Window Wars: Quartz vs. Titanium

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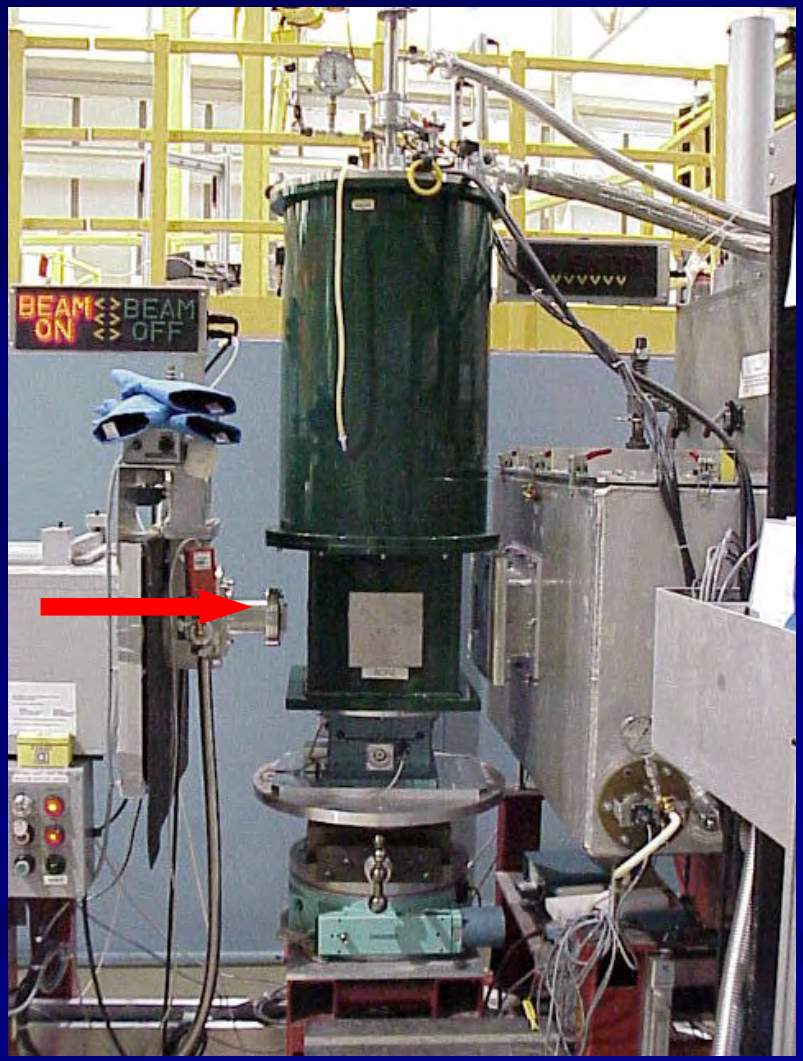
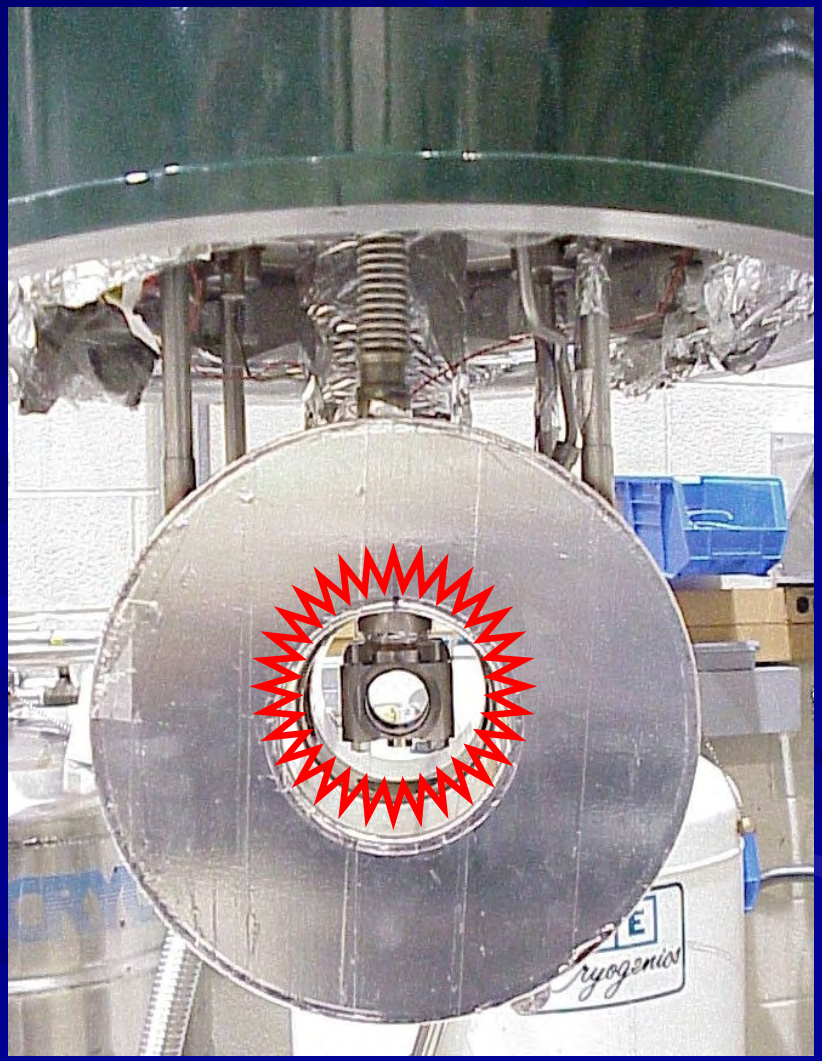
What am I talking about?

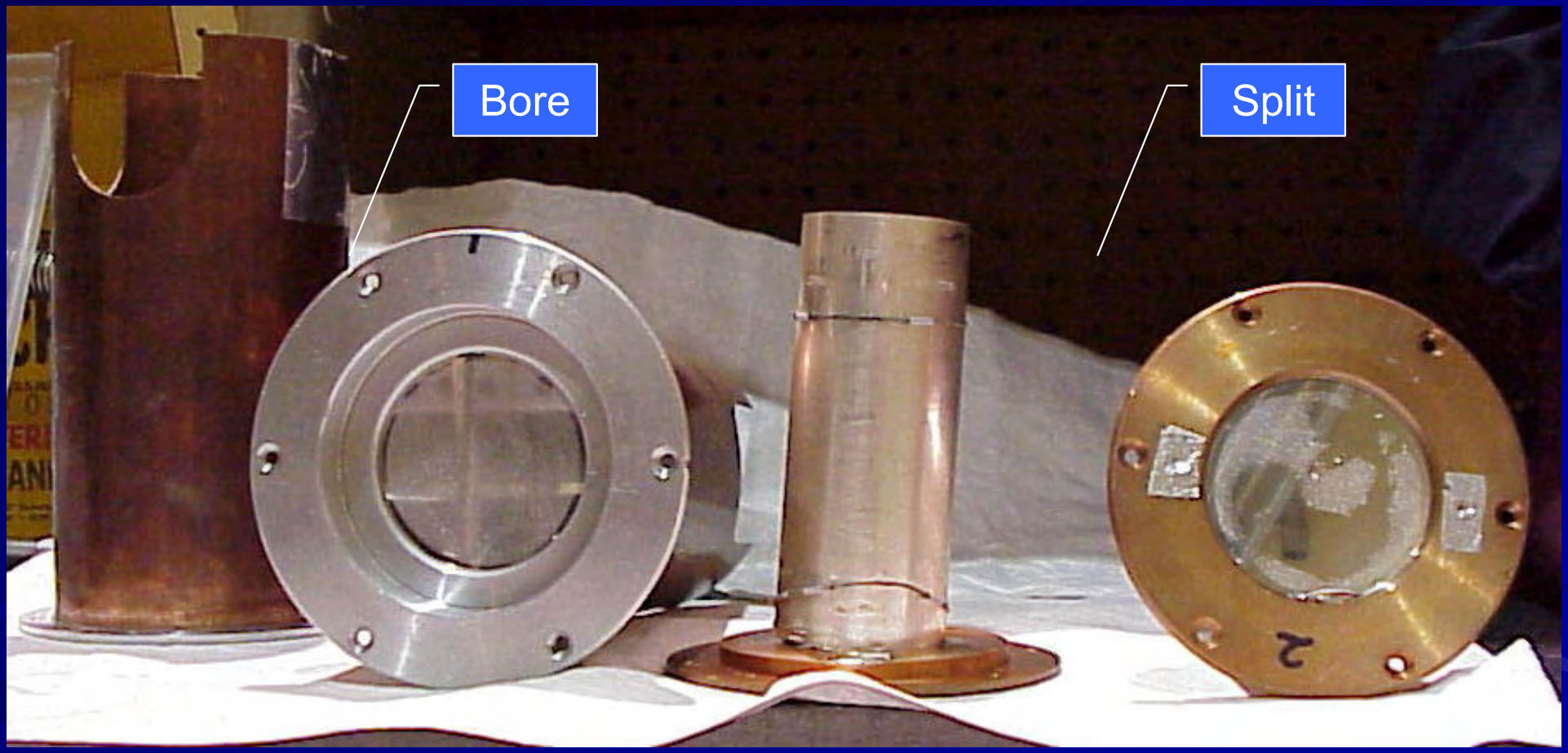
- 9T Horizontal Field Magnet for use on SANS
  - Specifically the neutron window at the bottom of the sample well
    - The cryostat and magnet
    - The original design using sapphire windows
    - The same design but with titanium windows
    - A new quartz “cup” design
    - The how and why we moved between the three
    - Conclusions

The Cryostat and Magnet





Nitrogen Shield Windows

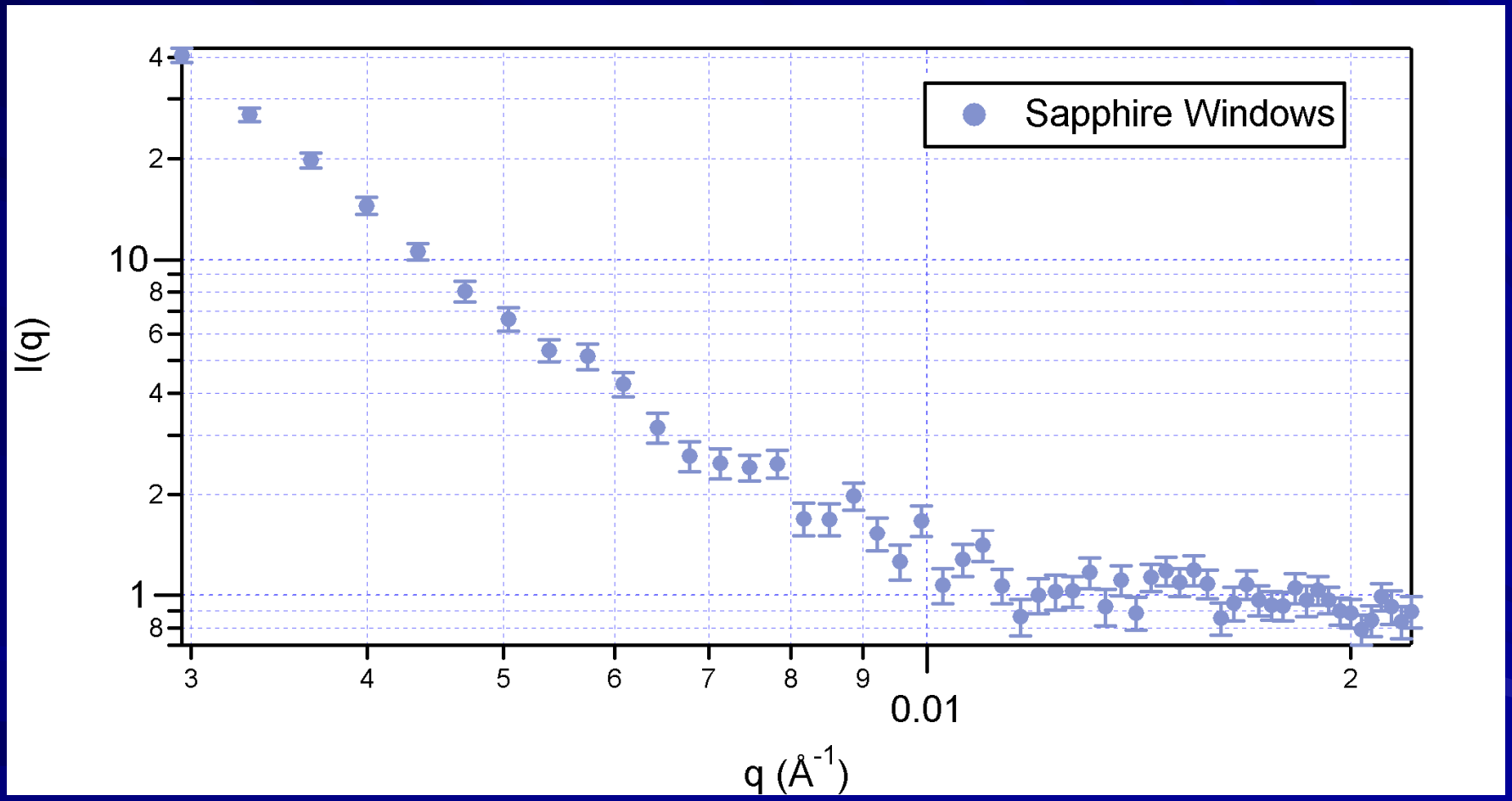


Original Design Features

- Titanium body
- Four bolt/nut clamp assy.
- Sapphire windows
- Stycast 1266 epoxy

- Positives
  - Low background
  - Good sample access
- Negatives
  - Fragile
  - Difficult to repair or remake
  - Lacks space below beam

Sapphire Background



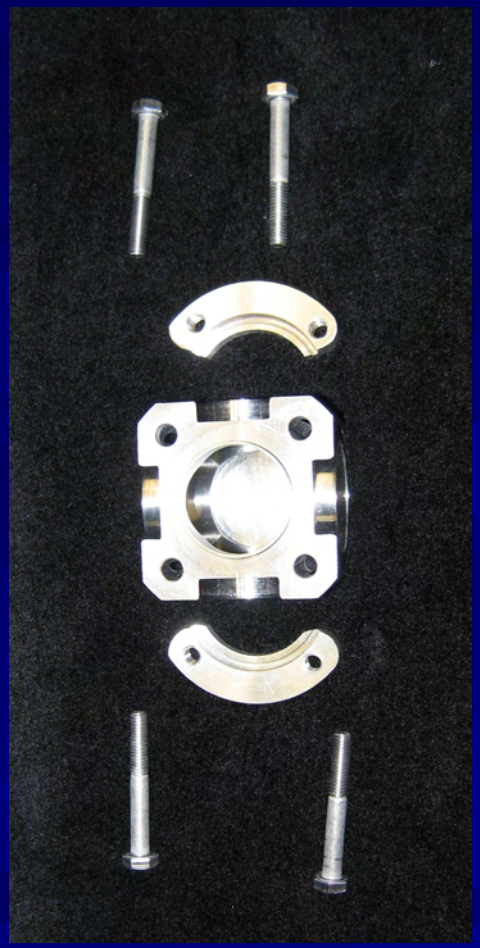
The Trouble Begins…Quickly

- Window is blown out during **first** experiment('03)
  - This was user error (I won't name names)
- We attempt to repair it, but fail
  - Discover epoxy solvent (Dynasolve 165) is nasty stuff
- We send it back to the manufacturer for repair
  - This is very time consuming
  - Could also be expensive
- With a lot more oversight the windows survive a few years

The Trouble Continues

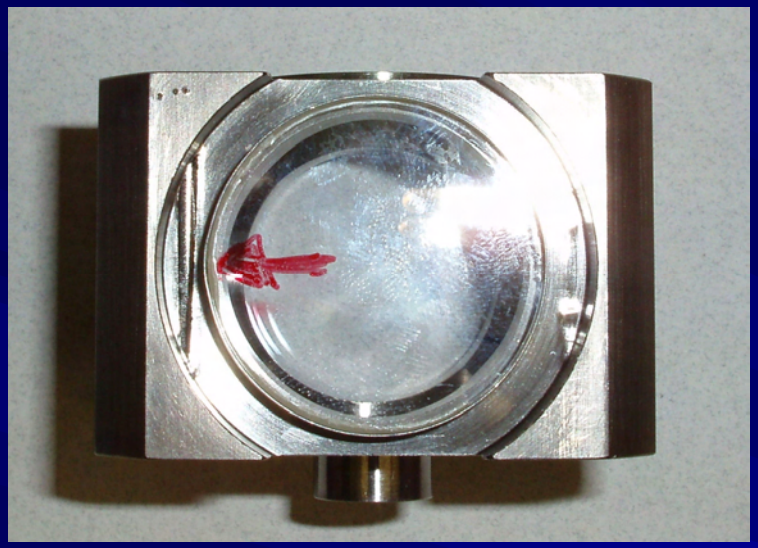
- Started having windows leak consistently(’06)
- Had a number of successful repairs (at least short term), but it wasn’t easy
  - Leaks were hard to locate
  - It was difficult to remove only one window
  - Same nasty solvent, others didn’t work
- New problem:
  - Windows were leak tight until assembled in magnet

Clamp Modification



- Caused by stress from bolts
- Modify assembly to:
  - Make indium seal with less force
  - Prevent stress fracturing epoxy seals
- 2 S.S. clamp / 4 Al screw assy
- Outcome:
  - Windows still leaked ☹
  - Easier installation though ☺

Titanium Time



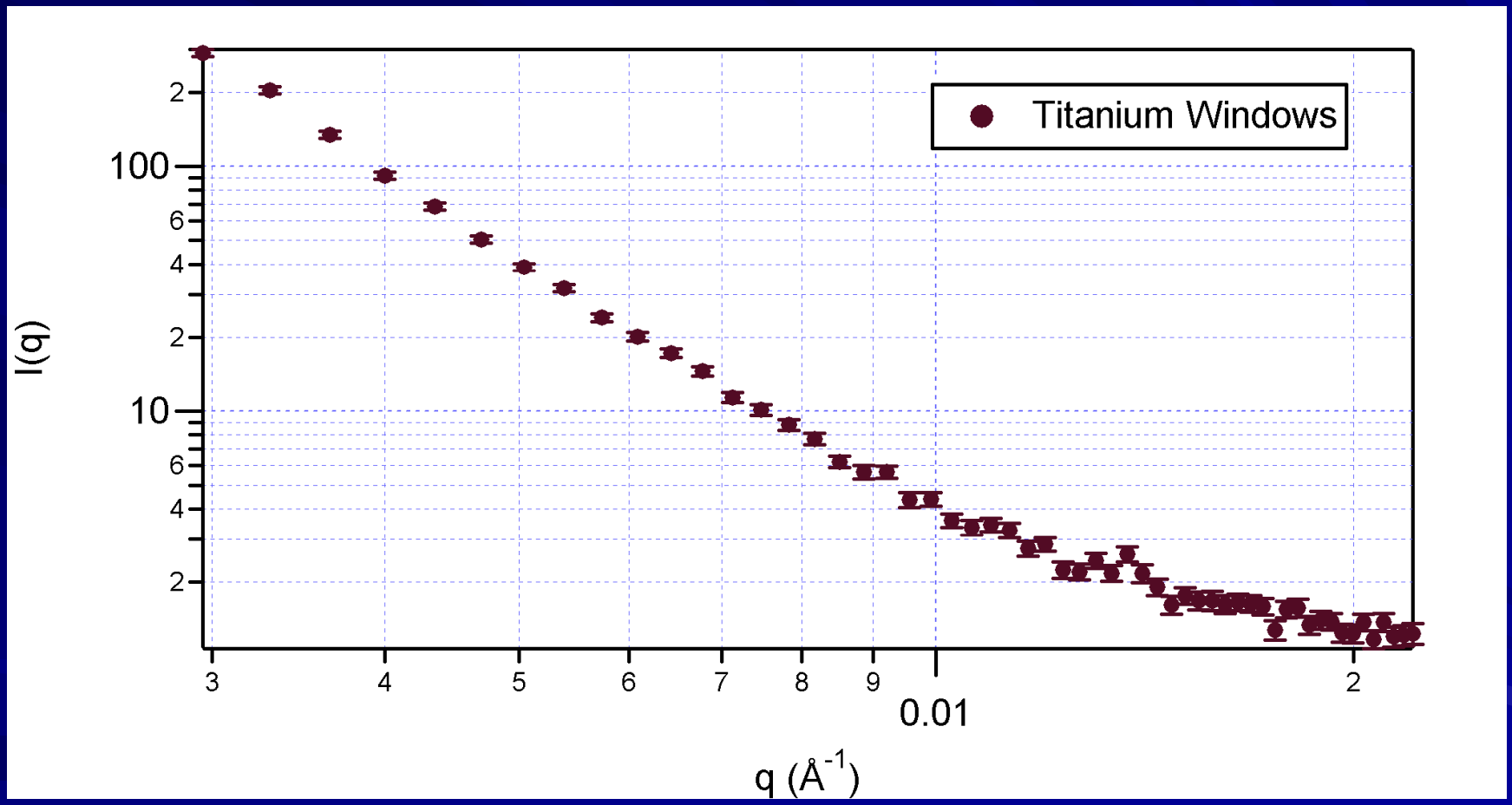
- Ti block damaged from multiple “repairs”
- Windows would not seal
- Current assembly was scrap

- Requirements for new design:
  - More robust sealing method (or no seals at all)
  - Acceptable window material
  - Manufactured in-house
  - Low risk design for now
- Solution:
  - Ti windows welded into the current Ti body

The Short Term

- Design Features:
  - 0.88 mm thick Grade 5 Ti
  - Welded directly into original Ti body
  - Same clamp design
  - Extremely robust
  - Implemented quickly
  - Ti was shown to be acceptable on SANS
  - It worked!

Titanium Background

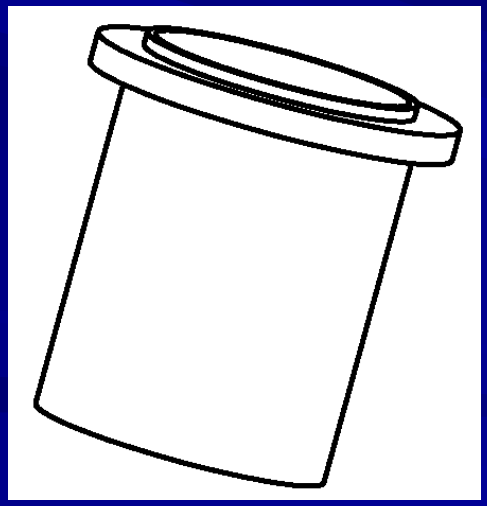


The Long Term

- At the same time we also started looking into a long term solution with no compromises
- A design that would combine the low background of the sapphire windows with the durability and reliability of the Ti ones

Initial Quartz Cup Design

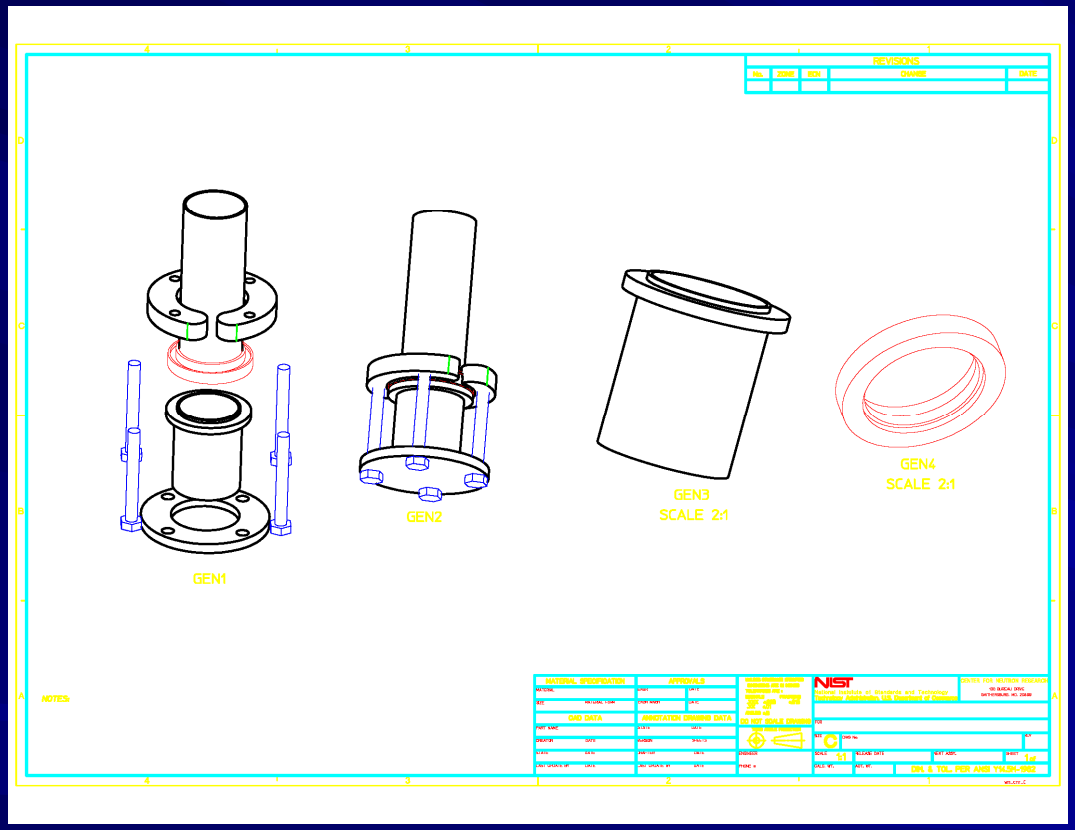
- Initial Idea:
  - Quartz cup made at NIST
  - Quartz to metal transition commercially available
  - A simplified clamp only touching metal



Why It Did Not Work

- Design never even got on paper
- Cryogenic quartz to metal transitions were all magnetic
- There was not enough room for the simplified clamp above the beam

Next Design



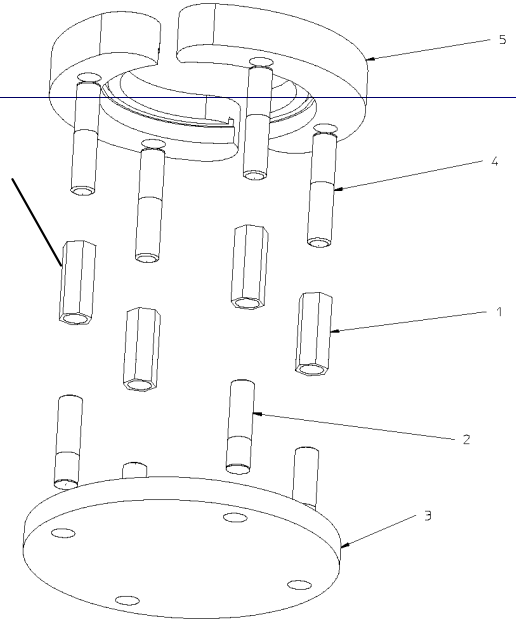
- Features:
  - Solid quartz cup
  - Thinned in beam path
  - Normal clamp style
- Questions
  - Thermal contraction
  - Overall length
  - Manufacturability of quartz cup

Clamp Assembly

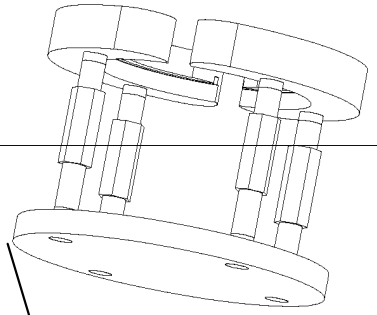
Material: Titanium

Turnbuckle

Overall Length



Exploded View



Assembled View

REVISIONS

No.	ZONE	ECN	CHANGE	DATE
1				

BOM: Clamp2_Assy

Pos	Qty	Part Name	Part No.	Material
1	4	turn_buckle	014-0625	TITANIUM
2	4	10-32_Rod	014-0628	TITANIUM
3	1	9T_Mag_Well_Ring_lower1	014-0629	TITANIUM
4	4	10-32_Rod.1	014-0626	TITANIUM
5	1	9T_Mag_Well_Ring.1.1	014-0627	TITANIUM

NOTES:

1. See BOM for part numbers and quantities.

MATERIAL SPECIFICATION
MATERIAL: PER ASSEMBLY
FINISH: SIZE:

MODEL DATA
MODEL NAME: Clamp2_Assy
CREATED: Evan Fitzgerald DATE: 8/21/07 2:31 PM

APPROVALS
ENGR: DATE:
ENGR MGR: DATE:

DRAWING DATA
SCALE: WGK DATE: 9/20/07 4:26 PM
VERSION: 1 SHEETS: 2
DRAFTER: Evan Fitzgerald DATE: 9/20/07 4:25 PM
LAST UPDATE BY: Evan Fitzgerald DATE: 9/28/07 9:44 AM

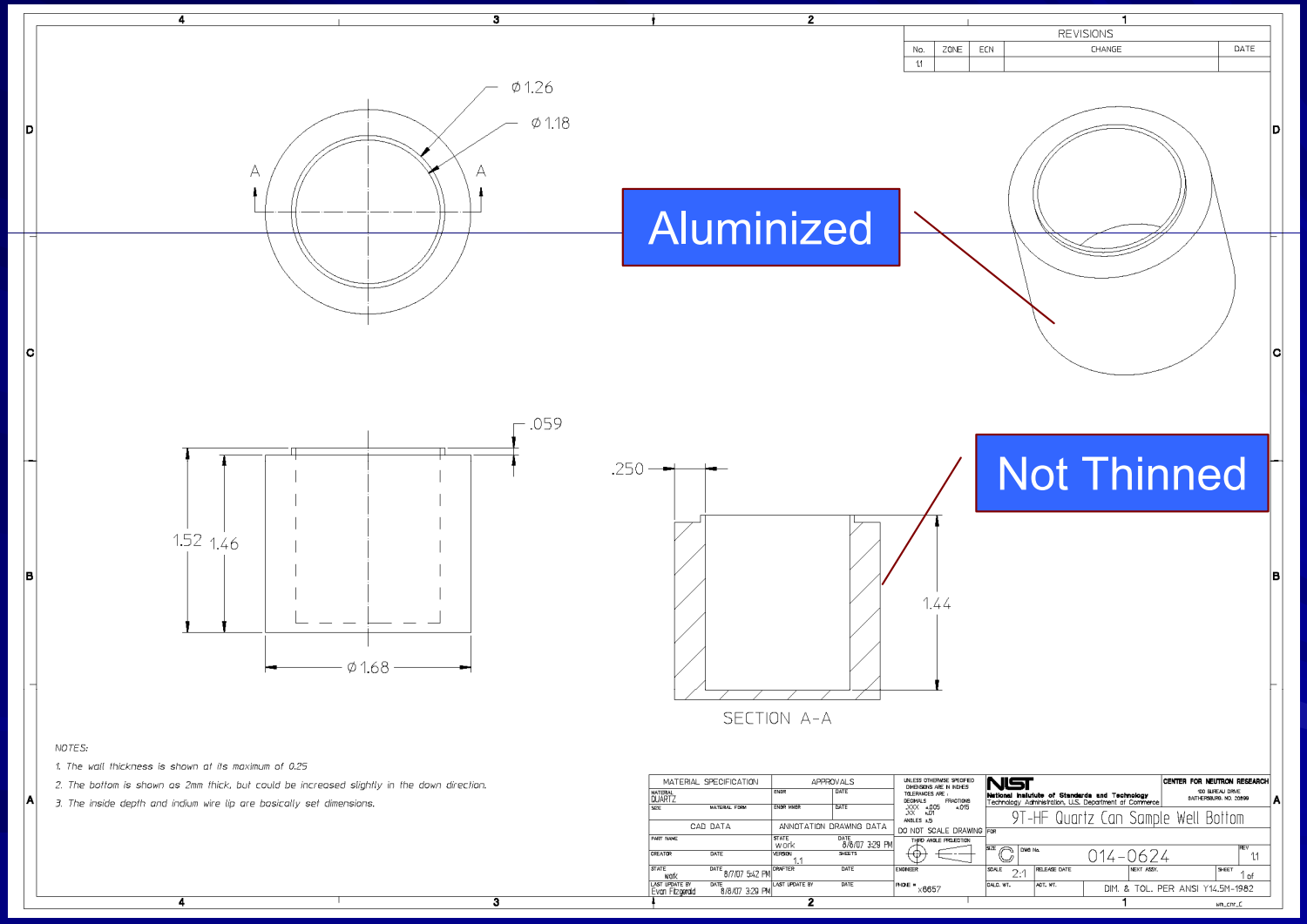
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
DECIMALS XXX ±.005 XX ±.01
FRACTIONS ±.015
ANGLES ±.5
DO NOT SCALE DRAWING
THIRD ANGLE PROJECTION
ENGINEER: Evan Fitzgerald
PHONE #:

NIST
National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce
CENTER FOR NEUTRON RESEARCH
100 BUREAU DRIVE
GAITHERSBURG, MD. 20899

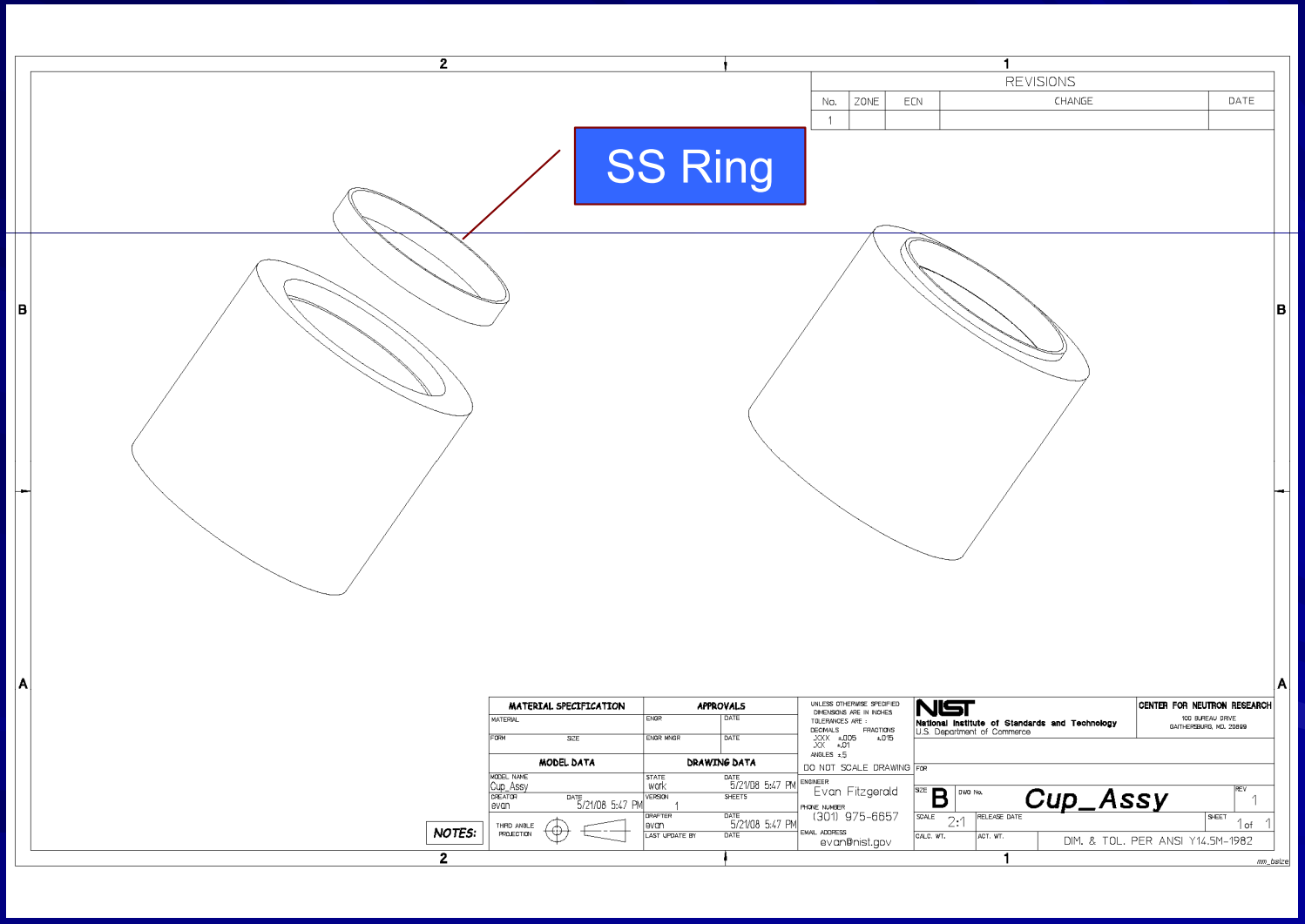
9T-HF ScMag Quartz Cup Clamp Assy.

SIZE: C DWG NO.: 014-0630 REV: 1
SCALE: 2:1 RELEASE DATE: SHEET: 1 of 2
DWG. WT.: ACT. WT.: DIM. & TOL. PER ANSI Y14.5M-1982

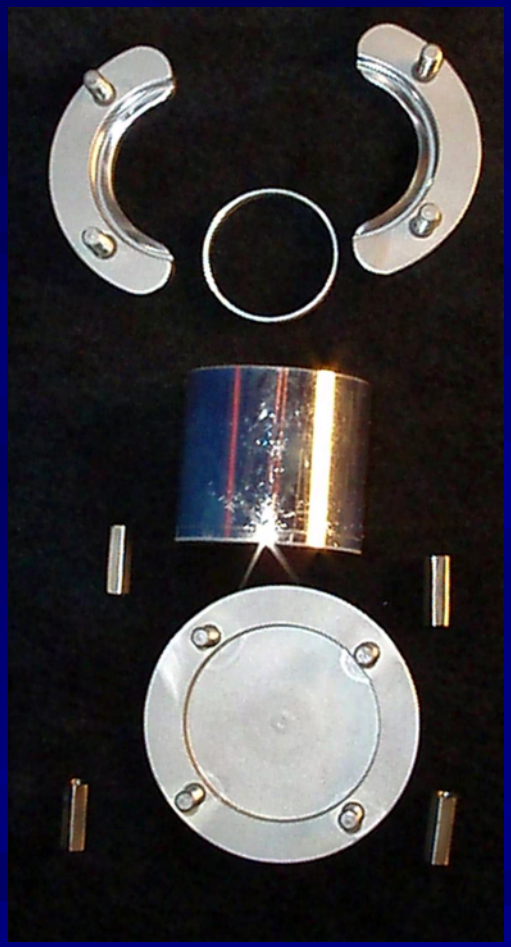
Not Quite Final Cup Design

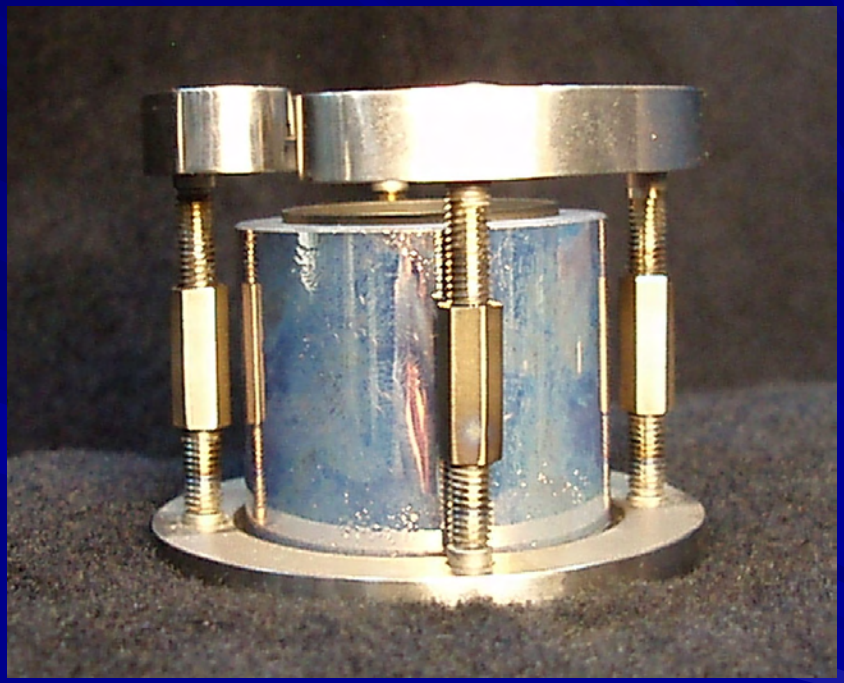


Final Cup Design



Final Product

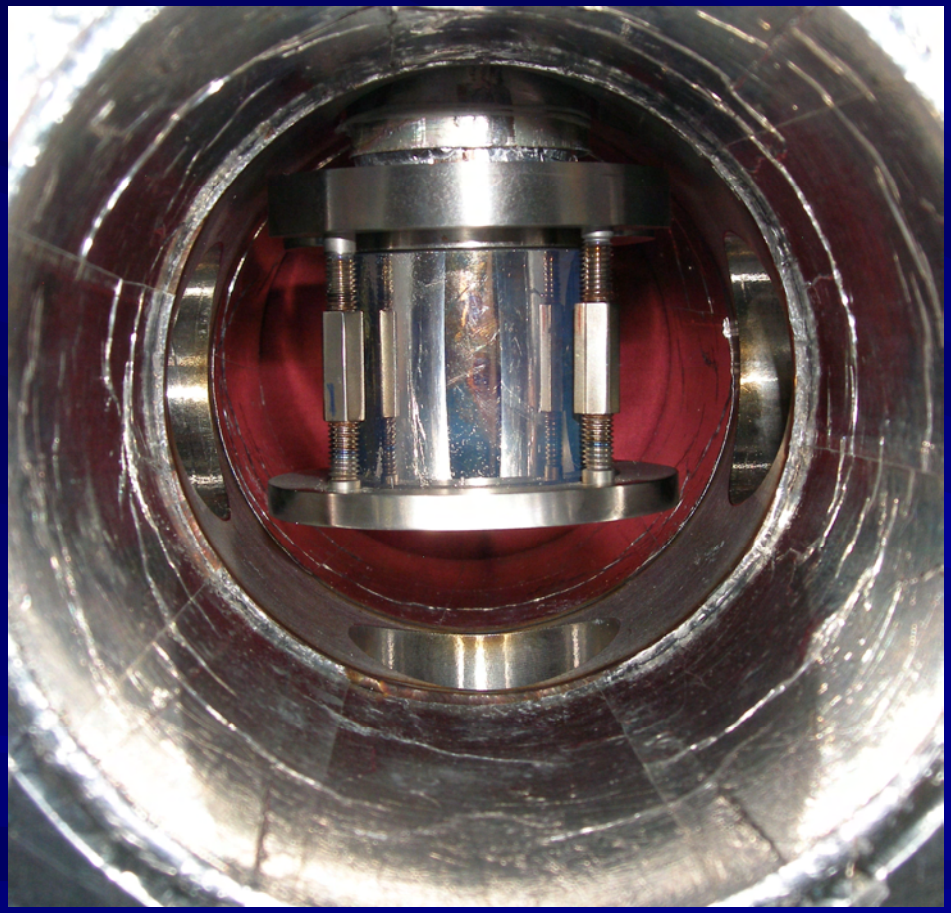




Final Touches

- Indium sheet under quartz cup
  - Smooth surface
  - Thermal contraction
- Slight modification to indium support ring

Installation

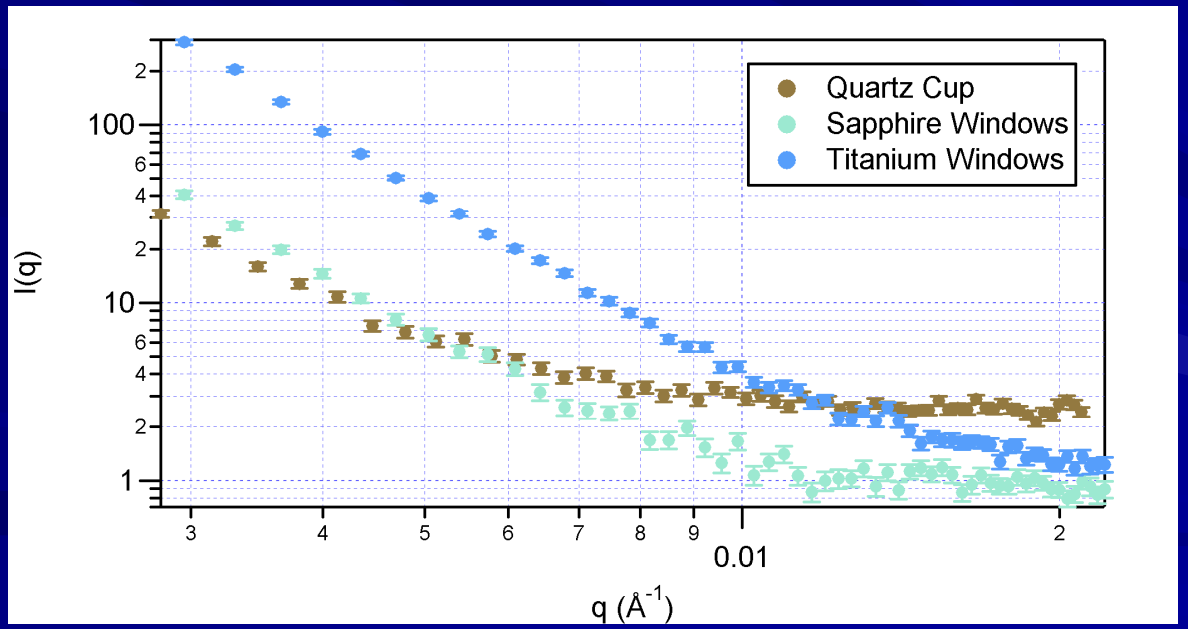


- Installation tedious, but simple
- LN2 shields were only casualty
- Leak tight through first cooldown to 2.9K


Weller

Conclusions

- Need to do more thorough offline tests including sample load/unload and thermal cycling
- Initial results are promising
- Background comparison as expected



Acknowledgements

- Sample Environment Team
  - Dr. Dan Dender, Dr. Jeff Lynn, Bill Clow, Julia Scherschligt
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  - Dr. Paul Butler, Dr. Lionel Porcar, Jeff Krzywon
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