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Title:	LANL LAr Cryostat
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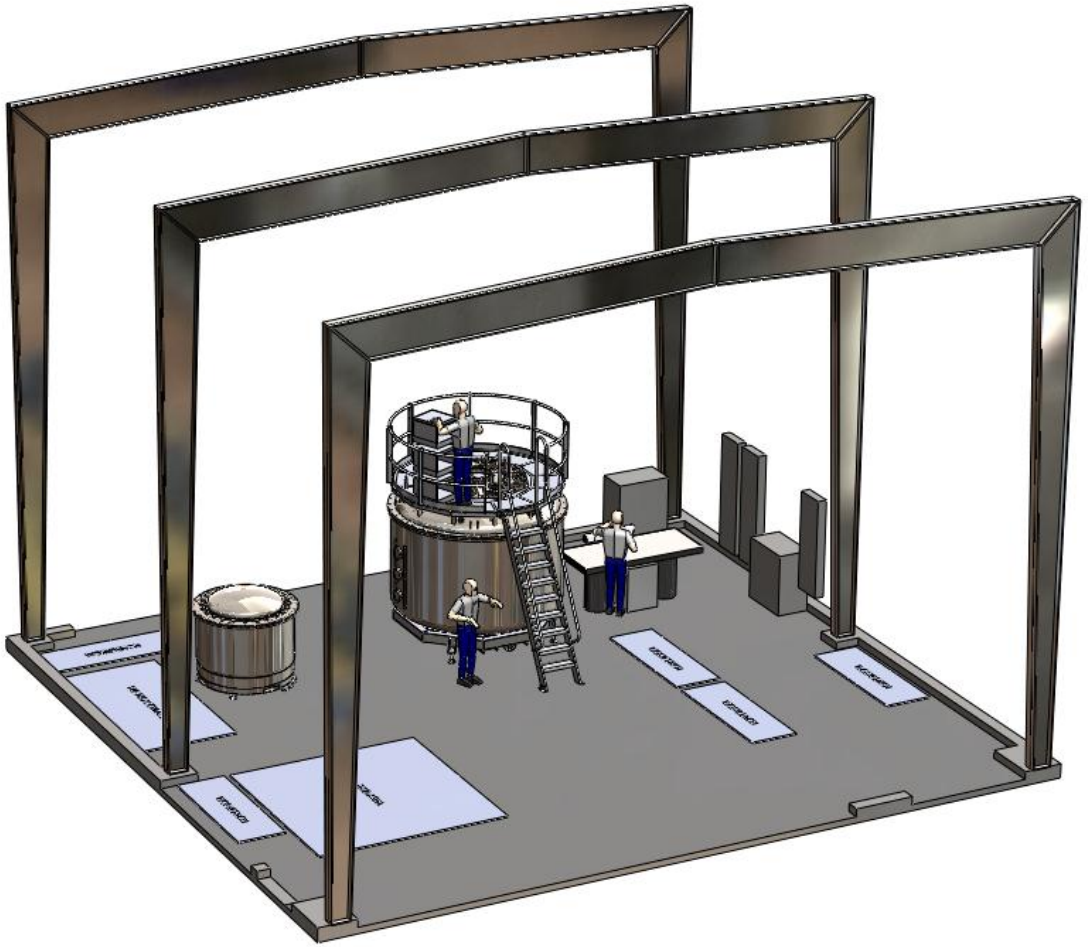
LANL LAr Cryostat

Ramsey 2/1/2013

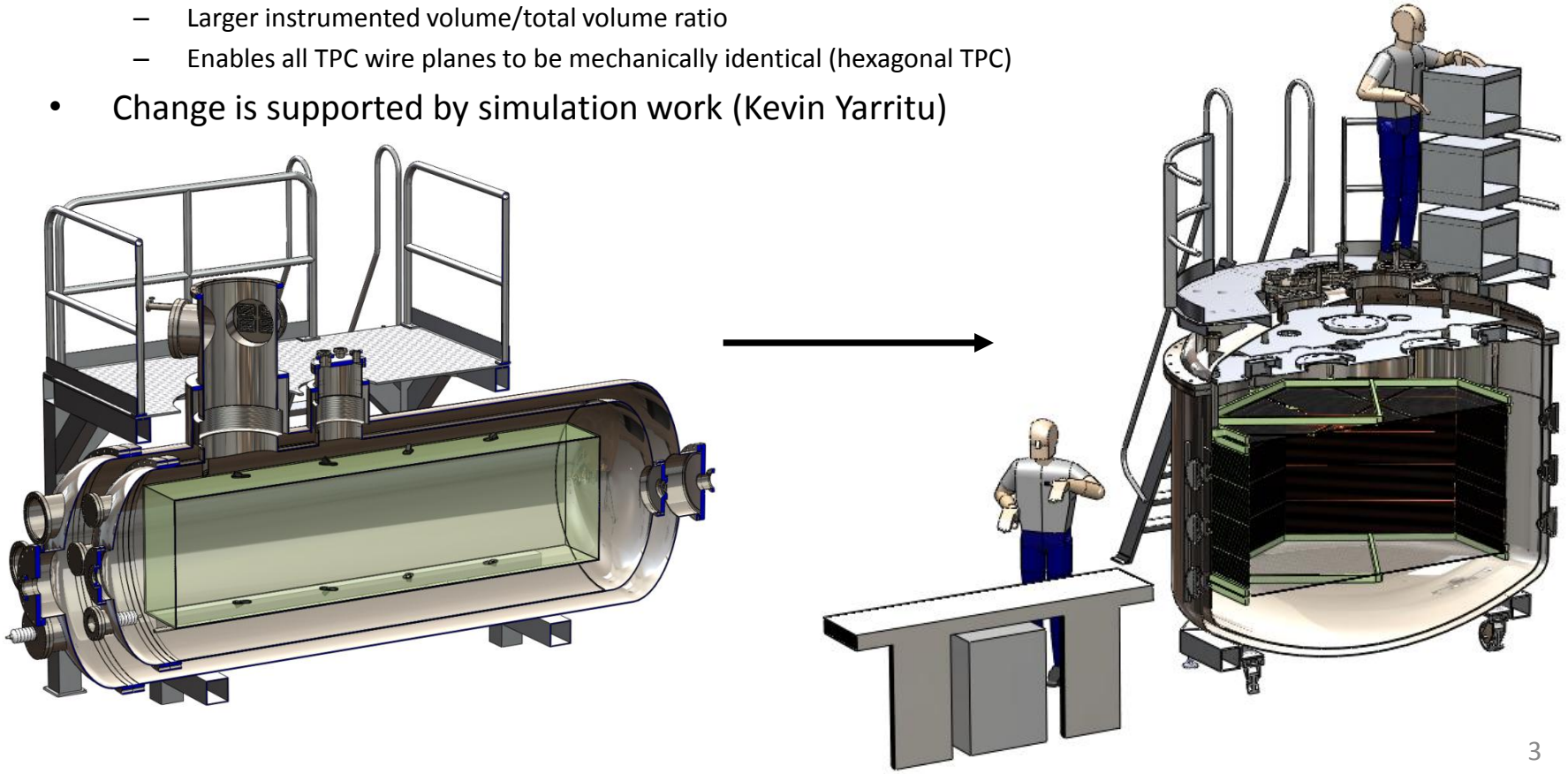


Cryostat design criteria

- Physics requirements
  - Accommodate as large a TPC as possible within budget
  - Allow optical access to the liquid argon volume for laser calibration system
  - Shape considered
- Mechanical
  - Provide mechanical provisions for instrumentation as well as cryogenic services
  - Maintain transportability
  - User safety

Major design revision

- Based on input from UCLA collaborator Hanguo Wang
- Significant improvement to system robustness and reduced risk associated with TPC work
  - Minimized disturbance of cryogenic and instrumentation connections when accessing the TPC
  - No large cryogenic seals
  - Larger argon volume
  - Larger instrumented volume/total volume ratio
  - Enables all TPC wire planes to be mechanically identical (hexagonal TPC)
- Change is supported by simulation work (Kevin Yarritu)

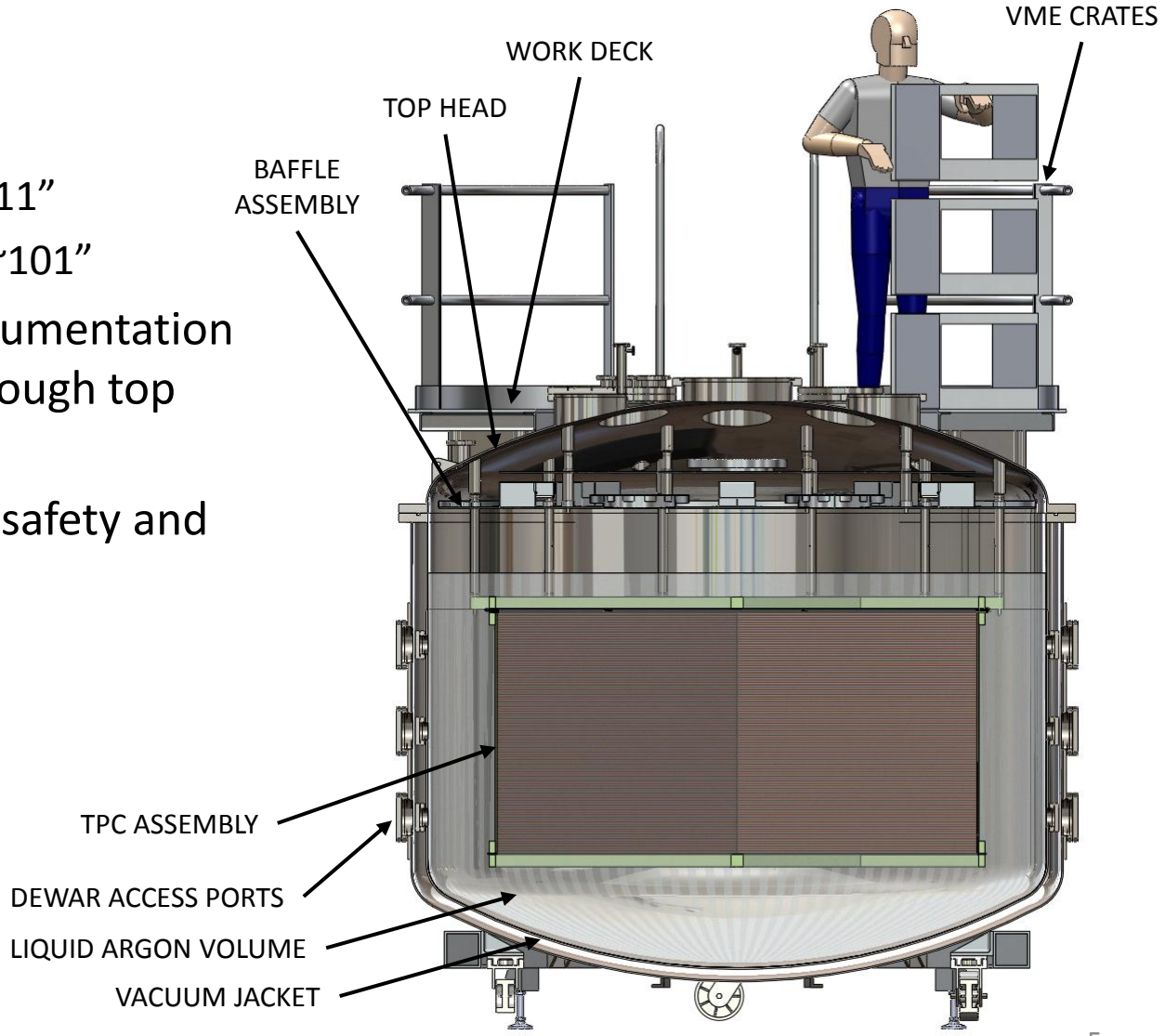


Schedule and cost impacts of design change

- Procurement of the cryostat is a major milestone in the LDRD project
- Original plan was to be prepared to place cryostat order at the beginning of FY13
- Cryostat delivery currently expected to arrive by end of August, 2013, based on expected bidding and delivery times
- Though new cryostat cost is higher than the original, the cost increase is within the contingency as originally presented

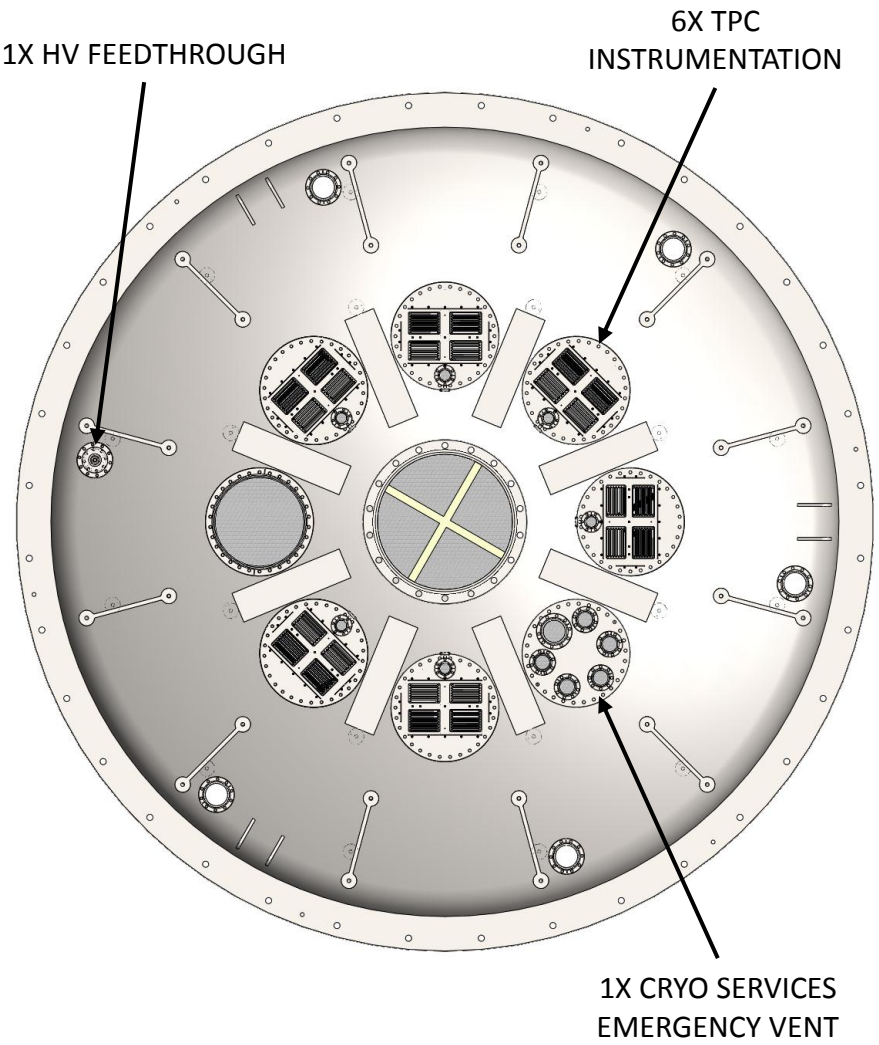
Overview of current design

- Capacity: ~7700 L
- External dimensions
  - Flange diameter – 111”
  - Work deck height - ~101”
- All cryogenic and instrumentation connections made through top head
- Work deck for worker safety and convenience



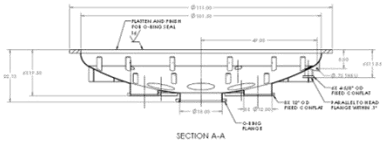
Overview (continued)

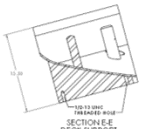
- Top Head Port layout
  - 8X 12” instrumentation/services ports (1 unsubscribed)
  - 1X 18” port (currently unsubscribed)
  - 6X 3” ports (5 currently unsubscribed)

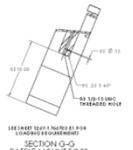


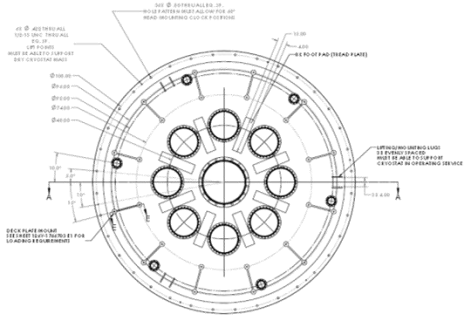
Overview (continued)

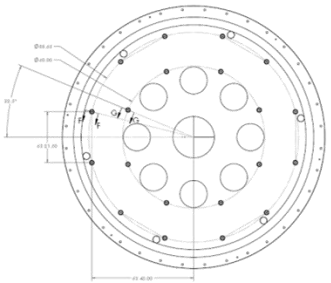
- Preliminary drawings have been prepared for cryostat RFQ
- Vendor will provide final drawings for LANL approval prior to commencing with fabrication

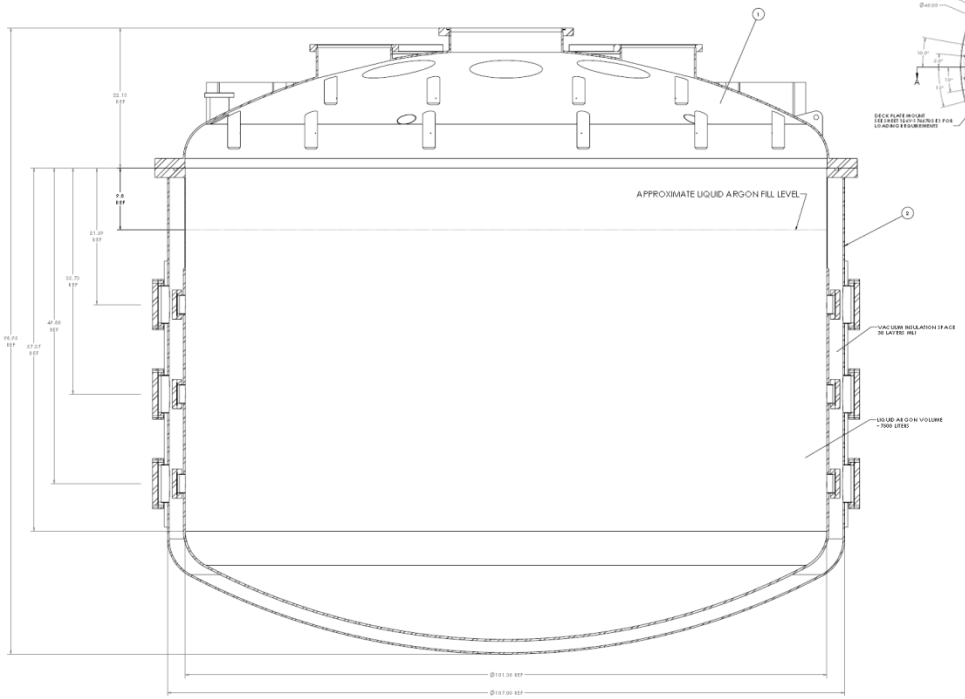












Safety

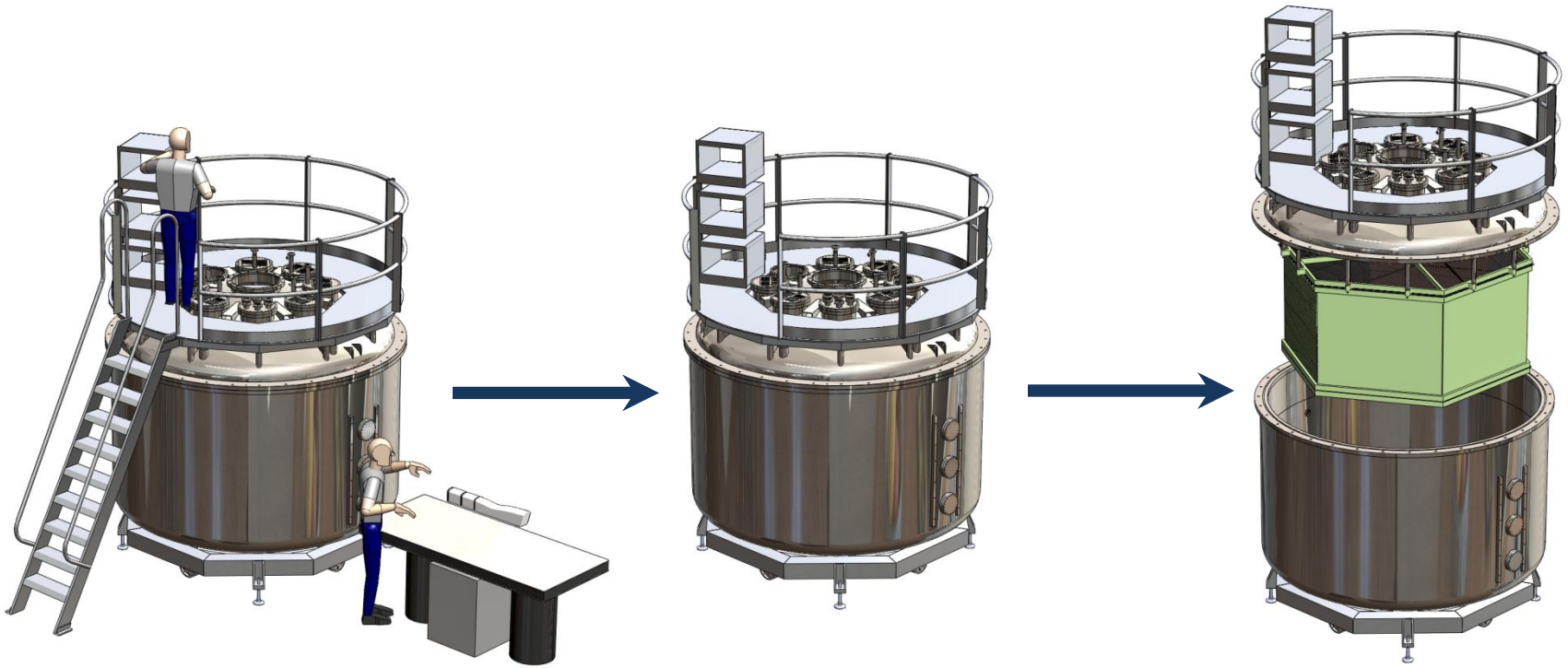
- Pressure safety
  - Design work has been done in coordination with LANL pressure safety personnel
  - Cryostat design uses all conventional features, and will thus be an ASME Section VIII Division 1 pressure vessel
    - ASME certification provides an independent QA check on the design and fabrication
    - Can also ease approval overhead when vessel is transported to other labs
  - Vacuum jacket relief per CGA-341
  - Liquid volume relief via burst disk/vent pipe
- Work deck
  - Included to provide safe access to top ports for workers
  - Mounts to the top of the cryostat

Inner Volume Surface Area (m2)	15.920	Wetted IVC Surface of Liquid Volume
Heating Rate (W/m2)	1800	Cryogenics 52 (2012) pp 331-335
Latent Heat of Evap (J/kg)	16081	
Total Heat Input (W)	28656	
Mass Flow Rate (kg/s)	1.782	
Flow through Straight Vent Pipe		STP Gas
Diameter (m)	0.161	6" Schedule 10 Pipe (6.357" ID)
L (m)	20	length estimate
Flow Area (m2)	0.0203	
STP Density (kg/m3)	1.784	
STP Flow Rate (m3/s)	0.999	
Vsonic @STP (m/s)	283.75	per DUC Design Doc, App. C
Average Flow Velocity (m/s)	49.06	
Mach Number	0.17	<.3 - Incompressible
STP Viscosity (Pa-s)	0.0000752	NIST
Reynolds Number	187400	
Friction Factor (Moody)	0.0320	e/D=.006
K1 (Straight Vent Pipe)	3.975	Crane, 1999
dP (Pa)	8535.93	Darcy Formula
dP (psi)	1.24	

Additional Ks (STP) and Resulting DP	K	dP (Pa)	dP (psi)	
Sudden constriction to vent pipe	0.5	1073.7	0.16	Crane, 1999
90° radiused tubing elbows	0.64	8245.7	1.20	(r/D=1), quantity estimated at 6
Fike Axius Rupture Disc	0.45	966.3	0.14	Ref Fike Technical Bulletin
Abrupt exit	1	2147.3	0.31	Crane, 1999
Total dP (psi)	**3.040**			

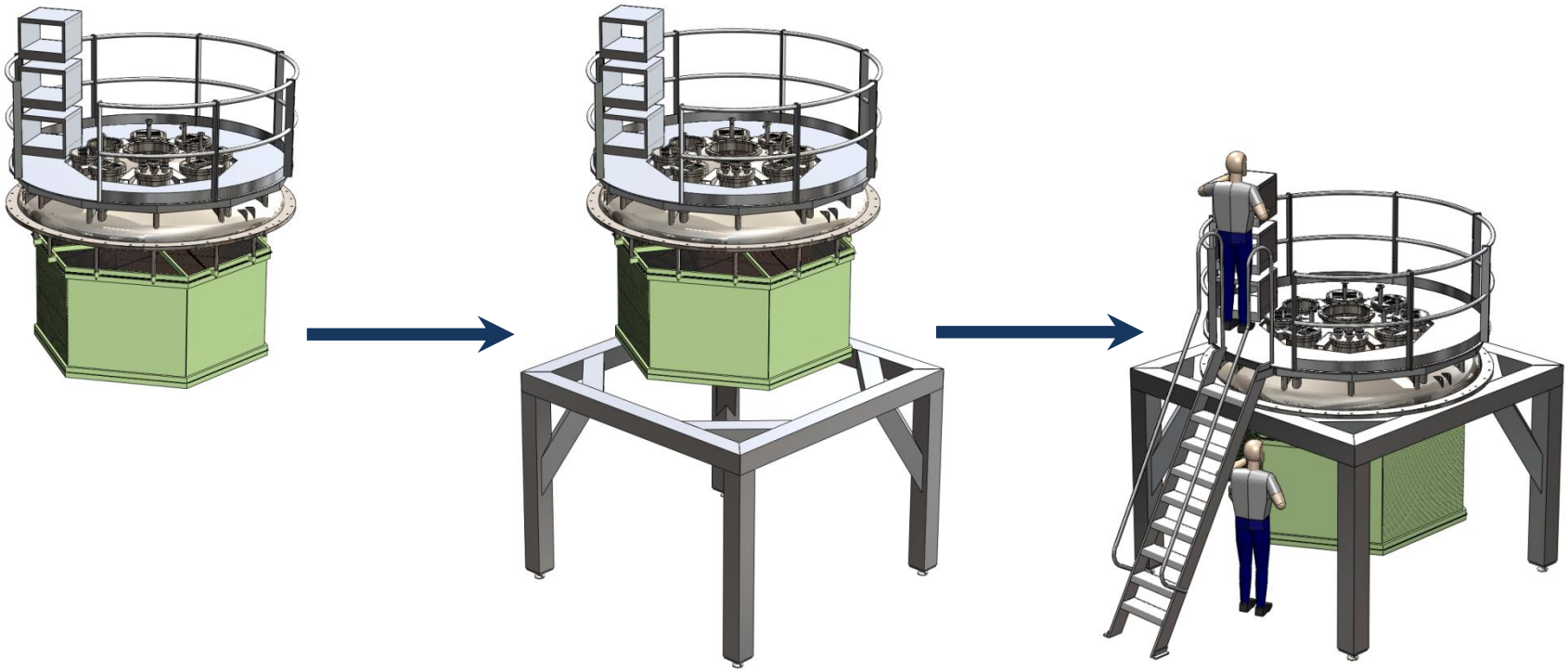
Assembly/maintenance(continued)

- TPC may be accessed by lifting the insert, removing the dewar, and placing the insert on a support stand



Assembly/maintenance(continued)

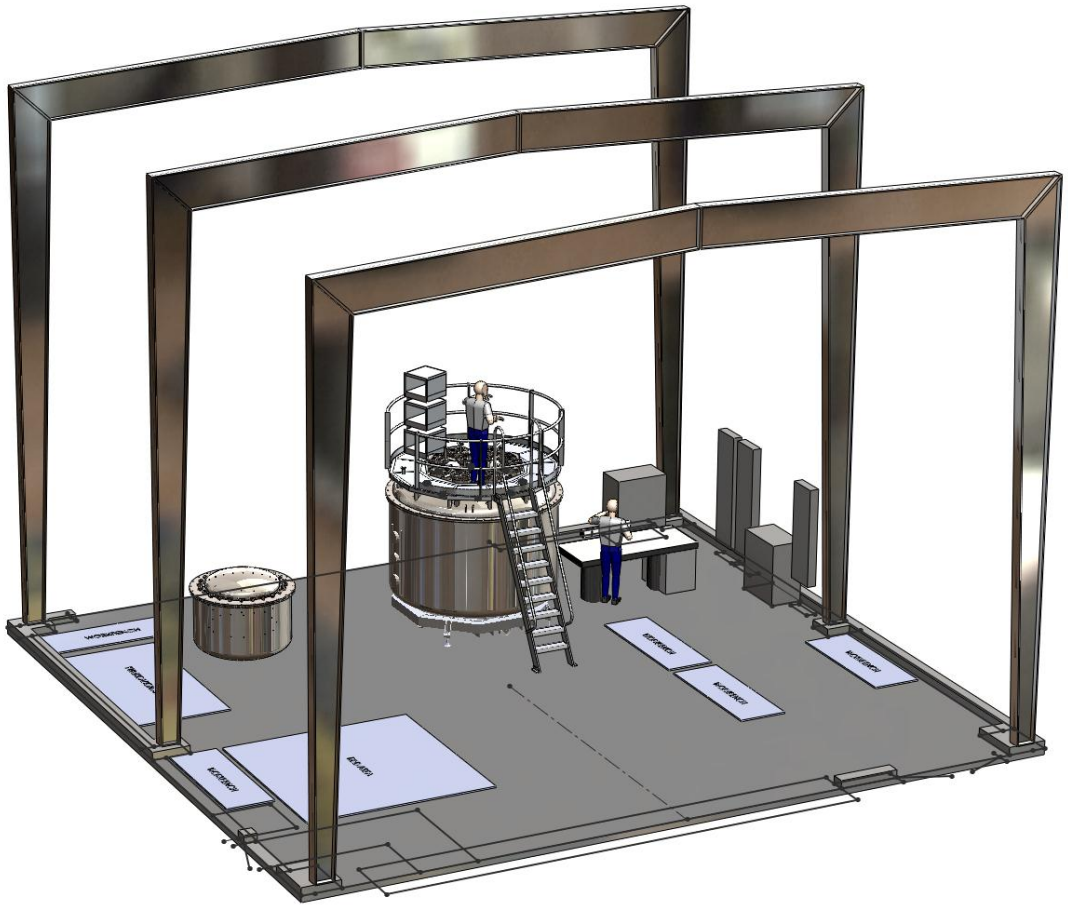
- Process may be reversed to re-insert TPC



Procurement process and status

Define cryostat requirements (physics/mechanical)	**COMPLETE**
Create preliminary design	**COMPLETE**
Preliminary drawings	**COMPLETE**
Coordinate with LANL pressure safety	**COMPLETE**
Obtain budgetary quote from vendor	**COMPLETE**
Compile procurement documentation	**COMPLETE**
Exhibits D (SOW) and H (Q/A)	**COMPLETE**
Form 410 approval (pressure safety)	**COMPLETE**
Purchase Request	**COMPLETE**
LISC (Laboratory Integrated Stewardship Council) Approval	**COMPLETE**
Buyer assignment	**COMPLETE**
Formal RFQ	**IN PREPARATION**
Bidding process	
Contract award	**EXPECTED BY FEB 28th, 2013**
Fabrication	
Vendor provides final fabrication drawing for LANL approval	
Materials order	
Machining/welding	
QA check	
Delivery to LANL	**EXPECTED BY AUGUST 30TH, 2013**

Questions?



Projected heat load - backup

- Note: cryostat vendor to provide heat load estimate with final drawings for LANL approval

Calculated Heat Load Summary	
Liquid Argon Prototype	
Ramsey 1/2013	
Argon Volume Rad Load (W)	30.25
TPC Supports (W)	55.01
L Ar Volume Support (W)	202.66
Instrumentation Wiring (W)	13.56
HV Conductor Wiring (W)	0.34
Viewport Light Load (W)	2.40
Laser Heat Load (W)	0.90
Total Heat Load (W)	305.11