



Proposta di Nuovo Esperimento ELBac (**E**xperiments with **L**aser **B**eam **a**ccelerated)

resp. naz. **Dario Giove**

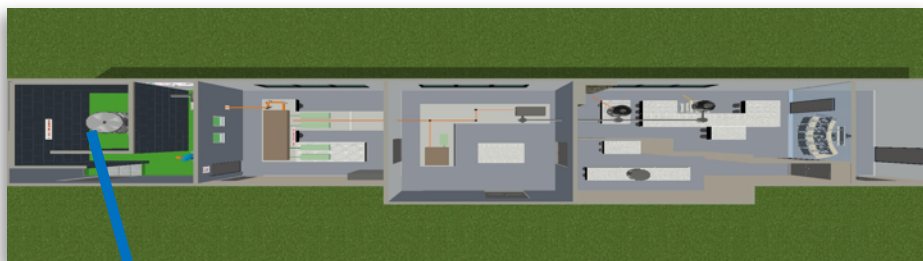
Sezioni di Milano, Pisa, Bologna, Firenze, Napoli

Collaborazione con IEO, HSRF e CERN

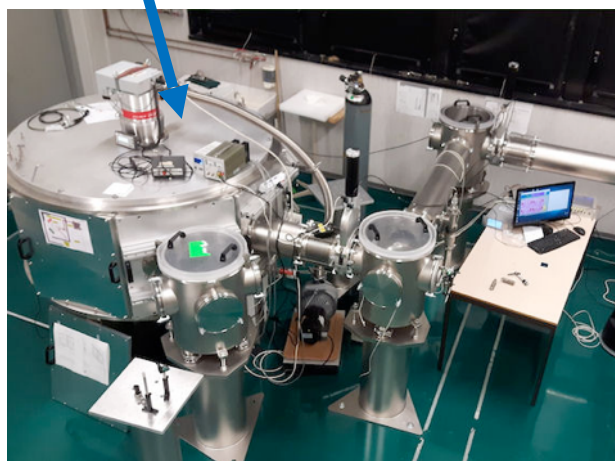
Background -Laser Induced Light Ions Acceleration

Starting in **2017** a Laser driven Light Ions Acceleration Beamline (**L3IA**) has been established based on a high intensity femtosecond laser system at **150 TW** peak power in the frame of a collaboration between INFN and CNR-ILIL. The original concept of the beamline relies on the Target Normal Sheath acceleration mechanism to generate light ions with MeV energy to use for material science and radiobiology applications.

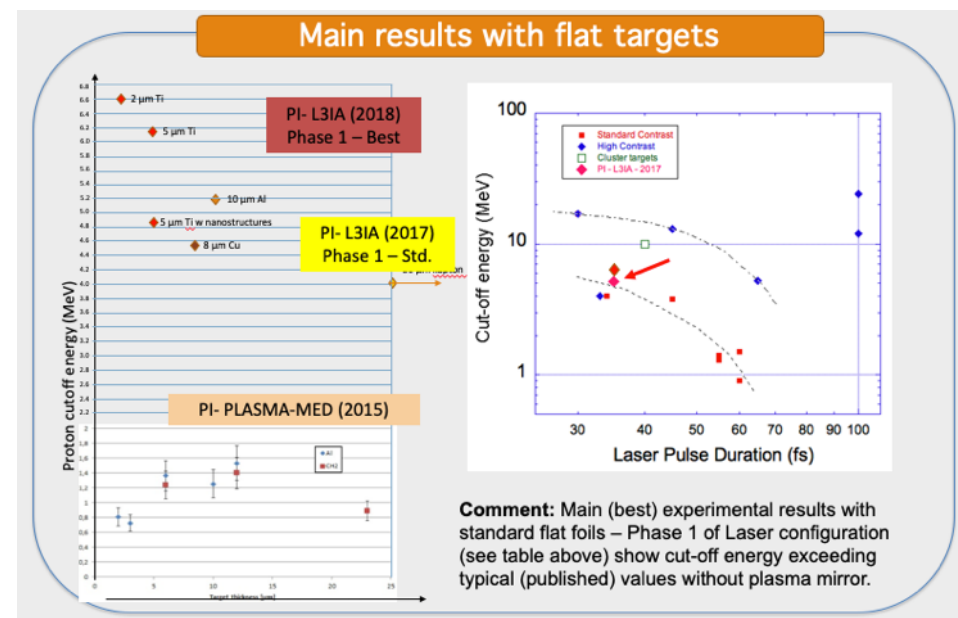
The same beamline has been used to produce high-energy electron bunches (in the **100 MeV range**) in interactions with supersonic gas-jets.



Laboratory view



Interaction chamber set up before the installation of the bunker



In June 2019 the max proton energy reached has been **6.6 MeV**. An increase up to 9 MeV is foreseen by October 2019 due to the increase in laser power.

Perspectives for 2020 and more ...

CNR has already defined an upgrade path for the laser system to reach a maximum laser power of 200 TW. This upgrade will benefit of further improvements in the laser pulse temporal shaping.

The beamline at that time will be the only one in Italy suitable to carry out experiments with these energies and one of the few in Europe.

The experimental set-up recently has been completed with the addition of a dedicated vacuum chamber for experiments isolated from the main interaction chamber. This results in lower EMP disturbances and in better measurement resolutions (energy, transverse spatial distribution, ...)

Beam formation experiments are scheduled to be carry out within the end of 2019 and the PMQ based scheme will be part of the beamline.

The situation above depicted suggested to propose a further activity that will use the beamline and related apparatus as a unique possibility to carry out experimental activities in the following areas:

1. Development of **improved techniques in laser acceleration** (protons, carbon ions, electrons)
2. Study of the possibilities and characteristics of applications of laser based acceleration schemes in **radiation therapy** according to new emerging scenarios
3. Development of an experimental scheme for a table top set-up to be used for **PIXE experiments** in cultural heritage framework

Application of laser-driven proton beams to cultural heritage: laser-driven PIXE

Previous/ongoing projects

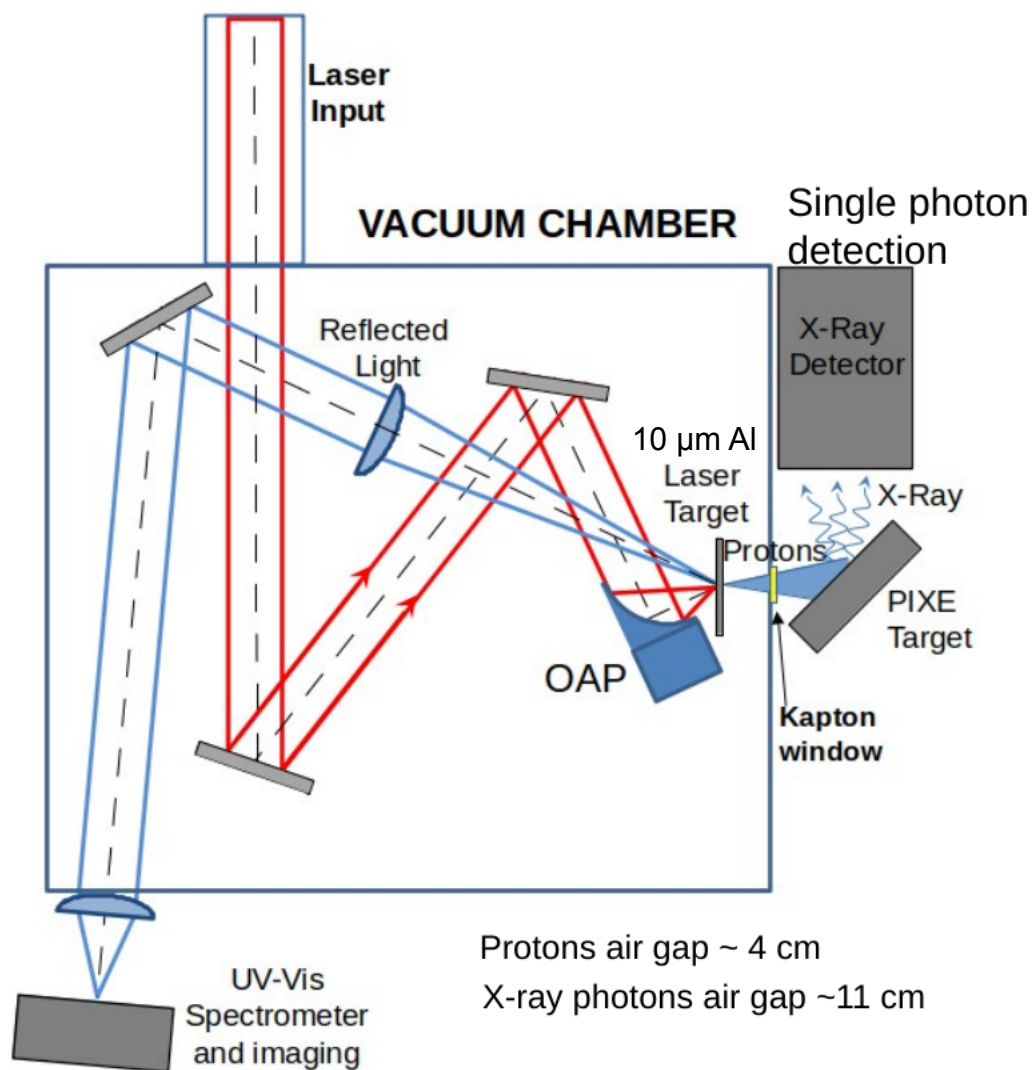
LaserPIXE is a technology Transfer project, co-funded by UE, through Regione Toscana, and VCS S.r.l (Parma-Italy), a company expert in custom vacuum chambers and components.

Research Partners: LABEC Laboratory (INFN-Florence), Institute of Clinical Physiology (CNR, Pisa).

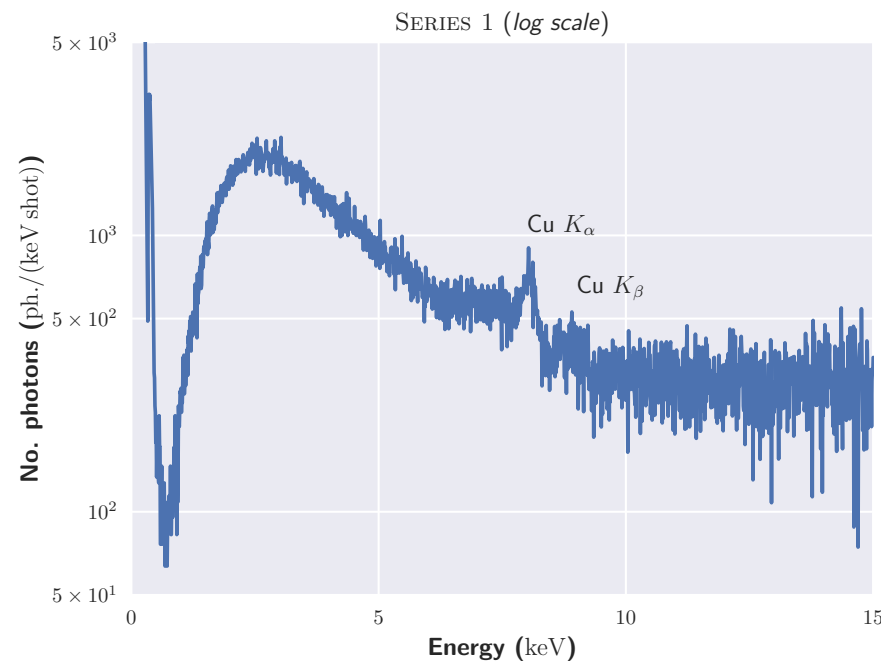
Goal: design a prototype proton laser-plasma accelerator (up to ~ 3 MeV) to perform PIXE measurements in ambient air.



Background: laser-driven PIXE – pilot experiment in Pisa



PIXE Target: **Copper**
 CCD camera



- 37 laser shots
- Proton energy < 2 MeV (TOF measurements)

Laser based acceleration goals for PIXE applications

The capabilities of the beamline shall be devoted to the following developments and use:

- Removal of X-ray and electron background
- Development of selection methods for reducing the proton beam energy spread
- Increase of repetition rates and reproducibility
- Tests of X-ray detectors and proton beam dose monitors for quantitative PIXE measurements
- Comparison with state-of-the arte accelerator based PIXE measurements at LABEC

Preliminary proposal

INFN Milano	> 3 FTE (including contribution from Politecnico of Milano and HSRF)
INFN Pisa	> 1 FTE (more people from CNR-INO Pisa will ask to be associated)
CNR Pisa	beside to people from CNR-INO, people from CNR – Istituto di Fisiologia Clinica (Pisa) will join the activity
INFN Bologna	>1 FTE
INFN Firenze (LABEC)	1 FTE (Chiari, RL, 20%, Carraresi 20%, Giuntini 20%, Lucarelli 20%, Mandò 20%)
INFN Napoli	> 1 FTE

Official letter of support from IEO that will provide the support for radiobiological studies along with the HSRF colleagues and CNR Institute of Clinical Physiology (D. Panetta and P. Salvadori)

Official letter of support from CERN that will provide the support for GEMPIX like detectors.

People from IEO will ask to be associated to INFN researches at INFN Milano

Financial plan

The experiment will be based on a 3 year timeline with a total request of 200 Keuro