Dose Profiler status

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Outline

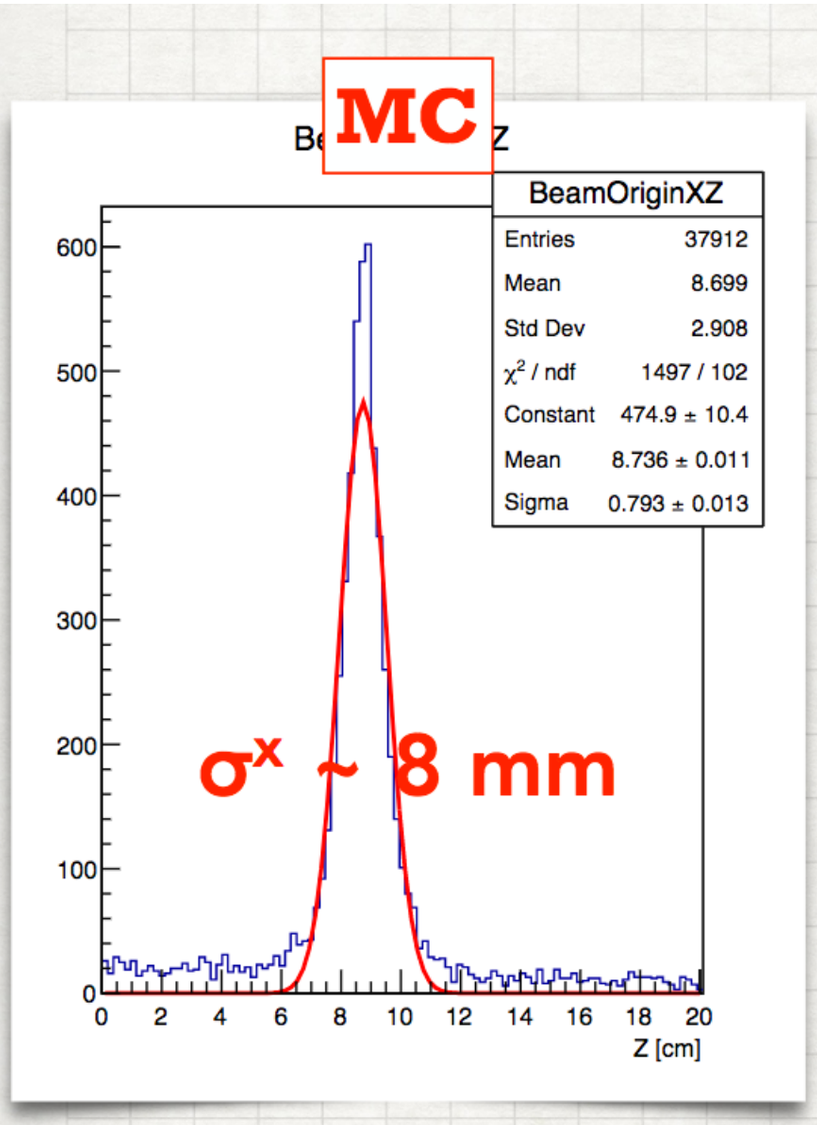
- **Back-tracing resolution** studies are still ongoing: new test-beam @CNAO with point-like targets.

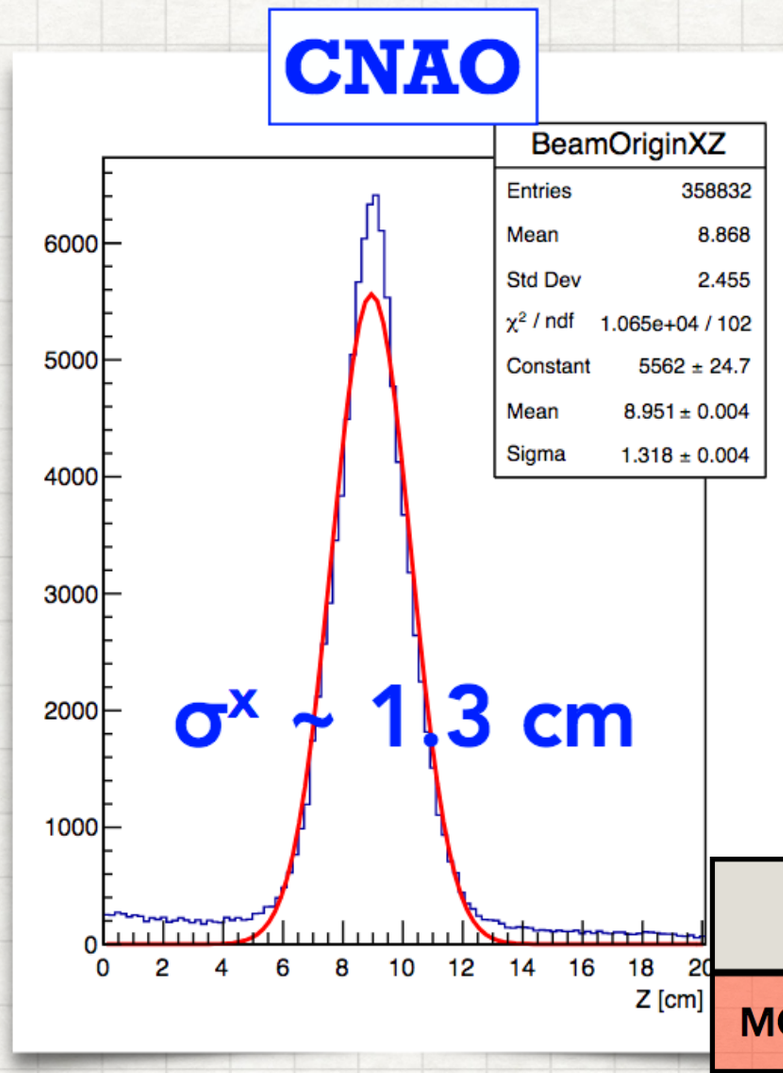
- **Hardware issues**: since the dead time optimisation has become crucial, we investigates on the dead time sources, looking for the possible bottle-neck. Moreover we discovered that BASIC instabilities, that lead to local inefficiencies.

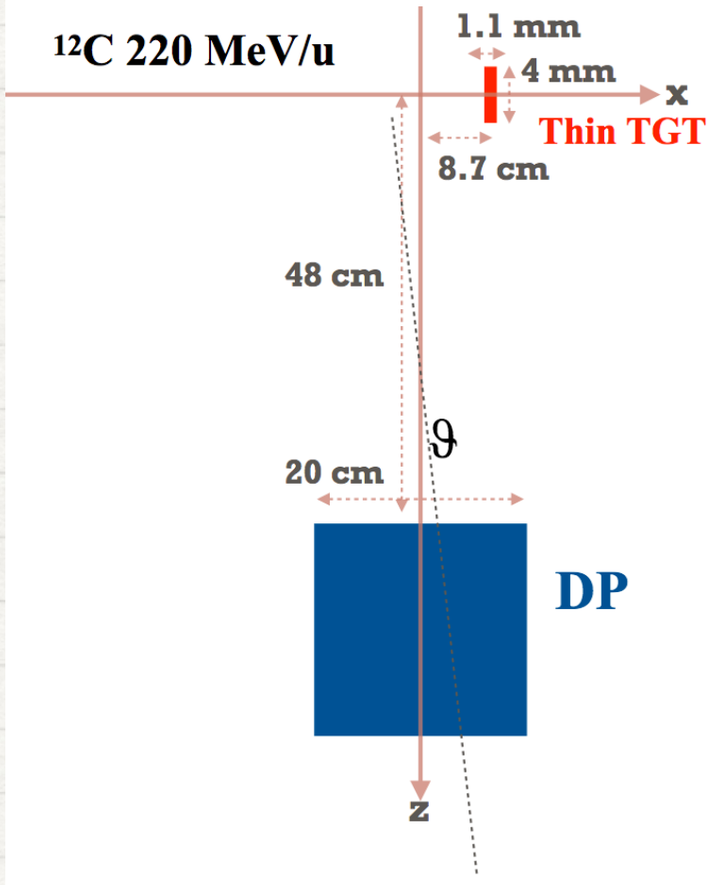
- **Dose delivery info integration**: @CNAO we had the opportunity to see and acquire the dose delivery signals that encode the voexel/ slice infos.

A quick recap…

- Panduit @50 cm, 90°: disagreement between data and MC not understood





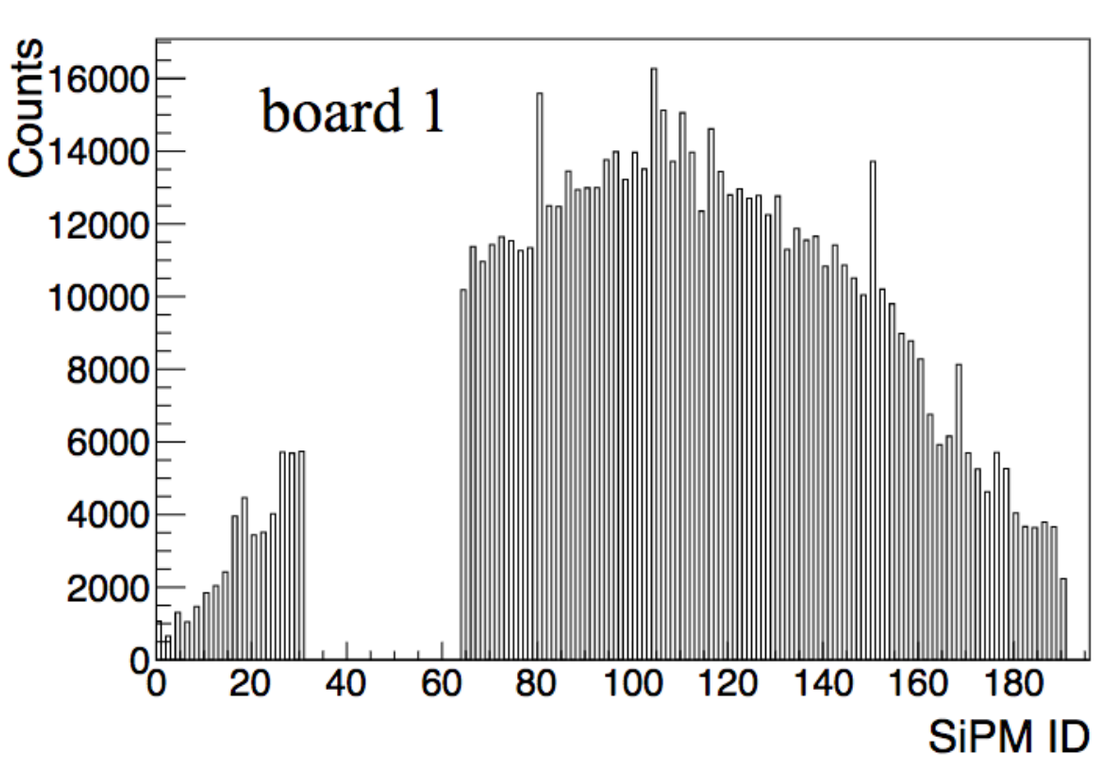


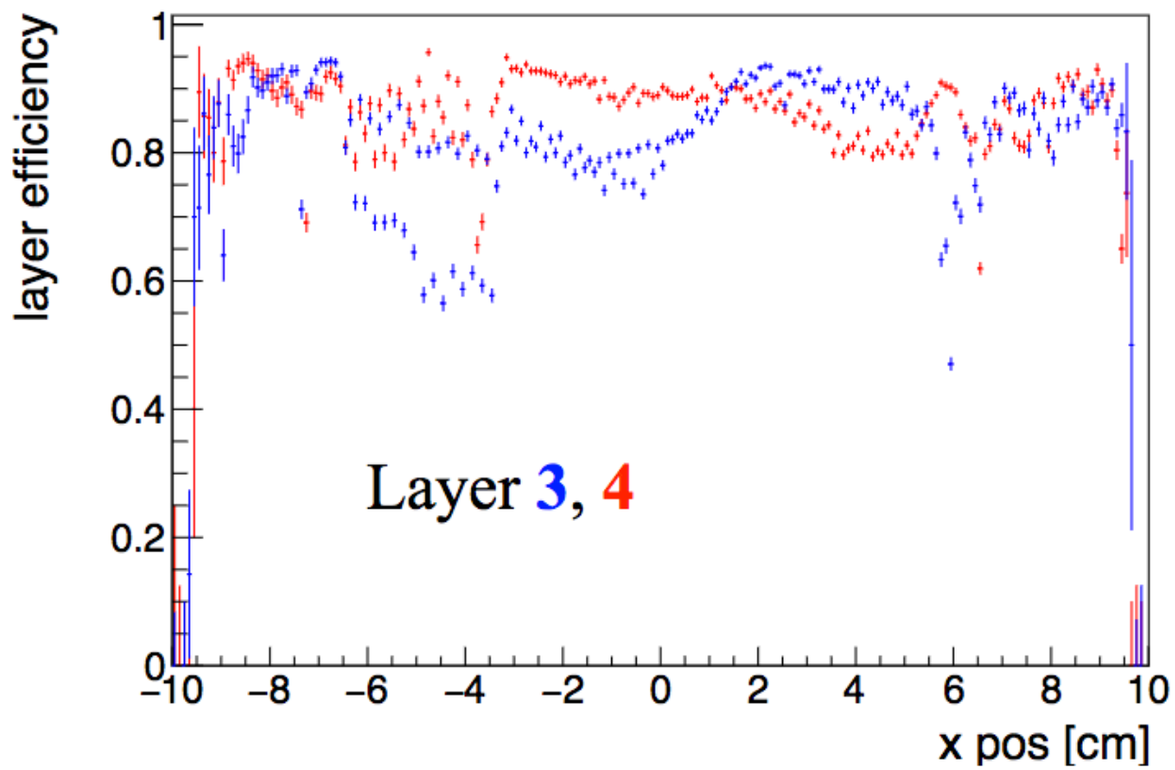
	σ^X	σ^X_{HE}
MC	8mm	4.5mm
CNAO	1.3cm	1.1cm

Experimental cluster size reproduced in MC

A new interesting discovery

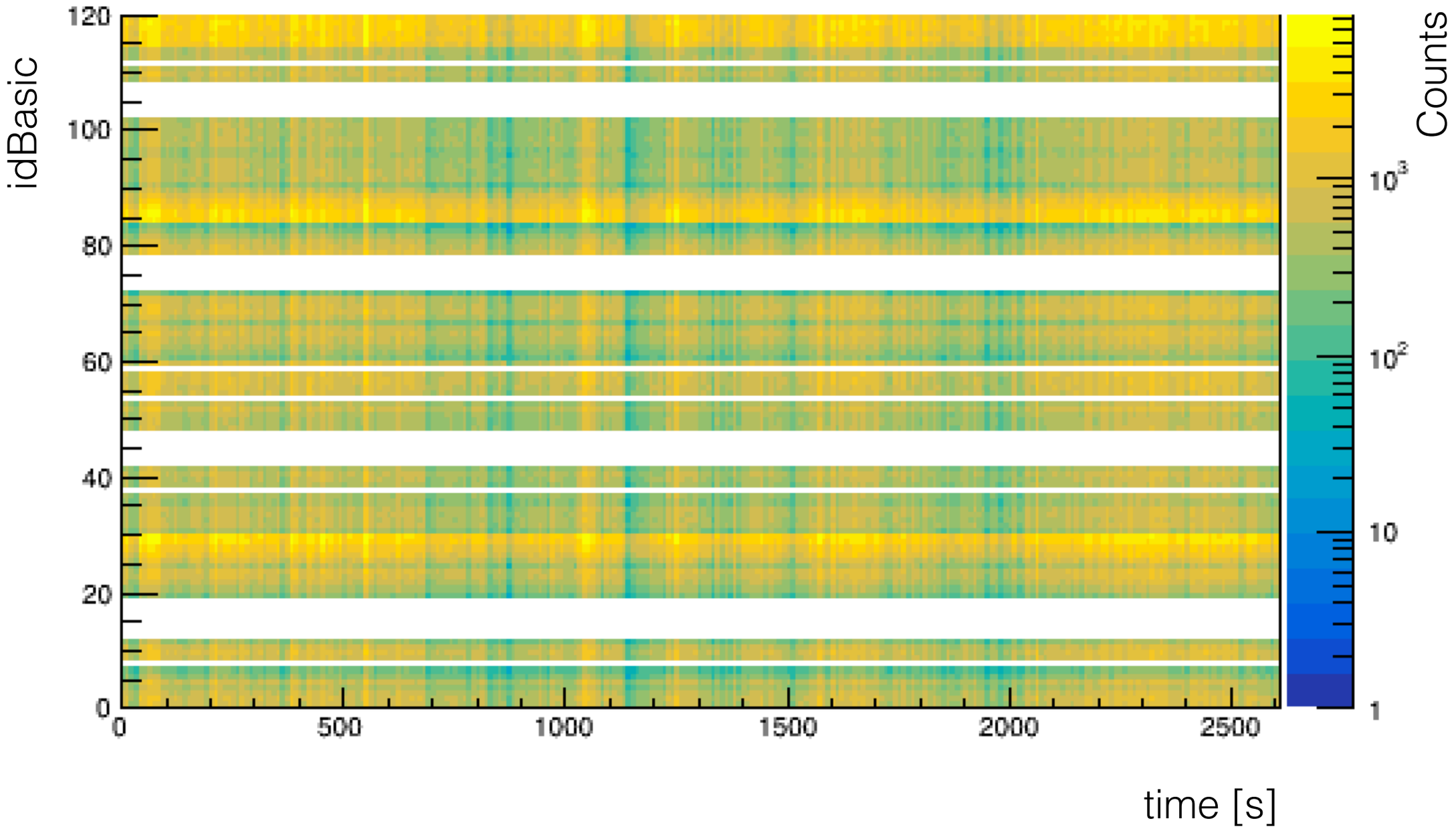
- From time to time, at the beginning of the DAQ, some BASIC stops working, not producing any response.
- Given the light cross-talk among the fibres, resulting in a mean cluster size of ~2, this effect is not easily spotted by eye as the tracking efficiency remain high





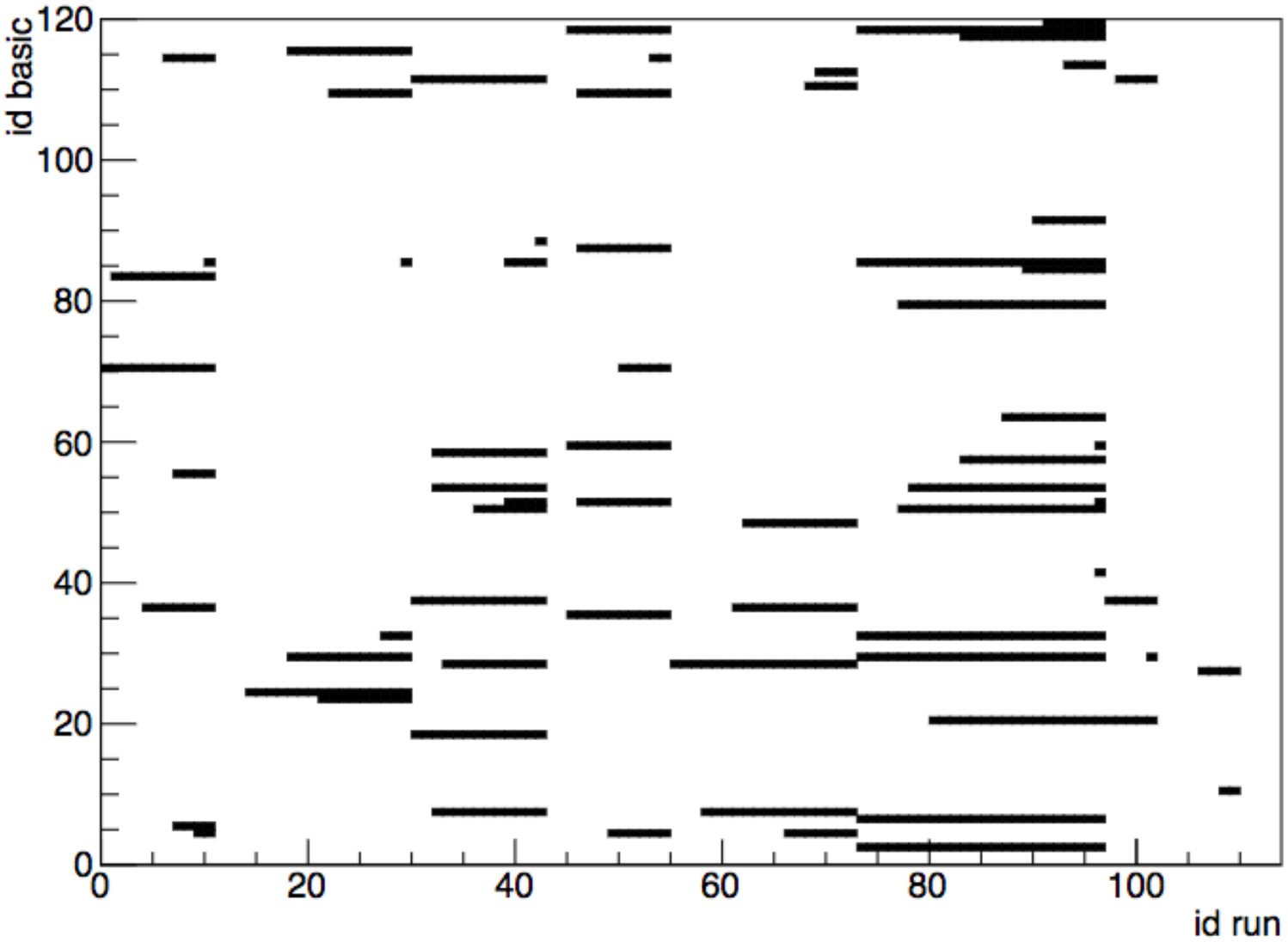
Possible diagnosis

- Looking at the basic occupancy as a function of the time, it seems that this issue is related to the basic configuration. However, a more detailed study has to be carried out.



Possible diagnosis

- We also studied the dead basics as a function of the run, in chronological order. It seems that a BASIC remains turned off until “something” happens (reconfiguration)?

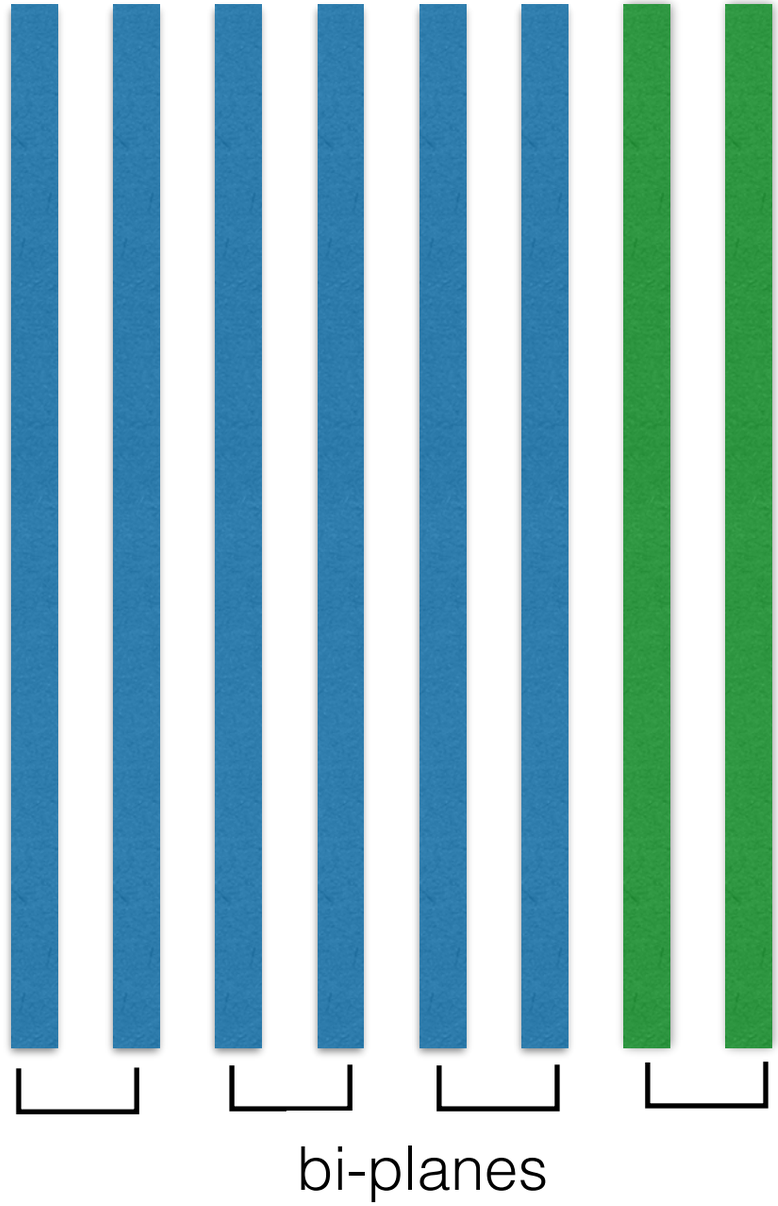


- The source of the problem is still unknown. Two main hypothesis: a) Basic automatic reset fail, b) error in the configuration application.

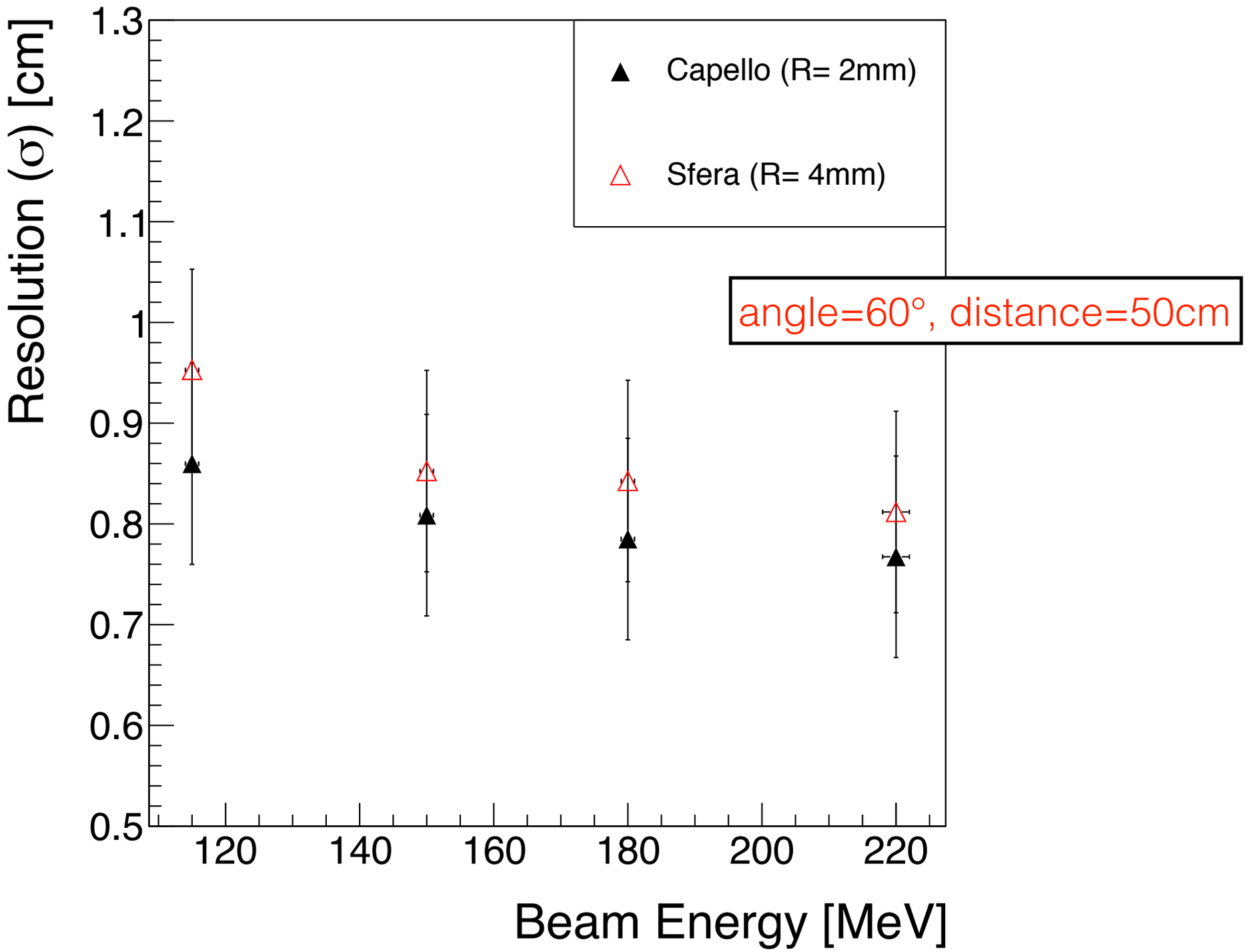
- Does this effect have an impact on the resolution? The answer is NO, since the efficiency remain high.

New test-beam(s) @CNAO

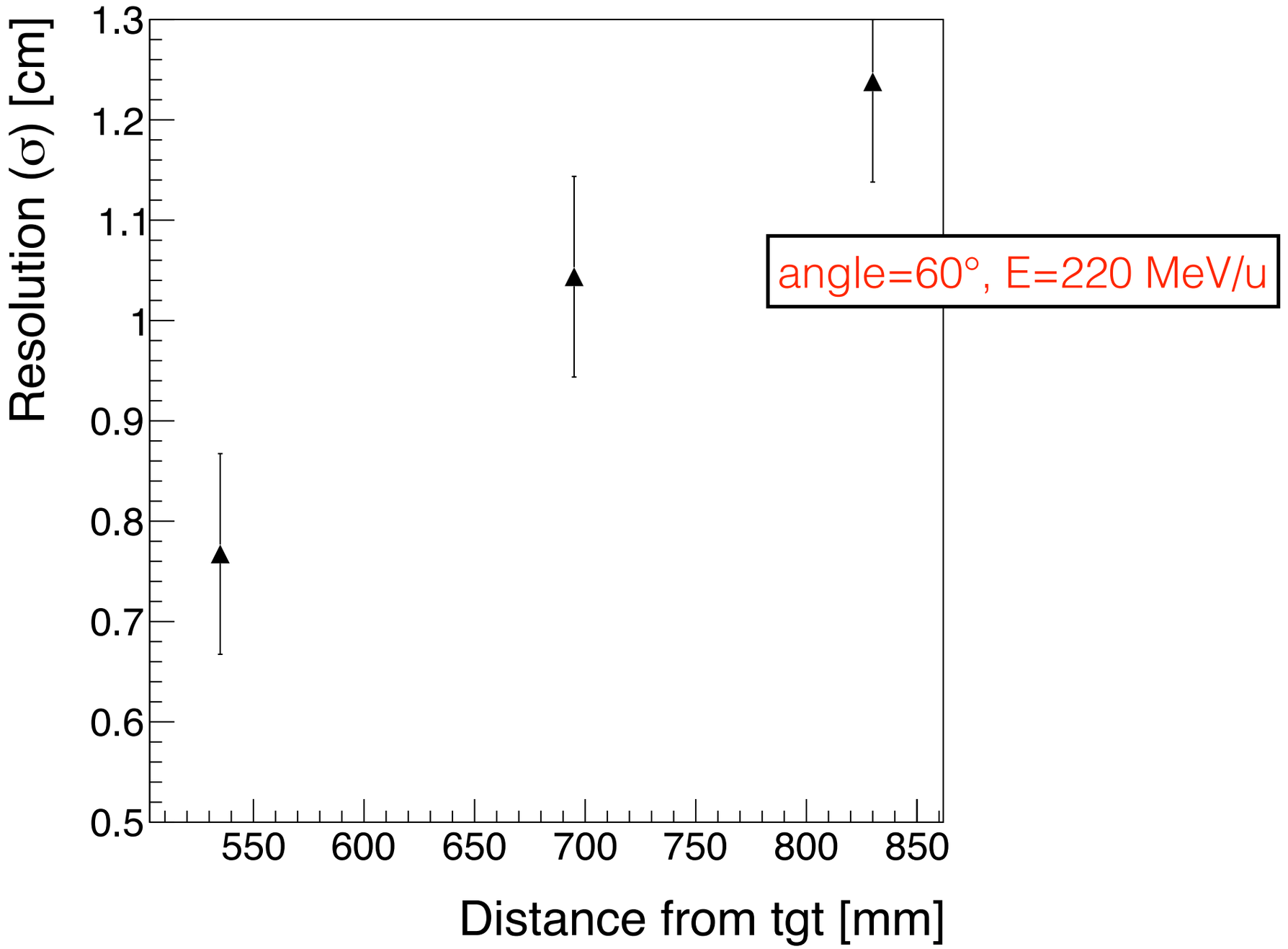
- We used thin target: 1.1 mm plastic wire, 2 mm aluminium wire, 4 mm diameter plastic sphere
- DP @ 90° and 60°
- TGT distances: 50cm, 70cm, 85cm
- Beam energies: 220MeV/u, 180MeV/u, 150MeV/u, 110 MeV/u
- Trigger: in july we used the coincidence between the 3 fibres bi-planes. Each bi-plane is active if a SiPM in both the x-y views goes over threshold.
- Since the dead time significantly limits the DAQ rate, we decided to include the scintillator bi-planes in the trigger logic, selecting fragments with higher energies (70 MeV threshold)



Measured resolution @ 50 cm

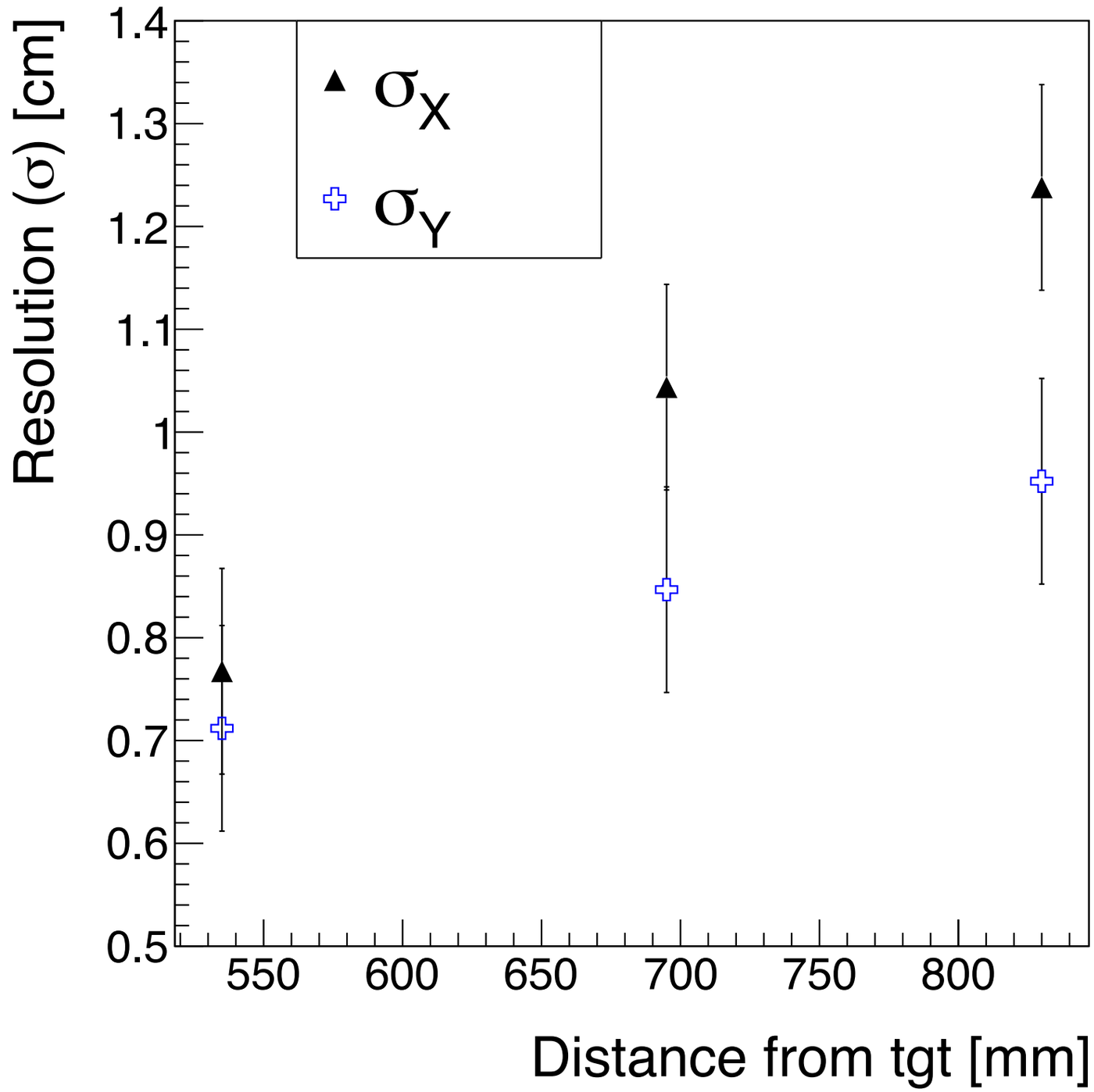


Resolution vs distance



- Distance becomes a crucial parameter to be optimised in the future

Resolution in X-Y views



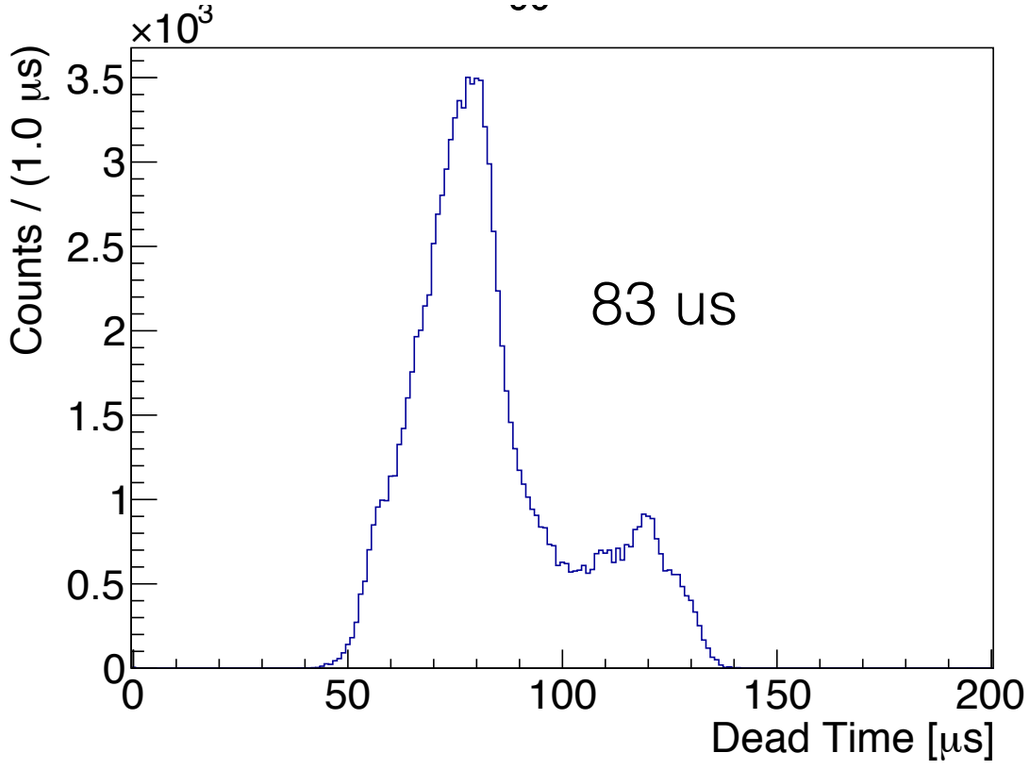
Summary

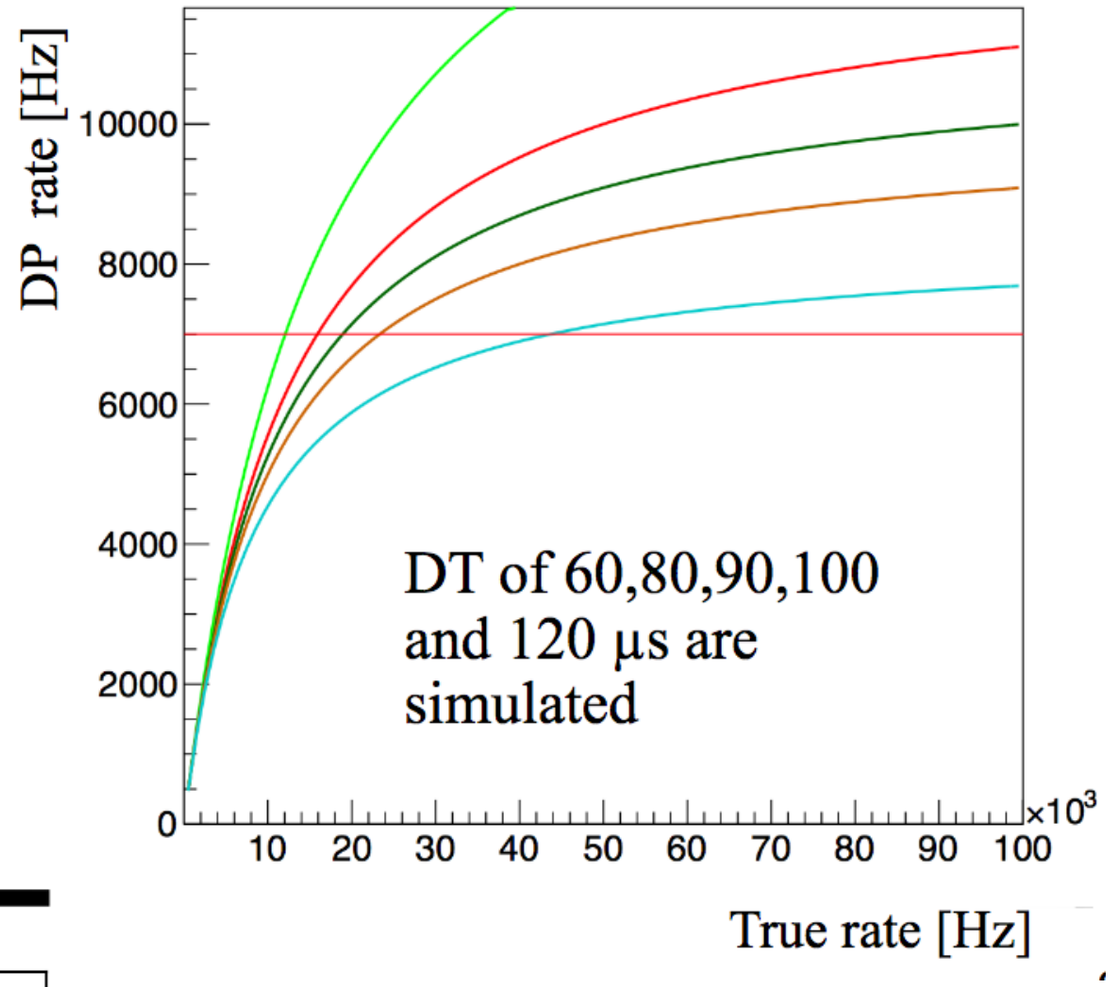
- MC + Al wire + plastic sphere are ~ in agreement. Resolution between 7mm and 9 mm are observed.
- Not understood discrepancy between X and Y view.
- The resolutions for data taken with the quadruple coincidence trigger are systematically better, as expected.
- The pl wire (panduit) remain anomalous, we still don't know the reasons.
- Given these numbers, 8 mm seems to be our actual limit. If we want to improve, we have to get closer…

	220 MeV/u	σ^X	σ^Y
90°	MC Pl wire	8.3mm	7.9mm
90°	Pl wire	1.4cm	8.4mm
60°	Sphere	8.8mm	6.5mm
60°	Al wire	8.6mm	7.4mm

Dead time: another recap

- The statistics that can be collected and used to monitor the BP is heavily affected, in clinical conditions with very high intensities, by the detector dead time



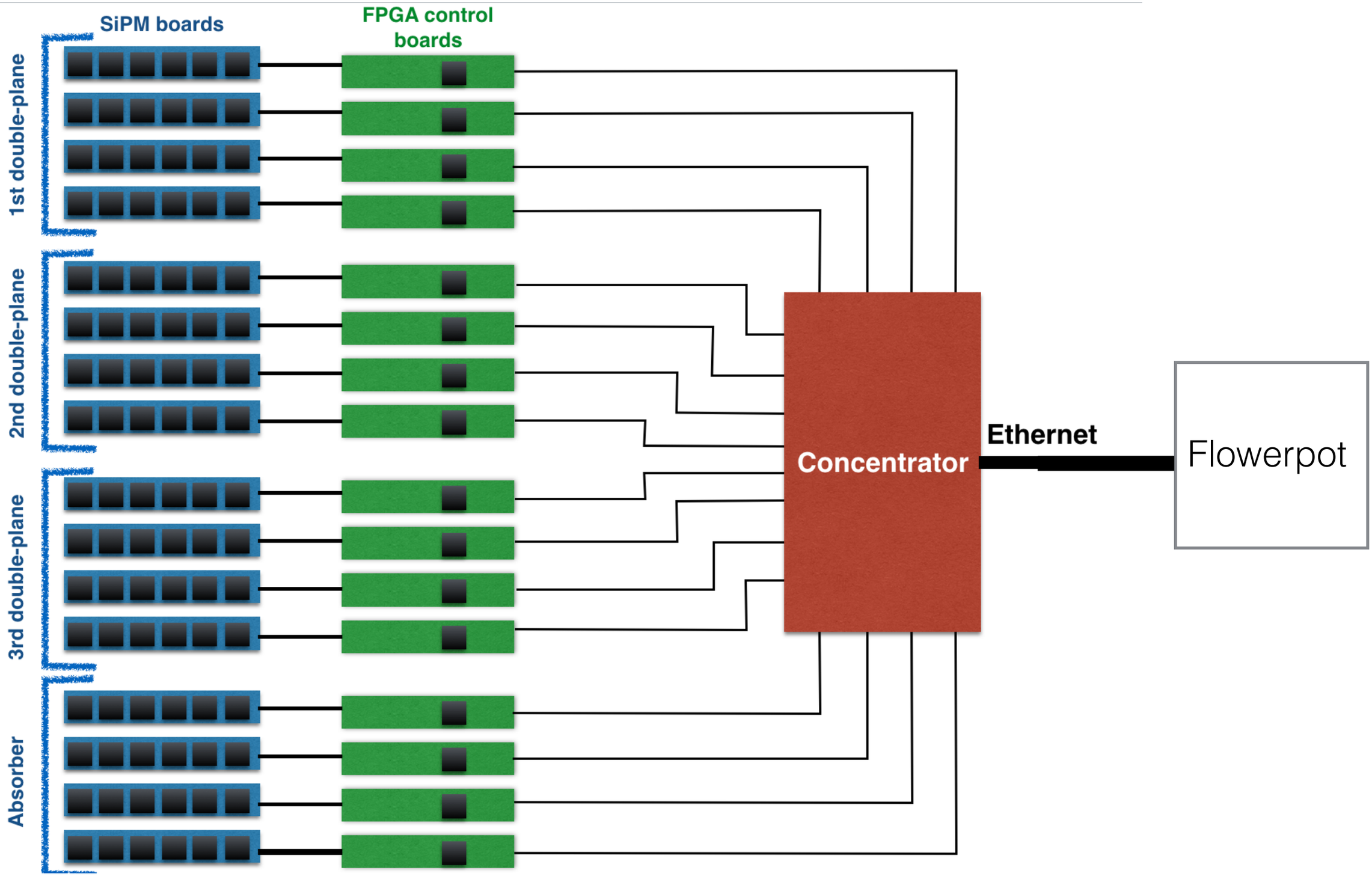


- number of reconstructed tracks

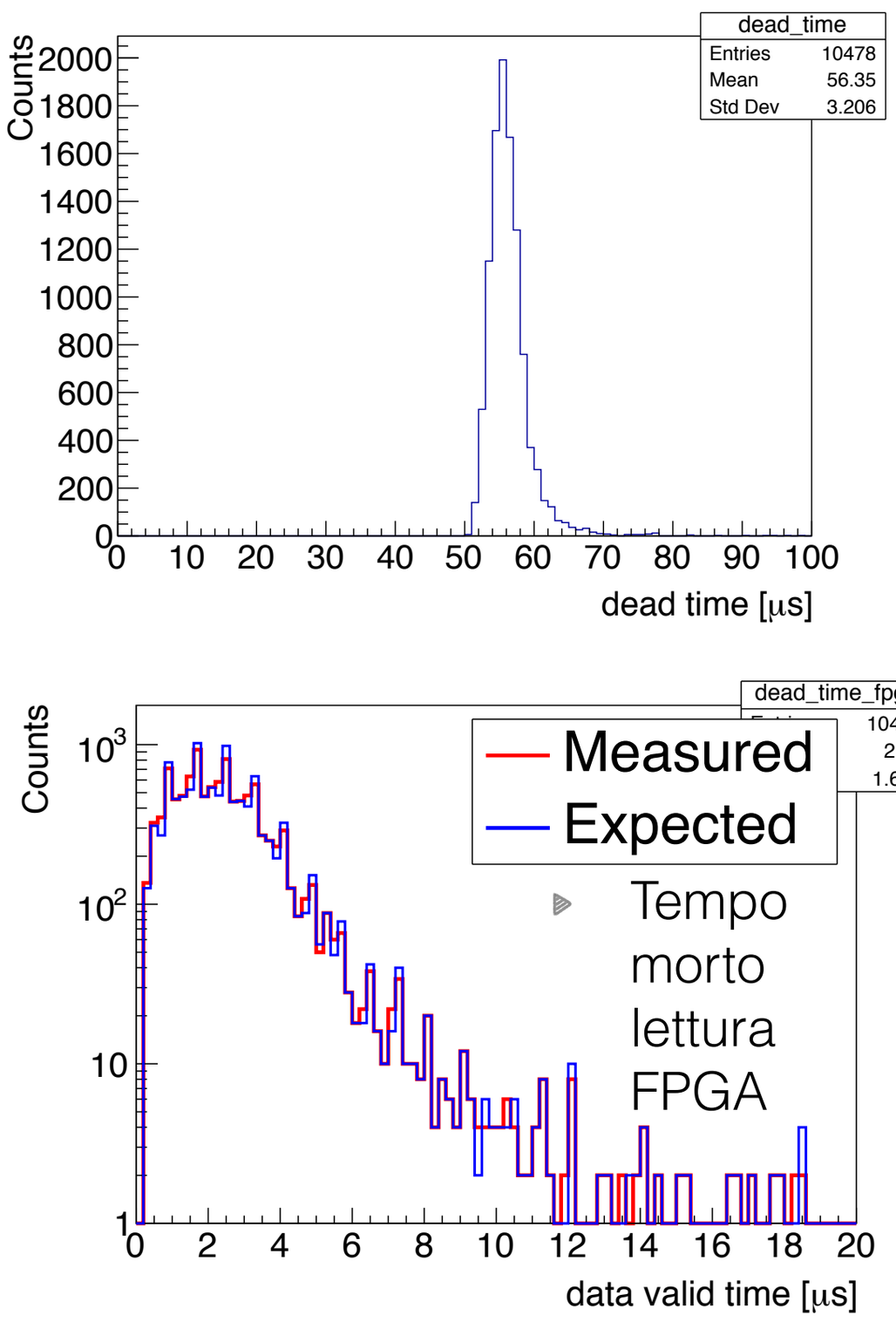
	real TP, PB	real TP, 9PB	real TP, slice
20μs DT, 60°	~40	~350	~5k

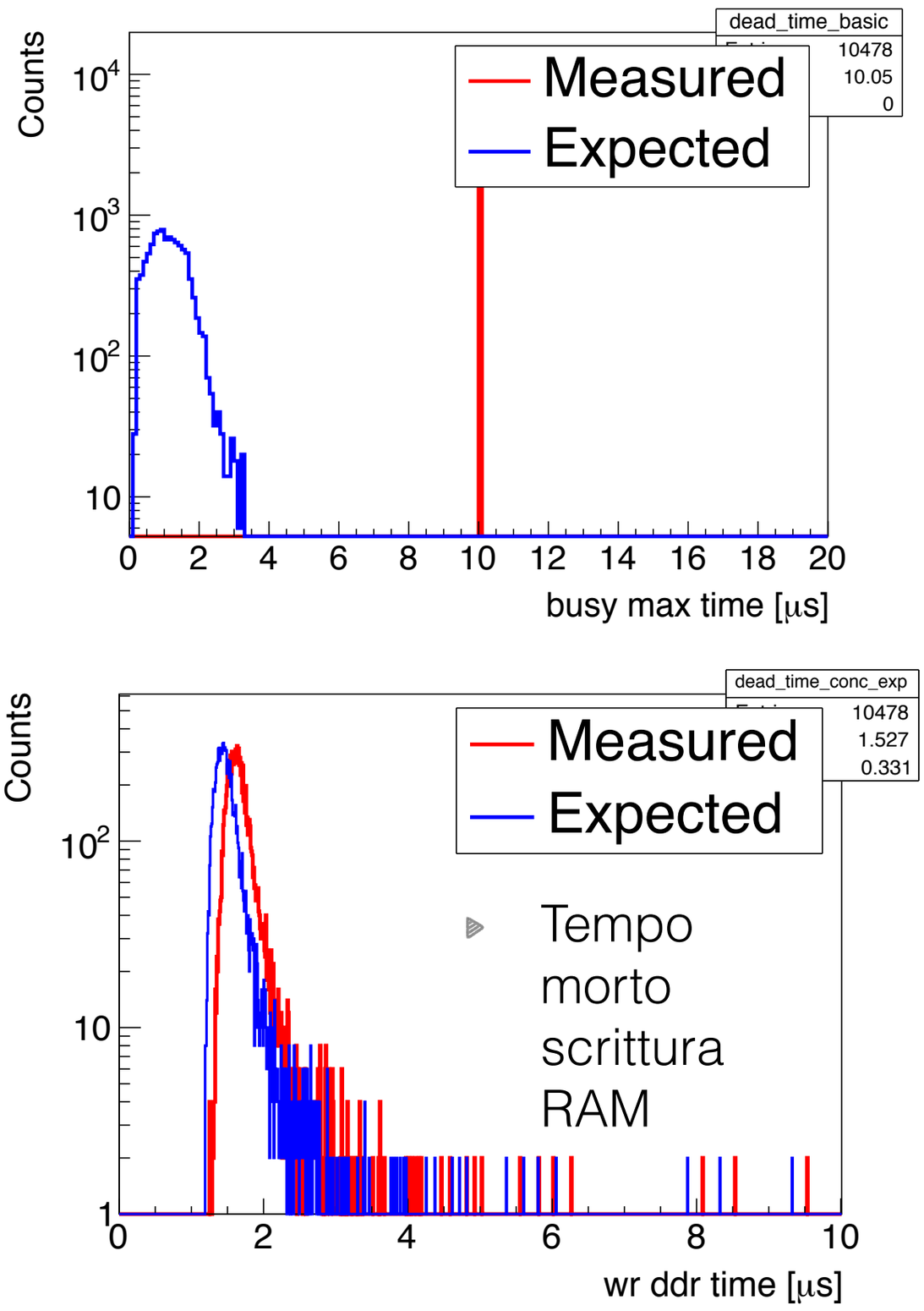
No DT scenario → x3

Dead time: DP read-out system

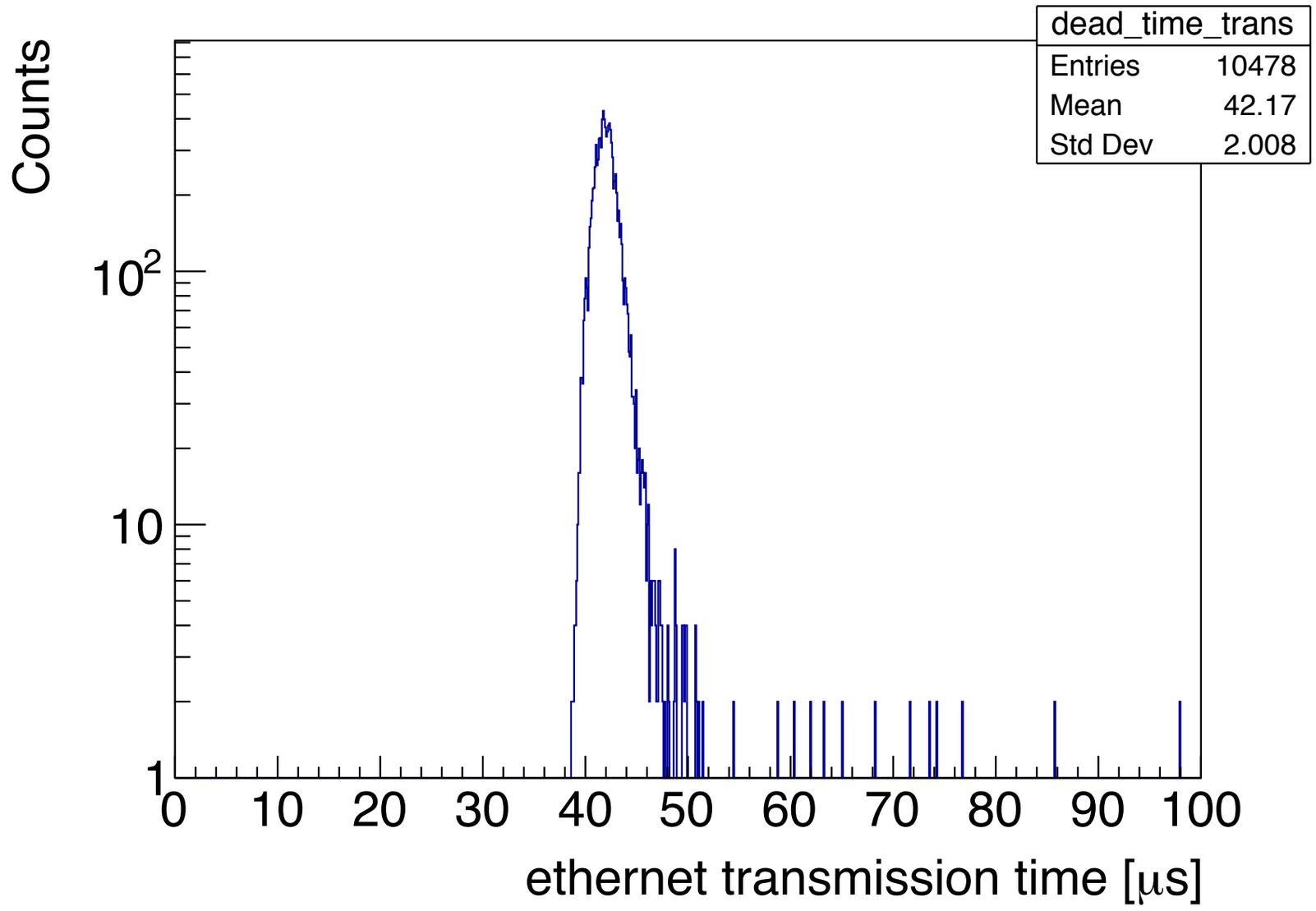


Dead time sources





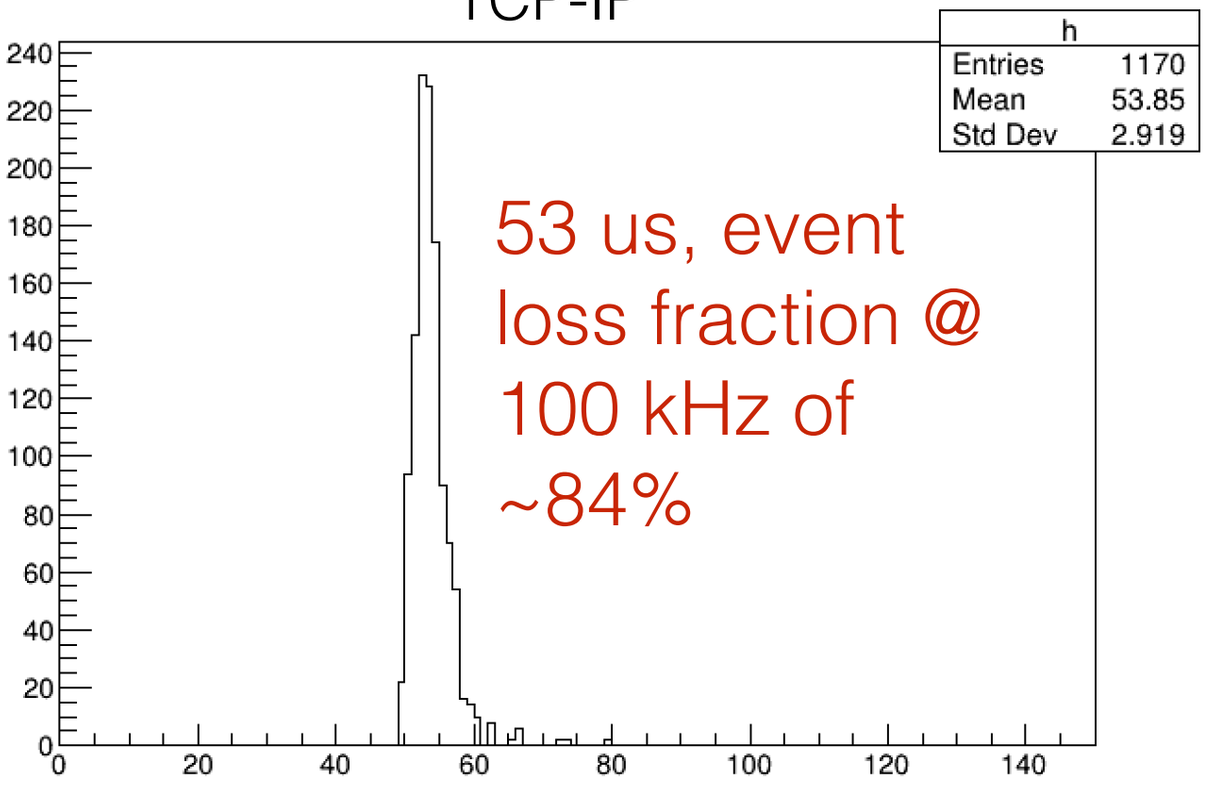
Transmission time



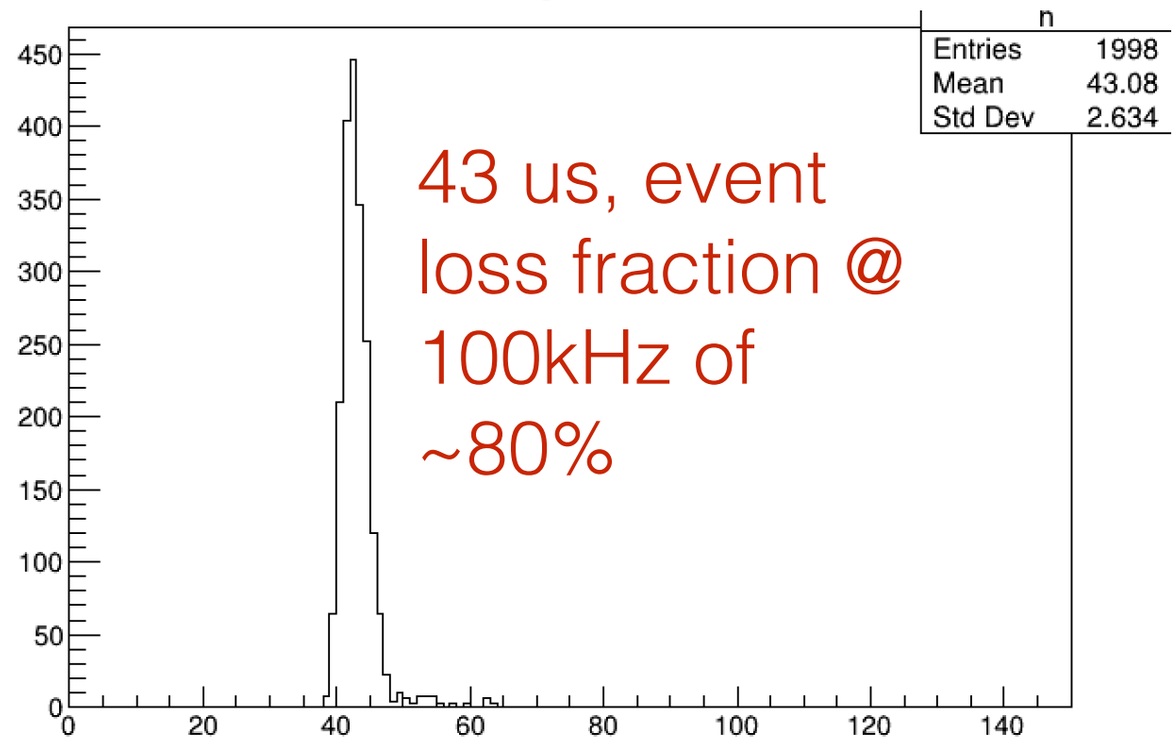
- Incorrect sleep time allocated for basics (window of 10 μs instead of 1 μs, to ensure the sync. of the BASICS boards reading)
- 40us dead time due to the ethernet transmission (TCP-IP protocol)

Protocol change

TCP-IP



UDP

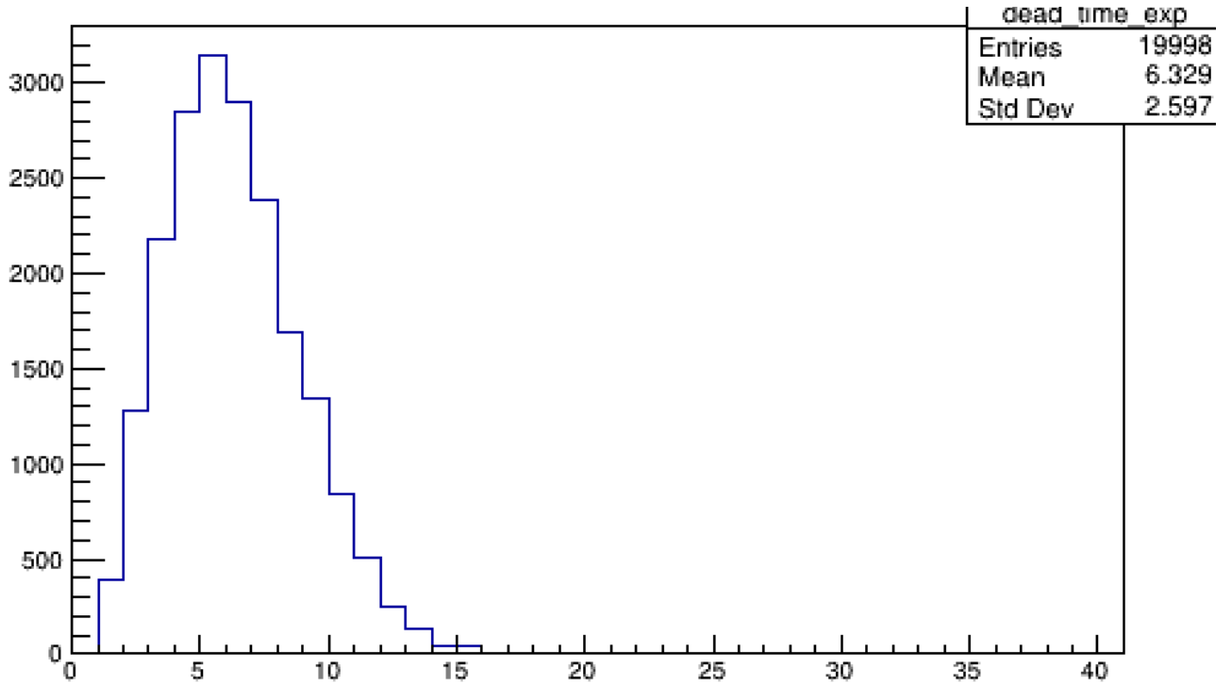


- 10 us improvement passing from TCP-IP to UDP protocol… We expected a larger improvement

New strategy: off-spill data acquisition

- We use an external beam-on/beam-off signal provided by the dose delivery system, saving the data in the concentrator RAM during the spill and performing the transfer when the beam is off!
- In this way the dead time due to the ethernet transmission is completely removed.

Which is the expected dead time?



run_rando_33.dat, 220MeV/u, 60°

Which is the needed throughput?

$$nCarbSpill = 2.0E8$$
$$t_{off} = 1.5\ s$$

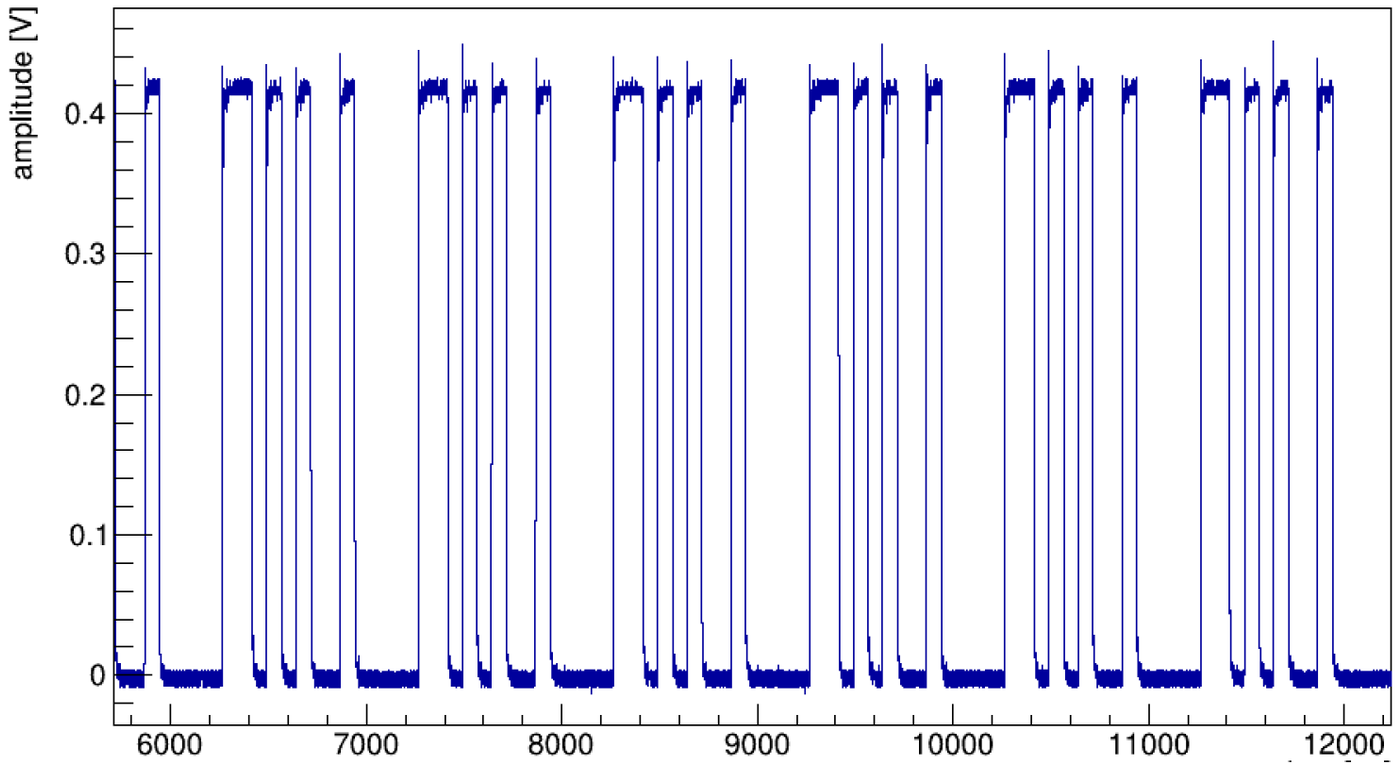
$$nReco = 1.93E5$$
$$nCarb = 1.0E9$$
$$daq\_rate = 11.2\ kHz$$
$$dead\_time = 85\ \mu s$$
$$evt\_size = 60$$

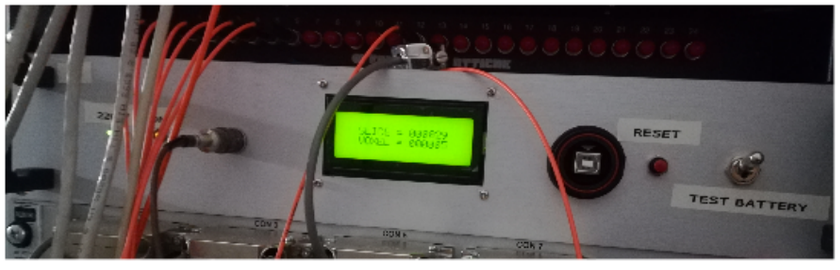
$\longrightarrow 20\ Mbyte$

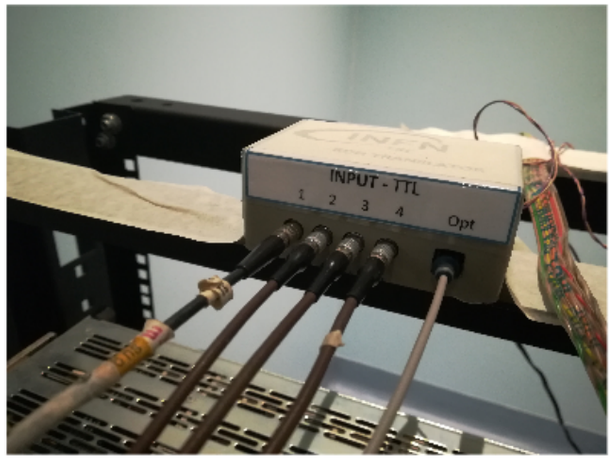
$\longrightarrow 65\ Mbit/s$ (no dead time)

Dose delivery signals

- Beam-on/ beam-off
- spot -id: period 75ns, 10 bit
- voxel-slice: period 4 us, 70 bit
- currently each slice is painted in a given spill: there's not chance _yet_ to have an energy change within a given spil







Working plan

- HW activities:
    a) Investigate the BASIC instabilities
    b) Implementing the new data transfer strategy in the read-out system
    c) Implement the dose delivery system data acquisition

- SW activities:
    a) Finalize the resolution studies
    b) Study the Bragg peak resolution using the data taken with RANDO
    c) Implement the full MC matter effect correction