Forward PID detector for GlueX

Baptiste GUEGAN

Introduction

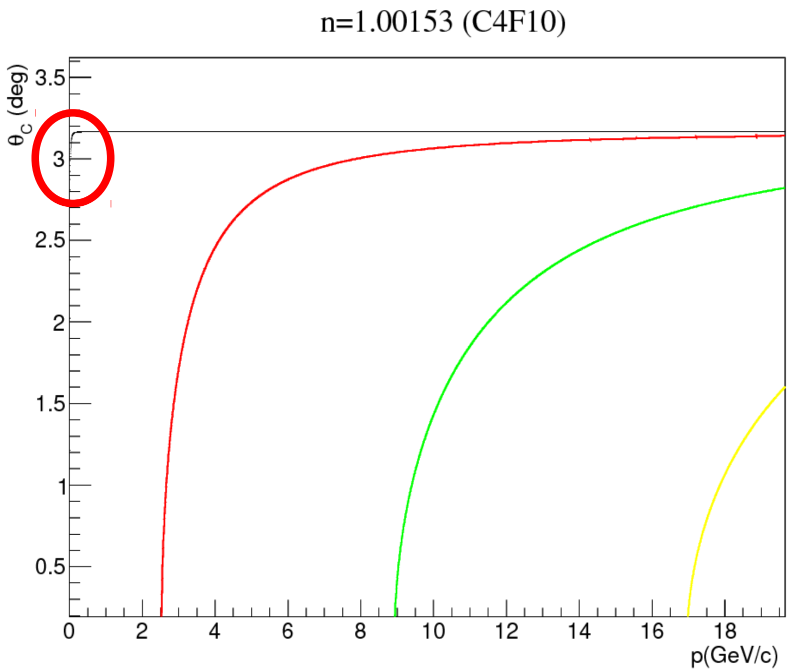
- Using both DIRC and threshold Cherenkov detectors to cover the whole momentum range

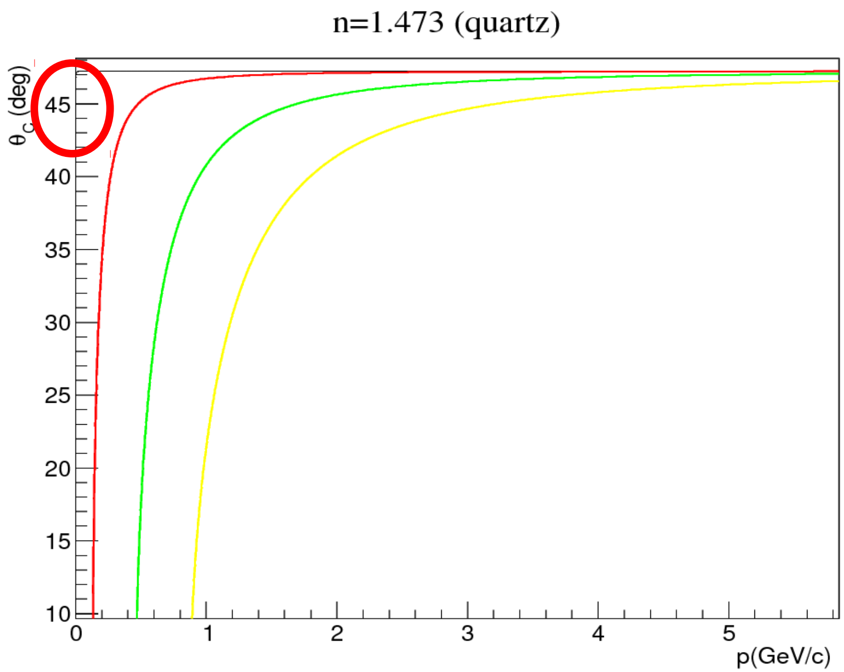
  → DIRC bars from BaBar experiment:
    - covering from ~2GeV(TOF) to ~4GeV (3σ separation for π/K)

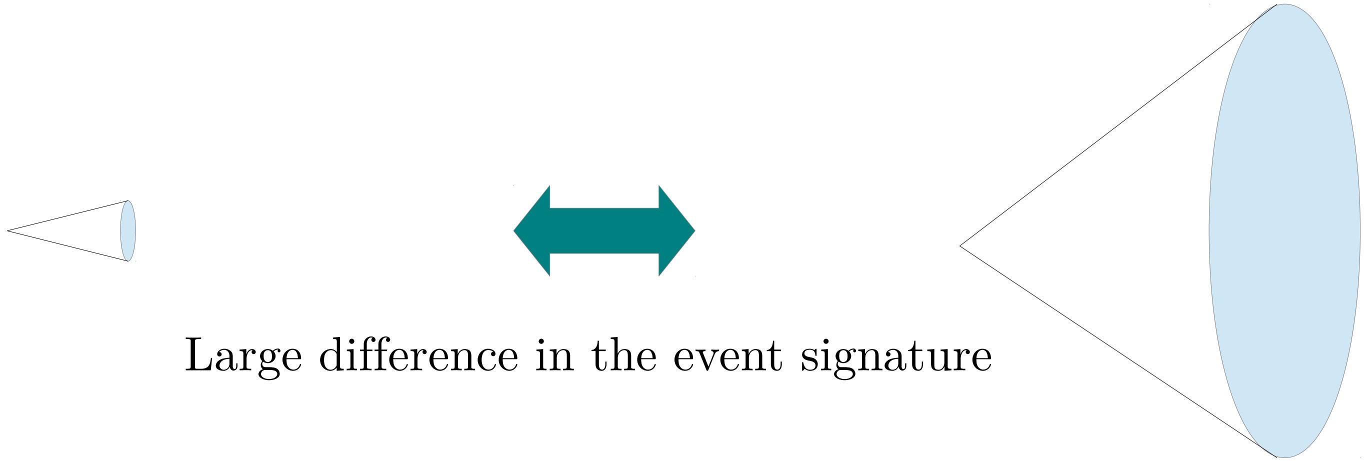
  → Regular threshold Cherenkov C4F10
    - covering from ~3GeV to ~8GeV

- Using the same read-out for both systems

Introduction





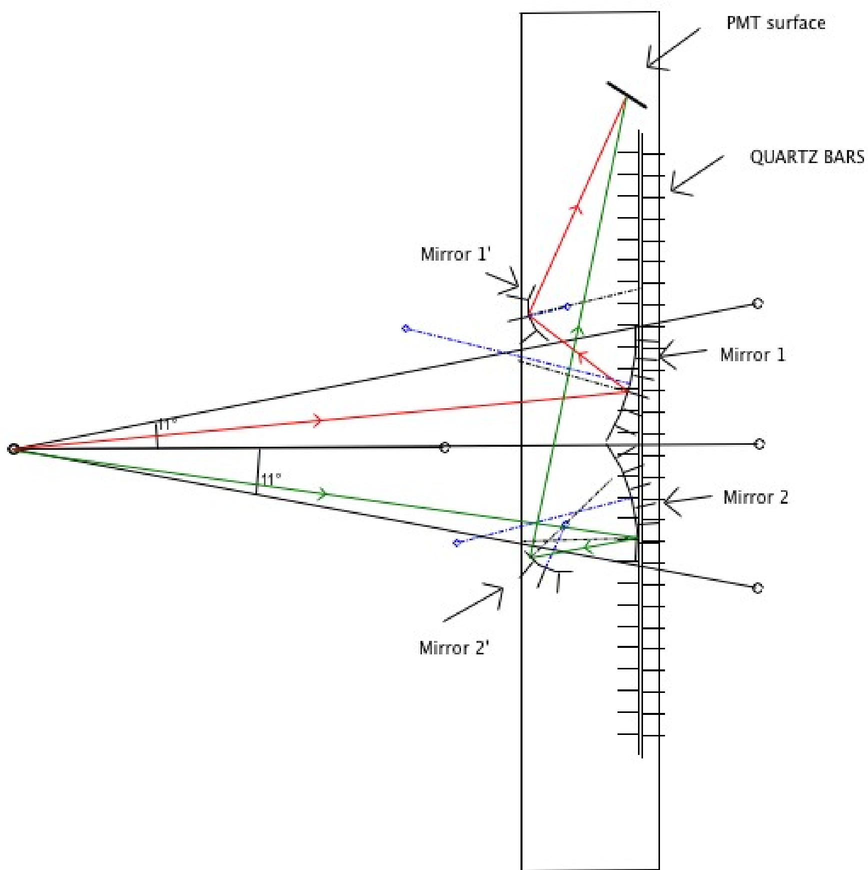


Large difference in the event signature

Different designs are possible

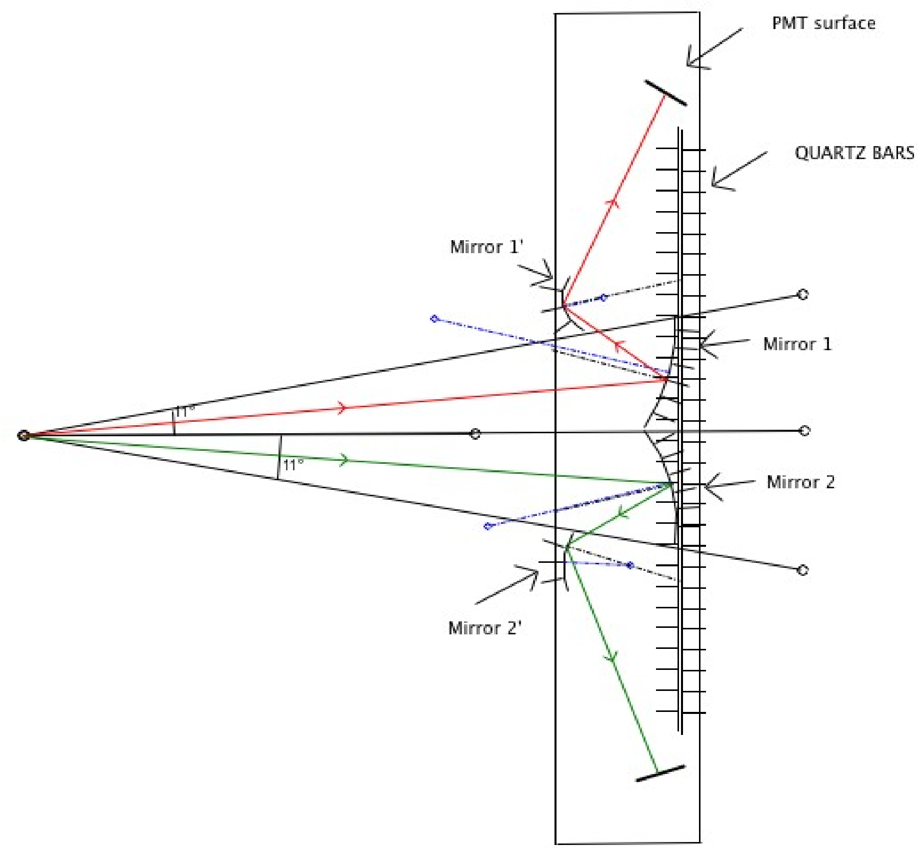
Using the 4.9m long bars (as the one used by Babar)

with one read-out:



- Less expensive
- Focusing mirror #2 more difficult
- Ambiguity signals

with two read-out:

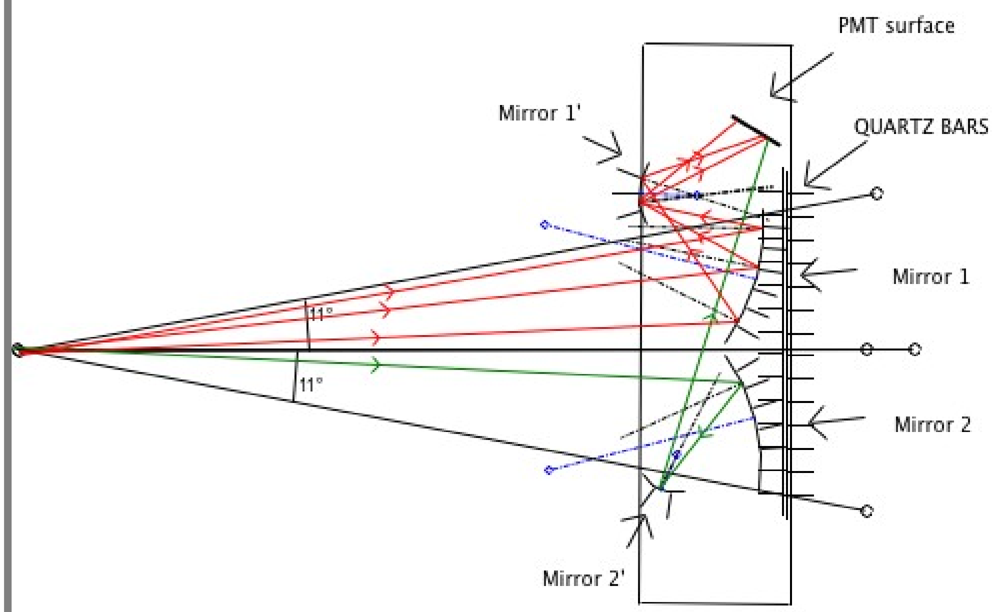


- More expensive
- Focusing light is easier

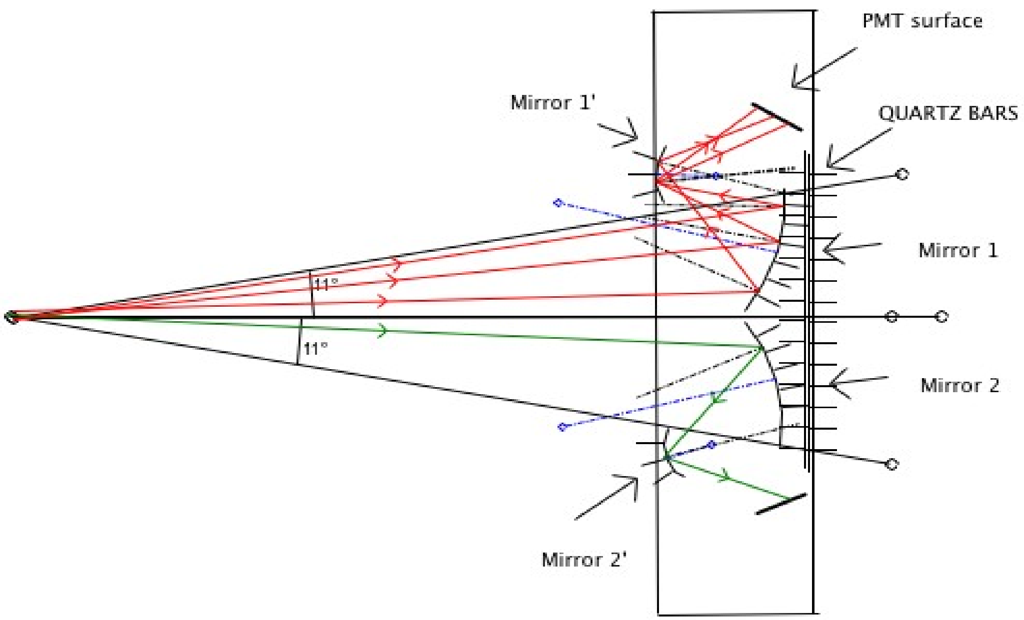
Different designs are possible

Using the 2.45m long bars (cut in two parts)

<u>with one read-out:</u>



<u>with two read-out:</u>



Compared to the 4.9m bars:

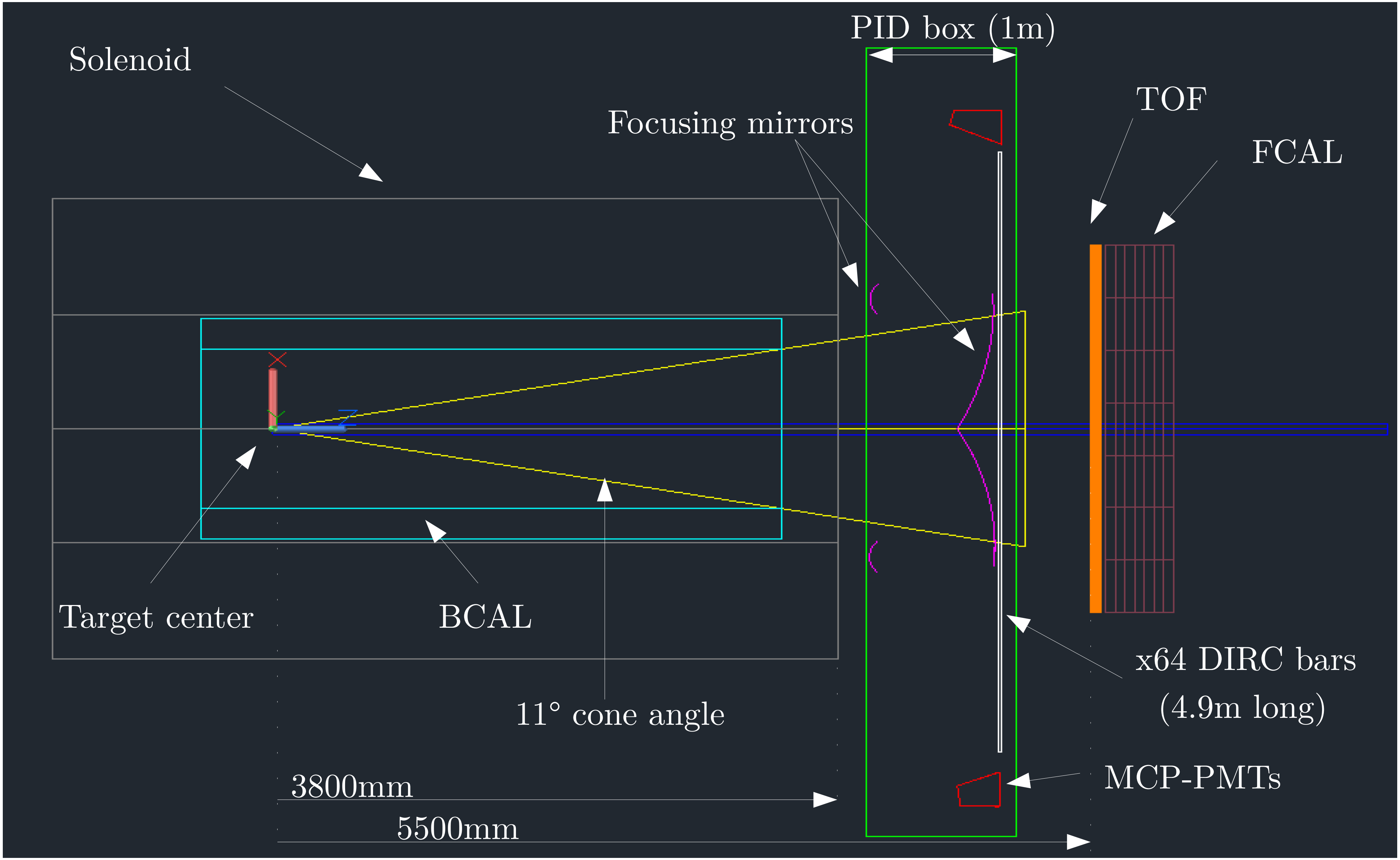
_focusing is easier

_only need 32 Babar's bars (cut in two)

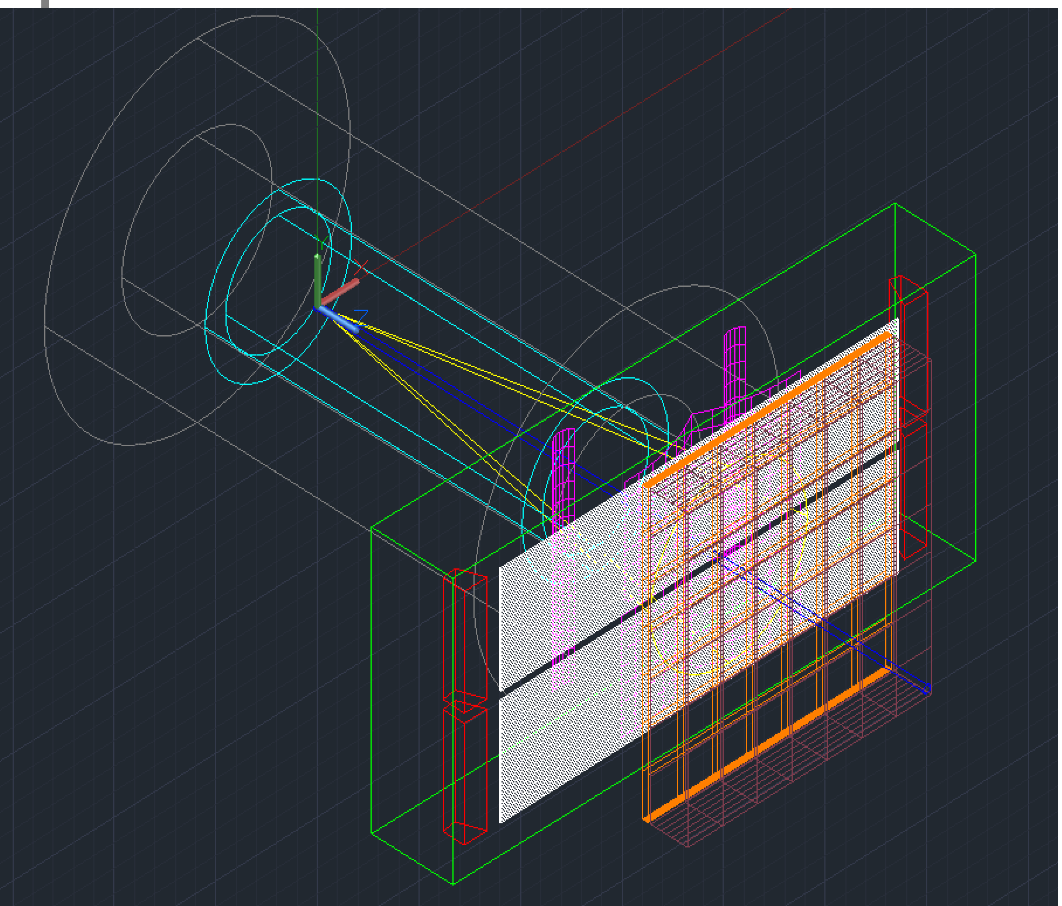
_box more compact, less gas needed

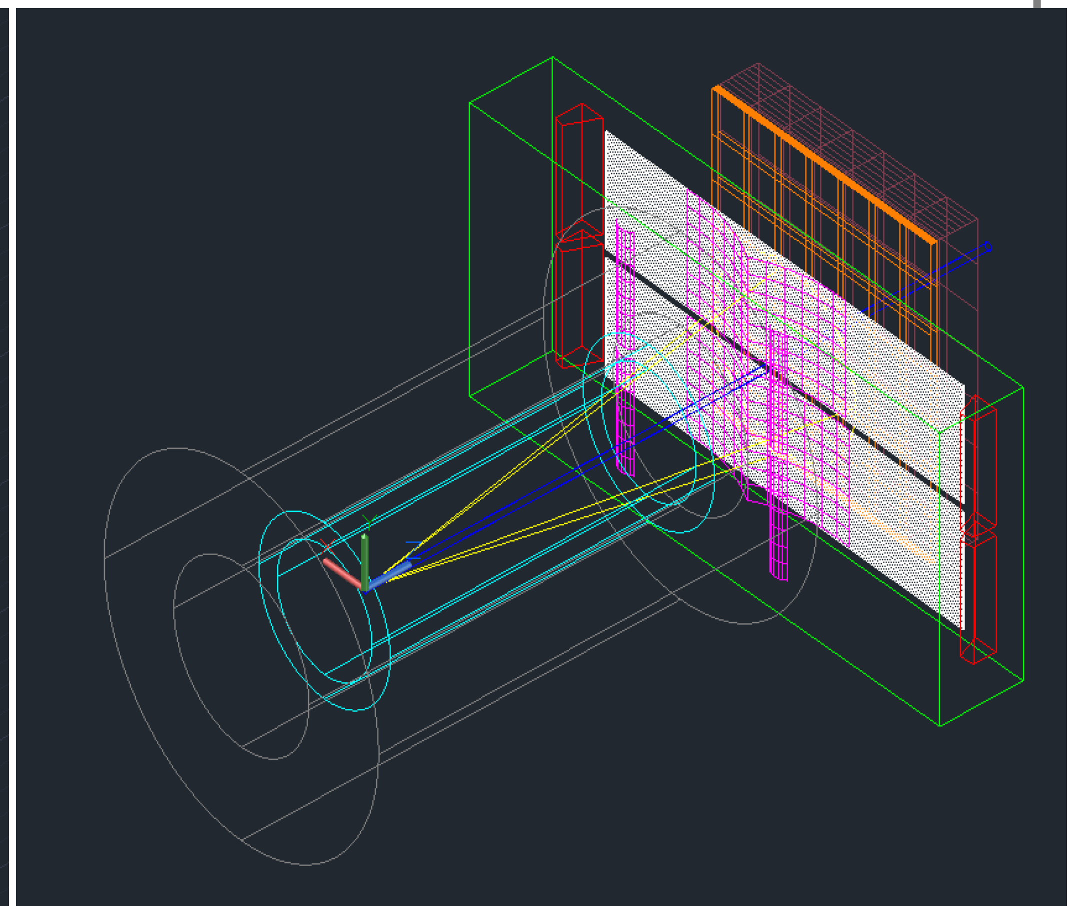
_ reduce the light attenuation

A first draft (top view)



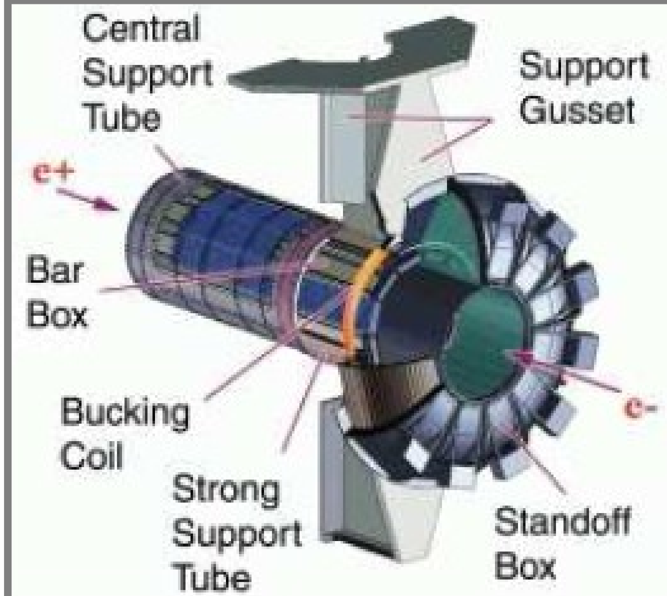
A first draft

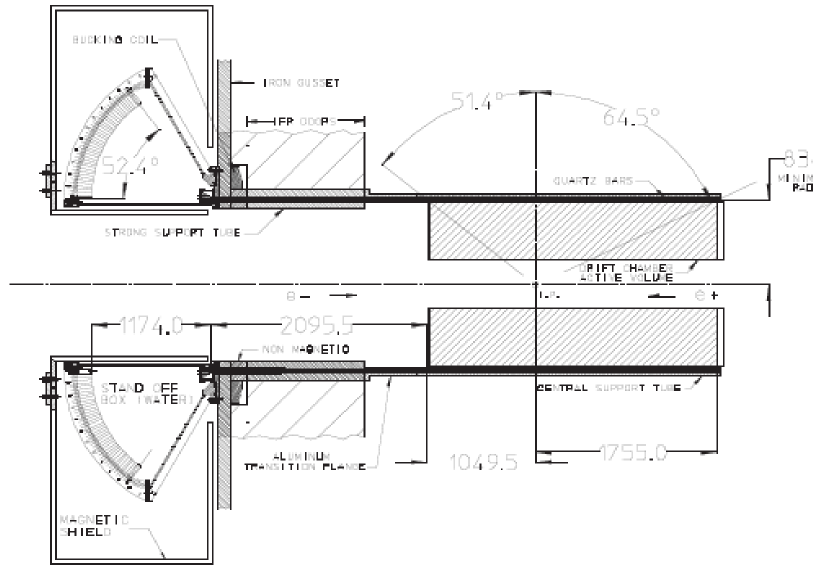


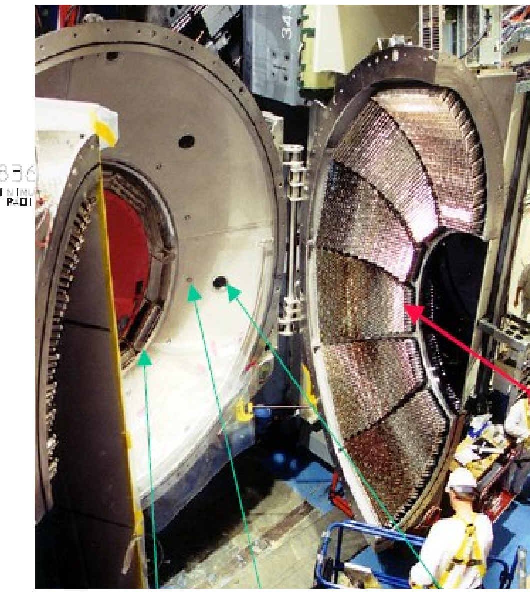


Backup slides

Design and requirements

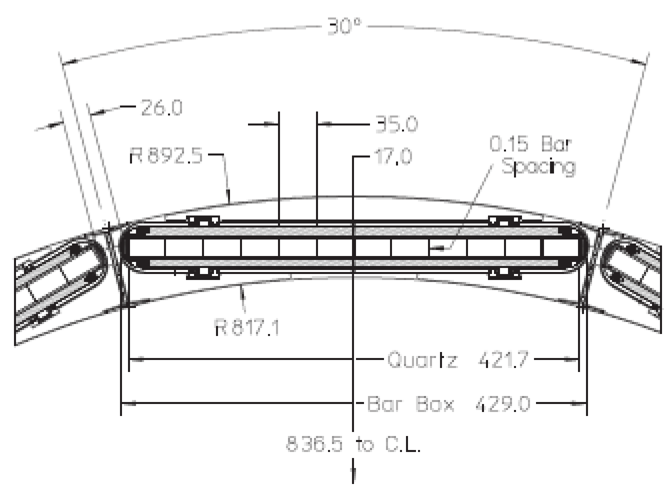




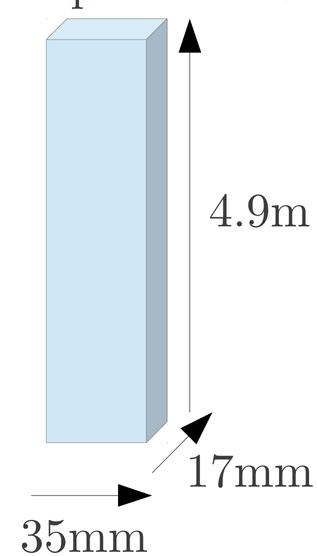


- Pions and kaons (from $B^0 \to \pi^+\pi^-$ and $B^0 \to K^+\pi^-$) must be well-separated: 1.7 and 4.2 GeV/c

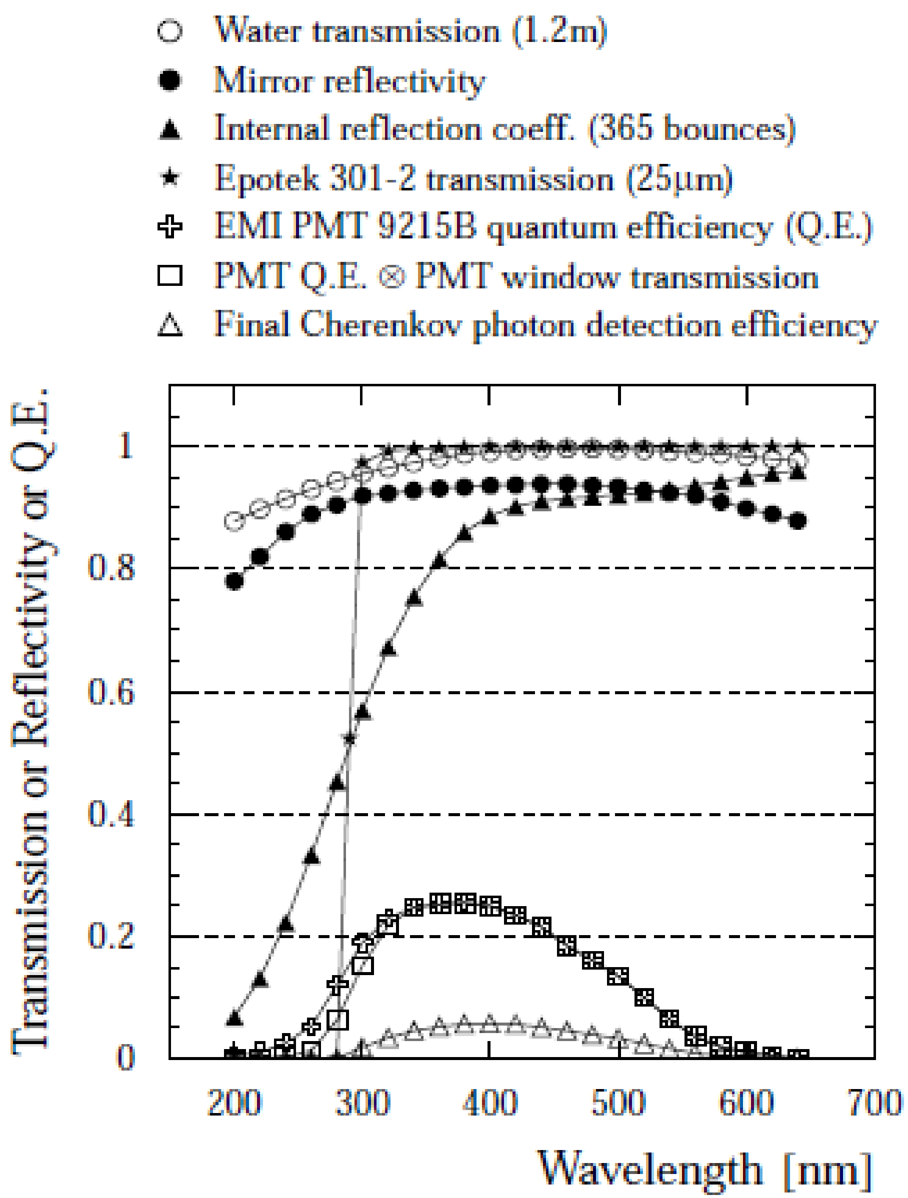
- The PID system should be thin and uniform in terms of radiation lengths (80mm of radial space, 19% radiation length)



x144 quartz bars



Efficiency



- 80% of the light is maintained after multiple bounces along the bars

- The expected number of photoelectrons (Npe) is ~25 for a β = 1 particle entering normal to the surface at the center of a bar, and increases by over a factor of two in the forward and backward directions.

Angular Resolution

The angle resolution of a single Cherenkov photon is dominated by

1. Imaging (bar dimension) (~ 4.2 mrad in BaBar)
2. Detection (granularity) (~ 6.2 mrad)
3. Chromatic smearing ($n = n(\lambda)$) (~ 5.4 mrad)
4. Photon transport in bar (~ 1 mrad)

... added in quadrature ➔ $\sigma_{\theta\gamma}$ = 9.3 mrad in BaBar

With a different imaging (e.g. focus) limited by 3. and 4.

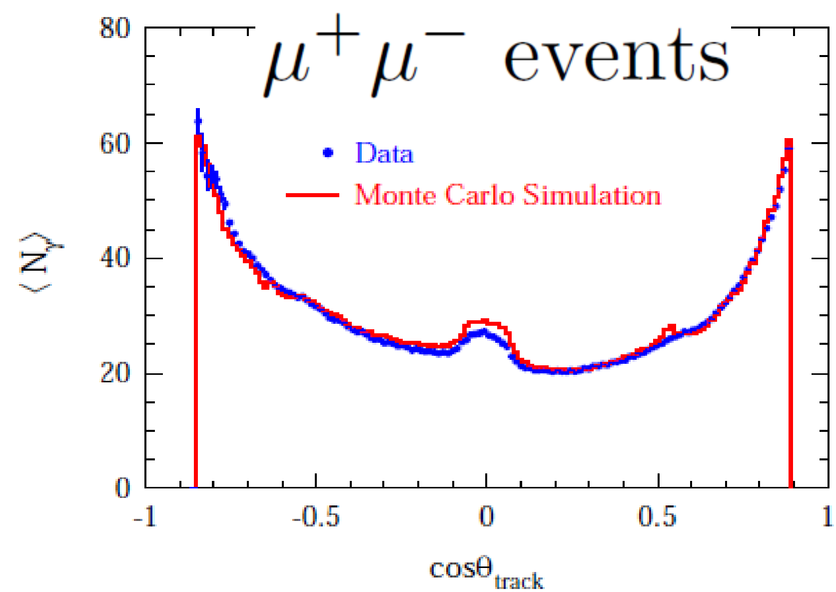
➔ $\sigma_{\theta\gamma} \approx 6$ mrad

Expect 25 photons (N_γ) or more

➔ total resolution/track, σ_{θ_C} :

$$\sigma_{\theta_C} \approx \sigma_{\theta\gamma} / \sqrt{N_\gamma} \oplus \sigma_{track}$$

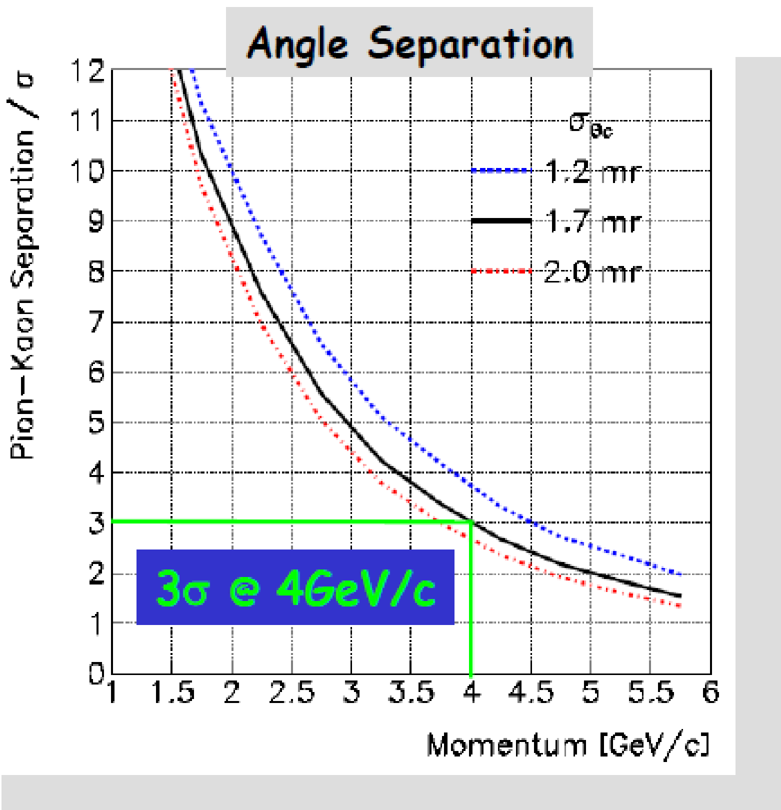
$$\approx 1.2 \text{ mrad} \oplus \sigma_{track}$$

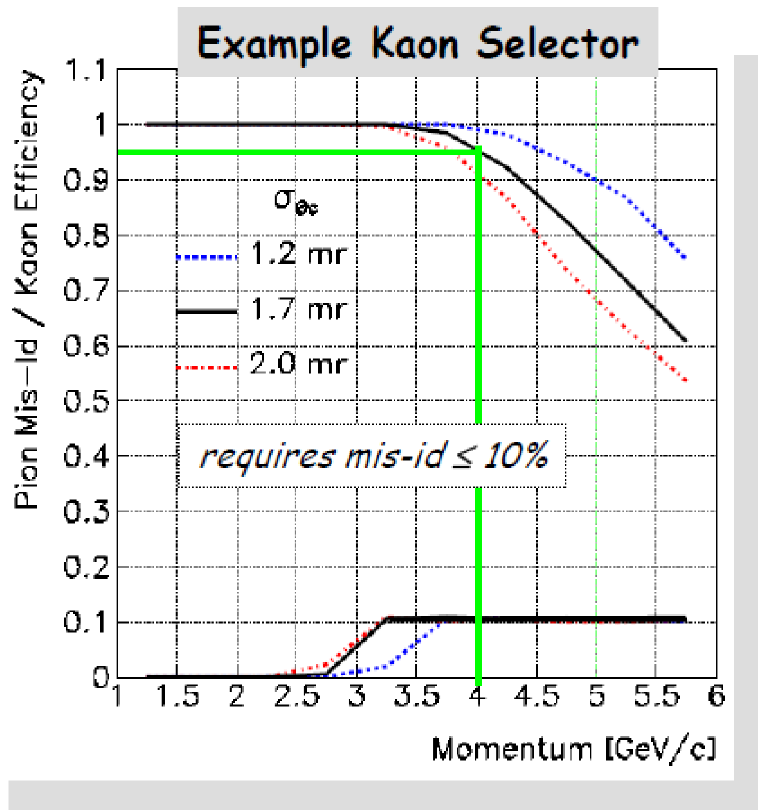


Kaon Identification

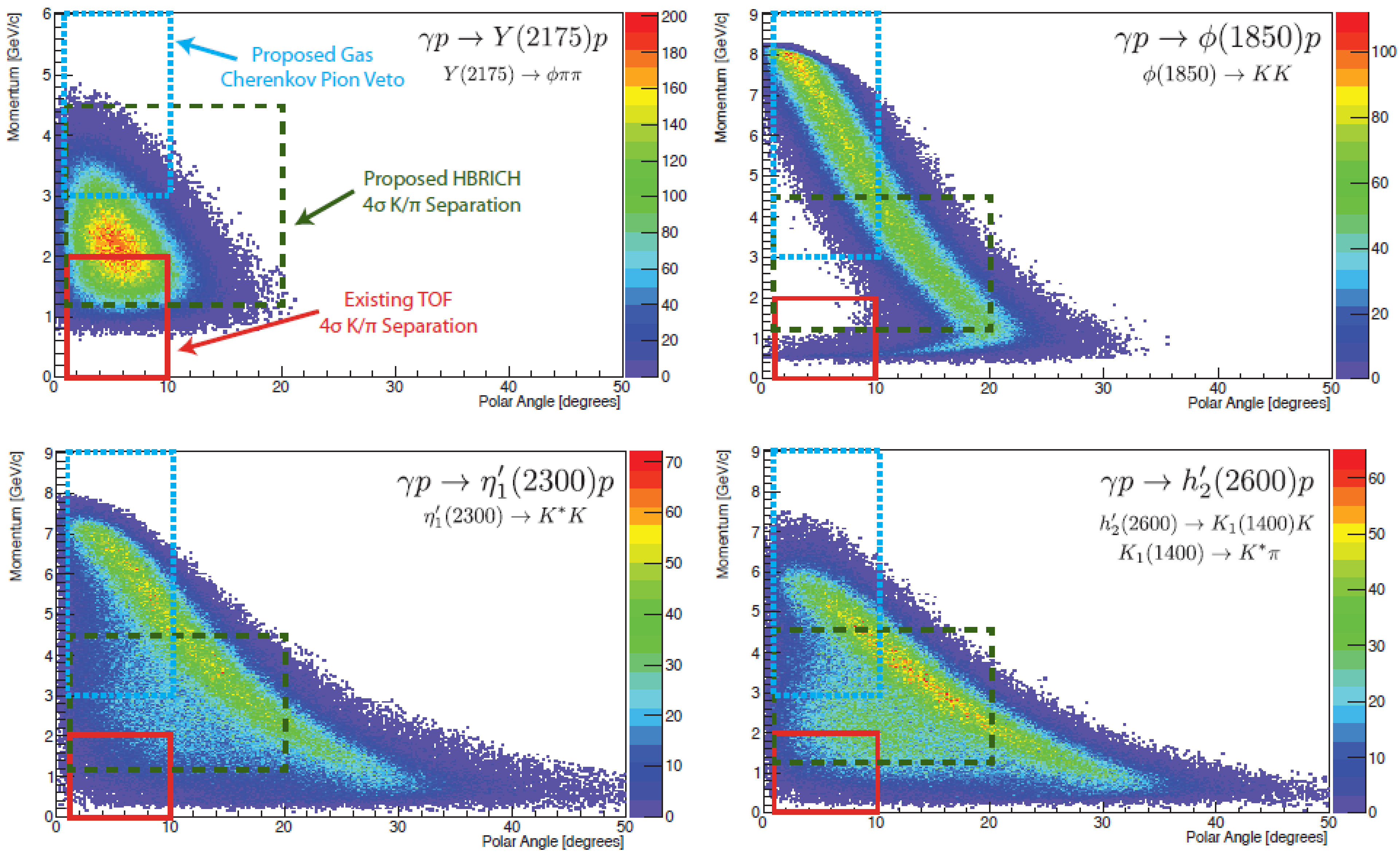
The characteristics of pion - kaon identification (separation) versus momentum with the track reconstructed in the FCDC for three different ***Cherenkov angle resolutions in a DIRC*** :

- 1.2 mrad : the best achievable
- 1.7 mrad : a design close to the BaBar DIRC
- 2.0 mrad : pessimistic scenario





The mean kaon selection efficiency and pion misidentification are ~95% and <10% resp.



$\gamma p \to Y(2175)p$
$Y(2175) \to \phi\pi\pi$
Proposed Gas Cherenkov Pion Veto
Proposed HBRICH 4σ K/π Separation
Existing TOF 4σ K/π Separation
$\gamma p \to \phi(1850)p$
$\phi(1850) \to KK$
$\gamma p \to \eta_1'(2300)p$
$\eta_1'(2300) \to K^*K$
$\gamma p \to h_2'(2600)p$
$h_2'(2600) \to K_1(1400)K$
$K_1(1400) \to K^*\pi$
Momentum [GeV/c]
Polar Angle [degrees]