Fermilab

Managed by Fermi Research Alliance, LLC for the U.S. Department of Energy Office of Science

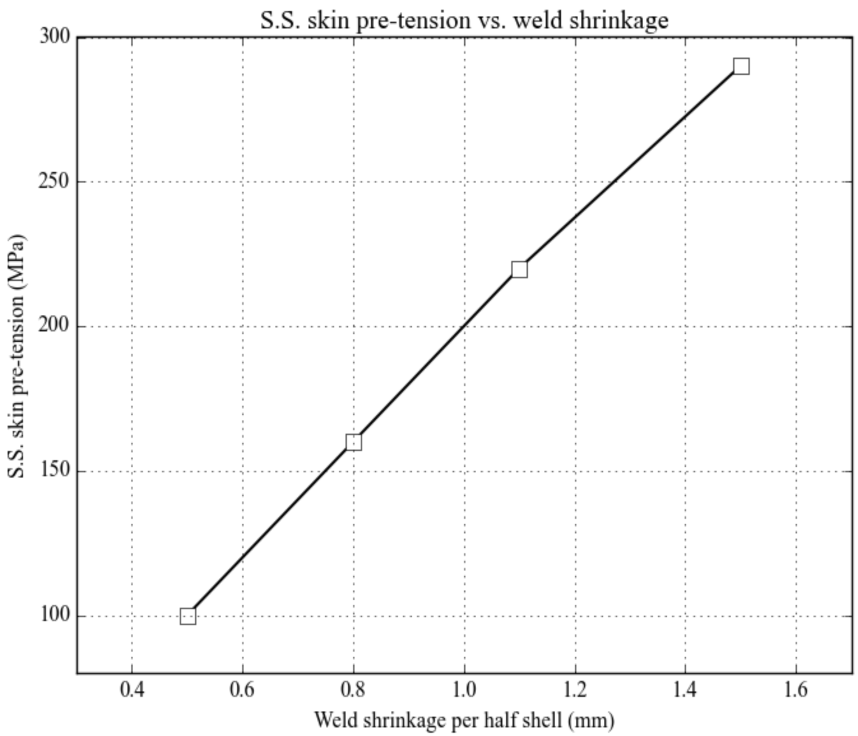
MQXFS1d Welding Status

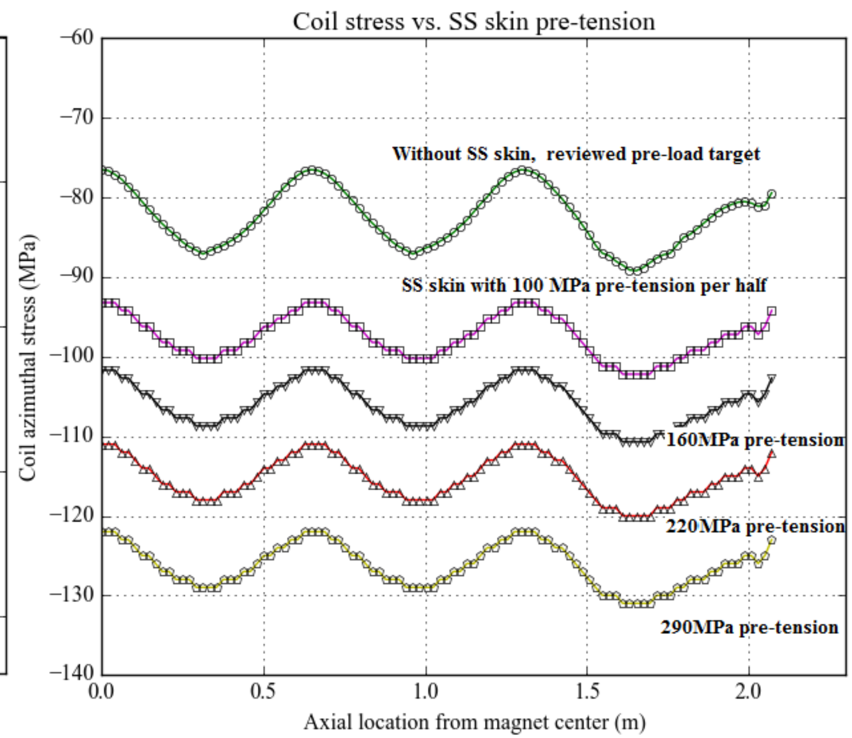
Antonios Vouris

Cold Mass Status Meeting

25 January 2018

Coil pre-stress changes with SS skin pre-tensions



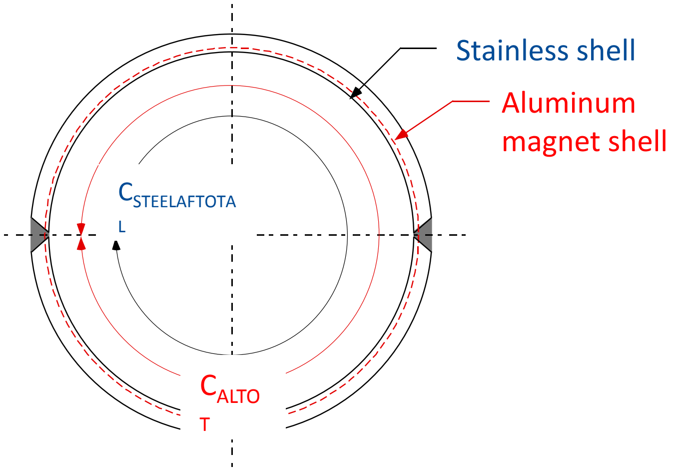


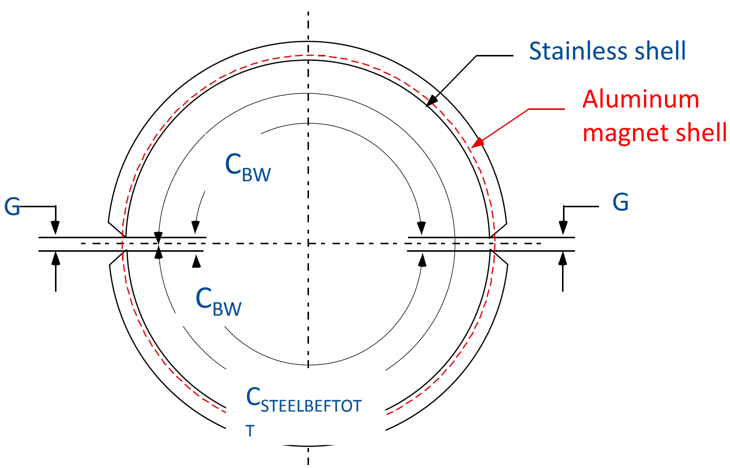
- Impact of the SS skin has been performed in our 3D model by applying different interferences between S.S. vessel and the magnet structure.
- The plot on the right presents the coil (pole) azimuthal stress along the magnet length with deferent SS skin pre-tensions induced by welding shrinkage.

Δ σ_{Coil} compared with Giorgio's results

- The coil stress increases by ~3.2 MPa / 0.1mm weld shrinkage (half shell). This denotes about 48 MPa coil stress increasing is expected for a 50 mil (1.5 mm) weld shrinkage (half shell).
- This value is close to the results Giorgio presented in the his slides "MQXF – Vessel Welding" (05/12/2017) .
- Both 2D and 3D results shows the current weld shrinkage is relatively high for the coil pre-stress.

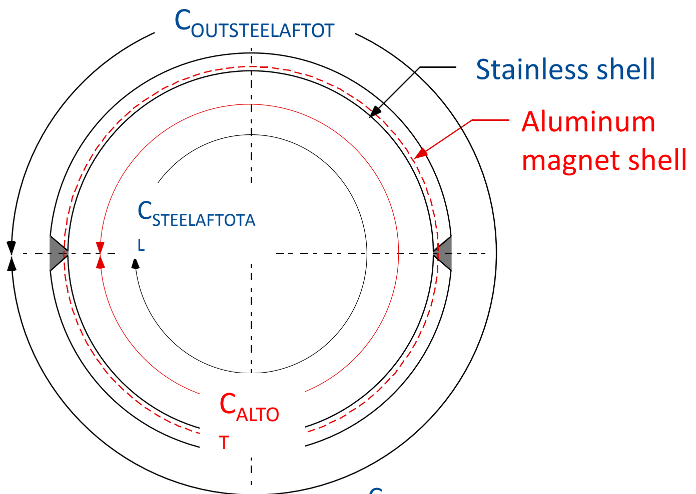
Calculation of Shell Weld Preparation

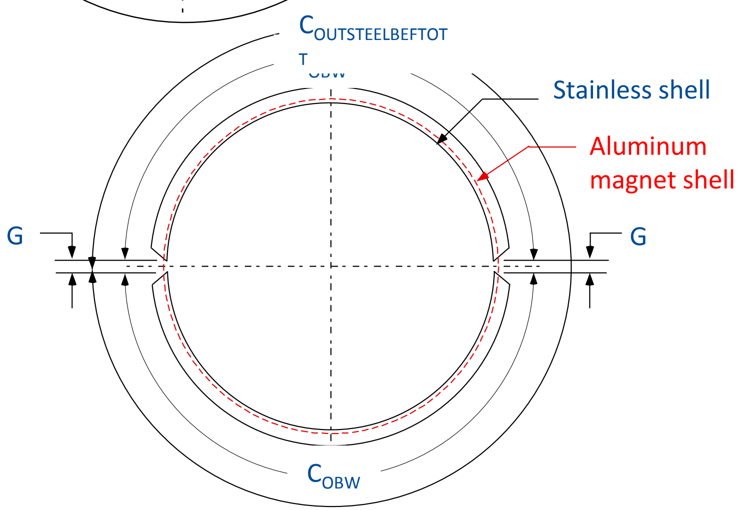




- C_{ALTOT} =Total Circumference of Outside surface of Aluminum shell
- $C_{STEELAFTOT}$ = Total Circumference of Inner surface of Steel shell after welding
- Measured dia. of Aluminum Shell O.D. = 614.657 mm = 24.199 in.
- *Criteria to achieve correct tightness after welding*: $C_{STEELAFTOT} = C_{ALTOT} - .020$ in.
- C_{ALTOT} = 24.199 in. x ∏ = 76.023 in.
- $C_{STEELBEFTOT} = C_{STEELAFTOT}$ + Total Shrinkage during welding
- Total shrinkage during welding = .090 in. (over entire azimuth) = .045 in. per side.
- Therefore, $C_{STEELBEFTOT}$ = 76.023 in. -.020 in. + .090 in. = 76.093 in.
- And the inside diameter of the steel before welding is 76.093/ ∏ =24.221 in.

- C_{BW} = Circumference of inside of steel shell half before welding
- G = Gap size before welding per side = .094 in.
- $C_{STEELBEFTOT} = C_{BW} + C_{BW} + G + G$
- Therefore, $C_{BW} = (C_{STEELBEFTOT} - 2G)/2$
- Therefore, C_{BW} = (76.093 in.– .188 in.)/2 = 37.952 in.





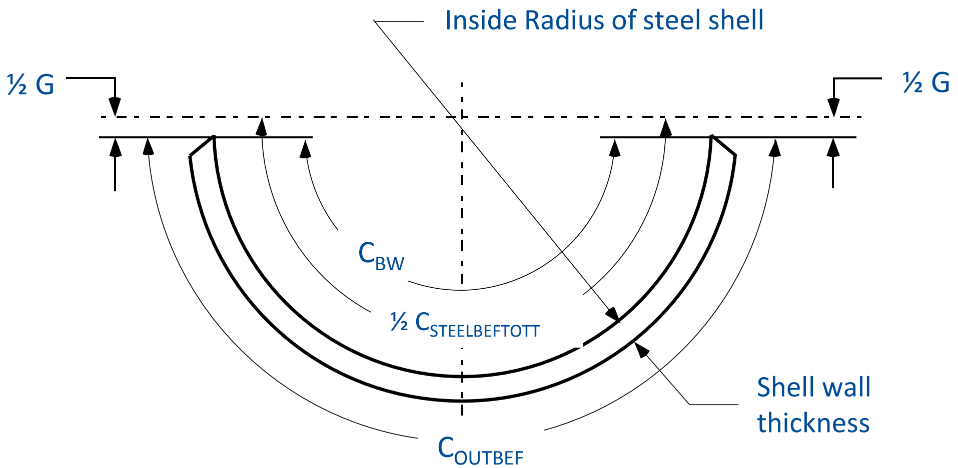
Calculation of Shell Weld Preparation

(Using Outside Diameter)

- C_{ALTOT} =Total Circumference of Outside surface of Aluminum shell
- $C_{STEELAFTOT}$ = Total Circumference of Inner surface of Steel shell after welding
- Measured dia. of Aluminum Shell O.D. = 614.657 mm = 24.199 in.
- Outside dia. Stainless Shell after welding = 24.199 in. + (.330)(2) = 24.859 in.
- *Criteria to achieve correct tightness after welding*: $C_{STEELAFTOT}$ = C_{ALTOT} - .020 in.
- Outside circumference of steel after welding = $C_{OUTSTEELLAFTOT}$ = 24.859 in. x ∏ = 78.096 in.
- $C_{OUTSTEELBEFTOT}$ = $C_{OUTSTEELAFTOT}$ + Total Shrinkage during welding
- Total shrinkage during welding = .090 in. (over entire azimuth) = .045 in. per side.
- Therefore, $C_{OUTSTEELBEFTOT}$ = 78.096 in. -.020 in. + .090 in. = 78.166 in.
- And the outside diameter of the steel before welding is 78.166/ ∏ =24.881 in.
  - C_{OBW} = Circumference of outside of steel shell half before welding
  - G = Gap size before welding per side = .094 in.
  - $C_{OUTSTEELBEFTOT}$ = C_{OBW} +C_{OBW} +G+G
  - Therefore, C_{OBW} = ($C_{OUTSTEELBEFTOT}$ - 2G)/2
  - Therefore, C_{OBW} = (78.166 in.– .188 in.)/2 = 38.989 in.

Shell Half before Welding

(Using Outside Diameter calculated geometrically)



½ $C_{STEELBEFTOTT}$ = 76.093 in/2 = 38.046 in.

½ G = .094 in./2 = .047 in.

C_{BW} = 37.952 in.

Wall thickness of shell = .330 inches.

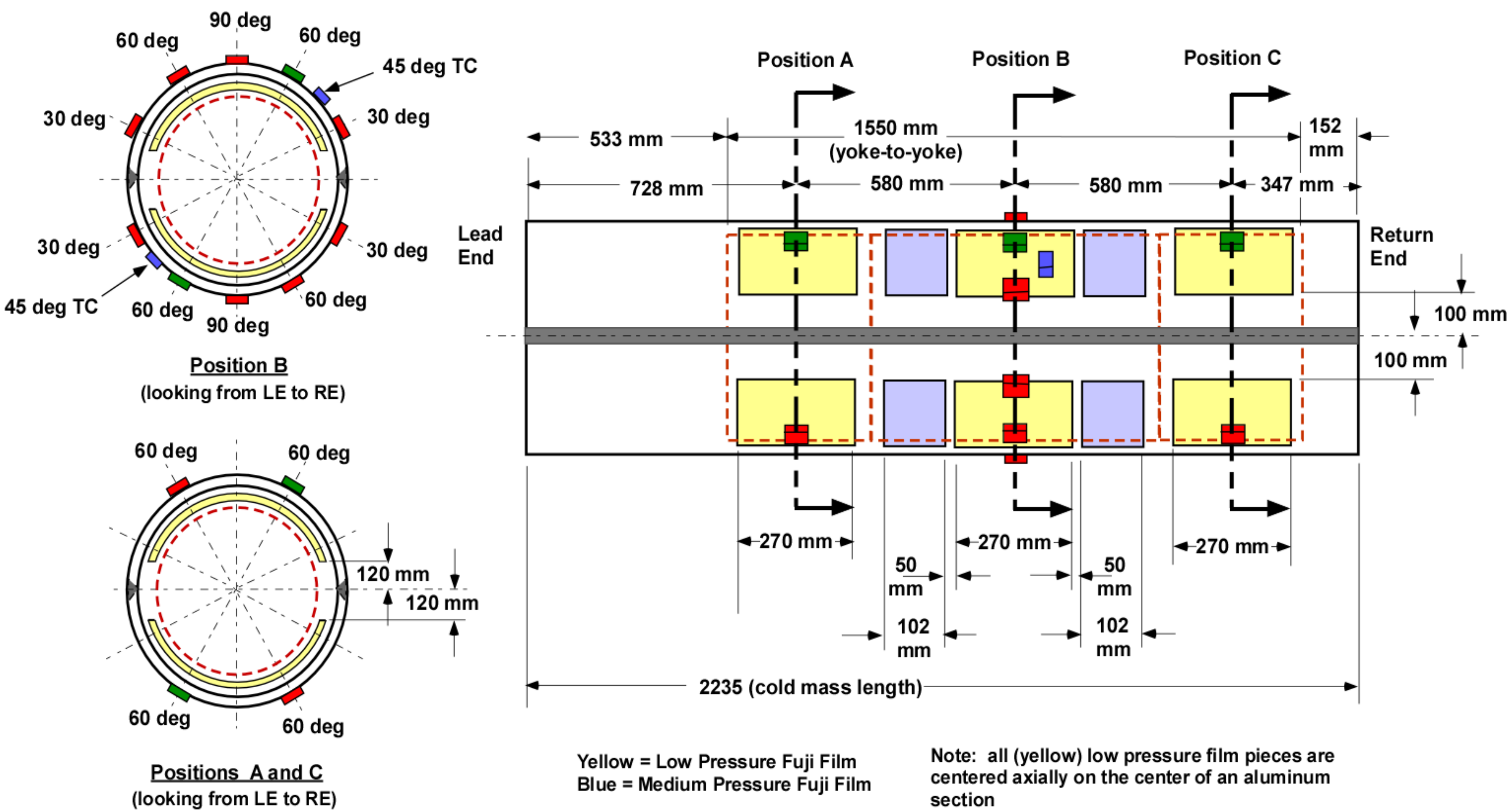
Inside dia of shell = 24.221 inches.

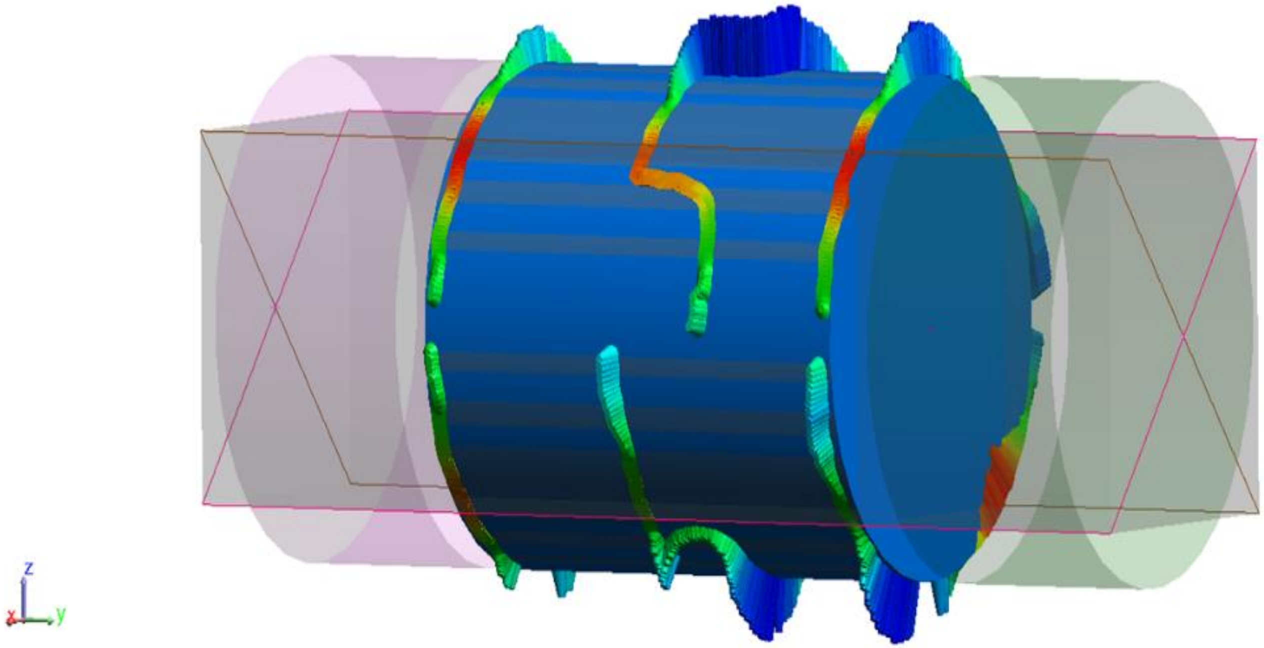
Outside dia of shell = 24.221 inches + (.330)(2) = 24.881 in.

Outside circumference of shell = 24.881 x ∏ = 78.166 in.

Therefore C_{OUTBEF} = outside circumference of shell half – (½ G)(2) = (78.166/2) – (.047)(2) = 38.989 in.

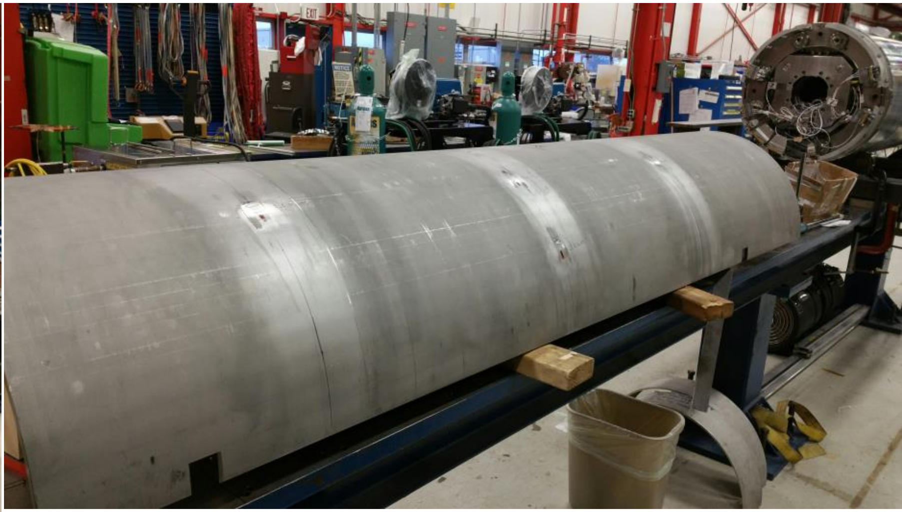
Fuji film plan

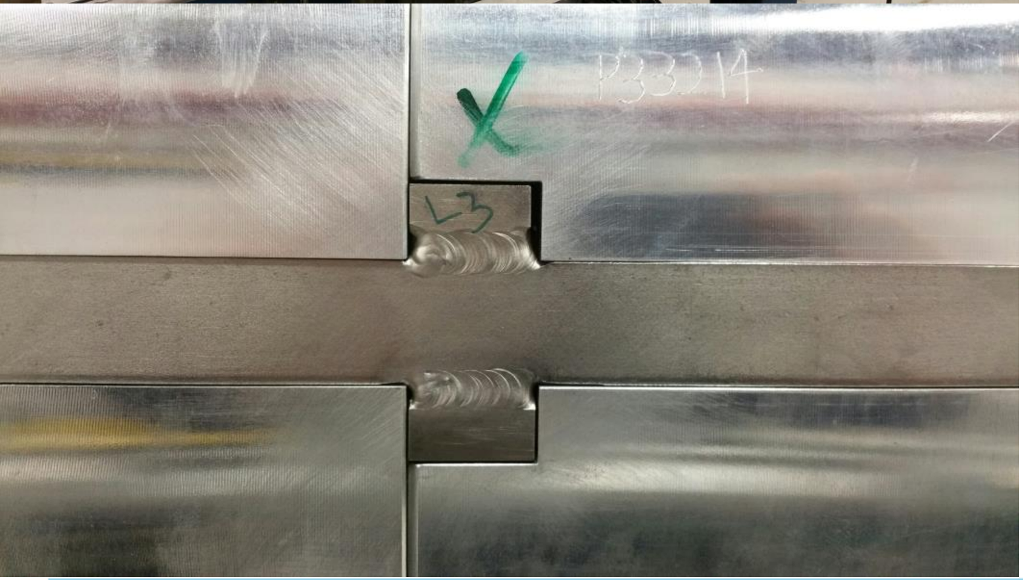




Measurements of center section of MQXFS1C shell.

Status





Next steps:

- Wire up the strain gauges
- Scribe the centerline both sides
- Insert the Fuji films
- Fit up the shells
- Welding
    - Final shell leveling wrt. equipment
    - Monitor temperatures
    - Measure strain gauges after each passes