NORTHROP GRUMMAN

ENGINEERING & SCIENCE STUDENT DESIGN SHOWCASE

FLORIDA TECH

CMS Inner Tracker Modules Testing

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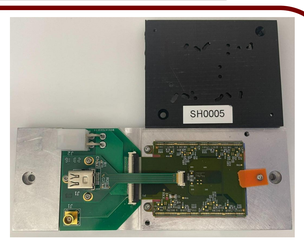
Description of Purpose/Problem:

Understanding the underlying nature of Higgs Physics requires upgrades to current technologies used within the CMS Inner Tracker. Due to the nature of b quarks and the difficulty reconstructing their tracks within current modules, a need for higher granularity modules has become an evident and pressing area in need of improvement. Searching for more nuanced interactions above background requires new modules be created, tested, and characterized for use within the next generation of physics research.

Florida Tech Inner Tracker Testing and Debugging Station:

***Modules at Florida Tech*:**
Modules from other institutions are tested and debugged as necessary at the FIT Test Stand

Example 1x2:
Module (RH0019)



Example 2x2:
Module (SH0005)

***Cold Box and DryAir*:**
Operating at a controlled humidity via a custom desiccator called the DryAir, the Cold Box ensures that modules do not overheat or spark due to humidity.

***FIT Cold Box*:** With Installed SH0005

***DryAir*:** Desiccator to reduce the dew point

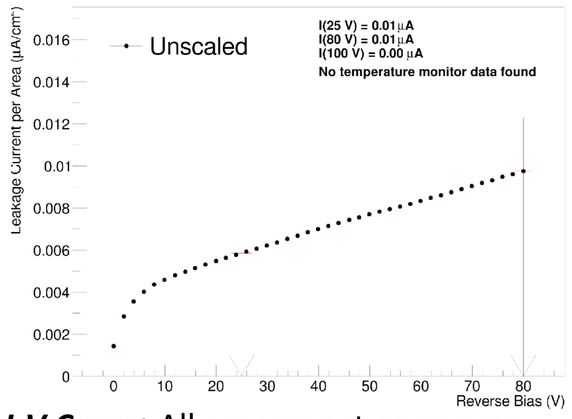
Florida Tech Cleanroom:

Chiller

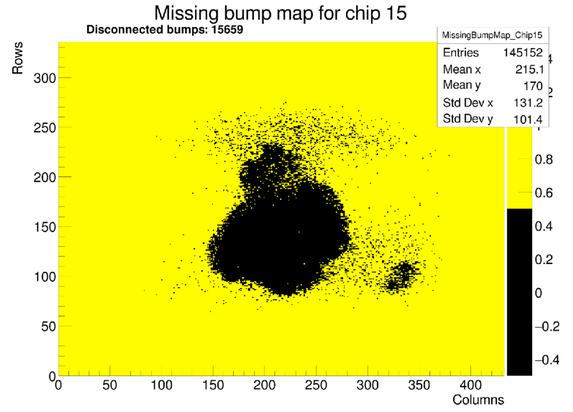
Portable Cleanroom, Coldbox, Particle Counter

A clean hood maintains ISO 1 conditions for testing and storage of the tested modules. The cold box is placed within and connected to a chiller for testing. Given the highly specialized and sensitive nature of the tested modules, such a clean room is critical to ensure fatal errors do not occur on the module.

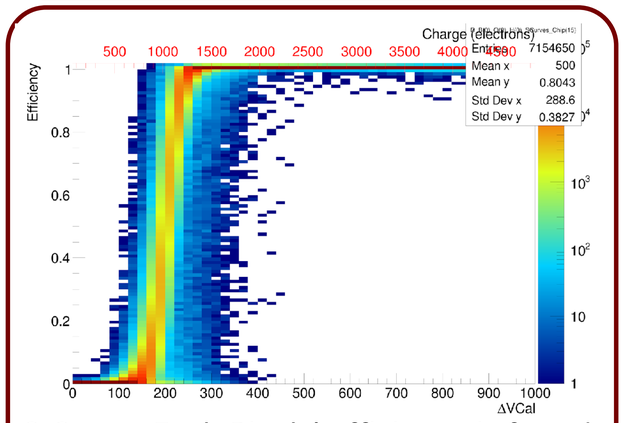
Characterization and Calibration Tests:



***I-V Curve*:** All sensors act as reverse-biased diodes that allow for characterizations of breakdown voltages. Ensures overall usability.



***Crosstalk/PixelAlive*:** Checks efficiency of either the individual pixel or its neighbors to check for catastrophic disconnects on the module.



***S-Curve*:** Each Pixels' efficiency is found as a function of charge injected. This is then used to set that pixel's threshold.

Future Work:

PANTHERA FLORIDA TECH / DAS / LAB

- Refine Panthera for community use.
- Improve test stand to test multiple modules quickly and effectively.
- Create more holistic documentation for debugging and testing.
- Upgrade cleanroom for added safety and reliability.
- Debug and fix failed modules.

Resources/Acknowledgements:

This is but a small portion of the overall experimentation and work done on the Florida Tech Modules Testing Stand. For more information, please reference the following.

- https://panthera.fit.edu
- https://ph2acf.docs.cern.ch/innerTracker/calibrations/

Conclusion:

Modules characterization and development is an important preliminary step for future work on better understanding Higgs Physics through higher luminosity experimentation at the CMS experiment. Without properly calibrated modules and testing procedures, as well as a good physical understanding of how the modules individually function, pursuits into this new realm of experimental physics will remain difficult to achieve and quantify beyond theory.