DOE Presentation 2007

From SLAC

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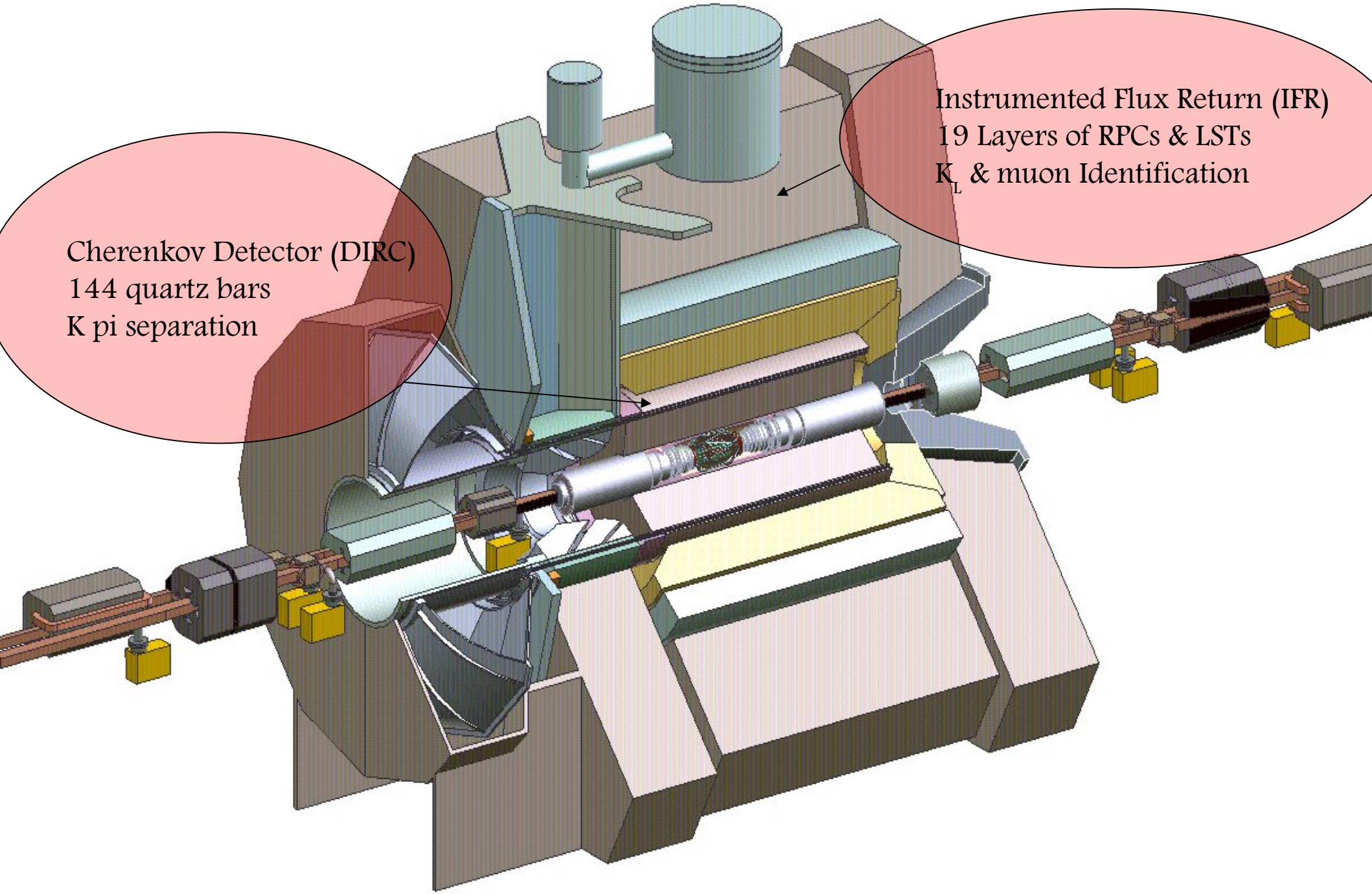
Outline

- BaBar's Instrumented Flux Return for detecting muons & K_L
- Original Resistive Plate Chamber (RPC) instrumentation
- Limited Streamer Tubes (LSTs) & their installation into Babar
- The Detector of Internally Reflected Cherenkov Light
- Analysis direction


Instrumented Flux Return (IFR)
19 Layers of RPCs & LSTs
K_L & muon Identification
Cherenkov Detector (DIRC)
144 quartz bars
K pi separation

Instrumented Flux Return (IFR)

- Purpose: – identification of muons

  – detection of K0L via hadronic shower

- The IFR is mostly iron configured to return the magnetic flux created by the BaBar 1.5 Tesla solenoid.

- 6 barrel sextants and 2 endcaps (not pictured)

- Graded segmentation (18 plates)

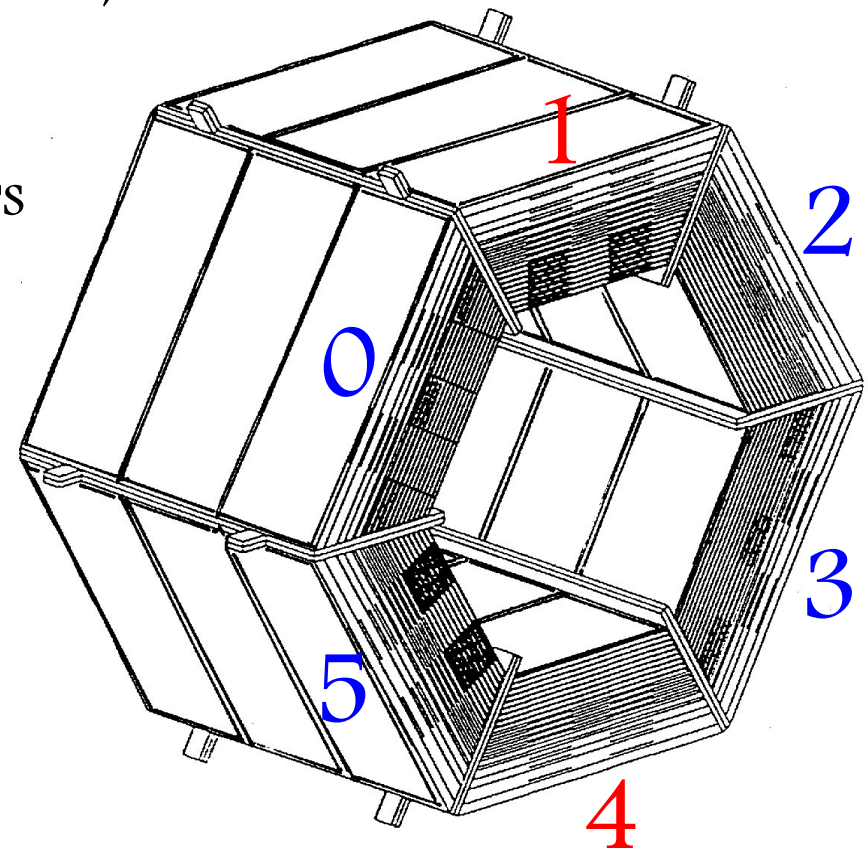
  instrumented with resistive plate chambers

  Barrel: 19 active layers (342 modules)

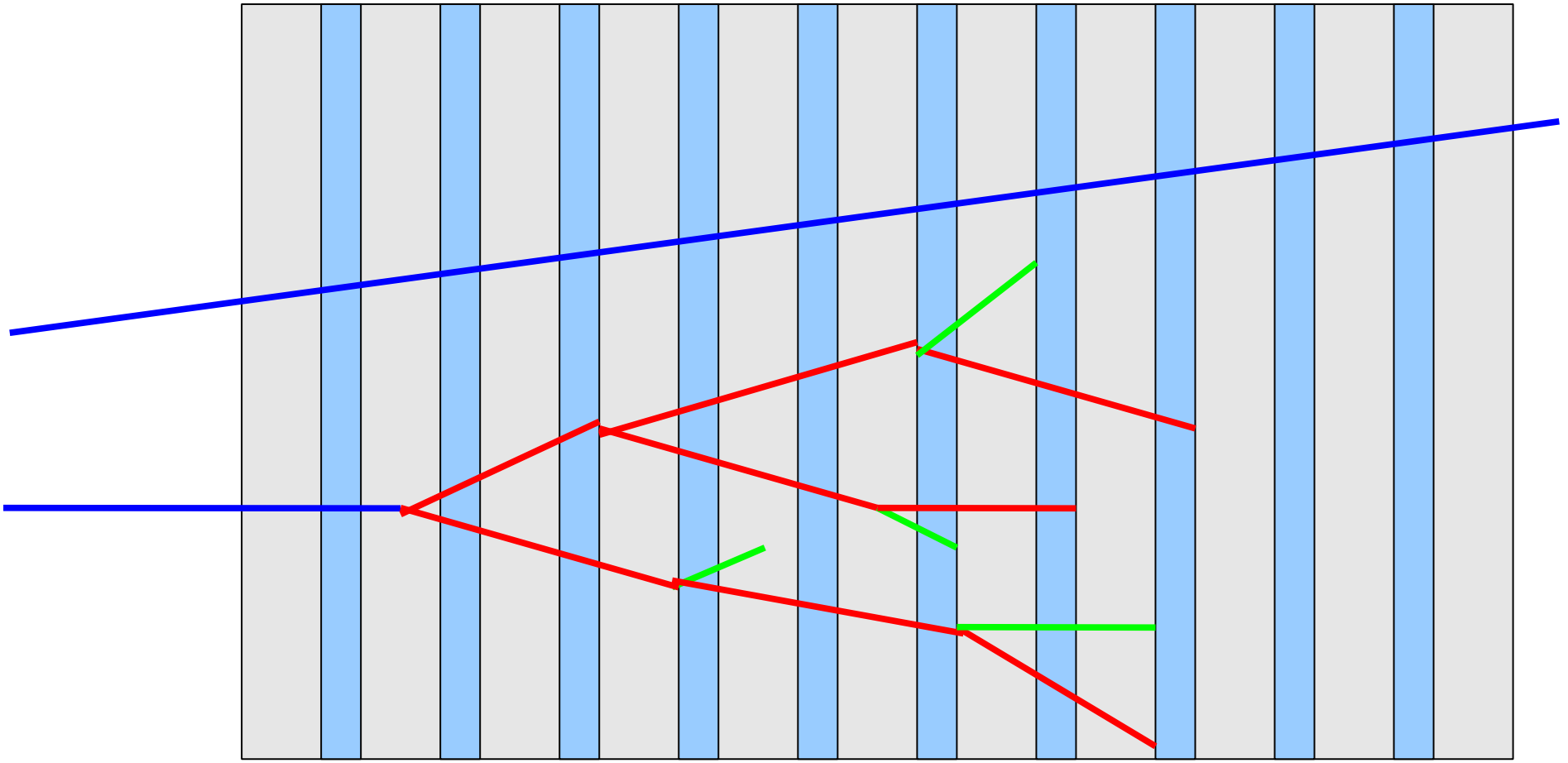
  2 cylindrical

  Endcaps: 18 active layers (432 modules)

  ➔ ~ 2300 m^2 of area covered

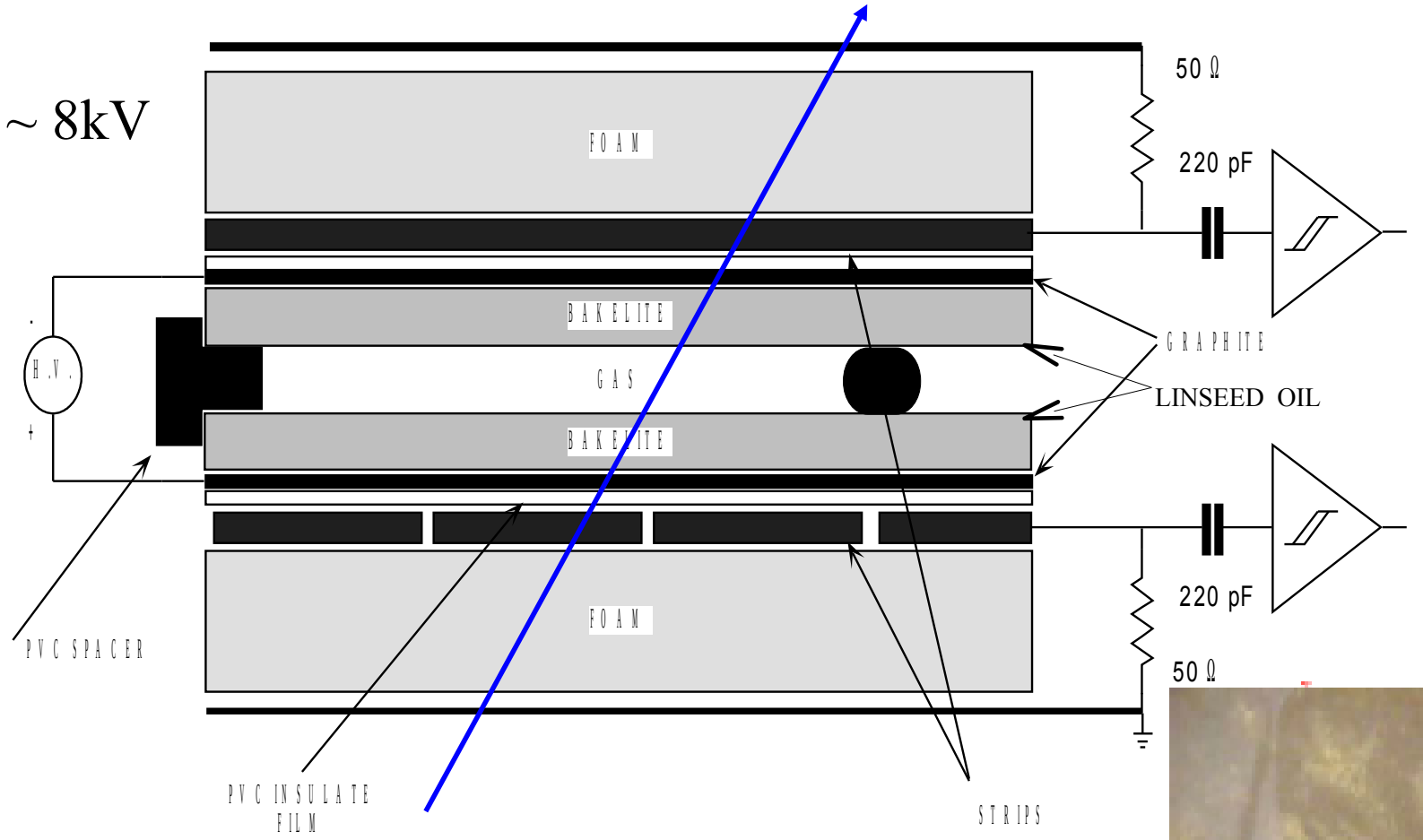


IFR Detection of $\mu^{\pm}$ and K_L



The IFR inserts detector layers into the matter (Fe) to detect the K_L shower particles. The sufficiently high energy muon passes right though the IFR however, since the interaction length of muons is much longer.

Resistive Plate Chambers (RPCs)

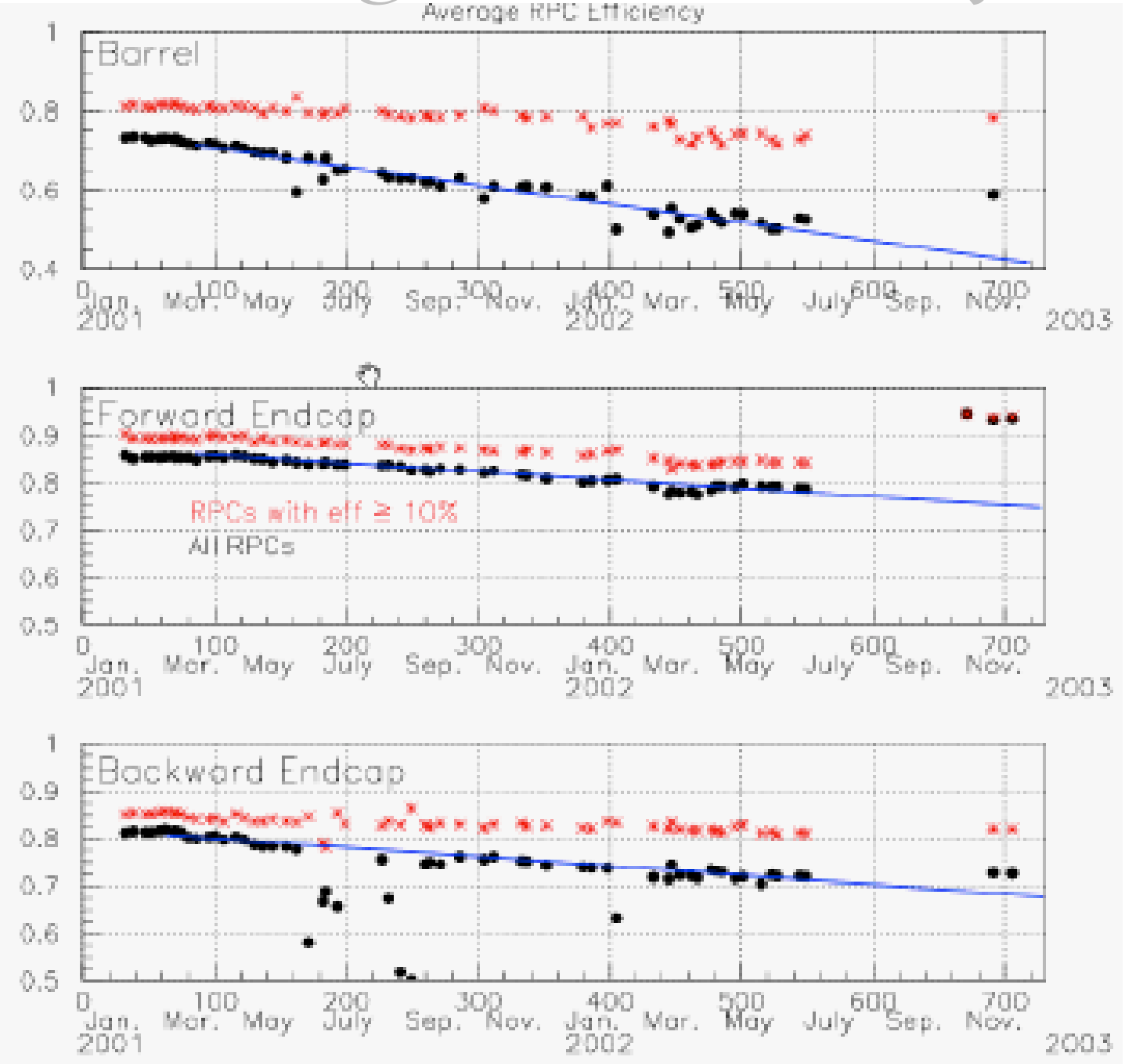


774 RPC chambers, operated in **streamer mode**

Local sparking caused damage along edges and buttons

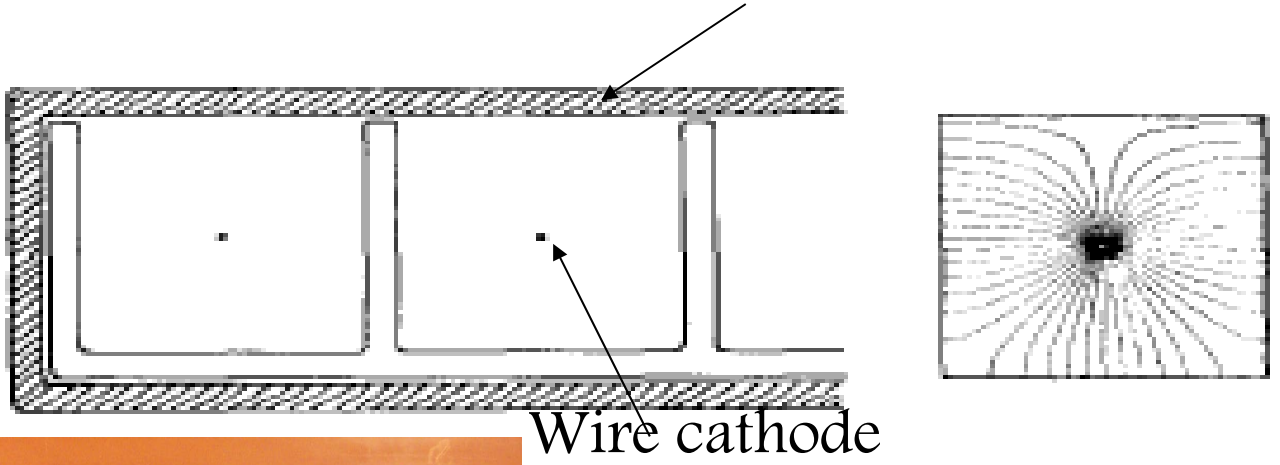
http://www.slac.stanford.edu/%7Ejjv/activity/Vavra_Ionic_Aging_talk.pdf

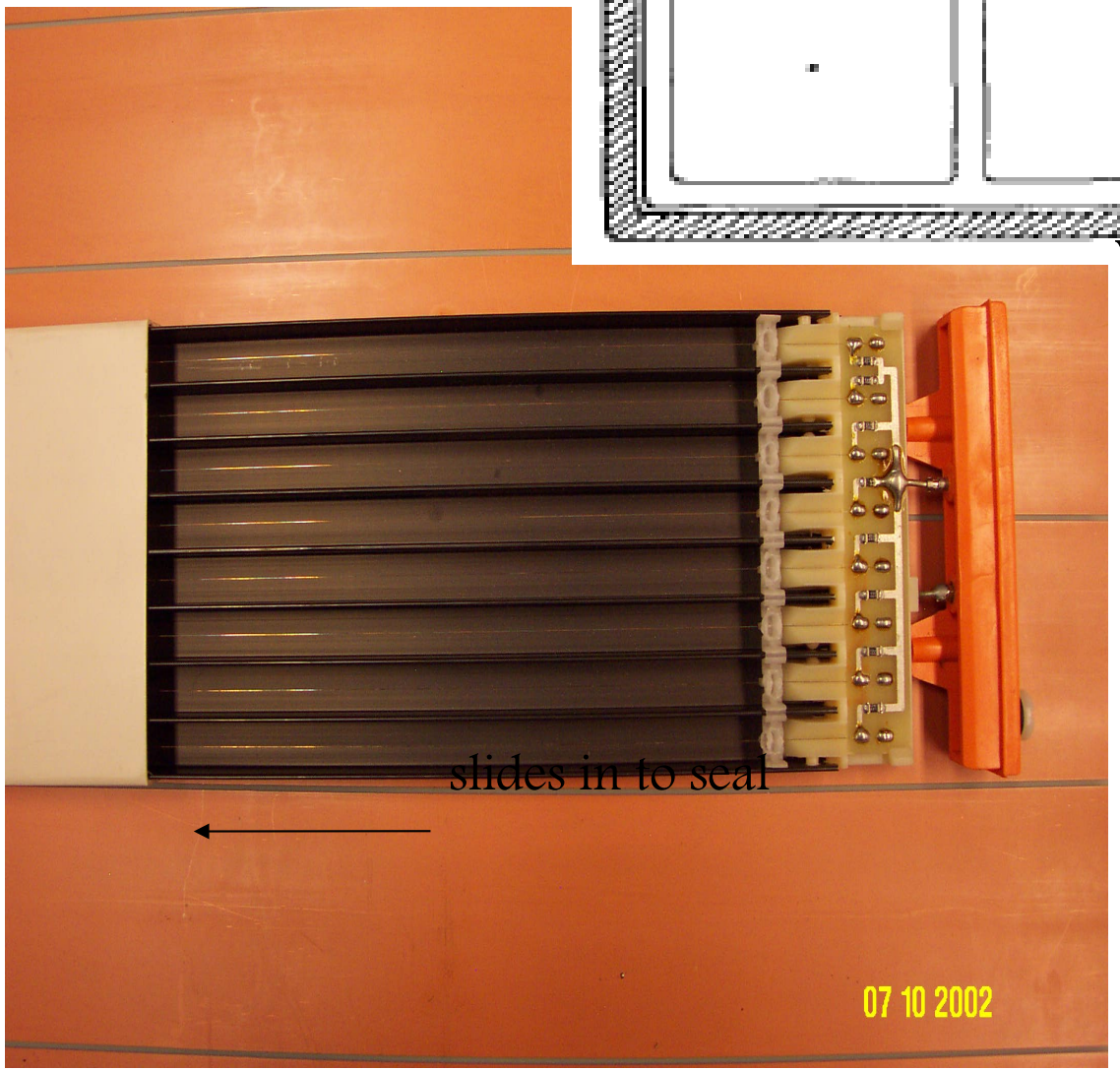
Average RPC Efficiency



LSTs

developed in Italy in the 1970s by Iarocci.

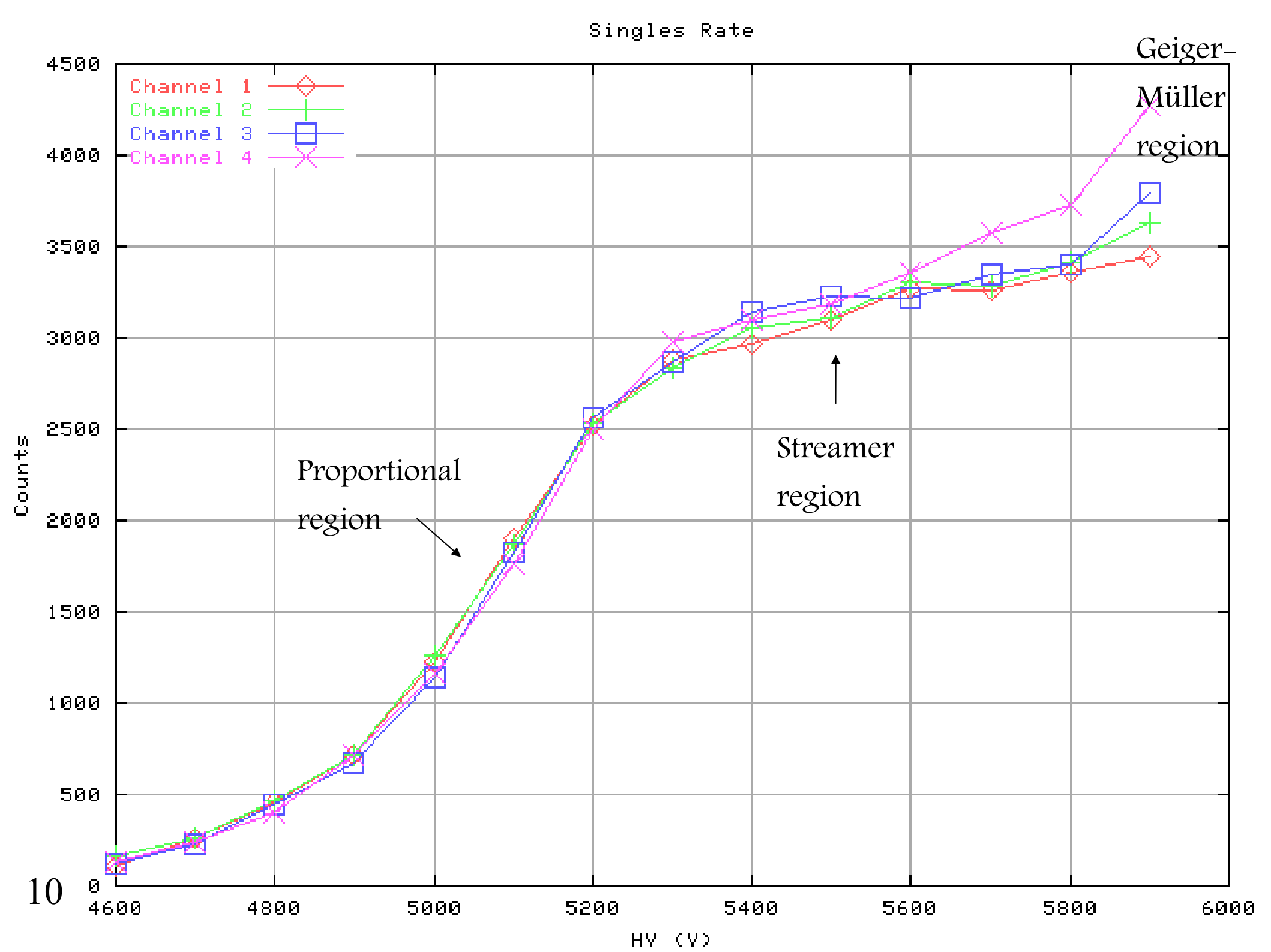




Gas mixture is
89% carbon dioxide,
8% isobutane and
3% argon

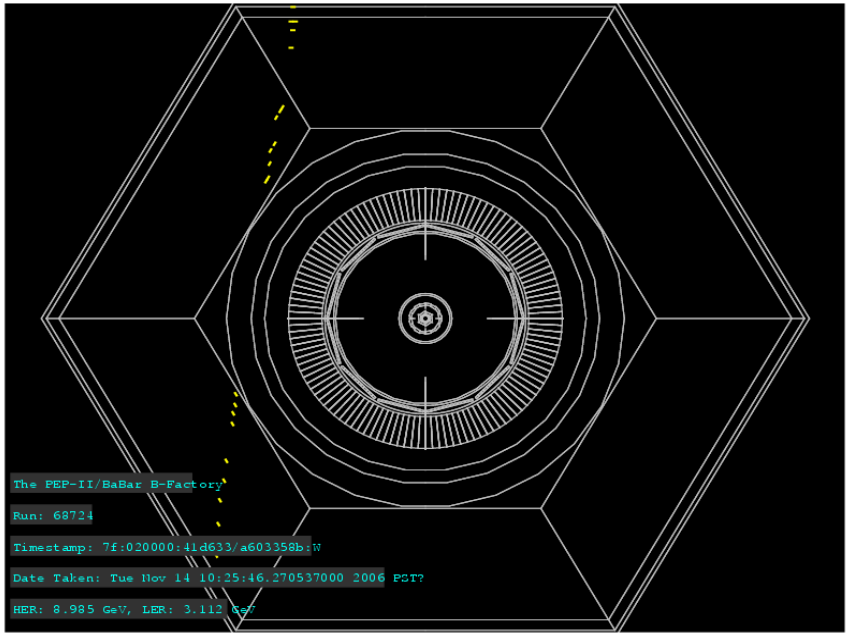
Pre-installation Testing

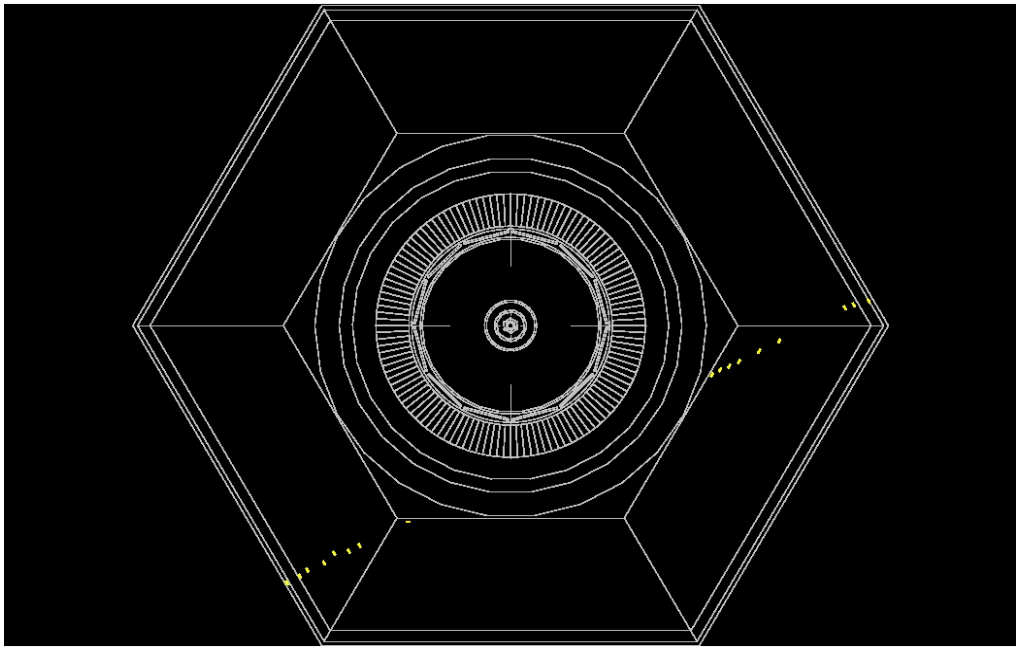
Daily shifts taking plateau curves with various levels of gas flow – I took roughly 1 block per week

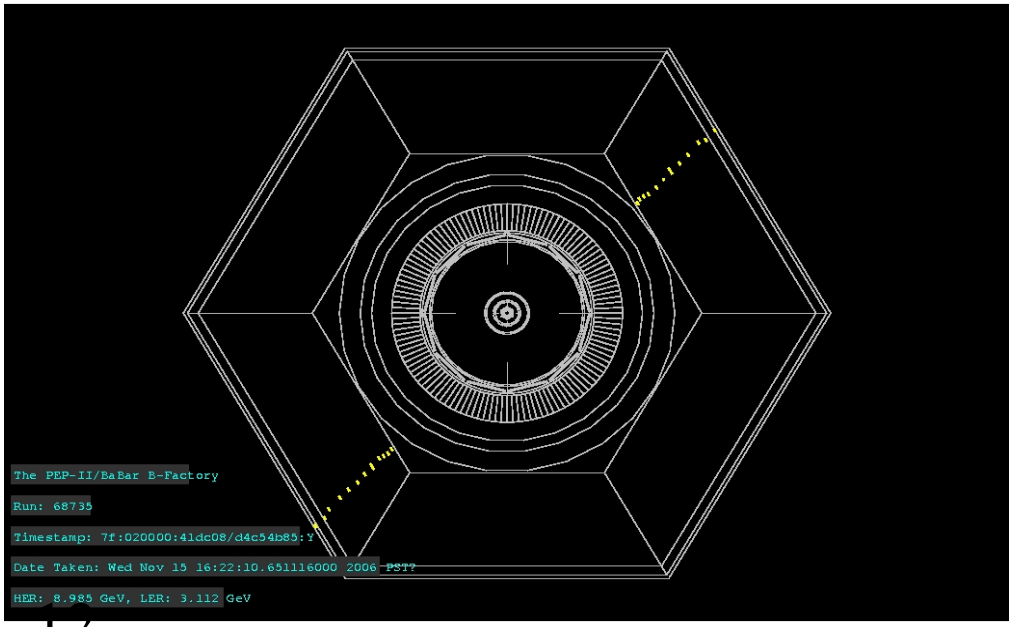

Singles Rate
Channel 1
Channel 2
Channel 3
Channel 4
Counts
HV (V)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
4600
4800
5000
5200
5400
5600
5800
6000
Proportional region
Streamer region
Geiger–Müller region

2006 Installation: My Involvement

- Installed over a 3 month period during BaBar's Fall shutdown of 2006 (other 2 sextants installed in 2004).
- Pulled HV cables under, over and around the detector to each of the modules.
- Built, wired and installed temperature & humidity sensors in the layers with the modules.
- Finished ahead of schedule.


The PEP-II/BaBar B-Factory
Run: 68724
Timestamp: 7f:020000:41d633/a603358b:W
Date Taken: Tue Nov 14 10:25:46.270537000 2006 PST?
HER: 8.985 GeV, LER: 3.112 GeV

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Run: 68735
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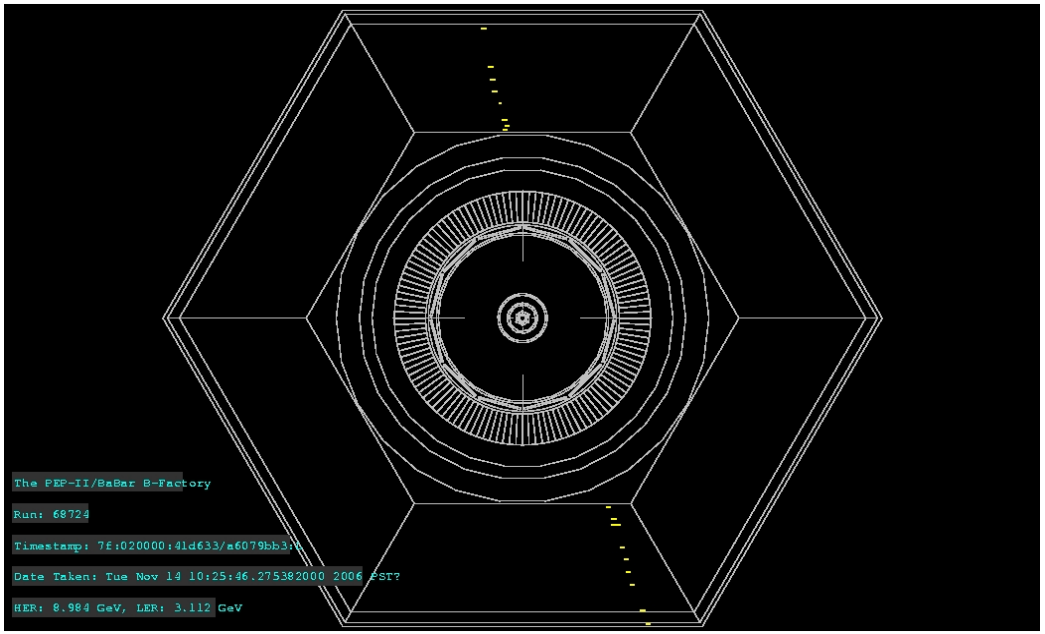
Date Taken: Wed Nov 15 16:22:10.651116000 2006 PST?
HER: 8.985 GeV, LER: 3.112 GeV


The PEP-II/BaBar B-Factory
Run: 68724
Timestamp: 7f:020000:41d633/a6079bb3:W
Date Taken: Tue Nov 14 10:25:46.275382000 2006 PST?
HER: 8.984 GeV, LER: 3.112 GeV

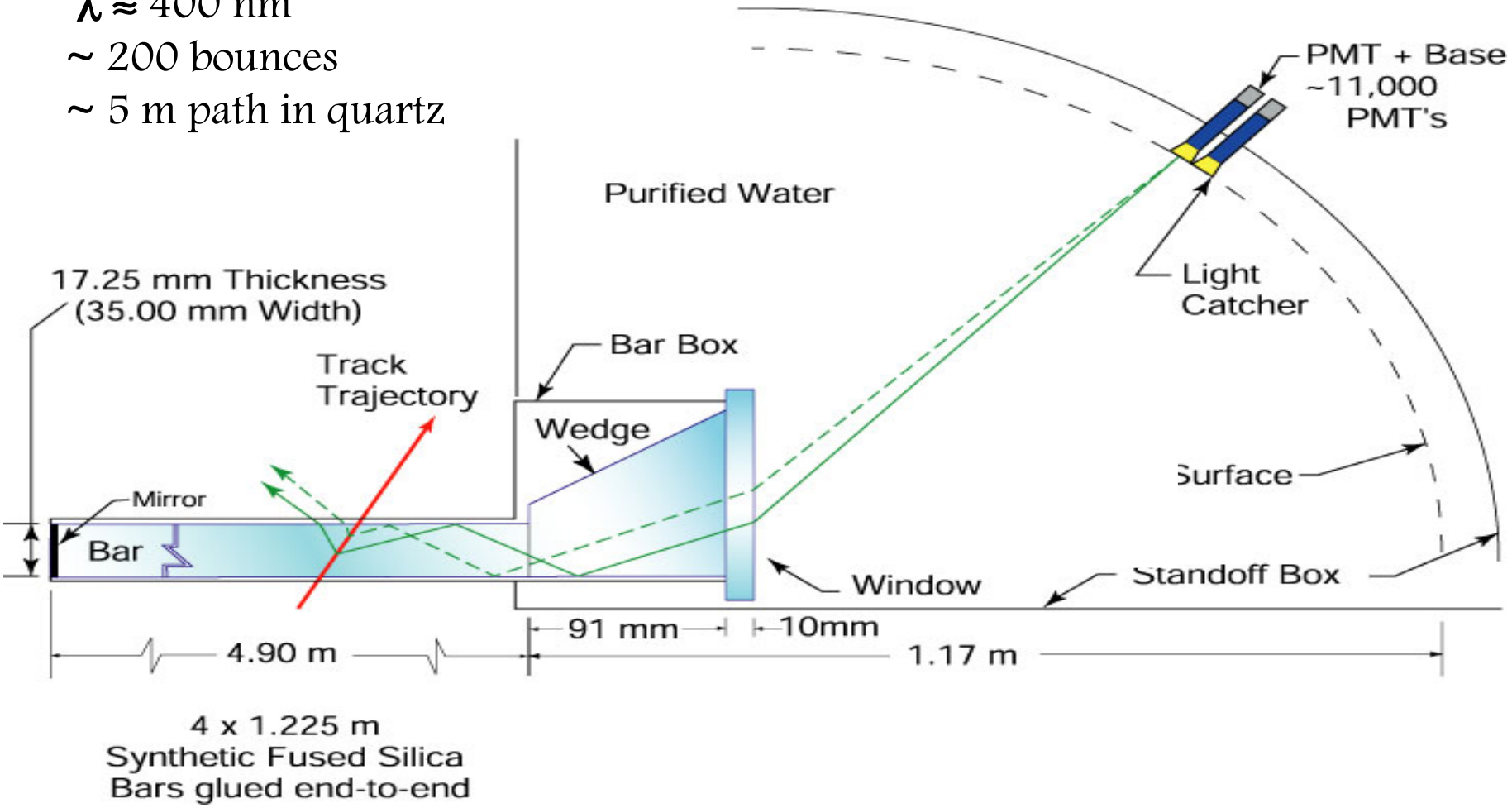
The Detector of Internally Reflected Cherenkov Light

Typical DIRC photon:

$\lambda \approx 400$ nm

~ 200 bounces

~ 5 m path in quartz

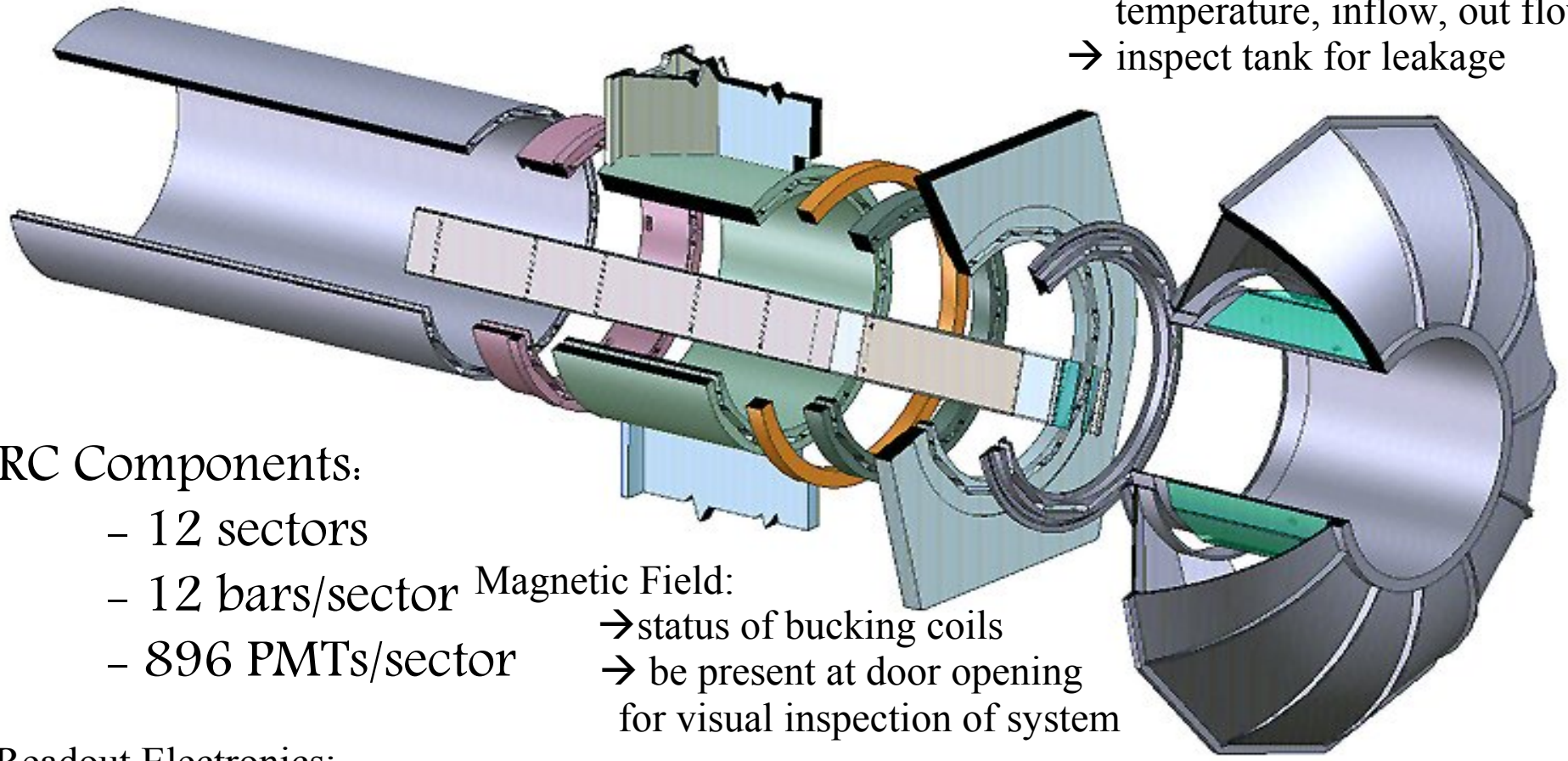


Uncertainty in single photon Cherenkov angle $\sigma(\theta_c)$ ~ 10 mrad

The DIRC

Quartz Bars:
- → in nitrogen atmosphere to keep them dry
- → check gas flow, temperature, humidity

Water: high transparency
- → water cleaning via filters, UV light
- → monitor water level, PH value, temperature, inflow, out flow rate
- → inspect tank for leakage



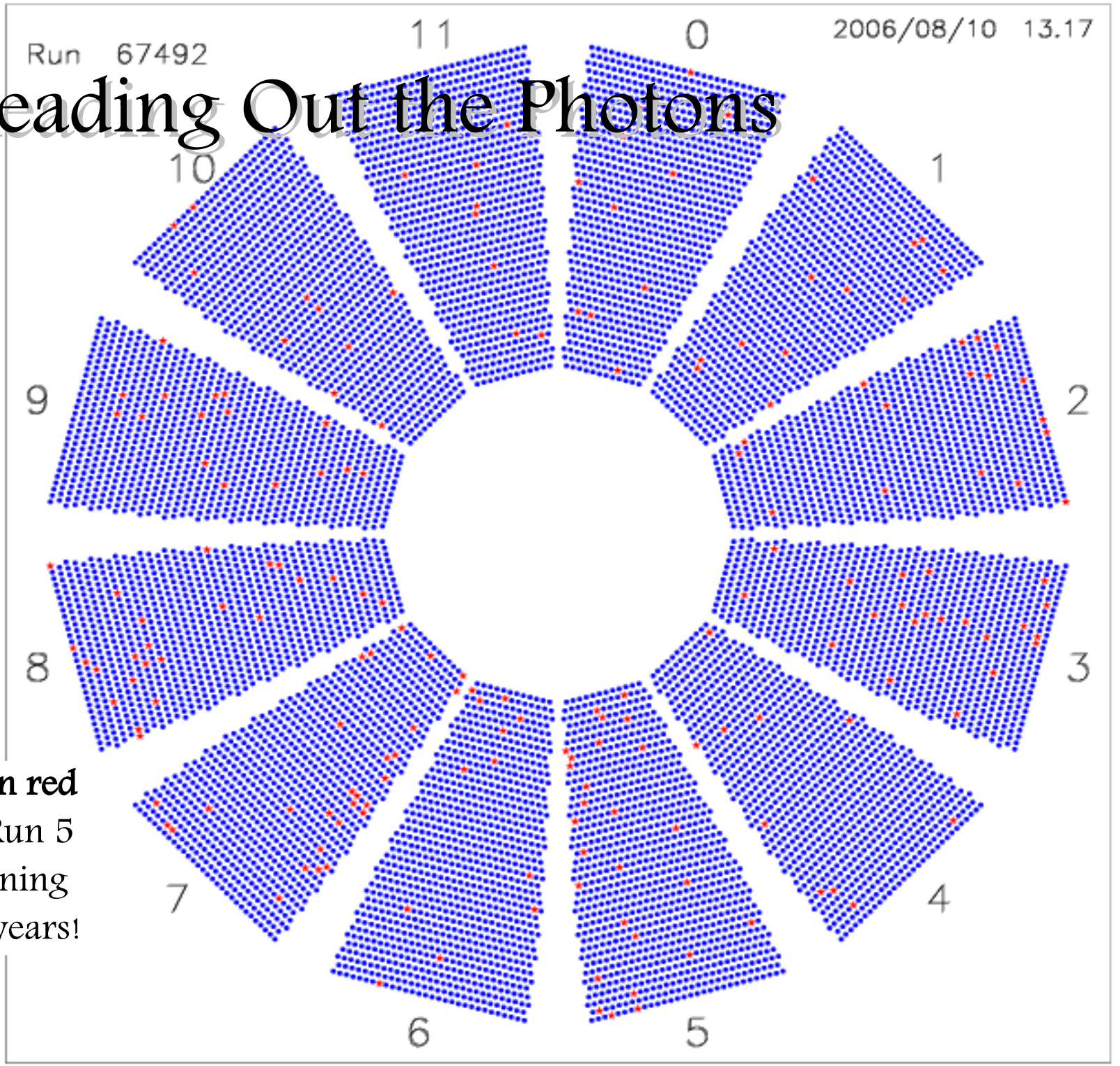
DIRC Components:
- 12 sectors
- 12 bars/sector
- 896 PMTs/sector

Magnetic Field:
- →status of bucking coils
- → be present at door opening for visual inspection of system

Readout Electronics:
- → visual inspection of cleanliness
- → exercise timing calibrations
- → monitor fan speed, temperature

PMTs: immersed directly in water
- → visual inspection of PMT front (milkiness)
- → inspect HV crates
- → calibration runs with LEDs
- → analysis of photon yield over long time period

Reading Out the Photons



Dead PMTs shown in red

190 at the end of Run 5

10562 still functioning

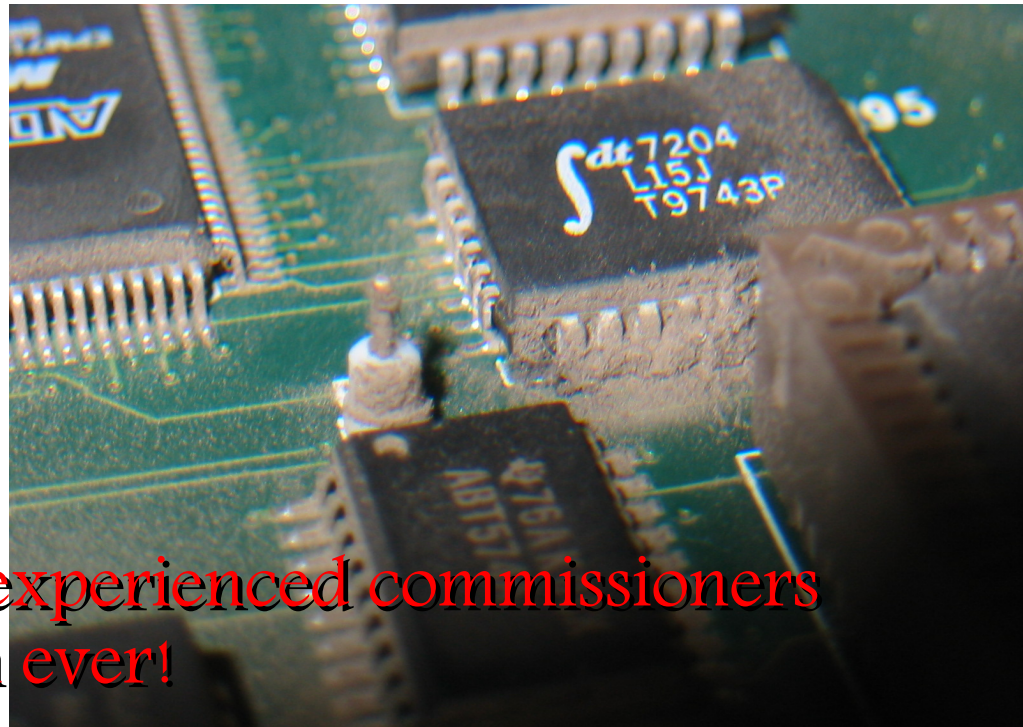
<2% loss over ~7 years!

DIRC Commissioner Duties

- Daily tour of systems including Nitrogen gas flow, electronics chiller, high voltage, and water,
- Monitor the front-end electronics fans online,
- Monitor the background levels and data quality,
- Verify calibrations are done correctly,
- Inform the BaBar shifttakers on the DIRC's status,
- Attend the daily operations meeting in IR-2 and report the day's goings-on,
- Record day's activities in the commissioner's log,
- Prepare weekly, monthly and quarterly reports.

DIRC Electronics Troubles

- All 180 circuit boards removed from the detector
  - Protective plates removed
  - Each board thoroughly cleaned
  - Conformal coating applied to prevent further problems
- Several of the crates also required repair
  - Faulty power supplies
  - CANBUS readout problems
- Crates cleaned and new filters added
- Everything tested and then put back together
- Monitoring of the DIRC by experienced commissioners is now more important than ever!

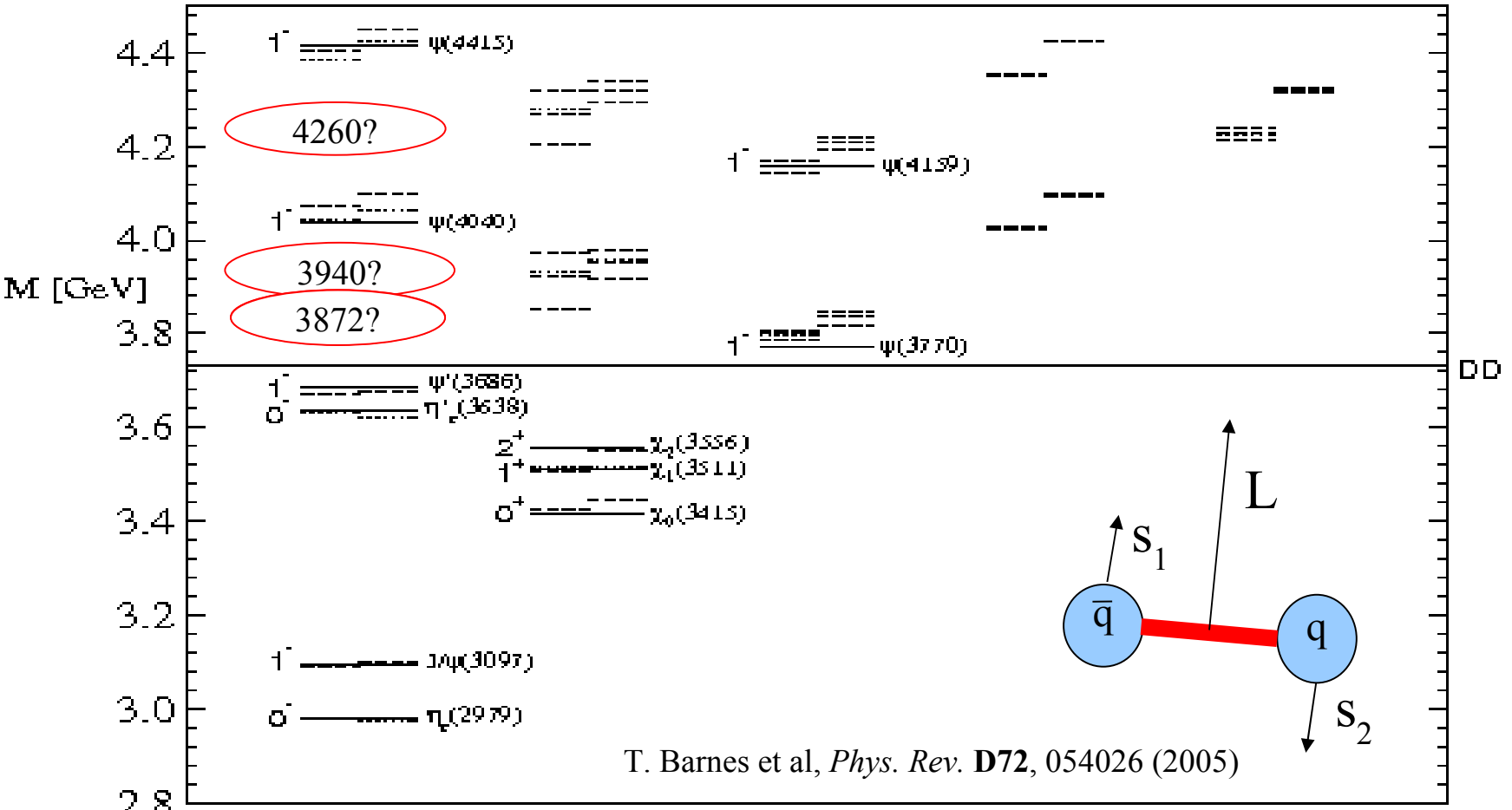


The Charmonium Spectrum

_____ Measured resonances

- - - - - - (on left) Non-relativistic model

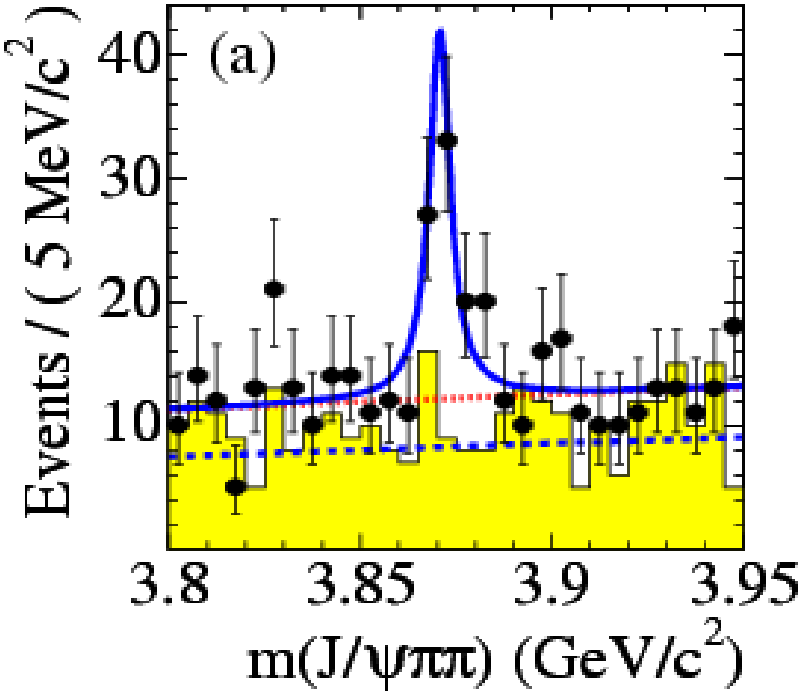
- - - - - - (on right) Godfrey-Isgur model



T. Barnes et al, *Phys. Rev.* **D72**, 054026 (2005)

X(3872) Search Strategy

- B meson decays
  - B -> X K, X -> J/ψ π π
  - B, K, pions can be charged or neutral
  - Only neutral X observed
  - Kinematics well defined
  - Expect ~250 Xs in BaBar's final data set of ab^{-1}
- Two stage analysis
  - 1) Filter (preliminary work done already at UT)
  - 2) Fine selection & likelihood fit



61.2 ± 15.3 events
6.1σ significance
mass 3871.3 ± 0.6 ± 0.1 MeV

Outlook

- My LST involvement was completed when the installation was finished
- Currently working as a DIRC commissioner through the summer
- Currently involved in DIRC studies
- Studied the focussing DIRC prototype undergoing tests at SLAC
- Analysis contiuation
- BaBar shifts
- Long term, I intend to return to TN to publish my analysis