

# Silicon Vertex Tracker for SuperB

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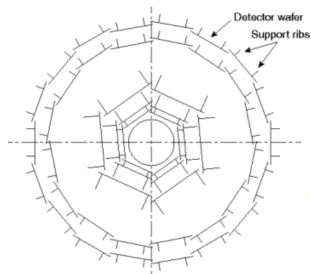
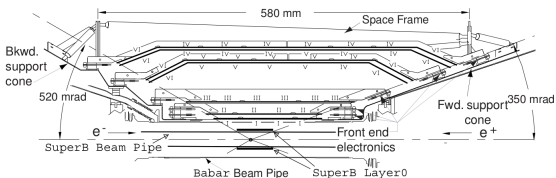
- 1 General Overview of Silicon Vertex Tracker (SVT)
  - Physics requirements
  - SVT Layers 1-5
  - Layer0 setup
- 2 Options for layer0
  - Striplets
  - Hybrid Pixels
  - MAPS
- 3 Outcome

# Physics requirements

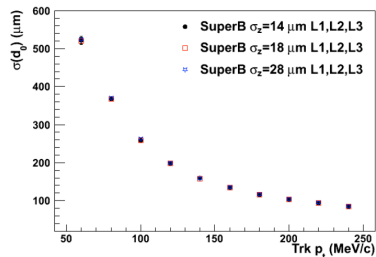
The SuperB SVT design is based on the BaBar vertex detector layout with an additional innermost layer closer to the IP (Layer0).

- 1 SVT together with drift chamber (DCH) and magnet provide track and vertex reconstruction.
- 2 For less energetic particles SVT must provide the complete track information.
- 3 SVT must provide the same precision of time dependent CP violation as BaBar detector with boost reduced from  $\beta\gamma = 0.55$  to  $\beta\gamma = 0.28$ 
  - 50 – 80  $\mu m$  for exclusively reconstructed modes.
  - 100 – 150  $\mu m$  for inclusively reconstructed modes.

# SVT Layers 1-5



- Five layers(1-5) of double-sided silicon strip detectors.
- Radial span 3 – 15 cm.



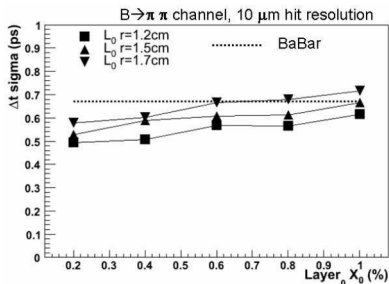
# Layer0

To meet the physics requirements mentioned for SuperB an additional 6th layer was introduced (Layer0). Requirements for Layer0:

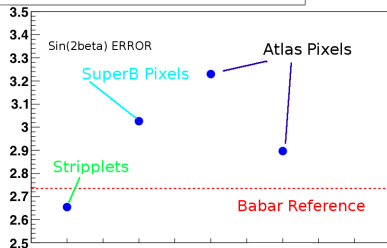
- Radius about 1.5 cm
- High granularity.
- low material budget.

Aspects that are being considered in projecting Layer0:

- 1 Background:
  - $e^+e^- \rightarrow e^+e^-e^-e^-$ .
  - Bhabha scattering.
  - Touschek.
  - two-photon events.
- 2 Sensor occupancy.
- 3 Radiation hardness.



Time-dependent analysis results for  $\bar{B} \rightarrow J/\psi K_S^0$

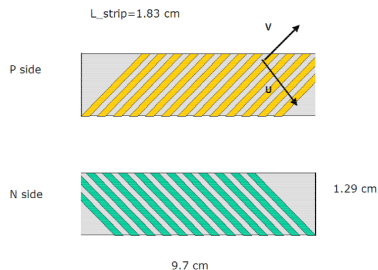


# List of options

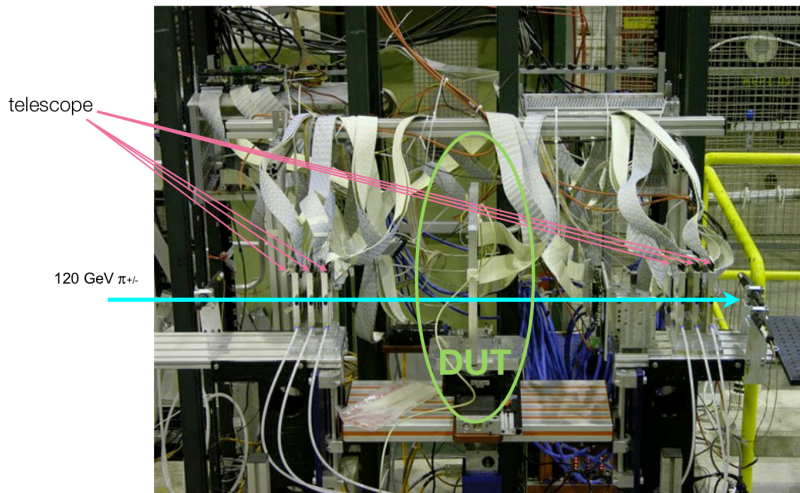
- 1 Double-sided silicon strip detector (Striplets).
- 2 Pixel detectors:
  - Hybrid pixels.
  - MAPS.

# Striplets

- $200\mu\text{m}$  thick, with  $50\mu\text{m}$  readout pitch.
- Rotated by  $\pm 45^\circ$ .
- Chip with 128 analog channels and 132 ns time window.
- Signal to Noise ratio: 26 to 1.
- Material budget:  $0.55\%X_0$
- Cluster rate:  $6.37\text{MHz cm}^{-2}$



# SVT Test Beam



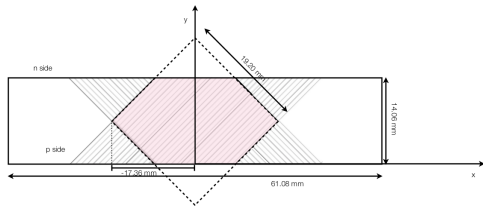
DUT = Device Under Test.



# SVT Test Beam

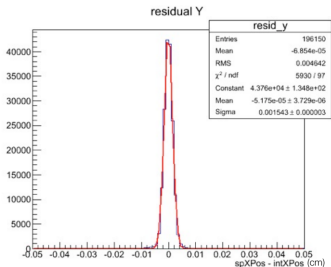
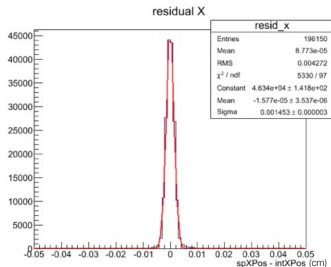
Work done by: Laura Fabbri (INFN Bologna)

- 1 Test done on DUT rotated by:  $0^\circ$ ,  $15^\circ$ ,  $30^\circ$ ,  $45^\circ$ ,  $60^\circ$ ,  $70^\circ$ .
- 2 1 week of data taking.
- 3 Thresholds = 20 or 15.

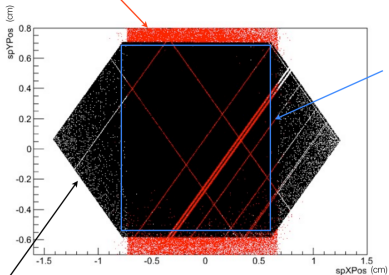


Procedure:

- Alignment done by minimizing residuals, on telescope and DUT.
- Cut on the residual:  $56\mu m$  and fiducial cut.



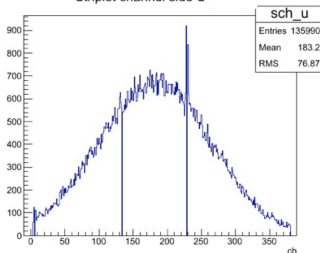
Telescope acceptance

fiducial  
cut

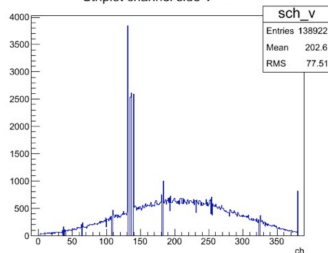
- Inactive strips not taken into account in the analysis

striplets space point  
(global coordinates after alignment)

Striplet channel side U

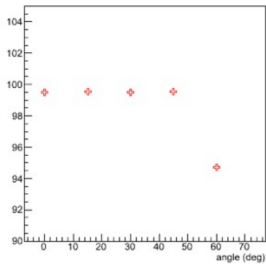


Striplet channel side V

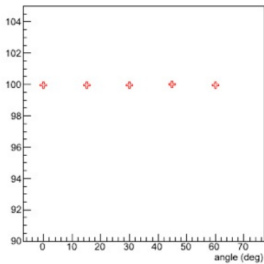


# Efficiency vs angle

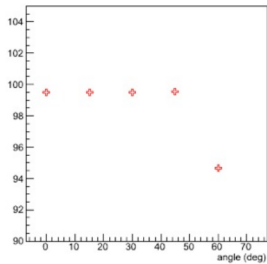
Eff side u



Eff side v



Total Eff



# Hybrid Pixels

- Pixels:  $50 \times 50 \mu m^2$  pitch.
- $200 \mu m$  thick.
- Front end chip optimised to work with  $100 MHz cm^{-2}$ .
- Organised in Mega Pixels (16 Pixels).
- Data-push readout featuring on-pixel data sparsification and time-stamp.
- Gain =  $42 mV fC^{-1}$ .



# Hybrid Pixels Test Beam Notes

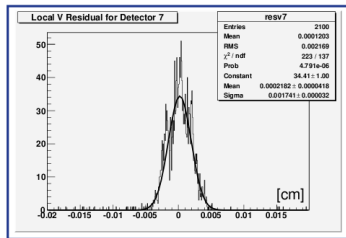
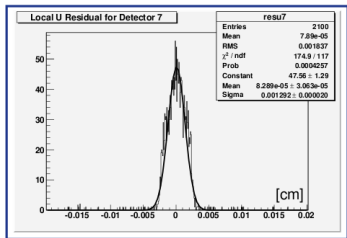
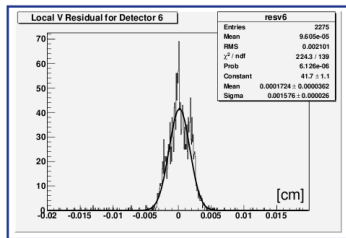
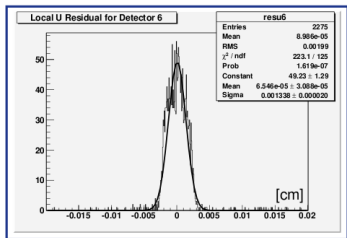
## Work done by:

A.Lusiani, M.Chrzaszcz, Nicola Neri, Benjamin Oberhof, Antonio Paladino.

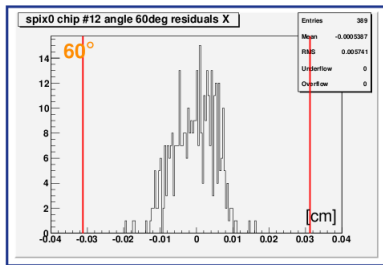
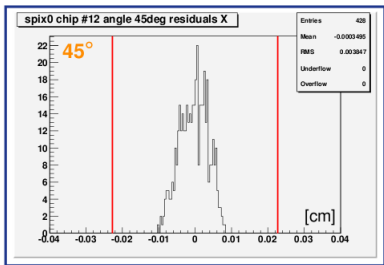
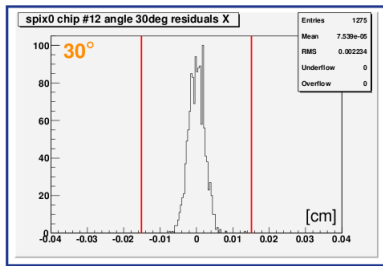
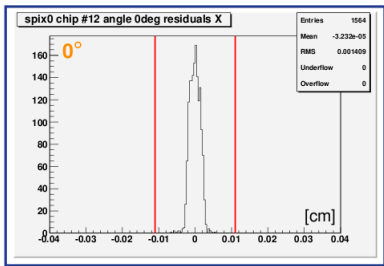
- Several thresholds, reference threshold 1/4 of a m.i.p. at normal incidence.
- Data took with 3 chips: 12, 53, 55.
- DUT rotated around at  $0^\circ$ ,  $15^\circ$ ,  $30^\circ$ ,  $45^\circ$ ,  $60^\circ$ ,  $70^\circ$ .
- 128 pixels along x (horizontal, u-axis), 32 pixels along y (vertical, v-axis).
- approximately parallel tracks, high momentum, negligible multiple scattering.

# Hybrid Pixels Test Beam Results

Typical resolution:  $20\mu\text{m}$ .

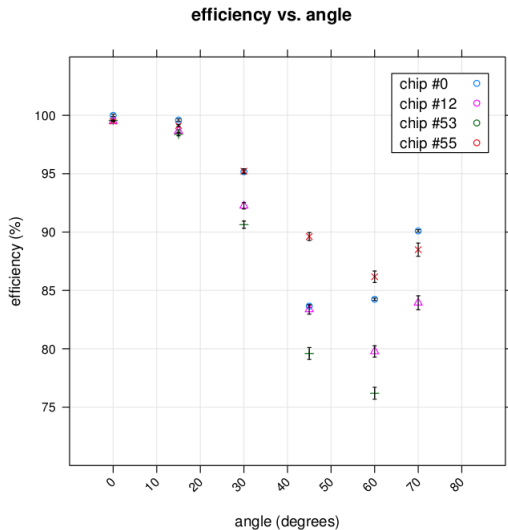


# Angular dependence of the residual



# Hybrid Pixels: Test Beam

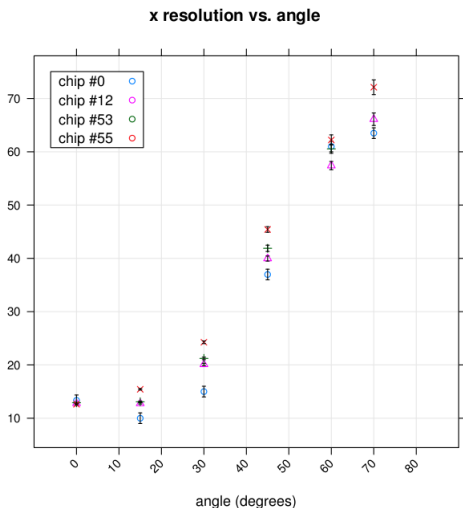
- To cross check our results, TOY MC was written.
- Good agreement with data.



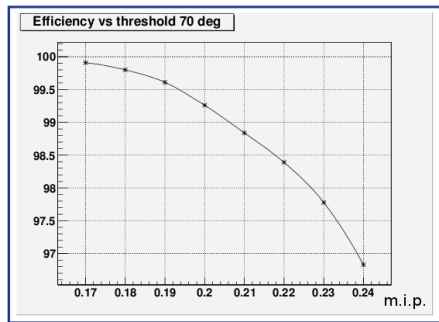
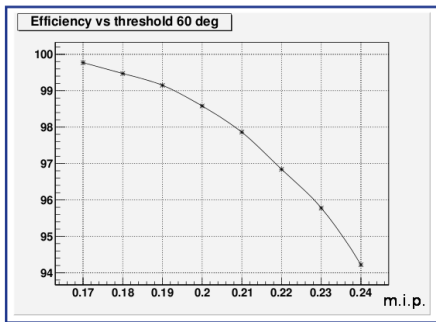


# Hybrid Pixels Test Beam Results

- To cross check our results, TOY MC was written.
- Good agreement with data.



# Threshold Simulations



## Conclusion

The next Test Beam will be done with lower threshold( 0.17 - 0.18 m.i.p.).

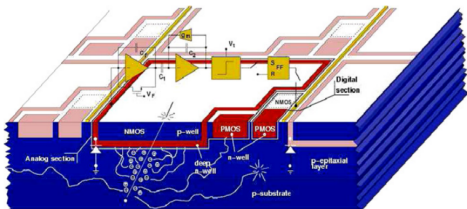
# Monolithic Active Pixels

- Newer, more challenging.
- Pixels:  $50 \times 50 \mu\text{m}^2$  pitch,  $50\mu\text{m}$  thickness.
- Active cooling is needed ( $2 \text{ W cm}^{-2}$ ).
- Implemented in Deep n-well.
- Full signal processing chain: large preamplifier, shaper, discriminator, in-pixel logic.

No TestBeam results yet. MC and lab results:

- Efficiency: 98%.
- 100ns timestamp.

Much more *R&D* to be done.



# Summary

The *R&D* work on the SuperB SVT is well advanced. Crucial issues for Layer0:

- Striplets most ready and working solution for the beginning of SuperB data-taking.
- *R&D* still needed.

Outcome of work on Hybrid Pixels:

- Study of the residuals and angular dependence.
- Smaller threshold planned for next simulations.

In the TDR(Feb 2012) both options will be presented. Final decision will follow after.