dRICH Split Considerations

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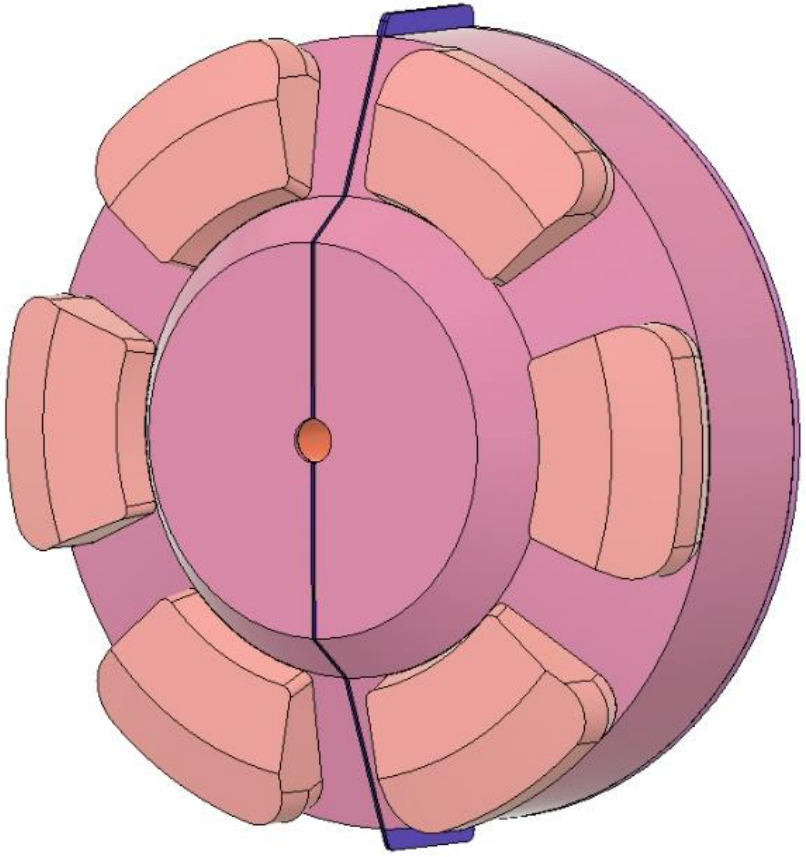
Known Parameters

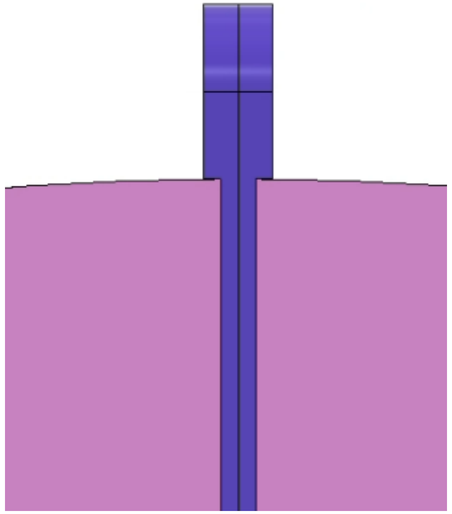
- C2F6 gas pressure < 1mbar pressure differential from atmospheric
- Outer Shell thickness ~10mm bulk carbon fiber (CF)
- Estimated weight of pfRICH ~2000kg

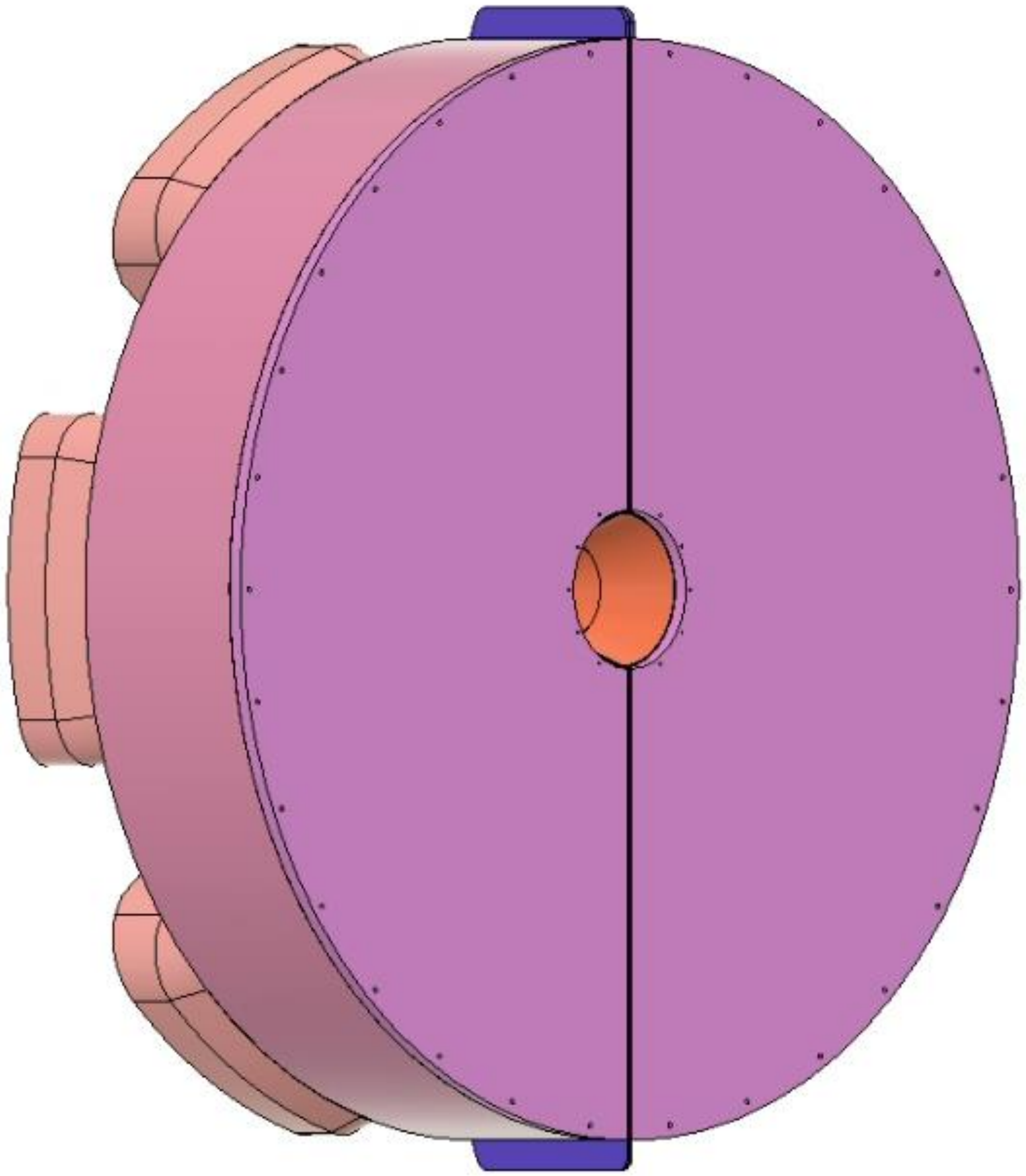
Assumptions/Questions

- In order to move forward with this determination, I needed to assume that the alignment of the two halves was most important to be constrained along the split faces. Using dowel pins and bolts at flanges at the top and bottom makes the most sense for this solution.
- However, if the two halves need to be oriented very tightly with each other a different mounting scheme would have to be implemented.
- My assumption is that the individual adjustments on the mirror would allow for slight misalignments if the vessel wasn't pointing directly at the IP and therefore a pins and bolts approach would make sense.
- **If tight alignment of the vessel is necessary, this will need to be known ASAP since the rest of these slides assume that there is an ability to adjust the mirrors or through software any mechanical misalignments that may occur.**

Modeled Split



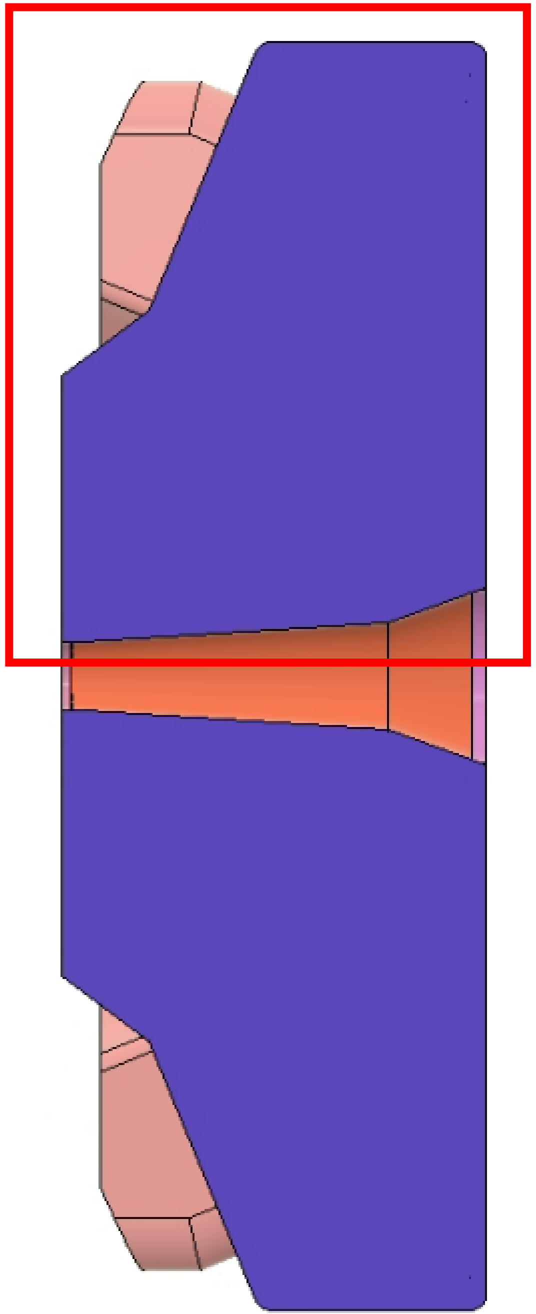




Deflection from Pressure Differential?

- Each purple segment (four in total), have an area of ~2876 in^2
- 1 millibar of pressure = 0.0145 psi
- 2876 in^2 * 0.0145 psi = ~41 lbf

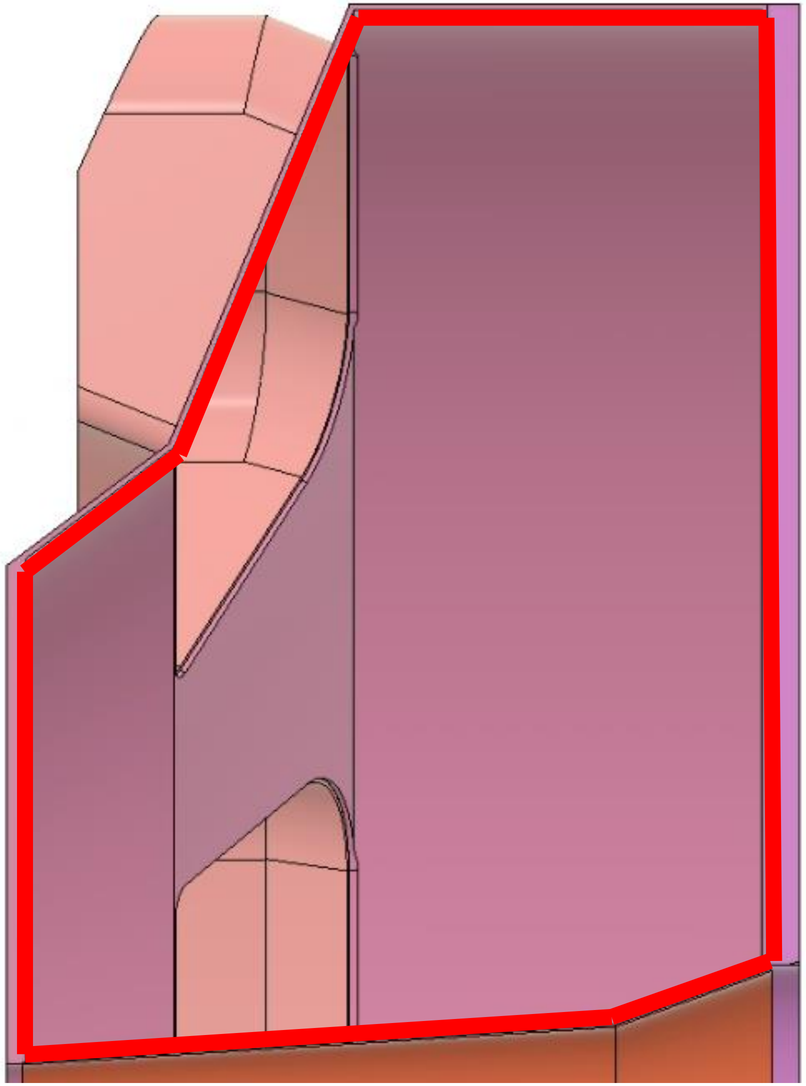
- Each purple segment has a total of 41 lb of force applied to it when pressurized (**negligible**)
- When the vessel is separated, we could make sure that the C2F6 gas is evacuated as a precaution.



Thickness of the Dividing Wall

A full flange (stepped?) would be needed where indicated (red), with a sealing solution and a fastening method

- Rest of the vessel walls = 10mm thickness
- We could continue to use the 10mm thickness for the dividing walls if we assume that the load will be transferred.
  - If we agree to fixture the vessel in a manner that minimizes deflection while halves are apart, we could make the walls much thinner.
- 10mm might be a good conservative start with goals of minimizing the total thickness depending on mounting solutions.



Worst-Case Shear Load

- In single shear:

Pin Dowel Shear Stress Equation:

$$\tau = (4 \cdot F) / (\pi \cdot d^2) \leq \tau_A$$

$$\tau_A = s_u / f_{os}$$

F = Force applied (lbs, N),
τ = shear stress on dowel pin [psi, MPa],
τ_A = allowable shear stress [psi, MPa],
s_u = Shear or yield strength of dowel pin material [psi, MPa],
f_{os} = Factor of safety for dowel pin and boards, typical 2 or greater,
d = pin diameter [in, mm],

Total Estimated Weight = 2000kg			
Worst case: one half of the detector is supported, the other half is free... 1/2 the weight is applied as a downward force			
Half estimated weight = 1000kg			
Convert to N = 9806 N			
Shear Stress on dowel pin =	309.6382	MPa	0.25" Dowel Pin
Convert to psi	44816.66	psi	0.25" Dowel Pin
Shear Stress on dowel pin =	77.40955	MPa	0.5" Dowel Pin
Convert to psi	11227.31	psi	0.5" Dowel Pin

Dowel Pin Selection

- Since one of the dowel pins might be slotted in the direction of shear force, the most conservative case (to use for this estimate) would be that only one dowel pin needs to withstand the shear load produced by gravity.
- 304 SS has a yield strength of between 30ksi and 45ksi, meaning a FOS of ~3-4.5 depending on specific material properties.
- Therefore, we could easily start with a ½” dowel pin in both the top and bottom flanges.

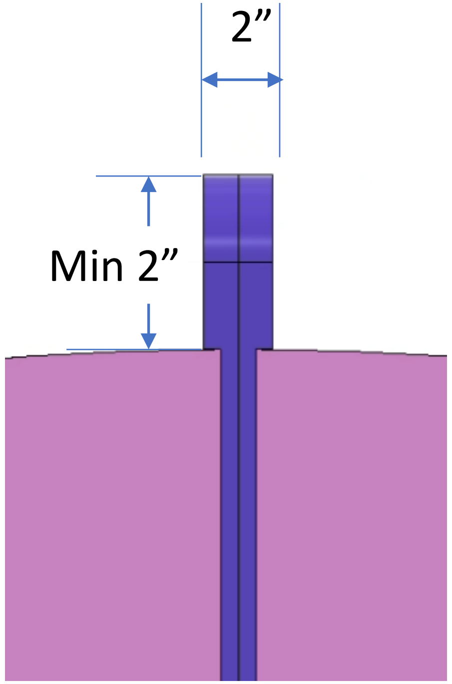
Doweled Joint (Top and Bottom)

- Typical rules of thumb for doweled joints:
  - Dowel length: 4*D
  - Fixed Portion: 1.5-2*D
  - Free Portion: 1-2*D
  - Use dowel pins the same size as the hardware used to fasten
  - Do not use more than two dowel pins to locate two parts together
  - Use a vent hole or vented dowel pins for blind holes
  - Use a slot on the clearance fit hole to deal with deviations in manufacturing and to ensure the part isn’t over constrained

Dowel Pin Selection Cont'd

- Dowel Length = 4 (0.5") = 2" (describes the total thickness of both flanges for the pin)
- Fixed Portion: 1.5-2 (0.5") = 0.75" – 1" on the interference side
- Free Portion: 1-2 (0.5") = 0.5"-1" on the slip fit side (slotted)

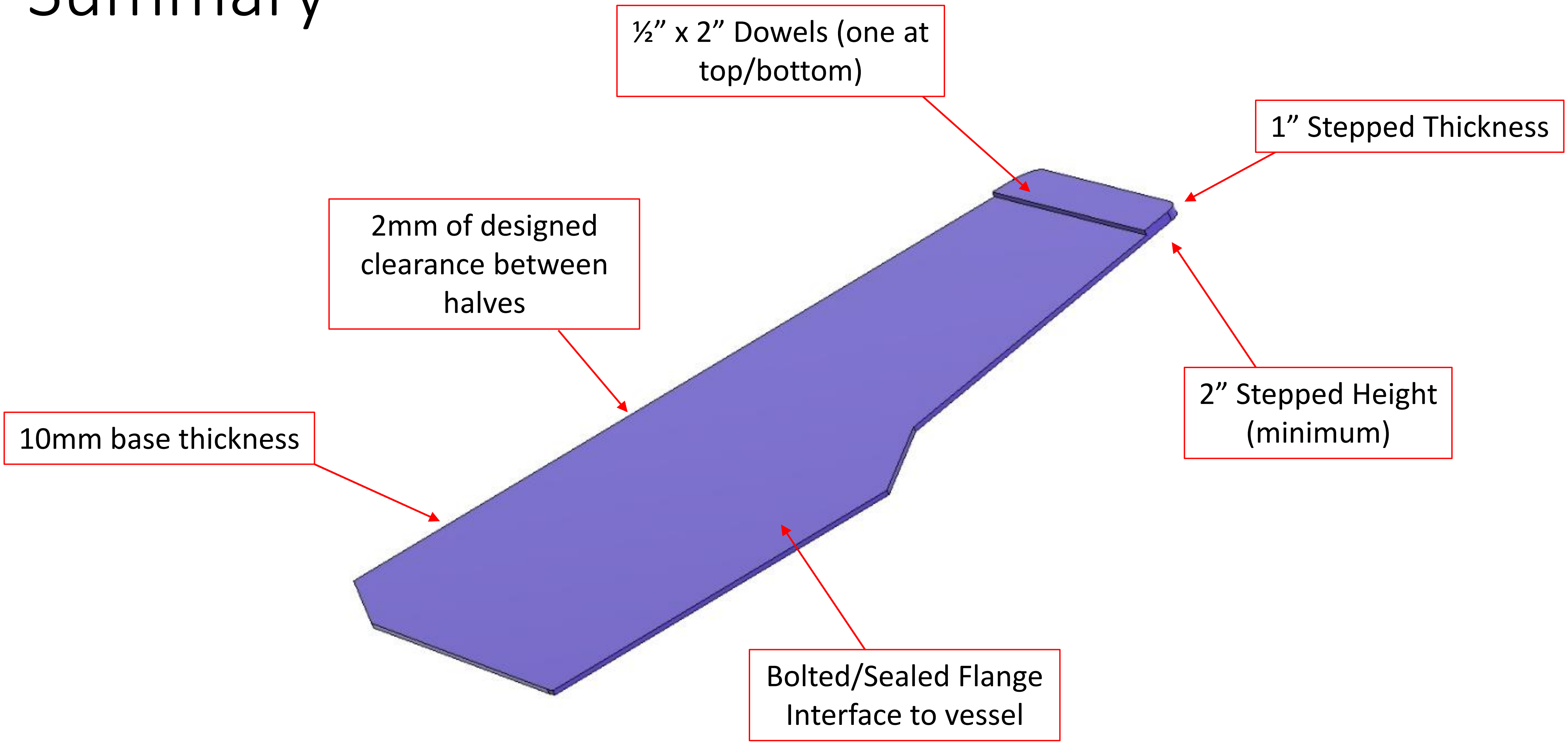
- ½" Hardware Should be specified for the bolting flange
  - Rule of thumb (2*D) for edge of part
  - Flange should be at least 2" tall
  - Total gap between OD of dRICH and inside of oHCAL
    - 195.25 cm – 180cm (radii) = 15.25cm = 6"
  - This gap is right in the middle of service routing so we should minimize the dimensions



Designed Clearance

- Since there will be tolerances needed for manufacturing and assembly misalignments, a conservative estimate for the tolerance between the two halves should be established
- This estimate should be based around experience, so I discussed with Sushrut Karmarkar (Purdue) what kind of flatness tolerances are typical on a dividing wall of this size
- I also discussed with Dan Cacace (BNL) what I had learned about the manufacturing as well as all the other constraints
- Based on what these discussions, **we should allow 2mm of designed tolerance between the halves.**

Summary


½” x 2” Dowels (one at top/bottom)
1” Stepped Thickness
2mm of designed clearance between halves
10mm base thickness
2” Stepped Height (minimum)
Bolted/Sealed Flange Interface to vessel