US Contributions to the Athena WFI

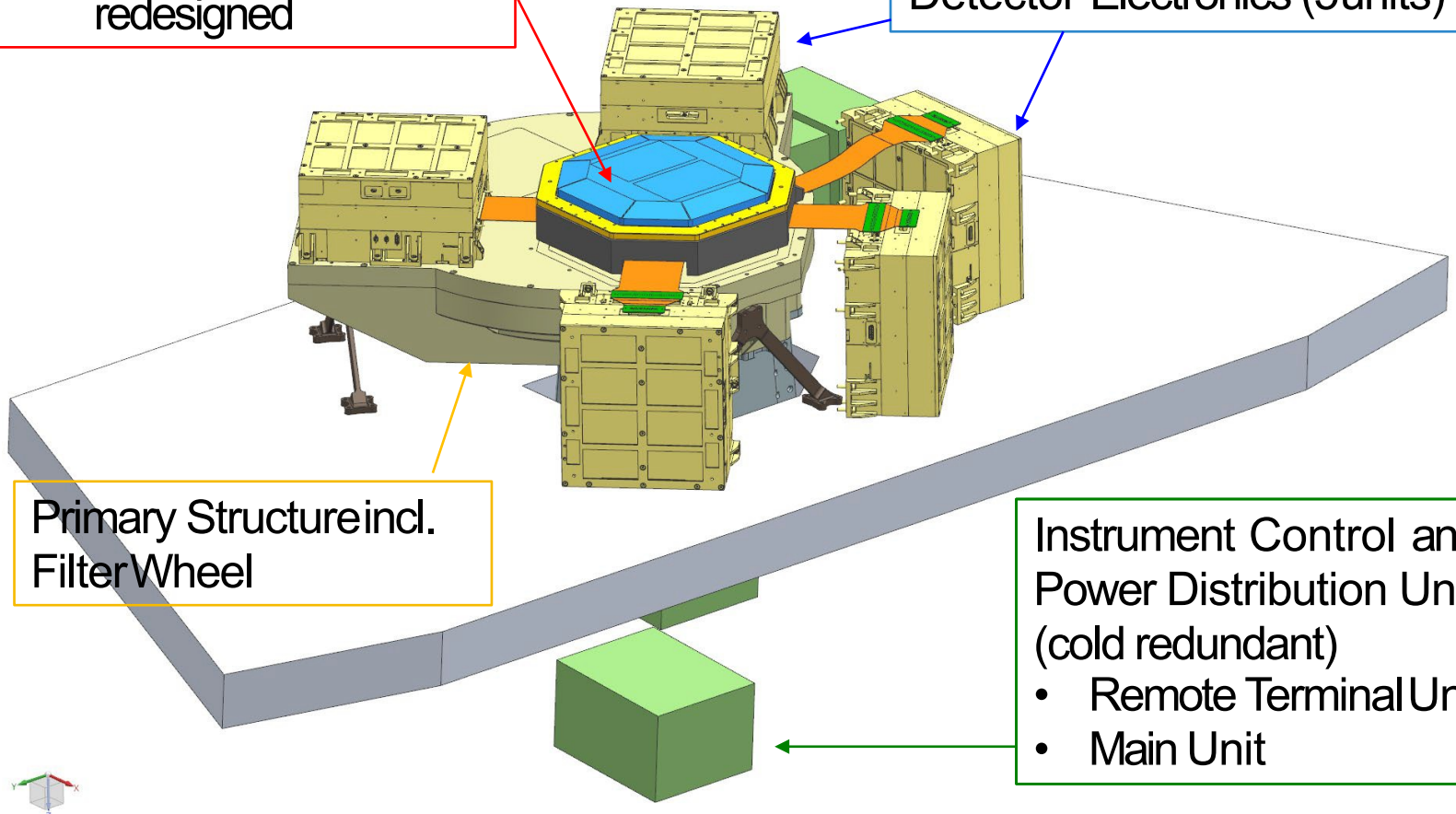
NAST Virtual Meeting
February 12, 2021

PSU, MIT, SAO, Stanford

WFI design

Camera Head (incl. 5 detectors) redesigned

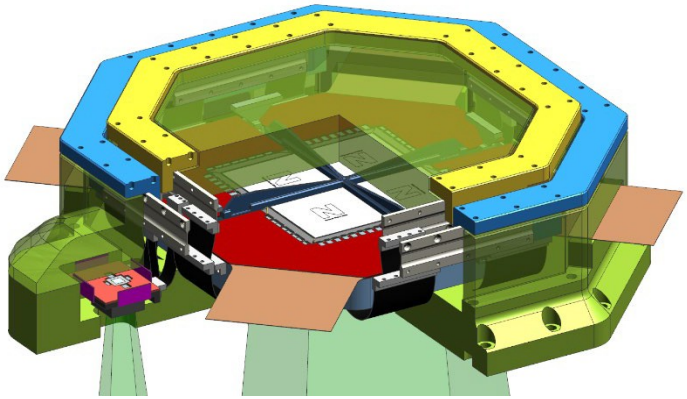
Detector Electronics (5 units)



Primary Structure incl. Filter Wheel

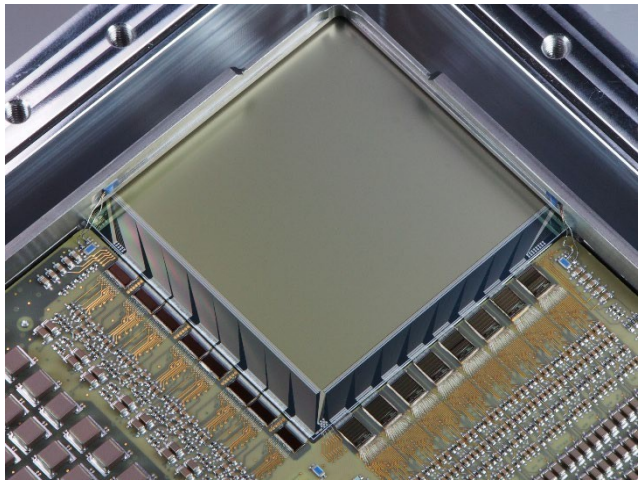
Instrument Control and Power Distribution Unit (cold redundant)
- Remote Terminal Unit
- Main Unit

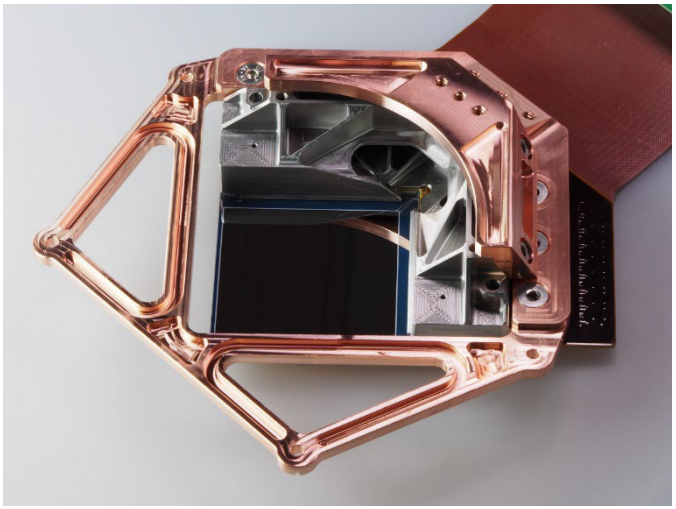
Flight-like Detector fabrication



LD (=quadrant) lab model assembled:

512x512 pixel DEPFET + 8x Veritas + 8x Switcher





Some yield issues are under investigation (low resistance between some contacts)

WFI Background Analysis

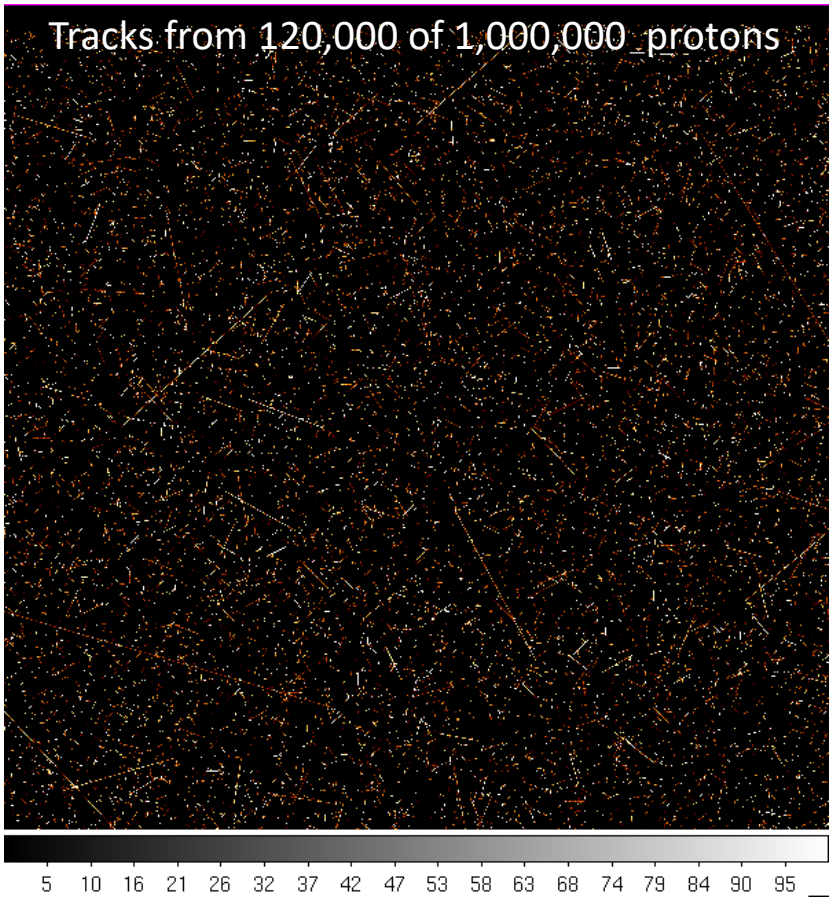
- 3-pronged approach:
  - Investigation of background in current missions
  - Investigation of background in GEANT-4 simulations
  - Investigation of AI approaches to background reduction

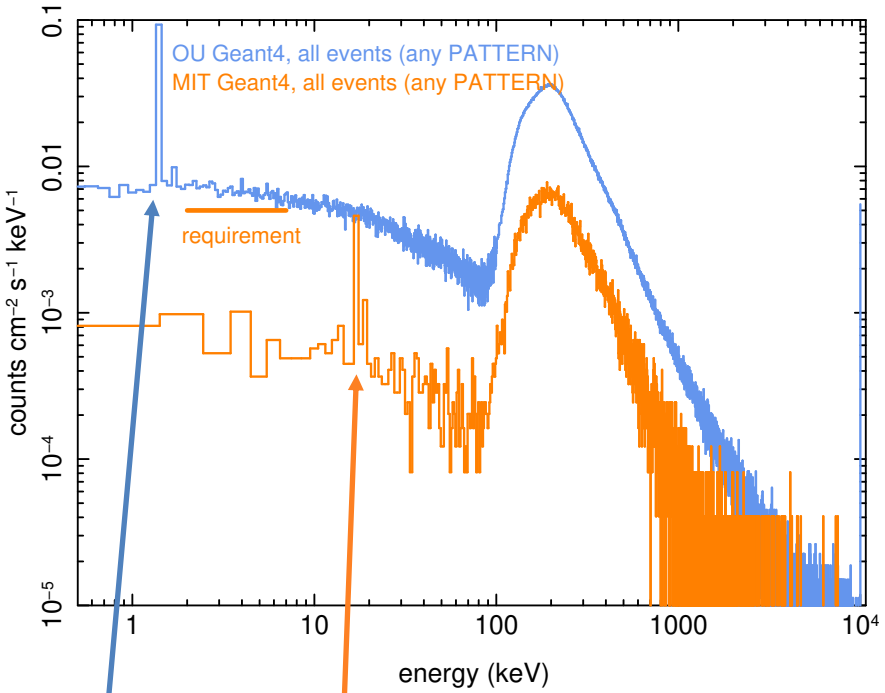
- Team is participating in the WFI Background Working Group

GEANT4:

- Modelling detector background with GEANT-4:
  a. MIT is performing Geant4 simulations and analysis. Need ~10x more statistics than OU simulations. Initial runs from last summer took 18 hours for 500,000 protons. Need ~50 million protons.
  b. Sept: 1 hr run time for 500,000 protons
  c. November: 10 days for 50,000,000
  d. December: 3 days for 1,000,000,000 protons. Computing problem solved.

MIT: Geant4 simulation testing (validation)





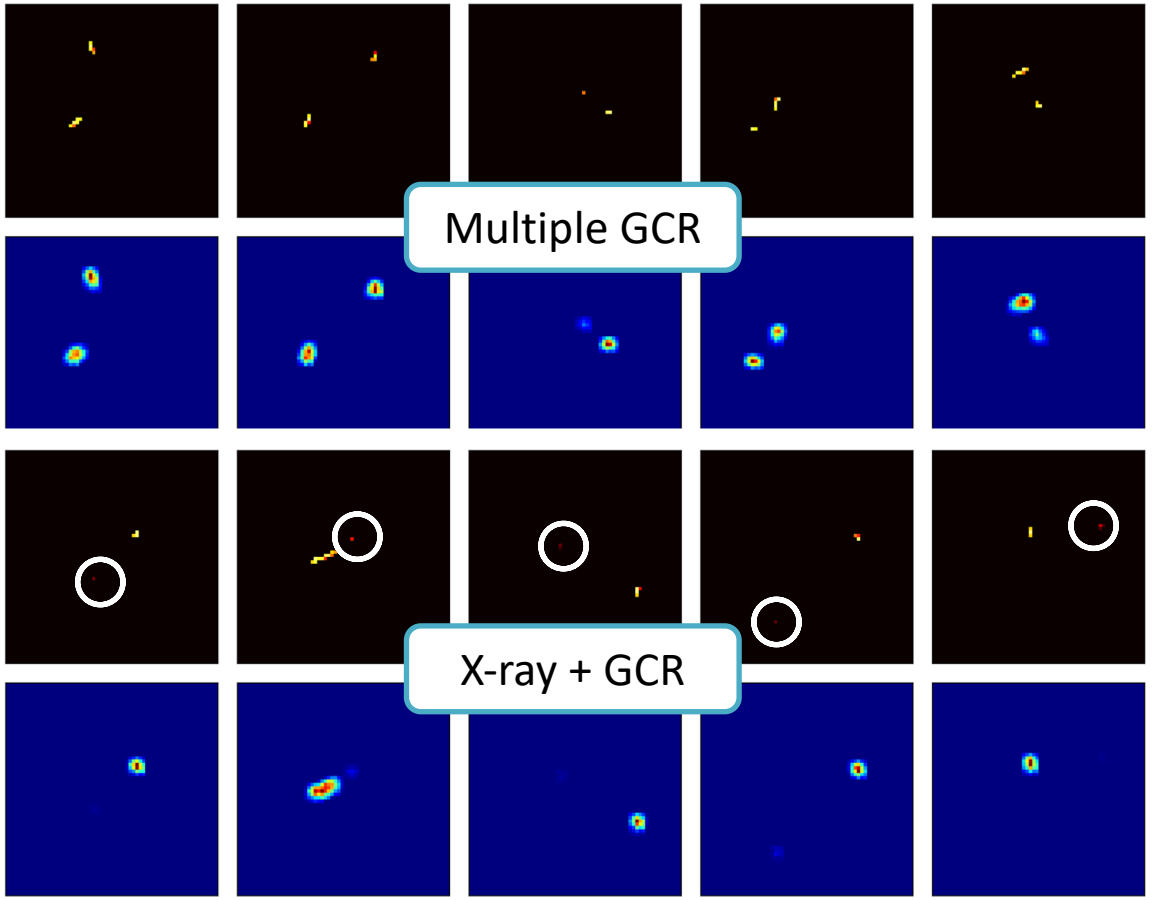
Al K in older mass model.

Mo L in newer mass model.

Same spectral shape for OU and MIT. Normalization issue under investigation.

AI approaches to background reduction:

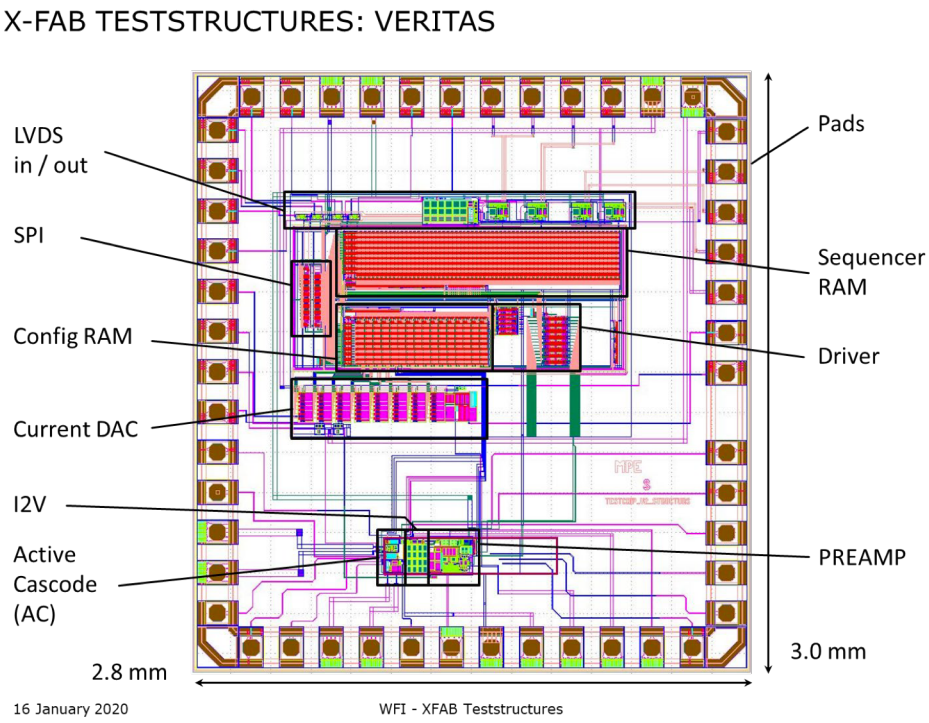
- Develop AI algorithms that detect and classify events within frames for next-generation, probabilistic ”grading” algorithm
- Early tests show how algorithm only activates on cosmic ray pixels, not X-ray pixels



Demonstrates feasibility of image segmentation algorithms to detect & classify events

VERITAS ASIC (Stanford)

- Conversion from AMS process to XFAB process underway
  - Transition requires optimization of transistors and adjustment of RC compensation
  - Requires full new layout
  - Test structures fabricated and tested
  - This work has been delayed by COVID-19 restrictions



Summary

- PSU, MIT, SAO, and Stanford continue to work on hardware and software contributions to the Athena WFI in the areas of
  - Transient source analysis
  - Background analysis
  - Front-end electronics design and testing