The BaBar Drift Chamber

Operational Overview and Long Term Prospects

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- Design

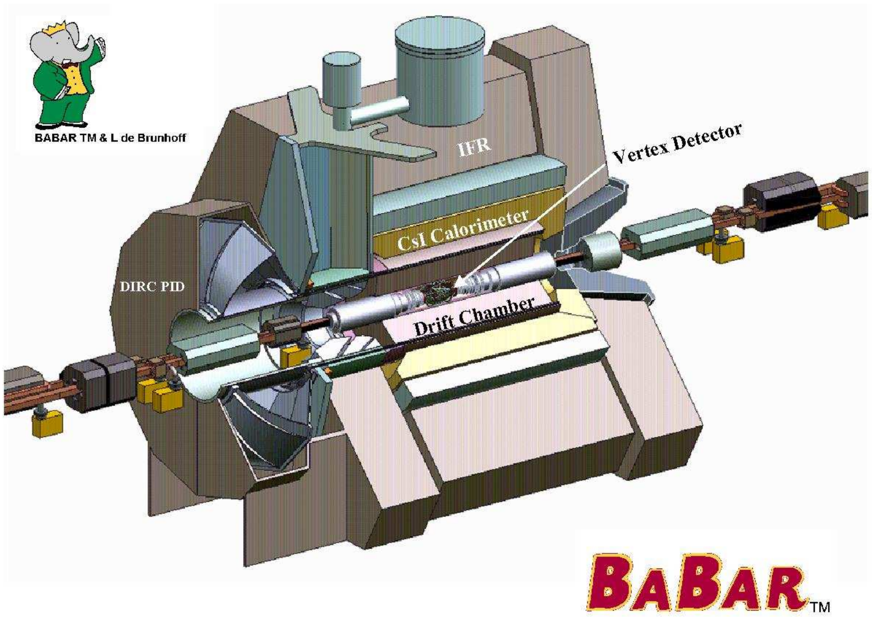
  Mechanical, Drift System, DAQ

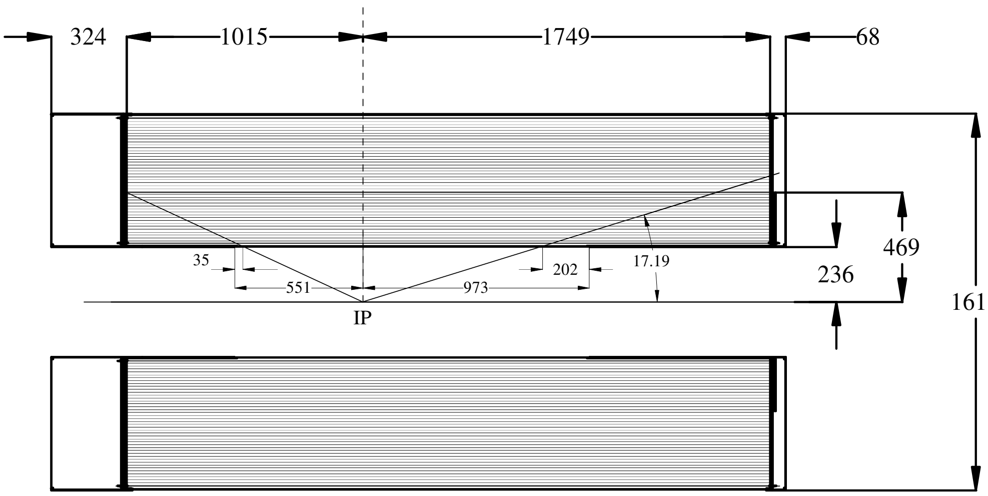
- Physics Performance
- Operational History
- Current Running
- Future Prospects

  Occupancy, Dose

  Aging and Remediation

The BaBar Drift Chamber

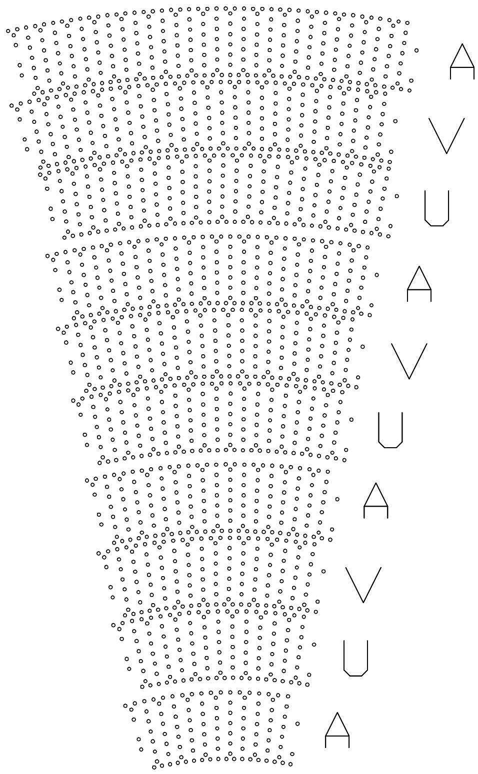


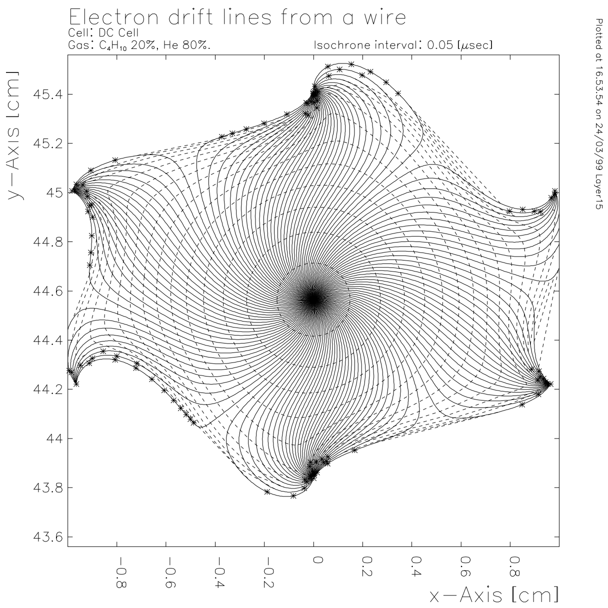


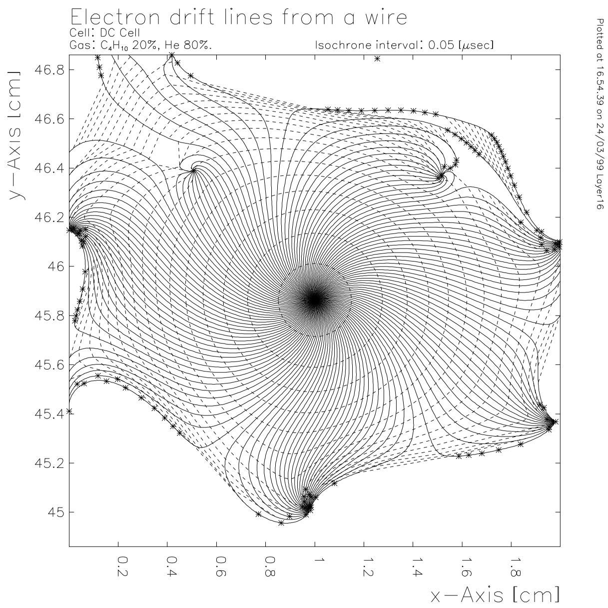
2.8 meters long, 81 cm outer radius, 24 cm inner radius

Drift System: Cells and Gas

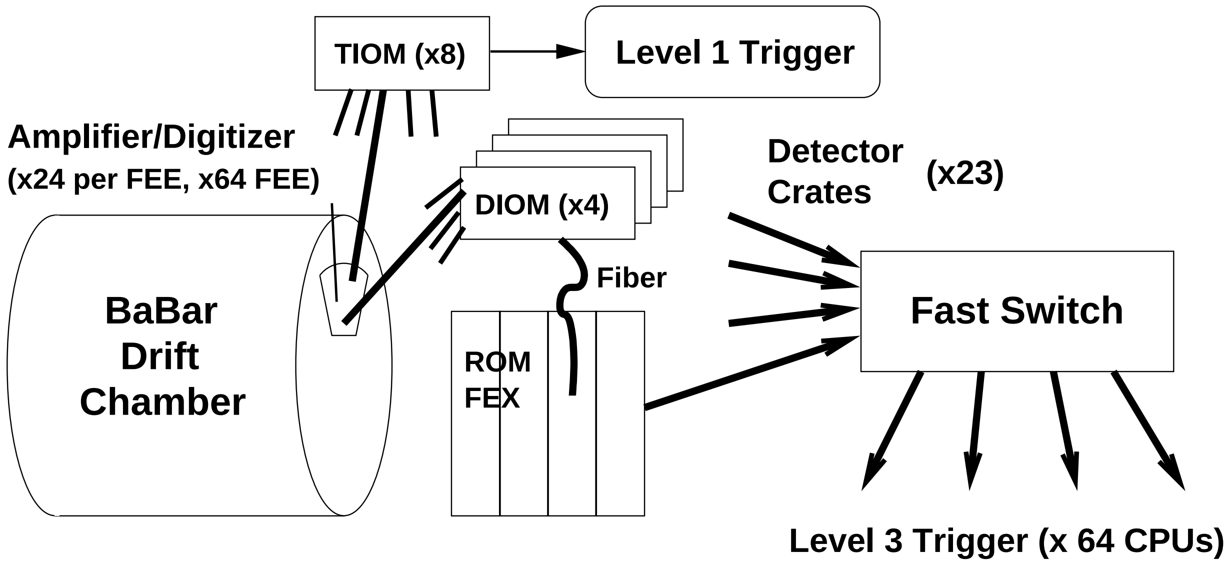
- 7,104 close-packed single-wire cells
- 4×10 layers axial and stereo
- 1.5 T magnetic field
- 80% He, 20% isobutane







Data Acquisition System

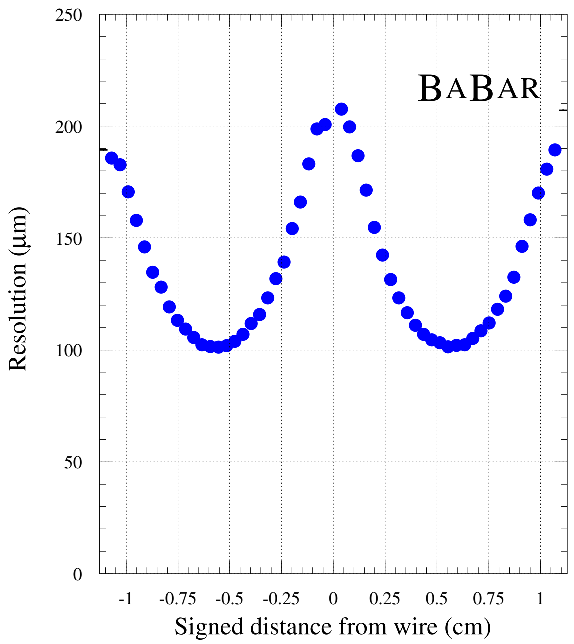


3×16 front-end assemblies
8 Trigger I/O modules (hits $\rightarrow$ Level 1 Trigger)
4 Data I/O modules (FEE $\rightarrow$ optical)
4 Readout Modules (extract time, dE/dx)

Design limit 3 kHz Level 1
Data size up to 64 kB per ROM per event

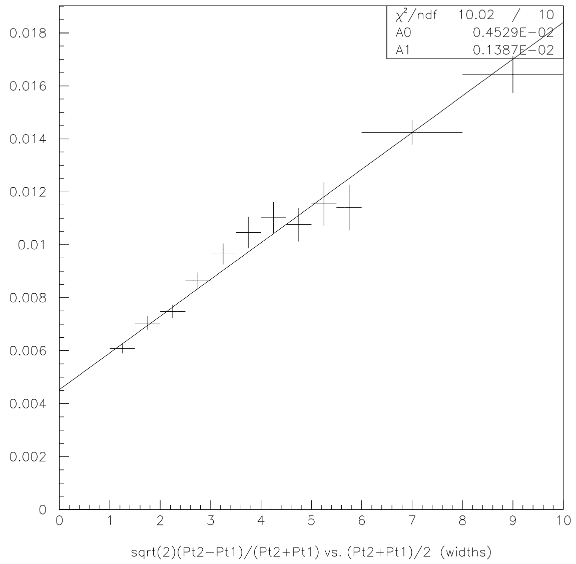
Physics Performance

Drift Chamber Hit Resolution

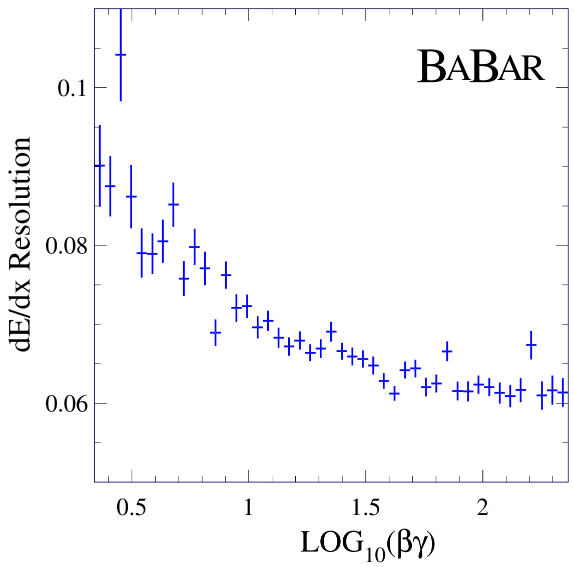


$$\sigma_{hit} \sim 100 - 140\ \mu m$$

$$\frac{\sigma_{p_T}}{p_T} \sim 0.45\% + 0.14\% p_T$$



Drift Chamber dE/dx Resolution
for Cosmics



$$\sigma_{dE/dx}(Bhabhas) \sim 7\%$$

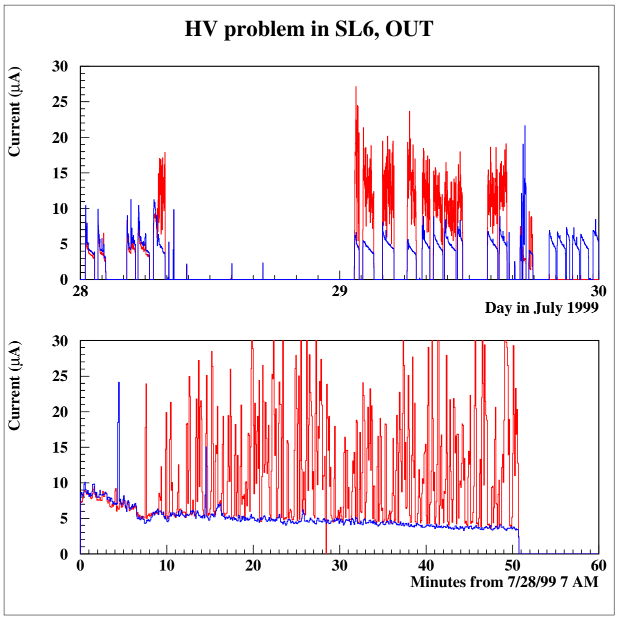
Operational History

Commissioned September 1998 – May 1999

Operated at 1960V, 80/20 mix, $<$ 10 ppm O_2

April 1999: HV accident damaged 13 pairs of guard wires. Disconnected from HV and allowed to float. No impact on physics.

July 1999: Rapid and repeated discharges on one HV channel in presence of beam.



Current Running

Added $\sim$ 0.4% water to gas mix, reduced operating voltage to 1900V, with affected region turned off. No further discharges anywhere in chamber since then.

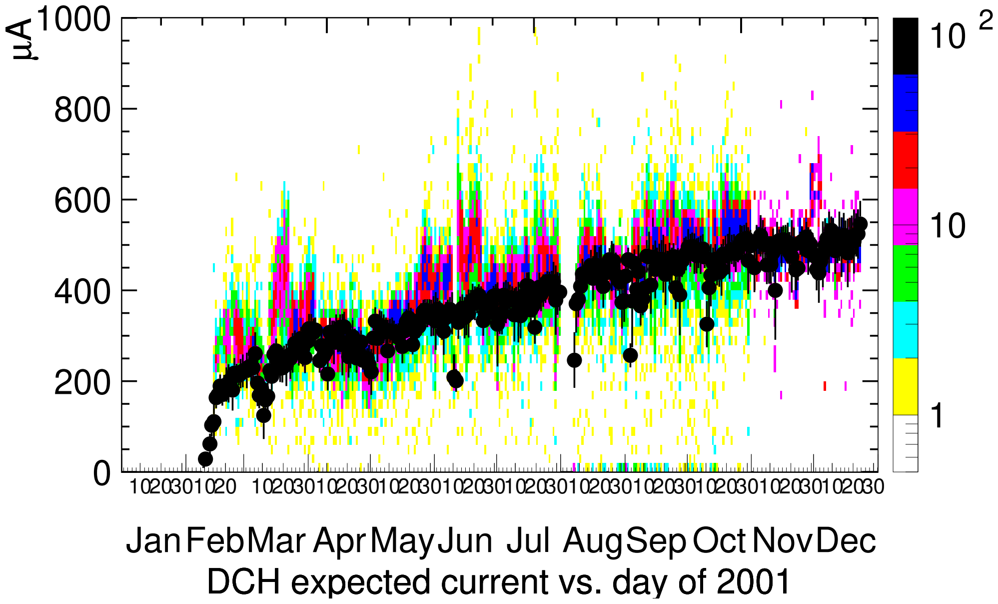
July 2000: Raised voltage to 1960V (1900V running had reduced tracking efficiency by $\sim$ 10%).

Feb 2001: Chamber operation has been stable at 1930V, 3500 ppm H_2O, $\sim$ 75 ppm oxygen.

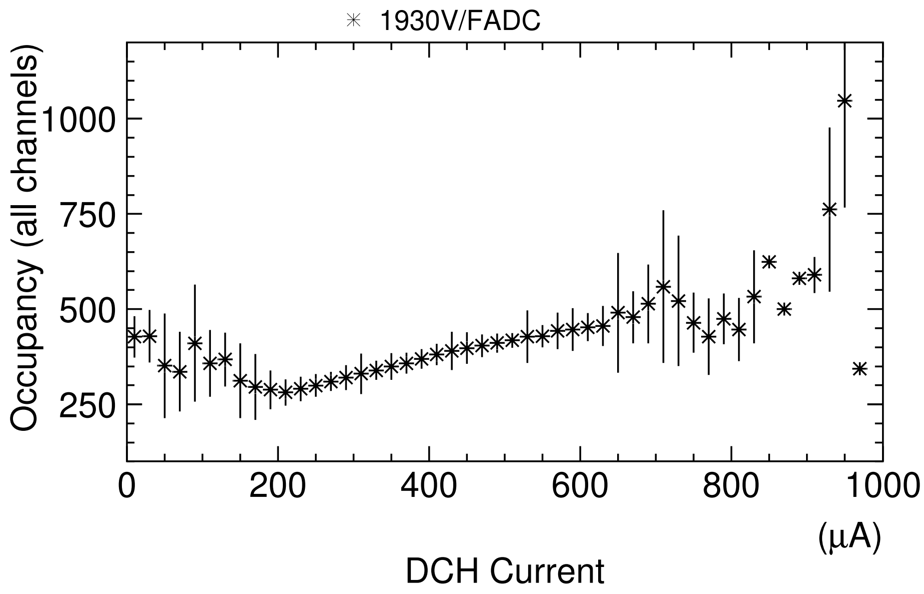
Gas gain is about 70–75% of original design, adequate for triggering and for physics. Software improvements restored tracking efficiency to 1960V levels.

Currents and Occupancy

Draws about 500 μA (0.25 nA/cm) with beam

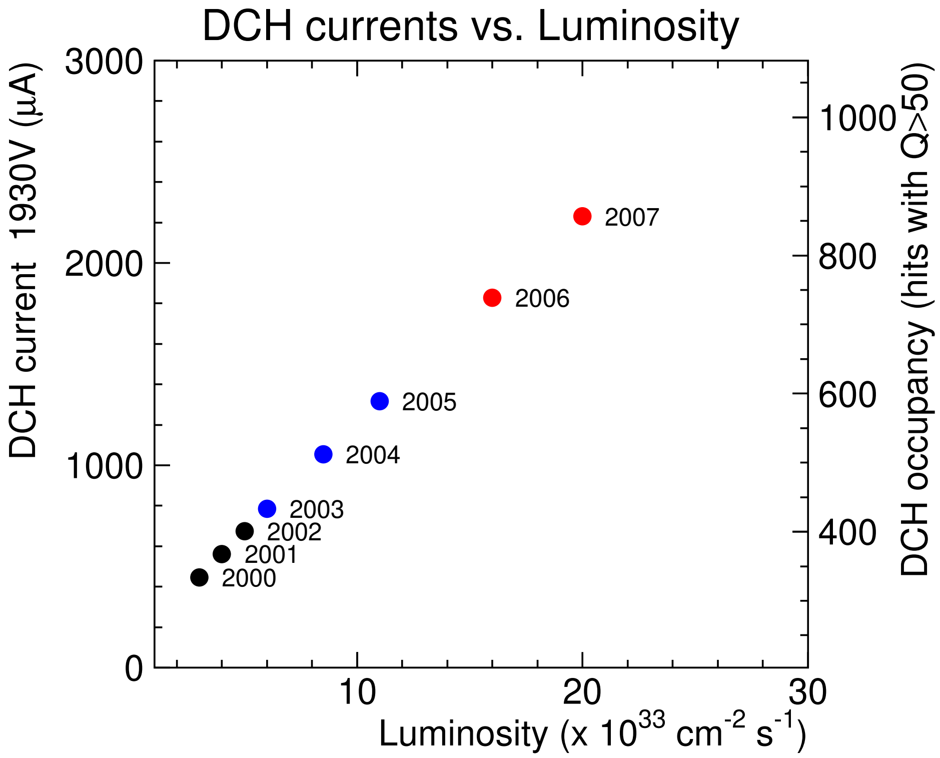


200 to 800 hits per event (excess from background)



Accumulated 5.3 mC/cm charge, $\lesssim$ 200 rad radiation

Luminosity Projections

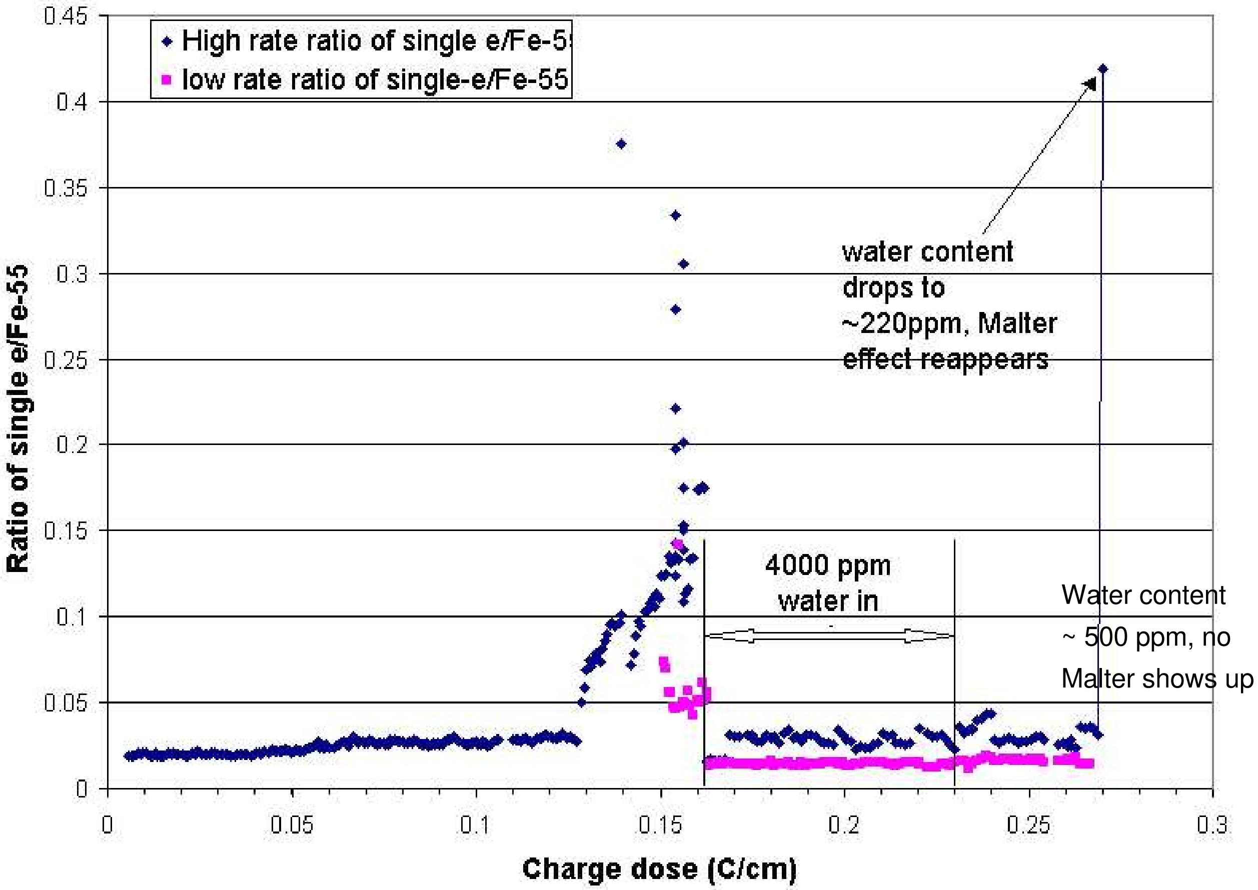


Occupancy $> 10\%$ after 2005

- Generally considered too high for good reconstruction (may not be true with BaBar software)
- Not uniform – inner layers may reach 100%. Bottleneck for DAQ and Level 1 trigger.
- Studies underway to reduce effective occupancy (tuning thresholds, subdividing readout, etc.).
- Unclear whether existing electronics can be adequately reconfigured, or if new design required.

Aging and Remediation

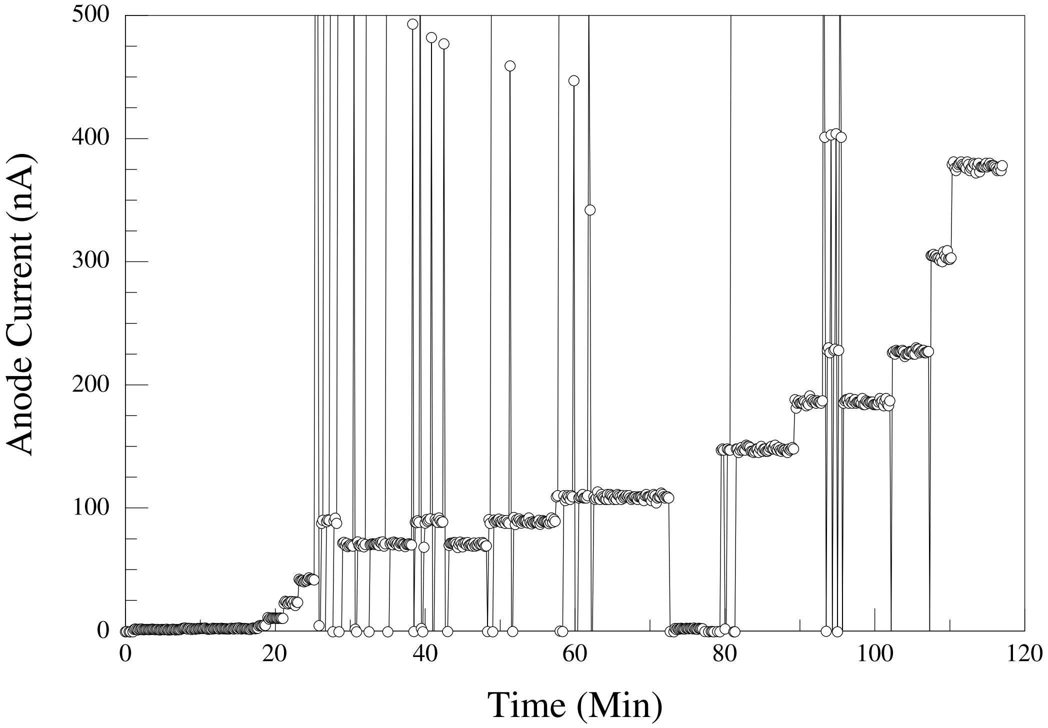
Aging studies from several institutions indicate that few per mil water (as in BaBar) can suppress (Malter) discharges



Aging and Remediation

Oxygen in high-rate environment seems to "cure" aging/Malter effects

A. Boysarski, SLAC-PUB 9058, hep-ex/0111090
Presented at Aging Phenomena Workshop, DESY



^{55}Fe source, 80/20 mix with 500 ppm O_2. Damaged chamber "trained" to reach high (undamaged) currents. Remained stable after removing O_2 from gas mix.

Glow discharge (HV with unquenched gas) with O_2 present may have similar benefit without requiring radiation source (^{55}Fe, ^{133}Xe, or beams). Promising studies are on-going.

Summary and Conclusions

The BaBar Drift Chamber is operating extremely well, and providing data at design resolutions.

- The mechanical and electrical systems should operate into the very high luminosity regime anticipated for the next five years
- Aging effects expected with any drift chamber appear to be controllable and potentially curable

The electronic readout system is problematic.

- We will need to reduce the apparent occupancy (noise hits, etc.)
- Provide usable data to trigger, and to perform at anticipated rates
- It is not clear whether the existing electronics are up to the task or not.

Any suggestions are welcome!