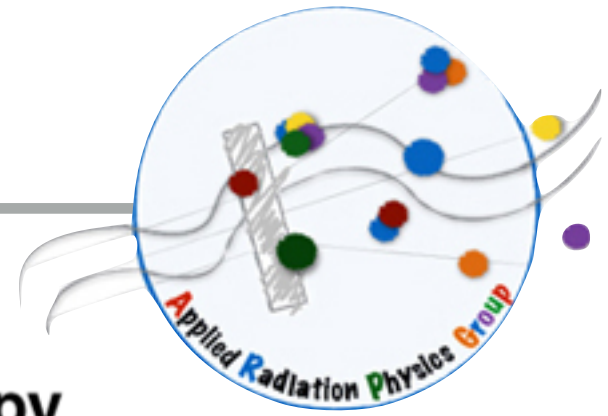# The DP paper

Giacomo Traini

giacomo.traini@roma1.infn.it

ARPG meeting, 21/12/2018

The Dose Profiler: a novel detector for Particle Therapy treatments online monitoring.

G. Traini[b,c] I. Mattei[a] G. Battistoni[a] M. G. Bisogni[g] M. De Simoni[b,c] Y. Dong[a,h] A. Embriaco[a]
M. Fischetti[f,c] M. Magi[f,c] C. Mancini-Terracciano[b,c] M. Marafini[e,c] R. Mirabelli[b,c] S. Muraro[g]
V. Patera[f,c,e] A. Schiavi[f,c] A. Sciubba[f,c,e] E. Solfaroli Camillocci[b,c] S. M. Valle[a,h]
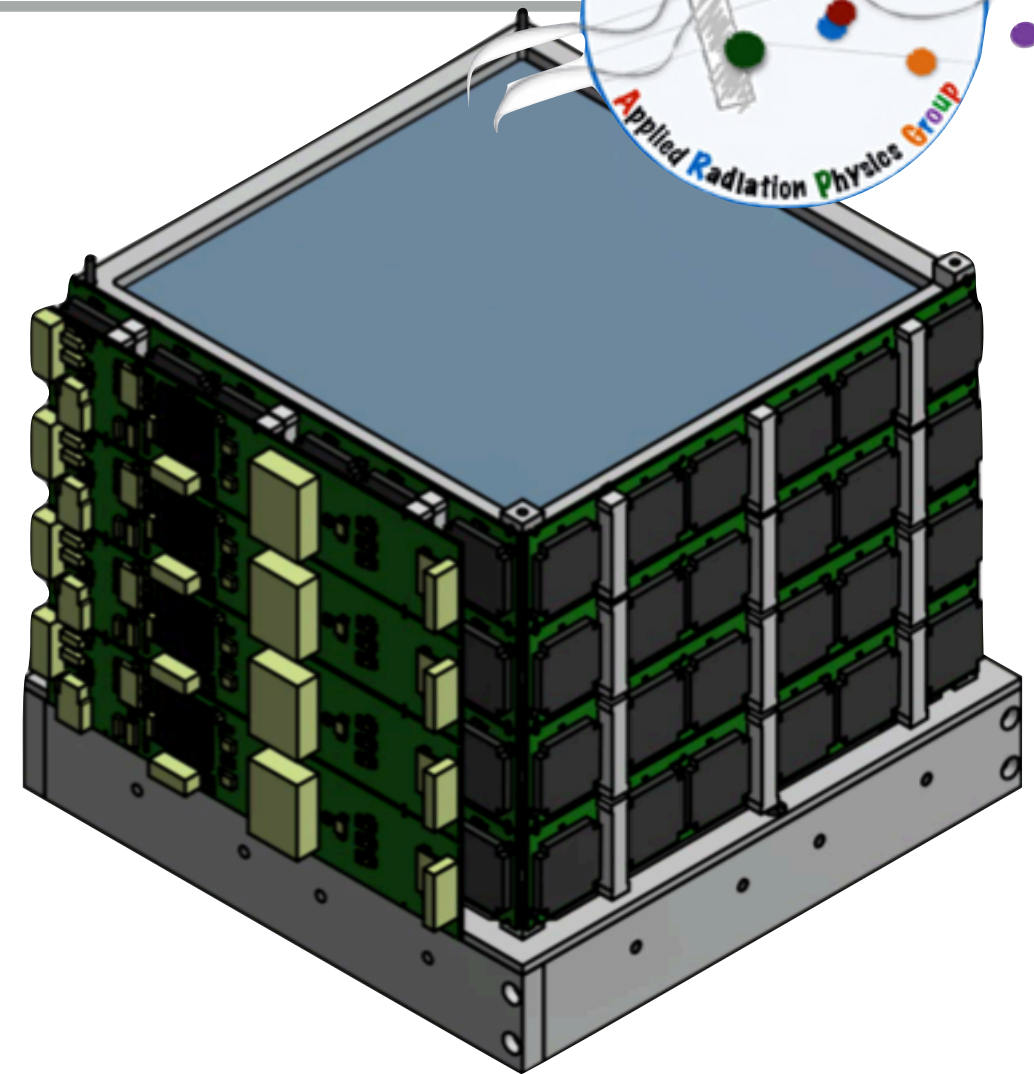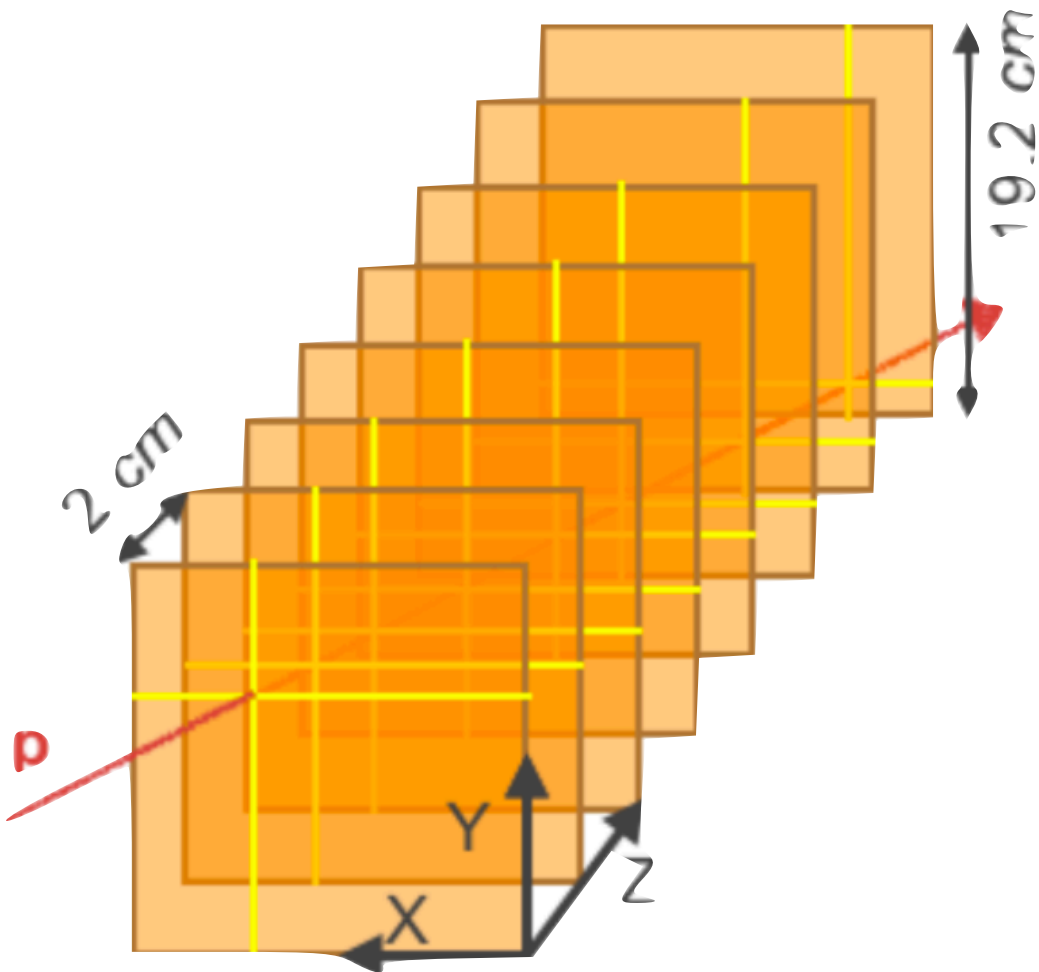A. Sarti[f,d,e]

To be submitted to JINST

▷ **Paper structure:**

   ▷ Detector design and experimental setup

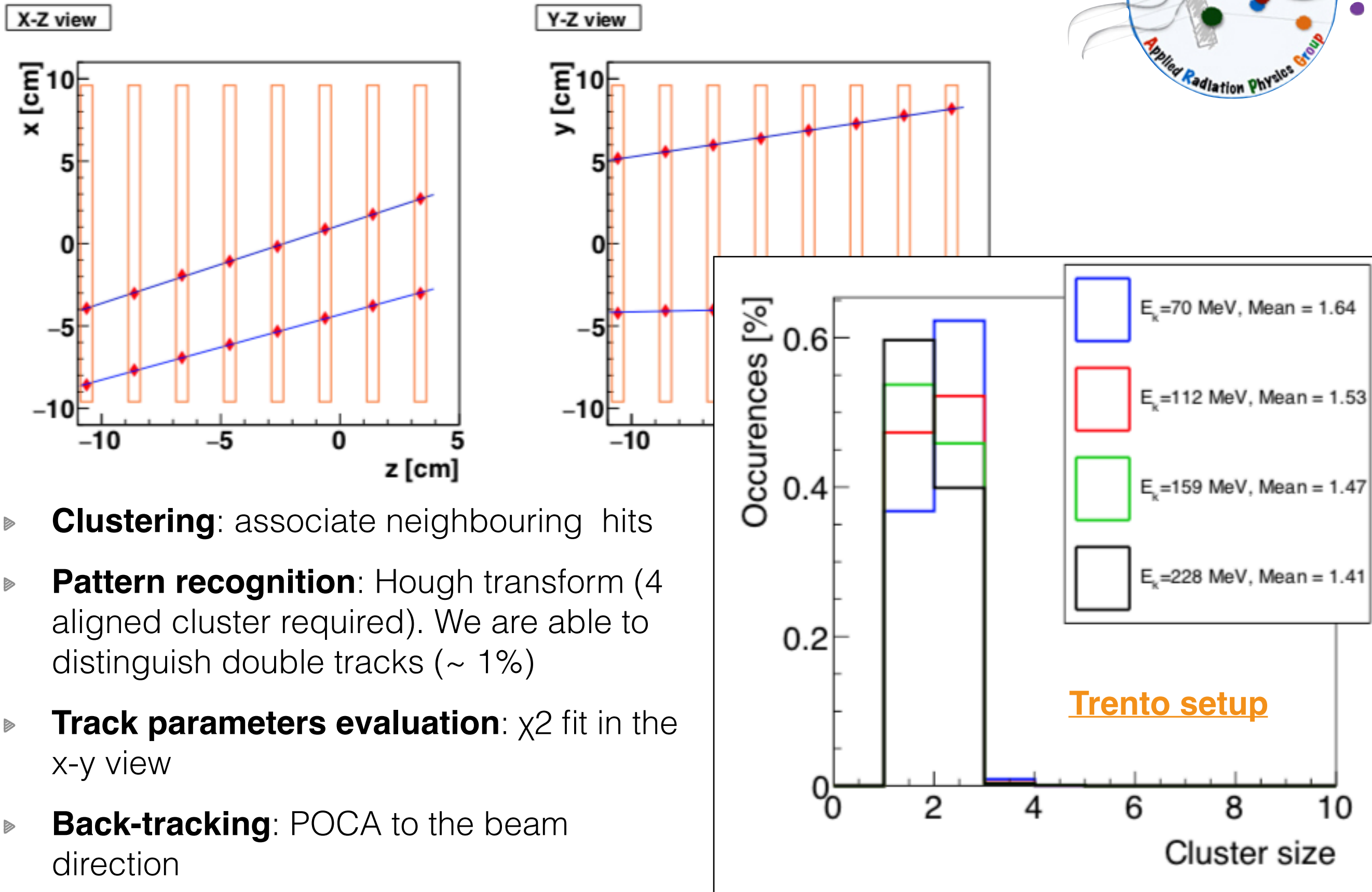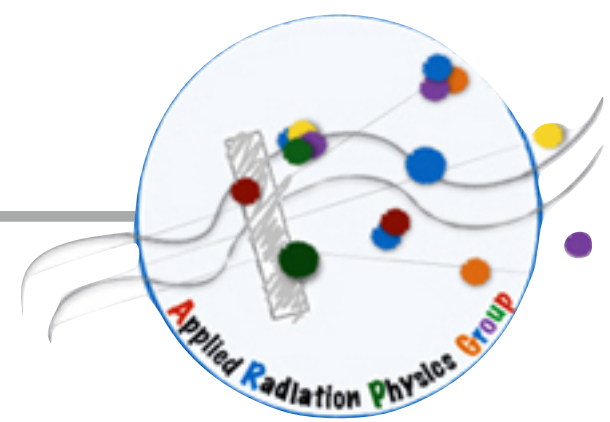   ▷ Event reconstruction and particle tracking

   ▷ Results

Detector design & experimental set

- **Detector design**: 8 fiber layers read-out by 3072 SiPM (new version with respect to that published in 2016)
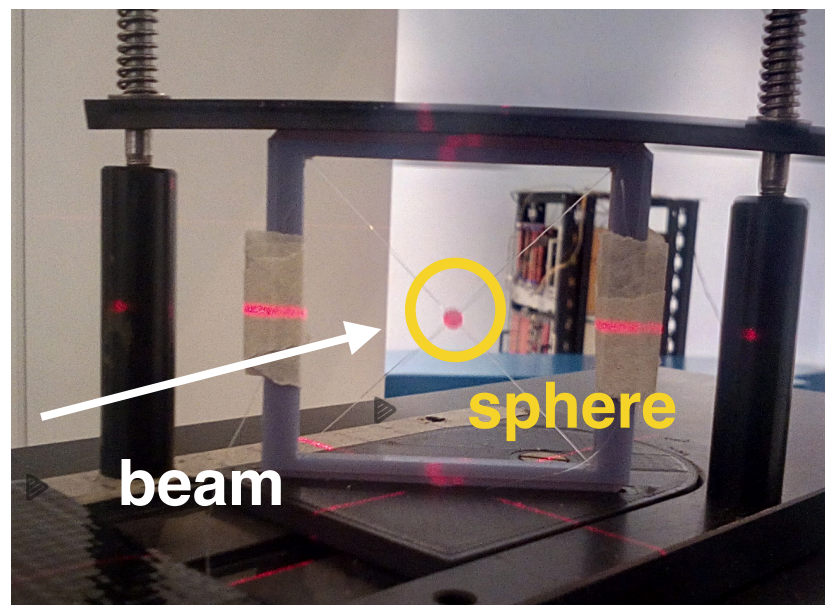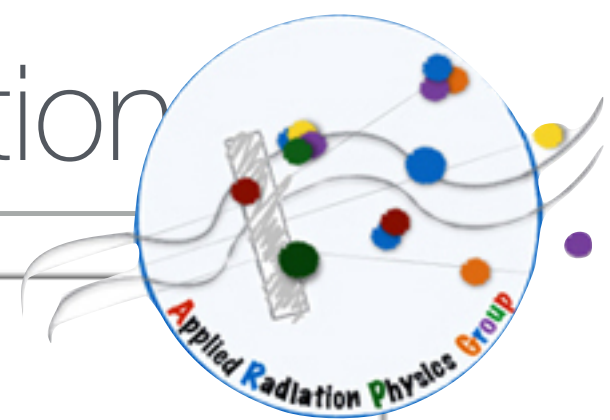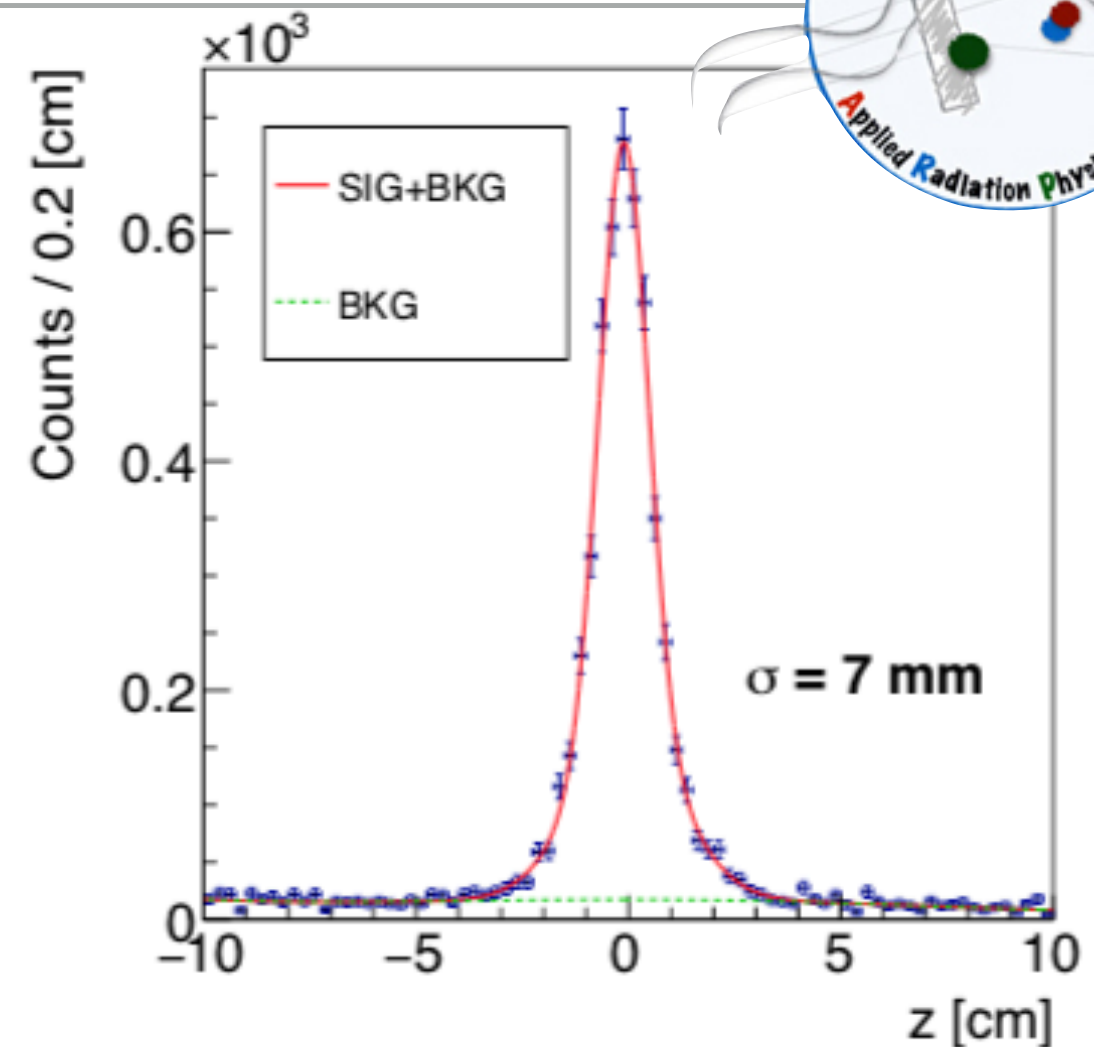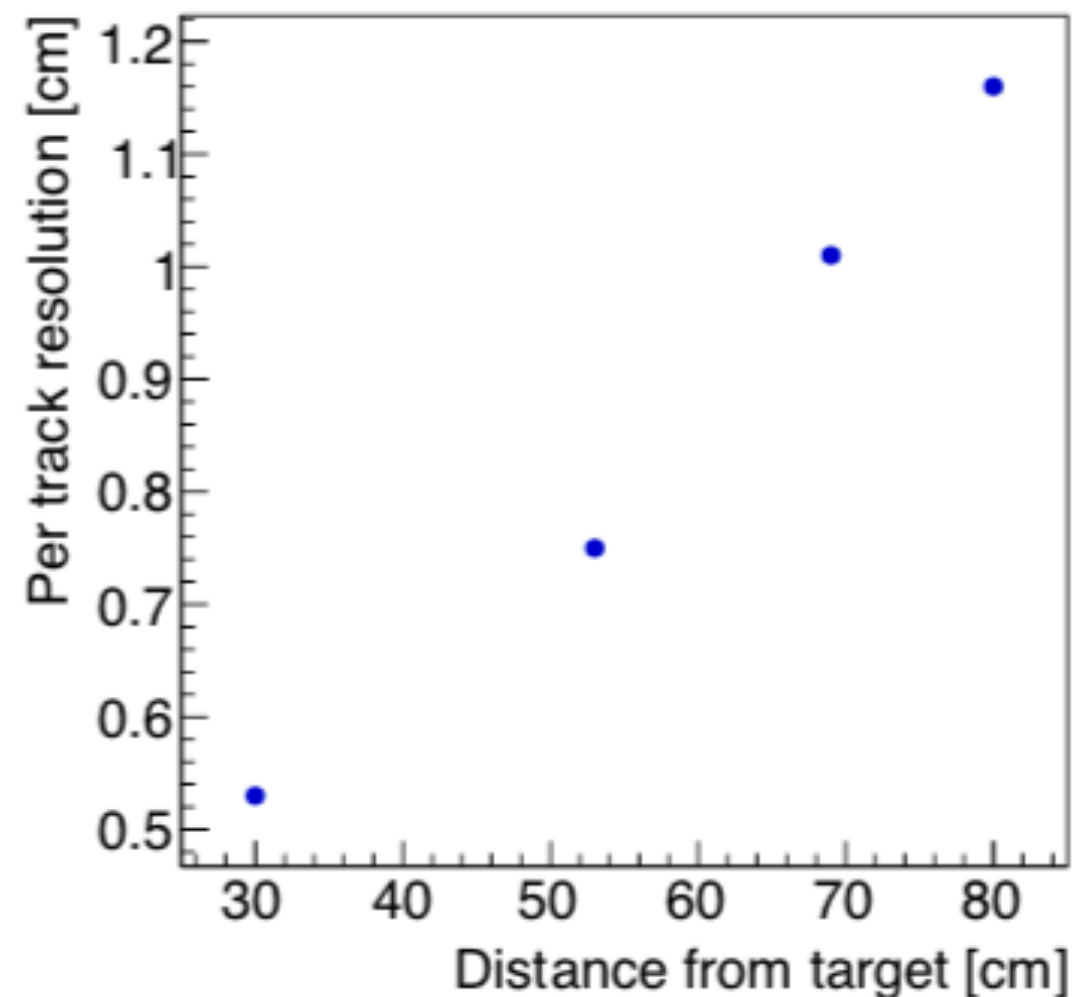
- **Read-out** structure and **trigger** architecture

- **Trento** setup: proton beams @ 70,110,160,220 MeV impinging the detector

- **CNAO** setup: ^{12}C beams on RANDO and small spherical targets

Event reconstruction

X-Z view

Y-Z view

E$_k$=70 MeV, Mean = 1.64

E$_k$=112 MeV, Mean = 1.53

E$_k$=159 MeV, Mean = 1.47

E$_k$=228 MeV, Mean = 1.41

Trento setup

▷ **Clustering**: associate neighbouring hits

▷ **Pattern recognition**: Hough transform (4 aligned cluster required). We are able to distinguish double tracks (~ 1%)

▷ **Track parameters evaluation**: χ2 fit in the x-y view

▷ **Back-tracking**: POCA to the beam direction

- ▷ **Backtracking resolution** for various distances from the room isocenter, evaluated by means the reconstruction of the position of small spheres. We show the profile @ 50cm (distance used in the INSIDE clinical trial)

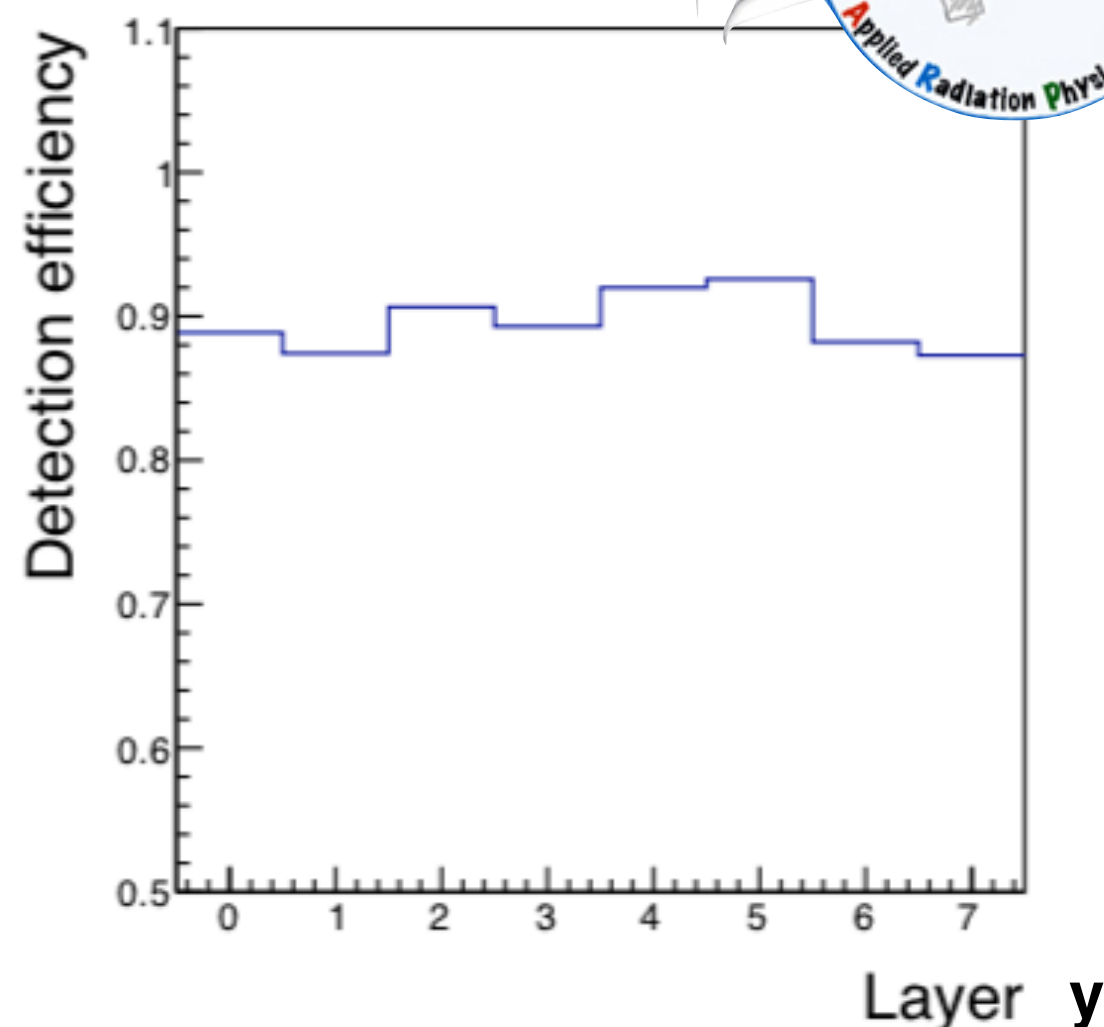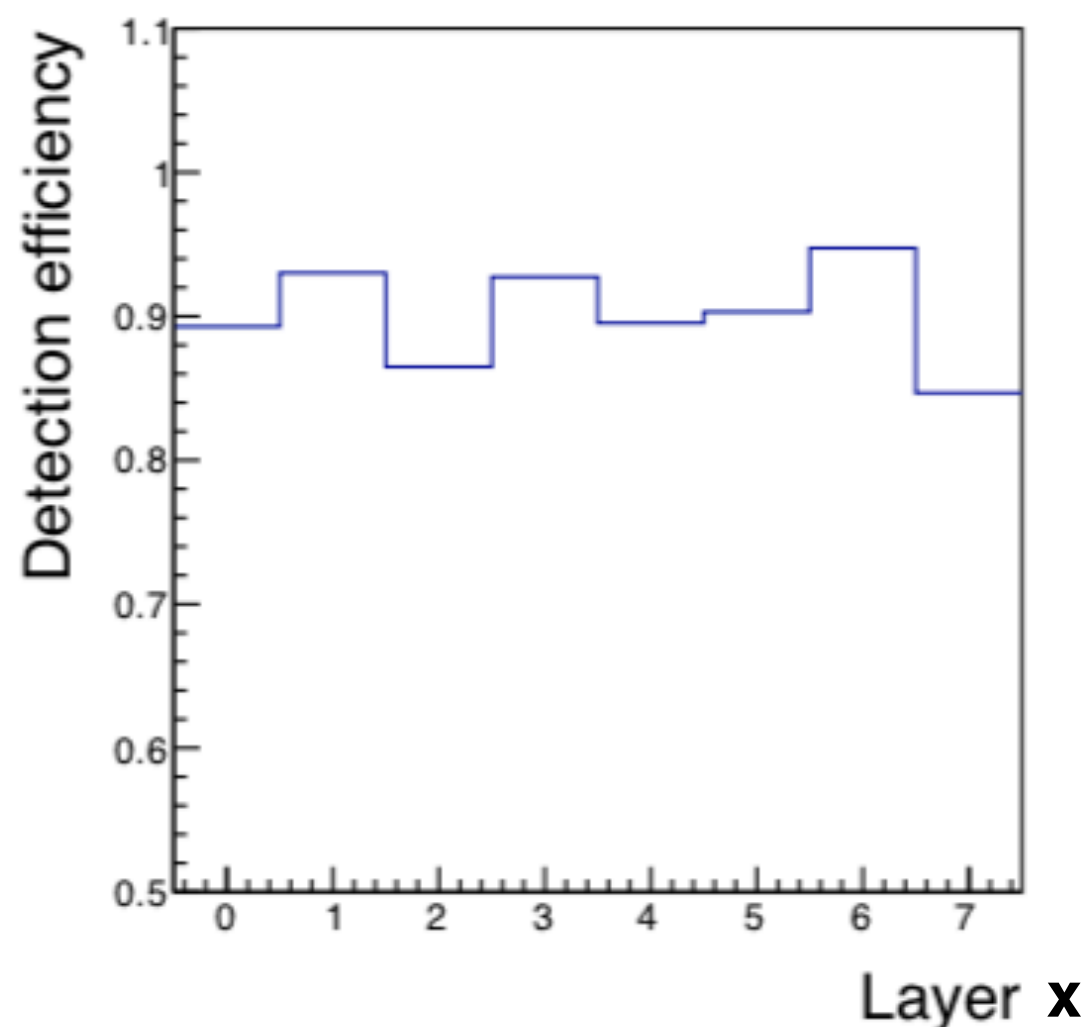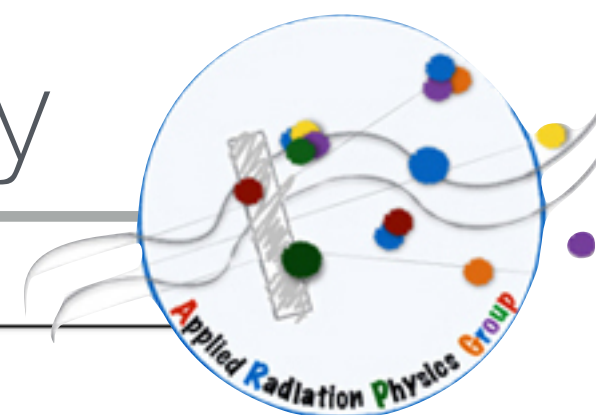- ▷ Fit with double gaussian (signal) + polynomial (background)

Results: DAQ rate & dead time

$\langle\tau\rangle \sim 4.3\ \mu s$
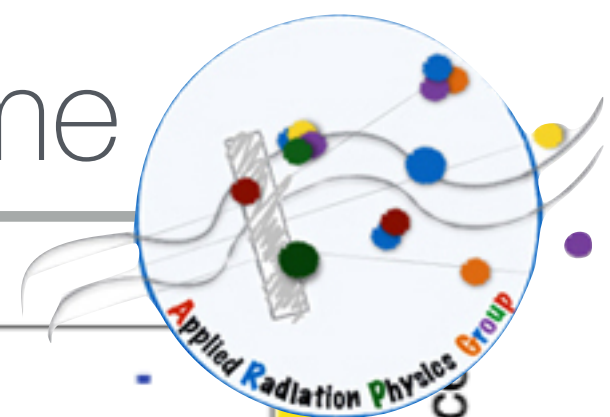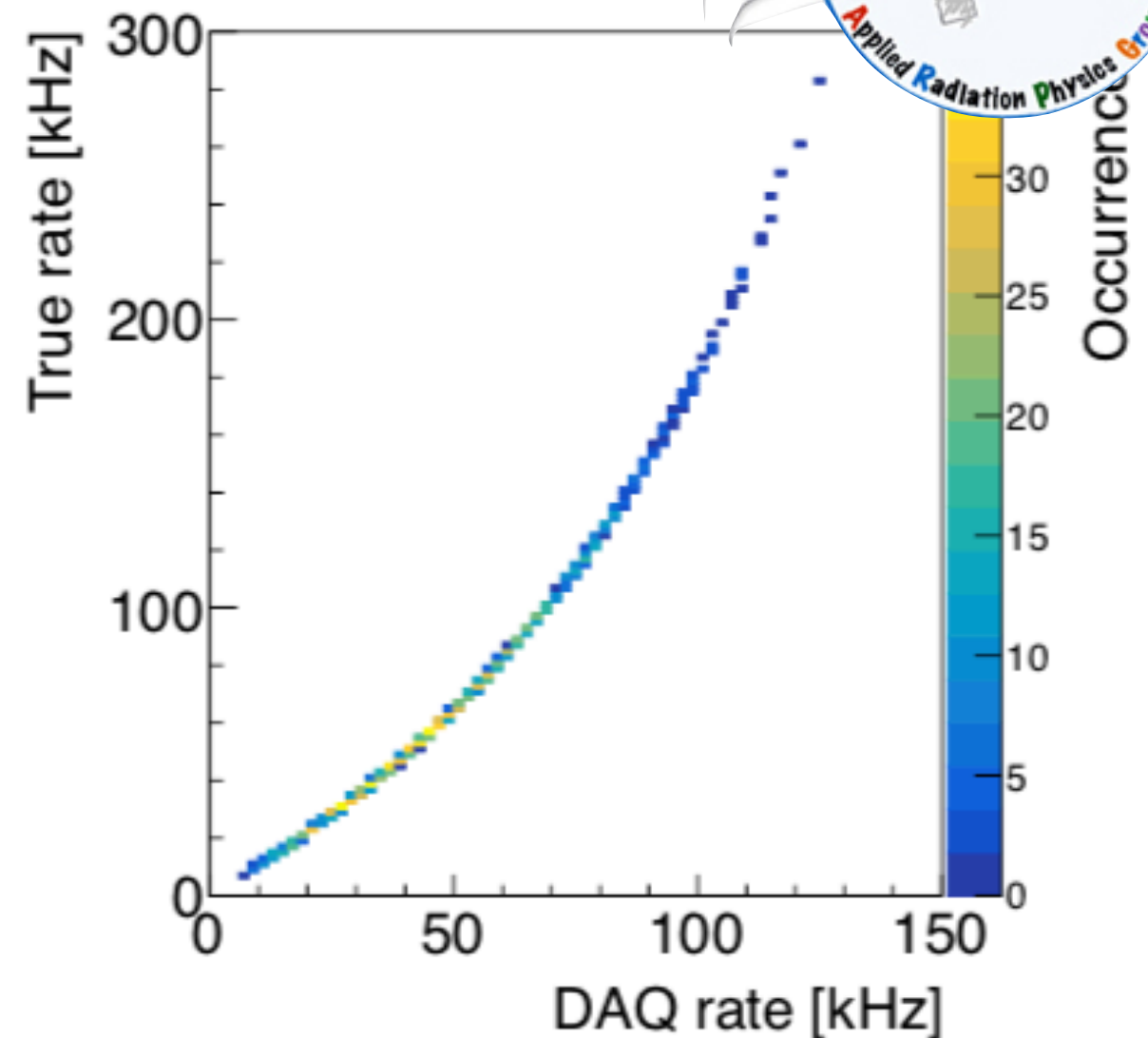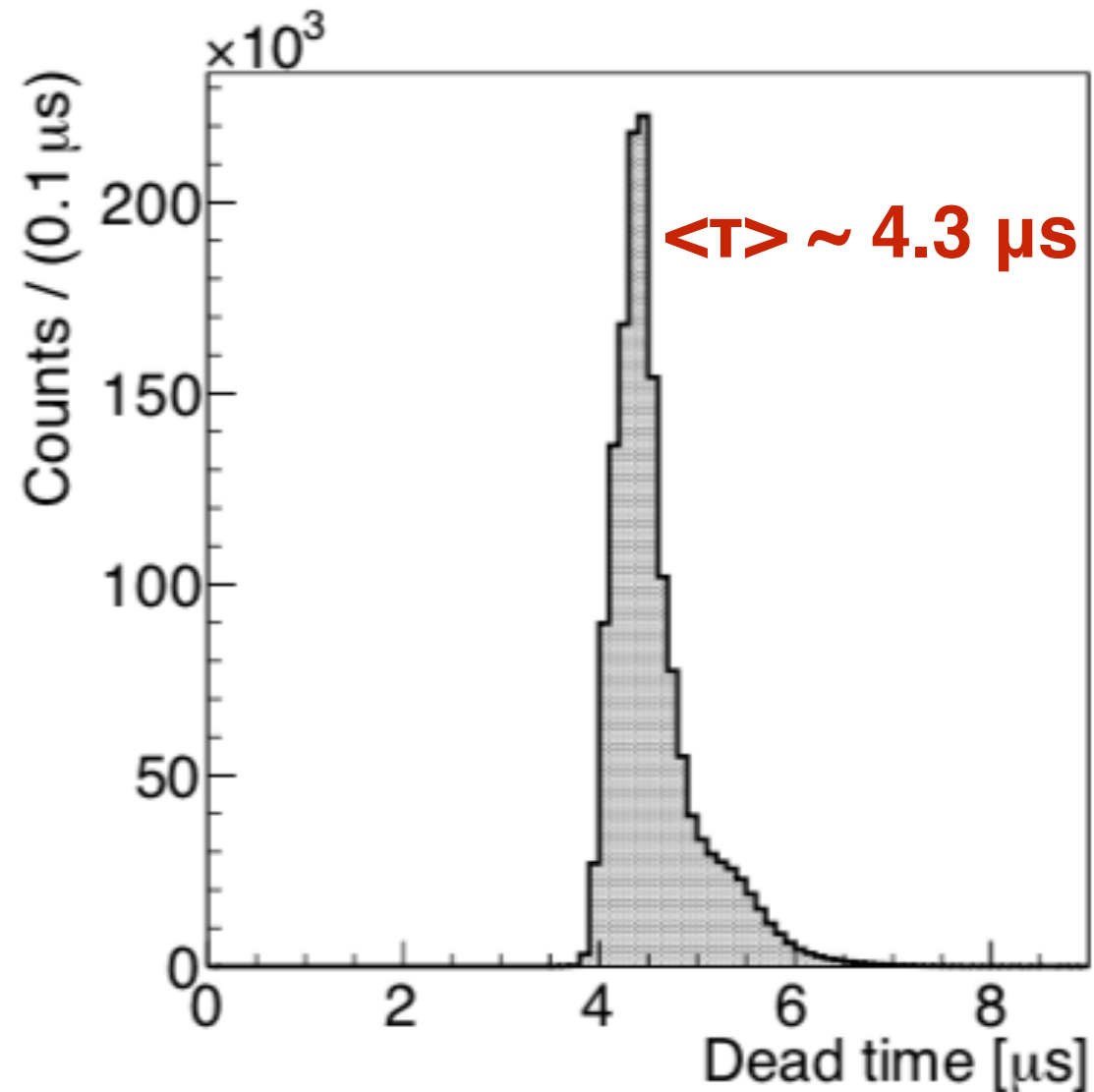
▷ **Dead time** and **DAQ rate** distribution from CNAO test beam of 23-25 Nov 2018 (last version of the firmware)

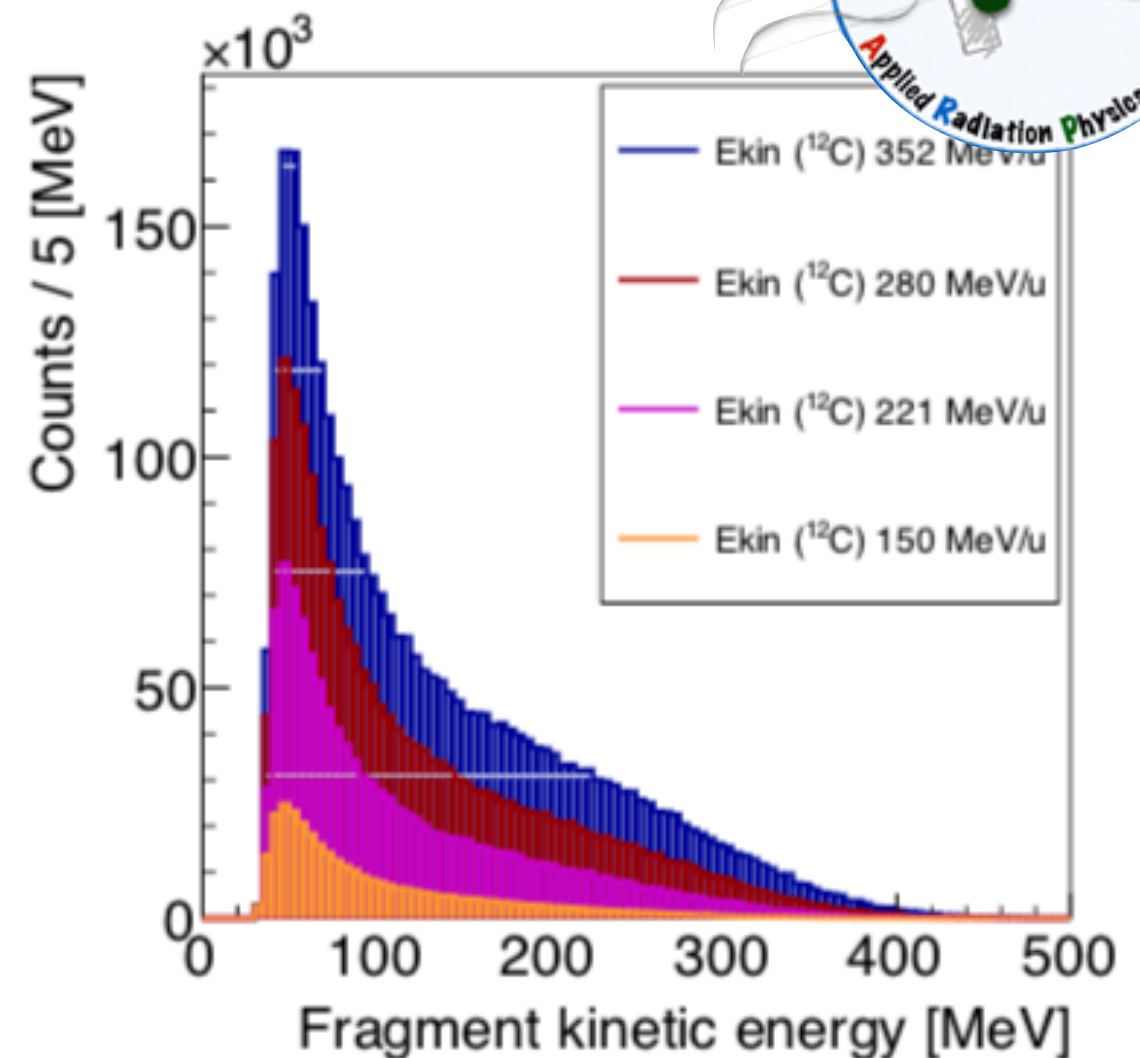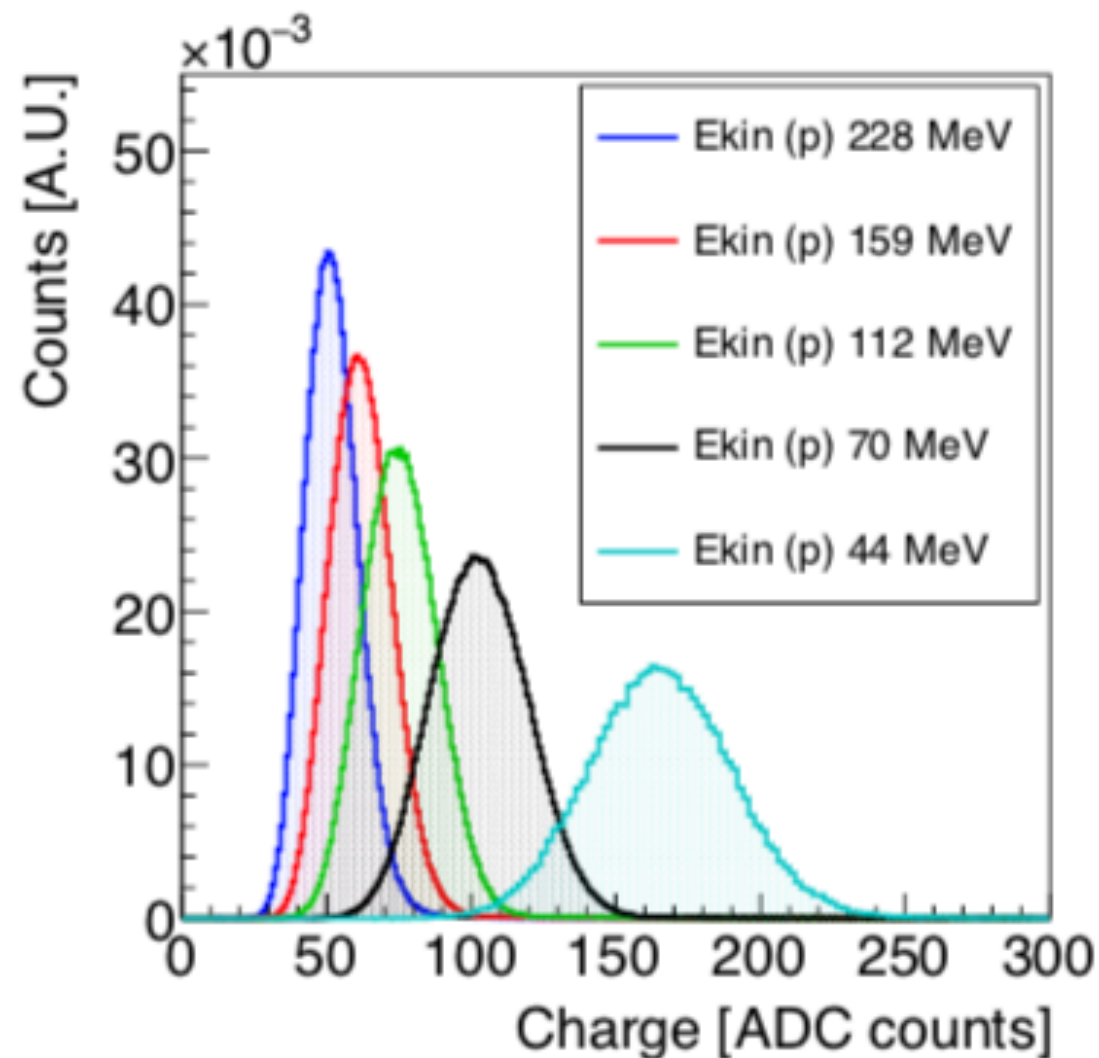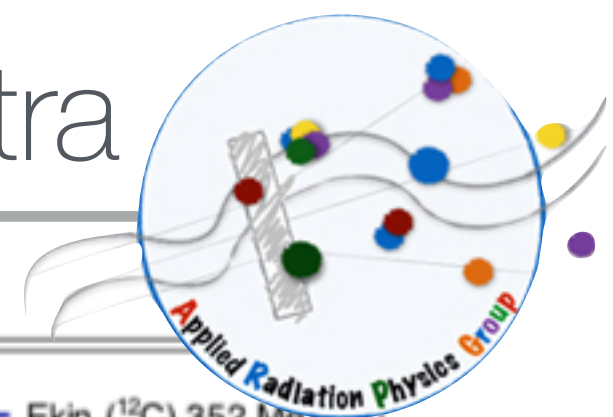▷ True rate expected in a treatment plan from that measured

$$R_{\text{true}} = \frac{R_{\text{meas}}}{1 - R_{\text{meas}}\tau}$$

Results: detection efficiency

- ▷ **Detection efficiencies**: evaluated on fragments emitted by a PMMA phantom (the only target available with the 8-layer DP version)

- ▷ Still missing: **systematic uncertainty evaluation,** using different methods for the efficiency measurement**.**

- ▷ **Energy spectrum of fragment** escaped by an anthropomorphic phantom, with the assumption that a tracks is a proton.

- ▷ The energy calibration has been obtained from the Trento data.

Conclusions
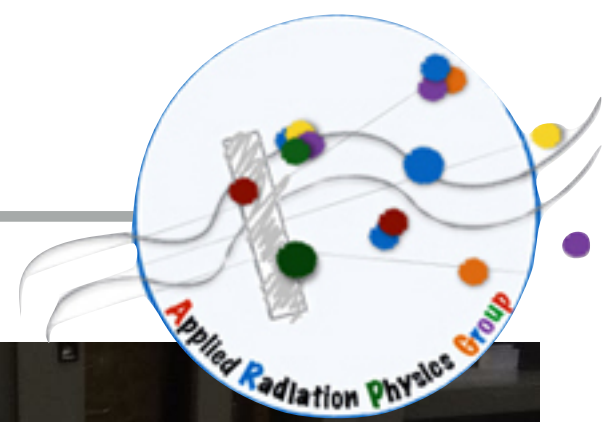
- The draft has been circulated to the SBAI people, we already received the first comments

- A final version will be sent to ARPG in January.