Deriving the effective focal plane for the CBM-RICH detector*

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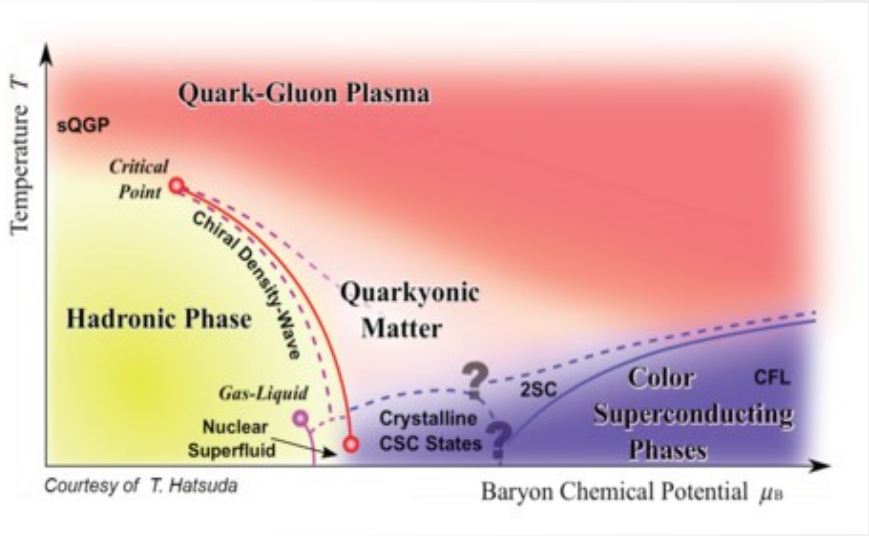
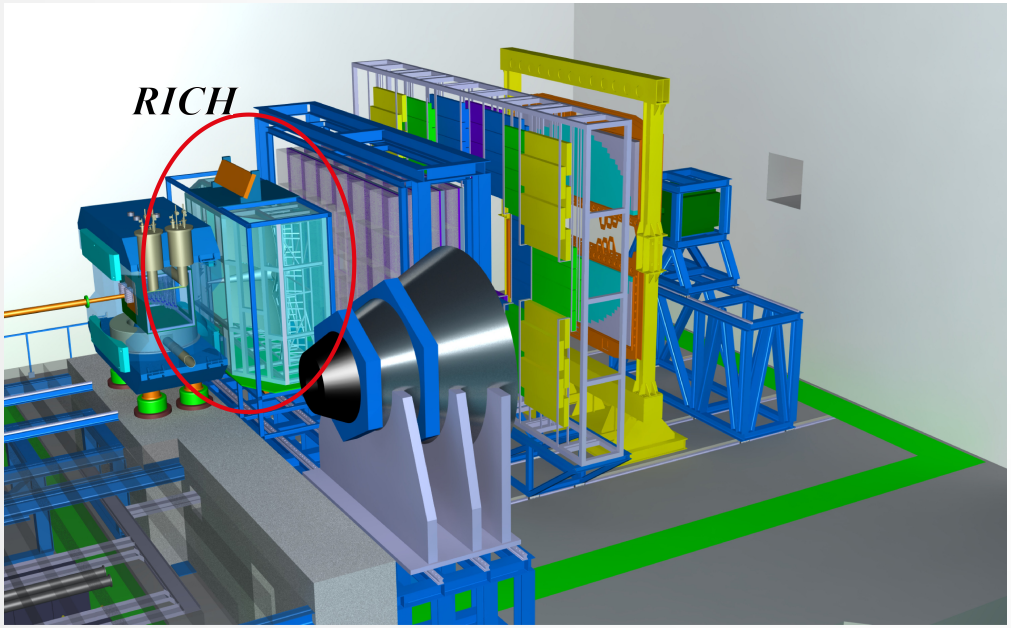
Compressed Baryonic Matter(CBM) experiment at FAIR

At top RHIC and LHC energies, QCD matter is studied at very high temperatures and very low net-baryon densities. For larger net-baryon densities and lower temperatures, it is expected that the QCD phase diagram exhibits:

- a rich structure such as a critical point;
- the predicted first order phase transition between hadronic and partonic matter;
- new phases like quarkyonic matter.





CBM will play a unique role in the exploration of the QCD phase diagram. It is designed for precision measurements of multidimensional observables including particles with very low production cross sections(like short-lived ρ).

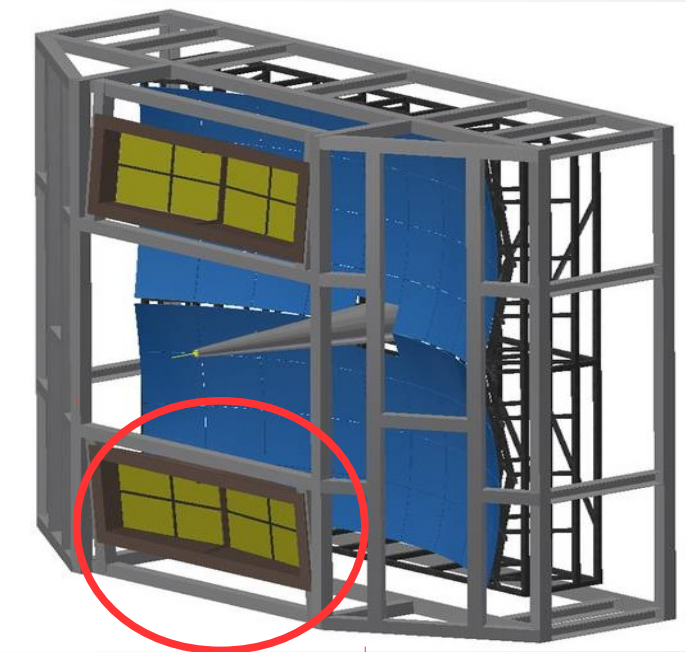
As leptons are not affected by final-state interactions, the di-leptonic decay offers the possibility to look into the fireball.

CBM-RICH detector

The RICH detector is designed to provide identification of electrons and pions.

CBM-RICH foresees three main parts: CO2 gaseous radiator, focusing mirror system and photon detector system.

- Detector will be positioned after magnet.
- The gas radiator is 1.7m long.
- The mirror plane is split horizontally into two spherical mirrors (4m x 1.5m), curvature 3m.
- Ring Cherenkov radiation will be projected onto four photon detector planes (1m x 0.6m)



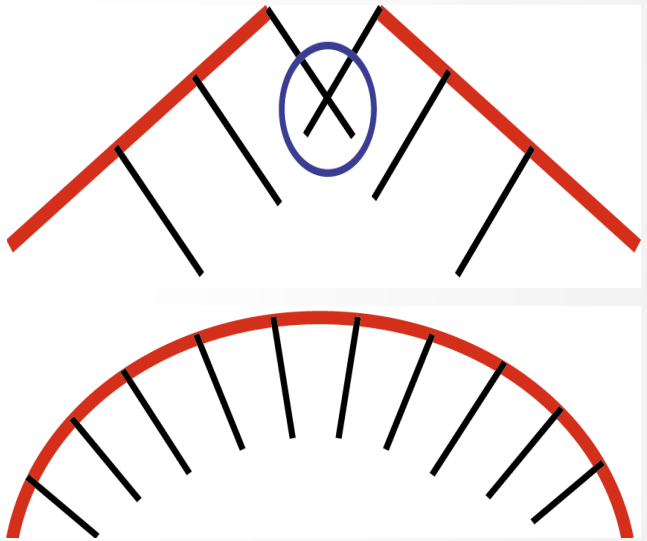
wing shape

Motivation

- Find ideal 3 dimension shape for PMT plane.
- Wing shape is only the approximation to ideal shape.
- First step → find focal plane

→ Technically spherical/cylindrical photon detector might be preferable compared to plane geometry.

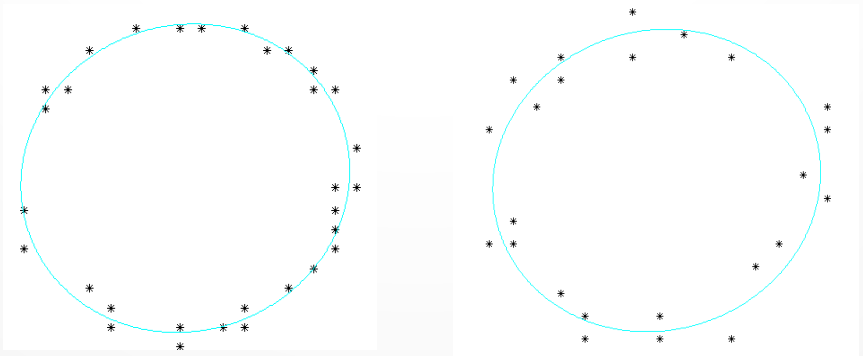
→ No dead space between left and right plane needed to provide space for electronic.



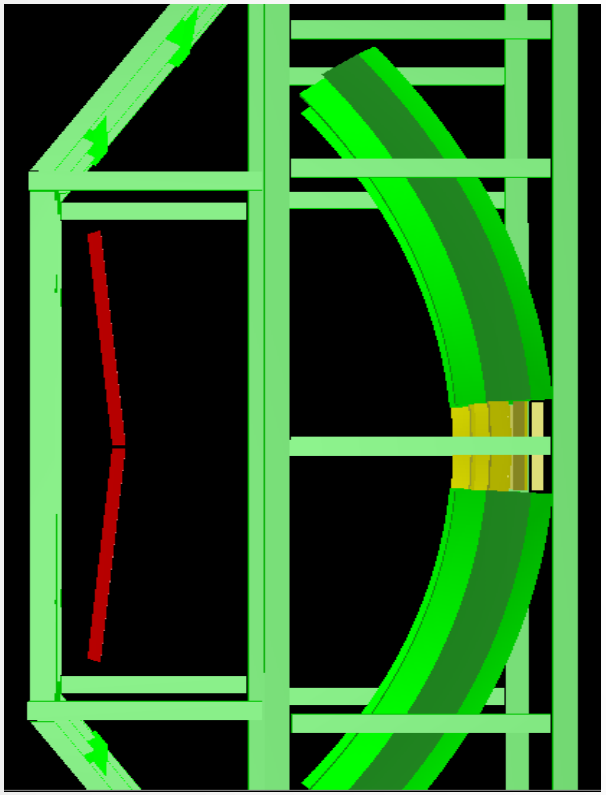
Question: what are the parameters for this form?

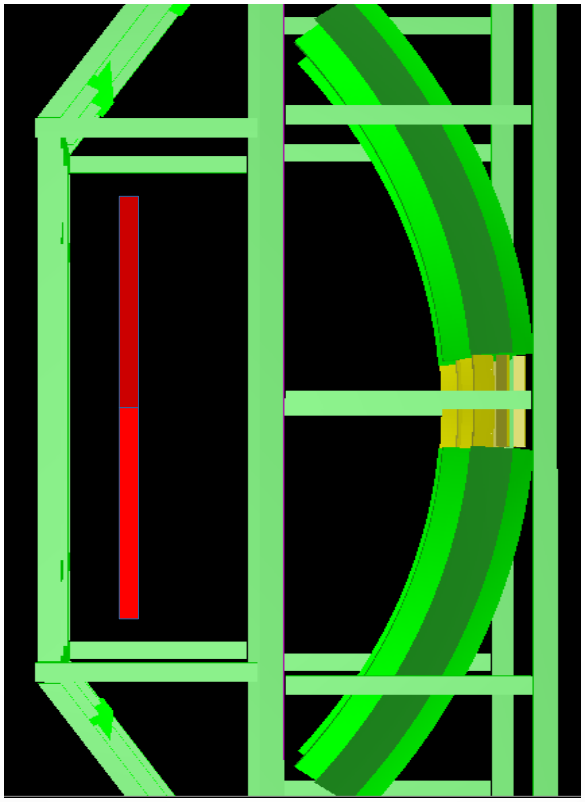
Concept

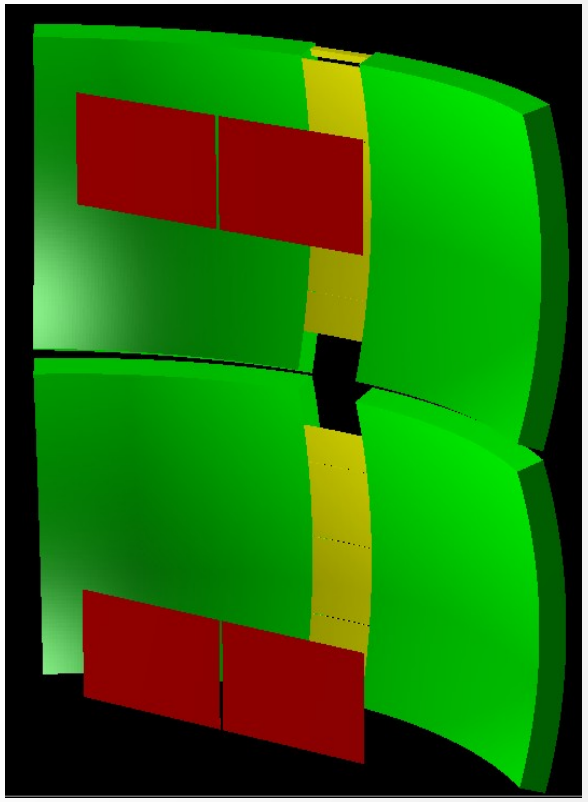
- Move the PMT-plane in z direction back and forward in several steps such that the optimal focal position will be crossed for each point (x,y).
- Simulation was performed for every step.
- For each step *dr (ring sharpness)* is calculated as function of (x,y).
- Z point with minimum *dr* should provide focal point for each individual (x,y) point



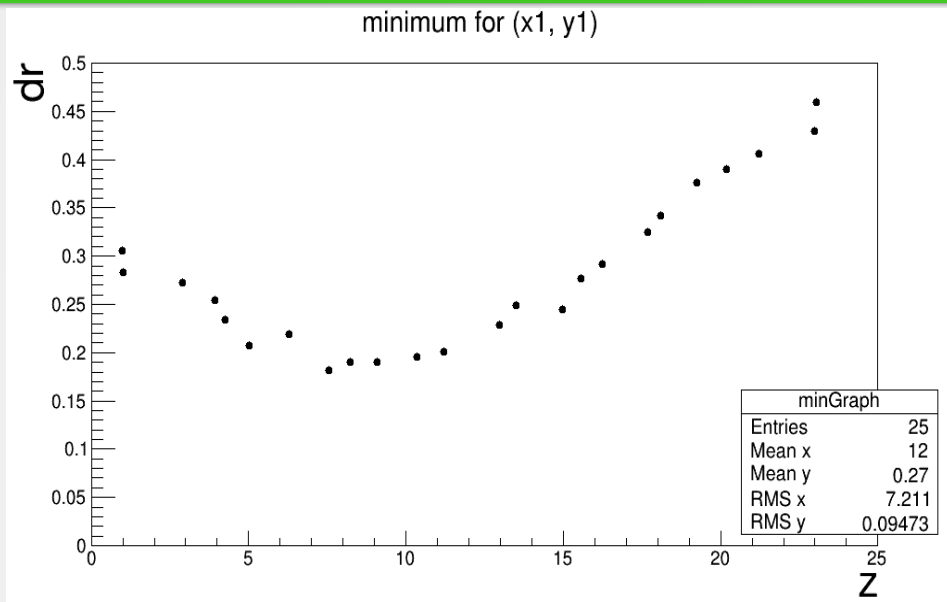
Changing tilted PMT-plane to untilted PMT-plane

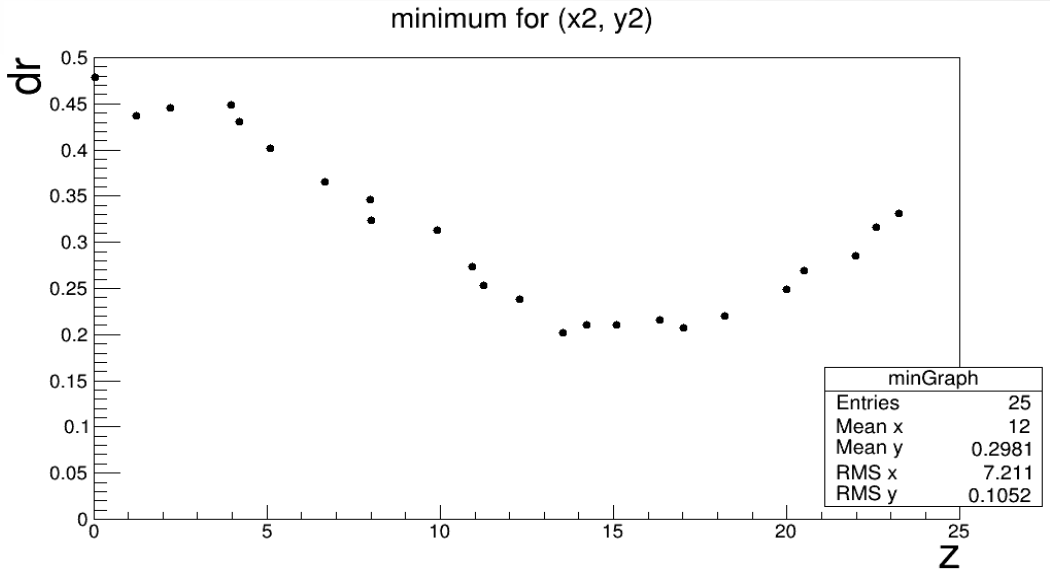


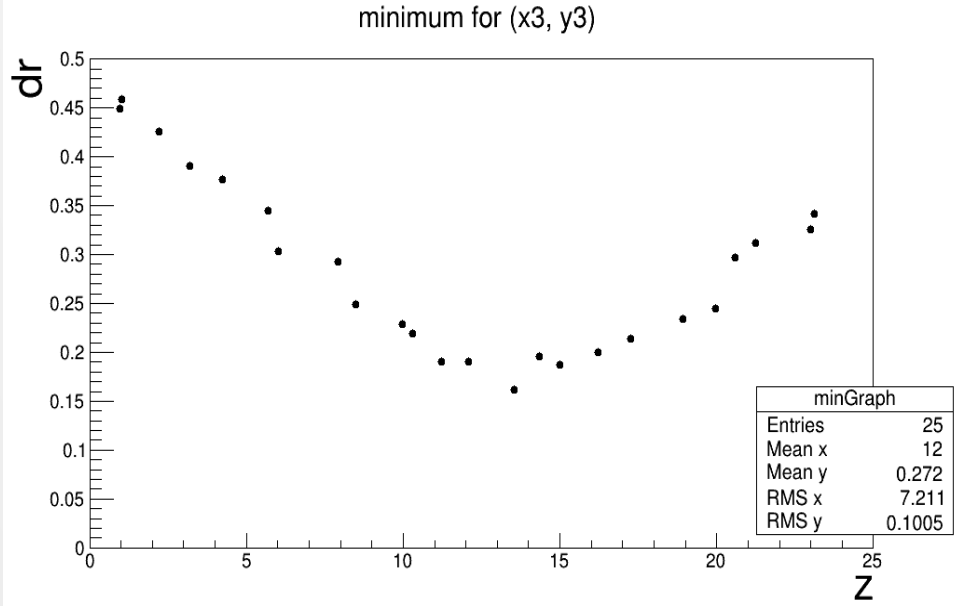


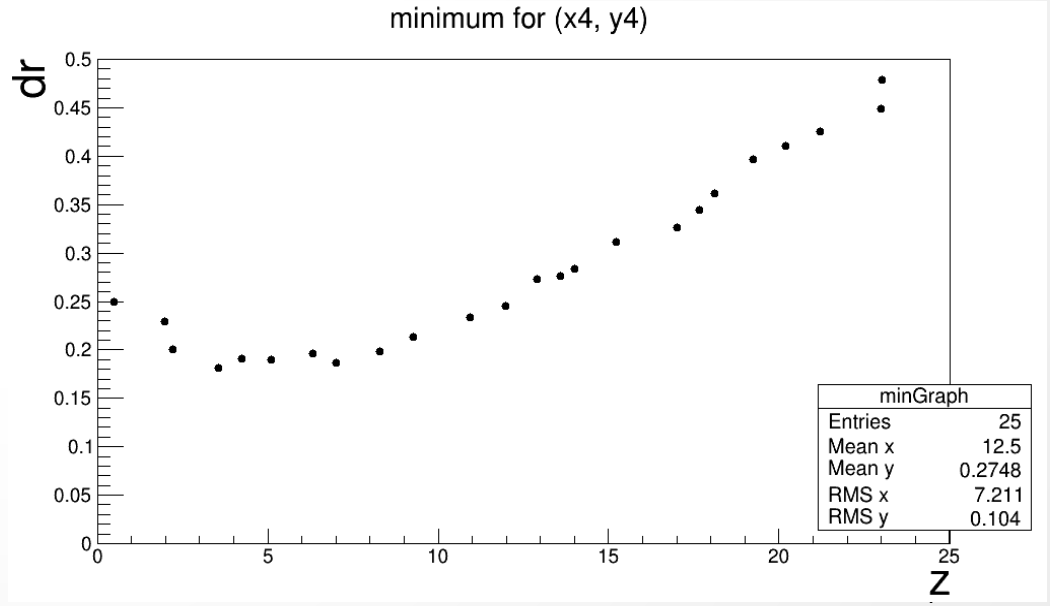


Choosing the minimum



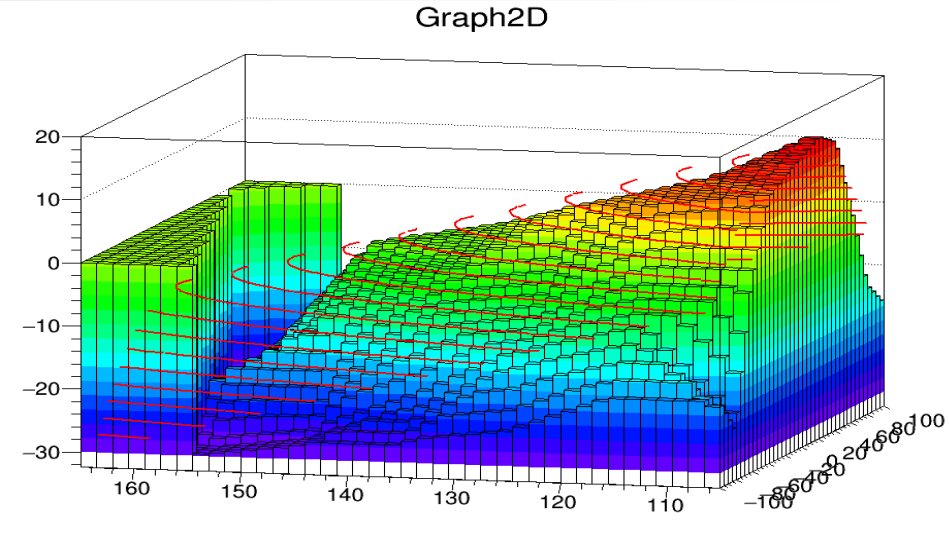




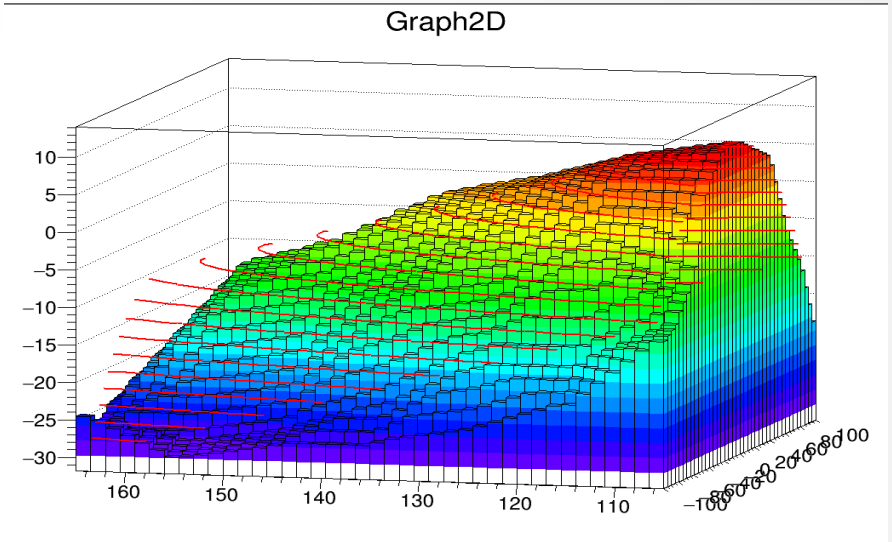


First results

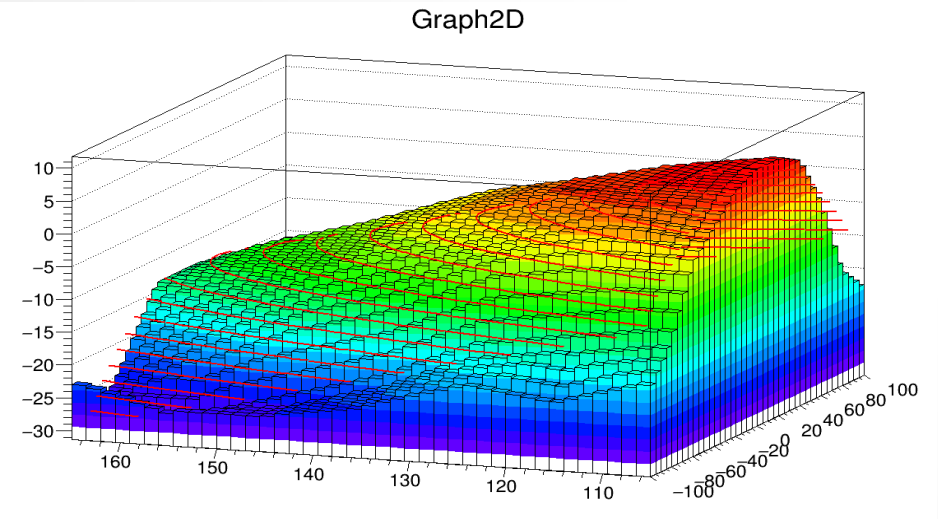
50 000 events with p = 0.75GeV/c



50 000 events with p = 1GeV/c



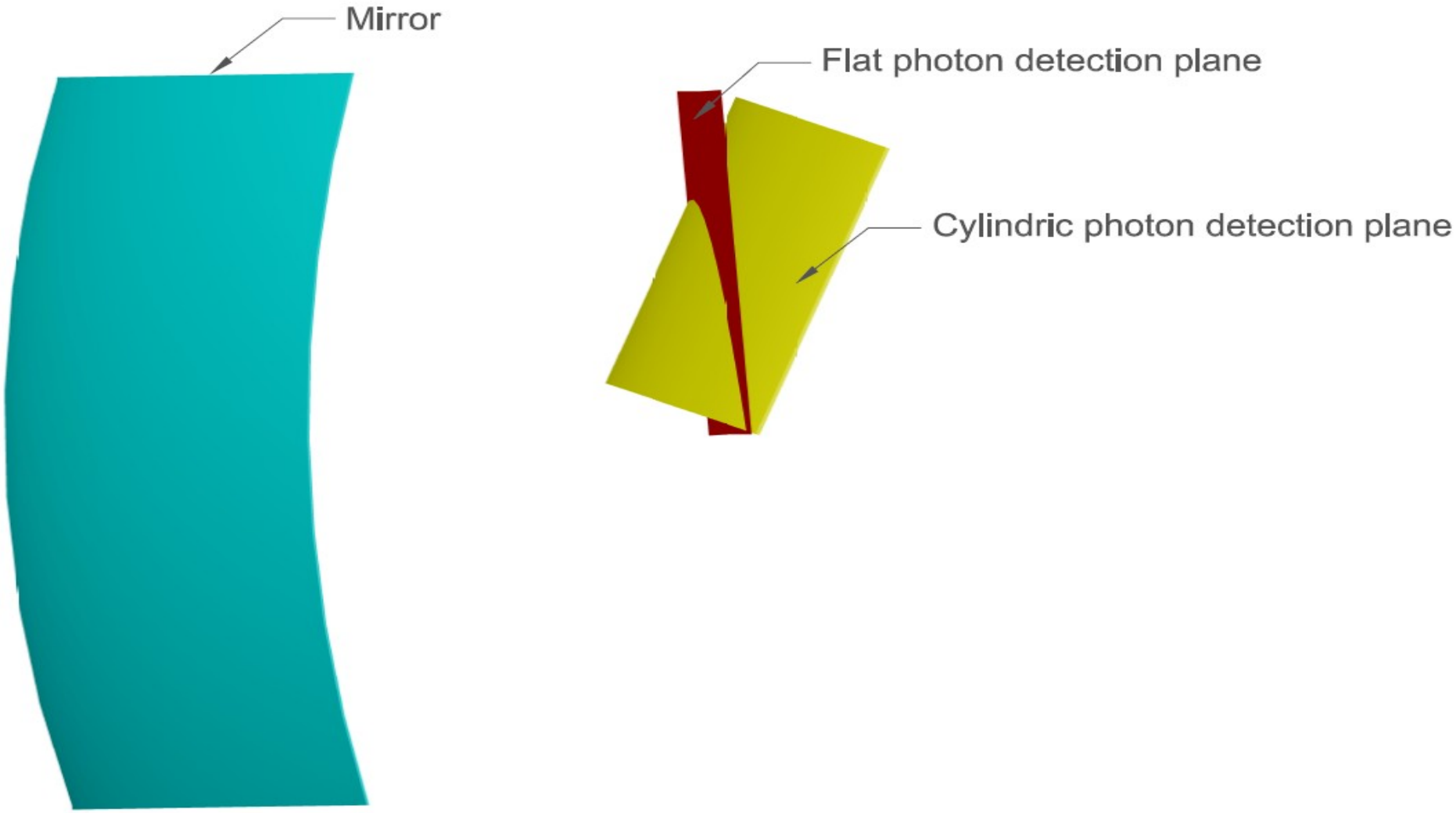
50 000 events with p = 2GeV/c



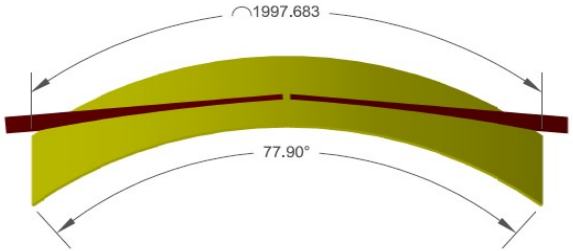
Fit results:

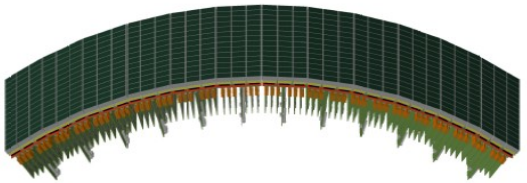
p =	0.75GeV	1GeV	2GeV
R =	1.44 m	1.45 m	1.6 m
Slope =	25.7 deg	22 deg	26 deg

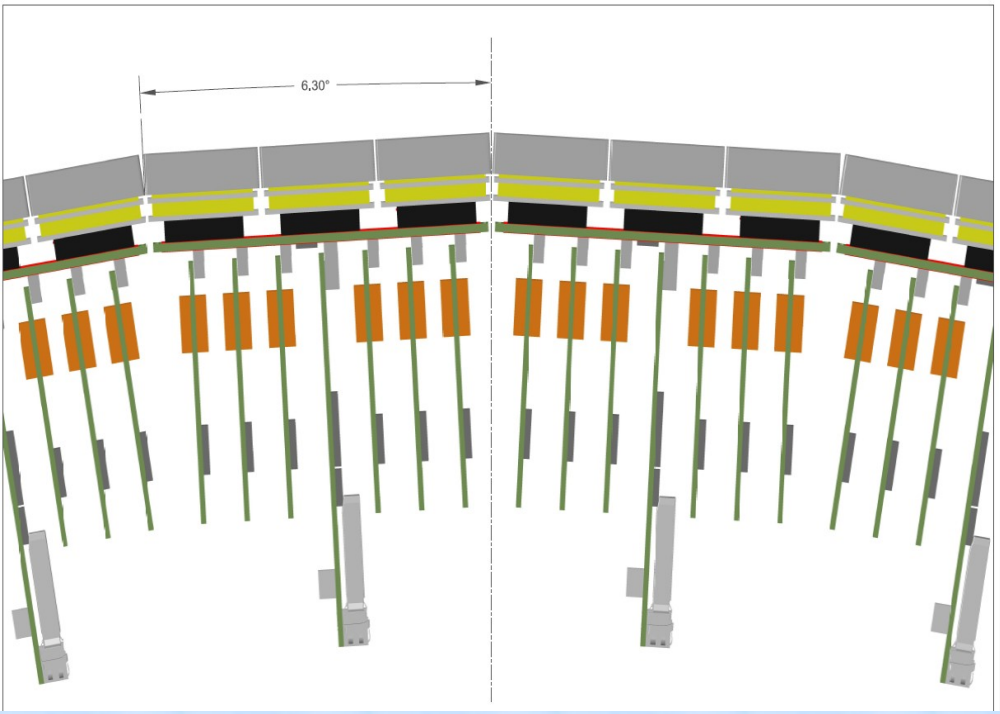
Comparison with present geometry

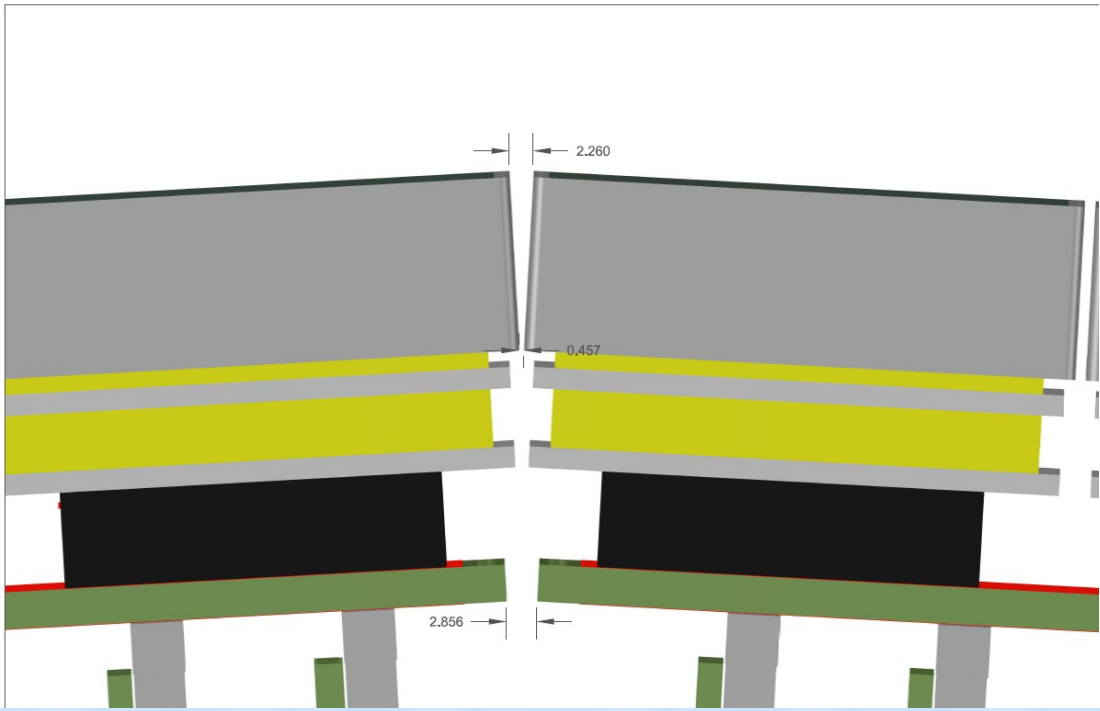


Modulation with PMT









Summary

- The first step to optimization RICH-geometry was done;
- Cylindrical geometry looks promising;
- Further optimization is needed using other parameters such as ellipticity and photon incident angle.