SuperB Detector Summary

SuperB Miniworkshop, Oxford 18/19th May 2011

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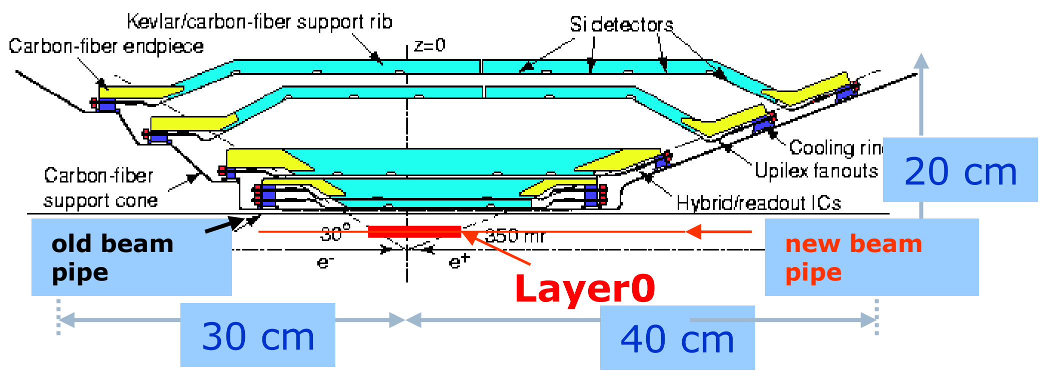
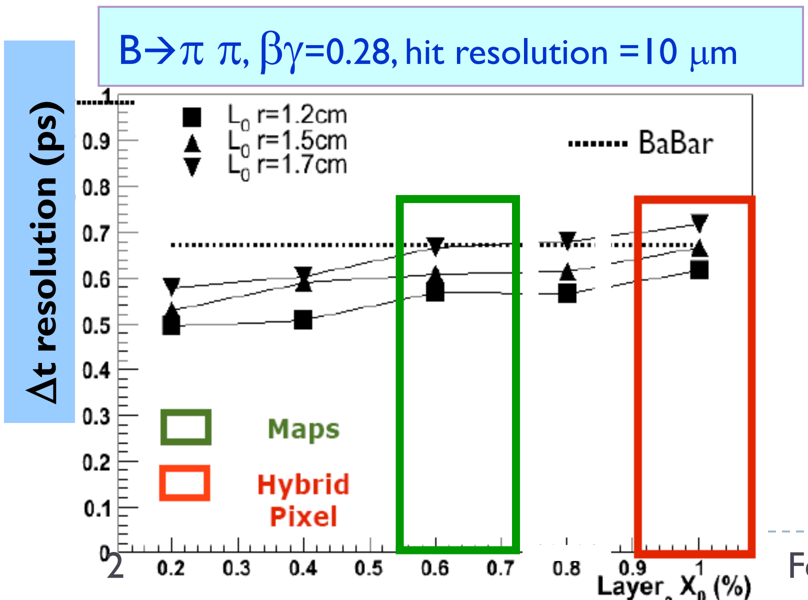
The SuperB Silicon Vertex Tracker

- SVT provide precise tracking and vertex reconstruction, crucial for time dependent measurements, and perform stand-alone tracking for low p_t particles.

- Based on BaBar SVT: 5 layers silicon strip modules **+** Layer0 at small radius to improve vertex resolution and compensate the reduced SuperB boost w.r.t PEPII

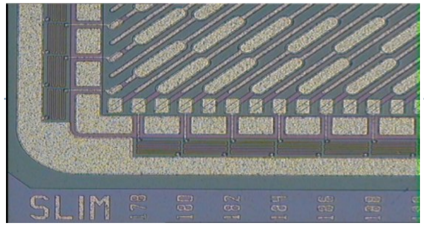




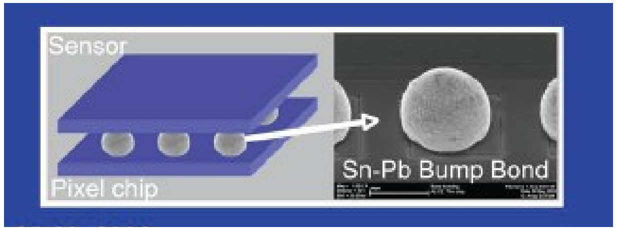
- Physics performance and back. levels set stringent requirements on Layer0:
  - R~1.3 cm, material budget < 1% X_0
  - hit resolution 10-15 um in both coordinates
  - Track rate > 5MHz/cm^2 (with large cluster too!), TID > 3MRad/yr
- Several options under study for Layer0

SuperB SVT Layer 0 technology options

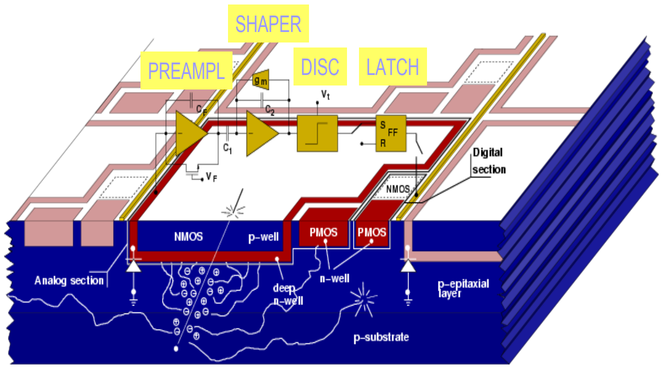
- **Striplets option: mature technology, not so robust against background occupancy.**
  - Marginal with back. track rate higher than ~ 5 MHz/cm^2
  - FE chip development & engineering of module design needed



- **Hybrid Pixel option: viable, although marginal.**
  - Reduction of total material needed!
  - FE chip with 50x50 μm^2, pitch & fast readout (hit rate 100MHz/cm^2) under development → FE prototype chip (4k pixel, ST 130 nm) successfully tested with pixel sensor matrix connected.

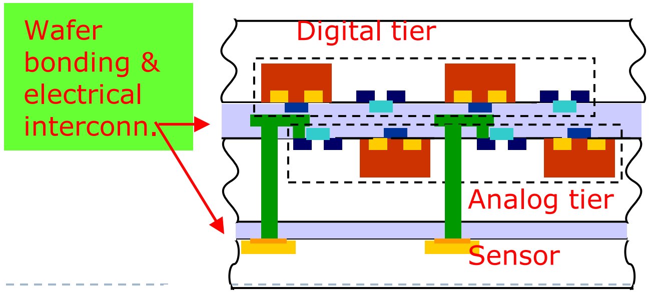


- **CMOS MAPS option: new & challenging technology.**
  - Sensor & readout in 50 μm thick chip!
  - Extensive R&D (SLIM5-Collaboration) on
    - Deep N-well devices 50x50μm^2 with in-pixel sparsification.
    - Fast readout architecture with target hit rate 100MHz/cm^2 & 100 ns timestamping developed..

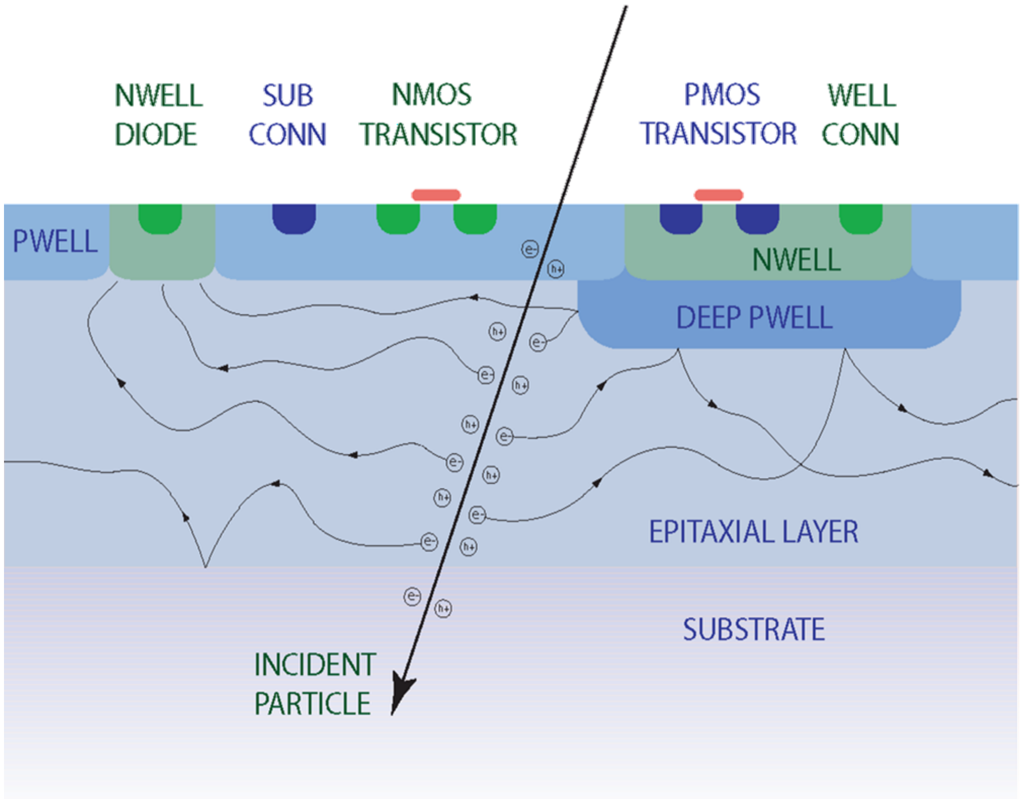


deep p well MAPS from RAL is a promising development.

- **Thin pixels with Vertical Integration: reduction of material and improved performance.**
  - Two options are being pursued (VIPIX-Collaboration)
    - DNW MAPS with 2 tiers
    - Hybrid Pixel: FE chip with 2 tiers + high resistivity sensor

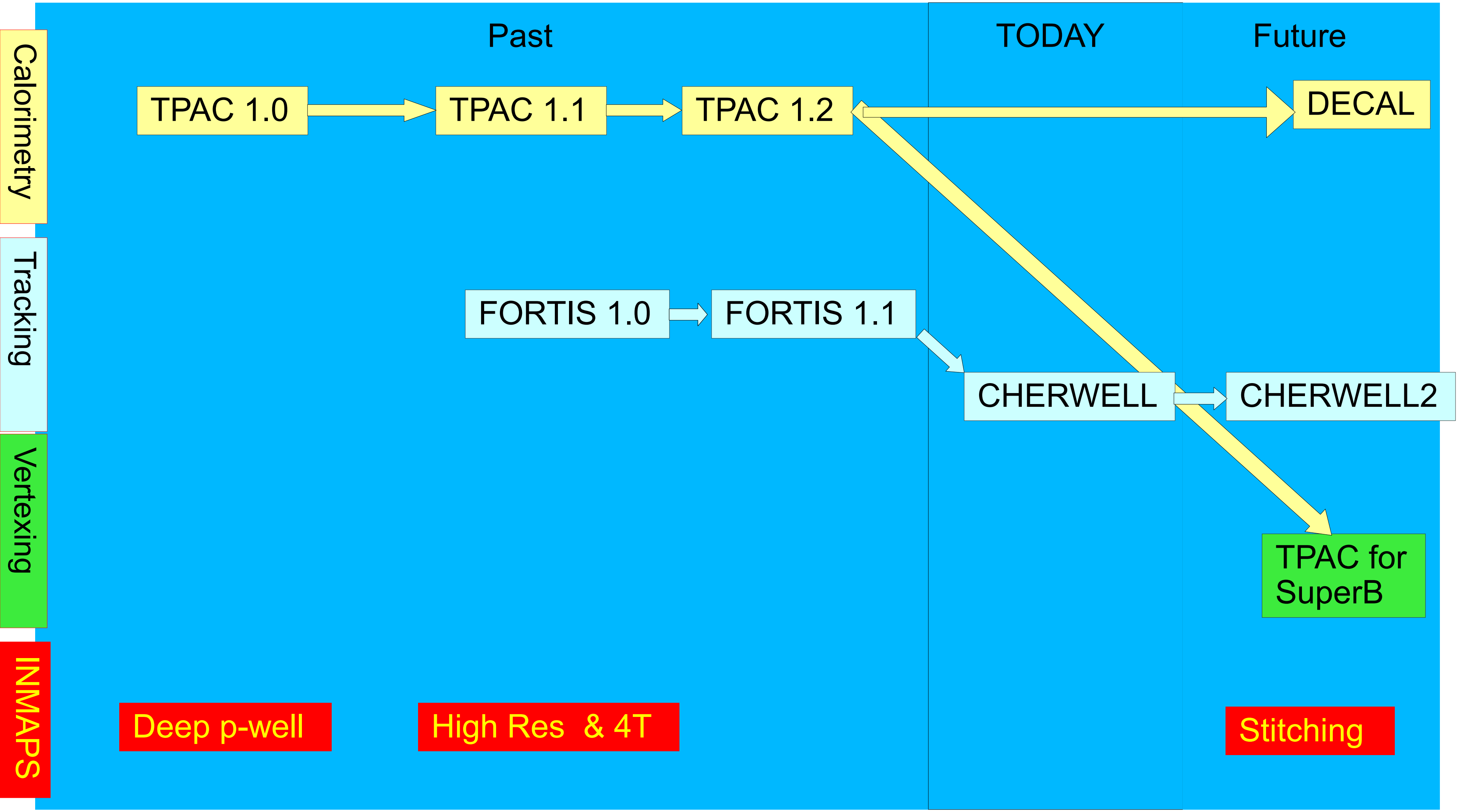


MAPS



- Charged particle generates free charge carriers in epitaxial layers.
- Due to doping profiles, electrons are confined to epitaxial layer.
- Electrons diffuse.
- When close to diode electrons collected
- Deep p-well protects electronics

(Pixel) Sensor Overview

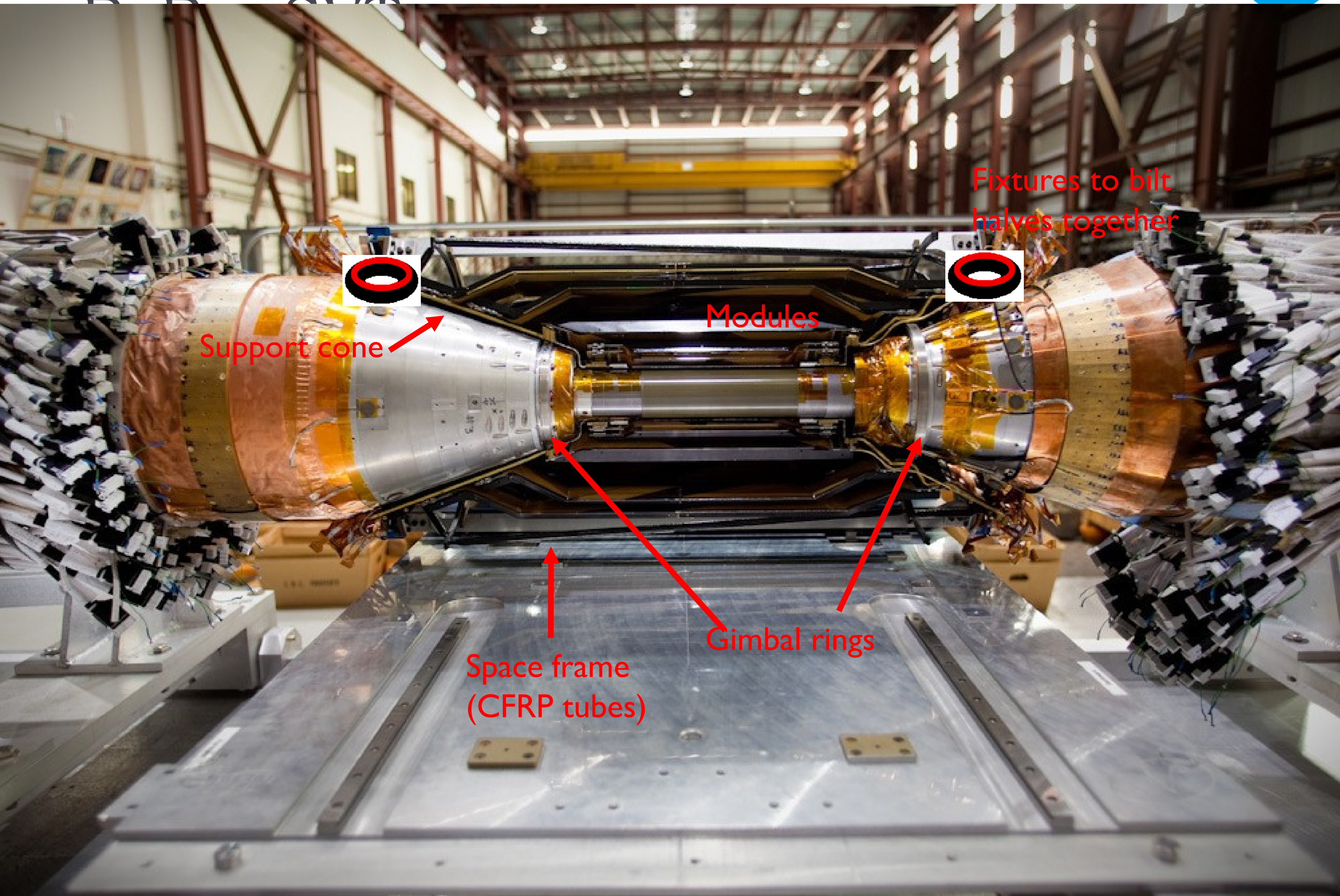


Strip sensors

- BaBar used 300μm double sided strip sensors made by Micron semiconductor.
  - 6 types of sensors (6 sets of masks, 6 geometries required)
- Need to design and fabricate a thinner version of these sensors.
  - Need to identify team to design masks.
  - Will require QA at production site.
  - Each sensor will need to be validated at a lab post-production in order to validate manufacturer specs and ensure only high quality sensors are used in modules.
  - Semi-automatic probe stations available in Pisa, RAL, QM for this purpose. Additional sites would be welcome.

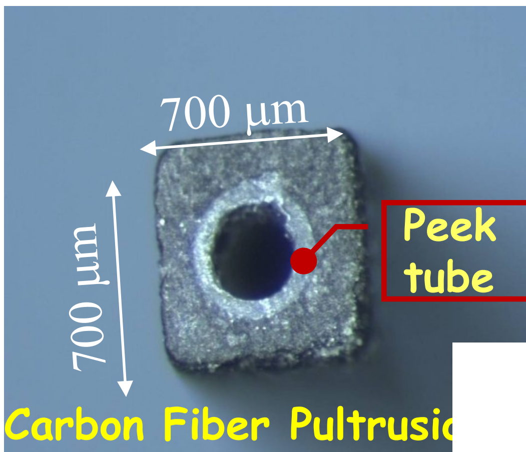
Mechanics

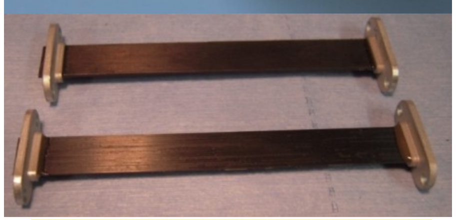
- L0:
  - Support from the beampipe
- L1-5
  - Support from the cryostat/tungsten shield
- Generic solution for inner/outer layers is independent of technology choices.
- Need to have quick access to the SVT/IR region for repair work during the lifetime of SuperB.


Fixtures to bilt halves together
Modules
Support cone
Gimbal rings
Space frame (CFRP tubes)

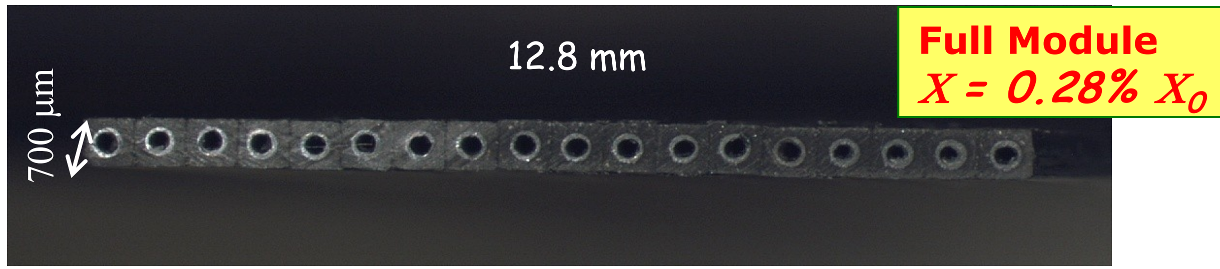
L0
Light pixel module support & cooling

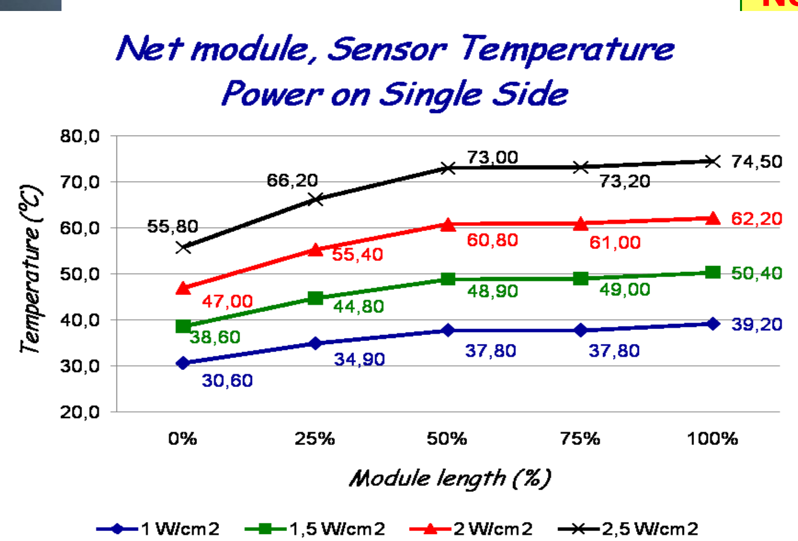
- Light support with integrated cooling needed for pixel module: P~2W/cm^2
- Carbon Fiber support with microchannel for coolant fluid developed in Pisa:
  - Total support/cooling material = 0.28 % X_0 full module, 0.15% X_0 net module
- Thermo-hydraulic measurements in TFD Lab: results within specs

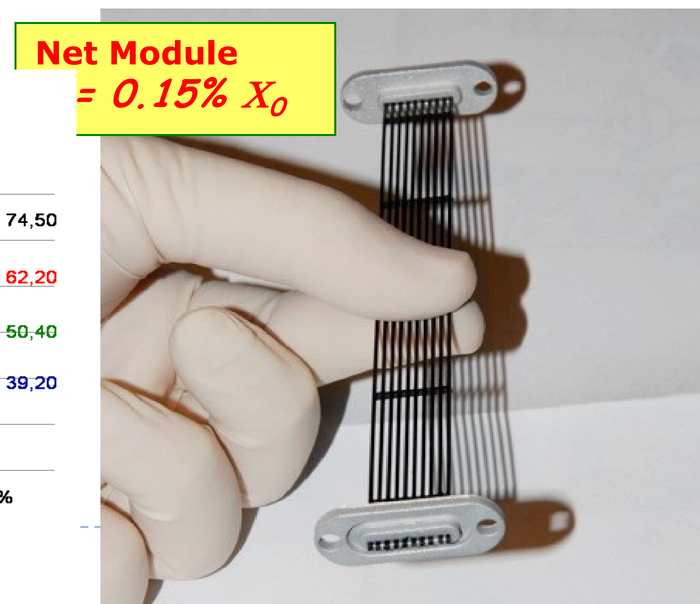




Full module supports with microchannels glued toghether

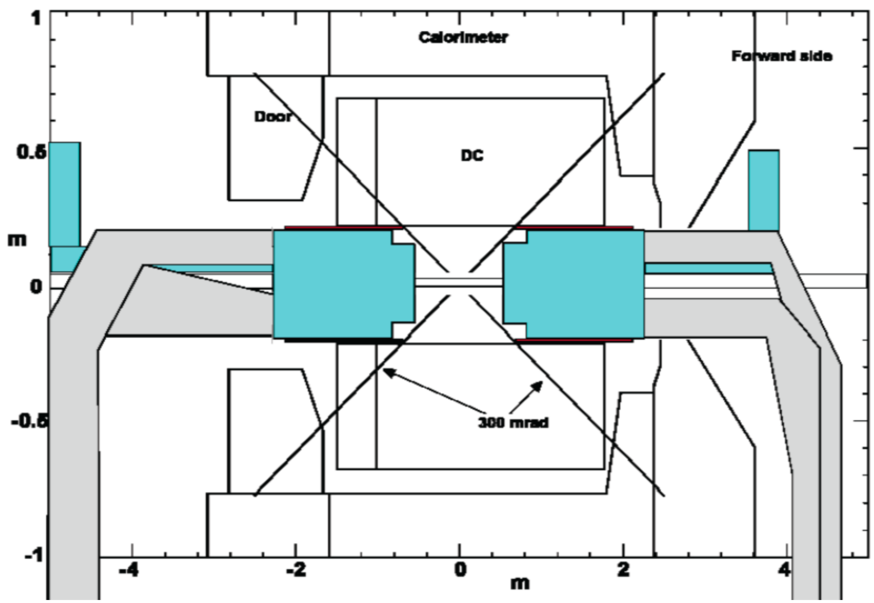






Fast extraction system

- Aim:
  - Access SVT/permanent magnets in the IR within a few days.
  - Central cryostat/magnet SVT supported off of the same object.
  - Modifications/repairs on the innermost detector/accelerator components will be relatively quick to perform.



Remove vacuum pipe in drift regions near IR.

Move ends of detector out of the way.

Slide cryostat support on rail (with tungsten shield and SVT).

Set up temporary clean room to replace L0 if damaged.

2-3 week turn around.

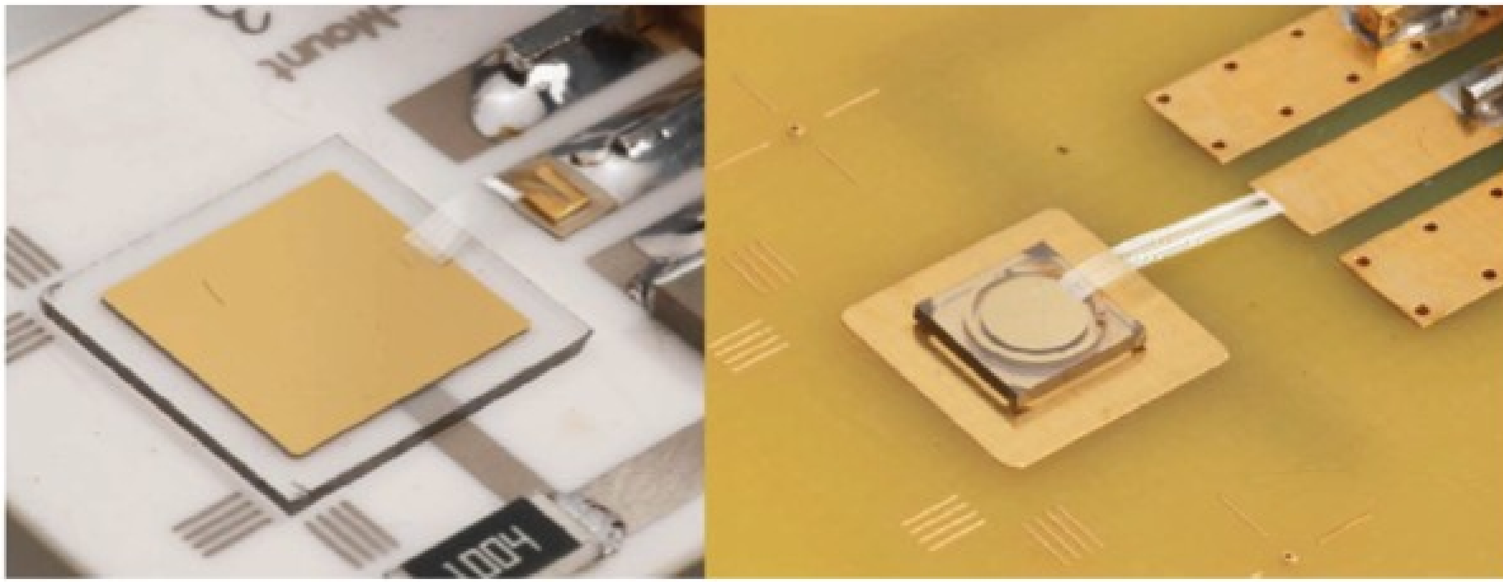
SVT Radiation Protection system

Overview

- Need to provide accelerator and detector control rooms with a real time monitor of flux in SVT.
  - Cumulative and instantaneous doses.
  - Required to generate an abort signal < 1msec response time (BaBar). In fact got 20ns response (limited by electronics).
- BaBar solution had two phases:
  - a set of Silicon pin diodes calibrated once per shift (early days)
  - a set of diamond diodes, calibrated automatically, at regular intervals during data taking.
- Diamond system better:
  - Radiation hard
  - Better S/N (larger band gap).
  - less downtime, more robust etc.
  - BaBar pCVD diamond sourced from UK (Element Six Ltd.)
  - Other sources Diamond Detectors (UK), Diamond Materials (GER), II-VI (USA)
- LHC and RD42
  - Solved the same problem (see CERN Courier May 2011 p18)
- SuperB will need a similar system:
  - Would be good to have fast readout so that we can see the structure of bunches (diagnostic for beam studies/detector based luminosity calculations).
  - A small, cheap system.
  - Something that could be interesting for MDI activities ... any UK interest?

SVT Radiation Protection system

CIVIDEC examples



pCVD 1cm x 1cm

sCVD,5mm x 5mm

Sensor cost ~£100
Cheap to build a sensor array for SuperB

14th Beam Instrumentation Workshop, E. Griesmayer

SVT Radiation Protection system

CIVIDEC detector + preamplifier

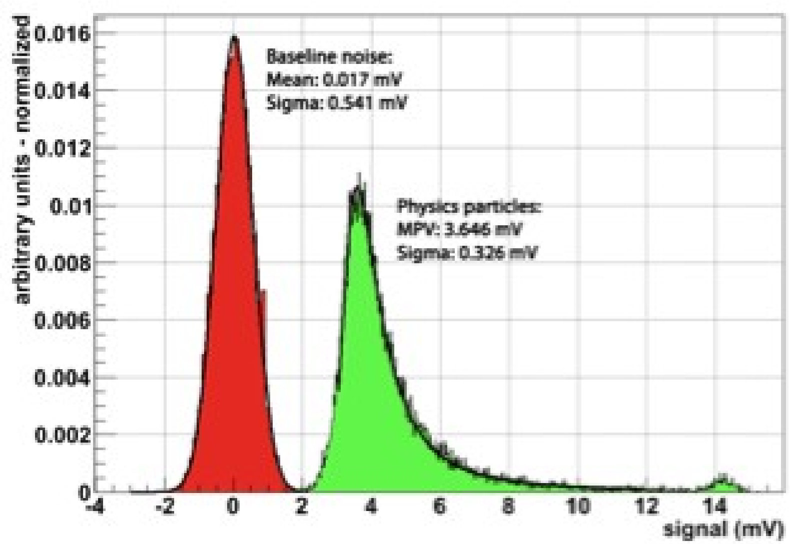
1 ns risetime
2ns pulse width
30ps resolution
Single particle detection

Cost in electronics:

• Option 1: cheap off of the shelf solution O(ns) resolution.

• Option 2: Fast electronics (becomes a beam diagnostic tool: on detector fast lumi monitor?)

•Assume Option 1 is good enough for SuperB (based on yesterday's discussion)



Computing

- UK contribute a significant fraction of SuperB GRID Monte Carlo production resources.
  - Little / no manpower require: minimum effort is to enable VO at site, and then SuperB uses available resources transparently.
- Large technical pool in computer literate people in the UK
  - opportunity to explore new technologies for a new project
    - Could feed back into running experiments (e.g. LHC) without exposing them to risk.
    - Timescale compatible with LHC upgrade (2021)
    - Need to embrace GRID more openly than BaBar (already being done within SuperB)

Computing

BaBar v SuperB comparison

	BaBar	SuperB	Units
Integrated Luminosity per year	150	1500	fb-1
Hardware Trigger rate (Level 1)	7	150	kTps
Hardware data rate (Level 1)	70-250	[illegible]	MB/s
Software Trigger rate (Level 3)	400	[illegible]	Tps
Software data rate (Level 3)	4[illegible]	[illegible]	MB/s
Data Events reconstructed	[illegible]	260	10^9/yr
Total raw data size	[illegible]	30	PB/yr
Data flow through computing system	[illegible]	>10000	TB/day
Data size (raw/"micro")	[illegible]	75/10	KB/evt
Total Reprocessed data size	0.6	160	PB/yr
Physics Streams/skims	250	?	#datasets
Code size (offline/o[illegible]	3.0/0.5		Mlines
Number of release[illegible]	24		
CPUs (DAQ/triggerin[illegible])	160/200/5000		cpus
Effort (SLAC/remote s[illegible])	20/20	?	FTE
On site computing fraction	50%	10% ?	

Essentially a small fraction of code could be re-used, this is an opportunity to start afresh with an improved system.

Computing

Computing - SuperB

- ***Good news:***
  - Can reuse most of the BaBar physics and Geant 4 simulation, event processing and analysis code for studying SuperB options.
  - Fast Simulation is successfully working on the Grid.
- ***Not so Good News:***
  - Code is old, becoming undocumented, written before C++ standard agreed, uses perl and TCL but not Python, not written for modern architectures, tied to Linux/Solaris, not written for Grid.

•New technology to adopt soon: e.g. OO GEANT in etc.
•C++: use whole language or restrict coding standards?
•Use python to glue system together
•should learn from other experiments e.g. CLEO-c/Belle

Parameter	typical Year
Luminosity (ab^{-1})	15
Storage (PB)	
Tape	113
Disk	52
CPU (KHep-Spec06)	
Event data reconstruction	210
Skimming	250
Monte Carlo	670
Physics analysis	570
Total	1700

Computing

Computing – Areas of Interest

- Software Quality
- Software Development
- Framework Architecture
- Software Management
- Programming Languages
- Multiple platform support
- Online/Offline code sharing
- New CPU architectures, GPUs
- Event persistence and data handling
- Conditions, Configuration, trigger DBs
- Documentation and Training

Many interesting areas for computing folks to play a role. BaBar experience of needing ~20FTE/yr to support computing is unusual... Other experiments have a few core people.

Summary

- RAL & QM are submitting an SoI to STFC for the 23rd May.
  - Focus to work on design and construction of the SVT in collaboration with INFN.
    - concentrate on sensors and mechanics.
- Funding envelope defined by JW is compatible with this.
- Aim to refine costing and submit proposal by the end of the year.
  - New groups are welcome to participate in this endeavour.
- Independent of that: Aim to work on bringing together the experimental flavour community into some common forum.