

Winter Nuclear and Particle Physics Conference 2018

HV Isolation of ITk Sensors

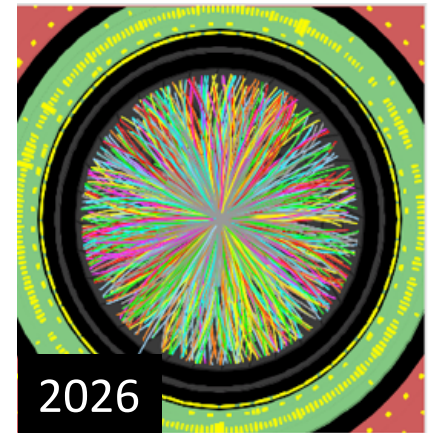
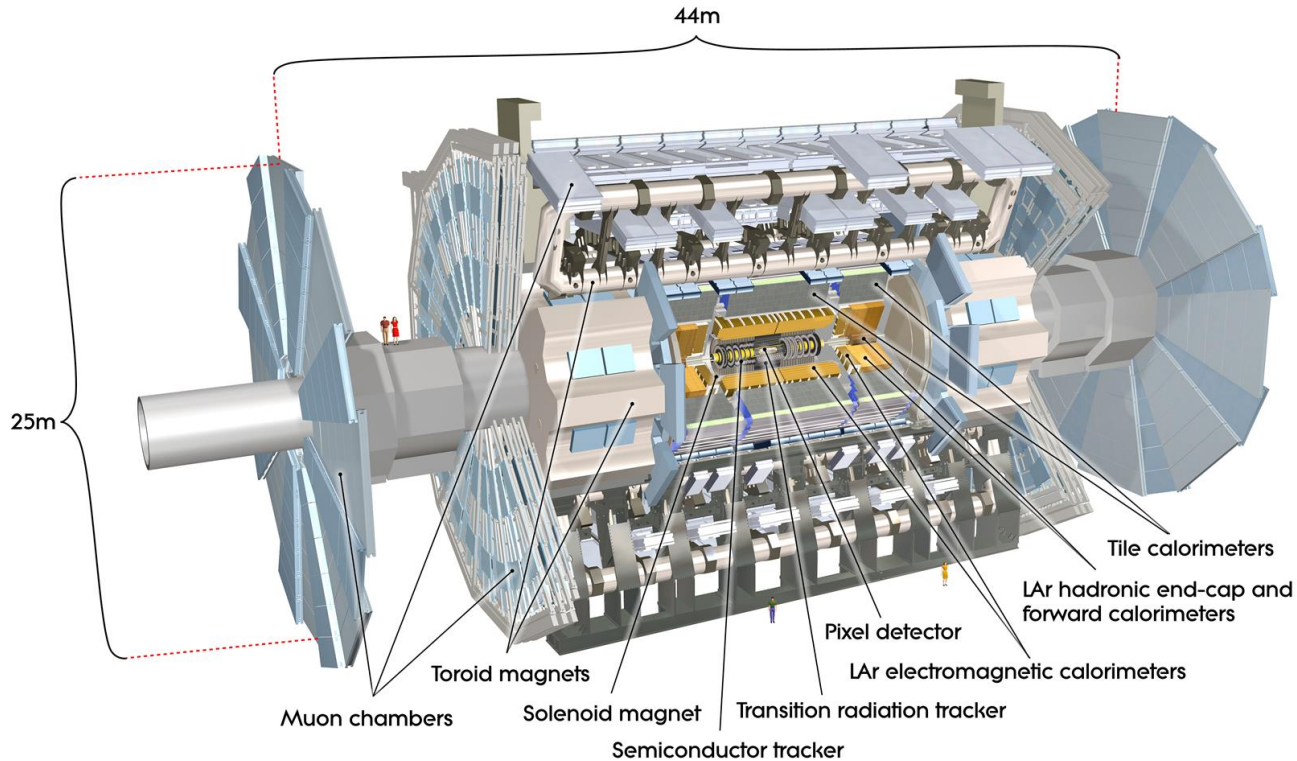
Konstantin Lehmann

Faculty of Science, Simon Fraser University

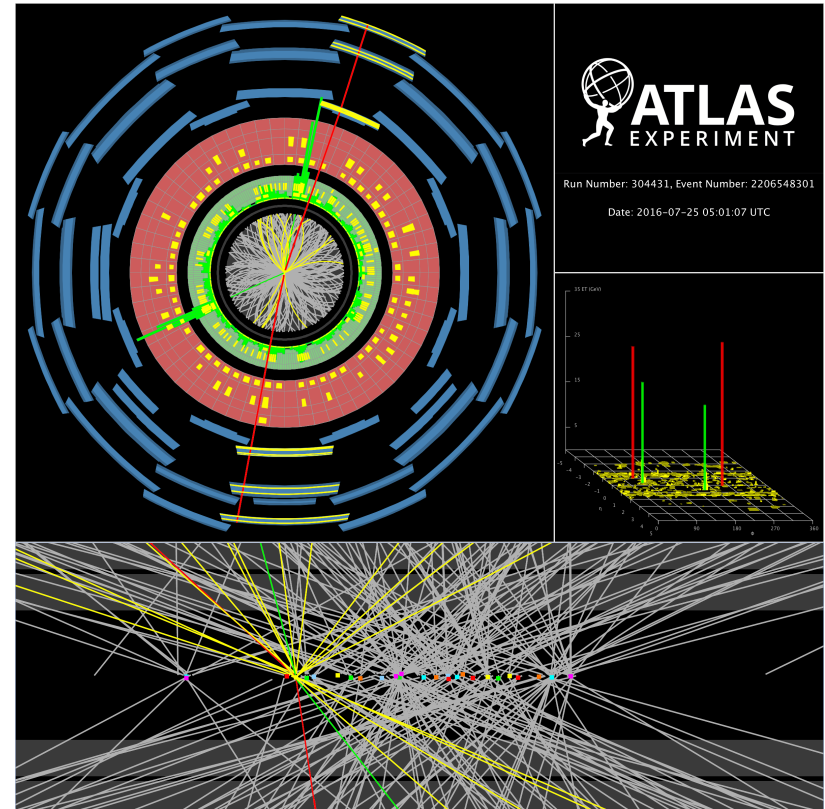
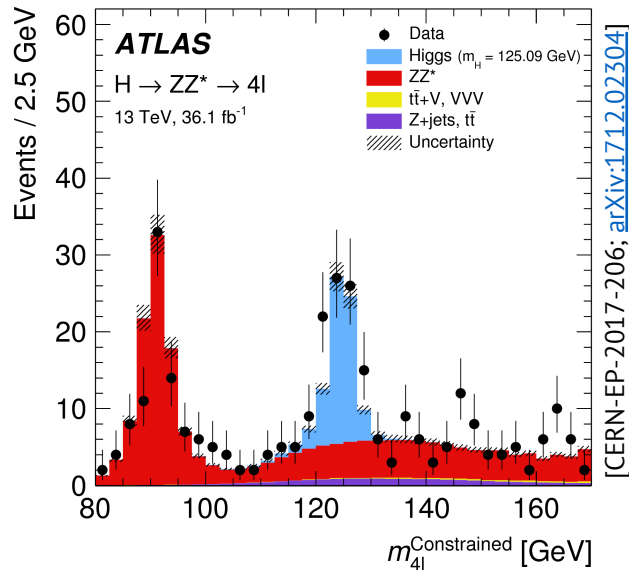
February 15th, 2018



ATLAS at CERN

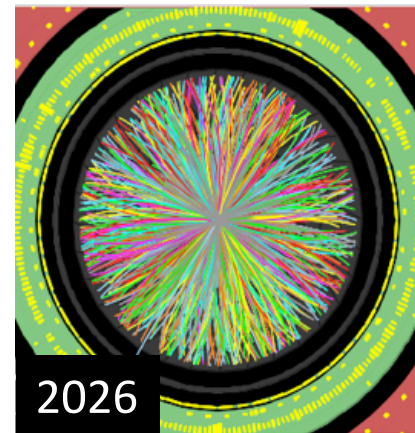
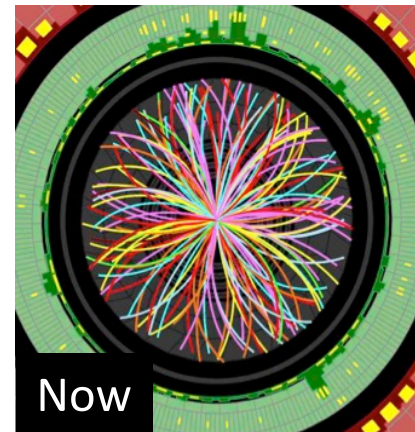
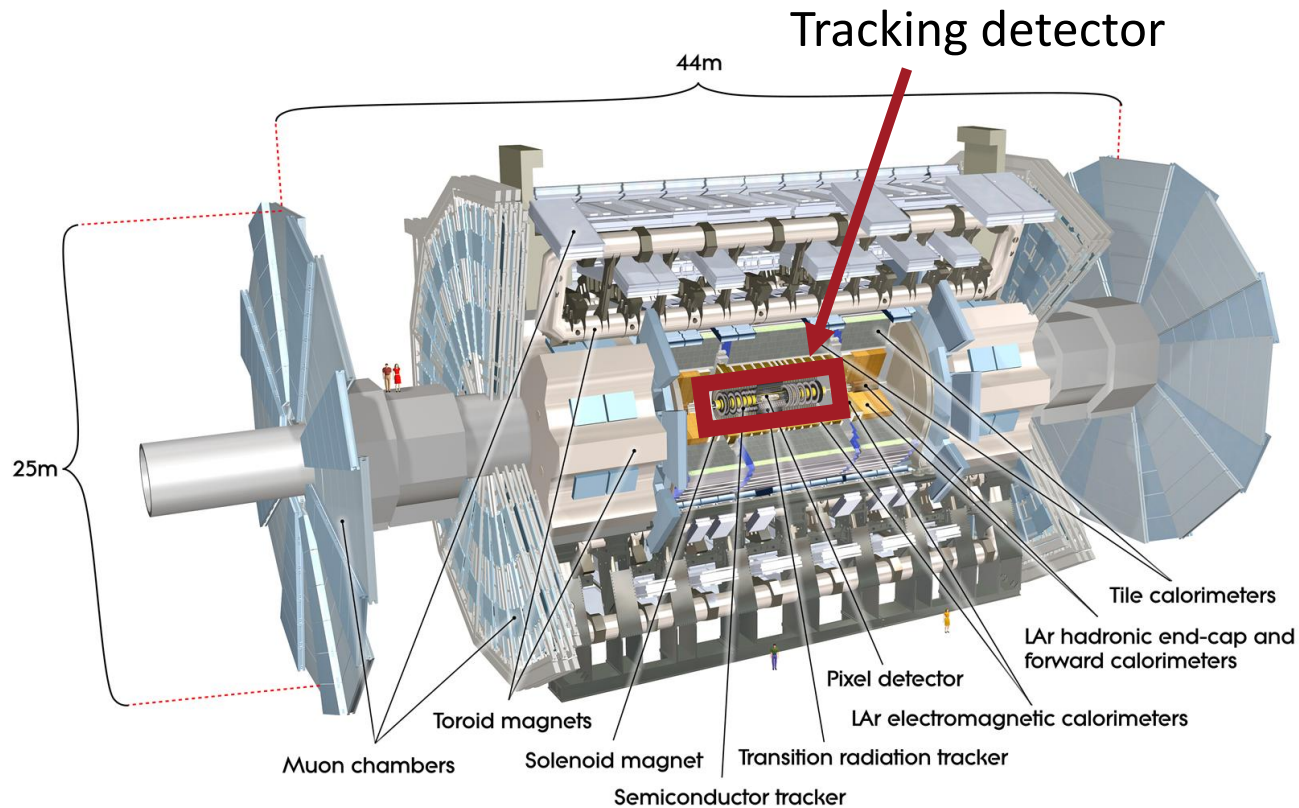


- Why is tracking important?
→ Resolve and identify all tracks

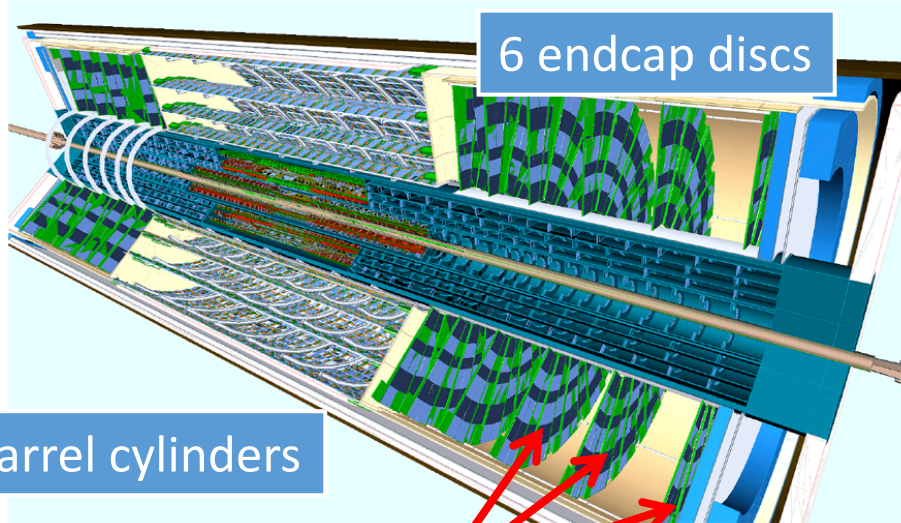


26 primary vertices

ATLAS at CERN



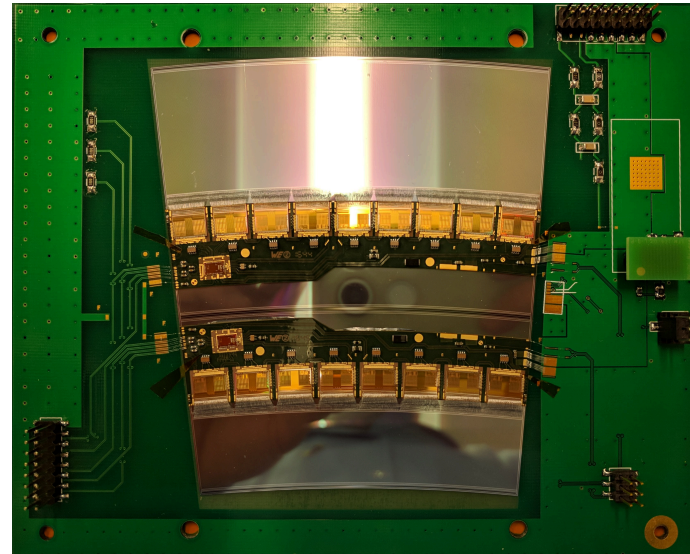
Inner Tracker (ITk) Strip Detector



2.5 disks to be built in

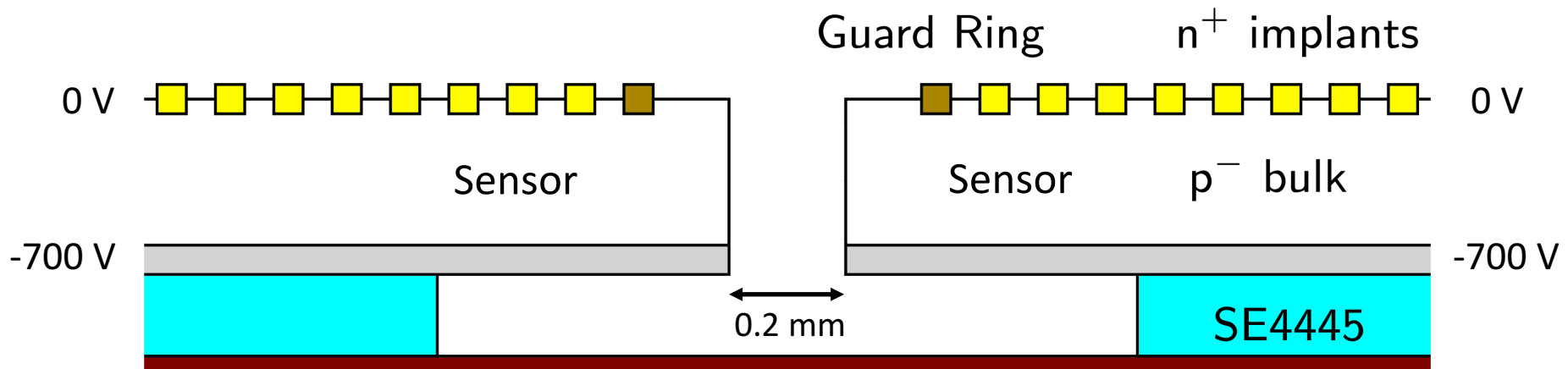


- Goal: Minimize dead area
 - Place sensors close to each other
- Risk: Sparks between sensors

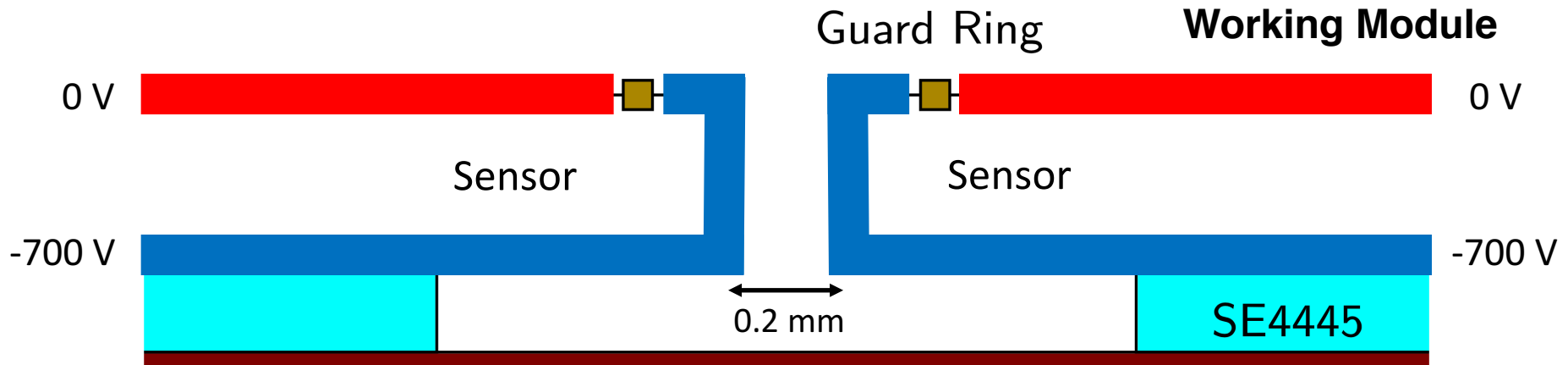


Inter-Sensor Isolation

- Silicon sensors
 - Reverse bias voltage: -700 V
 - Switch off, if module fails
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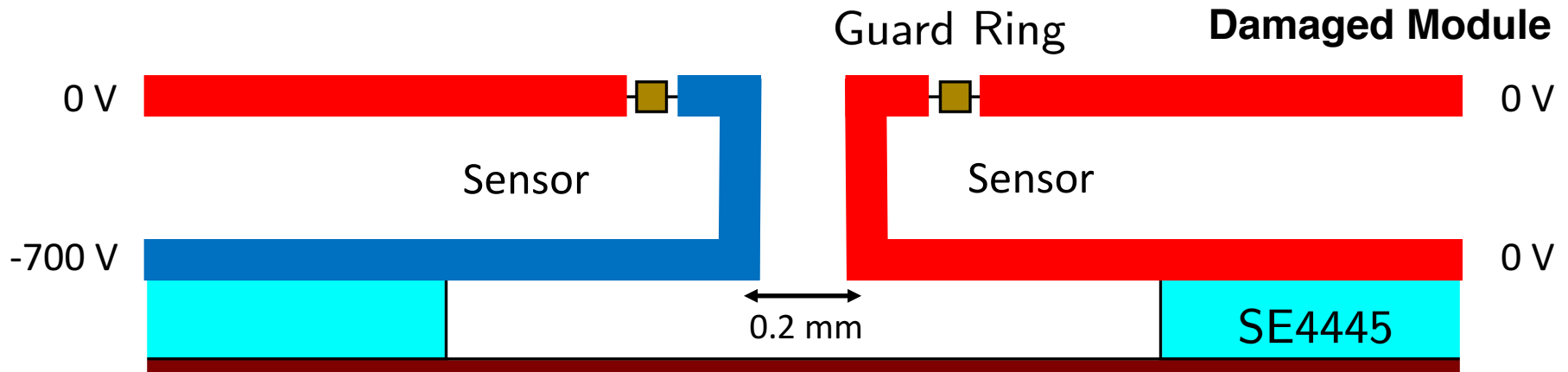


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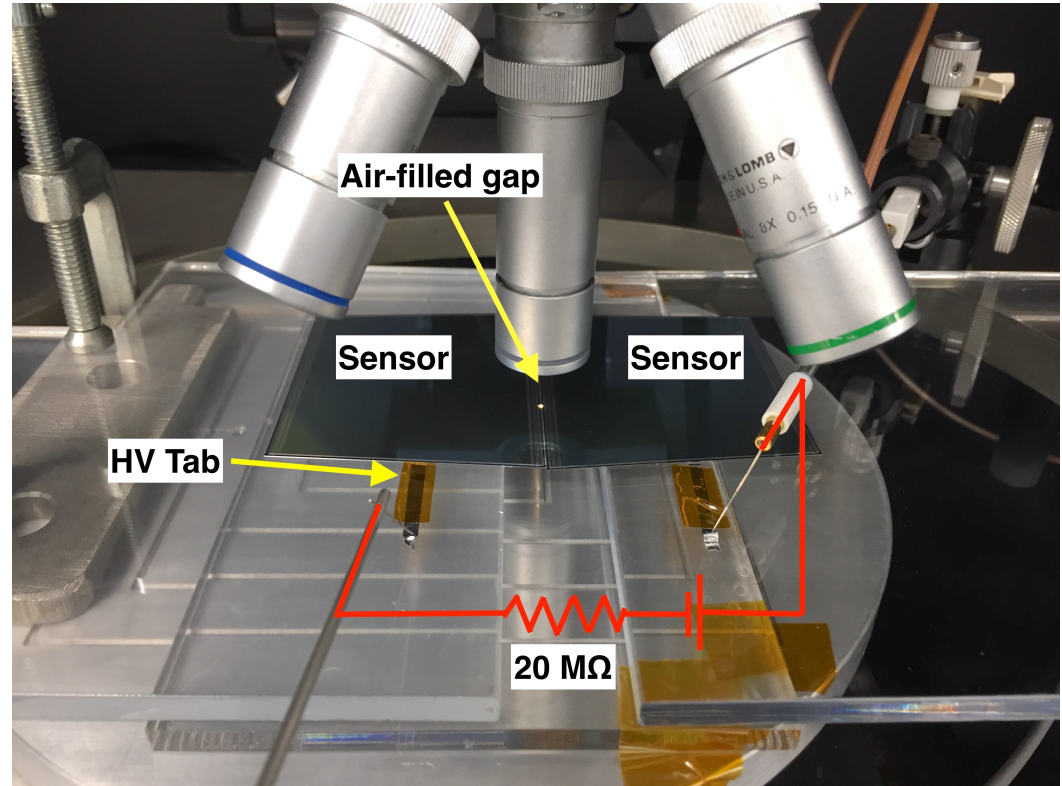
Required for safe operation:

- $\text{Current} < 70 \text{ nA} \leq \text{Leakage current}$

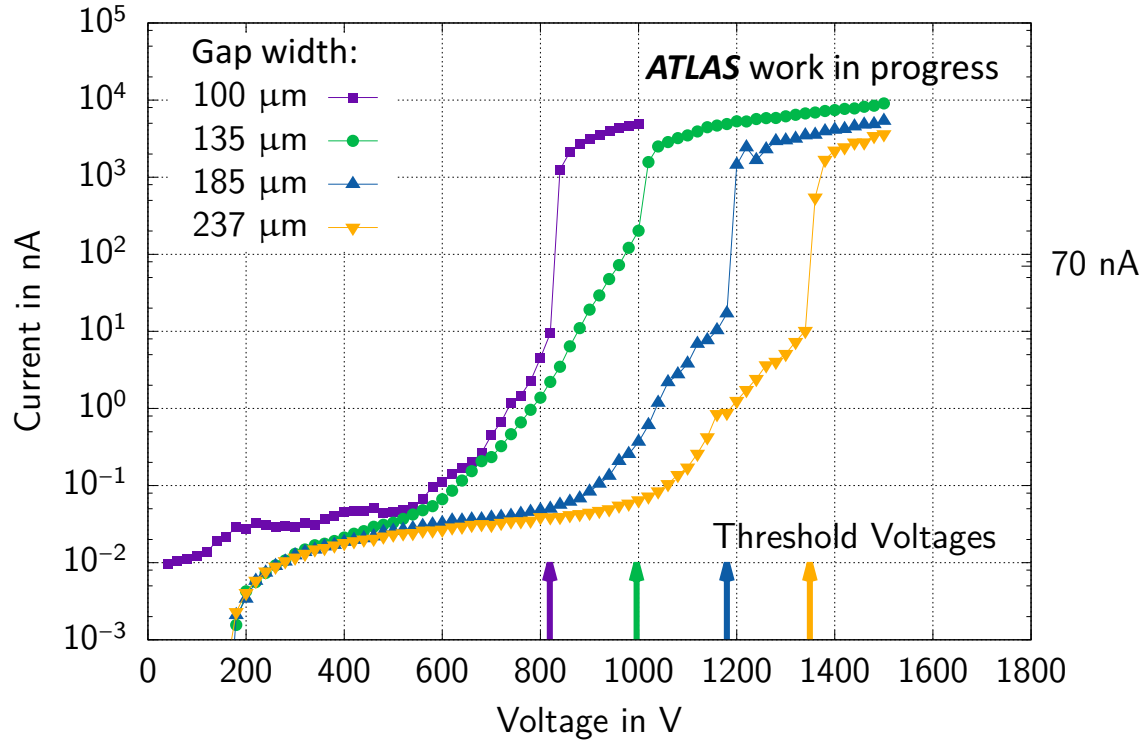
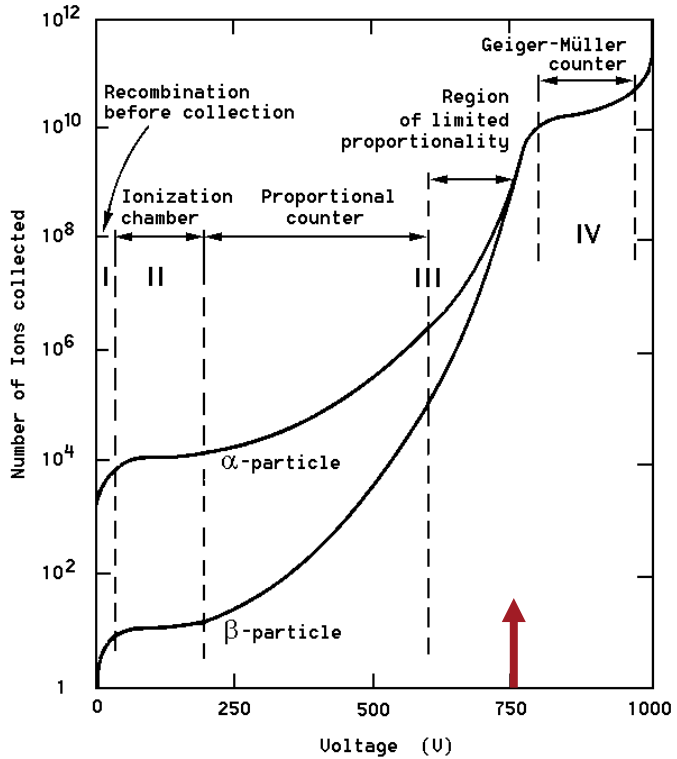


Setup

- Recreate situation in detector
- Use SCT sensors to approximate ITk sensors
- Control distance between sensors
- Contact backside
- Record current-voltage curves



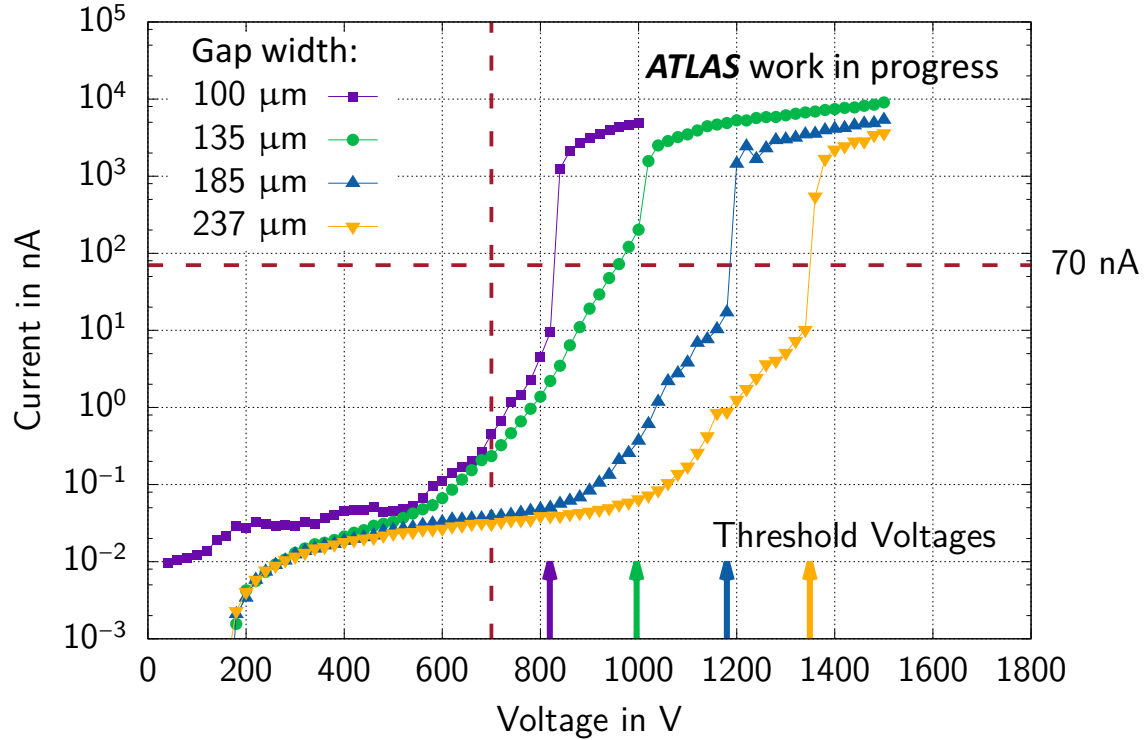
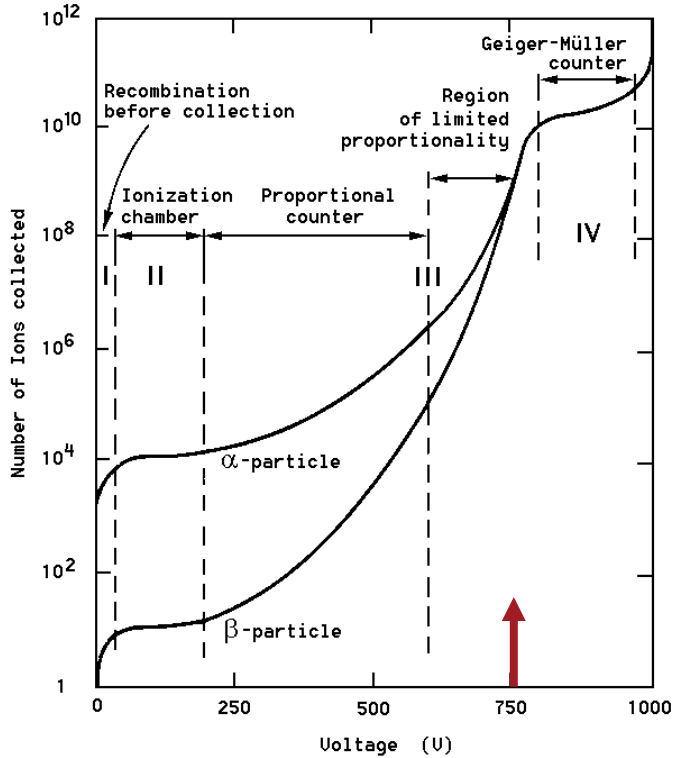
Current-Voltage Curves



Schematically: I(V) in gas detector

I(V) between SCT sensors

Current-Voltage Curves

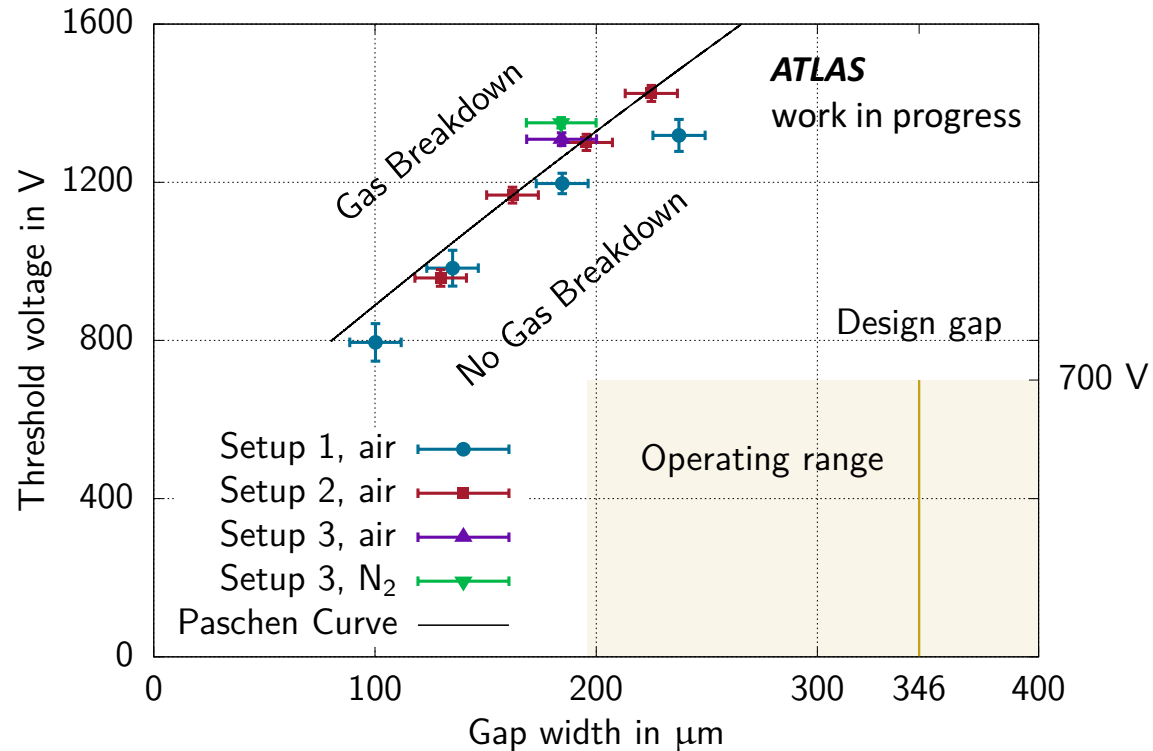


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I(V) between SCT sensors

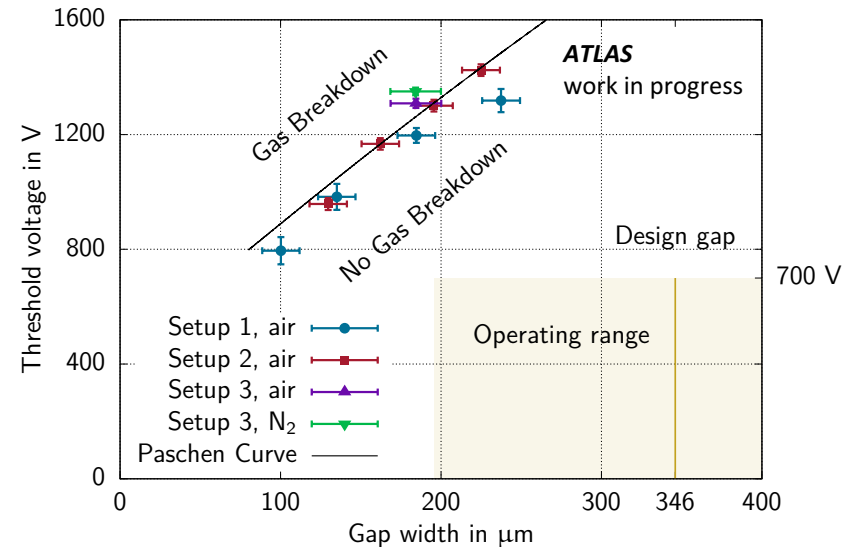
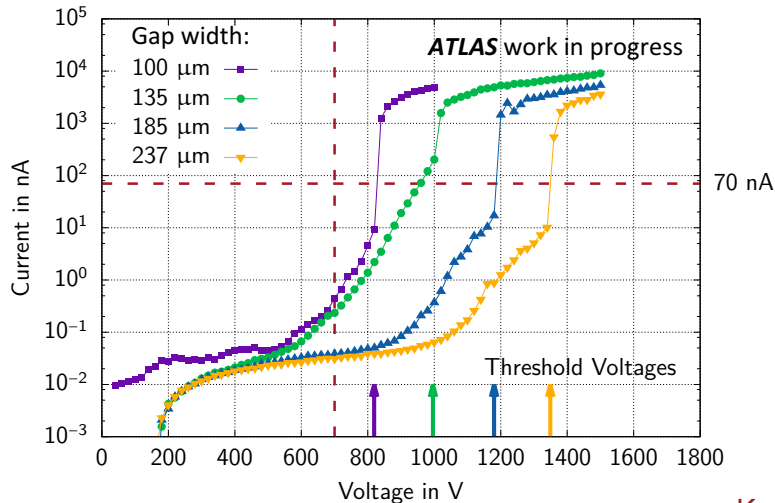
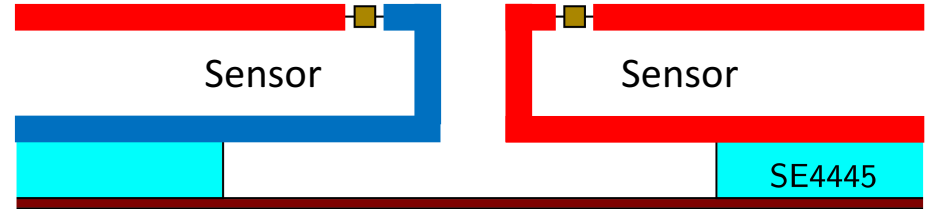
Threshold Voltage

- Measurements agree well
- Measurements linear (expected)
- Operating range far from gas breakdown

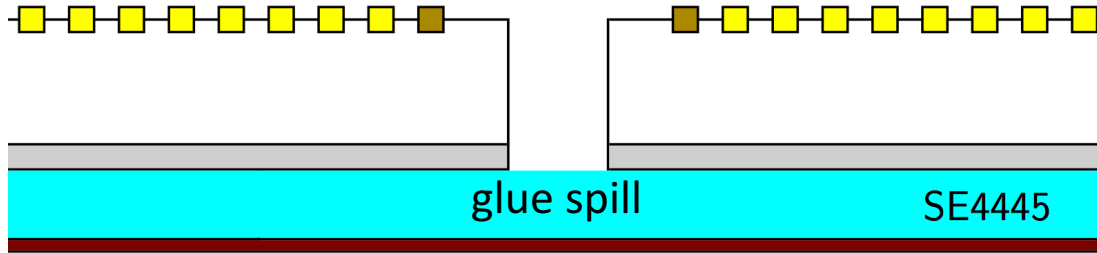


Summary

- Do ITk modules need to be insulated?
 - Current < Leakage current
 - Voltage < Threshold voltage
- No insulation necessary

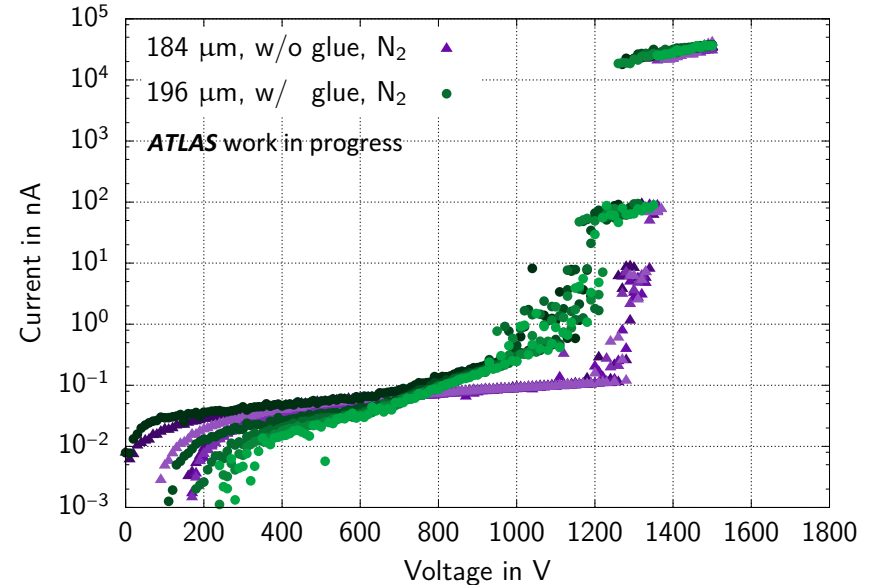


Risk of Glue Spills

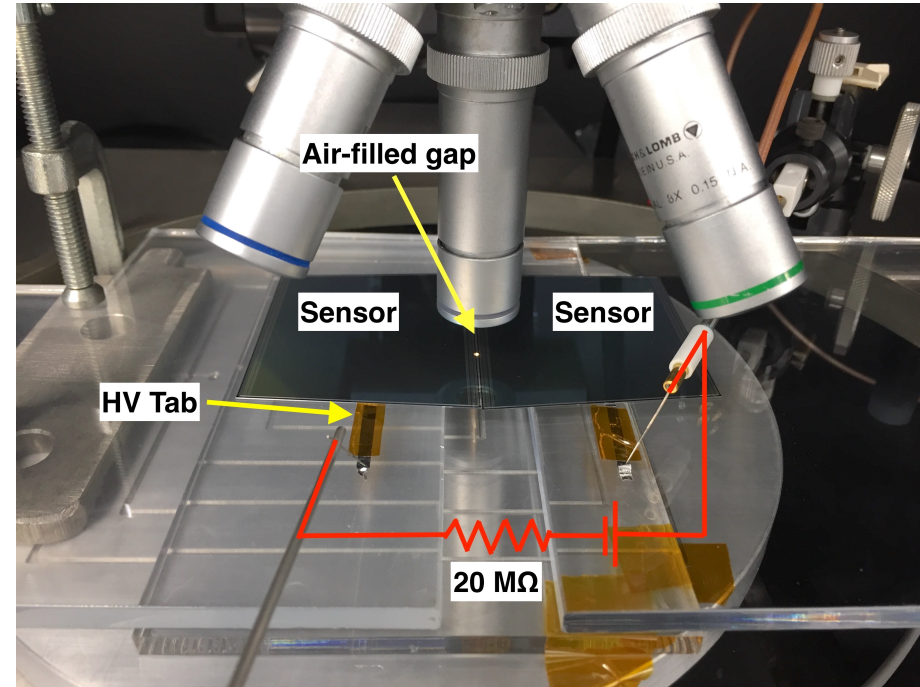
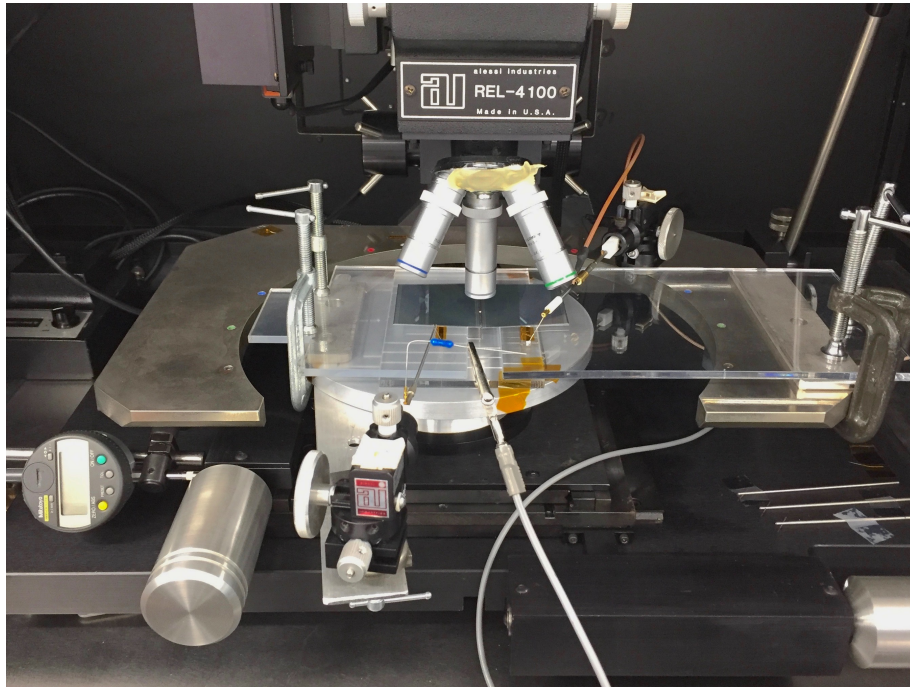


- Glue can run into gap
- Facilitates charge flow?

- Glue spill vs. clean gap
- Higher currents with glue
- Pronounced plateau
- Avoid glue in the gap



Measurement Setup



- Gas gap between SCT W32 sensors (Thanks to Freiburg!)
- Distance measurement with micrometer and microscope

- Voltage between backplanes using HV tabs
- Source meter: Keithley 2657a

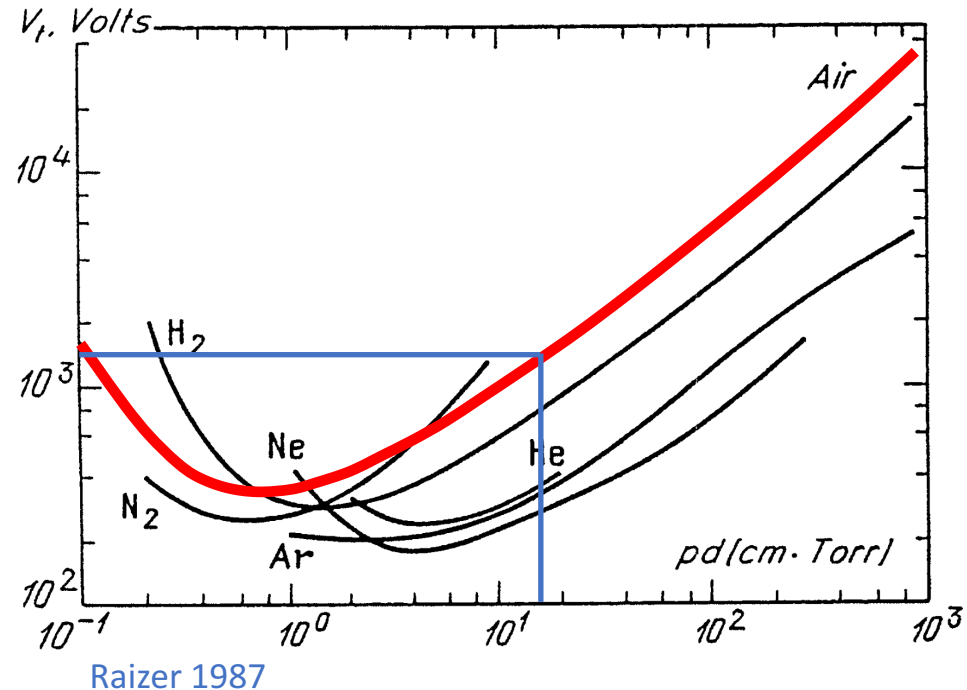
Scaling of Threshold Voltage

- Paschen's Law:

$$V_t = V_t(pd) = \frac{B(pd)}{C + \log(pd)}$$

with p = pressure, d = distance

- Large distance: $E = \frac{V}{d}$ small
- Small distance: No gas molecules to ionize



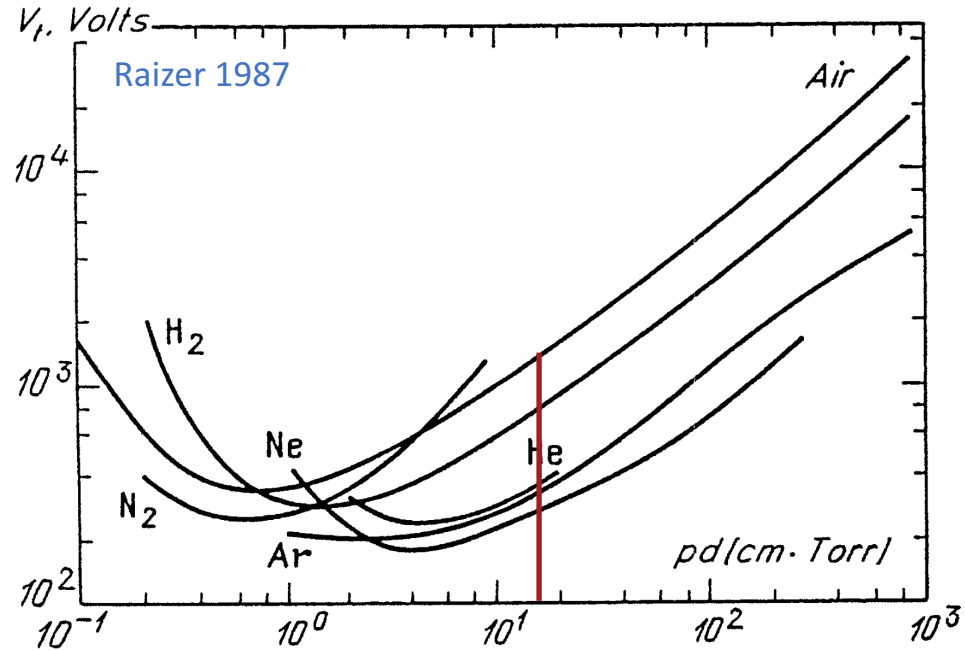
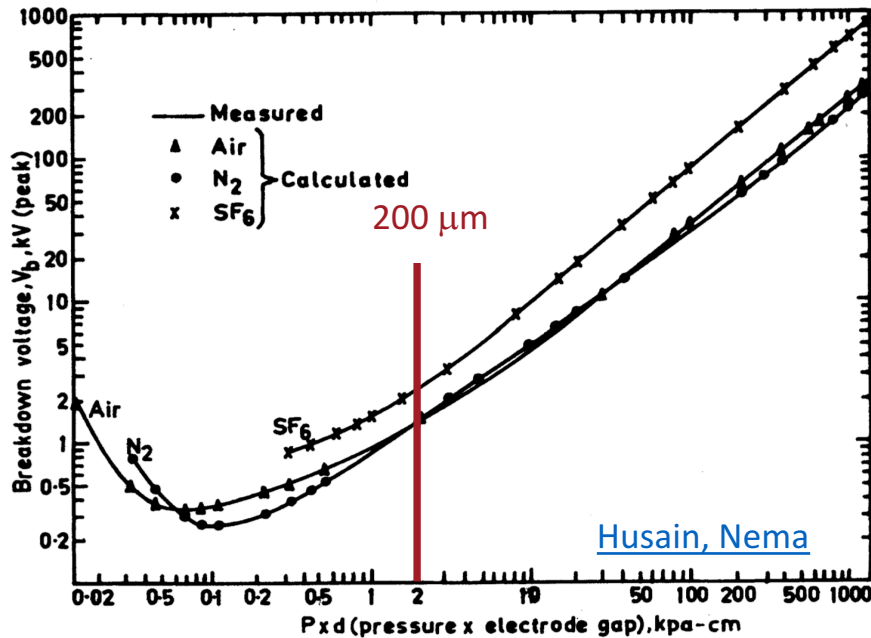
1 cm Torr \approx 13 μ m atm

What else affects Gas Discharge?

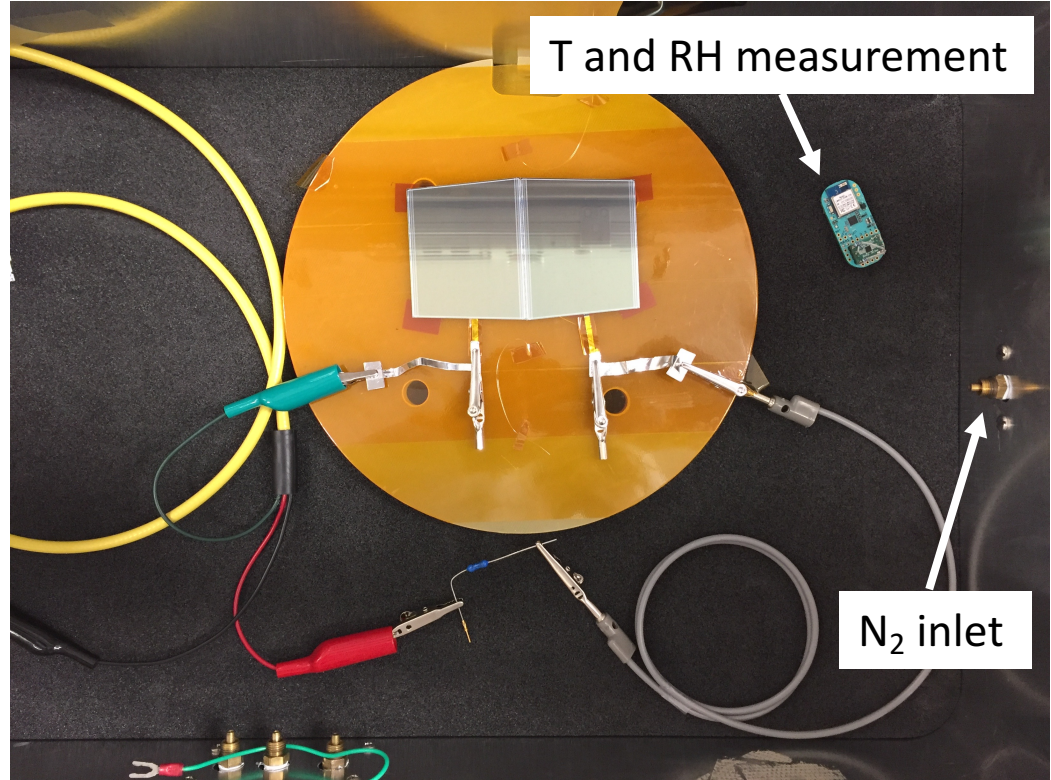
- ATLAS-altitude pressure
 - taken in to account using Paschen's Law
- 2T magnetic field
 - only important for end-caps, should only decrease current
- Edge surface: ITk stealth-diced, SCT blade-diced
 - conservative estimate
- Additional ATLAS radiation → increases gas discharge current
 - only small effect
- Does radiation change silicon edge?
- Gas discharge in nitrogen vs. air

Gas Discharge in Nitrogen vs. Air

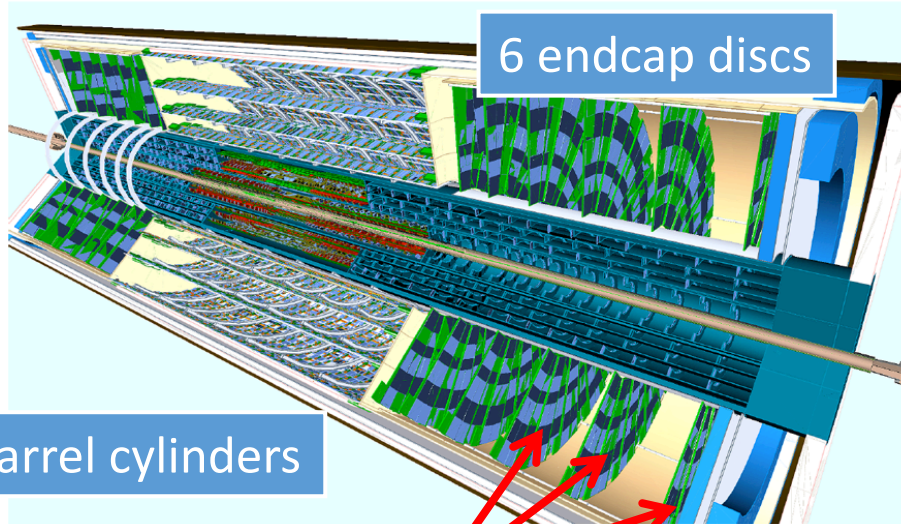
- Paschen curves for different gases



Setup 3



Inner Tracker (ITk) Strip Detector



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