Present status and plans for SVT performance studies

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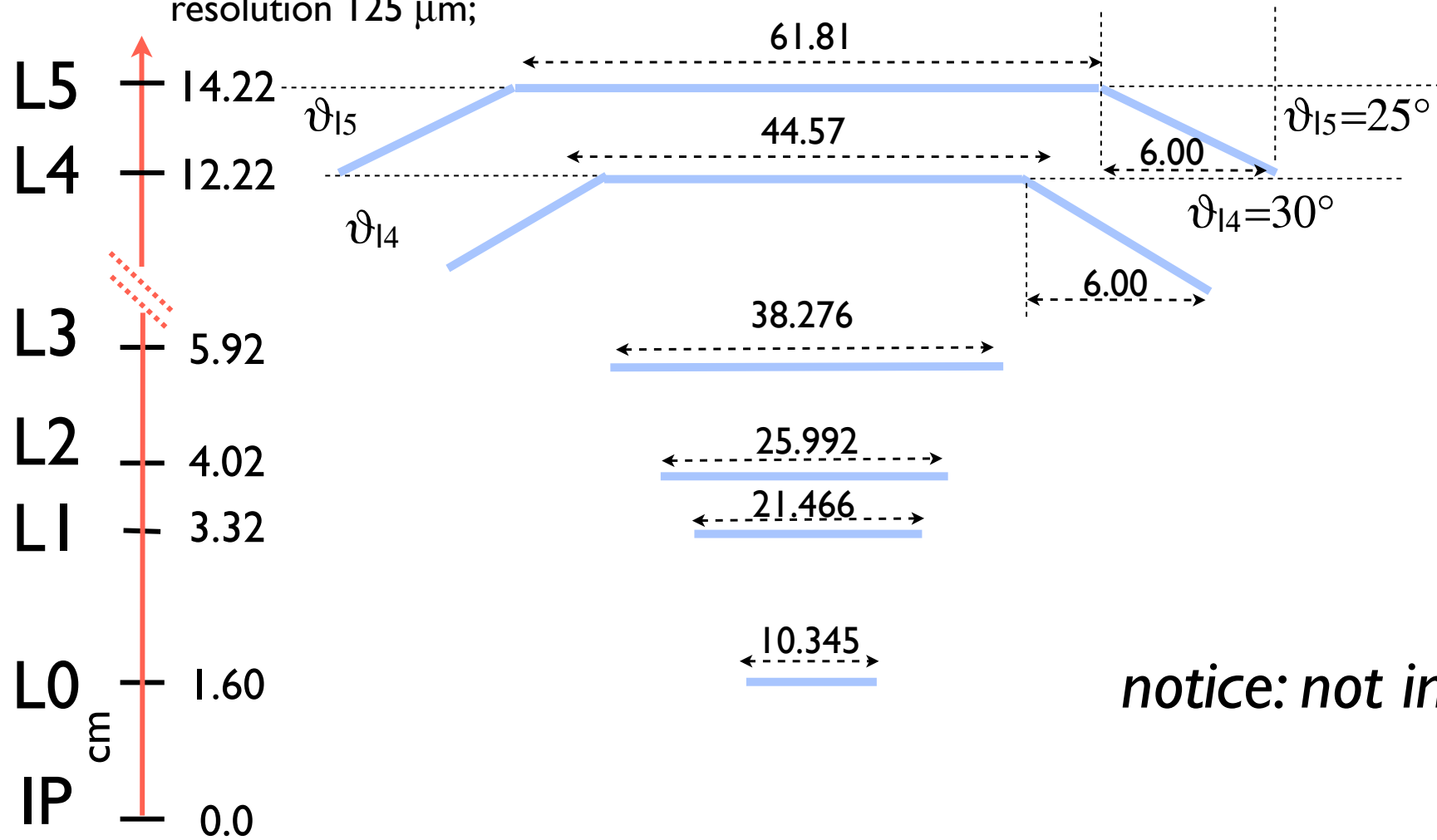
Svt meeting - 15 April 2011

Outline

- Introduction

- Present studies and results

- Plans and to do list

Introduction

- The baseline in FastSim for the Silicon Vertex Tracker (SVT) of SuperB consists in a 6 layer silicon detector;

- an additional Layer0 (L_0), at smaller radius, was introduced in order to maintain adequate proper-time resolution for B decays, in presence of a reduced center-of-mass boost: in BaBar was $\beta\gamma=0.56$, in SuperB will be $\beta\gamma=0.24$;

- the angular coverage of the SVT will reach ±300 mrad in the FW-BW direction;

- the outer layers (L_4-L_5) will have similar arch shape as in BaBar, and L_1-L_5 layers will be placed at almost identical radial position as in BaBar;

- the layer L_0 solution for the SVT baseline in FastSim *(as today)* is striplets: 200μm silicon, 0.4 % X_0, 8μm hit resolution.
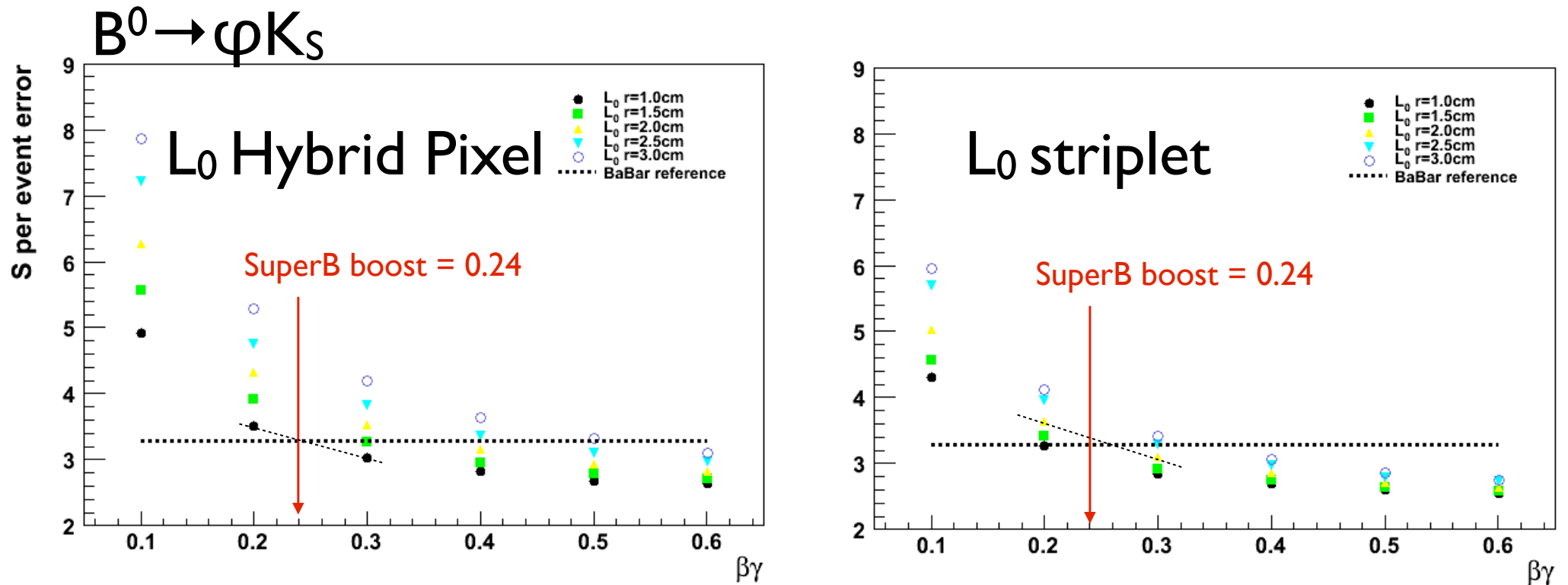
1. SuperB baseline in Fast Sim:

- SVT baseline: L0 + L1-L5 strip detectors, ±300 mrad angular coverage;

- DCH baseline: 10 SuperLayers (4 cell layers per SL); inner radius 23.6 cm, spatial resolution 125 μm;

L5 — 14.22

ϑ_{l5}

61.81

44.57

$\vartheta_{l5}=25°$

L4 — 12.22

ϑ_{l4}

6.00

$\vartheta_{l4}=30°$

6.00

L3 — 5.92

38.276

L2 — 4.02

25.992

L1 — 3.32

21.466

L0 — 1.60

10.345

cm

notice: not in scale

IP — 0.0

Coverage down to 300 mrad FW and BW

Striplet vs Hybrid Pixel:
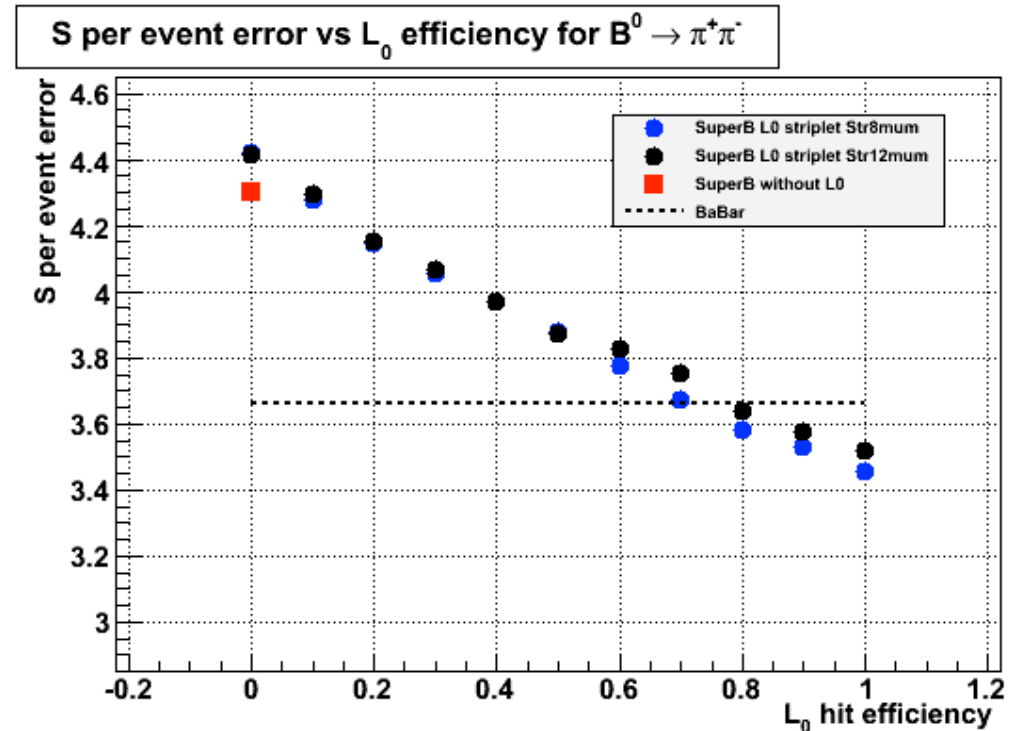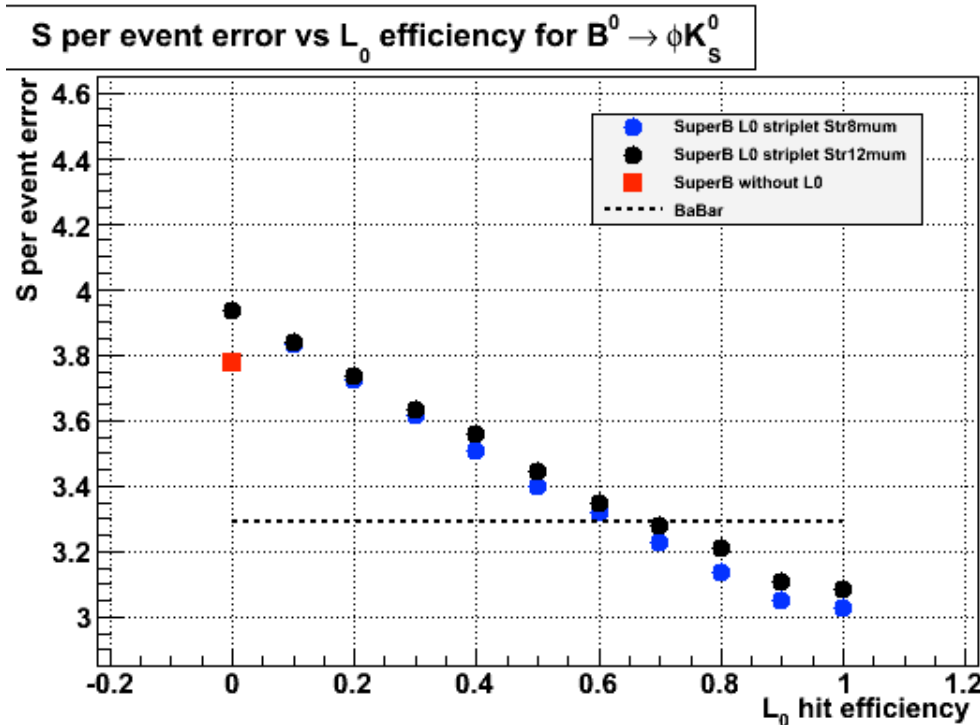# S per event error

$B^0 \to \varphi K_S$

Hybrid Pixel solution is reaching BaBar reference for S (sin(2β))
per event sensitivity with L_0 radius ~1.0 cm. Striplet solution can
afford a larger L_0 radius ~2.0 cm where bkg is lower.

5

Striplet vs Hybrid Pixels <u>vs</u>
degraded hit efficiency

S per event error vs L_0 efficiency for $B^0 \rightarrow \phi K_S^0$
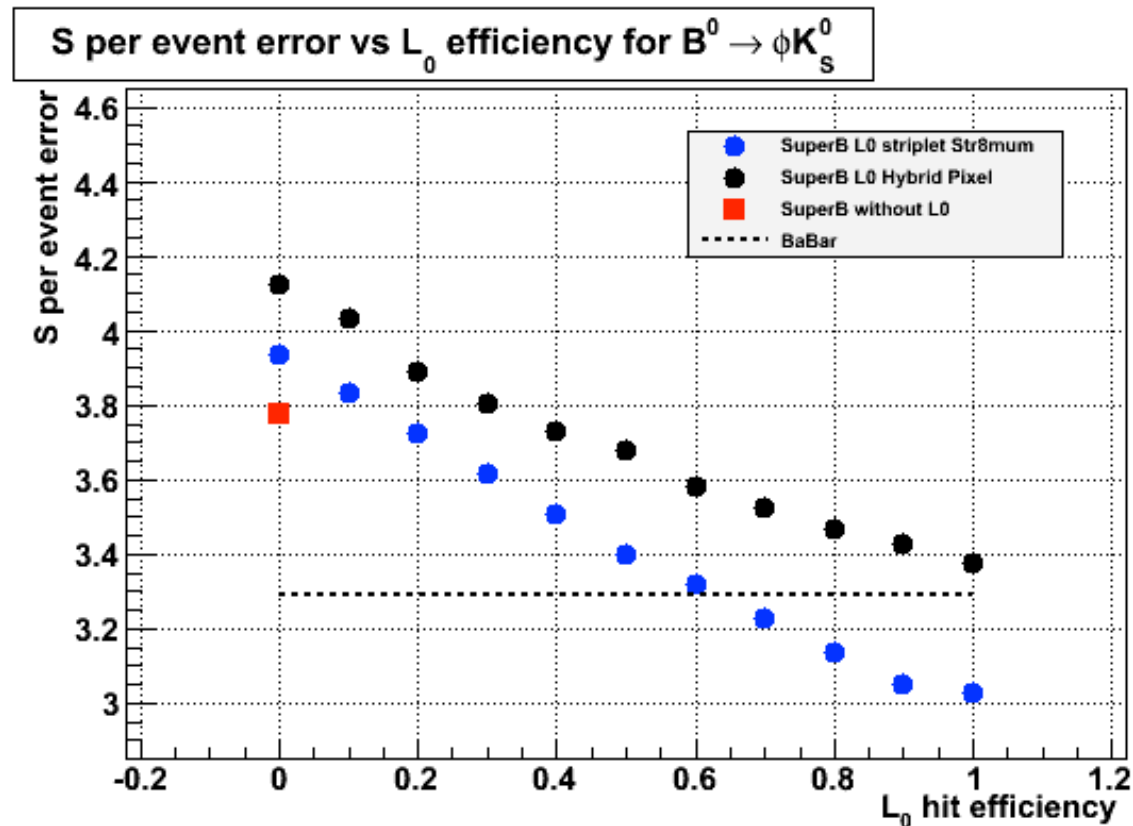
Striplet performance vs degraded hit resolution

Nominal resolution 8 μm.
Considering 50% worsening (12 μm) from high occupancy in L_0. Rough estimate (to be studied in detail) but seems to be a second order effect.

Background rate in L$_0$

Max rate: 20 MHz/cm^2
50um @ <13mm
200um @ ~19mm

PixelFreq Svt Layer 0

50um
200um

Pixel Frequency (MHz/cm2)

Inner Radius of Svt Layer0 (mm)

R. Cenci

In pinwheel geometry average radius <r> is about 1.12×min(radius).
Riccardo found with L$_0$ min(radius)=1.3 cm (<r>~1.45) a bkg rate of ~56MHz/cm^2 in his latest bkg study presented at Caltech meeting, Dec 2010).
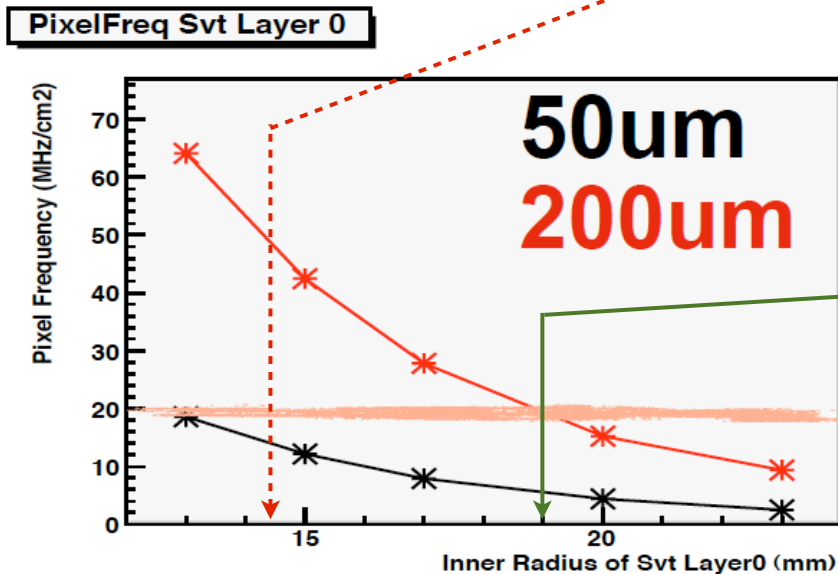
Striplet solution with <r>=1.9cm (min(radius) =1.7cm) seems to satisfy both proper-time resolution and bkg rate requirements.

Plans for further studies

- Update of FastSim configuration:

  - modeling of material budget for L_0 solutions for striplets and pixels according to recent developments;

  - possible changes in detector geometry (e.g. radius of layers);

- Implement a more realistic model for striplets in FastSim, with strips tilted at 45 degrees wrt detector.

- Evaluate impact of bkg hits on hit resolution and pattern recognition using FastSim.

- Should we consider time-dependent measurements at DDbar threshold? With $E_{cm} \sim$ 4 GeV the average momentum of particles is reduced and material budget in SVT is more relevant.

Hit Merging and PatRec Confusion in FastSim

- Reference: Doug Roberts talk at Orsay 2009, "Hit Confusion".

- In FastSim there is the possibility of evaluating the impact of bkg on hit resolution and on pattern recognition quality.

    - Hit Merging depends on resolution of the detector;

    - Pattern Recognition quality depends on the resolution of the track;

- Work To Do: PatRec Confusion code is corrently broken (Dave Brown will fix it) and striplet model is not currently modeled correctly in FastSim (I will work on that). That requires changes in `PacDet,PacEnv,PacTrk` packages.

Backup slides

Display of SVT modules

$\vartheta=0.300$

$\vartheta=0.300$

modules are symmetric wrt the IP.

beam axis
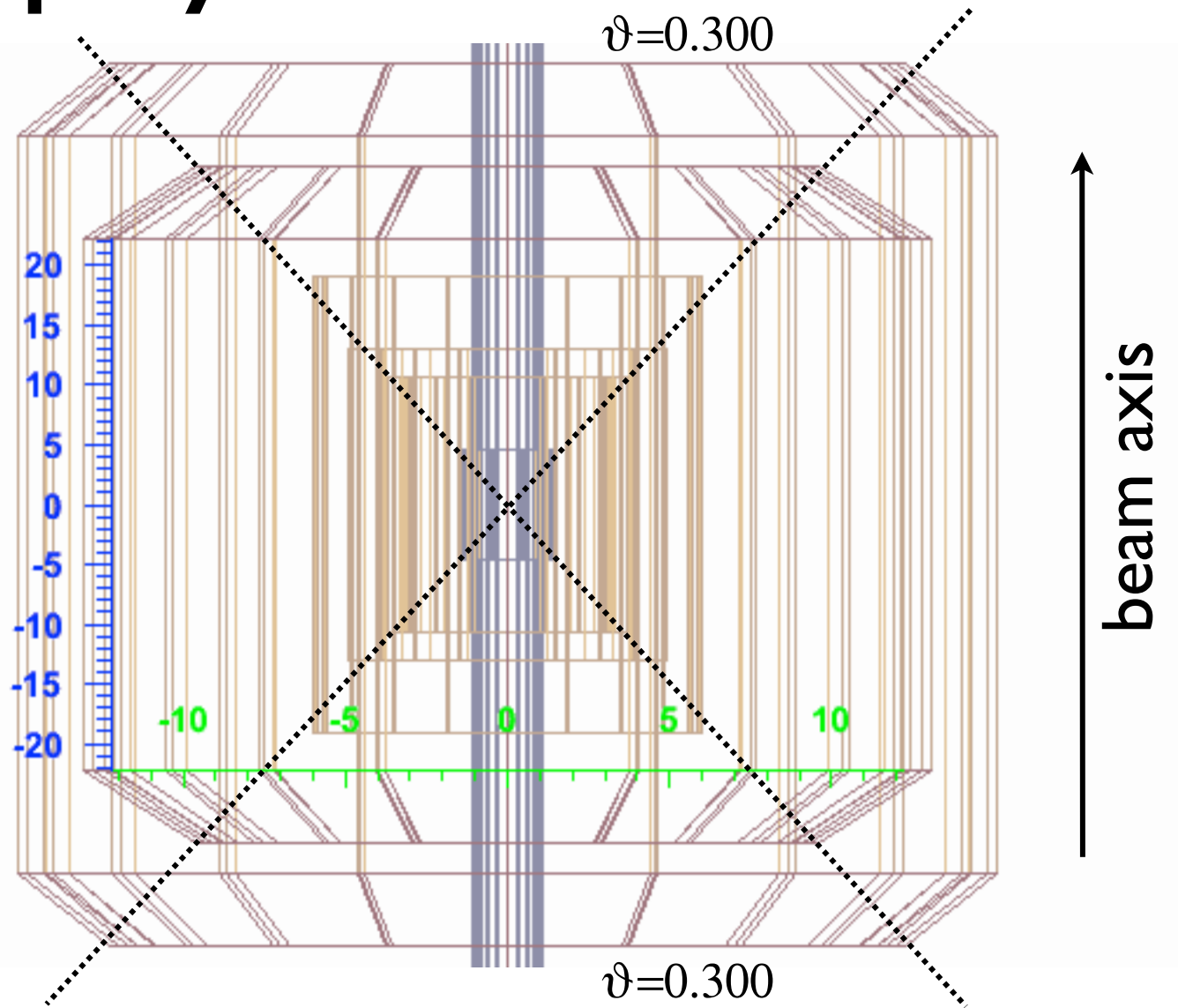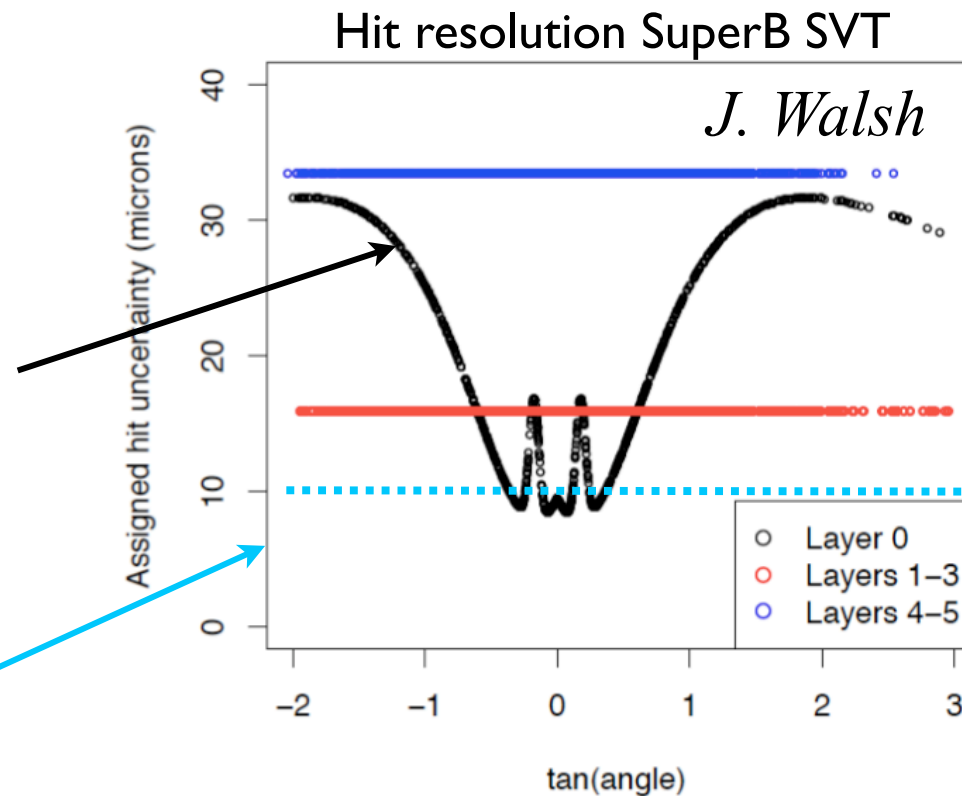
angular coverage in $CM_{12}\sim$ 95% (BaBar SVT ~89%)

L₀ solutions: striplets vs Hybrid pixels

Hybrid Pixel

- material= 1.08% X_0
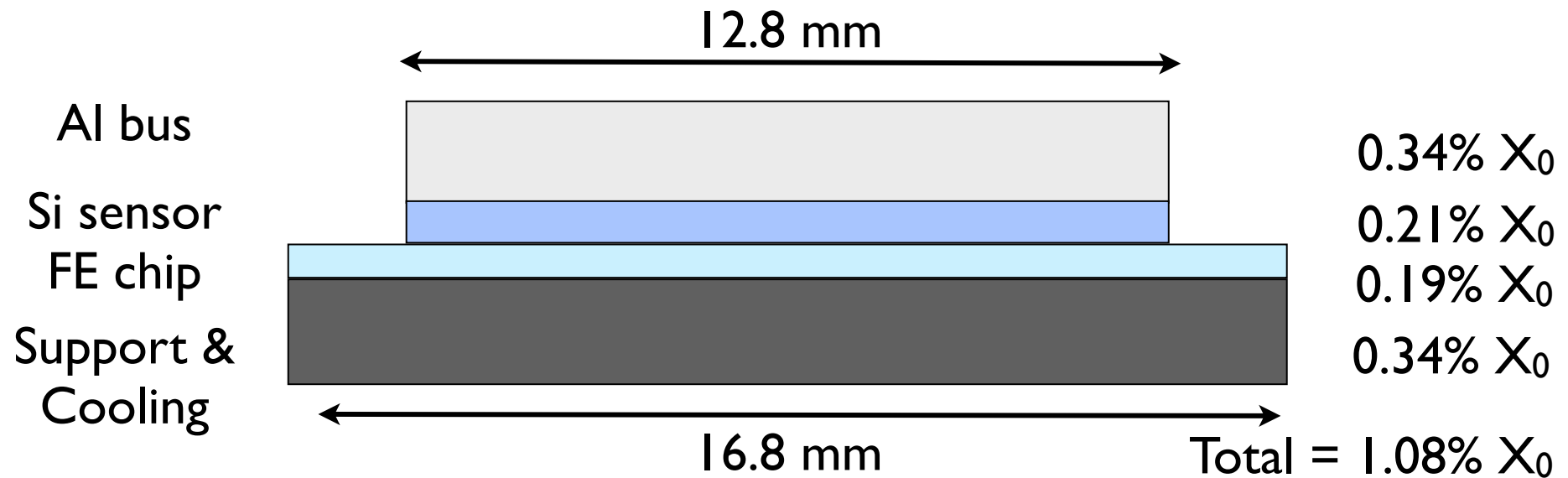- digital readout
- average radius = 1.60 cm
- hit res ~ <14 μm> (ad hoc model)

Striplets

- material= 0.4% X_0
- analog readout
- average radius = 1.60 cm
- hit res ~ 8 μm (core gaussian)

Hit resolution SuperB SVT

J. Walsh

Assigned hit uncertainty (microns)

tan(angle)

Legend	
○	Layer 0
○	Layers 1–3
○	Layers 4–5

Hybrid pixel solution

- Module cross section

12.8 mm

Al bus — $0.34\% X_0$

Si sensor — $0.21\% X_0$

FE chip — $0.19\% X_0$

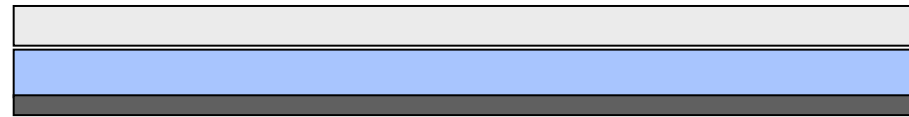Support & Cooling — $0.34\% X_0$

16.8 mm

Total = $1.08\% X_0$

Striplet solution

- Module cross section

Fan out
Si sensor
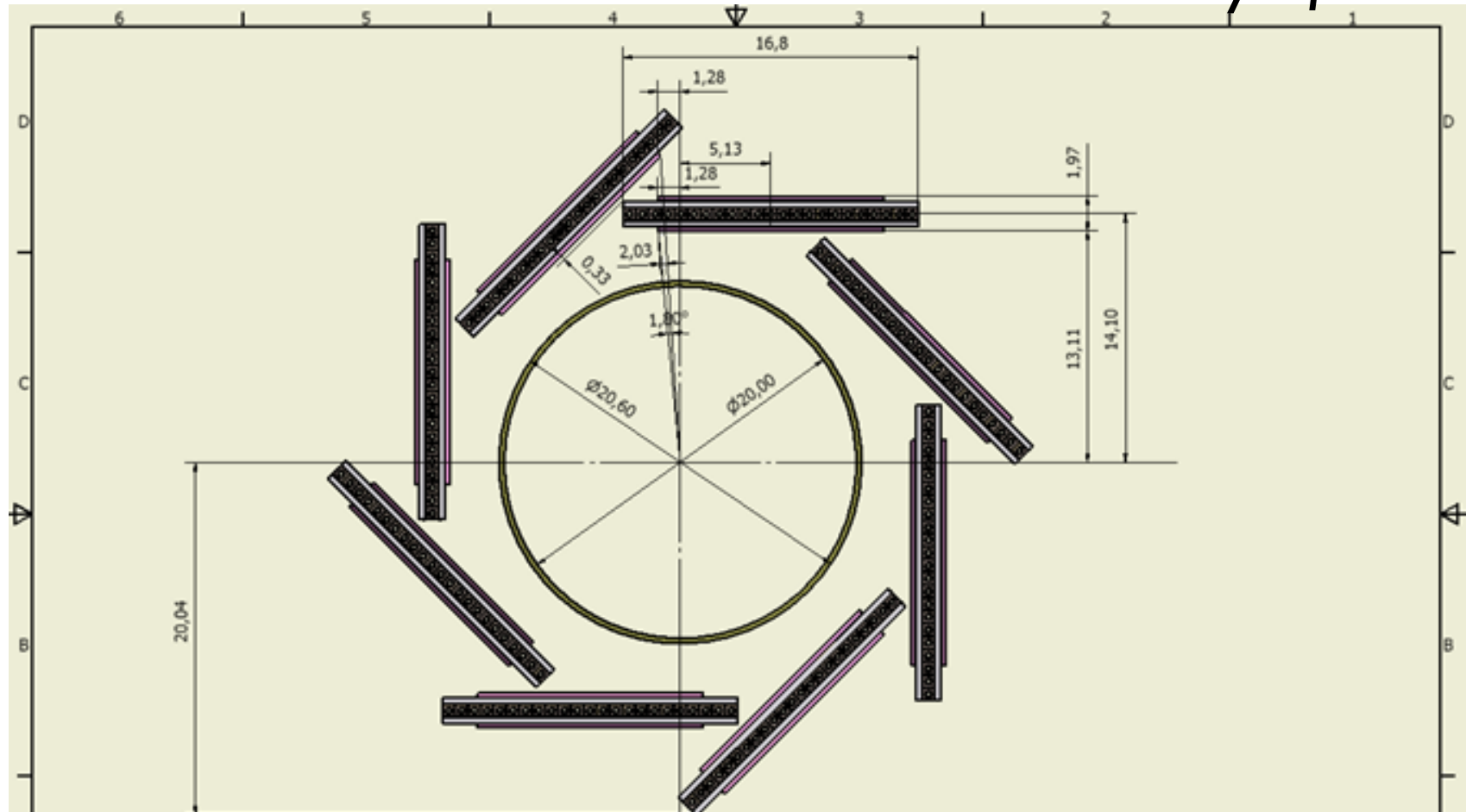Support

Si sensor overlap 3.4%

$0.14\% \ X_0$
$0.21\% \ X_0$
$0.05\% \ X_0$
Total = $0.40\% \ X_0$

Pinwheel layout for L_0
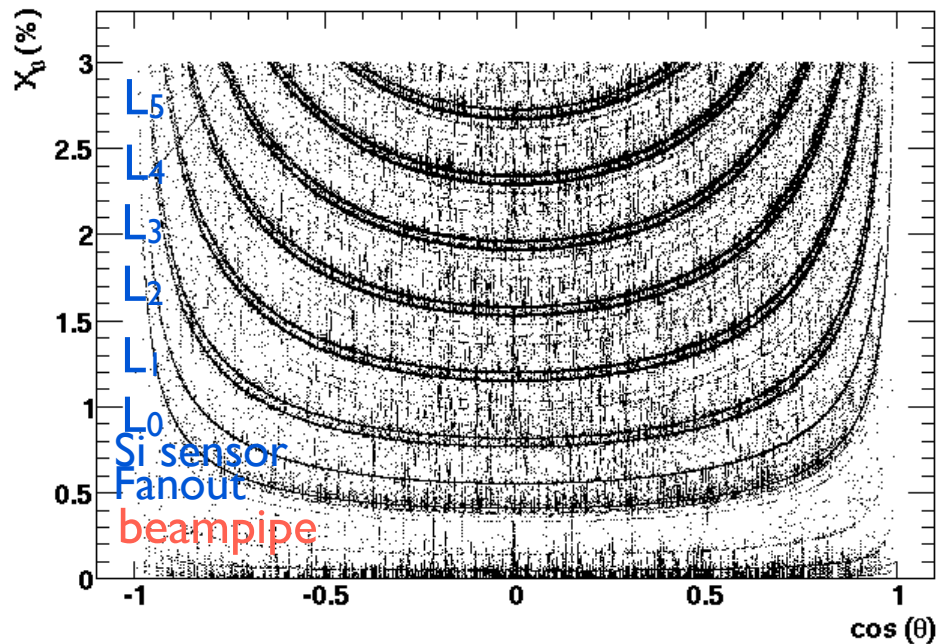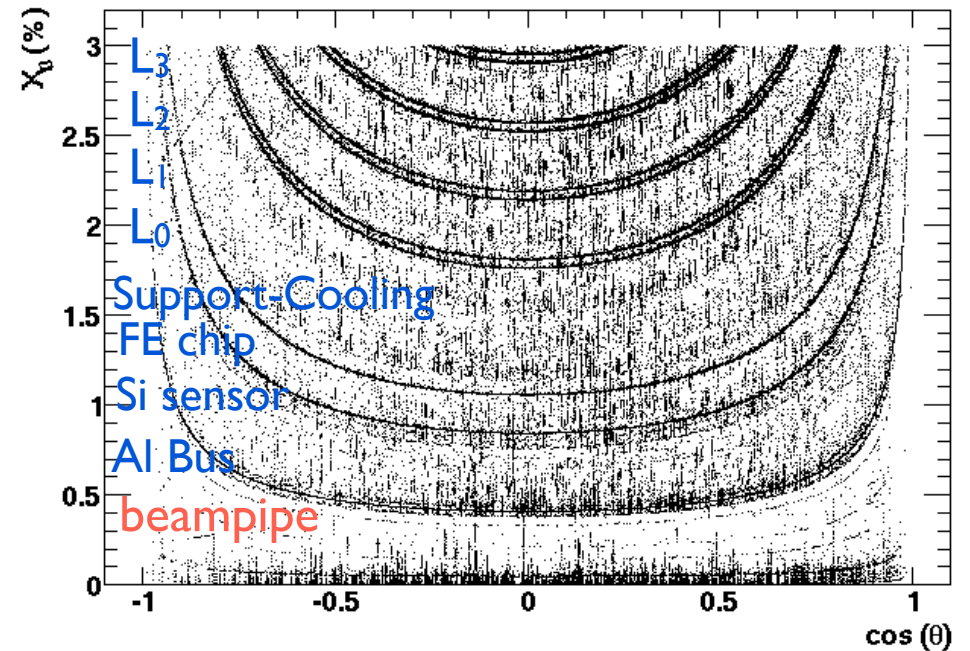
courtesy of F. Bosi

Design for MAPS solution

Mechanical design can be considered valid also for Hybrid Pixel solution though small changes could be applied when finalized design will be ready.

L_0 solutions and SVT material

Total SVT material is about 3.3% (2.4%) X_0 for L_0 Hybrid pixel (Striplets) solution.