The SiD Silicon Strip Sensor

Hybrid-Less silicon strip sensor designed by SLAC for the ILC:

- A strip pitch of 25 μm
- Alternate strips will be read out
- ~7 micron tracking resolution
- Thickness of 320 μm
- Material budget of 0.3% $X_0$
- An integrated pitch adapter and digital readout (KPiX)
  - Directly bump bonded to sensor surface
  - Signal routing through double metalization layer
**IV/CV measurements**

- Good behaviour:
  - ~100 nA currents, stable up to 300 V
  - Depletion voltage for all sensors at ~50 V
- Two sensors show breakdown beginning at 280 V → irrelevant for 60 V operational voltage.

![Bump Bonded Sensor with flex cable on the probe station](image)
Sensor performance

- For tests of the sensor performance the three distinct running modes of the Chip need to be understood:
  1. **Calibration**
     - Test of KPiX Chip performance
     - Only capacitive influence from the sensor
     - Charge to ADC calibration
  2. **Self triggering**
     - Triggering based on a charge threshold set by the user
  3. **External triggering**
     - Triggering based on an external logic signal fed into the DAQ board

- The performance of the sensor needs to be tested for each KPiX separately, problems need to be identified and solutions found.
Calibration results (Module 1 KPiX 1)

- Width in the calibration pedestal gives an estimate of the noise of the chip.
- Charge to ADC slope (red fit) shows whether the channel is functional or not.

Calibration pedestal

Charge to ADC calibration
Calibration results (Module 1 KPiX 1)

- ~100 non functioning channels (0 Slope) found on the KPiX → Unclear if problem comes from the KPiX or was introduced during assembly.
- ~80 channels with extremely low noise, lower than should be possible → ripped bump bonds
- Behavior not present in all KPiX, some show no disconnected channels and no slope of 0
  → No systemic problem but reason needs to be investigated further
Self triggering results

- KPiX can at most record four events per channel per data taking cycle
- Two KPiX show a very high amount of triggers even at large thresholds, a third KPiX is much more reasonable
  → Third KPiX feasible for testing with a radioactive source

Maximum possible amount of triggers
Self triggering results

- Time structured noise indicates system induced noise. Possibly pickup over long cables of current setup.
- Able to measure radioactive source with sensors.

Without Sr90 source

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<th>Time [a.u.]</th>
<th>Entries</th>
<th>Mean</th>
<th>Std Dev</th>
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With Sr90 source

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Parallel data taking

- In general no problem running multiple KPiX in parallel, one KPiX for some reason cannot be synchronized
  → Not systemic.
- Currently being investigated and checking for a potential firmware solution as a backup
Conclusion

- The first two sensors showed unexpected problems, sensor behavior, noise, open channels...
  → We know every component works

- Main suspect is the current assembly procedure:
  - Investigating the glue
  - Assembly tool

- Also currently suspecting some signal transfer problems → New electronics being designed

- Strategy: Understand assembly issues and identify solutions before producing further modules
Thank you for your attention

Fig.: Lycoris Têlescopium

Fig.: Lycoris Radiata
Sensor overview

- First two sensors assembled (#59 and #58)
  - Module 1 (Sensor #59):
    - Depletes well, showing low 350 nA currents at 60 V bias.
    - Can talk to both KPiX separately → 1 KPiX on this sensor appears to show a
different startup
    - Extremely high amount of triggers

- Module 2 (Sensor #58):
  - No longer depletes, shows resistor behavior → Not visible directly after gluing
appeared over time.
  - Can only talk to one of the two KPiX
  - Much lower amount of triggers at more reasonable thresholds

- Module 3 (Sensor #52)
  - Finished assembly last week, currently in testing

- Able to run multiple tracker KPiX together.
- Capable of seeing a radioactive source using the sensor as well as the impact form
different levels of ambient light.
The tracker system test setup