Hall A Cryogenic Target

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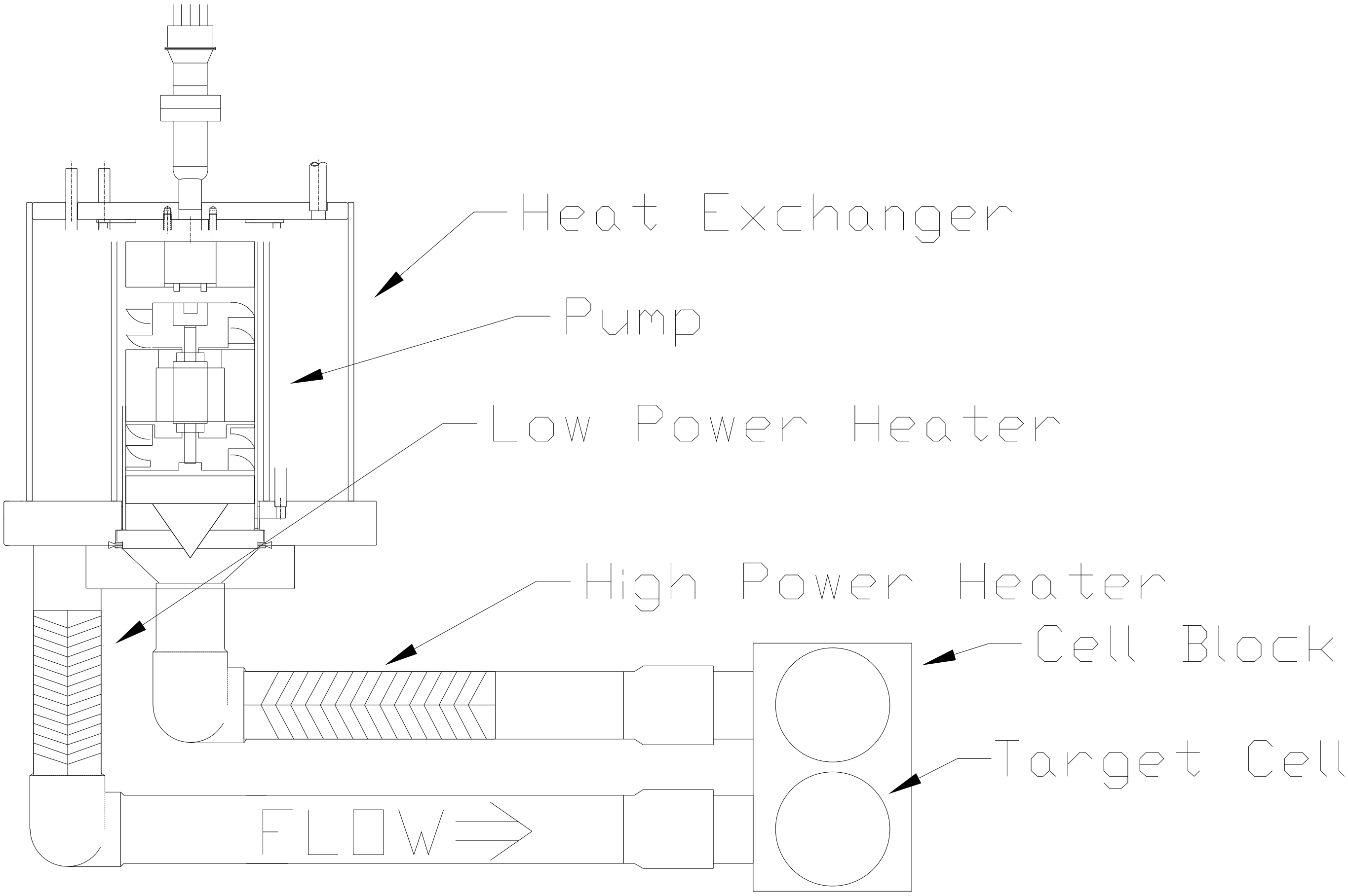
Overview

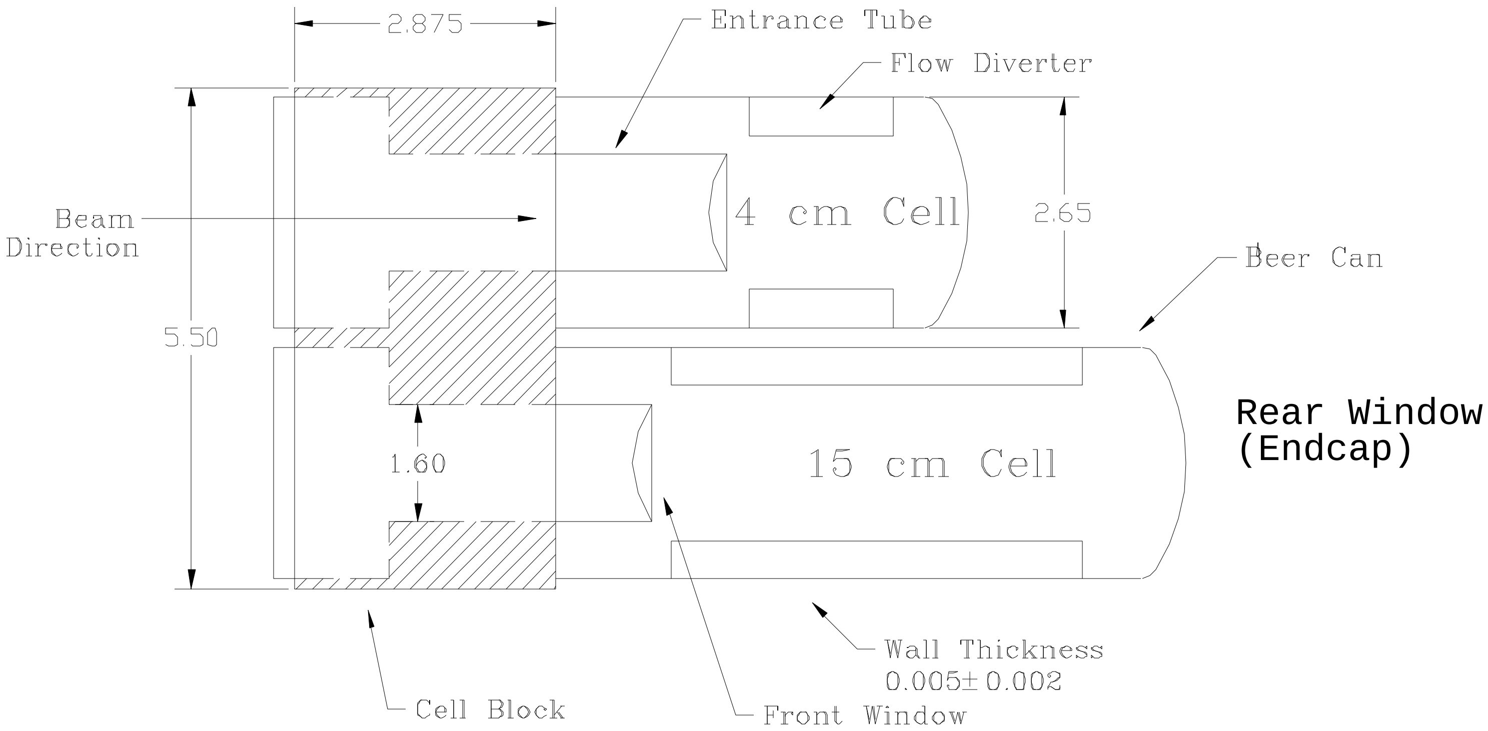
- General Physical Aspects
  - Loop design
  - Cell types
  - Solid targets
- ESR
- Fluid types and properties
- Further studies and development

Loop Layout


Heat Exchanger
Pump
Low Power Heater
High Power Heater
Cell Block
Target Cell
FLOW

Cell Block

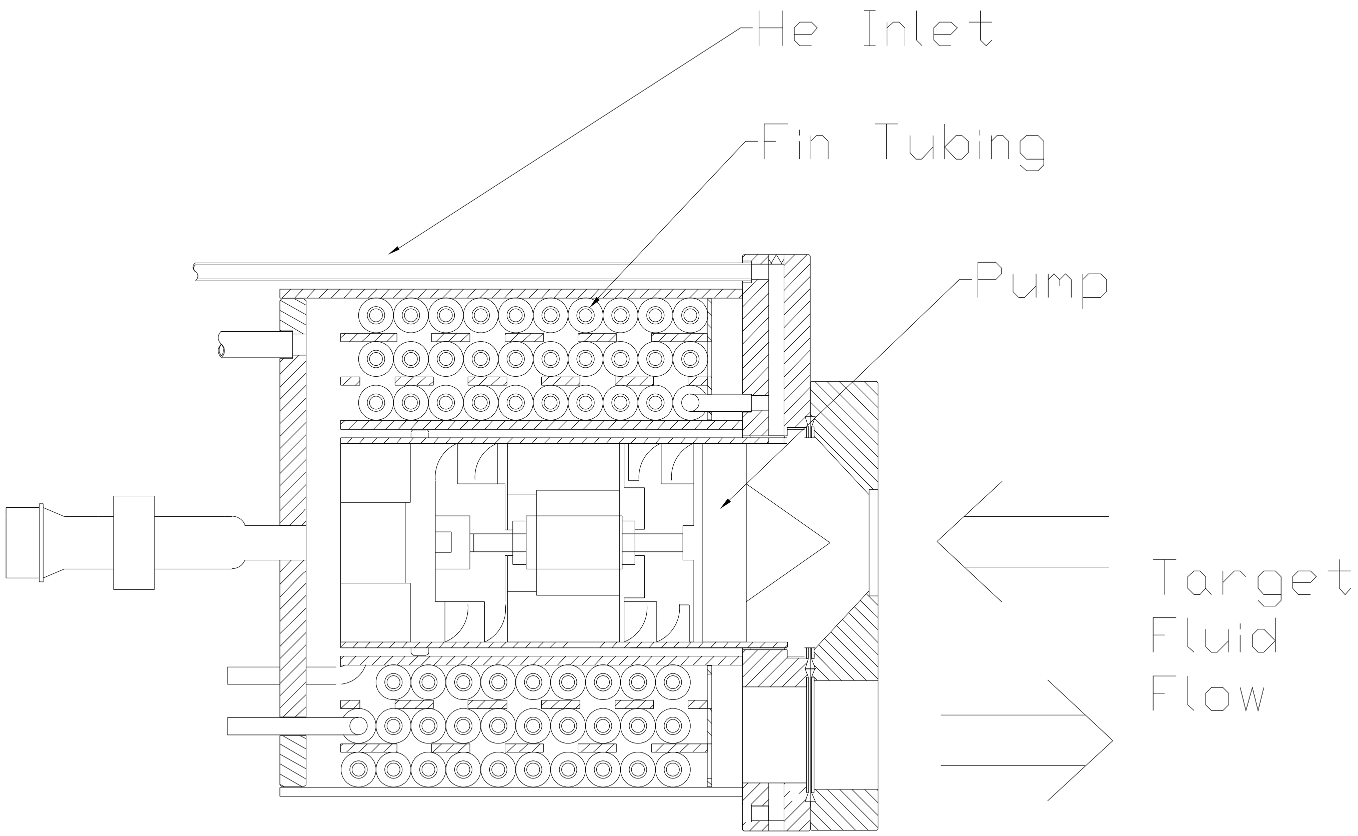
Coors beer can style cells



Factors of interest

- Thickness of entrance and exit windows
- Window materials
- Thickness of cell walls
- Cell geometry and purity of target fluid

Heat Exchanger



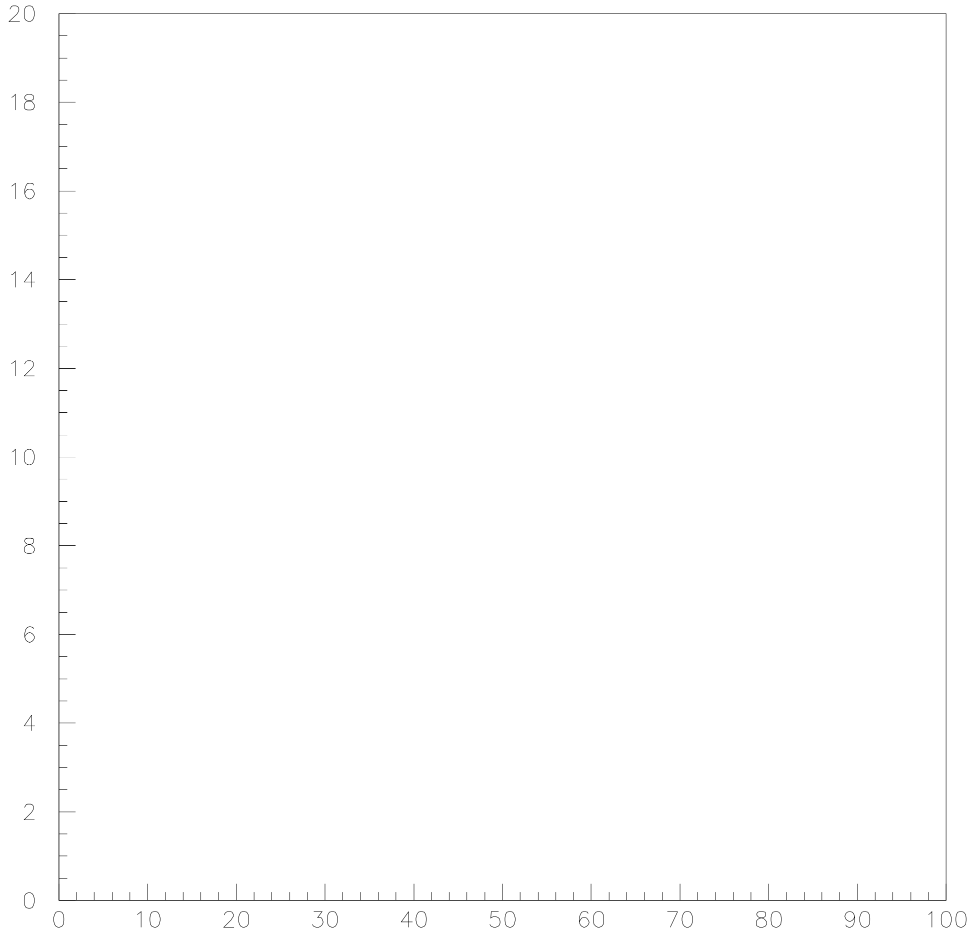
ΔT between fluid and coolant

Surface area fin tubing

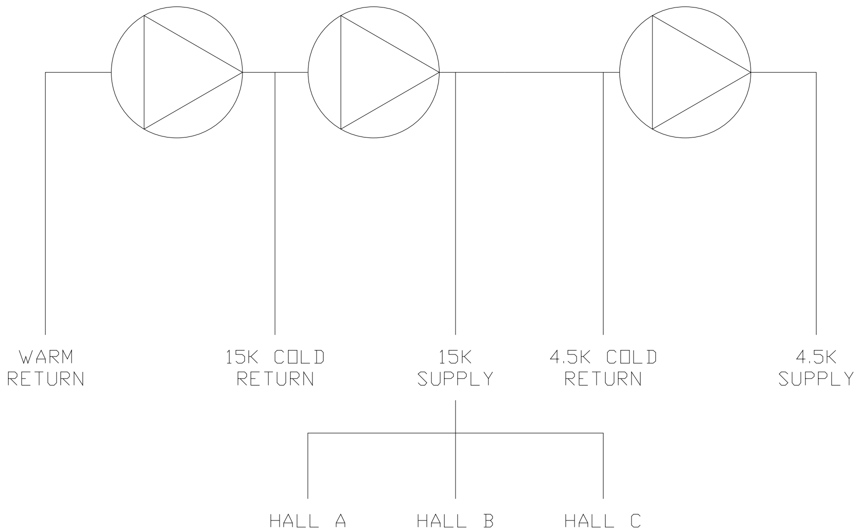
Target fluid flow

He flow through HX

Pressure Drop in HX



End Station Refrigerator



Power available from ESR depends on many factors

- Demands of other halls
- Return/Supply pressures and temperatures
- Temperature difference
- For 15K targets we can get 1kW

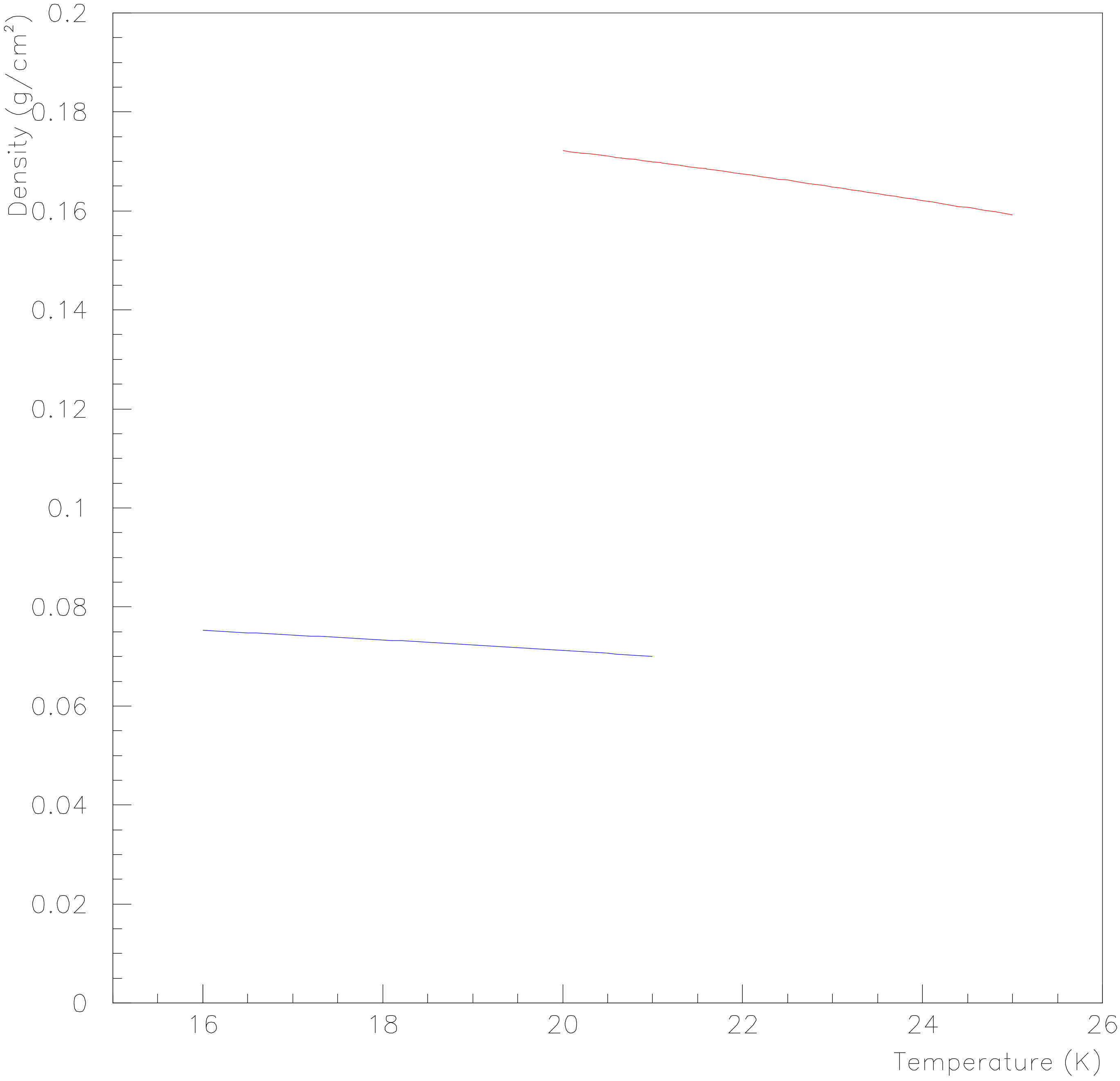
Cell Types

- Beer can style cells
  - Coors beer cans are made of 3000 series Al
  - Front entrance windows are made of 5000 series Al
  - Difficult to assemble, limited quantities available
  - Over time cell blocks can develop leaks in solder joints
  - Low pressure cells only
- Machined cells
  - Made from 7000 series Al
  - Robust and easily mounted
  - Difficult to machine but we can always make more
  - Can withstand pressures in He target

- Tuna can He cells
  - Can withstand high pressures
  - Cylindrical geometry
- Other types in development
  - Race track style cells
    - Developed at Cal Sate LA
    - Narrow cell structure will allow for minimum interactions with target fluid
  - Havar foil cells

Target Fluid Properties

- Properties of LH_2 and L^2H_2
  - Typical operating densities at 25 psia
    - 0.1675 g/cm^3 for Deuterium
    - 0.0723 g/cm^3 for Hydrogen
  - Variations of 1 psia cause $\sim$ 100 ppm change in density
  - Variations of 1 K cause $\sim$1.5% change in density
  - Target temperature is known to better than 100 mK
  - Density fluctuations from beam load dominate



Density (g/cm²)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
16
18
20
22
24
26
Temperature (K)

- Properties of He targets
  - Density of ^{4}He targets are typically 0.1387 g/cm^3
  - Variations of 1 psia cause $\sim$0.3% change in density
  - Variations of 0.5 K cause $\sim$ 4 % change in density
  - No phase change for beam load

Solid targets

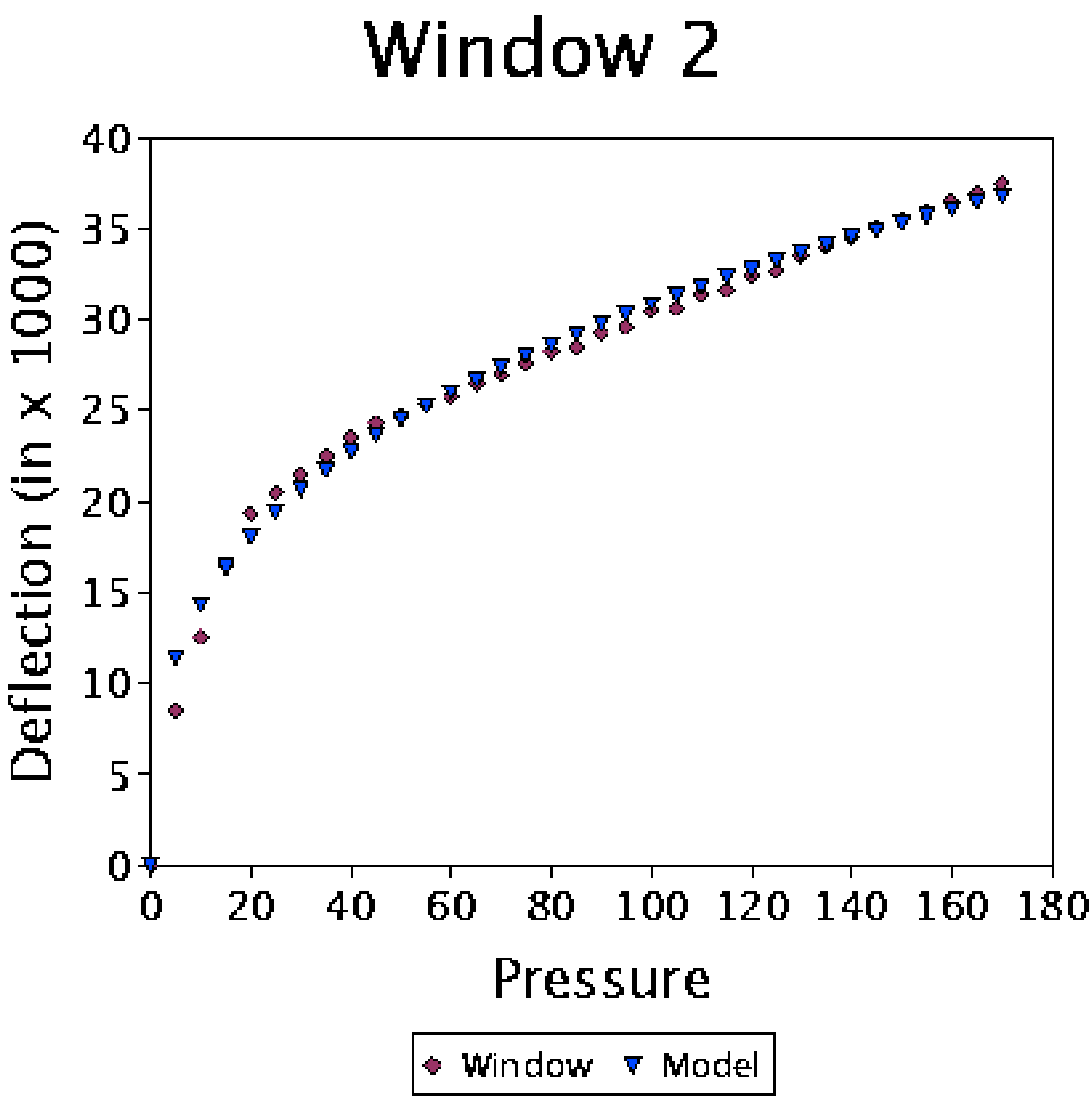
- The solid target ladder has been placed at Z=0
- It can hold up to 5 solid targets
- Optics sled has 9 foils
- Dummy targets are now on a sled system
  - can be arranged for 4, 10, 12, 15, 20 cm targets
  - thickness can be selected to better suit experiments and target lengths.
- Short solid target runs coupled with survey data provide information on spectrometer pointing

Survey and Alignment

- Alignment of the target is done with windows off target warm and no vacuum in scattering chamber
- None of these are conditions in which we run.
- The target will undergo motion
  - Evacuation of the scattering chamber
  - Cooling down target
  - This motion can be several mm in magnitude
- Keeping track of this motion is difficult
- Survey of the target prior to motion gives about 0.2mm measurement (2 mrad angles)
- Misalignments of the target can lead to significant changes in effective target length (1.5% for every 0.5 cm on 4 cm cell)

Further Studies and development

- Heat load from target fan
- New cell development
  - Havar windows
  - New shapes
  - Thinner windows
  - RF sputtered materials for cells and plating
- Improved target motion system
- Monitoring of vacuum and cryo motion


Window 2
Deflection (in x 1000)
Pressure
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100
120
140
160
180
Window
Model