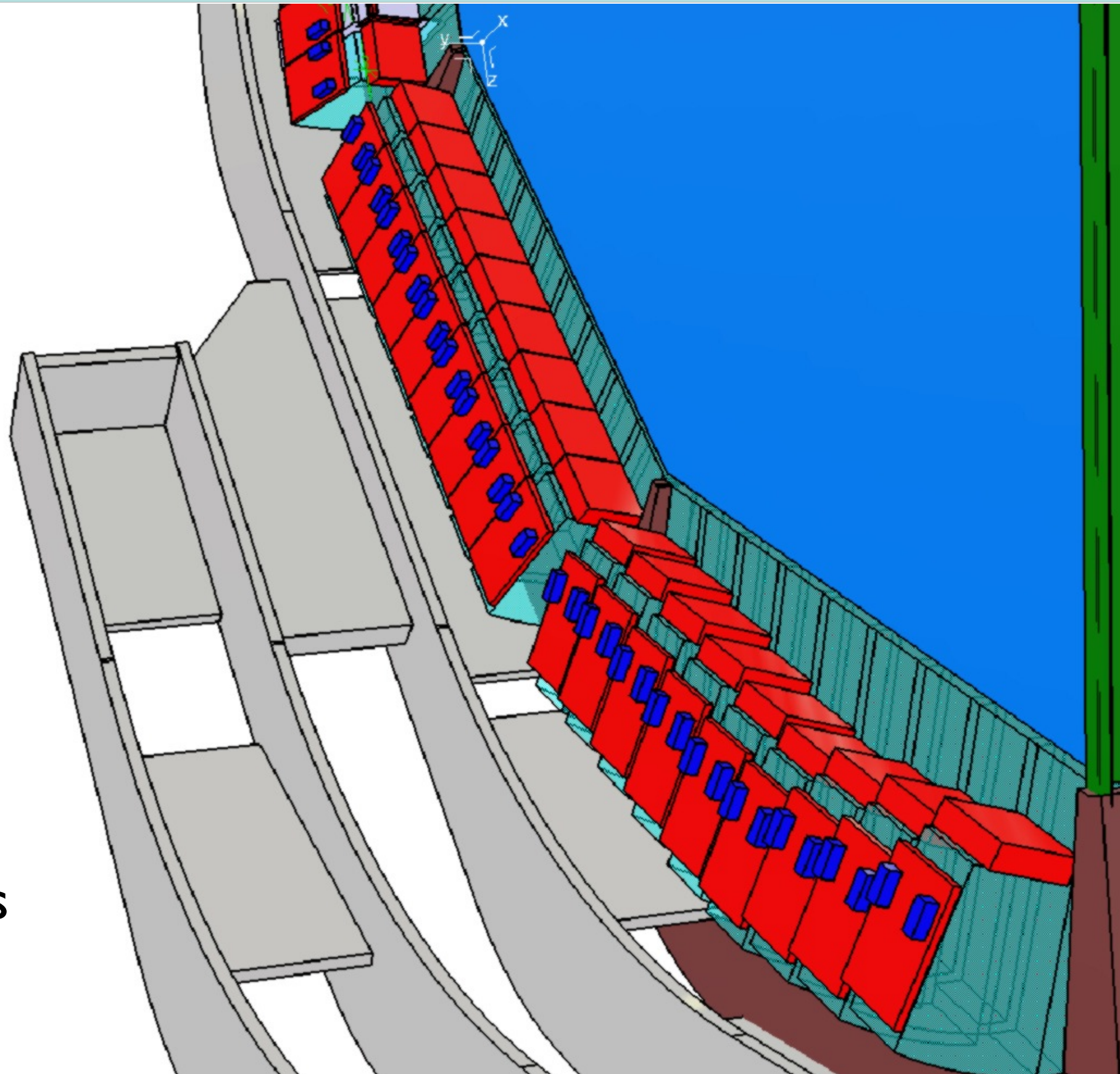


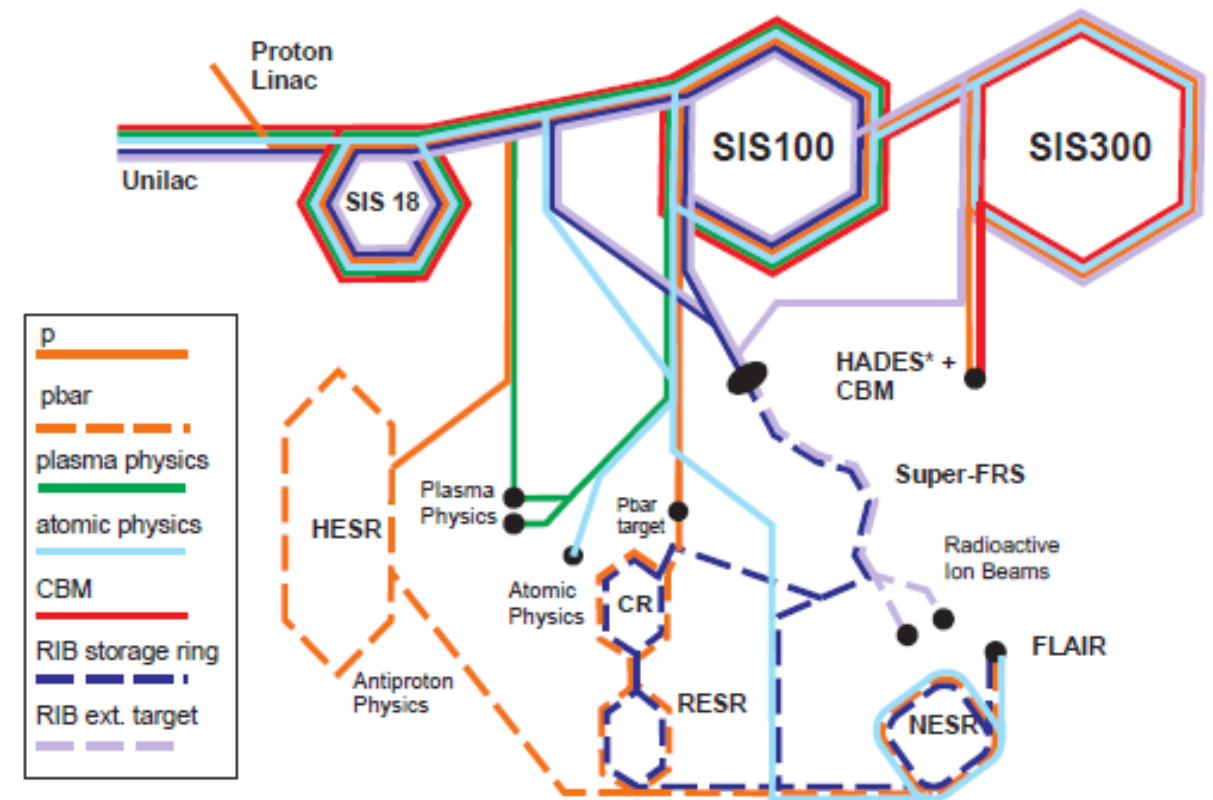
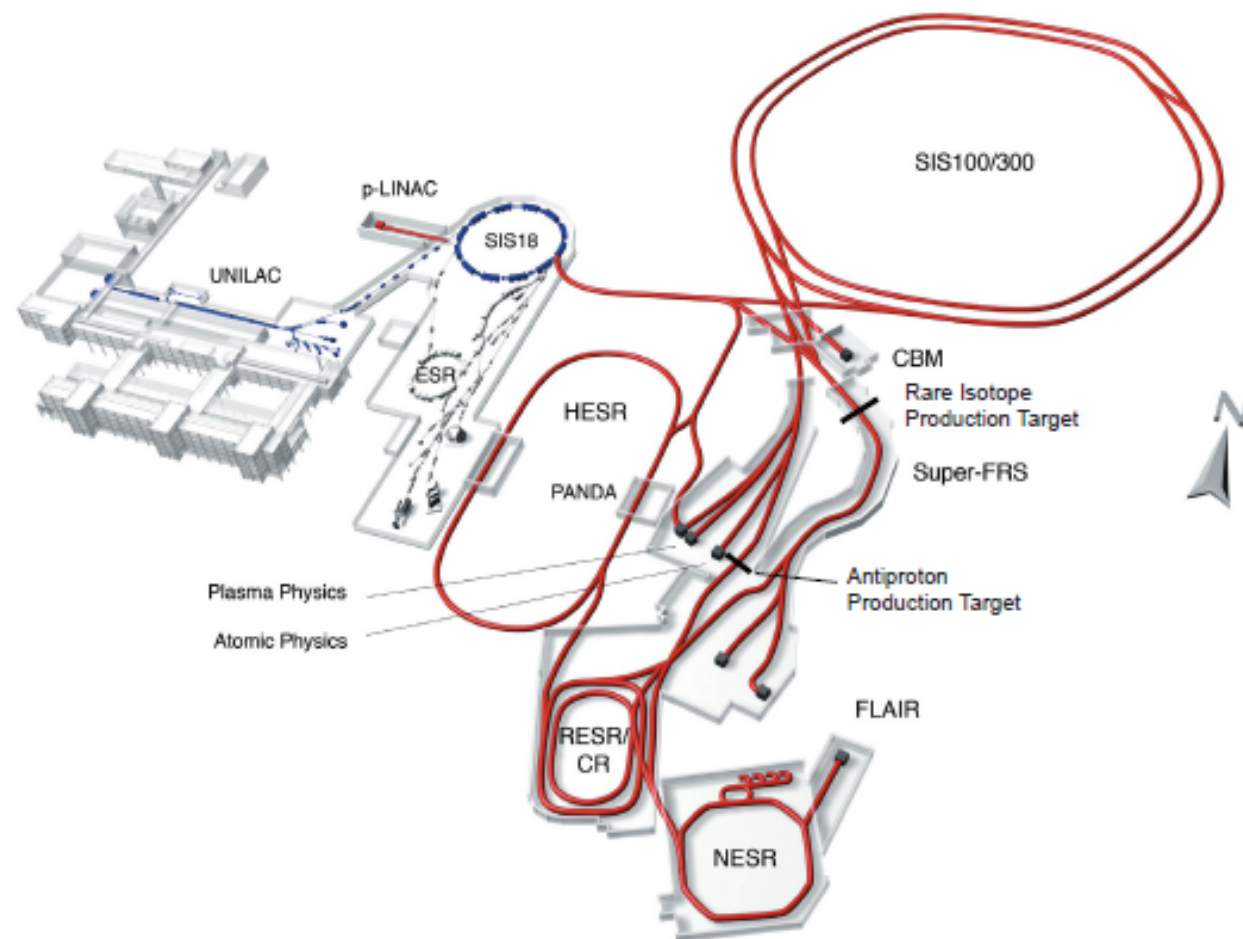
The PANDA Disc DIRC project at FAIR

Erik Etzelmüller, Klim Bigunenko, Michael Düren, Klaus Föhl, Avetik Hayrapetyan,
Kristof Kreutzfeldt, Oliver Merle, Julian Rieke, Mustafa Schmidt

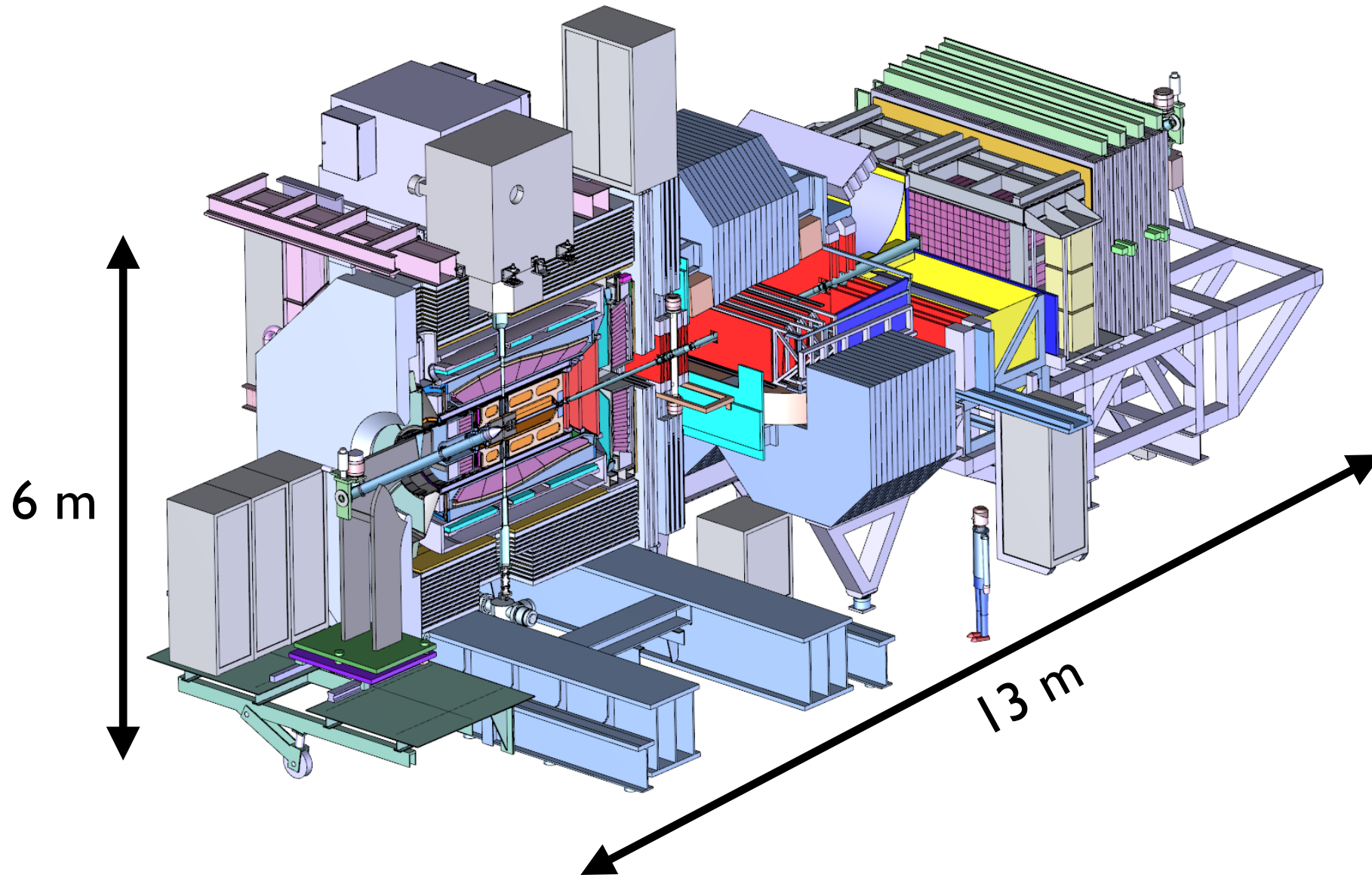
DIRC2015: Workshop on fast Cherenkov detectors
Rauischholzhausen, 12.11.2015

- PANDA @ FAIR
- DIRC design
- Simulation
- Optics and Readout
- Test experiments





- Large Upgrade of the existing GSI
- Versatile facility for different scientific topics
- PANDA is the only experiment dedicated to hadron physics and strong interaction



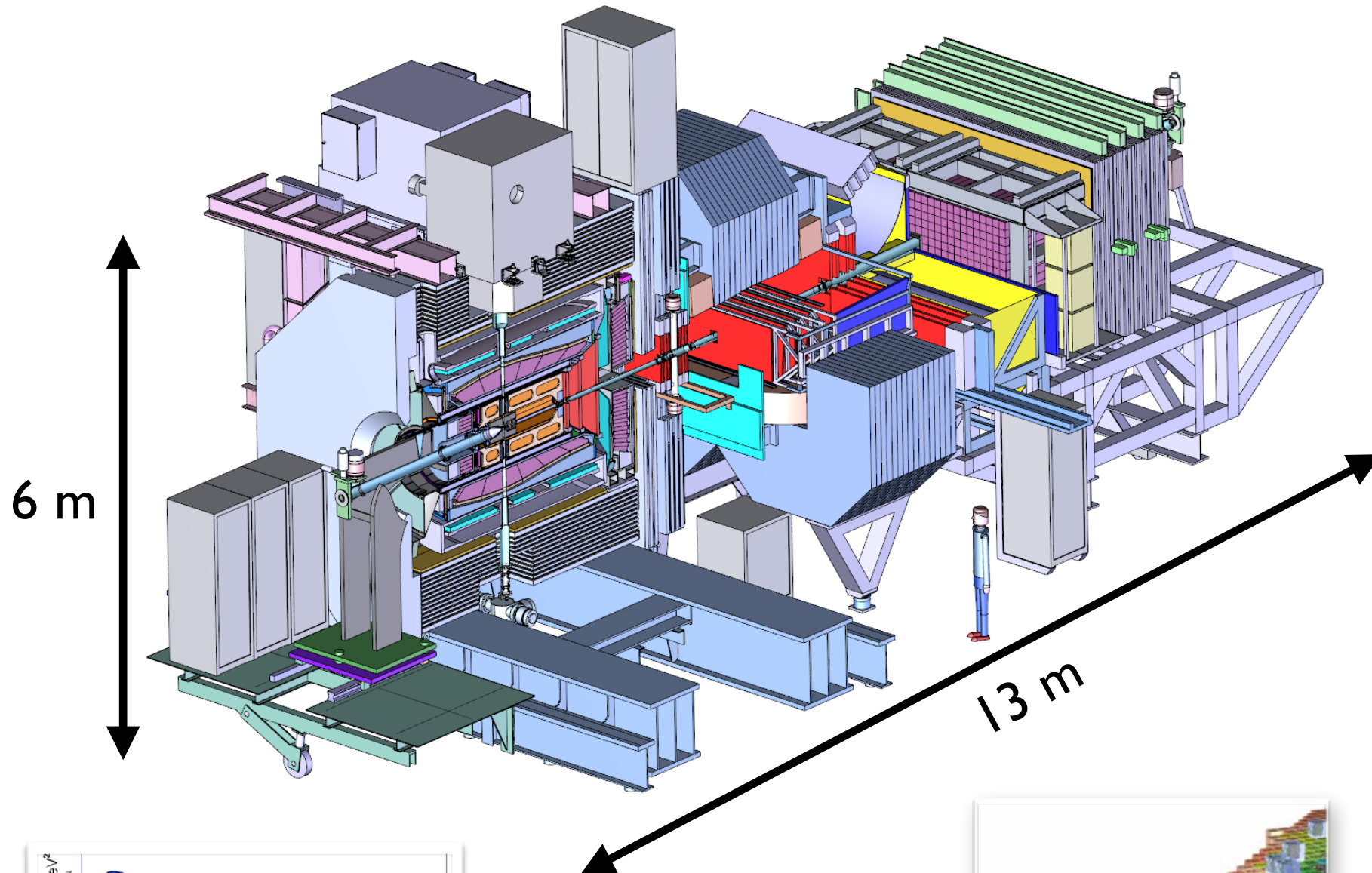
Detector:

- fixed p-target
- p @ 1.5 - 15 GeV/c
- momentum resolution

$$\frac{\Delta p}{p} = 4 \cdot 10^{-5}$$

- maximum luminosity

$$2 \cdot 10^{32} \frac{1}{\text{cm}^2 \text{s}}$$



Detector:

- fixed p-target
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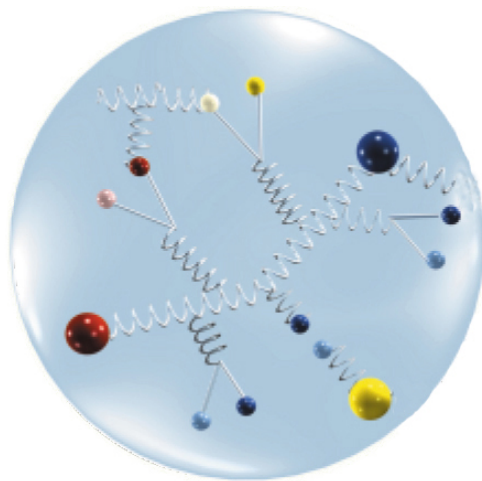
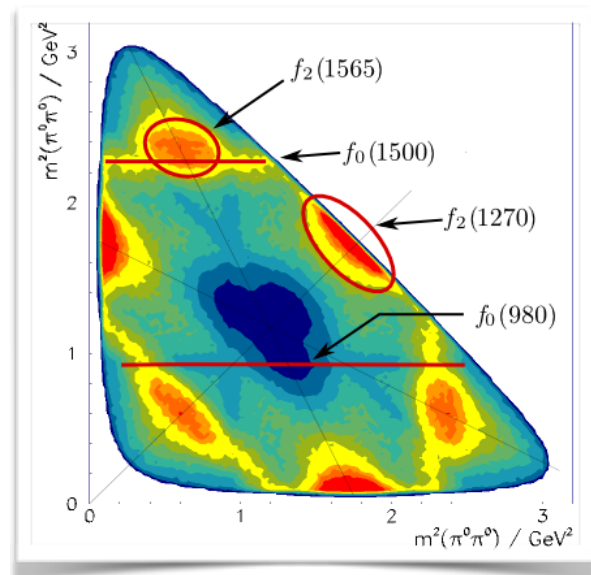
$$\frac{\Delta p}{p} = 4 \cdot 10^{-5}$$

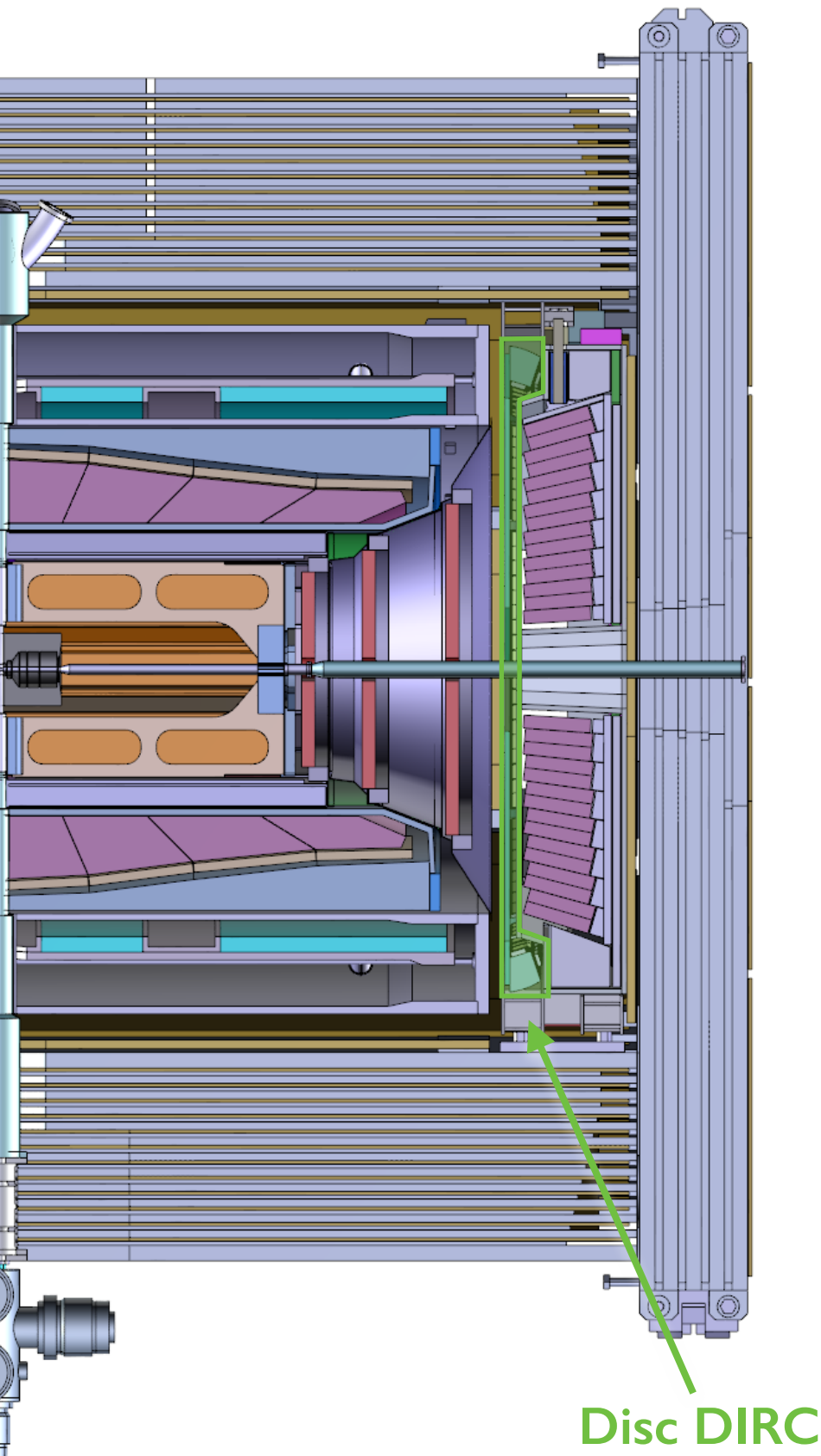
- maximum luminosity

$$2 \cdot 10^{32} \frac{1}{\text{cm}^2 \text{s}}$$

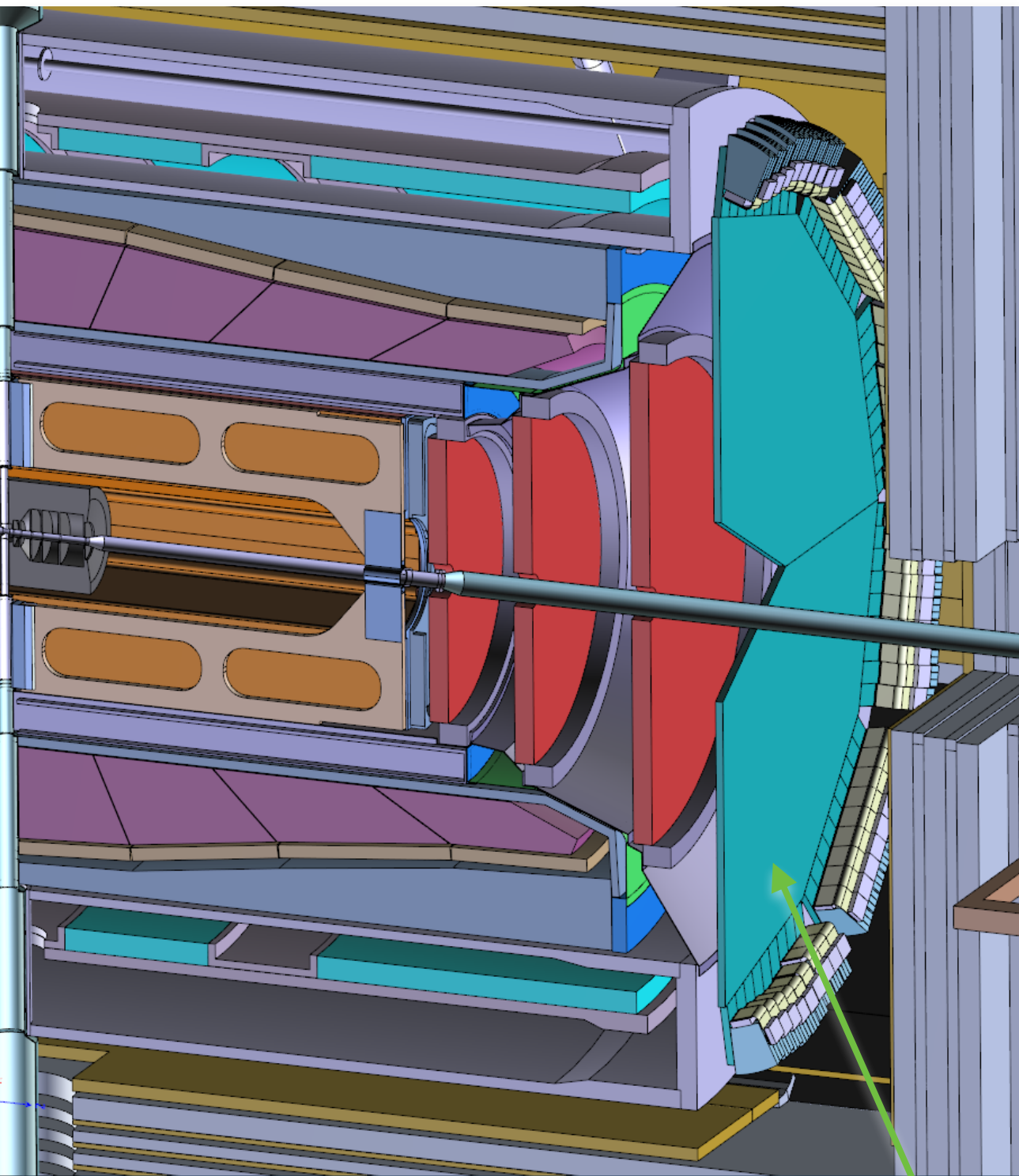
Physics:

- hadron spectroscopy
- nucleon structure
- hadrons in matter
- hypernuclei





- 4σ π/K separation up to 4.5 GeV/c
- continuous beam with interaction rates up to 20 MHz
- strong magnetic field
- high radiation level and photon dose
- high-precision and large-area optics
- high time resolution, data rate and channel density
- very limited space

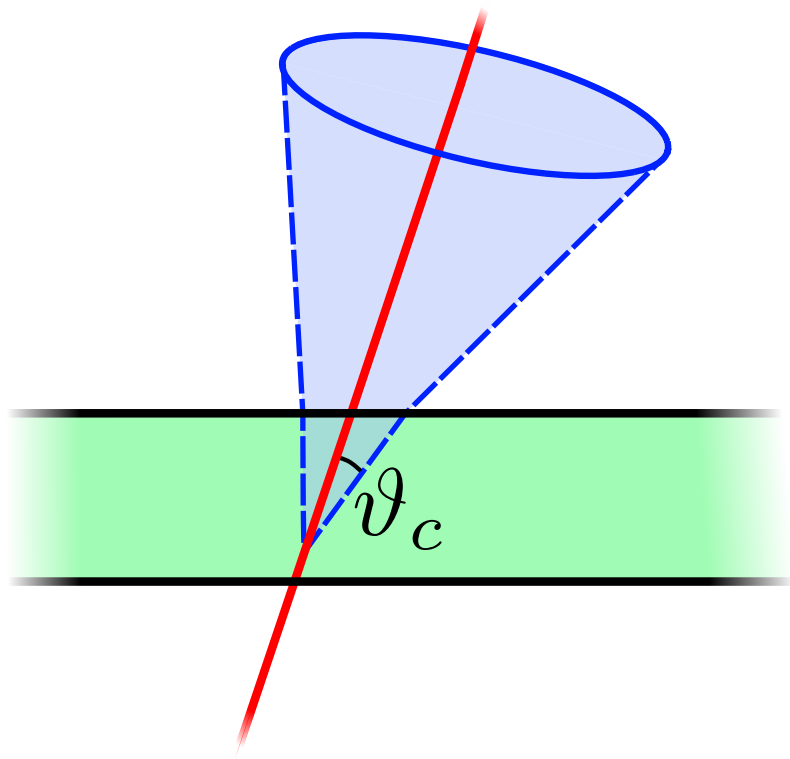


Disc DIRC

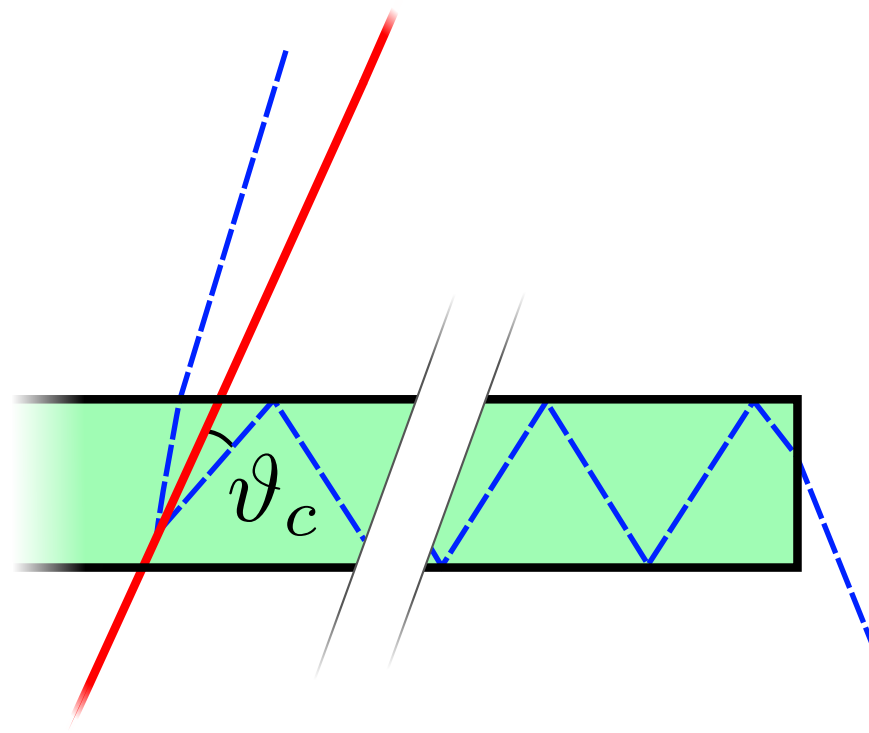
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$$\cos \vartheta_c = \frac{1}{n\beta}$$

$$\frac{dN^2}{dkdx} = \alpha z^2 \sin^2 \vartheta_c$$

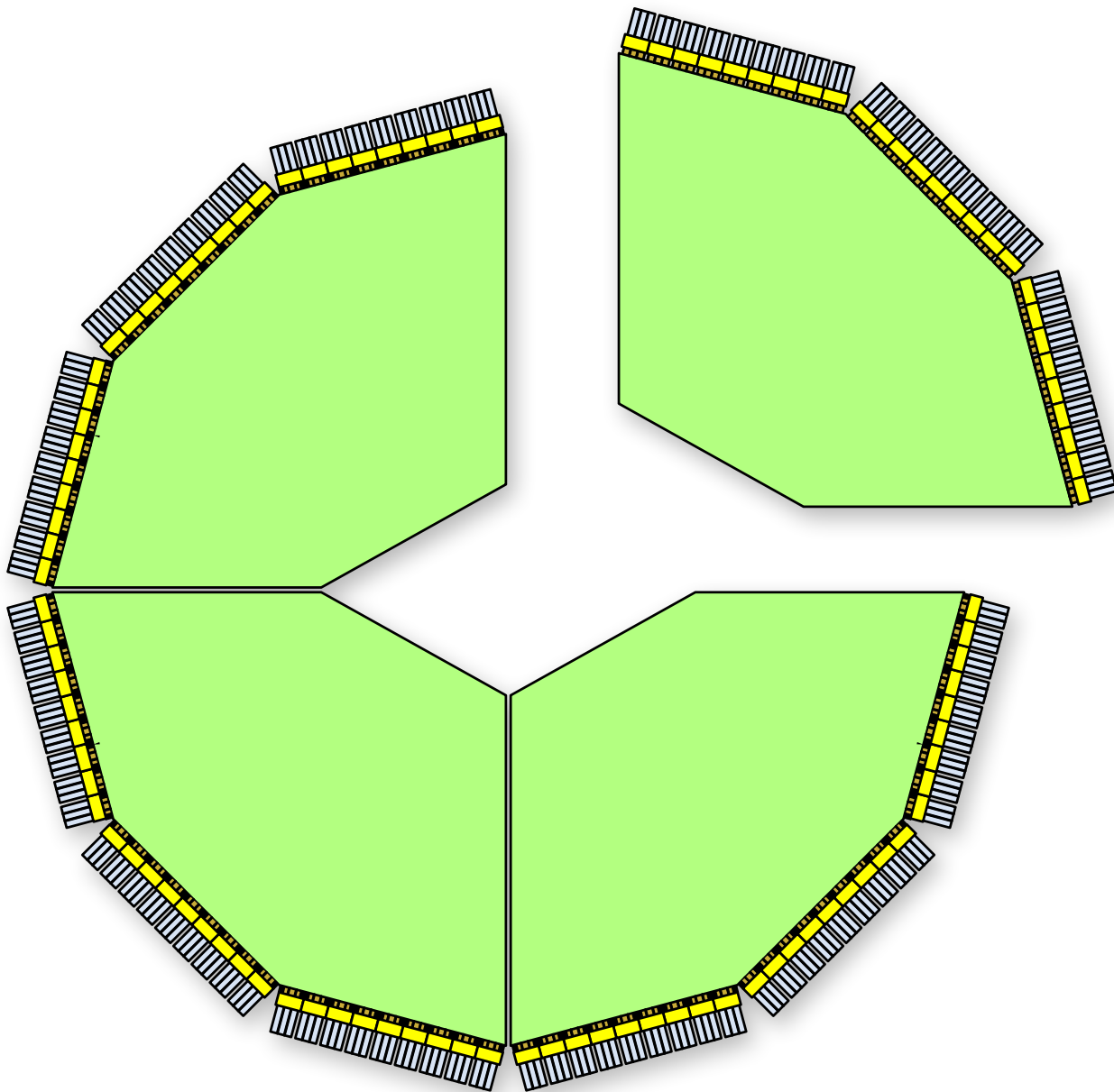


RICH

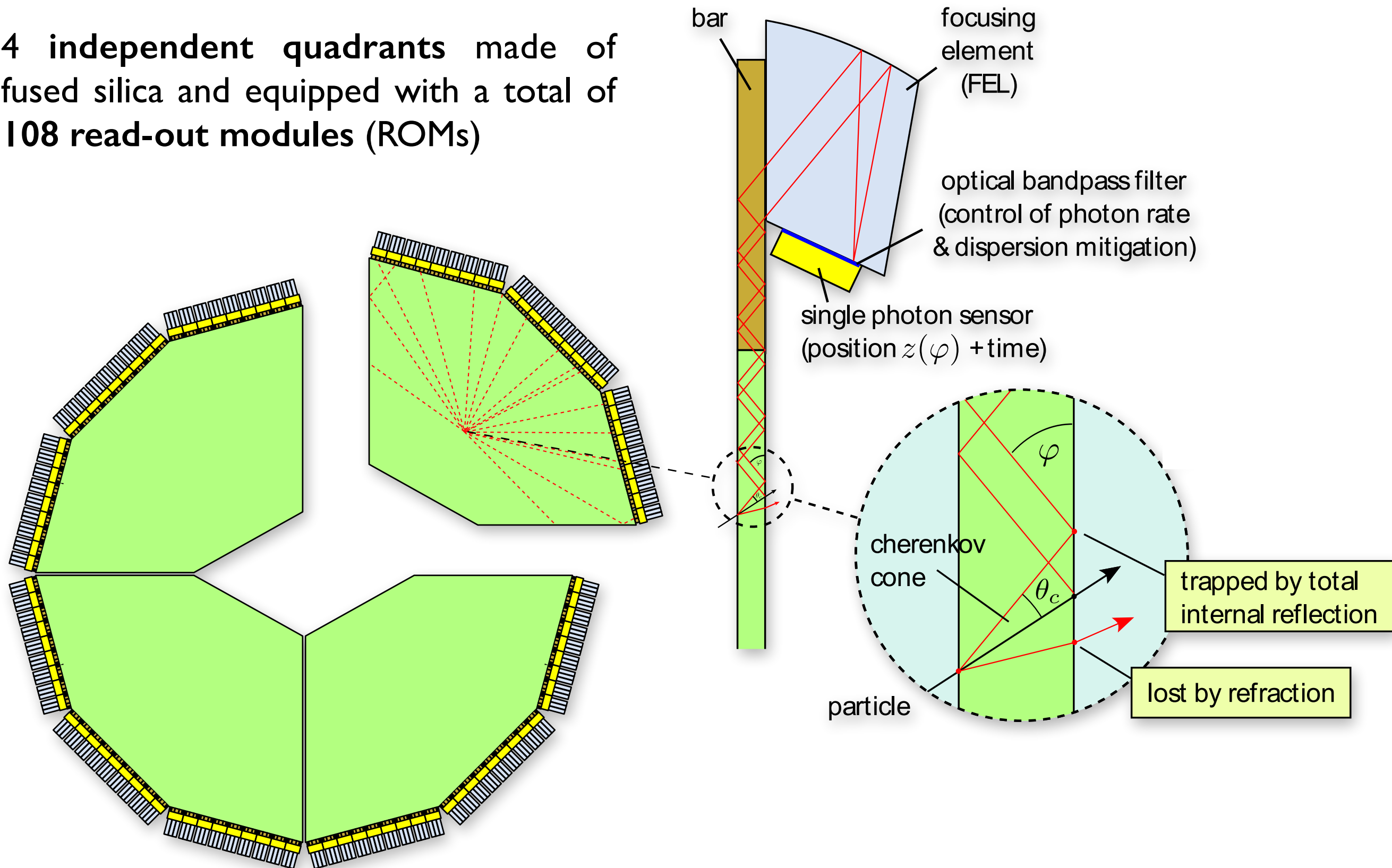


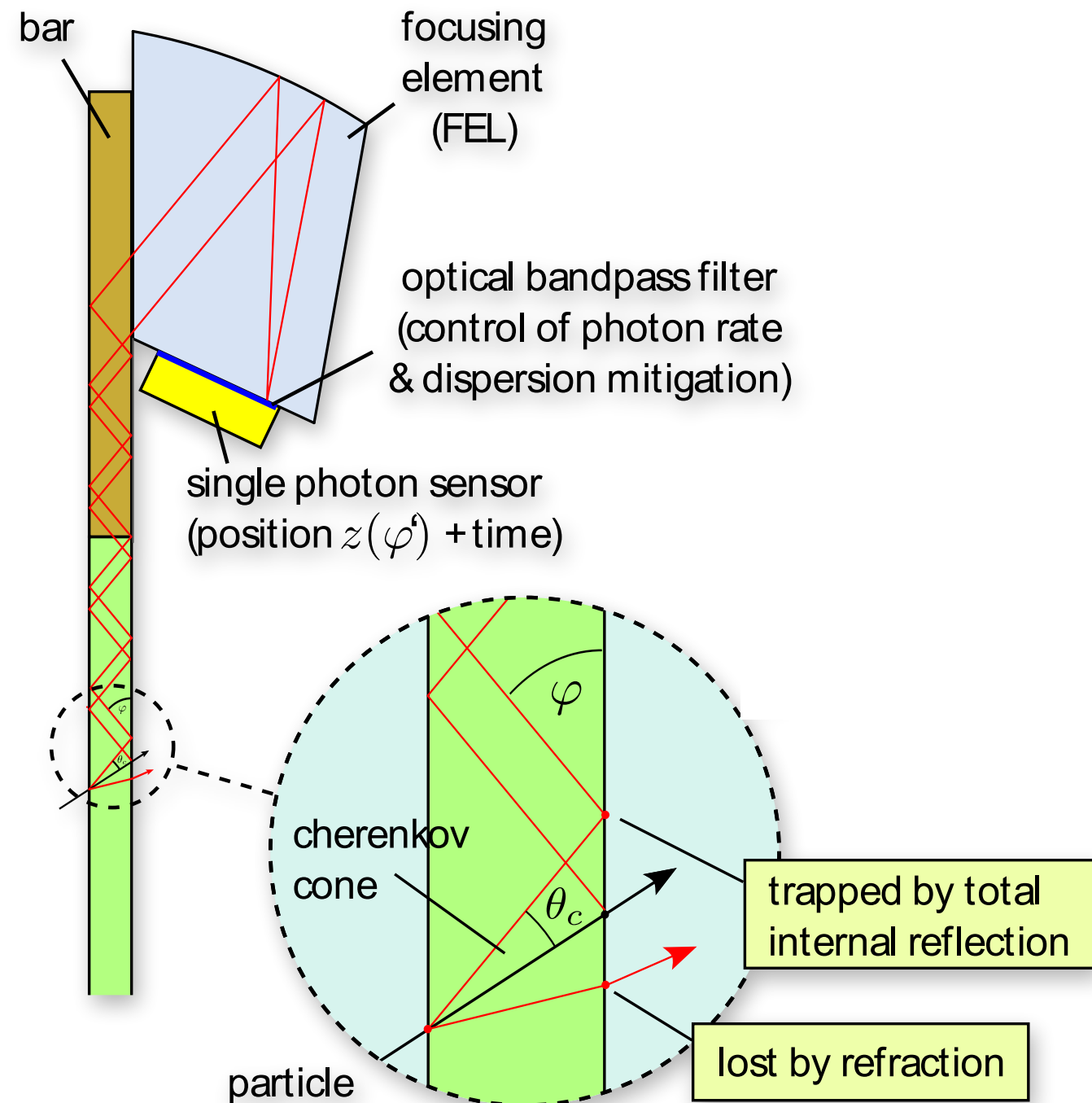
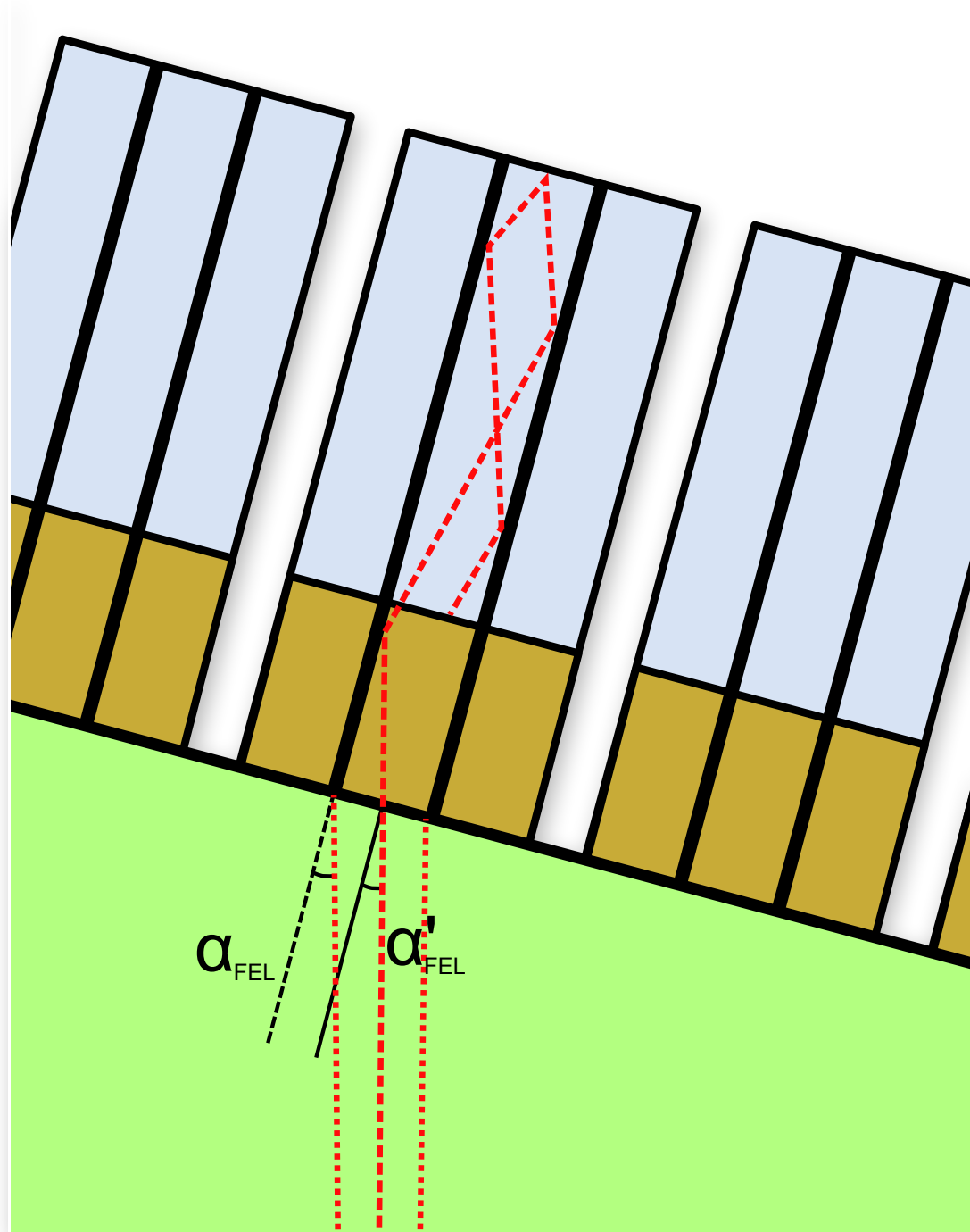
DIRC

4 independent quadrants made of fused silica and equipped with a total of 108 read-out modules (ROMs)



4 independent quadrants made of fused silica and equipped with a total of 108 read-out modules (ROMs)

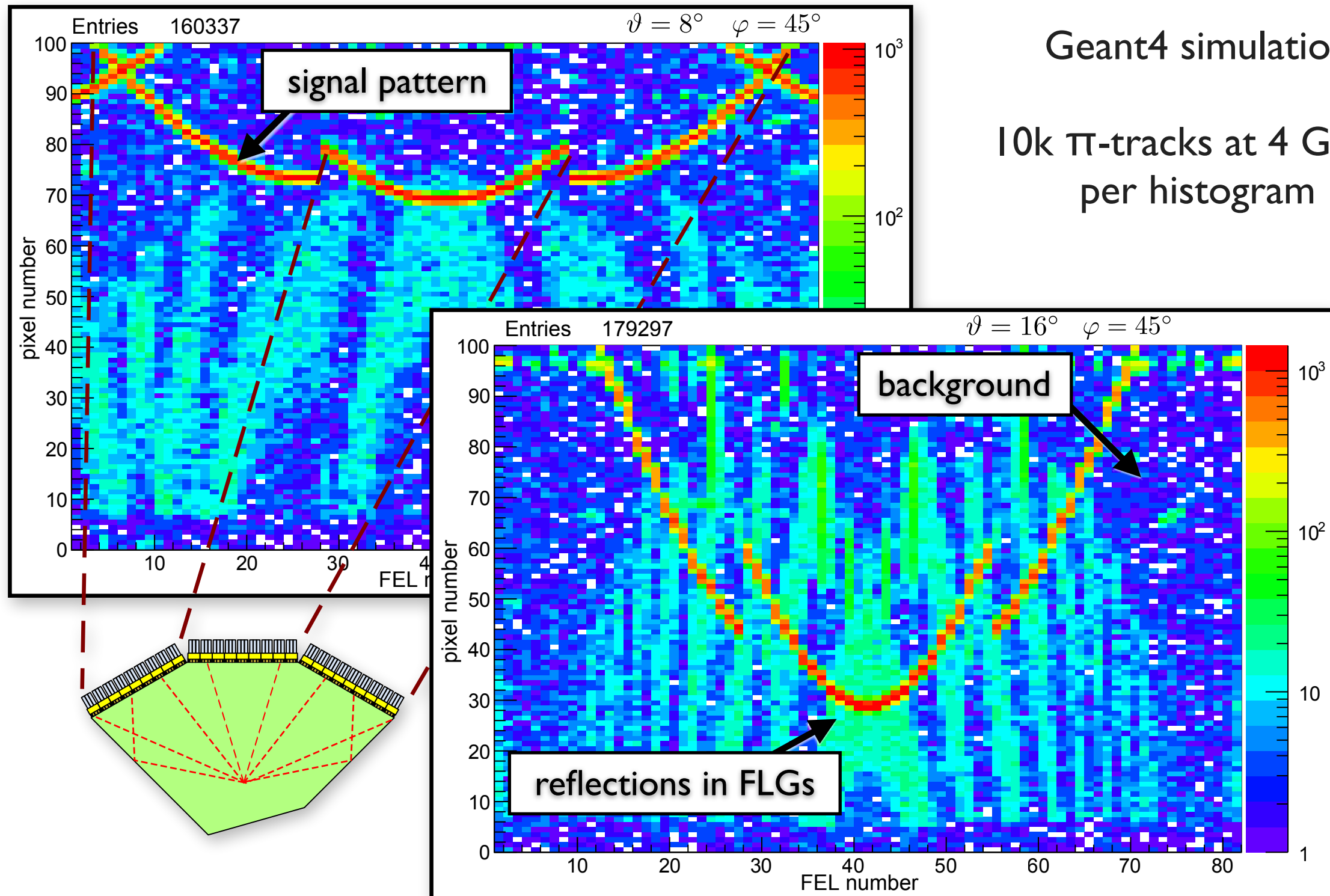




accumulated hit patterns

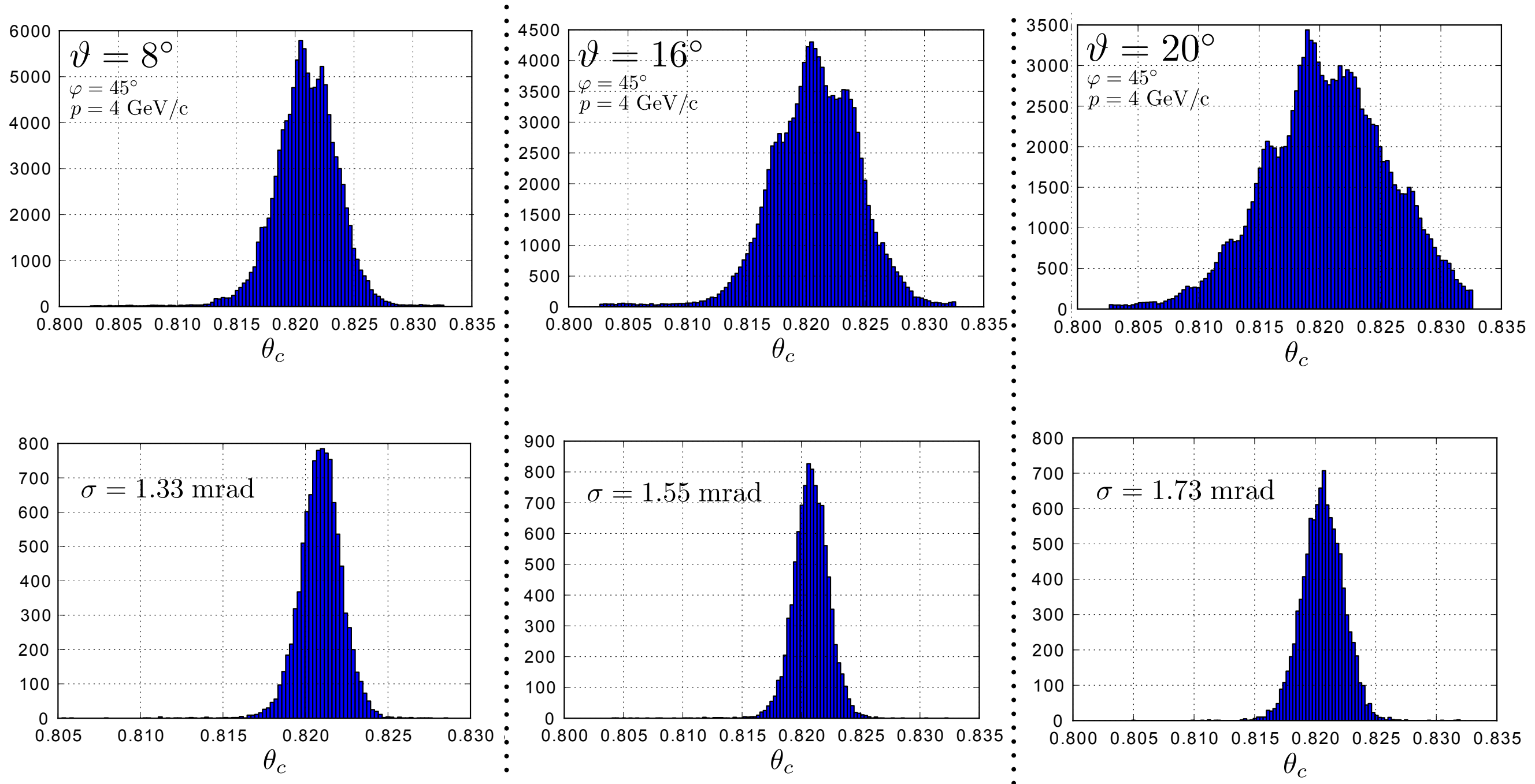
Geant4 simulation

10k π -tracks at 4 GeV/c
per histogram



O. Merle (RICH 13)

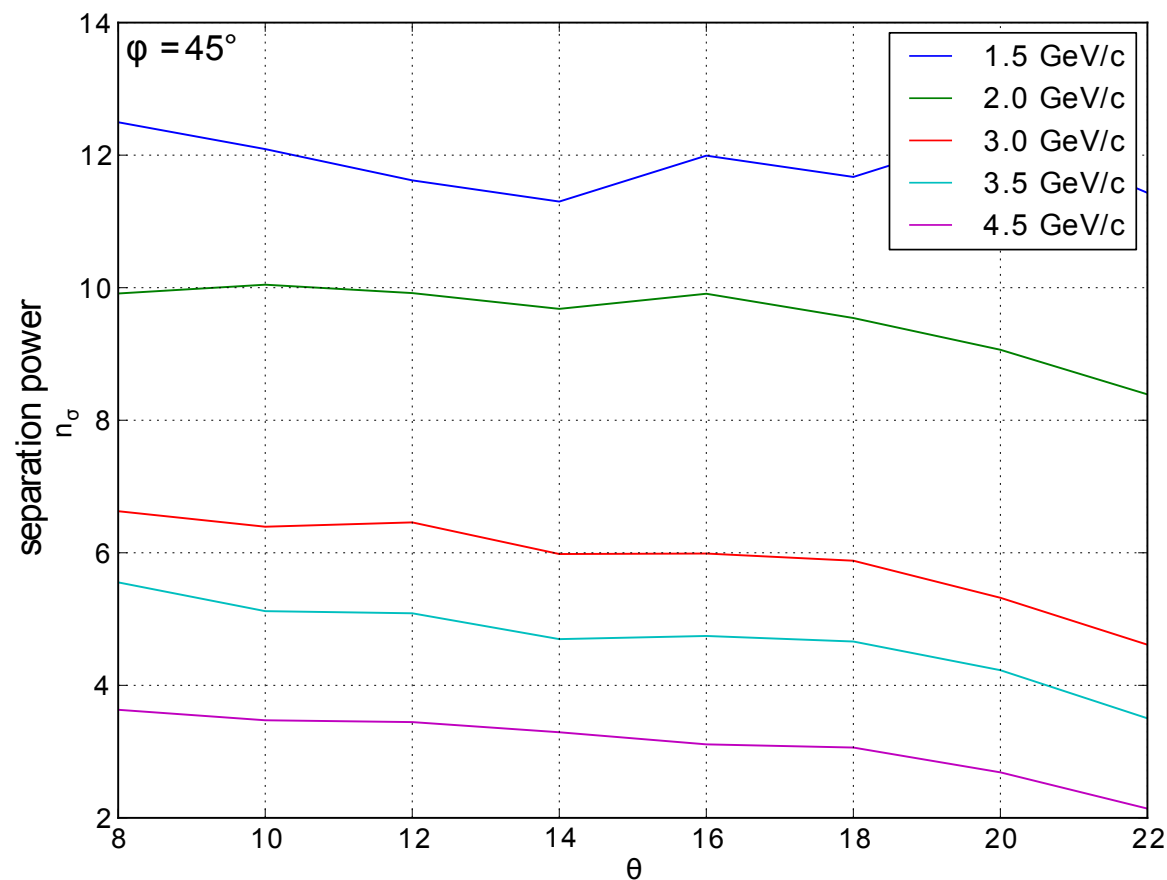
reconstructed θ_c per single-photon



reconstructed θ_c per track

O. Merle (RICH 13)

π/K separation theta vs. momentum

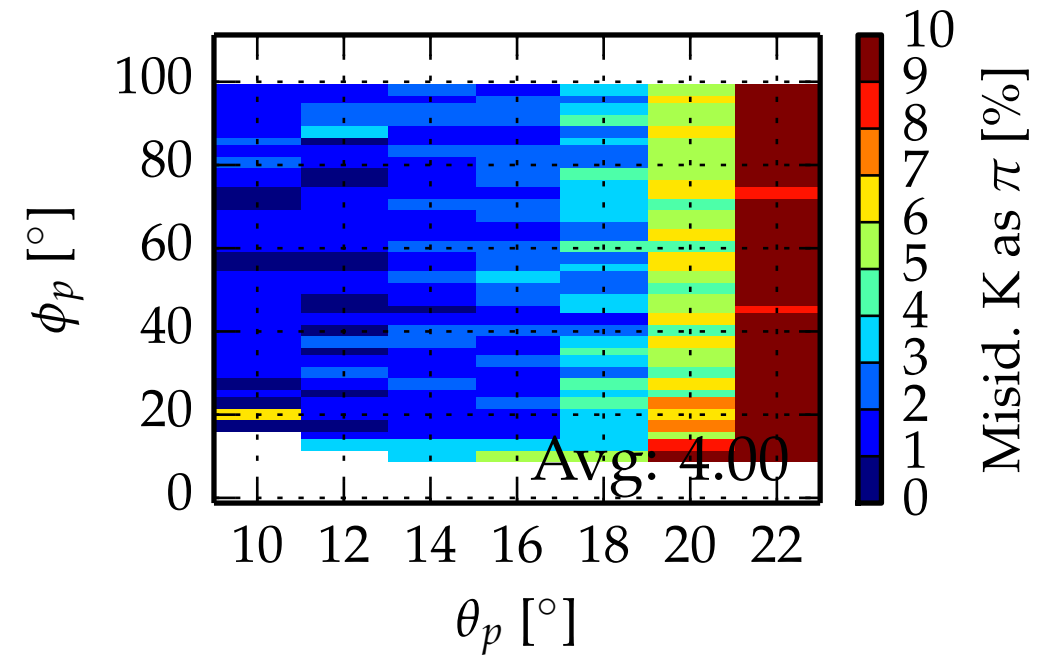


2 x 10k tracks/marker

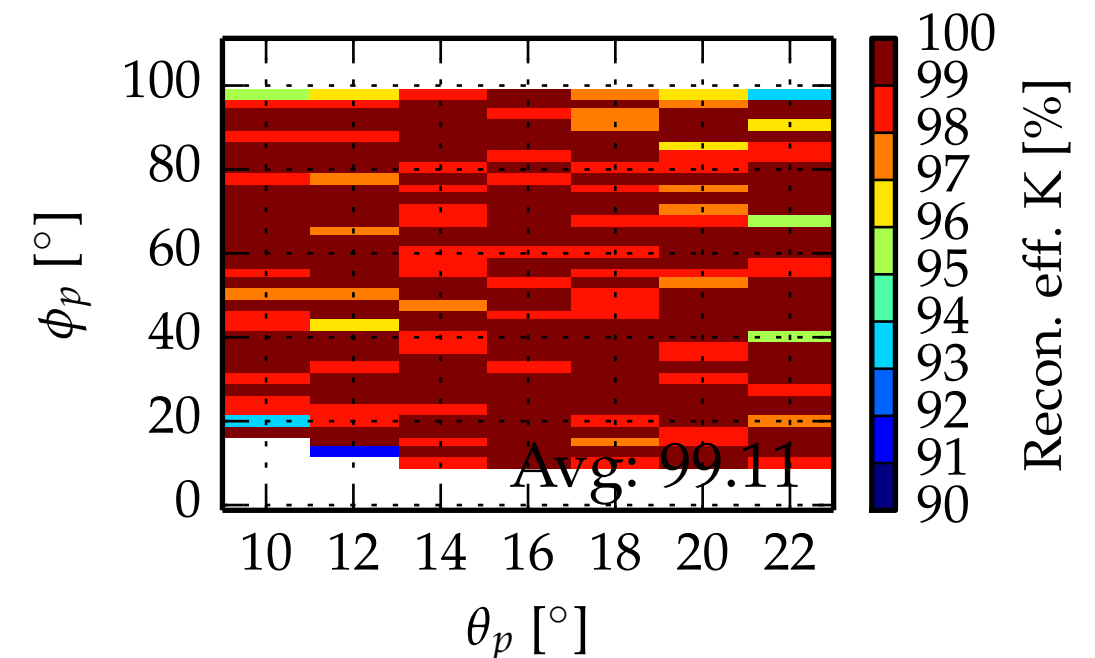
1 mrad smearing of track in θ and ϕ

0,5 mm pixel size, passband: 385 - 460 nm

K misidentification @ 4 GeV/c



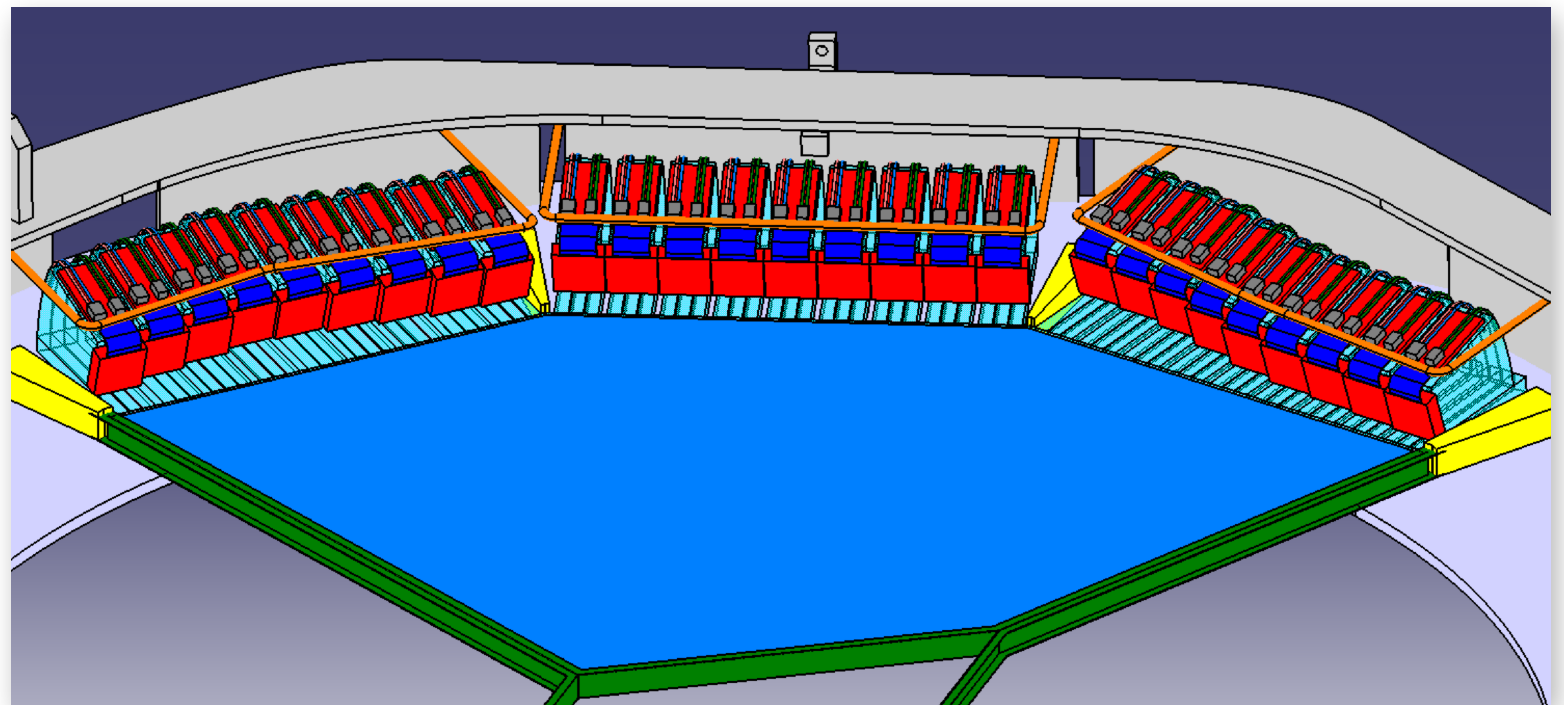
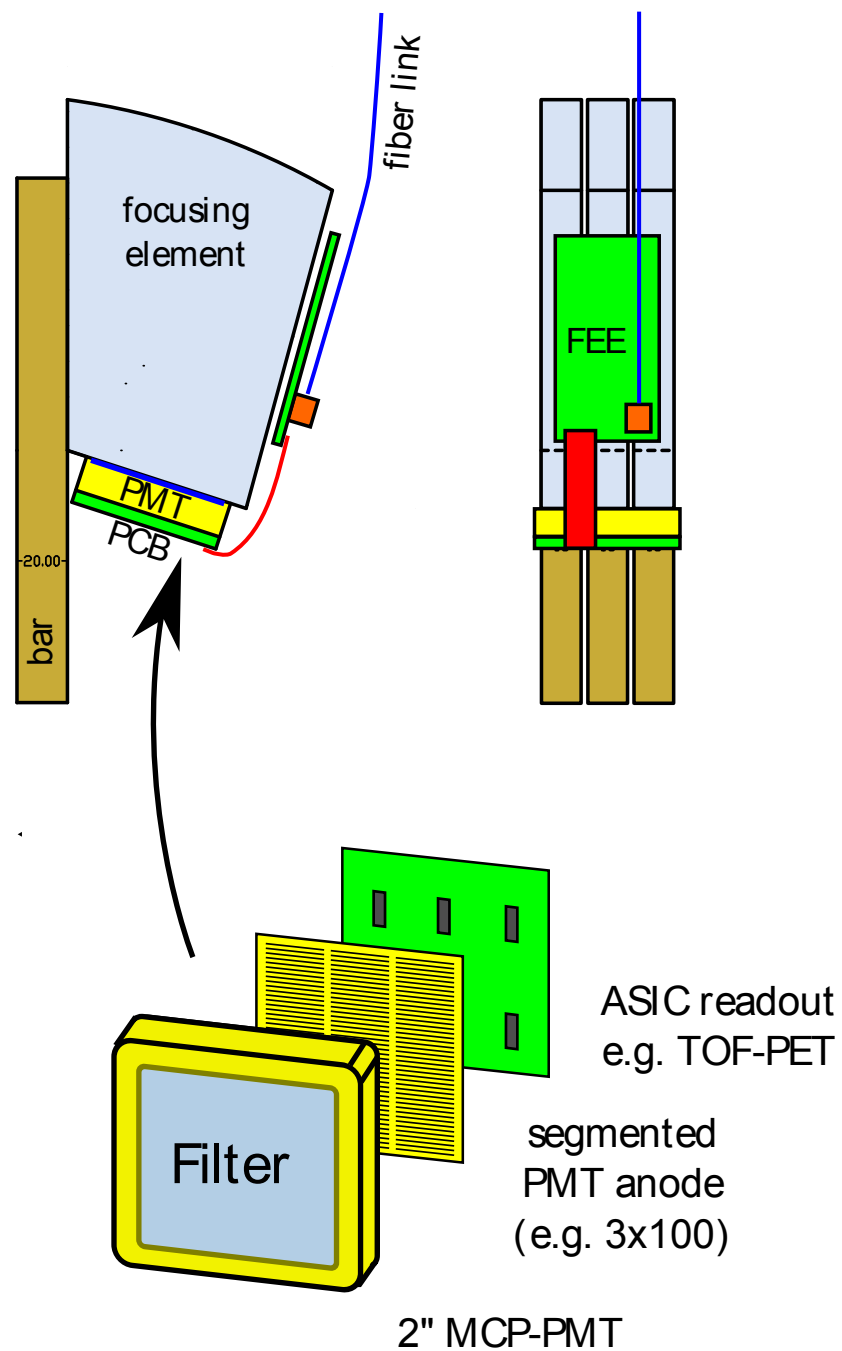
K reconstruction eff. @ 4 GeV/c

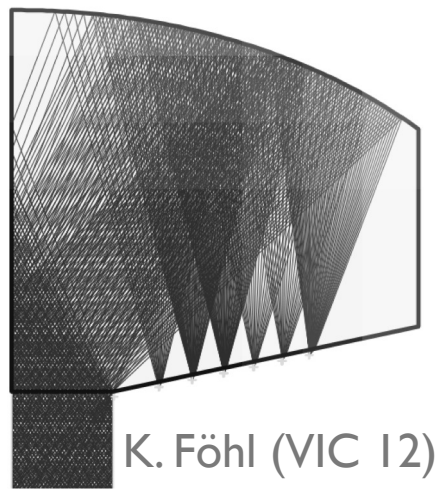


O. Merle (PhD-Thesis, 2015)

the envisaged ROM

- realization of the optomechanical system and the readout is ongoing
- different test setups for QA of sensors and optical components are available



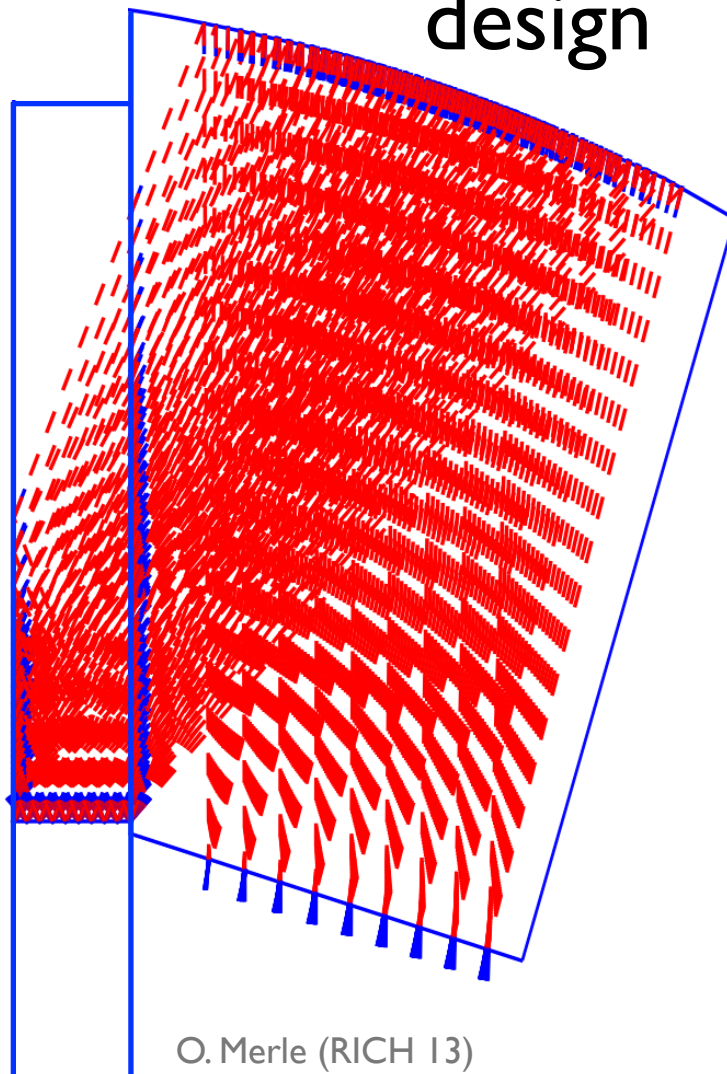


old dSiPM
design

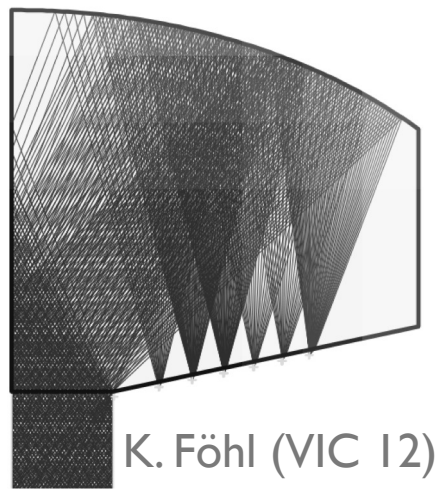


light-guides are to scale

new MCP-PMT
design



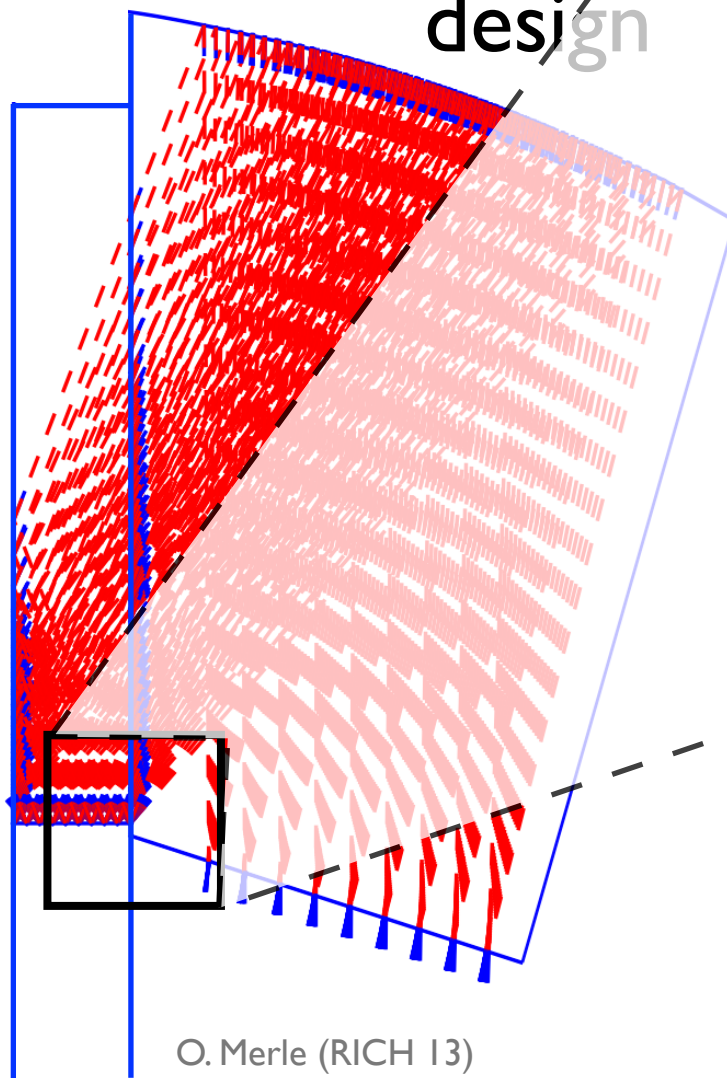
- spot width for focussing matches with the step size of the MCP-PMT anode



old dSiPM
design



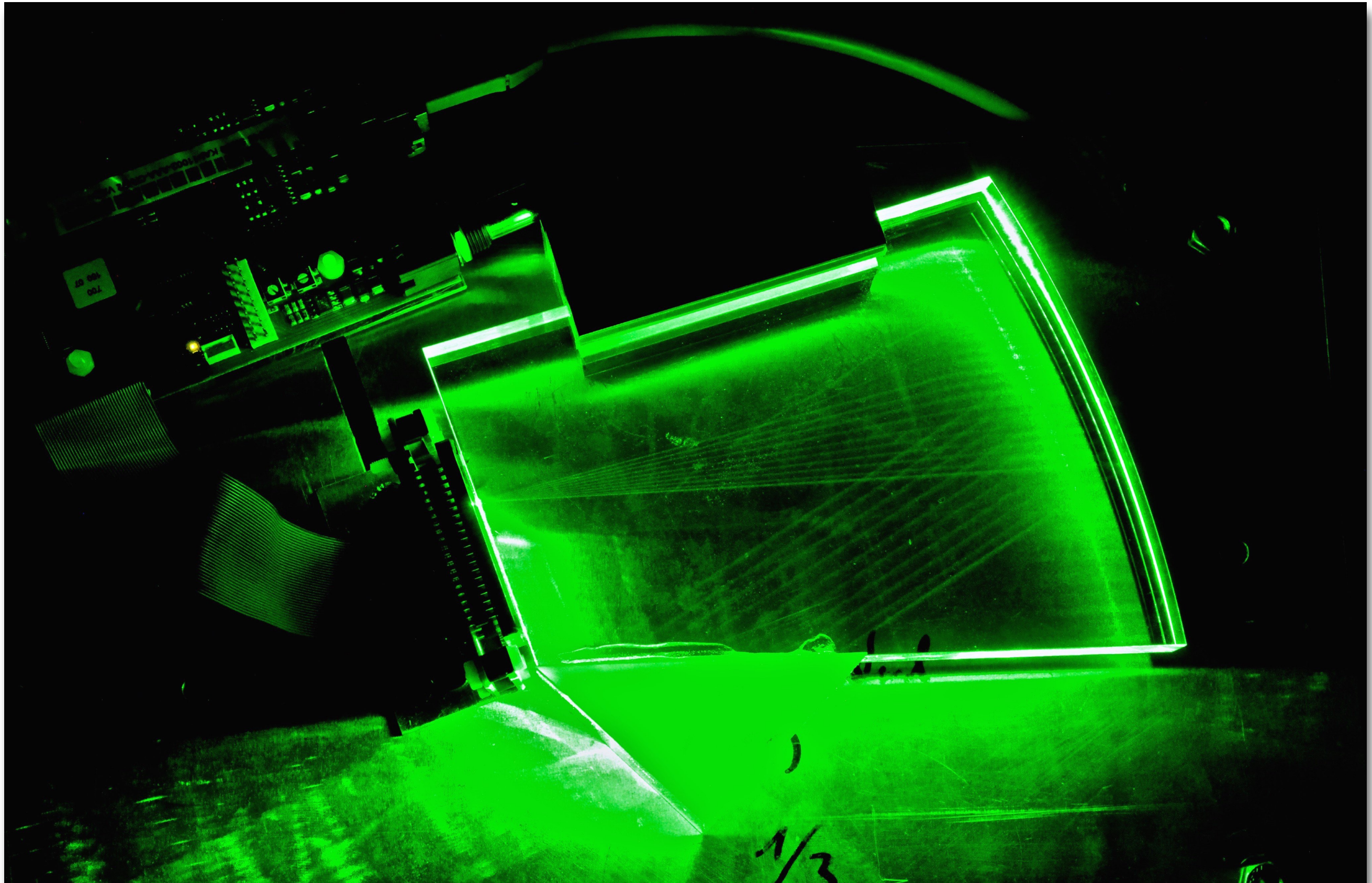
light-guides are to scale

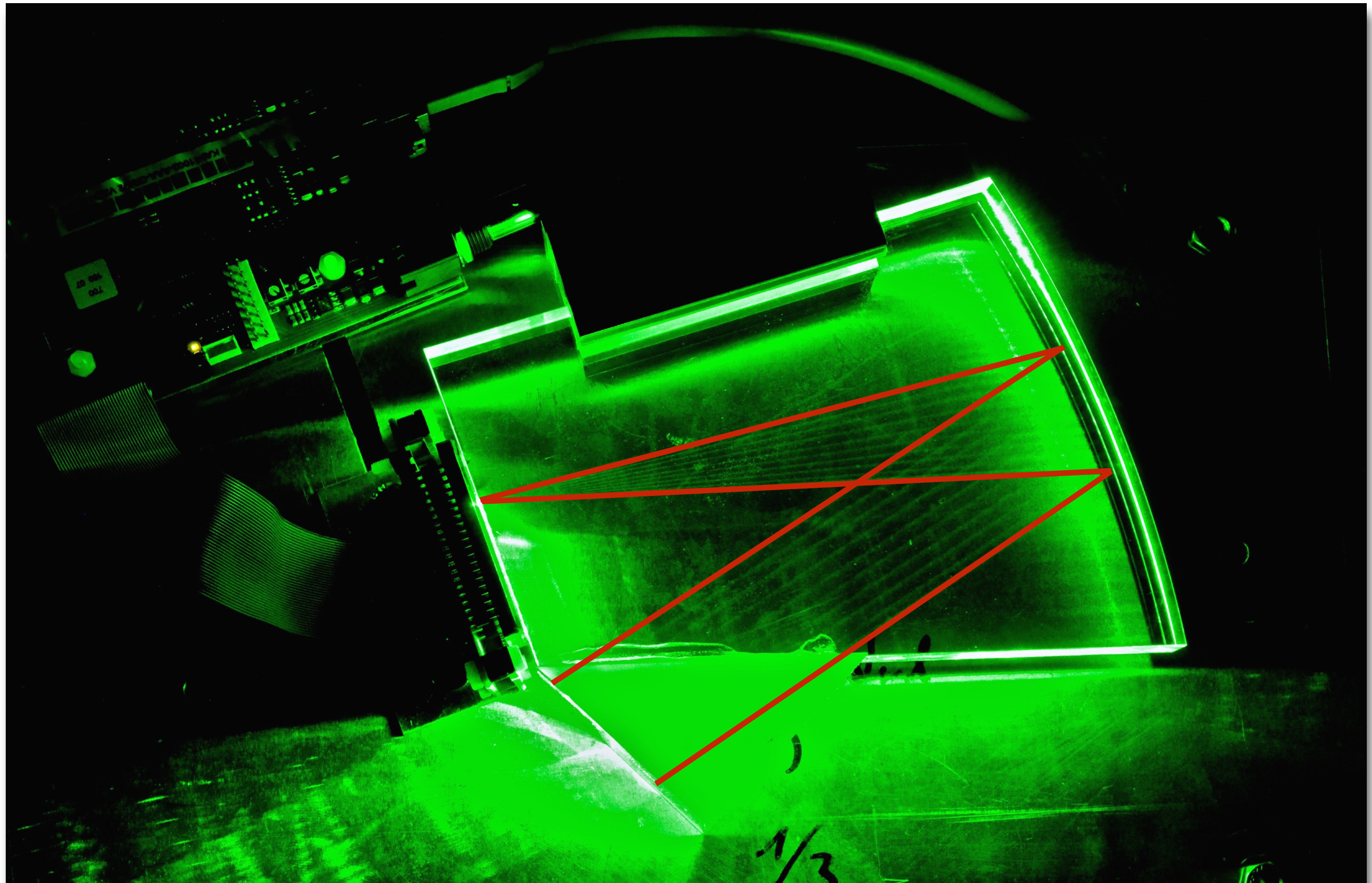


new MCP-PMT
design

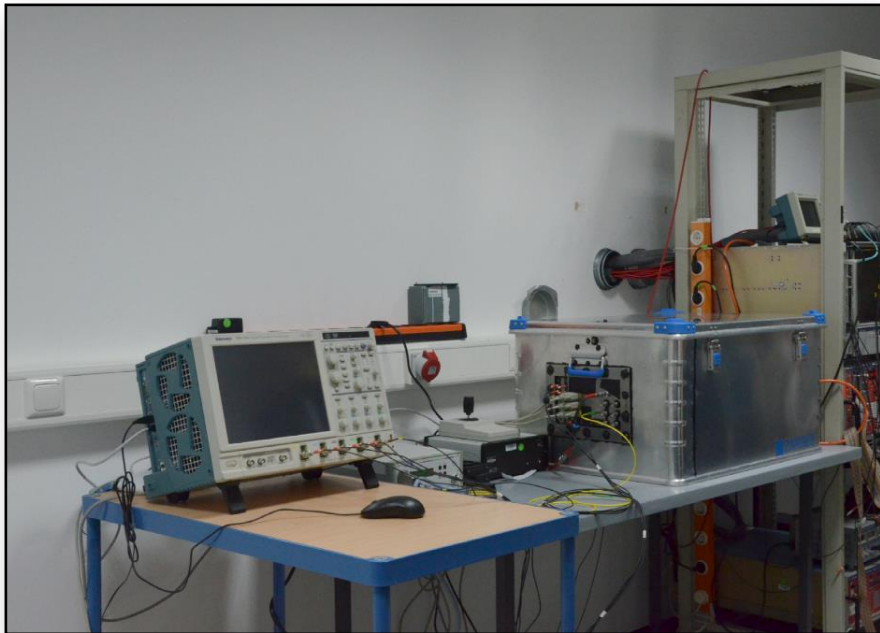


- spot width for focussing matches with the step size of the MCP-PMT anode
- non-adhesive bonding of prism and FLG prevents from losses or defocussing of trespassing photons





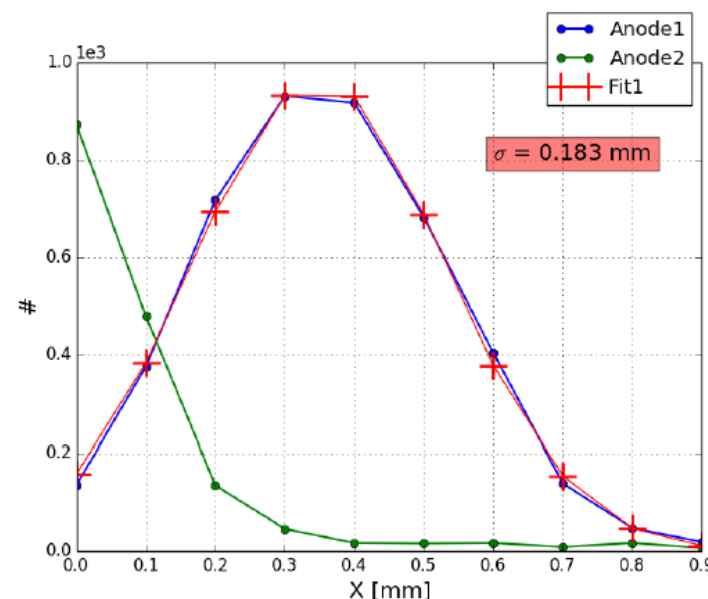
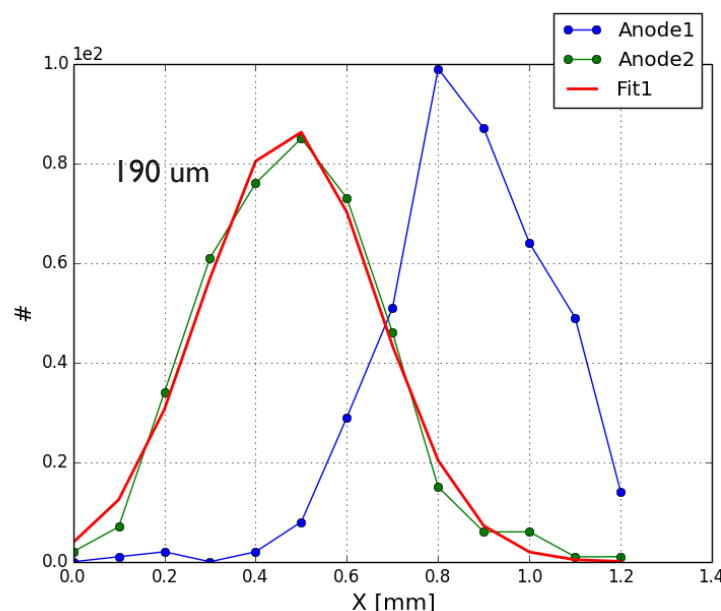
- automated setup for precise MCP-PMT QA measurements and setup with permanent magnets available
- Photonis MCP-PMT without proximity focussing works well in a magnetic field
- Hamamatsu measurements are on the way

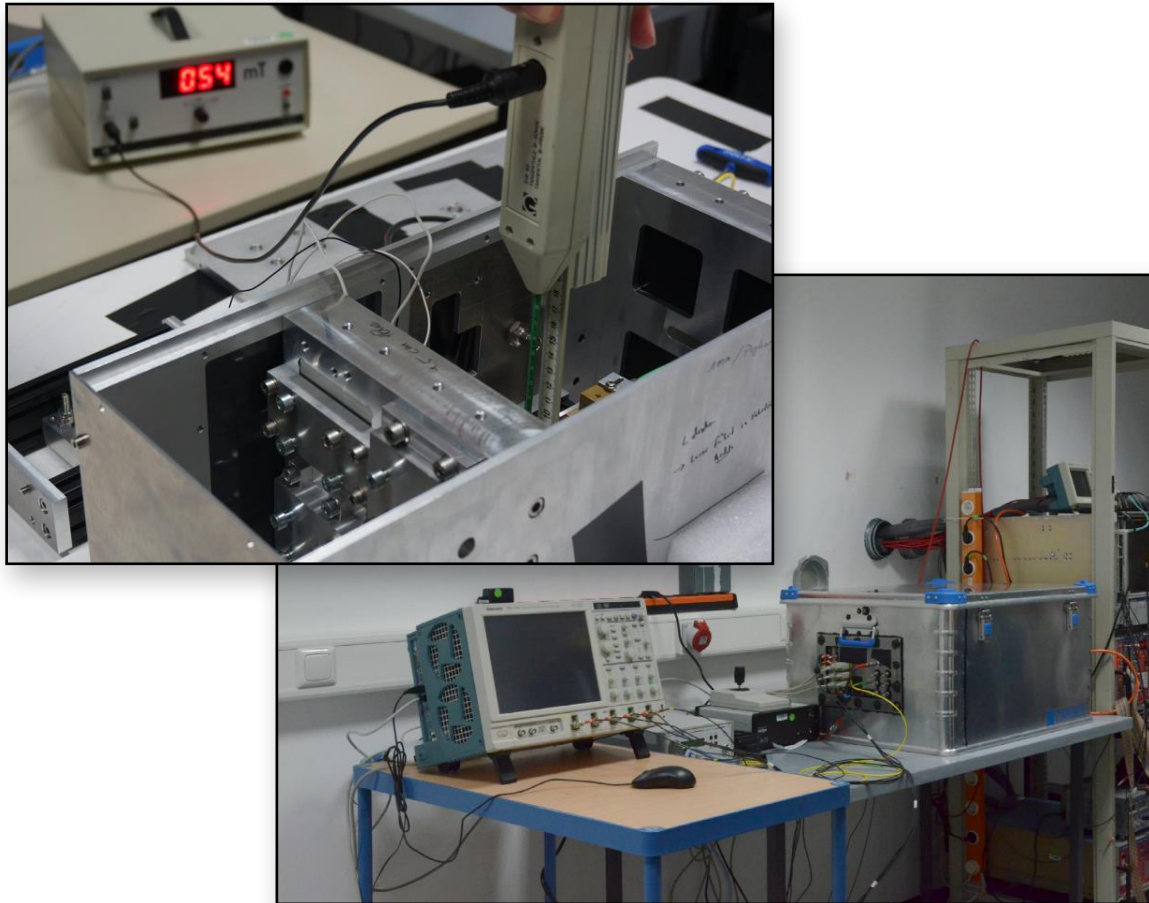


Photonis

Hamamatsu

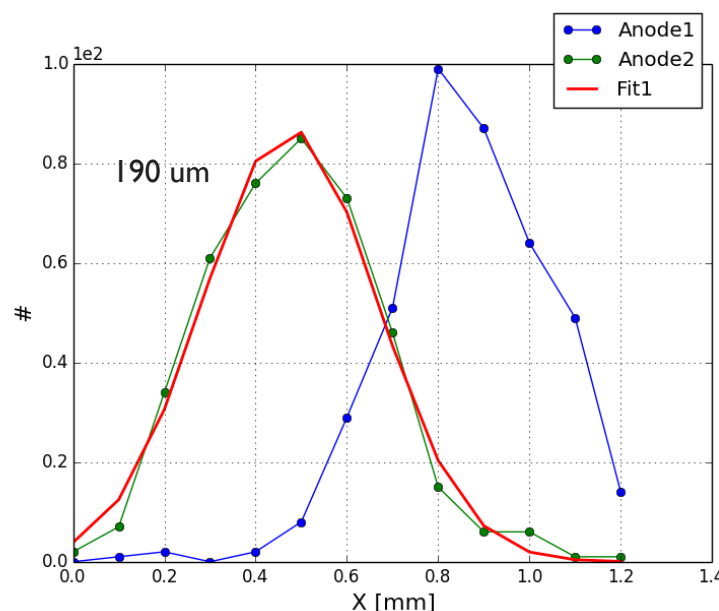
prox. focus



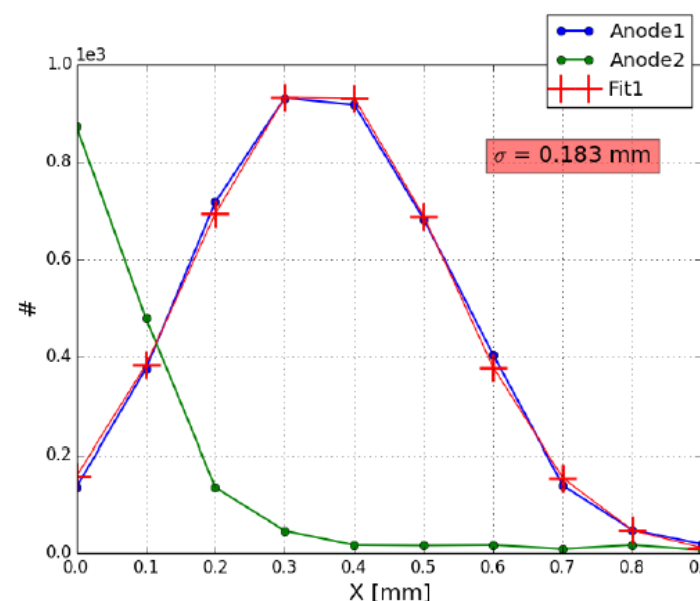


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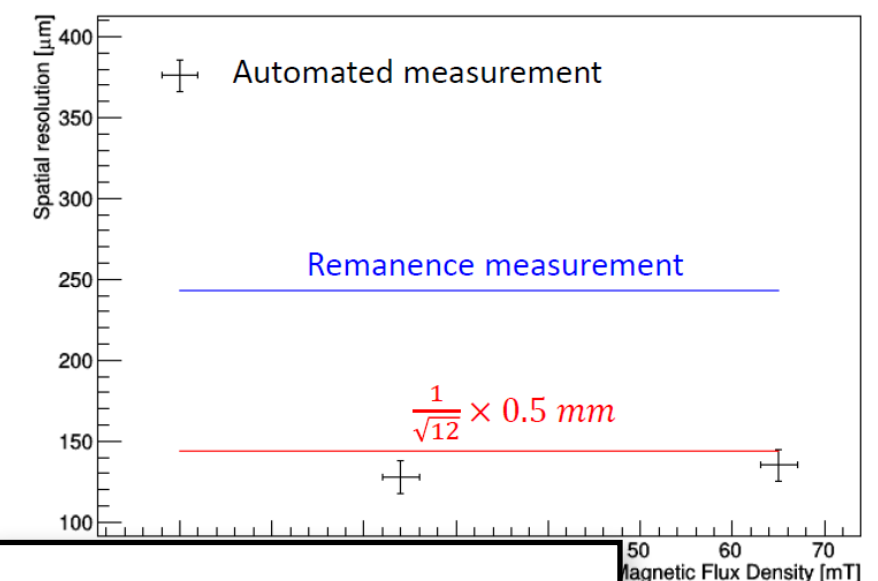
Hamamatsu



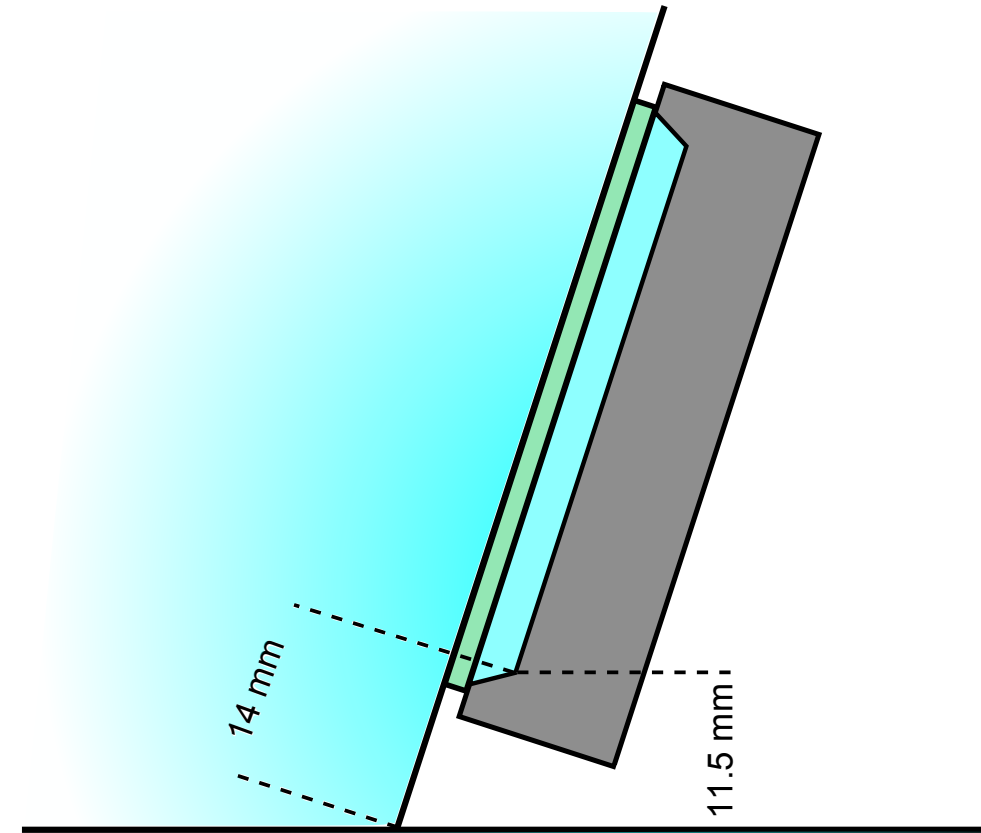
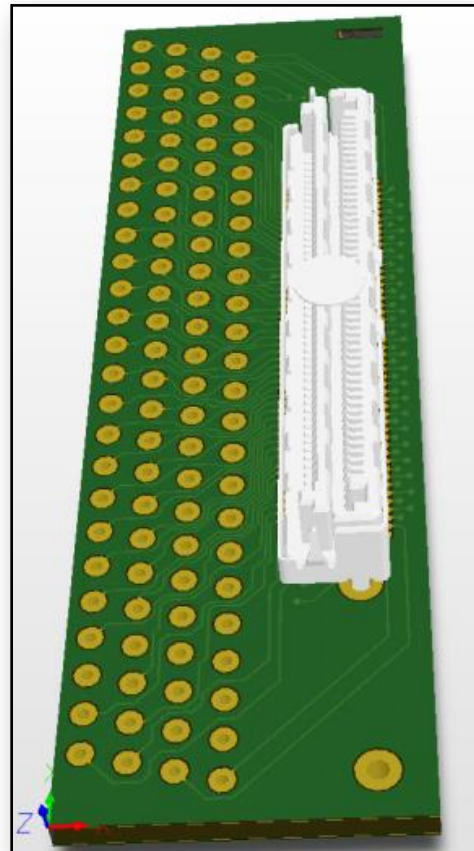
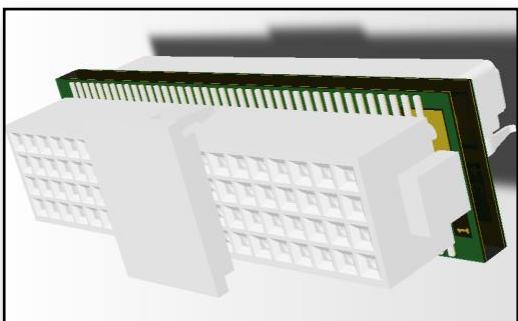
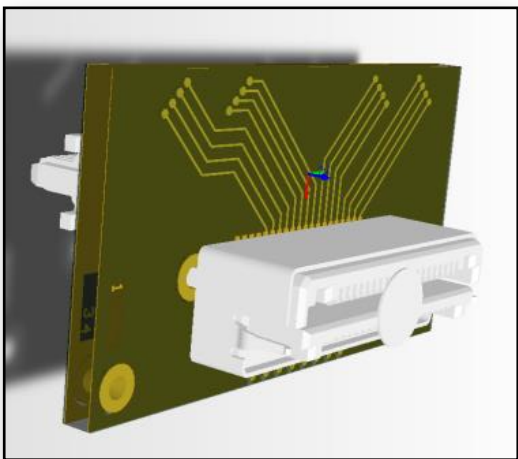
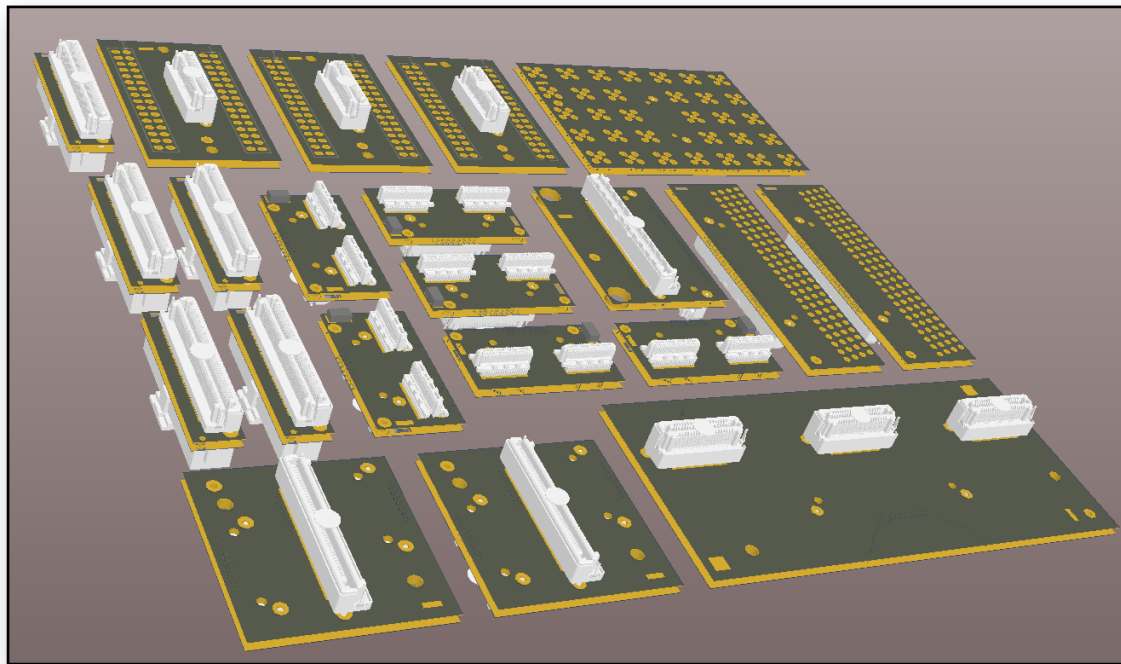
prox. focus



no prox. focus



see talk by J.Rieke



- pointed angle between prism and FLG requires a compact solution
- second iteration of PCBs is being produced in preparation for a TOFPET readout

see talk by L. Ferramacho



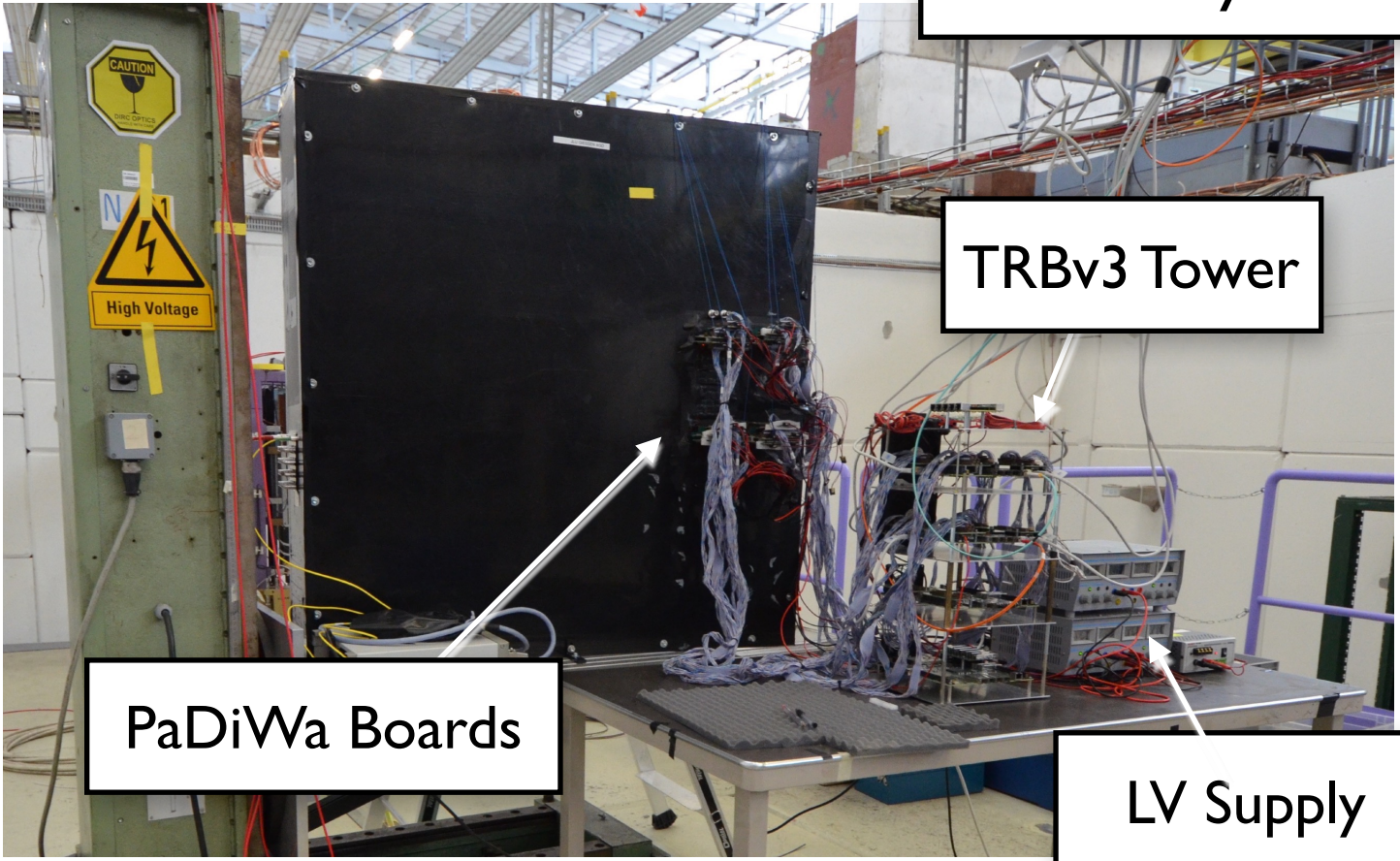
Barrel DIRC

Disc DIRC

Beamline

- joint testbeam of the Barrel and Disc DIRC prototypes
- mixed hadron beam up to 10 GeV/c
- common system for data taking (TRBv3)

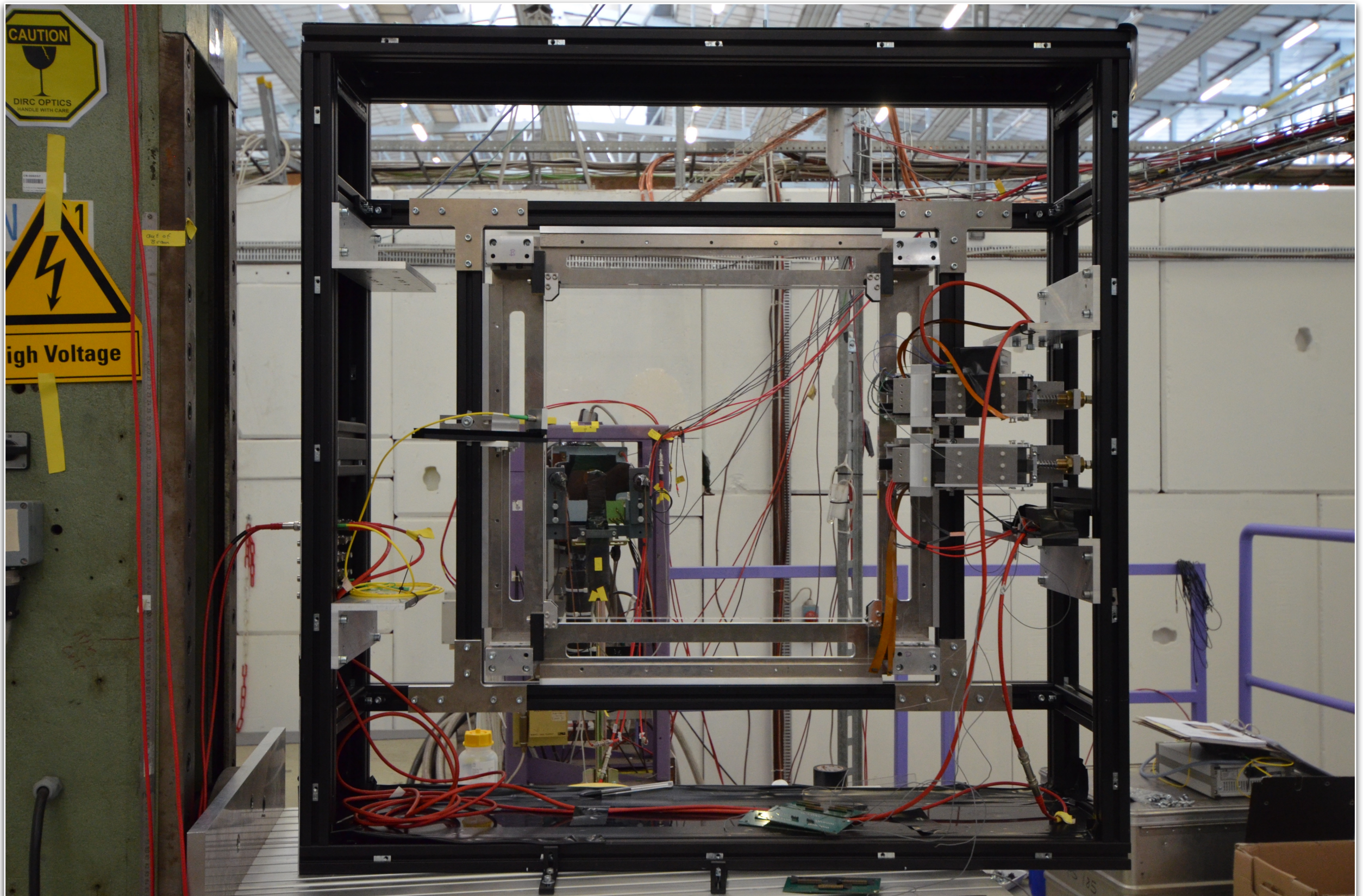
see talk by M.Traxler

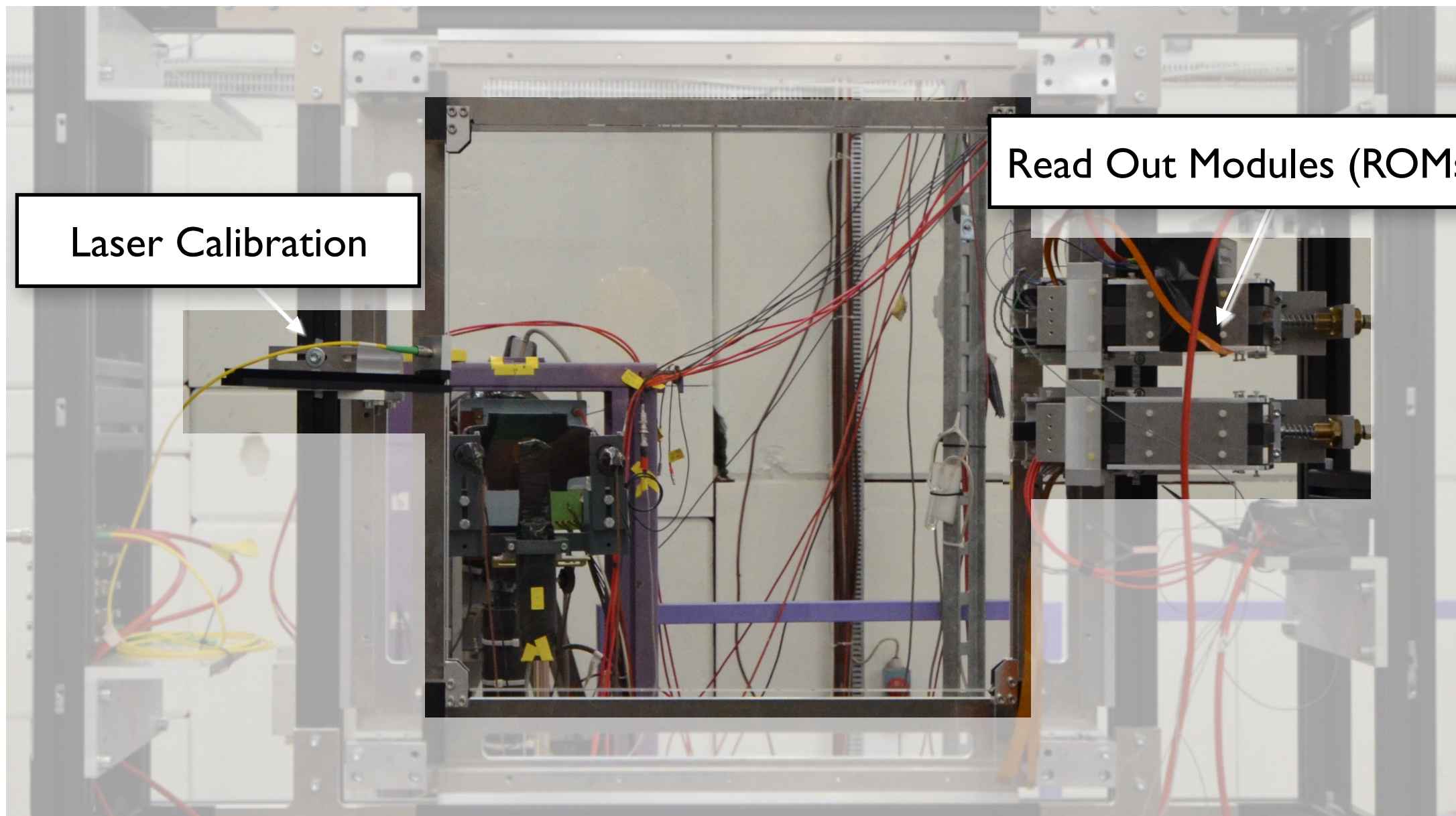


TRBv3 Tower

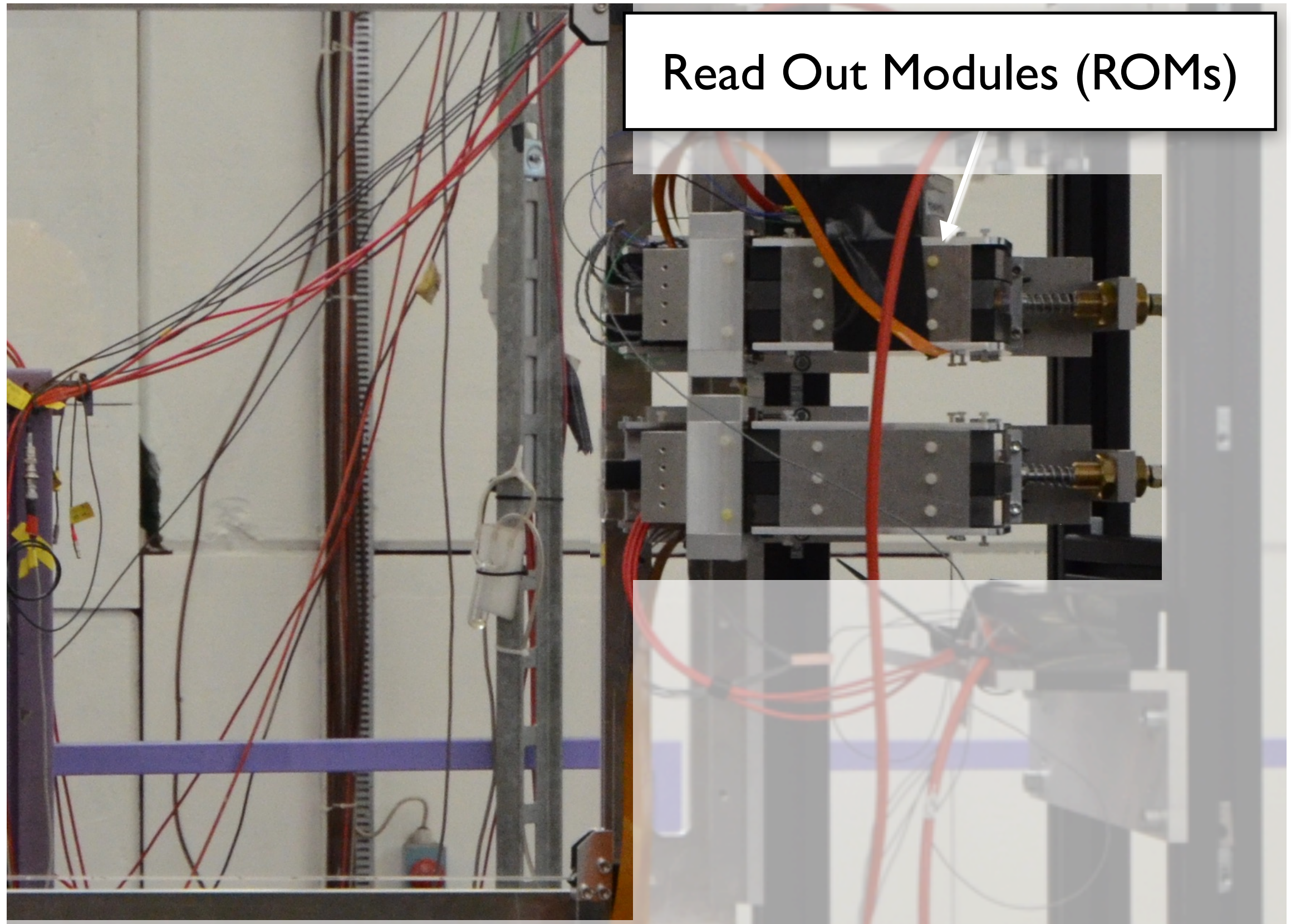
PaDiWa Boards

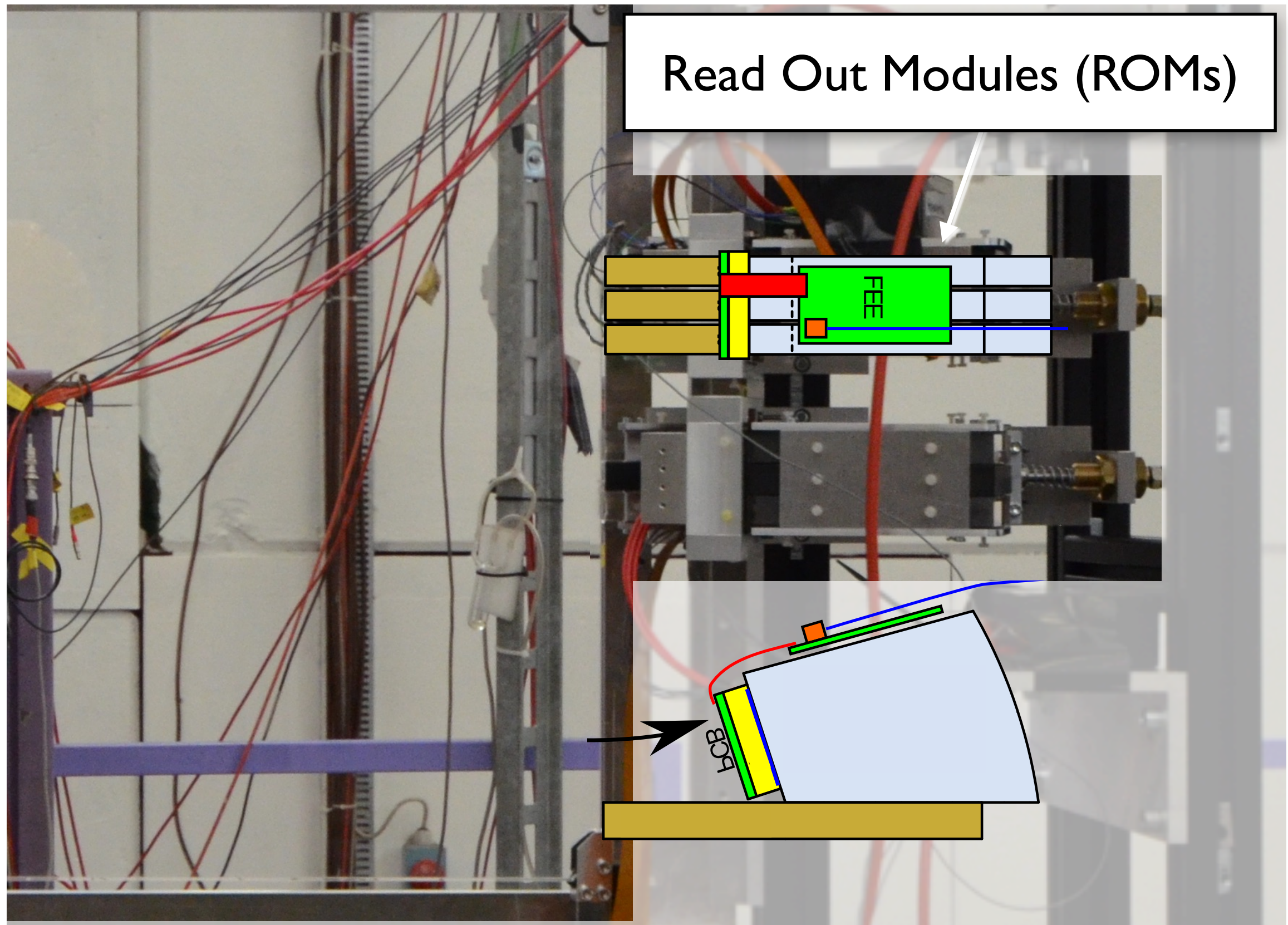
LV Supply

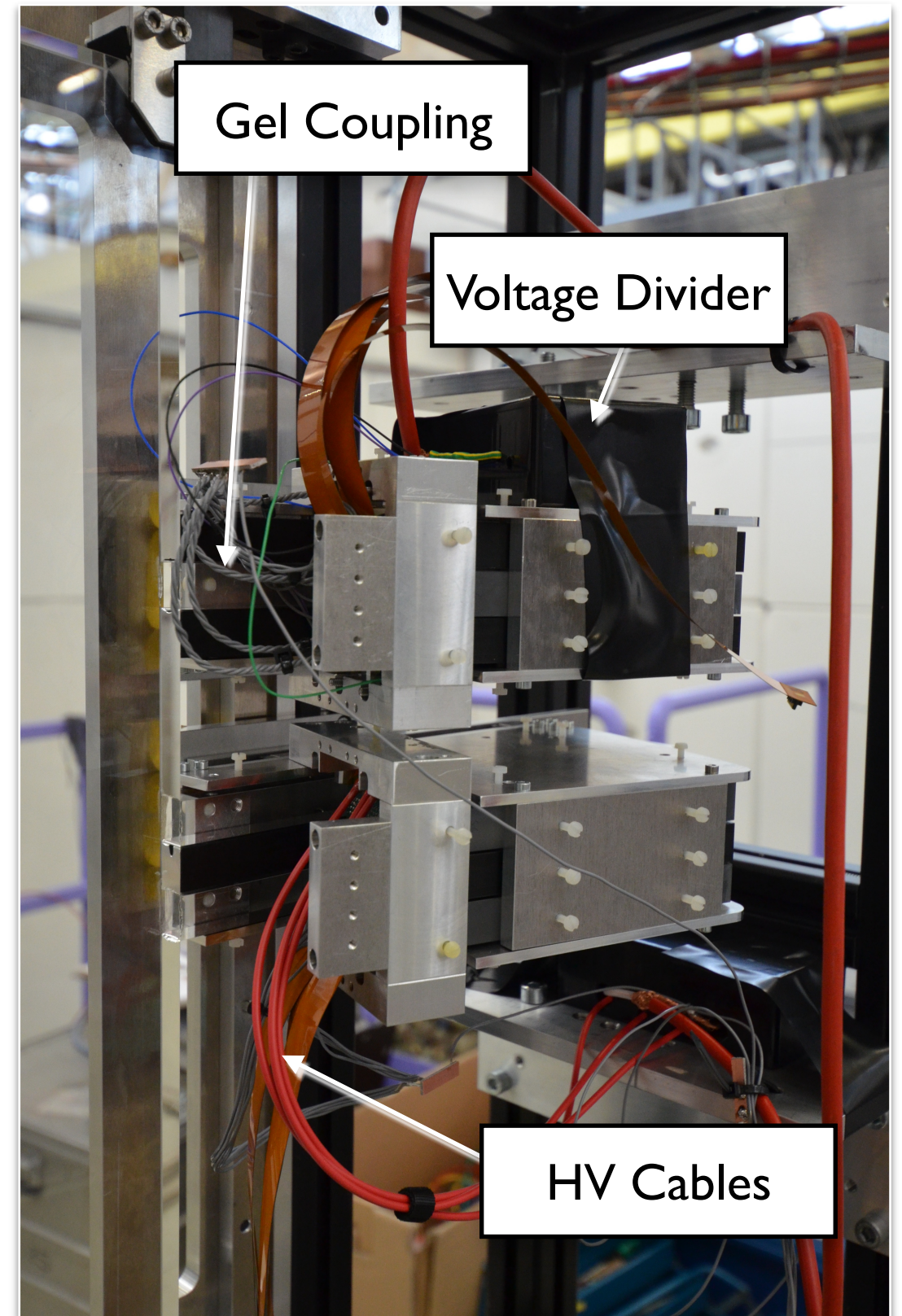
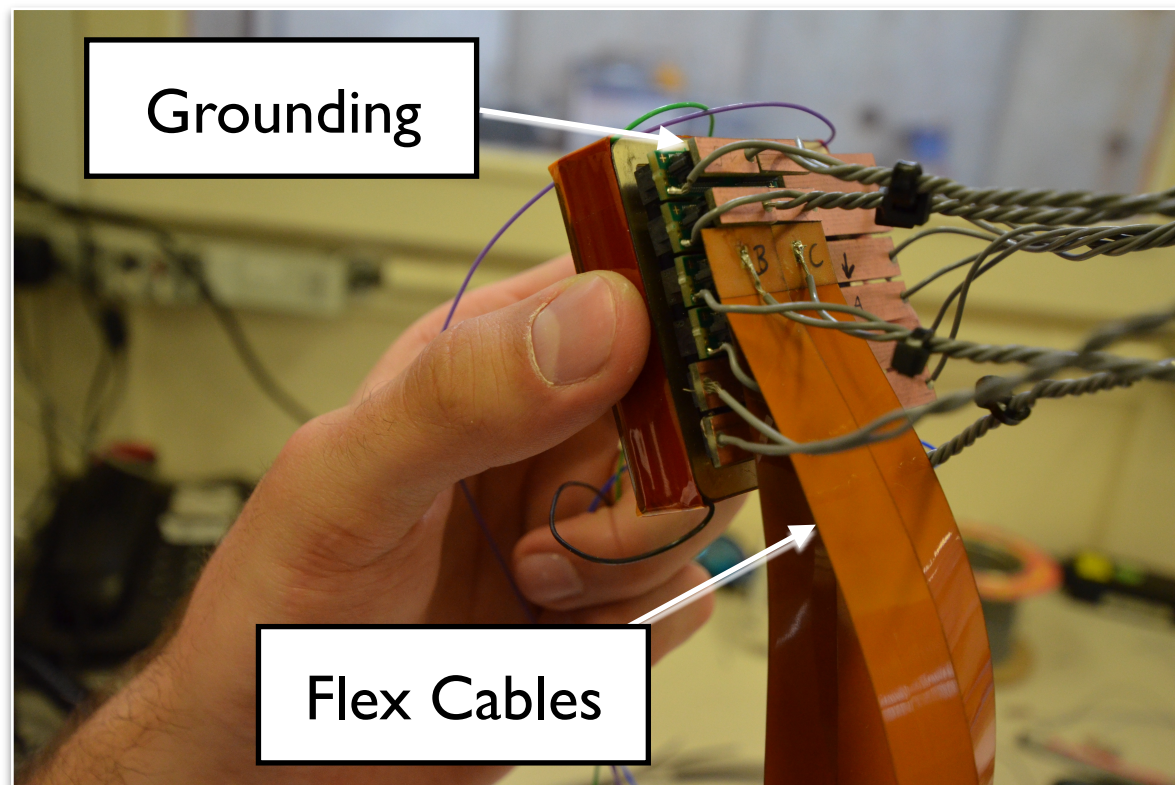
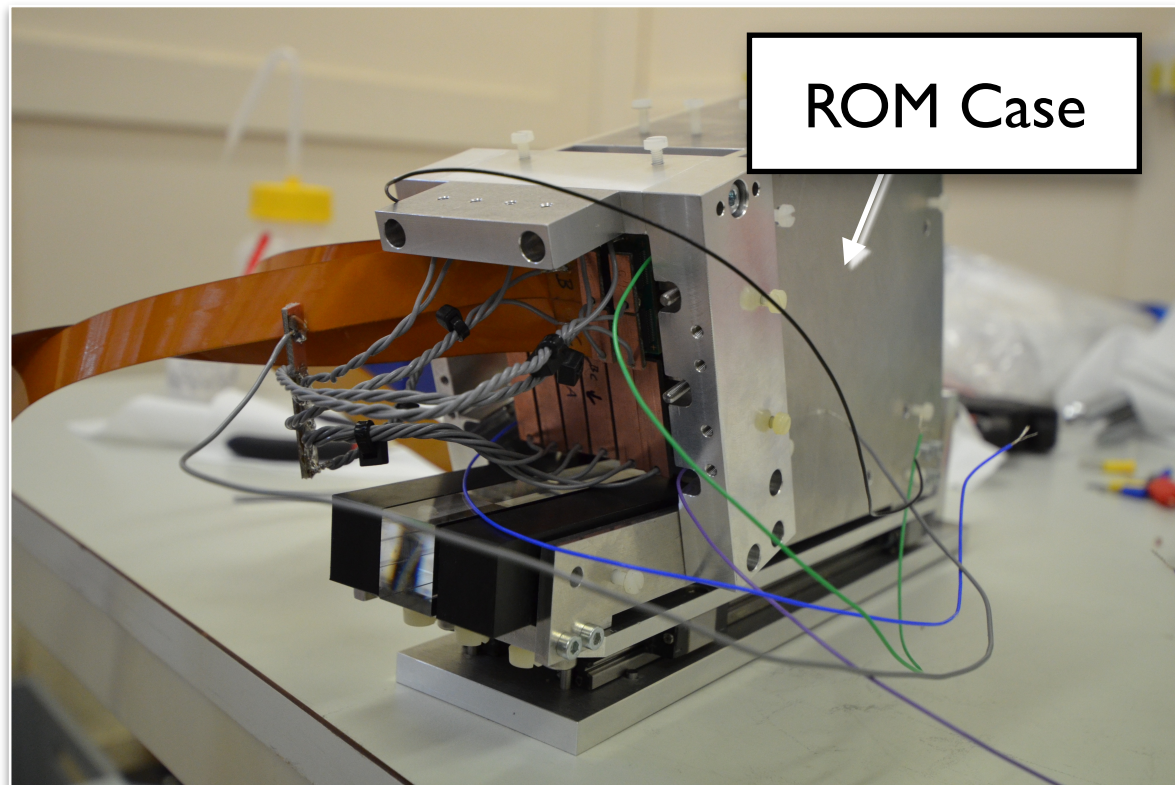


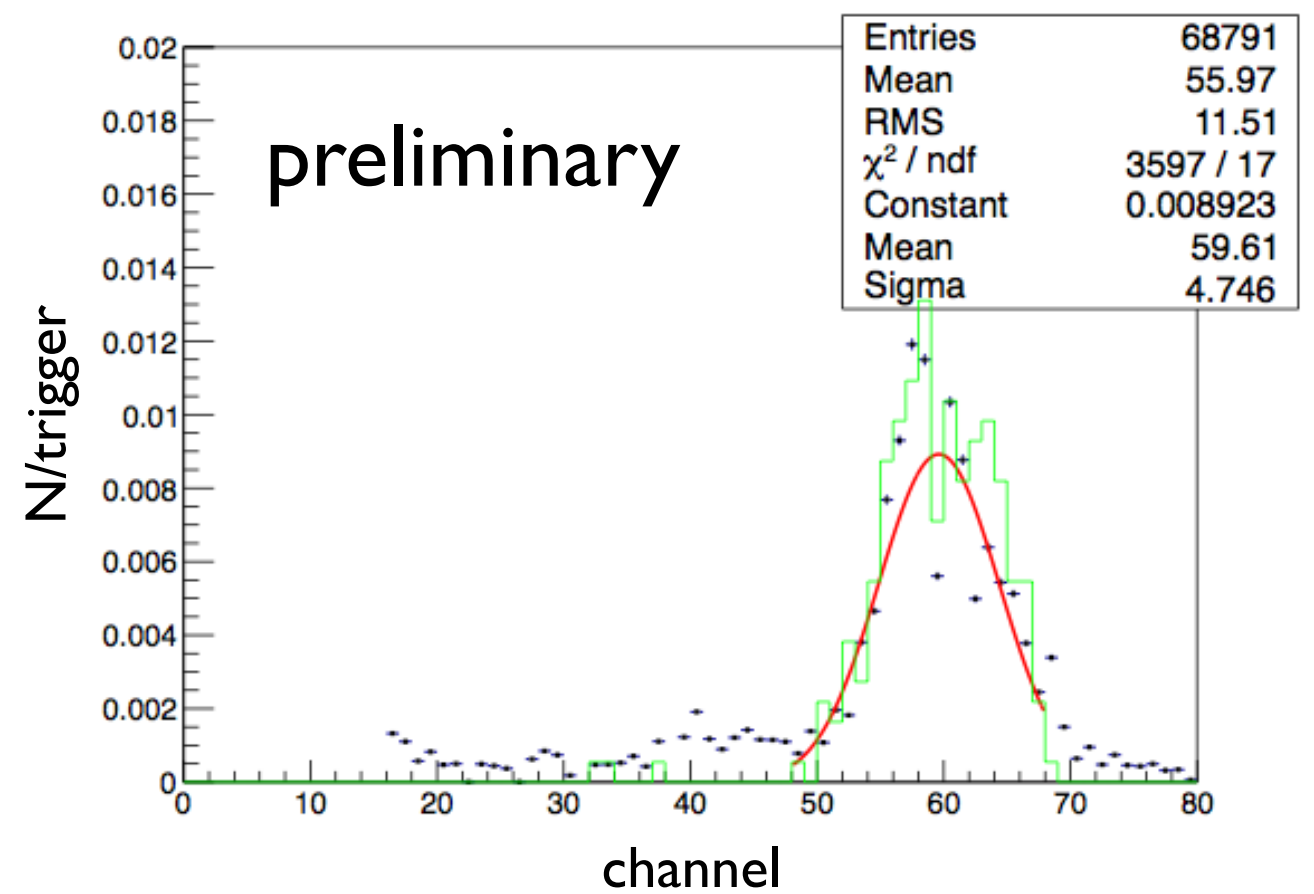
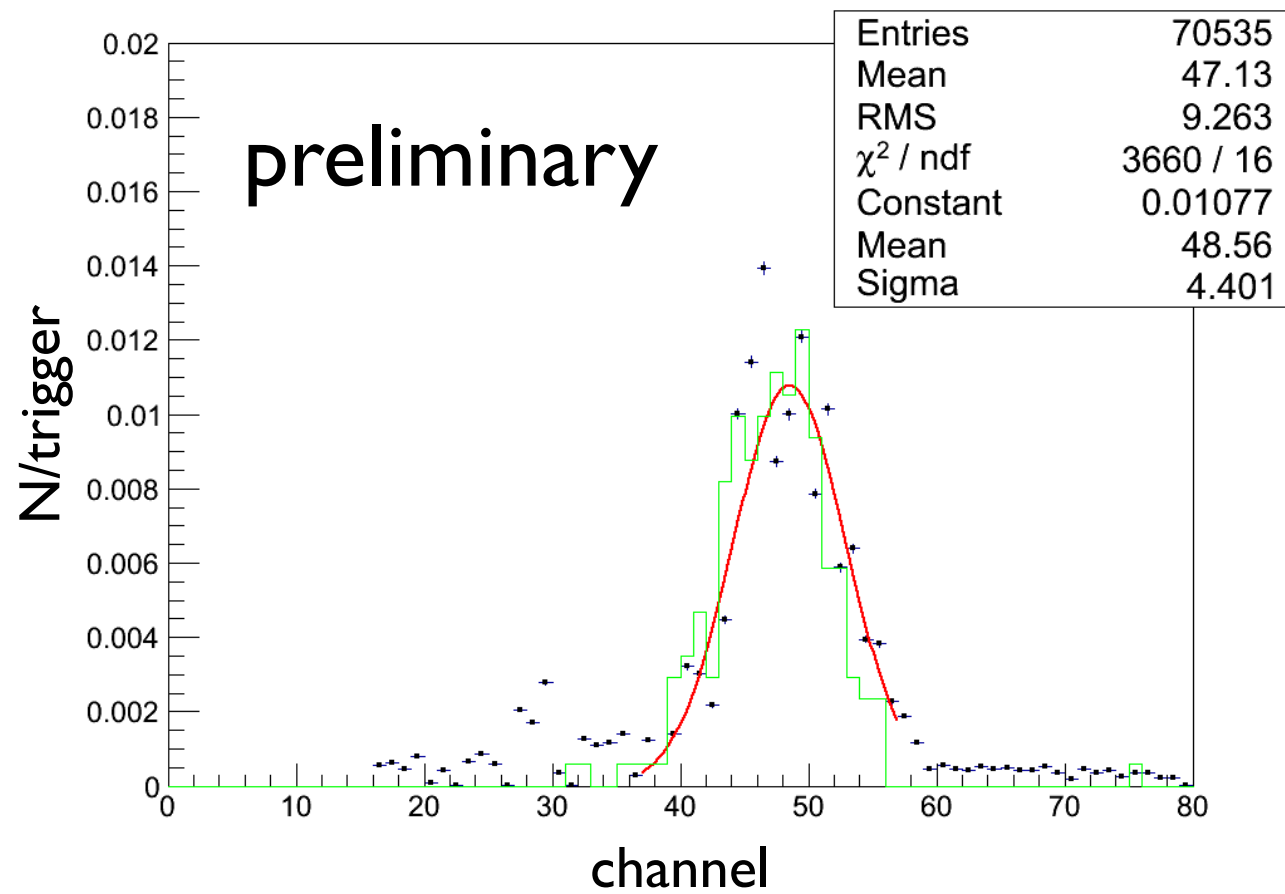


- Minimal setup with laser calibration
- Nevertheless over 300 readout channels
- Fused silica optics

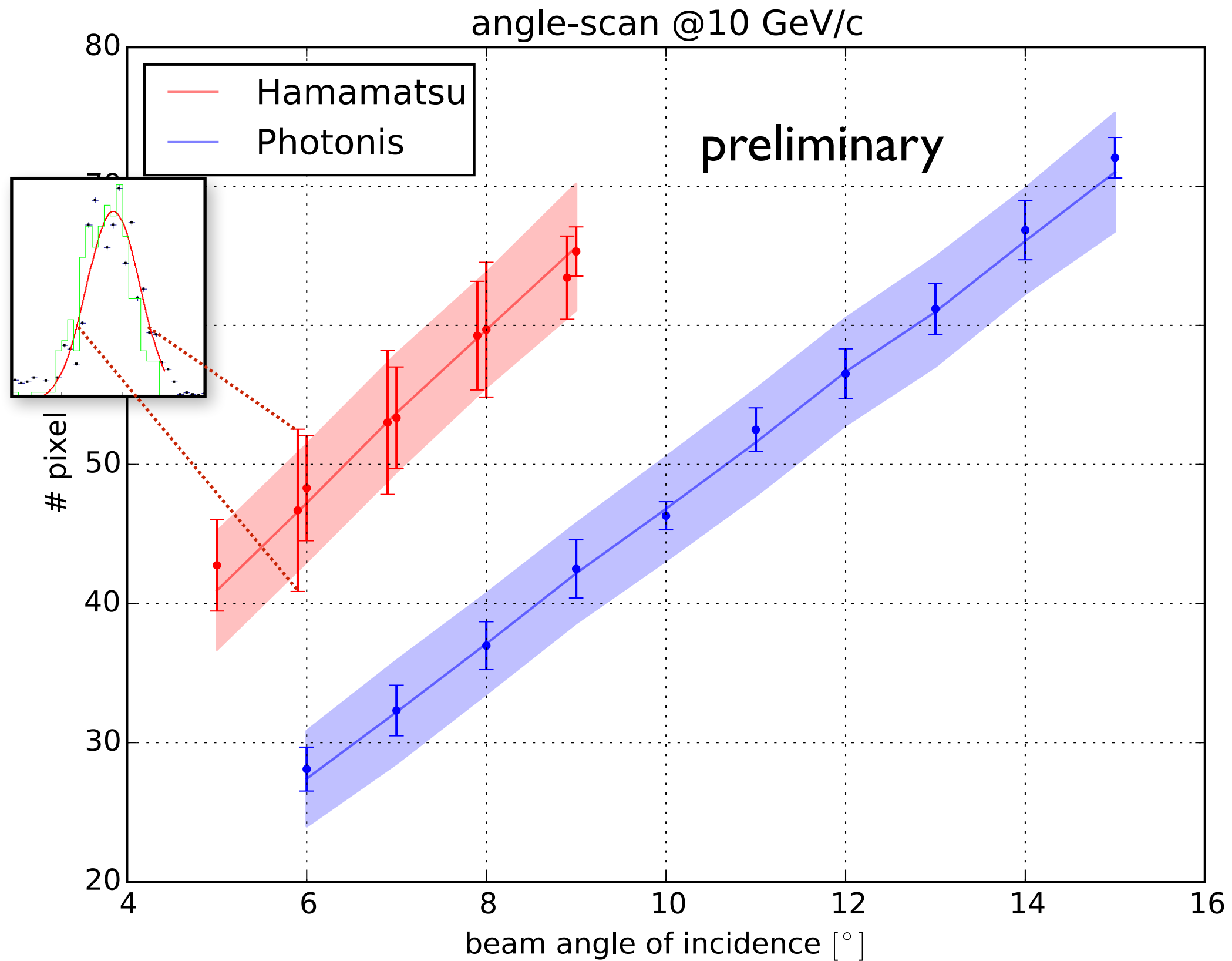


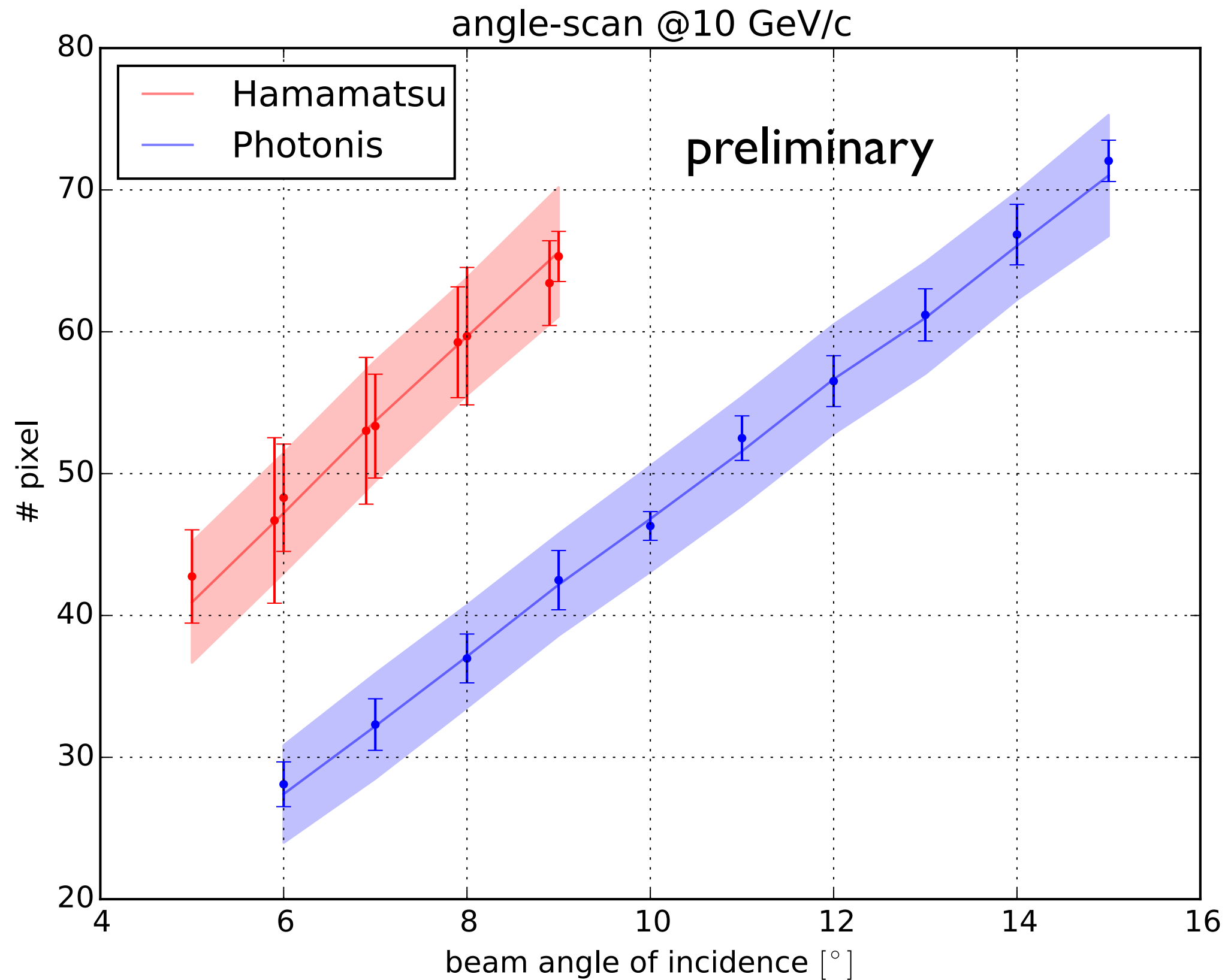




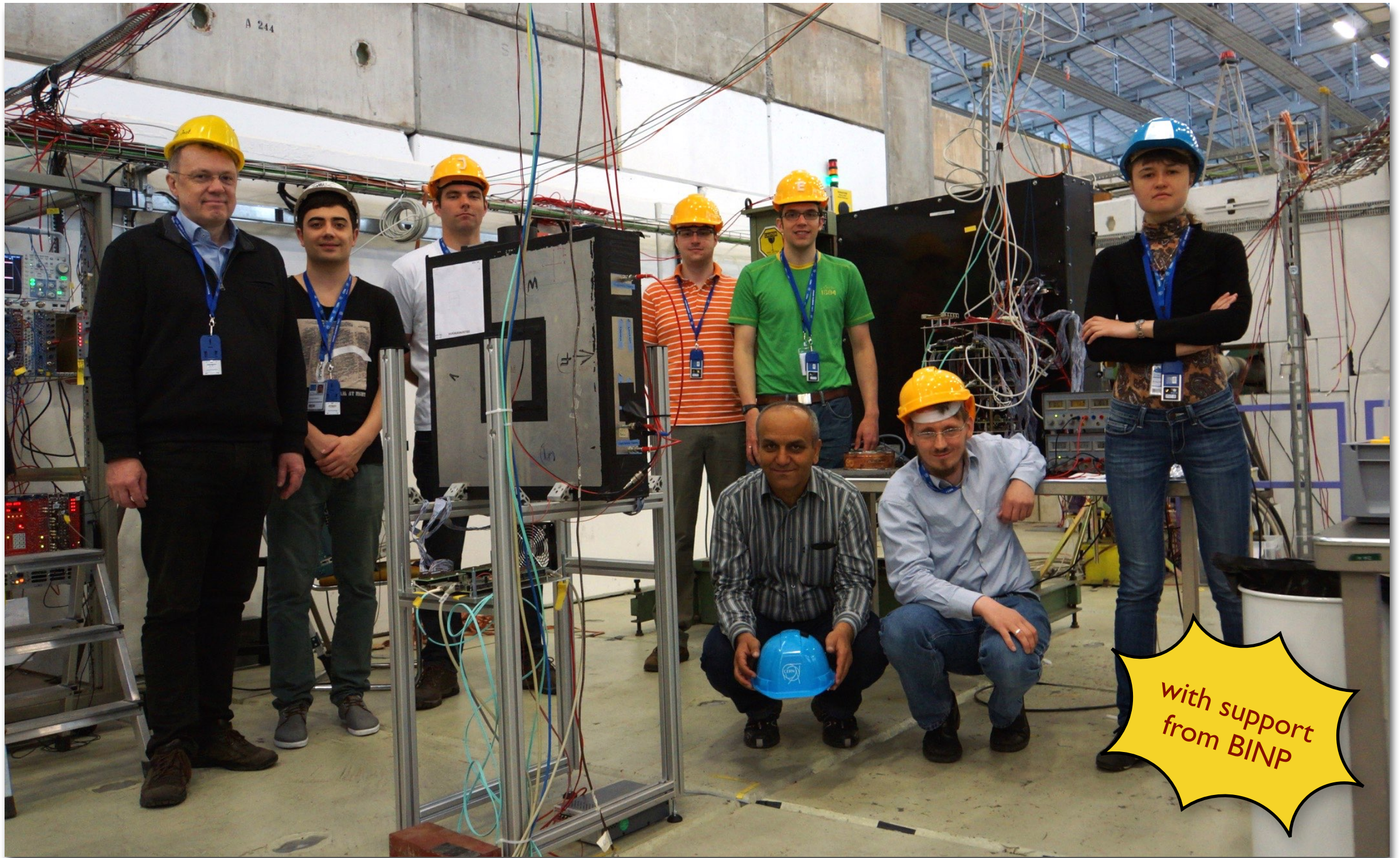


- 10 GeV/c mixed hadron beam
- angles of incidence are 6° (left) and 8° (right)
- Preliminary plots show a good agreement between MC and real data for number of hits vs. channel number



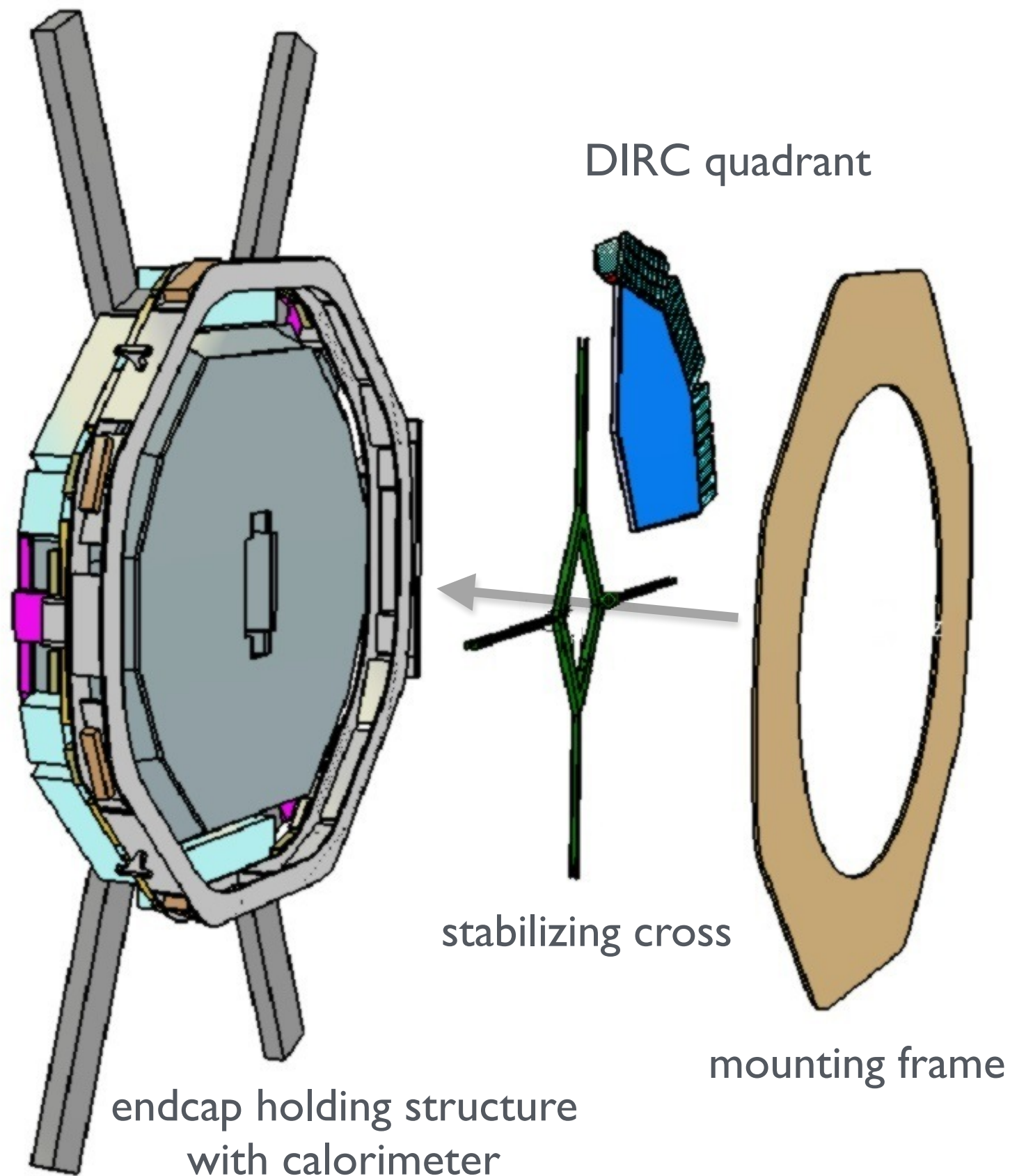


- final design found, realization is ongoing
- first prototype with final components has been tested
(analysis is ongoing)
- a larger prototype (with more ROMs) is currently being designed
- readout is being minimized and ASICs are being tested
- mechanical design and assembly has to be determined



Thank you for your attention

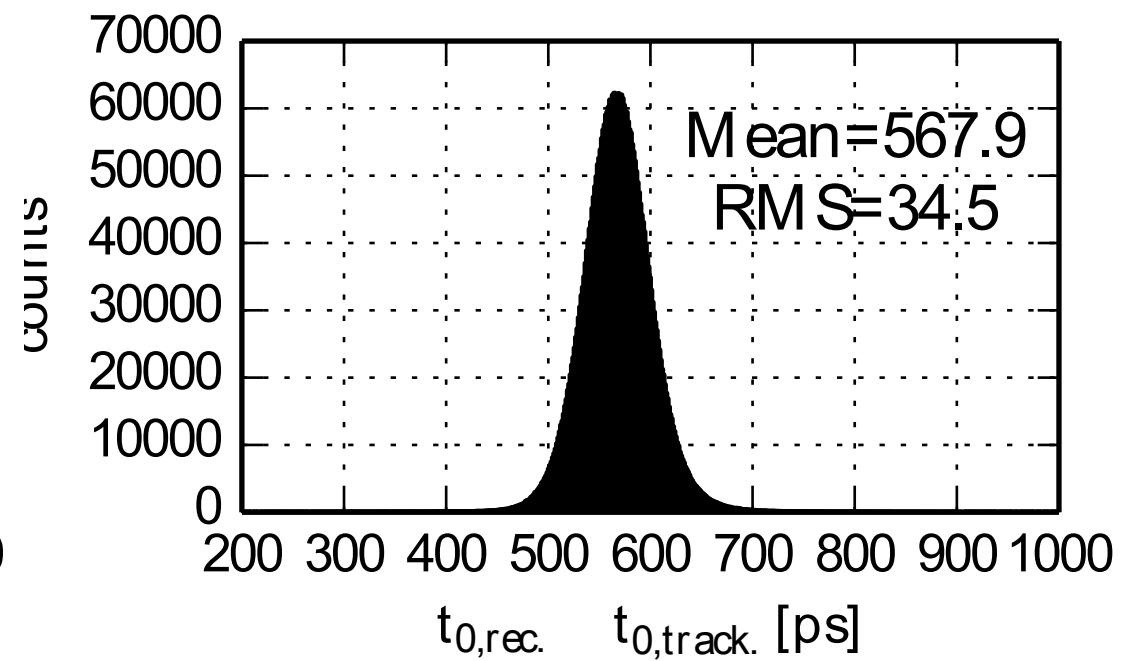
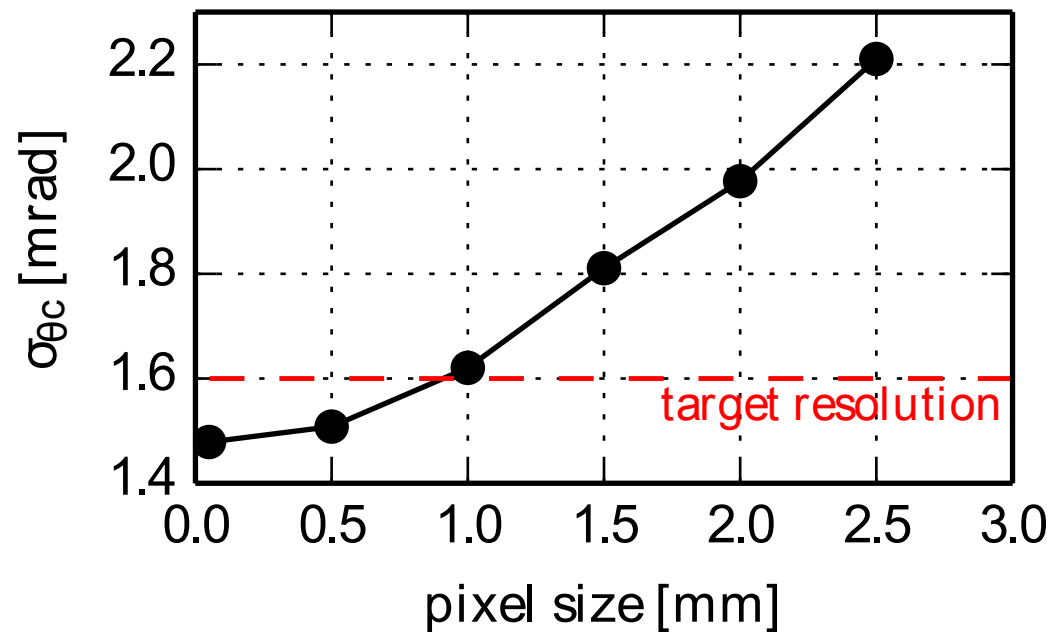
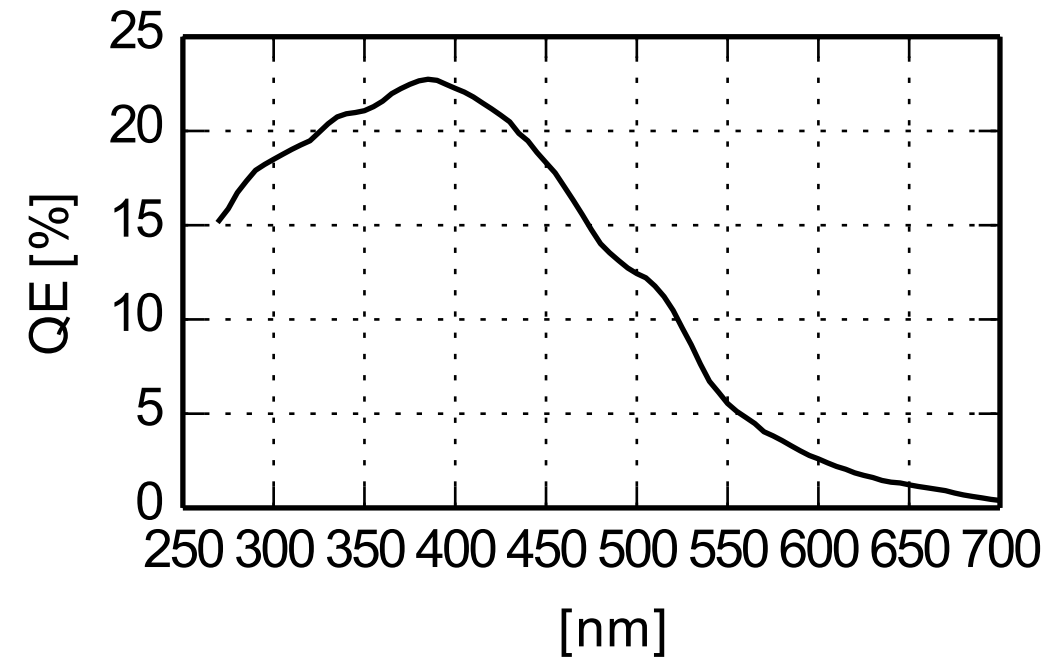
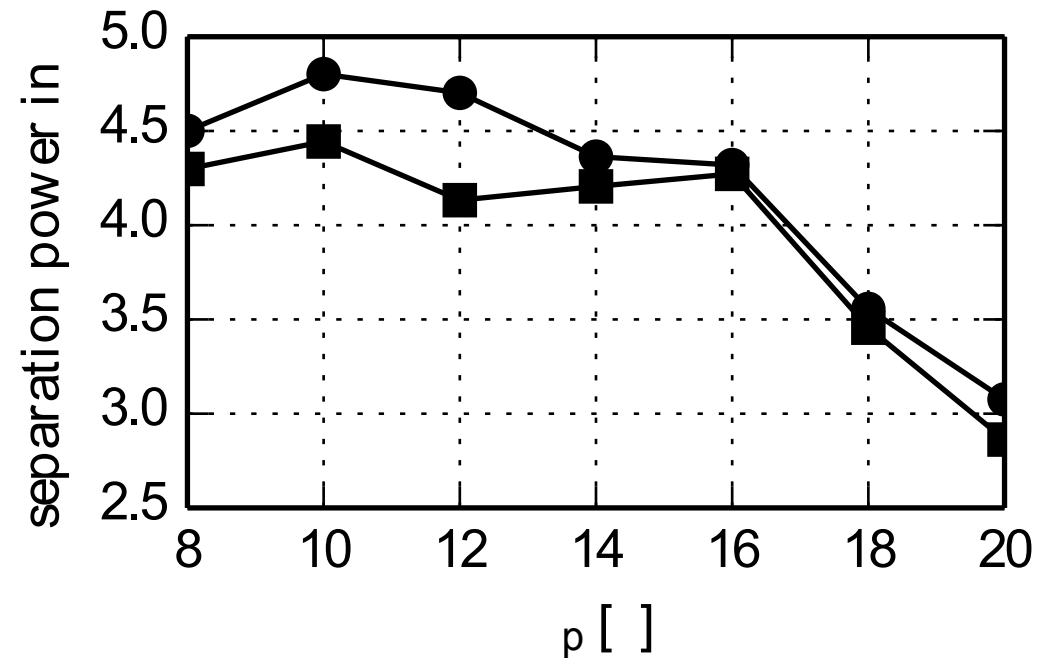
Backup

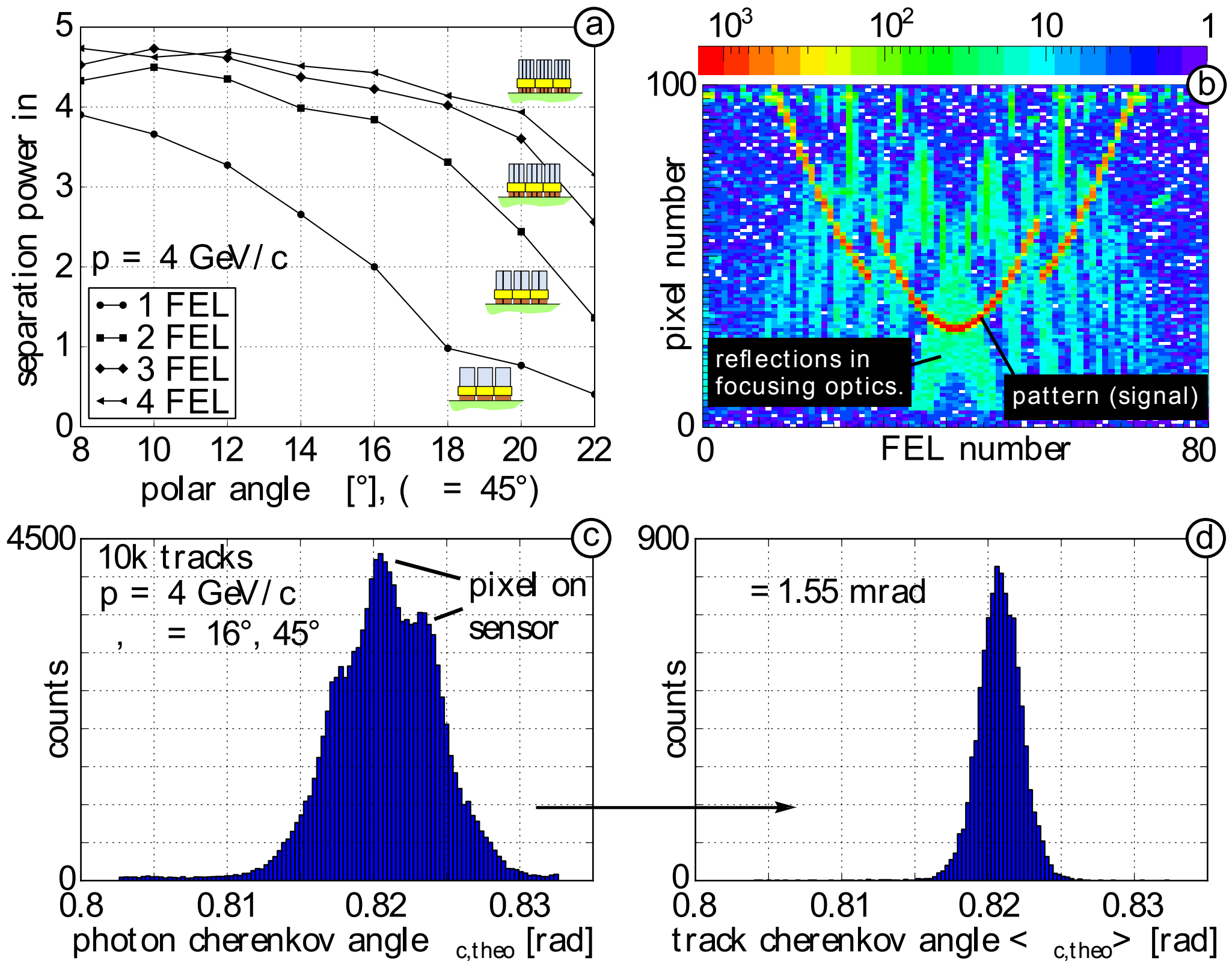


assembly of **DIRC** quadrants with **stabilizing cross** and **mounting frame** in horizontal position

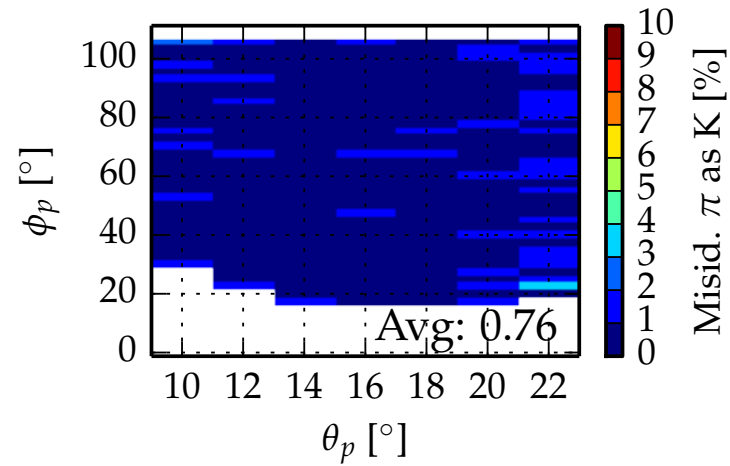
bring fully assembled **DIRC** to a vertical position using a custom-built mounting device

slowly move **DIRC** up to the **endcap holding structure**

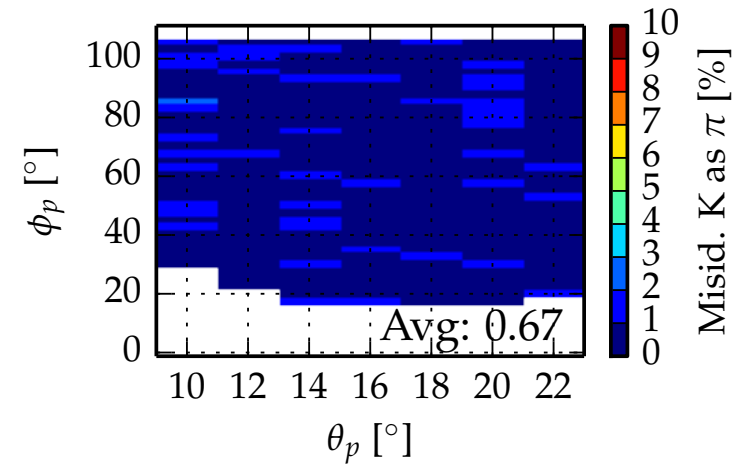




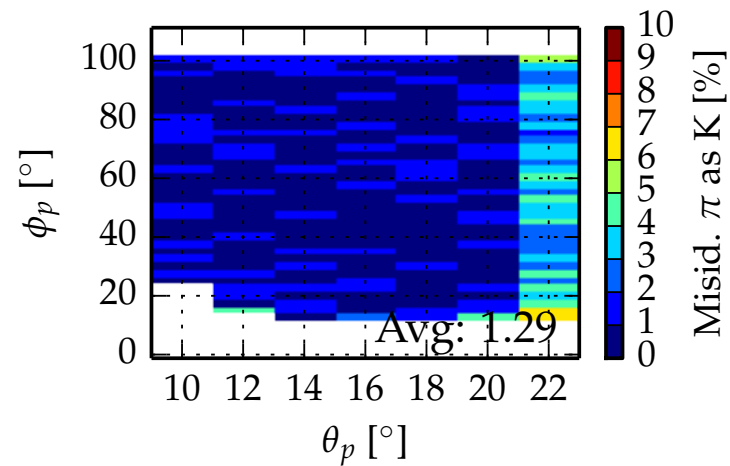
O. Merle (PhD-Thesis, 2015)



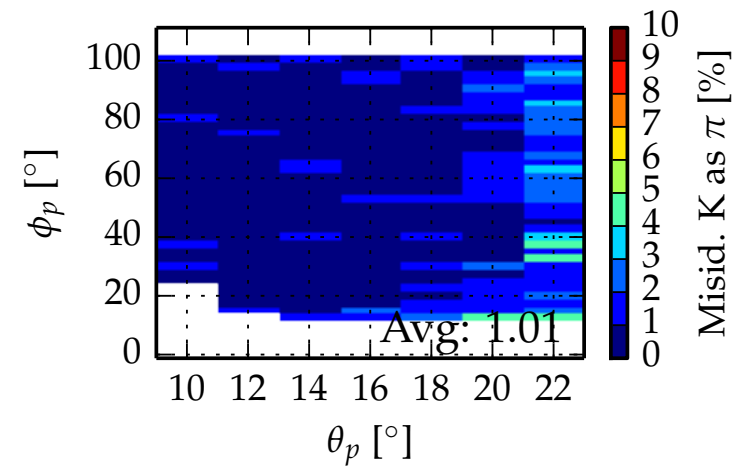
(a) π at 2 GeV/c



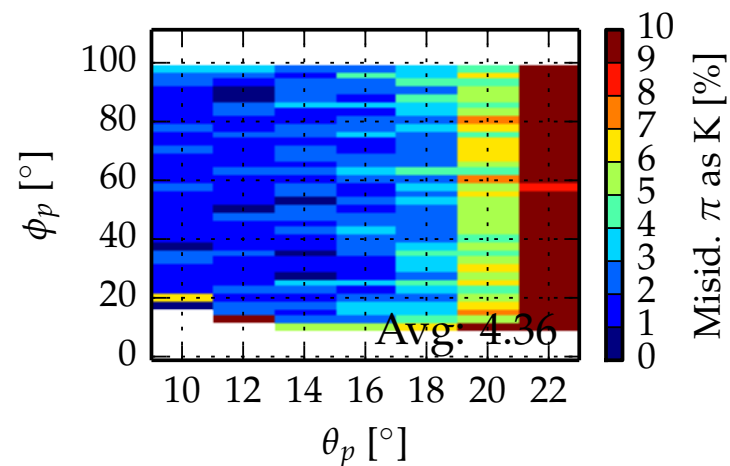
(b) K at 2 GeV/c



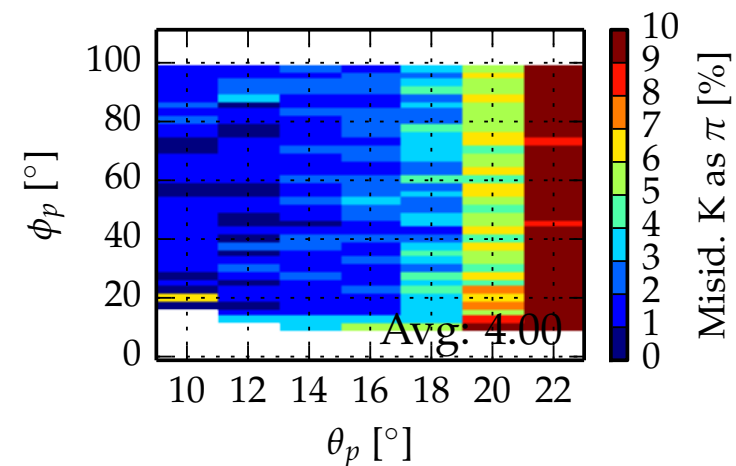
(c) π at 3 GeV/c



(d) K at 3 GeV/c

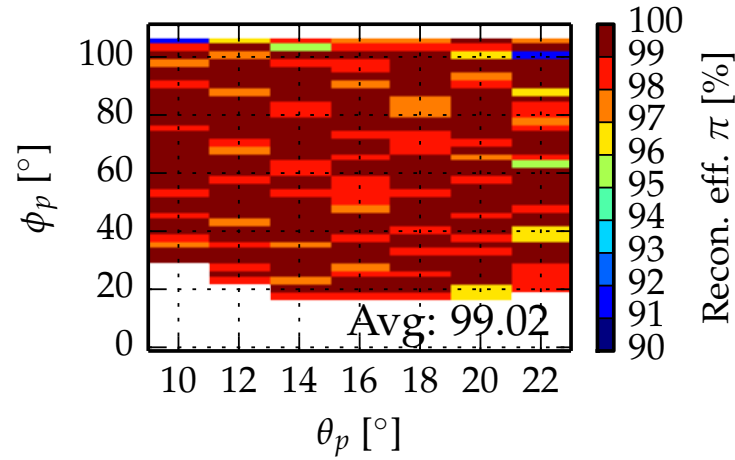


(e) π at 4 GeV/c

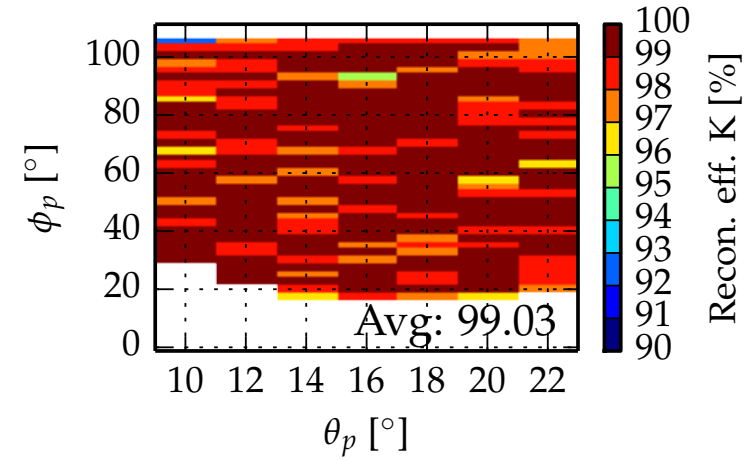


(f) K at 4 GeV/c

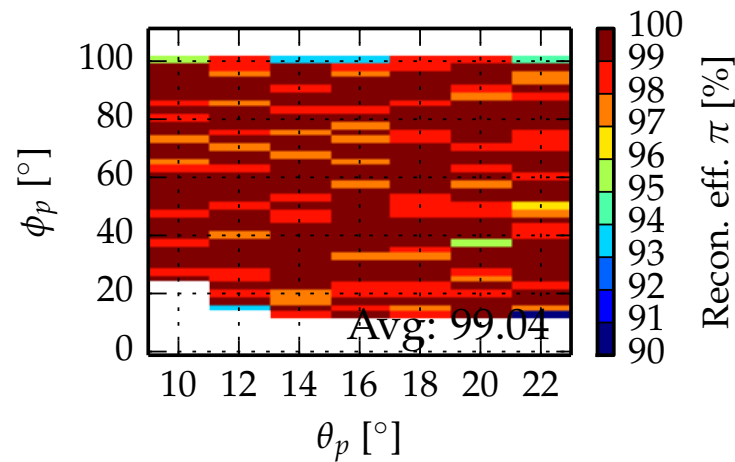
O. Merle (PhD-Thesis, 2015)



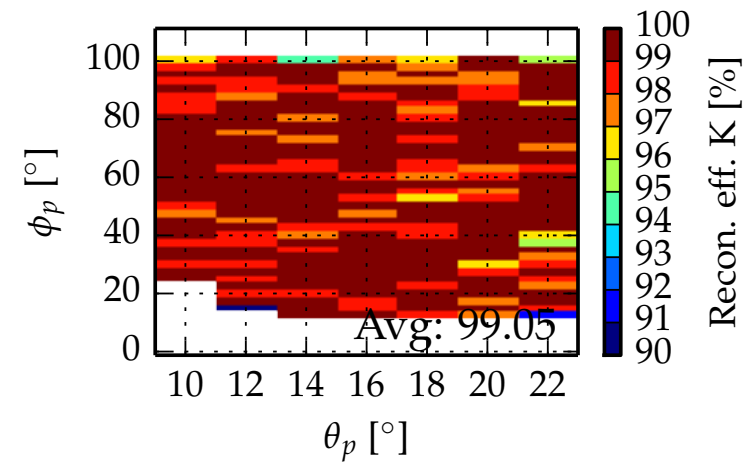
(a) π at 2 GeV/c



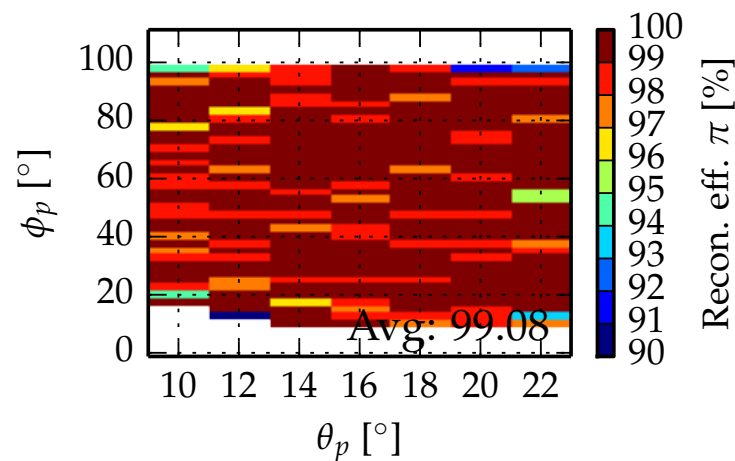
(b) K at 2 GeV/c



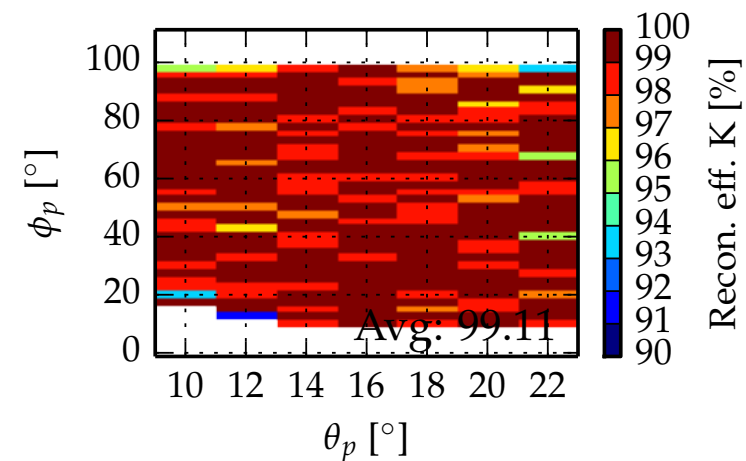
(c) π at 3 GeV/c



(d) K at 3 GeV/c

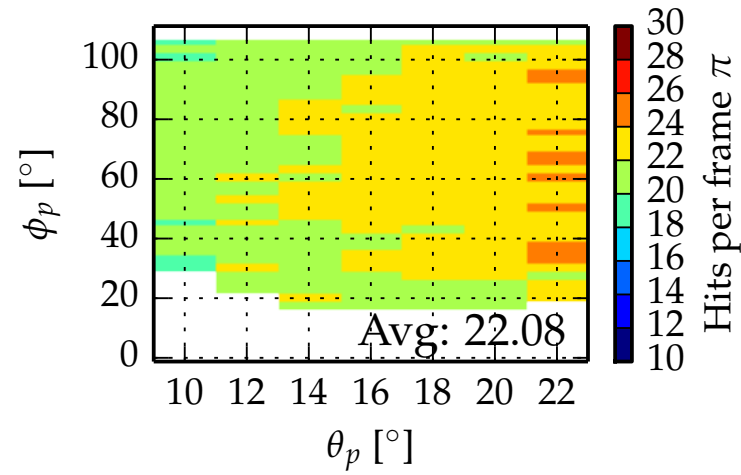


(e) π at 4 GeV/c

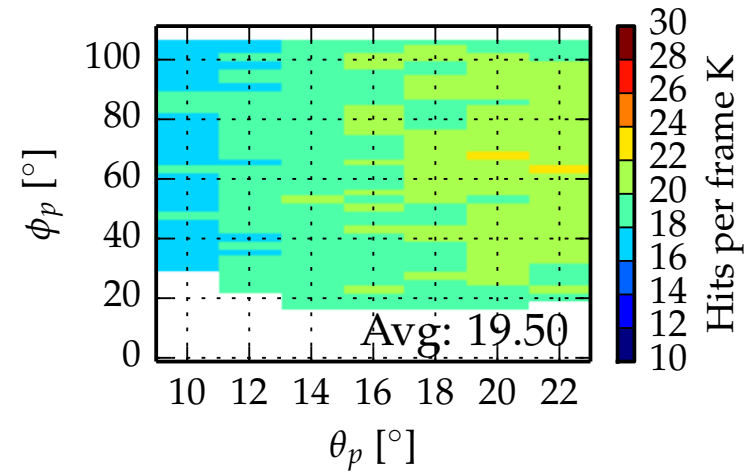


(f) K at 4 GeV/c

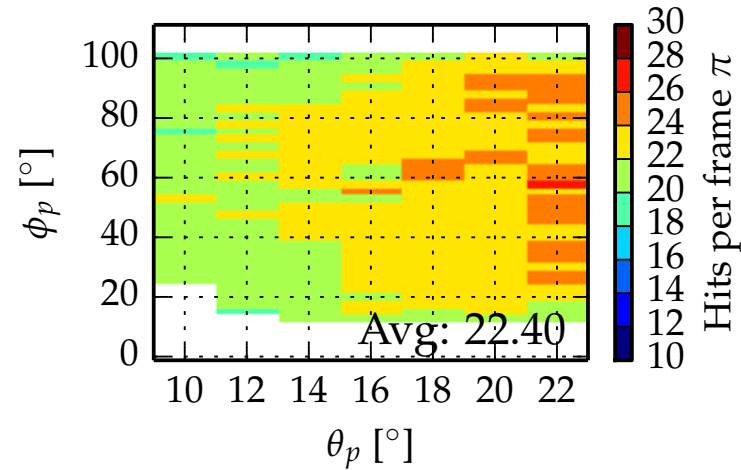
O. Merle (PhD-Thesis, 2015)



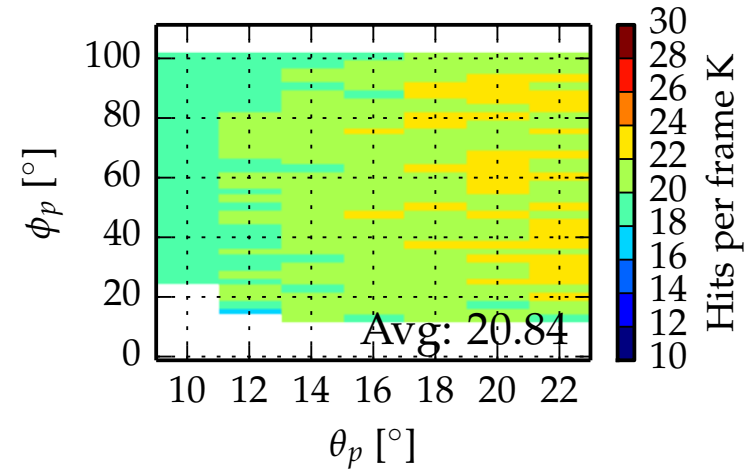
(a) π at 2 GeV/c



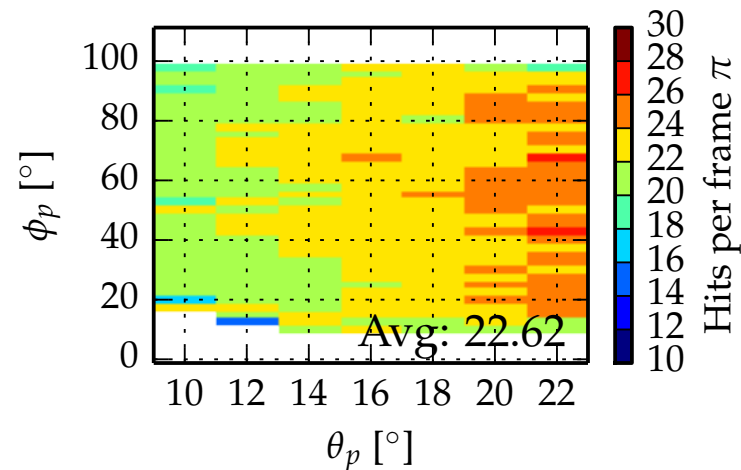
(b) K at 2 GeV/c



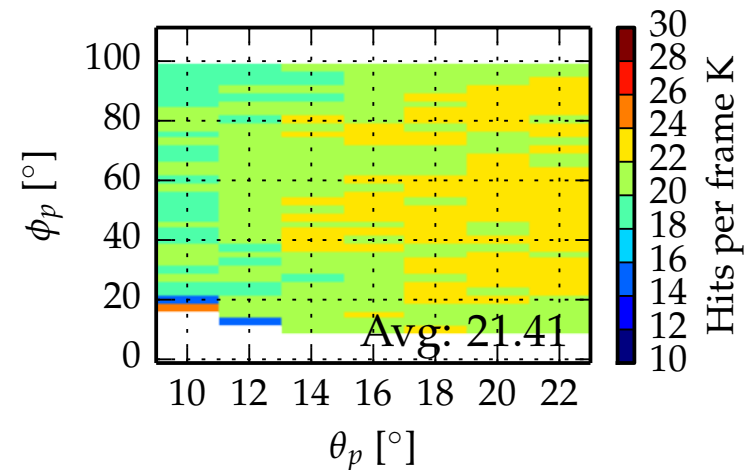
(c) π at 3 GeV/c



(d) K at 3 GeV/c

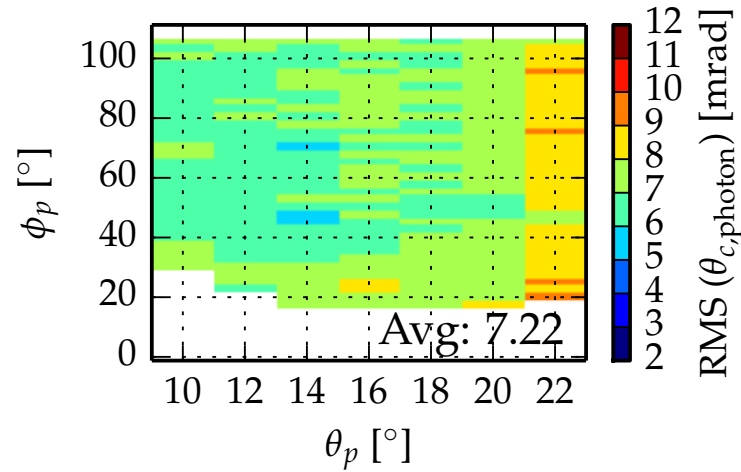


(e) π at 4 GeV/c

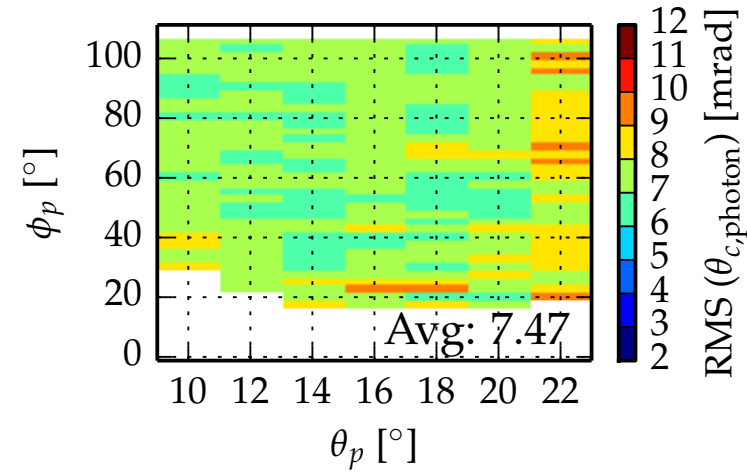


(f) K at 4 GeV/c

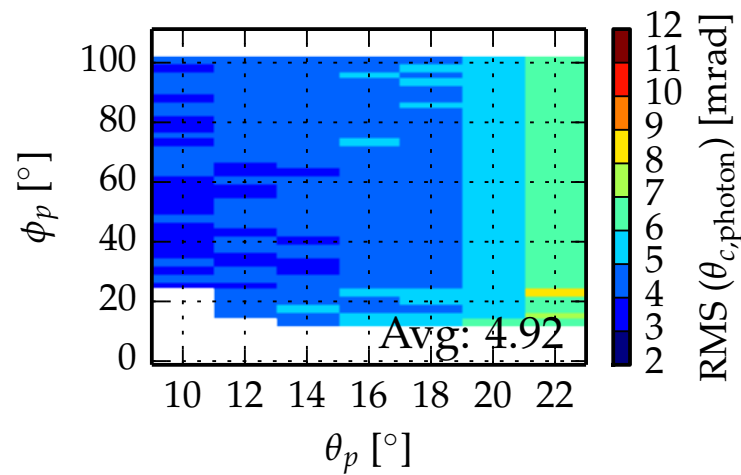
O. Merle (PhD-Thesis, 2015)



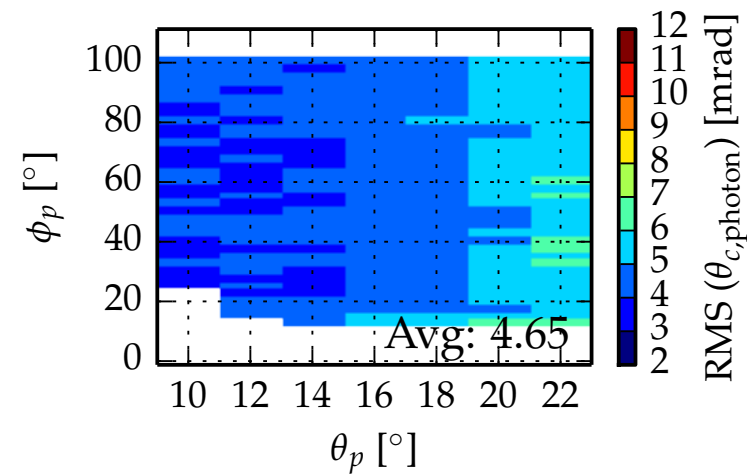
(a) π at 2 GeV/c



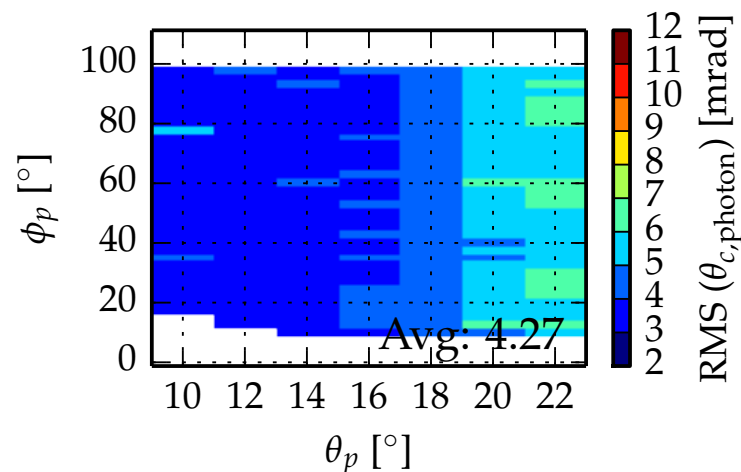
(b) K at 2 GeV/c



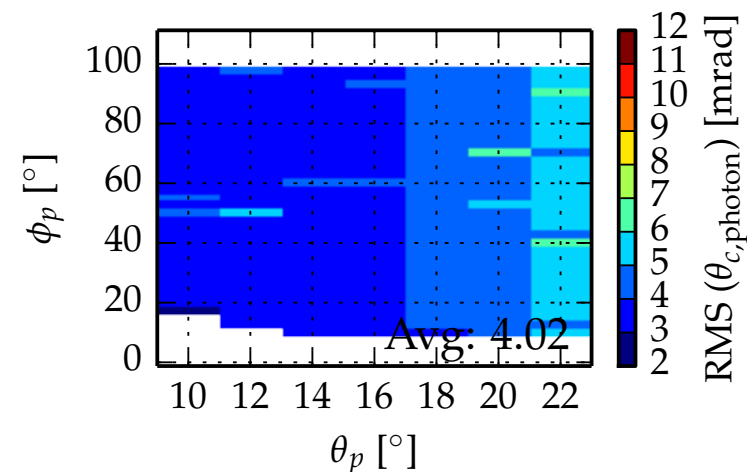
(c) π at 3 GeV/c



(d) K at 3 GeV/c



(e) π at 4 GeV/c



(f) K at 4 GeV/c

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