Absorber Design and Performance

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for absorber group: IIT/NIU/Miss/FNAL

Study II Editors' Meeting
BNL
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Outline:

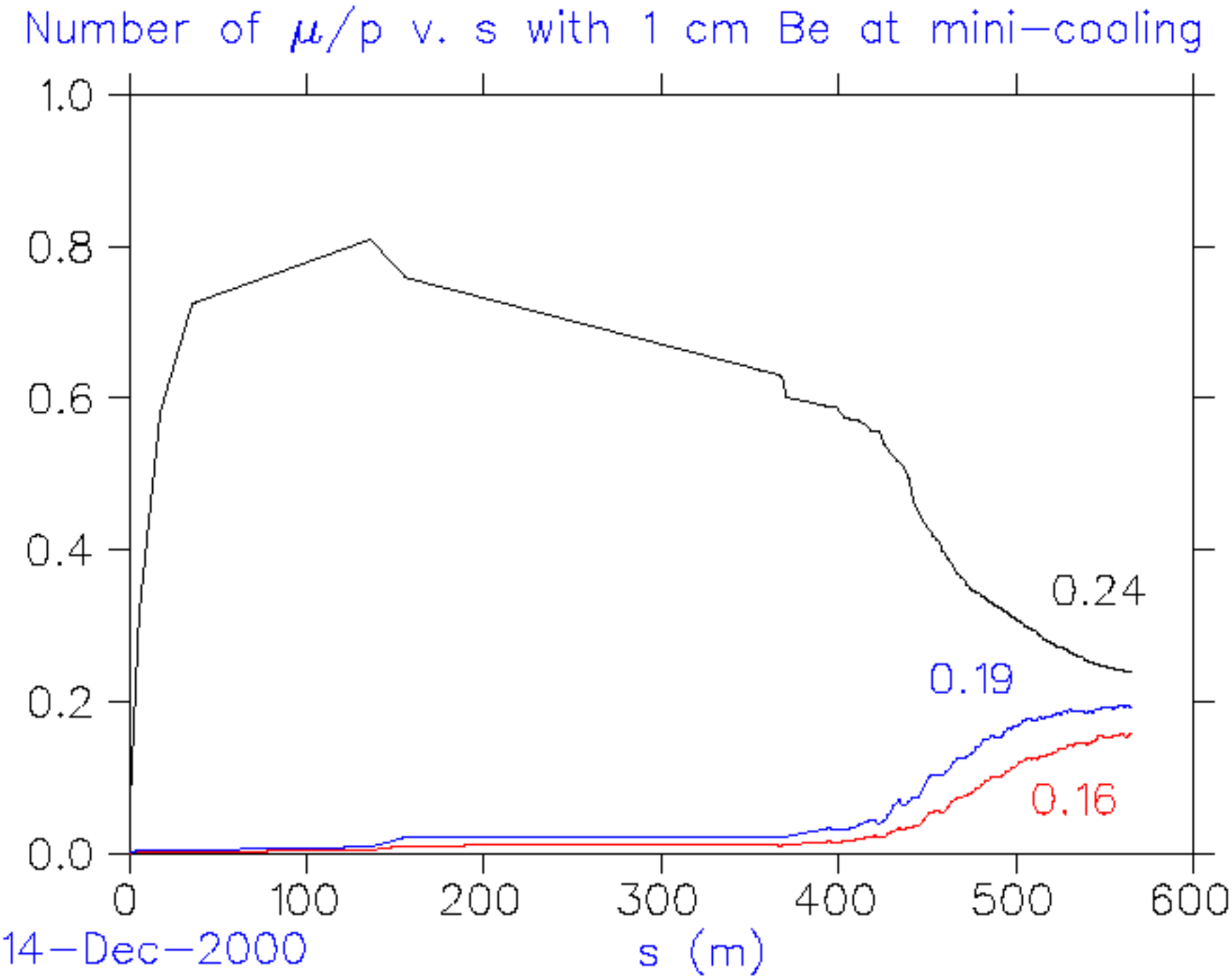
1. Study II absorber list
2. Absorber power dissipation
3. Heat transfer approaches
4. Window design
5. Absorber assembly
6. Timelines
7. Absorber cost estimates

"Baseline" Study II Absorbers:

- "Parameters version 2" calls for 2 minicooling absorbers and 2 designs for SFOFO absorbers:

Absorber	Length (cm)	Radius (cm)	Window thickness (μm)	Number needed
Minicool	175	30	≈300?	2
SFOFO 1	35	18	360	16
SFOFO 2	21	11	220	36

- H. Kirk simulation results (from 12/18/00 video meeting):


Number of μ/p v. s with 1 cm Be at mini-cooling
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500
600
0.24
0.19
0.16
14-Dec-2000
s (m)

Power Dissipation:

SFOFO Absorber 1:

- Each muon loses 0.3 MeV/cm × 35 cm = 10.5 MeV/absorber
- 1 MW beam = 2.6×10^{14} *p*/s at 24 GeV
- ≈ 0.6 μ/*p* at entrance to 1st SFOFO lattice

$\Rightarrow 1.6 \times 10^{14}$ μ/s × 10.5 MeV/μ × 1.6×10^{-13} J/MeV = 270 W

SFOFO Absorber 2:

- ≈ 2/3 as many muons, 60% as long ⇒ ≈ 40% as much

Absorber	Length (cm)	Radius (cm)	Window thickness (μm)	Number needed	Power diss. (kW)	Total power (kW)
Minicool	175	30	?	2	≈5.5	≈10
SFOFO 1	35	18	360	16	≈0.27	≈4
SFOFO 2	21	11	220	36	≈0.1	≈3

Heat Transfer:

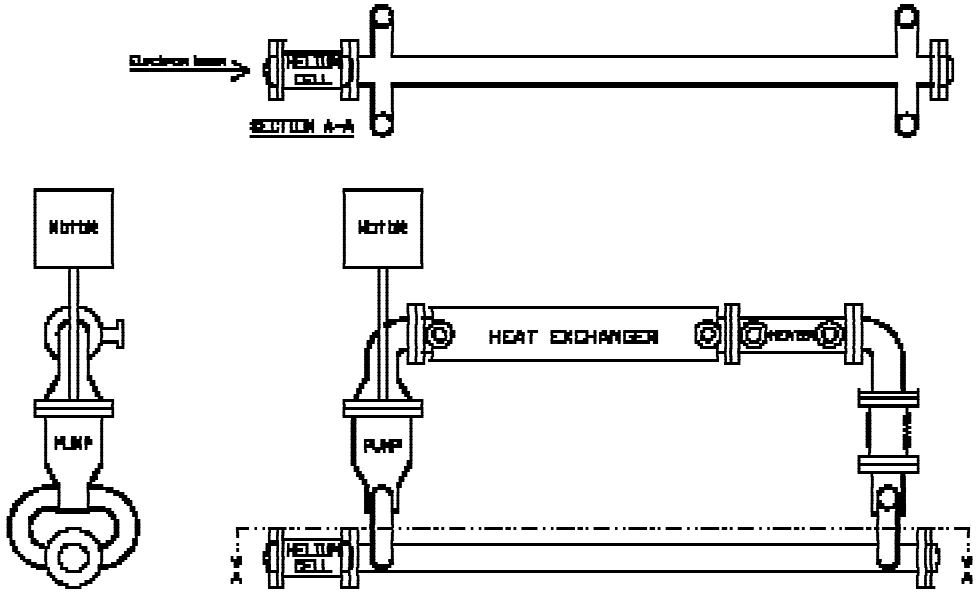
- Need to assure adequate heat transfer from core to periphery

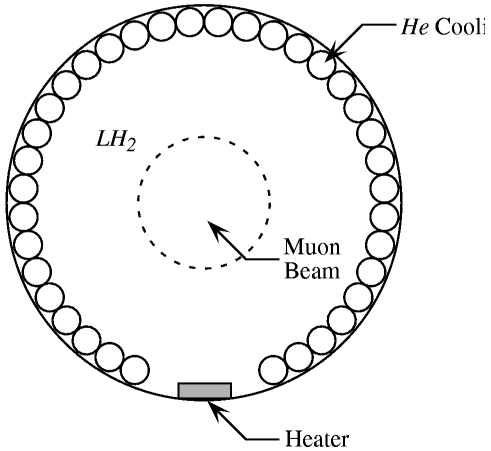
  ⇒ Avoid longitudinal flow

- **2 approaches:**

  1. Flow-through

  2. Convection

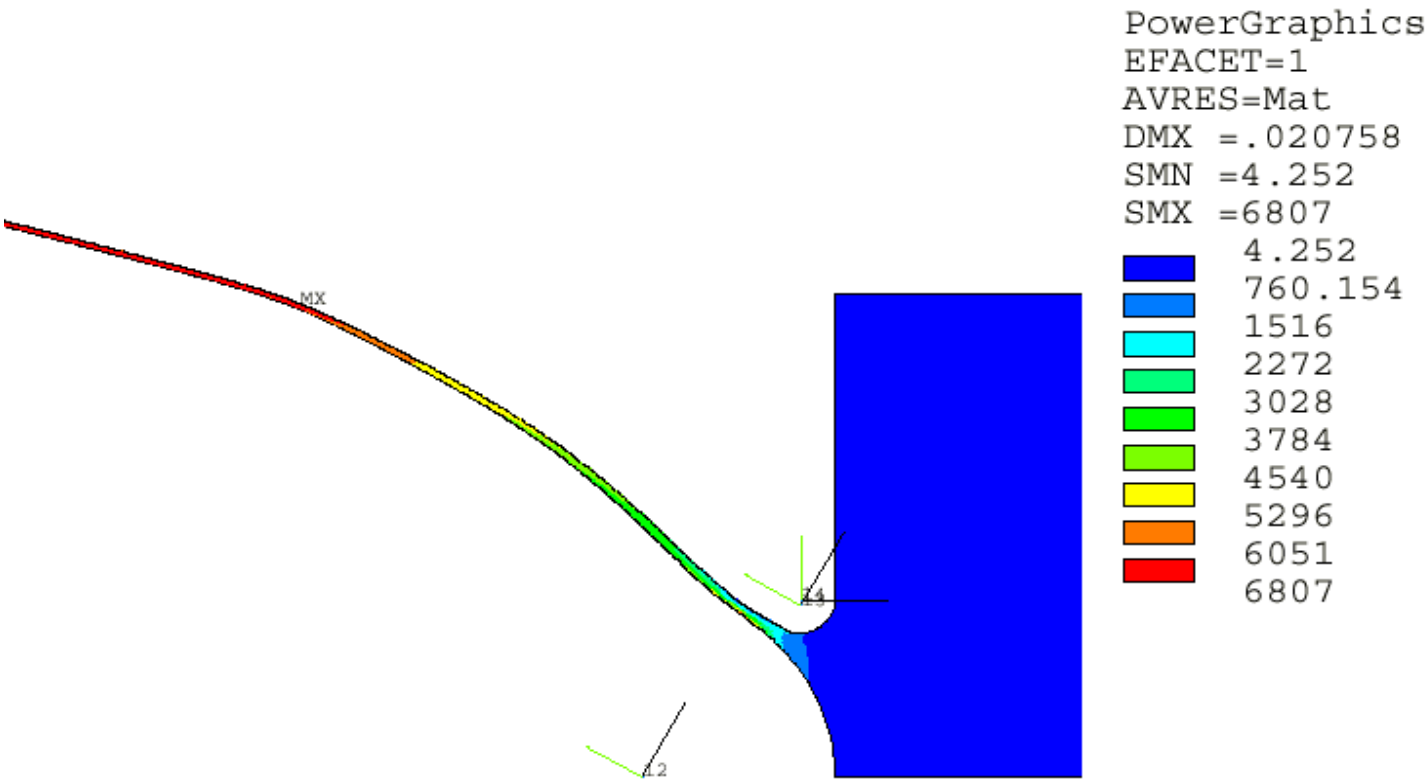




- Both appear feasible – further studies & tests in progress

Window Thickness:

- ANSYS F.E.A. study showed that tapered 6061-T6 Al torispherical window of 500-μm thickness and 15-cm radius is safe at 2 atm:



⇒ assuming linear, scales to:
360-μm thickness at 18-cm radius
220-μm thickness at 11-cm radius
at 1.2 atm

Thinner Windows?

From D. Summers:

Al alloy name	Composition	Density	Yield strength @300K	Tensile strength @300K	Tensile strength @20K	Rad. Length
	% by weight	(g/cc)	(ksi)	(ksi)	(ksi)	(cm)
6061-T6	1.0Mg 0.6Si 0.3Cu 0.2Cr	2.70	40	45	68	8.86
2090-T81	2.7Cu 2.2Li .12Zr	2.59	74	82	120	9.18

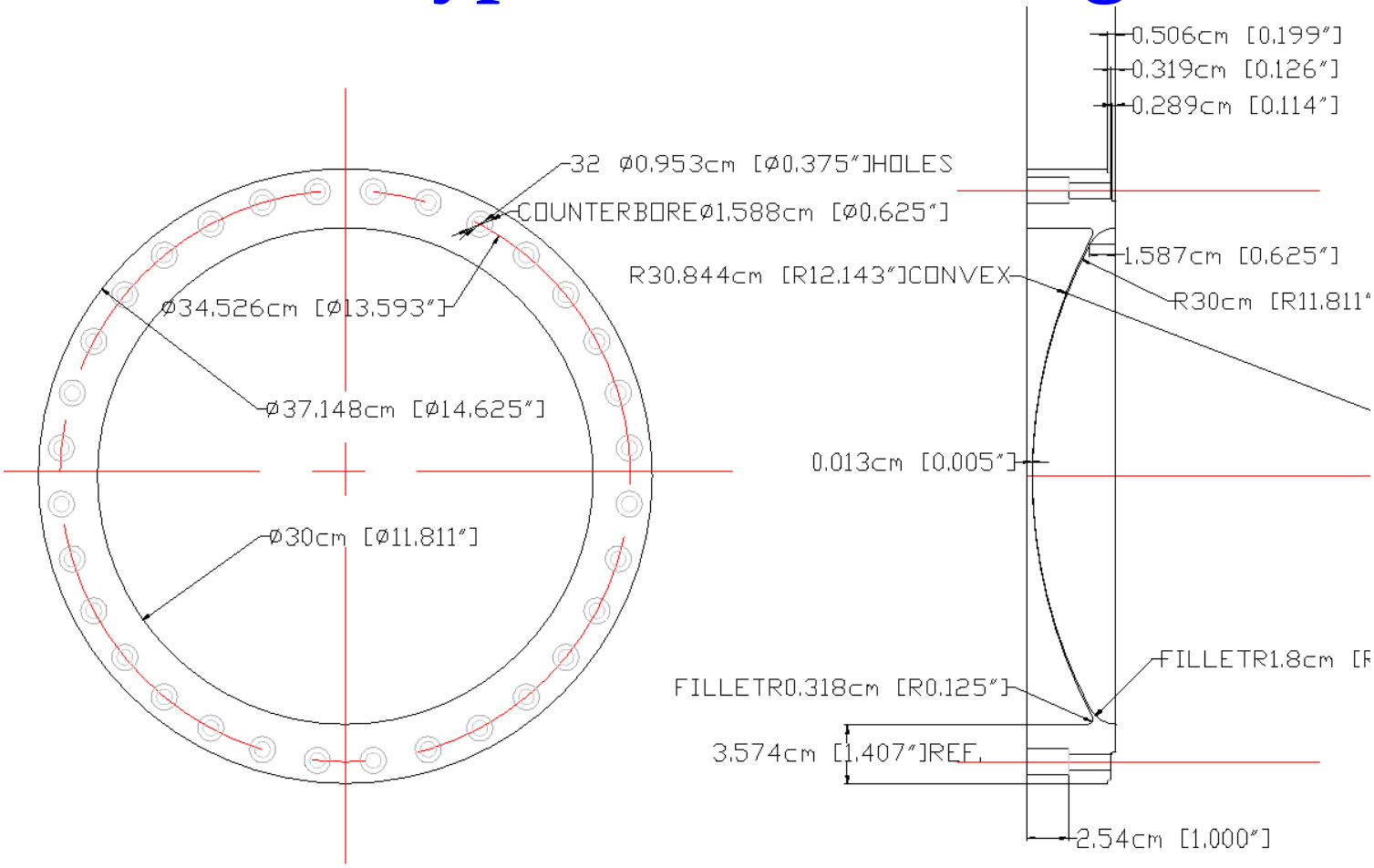
- "Aircraft alloy" 2090-T81 80% stronger than 6061-T6

$\Rightarrow$ Thickness can be reduced by $\approx$ 45% if desired

$\Rightarrow$ 200-μm thickness at 18-cm radius
125-μm thickness at 11-cm radius
at 1.2 atm

IF design scales $\approx$ linearly and
IF such thin foils can be manufactured with appropriate shape
(see below)

Prototype Window Design:



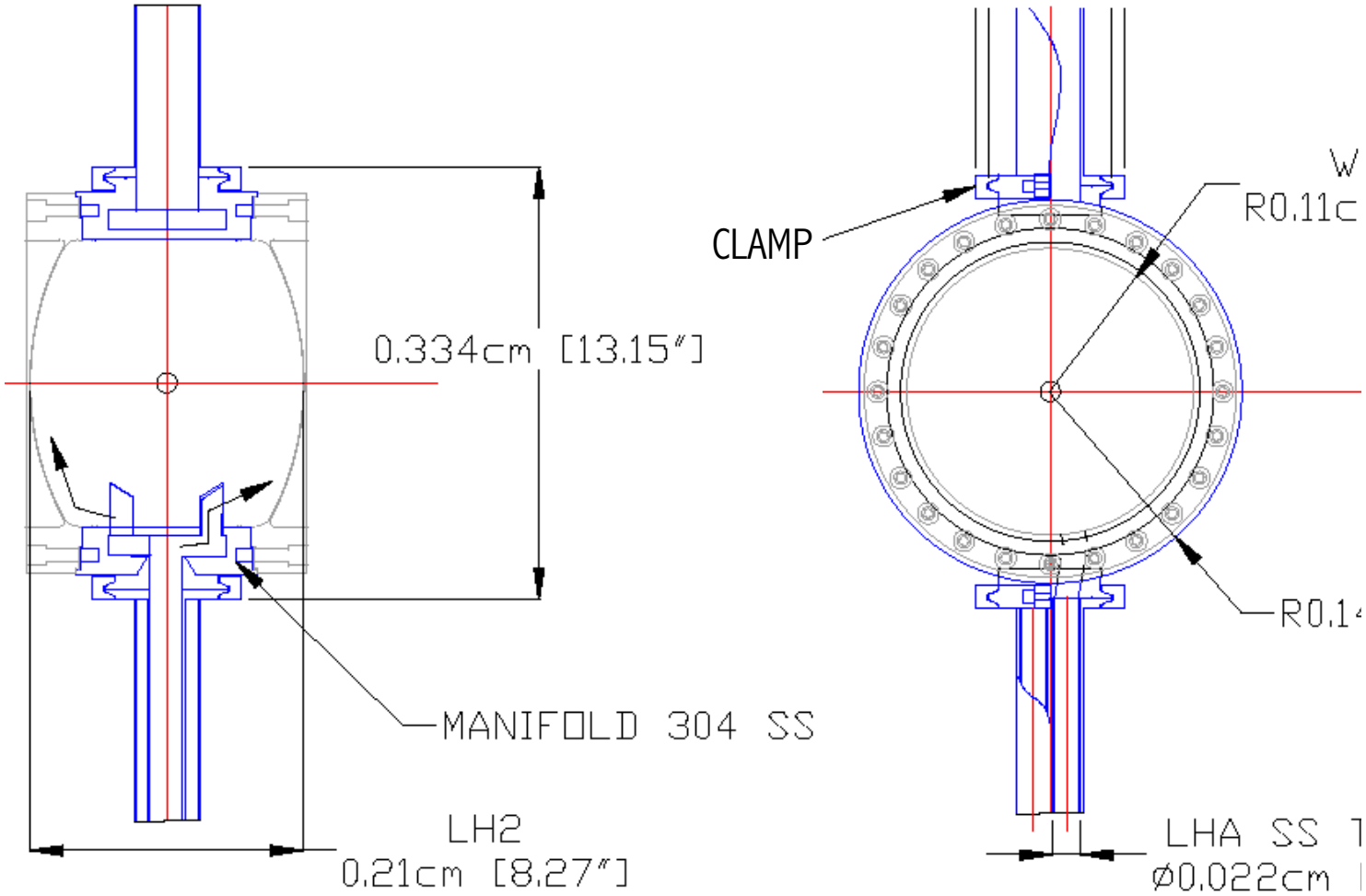
TEST ABSORBER WINDOW
PROFILE GEOMETRY

MATERIAL: 6061-T6

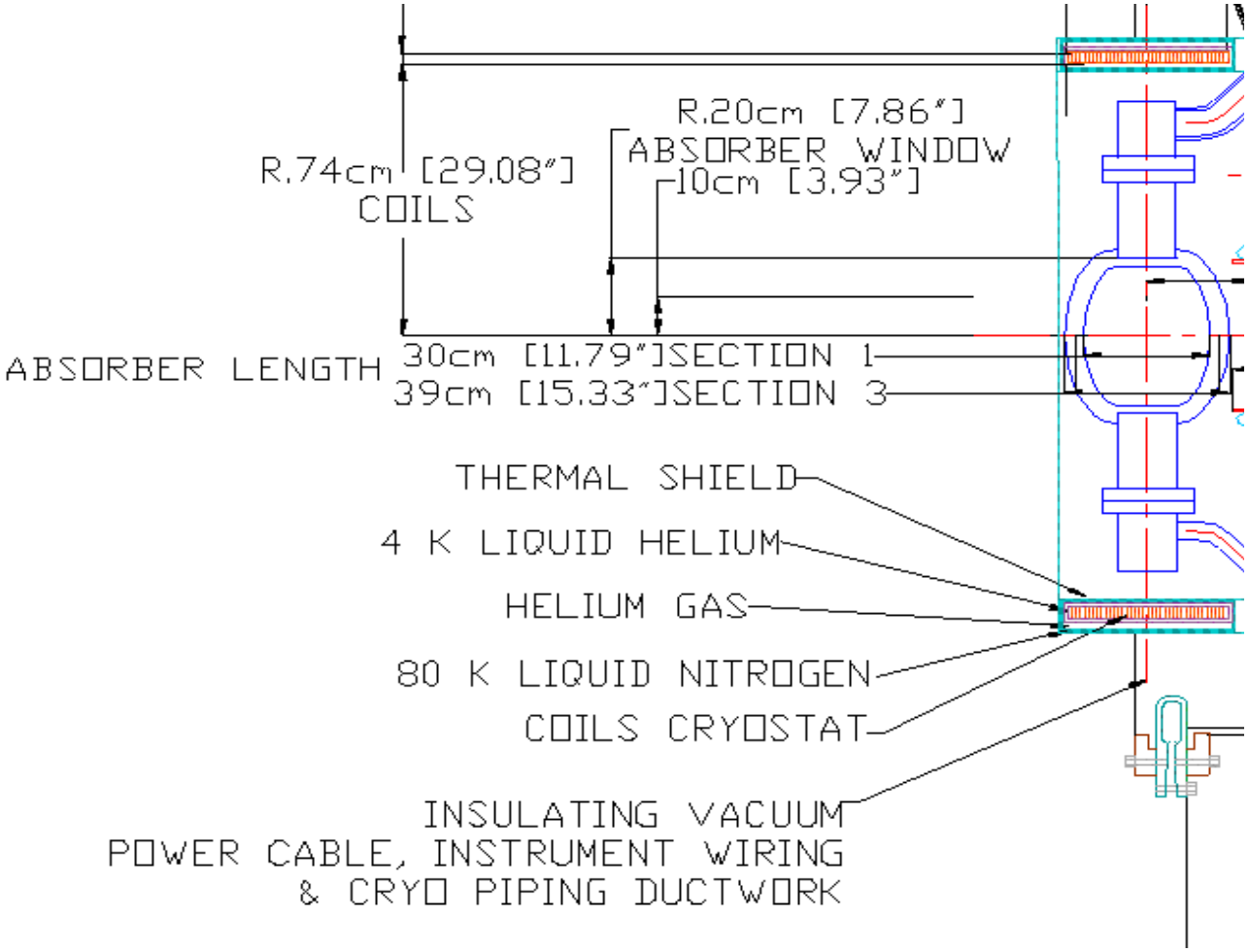
E.L.Black/IIT
8/2/2000
REV 5 8/5/2000
CURRENT DESIGN IN FABRICATION

Prototype-Window Movie:

SFOFO 2 Absorber Assembly:



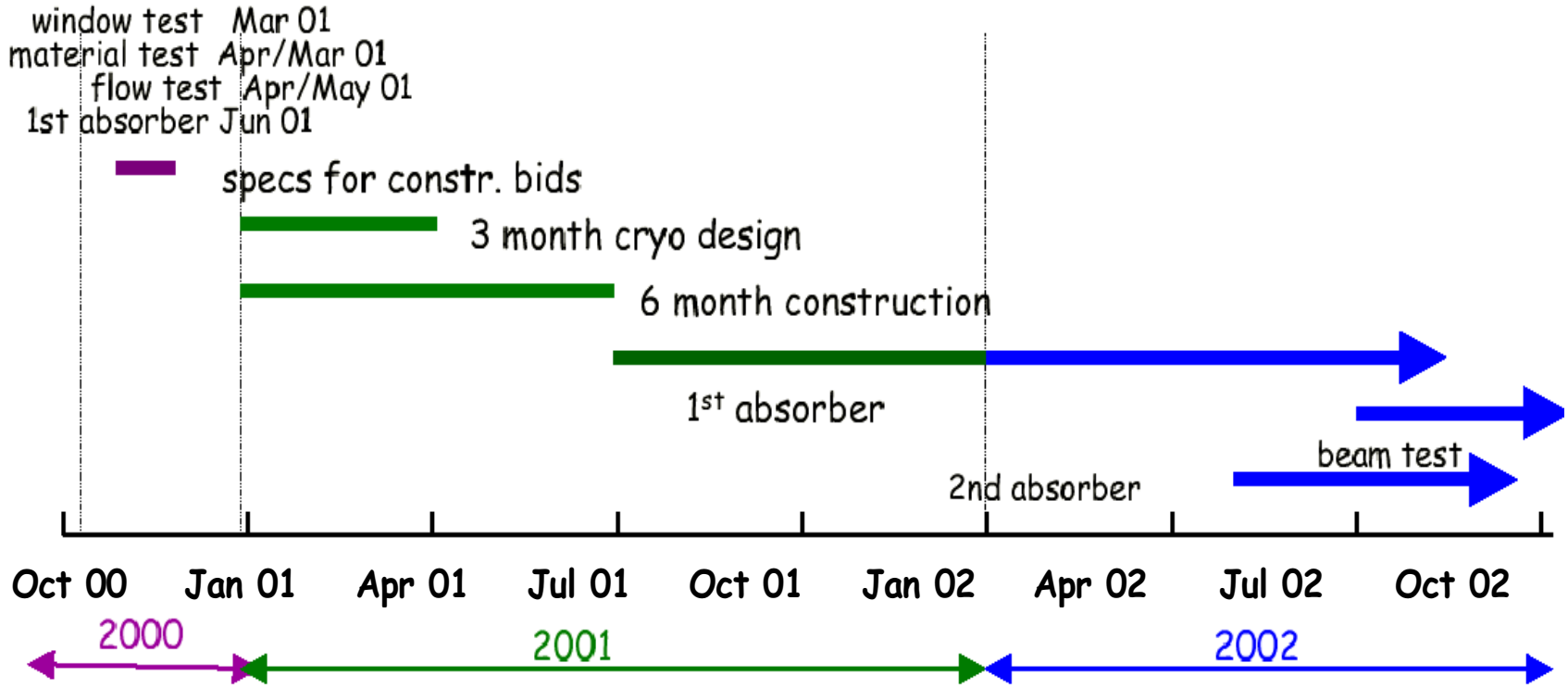
Double-Flip Absorber Assembly:



LH2 PROJECT TIMELINES (NEW)

R & D program:

1. Overpressure window test (FNAL requirement) (IIT/NIU/UMiss)
2. Cryogenic tests of AlBeMet at LH2 temperatures (vendor)
3. Fluid flow tests (IIT/NIU/FNAL)
4. Cryogenic LH2 absorber assembly, instrumentation and tests (IIT/NIU/UIUC/FNAL)



Cost Estimates:

	Absorber		Hydrogen Windows			Manifold	Assembly				
	dl (m)	Qnt.	rad.(m)	t(μm)*	Qnt.	dl (m)	lh2 Volume l	$/Manifold	$/Window		$/ assembly
MINI-COOLING H2 ABS.	1.75	2	0.30	375	4	1.15	438.25	$30,000	$40,000	$160,000	$220,000
									Subtotal	0	$151,394
Cool											
Assembly LATTICE 1 (2.75 m)										$0	
1,1	0.35	4	0.18	360	8	0.238	9.79	$18,000	$24,000	$192,000	$264,000
Match	0.35	2	0.18	360	4	0.238	9.79	$18,000	$24,000	$96,000	$132,000
1,2	0.35	4	0.18	360	8	0.238	9.79	$18,000	$24,000	$192,000	$264,000
Match	0.35	2	0.18	360	4	0.238	9.79	$18,000	$24,000	$96,000	$132,000
1,3	0.35	4	0.18	360	8	0.238	9.79	$18,000	$24,000	$192,000	$264,000
									Subtotal	$0	$1,056,000
Match	0	0	0		0					$0	
ASSEMBLY LATTICE2 (1.65m)										$0	
2,1	0.21	12	0.11	220	24	0.129	4.17	$11,000	$14,667	$352,000	$484,000
Match	0.21	2	0.11	220	4	0.129	4.17	$11,000	$5,441	$21,765	$43,765
2,2	0.21	8	0.11	220	16	0.129	4.17	$11,000	$5,441	$87,061	$175,061
Match	0.21	2	0.11	220	4	0.129	4.17	$11,000	$5,441	$21,765	$43,765
2,3	0.21	12	0.11	220	24	0.129	4.17	$11,000	$5,441	$130,592	$262,592
		52							Subtotal	$0	$1,009,184
									TOTAL	$1,541,184	$2,285,184

*Minimum thickness "t" is estimated assuming the hydrogen pressure at 1.2 atmospheres
Cost include some piping up to the outlet from the vacuum chamber