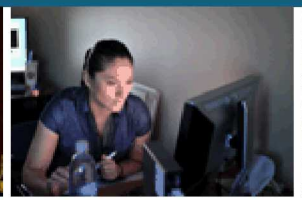
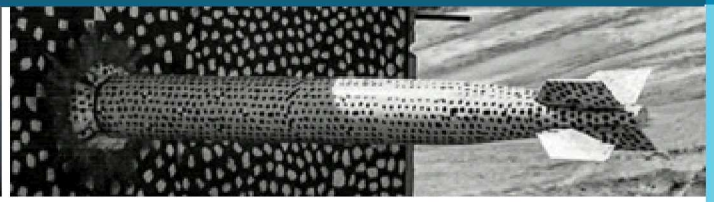
SAND2020-1821PE

Compact Digitizer Systems for Time-Resolved Measurements





PRESENTED BY

Quinn Looker, John L. Porter, John Stahoviak, Joel Long

hCMOS Workshop

Sandia NM 2/13/20

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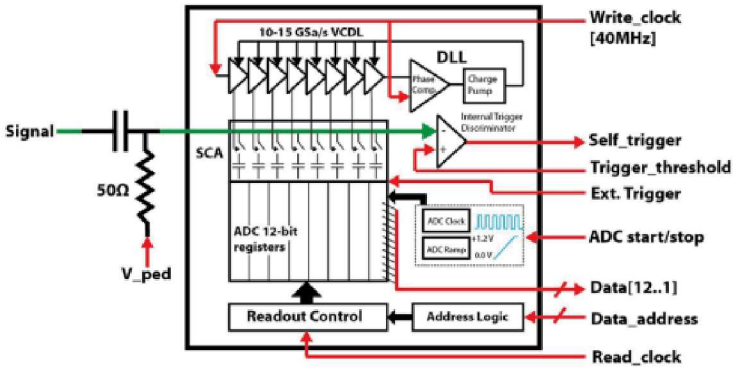
SAND

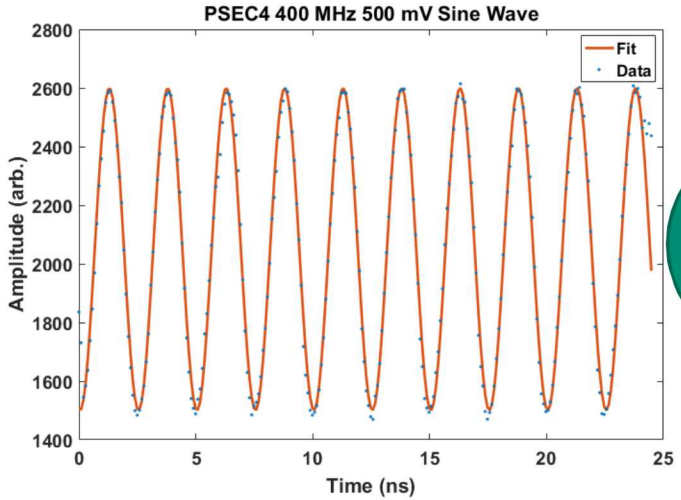
The PSEC4 ASIC is a vehicle for local digitization of time-varying signals

PSEC4

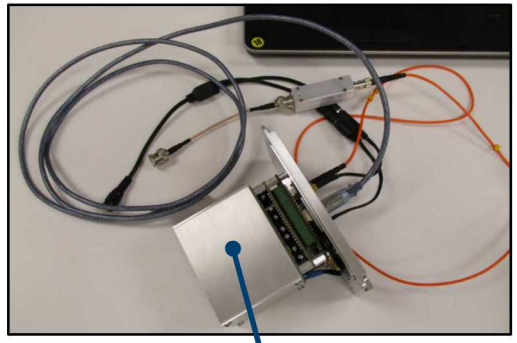
- Switched-capacitor array sample and hold architecture
- 6 channels, 256 sample depth, 10 GS/s
- ~1.5 GHz analog bandwidth



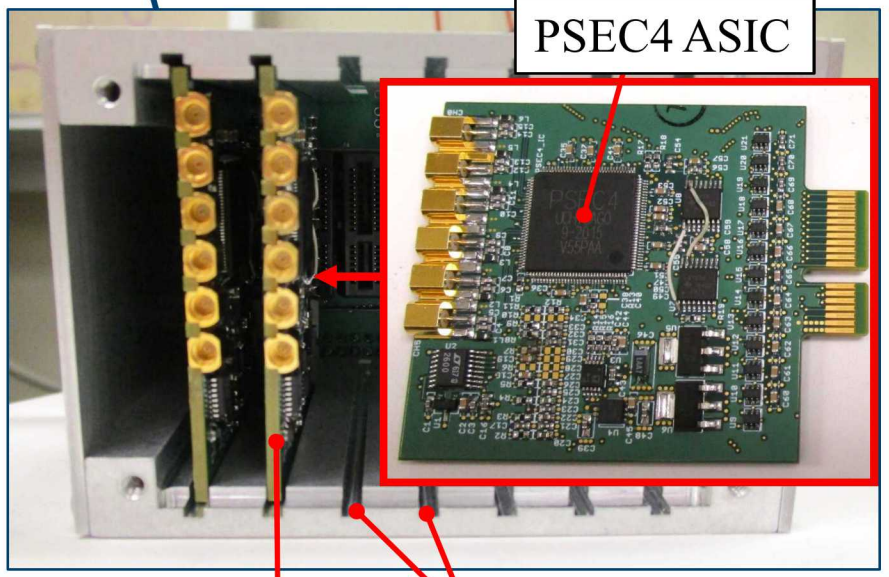
Oberla, NIM A 735, p. 452 (2014)



Example waveform recorded with 24-channel system

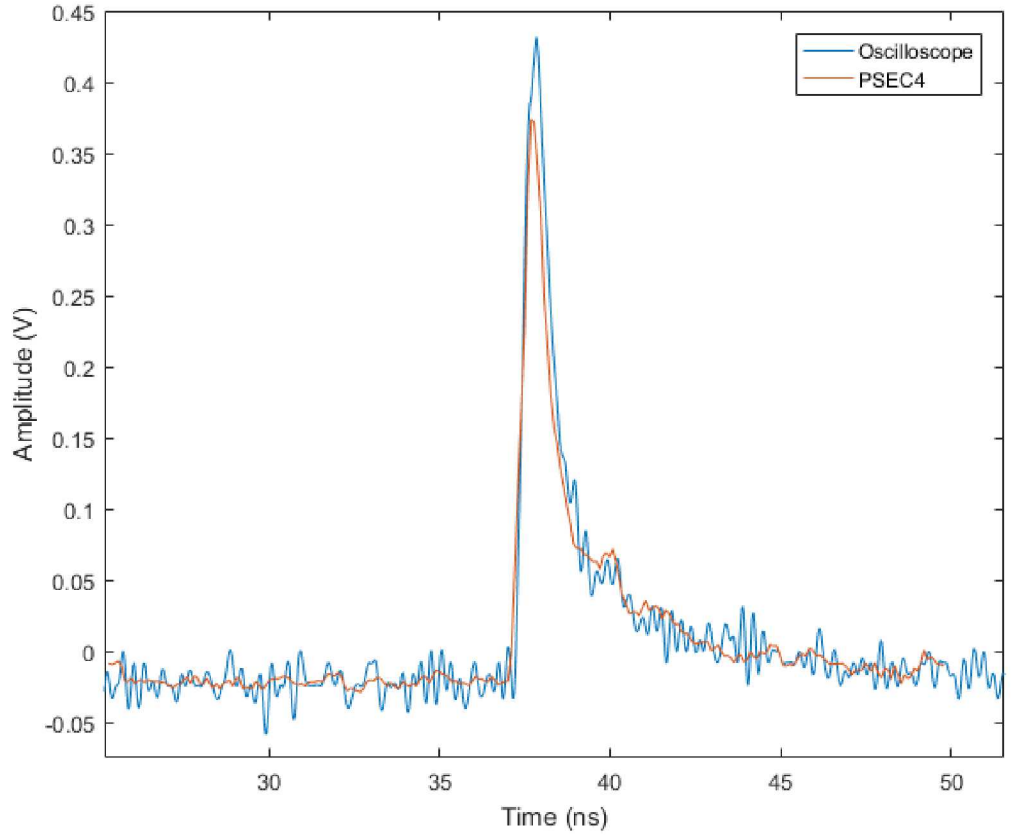


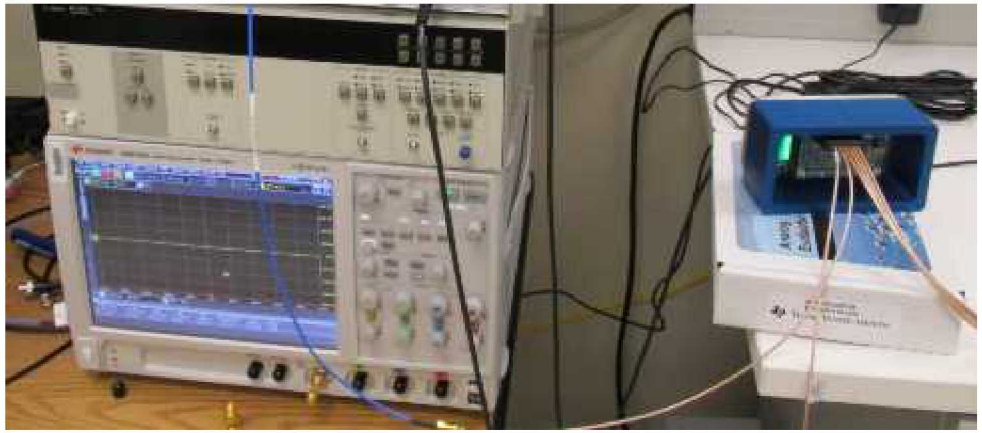
Multi-channel system constructed using PSEC4 host cards



The signal integrity is comparable to that obtained with an oscilloscope

X-ray photodiode waveform recorded on Tektronix 7000 series oscilloscope and PSEC4





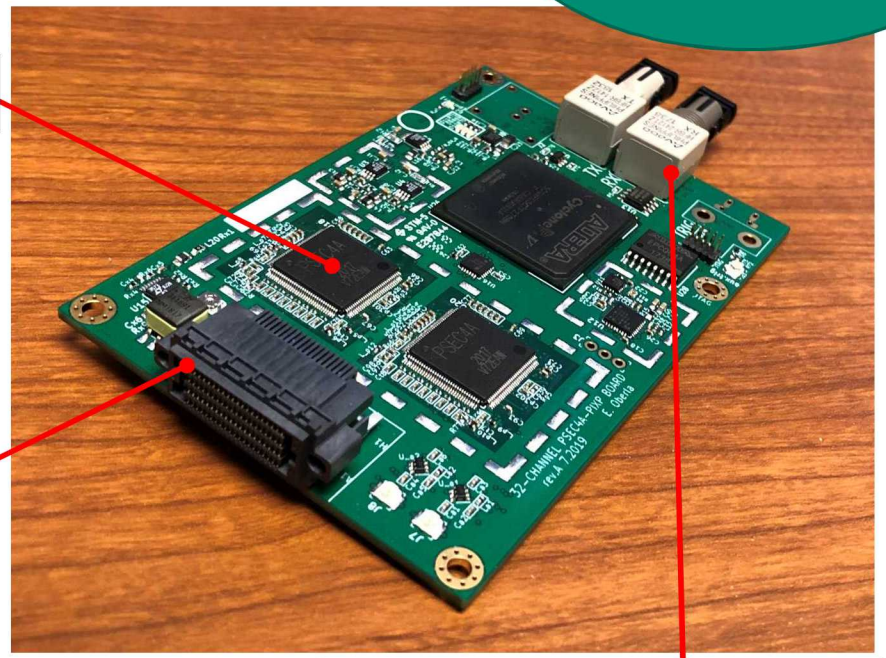
Same diode, 2 different shots; amplitude discrepancy may be due to varying shot energy

The PSEC4A updated design improves overall flexibility

PSEC4A
- Switched-capacitor array sample and hold architecture
- 8 channels, 512 sample depth, 10 GS/s
- ~2 GHz analog bandwidth

32-channel PSEC4A host board

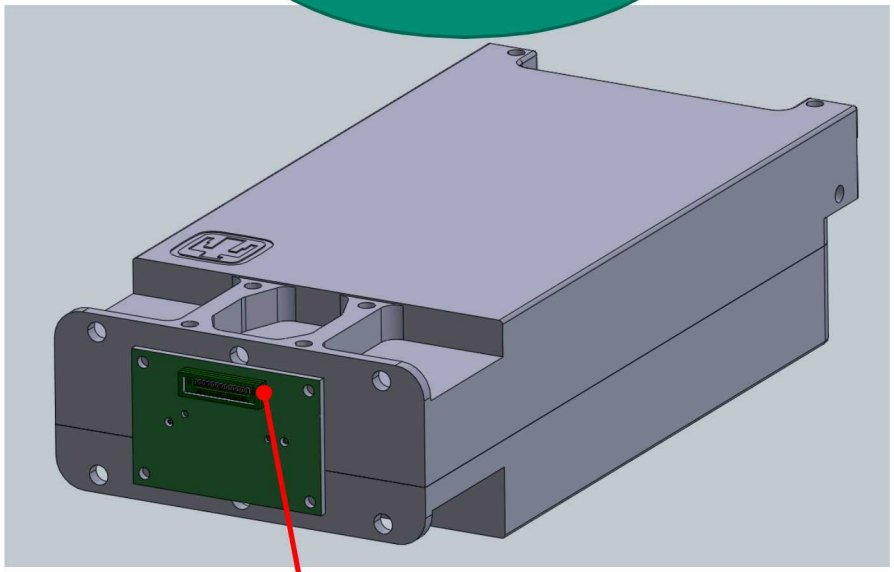
PSEC4A Chip (4 each)



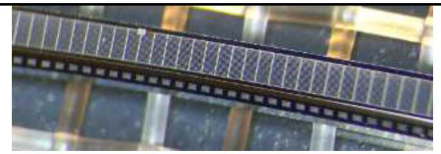
High-density input connector

Power and communication

Concept with enclosure and detector board



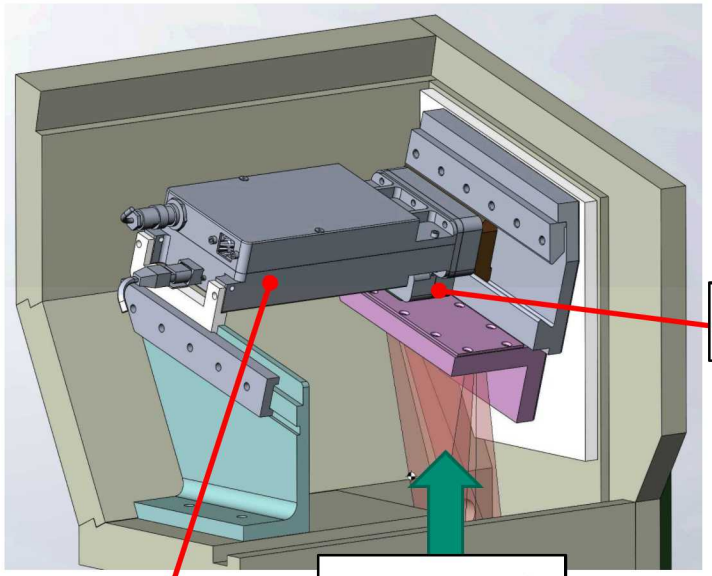
32-element detector array
0.25 mm pitch

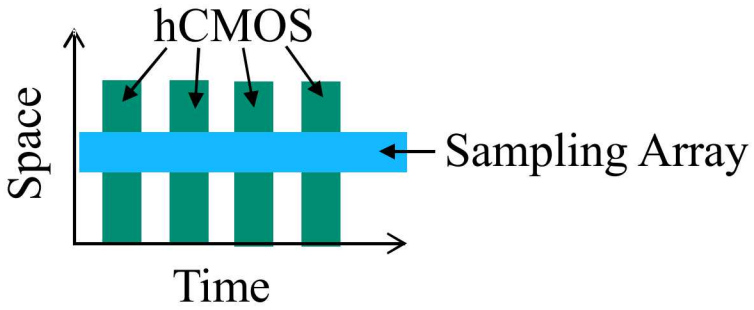


We anticipate the 32-channel system will be ready summer 2020

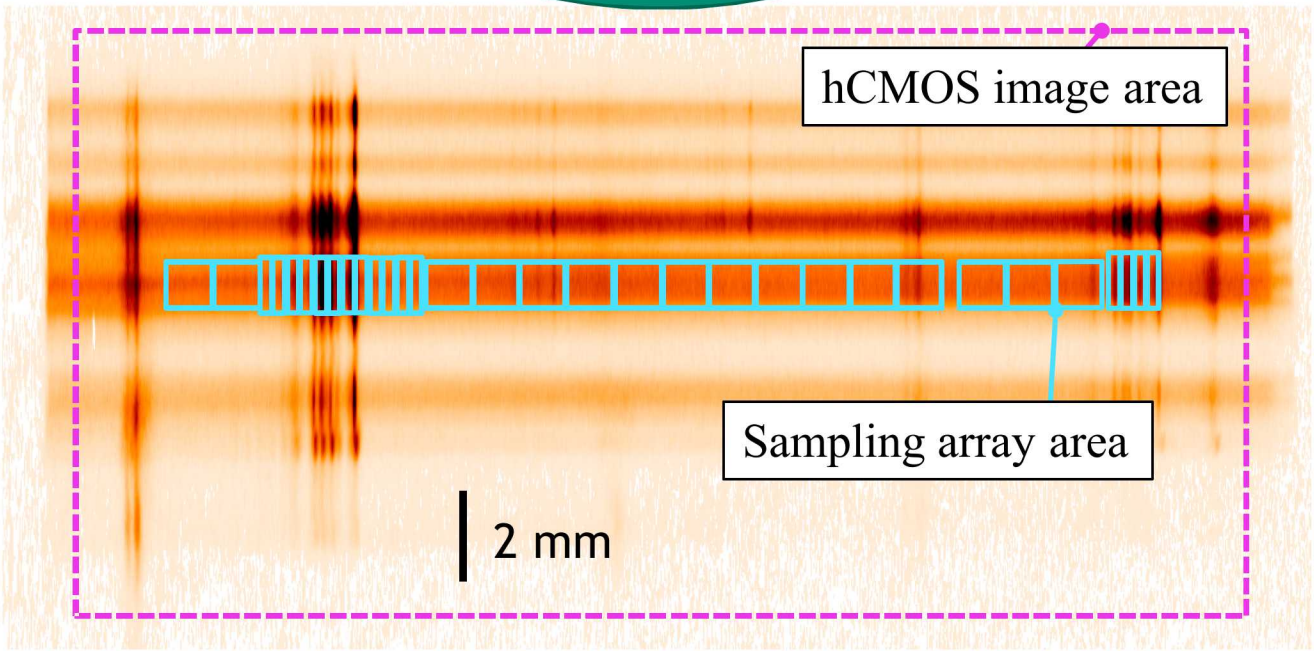
Use case: MONSSTR Time-Resolved Spectrometer

- Current plan is to use Icarus or Daedalus
- Continously time-sampling array could provide complementary information



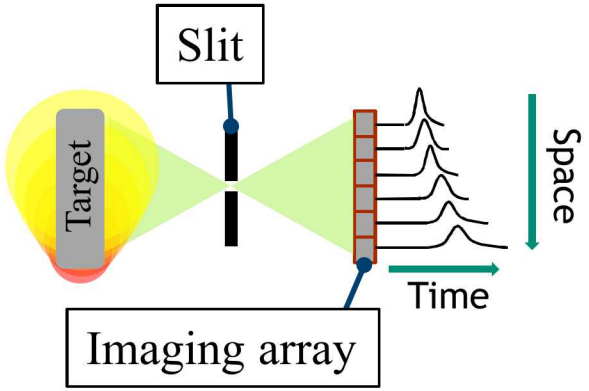


Example Spectral Data

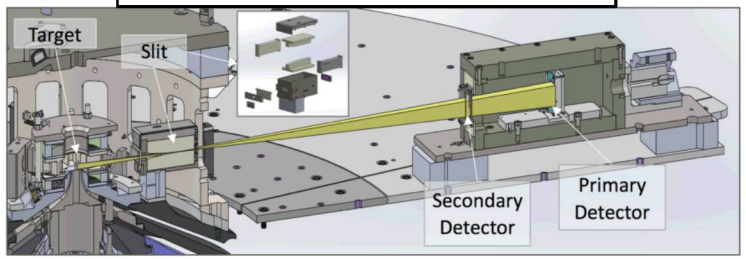


Use case: Slit Imaging Systems

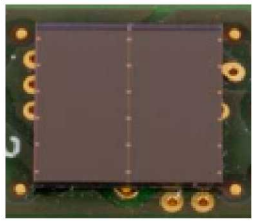
- ODIN is a one-dimensional, time-integrated neutron imager
- Virgil is a spectrally resolved, time-integrated x-ray imager
- Immense benefit by making each of these time-resolved



ODIN Neutron Imager



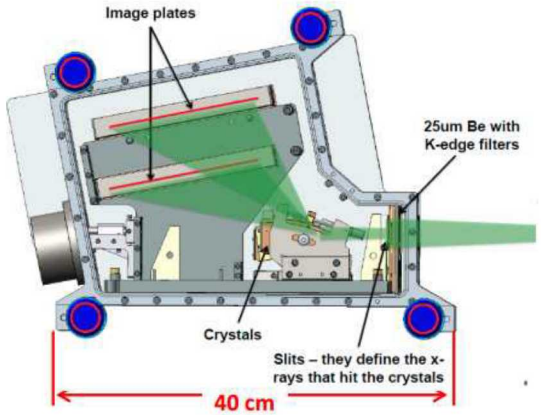
Ampleford et al., RSI 89 10I132 (2018)



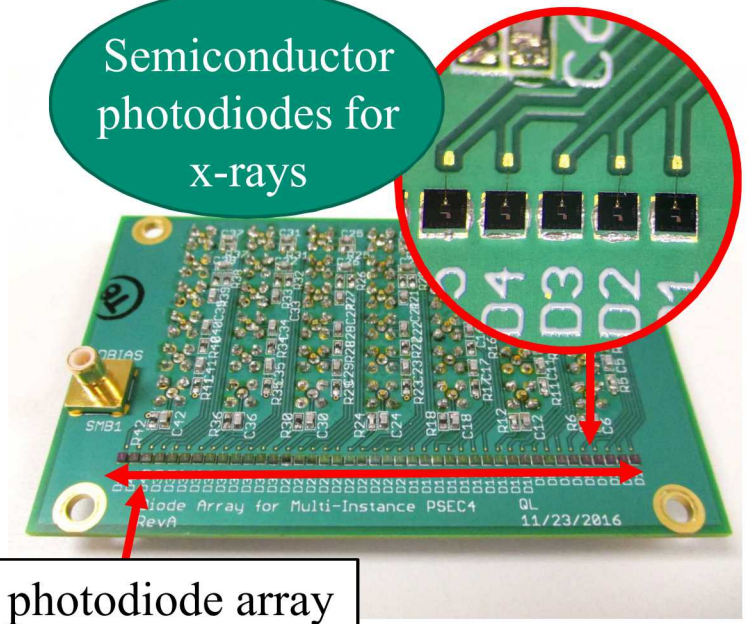
Scintillator/SiPM for neutrons

Time-integrated → Time-resolved

Virgil Spectrometer



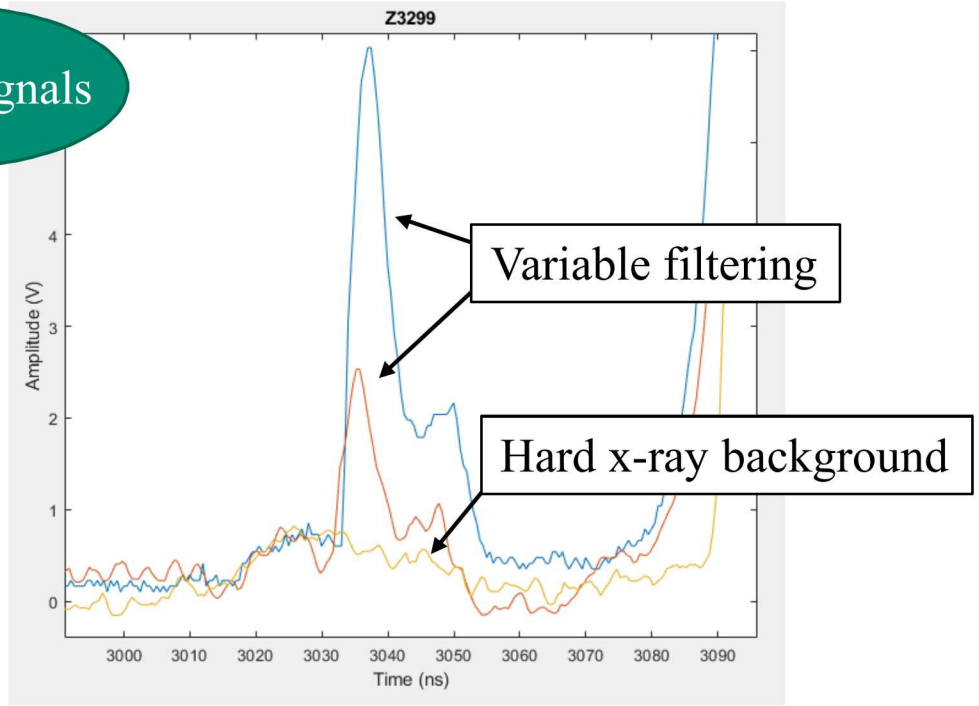
Semiconductor photodiodes for x-rays

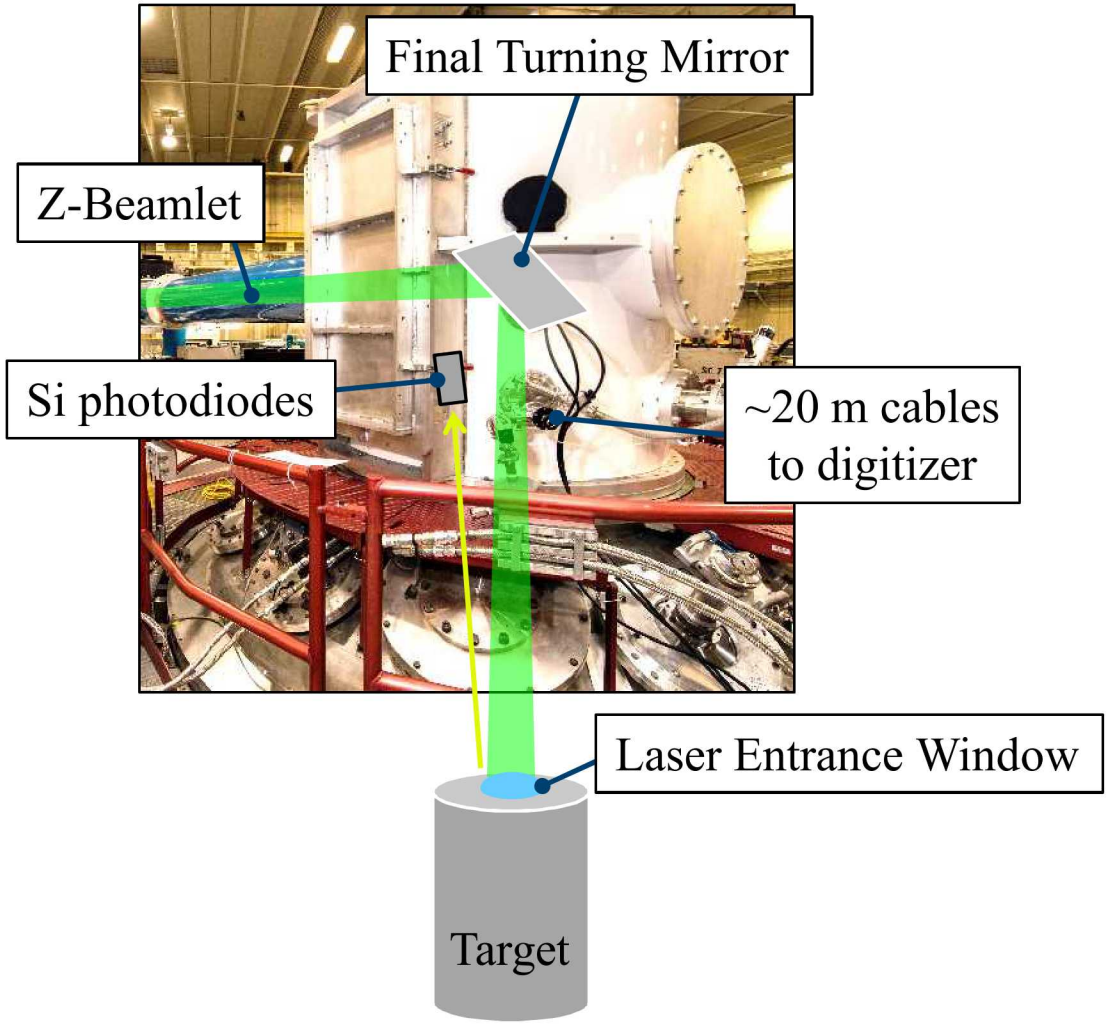


Use case: Filtered photodiode arrays

- Multiple filtered photodiodes track x-ray emission from MagLIF preheat plasma
- External cabling is an opportunity for electromagnetic interference
- Long data path difficult to co-time signals with sub-ns precision

Example signals





Development Needs

- Dedicated funding to develop readout electronics
  - Need to mature power and communication to ASICs
  - Best layout practices for signal integrity
- Clearly identified applications
  - General-purpose system too vague
  - Clear end goals will aid development
- Packaging and integration development
  - Several photodiode array options available
  - Greater flexibility at fine-pitch arrays with mature BGA process, TSVs, new packages, epoxy dam & fill