General overview

G. Cibinetto - INFN & Universita' di Ferrara

Super B Meeting

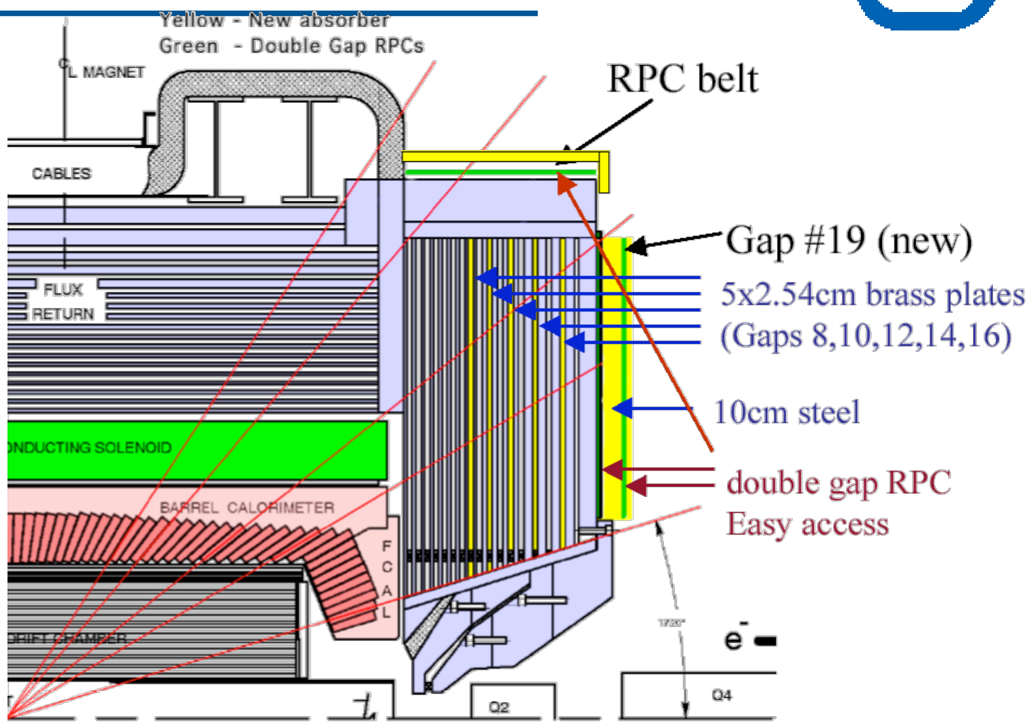
Elba May 31 - June 3, 2008

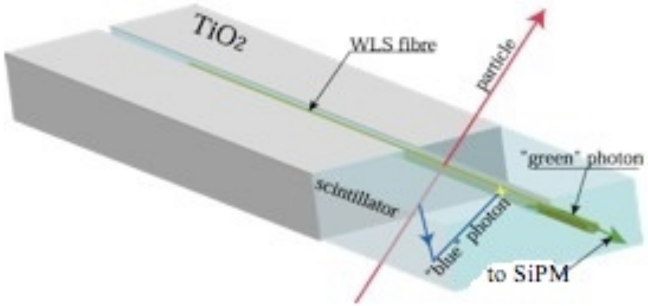
Outline

- Introduction
- Detecto R&D
  - The scintillators
  - The WLS fibers
  - The photon detectors
- Electronics
- Simulation
- Group organization and manpower

The IFR for super B

- The muon and K_L detector is build in the magnet flux return.
- It will be composed by one hexagonal barrel and 2 endcaps like in Babar.
- Plan to reuse BaBar iron structure





- Backgrounds will be problematic for gas detectors.

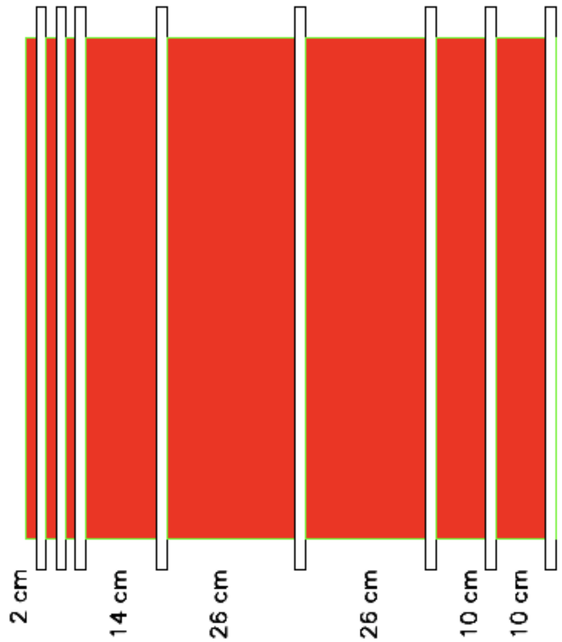
→ Use scintillation bars with WLS fiber

IFR requirements for super B

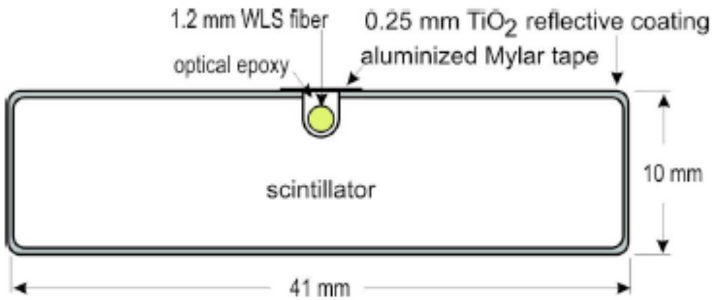
- Add iron to BaBar stack to improve μ ID:

    ➔ 7-8 detection layers should be enough

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



A possible layer configuration

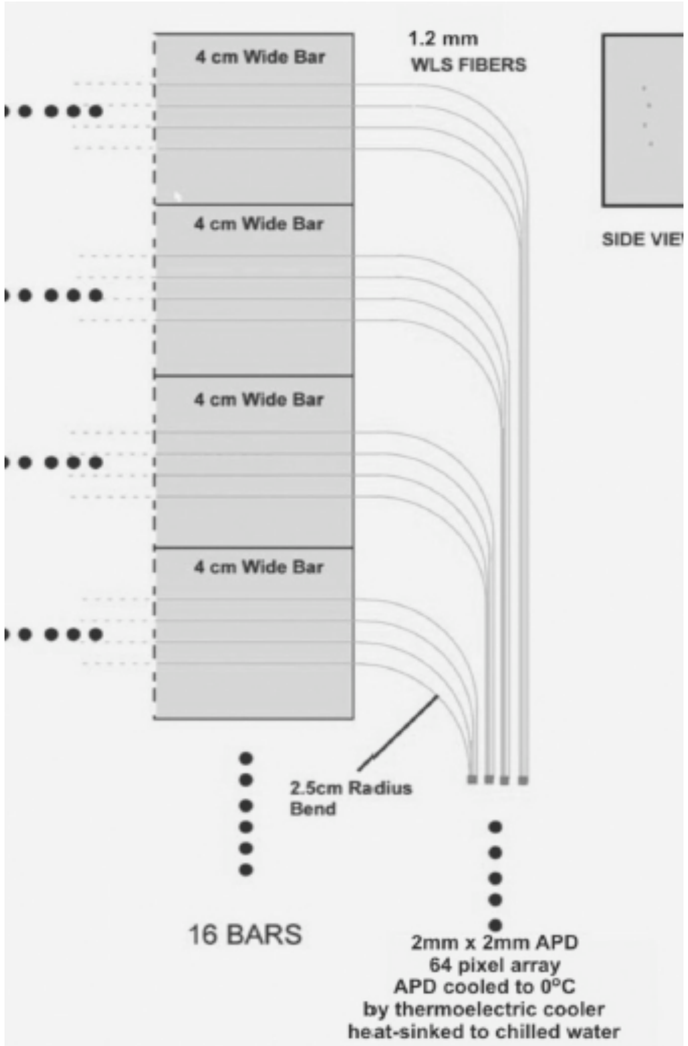


Scintillation bar geometry from CDR

Need to optimize:

- Scintillation bars geometry
- Number of active layers
- Where and how much iron we need to add

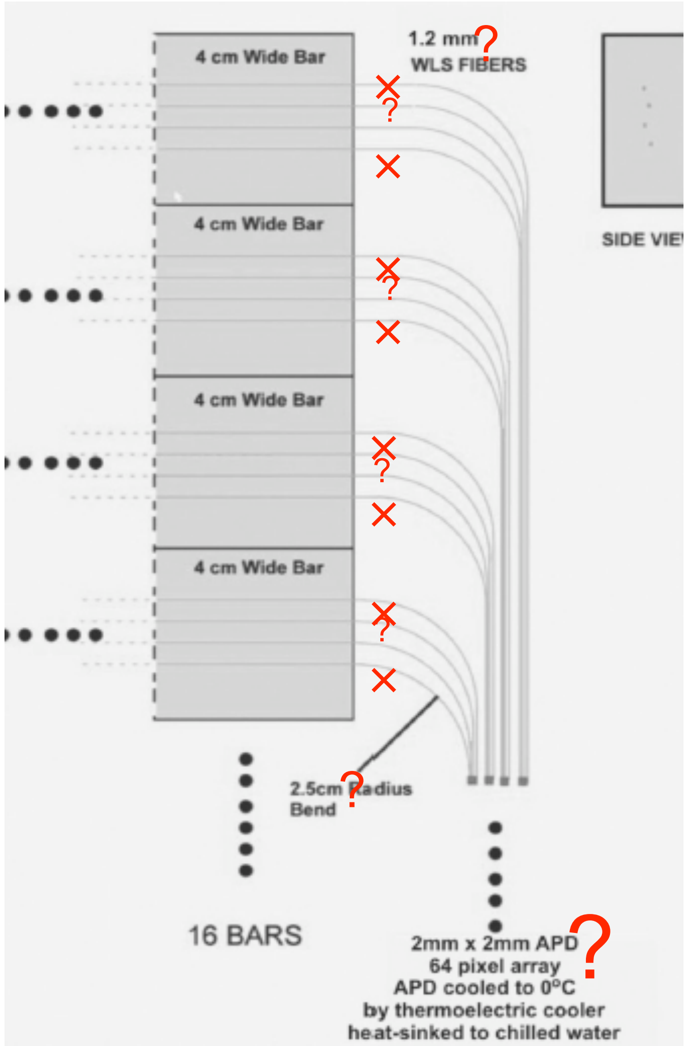
The CDR style IFR



- This technology was proposed also as replacement of the BaBar barrel.
- One coordinate will be measured by the position of the scintillation bar.
- 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.
- Need full simulation of the detector, reconstruction code and muon selectors. Not available for super B: reuse BaBar framework.

From CDR: possible 4 fibers readout

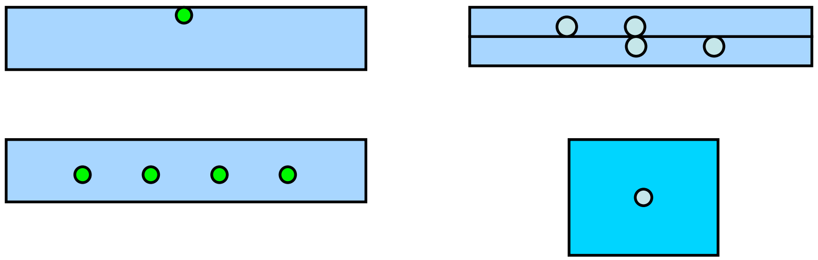
Evolving from CDR



- 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

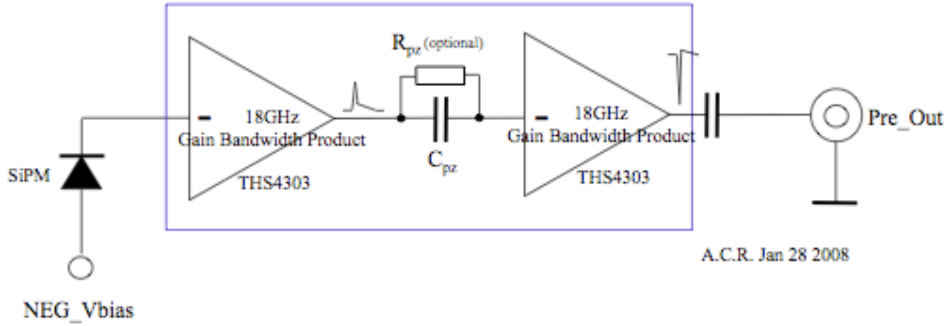
$$\left\{ \begin{array}{l} \frac{\Delta G}{G} = 75 \cdot \frac{\Delta V}{V} \\ \frac{\Delta G}{G} = 17 \cdot \frac{\Delta T}{T} \end{array} \right.$$

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

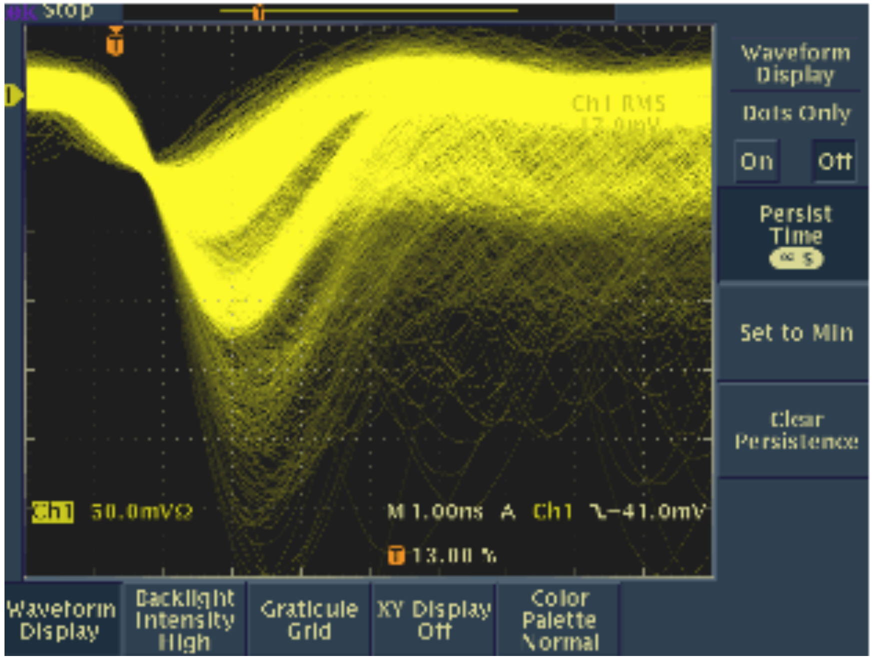
- Geiger mode APDs: MPPC (Hamamatsu), SiPM (FBK- IRST)
  - G >10^5
  - DE ≈ 40% (530nm) (DE = Q.E x Fill factor x Aval. prob.)
  - ~ 1ns risetime
  - ≈ 10 times less sensitive to V and T variations
  - Low bias voltage (50-70V)
  - Dark current rate @ room temperature : { 100s of kHz thr = 0.5 phe; few kHz if thr = 1.5 phe }

$$\left\{ \begin{array}{l} \frac{\Delta G}{G} = 7 \cdot \frac{\Delta V}{V} \\ \frac{\Delta G}{G} = 1.3 \cdot \frac{\Delta T}{T} \end{array} \right.$$

Electronics for SiPM readout



prototype amplifier
based on the Texas Instruments' THS4303

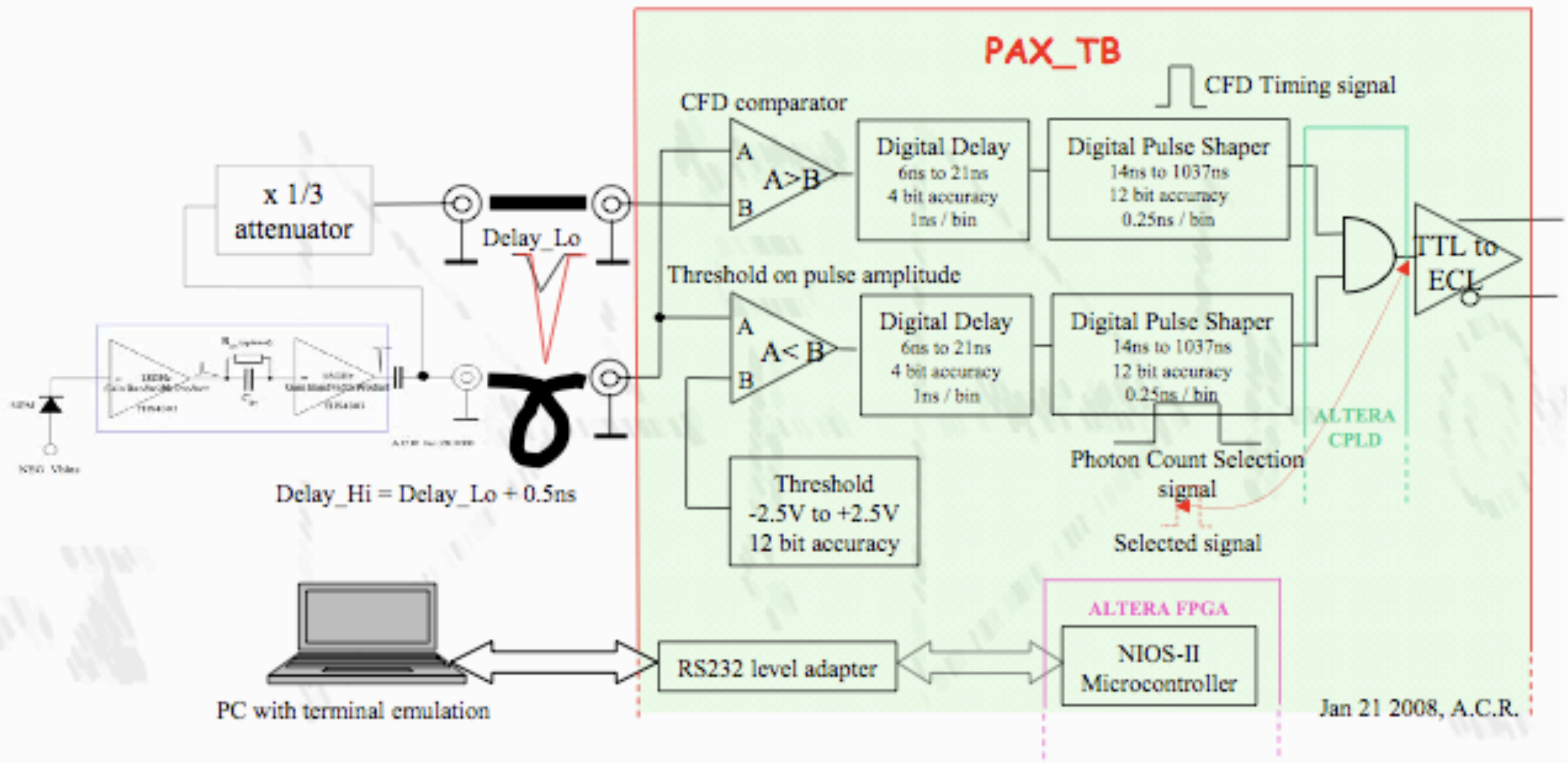


SiPM signal processing (amplification and possibly discrimination) is VERY LIKELY needed as close as possible to the SiPMs and thus inside the "iron".

Courtesy of Angelo Cotta Ramusino

Electronics for SiPM readout

A proposal for a SiPM Front End with constant fraction discriminator and “thermometer code” ADC: proof of principle implemented on the PAX Trigger Board (PAX_TB)



Block diagram of the SiPM signal processing chain proposed here to enhance, if necessary, the time resolution of the discrimination on the SiPM output.

Courtesy of Angelo Cotta Ramusino

Simulation

- A simulation working group has been setup in February.
- Activities in three directions
  - Fast simulation
  - Full Geant4 simulation
  - Detector optimization

SuperB IFR group institutions and manpower

At present:

- Ferrara INFN-University
- Padova INFN-University
- Roma1 INFN-University

Additional forces would be very helpful, in particular in the area of simulation

For the TDR:

- Establish the baseline layout of the detector (R&D on scintillator, fiber, SiPM, electronics,…+ simulations)
- Build and test a prototype (discussion at the end of the session)

To build, install and operate the final detector need more institutions

Other IFR talks

- Saturday
  - 09:30->10:30 Geant4 Simulation Session (G. Cibinetto)
  - 11:00->12:30 Computing (M. Rotondo)

- Sunday
  - 11:00->12:40 Backgrounds simulation and measurement (G. Cibinetto)

- Monday
  - 08:30->10:30 Simulation Tools (M. Rotondo)
  - 18:00->19:30 Electronics (A. Cotta Ramusino)