Striplet detectors in Slim5

Beam test results

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On behalf of Slim5 Collaboration

SuperB Workshop – Orsay, Paris – 15-18 Feb. '09

Outline

- Introduction
- Striplets
- Readout chip: FSSR2
- The beam test results
  - Noise, resolution & efficiency
- Conclusions

Summary

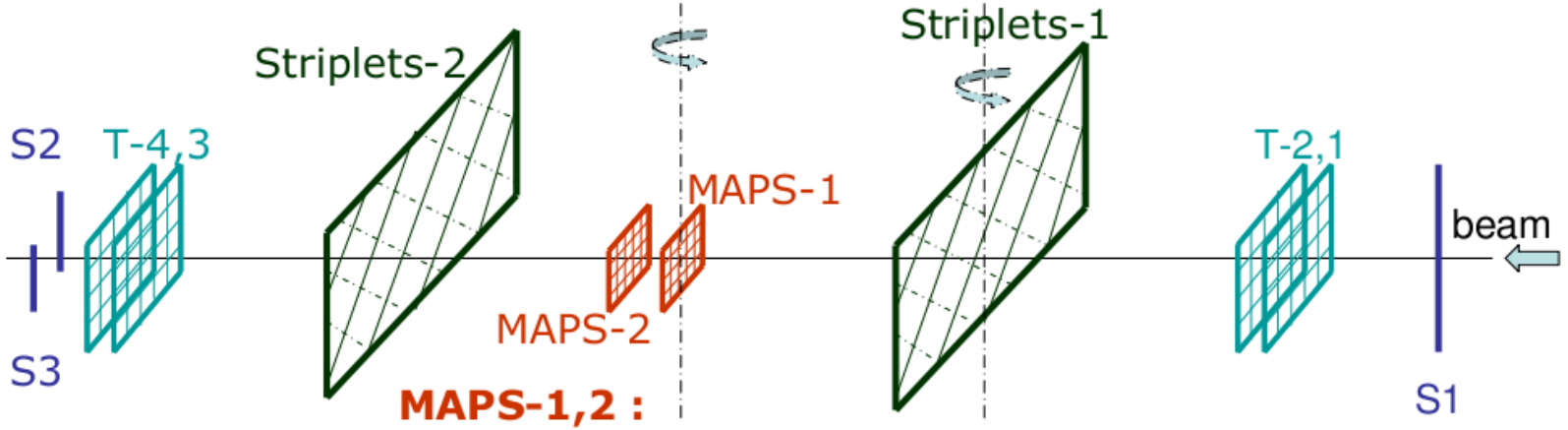
- Thin microstrip detectors with short strips (striplets) can be an option for the inner layers of SuperB-SVT
- A data-driven architecture was desired to read these sensors
- A mechanical support and a cooling system was built to test them on a beam @ Cern

Test Beam @ Cern

The "DEMONSTRATOR"

(conceptual)

S-1,2,3 scintillator (coinc. NIM/TTL output to the DAQ)



MAPS-1,2 :
active area ~10 mm²
Cell:50x50 μm² (300→100 μm-thick)

Reference telescope T-1,2,3,4:
area~2x2 cm²
DSSD 300 μm thick
25 p-side, 50 n-side mm pitch
50 μm r.o. pitch (3 chips FSSR2/side)

Striplets-1,2:
area 1.29x6.0 cm²
DSSD 200μm thick (∠45°)
25 p-side, 50 n-side μm pitch
50 μm r.o. pitch(3 chipsFSSR2)

Test Beam @ Cern

We will present features and results of striplet detectors

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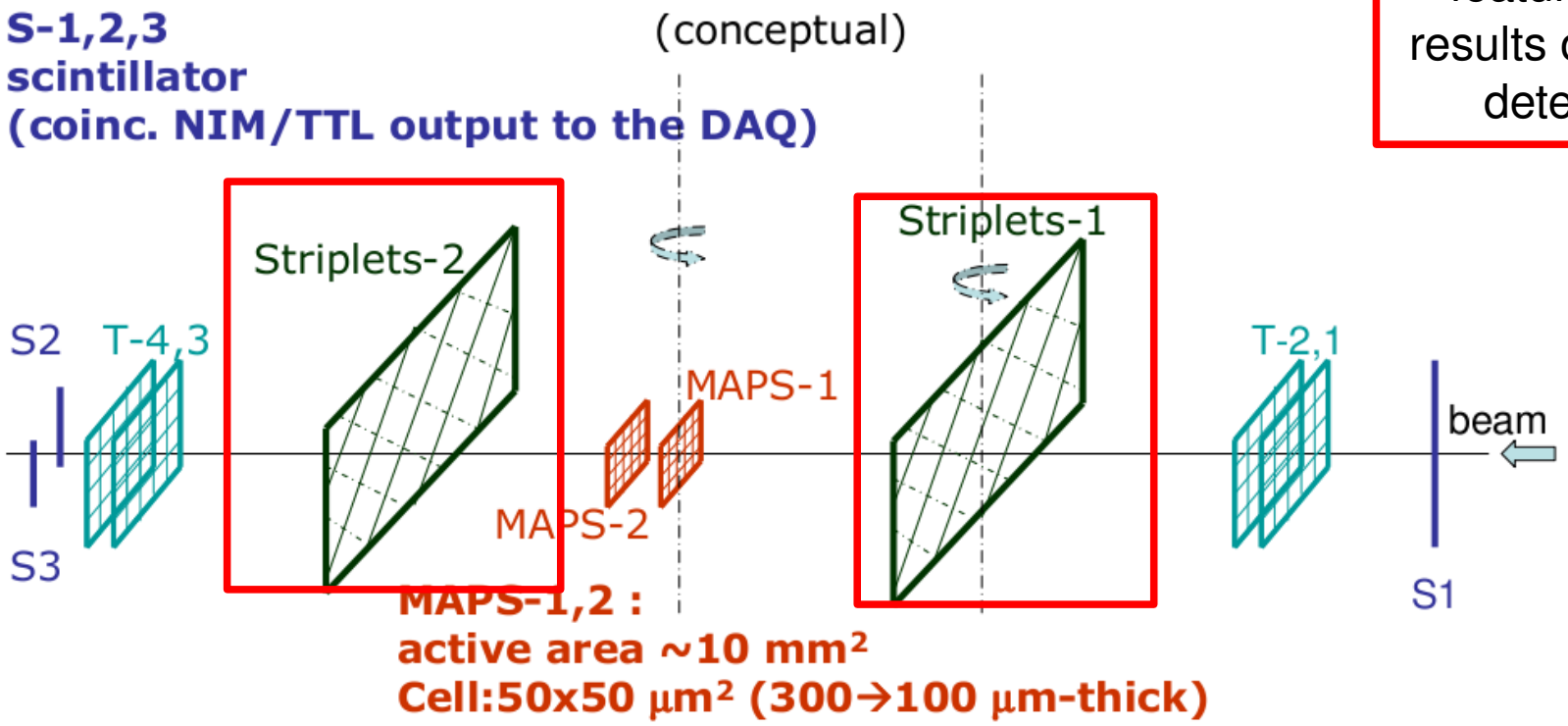

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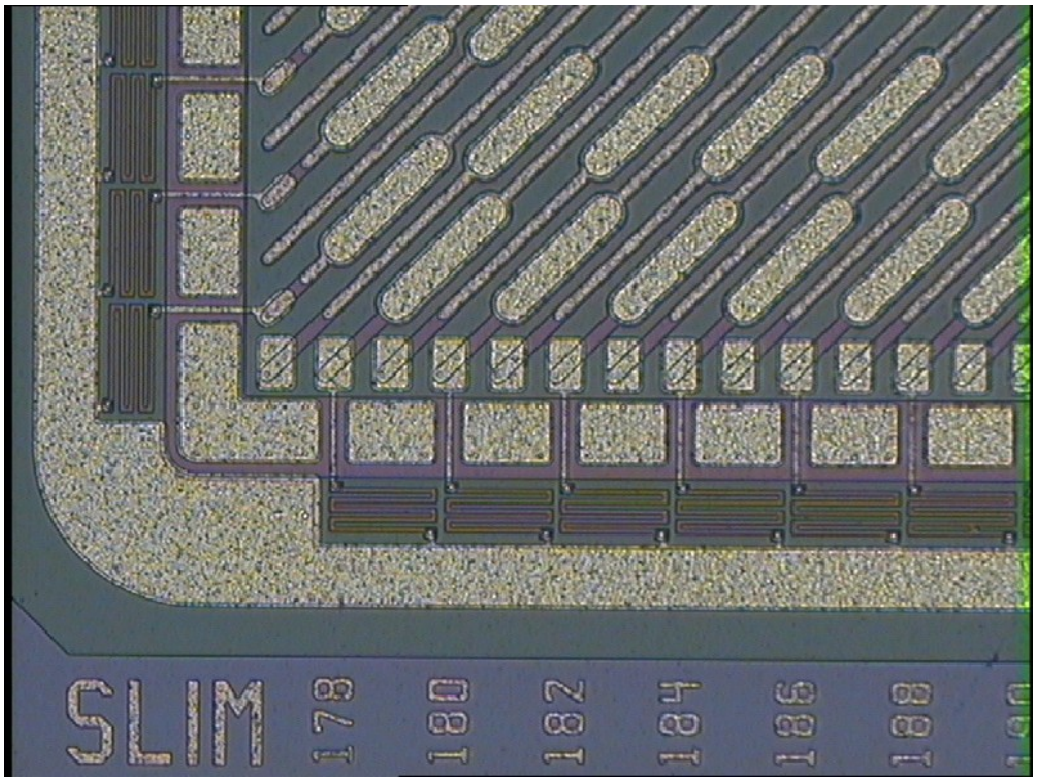
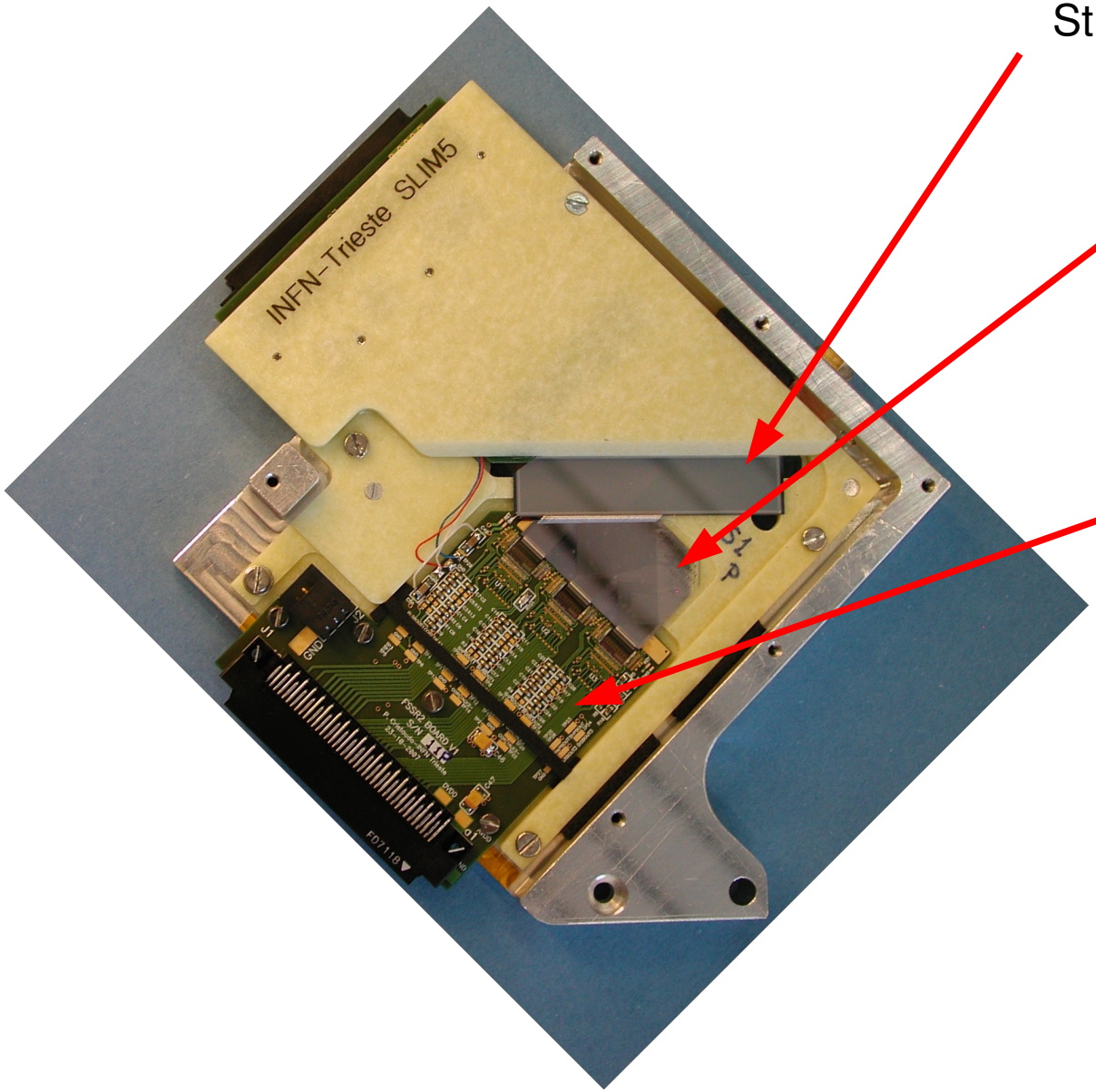
Striplets



- 200 µm-thick double-sided strip detector
  - ± 45° oriented strips
- Active area = 27 x 12.9 mm^2
- 50 µm pitch on p-side
- 50 µm pitch on n-side
- Strip capacitance ~ 4 pF

Assembled striplet module



Striplet sensor

Fanout circuit
(Aluminum traces on quartz)

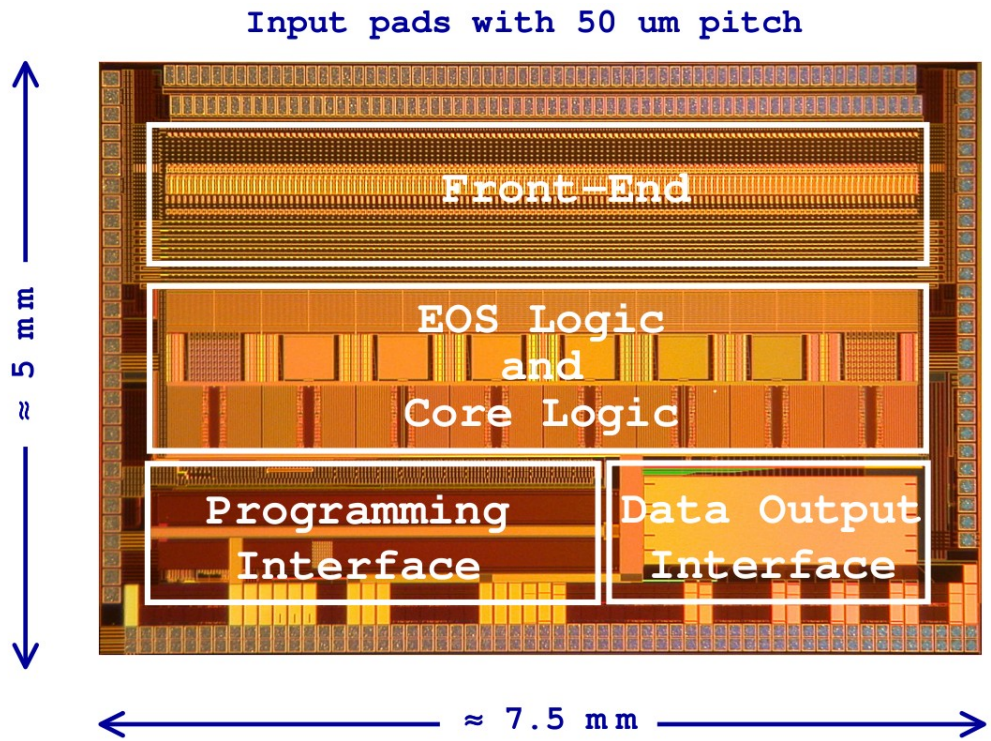
Hybrid with 3 FSSR2 chips

Fanout capacitance

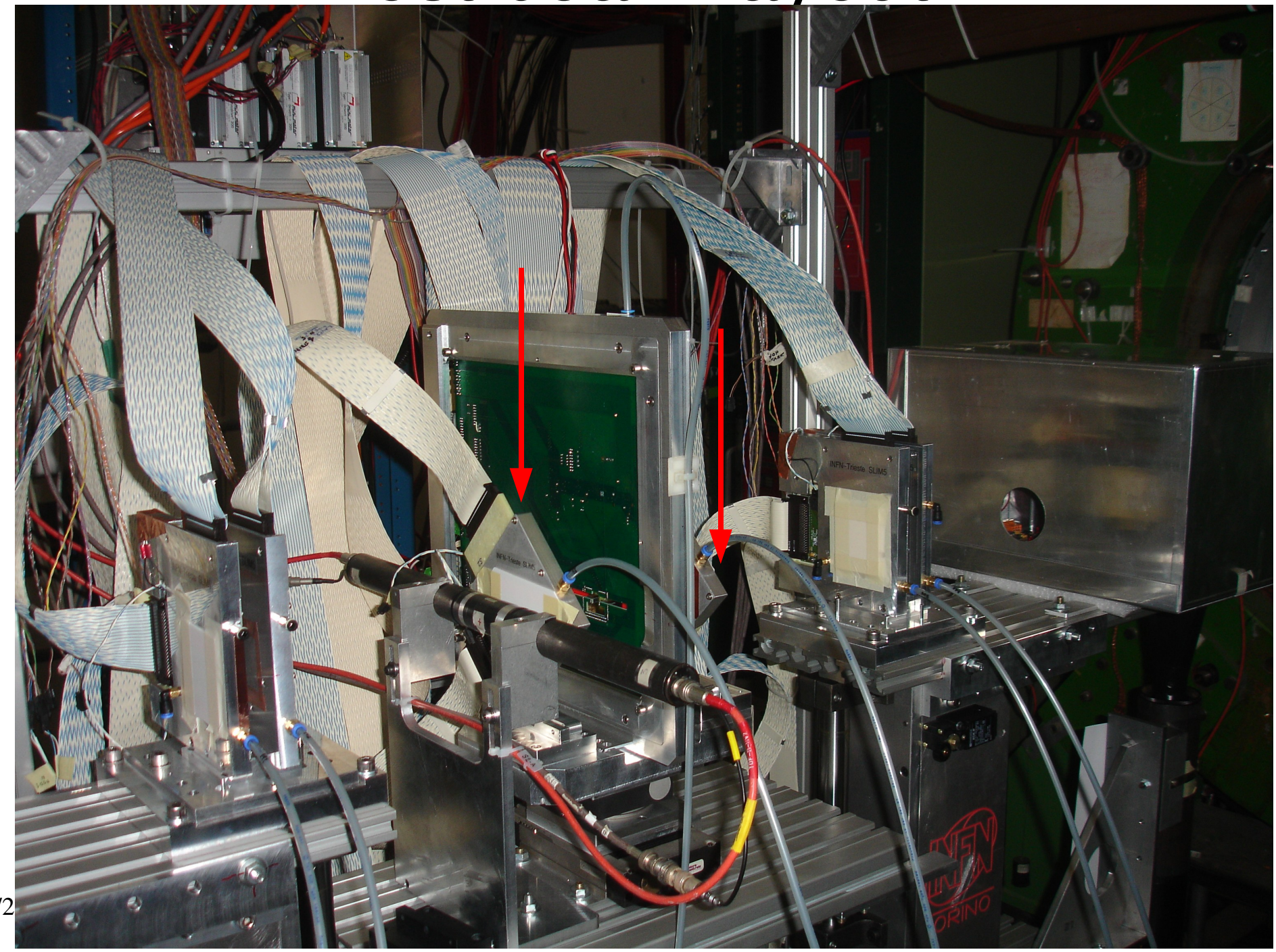
Chip	Channel	C (pF)
1	60	0,4
2	60	0,82
3	60	1,29

Readout chip: FSSR2

- Fermilab Silicon Strip Readout chip v2
- 128 analog channels, with address, time, and magnitude information for all hits
- Self-triggered readout architecture, with digital output
- Read out up to 70 MHz
  - Operated at 20 MHz

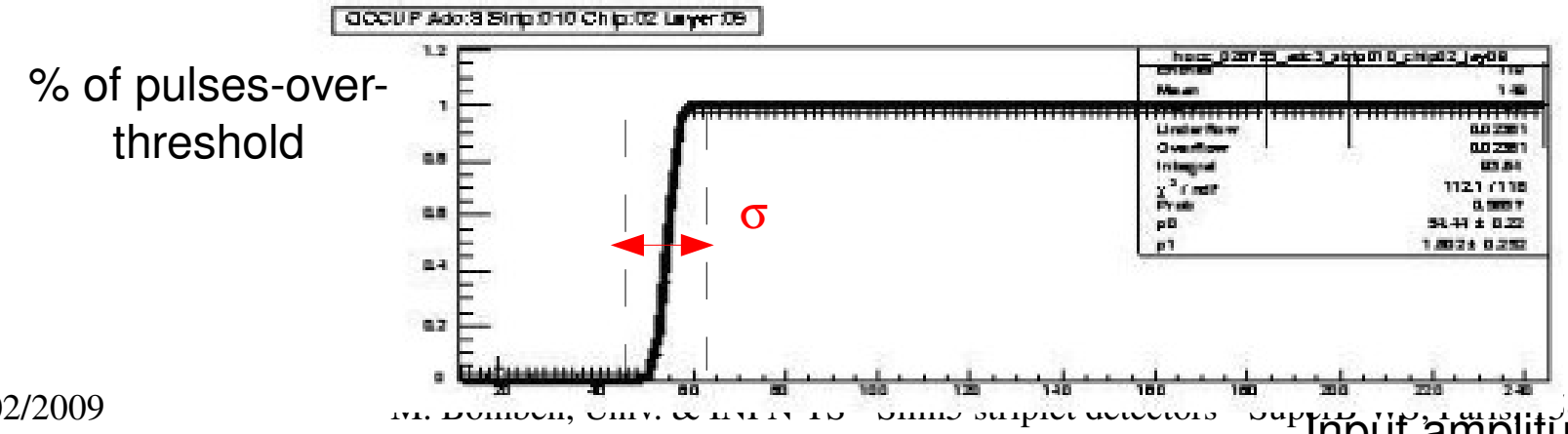


Test beam layout



Noise estimation

- Noise was estimated using FSSR2 internal-calibrator, during beam test
- At fixed threshold, input amplitude was increased, and fraction of pulses-over-threshold recorded
- The result is fitted with an erf function, where σ is the estimated noise

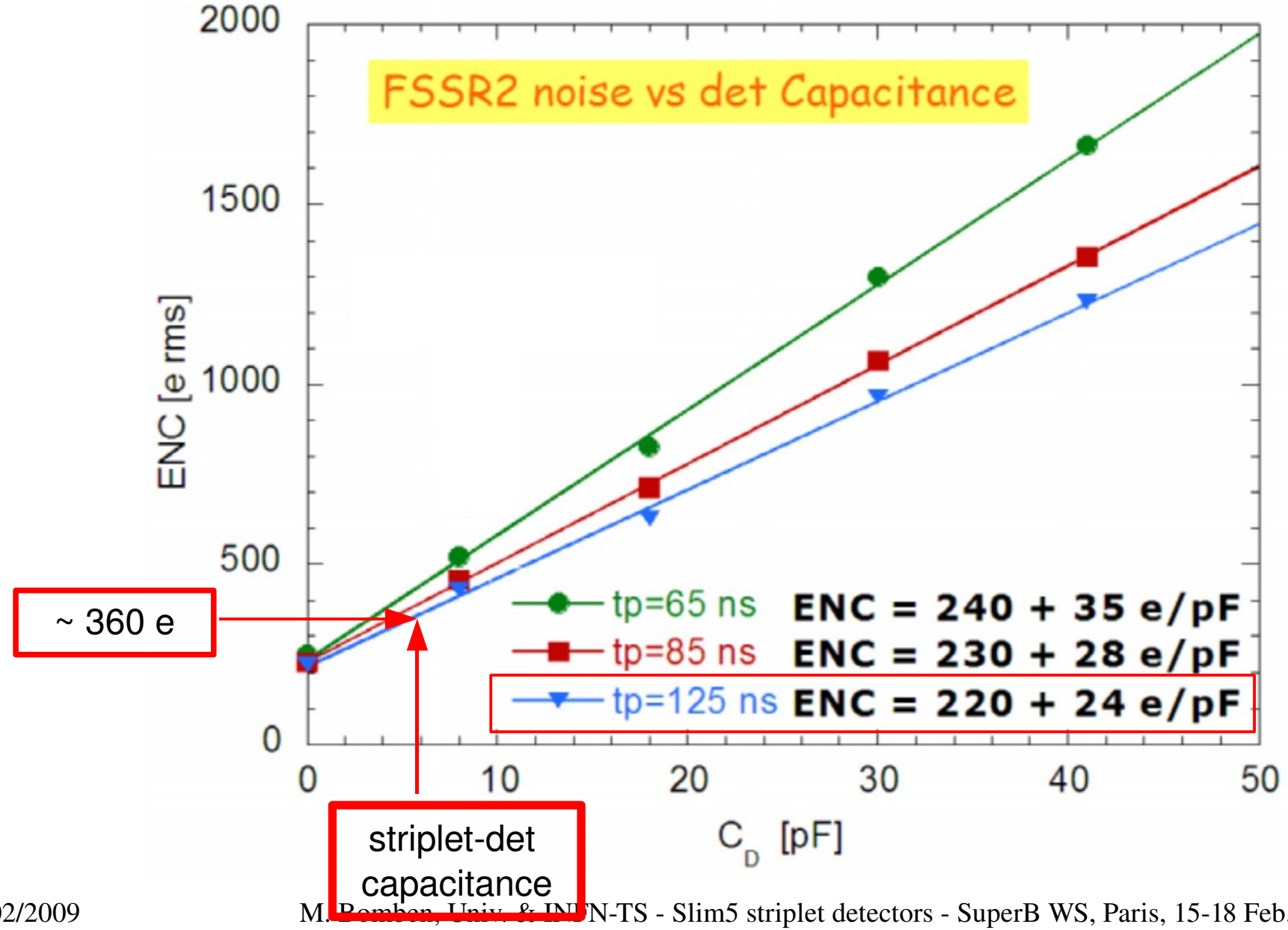


Noise from calibration

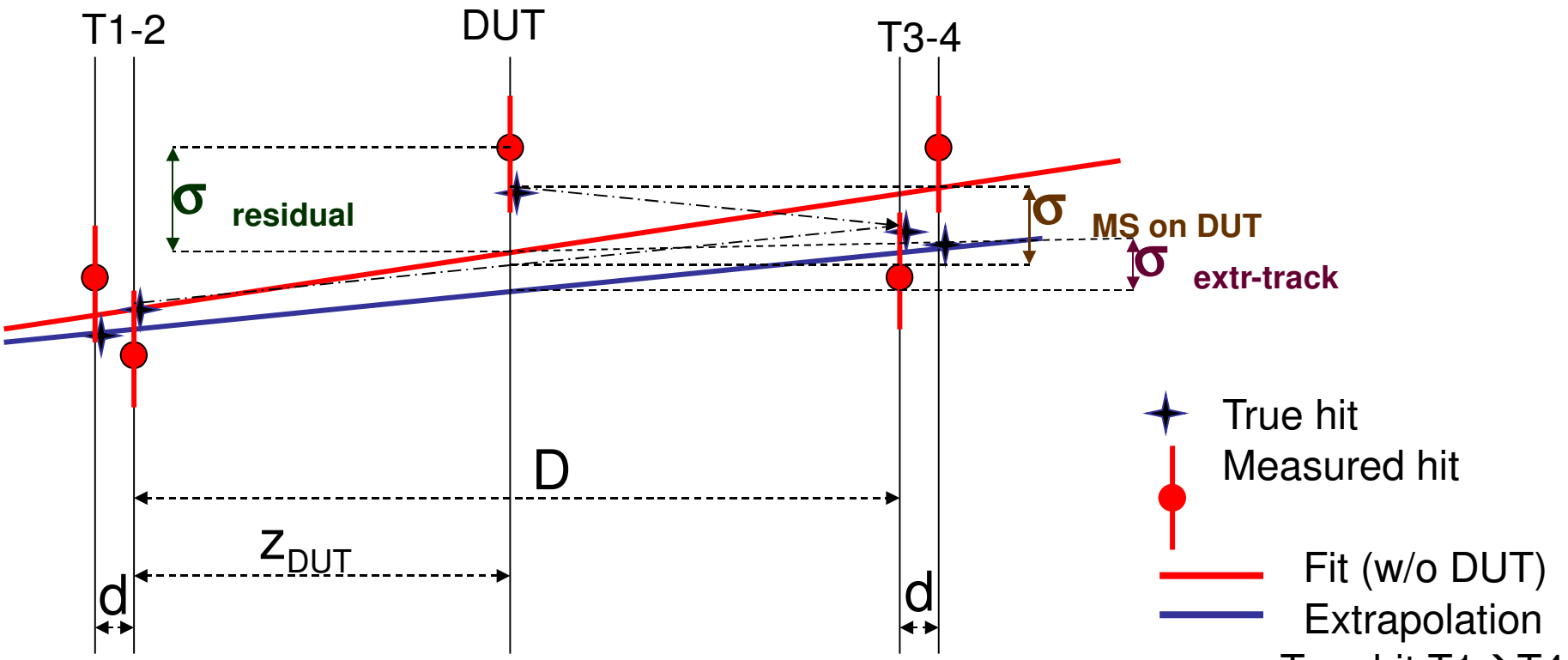
Noise evaluated using FSSR2 internal calibrator, during beam test

polarity	pos	neg
noise (enc)	630	1020
S/N	25	16

Comparison...


FSSR2 noise vs det Capacitance
ENC [e rms]
2000
1500
1000
500
0
0
10
20
30
40
50
C_D [pF]
tp=65 ns ENC = 240 + 35 e/pF
tp=85 ns ENC = 230 + 28 e/pF
tp=125 ns ENC = 220 + 24 e/pF
~ 360 e
striplet-det capacitance

Space point resolution

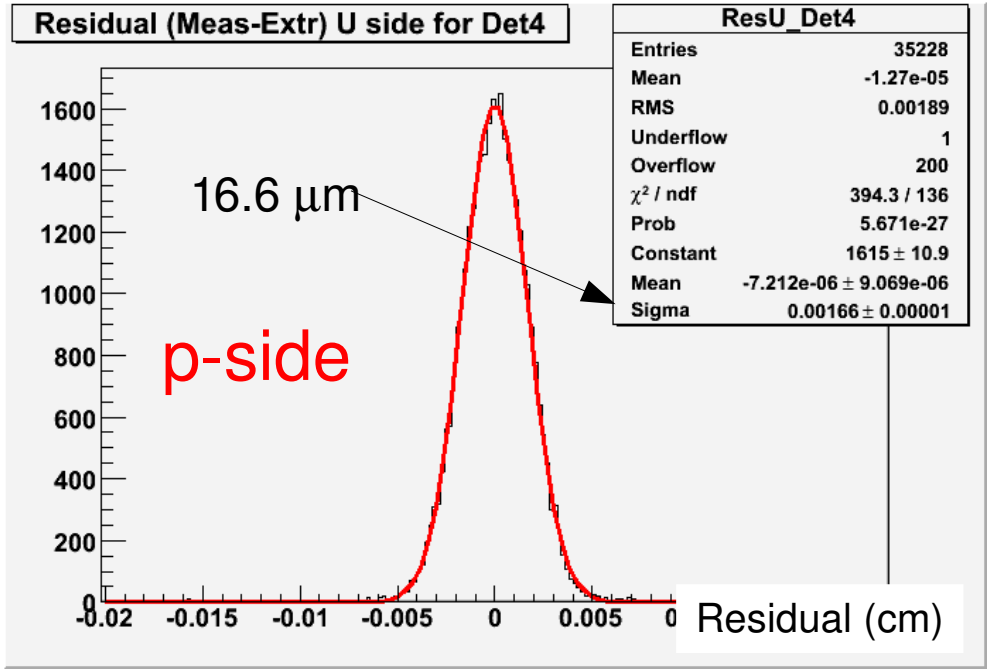


$$\sigma^2_{resolution} = \sigma^2_{residual} - \sigma^2_{extr\text{-}track} - \sigma^2_{MS\ on\ DUT}$$

Residual on DUT = measured pos. – extrapolated pos.

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

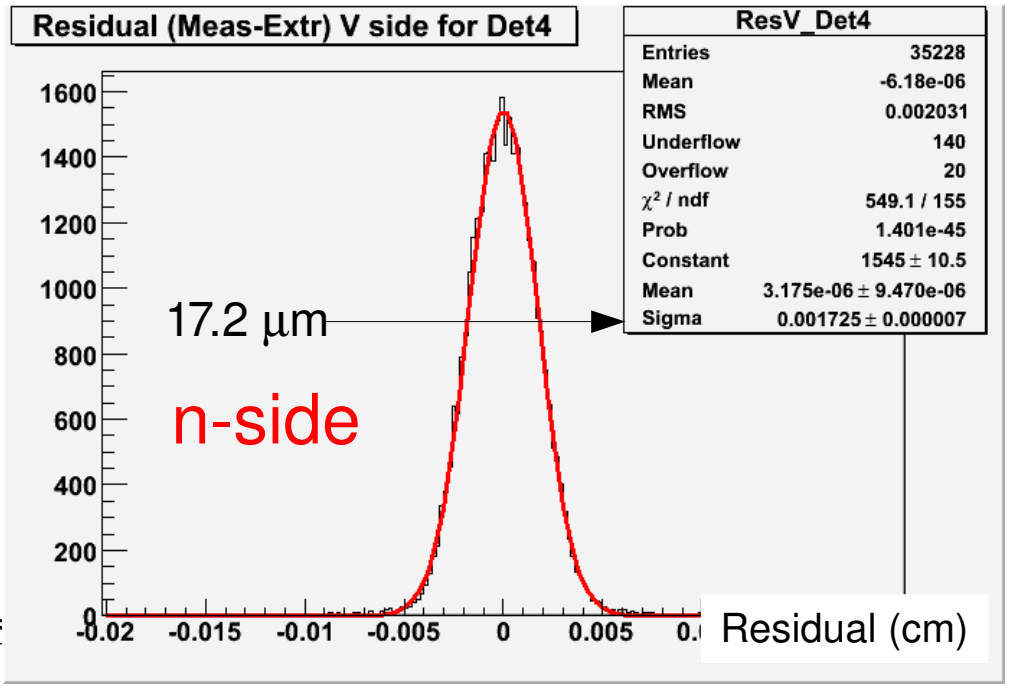
Preliminary striplet resolution



- p-Side: residual → 16.6 µm
- MS effect in 200 µm → 6.0 µm
- Telescope resolution → 3.5 µm
- Space Point resolution: 14.4 µm
- Pitch = 50 µm

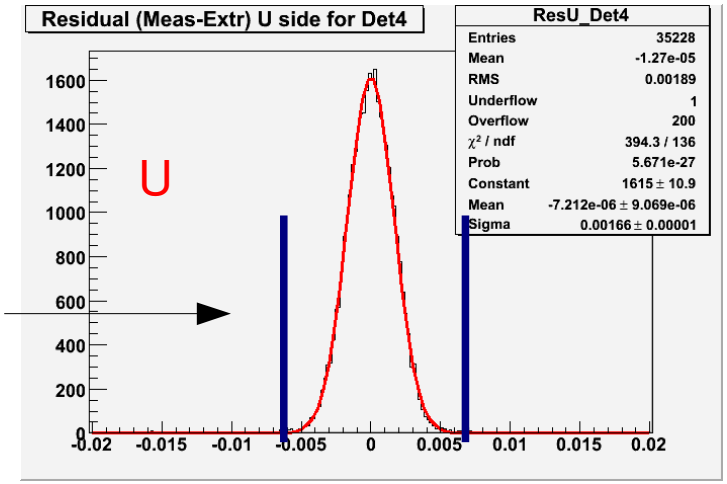
N.B. : 1 track per event
with P(χ^2)>10%

- n-Side: residual → 17.2 µm
- MS effect in 200 µm → 6.0 µm
- Telescope resolution → 3.5 µm
- Space Point resolution: 14.4 µm
- Pitch = 50 µm



Efficiencies

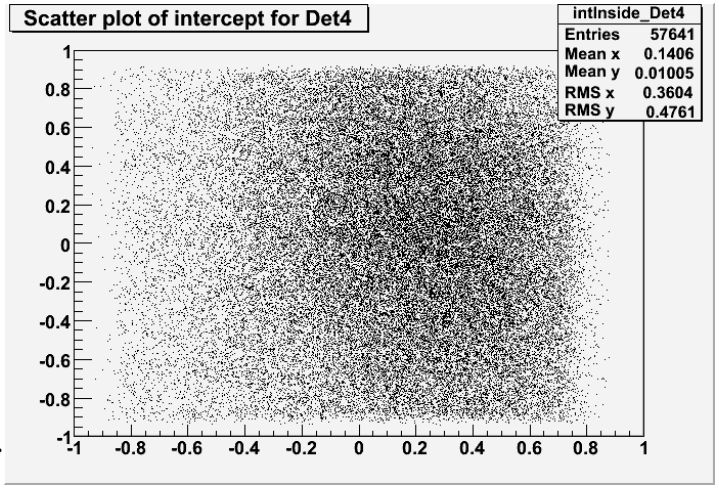
- p-Side = (98.5 ± 0.04)%
- n-Side = (98.3 ± 0.04)%



± 5 s.d.

Number of hits on DUT

$$\varepsilon = \frac{\qquad\qquad}{\qquad\qquad}$$



Number of track intercepts within DUT fiducial-region

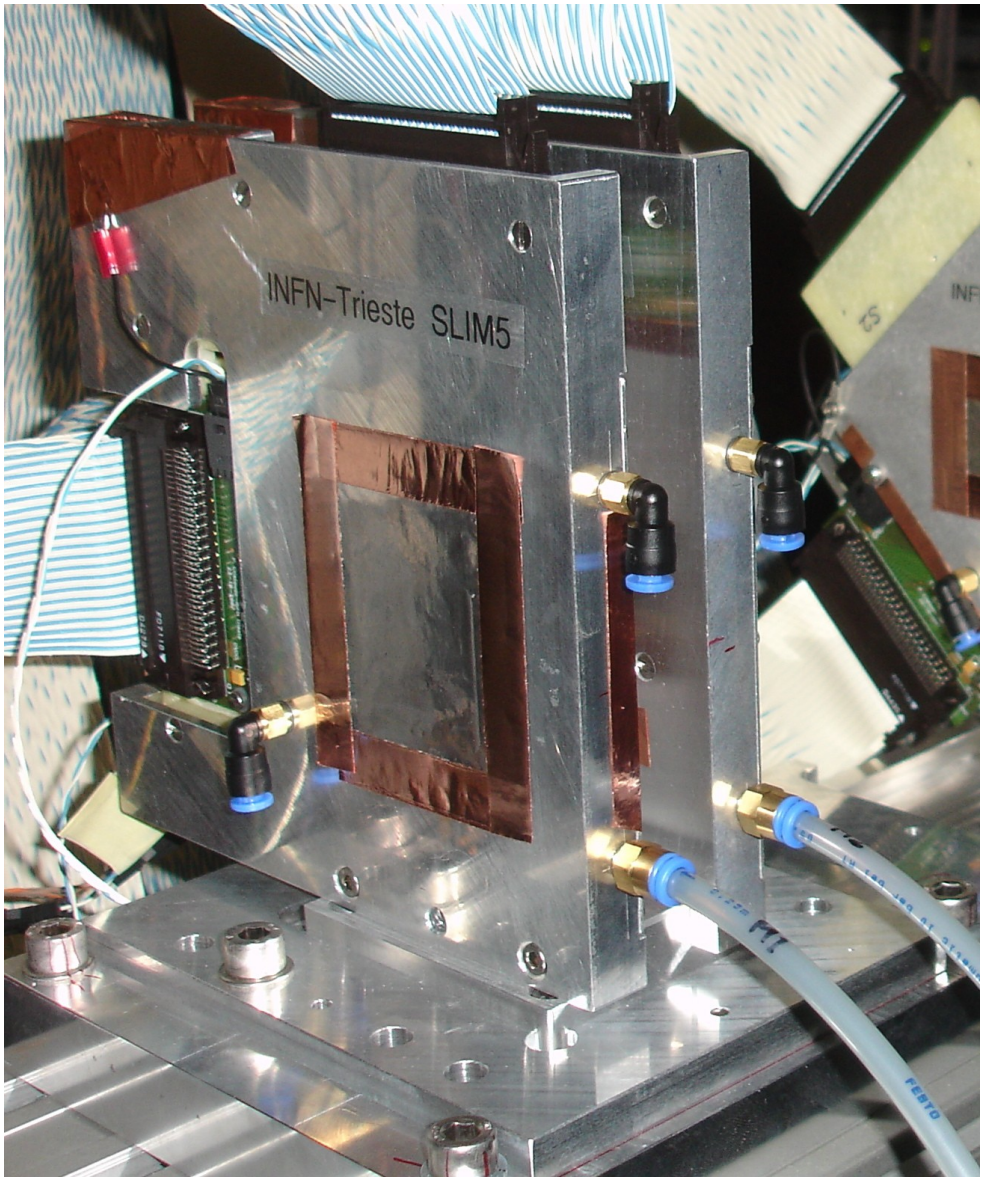
Conclusions

- Slim5 collab. developed double-sided telescope and striplet detectors, readout with FSSR2 chip
  - FSSR2 used for negative signals for the first time
    - Full characterization in progress
- Operation was very smooth
- Detector space-point resolutions were evaluated
  - Work in progress
- Striplets are > 98% efficient

That's it!

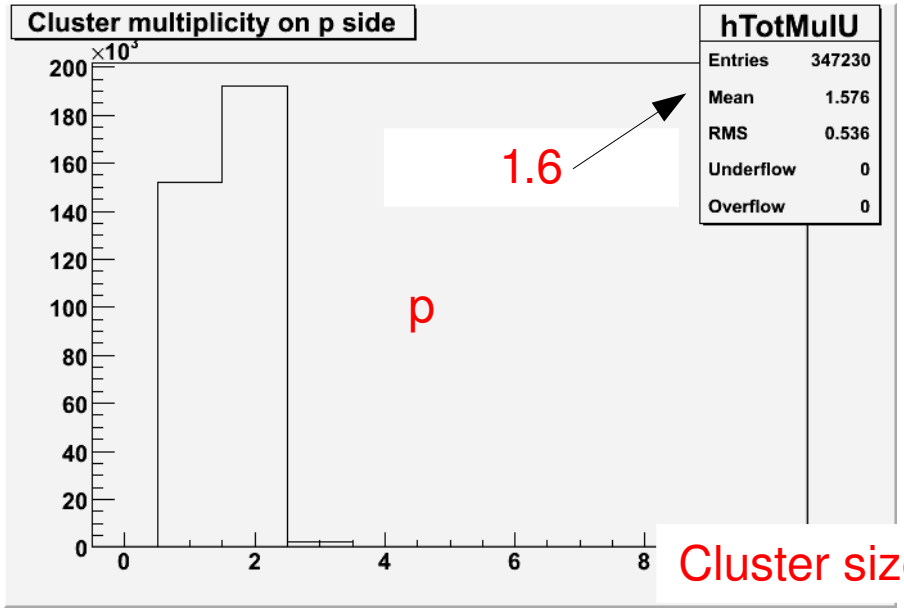
Backup slides

The test beam

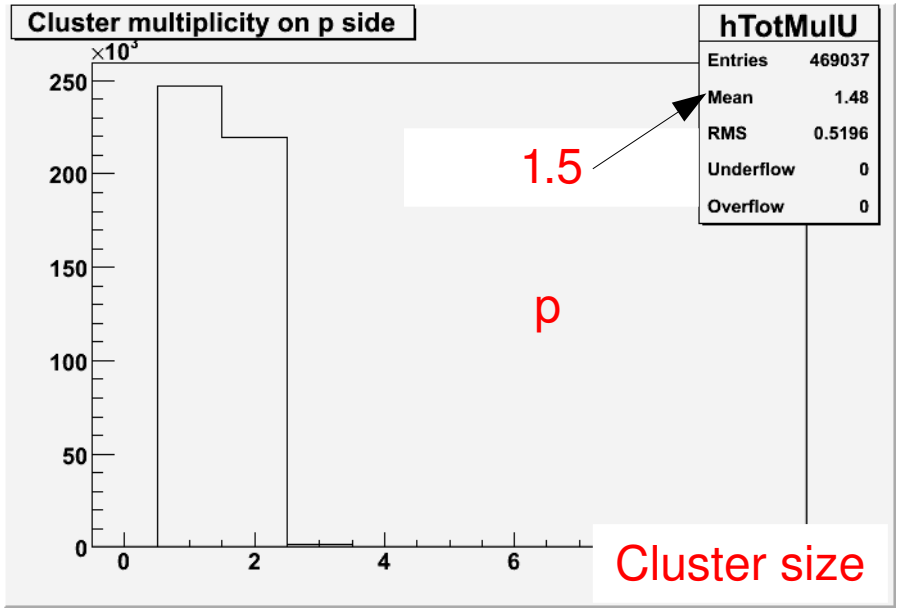


- September 1st - 22nd
- Several detectors tested
- Adjustable table, cooling system, FEE & DAQ worked synergically and perfectly

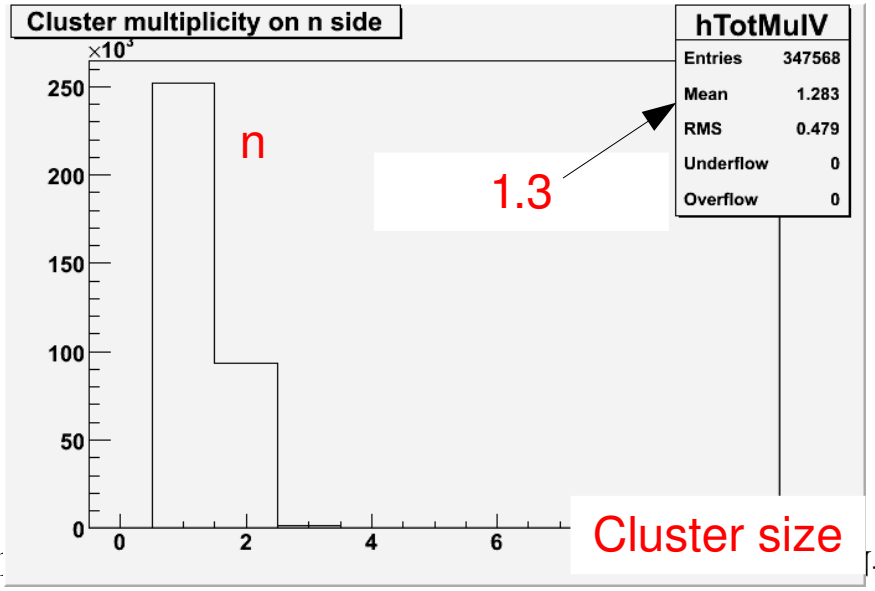
Cluster multiplicity

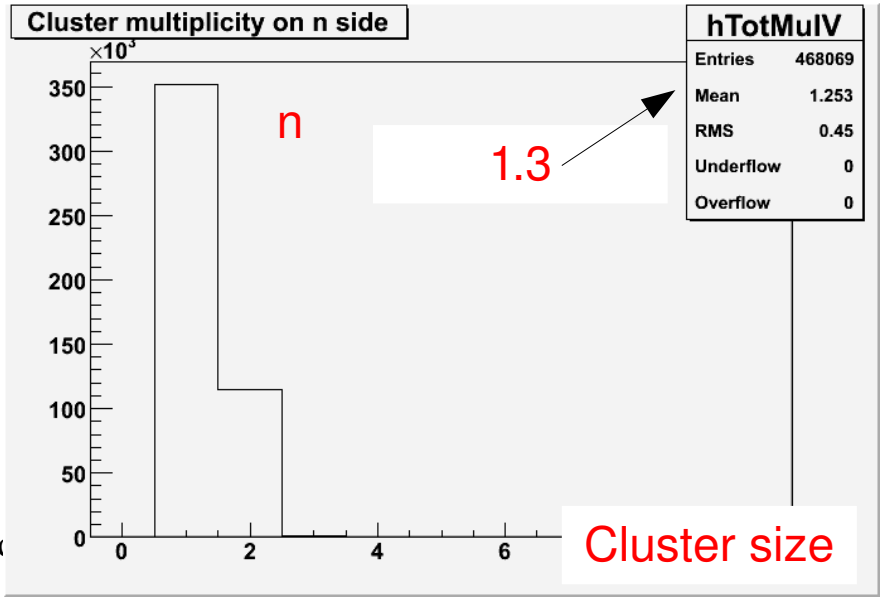


Tele

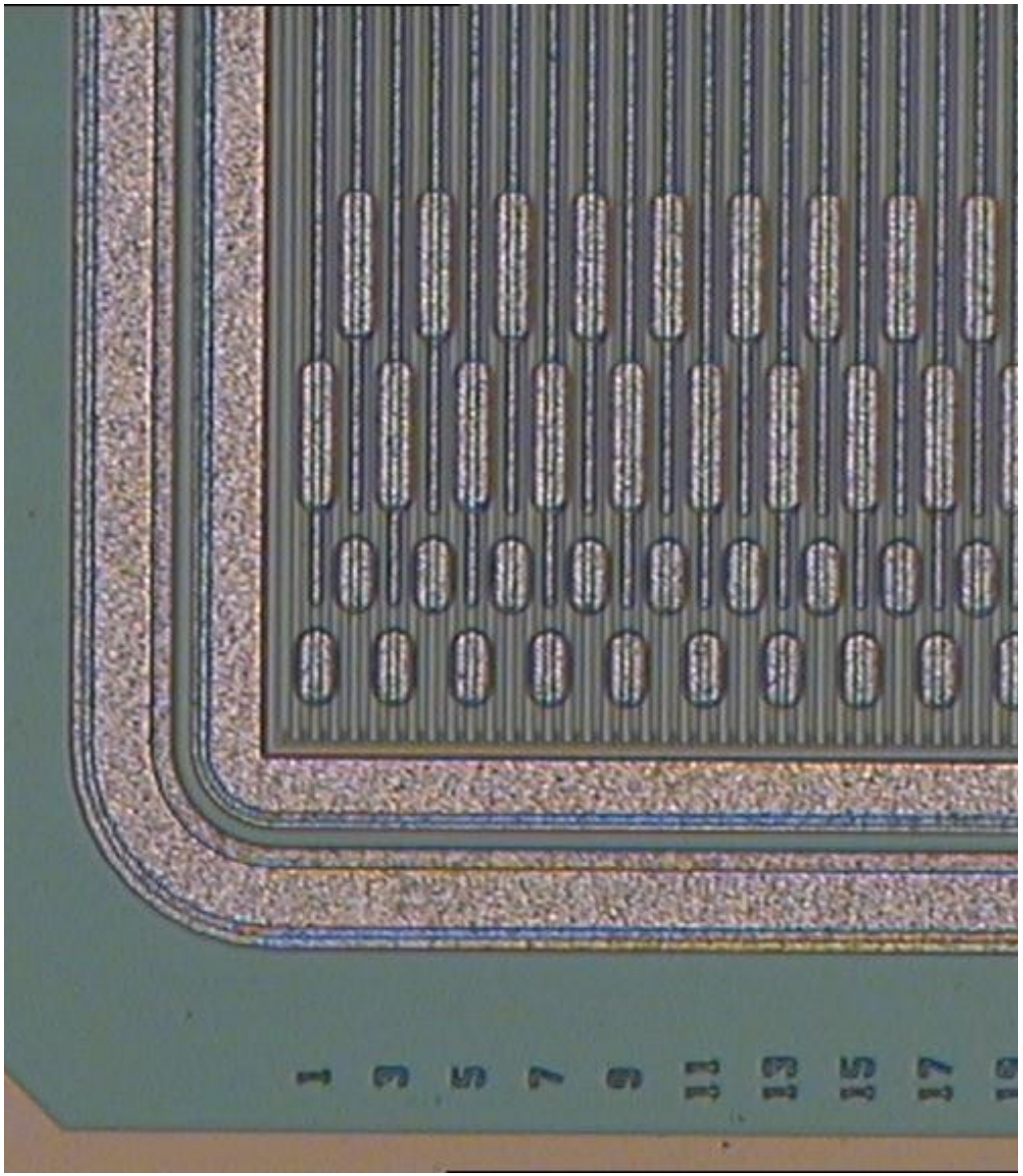


Striplets





Strip detectors



- 300 μm-thick double-sided strip detector
  - Ortoghonal strips
- 384 channels read per side
- Area ~ 19 x 19 mm^2
- 25 μm pitch on p-side
- 50 μm pitch on n-side
- Strip capacitance: 4.3 pF

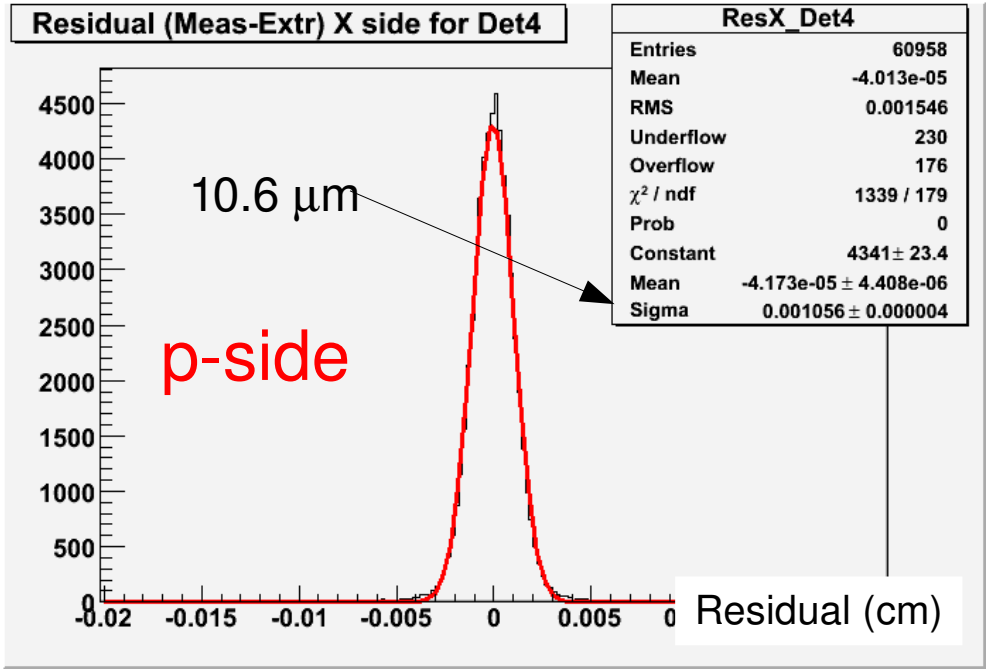
Fanout capacitance

Chip	Channel	C (pF)
1	60	0,73
2	60	1,15
3	60	1,32

Trieste contribution

- A total of 6 telescope modules and 3 striplets modules were developed
- Each module has:
  - 1 double-sided sensor
  - 3+3 FSSR2 chips
  - Fanout circuit
  - 2 hybrids
  - Stesalite support + Metal aluminium frame
- Bias and signal-routing system was realized too

Telescope resolution



- p-Side: residual → 10.6 µm
- MS effect in 300 µm → 6.6 µm
- Telescope resolution → 1.8 µm
- Space Point resolution: 7.7 µm
- Pitch = 25 µm

N.B. : 1 track per event
with P(χ^2)>10%

- n-Side: residual → 13.9 µm
- MS effect in 300 µm → 6.6 µm
- Telescope resolution → 5.8 µm
- Space Point resolution: 10.7 µm
- Pitch = 50 µm