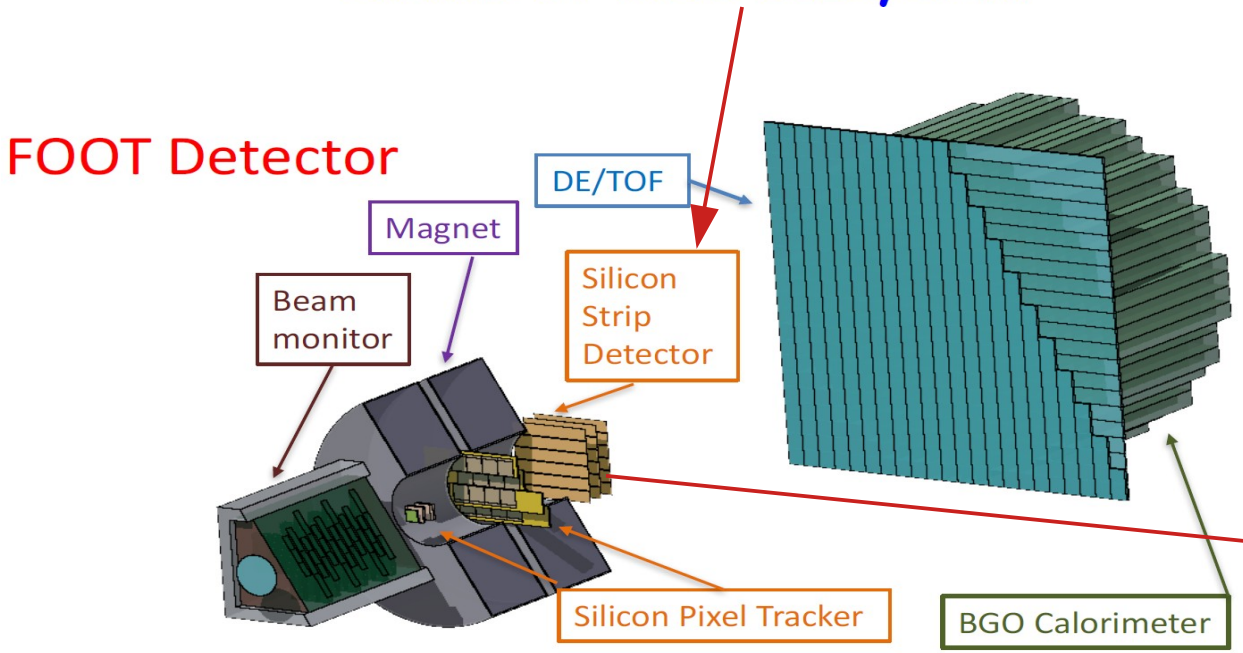
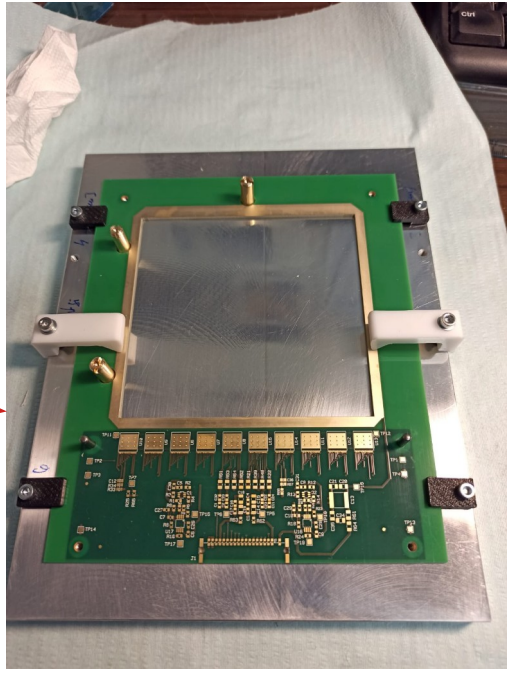
L. Servoli

Status of MSD subsystem

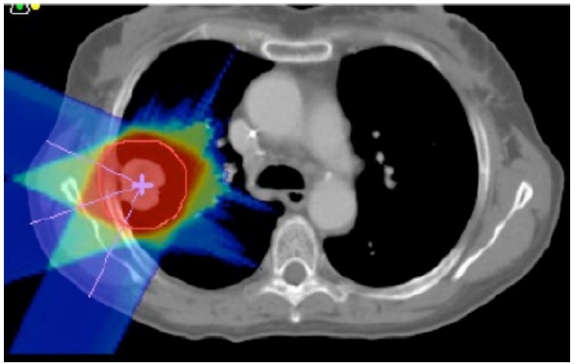




FOOT Purposes

a) Particle therapy improvements

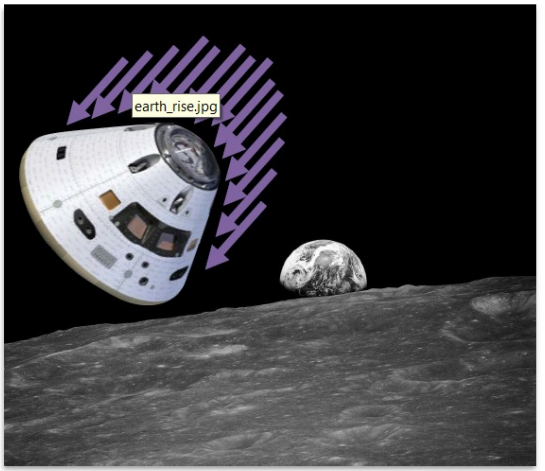
Hadrontherapy 150-400 MeV/u



Better knowledge of the nuclear fragmentation processes
→ better TPS, more patients and/or lower costs

b) Deep space radioprotection

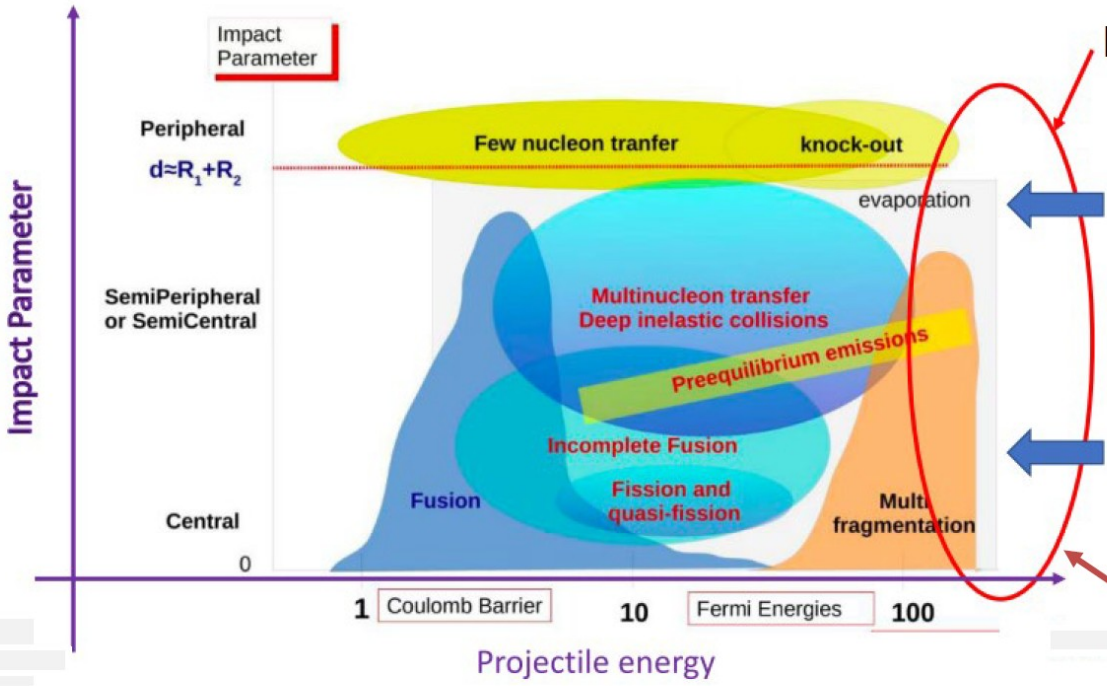
0.4-2 GeV/u



Solar particle events or Galactic cosmic rays

Purposes - continued

c) theoretical nuclear studies – fragmentation/clustering



FOOT region: not well explored

direct reactions:
High impact parameter
For example, in our case $^{12}C+X \rightarrow p+^{11}B$, $n+^{11}C$, …

"dissipative" reactions:
Low impact parameter

Clustering and nuclear models can be studied here

The FOOT Physics Program

Specific measurements related with Particle Therapy & Radioprotection in Space

- Using C, C_2H_4 ➔ cross sections on C and H
- Using C, C_2H_4, PMMA ➔ cross sections on C, O and H

PMMA is a combination of C,O,H.

Phys	Beam	Target	Energy (MeV/u)	Inverse or direct
Target Frag. PT	^{12}C	C, C_2H_4	200	inv
Target Frag. PT	^{16}O	C, C_2H_4	200	inv
Beam Frag. PT	^{12}C	C, C_2H_4, PMMA	350	dir
Beam Frag. PT	^{16}O	C, C_2H_4, PMMA	400	dir
Beam Frag. PT	^{4}He	C, C_2H_4, PMMA	250	dir
Rad. Prot.space	^{4}He	C, C_2H_4, PMMA	700	dir
Rad. Prot.space	^{12}C	C, C_2H_4, PMMA	700	dir
Rad. Prot.space	^{16}O	C, C_2H_4, PMMA	700	dir

open to other possible physics programs

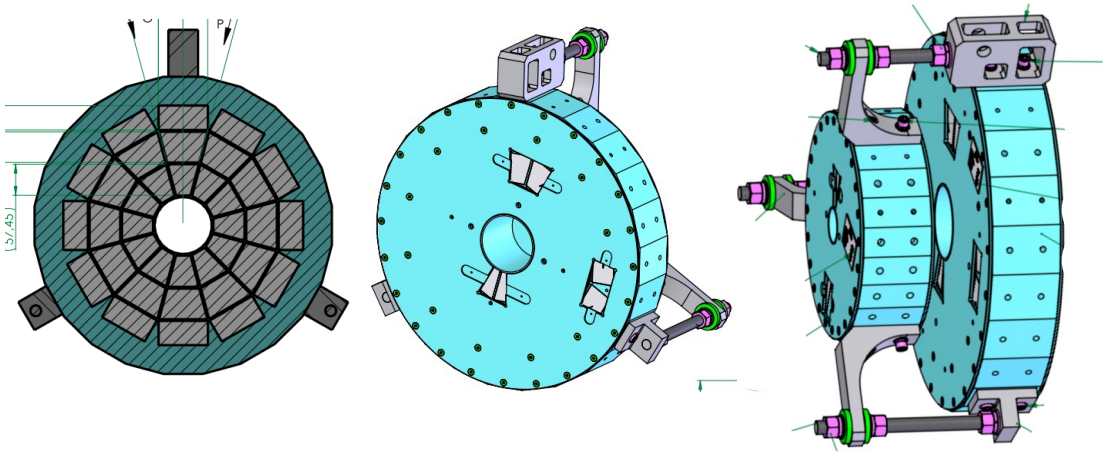
e.g. $^{12}C+C \rightarrow 3\alpha+X$ (clustering)

Fe+(Al, Si) →fragments (deep space radioprotection)

May 2023 status

- Three elements are needed for the assembly of the magnets:

- Yokes
- Magnetic elements
- Assembly tools



Assembly tools **delayed by two monthes**: beginning of june

Magnetic elements shipped by train. Arrived mid may.

Yokes and other mechanical pieces are at the firm since march.

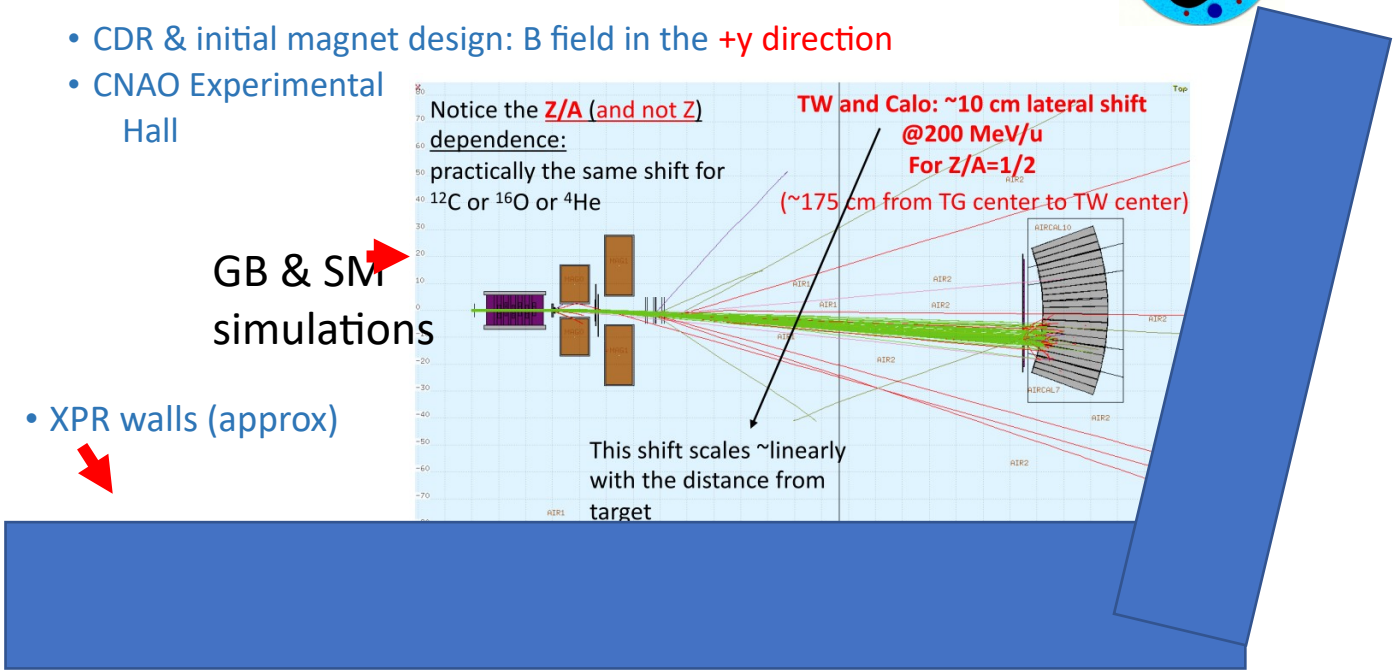
From neverending story…. Almost to the end

FOOT Collaboration asked for field reversal

- CDR & initial magnet design: B field in the +y direction
- CNAO Experimental Hall

GB & SM simulations

- XPR walls (approx)

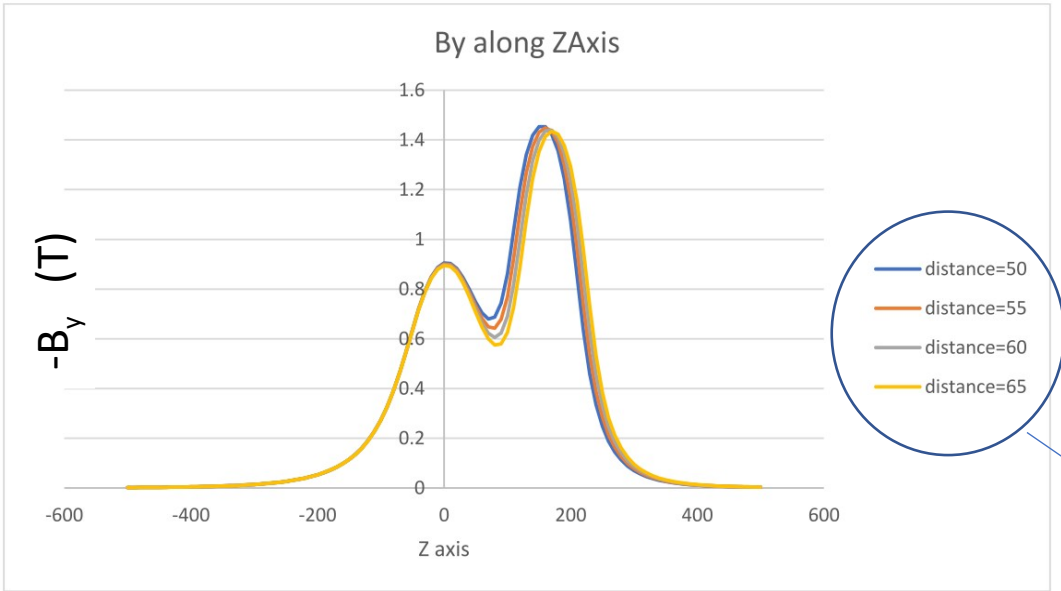


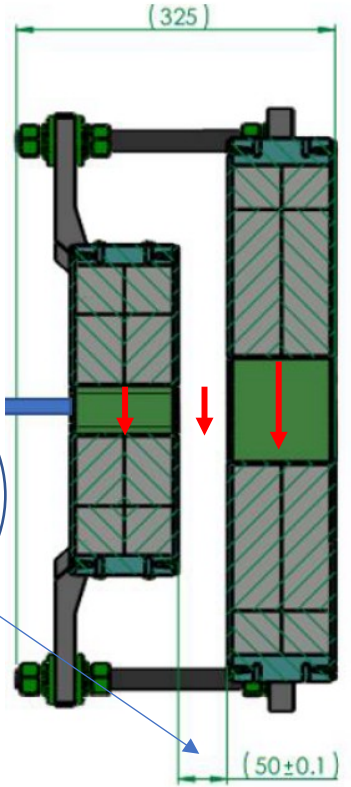
Why field reversal

- We are interested to have the beam at the center of the TW & CALO
  - → we'll shift TW & CALO accordingly, coming closer to the wall and reducing working space
- Walls are a (significant) source of secondary radiation: while it should be negligible for what regards tracking, noise at the TW and at the CALO might reduce the TW HIT & CALO efficiency.

- Soo….
- Smart suggestion (MM): what about to change the B polarity ?
- Charged fragments will be deviated toward the left, away from the wall…

Magnetic field reversed





Distance fixed to 55 mm

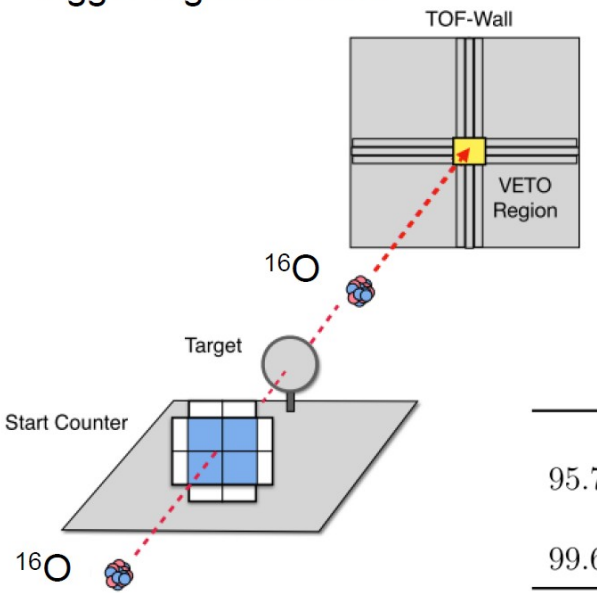
From neverending story…. Almost to the end

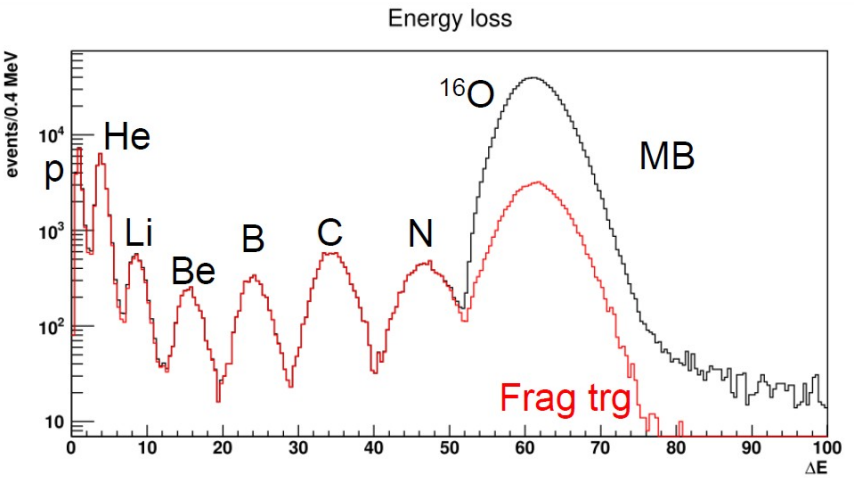
- Manifacturing M1: from 05/06 up to 27/06/23
- Manifacturing M2: from 26/06 up to 19/07/23
- Assembly M1+M2: from 20/07 to 26/07/23
- Measurements @ SigmaPhi: from 27/07 to 02/08/23
- Assembly and packing: from 03/08 to 30/08/23 (vacation time)
- Shipment: 31/08/23
- **Arrival at LNF: 13/09/23**

- **Measurements at LNF: one week from 13/09 to 15/10/23**

Fragmentation trigger (veto on high energy on TW)

Fragmentation events are at a level of few % → Better to implement a trigger logic on them!





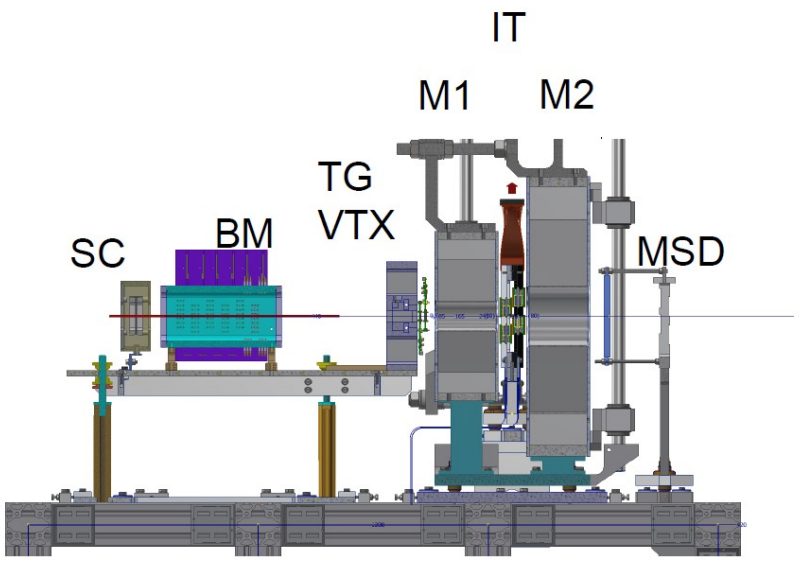
Trigger selection efficiencies (%)

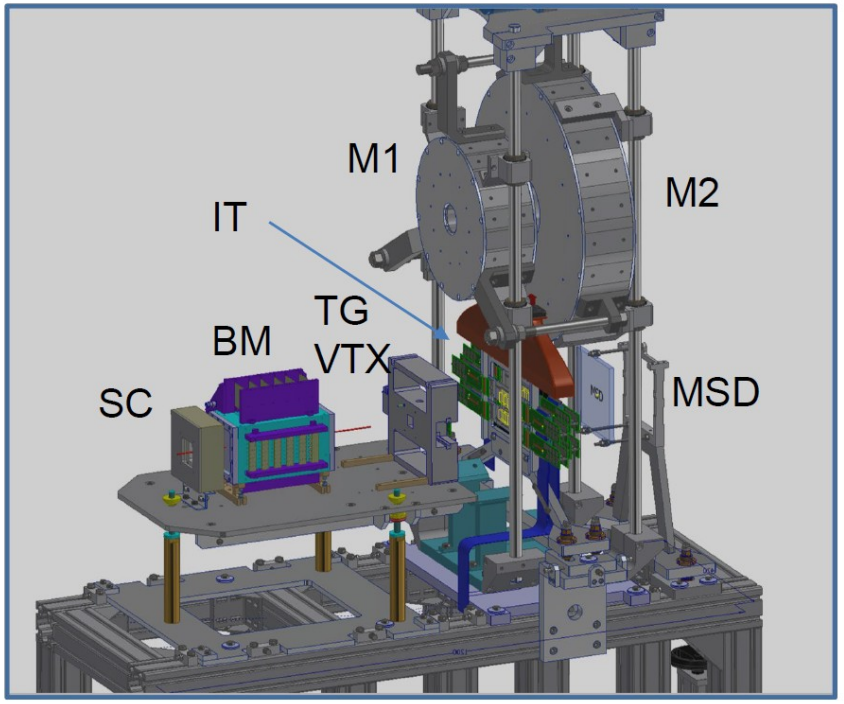
H	He	Li	Be
95.7 ± 0.2	98.2 ± 0.1	99.1 ± 0.2	99.3 ± 0.2
B	C	N	O
99.6 ± 0.1	99.8 ± 0.1	98.2 ± 0.1	8.46 ± 0.03

^{16}O rejection factor: 11,8

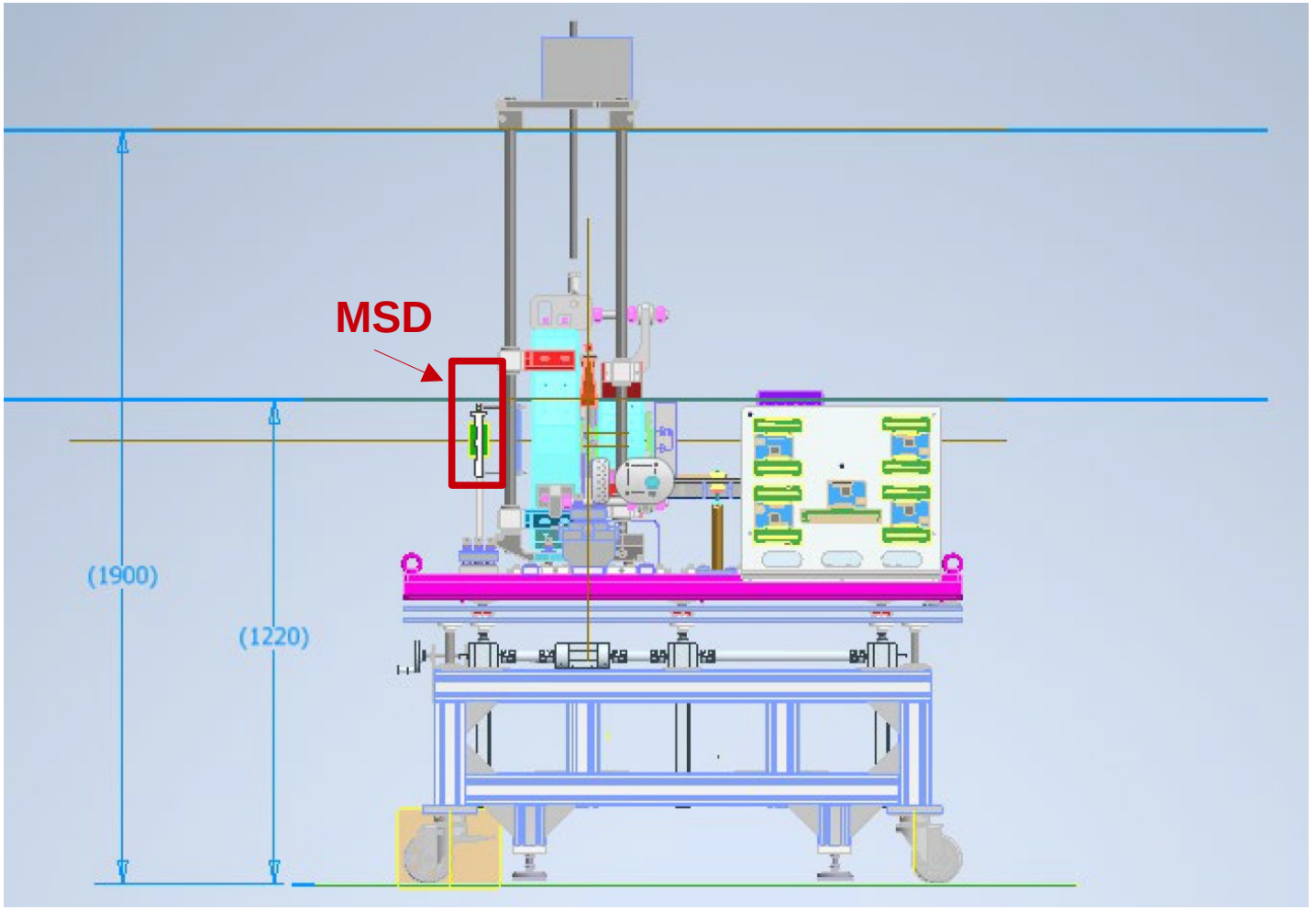
Tracker's Mechanics

Fully designed; tender assigned;
Realization on hold!

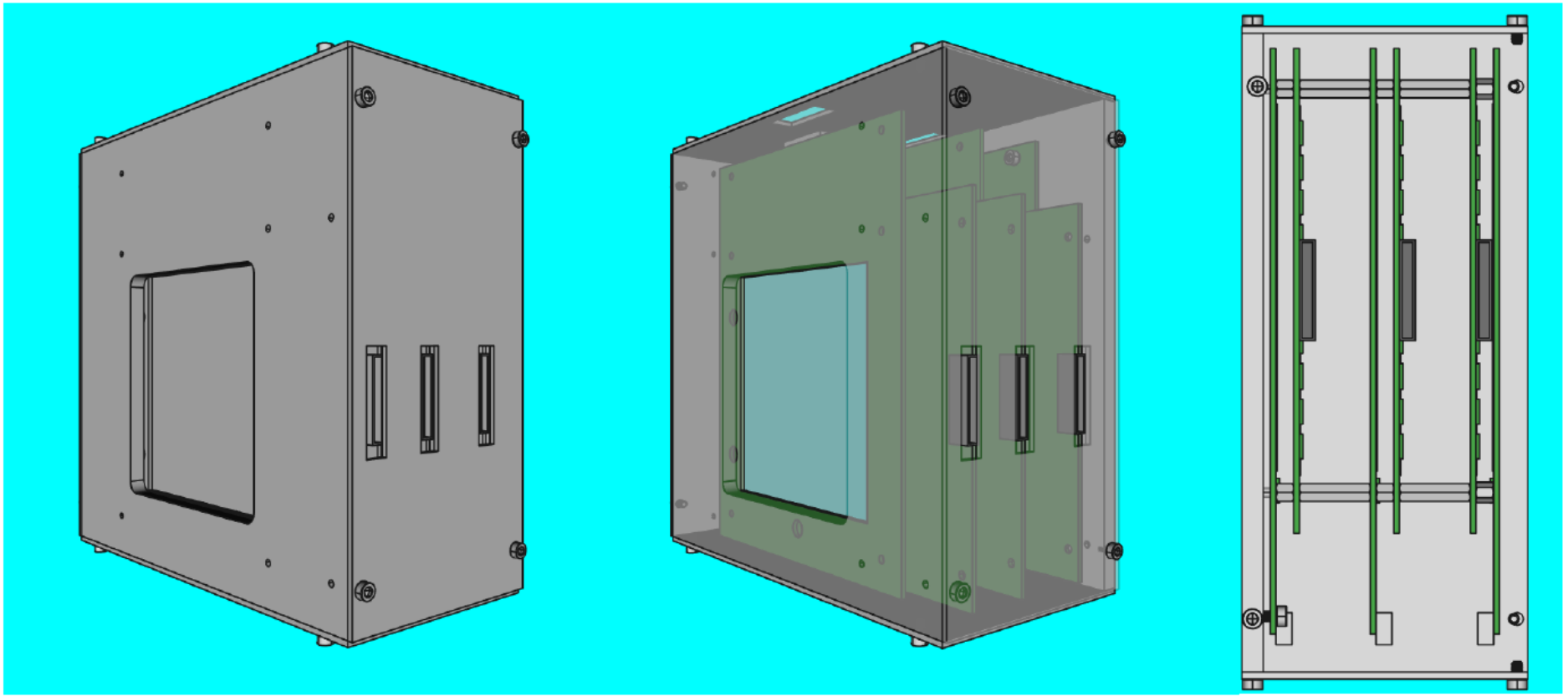




New mechanical setup

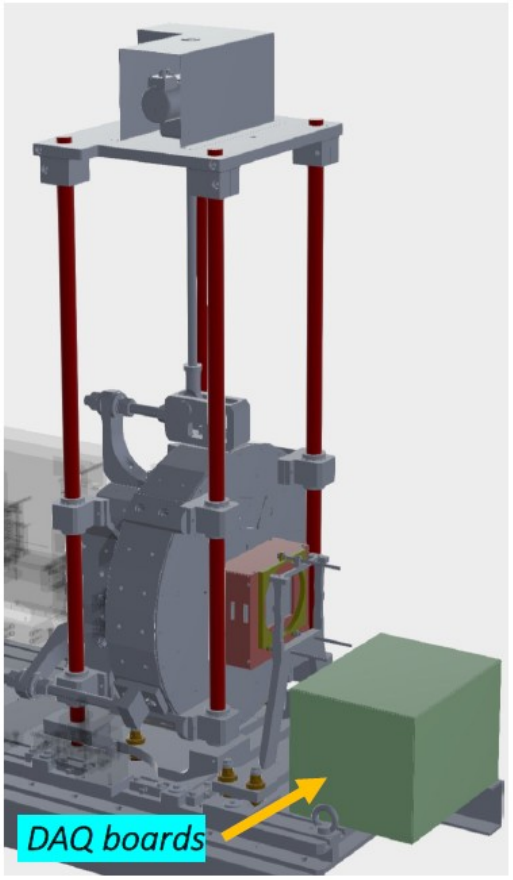


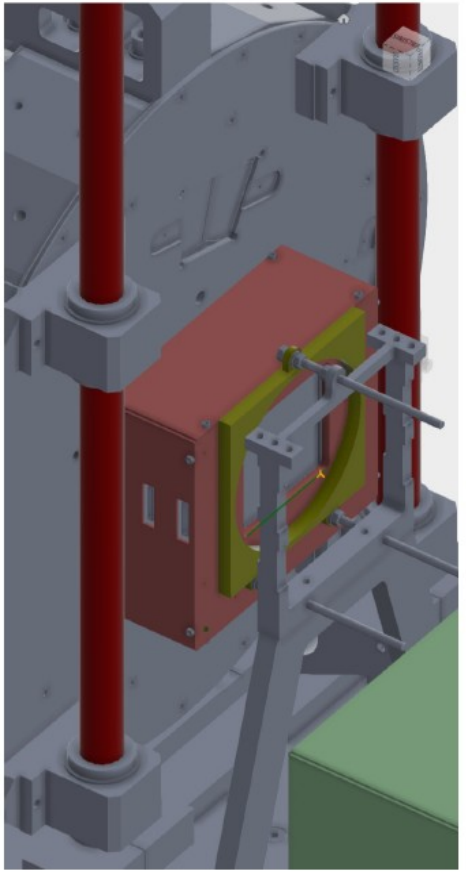
New MSD box (D. Aisa, G. Silvestre)



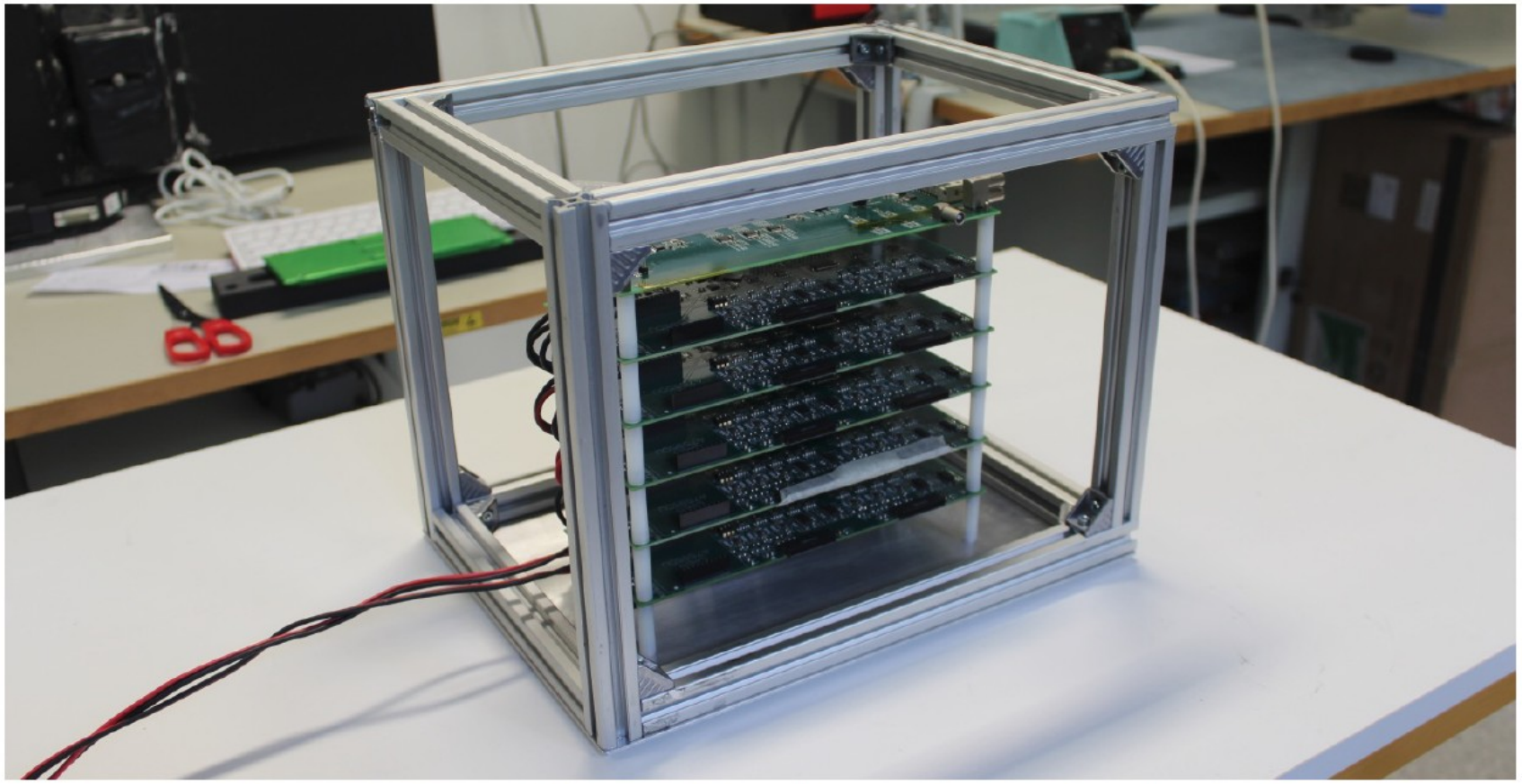
Single box solution for a smaller footprint (needed to place the MSD near the magnet exit window)

New MSD box (+ support)



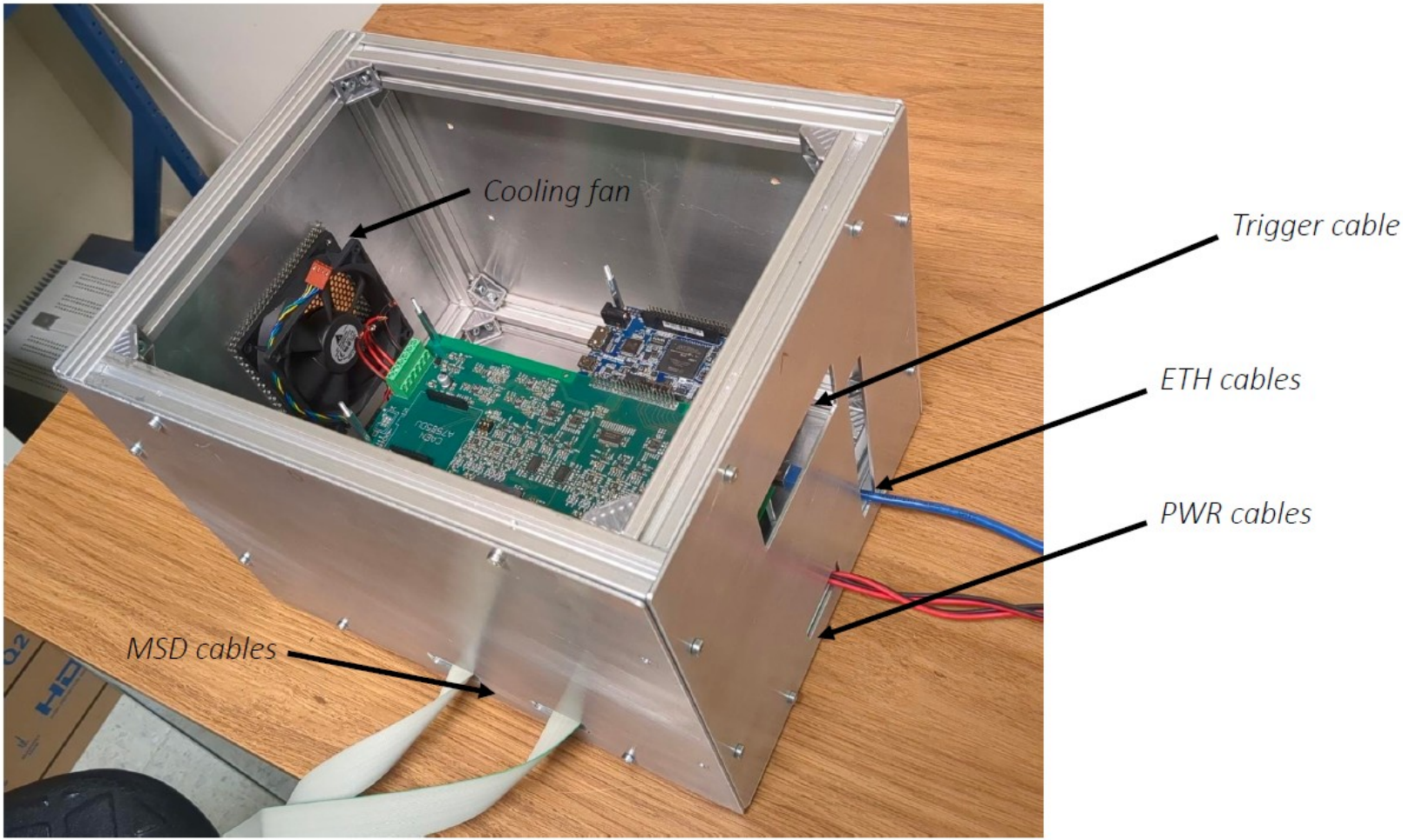


New DAQ boards box

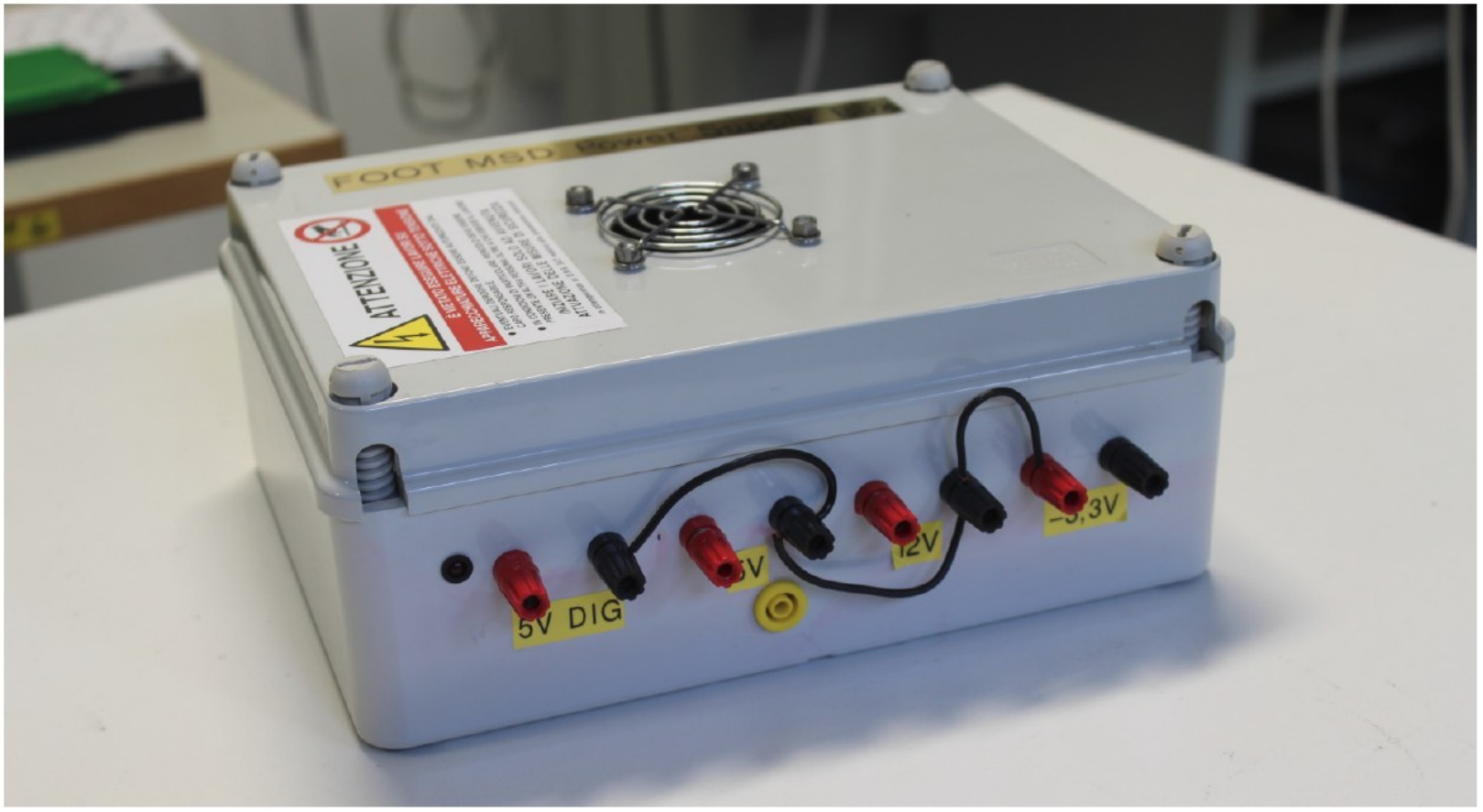


W x L x H: 320 mm x 250 mm x 240 mm (side panels missing from the photo)
Similar footprint to the previous one: spare boards already mounted on the stack (3 + 2 + Trigger Patch Panel)

New DAQ boards box



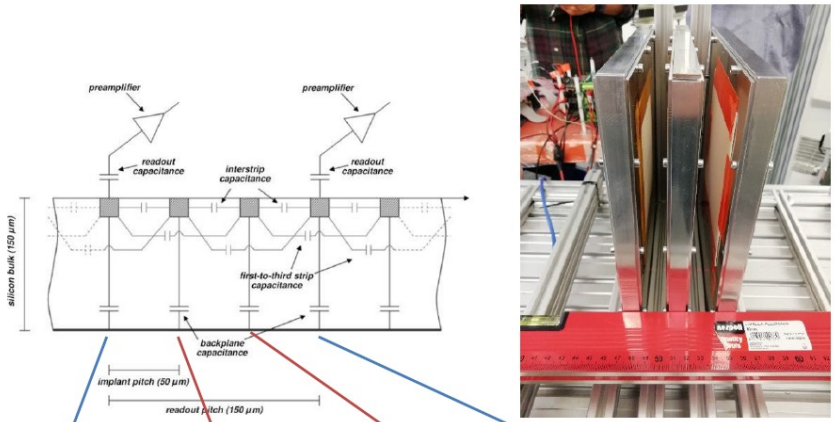
New Power Supply (M. Barbanera, G. Silvestre)



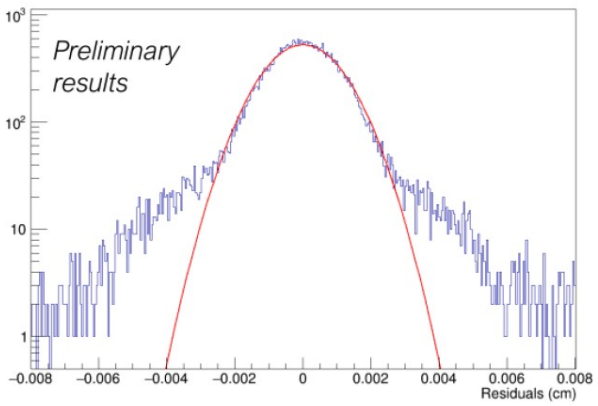
W x L x H: 250 mm x 210 mm x 110 mm
Much smaller footprint than previously used bench power supply

MicroStrip detector

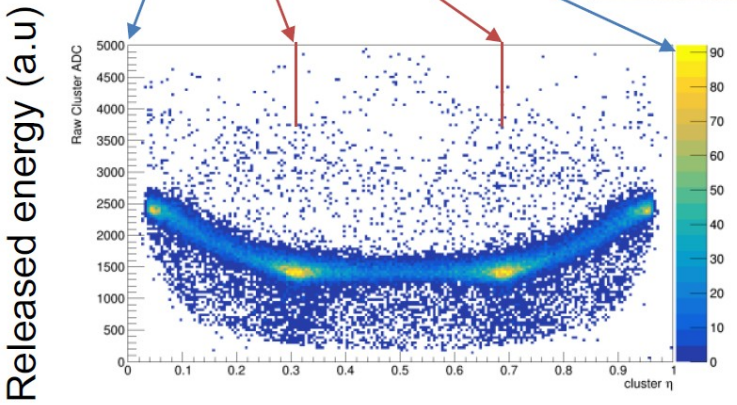
3 x-y planes used extensively since jun 2021
(3 more xy planes available)
50 um microstrip pitch, 150 um readout pitch



Track residuals



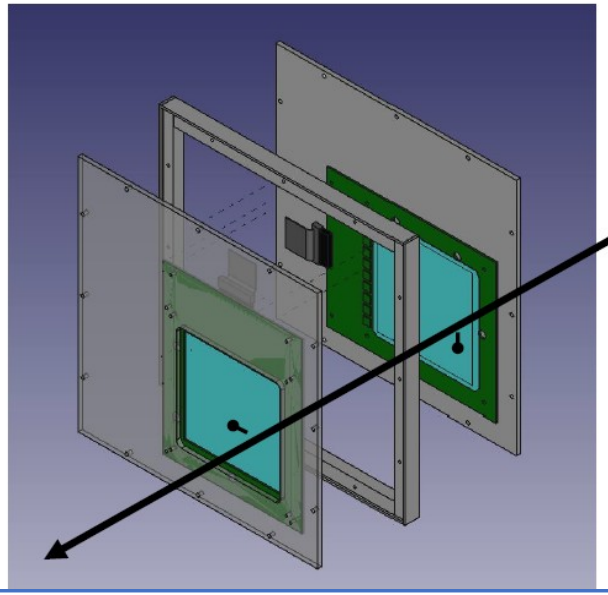
Resolution ≈ 12 μm



Before correction

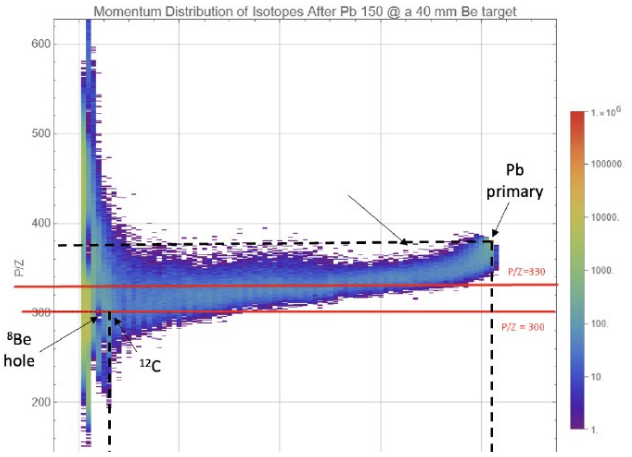
Studies ongoing to improve spatial end energy resolutions

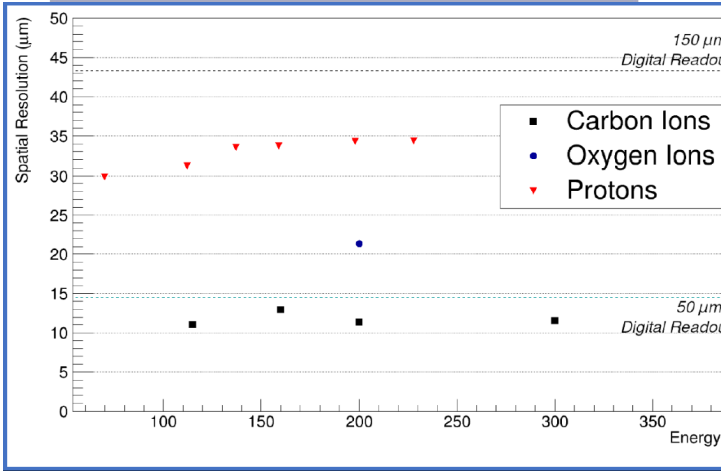
13

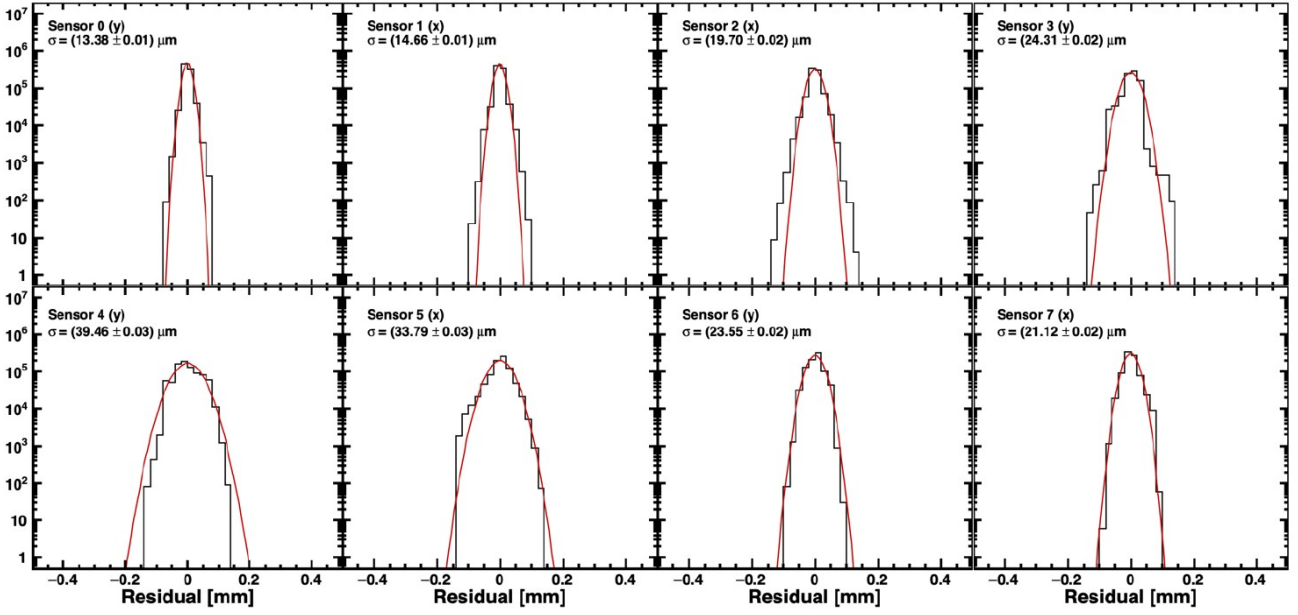


Test at CERN SPS.
Pb ions 150 GeV/c A
Be target
MSD performance and
η calibration

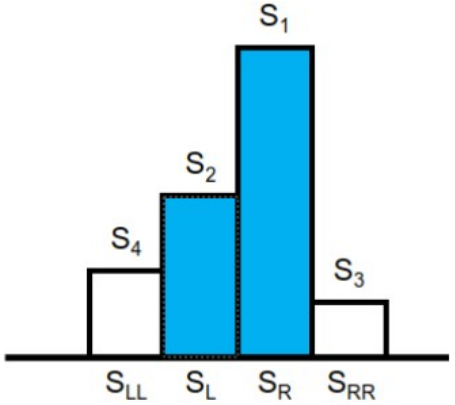
A. Oliva, G. Silvestre



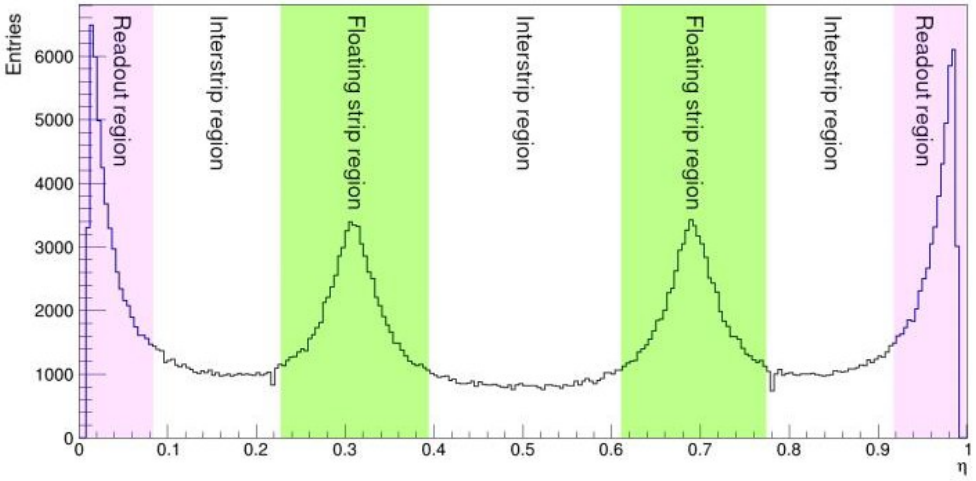


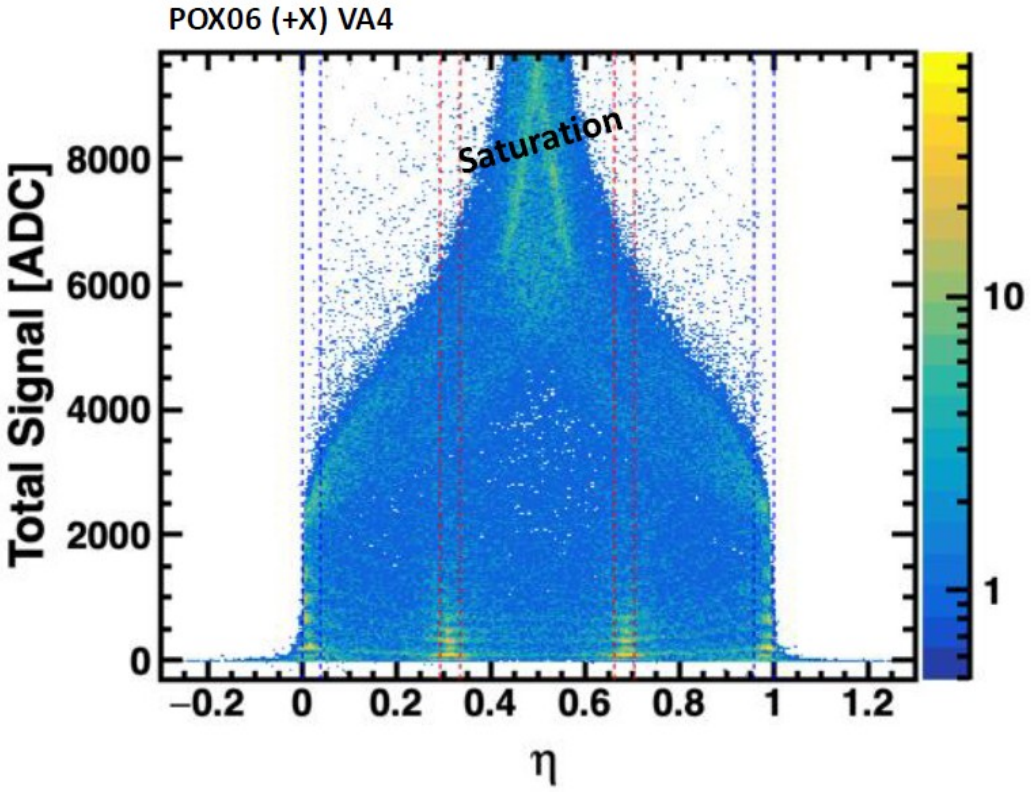


η function determination

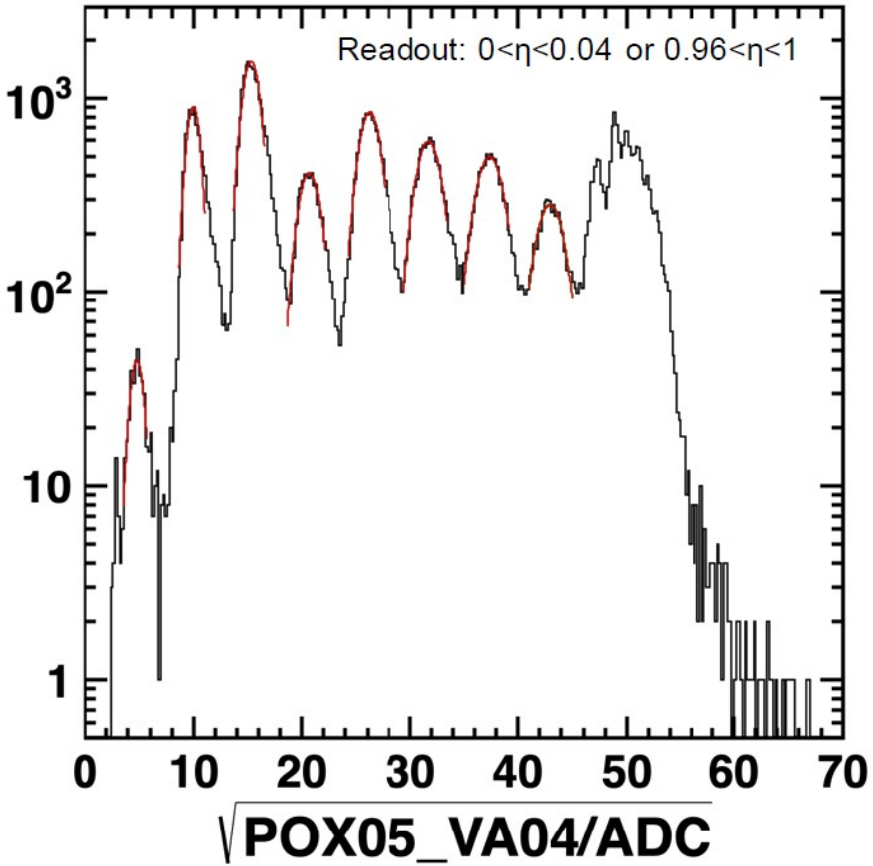


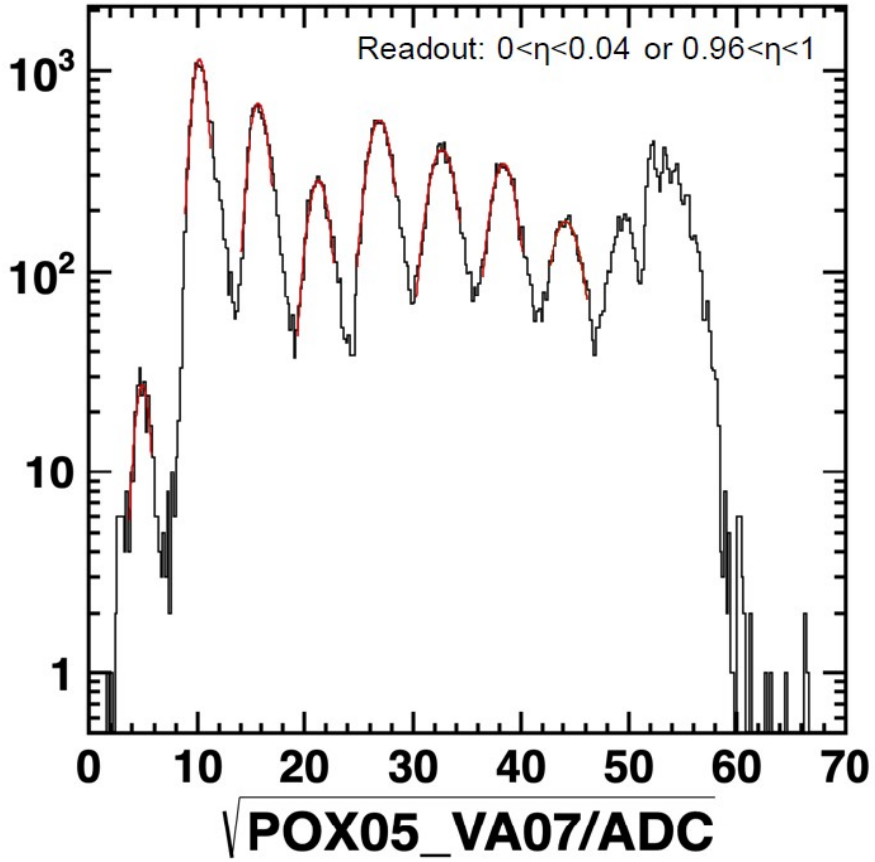
$\eta = S_R/(S_R + S_L)$: the center of gravity of the two highest readout strips (S_1 and S_2).



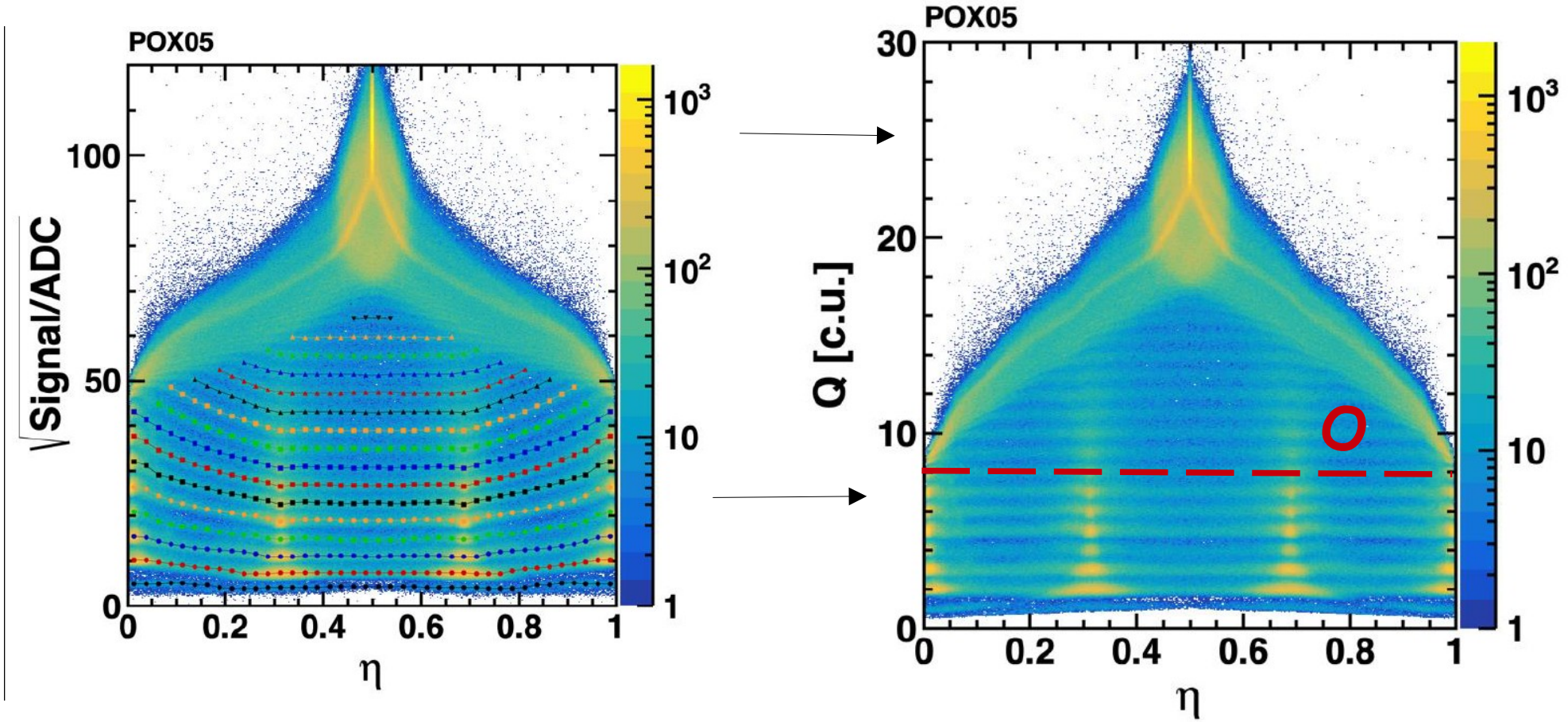


Calibrazione guadagno per ogni chip

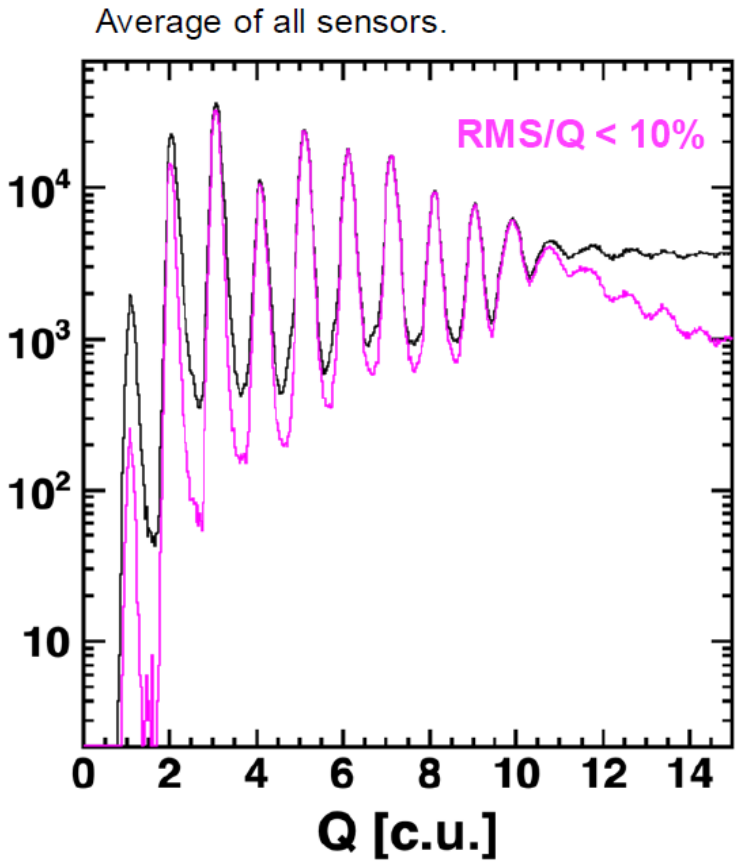


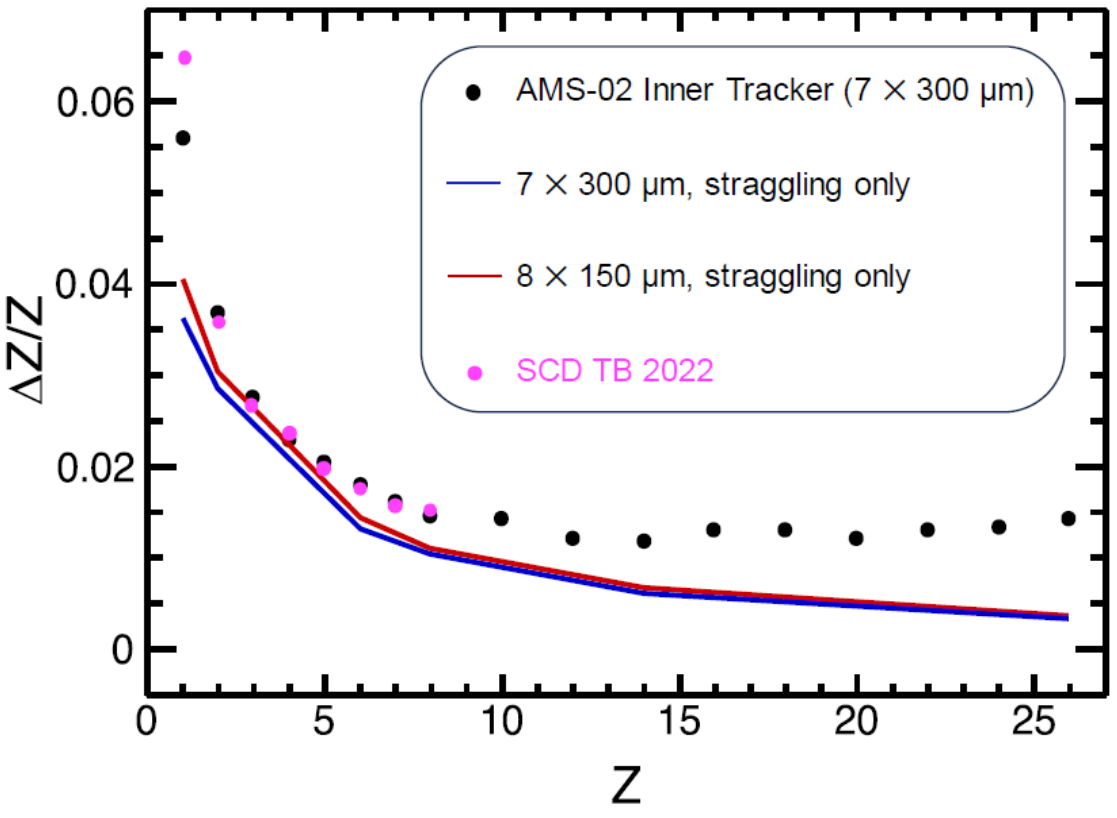


η function correction determination



Z identification





Attività in corso e futuro prossimo

Test a CNAO (Pavia) con ioni C in autunno per primo run con setup elettronico completo senza magnete. Analisi dati anche per fisica.

Analisi delle performance del sistema MSD in particolare modo:

- → **partecipazione al tracking senza campo magnetico;**
- → **ricostruzione della energia depositata in funzione della posizione intermedia della particella rispetto alle strip di readout;**

Possibile anche presa dati di tipo engineering con il magnete. Dati per commissioning sistema di tracker e misura impulso.

- → **partecipazione al tracking con campo magnetico;**

Pubblicazioni, Proceedings e Conferenze

→ "Characterization of 150 μm thick silicon microstrip prototype for the FOOT experiment" Gianluigi Silvestre et al 2022 JINST 17 P12012

→ "Test of a prototype Microstrip Silicon Detector for the FOOT experiment" G. Silvestre et al 2022 J. Phys.: Conf. Ser. 2374 012065

→ "The Microstrip Silicon Detector (MSD) data acquisition system architecture for the FOOT experiment" K. Kanxheri et al 2022 JINST 17 C03035

"A new photon calibration method for silicon microstrip sensors" F. Peverini et al, just submitted to JINST.

1) Conferenza: "Characterisation of the Microstrip Silicon Detector for the FragmentatiOn Of Target experiment" G. Silvestre at 15th Pisa Meeting on Advanced Sensors.

Manpower, Money e servizi...

L. Servoli (55%), G. Silvestre (50%),
G. Ambrosi (0%), K. Kanxheri (0%),
F. Peverini (0%), L. Salvi (20%-100%)
P. Placidi (20%), E. Fiandrini (20%)
B. Alpat (20%), M. Barbanera (20%)
Totale = 2.85 FTE

Consumi: 2 k€
Missioni: ~ 17 k€

Totale = 19 k€

Richieste ai servizi: entro la normale attività di un esperimento che potrebbe aver bisogno di ritocchi e manutenzione di sensori.

→ Meno di 1 m.u. in camera bianca.

→ Meno di 1 m.u. Officina Meccanica per adattamento e ottimizzazione interfaccia meccanica con la struttura di sostegno dell'esperimento.