Beam test results for the SuperB SVT thin striplet detector

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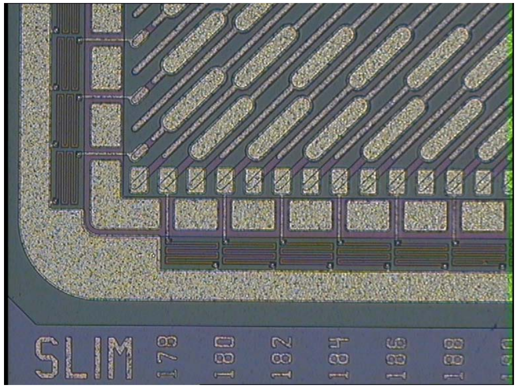
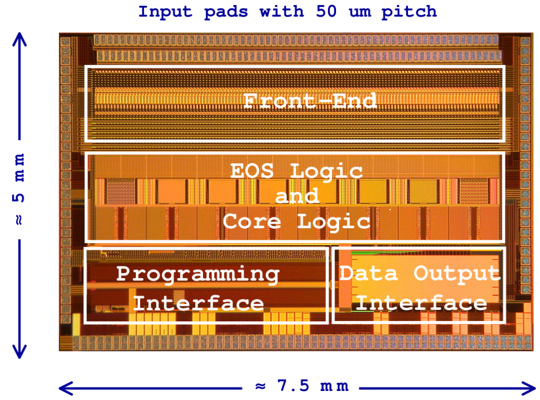
on behalf of SuperB SVT Collaboration



Outline



- The Silicon Vertex Tracker in SuperB
- The Setup of 2011 September Beam Test at Cern
- The Analysis Results: Efficiencies, Cluster Size and Spatial Resolution

Super B Silicon Vertex Tracker

- The SuperB is expected to deliver luminosity of 10^{36} cm^{-2} s^{-1} with a reduced beams asymmetry with respect to previous B-Factories

- This forces the SuperB detector to improve on typical vertex resolution, with a first layer very close (about 1.5 cm) to the beam (Layer0)

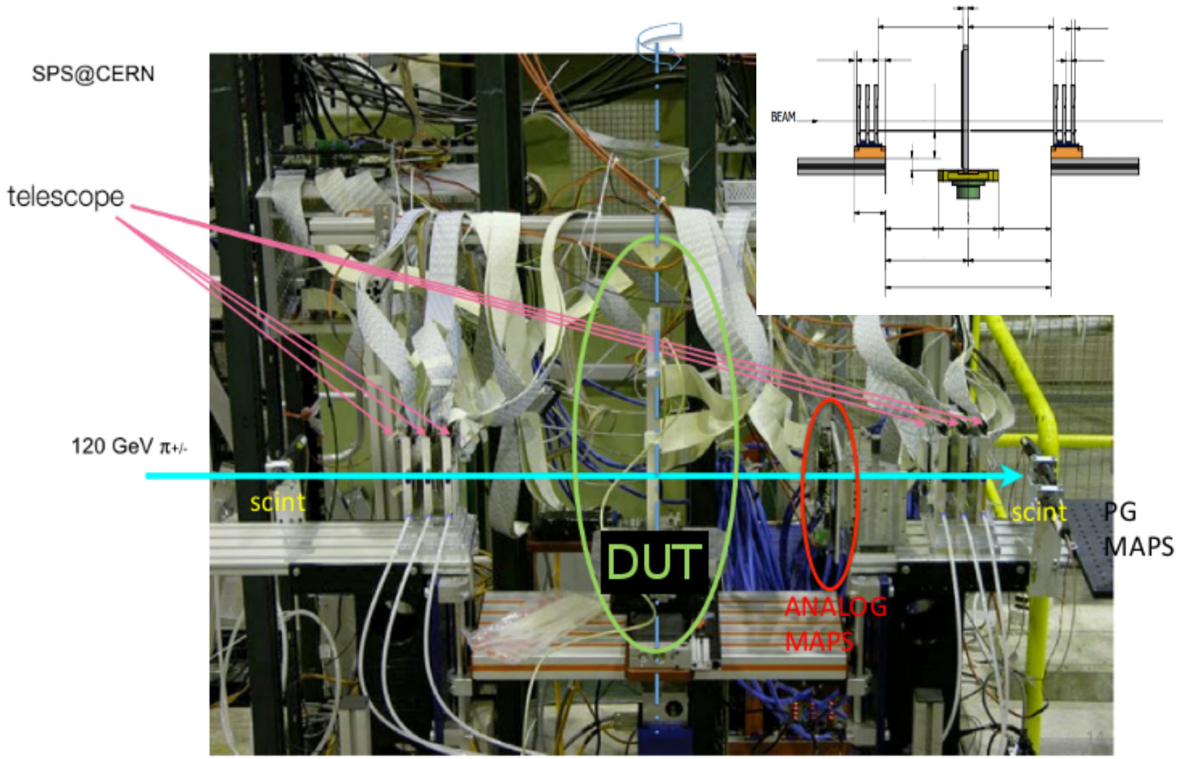
- The baseline option for the Layer0 will be a high resistivity sensor, with a thin silicon substrate (200 μm) and short (20 mm) double-sided strips (”Striplets”) at ± 45° angle to the detector's edge.

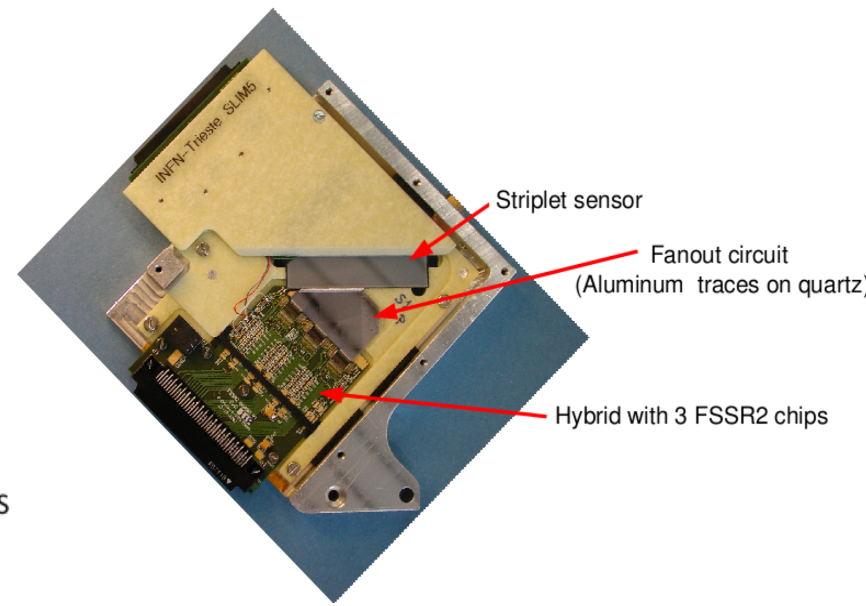
- Futhermore a good spatial resolution at angle up to 70° is an additional requirement

Test Beam

In September 2011 the SuperB collaboration submitted a striplets prototype to test the performance at different incident angle with 120 GeV/c pions' beam, at the SPS-H6 test-beam line at CERN.

The same prototype, with the same readout (data-driven FSSR2 chip), was already tested in a previous test beam in September 2008.





Active area 27 x 12.9 mm^2

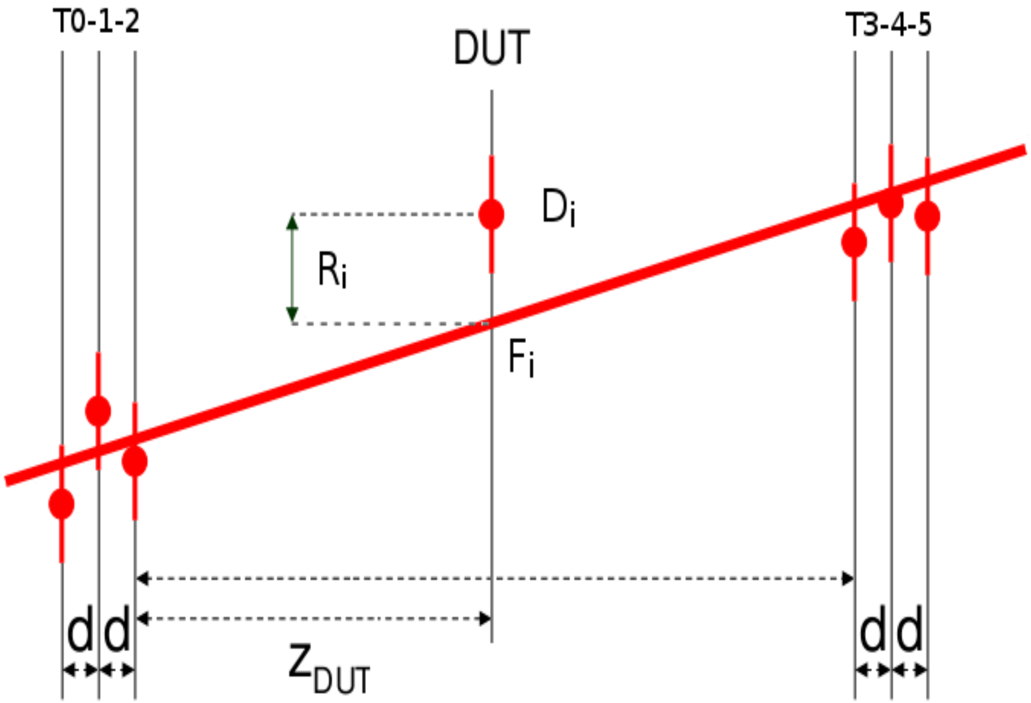
Test Beam: Setup

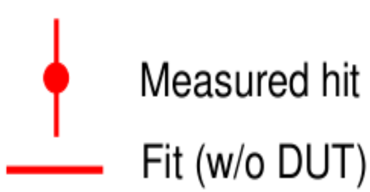
In the previous test beam first thresholds (hit, no-hit) were conservatively set to a rather high value ~ 4400 (6300) e-, ~ 27 (40)% MIP, respectively for p(n) striplets sides, causing a drop of efficiency in the full cluster measurement at large angles.

Now the threshold was set to ~ 3300 (4800) e-, ~ 20 (30)% MIP , respectively for p(n) striplets sides (at normal incidence 1 MIP is ~ 16000 e- in 200 μm).

Moreover the relative low beam energy (12 GeV) produced a larger multiple scattering than in September 2011 test beam.

Analysis results: Residual & Efficency

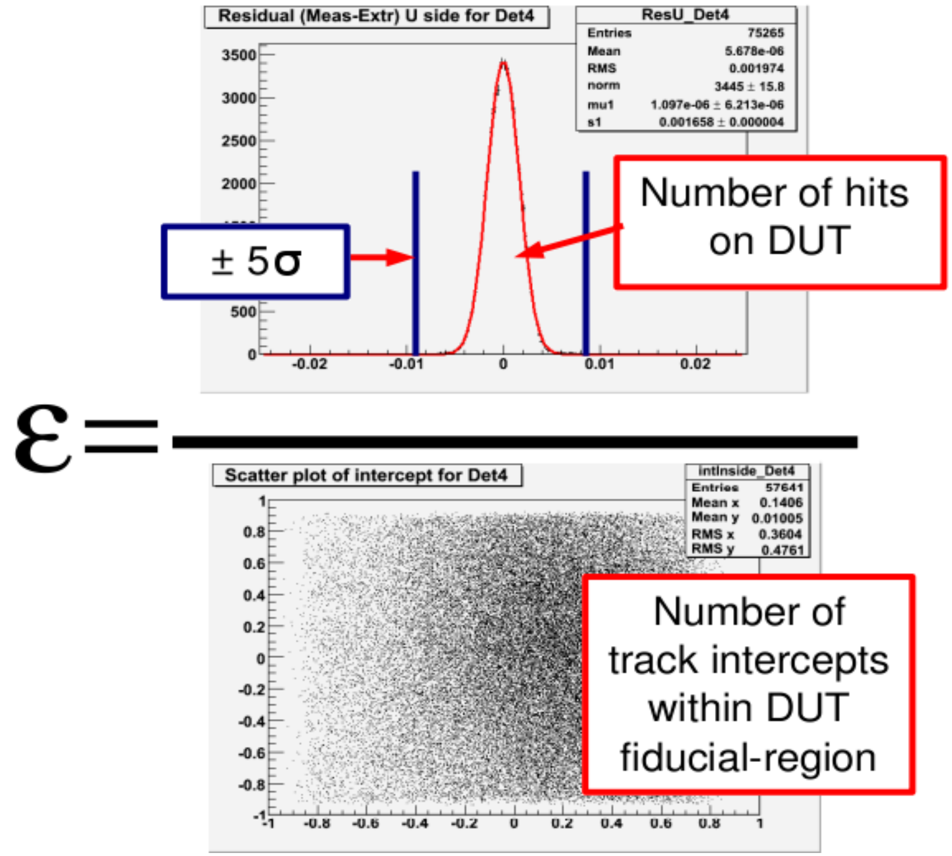




Ri = Residual associated with i-hit on DUT

Fi = Geometrical point obtained from telescope hits fit

Di = i-hit on DUT



We cut at 80 μm/cosϑ (~5σ) on residuals

Results from different runs are consistent within 0.2%. Both for low and high threshold an efficiency better than 99.4% is measured.

Efficiencies (%) within 80/cosϑ vs incident angle

Incident angle	Eff_P Low thr.	Eff_P High thr.	Eff_N Low thr.	Eff_N High thr.
0	99.5	99.4	99.5	99.3
15	99.4	99.4	99.4	99.4
30	99.6	99.5	99.6	99.4
45	99.6	99.7	99.6	99.3
60	99.6	99.8	99.6	99.3
70	99.8	99.9	99.8	99.7

Resolution from Residuals

The resolution of the DUT can be estimated from the residual distribution:

$$\sigma^2_{resolution} = \sigma^2_{residual} - \sigma^2_{extr\text{-}track} - \sigma^2_{MS\ on\ DUT}$$

Residual on DUT = measured pos. – extrapolated pos.

depends on $(z_{DUT}, reso_T, MS_T)$

With:
σ MS ~ 1 μm
σ extr-track ~ 7 μm

To estimate the sigma residuals several fits were tried.

The best results were given by 5 Gauss + Const:

Core Gauss 3 free parameters (Ntot, Mean, Sigma)

2 Gauss +-25μm 1 free parameter (same Mean, Sigma as Core)

2 Gauss +-50μm 1 free parameter (same Mean, Sigma as Core)

Resolution from Telescope

The extrapolated track resolution on the DUT can be estimated from the telescope resolution using this formula:

$$\sigma^2_{extr\text{-}track} = \frac{1}{2}\left(\frac{\sigma^2_{x\text{-}track}}{Cos(\vartheta)} + \sigma^2_{y\text{-}track}\right)$$

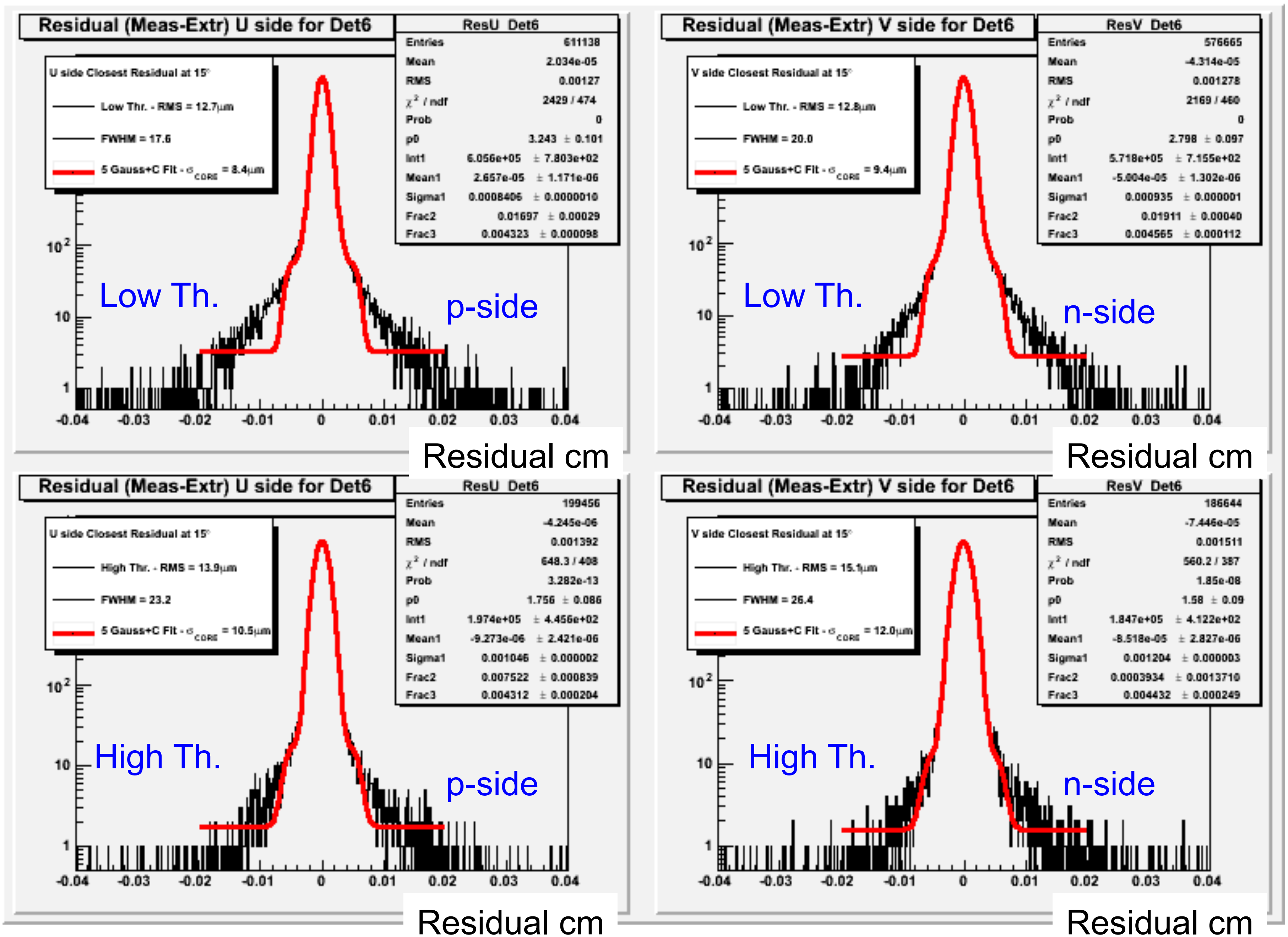
With:

$\sigma_{x\text{-}track}$ the resolution in x of telescope extrapolated track

$\sigma_{y\text{-}track}$ the resolution in y of telescope extrapolated track

ϑ the DUT rotation angle

15˚ - 5Gauss Fit of Residuals



Resolutions Residual vs incident angle Sigma CORE Low Threshold

Incident angle	Resolutions P Low thr. σ_{mis} (µm)	Resolutions P Low thr. σ_{cal} (µm)	Resolutions N Low thr. σ_{mis} (µm)	Resolutions N Low thr. σ_{cal} (µm)
0	11.6	9.2	12.1	9.8
15	8.5	4.5	9.5	6.2
30	9.7	6.2	10.7	7.7
45	13.0	10.1	13.8	11.2
60	16.7	13.5	16.8	13.6
70	25.2	21.7	31.5	28.7

Resolutions Residual vs incident angle
Sigma CORE High Threshold

Incident angle	Resolutions P High thr. σ_{mis} (μm)	Resolutions P High thr. σ_{cal} (μm)	Resolutions N High thr. σ_{mis} (μm)	Resolutions N High thr. σ_{cal} (μm)
0	12.9	10.7	13.4	11.3
15	10.5	7.7	12.0	9.6
30	10.4	7.3	11.0	8.1
45	12.6	9.7	13.8	11.2
60	17.0	13.9	18.9	16.2
70	31.9	29.2	34.6	32.1