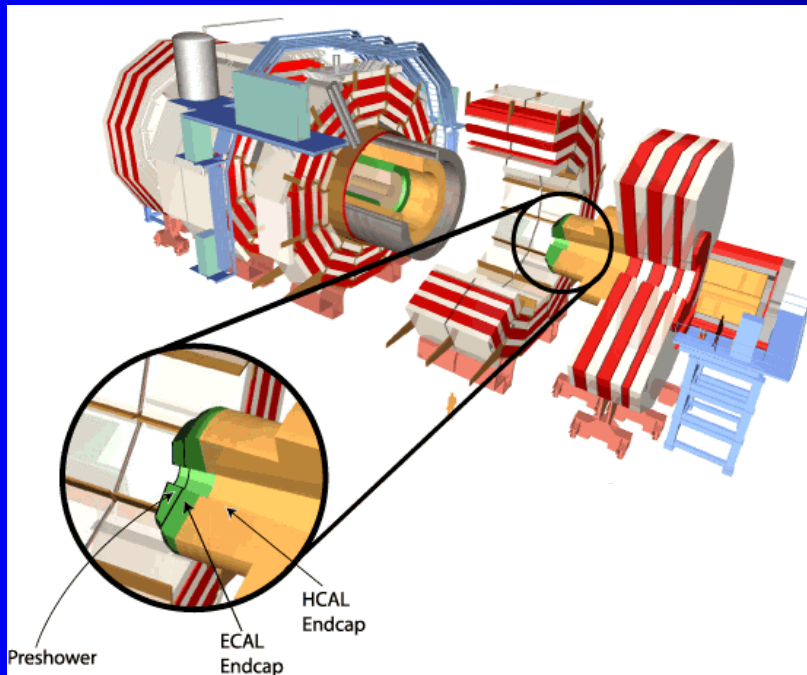


Experience with module assembly for the CMS Preshower

A. Peisert, CERN, and N. Zamiatin, JINR, Dubna

Preshower is part of the
Electromagnetic calorimeter



No constraints on the support material
Si sensors and front-end hybrids glued
to a ceramics support
Everything supported by an Al tile
Cooling through the tile
Si sensor: $63 \times 63 \text{ mm}^2$
32 strips, 1.9 mm pitch



4300 modules, 18 m^2 of silicon

Issues addressed for module assembly:

1. Alignment
2. Strength of gluing
3. Contact resistance for the bias voltage
4. Thermal contact
5. Possible damage
6. Time consumption
7. Bonding

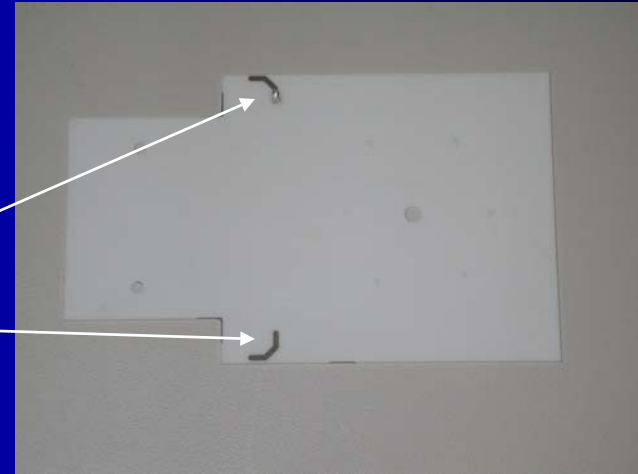
Alignment

- Required alignment precision $\leq 100 \mu\text{m}$ (physics and mechanical tolerances)
- Mechanical alignment of the edge of the sensor with respect to positioning pins is sufficient \Rightarrow **mechanical jigs**
- Measured alignment precision of 5 modules $\leq 20 \mu\text{m}$
- Strip alignment depends on the cutting precision – no problem encountered (better than $20 \mu\text{m}$)

Strength of the gluing

Ceramic support:

- supports the sensor and the hybrid
- provides the bias voltage
- araldite and conductive epoxy

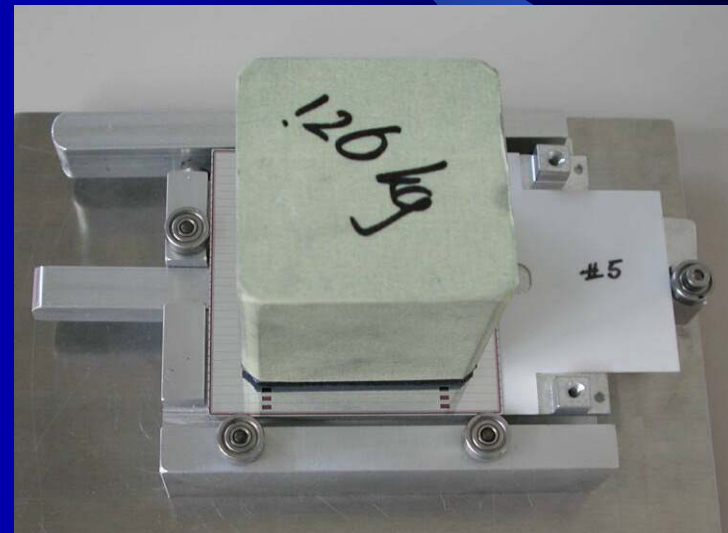
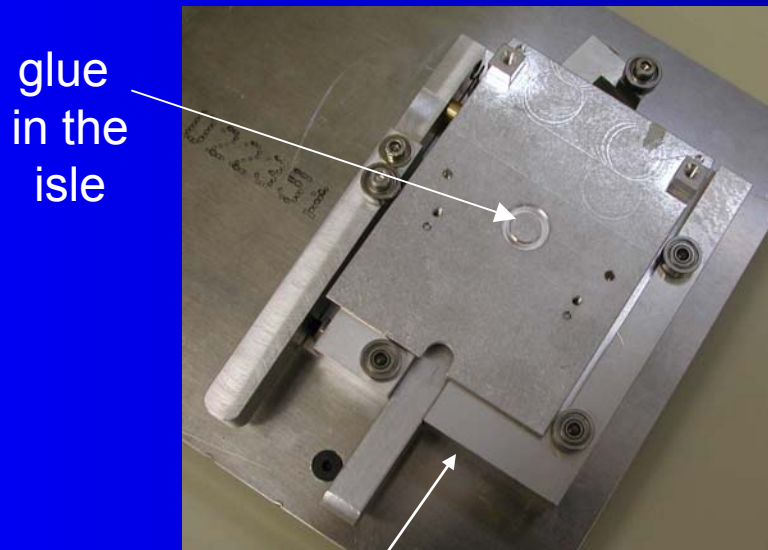


No problem encountered with the strength of gluing

Contact resistance sometimes high \Rightarrow increase surface of the gluing pads

Strength of gluing

Ceramics glued to the tile with araldite
Weight of 1.26 kg chosen to reduce the air gap
(heat evacuation through the tile)



left under weight for 24 hrs

Strength of gluing: ceramics to tile

Four out of nine ceramics came off the tile, all glue stayed on the tile.

Possible reasons: humidity or chemicals deposit from the processing

Ceramics cleaned with soap or perchloroethylene+soap.

Soap did not improve the adherence of the glue.

Ceramics cleaned with perchloroethylene are satisfying.



All ceramics will be cleaned in this way

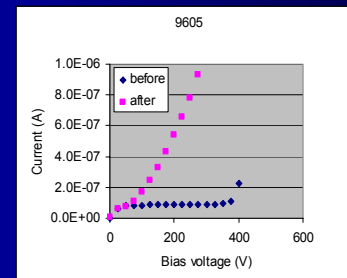
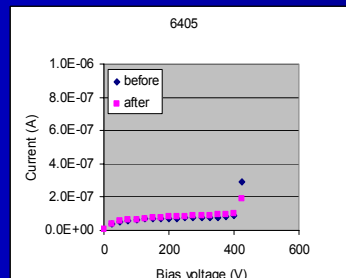
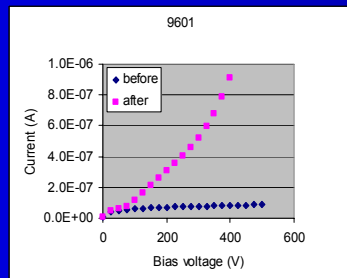
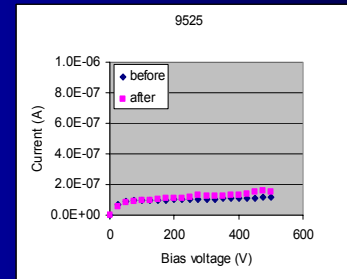
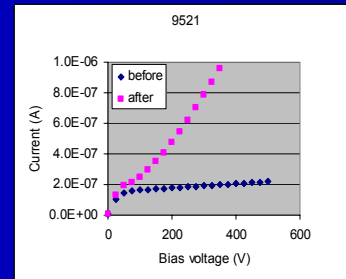
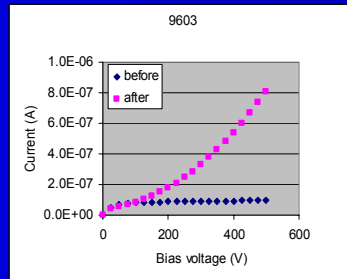
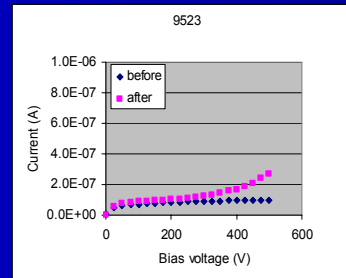
Thermal contact

- A weight of 1.26 kg was used to reduce the air gap between the silicon and the ceramics.
- The ceramics are not flat: distortions are in a band of a wavelength of the order of 5 cm to 10 cm and an amplitude of up to 0.2 mm peak-to-peak.
- The air gap does not depend on the glue thickness.
- According to our calculations the heat transfer should be fine.
- A simple tool was designed to gauge the distortions and, if necessary, to reject ceramics with distortions outside a specified value.

Possible damage: electrical

Total leakage current on 7 out of
9 μ -modules glued with a weight of 1.26 kg
(2 destroyed)

$$V_{fd} \leq 100 \text{ V}$$



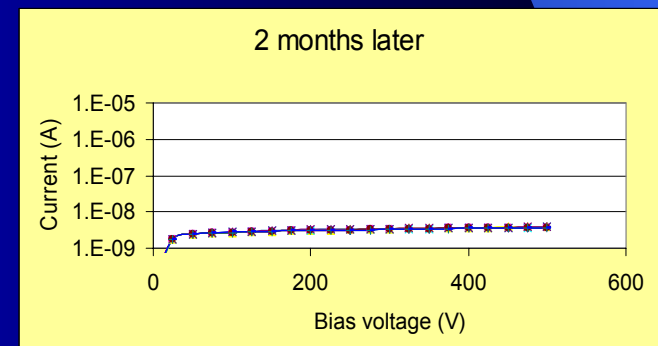
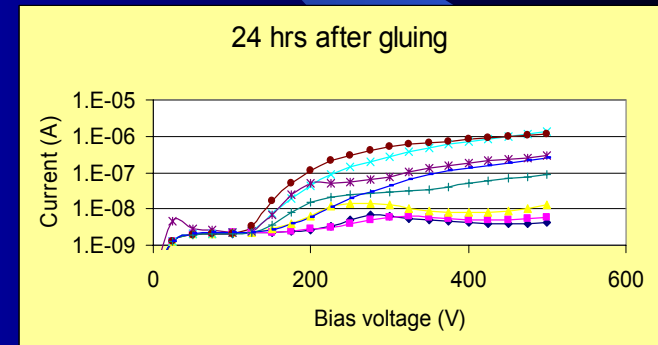
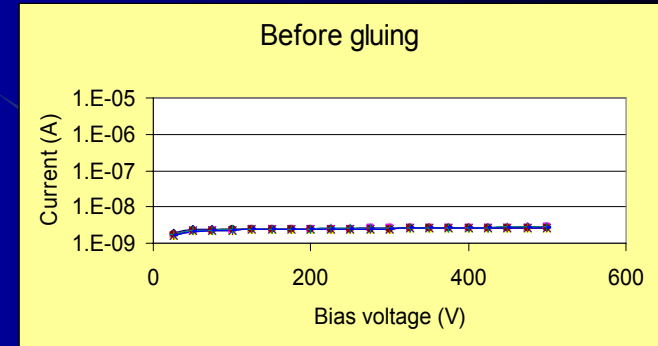
Possible damage: electrical

- Damage anneals with time and temperature
- Strip with higher current suffer more

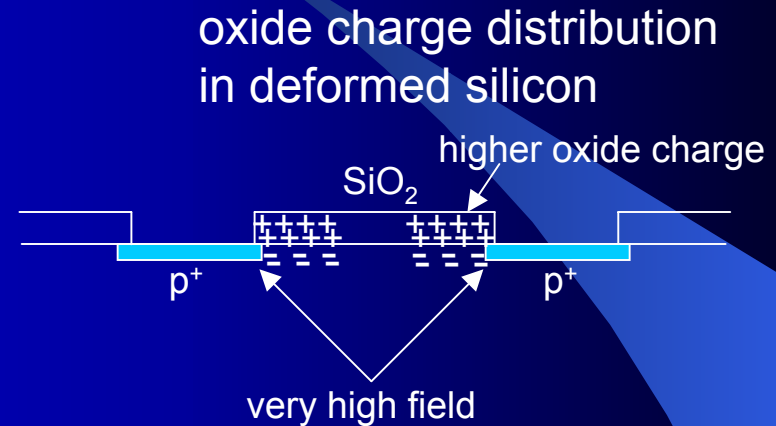
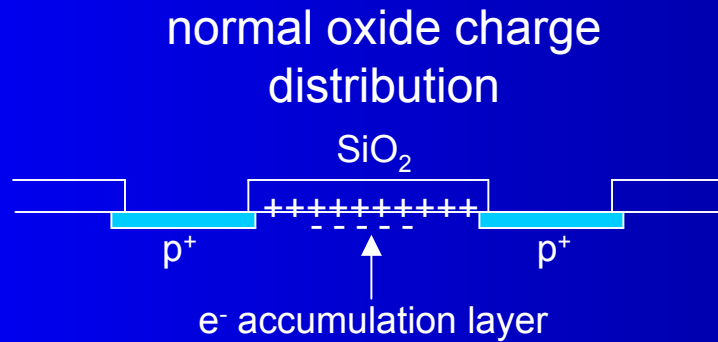


E-field at the Si/SiO₂ interface perturbed

Current from 8 strips



Possible damage: electrical

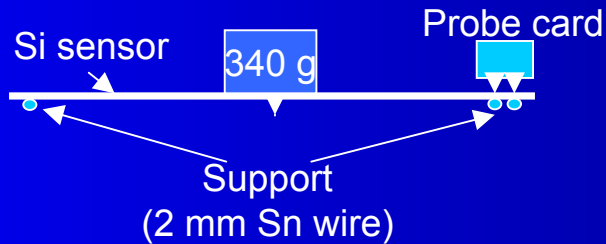


Let's deform the sensor in a controlled way and see what happens

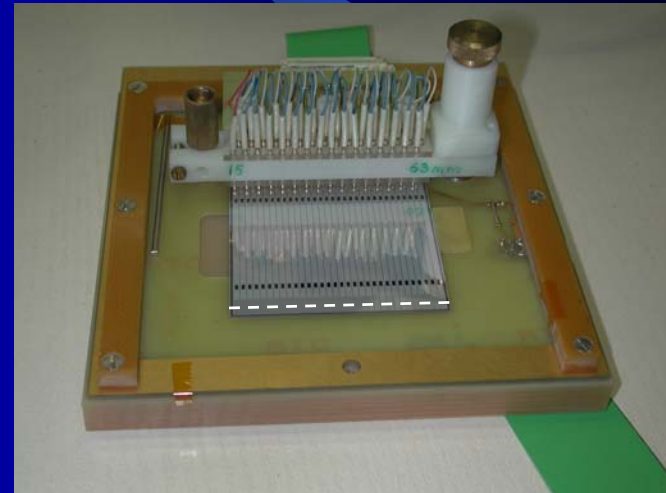
Tests of sensors under stress

Calculated weight to reproduce the deformation ~ 90 g
Deformation along the strips

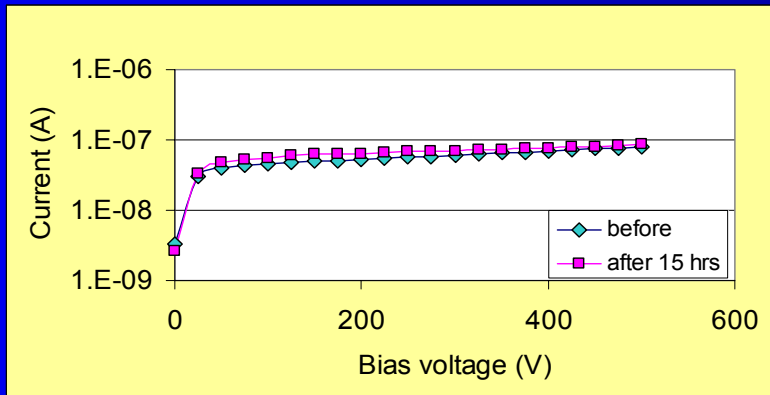
15 hours under weight



Probe station with 32 pins



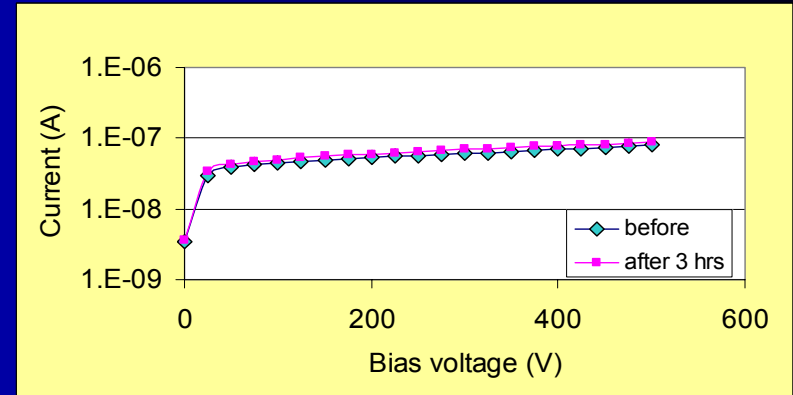
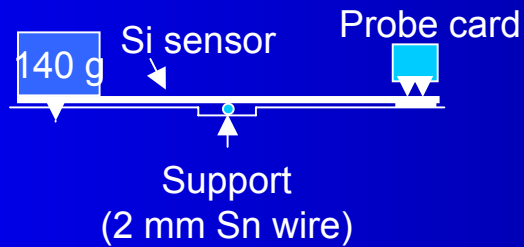
Total current: no difference



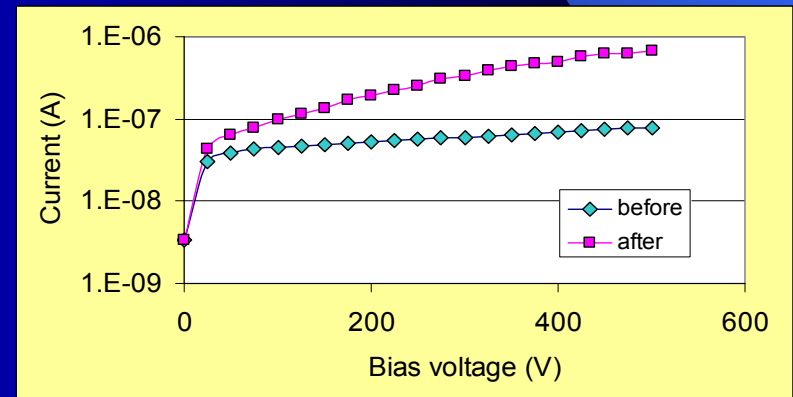
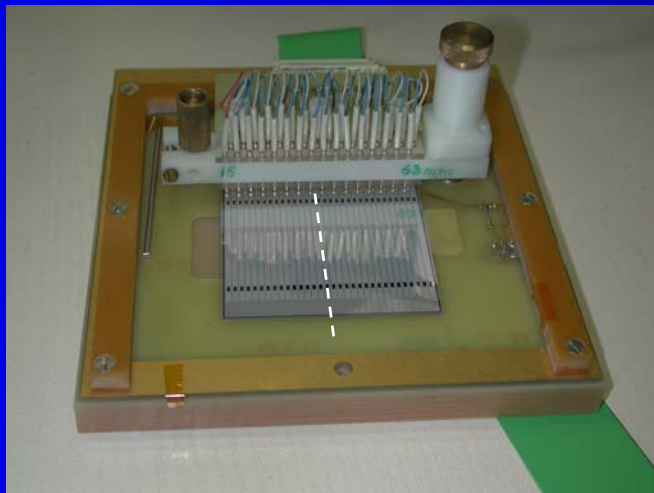
Tests of sensors under stress

Second deformation along the strips: same sensor, no current increase

3 hours under weight



Third deformation across the strips: same sensor

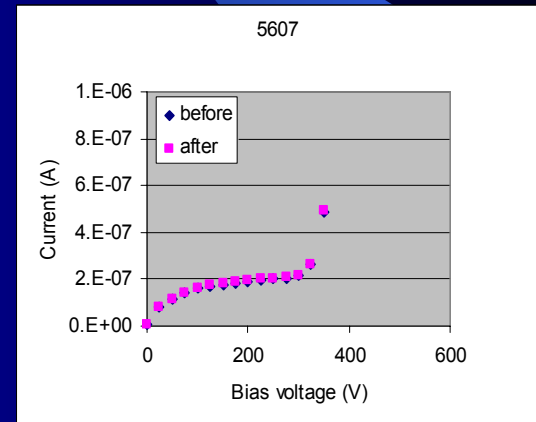
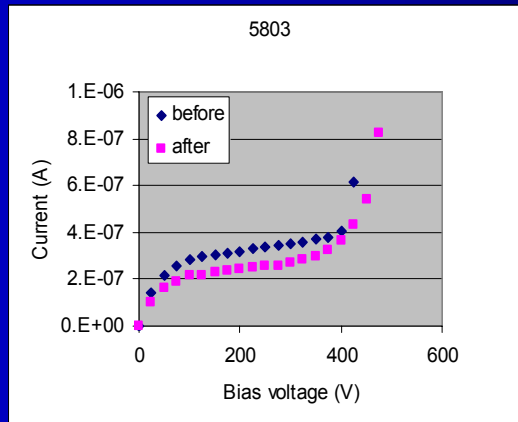
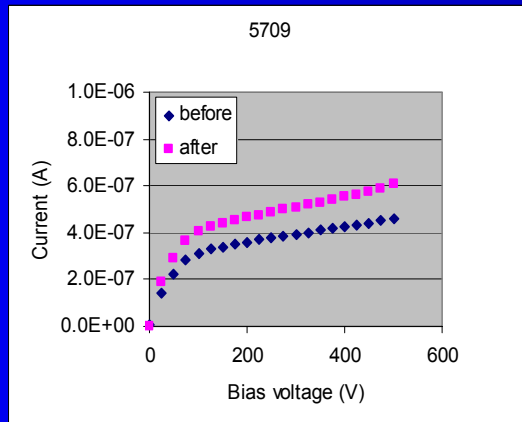
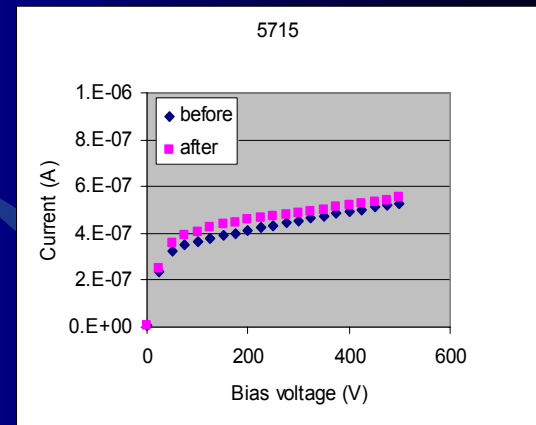
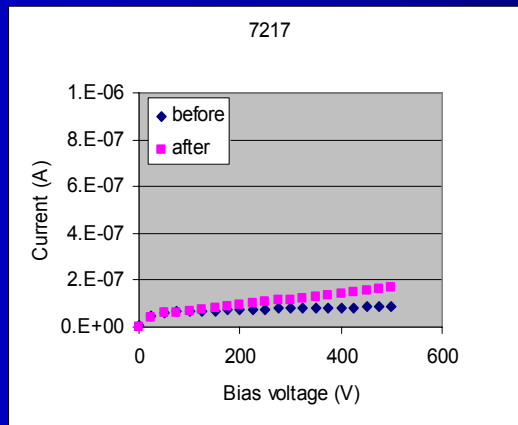
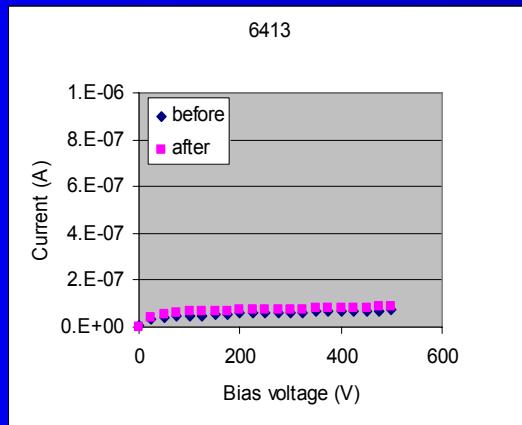


Current increase reproduced

Conclusions from tests of sensors under stress

- Mechanical deformation along the strips causes a redistribution of the oxide charge
- High electric field created near the edge of the p^+ implants \Rightarrow high current
- The effect anneals with time after the strain is removed
- The effect is the bigger the lower the quality of the oxide

Sensor glued with 0.6 kg or using vacuum



No degradation of the leakage current (small differences due to ΔT)

Summary and conclusions

- mechanical alignment satisfactory for precision
- thermal contact depends on the flatness of the ceramics, OK for our design
- high resistance of the bias line gluing, bias line needs to be redesigned, bigger pads
- problems with the adherence of the glue to the ceramics \Rightarrow industrial cleaning necessary
- increase of the leakage current observed on modules made using a weight of 1.26 kg
- reproduced by deforming the silicon across the strips in a controlled way
- modules made with 0.6 kg or vacuum are good