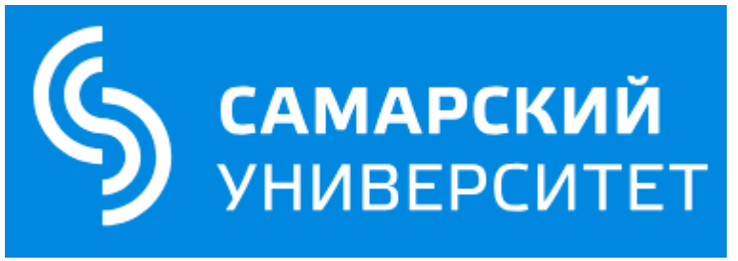
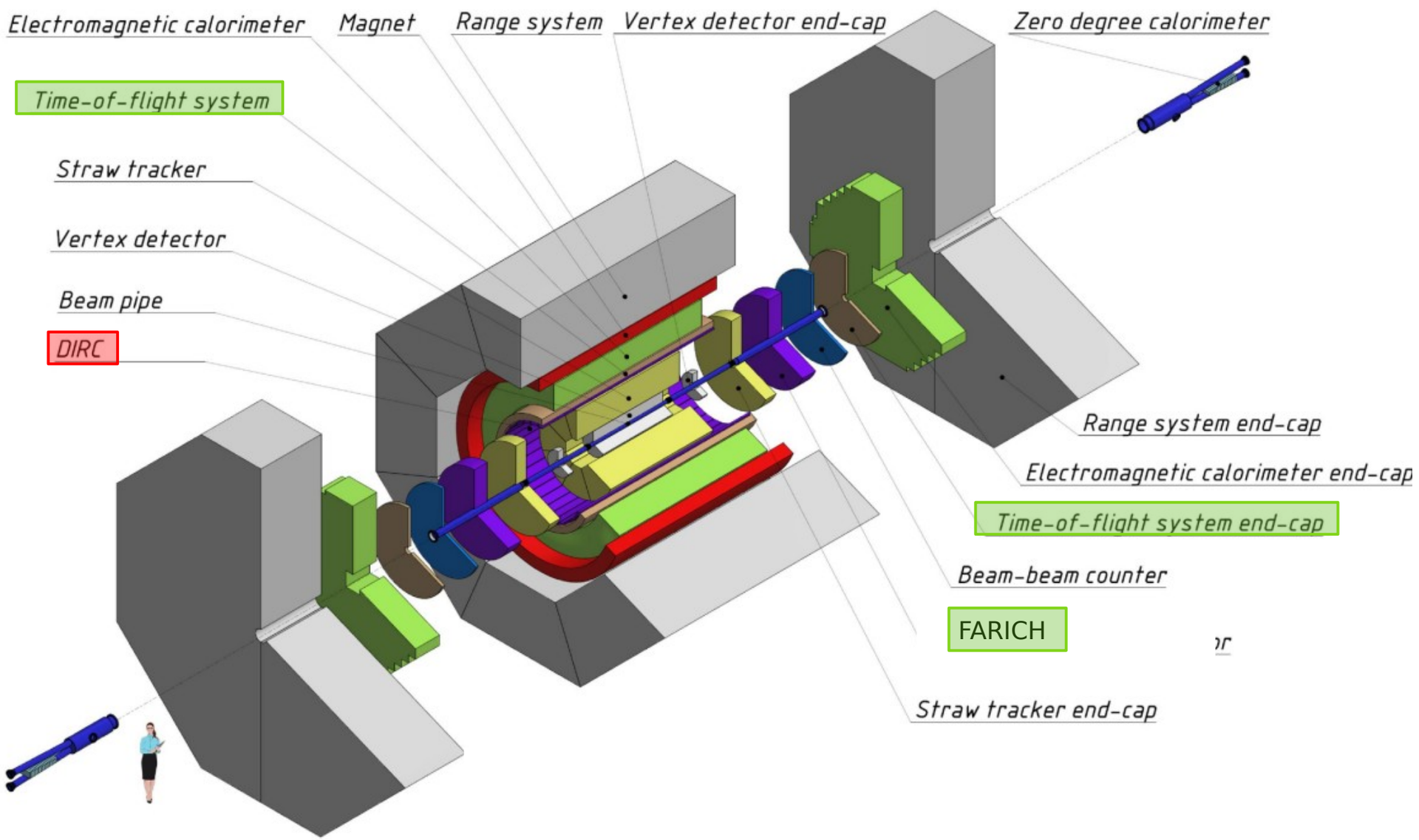


Particle Identification in SPD

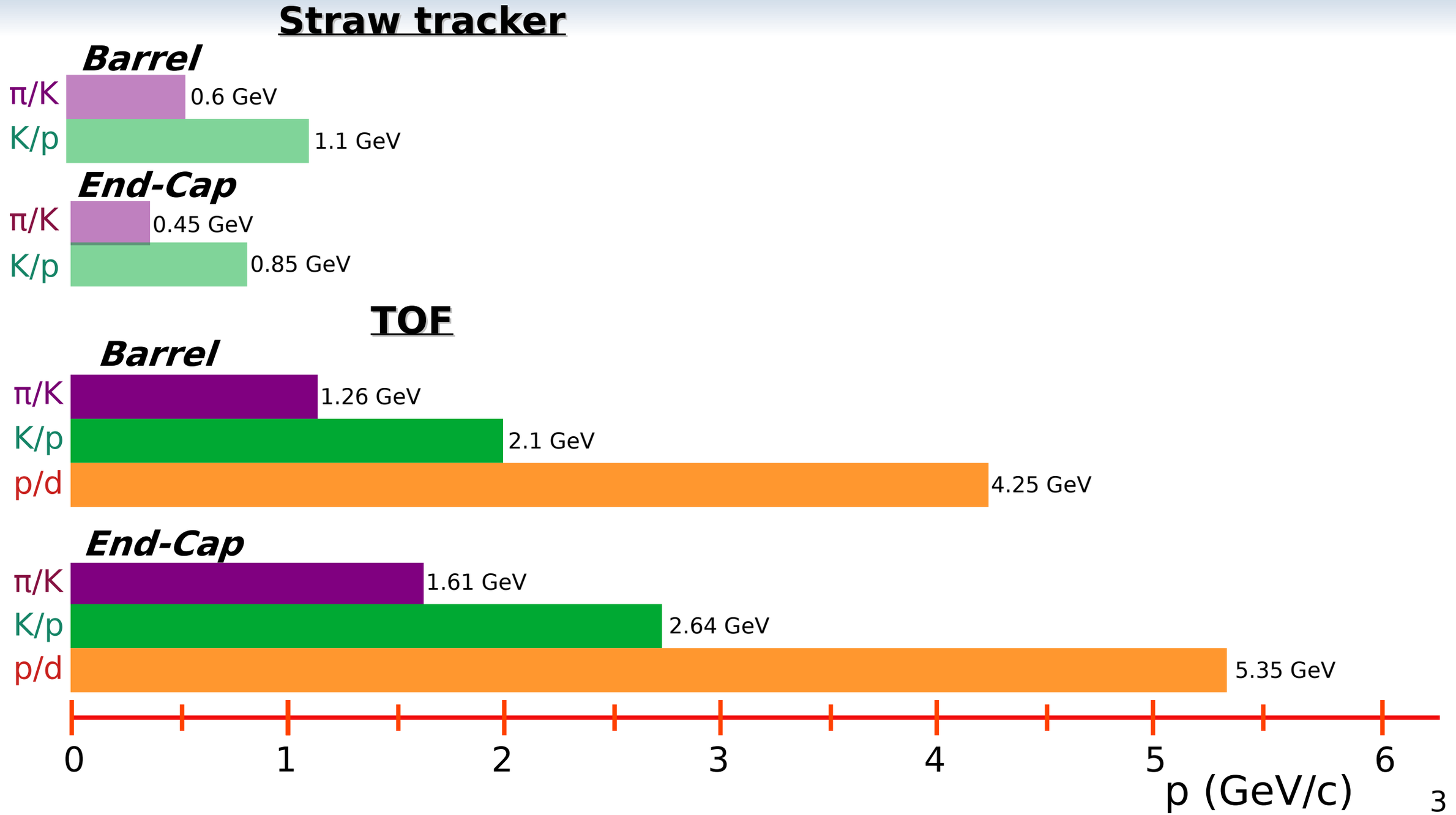
Artem Ivanov
JINR, Dubna

SPD Collaboration Meeting
25.10.2023

Particle identifications in SPD



PID in SPD: past status



Outline

1) PID in new TOF geometry
2) FARICH
3) DIRC
4) Conclusion

Outline

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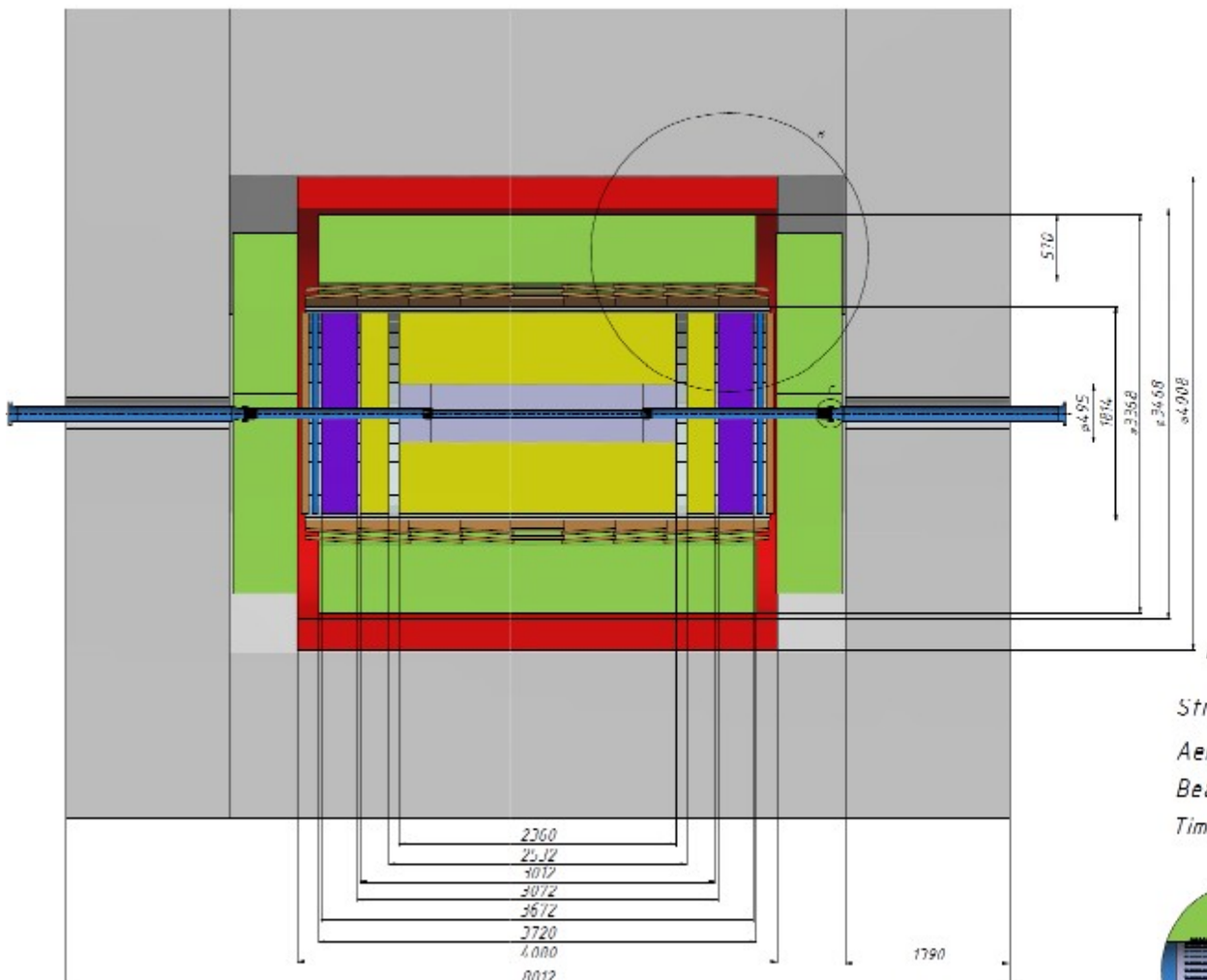
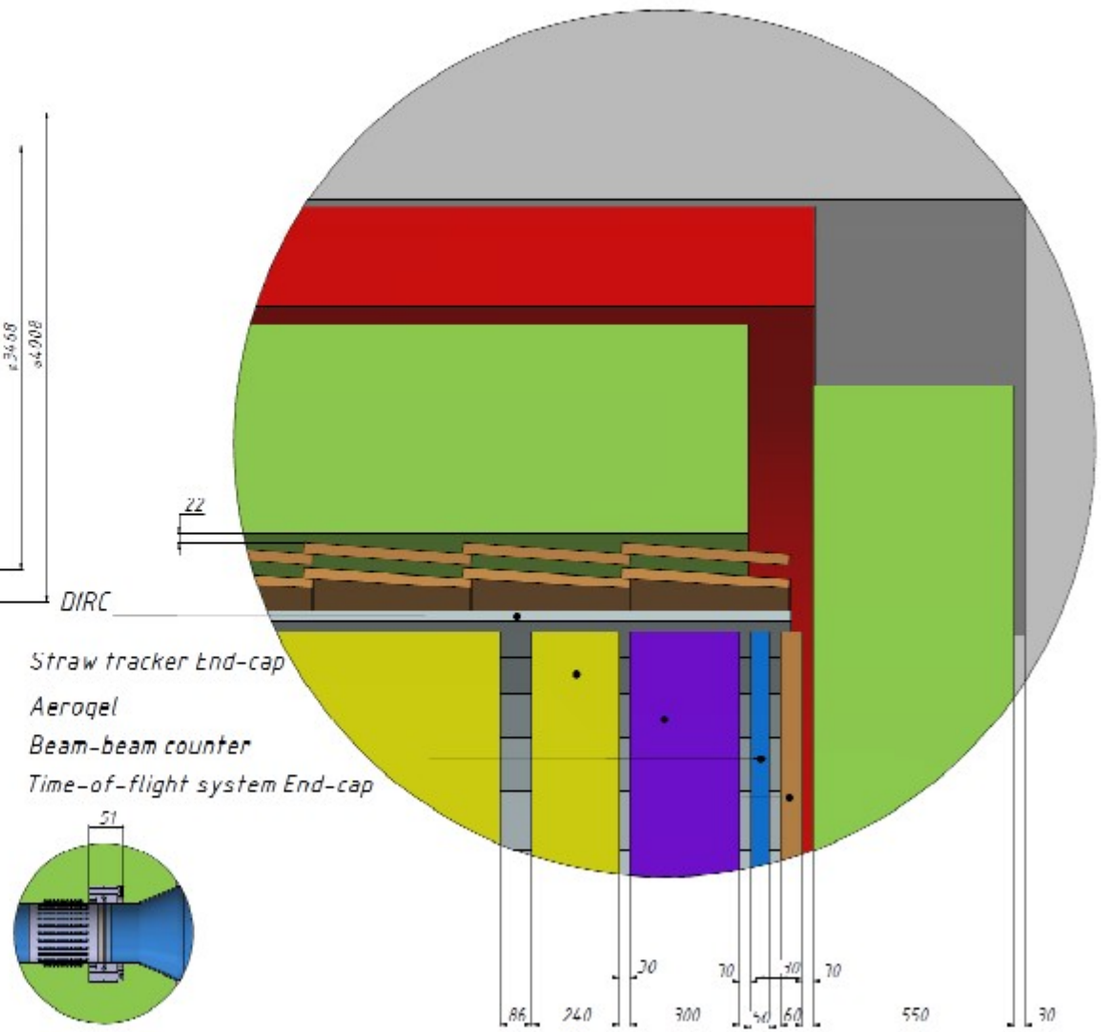
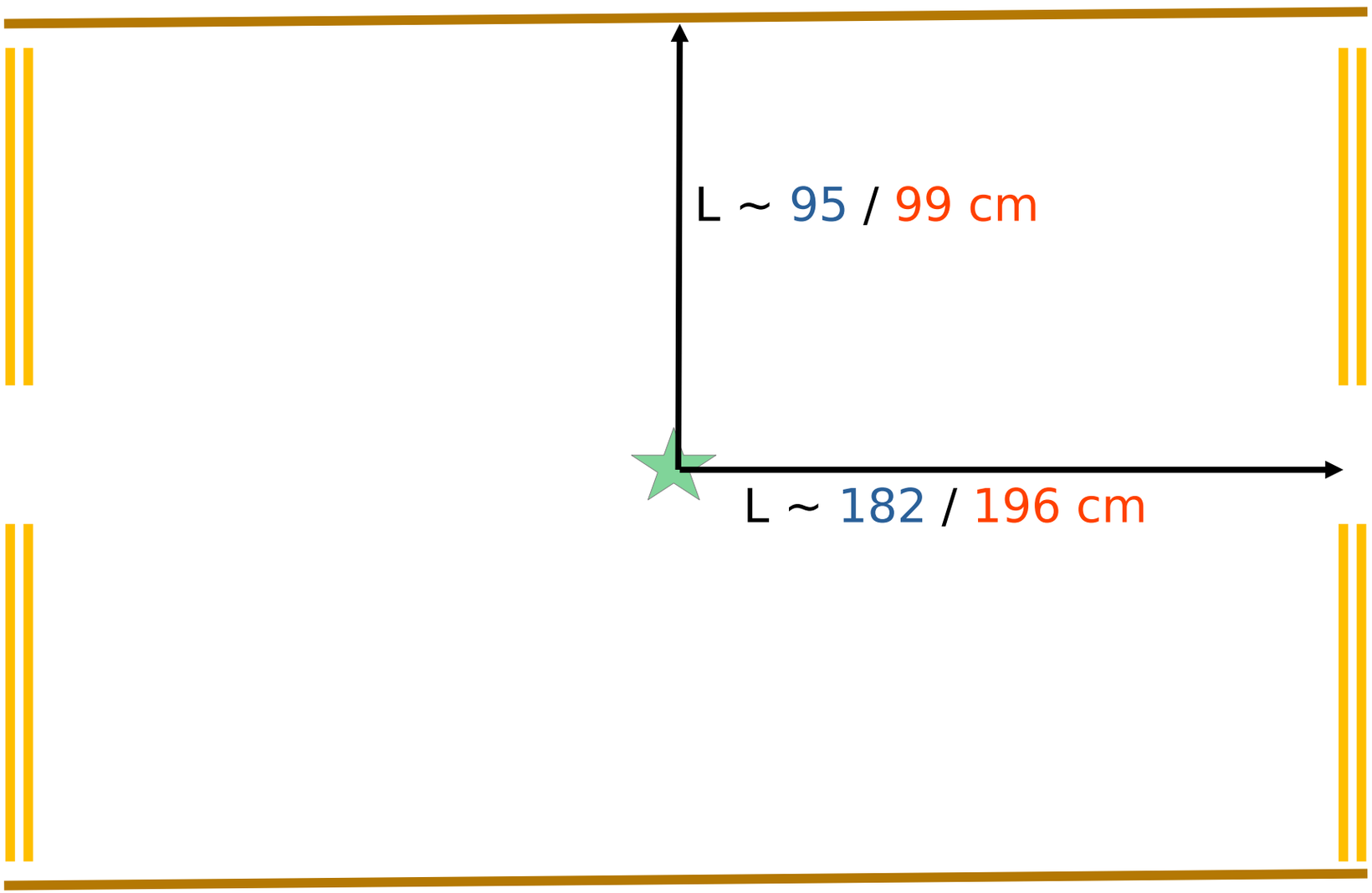
SPD geometry 2023



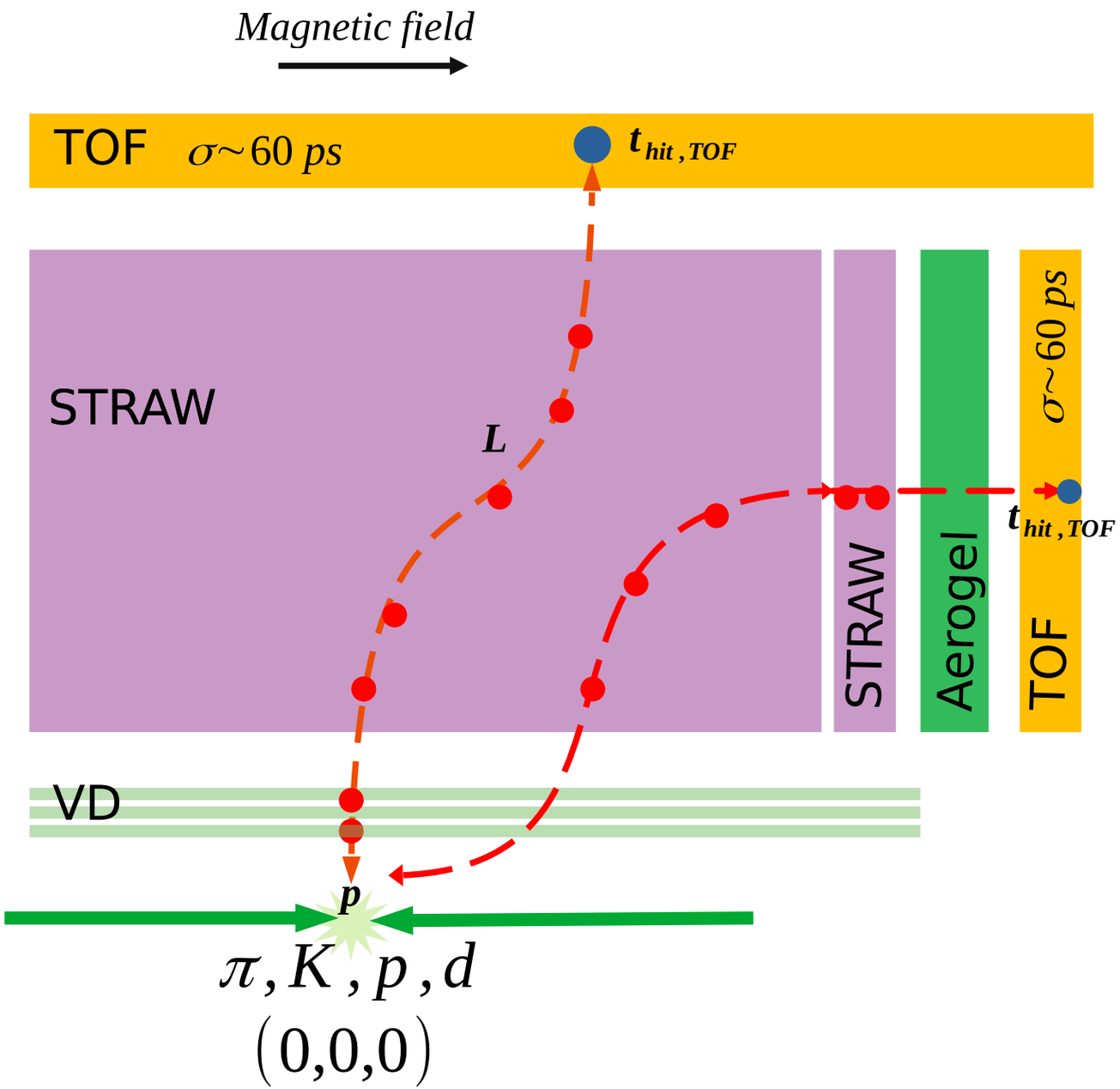


TOF geometry: changes

previous geometry
geometry 2023



TOF analysis



$$m^2 = \frac{p^2}{c^2}\left[\frac{t_{TOF}^2 c^2}{L^2} - 1\right]$$

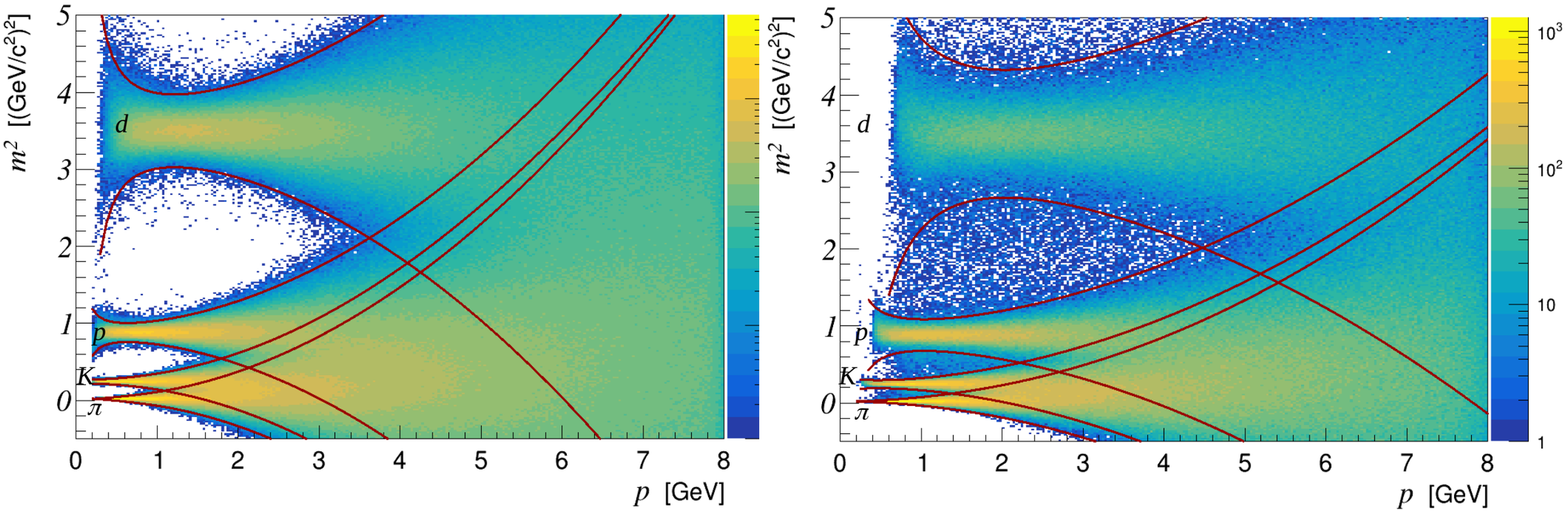
$$p \in [0.1; 8.0, step = 0.01\,GeV]$$

m^2 vs p

Barrel

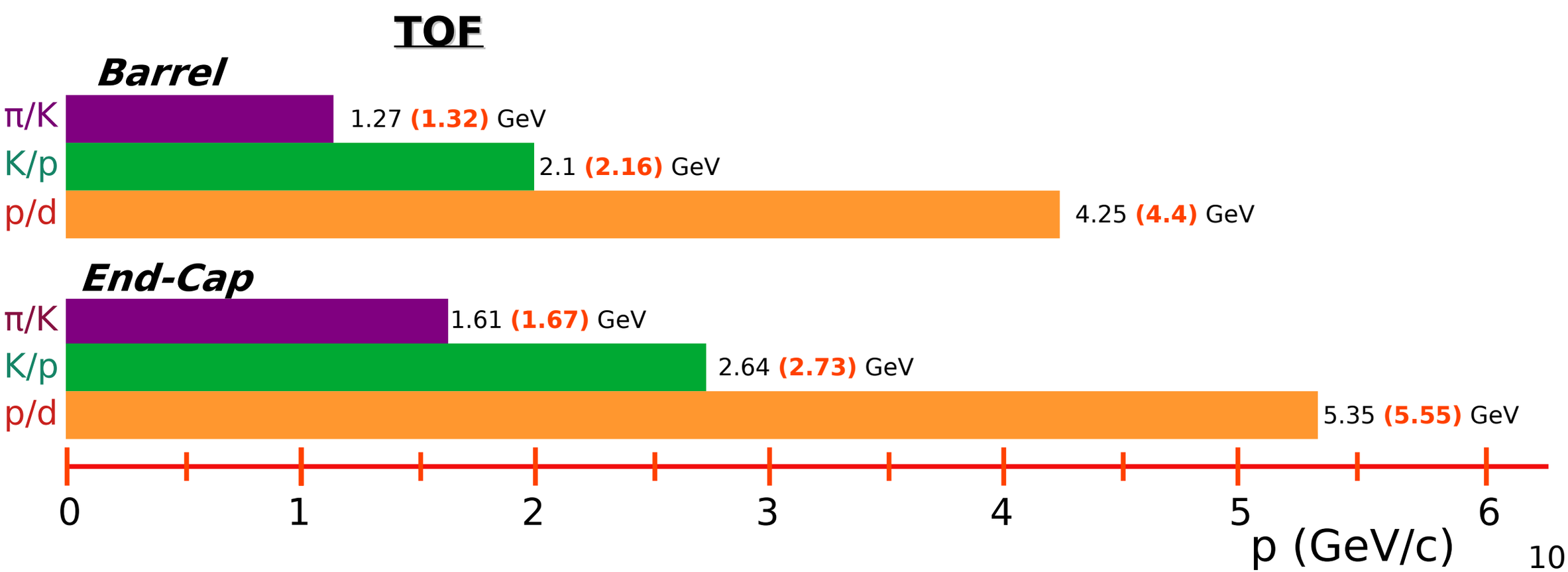
End-Cap

curves with $3\,\sigma$



PID in SPD: changes

Old geometry/New geometry



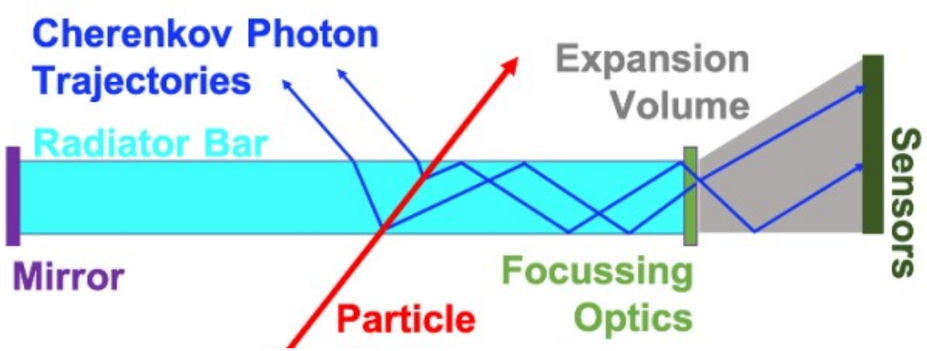
Outline

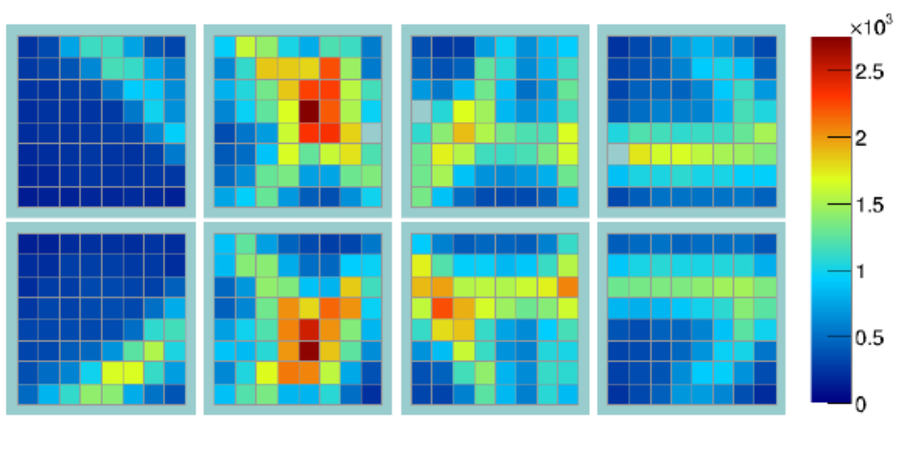
1) PID in new TOF geometry
2) DIRC
3) FARICH
4) Conclusion

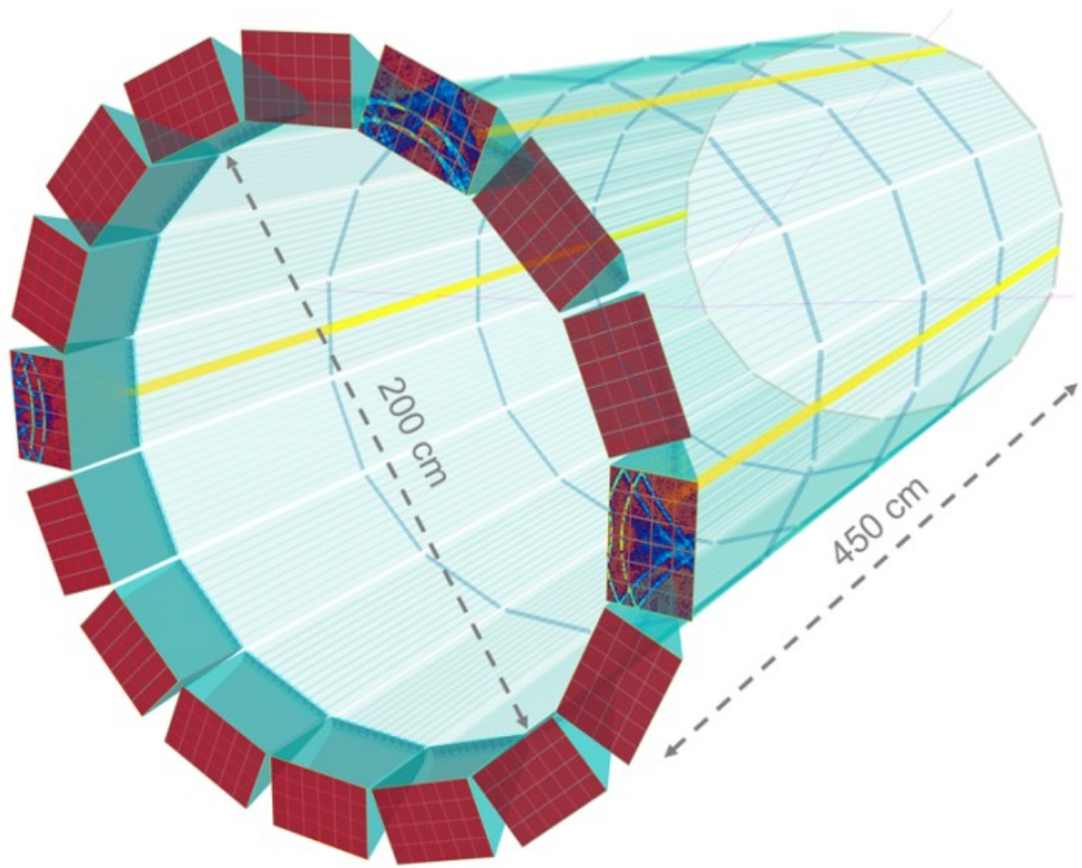
DIRC - Detection of Internally Reflected Cherenkov Light

Separate kaons and pions with at least 3 standard deviations for momenta up to 3.5 GeV/c

The PANDA Barrel DIRC Detector at FAIR







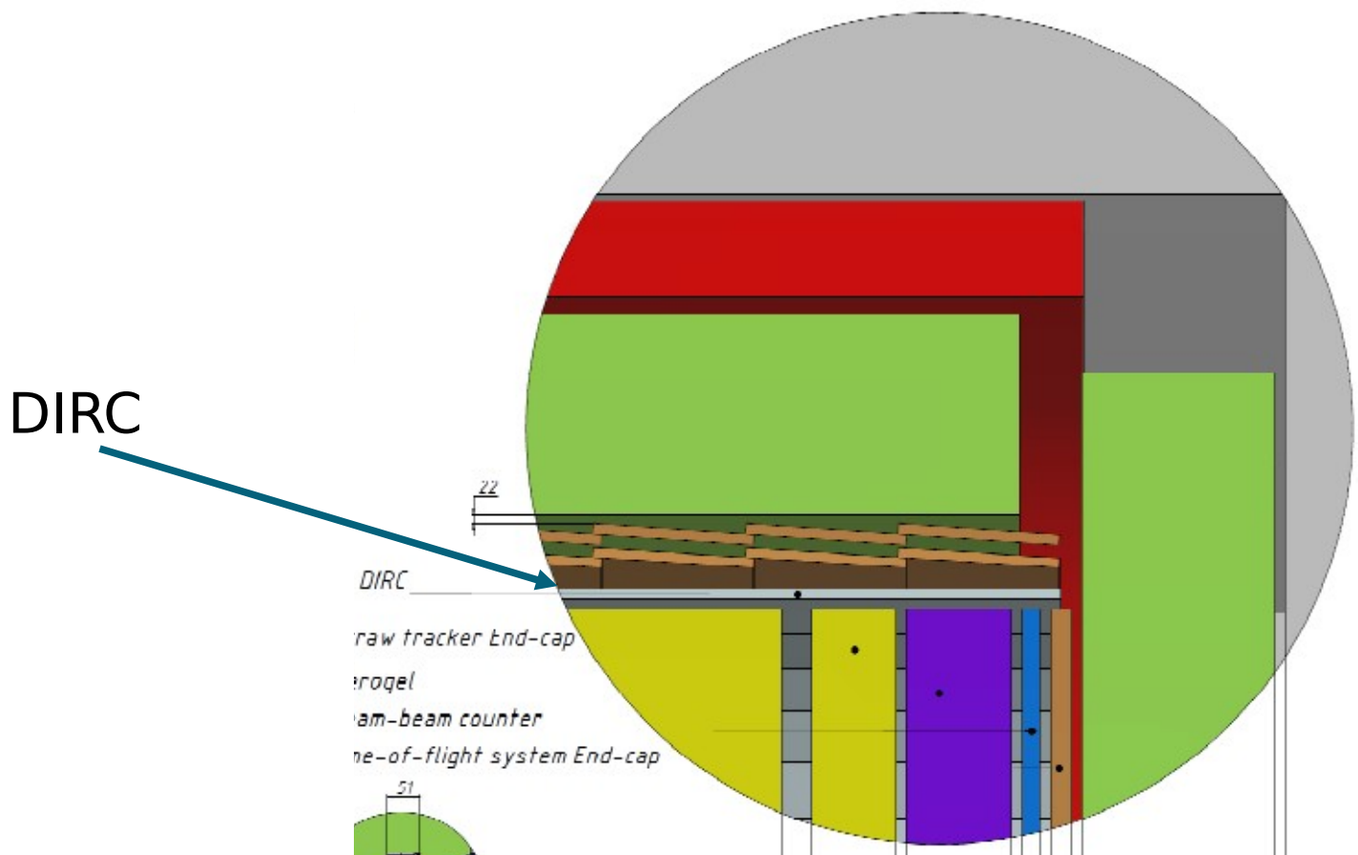
DIRC in SpdRoot: geometry

Module size = 77 (T) x 15 (W) x 3400 (L) mm

Number of module: 32

R: 907 mm

Location: between STRAW and TOF



DIRC in SpdRoot: material

Number of module: 32

Module size = 77 (T) x 15 (W) x 3400 (L) mm

Material: SiO_2 fused Silica (“Quartz”)

Atomic and nuclear properties of materials:

Silicon dioxide (fused quartz) (SiO_2)

Quantity	Value	Units	Value	Units
<Z/A>	0.49930			
Density	2.20	g cm^{-3}		
Minimum ionization	1.699	MeV $g^{-1}cm^2$	3.737	MeV cm^{-1}
Nuclear collision length	65.2	g cm^{-2}	29.64	cm
Nuclear interaction length	97.8	g cm^{-2}	44.47	cm
Pion collision length	91.9	g cm^{-2}	41.77	cm
Pion interaction length	128.8	g cm^{-2}	58.56	cm
Radiation length	27.05	g cm^{-2}	12.29	cm

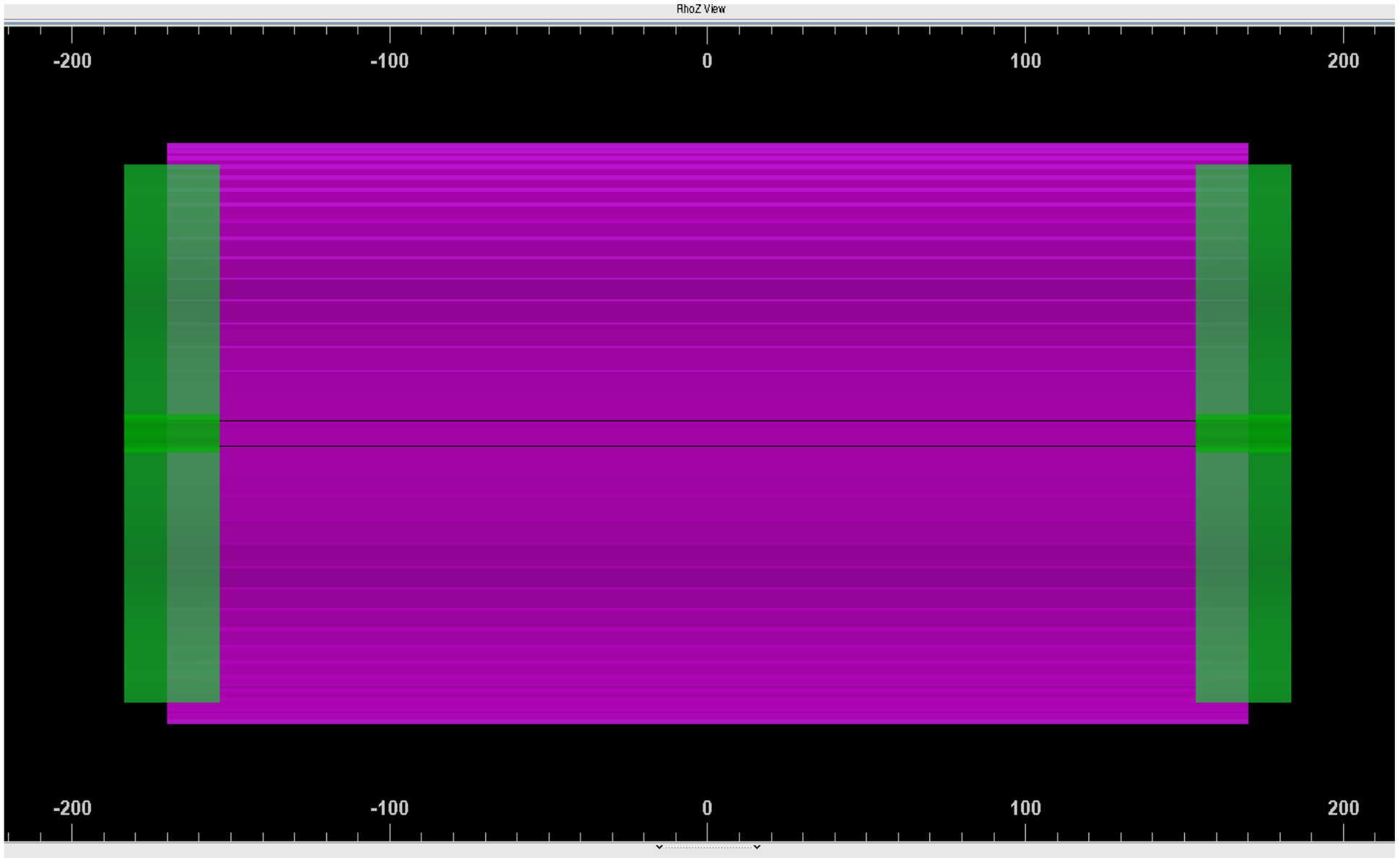
```
// fused material
TGeoElement *elSi = new TGeoElement("Silicon", "Si", 14., 28.09);
TGeoElement *elO = new TGeoElement("Oxygen", "O", 8., 16.00);

Double_t density = 2.200; // fused quartz
TGeoMixture *fusedsilica = new TGeoMixture("Quartz", 2, density);
fusedsilica->AddElement(elSi, 1);
fusedsilica->AddElement(elO, 2);
    Artem Ivanov, 4 months ago • implementation of DIRC detector
TGeoMedium *medfusedsilica = new TGeoMedium("medfusedsilica", 0, fusedsilica);
```

DIRC in SpdRoot: length

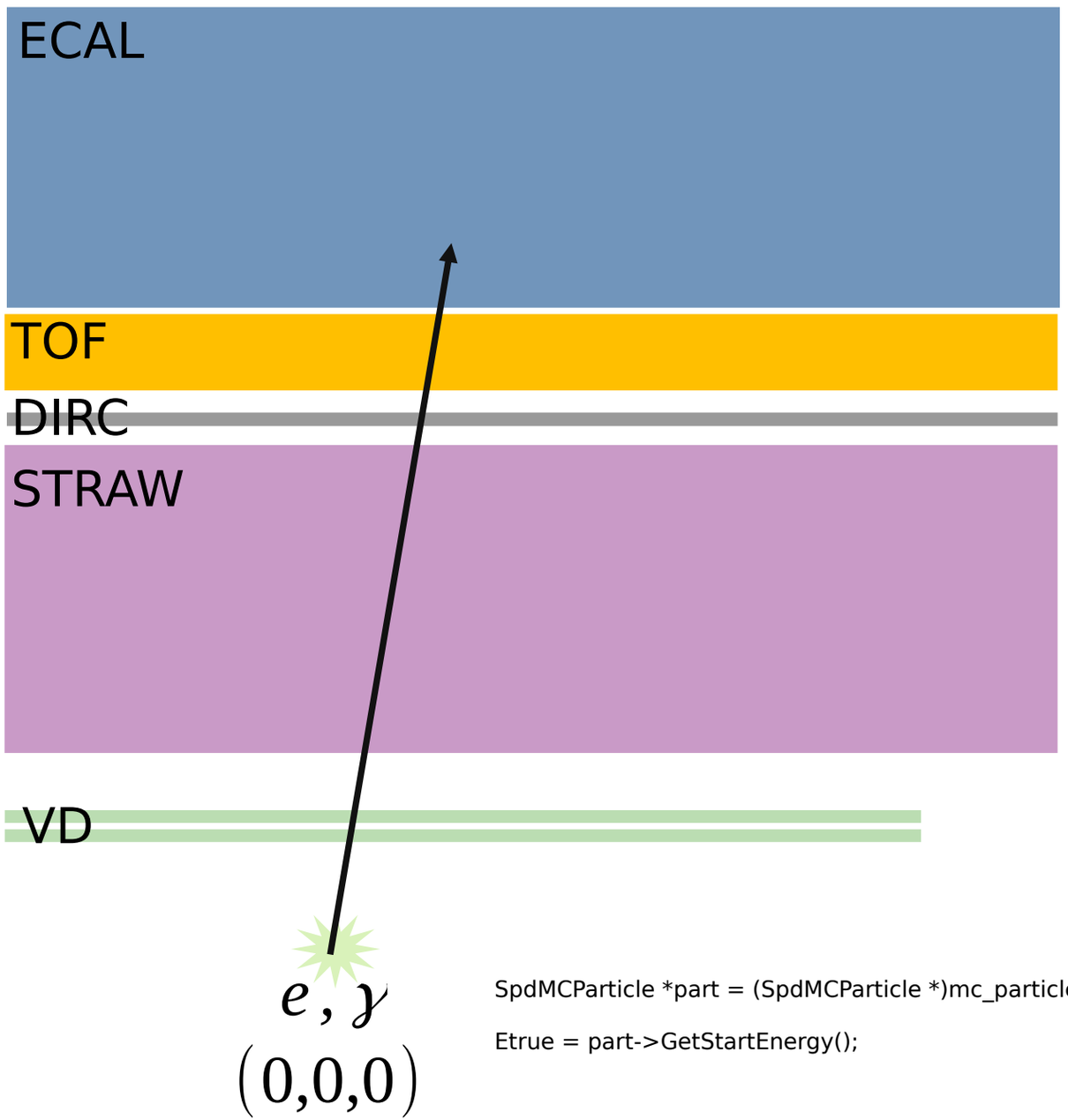
FARICH

DIRC



Study

In Barrel




```
SpdEcalRCParticle *part = (SpdEcalRCParticle *)EcalParticlesRC_→EcalParticlesRC_→At(ip);
Ereco = part->GetEnergy();
```

Generated two samples:

1) with DIRC
2) without DIRC

TOTAL NUMBER OF RAD.L.

L = 110 cm, 85 degree

With DIRC = 0.28

Without DIRC = 0.16

```
SpdMCParticle *part = (SpdMCParticle *)mc_particles->At(it);
Etrue = part->GetStartEnergy();
```

$$\Theta \in [40-160] \ \ degree$$

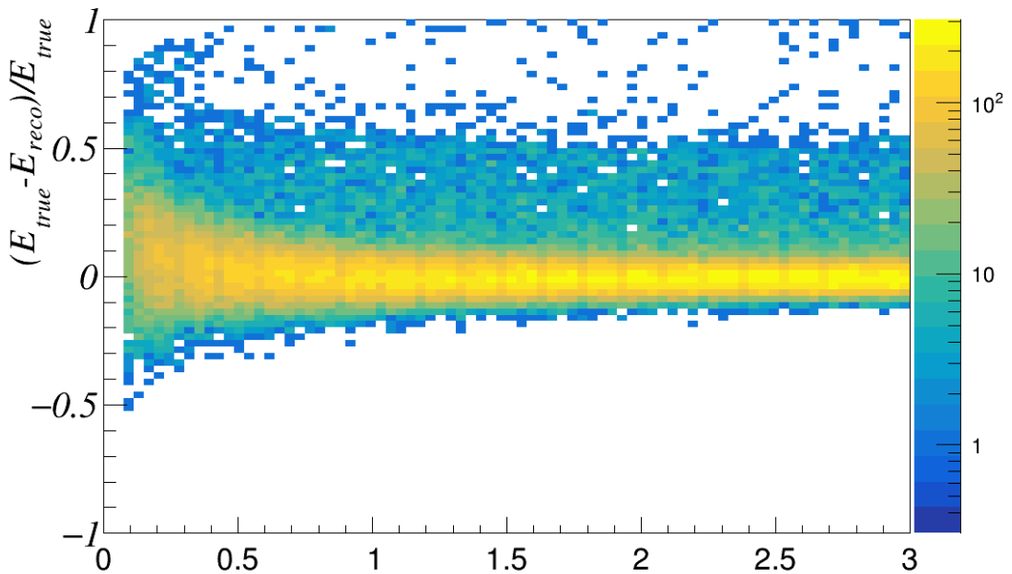
$$E \in [0.1; 3.0, step = 0.01\,GeV]$$

$(E_{true} - E_{reco})/E_{true}$

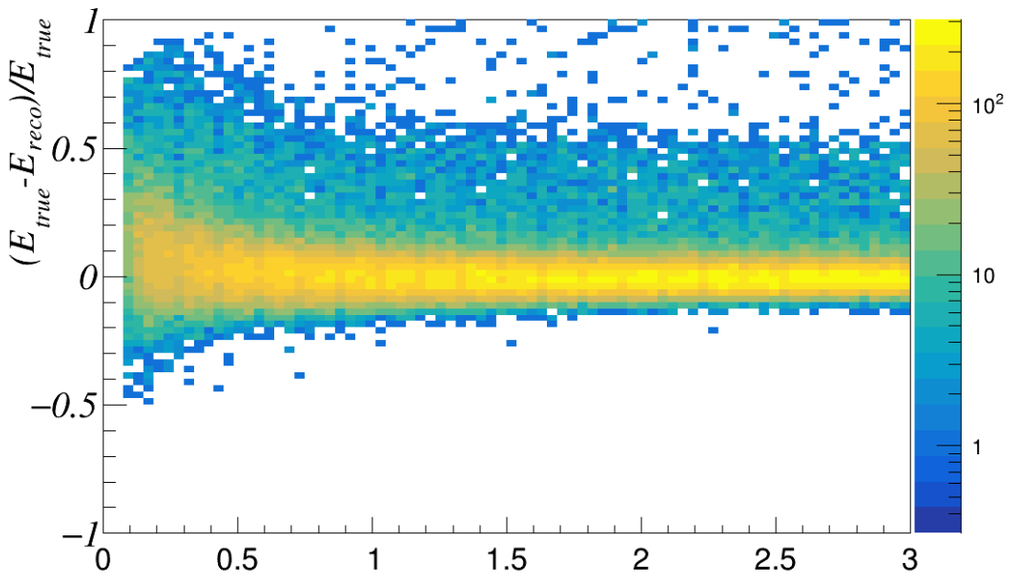
In Barrel

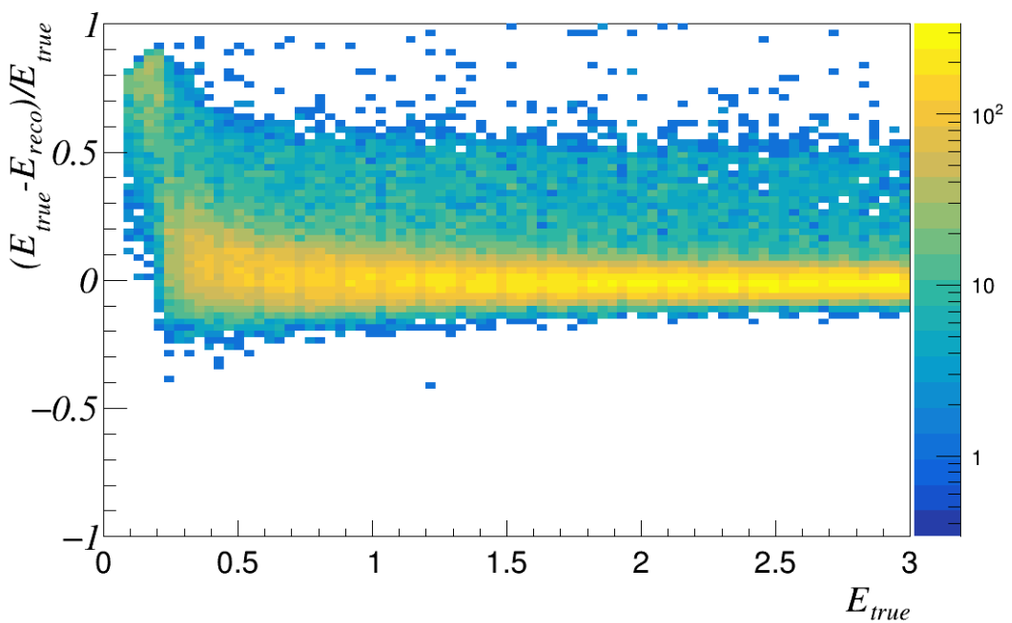
Without DIRC

With DIRC

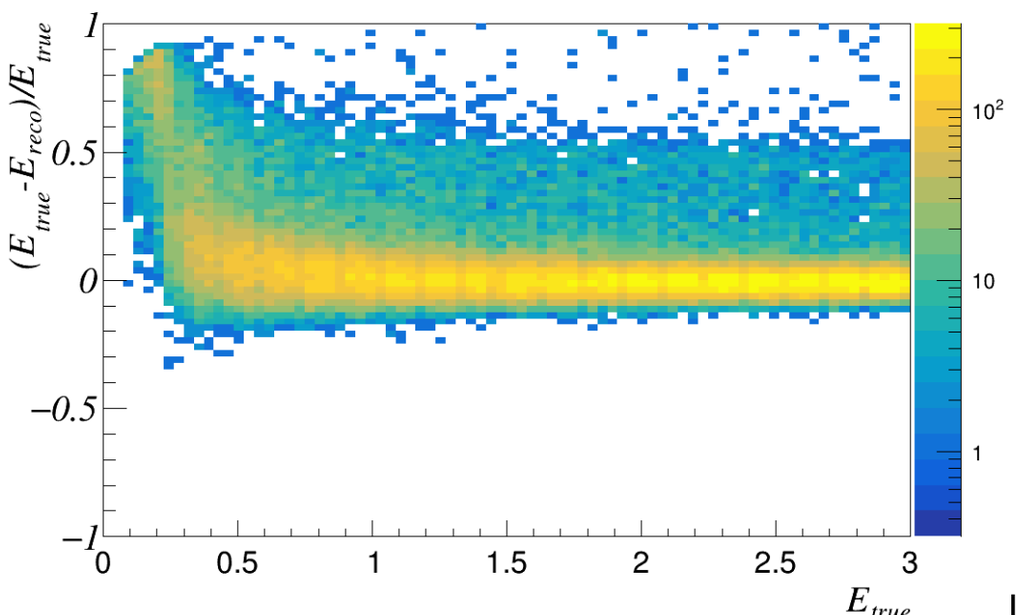


gamma





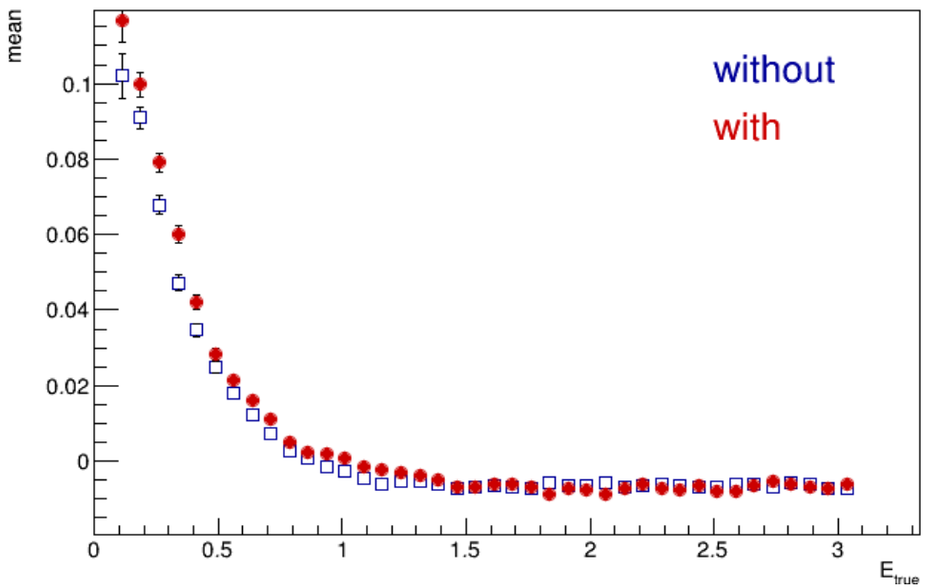
electron



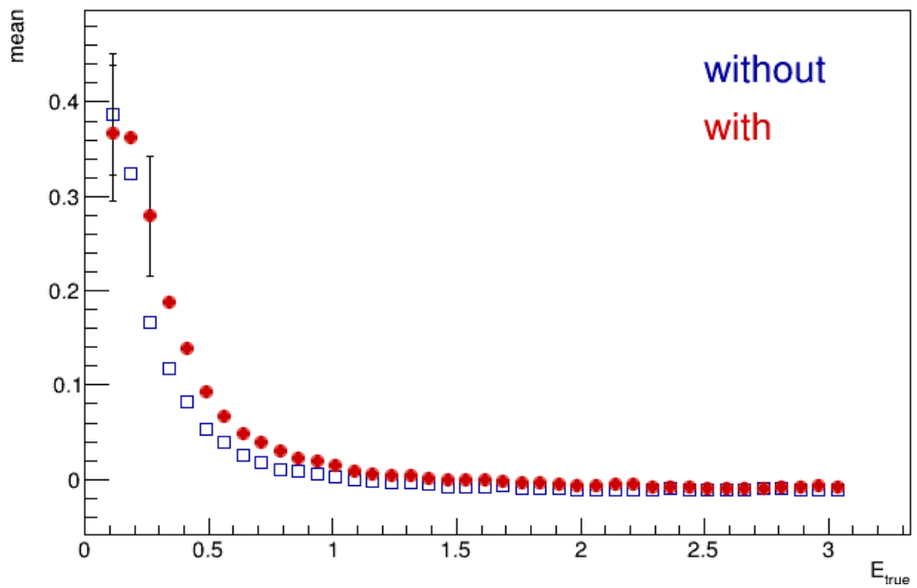
Mean and Sigma

In Barrel

photon

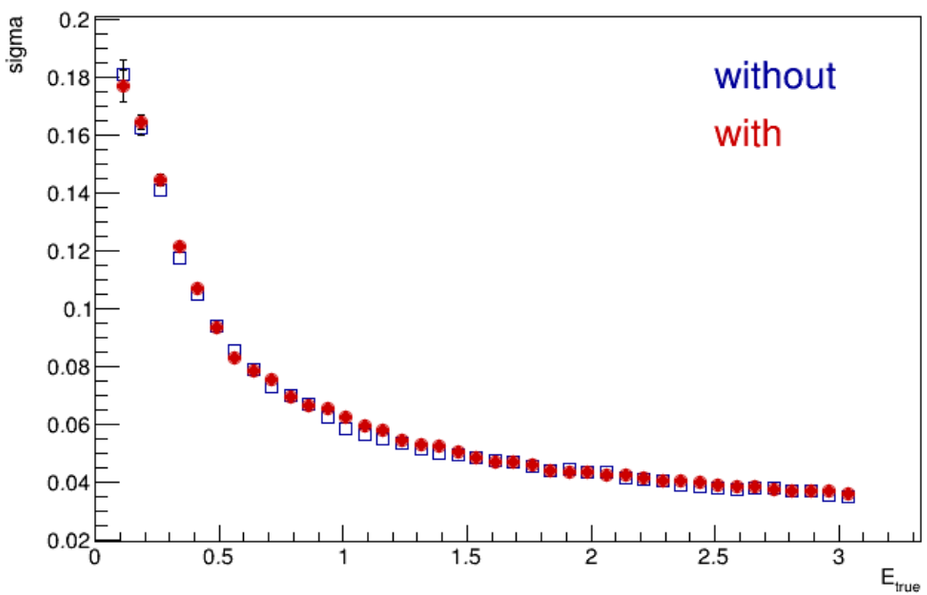


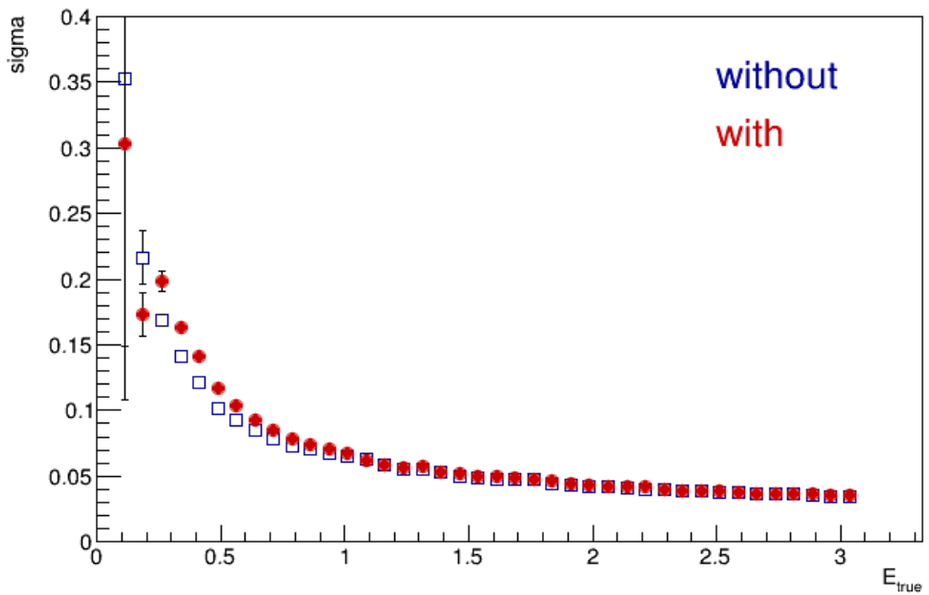
electron



mean

sigma



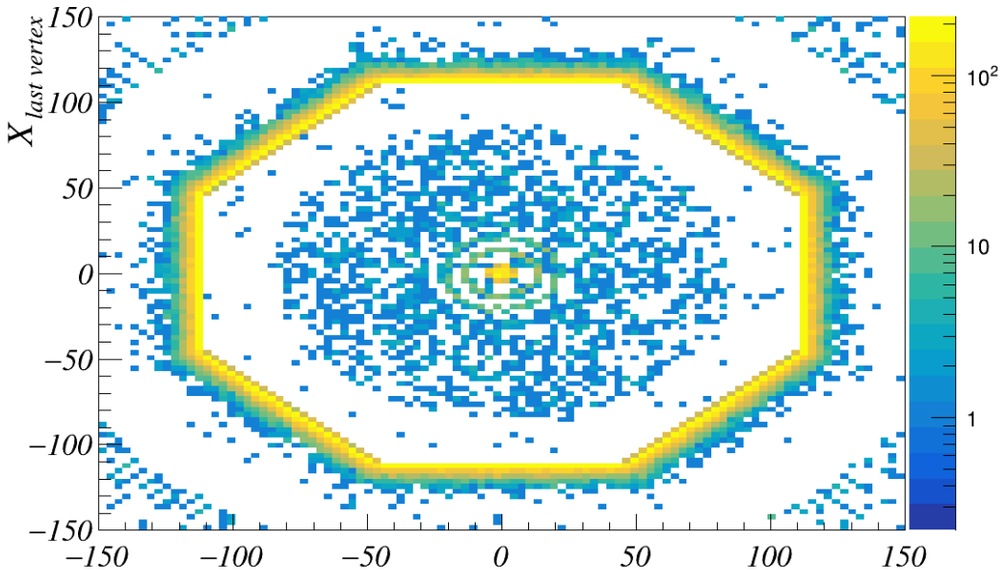


$X_{\text{last vertex}}$ vs $Y_{\text{last vertex}}$

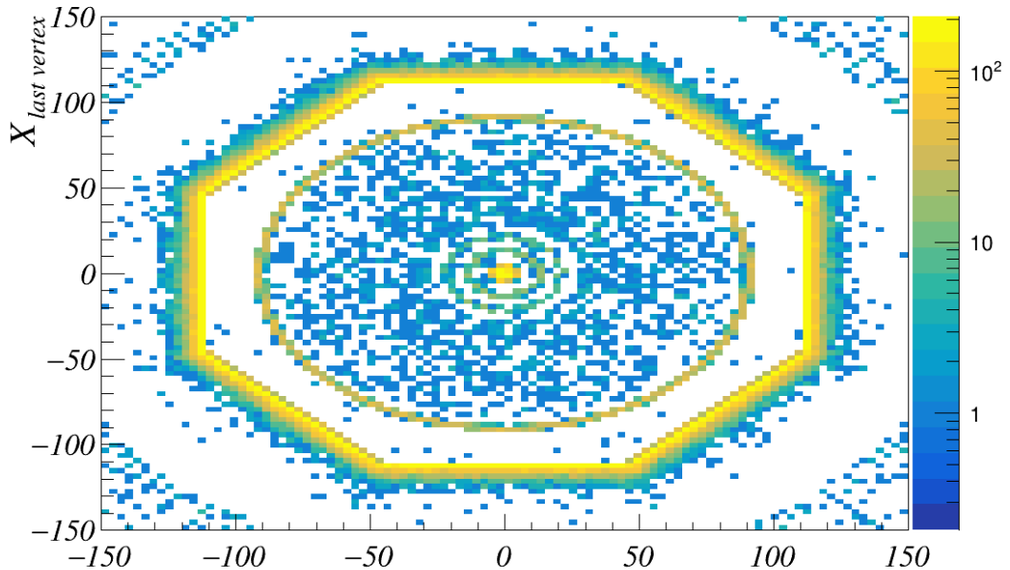
In Barrel

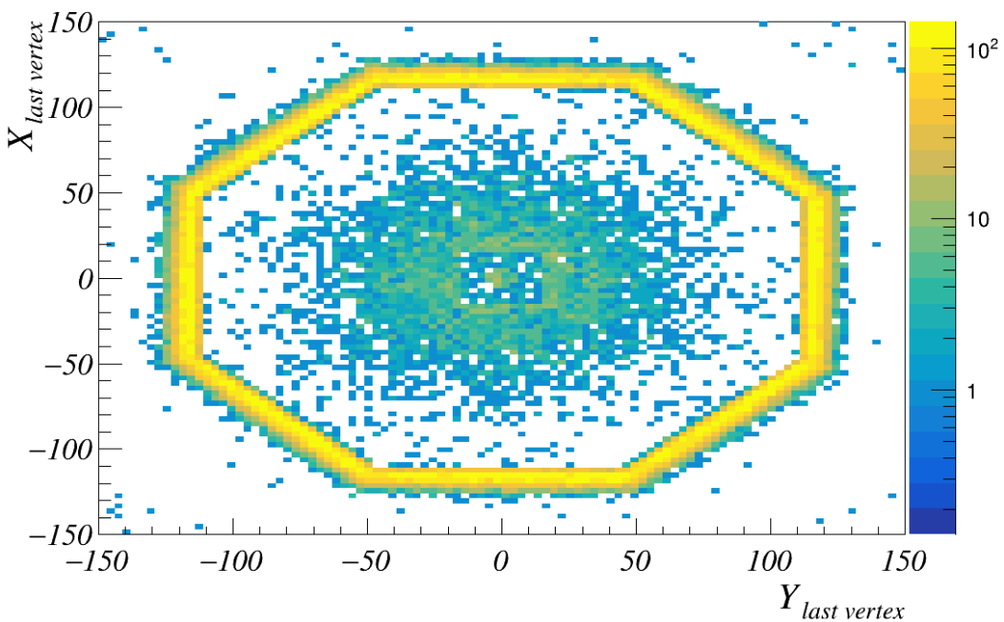
Without DIRC

With DIRC

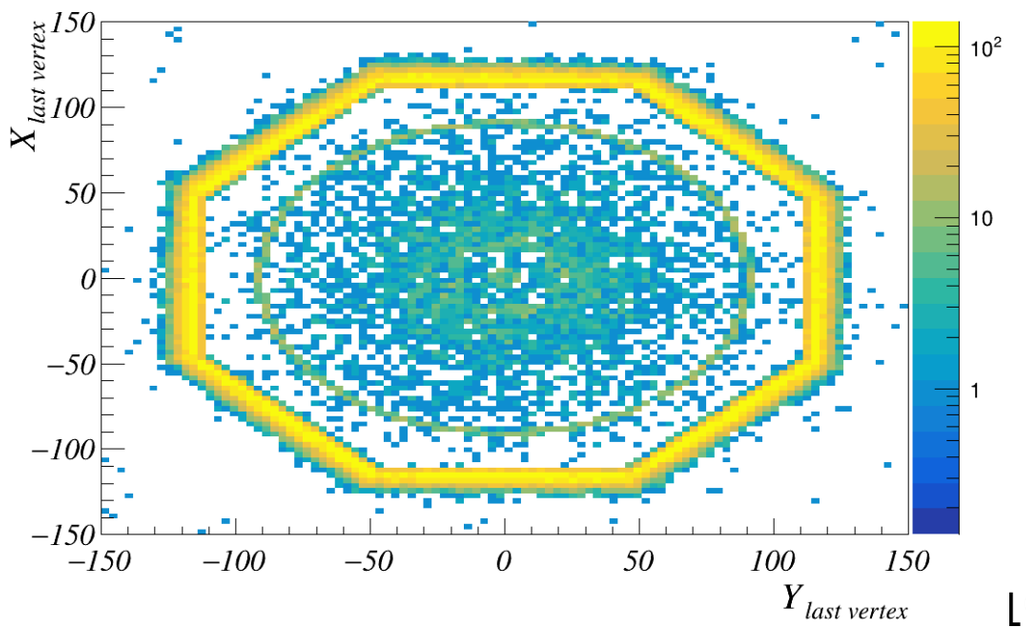


photon





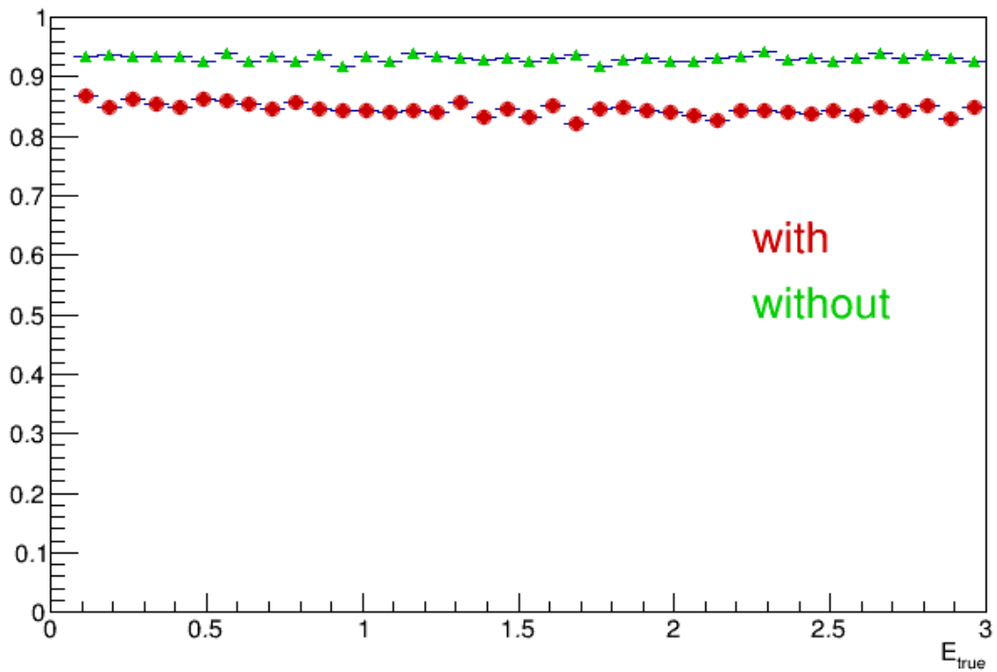
electron



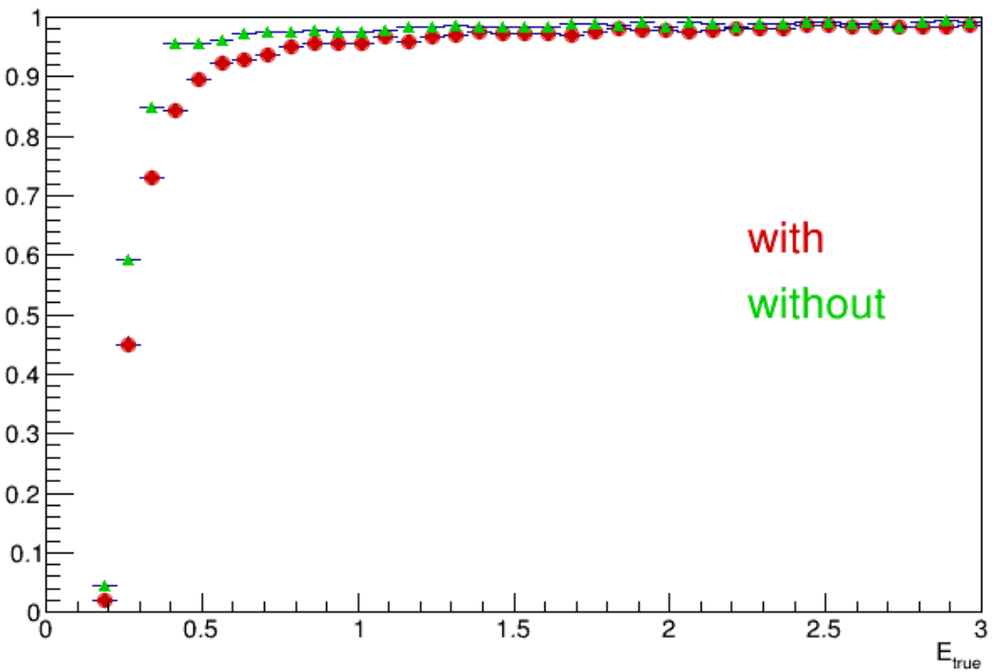
Efficiency

$$Eff = \frac{N_{\text{Last vertex in barrel}}}{N_{\text{total}}}$$

photon



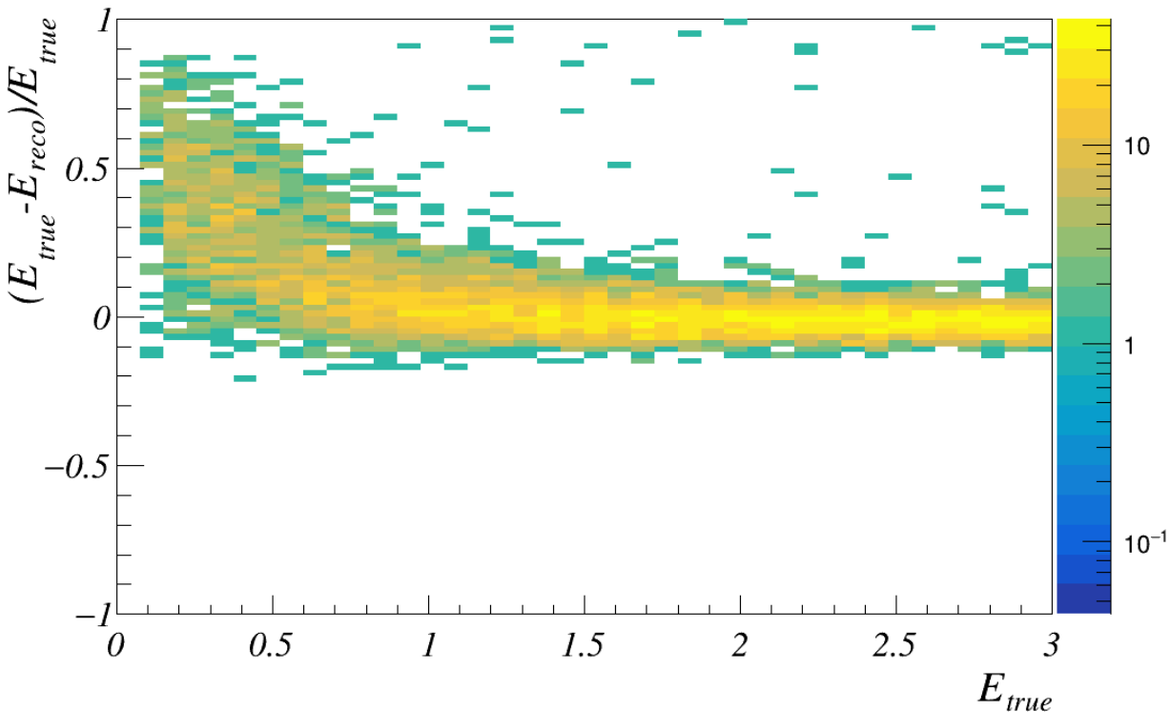
electron



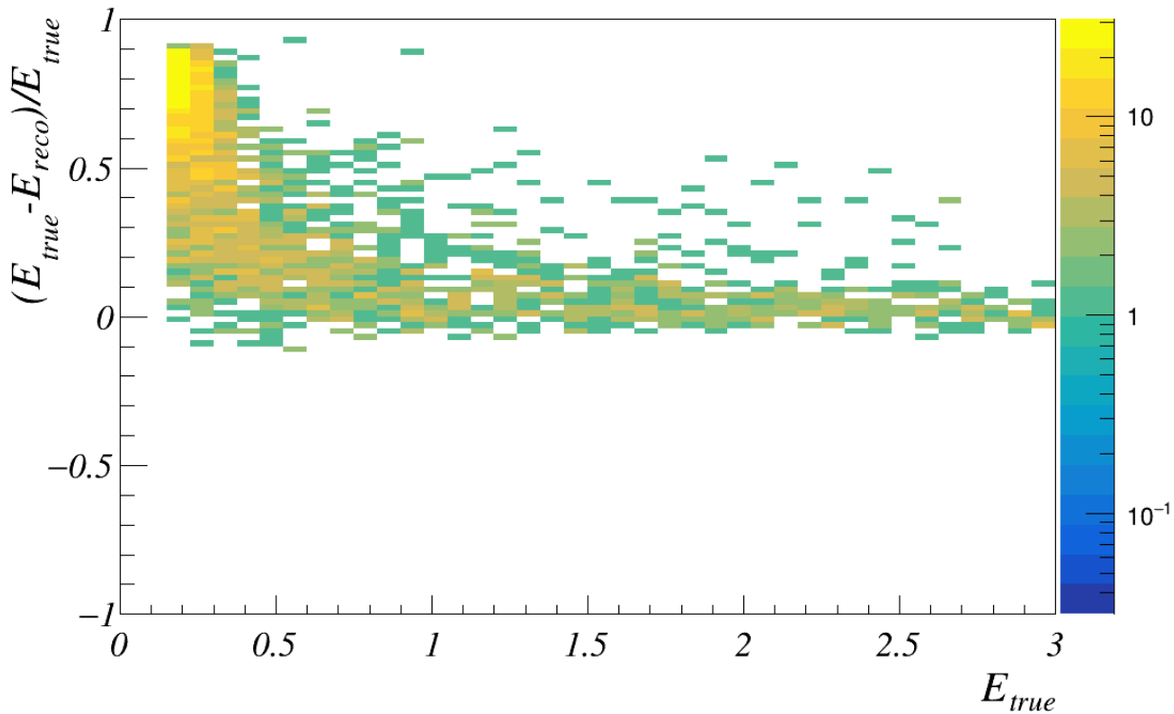
96% → 86%

$(E_{true} - E_{reco})/E_{true}$

photon



electron



$R_{\text{last vertex}}$ in [89 - 92]

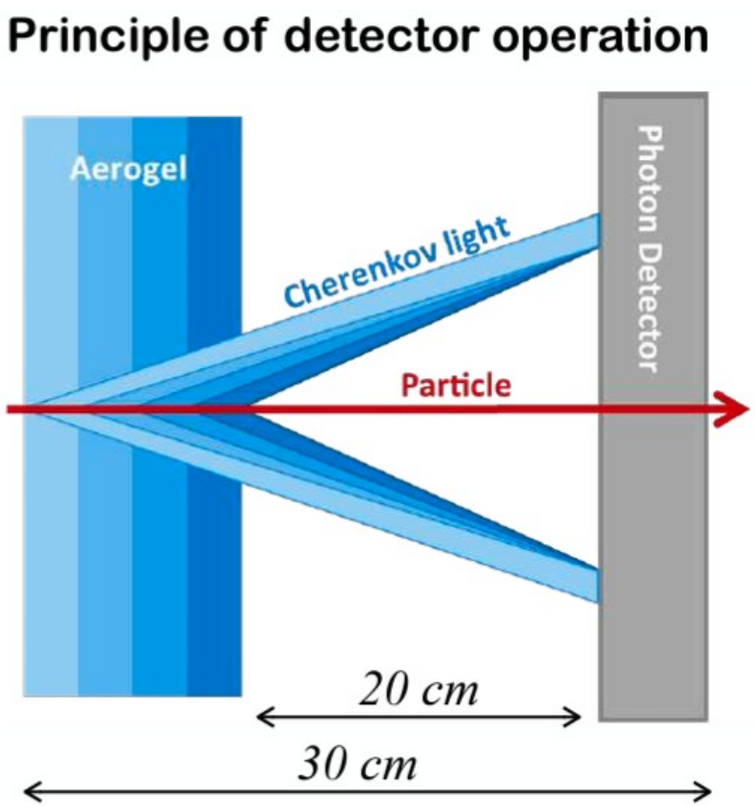
Outline

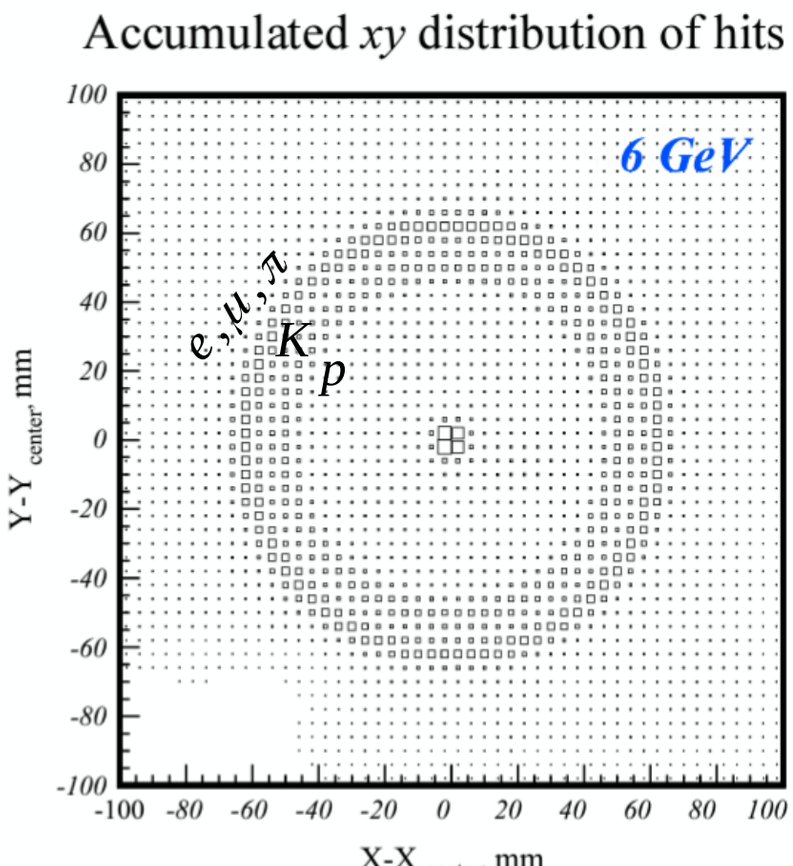
1) PID in new TOF geometry
2) DIRC
3) FARICH
4) Conclusion

Focusing Aerogel RICH (FARICH) detector

Purpose: identification of high momentum particles (p≳1.5 GeV)

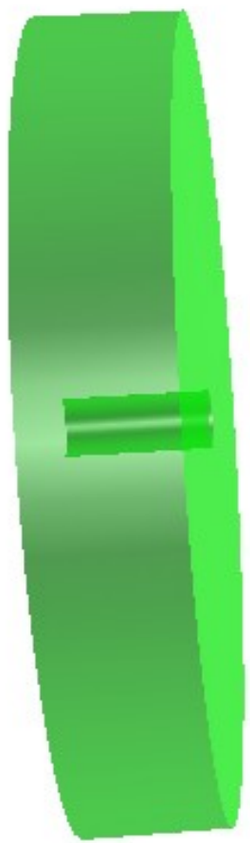
Requirement: π/K separation at 6 GeV/c up to 3.5σ

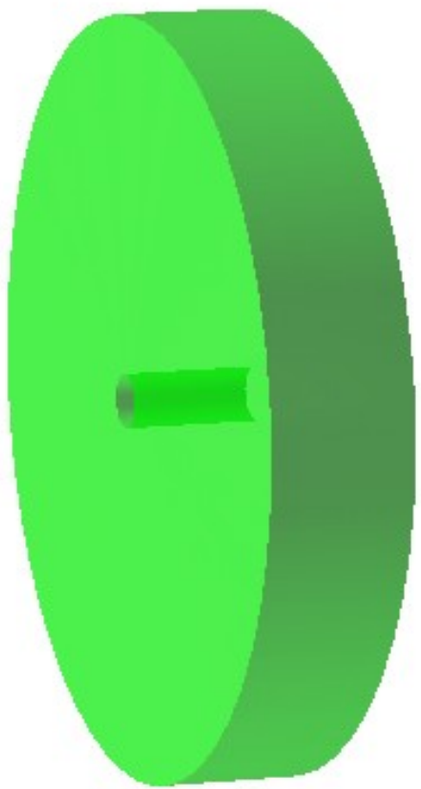




FARICH in SpdRoot

Current situation





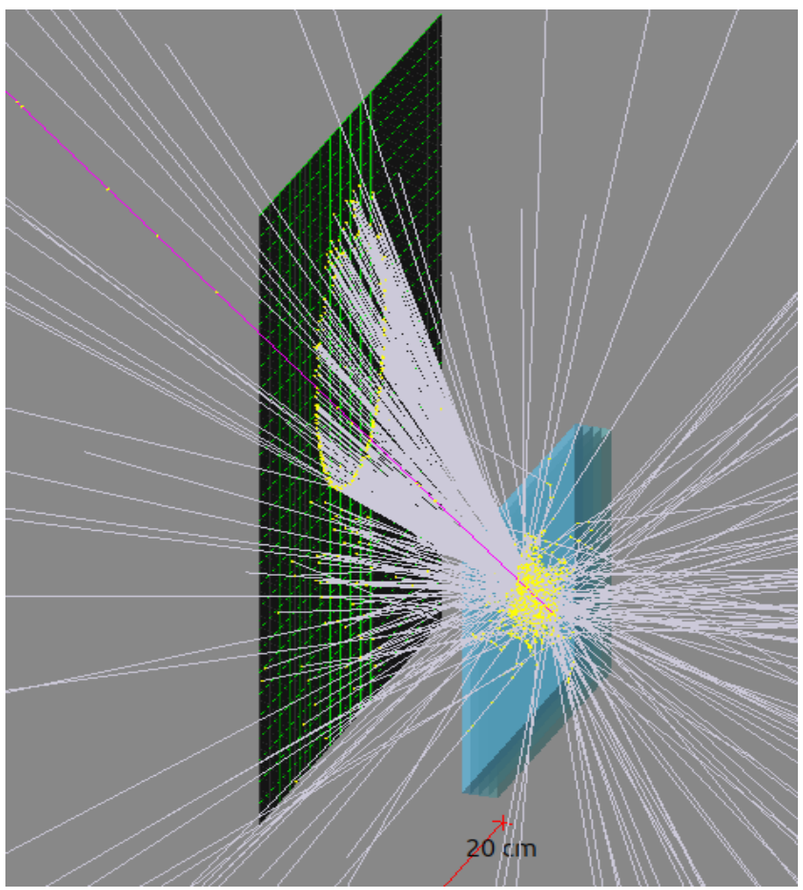
FARICH in SpdRoot: plan

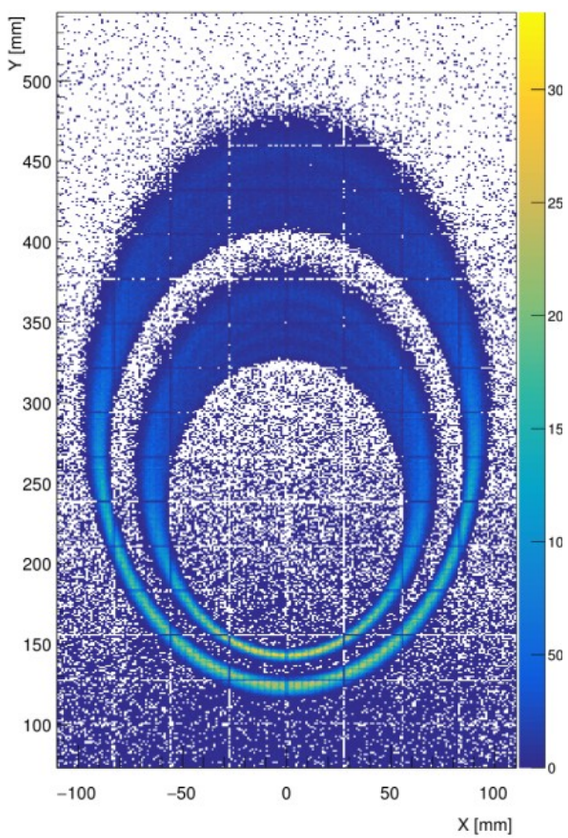
- **Implement to SpdRoot**

The first meeting with the Novosibirsk team took place on 26/09/2023

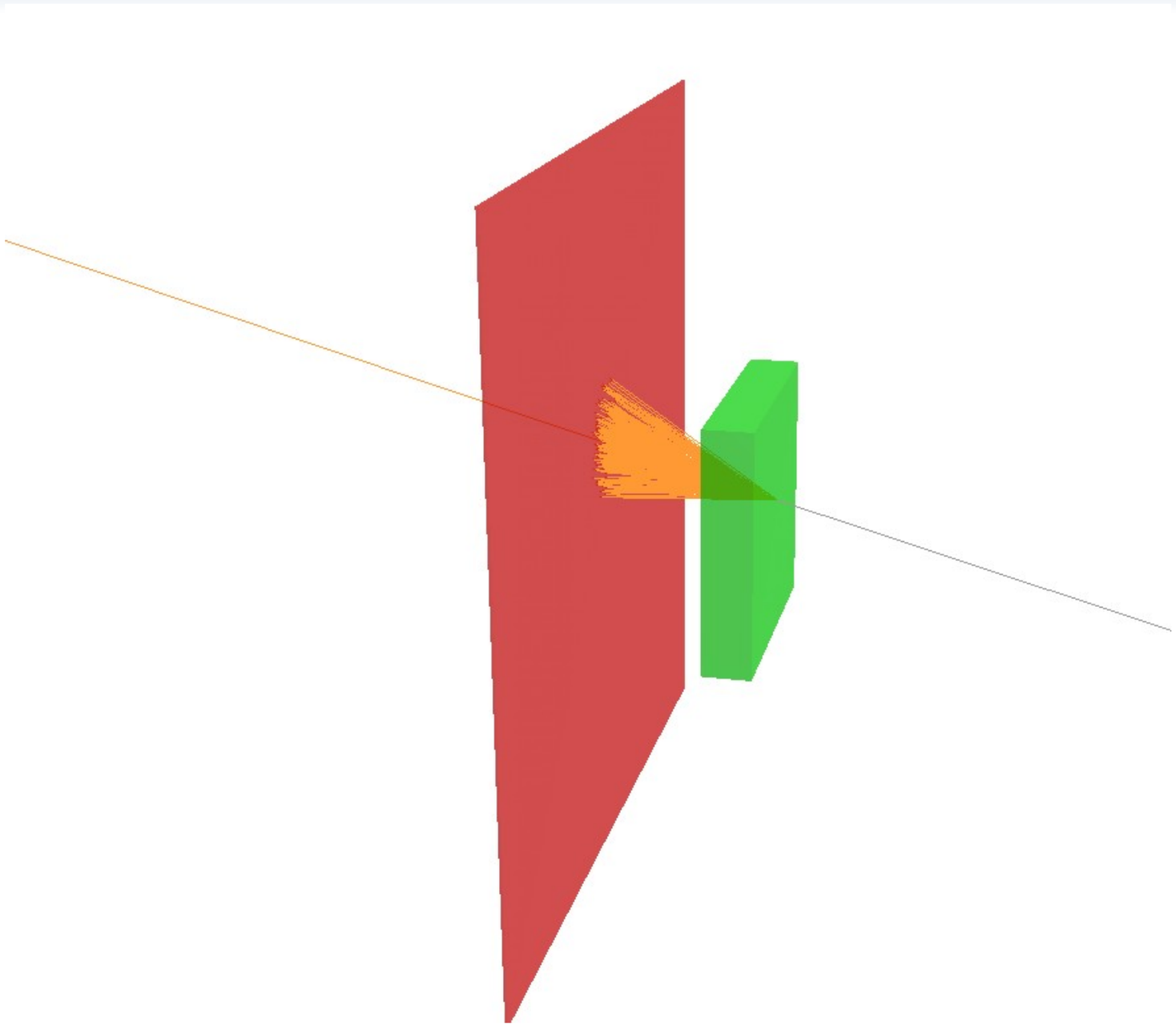
Based on stand-alone GEANT4 based simulation program from team Budker Institute of Nuclear Physics, Novosibirsk

Thanks to *A.Yu. Barnyakova, V.S. Bobrovnikov*





FARICH in SpdRoot: first steps



Conclusion

TOF

- TOF PID parametrizations for geometry 2023 is updated.

DIRC

- The influence of the DIRC detector material on particle reconstruction in ECAL was examined. 10% of photons stop in DIRC. But for them DIRC works as a preshower

FARICH

- Work on implementation FARICH in SpdRoot is started. Stand-alone GEANT4 based simulation program from Novosibirsk team is taken as the starting point.