OAK RIDGE National Laboratory

Moderator Reflector Assembly Fabrication and Acquisition

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MRA Lead Engineer

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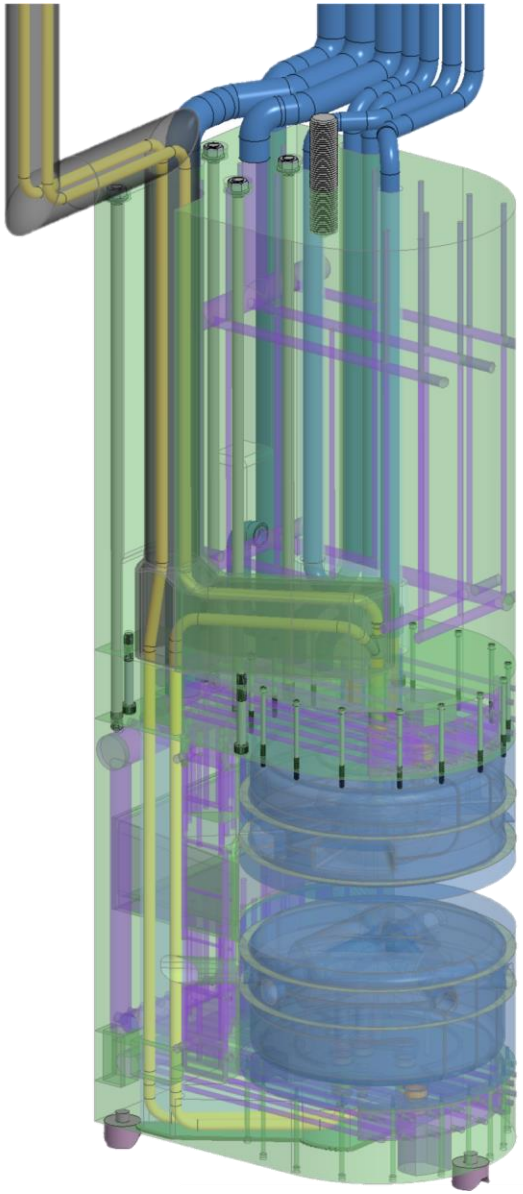
ORNL is managed by UT-Battelle, LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

Outline

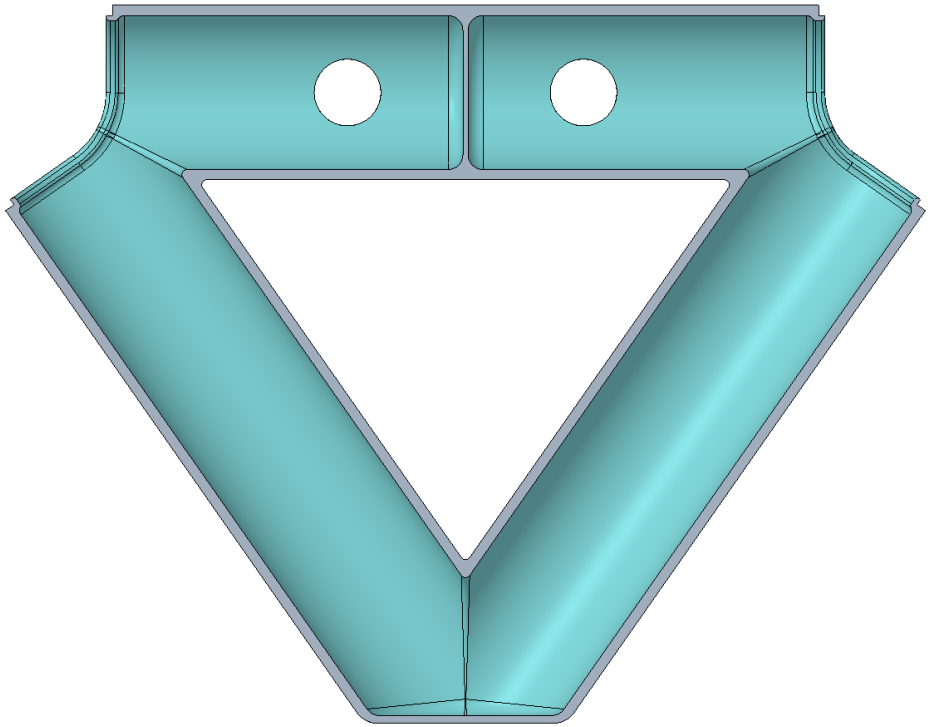
- Strategy
- Hydrogen Vessels
- Vacuum Vessels
- Reflector Vessels
- Backbone
- Piping
- Final Assembly
- Acqusition

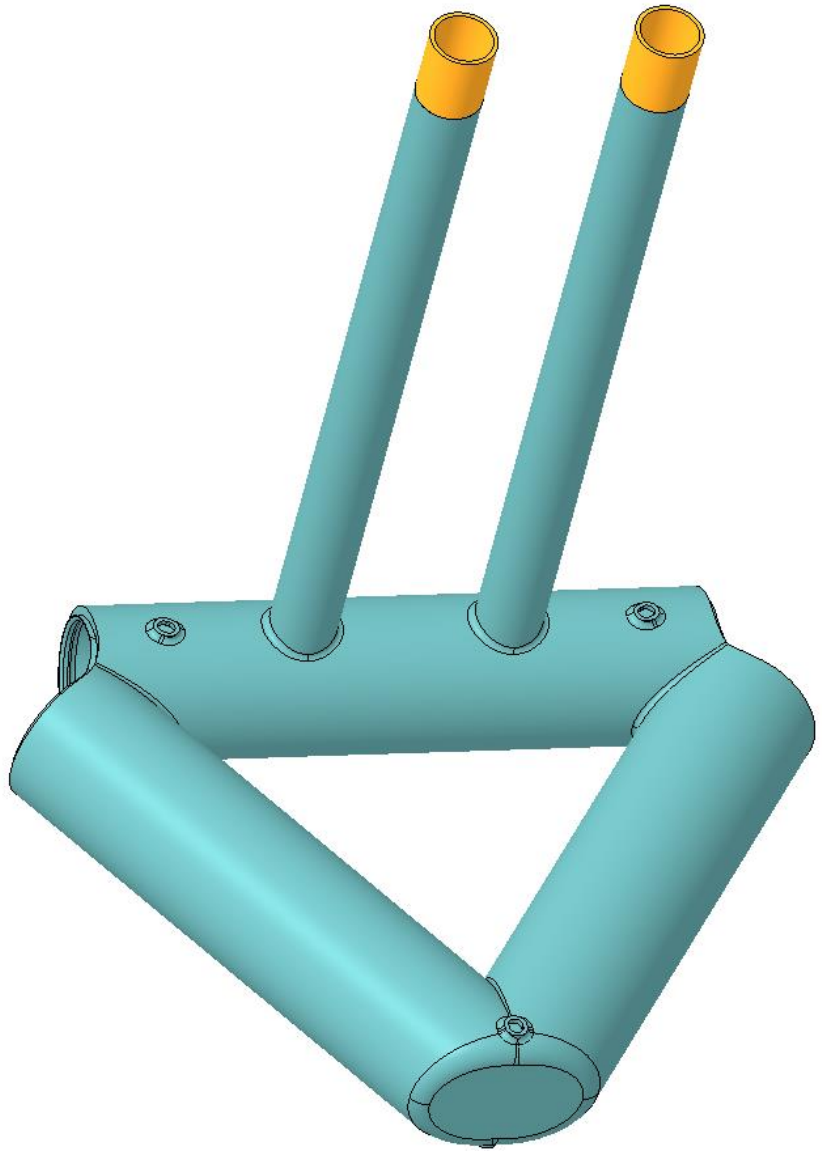


Strategy

- Minimize the quantity and complexity of welding by simplifying design
- Choose machining complexity and volume in order to reduce welding complexity and volume

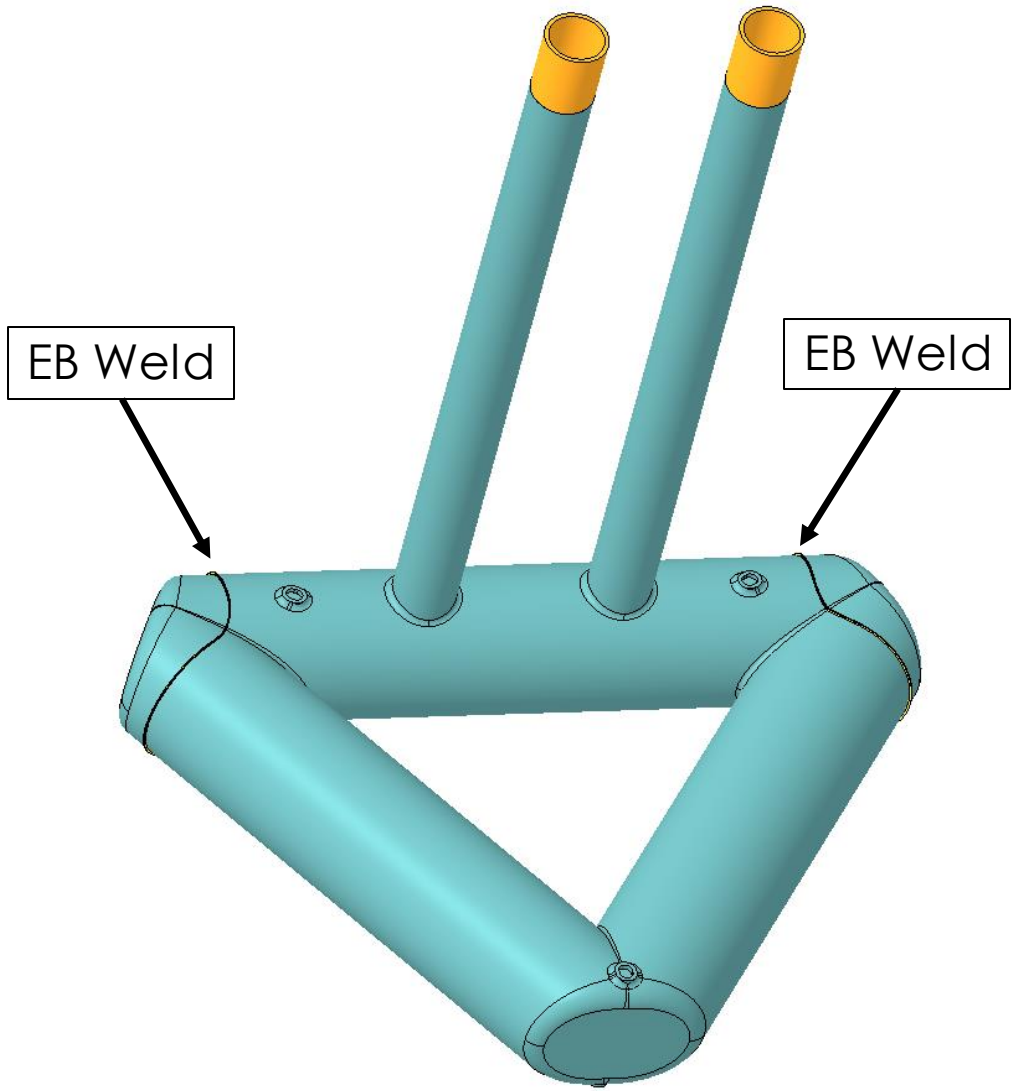
Hydrogen Vessel Body





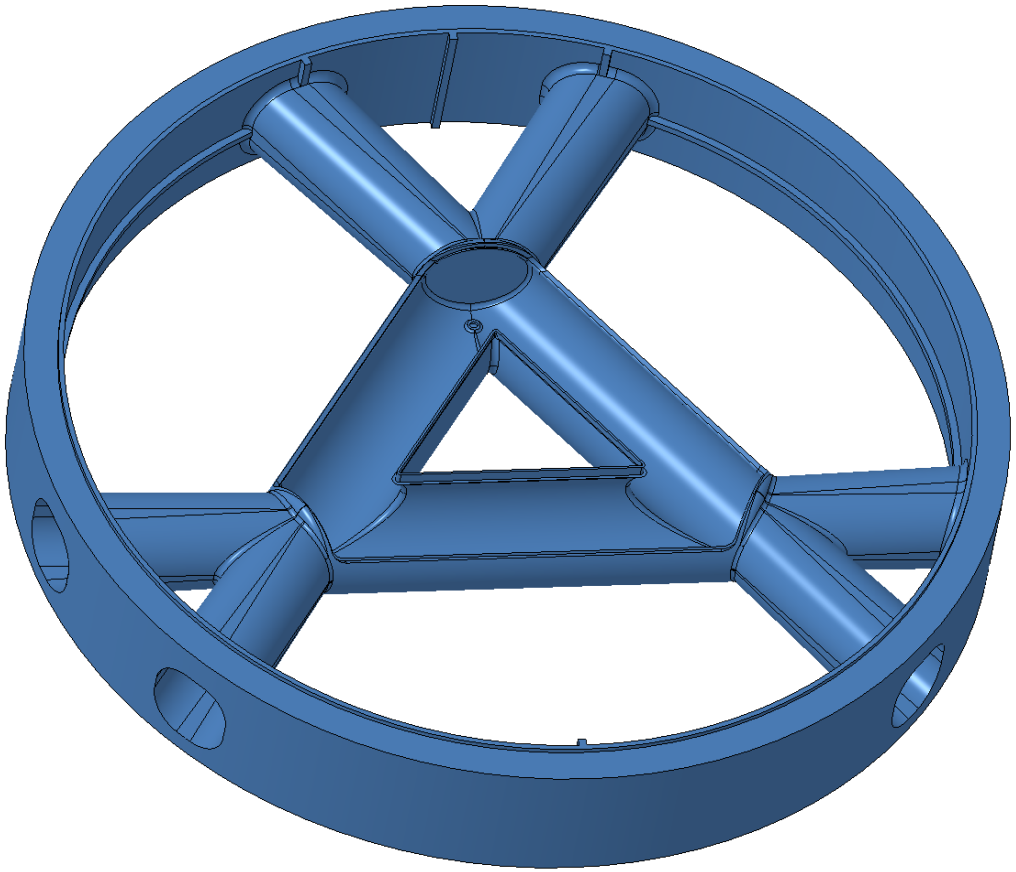
- Interface features and majority of hydrogen boundary integrated into single part

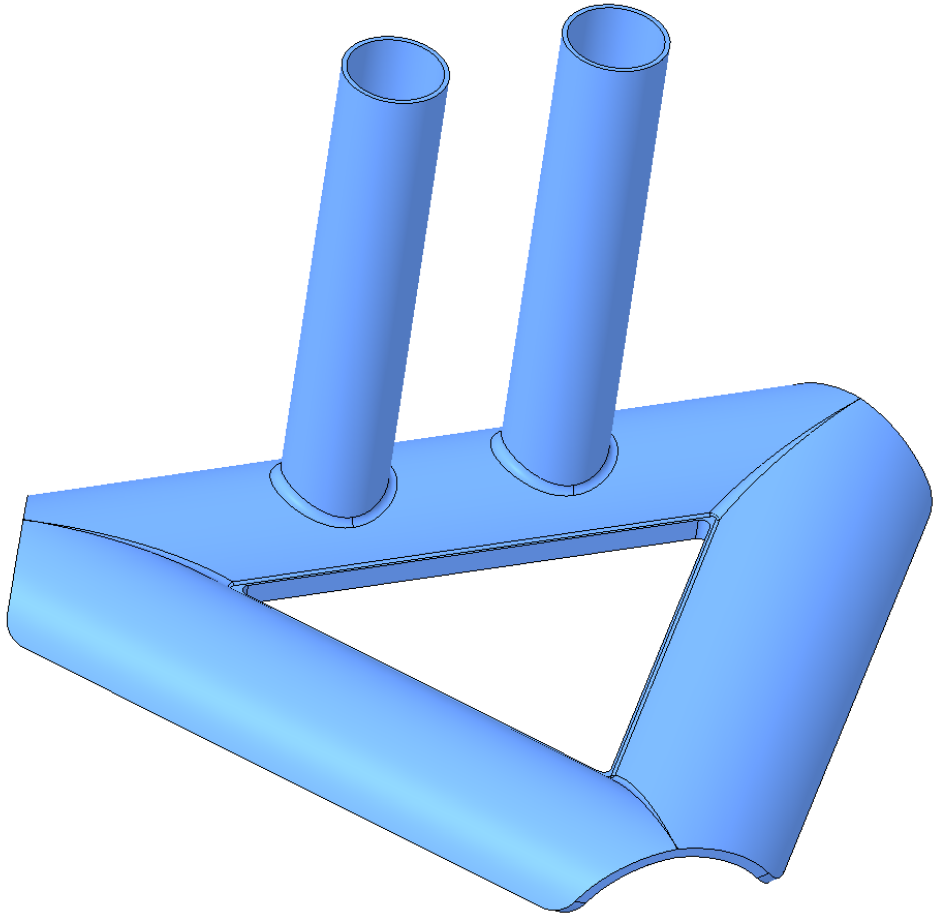
Hydrogen Vessel Weldment



- Constant 2 mm weld thickness welded in 2 passes with simple weld geometry

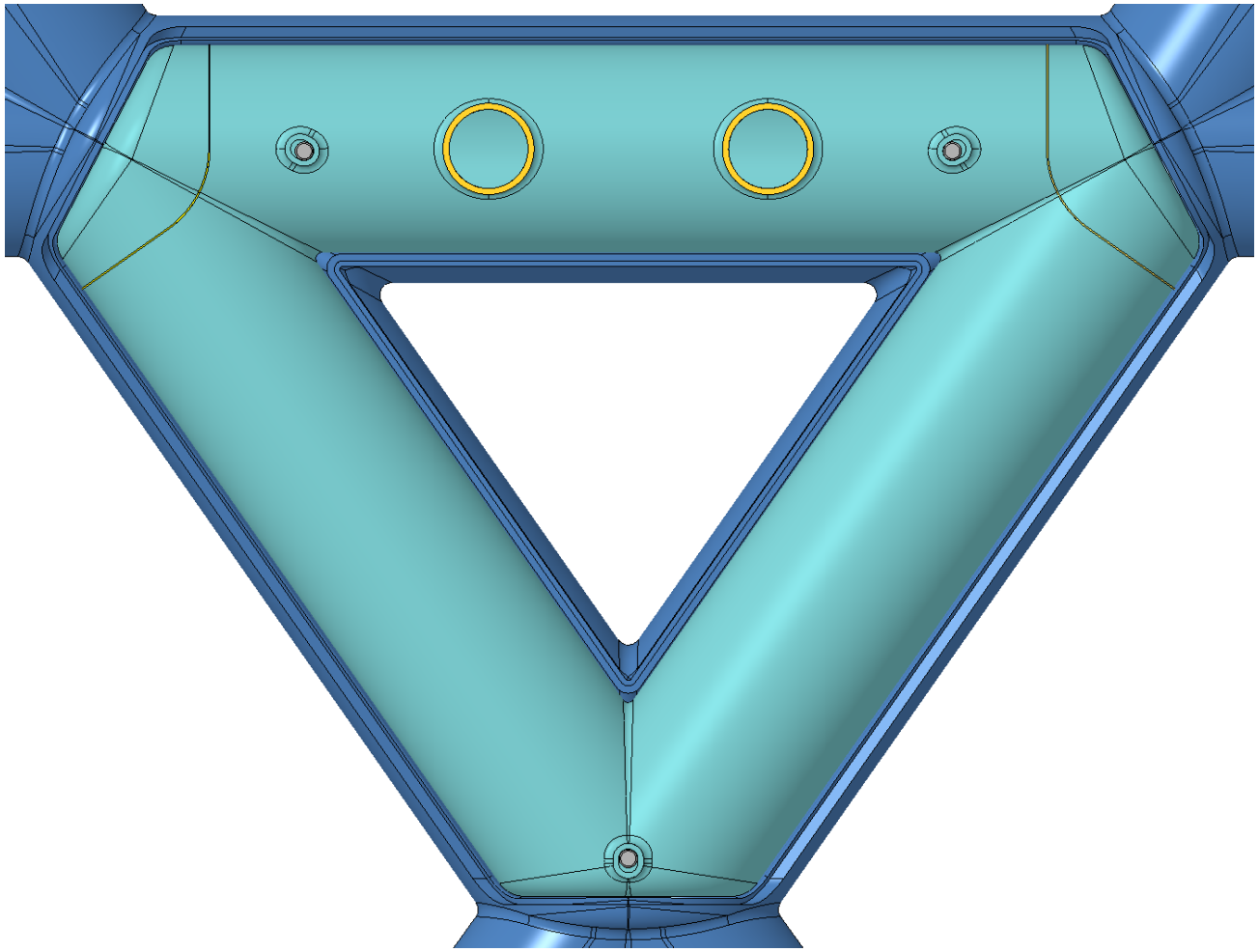
Vacuum Vessel Parts





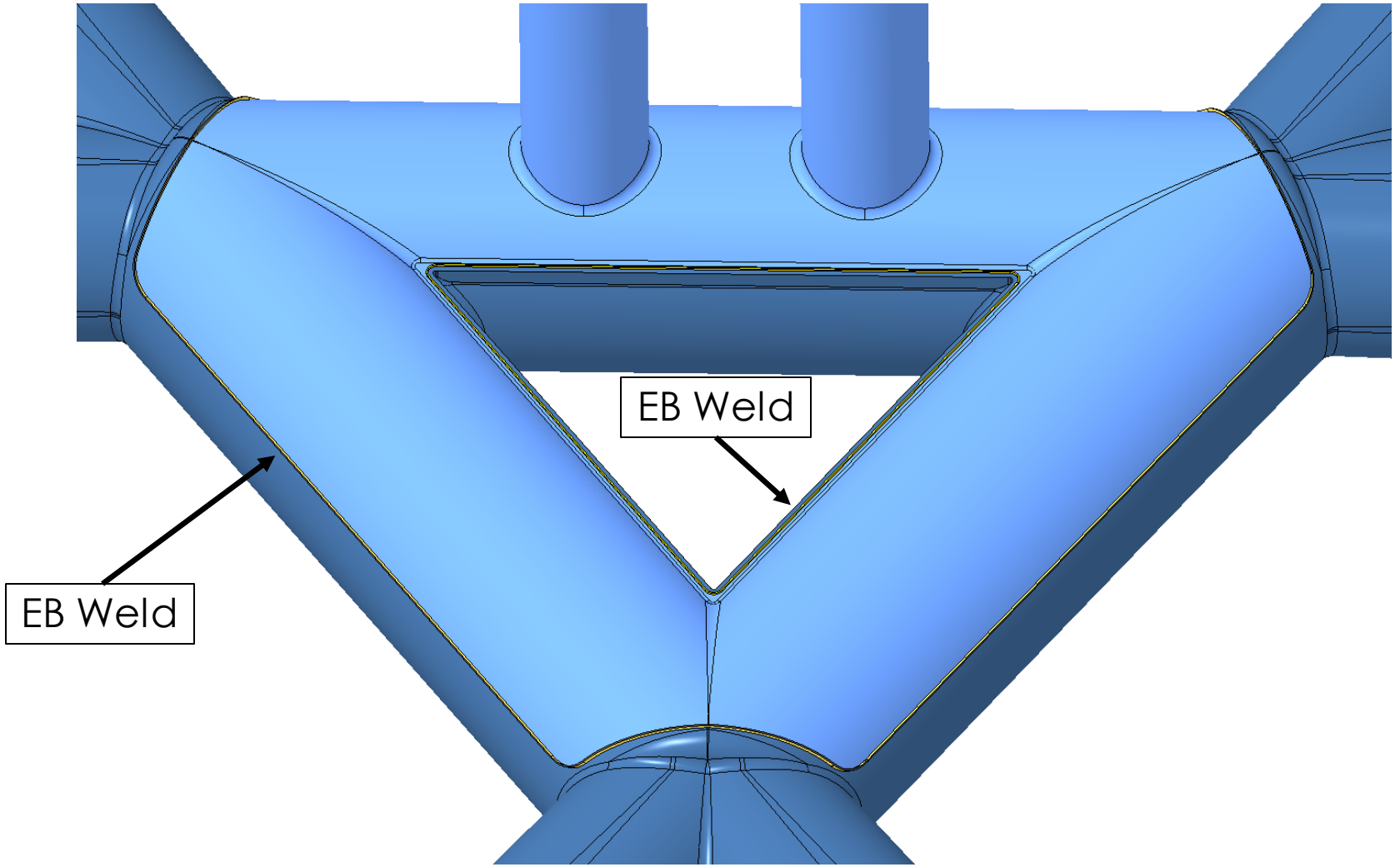
- Machined from single forgings – vacuum vessel body pushes machining complexity limit

Hydrogen Vessel Assembled in Vacuum Vessel



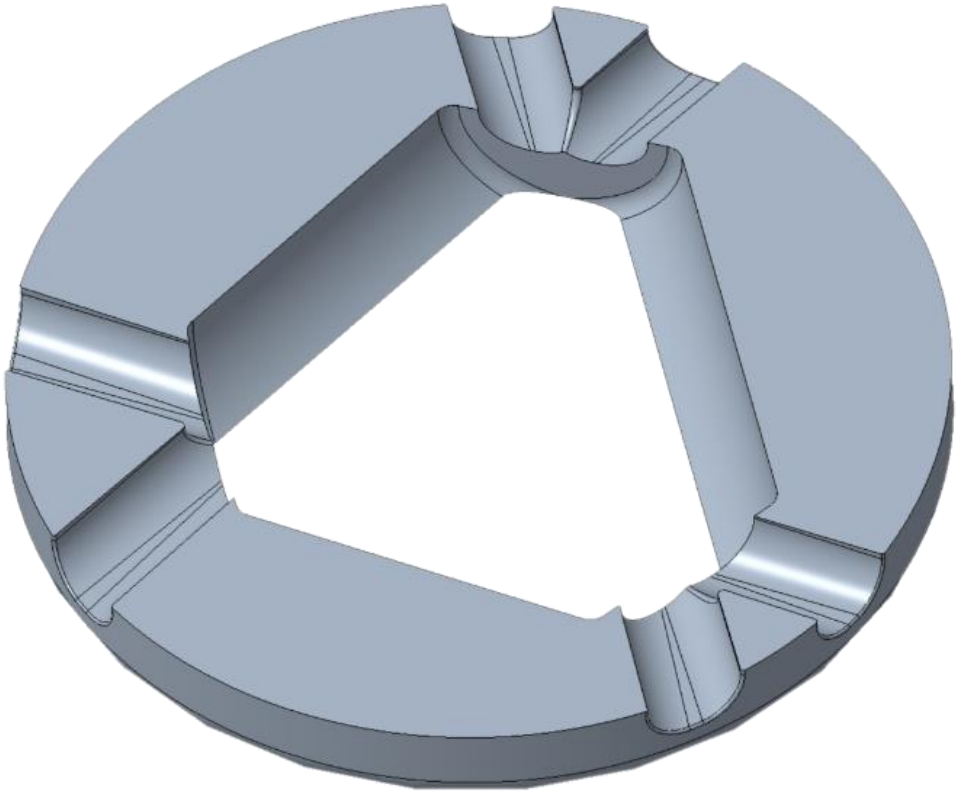
- Vacuum vessel body opening designed to just allow the hydrogen vessel to fit for assembly

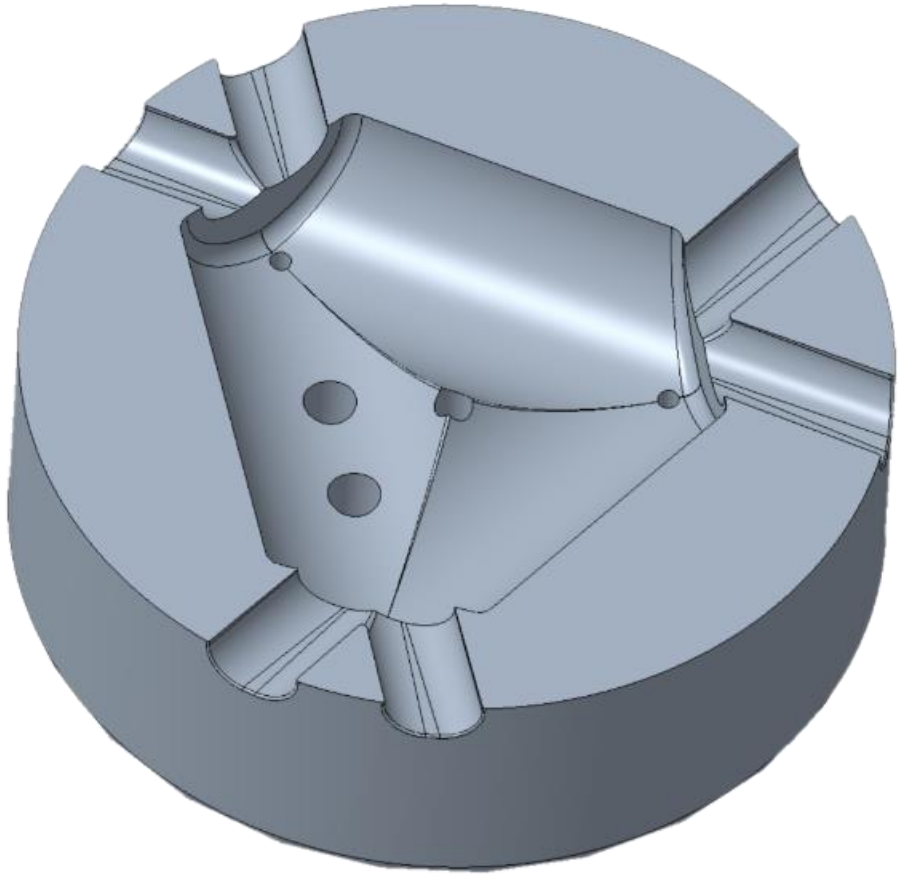
Vacuum Vessel Weldment



- The most complex step in the whole process! – expect extensive weld development

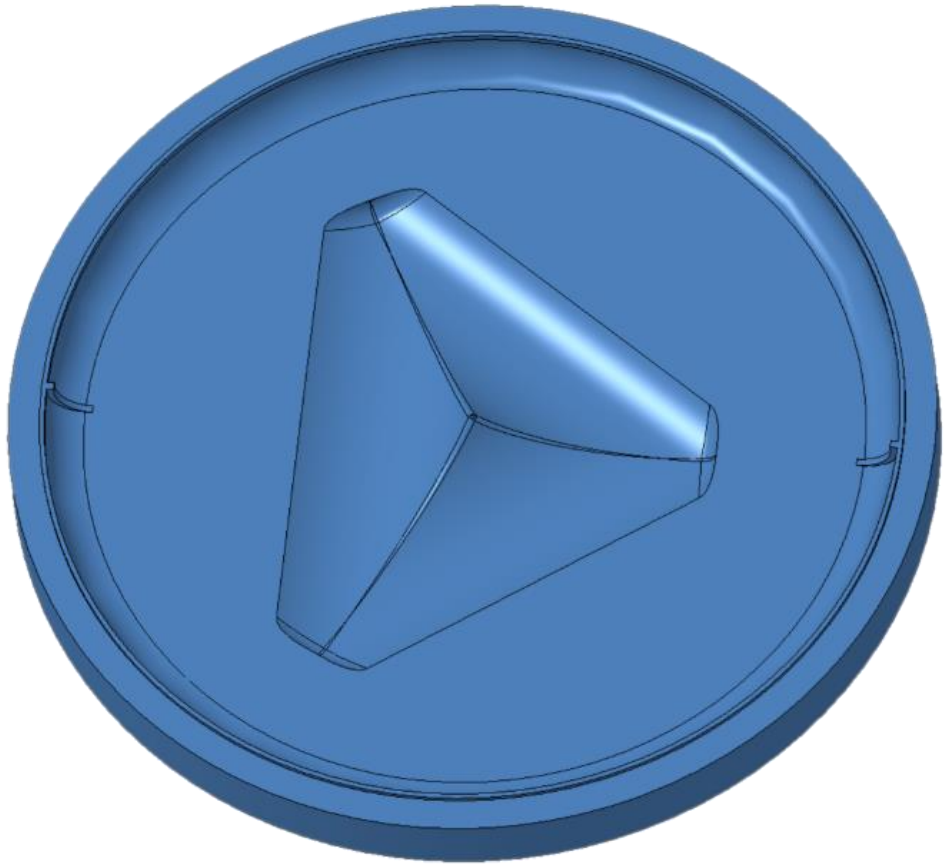
Beryllium Fabrication

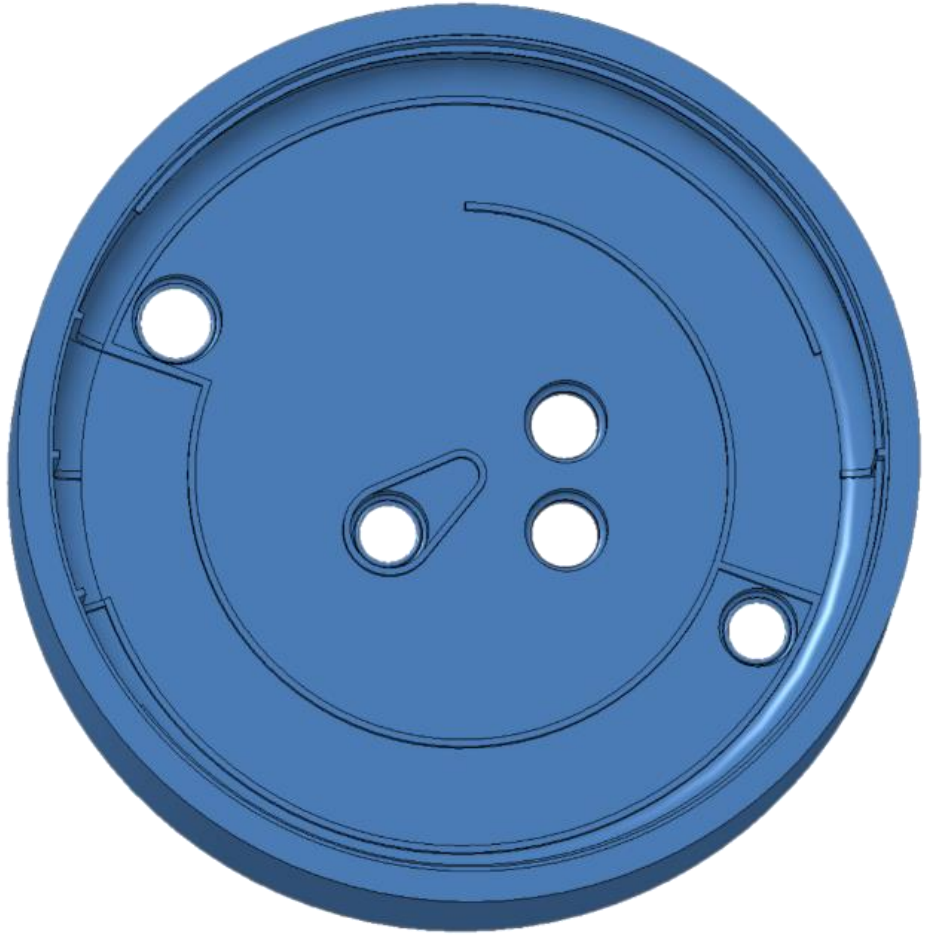




- Requires vendor experienced with mitigating Beryllium machining hazards
- Straightforward machining but requires precision for acceptable fit up without rework

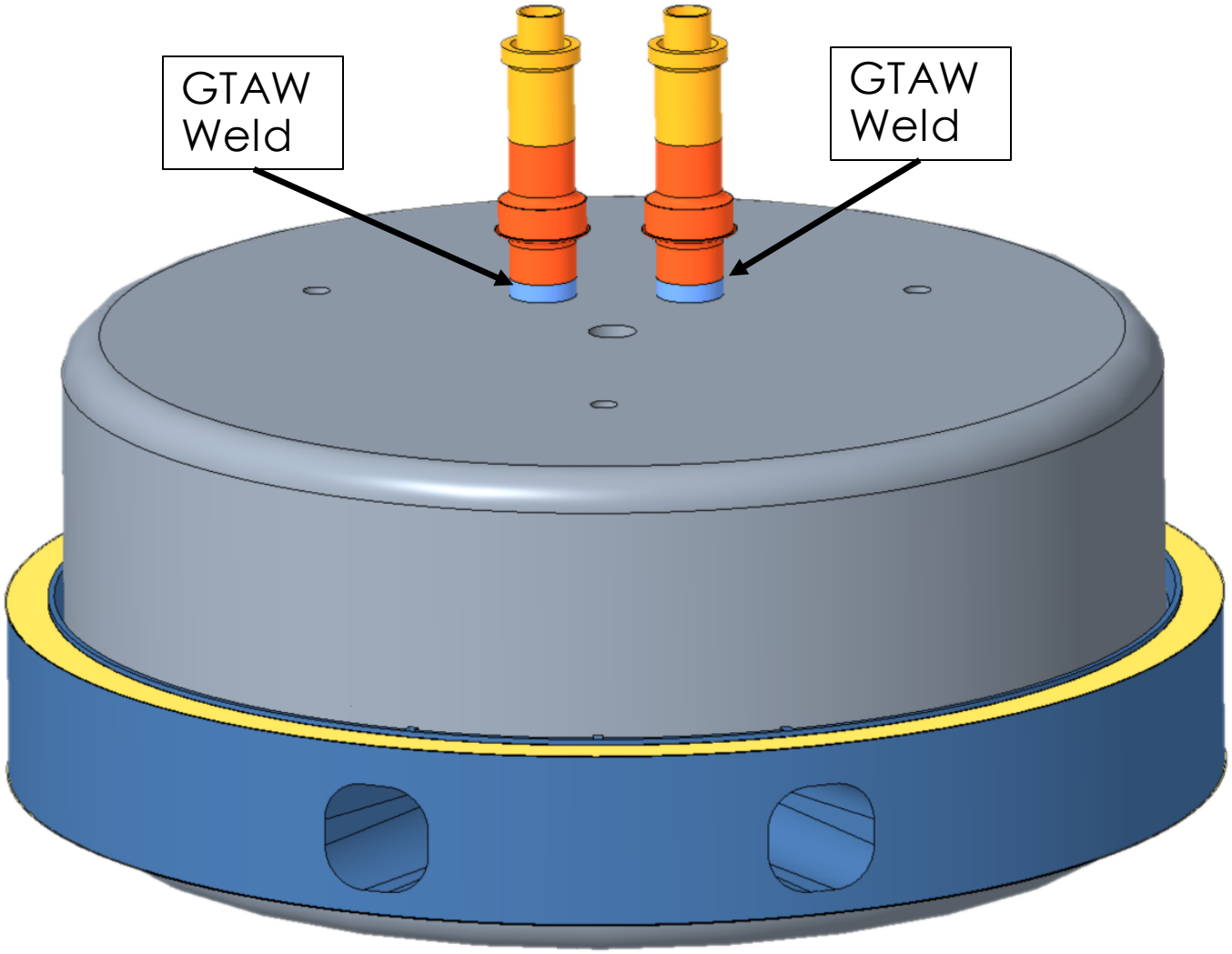
Reflector Vessel Parts





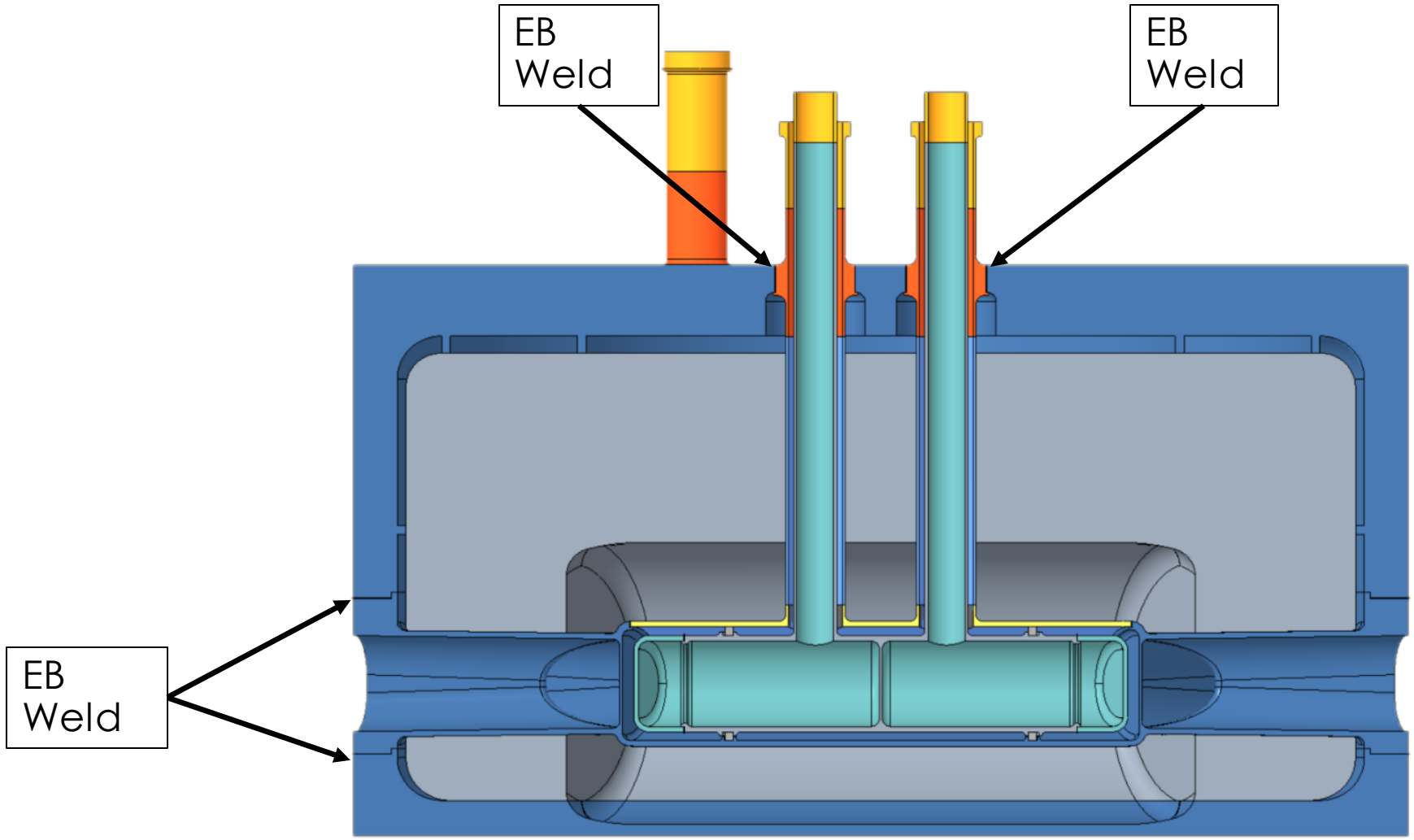
- Relatively straightforward 3 axis machining

Vacuum Tube Extension Welds



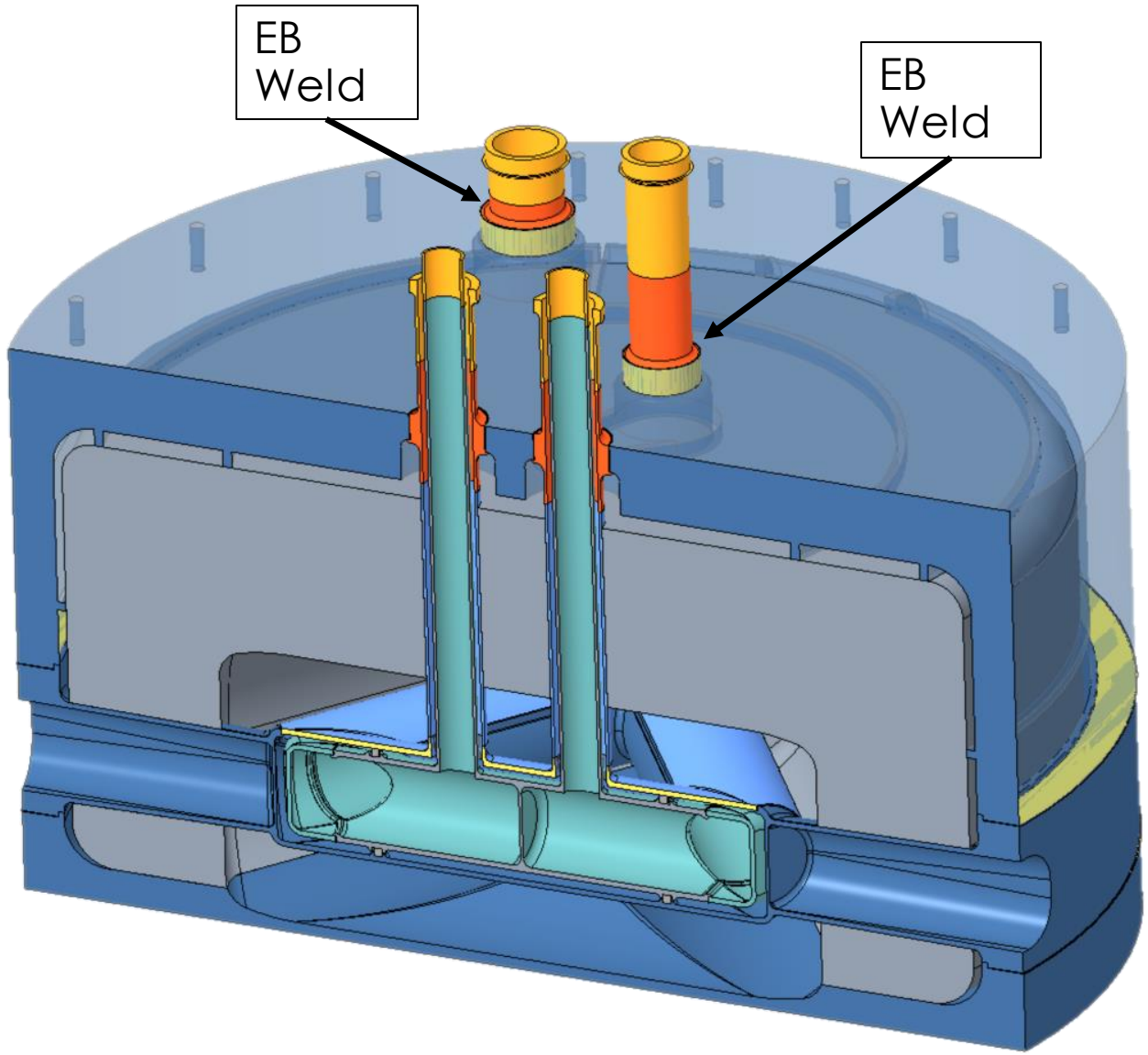
- Thin walled aluminum tube welds with tight access

Reflector Vessel Closure Welds



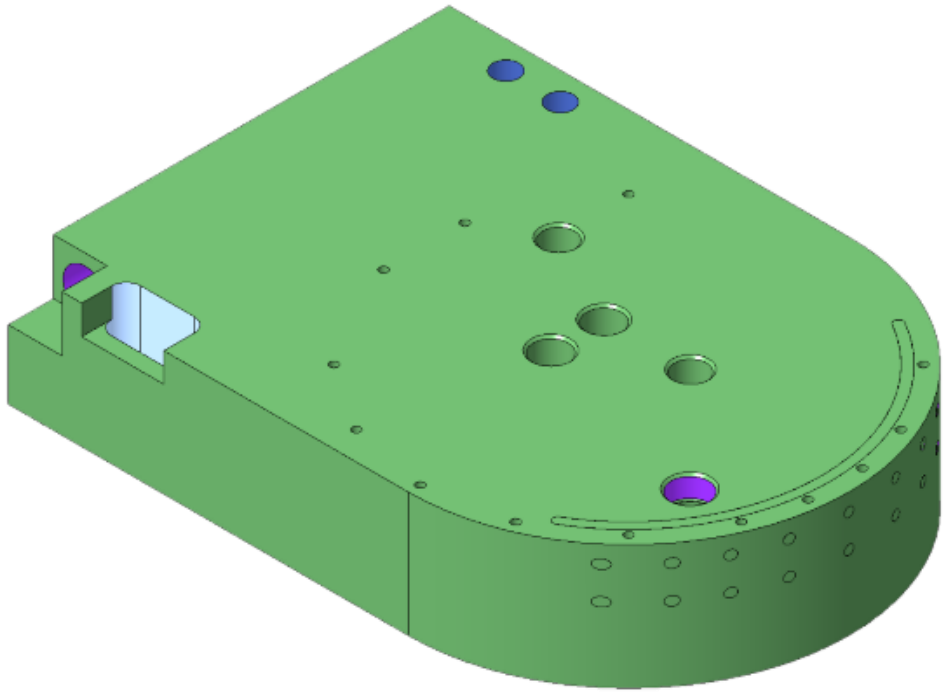
- Simple geometry aluminum EB welds

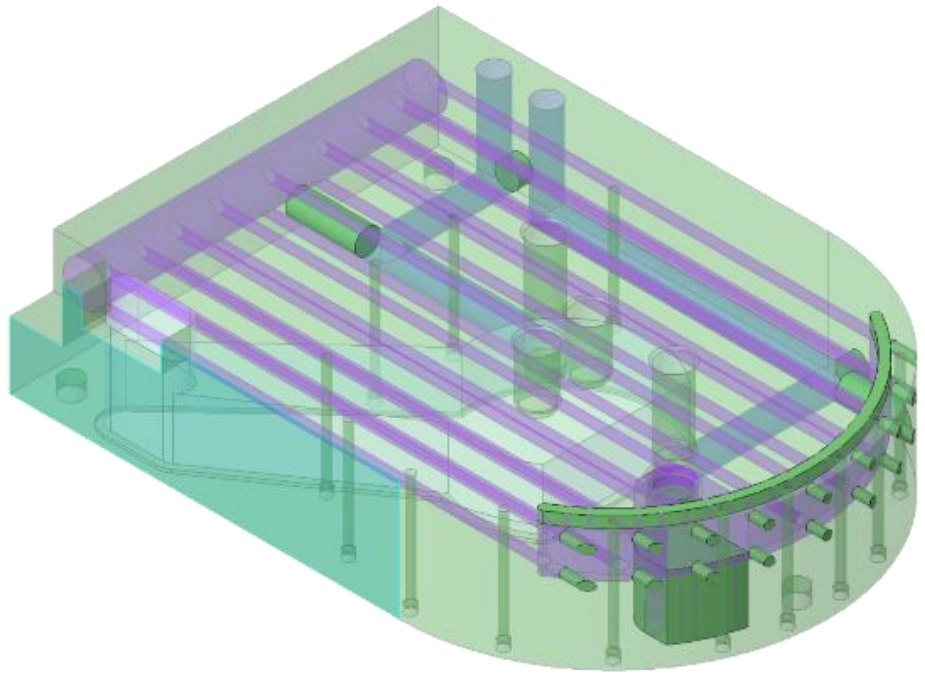
Reflector Vessel Additional Penetrations



- Process along with last EB weld step

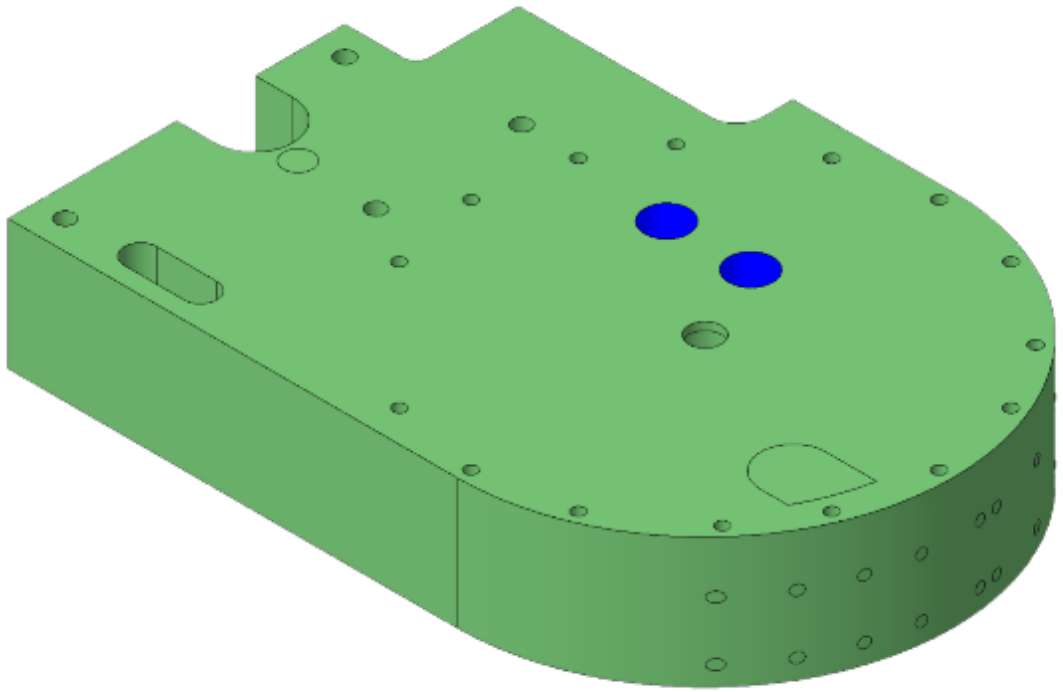
Lower Backbone

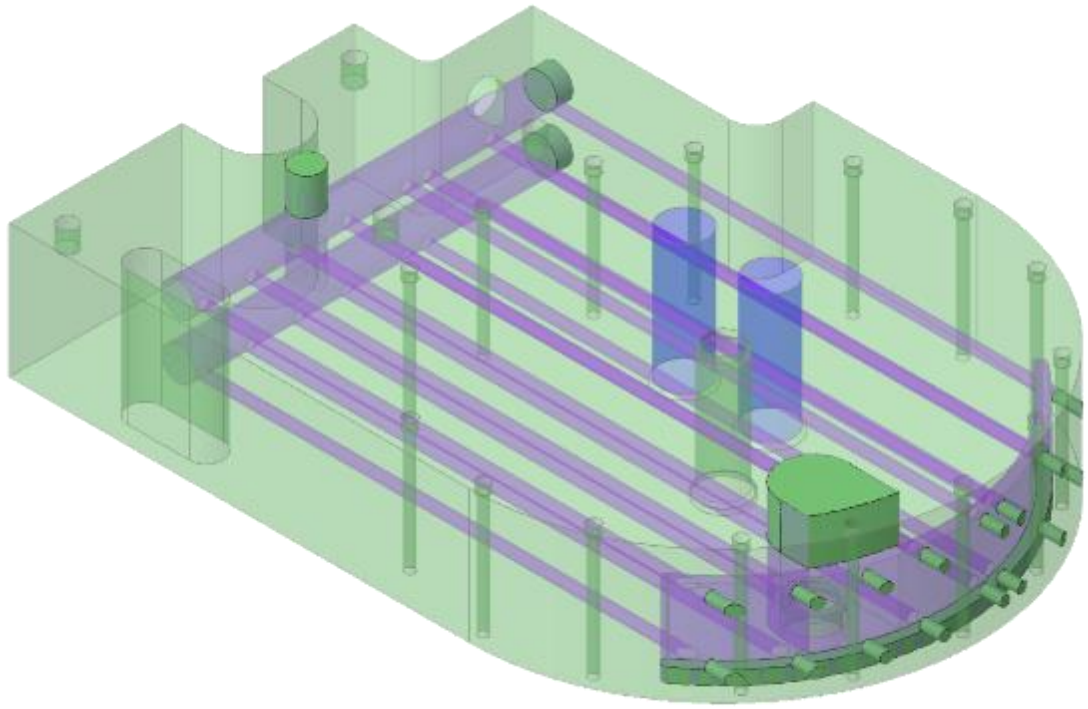




- Deep hole drilling (with tight drift requirements between vacuum penetrations)
- Manifold machining
- Subsequent plug and cover plate welding

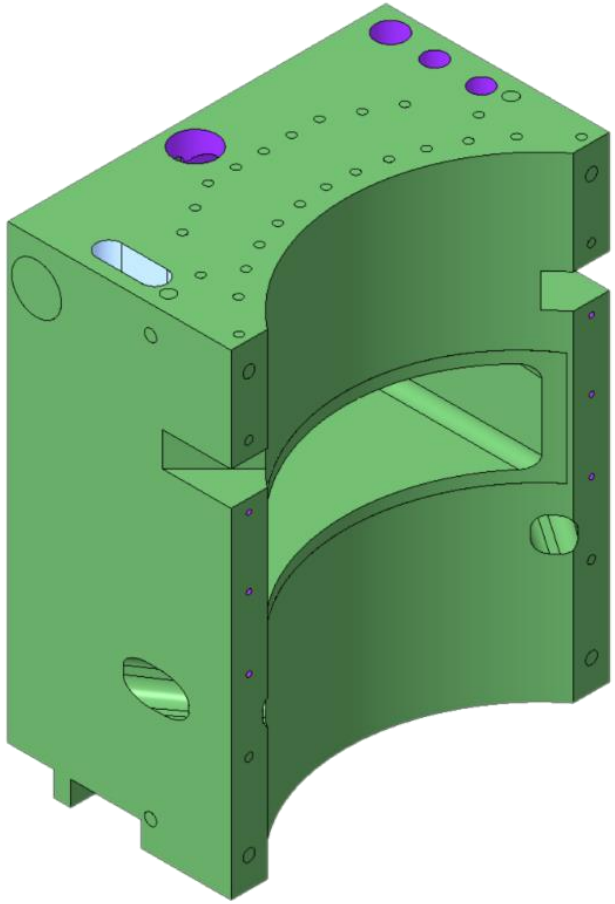
Upper Backbone

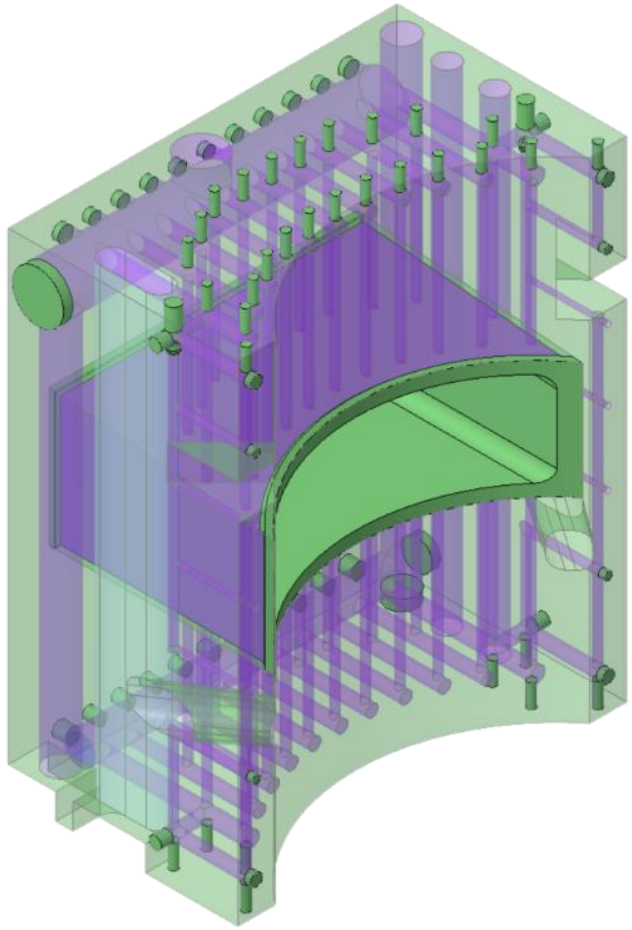




- Deep hole drilling and manifold machining
- Subsequent plug and cover plate welding

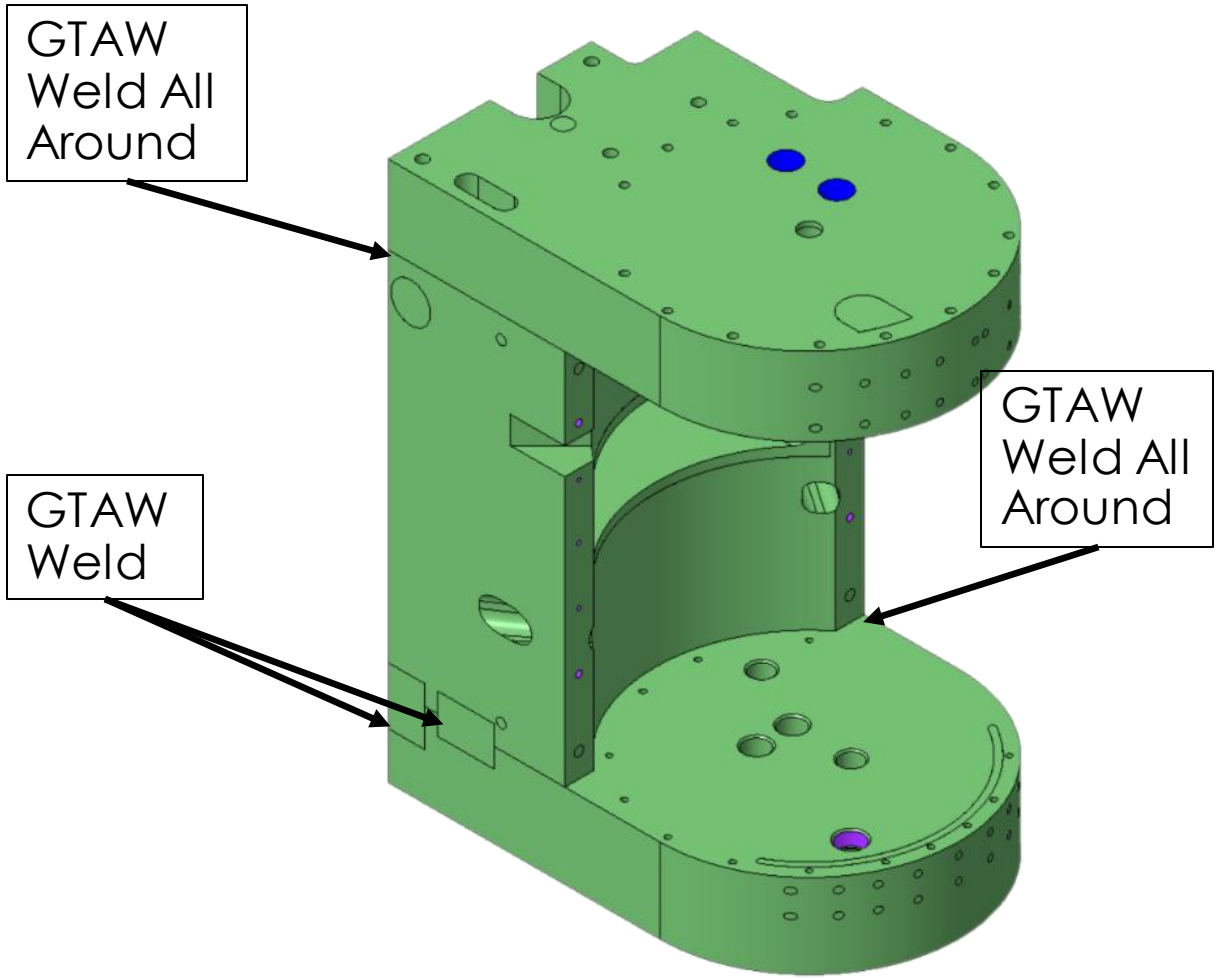
Middle Backbone

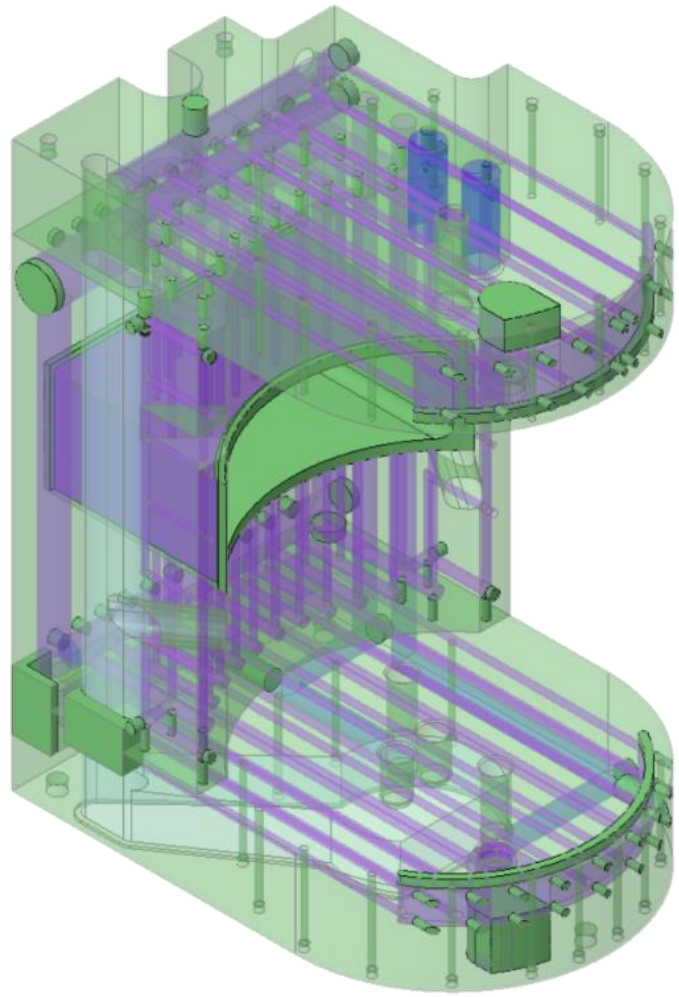




- Lots of deep hole drilling and plug welding
- Will look to reduce plug welds through manifolds top and bottom

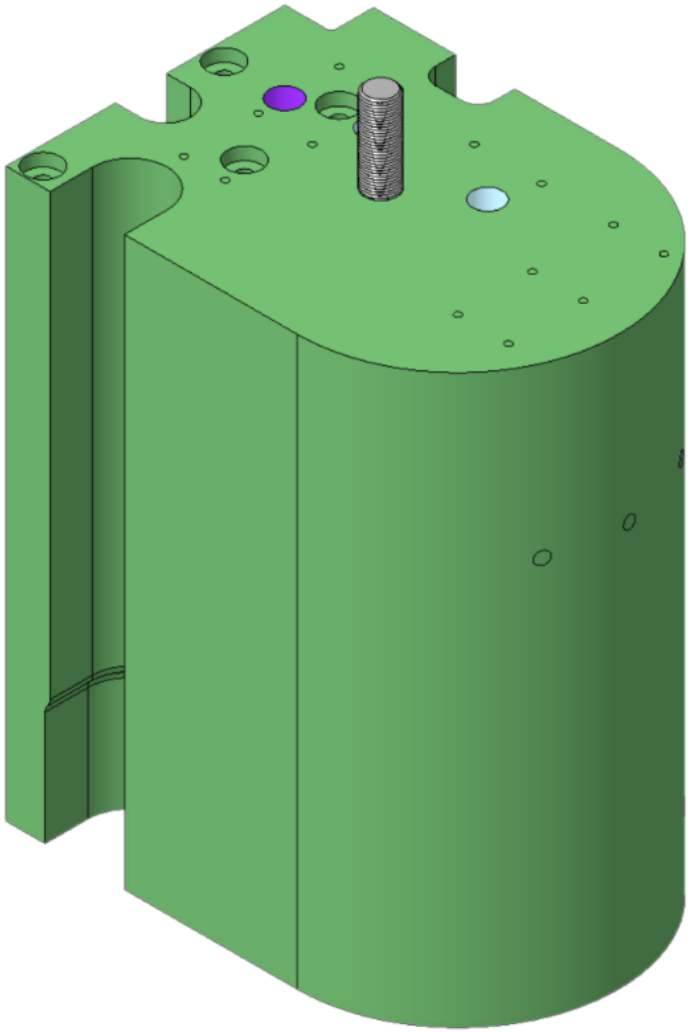
Backbone Weldment

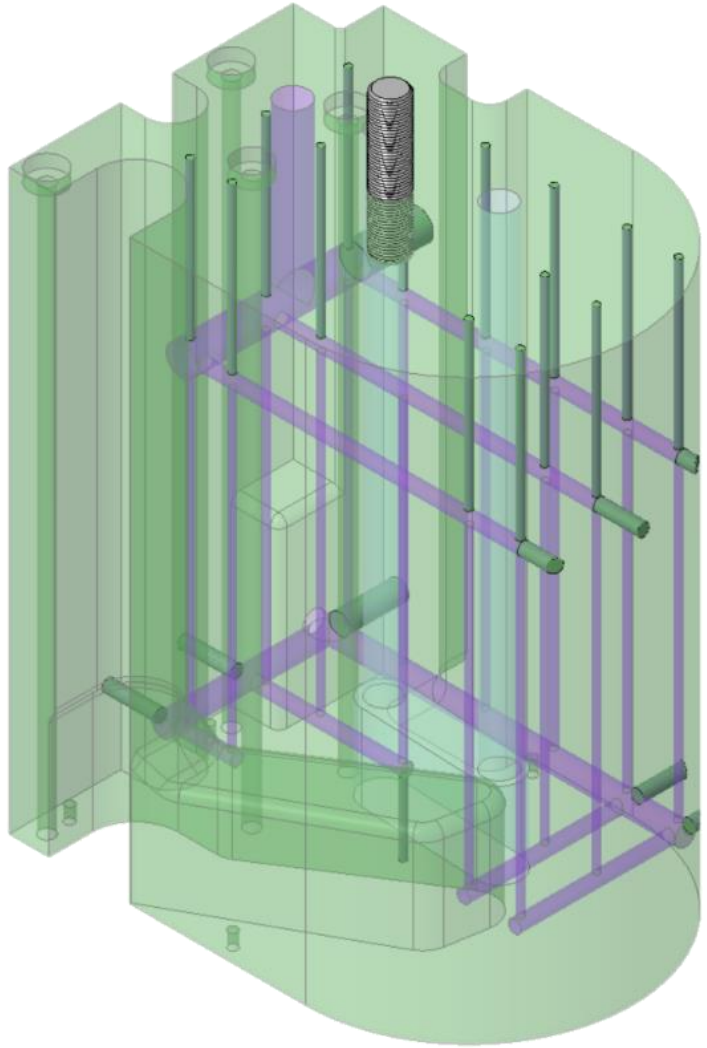




- Weld joint design needs improvement
- Post weld machine reflector vessel interfaces

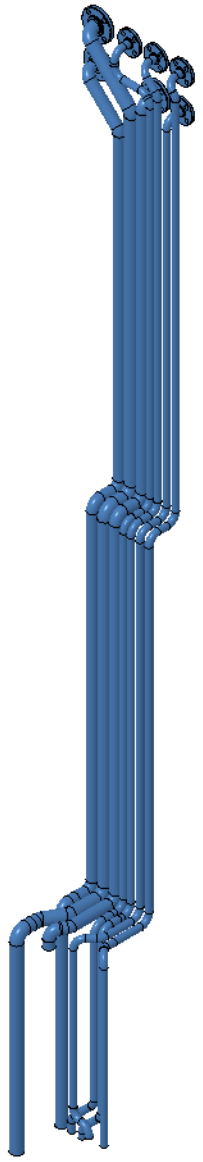
Backbone Shield Block





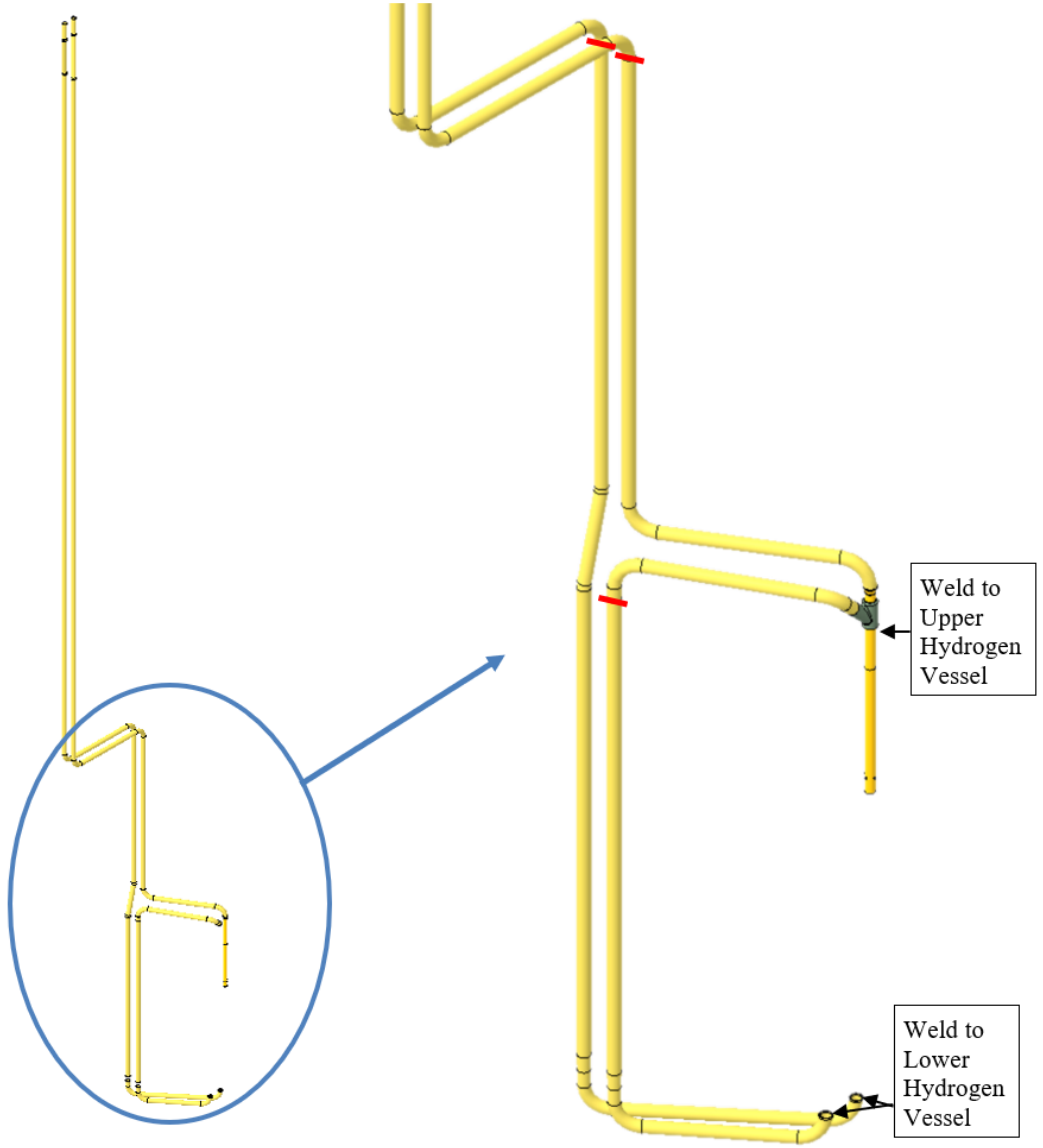
- Deep hole drilling and subsequent plug welding

Water Piping Fabricatior



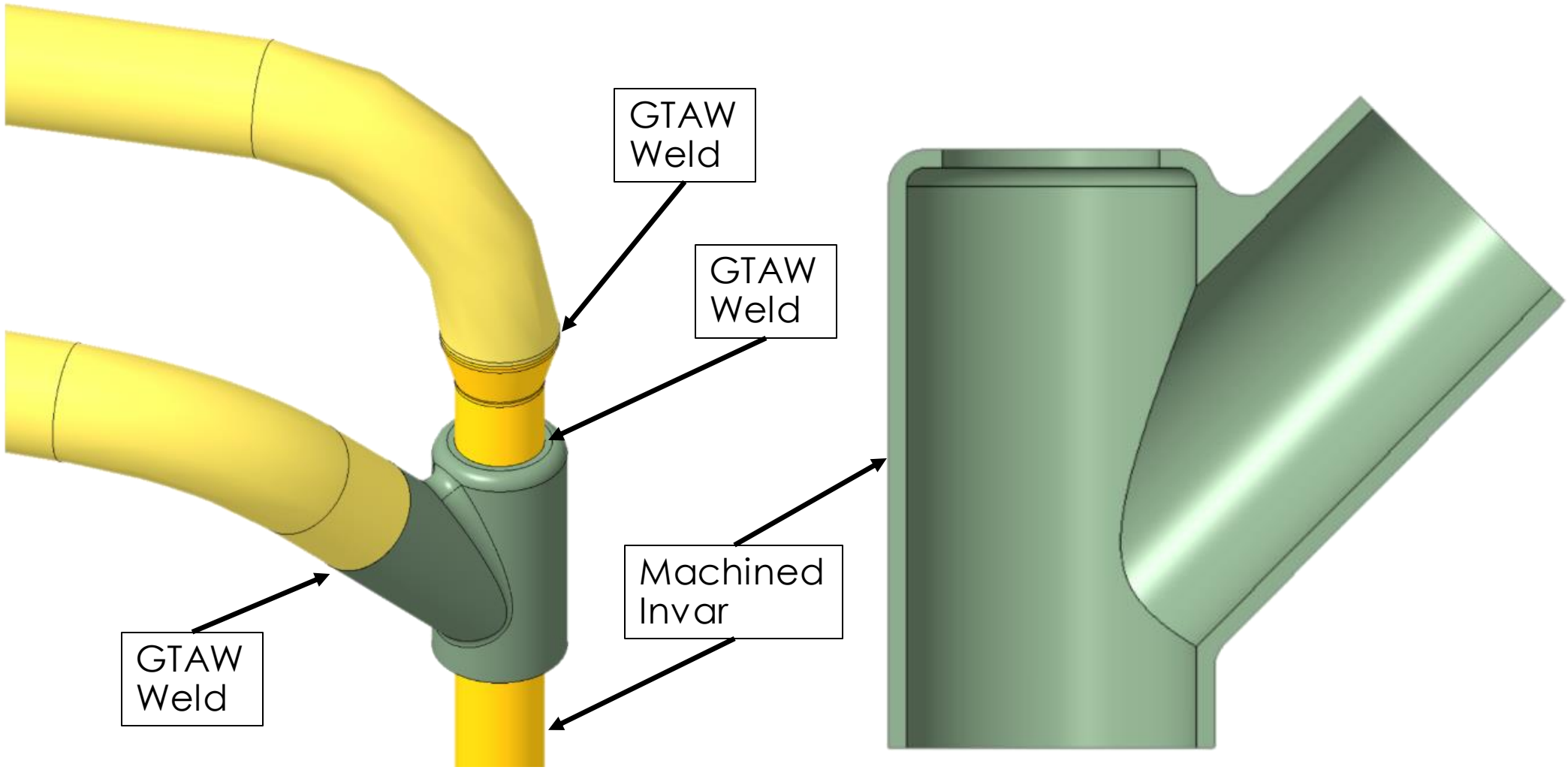
- Upper sections to be welded to lower straights at final assembly

Hydrogen Piping Fabrication



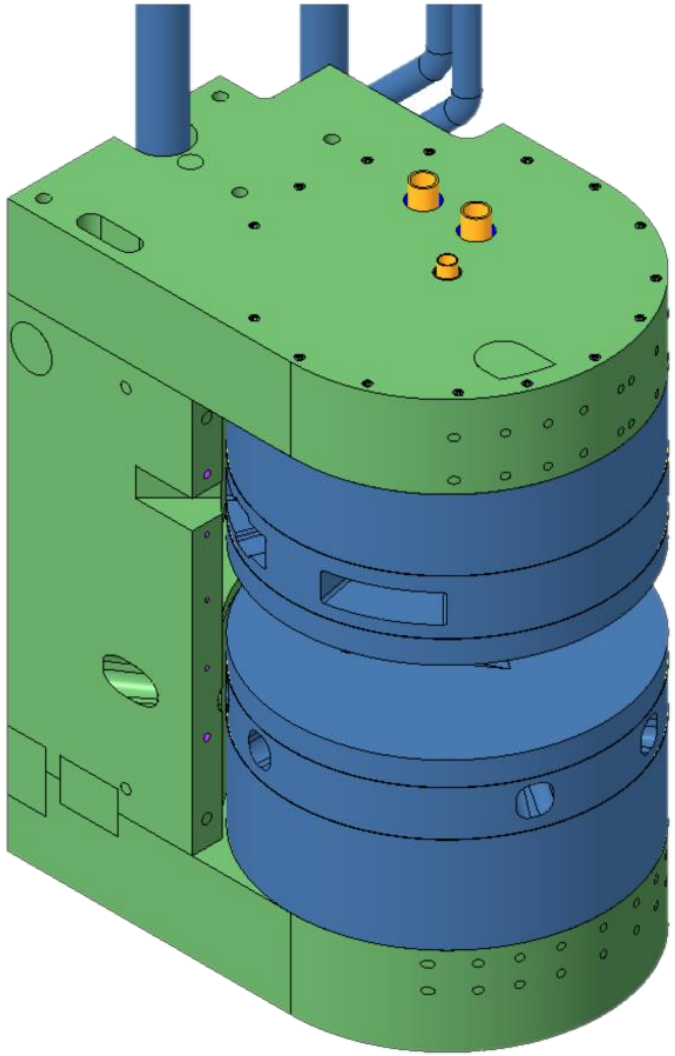
- Hydrogen piping delivered as 4 bent pipes and 1 weldment

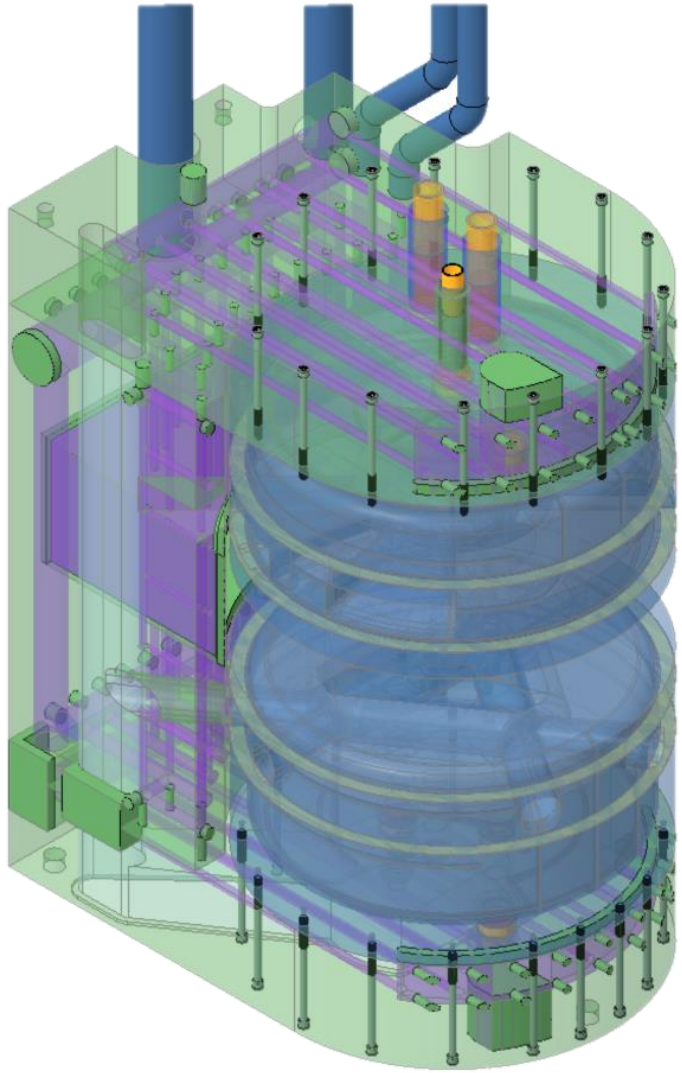
Upper Hydrogen Supply Stinger



- Hydrogen supply stinger weldment

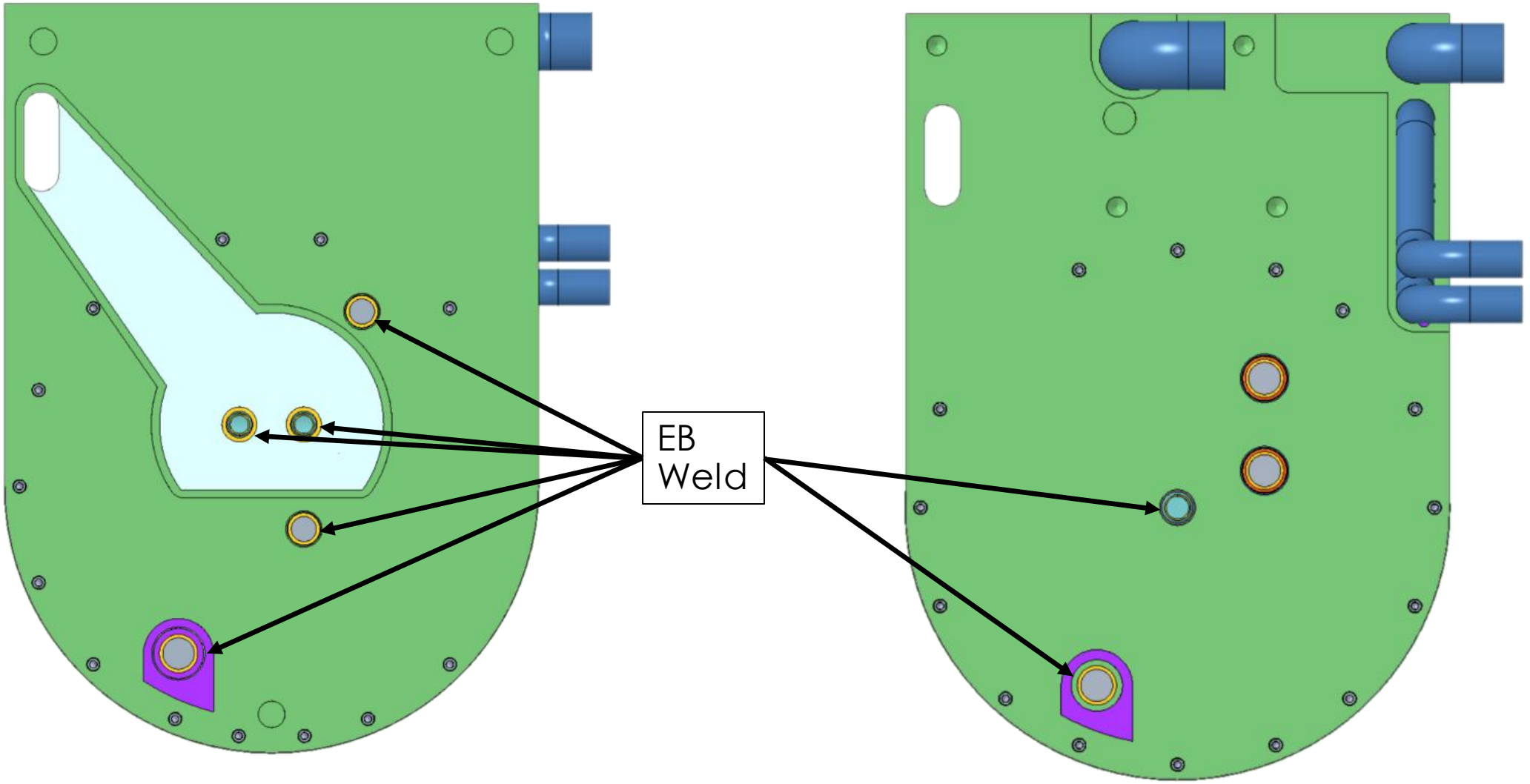
Reflector Vessels Bolted to Backbone





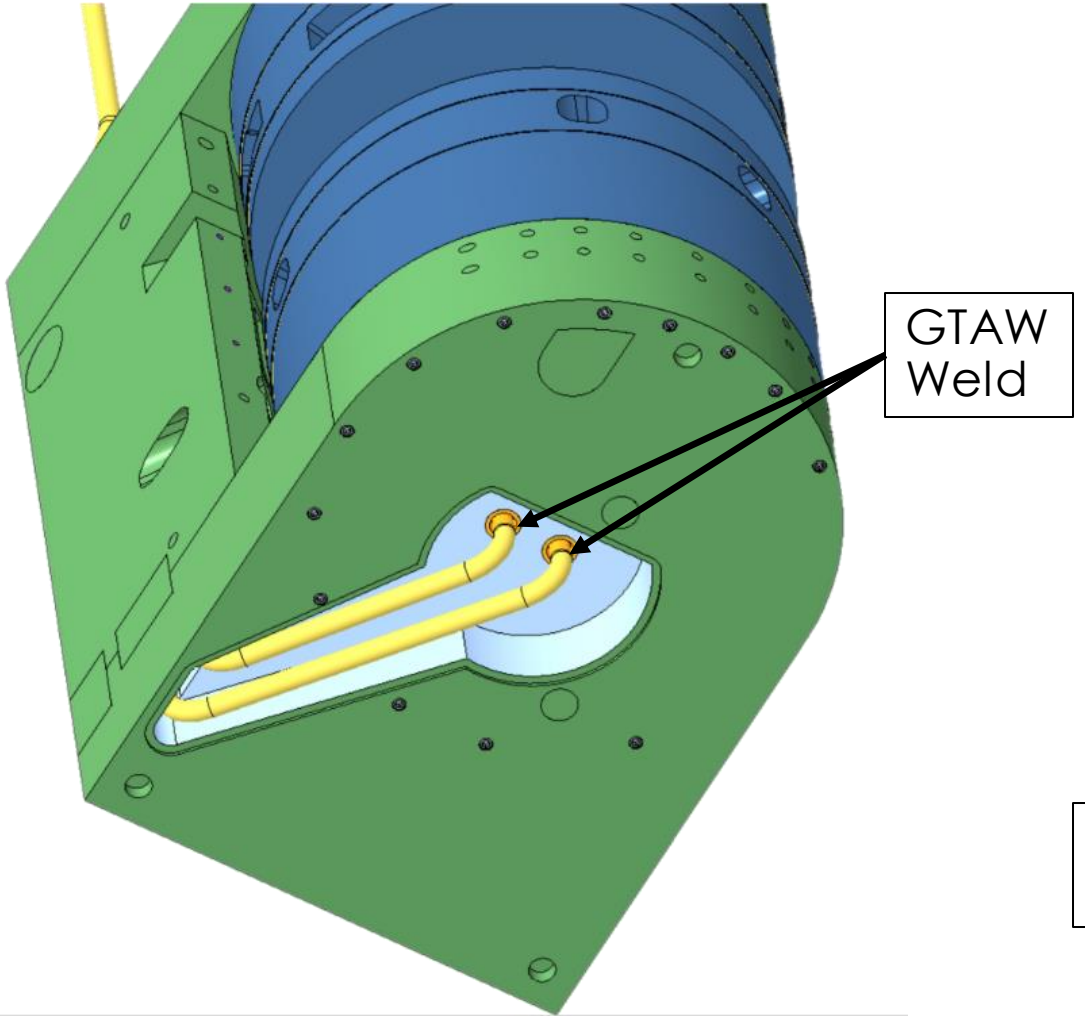
- Bolt tension maintained with Belleville washers

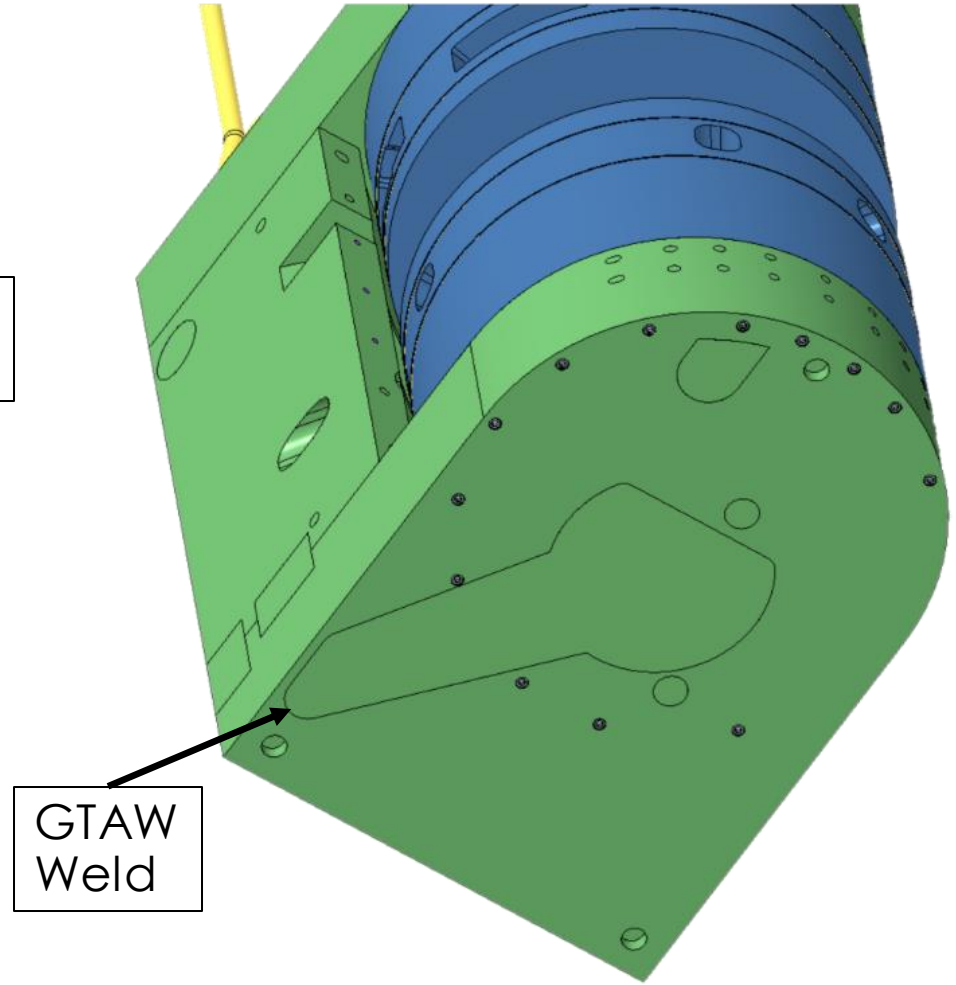
Reflector Vessel to Backbone Connections



- Fit up will be challenging!

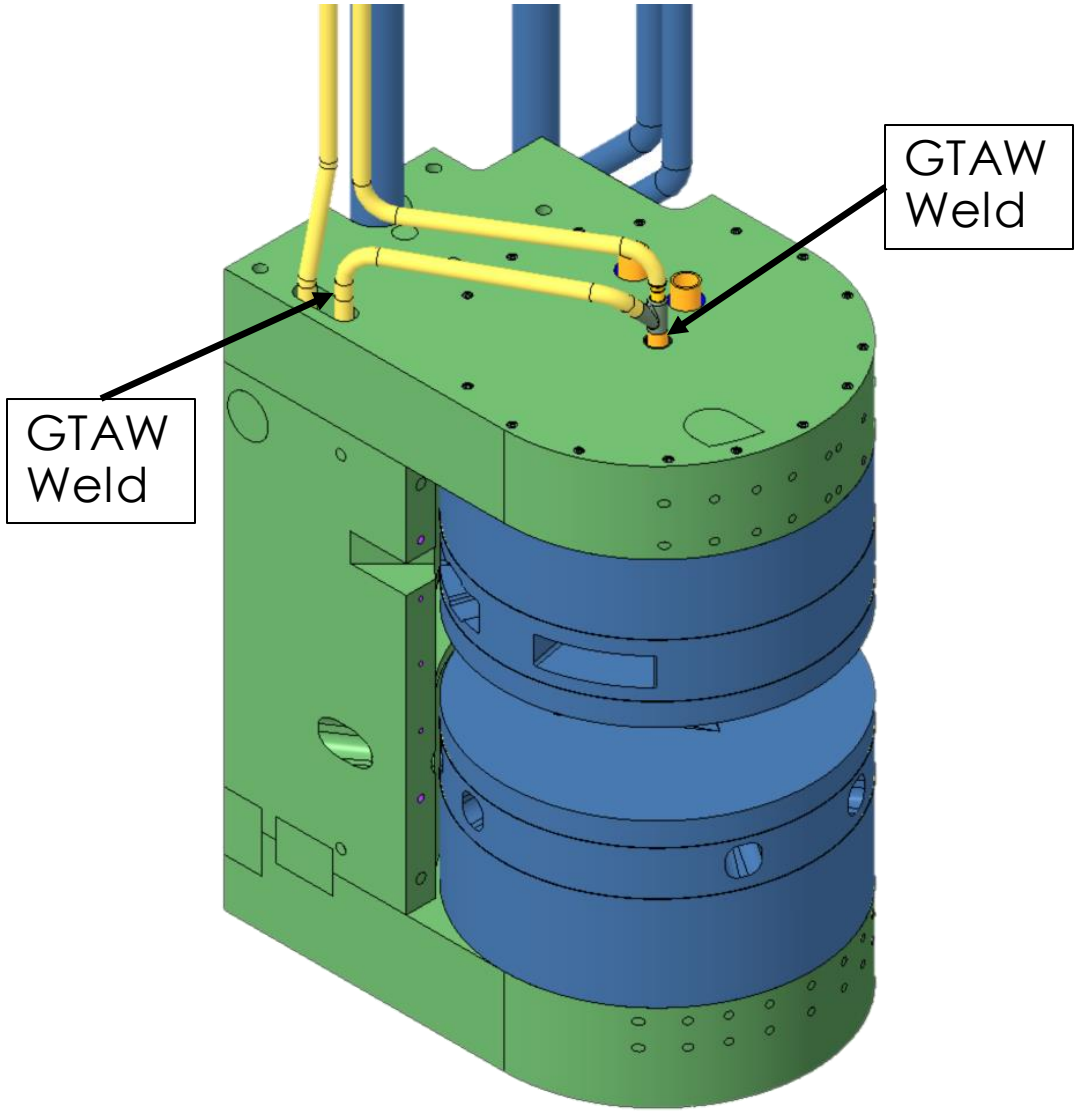
Lower Hydrogen Transfer Line Welding

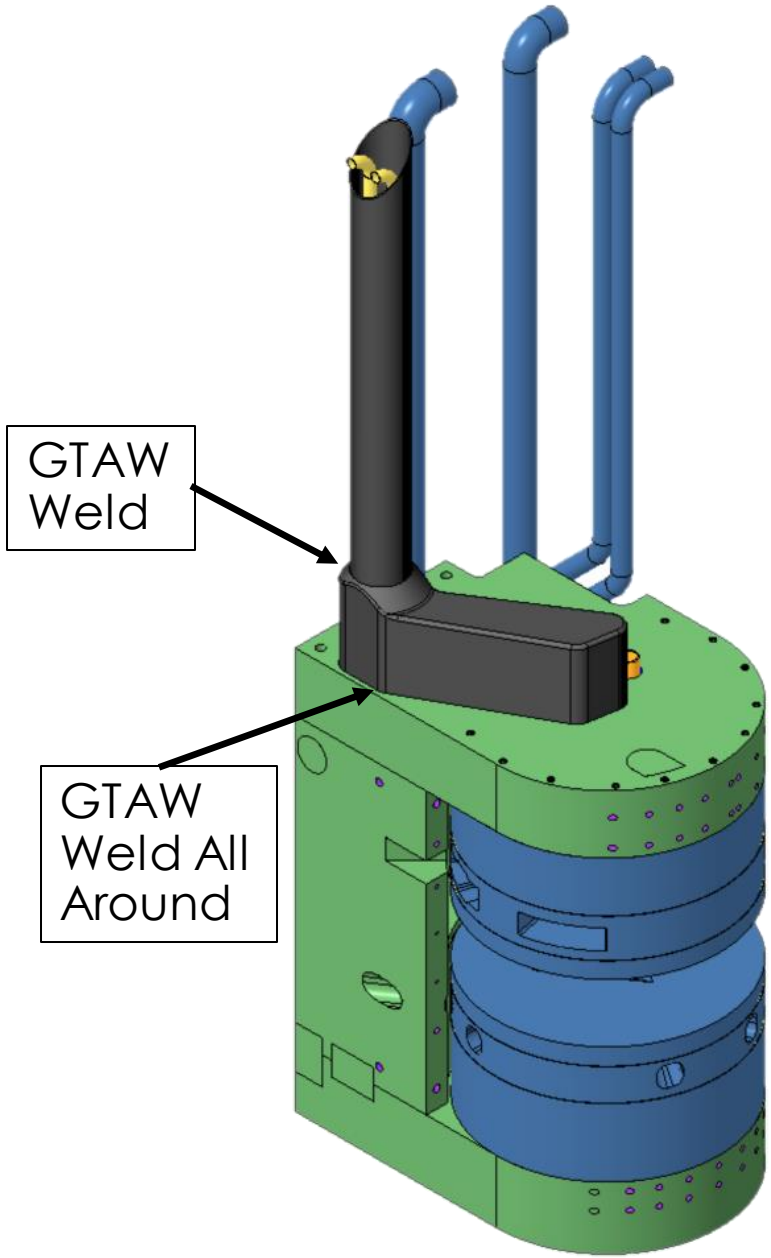




- Slide hydrogen pipes through vacuum passage
- Access for hydrogen line welding is tight

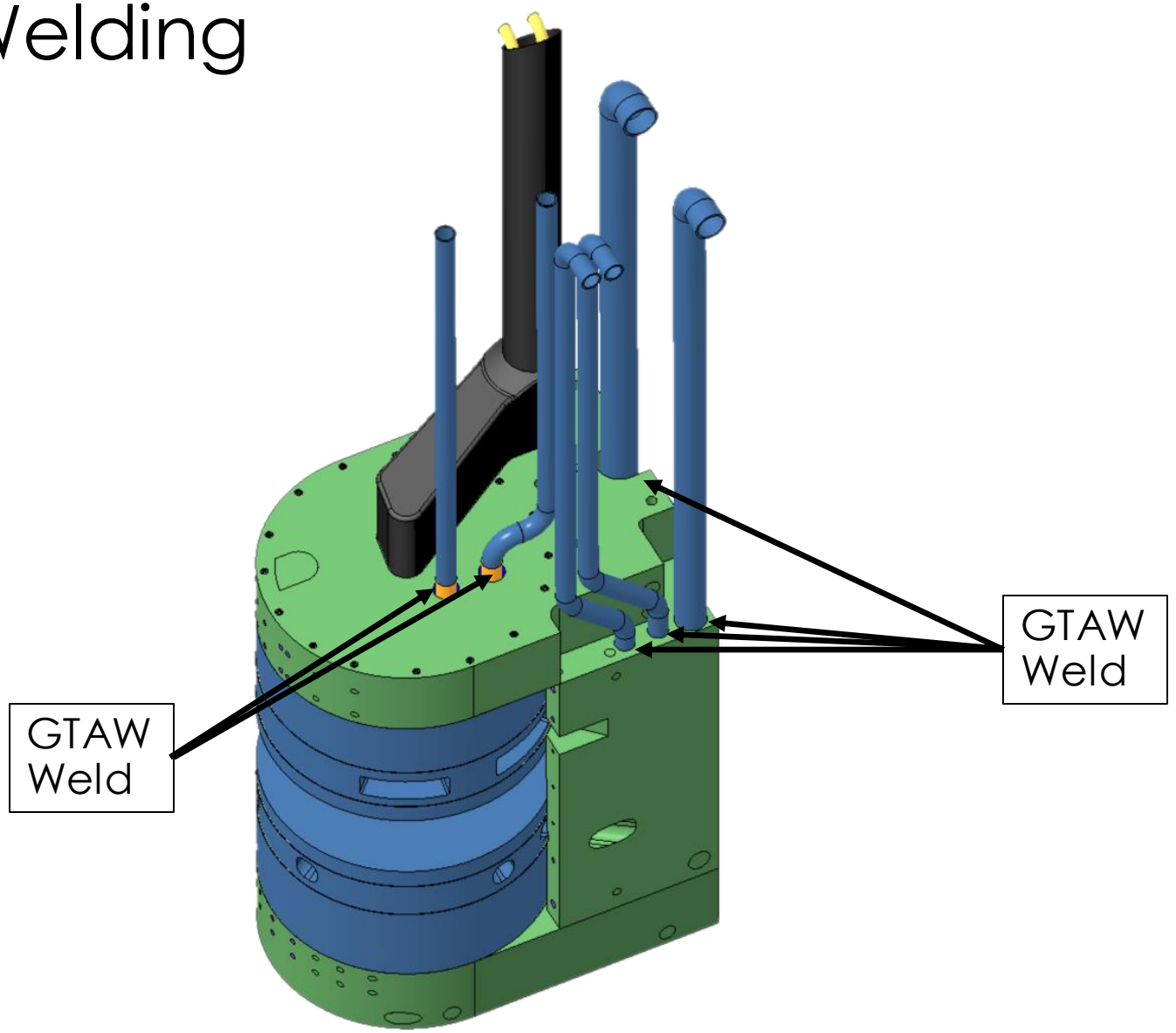
Upper Hydrogen Line Welding





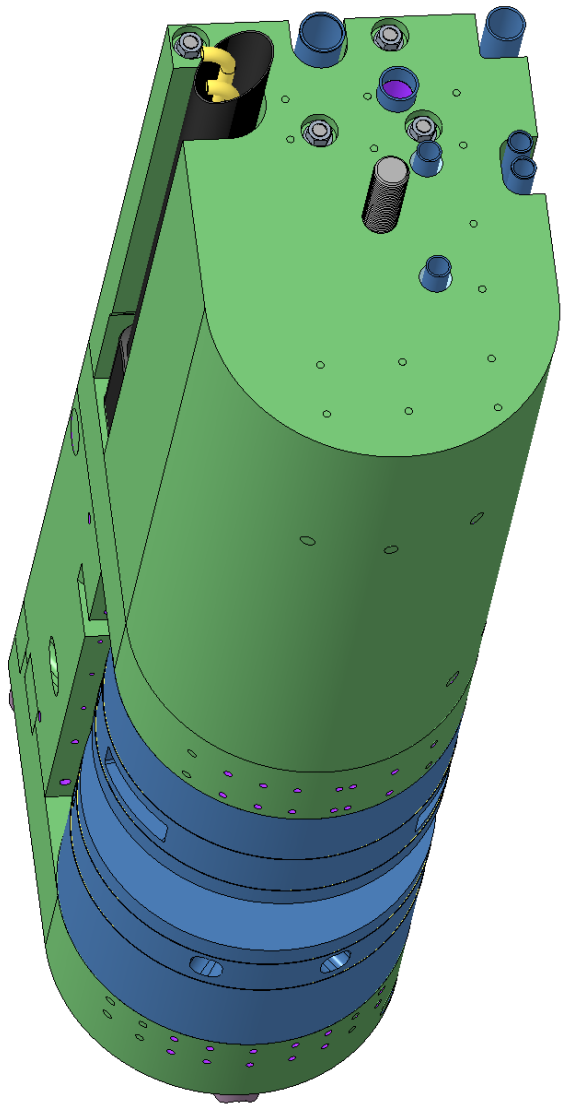
- Vacuum layer requires careful alignment

Water Piping Welding



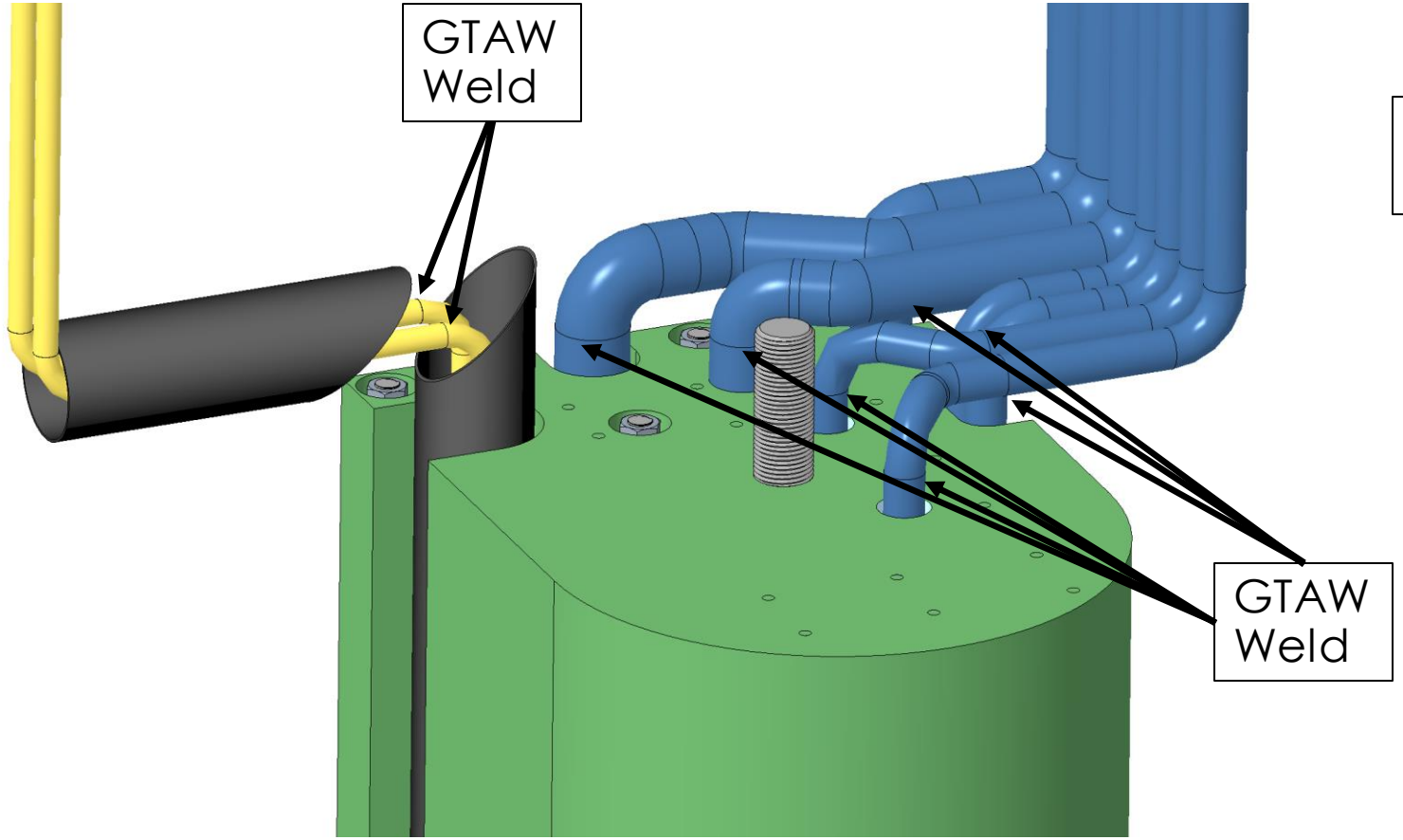
- 4 welds to middle backbone need to move up to upper

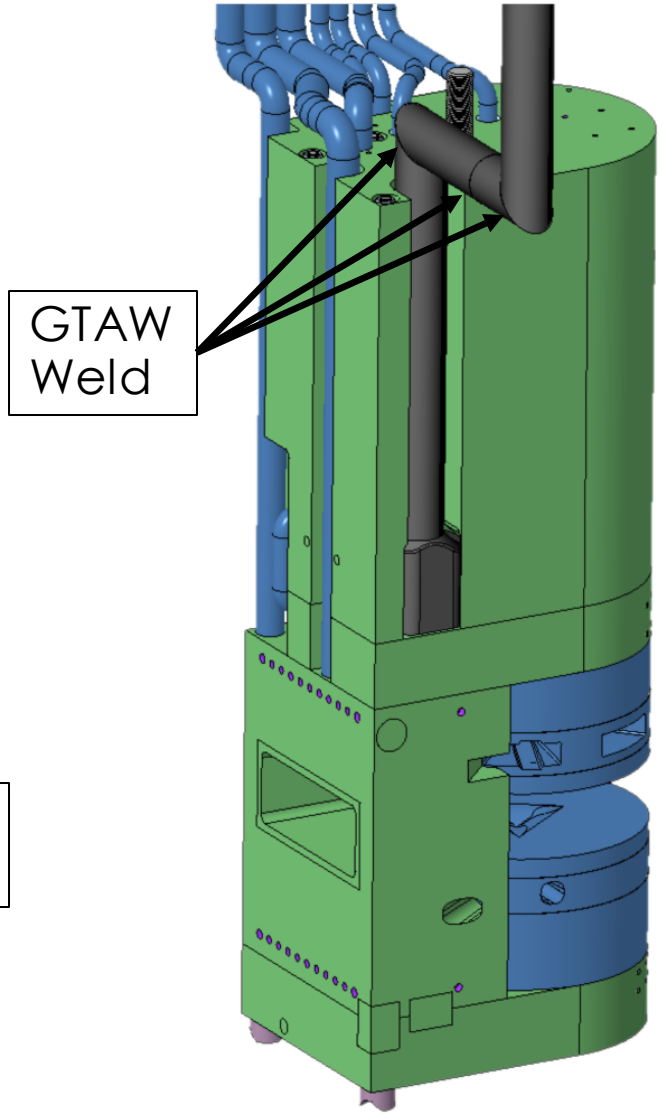
Bolt on Backbone Shield Block



- Shield block slid over piping and bolted in place

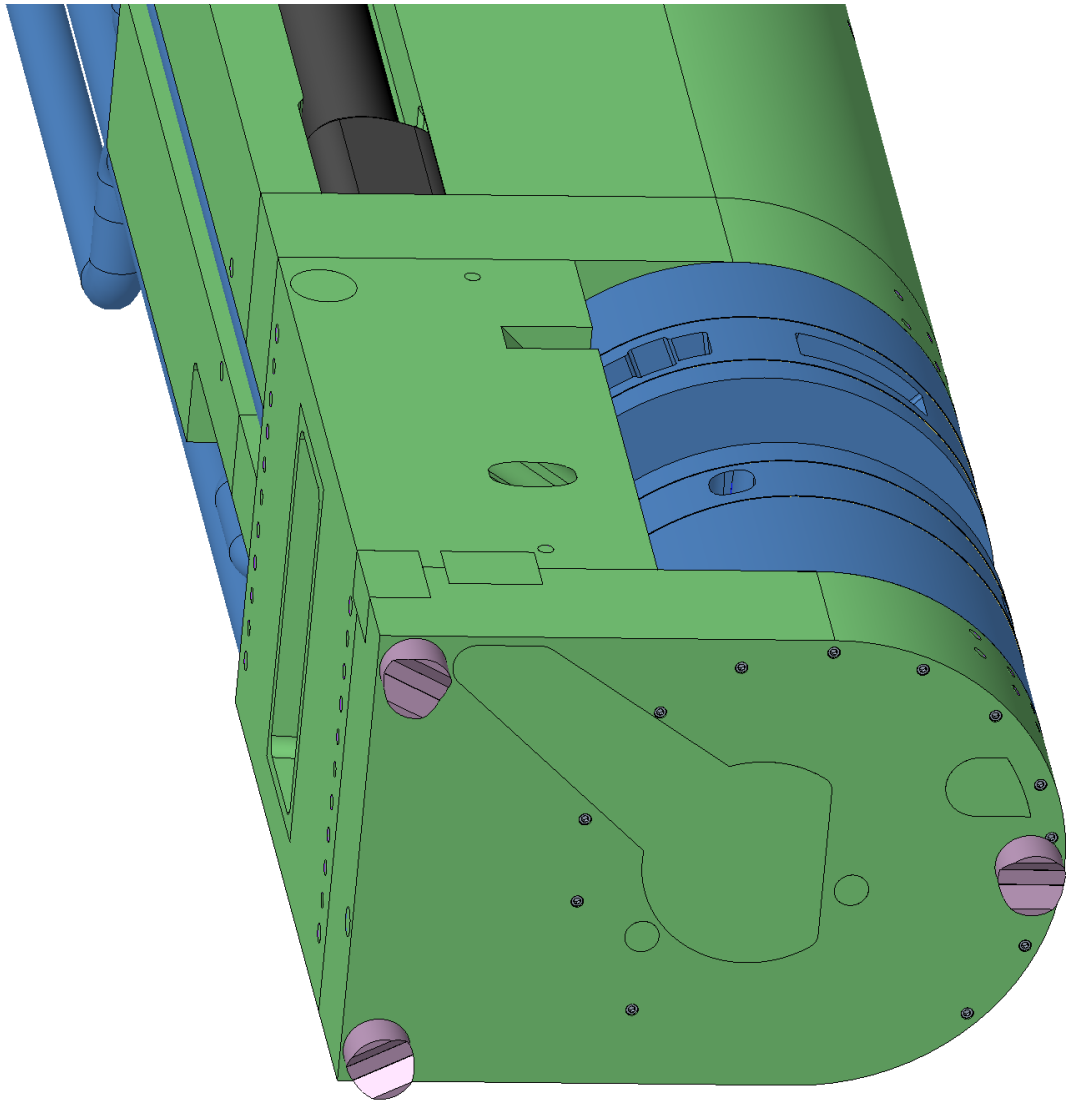
Piping Welds Above the Shield Block

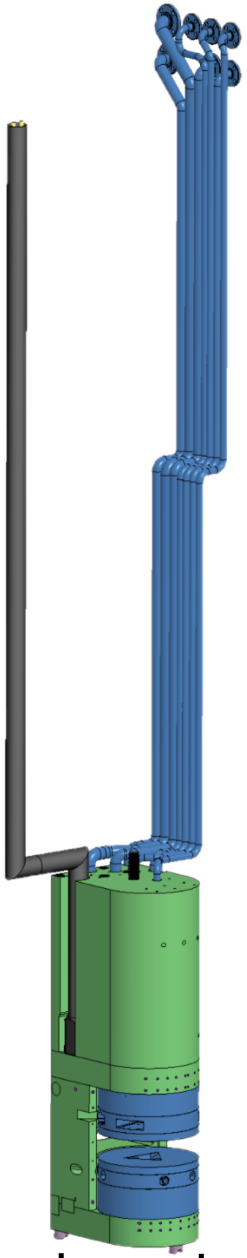




- Hydrogen pipes welded with long sleeve slid away
- Short sleeve just fits around the corner

Moderator Reflector Vessel Assembly





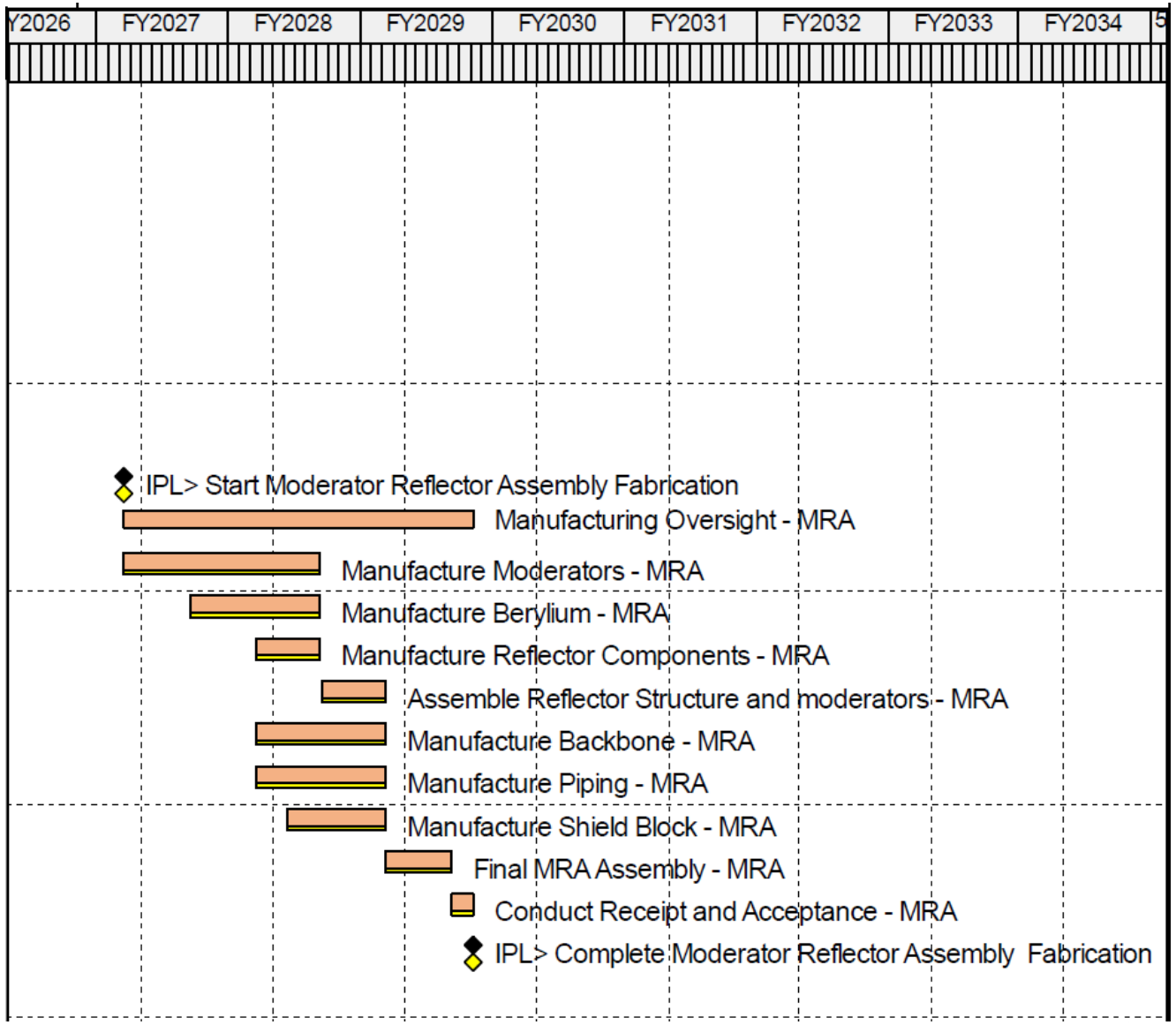
- Kinematic Mounts custom machined to moderator produce desired moderator locations

Moderator Reflector Assembly Acquisition

- Acquired in a series of build to print subcontracts
- Estimated total value of ~$4M

Moderator Reflector Assembly (MRA)		790	16-Jun-26 08:00	07-Aug-29 17:00	855	$4,026,232
Moderator Reflector Assembly		790	16-Jun-26 08:00	07-Aug-29 17:00	855	$4,026,232
Procurement/Fabrication		790	16-Jun-26 08:00	07-Aug-29 17:00	855	$4,026,232
TEMP - ORIGINAL CD1 Tasks		665	14-Dec-26 08:00	07-Aug-29 17:00	855	$4,026,232
TEMP - ORIGINAL CD1 Tasks		665	14-Dec-26 08:00	07-Aug-29 17:00	855	$4,026,232
TS04IPL491	IPL> Start Moderator Reflector Assembly Fabrication	0	14-Dec-26 08:00		822	$0
TS048150	Manufacturing Oversight - MRA	665	14-Dec-26 08:00	07-Aug-29 17:00	855	$0
TS043520	Manufacture Moderators - MRA	375	14-Dec-26 08:00	12-Jun-28 17:00	822	$1,153,855
TS043521	Manufacture Berylium - MRA	250	15-Jun-27 08:00	12-Jun-28 17:00	822	$1,000,756
TS043524	Manufacture Reflector Components - MRA	125	13-Dec-27 08:00	12-Jun-28 17:00	822	$253,829
TS043527	Assemble Reflector Structure and moderators - MRA	125	13-Jun-28 08:00	08-Dec-28 17:00	822	$133,589
TS043525	Manufacture Backbone - MRA	250	13-Dec-27 08:00	08-Dec-28 17:00	822	$258,871
TS043522	Manufacture Piping - MRA	250	13-Dec-27 08:00	08-Dec-28 17:00	822	$571,557
TS043523	Manufacture Shield Block - MRA	188	14-Mar-28 08:00	08-Dec-28 17:00	822	$223,766
TS043528	Final MRA Assembly - MRA	125	11-Dec-28 08:00	11-Jun-29 17:00	822	$430,008
TS043530	Conduct Receipt and Acceptance - MRA	40	12-Jun-29 08:00	07-Aug-29 17:00	822	$0
TS04IPL540	IPL> Complete Moderator Reflector Assembly Fabrication	0		07-Aug-29 17:00	855	$0

Moderator Reflector Assembly Timeline



Required Vendor Competencies

- Moderators and Reflector Vessels Fabrication
  - High precision, complex machining, management of EB welding, and accessibility from Oak Ridge for vendor oversight
- Beryllium Fabrication
  - Materion is only domestic Beryllium supplier and well integrated with machine shops capable of Beryllium machining
- Backbone Fabrication
  - Precision machining, deep hole drilling, and welding
- Final Assembly
  - Precision assembly, stainless steel welding, helium leak checking, and accessibility from Oak Ridge for vendor oversight