Can We Use **DIRC** Detector in SoLID for SIDIS Kaon PID?

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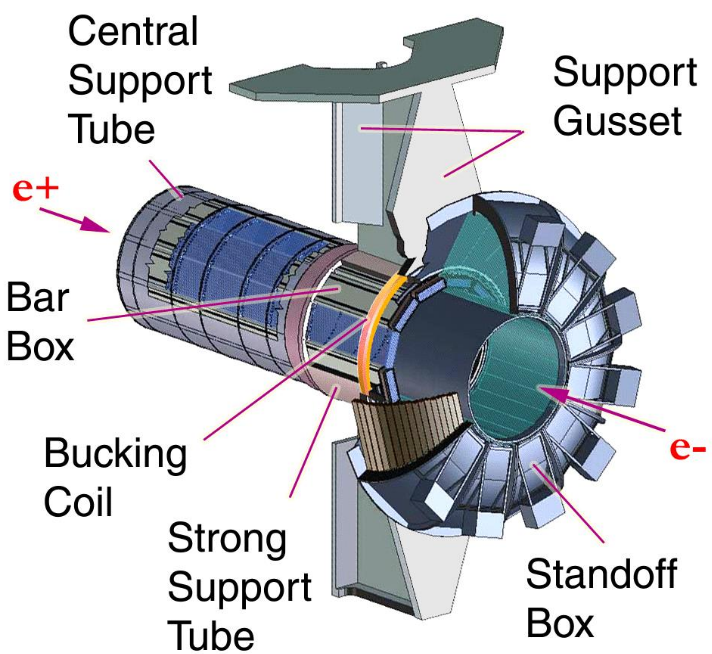
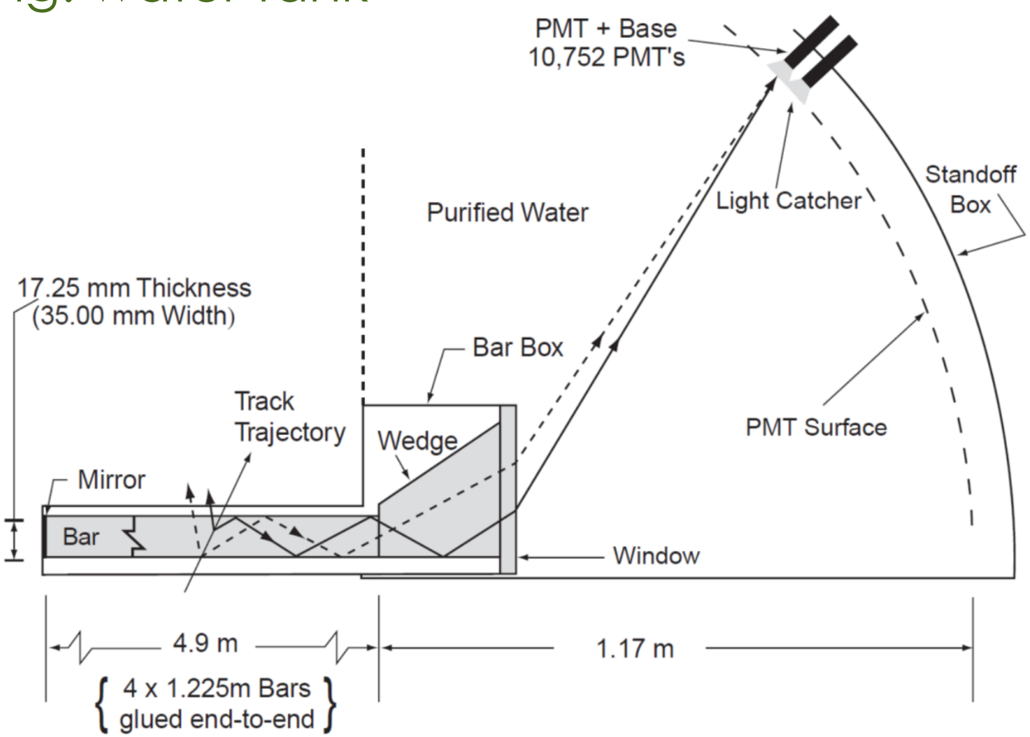
SoLID Collaboration Meeting

11/9/2013

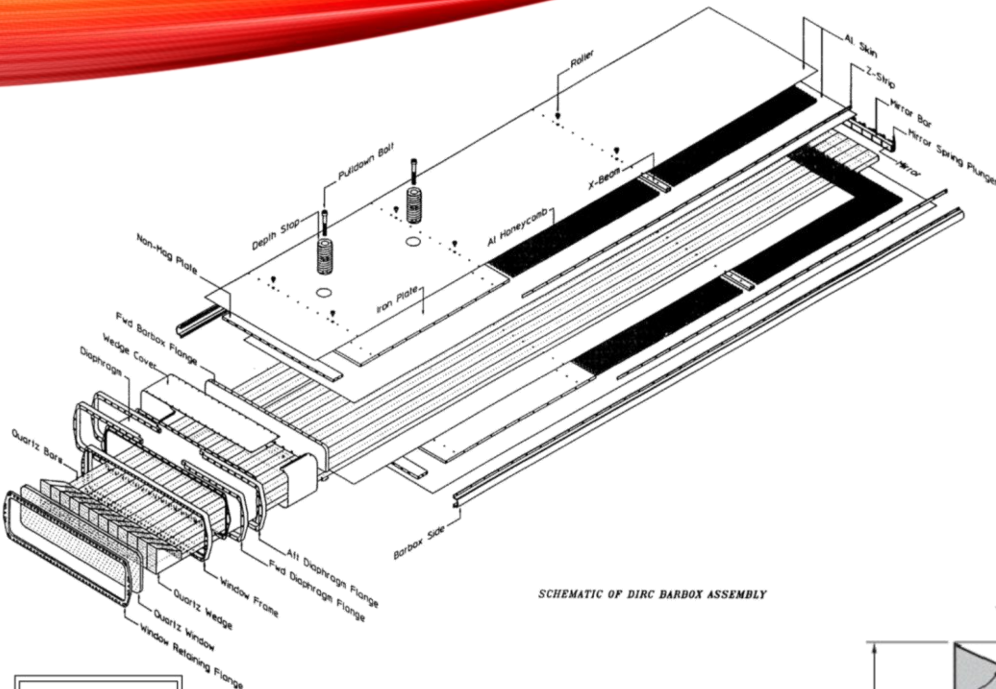
PRINCIPLE OF DIRC DETECTOR

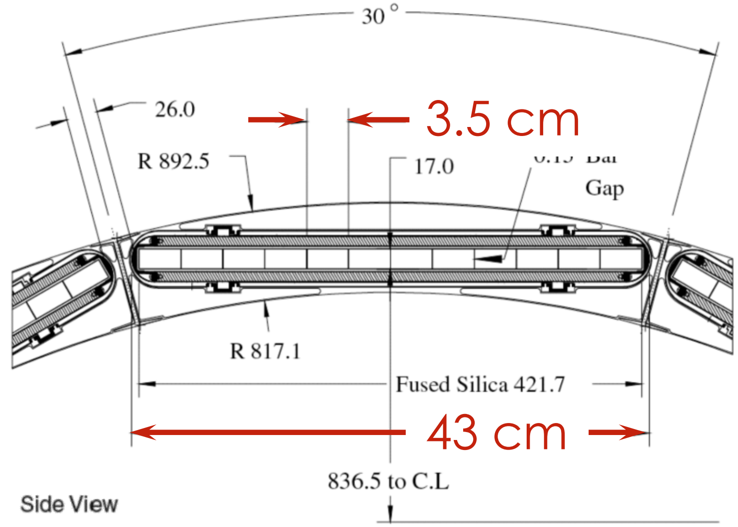
- **DIRC**: **D**etection of **I**nternally **R**eflected **C**herenkov lights
- BABAR DIRC:
  - The first and only built DIRC detector
  - Synthetic fused Silica radiator: n = 1.473
  - Pin-hole proximity focusing: water tank

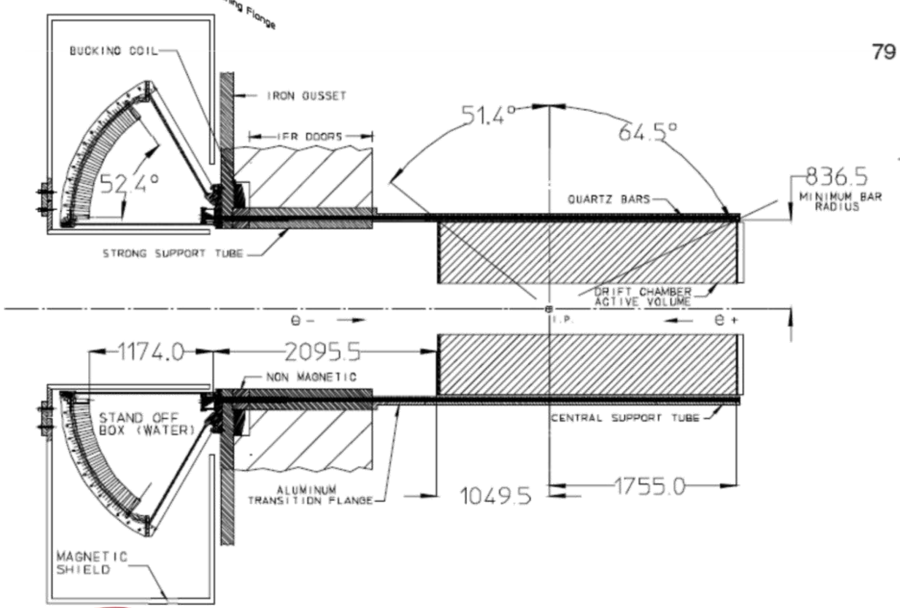


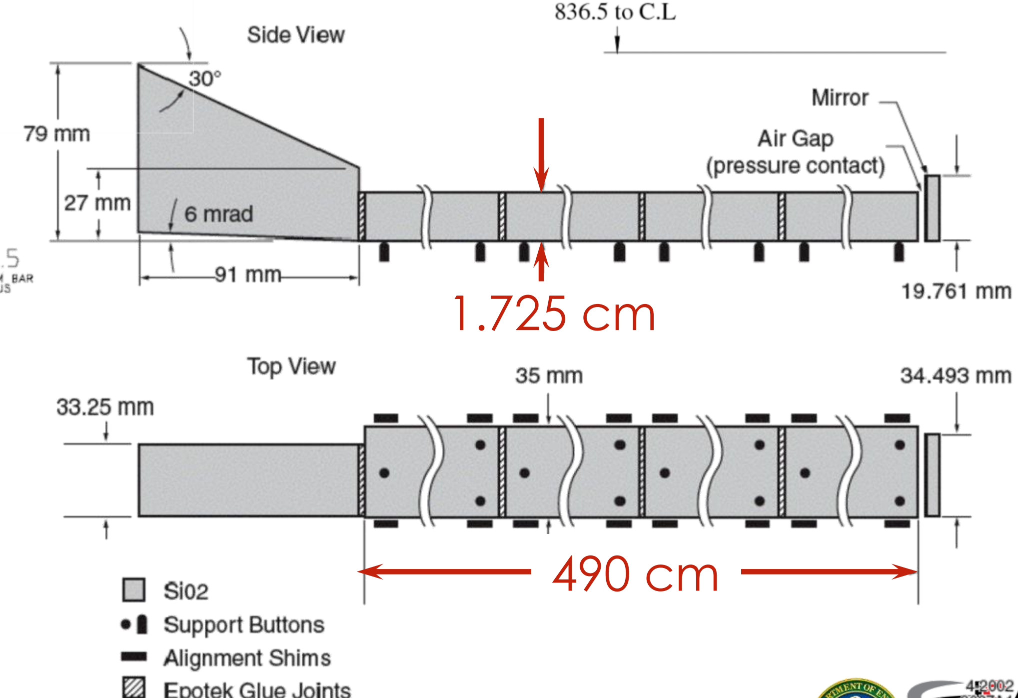


BaBAR DIRC Bar Boxes





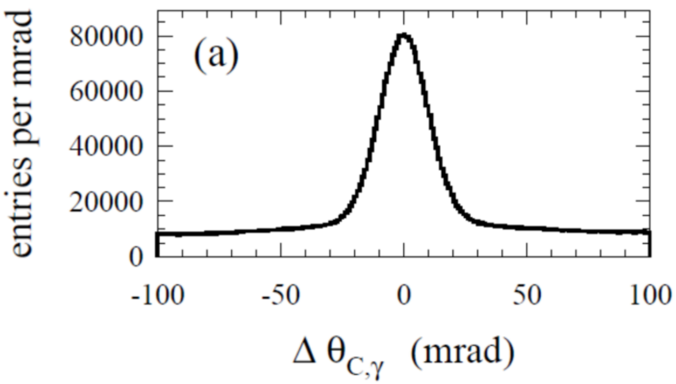


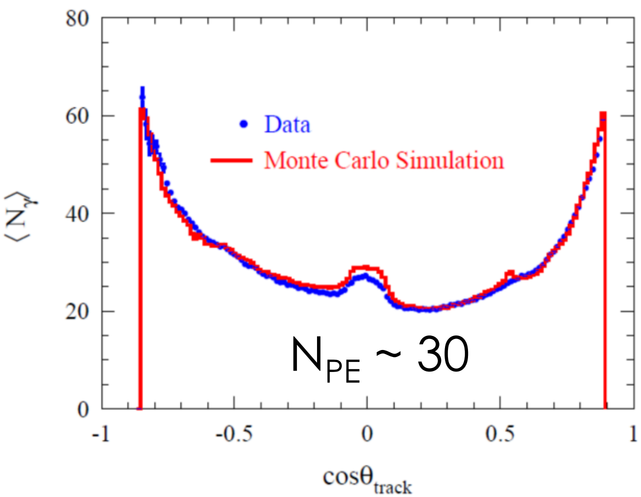


BaBar DIRC's Performance

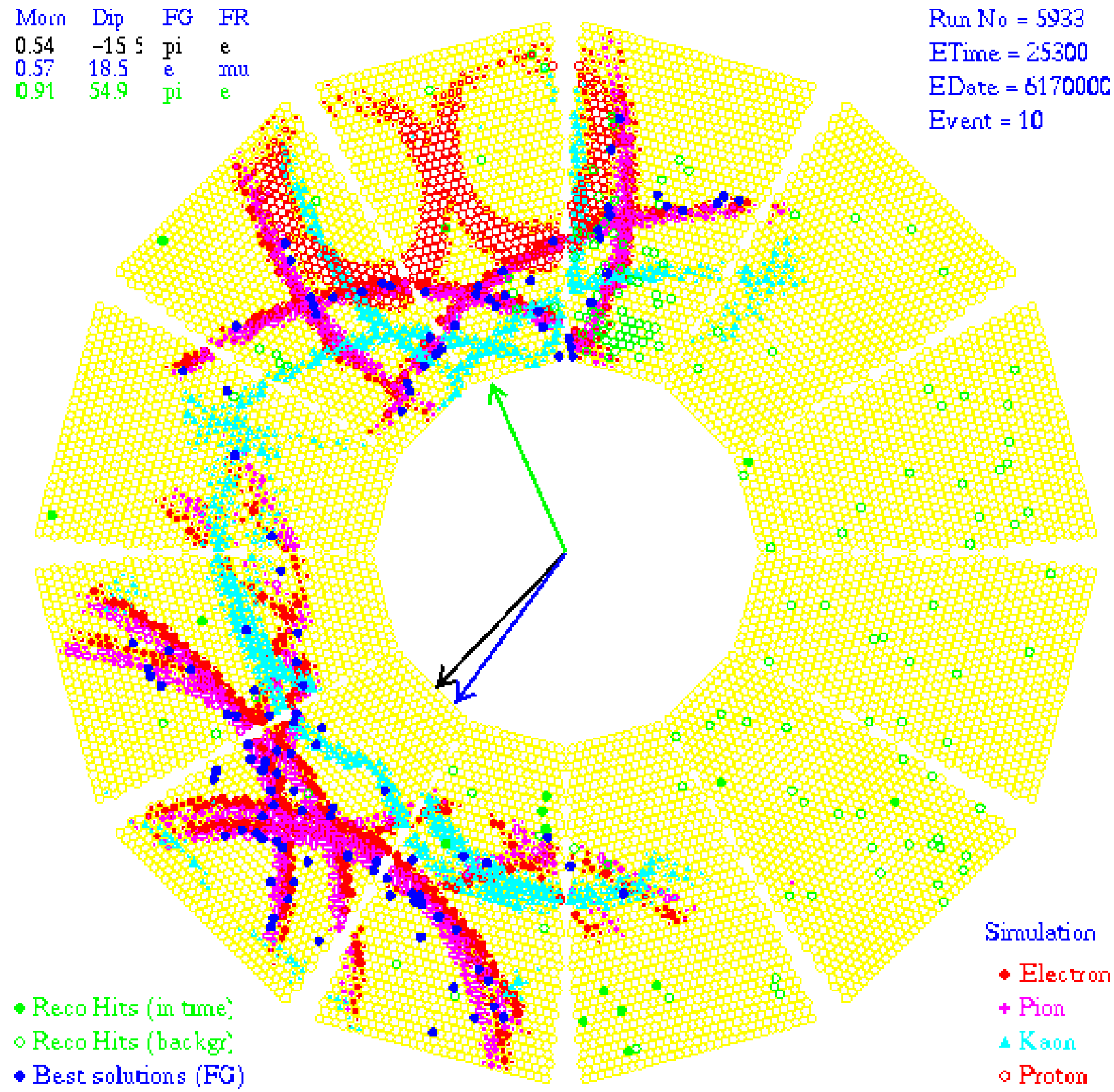
- 3σ K/π separation < 3.7 GeV/c

σ = 20 mrad





N_{PE} ~ 30



BaBAR DIRC Bars in Storage

Opportunities for SOLID

- BaBAR DIRC bars originally reserved for SuperB
  - Now available to other groups
- Schedule
  - Detailed proposal due by December 2013
  - Review committee
    - Blair Ratcliff, Jerry Va'vra, Bill Wisniewski, Brian Meadows
  - Recommendation to SLAC management
  - SLAC makes recommendations to DOE HEP
- Interested groups
  - GlueX, PANDA, PHENIX, LHCb, …

BaBar DIRC Equipment Requests

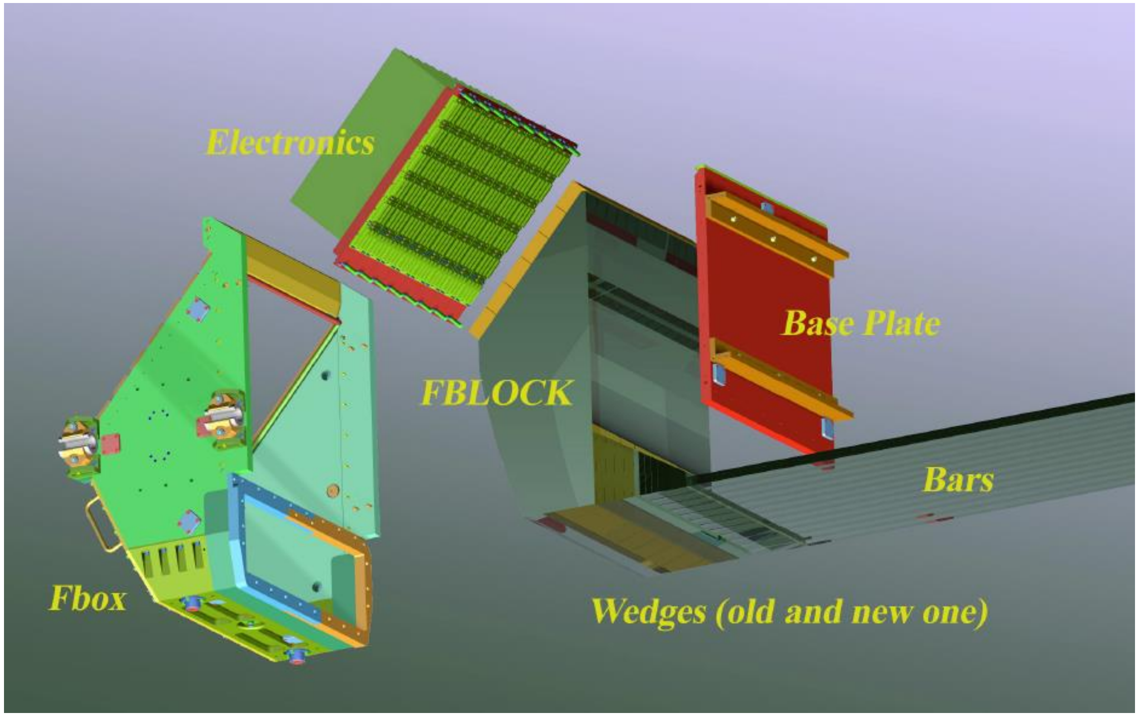
October 4, 2013

Dear Colleagues:

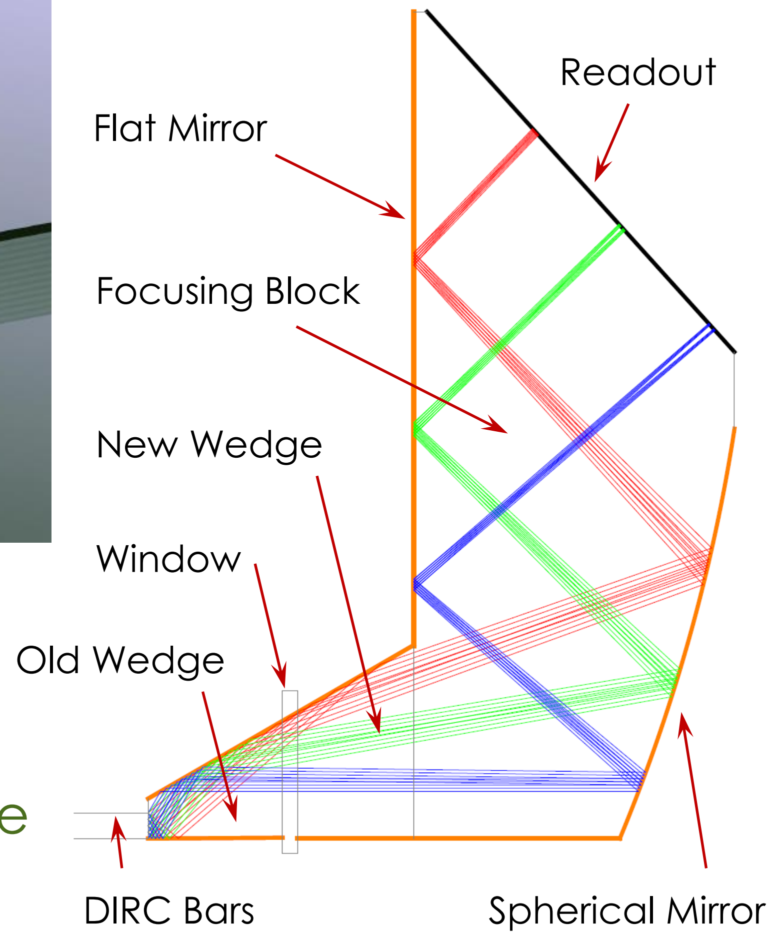
We are sending you this solicitation based either upon earlier communications or our knowledge of DIRC-like projects you are considering or have considered earlier. Since the SuperB project was terminated, SLAC PPA has been engaged in finding the best uses for valuable BaBar equipment that is now surplus and available. In particular, SLAC PPA and members of the BaBar DIRC community have received inquiries about potential reuse of DIRC components from a number of possible proponents. Given these multiple requests, SLAC PPA, with the support of DOE OHEP, has instituted a somewhat formal process to determine how these components should best be deployed. This process will comprise the following elements:

1. As an initial step, an expression of interest from proponents for the reuse of DIRC components should be sent by email to the committee chair (Blair Ratcliff) by Nov. 11, 2013.
2. A more detailed proposal from proponents should be sent by email to the committee chair by Dec. 9, 2013. We expect these proposals to be rather informal, with no strict lengths or formats defined, but would like the proponents to attempt to give the clearest possible picture of their intended reuse applications. The proposal would be most useful if it includes a synopsis of the physics that the DIRC elements will enable, a description of how this new DIRC fits into the larger detector, some description of the state of simulation used to understand the intended use, and a broader discussion of technical issues- including how the elements would be used, transported, etc., as well as a discussion of how the new device would be implemented (with a proposed schedule and estimated cost). Particular thought should be given to work elements that are intended to be done using SLAC personnel or facilities. There will be opportunities for questions and responses and other interactions between DIRC experts and proponents. Visits to see the DIRC

Focusing Design for DIRC

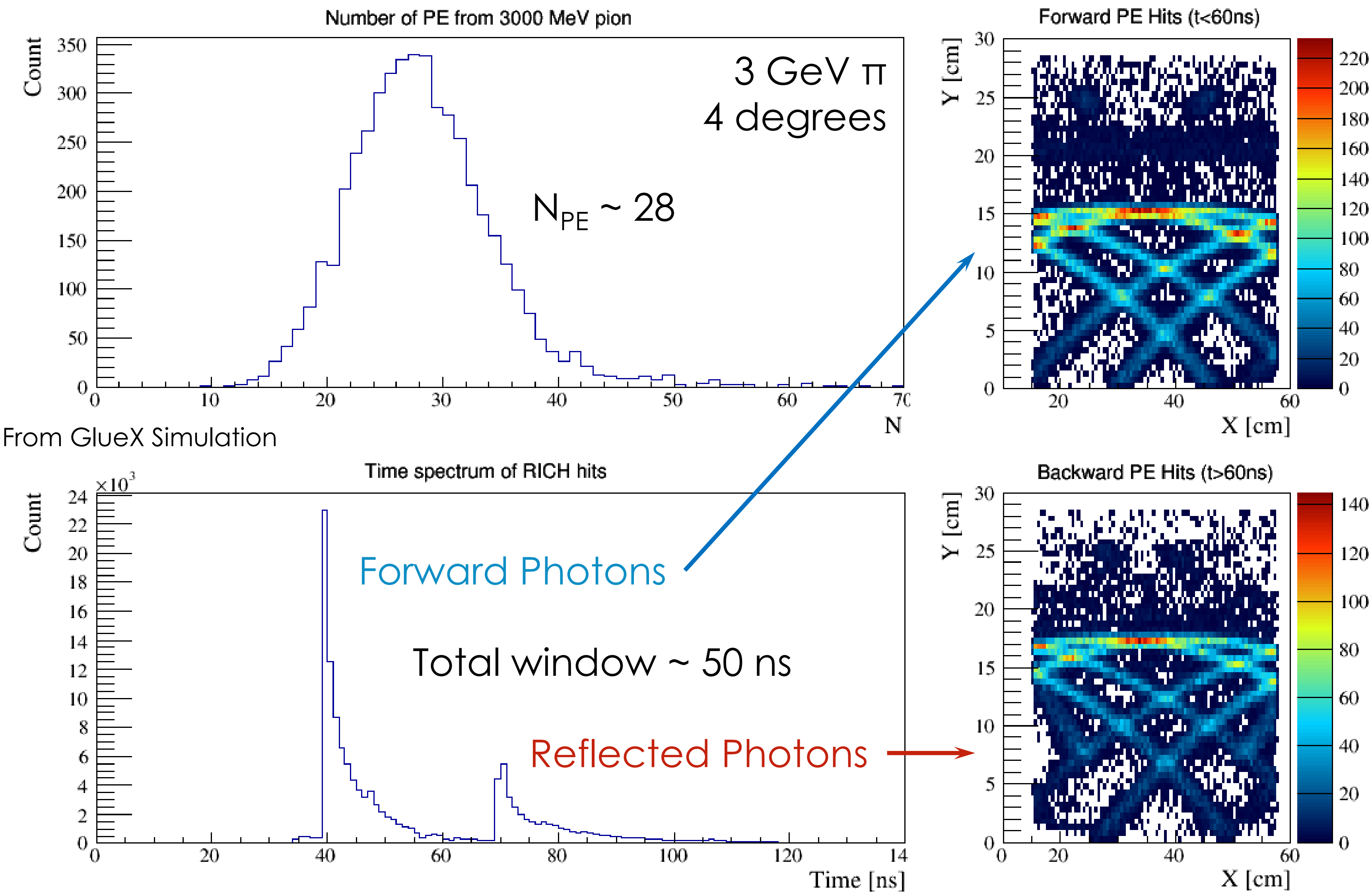


- Replace water tank by a focusing block made of Silica w/ mirrors coated
    - 25 times smaller, better performance
- Prototype in operation at SLAC

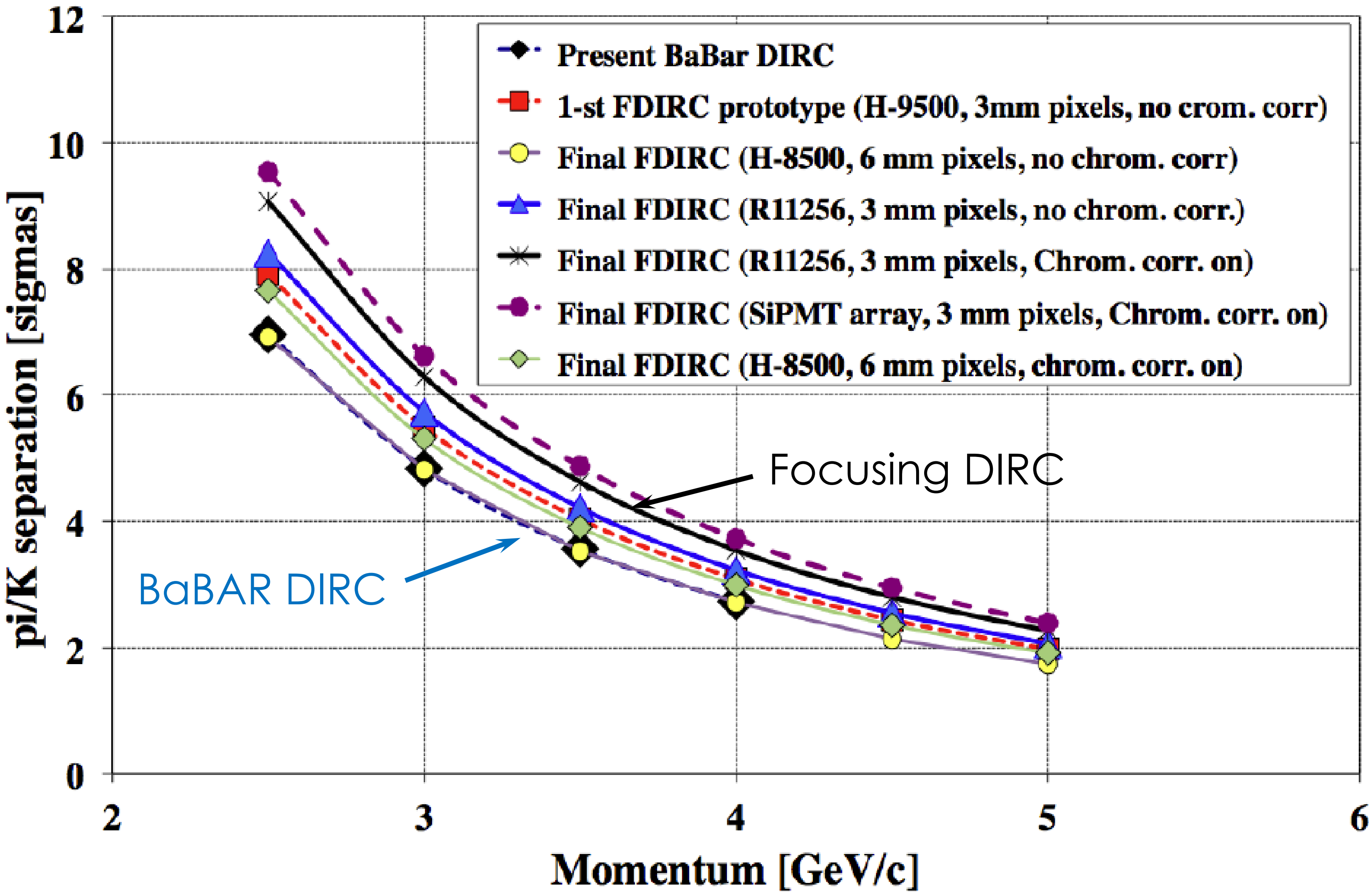


FBlock Prototype at SLAC

Typical Signal From FDIRC



EXPECTED DIRC PERFORMANCE

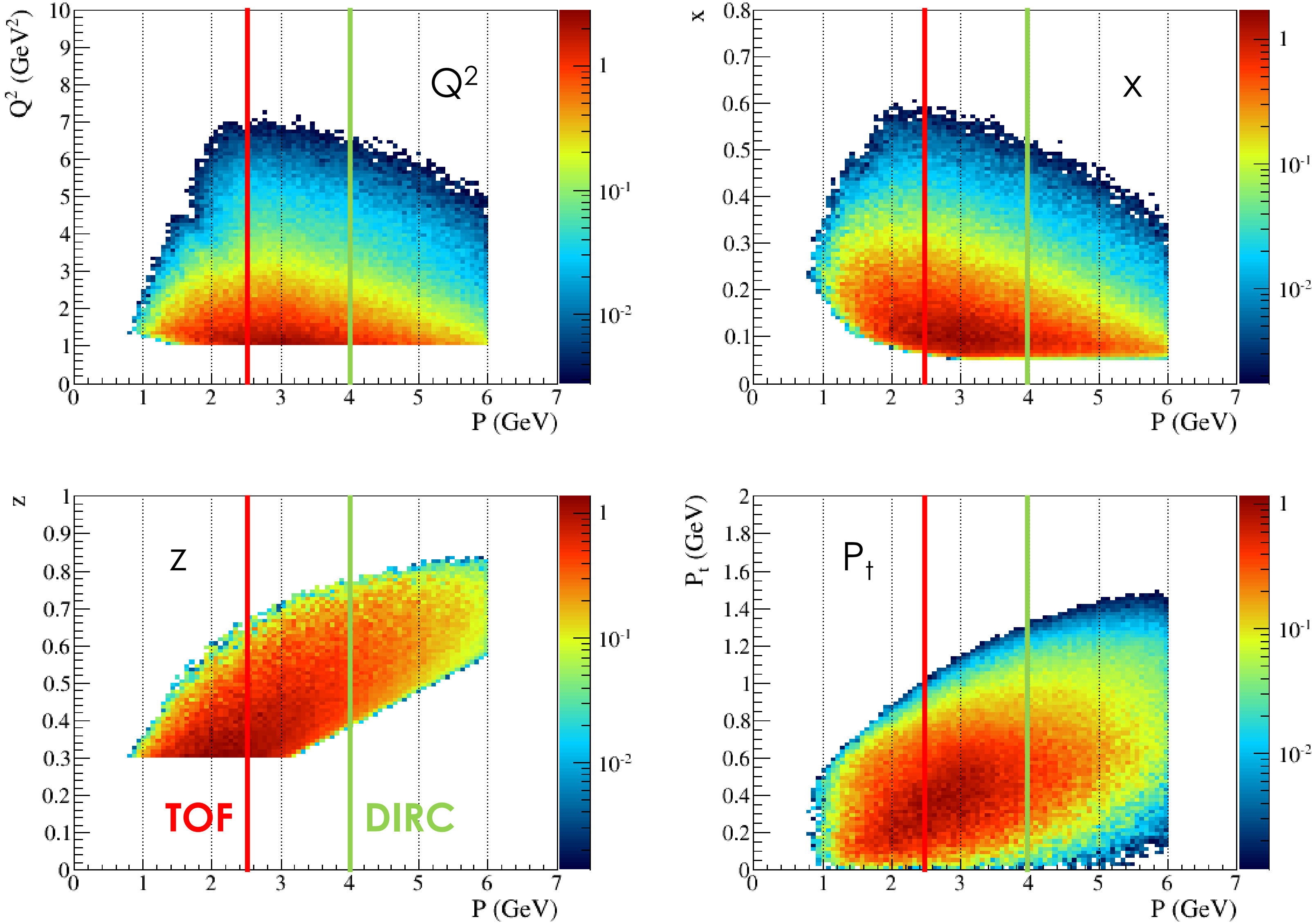


COST ESTIMATION

Item	Cost	Alternatives	Cost
Focusing Block + Mirror Coating	$95,000	Oil Tank + Mirrors	$40,000
New Wedge	$10,000		
MultiAnode-PMTs	$200,000	LAPPD MCP-PMTs	$40,000
Shielding Box	$45,000		
Supporting System	$40,000		
Calibration System	$7,000		
Total	**$407,000**		**$192,000**

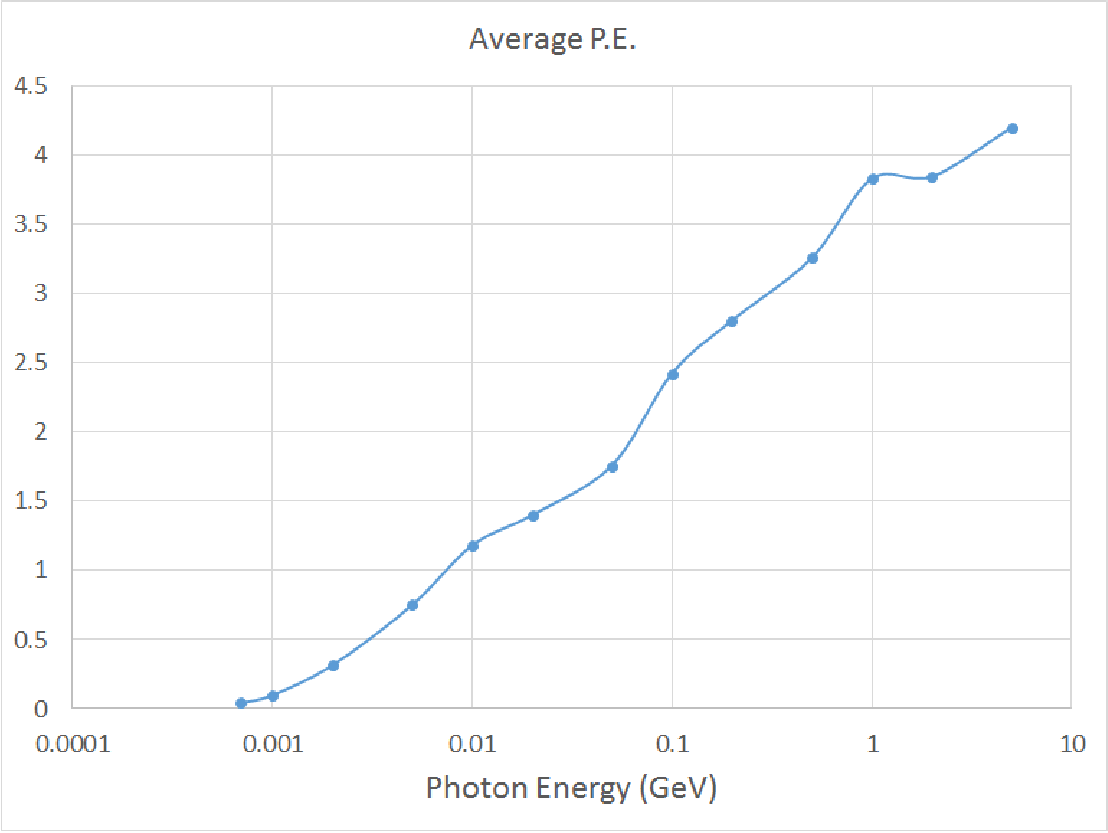
- Estimated cost for readout of ONE DIRC bar box

SIDIS Kaon Kinematics in SoLID



Background Simulation

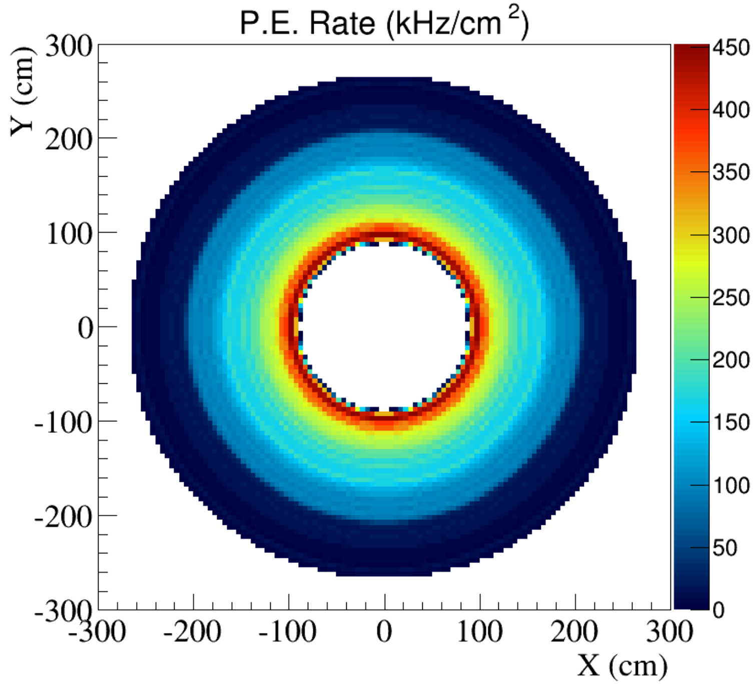
- EM/Hadronic background generated by Zhiwen
- $N_{P.E.}$ from charged particle follows $1-/n^2\beta^2$
- $N_{P.E.}$ from photons using GlueX simulation results

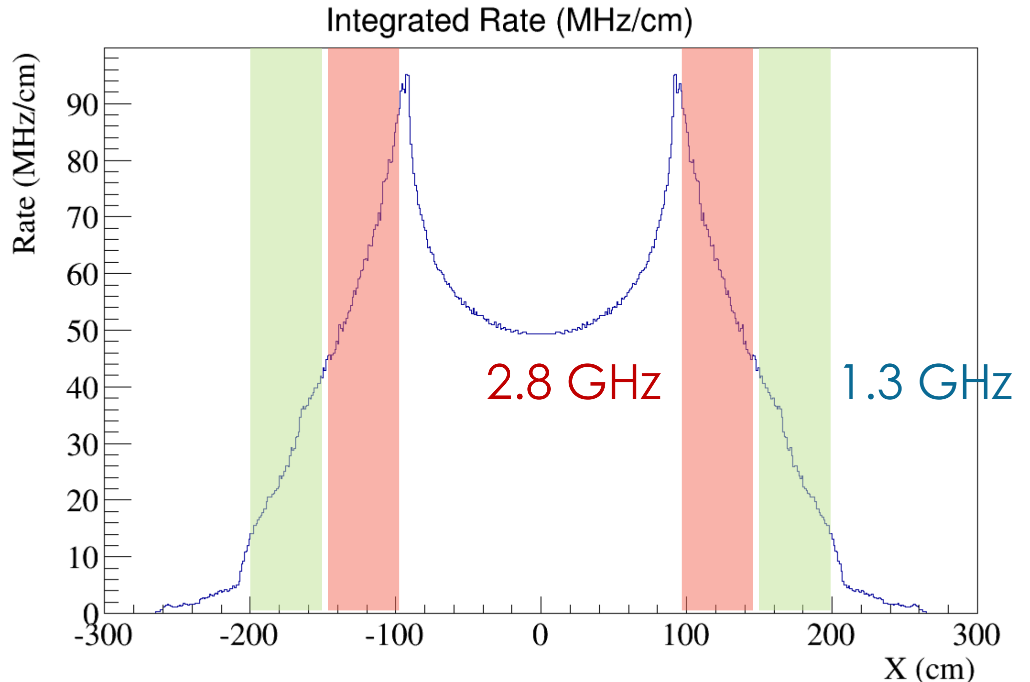


Estimated Background from ^{3}He

- Two DIRC boxes to cover 100 cm ~ 200 cm, 50 ns window
  - 100 – 143 cm: 2.8 GHz → 140 PE/window
  - 150 – 194 cm: 1.3 GHz → 65 PE/window
- Tighter 3D (2D position + time) cut with known track
  - likely to reduce background by a factor of 10 but not 100
- Proton target? Still under investigation

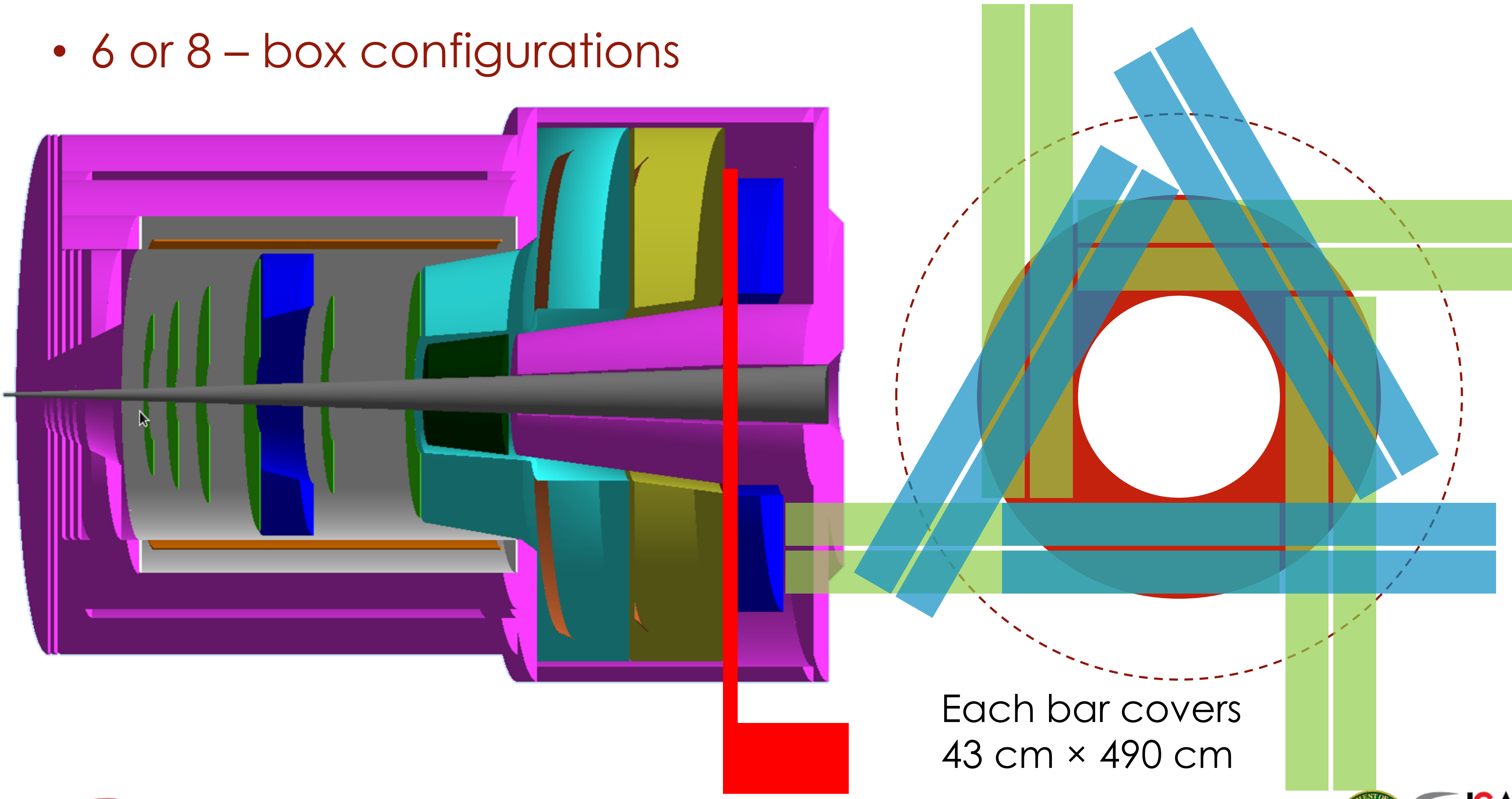
Background Composition:
65% Photon
35% $e^{\pm}$
< 2% hadron





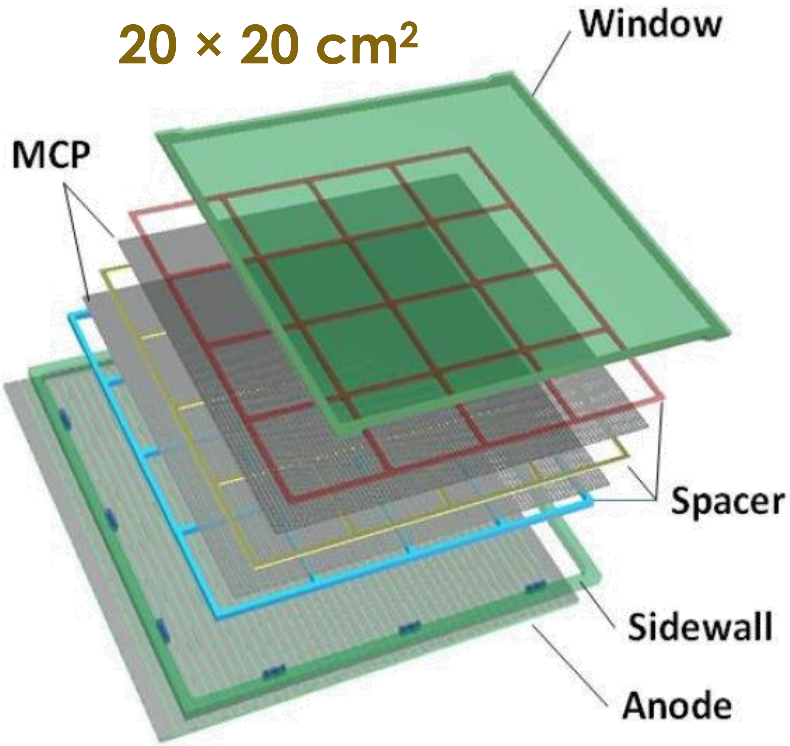
Positioning DIRC in SoLID

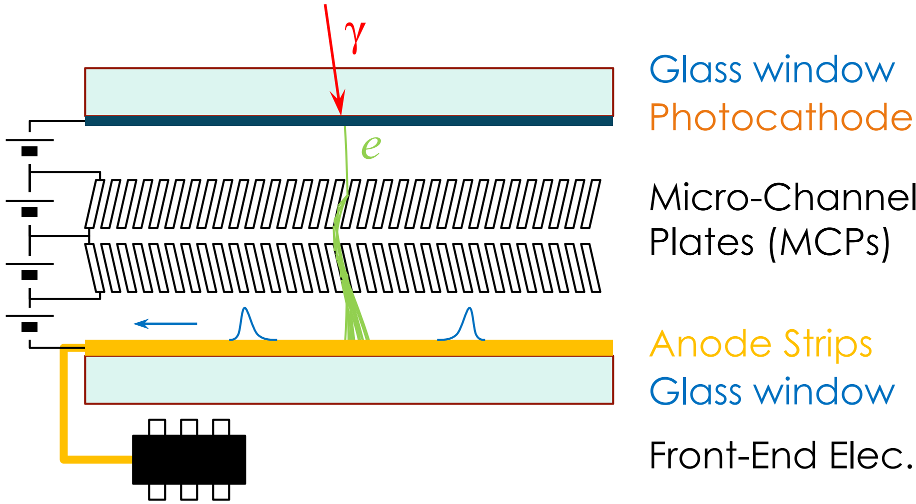
- Use original bar boxes (opening them may cause damage!)
- In between MRPC and Forward Calorimeter
- 6 or 8 – box configurations



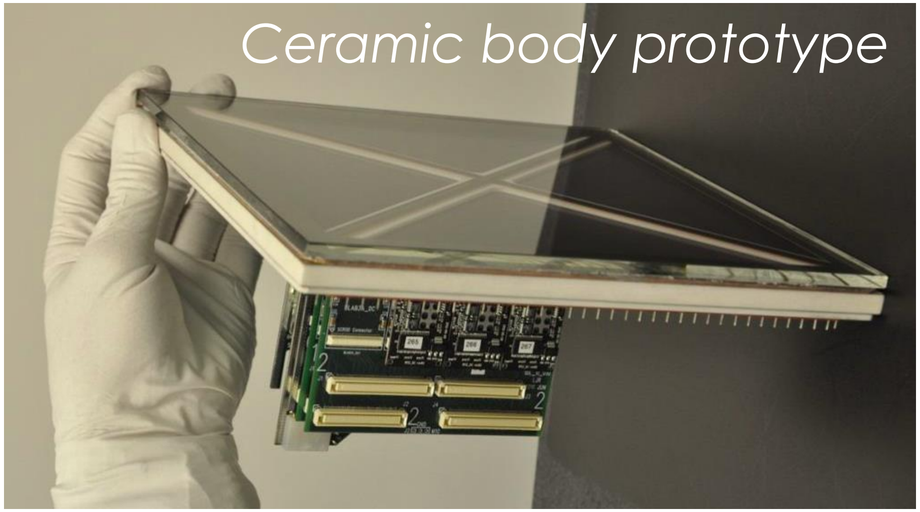
Each bar covers
43 cm × 490 cm

BACK TO MCP-PMTs





Compact size, good time resolution, expect good tolerance to magnetic field

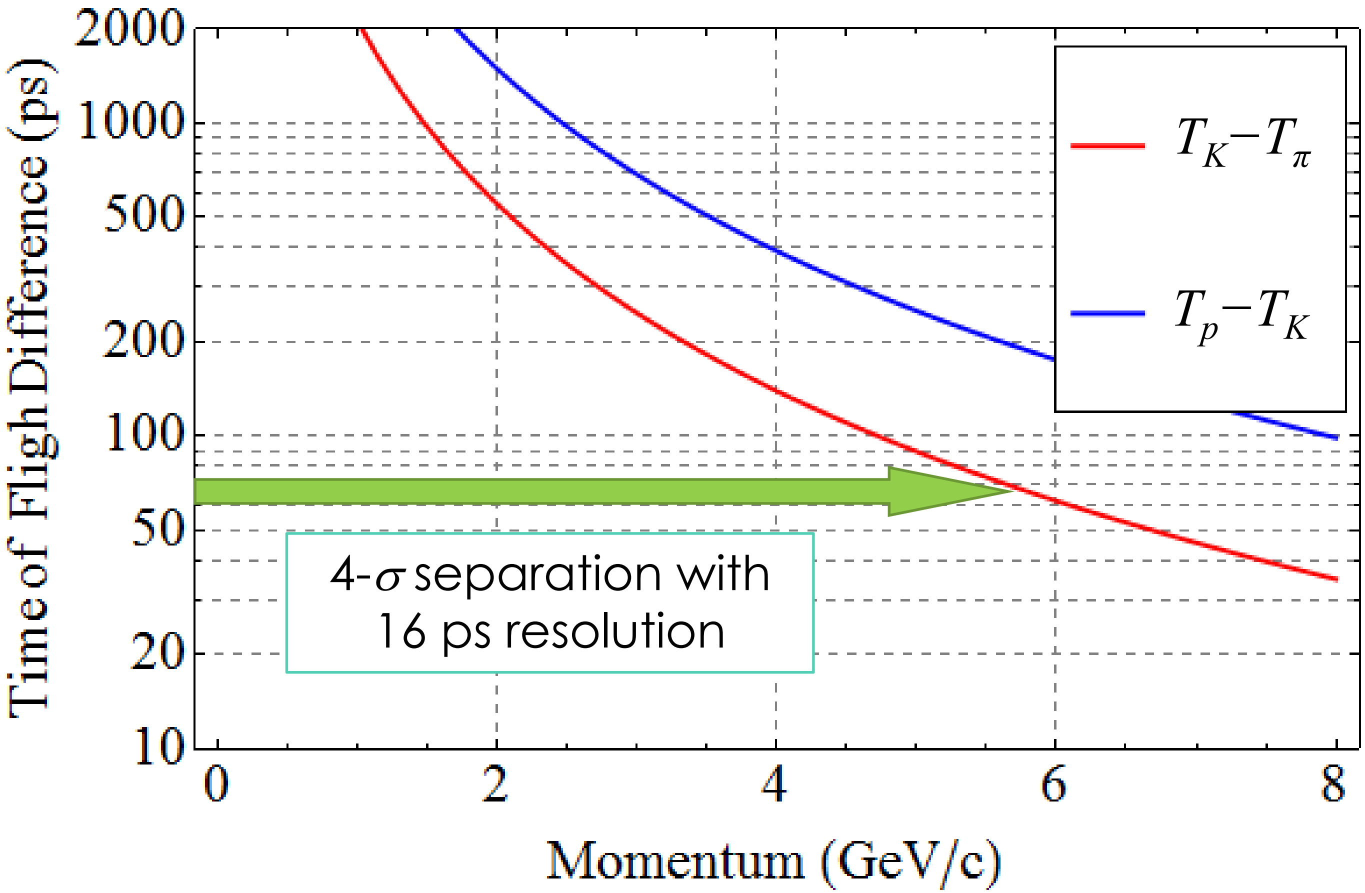


- Developed by the LAPPD Collaboration
- Absolute time resolution: 50 ps/p.e.
- Compact size, economic, expect good tolerance to magnetic field

TOF USING MCP-PMTS AT 6 METERS

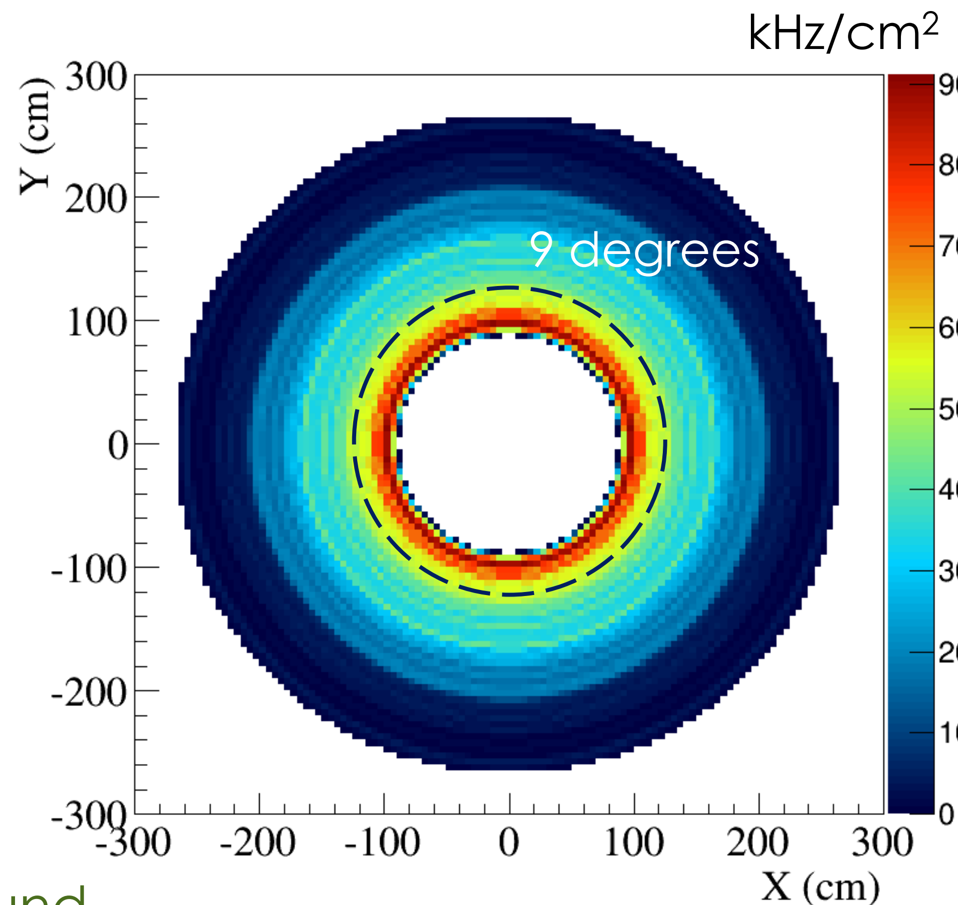
- Using front window as Cherenkov radiator:
  - 2 mm glass window gives about 10 photon electrons
  - Average time resolution: 16 ps

4σ separation up to 5.5 GeV/c !

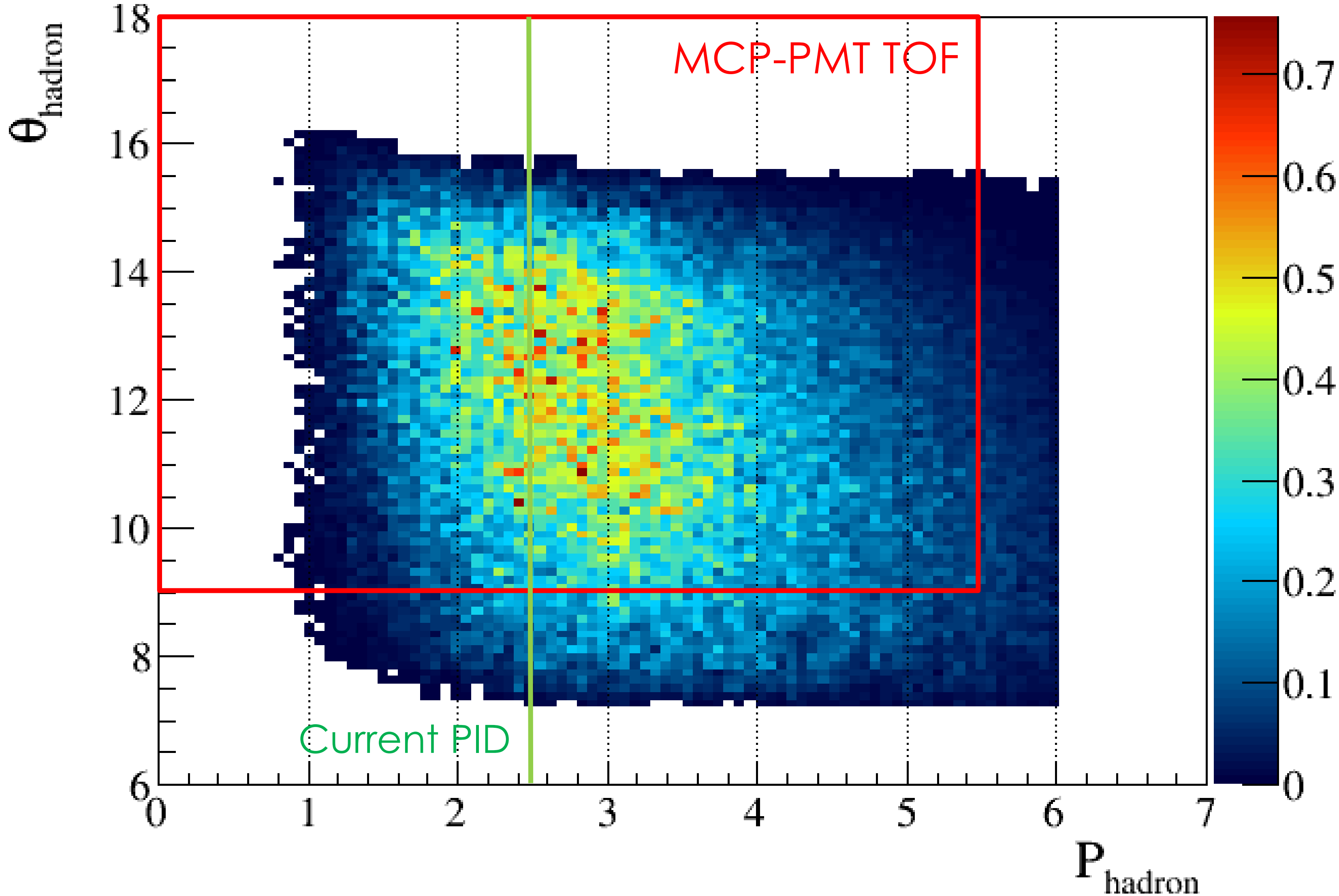


Background in TOF

- Rates scaled from DIRC study
  - Assume N_{pe} from photon scales quadratically
- Maximum Tolerance
  - MCP-PMT readout stripe
    - 20×0.5 cm^2
  - <1% double hit in 5 ns:
    - < 2 MHz
  - Theoretical Limit:
    - < 200 kHz/cm^2
  - Present prototype:
    - up to 50 kHz P.E./cm^2
- Forward Kaon coverage:
  - > 9 degrees
- More study needed
  - Other sources of background



Kaon PID Coverage using TOF



Summary

- BaBAR DIRC bars became available again
- Putting a DIRC detector in SoLID will greatly enhance Kaon PID to 4 GeV: study sea quark TMDs
- However, it is too good to be true due to extremely high EM background in ^{3}He SIDIS experiments
- Background in proton SIDIS still being investigated
- Time-of-Flight using MCP-MPT is quite promising, preliminary rate estimation shows feasibility, need more careful study