Development of an automated and programmable characterization system for silicon multi-strip sensors

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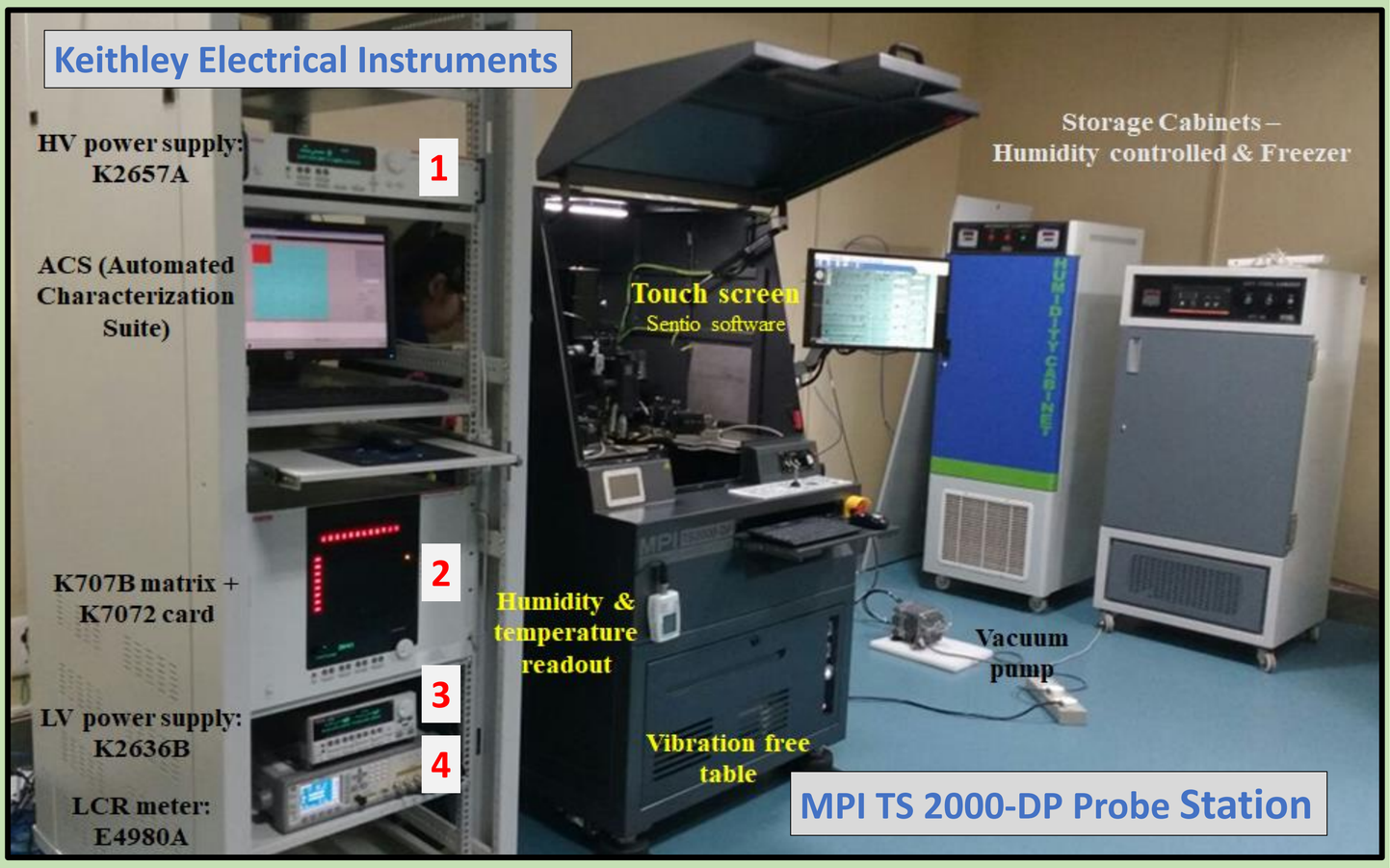
Tracker system in High Energy Physics experiments

- An integral part of giant particle identification detectors
- Constitutes mostly of Silicon sensors – pixel, multi-strip, etc
- Number of multi-strip sensors to be used in CMS HL upgrade is of the order of ~10^4
- To maintain the physics performance in radiation environment, stringent constraints put on the sensor tolerance criteria
- Not possible to easily replace faulty sensors → Crucial to ensure functioning of the sensors before installation into the giant detector

→ **A 'Quality Assurance' Inspection of the sensors is mandatory!**

→ **University of Delhi has developed an Automated & Programmable Characterization System – Probe station & set of Electrical Instruments.**

Sensor Qualification (SQ) System at Delhi



MPI Probe Station

- ❖ Electromagnetically shielded & dark measurement chamber along with provision for earthing to ensure low noise & low leakage current.
- ❖ Possible to control & monitor temperature & humidity within chamber.
- ❖ Motorized chuck movement of 210 mm x 340 mm x 10 mm in XYZ (translation) with 2 μm precision and 5° in θ (rotation).
- ❖ Of 6 micro-positioners (MPs), 2 MPs attached to chuck in order to maintain reverse bias condition during the measurements.

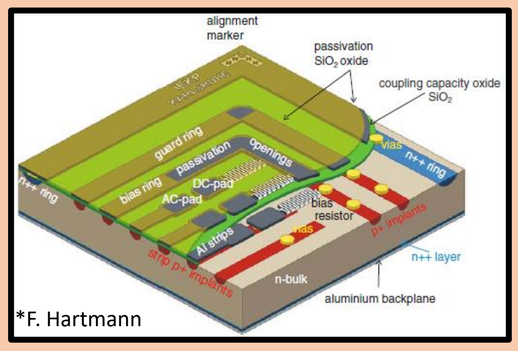
Set of #4 Keithley Electrical Instruments

- ❖ Capable of providing a voltage of up to 1.5 kV; current measurements of pA to mA; and capacitance measurements of the order of pF to µF.
- ❖ Switching matrix switches between different instruments according to the measurement to be performed.

Handshaking of MPI probe station & Keithley electrical equipments

- ❖ Probe station & electrical instruments integrated together to develop Sensor Qualification System.
- ❖ Both are interfaced through DAQ installed with Automated Characterization Suite (ACS) software in an automated manner.

Specifications of Strip sensor tested



*F. Hartmann

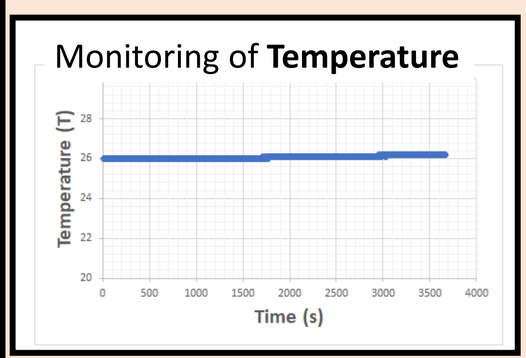
- Bharat Electronics Limited (BEL), India fabricated
- p-on-n, poly-silicon resistor biased & AC-coupled
- No. of strips = #512, each of width of 30 μm and pitch of 55 μm.

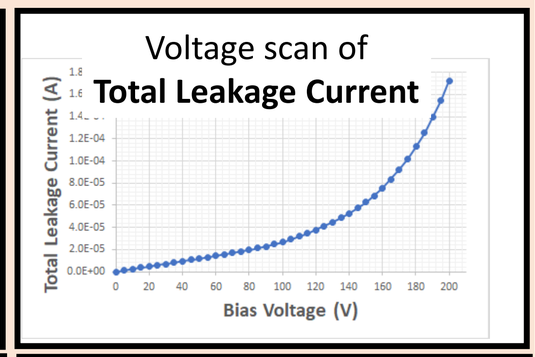
*Details can be found in: **G. Jain** et al., Development of AC-Coupled, Poly-silicon biased, p-on-n Silicon Strip Detectors in India for HEP Experiments. NIM A 882 (2018) 1-10.

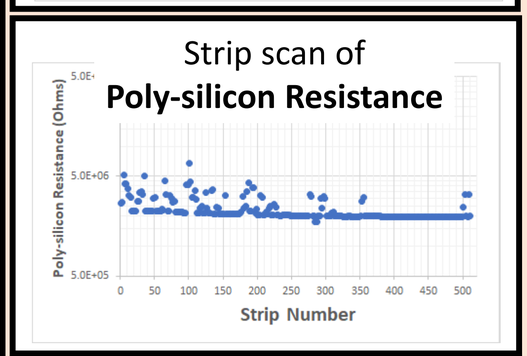
Parameters to be Monitored

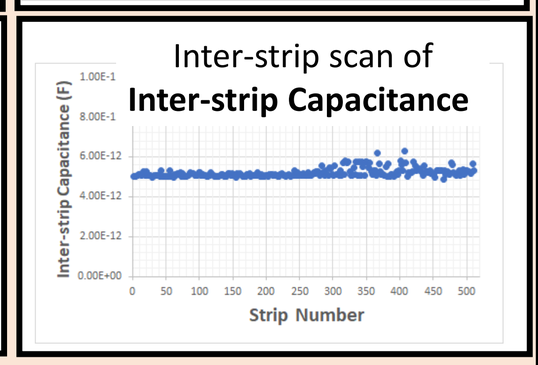
- ❑ **Environmental conditions:** Temperature, Humidity
- ❑ **Global Measurements:** Total Leakage Current, Backplane Capacitance
- ❑ **Strip Parameters:** Strip Leakage Current, Poly-silicon Resistance, Dielectric Current, Coupling Capacitance
- ❑ **Inter-Strip Scans:** Inter-strip Resistance, Inter-strip Capacitance

Automated data taking









- Excellent control over environmental conditions throughout the measurement run!
- Good stability observed for voltage scans.
- Strip & Inter-strip parameters display a good homogeneity over the strips.

Acknowledgement

The authors acknowledge DST, R&D grant University of Delhi, CSIR, UGC, Elba conference for financial support.