Testbeam with the latest Disc DIRC prototype

Klaus Föhl (on behalf of Julian Rieke)

PID session - PANDA meeting at GSI

7 March 2017

- PANDA Endcap Disc DIRC (EDD) and prototype
- Prototype optical components
- Testbeam area T24 at DESY
- Experimental set-up
- DAQ system based on TOFPET ASIC
- First testbeam results

Testbeam with the latest Disc DIRC prototype

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for the PANDA collaboration

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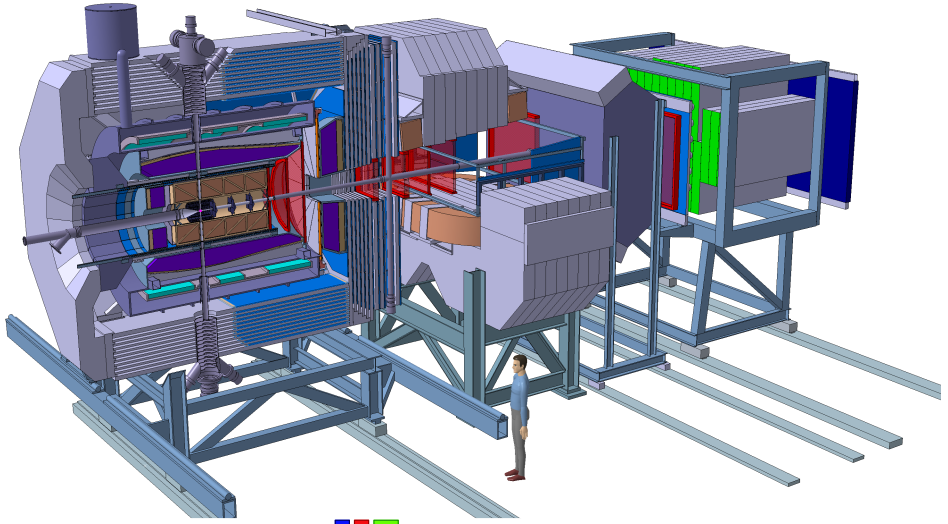
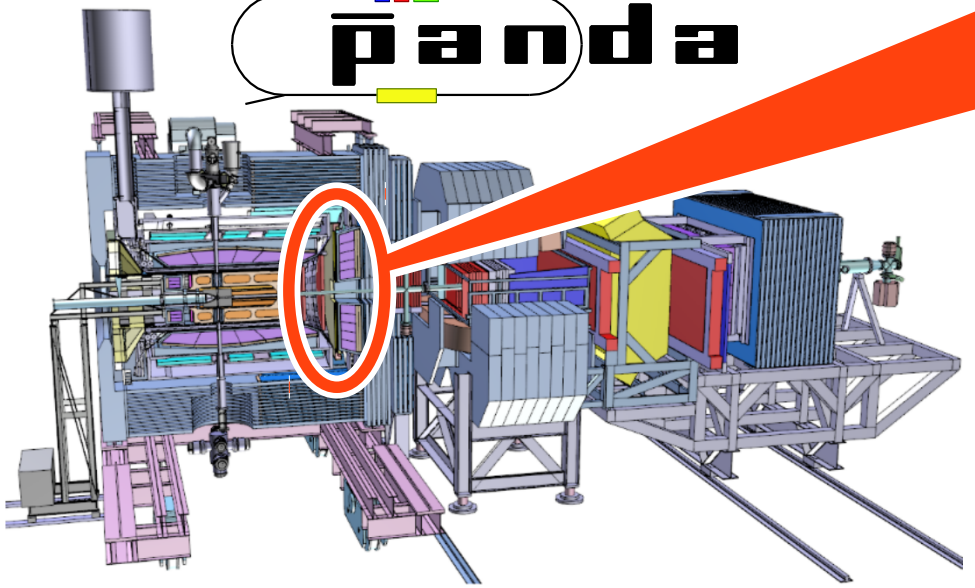
Münster 2017 – HK 44.4
DPG Frühjahrstagung / Spring Meeting
30 March 2017

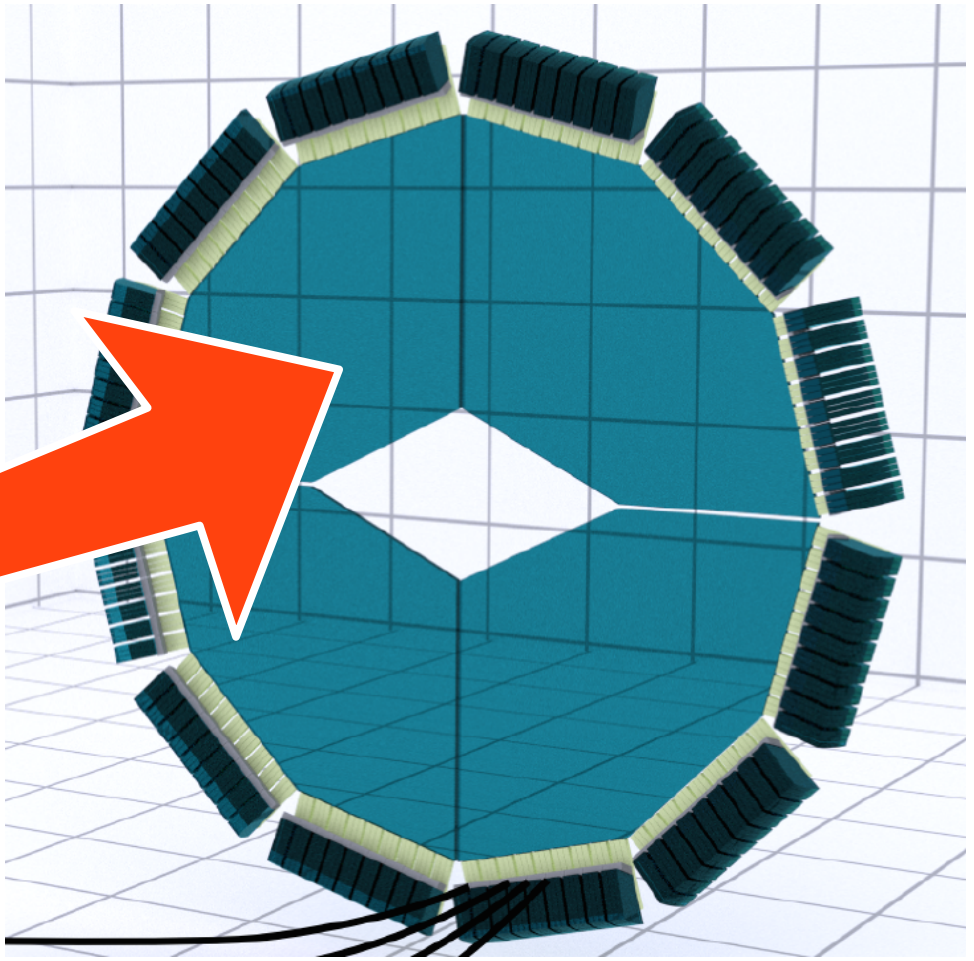
JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN
FAIR
HIC for FAIR Helmholtz International Center
GSI panda
Bundesministerium für Bildung und Forschung

EDD in PANDA





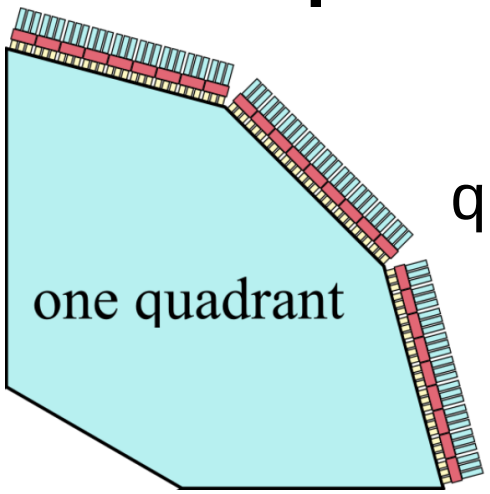
Target Spectrometer Forward Spectrometer



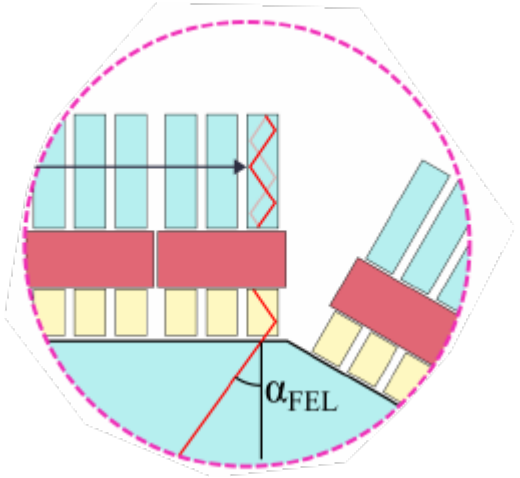
Endcap Disc DIRC

Components for EDD prototype

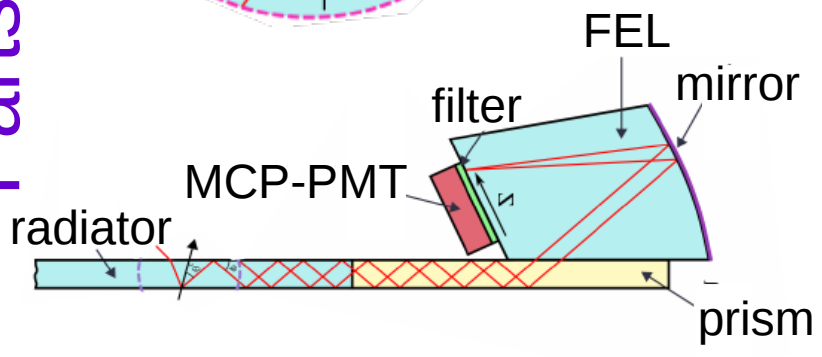
Parts of the EDD for PANDA

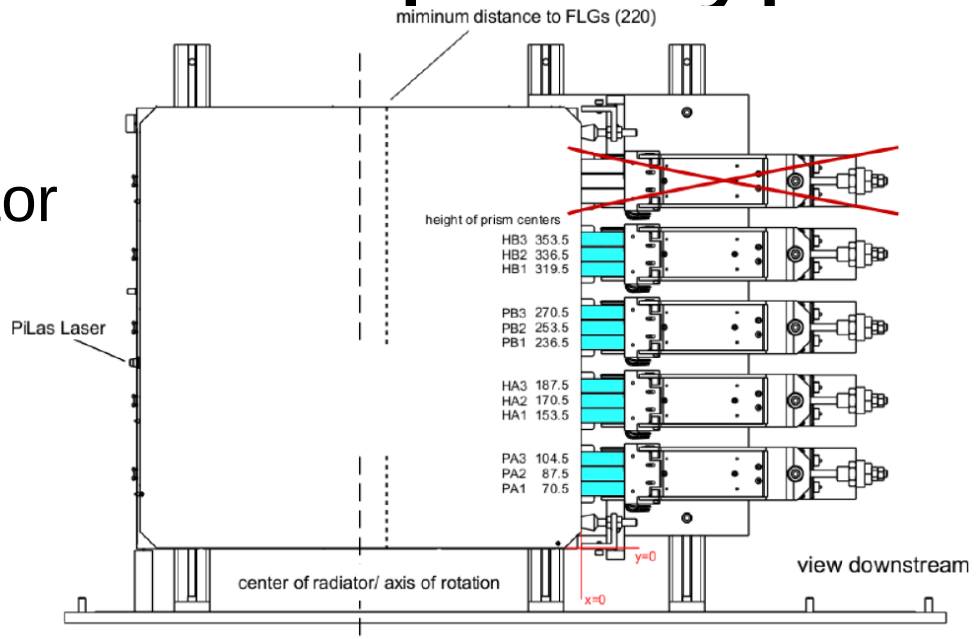


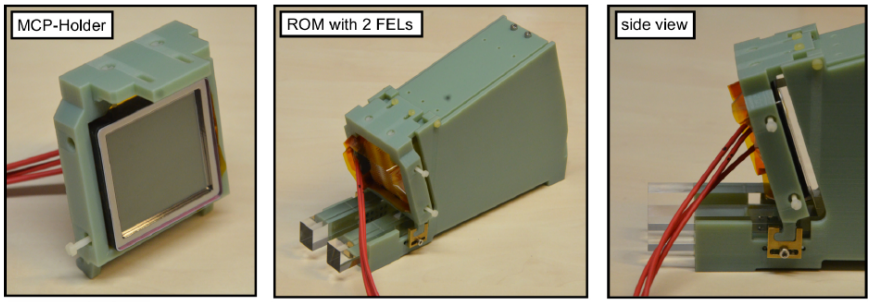
quartz radiator

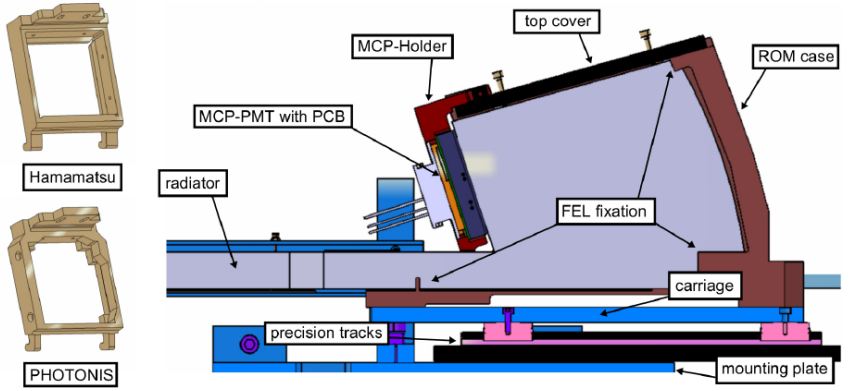


Read-out Modules







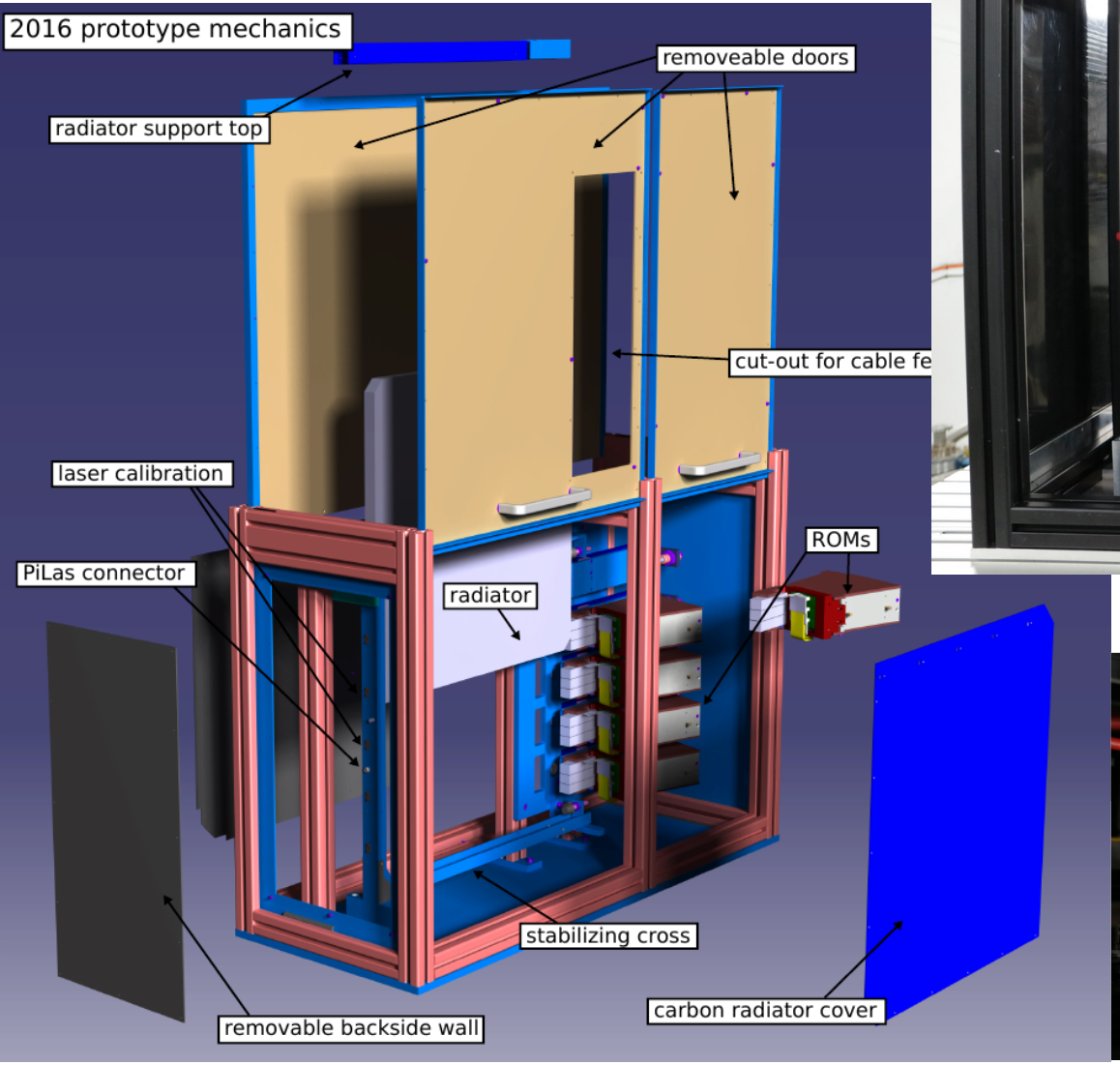


Prototype EDD components

EDD Prototype

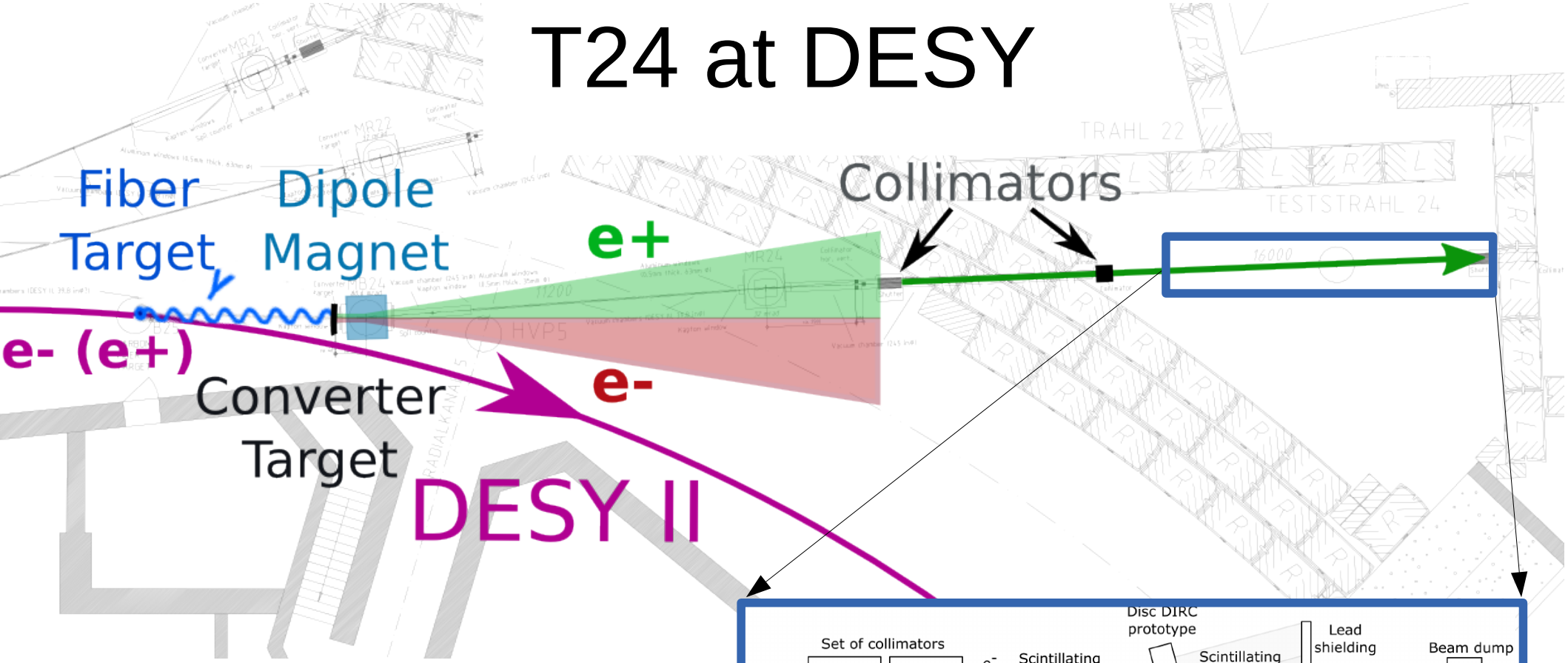
Prototype partially assembled.
View from ROM assembly side,
Upstream side in DESY 2016 test.

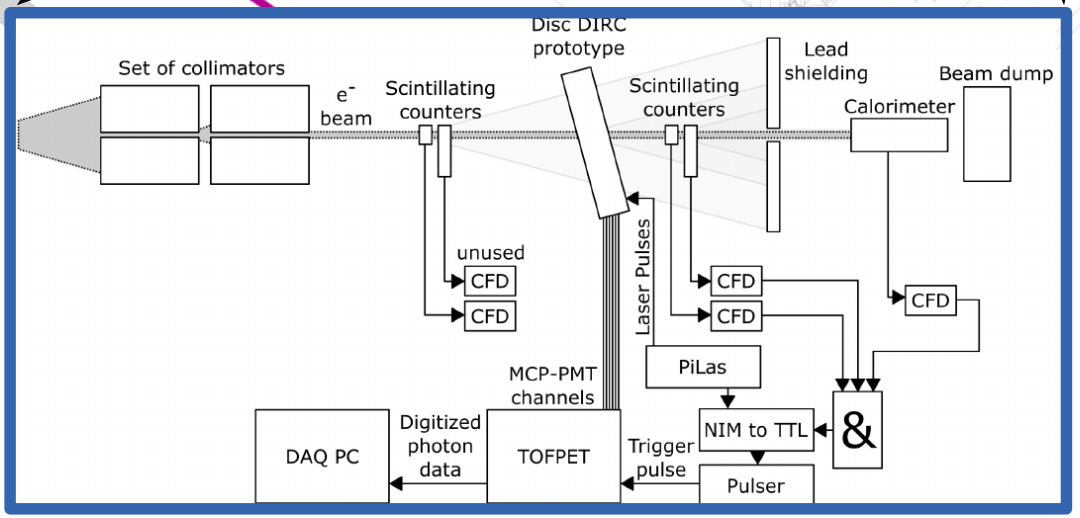
EDD 2016 prototype CAD 3D rendering



ROM with MCP in contact with quartz

T24 at DESY



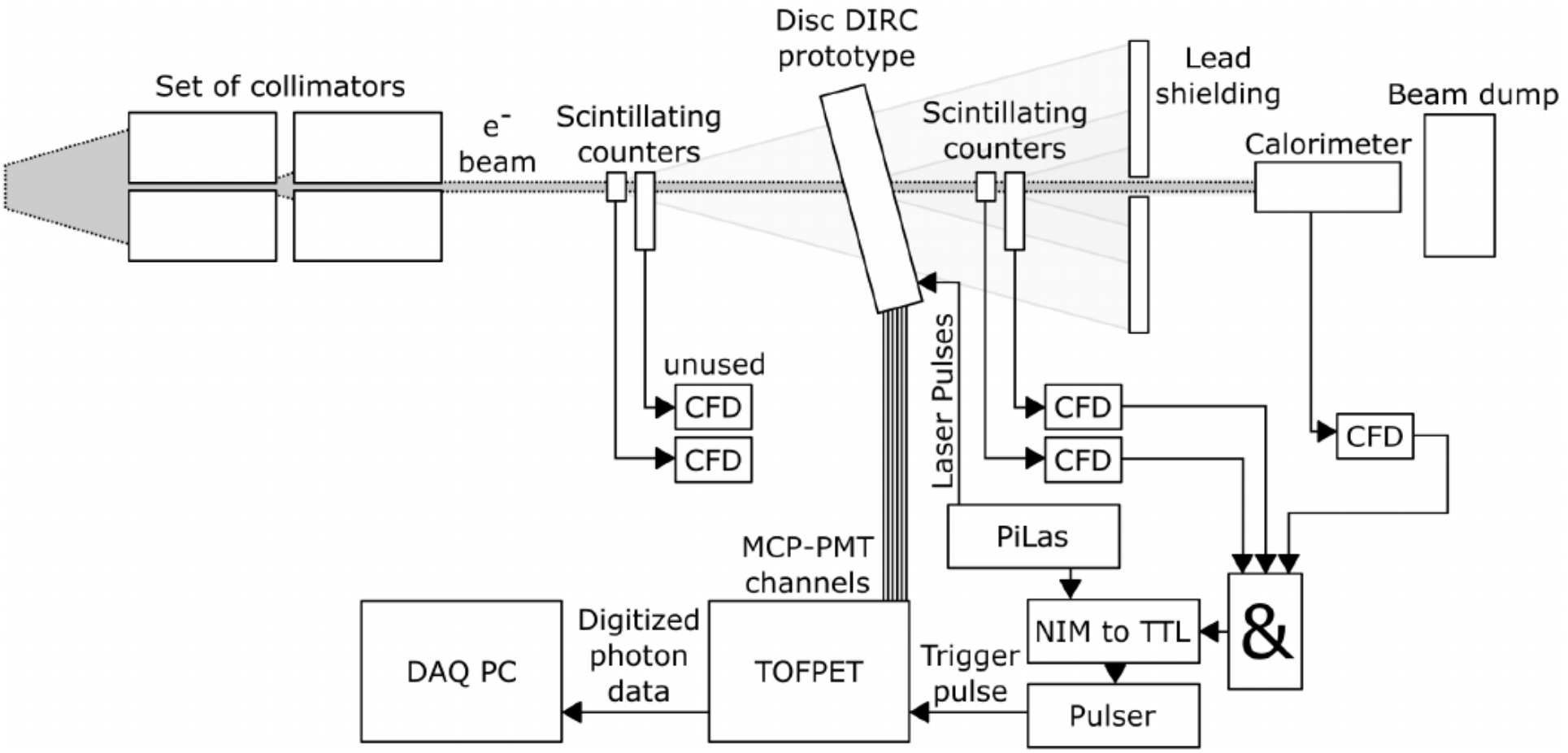


Beam characteristics

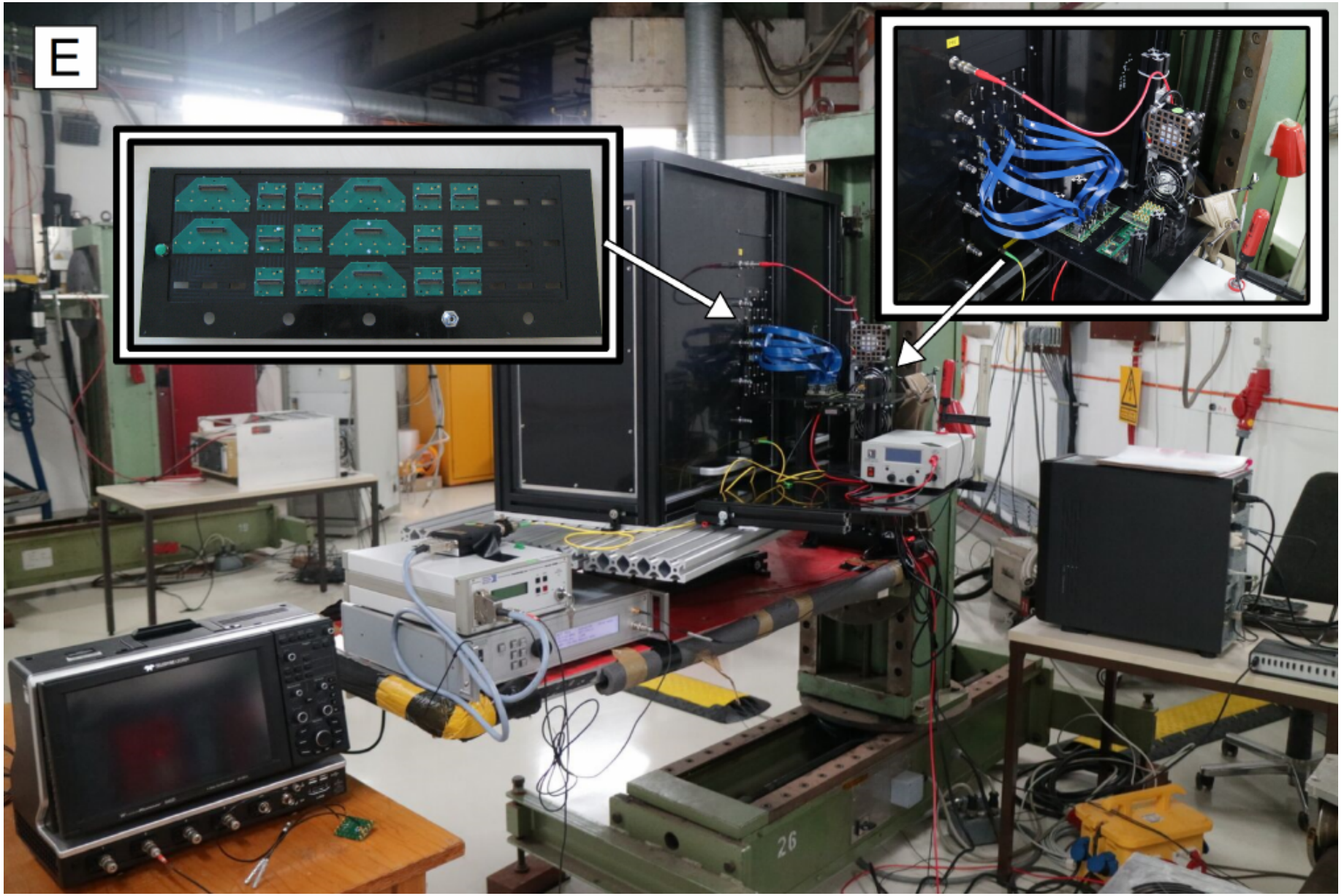
Spatial uncertainty of e^- on radiator	$\approx 5\,\mathrm{mm}$
Angular uncertainty of e^-	$\approx 1\,\mathrm{mrad}$
Beam momentum	$3\,\mathrm{GeV/c}$
Size of primary collimator	$5\times5\,\mathrm{mm}$
Size of secondary collimator	$15\times15\,\mathrm{mm}$

Testbeam at DESY – Teststrahl 24 Area

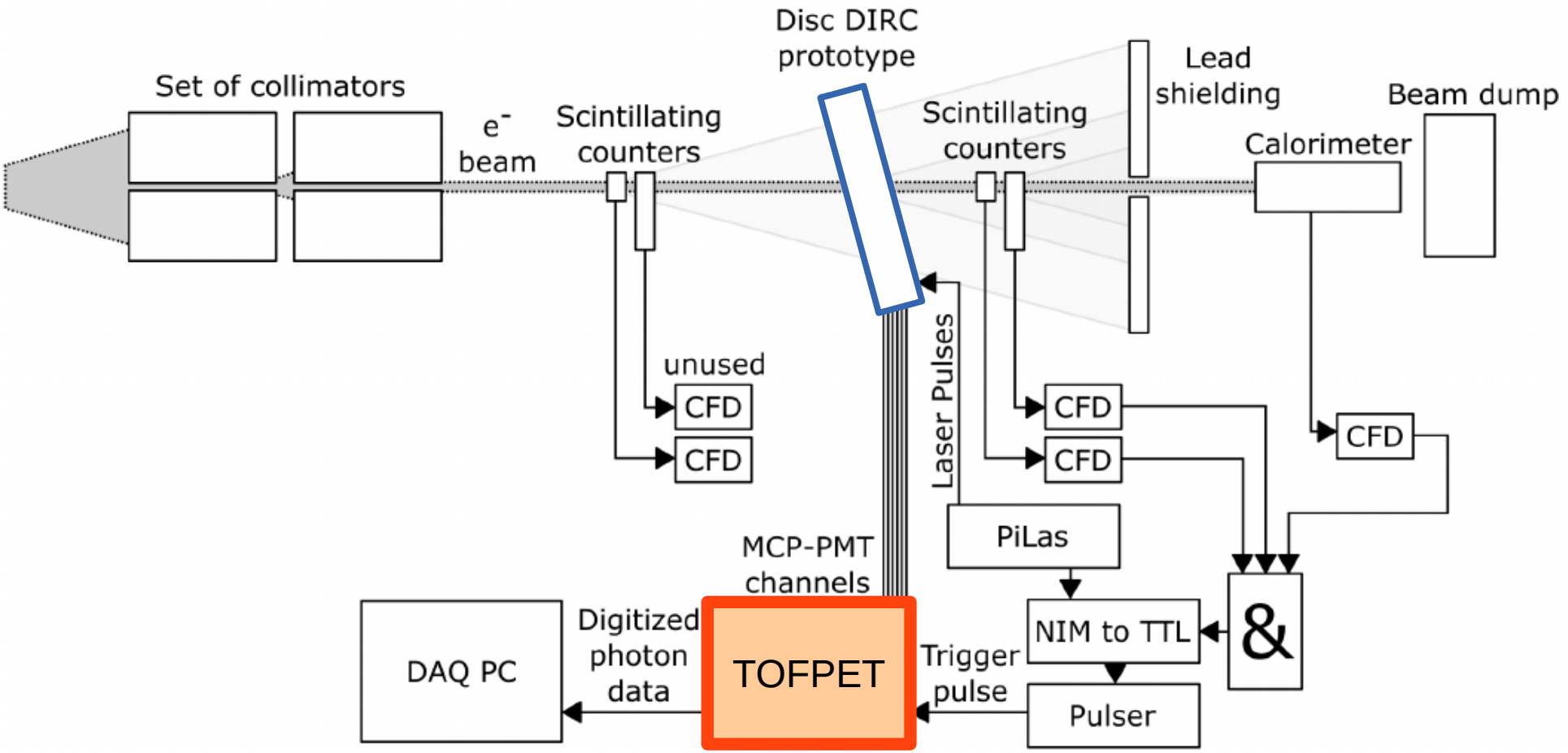
Experimental set-up - schematic



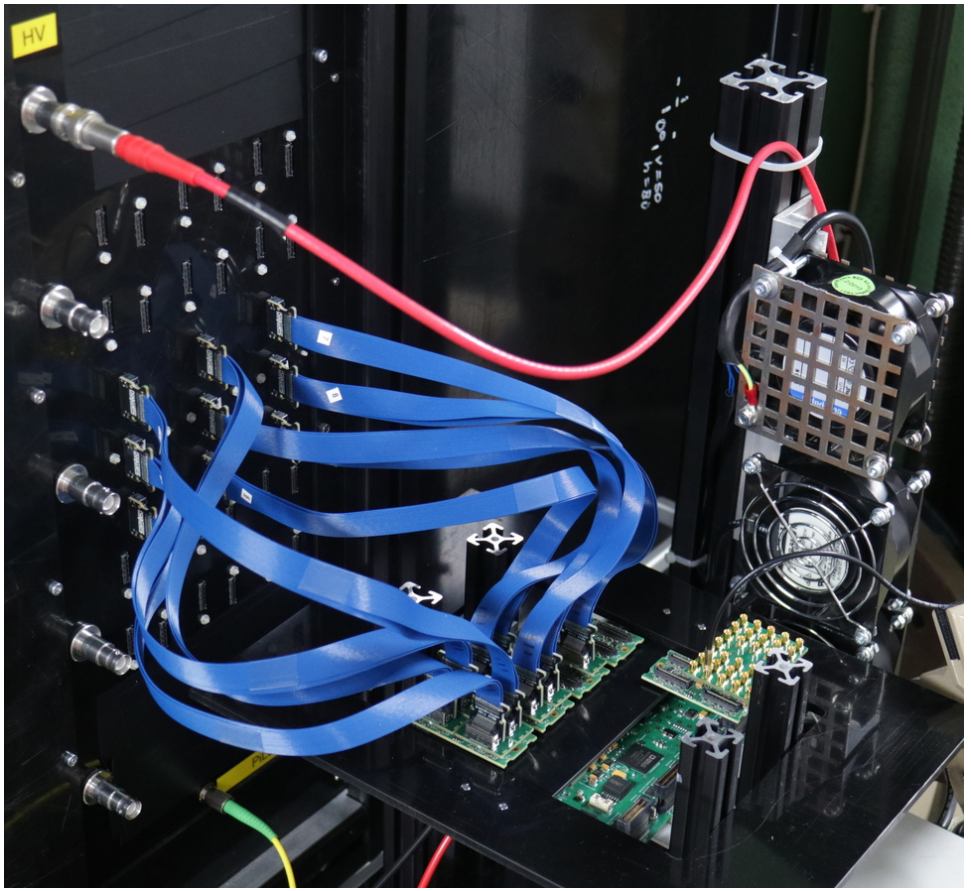
Experimental set-up – in situ

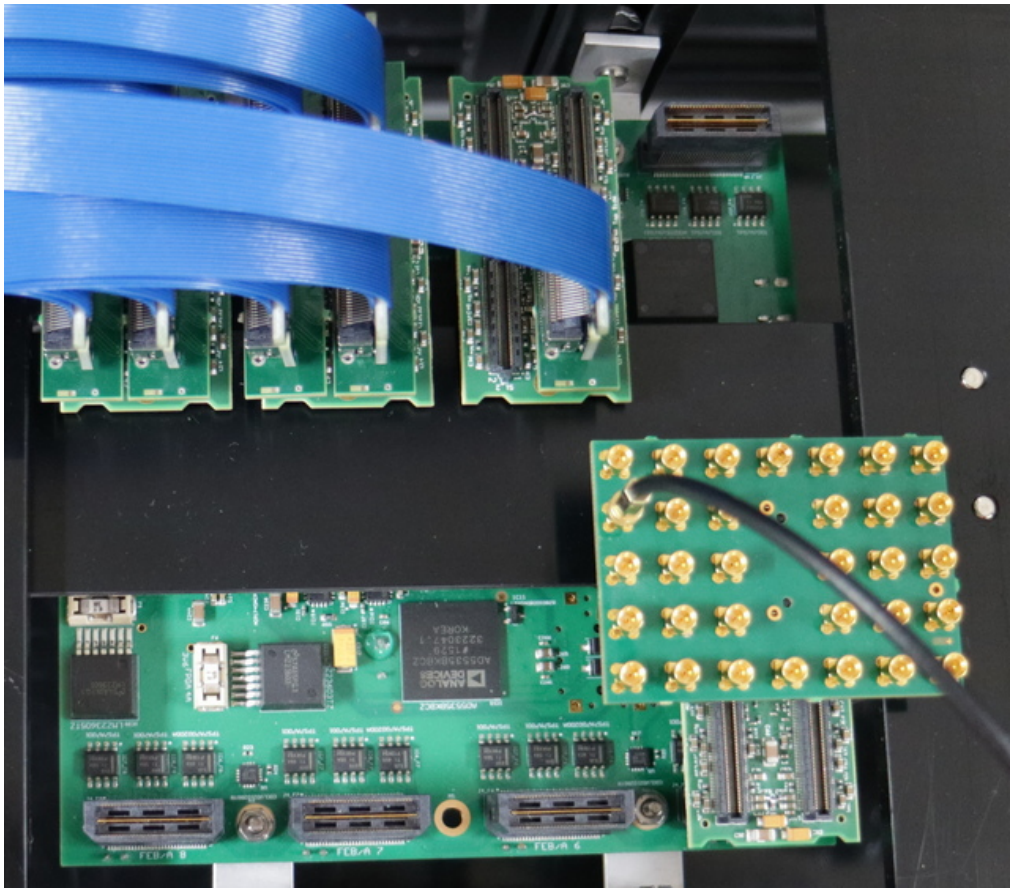


Experimental set-up – schematic 2



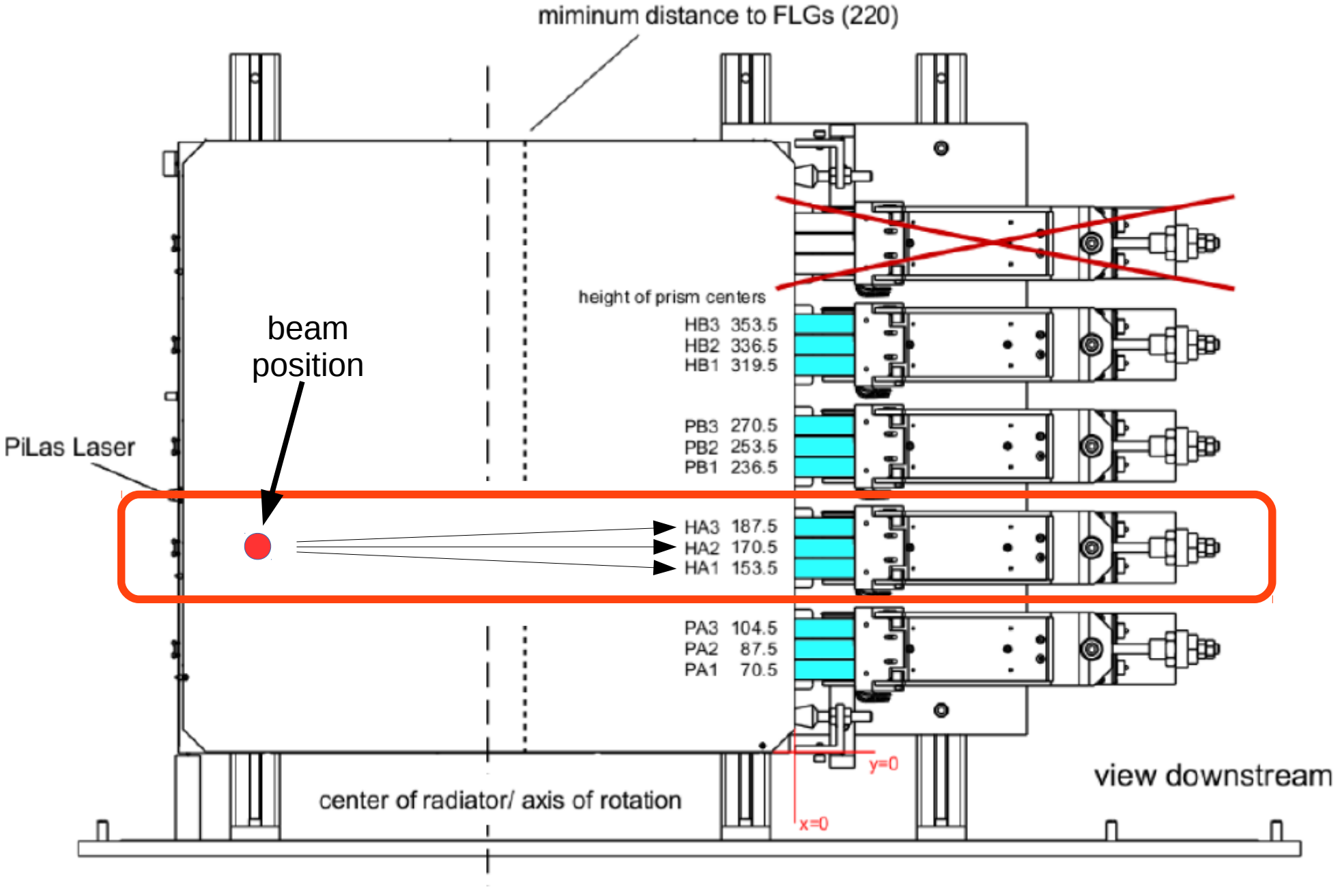
DAQ using TOFPET readout



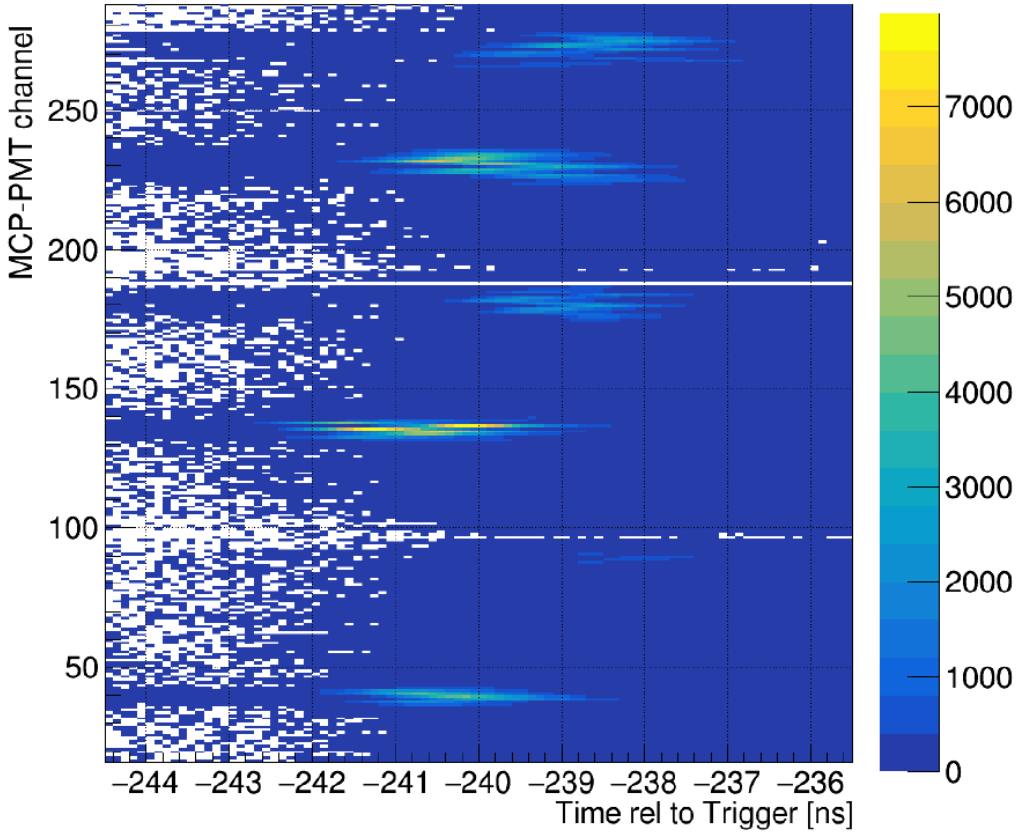


- High density coaxial cables
- Feed-through and adapter PCBs
- TOFPET boards A and board D

Beam positioning on radiator



Time and space patterns



time calibrated with laser pulser

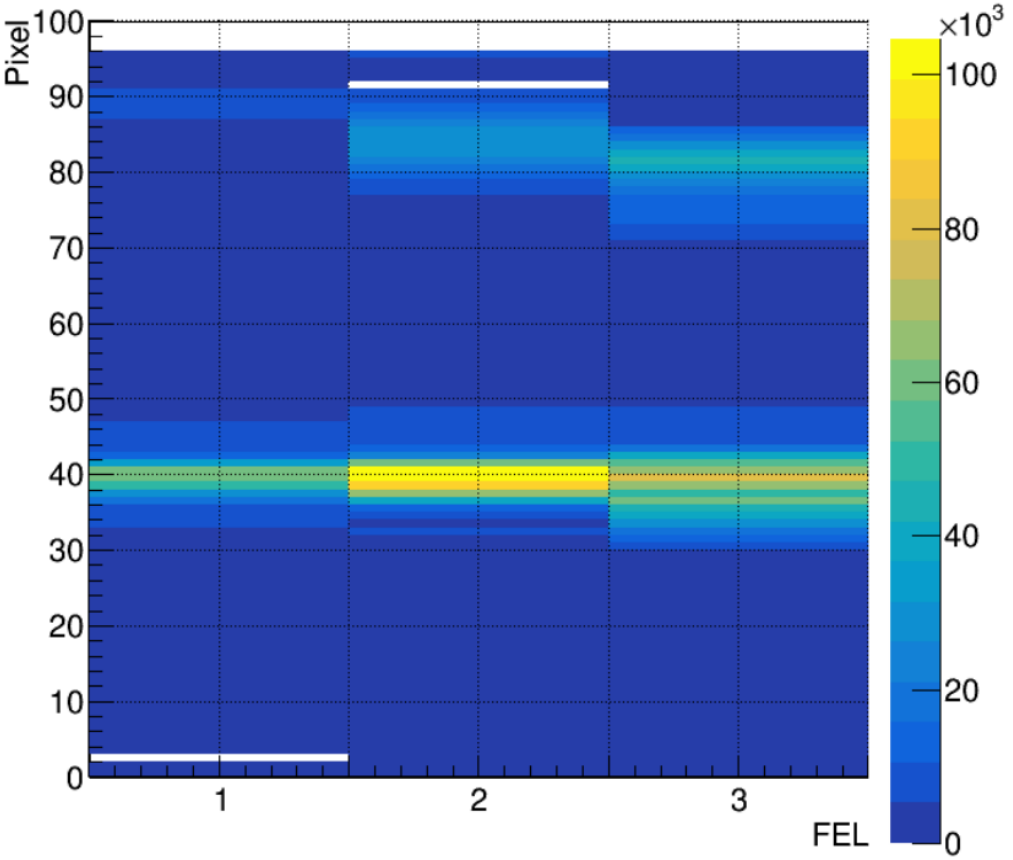
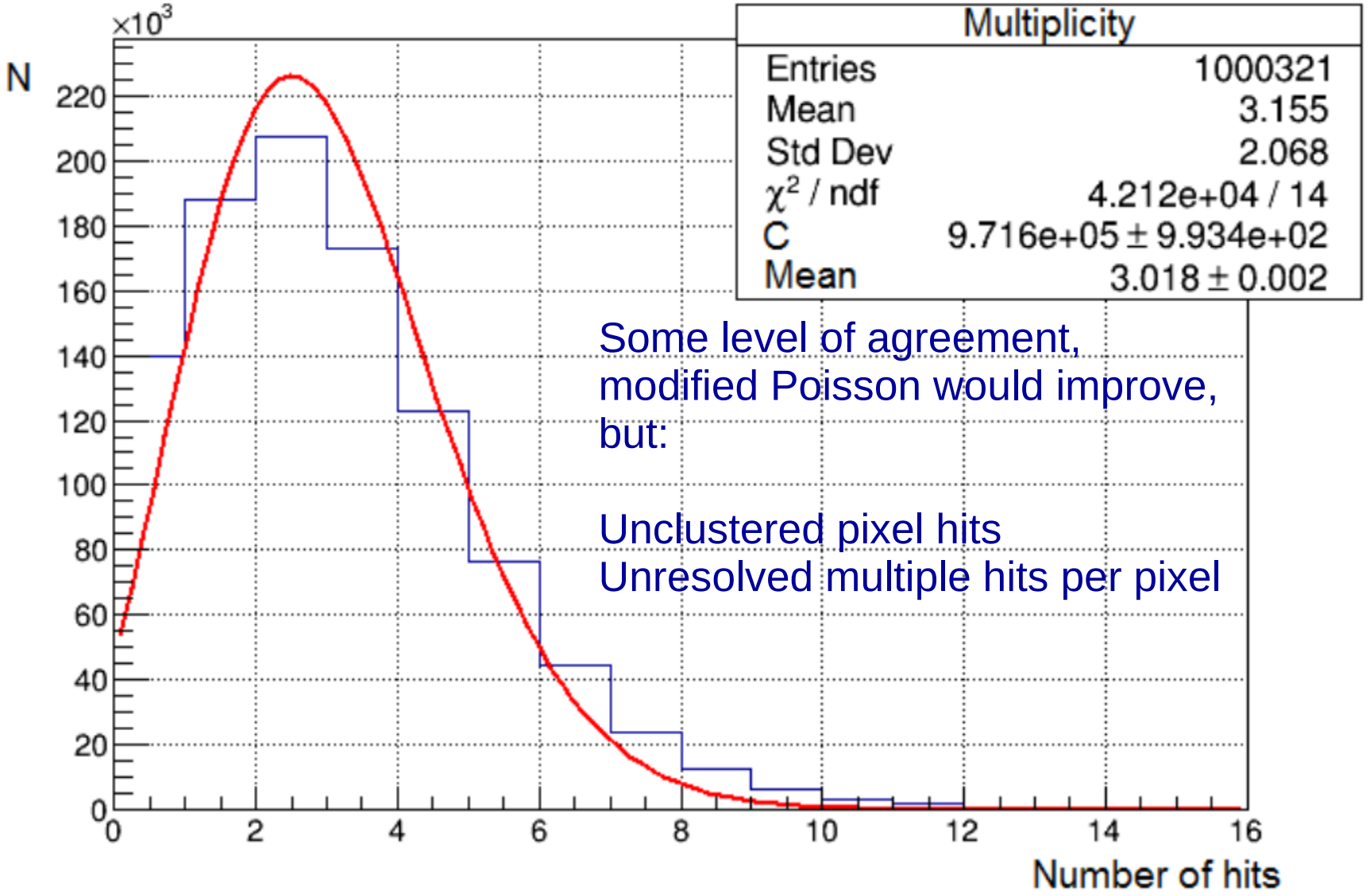


Figure 6.9: The hitpattern of the Cherenkov photon after applying timecuts.

- x = 453.9 mm, y = 170.5 mm, tilt 14 degrees
- > 1,000,000 triggers in 600 seconds

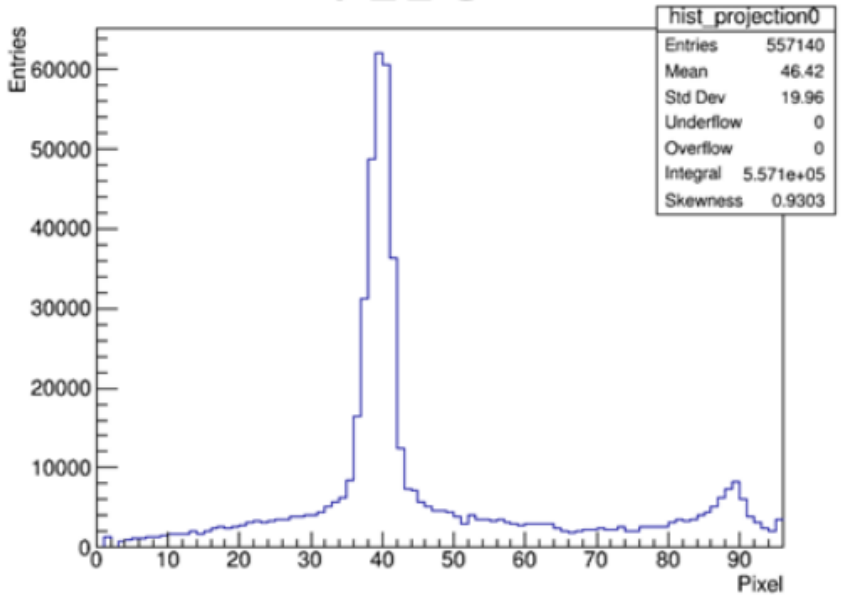
Poisson fit to multiplicity histogram

Not for DPG Münster

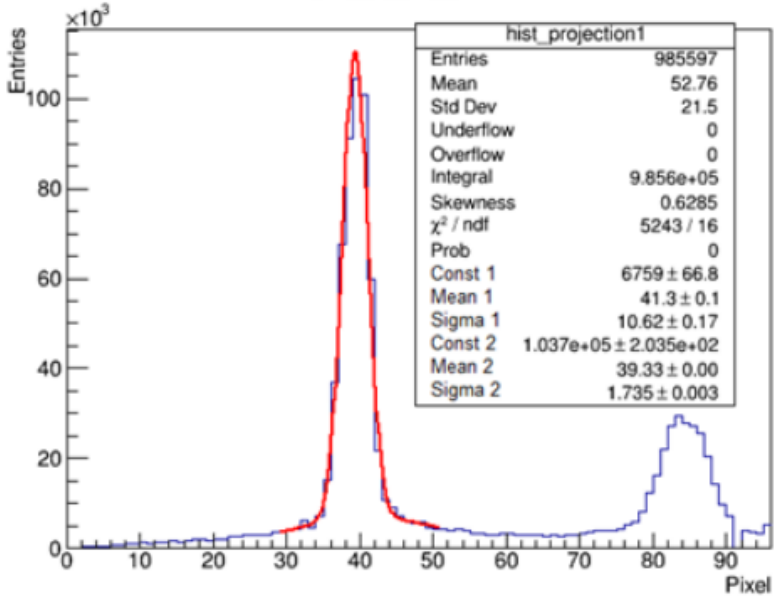


Spatial resolutions

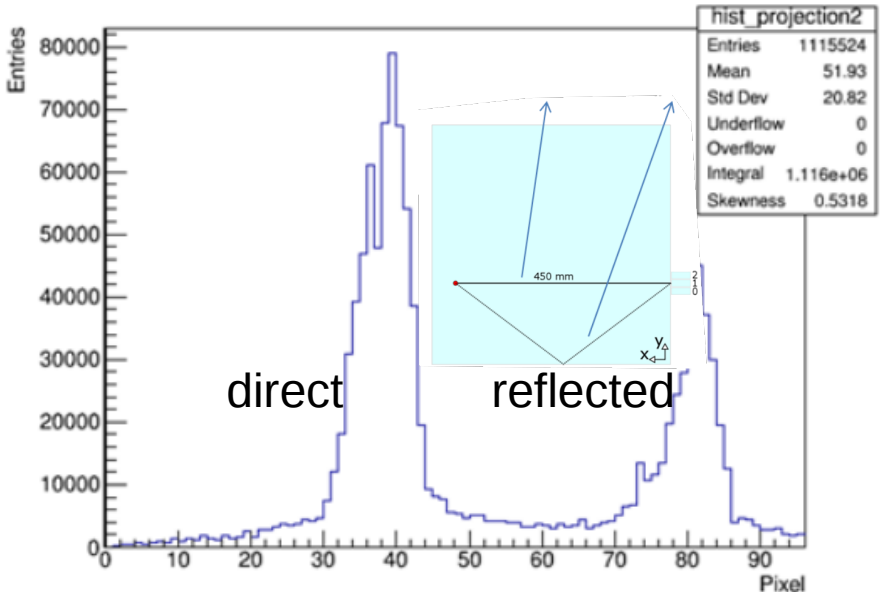
FEL 0



FEL 1



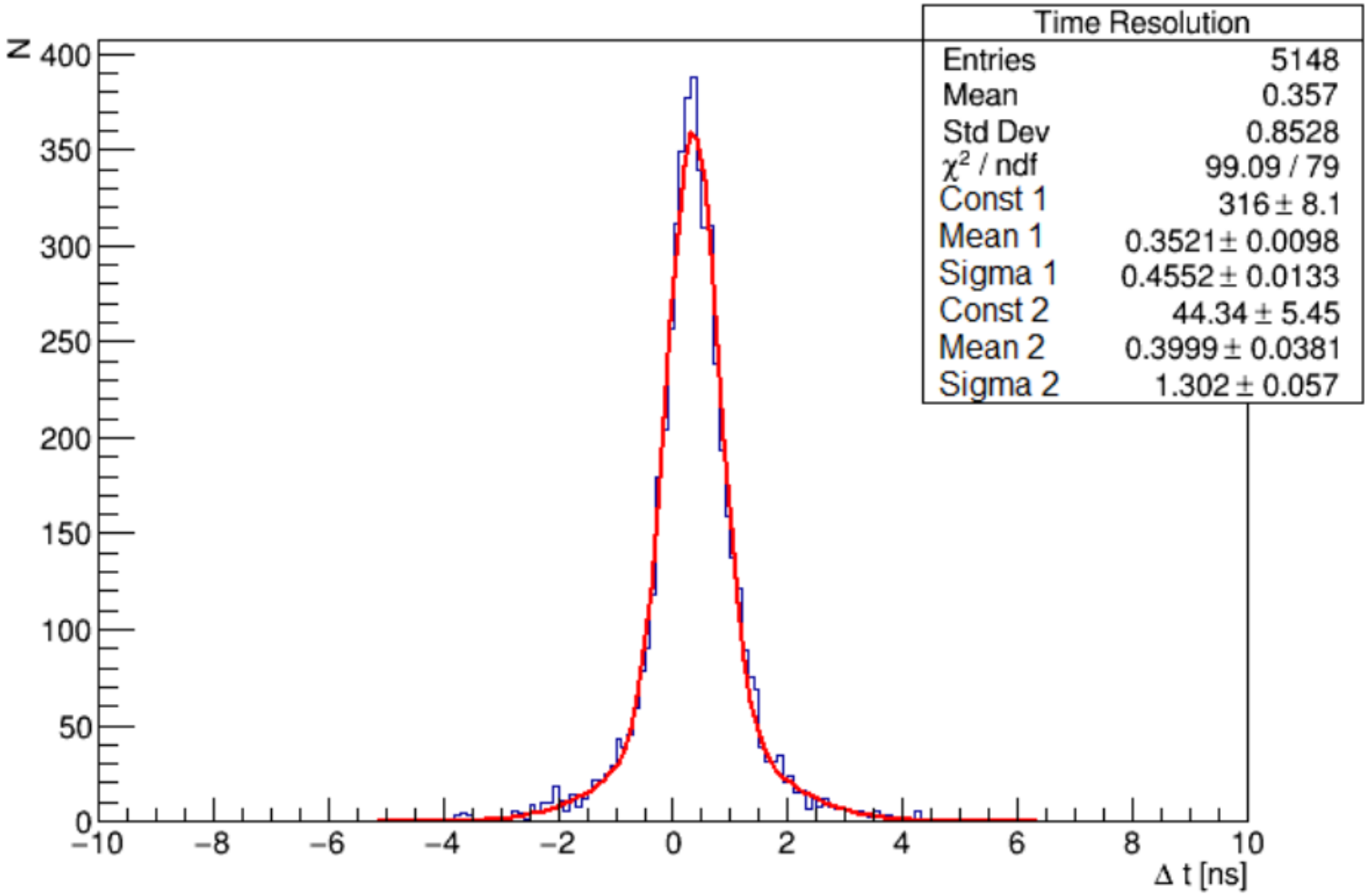
FEL 2



- FEL 0 : reduced light transmission
- FEL 1: σ = 1.73 pixel = 0.86 mm = 6.1 mrad
- FEL 2: misorientation of 1.5 mrad

  N.B. once mounted, an individual FEL cannot be adjusted, only the full ROM with its 3 FELs inside

Relative timing between pixels



Time resolution obtained from time differences between two directly illuminated pixels.

High resolution y scan

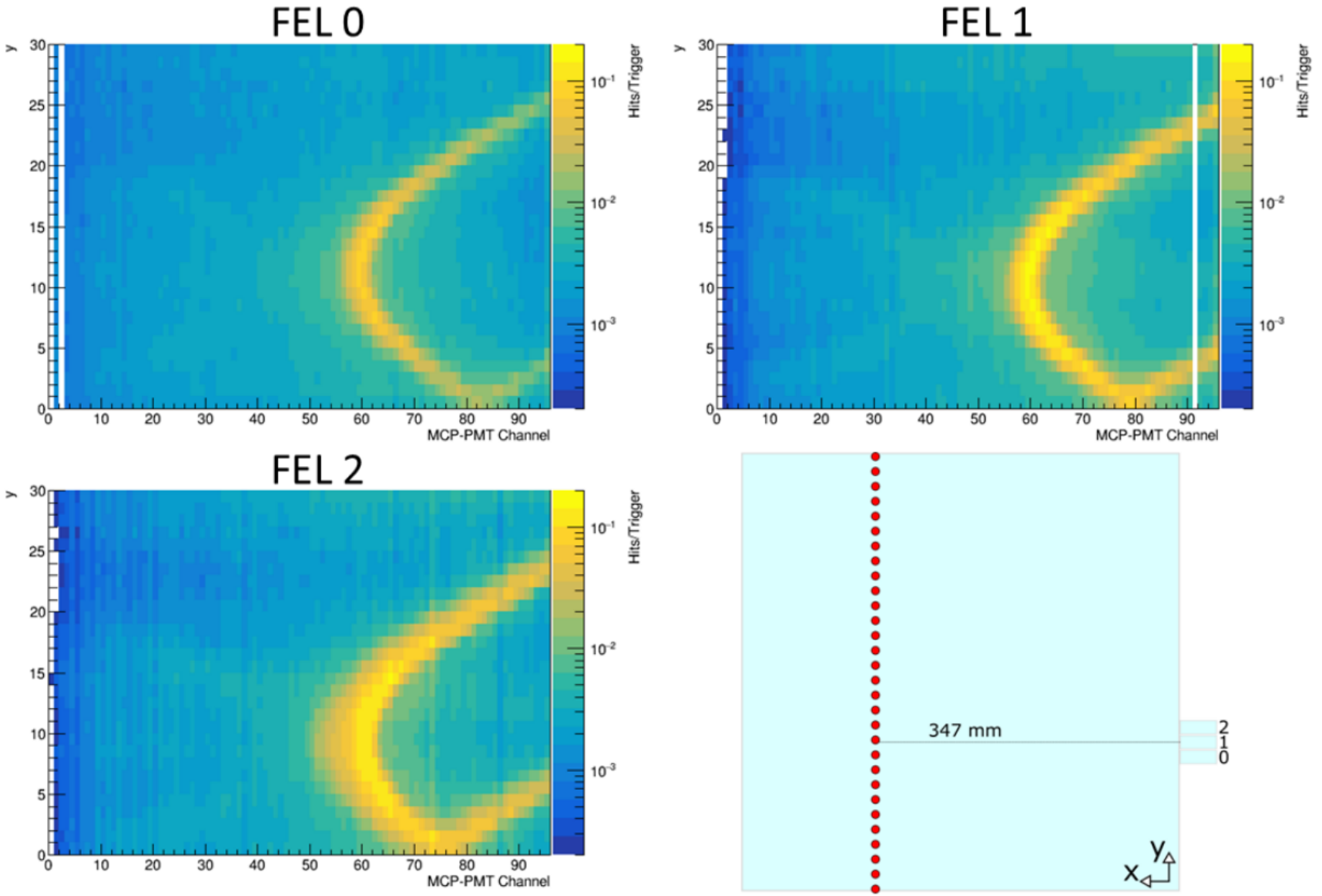


Figure 6.20: The high resolution y scan simulates a fully equipped radiator. The resulting structure is often called *Cherenkov Smile*.

Summary

- October 2016 test beam at DESY
- One calendar week of good test beam data
- Photon statistics look reasonable
  - Detailed understanding of pixel and cluster numbers need detector simulations
- Position resolution $\sigma = 6$ mrad
  - Full apparatus wavelength range, no filters used
  - Resolution dominated by chromatic dispersion
  - FEL2 in addition blurred by angle misorientation
- Timing between pixels $\sigma = 0.46$ ns
- Simulations to follow

Additional slides

Angle scan

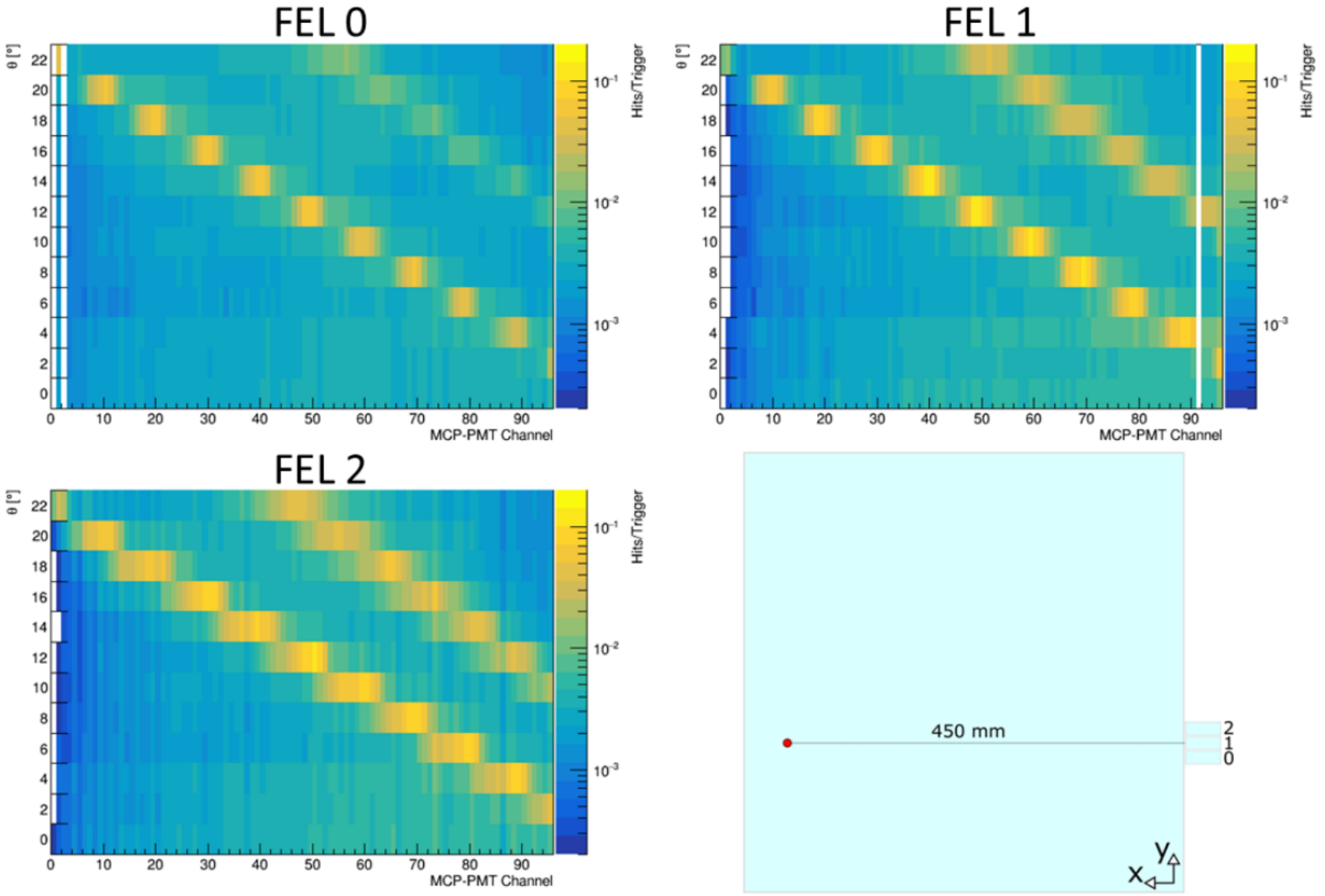


Figure 6.19: The angle scan. A rotation of the prototype translates into a linear displacement of the Cherenkov peak.

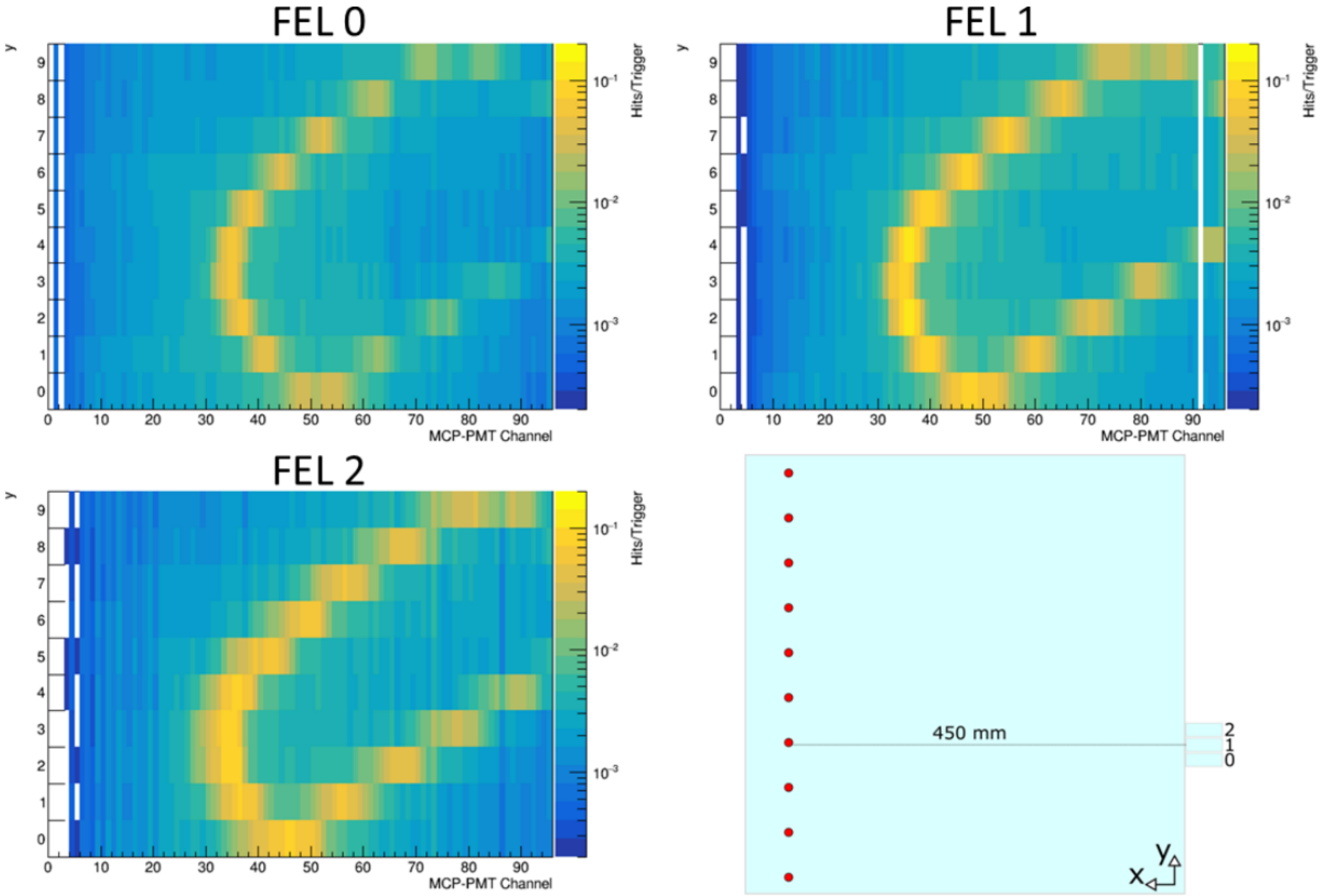
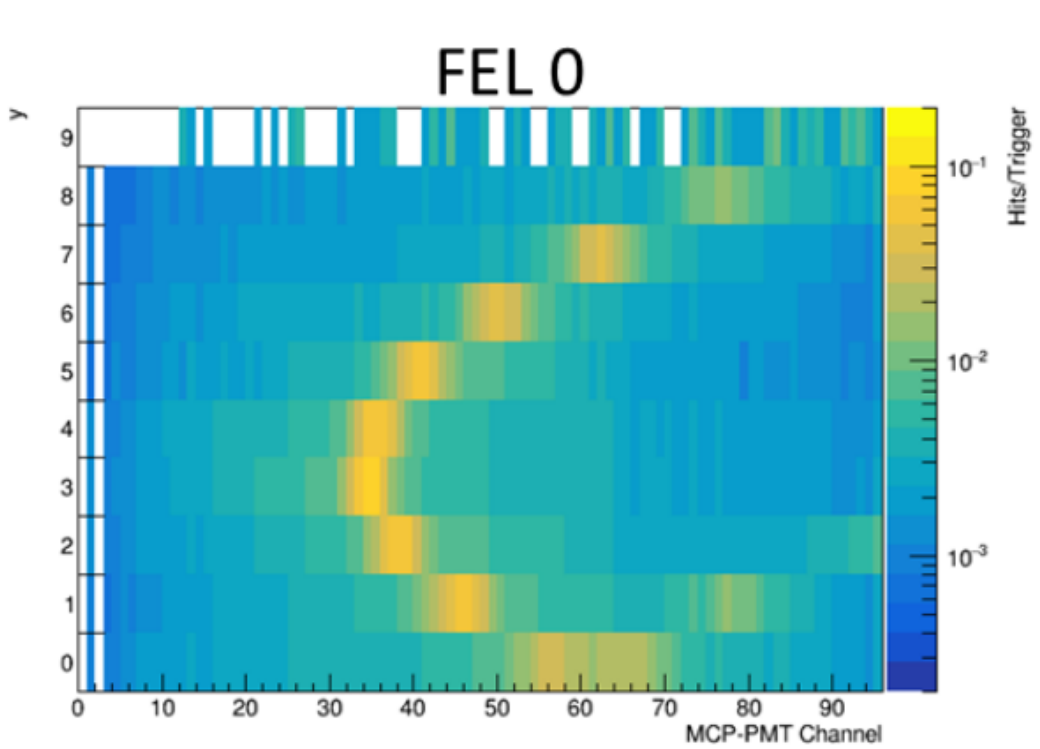
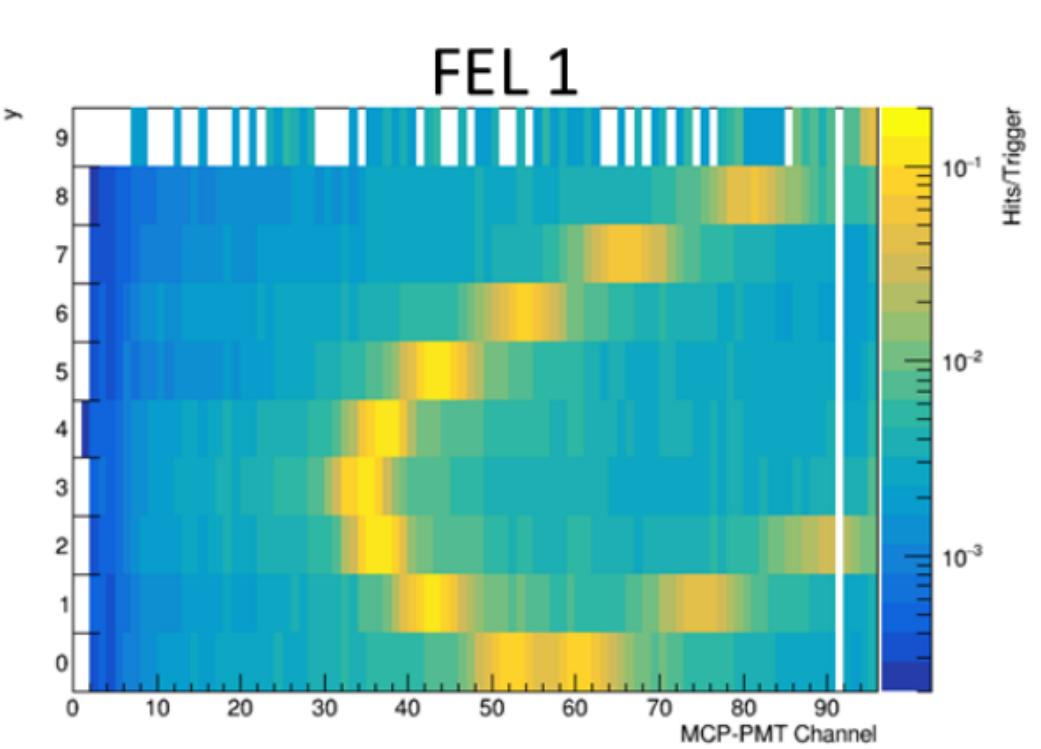
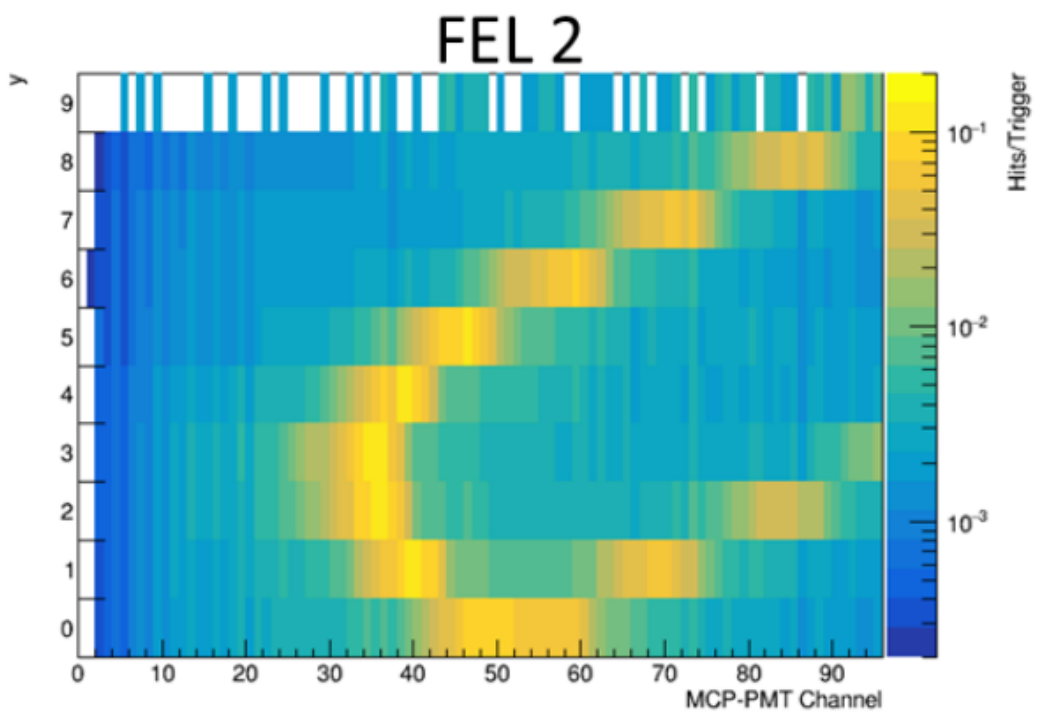
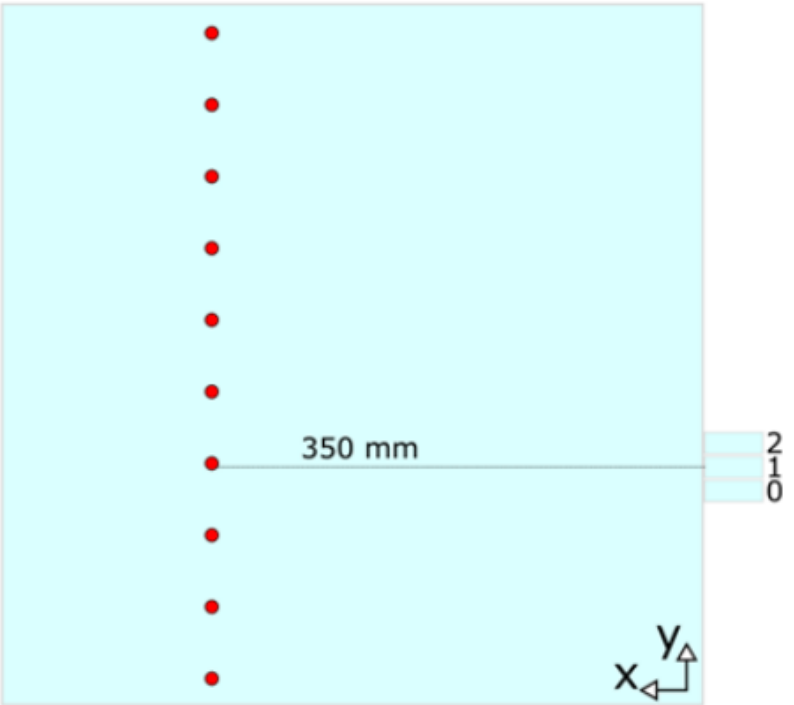


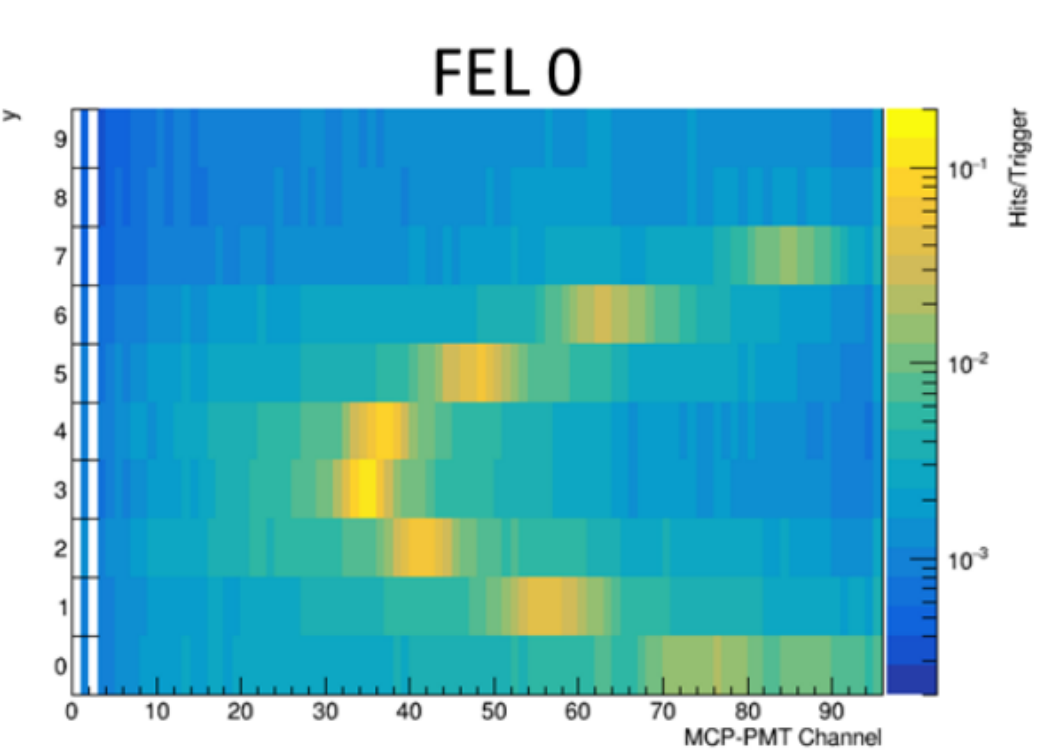
Figure 6.21: Part 1 of the XY Scan shows the smallest curvature.

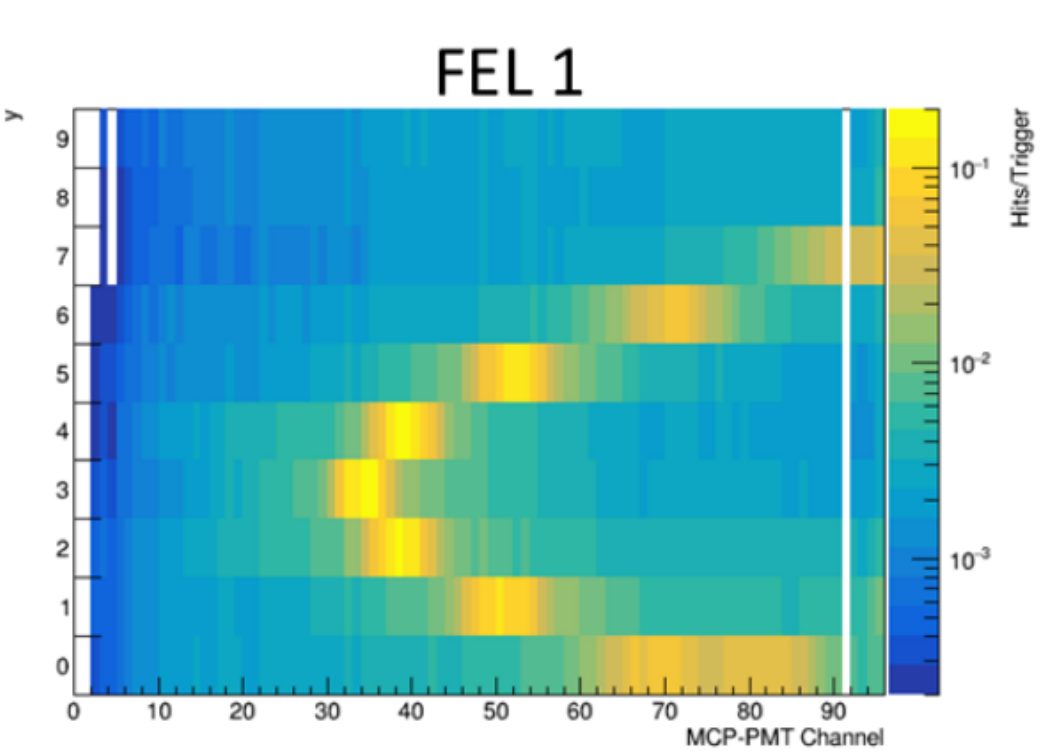

FEL 0
y
MCP-PMT Channel
Hits/Trigger

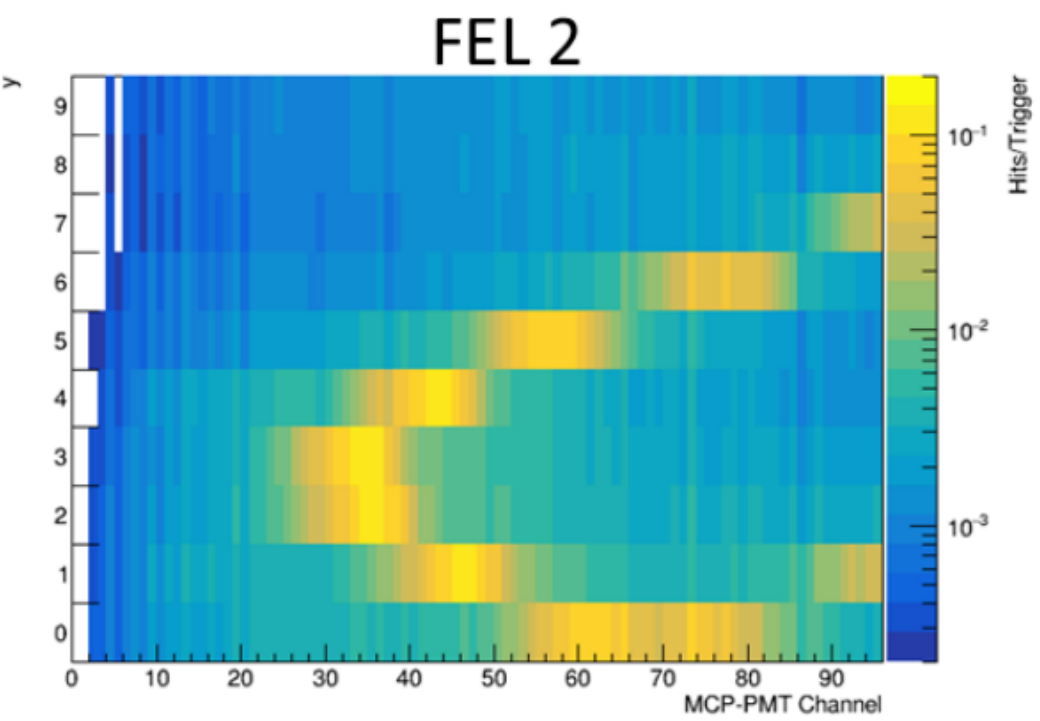

FEL 1
y
MCP-PMT Channel
Hits/Trigger

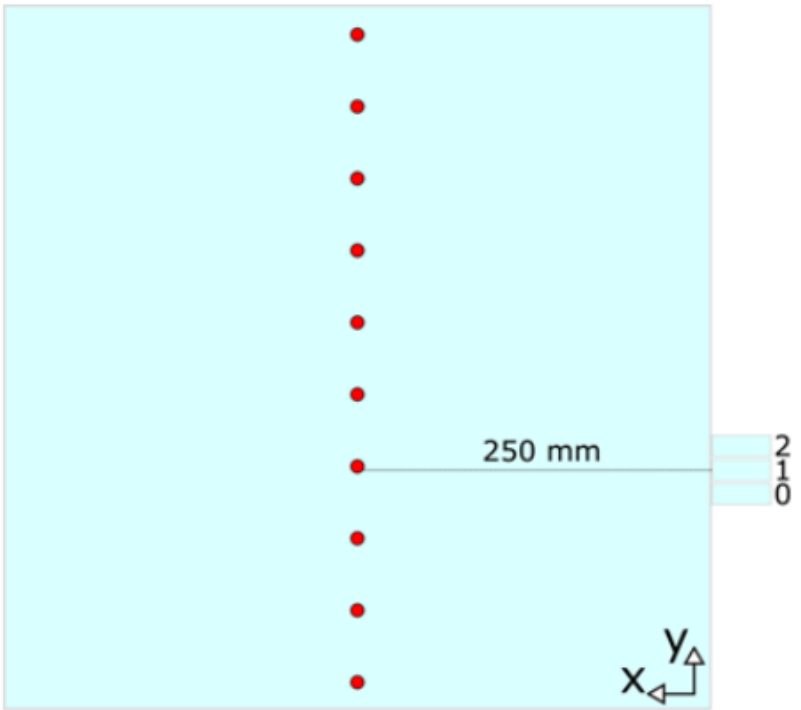

FEL 2
y
MCP-PMT Channel
Hits/Trigger


350 mm
2
1
0
y
x

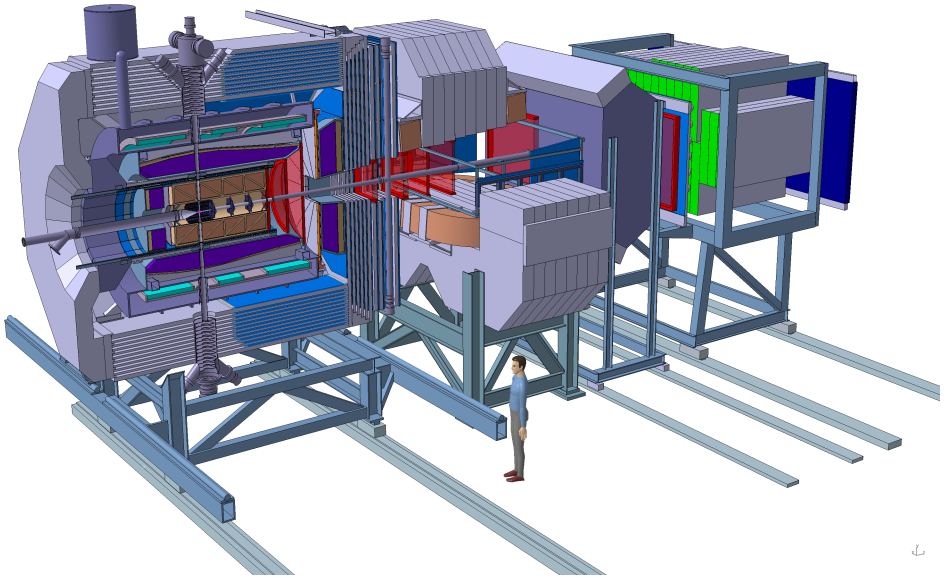

FEL 0
y
MCP-PMT Channel
Hits/Trigger

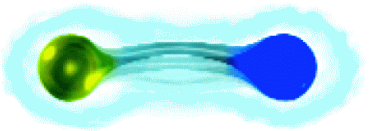

FEL 1
y
MCP-PMT Channel
Hits/Trigger


FEL 2
y
MCP-PMT Channel
Hits/Trigger

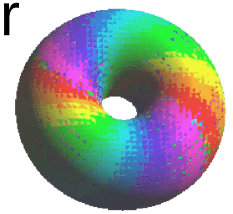

250 mm
2
1
0
y
x

Backup and quarry slides





- Hadron spectroscopy
  - Charmonium spectroscopy
  - Gluonic excitations (hybrids, glueballs)
- Charmed hadrons in nuclear matter
- Double Λ-Hypernuclei



- $\bar{p}p$ interactions
- cooled beam
- p=1.5-15GeV/c
- high interaction rate (~20MHz)

First Particle Identification with a Disc DIRC Detector

Klaus Föhl, Michael Düren,
Avetik Hayrapetyan, Benno Kröck, Yong Liu,
Oliver Merle, Daniel Mühlheim, Julian Rieke

AG Düren, II. Physikalisches Institut, Universität Gießen

VCI 2013
The 13th Vienna Conference on Instrumentation
13 February 2013

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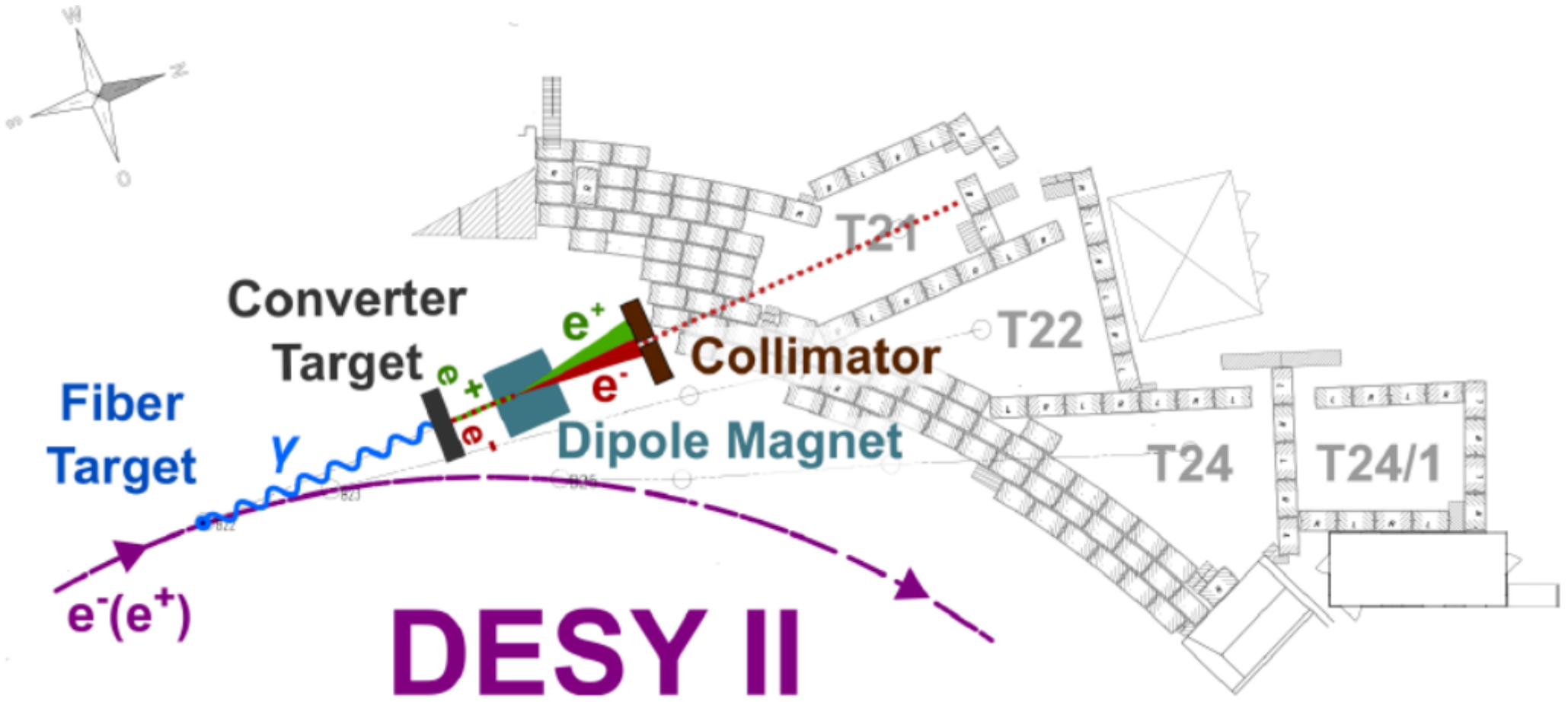
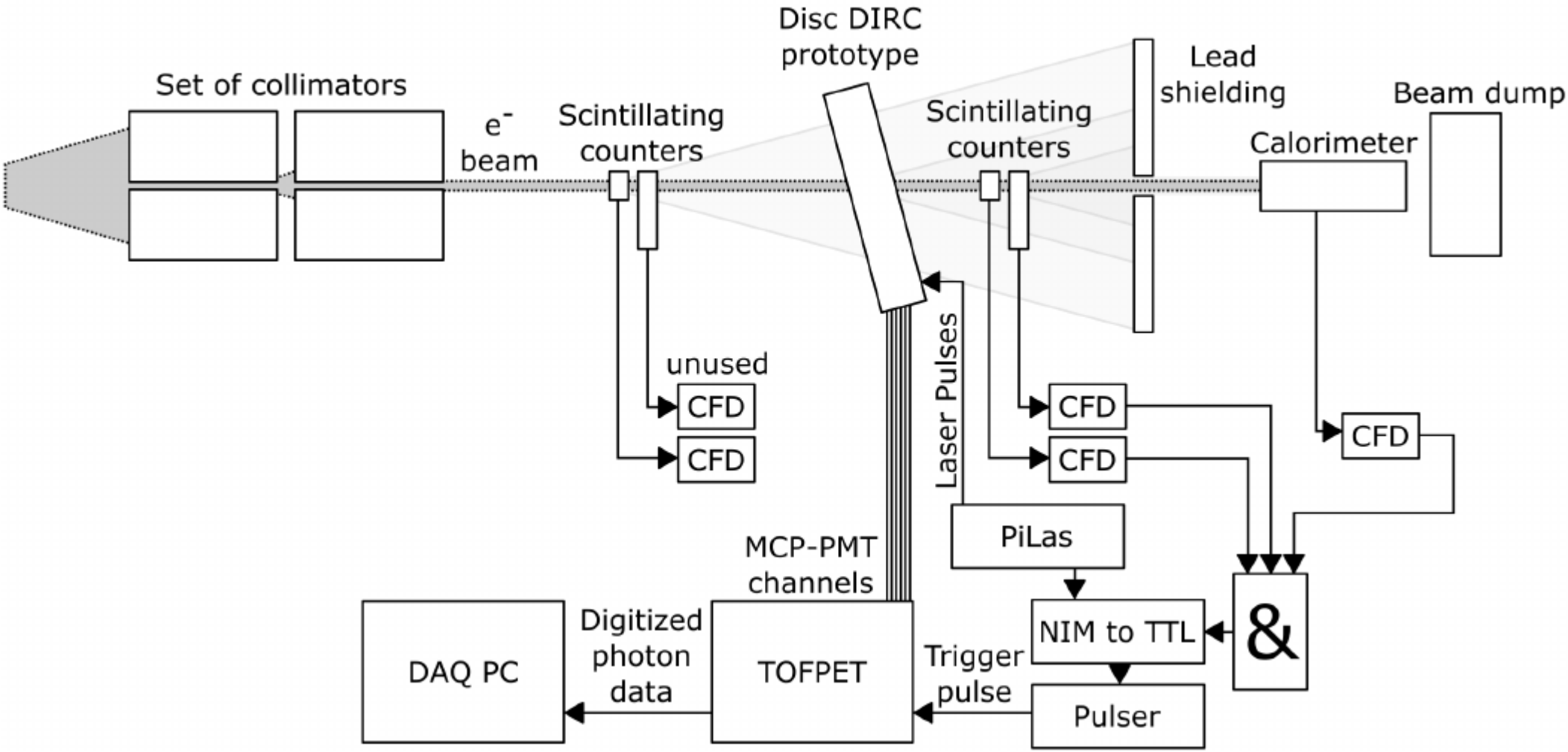
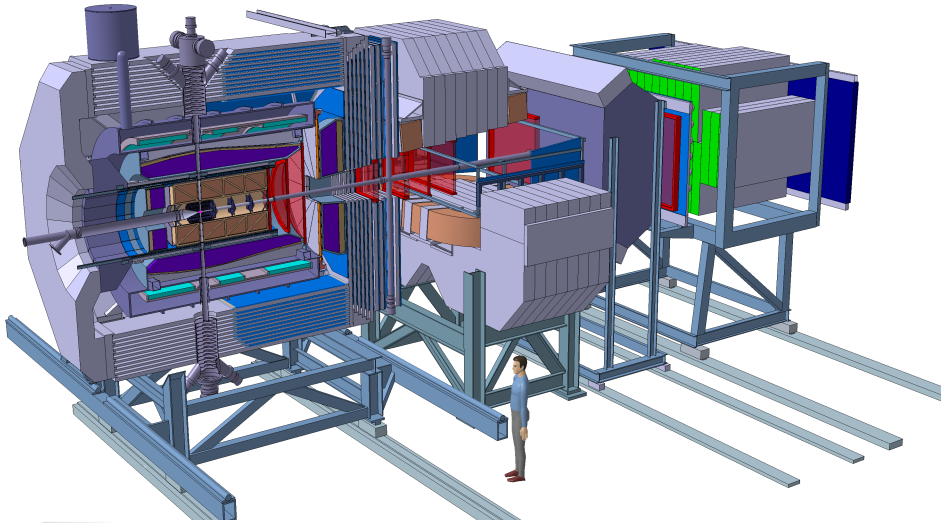
FAIR
HIC for FAIR
Helmholtz International Center
GSI
panda
Bundesministerium für Bildung und Forschung

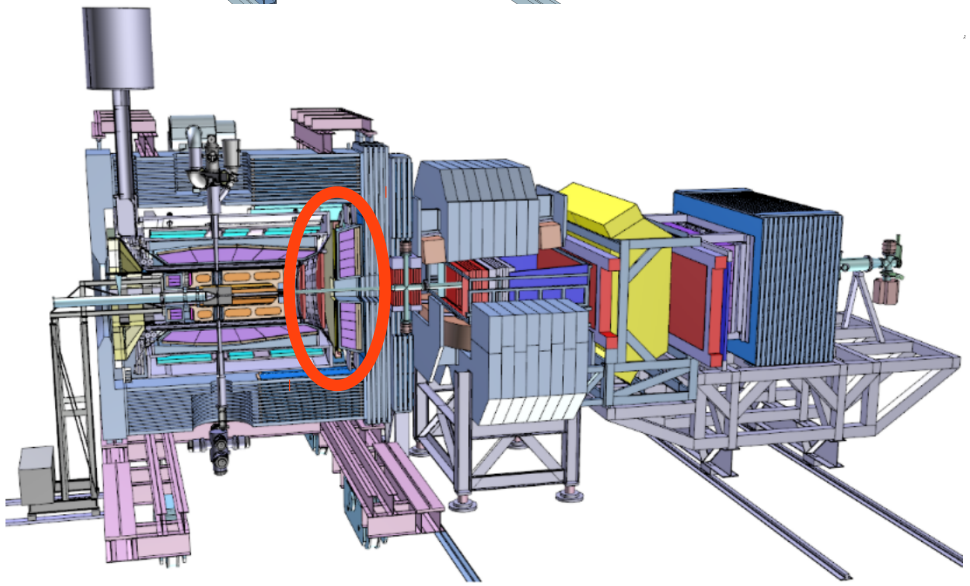

Converter
Target
Fiber
Target
γ
e+
e-
e+
e-
Collimator
Dipole Magnet
T21
T22
T24
T24/1
e-(e+)
DESY II

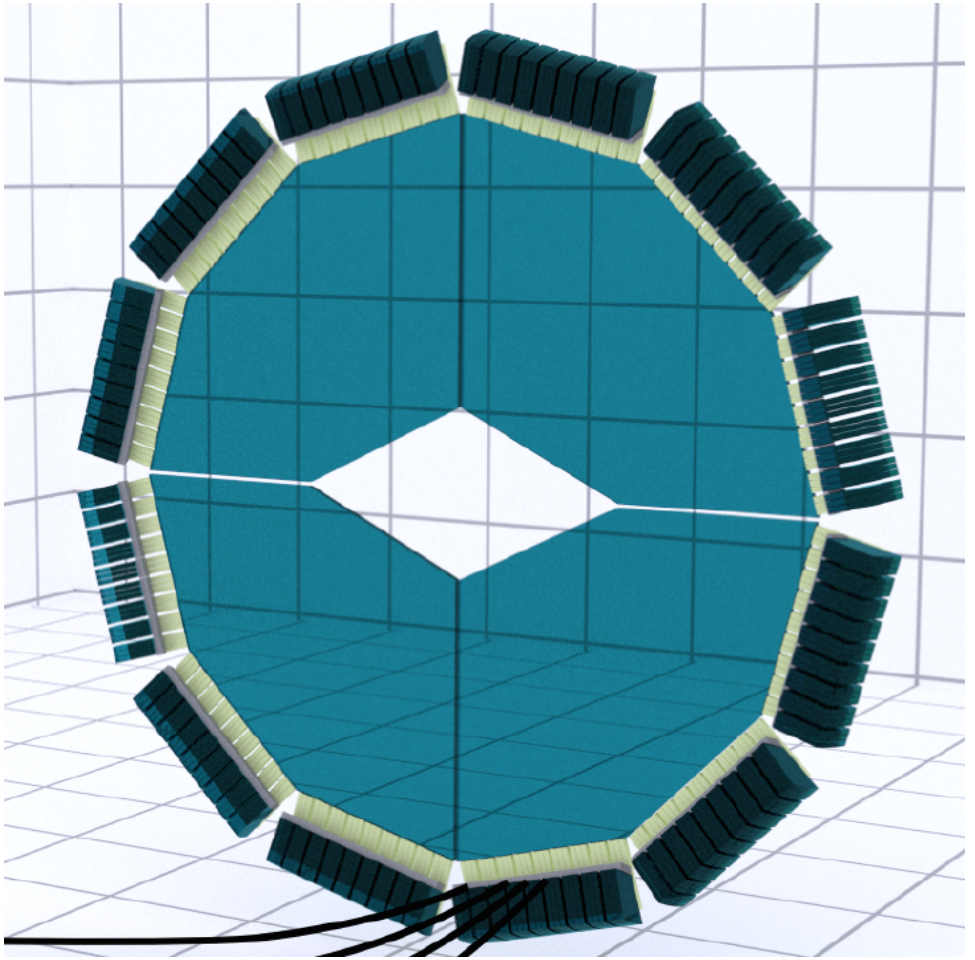
Schematic set-up



EDD in PANDA







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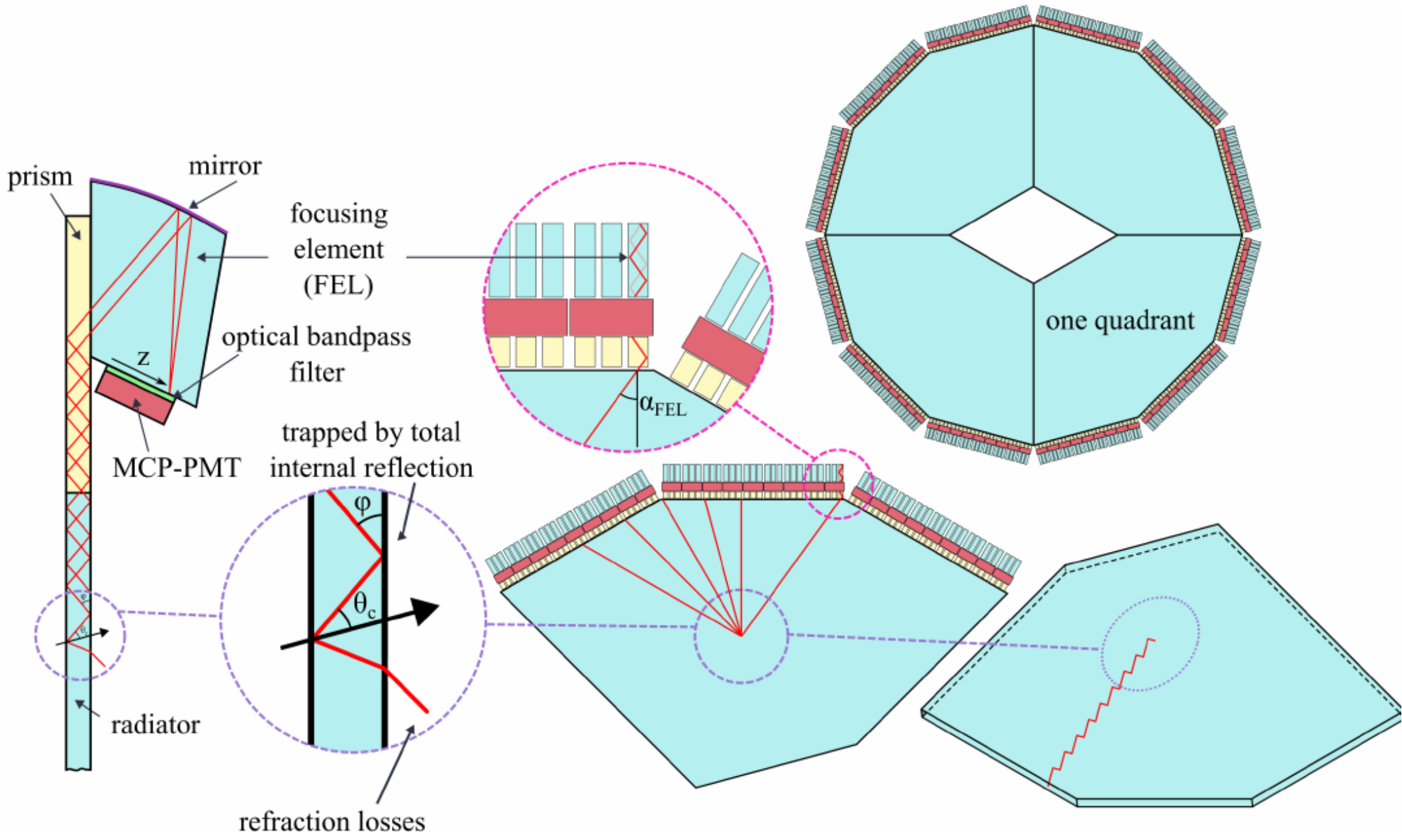
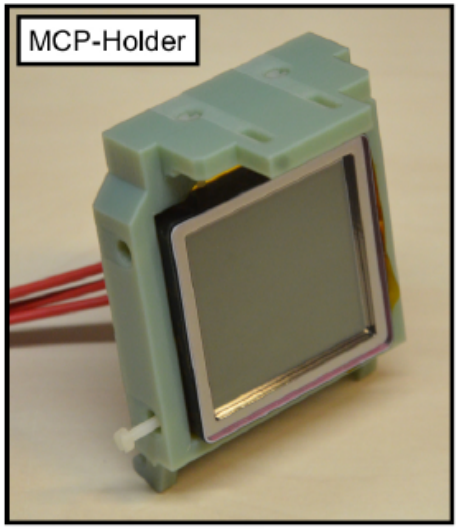
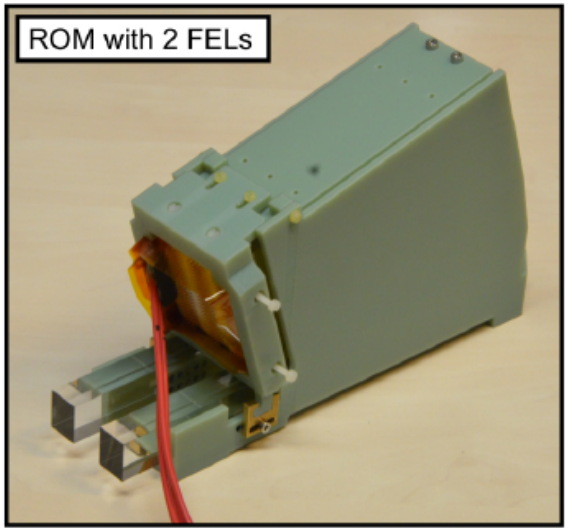
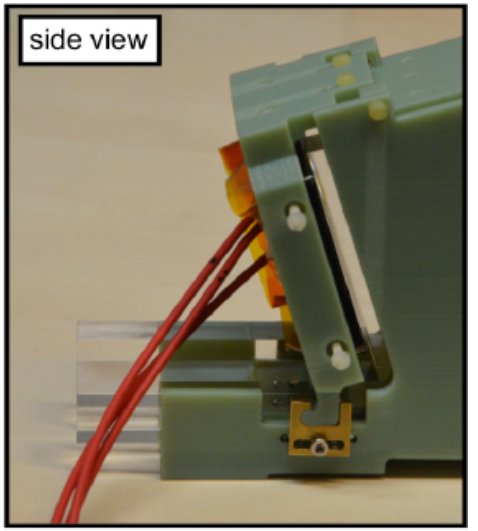
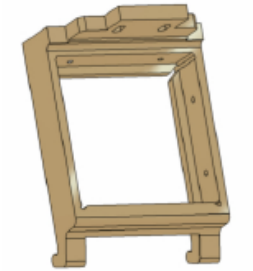

prism
mirror
focusing
element
(FEL)
optical bandpass
filter
z
MCP-PMT
trapped by total
internal reflection
φ
θc
radiator
refraction losses
αFEL
one quadrant

ROM and FEL

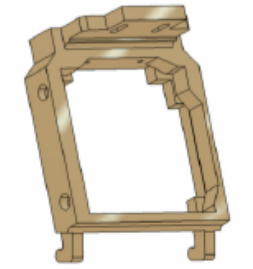




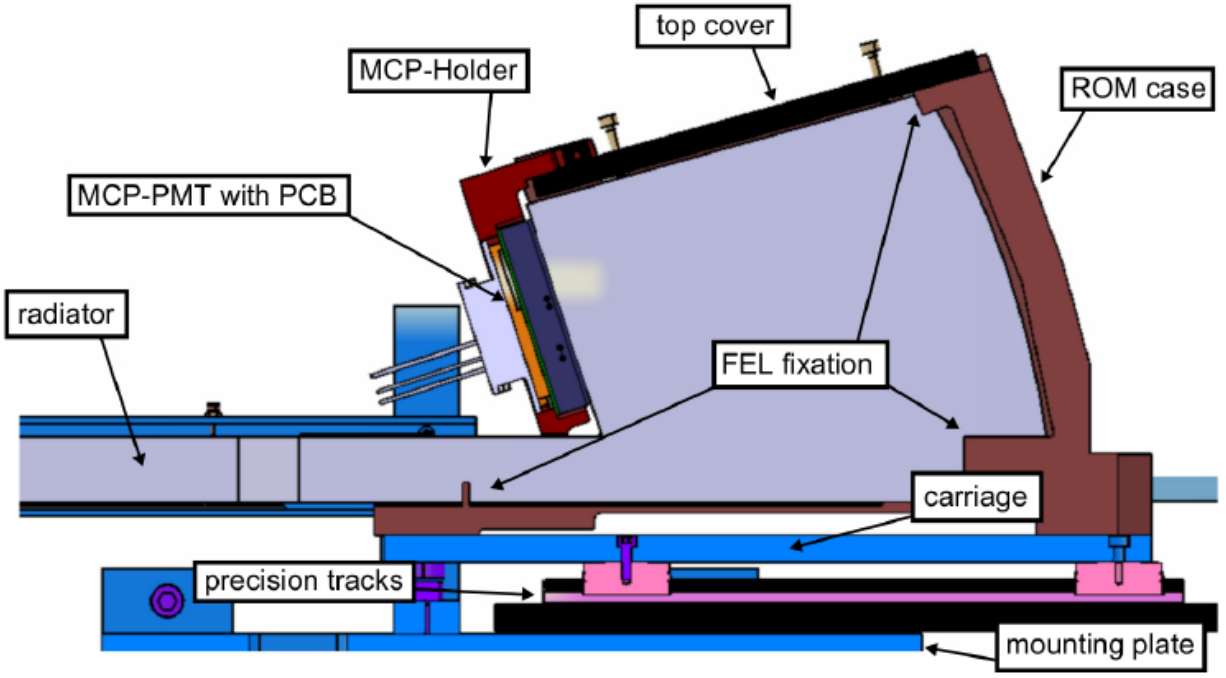




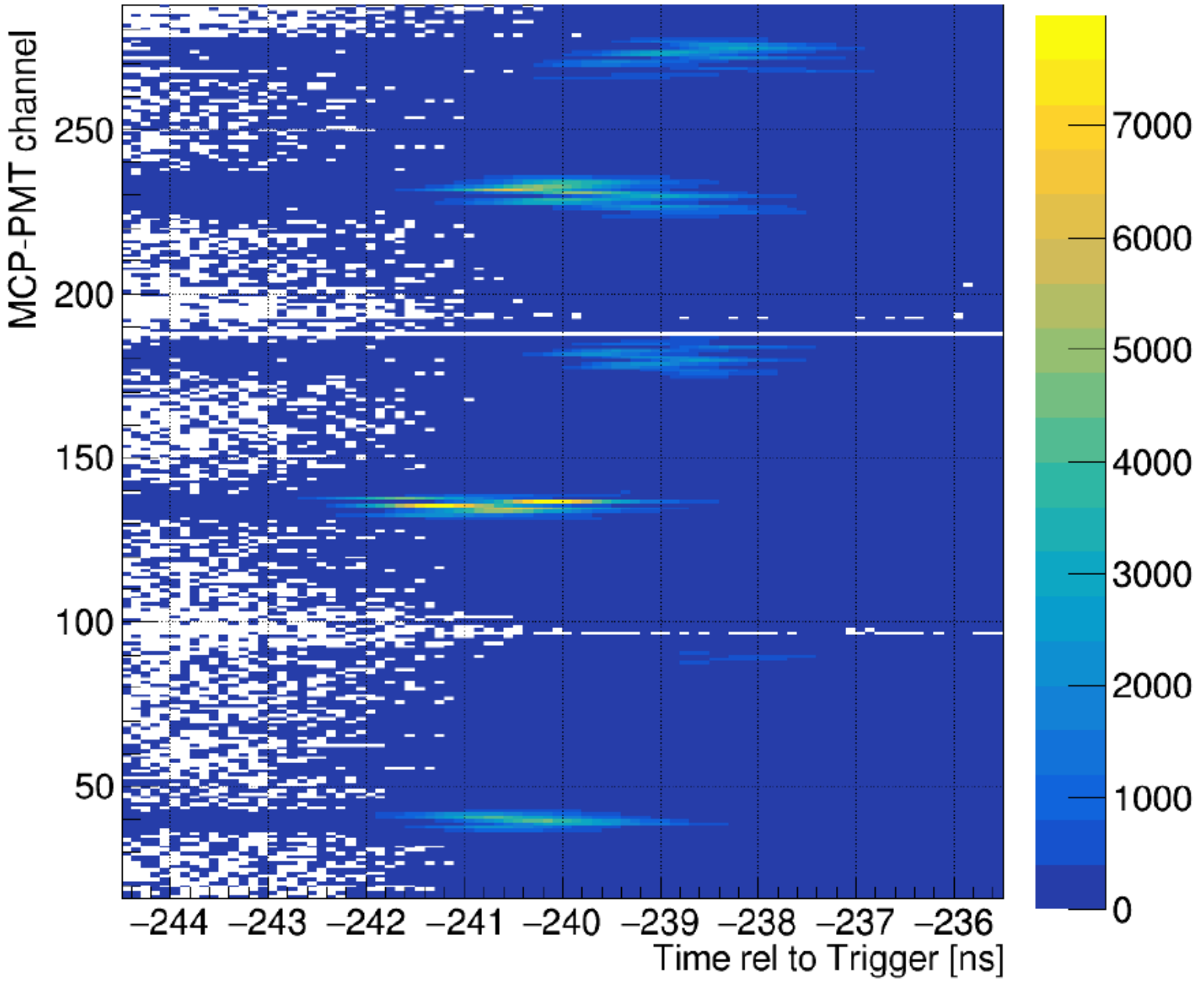
Hamamatsu



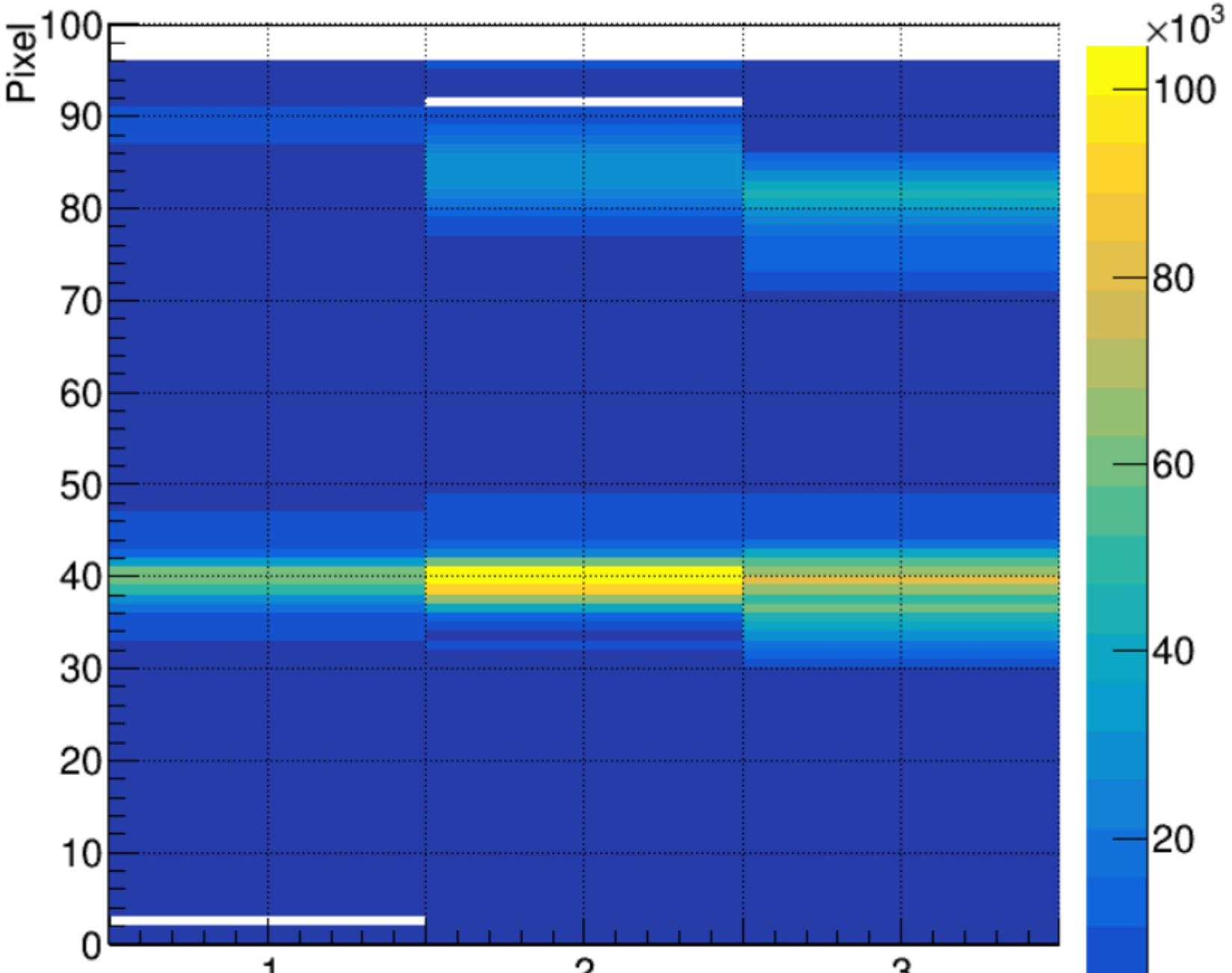
PHOTONIS



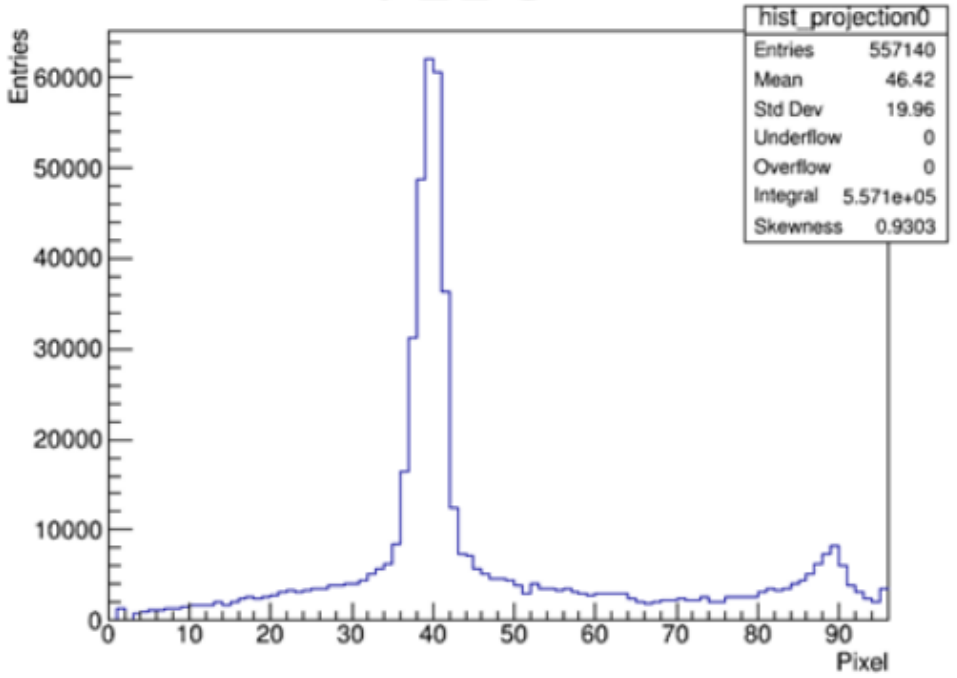
Raw data – not yet time-aligned



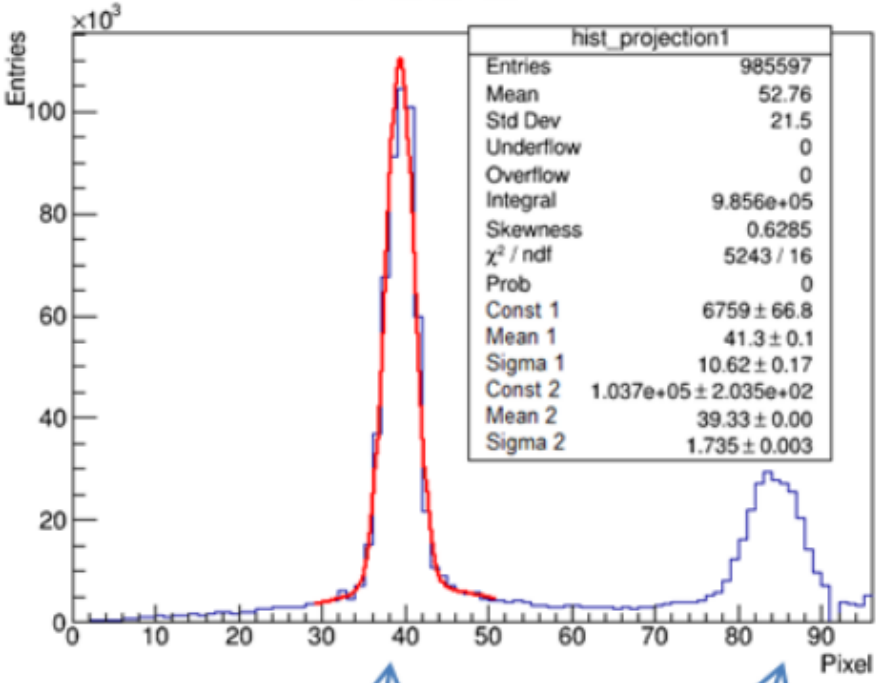
Pattern



FEL 0



FEL 1



FEL 2