The Upstream Tracker for the LHCb Upgrade

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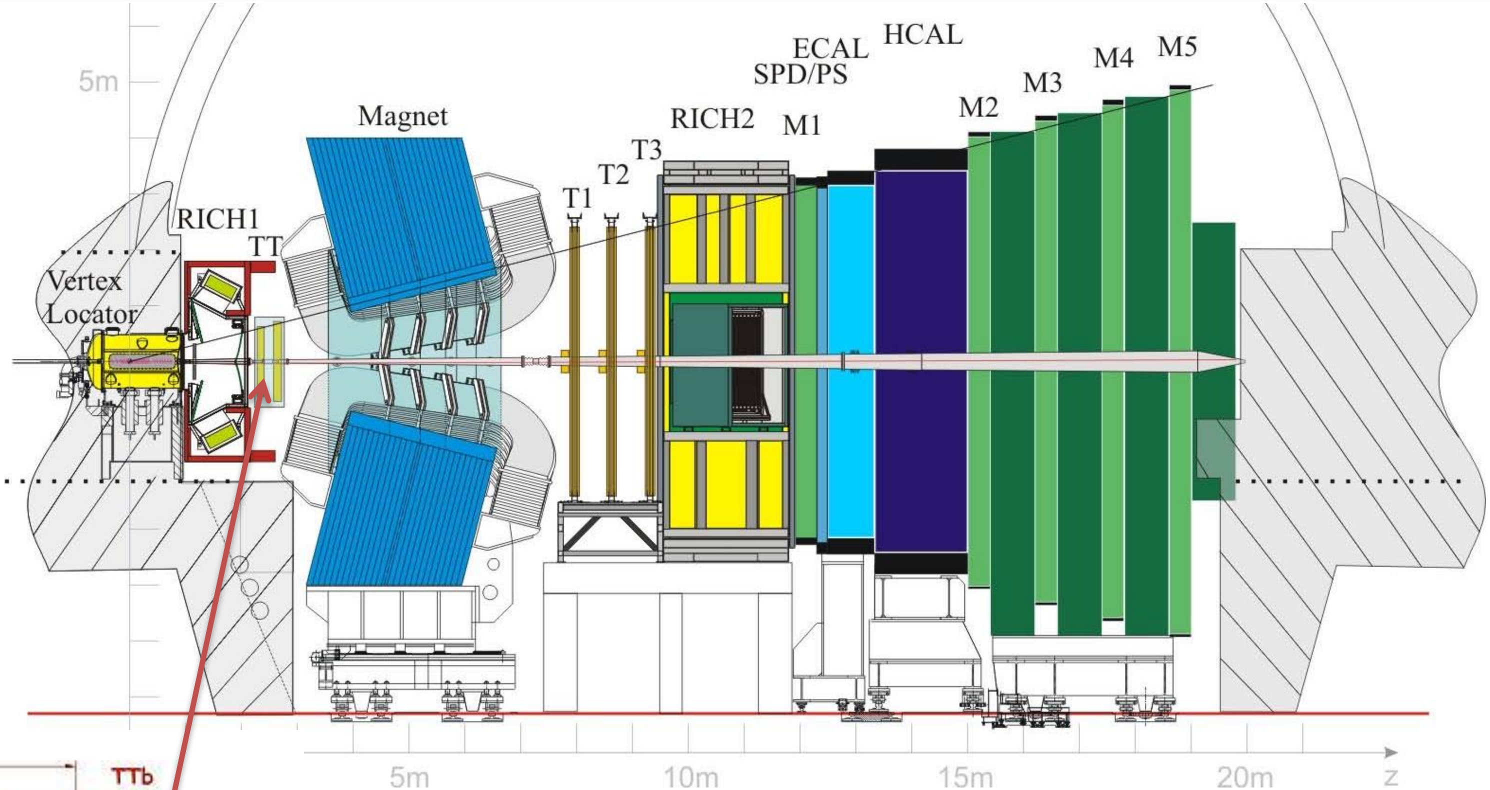
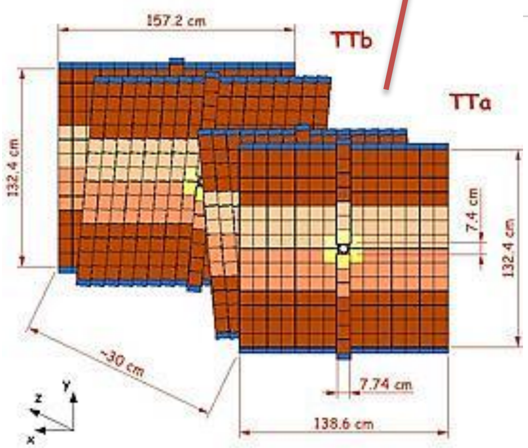
on behalf of the UT group

LHCb Tracking and Upgrade

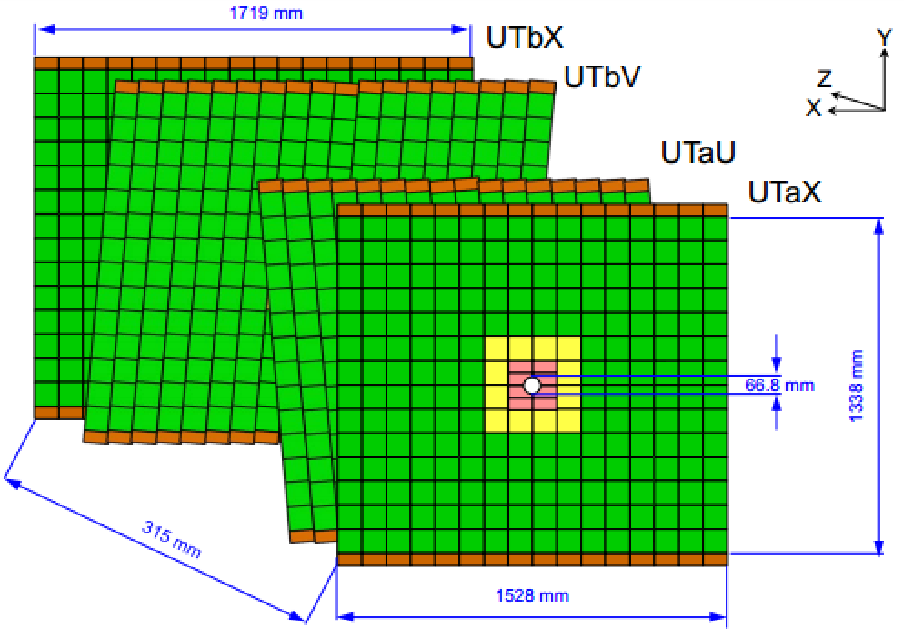


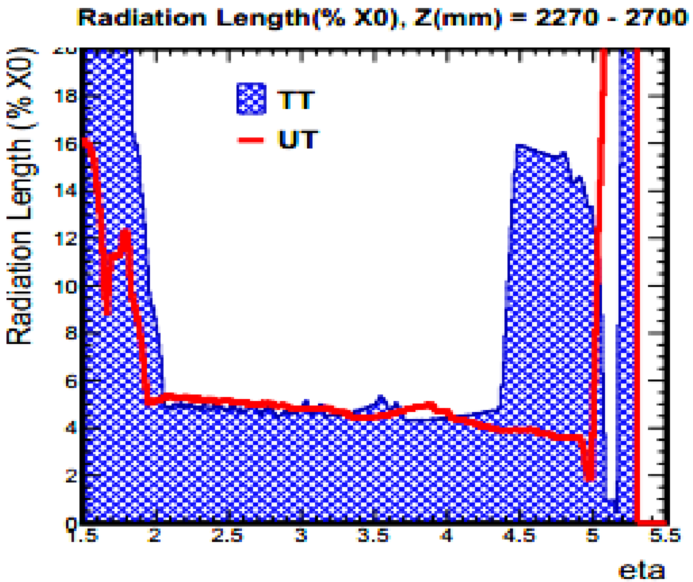


- **Current TT plays a important role in LHCb tracking**
- **LHCb upgrade involves an improvement in sensitivity by at least one order of magnitude**
  - Increased luminosity
  - Pure software trigger
- **The Upstream Tracker (UT) is the replacement for the TT detector**
  - Crucial for speeding up the trigger algorithm
  - Improved tracking performance

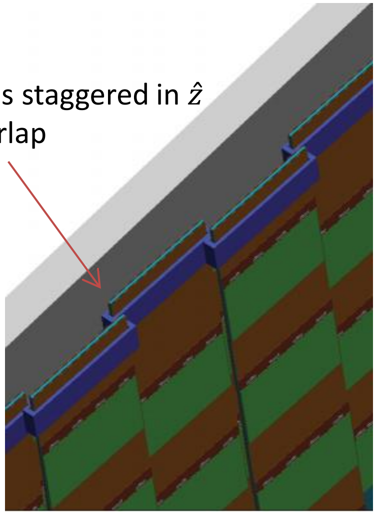
Features of the UT Upgrade

- **Similar geometry as TT**
- **Front end electronics (SALT ASIC) near sensor**
- **Full 40MHz readout**
- **Integrated cooling in stave support**
- **250µm silicon micro-strip detectors**
- **Sensor overlap in x-y coordinates**
- **Reduction in radiation length**



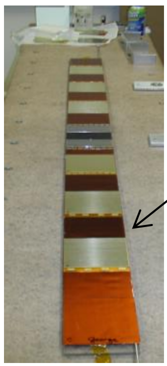


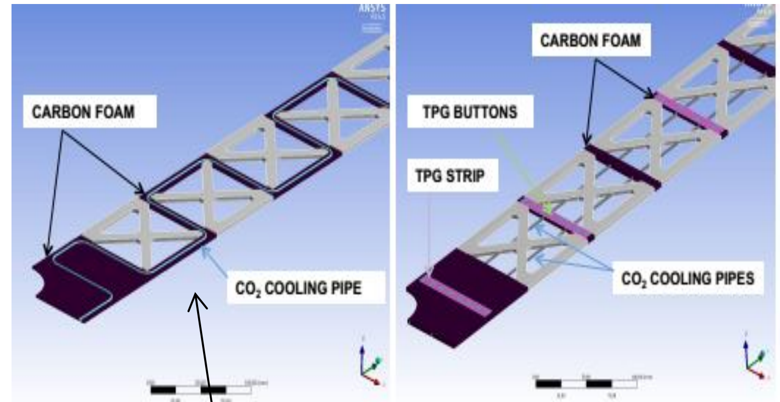
Adjacent staves staggered in $\hat{z}$ to allow $\hat{x}$ overlap

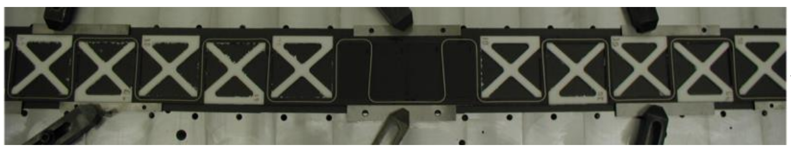


Highlights of UT Mechanical Design

- **Stave**
  - Carbon fiber facings with carbon/Rohacell foam core
  - Evaporative CO_2 cooling is integrated into stave via embedded snake-pipe cooling tube
  - First thermal mock-up showed good performance

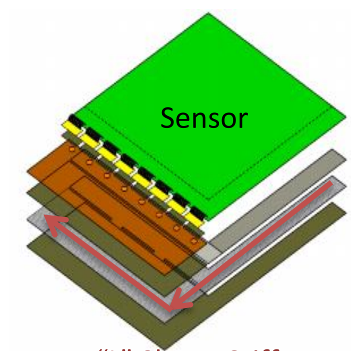




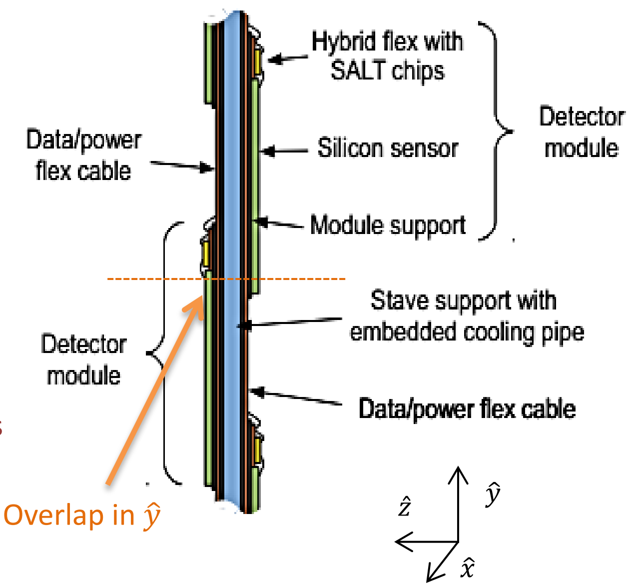


Baseline Configuration   Alternative Configuration

- **Module**
  - Components: SALT ASICs, module support, and silicon sensor
  - Mounted on front and back of stave
  - Designed to be removable if needed
  - Different variations in module support are being investigated

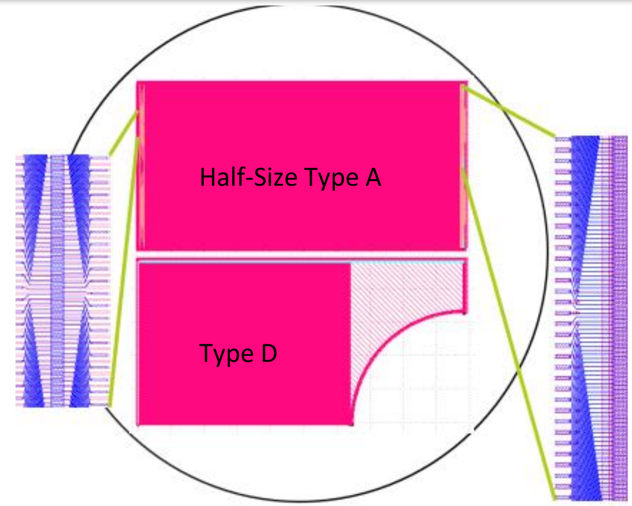


"L" Shape Stiffener as baseline module support

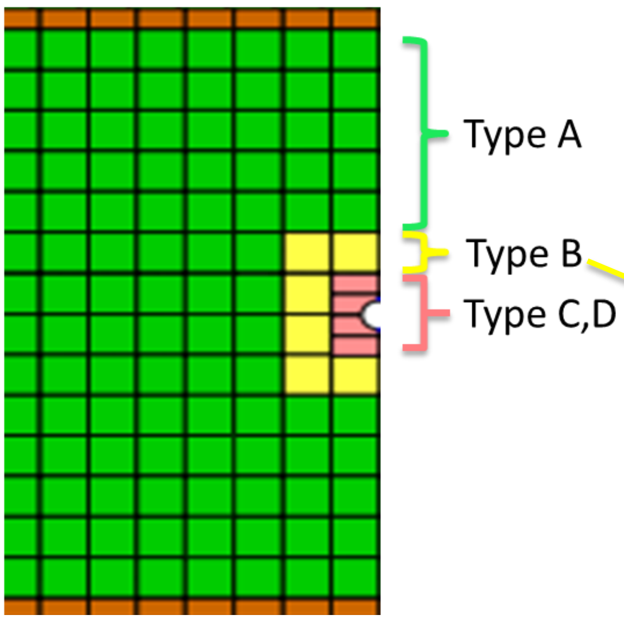


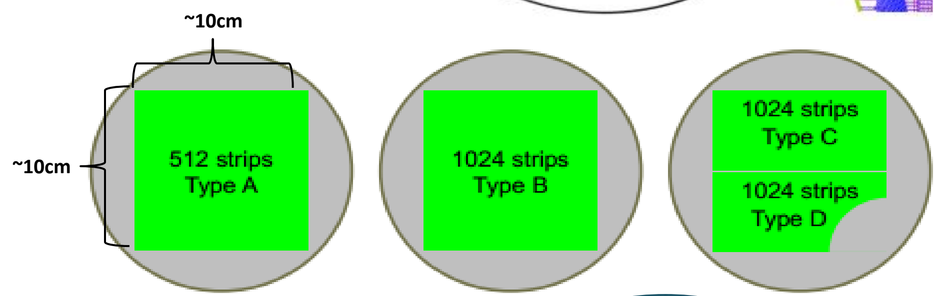
UT Sensors

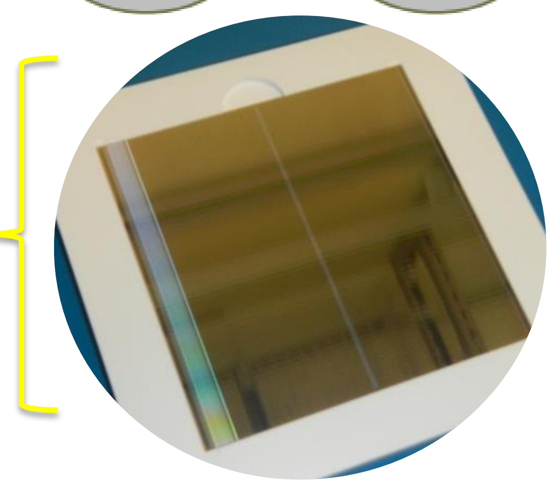
- **Sensor segmentation and technology is dictated by location**
  - Outer region sensors (A) are p-in-n with a strip pitch of ~180µm and length ~10cm
  - Central region sensors (B,C,D) are n-in-p for radiation hardness, and have a finer strip pitch and half the strip length
  - On detector pitch adapters for type A sensors
  - Sensors surrounding beam pipe have semi-circular cutout



Detector Half-Plane

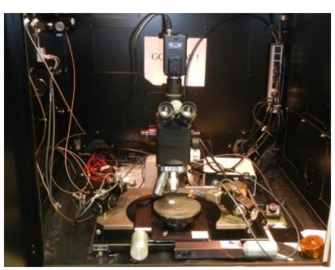


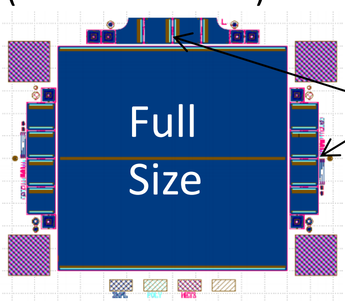




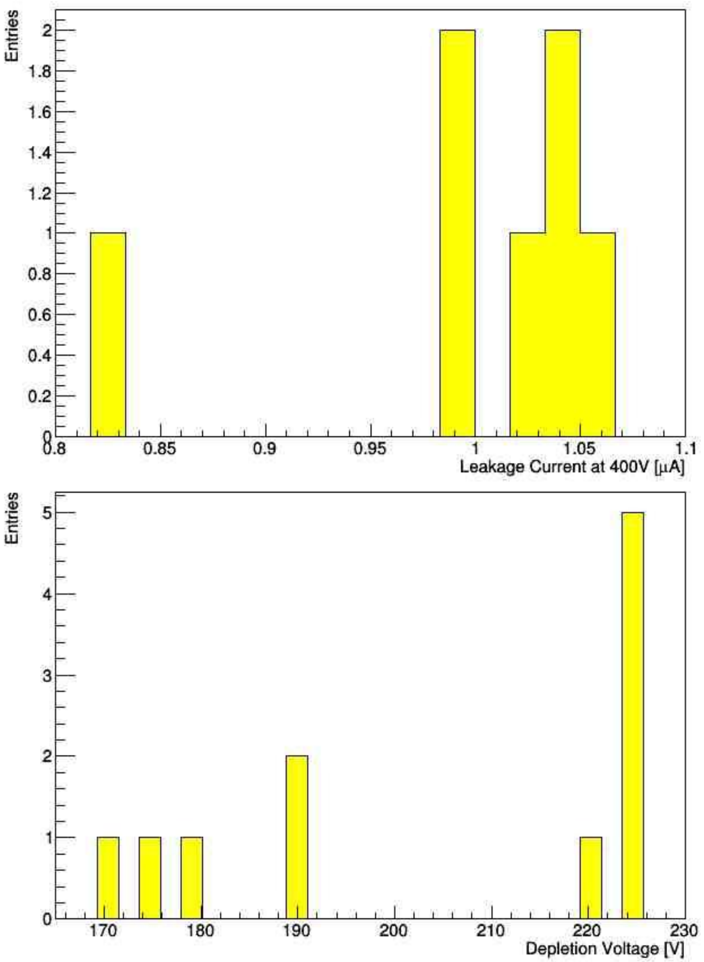
Sensor R&D (I)

- **Currently have:**
  - Full size type B sensors from two vendors
  - Type D and B-like mini-sensors from one
    - Produced on same wafers as full size sensors
  - Plan to receive more soon
- **Tests done so far:**
  - Sensor shape and optical scans for defects
  - Leakage current (IV) and depletion voltage (CV), both pre and post irradiation
  - Leakage current stability over several weeks
  - Characteristics at nominal operating temperature (< -5^{o}C)
  - Test beam studies (not shown here)



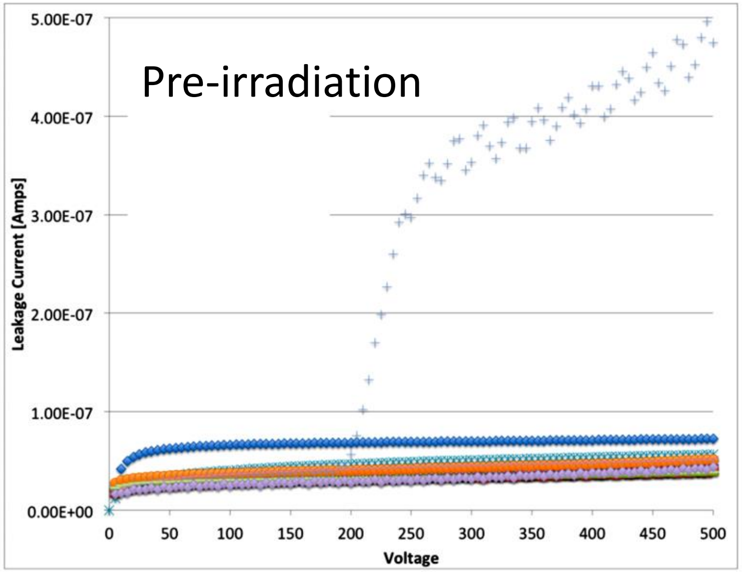


Full Size Type B Sensors (Room Temp.)

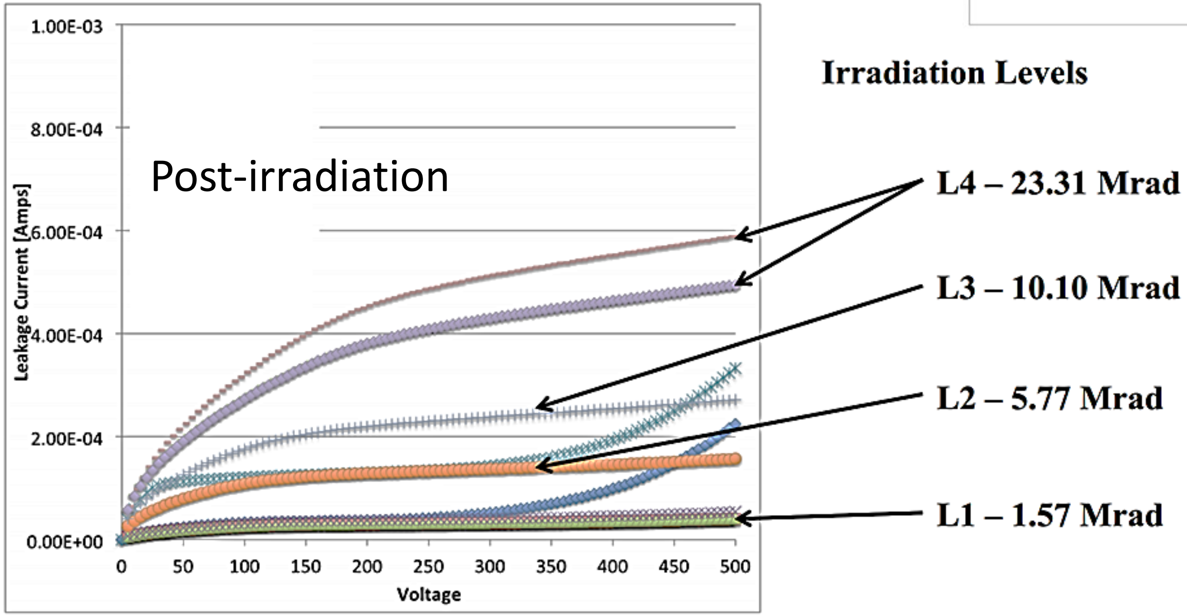


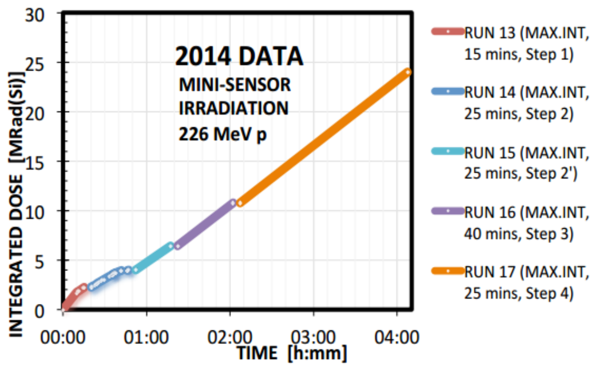
Sensor R&D (II)

- **Pre/post-irradiation IV measurement of mini sensors (before Oct. TB)**
  - Both Type D and B-like
  - In all but one sensor, pre-irradiation leakage currents were below 0.1μA
  - Post-irradiation leakage currents scaled with dose, as expected
  - Sensors with beam pipe cutout performed acceptably



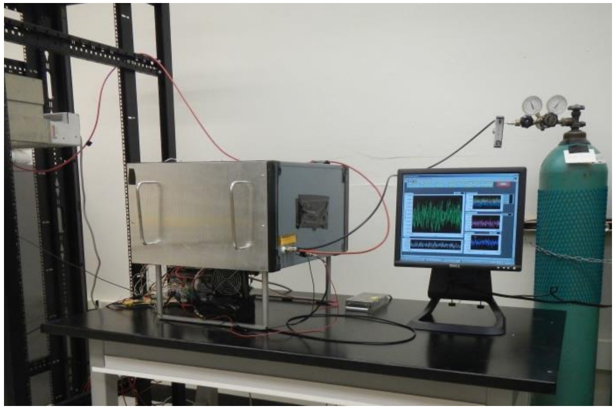
Irradiation Levels

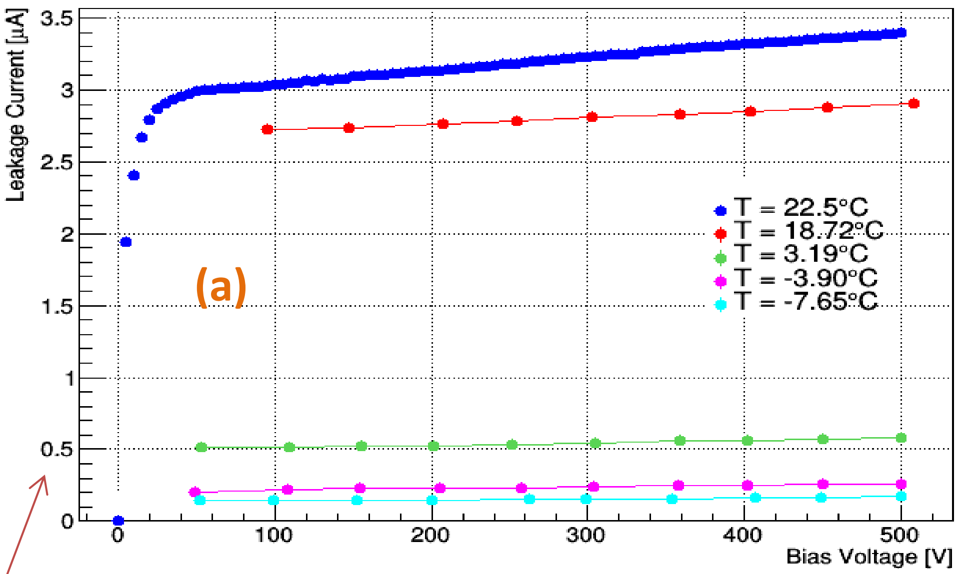




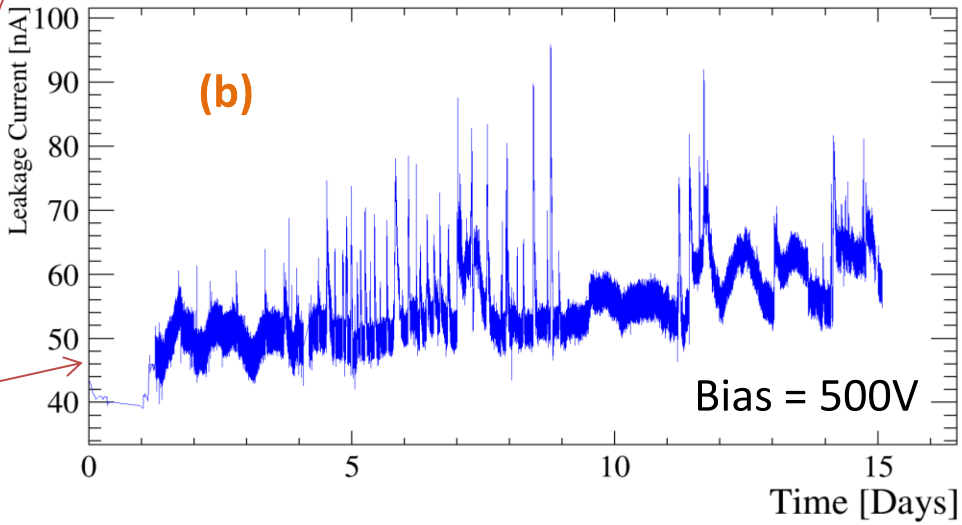
Sensor R&D (III)

- **IV scans (a) and stability (b) at nominal operating temperatures of full size type B sensors**





- Leakage current scales as expected
- No thermal-mechanical stress induced increases in leakage current



- Transient spikes under investigation
- Small modulations due to temperature changes

Concluding Remarks

- Lots of progressing R&D activities at Syracuse and collaborating institutions
- Expect R&D to continue into 2016 and construction and testing to start in 2015
- Goal is to finish construction and begin installation in 2018, and be ready for data taking in 2019

THANK YOU FOR YOUR ATTENTION!