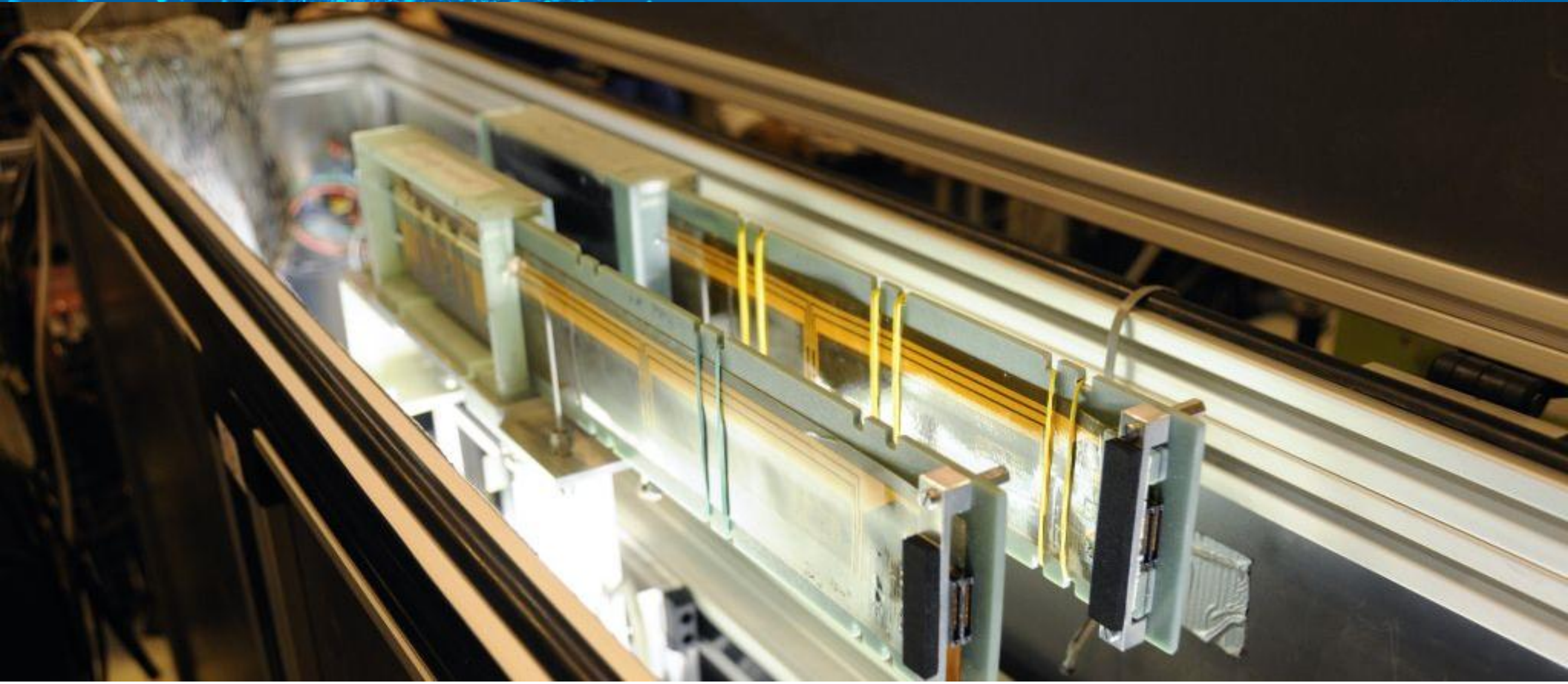

AIDA WP9.4: Status and Plans Vienna

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AIDA 1st Annual Meeting

29 March 2012

Outline

- Sensors and detectors modules
  - News on existing (SiLC) and new sensors
  - Options for modules with existing sensors
  - Design options for new sensors
- Progress on DAQ software and analysis framework
- Summary and discussion (with proposals)

Reminder: Sensor Procurement Options

- Try to get the existing HPK sensors already procured by the SiLC collaboration years ago
  - Discovered modules with the sensors in Paris
- Design and produce new sensors with
  - OnSemi
  - 2D Resistive Sensors from IFCA Santander/CNM Barcelona (not covered here)

Reminder: Answers from CALICE

We contacted CALICE (Felix Sefkow)

- **What should be the area to cover with silicon? 10x10 cm is rather easy, but anything more makes the project much more expensive.**
  We think that **10x10 cm2** is just sufficient, a **bit more** (12x12 or 15x15) would give us some safety margin.

- **How precise should the entry points in the calorimeter be defined, or, in other words, what is the (realistic) resolution you require for that?**
  A **sub-millimeter accuracy** would be by far sufficient. For most studies drift chambers would do, actually. However, for detailed uniformity checks more precision would be desirable, and **0.1 mm would cover it all**.

Sensor Procurement: SiLC Sensors

Remember:

- Large area sensor: 95 x 95 mm^2
- Very fine pitch: 50 µm
- Lots of channels: 14 x 128 = 1792

Plans for the rediscovered sensors

- Carefully recuperate sensors from module
- Testing (IV, CV and strip characterisation)

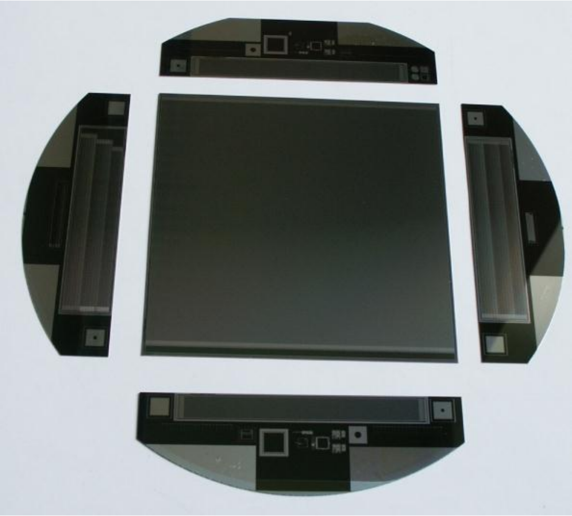
Caveats for usage

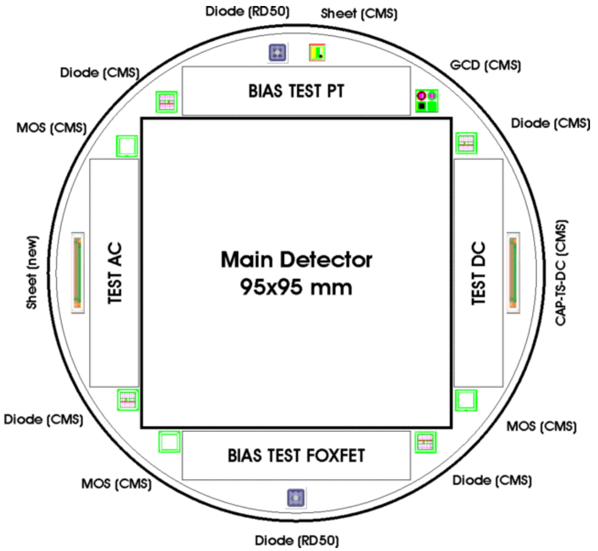
- Large number of strips and small pitch but requirements for resolution are much lower (≥ 100 µm)
- We might skip 2-3 strips (pseudo-intermediate-strips)

→ Example:

  - 3 intermediate strips
  - 1792 /4 = 448 channels = 3.5 APV25
  - pitch = 200 µm
  - digital resolution 200/sqrt(12) ≈ 60 µm

- Pitch adapters from APV25 to sensor

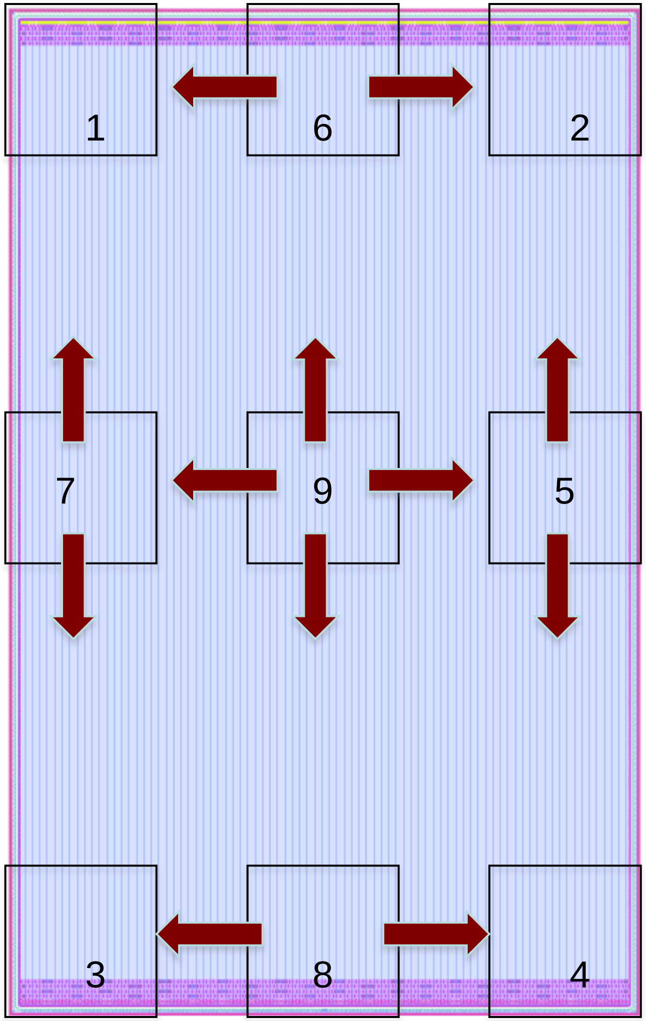




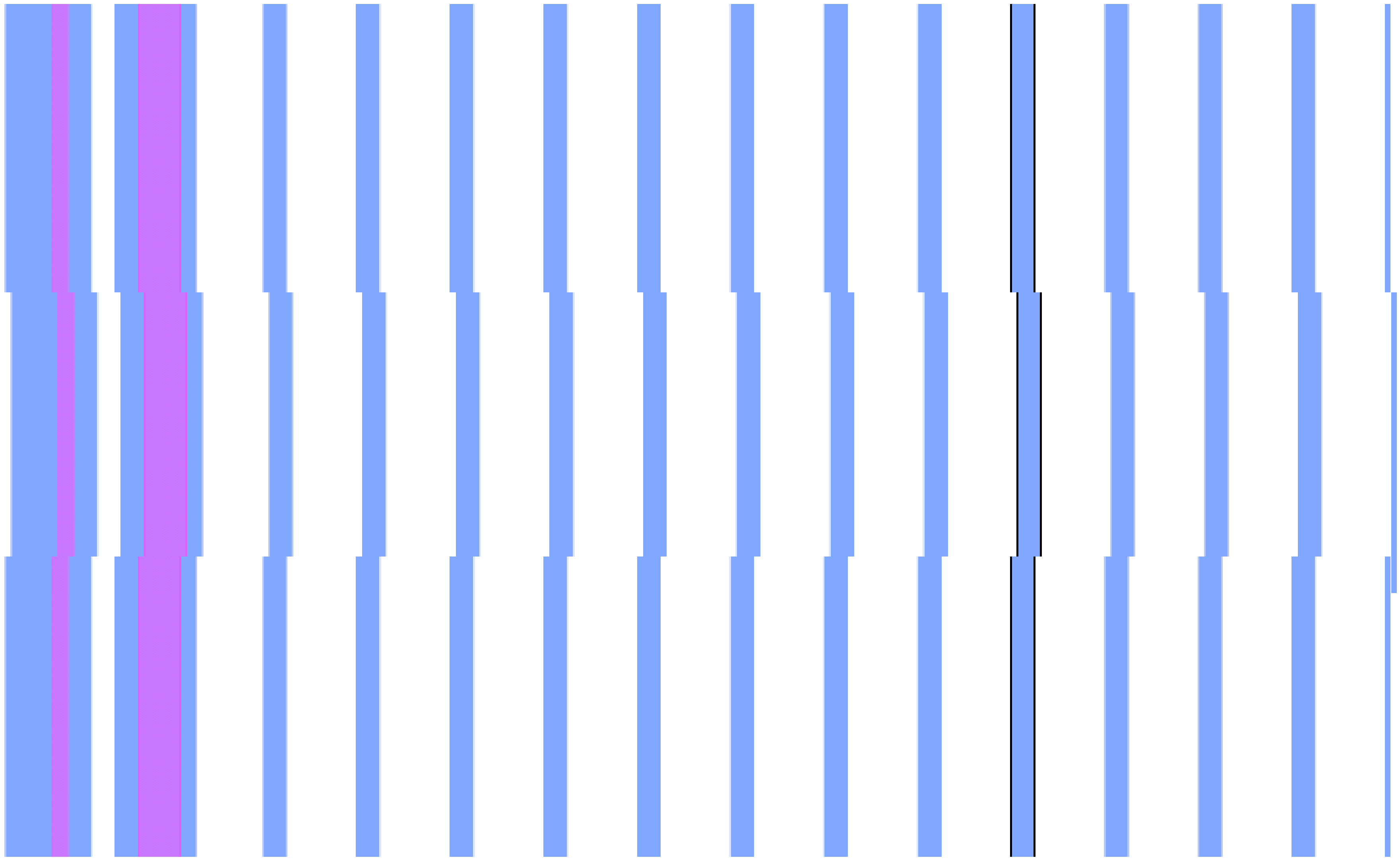
Sensor Development with OnSemi

- 4” and 6” production possible
  - Clearly want to go for 6” to get large sensors
- Idea to use stepper instead of full masks
  - Cheaper
  - Not clear if feasible
    - Alignment of steps with limited precission
    - Might introduce sharp corners
    - Prone to introduce local breakdown/microdischarge
  - Limits the number of structures on wafer
  - Design gets much more complicated

  → *Prefer to go with full masks!*
- Radiation Hardness?
  - Radiation hardness is not an issue of this project
  - Interesting for studies in LHC experiments
  - Would not hurt to use rad-hard material
- Suggestion:
  - High resistivity, high O concentration FZ
  - 200 µm thickness
  - n-on-p process with p-stop strip isolation



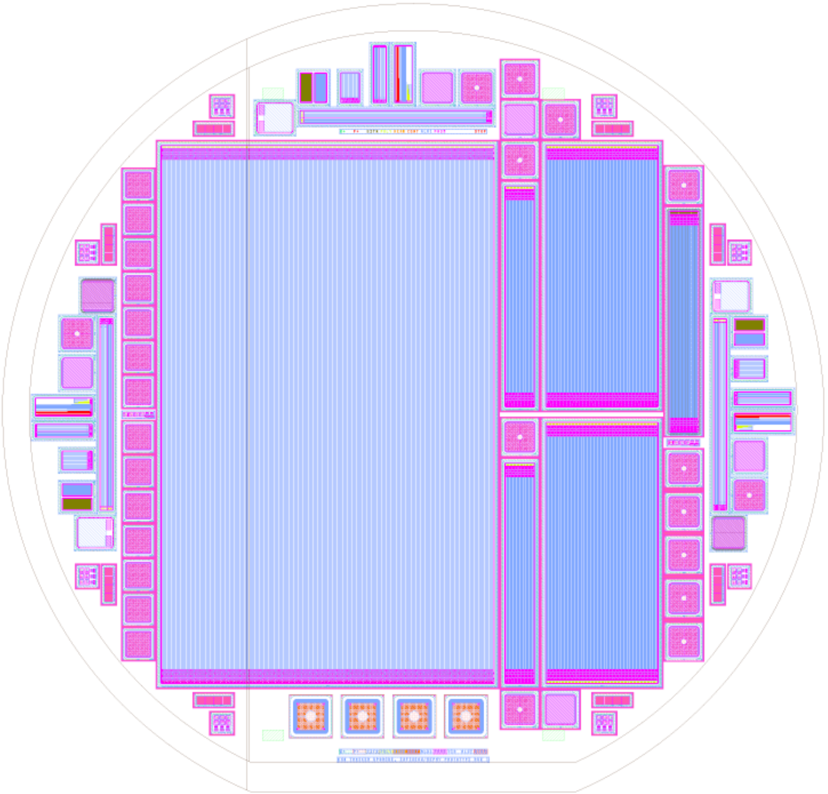
Stitching strips together



Wafer Layout

General Strategy

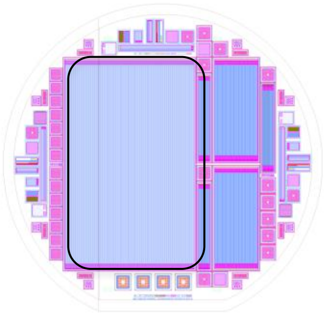
- Large main sensor
  - Use full area for 10 x 10 cm^2 main sensor?
  - Reduce size to have space for small test sensors
- Small test sensors
  - For studies on various sensor design choices
- Test structures
  - Fill all available space with standard and new test structures

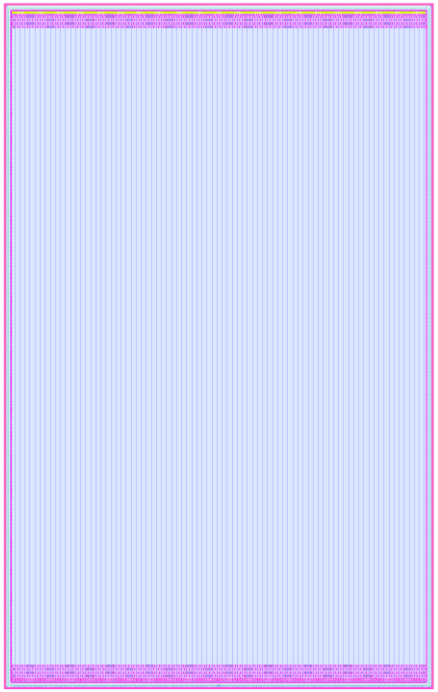


Wafer layout made by HEPHY as example

Main Sensor

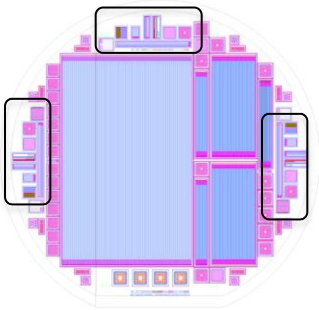
- Size
  - Maximum area: 10 x 10 cm^2
  - Full length, reduced number of strips (as in example) 10 x 6 cm^2
  - Reduced size but square shaped 8 x 8 cm^2
- 2D resolution: stereo solutions
  - Include stereo angle on sensor (inclined strips)
  - Identical square shaped sensors rotated on module
  - Use 90 stereo angle and use 2^{nd} metal layer for routing of the strips
- Pitch/Resolution
  - Very relaxed requirements from CALICE (100 µm resolution as best option)
  - Would prefer reasonably small pitch eg. 100 µm → usefulness of sensors for other applications
  - Limit number of readout channels using pseudo-intermediate-strips and get effective readout pitch of eg. 200 µm

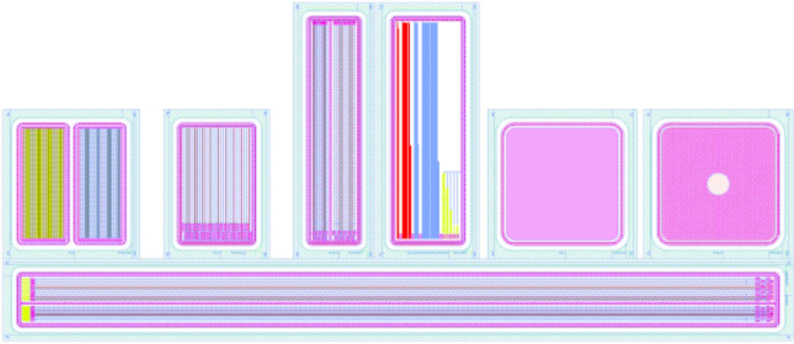




Test Structures: Standard Halfmoon

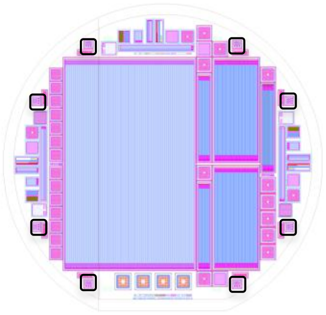
- Seven structures to measure specific parameters
- Allows assessment of the quality of the production process
- Has been an important tool in the CMS production
- Helps in identifying problems in the production and suggest improvements
- Vienna has extensive experience with such structures (design/measurement/interpretation)

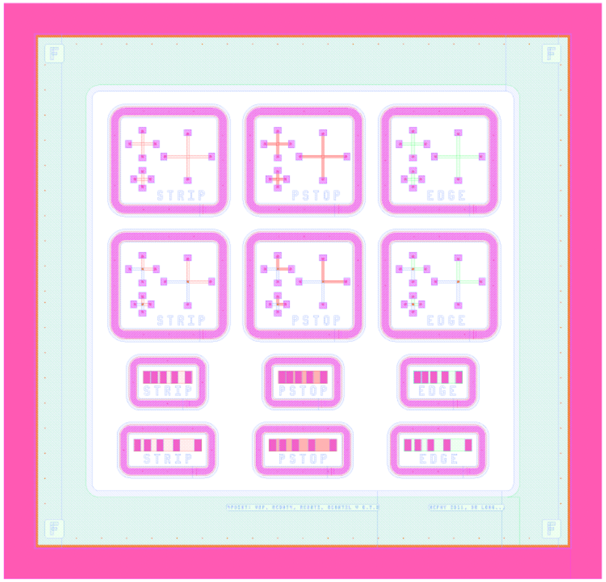




More Test Structures: Van der Pauw

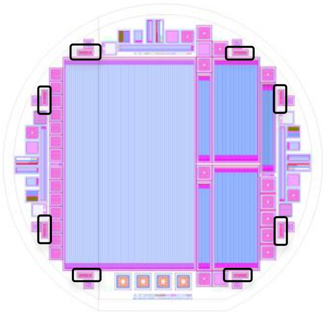
- Measure resistivity of implants
- Tiny structures
- Can be distributed around wafer to evaluate homogeneity of the production process
- We are evaluating different designs and want to optimise the layout

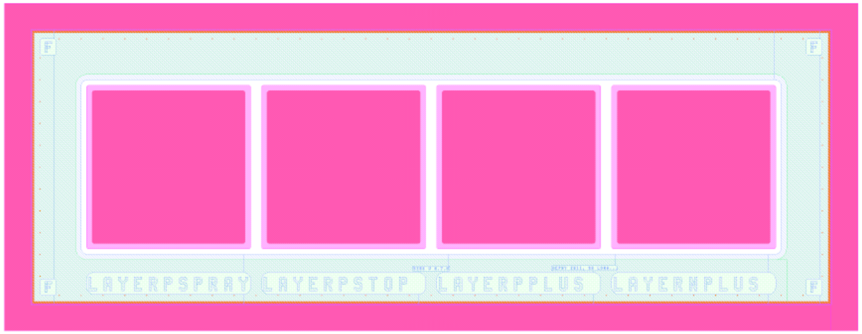




More Test Structures: SIMS Fields

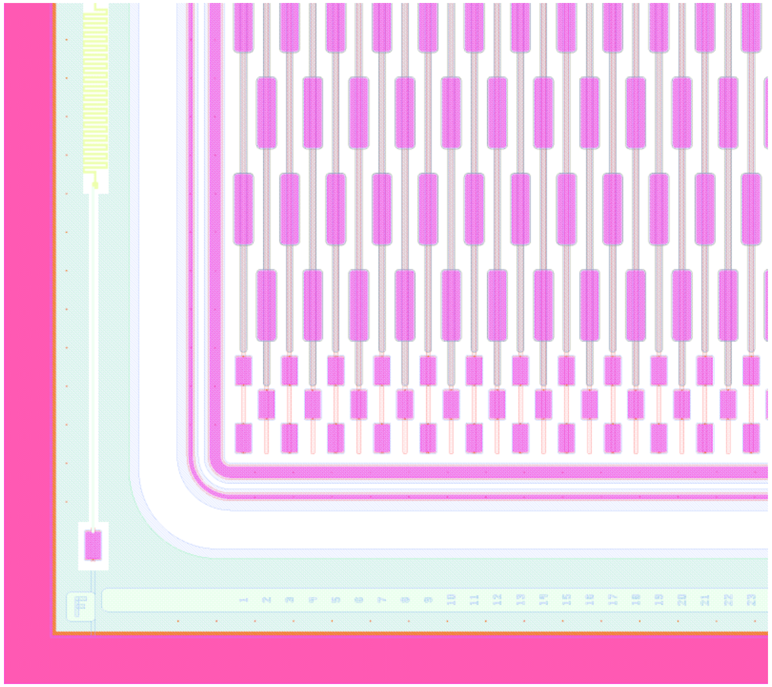
- Provides windows to naked silicon with different dopings
- Can be used to measure doping concentrations and resistivity
  - SIMS
  - SRP





Temperature Monitoring

- Measure temperature with resistive structure on sensor periphery
- Need to investigate thermal coefficients and resulting signals depending on material
  - Aluminium
  - Polysilicon with different doping concentrations
- Design test structures to evaluate different geometries
- Integrate promising versions into sensor periphery



Idea presented by Alberto Messineo for the CMS Tracker

Readout System and Software: APVDAQ

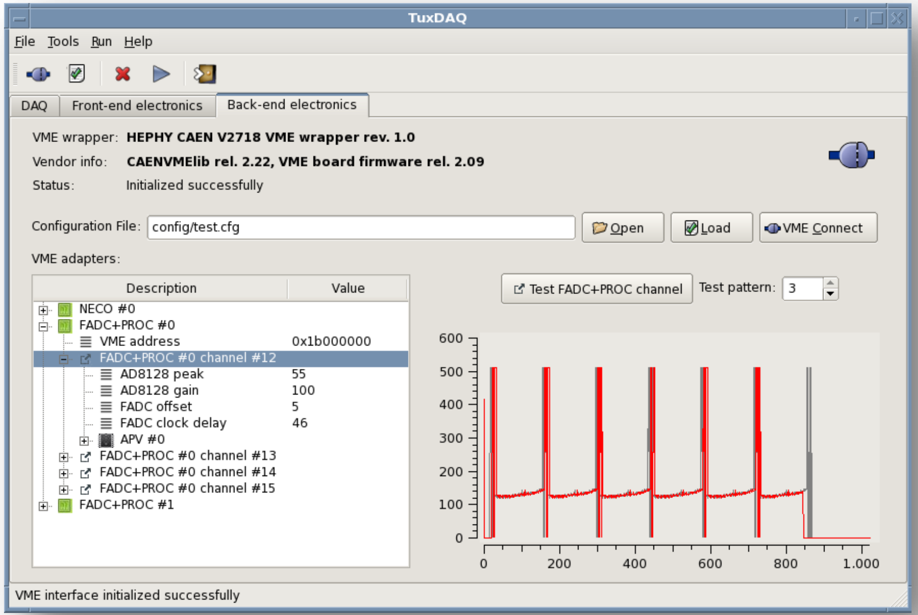
- Two related APV25 readout systems were designed/built at HEPHY
  - APVDAQ: small system for laboratory tests
  - Belle II readout prototype: medium sized system
- New large scale Belle II system will be built
  - This would leave us with more availability of the medium sized system

- Online DAQ software and offline analysis tools were not user friendly and based on proprietary framework (LabWindows/CVI)
- We want to rewrite software from scratch
  - Common, portable and free software frameworks: C++, ROOT, Qt GUI, etc…
  - Target Platform: Linux

Online DAQ: TuxDAQ

Online DAQ software

- Now implemented for the medium scale Belle II readout system
- Production version will be ready for testbeams in summer/autumn 2012
- Still needs implementation of online analysis to monitor data quality
  - Will be ported from HAT → see next slide
- Slight modifications needed to operate also the small APVDAQ system



Offline Analysis Framework: HAT

HAT: HEPHY Analysis Tool

- Flexible framework to analyse data from our HEPHY readout systems
- Modular OO code allows integration of data structures from other DAQ systems and the implementation of custom analysis steps
- Full analysis chain is now available and under extensive tests

Summary and Discussion

- Online DAQ and offline analysis tool is progressing well
- SiLC ~~sensors~~ modules have finally been discovered
  - Need to recuperate sensors and test them

- Discussion: existing SiLC sensors vs. design and produce new sensors
  - Proposal:
    - Make use of SiLC sensors (assuming that they are still OK)
    - In parallel develop a new wafer layout and produce sensors with OnSemi

- Discussion: SiLC sensor to module strategy
  - Proposal:
    - Use 3 pseudo-intermediate-strips
    - Use stereo angle of 90°
    - Readout from two sides

Summary and Discussion

- New sensor production
  - Still need to clarify plenty of details with OnSemi and CNM Barcelona

- Discussion: Design choices for a new sensor
  - Proposal
    - Go for a smaller but square shaped main sensor 8 x 8 cm^2
    - Readout pitch of 100 µm
    - Use single pseudo-intermediate strip → 200 µm pitch
    - Use stereo angle of 90°
    - Readout from two sides
    - Tile 2 or 4 modules to cover larger area