Silicon Vertex Tracker for SuperB

Marcin Chrzaszcz

Institute of Nuclear Physics PAN

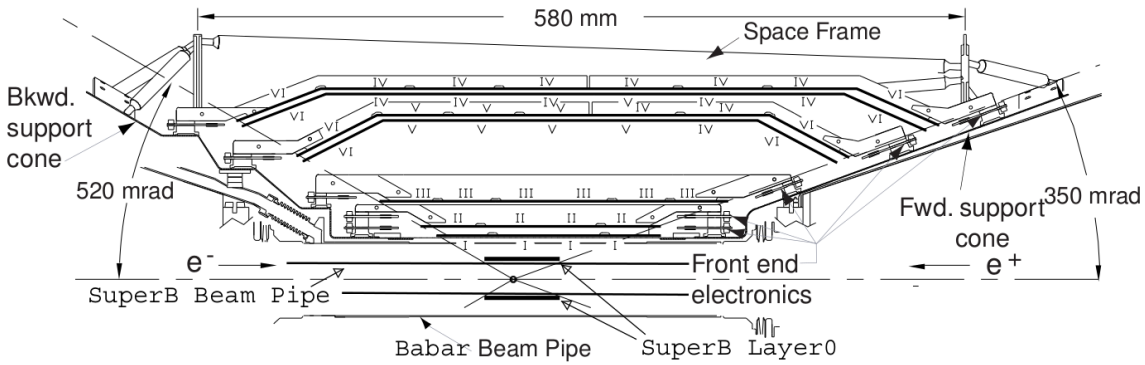
January 3, 2012

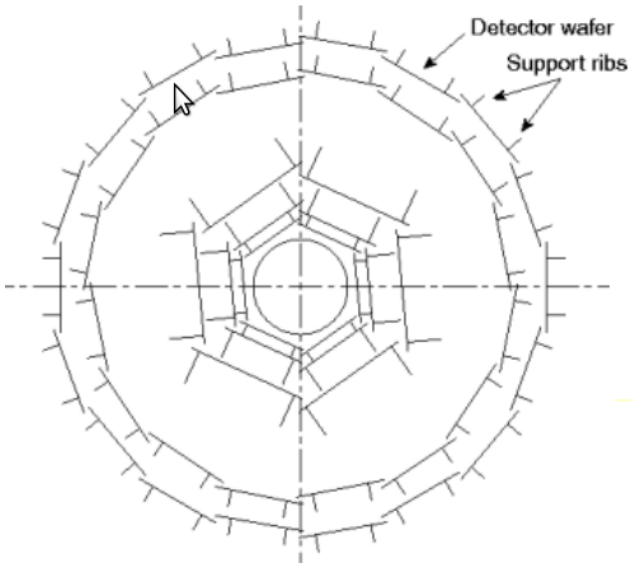
Layers

SuperB SVT is build with:

- Five layers of silicon strips, which design comes from Babar.
- Additional Layer0.

SVT Layer 1-5





- Five layers(1-5) of double sided silicon strip detectors.
- Radius between $3 - 15cm$.

MC studies showed that this solution meets with higher background conditions expected in SuperB.

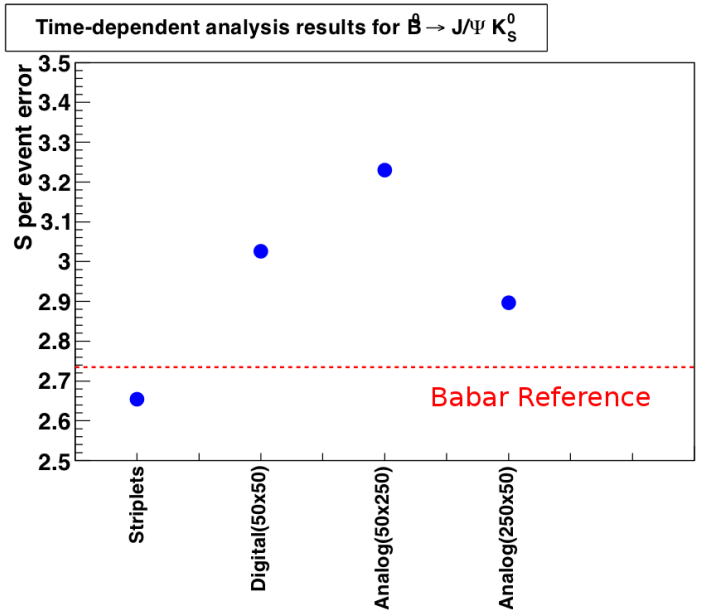
Physics requirement

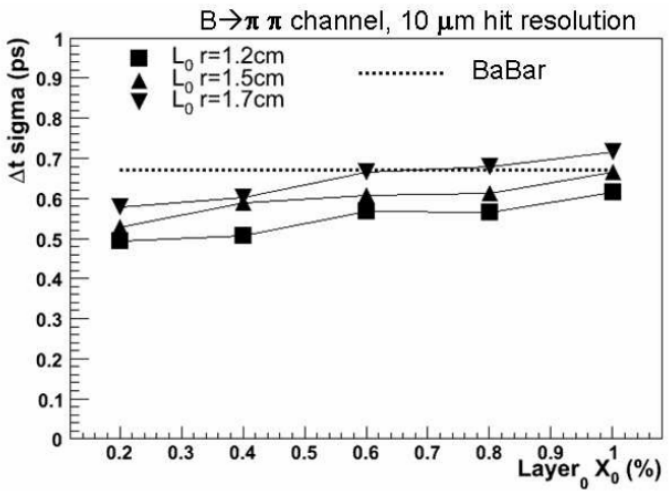
1. SVT together with drift chamber (DCH) and magnet provide track and vertex reconsturction
2. For low energetic particles SVT must provide the complete track information.
3. SVT must provide the same precision of time dependend CP violation as Babar detector with boost lowered from $\alpha\beta = 0.55$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

Layer0

To meet the requirements mentioned an additional 6th layer was introduced (Layer 0). Aspects that are beeing taken in projecting Layer0:

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



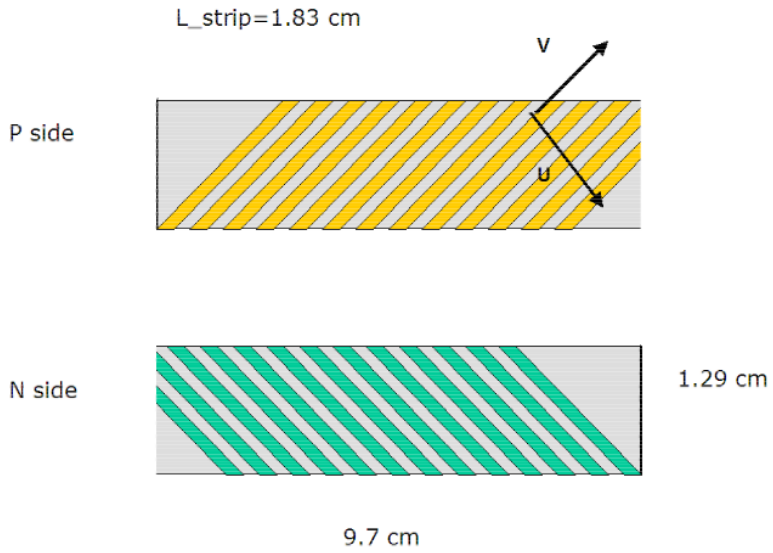


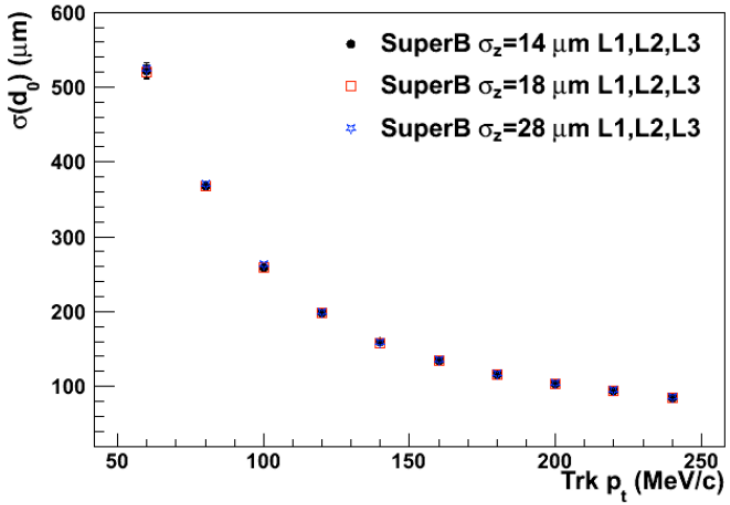
List of optons

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

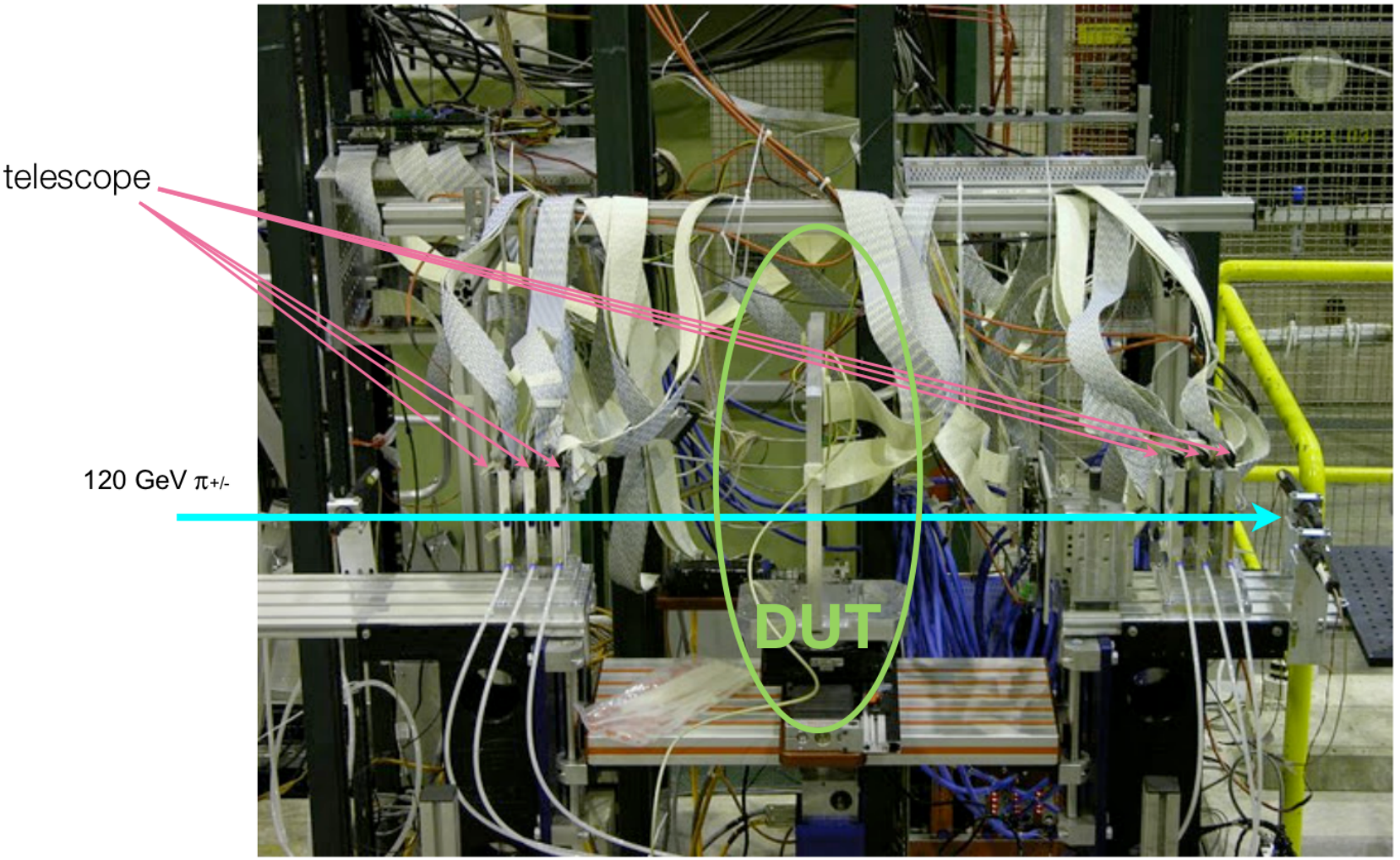
Striplets

- $200\mu m$ 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: $6.37 \frac{MHz}{cm^2}$





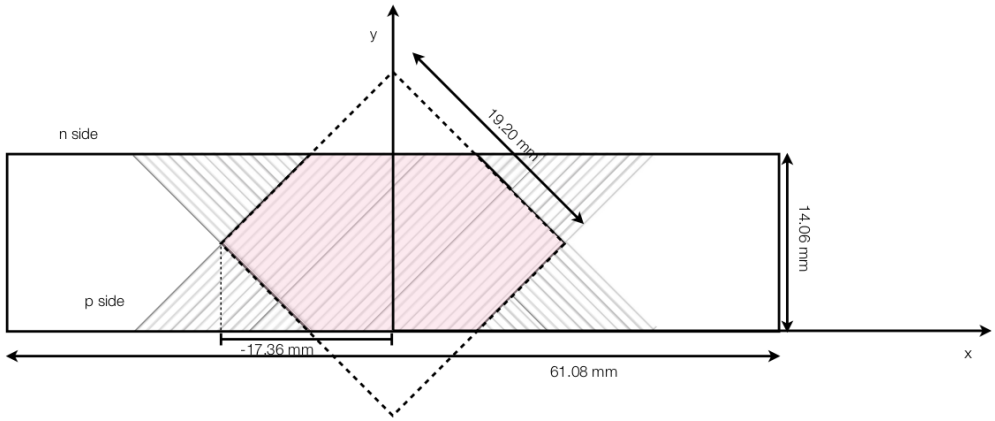
Test Beam

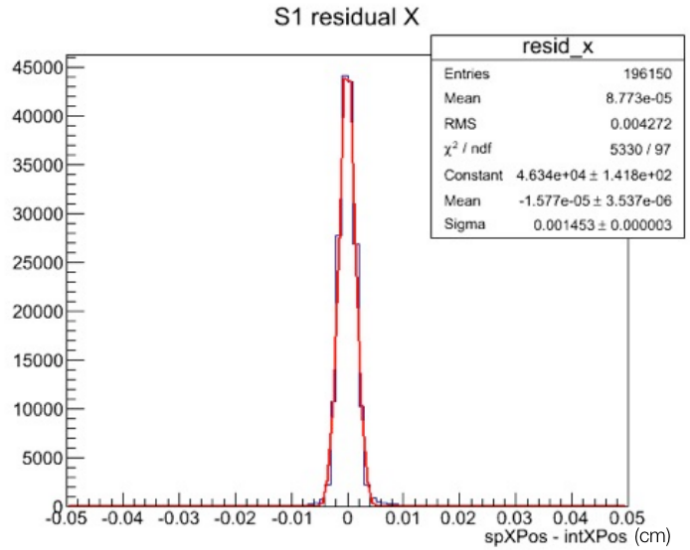


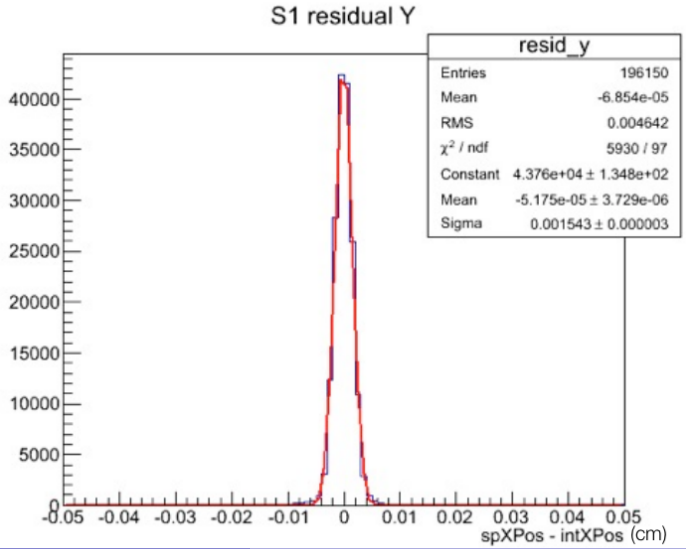
Test Beam

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)
3. Thresholds = 20 or 15.

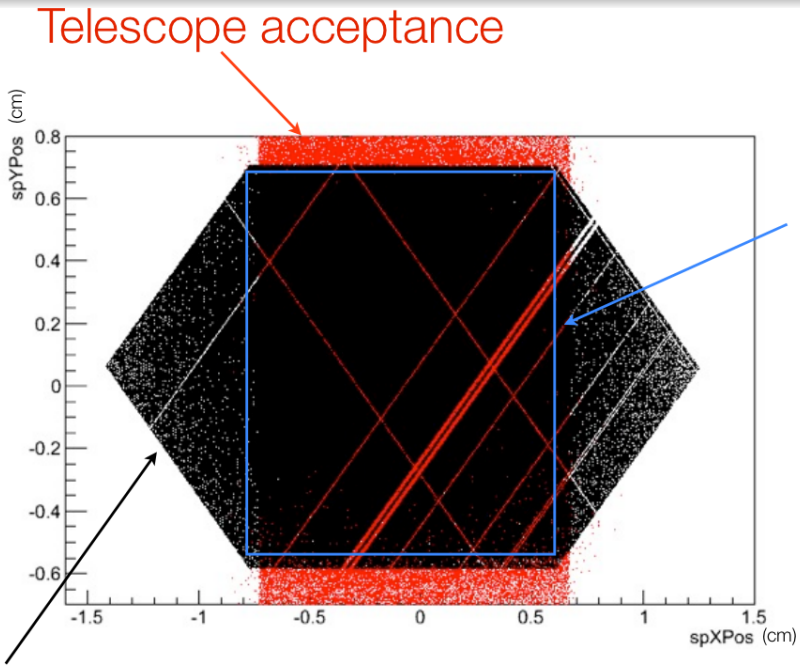




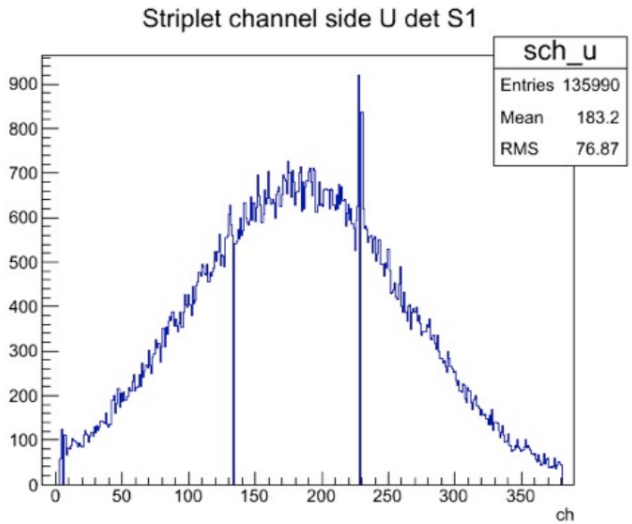


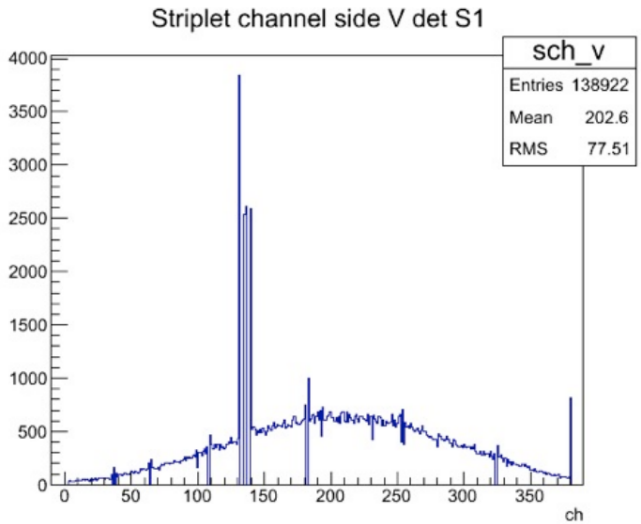
Procedure:

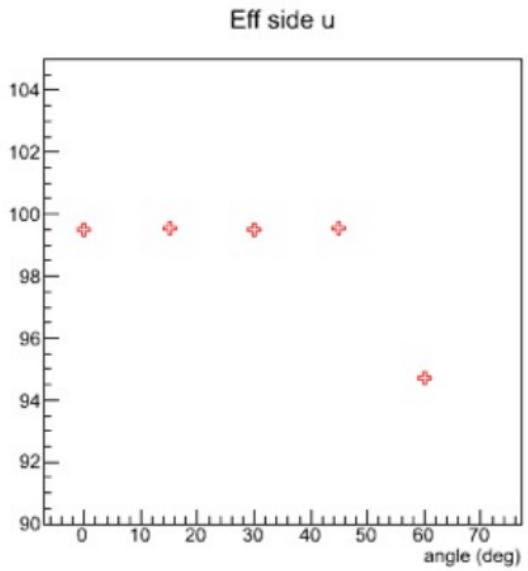
- Alignment done by minimizing residuals, on telescope and DUT.
- Cut on the residual: $56\mu m$ and fiducial cut.

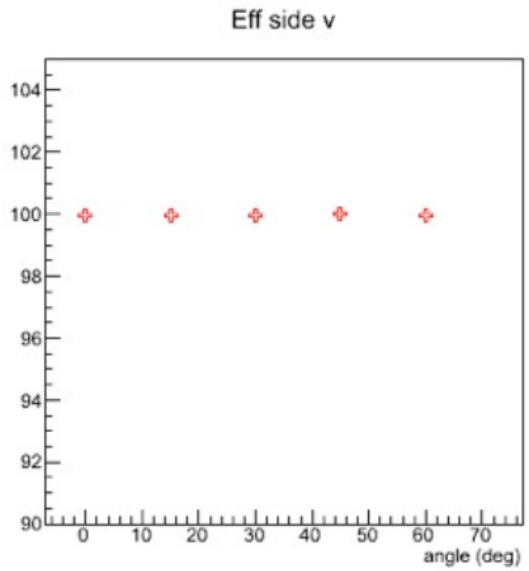


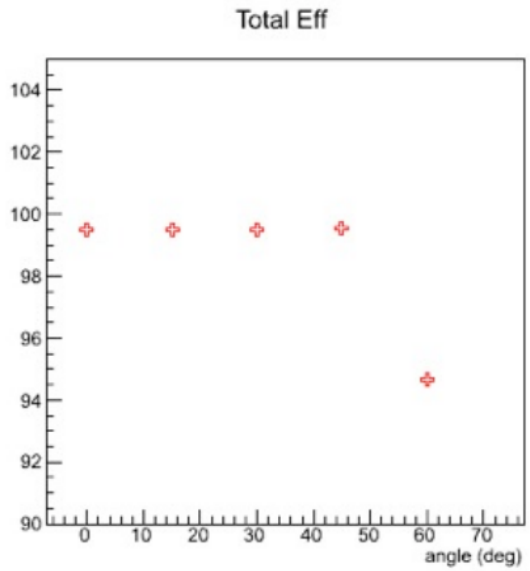
- Inactive strips not taken into account in the analysis











$$\varepsilon_u = \frac{n_{clusters}|spUPos - intUPos| < 56\mu m}{n_{int} \subset activeUregion}$$

$$\varepsilon = \frac{n_{clusters}|spUPos - intUPos| < 56\mu m \wedge n_{clusters}|spvPos - intVPos| < 56\mu m}{n_{int} \subset activeUandVregion}$$

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$\frac{mV}{fC}$.

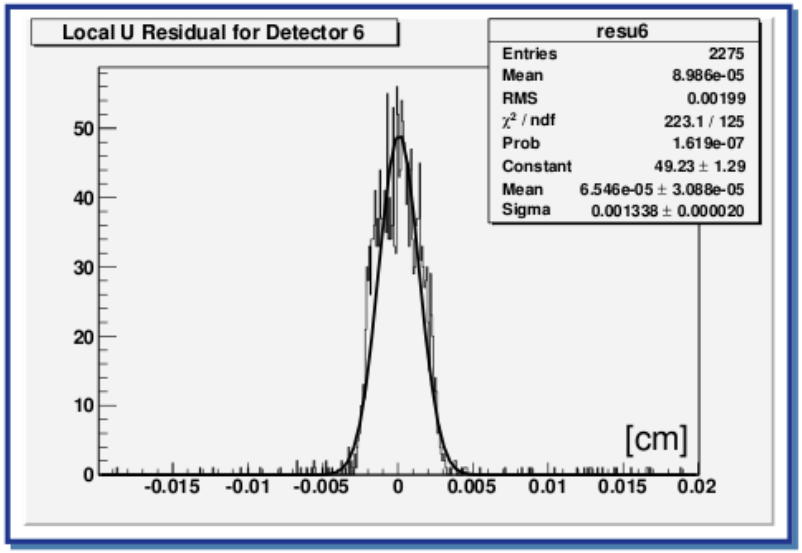
Hybrid Pixels Test Beam Notes

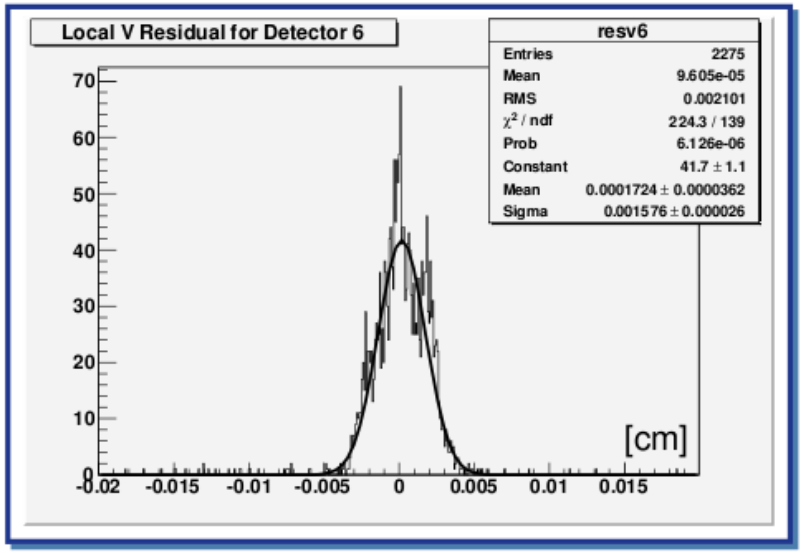
Work done by:

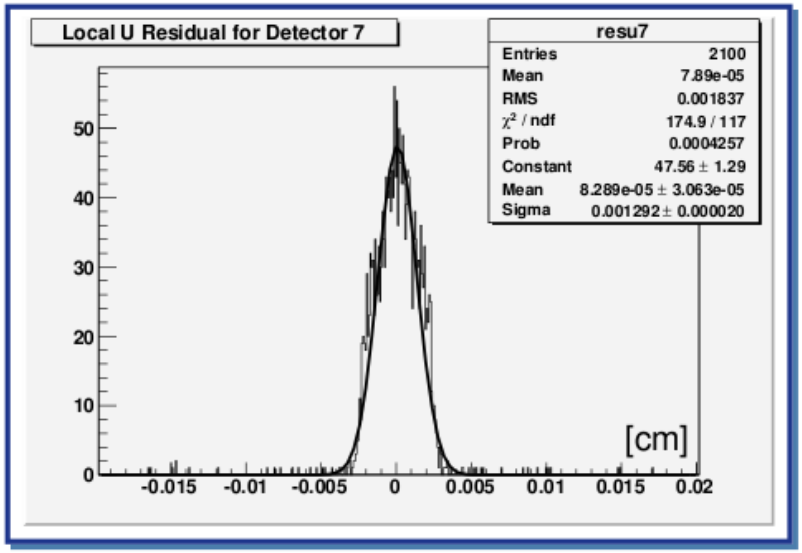
A.Lusiani, M.Chrzaszcz, Nicola Neri, Benjamin Oberhof, Antonio Paladino.

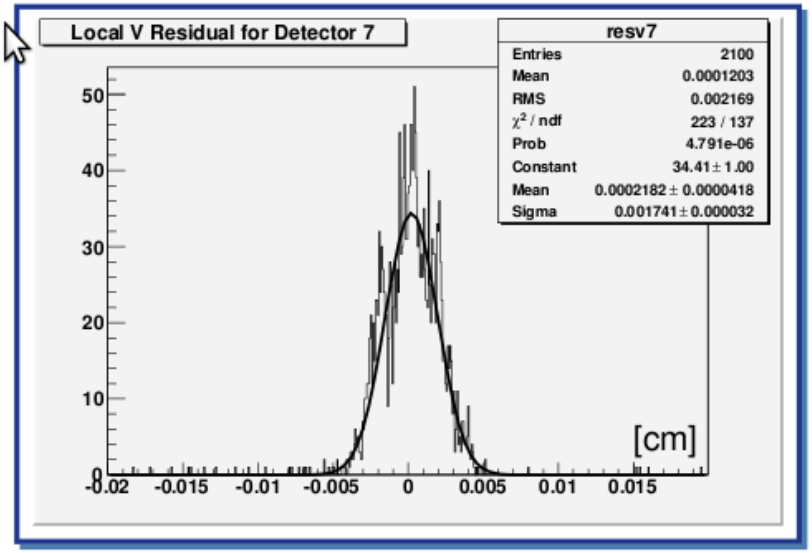
- Several thresholds, reference threshold 1/4 of a m.i.p. at normal incidence.
- Data took with 3 chips: $12, 53, 55$.
- DUT rotated around at $0^o, 15^o, 30^o, 45^o, 60^o, 70^o$.
- 128 pixels along x (horizontal, u-axis), 32 pixels along y (vertical, v -axis).
- approximately parallel tracks, high momentum,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

Hybrid Pixels Test Beam Results

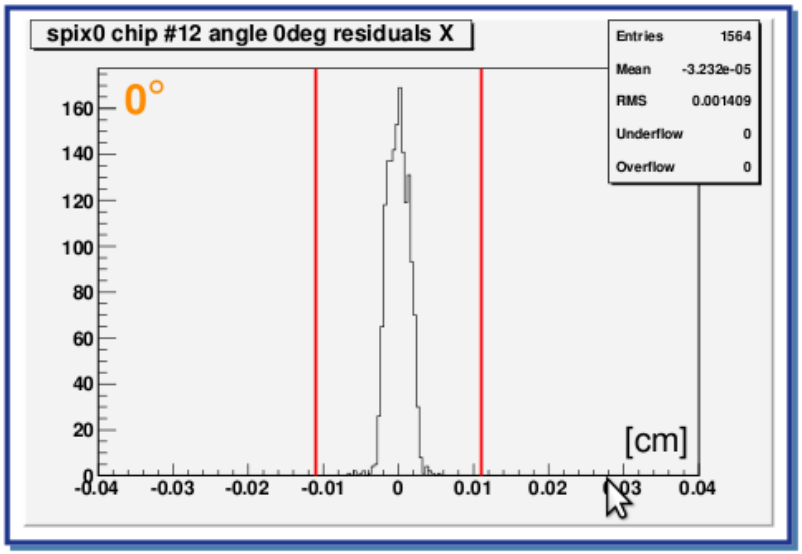


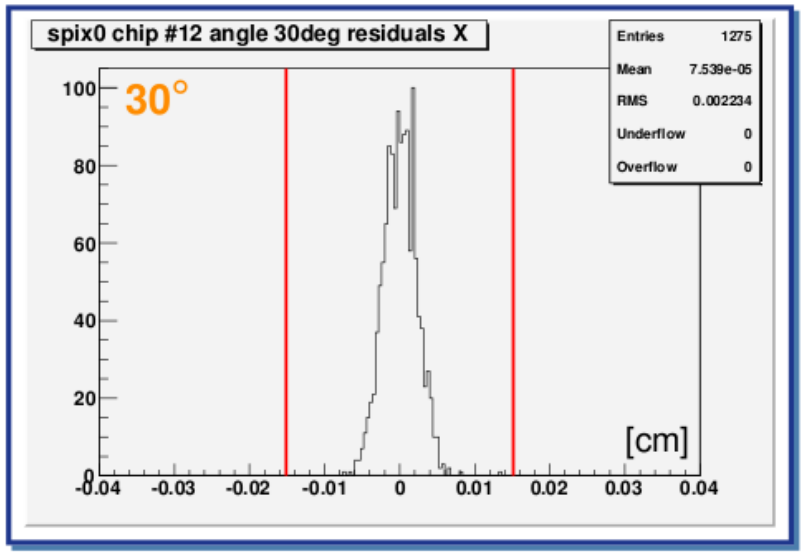


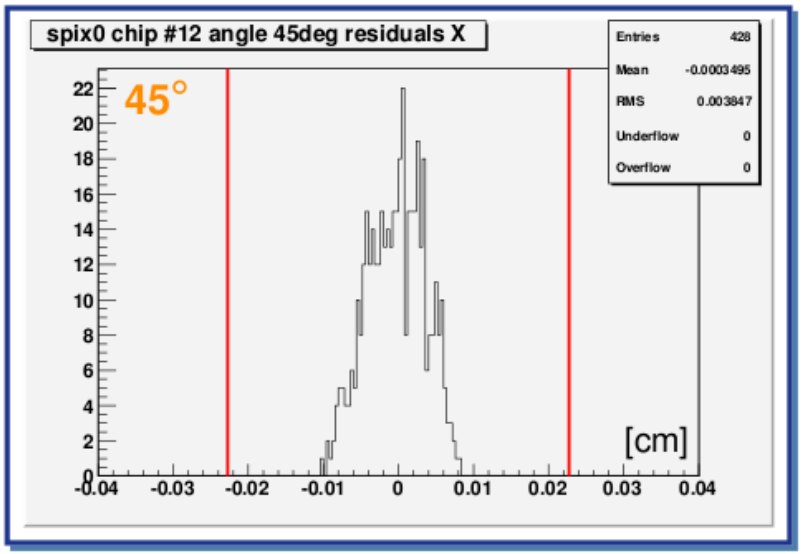


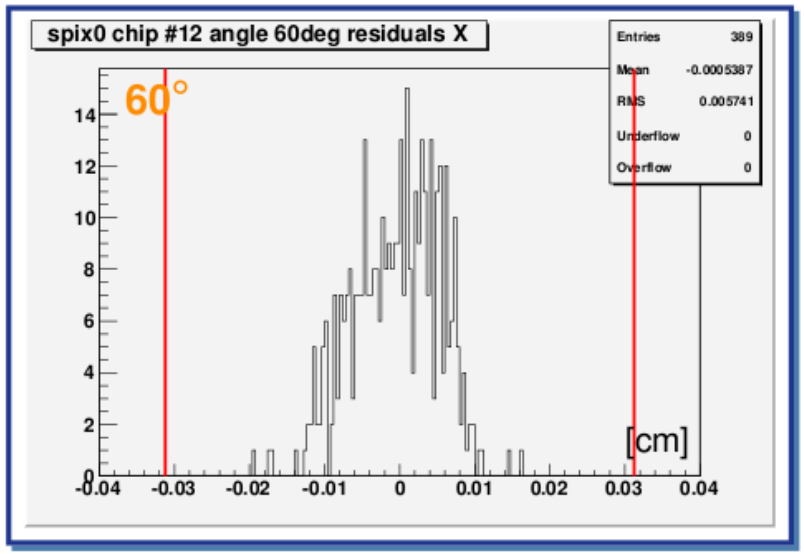


Hybrid Pixels Test Beam Results



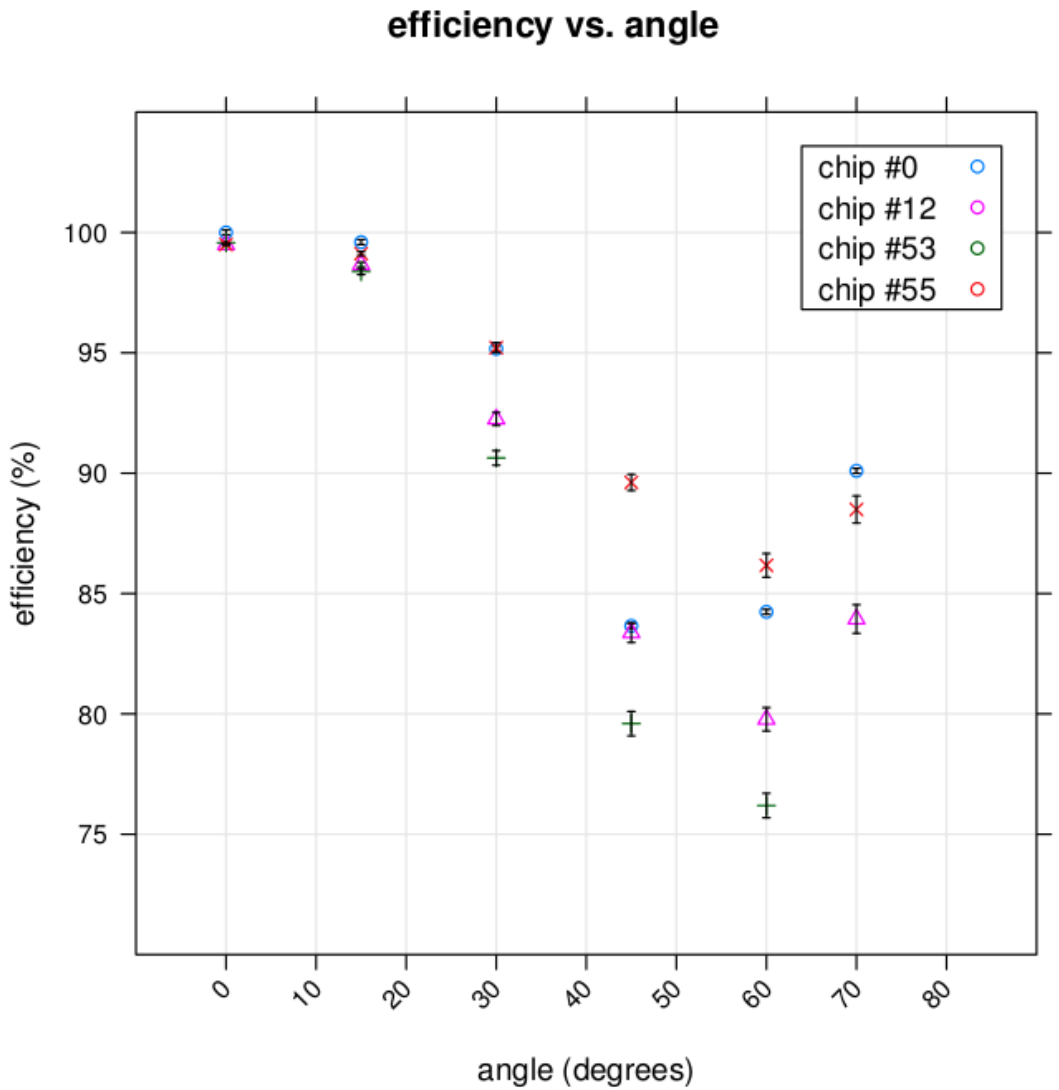






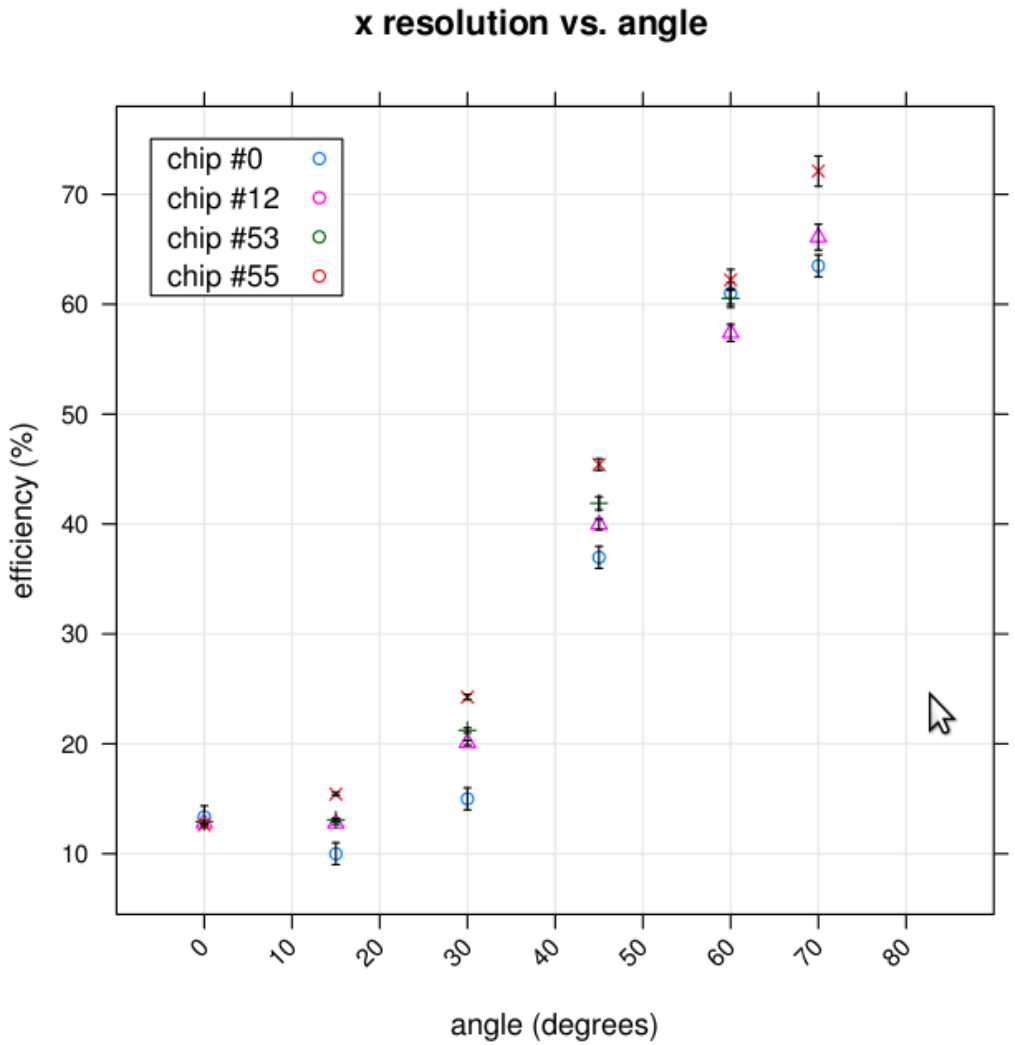
Hybrid Pixels Test Beam Results

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

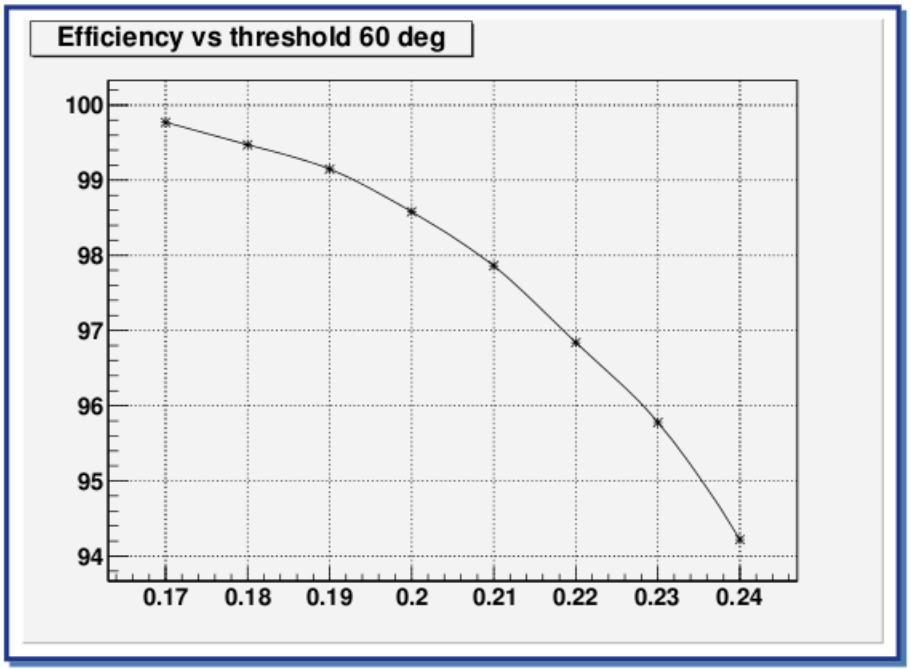


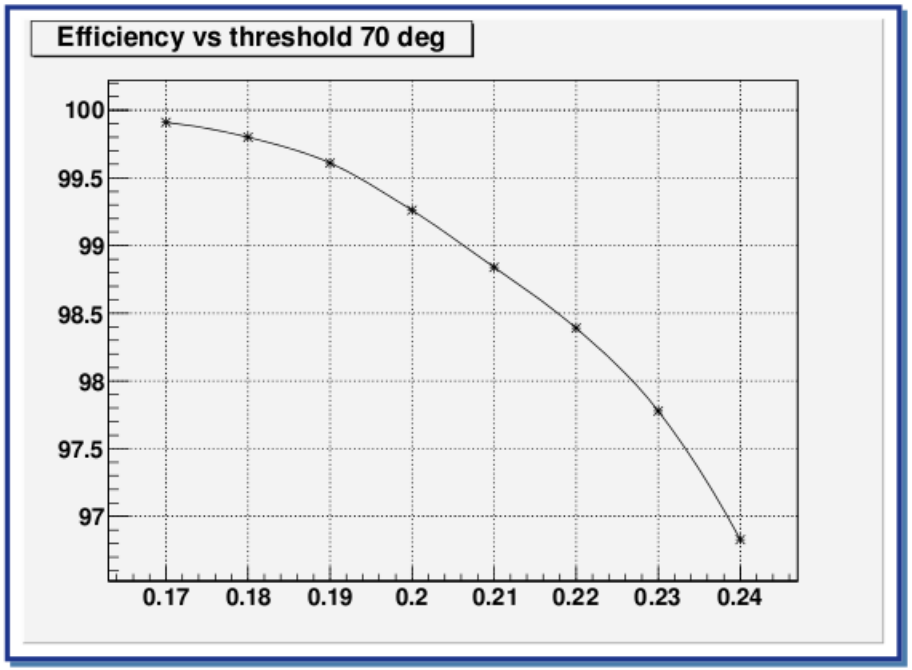
Hybrid Pixels Test Beam Results

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



Threshold Simulations



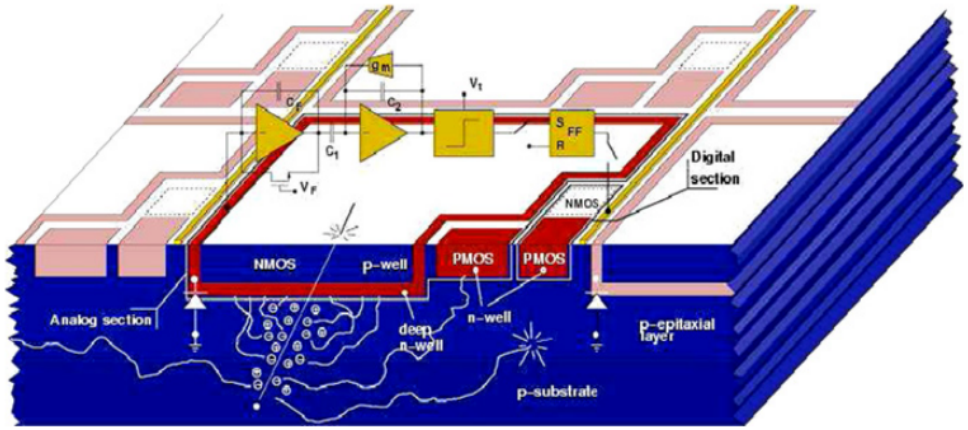


Conclusion

Next Test Beam will be done with lower threshold.

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.

Sum up

- SVT for SuperB will be equipped with more layers to overcome lower boost.
- Stripplets are the most propable solution for the Layer0.
- RD still needed.
- In the TDR(Feb 2012) both options will be presented. Final decision will follow after.