Si Tracker Laser Alignment
@ JR2 SITRA
Status Report

Iván Vila - Paris, 8th October 2007

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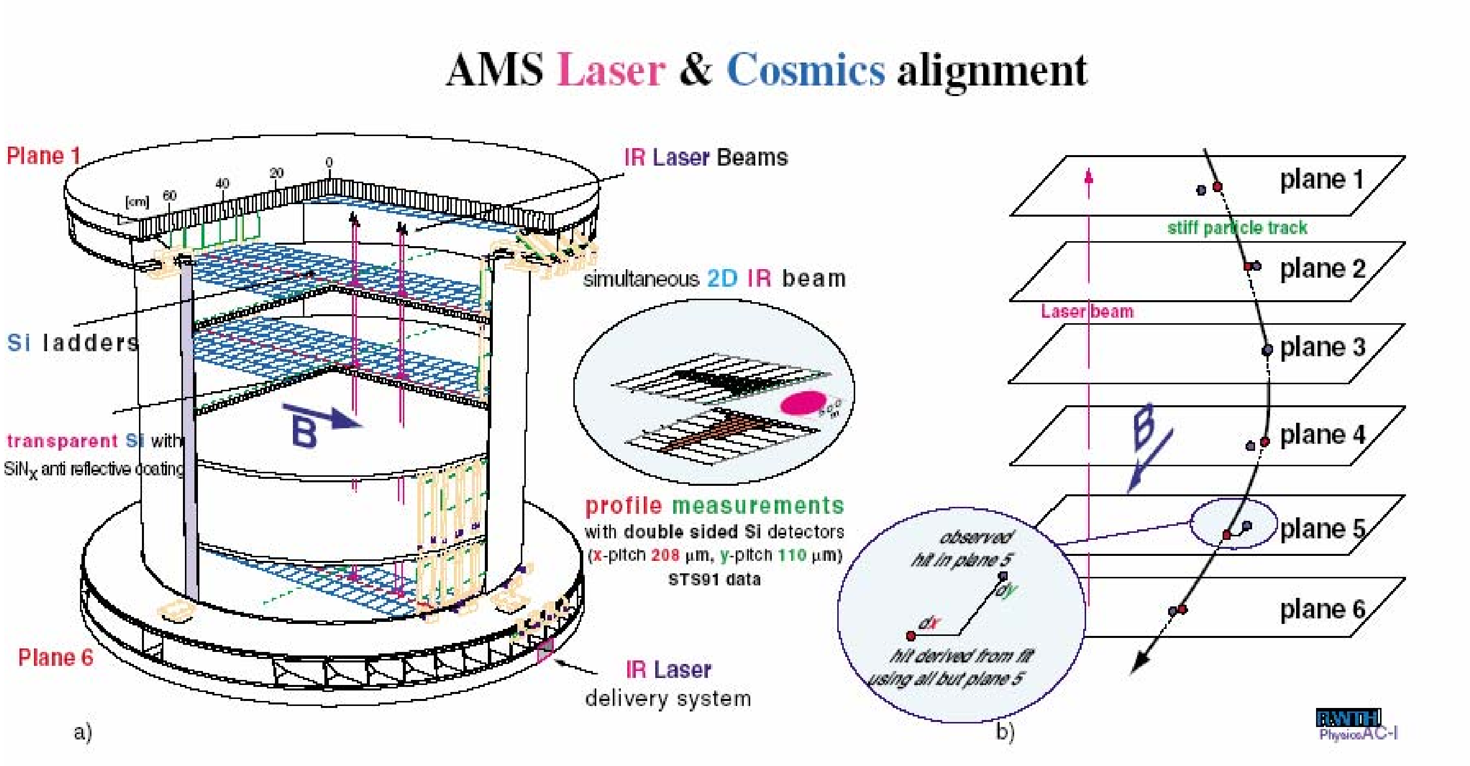
Outline

- Method reminder.
- R&D on microstrips “semitransparent” sensors.
- SiTRA alignment prototype.
- Short term schedule.

Reminder: Laser based alignment of Si Tracker

- Usage of collimated laser beams (IR spectrum) going through silicon detector modules. The laser beams would be detected directly in the Si-modules.

Accuracy **better than 2 microns** achieved in **1 second** (NIM A 511 (2003) 76–81)



Reminder: Laser based alignment of Si Tracker

- Advantages:
  - Particle tracks and laser beam share the same sensors removing the need of any mechanical transfer.
  - Minimum interference with Silicon support structures
  - No precise positioning of the aiming of the collimators. The number of measurements has to be redundant enough
  - Straightforward DAQ integration –sharing same Si DAQ.
  - System can be easily accommodated to any tracker design
  - The **movements interesting** for **physics** are directly monitored
  - Laser beam as **pseudo-tracks** may share the same track based alignment software

Current Activities:

- We are following two R&D lines:
  1. R&D on microstrip sensors: increase transmittance to the sensor to IR light.
  2. Produce an integrated Alignment prototype as part of the SiTRA tracker protype.

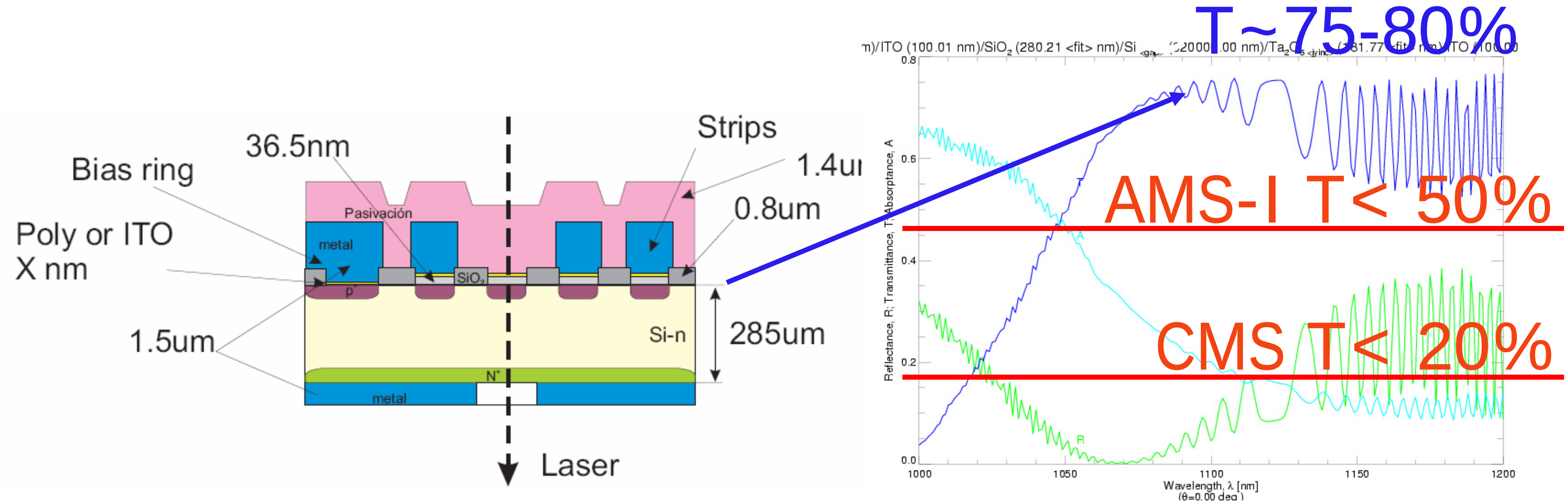
     Keep CMS-like sensor design with removed aluminium back-metallization in a 1cm diameter window.

R&D on "Alignment friendly" uStrip sensors

- System key issue: optical quality and transmittance of microstrip detectors
- R&D line – Improve the photodetection characteristic of "conventional" microstrips sensors.
- Two handles:
  - Replacing non-transparent Al electrodes by a Transparent Conductive Oxide (ITO, AZO, Poly,...)
  - Adjusting the layer thickness to reduce reflectance, including the AR coating in the default sensor design.

R&D on "Alignment friendly" uStrip sensors

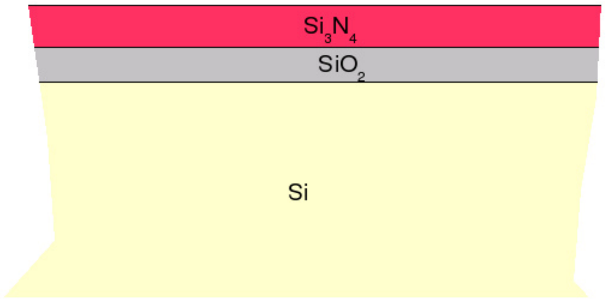
- Joint activity with CMN-IMB at Barcelona
- Naïve simulation replacing Al electrodes by ITO electrodes



Transparent µstrip sensors Detailed simulation

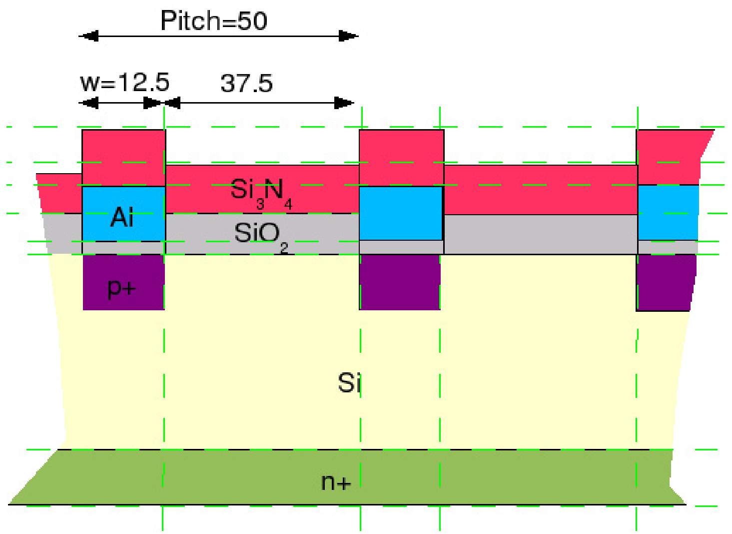
First calculations an **ideal sensor** scenario:

- Planoparallel layer surfaces
- Front and back polished
- Continuous (and infinite) layers
- Strip's layer is continuous
- No implants



Now studying a **realistic sensor**:

- Strips are segmented
- p+ strip implants (segmented)
- n+ implantation



Any discontinuous and repetitive structure produces a beam diffraction:

- Sensor strips (including the implants below them) are a linear diffraction grating
- Due to the presence of the strips, the layers on top are not smooth anymore, but they follow the strips orography

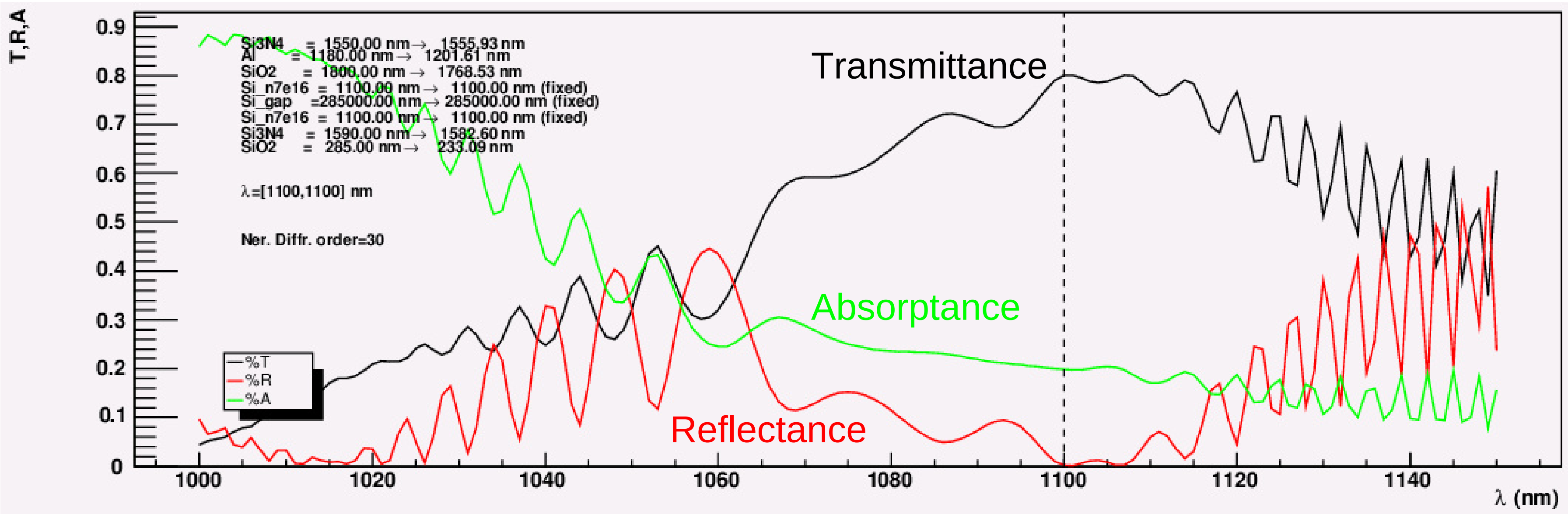
A real sensor (top right picture) is a superposition of 4 different linear gratings (p implants, electrodes, SiO2 and Si3N4

Optical simulation accounting for inhomogeneities along the layers ⇒ Rigourous Coupled Wave Analysis (RCWA)

Rigorous Diffraction: simulation

Realistic simulation is done

We can modify thicknesses and/or strip characteristics (width,pitch) to obtain maximum transmittance in the IR



We are working in an optimization of the sensor **to comply with sensor producer** and **laser spectral width tolerances**

Simulation has to be crosschecked against sensor prototypes produced by CNM-Barcelona. Production of material samples has already started.

R&D on sensors: Schedule

Done >Step 1 (2006-2007)

Proposal feasibility: detailed optical simulation, sensor feasibility

Now >Step 2 (third quarter of 2007)

First samples from CNM for optical characterization.

Measurement of optical parameters (T,R,A) of the materials

Agree a final stack design based on realistic optical simulation.

Validation of the optical simulation.

>Step 3 (4th quarter of 2007)

Production of sensor prototypes scaled-up –photolithographic method- with different semitransparent options as electrodes.

>Step 4 (2nd Quarter 2008)

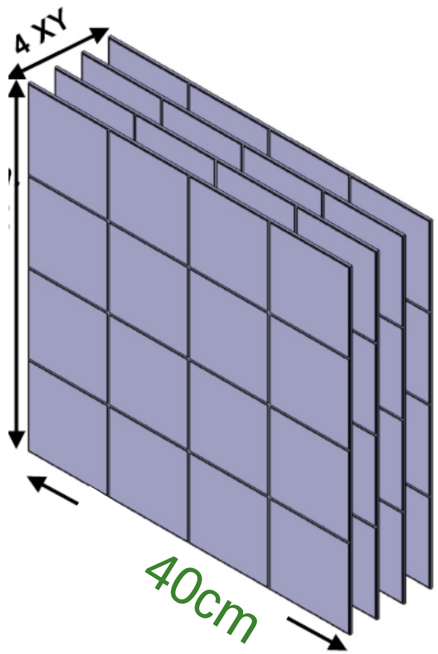
Operational real scale prototypes for optical, laser and beta source characterization of prototypes

>Step 5 (2008)

Final prototypes –with the selected design-, test beam characterization.

SiTRA Alignment Prototype

- Deliverable by 2009 Si Tracker alig. prototype
  - Integrated on full fledge tracking prototype to be delivered by the JRA2 SiTRA activity (sensors, FEE, mechanics, cooling, alignment,...)
- First prototype: Sensor procurement from HPK 35 units
  - single-sided DC type, isolated strips
  - Sensor size: approx. 95 x 95 mm^2
  - Wafer thickness : 320 μm
  - 15% of sensor “alignment friendly”
  - First prototype a la CMS.



3D test bench

- For Sensor characterization:
  - 3D motorized test bench
  - All components acquired (DAQ and trigger electronics, large range XYZ stages, laser source)
  - Currently working on mechanics and daq programing.
  - To achieve a maximum positioning accuracy we want to integrate a interferometer head for measuring the stages displacement with submicron accuracy.
  - First test with newly acquired HPK sensors.

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In Brief:

- R&D on new semitransparent microstrips sensors with CNM – IMB.
- EUDET report in preparation to document this novel approach
- In parallel, full fledged tracker prototype with integrated alignment system.