# Overview on Silicon strip detector

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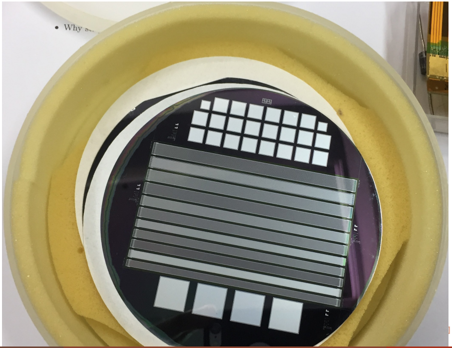
# Outline of the talk

- Motivation behind Silicon strip detectors (SSD)
- Principle and working of SSD
- Experiment
- Results
- Possible sources of uncertainty
- Conclusion

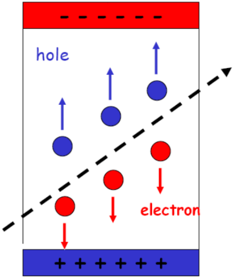
# Motivation behind Silicon strip detectors (SSD)

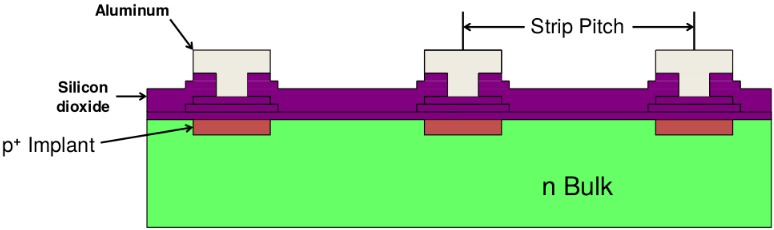
- Precise and efficient measurement of the trajectories of charged particles
- Energy required to create electron-hole pair in Si detectors is $\sim$3.0 eV
- Fast response time
- Flexibility of design
- SSDs are used to reconstruct the tracks and hence vertex of a particular event (in collider experiments)



# Principle and working of SSD

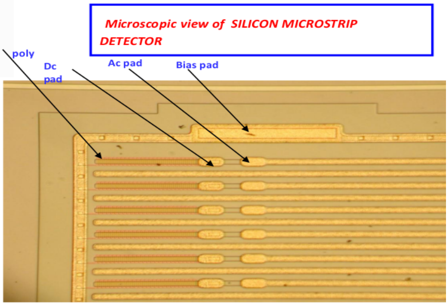
- Position resolution of silicon detectors is achieved by dividing a large area p-n diode into many small regions, either pixels or strips
- $p^+$ strips are used to deplete the n-type bulk material
- Incident ionizing particle $\longrightarrow$ depleted region $\longrightarrow$ creates electron-hole pairs $\longrightarrow$ holes drift towards $p^+$ (negative electrode) and the electrons drift towards $n^+$ (positive electrode) due to electric field in the depletion region.
- Collected charges produce a current pulse which is read out in particular strip giving the position of the ionizing particle
- Magnitude of the signal measured on a given strip depends on its position relative to the site of charge formation

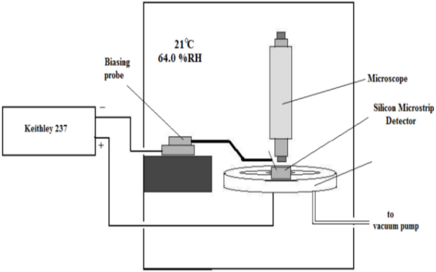


# Experiment

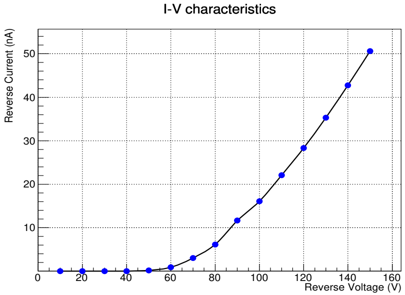
I-V and C-V characteristics of the detector to find the operating voltage

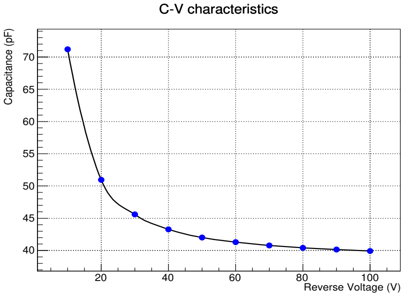



- For both characterizations, reverse bias voltage is applied to the biasing pad
- Positive potential is applied to the chuck on which detector rests
- The applied voltage and the reverse current/capacitance are measured by Keithley 237

# Results




- From I-V curve, the operating voltage should be high enough to get the signal and must be below than the breakdown voltage
- The operating voltage can be chosen over the constant capacitance region, where the depletion region remains constant

# Possible sources of uncertainty

- The tungsten probe should be touched properly on the bias pad
- Bias voltage should be increased in small steps and must be kept below the breakdown voltage
- The detector should be kept in a black box for minimizing the effect of ambient light
- Temperature, humidity, dust and other environmental factors should be controlled

**Pros**

- Good spacial resolution $\sim 50\mu$m
- Fast response time $\sim$ 10ns
- Flexibility of design

**Cons**

- Unable to distinguish multiple events within one readout period
- Radiation damage : replace often $\rightarrow$ costly
- Most cost in readout channels

**Other applications**

- In medical imaging, for X-ray energy range of 20-30 keV

*Thank you the entire SERB 2019 team!!*

# Back Up

**Table 1: Specification of Prototype detector**

| | |
|---|---|
| Wafer | n type Silicon, 4inch Diameter, 300 micron thickness |
| Resistivity | 5 KΩ-cm |
| Number of independent set of detectors | 11 |
| Type of implantation for strips | $p^+$ |
| Number of strips per set | 32 |

**Table 2: Specification of each set of Prototype detector**

| Set number | Strip length (µm) | Width (µm) | Pitch (µm) | Number of strips |
|---|---|---|---|---|
| 1 | 74734 | 12 | 65 | 32 |
| 2 | 74734 | 48 | 73 | 32 |
| 3 | 74734 | 12 | 80 | 32 |
| 4 | 74734 | 20 | 80 | 32 |
| 5 | 74734 | 35 | 80 | 30 |
| 6 | 74734 | 25 | 100 | 32 |
| 7 | 74734 | 35 | 100 | 32 |
| 8 | 74734 | 25 | 120 | 32 |
| 9 | 74734 | 35 | 120 | 32 |
| 10 | 74734 | 48 | 120 | 30 |
| 11 | 74734 | 25 | 135 | 32 |