A DIRC for GlueX

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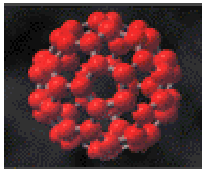


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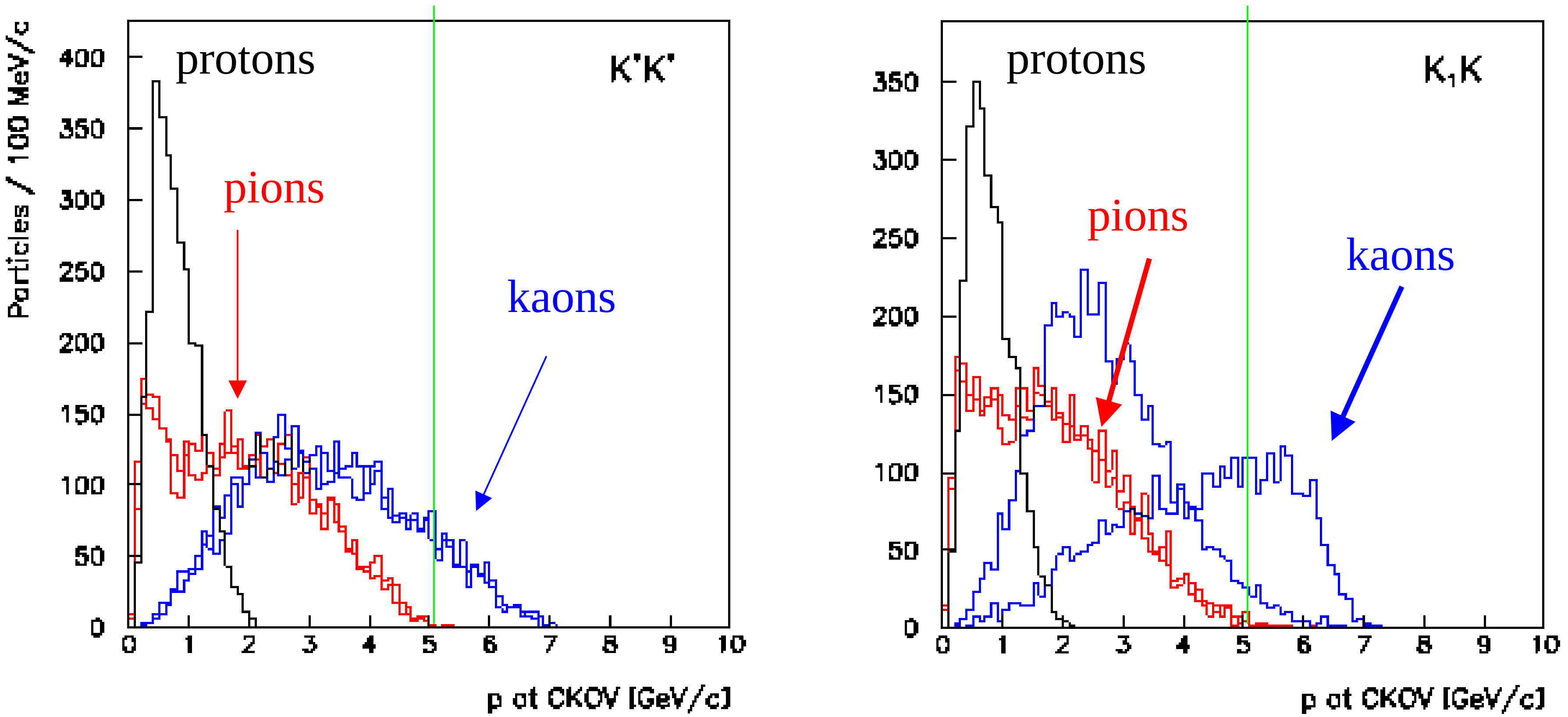
• Required Particle Identification

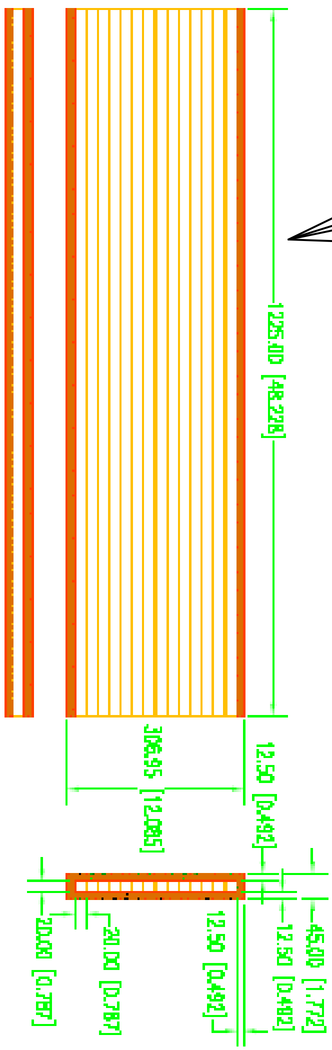
→ e.g. K*K*, K_1K does not need π/K separation above 5 GeV/c momentum



→ Towards lower momenta DIRC overlaps with dE/dX
→ TOF redundant ?

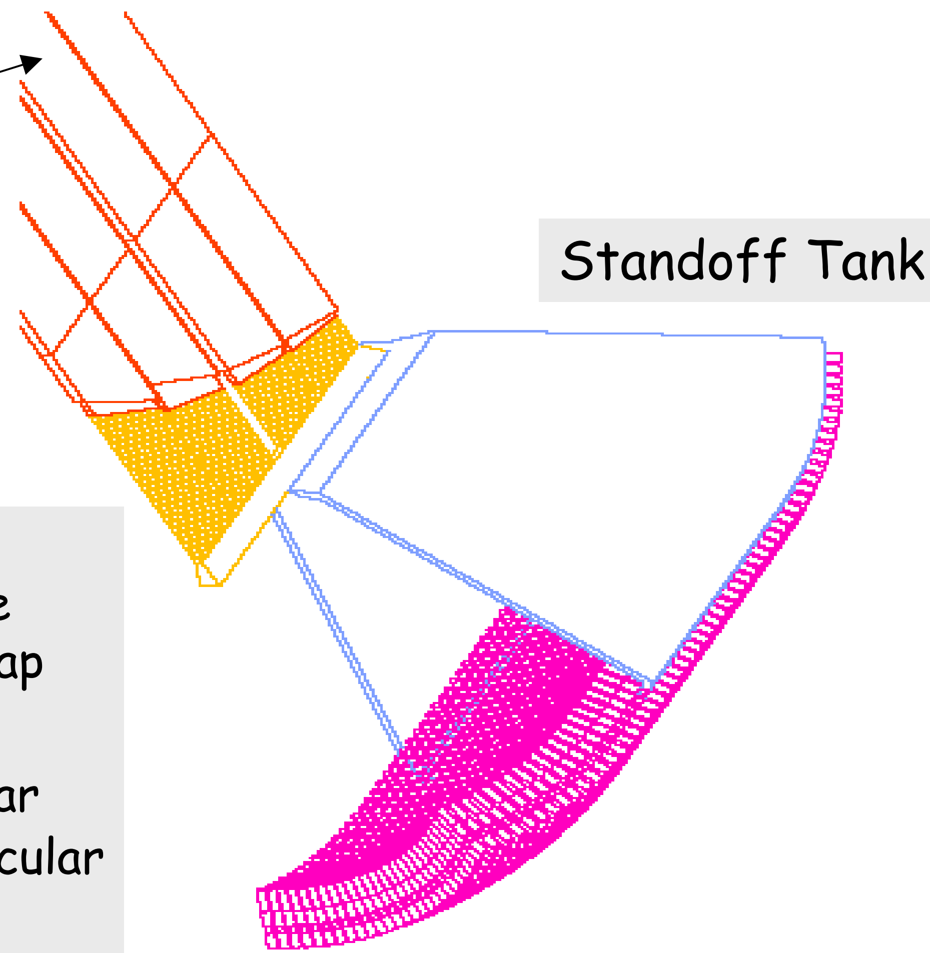
• A Preliminary Design

Turn cylindrical DIRC into flat DIRC e.g. with same imaging principle:
~ 60 DIRC-type bars (4 boxes) coupled to a water tank



4 bar boxes each placed behind the Solenoid with a gap for the beam.

~$\frac{1}{2}$ length of BaBar or less due to circular hole.



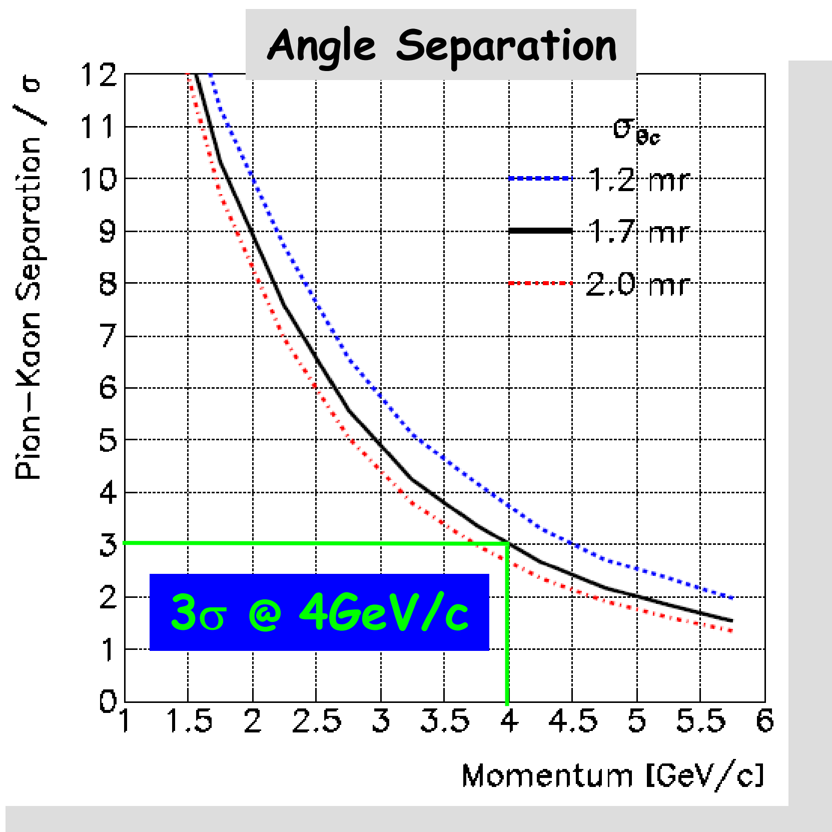
• The DIRC Performance

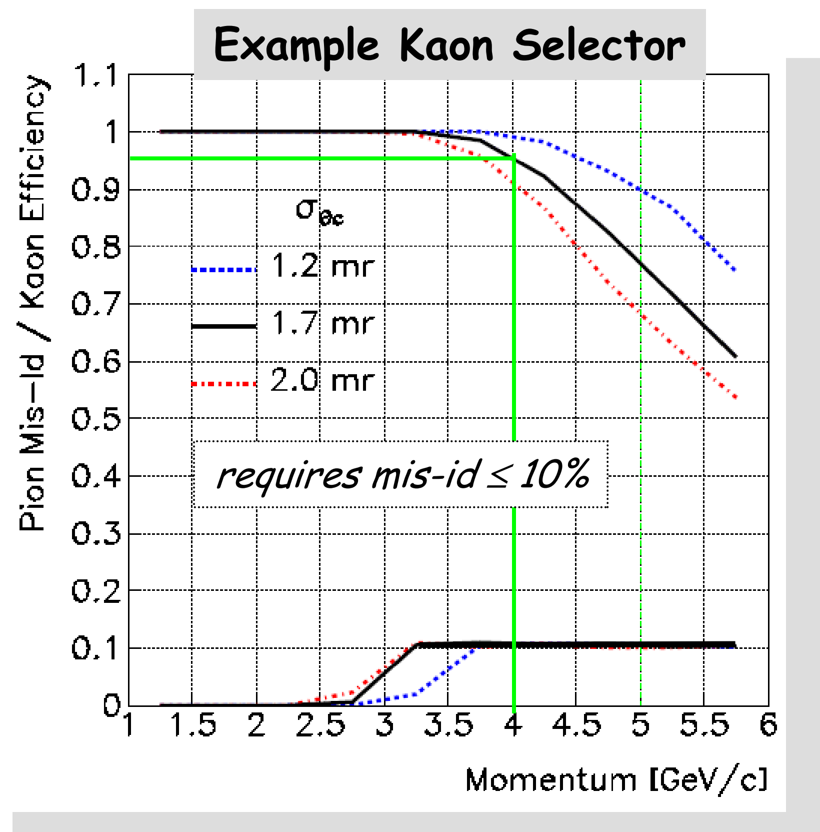
- **Threshold counter:** threshold momentum $p_{th}^{i} = 0.92 * m^{i}$
- **Ring Imaging**

➔**Covers momentum range 0.4 GeV/c …**

provides (with safety margin) **2σ π/K separation @5 GeV/c**

(i.e. kaon-selection efficiency >75% for <10% π-misid)





• A Cost Estimate for this Design

Material cost:	60 bars x $ 5k / bar	300 k
	30 optical elements/interface	60 k
	2000 PMT ($100/PMT + $100 readout)	400 k
	4 bar boxes	24 k
	support structure	20 k
	water tank	100 k
		904 k

→ Reserve 2 years to get bars (e.g. Zygo Connecticut)
or wait until available from BaBar (free) with handling at SLAC

Manpower: - 1 mech. engi., 2 craftsmen, 1 elect. engi.
- assembly: 2 mech. techn. , 1 electr. techn.

- prototype (1 barbox) was built from scratch with 10 people (SLAC+LBL) in 6 months (no clean room)
- 12 barboxes (144 x 4 bars + 144 optical elements glued) assembled within 1 year in class 1000 clean room
- support from SLAC possible (manpower, expertise, tools …)

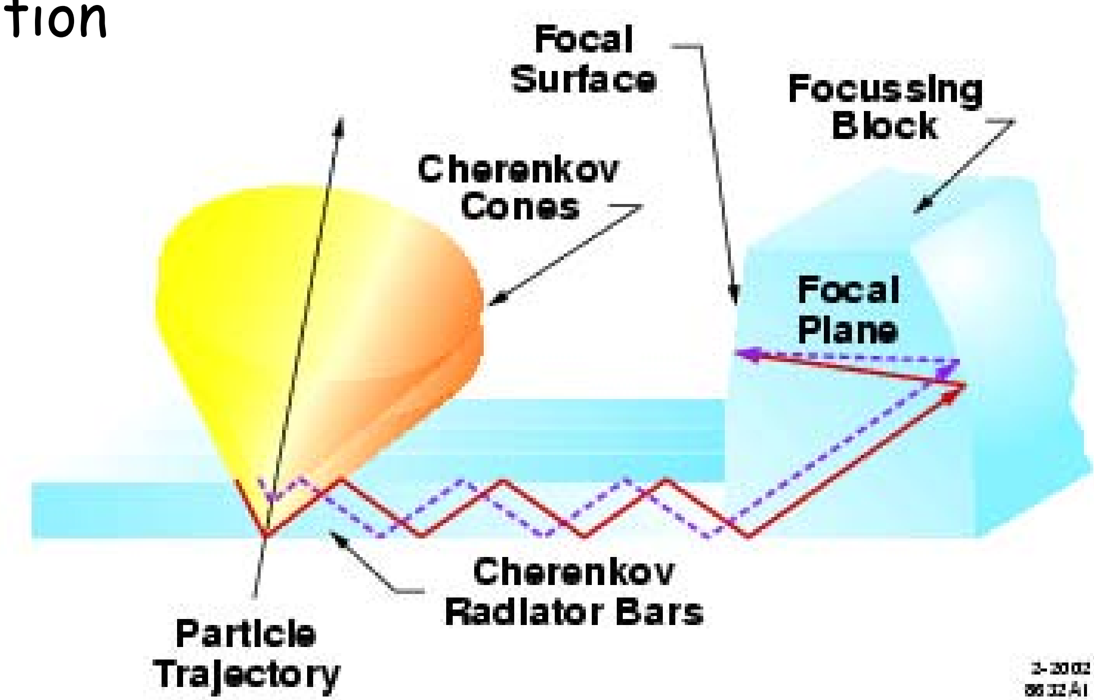
Howto: http://babar2.phys.utk.edu/~spanier/gluex/focus/drcnim.pdf

• New Compact Design

… under investigation at SLAC for a Super B-Factory.

Smaller sized photon-detector with focusing optics:

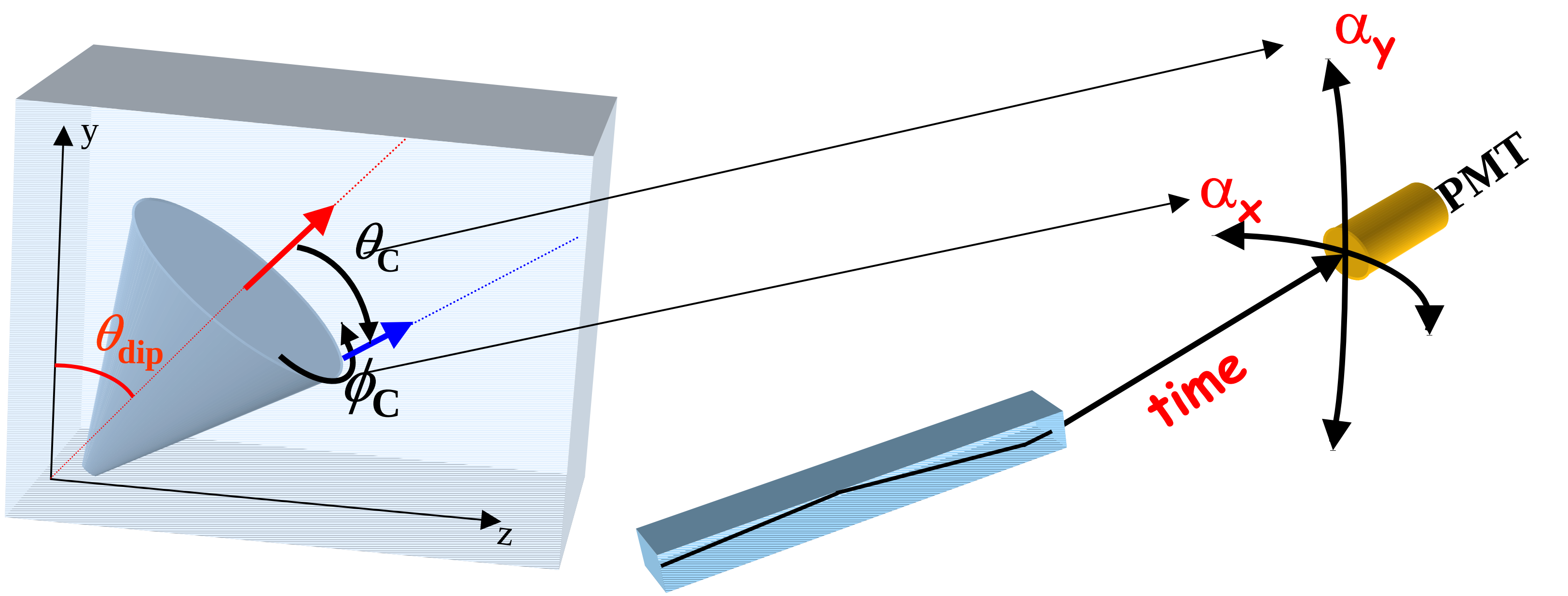
- get rid of water tank with different imaging (reduced background, maintenance)
- focusing removes bar-size uncertainty in the focusing plane
  ➔ improved geometrical (Cherenkov angle) resolution
- smaller detectors have better transit time spread
  ➔ improved timing resolution ($\sigma_{\Delta t}$ = 100 .. 200 ps) reduces chromatic uncertainty (and TOF capability)



Rem: Probably one large quartz plate with improved timing does the job.

• New Compact Design

In general, the DIRC is a 3D device.



The current DIRC uses pin-hole focus:

29mm diameter PMTs, $\sigma_{\Delta t}$ = 1.5 ns ; standoff distance: 1170 mm

➔exit angle resolution per photon

$\sigma_{\alpha x}$	=	10.6 mrad	(larger bar dimension)
$\sigma_{\alpha y}$	=	7.6 mrad	(more important coordinate)
$\sigma_{\Delta t}$	=	1.7 ns	(does not contribute; resolves ambiguity and reduces background)

Rem: the transition silica-water improves the angle resolution by about 10%

Rem: Particle ID likelihood based on hit pattern in PMT plane.

• New Compact Design

Focusing Optics examples

a) Focusing in y; pixel size 6mm x 6mm; standoff dist: 250mm

$\sigma_{\alpha x}$ > 10.6 mrad (no focus in this dimension)

$\sigma_{\alpha y}$ = 6.9 mrad

$\sigma_{\Delta t}$ < 200 ps (improves chromatic error)

b) Focusing in y; pixel 6mm in x, 2mm in y; standoff : 1000 mm x
250 mm y

$\sigma_{\alpha x}$ > 4.3 mrad (standoff means no bounce within distance)

$\sigma_{\alpha y}$ = 2.3 mrad

$\sigma_{\Delta t}$ < 200 ps (improves chromatic error)

➔ substantial improvement; increases separation at higher momenta.

R&D: - what pixelation / photon-detector
- how to modify the bar ends (rest of bar untouched)

Rem: Detector probably at lower radius ➔ not all bars needed

• Photon Detector Tests

Detector tests are ongoing at SLAC at present.
For material see:
http://babar2.phys.utk.edu/~spanier/gluex/

e.g. multi-anode PMT Hamamatsu H8500
8x8 channels; cost estimate: $5k/PMT ($80/channel)
No final readout design (lab design so far).

No final DIRC design, but design studies planned until this Summer'05.

➔ GlueX can benefit from the effort.

Extra slides …

• Cherenkov Angle Resolution in BaBar

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

total resolution/track, σ_{θ_C} :

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

Expect 25 photons (N_γ) or more