

XV FOOT General Meeting Trento, 11-13 December 2023



M. Villa
INFN Bologna & Unibo



Remembering where we came from

The slide features a light blue background with a white circular graphic. At the top left is a red circular logo with a stylized figure. The main title 'X FOOT Collaboration Meeting' is in blue, with the dates '24-26th may 2021' below it. The INFN logo is in the top right. A central image shows a person walking through a tunnel towards a bright light, with the text 'Are we at the end of the tunnel??' overlaid. A blue banner across the image reads 'Introductory Remarks'. Below the image, the name 'Vincenzo Patera' is written in red, and the Pixers logo is in the bottom right. Two circular logos with a footprint and the word 'FOOT' are positioned at the bottom left and right.

X FOOT Collaboration Meeting
24-26th may 2021

INFN

Introductory Remarks

Are we at the end of the tunnel??

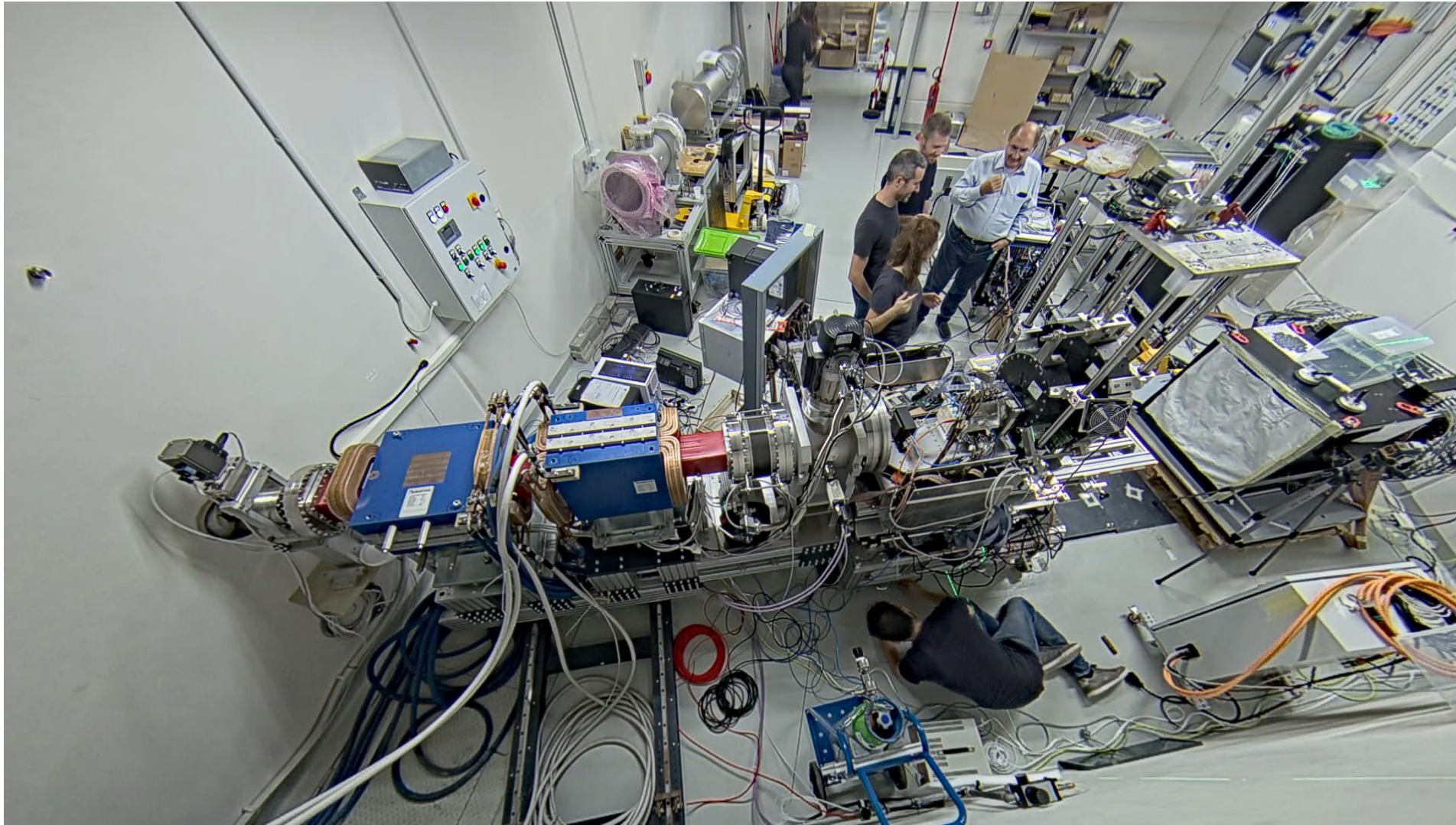
Vincenzo Patera

pixers

Dec 2023:
We definitely exited
from the tunnel!

Detector status @ dec 2023!

- **Electronic set-up:** completed!



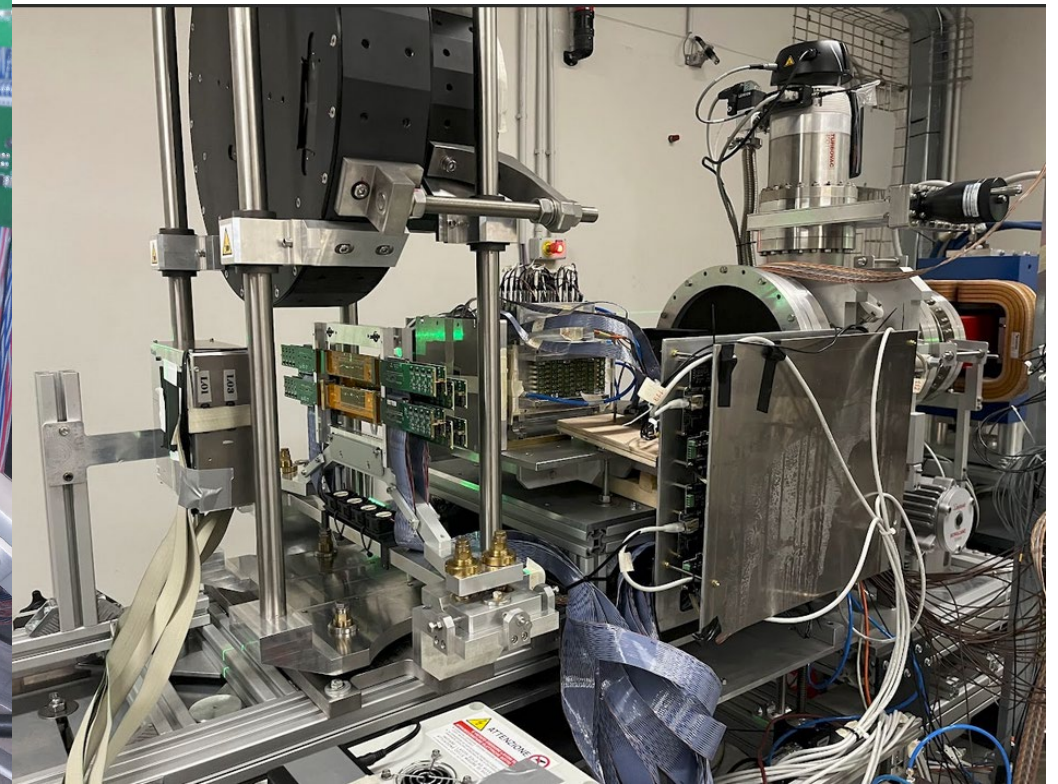
Magnet and Intermediate Tracker!



BTF test



CNAO set-up



Calorimeter!

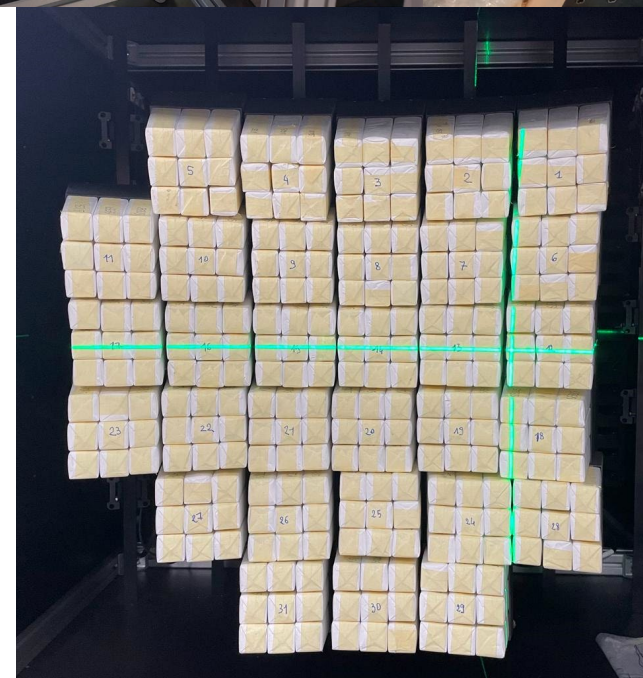
GSI 2021: single module



HIT 2022: 7 modules

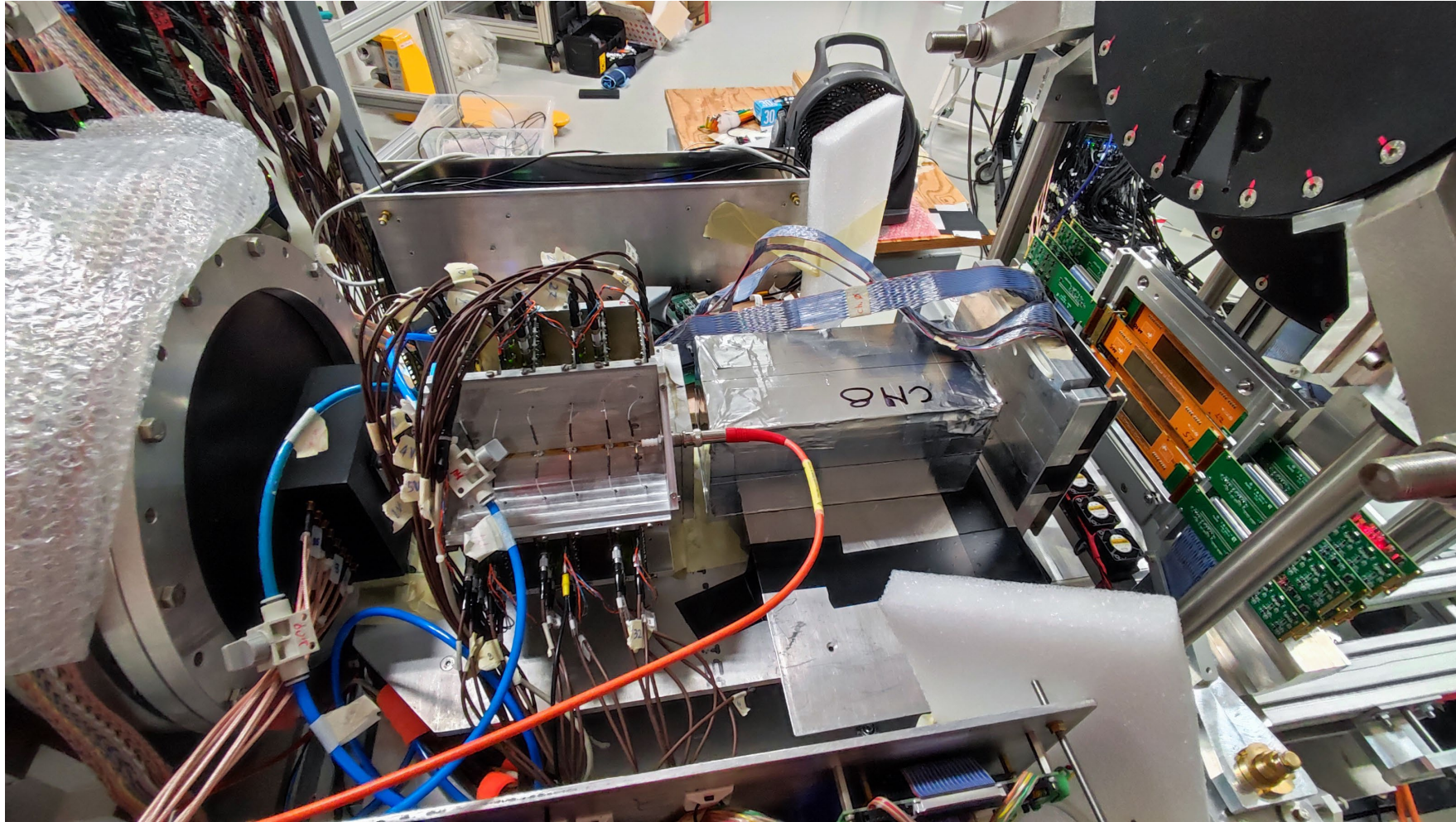


Oct 2023: mounting modules



CNAO 2023:
31 modules

Emulsions @ CNAO 2023



Tools



- **Monte Carlo:**
 - Continuously evolving and following the different set-ups used in data takings or contributing to the definition of the set-ups!
- **Trigger and Data Acquisition:**
 - Evolving with time and detectors on the beam line
 - More online controls; not yet finished!
- **Reconstruction software:**
 - Shoe: continuous development. Not at all an easy task!
 - Tuning at each data taking (alignment, noise, detectors on the beam line....). Magnet will introduce more challenges!
 - Emulsions: properly running

Tools are being used to get some physics!



Data takings



- **Electronic set-up:**
 - GSI 2021 (^{16}O , 200-400 MeV)
 - HIT 2022 (^4He , several energies)
 - CNAO 2022 (^{12}C , 200 MeV)
 - CNAO 2023 (^{12}C , 200 MeV, with IT & mag.)
- **Emulsions:**
 - GSI 2019
 - GSI 2020
 - CNAO 2023

We are full of data to analyze. Almost all samples have been processed for detector studies. Not all for physics. We just await volunteers!

Our «engineering run» (CNAO 2023) was successfull (*); now we have to tune our codes for a magnetic environment!



Slides requested for a presentation to the INFN Council

FOOT Experiment

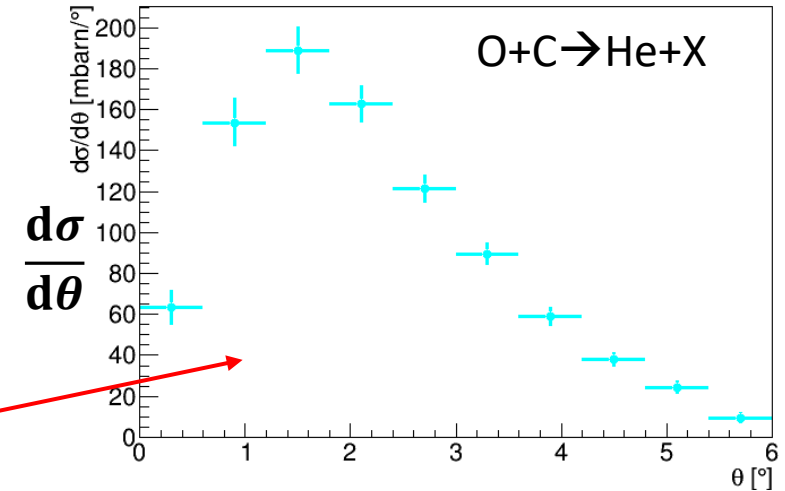
Measurement of fragmentation cross sections for **Hadrontherapy** and **deep space radioprotection**

Electronic set-up results (selection)

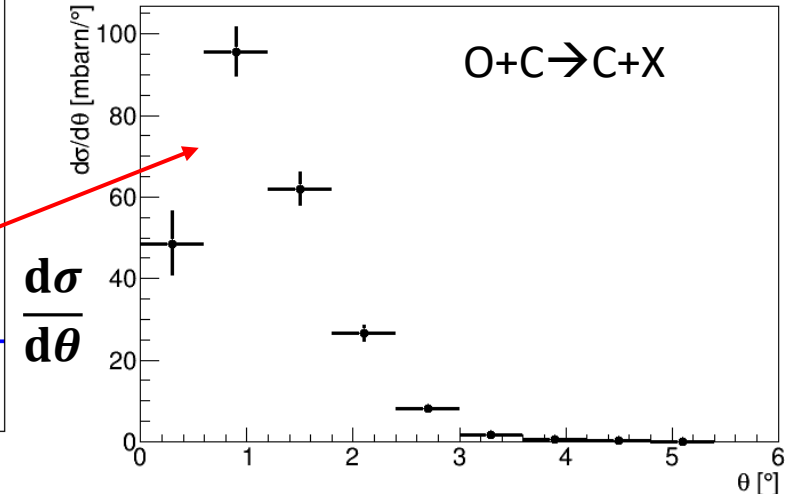
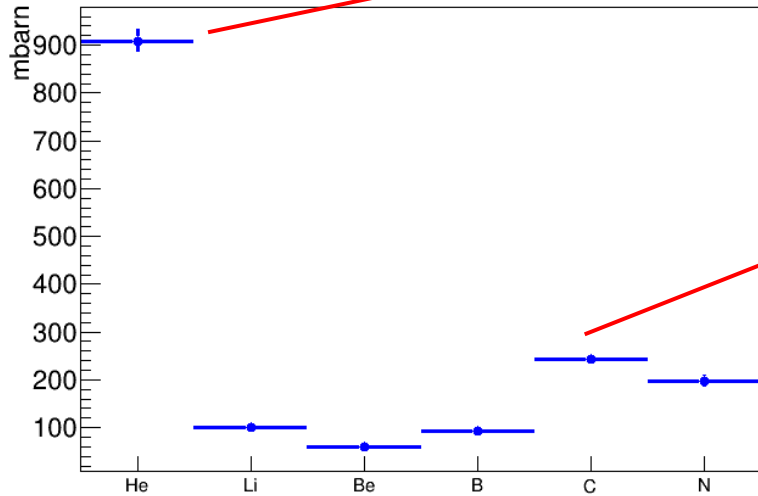
Measurements at GSI, Beam: ^{16}O , 400 MeV/N, Target: C

Results from first engineering runs (no tracking sensors included)

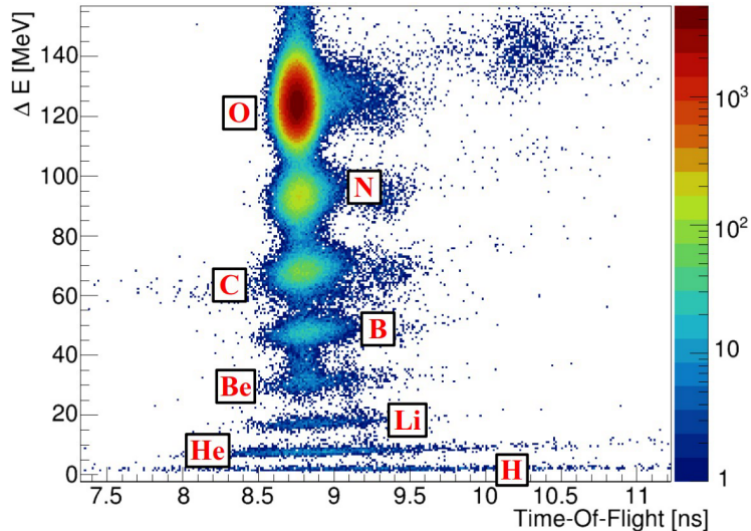
$p + C, O, N$	$\frac{d\sigma}{d\Omega'} \frac{d\sigma}{dE_{\text{kin}}}$
$C + C, O, Si$	
$Fe + C, Si, Al$	
Goal accuracy <5%	



Production cross section for specific elements

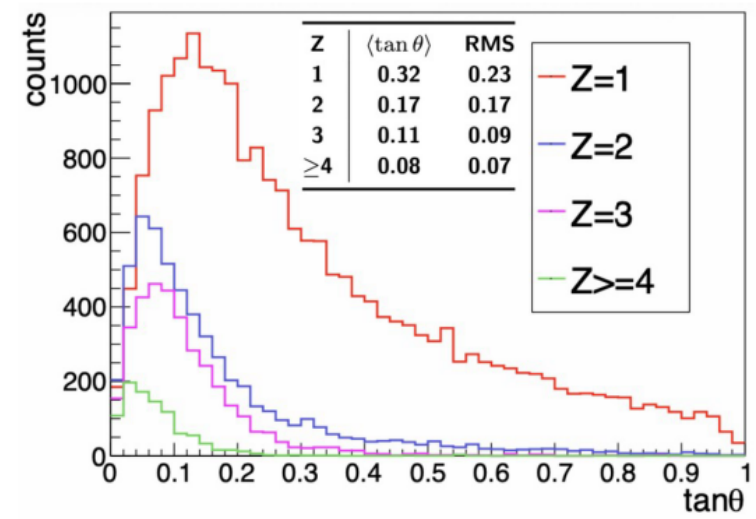
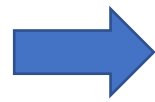
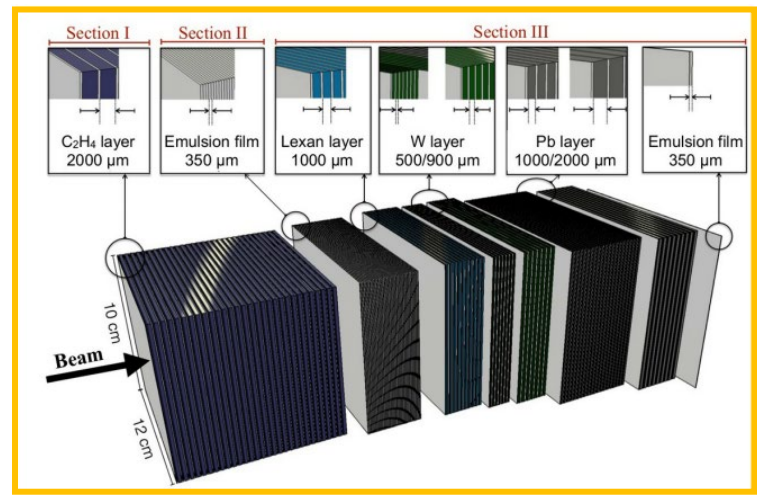


Particle identification



Slides requested for a presentation to the INFN Council

Emulsion set-up



Measurements at GSI
 Beam: ¹⁶O, 400 MeV/N
 Target: C

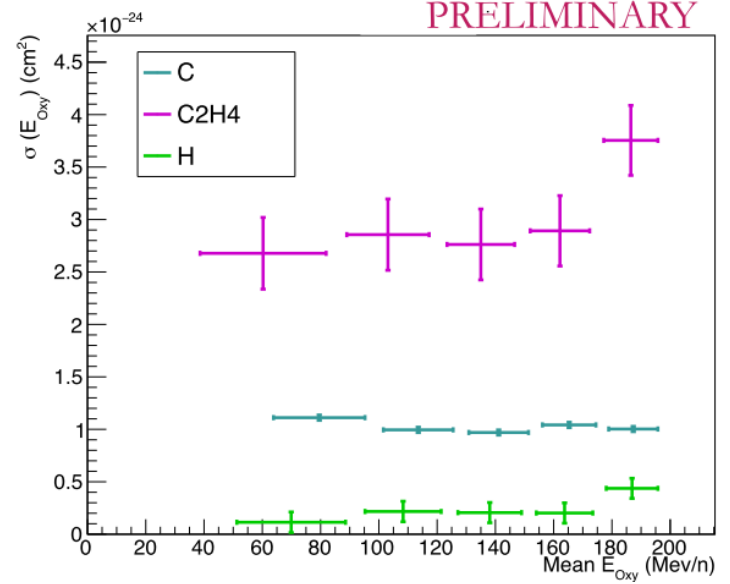
Measurements at GSI, Beam: ¹⁶O, 200 MeV/N, Target: C, C₂H₄

Two target technique to extract cross sections on H

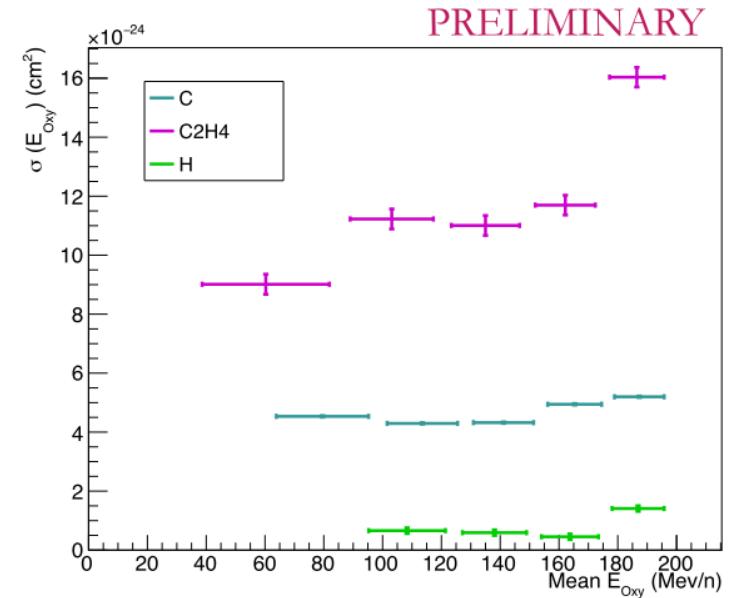
$$\sigma|_H = \frac{1}{4} (\sigma|_{C_2H_4} - 2\sigma|_C)$$

Reaction cross section counts interaction vertices
 Total production cross section counts charged tracks (ani Z)

Total reaction cross section



Total production cross section



FOOT impact on the community



The FOOT community is active on several fronts:
After the big successes on PRIN 2022,
we won a MAECI Project
Italy-Germany (FOOT @ GSI)



- Paper and conference proceedings
- Proposal writing
 - No proposal in waiting stage *at the moment*
- Agencies planning:
 - INFN 2024, Trento, 26-28 feb 2024



All these activities are signs of a healthy
and active collaboration!





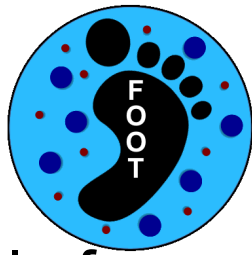
MAECI PROJECT:

Measuring Oxygen Fragmentation For Improved Ion Therapy Strategies (MOFFIITS)

- Call for cooperation between Italian research groups and German infrastructures
- Max requests: 200k€ to Maeci + 200k€ Italian agency +
200k€ German funds+ 200k€ German infrastructure

Submitted a FOOT-like program for 32h of beam time with ^{16}O at GSI. Energy range: 400-700 MeV. Detector: electronic & emulsions

MOFFITS Work packages



WP1: Nuclear emulsion set-up. The team, led by G. Galati, will be responsible for detector preparation (first year), its exposure to the beam, nuclear emulsion development, data acquisition and analysis, leading to the measurements of low charge fragments ($Z \leq 3$) cross section during the second year.

WP2: Electronic set-up. The team, led by P. Cerello, will be responsible for detector updates (addition of neutron detectors and Si beam monitors), their tuning and calibration during the first year, and actual data taking in the second year.

WP3: Simulation and data analysis. The team, led by S. Muraro and M. Toppi, will be responsible for all Monte Carlo simulations and of the reconstruction programs during the first year, while during the second year will work on the analysis of data taken with the electronic set-up, dedicated to fragments with higher charge ($Z \geq 2$).

WP4: Beam delivery. The GSI team, led by M. Durante, will be responsible for the delivery of high quality, low divergence and low intensity oxygen-16 beam, mainly to be performed in the second year.

Coordination among the different work packages will be led by M. Villa.

Cost adjustments



VOCI DI COSTO	PREVENTIVO ORIGINARIO	RIMODULAZIONE IN RELAZIONE AL CONTRIBUTO
a. Viaggi e soggiorni ricercatori/esperti e/o borsisti dal Paese Partner all'Italia	0,00	0,00
Travel money for italian researchers	27.000,00	27.000,00
c. Spese per prestazioni professionali	0,00	0,00
Personnel to recruit	84.000,00	84.000,00
Workshop and conferences	17.000,00	13.800,00
Publications	10.000,00	10.000,00
Consummables	53.000,00	57.000,00
h. Materiale inventariabile (max10% di SUBTOTALE COSTI)	8.000,00	0,00
Others (Van rental)	1.000,00	1.000,00
SUBTOTALE COSTI	200.000,00	192.800,00
j. Costi per personale strutturato (min 30% - max 40% di TOTALE COSTI)	140.000,00	132.800,00
k. Costi di gestione (max20% di SUBTOTALE COSTI + voce j.)	60.000,00	60.000,00
TOTALE COSTI	400.000,00	385.600,00

3 research checks for 12 months, 28k€ each

(1) Consummables
 - Layers and chemical components for nuclear emulsion films (20 k€)
 - Neutron and Si detectors, front-end electronics included (21 k€)
 - Mechanics (12 k€)

Total MAECI contribution

INFN (virtual) contribution



Plans for MOFFIITS

- 2024 Develop detectors (Silicon, neutron detectors & emulsions), mechanics and everything is needed
- 2025 (september-november) measurements at GSI
 - 32 h of beam: we need to decide the energy
 - PRIN 2022 will be close to finish → new TofWall, new Vertex



Time to start the meeting!

- Please stay in the allocated time
- Please upload your presentation as soon as possible
- Have a fruitfull meeting!

