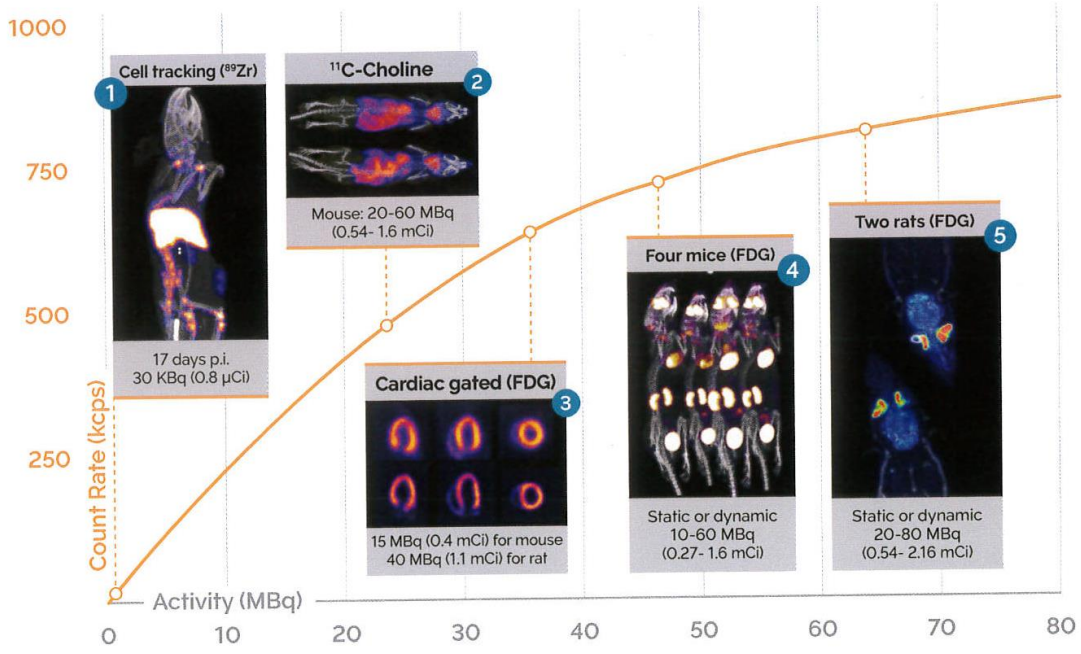
SiPM-based PET insert for simultaneous PET/MRI studies



Best PET image quality and widest dynamic range

The in-line PET subsystem features **real dynamic scanning** with the **best count rate performance** and **highest resolution** on the market, designed for **quantitative imaging** of mice, rats and even larger animals. When complemented with the PET insert the system covers **every possible application** in molecular imaging.

Dynamic range



UNCOMPROMISED APPLICATIONS WITH VERY LOW LEVEL OF RADIOACTIVITY

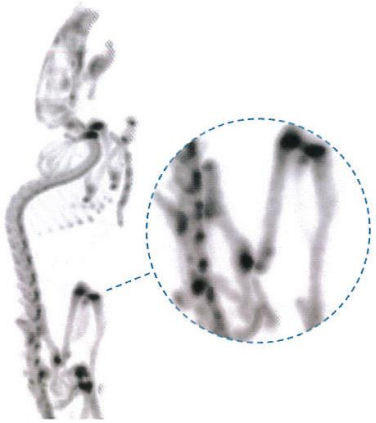
- Thick LSO crystals for **excellent sensitivity**
- **Small (3 ns) coincidence time window** neccesary for advanced corrections
- Advanced corrections (random, scatter, LSO background etc.) ensuring **quantification at low activity levels**
- **Best minimal detectable activity** on the market: 60 Bq (1.6 nCi)
- Inherently optimized for longitudinal e.g. long-term cell tracking 1 and cardiac studies 3

COPING WITH COUNT RATE: MASTERING STUDIES WITH HIGH DOSE

- Multichannel read-out electronics, ultra-fast data processing and advanced dead-time correction
- **Exceptional count rate performance** – peak noise equivalent count rate (NECR) for mouse is 850 kcps @ 60 MBq (1.6 mCi)
- **Fully quantitative** up to 60 MBq (1.6 mCi) and beyond
- Suitable for dynamic imaging up to 3 mice 4 or 2 rats 5 simultaneously
- Optimal for imaging of isotopes with **short half-life** (^{11}C, ^{13}N, ^{15}O etc.) 2

Resolving precise details with 700 µm spatial resolution

- **Finest pixelated** (1.12 mm×1.12 mm) lutetium oxyorthosilicate (LSO) crystal needles provide precise signal localization preserving spatial information in raw data
- Tera-Tomo™ 3D PET iterative reconstruction with **real-time Monte Carlo based physical modelling** unveiling the tiniest details on the image
- Large ring diameter and statistical depth of interaction compensation offer **homogeneous image quality** over the **entire field of view**



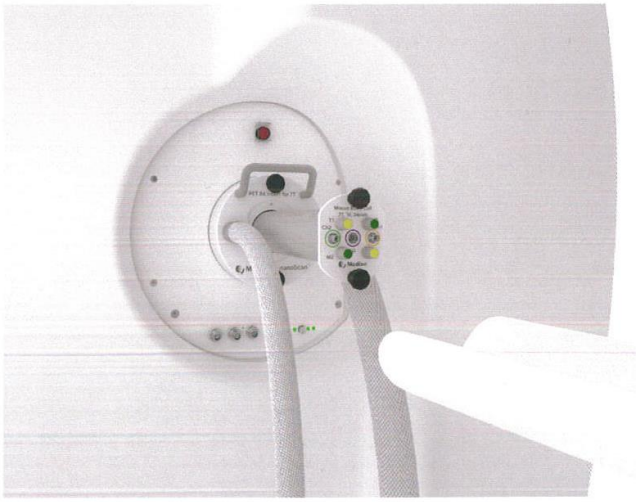
Largest transaxial field of view

- Bore size and transaxial field of view enabling scanning of **larger rats or multiple mice** in both modalities
- Excellent homogeneity and image quality over the **entire field of view**
- **Simultaneous multiple animal imaging** (up to 3 mice or 2 rats) with individual physiological monitoring

PET insert offering simultaneous multiparametric imaging

Due to the high level of integration the nanoScan® PET insert offers uncompromised image quality while giving access to a unique way of hybrid imaging by obtaining information from functional, metabolic and physiological processes in a simultaneous manner.

- Simultaneous PET/MRI imaging of total body mouse or rat brain
- Providing **high resolution** and **homogeneous image quality over the entire field of view** as a result of using dual layer Depth-Of-Interaction crystal blocks of the **finest LSO crystal needles**
- Removable, allowing access to the full-bore of the MRI and also making benchtop measurements possible
- Available as an upgrade for existing PET/MRI 3T, 7T and MRI 3T, 7T installations or as a standalone system



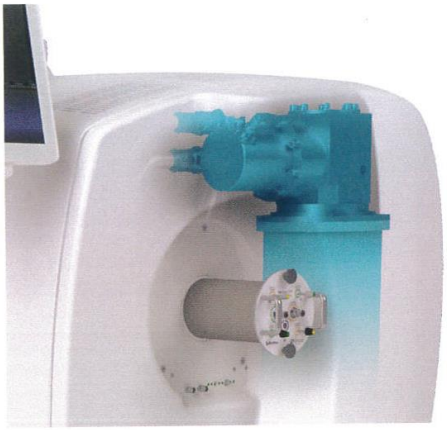
PET insert with the removable RF Coil

Easy to house, high-performance MRI platform

100% Cryogen-free magnet

The core of the nanoScan® MRI systems is the most robust **100% cryogen-free** superconducting magnet ever built for preclinical applications. It utilizes **conduction cooling** and **does not contain liquid helium or any other liquid cryogens** in any amount.

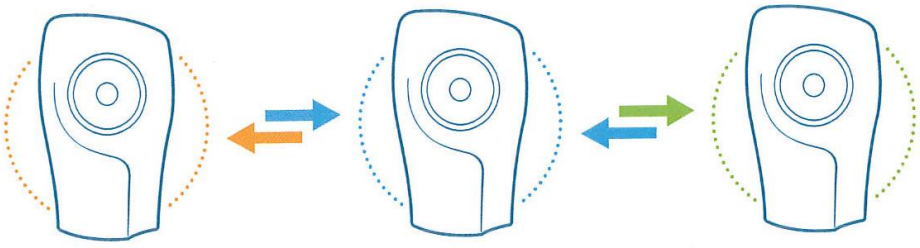
- It's base is a NbTi solenoid with multiple corresponding coils to maximize homogeneity and shielding thus reaching state-of-the-art homogeneity of **±0.1 ppm** @ 50 mm DSV and negligible fringe field outside the cryostat.
- Uniquely it features a **back mounted cryocooler to significantly reduce conducted vibrations** and to make maintenance easier.
- All electrically conductive cylindrical parts of the magnet were designed to minimize the residual eddy current after strong gradient pulses, this way achieving high quality DWI images.



Unique back mounted cryocooler significantly reducing vibrations

SmartMagnet™ – Self-monitoring and management system

The patented* SmartMagnet™ technology enables one-click selection between different magnet modes.



WARM MAGNET

- **Long breaks**
- Installation, relocation mode

COLD MAGNET

- **Fully operational** daily usage
- **Active quench protection** during usage through **self-supervision**

IDLE MODE

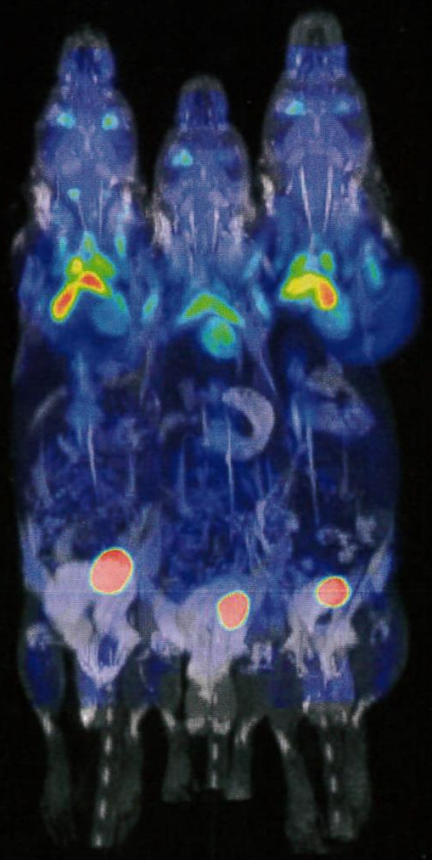
- Ideal for planned short breaks
- **Reducing operating costs**
- Low electricity consumption
- **Fast recovery time**
- Prolonging coldhead lifetime

*Discharge Controlled Superconducting Magnet and Superconducting Magnet Operating in Occasional Idling Mode

PET/MRI Applications

Multiple animal imaging with PET/MRI 3T

High throughput studies with the large diameter in-line PET ring. Simultaneous measurement of three tumor bearing mice. The integrated multi-animal workflow allows for automatic image segmentation resulting in separate DICOM images with quantitative SUV values.



ANIMAL MODEL: BALB/c mice

MRI ACQUISITION: GRE 3D Multi-FOV MRI, acq. time: 18 min, NEX: 4, TR: 10ms, TE: 3.1ms, TH: 0.8mm

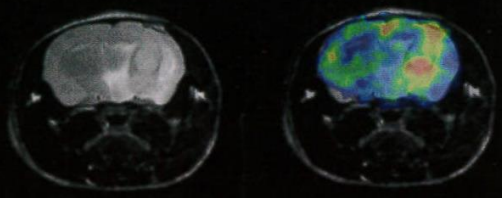
PET ACQUISITION: 20min static

RF COIL: 72mm Quadrature Tx/Rx volume coil

RADIOTRACER: ^{18}F-FDG, 4.87 MBq (131.6 µCi), 4.75 MBq (128.3 µCi) and 5.91 MBq (159.7 µCi)

^{18}F-FDG Glioma imaging in mouse brain

Combining the great soft-tissue contrast of MRI with the molecular specificity of PET, the nanoScan® PET/MRI systems are the perfect tool for the development of novel therapeutic and diagnostic strategies for glioma.



ANIMAL MODEL: C56BL/6 mouse (28 g)

MRI ACQUISITION: T2W FSE 2D, FOV: 32mm x 32mm, TH: 1mm, acq. time: 5 min

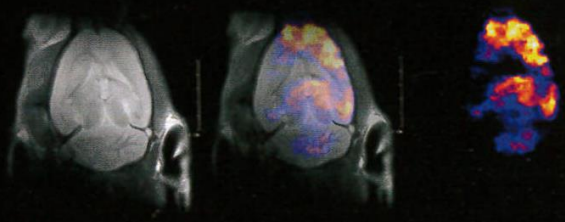
COILS: Quadrature Tx/Rx volume coil for mouse brain

PET ACQUISITION: dynamic

RADIOTRACER: 3.2 MBq (86 µCi)18F-FDG

^{18}F-FDG Stroke imaging in rat brain

The nanoScan® PET/MRI systems combine the excellent soft-tissue contrast of MRI with the molecular specificity of PET, making them the ideal tools for advancing novel therapeutics and diagnostics.



ANIMAL MODEL: Wistar rat

MRI ACQUISITION: T2W FSE 2D, FOV: 32mm x 32mm, TH: 1mm, acq time: 10 min

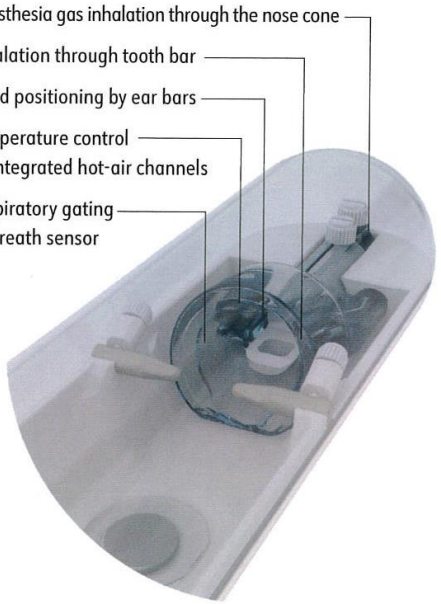
COILS: Quadrature Tx/Rx volume coil for transmission and 2ch phased array coil for signal reception

PET ACQUISITION: dynamic

RADIOTRACER: ^{18}F-FDG, 8 MBQ (216 CI)

Animal handling

MultiCell™ imaging chambers



Mouse M

Inner space: 134×26 mm
Outer dimension: 463×32 mm
Up to 40 g

Mouse L (Standard)

Inner space: 141×31 mm
Outer dimension: 466×40 mm
Up to 80 g
Also available in BSL3 version

Rat L (Standard)

Inner space: 249×60 mm
Outer dimension: 580×70 mm
Up to 600 g

Rat Dual

Inner space: 240×60 mm
Outer dimension: 590×70 mm
Up to 2×200 g

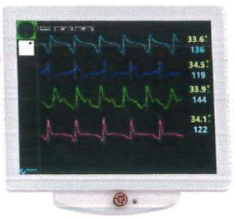
Mouse Triple

Inner space: 144×26 mm
Outer dimension: 488×70 mm
Up to 3×30 g

Mouse BSL-3

Inner space: 141×31 mm
Outer dimension: 578×60 mm
Up to 80 g

Monitoring and gating



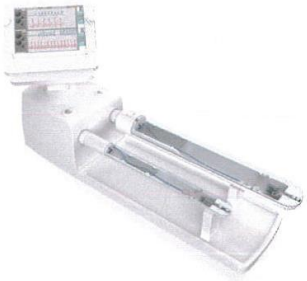
» ECG monitoring and triggering
» Respiration monitoring and triggering
» Temperature monitoring and control module
» Accesibble from touchscreen and workstation

Respiration and body temperature monitoring even up to four animals

PrepaCell™

Supporting complete animal preparation before the scan, setting of:
» Anaesthesia
» Heating
» Vital function monitoring

Eases workflow and increases throughput

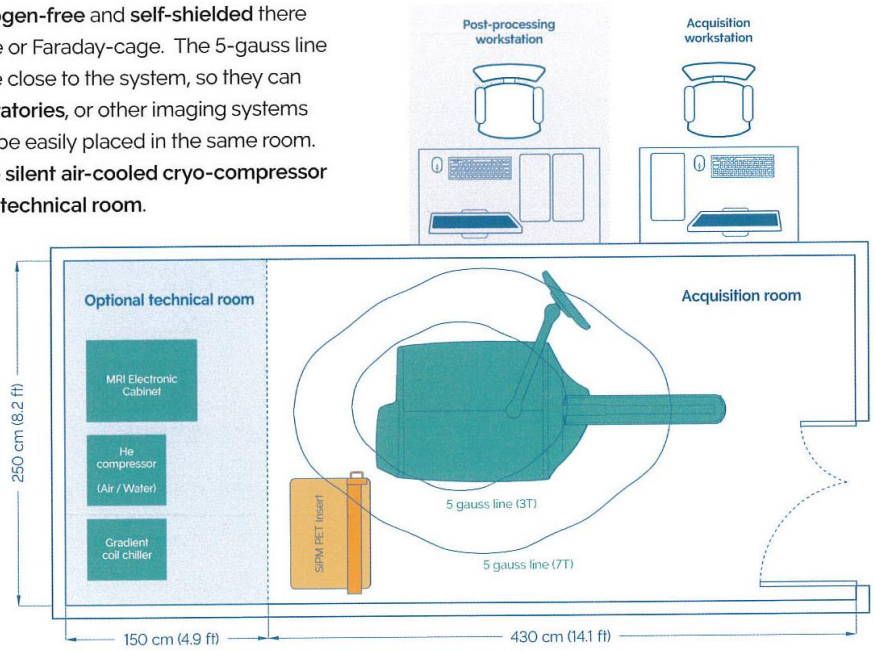


The imaging chambers are fully compatible with all Mediso manufactured imaging systems providing one-click connection for easy and fast workflow.

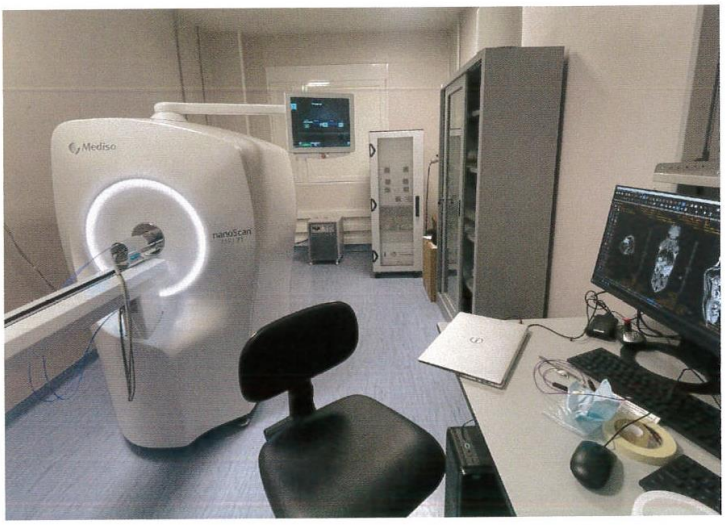
Minimal installation requirements

The **compact** and **light-weighted** nanoScan® MRI systems can be **installed** and run practically in **any laboratory** due to their low installation and maintenance requirements.

As the systems are **100% cryogen-free** and **self-shielded** there is no need of any quench pipe or Faraday-cage. The 5-gauss line for both 3T and 7T models are close to the system, so they can be placed in really **small laboratories**, or other imaging systems like PET/CT or SPECT/CT can be easily placed in the same room. Moreover, in case of using the **silent air-cooled cryo-compressor** there is **no need for separate technical room**.



- **Light-weighted systems with small footprint**
  480 kg / 970 kg (3T / 7T)
  1050 / 2140 lbs (3T / 7T)
  250 cm x 80 / 100 cm
- **Optional technical room** – In case of air-cooled cryo-compressor no separate technical room is needed
- Post-processing workstation – can be next to the acquisition workstation or at the researcher's room.
- SiPM PET insert – Optional upgrade for both 3T and 7T MRI systems.



nanoScan® MRI 7T reference installation with every system component (magnet, workstation, electronic cabinet, He-compressor, chiller) located in the same imaging room.

Specifications | nanoScan® PET MRI 3T and 7T

IN-LINE PET

Bore size
16 cm

Multiple animal imaging
up to 3 mice or 2 rats

Spatial resolution with Tera-Tomo™ (3D OSEM)
0.7 mm

Spatial Resolution with FBP (NEMA)
1.25 mm

Transaxial FOV
12 cm

Animal models
mouse, rat, marmoset, guinea pig

Noise Equivalent Count Rate for mouse (NEMA)
850 kcps @ 60 MBq / 1.65 mCi

Axial FOV
10 cm

Sensitivity
8 %

LSO crystal size
LSO (1.12×1.12×13 mm)

Noise Equivalent Count Rate for rat (NEMA)
250 kcps @ 60 MBq / 1.65 mCi

PET INSERT

Bore size
5.4 cm

Axial FOV
10 cm

Animal models
Mouse whole-body, rat brain

Transaxial FOV
4.5 cm

Spatial resolution with Tera-Tomo™ (3D OSEM)
0.7 mm

Sensitivity
10 %

LSO crystal size
Dual-layer (1.12×1.12×10 mm)

3T / 7T MRI

Magnet
Cryogen-free superconducting

Field strength
3T / 7T

Homogeneity
±0.1 ppm @ 50 mm DSV

Bore size
17 cm

Gradient coil inner diameter
101 mm

Gradient strength
Up to 1000 mT/m

Cryocooler
Back-mounted PulseTube

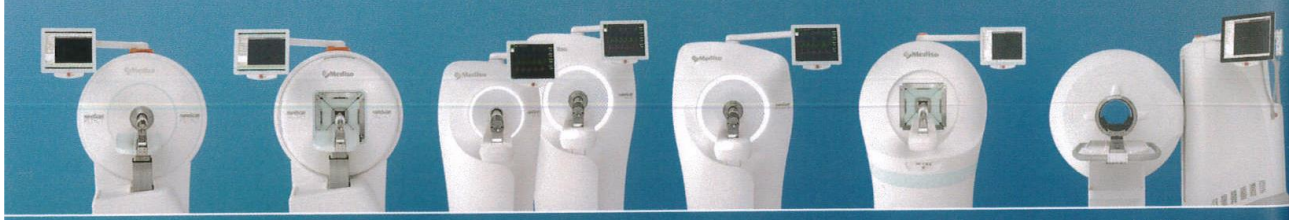
Quench protection
Yes, with SmartMagnet™

Faraday cage needed?
No, the system is self-shielded

Quench pipe needed?
No, the system is 100% cryogen-free

Rampable
Yes

300+ preclinical systems in **33** countries



nanoScan® PET/CT | nanoScan® SPECT/CT | nanoScan® MRI 3T/7T | nanoScan® PET/MRI 3T and 7T | nanoScan® SPECT/CT/PET | MultiScan™ LFER150 PET/CT

Mediso

Mediso Medical Imaging Systems
info@mediso.com www.mediso.com

Headquarters
Budapest, Hungary

Global offices

USA and Canada
Arlington, VA
sales@medisousa.com

Belgium
Auderghem
info.belgium@mediso.com

United Kingdom and Ireland
Farnborough
info@bartectechnologies.com

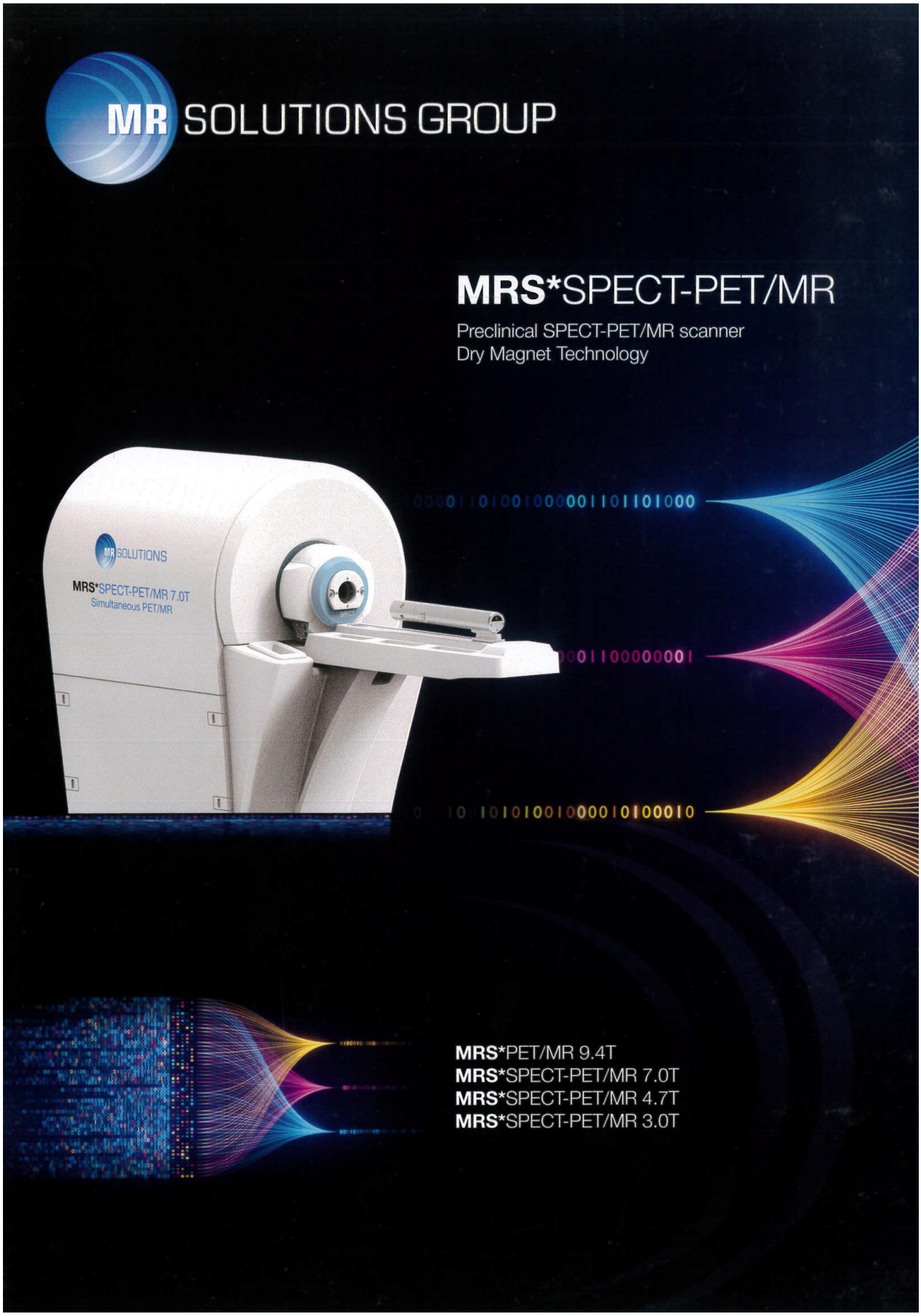
Poland
Łódź
biuro@mediso.pl

Germany and Austria
Münster
info@mediso.de

CE

NS-PM3T7T_0823_EN

(3) MR SOLUTIONS 公司 MRS*PET/MR 產品型錄



MRS*SPECT-PET/MR

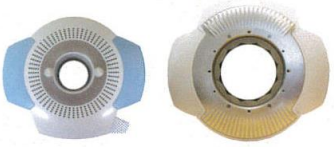
Preclinical SPECT-PET/MR scanner with dry magnet technology

MRS*PET/MR 9.4T - 7.0T - 4.7T - 3.0T
MRS*SPECT/MR 7.0T - 4.7T - 3.0T

MRS*PET INSERT
Simultaneous PET/MR acquisition

MRS*PET & SPECT CLIP-ON
Sequential SPECT-PET/MR acquisition

MRS*PET-IN 140, MRS*PET-IN 80 & MRS*PET-IN 40

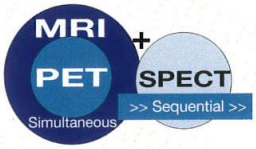


*MRS*PET-CO 80
*MRS*SPECT-CO

**MRS*PET-CO 140

Tri-modality imaging system:

1-Simultaneous PET/MR+SPECT



2-Sequential PET+MR+SPECT

Simultaneous or sequential PET/MR imaging?

Mainly defined by the interest of the researchers for multi-parametric information for a study on the same subject and at the same time.

MR SOLUTIONS has developed two PET scanners compatible with its cryogen-free preclinical MR up to 9.4T, **MRS***DRYMAG:

The **MRS***PET INSERT is designed for simultaneous acquisition with the MR modality. It permits multi-parametric information on the same animal for a particular study. For instance, during a PET acquisition of 30 minutes, several MR scans (T2, T1, DWI, etc.) can be performed, as an MR acquisition is usually shorter. All MR data acquired during the PET scan could then be merged automatically with the PET data once the acquisition is finished. Simultaneous PET/MR acquisition also has the advantage of reducing the duration of anaesthesia and can provide essential information about blood flow, as an example in cardiac and brain studies.

The **MRS***SPECT CLIP-ON can be connected in line on the same axis as the simultaneous PET/MR system for tri-modality imaging. The **MRS***SPECT CLIP-ON can be detached in 5 minutes from the MR and plugged into the **MRS***CT for SPECT/CT imaging.

The **MRS***PET CLIP-ON and **MRS***SPECT CLIP-ON are designed for sequential acquisition with the MR and CT scanners. PET, SPECT and the MR modalities are back to back, in-line on the same axis. The animal is automatically transferred from one modality to the other with a Motorized bed. Sequential PET/MR and SPECT/MR imaging cover most of the applications, but researchers with a main focus in oncology will probably select the sequential imaging. The MR with its high soft tissue contrast will have a superior detection, assessment and characterisation of tumours over a CT.

MRS*PET INSERT

MR Solutions has developed three versions of the MRS*PET INSERT:

- **MRS***PET-IN 140 for ≥42 cm bore size MR up to 15 cm axial FOV, simultaneous PET/MR imaging on 3 kg animals
- **MRS***PET-IN 80 for ≥31 cm bore size MR up to 15 cm axial FOV, simultaneous PET/MR imaging for 600 g rodents
- **MRS***PET-IN 40 for 17 cm bore size MR up to 10 cm axial FOV, simultaneous PET/MR imaging for wholebody mouse and rat head

PET insert can be removed in less than 5 minutes from the dry magnet and be operated as a stand alone PET device using a benchtop holder. Removing the MRS*PET INSERT allows to scan bigger animals, for instance 3 kg animals for the biggest bore MRS*DRYMAG magnet.

PET in the MR ≥24 cm
MRS*DRYMAG 24/31 cm bore + MRS*PET-IN 80
Rodents, marmosets simultaneous PET/MRI
MRS*DRYMAG 42 cm bore + MRS*PET-IN 140
up to 3 kg animals simultaneous PET/MRI

PET in the MR 17 cm
MRS*DRYMAG 17 cm bore + MRS*PET-IN 40
Mice whole body and rat head simultaneous PET/MRI

PET out of the MR ≥ 24 cm
MRS*DRYMAG 24 / 31 cm bore
Up to 3-4 kg animal whole body MRI
MRS*DRYMAG 42 cm bore
Up to 10 kg animal whole body MRI

PET out of the MR 17 cm
MRS*DRYMAG 17 cm bore
Mice, rats, marmosets whole body MRI

MRS*PET & SPECT CLIP-ON

- **MRS***SPECT-CO for 17and 24 cm cm bore size MR for 600 g rodents and marmosets for sequential SPECT/MR imaging.
- **MRS***PET-CO 80 for 17 cm bore size MR up to 15 cm axial FOV, for 600 g rodents and marmosets for sequential PET/MR imaging.
- **MRS***PET-CO 140 for ≥ 24 cm bore size MR up to 15 cm axial FOV, up to 3 Kg animals for sequential PET/MR imaging.
- **MRS***PET 220 for ≥ 31 cm bore size MR up to 15 cm axial FOV, up to 10 Kg animals for sequential PET/MR imaging.

The CLIP-ON is plugged on the front of the MR in the same axis for sequential PET/MR & SPECT/MR imaging. This configuration allows to keep the same bore size through the modalities. Moreover, the CLIP-ON can easily be dissociated from the MR and plugged on the CT.

SPECT/PET/MR 17 cm
MRS*DRYMAG 17 cm + MRS*PET-CO 80
Mice, rats, marmosets whole body PET/MRI and MRI

PET/MR ≥ 24 cm
MRS*DRYMAG 24 /31 cm + MRS*PET-CO 140
Up to 3 kg animal whole body PET/MRI and MRI
MRS*DRYMAG 42 cm + MRS*PET 220
Up to 10 kg animal whole body PET/MRI and MRI

MRS*SPECT-PET/MR

The ultimate cryogen-free SPECT-PET/MR: no liquid helium, no nitrogen

The best PET & MR technologies combined in one system

MRS*DRYMAG

The Dry Magnet technology

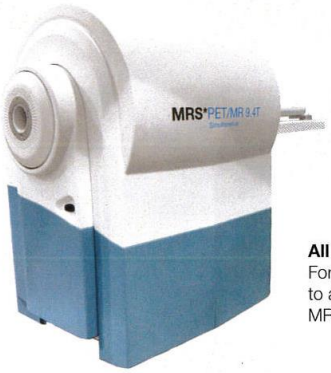
The **MRS***DRYMAG technology does not require liquid helium or liquid nitrogen for the cooling, hence the term dry magnet.

The safest and true cryogen-free technology

In case of quench, as there is no helium gas or liquid helium in the magnet, nothing will escape from the magnet. The pressure of the imaging room will remain the same, avoiding the setup of specific emergency exit doors.

No major site preparation, no quench valve or pipes required, no faraday cage required

MRS*SPECT-PET/MR does not need any specific room requirements such as quench pipes, quench valve or a liquid helium reservoir. There are no requirements for ceiling height beyond standard room construction.
MRS*DRYMAG SPECT-PET/MR can be installed almost anywhere in rooms as small as 8m² and on the highest floor of a building.
A **MRS***SPECT-PET/MR 3T weights 370 kg and a 7T 520 kg.



Installation in BSL Labs 1, 2, 3, 4 and SPF

Low maintenance cost for robust superconducting magnets

Upgradable magnet

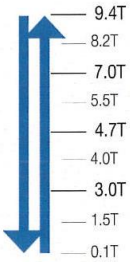
All system are upgradable.
For instance a 3T MR can be upgraded to a 7T PET/MR or a 7T SPECT-PET/MR on site at any time.

Variable field technology

Optionally the **MRS***DRYMAG can be ramped down and ramped up to any field strengths upon users choice.

For instance from 7.0T to 3T for clinical and preclinical translational imaging studies , to 1T for contrast agent development, to 0.5T for ex-vivo studies.

The system can move from one field to the other in minutes.



A large choice of coils for SPECT-PET/MRI

- Transmit/receive birdcage coils
- Surface coils / Phased array coils
- Multinuclear coils:
  ^{23}Na, ^{15}O,^{19}F, ^{31}P, ^{13}C, ^{3}He, ^{17}O,^{129}Xe
- Cryo-coils.

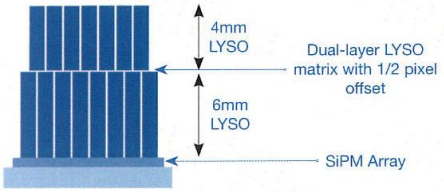
MRS*PET

The SiPM technology

The **MRS***PET for small animal imaging uses the latest silicon photomultiplier (SiPM) technology. The detector assembly (crystal/SiPM) allows true DOI (depth of interaction) with two pixelated layers of scintillator crystal with different matrices. This design enables the MR SOLUTIONS PET module to reach under 0.8mm resolution.

True DOI, Depth of interaction

All the PET systems from MR SOLUTIONS are built up with true depth of interaction hardware allowing a uniform high resolution across the entire field of view. All systems have dual-layer LYSO matrix with 1/2 pixel offset between the top and bottom layers.



Continuous PET detectors

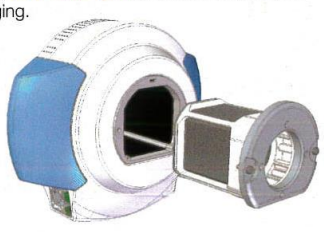
MRS*PET system is designed with continuous detectors all across its axis. It doesn't have several "rings" attached together, therefore with the continuous detector technology, there is no loss of detection as it is the case on other systems.

MRS*SPECT

Stationary Imaging - MULTI-PINHOLE

The **MRS***SPECT CLIP-ON series is designed for sequential imaging in combination with MR SOLUTIONS CT, MR and PET/MR. The module can acquire whole body mice and rats. The **MRS***SPECT is based on the multi-pinhole technology and it is stationary system without a gantry. Various multi-pinhole collimator are available depending of the application and the requirements for resolution and sensitivity.

This dramatically improves the workflow of the laboratory whilst reducing the cost since only one **MRS***SPECT CLIP-ON module is required for SPECT/CT and SPECT/MR imaging.



With MRS*DRYMAG technology
MR Solutions users are not the hostages of the helium shortage and its escalating price year after year.
MR Solutions preclinical MRI systems significantly reduce environmental impact.

PRECLINICAL SPECT-PET/MR

Simultaneous PET/MR and SPECT Imaging

Tri-modality imaging scanner

Preclinical PET/MR scanner with PET INSERT combined with MRS*SPECT-CLIP-ON

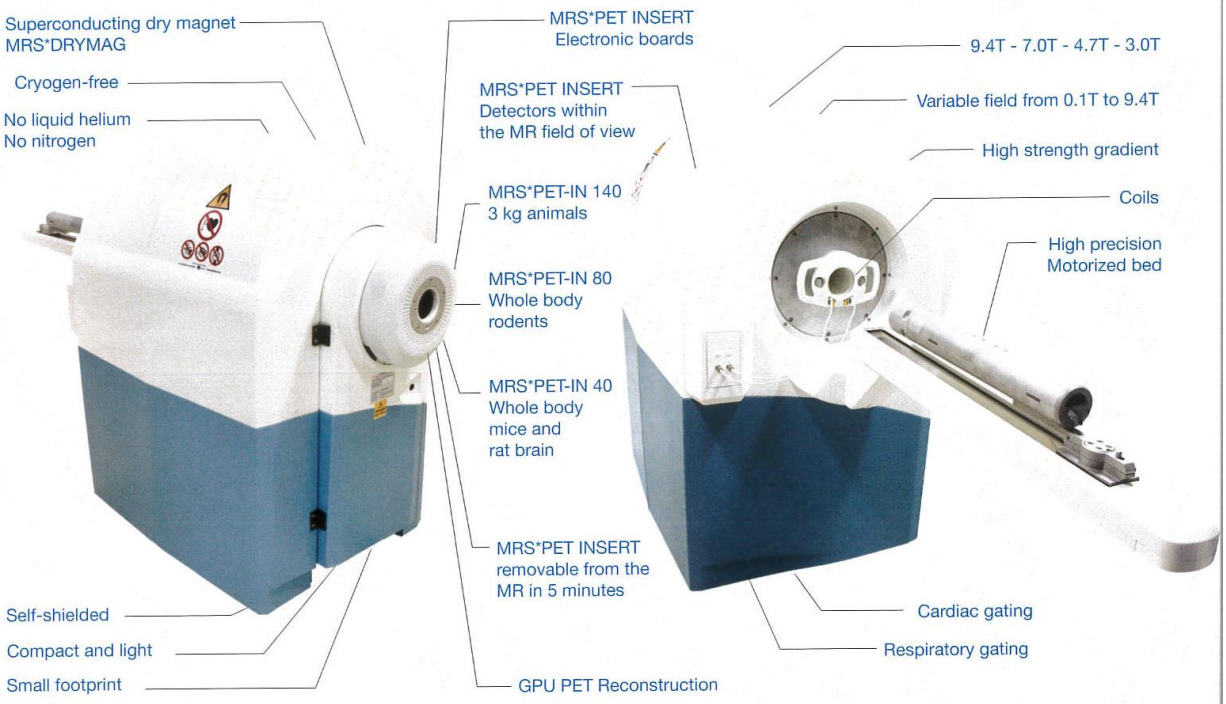
MRI PET Simultaneous + SPECT >> Sequential >>

MRS*PET INSERT for 9.4T - 7.0T - 4.7T - 3.0T

Simultaneous PET/MRI for whole body mice and rats up to 3 kg

Tri-modality imaging with SPECT CLIP-ON: SPECT-PET/MR

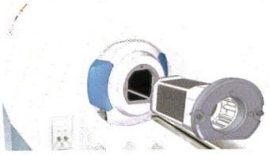
The MRS*PET INSERT is designed for simultaneous imaging in combination with all MRS*DRYMAG, cryogen-free MRI up to 9.4T. Three models are available: MRS*PET-IN 140 for 42 cm bore size magnets for 3 kg animals, MRS*PET-IN 80 for 24 / 31 cm bore size magnets for whole body rodents imaging and then MRS*PET-IN 40 for smaller bore magnets for whole body mice and rat brain imaging. The axial field of view can go up to 15 cm with continuous PET detectors.



MRS*PET INSERT

Stand alone PET acquisition

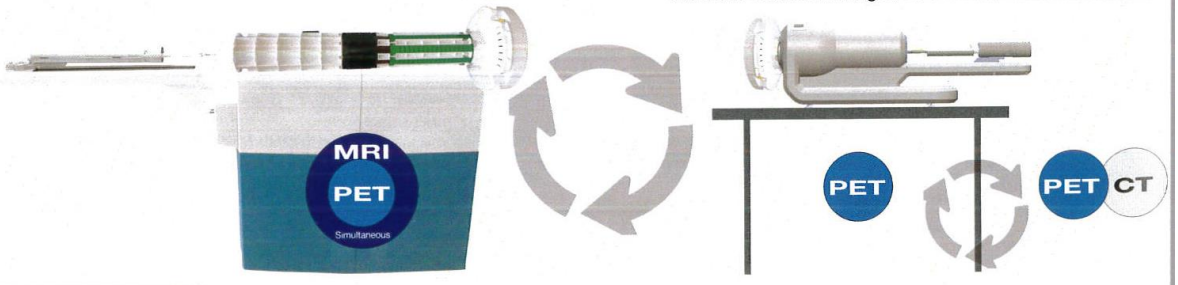
The PET INSERT can be removed from the PET/MR to give access to the full bore size of the MR. This allows to scan bigger animals up to 3 kg using the MR only. The PET INSERT can be operated as a stand-alone device using a dedicated benchtop holder built in with a Motorized bed.



MRS*SPECT-CLIP-ON

Tri-modality MRS*SPECT-PET/MR

The MRS*SPECT CLIP-ON can be attached on the front of the MRS*PET/MR allowing SPECT-PET/MR on the same animal



PRECLINICAL SPECT-PET/MR

PET/MR imaging
from mice to 3 kg animals imaging

PET/MR imaging
from mice to 10 kg animal imaging

MRS*PET/MR 9.4T

Dry magnet technology: Cryogen-free
Simultaneous and Sequential Imaging

MRS*PET/MR 7.0T

Dry magnet technology: Cryogen-free
Simultaneous and Sequential Imaging

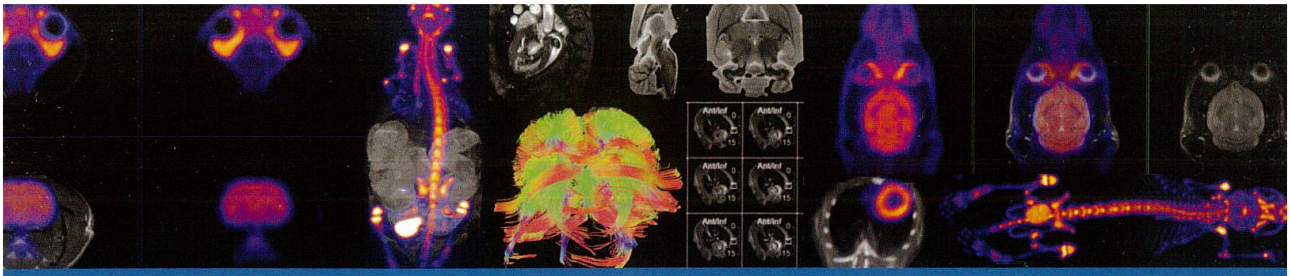
Main Specifications		
Model reference	MRS*PET/MR 9417	MRS*PET/MR 9426
Bore size	17 cm	26 cm
Animal type with MRS*PET CLIP-ON	Whole body mice, rats & marmosets, 600g	Whole body mice, rats, marmosets, 3 kg animals
Animal type with MRS*PET INSERT	Whole body mice & rat head	Whole body mice & rats
without MRS*PET INSERT	Whole body mice, rats & Marmosets	Whole body rodents, marmosets, 3kg animals
MRS*DRYMAG : MR component, dry magnet specifications		
FOV	70 mm x 100 mm axially	160 mm DSV
5 gauss line (m)	1.1 radially x 1.3 axially	1.7 m radially x 1.9 axially
Magnet Technology / Cooling	Dry Magnet technology MRS*DRYMAG Cryogen free (no liquid helium and no nitrogen)	
Variable fields	Yes, for Powerscan version: up to 3 additional stengths	
Integral RF shield	Yes, self shielded	
Gradient strength	600 mT/m all directions	600 mT/m all directions
Gradient upgrade	1029 mT/m for Powerscan	800 mT/m for Powerscan
Coils	Volume, surface, phased array, multinuclear, Cryo-coils	

MRS*PET : PET specifications for CLIP-ON and INSERT				
PET-INSERT (IN) PET-CLIP-ON (CO)	MRS* PET-IN 40	MRS* PET-CO 80	MRS* PET-IN 80	MRS* PET-CO 140
Clear bore size (mm)	60	112	112	151
Transaxial. FOV (mm)	40	80	80	140
Axial FOV (mm)	50.4 (PET-CO 801, 1401), 102.48 (PET-CO 802, 1402) & 151.2 (PET-CO 803, 1403) 50.4 (PET-IN 401, 801), 102.48 (PET-IN 402, 802) & 151.2 (PET-IN 803)			
Extended aFOV	300 mm with Motorized bed			
Depth of Interaction	Yes- true DOI from hardware configuration			
Spatial Resolution with 3D OSEM (mm)	0.7			≤0.8
Sensitivity	up to 11% depending of the configuration			
MRS*SPECT : SPECT specifications for CLIP-ON				
SPECT-CLIP-ON	WIP @9.4T	WIP @ 9.4T		
Clear bore size (mm)	90	90		
Dimensions and weight with animal table				
DRYMAG (mm)	1600 (h) x 2600(l) x 1100(w)	1525 (h) x 2545 (l) x 989 (w)		
Total Weight	<750 kg	<1450kg		

Main Specifications				
Model reference	MRS*PET/MR 7017	MRS*PET/MR 7024	MRS*PET/MR 7031	MRS*PET/MR 7042
Bore size	17 cm	24 cm	31 cm	42 cm
Animal type with MRS*PET CLIP-ON	Rodents, marmosets 600g	≤ 3kg animals	≤ 5kg animals	≤ 10 kg animals
Animal type with MRS*PET INSERT	Whole body mice & rat head	Rodents & Marmosets	Rodents & Marmosets	≤ 3kg animals
without MRS*PET INSERT	Rodents & Marmosets	≤ 3kg animals	≤ 5kg animals	≤ 10 kg animals
MRS*DRYMAG : MR component, dry magnet specifications				
FOV (mm)	70 x 100	135 DSV	190 DSV	240 DSV
5 gauss line (m)	0.85 x 1.6 axial.	1.1 x 1.3 axially	2.1 x 2.7 axially	3.0 x 3.5 axially
Magnet Technology / Cooling	Dry Magnet technology MRS*DRYMAG Cryogen free (no liquid helium and no nitrogen)			
Variable fields	Yes, for Powerscan: up to 3 additional stengths			
Integral RF shield	Yes, self shielded			
Gradient strength	600 mT/m	560 mT/m	400 mT/m	136 mT/m
Gradient upgrade	1029 mT/m	800 mT/m	800 mT/m	260 mT/m
Coils	Volume, surface, phased array, multinuclear, Cryo-coils			

MRS*PET : PET specifications for CLIP-ON and INSERT								
PET-INSERT (IN) PET-CLIP-ON (CO)	PET-IN 40	PET-CO 80	PET-IN 80	PET-CO 140	PET-IN 140	PET-CO 140	PET-IN 140	PET-CO 220
Bore size (mm)	60	112	112	151	151	151	151	290
Transaxial FOV (mm)	40	80	80	140	140	140	140	220
Axial FOV (mm)	50.4 (PET-CO 801, 1401), 102.48 (PET-CO 802, 1402) & 151.2 (PET-CO 803, 1403) 50.4 (PET-IN 401, 801), 102.48 (PET-IN 402, 802, 1402) & 151.2 (PET-IN 803, 1403)							202
Extended aFOV	300 mm with Motorized bed and 600 mm for 42 cm magnet bore							
Depth of Interaction	Yes- true DOI from hardware configuration							
Spatial Resolution with 3D OSEM (mm)	0.7	0.7	0.7	≤0.8	≤0.8	≤0.8	≤0.8	≤1.3
Sensitivity	up to 11% depending of the configuration							
MRS*SPECT : SPECT specifications for CLIP-ON								
SPECT-CLIP-ON	MRS*SPECT/MR	MRS*SPECT/MR	N/A	N/A				
Bore size (mm)	90	90						
Dimensions and weight with animal table								
DRYMAG (mm)	1525 x 2545 x 989	1525 x 2545 x 989	1700 x 1700 x 1900	1700 x 1700 x 1900				
Total Weight	<500 kg	<600 kg	<1350 kg	<3500 kg				

PRECLINICAL SPECT-PET/MR



PET/MR imaging
from mice to 10 kg animals imaging

PET/MR imaging
from rodents to 10 kg animal imaging

MRS*PET/MR 4.7T

Dry magnet technology: Cryogen-free
Simultaneous and Sequential Imaging

MRS*PET/MR 3.0T

Dry magnet technology: Cryogen-free
Simultaneous and Sequential Imaging

Main Specifications				
Model reference	MRS*PET/MR 4717	MRS*PET/MR 4724	MRS*PET/MR 4731	MRS*PET/MR 4742
Bore size	17 cm	24 cm	31 cm	42 cm
Animal type with MRS*PET CLIP-ON	Rodents, marmosets 600g	≤ 3kg animals	≤ 5kg animals	≤ 10 kg animals
Animal type with MRS*PET INSERT	Whole body mice & rat head	Rodents & Marmosets	Rodents & Marmosets	≤ 3kg animals
without MRS*PET INSERT	Rodents & Marmosets	≤ 3kg animals	≤ 5kg animals	≤ 10 kg animals
MRS*DRYMAG : MR component, dry magnet specifications				
FOV (mm)	70 x 100	135 DSV	190 DSV	240 DSV
5 gauss line (m)	0.75 x 1.5 axially	1.0 x 1.2 axially	1.9 x 2.5 axially	2.5 x 3.2 axially
Magnet Technology / Cooling	Dry Magnet technology MRS*DRYMAG Cryogen free (no liquid helium and no nitrogen)			
Variable fields	Yes, for Powerscan: up to 3 additional stengths			
Integral RF shield	Yes, self shielded			
Gradient strength	600 mT/m	560 mT/m	400 mT/m	136 mT/m
Gradient upgrade	1029 mT/m	800 mT/m	800 mT/m	260 mT/m
Coils	Volume, surface, phased array, multinuclear, Cryo-coils			

MRS*PET : PET specifications for CLIP-ON and INSERT								
PET-INSERT (IN) PET-CLIP-ON (CO)	PET-IN 40	PET-CO 80	PET-IN 80	PET-CO 140	PET-IN 140	PET-CO 140	PET-IN 140	PET-CO 220
Bore size (mm)	60	112	112	151	151	151	151	290
Transaxial FOV (mm)	40	80	80	140	140	140	140	220
Axial FOV (mm)	50.4 (PET-CO 801, 1401), 102.48 (PET-CO 802, 1402) & 151.2 (PET-CO 803, 1403) 50.4 (PET-IN 401, 801), 102.48 (PET-IN 402, 802, 1402) & 151.2 (PET-IN 803, 1403)							202
Extended aFOV	300 mm with Motorized bed and 600 mm for 42 cm magnet bore							
Depth of Interaction	Yes- true DOI from hardware configuration							
Spatial Resolution with 3D OSEM (mm)	0.7	0.7	0.7	≤0.8	≤0.8	≤0.8	≤0.8	≤1.3
Sensitivity	up to 11% depending of the configuration							

MRS*SPECT : SPECT specifications for CLIP-ON				
SPECT-CLIP-ON	MRS*SPECT/MR	MRS*SPECT/MR	N/A	N/A
Bore size (mm)	90	90		
Dimensions and weight with animal table				
DRYMAG (mm)	1525 x 2545 x 989	1525 x 2545 x 989	1700 x 1700 x 1900	1700 x 1700 x 1900
Total Weight	<500 kg	<600 kg	<1350 kg	<3500 kg

Main Specifications				
Model reference	MRS*PET/MR 3017	MRS*PET/MR 3024	MRS*PET/MR 3031	MRS*PET/MR 3042
Bore size	17 cm	24 cm	31 cm	42 cm
Animal type with MRS*PET CLIP-ON	Rodents, marmosets 600g	≤ 3kg animals	≤ 5kg animals	≤ 10 kg animals
Animal type with MRS*PET INSERT	Whole body mice & rat head	Rodents & Marmosets	Rodents & Marmosets	≤ 3kg animals
without MRS*PET INSERT	Rodents & Marmosets	≤ 3kg animals	≤ 5kg animals	≤ 10 kg animals
MRS*DRYMAG : MR component, dry magnet specifications				
FOV (mm)	70 x 100	135 DSV	190 DSV	240 DSV
5 gauss line (m)	0.65 x 0.8 axially	1 x 1.3 axially	1.7 x 2.2 axially	1.6 x 2.1 axially
Magnet Technology / Cooling	Dry Magnet technology MRS*DRYMAG Cryogen free (no liquid helium and no nitrogen)			
Variable fields	Yes, for Powerscan: up to 3 additional stengths			
Integral RF shield	Yes, self shielded			
Gradient strength	600 mT/m	560 mT/m	400 mT/m	136 mT/m
Gradient upgrade	1029 mT/m	800 mT/m	800 mT/m	260 mT/m
Coils	Volume, surface, phased array, multinuclear, Cryo-coils			

MRS*PET : PET specifications for CLIP-ON and INSERT								
PET-INSERT (IN) PET-CLIP-ON (CO)	PET-IN 40	PET-CO 80	PET-IN 80	PET-CO 140	PET-IN 140	PET-CO 140	PET-IN 140	PET-CO 220
Bore size (mm)	60	112	112	151	151	151	151	290
Transaxial FOV (mm)	40	80	80	140	140	140	140	220
Axial FOV (mm)	50.4 (PET-CO 801, 1401), 102.48 (PET-CO 802, 1402) & 151.2 (PET-CO 803, 1403) 50.4 (PET-IN 401, 801), 102.48 (PET-IN 402, 802, 1402) & 151.2 (PET-IN 803, 1403)							202
Extended aFOV	300 mm with Motorized bed and 600 mm for 42 cm magnet bore							
Depth of Interaction	Yes- true DOI from hardware configuration							
Spatial Resolution with 3D OSEM (mm)	0.7	0.7	0.7	≤0.8	≤0.8	≤0.8	≤0.8	≤1.3
Sensitivity	up to 11% depending of the configuration							

MRS*SPECT : SPECT specifications for CLIP-ON				
SPECT-CLIP-ON	MRS*SPECT/MR	MRS*SPECT/MR	N/A	N/A
Bore size (mm)	90	90		
Dimensions and weight with animal table				
DRYMAG (mm)	1525 x 2545 x 989	1525 x 2545 x 989	1700 x 1700 x 1900	1700 x 1700 x 1900
Total Weight	<500 kg	<600 kg	<1350 kg	<3500 kg

Animal Handling

Anaesthesia | Cardiac Gating | Respiractory Gating | Pathogen-free beds

The Imaging beds on MR SOLUTIONS systems are designed to provide important support functions to the animal during the preparation stage and throughout the imaging process. The beds provide anaesthetic gas to the animal and thermo-regulation of the animal during the scan.

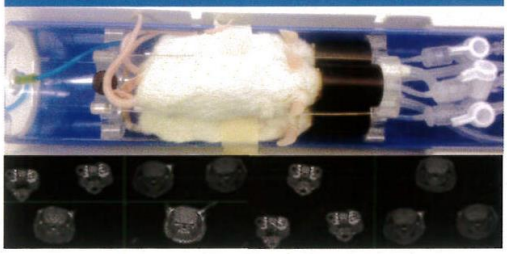
Pathogen-free Imaging Cells with physiological monitoring for mice, rats, marmoset, monkeys and rabbits.

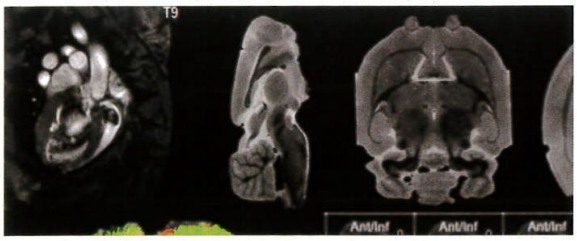
Ensures reproducible imaging conditions for longitudinal studies and provides a pathogen-free environment for immunodeficient animals and infectious disease studies.

ANIMAL IMAGING BEDS MRI COMPATIBLE

Mice Ø38mm | Rats Ø70mm | Large animals 3 kg up to 12 kg Ø115mm Ø150mm

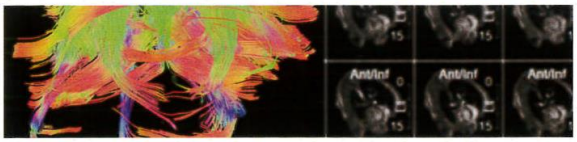
High-throughput scanning
Imaging 3 mice simultaneously

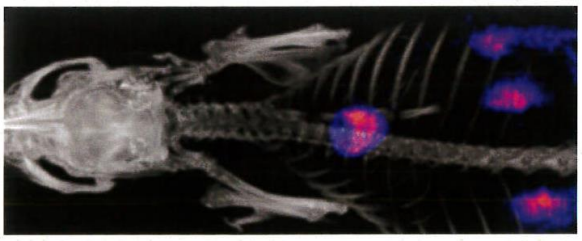




Advanced MRI Sequences

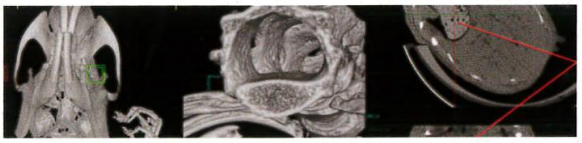
MRS*DRYMAG & **MRS***SPECT-PET/MR





PET/SPECT/CT imaging

Available with all **MRS***CLIP-ON



MR SOLUTIONS products and services			
Molecular Imaging	Magnetic Resonance Imaging	Molecular & Magnetic Resonance Imaging	Applications
PET/SPECT/CT PET/CT SPECT/CT CT PET, SPECT	Cryogen-free MR / Dry Magnet Wet magnet refurbishment Magnet development Gradients Coils	PET/MR 9.4T SPECT-PET/MR 7.0T SPECT-PET/MR 4.7T SPECT-PET/MR 3.0T PET INSERT for MRI	Preclinical Clinical Food Quality control Oil industry

For more information on other products please contact our team at information@mrsolutions.com

PRECLINICAL SPECT-PET/MR

(4) Bruker 公司 BioSpec Maxwell MRI 產品型錄

BioSpec Maxwell MRI

- Intelligent Preclinical MRI
  3 Tesla, 7 Tesla, and 9.4 Tesla

Innovation with Integrity

MRI

Make the Move to Intelligent MRI

Liquid cryogen-free MRIs take the first step towards cryogen independence, saving both time and money by eliminating the financial expense of cryogen acquisition and the time involved in the tedious fillings, all while conveniently **fitting in every lab**.

BioSpec Maxwell MRIs take MRI innovation to the next level with automated self-supervision, enabling significant reduction of service requirements during installation and throughout the lifetime of your instrument.

This **automated self-supervision** puts the power in your hand to auto-cool and auto-charge the instrument. Combined with **remote monitoring**, it lets you sleep well at night, knowing that your BioSpec Maxwell MRI continually self-regulates to its optimal state so that your research remains undisrupted.

Preclinical MRI at 3 Tesla, 7 Tesla, and 9.4 Tesla with simplified handling and streamlined scanning and analysis combined with full research flexibility provides a completely new small rodent imaging experience.

Put your focus on your research.
Let your BioSpec Maxwell MRI do all the rest.

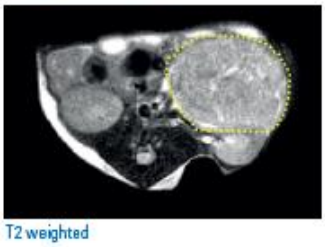
Applications

BioSpec Maxwell MRIs with their leading sequence portfolio and ready-to-use imaging protocols support a wide range of research applications, enabling breakthrough discoveries in preclinical research.

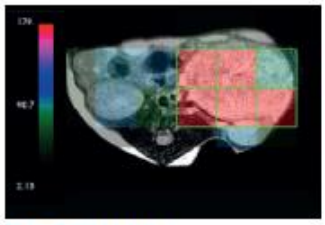
Oncology

Spectroscopic imaging of hyperpolarized pyruvate and lactate conversion reveals intertumoral variation in patient derived renal cell carcinoma. 2D EPSI at 3T after infusion of hyperpolarized [1-^{13}C] pyruvate in mouse model.

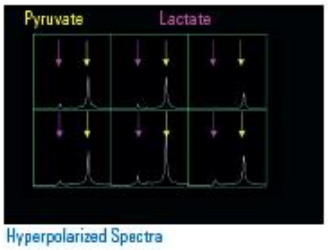
Courtesy: R. Sriram, S. Subramaniam, D. Peehl, J. Kurhanewicz et al. Pre-Clinical MR Imaging Core, University of California, San Francisco, USA



T2 weighted



T2 weighted + Lactate



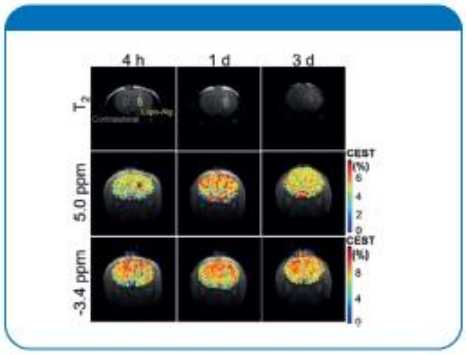
Hyperpolarized Spectra

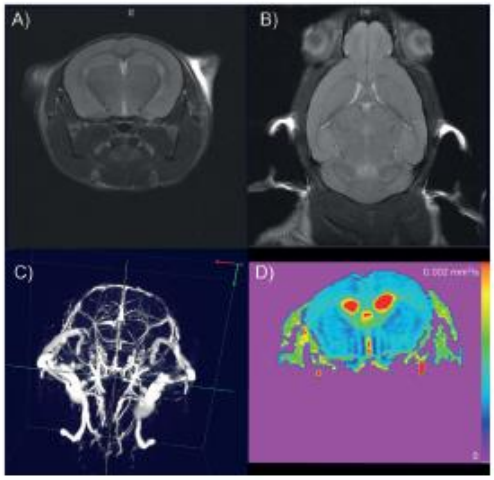
Drug Development

CEST imaging at 3T enables monitoring of compositional changes of hydrogel-based drug treatment for glioblastoma multiforme (GBM), providing valuable insights for treatment refinement.

Courtesy: K.W.Y. Chan, City University of Hong Kong, Kowloon Tong, Hong Kong

Reference: Han, et al., CEST MRI detectable liposomal hydrogels for multiparametric monitoring in the brain at 3T. Theranostics 2020; 10(5): 2215-2228. doi: 10.7150/thno.40146





Neurological Studies

Mouse neuro imaging at 9.4T. A+B) T2 weighted RARE images C) Time of Flight Angiography and D) ADC mapping. Combined with high resolution morphological data, perfusion details and quantitative diffusion provide a fuller picture when characterizing neurological diseases.

Maximum Productivity

Ease of Use from the Very Beginning

BioSpec Maxwell MRIs fit perfectly into existing lab structures, expanding biomedical research capabilities with easy-to-use MRI. User comfort and confidence is put at the forefront with these small instruments that give the user a feeling of sureness.

Touchscreen animal positioning and animal cradles with a quick-lock interface automatically connecting all monitoring and life support connections make preparation fast and easy. With over 100 pre-validated protocols for studies on i.e., morphology, perfusion, and angiography to use right out of the box, and intuitive workflows including automatic quantification, even scientists who are new to MRI to have the certainty that they will achieve the results they desire.

Combining a BioSpec Maxwell MRI with a state-of-the-art PET insert or inline module expands the range of research possibilities to provide even deeper insights using one integrated instrument.

Perfect small rodent imaging has never been easier.

- Animal cradles with quick-lock interface automatically connect all monitoring and life support connections
- Open and closed cradles with anesthetic gas exhaust connection and i.v. tracer injection route
- Water and air heating for animals available
- 3-mouse cradle for enhanced throughput available
- Accurate animal positioning with the motorized Animal Transport System, including touchscreen operation even with gloves for a simplified, precise workflow
- Automatic multi-station imaging for elongated field of views
- ParaVision 360 software with over 100 validated and ready to use *in vivo* protocols and scan programs for mice and rats
- Streamlined workflows including automatic quantification
- Upgradable with state-of-the-art PET for simultaneous or sequential PET/MR

Technical specifications	
Magnet Technology	Maxwell liquid cryogen filling-free
Field Strengths	3 Tesla, 7 Tesla, 9.4 Tesla
Bore size	17 cm
Hold-time	Minimum of 6 hours[1]
Faraday cage required	No
Quench pipe required	No
Minimal vibration pulse tube cooler	Yes
MRI CryoProbe compatible	Yes
Integrated PET insert or inline available	Yes
Advanced ParaVision 360 software	Yes
Dimensions (LxWxH)	2.71 m (3T: 2.54 m) x 0.96 m x 2.06 m (3T: 1.94 m)
Weight	<1.75 t (3T: 1.35 t)

[1] 3T: 4 hours, 9.4 T: 4 hours during power outage

For More Information

Bruker BioSpin

info@bruker.com
www.bruker.com

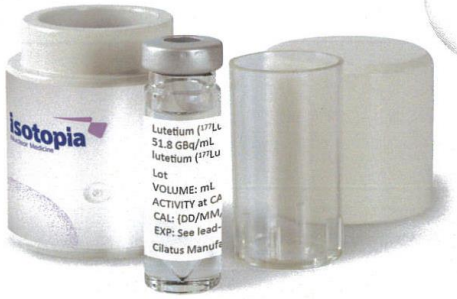
(5) isotopia 公司 Lu-177 射源資料

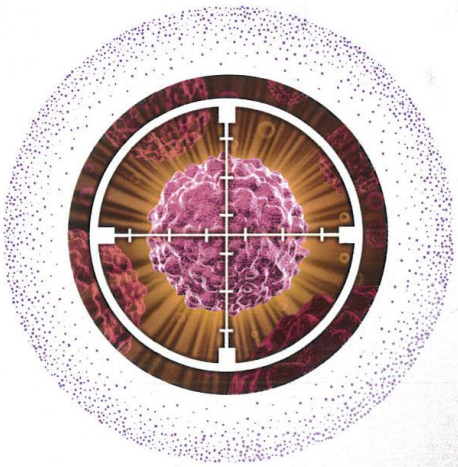
isotopia
Nuclear Medicine

Lutetium (^{177}Lu) chloride

51.8 GBq/mL radiopharmaceutical precursor, solution

Targeted molecular radiotherapy





EUROPEAN MARKETING AUTHORIZATION

Rev A. January 2023

Lutetium (^{177}Lu) Solution for Radiolabeling

Specifications

Chemical Form	LuCl3 in HCl 0.04N
Packaging	10 mL molded vial closed with fluorotec septum and open top crimp seal 5 mL V-shaped vial closed with fluorotec septum and open top crimp seal

Test	Specification- Lu 177 N.C.A
Appearance	Clear, colorless solution
pH	1.0 – 2.0
Identification A *(Gamma spectrometry)*	Gamma photons with 208 KeV and 113 KeV present
Identification B *(pH)*	1.0 – 2.0
Identification C *(iTLC)*	The retardation factor of the principal peak in the chromatogram obtained in the test for radiochemical purity is 0.4 to 0.7
Specific Activity *(by ICP-OES at end of production)*	>3000 GBq/mg (>81 Ci/mg)
Chemical Purity *(by ICP- OES at end of shelf life)*	Cu ≤ 1.0 µg/GBq Fe ≤ 0.5 µg/GBq Pb ≤ 0.5 µg/GBq Zn ≤ 1.0 µg/GBq Yb ≤ 1.0 µg/GBq
Radioactive concentration *(at end of production)*	51.8 GBq/mL ± 10%
Radionuclidic Purity *(Gamma spectrometry at end of shelf life)*	^{175}Yb ≤ 0.1%
	The total radioactivity due to other radionuclides impurities ≤ 0.01%
Radiochemical Purity *(by iTLC)*	[^{177}Lu]lutetium(III) ion ≥99%
Bacterial endotoxins	< 35 EU/mL
Sterility	Sterile (by autoclaving)

(6) SHINE 公司 Lu-177 射源資料

Next Generation Cancer Therapy

SHINE is dedicated to facilitating the worldwide supply of n.c.a. lutetium-177 with enhanced scalability and security of supply.

Key Advantages

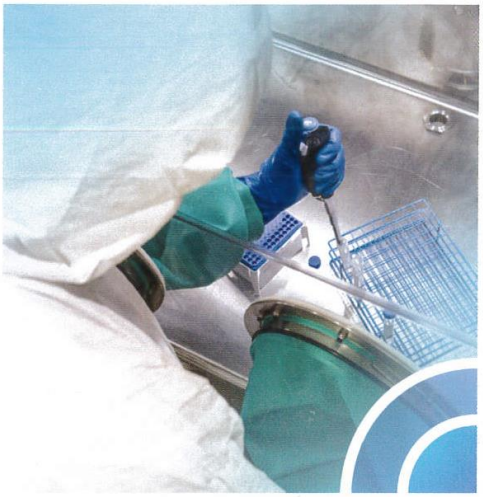
- U.S.-based production and logistics
- Expanded U.S. production coming online in late 2023
- Exceeds European Pharmacopeia standards
- U.S.-based proprietary ytterbium-176 enrichment
- Produced in accordance with current Good Manufacturing Practice
- Drug Master File submitted to U.S. Food and Drug Administration (FDA)
- Commercial facility in Europe planned for 2025

SHINE | HEALTH ILLUMINATED

n.c.a. Lu-177

Vertically Integrated Production for Readily Available Product

We are working to become the first vertically integrated manufacturer of n.c.a. lutetium-177 in the world. By establishing a proprietary U.S.-based supply of Yb-176, we have reduced market dependency for sole-sourced critical raw material.



n.c.a. Lu-177 Product Specifications

Packaging Options	• 10 mL flat bottom glass vial • 2 mL flat bottom glass vial • 2mL conical glass vial
Radiolabeling Yield	≥ 99%
Chemical Form	n.c.a. $LuCl_3$ in 0.04M HCl solution
Specific Activity	ART >3,000 GBq/mg
Radionuclidic Purity	>99.9% ^{177}Lu
Radiochemical Purity	>99% as $^{177}LuCl_3$
Shelf Life	10 Days

The Future of Cancer Treatment is Now

To learn more, call (608) 530-5653 or email orders@shinefusion.com

3400 Innovation Ct.
Janesville, WI 53546

SHINEfusion.com

@ShineFusion

(7) Eckert & Ziegler 公司 Ac-225 射源資料

(8) TERTHERA 公司 Tb-161 射源資料

TERTHERA

TERBIUM THERANOSTICS

PRODUCT INFORMATION

Potential indications prostate, breast, neuroendocrine and solid cancers

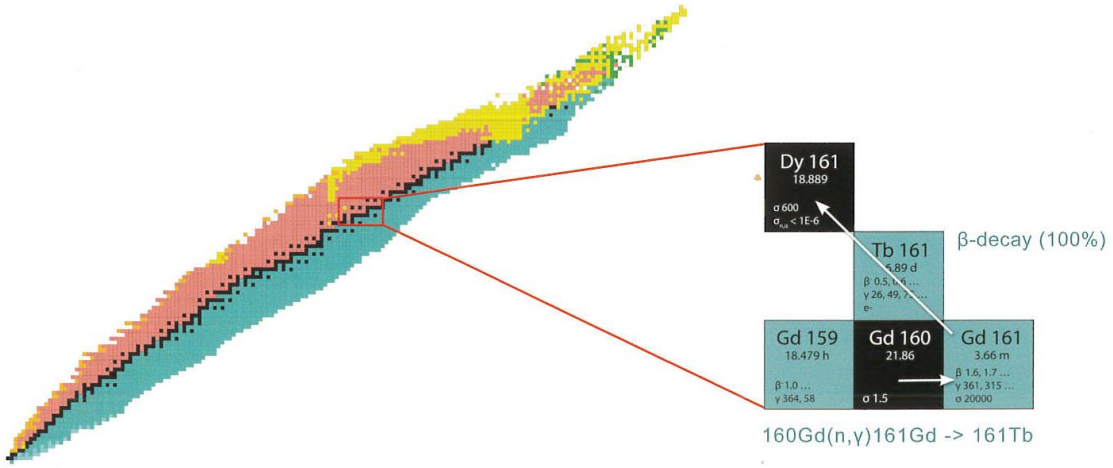
Eβ 154KeV (average)
Eγ 49keV (17%) 75keV (10%)

Product Tb-161 in aqueous 0.05M HCl
Decays to stable Dy-161

Factor 3 higher cellular absorbed dose
High LET Conversion & Auger electrons

Chemical purity >99% (ICP-MS)
Radiochemical purity >99% (TLC)

Global availability from Q1 2023
not for direct administration to humans



+31 (0)76 - 8200970
support@terthera.com
www.terthera.com

SIGN-UP for the next round of Terbium-161

References (2/2): [5] Müller et al, Direct in vitro and in vivo comparison of 161Tb and 177Lu using a tumour-targeting folate conjugate (2013); [6] Grünberg et al, Anti-L1CAM radioimmunotherapy is more effective with the radiolanthanide terbium-161 (2014); [7] Marion de Jong et al, Evaluation in vitro and in rats of 161Tb-DTPA-octreotide (1995)

OUR MISSION

At TerThera we aim to meet the growing demand in cancer healthcare using Terbium-161 by enabling out-patient Radioligand Therapy (RLT) to treat an increasing number of patients on daily basis.

TERBIUM-161 NCA

Carrier free lanthanide Terbium-161, produced by neutron activation of Gadolinium-160, is a promising radionuclide for RLT exhibiting comparable chemical characteristics to known radiolanthanides. Early research suggests that as much as **16-fold increase in Auger and conversion electrons** is emitted by Terbium-161 resulting in potential **3-fold higher cellular absorbed dose improving anti-tumor capabilities** for primary and (micro)metastasized cancers.

RADIOLIGAND THERAPY

Using PSMA and SST analogues, Tb-161 has shown an **excellent bioequivalence** and may provide for a **higher spatial resolution** SPECT compared to known radiolanthanides leading to the **detection of smaller lesions**. With the cellular absorbed dose increased, as well as for **undetectable (micro)metastasis**, the overall disease control could be improved. And when optimizing the general **radiation safety**, the treatment room capacity may be extended for RLT.

SIGN-UP for the next round of Terbium-161

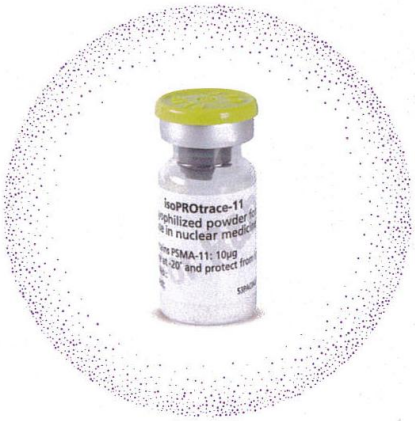
Minervum 7070
4817 ZK Breda
The Netherlands
+31 (0)76 - 8200970
support@terthera.com
www.terthera.com

References (1/2): [1] Bernhardt et al, Dosimetric Analysis of the Short-Ranged Particle Emitter 161Tb (2021); [2] Marin et al, Establishment of a clinical SPECT/CT protocol (2020); [3] Alcocer-Ávila et al, Radiation doses from 161Tb and 177Lu (2020); [4] Müller et al, Terbium-161 for PSMA-targeted radionuclide therapy of prostate (2019)

(9) isotopia 公司 PSMA-11 前驅物資料

isotopia
Nuclear Medicine

Imagine that the complex 68Ga PSMA labeling process has just turned into a simple **1 vial, 5-minute** preparation kit



Multi patient vial

isoPROtrace-11 Kit
for PSMA-11 labeling

A dedicated kit for **68Ga PSMA-11** labeling to use as a PET CT tracer for prostate cancer imaging and diagnosis.

- The **isoPROtrace-11 Kit** we have developed is a safe, ready-to-use, single vial for producing multi-doses and dispensing them within 5 short minutes.
- Unique patented formula
- Eliminates the need for costly modules and consumables
- Enhances efficiency, saves time and money
- Minimizes the technician's exposure to isotopes

Method	isoPROtrace-11 Kit	Conventional Semiautomated synthesis
Additional reagents added	Not needed	Needed
pH adjustments	Not needed	Requires adjustment
Heating step	Not needed	Needed
Purification	Not needed	Needed
Time to final product	5 min	30 min

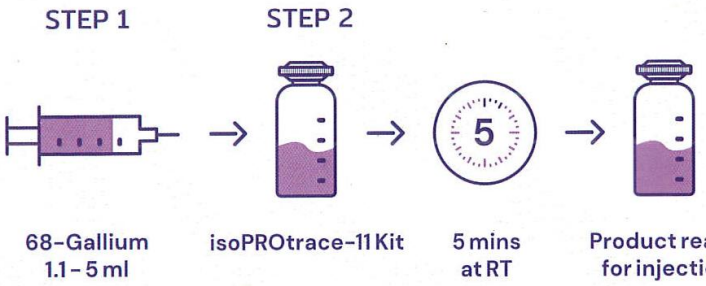
5 minutes incubation time

No heating steps necessary

Multi patient vial

isotopia
Nuclear Medicine

1 vial- 2 simple preparation steps



isoPROtrace-11 kit

STEP 1 - Inject 1.1 - 5 ml 0.1M ^{68}Ga or 2.2 - 4 ml 0.05M ^{68}Ga into the kit vial

STEP 2 - Shake the vial and let it incubate for 5 minutes at room temperature

At the end of this brief process, the product is ready for use.

Compatible with the three major generators, and accelerator produced 68Ga.

Radiolabeled Kit Specifications	
Appearance	Clear and colorless solution, free of visible particles
pH after radiolabeling	4.0-8.0
Radio-Chemical Purity	≥ 95%
Radio-Chemical Yield	≥ 99%
Sterility	Sterile
Bacterial Endotoxins	< 175/V V being the maximum recommended dose in milliliters

GOOD MANUFACTURING PRACTICE GMP COMPLIANT

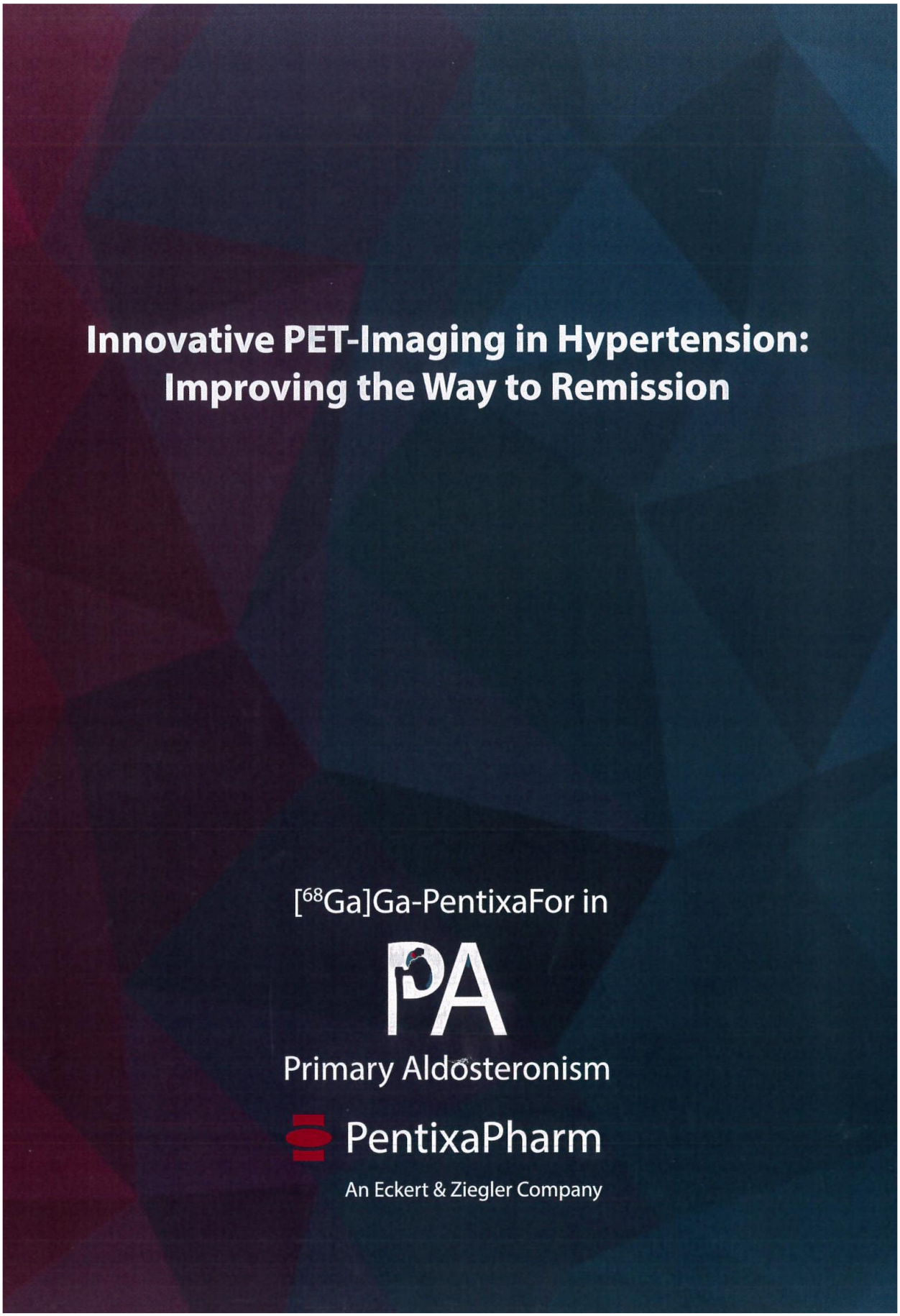
*Any use of this product is on an investigational basis or for use in approved clinical trials only.
This product has not received marketing authorization in any jurisdiction to date.

References
1. "[68Ga]Ga-PSMA-11: The First FDA-Approved 68Ga-Radiopharmaceutical for PET Imaging of Prostate Cancer"
U. Hennrich. 2021 MDPI journal.
2. "68Ga-labeled PSMA-11 (68GaisoPROtrace-11) synthesized with ready to use kit: normal biodistribution and uptake characteristics of tumour lesions"
M. Muchnik Kurash. 2020 Scientific Reports.
3. "Enhancing capacity and synthesis of [68Ga]68-Ga-PSMAHBED- CC with the lyophilized ready-to-use kit for nuclear pharmacy applications"
H. Golan. 2020 Nuclear Medicine Communications.
4. "Performance of a Prostate-Specific Membrane Antigen Positron Emission Tomography/Computed Tomography-Derived Risk-Stratification Tool for High-risk and Very High- risk Prostate Cancer"
M. Xiang. 2021 JAMA Network Open.

isotopia
Nuclear Medicine

Isotopia Molecular Imaging LTD
39 Alexander Yanai St Segula Industrial Park Petach Tikva 4927735 Israel | **Tel** +972 3 913 0314
info@isotopia.co.il | isotopia-global.com

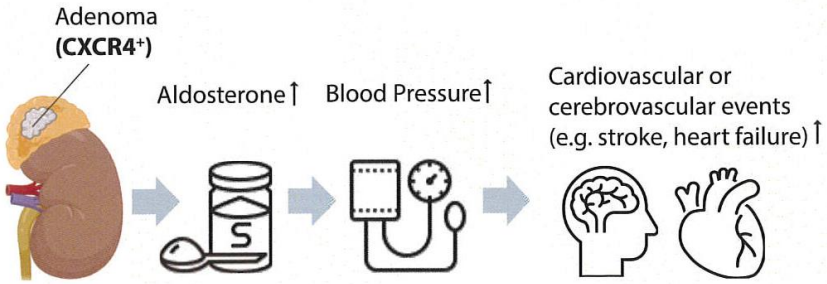
(10) Eckert & Ziegler 公司 Ga-68-PentixaFor 藥物資料



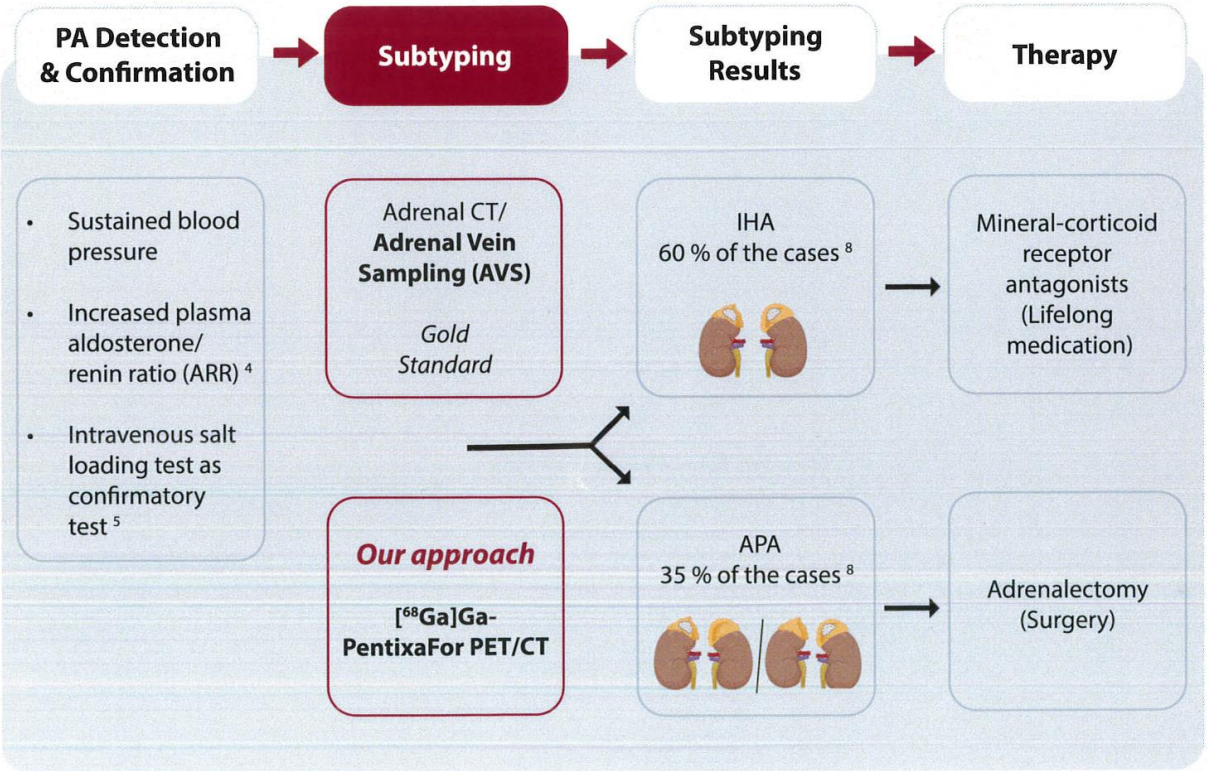
Medical Background

- Primary Aldosteronism (PA)/Conn's Syndrome is the most common cause of secondary hypertension.[1,2]
- Bilateral idiopathic hyperplasia (IHA) and aldosterone producing adenomas (APA) are subtypes of PA.[3]
- The disease is often underdiagnosed, but new data show an incidence of 6-13 %.[4]

- CXCR4 is known to be **overexpressed** in aldosterone-producing adenomas causing PA.[5]
- CXCR4 overexpression can be used to **identify patients** with APA for surgery![5]

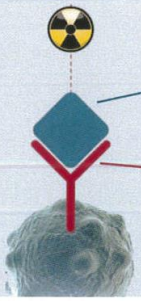


Journey of Patients with PA



Our Approach

PentixaPharm is developing [^{68}Ga]Ga-PentixaFor as innovative PET/CT imaging tracer to subtype patients with PA to enable cure by surgery (adrenalectomy).



[^{68}Ga]Ga-PentixaFor
(Gallium(^{68}Ga)boclatixafortide)

CXCR4 expressing Adenoma

Subtyping of PA

Current standard (AVS) has several limitations in comparison to the innovative [^{68}Ga]Ga-PentixaFor PET/CT imaging:

Adreal Vein Sampling

Complicated procedure

- Invasive[6]
- Time-consuming[7]
- Low success rates[6,8,9]
- Patient-burden: Risk of complications[9-11]

Unreliable

- No standardized procedure & interpretation[12]
- Medication influences AVS results[13]

Low availability

- Requires experienced physicians[14]
- Long waiting periods

High costs

- For private payers and healthcare systems[15]

[^{68}Ga]Ga-PentixaFor PET/CT

Easy execution

- **Non-invasive**[21,16]
- **Fast**
- **Safe**: No reported side-effects in >1300 patients[5,16-21]
- **Practical**: No change of medication needed[5,16-21]

Reliable

- High accuracy and image contrast[5,16-21]
- Standardized, easy & robust method[22]
- No known interference by medication[5,16-21]

High availability

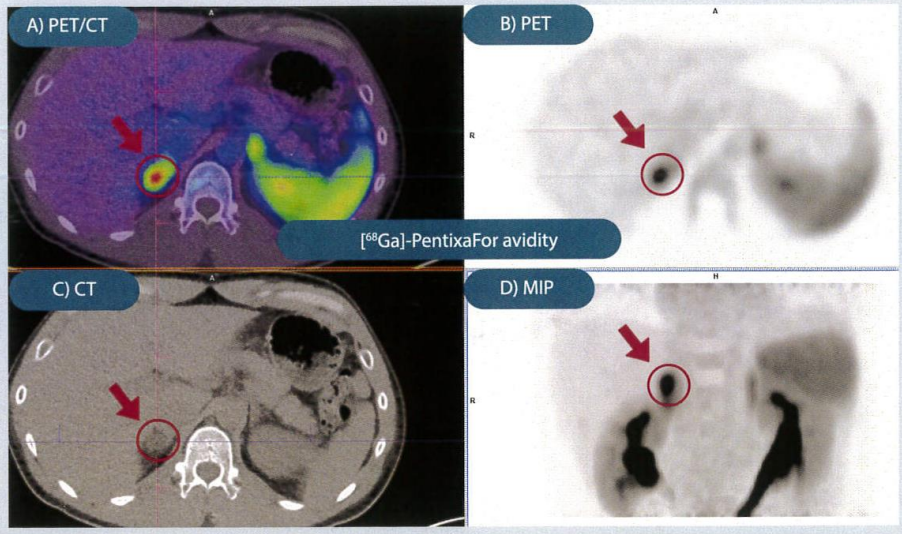
- High availability of PET/CT systems

Lower costs

- No need of repetition due to failure[5,16-21]

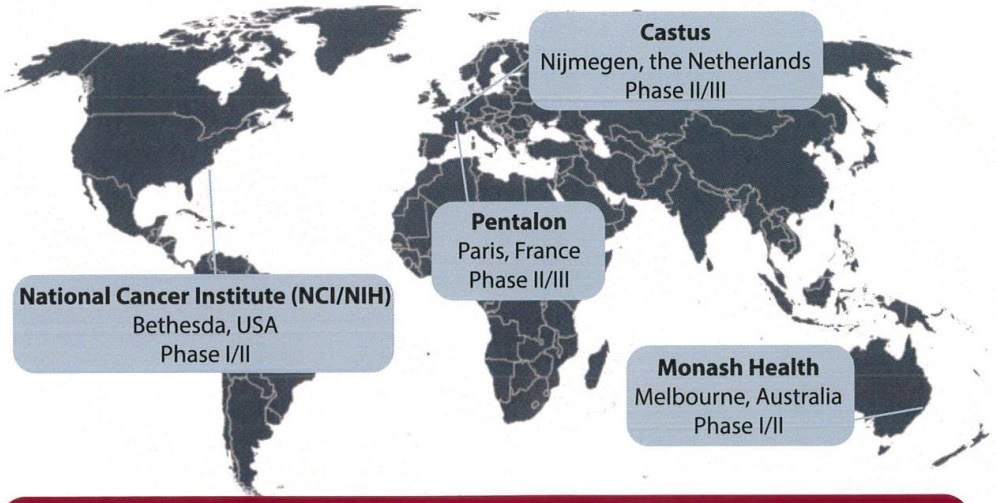
Clinical Data

Scans show a 21 mm right adrenal nodule with intense uptake of [^{68}Ga]Ga-PentixaFor. Positive aldosterone hypersecreting adenoma was confirmed to be concordant with AVS.



Transaxial (A-C) / coronal (D) slices show a right adrenal nodule with intense [^{68}Ga]Ga-PentixaFor avidity obtained by CT, PET, PET/CT and Maximum Intensity Projection (MIP). Images were provided by the Endocrine Hypertension team at Monash Health and Hudson Institute of Medical Research, Australia.

[^{68}Ga]Ga-PentixaFor IIS program



We are currently planning a clinical development program to bring [^{68}Ga]Ga-PentixaFor to the market.

PentixaPharm GmbH
Bismarckstraße 13
97080 Würzburg | Germany
Tel. +49 931 991360-76
www.pentixapharm.com

PentixaPharm
An Eckert & Ziegler Company

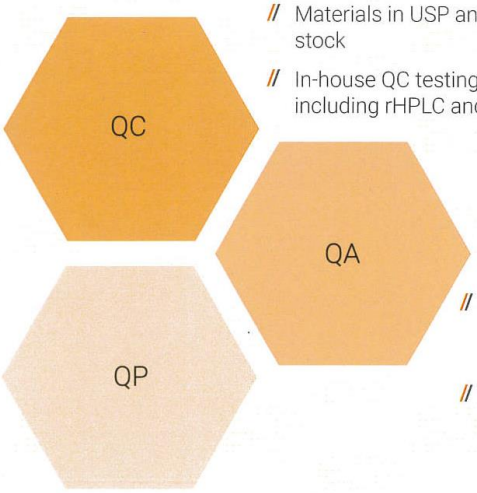
References

1)Abad-Cardiel et al., 2013, Rev Esp Cardiol.; 2) Gkaniatsa et al., 2021, The Journal of Clinical Endocrinology & Metabolism.; 3) Fanguigli et al., 2011, Int J Hypertens.; 4) Kyser et al., 2016, The Journal of Clinical Endocrinology % Metabolism; 5) Heinze et al., 2018, Hypertension.; 6) Adrenal Vein Sampling for Conn's Syndrome of the Adrenal Gland. Accessed August 21, 2023. https://www.adrenal.com/conn-syndrome/adrenal-vein-sampling; 7) Loberg et al., 2021., Rofo.; 8) Monticone et al., 2018, Lancet Diabetes Endocrinol.; 9) Lee et al., 2021, Ther Adv Endocrinol Metab.; 10) Hannah-Shmouni et al., 2017, J Clin Hypertens; 11) Fuss et al., 2018, Eur J Endocrinol.; 12) Quencer et al., 2021, CVIR Endovascular.; 13) Nagasawa et al., 2019, J Hypertens.; 14) Rossi et al., 2012, The Journal of Clinical Endocrinology & Metabolism.; 15) Deinum et al., 2018, Hypertension.; 16) Baz et al., 2022, BMJ Open; 17) Herrmann et al., 2015, J Nucl Med.; 18) Ding et al., 2020, Clin Nucl Med.; 19) Ding et al., 2021, Journal of Nuclear Medicine; 20) Gao et al., 2022, Eur Radiol.; 21) Hu et al., 2022; 22) Buck et al., 2022, J Nucl Med.; 23) Zheng et al., 2023, J Clin Endocrinol Metab.; 24) Funes Hernandez et al., 2023, Am J Kidney Dis.; 25) Reincke et al., 2021, Lancet Diabetes Endocrinol.; 26) Kline et al., 2020, J Clin Endocrinol Metab.; 27) Wachtel et al., 2016, Journal of Surgical Oncology

ROTOP CDMO Services

modular concept // based on your needs

cGMP Release



// Materials in USP and Ph.Eur. quality available from stock
// In-house QC testing e.g. HPLC, KFT and radiolabeling including rHPLC and iTLC

// European QP release service
// Fully inspected by e.g. US-FDA, TMMDA, MFDS

// Full cGMP system in place and ensured by external audits e.g. FDA
// Specialized QA for development during clinical study

Supply

// Country-specific labeling and packaging services
// For approved products and for IMPs
// Cold kits and radioactive products

Distribution

// Worldwide network of specialized sales partners
// Access to well-known key account sites and key opinion leaders

Logistics

// GDP-compliant transportation of cold kits, radiopharmaceuticals and investigational medicinal products (IMPs)
// Network of qualified logistics partners
// Access to European DHL Hub in Leipzig

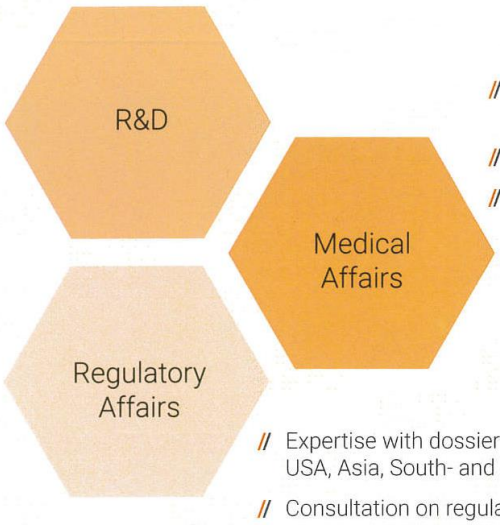
ROTOP Pharmaka GmbH cdmo@rotop-pharmaka.com www.rotop-pharmaka.com

ROTOP CDMO Services

modular concept // based on your needs

Development

// API development
// Cold kit development including lyo cycle development and radiolabeling performance testing
// Ready-to-use radiopharmaceutical development



// Support of national clinical programs, IITs
// Pharmacovigilance service
// Medical-scientific support for regulatory consultations

// Expertise with dossier submissions within the EU, USA, Asia, South- and Latin America and Australia
// Consultation on regulatory strategies for cold kits and radiopharmaceuticals

cGMP Manufacturing

// In-house cGMP manufacturing of APIs in the field of small molecules, peptides and aggregates
// Modern cGMP laboratories

API

// Over 20 years' expertise in the field of cold kit development and cGMP manufacturing
// Clinical supply and CMO possible

Ready-To-Use
Radiopharmaceuticals

// cGMP laboratories with hot cells including synthesis unit and dispensing unit
// No limitation for nuclides

ROTOP Pharmaka GmbH cdmo@rotop-pharmaka.com www.rotop-pharmaka.com

(12) HWM (WALISCHMILLER) 公司產品型錄

QUALITY FOR SAFETY

Wälischmiller Engineering is a specialist manufacturer of remote-handling and robotics solutions for over 60 years for environments that are inaccessible to humans.

The need to ensure the highest levels of safety in these environments means that all our products are designed and manufactured to the strictest quality criteria. Our focus on product quality and operational safety marks us out as one of the world leaders in the market. Our company slogan influences us every day and in everything we do: Quality for Safety.

At Wälischmiller Engineering, we take pride in offering turnkey solutions. We provide a fully integrated service that extends from planning and product development all the way to manufacturing and installation.

By working closely with our specialist engineers and project managers, you can be confident of receiving not just an off-the-shelf product, but a bespoke solution to your problems that offers the highest quality and a guarantee of long-term operational safety and efficiency for your staff.

Our quality management system has been certified to DIN EN ISO 9001:2008 and to KTA 1401 safety standard of the Nuclear Safety Standards Commission. Our environmental management system is certified according ISO 14001:2015. Our robotic system TELBOT® is certified according ATEX category 1/ zone 0.

We are certified acc. to
ISO 9001:2008
ISO 14001:2015

Delivery of the first A200 master-slave manipulators to the Research Centre at Jülich in Germany
1966

Development of the A1000 power manipulator for remote handling of heavy loads
1979

Delivery of the first TELBOT® handling robot to AECL Atomic Energy in Canada
1990

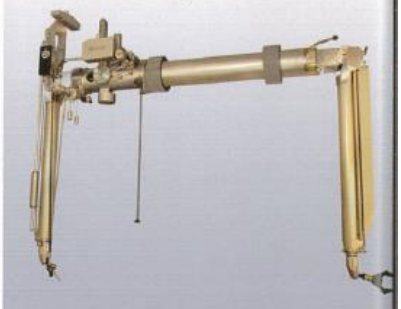
The "blue hall" with a height of 15 meters and a water pool with a depth of 5 meters are completed in Markdorf. The facilities are used for product assembly and testing.
1995

MASTER-SLAVE MANIPULATORS

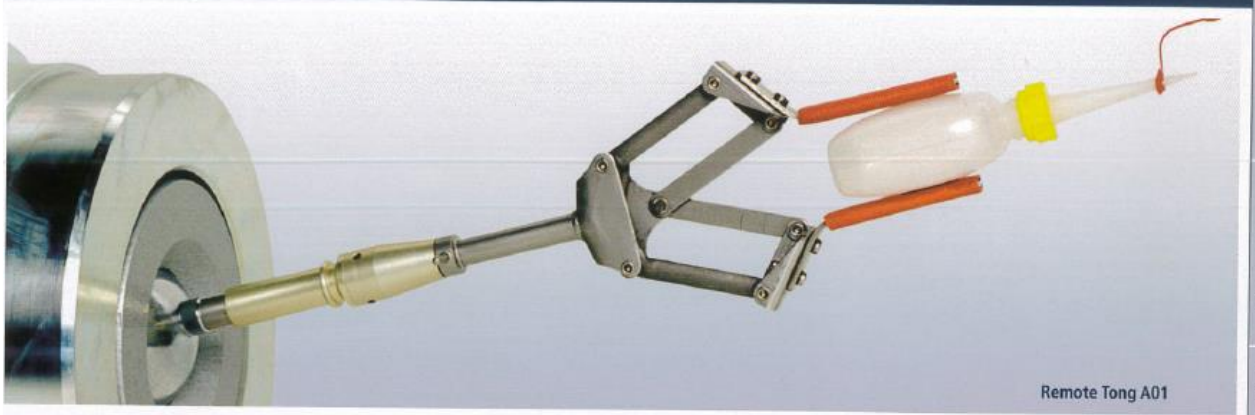
Telescopic Master-Slave Manipulator A100

Articulated Master-Slave Manipulator A200

Master-Slave Manipulator A203



Telescopic Master-Slave Manipulator A100



Remote Tong A01

Wälischmiller Engineering has been manufacturing master-slave manipulators for use behind shielding walls since the 1950s. Since then, we have become one of the world's leading manufacturers of remote handling equipment.

Thanks to their modular design, Wälischmiller Engineering systems can be configured to perform a variety of tasks in areas inaccessible to humans.

UNIVERSAL TONGS A01

The A01 is designed to perform simple remote handling tasks involving radioactive substances.

MASTER-SLAVE MANIPULATOR A203

The A203 is employed in small cells and boxes, mostly in the nuclear medicine.

ARTICULATED MASTER-SLAVE MANIPULATOR A200

This system is designed for medium-sized, lead-shielded or concrete-shielded cells.

TELESCOPIC MASTER-SLAVE MANIPULATOR A100

These manipulators are often installed in medium-sized and large concrete-shielded hot cells. The modular manipulator transfers the master arm movements to the slave arm by means of rotating shafts inside the shielded through-wall tube.
The master arm of the A100 can be replaced by a drive unit with servo motors. This can be assembled directly on the slave-arm or on the through-wall tube of the telescopic manipulator A100. The manipulator can be controlled with joysticks in a secure area with a controller and a visualisation system.

More information about Articulated Master-Slave Manipulator A200
www.hwm.com/products/articulated-master-slave-manipulator-a200.html

WÄLISCHMILLER HWM
Quality for Safety.

Articulated Manipulator System HWM A200

Flexibility for Precision

Articulated Manipulator System HWM A200

Are you looking for a manipulator for a facility that handles dangerous substances? You have come to the right place! You have found the right manipulator: our A200.

Specially designed for the nuclear industry, the A200 is suitable for smaller cells or boxes such as those used in nuclear medicine.

Safe, comfortable and thus easy to handle

The manipulator consists of a master arm and a slave arm, linked by a through-wall tube. Transfer of motion is entirely mechanical. The slave arm carries out the movement directly and simultaneously that you specify via the master arm. A weight counterbalance facilitates the handling of weights up to 10 kg. The A200 provides a feeling of operational security which adds to your working comfort.

The A200 is simply constructed and therefore more robust. This means that your operating costs can be reduced to a minimum. One thing we are sure of: you will get on well with the A200 day in, day out.

A manipulator for every cell

The unique feature of our manipulator is that the slave arm is longer than the master arm. This is useful for reaching objects that are farther away. The working area of the master arm, however, remains within the scope of your own physical movement. Slave arms in various lengths are available (preferably 1100 mm). The advantage for you is that the working area of the A200 can simply be adjusted to suit your cell.

Materials

Materials have been specially selected for the nuclear industry. We use radiation-, acid- and corrosion-resistant materials. This means you can be confident that you are purchasing a durable manipulator of the highest quality.

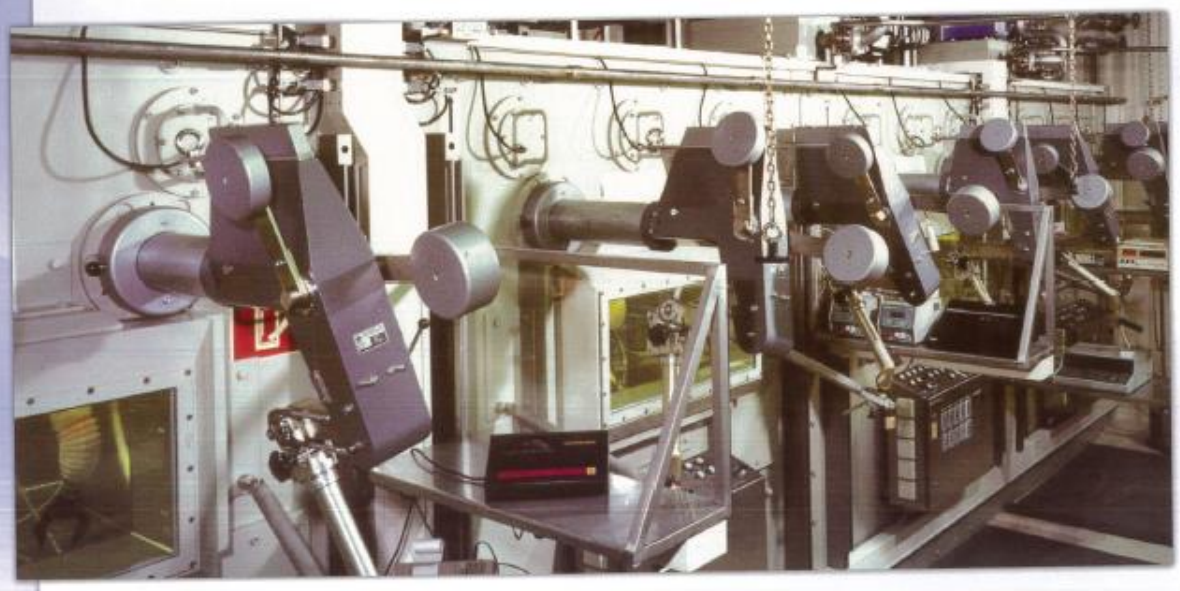
The A200 Series

The A200 is suitable for installation heights of 1.85 m to 2.25 m. The manipulator is available in three versions:

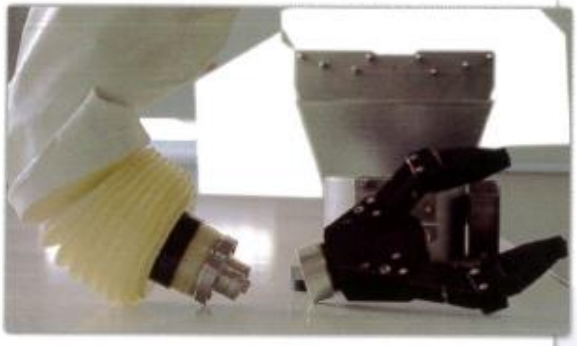
- The A201 comes with non-gas-tight through-wall tube.
- The A201E has an additional electrical adjustment facility for horizontal and vertical movement.
- The A202 has a gas-tight through-wall tube in the shielding wall.

Fields of application

- assemblies behind shielding walls
- smaller hot cells or boxes in:
  - nuclear medicine and isotope production
  - research facilities
  - sorting plants for radioactive waste
  - the chemical industry
  - the biotechnology industry
- support of automatic processes in hot cells
- auxiliary manipulator for the decommissioning of nuclear power stations



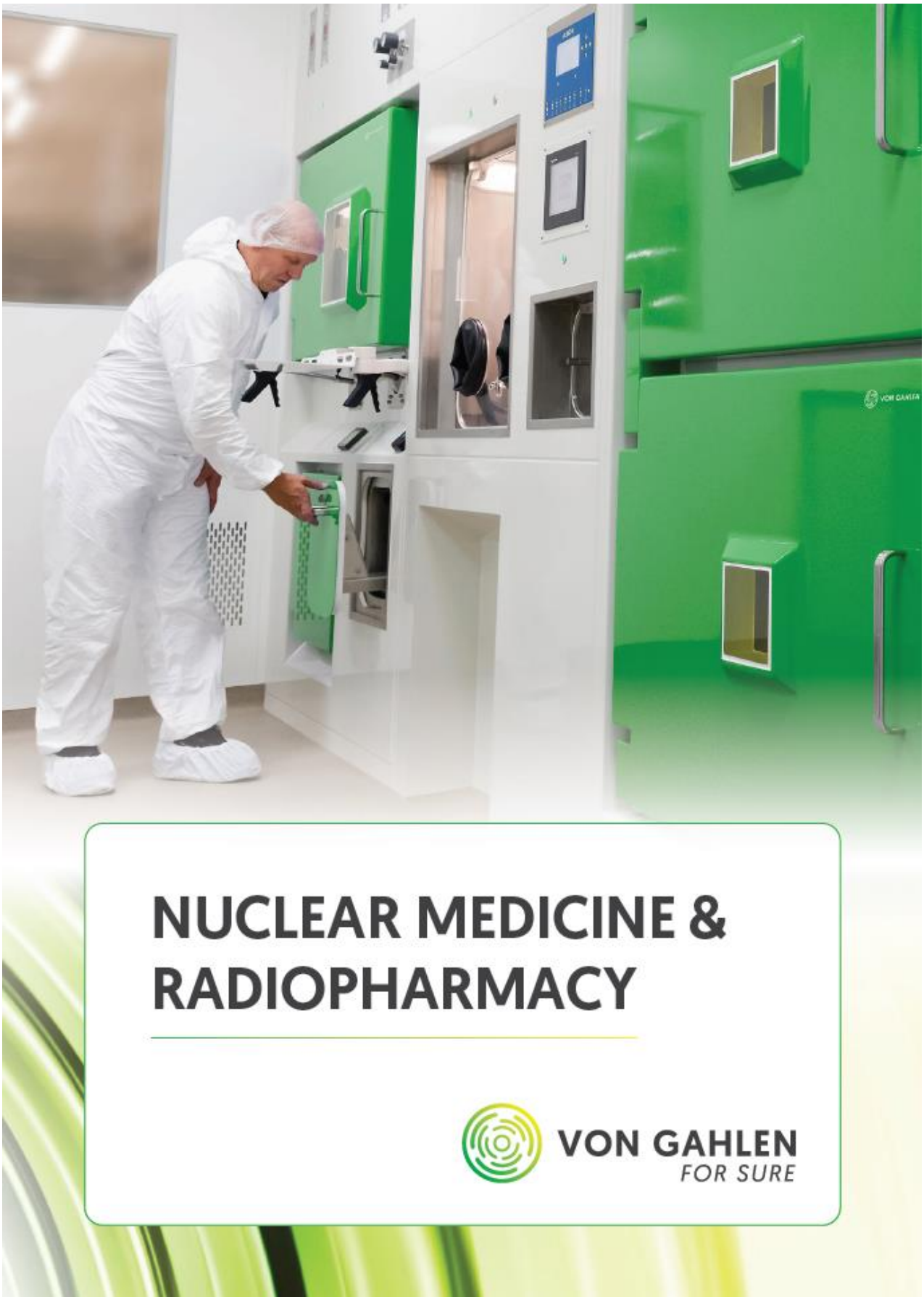
An overview of A200 accessories



You can also count on our competence in the area of accessories. As specialists we can provide you with individually tailored versions:

- protective covers (booting) for contamination prevention, sealed into the shielding wall and exchangeable from the cold side
- changing device for gripper jaws, gripper tongs, tools and protective covers
- locking device for movement with or without operational load
- shielding in the through-wall tube
- wall lock and positioning device with signal output
- manipulator change trolley, transportation trolley and changing device
- changeable gripper tongs, gripper jaws and tools
- PE evacuating bag system for contamination-free outward transfer of manipulators
- through-wall tubes, box flanges and shielding plugs
- electric and manual handling tools

(13) VON GAHLEN 公司鉛室產品型錄



INTRODUCTION

Von Gahlen is a modern state-of-the-art manufacturer of radiation shielding products. Since its founding in 1973, Von Gahlen has become an industry leader in radiation shielding and process technology, providing the nuclear medicine community with reliable, high quality products that meet or exceed industry standards and safety requirements. Von Gahlen radiation shielding products are found all over the world, ranging from the smallest syringe shield to the largest turnkey hot cell installations.

WE PROVIDE THE FOLLOWING PRODUCTS

Nuclear medicine & radiopharmacy

- Hot cells
- PET Radiopharmaceutical production & research
- Shielded hoods
- Shielded glove box
- Compact technetium solution
- Shielded laboratory furniture
- Isotope work stations
- Interlocking lead bricks
- Isotope storage safes
- Shielded waste containers
- Personal protection
- Transport carts
- Phantoms

Radiopharmaceutical packaging

- Type A shipping containers
- Lead shipping containers

Find more information about our complete product line on our website: **www.vongahlen.com**.

If you have any questions, please do not hesitate to contact our sales team! **sales@vongahlen.com**

RADIOPHARMACEUTICAL PRODUCTION & RESEARCH

The line of hot cells for PET radiopharmaceutical production and research incorporates the latest designs of all required units meeting current GMP regulations. The line of Hot cells is integrated into a clean room with a technical corridor behind the cells. The layout of the line of hot cells provides an optimal logistic flow of materials.

HOT CELLS

Different models of hot cells are available designed for specific purposes. Each cell is standard equipped with a hinged acrylic door with special seals to maintain airtightness in the cell, behind the shielded front door. The interior and exterior smooth finish of all cells comply with the current pharmaceutical regulations for cleaning, decontamination and validation. The exterior finish is traffic white (RAL 9016).

Dispensing hot cell with laminar down flow for aseptic dispensing of PET radiopharmaceuticals. For manipulation the cell is equipped with two lead shielded spherical units including an easy to use tong manipulation system. Integrated retrieval drawer for collection of the product vial in a Type A transport container. The hinged front door is fitted with a lead glass window and the acrylic door includes two glove ports. Inside the cell is an integrated dose calibrator shielding and pneumatic ionization chamber lift.

The synthesis hot cell is available in a single- and stacked (double) model. All commercially available synthesis units fit in this model. The cell is equipped with fully shielded target lines, floor- to cell level. Inside the cell the synthesis unit is placed on the stainless steel tray that can slide out for easy access.

The research hot cell is especially designed for PET research purposes. The cell has a vertical motor driven front door with safety interlocks and a large lead glass window. Behind the shielded sliding side door is also a hinged acrylic door. The cell is equipped with fully shielded target lines from floor- to cell level.

DISPENSING HOT CELL

The dispensing hot cell model DPB-LDF is designed for aseptically dispensing sterile radiopharmaceutical solutions under an integrated laminar down flow providing a GMP class A environment.

This cell is a complete solution including; shielded compartment with 75 mm lead on all sides and an internal stainless steel box with rounded corners for easy cleaning. The DPB is available in two widths and can be equipped with an airlock or with a preparation isolator on the left or right side. Either of these are connected to the main compartment with inner, airtight, lead shielded sliding doors.
These compartments help you to design the required cascade of air quality values needed to dispense your radiopharmaceutical solutions according to current GMP requirements.

Model VG-DPB-LDF

CLICK HERE

- Ball tong units for handling materials in the cell
- Product retrieval drawer
- Ion chamber shielding with ionization chamber lift
- Highly configurable options

To optimize the configuration of the dispensing hot cell to your specific needs, the following options are available:

- Hydrogen peroxide vapor (HPV) for automated hot cell decontamination.
- Preparation box (PB-B). Designed for aseptic preparation of sterile consumables including shielded transfer hatch to dispensing hot cell.
- Preparation box (PB-AB-LDF). Designed for aseptic preparation of sterile consumables in HEPA filtered laminar down flow including shielded transfer to dispensing hot cell.
- Shielded air lock (SA-B). Designed for the transfer of sterile consumables via opening with tray to dispensing hot cell.
- Solid waste vault
- Analog gauge for measuring the pressure drop over the down flow filter
- Open vial dose divider semi-automatic (OVDD-SA) or fully automatic (OVDD-FA)
- Closed vial dose divider semi-automatic (CVDD-SA)
- Universal support (outlet, cable pass through, arm for laptop or ion chamber control unit)
- Digital pressure gauge instead of analog gauge
- Radiation detection system including safety interlock
- Extended cover plates to specified height
- Autoclave integration

SYNTHESIS HOT CELLS

SINGLE SYNTHESIS HOT CELL

The synthesis box model SB2 is designed to house most commercially available synthesis units meeting cGMP guidelines. It provides one shielded compartment with shielding of 75 mm lead in all directions. An internal stainless steel box with large radius corners for easy cleaning and an extractable tray for easy and ergonomical access to the module making it a user friendly synthesis box design. The air inlet is Hepa filtered, air is taken from the front side.
Front acces is through 2 doors, the primary hinged lead shielded door and a secondary hinged acrylic door is equiped with special seals to maintain airtight integrity. The Synthesis box as a standard is equipped with: shielded target line (from floor level to compartment bottom), power connections and basic gas connections.
Several options like lead glass windows, charcoal filters on exhaust, different gas connections and a laptop support are available for the SB2.

CLICK HERE

Model VG-SB2

- cGMP compliant (Class B air inside compartment)
- Space for several features, for example generator vault, HPLC compartment, solid/liquid waste vault, product retrieval vault
- Highly configurable options

STACKED SYNTHESIS HOT CELLS

The synthesis box model SB2S is designed to house most commercially available synthesis units meeting cGMP guidelines. It provides two shielded compartments with shielding of 75 mm lead in all directions. An internal stainless steel box with sufficient radius in all corners for cleaning and a extractable tray for easy and ergonomical access to the module making it a user friendly synthesis box design. The air inlet is Hepa filtered, air is taken from the front side.

The front doors consists of 2 doors each, the primary hinged lead shielded door and a secondary acrylic door with special seals maintains airtight integrity. As a standard these synthesis boxes are equipped with: shielded target line (from floor level to compartment bottom), power connections and basic gas connections.

Several options like lead glass windows, charcoal filters on exhaust, different gas connections and a laptop support are available for the SB2S.

Model VG-SB2S

- cGMP compliant (Class B air inside compartment)
- Steel structure to support all components
- Highly configurable options

CLICK HERE

RESEARCH HOT CELLS

RESEARCH HOT CELL

The research hot cell model HCR is a very versatile hot cell. The HCR can be configured to meet any laboratory layout with various hot cell connections, a large lead glass window providing full view of the interior and air environmental control. The HCR is precisely engineered and constructed for continuous dependable protection and reliable everyday laboratory use.
As a standard this cell is fitted with shielding for the ionization chamber and basic gas connections. Behind the vertical motor driven lead shielded door, the acrylic door maintains airtight integrity. The main compartment is shielded with 75 mm of lead on all sides. The internal stainless steel box with rounded corners is easy to clean.
Several options such as various gas taps, laptop support and ion chamber lift are available for the HCR.

Model VG-HCR

CLICK HERE

- High speed access door
- Large interior space
- Integrated ion chamber shielding
- Highly configurable options

RESEARCH HOT CELL WITH TONG

This research hot cell model HCT is Von Gahlen's most versatile hot cell. The HCT can be configured to meet any laboratory layout with various hot cell connections, a large lead glass window providing full view of the interior, air environmental control, multiple product manipulation and product retrieval options.
As a standard this cell is fitted with shielding for the ionization chamber and basic gas connections. Behind the vertical motor driven lead shielded door, the hinged acrylic door maintains airtight integrity. The main compartment is shielded with 75 mm of lead on all sides. The internal stainless steel box with rounded corners is easy to clean. Several options such as various gas taps, laptop support and ion chamber lift are available for the HCT.

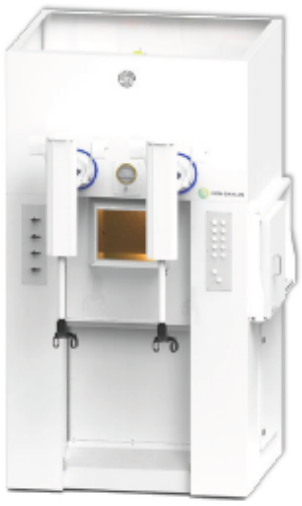
CLICK HERE

Model VG-HCT

- High speed access door
- Large interior space
- Product retrieval drawer
- Remote manipulation system
- Integrated ion chamber shielding
- Highly configurable options

MODULAR HOT CELLS

The modular hot cell model MHC is a very versatile hot cell. The MHC can be configured to meet any laboratory layout with various hot cell connections, large lead glass window providing full view of the interior, air environmental control, multiple product manipulation and product retrieval options. The MHC is precisely engineered and constructed for continuous protection and reliable everyday laboratory use. The design of the MHC allows for the use of various master slave manipulators.



As a standard this cell is fitted with shielding for the ionization chamber and basic gas connections. Behind the vertical motor driven lead shielded door, the hinged acrylic door maintains airtight integrity. The main compartment is shielded with 75 mm of lead on all sides. The internal stainless steel box with rounded corners is easy to clean.
Several options such as various gas taps, laptop support and ion chamber lift are available for the MHC.

Model VG-MHC

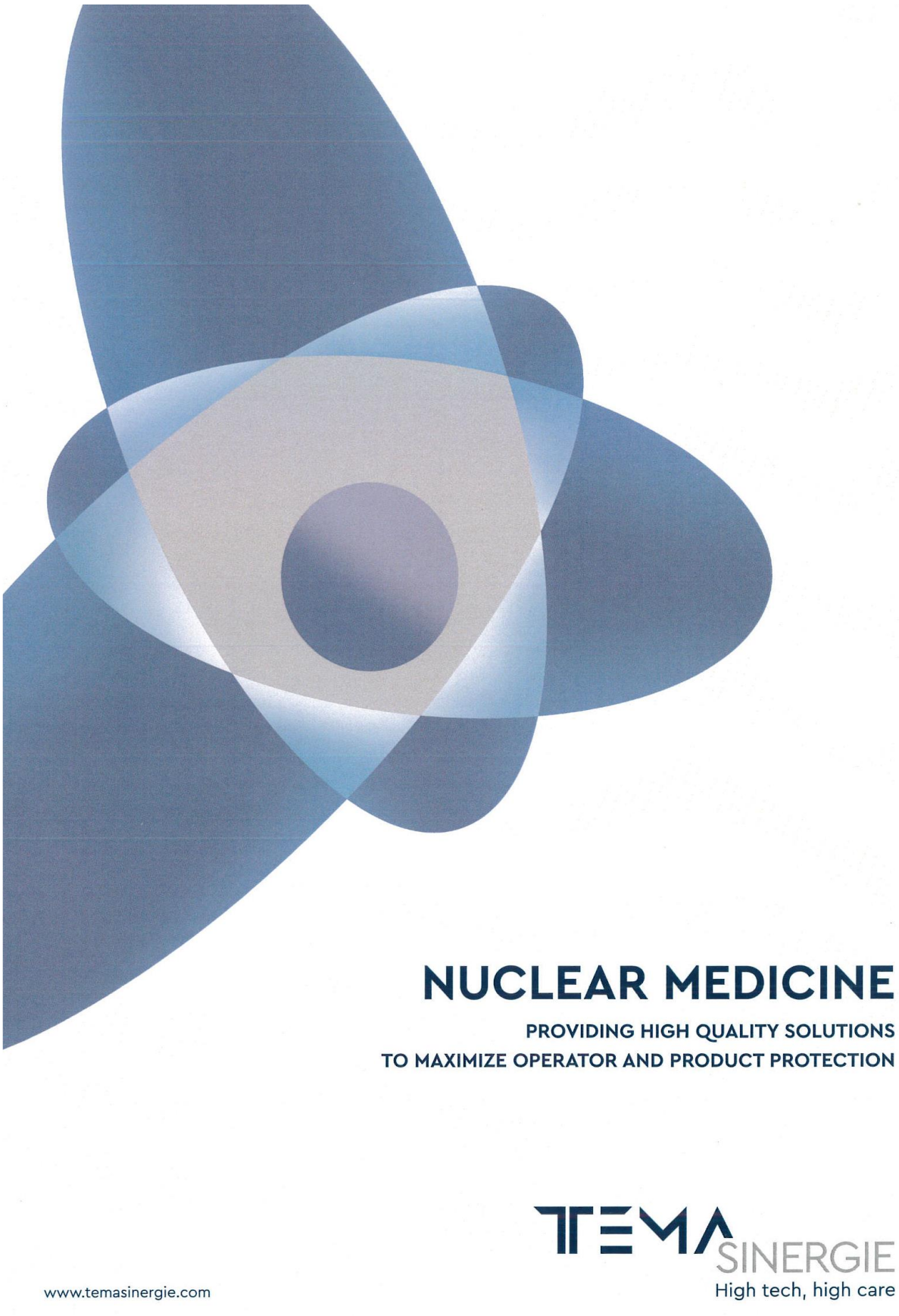
- High speed access door
- Large interior space
- Master slave manipulation system
- Integrated ion chamber shielding
- Highly configurable options

CLICK HERE

To optimize the configuration of the modular hot cell to your specific needs, the following options are available:

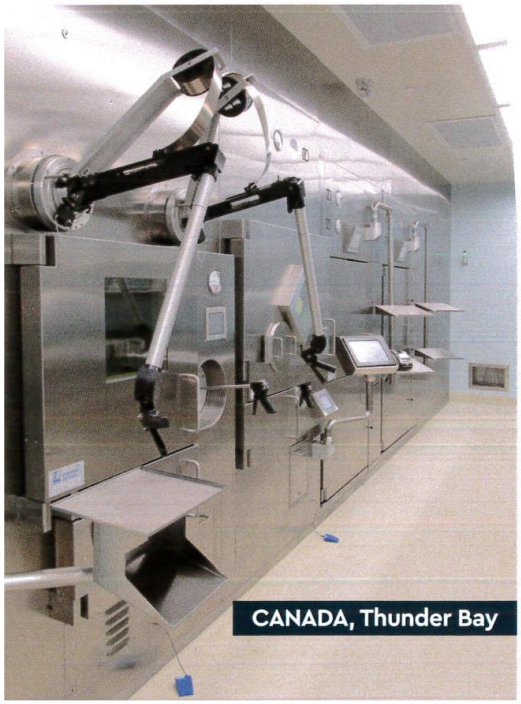
- Master-slave manipulators, CRL type G-LDR
- Lead plugs instead of master-slave manipulators
- Extended gas regulation
- Storage cabinet beneath main compartment
- Solid and or liquid waste vault
- Digital pressure gauge instead of analog gauge
- Internal HEPA/Charcoal filter
- External shielded HEPA/Charcoal filter
- Ionization chamber shield for dose calibrator, 50 mm/2 inch or 75 mm/3 inch lead
- Ionization chamber lift
- Foot pedal control for ionization chamber lift
- Universal support (outlet, cable pass through, arm for laptop or ion chamber control unit)
- Glove ports in shielded front door with hinged plugs
- Glove ports in acrylic door
- Radiation detection system including safety interlock on front door
- Extended cover plates to specified height

(14) Tema 公司鉛室產品型錄



RADIOPHARMACY

AUSTRALIA, Adelaide



CANADA, Thunder Bay

IRELAND, Dublin

CLINICAL APPLICATION

PET Application

^{18}F
^{11}C
^{13}N

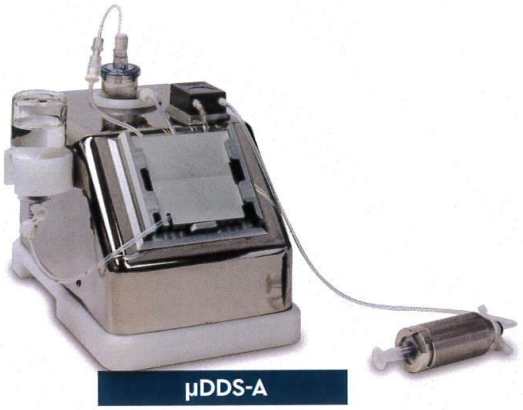
^{68}Ga

Blood Labeling

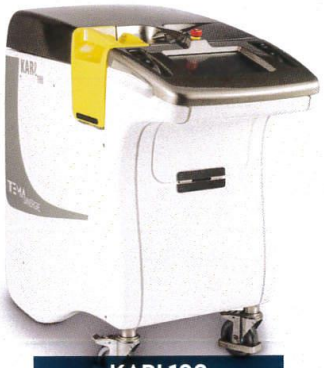
Conventional NM

DISPENSERS

NEXT



µDDS-A



KARL100

CRP

INJECTORS

RAD-INJECT

MONITORING

ENVIRO

GLOVE LEAK TEST SYSTEM

AGLTS

附錄（四）COMECER、TEMA 公司與 INFN-LNL 研究機構邀請函

(1) COMECER 公司參訪邀請函

COMECER
AN ATS COMPANY

Castel Bolognese September 7, 2023

Subject: Letter of invitation for visa application

Dear Sir/Madam,

On behalf of Comecer S.p.A., I am writing in support of the business visa application for the undermentioned attendees. They are hereby invited to visit our company at Via Maestri del Lavoro, 90-48014 Castel Bolognese (RA), Italy on September 14, 2023 for the purpose of discussing current and future projects.

Their personal details can be found below:

Surname	Name	Passport No.	Nationality	Date of Birth
Farn	Shiou-Shiow (Amanda)		Taiwan	
Weng	Mao-Chi		Taiwan	

Contact person in Comecer S.p.A.:

Mr. Fabio Salvini

E-mail: fsalvini@comecer.com

Phone No.: +39 346-503-5188

The travel expenses for board and lodging, domestic & international flights, insurances, and health services shall be borne by themselves.

Necessary documentation can be found in the attachments.

Yours faithfully,

Simone Volpi

Comecer Legal Representative

Comecer S.p.A.
Società soggetta a direzione e coordinamento della società ATS Corporation
Via Maestri del lavoro, 90 | 48014 Castel Bolognese (RA) Italy | t: +39 0546 656378 | f: +39 0546 656383
comecer@comecer.com | www.comecer.com
C.F./P.I./VAT Nr.02404790392 | CAP.SOC.EURO 1.000.000 i.v.
R.E.A.C.C.I.A.A.RA198608 | REG IMPR.RA:02404790392

(2) TEMA 公司參訪邀請函

TEMA SINERGIE
High tech, high care

Institute of Nuclear Energy Research
- Isotope Application Division
1000 Wenhua Rd. Jiaan Village
Taoyuan City 32546, TAIWAN

TO WHOM IT MAY CONCERN

Faenza, September 5th 2023

Your Ref.:		
Our Ref.:	**23331-INVITATION LETTER**	CV
SUBJECT:	**Invitation Letter for Shiou-Shiow Farn and Mao-Chi Weng**	

We

TEMA SINERGIE S.p.A.
Via Malpighi, 120
48018 Faenza (RA) – Italy

hereby confirm that

Dr. **Shiou-Shiow Farn** [Deputy director/Researcher] Passport n.

and

Dr. **Mao-Chi Weng** [Assistant engineer] Passport n.

have been invited by us to visit our facility on **September 14th 2023.**

Best regards
Ing. Stefano Piancastelli
CEO

TEMA SINERGIE
Tema Sinergie S.p.A.

(3) INFN-LNL 研究機構參訪邀請函

Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI LEGNARO

September 10, 2023

Dr. Shiou-Shiow Farn
Deputy Director
Institute of Nuclear Energy Research (INER)
1000 Wenhua Rd Jiian Village, Longtan District
Taoyuan City, 355446, Taiwan (ROC)

Invitation Letter

Dear Dr. Shiou-Shiow Farn,

In view of potential scientific and technical collaboration between our laboratories for the development of innovative systems regarding the high power cyclotrons and their use in physics and applications, we are pleased to invite you to visit our National Laboratory in Legnaro (PD), Italy. During your visit we will show the actual installation of SPES facility at LNL and in particular the high power cyclotron and the beam transport lines supplied by Best Theratronics company.

The present letter has been sent to you to whom it may concern. The visit is scheduled for Friday September 15, 2023.

Looking forward to seeing you in Italy.

Cordially,

Mario Maggiore

Cyclotron Service Head

Viale dell'Università, 2 - 35020 Legnaro (PD) – Tel. +39 049 8068356 Fax +39 049 8068514
http://www.lnl.infn.it - lab.naz.legnaro@pec.infn.it - C.F. 84001850589

Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI LEGNARO

September 10, 2023

Dr. Mao-Chi Weng
Assistant Engineer
Institute of Nuclear Energy Research (INER)
1000 Wenhua Rd Jiian Village, Longtan District
Taoyuan City, 355446, Taiwan (ROC)

Invitation Letter

Dear Dr. Mao-Chi Weng,

In view of potential scientific and technical collaboration between our laboratories for the development of innovative systems regarding the high power cyclotrons and their use in physics and applications, we are pleased to invite you to visit our National Laboratory in Legnaro (PD), Italy. During your visit we will show the actual installation of SPES facility at LNL and in particular the high power cyclotron and the beam transport lines supplied by Best Theratronics company.

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附錄（五）計畫同仁對 INFN-LNL 提問回覆內容

1. the current status of their fast neutron project.

   A: This area will be dedicated for neutron generation for fast and for neutron source target. But at the moment, everything is stopped because of the priorities. Complete the facility and provide for the beam not for neutron. Unfortunately, we don't have the issues for following also these items here. but. I'm not the expert on this, but what I can see is that in the past years we developed the real target for neutron generation for making a different experiment in this area. The prototype of all the target has been done I think two years ago. it was tested with just for the point of view of a thermal mechanics with the electron beams. But. at the moment, then the status was frozen two years ago more or less. Then there's not any development in there. maybe we should have a collaboration agreement with the South Korean colleagues that asked us to provide the prototype of brilliant Target in order to test in their facility. But at the moment, we are not working on it. This is the stage. But it's just on the paper. There's no any fund for this.

2. For easy decommissioning in the future, how they design/deal with the surface layer of the shielding wall? It'd better to have a picture.

   A: The shielding thickness is related to the energy and intensity. The current density in carrying density of the primary beam in our case. the minimum thickness of the wall here is 3 meters, the material is concrete with iron. For the target you can see an increase of thickness up to 4 meters, because we have here efficient we produced $10^{10\text{-}13}$ neutrons per second not as a nuclear plant but of course in important flux of neutron. Then these shield is 4 meters. the decommissioning of these kind of plant is cover everything with the graph, this is more or less as a nuclear plant. The nuclear plant has more or less the same procedure for disposal. then the core of the nuclear power generally stays underneath that underground level in order to cover everything with the ground and make a sort of huge. We will have the same. There's no any program I mean there will be a program because the agency, the national agency for disposal asked us to have a procedure for disposal of everything. But the first step is to cover everything with the ground, Of course, the most activated part will be sent to a dedicated national storage or disposal, not here. We don't have here possibility to storage anything for unlimited time. For different presentation that we did worldwide in the conference all but there is also some reference in literature. Then you can calculate the shielding is very simple. What has been done here is the Monte Carlo simulation in order to from the source, then putting in the code the source of neutron and gamma

and then after that in order to have zero, let me say zero is not zero but those radiations outside of the building in the environment. But this is just one meter of thickness, but the radiation is stopped here.

The building was done by us. The building is completely our responsibility, we choose at that time I think more than ten years ago because you have to imagine that we started the design of the building on 2009 and for instance, my role was at that time to stabilize, to decide the layout of this room, this room layout of preliminary, the layout of the beamline. I gave a just the parameter of this area to my colleague from radio protection and they gave me these results here. So the distance, the distance is related because we have a lot of space inside here. of course we decide to have these for everything and generally you can choose also to limit these areas here very to have a very short area. For instance, you can choose to leave the combination outside of the first shielding shell. This is a strategy that's depend on you. Then you decrease also the volume of way that you have to retreat. That's depend. The target generally is the most source of the of the radiation. then the target in the bunker and the bunker must be designed in the proper way related to the target.

Cyclotron is another source of radiation and you can leave it here. because the most important part of the cyclotron activated part are the exit leads. Here we have two collimators that intercept the beam just after the extraction and we shape the beam with this. then here and here we have very activated part. the jaws, the puddle over the collimator are very activated, but during the along the beamline you don't have much more, so much power losses. apart if you make some error in alignment or so, you can reduce as much as possible this area here in order to reduce the volume for treatment and concentrate here, if you have a target station around here.

Our choice was completely different, but this is our strategy because we have a lot of volume of air to treat with our system. This is my design. I decide to make this way because otherwise I have to cut everything and confine the radiation just in fall in a small, I decided to have this and this is the result we have a lot of space to move inside. We have large space inside, this is advantage, from the point of view of people working here is very good because you have a very good area where this is important for people working here because the ambient and the environment is not so good. I mean you have activated part radiation. So if you are also in a small space where you can have some problem, for instance, if you want, I think you can visit Arronax facility.

Annex facility is more or less the same with another machine similar to the competitor, but the area containing the cyclotron is very small.

3. Beamline layout and beam spot size of the proton lab.
   A: what we did is to make the modularity of the beamline, you will find ever the same module repeating and towards, towards, towards the focuser. The optics is well determined by these kind of this is done by us and implemented by best people. this is a choice also a strategy. because otherwise you can use a different strategy in the beam optics that depend. if you are a physicist, accelerator physicist, but you can also choose to have a triplet, a triplet inside here just to reduce the number of records. But you should have some problem in beam optics. Then we've decided to have these modularity, waste, it mean the size of the smallest size of the green in the precise pointer here in the middle of the drift more or less. These allow us to simplify the beam of possible. It's both sides. I think is about that spend few centimeters 1 centimeter, that's depend a low energy. You have a small siding larger than at the low end that energy, the beam energy is smaller.

4. The local shielding design for their fast neutron target.
   A: the local shielding has not provided by me. Exactly the same of this on the power that you leave on the target. if I. remember well, there are fitness of varying from 2-3 meters, no less. we need some increase some shielding here just for also these in order to decrease the radiation of neutron outside. We plan to move to install here some blocks in order to improve these thickness from 1 meter and 1 meter and half. This is more or less, but is in this region was very heavy and then this one.

5. How do they control the humidity and temperature? with central air conditioning or local air conditioning? How does the air outlet and inlet look like in the instrument hall?
   A: We operate at 60% of humidity if I remember where 60-65% the temperature 22-24 Celsius degree. And you have to imagine that here is negative pressure, we have three level of negative pressure, -80 or -60 and zero Pascal. We have a sort of whole a trap here than if we have problem here. The radiation, and the staying here, there's no any leak. Every shielding door also these was sealed, then negative pressure with two different levels then this is -60 Pascal, not so much. The -80 Pascal is very small different pressure to maintain the that gradient operation stable. It seems like this is the entrance room. We have

two barrier one and two because this is a very dangerous path, normal zero means not negative pressure. The target you expect to have the target. In that case you should have negative pressure respect to the external area, because otherwise if you have some problem you'll come outside. Change the air change in 1111 minute one hour. I don't remember this. I'm accelerator physicist and I have a remember this number when I operated machine.

The ventilation system of the cyclotron where the target is completely separated from other parts, it's not like in Japanese facility, after the accident they had the air contaminated, go everywhere. This is a completely different, completely separated and sealed. Then we have an argon's dedicated detector, exactly dedicated detector that monitor the status their activity of the air. And give the green light in order to release the air outside. Then what we produce here is strictly monitored by Legano, we don't release anything outside anything, the national limit, few background, and so on the outcome. Gas is coming from the pump from coming from the beam line are storage in the gas recovery system here we have don't know much how many liter we have of storage. Stationary storage, I mean we take all news not from the cyclotron but from because the cyclotron really is very low activation area and is controlling it in the other way.

But from the front end and everything here where we accelerate, we transport the exotic beams and adjective ion beams we storage the activated the exhaust molecule coming from the vacuum system inside here. We storage the radiative isotope here, the contaminant here for a long time needlessly to lowering the activation and then we can release. Ventilation for the area. Dedicated system for the exhausting, molecular exhausting gas from the beam line. Everything is controlled. we can storage the time that we need to lower it, there is a valve. Not only one but a lot of valve. that the system control in order to allow the gas coming in the cabin final came in where before the came in we have another evaluated exactly situation. We monitoring continuously.