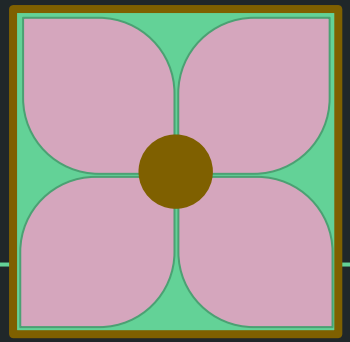
Photon-Based Detector Workshop
Friday Dec 18, 2020



Light & Charge Pixel Readout

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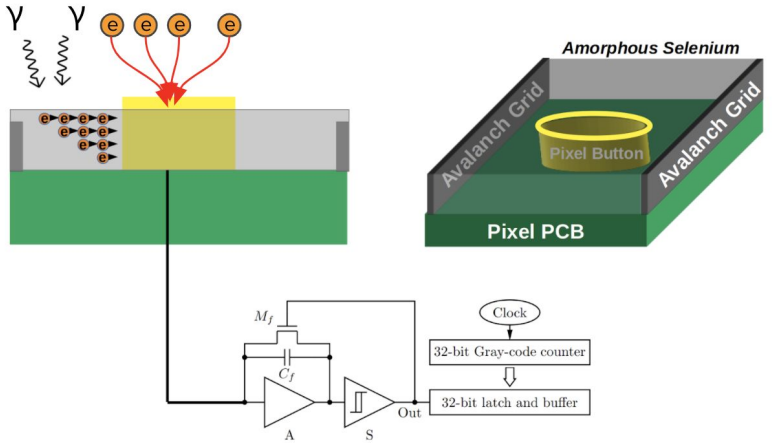
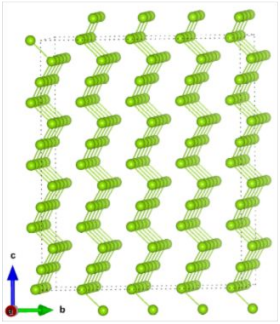
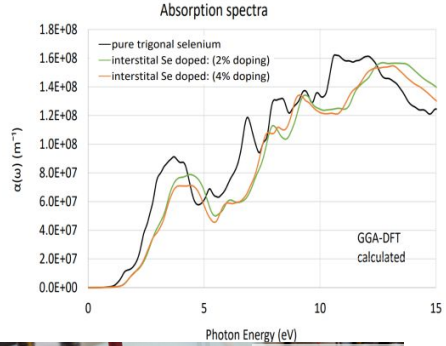
ASe Multiple Modality pixels: the idea in a nutshell

Idea: Develop a pixel that reads simultaneously both fC ionization charge and VUV light for nobel element time projection chambers.
Scope: Combine the benefits of 3D pixelated charge readout and a full exploitation of the scintillation light (native 3D reco, improved energy resolution w/ light augmented calo, lower energy thresholds) for detailed neutrino/low E events detection.
How: Coat the pixels with a thin films sensitive to VUV light. First choice is amorphous selenium (A-Se) other materials are under consideration. Ionization charge is collected by the pixel central button. The VUV photon creates an electron-hole pair in the semiconductor. This charge is amplified by biasing the pixel and is read out after gain amplification via Q-pix readout.
Potential: extremely vast active surface (= cathode), high QE
Applications: TonPlus Scale TPCs:
DUNE module of opportunity, DM and ν0ββ
Current funding for preliminary R&D:
Gramellini's FNAL LDRD & Asaadi's ECA



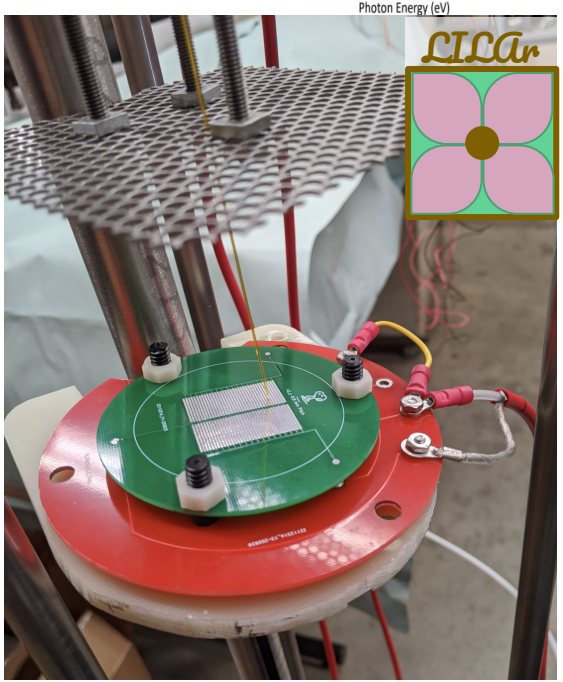
R&D on Light: LILAr



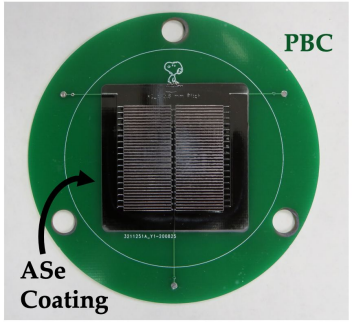


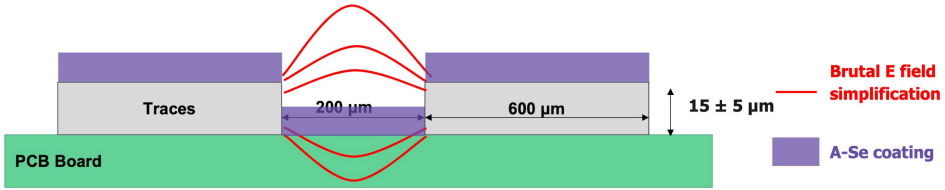
VUV Photosensitive films consistent with q-Pix charge sensitivity:

- A-Se has very positive optical properties for VUV photons, used in medical devices (never in cold)
- A-Se material development in collaboration w/ UTA condensed matter theorists. Simulation of the optical-electrical properties on their way.
- We built the first setup for cold and vacuum characterization tests of the prototype boards: **we saw signal in vacuum at XENON wavelengths**!
- Other thin films material under consideration, (e.g. pyroelectric materials)
- Very promising first steps, possible more results on the white paper time scale!



First coatings





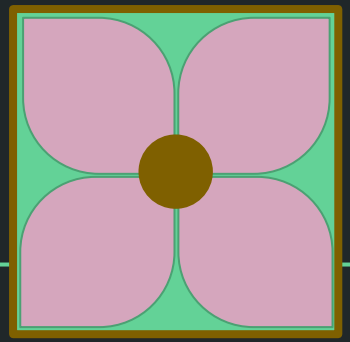
Takeaways

Kiloton scale (LAr)TPC's offer many challenges to fully exploit the rich data they offer:
new ideas for readout needed to fully leverage TPCs light & charge capabilities… & optimize for discovery!

Low threshold pixel based readout can optimize for discovery the impact of these detectors, especially if coupled with a powerful light detection system: full exploitation of charge and light interplay in noble TPCs.
Unorthodox solutions required: qpix readout + photosentive thin films.

The successful demonstration of a high efficiency VUV photodetector capable of detecting ionization charge has the potential to revolutionize the use of scintillation light in future liquid noble detectors expanding their physics reach to heavy sterile neutrinos, DM searches, 0νββ, rare decay searches and supernova neutrinos.

R&D has been funded for a full exploration of photosensitive films which have the potential to unlock such a technology. First promining steps, hopefully more to come in view of the snowmass white paper.



Thank you!