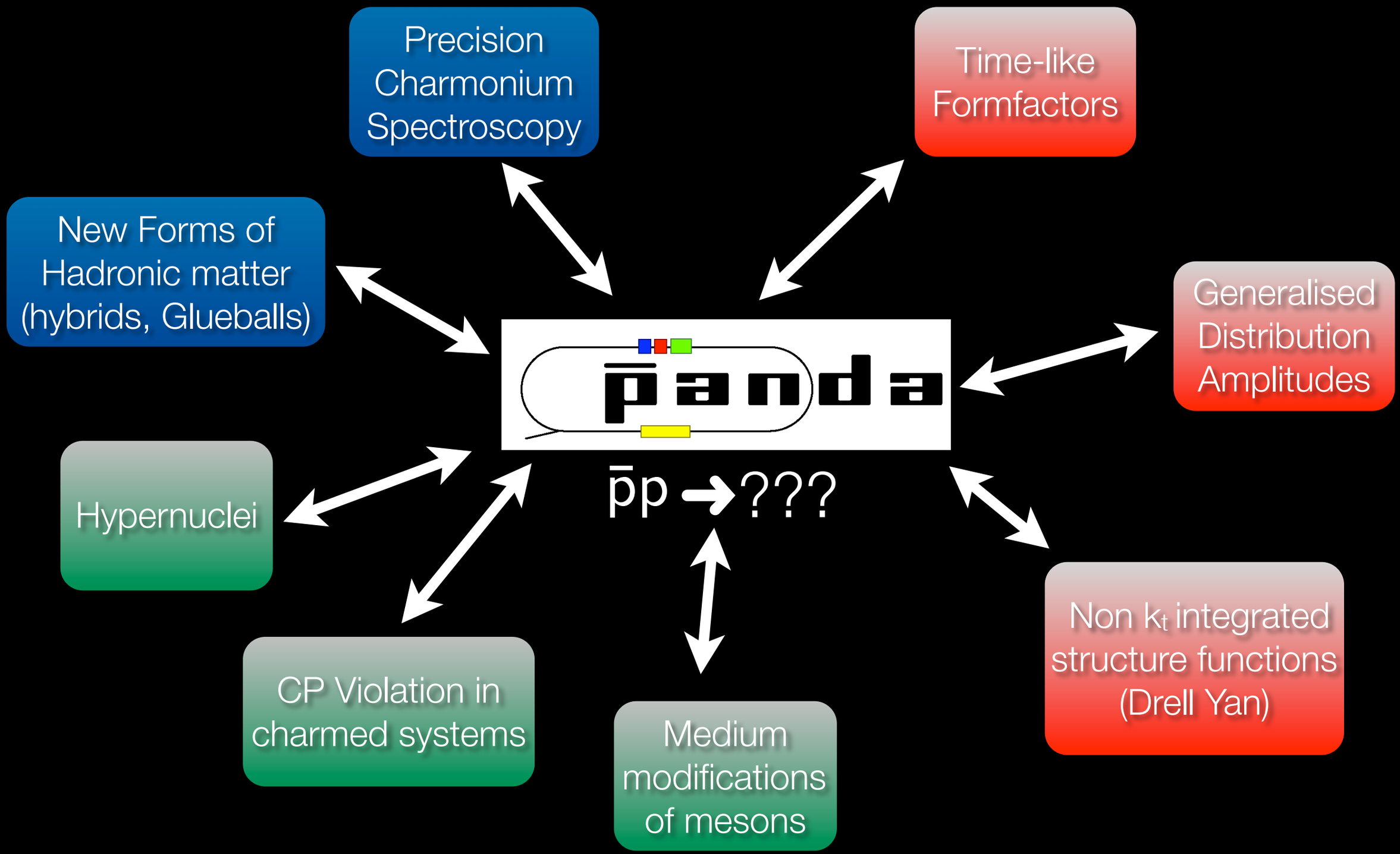
University of Glasgow

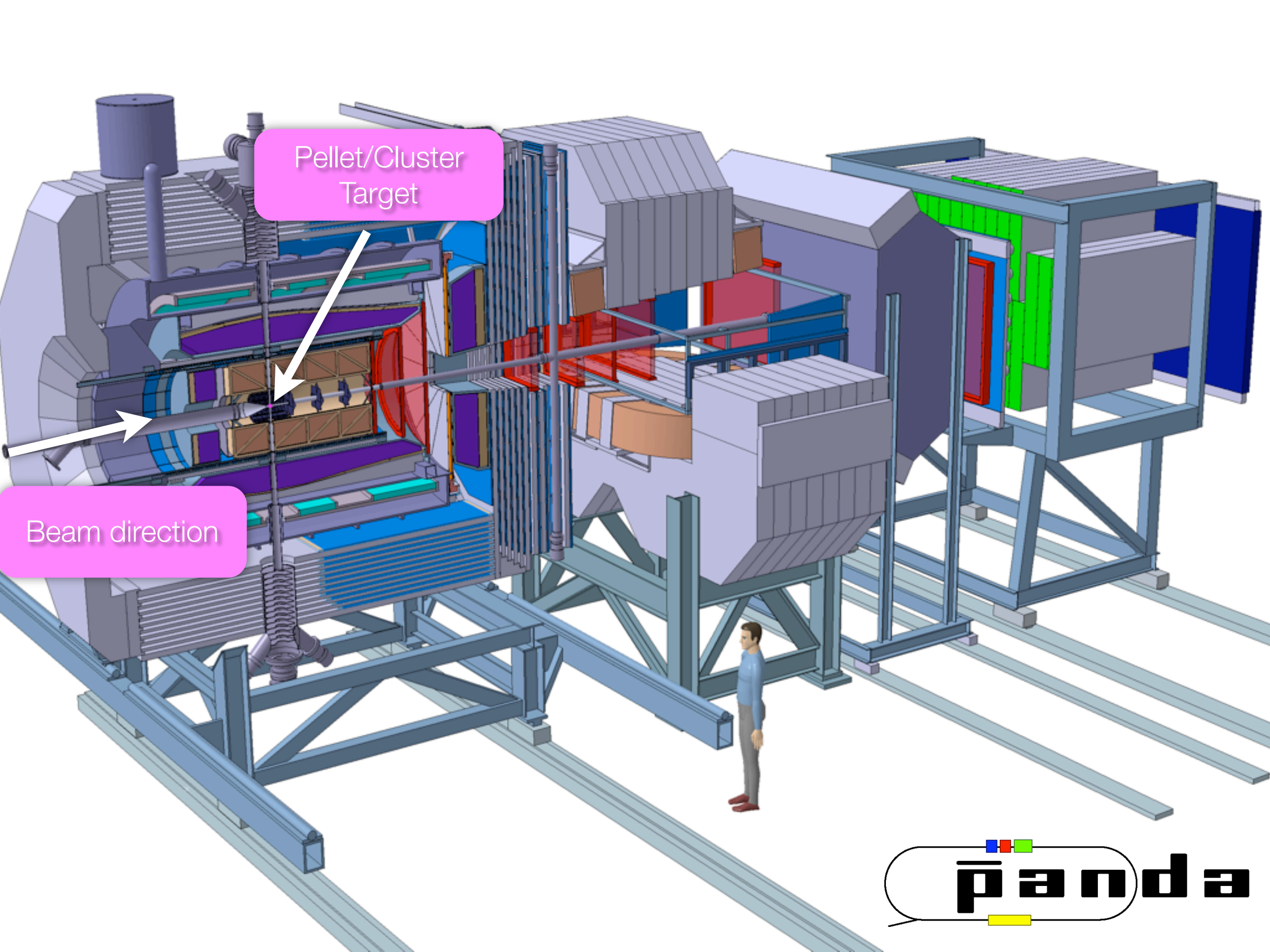
Development of DIRC counters for the PANDA experiment at FAIR

Bjoern Seitz, University of Glasgow
for the PANDA Collaboration

VCI 2010, Vienna, Austria, 18 February 2010

Physics at PANDA

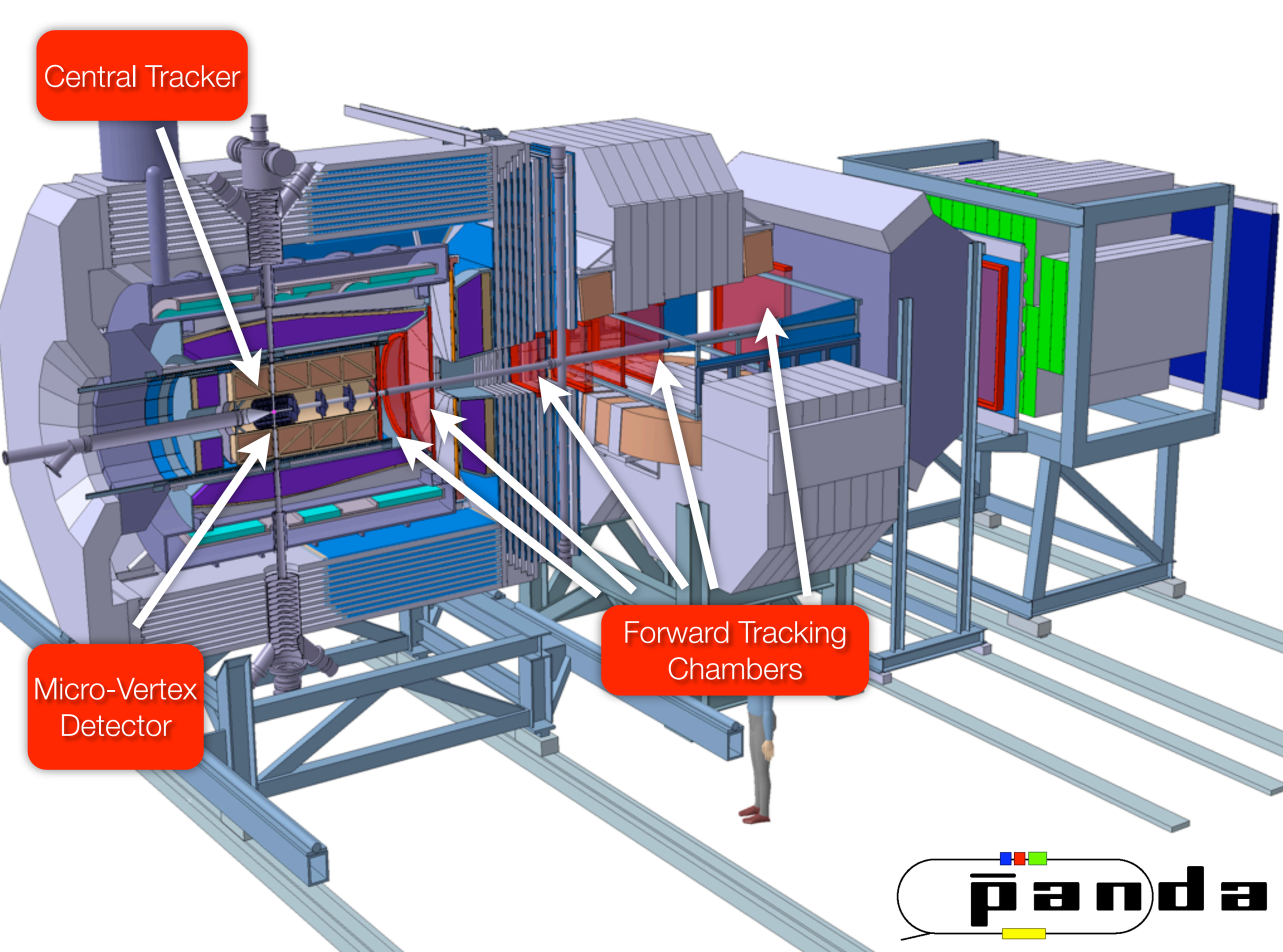


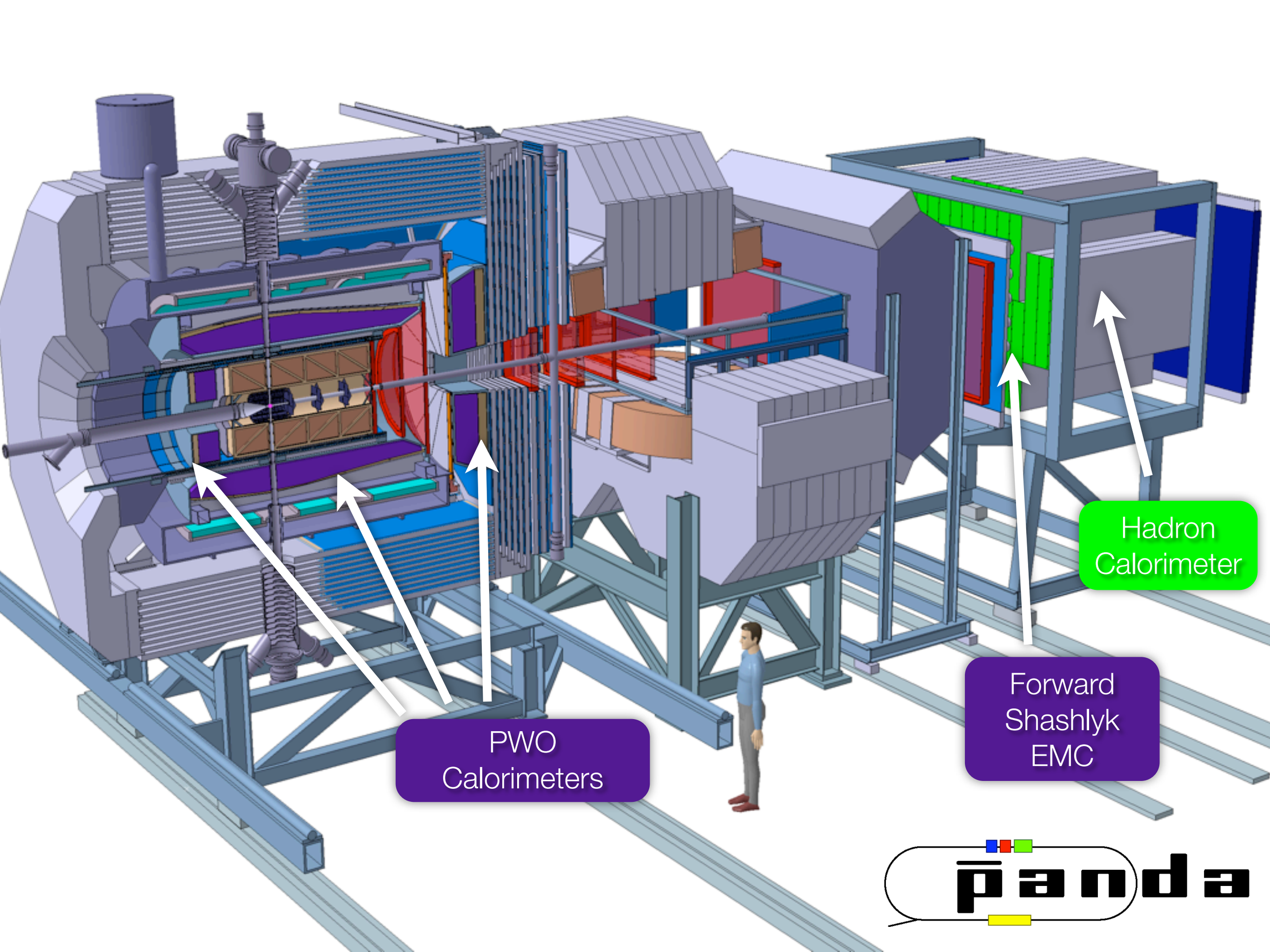

Pellet/Cluster
Target
Beam direction
panda

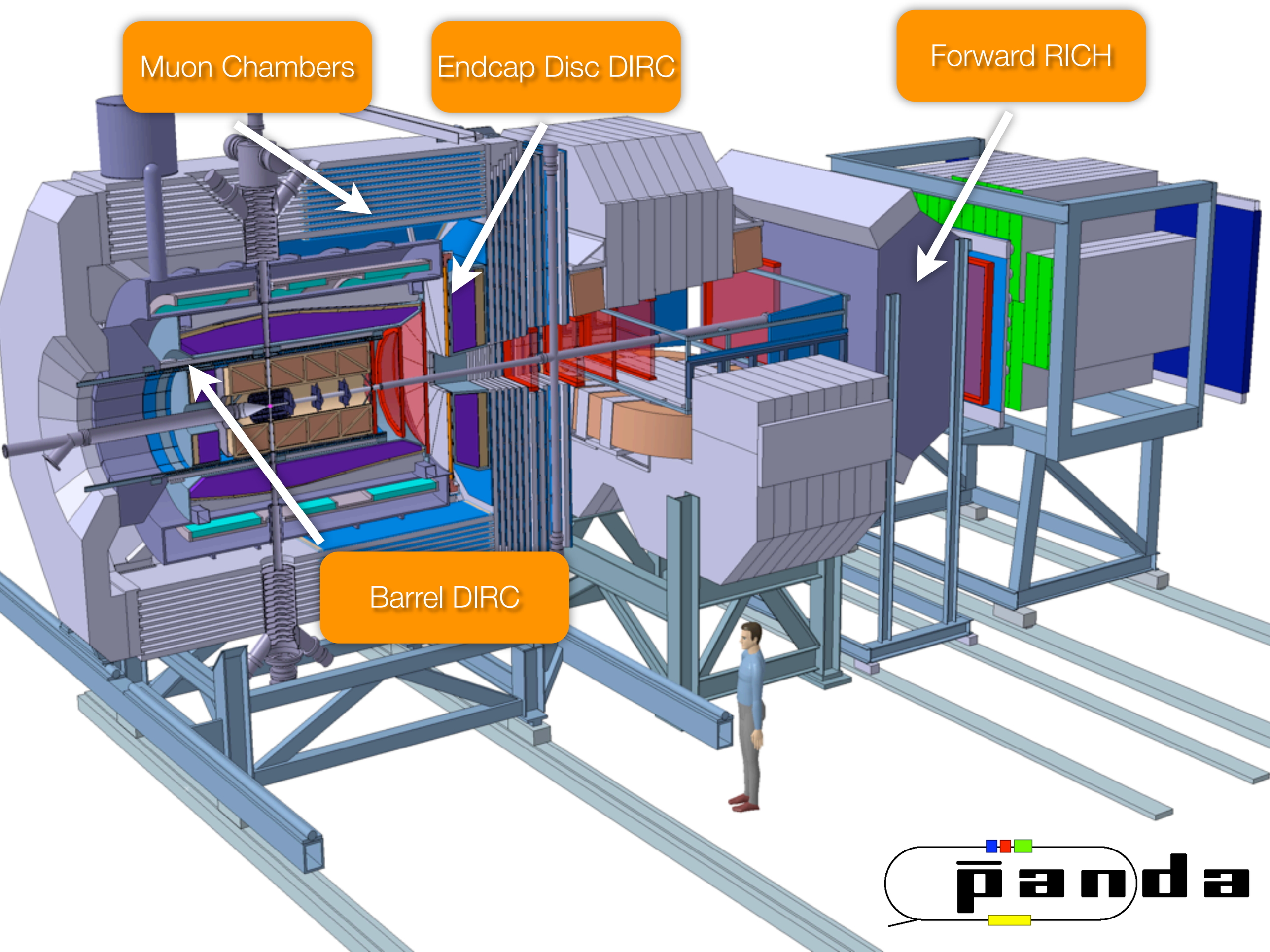
Central Tracker

Micro-Vertex Detector

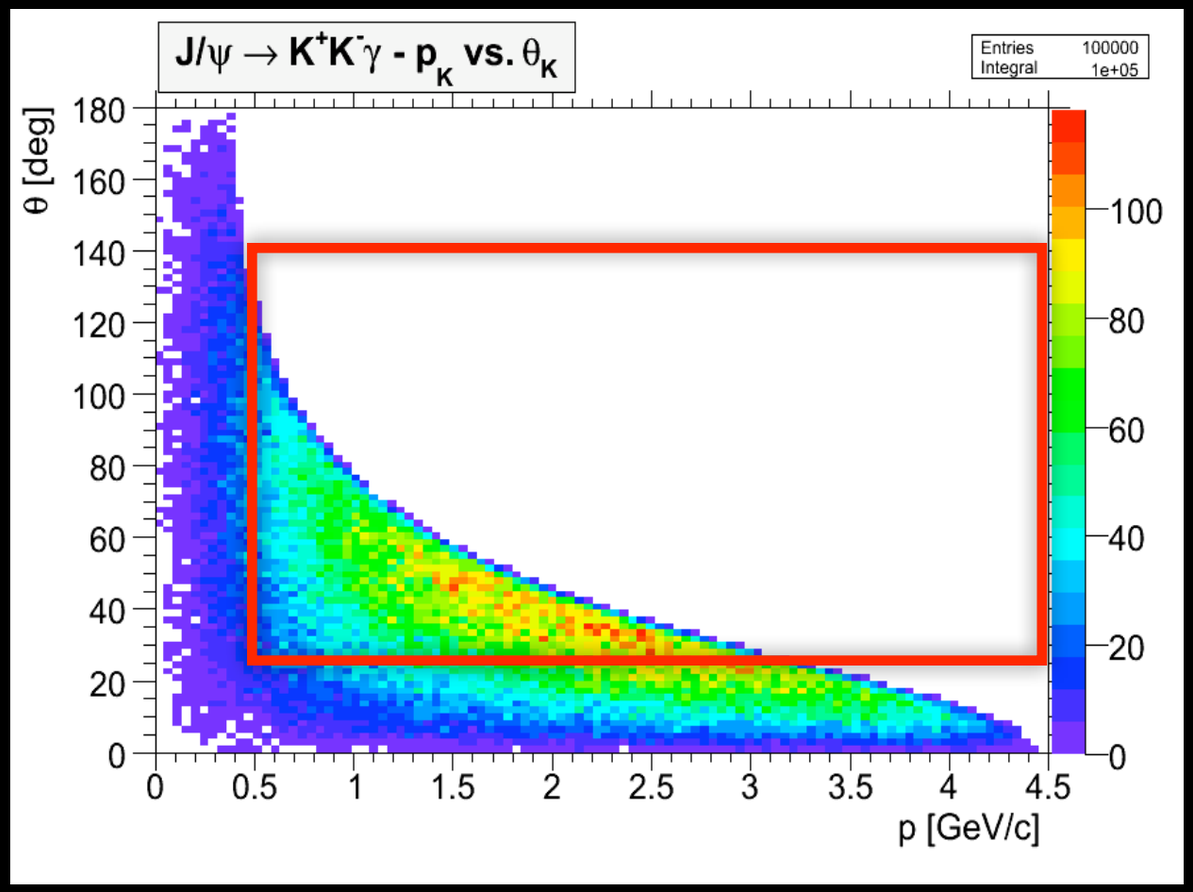
Forward Tracking Chambers

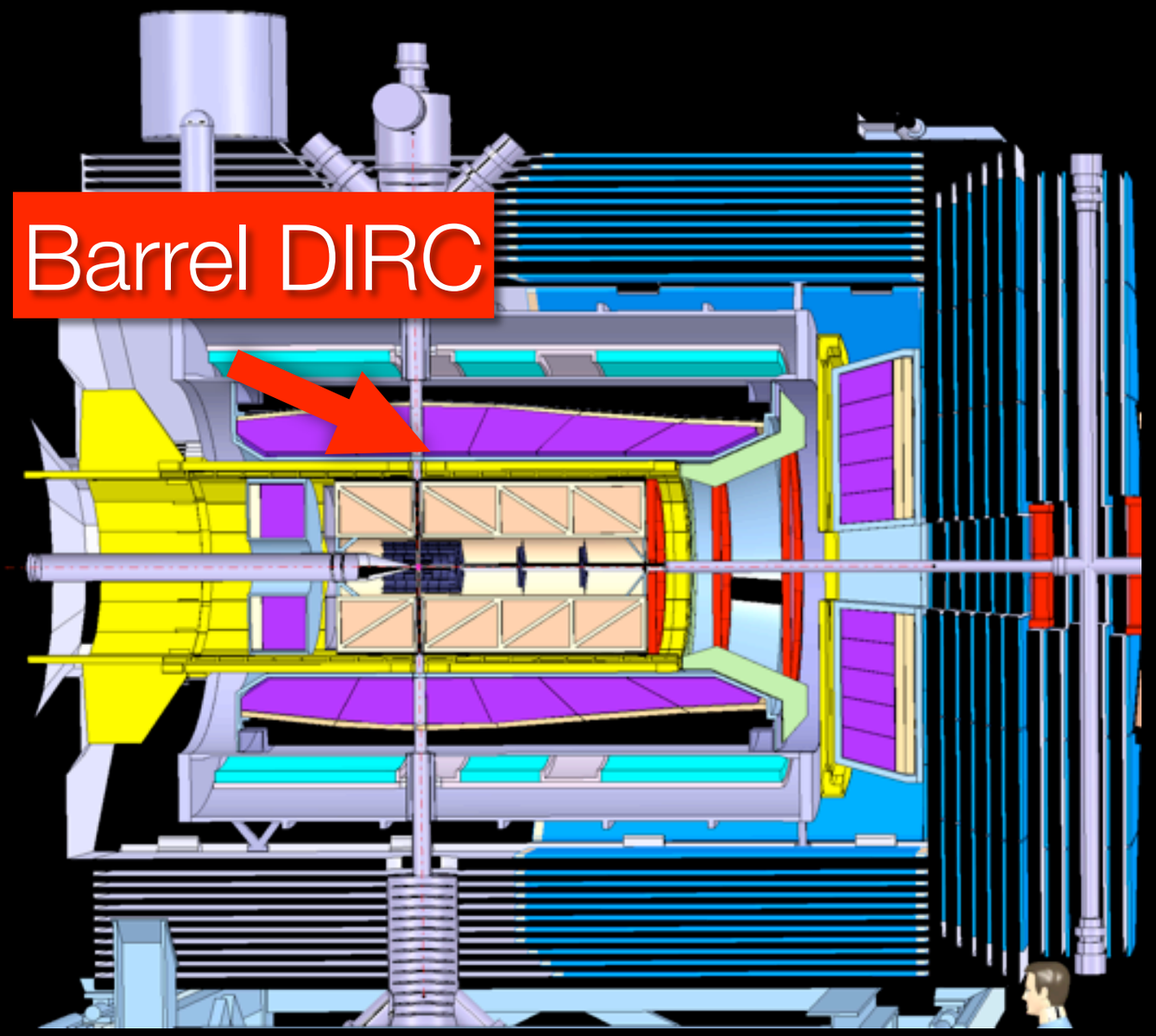



Hadron
Calorimeter
Forward
Shashlyk
EMC
PWO
Calorimeters
panda


Muon Chambers
Endcap Disc DIRC
Forward RICH
Barrel DIRC
panda

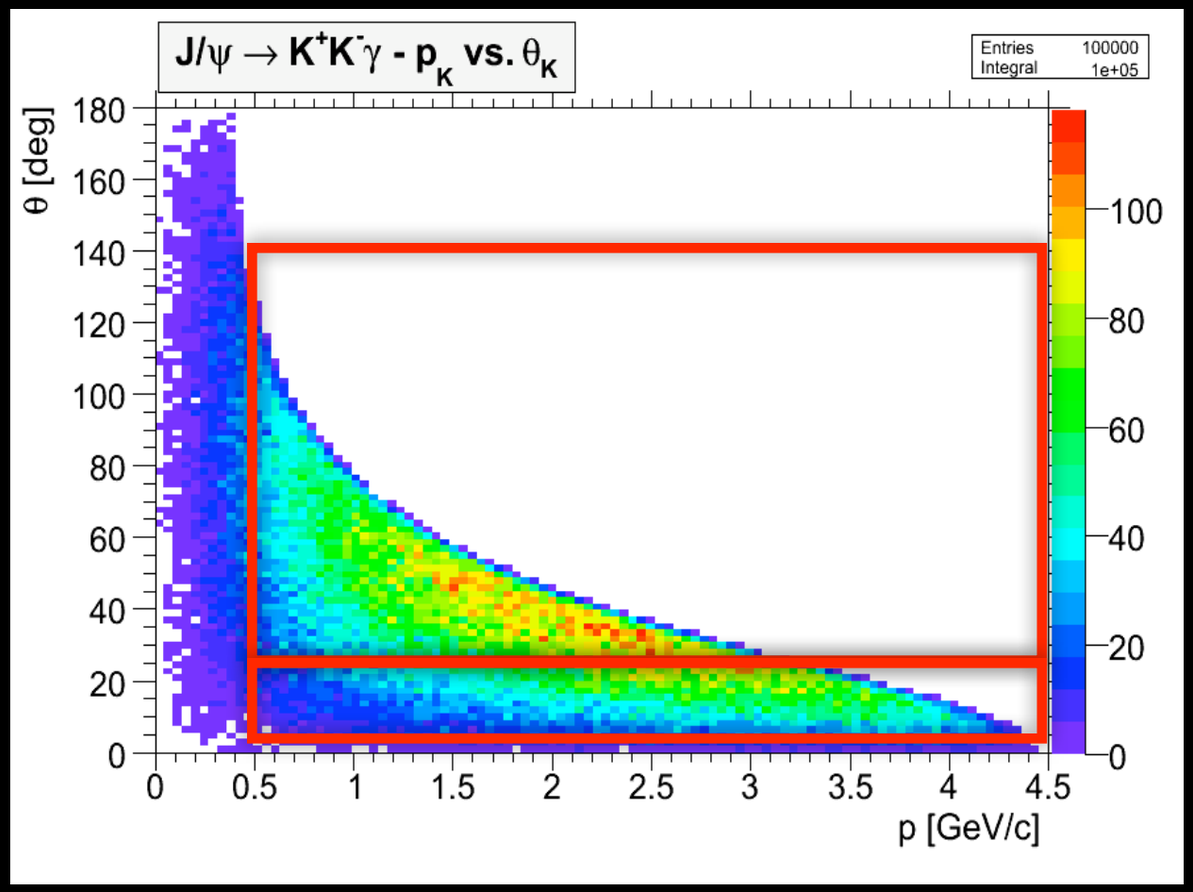
Detector Requirements

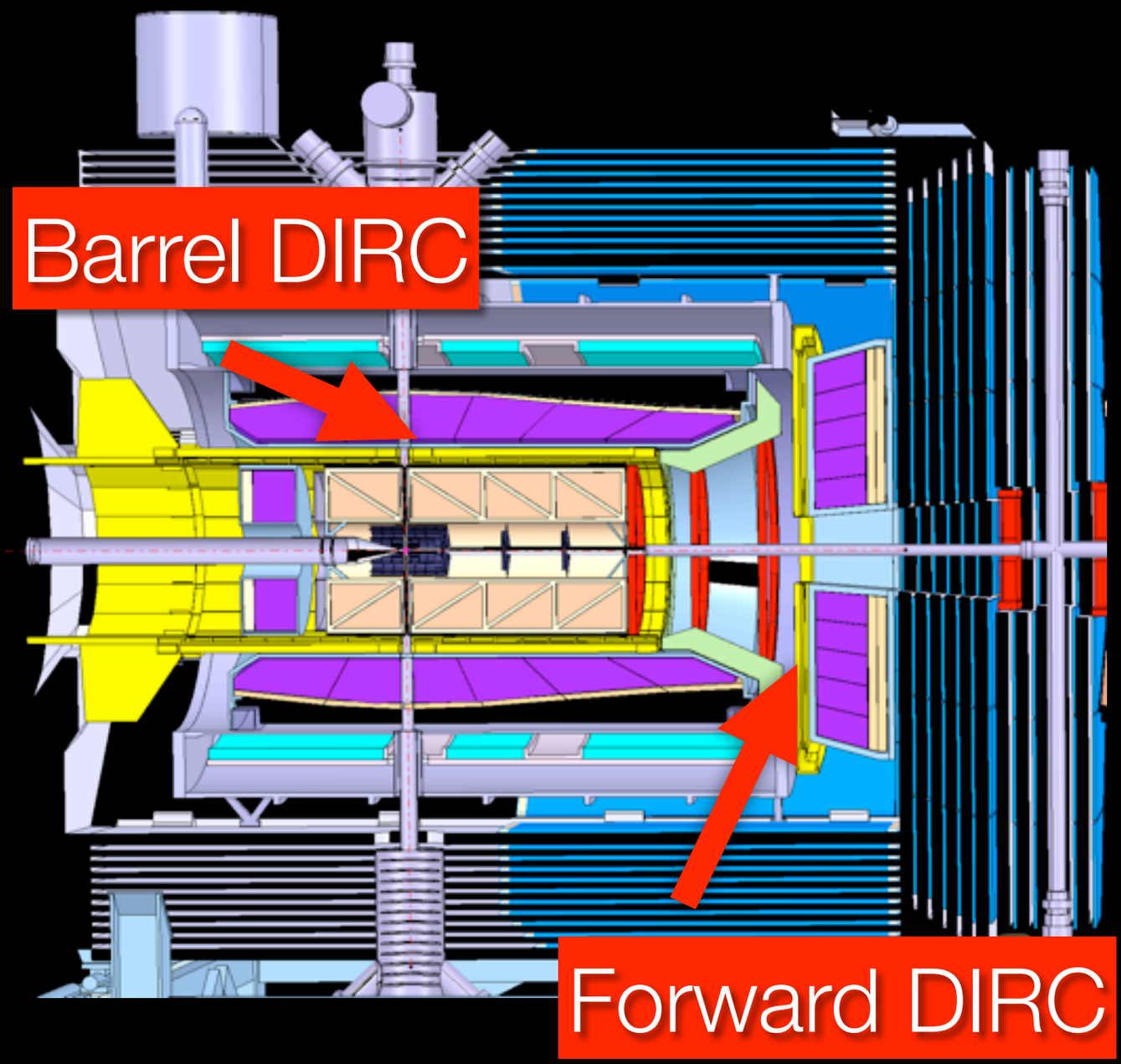




Target Spectrometer

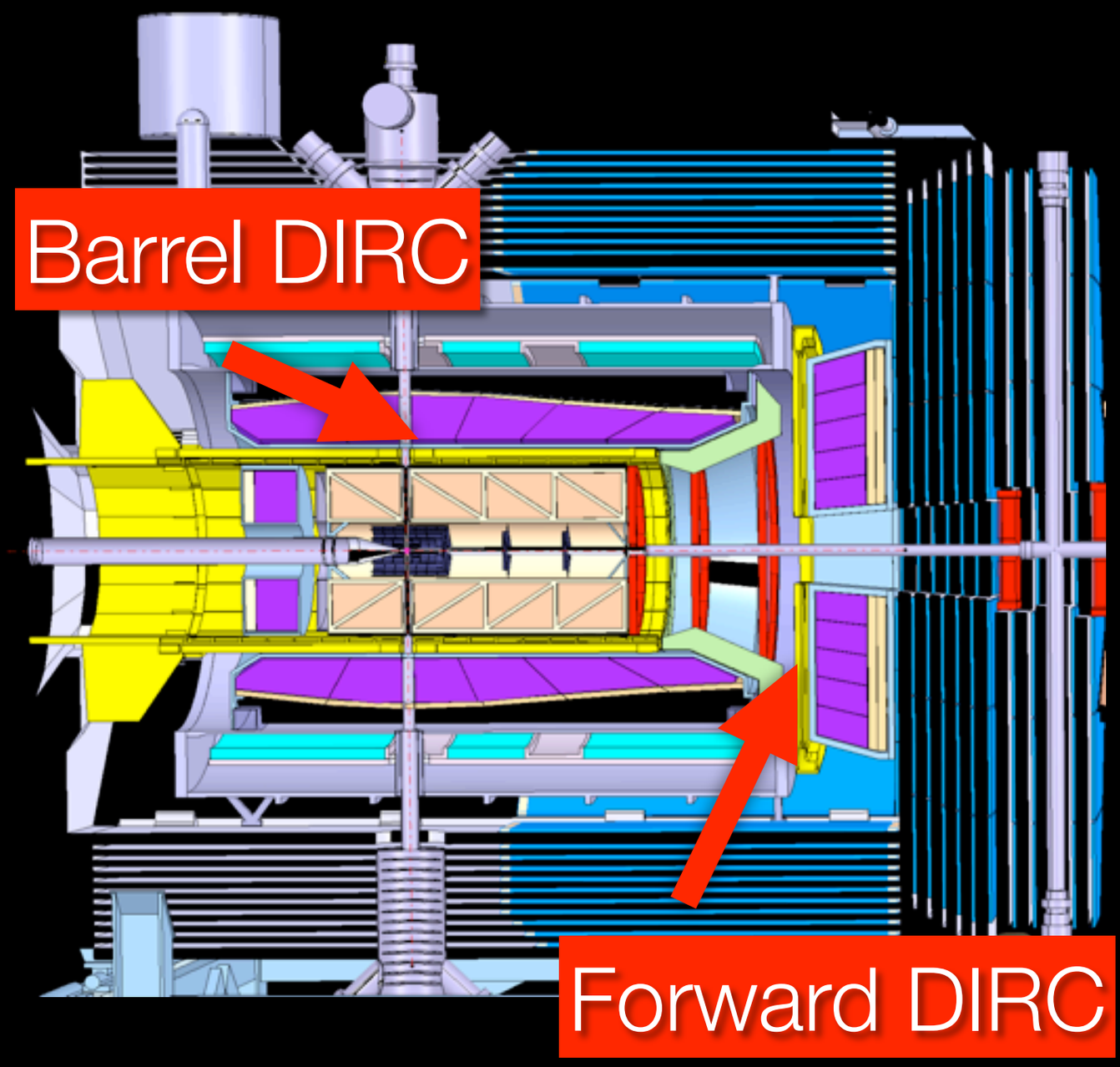
Detector Requirements





Detector Requirements

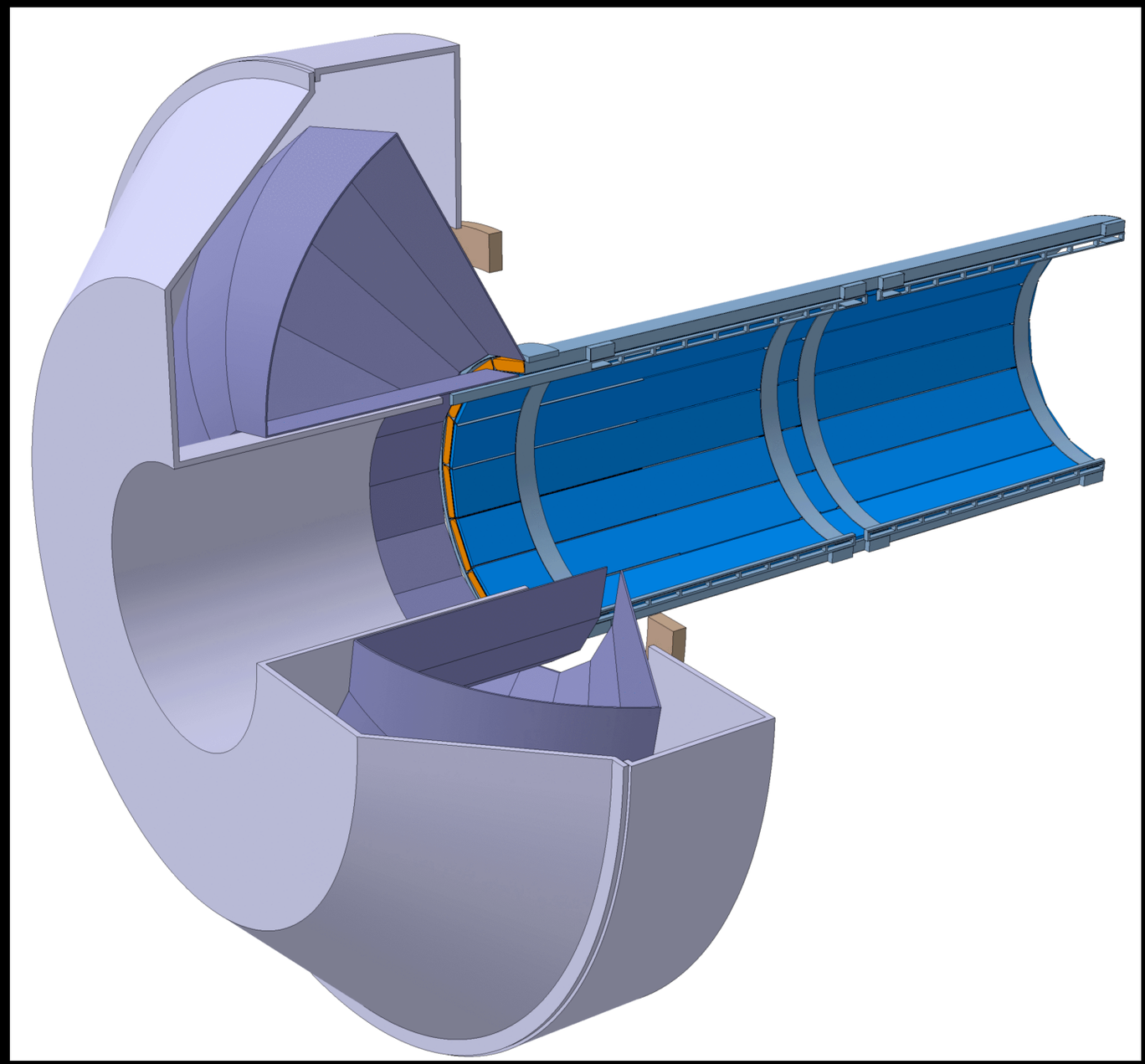
- PANDA is an anti-proton annihilation experiment at $\sqrt{s} \leq 5.5$ GeV/c
- Full angular coverage and very good PID mandatory
- Detector system will operate at 20 MHz average interaction rate
  - radiation hard (>100krad)
  - high count rates (~1.5 MHz/ cm^2)
  - excellent time resolution (< 300 ps)
- Detector has to work in magnetic field up to 2 T
- small radiation length



PANDA’s DIRC Systems

Design of the Barrel DIRC

- Barrel geometry similar to BaBar design
- read-out and imaging at the upstream end
- Use focussing optics for compact design
- 96 fused silica bars, 2600x17x35mm^3
- 2D+t imaging (3D DIRC)



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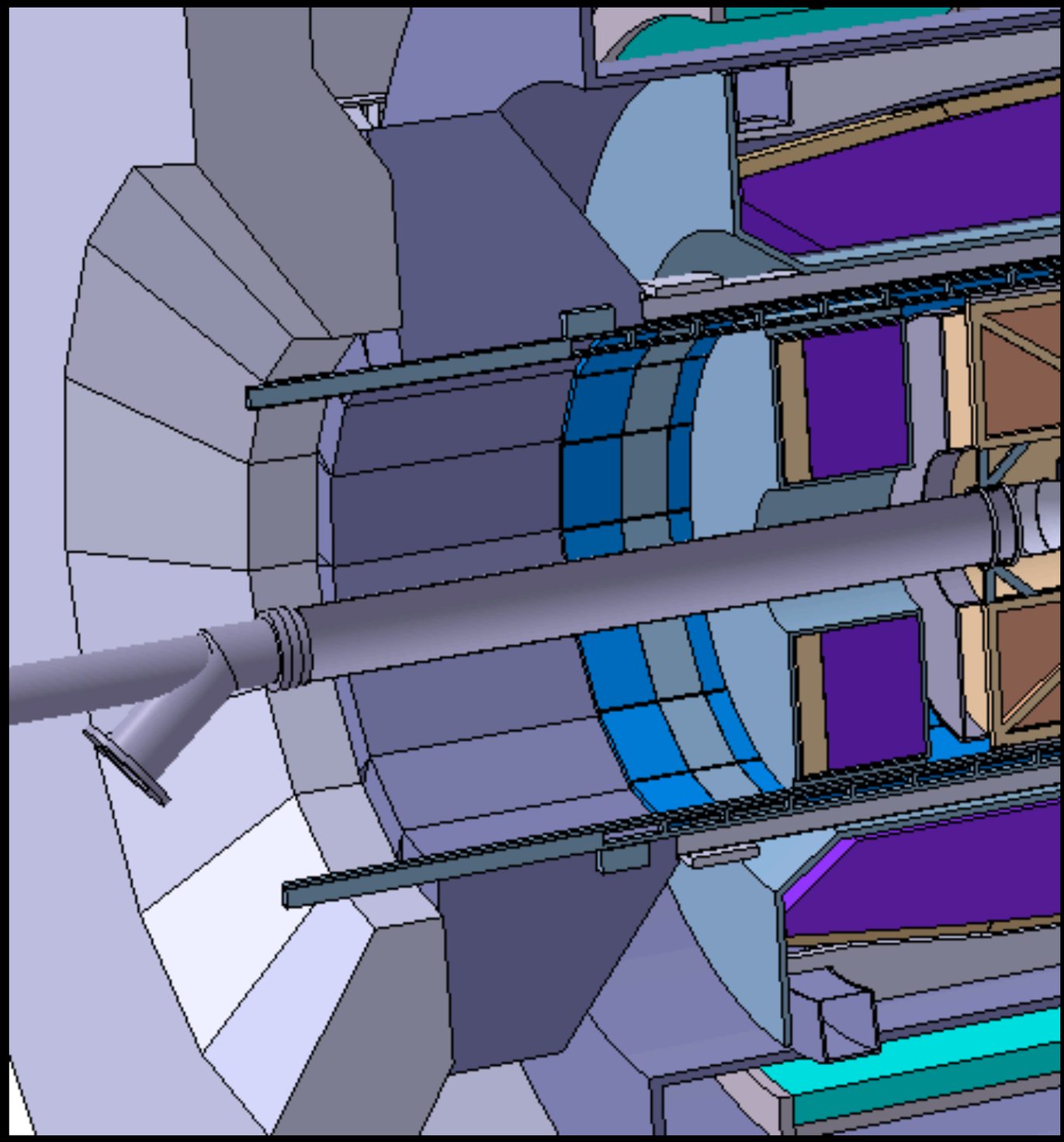
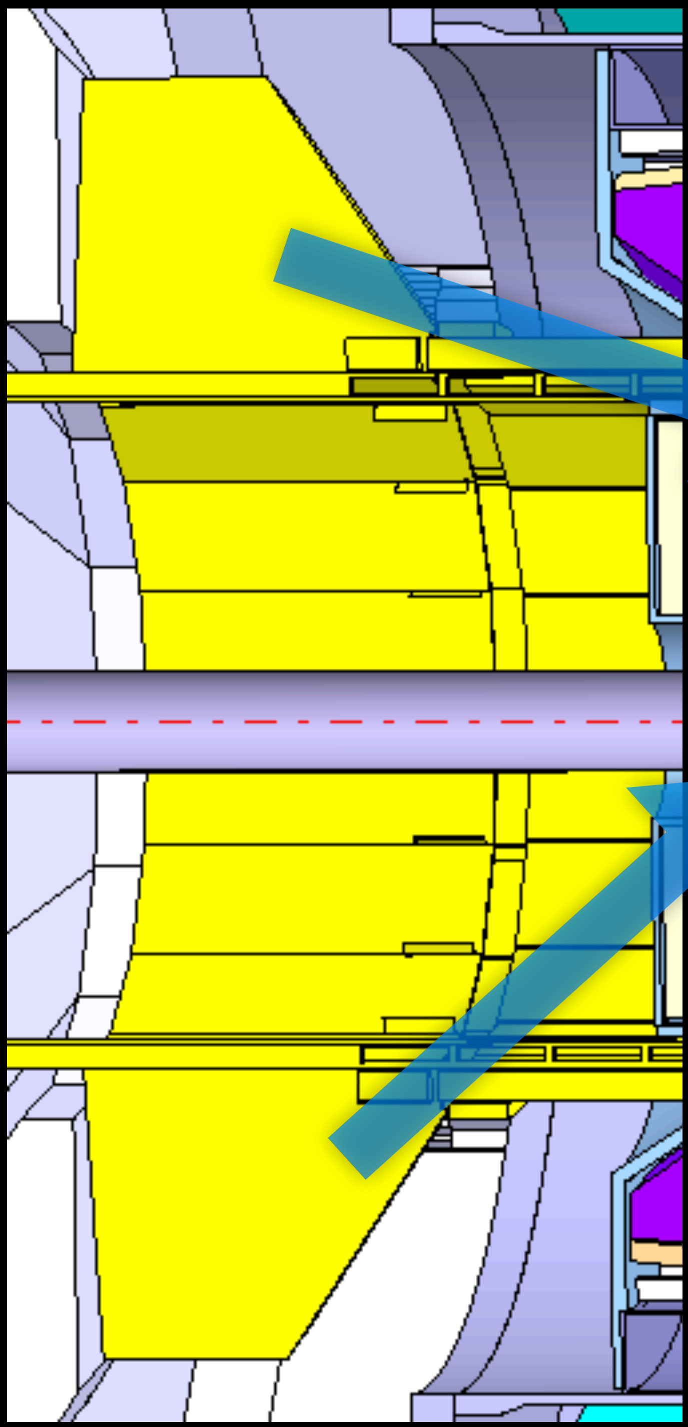
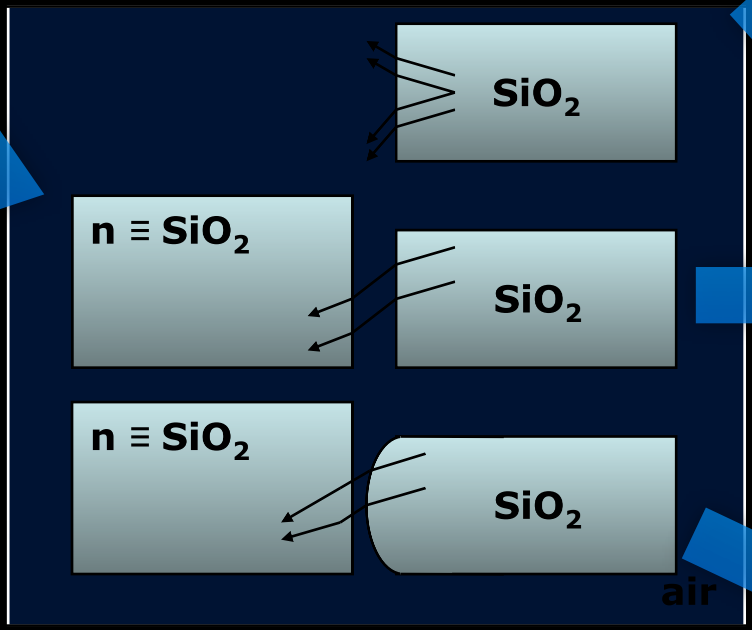
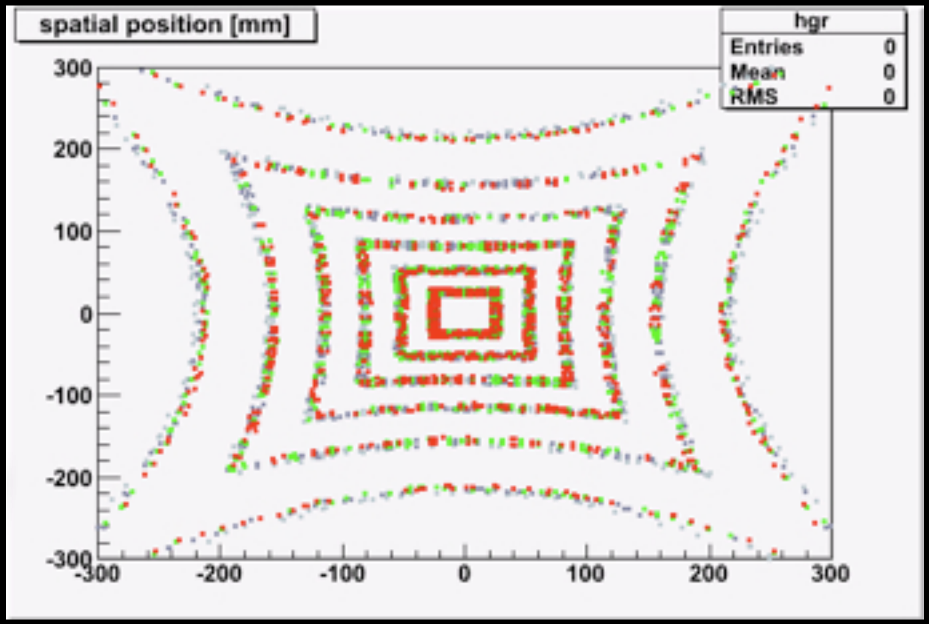
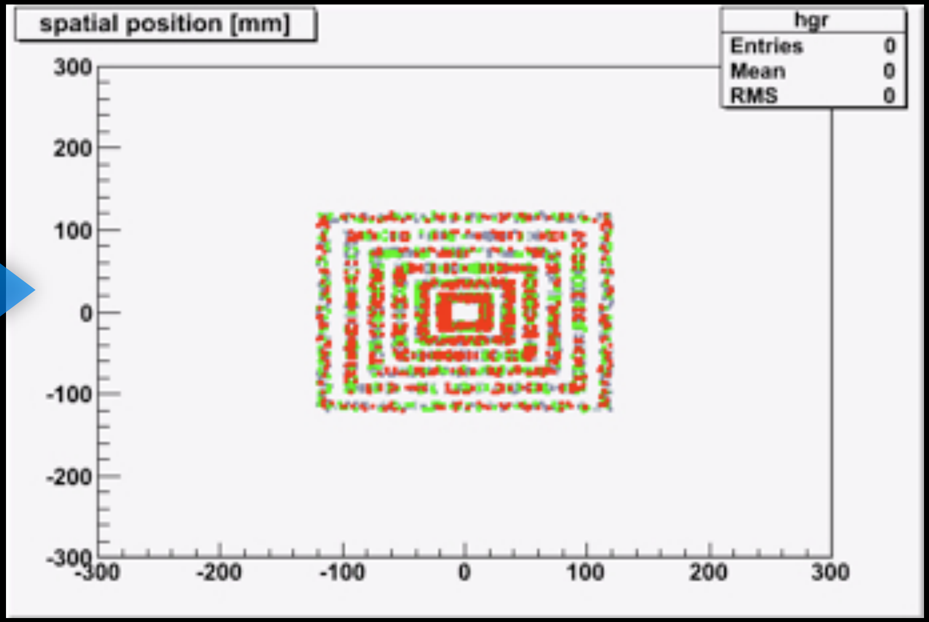


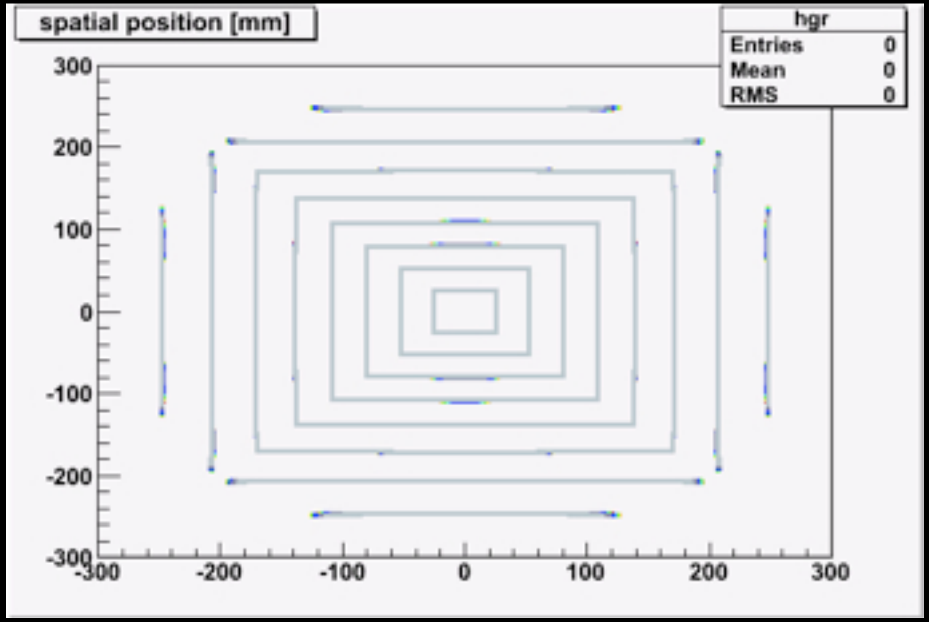
Imaging Solution



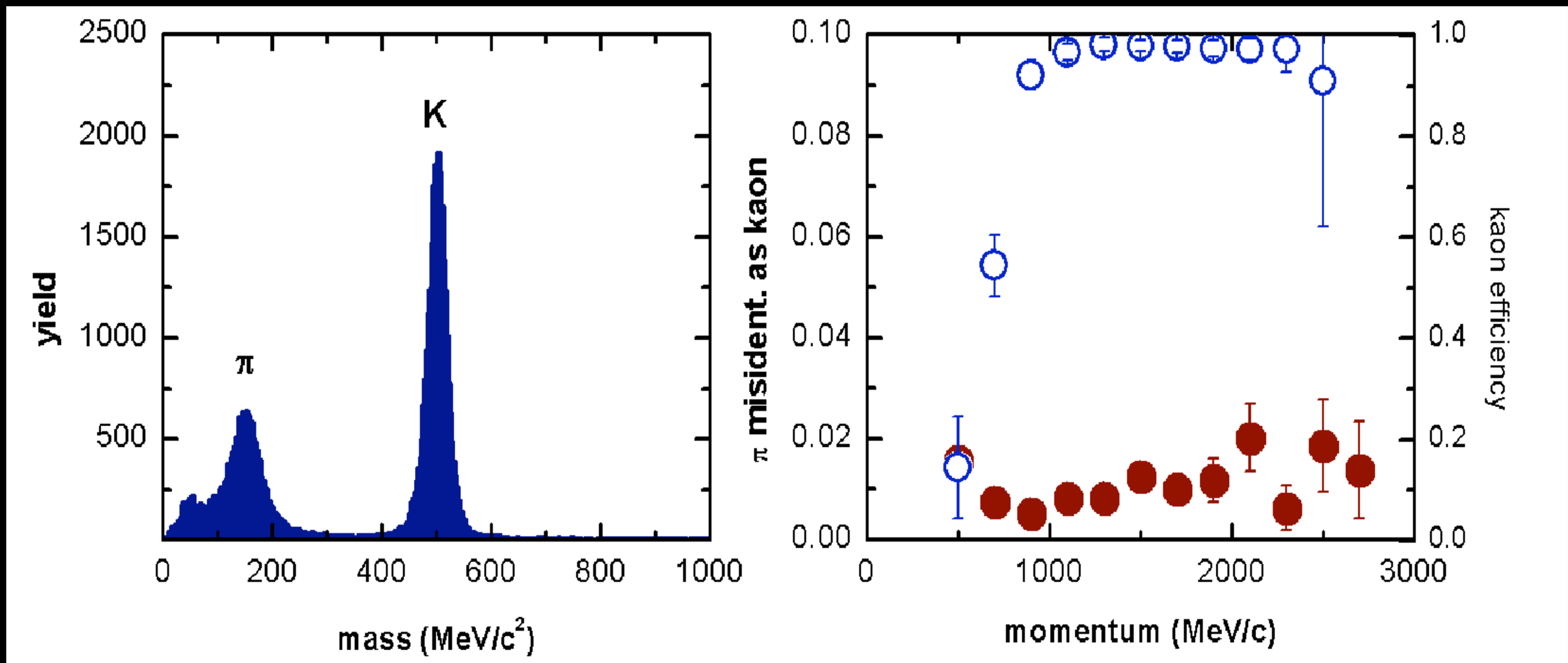








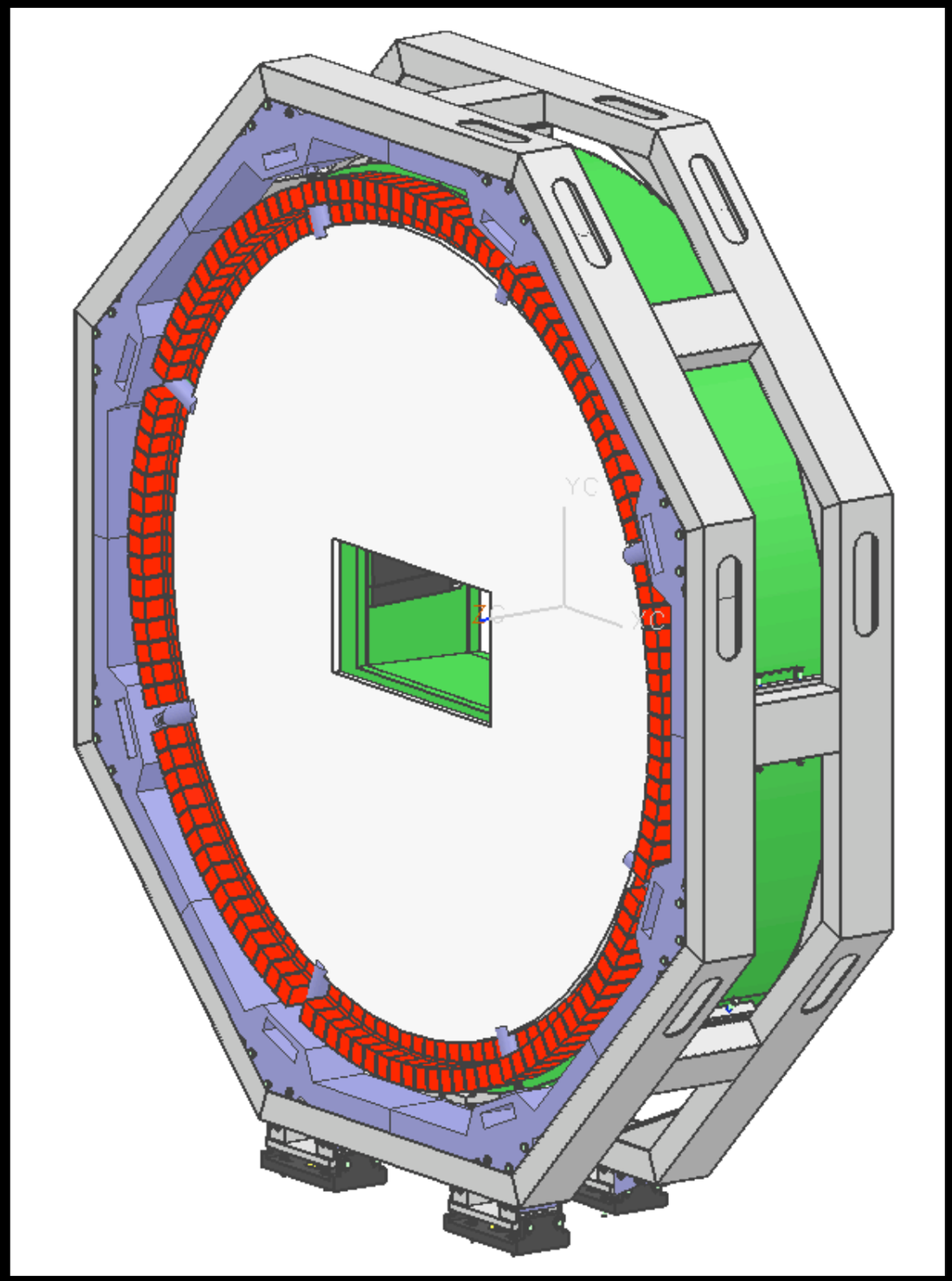
Expected Barrel DIRC Performance



$\bar{p}p \rightarrow J/\Psi\phi$ $\sqrt{s} = 4.4\text{GeV}$

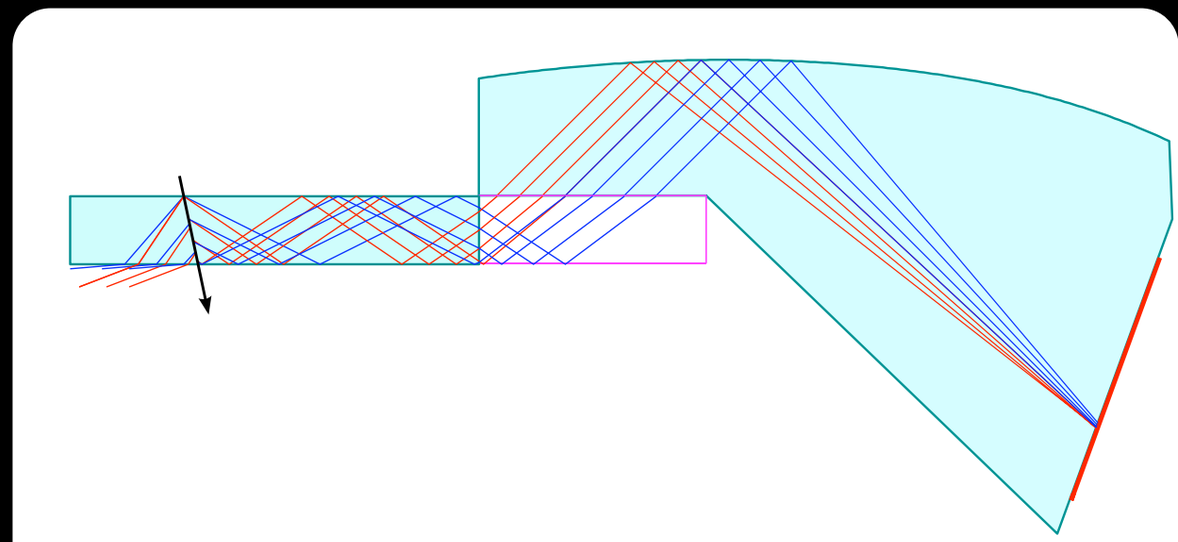
Focussing Disc DIRC

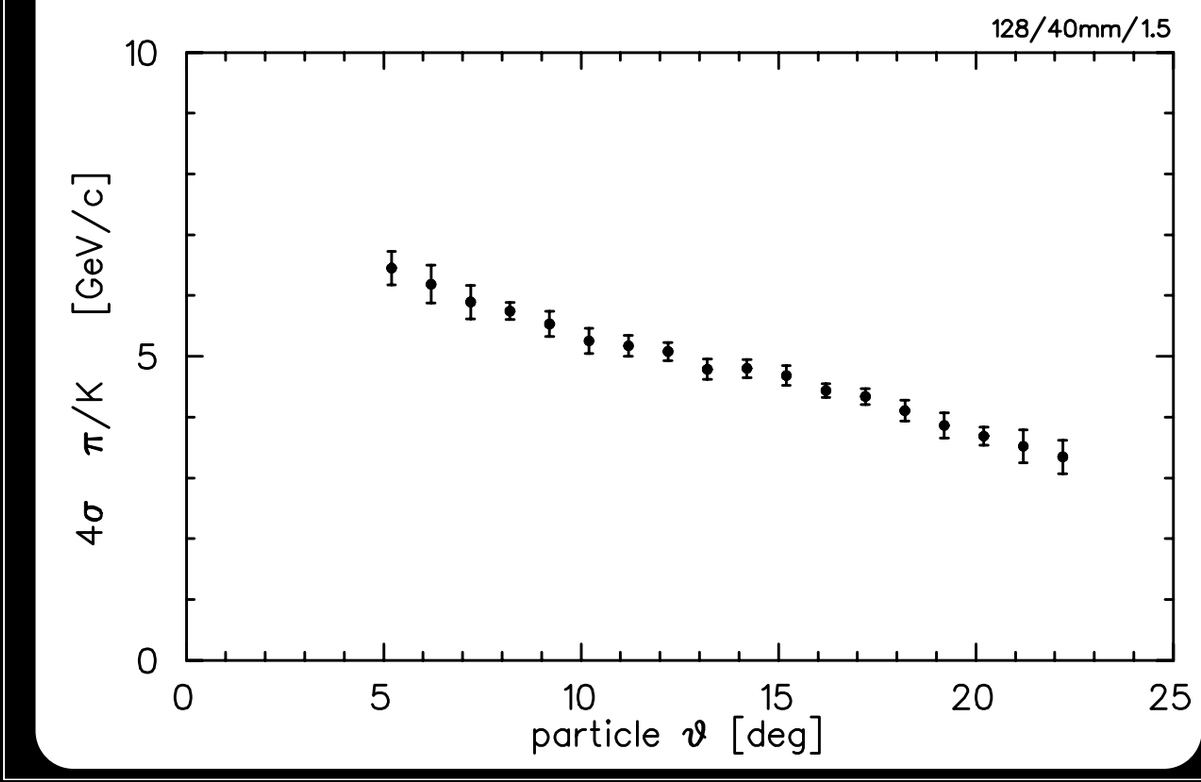
- Image reconstruction in 2D
- Timing for event correlation and background subtraction
- Radiator: Suprasil,
  20 mm thick, 1100 mm radius
- focussing optics for imaging with dispersion correcting elements
- compact detection plane on each light guide (50x50 mm^2)
- 128 light guides, 4096 R/O channels

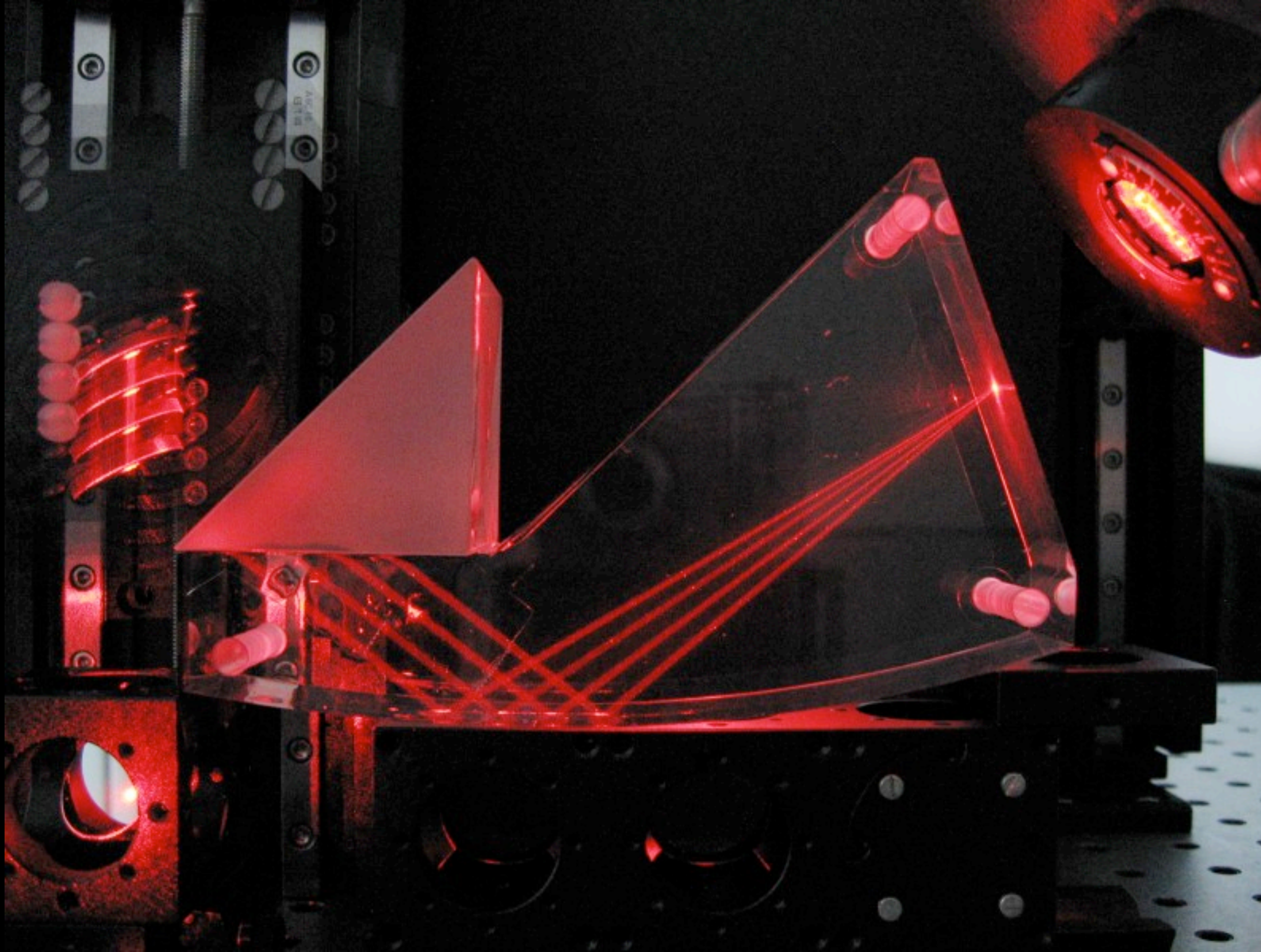


Focussing Disc DIRC Imaging

- Cherenkov images will be pattern in θ/ϕ space
- Focussing optics images θ
- θ will be measured by PMT
- ϕ is given by the light guide
- Lightguide design optimised for 50x50 mm^2 focal plane
- Transition from fused silica to LiF and back has two-fold prism effect and mitigates dispersion

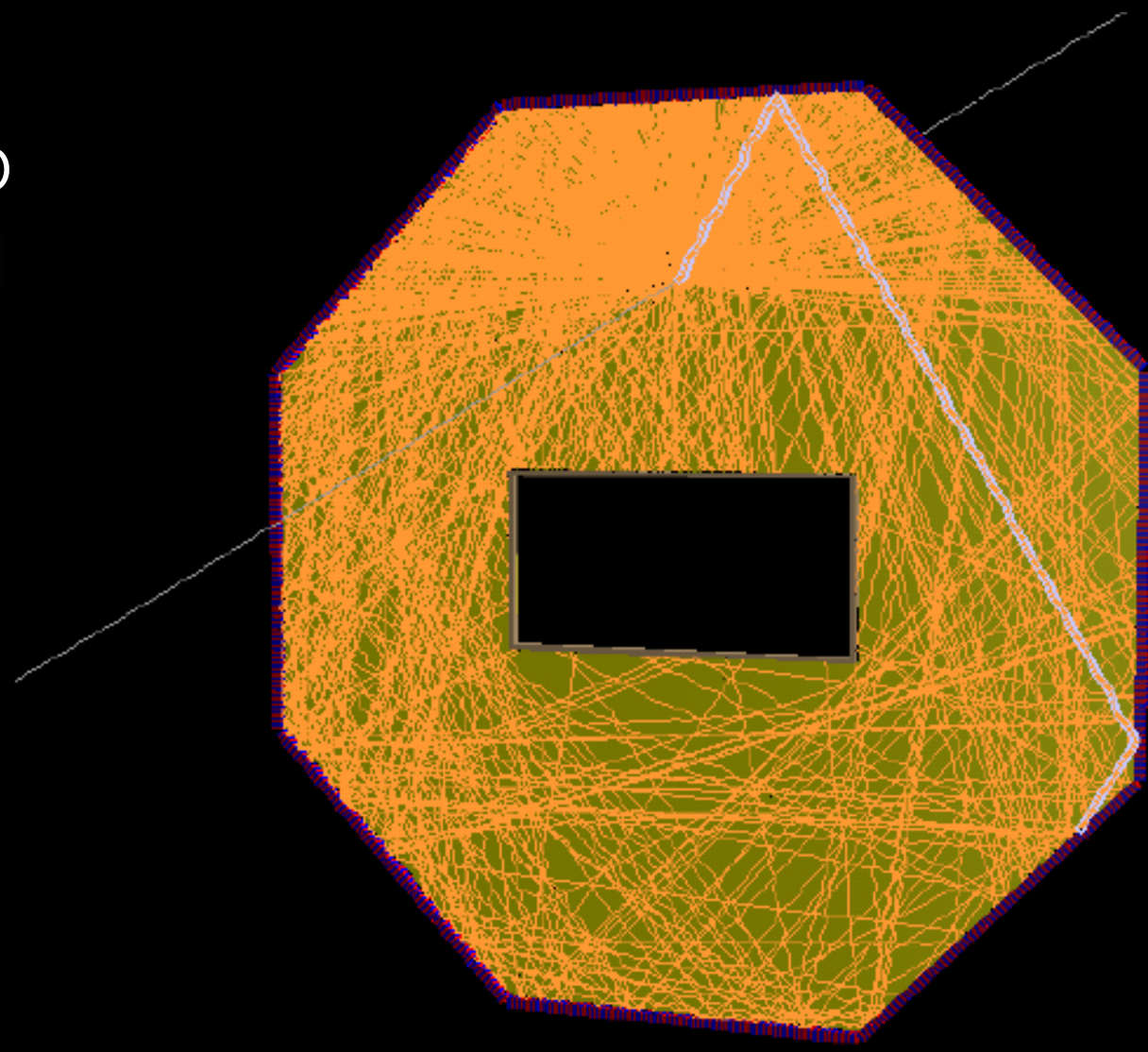






Time-of-Propagation DIRC

- Reconstruction in 1D+t
- Use time of propagation to reconstruct second spatial co-ordinate
- Dichroic mirrors to select wavelength band and to enhance light path
- Less read-out channels
- requires single photon detection and $\Delta t < 50ps$
- performance similar to FDD



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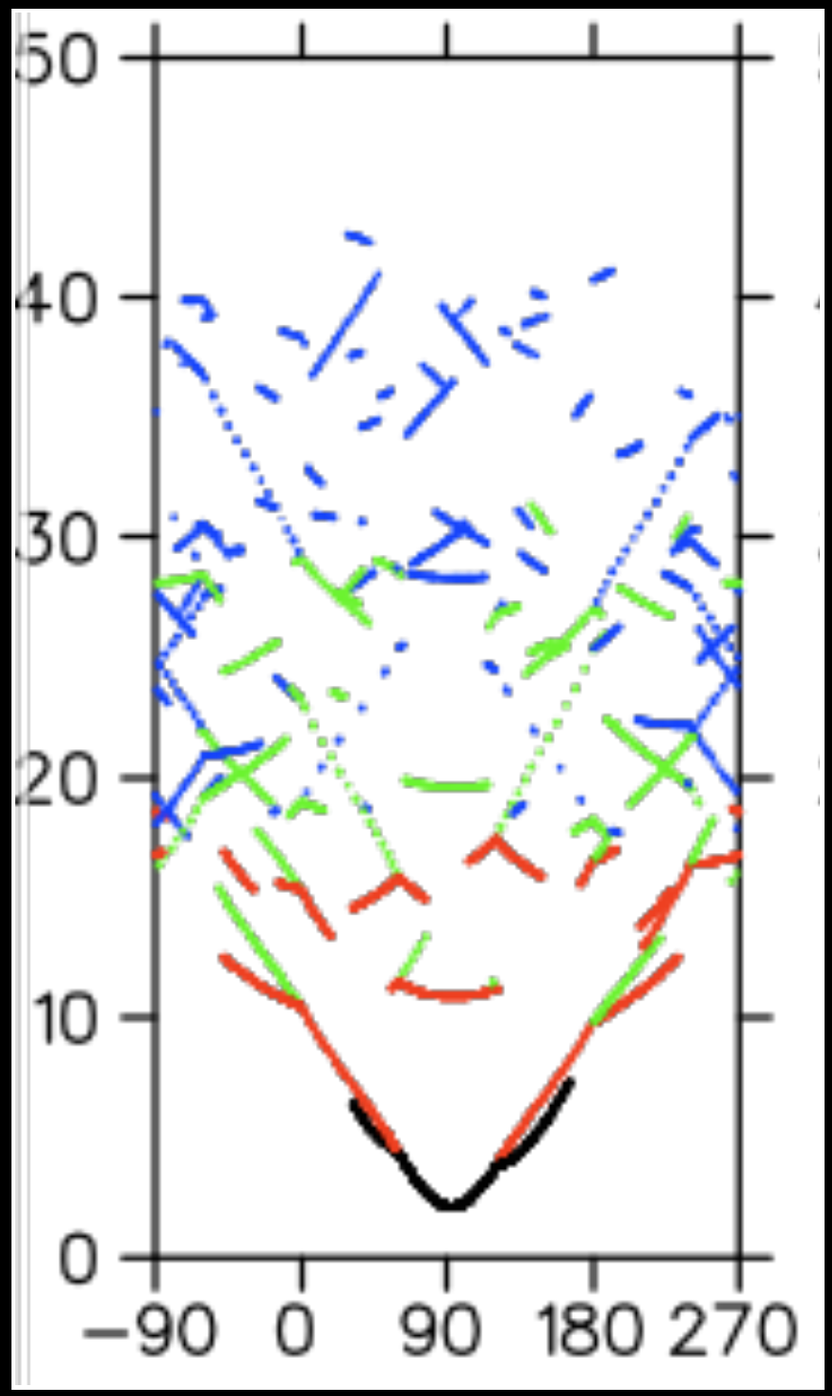
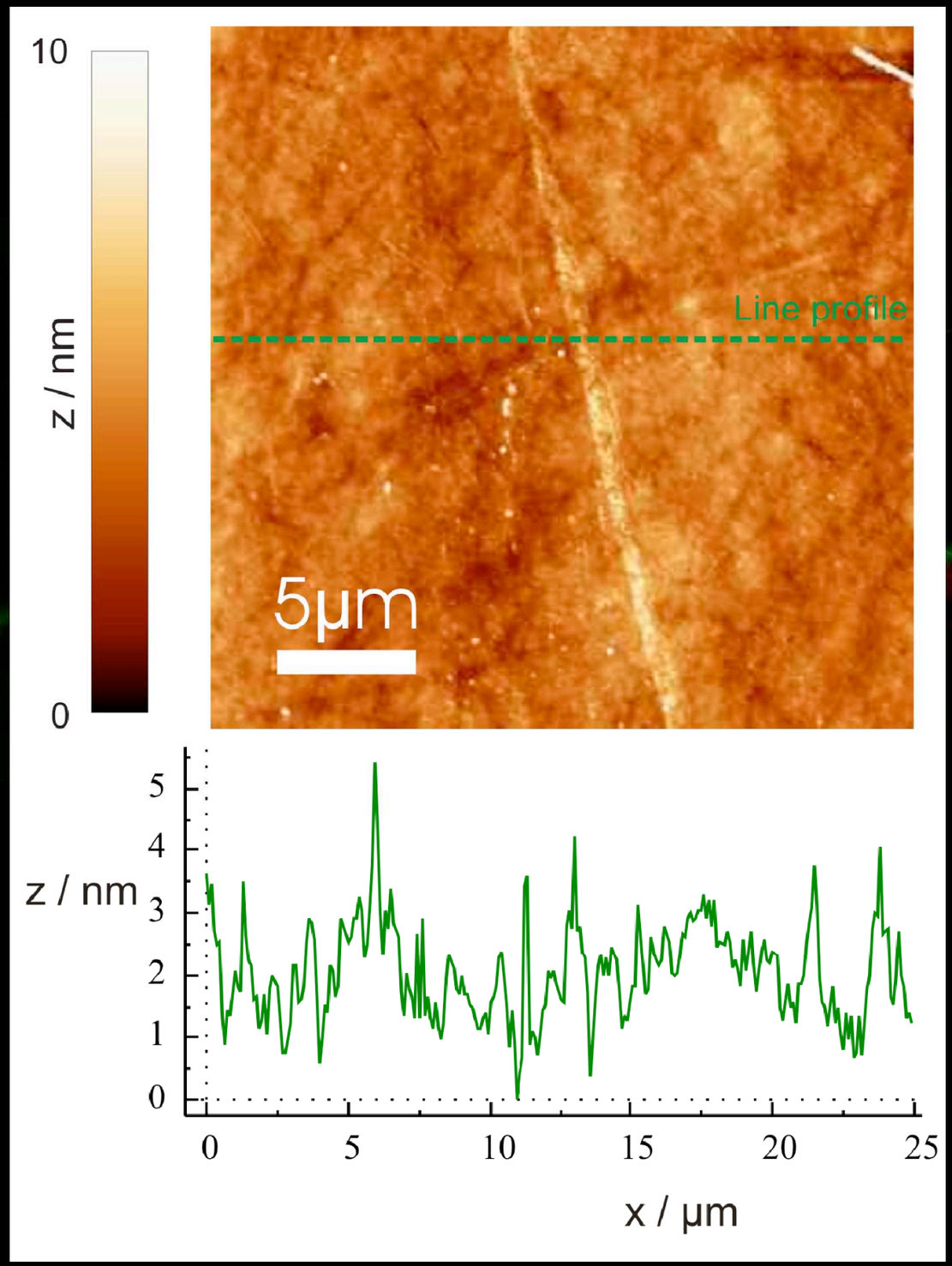


Common Developments

Photon Propagation

- Transmission properties of all components (radiator, glue, LiF) studied in detail
- $\lambda_{cut\text{-}off}$ = 300 nm
- All components tested to be sufficiently radiation hard
- Surface quality control by transmission/reflection measurements and AFM
- Manufacturer delivers according to specifications



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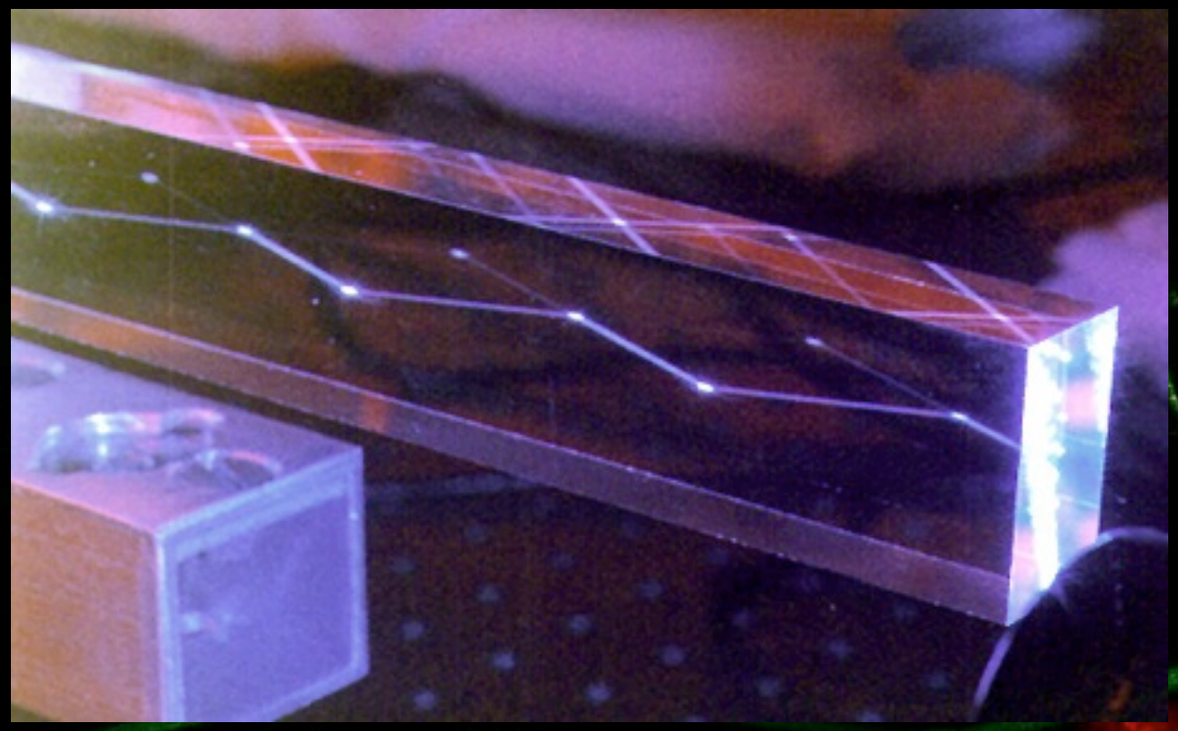
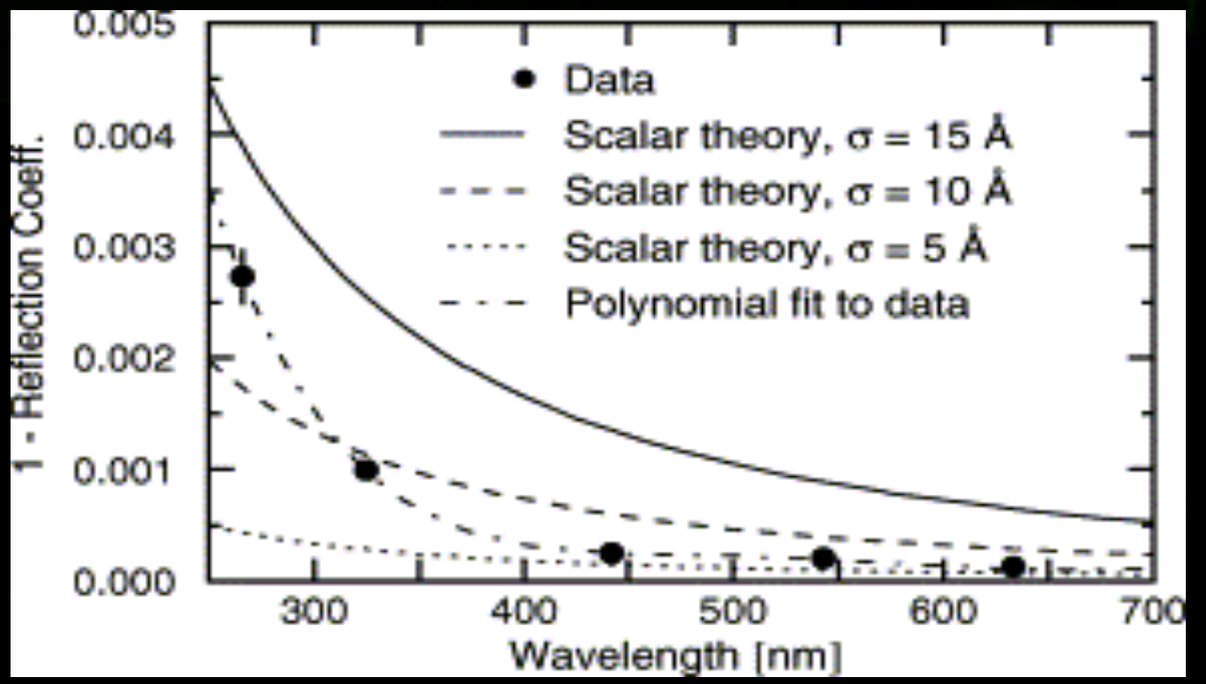
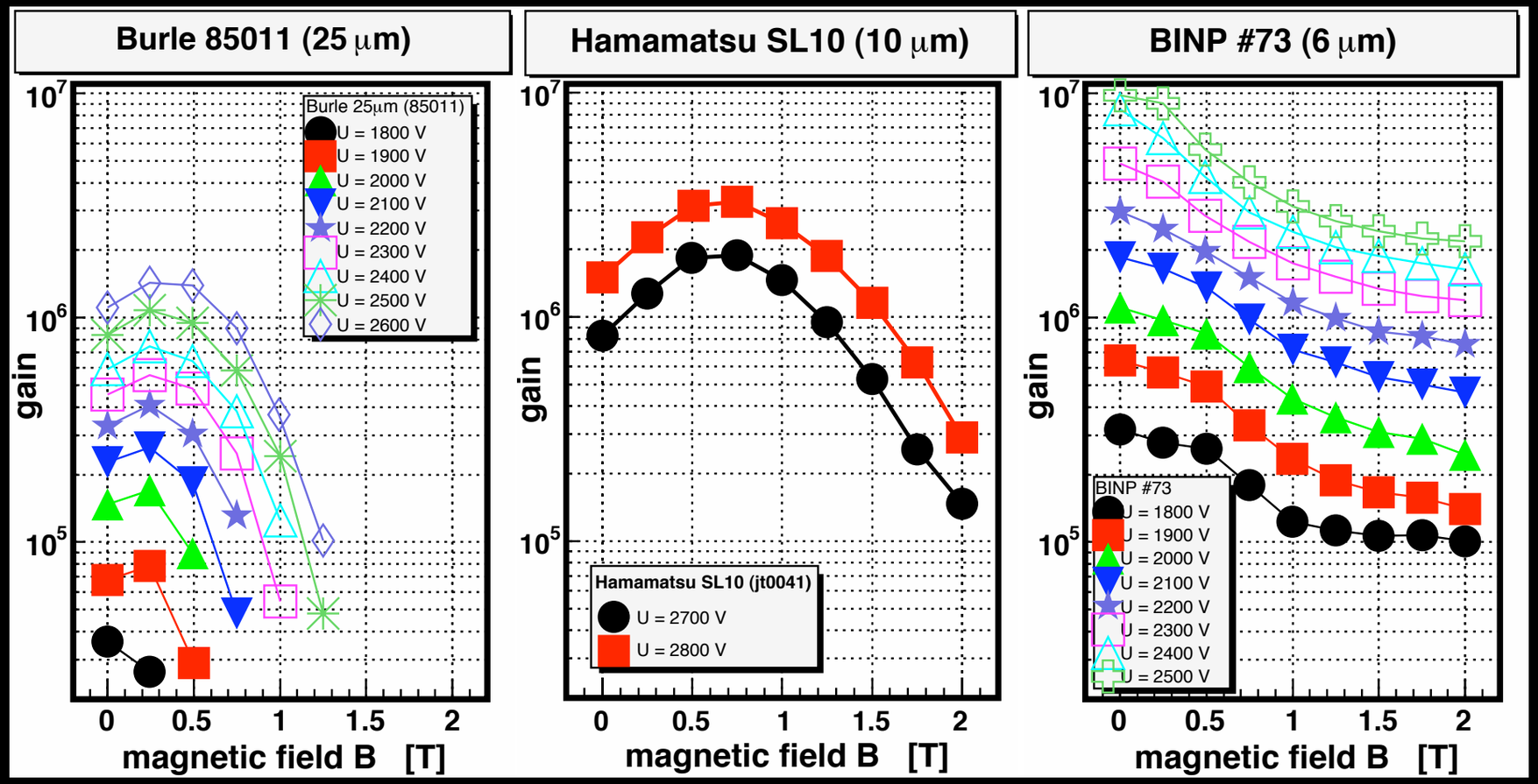




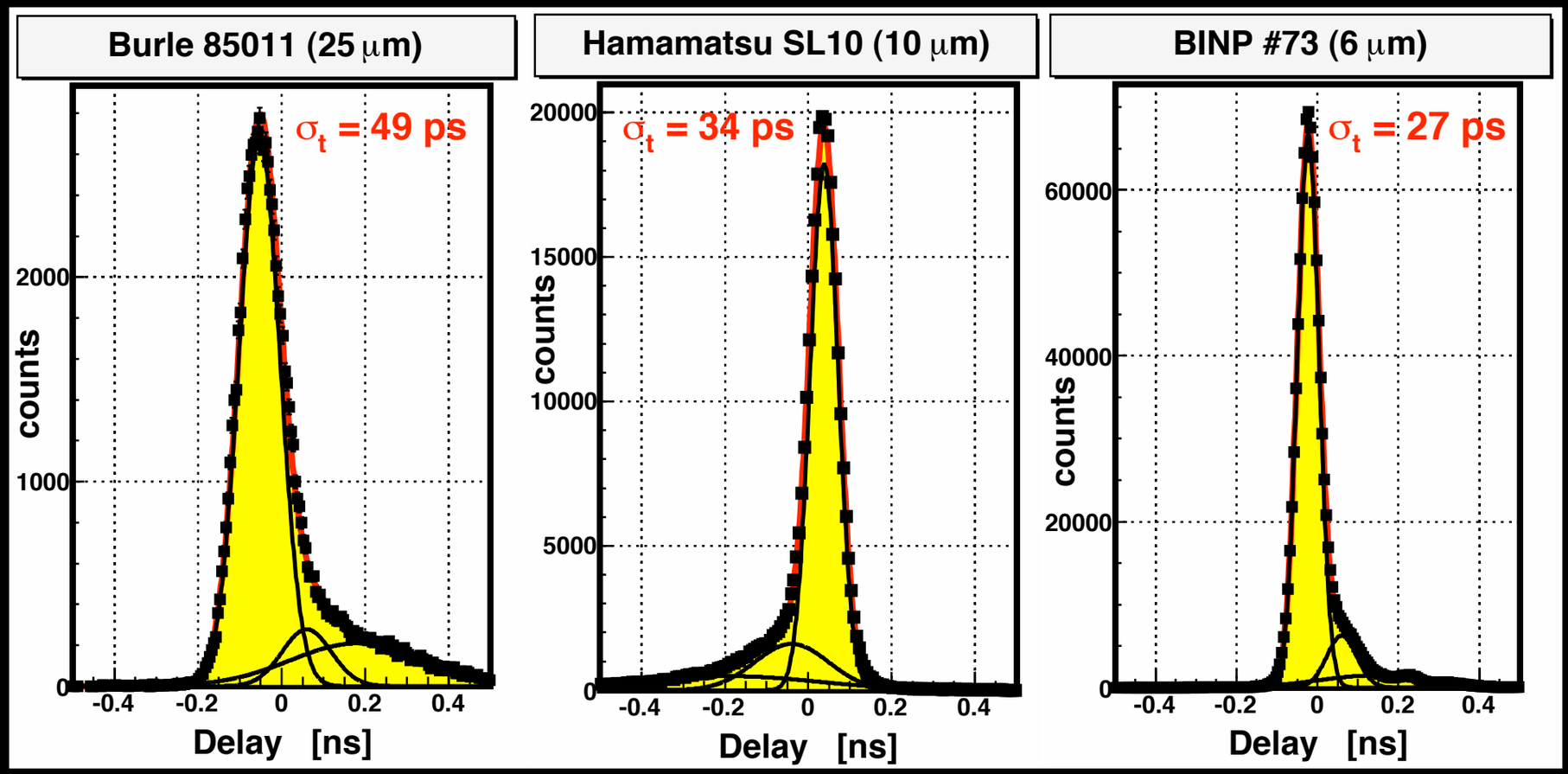
from: J. Cohen-Tanugi, NIM A5115(2005)680

Photon Detection Systems



- Investigate MCP-PMTs
- good response in magnetic fields
- good time resolution
- multipixel version with good uniformity
- rate dependence and lifetime are still a concern

Photon Detection Systems



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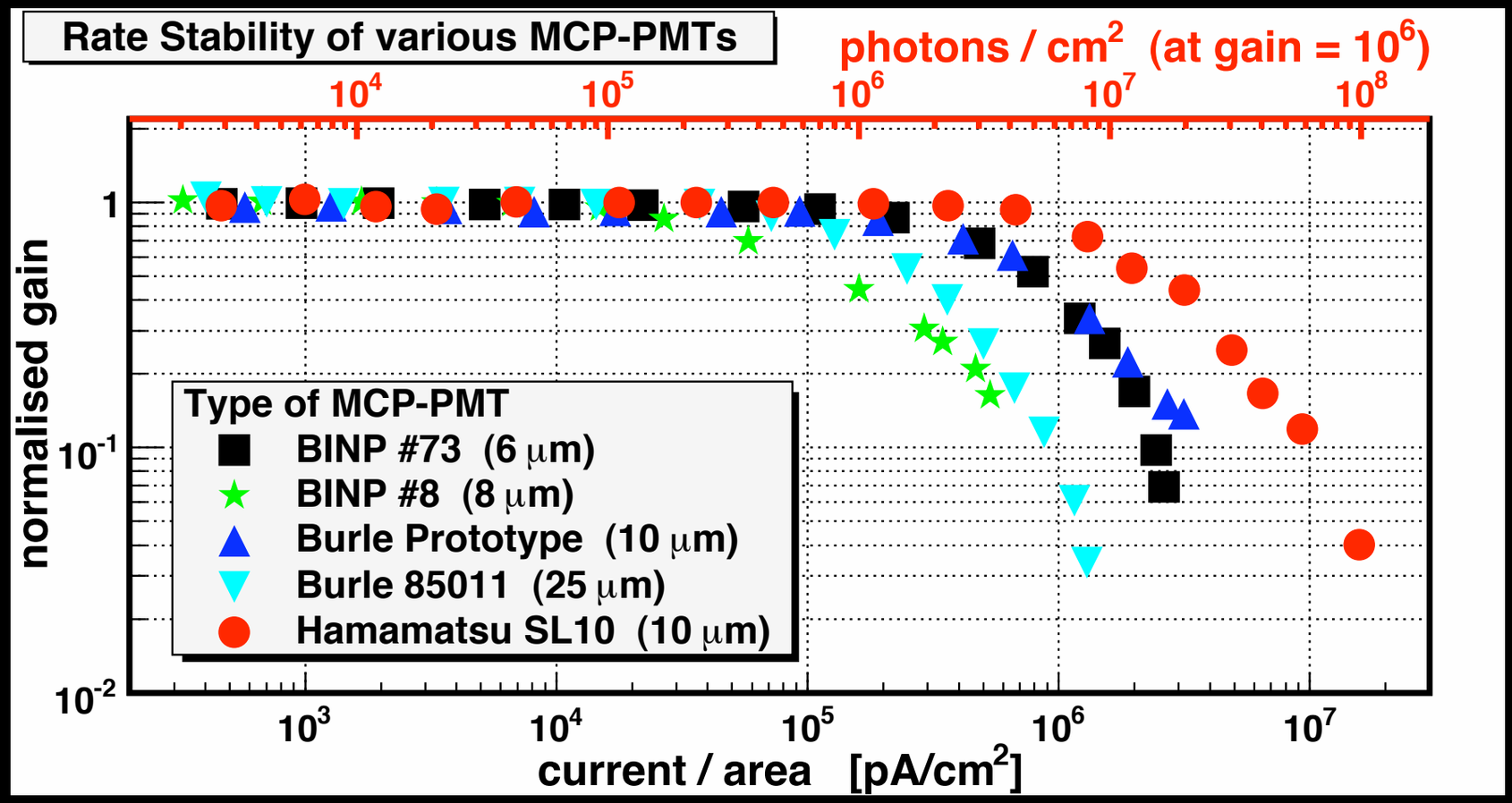

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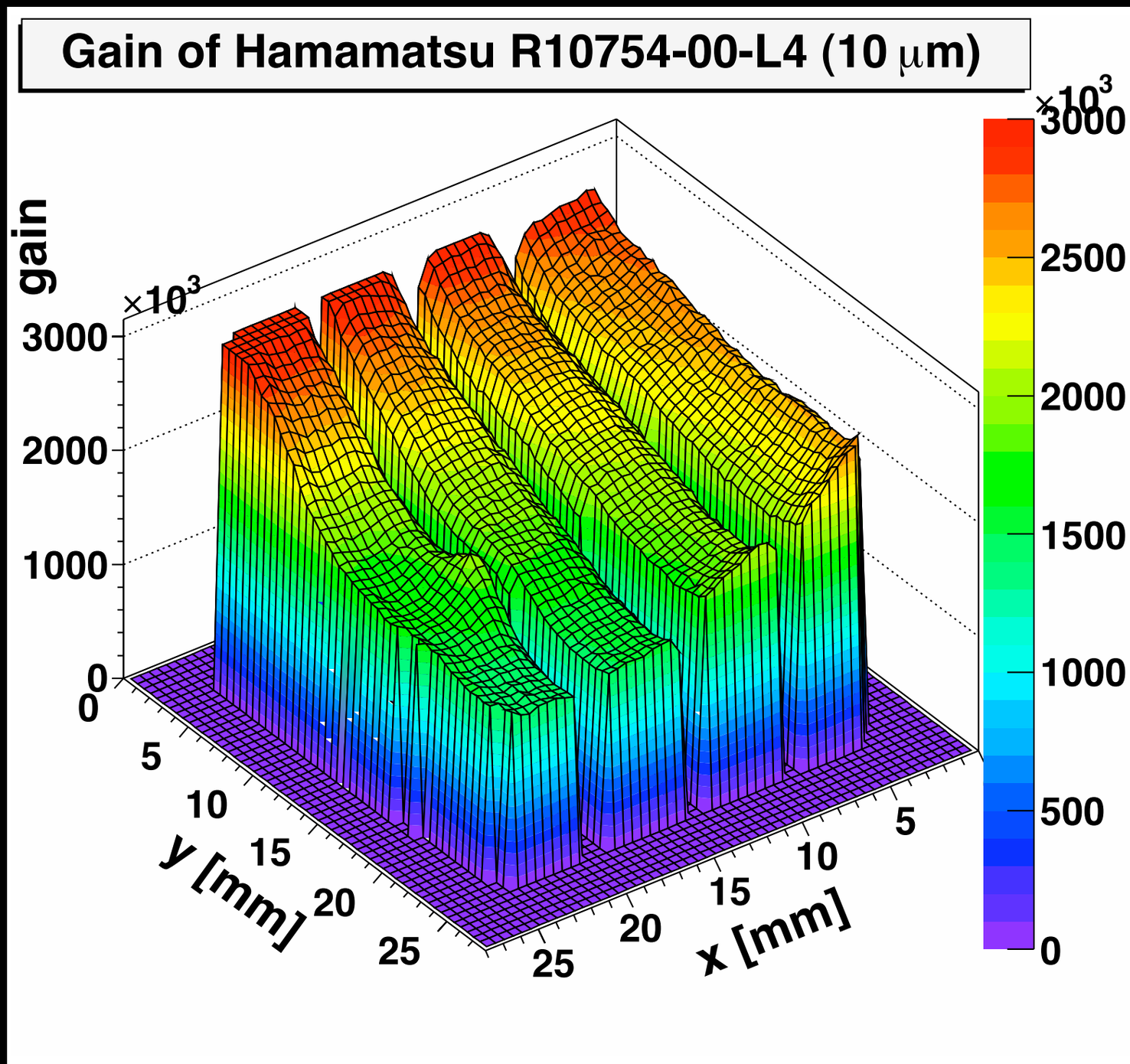
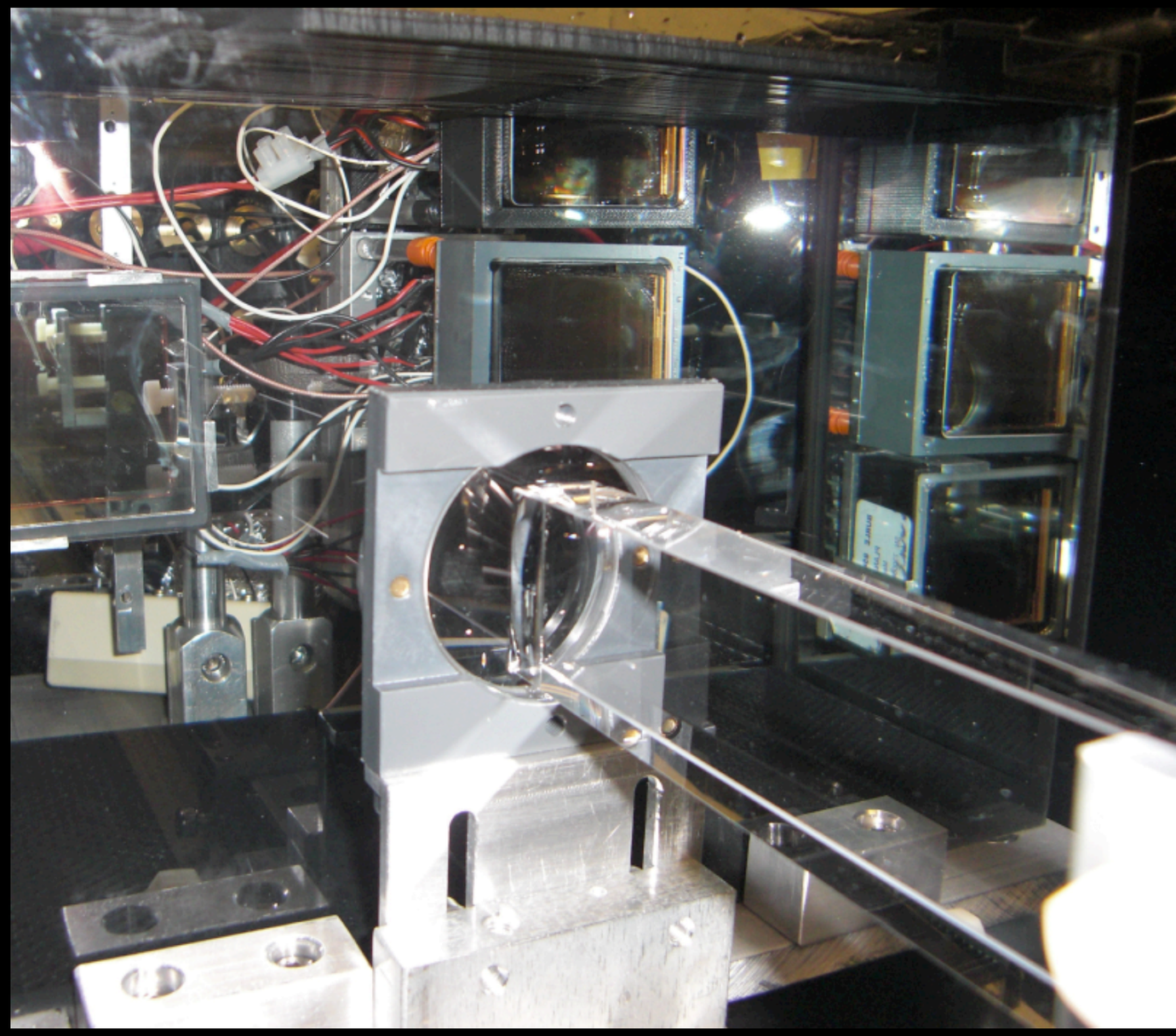


Detector Prototypes

Barrel DIRC Prototype

- Aim to test imaging scheme
- Use p beam (β =0.95) at variable incidence
- Image on four Planacon MCPs
- Read-out by NINO ToT converter and HADES TRB v2 boards
- Multiplicity follows expected pattern



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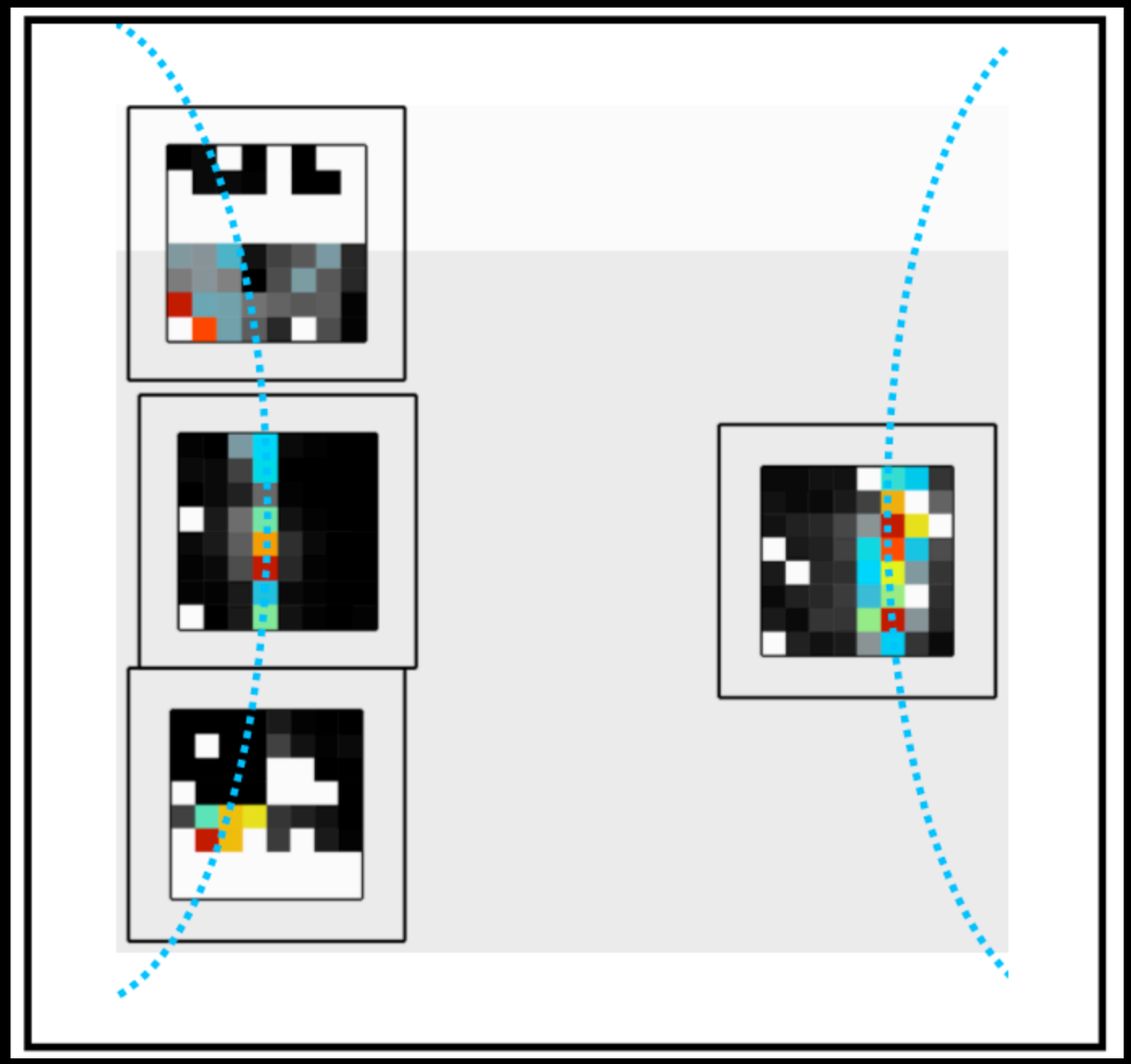
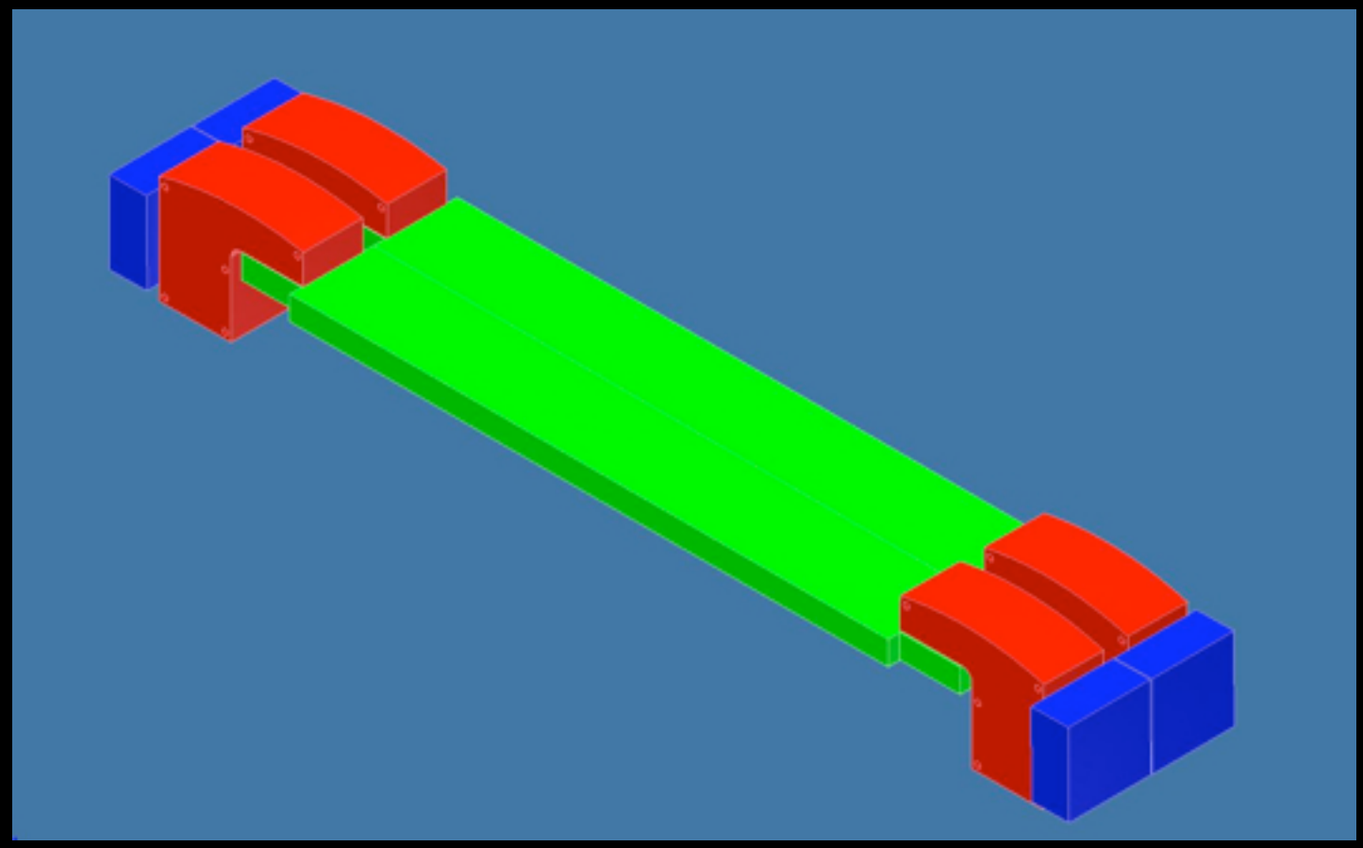


Disc DIRC Prototypes

- FDD prototype emphasises
  - radiator properties
  - dispersion correction
  - focussing optics
  - photon detection
  - angular dependence
- TDD investigates photon propagation and timing
- Continue studies with electron and mixed hadron beams in 2010/2011



Radiator	fused silica	500x70x20 mm^3
dispersion correction	LiF	50x50x20mm^3
LG	fused silica	
PMT	Planacon MCP PMT	4x32chn
Read-out	Ortec Preamp	CAEN CFD,QDC,TDC

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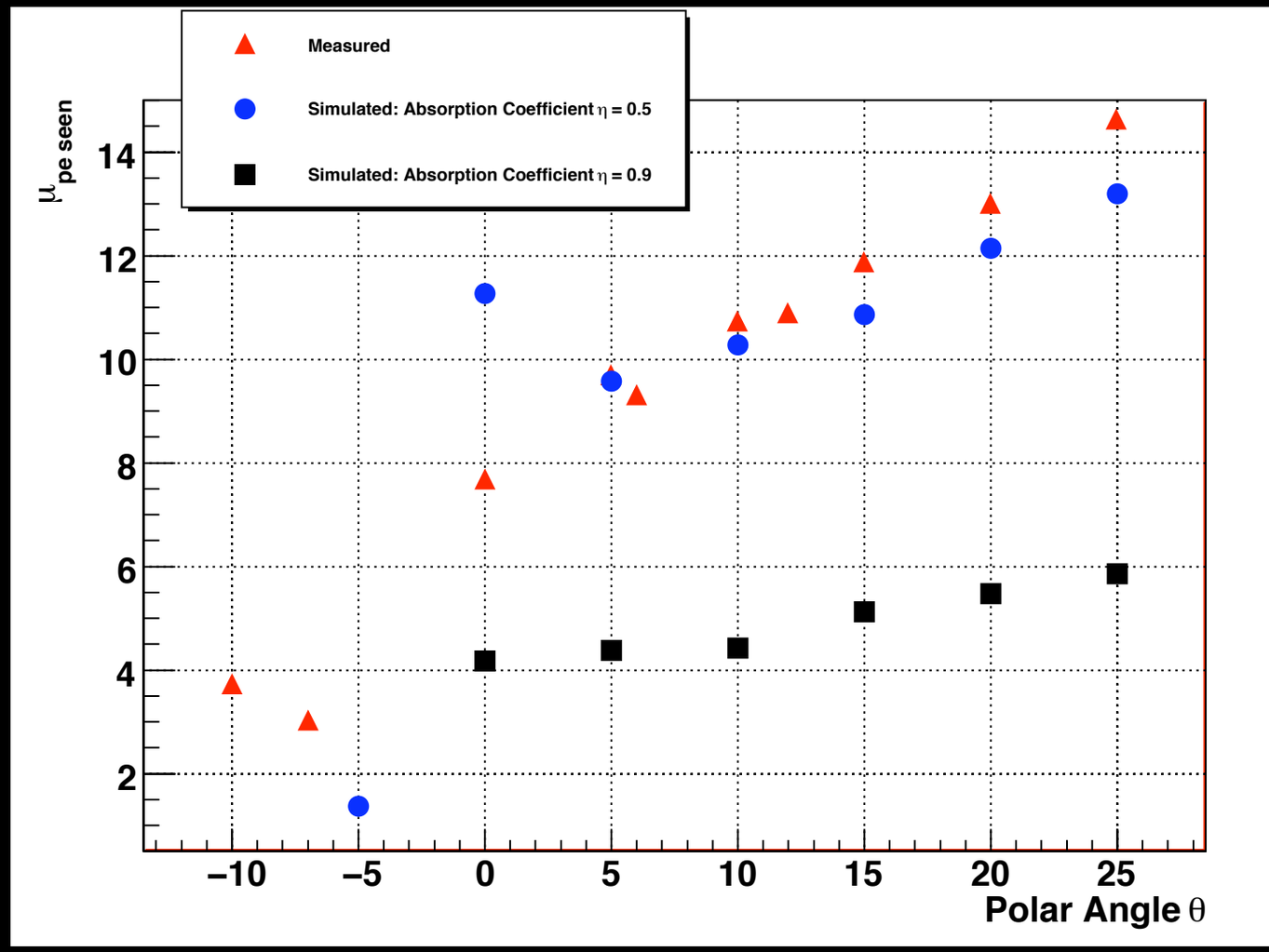

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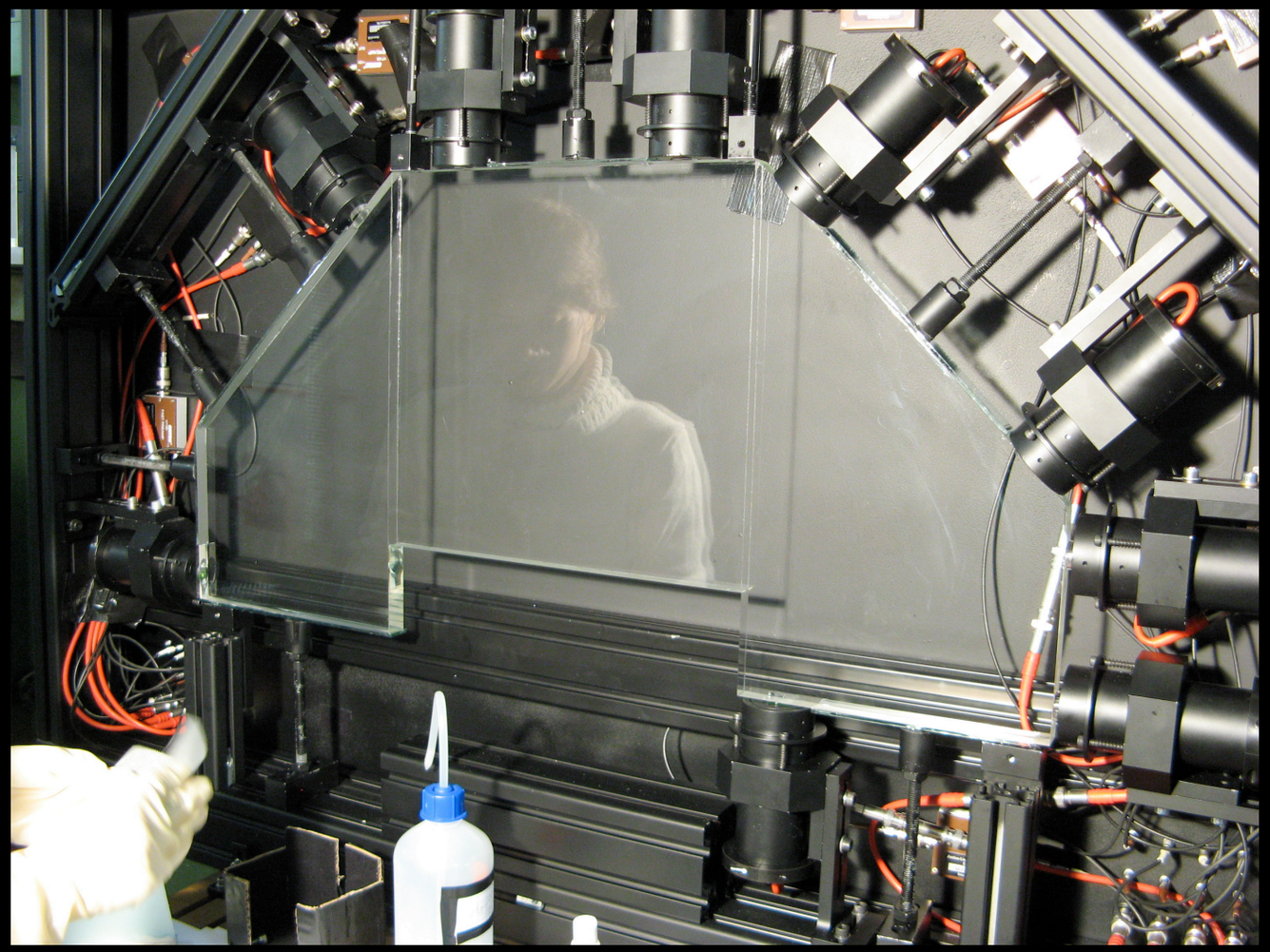

Summary and Outlook

- PANDA will employ DIRC counters as compact PID devices
- Four main aspects in the construction of a DIRC
  - photon generation
  - photon transport
  - photon detection
  - image reconstruction
- Each aspect is studied individually
- Candidate systems for Barrel DIRC, FDD and TDD identified
- Prototypes constructed, beam tests have started

PANDA Cherenkov group (GSI, INFN Ferrara, JINR Dubna, SMI Vienna and the Universities of Edinburgh, Erlangen-Nürnberg, Gießen and Glasgow) and EU JRA HadronPhysics 2 - *DIRCs*

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Thank you very much for your attention !

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