

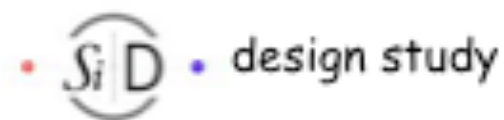
RPC Option for SiD Muon System

H. R. Band

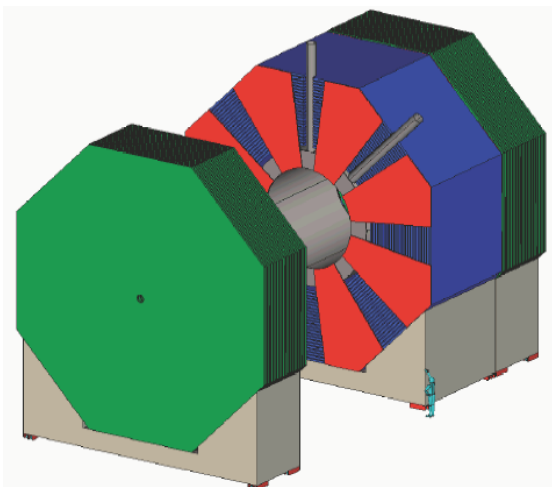
University of Wisconsin



SiD Muon DOD

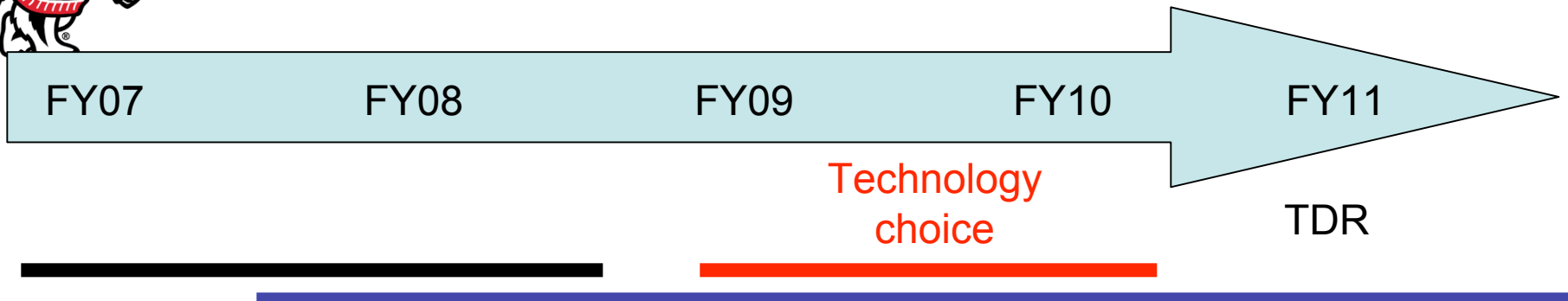


- **SiD**
 - 2.3 m thick flux return
 - 15 layers
 - Tail-catcher ?
- **Modest detector requirements**
 - Muon bkgds with spoilers
 $1.2 \cdot 10^{-3} \text{ Hz/cm}^2$ (Mokhov)
 - ~1 cm resolution
- **Many technology choices**
 - RPCs - 3 cm x/y strips **-or-**
 - Scintillators 4.1 cm x or y planes





R&D - Simulation

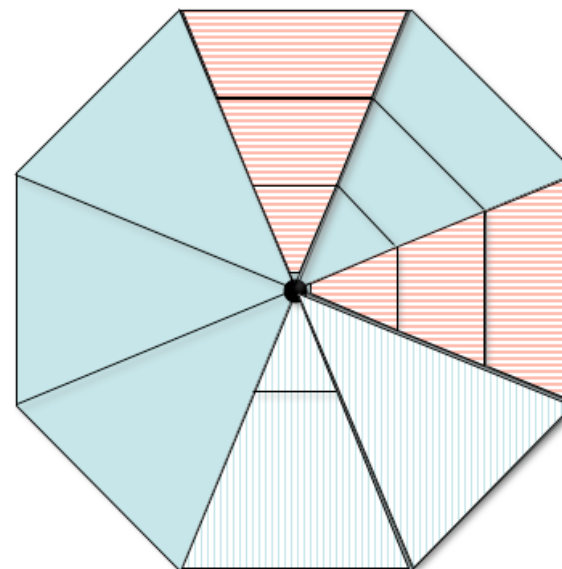


- *Generic Detector studies - see Caroline's talk*
 - # layers?
 - Resolution?
 - Tail-catcher?
- *Specific technology designs*
 - Steel geometry
 - Maximize coverage
- *Muon particle ID in Hcal/muon*



SiD - RPC Design

- **Barrel**
 - Size $\sim 2.9 \times 5.9 - 5.6 \times 5.9$ m
 - With (15 layers) 10 RPCs per layer per octant for a total of 1200 RPCs in the barrel with area of ~ 2700 m².
- **Endcaps**
 - 3 RPCs per octant per layer the endcaps would have 720 RPCs with a area of 3400 m².
- 6100 m² (15 layers) - 2600 chambers @ 2-3 m²
- 350,000 channels
- 5200 Digitizing chips (KPIX?)
- **RPCs**
 - 3 cm pitch ~ 1 cm resolution
 - XY readout
 - Single or double gap?
 - Glass or Bakelite ?





RPC R&D Issues

- *RPCs have proven to be less robust than initially promised*
- *Many observed failure modes*
 - *Improperly cured linseed oil*
 - *Eroded graphite coatings*
 - *Too much humidity - BELLE glass RPCs*
 - *Too little humidity - BaBar bakelite RPCs*
- *However, extensive R&D has led to a better understanding of aging mechanisms*
 - *Improved construction techniques*
 - *Avalanche mode*
 - *Humidified gas*
 - *Aging tests to 10 LHC year equivalents*
- *Will know in several years from the operational experience of CMS, ATLAS, BELLE, BaBar if RPCs can be made reliable*



Status of present streamer mode RPCs

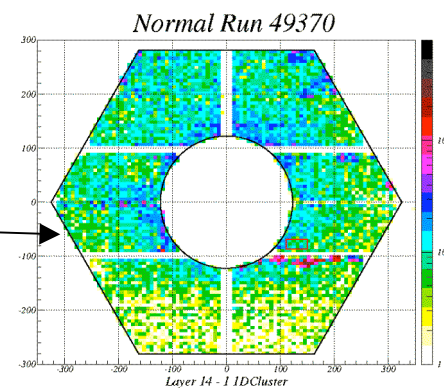
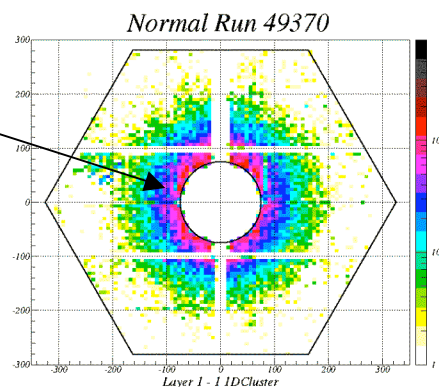
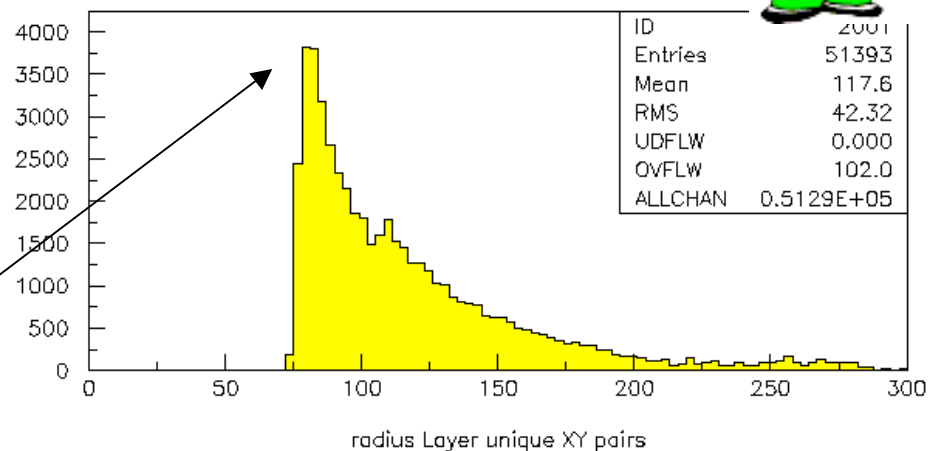
- *BELLE glass RPCs doing well after changes to gas plumbing*
 - *No signs of aging when rates are limited ($< 0.2 \text{ Hz cm}^2$)*
 - *Outer endcap layers turned off*
- *2nd generation BaBar Bakelite RPCs*
 - *$< 2 \text{ Hz/cm}^2$ few problems in 4 years*
 - *$>20 \text{ Hz/cm}^2$ losing efficiency*
- *BES III installing $\sim 2000 \text{ m}^2$ of Bakelite RPCs*
 - *Innovative plastic film surface - no linseed oil*
 - *Prototypes show stable performance*



BaBar Forward Endcap RPCs

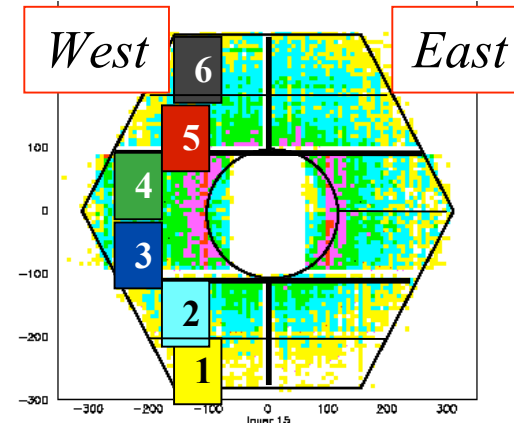


- 2nd generation RPCs
- Large variation in background/signal rates
- Inner layers rate peaks around beamline $>20 \text{ Hz/cm}^2$
- Lowest rates $<.1 \text{ Hz/cm}^2$
- Outer layers have more uniform background rates 2-6 Hz/cm^2

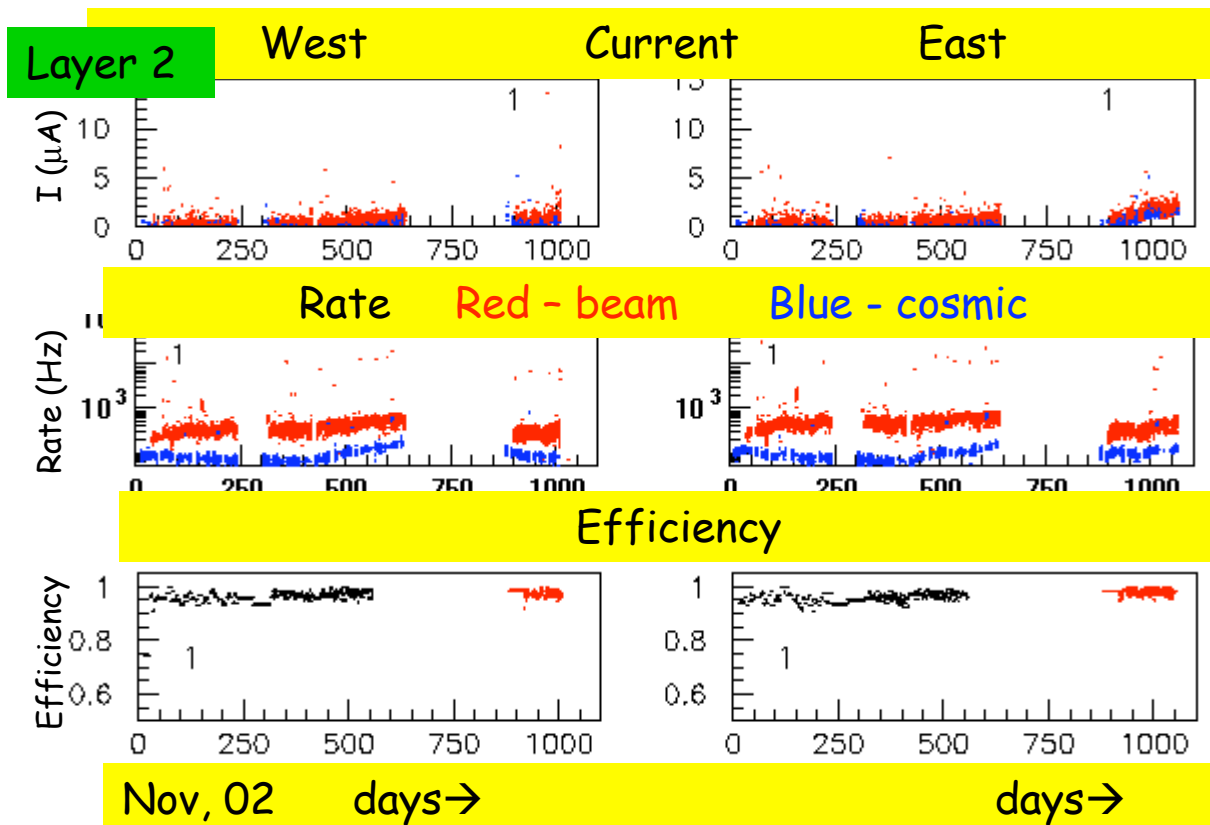




Top/Bottom RPCs



- *Top-6 & bottom-1 RPCs of inner layers have very low rates*



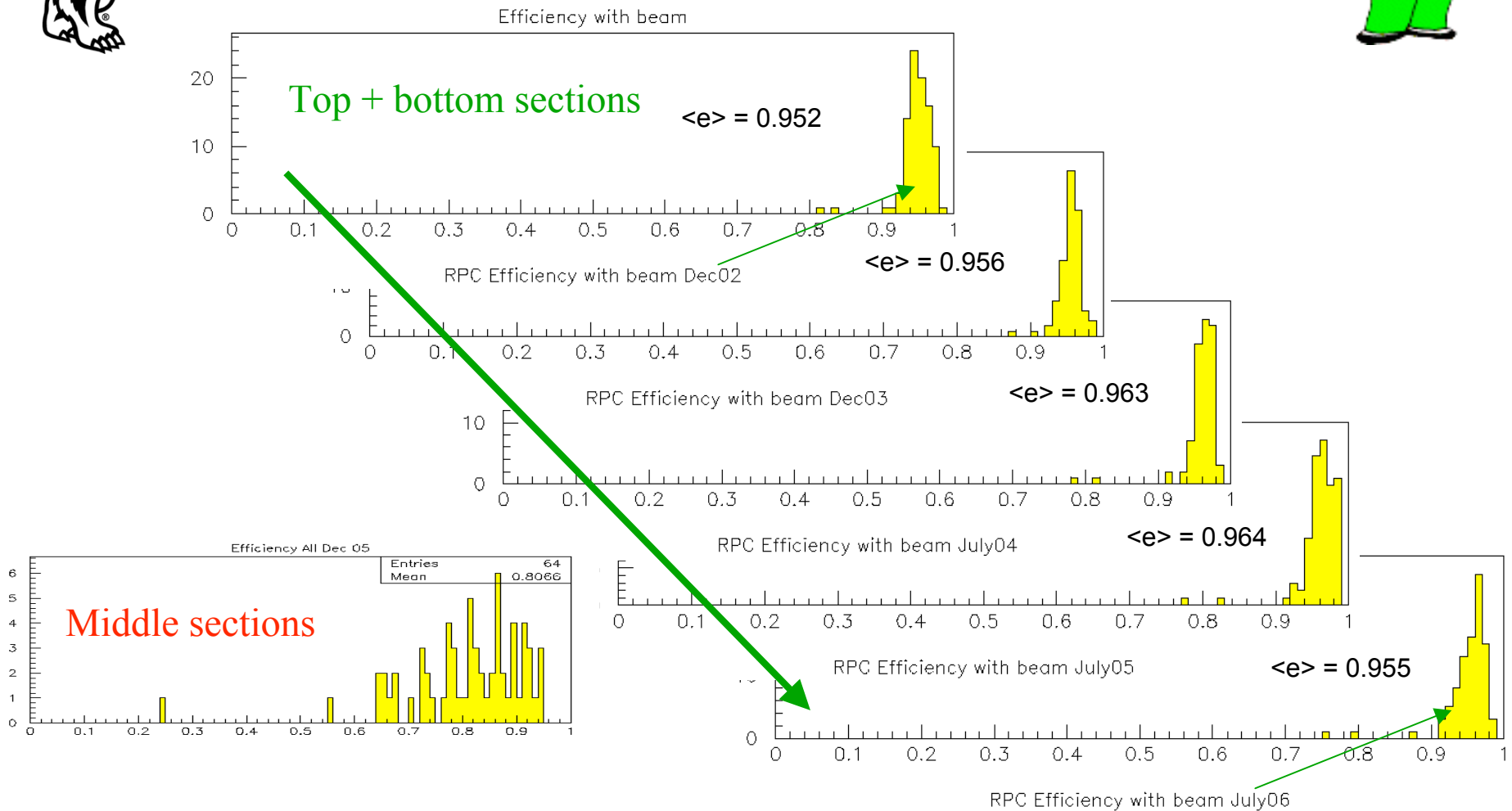
- *Currents, rates, & efficiency stable*
- *Positions 2 & 5 are similar but may have higher currents*
- *112/192 RPCs*
- *Most Top/Bottom Chambers expect $< 0.1 \text{ C/cm}^2$ by 08*

7/19/06

H. R. Band U. of Wisconsin



Measured Efficiency with μ pairs

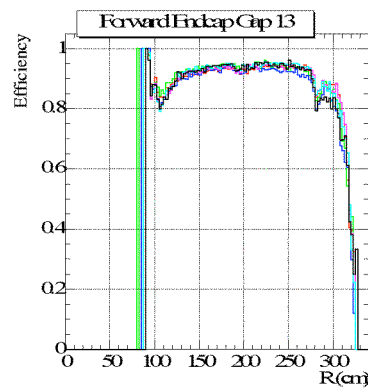
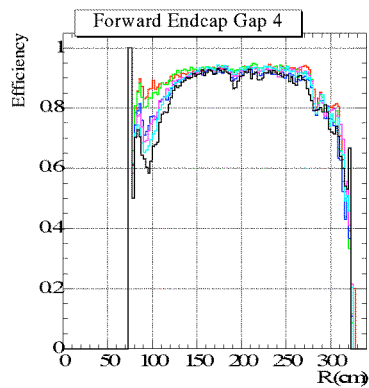
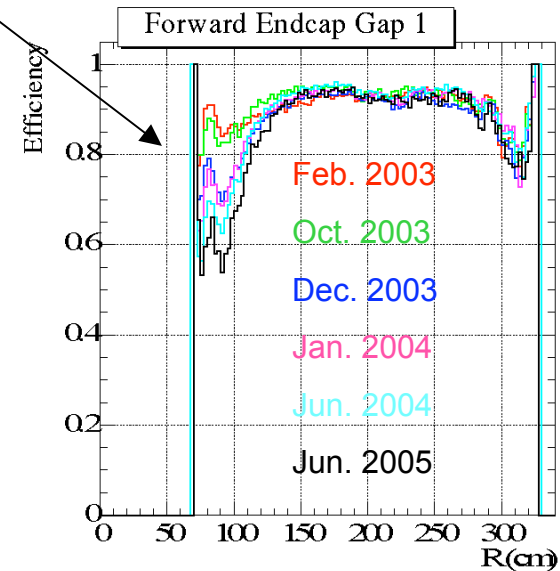
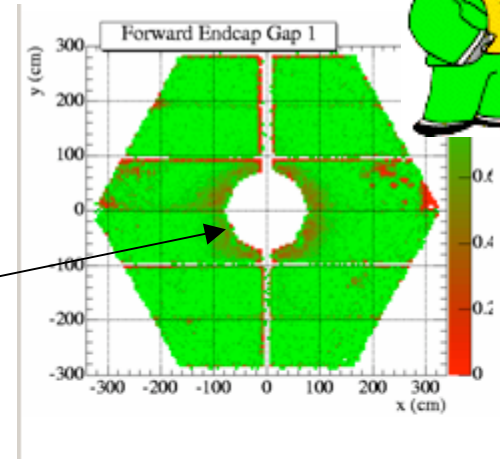




Small Radii



- *Middle RPCs exhibit a rate dependent inefficiency that gets worse with time*
- *Eff. OK with cosmics only*
- *Not improved by humid gas*





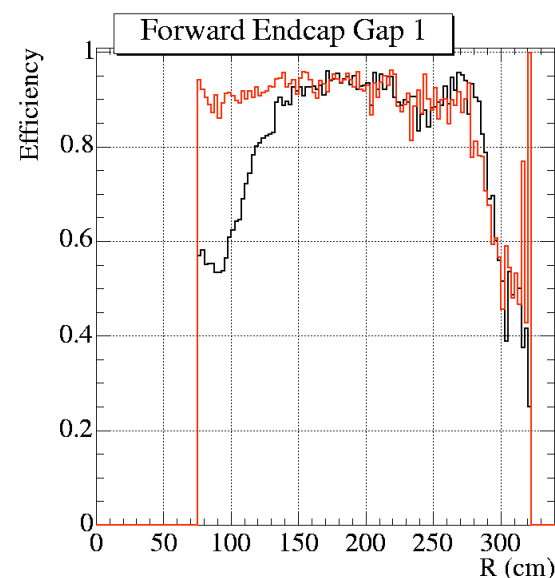
Avalanche Mode



- *3 middle RPCs converted to avalanche mode operation in 2005*
 - *Preamps*
 - *Gas*
- *Currents dropped by 1/5*
- *Noise rates doubled*
- *Efficiency improved*

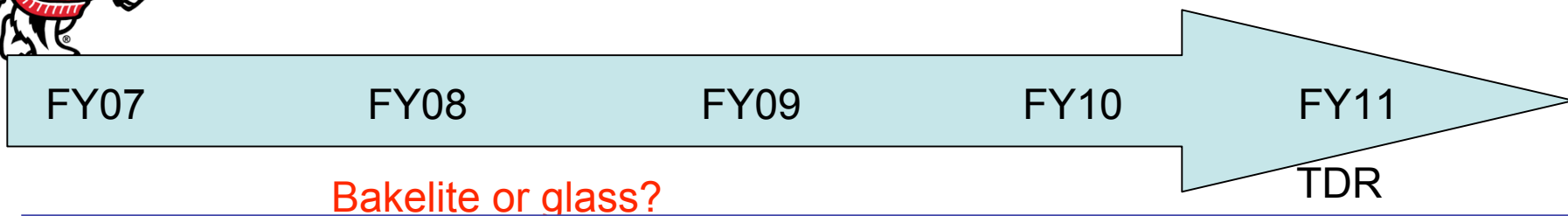
Avalanche mode

Streamer mode





SiD R&D - RPCs

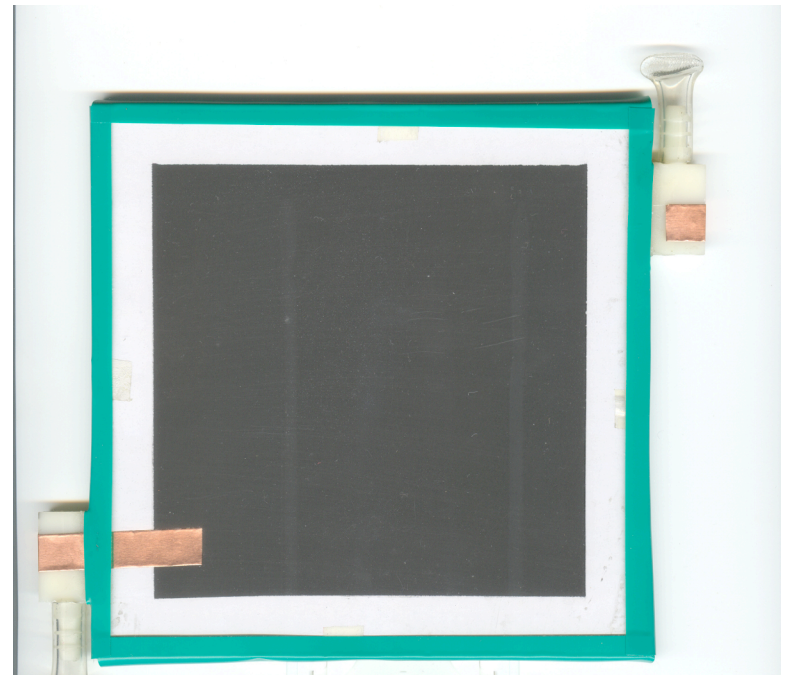


- **Does KPIX chip work well with RPCs?**
 - Need <100 channels / chip
 - Want longer live time
 - Monitor efficiency with cosmic rays
 - Test 64 channel KPIX version with real RPCs, pickup strips
- **RPC aging**
 - Experience at low rates encouraging
 - Continue study of high rate problems to understand all aging mechanisms
 - Test BESIII RPCs
- **Develop cost models**



RPC Aging Studies

- *BaBar(Wisconsin&Roma)*
 - *Avalanche mode*
 - *Fluorine production (HF) & absorption*
 - *Humidity*
 - *High Rate effects*
 - *Princeton*
 - *Avalanche mode*
 - *Surface quality studies*
 - *Gas*
 - *Fluorine production (HF) & absorption*
 - *Bakelite Experience*
 - *Need glass RPC tests*
- *Study BES III RPC response to humidity and HF*





Summary

- *Expect*
 - *RPCs to maintain cost advantage over other technologies*
 - *RPC Aging issues will be under control*
- *R&D plan will hopefully prove both*