

Introduction and Motivation

- Silicon photomultipliers (SiPMs) are a small, lightweight, and low voltage alternative to photomultiplier tubes.
- These properties make SiPMs ideal for constructing a lightweight and compact dual-particle imager.

Mission Relevance

The NNSA missions of nonproliferation and counterterrorism require radiation detection systems which can help reduce the risk of nuclear proliferation. This SiPM-based detection system has been demonstrated to detect and image special nuclear material (SNM), in a form factor that is suitable for field use.

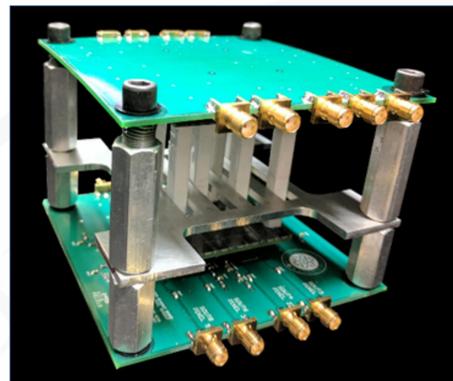


Fig. 1: Handheld dual-particle imager

Next Generation of Boards

- 8+ stilbene pillars and 2 inorganic pillars
- Neutron imaging
- Gamma-ray imaging with full-energy deposition

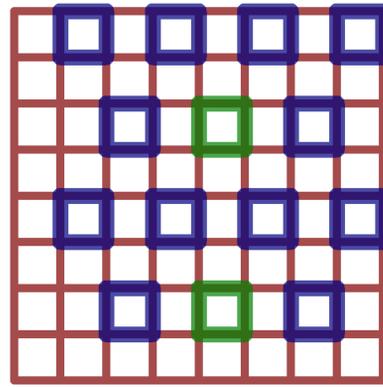


Fig. 6: Placement of 8 (+4) stilbene bars and 2 inorganic bars on SiPM array

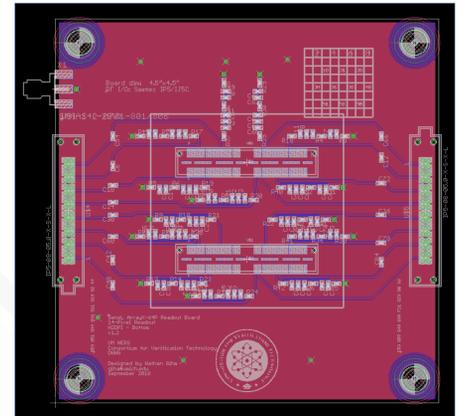


Fig. 7: Next generation board layout

Custom Electronics

Passive Readout Circuit

- Simple passive readout design for each array pixel
- Bias filter, shunt resistor to convert current pulse to voltage

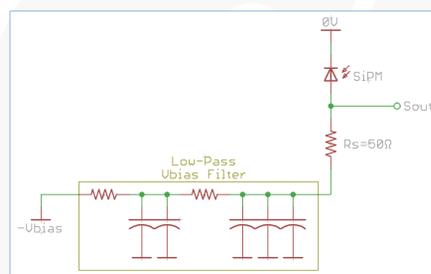


Fig. 2: Passive circuit schematic

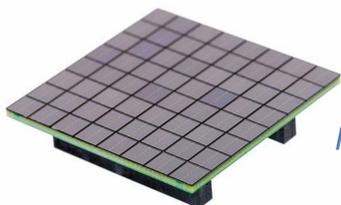


Fig. 3: SensL ArrayJ-64P SiPM array

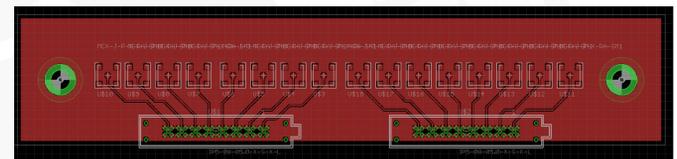


Fig. 8: Intermediate board for readout to digitizer

In the Future: Pixel Grouping

- Large gains in efficiency with same data throughput
- Actively summed pixel readouts
- Tradeoff: Losses due to noise, light collection, and spatial resolution

Current Generation of Boards

- 8 stilbene pillars
- Neutron imaging
- Gamma-ray imaging using approximation (no full energy deposition)

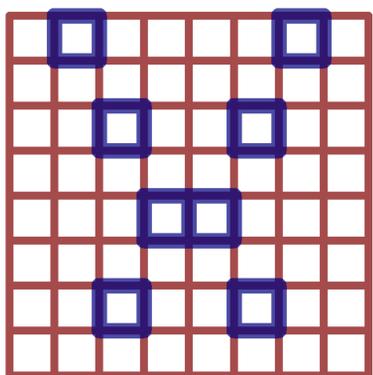


Fig. 4: Placement of 8 stilbene bars on SiPM array

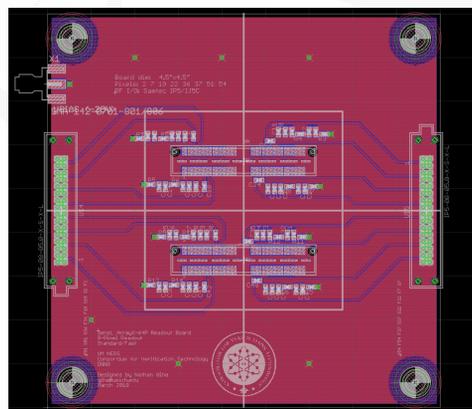


Fig. 5: Current generation board layout

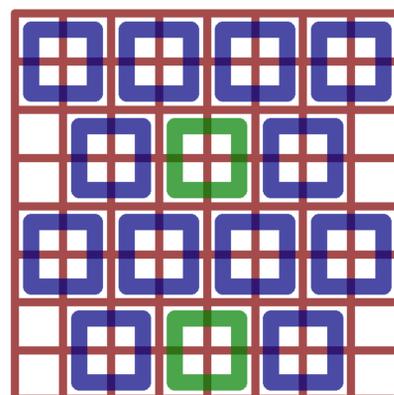


Fig. 9: Placement of 8 (+4) 12x12 mm² stilbene bars and 2 inorganic bars on SiPM array

Conclusion

This work expands the functionality of the handheld dual-particle imager, an instrument which detects, locates, and identifies SNM. By adding additional detector volumes in the form of more and larger scintillators, these custom electronics aim to decrease the time required to produce an image.