SPES MED

Principal Investigator

Prof. Emilio Mariotti, INFN-PI.

INFN Research Units

Pisa, Padova, Milano, Pavia, LNL.

Research Fields

Nuclear Physics, Medical Radionuclides, Cross Section Measurements, Radiation Detectors.

Duration

3 years.

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The SPES Project

The SPES project
(Selective Production of Exotic Species)

SPES-α
Cyclotron and related infrastructure

SPES-β
ISOL facility and the acceleration of neutron-rich unstable nuclei

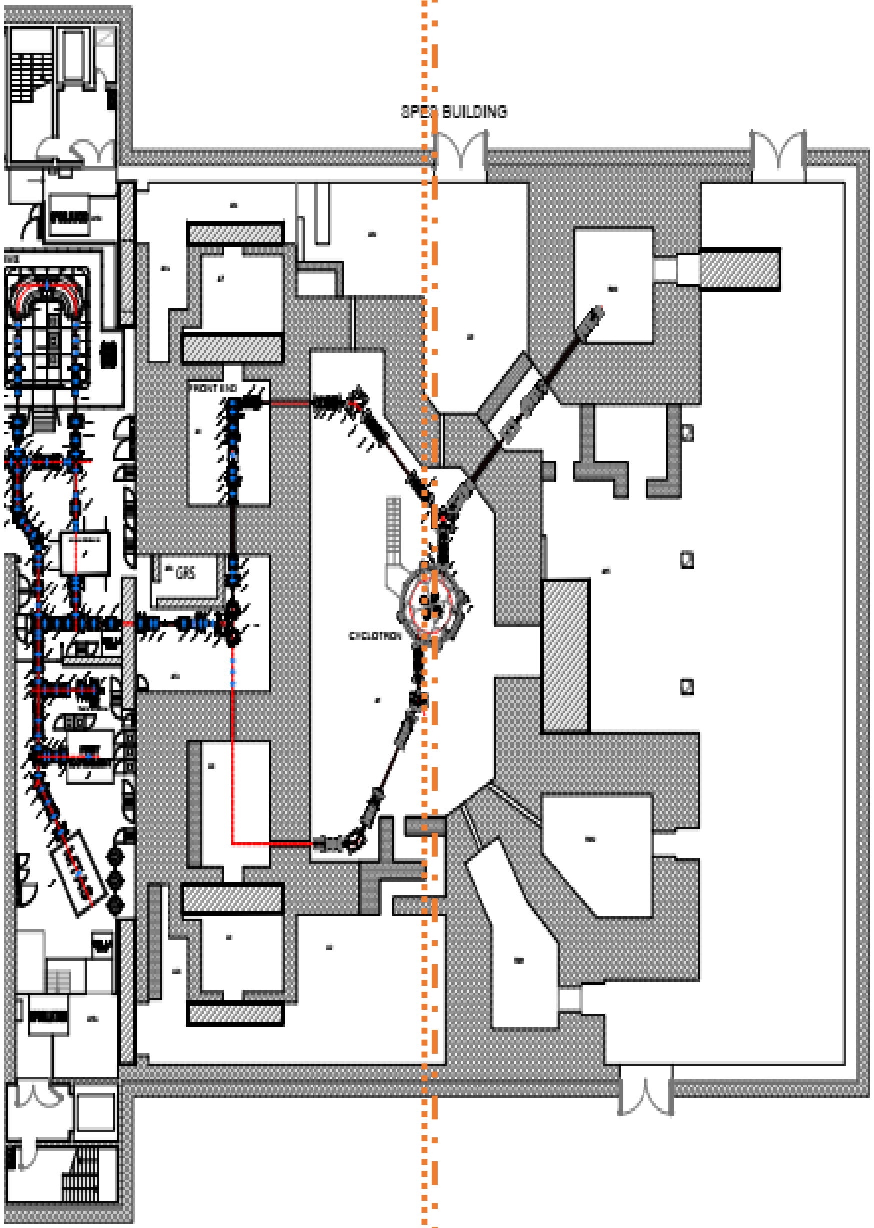
SPES-δ
Multidisciplinary neutron sources

SPES-γ
Production of radionuclides for applications

LARAMED & ISOLPHARM
SPES exotic beams for medicine

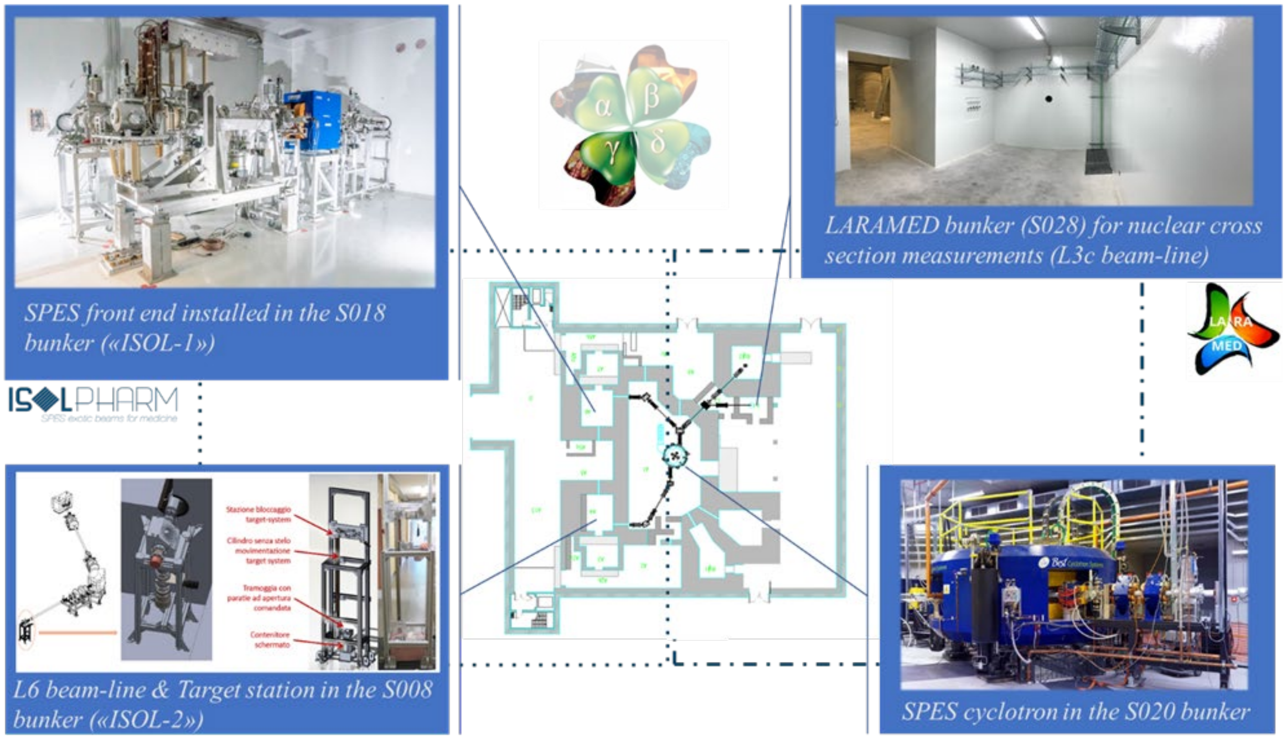
SPES-γ: Produzione di radionuclidi per le applicazioni

Production of
Medical-Radio-Isotope
using the
ISOL technique



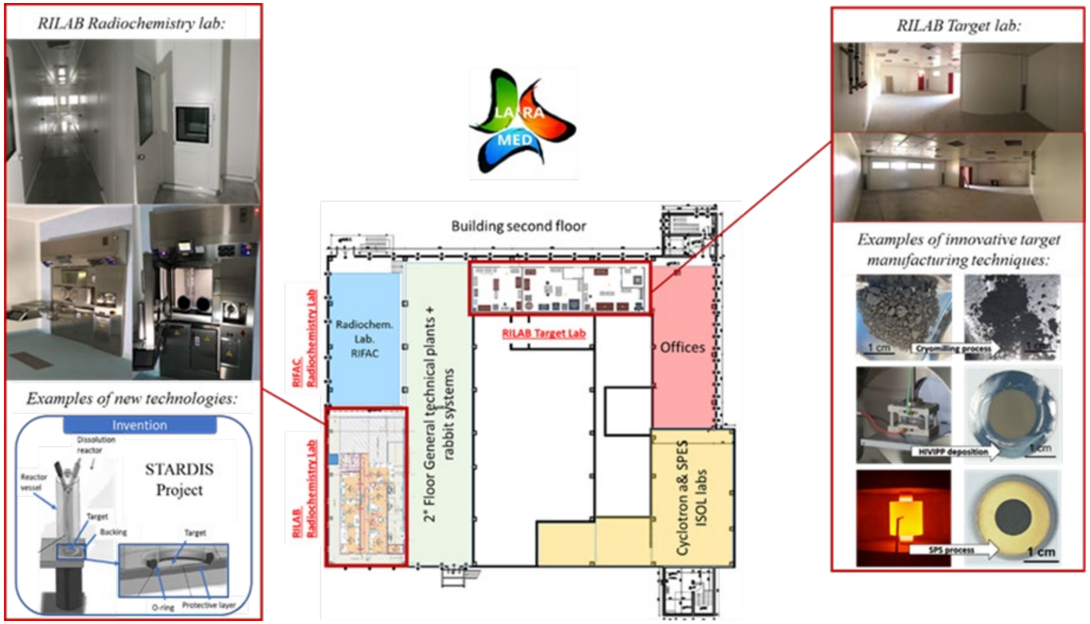
Direct production of
Medical-Radio-Isotope
using the
Cyclotron

SPES-γ: **Produzione di radionuclidi per le applicazioni**



Due bunker per l'irraggiamento:

1. **misure di sezioni d'urto nucleari per fasci di protoni <100 nA;**
2. irraggiamento di bersagli solidi ad alta intensità



Due laboratori al secondo piano:

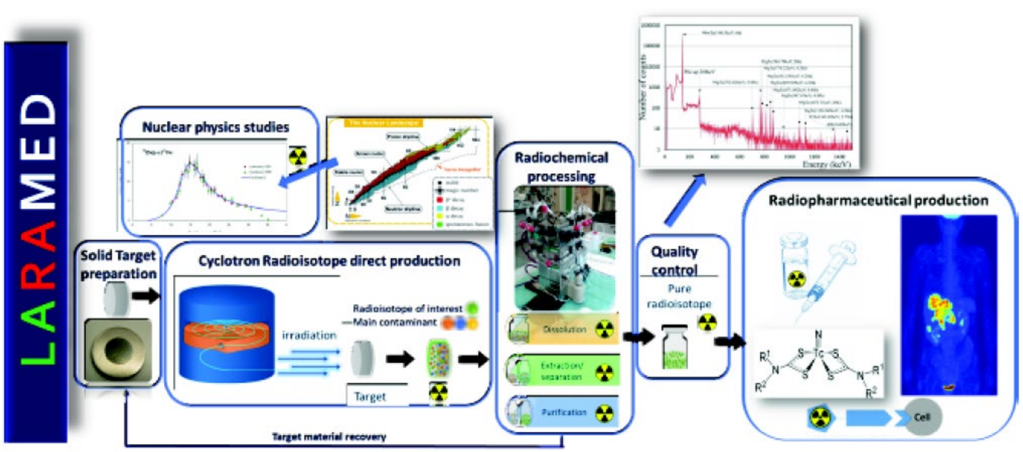
1. preparazione bersagli;
2. **radiochimica, R&D per produzione, separazione e purificazione**

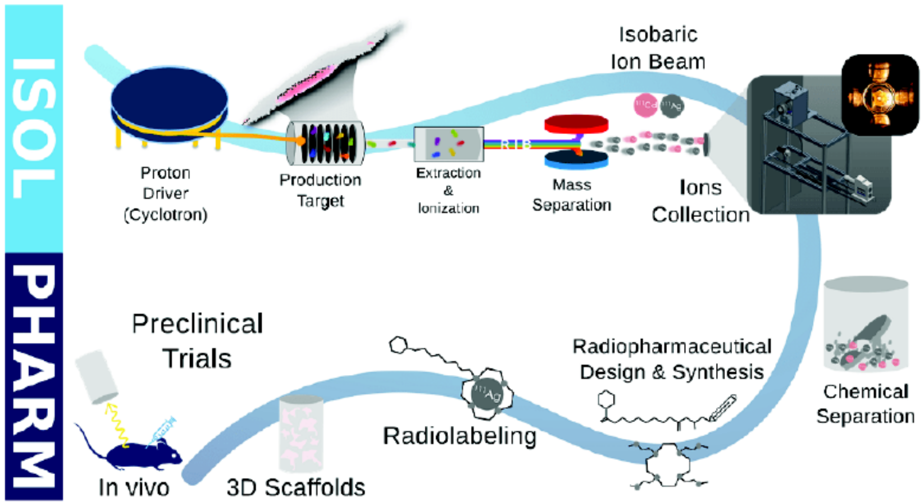
General goals

- Perform measurements of nuclear cross sections aiming at the optimization of medical radionuclides production (**WP1**), also using nuclear modelling tools to find out the best irradiation conditions (WP3);

- Provide a precise measurement of the ISOL production yields originating from SiC and TiC targets (WP2);

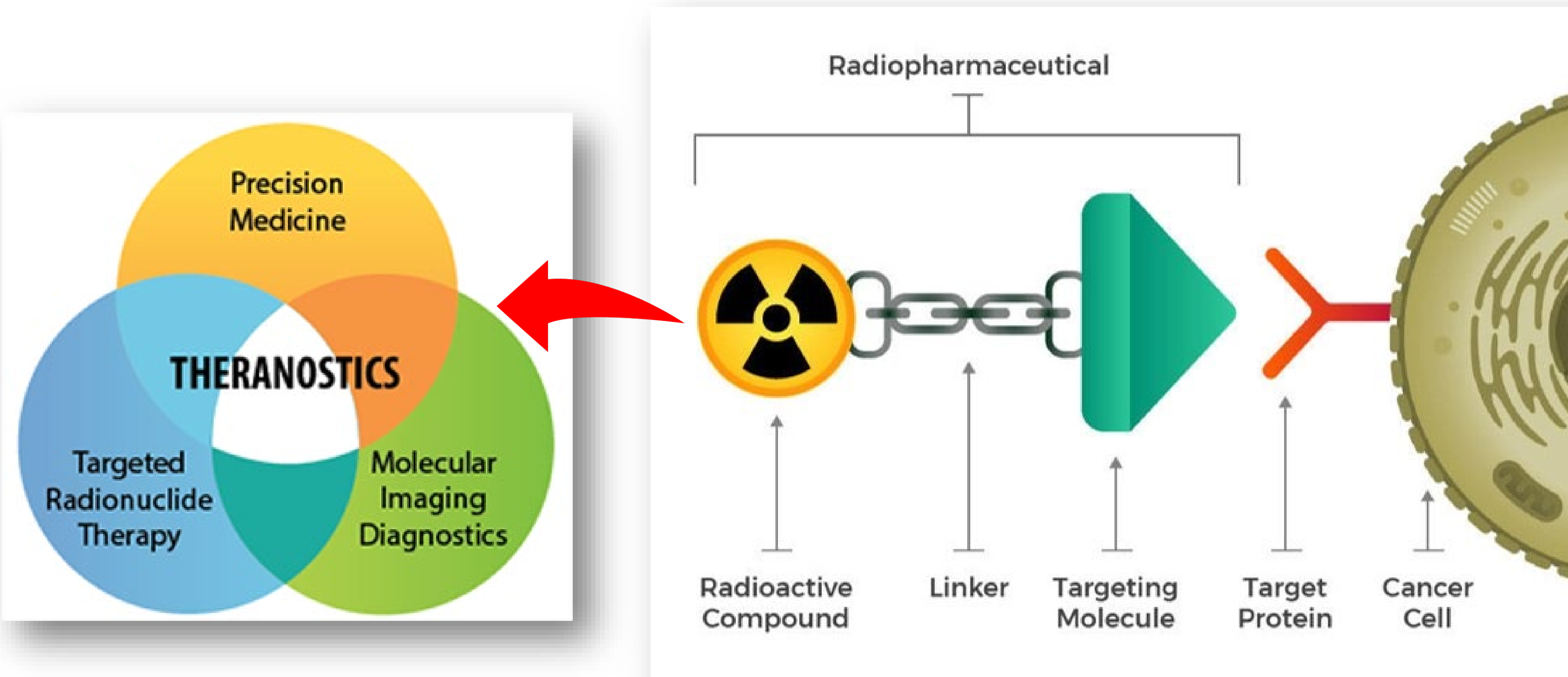
- Compare the produced data with the existing simulation libraries, with the purpose of providing an experimental benchmark when the theoretical predictions fail (WP3).





WP1 - Nuclear cross section measurements

In nuclear medicine, a wide variety of radioisotopes is needed to provide: diagnostic, therapeutic and (possibly) theragnostic capabilities



WP1 - Nuclear cross section measurements

Main goal: measure unexplored nuclear reactions leading to the production of both the radionuclide of interest and its contaminants, aiming to find out the best irradiation parameters for each specific case.

The nuclear reactions of interest are:

- ^{49}Ti(d,x)**^{47}Sc** up to 30 MeV, in collaboration with the ARRONAX facility (LNL team, 1 year);
- ^{68}Zn,^{70}Zn(p,x)**^{67}Cu,^{64}Cu** for proton beams with energy higher than 70 MeV, in collaboration with the i-Themba facility (LNL team, 1 and 2 year);
- ^{70}Zn(p,x)**^{67}Cu,^{64}Cu** in the energy range 25-50 MeV at SPES (LNL team, 3 year);
- ^{159}Tb(p,5n)**^{155}Dy** $\rightarrow$**^{155}Tb** up to 70 MeV at SPES, also in the framework of the PRIN PNRR 2022 entitled "APHRODITE-155" and focused on ^{155}Tb production (**LNL** and **MI team**, 1 year);
- ^{nat}Eu(α,x)**^{155}Tb** in the energy range 10-30 MeV in collaboration with **ARRONAX facility** (1 year) and with **Czech Nuclear Physics Institute CAS** (1 and 2 year) (**MI team**);
- ^{nat}Gd(p,x)**^{152,149}Tb** in the energy range 40-70 MeV at SPES (**LNL** and **MI team**, 2 and 3 year) and at energies up to 200 MeV in collaboration with **i-Themba facility** (**LNL** and **MI team**, 2 and 3 year);
- ^{nat}Gd(α,x)**^{152,155}Tb** in the energy range 10-70 MeV in collaboration with **ARRONAX facility** (**MI team**, 1 and 2 year) and **CAS** (**MI team**, 2 and 3 year).

WP1 – MI team

		Imaging		Therapy		
Isotope	Half-life	β^+ $E_{average}$ [keV] (I)	X and γ with I > 10% [keV] (I)	β^- $E_{average}$ [keV] (I)	Conv. & Auger electrons (>1 keV) $E_{average}$ [keV] (I)	Energy α [keV] (I)
^{149}Tb	4.1 h	730 (7%)	42-50 (69%), 165 (26%), 352 (29%), etc.	-	32 (85%)	3967 (17%)
^{152}Tb	17.5 h	1140 (20%)	42-50 (65%), 344 (64%)	-	36 (69%)	-
^{155}Tb	5.32 d	-	42-50 (108%), 87 (32%), 105 (25%)	-	19 (204%)	-
^{161}Tb	6.89 d	-	45-53 (39%), 75 (10%)	154 (100%)	19 (227%)	-

- Irradiations on **^{159}Tb** with **p**;
- Irradiations on **^{nat}Gd** with **p** and **α**;
- Irradiations on **^{nat}Eu** with **α**.

UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI FISICA

INFN LASA
Istituto Nazionale di Fisica Nucleare
Laboratorio Acceleratori e Superconduttività Applicata

FTE and Budget

MI			
Name	**Expertise – Activity in the project**	**WP**	**FTE**
Simone Manenti (MI local resp.)	Experimental physicist	1	0,6
Flavia Maria Groppi Garlandini	Experimental physicist, associate professor	1	0,3
Michele Colucci	Physics PhD student at Milano University	1	0,3
Francesco Broggi	Dipendente INFN	1	0,3
Elisa Persico	Experimental physicist	1	0,5
Total MI FTE			2,0
Total project FTE			~15

		Year 1	Year 2	Year 3	Total
		[k€]	[k€]	[k€]	[k€]
	WP1 - Nuclear cross-section measurements				
EQUIPMENT (INV)	-	0	0	0	0
CONSUMABLES	Targets and custom clearance	20	5	0	25
	Maintenance	2	2	2	6
	Radioactive transport	8,5	8,5	8	25
TRAVELS	Travels for experimental activity	13,5	18,5	21	53
PUBLICATIONS	Publication fees	3	3	3	9
	TOTAL WP1 - Milano	47	37	34	118
	Total Budget	145	89	71	322

Grazie per l'attenzione!

Extended Gantt and Budget

		Year 1				Year 2				Year 3			
		M3	M6	M9	M12	M15	M18	M21	M24	M27	M30	M33	M36
	WP1 - Nuclear cross-section measurements												
MS1.1	159Tb(p,5n)155Dy → 155Tb up to 70 MeV at SPES	→			●								
MS1.2	49Ti(d,x)47Sc at ARRONAX facility up to 35 MeV	→				●							
MS1.3.1	natEu(a,x)155Tb at ARRONAX	→				●							
MS1.3.2	natEu(a,x)155Tb at Czech Nuclear Physics Institute CAS			→				●					
MS1.4	68,70Zn(p,x)67,64Cu up to 200 MeV at i-Themba lab			→					●				
MS1.5.1	natGd(p,x)152,149Tb in the energy range 40-70 MeV at SPES				→						●		
MS1.5.2	natGd(p,x)152,149Tb up to 200 MeV at i-Themba lab						→						●
MS1.6.1	natGd(a,x)152,155Tb at ARRONAX			→				●					
MS1.6.2	natGd(a,x)152,155Tb at Czech Nuclear Physics Institute CAS							→					●
MS1.7	70Zn(p,x)67Cu,64Cu in the 25-50 MeV range at SPES												●

		Year 1	**Year 2**	**Year 3**	**Total**
		[k€]	[k€]	[k€]	[k€]
	WP1 - Nuclear cross-section measurements				
EQUIPMENT (INV)	-	0	0	0	0
CONSUMABLES	**Targets and custom clearance**	**20**	**5**	**0**	**25**
	Maintenance	**2**	**2**	**2**	**6**
	Radioactive transport	**8,5**	**8,5**	**8**	**25**
TRAVELS	**Travels for experimental activity**	**13,5**	**18,5**	**21**	**53**
PUBLICATIONS	**Publication fees**	**3**	**3**	**3**	**9**
	TOTAL WP1 - Milano	**47**	**37**	**34**	**118**
	Total Budget	**145**	**89**	**71**	**322**