

Cold Box for AC-LGAD Properties Characterization

Grigory Nigmatkulov
University of Illinois Chicago

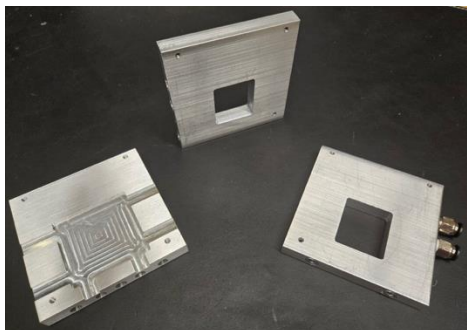
Sensor Characterization at Different Temperatures

- **Avalanche gain is strongly temperature-dependent**
 - Lower temperatures shift breakdown voltage, modify impact-ionization coefficients, and change effective gain → critical for stable timing performance.
- **Charge-sharing and resistive network behavior vary with temperature**
 - Sheet resistance, interpad coupling, and diffusion lengths change, affecting spatial resolution and signal linearity in AC-coupled readout.
- **Timing resolution is temperature-sensitive**
 - Increased carrier mobility and reduced noise at low T improve rise times and jitter; high T leads to degradation and early breakdown.
- **Leakage current drops exponentially at low temperatures,**
 - reducing shot noise and extending operational voltage range — essential for high-radiation environments.
- **Radiation-damaged devices exhibit different temperature responses**
 - cooling partially restores gain uniformity and timing after fluence exposure; must be mapped for detector longevity and calibration.
- **Electronic noise and impedance depend on sensor temperature,**
 - influencing optimal shaping times and front-end design.
- **Environmental control is required for stable operation:**
 - sensor performance drifts with temperature → need calibration curves for reconstruction, gain normalization, and long-term monitoring.
- **Detector integration requires a validated operational window:**
 - understanding temperature effects defines safe bias voltages, prevents runaway breakdown, and ensures uniform response across the sensor.

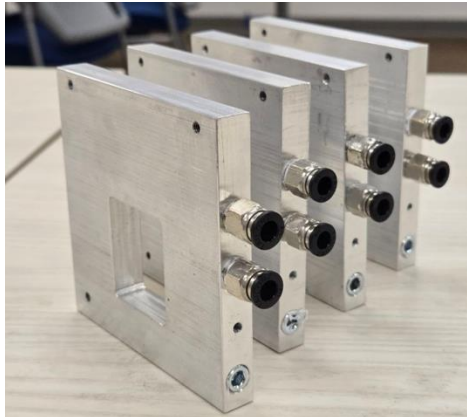
Cold Box

- To start the characterization a set of tools was designed, machined, assembled, and tested at UIC
- At the current stage:
 - A cold box have been designed that can be integrated to the telescopes
 - A TCT setup at UIC has been upgraded for sensor characterization at different temperatures

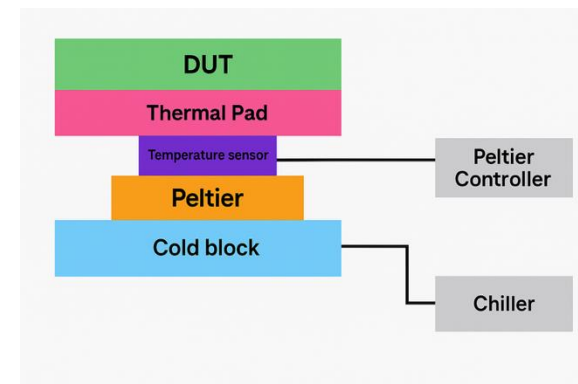
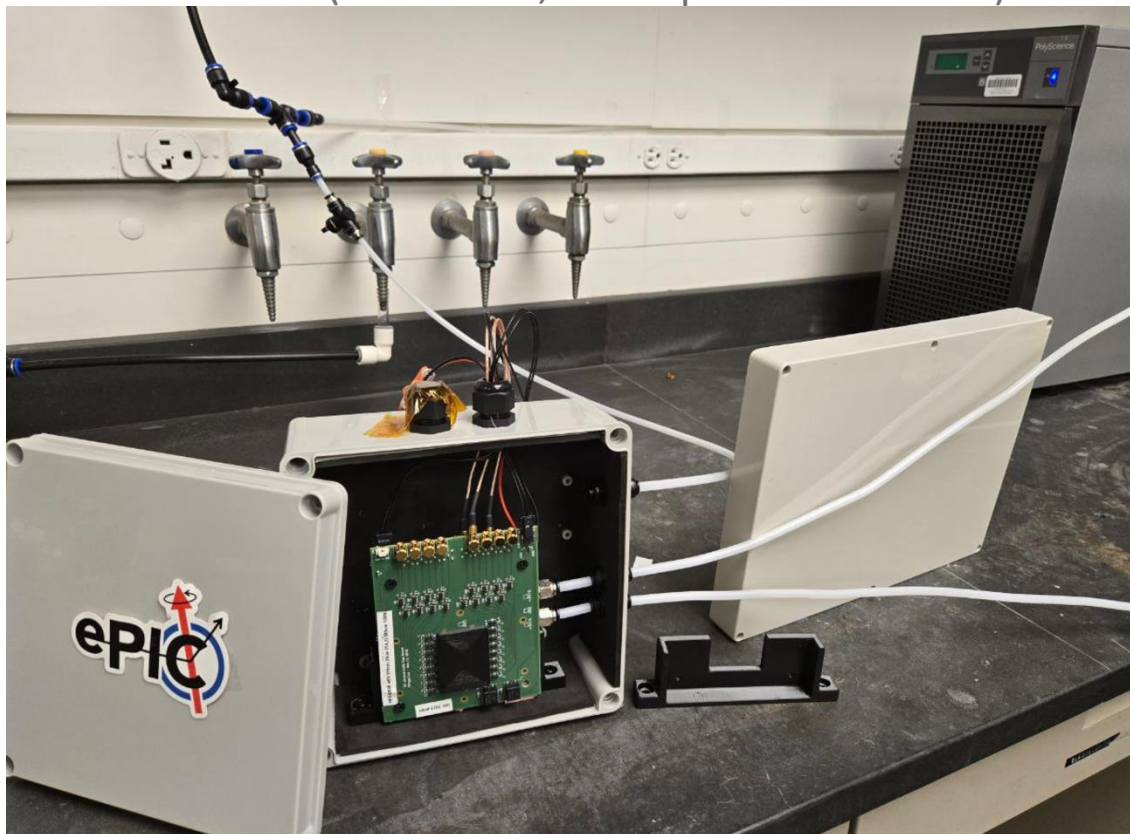
Cold blocks



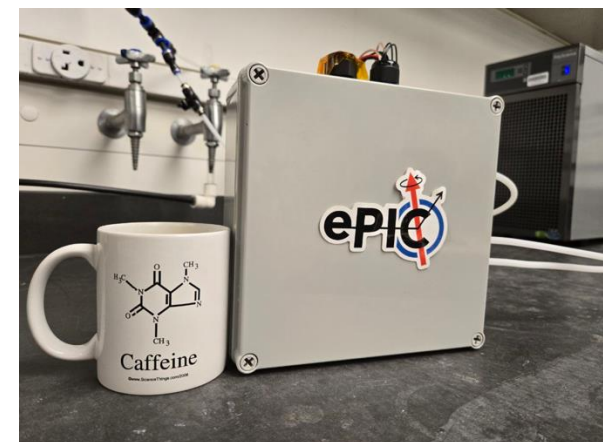
Cold blocks for test beams



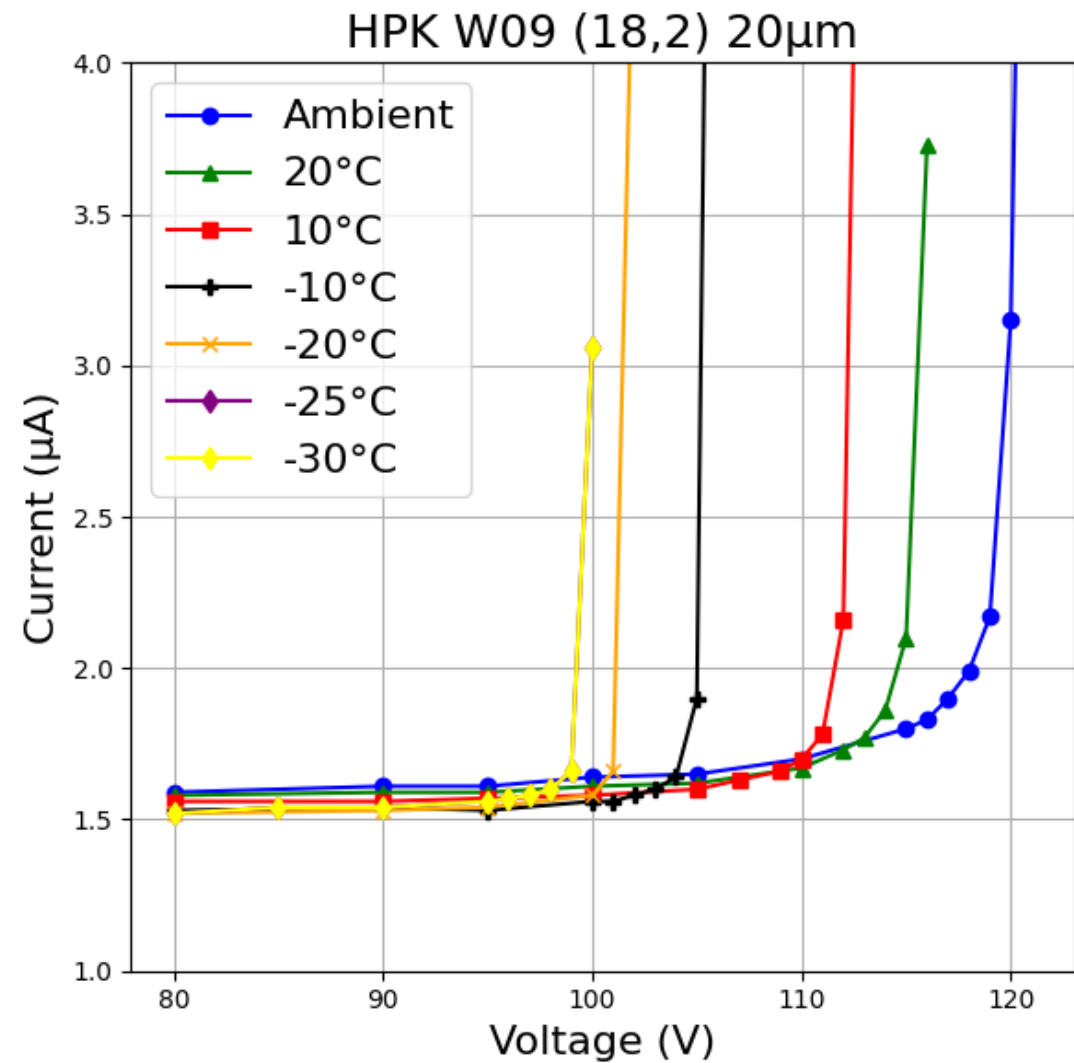
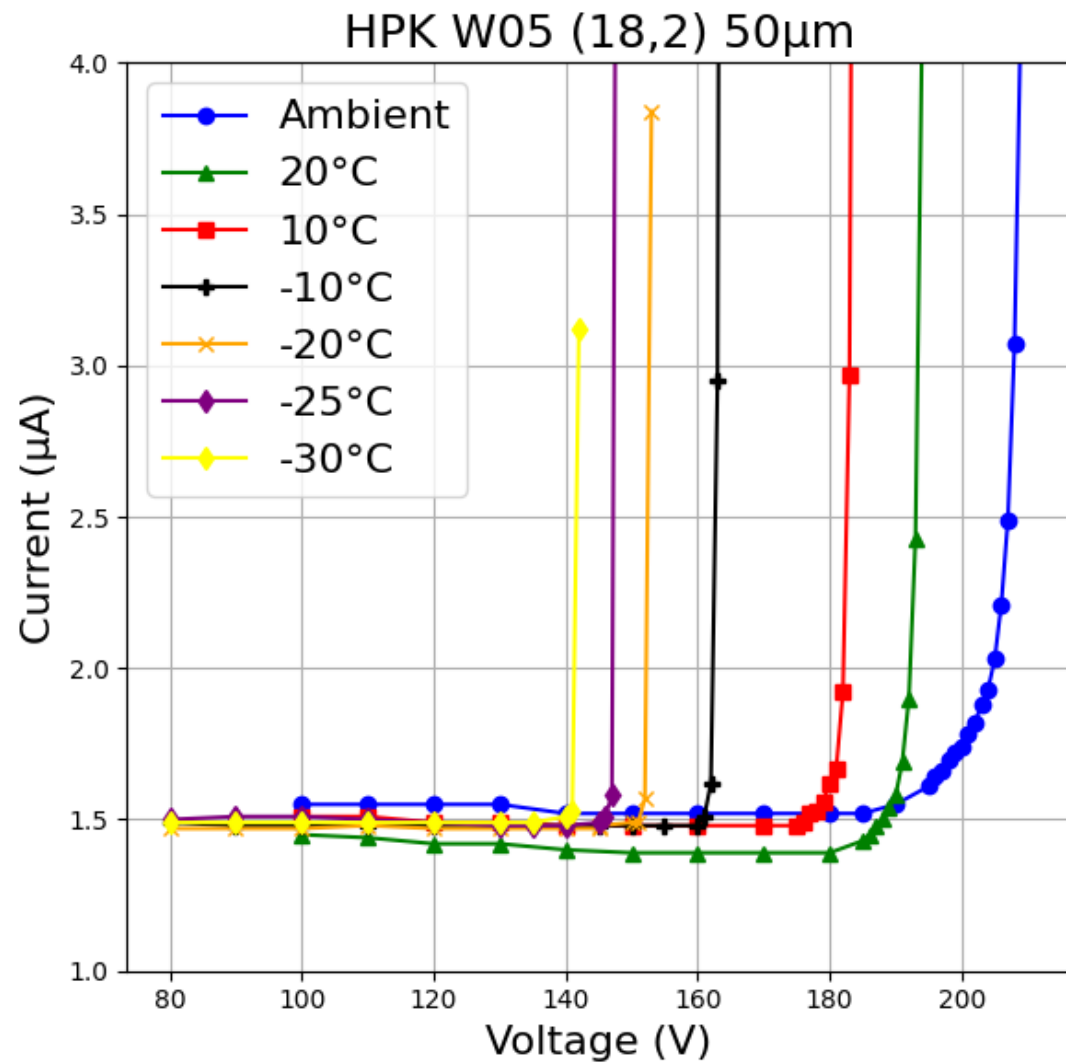
Cold box (front view; some parts are shown)



Cold box (scale)



IV Scans of the 1cm Strip Sensors



- The parts for the temperature-controlled AC-LGAD characterization have been developed, machined, and tested at UIC
- The first IV scans in a broad temperature range (from -30C to ~25C) have been performed for 1cm sensors
- We ask for the full-size sensors (both strip and pixel) for characterization at different temperatures using the TCT setup at UIC:
 - IV scans
 - Coordinate and time resolutions

