

Scintillating Bubble Chambers for WIMPs and reactor CEvNS

For FNAL Snowmass Det R&D planning,
Mostly borrowed from:

Matthew Bressler* and
Rocco Coppejans

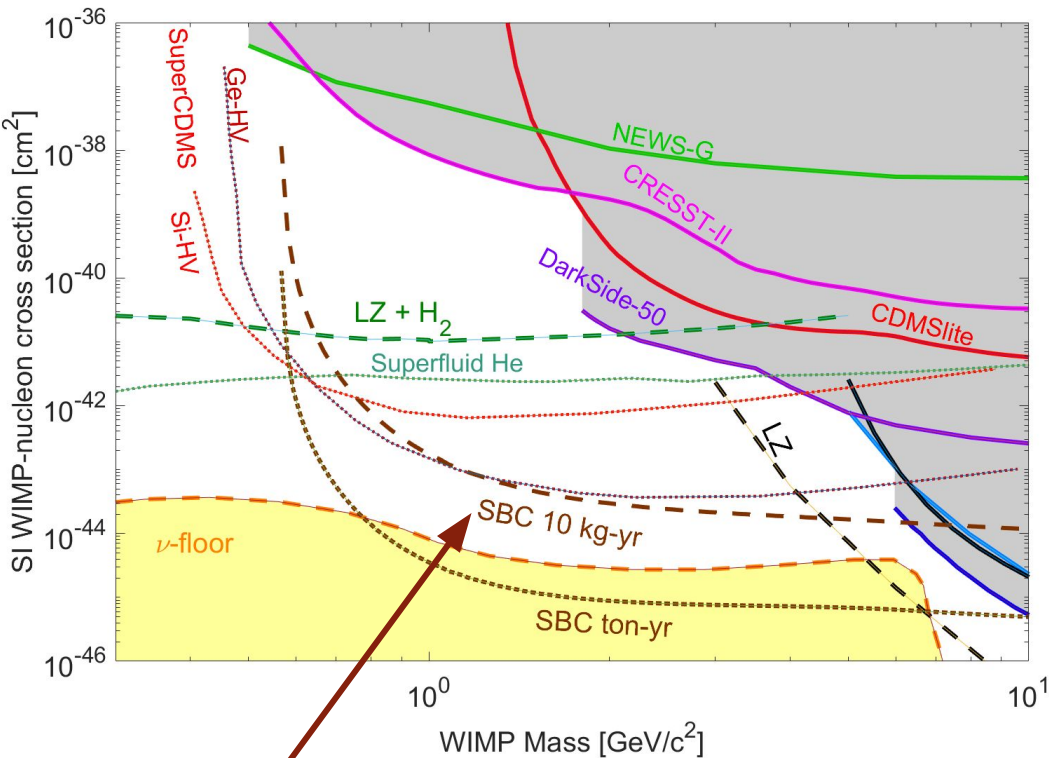
SBC Collaboration

APS Virtual April Meeting

(*2020 GIRA recipient!)



Scintillating Bubble Chamber: Direct Detection Reach

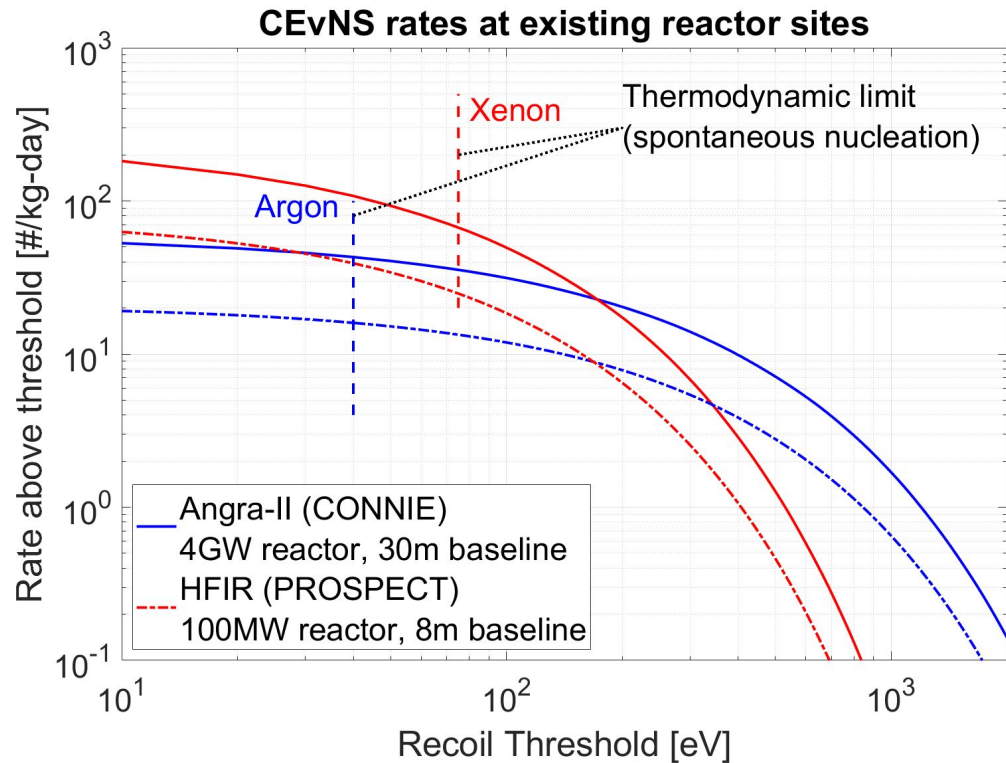


Clone of FNAL LDRD 2018-003,
has GW-1 approval @ SNOLAB

Scintillating Bubble Chamber

- Scalable
- ER-blind
- Sub-keV recoil detection (bubble nucleation)
 - Target threshold: 100 eV argon recoils
- Energy information from scintillation
 - Target: 5 keVnr resolution

Scintillating Bubble Chamber: Reactor CEvNS Reach



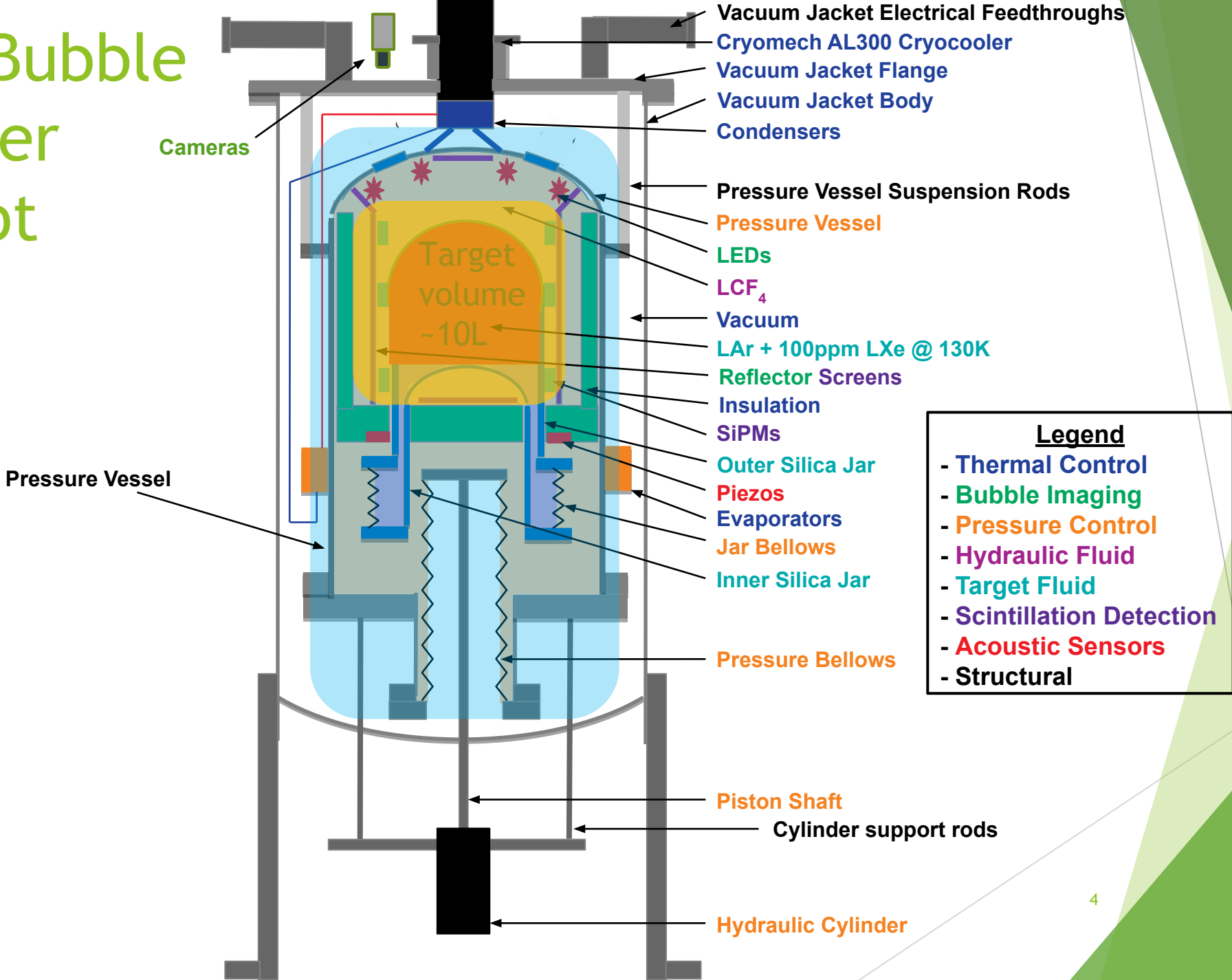
Scintillating Bubble Chamber

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Collaborating with UNAM to identify reactor site for SBC.

Of interest: ININ (Salazar, Mexico)
1 MW, 2-3m baseline

Argon Bubble Chamber Concept

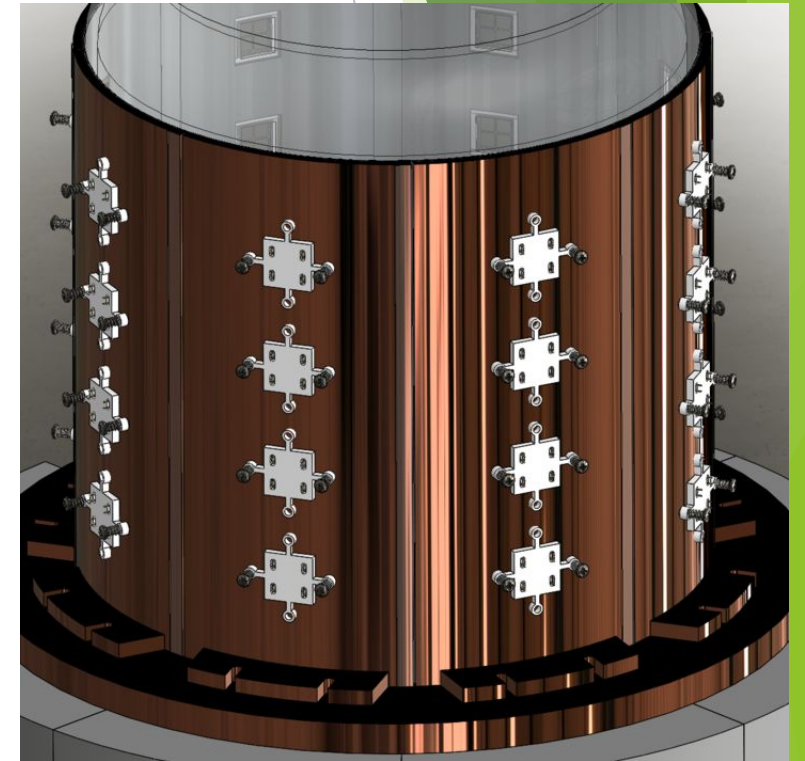
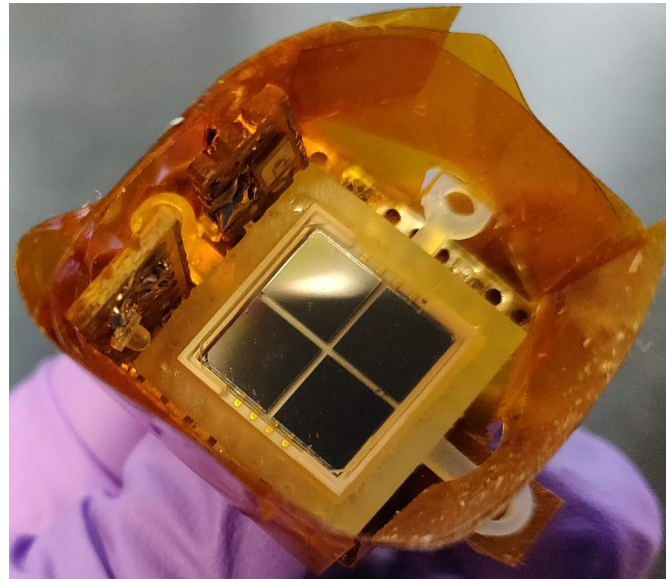


- Legend**
- Thermal Control
 - Bubble Imaging
 - Pressure Control
 - Hydraulic Fluid
 - Target Fluid
 - Scintillation Detection
 - Acoustic Sensors
 - Structural

Argon Chamber Systems

- ▶ Light collection:
 - ▶ 30 VUV silicon photomultiplier quads immediately next to the argon-containing jar
 - ▶ Custom electronics by TRIUMF

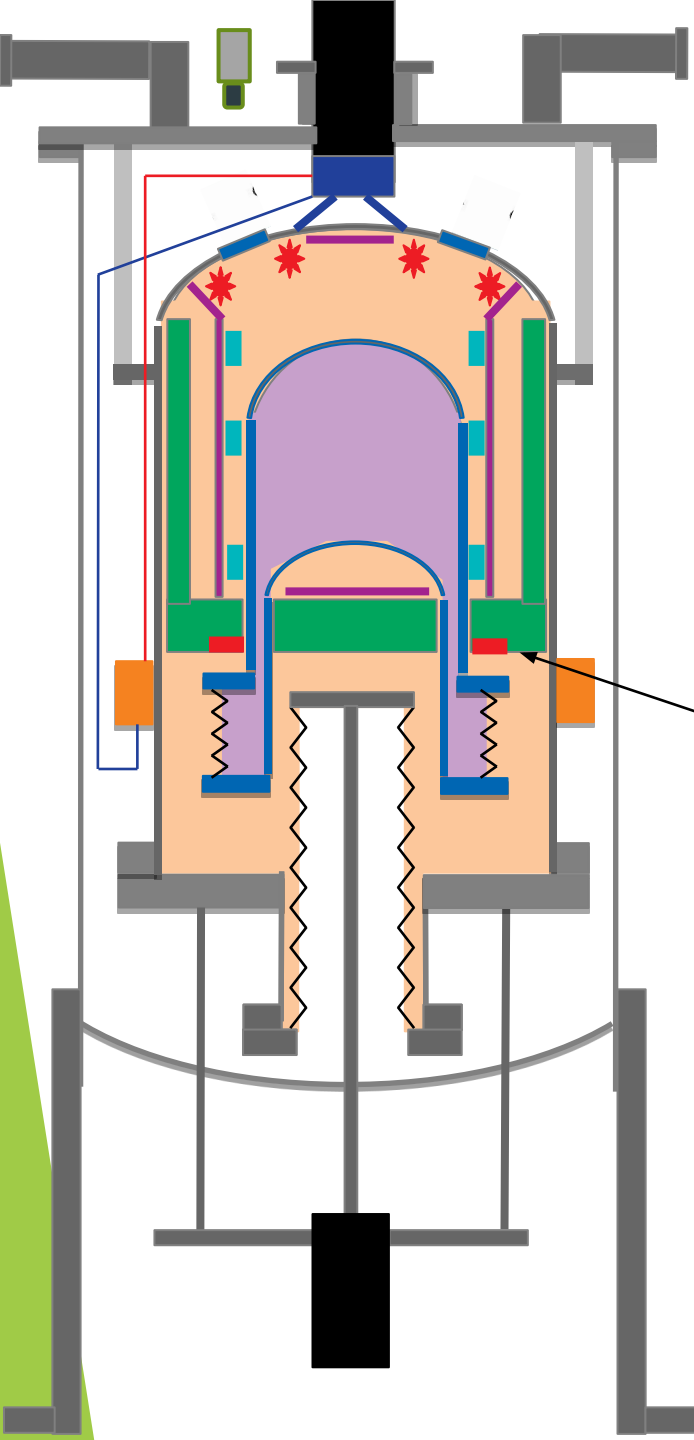
LAr + 100ppm LXe @ 130K
Reflector Screens
SiPMs



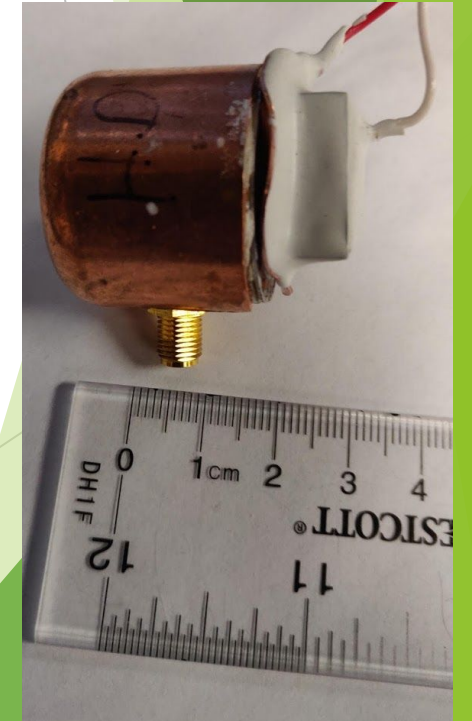
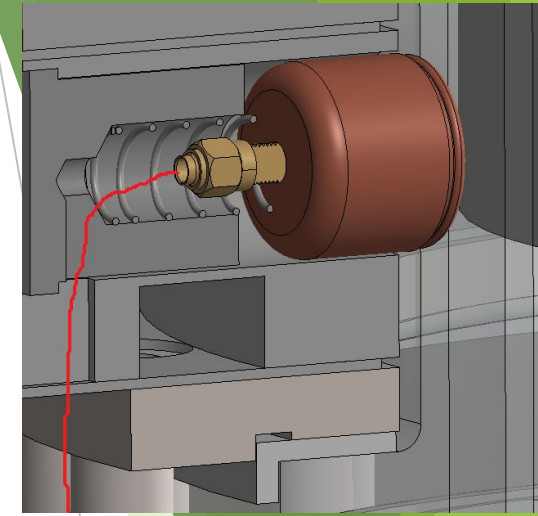
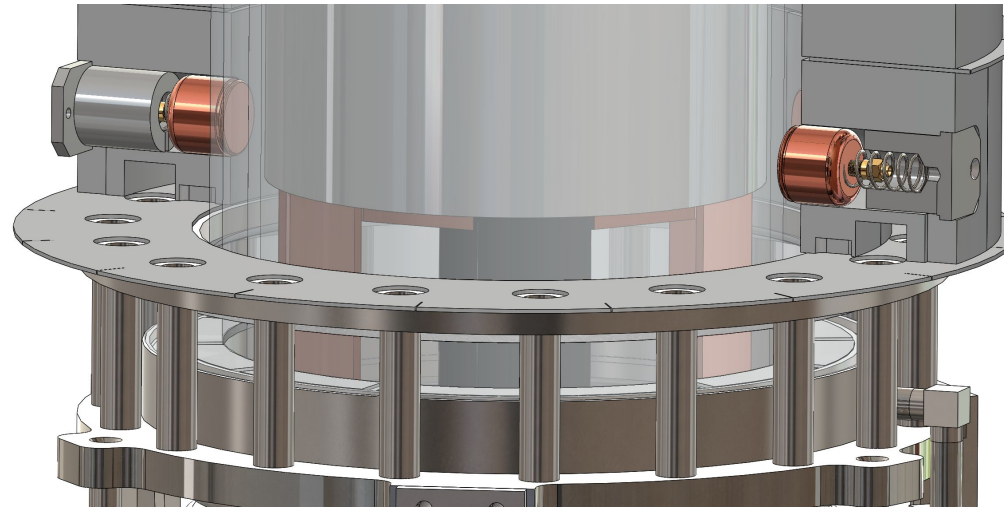
Argon Chamber Systems

- ▶ Acoustics:

- ▶ 8 piezoelectric transducers held against the jar, assembled and characterized by IUSB



Piezos

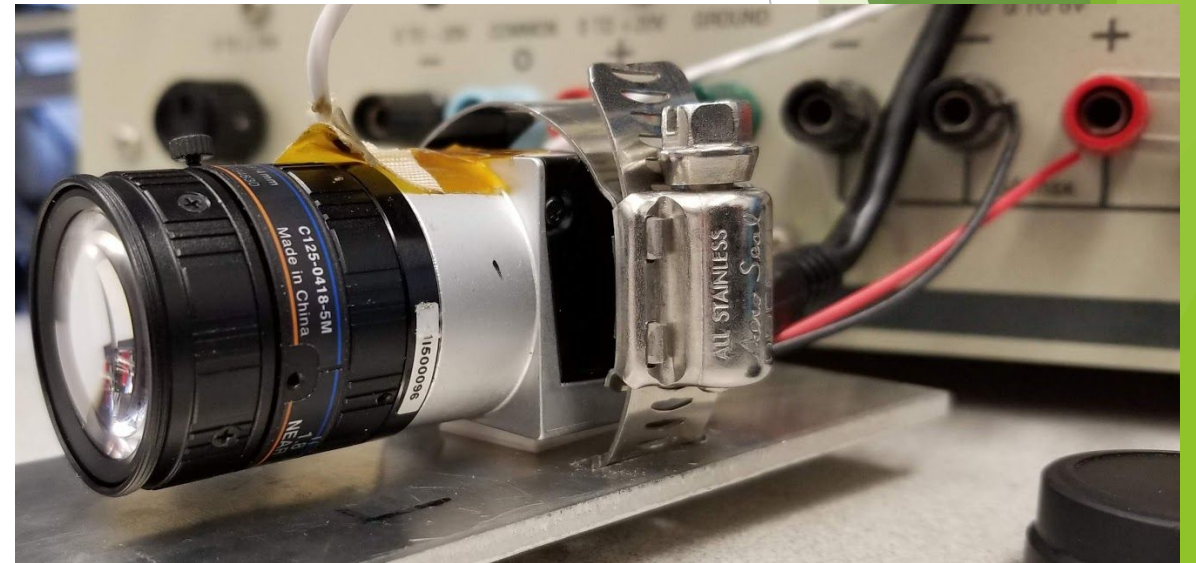


Argon Chamber Systems

- ▶ Cameras:

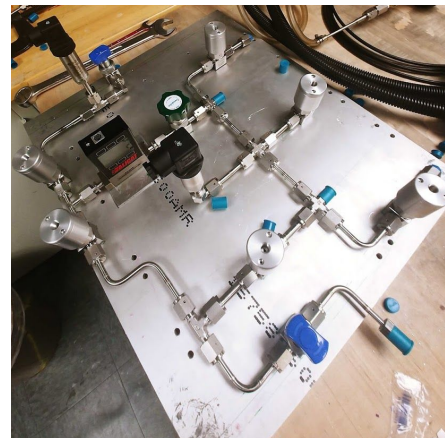
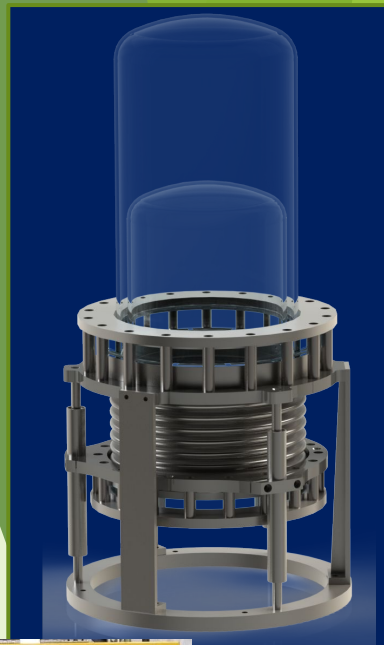
- ▶ 3 Basler ace 200 fps 1.3 MP cameras
- ▶ Will be either in the vacuum space at viewports on the pressure vessel, or outside of the cryostat with periscopes

Cameras



SBC-Fermilab Status

- ▶ Pressure vessel and vacuum cryostat are at Fermilab
- ▶ The pressure vessel and pressure bellows have been pneumatically tested to $1.1 \times \text{MAWP}$, no leaks or issues found
- ▶ Fluid systems design complete (under review), parts arriving
- ▶ Inner assembly design almost complete
 - ▶ Jars, bellows are ordered
 - ▶ Shop drawings ready for operations restarts at collaborating institutions



Snowmass White Paper content (very preliminary)

- ▶ Generic Detector R&D topics pushed by SBC:
 - ▶ Xe+Ar Doping
 - ▶ High-pressure cryogenic instrumentation
 - ▶ SiPMs
 - ▶ Cameras
 - ▶ Acoustic sensors
 - ▶ Nuclear Recoil calibration strategies @ 100 eV
- ▶ Specific R&D pushed by SBC
 - ▶ Concept development for ton-scale and beyond
 - ▶ Active acoustic imaging
 - ▶ Surface treatments for metal-wall chambers
- ▶ Direct Detection long-term plan + physics case
- ▶ CEvNS long-term plan + physics case

SBC: Scintillating Bubble Chamber



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