Silicon Vertex Tracker for SuperB

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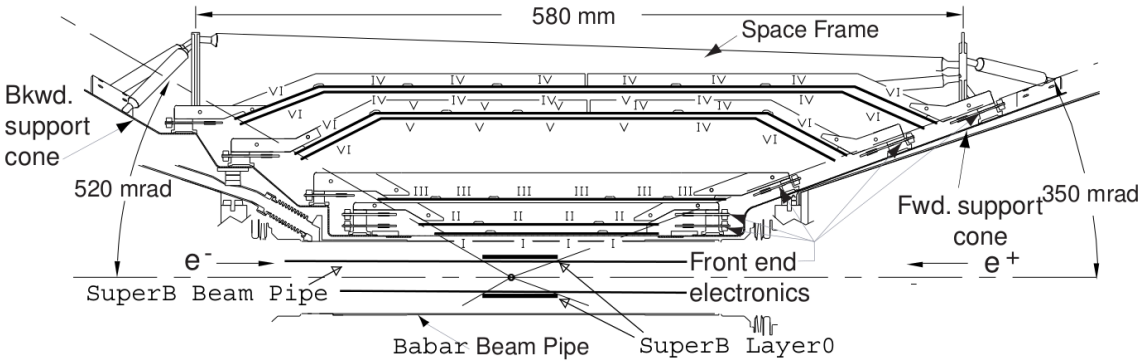
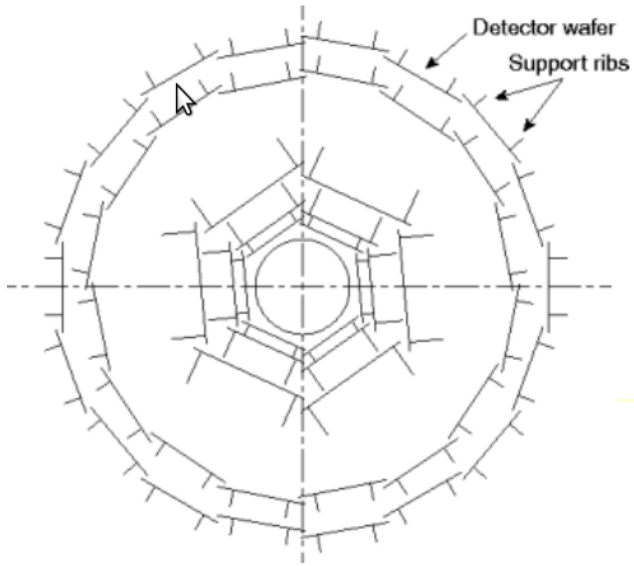
Physics requirements

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

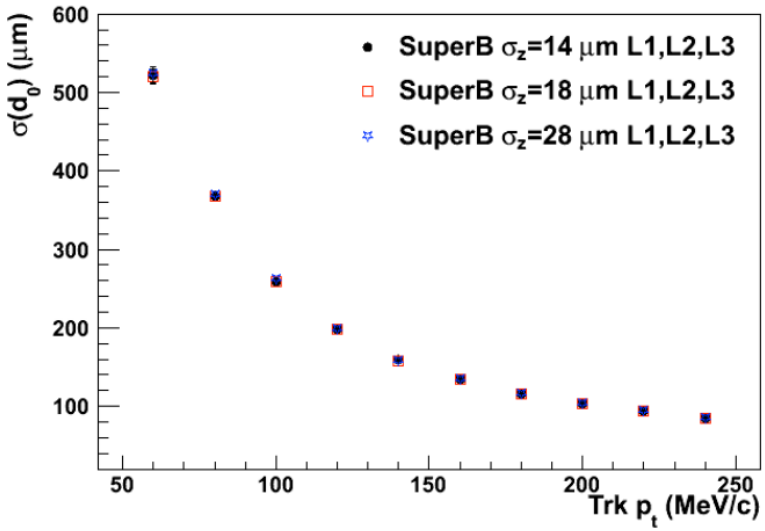
1. SVT together with drift chamber (DCH) and magnet provide track and vertex reconsturction
2. For low energetic particles SVT must provide the complete track information.
3. SVT must provide the same precision of time dependend CP violation as Babar detector with boost reduced from $\alpha\beta = 0.55$ to $\alpha\beta = 0.28$
   - $50 - 80\mu m$ 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.
- Radius span $3 - 15$ cm.



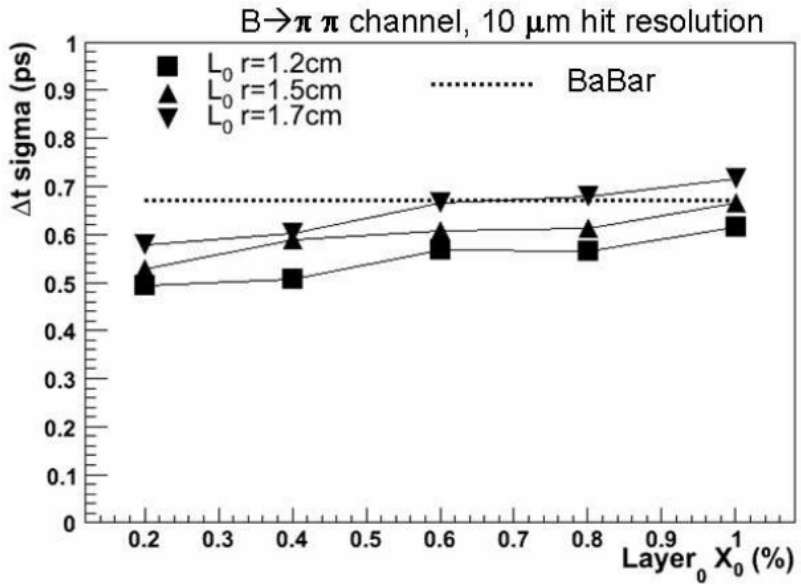
Layer0

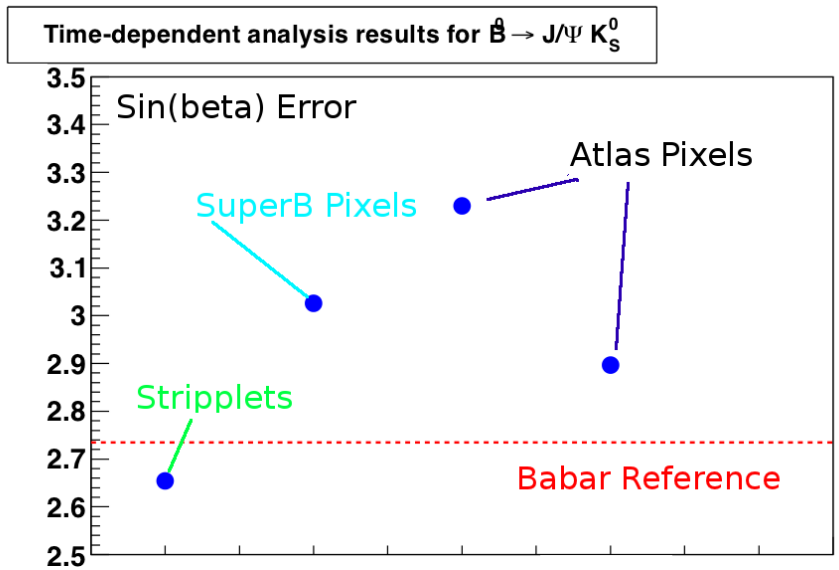
Reguirements on Layer0:

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

To meet the requirements mentioned an additional 6th layer was introduced (Layer0). Aspects that are beeing taken in projecting Layer0:

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



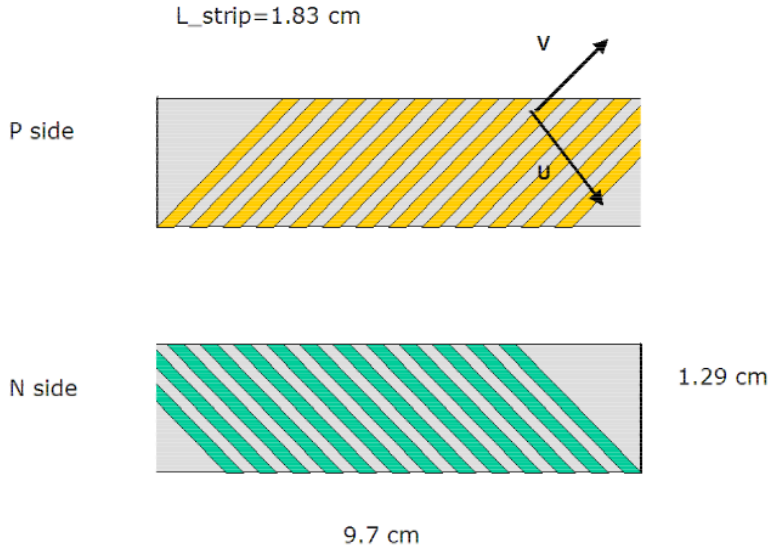


List of optons

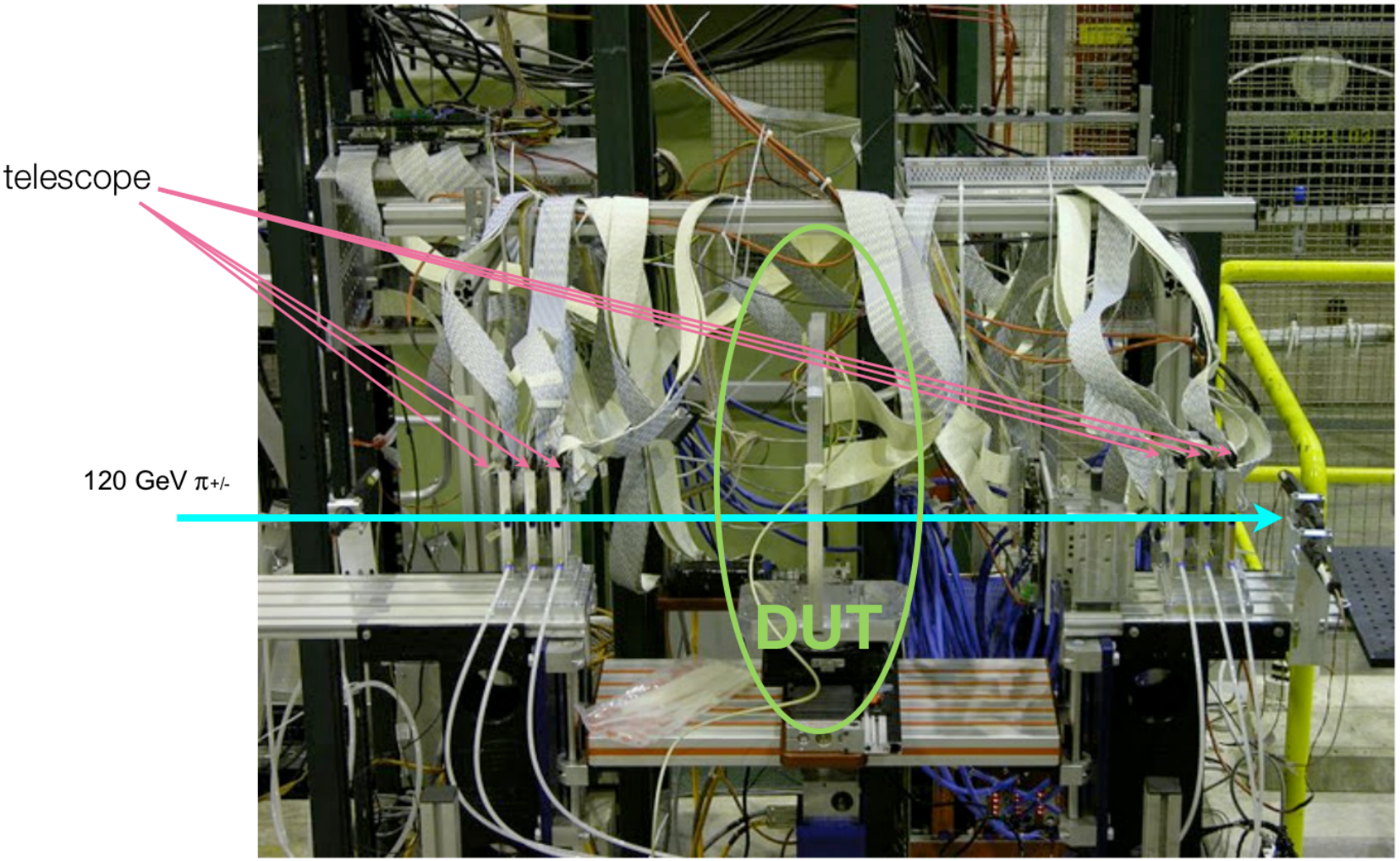
1. Double-sided silicon strip detector (Striplets).
2. Pixel detectors:
   - Hybrid pixels.
   - MAPS.

Striplets

- $200\mu m$ thick, with $50\mu m$ readout pitch.
- Rotated by$\pm 45^0$.
- Occupancy: 0.8%; 4% with safety factor.
- Chip with 128 analog channels and 132 *ns* time window.
- Signal to Noise: 26.
- Material budget: $0.55\% X_0$
- Cluster rate: $6.37 \frac{MHz}{cm^2}$



SVT Test Beam

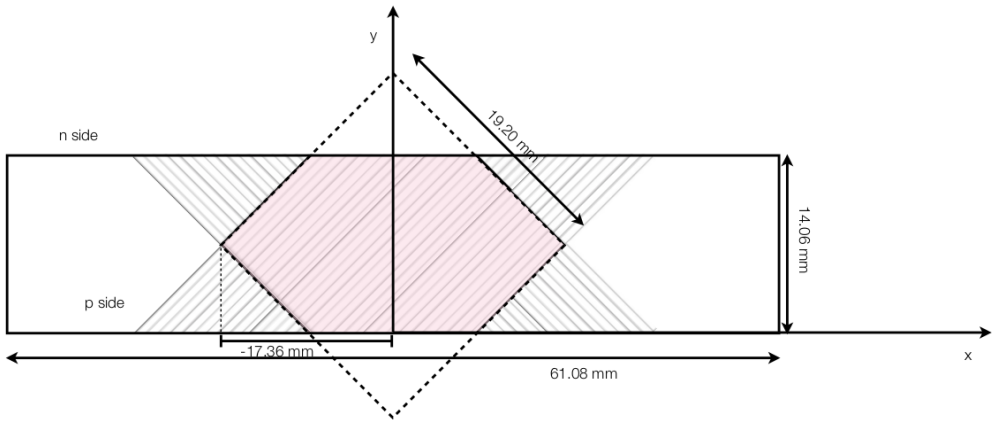


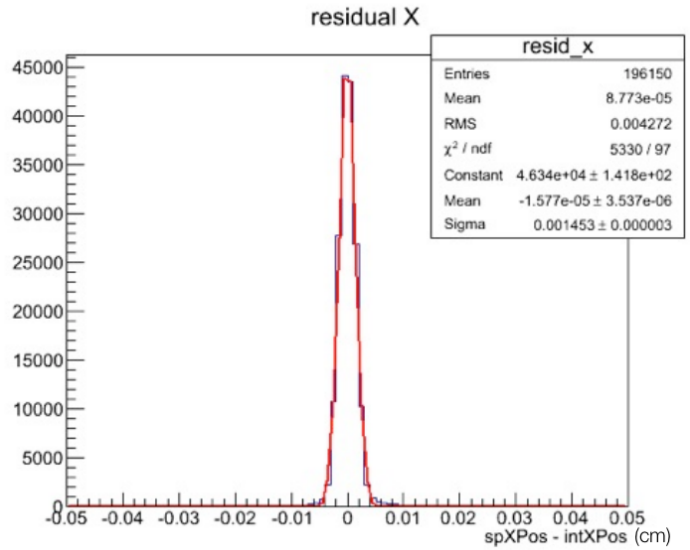
DUT = Device Under Test.

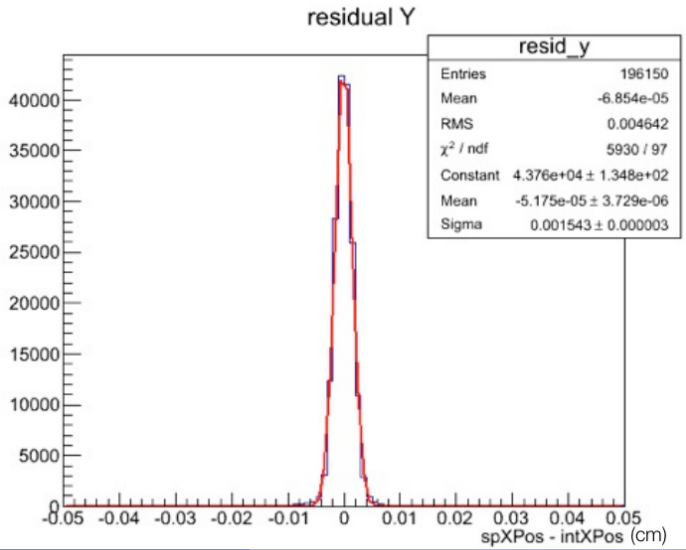
SVT Test Beam

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. (Alberto please confirm this, mayby u know how many triggers you took)
3. Thresholds = 20 or 15.

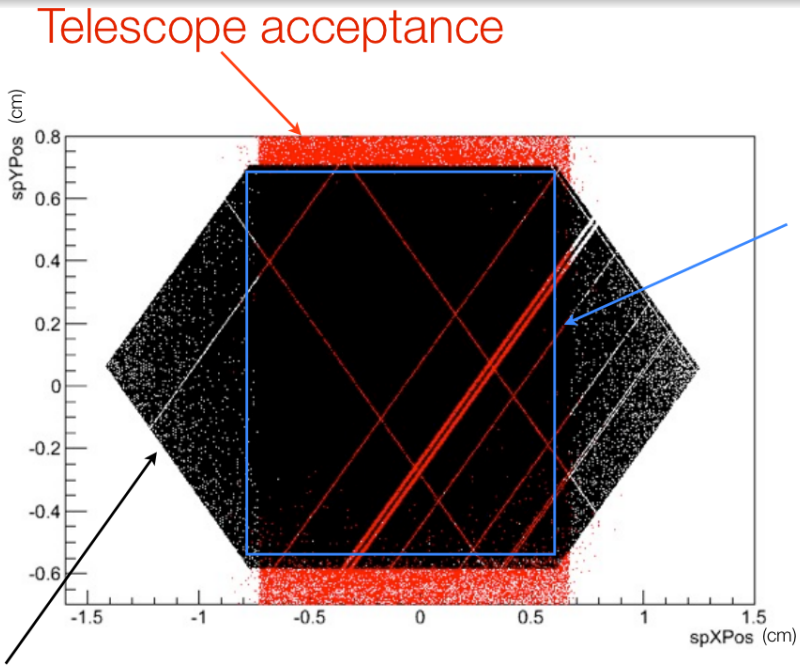




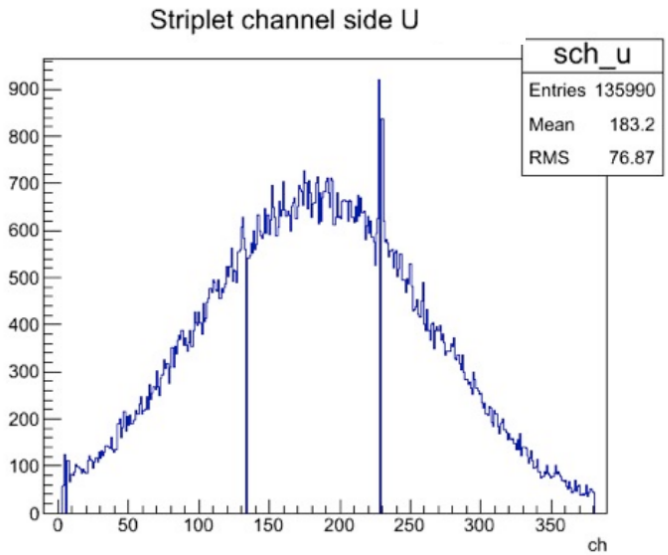


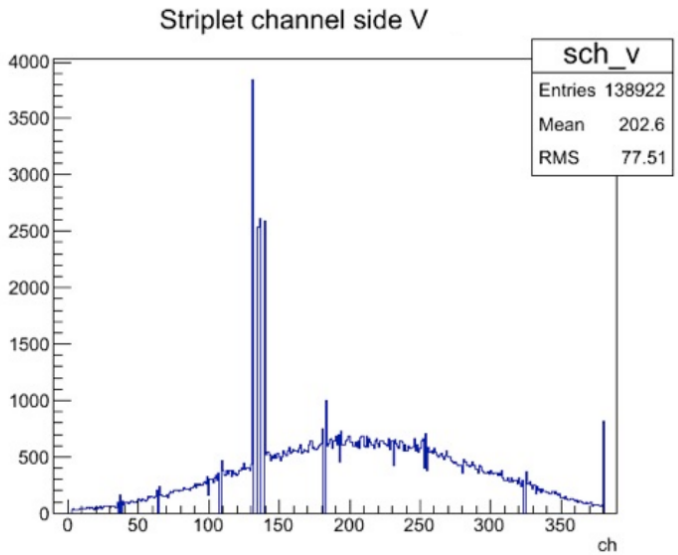
Procedure:

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

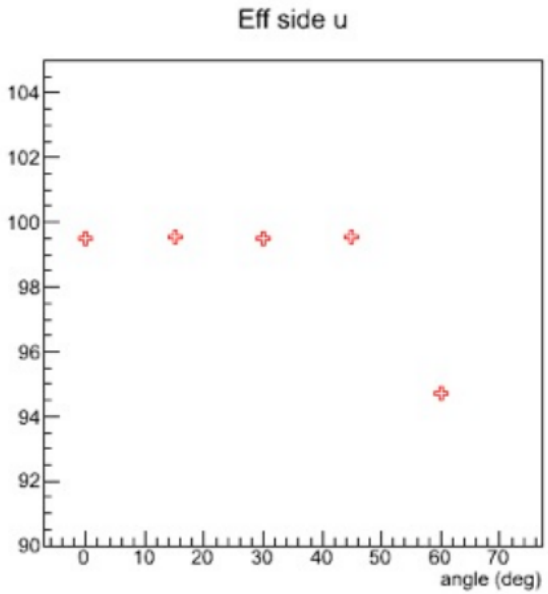


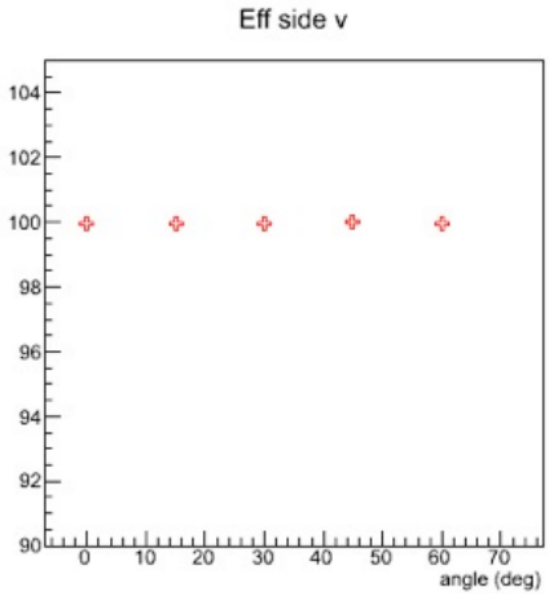
- Inactive strips not taken into account in the analysis

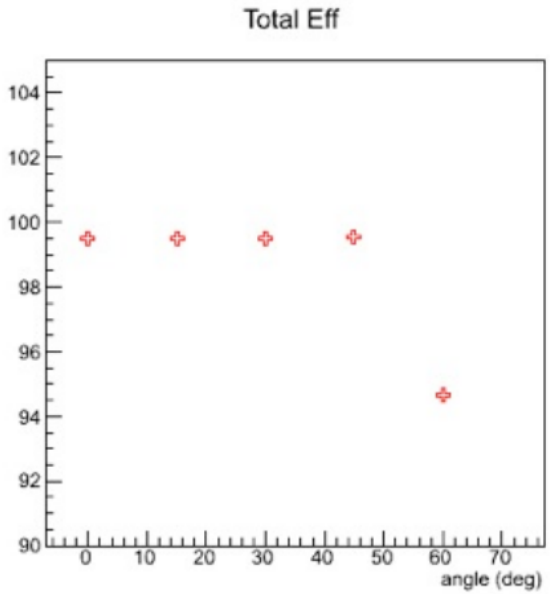




Efficiency vs angle







Hybrid Pixels

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

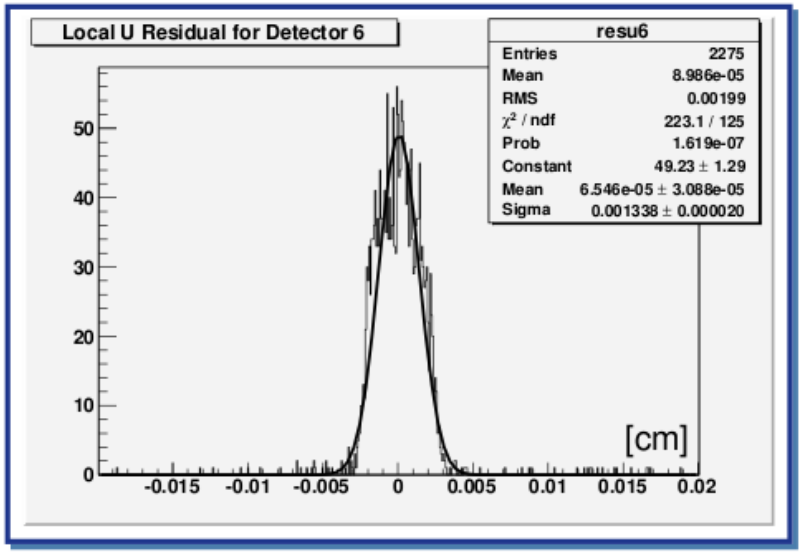
Hybrid Pixels Test Beam Notes

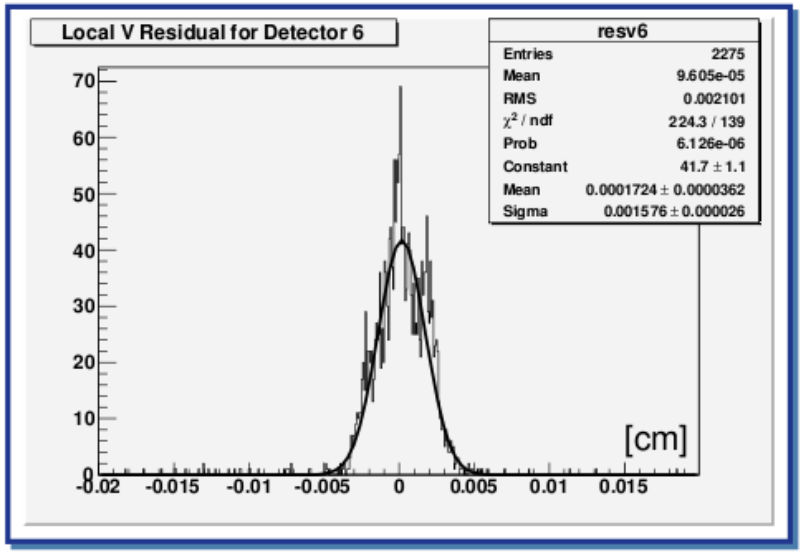
Work done by:

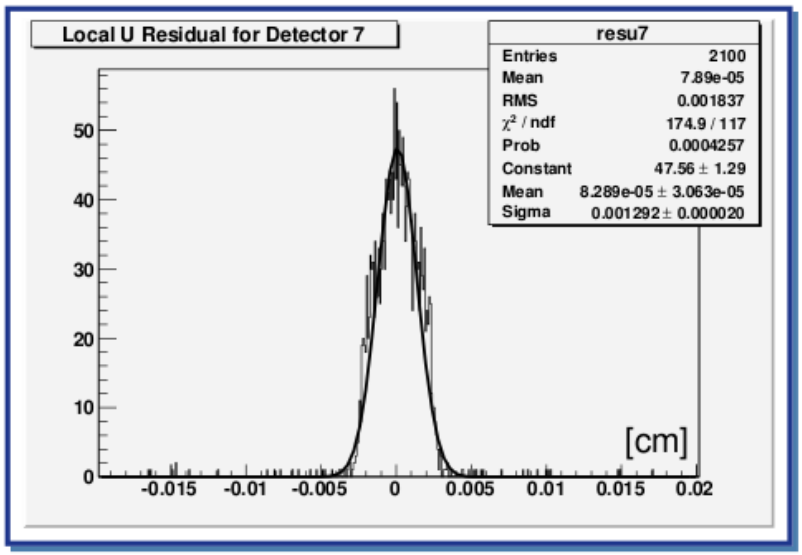
A.Lusiani, M.Chrzaszcz, Nicola Neri, Benjamin Oberhof, Antonio Paladino.

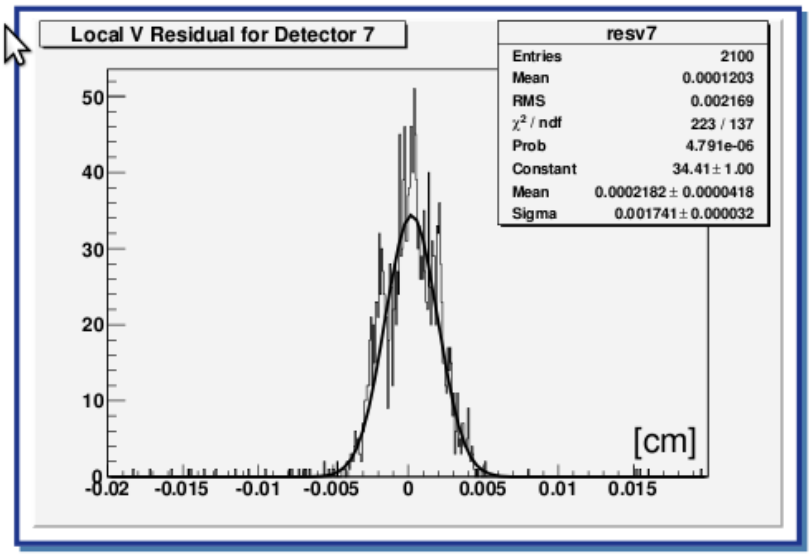
- Several thresholds, reference threshold 1/4 of a m.i.p. at normal incidence.
- Data took with 3 chips: $12, 53, 55$.
- DUT rotated around at $0^o, 15^o, 30^o, 45^o, 60^o, 70^o$.
- 128 pixels along x (horizontal, u-axis), 32 pixels along y (vertical, v -axis).
- approximately parallel tracks, high momentum,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

Typical resolution: $20\mu m$.

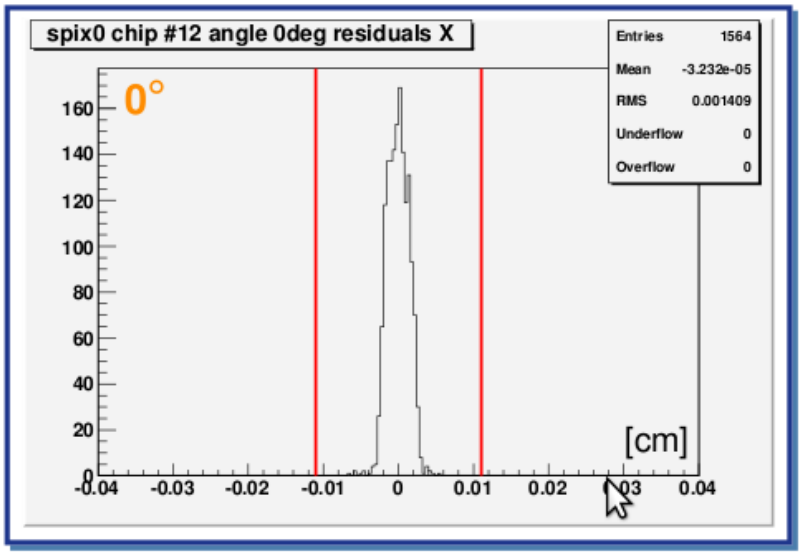


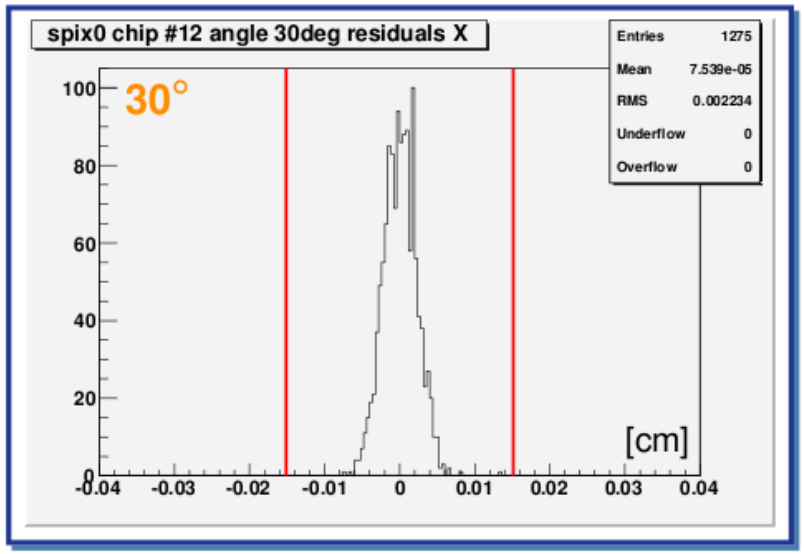


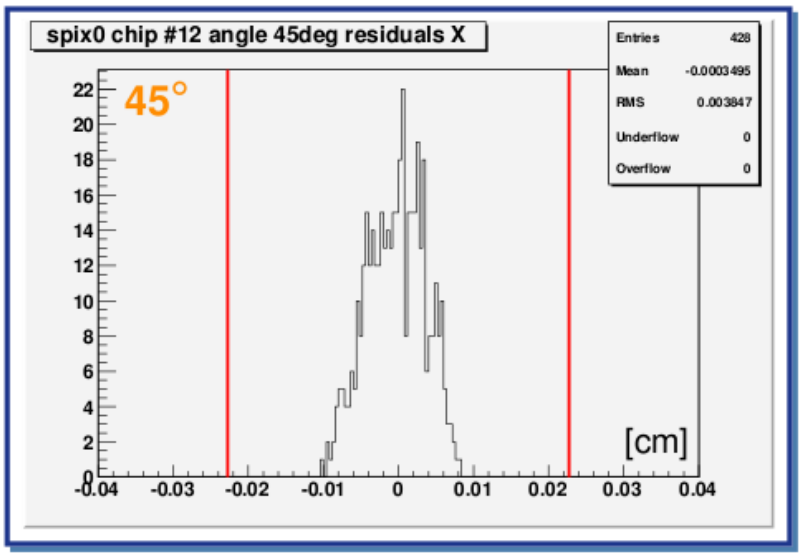


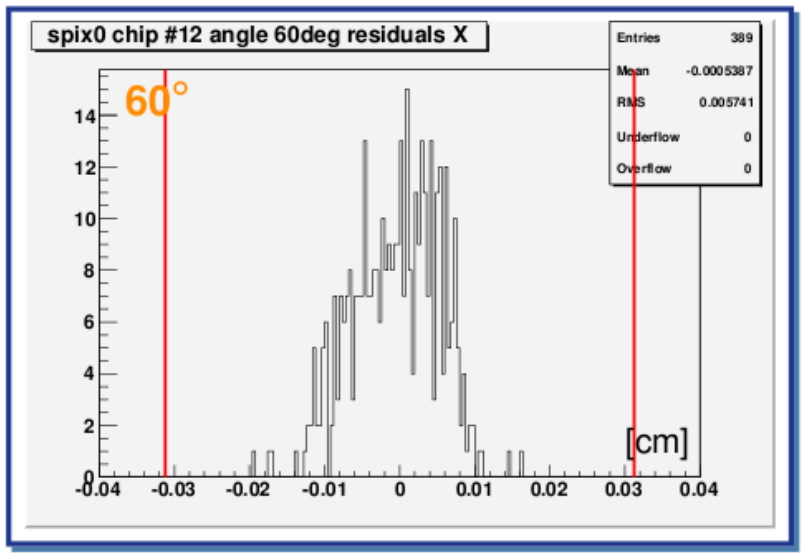


Angular dependence of residum



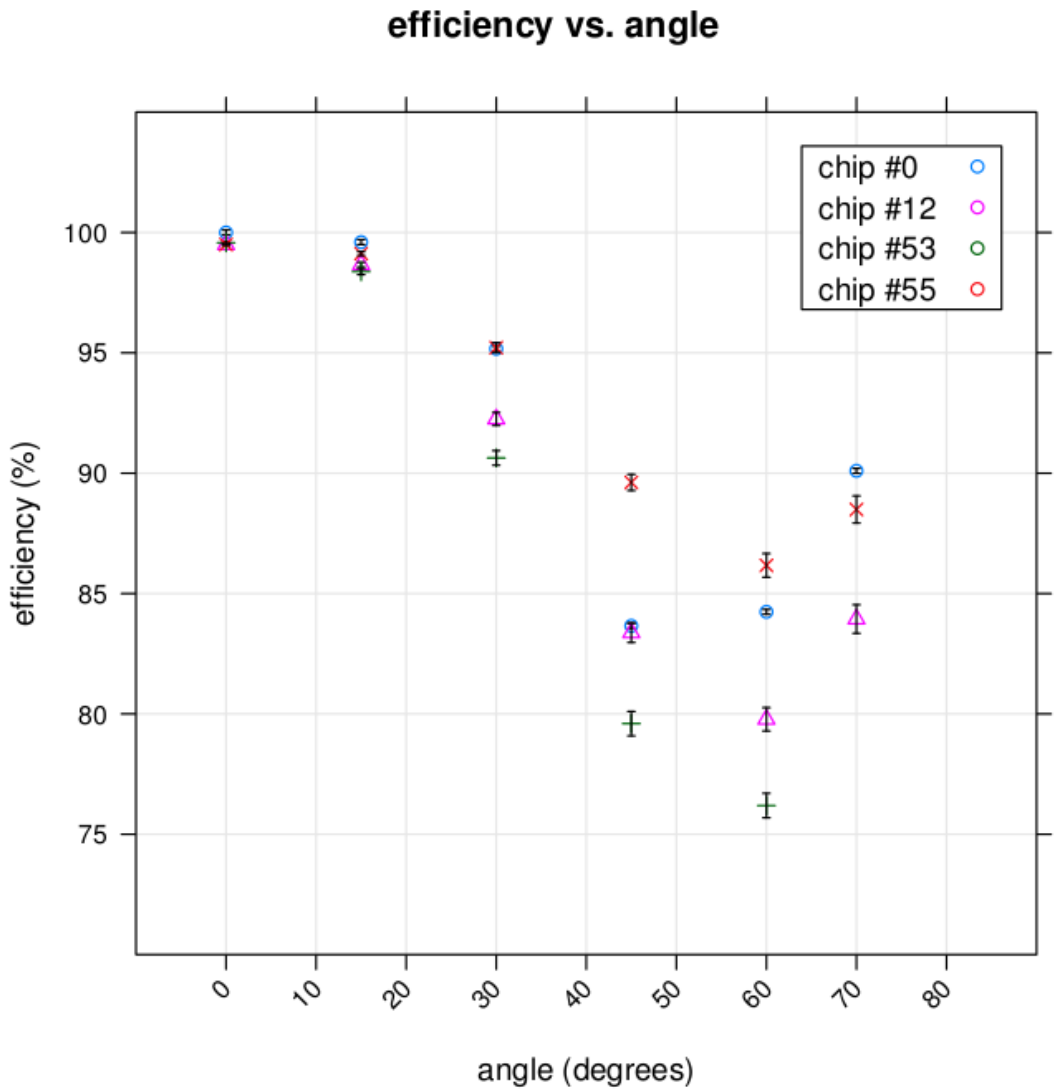






Hybrid Pixels Test Beam Results

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



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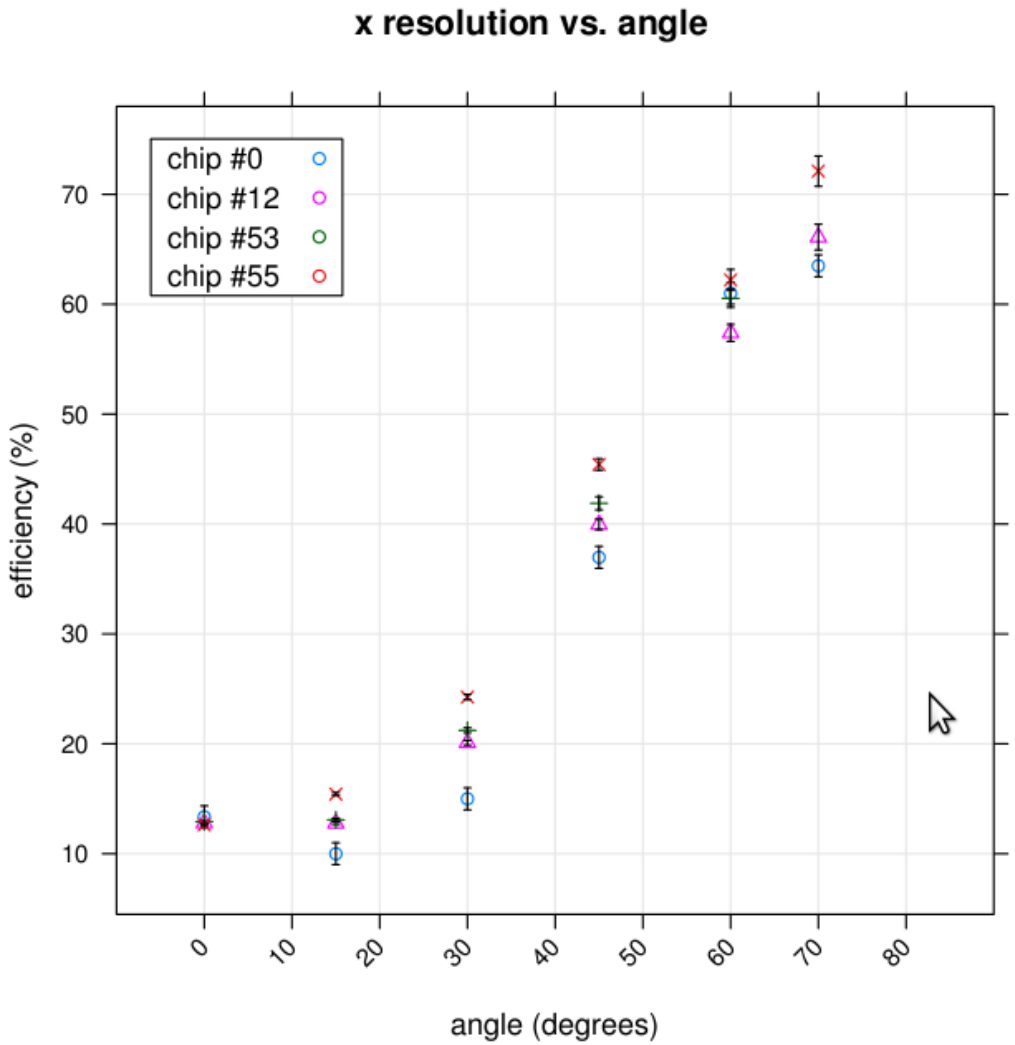
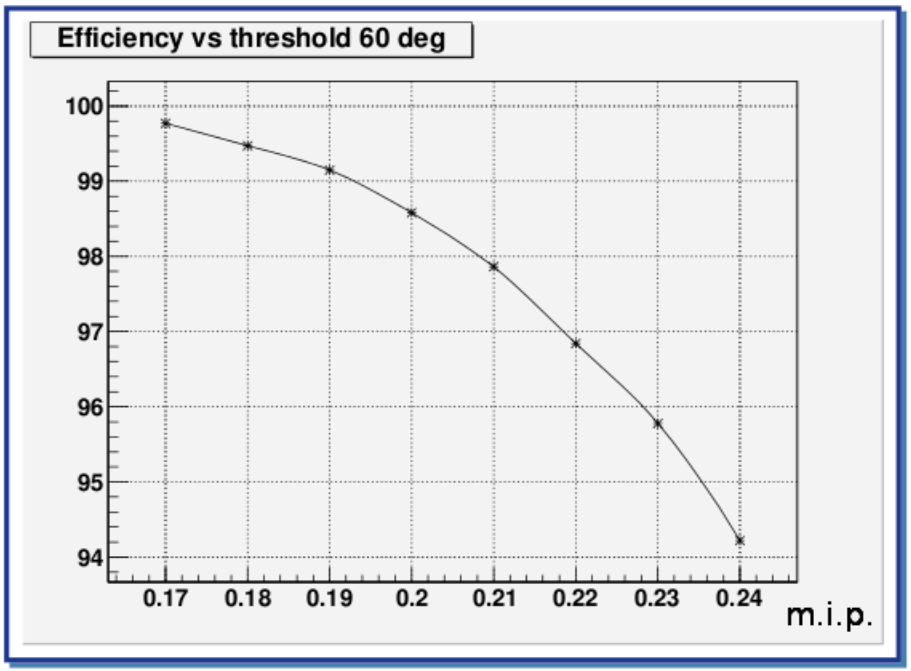
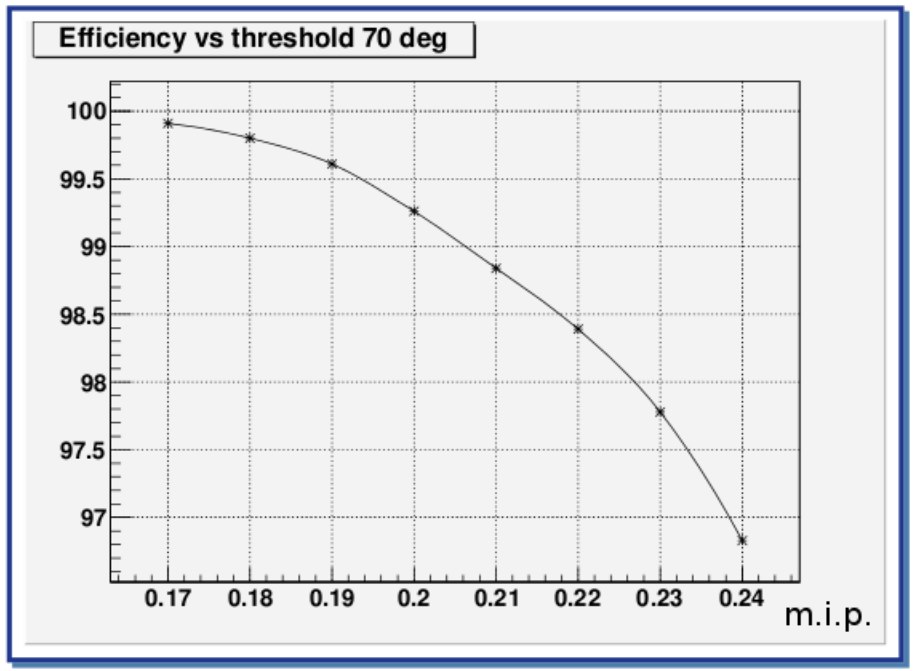


Threshold Simulations



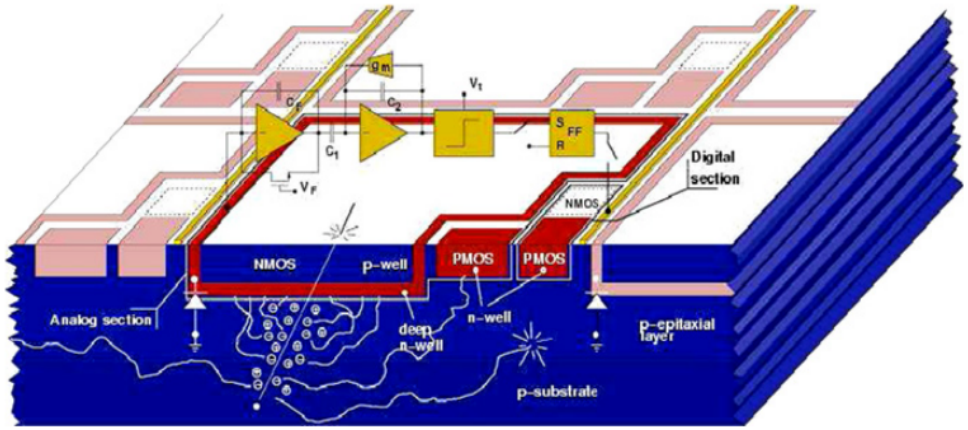


Conclusion

Next Test Beam will be done with lower threshold(0.18 m.i.p).

Monolithic Active PixelS

- Newer, more challenging.
- Pixels: 50 x 50 μm^2 pitch.
- Implemented in Deep n-well.
- Full signal processing chain: large preamplifier, shaper, discriminator, in-pixel logic.



No TestBeam done. MC and lab results:

- Efficiency:98%.
- 100ns timestamp.

Much more RD to be done.

Summary

The RD work on the SuperB SVT is well advanced. Crucial isueas for Layer0:

- Stripplets are the most propable solution.
- RD still needed.

Out come of this work:

- Study of the residum and angular dependence.
- Smaller threshold for future comming from Simulations.

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