Basic Bringup: Cryorefrigerator

# Introduction

This document is an ongoing document detailing the current status of the quick test cryorefrigerator. The intent of this document is to note current problems and attempted solutions as well as providing a history for the project.

# Goals

The goal of this project is to make a cold chamber that can quickly and cost effectively reach a few temperatures. The use for this system would be quick tests of samples prior to placing them in the main cryostats that take ages to reach temperature.

# Progress

A broad strokes design was settled on for the cold chamber. A decommissioned refrigerator tube will make the outside body of the new fridge. Then by simply having a new top plate machined we will have a sealed system.

The top plate will require a hole pattern such that the PT415 by Cryomech can bolt directly to the top plate. In addition to that a series of KF50 and potentially KF25 flanges should be machined into the plate.

Going forward the most time sensitive step is to submit the job to STS. For this reason we will mock up the top plate in a CAD software and hopefully submit the job before fleshing out the details of the assembly and experiments that are intended to be run.

For CAD see the CAD folder.

Cryomech has been emailed requesting a CAD file for the PT415. Cryomech has obliged in giving the cad files under the condition that we don’t plan on taking the PT415 out of the country (a matter of national security as far as I can tell…)

# Stress analysis

Inventor professional has a built in FEM solver for stress. Using this tool it is straightforward to get a rough idea of the deflection which the plate will see under vacuum. A pressure of 15psi was applied to the surface of the plate with the vacuum jacket marked as an immovable object. The result of the calculations is shown in the image below. The takeaway is that for a ¾” austenitic stainless steel plate a maximal deflection of 0.002” is expected.

This is of course just a simulated estimation. Some limitations include gravity not being factored in, using a generic austenitic steel grade for the simulation instead of specifying 316L stainless steel (for example). Also, the weight and the added rigidity of having the flanges populated with equipment was ignored for this test.



A further test with gravity found no difference. Also initial investigations into the natural harmonics of the steel plate show that modifying the orientation of the holes does not have a significant effect on the dominant vibrational mode. You can see that the spherical harmonics for a disk are predominant (as expected) with additional modes due to the corners vibrating.

Talk with Jan checklist

* Bulkhead clamp dimentions (I used Kurt J Leskar , but mks has slightly different dimentions)
  + <https://www.lesker.com/newweb/flanges/flanges_technicalnotes_kf_1.cfm>
  + https://www.mksinst.com/docs/UR/isokf.pdf
    - there should be a universal bolt pattern
    - checked and the drawing matches the pattern
* Density of KF flanges is acceptable (we could squish them closer together for an extra fillange or two if that’s worth it)
* Do we want to keep all of the screws for the plate metric?
  + Use 10-32 bolts for all the KF stuff
    - No change needed
* Bolt pattern for the legs, I’ve allotted four posts each 2”x2”
  + 1.25” legs use some adapter 2”x2” 4 bolt legs
* Distance to inner wall of vacuum jacket – does that leave enough for radiation shield?
  + Need at least one kf50 fillange that is 1+1+4” from the vacuum jacket
  + Allow for 2” for radiation shield
    - Managed to fit 6xKF50, 4xKF25, and 2xKF16 within the jacket minus 2” on each side for radiation shield.
* O-ring groove for the PT415
  + Size of O-ring
    - 1/8” o-ring
    - Liquid helium plant may have a land pattern
      * Changed the o-ring
  + Choice of bolts?
* Inventor stress analysis says that 15psi will cause a maximal deflection of 0.0023” in the centre of the mounting plate. This is fine right? (I’ll ask harmen about his program as well)
  + Harmen’s program is tied to a computer and probably some ancient dos program which uses the closed from solution for a disk with fixed edges boundary condition.
  + 20thou is ok
  + Check with gravity
    - Gravity has no ~effect
* A plate of steel might be uneven by up to 40 thou, this means for o-ring surfaces the plate will have to be locally flattened. This is ok right?
  + Talk to MDC for potentially a flattened plate
  + Talk to local machine shops for grinding the existing plate flat
* The shop has 2’x4’ plate in stock, should we keep the extra 2’ on one of the sides?
  + Add an extra 2” on each side if possible
* Need bolt pattern on bottom of the plate as well as top, for one of the KF50s, that one has to be in the centre as well.

Notes for Harmen

* Need more accurate measurement of bolt pattern for vacuum jacket
* Is the plate on hand 304 stainless?
  + It’s not!
* The flatness is a real issue, we’ll either purchase a flat plate, or get the current plate ground, or get a company which can achieve the required flatness to make the whole part