

The TRISTAN Detection Module: a 166-Pixel Monolithic SDD Array for Beta Spectroscopy

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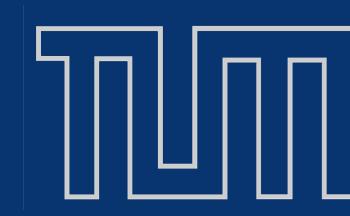
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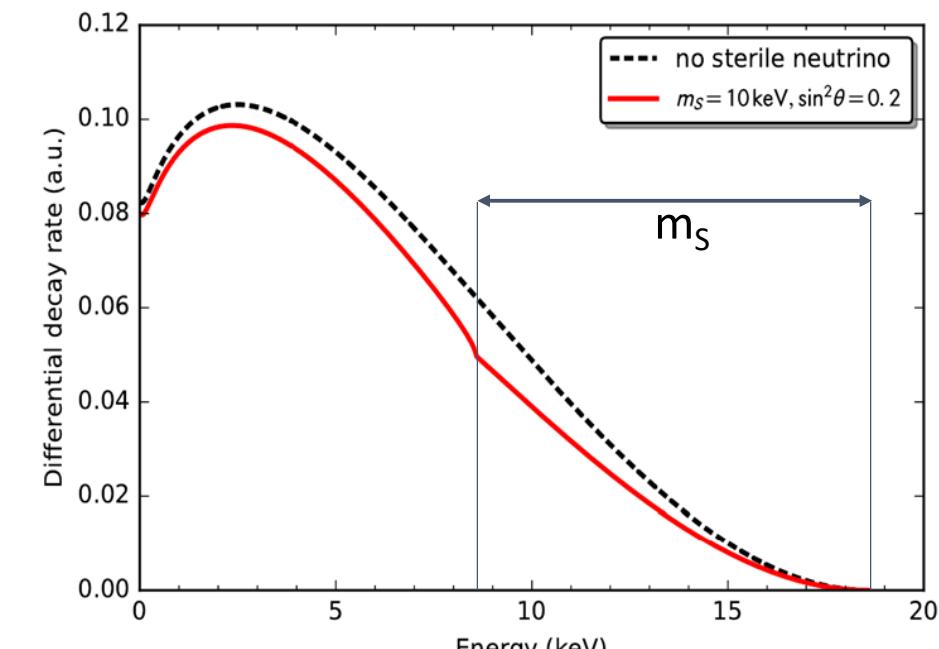
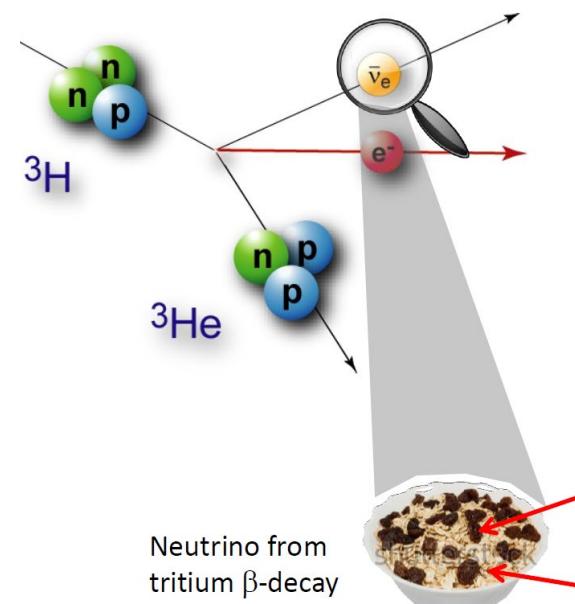
3 Max-Planck-Institut für Physik (MPP), München, Germany

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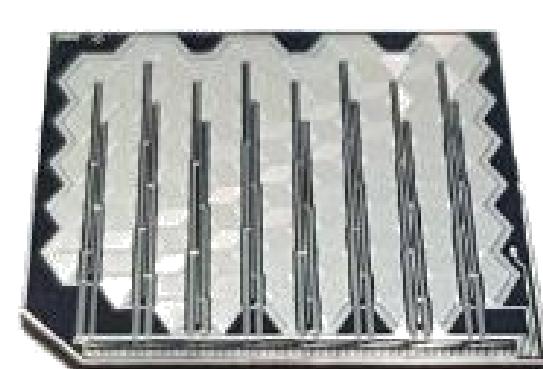
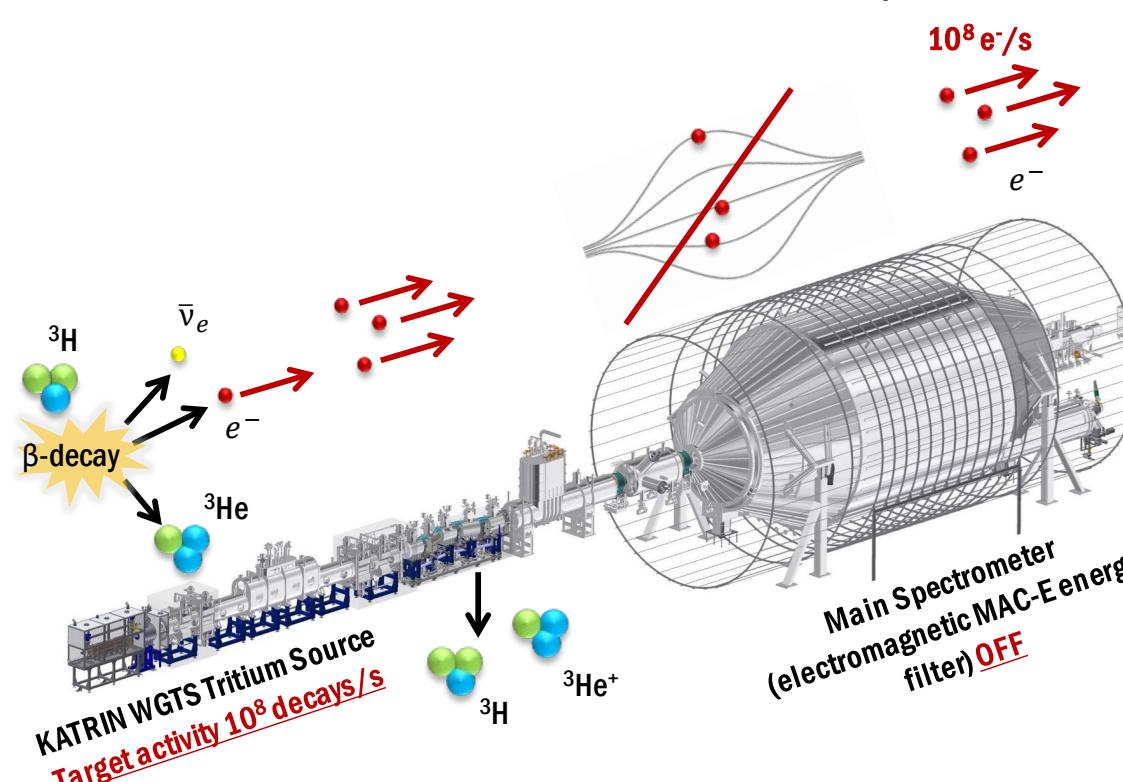
5 Halbleiterlabor der Max Planck Gesellschaft (HLL), München, Germany



Goal: discover the existence of a **sterile neutrino** in the keV mass range by looking at **alterations of the whole beta spectrum** of the Tritium decay



Approach: upgrading the KATRIN experiment with a new TRISTAN detector (21 modules)



166 Pixels
3mm diameter integrated JFET

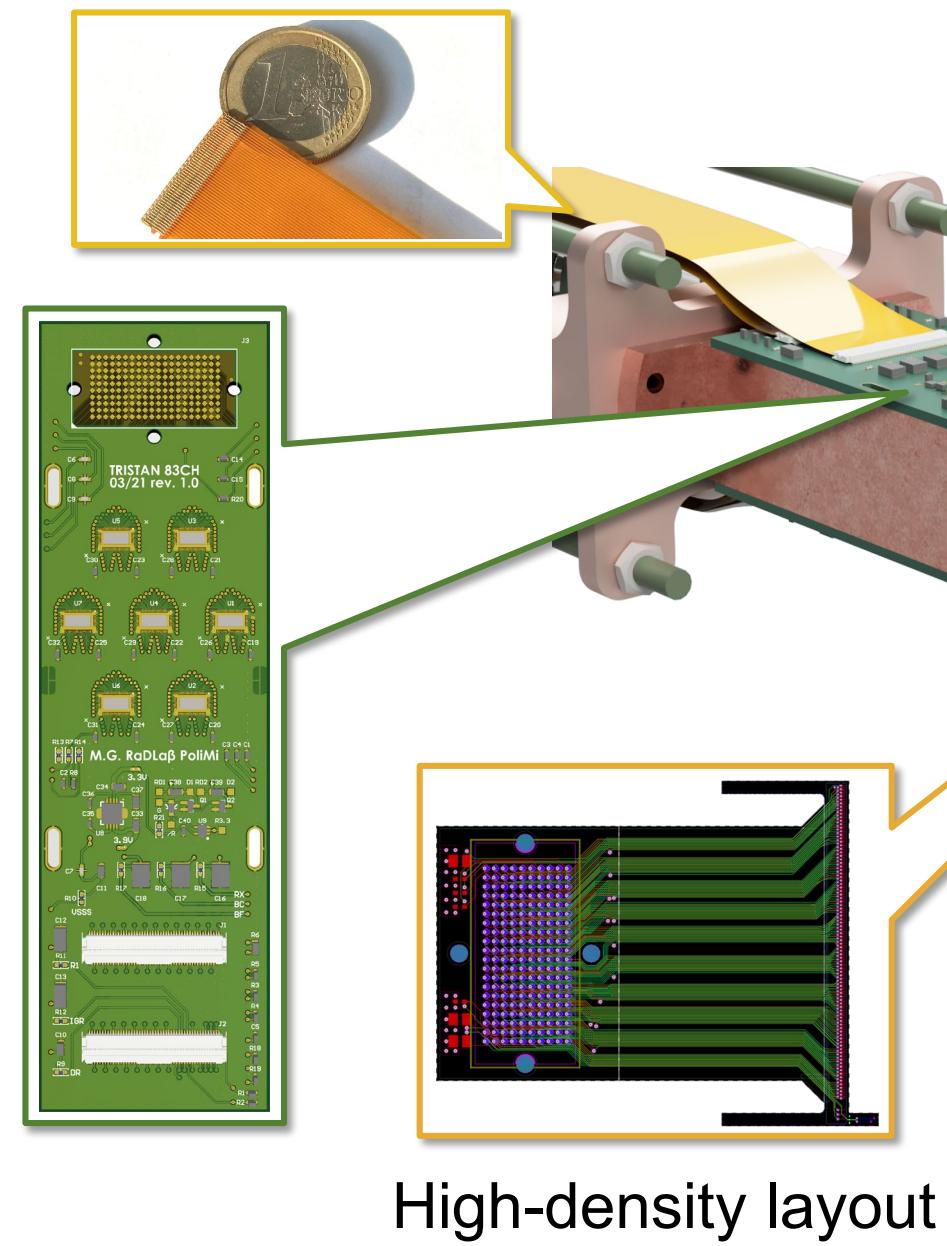
Challenges:

- High rate: 100kcps/pixel
- Energy resolution: 300eV @20keV
- Vacuum (10^{-8} mbar) and \sim T B field
- Charge sharing and backscattering
- Signals density and integrity

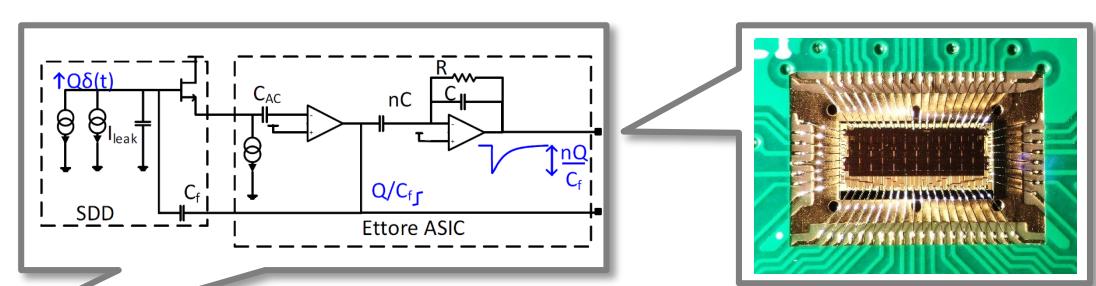
Detection Module

Vacuum Electronics

Rigid-Flex Boards for compactness
2x 83-ch ASIC boards



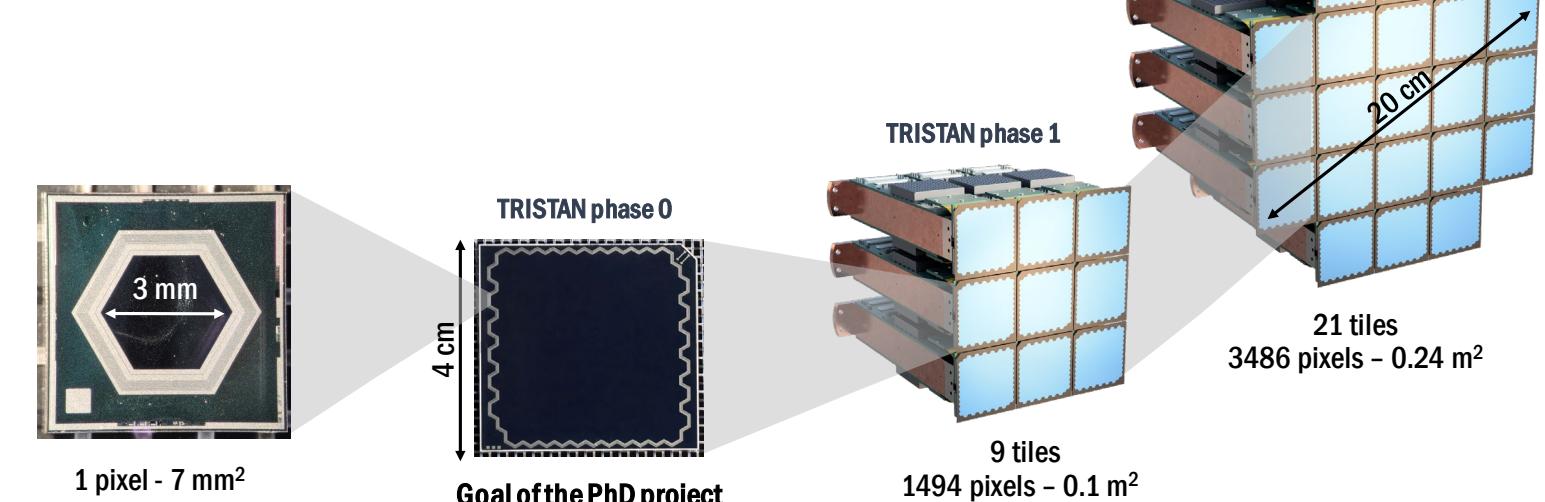
FE: ETTORE ASICs: **12-channel low-noise charge preamplifier** for SDDs with JFET with pulsed reset



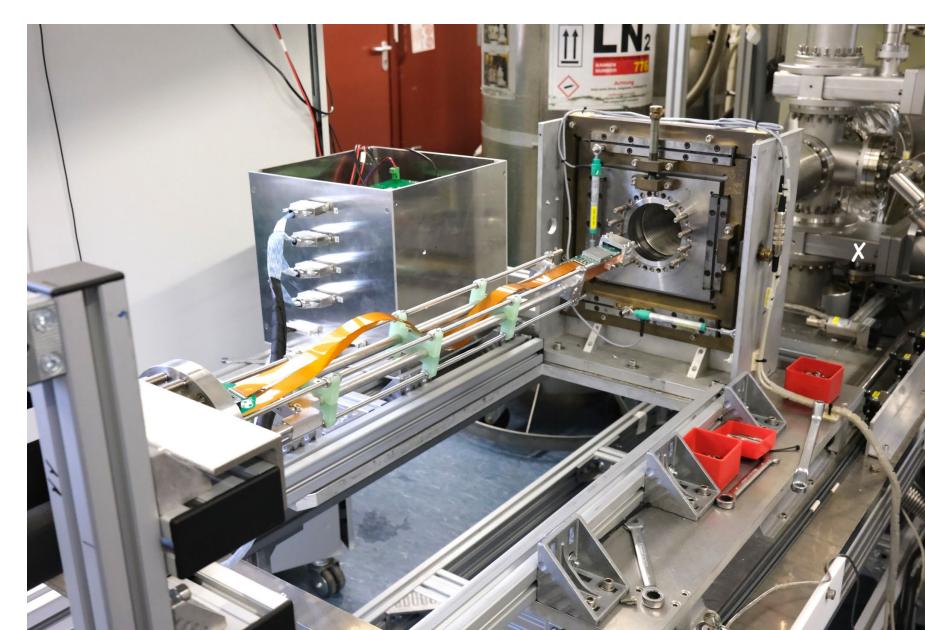
4-Side Buttable Detector

CeSiC interposer

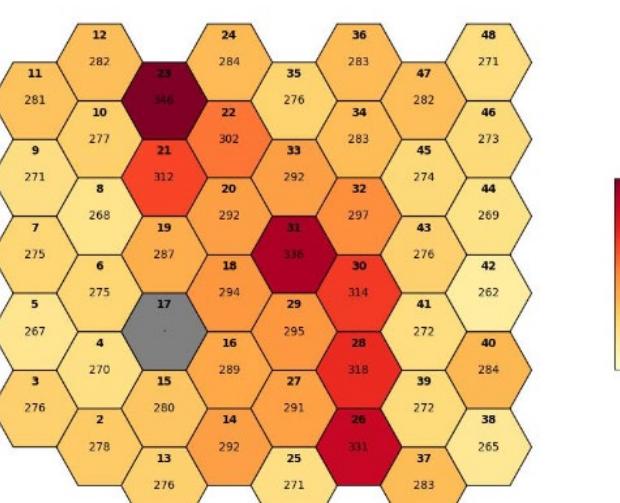
Scale-Up Roadmap



Validation in KATRIN Monitor Spectrometer

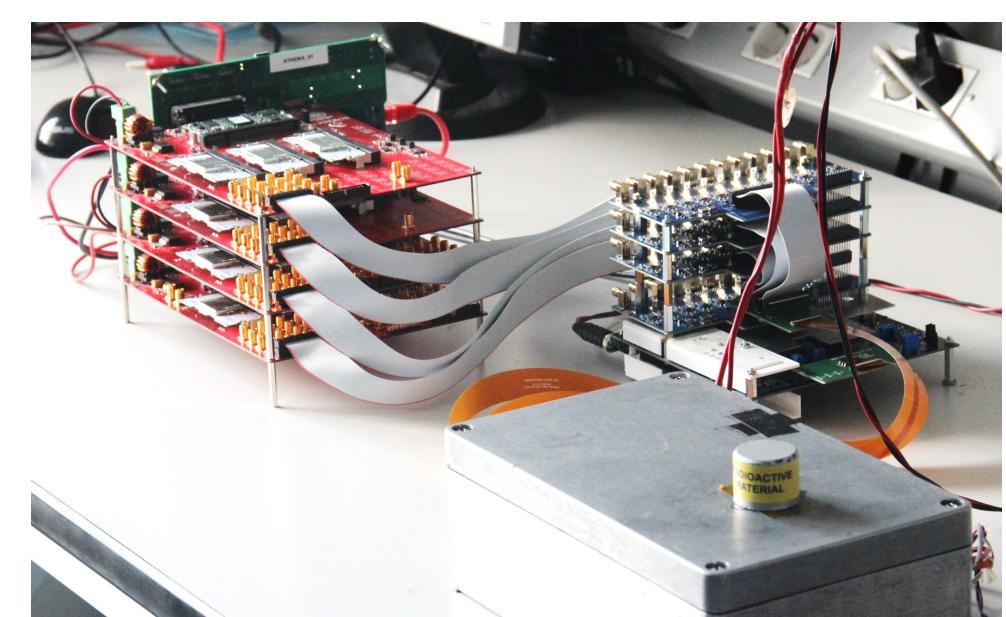


47-Pixel Module

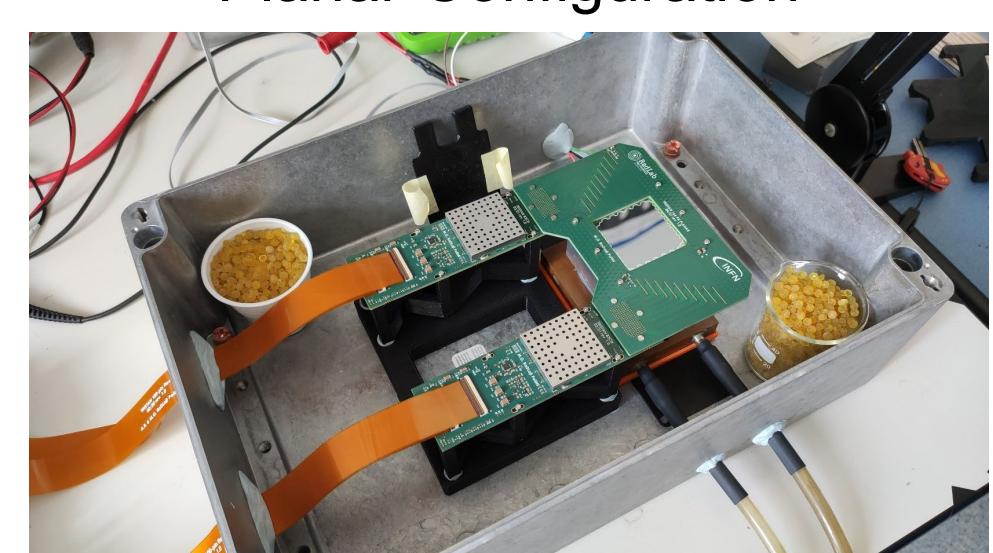


Laboratory Characterization

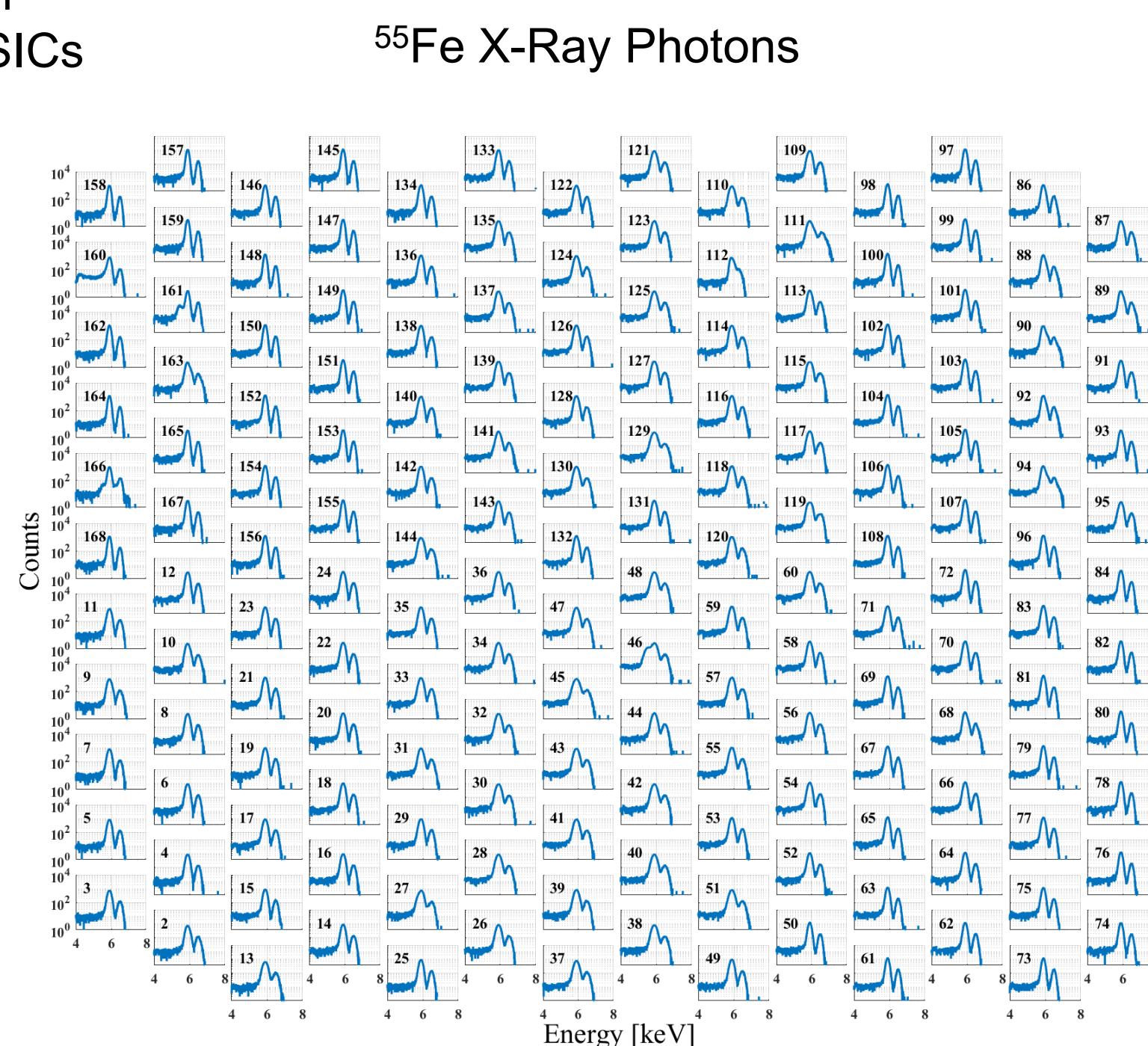
Athena FPGA-based 192-channel analog processing and acquisition platform including 12 SFERA APP ASICs



Planar Configuration

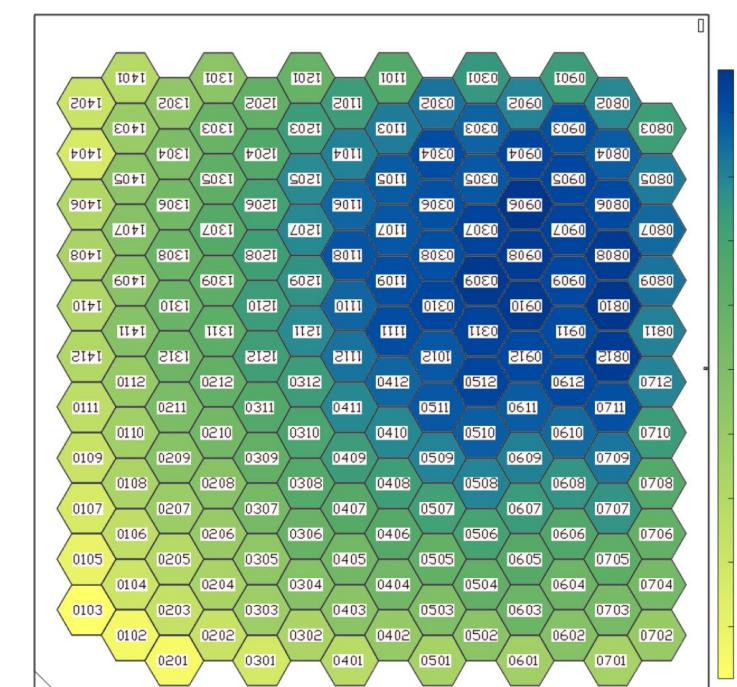


166 Simultaneously Acquired Spectra

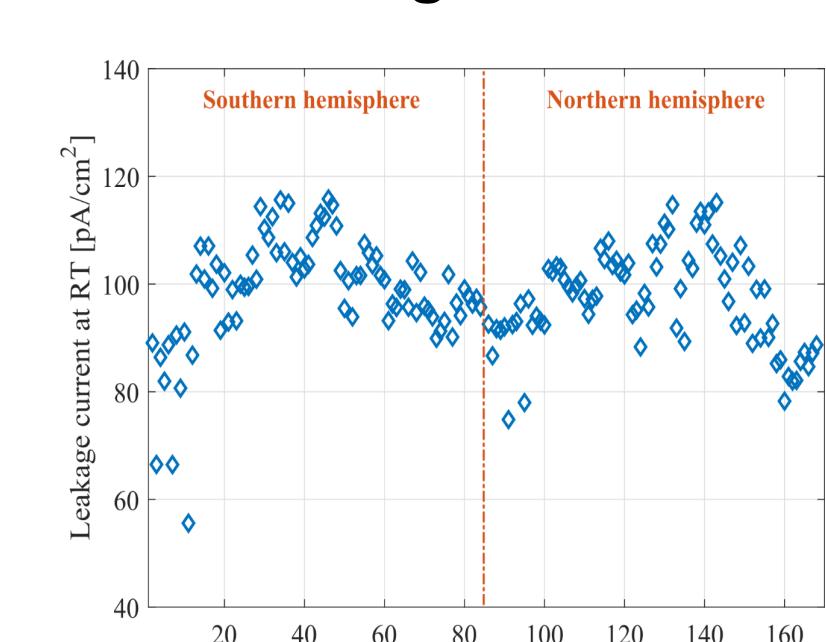
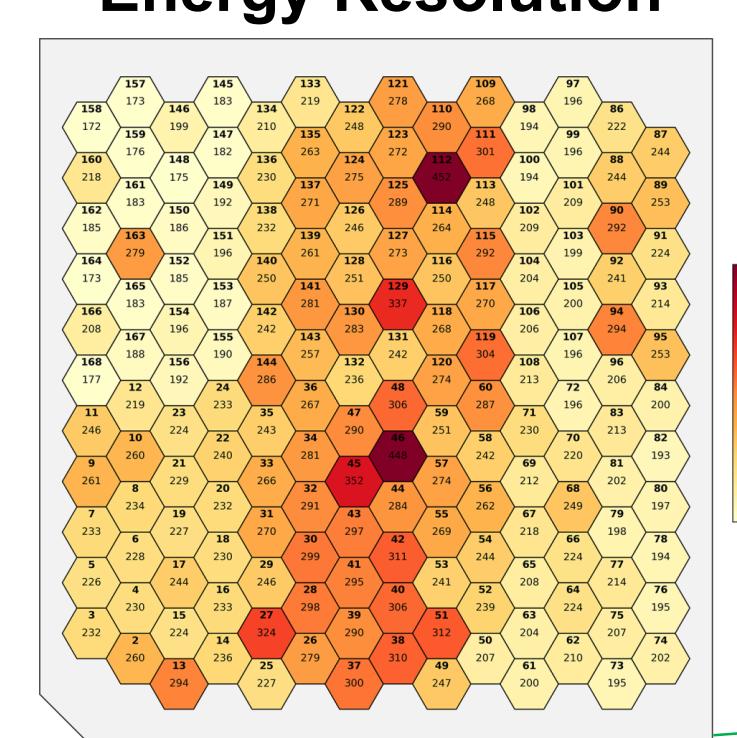


55Fe X-Ray Photons

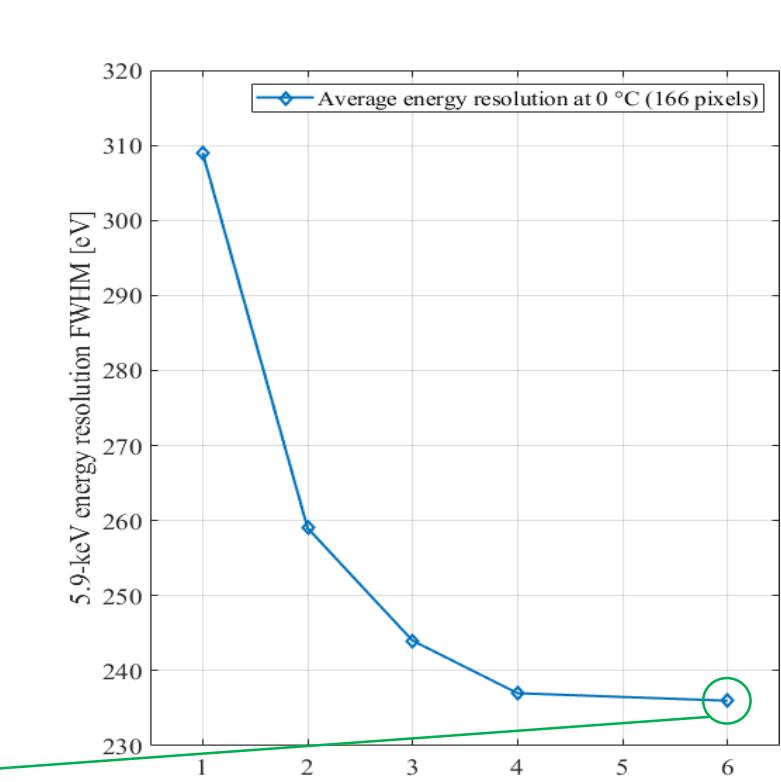
Events rate



Energy Resolution



Leakage Current



- [1] M. Gugliatti et al. "Characterization of a silicon drift detector for high-resolution electron spectroscopy" *NIM A* 979 (2020): 164474.
[2] P. King et al. "Design and characterization of Kerberos: a 48-channel analog pulse processing and data acquisition platform" *JINST* 16.07 (2021): T07007.
[3] M. Biassoni et al. "Electron spectrometry with Silicon drift detectors: a GEANT4 based method for detector response reconstruction" *European Physical J. Plus* 136.1 (2021): 1-13.
[4] S. Mertens et al. "Characterization of silicon drift detectors with electrons for the TRISTAN project" *Journal of Physics G: Nuclear and Particle Physics* 48.1 (2021): 015008.
[5] M. Gugliatti et al. "Towards the TRISTAN detector: Characterization of a 47-pixel monolithic SDD array" *NIM A* (2021), 166102.