



**Istituto Nazionale di Fisica Nucleare  
LABORATORI NAZIONALI DI LEGNARO**

# Education and outreach using LNL accelerators' complex

LNL User Community Annual Meeting

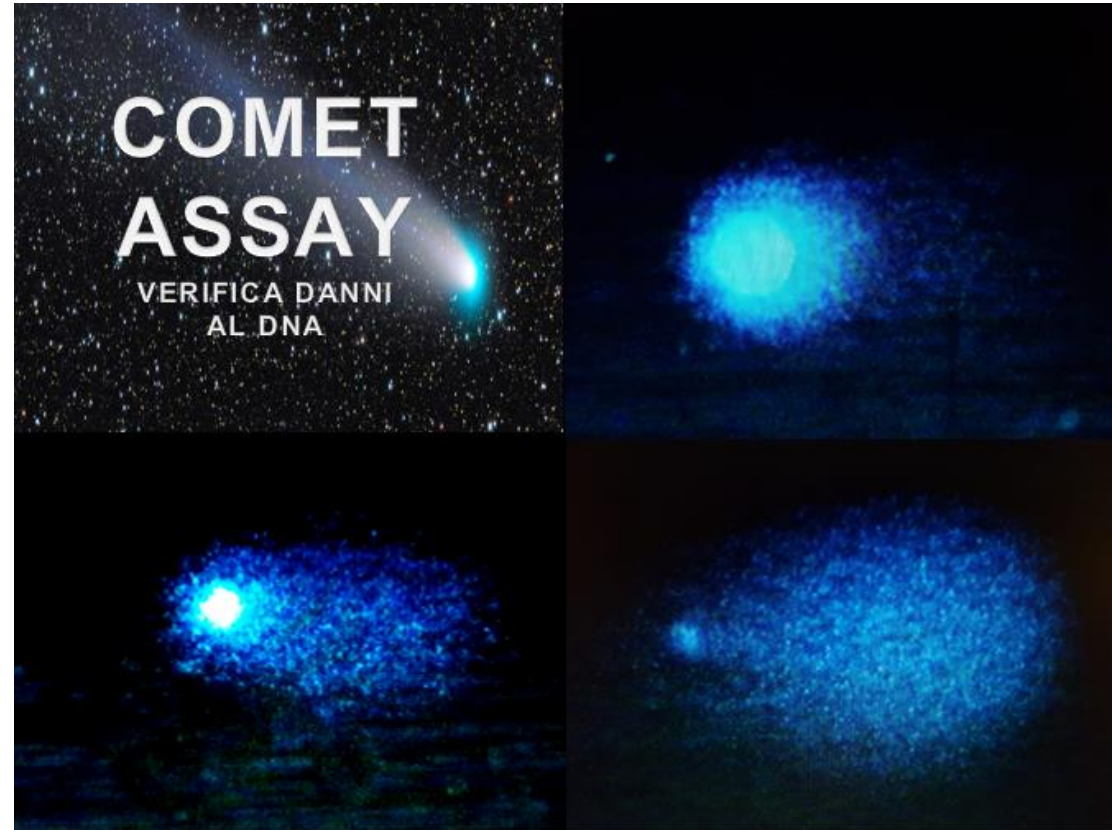
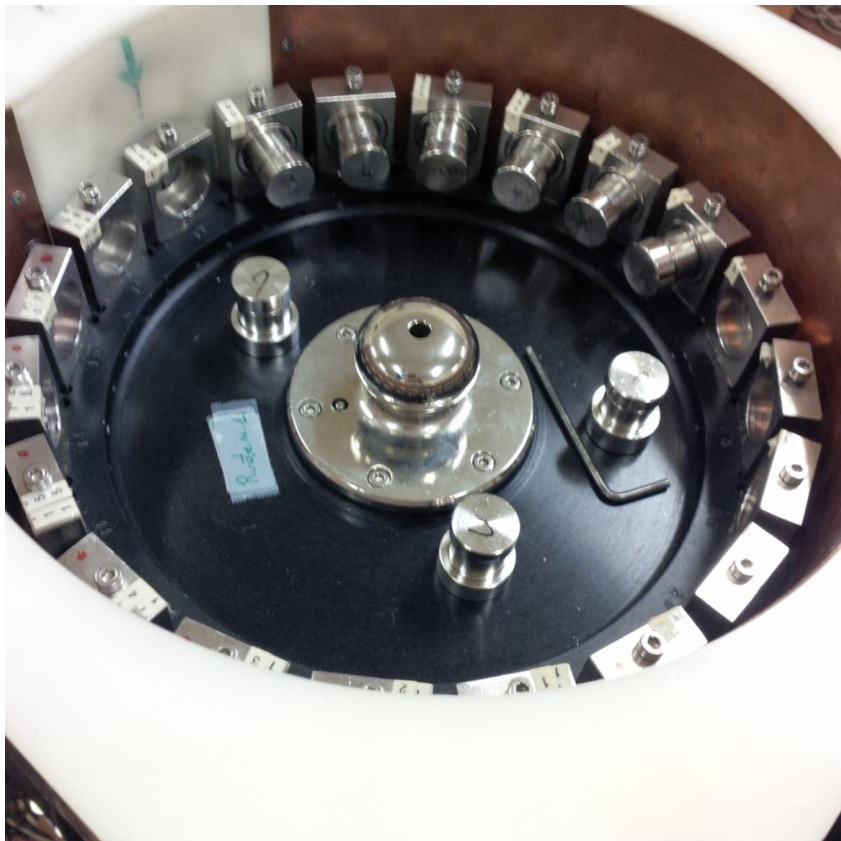
*Andrea Gozzelino*

*Referente locale Comitato Coordinamento Terza Missione (CC3M)*

# Stage @ CN



Radiobiology  
Radiobiology line – continuous proton beam at 3.1 MeV



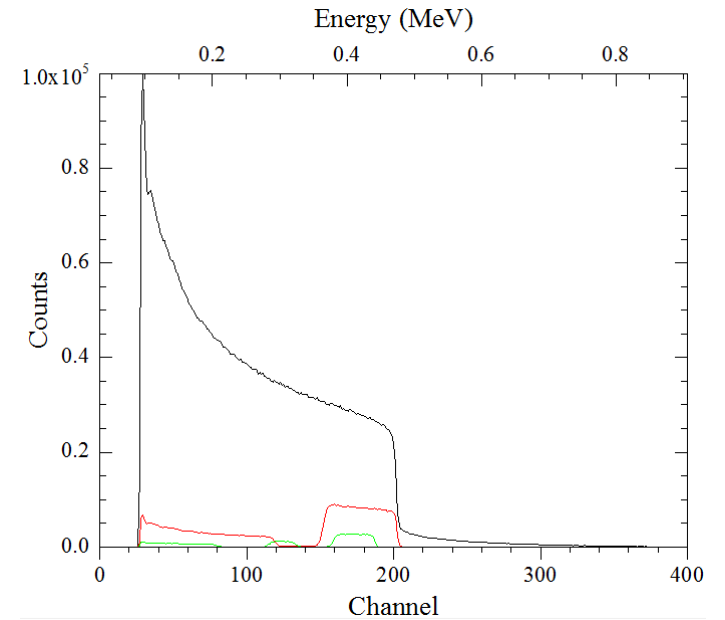
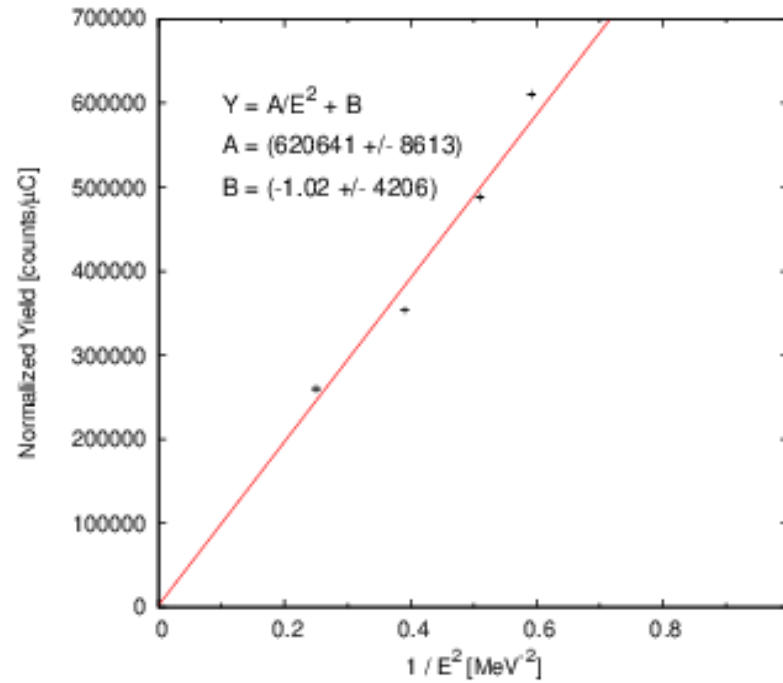
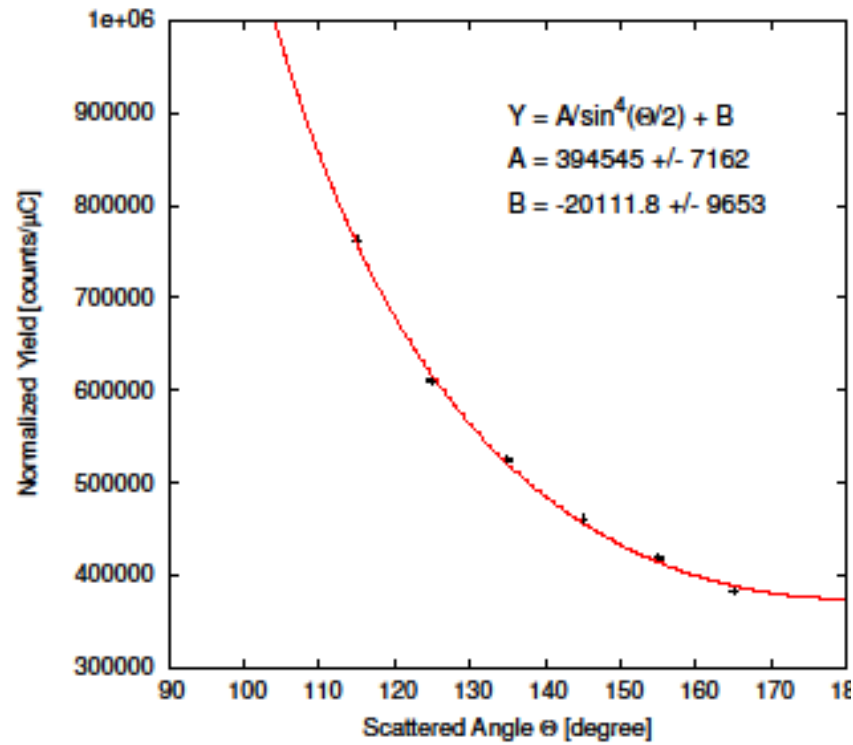
**PUBLIC:**  
Students at high school  
(last year of the cycle)

# Stage @ AN2000



Rutherford's experiment + Informatics and experimental physics  
beam line 60° - Rutherford Backscattering with continuous  $\alpha$  beam at different energies

PUBLIC:  
Students at high school  
(last year of the cycle)



- Au
- Au/Ni
- Ru/Cr/Si

# Students on shift @ AN2000

## Cultural Heritage applied physics – Experiment ALCHIMIA (INFN Torino)

10 students at high school Liceo Artistico Modigliani in Padua stay one afternoon in the AN2000 control room during data taking beam line  $0^\circ$  with continuous proton micro beam

The activities is on going since two years.

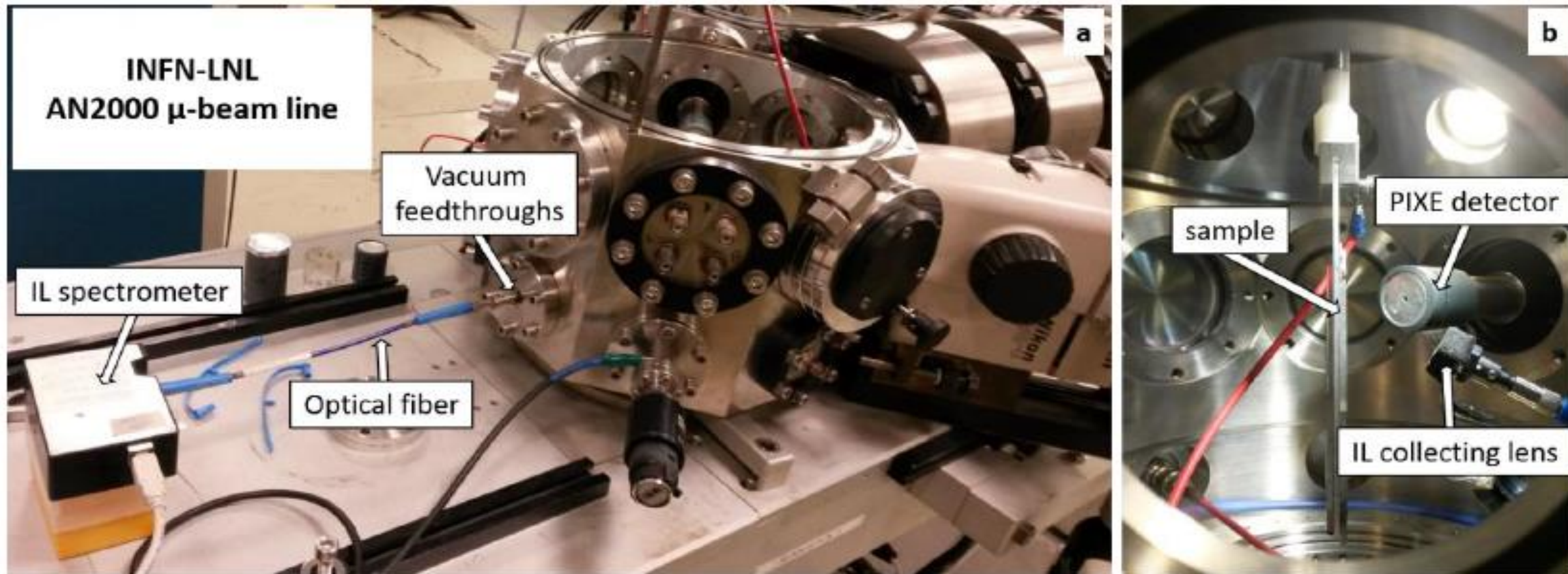
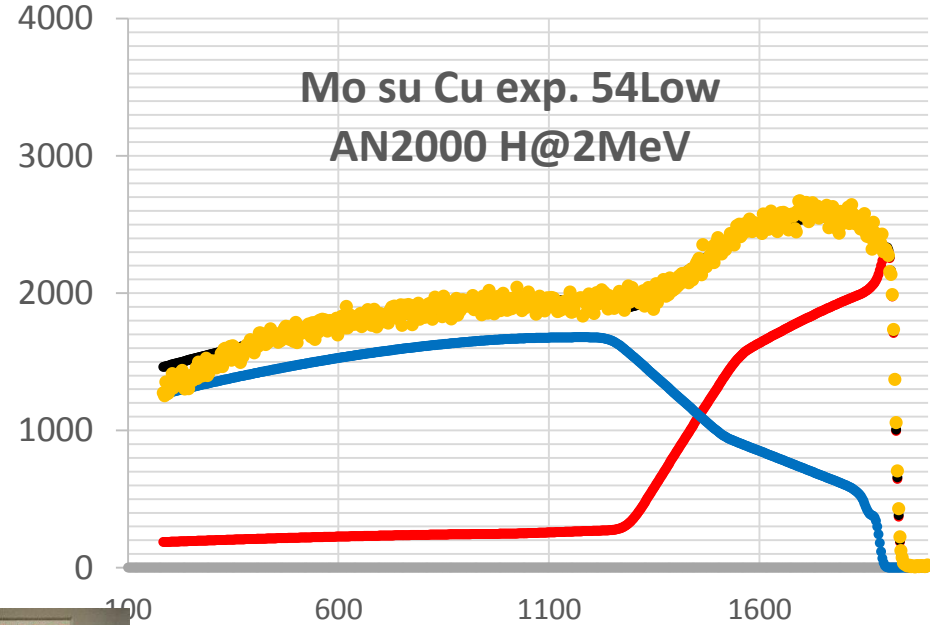
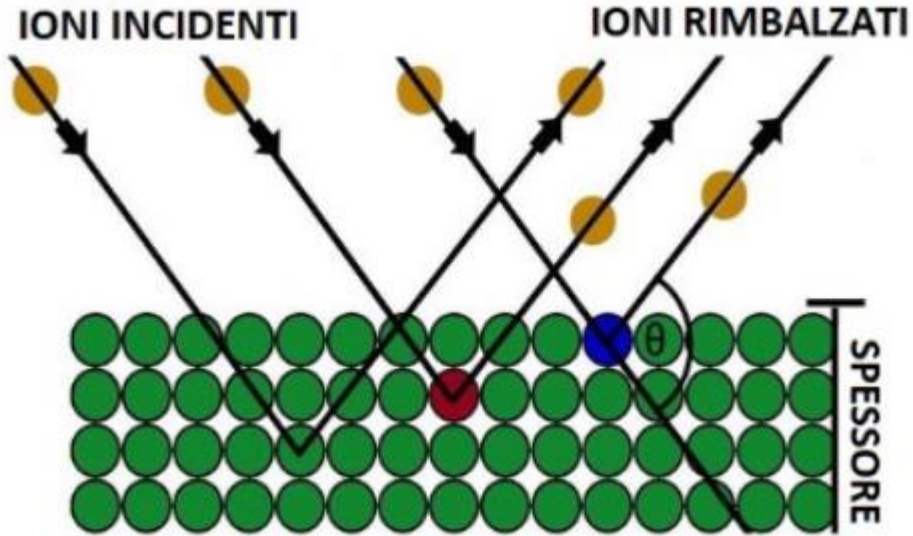


Fig. 1. a) the microbeam line with the installed IL setup; b) the internal part of the vacuum chamber with the IL collecting lens.

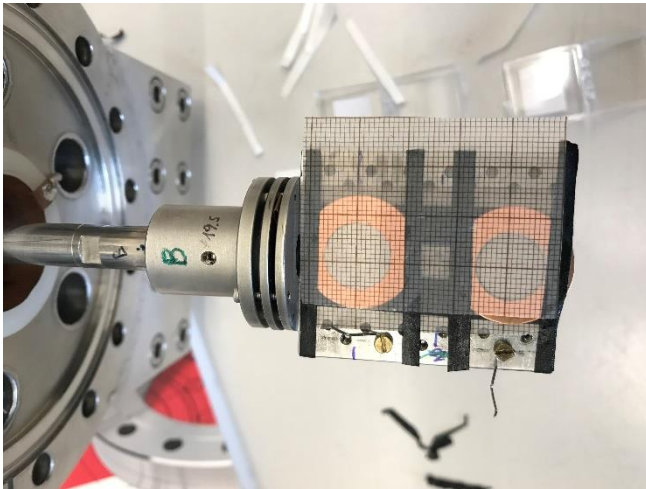
# Activities in itinere @ AN2000

## E\_PLATE

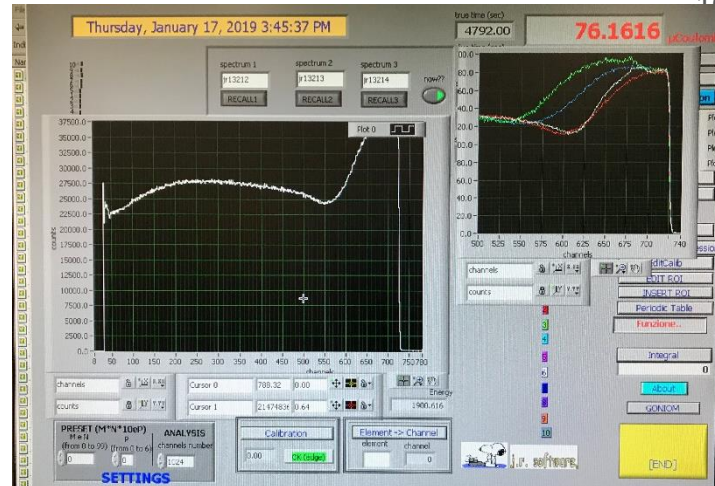
2 students at high school Liceo Scientifico Fermi in Padua stay 60 hours in March-June 2019 at LNL



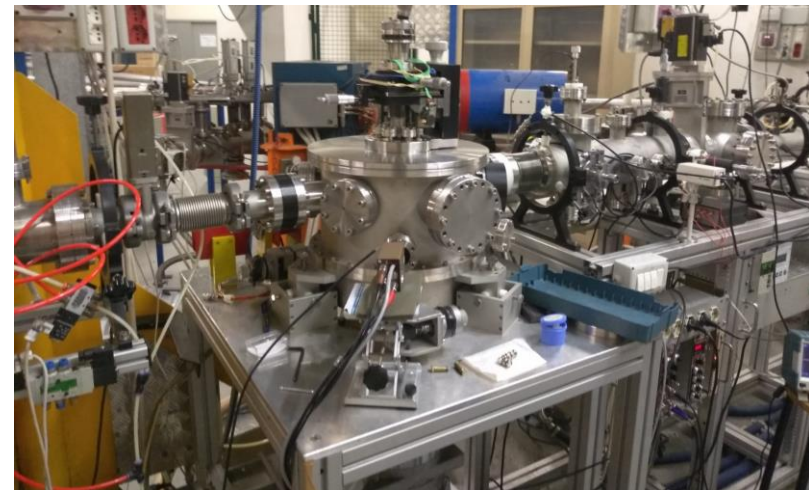
- Mo
- O
- Cu
- Tot
- 54L+2



November 4 and 5, 2019



Comitato Utenti



# Future



## Misura\_CC3M

one day every two months dedicated to high school students that perform a measurement at AN2000 (RBS, PIXE, ...)  
focalizing technical aspects

**THANKS to colleagues' availability (Ivano Lombardo, Antonio Cacioli, Luca Silvestrin)**

One day at AN2000 in spring 2020 will be dedicated to Scuola Navale Morosini from Venice to perform an experiment about sea aerosol (PIXE).

## Programma INFN Docenti (PID)

February 10-14, 2020: 32 Italian high school teachers selected among more than 250

## Pre\_ESOF with ELETTRA and INFN Trieste

March 12 and 13, 2020: 16 European high school teachers

## Stage at LNL

June 17 and 18, 2020: experiments at AN2000 and CN

# Education of master students

Experiment conducted by first-year students of the master's degree in physics at the University of Padua in the course 'Advanced techniques of nuclear physics' with publication of an article on the Annual Report of the LNL. TANDEM accelerator, PISOLO in experimental hall II [May 15 and 16, 2018]

## Sub-barrier cross sections in the fusion of $^{28}\text{Si}+^{100}\text{Mo}$

The aim of this experiment was the measurement of the fusion cross section of the  $^{28}\text{Si}+^{100}\text{Mo}$  reaction around and below the Coulomb barrier. The measurement was performed by detecting the evaporation residues (ER). The results have been compared with the theoretical predictions using the code CCFULL with the Woods-Saxon nuclear potential and couplings with inelastic excitations. Students obtained the fusion cross sections of  $^{28}\text{Si}+^{100}\text{Mo}$  using a  $^{28}\text{Si}$  beam provided by the XTU Tandem of LNL in the energy range from 85 MeV to 125 MeV in the laboratory frame.

Cross section values obtained.

$E_{\text{CM}}$ [MeV]	$\sigma$ [mb]
$65.91 \pm 0.08$	$0.03 \pm 0.02$
$71.38 \pm 0.09$	$18 \pm 3$
$74.50 \pm 0.09$	$50 \pm 8$
$79.2 \pm 0.1$	$(0.13 \pm 0.02) \cdot 10^3$
$97.2 \pm 0.1$	$(0.7 \pm 0.1) \cdot 10^3$

G. Montagnoli, A. Stefanini  
are the teachers and tutors.

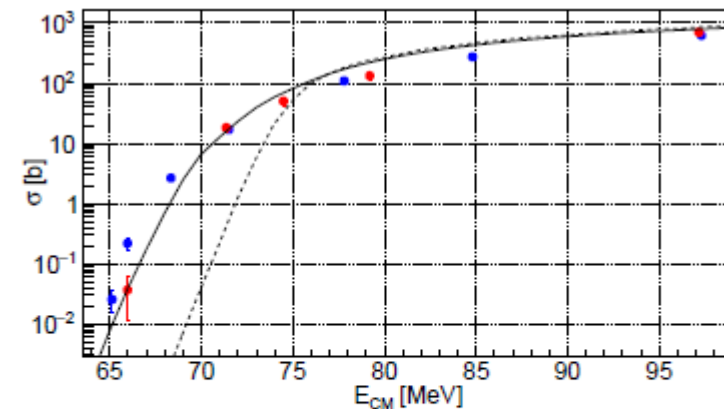


Fig. 3. Fusion cross section. The figure displays data taken during our experimental session (red) and also data taken from previous, related experiments [3]. The dashed line represents the no coupling limit, the smooth line the 2+/2+ coupling (calculations).

# Conclusions



- CN and AN2000 decisively support the third mission activity at LNL with more than 5 days (each) of measurement per year. The calendar of the machines must be compatible with the school timetable and the availability of the tutors.
- TANDEM strongly supports the educational activities for master students in physics at the University of Padua.
- The third mission and didactic are objectives on which the laboratories of Legnaro, and in general the INFN, point.
- **GUIDED TOURS: at least one accelerator and one experimental room are included in the itinerary of each visit.**

**Thank you very much!**