HEPHY

Institute of High Energy Physics

Testbeam 2009 at SPS

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SiLC evo Meeting

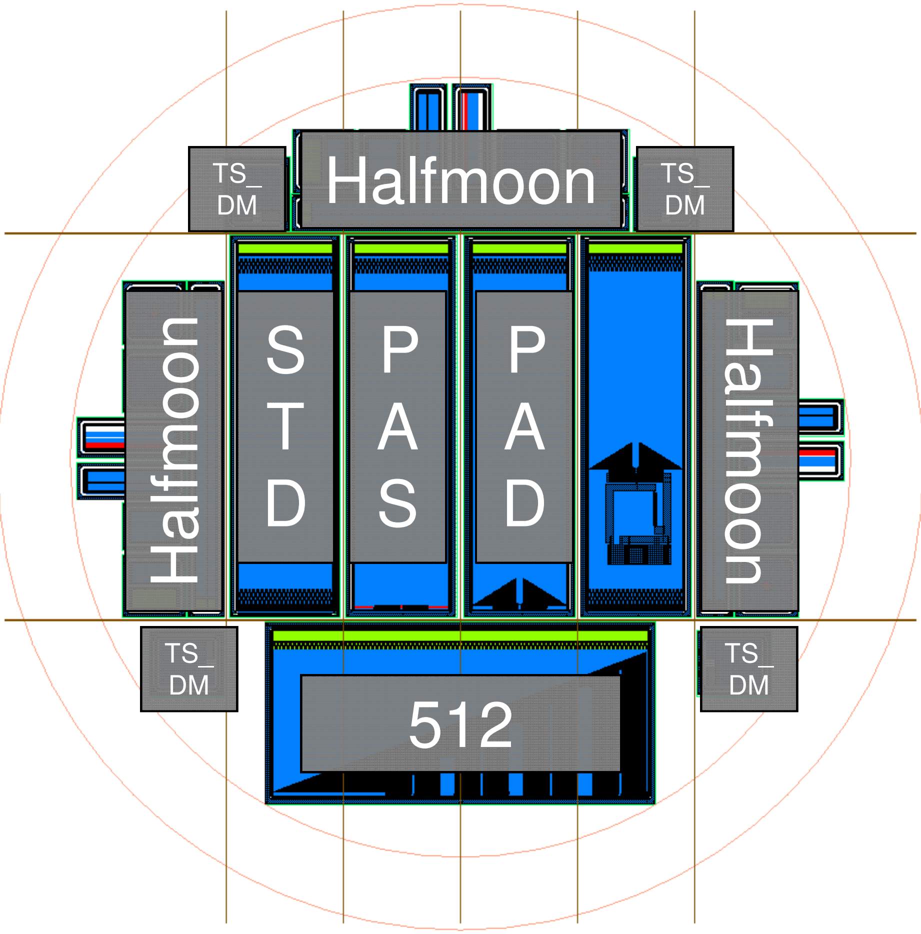
13. October 2009

Initial Situation

- Production of standard set of teststructures at ITE Warsaw in 2007
- New run with ITE Warsaw in 2009
  - We still have ≈ 40 4-inch wafers from Topsil
  - Implement a double metal process with 9 layers
  - Stop processing for some wafers after 1st metal
    → for better comparison
    → similar to HPK Order
- Current teststructures (single metal)
- Design new testsensors with integrated pitch adapters (single and double metal)

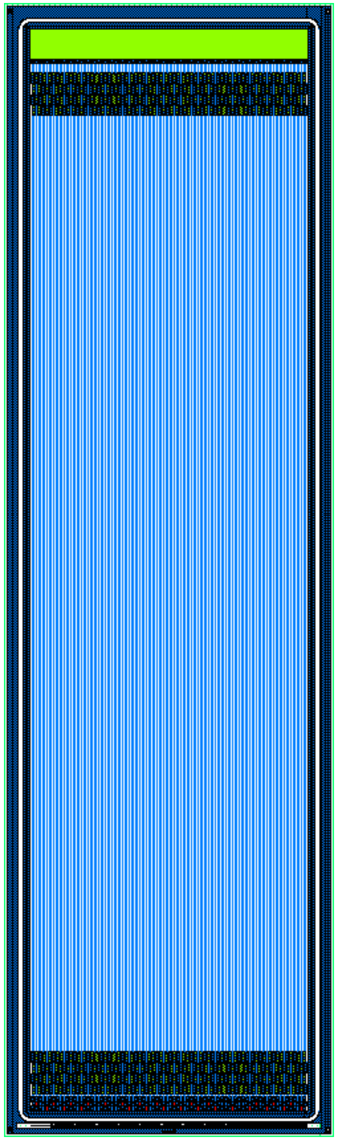
Wafer Overview

- 3 full halfmoons with improved teststructures
- Additional teststructure (4 x TS_DM)
  - large double metal capacitor
  - oxide thickness between metals
- 5 AC coupled sensors, 80 µm pitch, different integrated PAs:
  - 4 x 128 strips
  - 1 x 512 strips
- Naming scheme for sensors:
  - Run Name: ITE09
  - Wafer Number: W_
  - Structure Name: STD, PAD,…



Standard (ITE09W_STD)

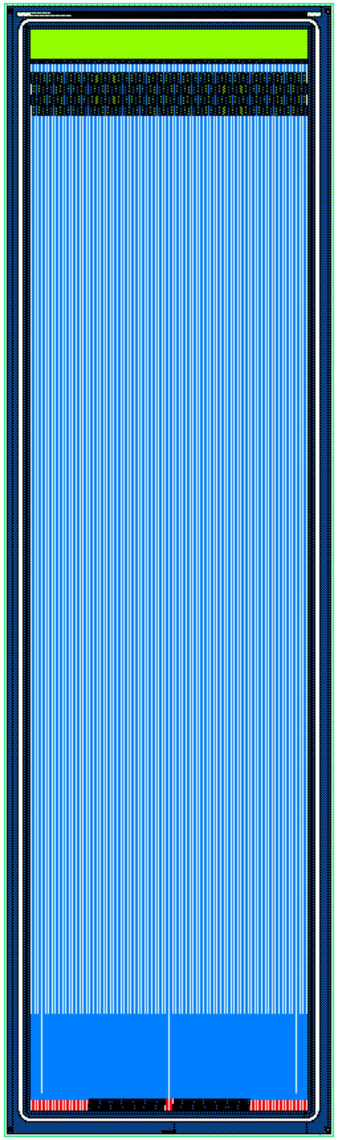
- Standard AC coupled sensor
- 128 strips, 80µm pitch, 20µm width
- Biasing: polysilicon resistor
- Metal overhang at strips 5µm
- Biasring with 10µm overhang
- Guardring with 20/10µm (out-/inside)



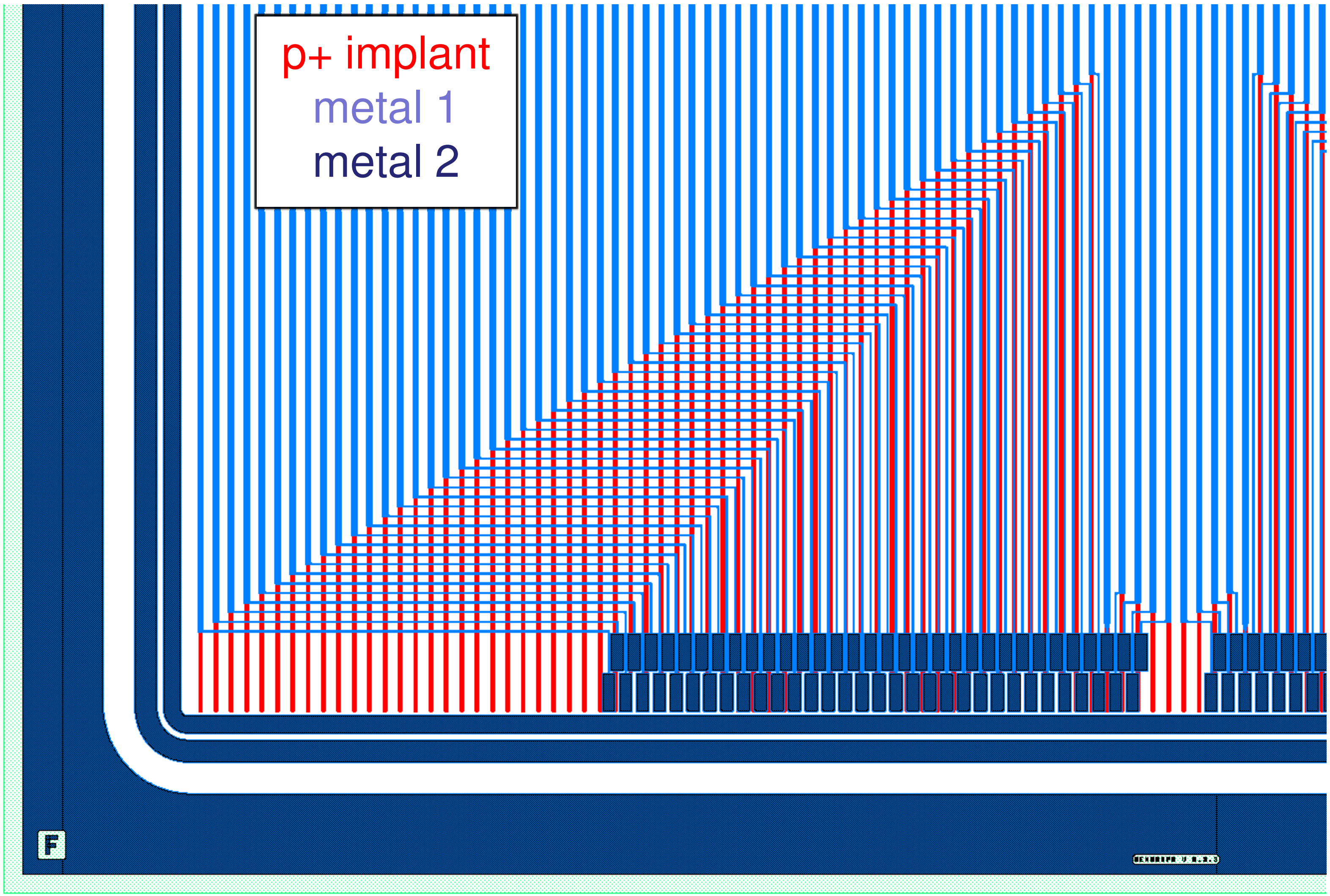
PA Single (ITE09W_PAS)

Same as Standard but:

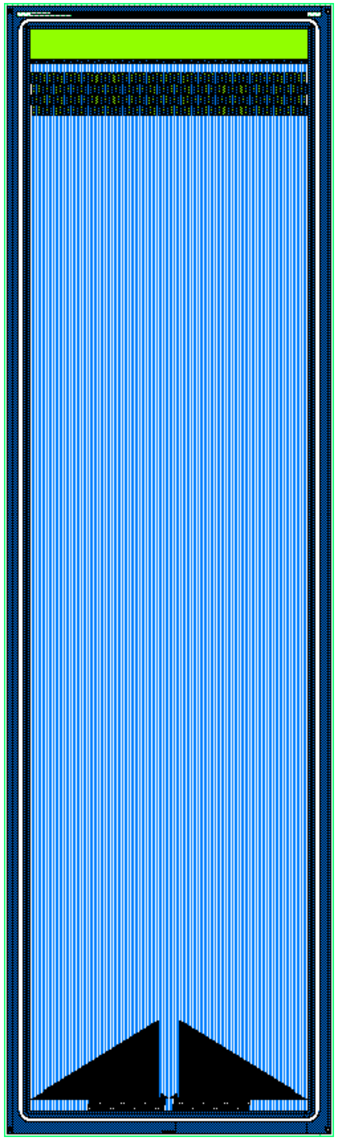
- On-Sensor readout routing in first metal layer
- Readout metalisation converges to APV pitch at one side
- Reduced SNR at PA region
- Increased crosstalk due to routing
- No 2nd metal layer needed!



PA Single: Closeup



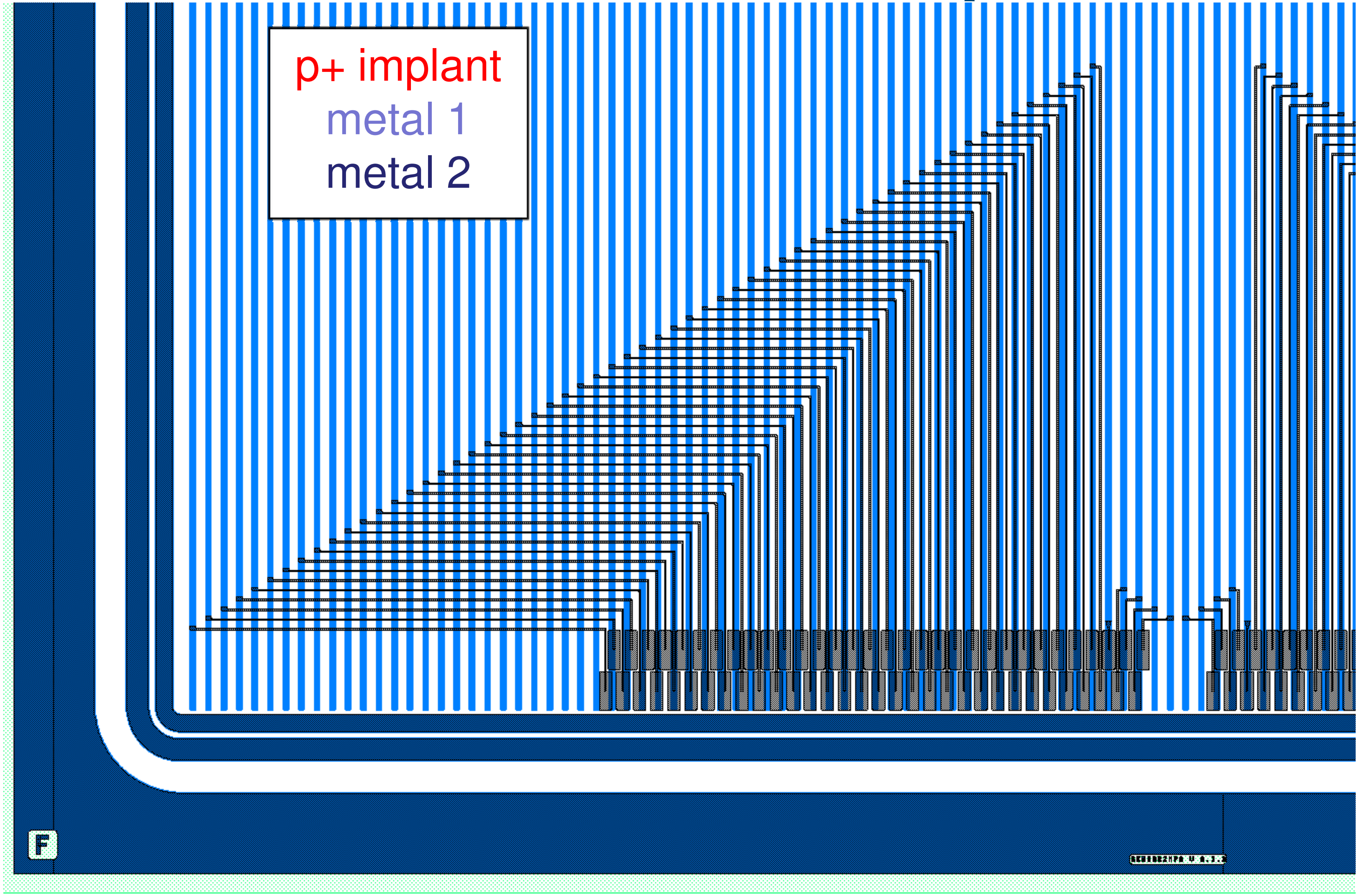
PA Double (ITE09W_PAD)



Same as PA Single but:

- Routing moved to 2nd metal layer
- Readout metalization covers entire strip
- No inefficiencies in PA region
- Lower crosstalk
- 2nd metal design needs more process steps → more expensive

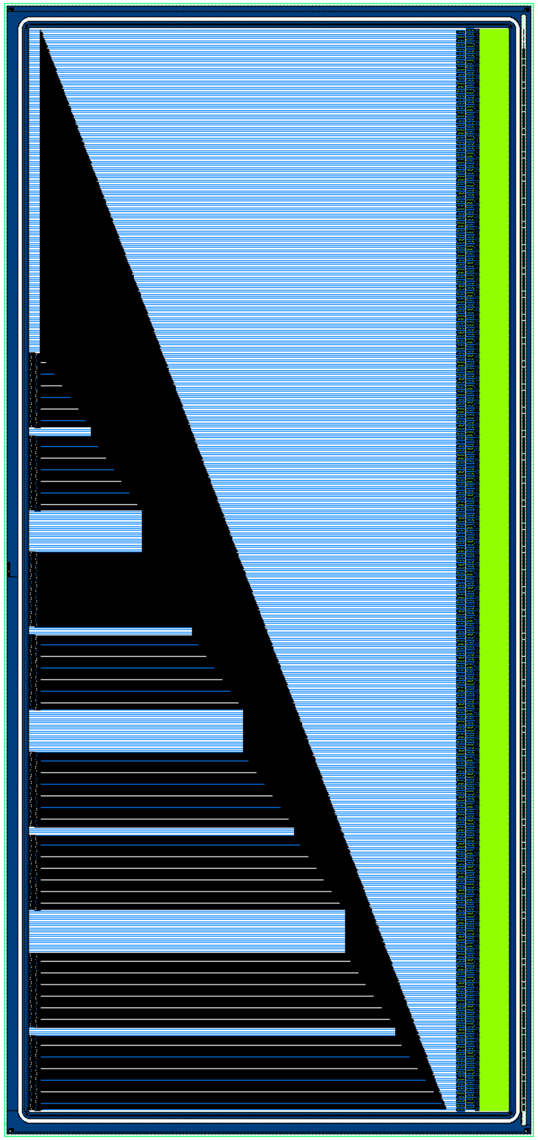
PA Double: Closeup



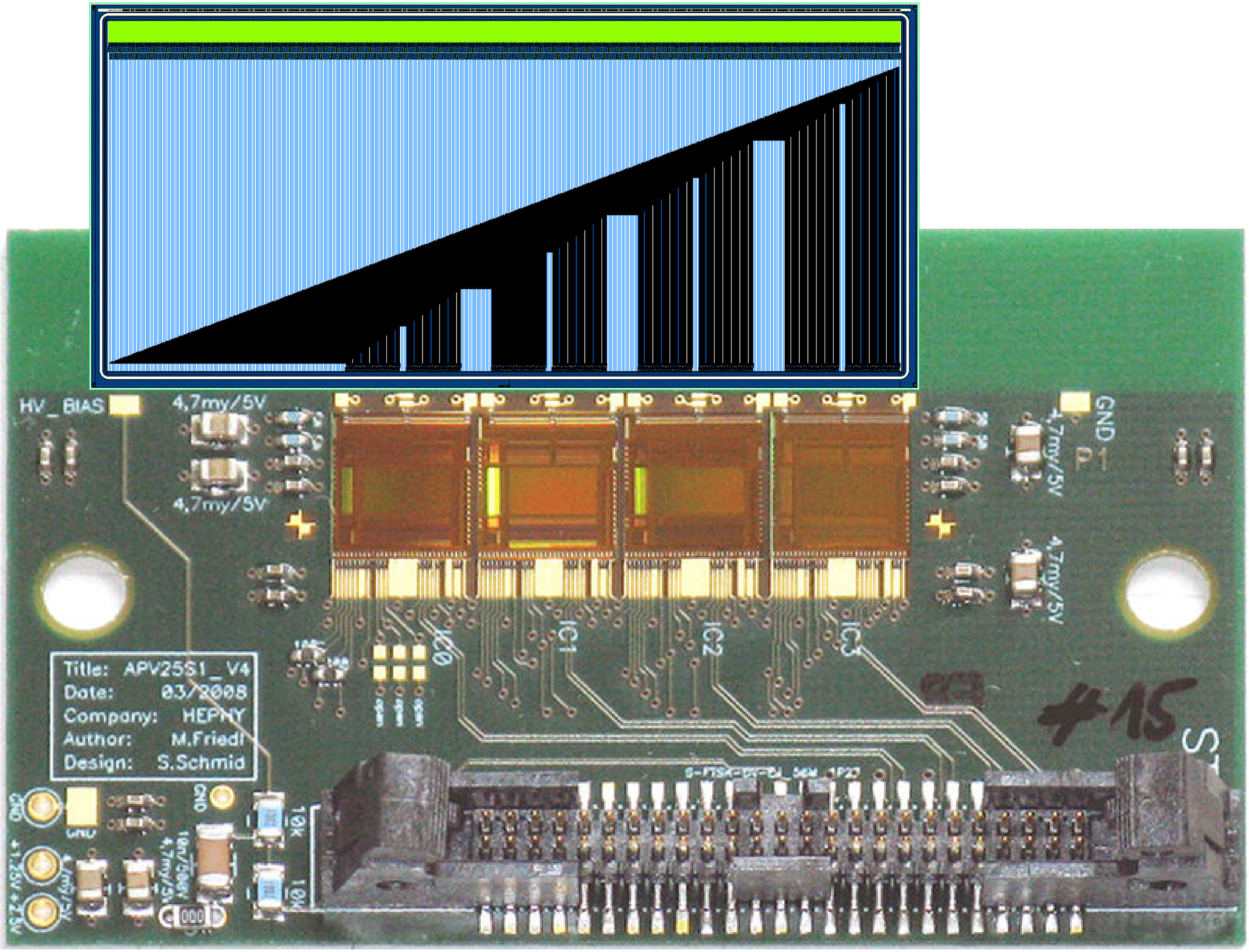
512 Strips (ITE09W_512)

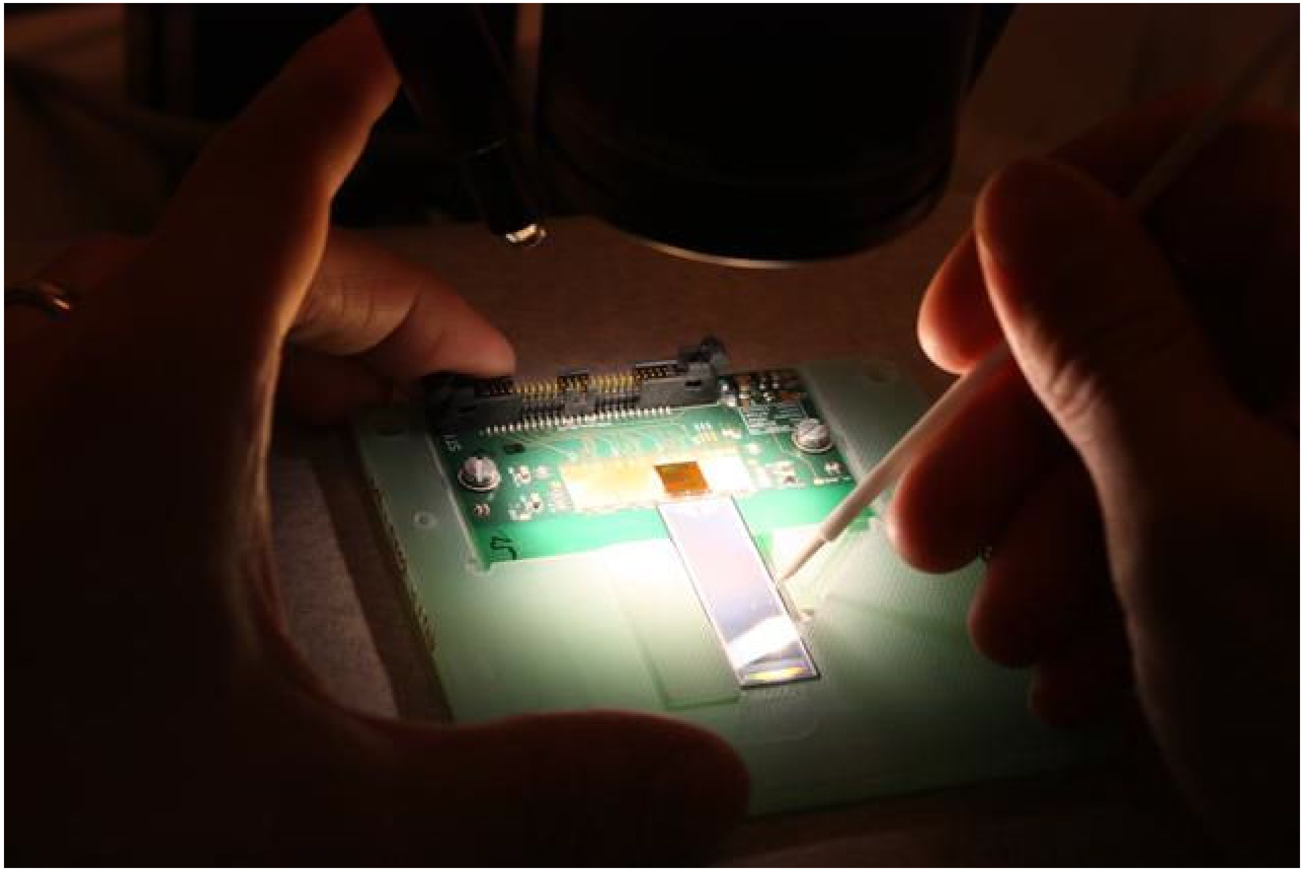
Same Strip Geometry as other Sensors but

- 512 short Strips
- Long routing lines to test influence on SNR and Crosstalk
- Routing is for a custom 4 x APV Hybrid
- Hybrid fits APVDAQ readout system



Routing fits to hybrid



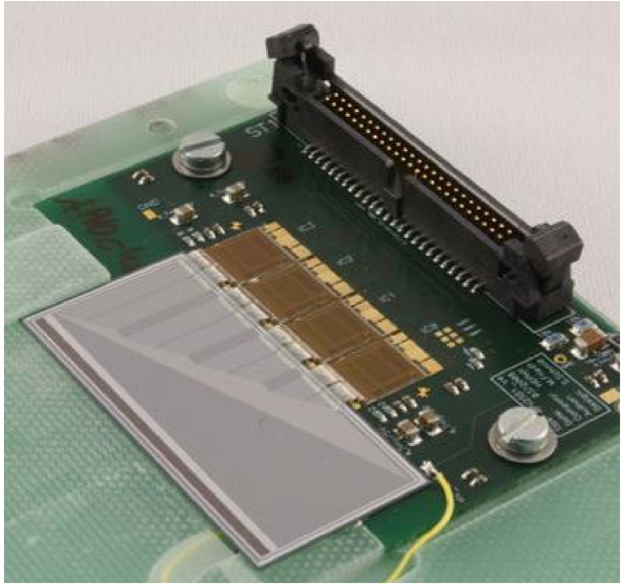


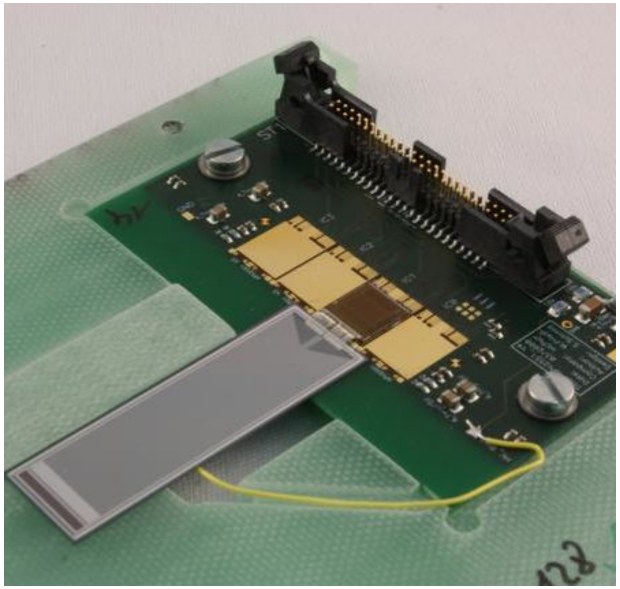
Module Construction

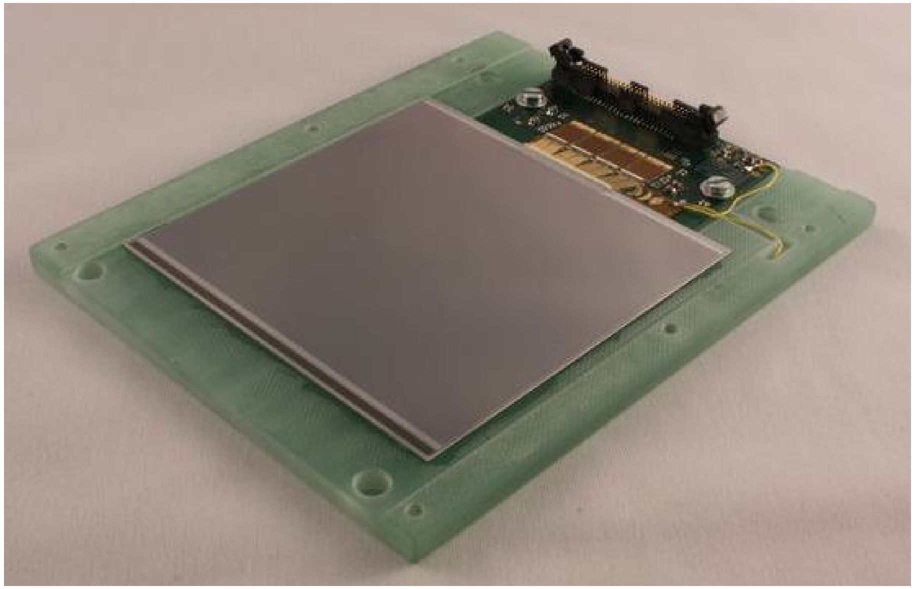
Testbeam modules designed and built around ITE’s sensors

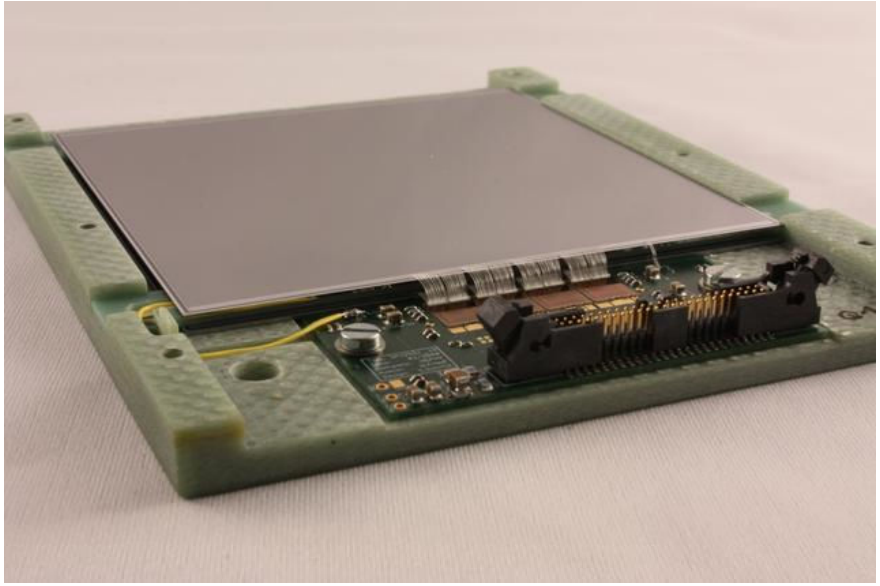
Module Types

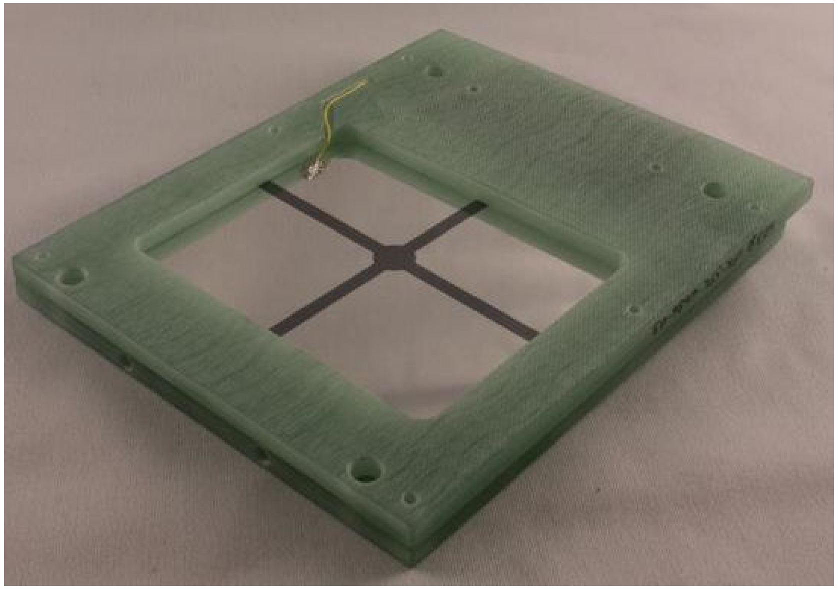
- ITE Warsaw Sensor:
  - 3 x 512
  - 2 x STD
  - 2 x PAS
  - 2 x PAD
- 2 x Alignment Modules
- 2 x Pt Module
- 2 x SiLC-HPK halfmoons for stereo measurements
- Stack of last years multigeometry sensors for calibration

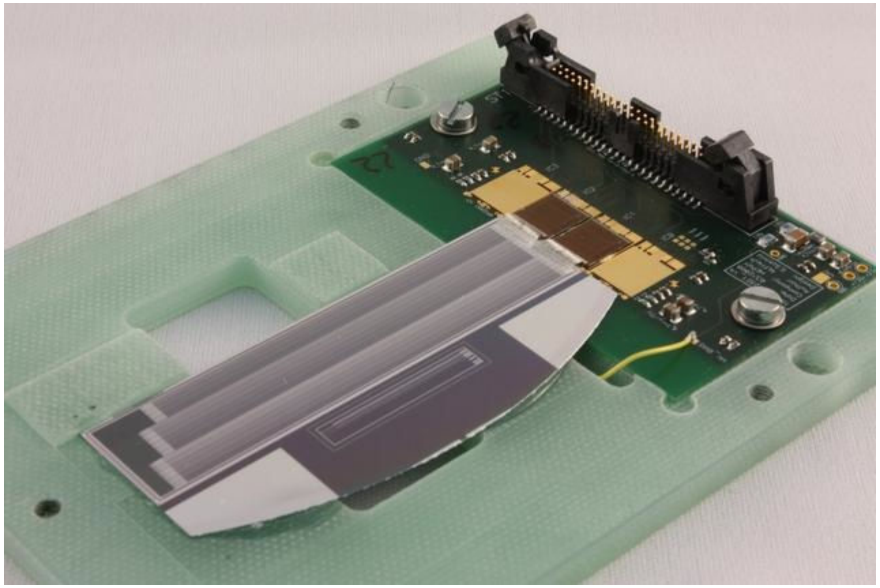


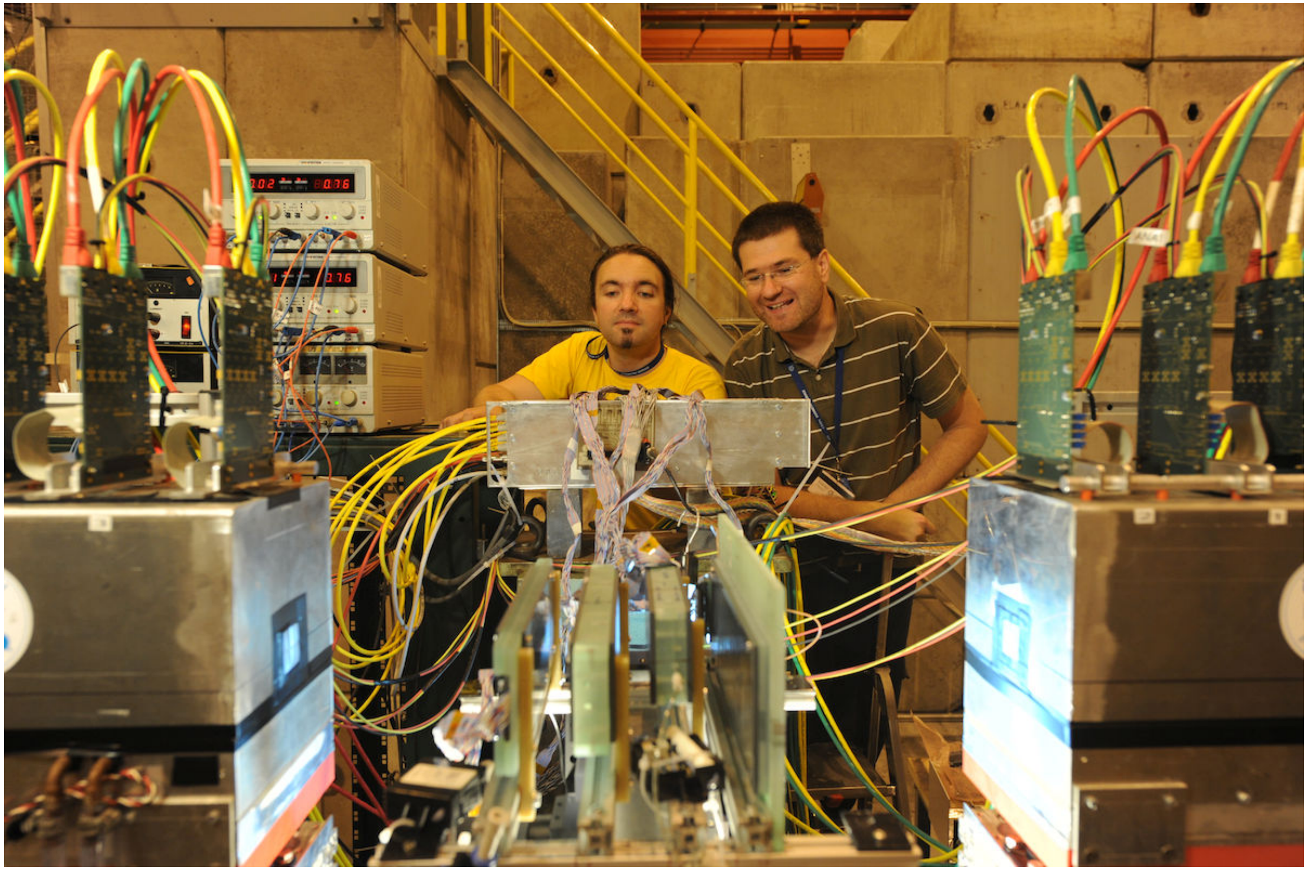












Testbeam at CERN's SPS

Remarks and Pictures from the testbeam at Cern's SPS

Remarks

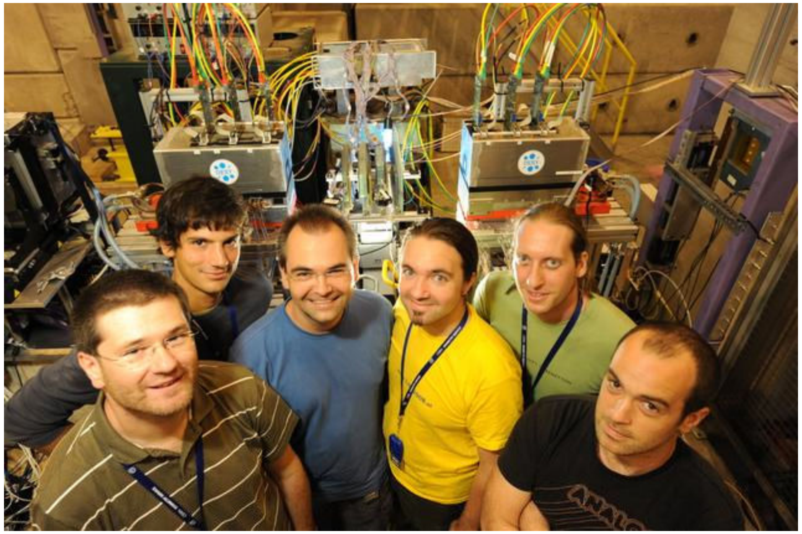
Testbeam at CERNs SPS

(19. to 26. August 2009)

- CERN SPS North Area: H6B
- Low intensity 120 GeV with
  - Pi+ 55.67 %
  - p 38.95 %
  - K+ 5.38 %
- We used the EUDET Beam Telescope to get triggers and tracks
- Readout chain from HEPHY's Electronic 2 Group
- Slow control/monitoring: HV, T, RH, Cooling
- Full remote control

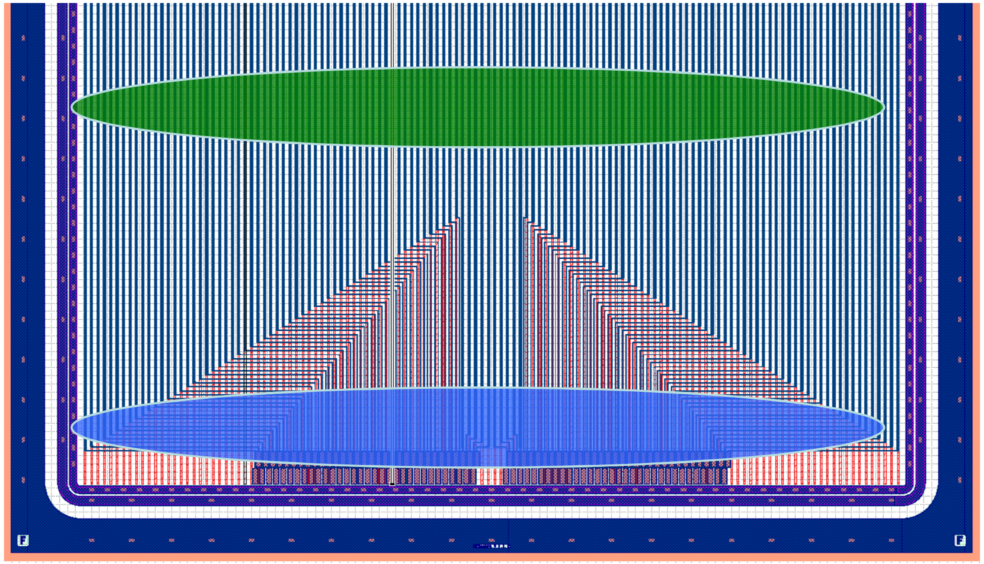
Results

- 3.2 Million events
- 1 TB of data
- Full Logbook at
  http://elog.hephy.at/testbeam-SPS09/

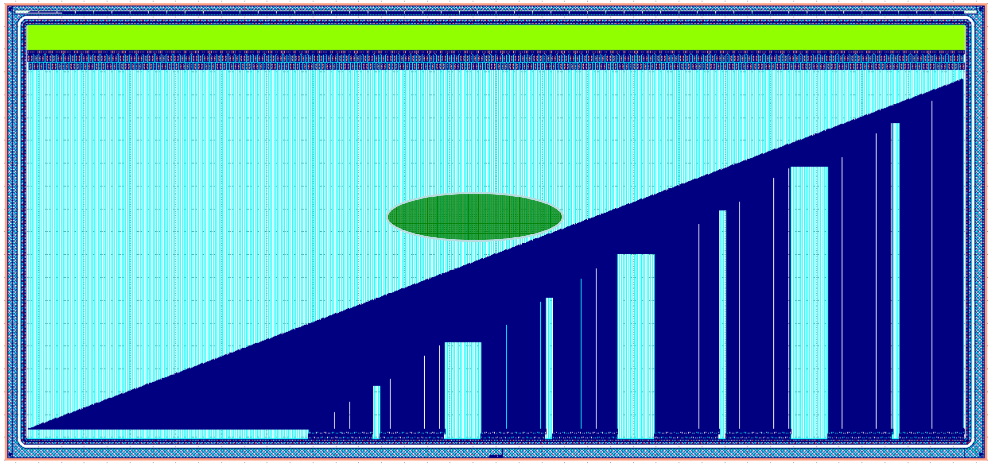


ITE Runs

- ITE Sensors with integrated PAs
  - Beam inside PA area
  - Beam on strip area
  - Z - information from rotated SiLC sensor

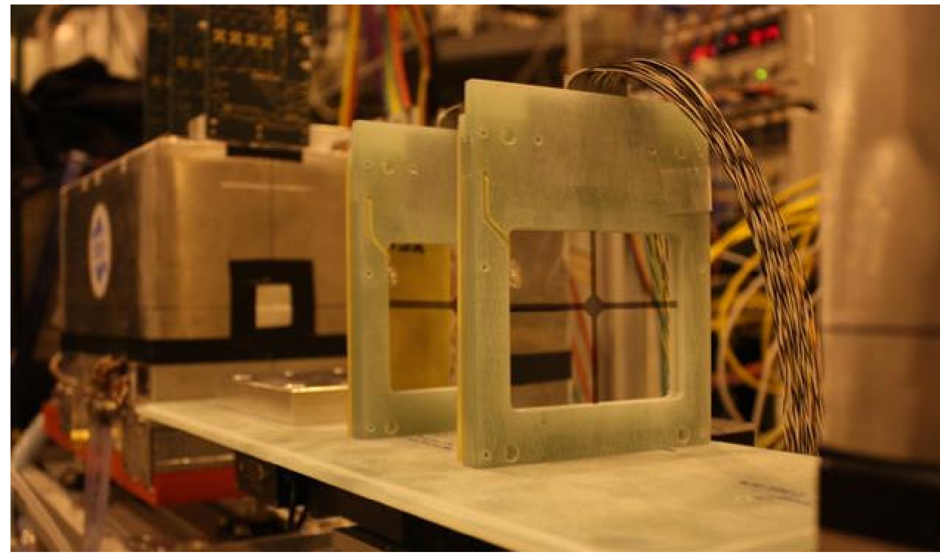


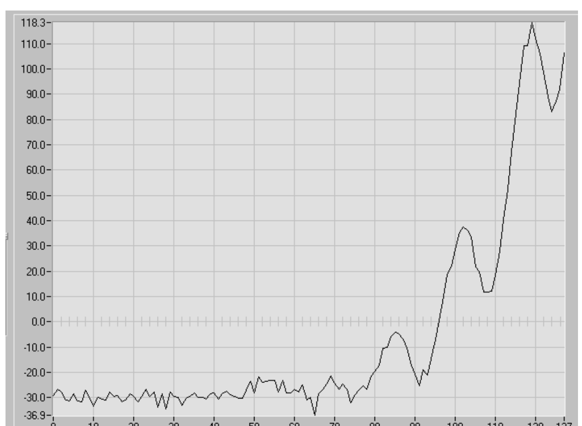
- ITE Sensor with 512 Strips
  - Beam in center
  - Exact locations to be determined

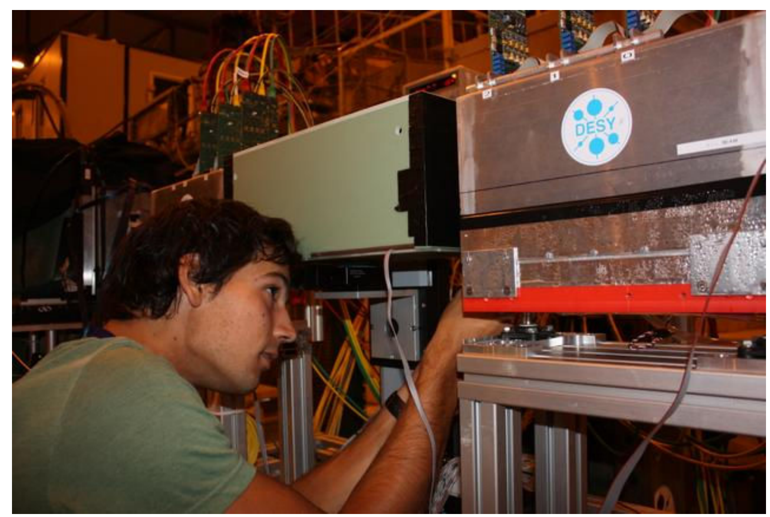


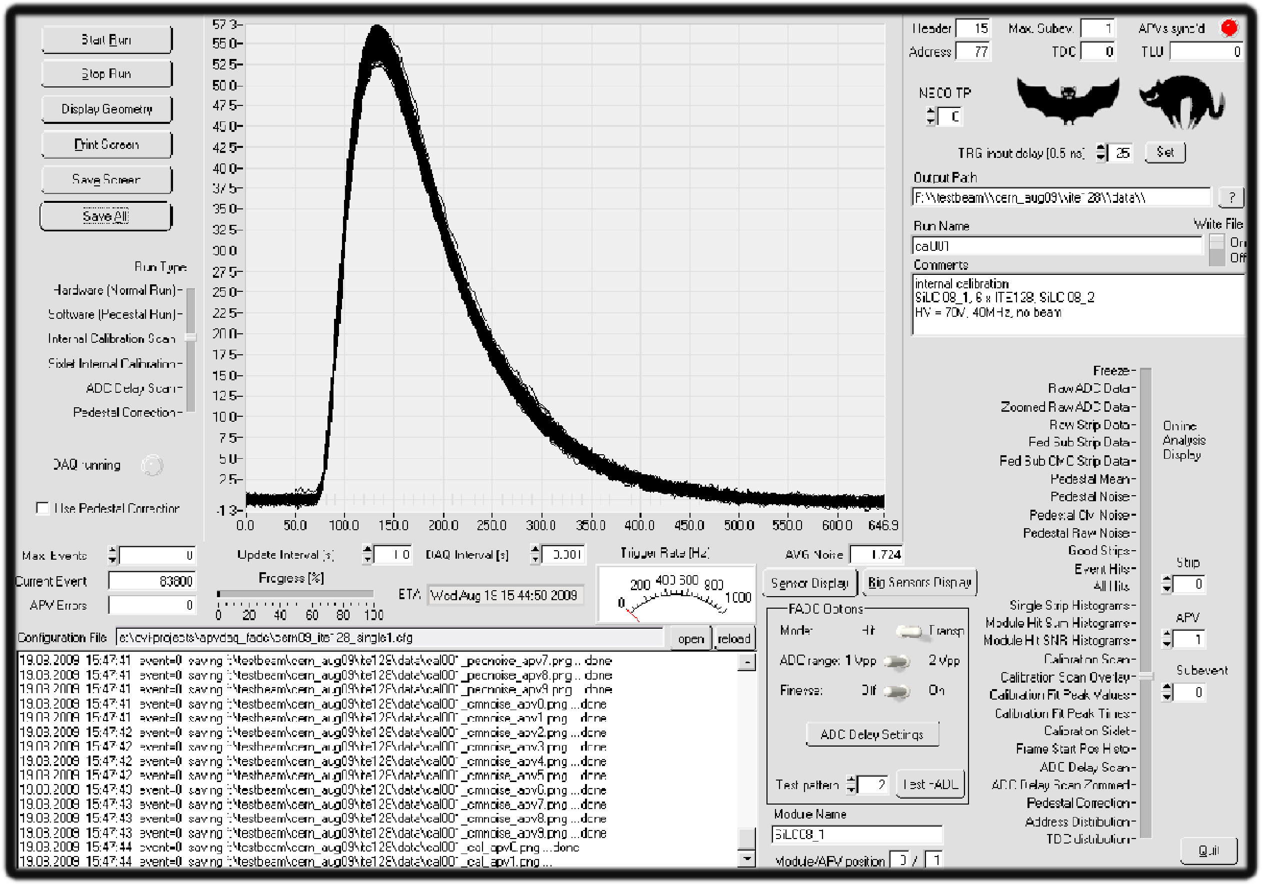
Alignment module runs

- Alignment Moduls:
  - Two modules mounted on base plate together with laser collimator (end of optical fiber)
  - Beam and Laser runs







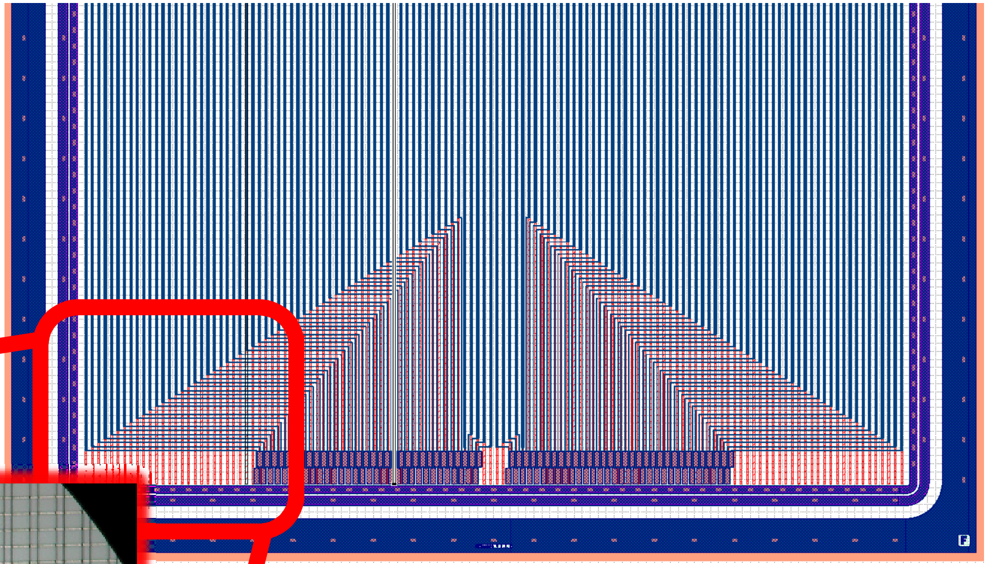


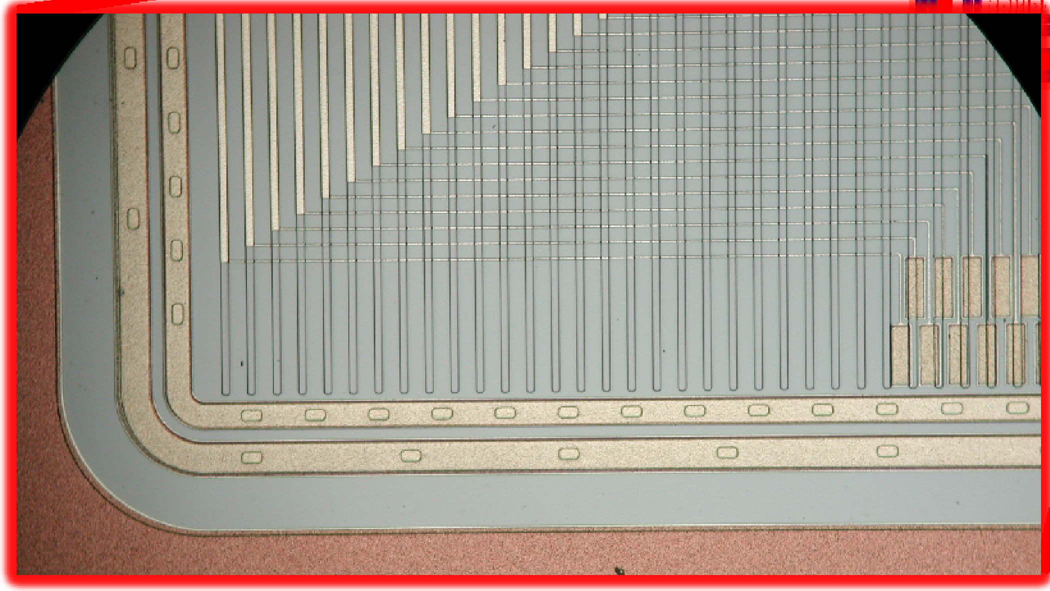
Analysis Results

First tentative results form the testbeam analysis

Signal loss in ITE09W_PAS

- Pitch Adapter in first metal layer
- Readout metalization used to route strip to readout pads
- No metalisation over strip in PA region

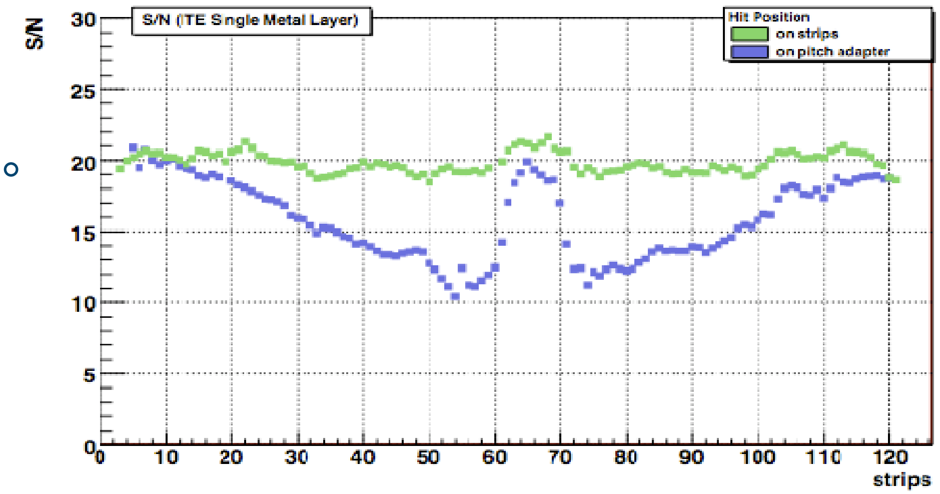


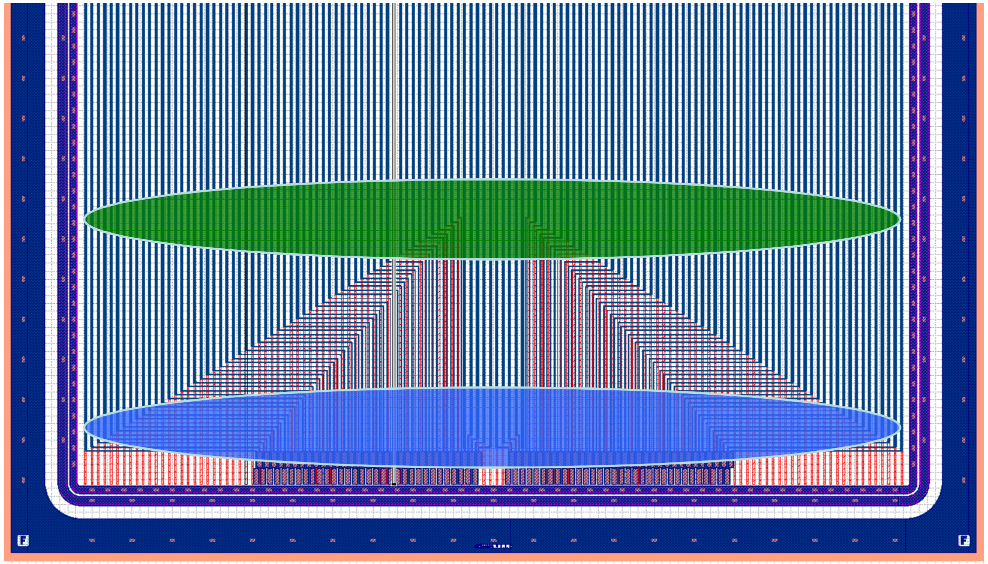


- Higher capacitance per strip due to routing
- Signal loss due to higher resistivity of p+ compared to aluminium

Signal loss: tentative result

- Data is taken from two runs
- Height information from additional sensor rotated by 90°
- Each hit position represents SNR of a cluster with hit location estimated at the respective strip
- Closer look on signals and noise separately necessary to disentangle effects

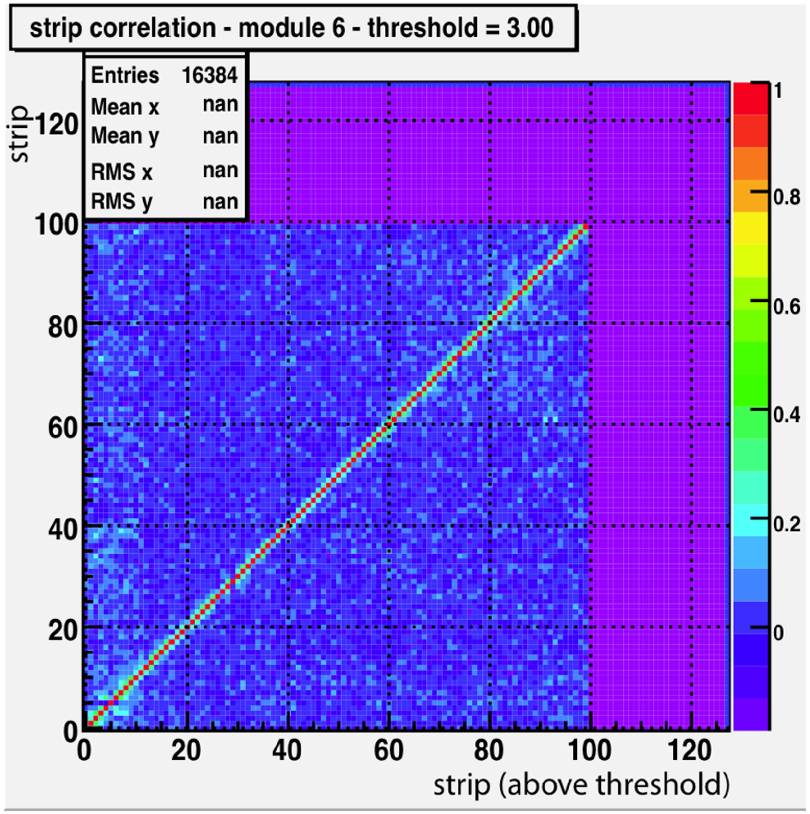




Cross talk

Correlations using rank correlation coefficient (Kendall's Tau)

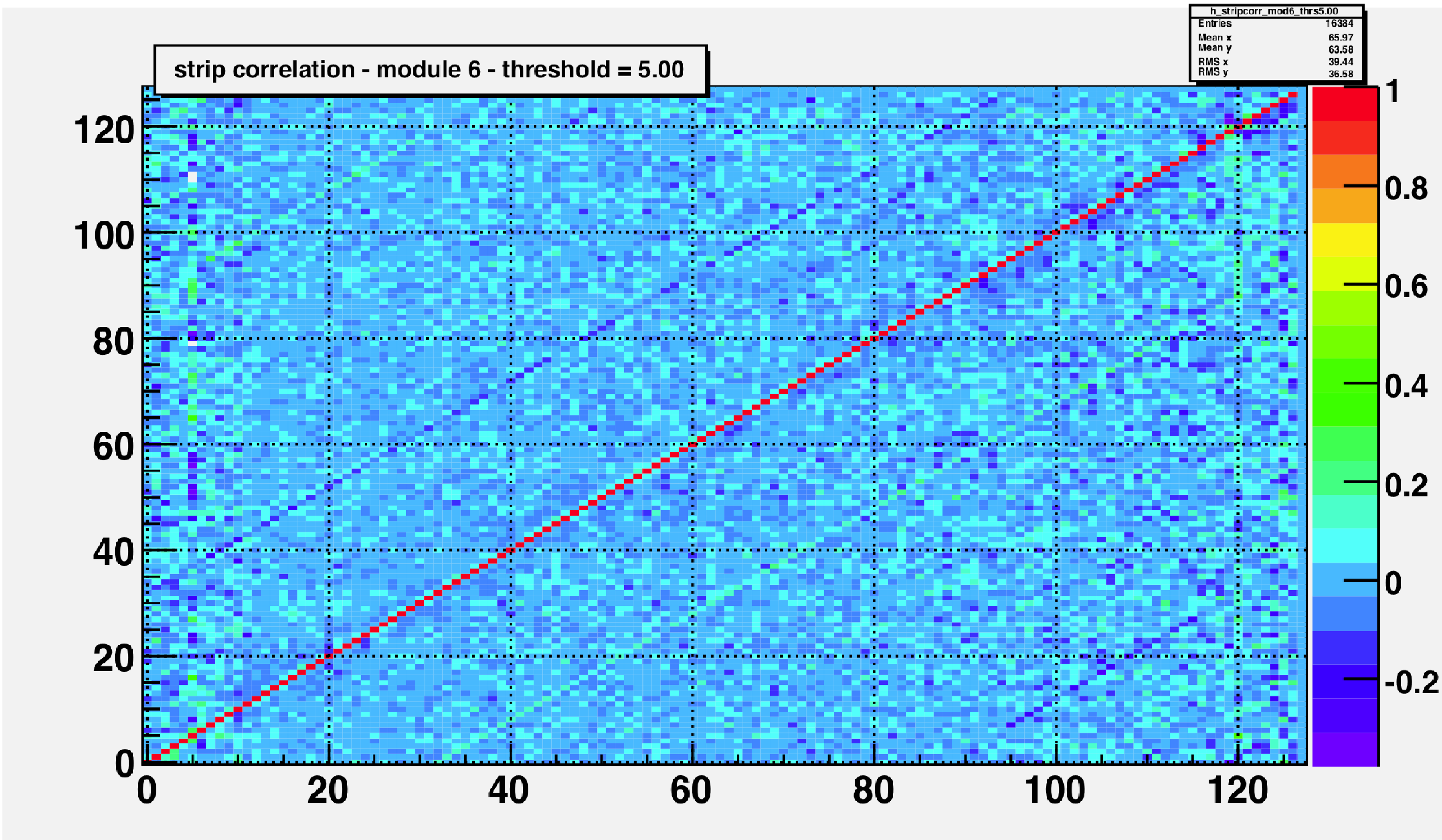
- X-Axis: Strip is hit with $S_X > 5$ x noise
- Y-Axis: Compare signals S_Y on all other Strips between 2 events
  - If $S_{X,1} > S_{X,2}$ and $S_{Y,1} > S_{Y,2}$ or $S_{X,1} < S_{X,2}$ and $S_{Y,1} < S_{Y,2}$ increase τ
  - If $S_{X,1} > S_{X,2}$ and $S_{Y,1} < S_{Y,2}$ or $S_{X,1} < S_{X,2}$ and $S_{Y,1} > S_{Y,2}$ decrease τ
- Compare all permutations of events
- τ is very sensitive to even small correlations
- It does not indicate the strength of the coupling between strips



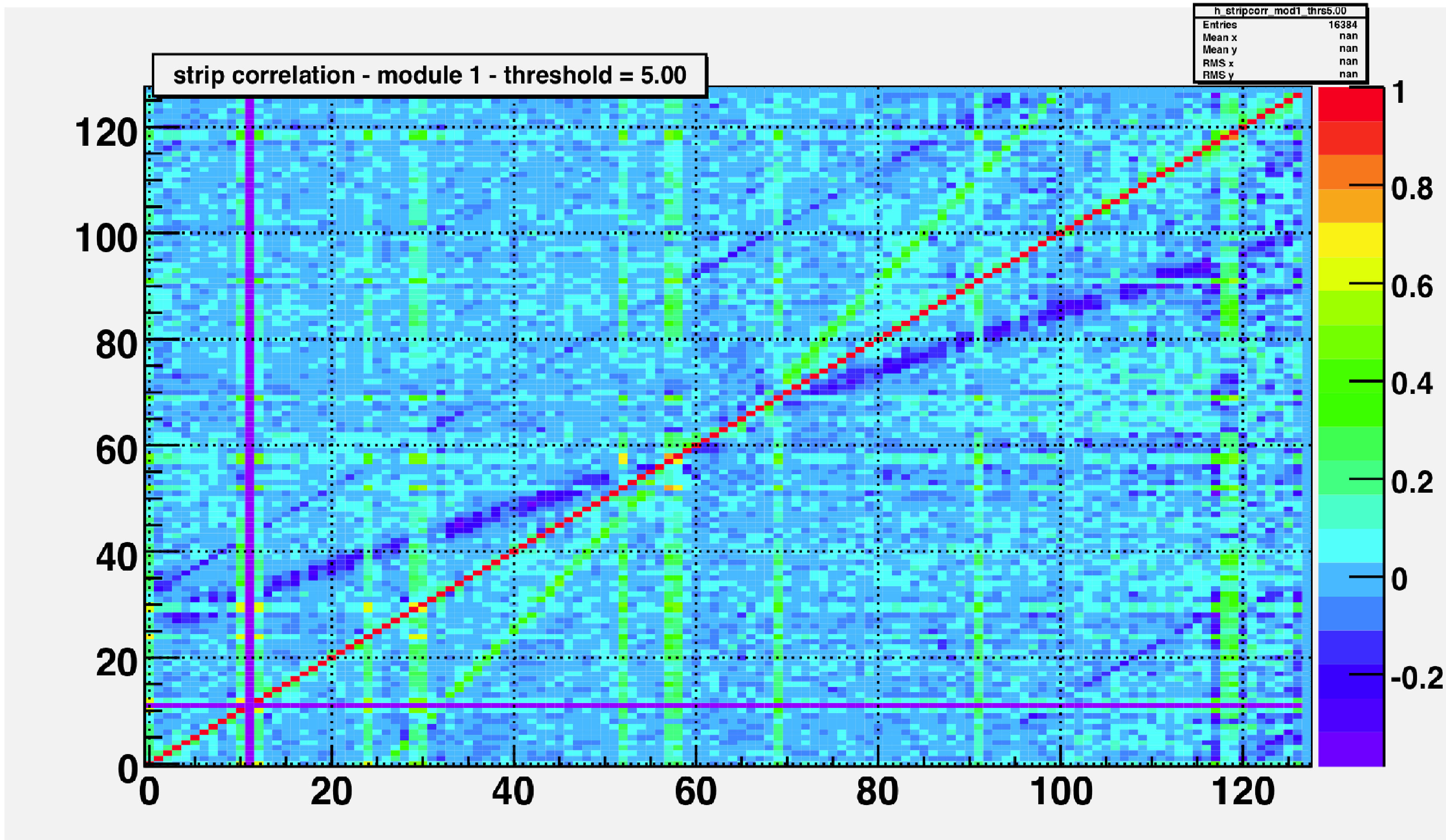
$$\tau = \frac{n_c - n_d}{\frac{1}{2}n(n-1)}$$

n_c concordant pairs
n_d discordant pairs
n total pairs

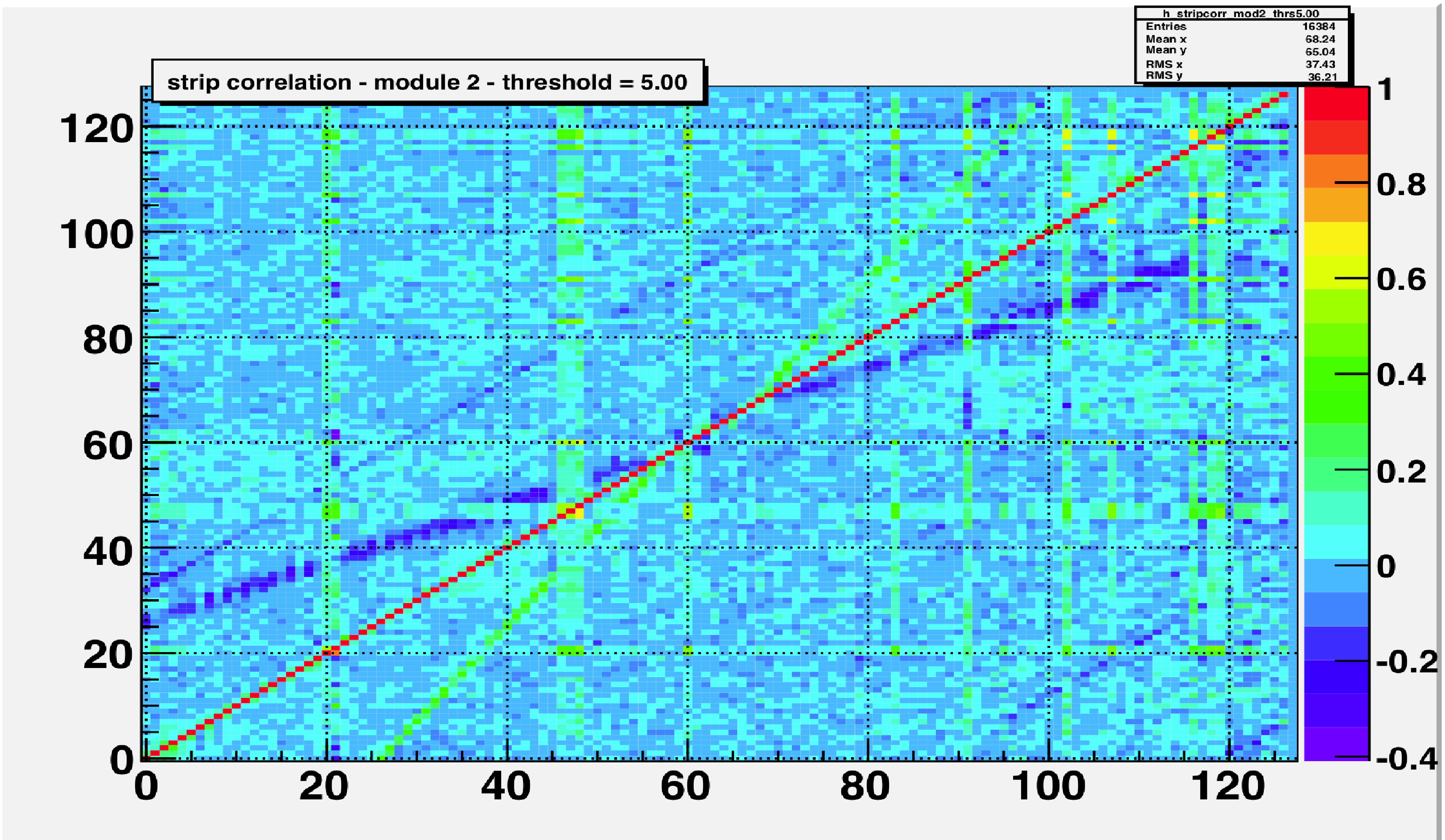
Standard


h_stripcorr_mod6_thrs5.00
Entries 16384
Mean x 65.97
Mean y 63.58
RMS x 39.44
RMS y 36.58
strip correlation - module 6 - threshold = 5.00
0
20
40
60
80
100
120
1
0.8
0.6
0.4
0.2
0
-0.2

Pitch Adapter Single Metal



Pitch Adapter Single Metal



Thank you for your attention!