Development of a controlled VUV light source

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nEXO

Introduction

- We are developing a light source to produce and characterize xenon electroluminescent light for the testing and characterization of SiPMs that will be used in the nEXO detector[1].
- The aim is to use an externally controlled UV light source to produce 172nm photons in gaseous Xe.
- The wavelength of this light is the same as that produced by events inside the nEXO TPC, allowing for SiPMs to be tested with realistic signals.

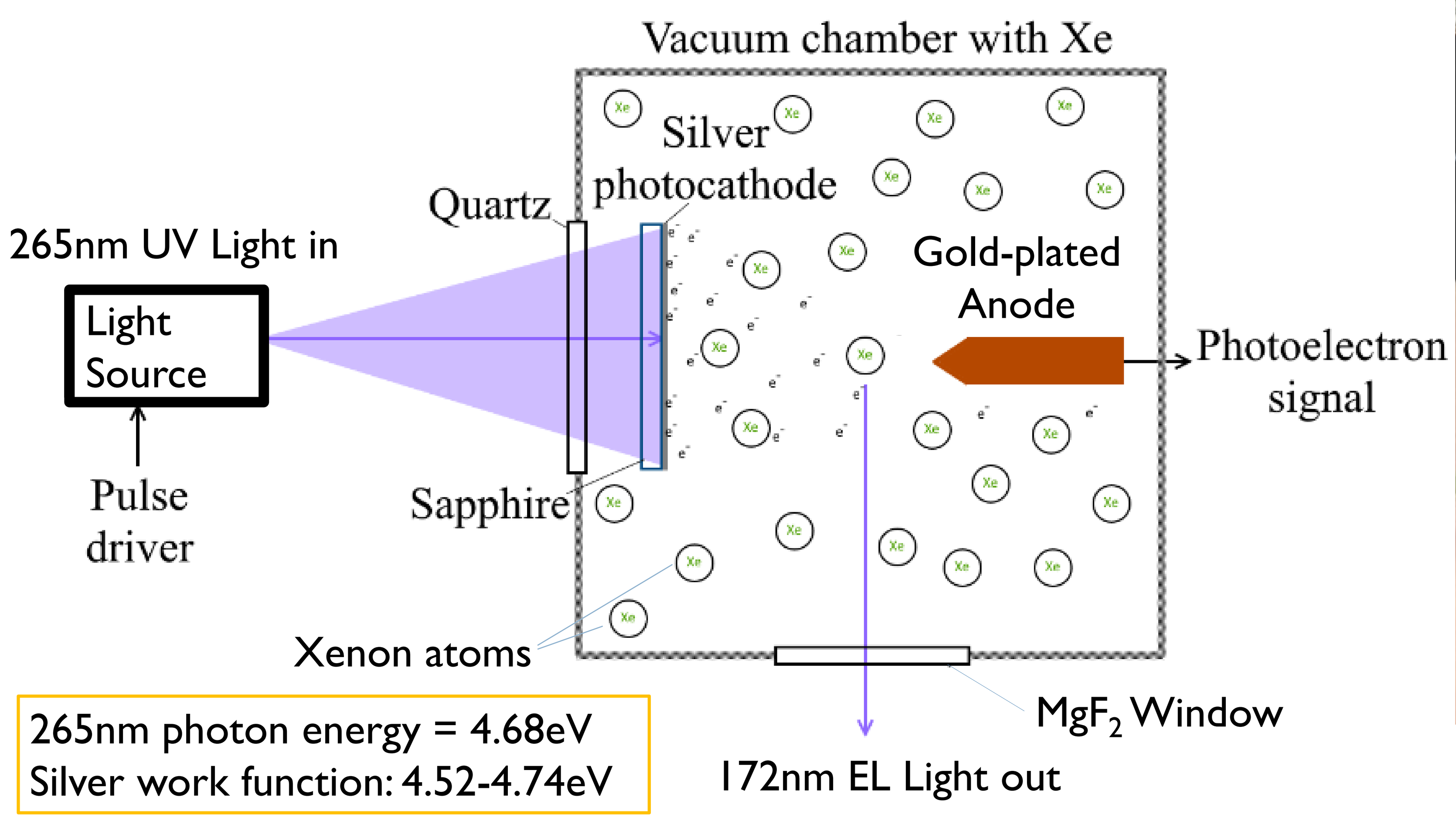

Figure 1. Schematic diagram and working principle of the ELS[2].

Operating Principle

1. UV light source sends a 265nm light pulse to a Sapphire window plated with a ~20nm thick silver coating[3].
2. Photoelectrons get ejected from the silver plating and enter the gaseous Xe.
3. Potential applied to the gold-plated anode creates an electric field which accelerates electrons through the gas volume.
4. Inelastic collisions produce excited xenon dimers which emit 172nm photons upon relaxation[4].
5. Electroluminescent light exits through a Magnesium Fluoride viewport (~85% transmission at 172nm)[5].
6. 172nm light output collected by a PMT or SiPM, drifting electron signal collected at anode gives charge readout.

Experimental Setup

- The ELS chamber is made using a 2.75" CF spherical cube with viewports mounted on it's sides.
- It features an SHV connection on the back connected to a high voltage pin inside the chamber, allowing kV range potentials to be applied to the anode needle.
- A regulator allows the gas pressure inside the chamber to be controlled once Xe filling begins.

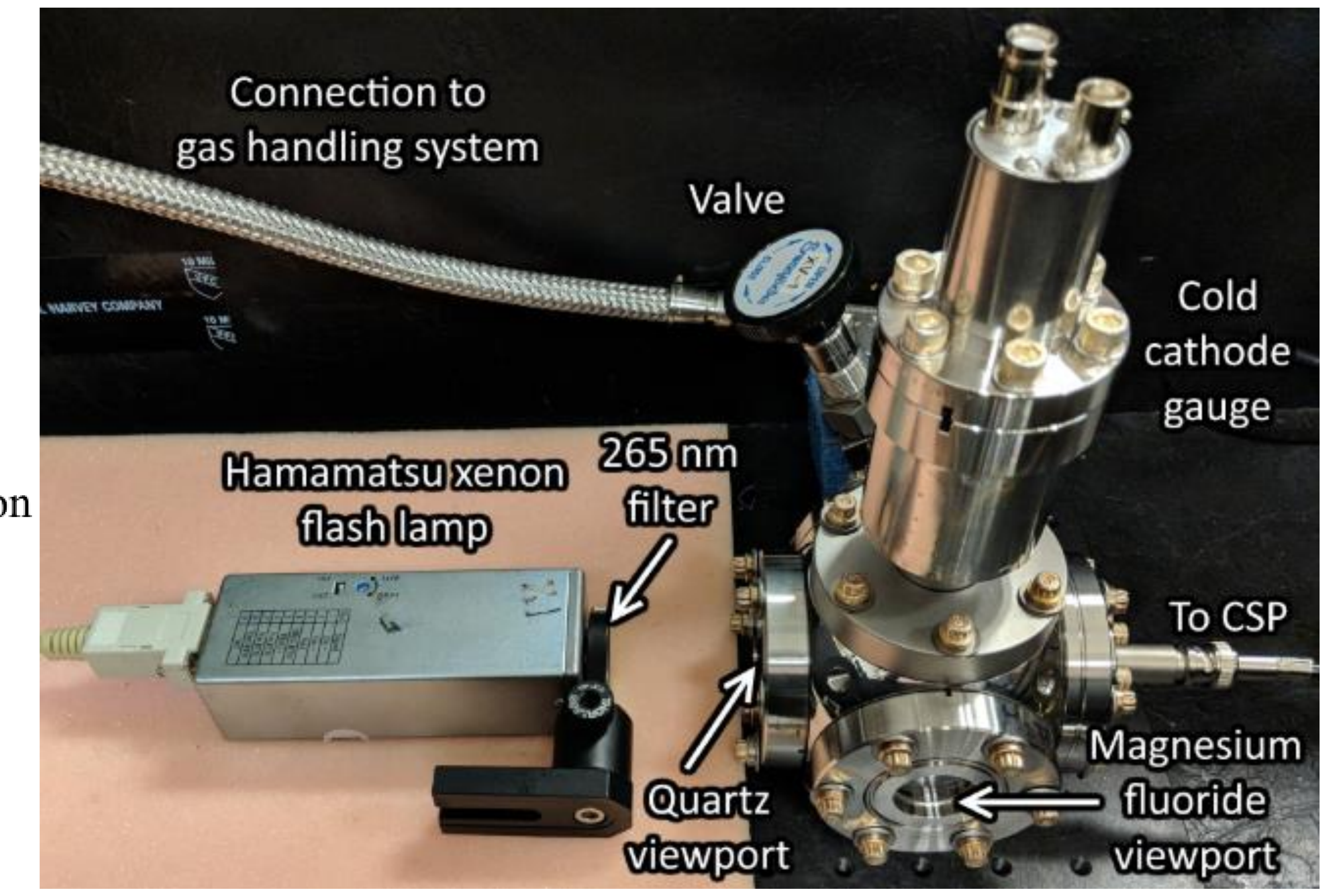

Figure 2. ELS Vacuum chamber on bottom right, a Xenon flash lamp and a 265nm broadband filter (12nm FWHM) used to limit photon energies close to Ag's work function[2].

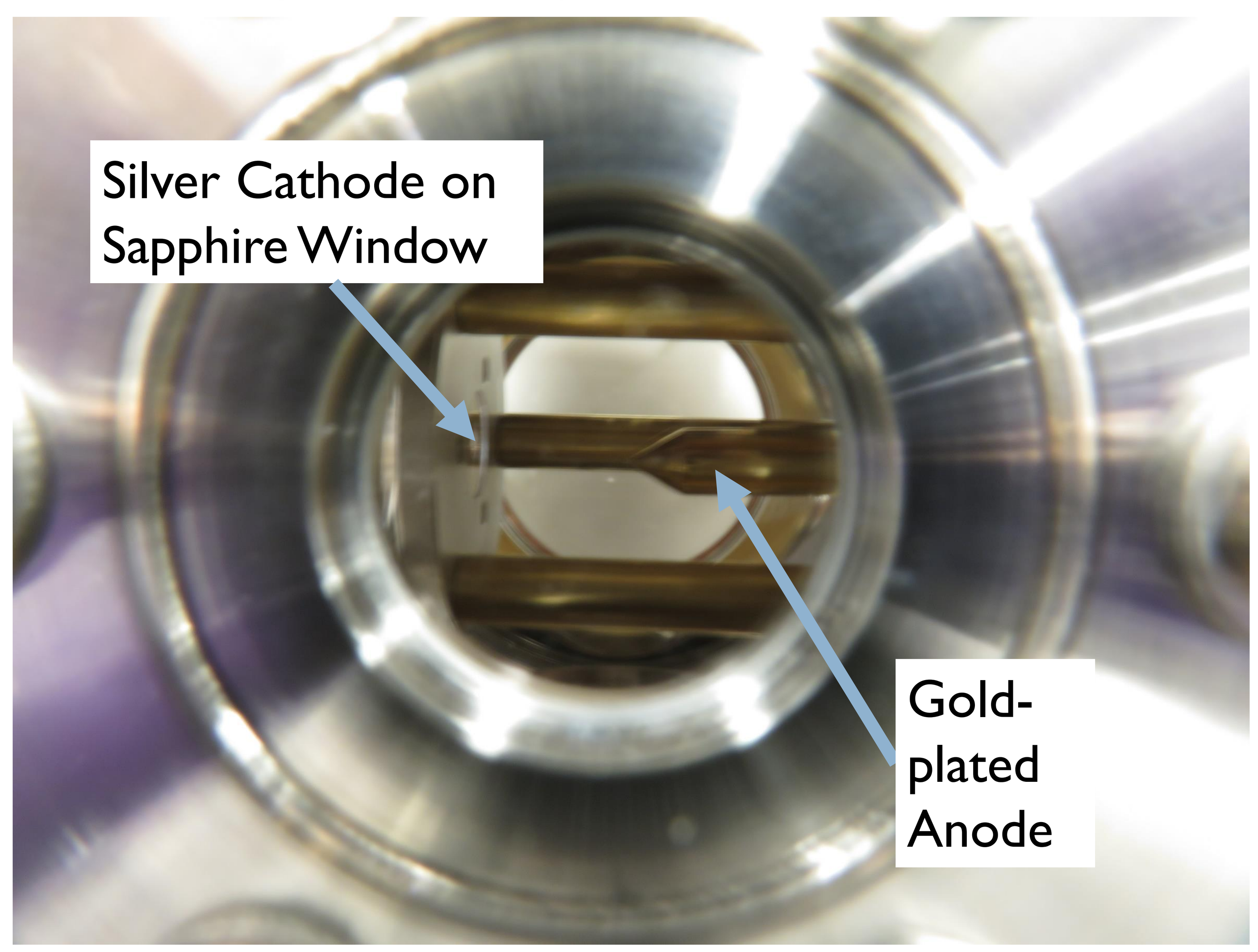

Figure 3. Photocathode and Anode needle inside the vacuum chamber. They are attached to one single flange which allows easy component swapping.

Charge Collection Measurements

- Pulsed a Hamamatsu Xenon Flash Lamp (185nm-2000nm emission spectrum) with the chamber at vacuum to verify charge collection.
- Used broadband UV filters centered at 265nm to filter out lower wavelengths and visible light that might produce photoelectrons from materials other than the silver.

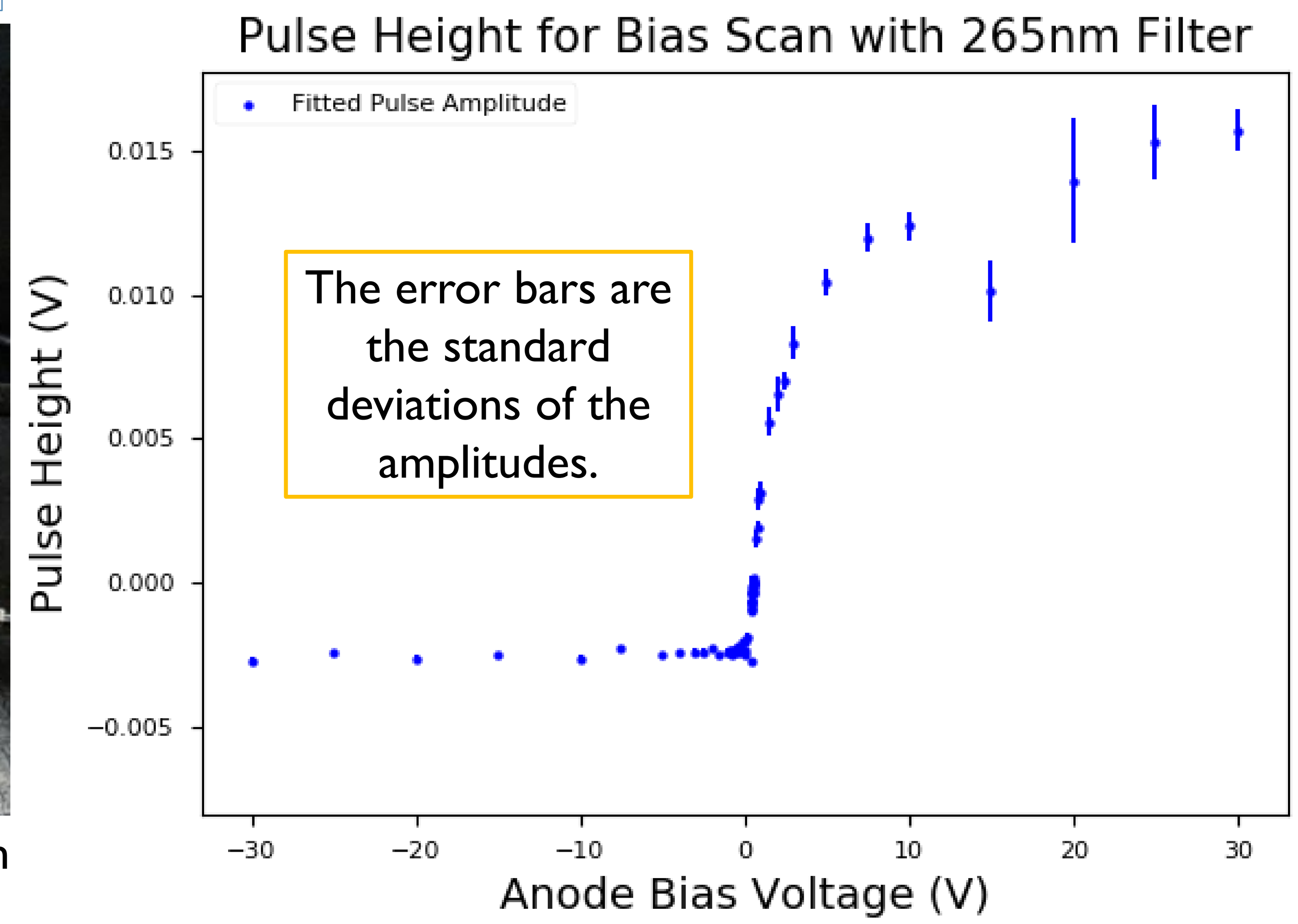

Figure 4. Averaged pulse heights for 200 charge collection measurements per bias. As the potential becomes positive more and more electrons are collected at the anode.

Future Steps

- We will fill the chamber with 2-3bar of Xe and measure electroluminescent light pulses.
- The various parameters of these electroluminescent light pulses can be characterized as functions of:
  - The anode geometry and distance from the photocathode.
  - The potential applied to the anode.
  - The material used to coat the Sapphire window.
  - The wavelength and pulse energy of the external UV light source.

References

1. https://arxiv.org/abs/1805.11142
2. S. Al-Kharusi & T. Nguyen Development of an electroluminescent light source for nEXO
3. O. Chammaa & C. Morison Design and Development of a Xenon Gas Electroluminescent Light Source for nEXO
4. https://arxiv.org/abs/physics/0702142
5. https://www.esourceoptics.com/vuv_material_properties.html

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