Neutrinos as a Novel Probe of Nucleon Structure

Let's use neutrinos as a window into Nonperturbative QCD

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Undergraduate at Howard University (BS x 2, Math, Physics, 2009)

Masters at the University of Michigan, Ann Arbor (MS, Applied Physics, 2013)

Masters at Howard University (MS, Atmospheric Physics, 2014)

PhD at the University of Michigan, Ann Arbor with Christine Aidala (PhD, Applied Physics 2018)

Graduate work in High-Energy Nuclear Physics and Nucleon Structure at SeaQuest, ***specific work on the light-quark flavor asymmetry and transverse structure of the nucleon***. **Liquid H2/D2 Target lead.**

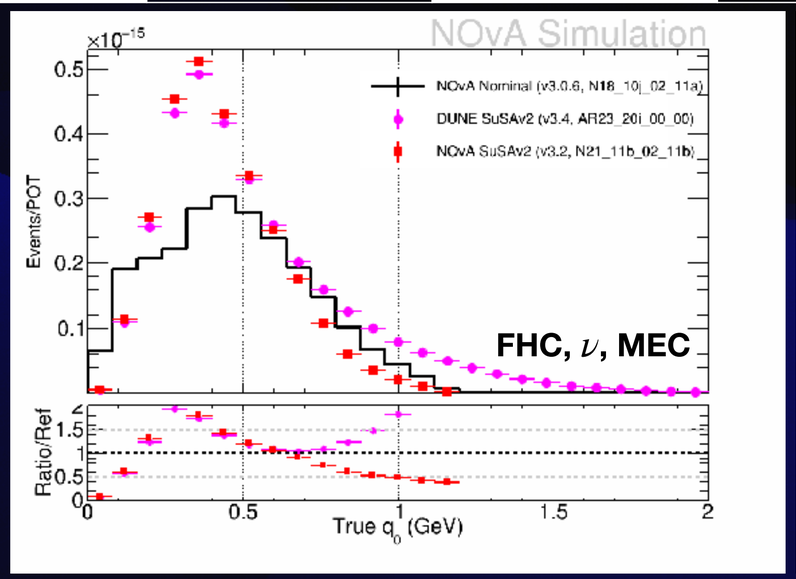
Postdoc at Fermilab under **Alex Himmel**. Current work on **NOvA as Cross Section Modeling Convener**, **DUNE Prototype Detectors**, and **H2/D2 Bubble Chamber LDRD.**

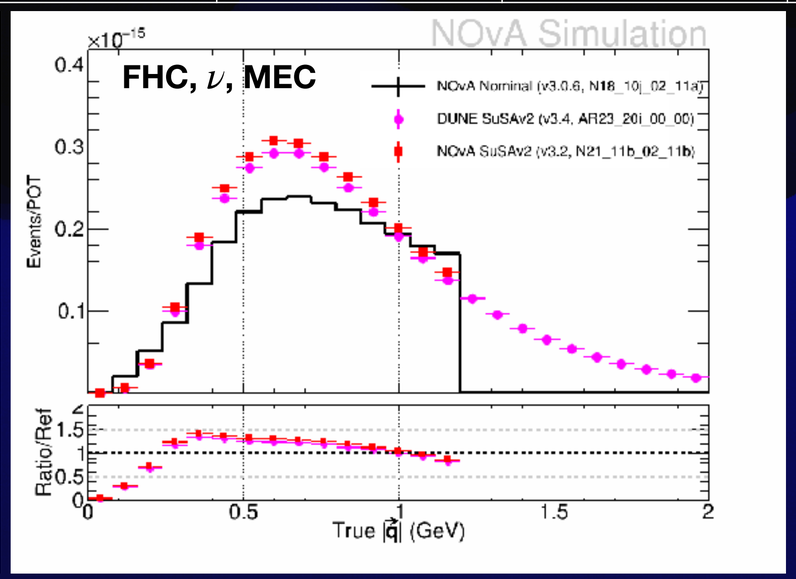
Ramson Group: Maria Martinez-Casales, Hilary Utaegbaulum, Amit Pal, Maya Wallach, Rashawn Carter

Models Considered for Future Analyses

Considerations for Meson Exchange Currents

CMC	Initial State	QE	MEC	Res	DIS	Final State	Tune
AR23_20i_00_000 (3.4)	LFG*	Valencia	SuSAv2 2p2h*	Berger-Seghal	Bodek-Yang*	hA2018*	Free-Nuke



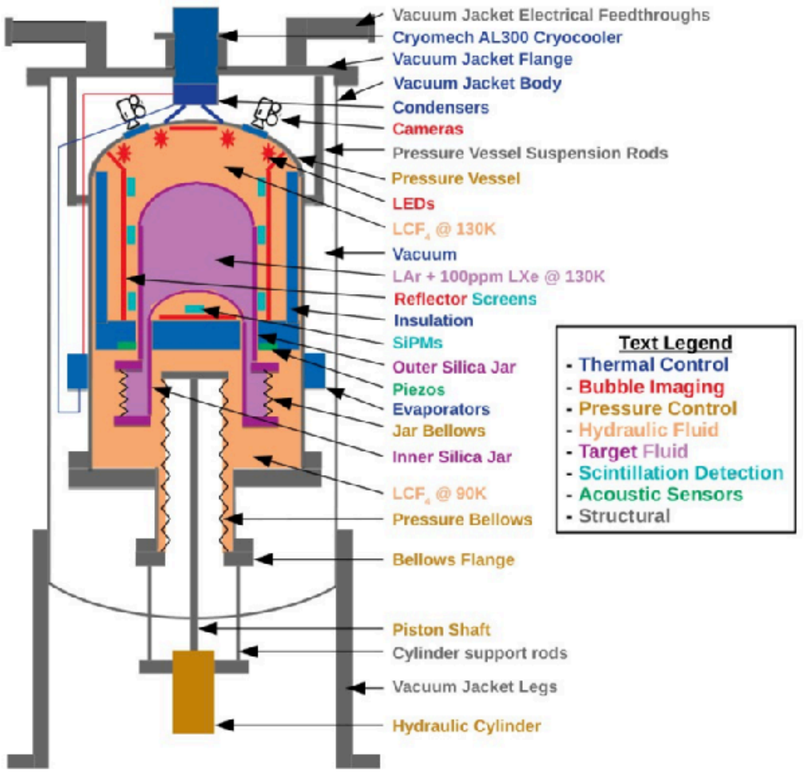


Significant adjustment of MEC over the entire range, **expansion** of the phase space in momentum transfer!

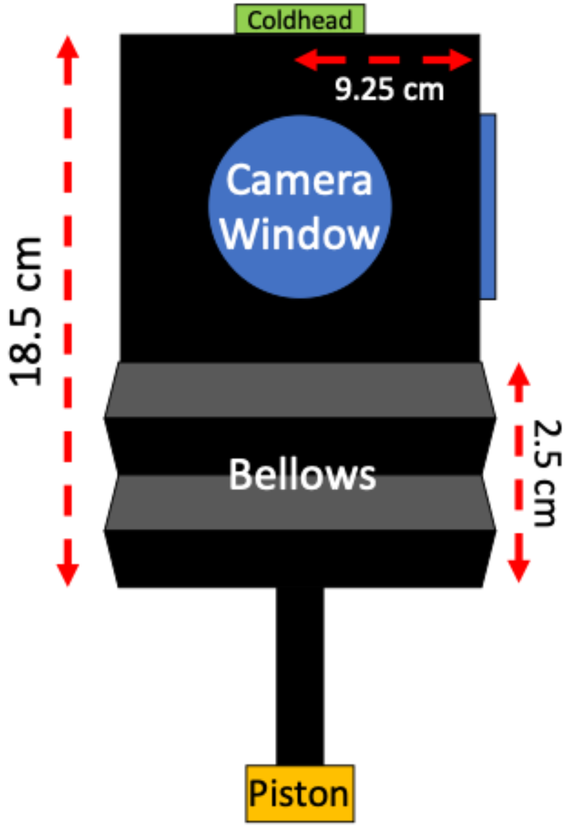
Significant reduction of events in the lowest MEC bins for energy and momentum transfer. ***Active discussion in NOvA about approach.***

Modern Adaptive Modular Bubblechamber Archetype (MAMBA) Goals

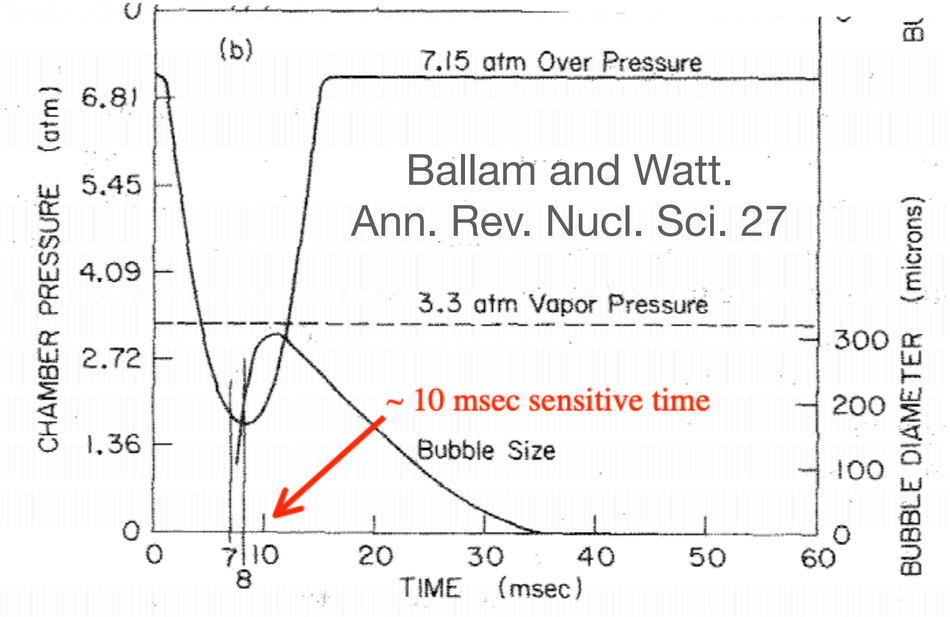
Let's adapt modern chambers to do fundamental physics!



SBC Prototype



MMBC Concept 1



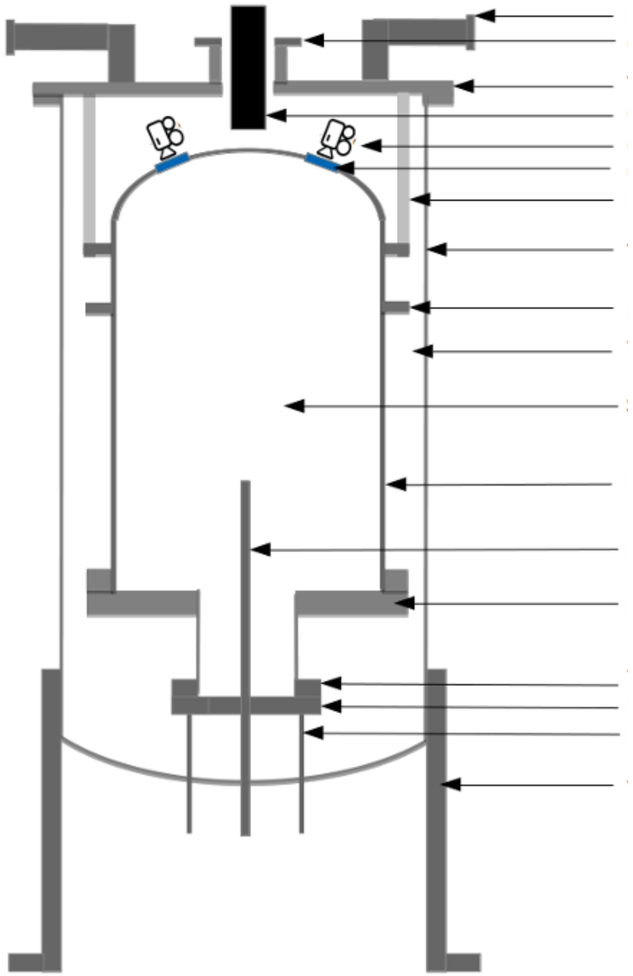
SLAC 1m Hybrid Chamber

Major thrust of this LDRD will be using a ~5L prototype to investigate how to reduce the cycling time *and/or* expand the sensitive time!

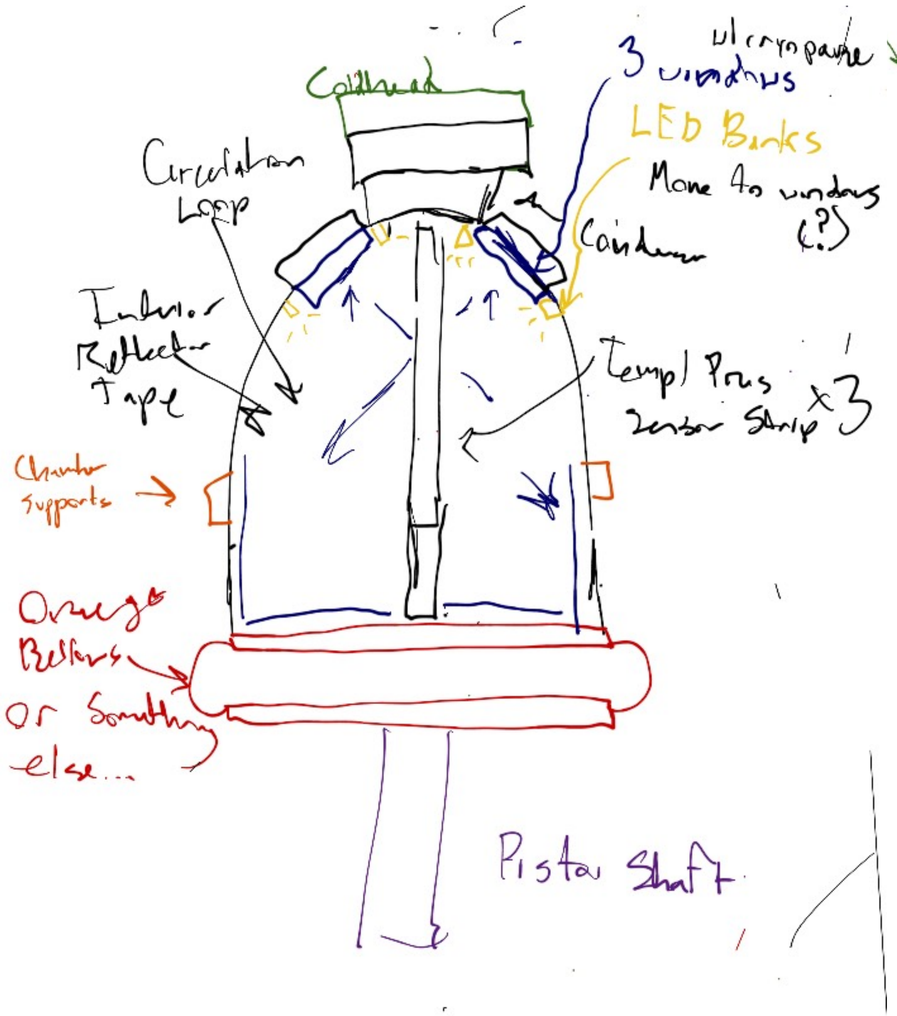
Success allows the creation of a *modular* production prototype (~2m characteristic length/ ~Eight/Quarter-ton mass).

Pressure Vessel (Part One)

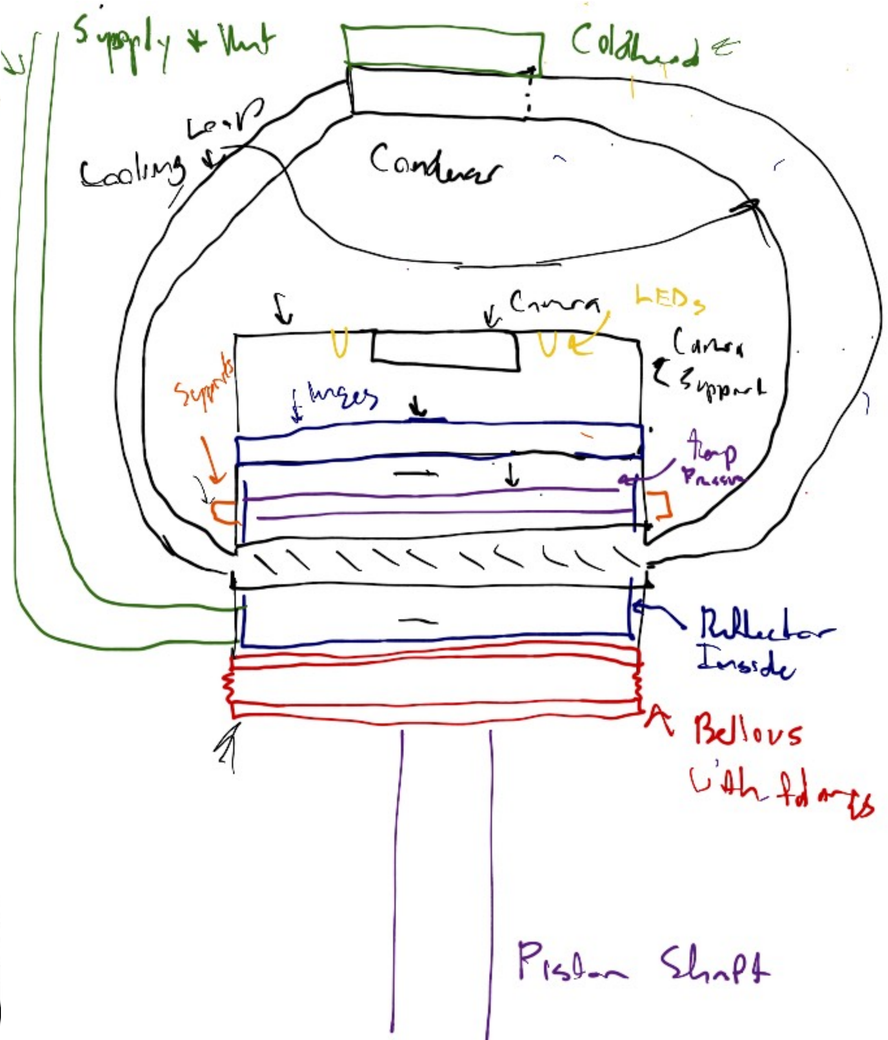
The most design intensive part!



SBC Pressure Vessel



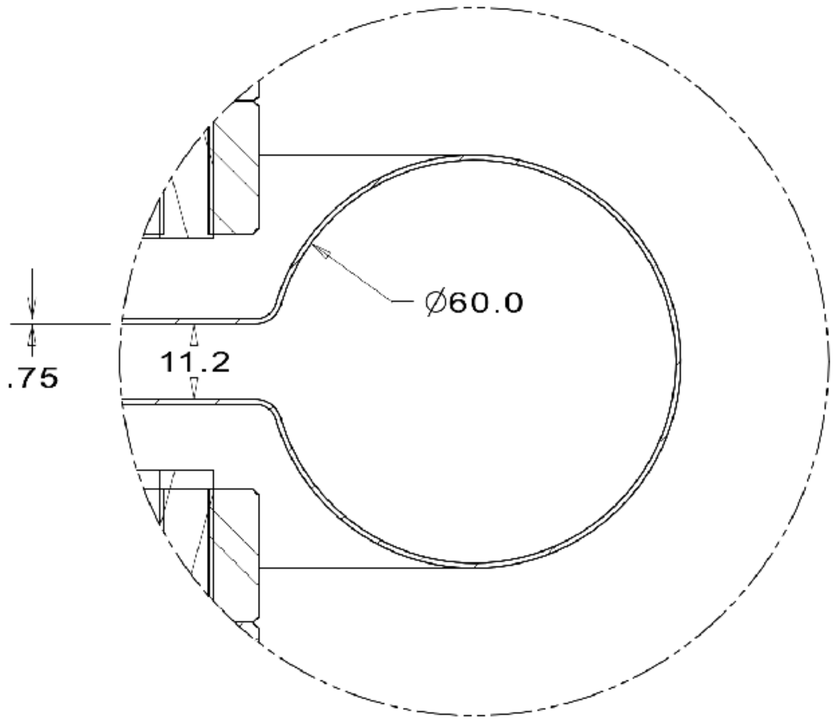
MMBC Pressure Vessel Concept 2

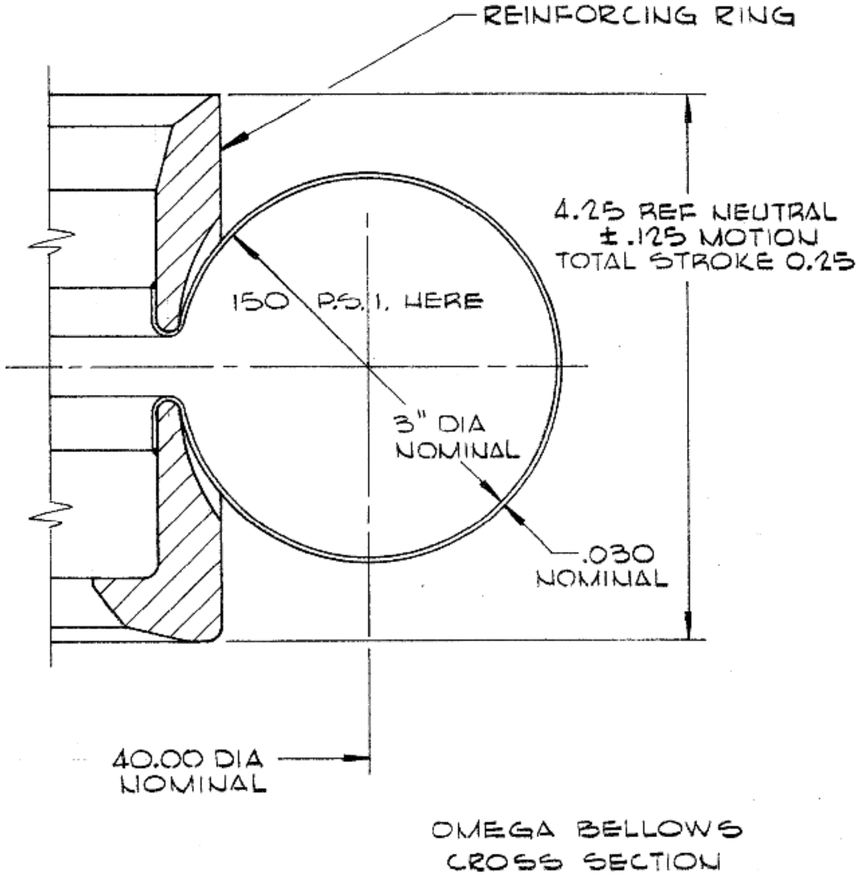


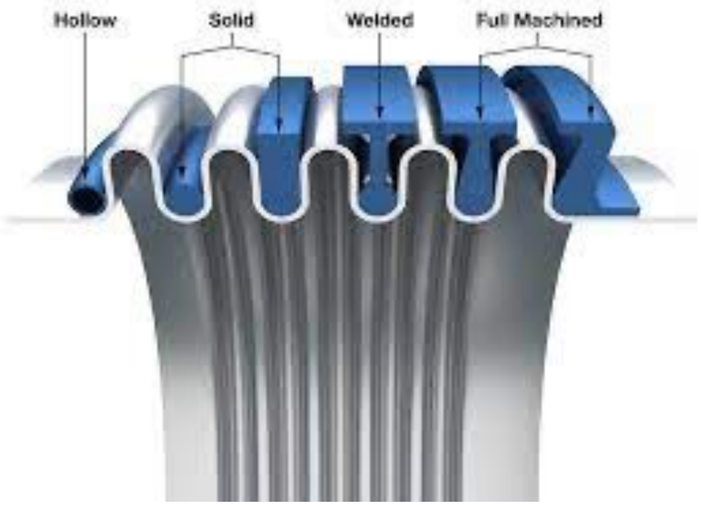
MMBC Pressure Vessel Concept 3

Pressure Vessel (Part Two)

The bellows, another design intensive part







Traditional Reinforcement Idea

MAMBA Bellows Concept 1

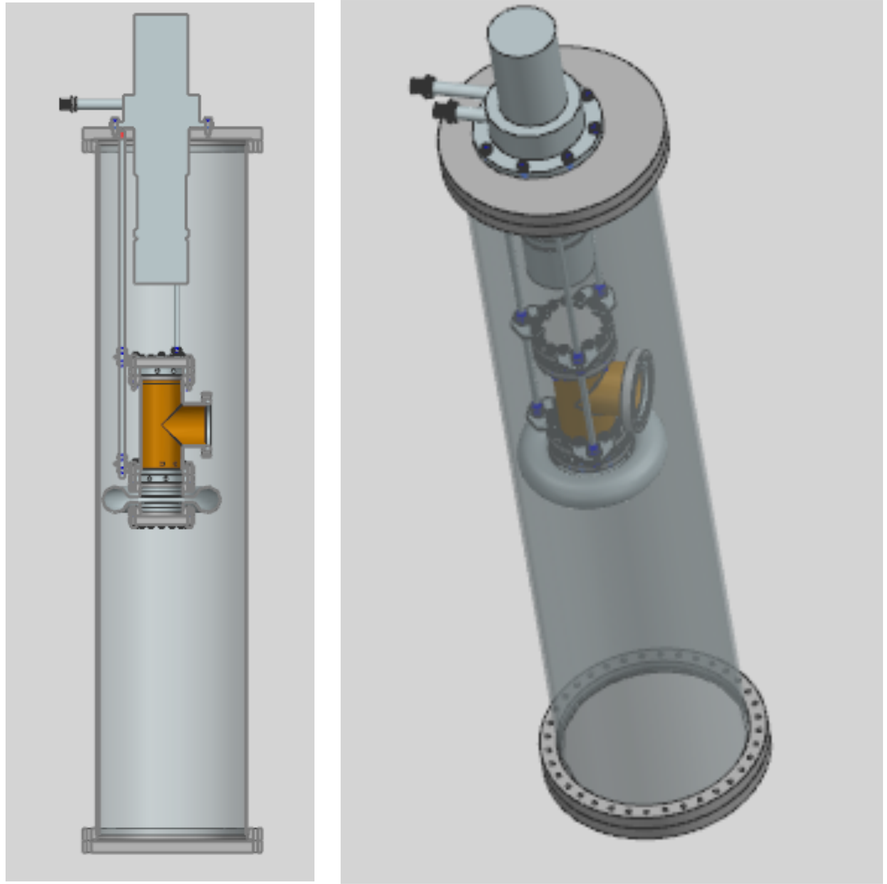
SLAC 40” Hydrogen Bubble Chamber Bellows

Extensive communication with multiple manufacturers, design of bellows still in flux. Awaiting FEA analysis to predict deformation for Bellows Concept 2.

Pressure Vessel (Part Three)

The most design intensive part!

MAMBA Pressure Vessels



MAMBA Pressure Vessel, Cold Head, and Bellows

Switch to Conflat Lesker Tee Satisfies all requirements of bubble chamber and simplifies design at 2% of projected costs.

Hydraulic Cylinder, Piston, & Shaft

Responsible for Volume Actuation

- Considerable innovation here!
  - SBC using hydraulic actuation is custom developed for their needs. Our needs are different!
  - Entire class of linear actuators provide precision, power, and flexibility.
  - Trade-offs between size, power, however current device promises ~10kN Continuous
  - Working out placement of actuator outside of the Vacuum Jacket with associated bellows on bottom flange.

Current Objectives for Building a MAMBA

Major Update to Project Objectives after the First Year

Scope has been updated!

- **First Objective (Q2/FY24)** A fully leak checked, pressure ready, and vacuum ready device in MiniBooNE Hall.
- **Second Objective (Q3/FY24)** First fill and tests of hydrogen safety system
- **Third Objective (Q1/FY25.0)** 1 Hz cycling time.
- **Fourth Objective (Q1/FY25.0)** Minimum possible cycling time.
- ~~**Fifth Objective (Q1/FY25.0)** Maximum active time without interior changes. Polish, coating, or plating and retest maximum active time.~~
- **Fifth Objective (Q2/FY25)** Precision track reconstruction on cosmic ray muons.

Reach Goal

- **Sixth objective (Q3/FY25)** sync to the Fermilab Testbeam clock and observe hadron decays.