SuperB IFR detector

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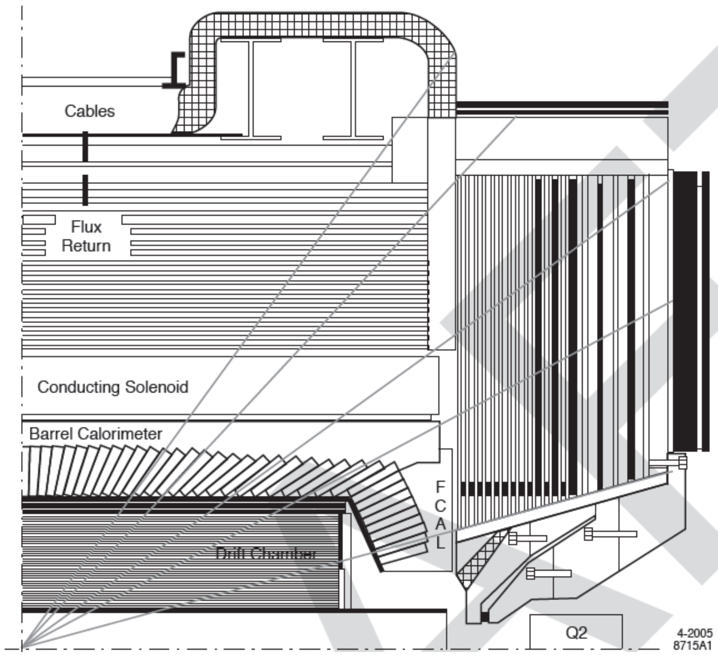
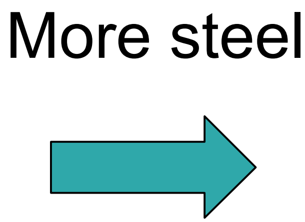
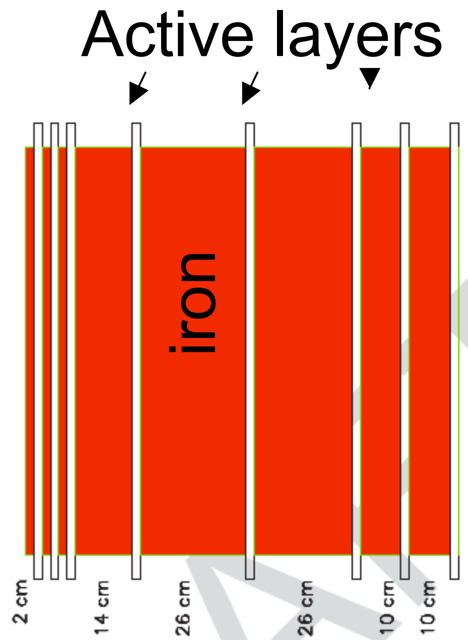
Outline

- Baseline for a muon (and KL) detector
- Machine background
- Scintillator option
  - *N.B.:The source of information (and slides) on scintillators are 2002 BaBar IFR barrel upgrade review documents.*

SuperB IFR Geometry



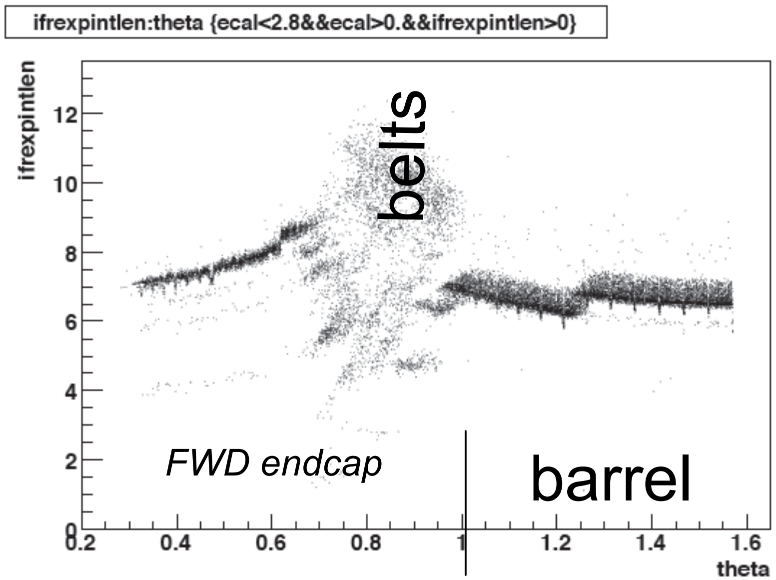




- Active layers interleaved with iron absorber
  - Same for endcaps and barrel (symmetric detector)

Muon Identification

Expected interaction lengths (nλ)

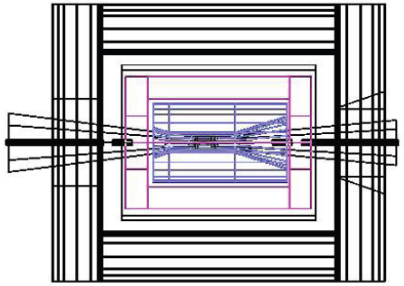


	Loose selection		Very Tight selection	
momentum	μ eff.	π misid.	μ eff.	π misid.
0.8 GeV/c	48	2.3	42	1.8
1 GeV/c	66	5.4	54	3.0
2 GeV/c	82	2.0	74	1.3
5 GeV/c	84	1.9	79	1.2

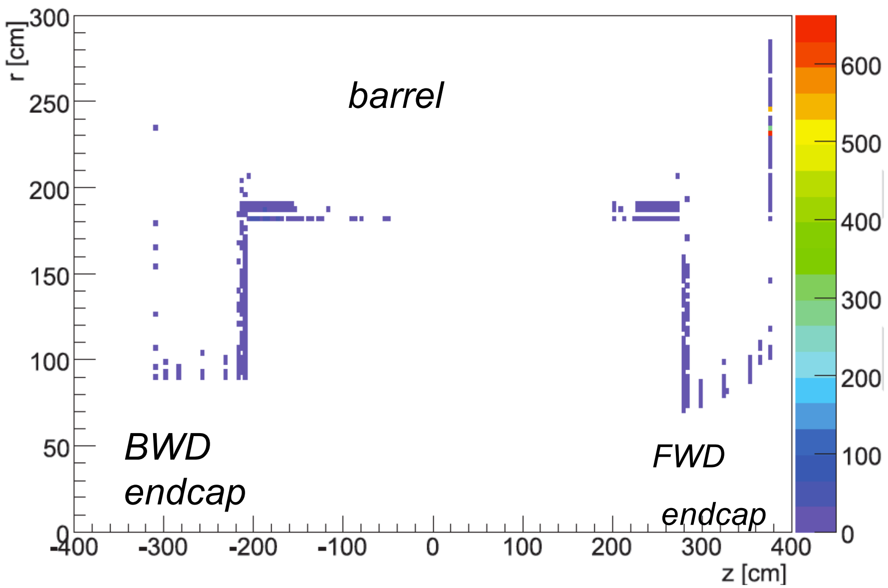
– Basic identification algorithm based on $\lambda_{measured}$
  - Based on SP BaBar simulation
  - Performance better than BaBar anyway

Machine Background

- From simulation of SuperB detector
  - (& interaction region)



1940 bunch crossing (231 MHz)



Hottest regions corresponds to few 100Hz/cm^2

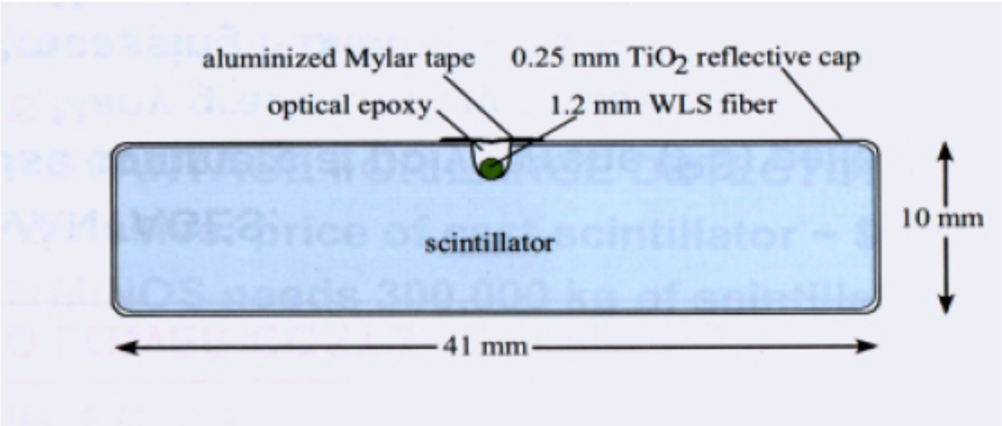
At limit for operating RPC in avalanche

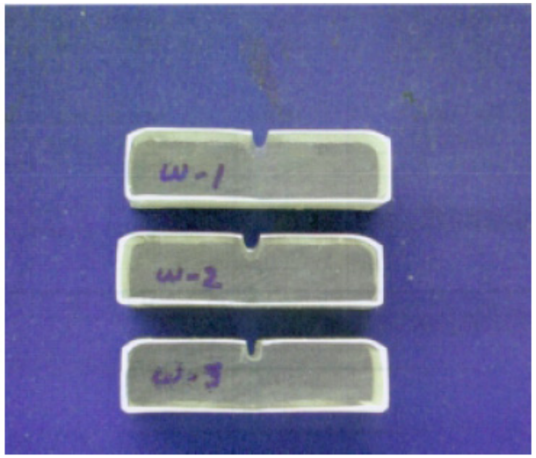
A scintillator-based active detectors seems to be more conservative

(and apparently only 50% more expensive)

Extruded scintillators

MINOS USES A LARGE VOLUME OF CHEAP CO-EXTRUDED SCINTILLATOR BARS (8m x 4cmx1cm) WITH SINGLE 1.2mmØ Y11-175 multiclad WLS FIBER EPOXIED IN EXTRUDED GROOVE





MINOS PRODUCTION BARS SHOWING 4 x 1 cm^2 CROSS SECTION WITH CO-EXTRUDED TiO_2 AND GROOVE FOR WLS FIBER

WLS FIBER → LONG CLEAR FIBER → PIXELATED PMT

STARTED LOOKING AT WHETHER SCINTILLATOR BARS COULD BE READ OUT SIMPLY BY ATTACHING A LARGE AREA APD (25mm^2 Hamamatsu S8664-55 APD for CMS) TO EACH END

- ΔT OF EACH END OR PULSE HEIGHT COULD Z POS.

Material from IFR upgrade review

STATUS REPORT #1

Peter Kim, Rafe Schindler,
Joerg Stelzer, David Hitlin, William Wisniewski,
Michael Lometti, Deborah Berebechez, David Nelson,
Martin Kocian, Gregory Dubois - Felsmann

The Stanford Linear Accelerator Center
&
The California Institute of Technology

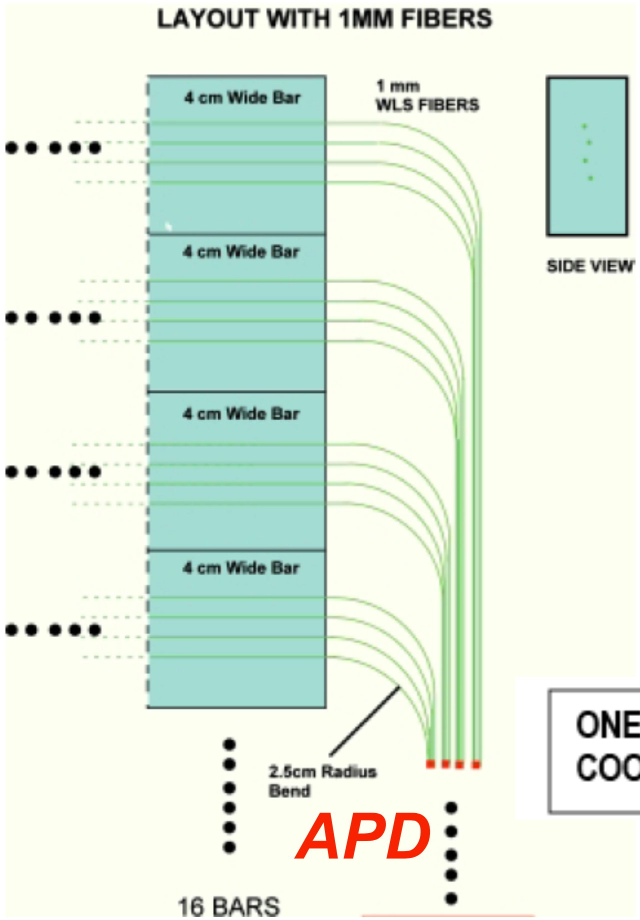
System proposed in ‘02

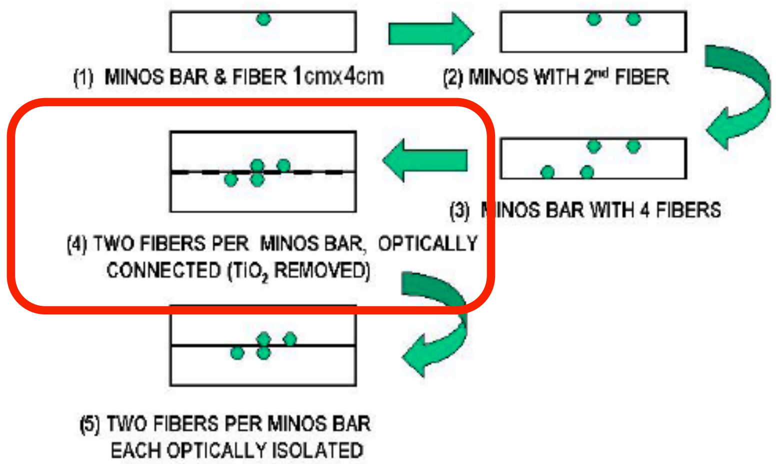
SEGMENT SYSTEM AS 3 MODULES PER LAYER PER SEXTANT IN PHI DIRECTION & FULL LENGTH (3.7m) ALONG THE BEAM

- **EACH MODULE HAS 16 STRIPS 4cm to 6cm IN WIDTH**

Higher light yield (3x MINOS)

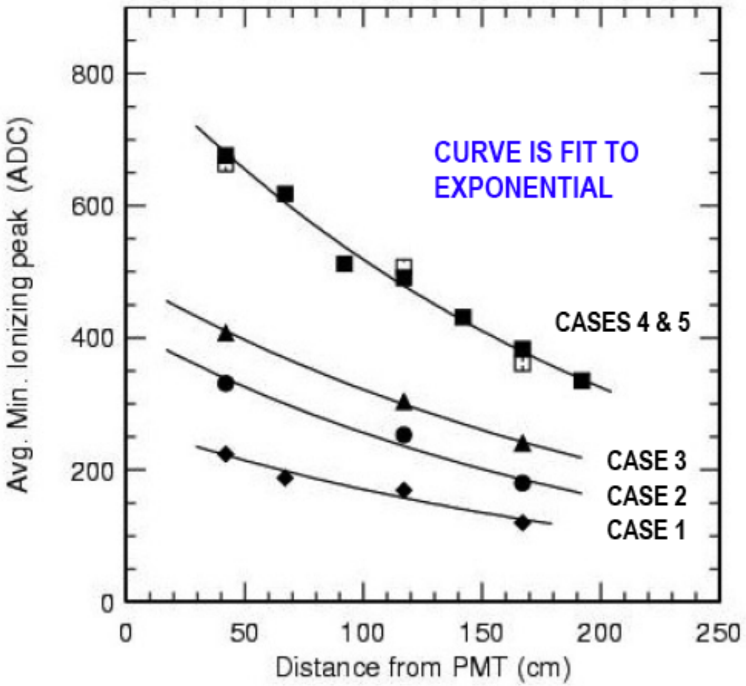
Require flowing dry N_2





R&D ongoing (in 2002)

ATTENUATION LENGTH MEASUREMENTS FOR 5 CASES



RESULTS ON SNGL SIDED POSITION RESOLUTION MEASURMENTS (PMT)

GEOMETRY	LY (42cm)	λ (cm)	σ_L (cm)	σ_L (cm)
			Near to PMT (42 cm)	Away From PMT (167cm)
1	1.00	217	33	38
2	1.47	208	27	32
3	1.81	238	26	32
4	3.02	213	26	24
5	2.96	208	27	29

σ ~ 25→30cm

USES ONE END & NO PULSE HEIGHT INFO; ←SHOULD IMPROVE WHEN BOTH ENDS USED

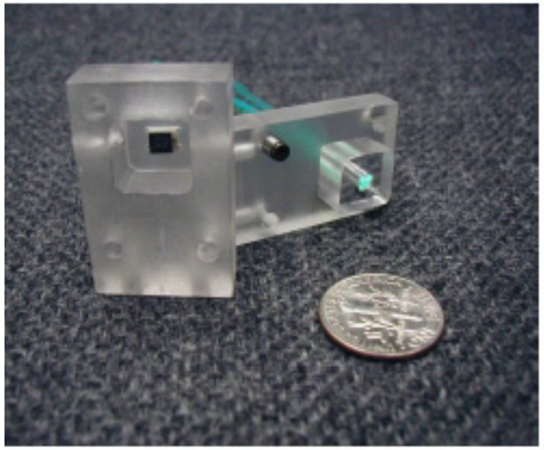
MC PREDICTS CONTRIBUTION OF RISETIME FROM GEOMETRICAL & LIGHT PROPOGATION EFFECTS TO GO FROM 0.2 TO 1.5 ns ←SMALL

It was worse than MINOS

Experience with APD

IMPLIES NEED FOR MODEST COOLING: NOISE DECREASES, & GAIN INCREASES

- RMD's S0223 (2x2mm^2, 0.7pf/mm^2)
- AT ~1850v QE > 65% at >530 nm, gain >1000X,
- ~5 NS RISETIME AT 500nm
- FIGURE OF MERIT: ~90% EFF AT ROOM TEMP WITH ~50 γ INCIDENT at ~500 nm, INCL. NOISE SOURCES
- FEW PHOTON COUNTING WITH MODEST COOLING (~ 0^0 C)
- RADIATION TESTED AT PSI – OK TO ABOUT 1 X 10^{12} n/cm
- RMD MAKES ARRAYS OF THESE AS WELL (4 X 4)
  - MOST COST EFFECTIVE PER PIXEL



2mm x 2mm RMD APD IN CONNECTOR ALIGNING IT TO 4 x Y11 FIBERS

Cooling required down to about 0°C (better S/N performances)
[Need a cooling water loop]

N.B: readout electronics can largely reuse the design of BaBar DIRC Electronics (TDC)

Proposed componets (barrel)

- **Extruded Scintillator Bar With Co-Extruded TiO_2 Outer Coating**
  - ~7000 strips each 3.7m L X (4 → 6)cm W X 2cm H
  - Strips have four 1.6mm h x 1.4 mm w grooves extruded
- **Wavelength Shifter Fiber With Double Cladding**
  - 112 KM Kuraray Y11 Fiber (~ 175 ppm)
  - 1→1.2 mm Diameter Round
- **Avalanche Photodiode Array**
  - RMD A1604 Package (16 Pixels x $4mm^2$)
    Incl. Mod. To Ceramic Substrate For TE Cooler Mount

- **16 Strip Module Components (3 Modules/Sextant Layer)**
  - Al Base, Al Cover, Endplates
  - Fiber Routing Comb (16 X 4 = 64 fibers)
  - WLS-Fiber To APD Optical Connector
  - Thermoelectric (TE) Cooler Package For APD
  - APD Mounting and Preamplifier Card
  - Laser Diode Flasher (?)
- **Internal & External Electronics**
  - Preamplifier (possible coupled to APD Substrate)
  - Discriminator (Possibly multi level with bits recorded)
  - TDC (<1ns Resolution Desired)

Budget (updated to 07)

	EDIA[mm]	Labor[mm]	M&S[keuro]
IFR (scintillator)	**56**	**54**	**1268**
System engineering	24	0	0
scintillator strips + WLS fiber	0	0	320
Module factory retooling	0	3	15
Module fabrication	0	27	68
module installation	0	0	14
APD/preamp + cooling system	5	0	663
Services	3	6	14
LED pulser system	0	0	24
Detector Assembly	24	18	151

Electronics

IFR	**64**	**141**
Preamp/discriminator	22	59
design/test prototype	22	25
production	0	34
preamplifier board	9	15
design & prototype	9	3
production	0	12
cable to DFB	0	8
DFB board	30	18
design/test prototype	30	5
production	0	13
components/panel/connectors	0	26
test	3	15

R&D now

Some ideas from reading BaBar docs

- *Put together an extruded bar at home*
  - *Learn how to extrude scint bars ? Caltech machine ?*
- Optimization
  - Try increase light yield (reevaluate different design)
  - Better z resolution (time) - risetime in preAmp
- APD
  - » Reduce electronic noise, find optimal S/N at room temp.
  - » Demonstrate cooling is feasible
  - » Study optical epoxy
  - » No problem in fringe magnetic field ?