





Progetto speciale SPES


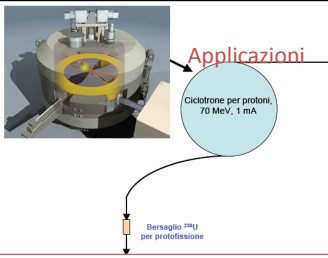

SPES*: the hope of the laboratory



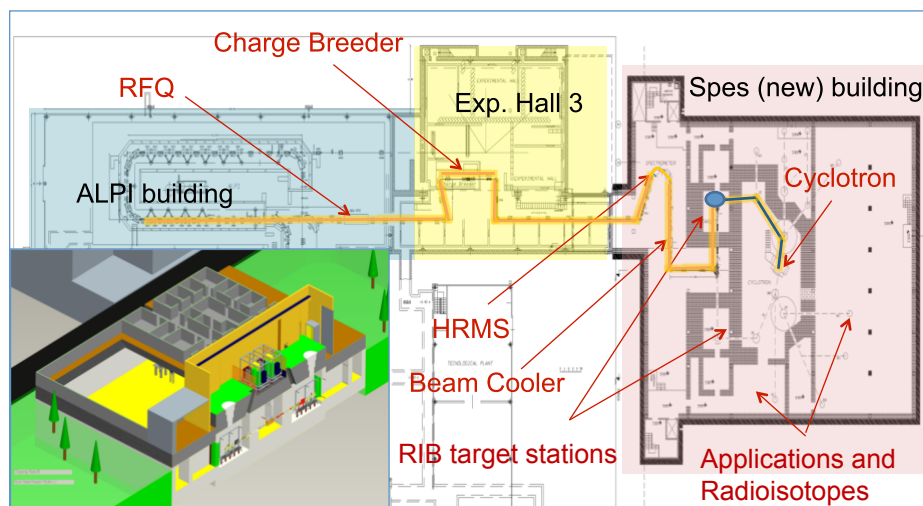
- SPES is a research project centered on **basic nuclear physics and astrophysics, with applications** to :
 - production of radionuclides of medical interest;
 - generation of neutrons, for material studies, nuclear technologies and possibly health
- **SPES, together with the operation of existing machines, is the future of the laboratory**
- There has been a strong acceleration in the last twelve months

* SPES, Selective Production of Exotic Species, is the latin word for Hope

Le fasi di SPES	
 <ul style="list-style-type: none"> • Acquisizione, installazione e commissioning di un ciclotrone ad alta intensita' (protoni ~1mA, 70 MeV su 2 uscite) • in costruzione • Realizzazione delle infrastrutture di base (piano dei lavori approvato da INFN, la gara di appalto partirà a Luglio 2012) • Sviluppo Sorgente ISOL Impegno: ~ 21 M€ 	 <ul style="list-style-type: none"> • L'interesse principale per la Fisica Nucleare e' nello studio delle reazioni con fasci radioattivi riaccelerati • Selezione, trasporto e riaccelerazione dei fasci esotici con il linac superconduttore ALPI (già installato a LNL) • Per SPES-β sono necessari 25 M€. Progetto Premiale MIUR: 22 M€
<ul style="list-style-type: none"> • Produzione di nuovi radioisotopi di interesse medico con fascio del ciclotrone • Stazioni di irraggiamento e bersagli • Moduli di sintesi • Progetto premiale LARAMED: 20-30 M€, a seconda del numero di linee di produzione 	<ul style="list-style-type: none"> • facility per neutroni utilizzando il fascio del ciclotrone • Sviluppo bersagli di potenza • Moderatori e linee di fascio • Integrazione con progetto premiale MUNES (15 M€) (accordo SOGIN)

 <h3>SPES-α: at the heart of the laboratory</h3> <ul style="list-style-type: none"> • In 2003 INFN has approved and financed (with 16.3 Meuro) the phase α of SPES, consisting of: <ul style="list-style-type: none"> - Acquisition, installation and commissioning of a cyclotron with high current (~1mA) and energy up to 70 MeV (machine under construction by BEST). - Building for the cyclotron and experimental stations (design has been finalized, tender just completed) - INFN added 3M Euro in december 2011 - In spring 2014 building complete and cyclotron delivered to LNL 	 <p>The cyclotron will have two outputs:</p> <ul style="list-style-type: none"> -one for physics of radioactive ion physics" -another dedicated to applications 
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SPES layout:



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Where we are

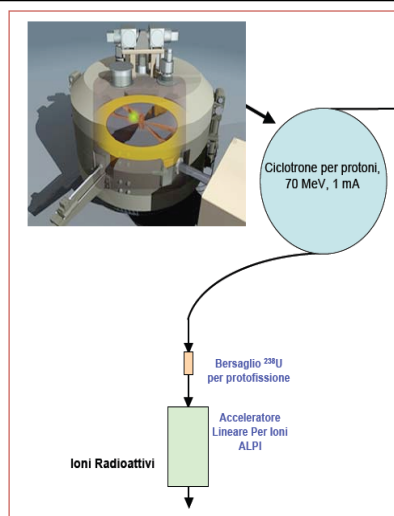
Already done:

- **Building:** on completion the international bid
- **Cyclotron:** on construction by BEST (Canada)
- **ISOL target:** prototype developed and under operation in lab
- **Safety & control:** obtained the authorization to the cyclotron operation, under implementation a Quality and Safety System

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SPES- β : the re-acceleration of radioactive ions

- SPES- α produces radioactive ions by collision of protons on a UCX target
- The principal physics interest is in the production of collisions of these nuclei after re-acceleration
- The re-acceleration will exploit the ALPI-PIAVE system already installed at LNL
- The existing operational agreement (LEA, Laboratori Europei Associati) foresees SPIRAL2 and SPES as partners of a joint activity
- For SPES- β 25-35 Meuro and three years are needed.
- This part has been approved but not yet financed by INFN



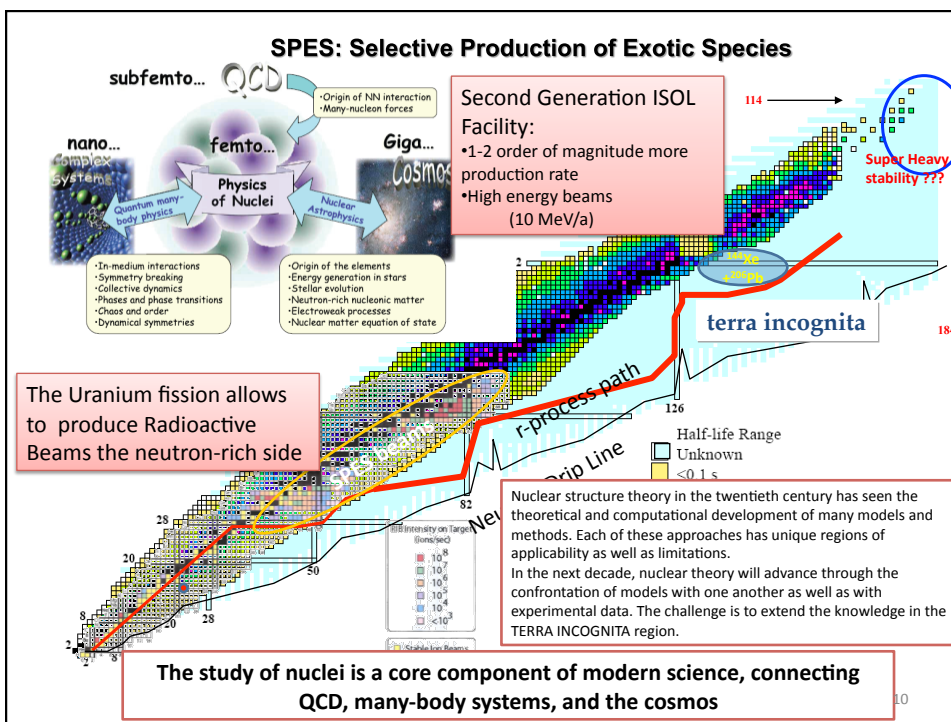
The first year of SPES-beta has just been financed by MIUR with 5.6 Meuro within the Premium projects 2011

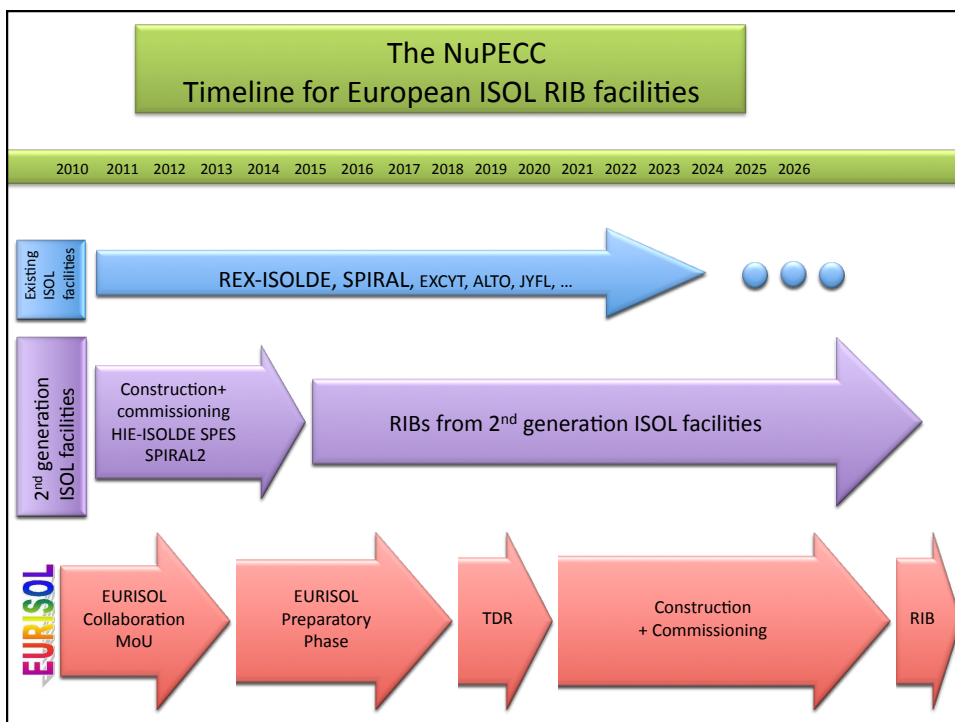
What to do

- Radioactive beam selection and transport
- Charge breeder for increasing the charge state
- RFQ for pre-acceleration
- Upgrade of the ALPI superconductive Linac
- General control system for operation and safety

Relevant milestones of SPES beta

	2013	2014	2015
SPES ISOL	<ul style="list-style-type: none"> -design of radioactive beam transfer line and vacuum system upgrade -Engineering of preacceleration RFQ - construction of the first prototype module. - Partial installation of the charge breeder system -Up-grade of the Alpi cryogenic system 	<ul style="list-style-type: none"> - Development of mass separator and radioactive beam transport system -Installation of laser system for selective ionization -radiation protection safety and controls -RFQ construction Second ISOL target Infrastructure upgrde and new service plant 	<ul style="list-style-type: none"> -Upgrade of technical plant (target handling, UCx Lab, Hot Cell) -Installation of pre-acceleration RFQ -High Resolution mass separator -Completion of Charge Breeder and radioactive beam line transfer
Cost	5.6 Meuro	11 Meuro	10.2 Meuro






Second generation ISOL facilities in Europe (UCx target)

Production and study of neutron-rich nuclei


	Primary beam	Power on target	UCx target	Fission s ⁻¹	Reaccelerator	Nominal energy AMeV A=130
HIE ISOLDE upgrade	p 1-1.4 GeV - 2 μA	2 kW	Direct (150g)	4·10¹²	SC Linac	5-10
SPIRAL2	d 40 MeV 5mA	200 kW	Converter (4000g)	10¹³ 10¹⁴	CIME Cyclotron	5
SPES	p 40 MeV 200 μA	8 kW	Direct (30g)	10¹³	ALPI SC Linac	10

Synergy & complementarity
 will offer to the European nuclear physics community up-to date facilities to improve the knowledge of nuclei





SPES second generation ISOL facility:

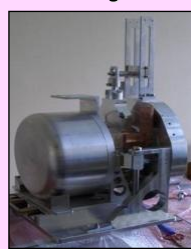
10¹³ fissions/s




Driver:
'Commercial' cyclotron

Production Target:
NEW CONCEPT!
Multi-foil UCx direct target

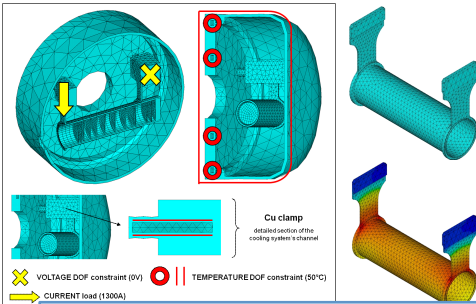


Post Accelerator:
Normal conductive RFQ
(new development)
&
Alpi existing complex



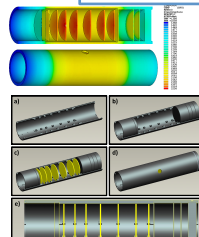
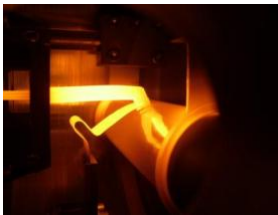
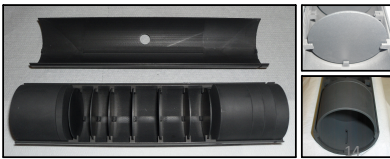
NEW DIRECT TARGET CONCEPT to operate with 10kW proton beam

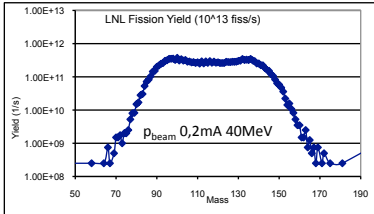
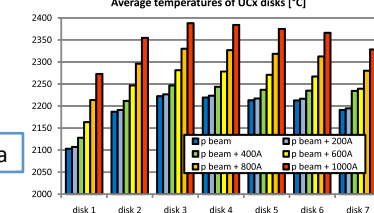
The SPES choice: optimize the Direct Target design and material production to reach 10¹³ fissions/s



Legend:
X VOLTAGE DOF constraint (0V)
● TEMPERATURE DOF constraint (50°C)
→ CURRENT load (1300A)
□ Cu clamp detailed section of the cooling system's channel

Collaboration with Ingegneria Industriale Padova

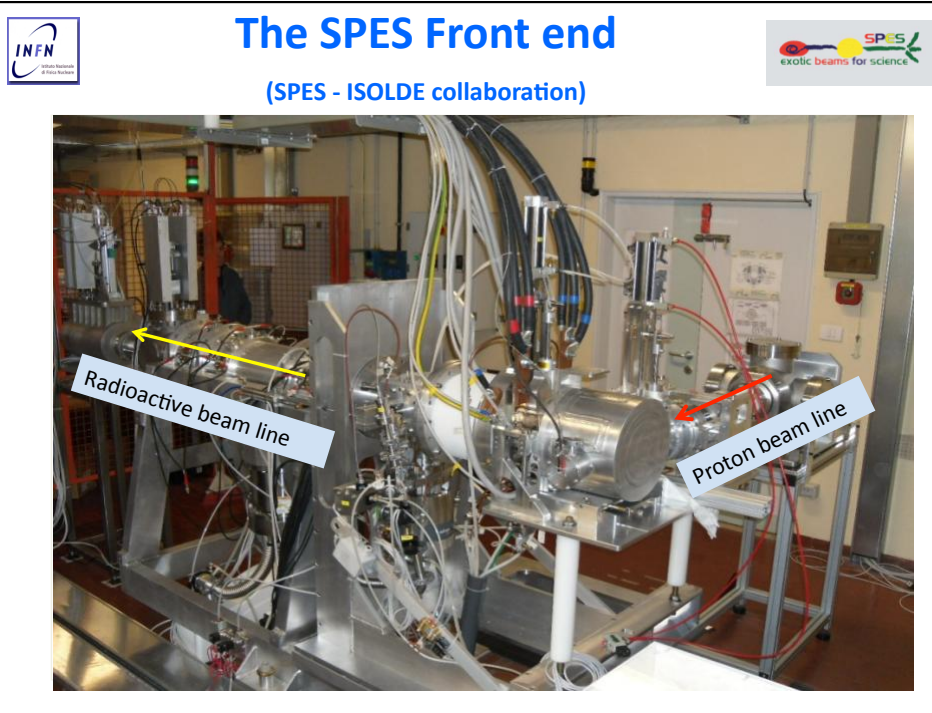




The ISOL SPES Laboratories



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The SPES Front end

(SPES - ISOLDE collaboration)



Actual status

Already done:

- **Building:** the international bid just completed
- **Cyclotron:** on construction by BEST (Canada)
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- **Safety & control:** authorization to the cyclotron operation just obtained, a Quality and Safety System under implementation

To be done:

- **Radioactive beam selection and transport**
- **Charge breeder for increasing the charge state**
- **RFQ for pre-acceleration**
- **Upgrade of the ALPI superconductive Linac**
- **General control system for operation and safety**

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Details of investments in Meuro for 2013 financed by MIUR as Premial Project 2011

Low Beta Upgrade Completion	0,2
Alpi Cryogenics upgrade (Valve Box replacement)	0,9
Diagnostics and Control	0,1
Charge breeder (beyond source core)	1,4
Design of radioactive beam transfer line and vacuum systems upgrades	1,6
RFQ pre-accelerator design and prototype	1,2
Personnel	0,2
TOTAL	5,6

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Details of investments in Meuro for 2014
 (10M€ to be submitted as Premial Project 2012
 1 M€ to be submitted to INFN)

Radiation protection, Safety and controls	1,5
Resonant Laser system for selective element ionization	1,1
Mass separator radioactive vacuum system and beam transport	3,5
RFQ construction	2
Special buildings accessories: shielded Doors, new service plant	2
Personnel	0,4
Consumables and mobility	0,5
TOTAL	11

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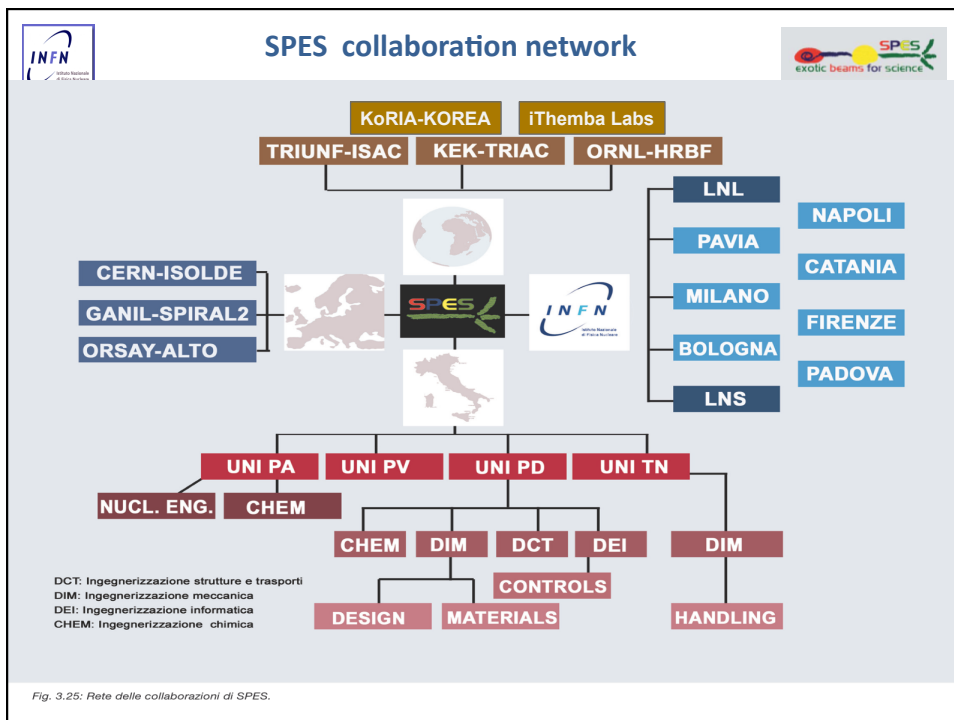
Details of investments in Meuro for 2015
 (9,2 M€ o to be submitted as Premial Project 2013
 1 M€ to be submitted to INFN)

Radiation protection, Safety and controls	1
Building upgrade for UCx laboratory and infrastructures	1,5
High resolution Mass separator and radioactive beam diagnostic	3
Hot Cell for targets handling	1,5
Remote radioactive target handling and exhaust target storage system	1,5
Personnel	0,7
Consumables and mobility	1
TOTAL	10,2

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SPES Schedule September 2012

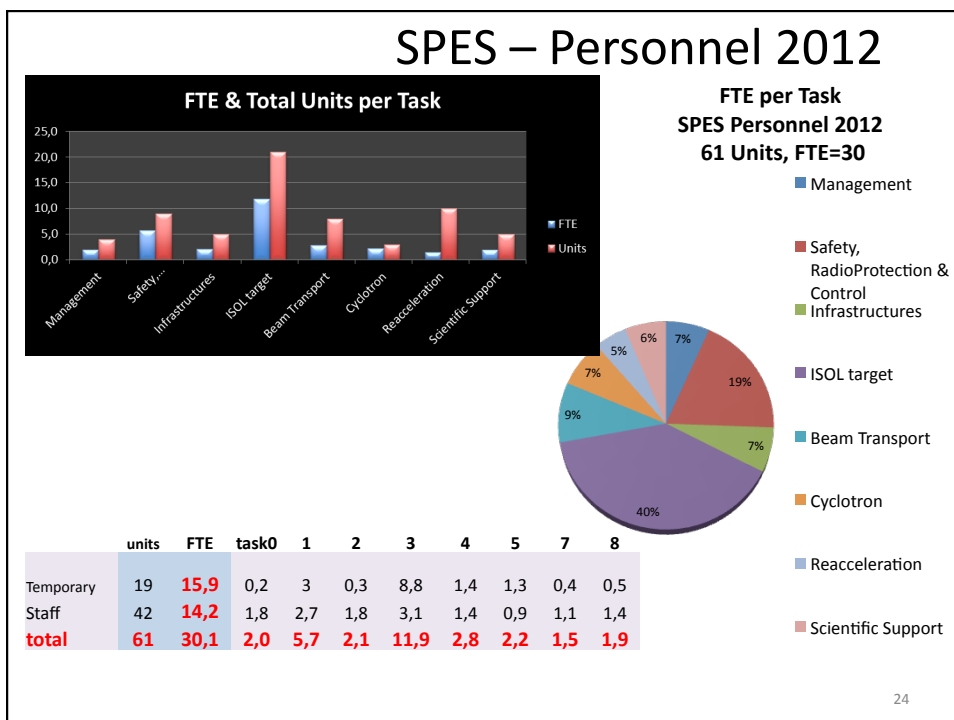
	2010	2011	2012	2013	2014	2015
Meuro	10	0.5	14	11	14	2
Main item	cyclotron		Building Reaccel	RIB transp Reacceler.	UCx lab RIB transp Reaccel	commissioning
Facility preliminary design completion						
Prototype of ISOL Target and ion source						
ISOL Targets construction and installation						
Authorization to operate and safety		Cyclotron operation		UCx operation and safety		
Building's Tender & Construction	building project					
Cyclotron Tender & Construction and delivery						
Alpi up-grade & pre-acceleration (RFQ)						
Design of RIB transport & selection (HRMS, Charge Breeder, Beam Cooler)						
Construction and Installation of RIBs transfer lines and spectrometer						
Complete commissioning						



INFN and University participation to SPES

	Items in charge
LNL	Main responsible and construction site
LNS	Cyclotron overview, radioactive beam transport and mass separation, on-line target test-bench installation, ISOL special infrastructure consult (EXCYT)
INFN-Bologna	Mechanical construction of on-line ISOL front-end and Target handling
INFN e Uni Pavia	Laser source development, construction of SPES ISOL front-end
INFN Milano	construction of SPES ISOL front-end
INFN Pd, Bo, To	Collaboration to SPES - RFQ design and construction (IFMIF collaboration)
Uni Trento	Design of target handling system
Uni Padova	UCx and target materials development, Target thermo-mechanical design, control system,
Uni Palermo	Nuclear engineering risk analysis
INFN Mi, To, Pd, Fi, Na, Ct	Scientific activities

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Conclusions

- ❑ SPES is a competitive project for the production of radioactive beams by ISOL method
- ❑ is part of the NUPECC long range plan and operate in sinergy with the european facilities for Nuclear Physics
- ❑ is involved in the europen collaborations ENSAR and NUPNET; was active in EURISOL design.
- ❑ allows the operation of an applied physics facility in parallel to the ISOL facility
- ❑ the construction phase is started with the participation of LNL, LNS and others INFN Divisions (Bo, Pv, Mi, Pd, Fi, Na, Ct)

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To be done:

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The SPES Premial Project

Total cost of the project:	51Meuro
Submitted a three years Premial Project to MIUR	22 Meuro
Financed the first year with 5.6 Meuro	
INFN investment up today:	
Cyclotron	10.5 Meuro
consumables and others from 2006	3 Meuro
on the way to order the building (co-financial effort in the MIUR Premial Project)	(8 Meuro)
Further investment expected for infrastructure completion & consumables	(8 Meuro)

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The SPES Premial Project

Details of premial project submitted to MIUR for 3 years

	Year 1		Year 2		Year 3	
	INFN	MIUR	INFN	MIUR	INFN	MIUR
TASK_01 - control and safety	500		1000		1900	
TASK_02 - infrastructures	6000		2000		1800	
TASK_05 - Cyclotron			300		350	
TASK_03 - ISOL target and UCx Laboratory	1140			1100		2500
TASK_04 - RIB's transport and selection				2500		3300
TASK_07 - Re-Accelerator*		5400		3000		2700
personnel TD		230		450		720
consumable	350		360		250	
domestic travels	50		50		50	
abroad travels	100		90		50	
* New RFQ and ALPI upgrade	8140	5630	3800	7050	4400	9220

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Relevant milestones

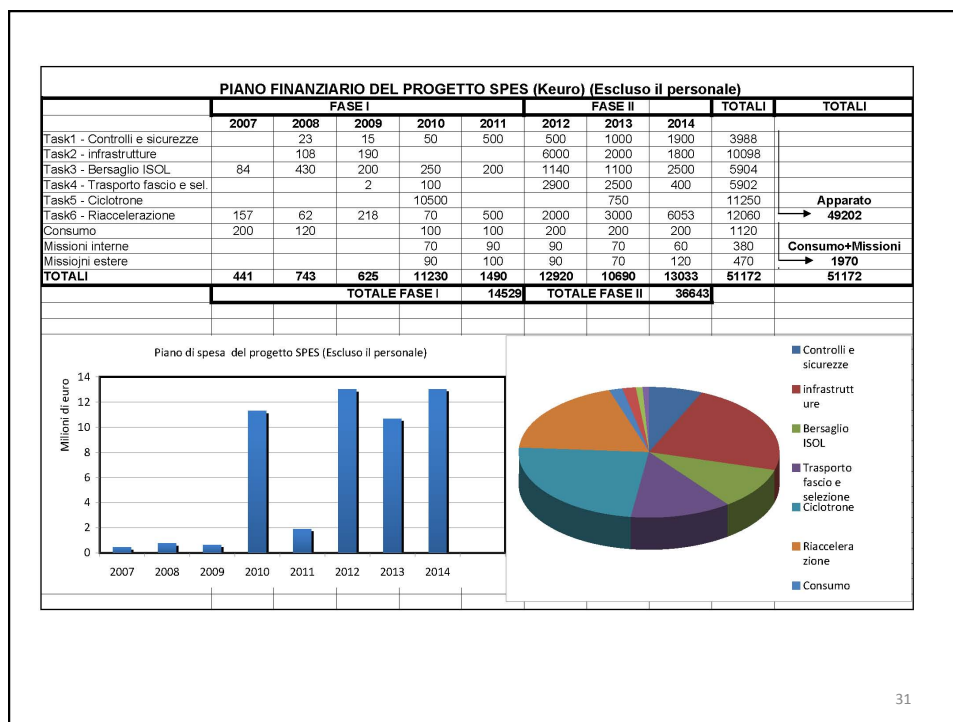
	I ANNO	II ANNO	III ANNO
SPES ISOL	<ul style="list-style-type: none"> -Completion of international bid for buildingconstruction -Development of LASER and FEBIAD sources. Characterization of ISOL system . -Design of preacceleration RFQ and construction of the first prototype module. - Partial installation of the charge breeder system - Up-grade of the cryogenic system of the ALPI linac 	<ul style="list-style-type: none"> - Characterization of UCx at the LNS on-line ISOL test-bench - Development of mass separator and radioactive beam transport system - Installation of laser system for selective ionization - Cyclotron construction upgrade (in firm test) - Avanzamento lavori edilizia 	<ul style="list-style-type: none"> -Building completion. -Cyclotron construction upgrade (acceptance test) - Installation of pre-acceleration RFQ and refurbish of ALPI for radioactive beam acceleration - Completion of Charge Breeder and radioactive beam line transfer

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Relevant milestones

	I ANNO	II ANNO	III ANNO
SPES ISOL	<ul style="list-style-type: none"> -Completamento gara edilizia -Produzione fasci ISOL in laboratorio con sorgente LASER e FEBIAD. -Progettazione e prototipo RFQ di preaccelerazione - Acquisizione parti dl sistema charge breeder - Up-grade criogenia Linac ALPI 	<ul style="list-style-type: none"> - Studio di produzione fasci esotici su test-bench on-line a LNS. - Sviluppo linea di trasferimento e selezione fascio esotico - Installazione sistema laser per ionizzazione selettiva - Avanzamento lavori ciclotrone secondo contratto - Avanzamento lavori edilizia 	<ul style="list-style-type: none"> -Completamento edilizia. -Completamento ciclotrone in sede ditta costruttrice. - Installazione del sistema di preaccelerazione e adeguamento dell'acceleratore ALPI ai fasci esotici - Completamento Charge Breeder e linea di trasferimento fascio esotico

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Economical plan

SPES	compartecipazione INFN al Progetto Premiale					
	I ANNO		II ANNO		III ANNO	
Costi in Meuro	-Radioprot e sicurezze	0.5	- Radioprot e sicurezze	1	- Radioprot e sicurezze	1.9
	-Edilizia	6	-Edilizia	2	-Edilizia *	1.8
	-Consumo + Mobilità	0.5	-Consumo + Mobilità	0.5	-Consumo + Mobilità	1.0
	-Bersaglio ISOL	1.14				
	-(Ciclotrone già acquisito)	10.5				
TOTALE		8.14 + 10.5		3.5		4.7

Edilizia * = spese aggiuntive di edilizia e impiantistica per laboratorio applicazioni

SPES:	richieste Progetto Premiale MIUR					
	I ANNO		II ANNO		III ANNO	
Costi in Meuro	-Riaccelerazione	5.4	-Riaccelerazione	3	-Riaccelerazione	2.7
	-Personale TD	0.23	-Trasporto fascio	2.5	-Trasporto fascio	3.3
			-Laser ionizz. Selett.	1.1	-Bersaglio ISOL	2.5
			-Personale TD	0.45	-Personale TD	0.72
TOTALE	Totale	5.63	Totale	7.05	Totale	9.22

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