

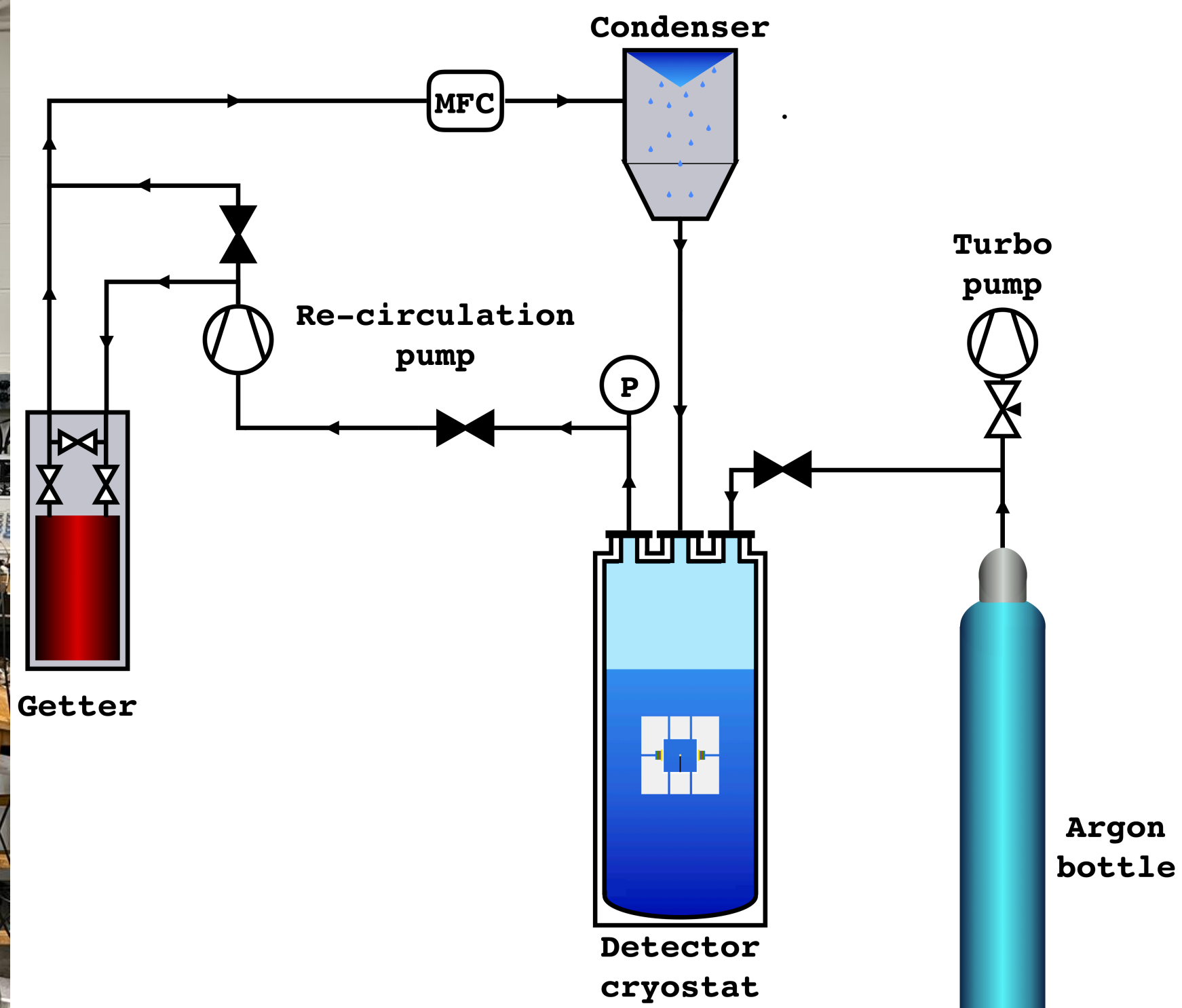
LEAR and R&D activities

Claudio Savarese
Princeton University



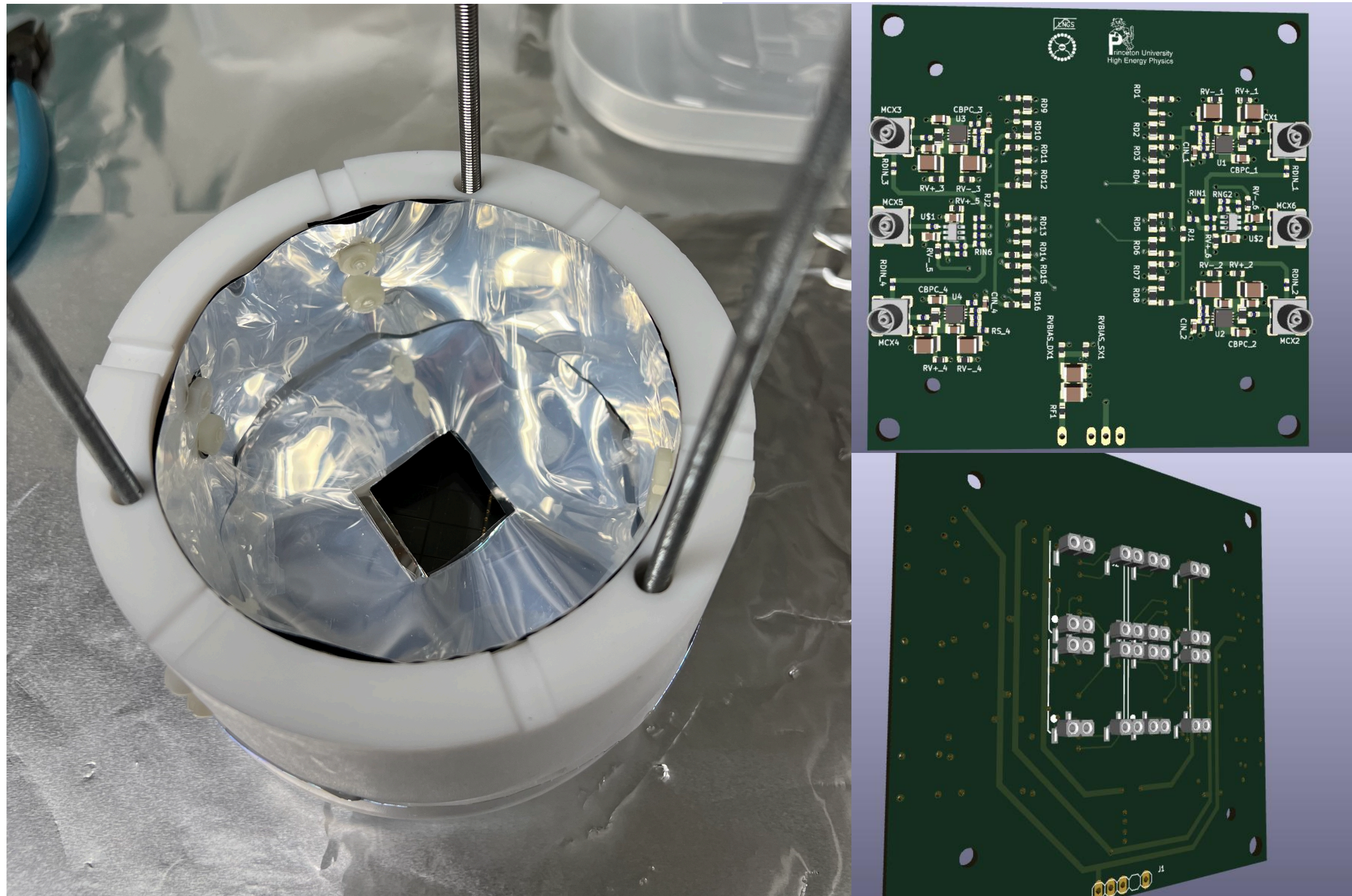
*X-ART kickoff meeting
April 5th 2023*

LAr cryogenic system



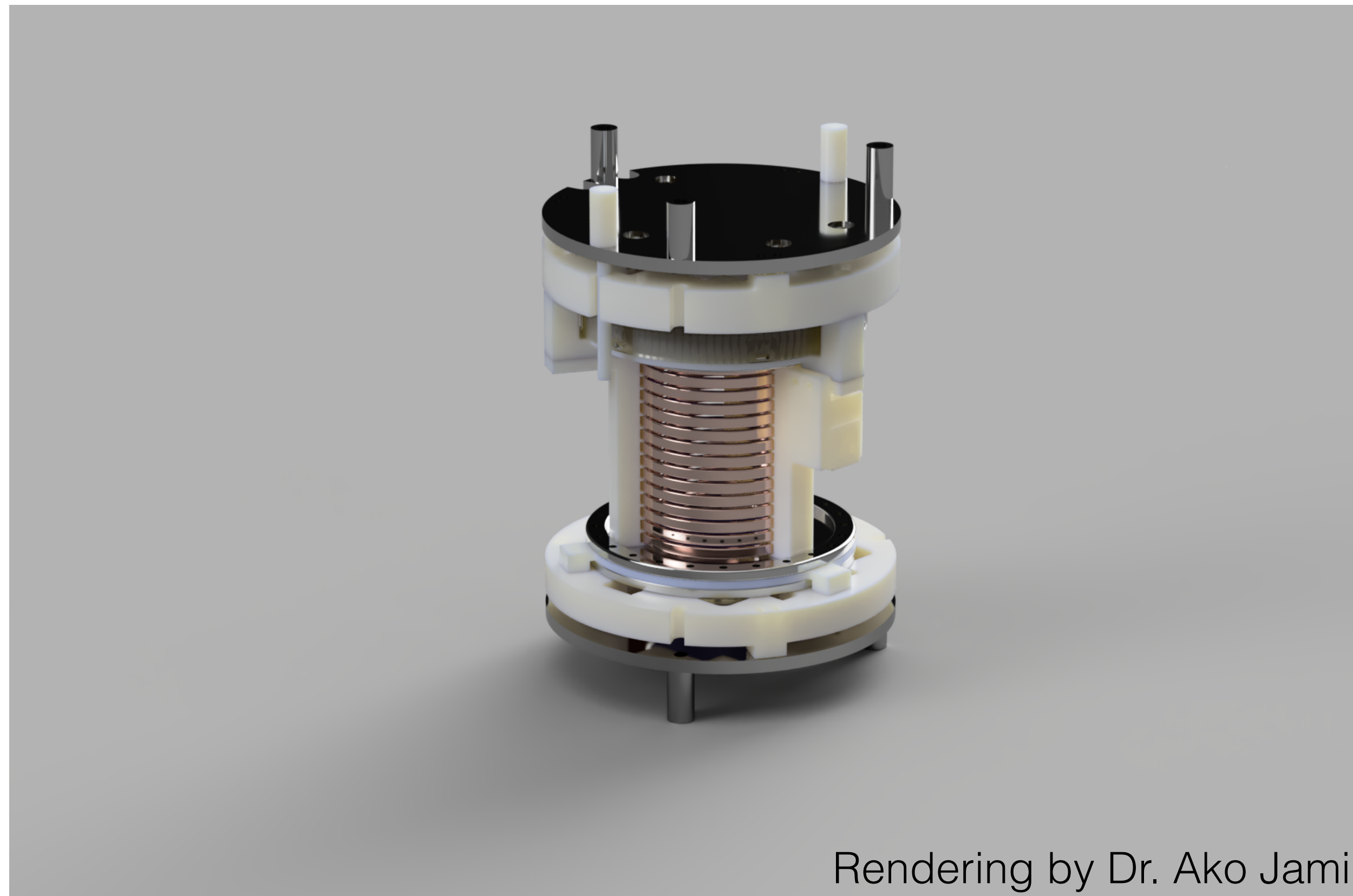
- Current system:
 - Condenser (PT90 driven)
 - SAES Getter
 - Recirculation pump
- No need for LN, but requires chilled water for the PT90.
- Not shown: Xe bottle + buffer volume for low concentration LArXe mixtures (up to a few hundreds of ppm)

Single Phase detector



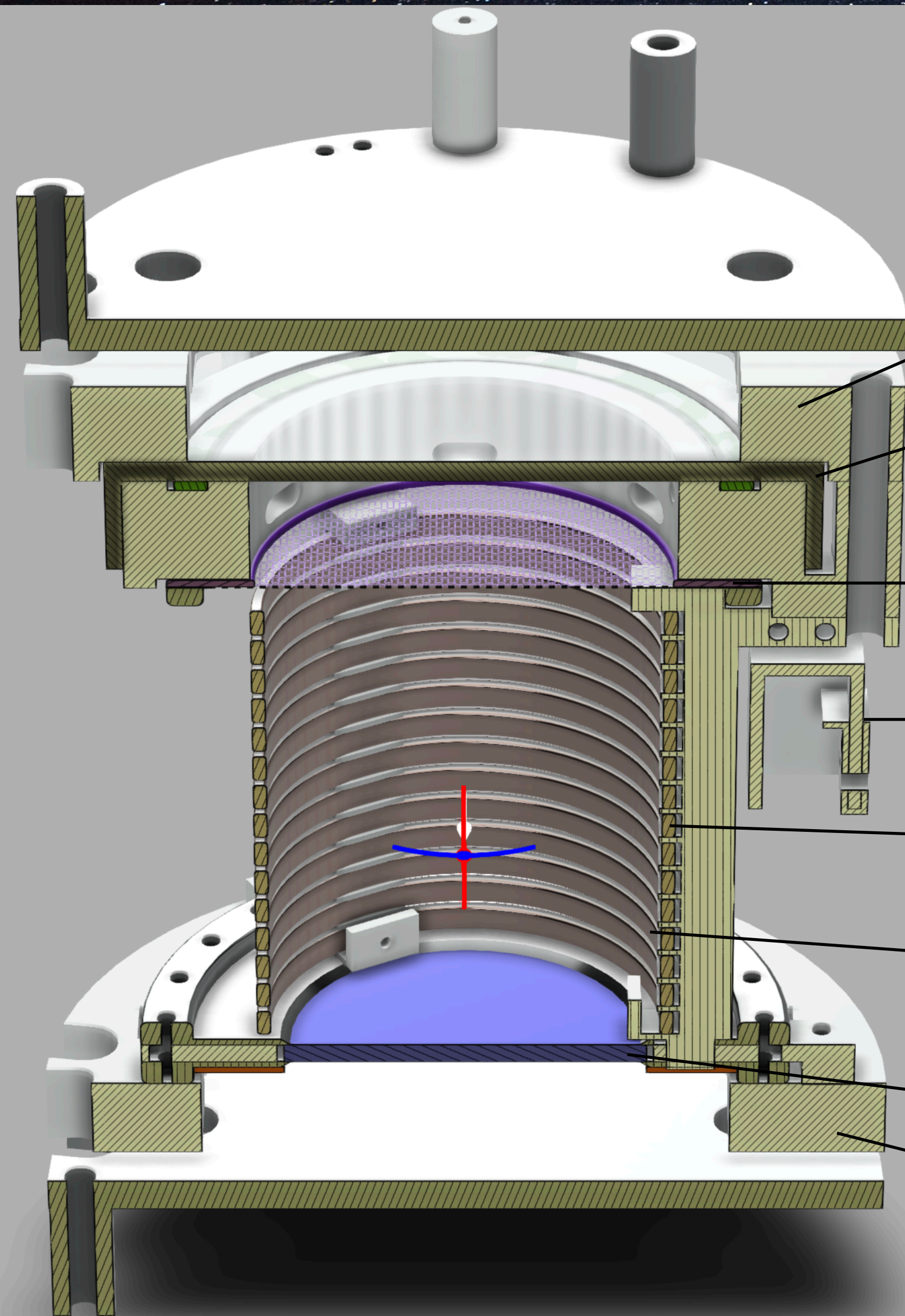
- Currently used for relative measurement of **reflectivity** of 3M foil vs Tyvek for DS-20k outer veto
- PTFE body with 2 independent chambers
- Readout by 2 “DS-20k” SiPM tiles
- New FEBs for 16 Hamamatsu SiPMs designed and ordered. First tests within ~2weeks (L. Tabirian - PU)

LEAR TPC



- **Low Energy Argon Response (LEAR)**
- Multi-purpose instrument for R&D studies
- Drift region design specs:
 - Volume: $\text{Ø} \times \text{H}$: 5cm \times 8cm
 - Active mass: ~850g
 - Drift field: 200V/cm
- Gas pocket design specs:
 - Thickness: 1cm
 - Extraction field: 2.8kV/cm
 - Electroluminescence field: 4.2kV/cm
 - Radial uniformity: ~5% (2D simulation)
- HV scheme:
 - (+) Anode, Grounded Grid, (-) Cathode

LEAR TPC



Top SiPM tile holder (PTFE)

Anode + Gas pocket volume: in-house ITO-coated Fused Silica Diving bell (produced). ITO coating recipe undergoing final reproducibility tests before deposition

Extraction Grid (SS hexagonal mesh)

Bubbler (PTFE)

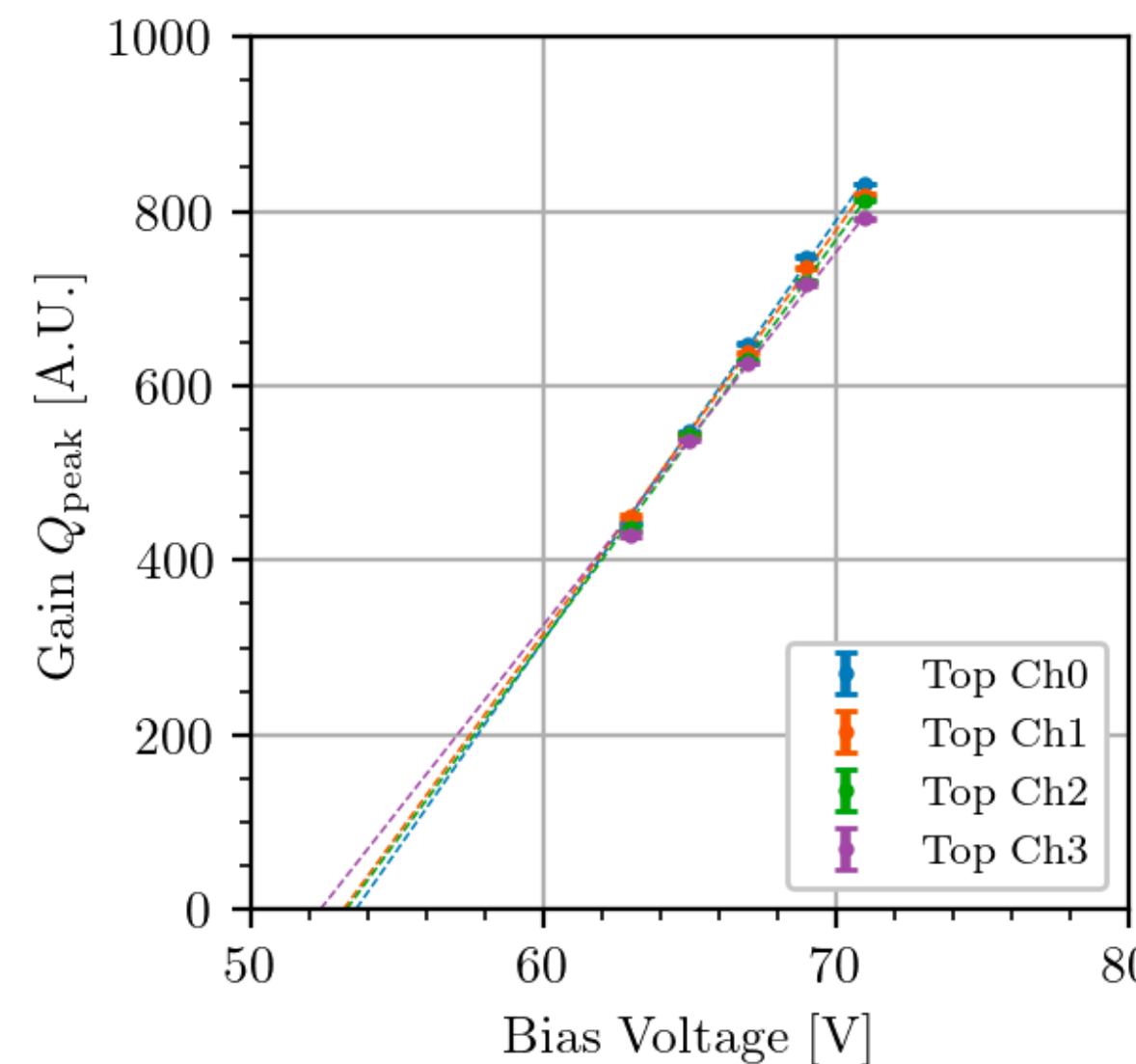
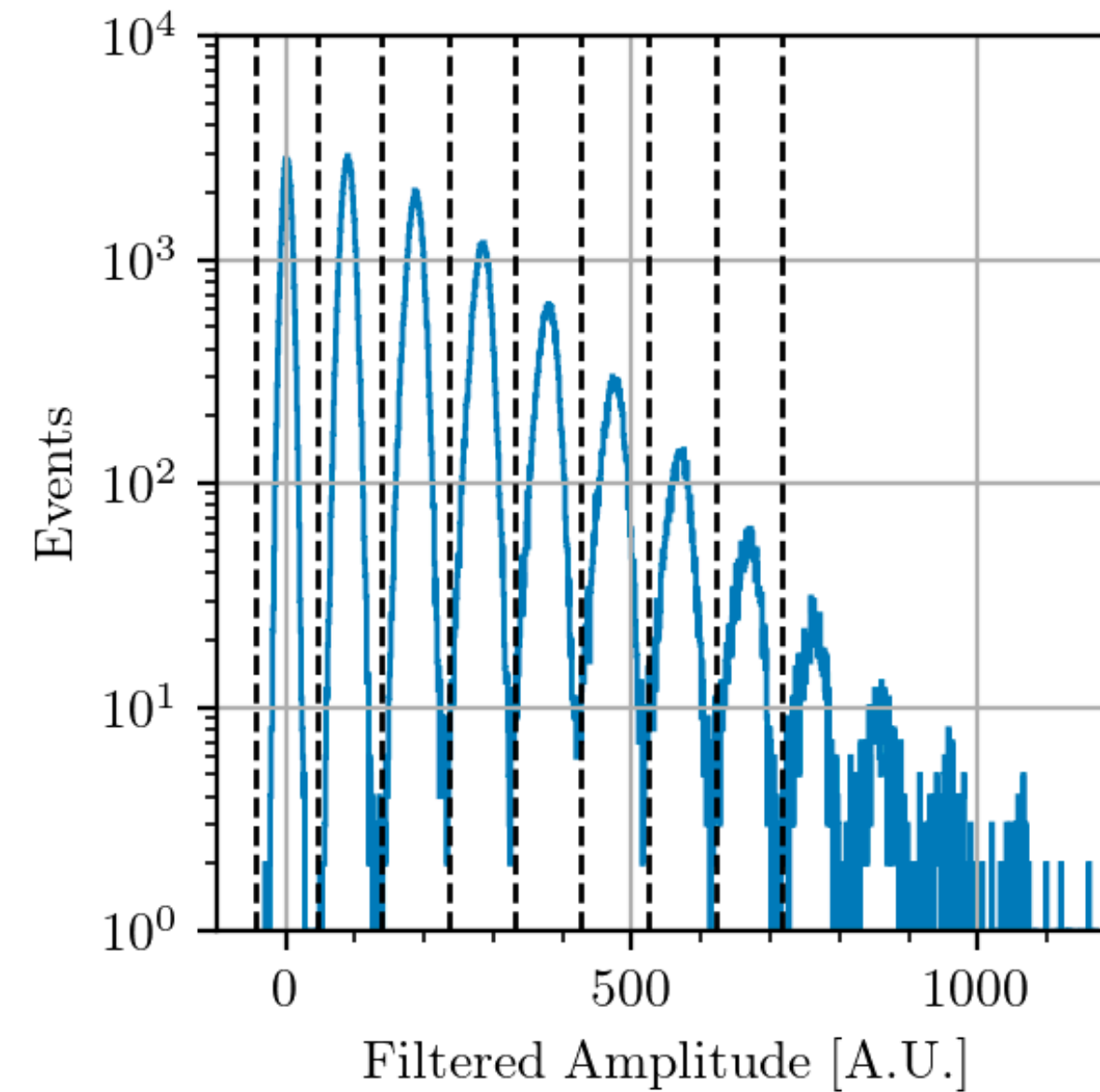
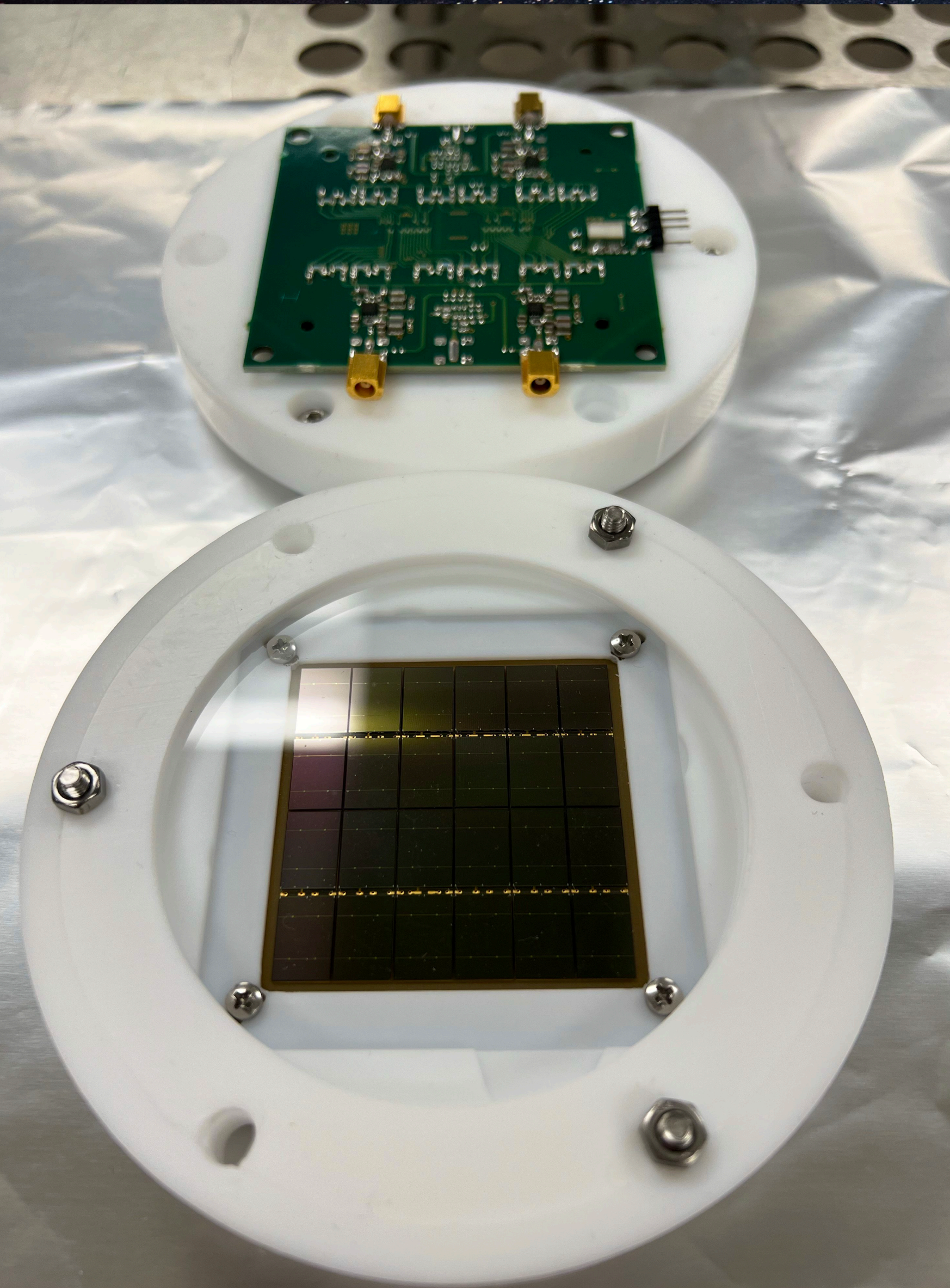
Field cage rings (Copper)

Reflector (3M foil) + wavelength-shifter (TPB)
Evaporator under construction

Cathode (In-house ITO-coated Fused Silica disk)

Bottom SiPM tile holder (PTFE)

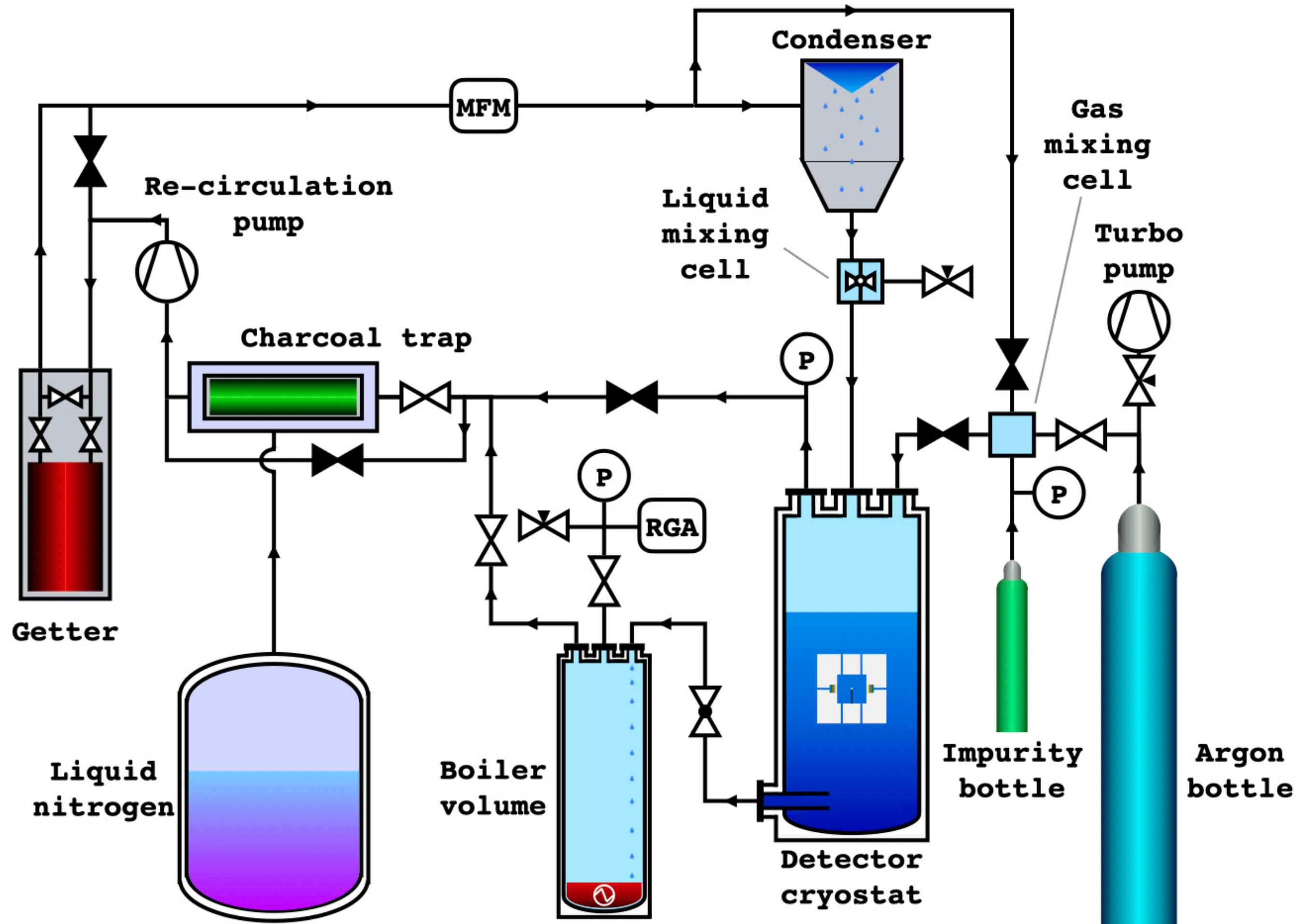
Readout



- 2 SiPM arrays (top and bottom)
- 4 channels/array (6.25 cm²/channel)
- Granularity can be pushed up to 24 channels per array (DAQ limited)
- Channels calibrated using single phase chamber (A. Sung)
- ADC: CAEN V1720 (2V_{pp} 250MS/s)
- Data storage: local lab machine (temporary) and on PU DELLA cluster

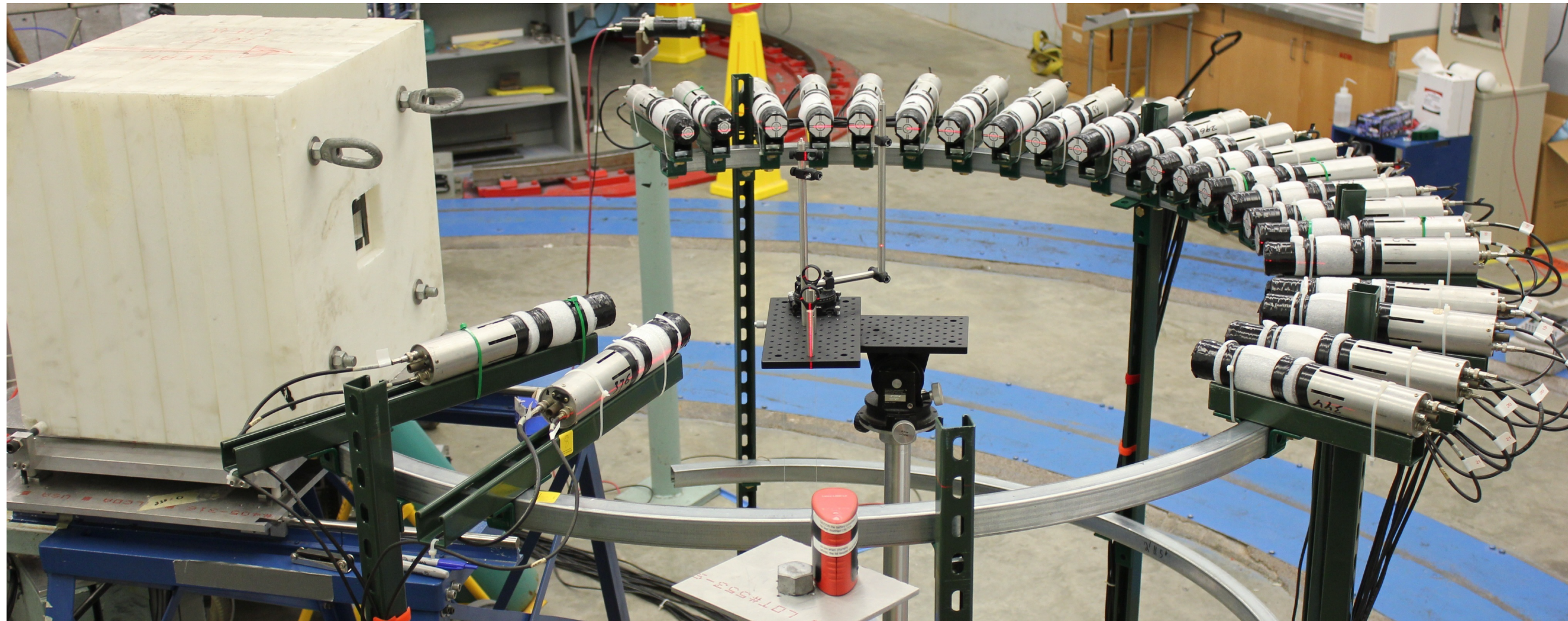
Spurious Electrons

PI&D from NSF proposal on SE

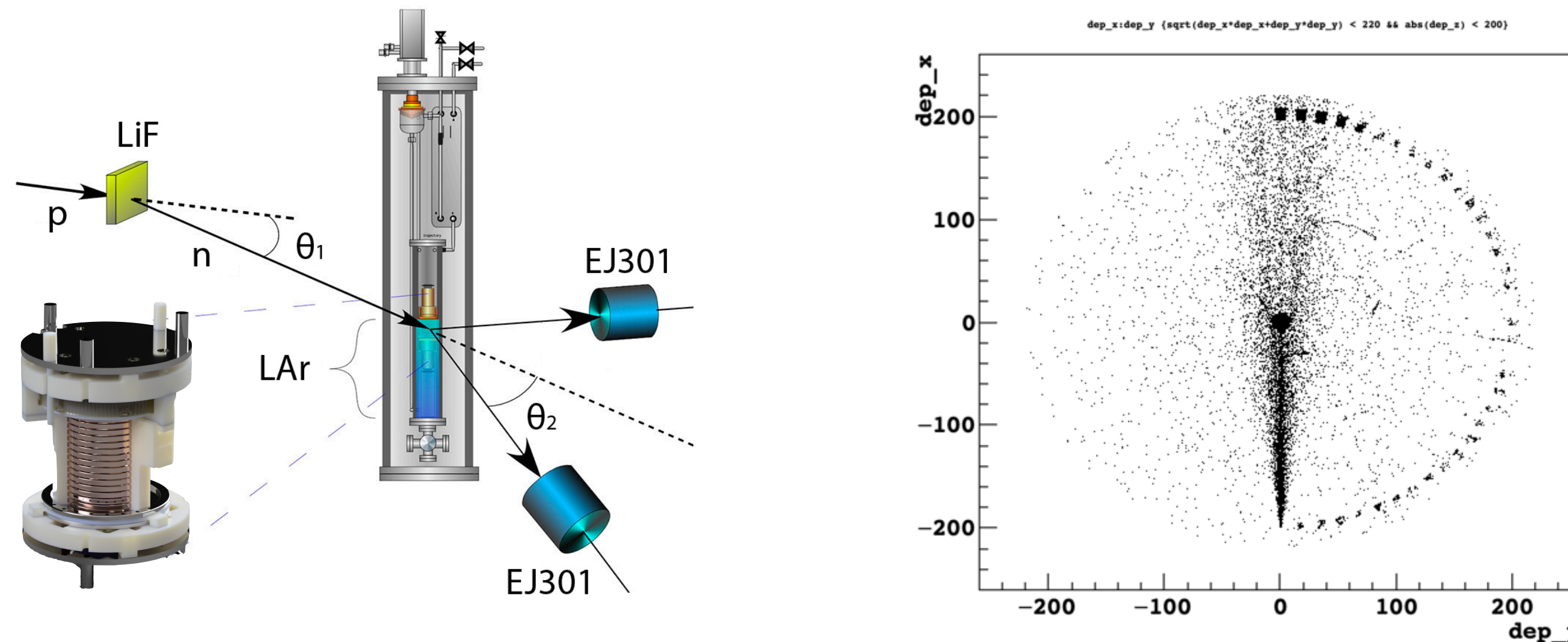


- Idea: “pollute” LAr in a controlled manner and study the SEs events
 - Develop reliable loading techniques
- Stimulate the production of SEs with localized high energy deposits (i.e. α decays, perhaps source dissolved in LAr)
- Study SEs with different introduced impurities to match observations in DS50
- Develop purification techniques

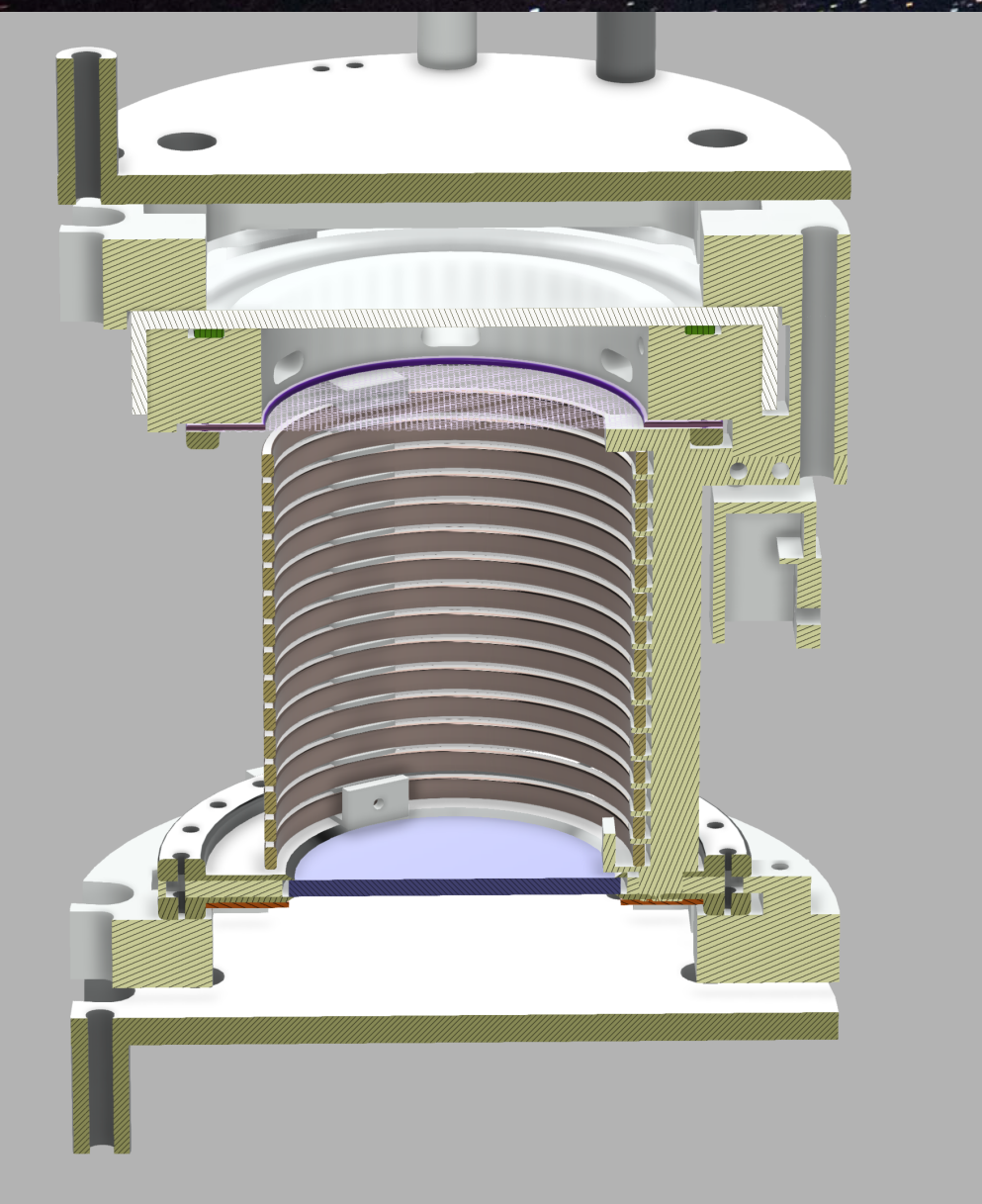
LEAR @ TUNL



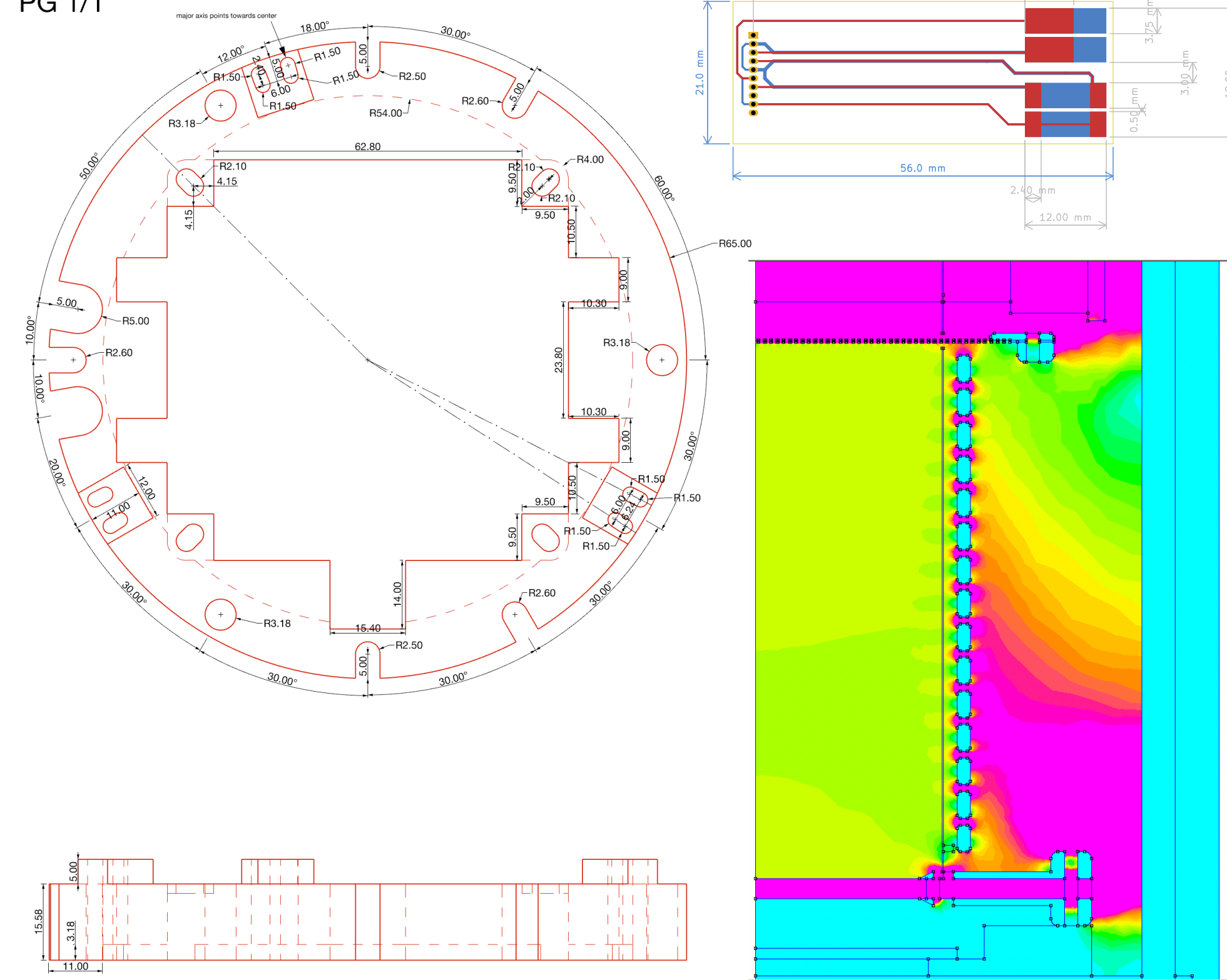
- TUNL facility and support of local team (Prof. Barbeau) with expertise in ionization yield measurements.
- Pulsed neutron beam with array of 30 ND:
 - Closed kinematics - Selection of E_{nr}
 - Pulsed - Timing cuts for bkg suppression
 - Flexible beam energy (down to 50keV) and repetition rate (16ns to $\sim 100\mu s$) for selection of optimal working point
- Aim: measure Q_Y in 0.5-15keV_{nr} range
- MC simulations started



Project Gallery



HOLDER STRUCTURE TOP TILE
PG 1/1

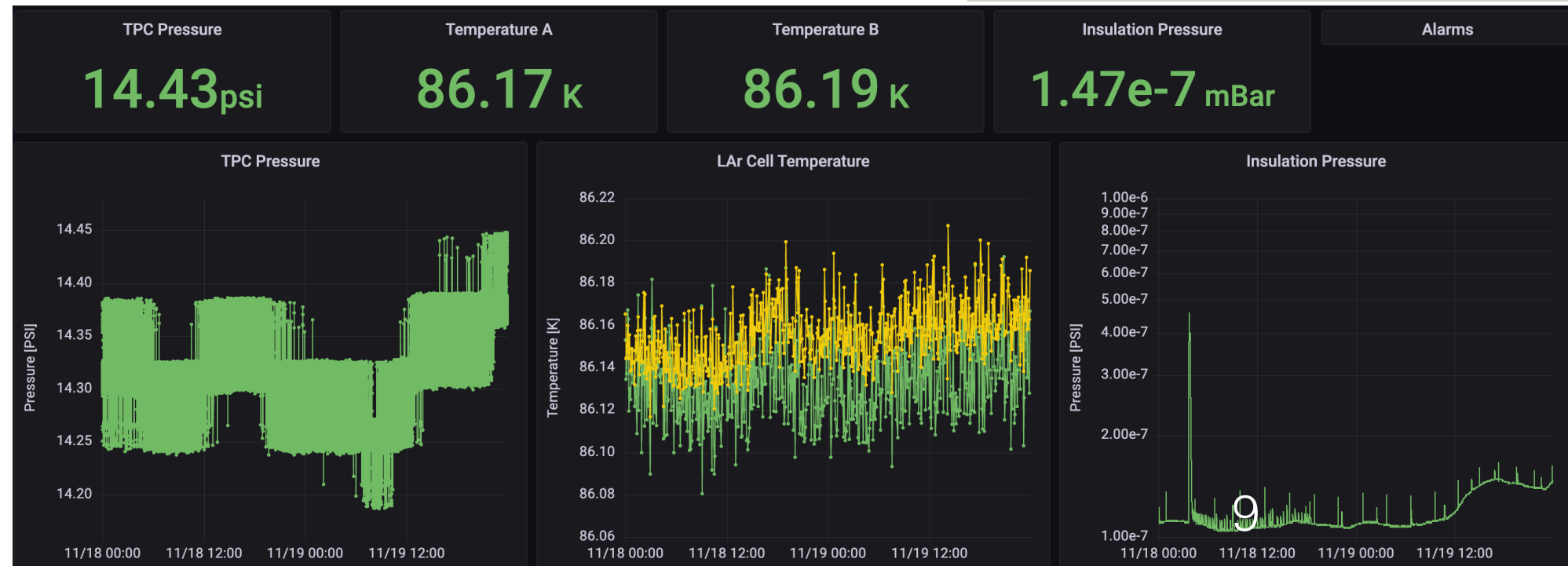
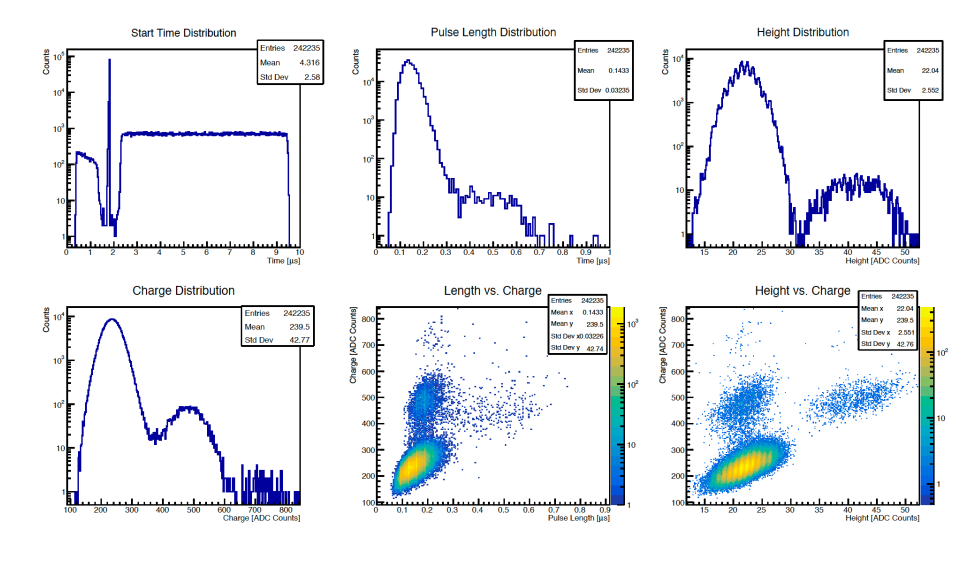
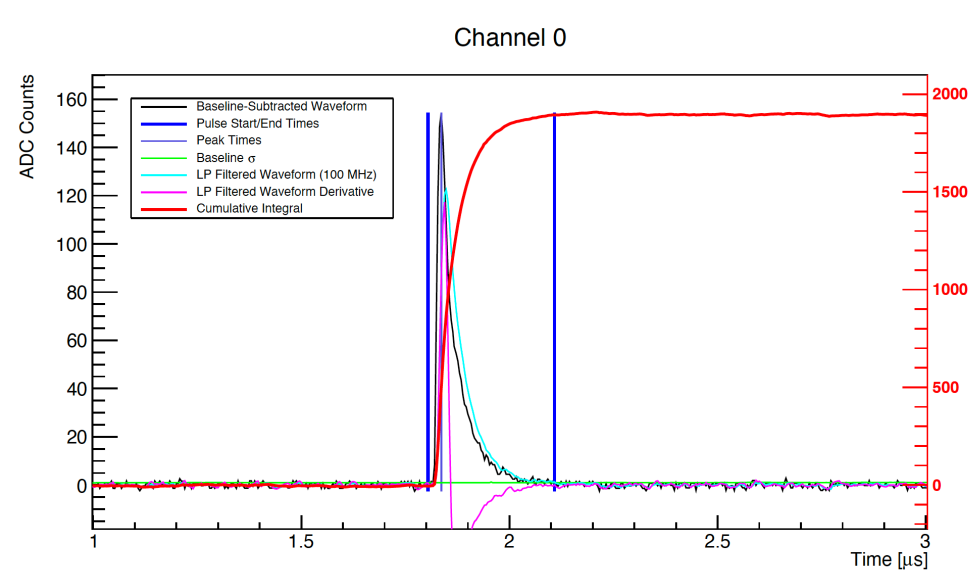


Completed:

- Original design, technical drawings and electric field simulations by [H. Helton \(PU\)](#)
- Reconstruction and Monte Carlo SW by [E. Berzin \(PU\)](#)
- SiPM calibration and noise studies by [A. Sung \(PU\)](#)

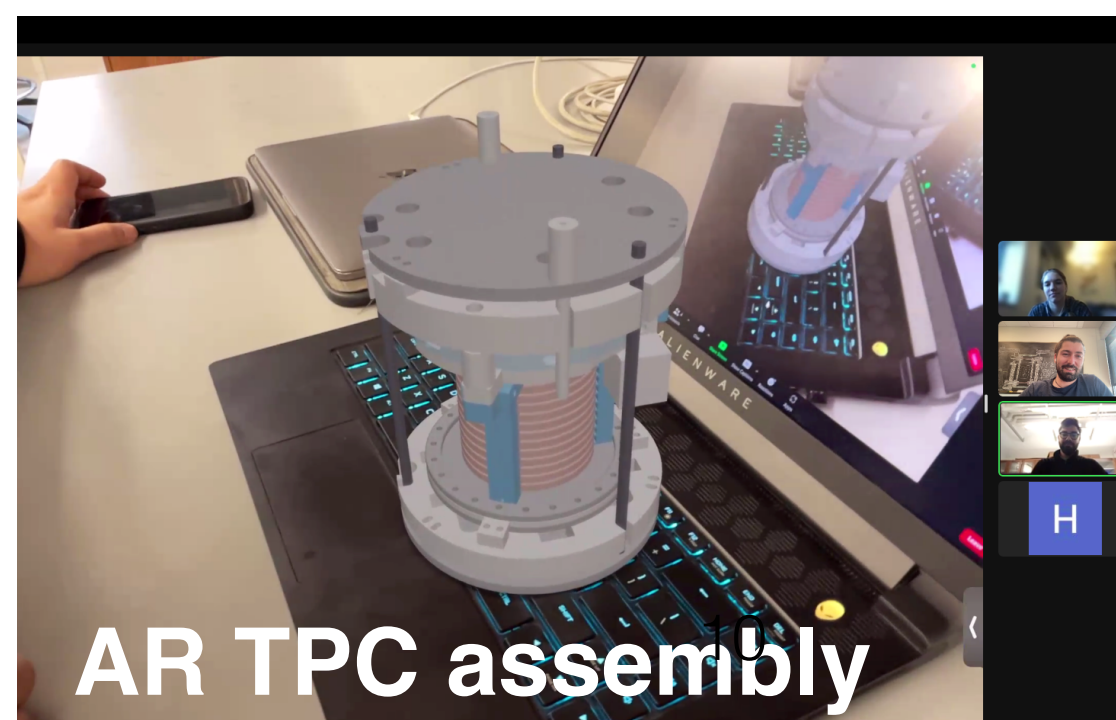
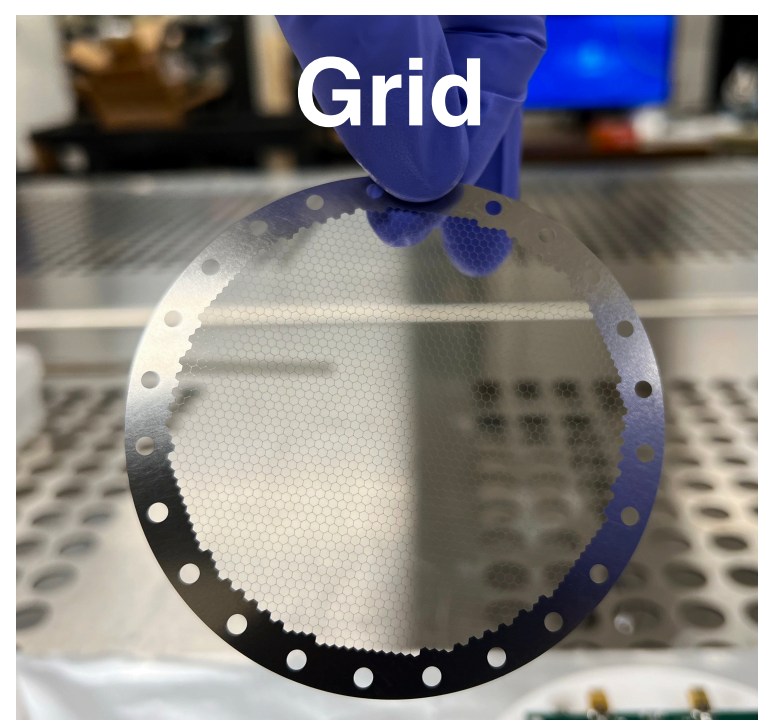
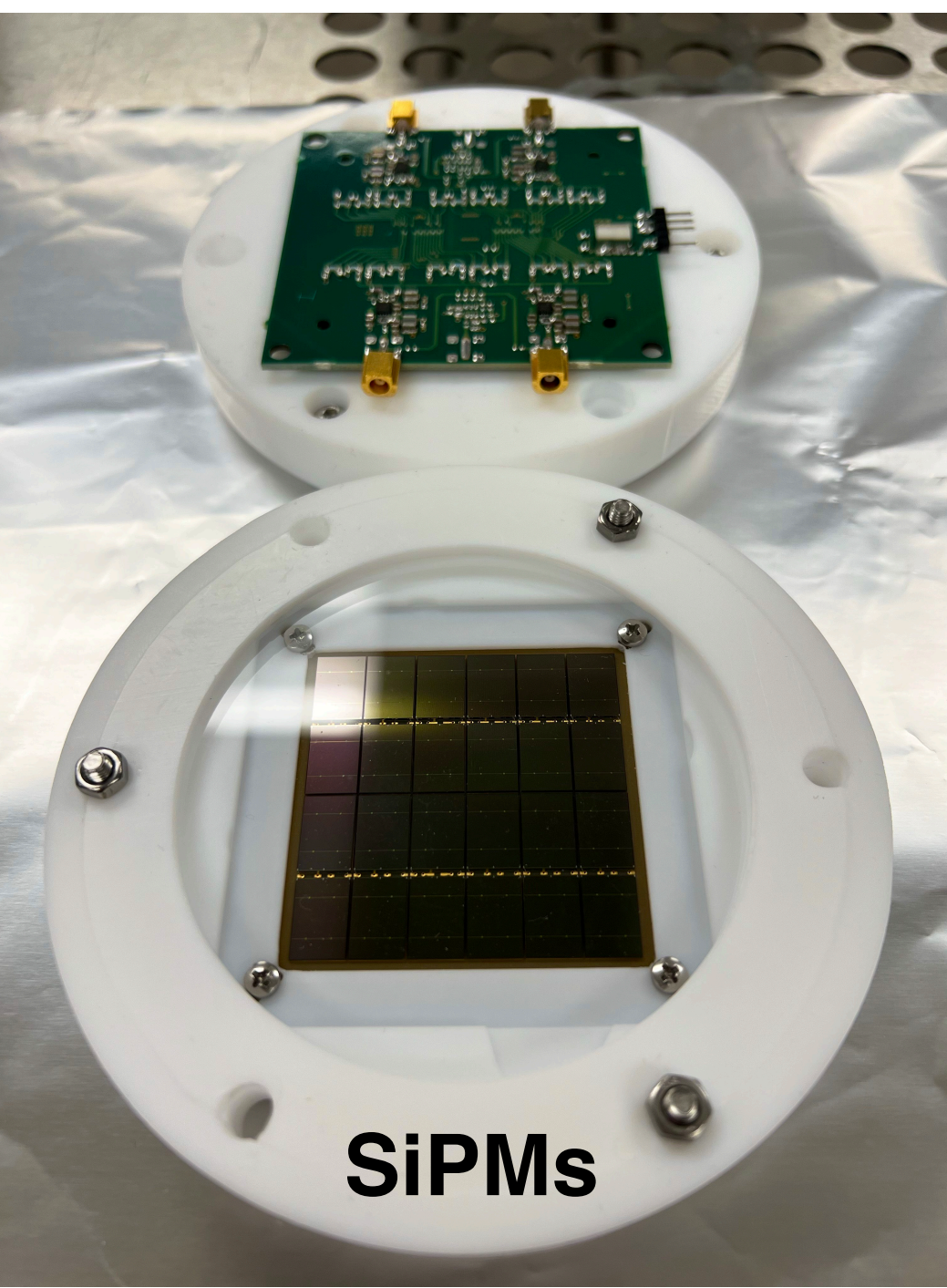
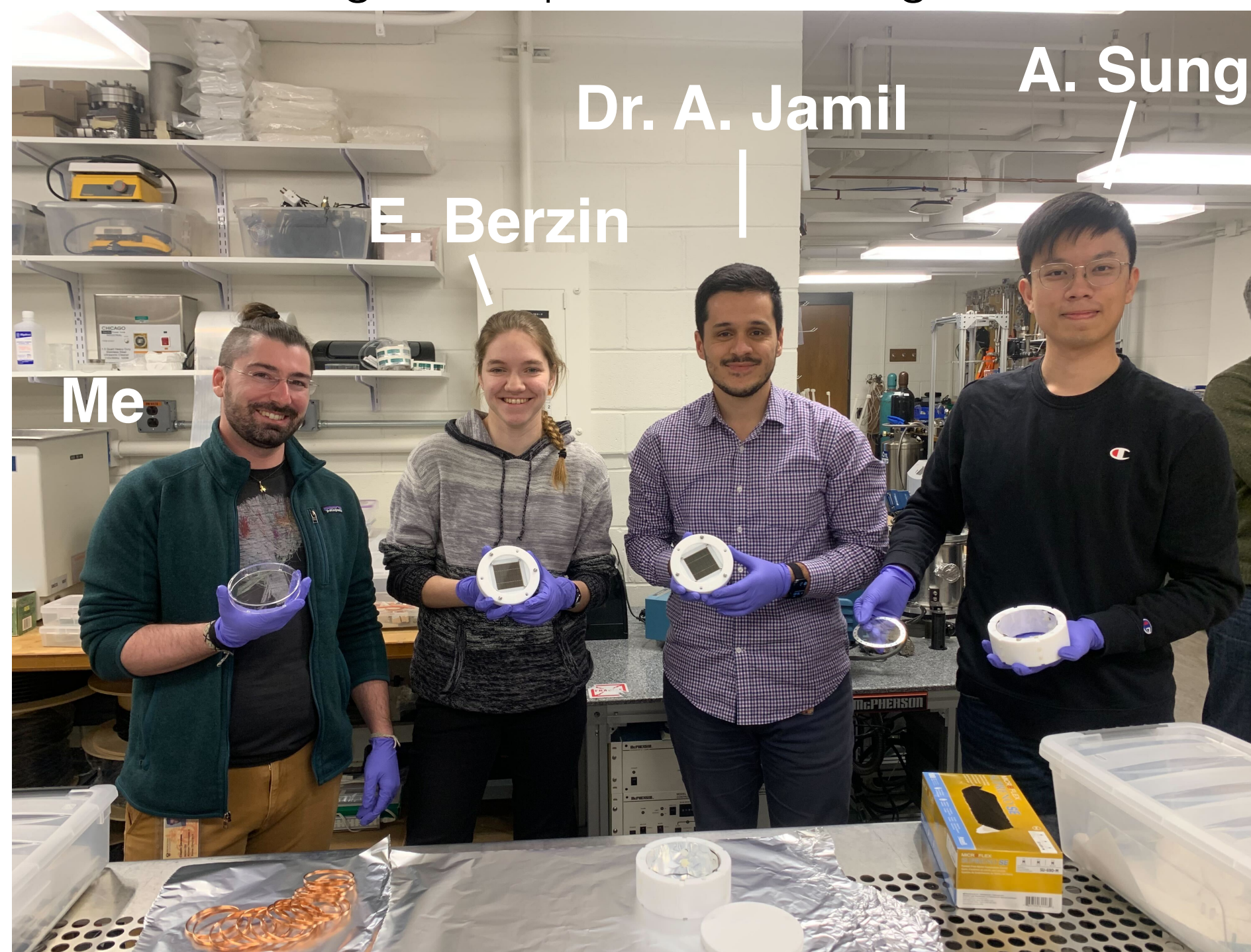
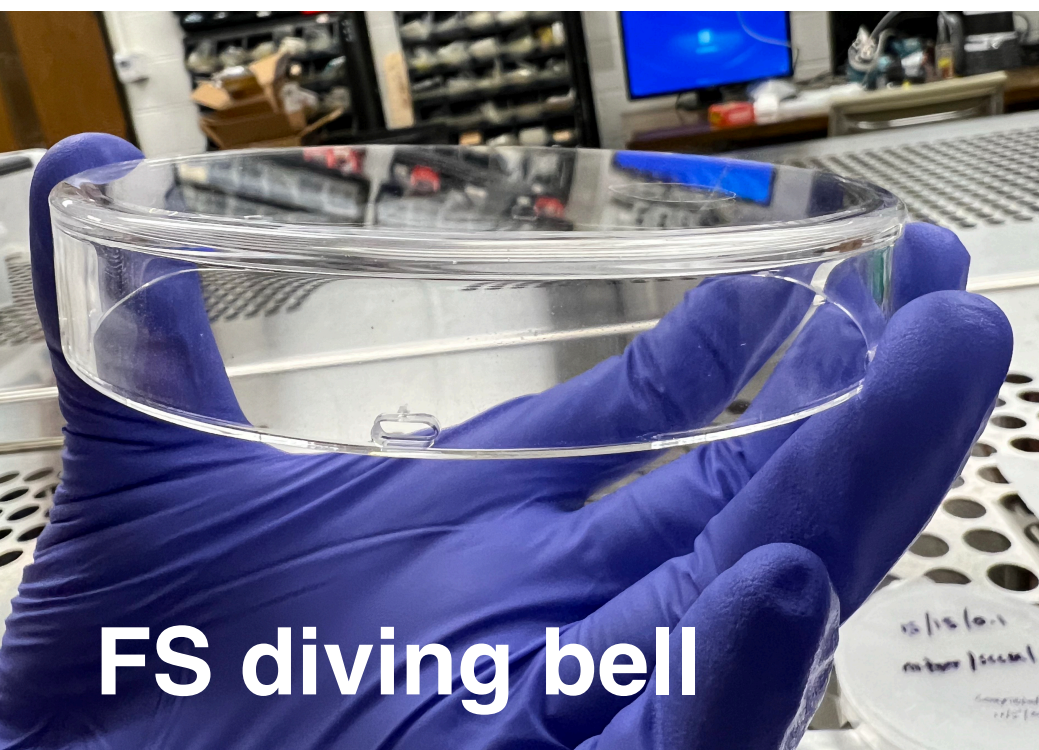
In progress:

- Machining of PTFE and stainless steel mechanical structure by [R. Kazmi \(Williams College\)](#) and [Hoang Nguyễn Le \(Williams College\)](#)
- HV system preparation and testing by [E. Berzin \(PU\)](#)
- Anode and Cathode ITO deposition by [J. Sledge \(PU\)](#)
- Level sensor design and testing by [E. Berzin \(PU\)](#)
- TPB evaporator construction by [A. Redante \(PU\)](#)
- Cryogenic system slow control by [A. Jamil, A. Sung \(PU\)](#)



Project Gallery

Missing in this picture: J. Sledge, A. Redante



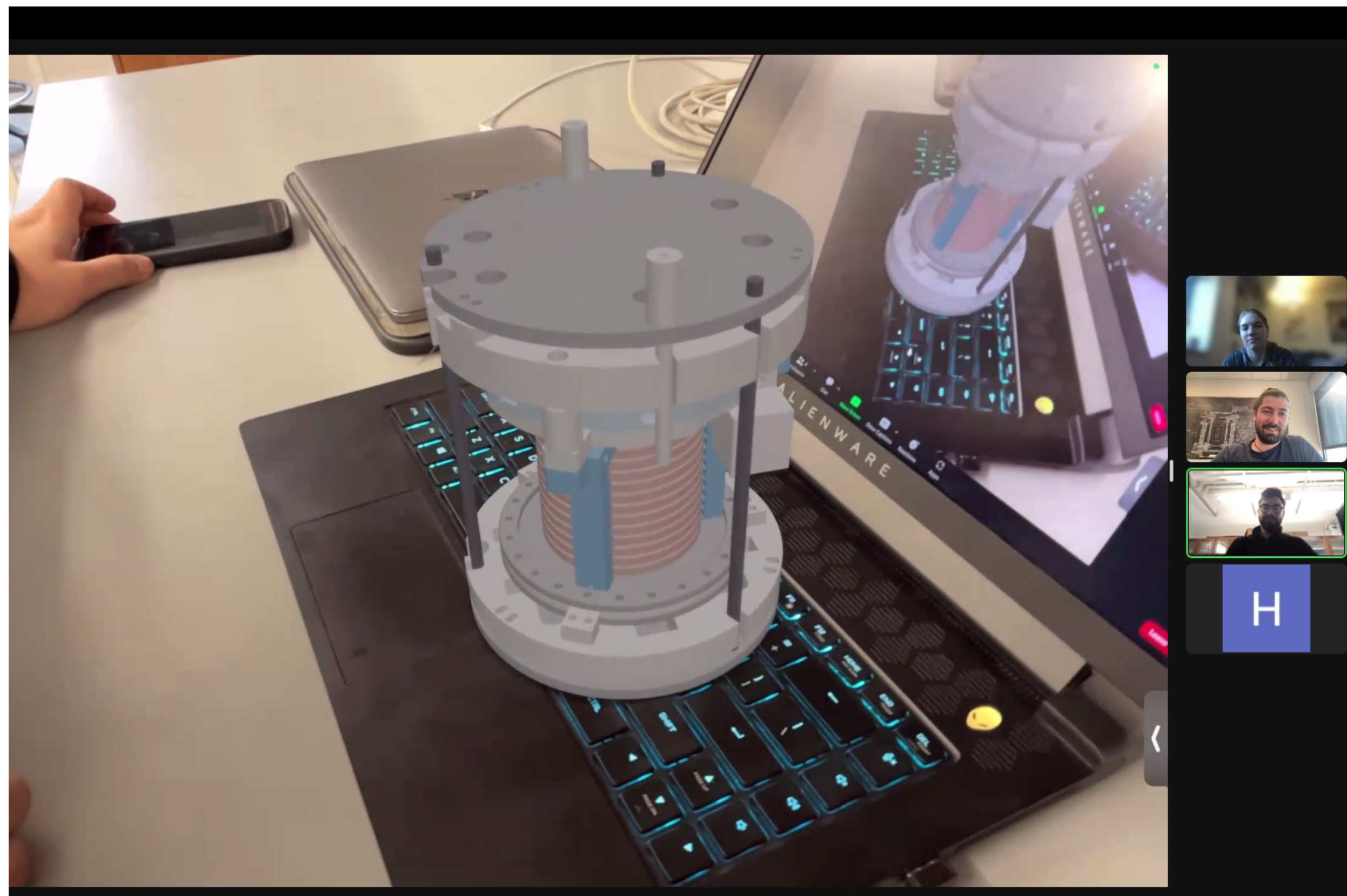
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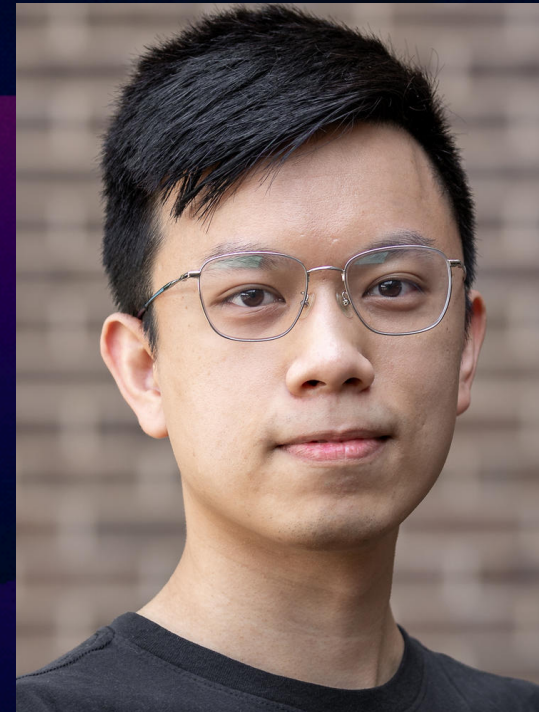
Princeton University

Dr. Ako Jamil



Dicke Fellow

Allan Sung



Ph.D. Thesis

Elizabeth Berzin



Senior Thesis
Junior Paper
Summer Research

Jae Sledge



Senior Thesis

Hanako Helton



Summer Research

James B. Hall



Senior Thesis

Gab Montefalcone



Junior Paper

Williams College, UC Riverside, AstroCENT

Graham Giovanetti



PI at Williams

Rafay Kazmi



Senior Thesis

Hoang Nguyễn Le



UG Research

Shawn Westerdale



PI at UCR

Masayuki Wada



PI at AstroCENT

Masato Kimura



Postdoc