SuperB G4 Full Simulation
PID (=DIRC) Status

The short version...

No one is actively working on this!

There is also a longer version...

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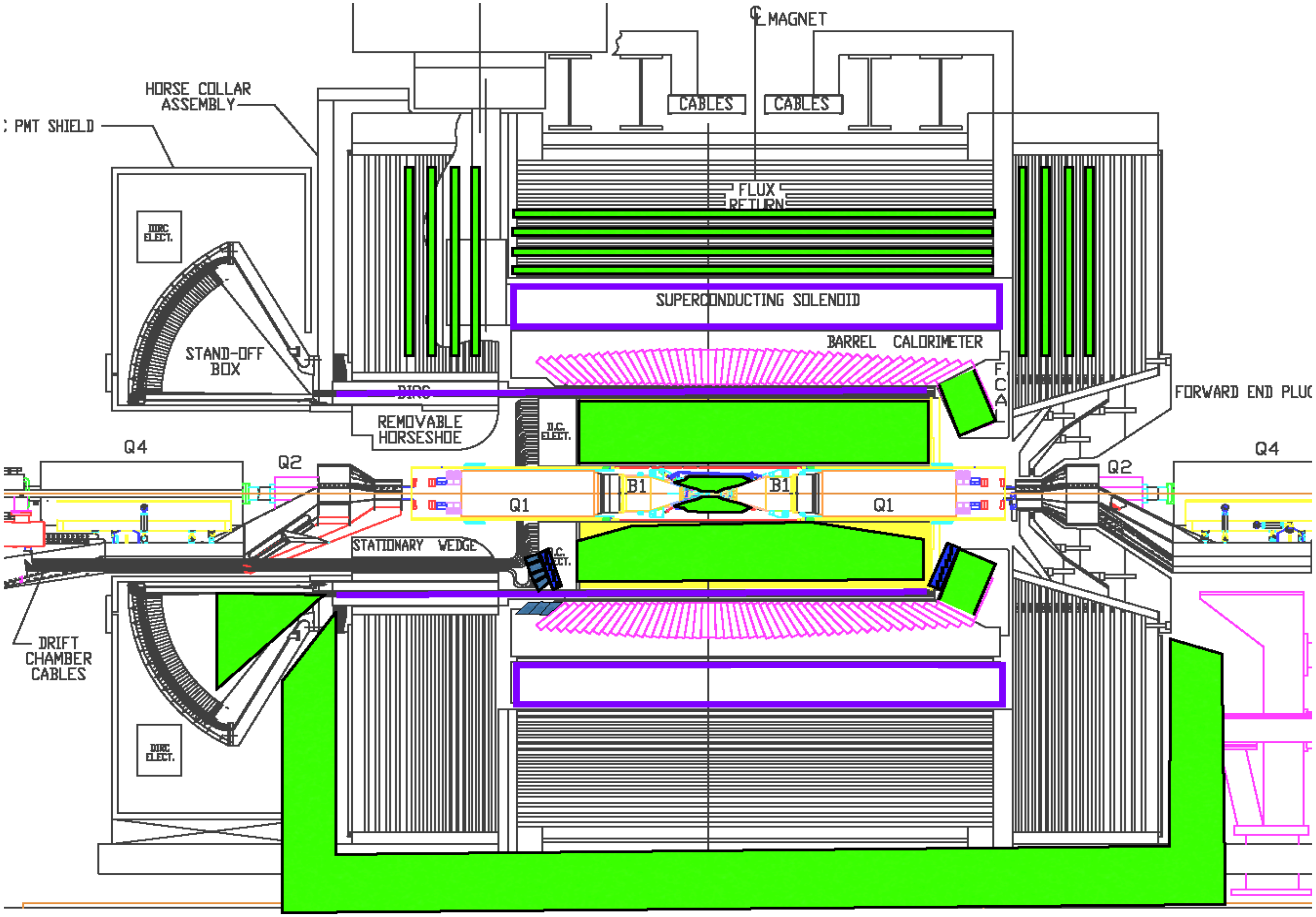
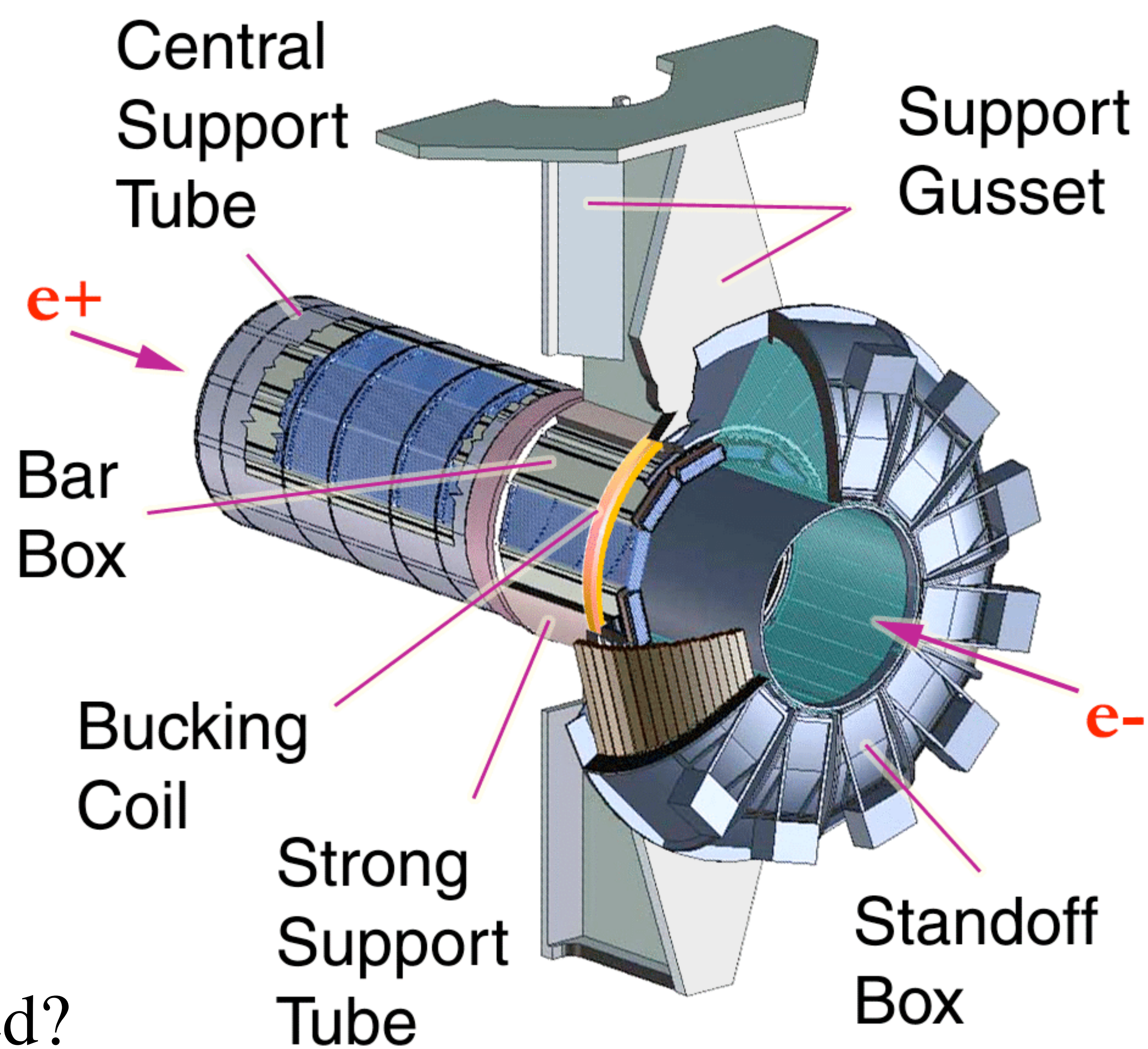
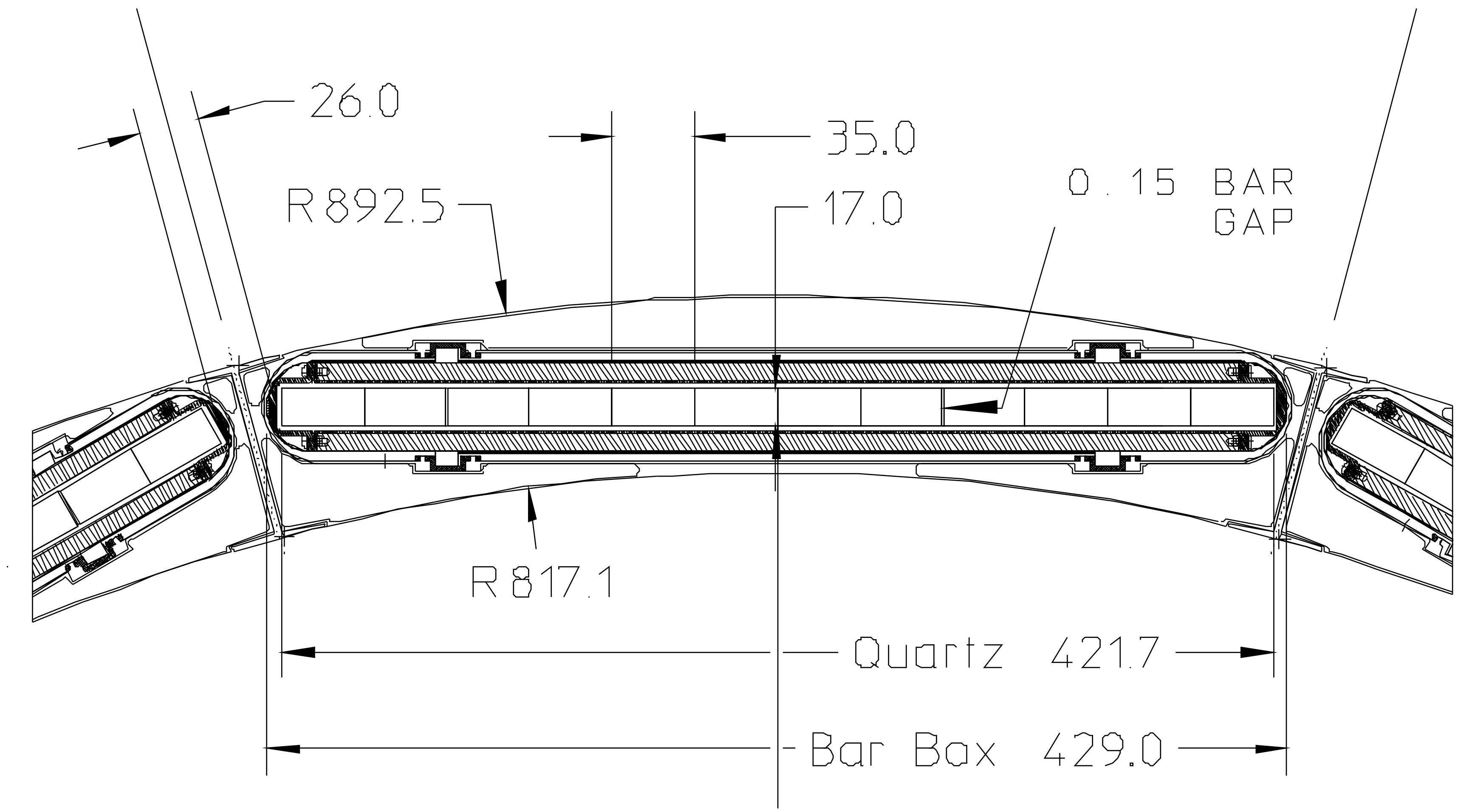


All proposed versions of SuperB include the DIRC



What is needed?

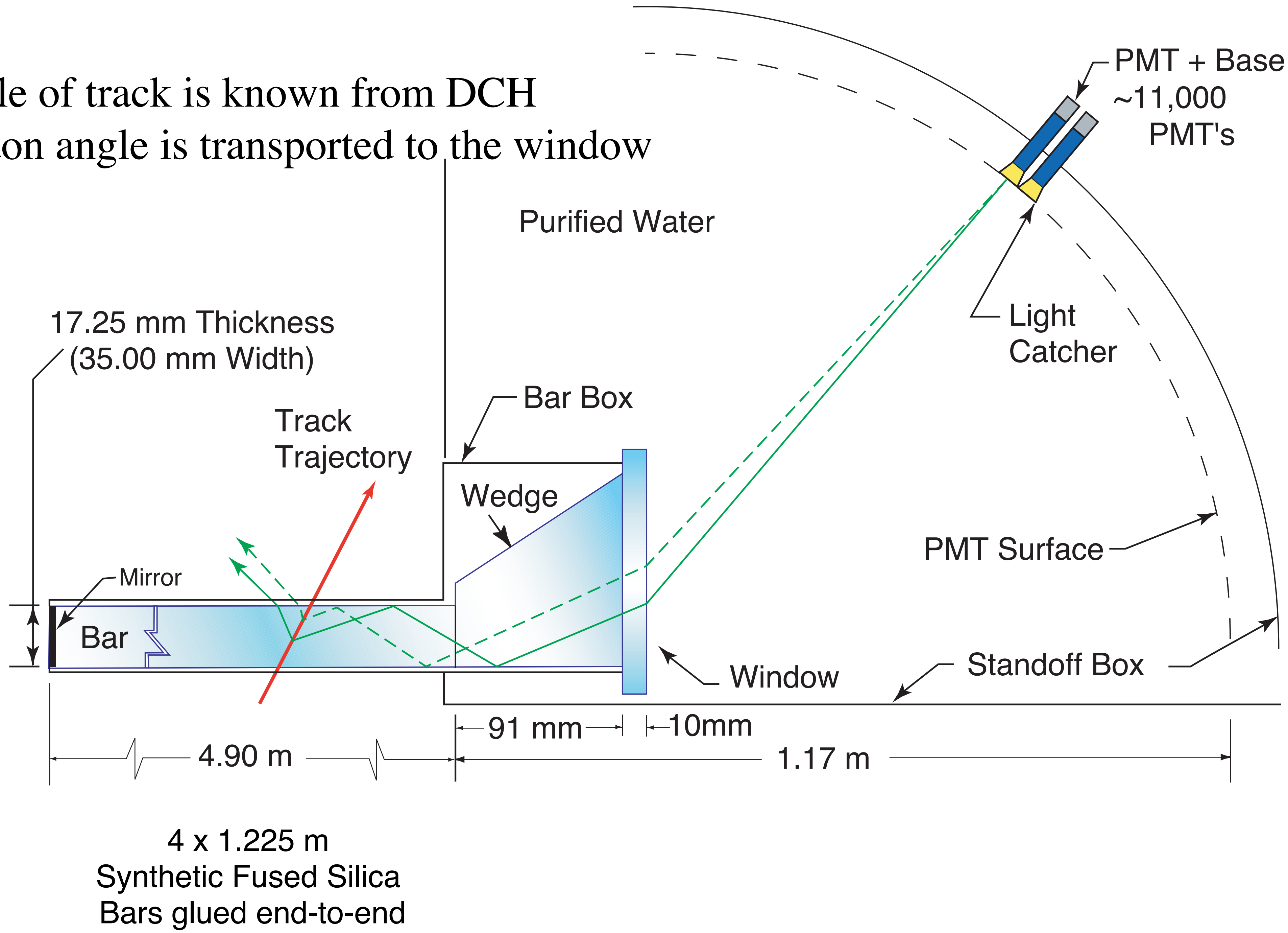
- detailed material distribution (affects EMC and IFR)
- simulation of Cherenkov process



BaBar G4 simulation contains a detailed material model

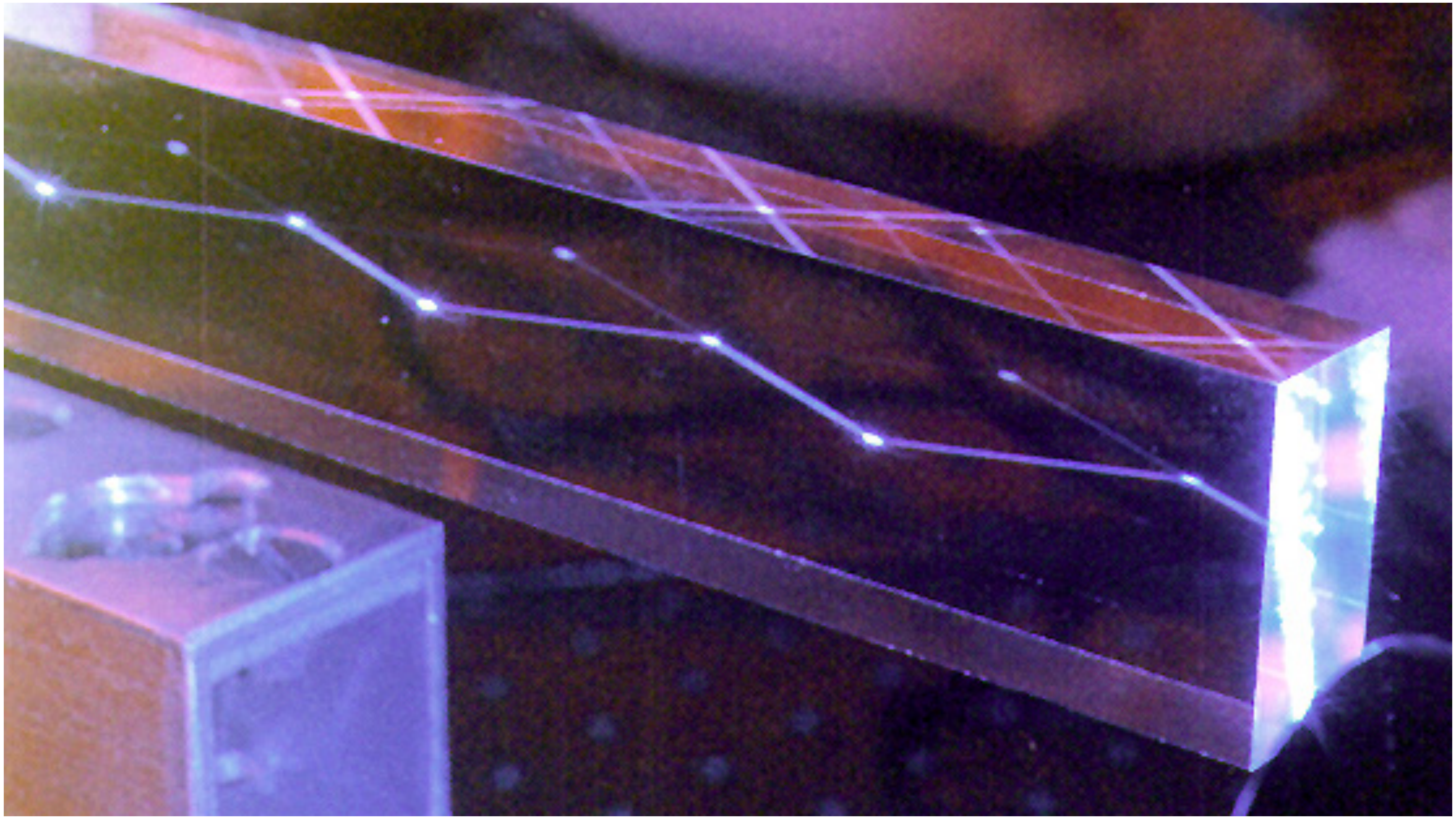
Easy to re–use

Angle of track is known from DCH
Photon angle is transported to the window



Schematic of DIRC principle

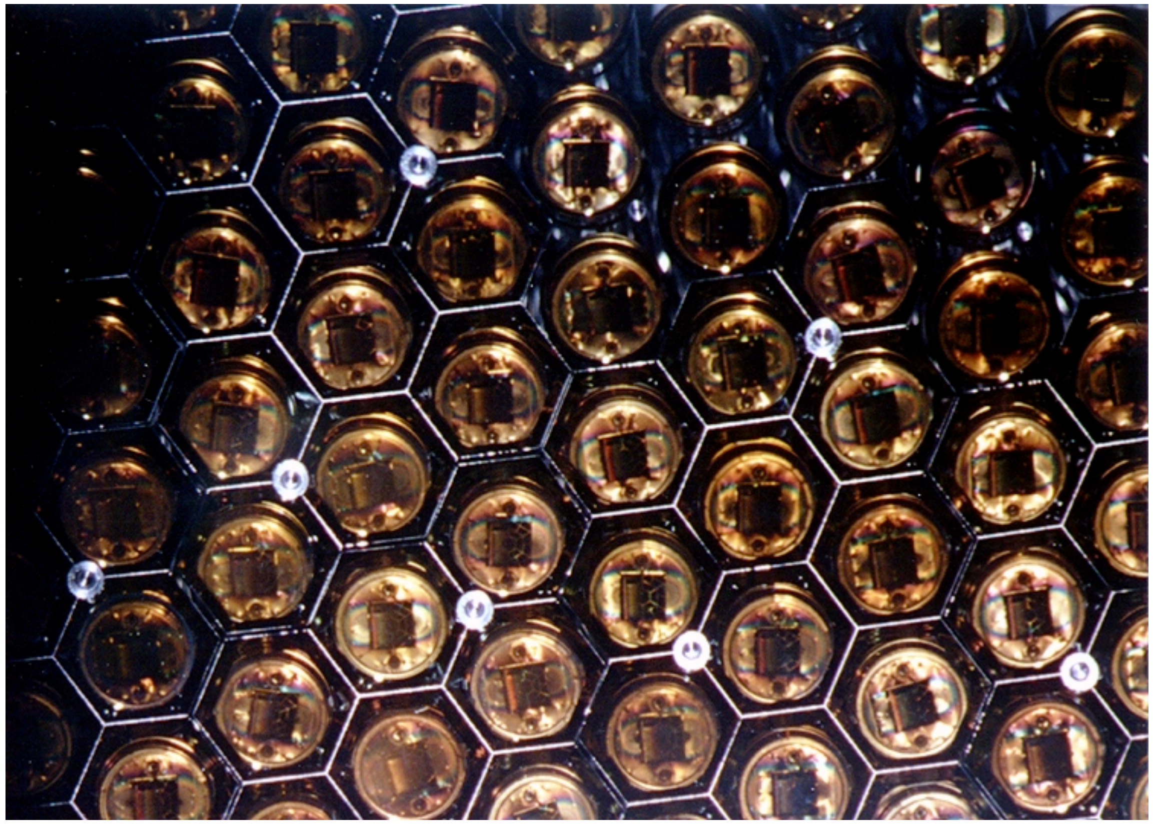
Detector of Internally Reflected Cherenkov light



Require very tight tolerances on bars:

- flat & smooth surfaces
- square & sharp edges

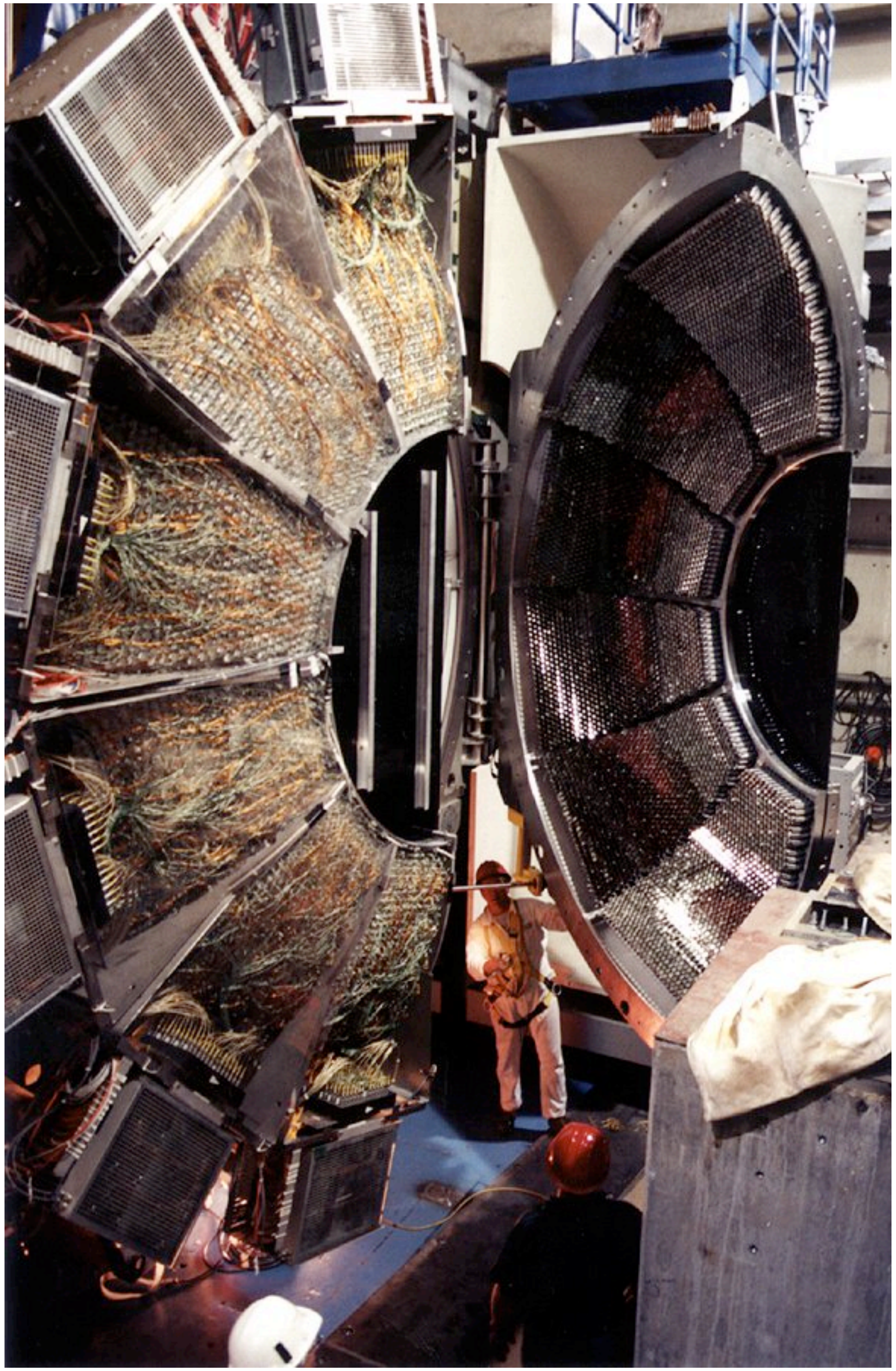
Visibility of laser beam → imperfections!



close-up of PMTs

Photon detectors will be replaced / re–designed.

Standoff box, one door open



Detailed simulation of Cherenkov process

- above threshold, EM "shock wave" on a cone
- $\cos\vartheta_c = 1 / \beta n$ (n~1.473); dispersive, $n = n(\lambda)$
- propagates at group velocity — $c/\{n - \lambda\, dn/d\lambda\}$
- when $\beta n > \sqrt{2}$, some photons always captured
- photon radiation rate ~ $\sin^2\vartheta_c$ ⇨ few photons to detect close to threshold
- get accurate measurement of time of arrival of photons; very effective in removing background

In BaBar, this simulation uses the DetectorModel package

Detailed simulation of Cherenkov process

Most of the code should be re–usable!
We did not always ray–trace every photon…
In a bar, photons are propagated to the wedge in a single step

Processes which are taken into account, most f(λ):

- optical dispersion
- absorption in bulk material
- surface roughness losses at total internal reflection
- mirror reflection
- reflection at glue joints (mis–matched index)
- quantum efficiency of photon detectors

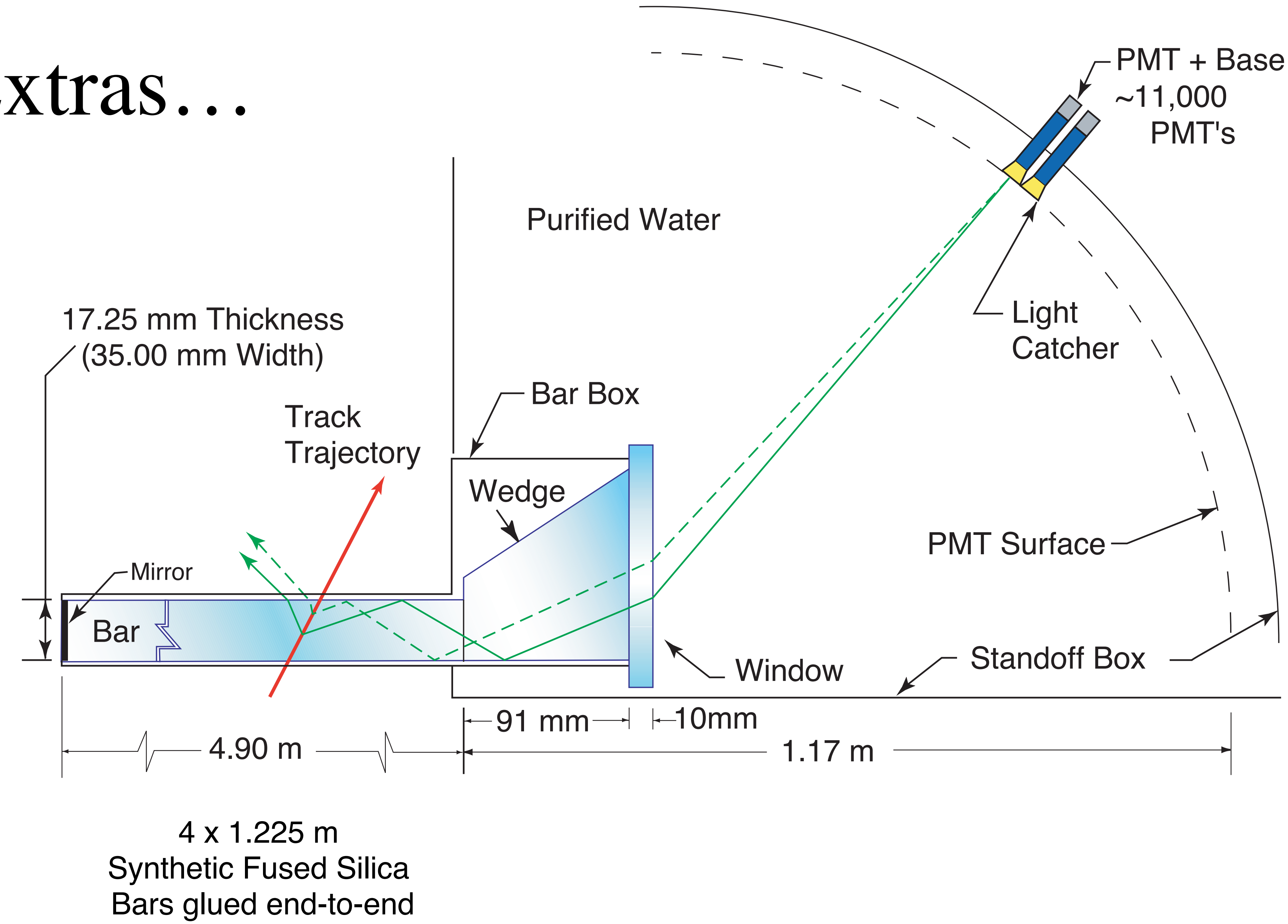
R&D on a Focusing DIRC

- Work has been done with a stand–alone Geant4 application in conjunction with R&D
- Based on BaBar DIRC experience, a comparable Cherenkov simulation was implemented, using entirely Geant4 classes. Caveat: the main implementer has left HEP.

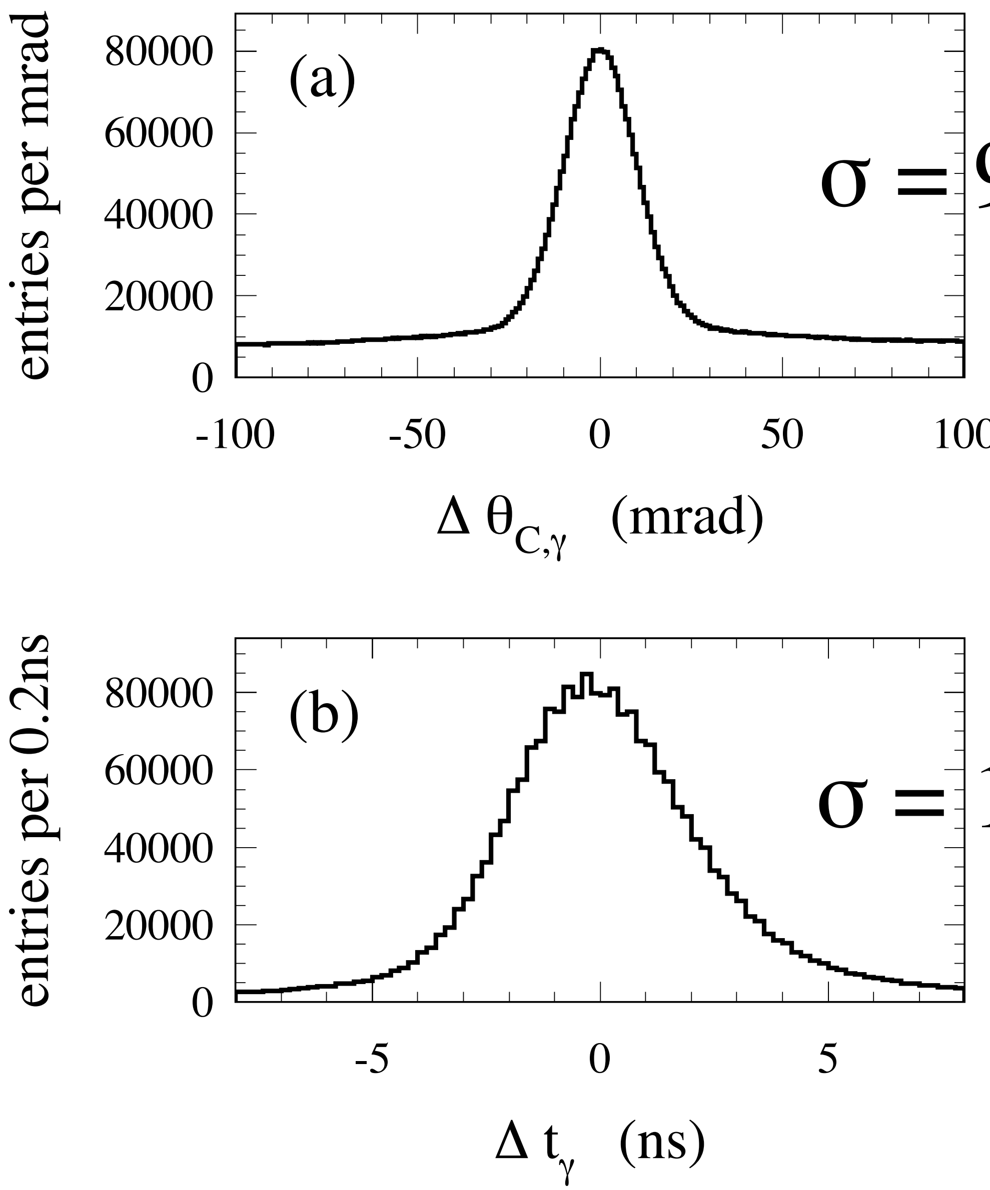
Summary

- No one is actively working on this!
- Depending on priorities and manpower, progress could be made on quite quickly.
- Volunteers are welcome! (Previous experience with BaBar code would likely be helpful.)

Extras…



- Many ray ambiguities: up/down, left/right, forward/ backward, wedge/no-wedge
- Typically only 2—3 sensible solutions



σ = 9.6mrad

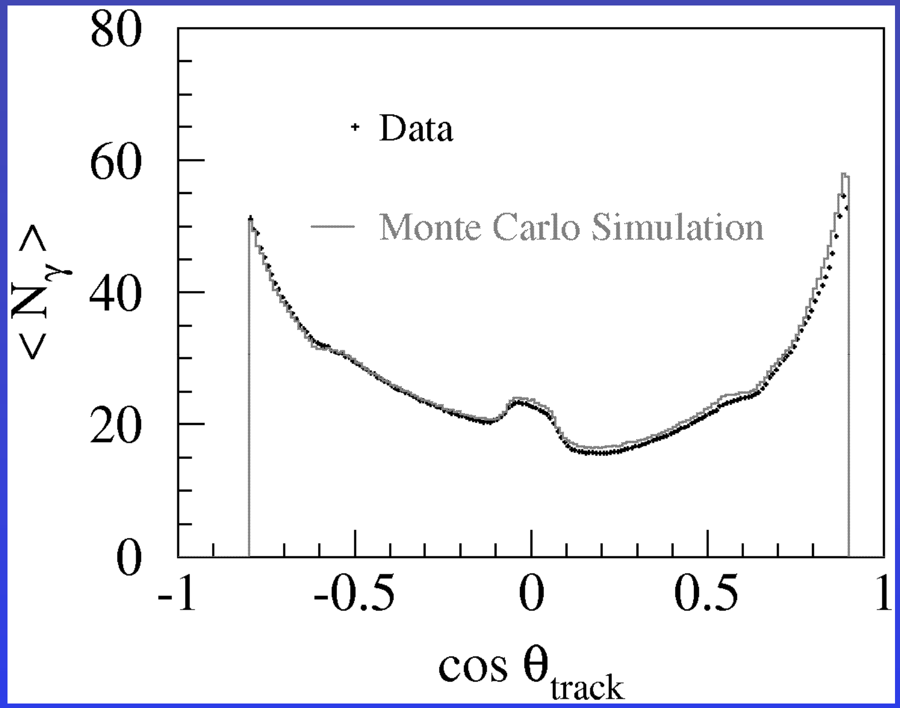
~7mrad bar/PMT size
5.4mrad dispersion

σ = 1.7ns

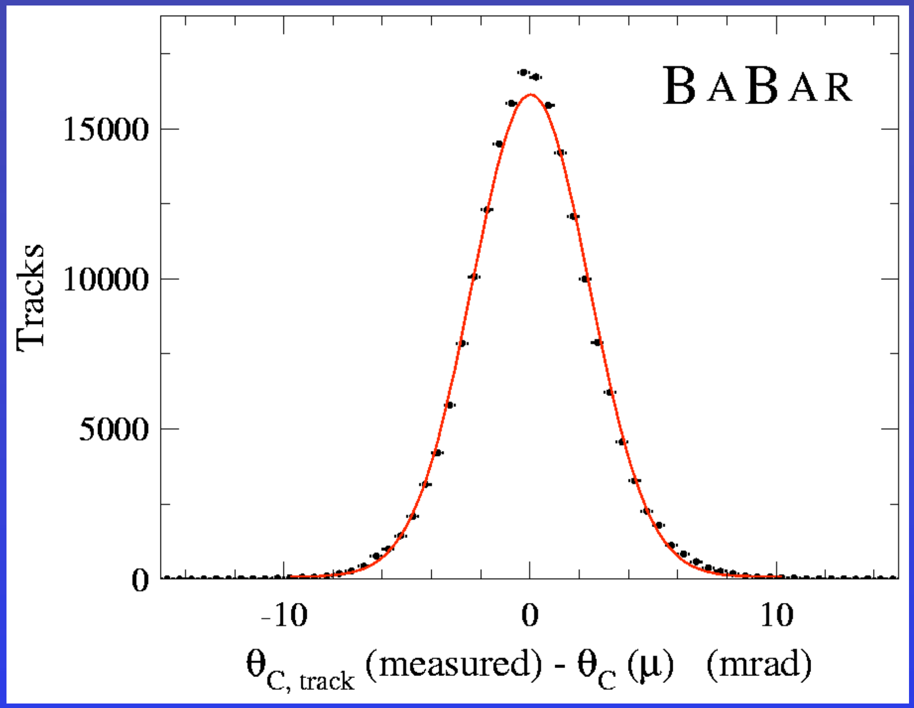
Single photon performance from di-muon events

DIRC PERFORMANCE

Number of Cherenkov photons per track (di-muons) *vs*. polar angle:



Resolution of Cherenkov angle fit per track (di-muons):



Between 20 and 60 signal photons per track.

$\sigma(\Delta\theta_c) = 2.4$ mrad

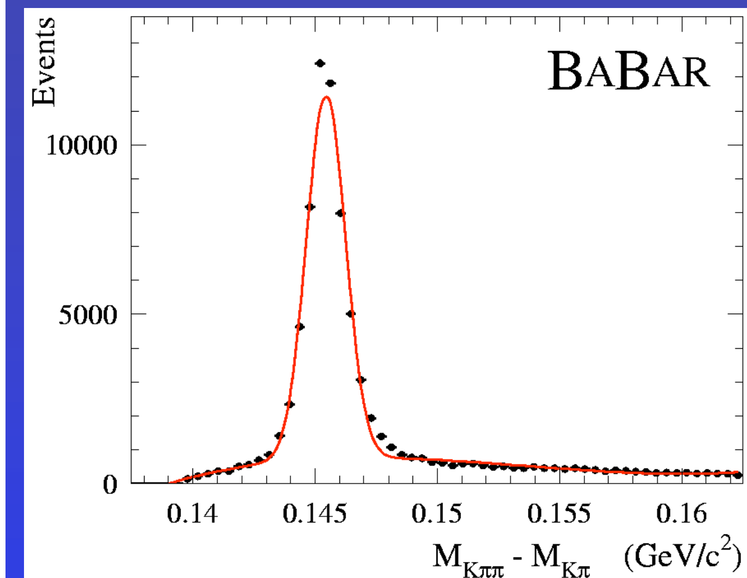
Very useful feature in BABAR environment:
higher momentum correlated with larger polar angle values
$\rightarrow$ more signal photons, better resolution ($\sim 1/\sqrt{N}$)

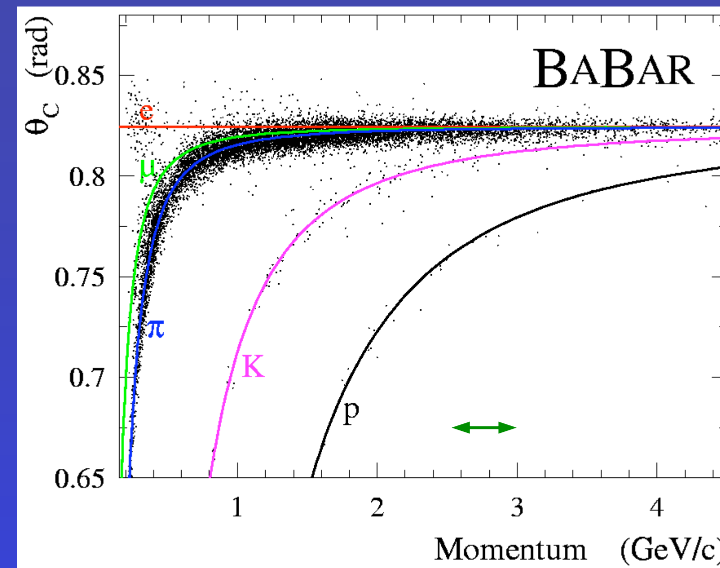
Track Cherenkov angle resolution is within ~10% of design.

Should improve with advances in track- and DIRC-internal alignment.

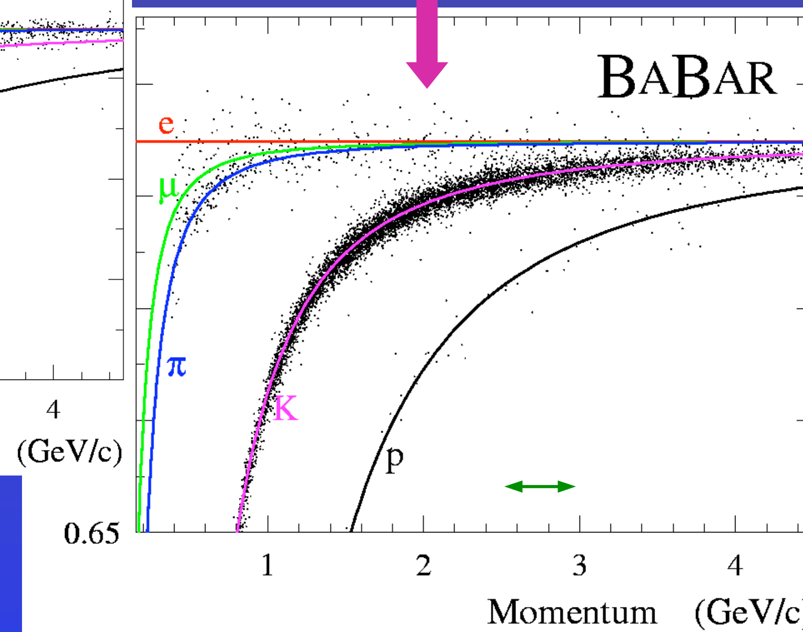
DIRC PERFORMANCE

$D^{*-} \rightarrow D^0 \pi^-$
$\quad \hookrightarrow K^- \pi^+$

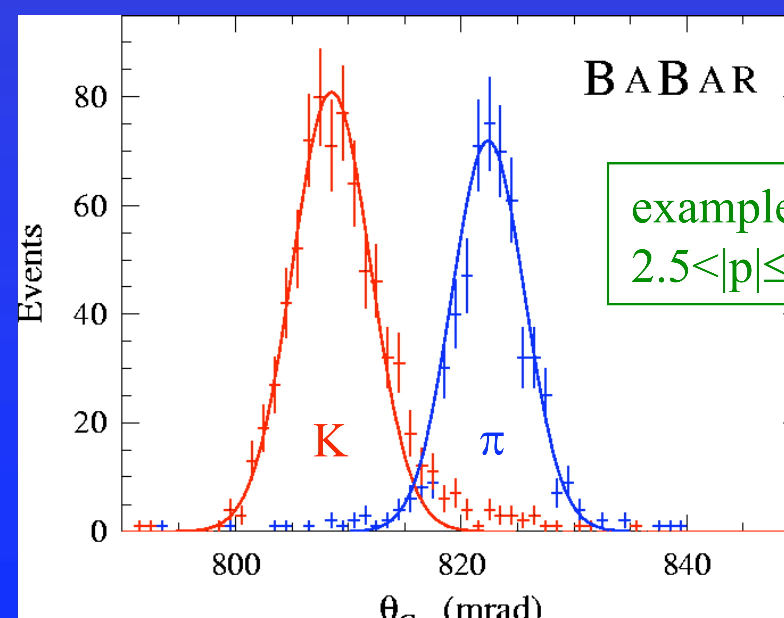




kinematically identified
π and K



- Select D^0 candidate control sample with mass cut (± 0.5 MeV/c^2)
- π and K are kinematically identified
- calculate selection efficiency and mis-id
- Correct for combinatorial background (avg. 6%) with sideband method.



example:
2.5<|p|≤3GeV/c