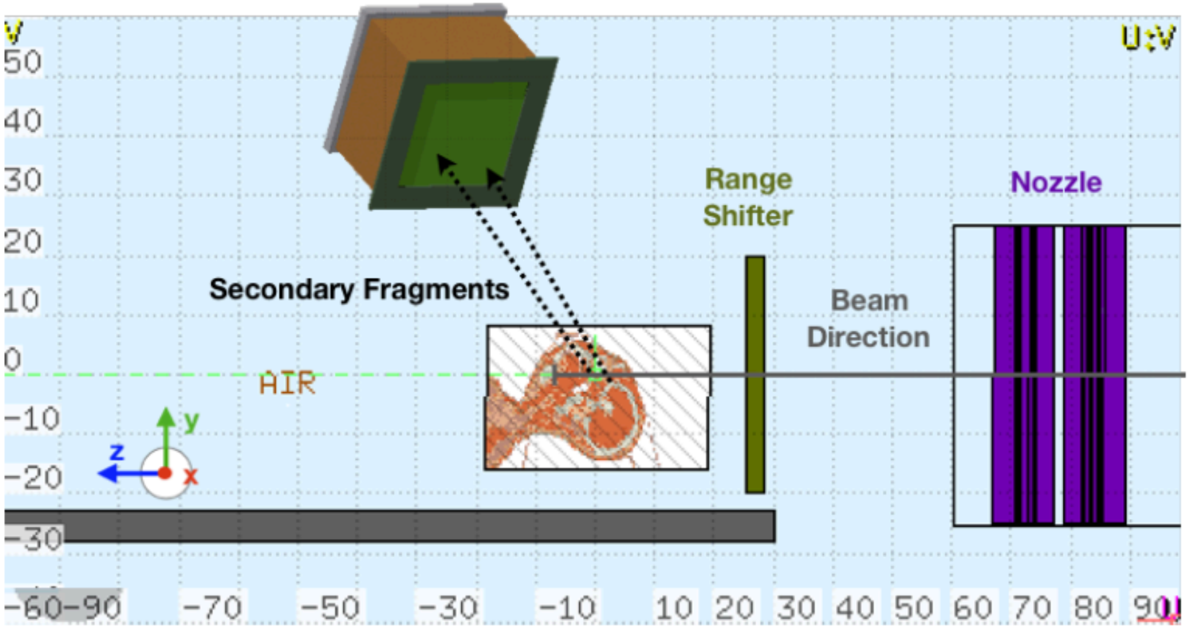
INSIDE clinical trial: data/MC comparison

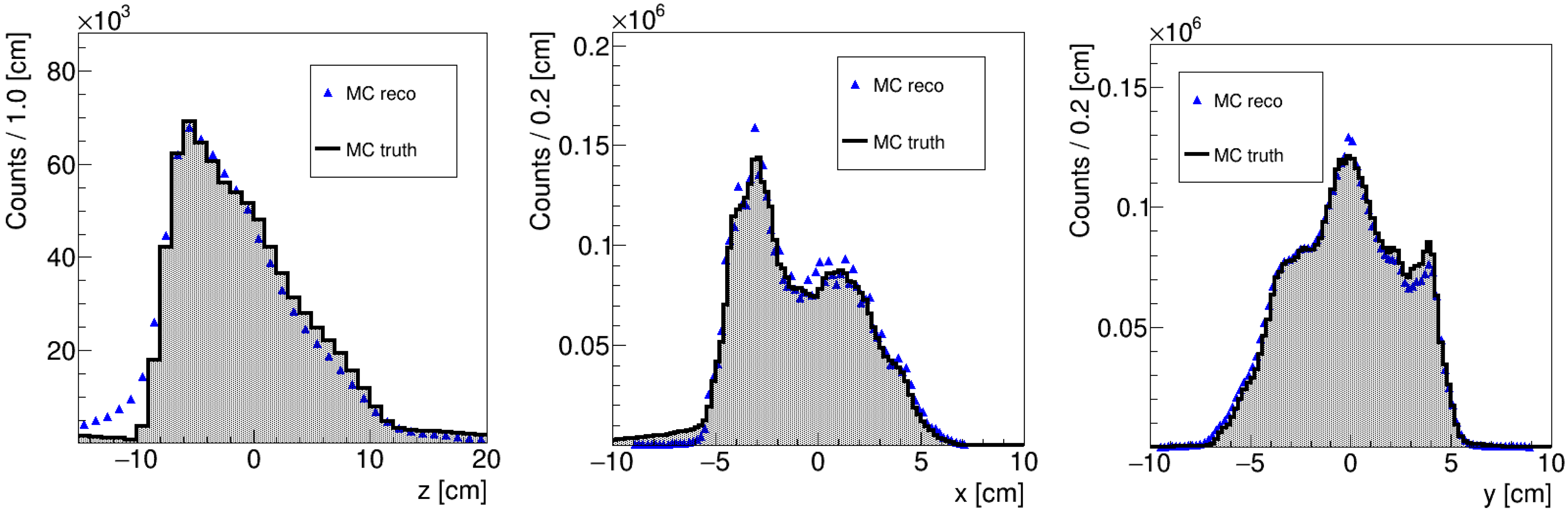
MC PZ4



Patient ID	PZ4
n. fractions	16
re-eval CT	after 8 fr.
field0 (angle)	0°
field1 (angle)	310°
field2 (angle)	/
dose [GyE]	68.3

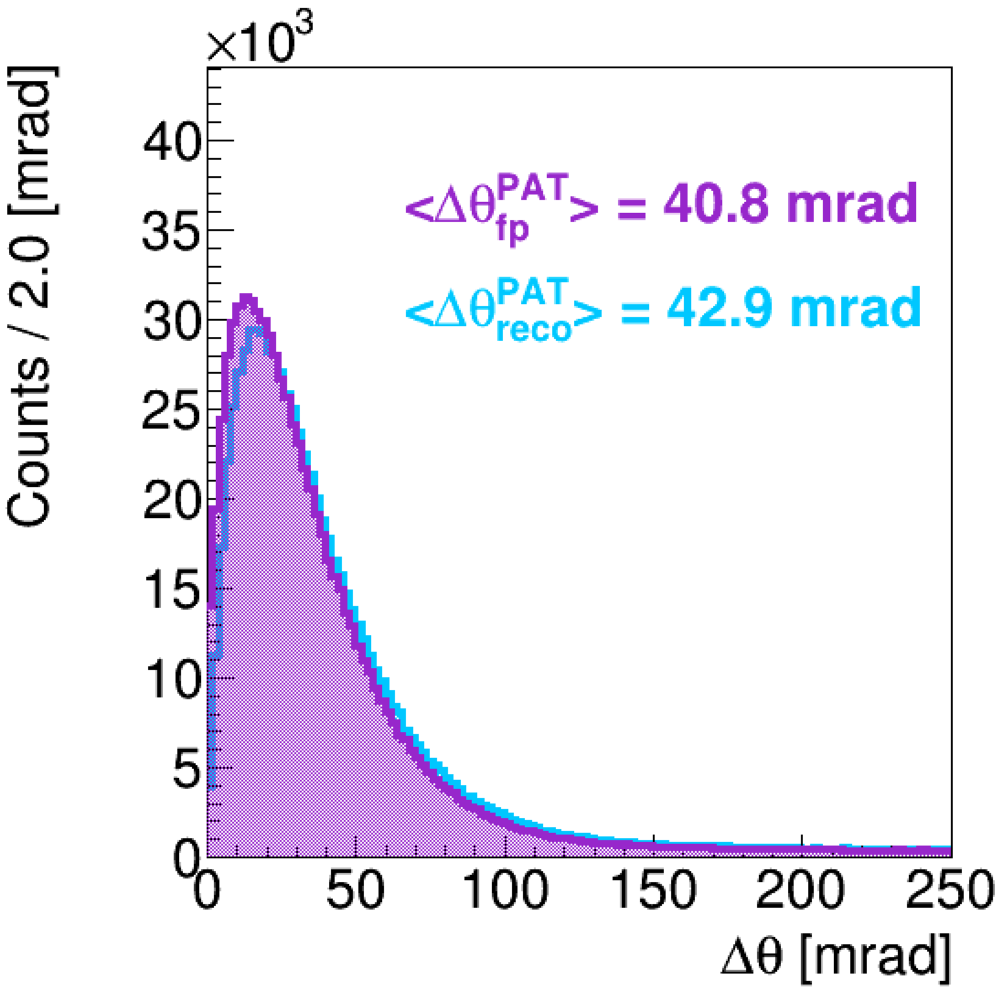
- ~33k pencil beams in 58 slices (Ekin between 126 MeV/u and 278 MeV/u)
- ~1.8E9 primary ions

MC emission profiles



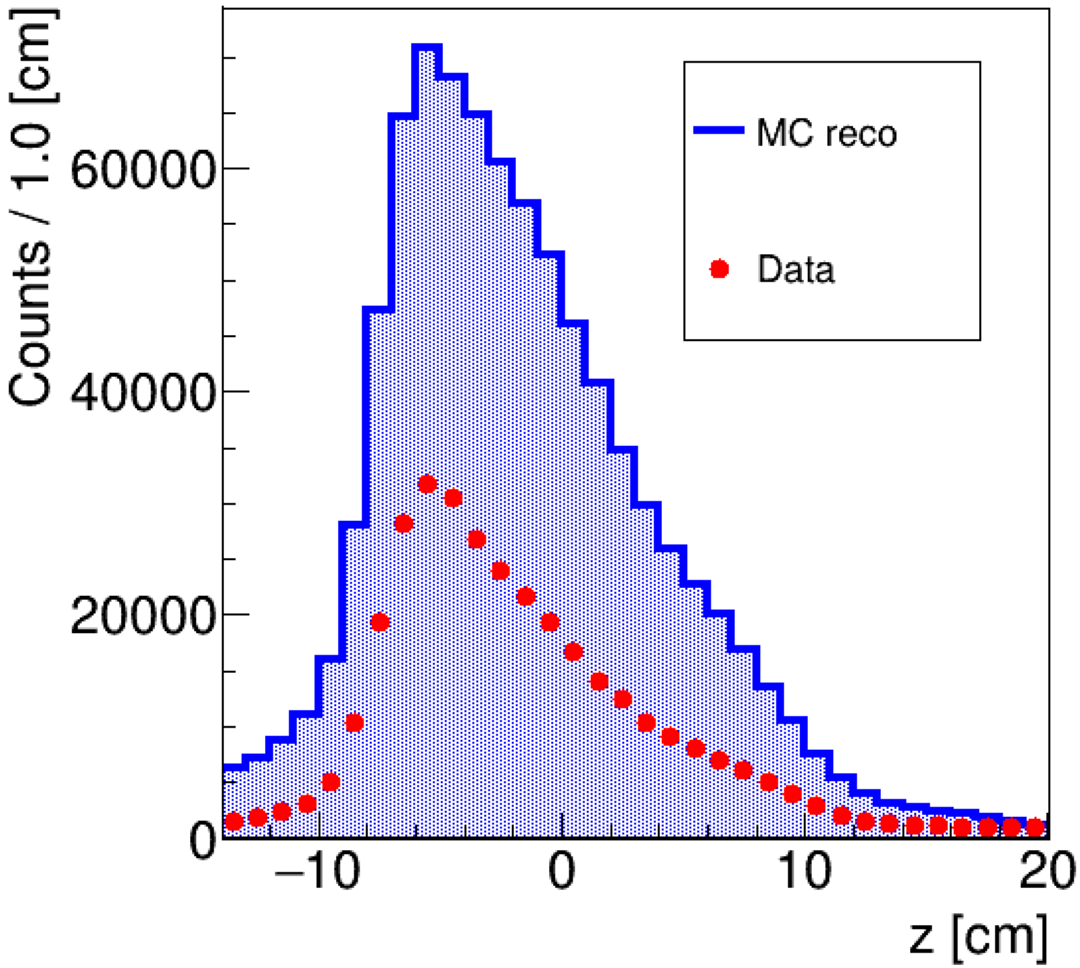
- The detector experimental features (thresholds, efficiency, cross-talk) are included in the reconstruction
- ~4.2E6 tracks are triggered and reconstructed using the Hough transform

Multiple scattering and angular reso



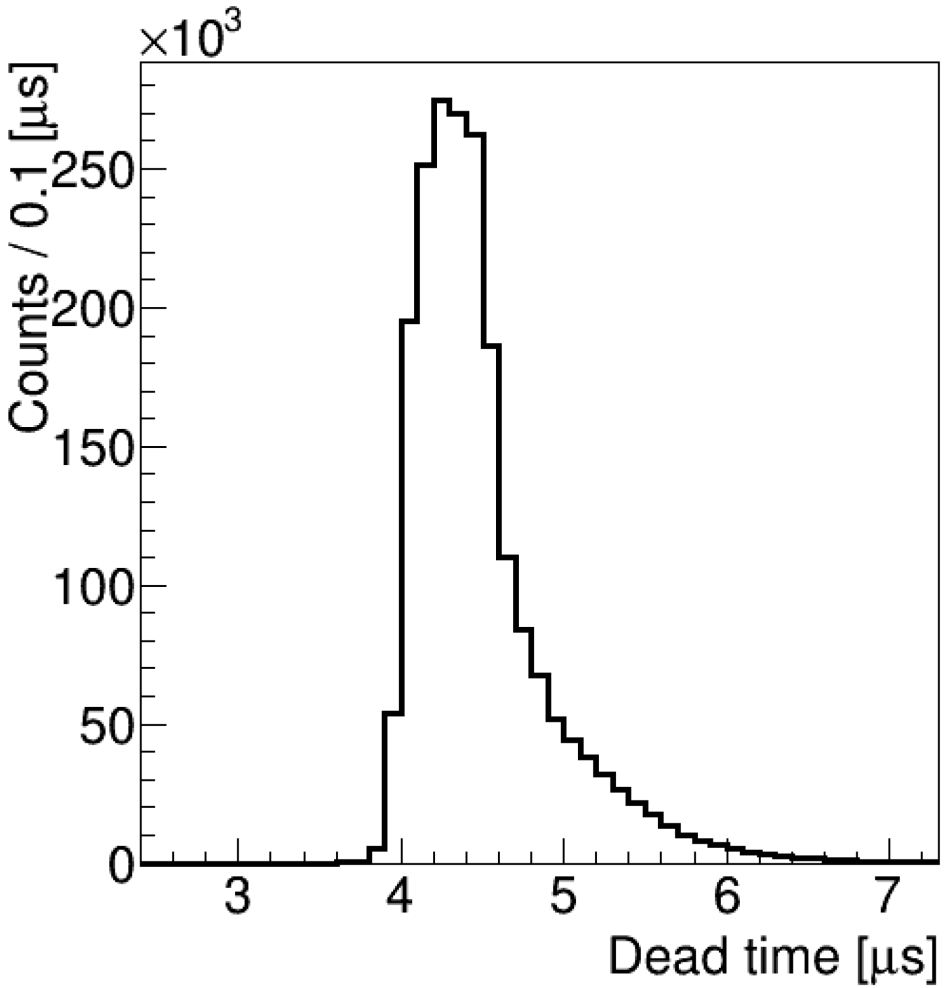
- The impact of multiple scattering has been evaluated computing the angle θ_{FP} between the momentum at production and the momentum at the first fiber plane of the DP
- The overall angular resolution has been evaluated computing the angle θ_{reco} between the momentum at production and the reconstructed momentum

Data raw/MC



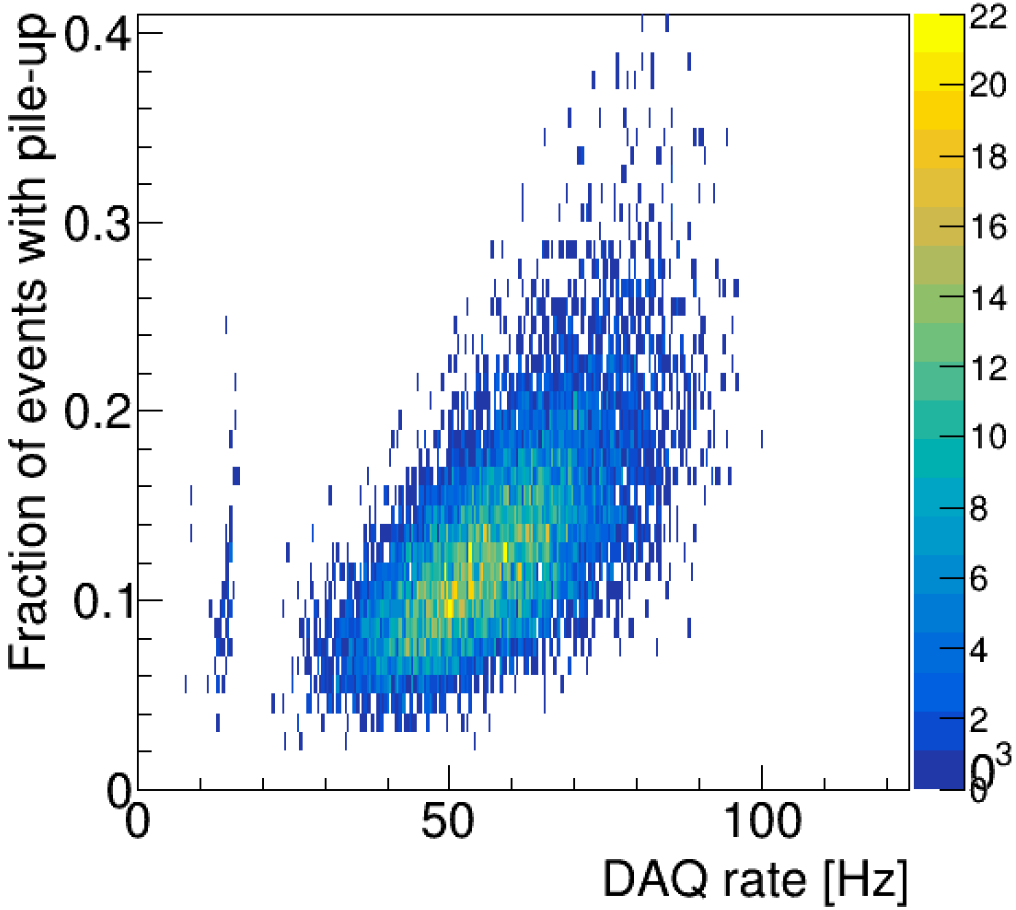
- The z-profile is obtained selecting the triggered events with track multiplicity == 1
- We observe a discrepancy of a factor ~2: this is due to the impact of the detector dead-time (as expected given the DAQ rate) and also the rejection of the pile-up events

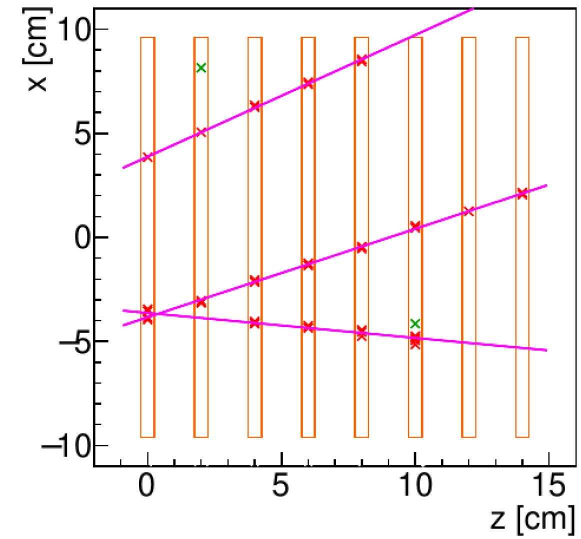
Dead time



- The detector dead-time does not depend on the DAQ rate, but only depends on the event size
- Given the DP dead time, the measured rate can be translated in a “true” fragment rate > 100kHz

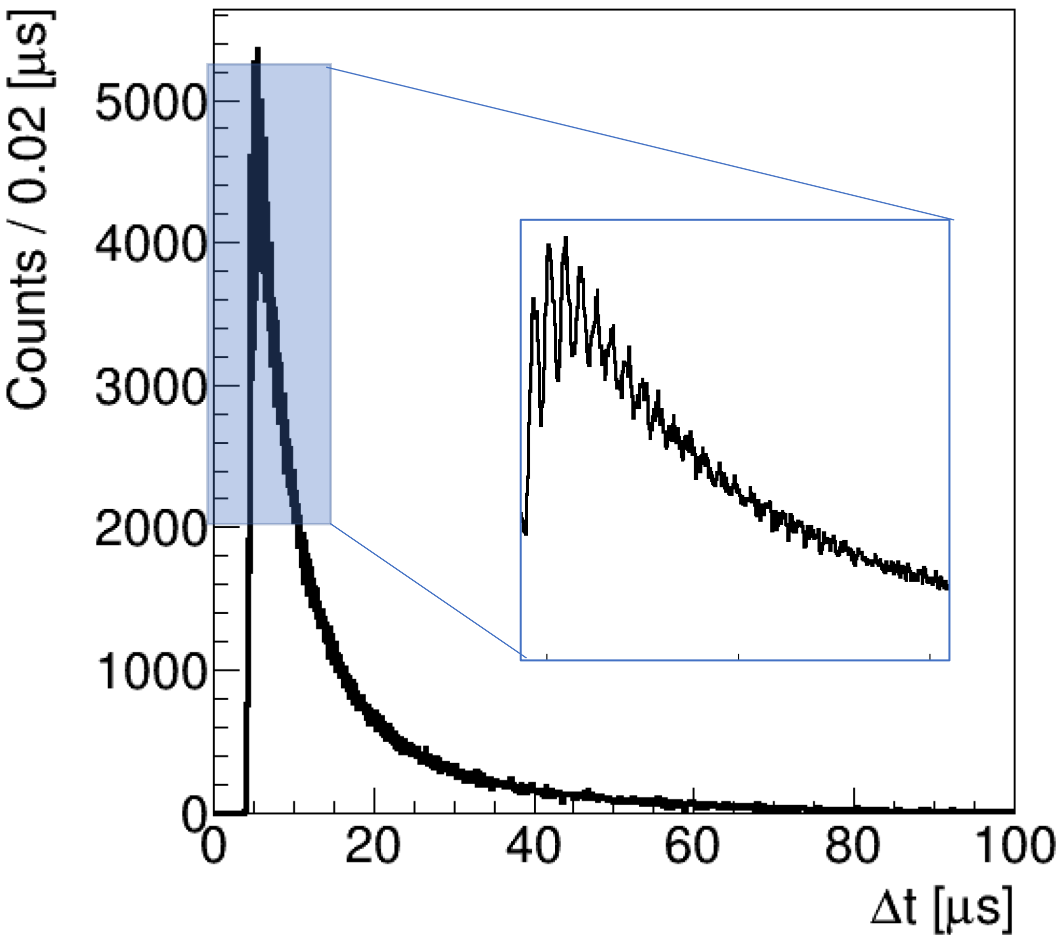
Pile-up





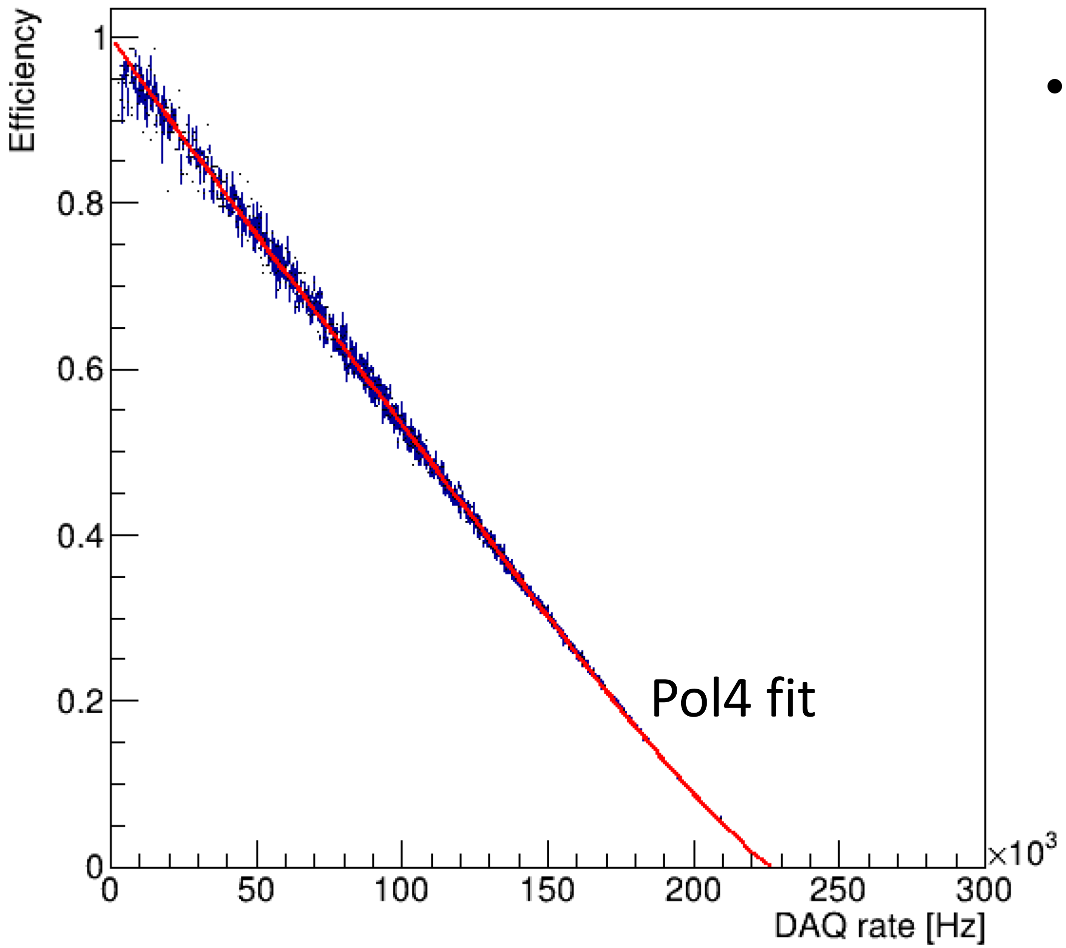
- As expected, the events with track mul. >1 depends on the DAQ rate (ranging between 30 and 80 kHz)

Back to the past…



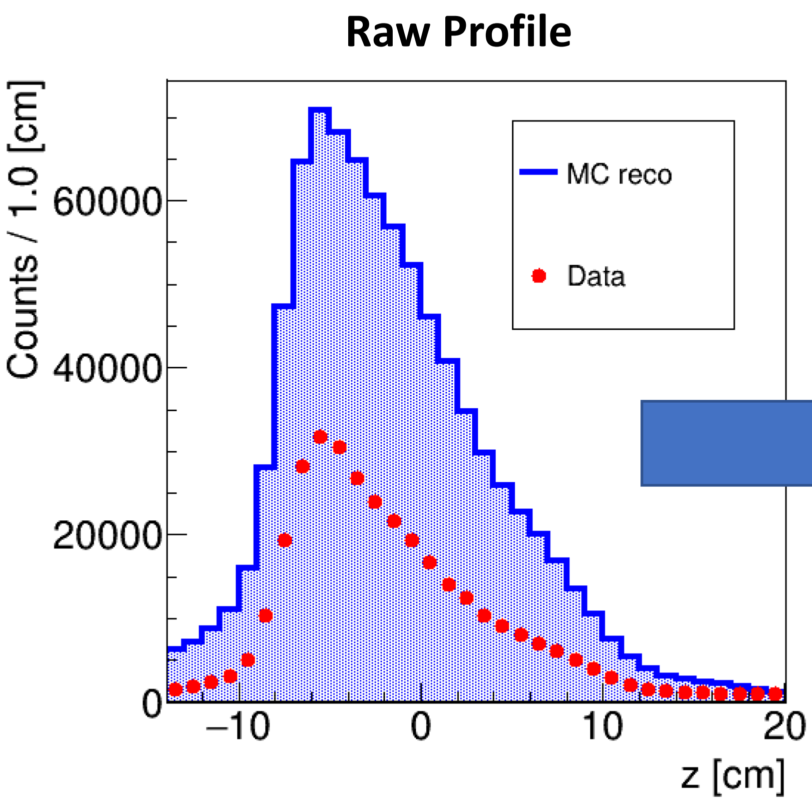
- From the distribution of the Δt between the events the CNAO beam time structure could be observed!
- Bunches with period of ~ 400ns

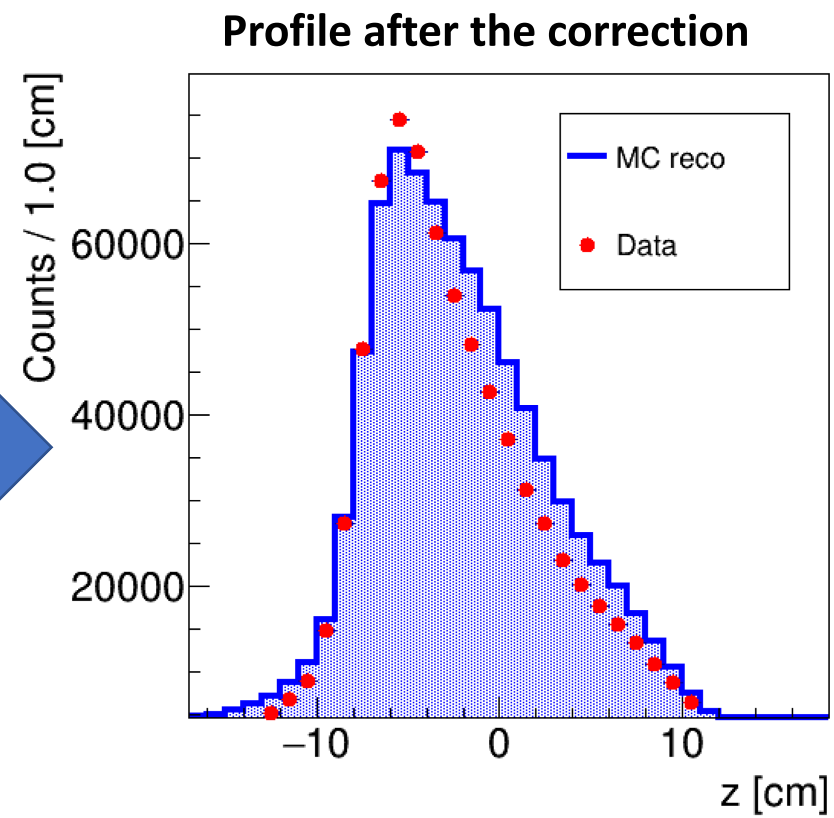
Dead time – pile up efficiency



- We estimated a collection efficiency as a function of the measured DAQ rate by means of a toy MC in which we took into account the beam time structure, the measured dead time, and the coincidence time window (~200ns)

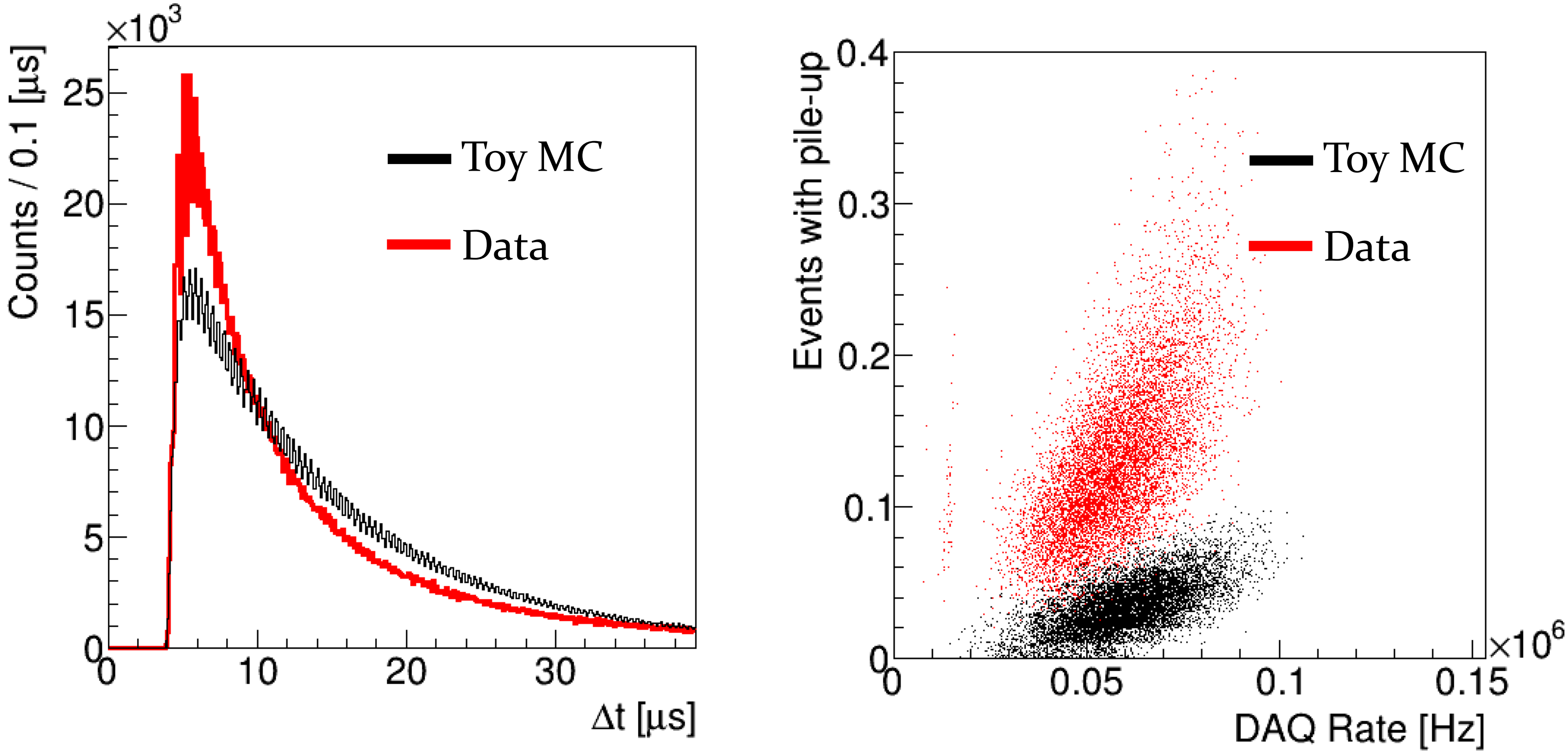
Data/MC comparison





- The corrected profiler has been obtained applying a factor 1/ε(rate) event by event. A good agreement with the MC is found but…

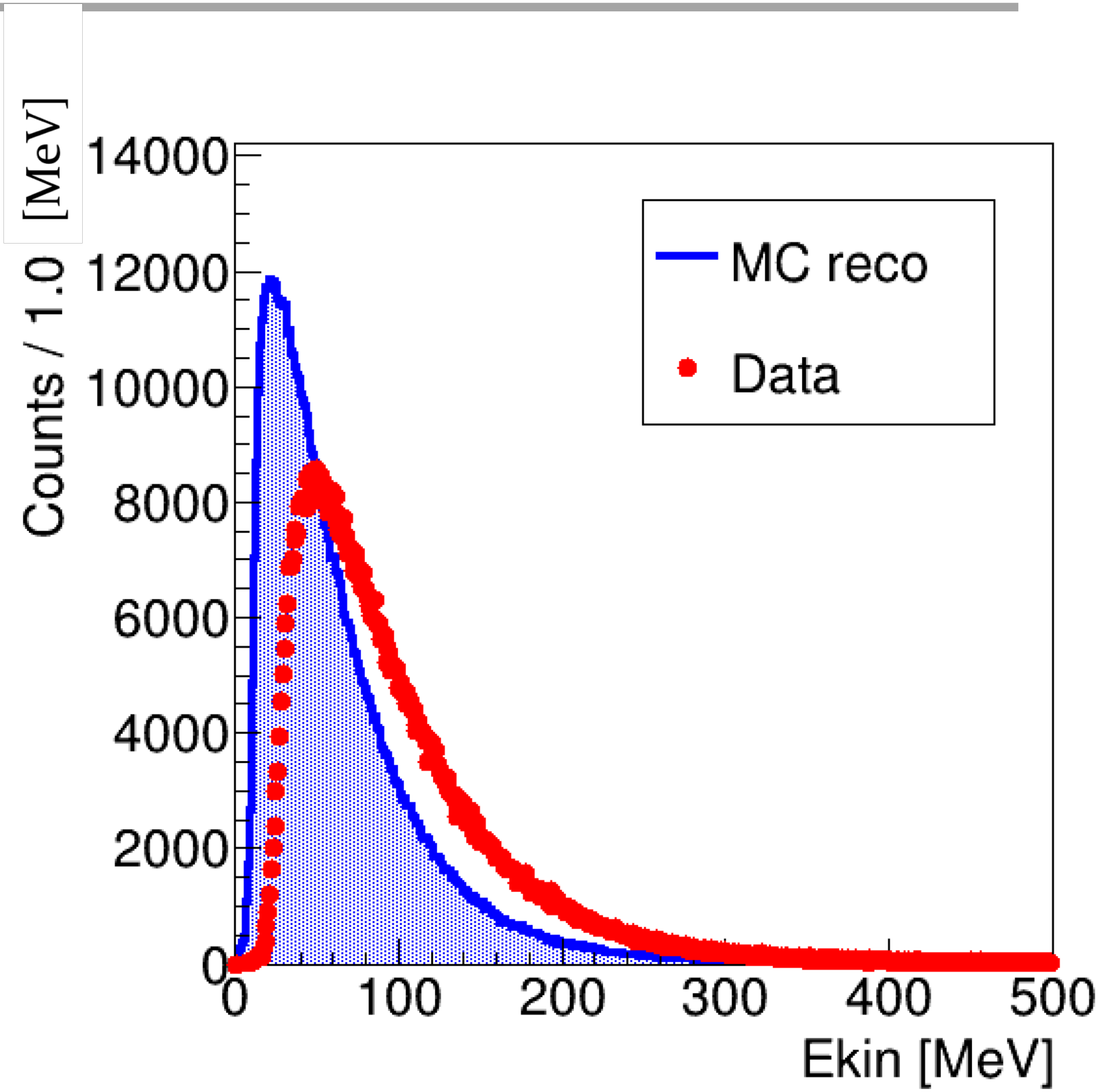
There is still something to understand



The event time structure is not well reproduced by the toy at the involved rate , as well as the estimated pile-up fraction… this has to be investigated

Kinetic energy

- MC: true ekin smeared with experimental resolution (Trento2017)
- Data: ekin obtained by means of the calibration performed in Trento 2017
- A data/MC discrepancy on the energy spectrum would be not a problem… (we known that MC is not reliable) but the different Ekin threshold does → <u>miscalibration</u>?



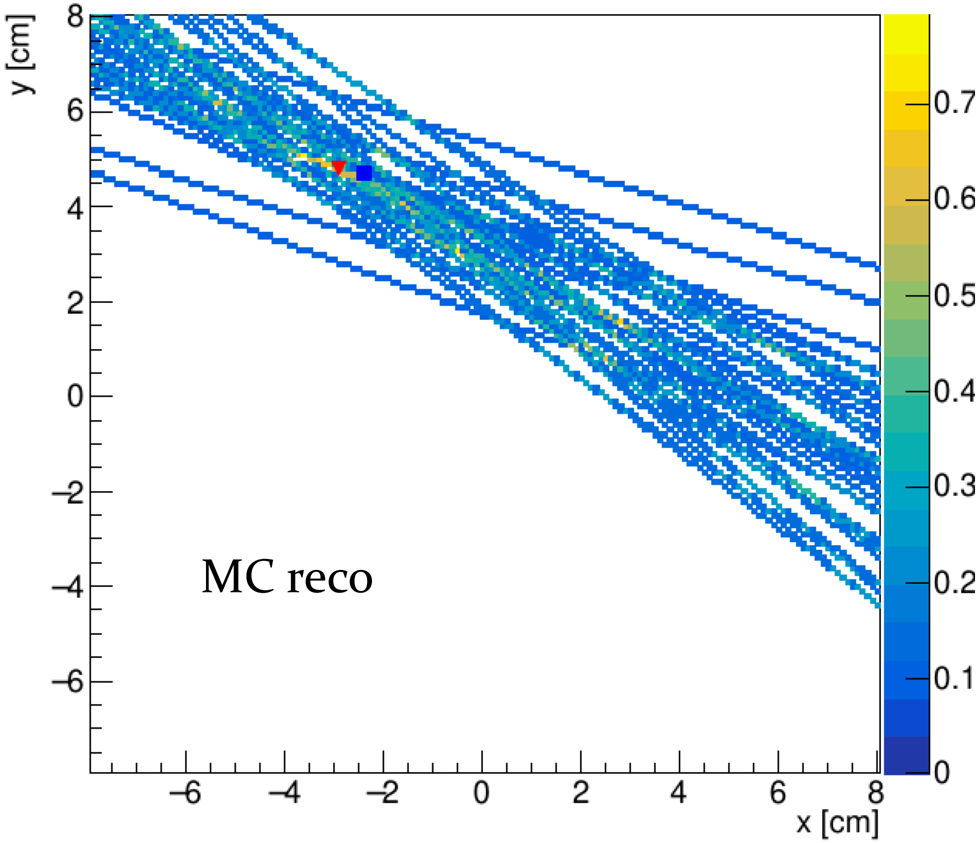
Frontiers paper

frontiers

Online monitoring of carbon ion beams for particle therapy: results from a clinical trial performed at CNAO

- To be submitted within 31 august
- We will circulate a first draft at the end of July
- Topic: monitoring in the transverse plane

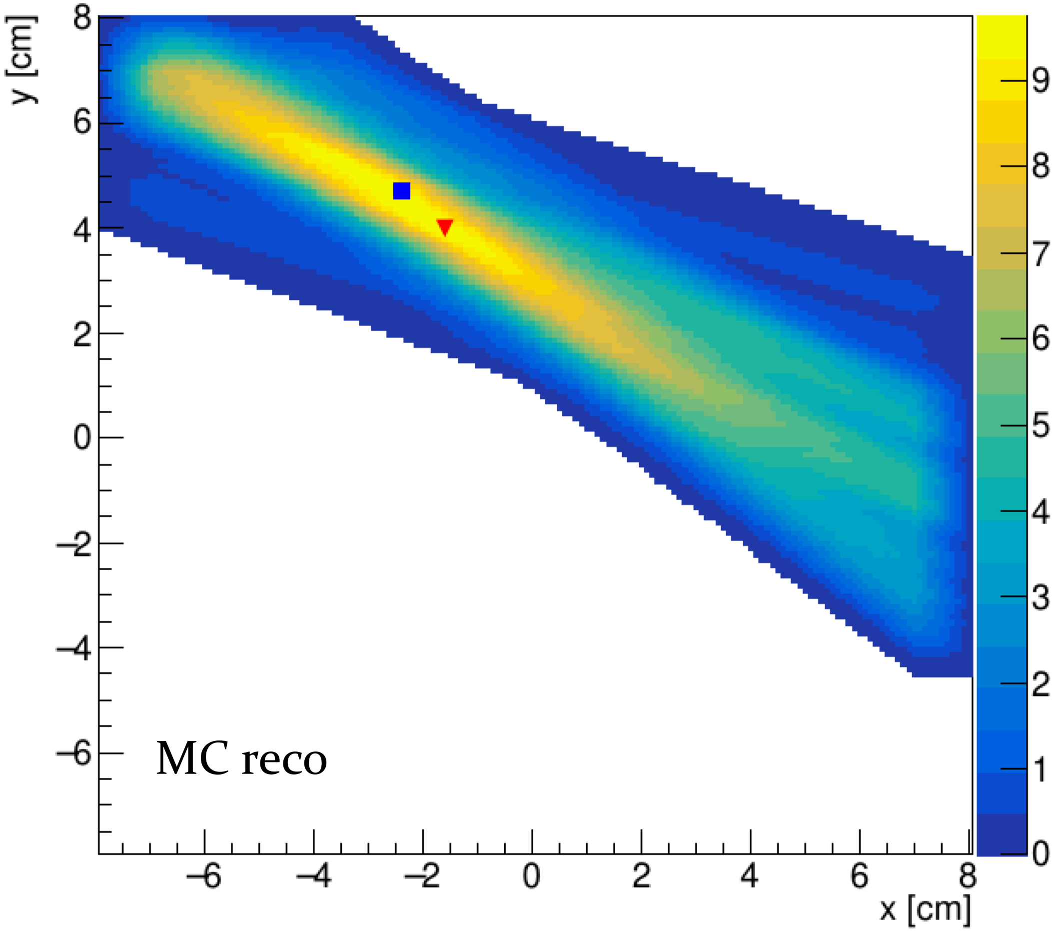
Monitoring in the transverse plane



- I compute the track projection on the transverse plane (x-y)
- Binned representation of transverse plane (x-y)
- I assign to each bin the value of the path of the track inside that bin.
- I look for an accumulation point

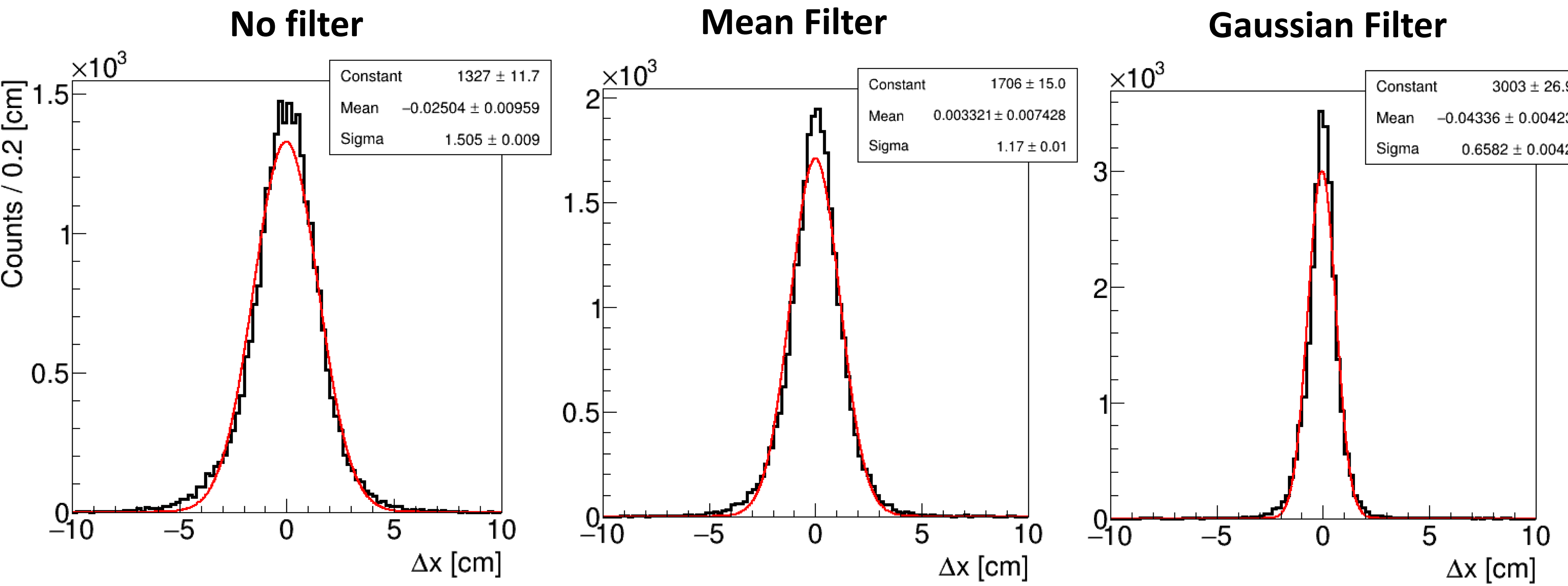
The bin size choice is obviously crucial for the accuracy of the method. I found better results with “small” bin (1mm x 1mm) and applying a filter a posteriori

Monitoring in the transverse plane



- 2D Gaussian filter (1 cm sigma in both the directions)

Impact of the filters choice



- I evaluated the difference between the nominal x position (given by the treatment plan) and the reconstructed one (Δx), PB per PB. I selected only the PBs with at least 50 reconstructed tracks.

- The filter choice seems to have a significant impact. A resolution of 7mm is found with the best choice, at present.

To do…

- Compare data/MC superPB per superPB (Serena is helping in doing that)
- Validate the estimate of the «collection efficiency».
- Check the ekin calibration (selecting the straight fragments that stop in the DP?)
- Optimize the filter choice in when monitoring the beam in the x-y plane