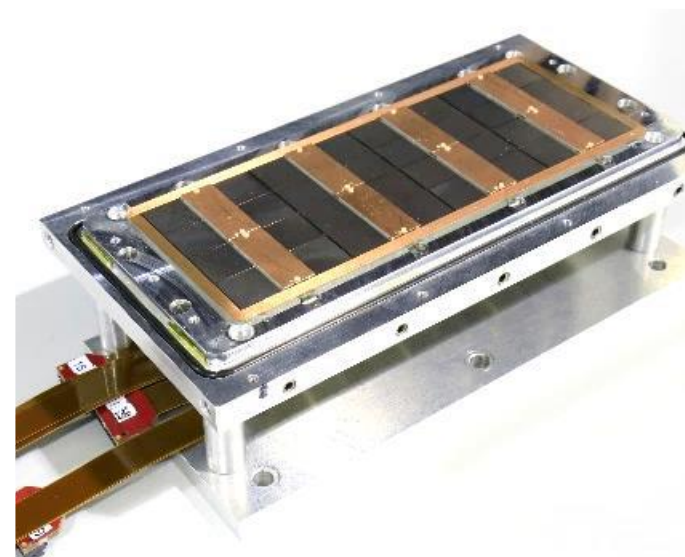
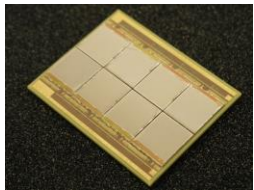
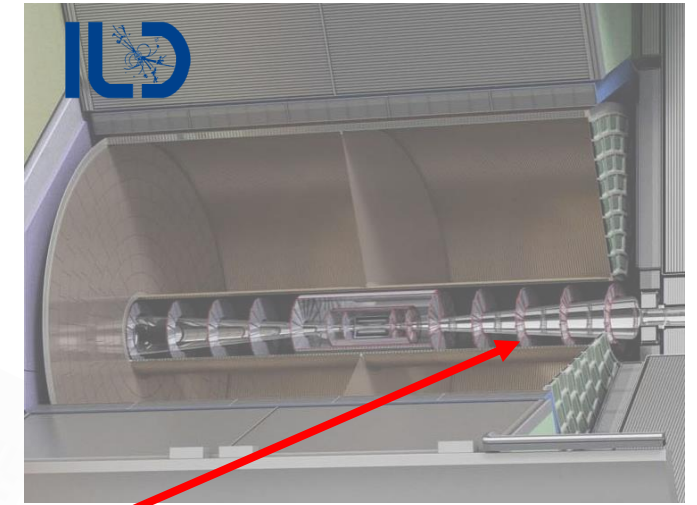


Yevgen Bilevych, Klaus Desch,
 Harry van der Graaf, Fred Hartjes,
 Jochen Kaminski, Peter Kluit,
 Naomi van der Kolk,
 Cornelis Ligtenberg,
 Gerhard Raven, and
 Jan Timmermans

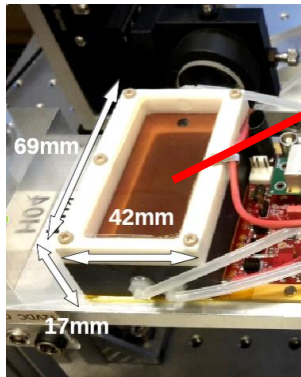


8 Quad Module

Pixel TPC



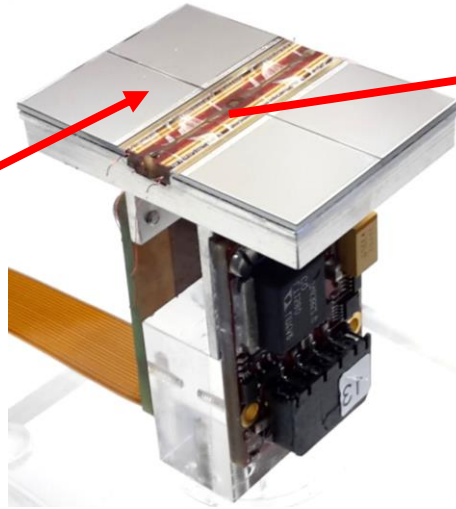
(Octopuce)



(TimePix1)
(2007-14)

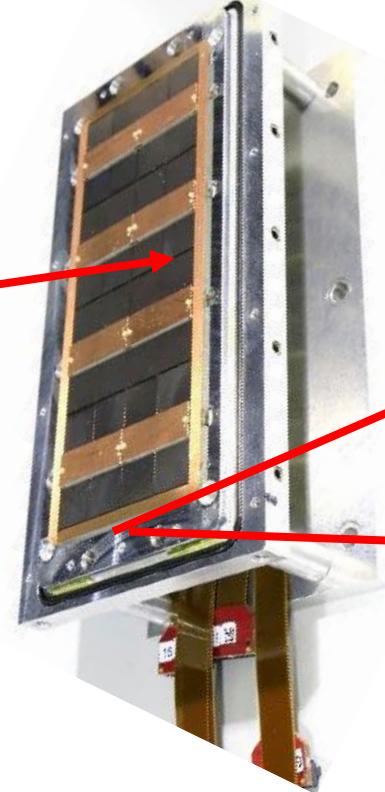
TPX3 chip

2017



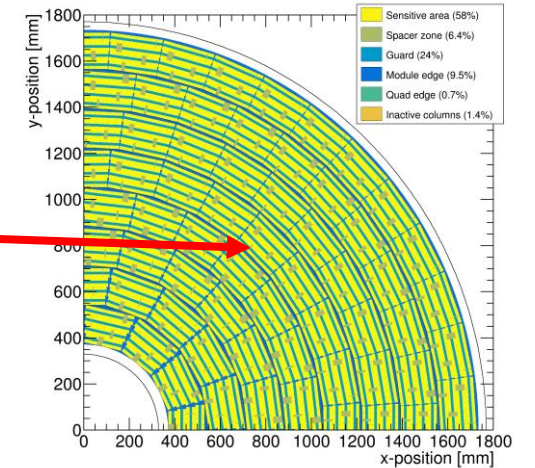
Quad

2018



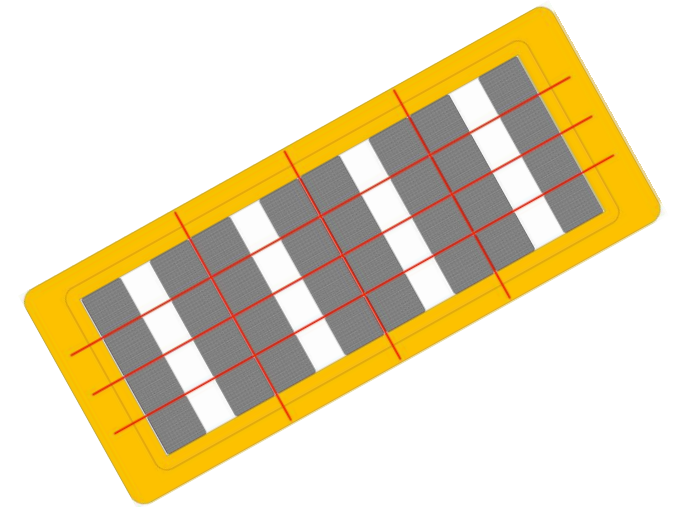
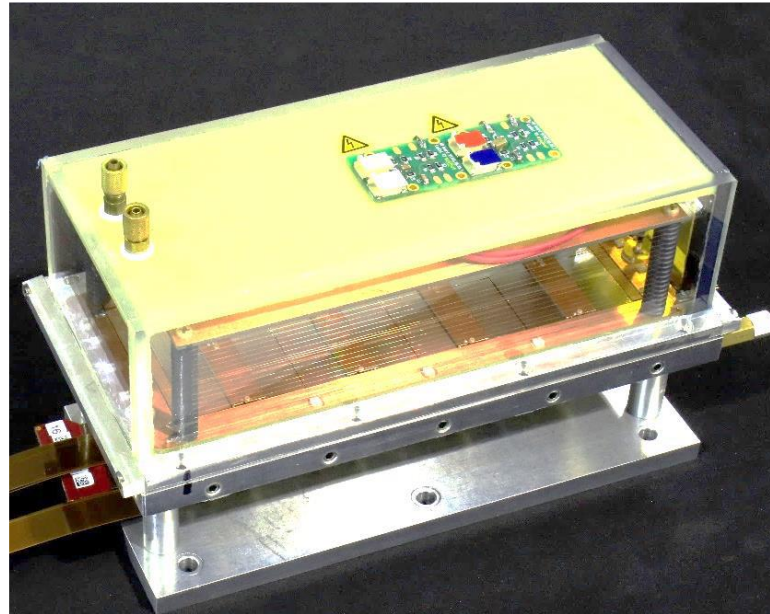
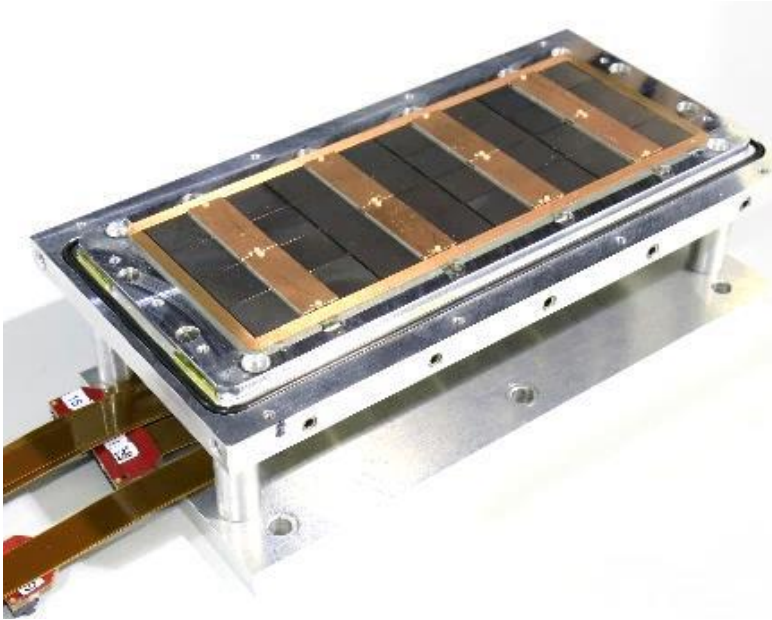
Module

2019

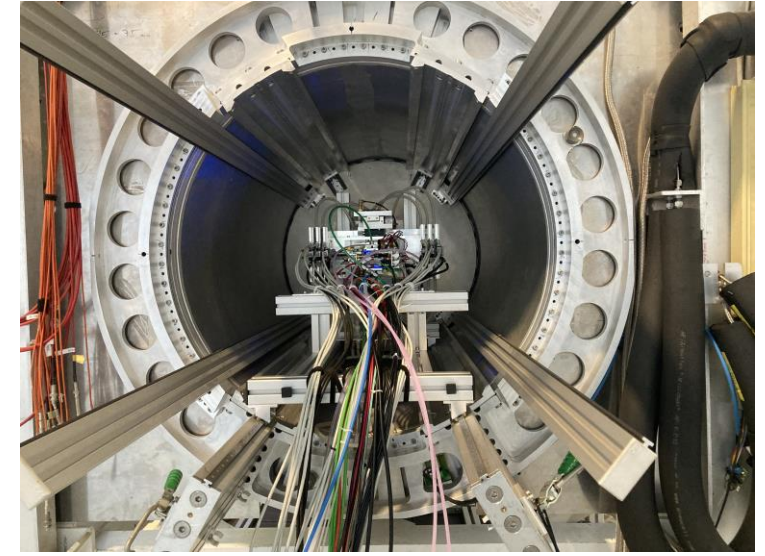
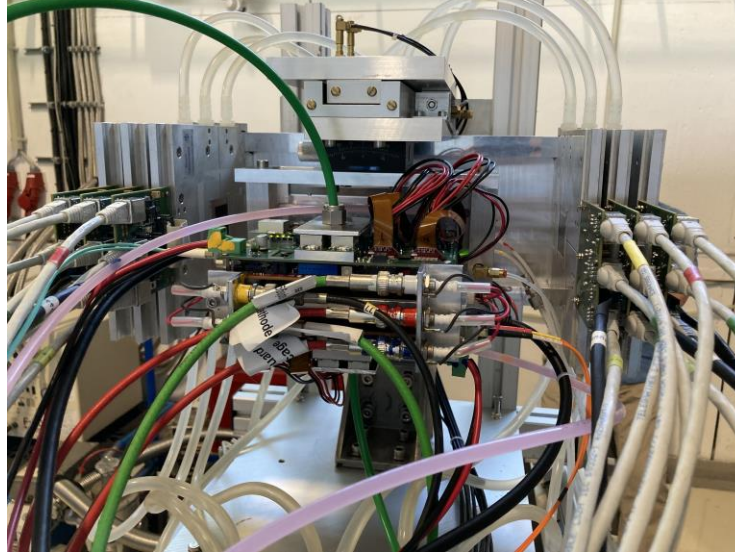


TPC plane

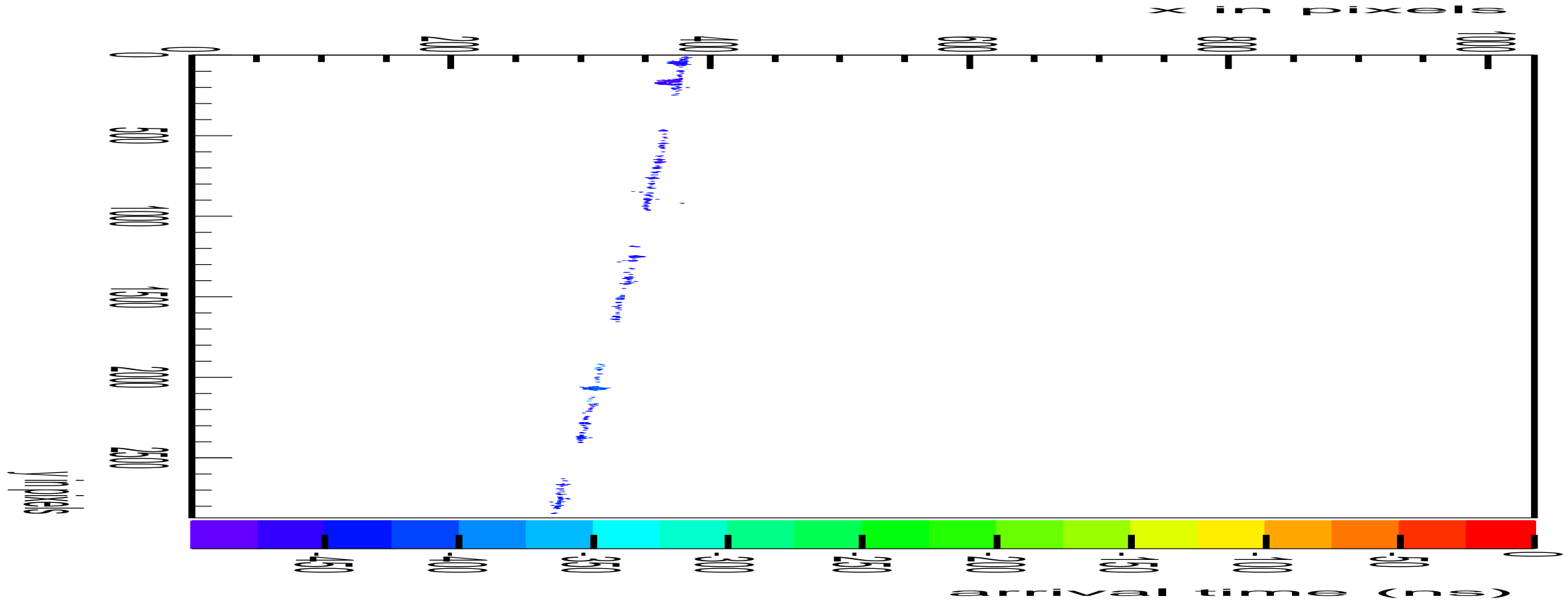
8-QUAD module with field cage



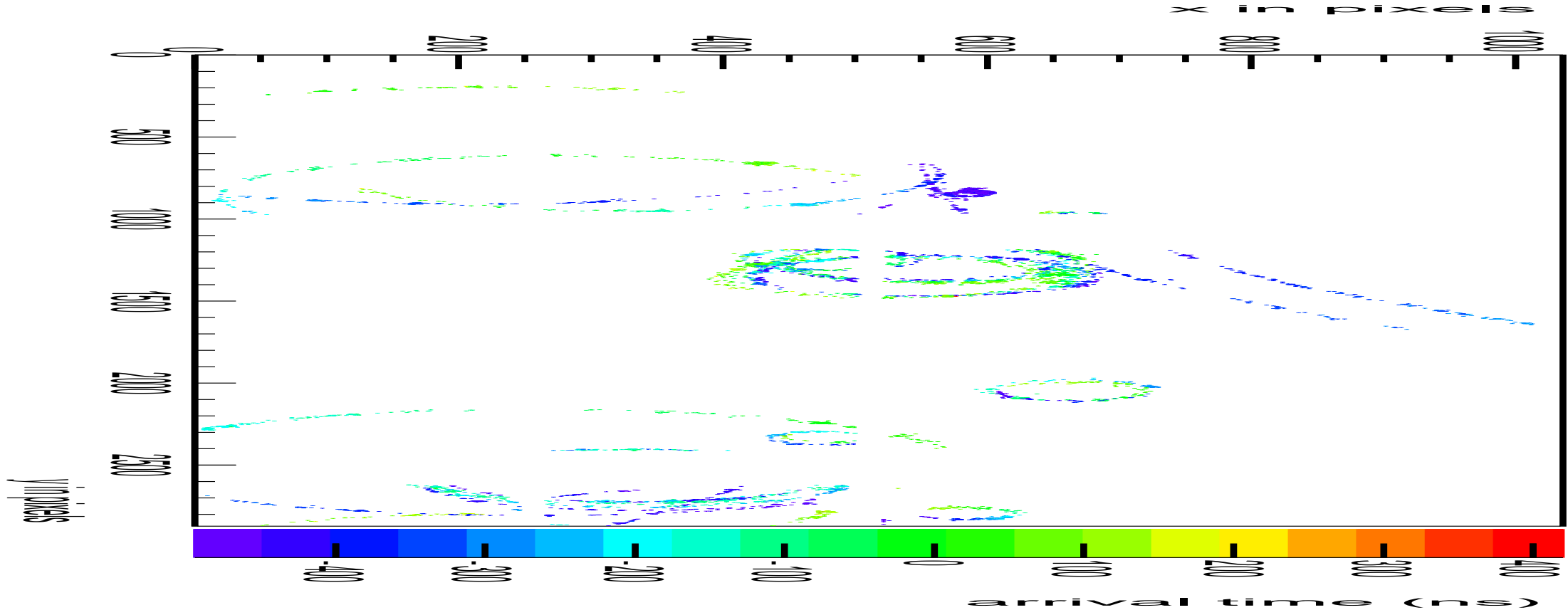
in red guard wires



Mounting the 8 quad module between the silicon planes
sliding it into the 1 T PCMAG solenoid



DESY DESY DESY
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LUTZ VON DER ESTEREN
KIMBERLY EICHT
DESIK



DESY Testbeam Experiment
Konrad-Zuse-Institut für Informatik
DESY Testbeam Experiment

- High statistics data taken with $B=0, 0.5$ and 1 T fields
- Electron Beam momenta of $6, 5$ and smaller sets with $4,3,1$ GeV
- The stager allowed to move the 8 Quad Module
 - 3 positions x and 4 in z (drift)
- Some data was taken with a rotated Module to allow studies of e.g. ExB deformations

- The Mimosa Silicon telescope was described and aligned using the corryvreckan software with the General Broken Lines (GBL) track model. The 'corryv' software was updated to allow for a curved track fit

Setup with Telescope planes

5 4 3

2 1 0



beam exit

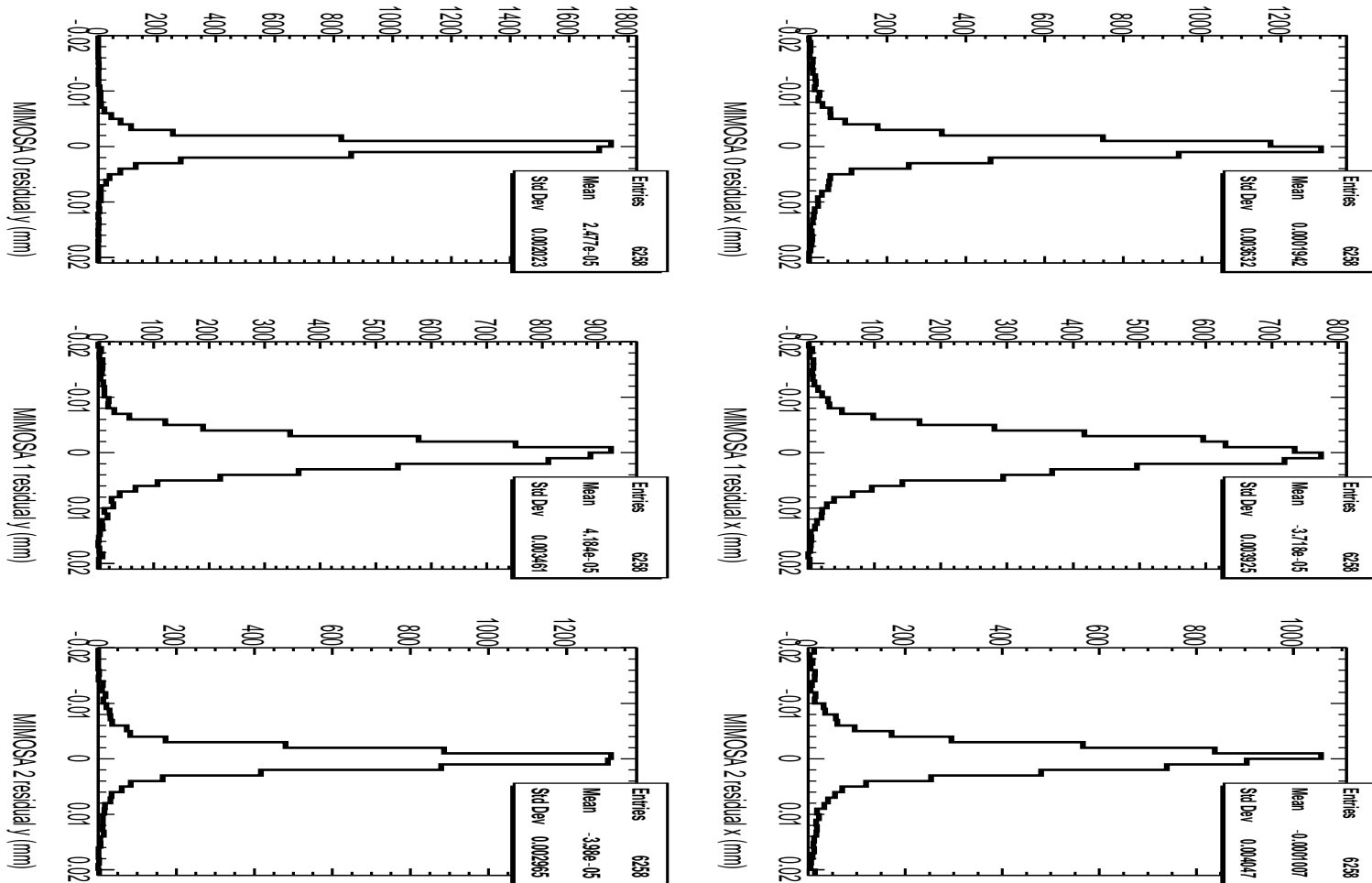
← z axis

beam entry
z=0

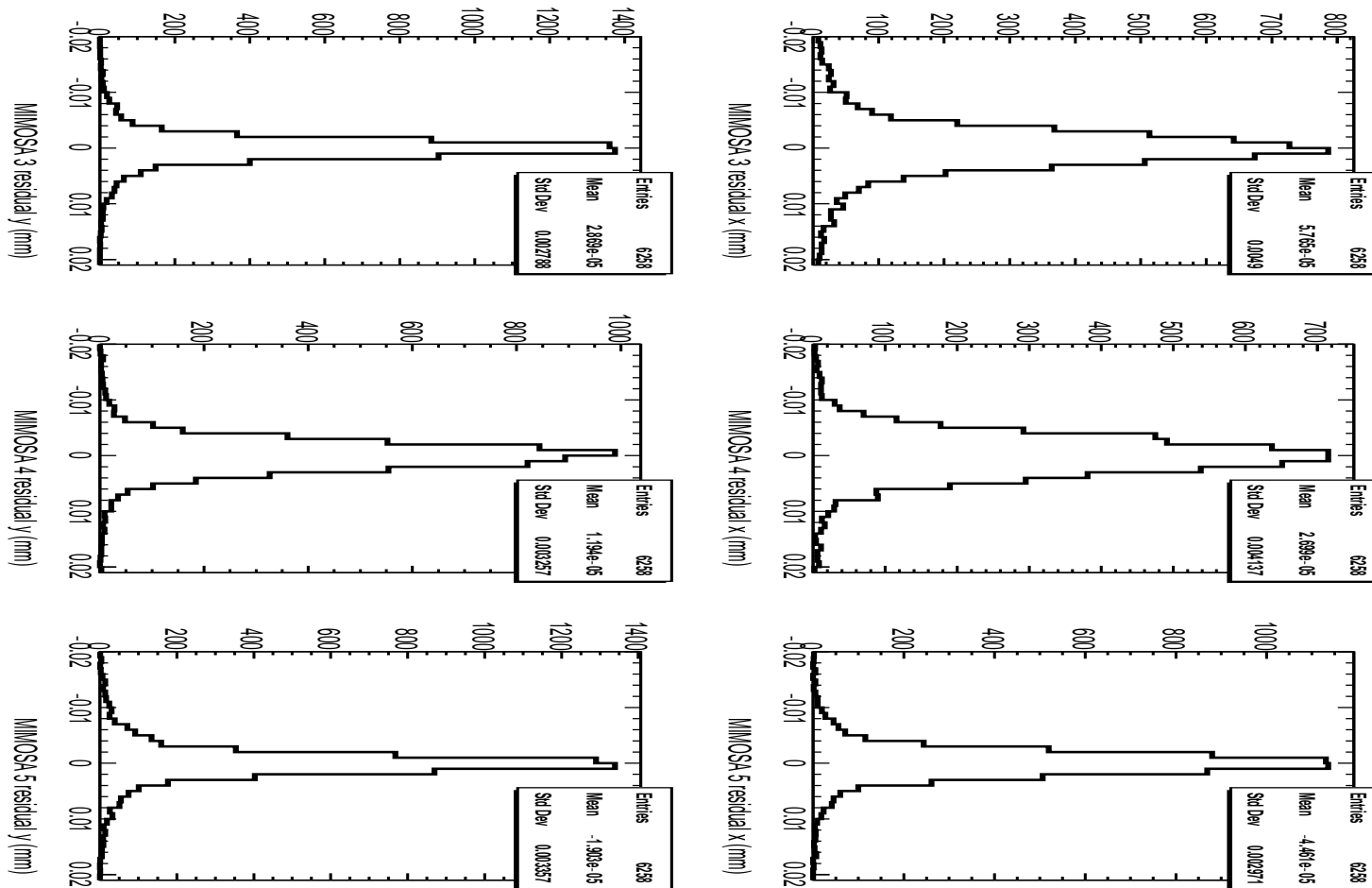
DESY Telescope Alignment

B=0 T run 6905

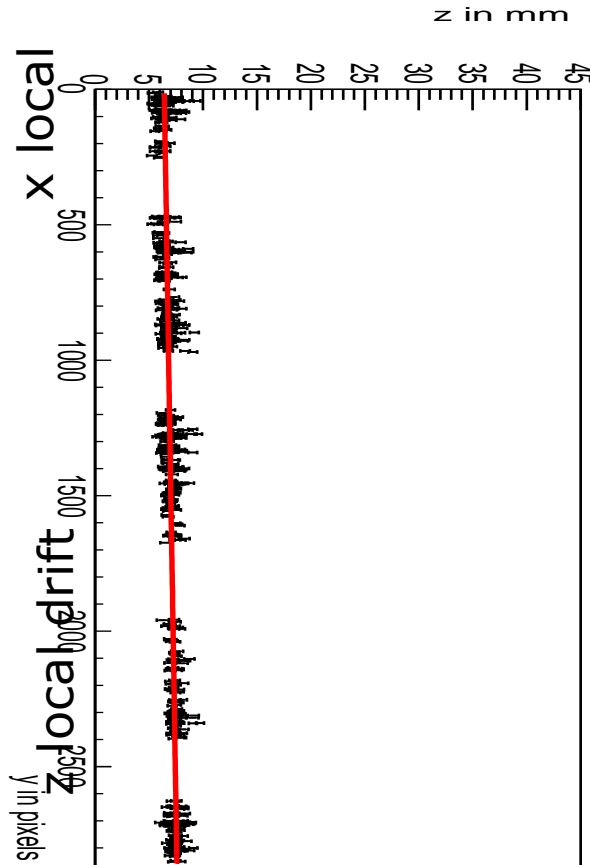
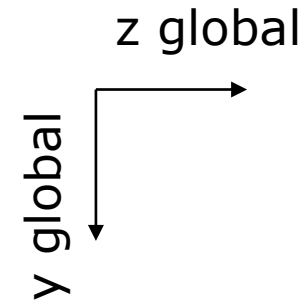
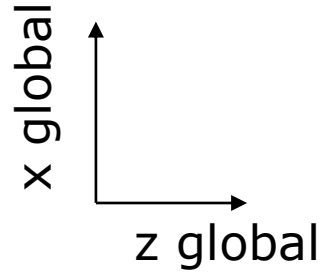
Preliminary



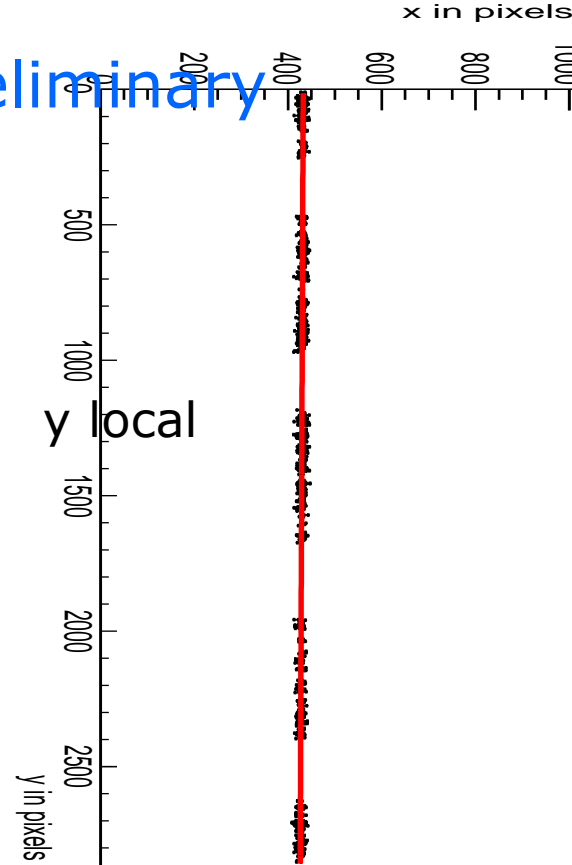
Preliminary



- Preliminary results for Run 6916 B=0 T p =6 GeV will be presented
- Tracks are preselected using the Mimosa Telescope
- Matching between Telescope track and hits local x 2 mm and z 5 mm
- Performed an alignment of the 8 quad module:
 - local frame xy and z (drift) positions; angles dx/dy and dz/dy
 - Adjusted t0 and x per chip
- Time slewing applied using ToT:
 - δt (ns) = $18.6 / (0.1577 + \text{ToT}(\mu\text{s}))$
- Drift velocity (E=280 V/cm) 78 $\mu\text{m}/\text{ns}$
- A local fit is performed to the track hits using errors:
 - $\sigma_{xy} = 250 \mu\text{m}$ and $\sigma_z = 425 \mu\text{m}$ (slight dependence on ToT)



Preliminary



DESY LCTPC-Pixel Testbeam Run 6916 Event 12 Bfield 0 T beam momentum 6 GeV/c

Track 1050 hits

$$\chi^2_{xy} = 912/1048$$

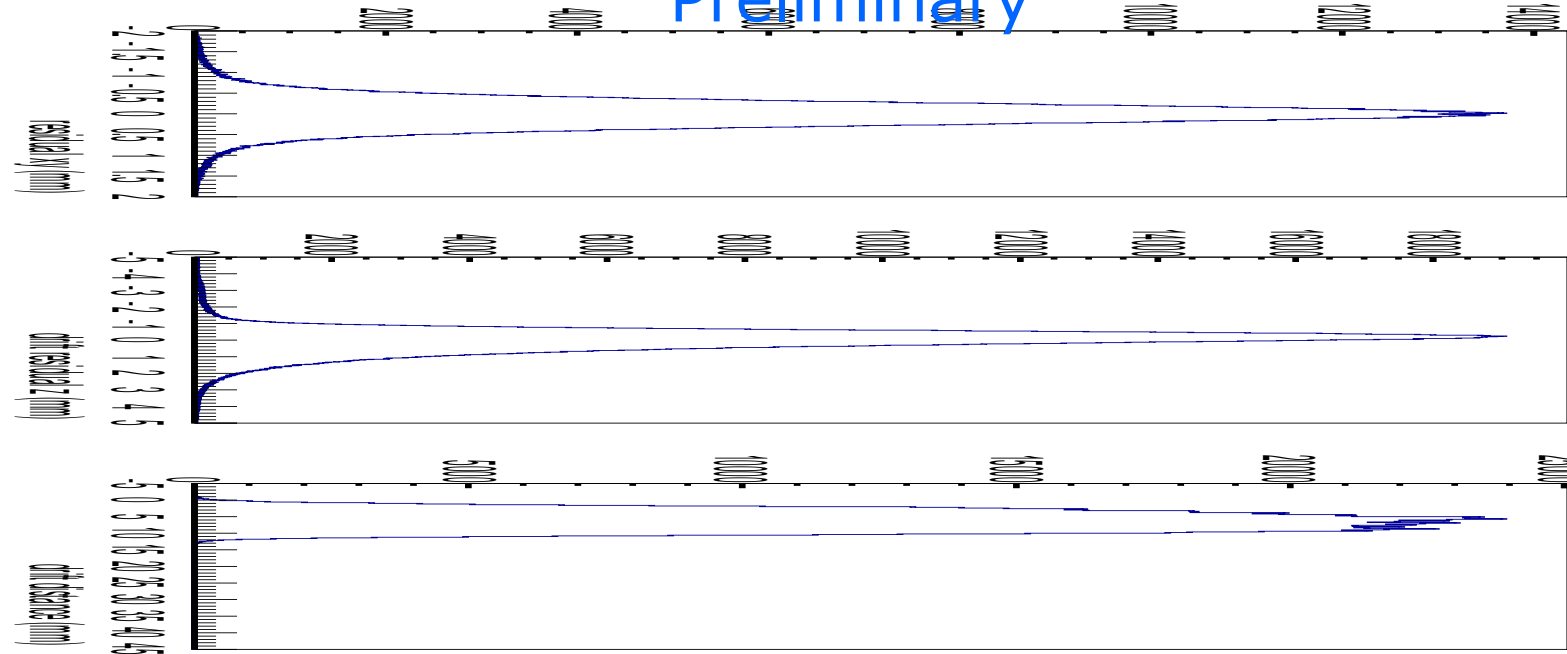
$$\chi^2_z = 1740/1051$$

(no asymmetric tail or outlier removal applied)

Run 6916 B=0 T p =6 GeV

$\sigma_{xy} = 250 \mu\text{m}$ and $\sigma_z = 425 \mu\text{m}$ 1M hits

Preliminary



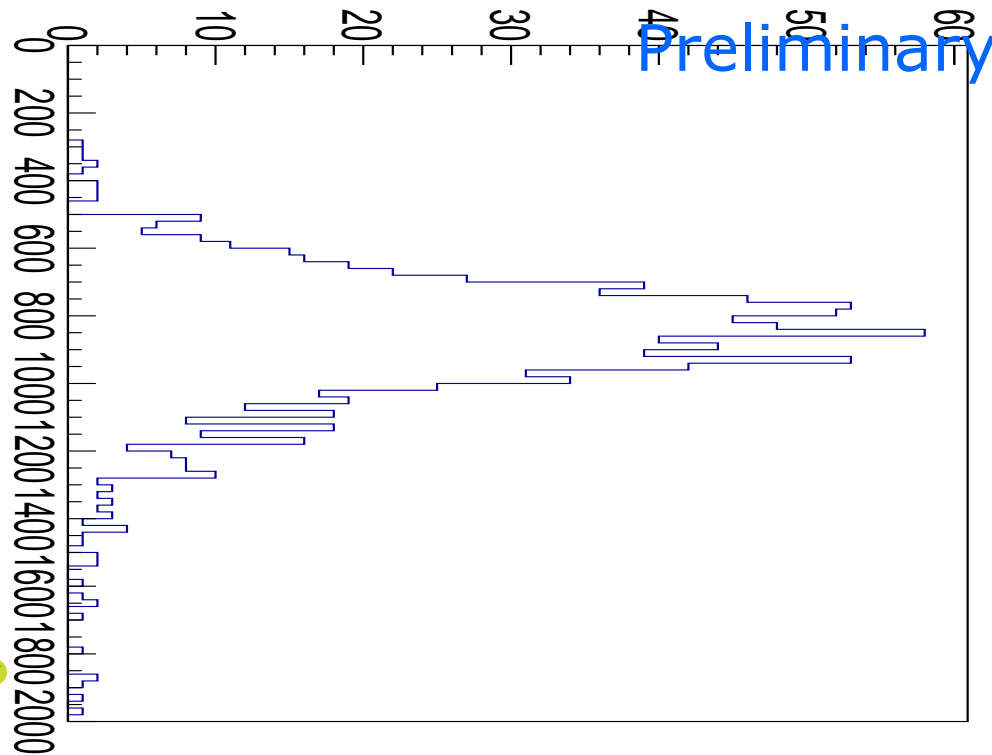
<mean> 6.4 mm

Run 6916 B=0 T p =6 GeV

Track selection:

more than 100 hits in concentrator 0 and 1

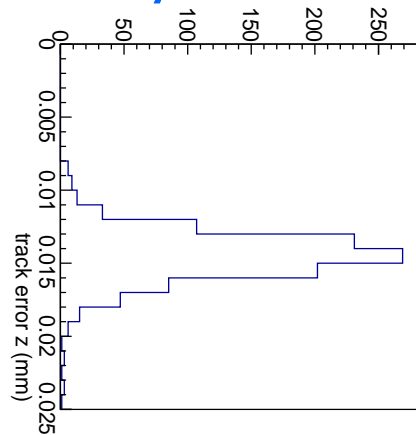
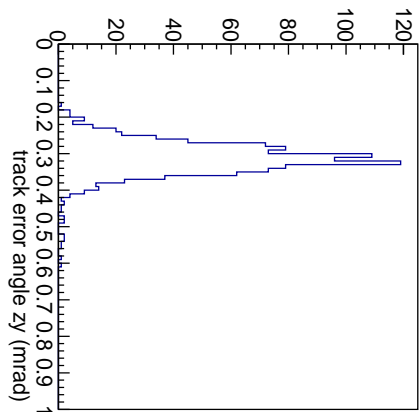
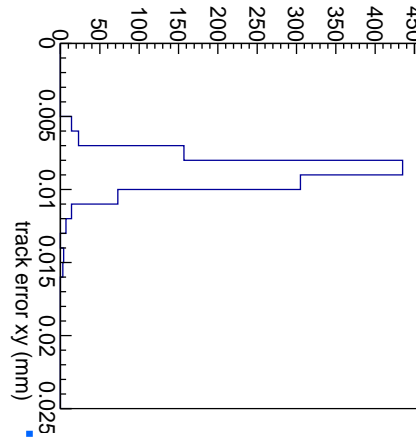
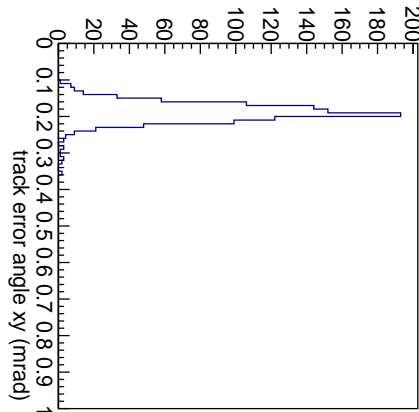
more than 50% of the hits should be on the tracks



1060 selected tracks

Impressive 900 hits / track

module or track length 157.96 mm



Preliminary

Tracking precision:

position $9 \mu\text{m}$ (xy) $13 \mu\text{m}$ (z)
 angle 0.19 mrad (dx/dy) 0.25 mrad
 module tracklength = 157.96 mm

Note that in a B field because of the reduced diffusion the tracking precision will improve substantially

Pixel TPC conclusions

- First preliminary results of the 8 Quad Module in the DESY test beam in June 2021 have been presented
- The run 6916 B=0 T with p=6 GeV has been analysed
- The Mimosa telescope has been aligned using the corryvrecan software and tracks fitted with the GBL package
- The 8 quad module data is decoded and matched to the tracks
- The single electron resolution is:
 - $\sigma_{xy} = 250 \mu\text{m}$ and $\sigma_z = 425 \mu\text{m}$ (mean drift distance of 6.4 mm)
- In total 1060 tracks were selected with 900 hits on track
- The tracking precision: position $9 \mu\text{m}$ (xy) $13 \mu\text{m}$ (z) in angle 0.19 mrad (dx/dy) 0.25 mrad
- Note that the module or tracklength is 157.96 mm
- This is very promising: more precise results can be extracted

Backup General Pixel TPC conclusions

- A single chip GridPix detector was reliably operated in a test beam in 2017
 - Single electron detection => the resolution is primarily limited by diffusion
 - Systematic uncertainties are low: < 10 μm in the pixel xy plane
 - dE/dx resolution for a 1 m track is 4.1%
- A Quad detector was designed and the results from the 2018 test beam presented
 - Small edge deformations at the boundary between two chips are observed
 - added guard wires to the module to obtain a homogeneous field
 - After correcting the edges, deformations in the transverse plane shown to be < 15 μm
- An 8-Quad module has been designed with guard wires
 - Deformations in the transverse plane for one quad are shown to be < 15 μm
- Test beam data taken at DESY in 2021 are being analysed
- A pixel TPC has become a realistic viable option for experiments
 - High precision tracking in the transverse and longitudinal planes, dE/dx by electron and cluster counting, excellent two track resolution, digital readout that can deal with high rates
 - A double grid will allow to reduce the Ion back flow distortions substantially