Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI LEGNARO

Laboratori Nazionali di Legnaro – INFN

A new CSN5 experiment proposal

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ISOLPHARM method

ISOLPHARM
SPES exotic beams for medicine

INFN
Istituto Nazionale di Fisica Nucleare

Proton Driver (Cyclotron)

Production Target

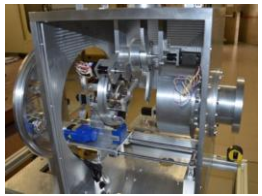
Extraction & Ionization

Mass Separation

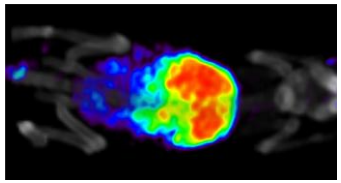
Isobaric Ion Beam

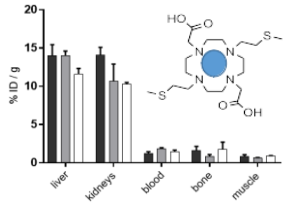
Ions Collection

Design & construction of the IRIS system for radioisotope deposition and spectroscopic characterization



PET/CT fused image 24 h after the radiolabeled compound injection





DO2A2S-^{64}Cu ex-vivo biodistributions

Preclinical Trials

In vivo

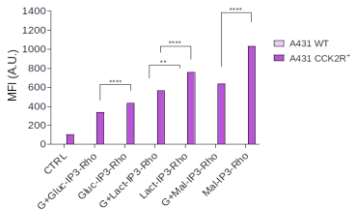
3D Scaffolds

Radiolabeling

Radiopharmaceutical Design & Synthesis

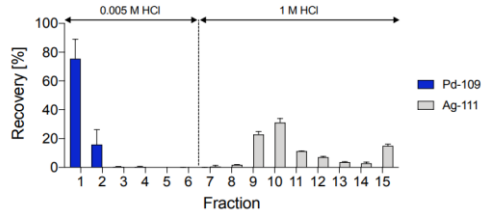
Chemical Separation

Results from ISOLPHARM CSN5 experiments



Development of 2nd gen. ligands: increased uptake and total competition with more hydrophilic linkers

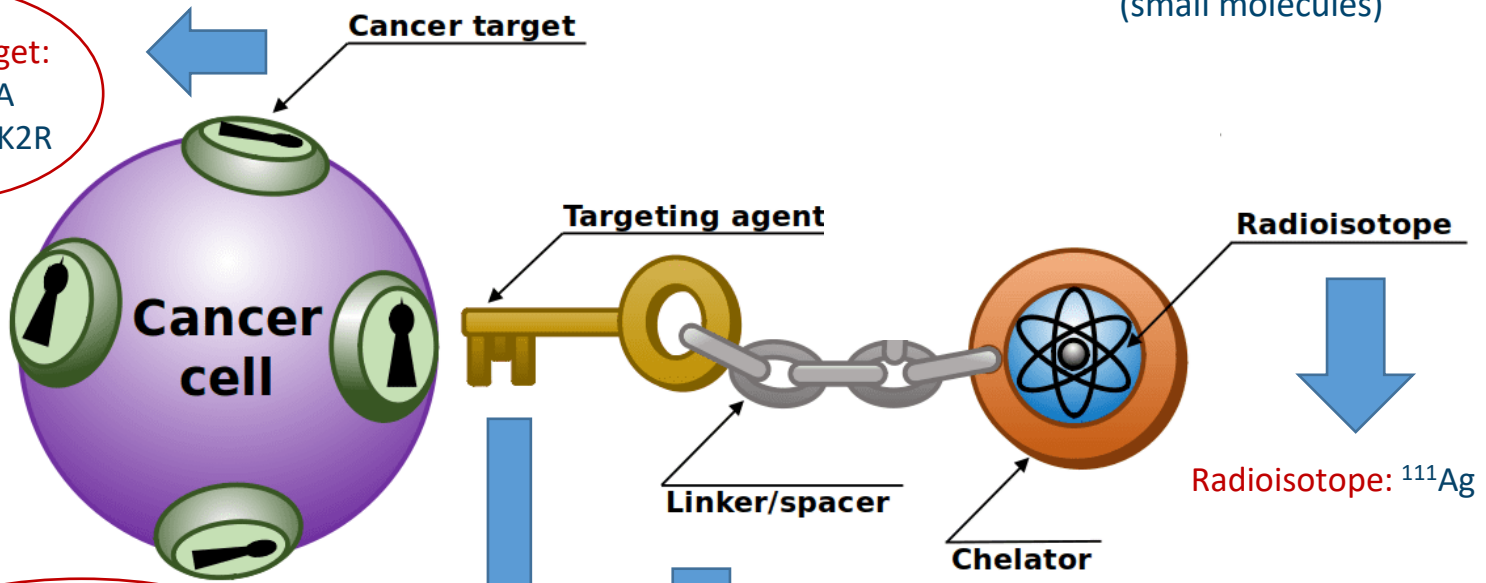
Pd/Ag chemical separation



Radiopharmaceutical frame

(small molecules)

Cancer target:
Now: PSMA
Before: CCK2R



Radioisotope: ^{111}Ag

Targeting agent:
Now: PSMA-617
Before: Z360 (for CCK2R)

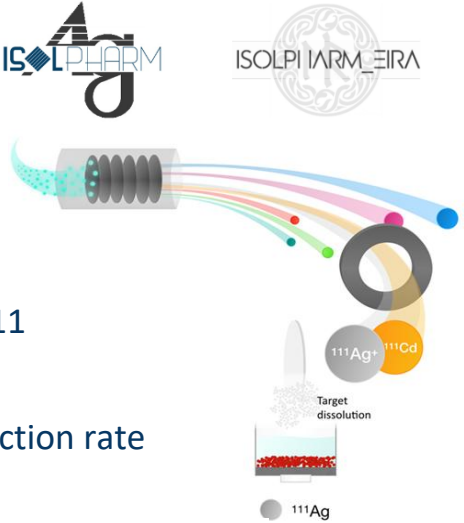
Linker: Bifunctional

Chelator: DO4S

Experiments: why ^{111}Ag?

^{111}Ag properties

- **β^- emitter** (average energy **360 keV**)
- Good half-life (**7.45 days**)
- Average tissue penetration (1.8 mm)
- Medium energy γ **rays** -> SPECT?



→ In the market no radiopharmaceuticals radiolabeled with silver-111

→ Silver-111 can be produced @ SPES with high purity & high production rate

→ No isobaric radioactive contamination in the implantation foil (also with LASER off!)

→ ^{111}Ag exhibits theranostic properties similar to ^{177}Lu which was recently approved by FDA

→ ^{111}Ag behaves similarly to ^{186}Re, recently studied in phase I/II clinical trials

ISOLPHARM: over 10 years of activity

INFN experiments

PRIN

2014 – 2017 — Interdisciplinary study group on production of medical radioisotopes at SPES

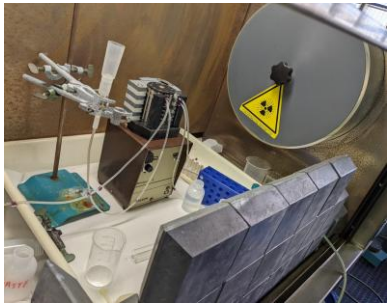
2018 – 2019 — Simulations and feasibility evaluation of Ag as radiopharmaceutical precursor

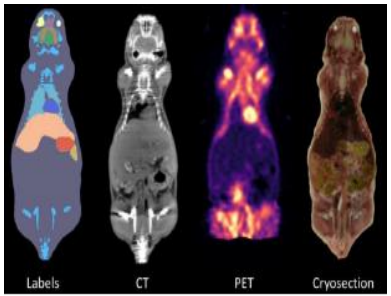
2020 – 2022 — First production of ^{111}Ag in reactor and beginning of *in-vitro* and *in-vivo* testing

2023 – 2025 — Characterizing the 2D/3D *in-vitro* therapeutic effect of ^{111}Ag and its imaging capabilities

2025 – 2027 — First nuclear measurements of radionuclide production at SPES

2024 – 2025 — Technological aspects of radionuclide production (target, ion source, implantation…)





Collaboration infrastructures

The SPES_MED experiment (2025-2027)

First nuclear measurements at SPES financed by INFN-CSN3!

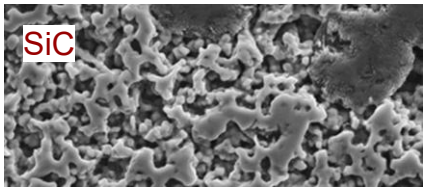
Work packages

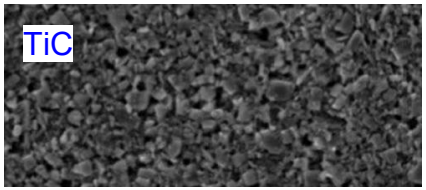
1) Cross-section measurements (LARAMED project)
2) ISOL production yield measurements (ISOLPHARM project)
3) Theory and simulations

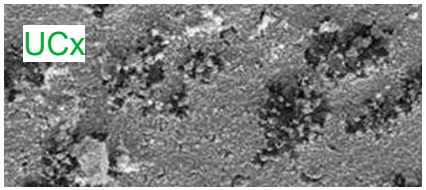
The SPES_MED scenario

WP2 aim: measuring the **ISOL production yields of radiotracers** with applications in biology, medicine, environment, industry.

2025: **^{24}Na** and **^{7}Be** from SiC target (currently out of SPES_MED)
2026: ^{28}Mg from SiC target (low activity expected)
2027: ^{51}Cr (low activity expected), **^{43}K** from TiC target + ^{111}Ag from UC_x







High-production nuclides could be used in a **CSN5** experiment!

Radiobiology lab at LNL?

Open questions after ADMIRAL

1) Which are the radiobiological advantages of ^{111}Ag with respect to other β^- emitters?

2) Can ^{111}Ag be used in radiopharmaceutical therapy against prostatic tumors with PSMA-617 (already used with ^{177}Lu) as a targeting agent?

3) Can its γ imaging be used in a SPECT?

4) Can its β imaging be used for cell uptake measurements?

5) Can the SPES_MED nuclides provide interesting radiobiological data?

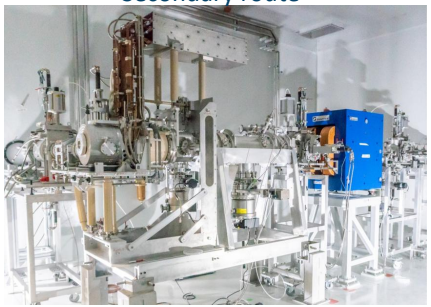
ISOLPHARM_APEX (2026-2028)

ISOLPHARM_APEX

^{111}Ag-PSMA-617 EXperiments

Main route

Secondary route

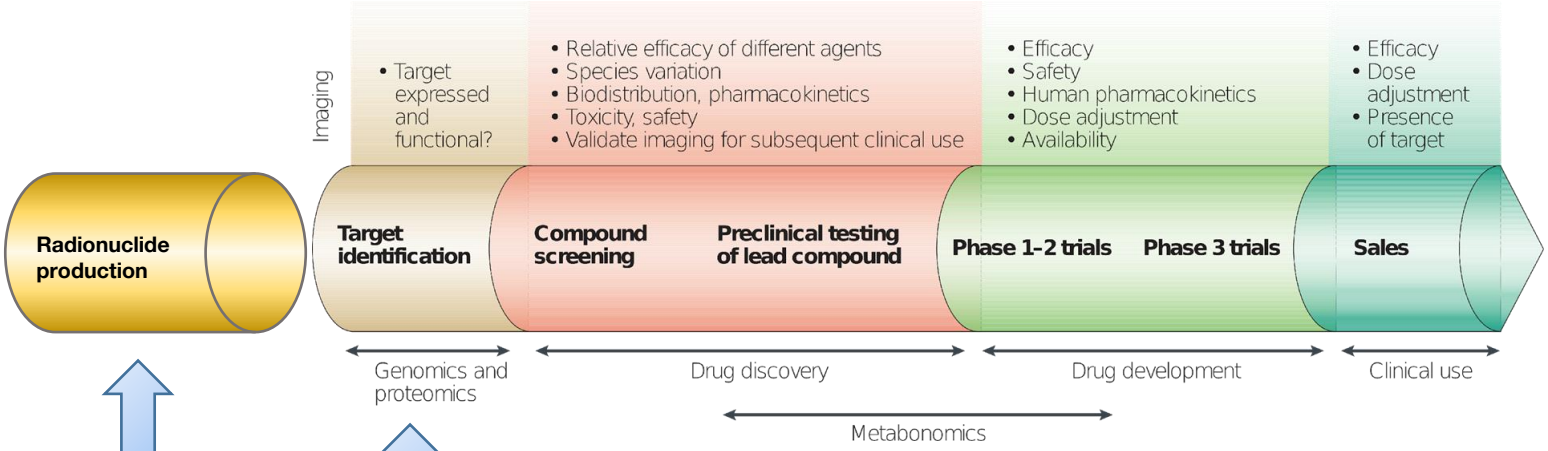


Radionuclide production at LENA and SPES

Main goals

1) Understanding the dosimetry of ^{111}Ag-PSMA-617 in living systems such as cells, small animals and human patients.
2) Studying this radiopharmaceutical in cancer cell cultures in 2D monolayers and in 3D tissue-mimicking scaffolds.
3) Observing the biodistribution and the effects of theranostic ^{111}Ag-PSMA-617 on small animals.
4) Investigating the radiobiological response to low-dose-rate radiation using the first nuclides obtainable at SPES.

The long road to (radio)pharmaceuticals

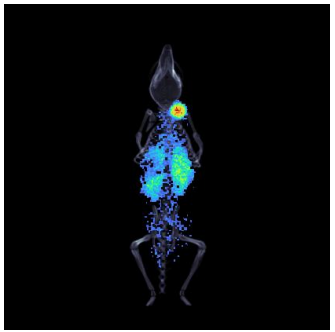


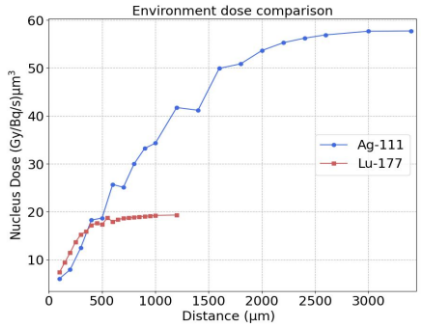
~ 12 years

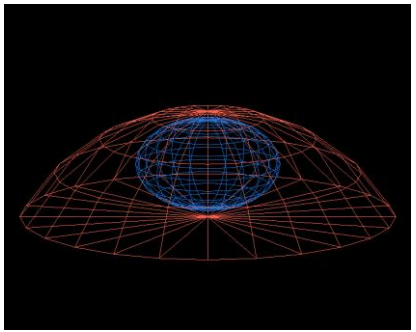
ISOLPHARM_APEX is aimed at the completion of the *preclinical testing* block

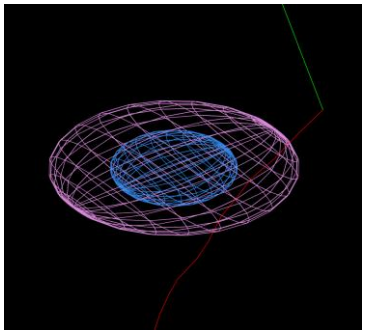
WP1 – SILICO

- Computational dosimetry at cell and organ level
- Survival models and DNA damage study
- Monte Carlo simulations for imaging prototypes



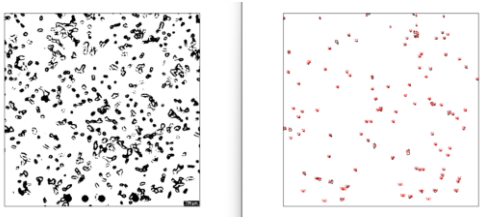




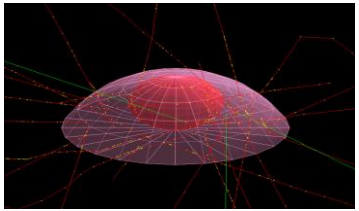


WP1 methodology

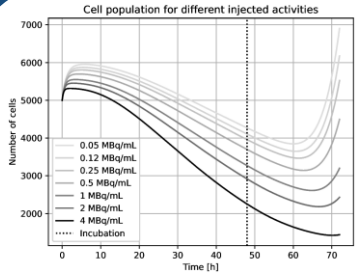
Silico for vitro



Cell shape and dimensions are retrieved from microscopy via image-processing software.

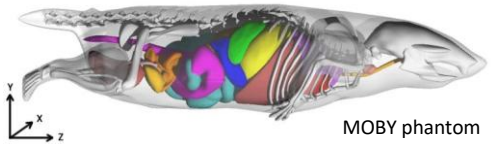


Monte Carlo simulations compute the absorbed dose per activity unit (***S-value***) and the consequent **DNA damage**.



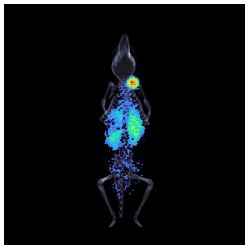
Biophysical models help understanding the **dose-rate curve** and the **DNA repair dynamics**.

Silico for vivo



MOBY phantom

Monte Carlo simulations are performed using commercial **virtual phantoms** or **CT** images; the **input biodistribution** can be measured **ex vivo** or taken from **PET/SPECT** imaging.



Simulations can provide **organ S-values** for treatment plans as well as **imaging previews** to tune the devices.

WP2 – VITRO

- Clonogenic survival assays
- Uptake measurements with β imaging
- *Foci* assays

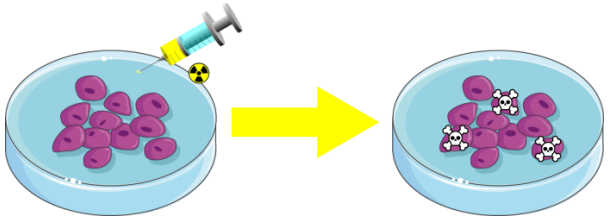
2D and 3D radiobiology

Cold studies

^{111}Ag-PSMA-617

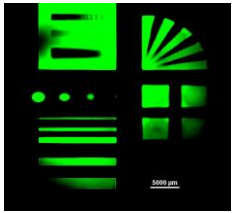
Radiotracers

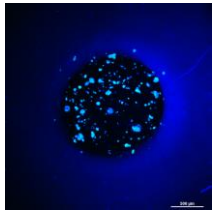
Other nuclides



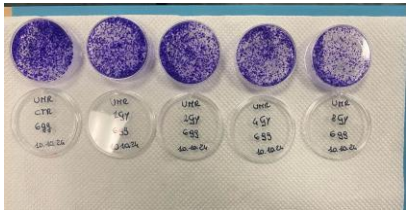
WP2 methodology

DNA damage and cell survival

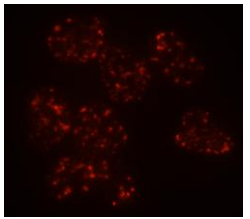




3D tissue-mimicking scaffolds are optimized for the cell lines under study.



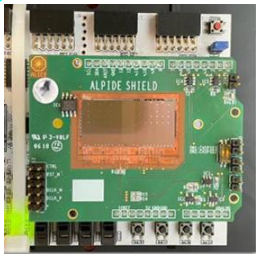
Cell death and vitality are evaluated by means of **clonogenic survival assays**.



2D/3D ***foci* assays** visualize the real-time DNA damage imparted by the treatment.

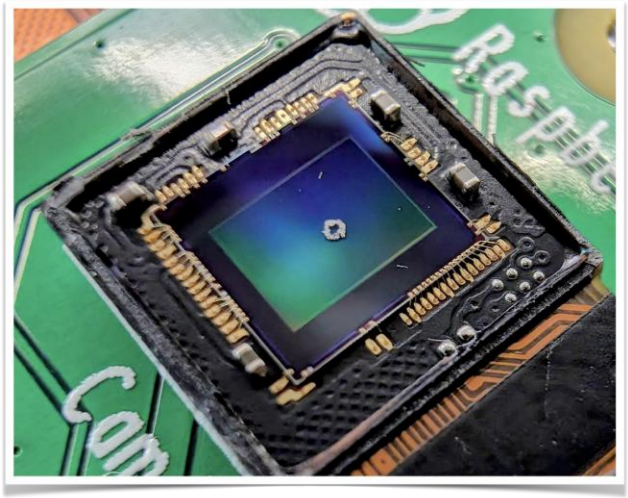
Uptake measurements

The **uptake** of radiopharmaceutical is generally evaluated with γ counters analyzing pellets of cells and is fundamental for dosimetric assessments.



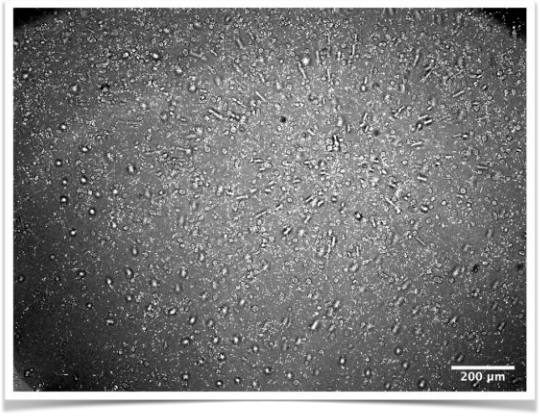
High-resolution **β imagers** allow to discriminate membrane and cytoplasm absorption and can be used on 3D scaffolds.

WP2 – VITRO

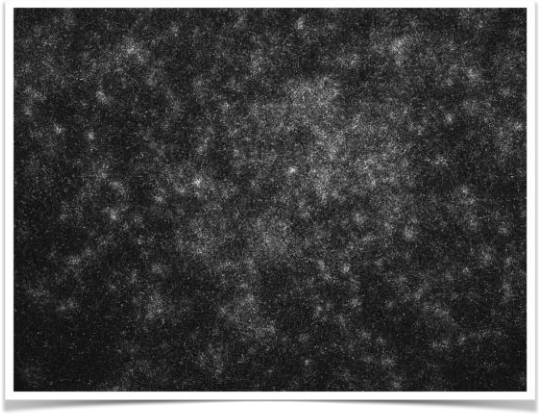


The CMOS camera

Glioblastoma cells imaging



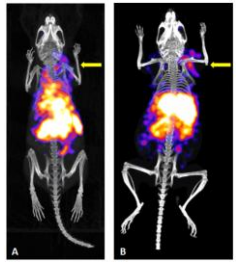
Brightfield image

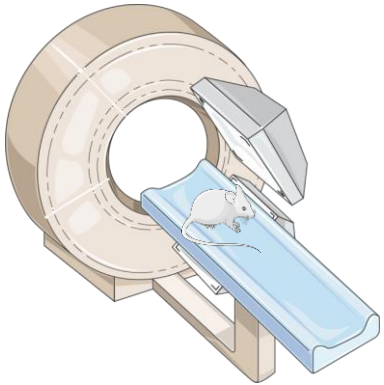


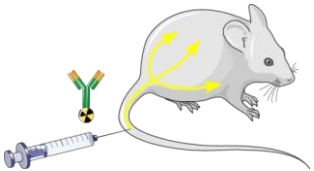
Positron image

WP3 – VIVO

- Biodistribution *ex vivo* of ^{111}Ag-PSMA-617
- Preclinical experiments *in vivo* with ^{111}Ag-PSMA-617 and ^{177}Lu-PSMA-617 for comparison
- γ imaging and radiomics





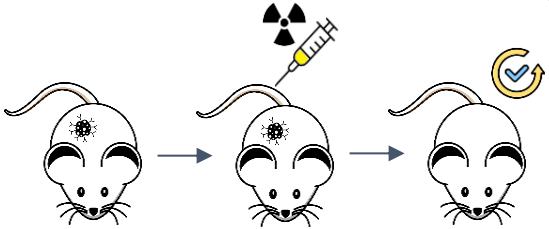


WP3 methodology

Preclinical experiments

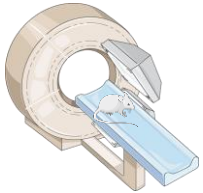
The **ex-vivo biodistribution** is preliminarily evaluated with free, chelated and targeted nuclide in healthy mice.

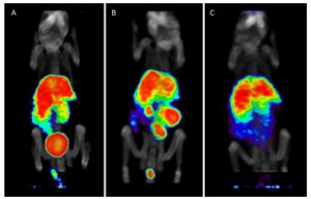
The procedure is repeated in mice **transfected with tumors** expressing or not expressing the target receptor.



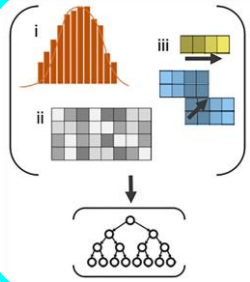
The **therapeutic effect** is finally assessed evaluating the **recovery** of treated mice.

Imaging and radiomics





The real-time biodistribution can be visualized via 2D **autoradiography** and 3D **PET/CT** or **SPECT/CT** imaging; a ^{111}Ag-tailored **γ camera** is also available from ADMIRAL.



PET/CT or SPECT/CT imaging can also be used to extrapolate **radiomic features**.

WP3 methodology

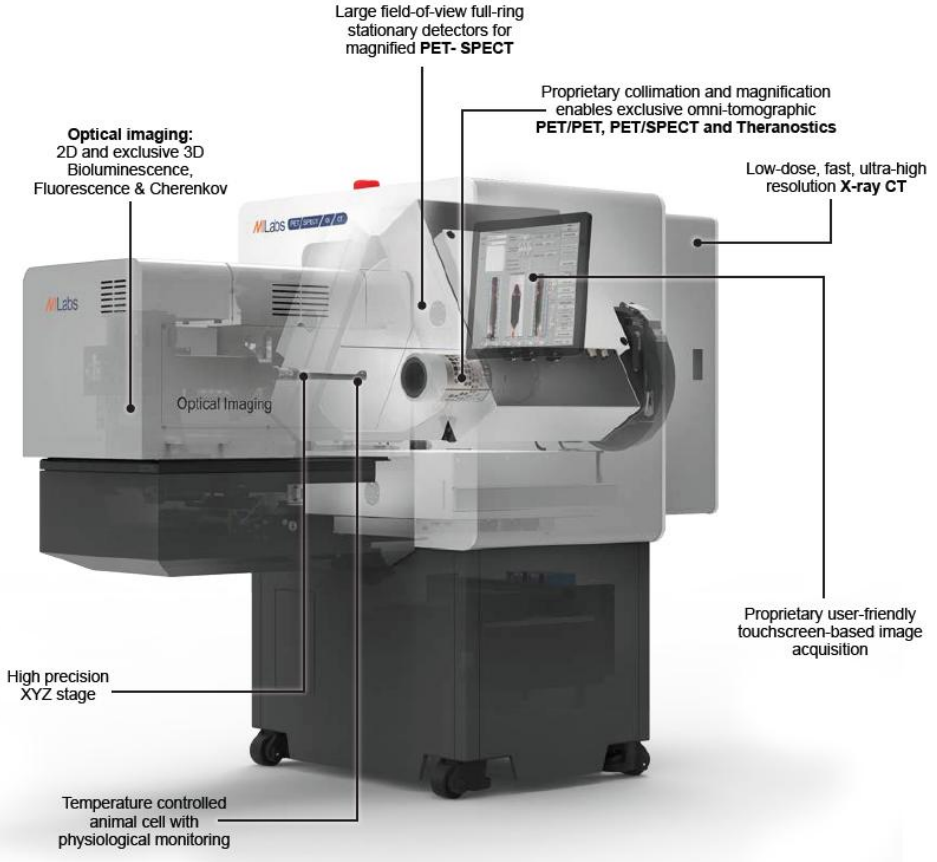
MiLabs SPECT/CT/OI

Stationary multi-pinhole SPECT

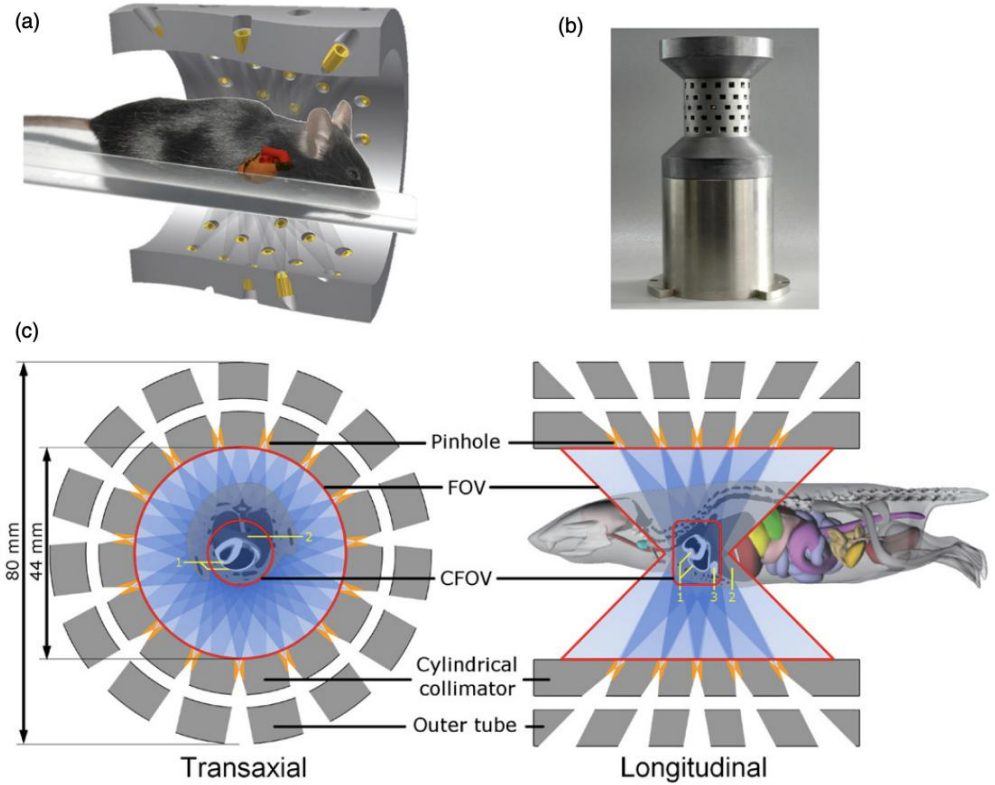
Variable magnification microCT

Optical imaging

- 2D fluorescence/bioluminescence/ cherenkov
- 3D FLT/BLT

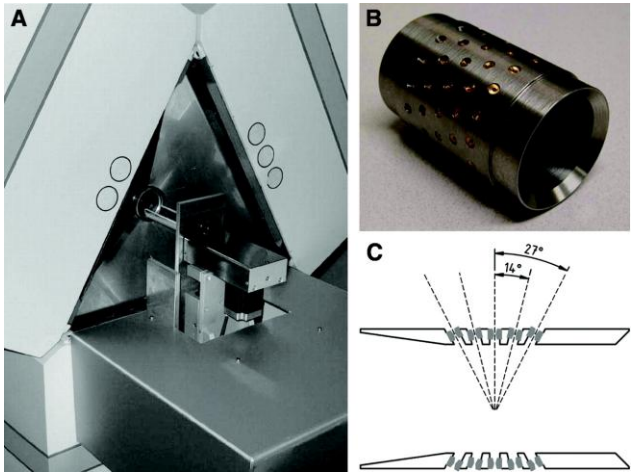


WP3 methodology

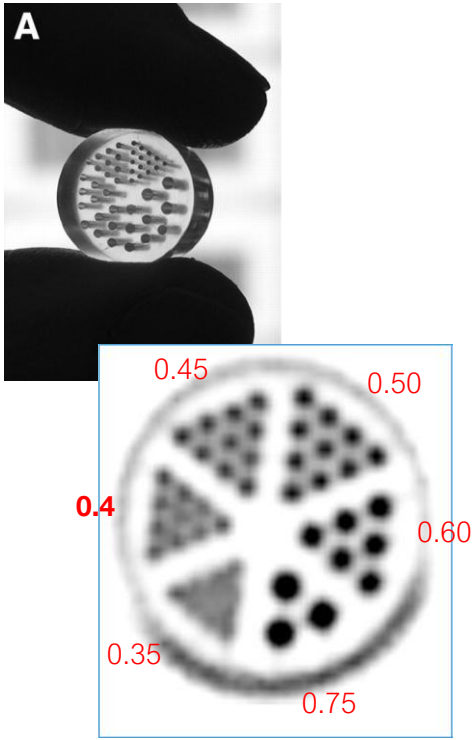


WP3 methodology

Multi-pinhole concept



Freek J. Beekman et al., Journal of Nuclear Medicine Jul 2005, 46 (7) 1194-1200;



Gantt diagram

		Year 1				Year 2				Year 3				Notes		
		M3	M6	M9	M12	M15	M18	M21	M24	M27	M30	M33	M36	Required for	Publications	Divisions
	WP1 – SILICO (leader: S. Bortolussi)															
T1.1	Image-based Monte Carlo dosimetry for prostate cancer cells	→	●											T2.1-T2.6	A, B	LNL, PD, PV
T1.2	Internal Monte Carlo dosimetry of biodistribution study with healthy mice	→			●									T3.5	C	LNL, PD, PV
T1.3	Internal Monte Carlo dosimetry of biodistribution study with tumor-bearing mice					→			●					T1.5, T3.6	D	LNL, PD, PV
T1.4	Biophysical model validation with radiobiological data			→					●						A	LNL, PD
T1.5	Dosimetric planning for preclinical trials with tumor-bearing mice and dosiomics							→			●			T3.6	E	LNL, PD, PV
T1.6	Validation of DNA damage models using radiobiological data and Geant4-DNA							→					●		F	LNL, PD
T1.7	Preliminary dosimetric predictions for human patients										→		●		E	LNL, PD, PV
	WP2 – VITRO (leader: D. Maniglio)															
T2.1	2D radiobiology of Ag-111-PSMA-617 on prostate cancer cells	→			●									T1.4	A	PV
T2.2	2D radiobiology of Lu-177-PSMA-617 on prostate cancer cells	→			●									T1.4	A	LNS
T2.3	β imaging of 2D cell culture uptake	→			●									T2.1	A	PD, PI
T2.4	3D radiobiology of Ag-111-PSMA-617 on prostate cancer cells					→			●						B	PV, TIFPA
T2.5	Microscopy and β imaging of 3D cell culture uptake					→			●					T2.4, T2.6	B	TIFPA, PD, PI
T2.6	3D radiobiology of Ag-111-PSMA-617 on prostate cancer cells in bioreactor									→			●		B	PV, TIFPA
T2.7	2D radiobiology of SPES radionuclides							→					●	T1.6	F	LNL
	WP3 – VIVO (leader: F. P. Cammarata)															
T3.1	Authorization request to work with Ag-111 in mice at CAPiR and CISUP	→	●											T3.4-T3.6	-	PI, LNS
T3.2	γ camera and SPECT imaging of Ag-111 in phantoms													T3.7	G	BO, PI
T3.3	ARG imaging improvement using the γ camera collimator													T3.4-T3.6	G	BO, LNS
T3.4	γ imaging and *ex vivo* biodistribution study of Ag-111-PSMA-617 in healthy mice													T1.2	C	LNS, PI, LNL
T3.5	γ imaging and *ex vivo* biodistribution study of Ag-111-PSMA-617 in tumor-bearing mice													T1.3	D	LNS, PI, LNL
T3.6	Preclinical experiments and γ imaging using Ag-111-PSMA-617 on tumor-bearing mice												●	T1.7, T3.7	E	LNS, PI, BO
T3.7	Radiomic features evaluation from SPECT/CT of preclinical studies												●		H	LNS

→	Activity started
●	Deliverable/milestone reached

Publication/report schedule

Index	Year	Theme
A	2027	2D radiobiology of Ag-111-PSMA-617
B	2029	3D radiobiology of Ag-111-PSMA-617
C	2027	Biodistribution in healthy mice
D	2028	Biodistribution in tumor-bearing mice
E	2029	Preclinical trials of Ag-111-PSMA-617
F	2029	Validation of DNA damage models
G	2029	Scintigraphy with Ag-111 γ camera
H	2029	Radiomics

Endorsement of hospitals

Alla C.A.

Dr. Alberto Andrighetto

P.I. del progetto ISOLPHARM-APEX

Oggetto: Manifestazione di interesse al progetto ISOLPHARM-APEX

La S.S. di Chimica Radiofarmaceutica afferente alla S.C. di Medicina Nucleare dell'AUSL-IRCCS di Reggio Emilia manifesta interesse per gli obiettivi proposti ed i risultati eventualmente conseguiti nel progetto in oggetto. In particolare, nello sviluppo di nuovi radionuclidi metallici per diagnosi e terapia Medico Nucleare.

Reggio Emilia, 8/4/2025

Santa Maria Nuova (Reggio Emilia)

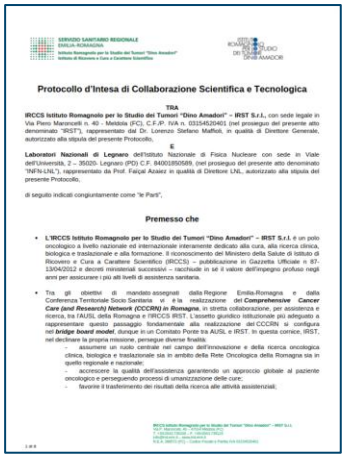
Alla C.A. Dr. Alberto Andrighetto
P.I. del progetto ISOLPHARM-APEX

Oggetto: Manifestazione di interesse al progetto ISOLPHARM-APEX

Il Laboratorio di Radiochimica afferente alla UOC di Medicina Nucleare Centro PET – Ciclotrone dell'A.O.E. Cannizzaro di Catania manifesta interesse per gli obiettivi proposti ed i risultati eventualmente conseguiti nel progetto in oggetto. In particolare, nello sviluppo di nuovi radionuclidi metallici per diagnosi e terapia medico nucleare.

Catania, 06/05/2025

Cannizzaro (Catania)



Protocollo d'Intesa di Collaborazione Scientifica e Tecnologica

TRA

IRCCS Istituto Romagnolo per lo Studio dei Tumori "Dino Amadori" – IRST S.r.l., con sede legale in Via Piero Maroncelli n. 40 - Meldola (FC), C.F./P. IVA n. 03154520401 (nel prosieguo del presente atto denominato "IRST"), rappresentato dal Dr. Lorenzo Stefano Maffioli, in qualità di Direttore Generale, autorizzato alla stipula del presente Protocollo,

E

Laboratori Nazionali di Legnaro dell'Istituto Nazionale di Fisica Nucleare con sede in Viale dell'Università, 2 – 35020 Legnaro (PD) C.F. 84001850589, (nel prosieguo del presente atto denominato "INFN-LNL"), rappresentato dal Prof. Faical Azaiez in qualità di Direttore LNL, autorizzato alla stipula del presente Protocollo,

di seguito indicati congiuntamente come "le Parti",

Premesso che

- **L'IRCCS Istituto Romagnolo per lo Studio dei Tumori "Dino Amadori" – IRST S.r.l.** è un polo oncologico a livello nazionale ed internazionale interamente dedicato alla cura, alla ricerca clinica, biologica e traslazionale e alla formazione. Il riconoscimento del Ministero della Salute di Istituto di Ricovero e Cura a Carattere Scientifico (IRCCS) – pubblicazione in Gazzetta Ufficiale n. 87-13/04/2012 e decreti ministeriali successivi – racchiude in sé il valore dell'impegno profuso negli anni per assicurare i più alti livelli di assistenza sanitaria.
- Tra gli obiettivi di mandato assegnati dalla Regione Emilia-Romagna e dalla Conferenza Territoriale Socio Sanitaria vi è la realizzazione del ***Comprehensive Cancer Care (and Research) Network (CCCRN) in Romagna***, in stretta collaborazione, per assistenza e ricerca, tra l'AUSL della Romagna e l'IRCCS IRST. L'assetto giuridico istituzionale più adeguato a rappresentare questo passaggio fondamentale alla realizzazione del CCCRN si configura nel ***bridge board model***, dunque in un Comitato Ponte tra AUSL e IRST. In questa cornice, IRST, nel declinare la propria missione, persegue diverse finalità:
  - assumere un ruolo centrale nel campo dell'innovazione e della ricerca oncologica clinica, biologica e traslazionale sia in ambito della Rete Oncologica della Romagna sia in quella regionale e nazionale;
  - accrescere la qualità dell'assistenza garantendo un approccio globale al paziente oncologico e perseguendo processi di umanizzazione delle cure;
  - favorire il trasferimento dei risultati della ricerca alle attività assistenziali;

IRST D. Amadori (Meldola, FC)

IFC - Istituto di Fisiologia Clinica
Consiglio Nazionale delle Ricerche

Alla C.A.

Dr. Alberto Andrighetto
Responsabile del Progetto ISOLPHARM-APEX,
INFN-Laboratori Nazionali di Legnaro

Oggetto: manifestazione di interesse per il progetto ISOLPHARM-APEX

Caro Alberto,

Invio la presente comunicazione da parte del Laboratorio See-Life di Imaging Biomedico del CNR di Pisa, per esprimere il vivo interesse scientifico verso il progetto ISOLPHARM-APEX, in particolare per la possibilità di utilizzo sperimentale dei complessi dell'isotopo terapeutico 111Ag.

Saluti Cordiali,

Dr. Luca Menichetti

Pisa, 13/06/2025

IFC-CNR Pisa

[Loading...]

Spedali Civili (Brescia)

Pisa prospect

	Pisa			
	Name	WP	FTE	Status
UNIPI	Nicola Belcari (PI local resp.)	2, 3	0.4	Experimental physicist, associate professor at UNIPI
UNISI	Emilio Mariotti	3	0.1	Experimental physicist, associate professor at UNISI
UNIPI	Giancarlo Sportelli	2, 3	0.3	Experimental physicist, associate professor at UNIPI
IFC-CNR	Luca Menichetti	3	0.2	Radiochemist, CNR researcher
IFC-CNR	Daniele Panetta	3	0.2	Medical physicist, CNR researcher
	Total PI FTE		1.2	T=0; R=1.2

Pisa							
Type	ID	Item	WP	Year 1 [k€]	Year 2 [k€]	Year 3 [k€]	Total
Consumables	17	Laboratory material	3	1	1	1	3
	18	New components for β detector	2	1	0	0	1
	19	Mice for in-vivo experiments	3	2	5	5	12
Services	20	Access to the Eurobioimaging facility	3	2	3	3	8
Shipping	21	Shipping of Ag-111, etc.	3	1	1	1	3
Travels	22	Travels for experimental activity	2, 3	1	1	1	3
Total PI				8	11	11	30

Pisa prospect

	Pisa			
	Name	WP	FTE	Status
UNIPI	Nicola Belcari (PI local resp.)	2, 3	0.4	Experimental physicist, associate professor at UNIPI
UNISI	Emilio Mariotti	3	0.1	Experimental physicist, associate professor at UNISI
UNIPI	Giancarlo Sportelli	2, 3	0.3	Experimental physicist, associate professor at UNIPI
IFC-CNR	Luca Menichetti	3	0.2	Radiochemist, CNR researcher
IFC-CNR	Daniele Panetta	3	0.2	Medical physicist, CNR researcher
	Total PI FTE		1.2	T=0; R=1.2

Altre richieste di servizi in sezione

- Laboratorio di Alte tecnologie (2 settimane anno)
- Progettazione meccanica / prototipazione (2 settimane anno)

Resume

WP1 – SILICO

Monte Carlo dosimetry in murine and cellular geometries; development of models for DNA damage repair and cell survival.
Divisions involved: PD, LNL, PV.

WP2 – VITRO

2D and 3D radiobiology using ^{111}Ag-PSMA-617, other nuclides for comparison and radiotracers, including also cold studies for the 3D part. β imaging for cell uptake measurements.
Divisions involved: PV, TIFPA, LNS, LNL, PD, PI.

WP3 – VIVO

In vivo experiments with ^{111}Ag-PSMA-617, radiomics and imaging using γ camera prototype, SPECT/CT and ARG. Imaging calibration using phantoms.
Divisions involved: LNS, PI, BO.

Possible international partners: **BIOEMTECH** (SPECT imaging), **CNEA** (currently studying ^{177}Lu-DTPA complexes)

Fallout

- With successful preclinical trials using ^{111}Ag-PSMA-617 against prostatic tumors, **clinical trials** could begin
- Possible **commercialization** γ and β imaging prototypes, if their goals in terms of resolution and efficiency will be satisfied
- Production of low-dose-rate **radiobiological data** as benchmark for DNA damage and repair models with SPES_MED nuclides

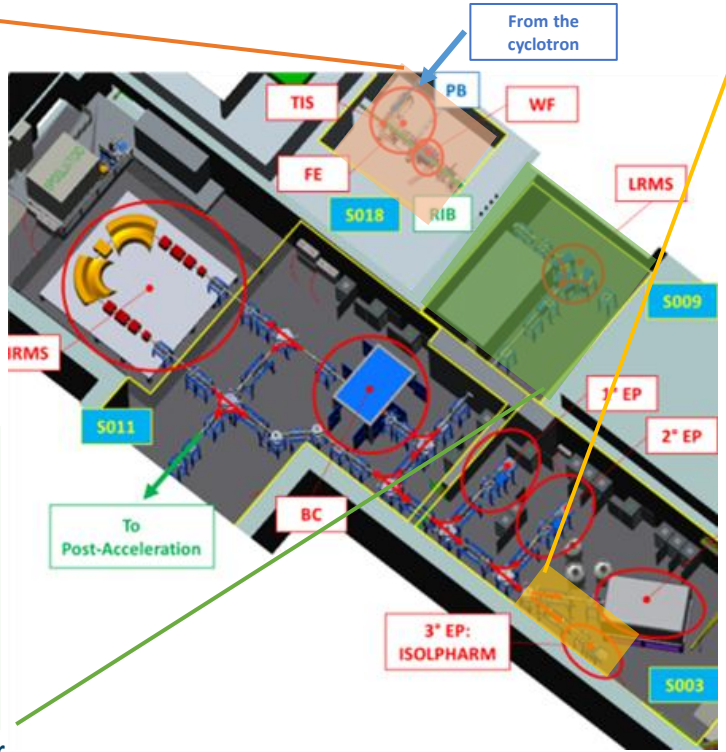
Thank you!

Backup slides

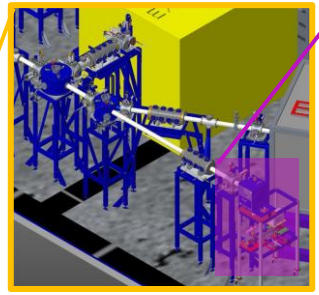
The ISOLPHARM facility

SPES ISOL bunker
(already installed!)

SPES Low Resolution Mass Spectrometer
(WIP installation)

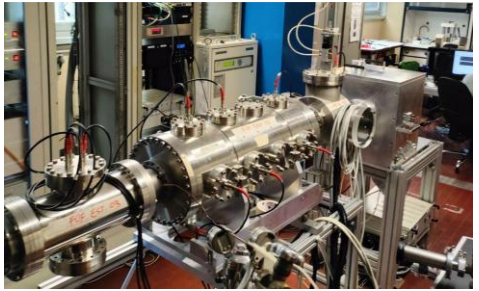


ISOLPHARM beamline and IRIS (ISOLPHARM Radionuclide Implantation Station) system

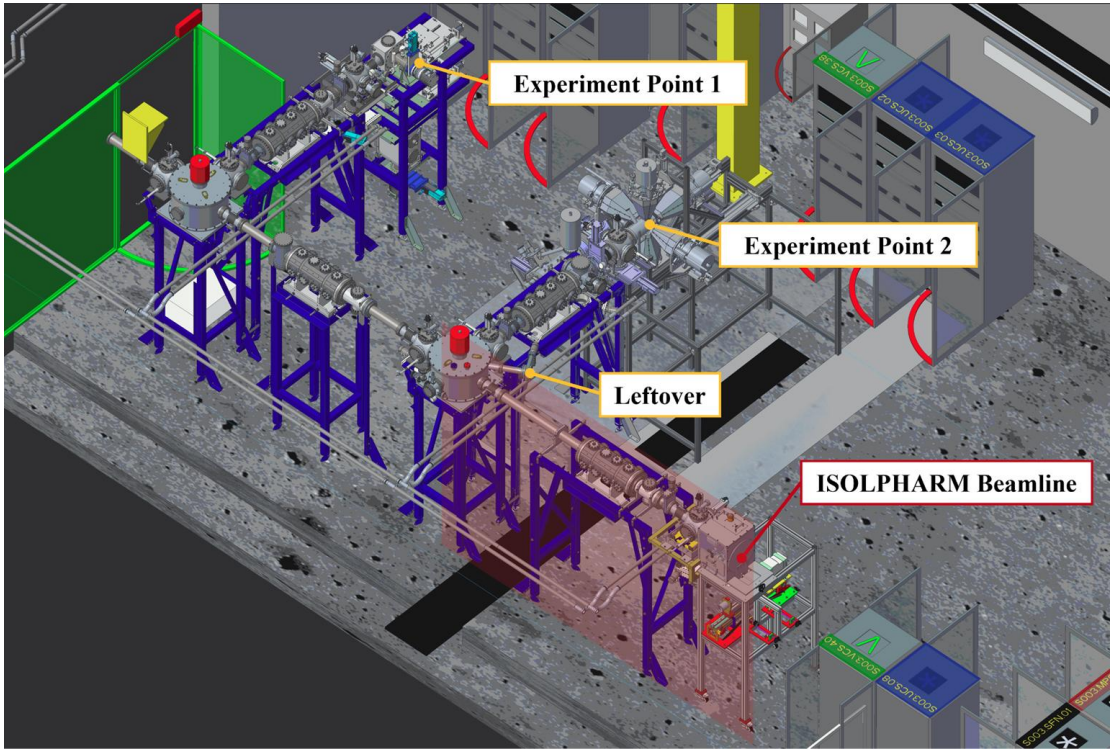


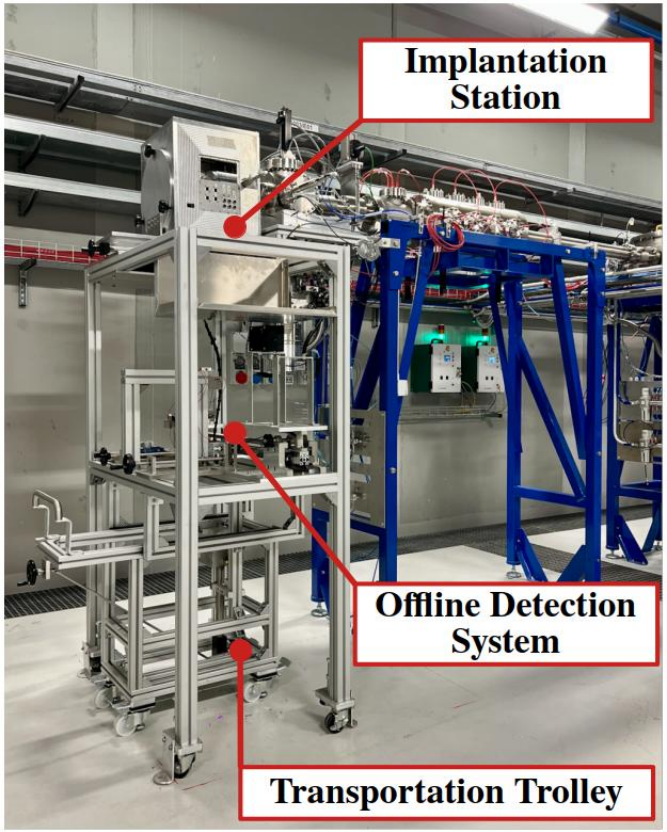
Beamline design almost complete!

IRIS system built and tested at the SPES offline lab!



IRIS: ISOLPHARM Radionuclide Implantation Station





ADMIRAL achievements

WP1 - Radiopharmaceutical production

- Optimization of chelators for Ag
- Optimization of Ag production and separation
- Development of 3D scaffolds for prostatic cancer cells

WP2 - β imaging

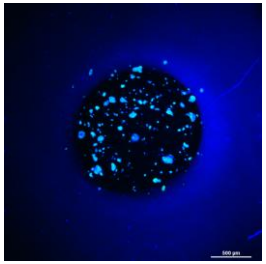
- 2D β imager “DUMBO” construction
- Characterization tests with ^{111}Ag

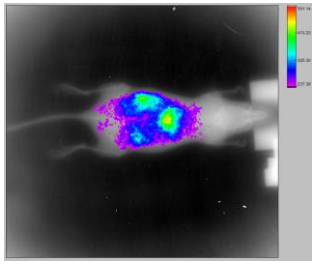
WP3 - γ imaging

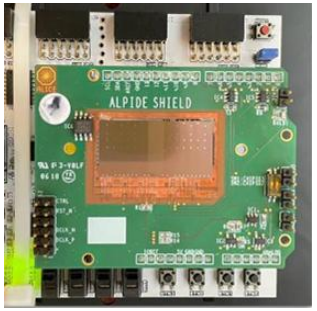
- ^{111}Ag γ camera prototype development
- Characterization tests with ^{111}Ag

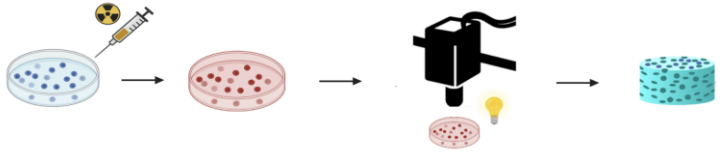
WP4 - Targeted radiobiology

- 2D survival of different cell lines treated with free ^{111}Ag
- Protocol for experiments in 3D scaffolds
- Cell dosimetry and DNA damage/repair models





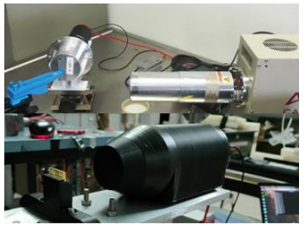




ISOLPHARM_EIRA achievements

Task 1 - Physics

- Production of ^{111}Ag via radiative neutron capture using ^{110}Pd or ^{nat}Pd targets
- Spectroscopic system for radiation measurements at the reactor and ex vivo
- Study of laser photo-ionization schemes of Ag for SPES laser ion source

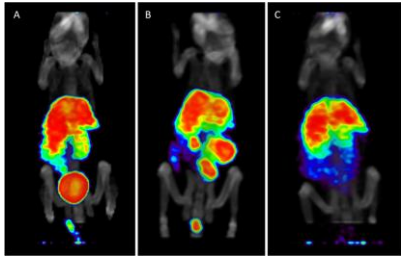


Task 2 - Chemistry

- Ag/Pd separation protocol after irradiation at LENA
- Development of stable chelators for Ag

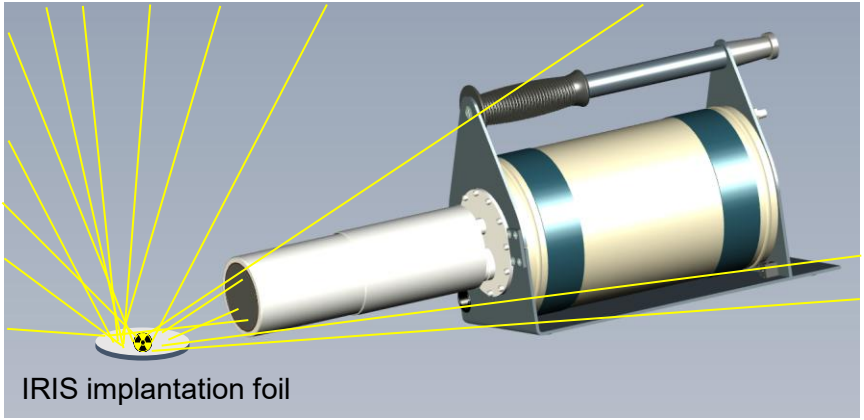
Task 3 - Biology

- Synthesis of linkers and targeting agents for CCK2R
- “Cold” affinity tests in vitro
- Biodistribution and stability tests in vivo using PET/SPECT radionuclides



SPES_MED vs ISOLPHARM_APEX

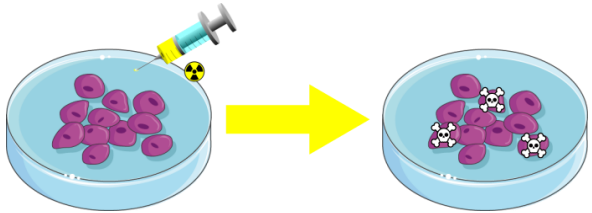
SPES_MED: nuclear measurements (approved by CSN3)

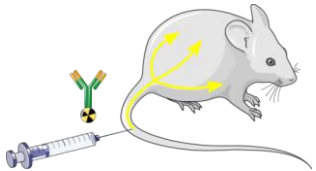

IRIS implantation foil

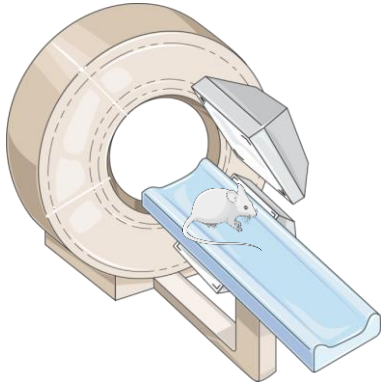
After measurements, either:

- dispose of the radionuclide
- reuse it for applications

ISOLPHARM_APEX: application to radio-biology and medicine (to be submitted to CSN5)







Project FTE

LNL			
Name	WP	FTE	Status
Alberto Andrighetto (National resp.)	2	0.5	Experimental physicist, technology executive
Stefano Corradetti (LNL local resp.)	2	0.1	Materials engineer, technologist
Valerio Di Marco	2, 3	1	Chemist, associate professor at UNIPD
Laura Orian	2, 3	1	Chemist, associate professor at UNIPD
Omorjit Singh Khwairakpam	2	0.1	Experimental physicist, post-doc
Total LNL FTE		2.7	T=0.6; R=2.1

Padova			
Name	WP	FTE	Status
Alberto Arzenton (National resp.)	1, 2	0.6	Theoretical physicist, research scholar at UNIPD
Marcello Lunardon (PD local resp.)	2, 3	0.5	Experimental physicist, associate professor at UNIPD
Sandra Moretto	2, 3	0.1	Experimental physicist, associate professor at UNIPD
Lisa Zangrando	1	0.1	Computer scientist, technologist
Total PD FTE		1.3	T=0.1; R=1.2

Bologna			
Name	WP	FTE	Status
Matteo Negrini (BO local resp.)	3	0.2	Experimental physicist, researcher
Anselmo Margotti	3	0.2	Experimental physicist, technology executive
Carla Sbarra	3	0.2	Experimental physicist, researcher
Giuseppe Baldazzi	3	0.3	Experimental physicist, associate professor at UNIBO
Edoardo Borciani	3	0.5	Physics PhD student at UNIBO
Total BO FTE		1.4	T=0.2; R=1.2

LNS			
Name	WP	FTE	Status
Giorgio Russo (LNS local resp.)	3	0.3	Experimental physicist, CNR researcher
Francesco Paolo Cammarata	3	0.5	Biologist, CNR researcher
Cristiana Alberghina	3	1	Biologist, post-doc at UNICT
Alessandro Stefano	3	0.3	Computer engineer, CNR researcher
Total LNS FTE		2.1	T=0; R=2.1

Pavia			
Name	WP	FTE	Status
Antonietta Donzella (PV local resp.)	1, 3	0.6	Computational physicist, technologist at UNIBS
Giorgio Biasiotto	2	0.2	Biochemist, associate professor at UNIBS
Roberto Bresciani	2	0.2	Biochemist, associate professor at UNIBS
Carlo Rodella	1, 2	0.4	Medical physicist at Spedali Civili di Brescia
Federica Saiani	1, 2	0.4	Medical physicist at Spedali Civili di Brescia
Andrea Salvini	2, 3	0.3	Radiochemist, technologist at UNIPV-LENA
Andrea Gandini	2, 3	0.3	Radiochemist, technologist at UNIPV-LENA
Fabio Zelaschi	2, 3	0.2	Radiochemist, technologist at UNIPV-LENA
Silva Bortolussi	1, 2	0.2	Experimental physicist, associate professor at UNIPV
Marco Di Luzio	2	0.5	Metrologist, INRiM researcher
Giancarlo D'Agostino	2	0.5	Metrologist, INRiM researcher
Laura Cansolino	2	0.3	Biologist, technologist at UNIPV
Cinzia Ferrari	2	0.4	Biologist, technologist at UNIPV
Total PV FTE		4.5	T=2.1; R=2.4

Pisa			
Name	WP	FTE	Status
Nicola Belcari (PI local resp.)	2, 3	0.4	Experimental physicist, associate professor at UNIPI
Emilio Mariotti	3	0.1	Experimental physicist, associate professor at UNISI
Giancarlo Sportelli	2, 3	0.3	Experimental physicist, associate professor at UNIPI
Luca Menichetti	3	0.2	Radiochemist, CNR researcher
Daniele Panetta	3	0.2	Medical physicist, CNR researcher
Total PI FTE		1.2	T=0; R=1.2

TIFPA			
Name	WP	FTE	Status
Devid Maniglio (TIFPA local resp.)	2	0.5	Experimental physicist, associate professor at UNITN
Alessio Bucciarelli	2	0.7	Material scientist, researcher at UNITN
Annalisa Tirella	2	0.7	Biomedical engineer, associate professor at UNITN
Antonella Motta	2	1	Biomedical engineer, full professor at UNITN
Total TIFPA FTE		2.9	T=0; R=2.9

Total project FTE	16.1	T=3.0; R=13.1