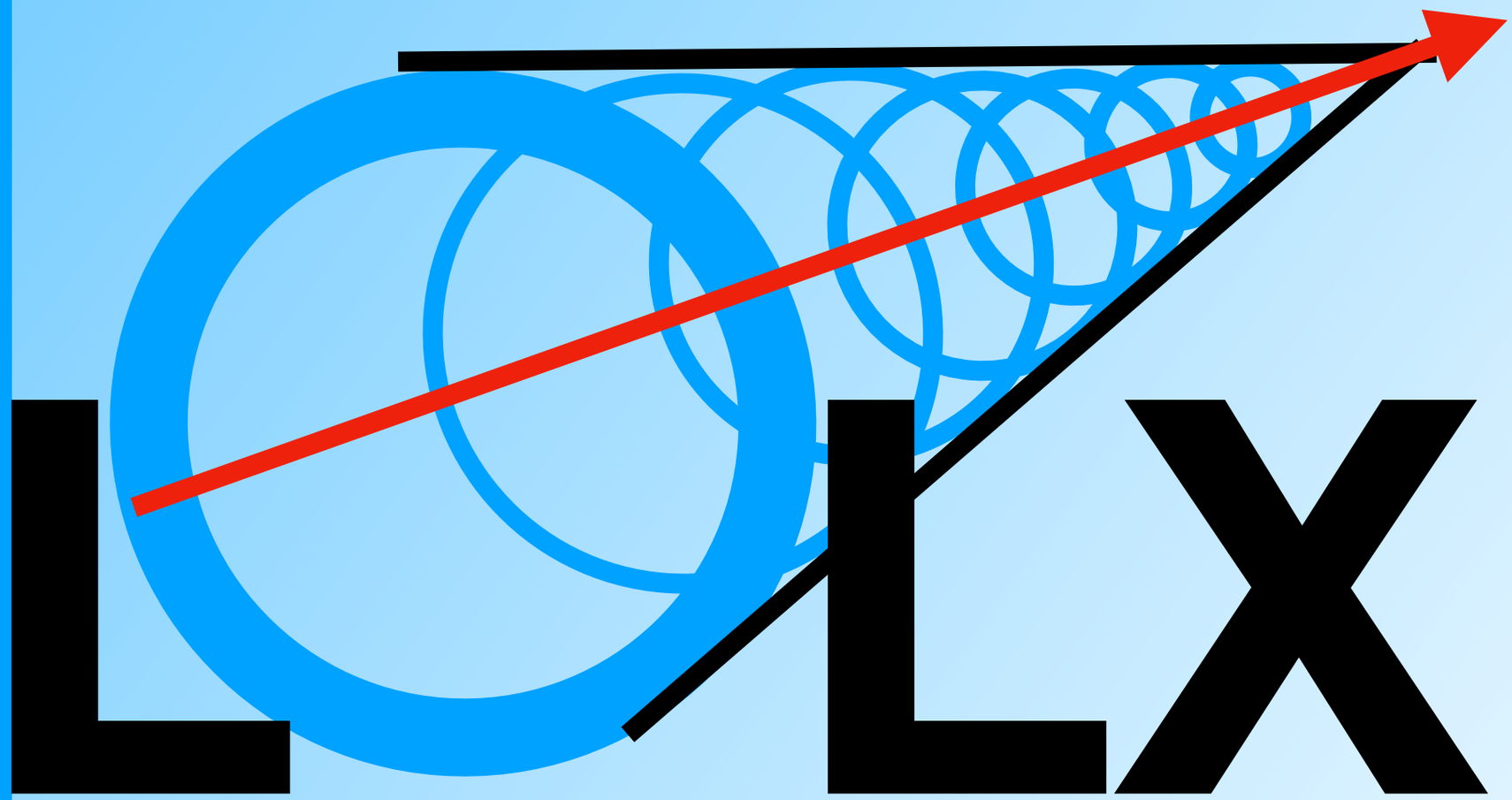


Light-only Liquid Xenon

Thomas McElroy
for the LoLX Group

CAP Congress
June 6th, 2019

LoLX Overview

- **LoLX aims to perform precision measurements of the light output of LXe.**
- **Studying the precise timing of the scintillation and Cherenkov light emission to develop new background rejection techniques for rare event searches.**
- **Pave the way for TOF-PET scanners with 10 ps time resolution.**

3 Major Phases of the Project

- Cherenkov and Scintillation Yields (~16 ns)
- Time structure in scintillation light (~100 ps)
- 3D SiPM and measure rise time of scintillation (~10 ps)

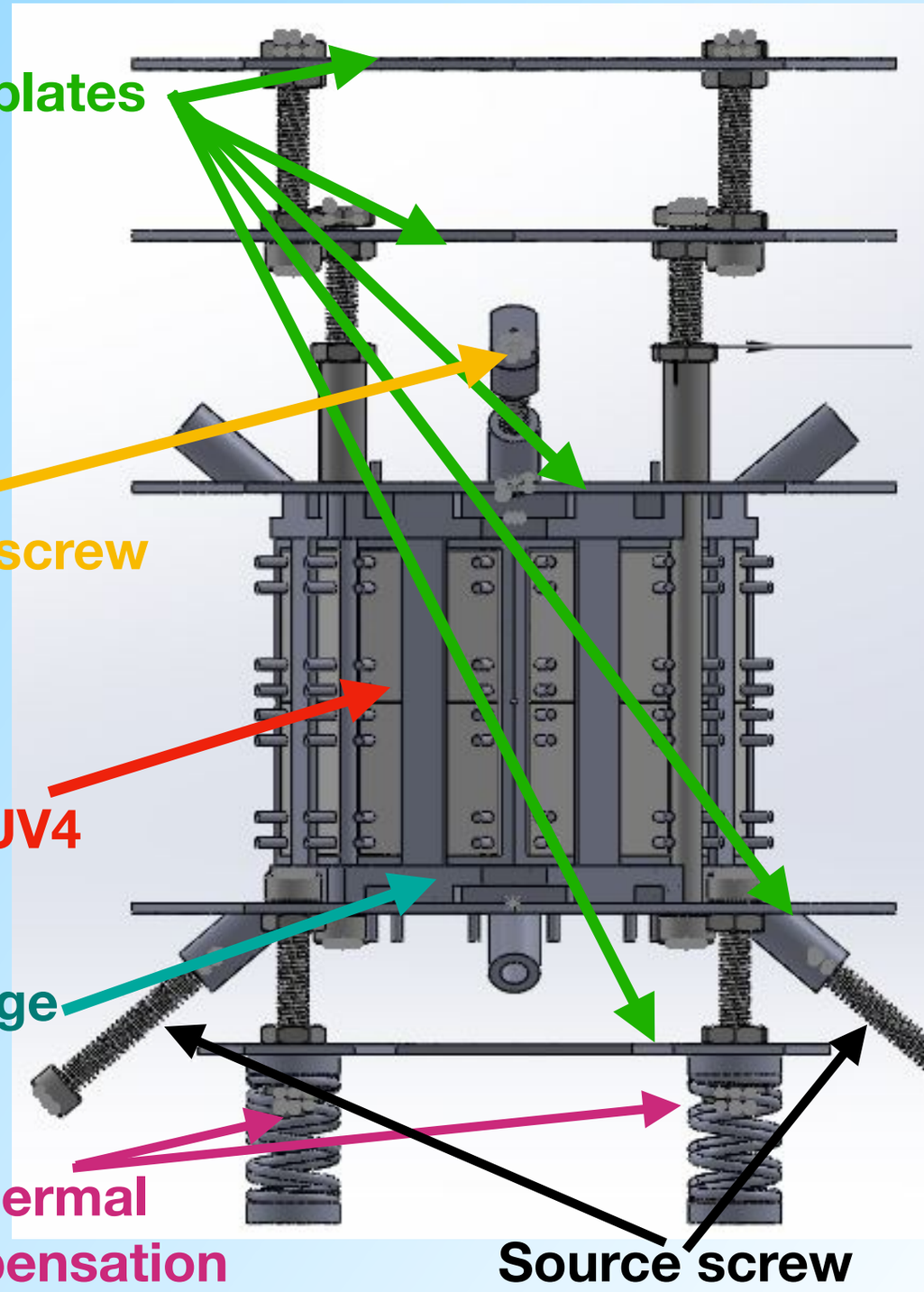
LoLX Overview

Phase 1 Objective:

- Measure scintillation and Cherenkov yields.
- Verify GEANT4 optical simulations using ex-situ optical measurements.
- Gain experience running many SiPM channels.

Phase 1 Detector

- 24 Hamamatsu VUV4 Quad SiPMs.
- 22 SiPMs covered with long-pass filters.
- 1 SiPM covered with 175 nm band-pass filter.
- Octagonal Cylinder Geometry.
- Utilizing 3D printing to make SiPM Cage.

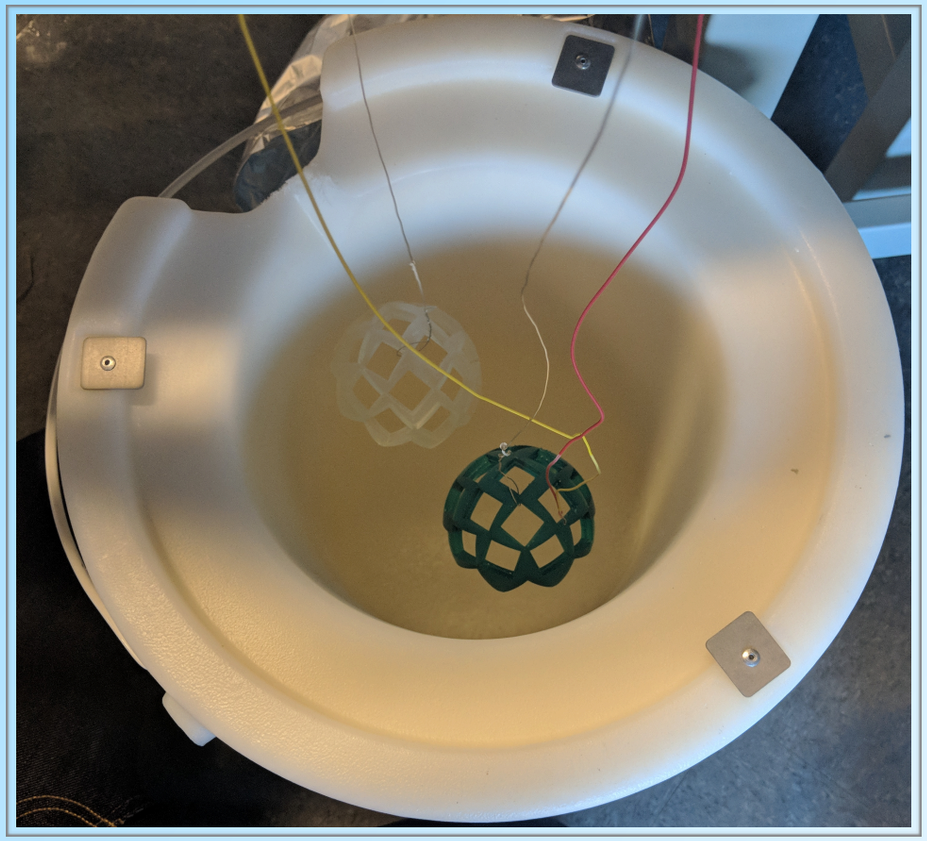


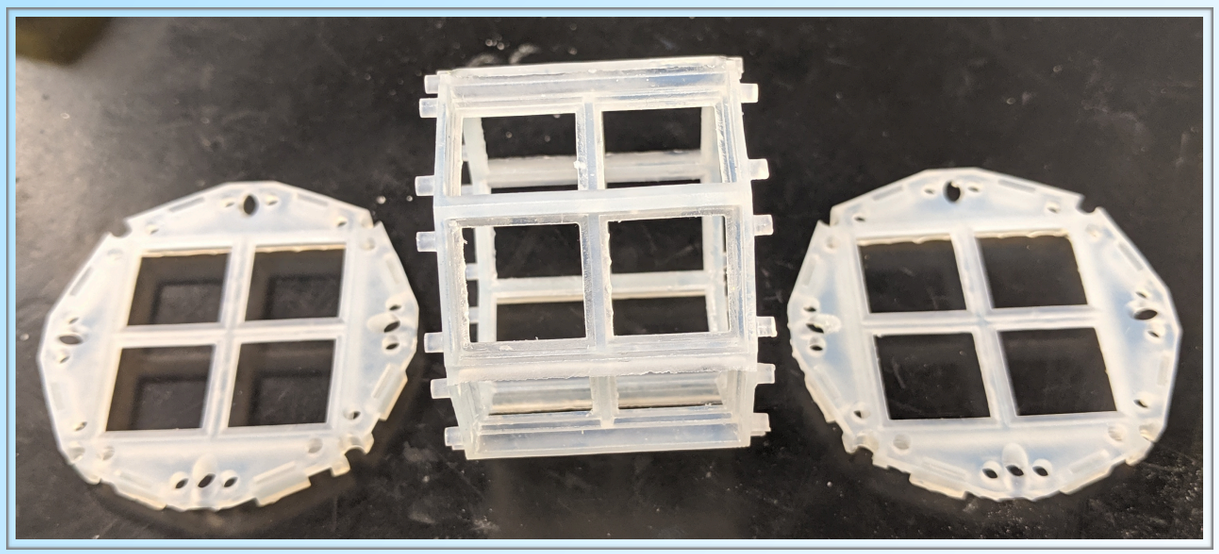
3D Printed Materials

- **Have investigated Formlabs SLA 3D printing resins for use in Vacuum and Cryogenic environments.**

- **Durable resin was the only resin that survived cryogenic shock.**

- **With a 60^{o}C bakeout, vacuum pressure of O(10^-8 torr) was reached with 80 L/s turbo pump.**

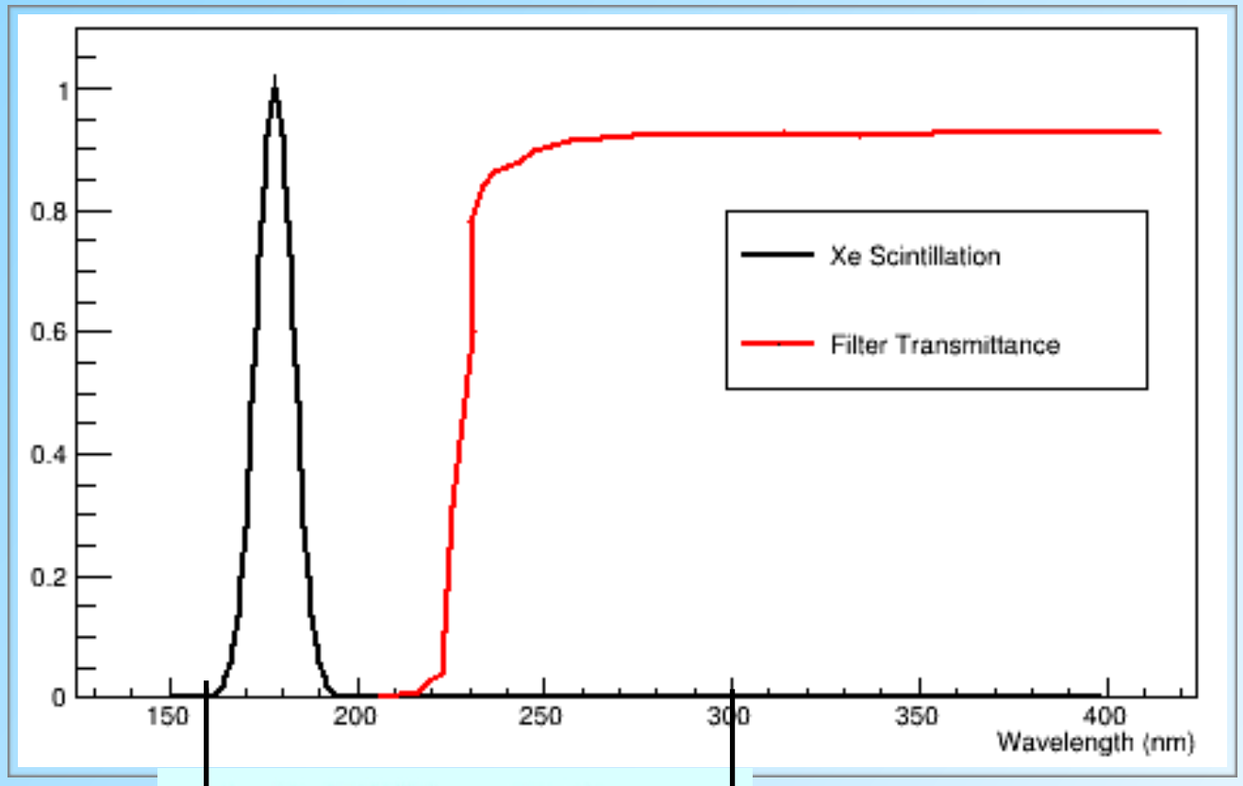




Optical Filters

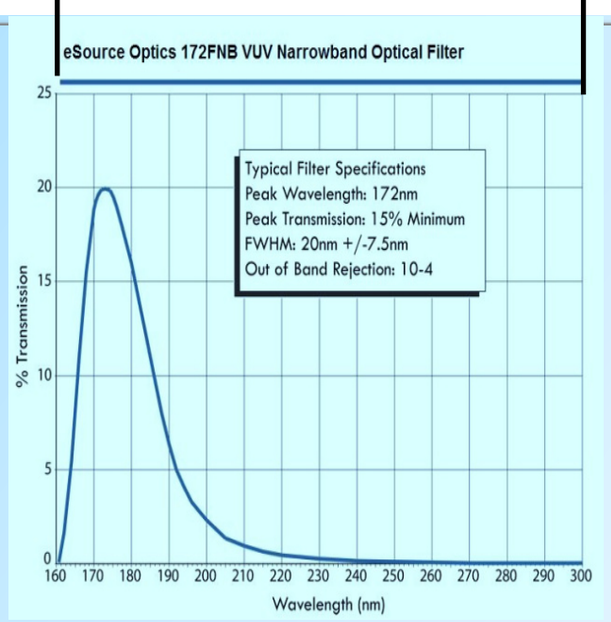
Long-pass Filters

- **Newport CGA-225 Filters**
- **50% transmission at 225 nm**
- **Cover all but two of the VUV4 SiPMs**



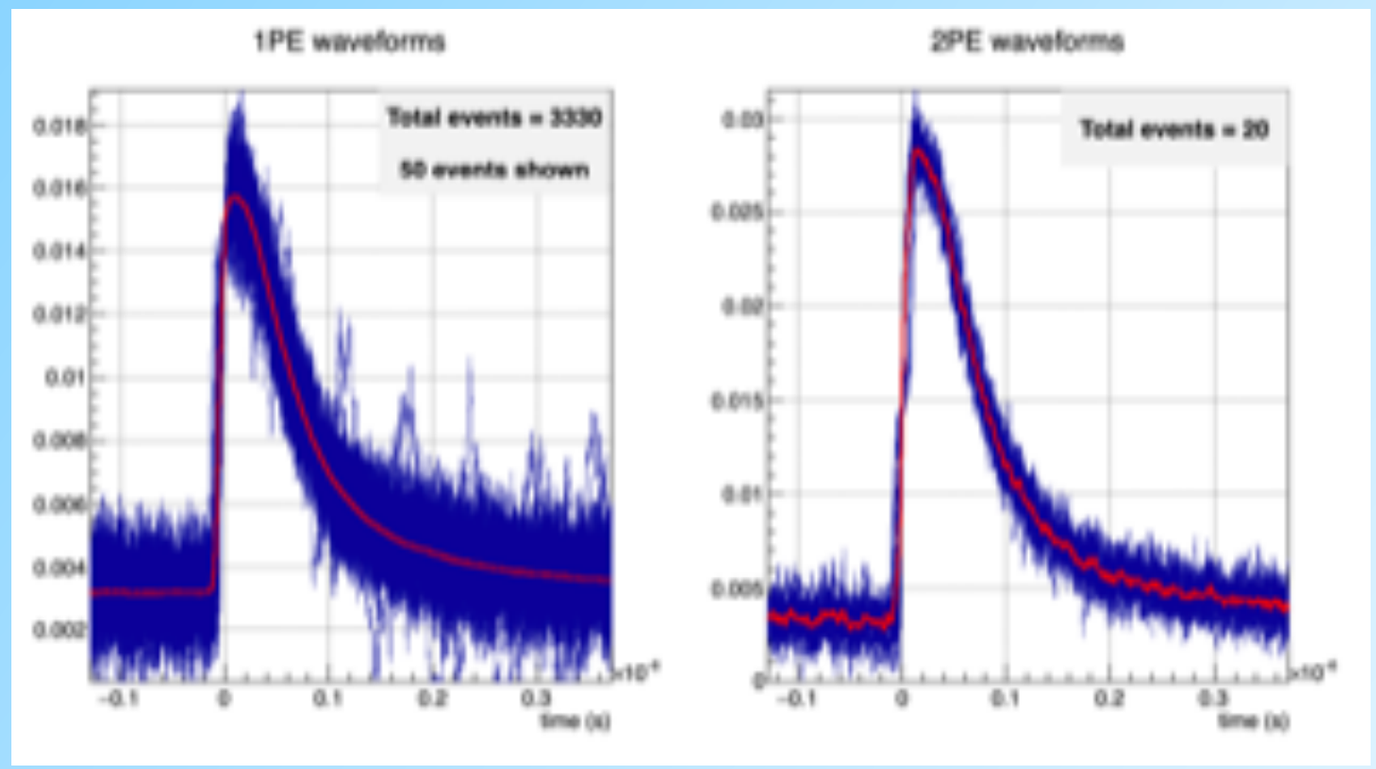
Band-pass Filter

- **eSource Optics UV bandpass filter**
- **175nm with ~20 nm FWHM**
- **Cover 1 SiPM in case external cross-talk is too high.**



Electronics/DAQ

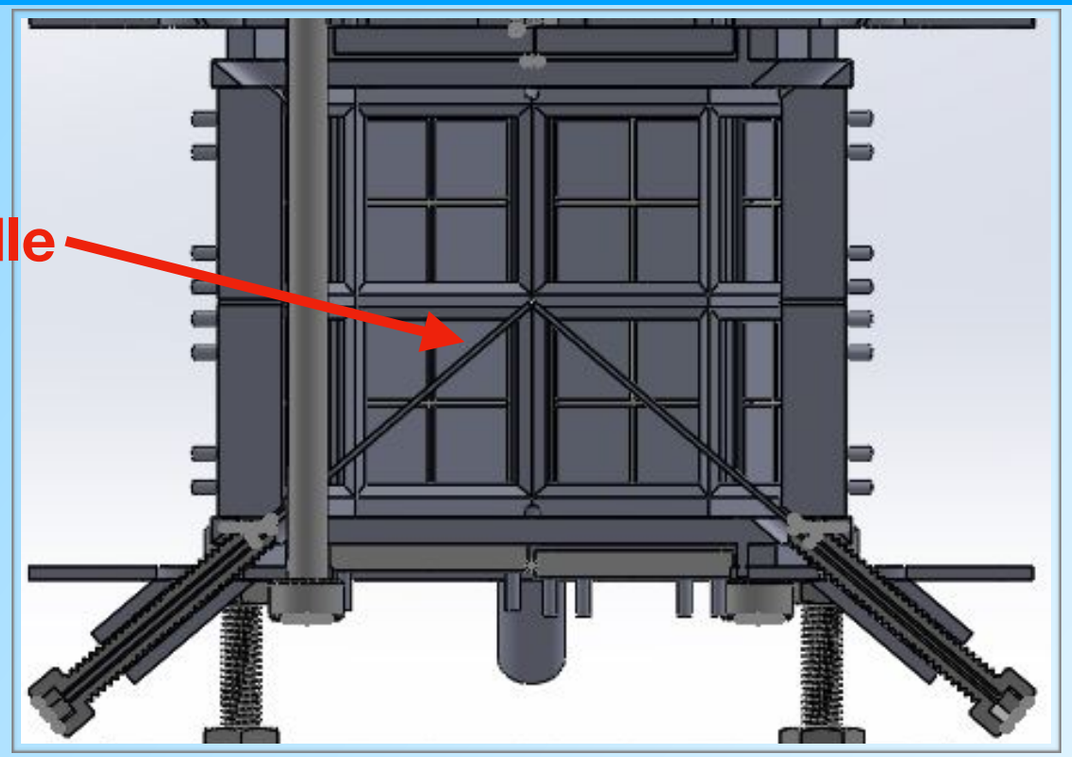
- **Analog electronics**
- **V1740 (64 MSPS)**
- **More in Austin de St. Croix's talk**



Radioactive Sources

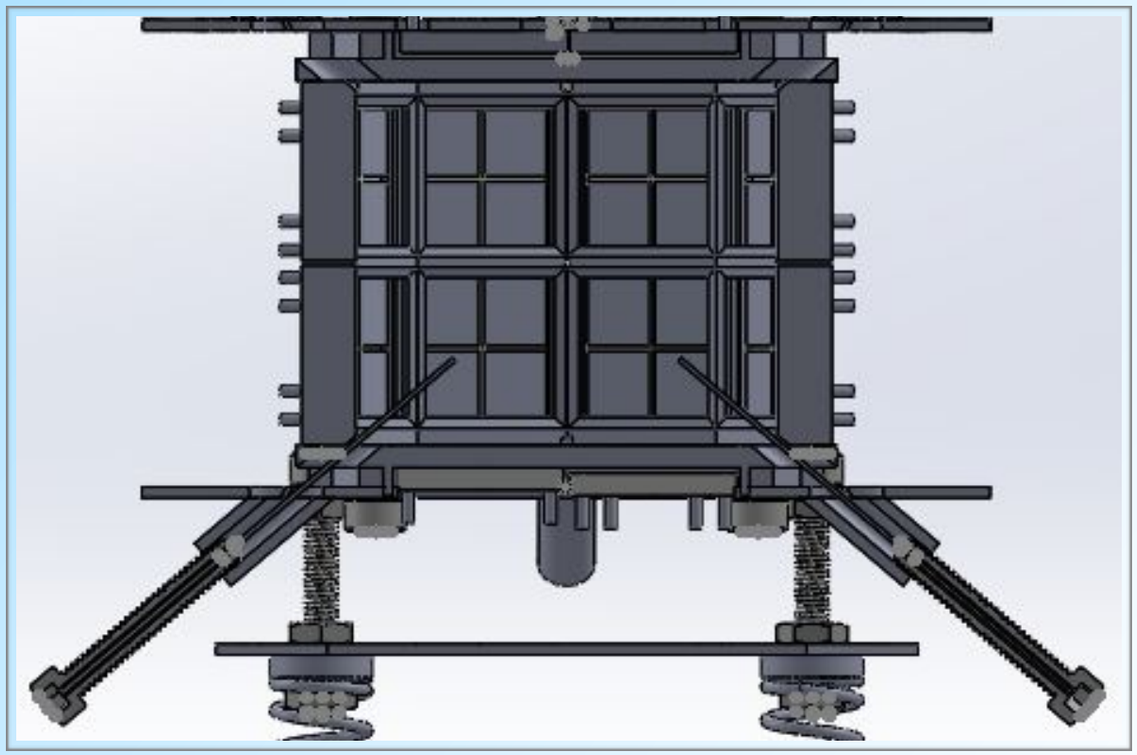
Source 1:

- **90Sr beta source**
- **0.546 MeV 90Sr decay, 0.94 MeV 90Y decay**
- **370 Bq**



Source 2:

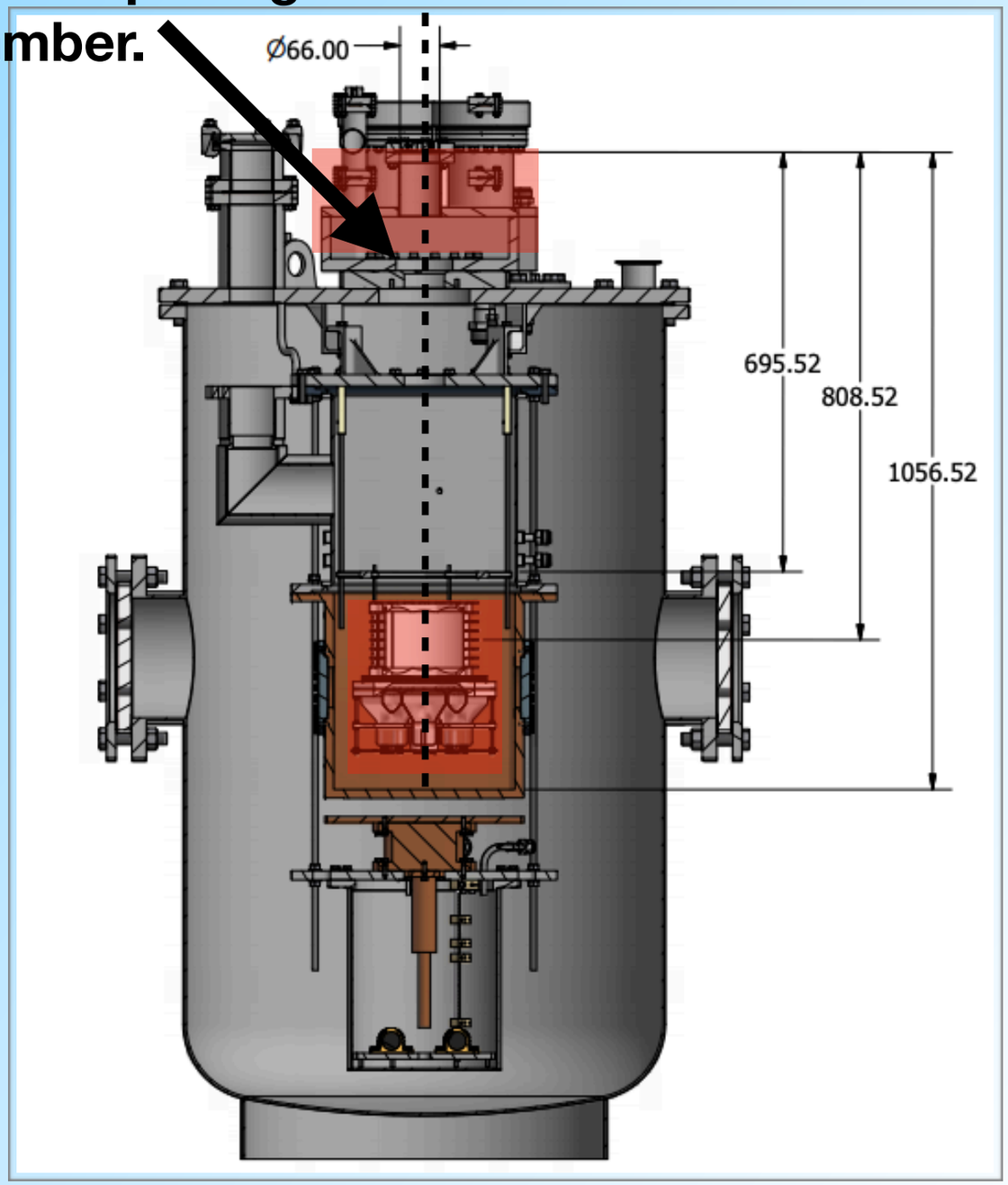
- **210Po alpha source**
- **5.3 MeV**
- **370 Bq**



Cryostat and LXe

Adapter flange allows the LoLX detector do be inserted through top port without opening full chamber.

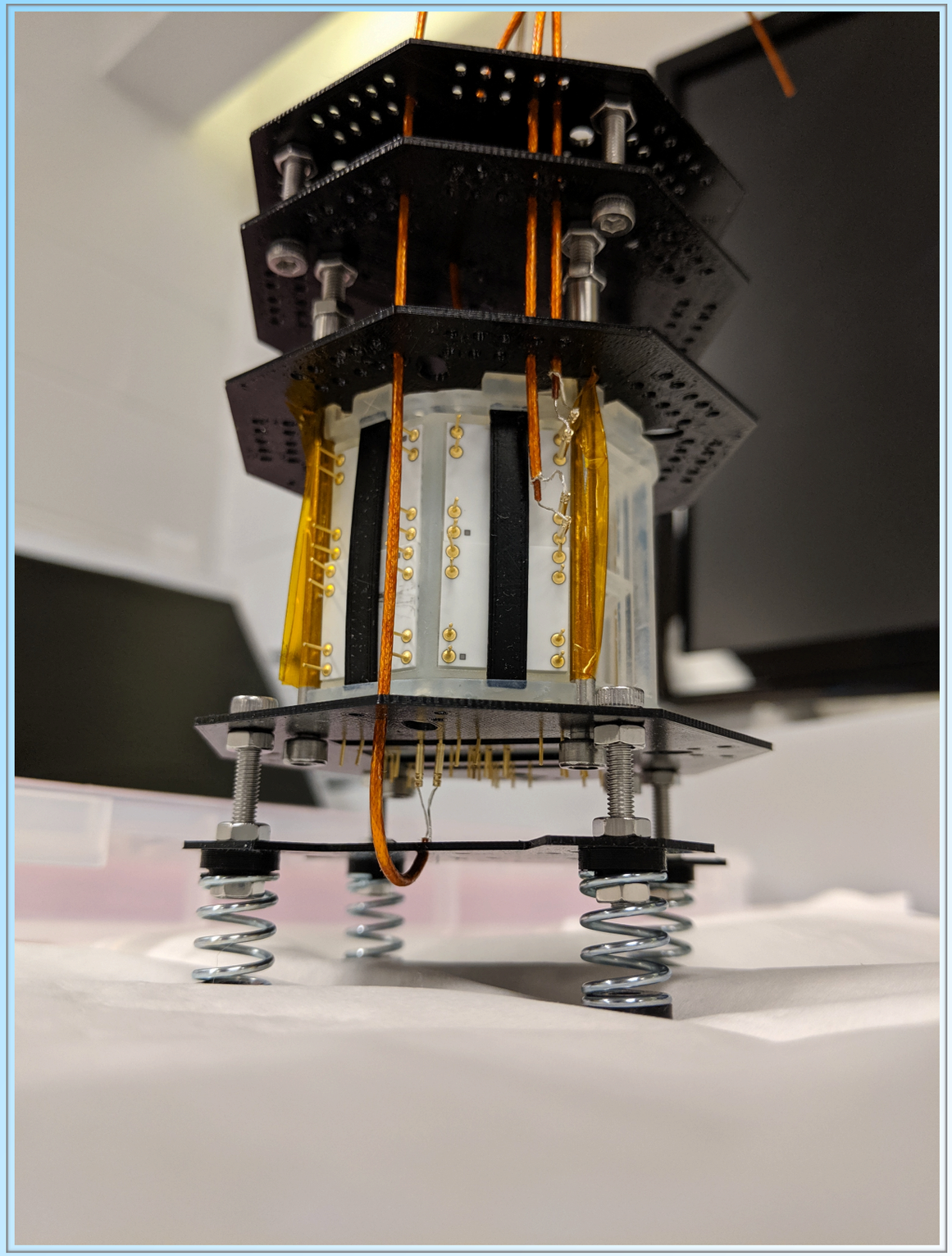
- **Razvan Gornea's Cryostat at Carleton**
- **~17 kg of Xenon available**
- **Building adapter flange to connect LOLX feedthrough.**
- **Filler blocks will be installed in main chamber to better hold the LXe around the detector.**



Test Assembly

- **3D printing parts prefabrication to test out full design**

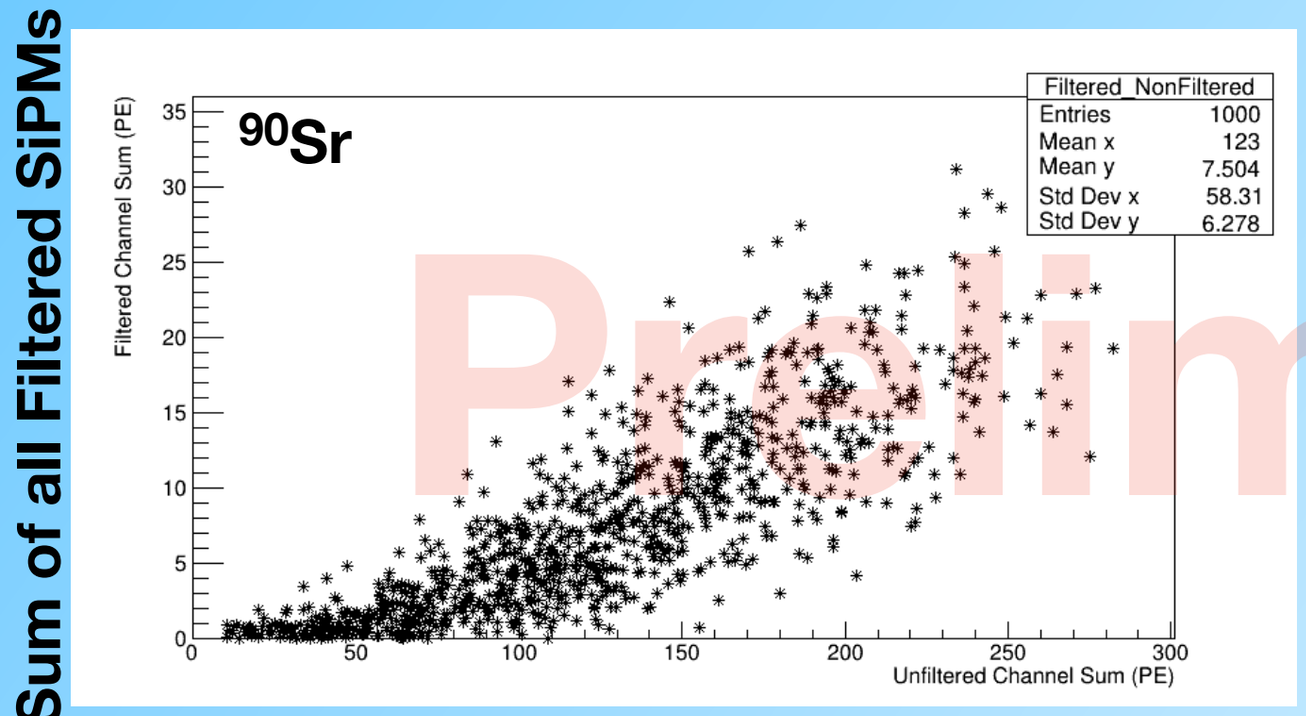
- **Have run through assembly process to make sure everything goes smoothly.**

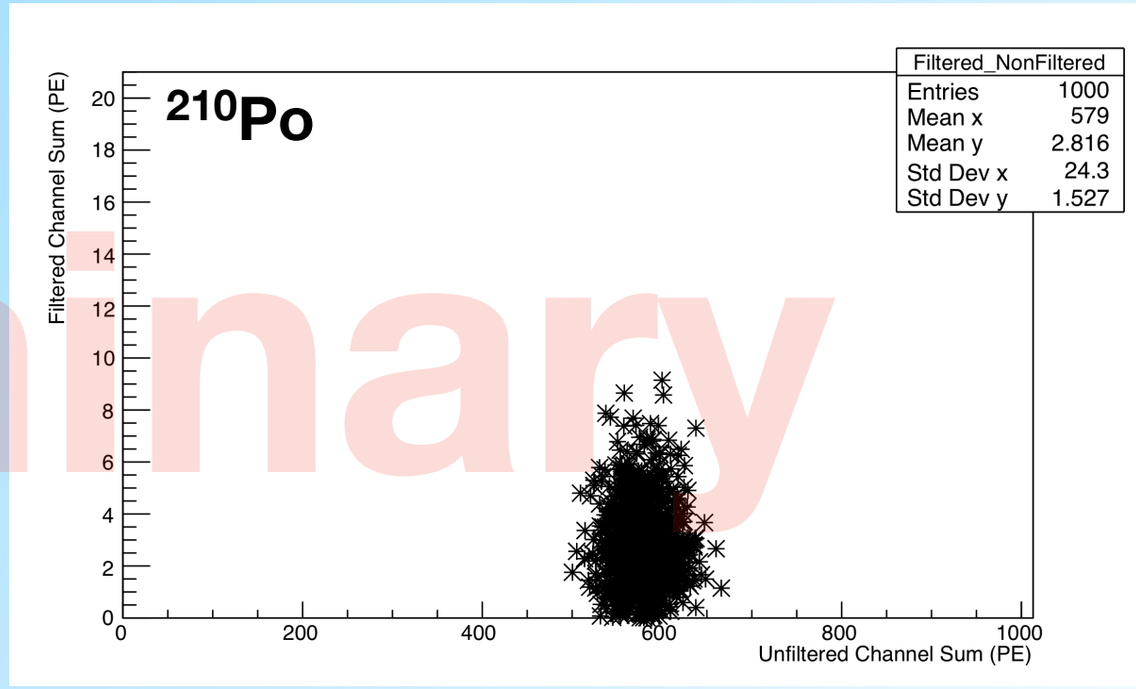


Simulation

- **Run with ^{90}Sr and ^{210}Po needle source**

- **Input ex-situ optical measurements for all detector materials and components performed at TRIUMF.**





Preliminary

Phase 2

- **Update electronics and DAQ for better timing resolution.**
- **O(100 ps) resolution**
- **Study the prompt (0.1 to 5 ns) timing characteristics of scintillation light.**
- **Study PSD in LXe with ~X10 time resolution of previous studies[1-3].**

Electronics/DAQ Upgrade:

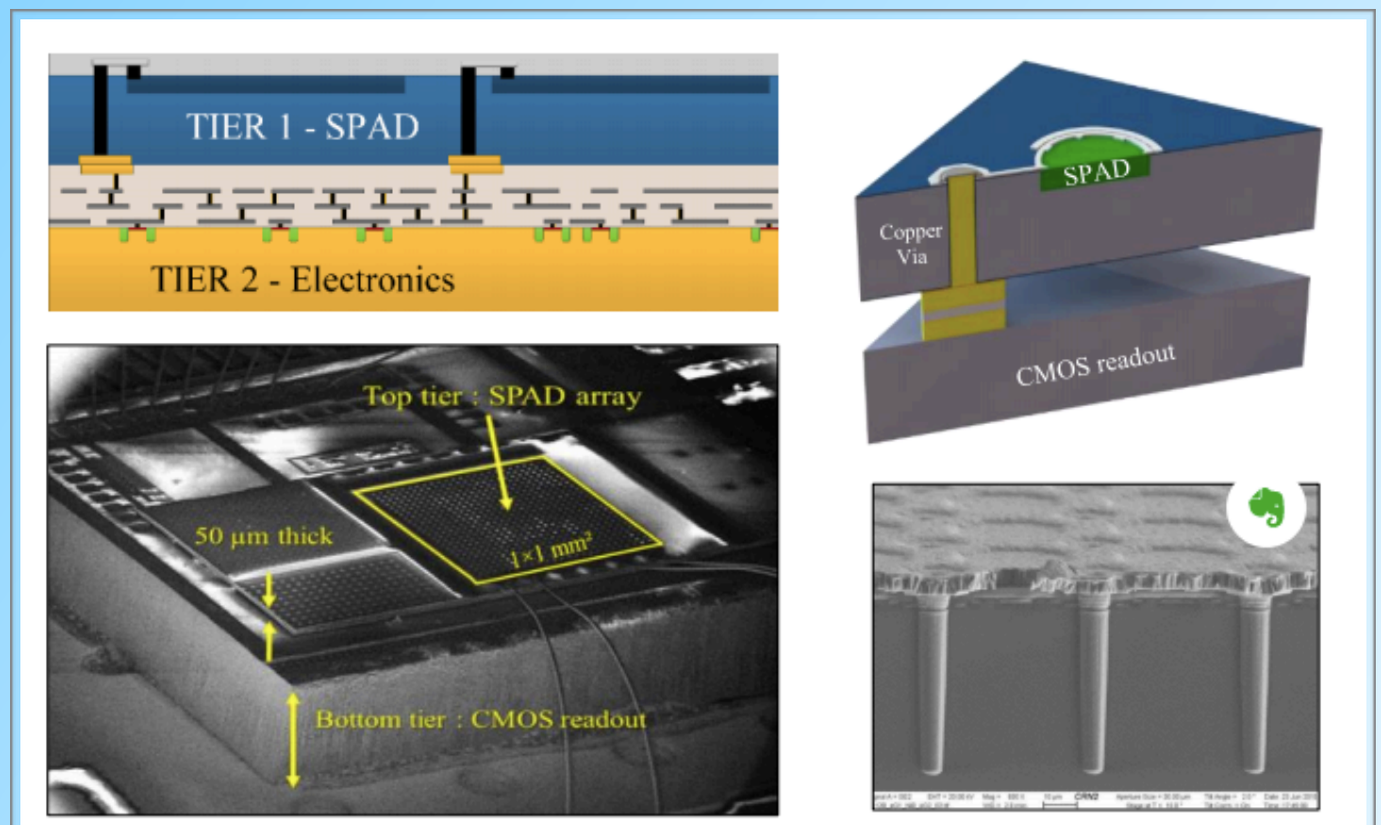
- **WaveDREAM boards being developed by Pisa and PSI group for MEG2.**
- **1-5 GSPS**
- **1V dynamic range at 12 bit resolution**
- **16 channels per board**
- **1024 S/ch**

M. Francesconi, IEEE-Real Time Conference, 09-11/06/2018

[1]arXiv:1802.06162v2,[2]arXiv:1803.07935v3,[3]arXiv:1604.01503v3

Phase 3

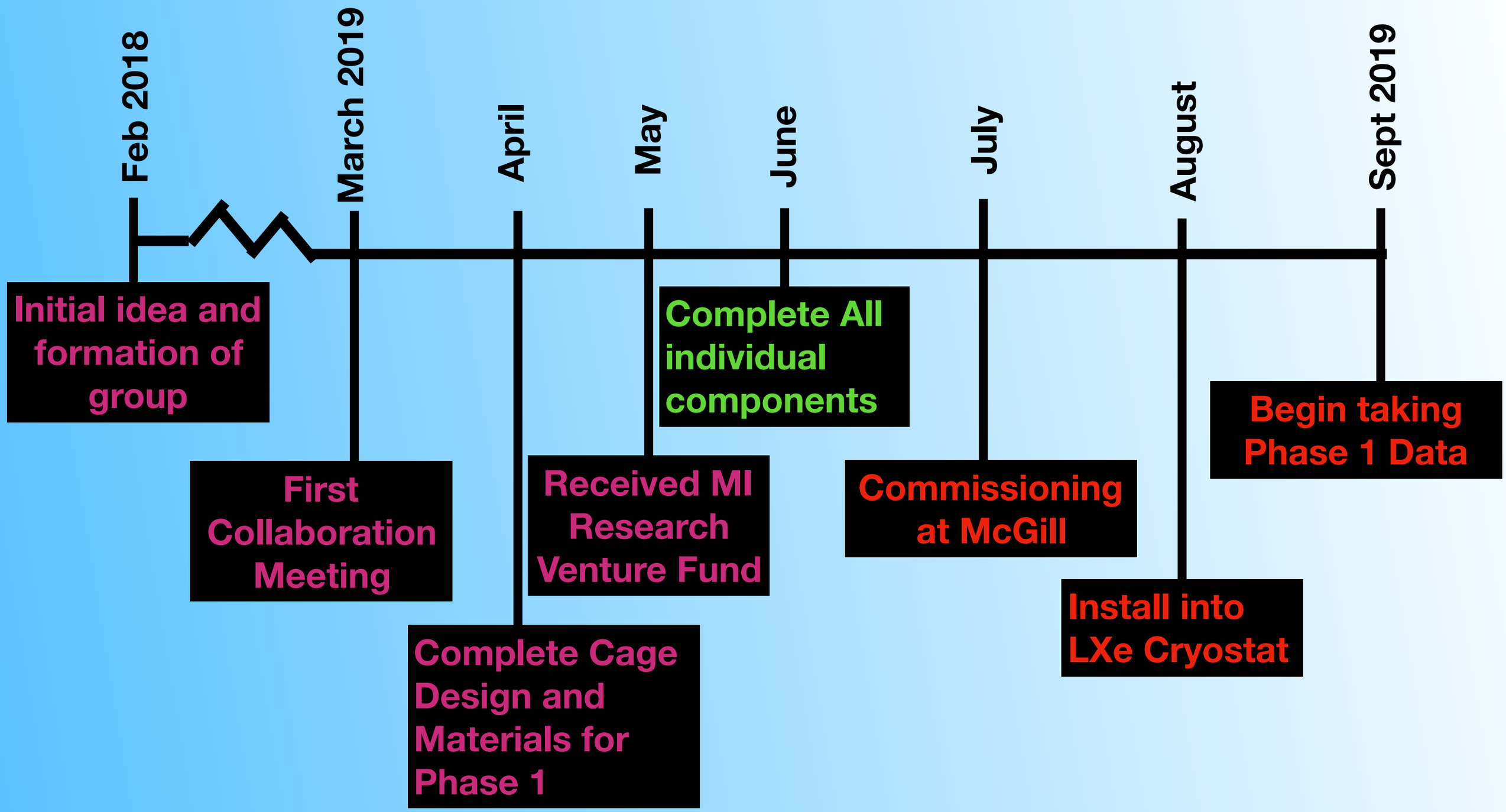
- **Integrate 3D SiPMs from Sherbrooke**
- **Measure rise time of scintillation with ~10 ps time resolution.**
- **Separation of scintillation and Cherenkov light with timing.**



Sherbrooke's First 3D Digital SiPM: Measurements, Recommendations and Future Work, J.-F. Pratte et al. (NSSMIC 2016)

See J.-F. Pratte's talk

Timeline


Feb 2018
March 2019
April
May
June
July
August
Sept 2019
Initial idea and formation of group
First Collaboration Meeting
Complete Cage Design and Materials for Phase 1
Received MI Research Venture Fund
Complete All individual components
Commissioning at McGill
Install into LXe Cryostat
Begin taking Phase 1 Data

LOLX Group

TRIUMF

Fabrice Retiere, Pietro Giampa, Aleksey Sher, Austin De Ste Croix, Shirin Edalatfar, Mark Ward, Peter Margetak and Emily Polak

Carleton UNIVERSITY

Razvan Gornea, Simon Viel and Damian Goeldi

McGill University

Thomas Brunner, Thomas McElroy, Tsvetelin Totev and Jasmine Zhang

INFN Istituto Nazionale di Fisica Nucleare SEZIONE DI PISA

Luca Galli, Giovanni Signorelli and Simone Stracka

UNIVERSITÉ DE SHERBROOKE

Marc-André Tétrault, Frédéric Vachon and 3D SiPM Group