



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



# Education and outreach using accelerators

LNL User Community Annual Meeting  
Andrea Gozzelino and Luisa Pegoraro

# Stage for high school students

Stage at LNL, 19-30 June 2023

40 Italian high school students coming from 31 schools in 15 “provinces” in 4 Italian regions

**One beam time day at AN2000**

## AN2000

### Rutherford’s experiment + Informatics and experimental physics

Tutors: Irene Zanon, Daniele Mengoni, Andrea Gozzelino, Nicola Toniolo, Michele Gulmini

Technique: Elastic Back Scattering (EBS)

Proton beam with different energy – beamline 60° - Targets: thin layers (including gold)

We would like to thank Matteo Campostrini and the operators

High school students experiment required energy changes to study “Yield versus beam energy”. The operators went from 2.0 MeV to 0.4 MeV in step of 0.1 MeV, using “asta di corto/short shaft”. The lowest proton beam energy useful to easily measure with EBS in beamline 60° is 0.6 MeV.

Following this measurement, the accelerator team made an analogue test with alpha particle, devoted to discover the lowest possible energy.

→ *The day of stage was also useful to investigate the working conditions of AN2000 machine.*

# Stage for high school students

Students @ AN2000 accelerator in June 2023



# Programma INFN Docenti

INFN Training Program for Teachers at LNL, 23-27 October 2023 – Fifth edition @LNL  
26 Italian high school teachers

**Two of the four experimental activities involve LNL accelerators**  
**(2 days for AN2000, 2 days for CN)**

## AN2000

### **Nuclear physics applied to cultural heritage**

Tutor: Andrea Gozzelino

Technique: Particle Induced X ray Emission

Proton beam at 2.0 MeV - beamline  $90^\circ / 0^\circ$

Target: coloured Kremer pigments

## CN

### **Nuclear physics applied to materials**

Tutor: Valentino Rigato, Matteo Campostrini

Technique: Elastic Back Scattering

$\alpha$  continuous beam at 3.1 MeV - beamline  $-15^\circ$

Target: thin layers

# Programma INFN Docenti

Teachers of fifth edition @LNL in October 2023



# Measurements CC3M for students

Italian high school students become assistants to experimental researchers for 4 hours

## AN2000

**ALCHIMIA** proton micro beam in beamline  $90^\circ/0^\circ$  for PIXE and IBIL in cultural heritage field

**SISAR** proton micro beam in beamline  $90^\circ/0^\circ$  for PIXE in environmental field

**ChNET\_LNL** proton micro beam in beamline  $90^\circ/0^\circ$  for PIXE in cultural heritage field

## TANDEM-ALPI-PIAVE

On February 7th, 2023, seven students stay in the AGATA experimental box and follow the shifters during the data taking phase. Colleagues explain them some issues of physics, electronics, and informatics.

On October 12<sup>th</sup>, 2023, six students follow as assistants the afternoon shift for AGATA experiment 23.006 with TANDEM  $^{44}\text{Ca}$  beam.

Students involved in “measurements CC3M at LNL” show this 4-hours experience in oral examination during the graduation of high school.

**Since 2018, 75 students have experienced these special events!**

# Measurements CC3M

Some high school students in AN2000 control room



# Education of master students

**CN**

**Nuclear physics experiment**

**Dosimetry**

**AN2000**

**Material physics experiment**

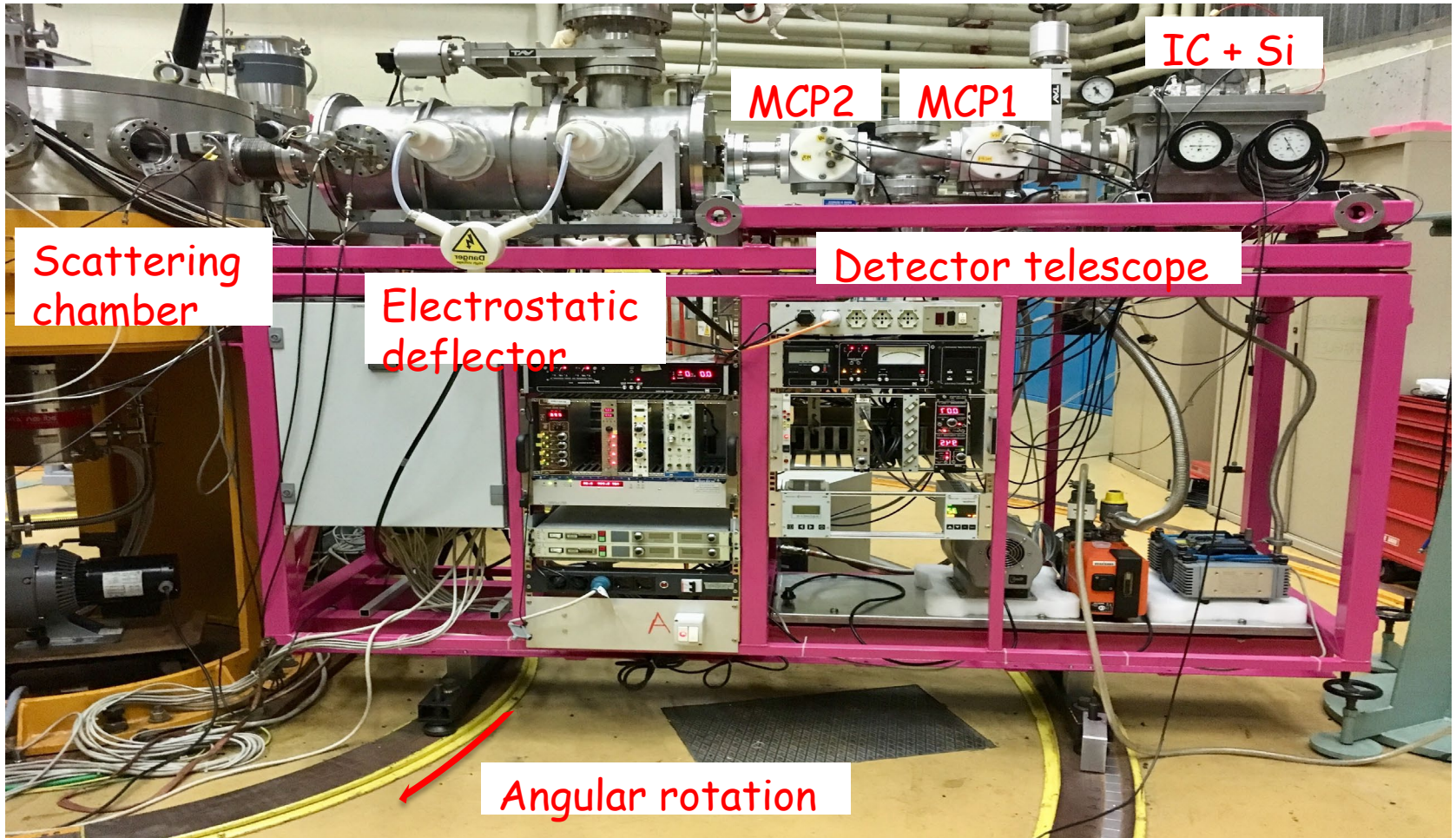
**TANDEM**

**Nuclear physics experiment with PISOLO**

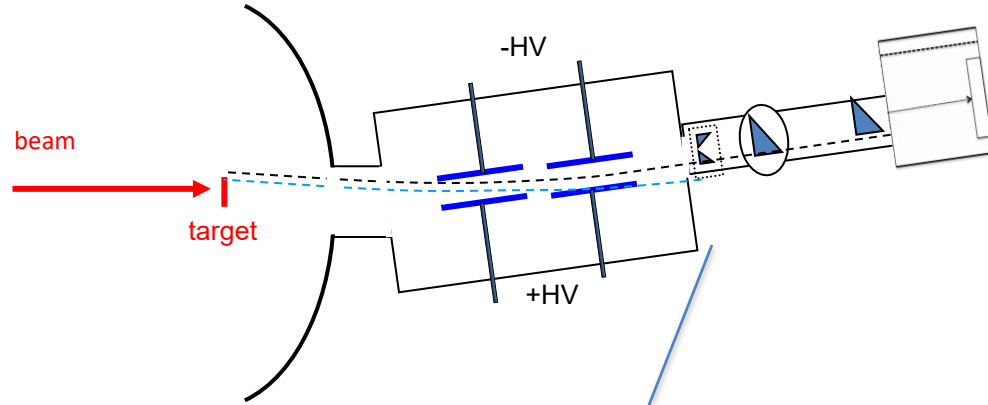
More than 20 University students are engaged in these experimental activities.



## The electrostatic deflector set-up PISOLO at the LNL - INFN

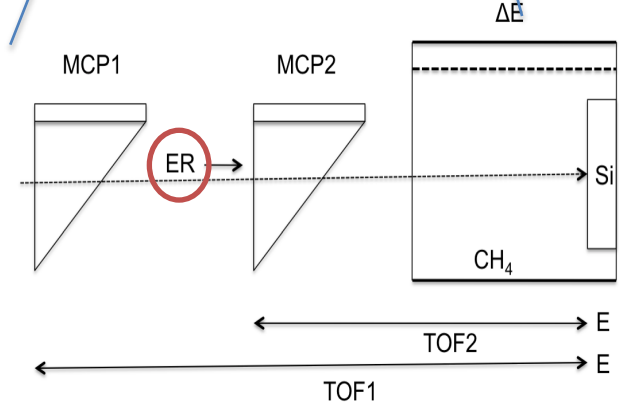
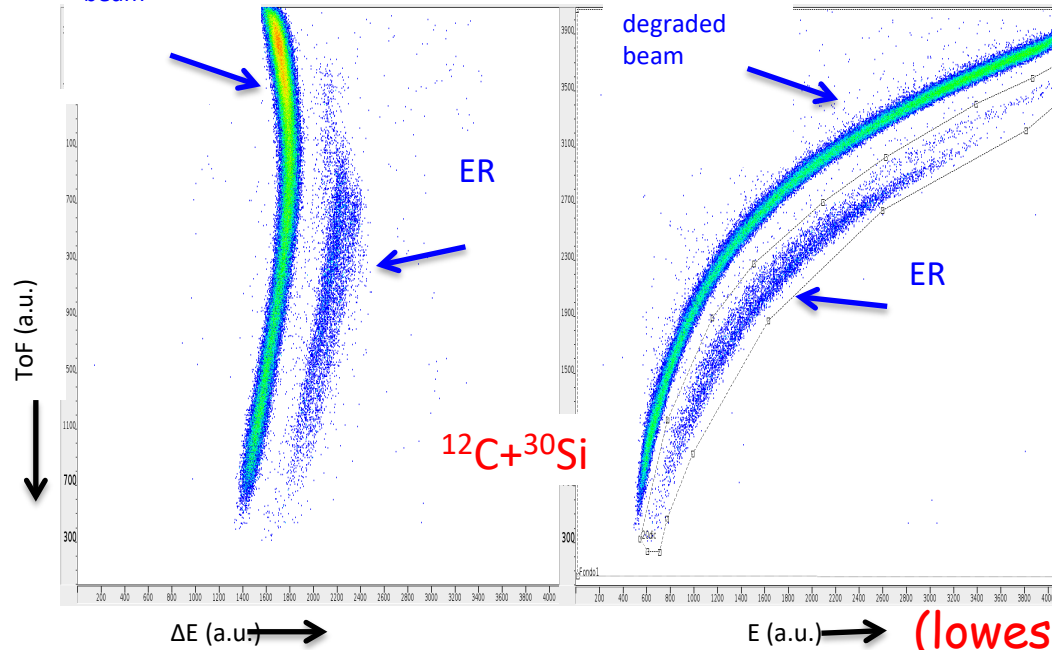


# Detector set-up and E-ToF matrices



degraded beam

degraded beam



(lowest measurable cross section  $\approx 0.5-1 \mu\text{b}$ )



**Accelerators are very important for 3M!  
Thank you for your attention!**