

Hybrid a-Se/CMOS and Its Applications

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Why Amorphous Selenium



Selenium is part of the **chalcogen group** (Group VI) in the periodic table, along with oxygen, sulfur, tellurium, and polonium.

Amorphous selenium is widely used commercially in **X-ray detectors**.

- **Large area, low cost, maturity**
- Good absorption properties for relatively low energy
- Low dark current ($E_g = 2.2\text{eV}$)
- **Potential for gain (avalanche) at low fields ($>70\text{ V}/\mu\text{m}$)**
- High spatial resolution (direct detector)

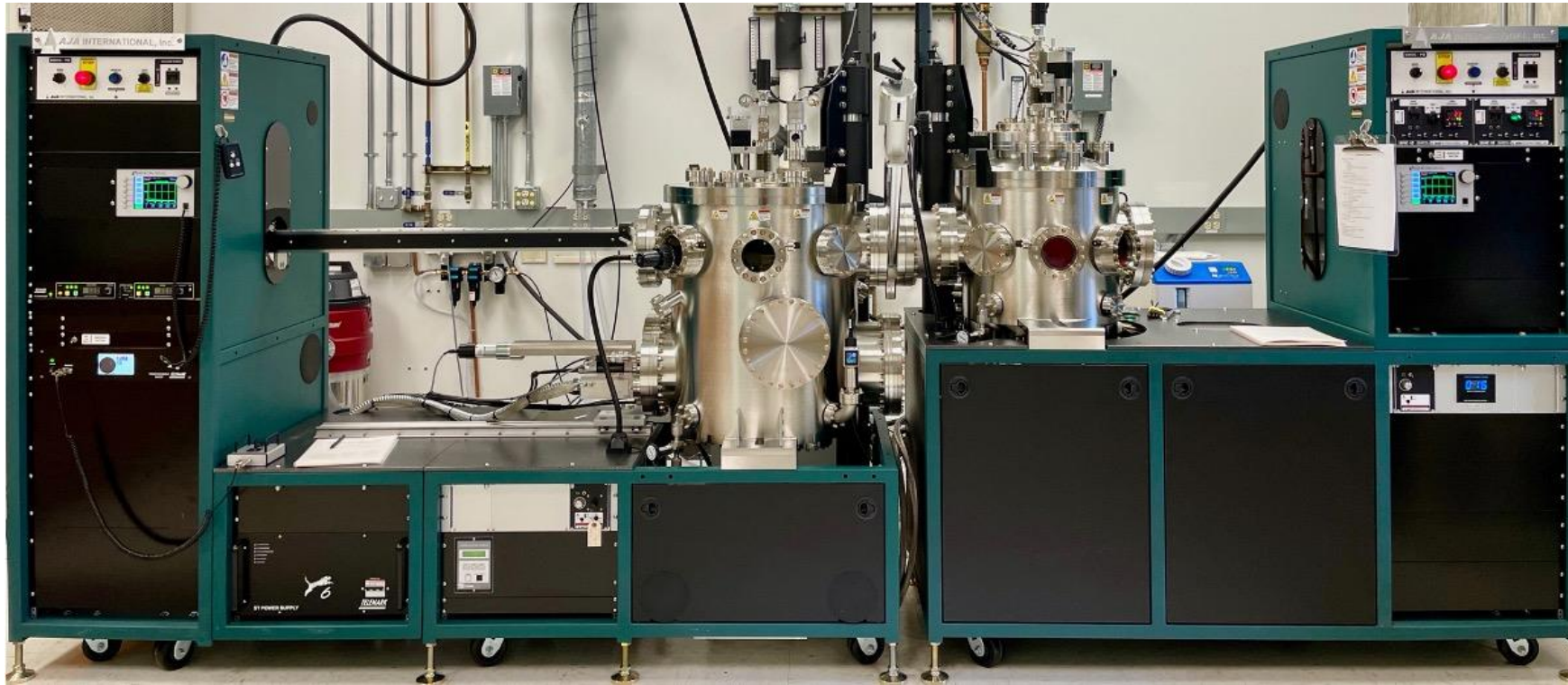
Why Amorphous Selenium



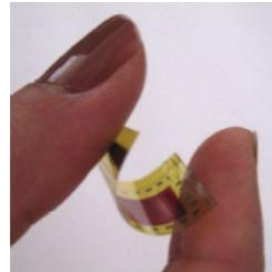
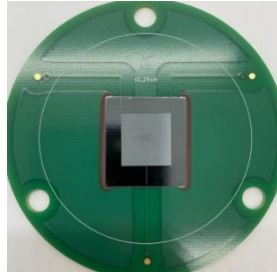
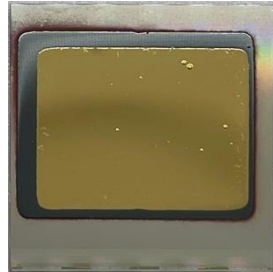
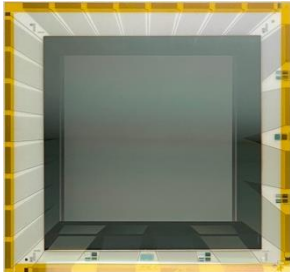
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K. Tanioka, *Nucl. Instrum. Methods A*, 608, S15-S17, 2009.

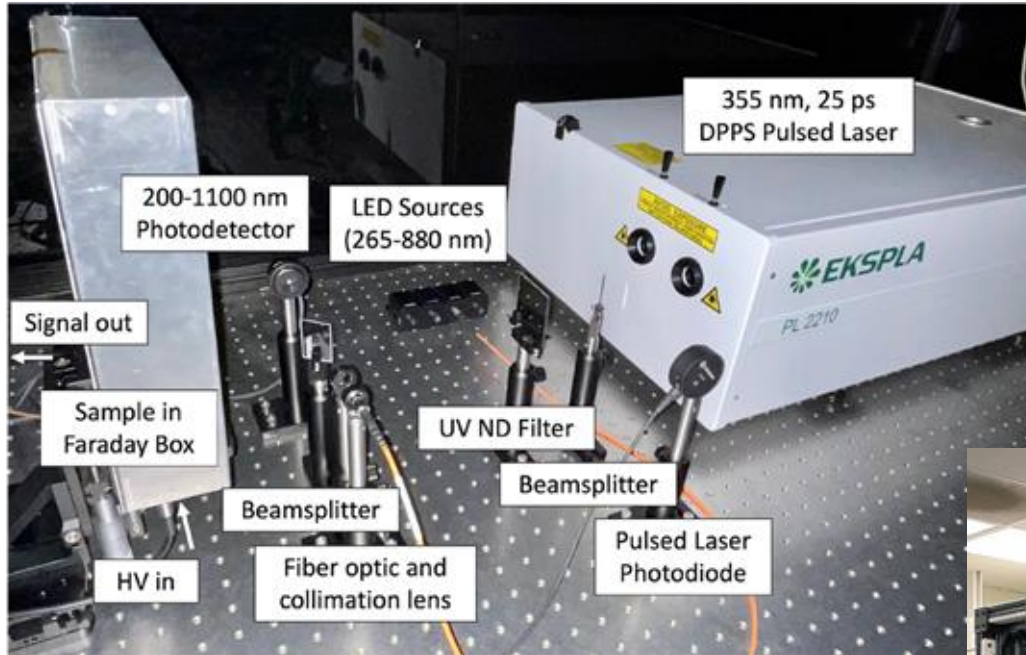
Fabrication Facilities for In-House Detector Development



- RIL hosts a custom-built, dedicated selenium thermal evaporator and e-beam deposition systems
- Capable of multi-material depositions, including all layers for detector architecture
- One of the few U.S. research facilities capable of complete large area a-Se detector fabrication

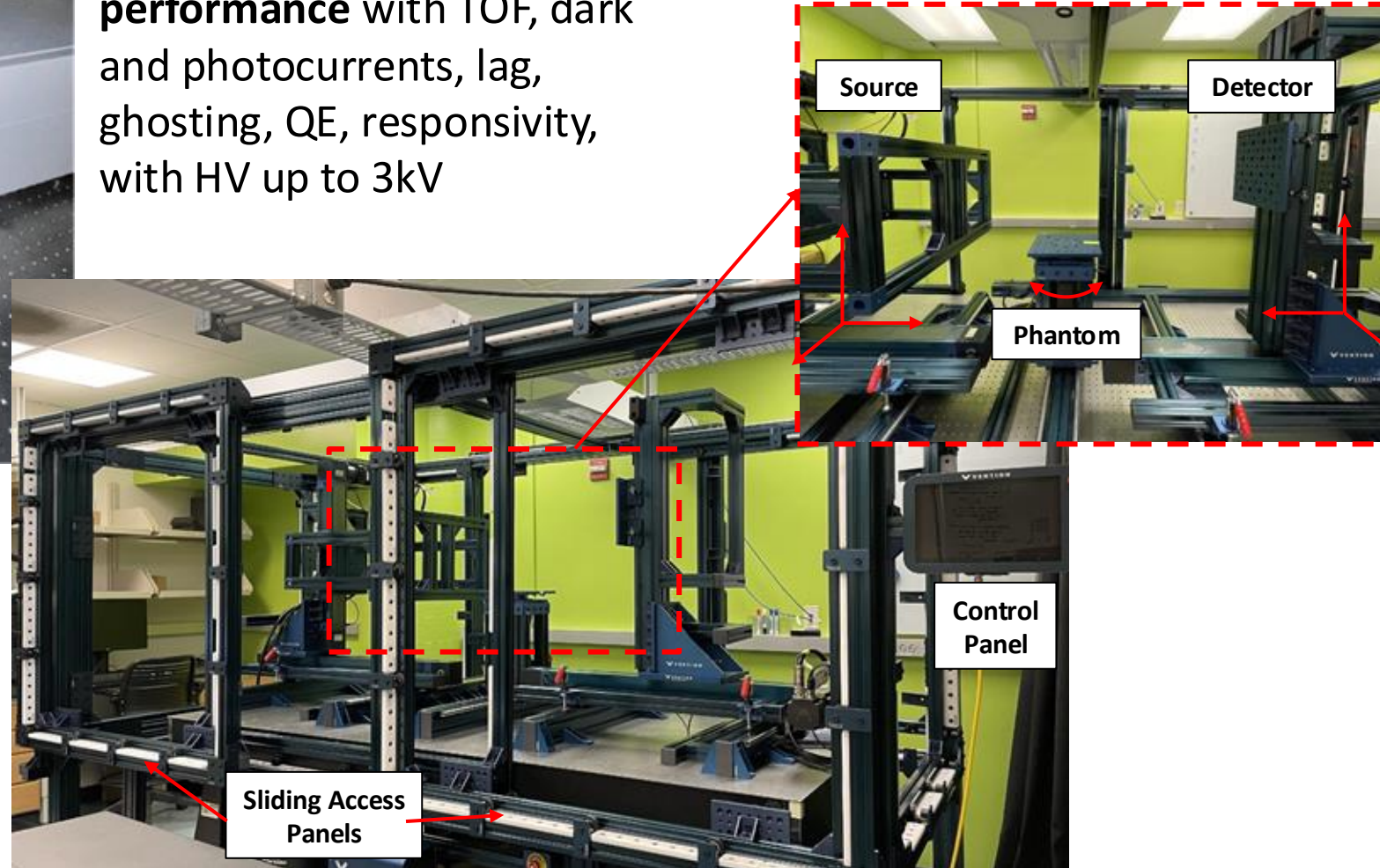


Characterization for UV-VIS-NIR and X-ray Detection

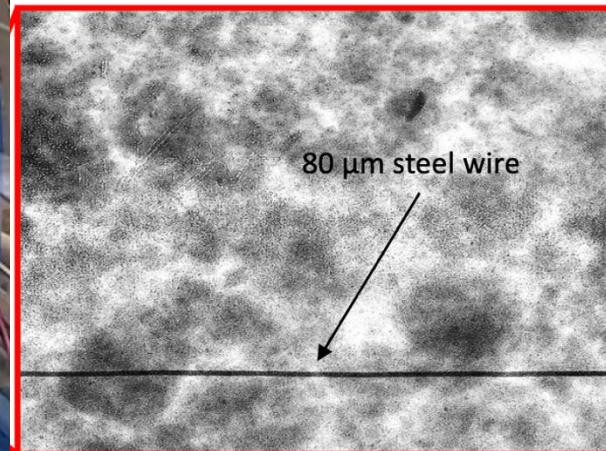
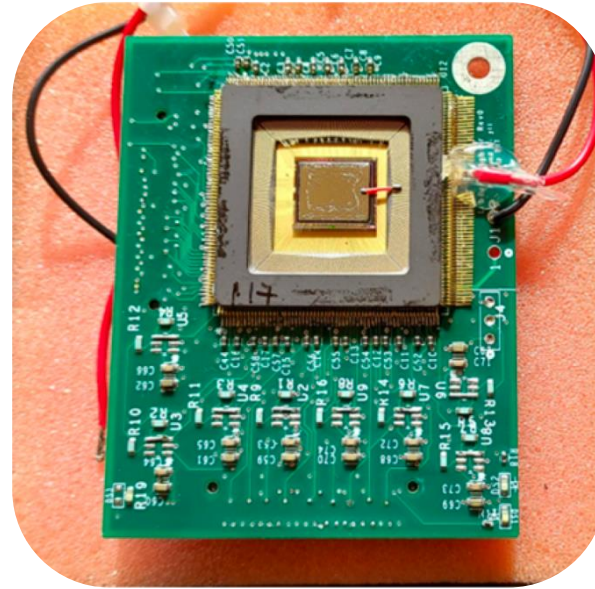
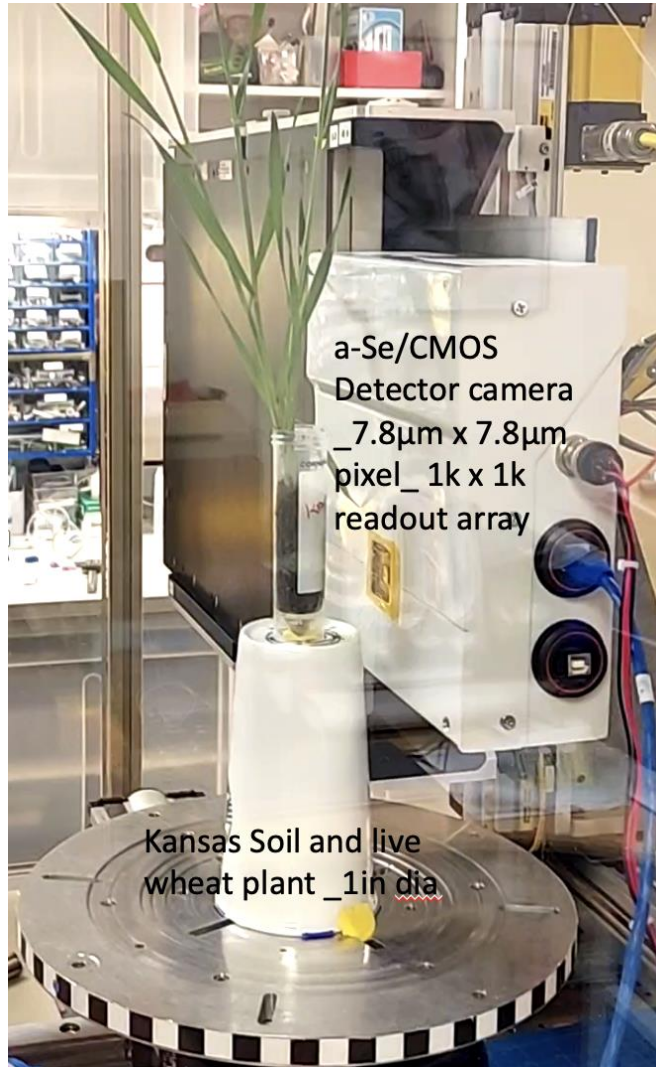


Material and detector performance with TOF, dark and photocurrents, lag, ghosting, QE, responsivity, with HV up to 3kV

X-ray test bench with swappable sources, detectors, and CT capability for evaluating detector performance and demonstrating applications



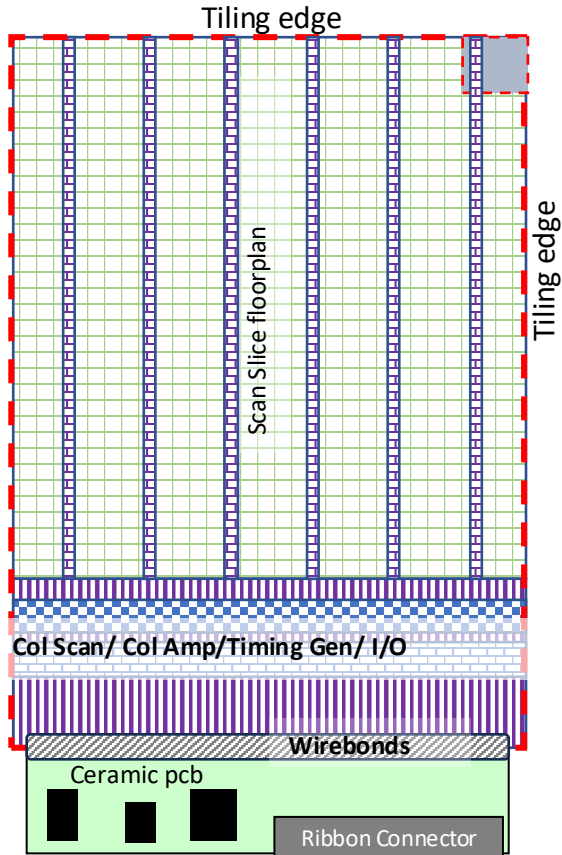
Selenium-CMOS Hybrid Detector



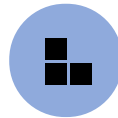
- Porosity and air space fraction
- Vessel diameters and connectivity
- Root volume, length, and branching
- How roots develop and how their architecture changes in response to environmental factors.
- How different soil types and condition affect roots growth and how plants respond to those conditions.

High Speed, High Resolution, Large Area Detection

3-side tileable detector and readout tile



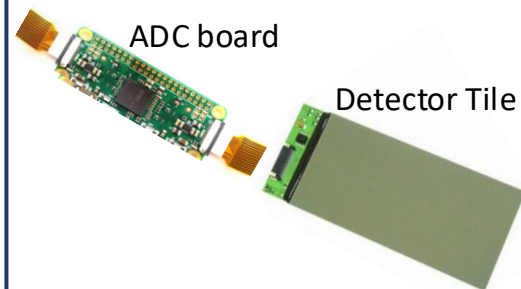
Next steps: wafer
fabrication and testing



Modular Tiled Design

- 7 μ m pixel pitch CMOS chips
- Frame rates exceeding 30fps
- Tileable architecture for scaling

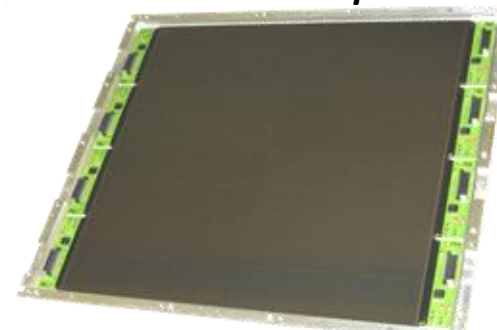
Tile module with ADC



Scalability & Customization

- Application-specific camera design
- Modular tile composition
- 25cm x 30cm panel target

Tiled detector panel



Technical Implementation

- 8 x 1 modular tiling configuration
- Seamless tile integration
- Large-area coverage capability

Tiled Assembly

