Dual-radiator RICH update: mirror configuration

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in behalf of the EICPID RICH collaboration
Santa Fe meeting, Sept 29 2015

Brief overwiev and coming next

- Dual-radiator RICH in hadron endcap for MEIC detector concept: goal π/K/p ID up to 50 GeV
- Proximity configuration: studied and excluded, can not garantee momentum coverage up to 50 GeV (June-July 2015)
- Magnetic field effect on the cherencov RICH ring resulution (Aug-Sept 2015)
- Outward-reflecting mirror configuration: under study (an update of the proposed geometry is the subject of this presentation)
- Mirror configuration (leading order estimation), coming next:

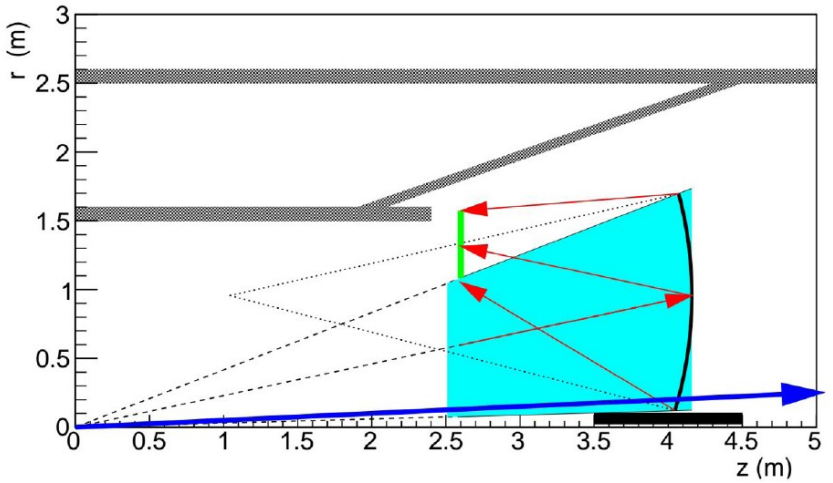
  - leading order estimation of the effective number of photons taking into account radiators thickness, QE, transmittance, reflectivity etc.

  - total radiation length of the RICH detector package

  - requirement on tracking input

- Mirror configuration: setup of the concept in Geant4 (in parallel with the others “coming next”)

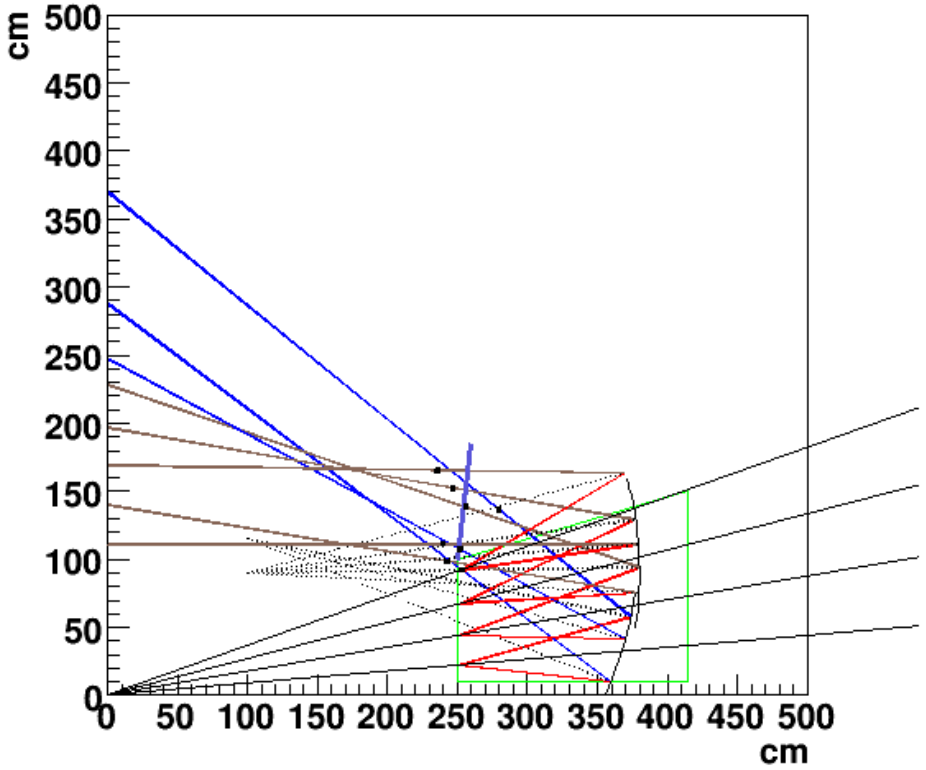
Towards a realistic mirror configuration

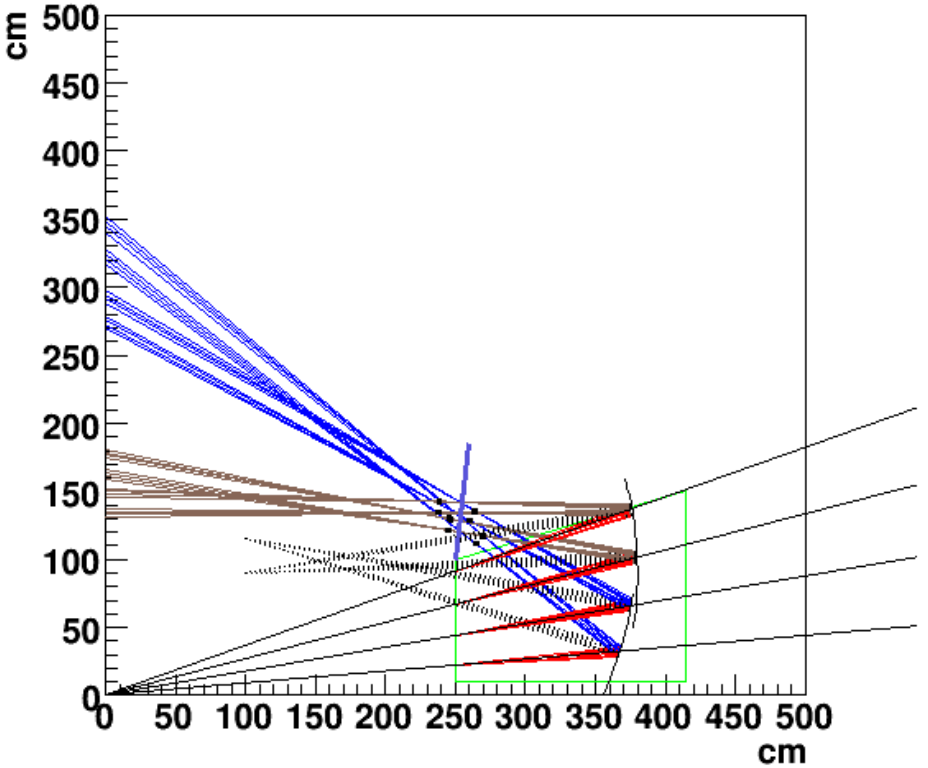


- A 2D optical ray tracing software has been developed (based on C++)
- The reflection of the Cherenkov photons can be simulated for different radiators and different mirror/fresnel lens configurations
- The photon-detector position can be studied in relation to the focal plane

Configuration 1: two spherical mirrors

Thickness of the Aerogel = 4 cm. 4+4 photons generated 1 each cm in the Aerogel.
4+4 photons generated 1 each 20 cm in the CF4 gas.
The black dots are the focal points.





Radius of the two mirrors = 280 cm.

In a future detailed 3D simulation the detector plane sould/could be not flat.

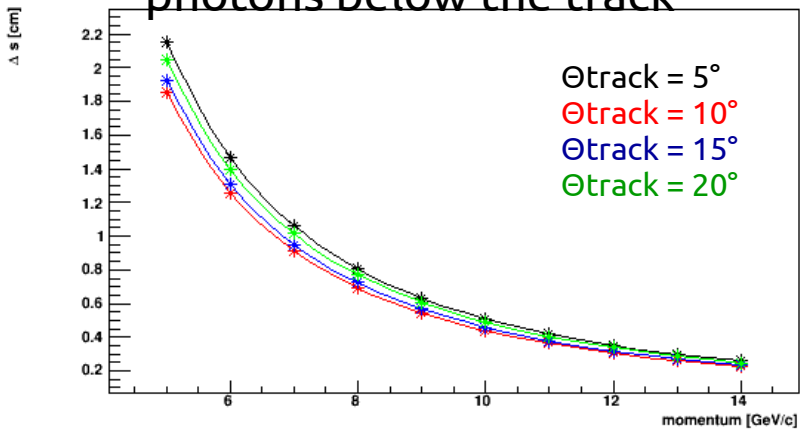
Configuration 1: leading order study

- A sample of events with uniform random emission of photons in the aerogel/gas region has been generated for different track angles
- From them the difference of the mean value of the distributions of the position (called Δs in the following plots) of pions and kaons on the detector (violet segment in slide 4) has been inferred as a function of the particle momentum
- The goals is a tread off between reducing as much as possible the spatial extenction of the photon detector, placing at the same time the detector plane as closer as possible to the focal region
- Note: this is a 2D ray tracker --> leading order extimation

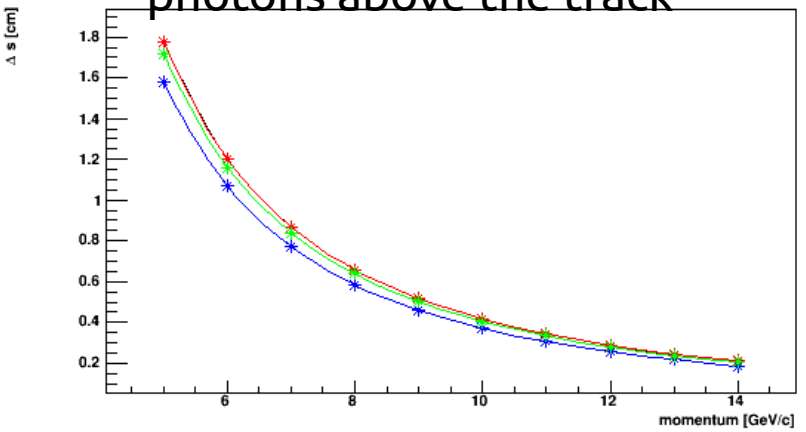
Configuration 1: leading order study

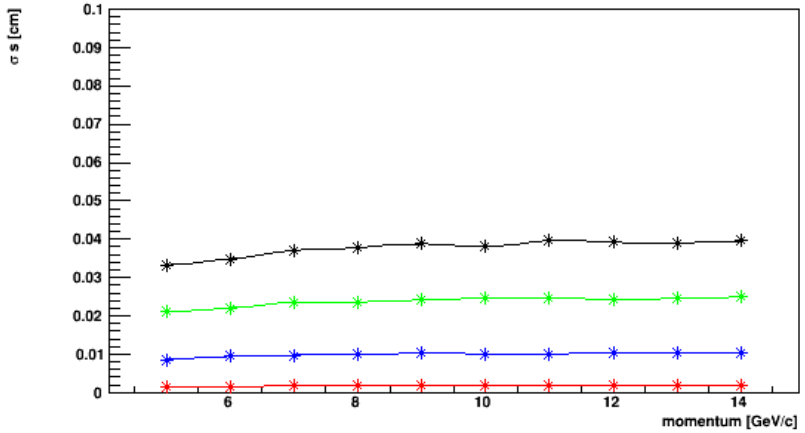
Aerogel: Mean separation between the photons of *pion* and *kaon* in the detector plane (violet segment in slide 4) as a function of the momentum

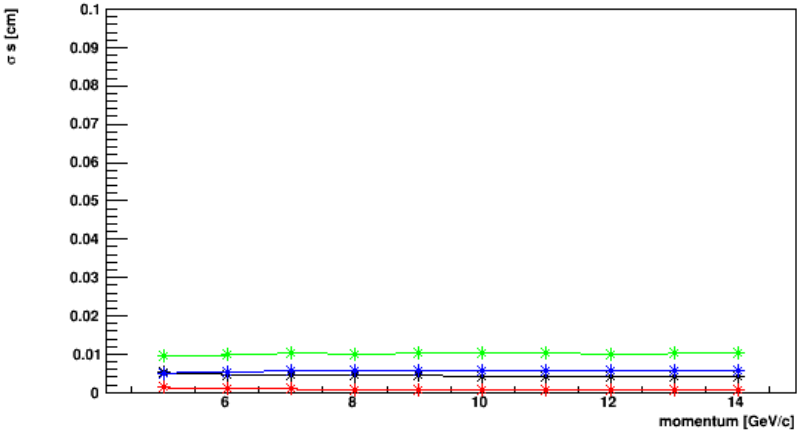
photons below the track



photons above the track





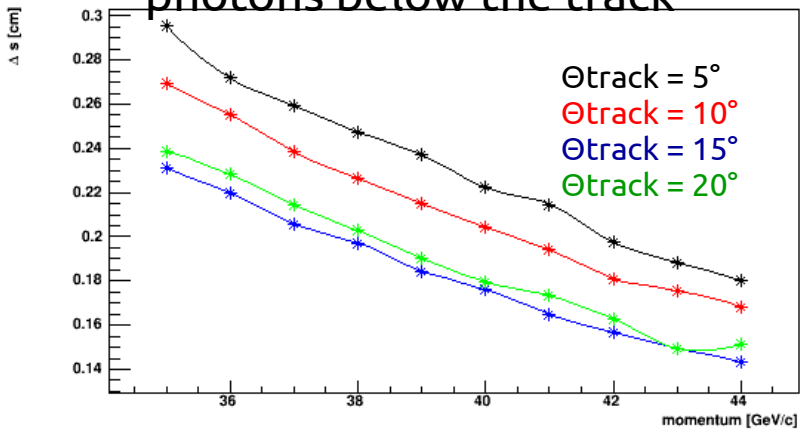


σs (panels below) is the major between the sigmas of the distributions of the position of pions and kaons on the detector

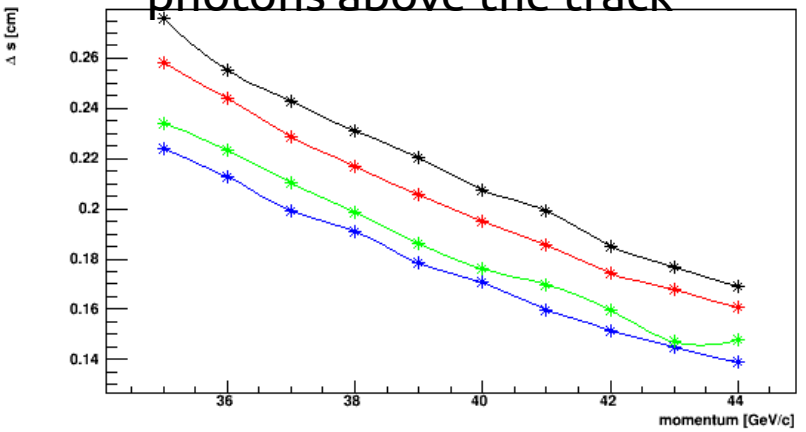
Configuration 1: leading order study

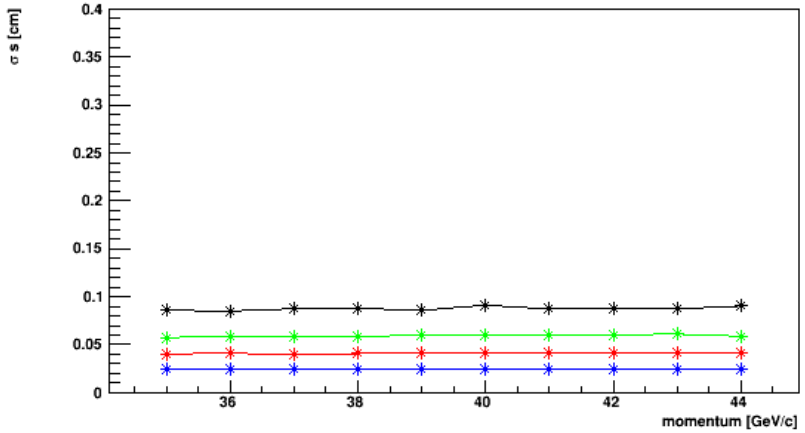
CF4 gas: Mean separation between the photons of *pion* and *kaon* in the detector plane (violet segment in slide 4) as a function of the momentum

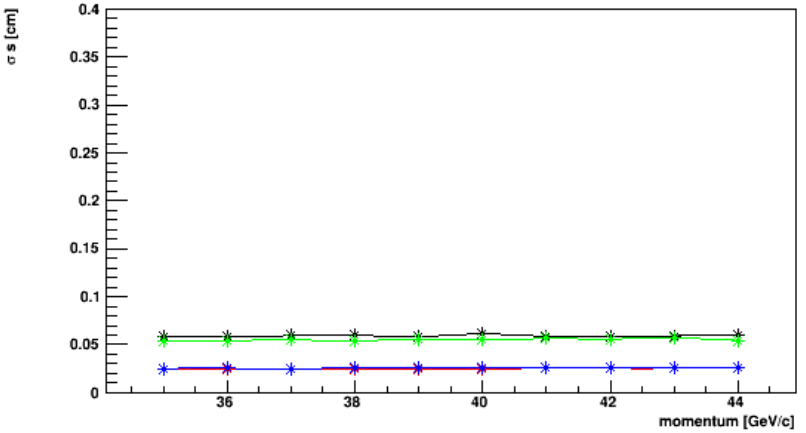
photons below the track



photons above the track



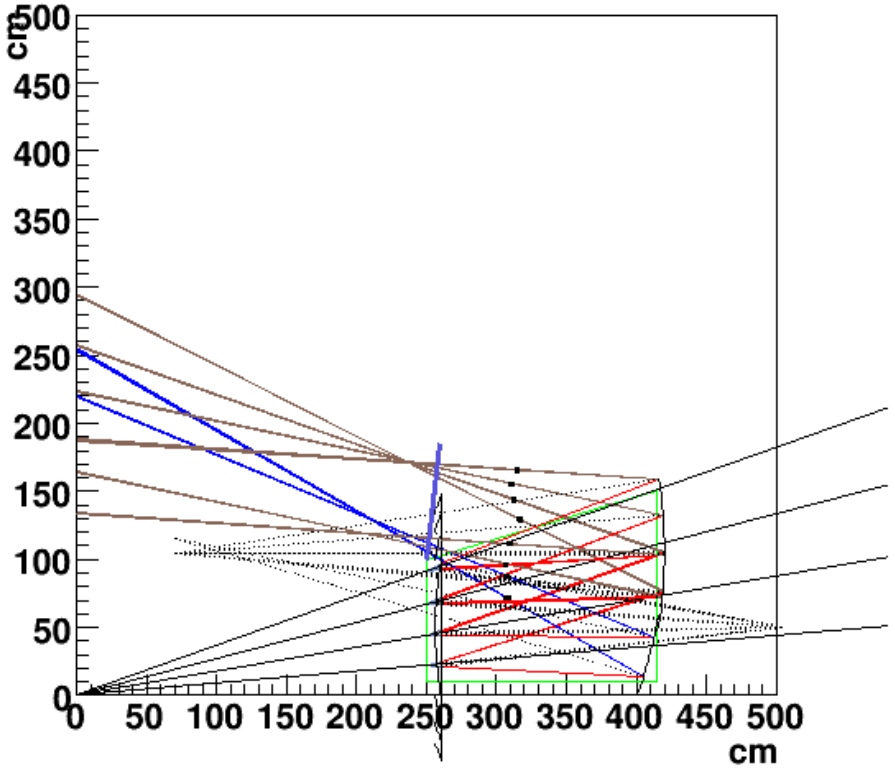


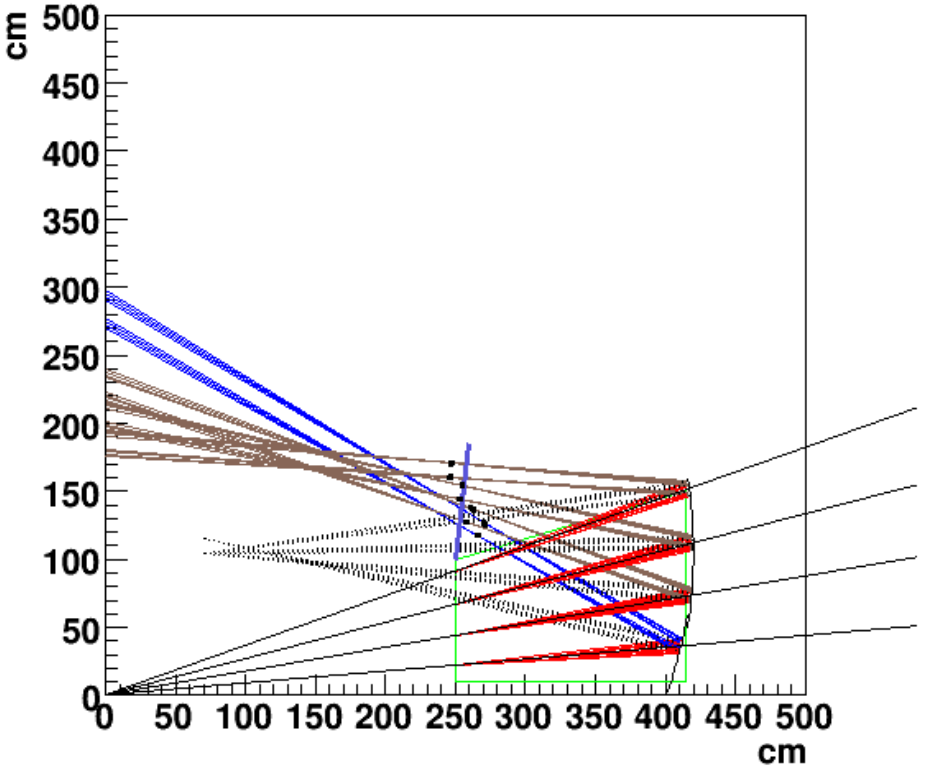


Note that for a pxel size of 3 mm one has also: $_{pixel} = 3/\sqrt{12} \simeq 0.08\ mm$

Configuration 2: two spherical mirrors & fresnel lens

Thickness of the Aerogel = 4 cm. 4+4 photons generated 1 each cm in the Aerogel.
4+4 photons generated 1 each 20 cm in the CF4 gas.
The black dots are the focal points.





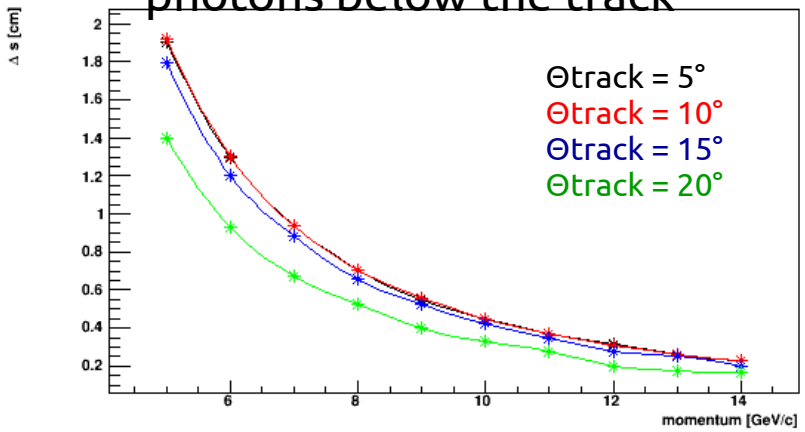
Radius of the two mirrors = 350 cm

Note: Aerogel photons and gas photons have defferent focal planes, because Aerogel photons have to pass two convergent optical devices.

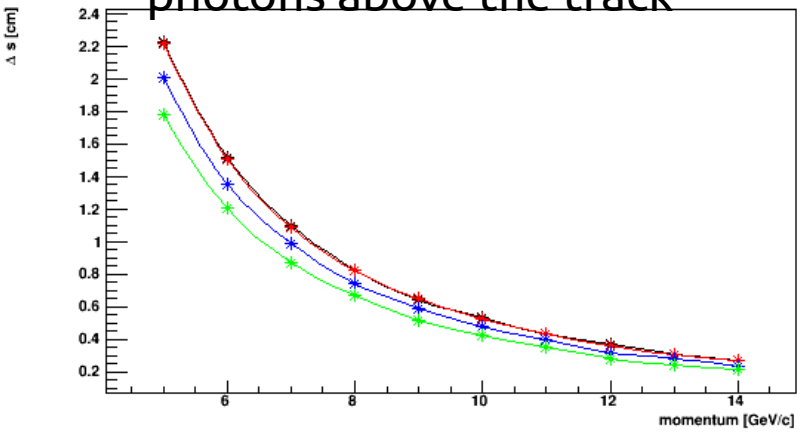
Configuration 2: leading order study

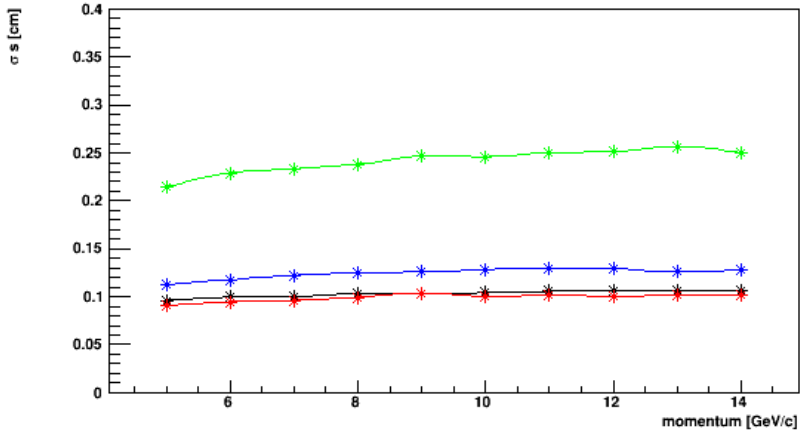
Aerogel: Mean separation between the photons of *pion* and *kaon* in the detector plane (violet segment in slide 8) as a function of the momentum.

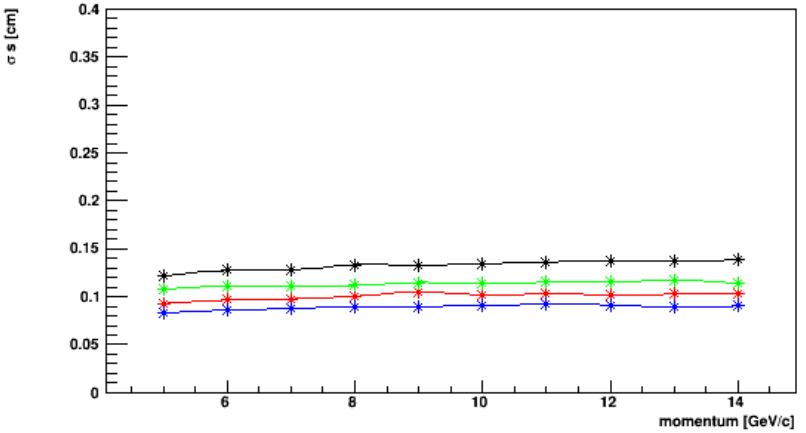
photons below the track



photons above the track





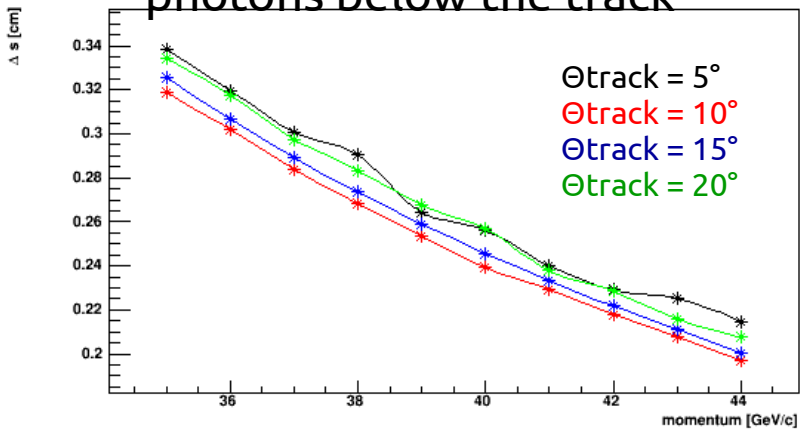


The sigma of the distributions is higher with respect to the lesnsless configurations, because of the major distance between focal plane and detector.

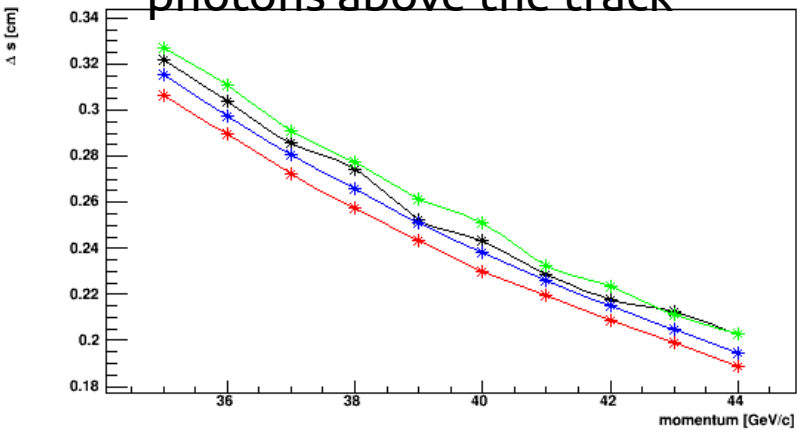
Configuration 2: leading order study

CF4 gas: Mean separation between the photons of *pion* and *kaon* in the detector plane (violet segment in slide 8) as a function of the momentum.

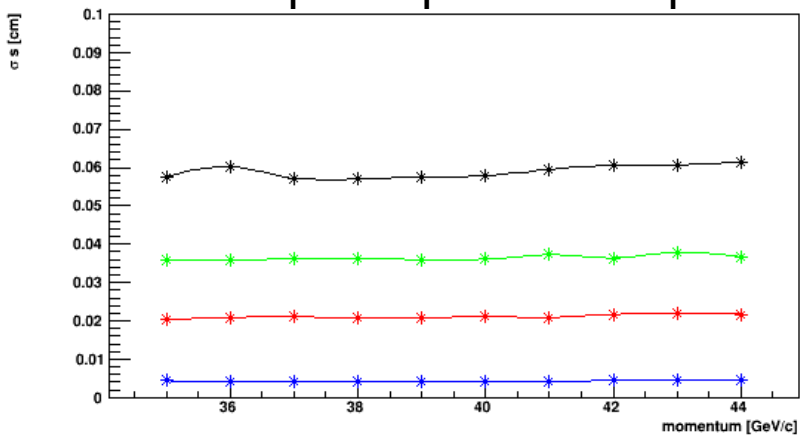
photons below the track

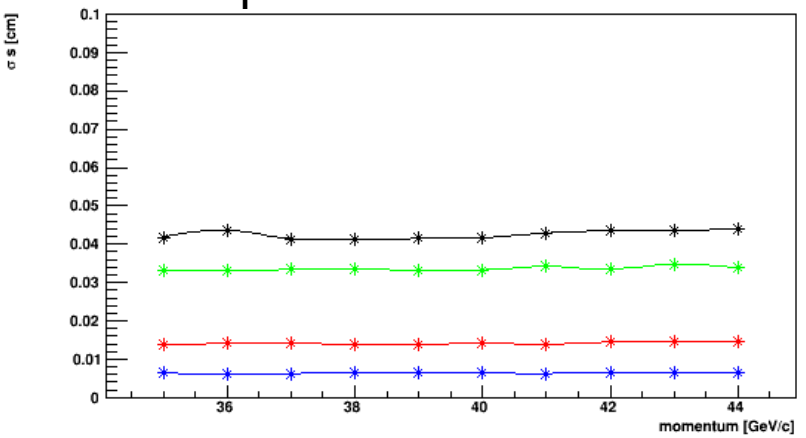


photons above the track



Larger radius for the mirror (3.5 m) means also larger spatial particles separation on the detector plane

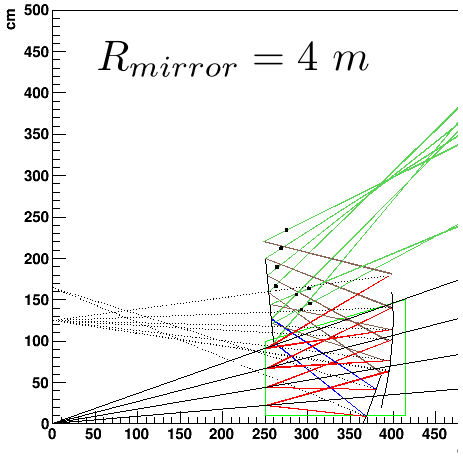


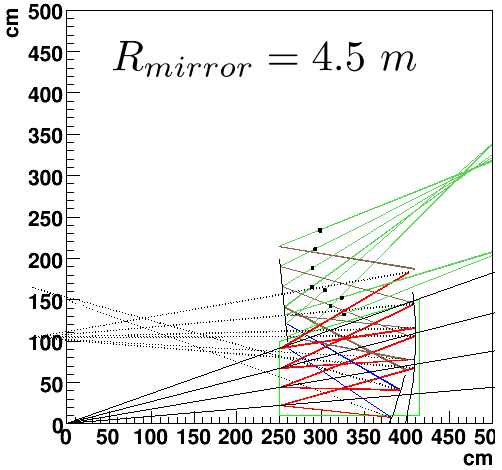


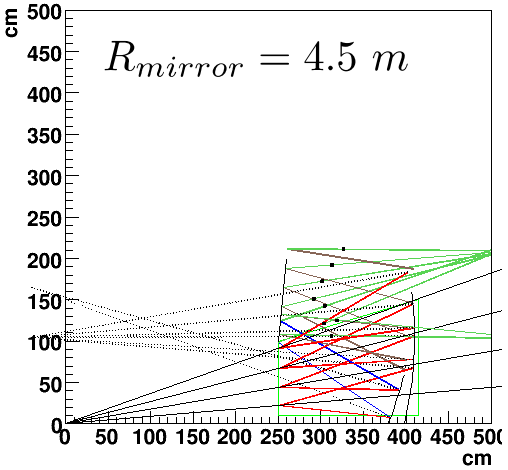
Note that for a pxel size of 3 mm one has also: $pixel = 3/\sqrt{12} \simeq 0.08\ mm$

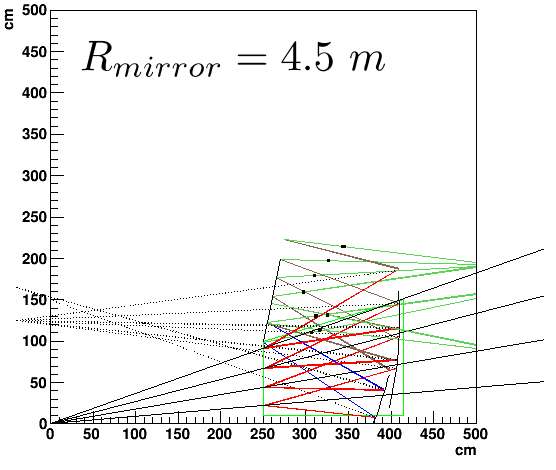
Configuration 3: double bounce

Aerogel

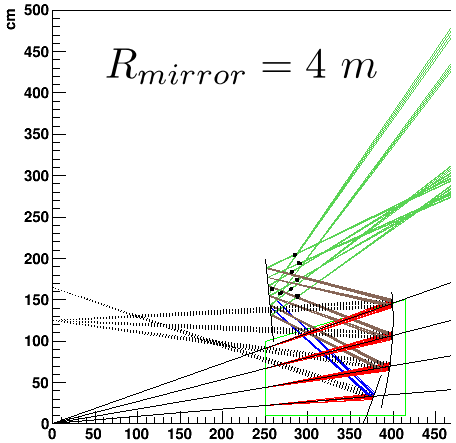


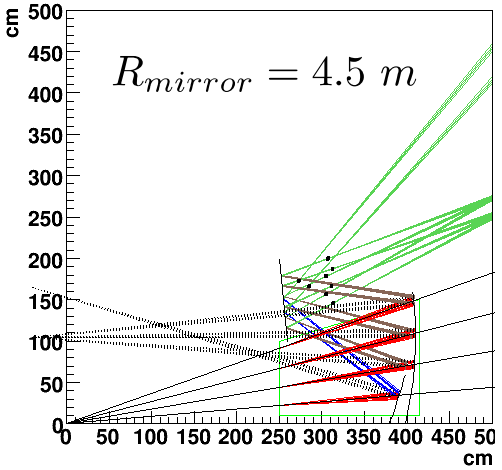


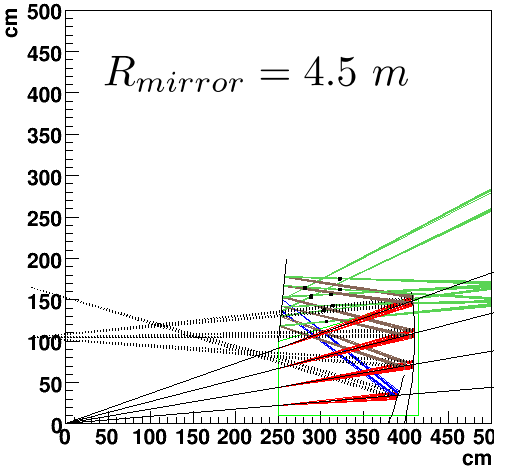


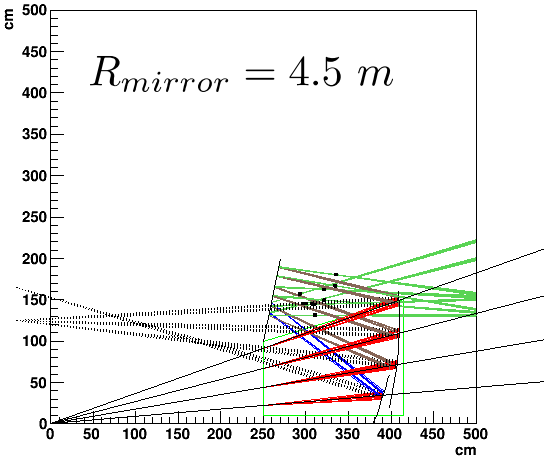


CF4 gas









Radius of the two mirrors = 450 cm --> focal in reasonable position, but not easy to collect the photons in a small region.

Comments and next developments

- Configurations 1 and 2 can be studied in detail (3D)

- Next steps for mirror configuration:

  - Give a leading order estimation of the effective number of photons taking into account radiators thickness, QE, transmittance, reflectivity etc.

  - Develop a 3D Monte Carlo Geant4/GEMC based in order to perform a detailed study