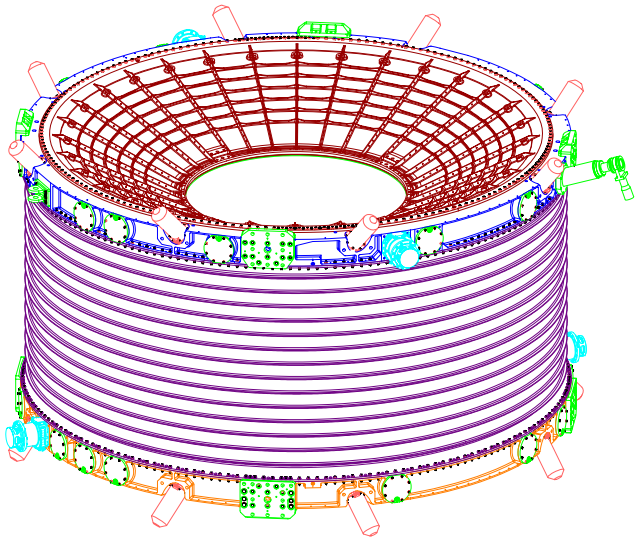
Alpha Magnetic Spectrometer (AMS) - 02

Critical Design Review

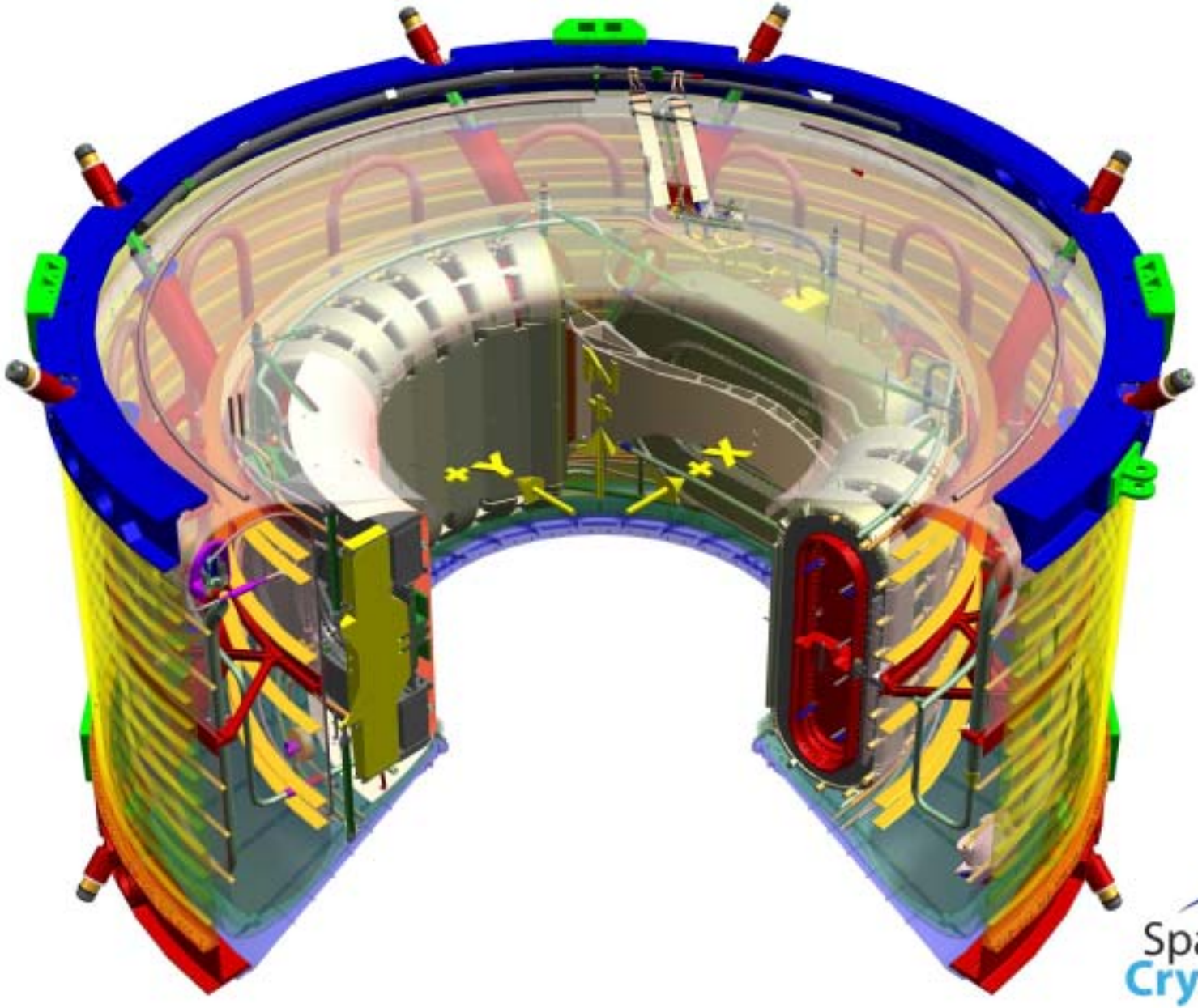
Vacuum Case Mechanical Design



Phil Mott

May 13-16, 2003

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

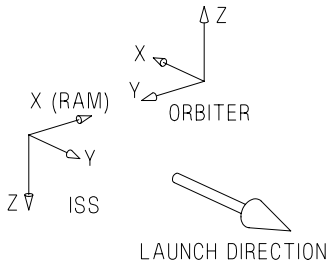


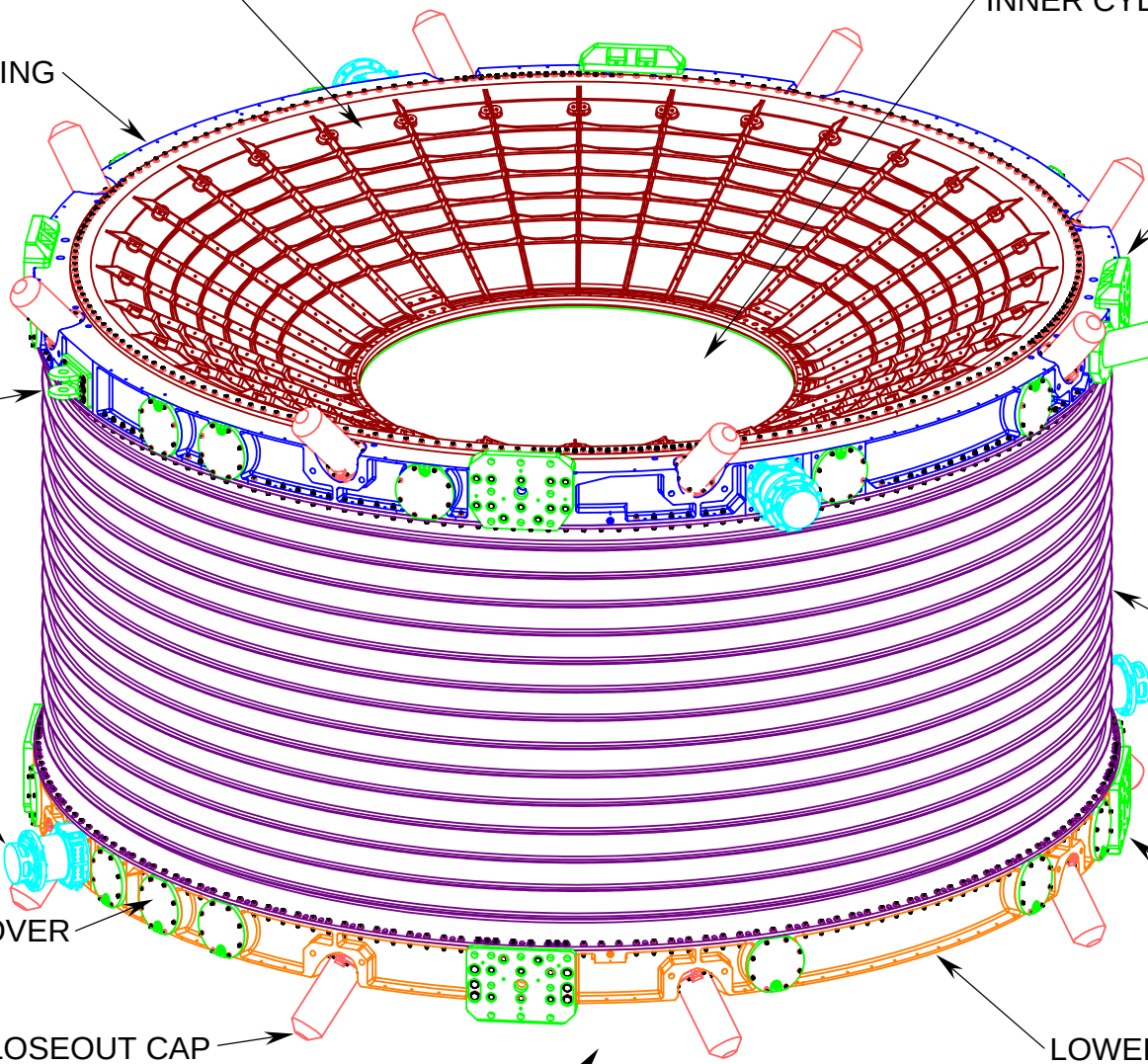
Space Cryomagnetics

Flight Cold Mass

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

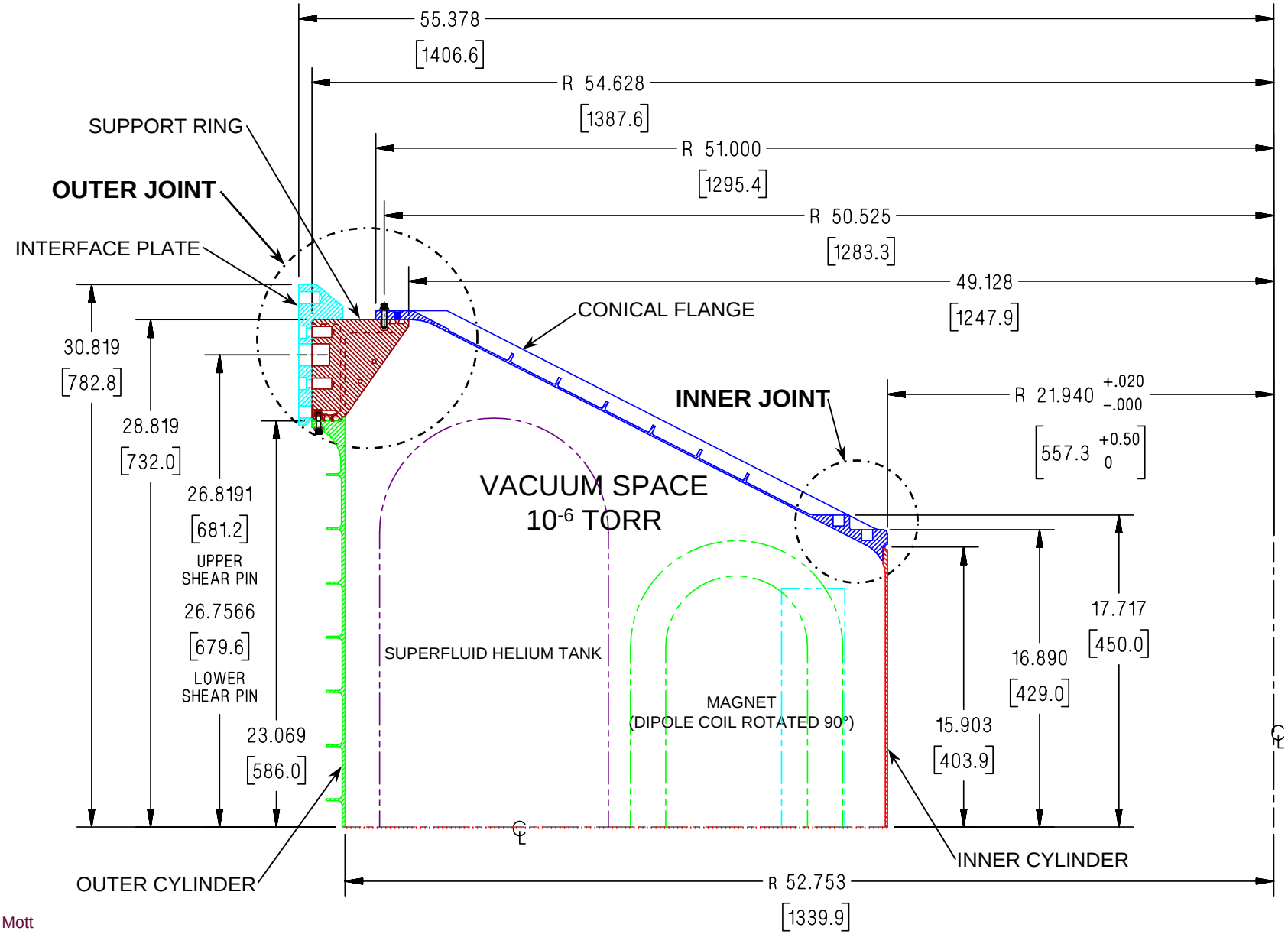
Vacuum Case





Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Vacuum Case Cross Section



Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Vacuum Case Overview

- The Vacuum Case (VC) is a structural member of the USS-02 and supports the superconducting cryogenic magnet.
- Two identical Vacuum Cases will be built:
  - Structural Test Article (STA)
  - Flight
- The VC weighs 1,587 lbs and is approximately 9 feet in diameter by 5 feet high.
- Vacuum Case Major Components:
  - Upper Conical Flange
  - Lower Conical Flange
  - Upper Support Ring
  - Lower Support Ring
  - Inner Cylinder
  - Outer Cylinder

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Vacuum Case Overview (cont.)

- The Vacuum Case attaches to the USS-02 at 10 locations:
  - 8 Interface Plate locations (4 Upper & 4 Lower)
  - 2 Diagonal Struts (Upper)
- The superconducting cryogenic magnet is being designed and fabricated by ETH/Space Cryomagnetics Ltd. (SCL) in Culham, England.
- The magnet is supported inside the VC by 16 straps attached to the Upper & Lower Support Rings. (The straps will be covered in a later presentation.)
- There are 25 Feedthru Ports, not including the strap ports, that are used for Cryocoolers, Cryocooler Access Ports, Fill Ports, Vent Ports, Burst Discs, Current Leads, and cable/tube routing into and out of the Vacuum Case.

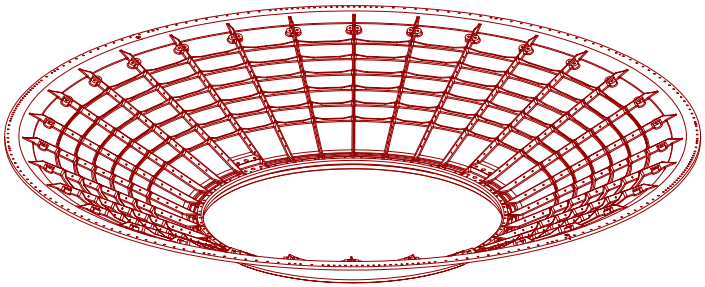
Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

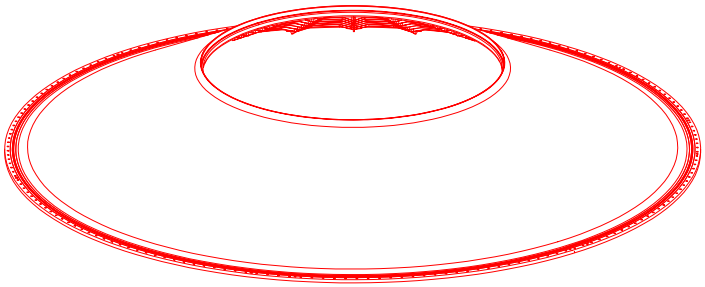
Vacuum Case Overview (cont.)

- **Feedthru Ports that are not used will be sealed with a blank cover plate.**
- **All O-Ring joints are sealed with a double O-Ring configuration.**
- **A test port is located between each O-Ring for individual leak checks**

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Conical Flange, Upper & Lower





- Al 2219-T62 Spin Forming
- Original plate was Al 2219-T0 2.25” thick
- Plate is spin formed, solution heat treated, and aged to final condition.
- Total spin form blanks: 7
- All 7 spin form blanks were processed identical to the qualification spin formed blank.
- Spin Form procedures were reviewed and approved by NASA/ES.
- Final machined parts are dye penetrant inspected.

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Conical Flange, Upper & Lower (cont.)

- **Qualification Spin Form**
  - **Material tensile test samples were taken from throughout the blank.**
  - **Both L and LT directions were tested. 10 locations for each direction.**
  - **All test samples exceeded MIL-HDBK-5 values for Al 2219-T62 plate.**

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Conical Flange, Upper & Lower (cont.)

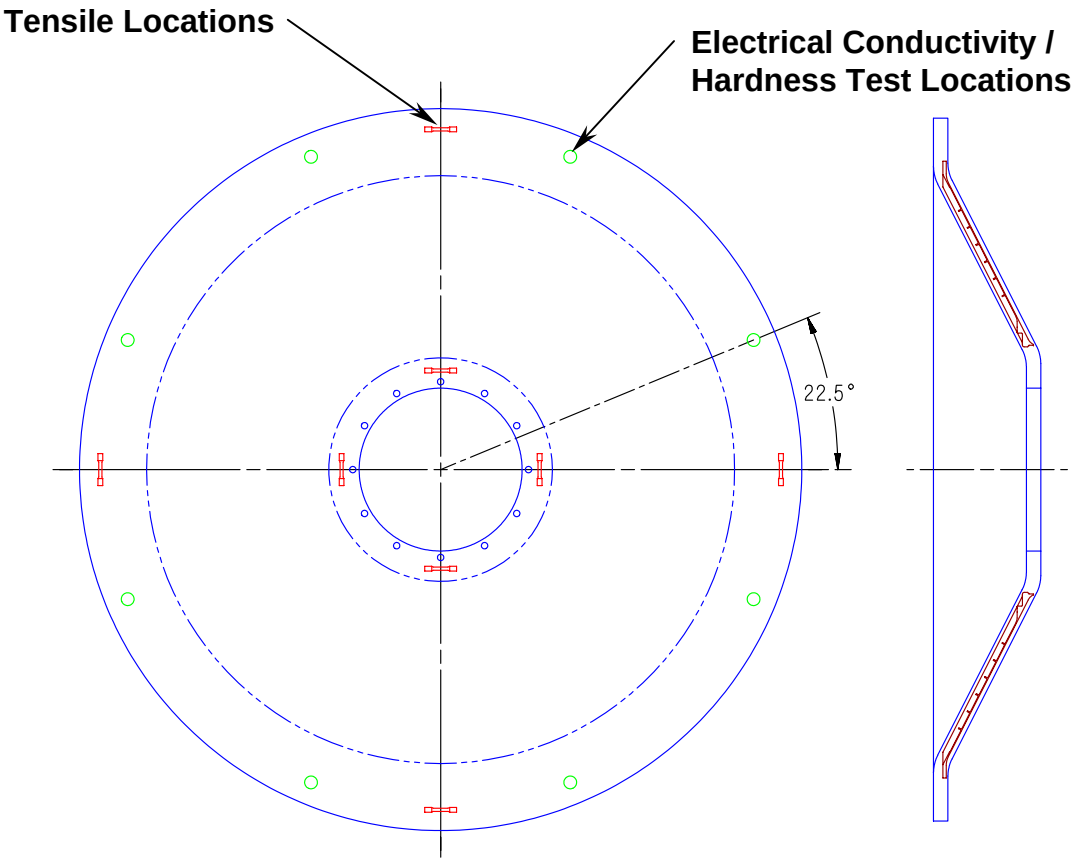
Qualification Spin Form Tensile Test Results

ID	Yield PSI @ .2%	MIL-HDBK-5 "A" Value	Tensile PSI @ max	MIL-HDBK-5 "A" Value	Elong (%)	MIL-HDBK-5 Value
L1	38040	36000	55800	54000	13.0	7.0
L2	37940	36000	56580	54000	14.0	7.0
L3	37540	36000	56310	54000	13.0	7.0
L4	39460	36000	58860	54000	12.0	7.0
L5	40130	36000	56990	54000	13.0	7.0
L6	38550	36000	56810	54000	12.0	7.0
L7	37890	36000	56360	54000	13.0	7.0
L8	38100	36000	57350	54000	14.0	7.0
L9	40420	36000	60080	54000	12.0	7.0
L10	40020	36000	57850	54000	13.0	7.0
LT1	37740	36000	56410	54000	12.0	7.0
LT2	37840	36000	56530	54000	12.0	7.0
LT3	37390	36000	56390	54000	13.0	7.0
LT4	39970	36000	59910	54000	11.0	7.0
LT5	40580	36000	58690	54000	13.0	7.0
LT6	39010	36000	58100	54000	11.0	7.0
LT7	38710	36000	57550	54000	12.0	7.0
LT8	38300	36000	57550	54000	12.0	7.0
LT9	38700	36000	58840	54000	12.0	7.0
LT10	40430	36000	57320	54000	12.0	7.0

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Conical Flange, Upper & Lower (cont.)

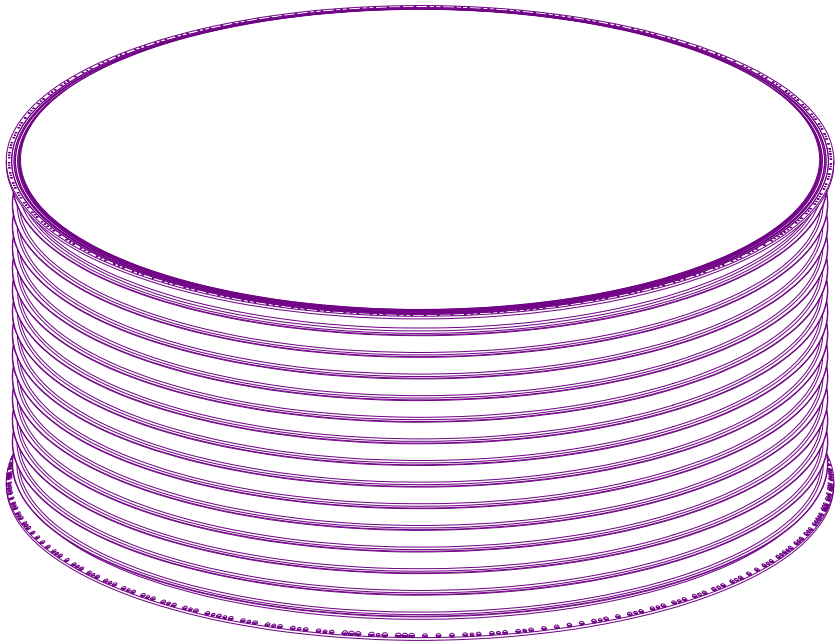
Spin Form Blank Material Test Layout



- **Spin Form Blank Tests (for all production blanks)**
  - **Electrical Conductivity**
    - **Test per AMS 2658**
    - **8 places on both flanges**
  - **Hardness**
    - **Test per AMS 2658**
    - **8 places on both flanges**
  - **Tensile**
    - **Test per ASTM B557**
    - **L & LT directions**
    - **4 places on both flanges**

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Outer Cylinder



- Al 7050-T7451 Rolled Ring Forging.
- Forging Size:

  OD = 109.62

  ID = 104.75

  H = 53.25
- Forging requirements and inspection data were reviewed and approved by NASA/ES.
- Ring stiffened structure.
- Fabrication was started on both forgings but stopped due to payload weight increase.

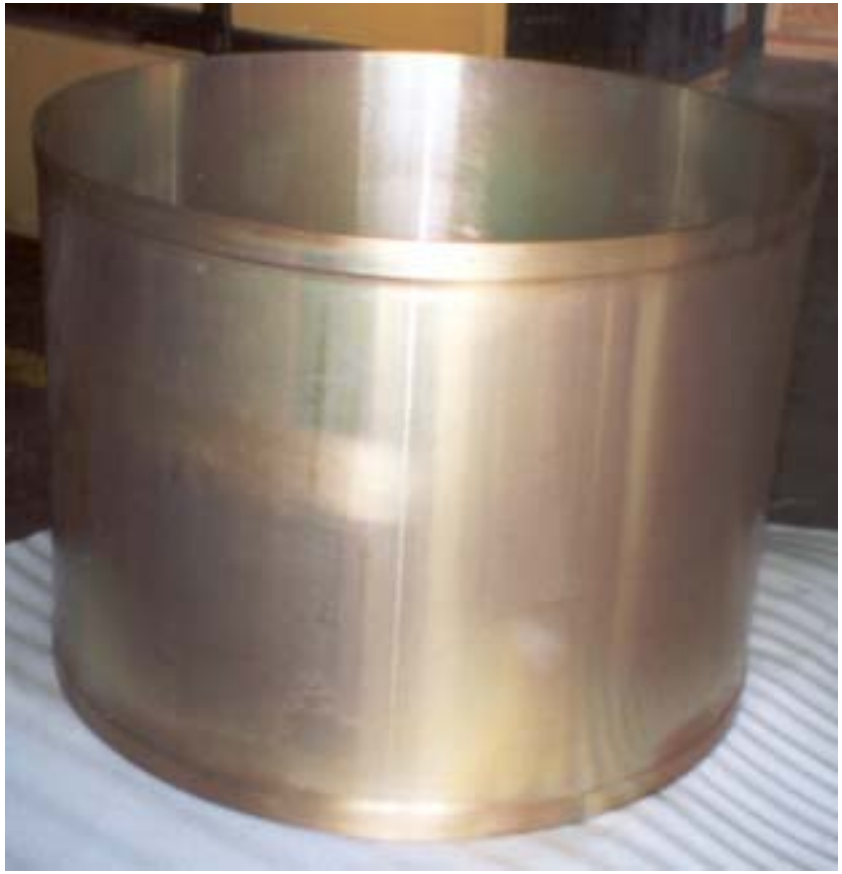
Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Outer Cylinder (cont.)

Initial Machining

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

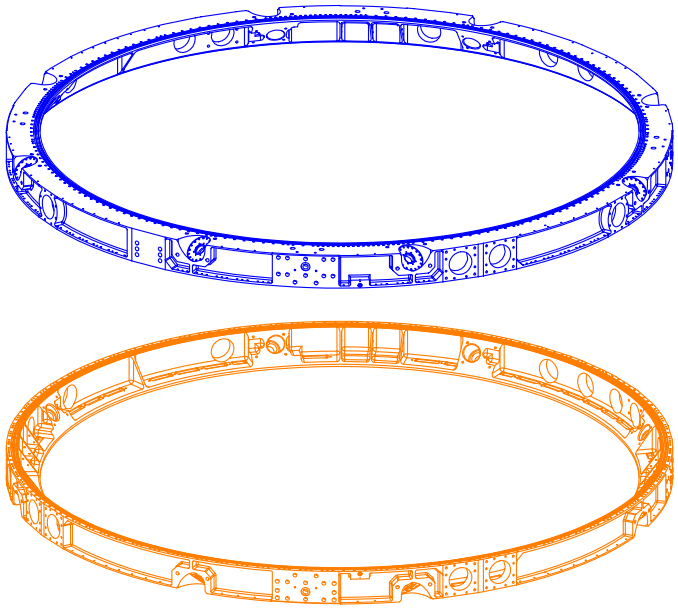
Inner Cylinder



- Al 2219-T851 Rolled Ring Forging.
- Forging requirements and inspection data were reviewed and approved by NASA/ES.
- Monocoque structure.
- Initial machining has been completed. Inner Cylinders are left long and completed at assembly.
- Final machining includes machining to the proper length, with weld shrinkage allowance, and machining the weld groove.

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Support Ring, Upper & Lower



- Al 7050-T7451 Rolled Ring Forging.
- Forging Size:

  OD = 110.00

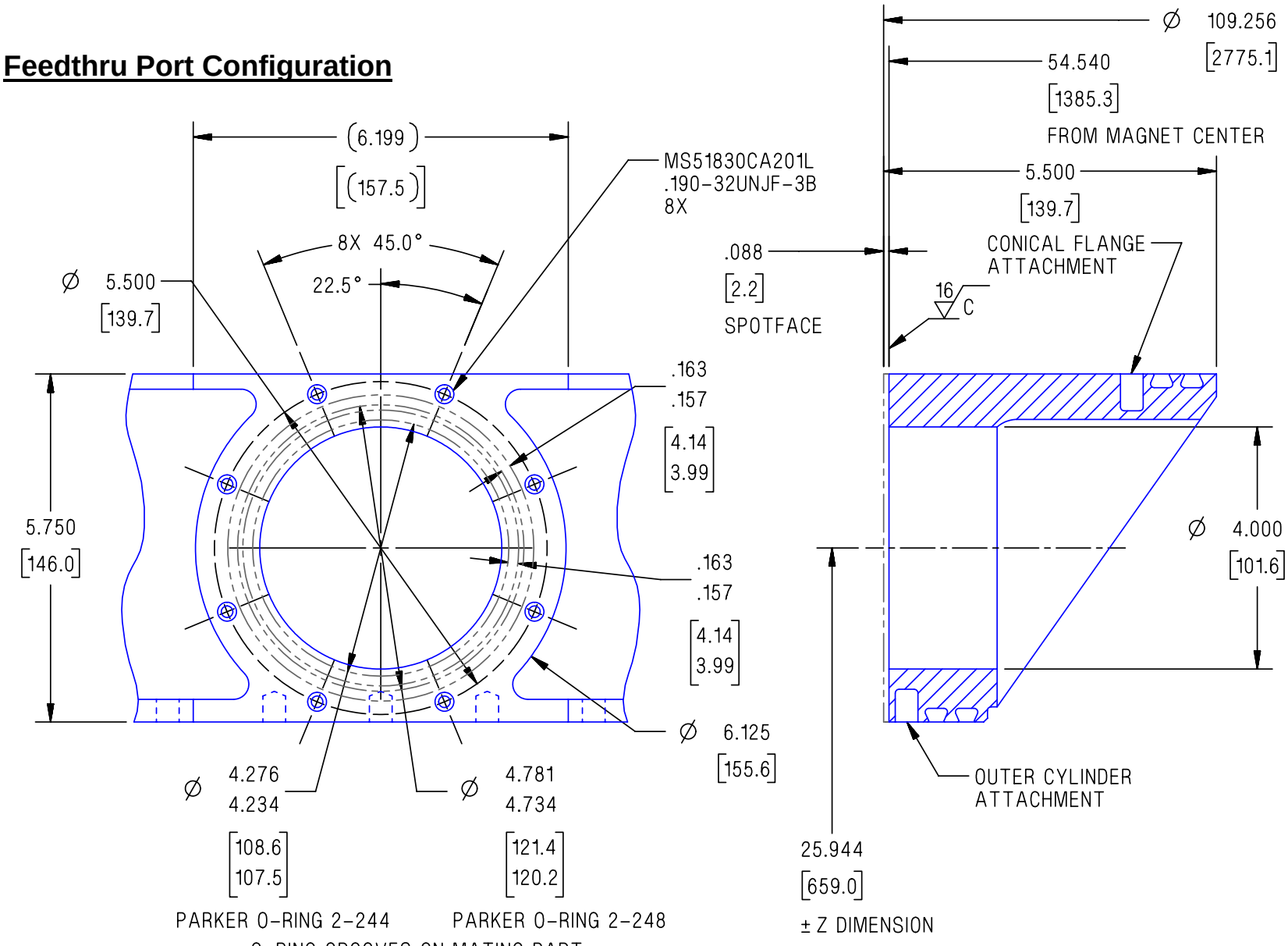
  ID = 97.50

  H = 6.500
- Forging requirements and inspection data were reviewed and approved by NASA/ES.
- One Forging will be cut up and used for material tests.
- All 16 straps attach to the Support Rings.
- All Feedthru Ports are located in the Support Rings.

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Support Ring, Upper & Lower (cont.)

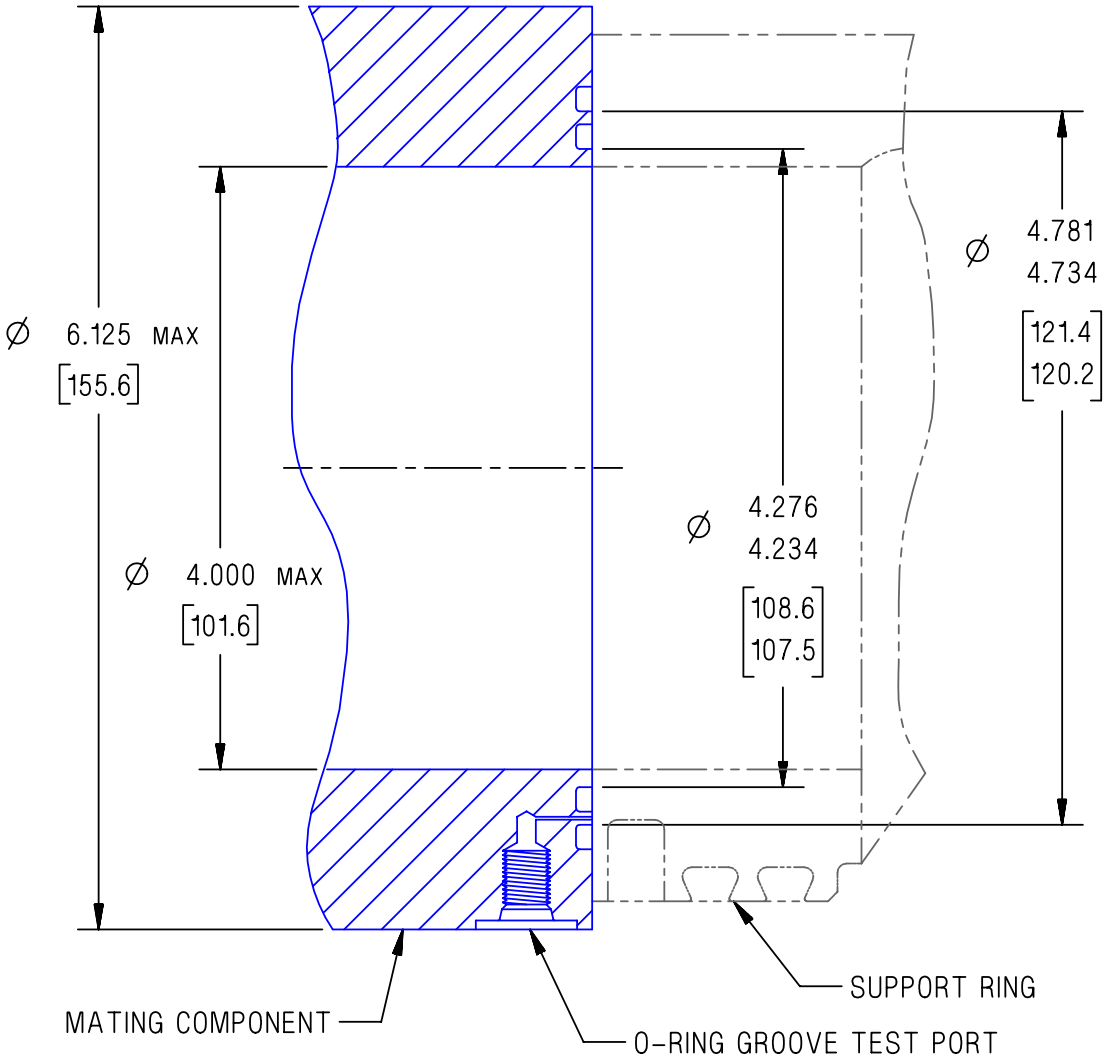
Feedthru Port Configuration

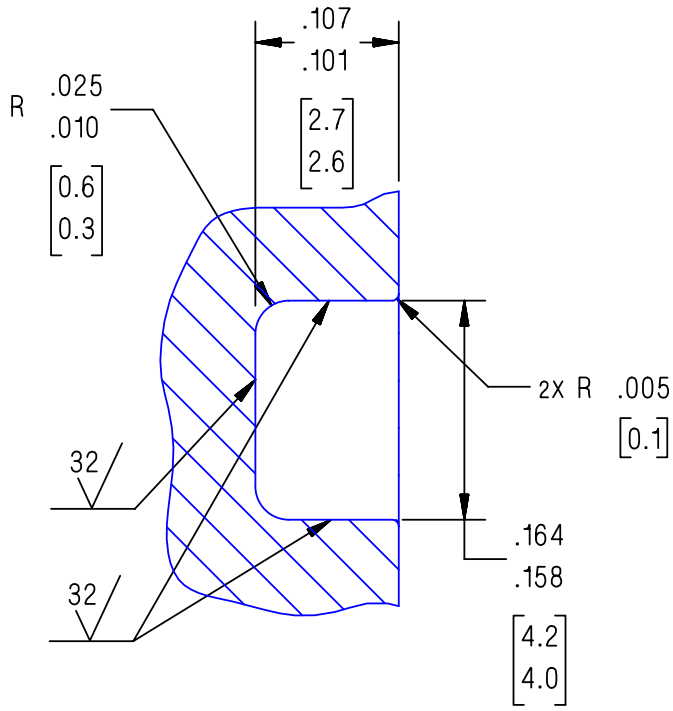


Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Support Ring, Upper & Lower (cont.)

Feedthru Port Mating Component

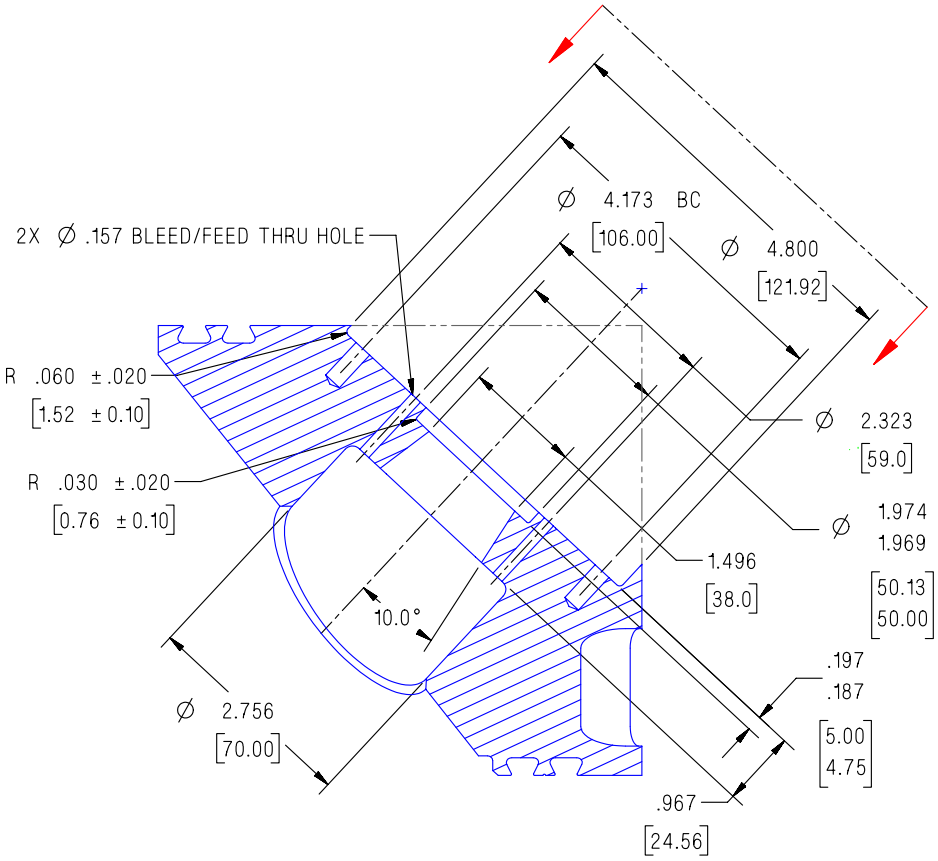


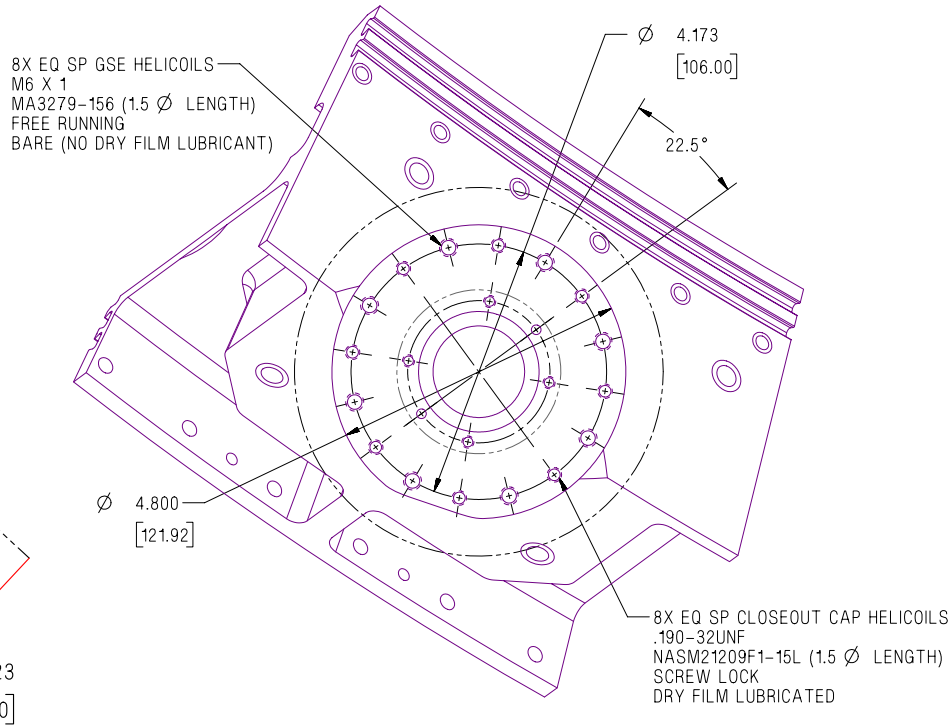


O-RING GROOVE DETAIL

Support Ring, Upper & Lower (cont.)

Strap Port

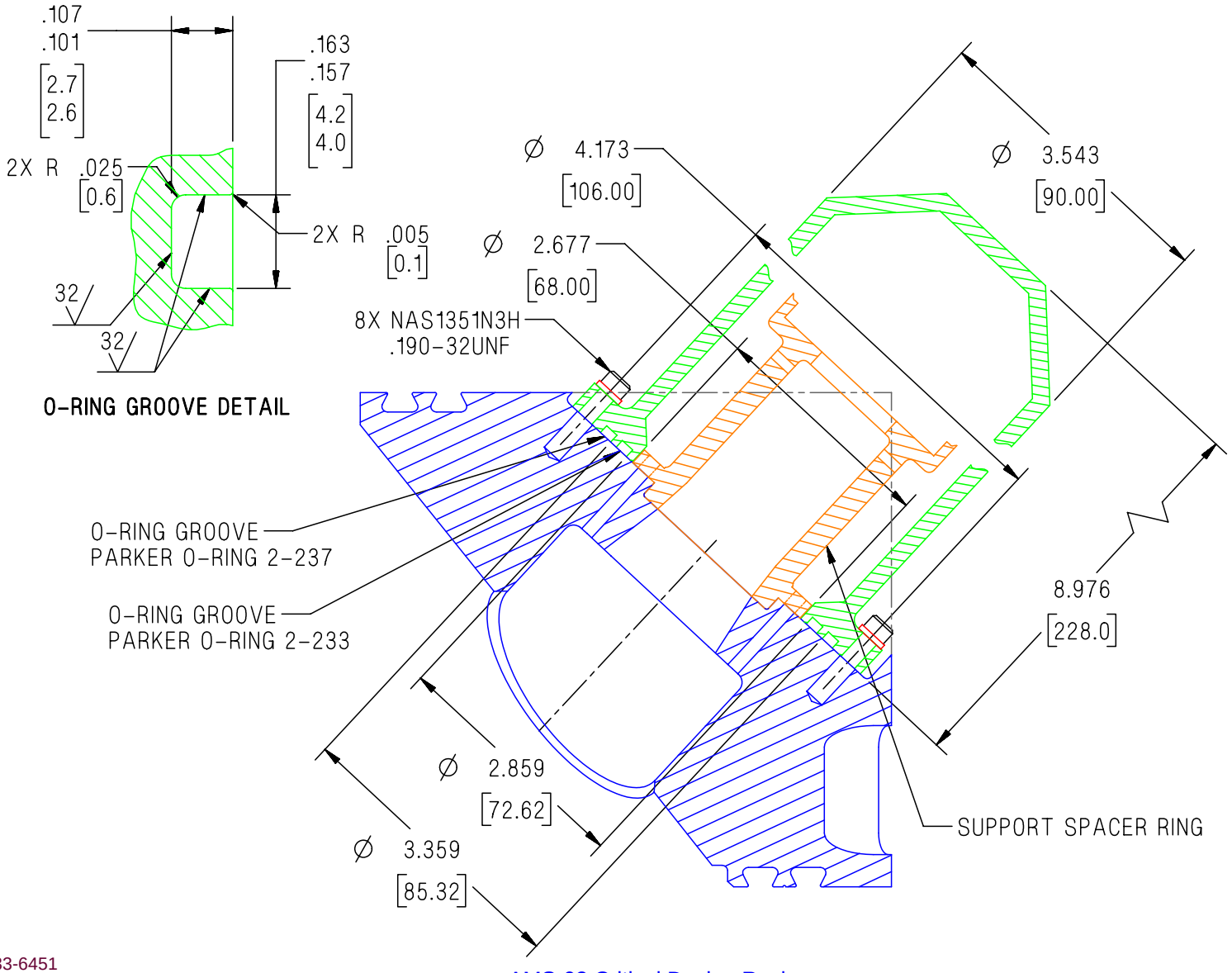




Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

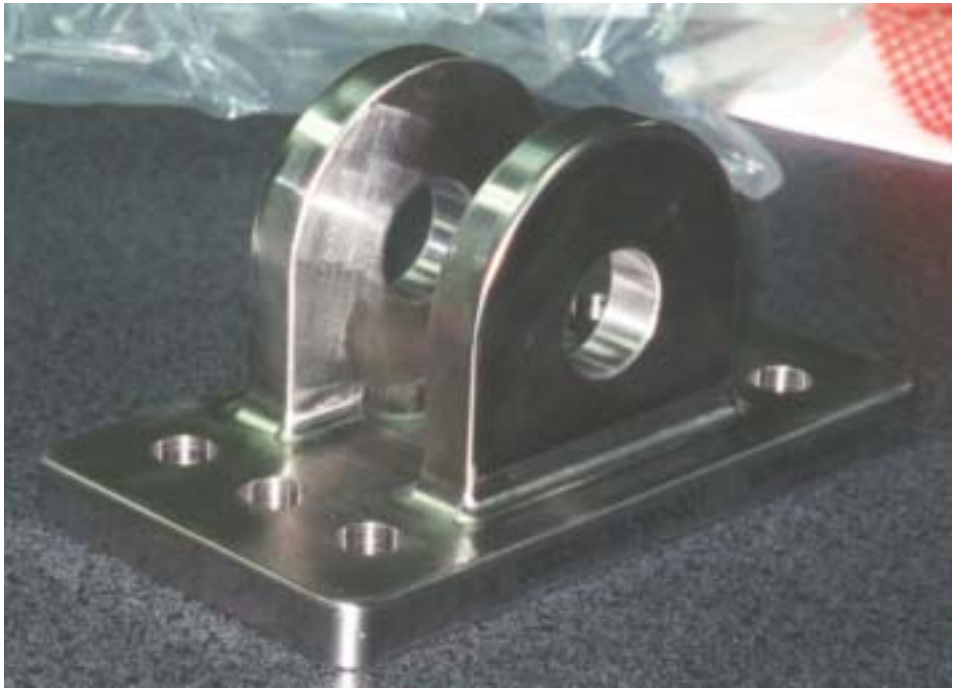
Support Ring, Upper & Lower (cont.)

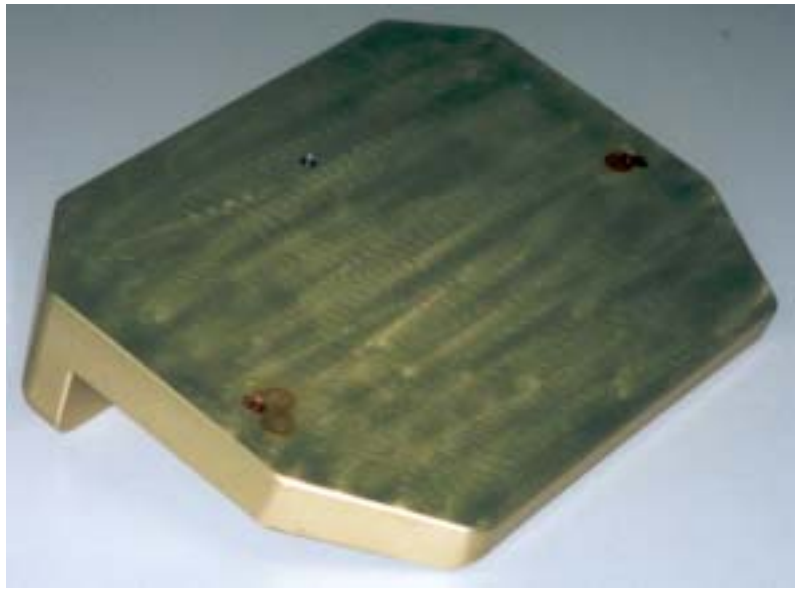
Strap Port with Closeout Cap

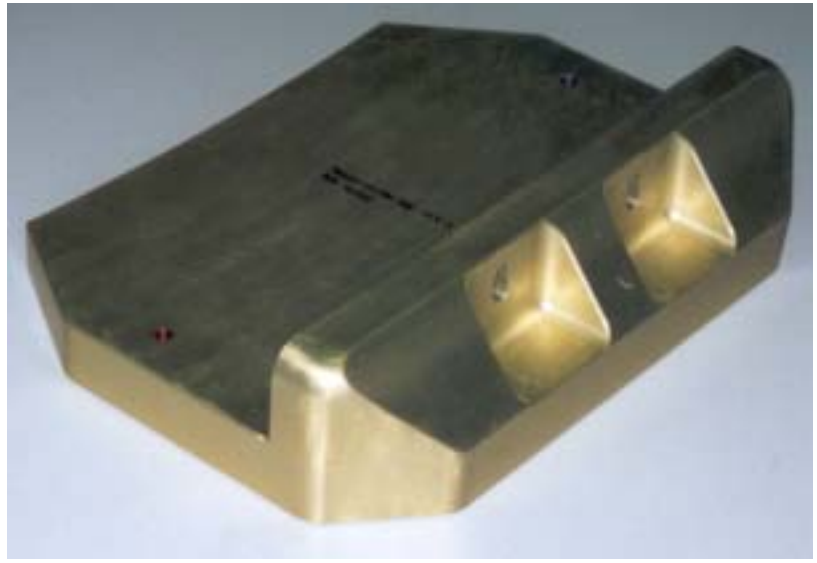


Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Interface Plates & Clevis Plates







Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Inner Joint

- **Welded Joint – U Groove Design, 2 Pass.**
- **O-Ring joint not possible due to keep out zones on both sides of the joint, Magnet and Tracker/ACC.**
- **Assembly constraints did not allow for O-Ring mating flange. Flange would compress the insulation around the Cryomagnet thereby reducing the endurance.**
- **Piston style O-Ring did not allow for required compression to obtain a high quality vacuum seal.**
- **Joint is designed for 3 welds – Initial plus 2 contingencies.**
- **Weld crown will be shaved flush to accommodate ultrasonic inspection.**

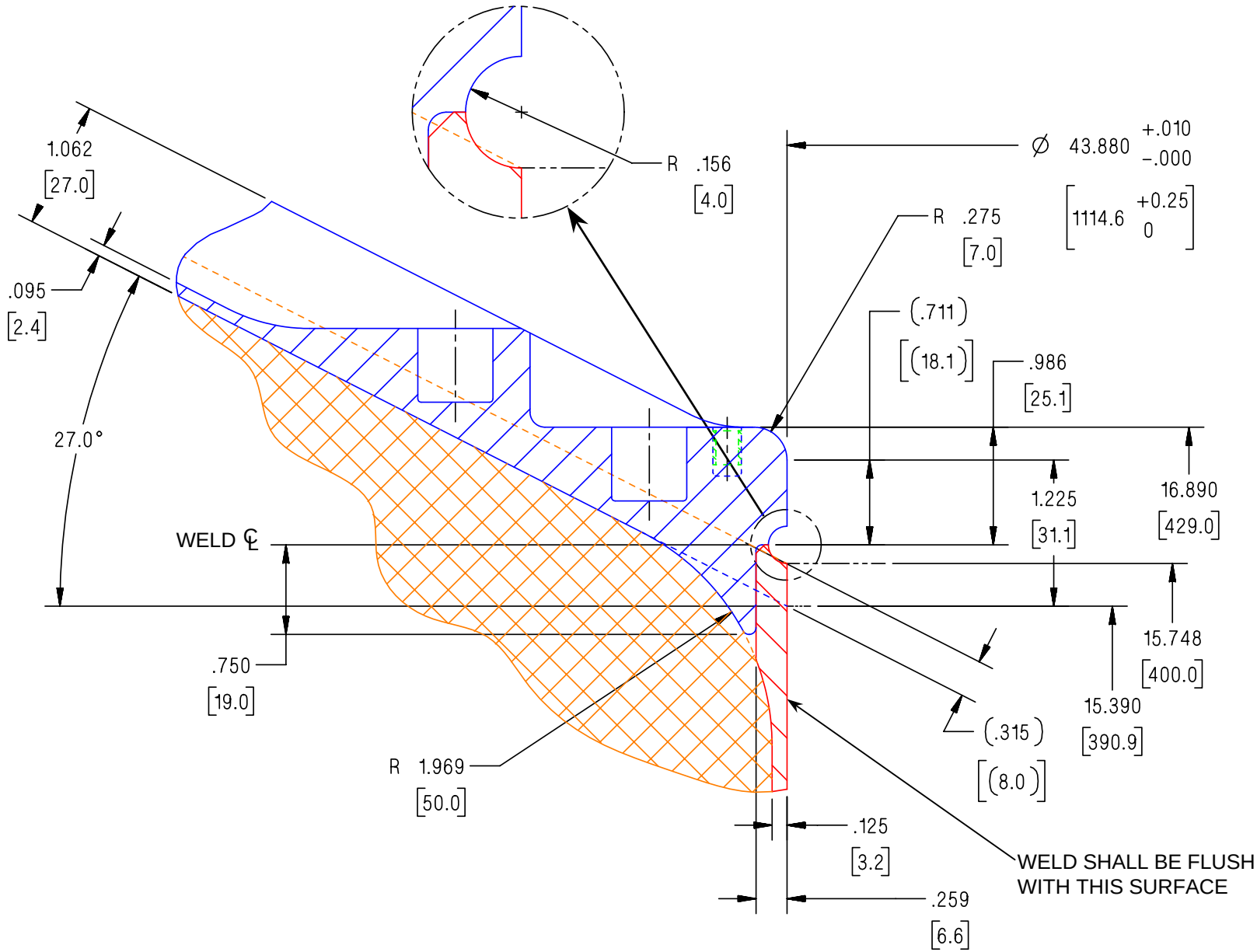
Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Inner Joint (cont.)

- Three complete closeout welds will take place prior to the closeout weld on the Flight Assembly:
  - First Article (initial & 1 re-weld)
  - STA at vendor's facility for pressure and leak tests.
  - STA at SCL in Culham, England.

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Inner Joint Detail



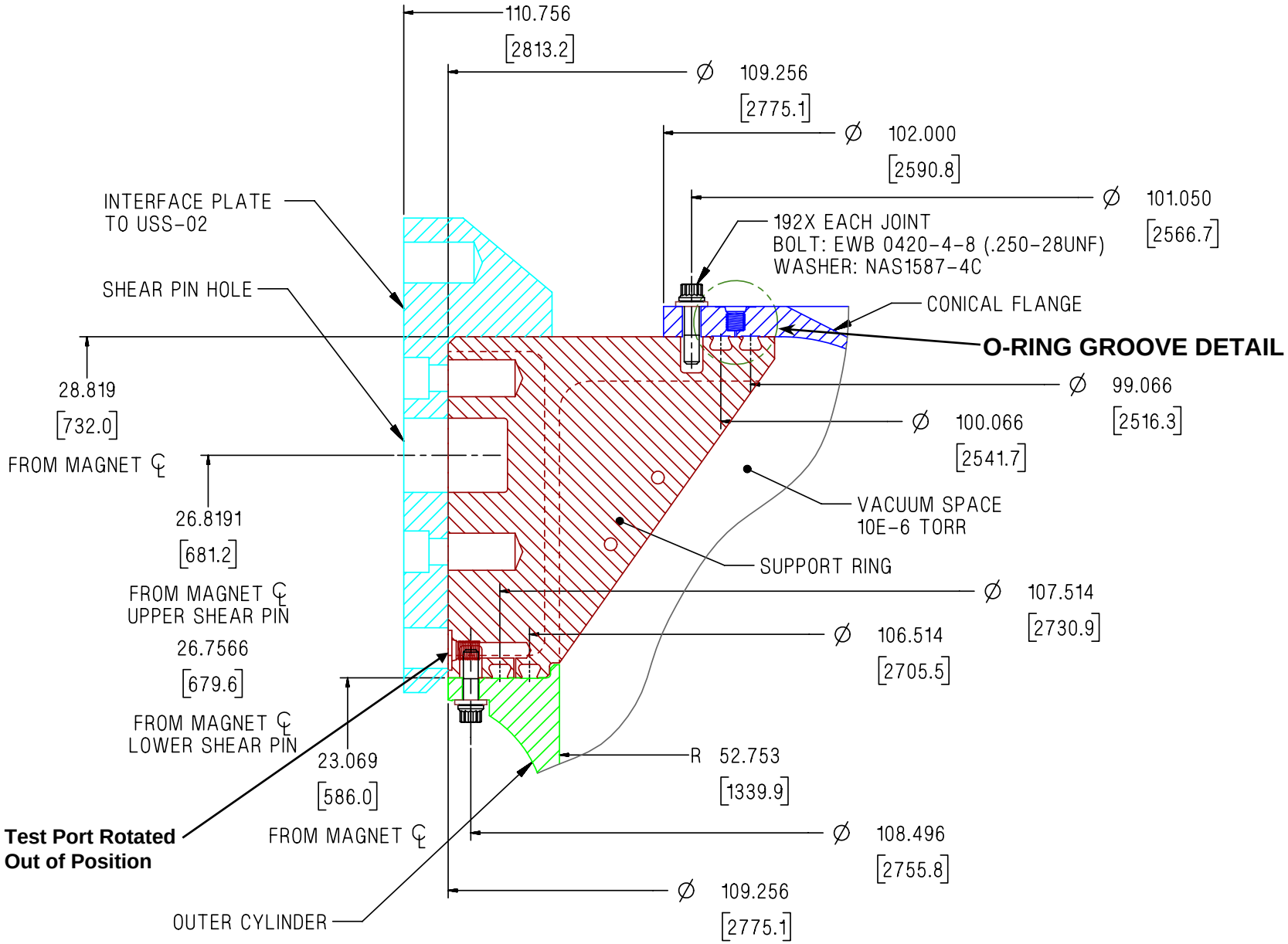
Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Outer Joint

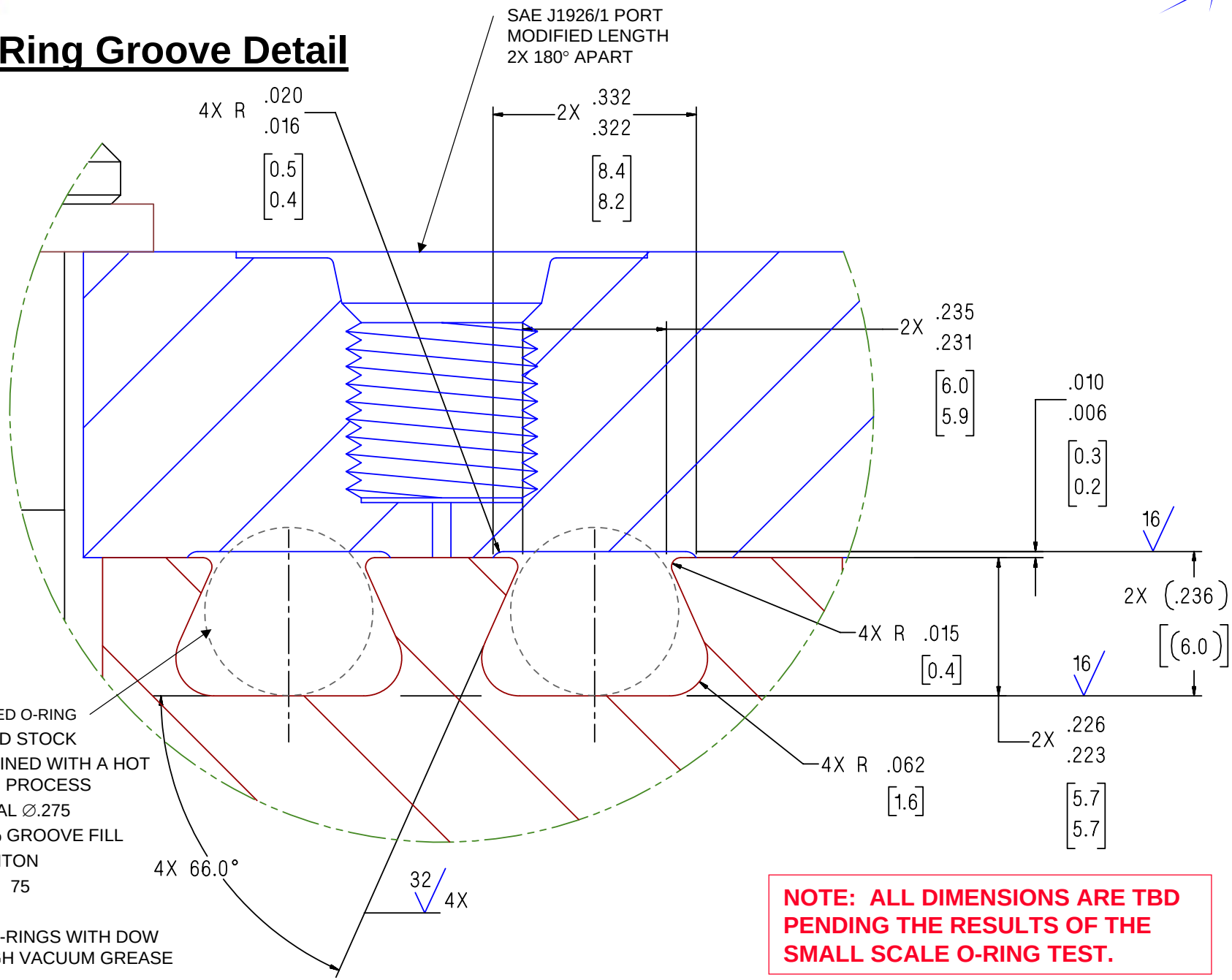
- Double O-Ring bolted joint.
- Mechanical attachment:
  - Conical Flange, Upper: 232 .250-28UNJF
  - Outer Cylinder, Upper: 192 .250-28UNJF
  - Outer Cylinder, Lower: 168 .250-28UNJF & 32 .3125-24UNJF
  - Conical Flange, Lower: 192 .250-28UNJF
- O-Ring material is Viton, 75 Durometer.
- Test ports between each O-Ring for individual leak checks.
- O-Ring configuration is currently undergoing evaluation on the O-Ring Test Fixture (OTF) in J13.

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Outer Joint Detail



O-Ring Groove Detail



UNCOMPRESSED O-RING
PARKER CORD STOCK
ENDS ARE JOINED WITH A HOT VULCANIZING PROCESS
(∅.250) ACTUAL ∅.275
MINIMUM 95% GROOVE FILL
MATERIAL: VITON
DUROMETER: 75

LUBRICATE O-RINGS WITH DOW CORNING HIGH VACUUM GREASE

NOTE: ALL DIMENSIONS ARE TBD PENDING THE RESULTS OF THE SMALL SCALE O-RING TEST.

Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Existing Hardware

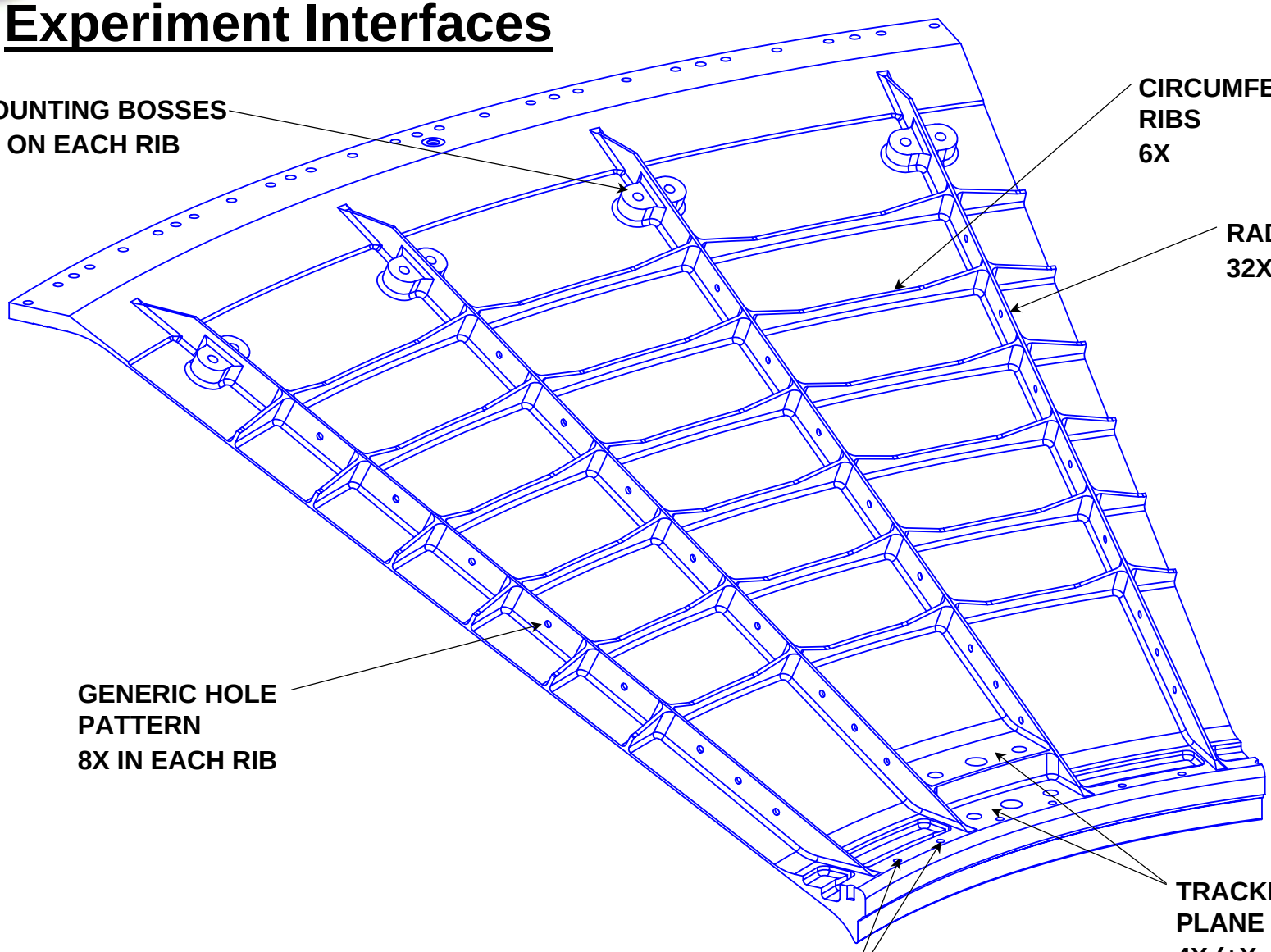
Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Experiment Interfaces

- **Tracker and ACC interfaces on the Upper & Lower Conical Flanges.**
- **Numerous generic holes around the outside of the Vacuum Case.**
- **Numerous generic holes inside the Vacuum Case for cable and tube routing.**
- **All details can be found the the Vacuum Case ICD, JSC 29202.**

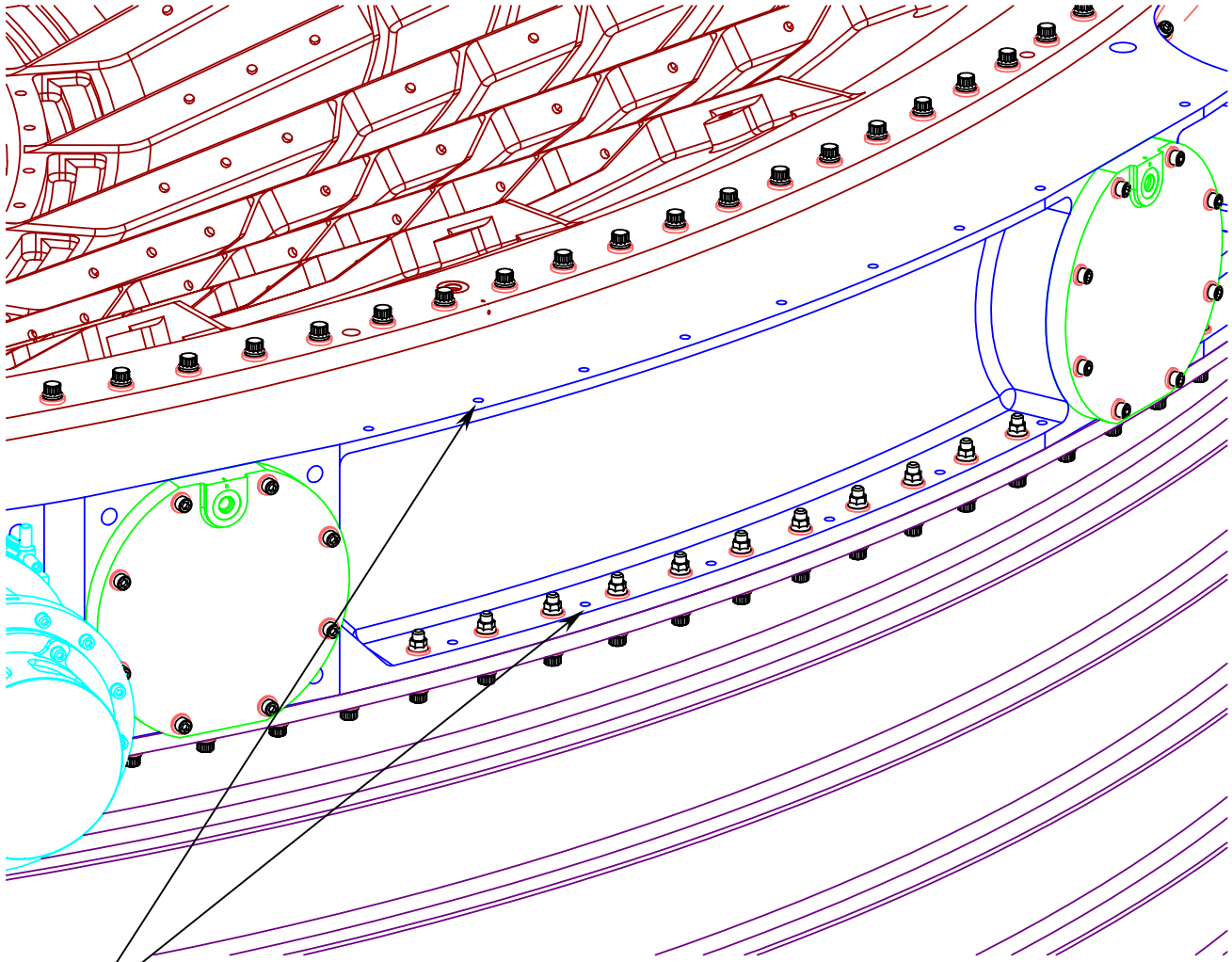
Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Experiment Interfaces



Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com

Experiment Interfaces



Phil Mott
Phone: 281-333-6451
Email: phil.mott@lmco.com