

Miniaturization Achievements and Performance Enhancements in the New Generations of ArduSiPM All-in-One Detector Technologies

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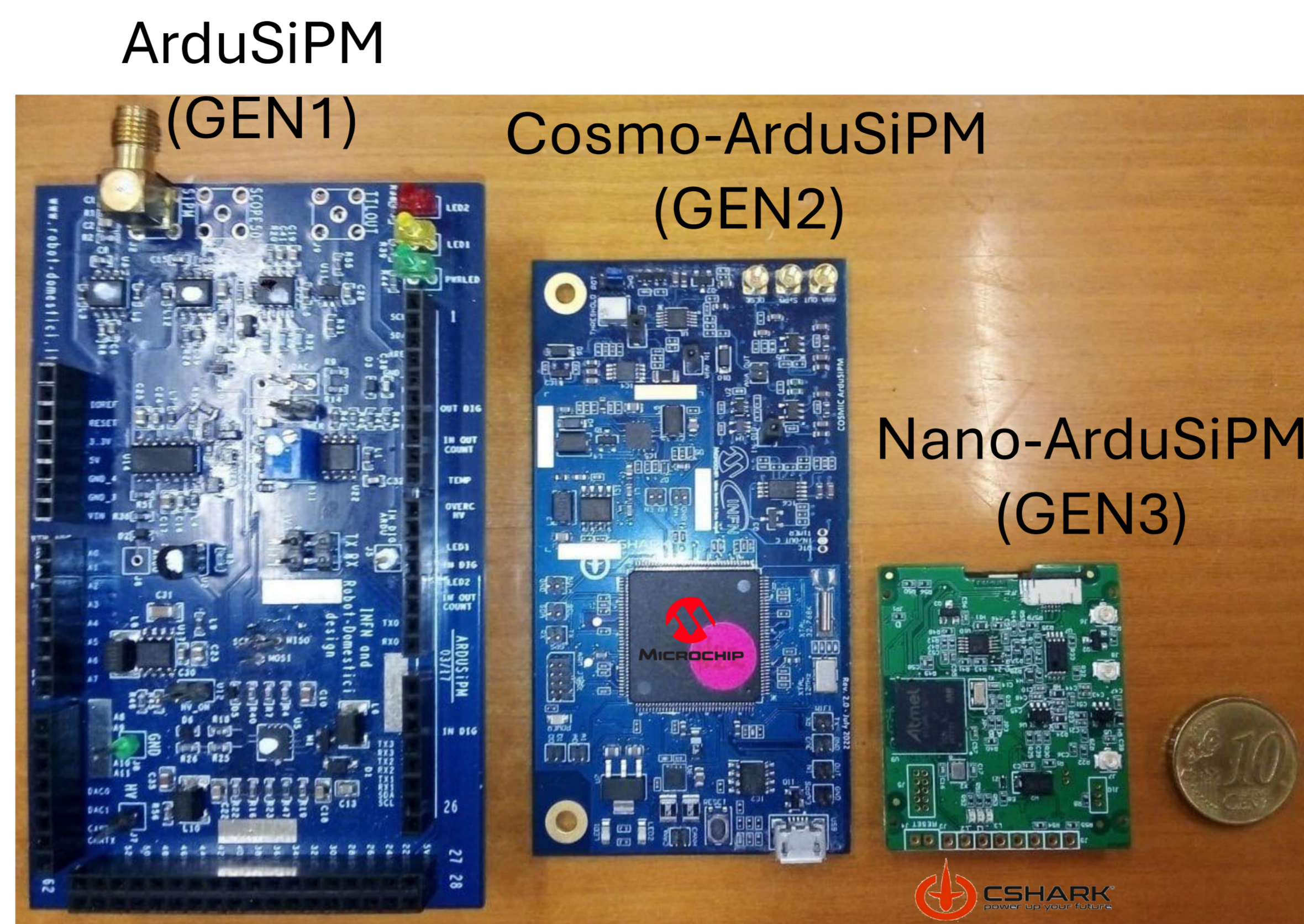
The ArduSiPM idea

The INFN Roma1 group has designed a new structure of all-in-one scintillator particle detectors, exploiting the latest innovations in silicon photomultiplier (SiPM) and System on Chip (SoC) technology.

V. Bocci, G. Chiodi, F. Iacoangeli, M. Nuccetelli and L. Recchia, "The ArduSiPM a compact trasportable Software/Hardware Data Acquisition system for SiPM detector," 2014 IEEE Nuclear Science Symposium and Medical Imaging Conference doi: 10.1109/NSSMIC.2014.7431252

ArduSiPM Technology use intensively the internal peripherals of the microcontroller, except for the analog circuits, making these devices compact and high-performance.

Using firmware and off-the-shelf SoCs, instead of custom ASICs, reduces costs, accelerates development, and eases upgrades to new commercial SoCs.

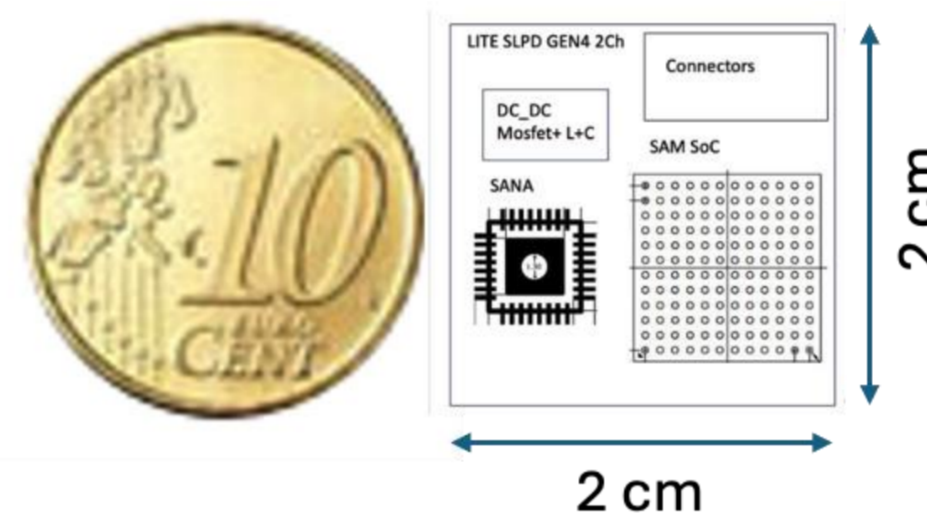


INFN Research Project **MICRO** (2021-2023) and **LITE-SLDP** (2024-2026) have produced two new generation of smaller and more performant detectors.

The **CosmoArduSiPM** (GEN2) is suitable for space missions and has a Radiation Tolerant version (optional) of SoC Microchip SAMV71 320 MHz, ARM®Cortex®M7. It include a doble channel board into a 0.1U standard CubeSat dimension.

The **NanoArduSiPM** packs all the features of its predecessor into a tiny 42 x 36 mm² board, available for nanosat missions.

In development...

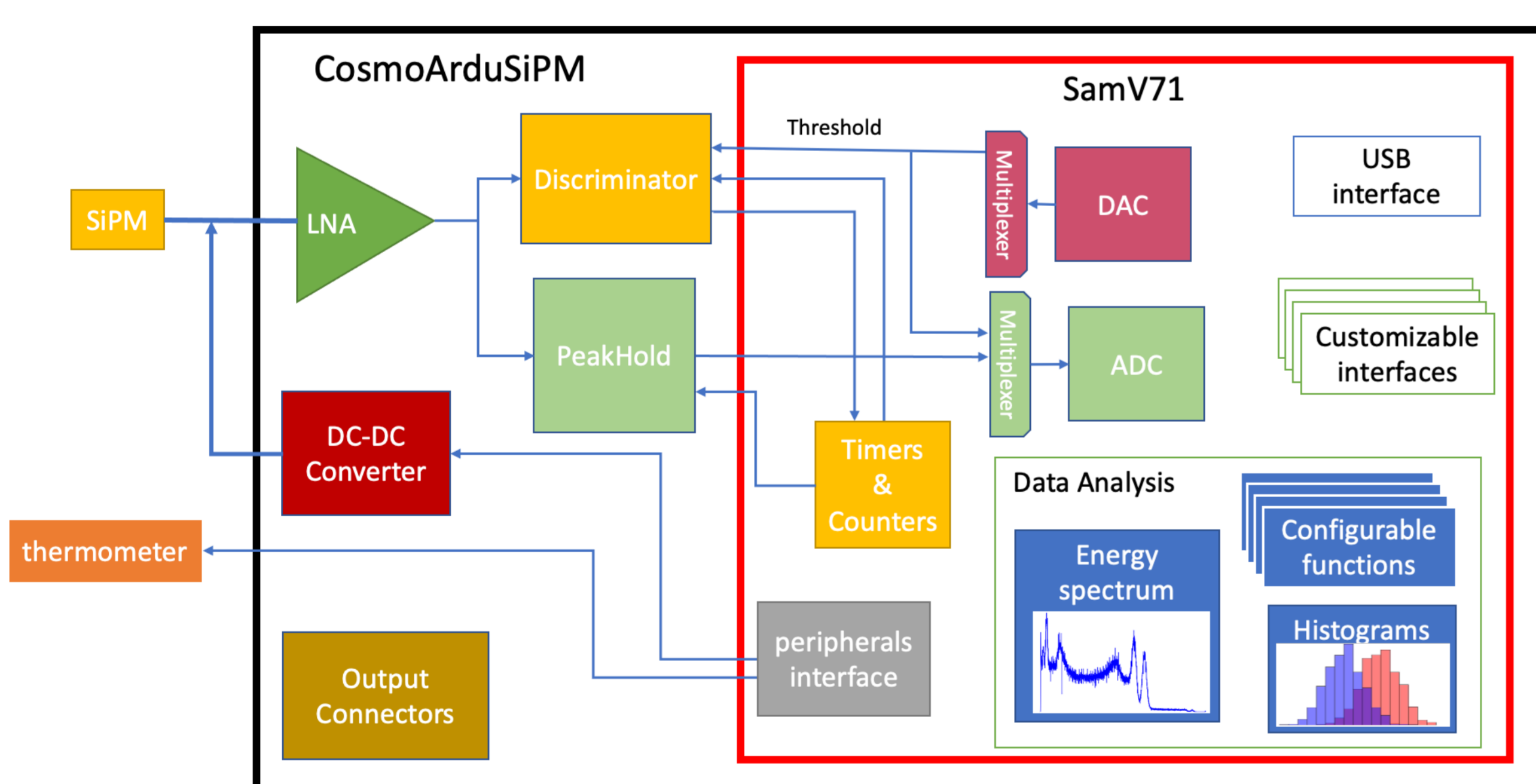


- **GEN4** , 2cm x 2cm =4 cm² , 6 gr. , 2 channels
- analog circuits developed within an ASIC in 0.35µm CMOS technology.
- Segmented TDC to reach 100ps of time resolution

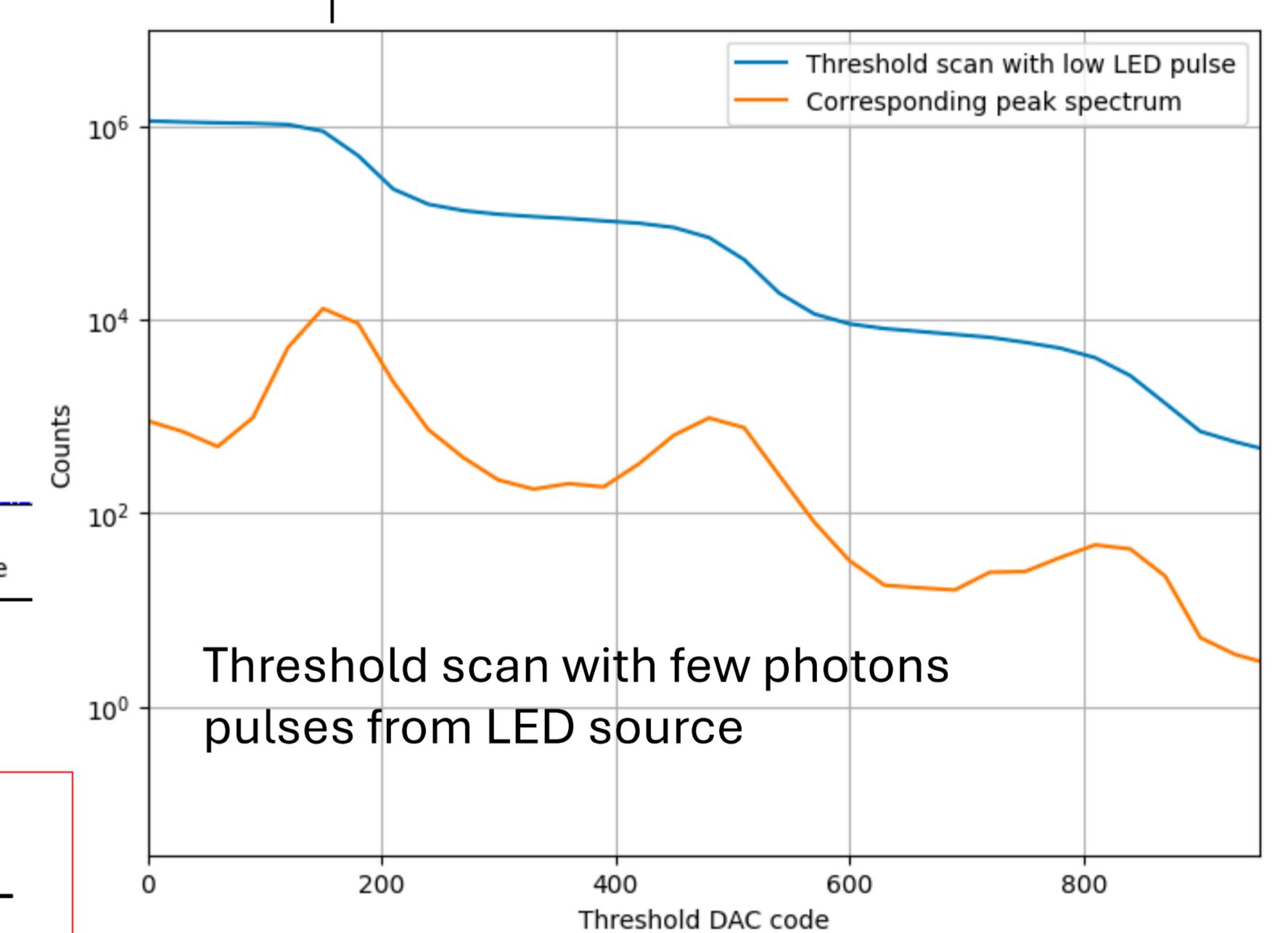
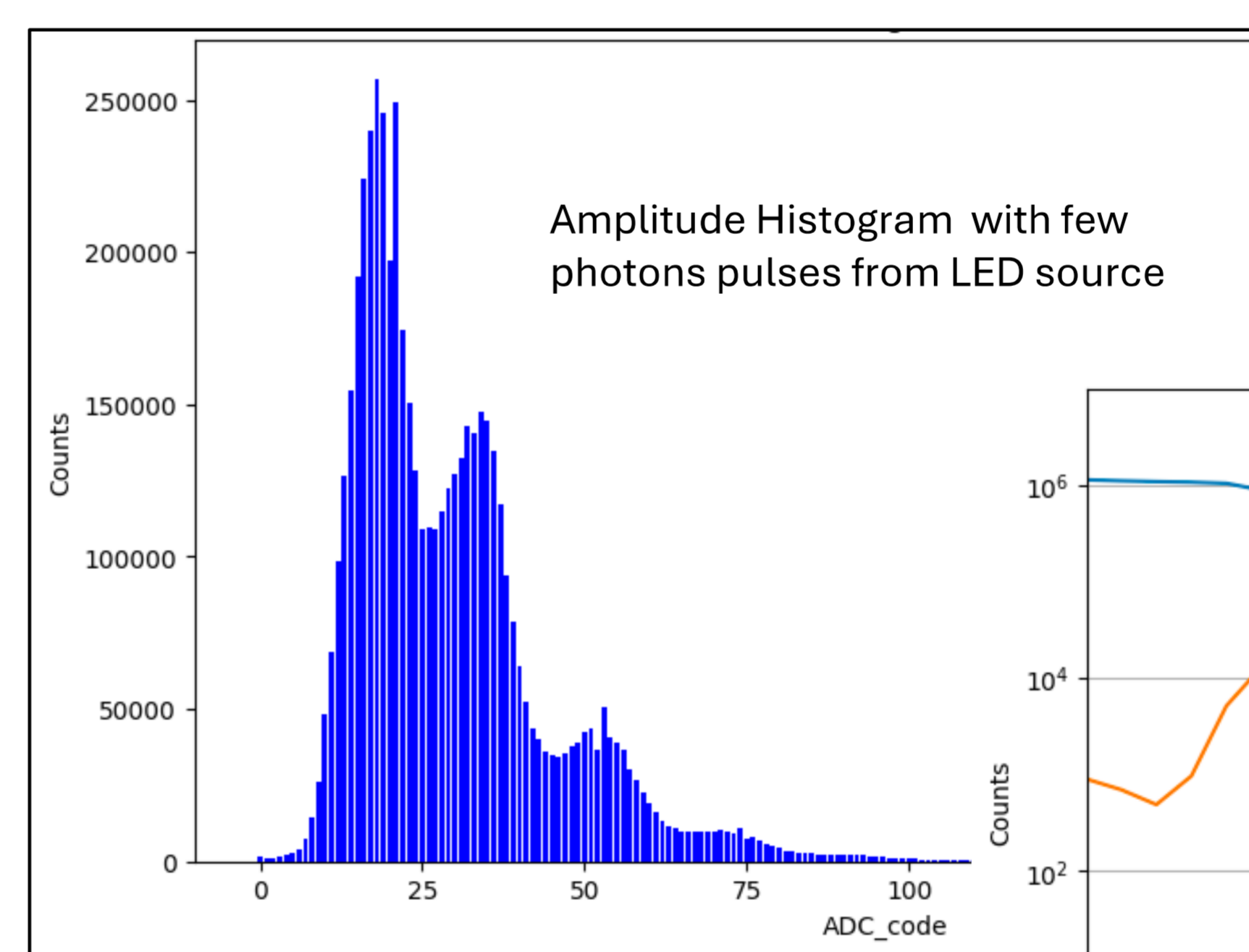
Performance Enhancements in the New Generations of ArduSiPM:

- Lightweight and compact (21 grams, 0.1 U CubeSat for GEN2; 10 grams, PocketQube satellite for GEN3)
- Low power (<1Watt full operational)
- Configurable firmware
- Seamless integration with different On-Board Computers
- Configurable Firmware
- Cost-effective and easy to develop
- Rad-tolerant version of SoC available on the market (GEN2)

Bloch Diagram of ArduSiPM Technology

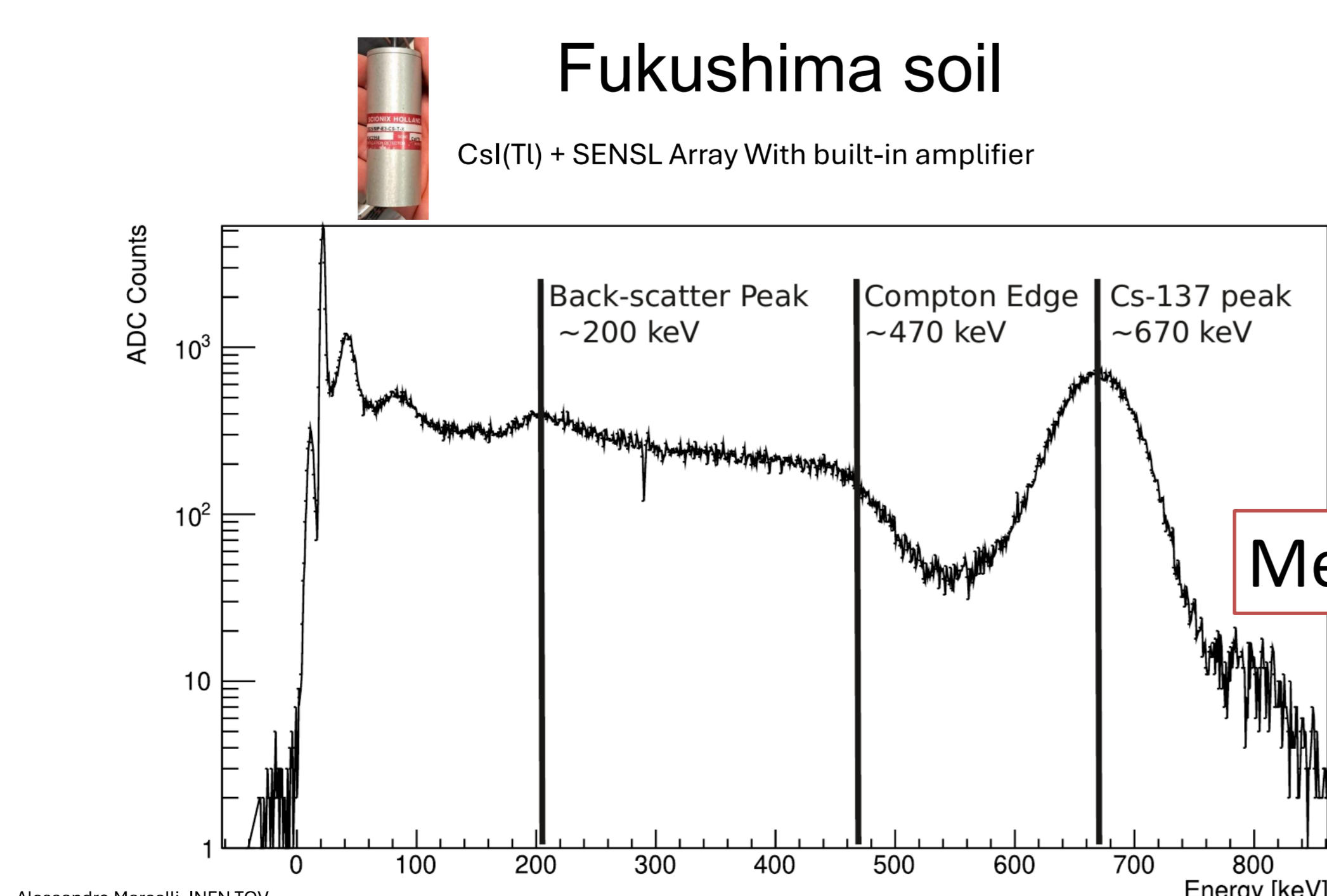


Simple analysis functions are implemented on ArduSiPM firmware, such Amplitude histogram generator or threshold scan



Additional analysis or data compression functions can be implemented on an ad-hoc basis.

Coupled with fast plastic scintillator, this technology is used as cosmic ray counter, trigger or beam losses monitor in several experimental activities, meanwhile it can be used gamma detector with inorganic scintillating crystals. Moreover, the firmware of Cosmo ArduSiPM can be configured to fast analysis data and to produce the gamma spectrum.



Measured with GEN2

Ba133 Source

