Light Collection for the Scintillating Bubble Chamber (SBC)

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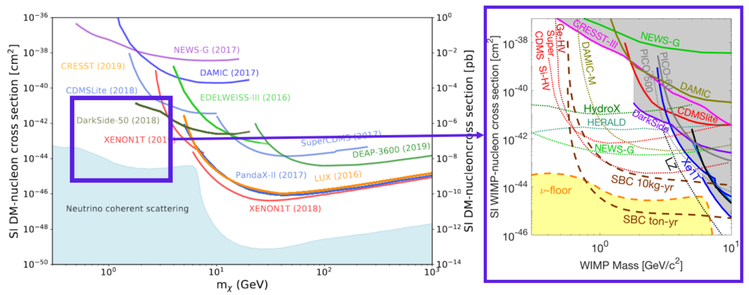
Abstract

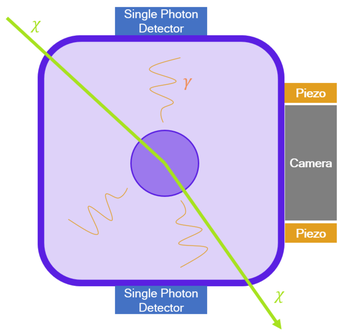
The ongoing search for dark matter continues to evolve, and the quest to reach lower cross-sections is leading to new technologies. One of the newer proposals involves the use of a bubble chamber which employs noble elements (such as argon and xenon) as the active mass. Combining recent developments of bubble chambers with liquid noble gases allows additional scintillation data to be collected. Scintillating bubble chamber (SBC) plans to achieve a threshold as low as 100eV using this technology for the detection of dark matter. To maximize light collection, SBC is required to characterize 32 Hamamatsu VUV4 SiPMs (silicon photomultipliers). The characterization includes the dark noise rate, photo detection efficiency, and crosstalk as a function of temperature and breakdown voltage. This poster will show the current progress, and some preliminary results.

Motivation: explore low-mass DM parameter space



SBC is the combination of two technologies: bubble chambers and liquid noble gas detectors

- In bubble chambers, great ER rejection and scalable [1].
- In liquid noble gases, energy and timing information is available from scintillation.
- Both technologies can be combined for an improved ER rejection and **most importantly, scintillation takes energy from bubble creation [2].** hypothetically lowering the Seintz threshold.



UV sensitive SiPMs as the light collection solution for SBC

- UV SiPMs are sensitive to LAr and LXe wavelength **without the need of a waveshifter.**
- **UV SiPMs tolerate LAr and LXe temperatures with a greatly reduced dark noise rate.**

SiPM Distribution in SBC. LAr SiPMs as the bubble light collection SiPMs, and LCF4 SiPMs as vetoes

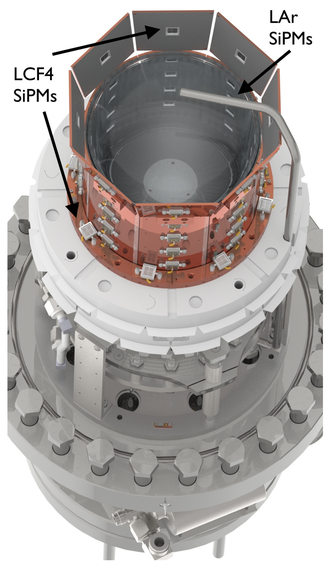
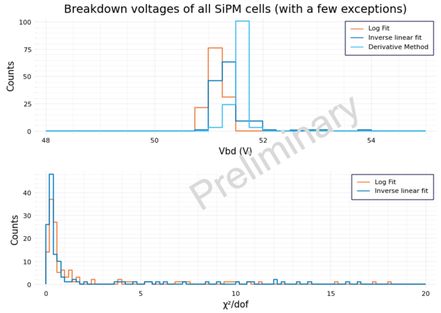


Fig. 4: SiPM distribution/SBC inner assembly

Fig. 5: SBC Render

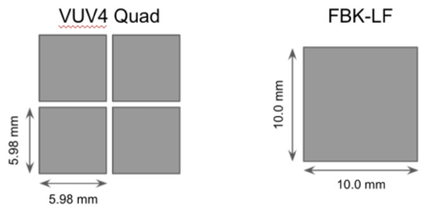
SBC-Queens work: characterize 34 VUV4 Hamamatsu SiPMs vs Temperature

- Characterization includes: dark noise rate, breakdown voltage, APA (additional pulse avalanches), and CDA (correlated delayed avalanches) at LAr to ambient temperatures.
- Construction and testing is near finalization and expected to have results by the end of the year.



SBC Future: FBK SiPMs

- VUV4 SiPMs were found to be too radioactive for our dark matter search.
- We entered an agreement with nEXO to procure 2 wafers of FBK-LF with comparable performances to the VUV4.
- We are developing a new "radio-clean" packaging for the FBK-LF with the same footprint as VUV4 to minimize design changes.



SBC Timeline

- **SBC-Fermilab: Assembly (Present - 2022), Science operation (2022 - 2024)**
- **SBC-SNOLAB: Assembly (2022 - 2024), DM search (2024-2024)**

References

[1] C. Amole et al. (PICO Collaboration) (2017) Phys. Rev. Lett. **118** 251301
[2] D. Baxter et al. (2017) Pys. Rev. Lett. **118** 231301