dE/dx and TOF Scintillator

M. G. Bisogni, N. Belcari, N. Camarlinghi, P. Carra, E. Ciarrocchi, A. Del Guerra, M. Francesconi, L. Galli, A. C. Kraan, A. Moggi, M. Morrocchi, V. Rosso, G. Sportelli

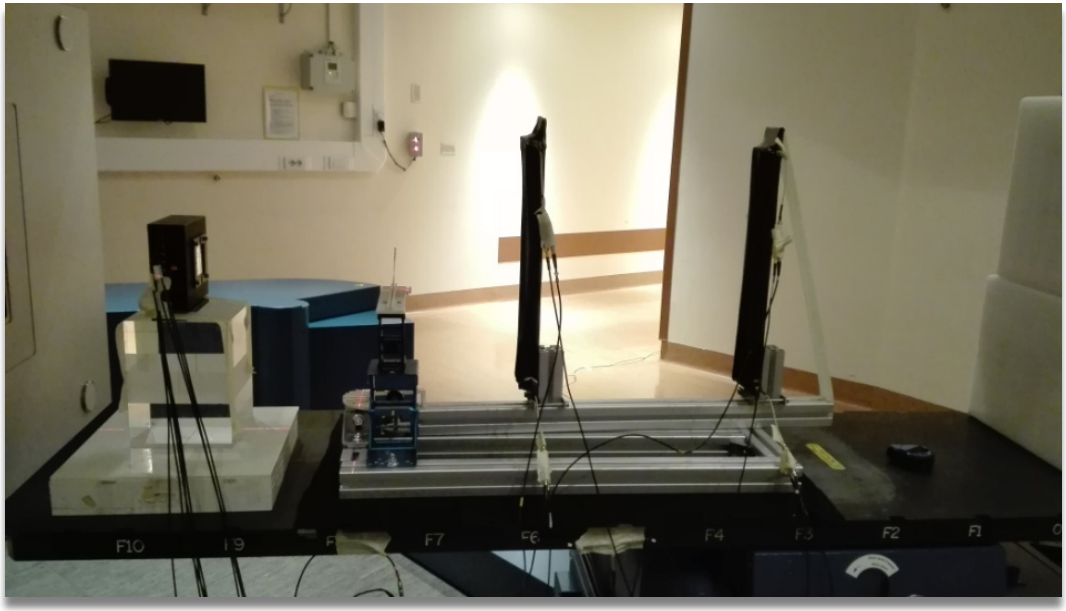
Tests on Particle Identification

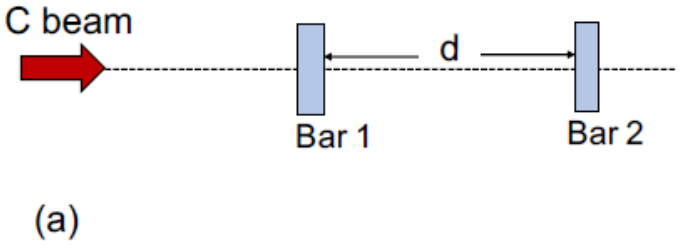
Aafke Kraan

The angle between the two bars and the target can be changed.
A PVT target of 4 mm was used.

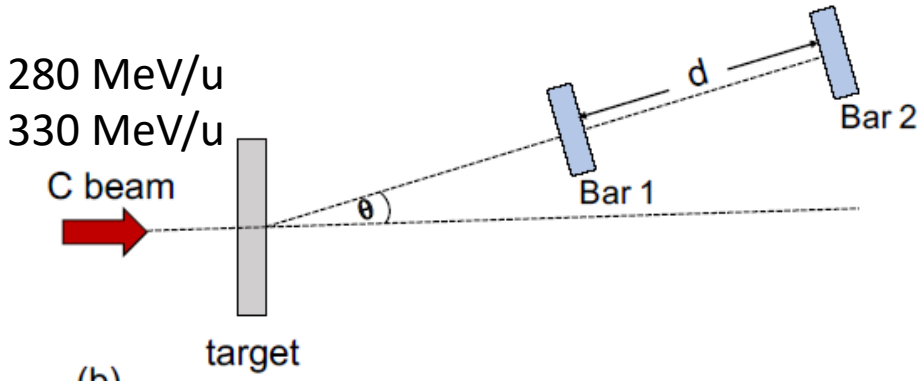
Two angles were investigated:
- 8.3 deg (only protons and helium)
-3.2 deg (up to Z = 6)

-The distance between the bars was set to 40 cm





(a)



(b)

Bar Calibration with Carbon

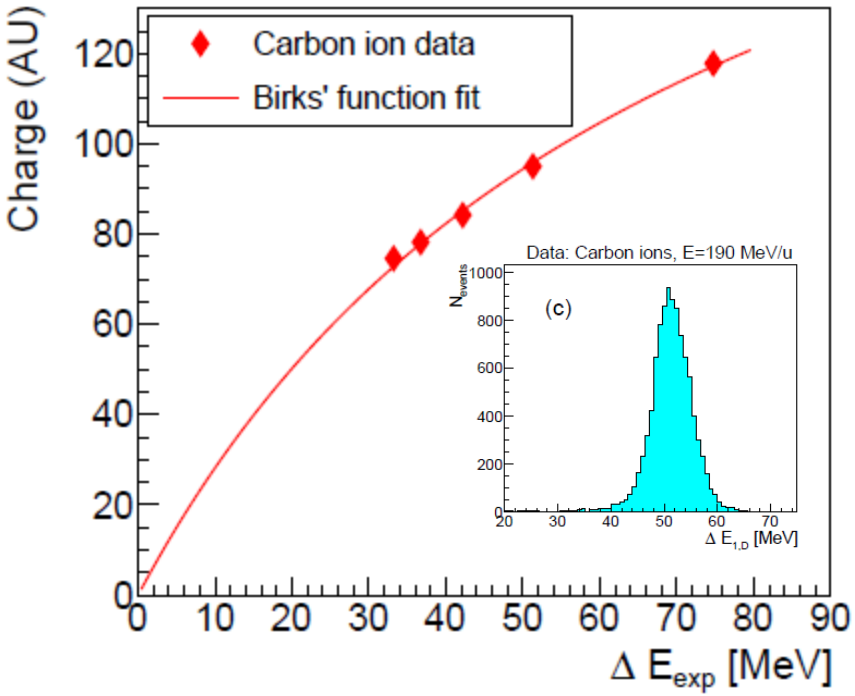
Used 5 different energies, with the beam at the center of the two bars.

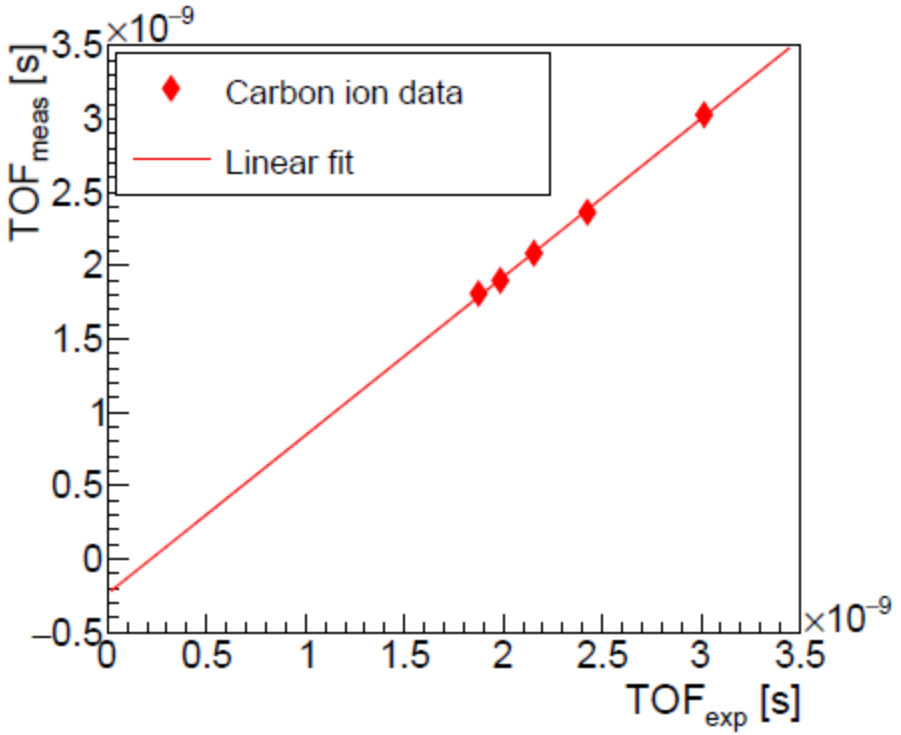
E = 115, 190, 260, 300, 400 MeV/u

Saturation effect fitted as:

$$Q_{i,D}^{mode} = p_{a,i} \cdot \frac{\Delta E_{i,exp}^{mode}}{1 + p_{b,i} \Delta E_{i,exp}^{mode}}$$

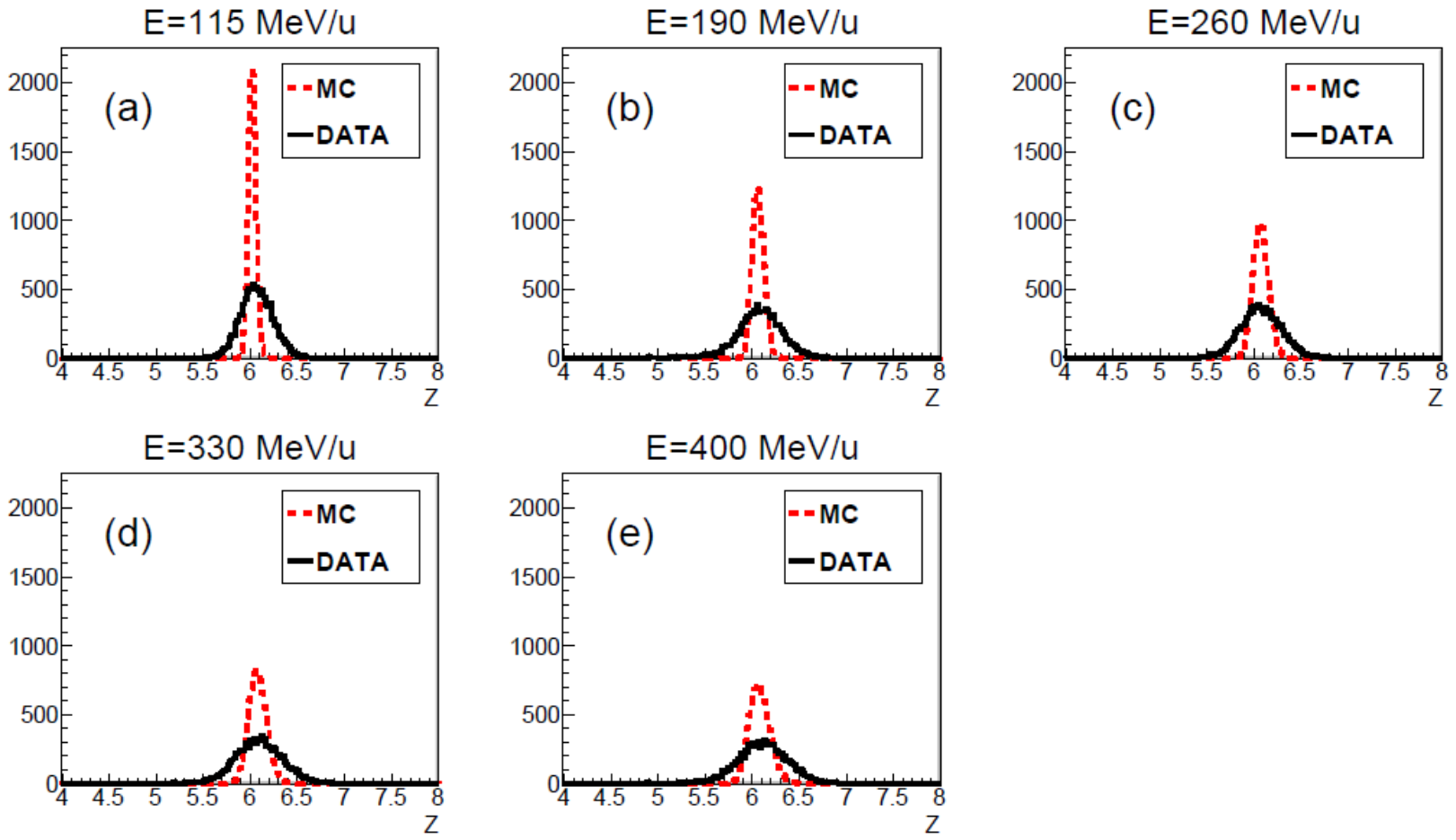
$$\Rightarrow \quad p_{b,2} = 1.13 \times 10^{-2}\ \mathrm{MeV}^{-1}$$



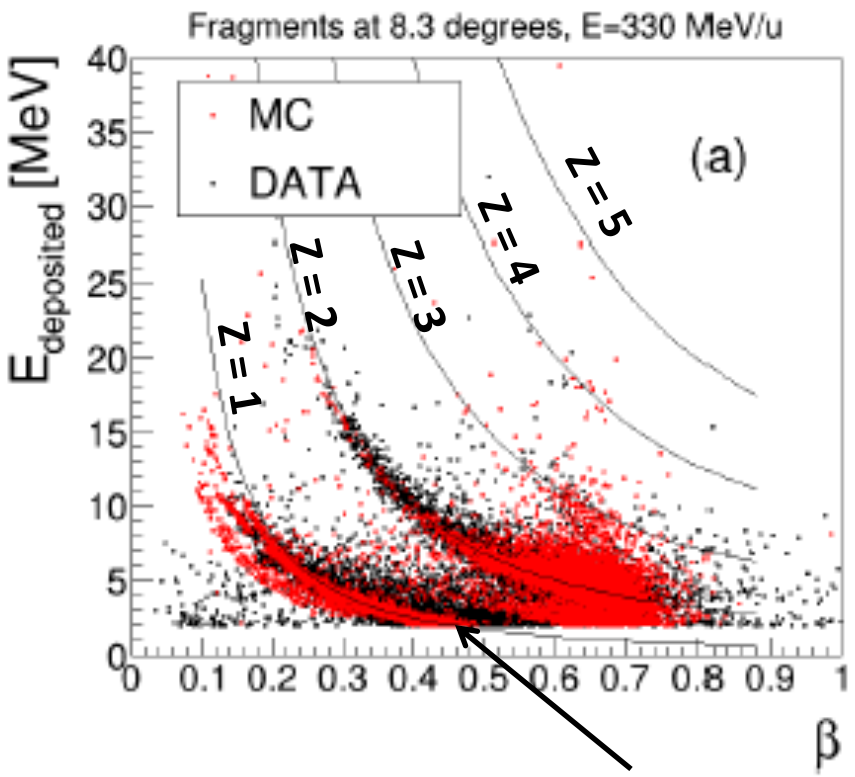


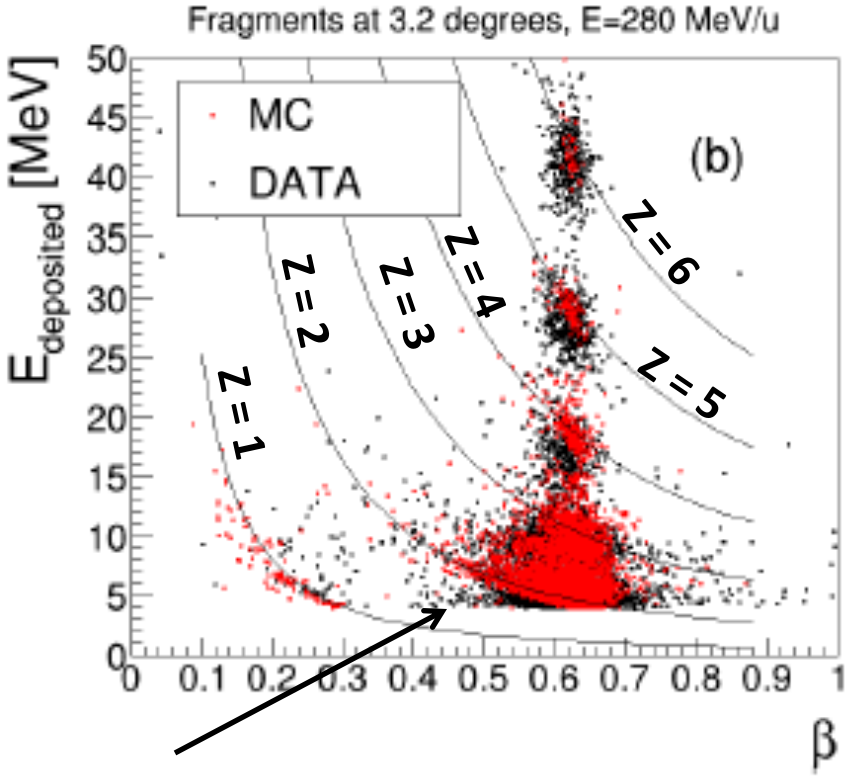
Z reconstruction test

Z reconstruction performed on the calibration set.



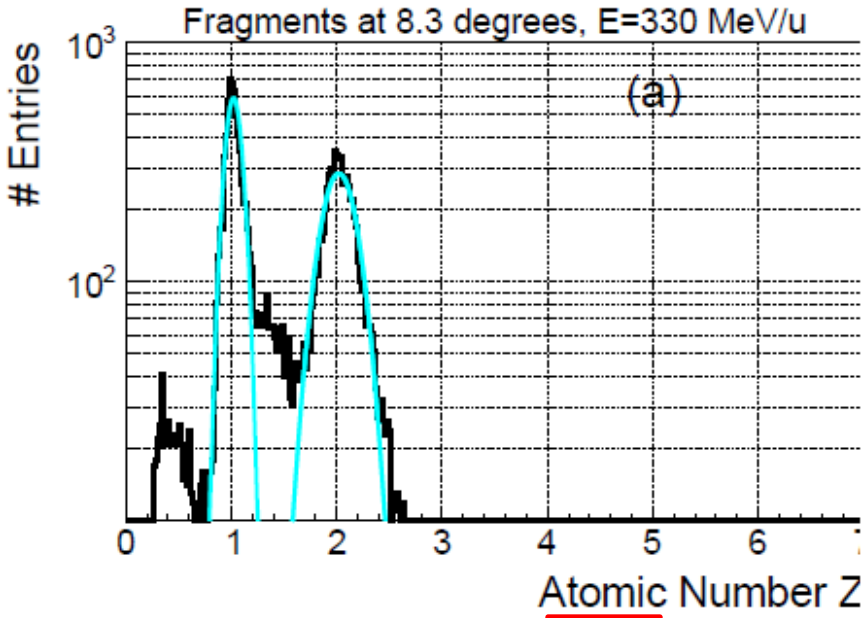
Fragmentation measurement

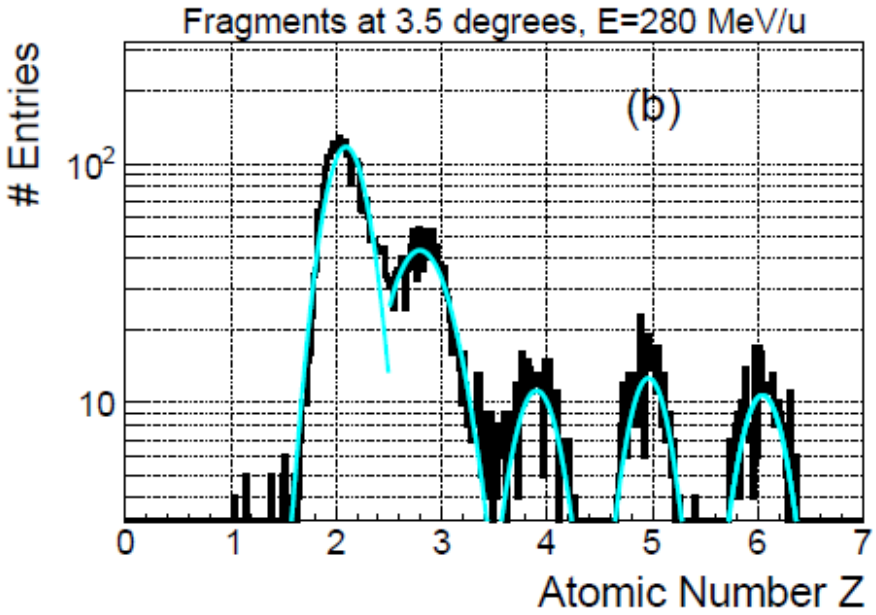




The same energy cut is applied to simulation and data
(2 MeV at 8.3 deg and 4 MeV at 3.2 deg)

Fragmentation measurement (2)

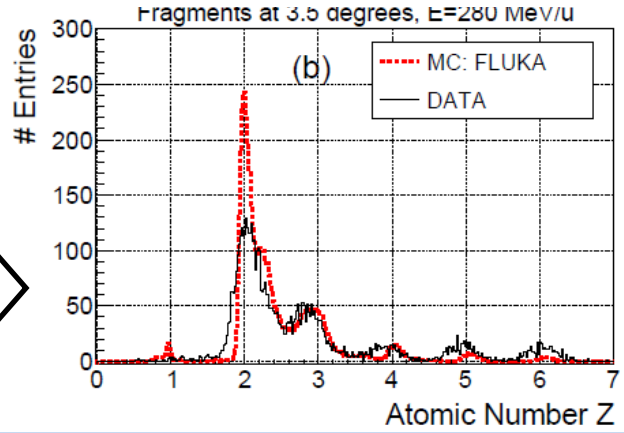




Angle	Energy	Z	$\mu(Z)$	$\sigma(Z)$
8.3 degrees	330	1	1.02	0.08
		2	2.02	0.17
3.5 degrees	280	2	2.10	0.19
		3	2.80	0.26
		4	3.88	0.21
		5	4.94	0.19
		6	6.00	0.21

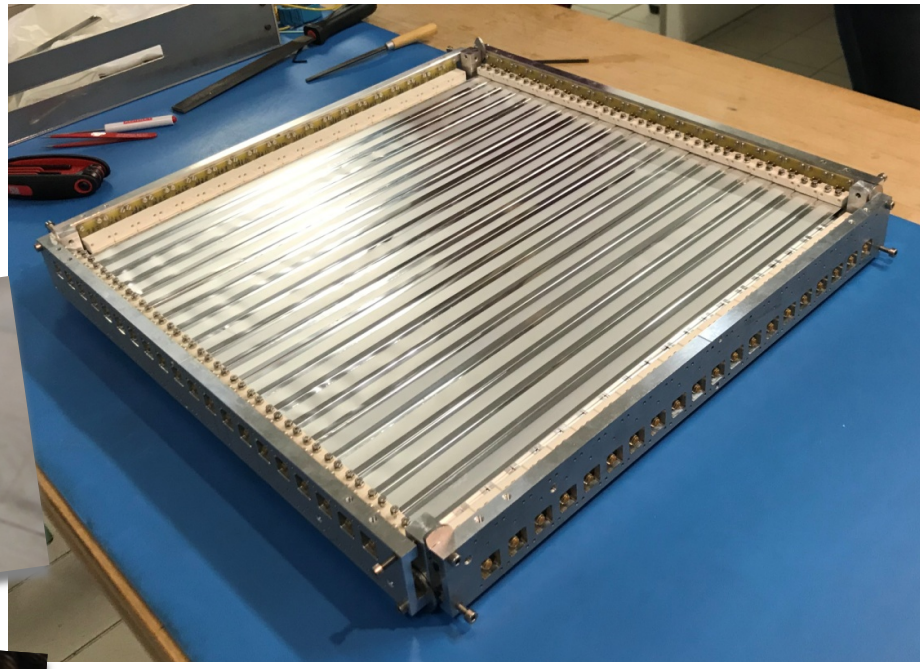
All the 6 Z can be distinguished!

Comparison of the distribution between data and simulation



Development of the final detector

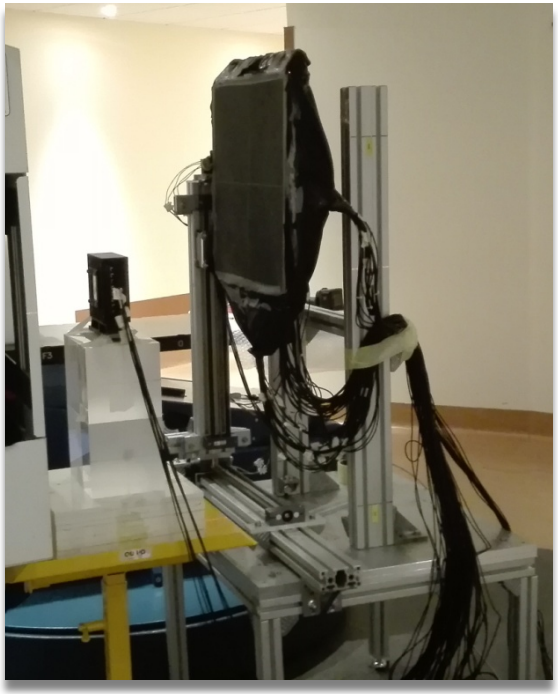
Matteo Morrocchi

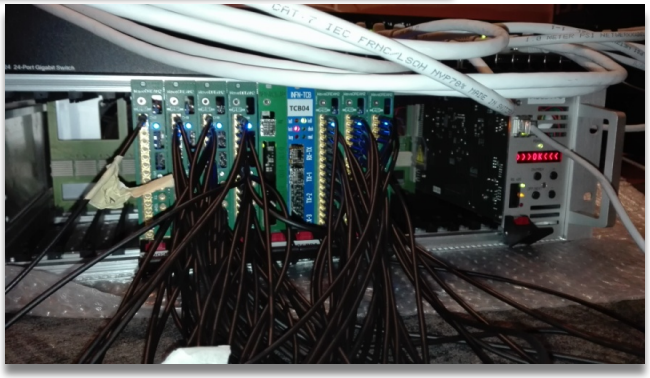


20 + 20 bars for an area of 40 x 40 cm^2

320 SiPM read-out by 80 analog channels sampled at 4 Gsps by the WaveDAQ system

Detector Scan

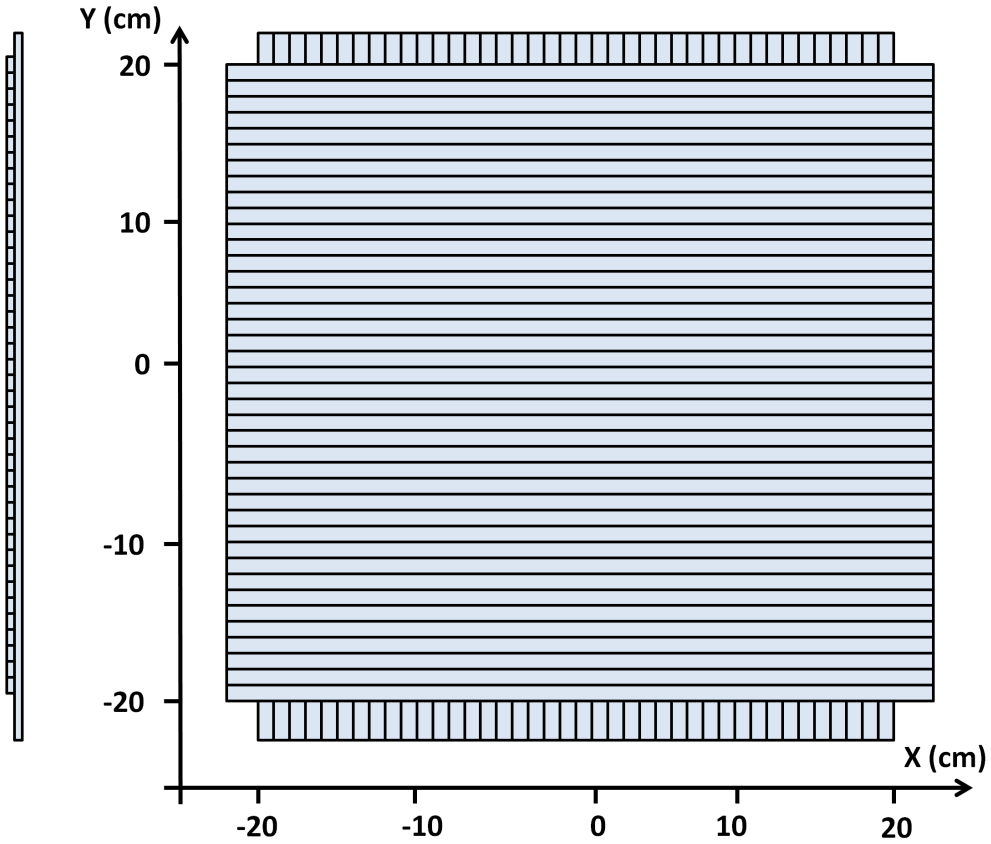




Calibration of the time and energy response of each bar (analysis still ongoing)

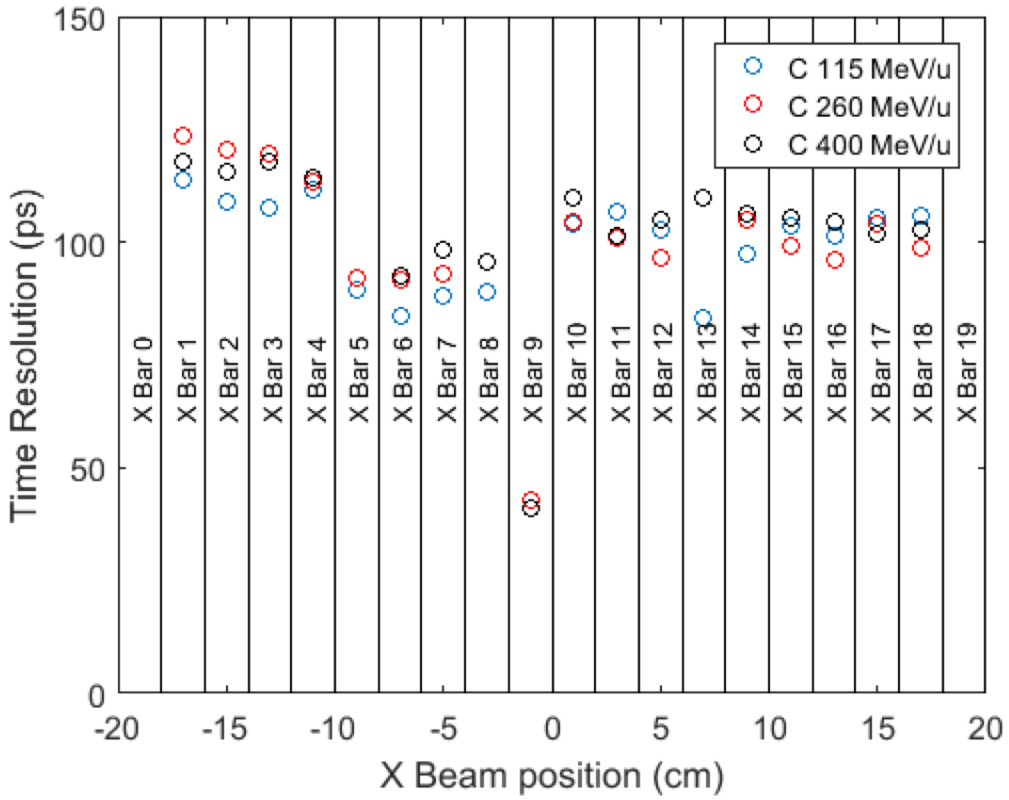
- P 60 MeV
- C 115 MeV/u
- C 260 MeV/u
- C 400 MeV/u

Beam

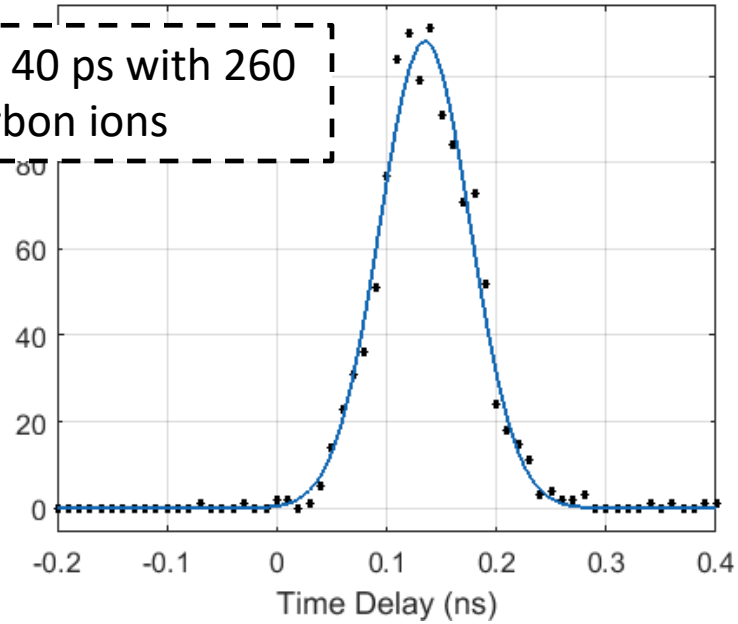


Time Resolution

Time resolution between the two central bars of 40 ps

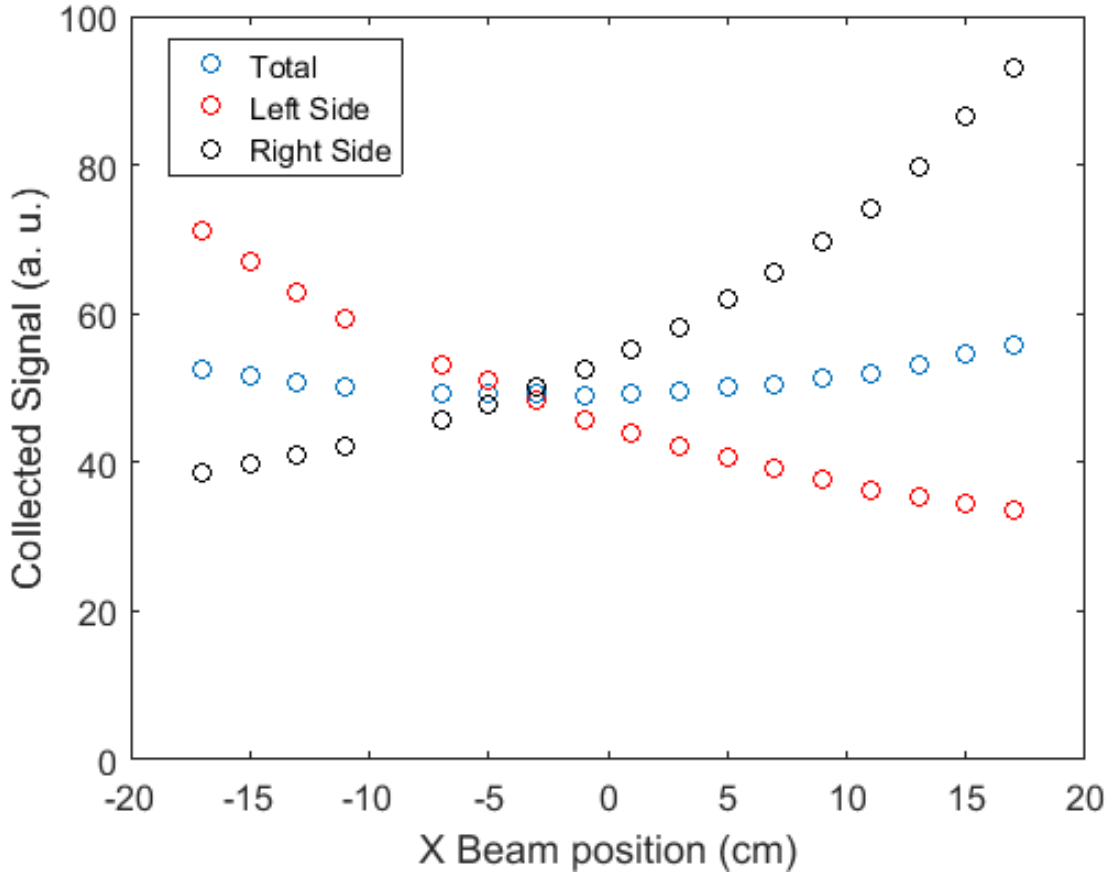


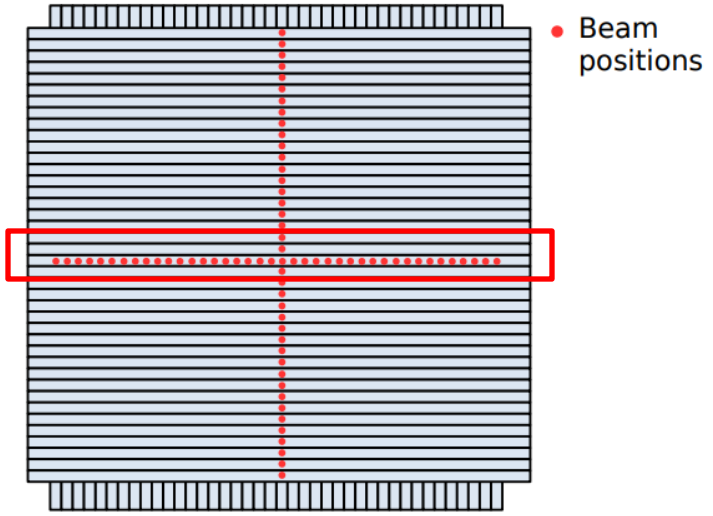
CTR of σ = 40 ps with 260 MeV/u Carbon ions



Time resolution involving different Wavedreams needs to be refined to take into account clock skew between boards.

Central bar scan

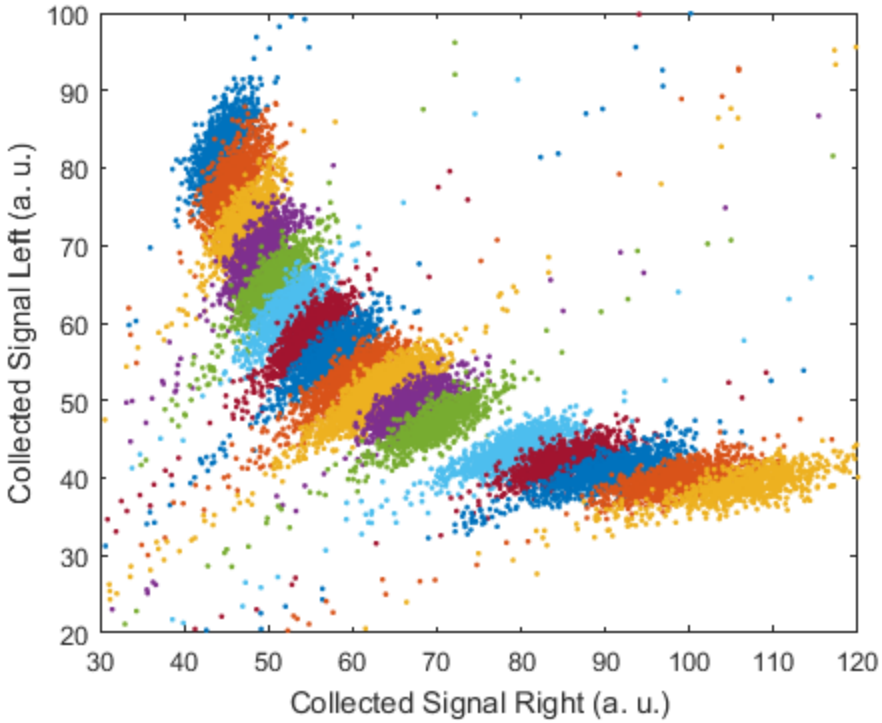


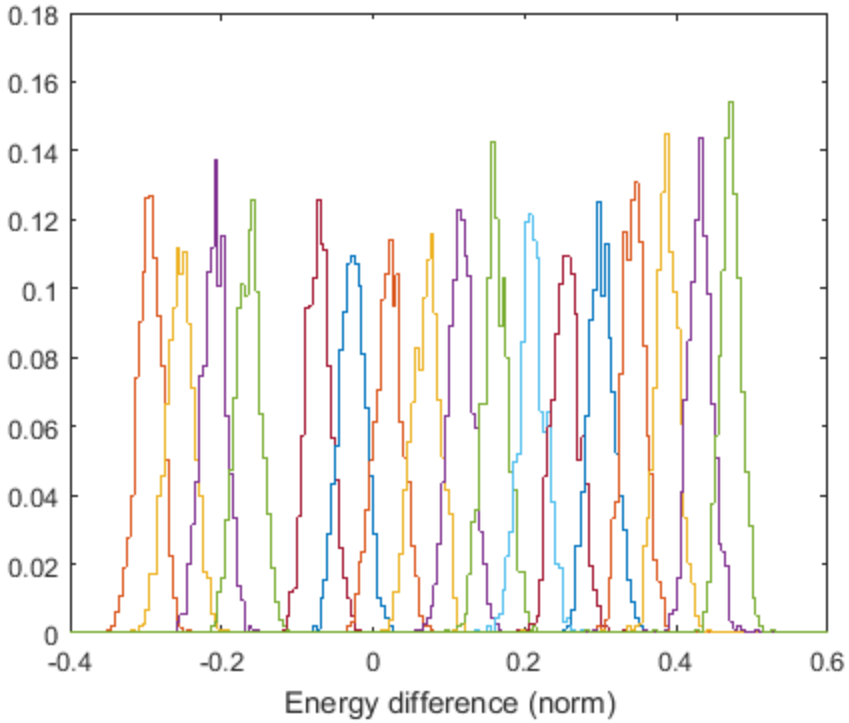


Study of the attenuation of the light in the central bar, an uniformity of response within 5% is obtained. Further correction achievable with a point-to-point calibration

Bar identification

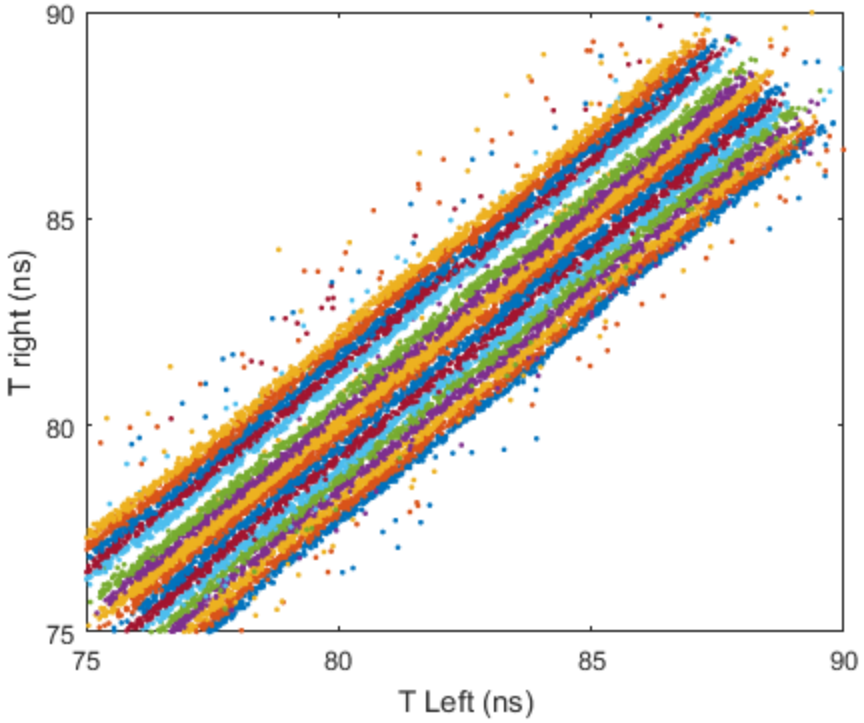
Signal collected at the two sides of the central bar as a function of the beam position (irradiation has been performed at 2 cm step, at the center of each bar).

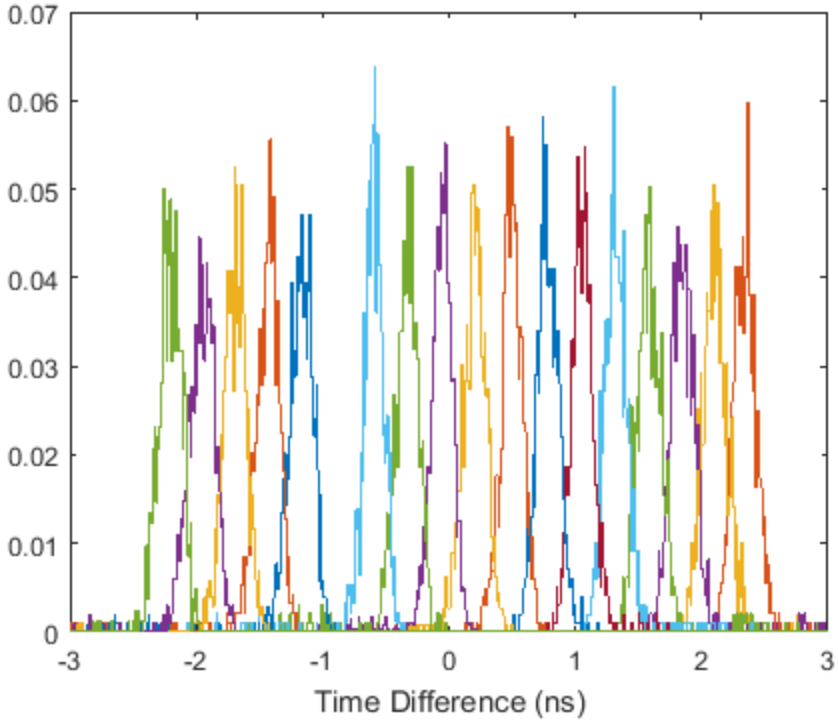




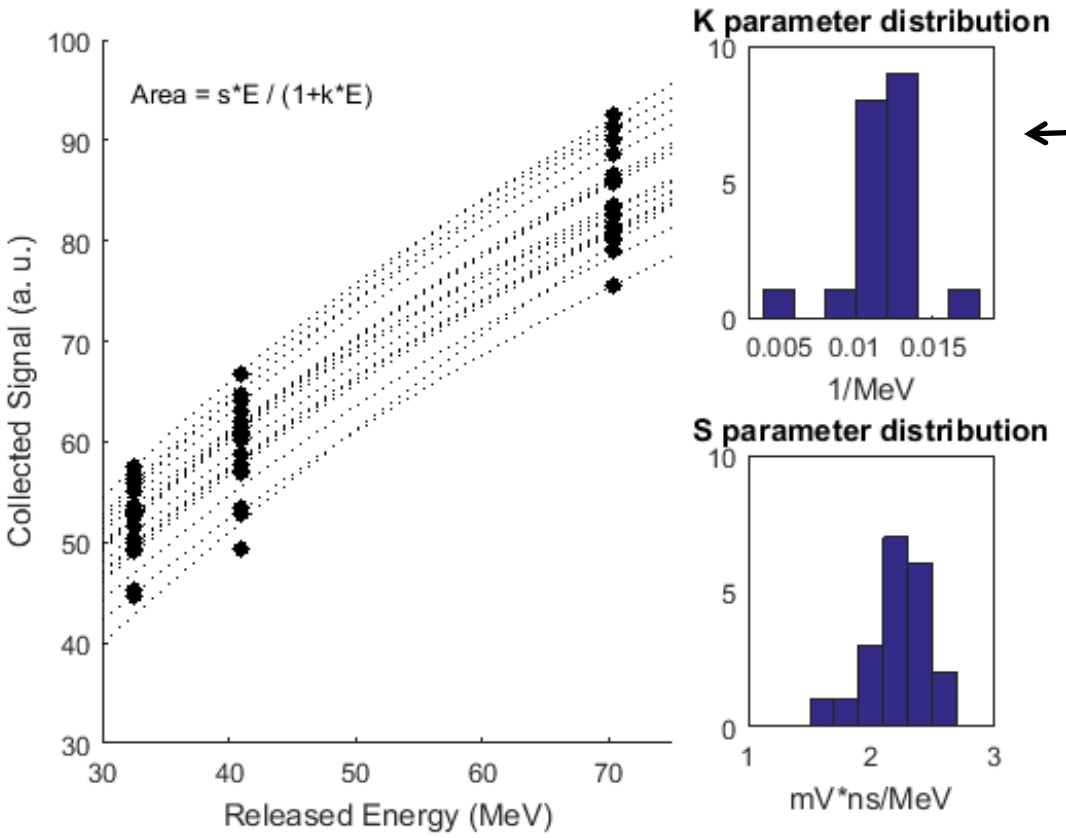
Bar identification (2)

Trigger time at the two sides of the central bar as a function of the beam position (irradiation has been performed at 2 cm step, at the center of each bar).
The absolute value of the trigger time is not related to the start counter, so it is not related to the Time of Flight of the particle.





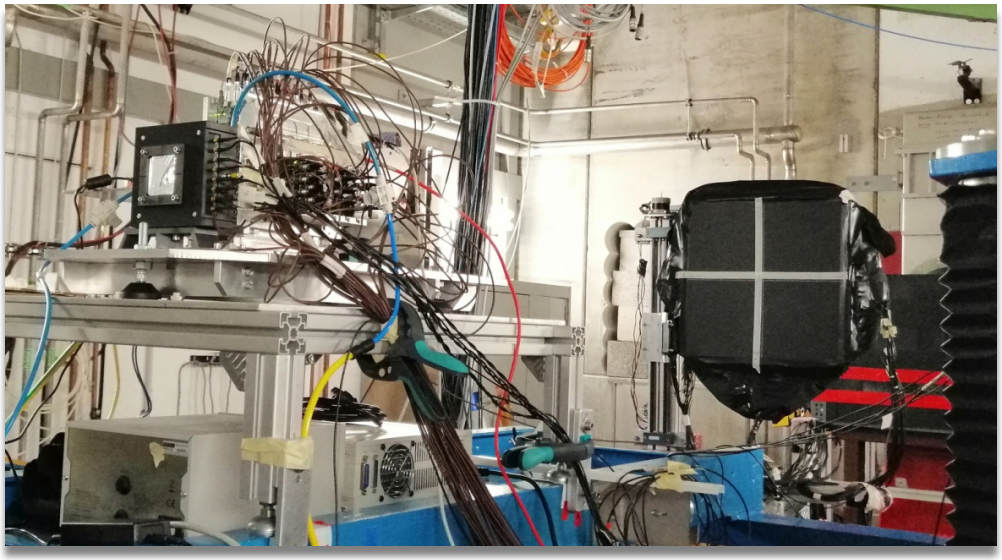
Energy Response

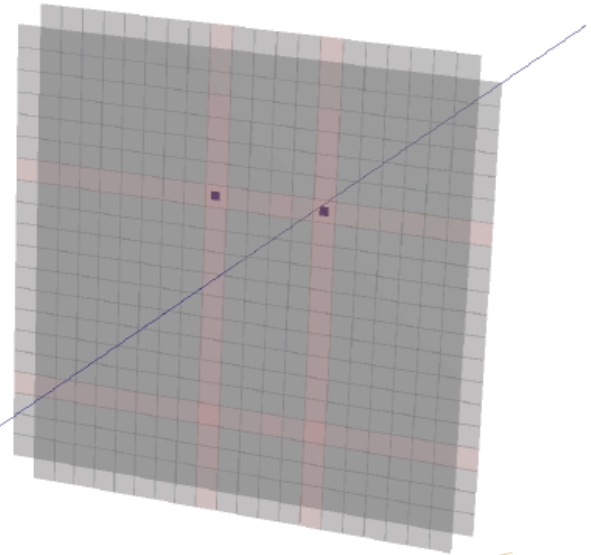


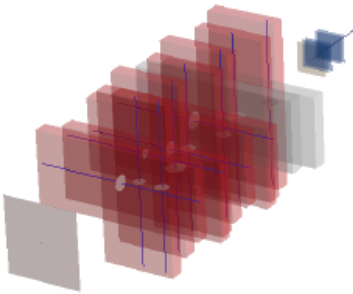
The slope of the saturation curve (K parameter) is compatible with the values that we obtained with the previous prototype

Calibration is not completed:
A board of the WaveDAQ needed to be replaced after calibration and some bars did not have enough statistics to perform an accurate calibration.
Another calibration will be needed in the future.

Test Beam GSI







Test of different Trigger and scan of the central bars of the whole detector with 400 MeV/u Oxygen.

Analysis still ongoing.

Trigger tests@ GSI

Luca Galli

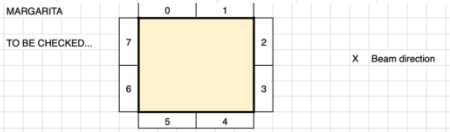
slot

	0	1	2	3	4	5	6	7	DCB/ANC	TCB	8	9	10	11	12	13	14	15	
node association					WD027 Margarita	WD078 TOF X0	WD079 TOF X1	WD080 TOF X2/Y0	Anc	TCB FOOT	WD081 TOF Y1	WD082 TOF Y2	WD094 VETO						
					Cha 0 -> 7	Bar 0-> Bar 7	Bar 8 -> Bar 16 (bar 9 excluded)	Bar 17 -> Bar19			Bar 5-> Bar 13 (Bar 9 excluded)	Bar 14 -> Bar 19	Central X and Y bars						
					emply			Bar 0 -> Bar4					empty						
					empty														
					empty														
	EMPTY	EMPTY	EMPTY	EMPTY	empty									EMPTY	EMPTY	EMPTY	EMPTY	EMPTY	MSCBXXX
					ch 0->7	ch 0->15	ch 0->15	ch 0->15			ch 0->15	ch 0->11	ch 0->3						

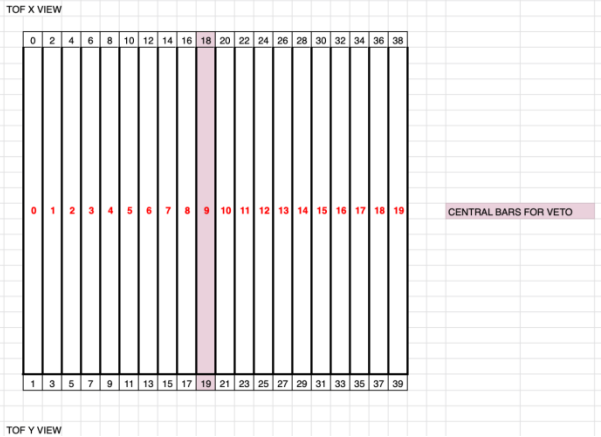
DEDX-TOF: connected to WDB in slot 5,6,7,8,9,q0 Xn are one view and Yn are the other

Margarita: connected to WDB in slot 4

Ch MARGARITA	Nome WD	Slot WD	Ch WD
0	wd027	4	0
1	wd027	4	1
2	wd027	4	2
3	wd027	4	3
4	wd027	4	4
5	wd027	4	5
6	wd027	4	6
7	wd027	4	7

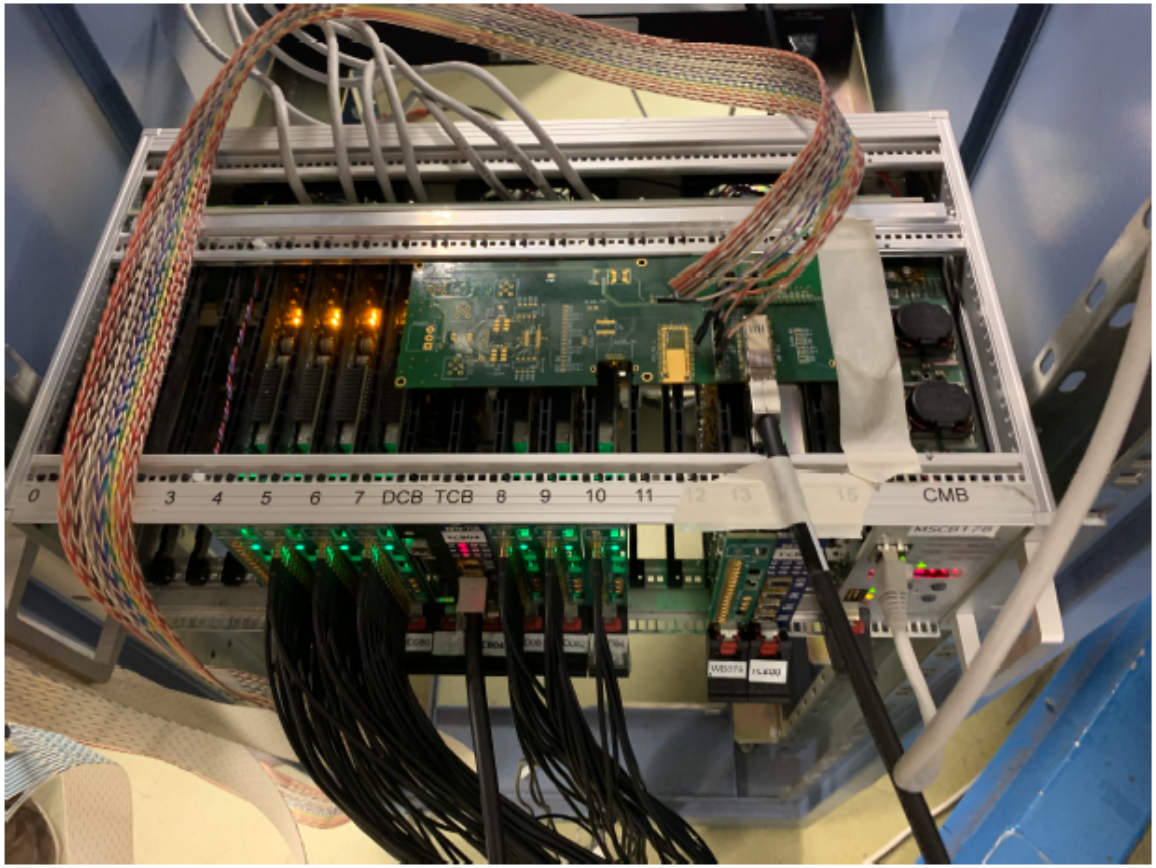


Ch TOF	Barra TOF	Nome WD	Slot WD	Ch WD
0	X 0	wd078	5	0
1	X 0	wd078	5	1
2	X 1	wd078	5	2
3	X 1	wd078	5	3
4	X 2	wd078	5	4
5	X 2	wd078	5	5
6	X 3	wd078	5	6
7	X 3	wd078	5	7
8	X 4	wd078	5	8
9	X 4	wd078	5	9
10	X 5	wd078	5	10
11	X 5	wd078	5	11
12	X 6	wd078	5	12
13	X 6	wd078	5	13
14	X 7	wd078	5	14
15	X 7	wd078	5	15
16	X 8	wd079	6	0
17	X 8	wd079	6	1
18	X 9	wd094	10	0
19	X 9	wd094	10	1
20	X 10	wd079	6	2
21	X 10	wd079	6	3
22	X 11	wd079	6	4
23	X 11	wd079	6	5



7 boards used to read Margarita and ΔE-TOF

WaveDAQ

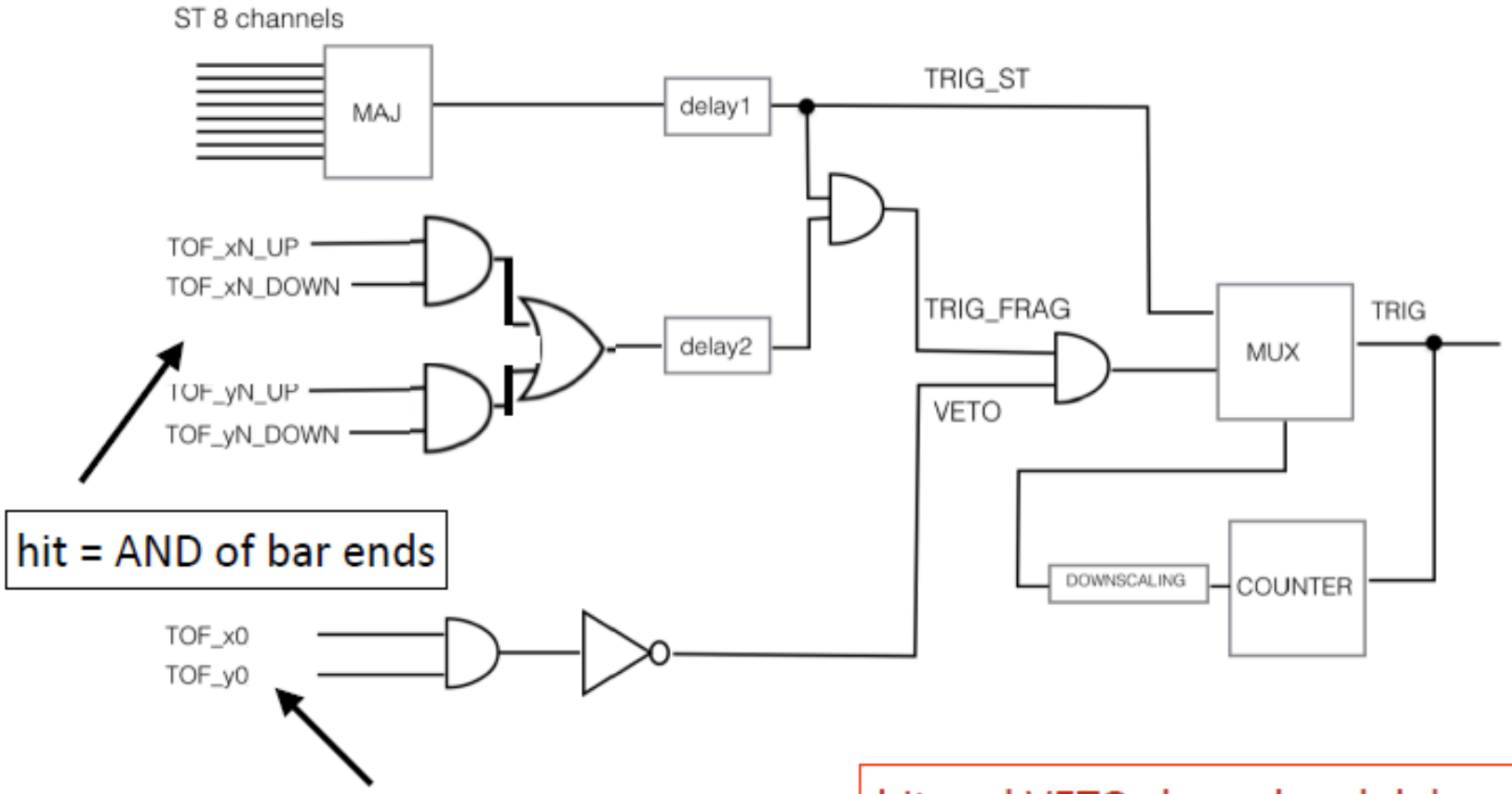


FOOT trigger @GSI

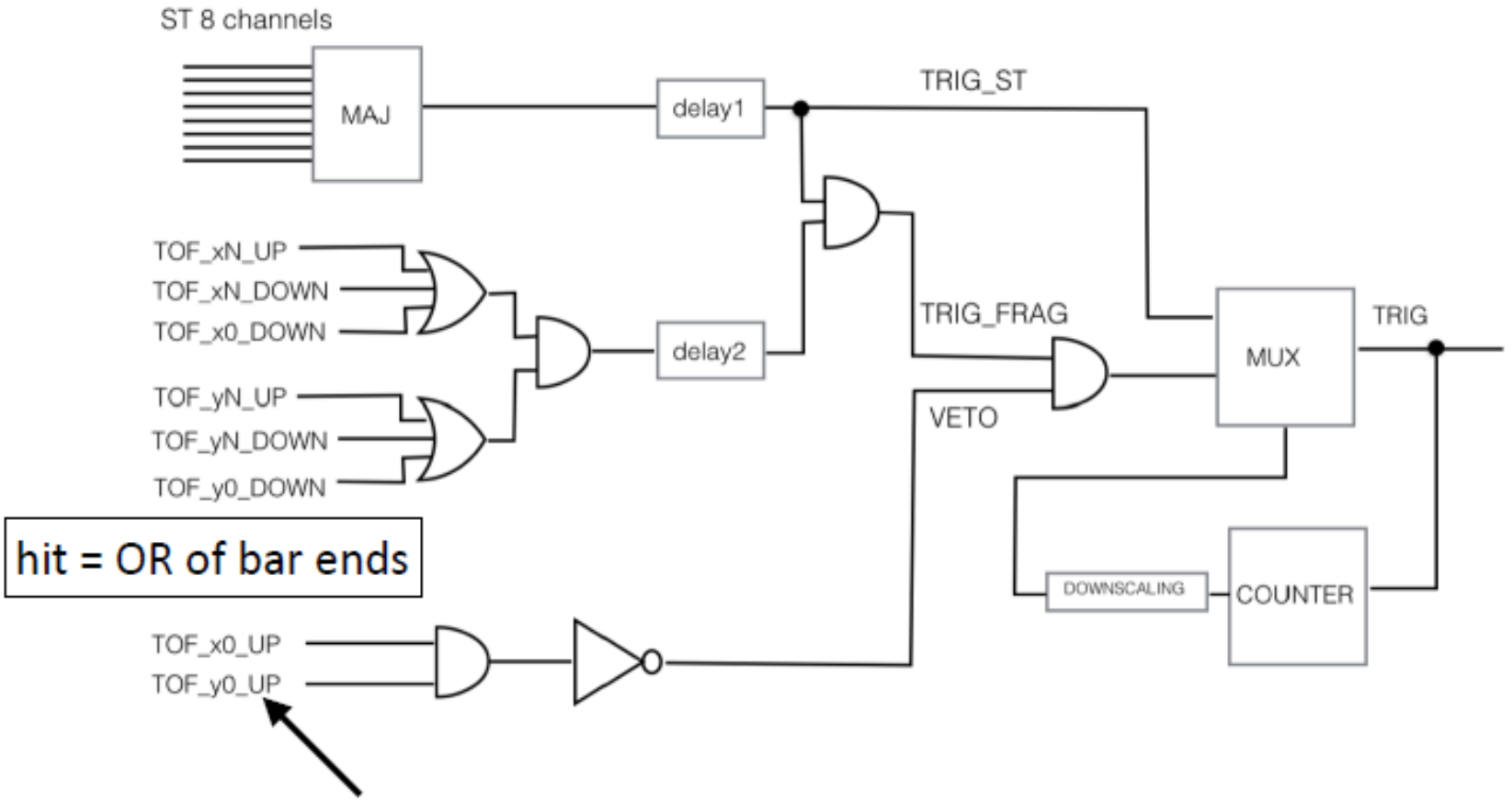
List of available online selection algorithms

- *FOOT - "Pisa version"*
- *FOOT - "Rome version"*
  - see next slides
- *Margarita majority*
  - SW programmable majority value
- *Margarita OR*
- *TOF in stand alone*
  - bar hit SW programmable as the AND or the OR of bar ends
  - TOF hit SW programmable as the AND or the OR of the X/Y views
- *pedestal*
  - 854Hz periodic trigger

FOOT trigger “Pisa”



FOOT trigger “Rome”



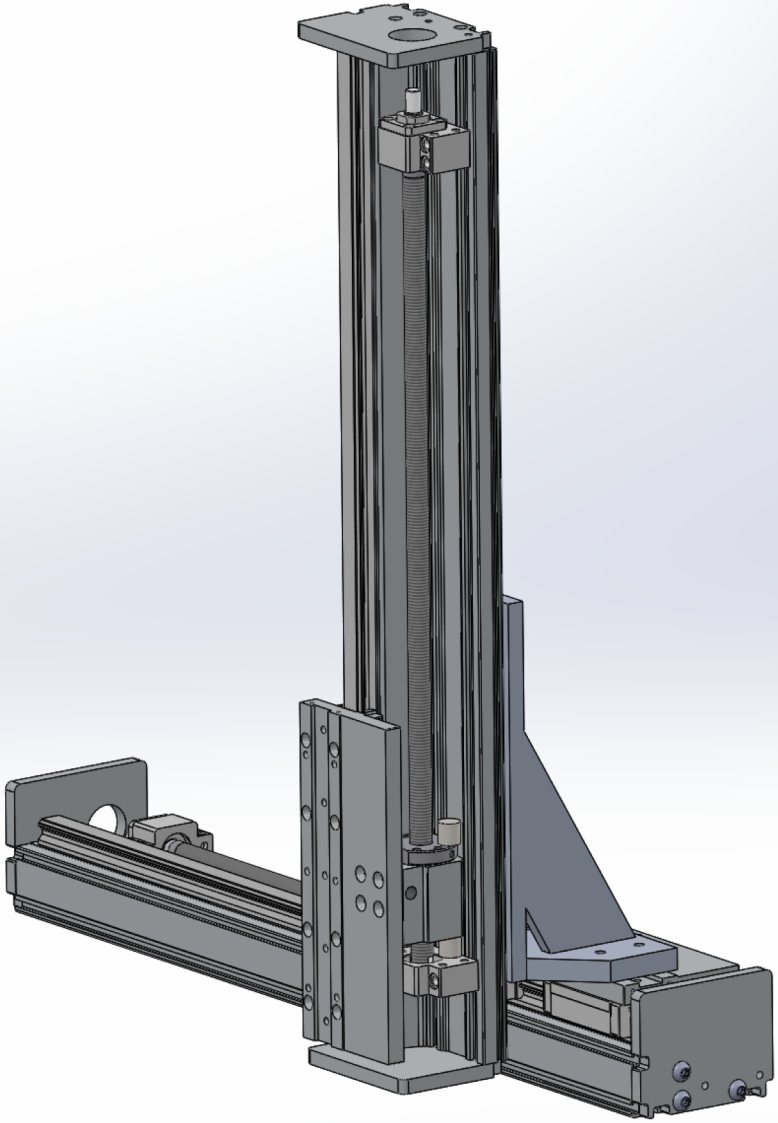
Comments on Trigger

- All trigger have been tested and released @GSI and in the test beam @CNAO
- Unfortunately we have no data with “properly configured” FOOT trigger
    - *at the first attempt I (Luca) misconfigured the .xml configuration file, the VETO shaper width was set to a wrong value*
        - as a result the VETO was not working at all
- The last day we fixed the configuration and measured the VETO trigger rate to be 10% of the Margarita Majority
    - *we checked both FOOT trigger versions*
        - we lost the beam when attempting the first good FOOT trigger data taking
- All the data were taken with Margarita Majority

Next steps:

- Efforts must be spent in the development of the software (SHOE) and analysis

- A new mechanics is going to be developed

- New calibration of the detector can be foreseen at the begin of the next year

-The work on the simulation of the detector is going on:
new master student in the team (Roberto Zarrella)