The Selena Neutrino Experiment will utilize amorphous Selenium-82 (aSe) coupled to pixelated CMOS imaging devices to probe fundamental neutrino physics. The spatiotemporal resolution of CMOS imaging devices allow for unparalleled background rejection in neutrinoless double-beta decay (νββ) searches [1].

### Science Goals

The Selena neutrino experiment makes use of 82Se to perform a search for νββ free from the background of natural radioactivity. We achieve this since:

- $Q_{νββ} = 2981$ MeV, which sits above most natural radioactive backgrounds
- CMOS track geometry reconstruction and event timing can be used to tag decay chains from $^{214}$Bi and $^{214}$Po
- Bragg peaks can be used to differentiate single β events and γ-ray interactions.

### Current Prototype

The current prototype detector module implements the Topmetal-II chip [1] as the pixel charge sensing device with 500µm of aSe deposited by Hologic Inc. Each toplevel pixel contains an exposed electrode made from the topmost metal layer. The electrode is directly connected to the input of a charge sensitive preamplifier (CSA). By tuning the CSA decay time for long signal retention, we can multiplex the signals from each pixel into a single output for readout using a rolling shutter. Initial results indicate a noise performance of ~28 electrons.

### The Open-Source Sky130 Process

As of June 2020, the Skywater Foundry was the first foundry to offer a fully open-source process (PDK) sponsored by Google. Traditionally under expensive licenses and limited NDAs, the Skywater Open PDK acts as an entry point into CMOS ASIC (application specific integrated circuit) design for physicists. Crucially, the open-source design of our sensor will allow for greater collaboration amongst collaborators and iteration, long after any NDA expires. Fabrication is offered through collaboration with efabless, which offers both a free, open-source based, chip foundry and a paid reservation service.

### The TopmetalSe

The final Selena detector modules require the design of a custom CMOS imager, known as the Topmetal-Se. We are currently in the process of designing the Topmetal-Se in the SkyWater open 130nm process and will be receiving our first prototypes in Fall 2022.

### Development of a hybrid amorphous selenium/CMOS charge sensor for the Selena neutrino experiment

S. Bogdanovich 1, A.E. Chavarria 2, C. Galbiati 3, X. Li 1, Y. Mei 1, X. Ni 2, A. Piers 2, B. Polischuk 3, T. Van Wechel 2

1-Hologic Inc. 2-University of Washington 3-Princeton University 4-Lawrence Berkeley National Lab

### References