General overview

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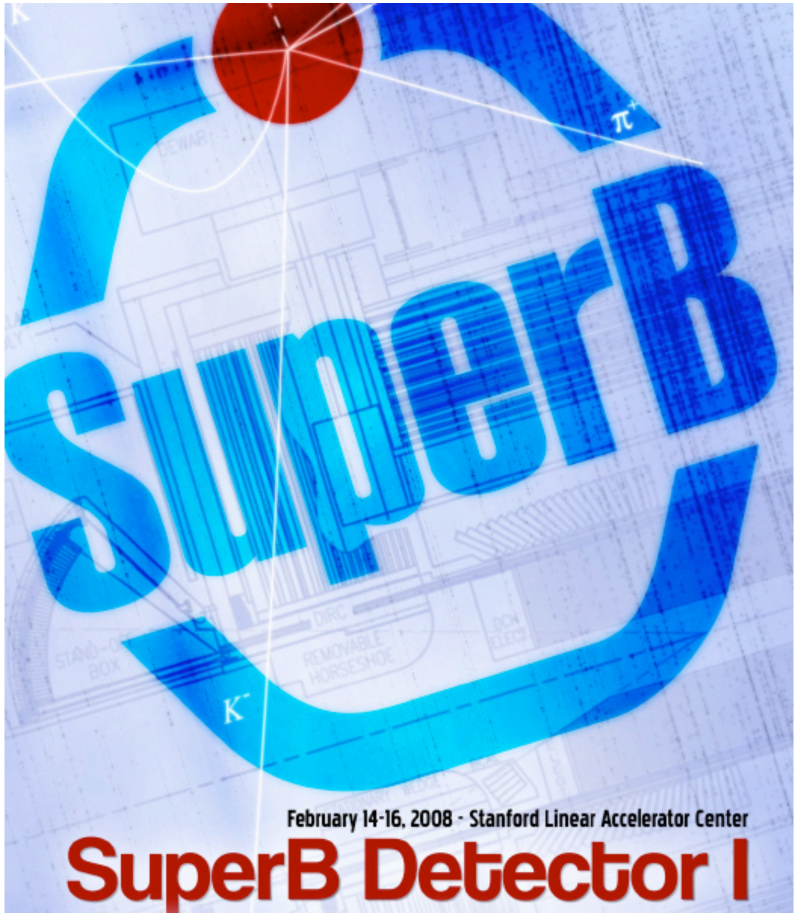
SuperB Detector R&D Workshop

SLAC Feb 14-16, 2008

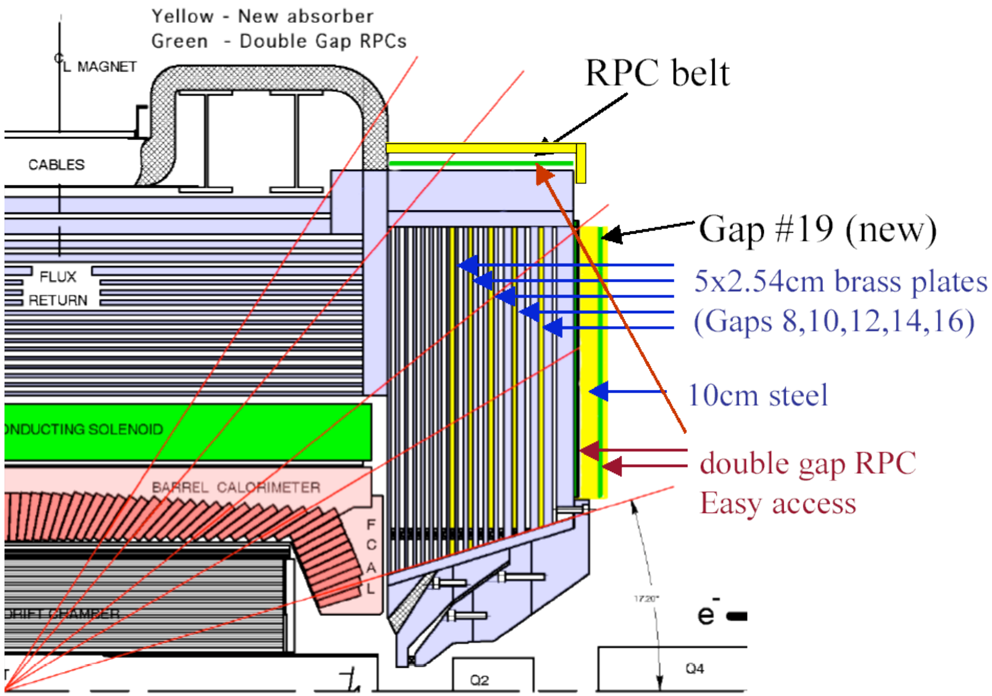
Outline

- The IFR concept
- The scintillator choice for super B
- The scintillators
- The WLS fibers
- The photon detectors



The IFR for super B

- The muon and K_L detector is build in the magnet flux return.
- In BaBar it's composed by one hexagonal barrel and 2 endcaps
- The iron is instrumented with LSTs in the barrel and with RPCs in the endcaps.
  - 16 RPCs active layers
  - 12 LSTs active layers
- RPC belt chambers have been added to the forward endcap to improve the coverage.



IFR requirements for super B

- Add iron to BaBar stack to improve μ ID:

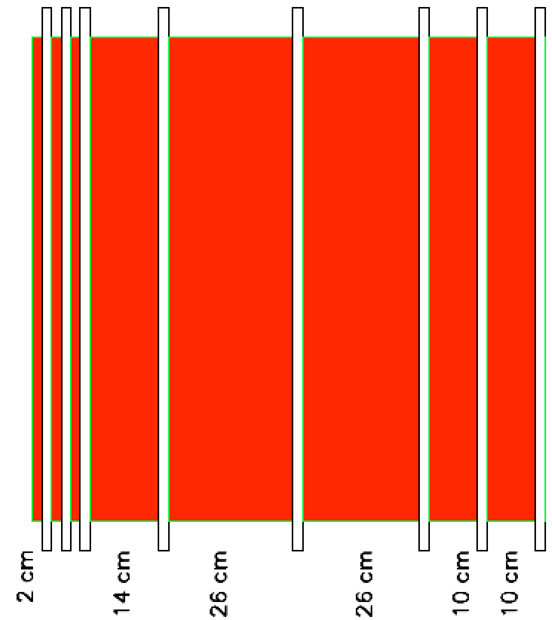
  ➔ 7-8 detection layers.

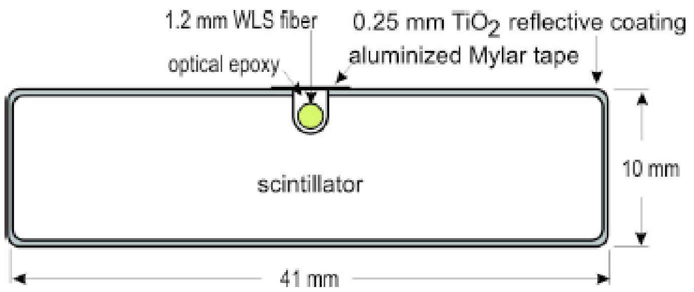
- Re-use BaBar steel (still to be fully assessed)

- Keep longitudinal segmentation in front of stack to retain K_L ID capability.

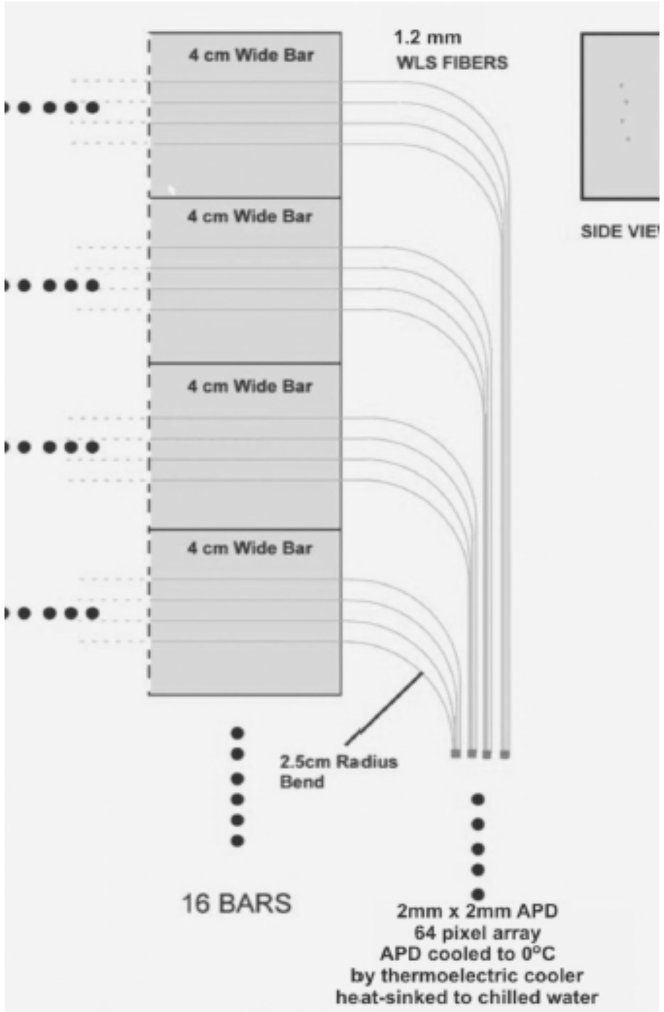
- Backgrounds are problematic for gas detectors.

  ➔ Use Minos style scintillation bars.





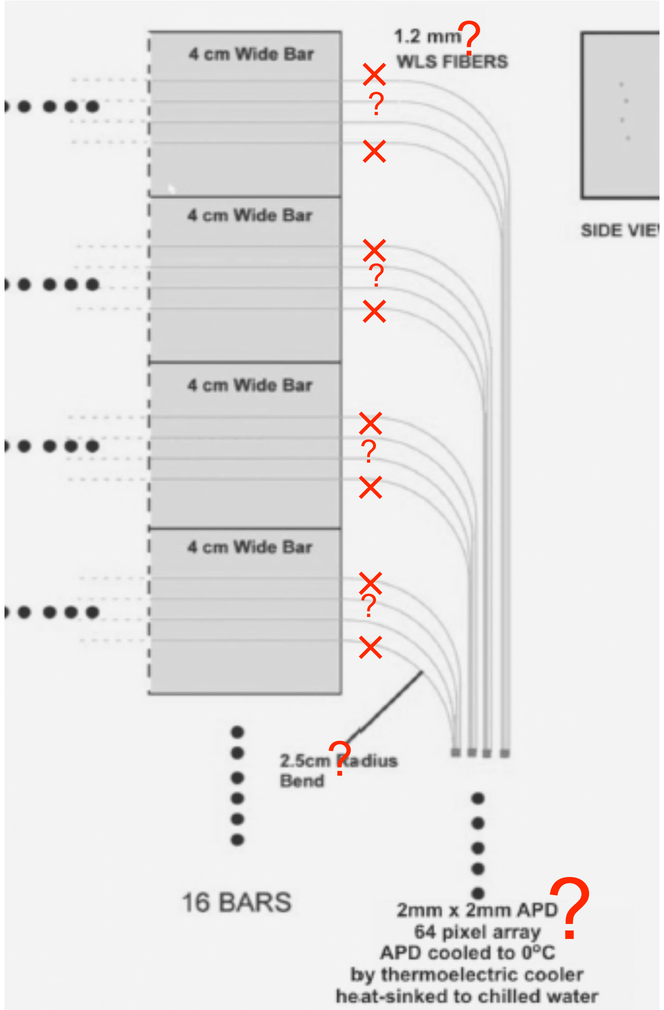
The Minos style IFR



- This technology has been proposed as replacement of the BaBar barrel.
- One coordinate will be measured by the bar position.
- The other coordinate by measuring the time at both end of the bar.
- Need input from simulation and background evaluation.
  - Time resolution and spatial segmentation
  - Number and location of active layers.
  - Where to add iron if needed
- Need full simulation of the detector, reconstruction code and muon selectors. Not available for super B: reuse BaBar framework.

From CDR: Minos style layout

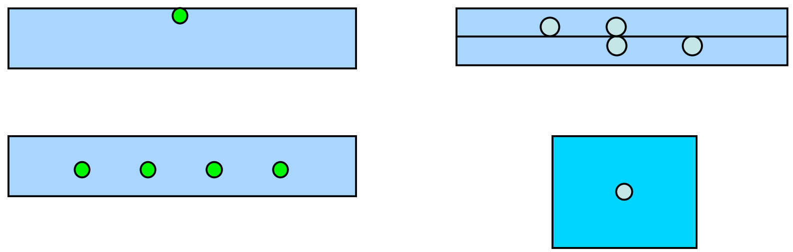
The super B style IFR



- Some of the questions that we are trying to answer"
  - Number of fibers per scintillation bar: may be only one or two.
  - WLS fiber diameter (1 mm), shape decay time, …
  - Use Geiger Mode APDs instead of APDs?
  - What is the best mechanical design
  - What electronics
  - Read one or two side of the scintillator

The scintillator bars

- In contact with FNAL-NICADD facility
- Various candidates:



- We have some spares from Minos and Itasca company that we are using for R&D
- In a second stage of the R&D we'll have to make our own prototype.

The WLS fibers

- Baseline: Kuraray Y11-175 Φ=1.0 mm, round, double cladding
  - Trapping efficiency = 5.4%
  - Attenuation Length ~ 3.5m
  - Emission peak: 476 nm

- Possible alternatives:
  - Different diameter/dopant concentration: increase the light yield
  - Square shape: higher trapping efficiency (~+30%)
  - Bicron BCF-92 fibers (round multiclad):
    - Trapping efficiency = 5.6%
    - Attenuation Length ~ 3.5m
    - Emission peak: 492 nm
    - Decay time: 2.7 ns (Y11-200 is ≈10ns), faster → better time resolution

Fiber readout

- APD:
  - For BaBar R&D was considered the model RMD #S0223:
    - G>1000
    - QE=65% (>530 nm)
    - 5ns risetime
    - High bias voltage (1850V) → difficult to stabilize
    - G very sensitive to V and T variations

$$\begin{cases} \frac{\Delta G}{G} = 75 \cdot \frac{\Delta V}{V} \\ \frac{\Delta G}{G} = 17 \cdot \frac{\Delta T}{T} \end{cases}$$

  - Hamamatsu APDs have lower gain (few 100), bias voltage 400- 500 V

- Geiger mode APDs: MPPC (Hamamatsu), SiPM (FBK- IRST)
    - G >10^5
    - DE ≈ 40% (530nm) (DE = Q.E x Fill factor x Aval. prob.)
    - ~ 1ns risetime
    - ≈ 10 times less sensitive to V and T variations

$$\begin{cases} \frac{\Delta G}{G} = 7 \cdot \frac{\Delta V}{V} \\ \frac{\Delta G}{G} = 1.3 \cdot \frac{\Delta T}{T} \end{cases}$$

    - Low bias voltage (50-70V)
    - Dark current rate @ room temperature : { 100s of kHz thr = 0.5 phe; few kHz if thr = 1.5 phe }

Conclusions

to be continued…