Upgrading the BACoN liquid argon cryogenic system to study light

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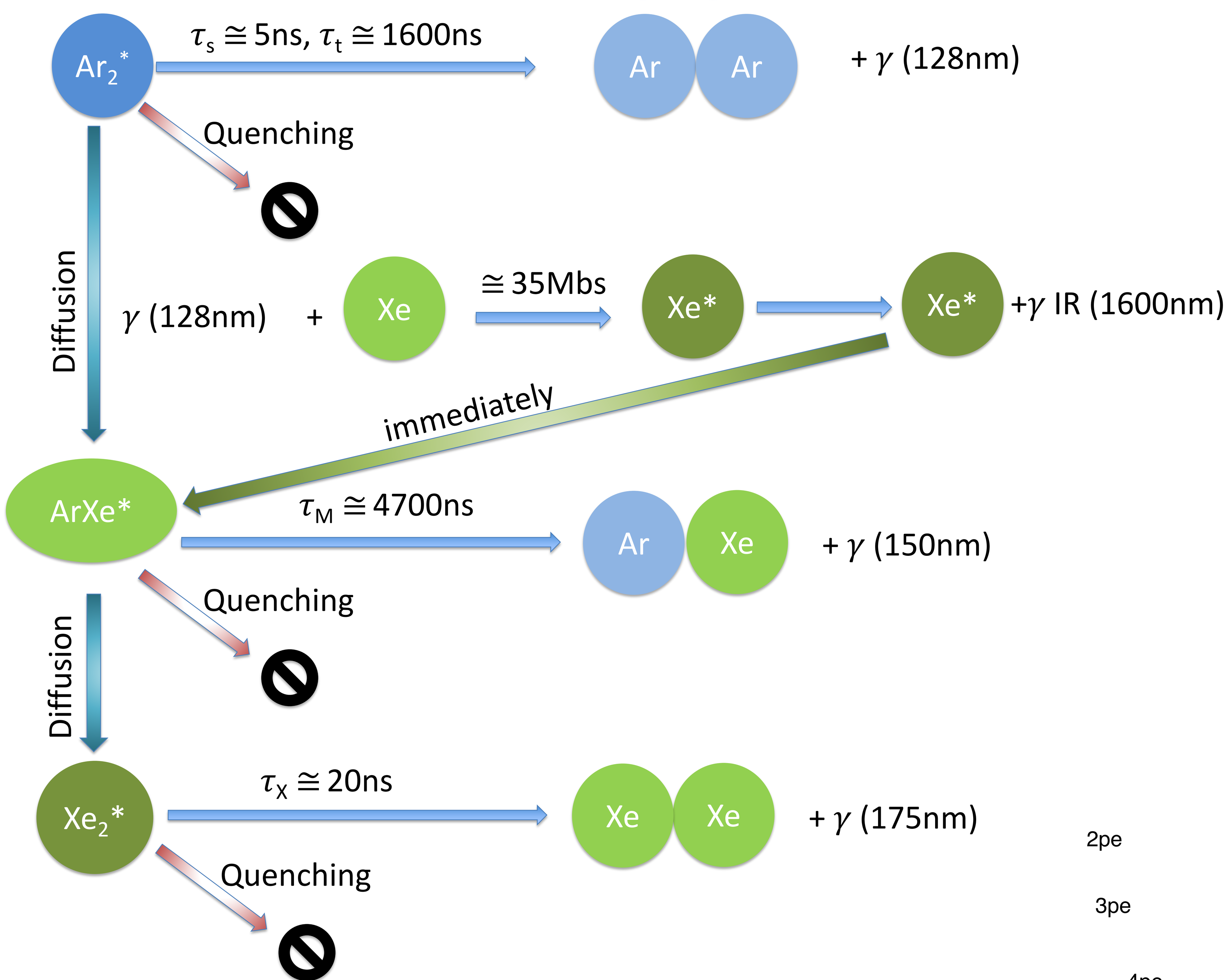
Abstract

The study of scintillation light yield from liquid argon is interesting for many nuclear and particle physics experiments. Doping a few amounts of xenon in liquid argon could significantly shift the wavelength of scintillation light, time profile, and increase yield of the scintillation light. The measurement will be performed using BACoN system at the University of New Mexico. It consists of a stainless-steel cryostat vacuum system filled with liquid argon. The BACoN system is currently being upgraded to enhance its capability of studying Xenon doped liquid argon scintillation light. An array of silicon photomultipliers (SiPMs) will be deployed and to be complemented by a new PMT. The upgrade plan also includes the deployment of germanium detectors to mimic the setup of the LEGEND neutrinoless double beta experiment. The project is supported by DOE and NSF via LANL/LDRD, UNM and USD. In this poster, we will describe the current progress and plan of the BACoN upgrade efforts.

LAr scintillation and xenon doping mechanism



2pe

3pe

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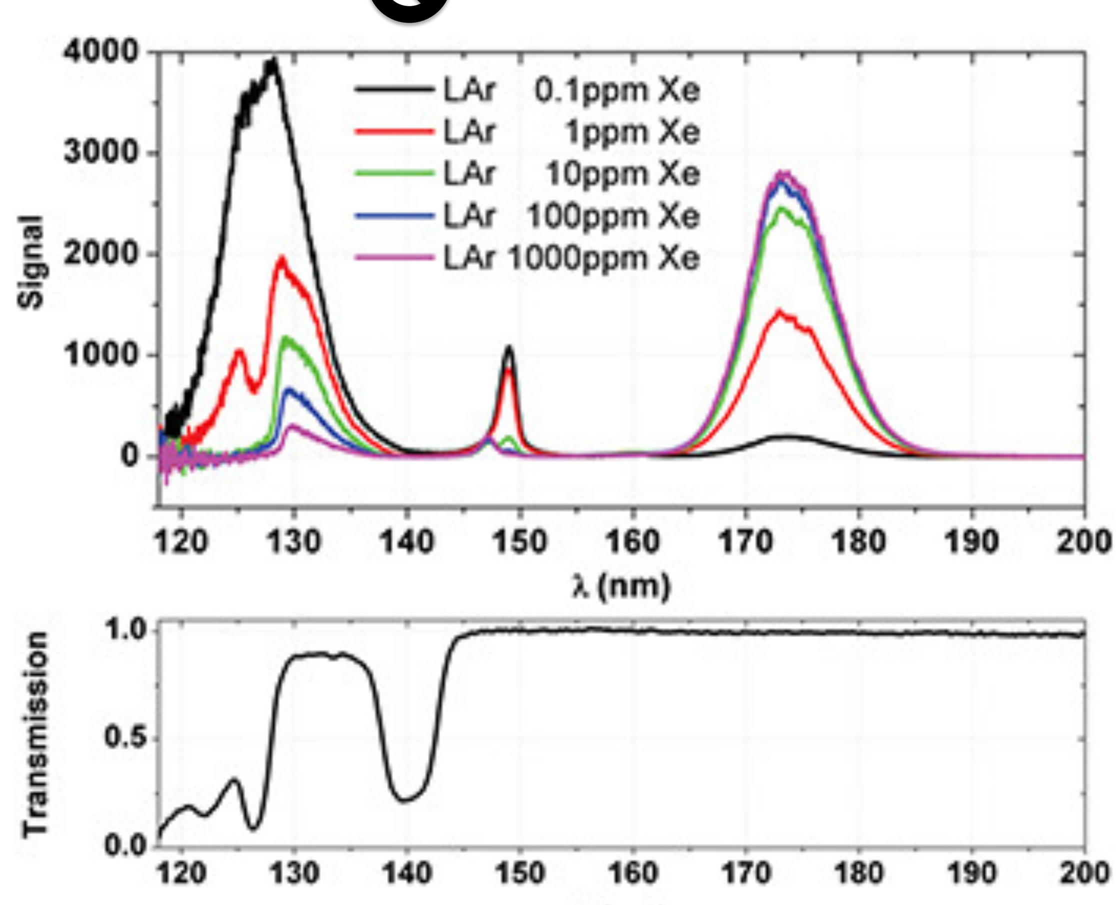
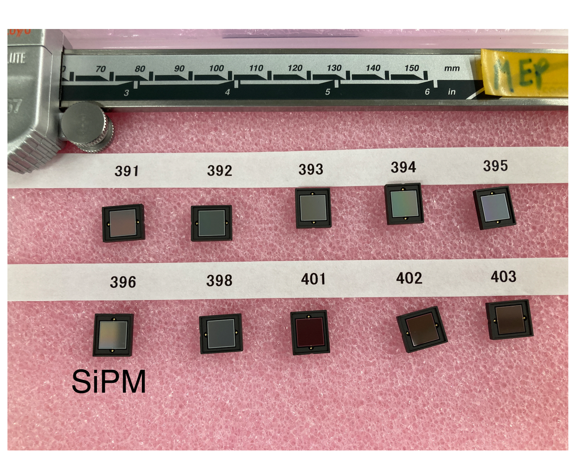


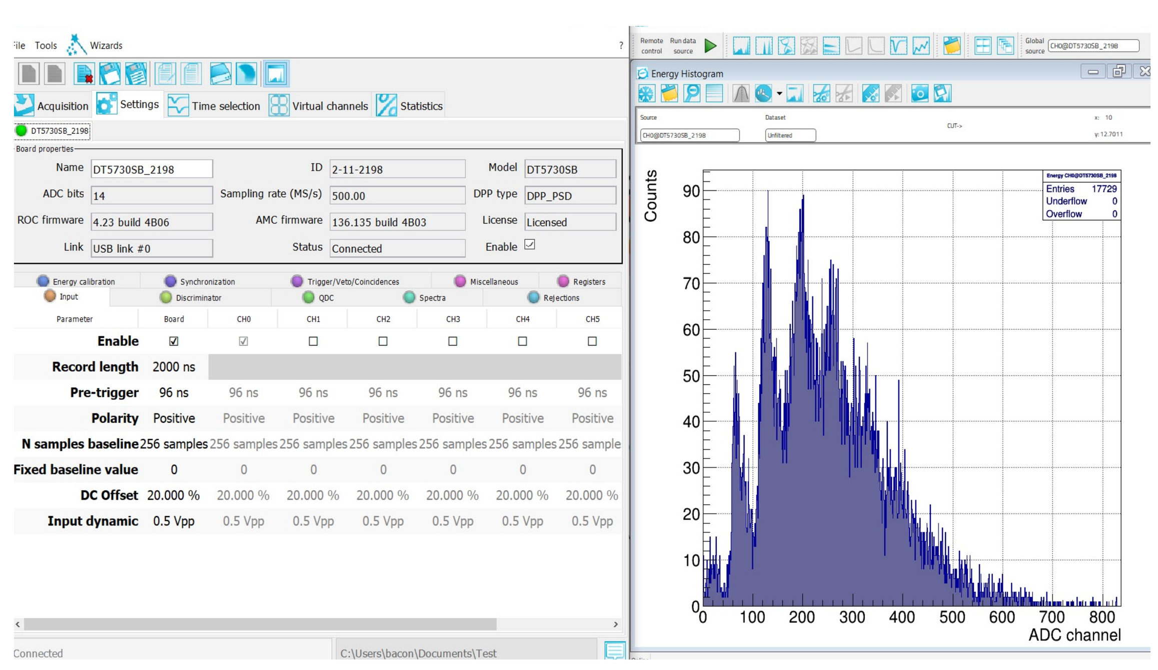
K_q = collision de-excitation factors due to quenching
k_x is a xenon dopant diffusion reaction rate.
τ_M, τ_x are inversely proportional to xenon concentration.

S,T, and M states have collision quenching process which contributes to the light loss. 1/(7.7μs)

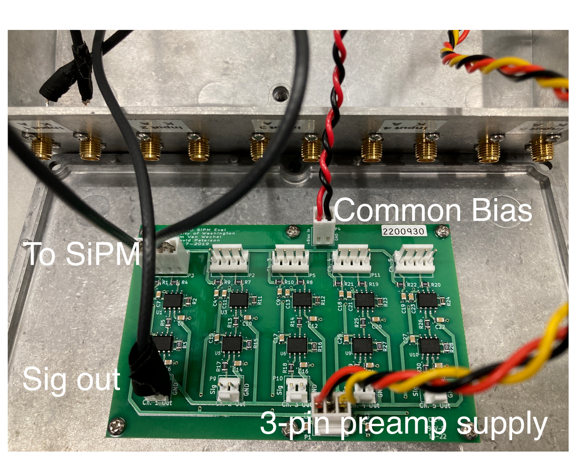
Light sensor, circuit design, and data acquisition system



Hamamatsu VUV4 MPPC silicon photomultipliers



Data acquisition software, Compass

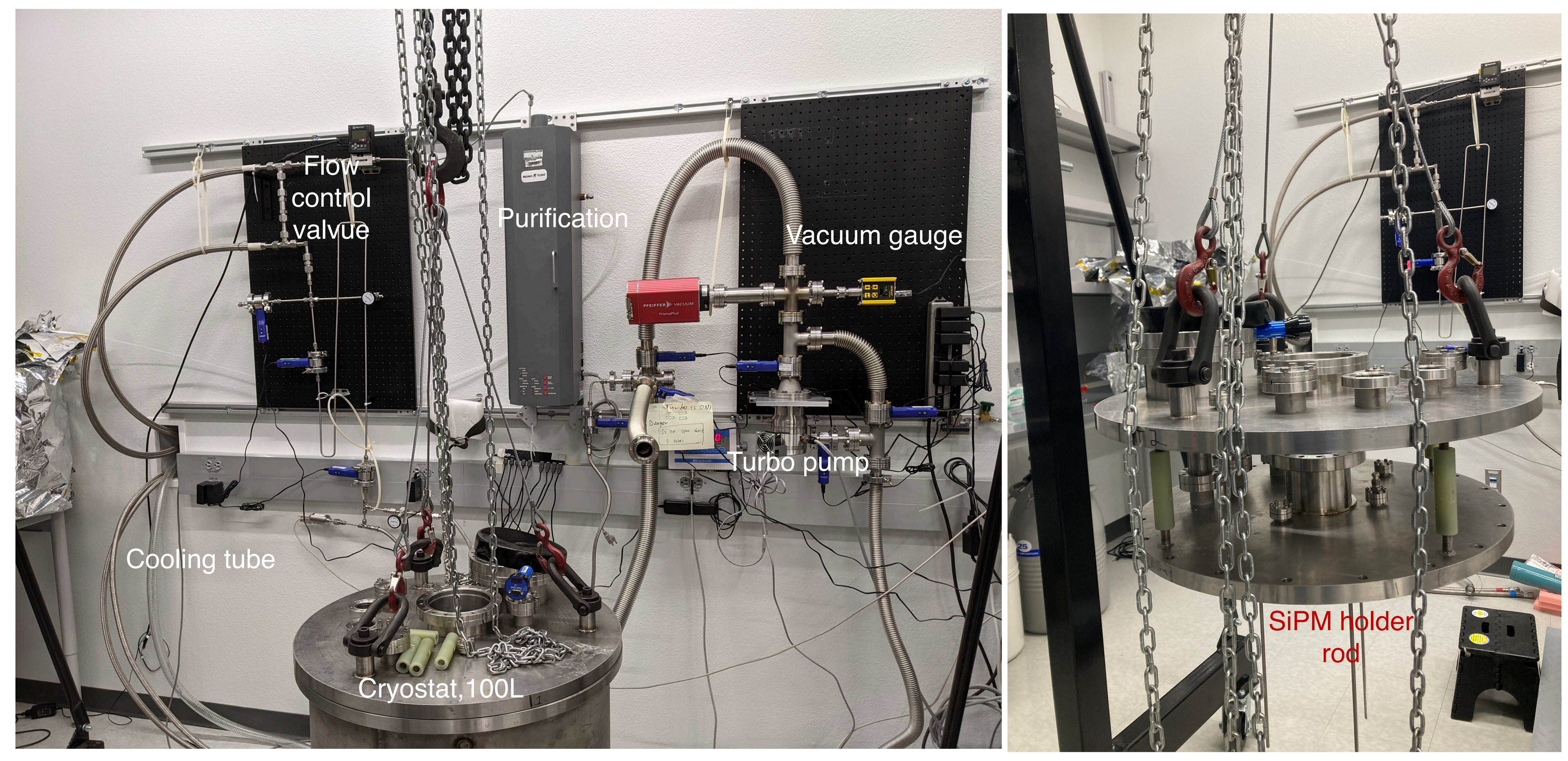


Bias supply and signal amplification circuit board(UW)

Desktop digitizer DT5730[11]

Led driver SP600[11]

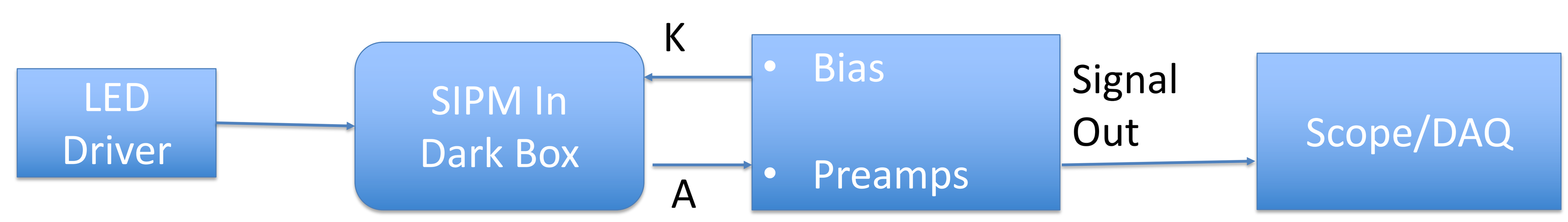
The liquid argon test stand at UNM (under construction)



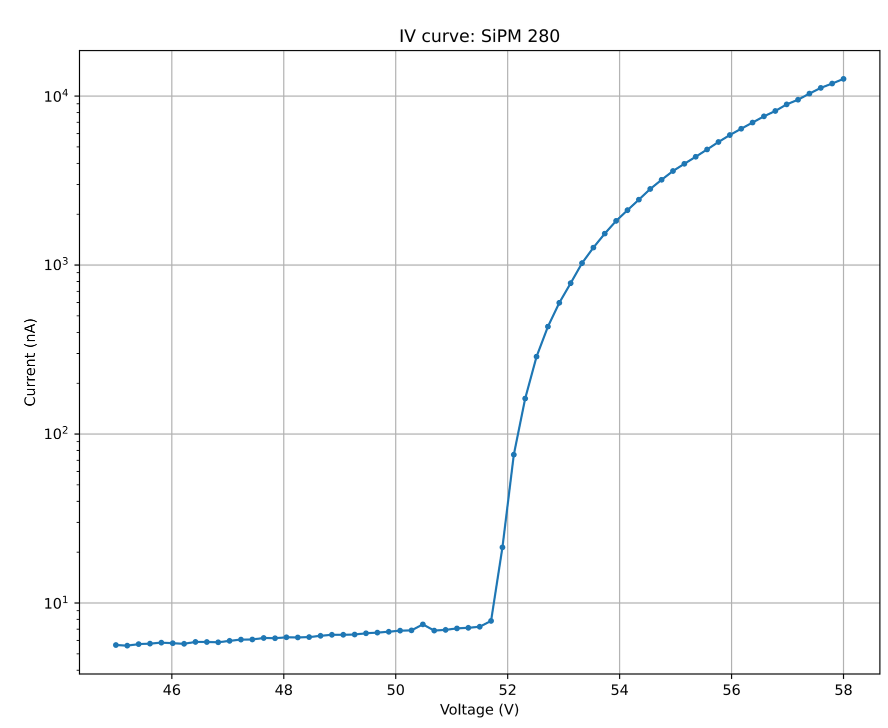
The BACoN system, under construction, showing cylindrical vessel with flanges, Ar purification system, vacuum system with turbo pump, and associated plumbing (left).

Inner view of the vessel showing 3 rods for SiPM attachments (right).

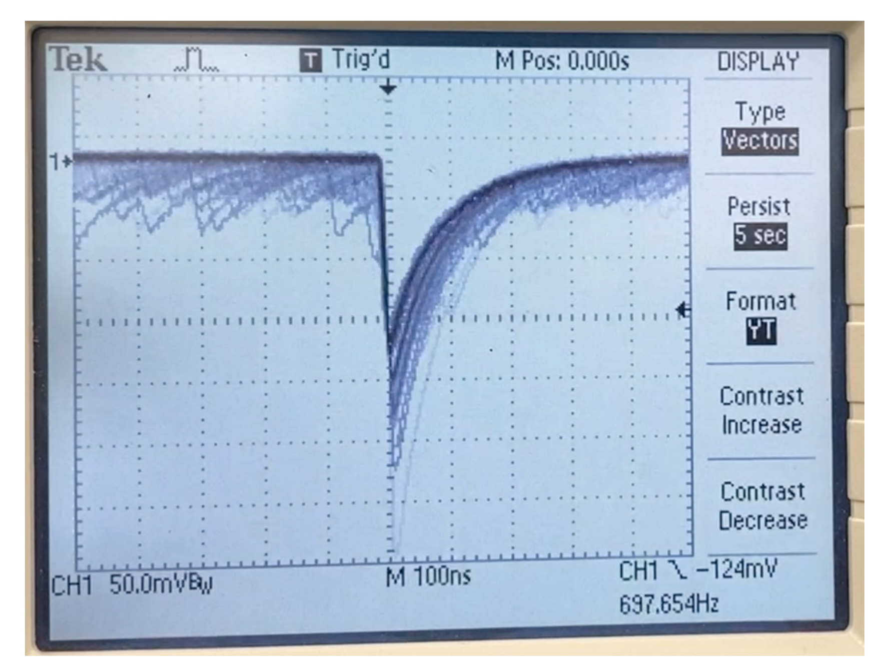
Characterization of SiPM



Schematic diagram of SiPM characterization



IV characteristic of SiPM with breakdown voltage



SiPM waveform seen by scope for quantized photo-electrons

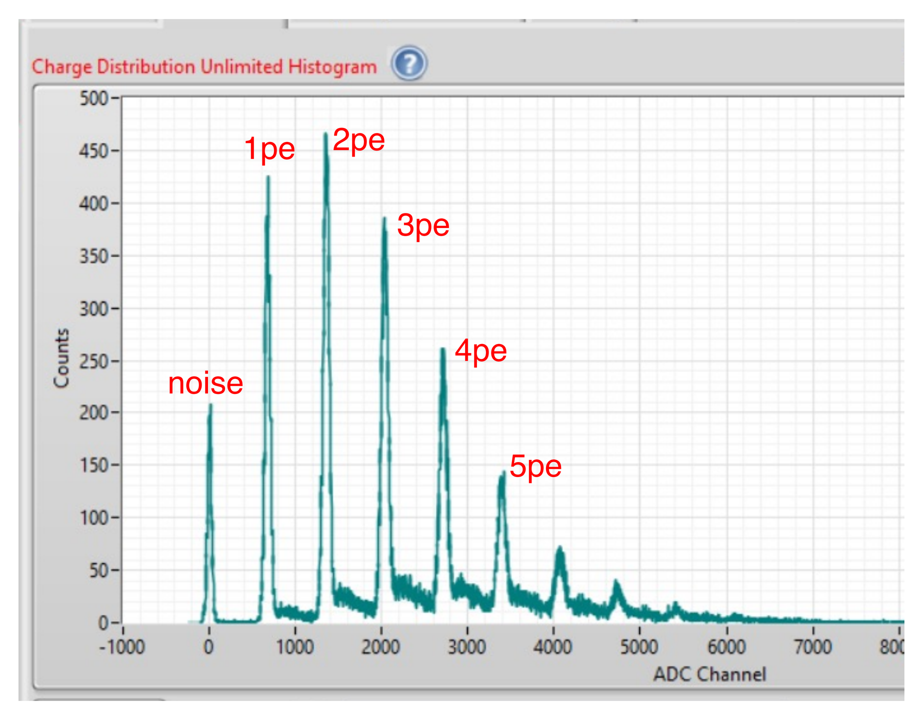
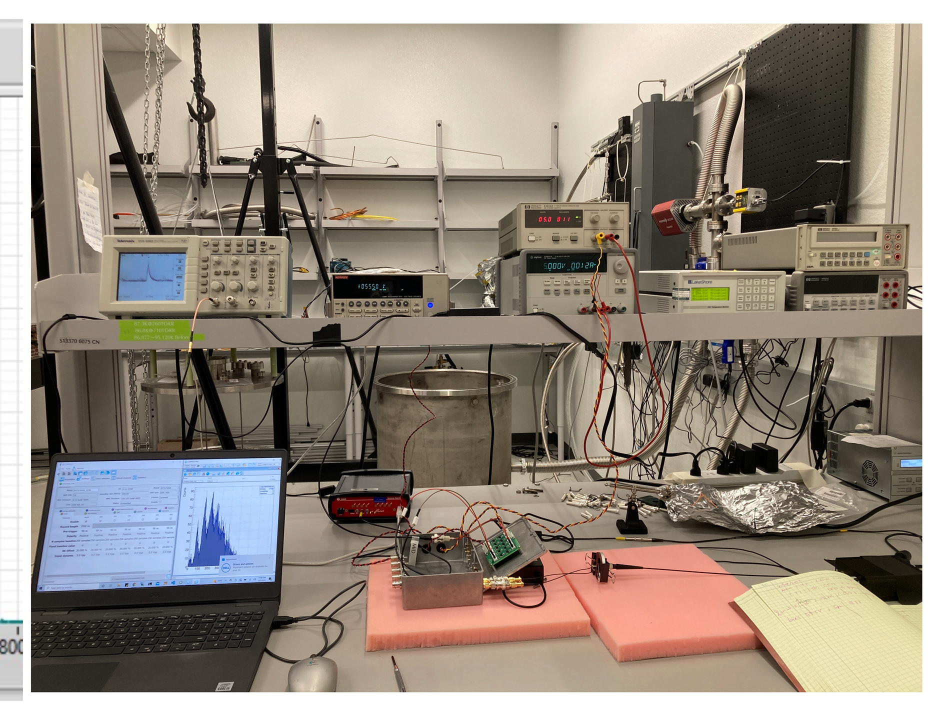


Photo-electron spectrum distribution with low light and HV 52.5V bias



Bench test setup for SiPM Characterization

Conclusion and outlook

1. Upgrade of LAr test stand setup is about to be finished.
2. Cryostat uses PMT, SiPM, led light and Americium gamma source for triggering and calibration.
3. Develop a time development of light yield with for amount of Xe doping.
4. Finer doping below 1ppm to extract the quenching rate and absolute light yield per deposition.

References:

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Supported by DOE,NSF via LANL/LDRD, UNM, and USD