JRA2 TA2-SiTRA - Status Report

Helsinki U. Helsinki (Fi), LPNHE-U. Pierre & Marie Curie/CNRS-IN2P3 (Fr), Charles U. in Prague (Cz), IFCA (CSIC-U. Cantabria) Santander (Sp).

Also contributing to this activity the associated members:
CNM-IMB (CSIC) Barcelona, Obninsk State U Rusia, HEPHY Vienna

*Work also performed within the **SiLC R&D collaboration***
(U. of Barcelona ,Torino INFN, ITE Warsaw)

EUDET Annual Meeting, U. Genève 20th October '09

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Outline

- Introduction:
  - SITRA task scope.
- '09 Activities Report:
  - Infrastructure:
    - DAQ and FE chip.
    - Mechanics: Modules, faraday cage.
    - Alignment
    - Chip/sensor interconnections
- Transnational Access

Introduction

- The SiTRA must provide:
  - => The Silicon Modules and Silicon prototypes
  - => The Faraday & cooling cage
  - => The 3D Table
  - => The alignment system
  - => The FE readout chips
  - => The DAQ system

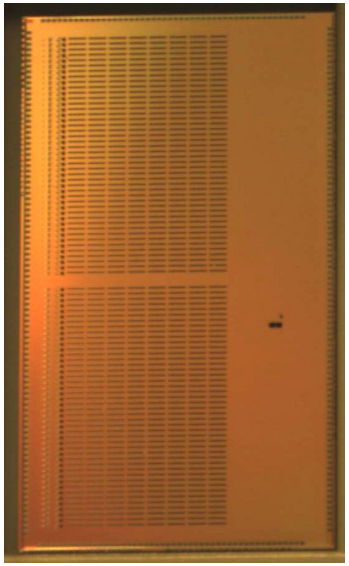
HERE, STATUS REPORT ON THESE ITEMS AND SOME OTHERS CLOSED RELATED R&Ds FROM ASOCIATES.

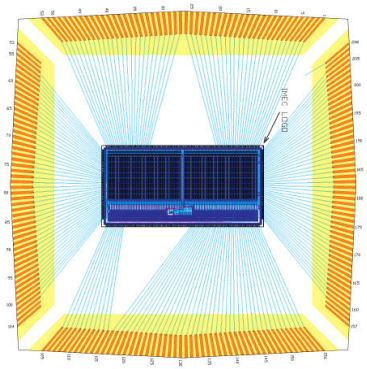
FE R/O CHIP & DAQ

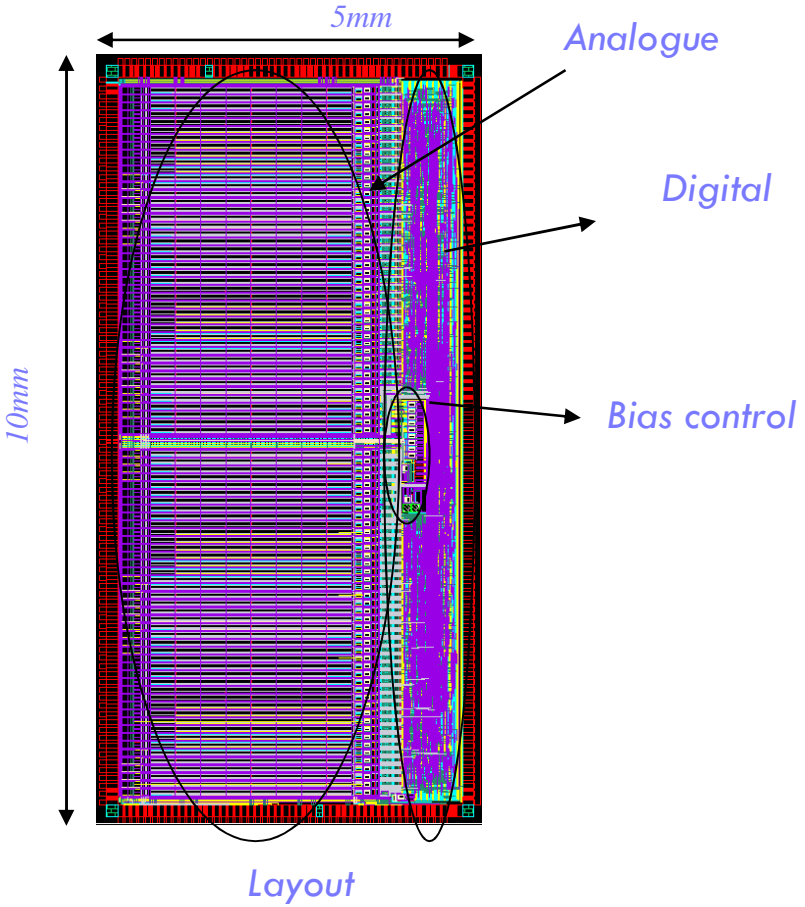
INFRASTRUCTURE

FE R/O chip SiTR_88

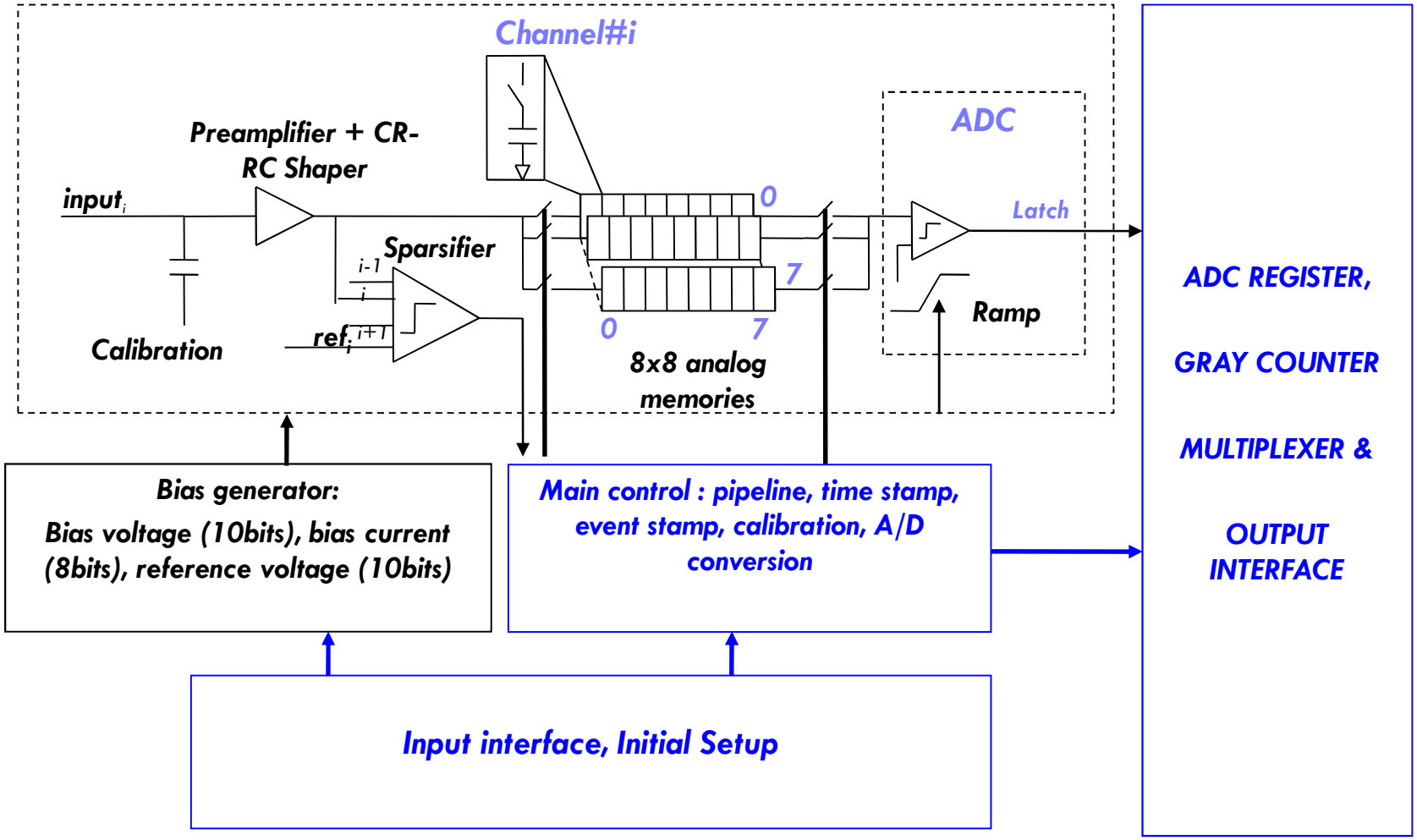
- UMC 130nm
- 88 Channels
- Received in oct 08



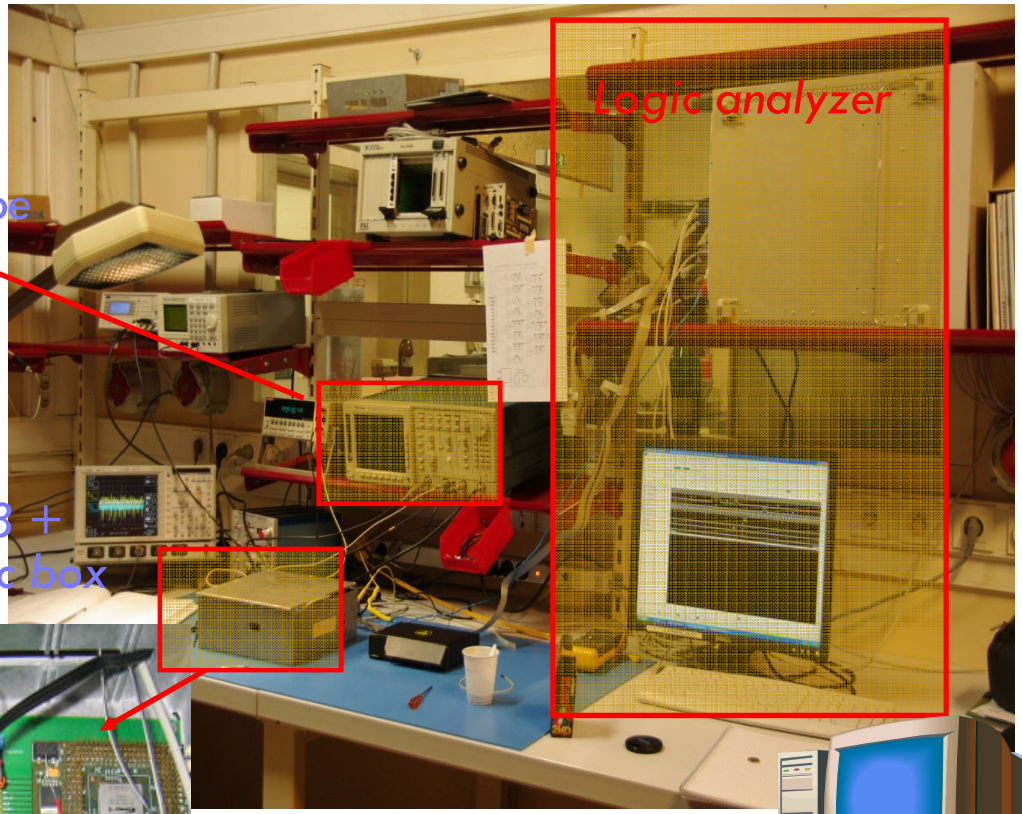


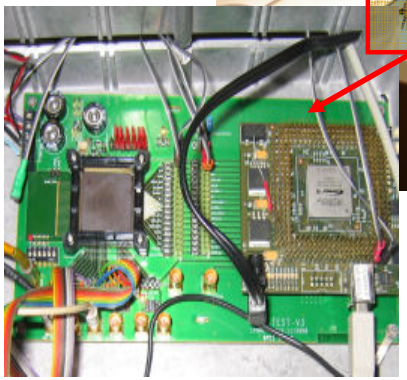


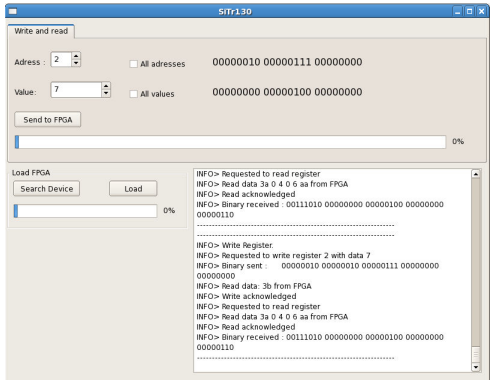
FE R/O chip 88-channel



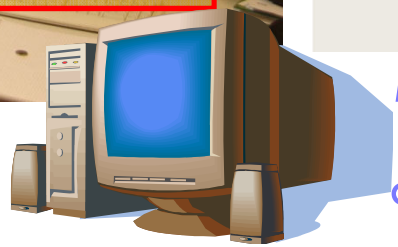
Lab test bench of SiTr_88







USB link

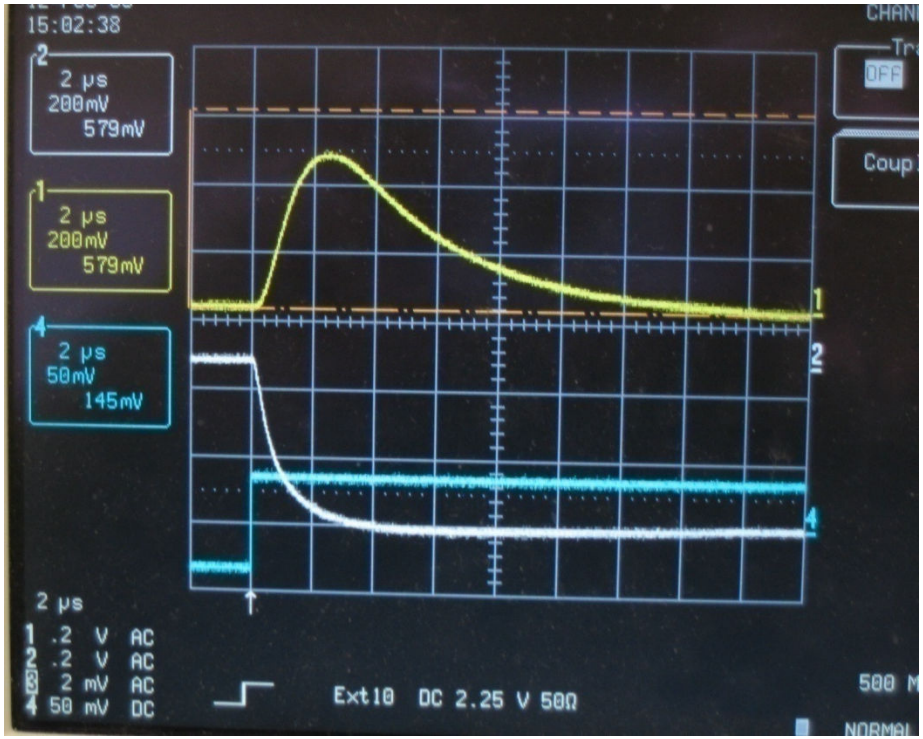


PC and C++ based program allows the control of the circuit

Results from analogue part

- Problem with the serial to parallel input of the digital part
- Analog part accessible through 88th channel fully equipped with test points

- Preamp → white track
- Shaper → yellow track
- Power supply →1.3 mW/channel
- Linearity → 2.6% up to 24 MIP



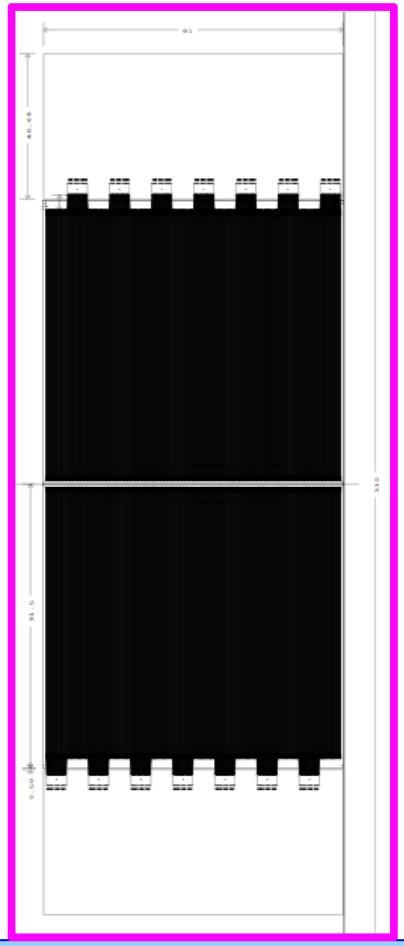
New SiTr_128 development

- *Optimized silicon surface by using 2f/um² process & reduce analog memories to 4x8*
- *Modular structure by bloc of 64-channel*
- *JTAG integration possibilities*
- *More test & calibration sub-circuit*
- *Possibility to use IBM 130nm CMOS*
- *The direct connection "bump-bonding" is under investigated*

The related DAQ system: Hardware part

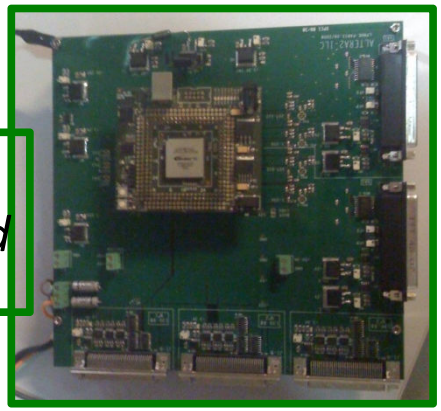
- The number of channels to read out is growing
  - Alignment tests (2009)=> 2560 channels
  - Combined calo tests (mid-2010) => 15000 à 20000 ch
  - 2011-2012 -> much more !!!
- DAQ hardware “Kit” , evolutive system
  - VA1 (VFE reference), SiTR_130 and new prototypes, mixed mode FE (Ref+SiTR_130)
  - XILINX modules: Altera/USB (currently available→ Altera/(Ethernet, USBx)? Under development

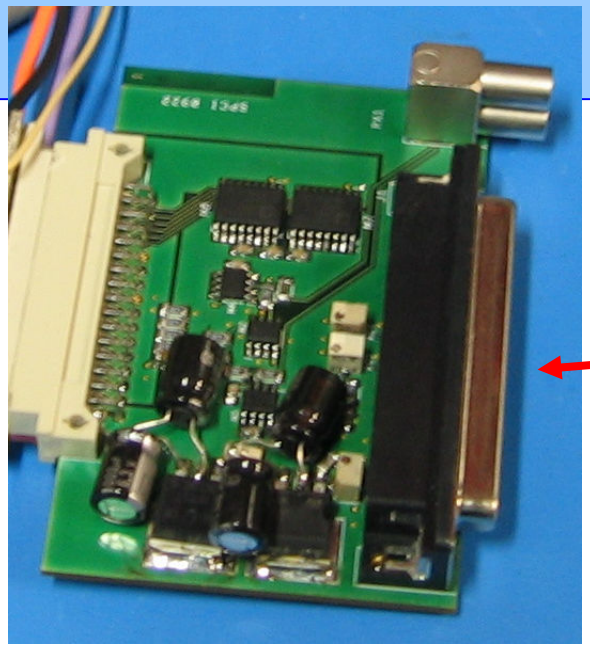
Redesign of the module for the new SiTR_130-128

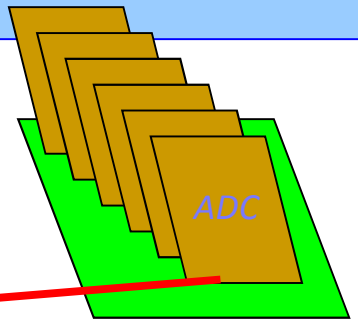


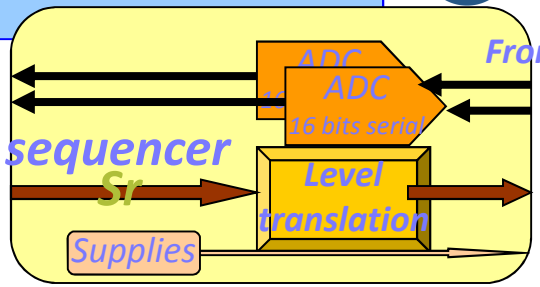
FPGA system for VA1 only

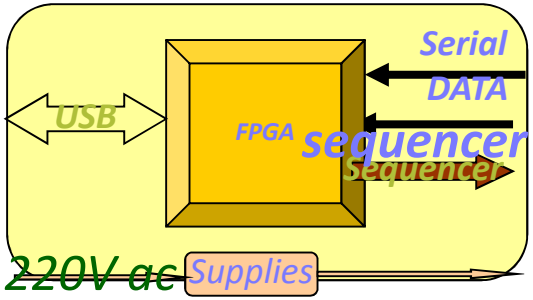
Version For mixed FE chips

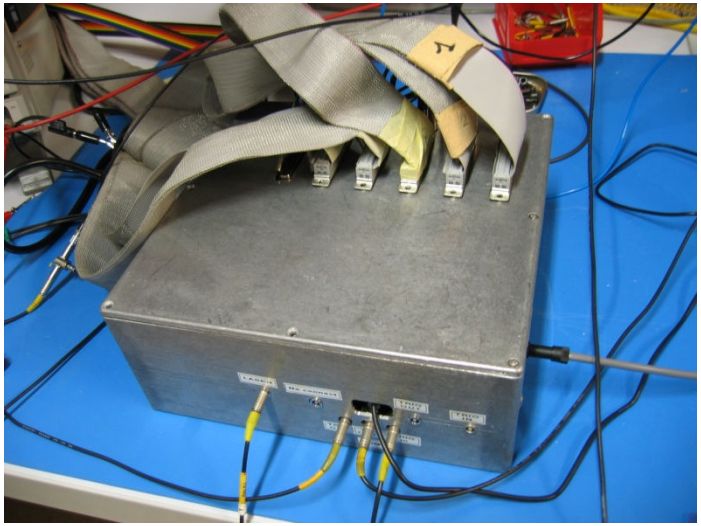












The electronic box

A new DAQ electronics for VA1' readout only

Only one USB link for the whole box

USB → *In study* → TCP IP

MECHANICS

INFRASTRUCTURE

Construction of the Silicon modules

- Design of the modules

Modules are made of two sensors bonded to each other (bonding performed at CERN bonding Lab)

Flexibility wrt the FE chip (hybrid board can be replaced)

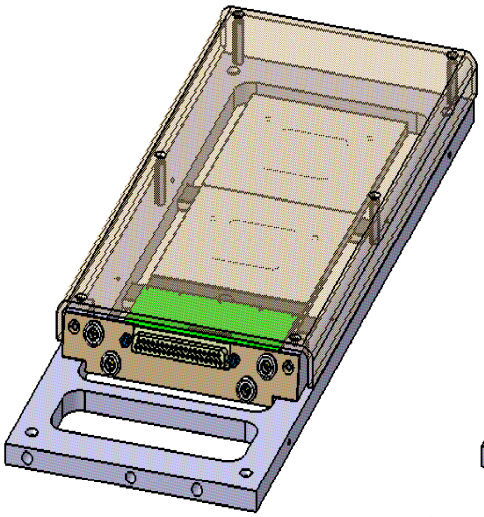
All kinds of sensor types can be included in this structure

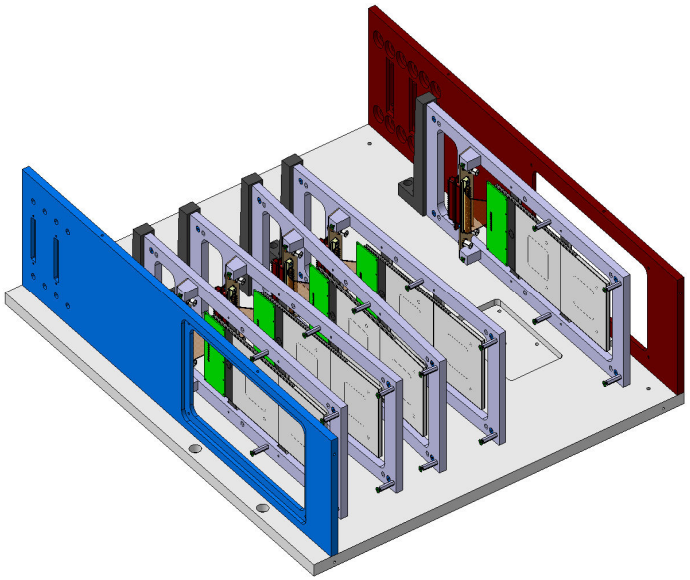
Special case are the alignment friendly modules

(laser IR integrated in the system)

Tests with radioactive source is integrated as well

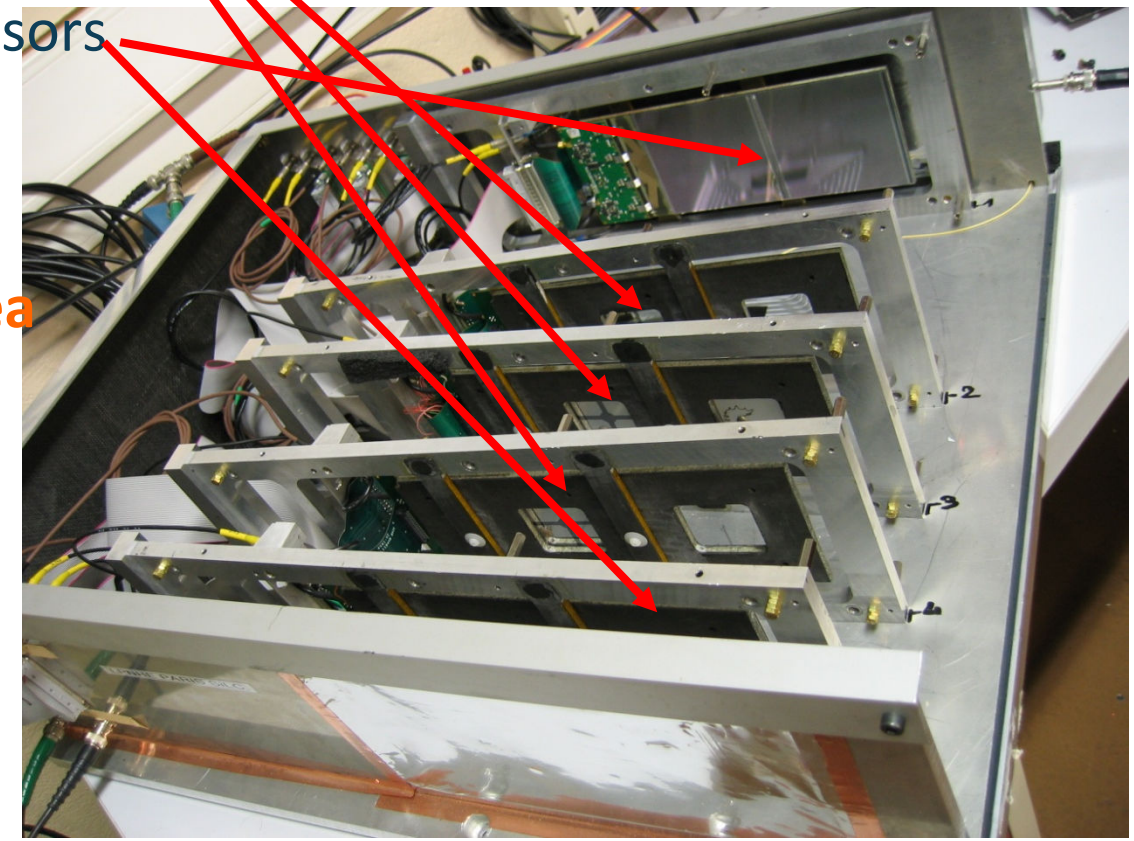
Easy to manipulate -> robust support structure





Inside the Faraday cage

- 3 modules with friendly aligned HPK sensors
- Surrounded with 2 non AL treated HPK sensors
- Electronics from VA1®
  - 512 ch **per** sensor,
  - 25.4 mm **active area**



The 3D Table for test beam at CERN

INFRASTRUCTURE

SiTRA infrastructure: Laser Alignment System

- Goal:
  - Include a laser-based alignment on SiTRA tracking infrastructure.
- Baseline:
  - CMS-like HPK large area sensors with back-side Al removed. No further optical optimization.
- Beyond the baseline (R&D on sensors):
  - Minimal modification of standard u-strip sensor to boost NIR light transmittance.

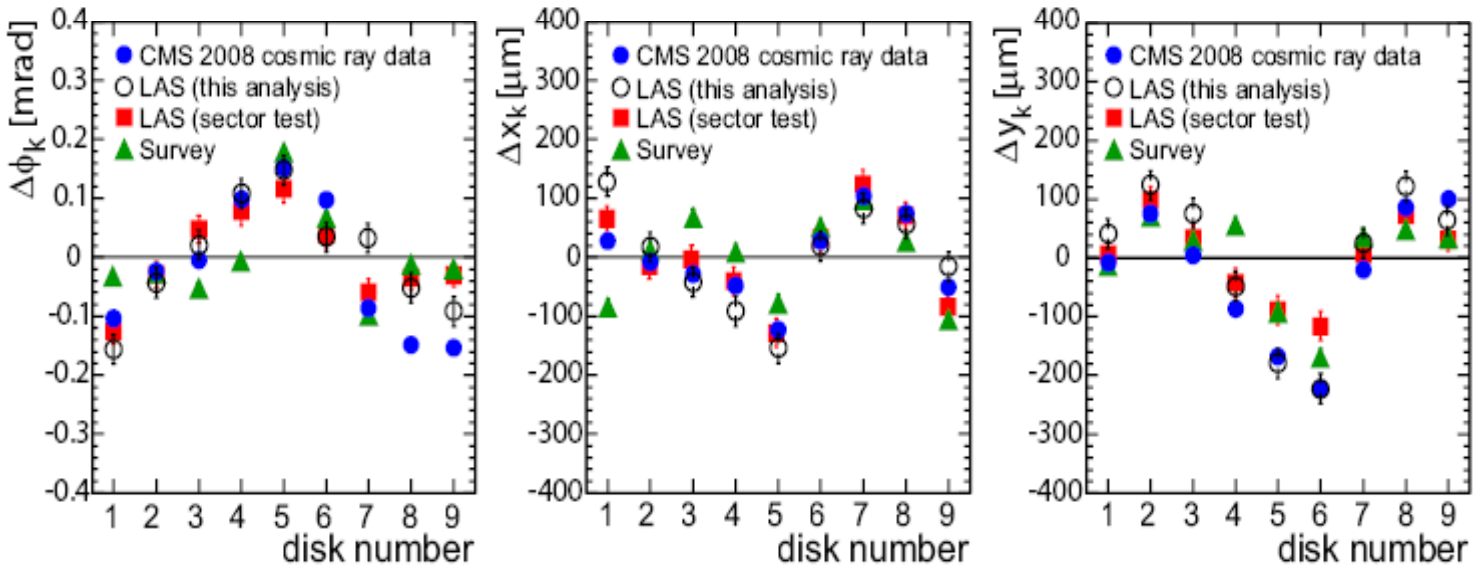
Alignment: Baseline at Work - CMS LAS

Optimization of sensors not included from beginning of sensor design:

lower transmittance ~<20%

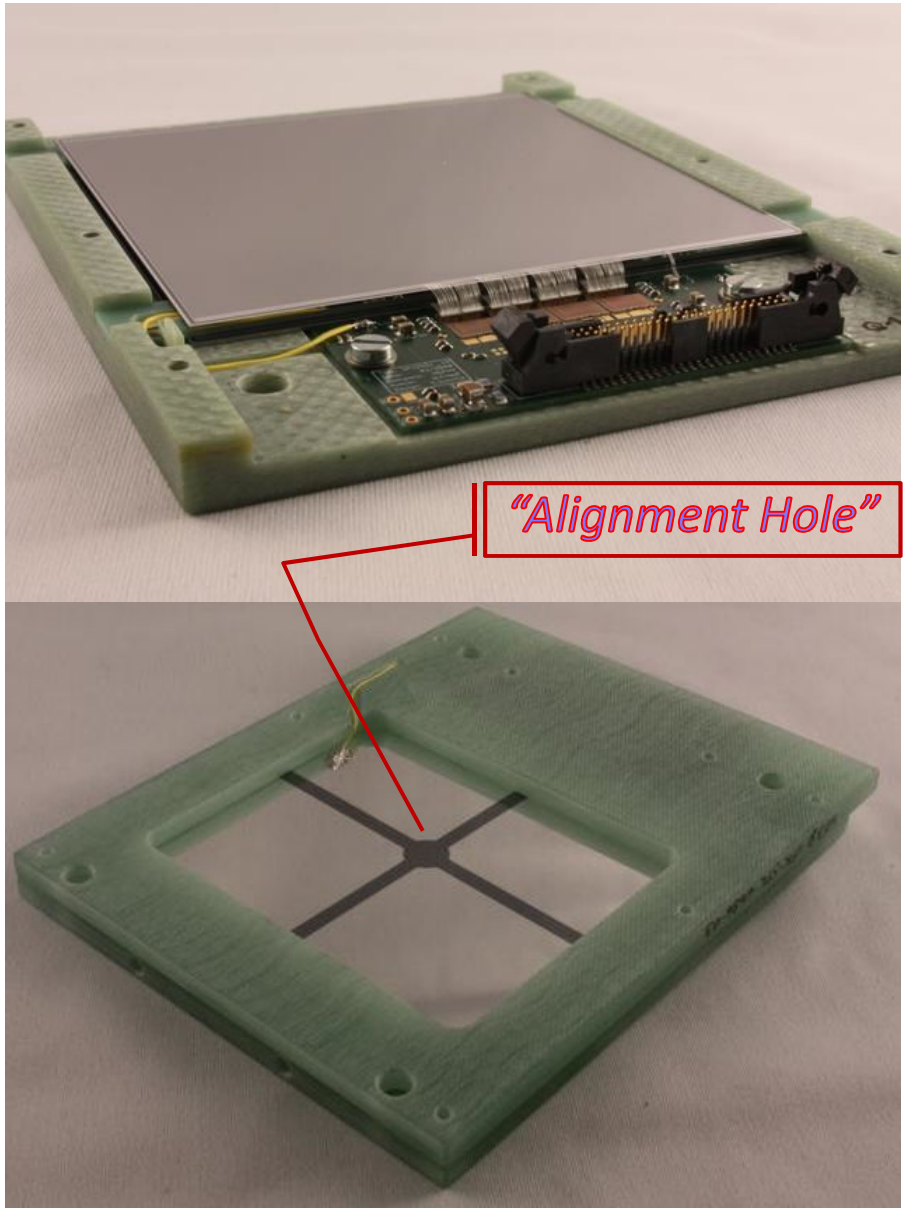
Some sensors need to be operated in saturation

Track-based and laser-based consistent at few tens of microns



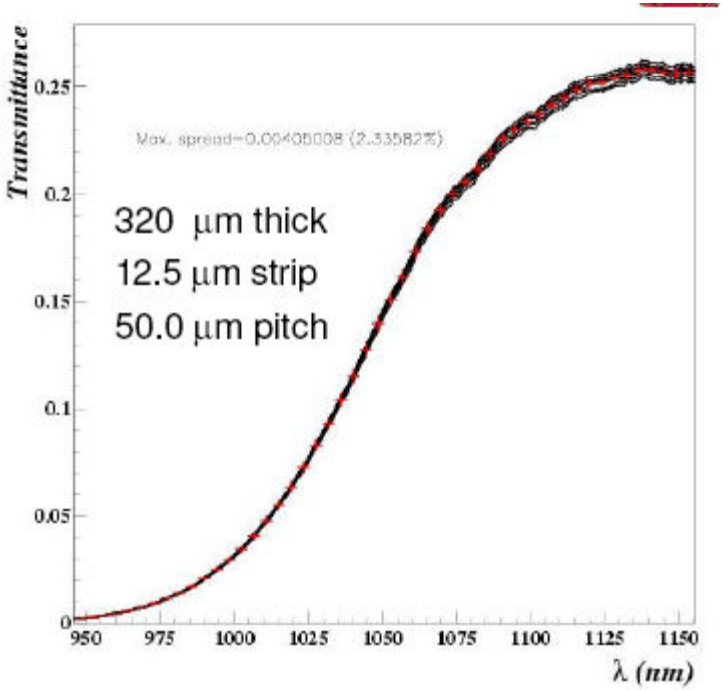
(CMS first paper at JINST !!)

SiTRA Alignment – HPK Alignment sensors.

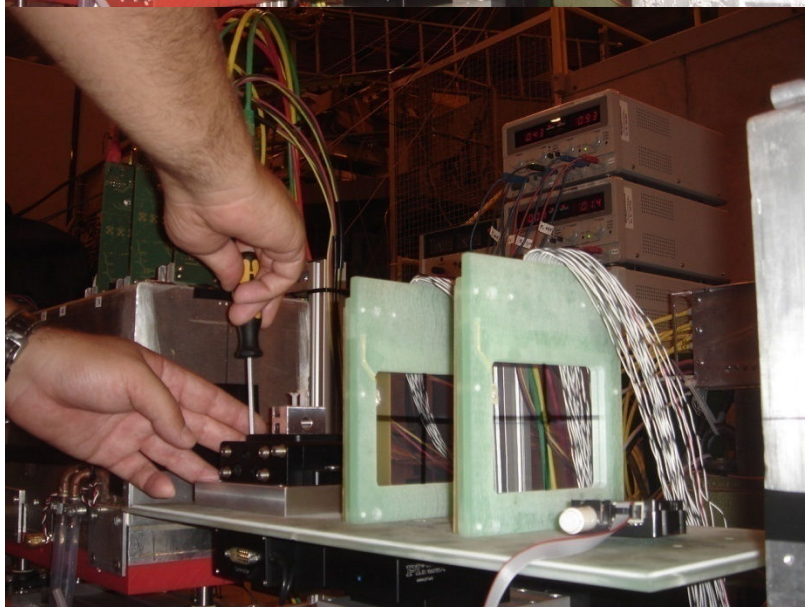


Two single –sensor modules R/O with APV25 Chips (512ch)

NIR Transmitance ~ 15-20%



SiTRA Alignment – SPS Test beam



AIM:

Assessment of SNR for backside removed metallization.

Comparison between track-based and laser alignment.

Testbeam at CERNs SPS

(19. to 26. August 2009)

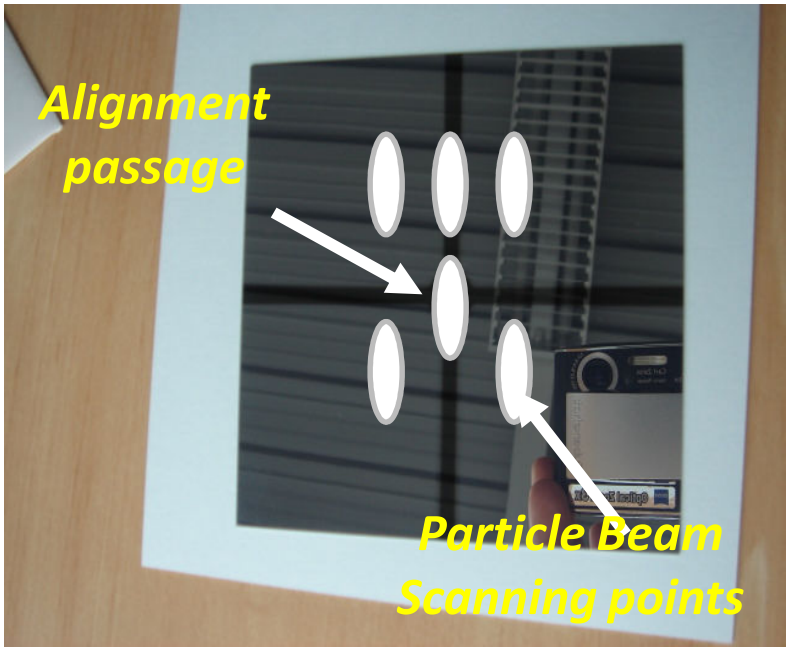
- CERN SPS North Area: H6B
- We used the *EUDET* Beam Telescope to get triggers and tracks

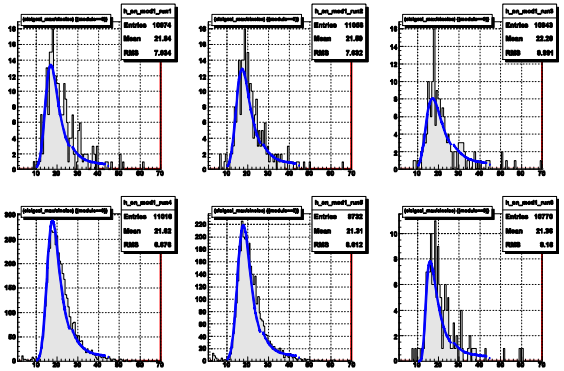
Results

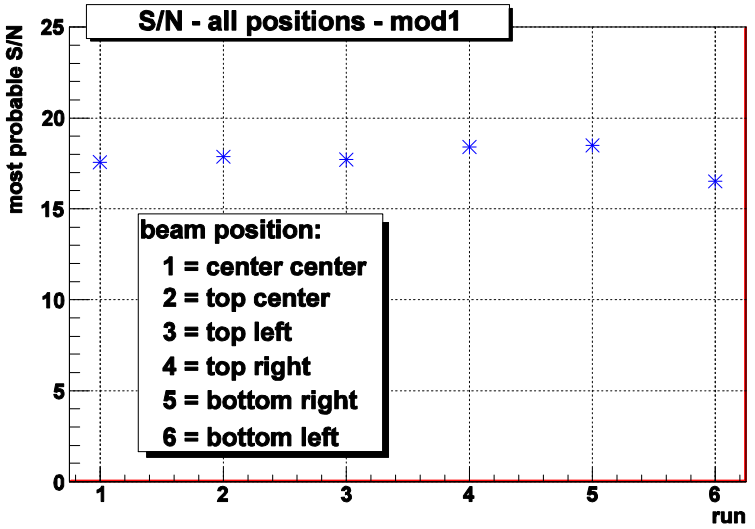
- About beam 100Kevents + laser 100Kevents.
- Analysis still in progress

Preliminary TB results

- SNR sensor scanning comparing Back side with Al vs. n Back side with Al metallization

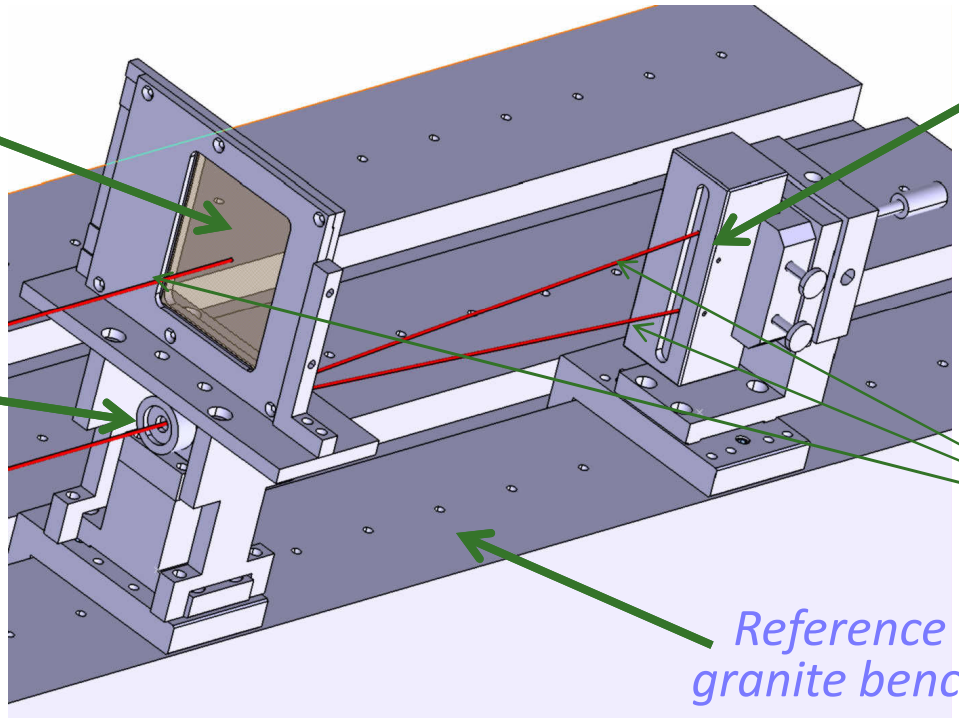






Absolute accuracy Determination

- Direct comparison with interferometric measurement (accuracy better than 1 um).

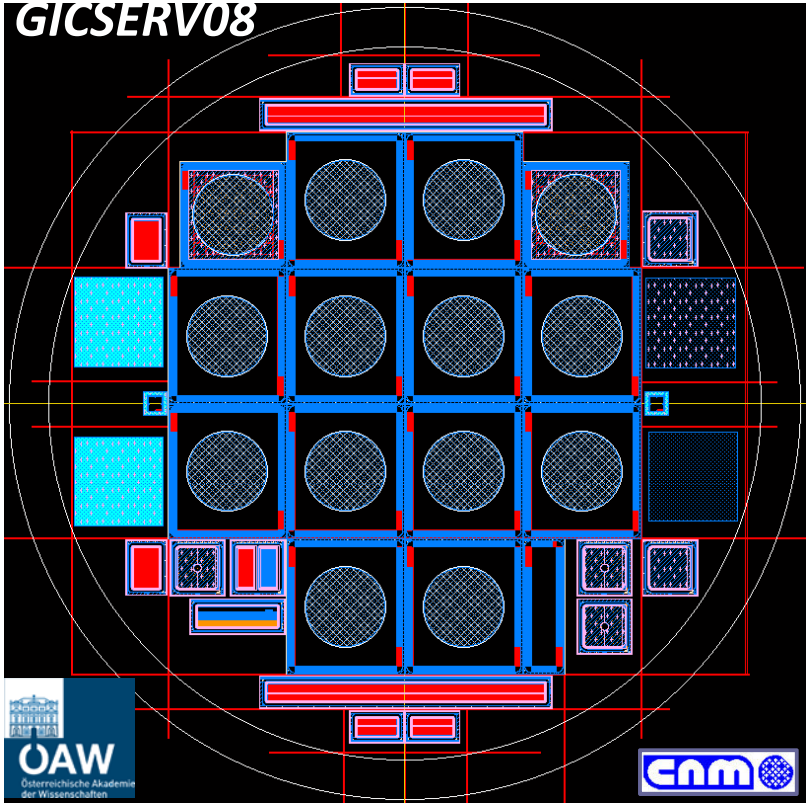


- Straightness measurement configuration all parts available currently being mounted

CNM Transparent sensors

- *Prototypes built by CNM-Barcelona (Spain)*

- *Aims:*
  - *Test %T vs multigeometry*
  - *Use optical test structures (continuous layers) to extract refraction index and control deposition*
  - *Test of electrical test structures*

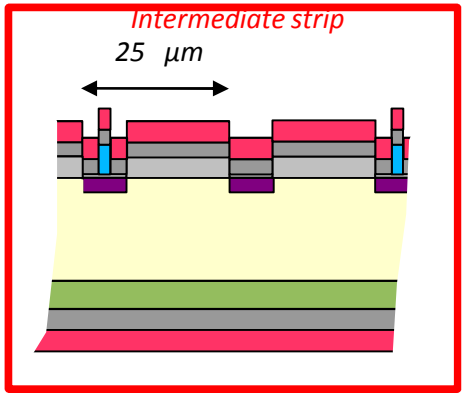


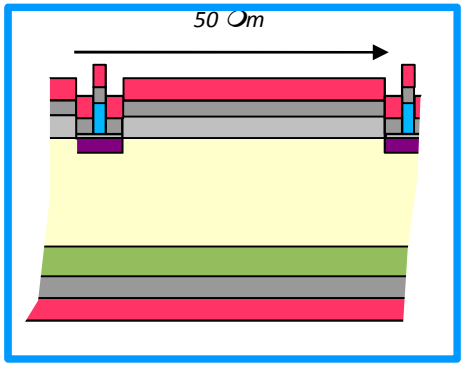
- *5+1 wafers*
- *12 ustrip detectors per wafer (6 with intermediate strips, without metal contacts)*
- *50 um RO pitch (25 um interm. strip)*
- *256 RO strips*
- *1.5 cm length varying strip width (3,5,10,15 um)*

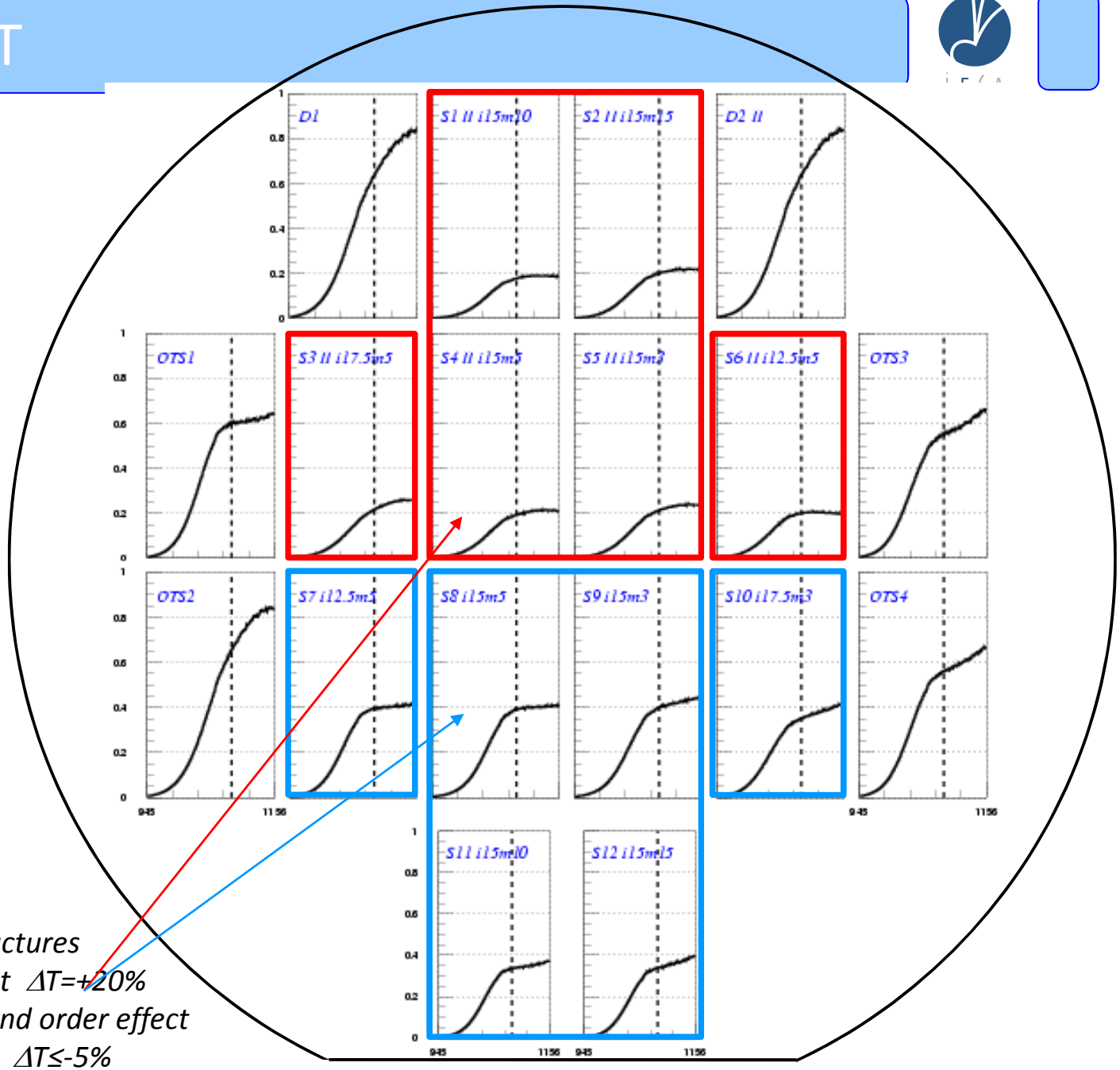
- *Mask designed by **D. Bassignana** (CNM)*
- *Electronic test structures designed by **M. Dragicevic** (Vienna) including:*
  CAP TS AC, CAP TS DC, CMS Diode, MOS, GCD, Sheet
- *Optical test structures available (Si, Si+p^+,SiO_2, SiO_2+passivation)*

Wafer 1:: %T

measured

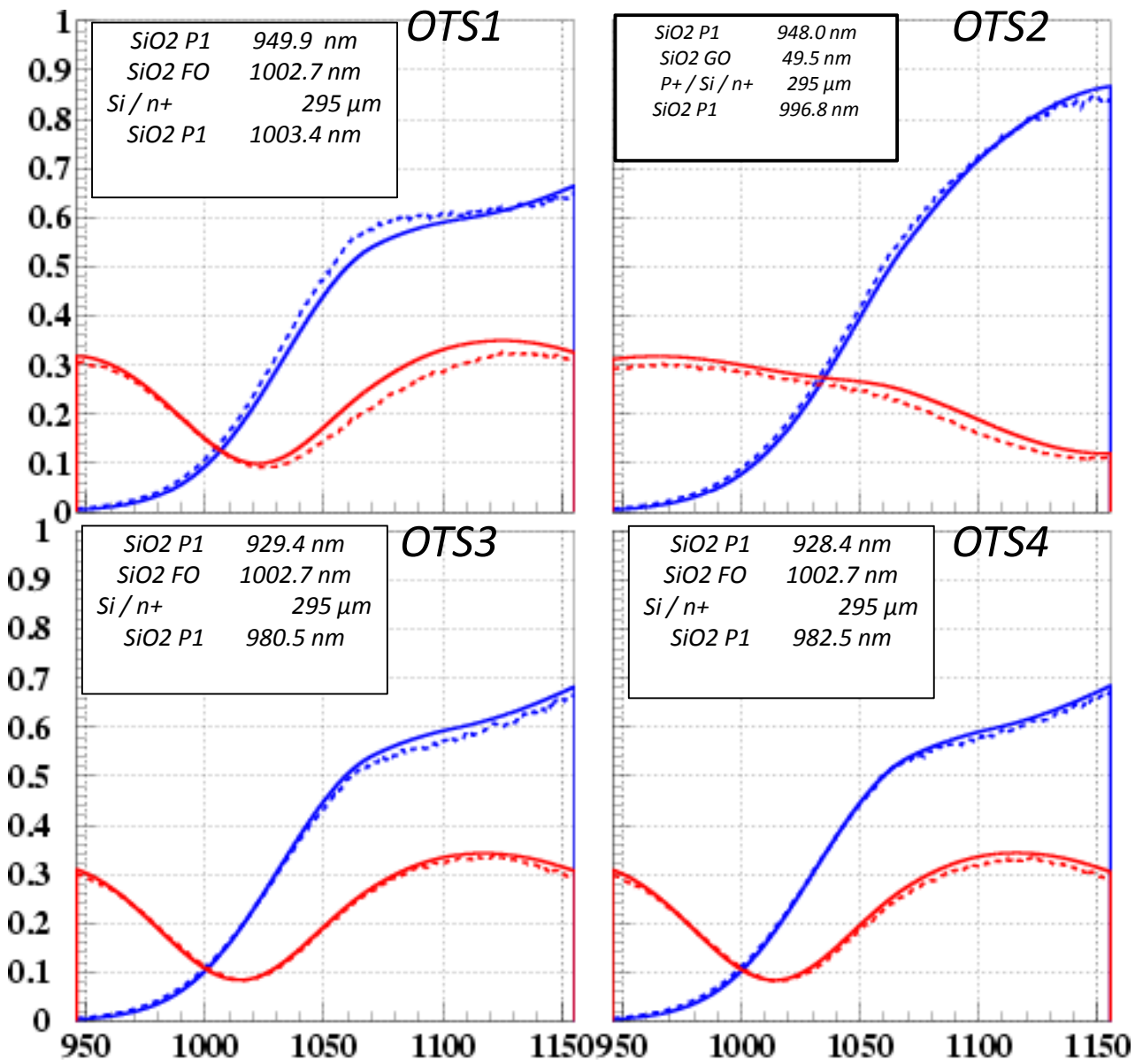






- *T~70-80% test structures*
- *No intermediate implant ΔT=+20%*
- *Metal width [3-5] um: second order effect*
- *Metal width >10 um: ΔT≤-5%*

Alignment - Measurement vs. Simulation



Optical Test structures simulated (no fit involved)

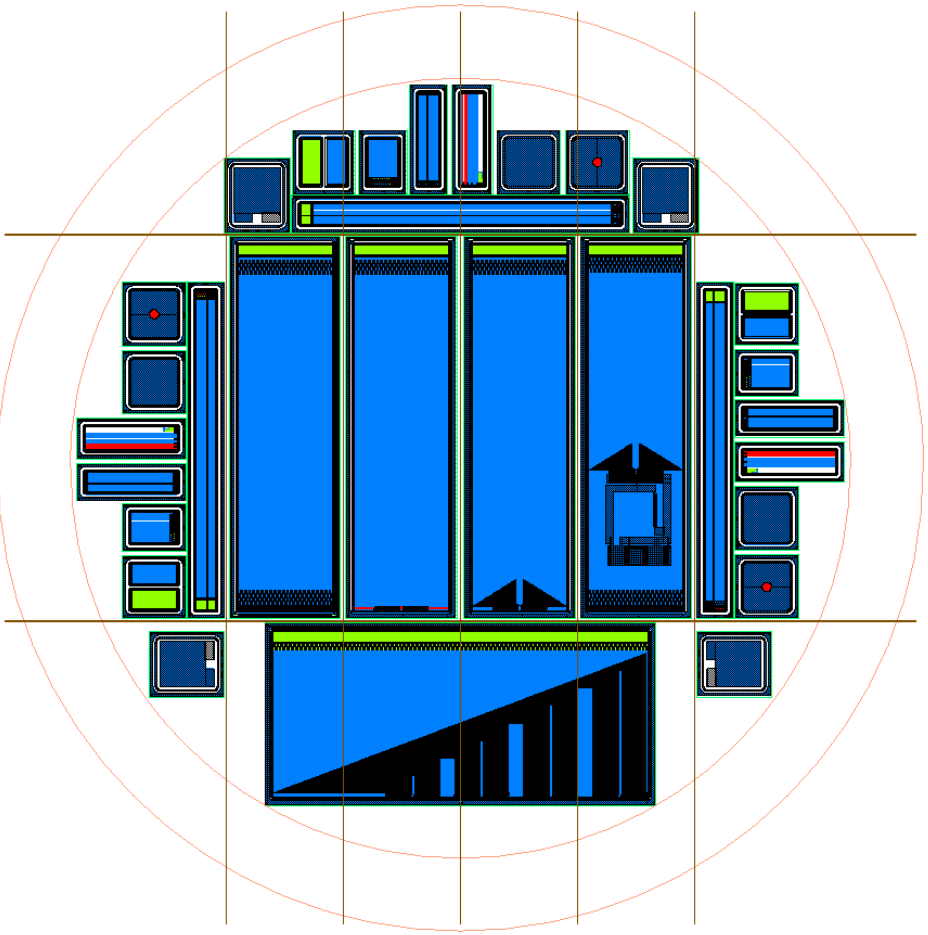
1st result: Transmittance of Si can be increased by ~30% with just 2 layers of 1 µm SiO2

%T meas
%T sim
%R meas
%R sim

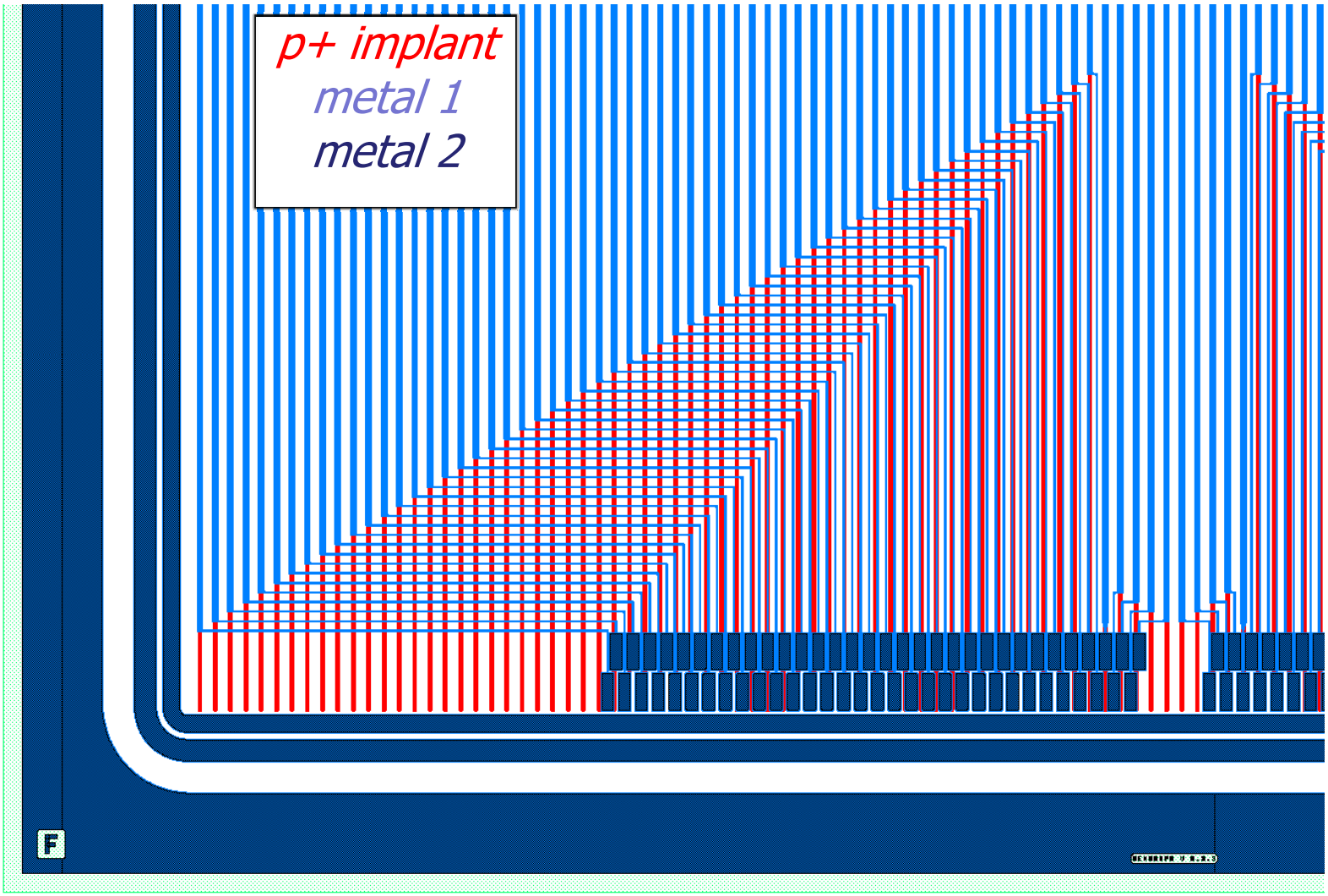
Sensor-Chip interconnects

INFRASTRUCTURE

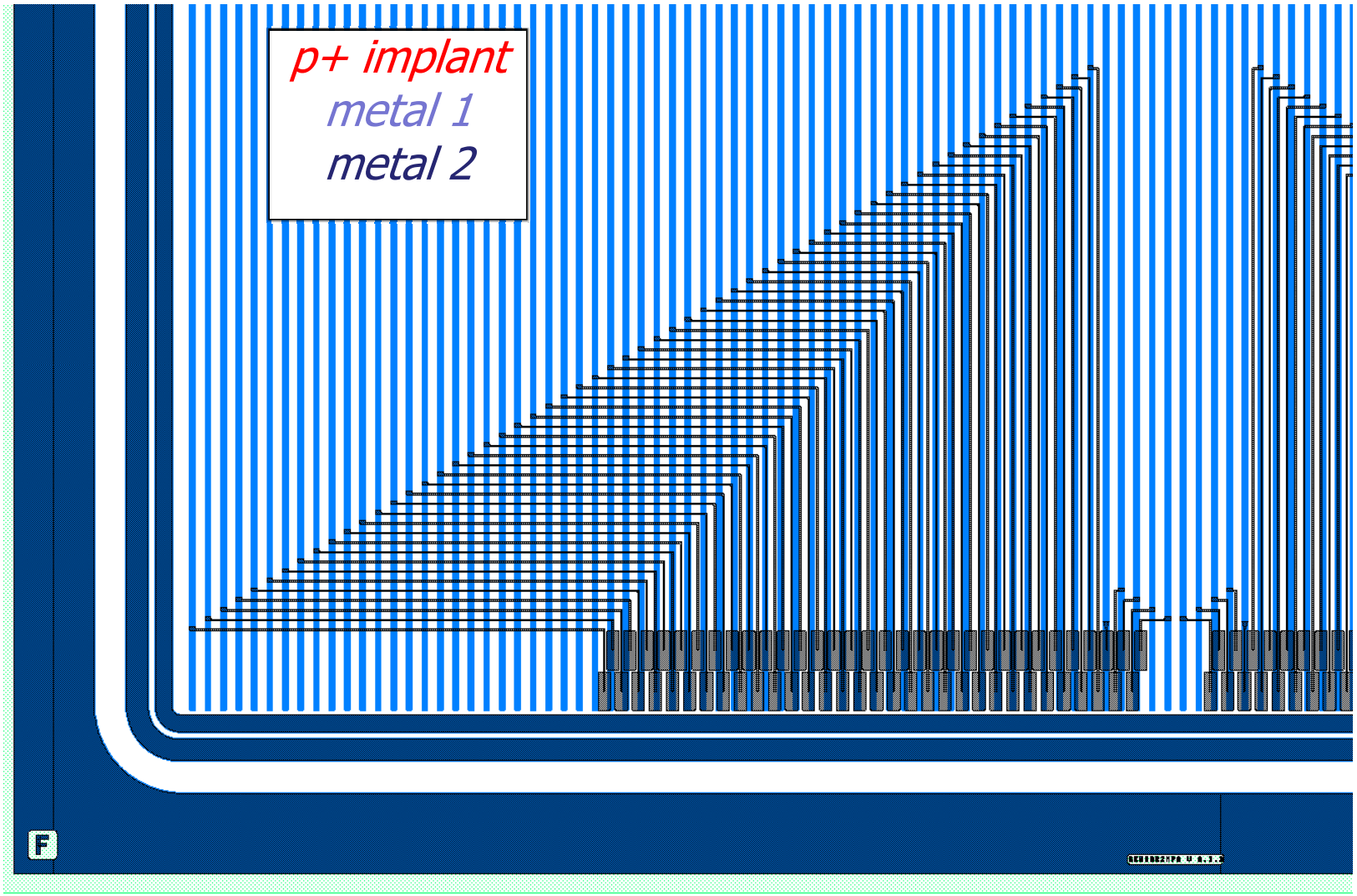
- 3 full halfmoons with improved teststructures
  - same design as for HPK thin sensor order
- Additional teststructure (4 x TS_DM)
  - large double metal capacitor
  - oxide thickness between metals
- 5 AC coupled sensors, 80 µm pitch, different integrated PAs:
  - 4 x 128 strips
  - 1 x 512 strips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



PA Single: Closeup



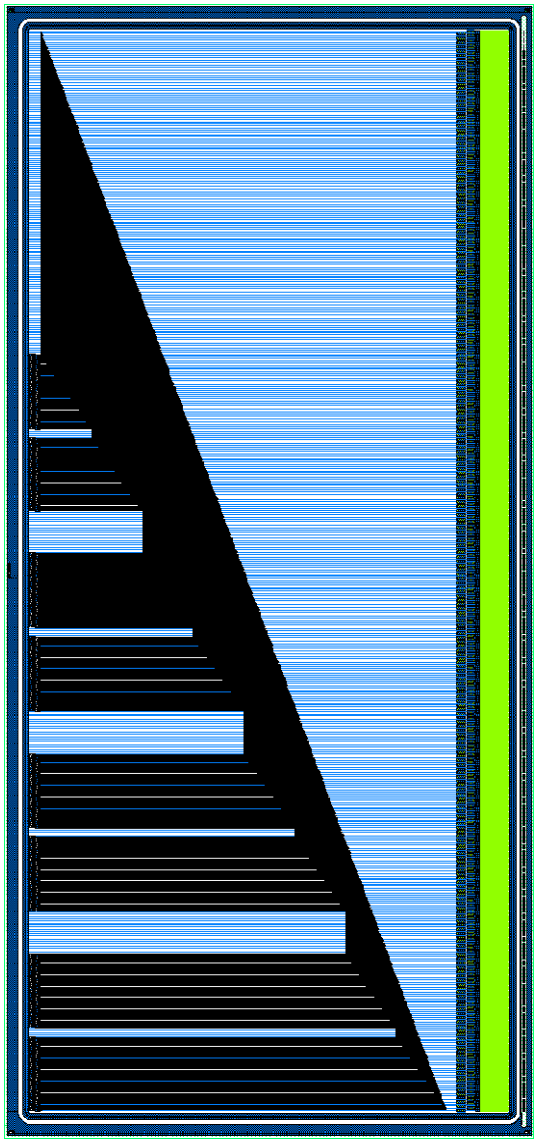
PA Double: Closeup



512 Strips (ITE09W_512)

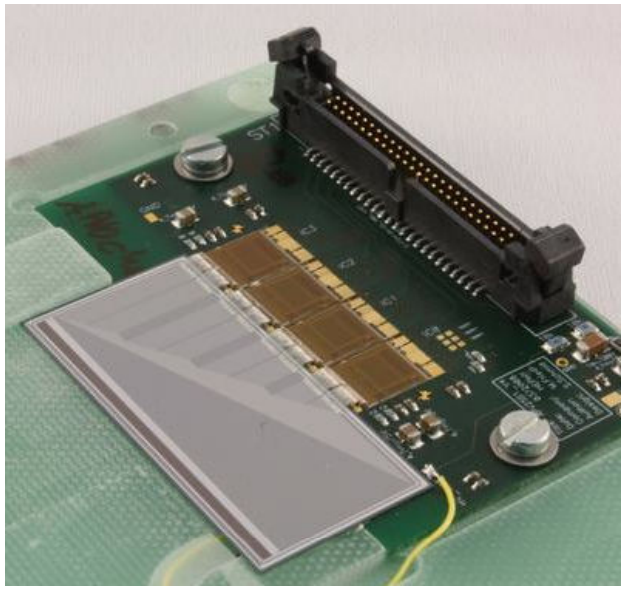
Same Strip Geometry as other Sensors but

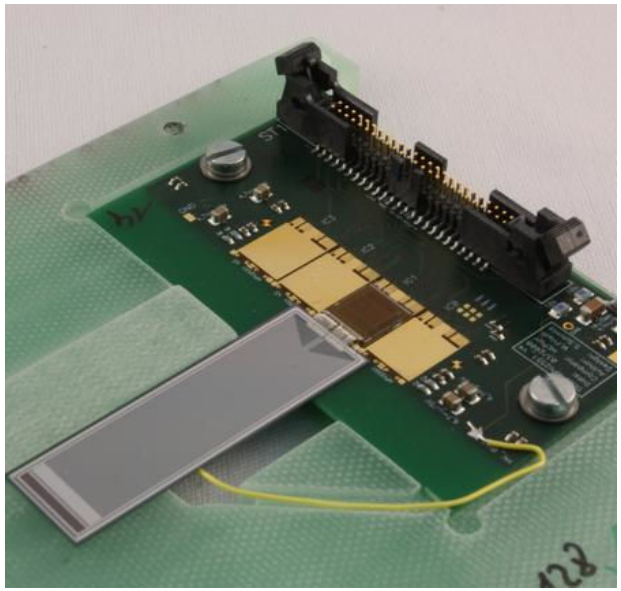
- 512 short Strips
- Long routing lines to test influence on SNR and Crosstalk
- Routing is for a custom 4 x APV Hybrid
- Hybrid fits APVDAQ readout system



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 halfmoon for stereo measurements
- Stack of last years multigeometry sensors for calibration





Testbeam at SPS

Testbeam at CERNs SPS

(19. to 26. August 2009)

CERN SPS North Area: H6B

Low intensity 120 GeV with

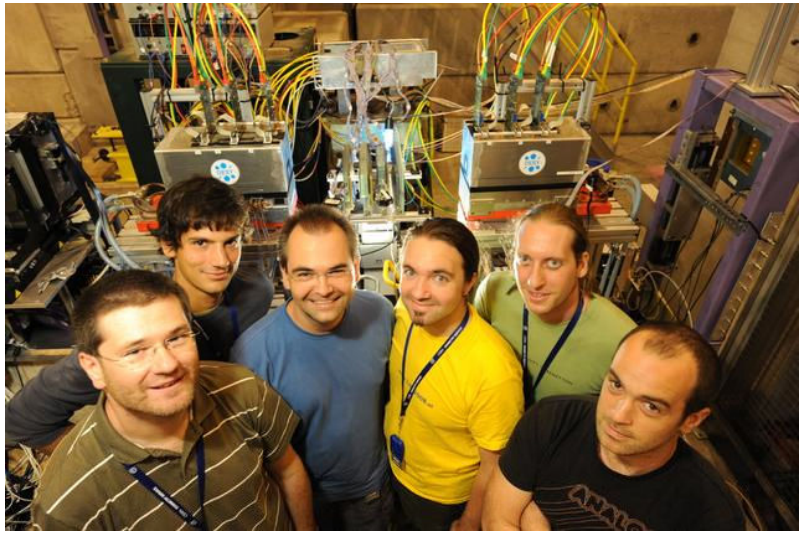
Pi+	*55.67 %*
p	*38.95 %*
K+	*5.38 %*

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



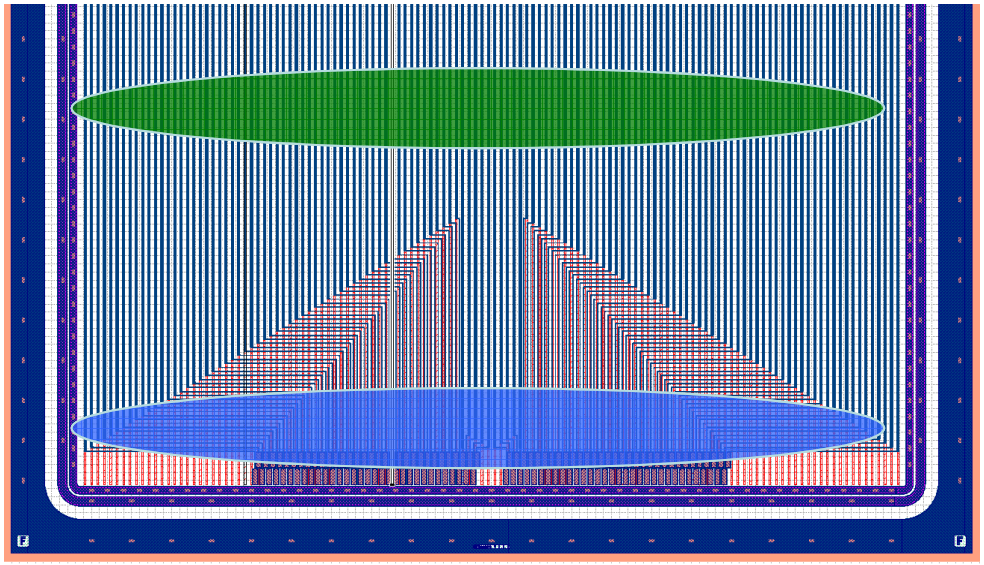
Results

3.2 Million events

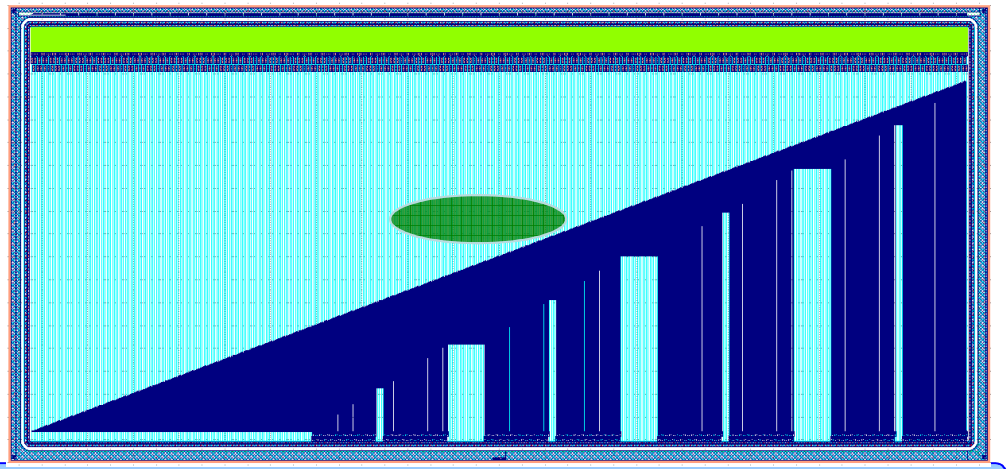
1 TB of data

Full Logbook at
http://elog.hephy.at/testbeam-SPS09/

- ITE 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



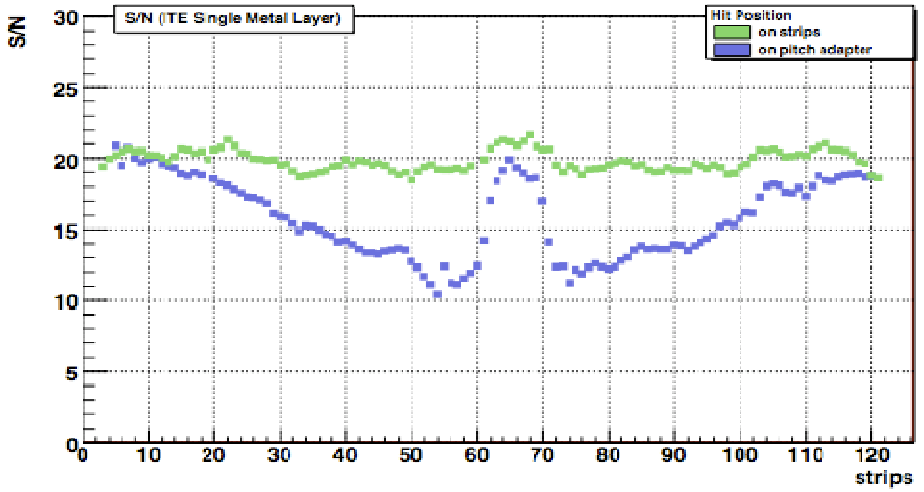
Signal loss: tentative result

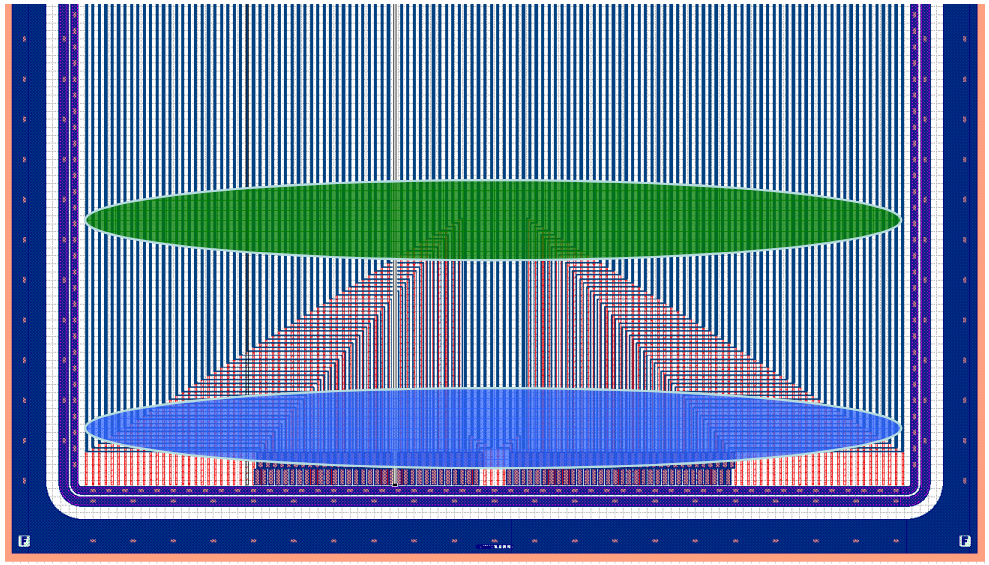
Data is taken from two runs

Height information from additional sensor rotated by 90°

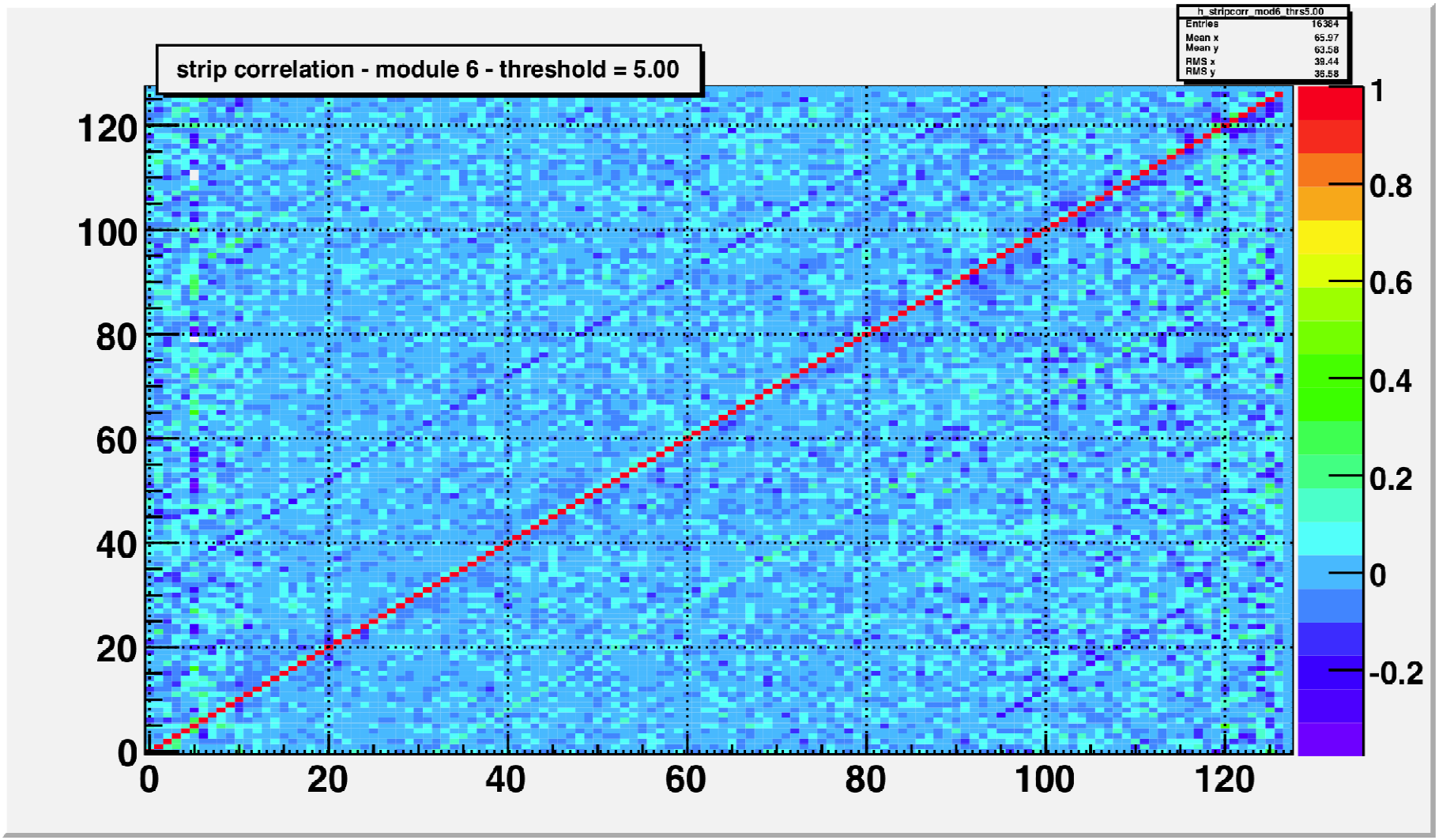
Each hit position represents SNR of a cluster with hit location estimated at the respective strip

Closer look on signals and noise separately necessary to disentangle effects

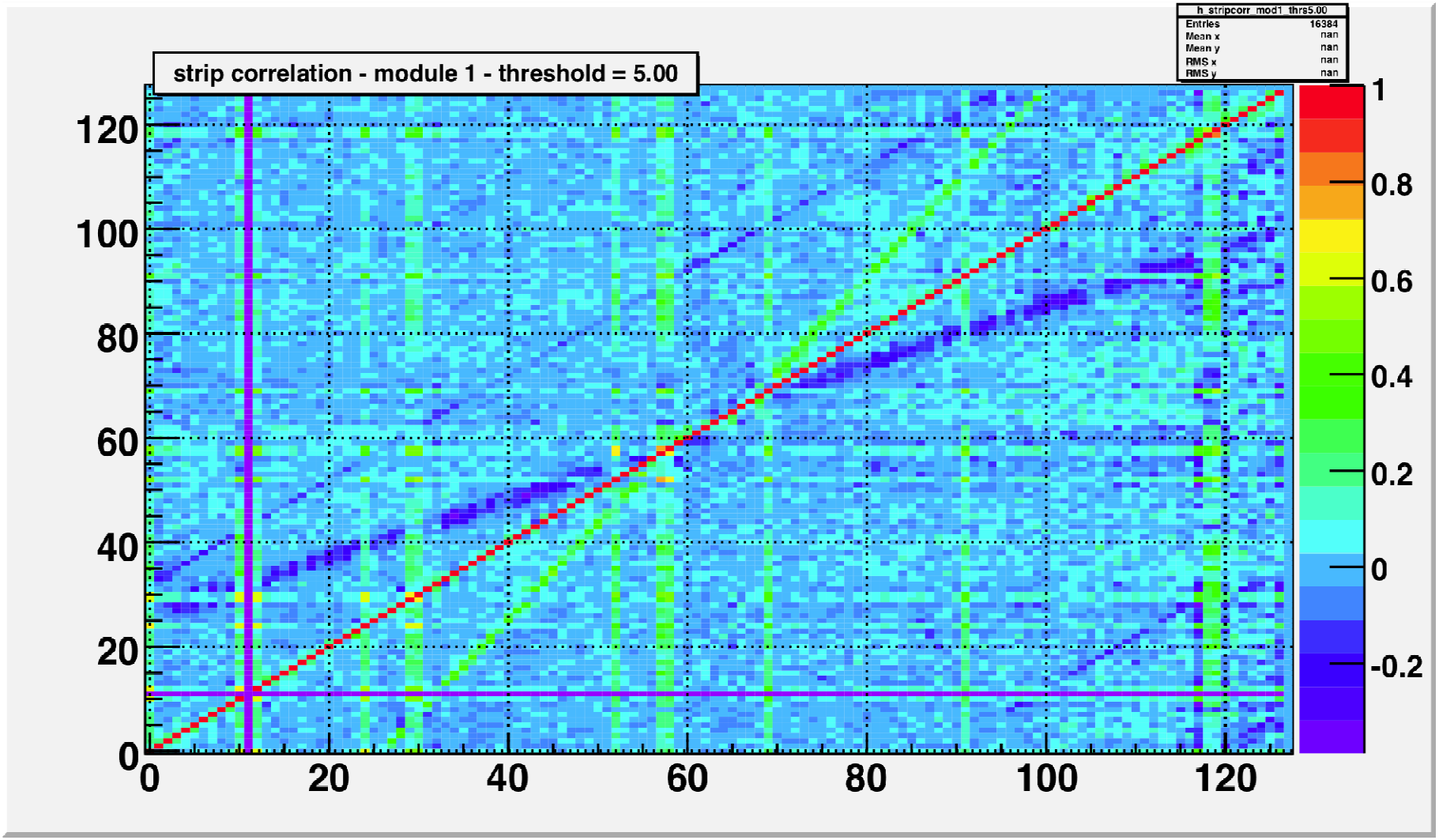




Standard


strip correlation - module 6 - threshold = 5.00
h_stripcorr_mod6_thrs5.00
Entries 16384
Mean x 65.97
Mean y 63.58
RMS x 38.44
RMS y 36.58
0
20
40
60
80
100
120
1
0.8
0.6
0.4
0.2
0
-0.2

Pitch Adapter Single Metal



TRANSNATIONAL ACCESS

Transnational Aspects

1 - Tests of the current alignment system with with the IR laser (Santander laser test bench) and at SPS test beam still in 2009, conducted by the ***Torino team***

2- Tests of new sensor technologies conducted by ***HEPHY-Vienna***

at CERN SPS (15-30 August 2009) (see Th.Bergauer's presentation) . Will be pursued next year.

3 - Combined tests with calorimetry: dual readout test beam at CERN (2010), conducted by italian teams *(Pisa)*

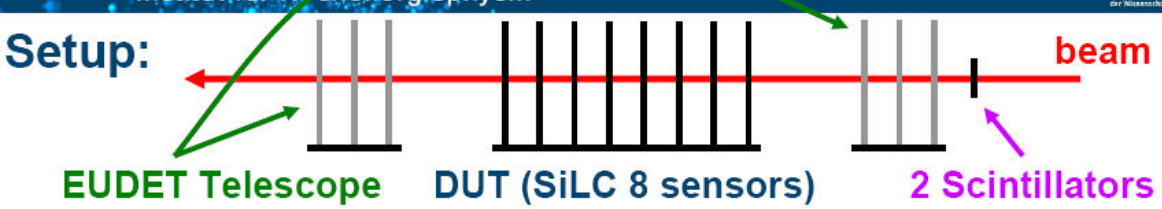
4- Tests of new sensor technologies: tests of news sensors including new pixel technologies from ***IRST, VTT*** (in preparation for 2010): modules will be made at LPNHE&CERN and will be included in the present standalone test infrastructure.

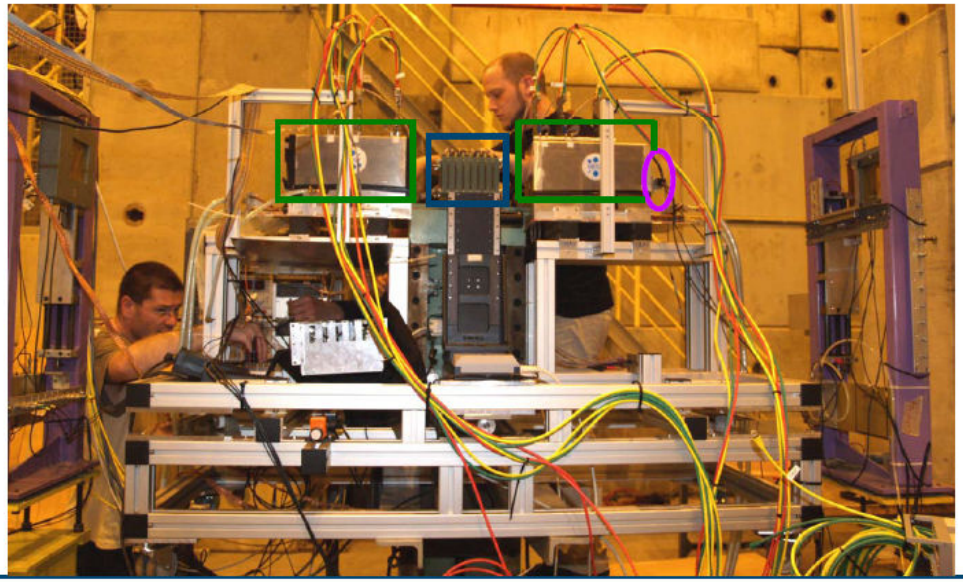
HEPHY tests infrastructure studies:

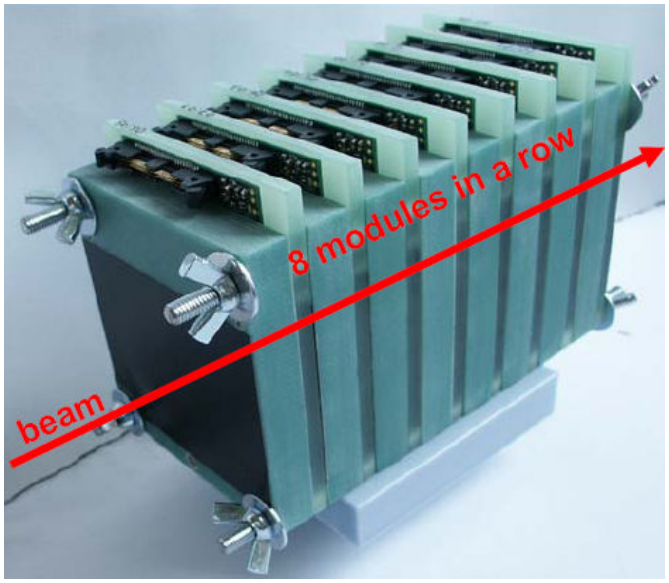
HEPHY Institut für Hochenergiephysik

ÖAW

Setup:

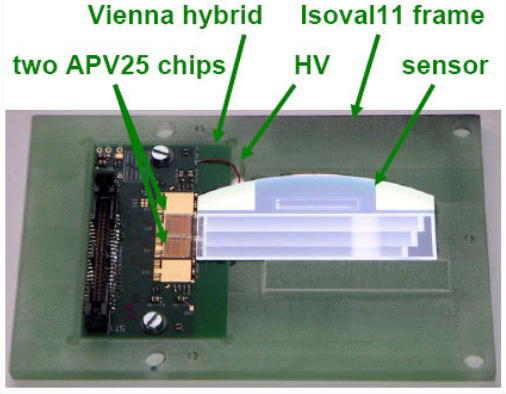




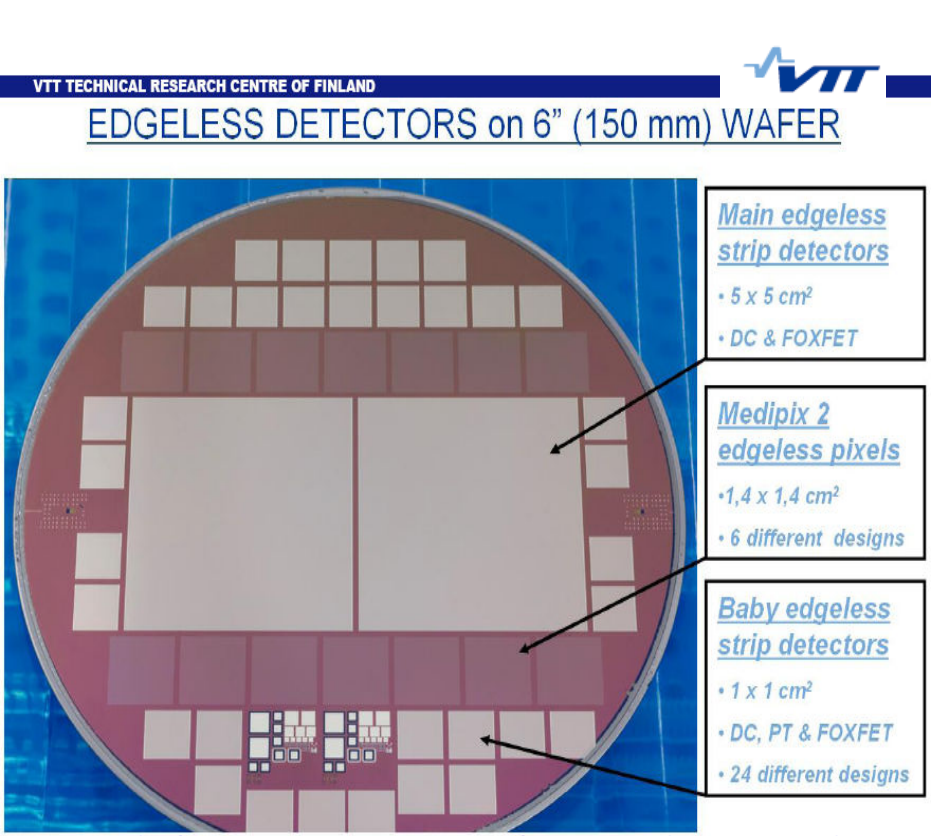


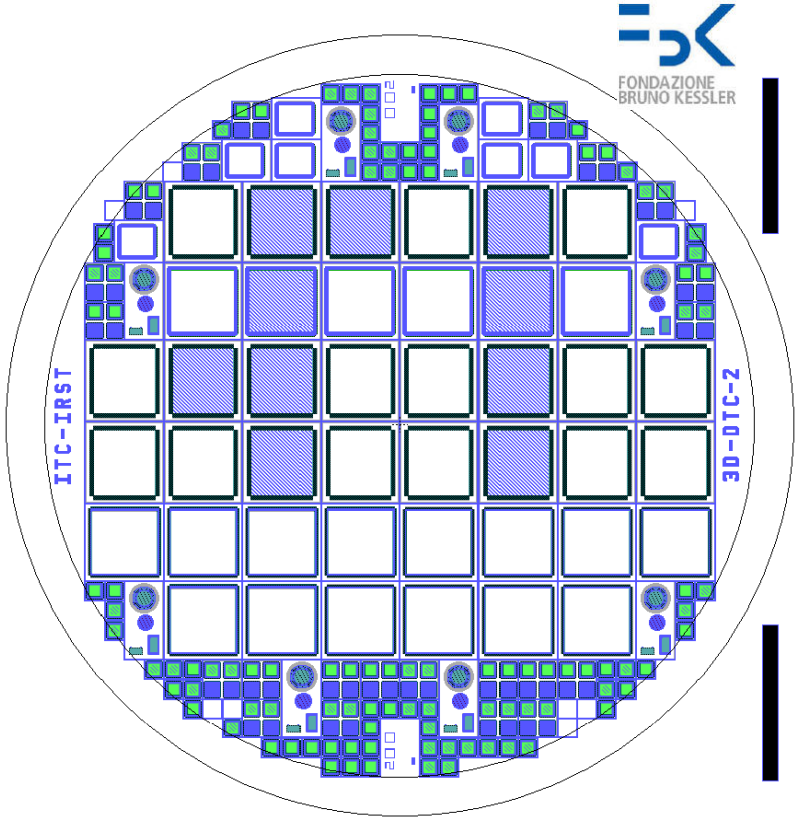
without top cover

microbonds are used to connect hybrid, APVs and sensor



Using standalone structure to test

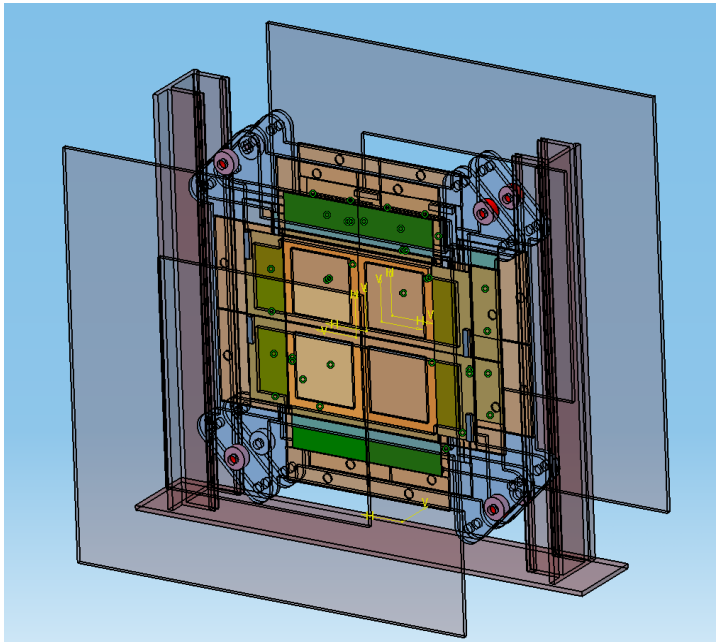


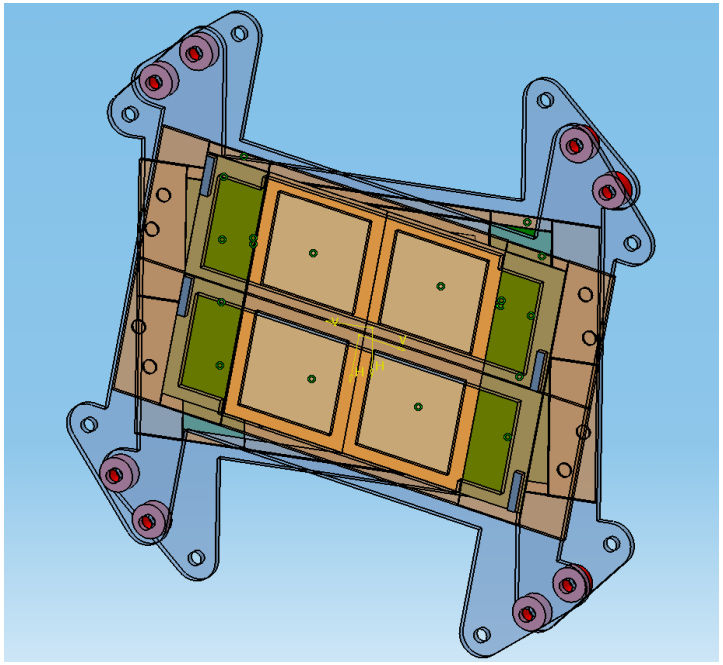


Modules are going to being designed at LPNHE to host various types of new sensor Strip prototypes: new edgeless strip sensors (left) with 5x5cm2 sensors; new short Strip sensors (right) 1.5x1.5 cm2, in 3D technology amd planar edgeless strip sensors 2.5x5cm2 prototypes

Construction of new larger modules for

Under preparation for next year first for CALICE (can be adapted to other calorimetry tests
urface to be covered: 18x18cm2 in 2010 tests=> first 2 false double sided modules are bui





Design allows to study various coupling angles between the single sided modules
(XUV or small angle tilted modules for false double sided case)

Summary

- SiTRA activites include: construction of prototypes, design of new FE electronics (based on ref. Chips and new chips), development of the associated DAQ (hardware & software), cooling-Faraday cage and 3D Table, plus a full alignment system based on IR laser system.
- Transnational based applications of these various infrastructures are occurring in 2009 (2) and at least 2 other before the completion of the programme in 2010.

THANK YOU!