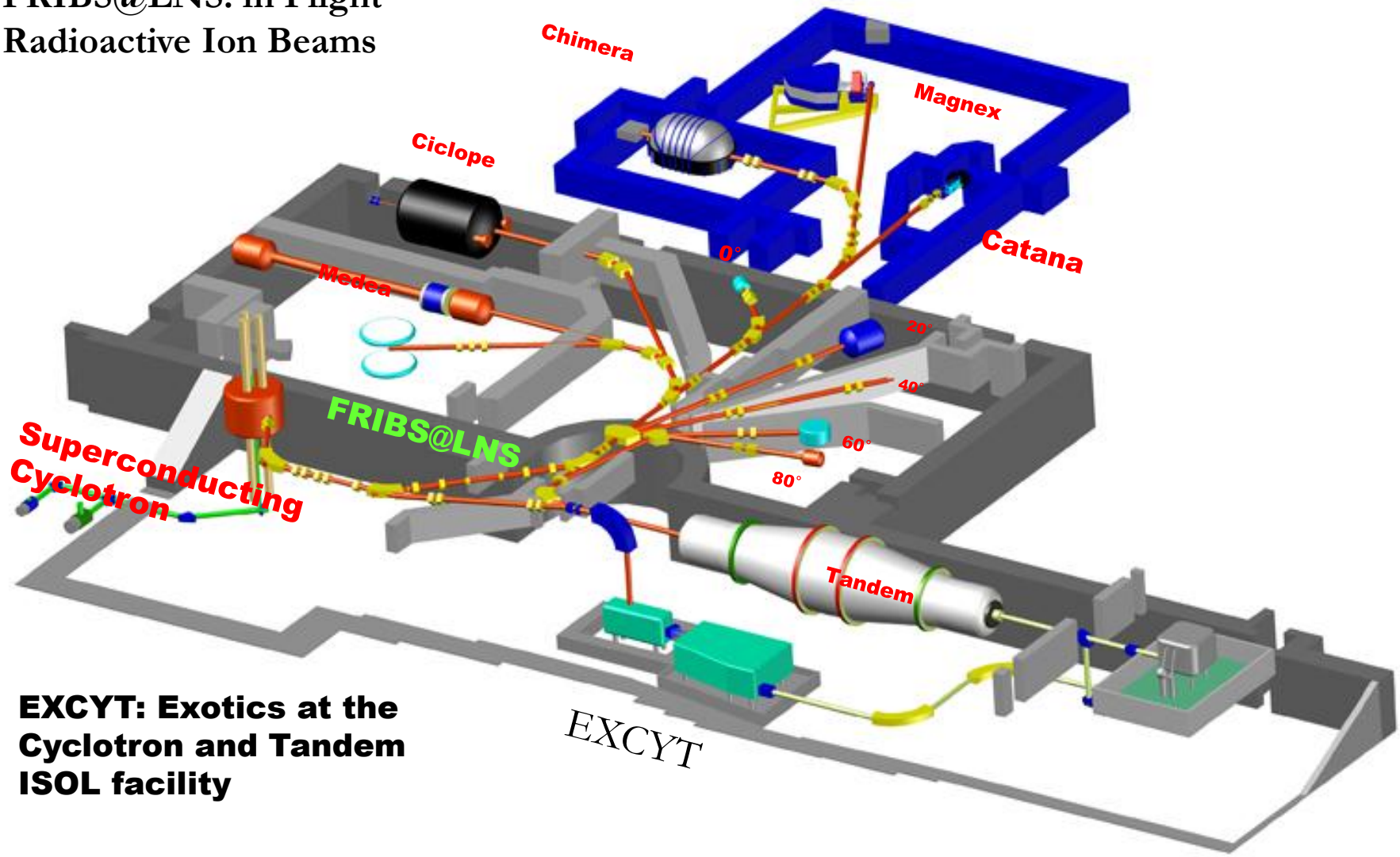

INFN - Laboratori Nazionali del Sud

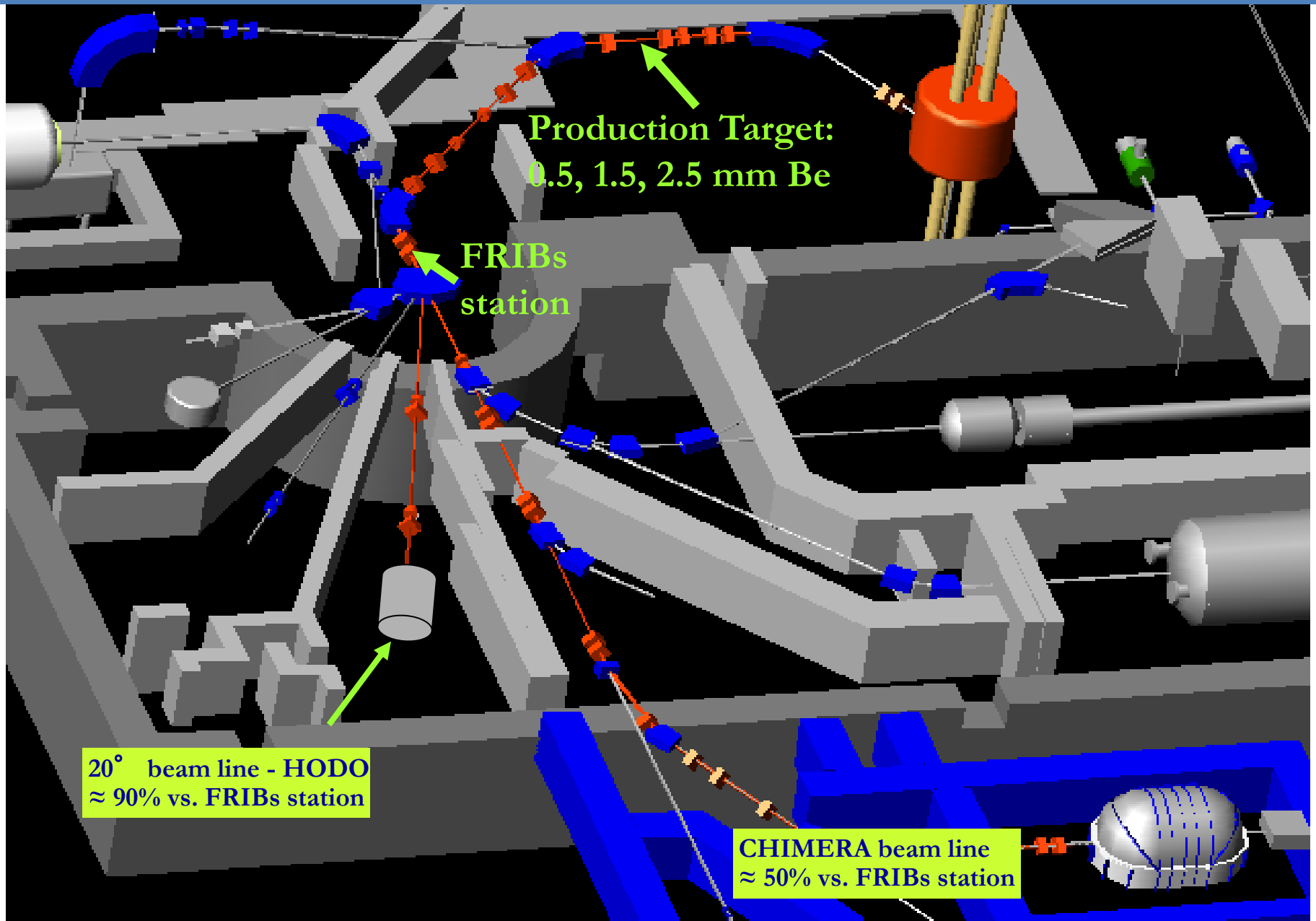
LNS lay-out: accelerators and experimental halls

FRIBS@LNS: in Flight Radioactive Ion Beams



EXCYT: Exotics at the Cyclotron and Tandem ISOL facility

FRIBS@LNS: in Flight Radioactive Ion Beams



Main LNS experimental apparata for Nuclear Physics

MAGNEX*EDEN

- Light nuclei structure
- Nuclear astrophysics
- Spectroscopy
- Structure effects on reaction mechanism

CHIMERA

- GDR
- Caloric curve & phase transition
- Multifragmentation
- Isospin dependence of EoS
- Di-proton decay

2011: ENSAR Transnational access

"LNS experimental resources upgradining for excellence researches in Nuclear Astrophysics, with stable and radioactive beams"

The availability at LNS of a system that allows to produce radioactive beams (EXCYT) togheter with the well-established technique to produce "virtual" neutrons by the Trojan Horse Method will make our lab as the first laboratory where it is possible to study reactions between neutrons and instable nuclei, both for Nuclear Astrophysics researches and Nuclear structure studies and Mechanisms reactions.

This will be possible due to the LNS experimental resources upgrading, supported essentially by "Premiali" funds, for excellence researches in Nuclear Astrophysics.

The aim of this project is to perform "bare" nucleus cross sections measurements of key astrophysics reactions in the astrophysics energy range and thermonuclear fusions reactions that concern the fusion energy production.

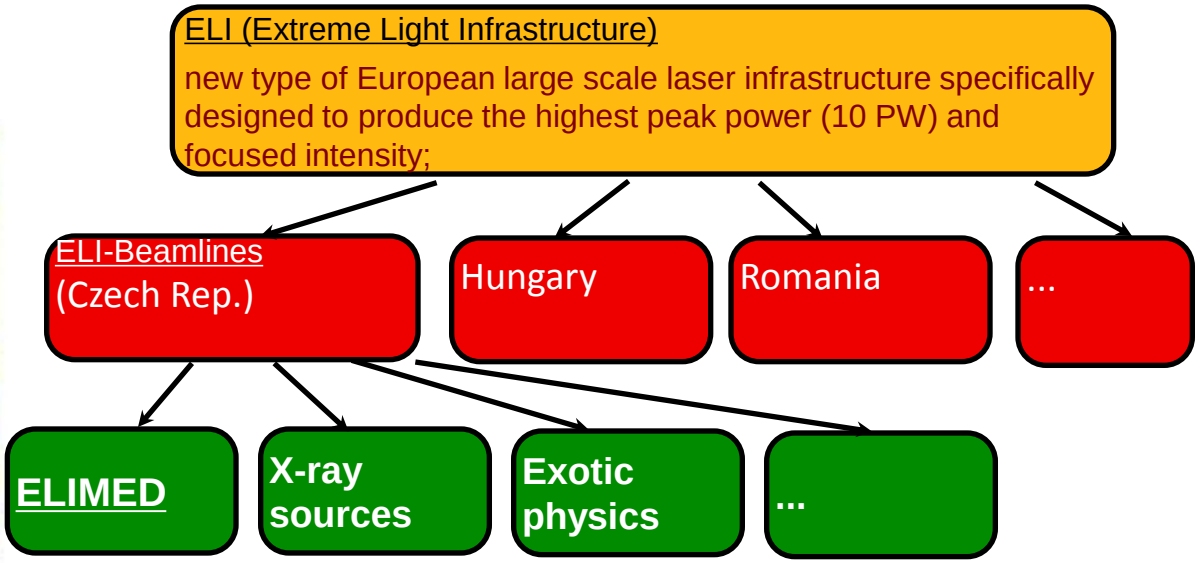
For example, to know the $^{10}B(p,\alpha 0)^{7}Be$ cross section it is crucial to understand the natural B usability as clean fuel.

This is an example that shows the strong correlations between Nuclear structure and Nuclear Astrophysics studies.

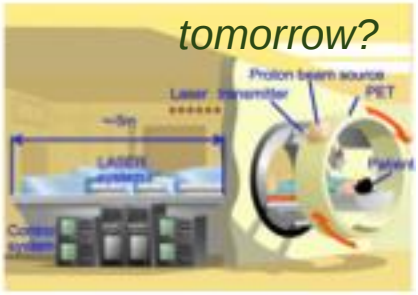
It will be possible to perform such measurements, with the necessary precision, thanks to the upgrading both of the TANDEM and of the SERSE source, to produce radioactive beams with the proper intensity necessary for the Nuclear Astrophysics measurementes proposed.

Moreover, these studies will make use also of the detectors upgrade, already working at LNS, such as the particles detector ASTRHO and the magnetic spectrometer MAGNEX, using also the neutron detector EDEN (MoU IN2P3 - INFN). A specific upgrading activity, that exploit the state-of-the-art thecnology to make in the forefront accelerators and detectors is one of the NuPECC Long Range Plan 2010 recommendations, to support and to upgrade the existing facility in the European Laboratories that can produce beams with some specific features.

ELI-Beams and the ELIMED idea



- Why ELIMED?
  - Realization of a facility at ELI-Beamlines, to *demonstrate the clinical applicability of the laser-driven protons*
  - **Compactness, cost-reduction**, new pioneering treatment modalities



- Why ELIMED at INFN?

-The project we are proposing is related to the preparatory phase of ELIMED (2013-2015): optimisation of the proton beams, transport, diagnostic dosimetric and radiobiologic studies.

ELIMED MoU

- It was born by an idea of FZU of Prague and INFN-LNS researchers
- A MoU (Memorandum of Understanding) between INFN-LNS and ELI has been signed and officially started the activity


Fyzikální ústav
Akademie věd ČR, v.v.i.

INFN

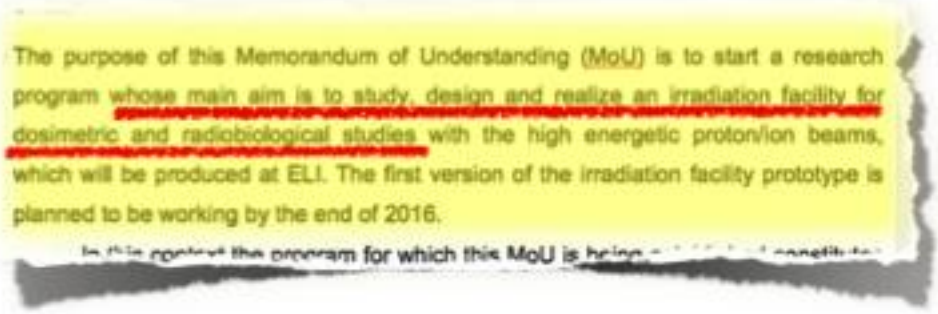
Memorandum of Understanding for a scientific and technologic collaboration towards medical applications at ELI Beamlines

Between the

ELI-Beamlines, Institute of Physics of AS CR, public research institution (FZU),
Prague, Czech Republic

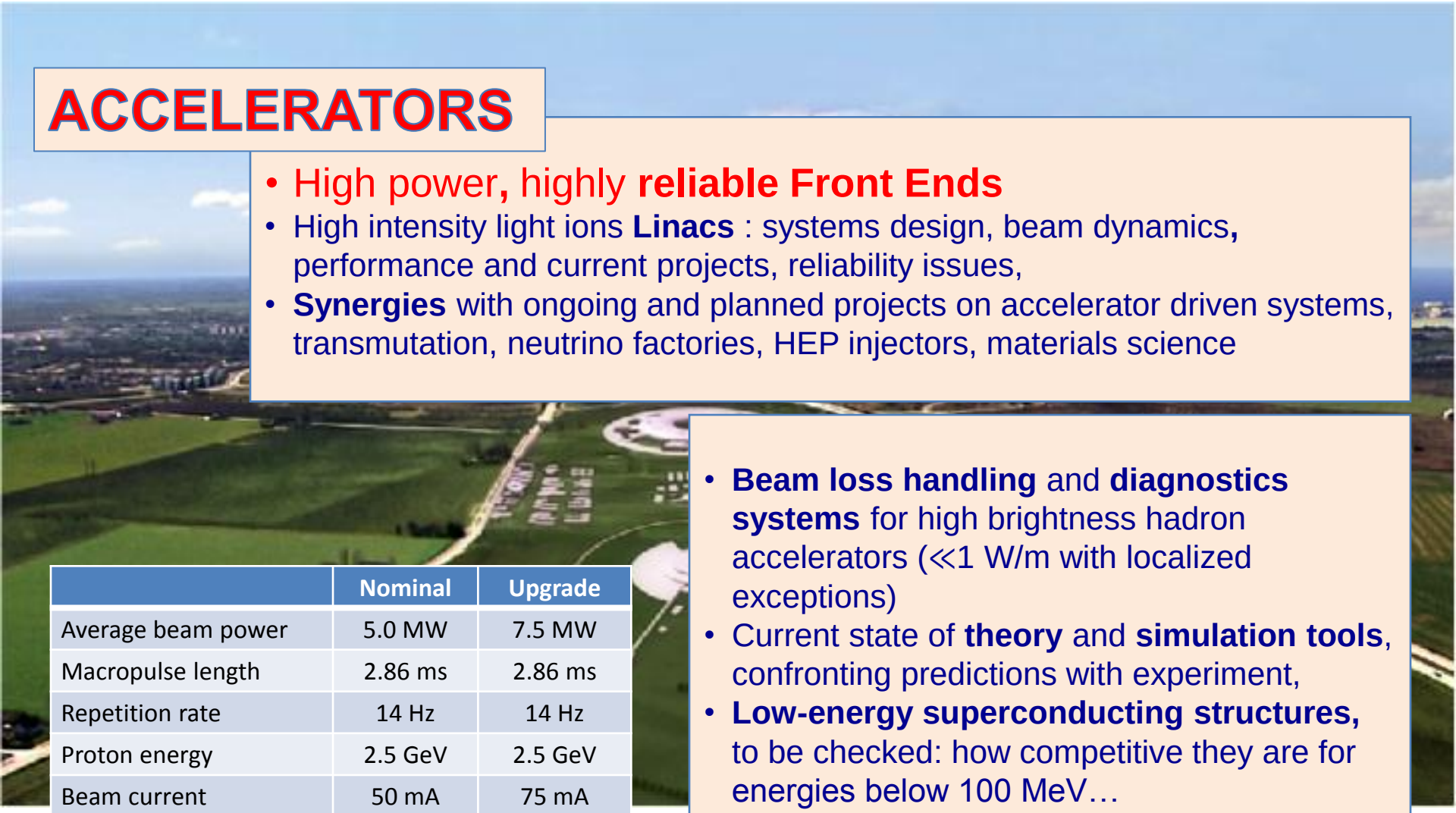
And

Laboratori Nazionali del Sud (LNS), of INFN, public research institution,
Catania, Italy


The purpose of this Memorandum of Understanding (MoU) is to start a research program whose main aim is to study, design and realize an irradiation facility for dosimetric and radiobiological studies with the high energetic proton/ion beams, which will be produced at ELI. The first version of the irradiation facility prototype is planned to be working by the end of 2016.

ELI Tender in progress for ELIMED

European Spallation Source – Lund (Sweden)



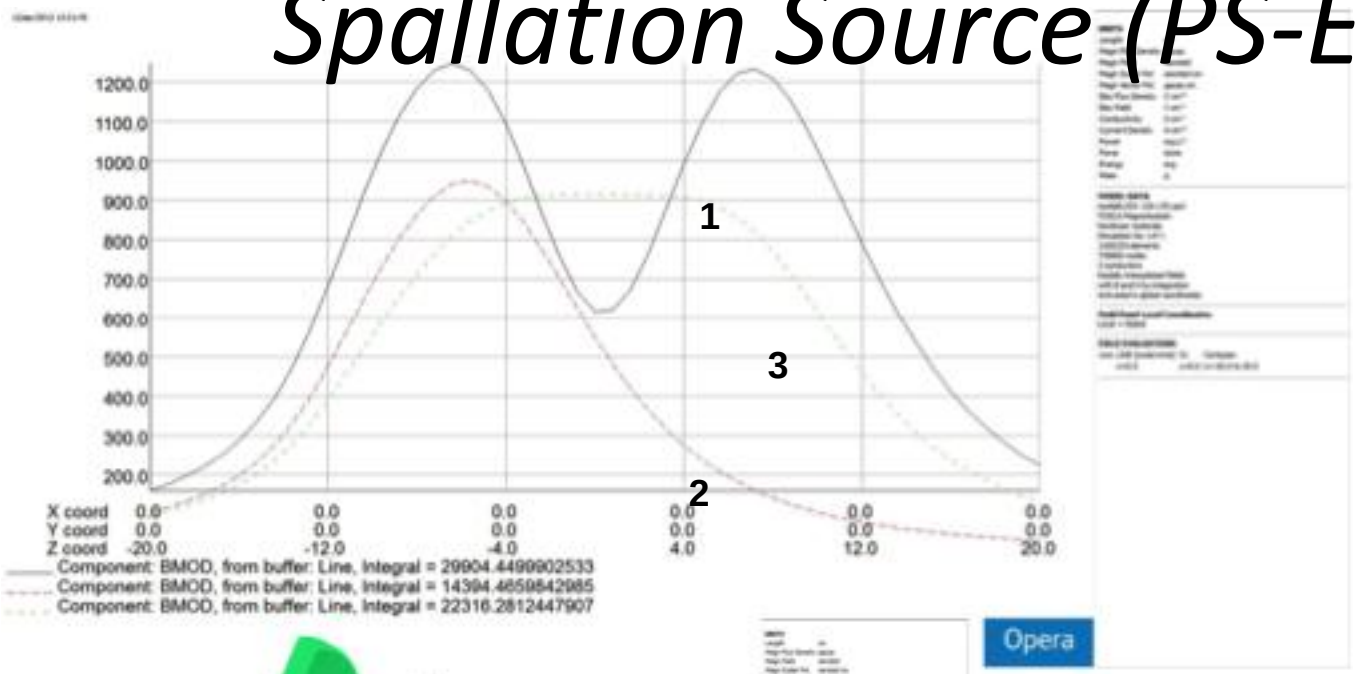
ACCELERATORS

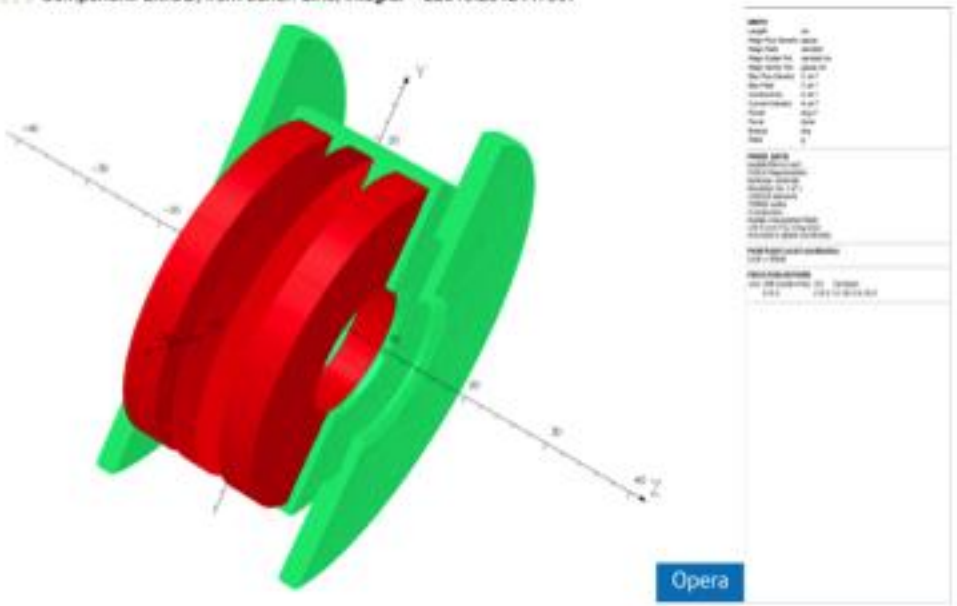
- High power, highly **reliable Front Ends**
- High intensity light ions **Linacs** : systems design, beam dynamics, performance and current projects, reliability issues,
- **Synergies** with ongoing and planned projects on accelerator driven systems, transmutation, neutrino factories, HEP injectors, materials science

	Nominal	Upgrade
Average beam power	5.0 MW	7.5 MW
Macropulse length	2.86 ms	2.86 ms
Repetition rate	14 Hz	14 Hz
Proton energy	2.5 GeV	2.5 GeV
Beam current	50 mA	75 mA
Duty factor	4%	4%
Beam loss rate	< 1 W/m	< 1 W/m

- **Beam loss handling** and **diagnostics systems** for high brightness hadron accelerators (≪1 W/m with localized exceptions)
- Current state of **theory** and **simulation tools**, confronting predictions with experiment,
- **Low-energy superconducting structures,** to be checked: how competitive they are for energies below 100 MeV…

Proton Source for European Spallation Source (PS-ESS)





1. "Simple mirror";
2. "Magnetic Beach"
3. "Off-Resonance configuration"

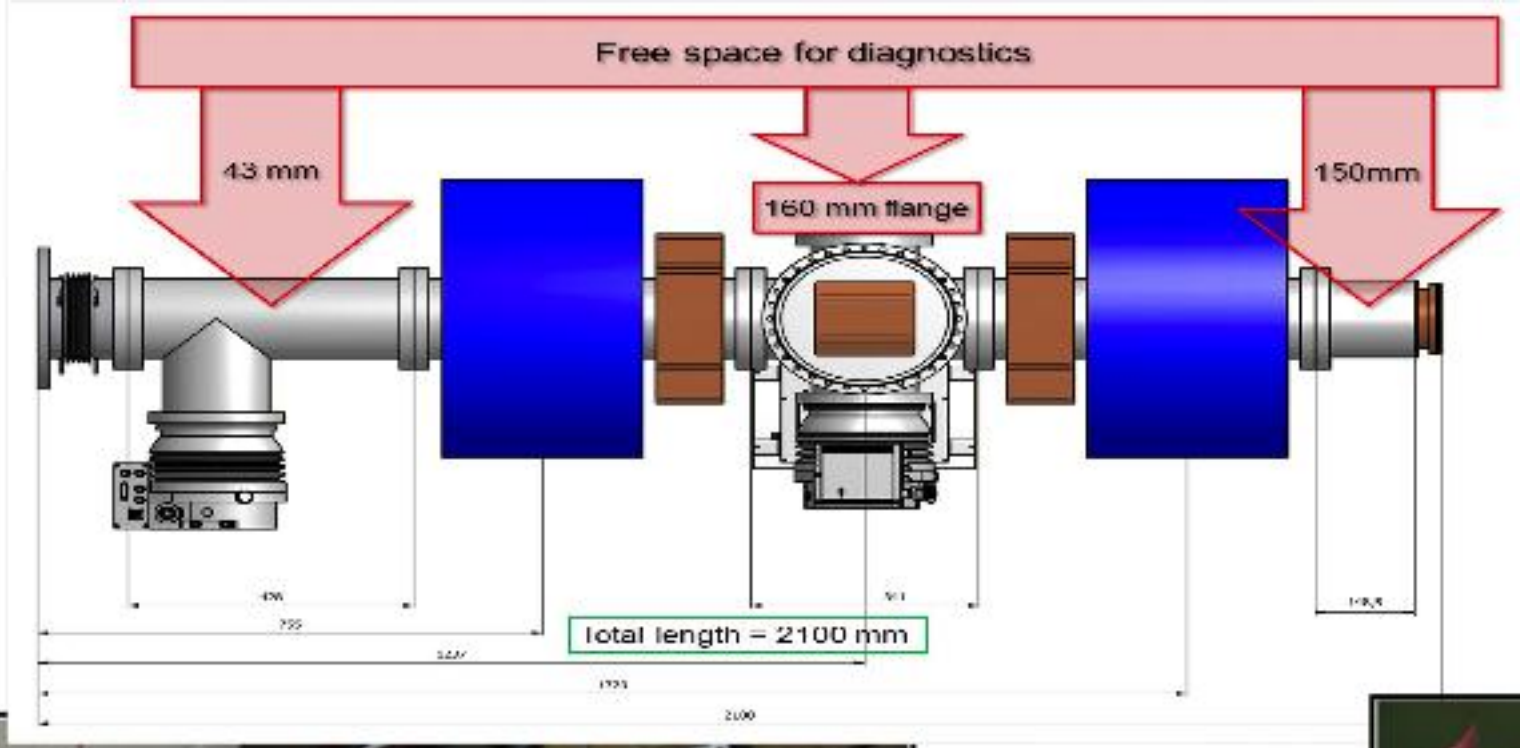
2.45-3 GHz operations

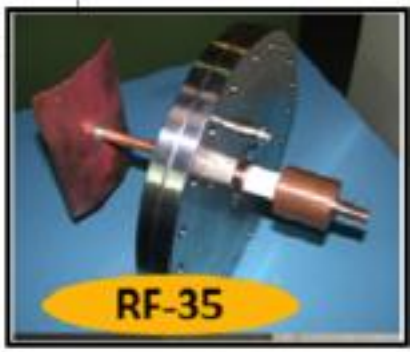
60-120 mA of protons

Reliability above 99.9%

Emittance< 0.2π mm mrad

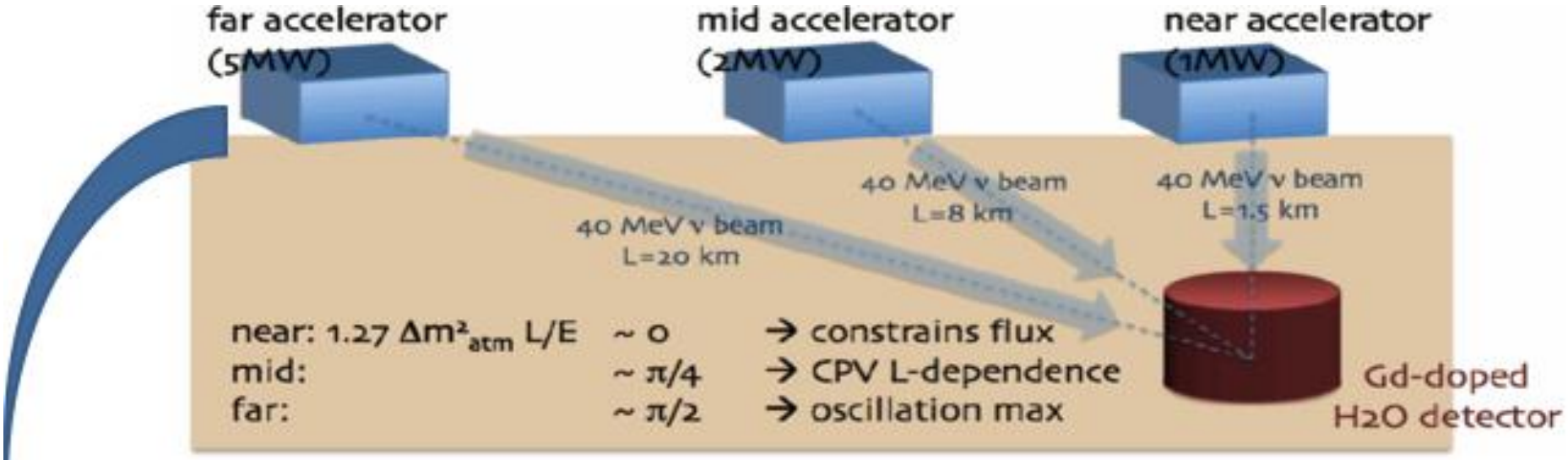
LEBT



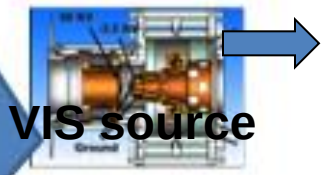


- **Chopper built at INFN-LNS and already delivered to GANIL for SPIRAL 2**

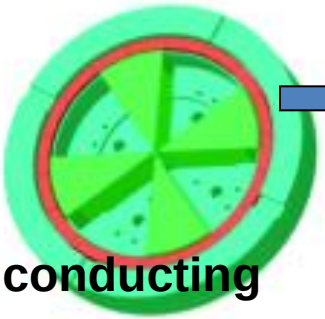
DAEδALUS: experiment overview



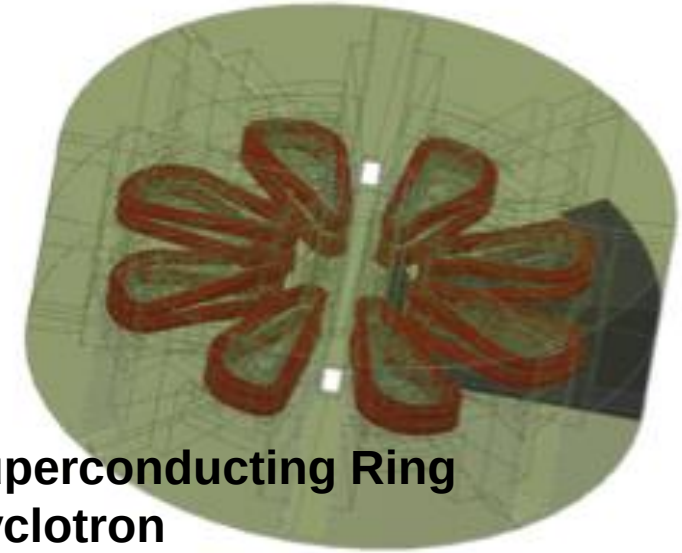
Accelerator Complex designed by LNS



VIS source



Normal conducting Cyclotron



Superconducting Ring Cyclotron

The scientists of LNS are member of the DAEdALUS collaboration. The main contribution of our scientists is to design an accelerator complex based on cyclotron accelerator able to accelerate the H2+ beam, to deliver proton beam at 800 MeV with an average power about 2 MW! The injector cyclotron (Emax=60 MeV/n) can be used also to perform the experiment ISODAR to investigate the existence of sterile neutrinos

The anomalies that have been observed in the data from LSND, MiniBooNE, short-baseline reactor studies, and gallium source calibration runs, are often interpreted as due to sterile neutrinos and have motivated the development of the IsoDAR (IsotopeDecay-At-Rest) concept

ISODAR

Just Published on PRL

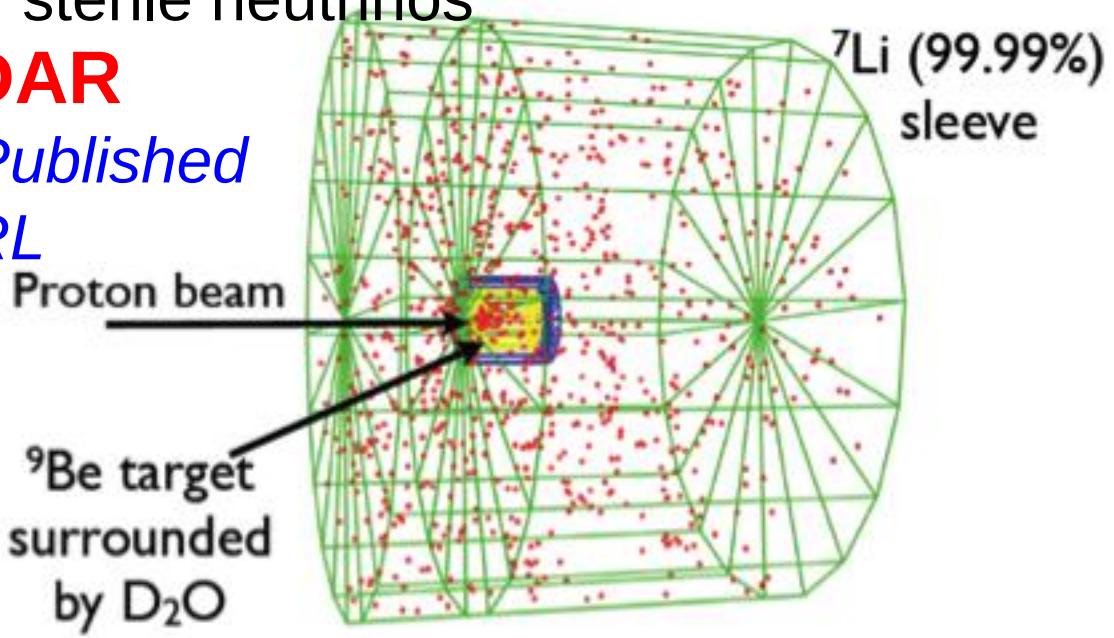


FIG. 1: A schematic of the IsoDAR target and surrounding volume design. The dots represent ^{8}Li ($\bar{\nu}_e$) creation points, obtained with 10^5 protons on target simulated. The surrounding graphite neutron reflector and shielding are not shown.

CONCLUSIONS

LNS can have a key role in the european framework:

- **In this decade for stable and RIBs at intermediate energy**
- **Leading role for Nuclear astrophysics (with FRIBs & Excyt beams and Troian Horse Methods)**
- **Strong contribution at the development of the European/Int. projects: ESS, ELI, Eurisol, DAEδALUS**
- **Advanced applications of Nuclear Physics: Hadronteherapy, Novel Imaging, Cultural Heritage, Radiobiology.**
- **An international Research Infrastructure for neutrino astrophysis and deep see applications (The site for KM3Net).**

LNS is becoming a lab for astrophysics (from KeV to TeV), never forgetting accelerators & interdisciplinary applications .