Charles University Prague
Institute of Particle and Nuclear Physics

Tests Of Laser In Silicon Detectors

Peter Kodyš, Zdeněk Doležal, Jan Brož,
Pavel Řezníček, Zbyněk Drásal, Peter Kvasnička

Progress of laser tests in Prague

1. Testing algorithms of strip detectors tuned
2. Set of standard tests and analyses: focusing, strip response, charge sharing
3. Different wavelengths: 650nm and 1060nm used
4. Angle (skew) scans
5. Optical head for direct beam power measurements in progress
6. Simulations of laser beam in Si (Zbyněk Drásal – next talk)
7. Deeper understanding of laser beam interaction with Si detectors
8. Preparing analysis macros

Testing procedures of strip detectors

The test system integrates:

- Short pulsed lasers 650 and 1060 nm (CERN)
- DAQ (VME – NI PCI-VME)
- oscilloscope (GPIB)
- pulse generator (GPIB)
- positioning stages 3D-2R (USB)
- 2 power supplies (USB-RS232)

ROOT based software allows

- High voltage (bias) control
- Focusing algorithms – rough, fine
- Position scans
- Timing scans
- Angle scans including deep focusing
- Environmental monitoring (temperature, humidity, power drops, bias drops, remote access and full processing from any place (VNC), automatic emergency system)

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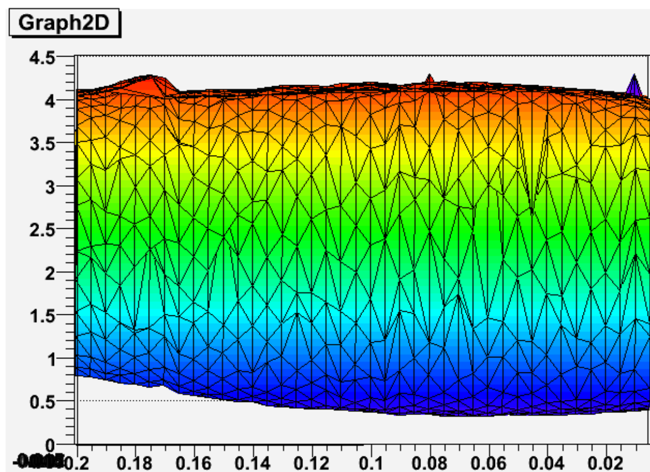
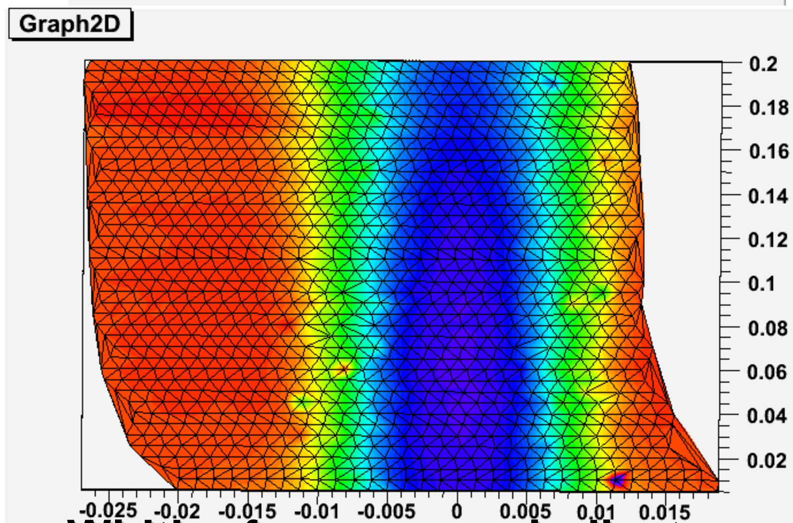
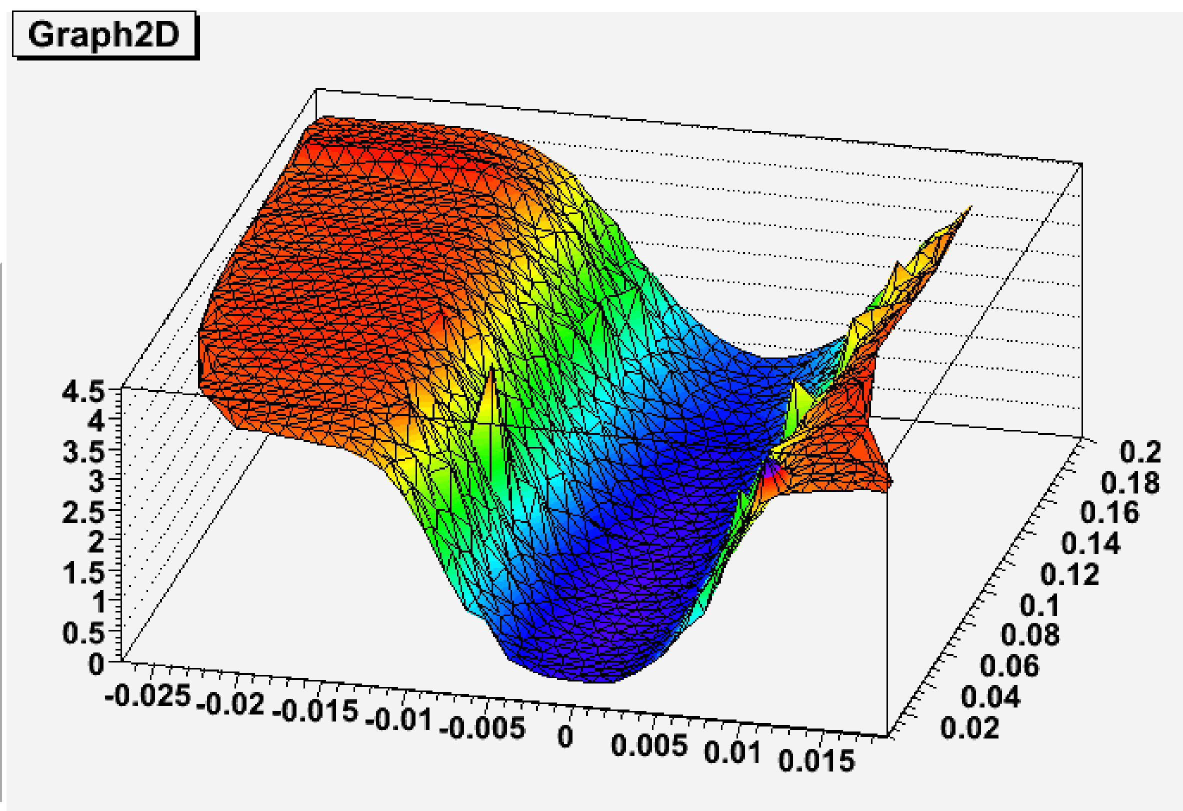
Set of standard tests and analyses: focusing, strip response, charge sharing



Detail of minima (flat in 60μm range)

Example of focusing matrix





Width of green area indicates laser focusing width

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Simulations of laser beam in Si

Subject of a separate talk by Zbyněk Drásal

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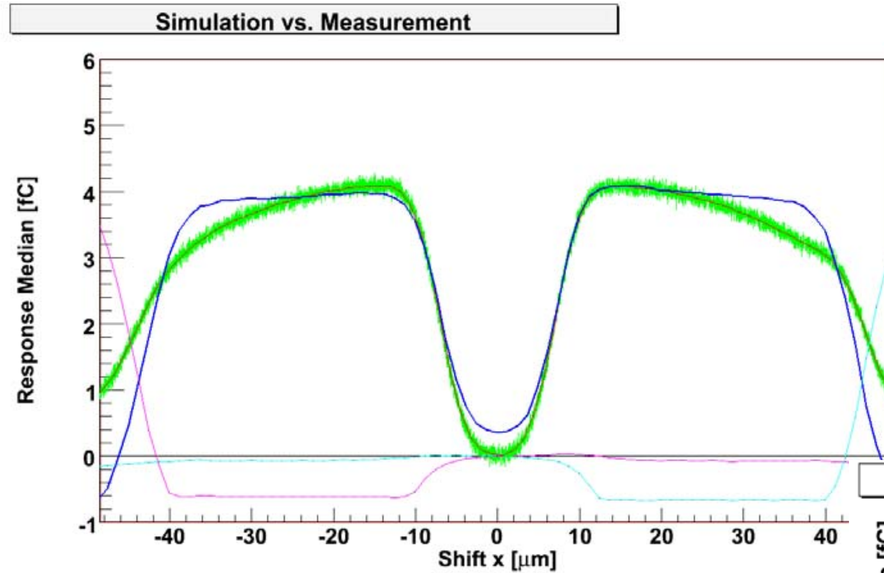
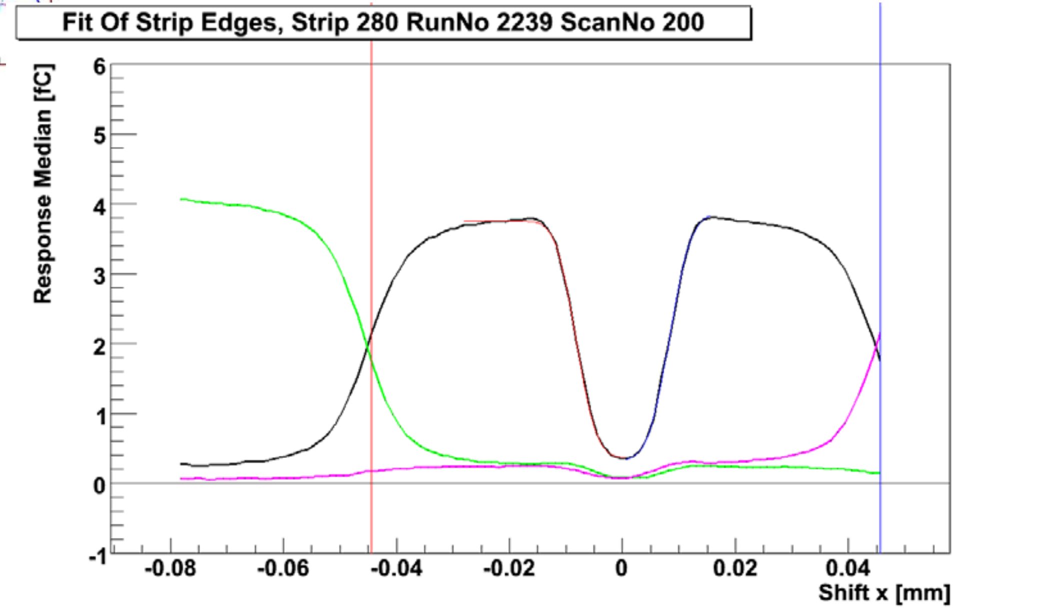
Different wavelengths: 650nm and 1060nm



CiS detector: wavelength 650nm, differences from simulations, negative charge induced in neighbour strips



CiS detector: 1060 wavelength – in very good agreement with simulations

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Angle (skew) scans (1)

Tilt laser beam

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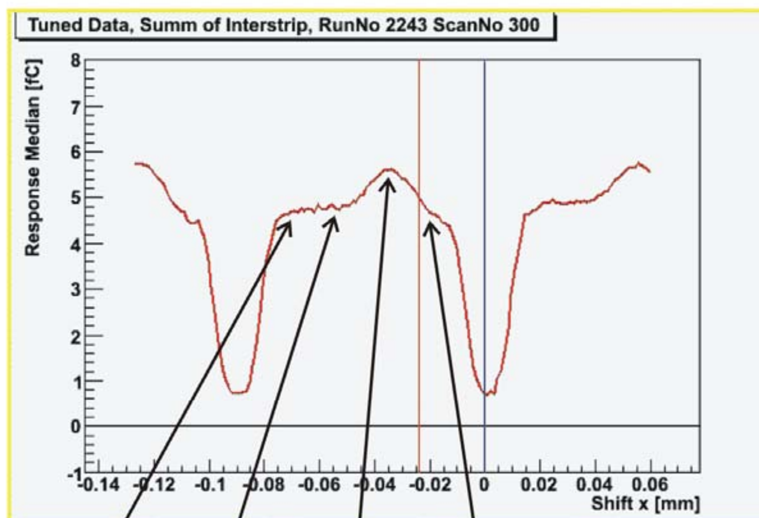
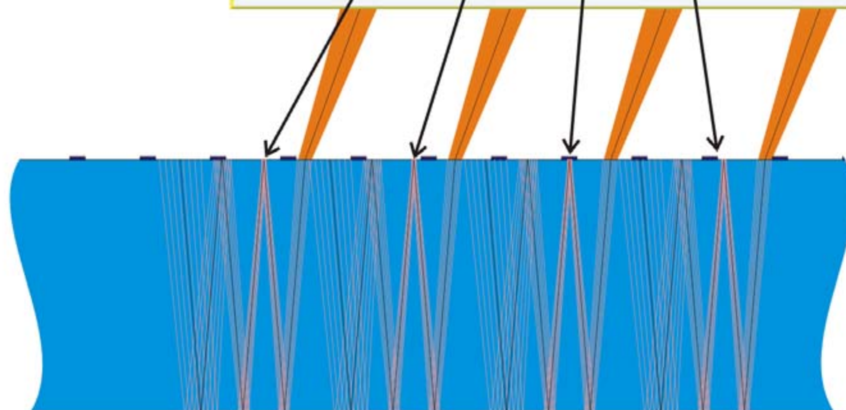
Angle (skew) scans (2)

Tilt laser beam

Focusing to top surface from
inside (deep focusing)





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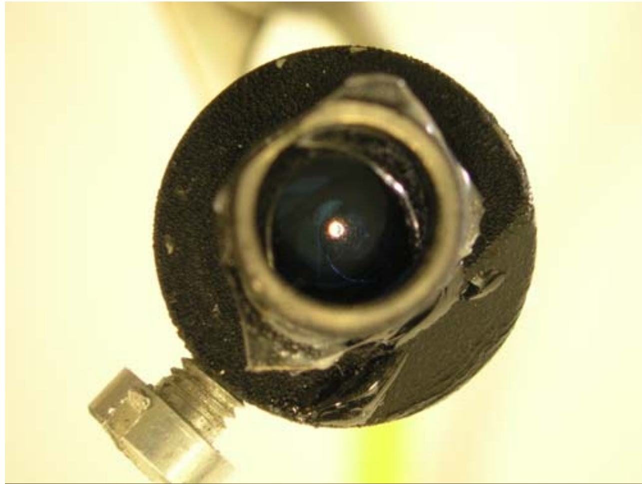
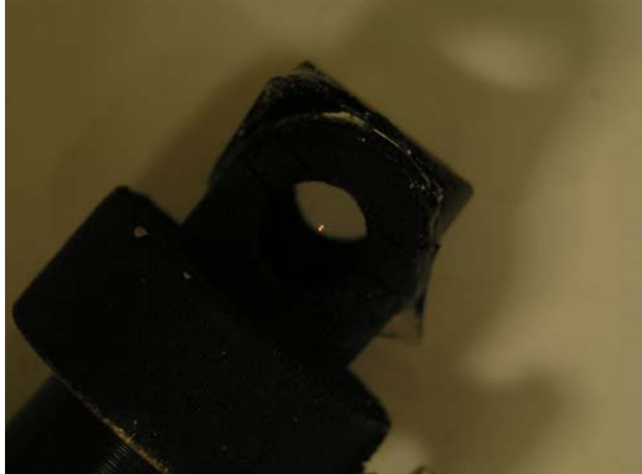
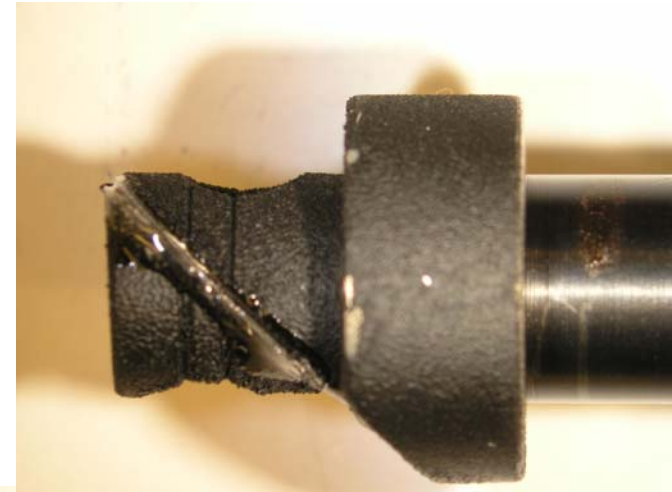
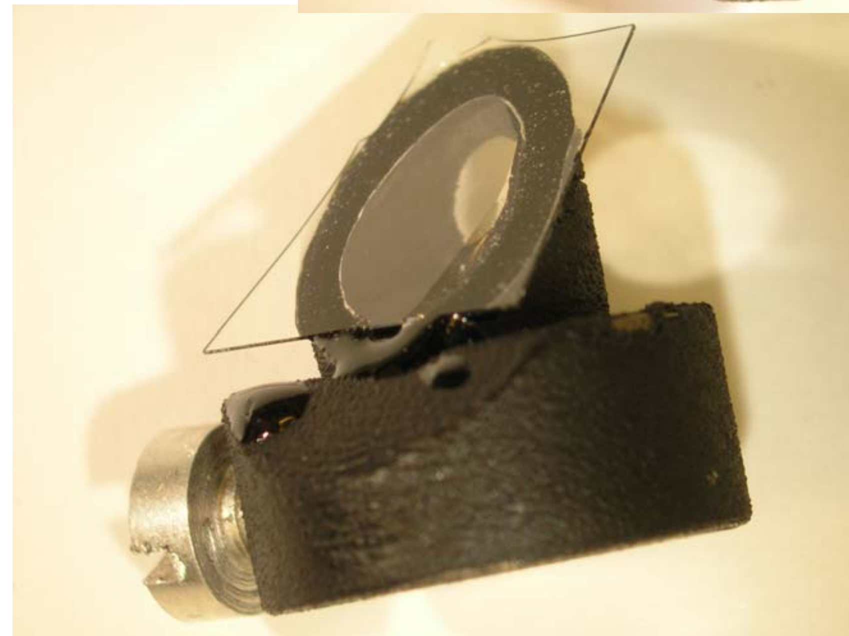
Optical head for power monitoring and reflectance measurement

1. Mechanical design and manufacturing done
2. Readout electronics under construction









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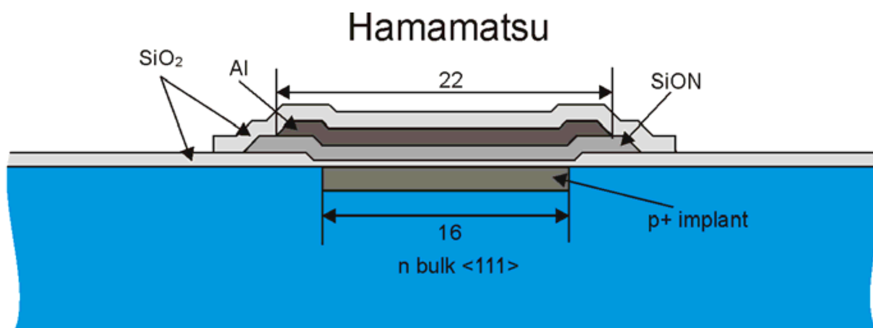
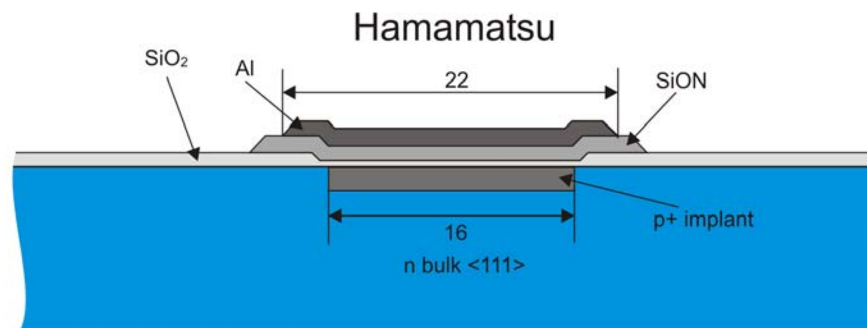
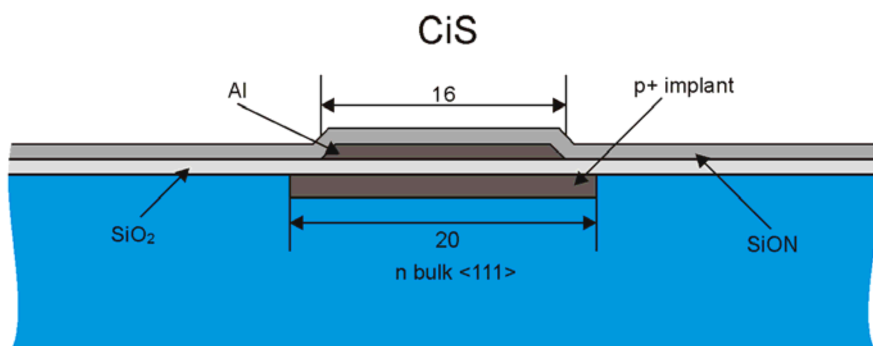
Deeper understanding of laser beam interaction with Si detectors

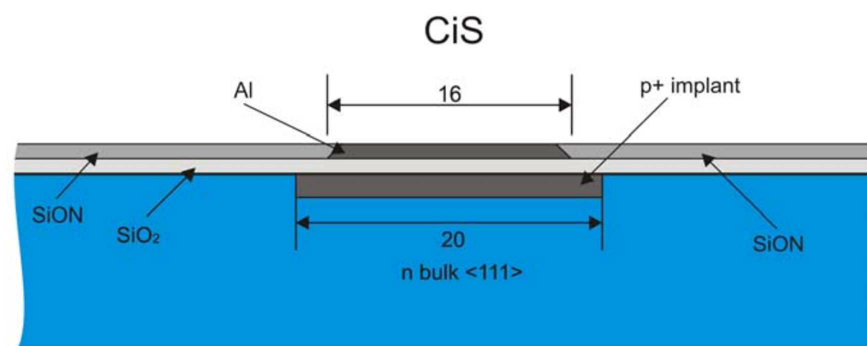
Surface structure on strip

Surface structure on bond pad









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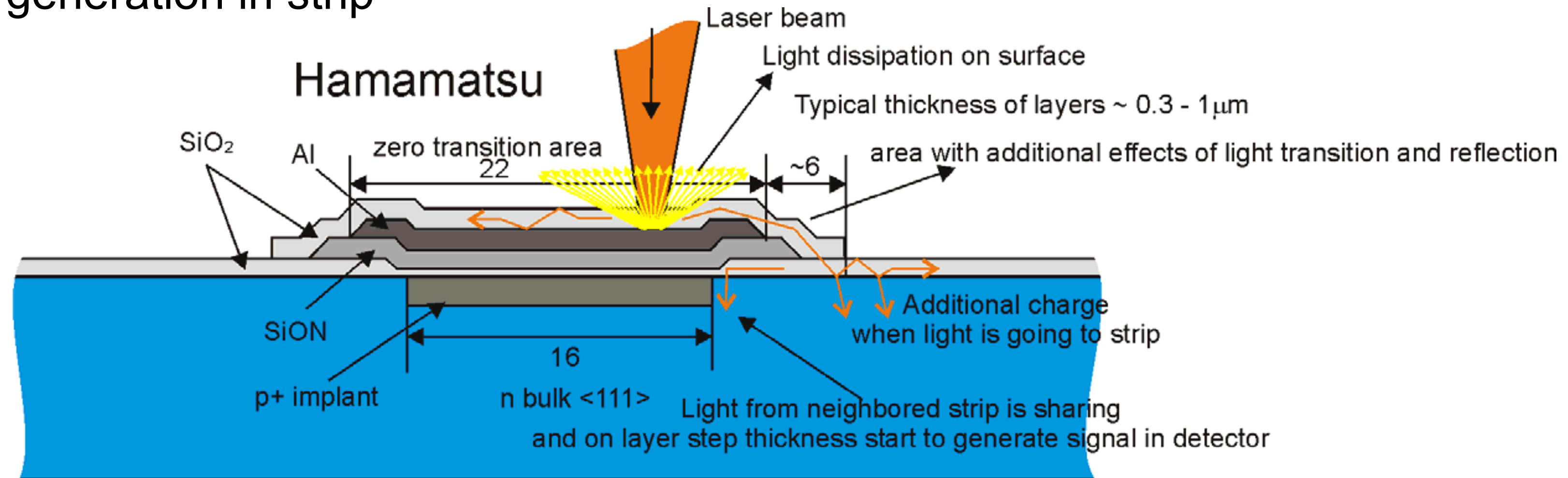
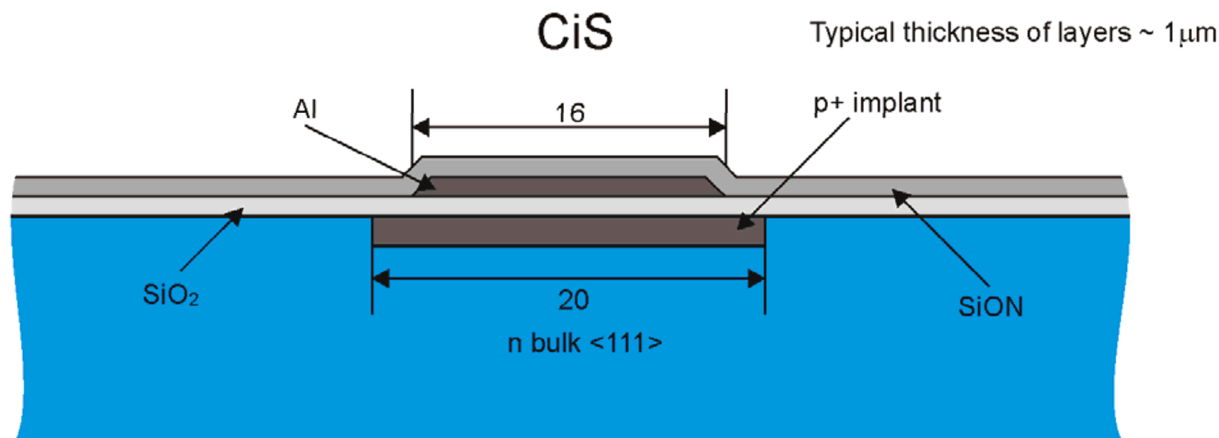
Deeper understanding of laser beam interaction with Si detectors

Charge generation in strip





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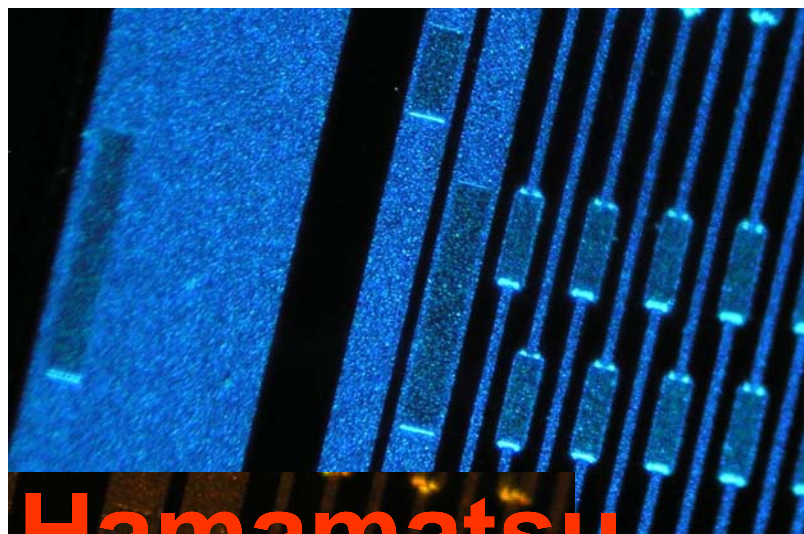
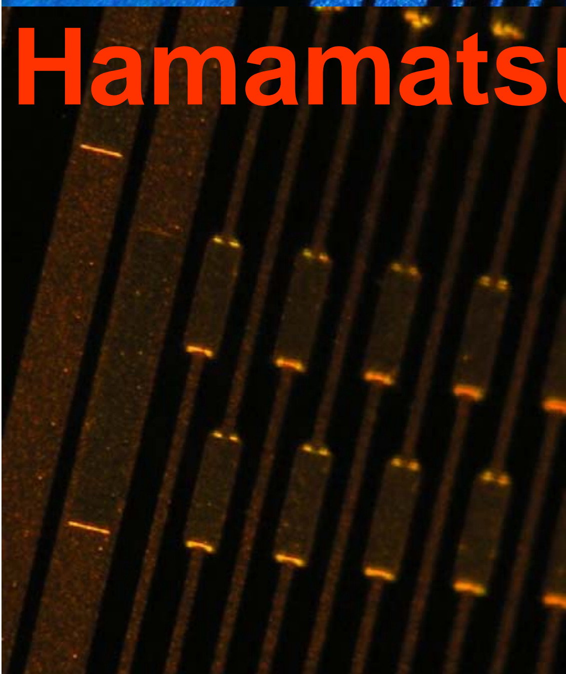
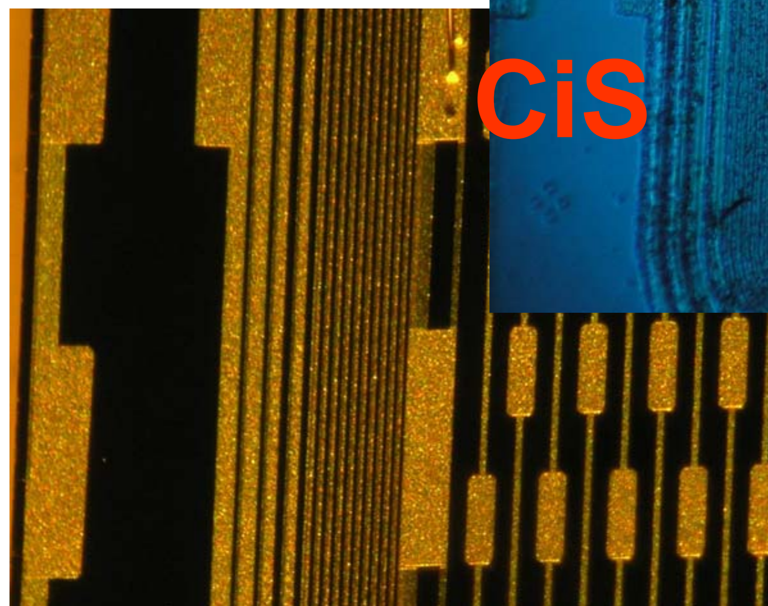


1. Surface
2. Coating
3. Thickness
4. Size
5. Technology



Hamamatsu



CiS

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Deeper understanding of laser beam interaction with Si detectors

Hamamatsu

CiS

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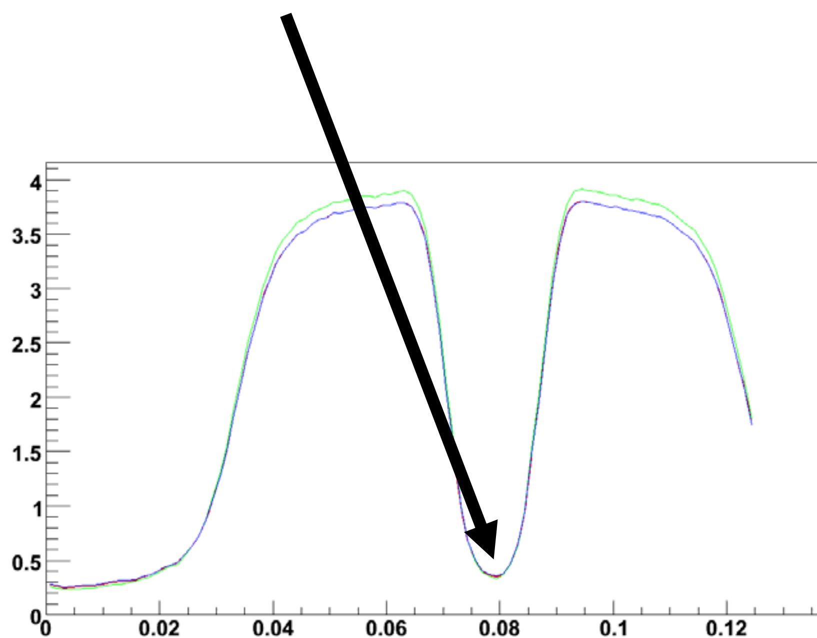
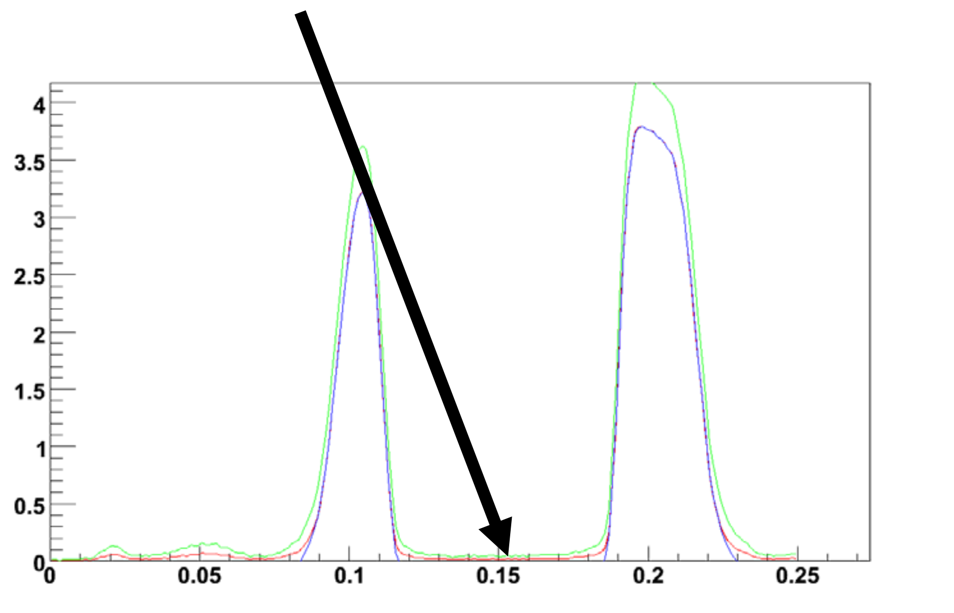
Deeper understanding of laser beam interaction with Si detectors

CiS

Response on strip with residuum charge sharing in protecting layer



Response on bond pad with no protection layers



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Deeper understanding of laser beam interaction with Si detectors

- Other possible effects influencing laser tests:
    - For 1060nm wavelength – thickness of silicon substrate changes: minima-maxima on interferences give about 30% changes in charge collection in ½ wavelength inside Si (~150nm) – relevant only in large area scans
    - For 650nm incomplete charge collection within integration time – charge is created in layer <4μm in weak electric field – dependent also from properties of coating layers (electric field gradients, conductivities, lost charge vacancies,…)
    - Irradiated detectors: additional diffusions, inhomogeneities

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Status of laser tests technique (1)

A well-defined and cheap method of detector testing is now available.

Main benefits:

- cheaper than standard test beams with real particles
- lightweight arrangement allowing easy transport
- generally available in labs
- good repeatability and reproducibility of results

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Status of laser tests technique (2)

Main features and capabilities:

- fine-tuning of readout electronics, timing of signals and DAQ software tuning (algorithms, sequences, delays)
- interstrip or interpixel response with micron resolution
- response measurement - linearity, dependence on other conditions, calibrations
- measurement of pulse shapes for injected charge ranging from fractions to thousands MIPs
- injection of extra large charge for regeneration time measurement or assessment of electronics damage
- measurement of high-rate charge injection (double pulse)
- depletion voltage measurement

Status of laser tests technique (3)

Main features and capabilities:

- signal / noise ratio
- thermal dependencies of properties
- all previous tests also for irradiated modules (sensor or/and FE)
- thickness homogeneity of sensor with precision in 100nm range
- in combination with simulations, good insight in silicon detectors response at theoretical level