Data takings overview

Matteo Morrocchi

XVII FOOT Collaboration Meeting

16-18 / 12/2024 Monastero di Cherasco – Cherasco (CN)

Summary of CNAO 2024 data taking: Main goals

- Vertex studies, both for optimization and for the analysis of CNAO2023 data
  - Efficiency study → Investigate efficiency with protons using the 2023 thresholds and 230 MeV protons
  - Threshold scan to optimize the efficiency for protons using C → C @ 200 MeV/u

- Calorimeter calibration
  - Using protons and carbon ions, each with at least three energies

- Increase the statistics of CNAO 2023 data, only with carbon target (no C_2H_4 was foreseen)

- NIT irradiation with carbon and protons, also using very low energies

Summary of CNAO 2024 data taking: What's new?

- For the first time we had the full calorimeter!
  → 320 crystals

- Work done on the vertex to repair a malfunctioning layer and to increase the width of the entrance window to avoid interactions between the beam and the frame

- New mechanics of the MSD (also new mapping in SHOE, already implemented)

- Beam was more centered in the VTX sensitive area

Summary of CNAO 2024: activities

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
28 Oct.	29 Oct.	30 Oct.	31 Oct.	1 Nov.	2 Nov. *06:00 - 14:00* Beam Tuning TOFpRad	3 Nov. *06:00 - 14:00* Beam Tuning TOFpRad
4 Nov.	5 Nov. Start of the installation	6 Nov. Installation Arrival DAQ	7 Nov. Installation (Cabling)	8 Nov. Installation & Power-On	9 Nov. *14:00 - 22:00* Beam Time	10 Nov. *14:00 - 22:00* Beam Time
11 Nov.	12 Nov.	13 Nov.	14 Nov.	15 Nov.	16 Nov. *06:00 - 14:00* Beam Time	17 Nov. *06:00 - 14:00* Beam Time
18 Nov. *22:00 - 04:00* Beamtime	19 Nov. *22:00 - 04:00* Beam Time	20 Nov. Dismount	21 Nov. Dismount	...	...	? Collection of irradiated materials

44 total hours of beamtime
(+ nights for beam preparation)

Keep in mind that TW and Calorimeter were moved in two of these runs (check elog for details: run 6957 & before 6962)

9 Nov	10 Nov	16 Nov	17 Nov	18 Nov	19 Nov
VTX study	Calo Calib.	Calo Calib.	Alignm.	----	NIT
VTX study	Calo Calib.	Calo Calib.	VTX study	VTX study	NIT
VTX study	Calo Calib.	Calo Calib.	VTX study	VTX study	NIT/ Target
VTX study	Calo Calib.	Calo Calib.	VTX study	VTX study	Target
VTX study	Calo Calib.	Calo Calib.	VTX study	Target	Target/ ---
VTX study	Calo Calib.	Calo Calib.	Target	Target/---	---
VTX study	Calo Calib.	Calo Calib.	Target	/	/
VTX study	Calo Calib.	Calo Calib.	Target/ VTX stuty	/	/

Some useful links…

Beam Configurations:

https://docs.google.com/spreadsheets/d/1dnkSTtFbxJcIgRlMSZLkkN6oKk2PBF6rYjleaOfnRWU/edit?gid=0#gid=0

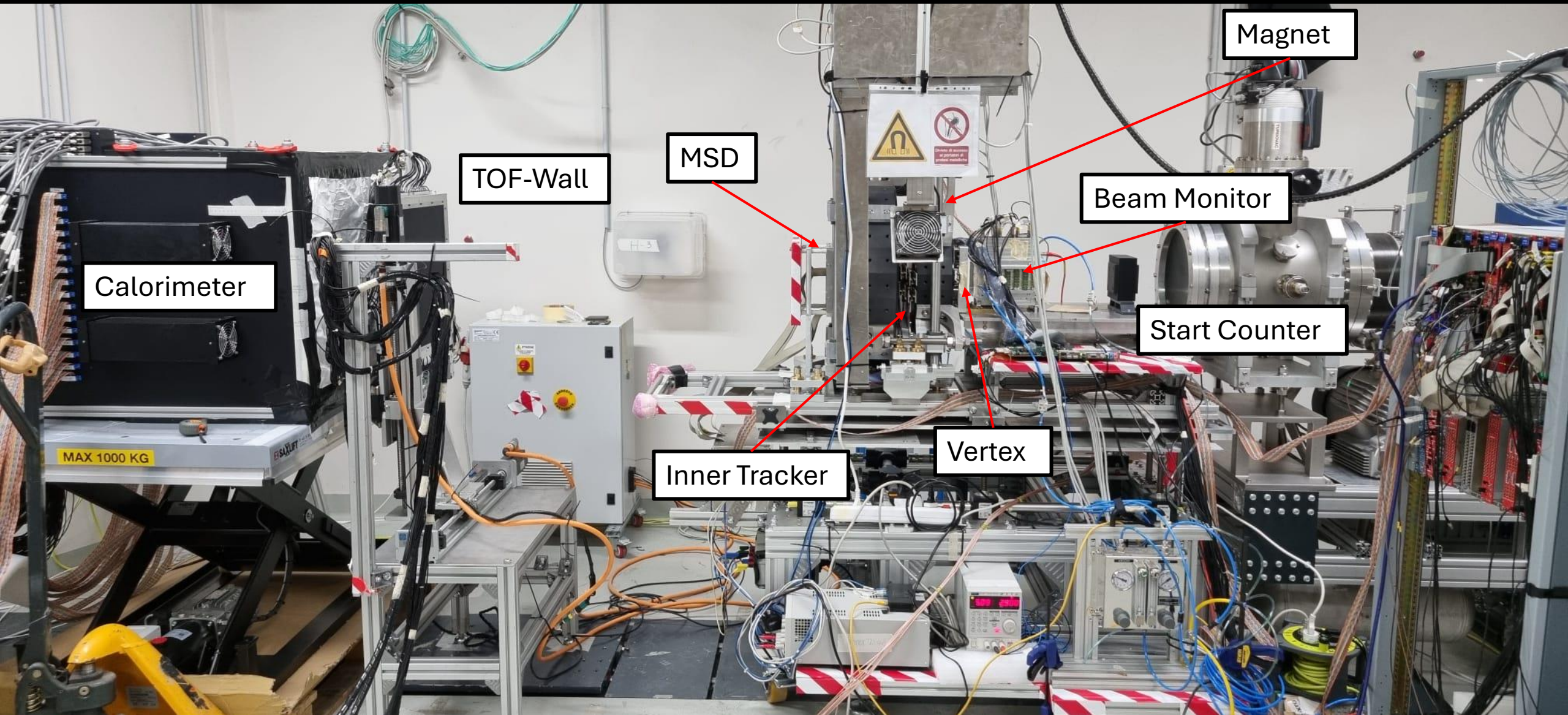
WaveDAQ connection:

https://docs.google.com/spreadsheets/d/1hk4TdgfkvoYjdsjldSWQQZtwZSucif55sulnaugNLGw/edit?gid=630435580#gid=630435580

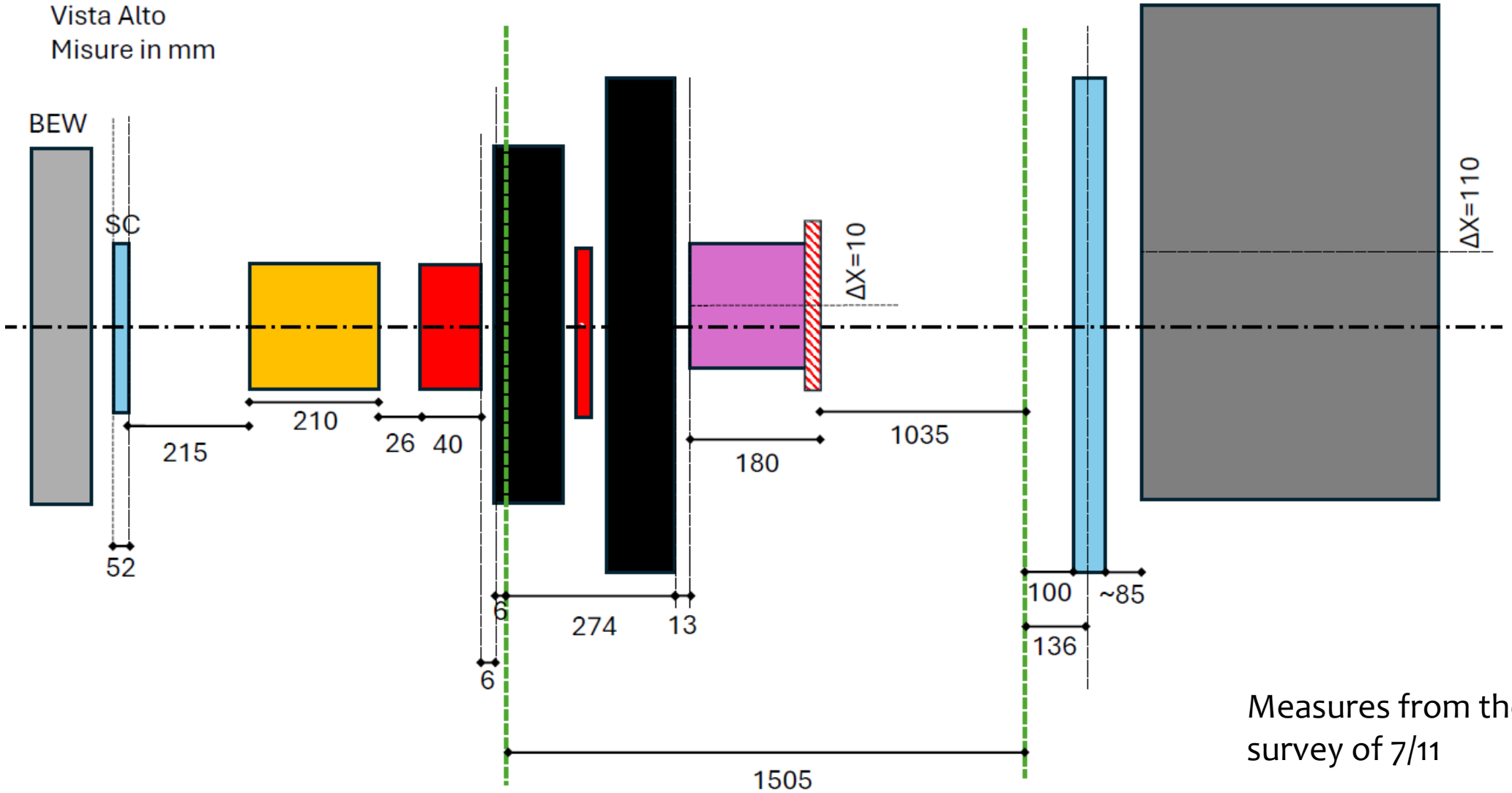
Elog:

https://arpg.sbai.uniroma1.it:8282/FOOTCNAO2024

Electronic setup



Electronic setup

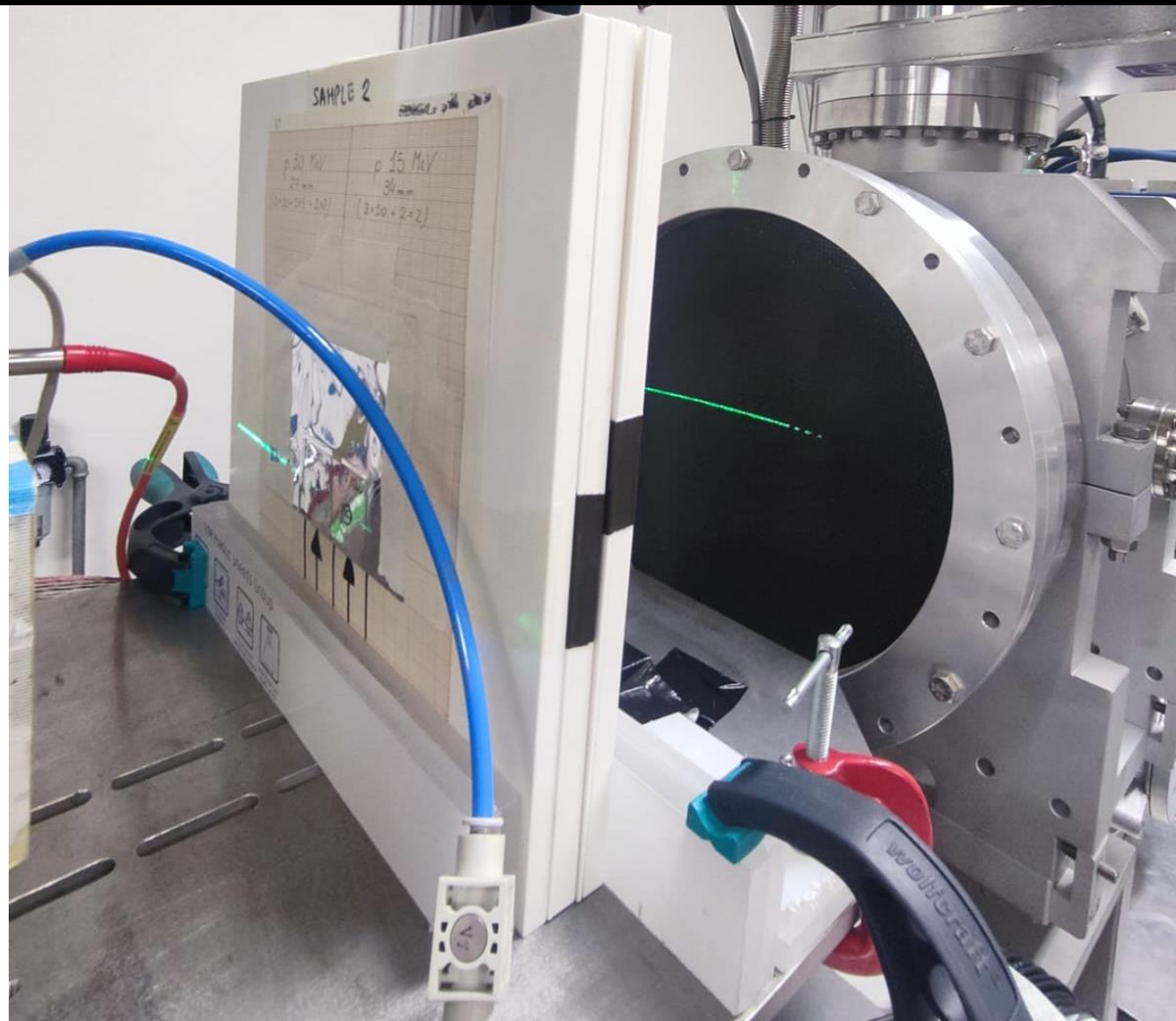


Measures from the survey of 7/11

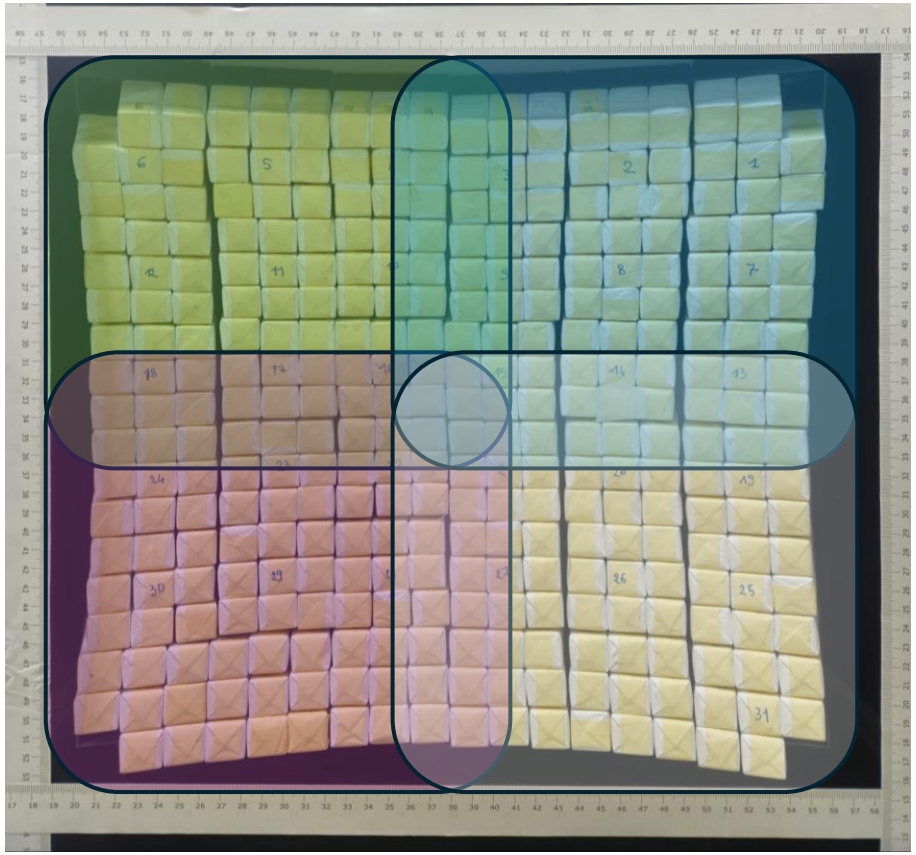
Emulsion setup

Sample 2	p	30 (degrader)	50 kHz	10^6	1min	27 mm solid water
	p	15 (degrader)	50 kHz	5*10^6	1min	34 mm solid water
Sample 3	p	30 (degrader)	50 kHz	10^6	1min	27 mm solid water
	p	15 (degrader)	50 kHz	2.5*10^6	1min	34 mm solid water
Sample 4	p	30 (degrader)	50 kHz	10^6	1min	27 mm solid water
	p	15 (degrader)	50 kHz	2.5*10^6	1min	34 mm solid water
Sample 5	p	45 (degrader)	50 kHz	10^6	1min	18 mm solid water
	p	55 (degrader)	50 kHz	10^6	1min	10 mm solid water
Sample 1	p	70	50 kHz	10^6	1min	
Sample 1	p	200	60 kHz	10^6	1min	
Sample 6	C	400	3 kHz	2 * 10^5	2 min	
Sample 6	C	200	3 kHz	2 * 10^5	2 min	

Still radioprotection issues for emulsion release…



Summary of CNAO 2024 data taking: Calorimeter Calibration



Calibration performed separately in four quadrants, about 4 hours per quadrant, at least 3 carbon energies and few proton energies.

- Only few channels had problems, sometimes related to the cable connectors that are particularly fragile
- We managed to perform the “screen-saver” scan on the required area with all the energies
- The calorimeter needs to be moved in the two directions after the end of the scan of each quadrant
  - The orientation of the crystals was not orthogonal to the beam
  - Sometimes (and only for some energies) the peaks were not clearly visible in all the crystals.
- Some crystals were irradiated on both days → repeatability study
- As always, we were limited by the absence of intermediate Z between proton and carbon.

Summary of CNAO 2024 data taking: Acquired data

VTX studies

Performed the study on the VTX about efficiency and threshold optimization

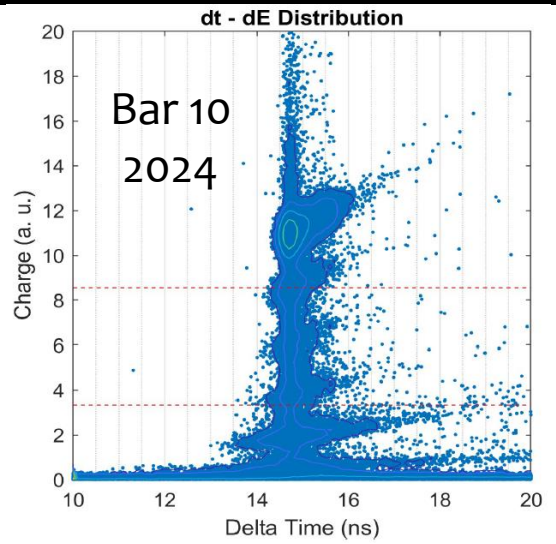
→ It took more time than expected, but it had high-priority in this data taking
Performed more than one time to fix issues with parameters configuration

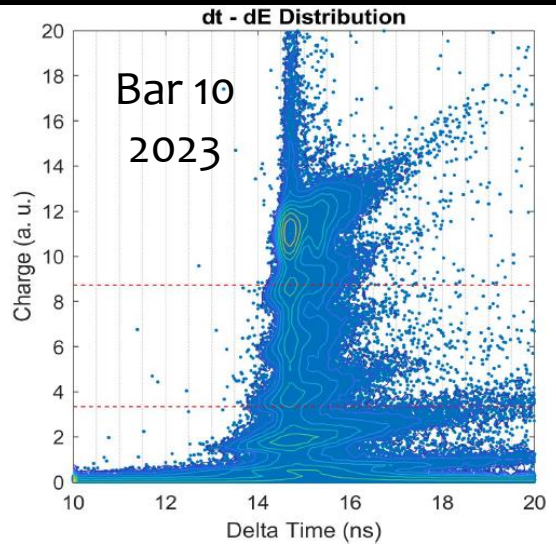
Physics data

Data with 5 mm Carbon target were acquired in part of the last two days:

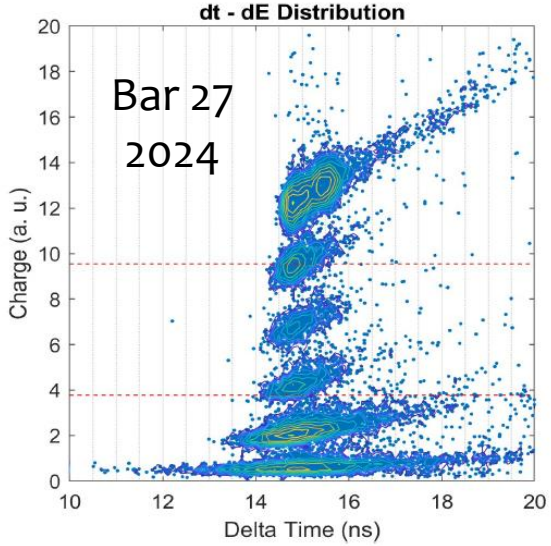
- About 2M events were collected (not much, but enough for some studies)
- Only minimum bias trigger (trigger on the SC) was used

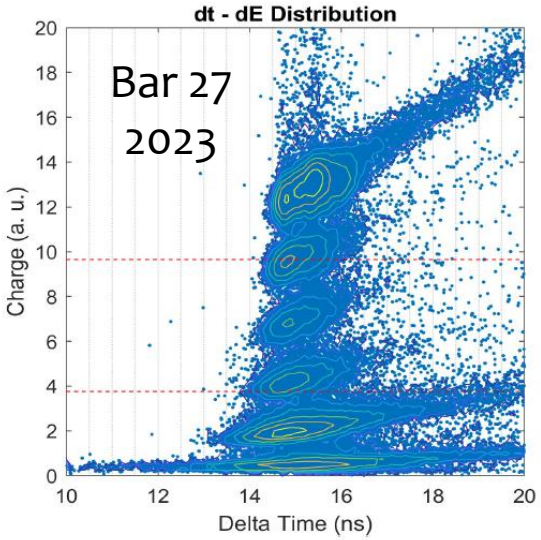
Summary of CNAO 2024 data taking: Physics data





Very similar distributions at the TW, of course we have less statistics this year





Some primaries hit passive materials also in CNAO 2024.
However, these events may be discarded during the processing

Summary of CNAO 2024: WaveDAQ

As for the WaveDAQ:

- The initial problem related to the trigger was due to the bad connection of a cable

- New issues with the firewall were solved, however these problems may rise again in future and (up to now) the same procedure must be repeated after every power cycle

- The last night, a problem (likely with the switch) occurred about an hour before the end of the data taking. The next morning, after a complete power cycle, we found the way to make the system work again. However, at the beginning of 2025, a backup switch will be procured

Possible improvements in future data takings?

Some possible improvements: elog

Elog entries may need to be codified in a more standard way:

- every shift one/two people were in charge to update the elog, in general most of the information is reported but the method used is error-prone and can be improved

→ The purpose is to use a standard form to be filled for each run, so to be sure not to forget information that may be important during the analysis

Some possible improvements: geometry

The geometrical survey is still a crucial point that needs to be improved.

The FOOT apparatus is composed of several detectors that have to be installed with several (too many) free parameters. Possible solutions for a smoother (and more controllable) installation have been discussed and should be considered

A rule of thumb: the effort increases exponentially with the precision that needs to be achieved. For further improvements we need also to quantify the needed resolutions on the detector positions.

Some possible improvements: geometry

- → The CNAO laser tracker (LT) can be used to align the table with the beam
  - → Meeting with Alessio at the end of the data taking.
  - → This will require maybe to move up the installation by some days, maybe one week.
  - → Each object that needs to be aligned with the LT needs to have markers in a set of calibrated positions compliant with the CNAO alignment system

- → A possible solution to ease the task:
  From now on, all the detectors that have to be installed on the table need to be positioned using reference pins or other references. This will ensure the reproducibility of the installation, and the measurement of the detector positions in a controlled environment.
  → This approach will reduce the difficulties also for data takings in other sites

  For the future, we should consider to avoid moving the system (especially the table) in an uncontrolled way after the initial installation… This time it was necessary for various reasons, but it is not the best

More in general

FOOT is a movable experiment; this has pros and cons:

- Detectors usually get together once a year in a non-relaxed situation ☺ and this is sub-optimal, each component (or at least the communication part) needs to be available, at the DAQ group request, for dedicated tests.

- Some detectors still need to be tuned/calibrated/optimized: dedicated data takings are foreseen for this purpose in the future. In general, the time dedicated to detector tests/calibration in the next data takings will be decreasing and we must be prepared.

  → 10M events for each energy, for each target → roughly 14 hr with an average of 200 evt/sec.

  With two targets, alignment, basic checks and emulsions, basically, we would have covered all the 2024 beamtime.

That’s all for now…