Silicon Vertex Tracker for SuperB

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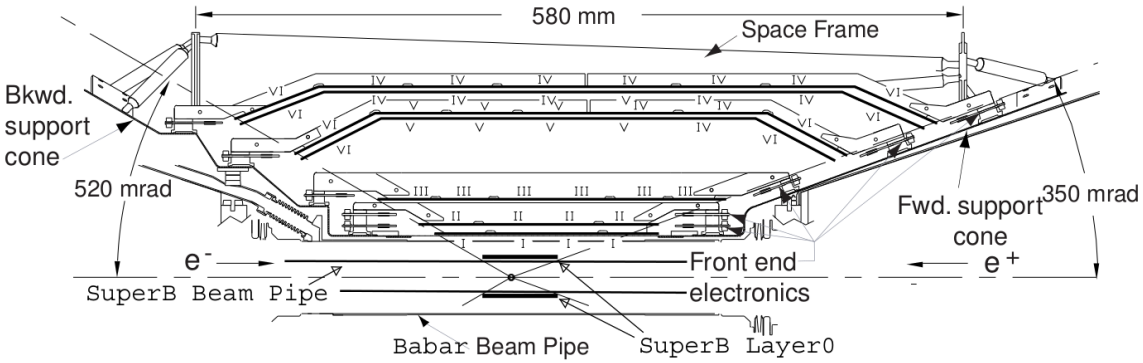
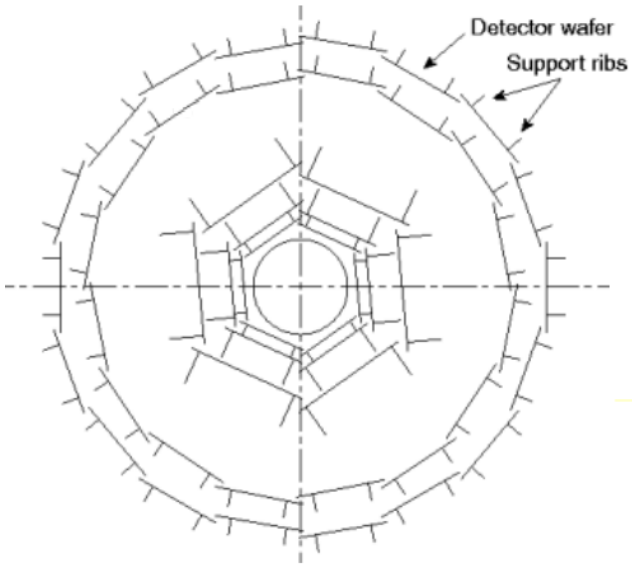
Physics requirements

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

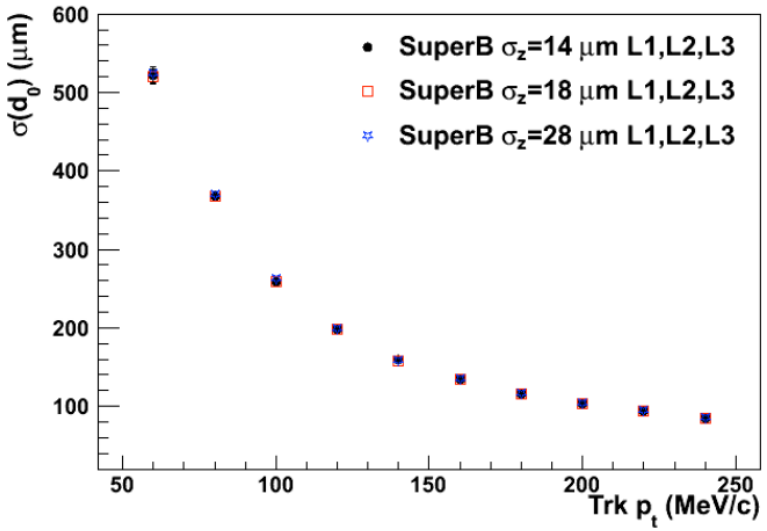
1. SVT together with drift chamber (DCH) and magnet provide track and vertex reconsturction.
2. For less energetic particles SVT must provide the complete track information.
3. SVT must provide the same precision of time dependent CP violation as BaBar detector with boost reduced from $\beta\gamma = 0.55$ 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.



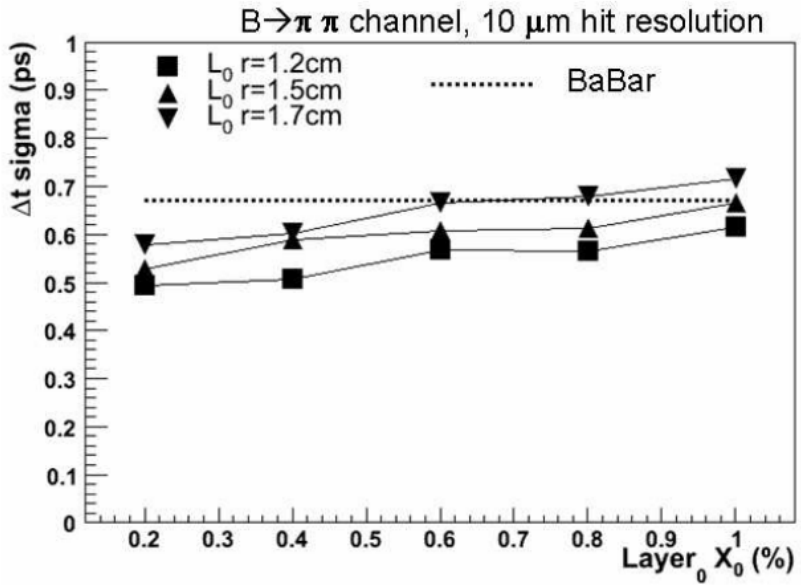
Layer0

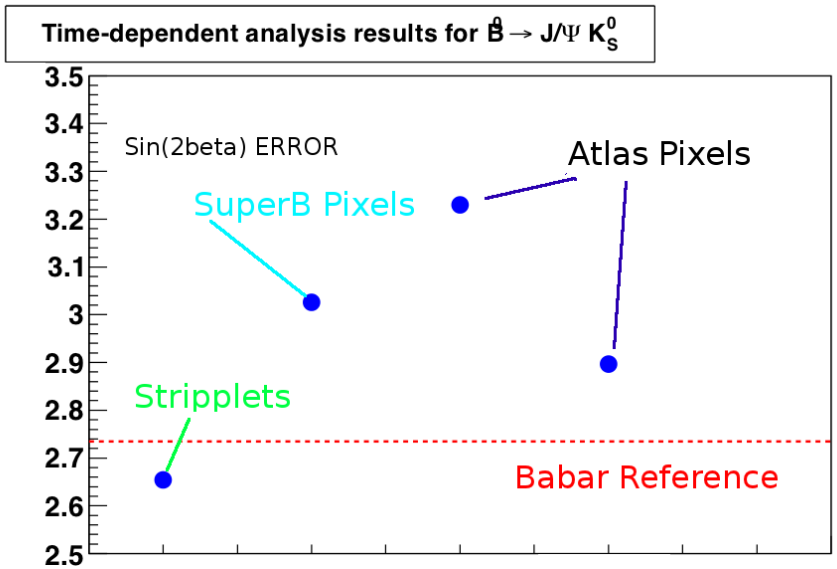
To meet the physics requirements mentioned for SuperB an additional 6th layer was introduced (Layer0). Reguirements for Layer0:

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

Aspects that are being considered in projecting Layer0:

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



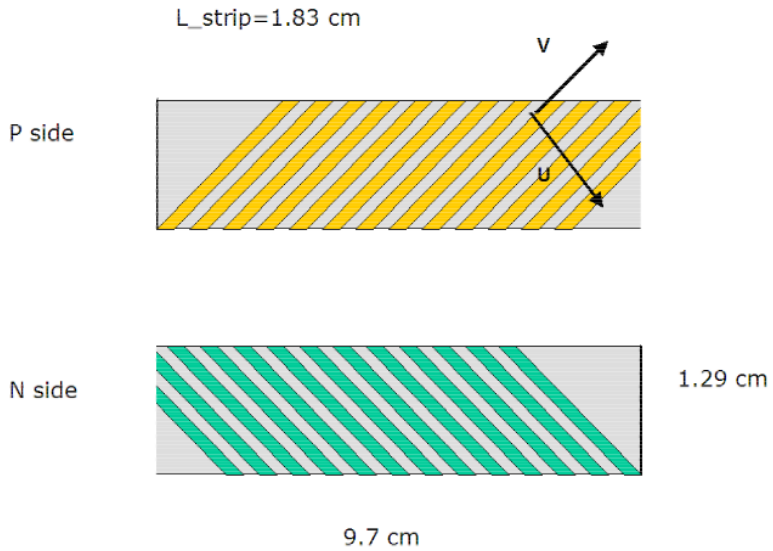


List of options

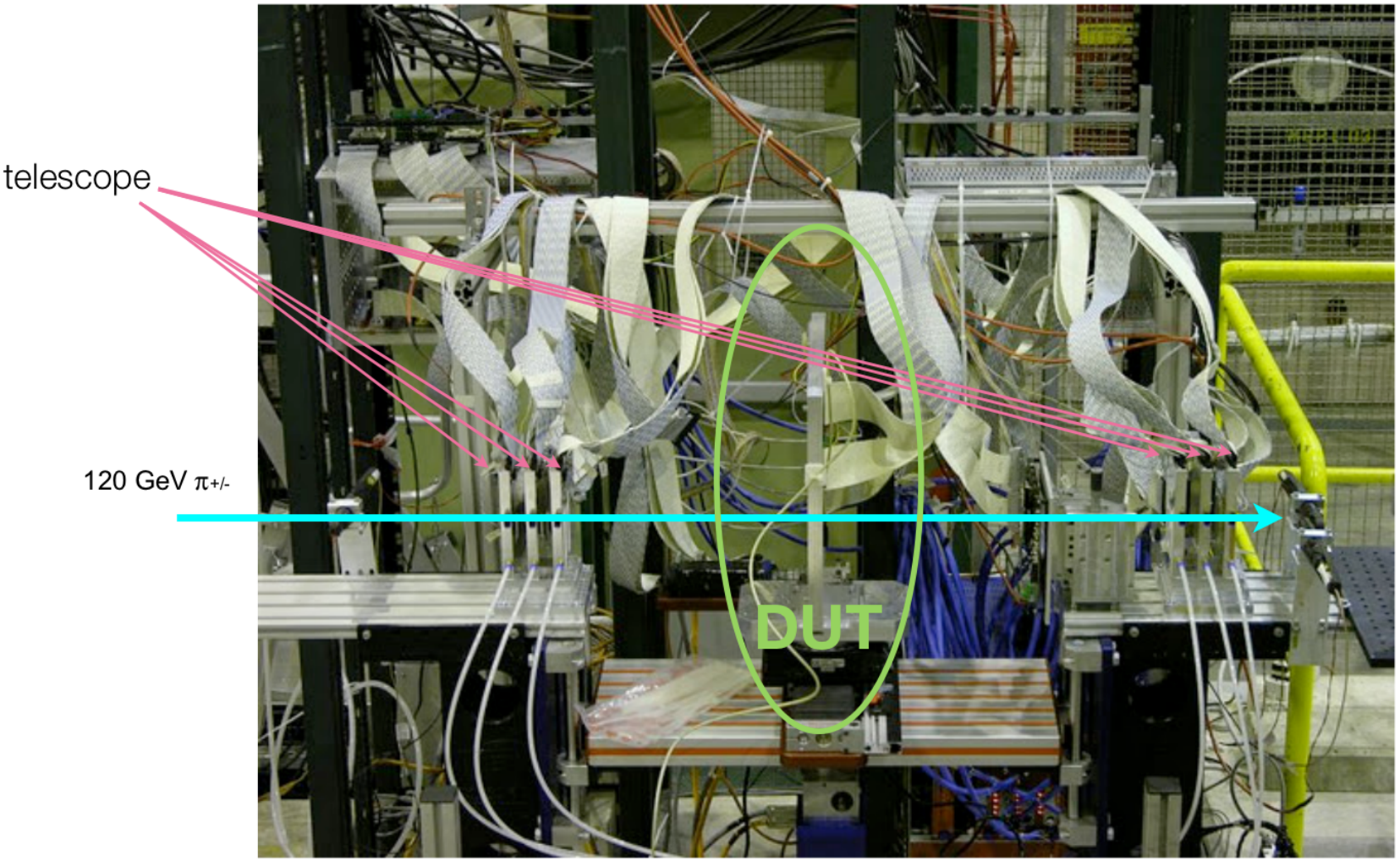
1. Double-sided silicon strip detector (Striplets).
2. Pixel detectors:
   - Hybrid pixels.
   - MAPS.

Striplets

- $200\mu m$ thick, with $50\mu m$ readout pitch.
- Rotated by$\pm 45^0$.
- 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: $6.37 MHz\ cm^{-2}$



SVT Test Beam

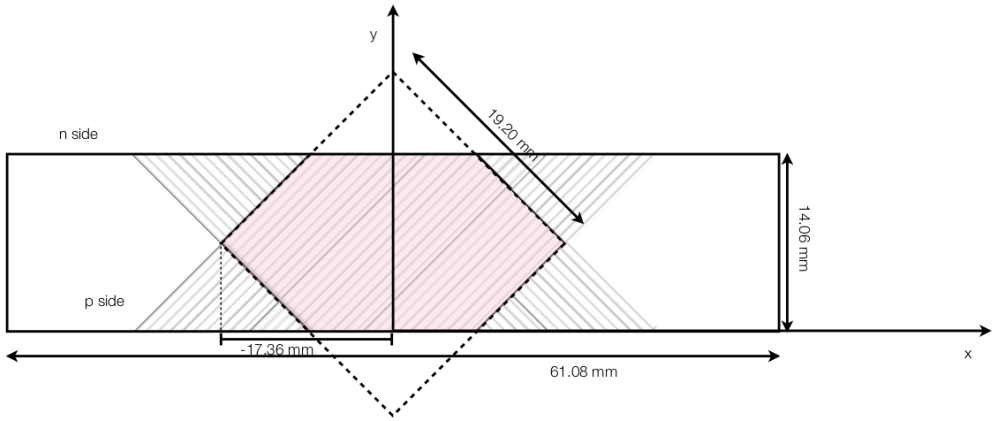


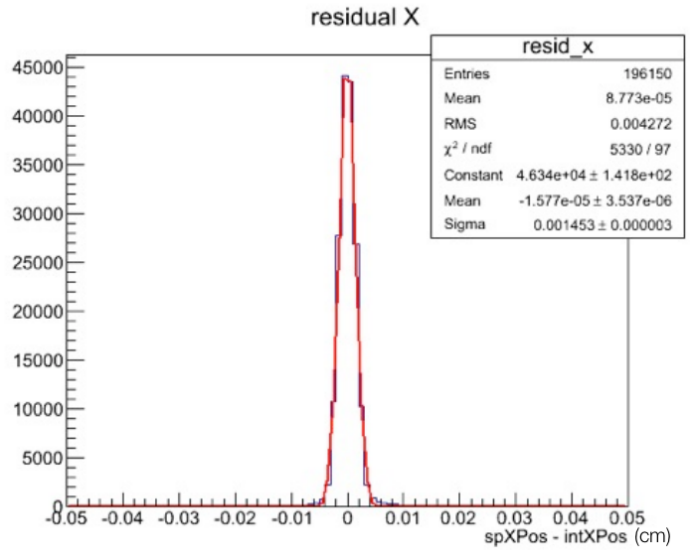
DUT = Device Under Test.

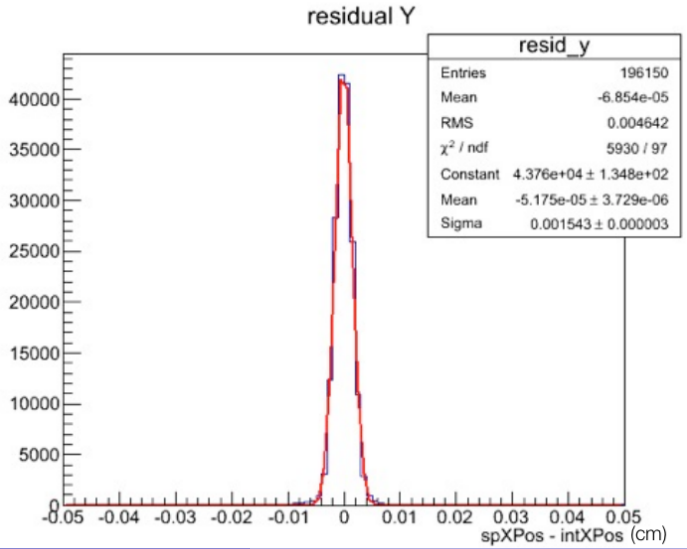
SVT Test Beam

Work done by: Laura Fabbri (INFN Bologna)

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

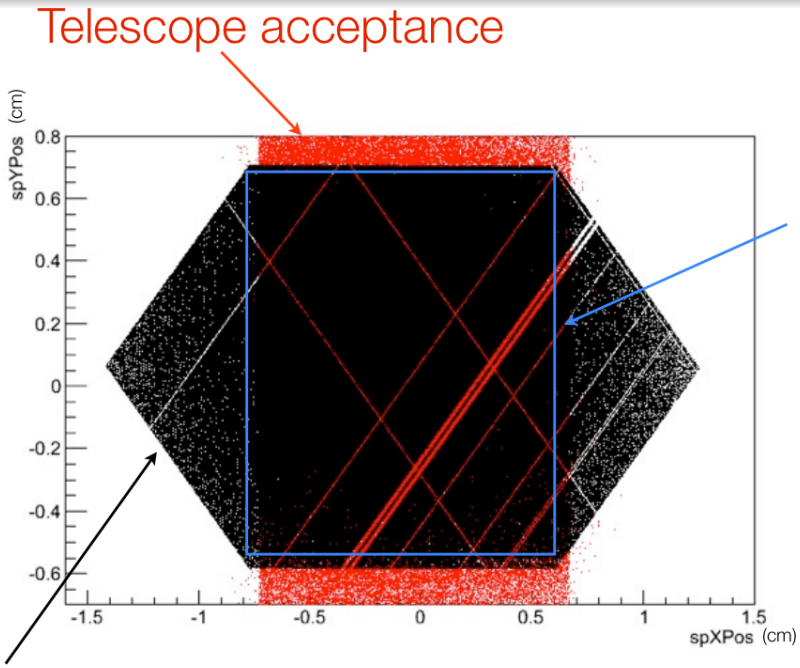




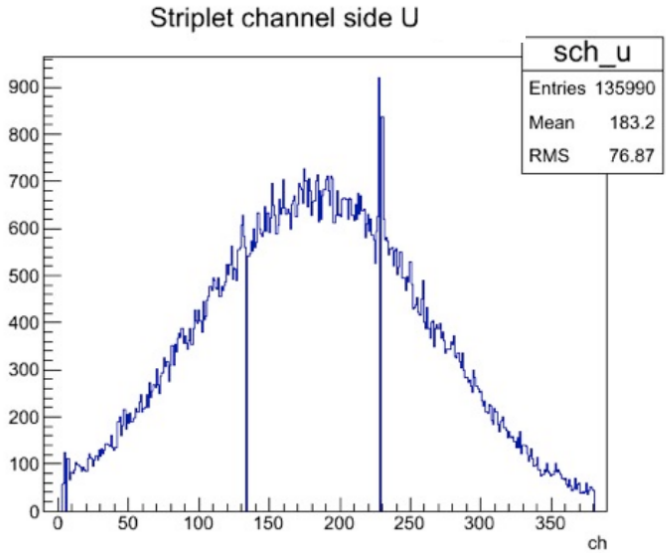


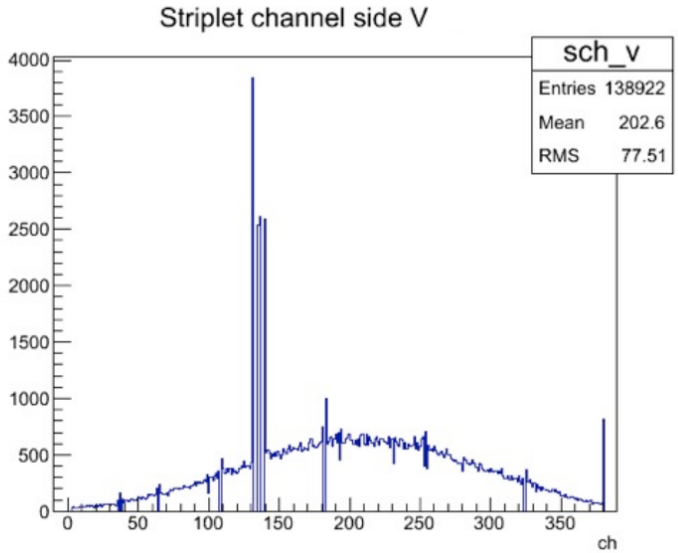
Procedure:

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

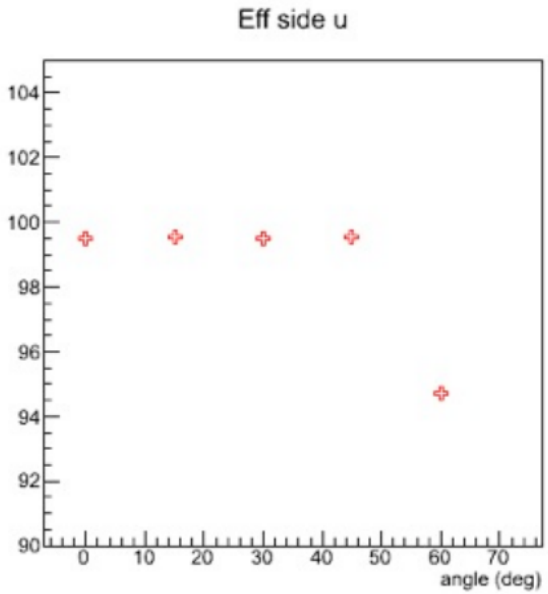


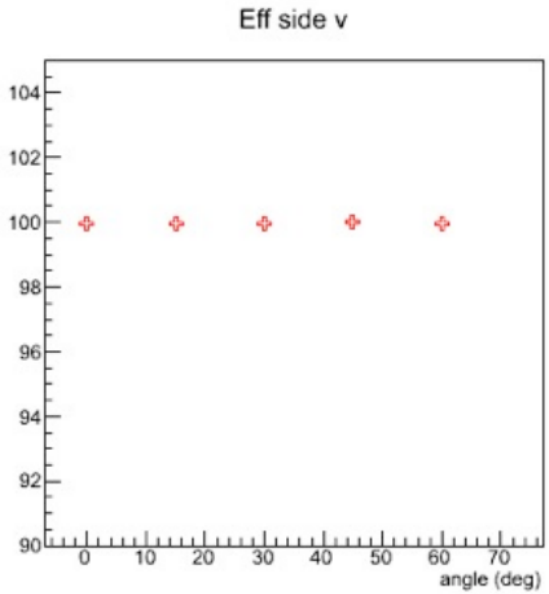
- Inactive strips not taken into account in the analysis

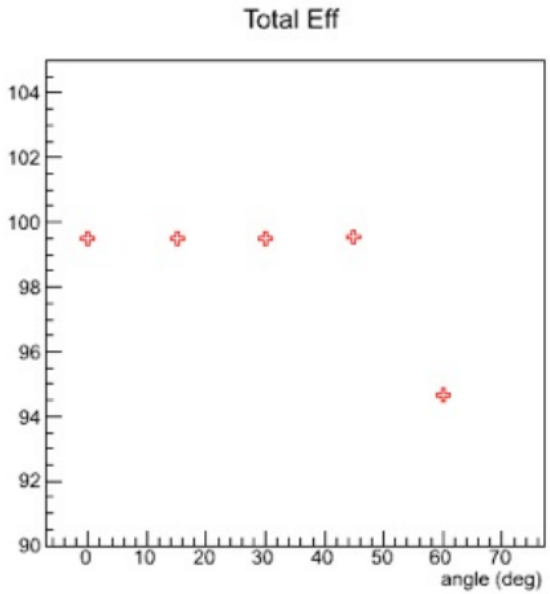




Efficiency vs angle







Hybrid Pixels

- Pixels: 50 x 50 μm^2 pitch.
- 200μm 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 = $42mV\ fC^{-1}$.

Hybrid Pixels Test Beam Notes

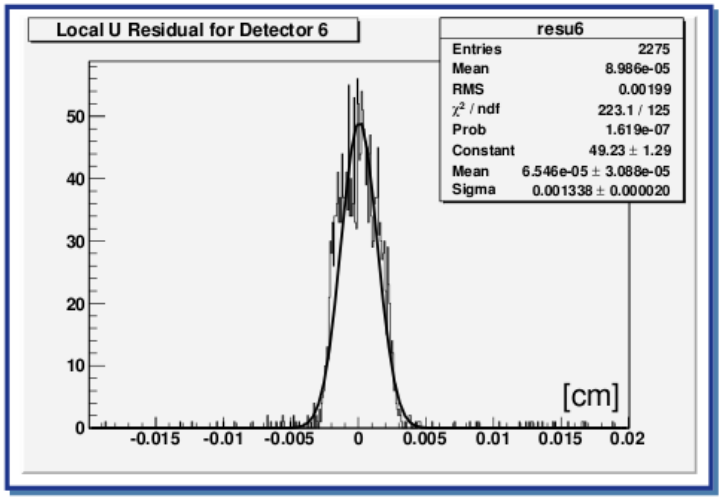
Work done by:

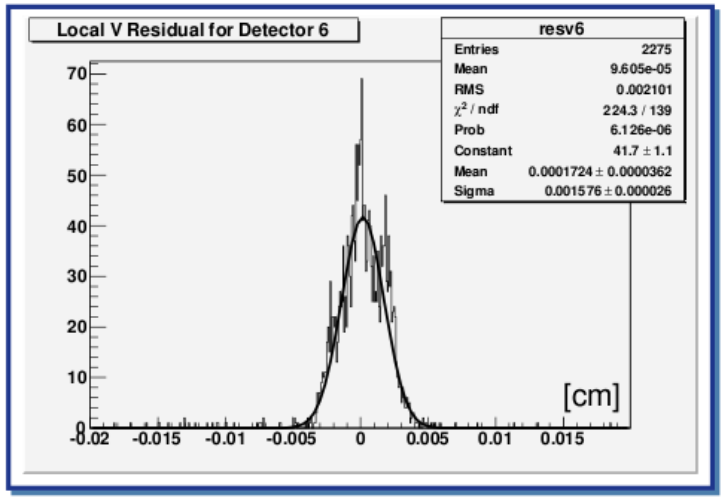
A.Lusiani, M.Chrzaszcz, Nicola Neri, Benjamin Oberhof, Antonio Paladino.

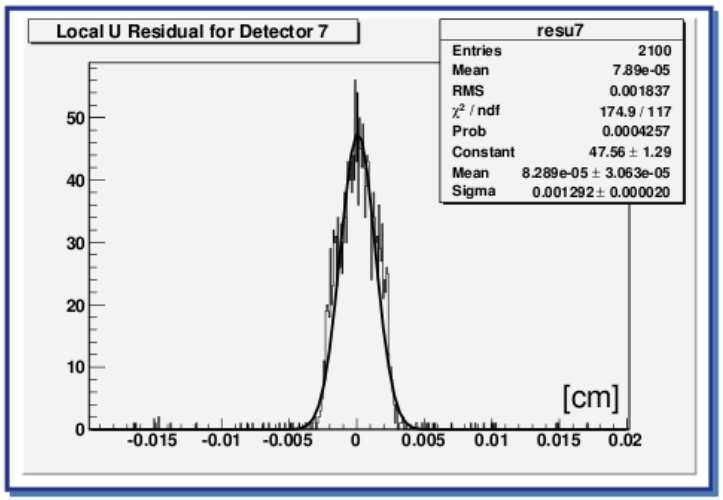
- Several thresholds, reference threshold 1/4 of a m.i.p. at normal incidence.
- Data took with 3 chips: $12, 53, 55$.
- DUT rotated around at $0^o, 15^o, 30^o, 45^o, 60^o, 70^o$.
- 128 pixels along x (horizontal, u-axis), 32 pixels along y (vertical, v -axis).
- approximately parallel tracks, high momentum,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

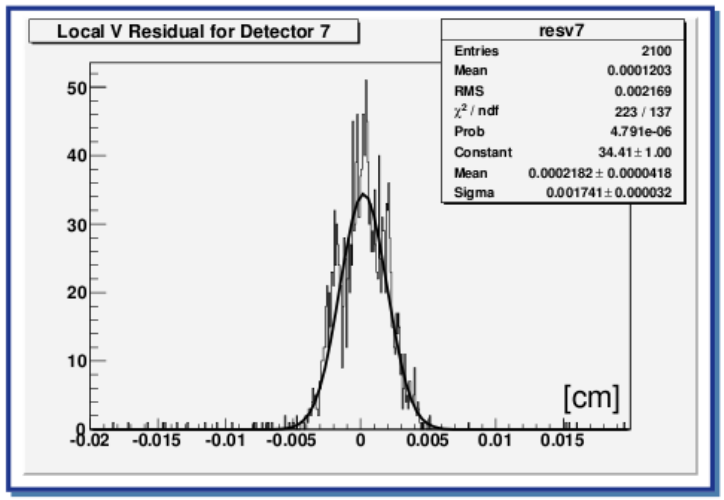
Hybrid Pixels Test Beam Results

Typical resolution: $20\mu m$.

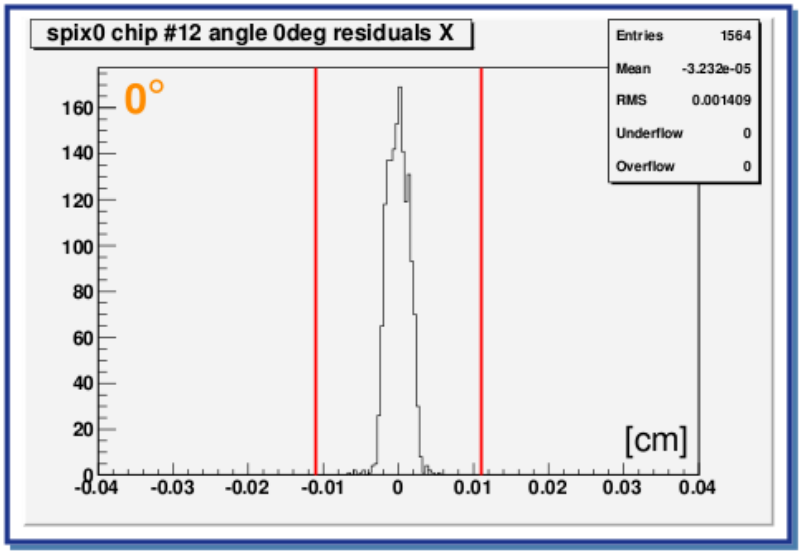


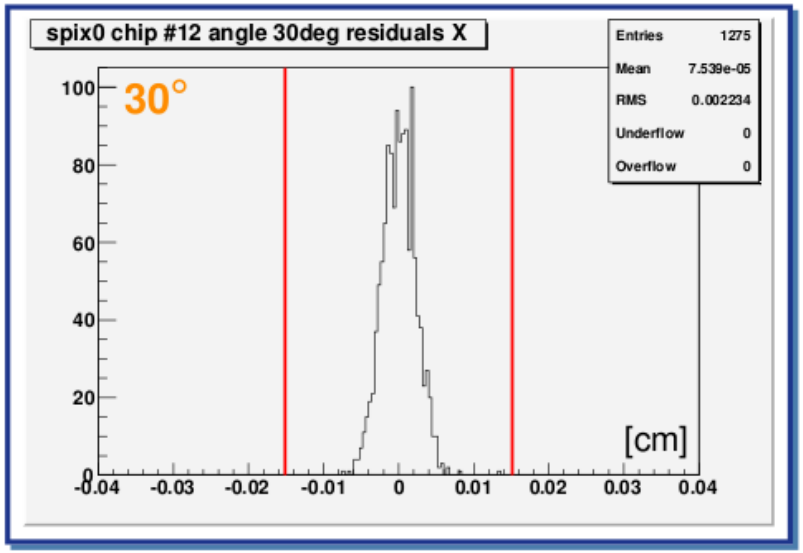


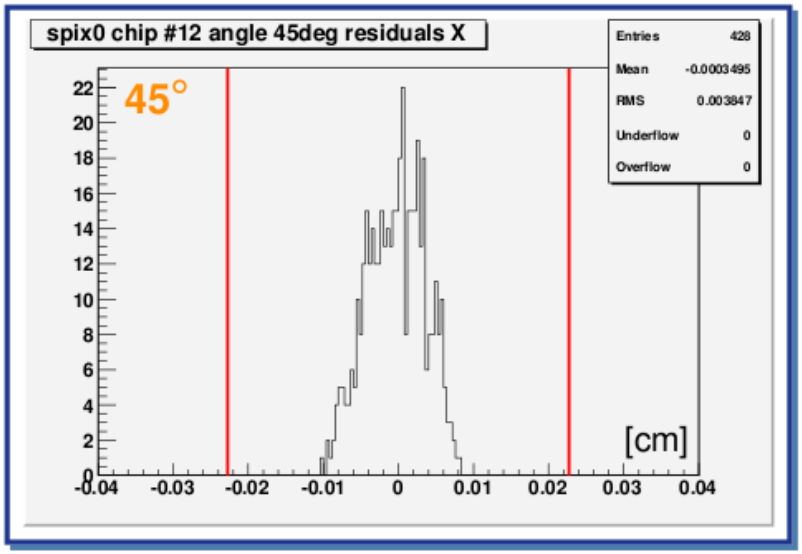


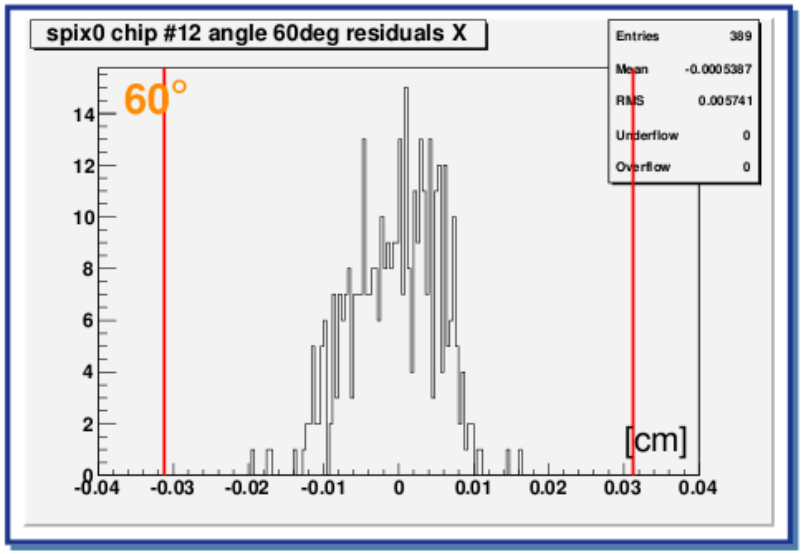


Angular dependence of the residual



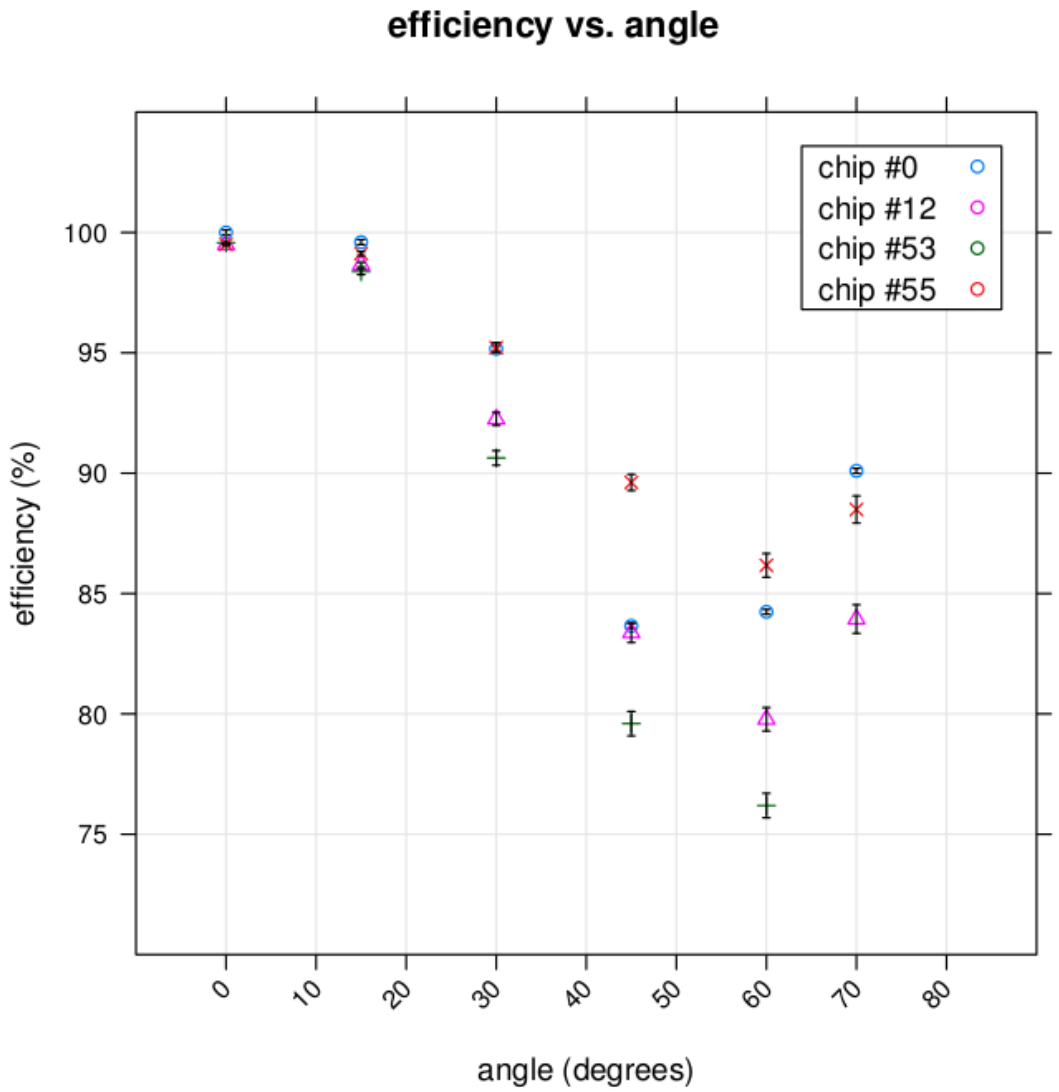






Hybrid Pixels: Test Beam

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



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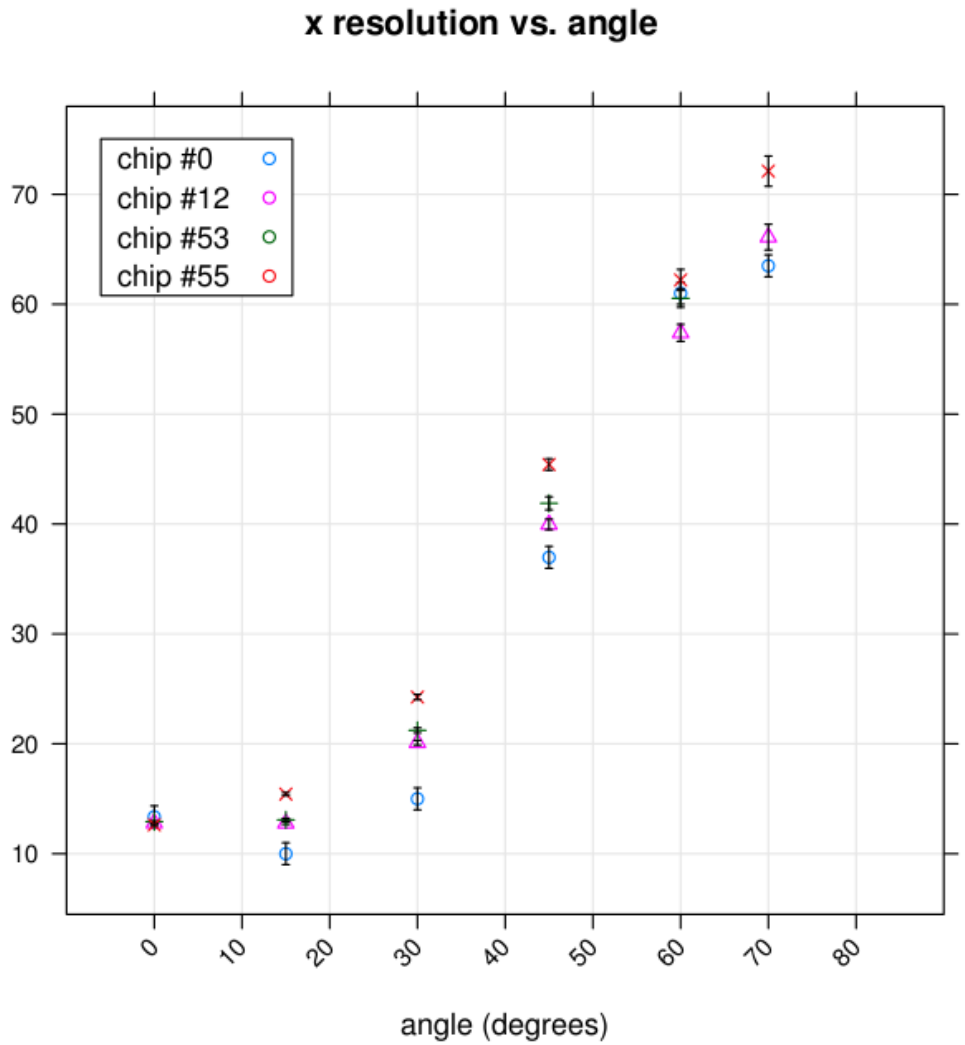
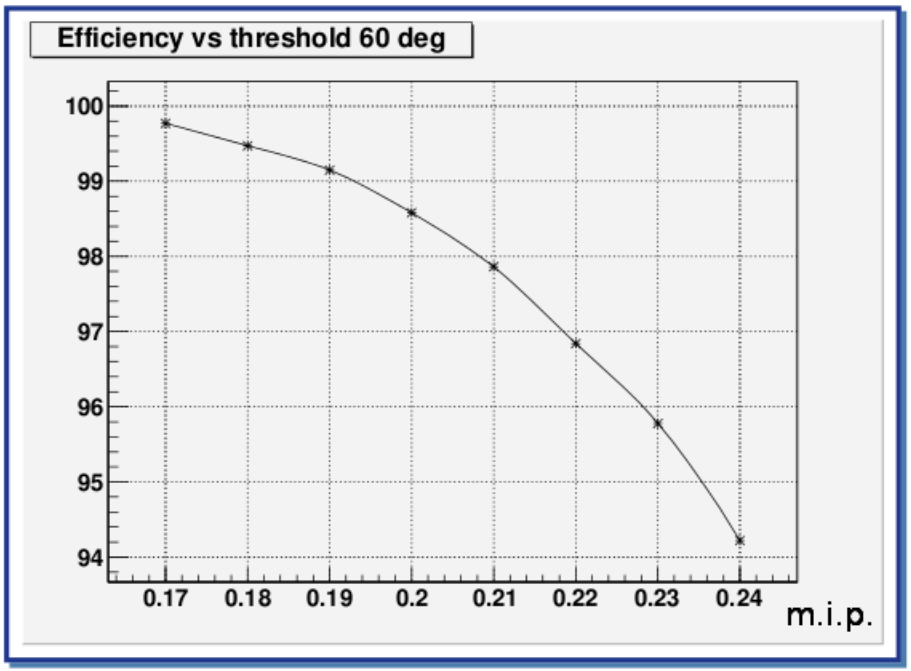
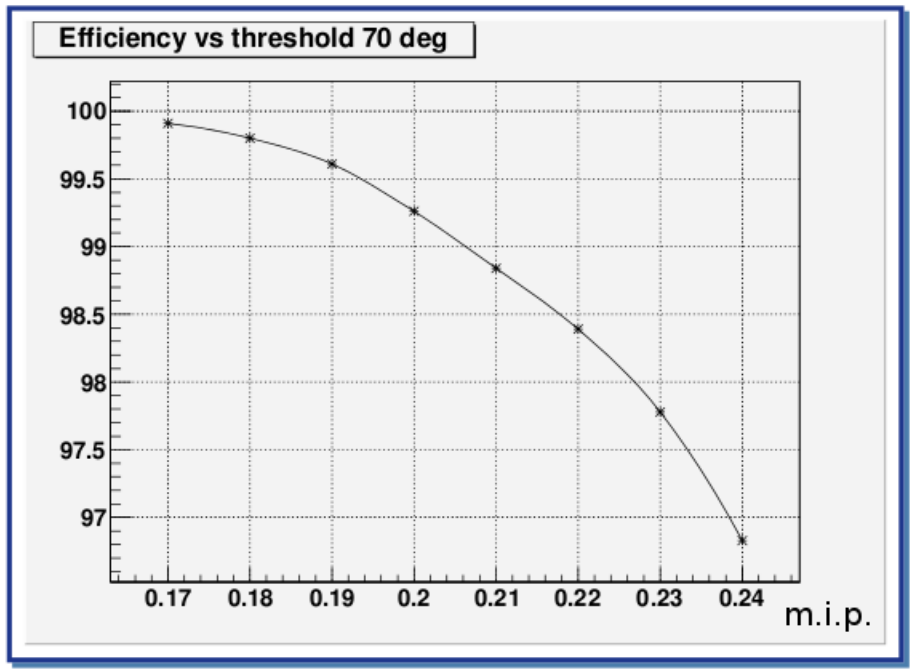


Threshold Simulations



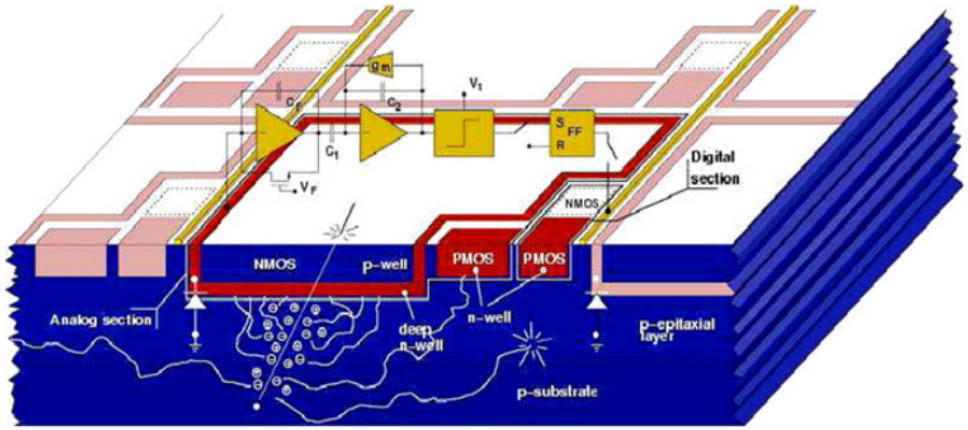


Conclusion

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 x 50 μm^2 pitch, 50μm thickness.
- Active cooling is needed (2 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.