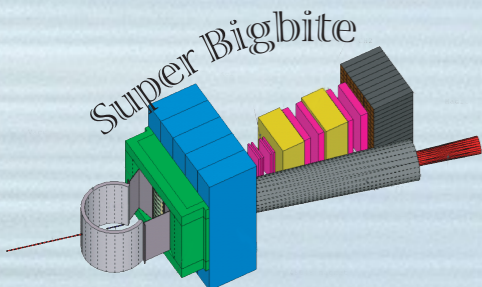


Update on the SBS G_E^n polarized ^3He target

- On track with our milestones
- Engineering is underway
- Highlights
 - ▶ Glass-and-metal technology tests complete; important lessons learned.
 - ▶ Record polarization achieved using dual-direction optical pumping
 - ▶ Apparatus for auxiliary polarimetry measurements coming online.
 - ▶ Stage-I cell production underway (3 vs. 6 liter cells)

G. Cates - UVa

SBS DOE Review, November 7, 2016



Progress on target milestones

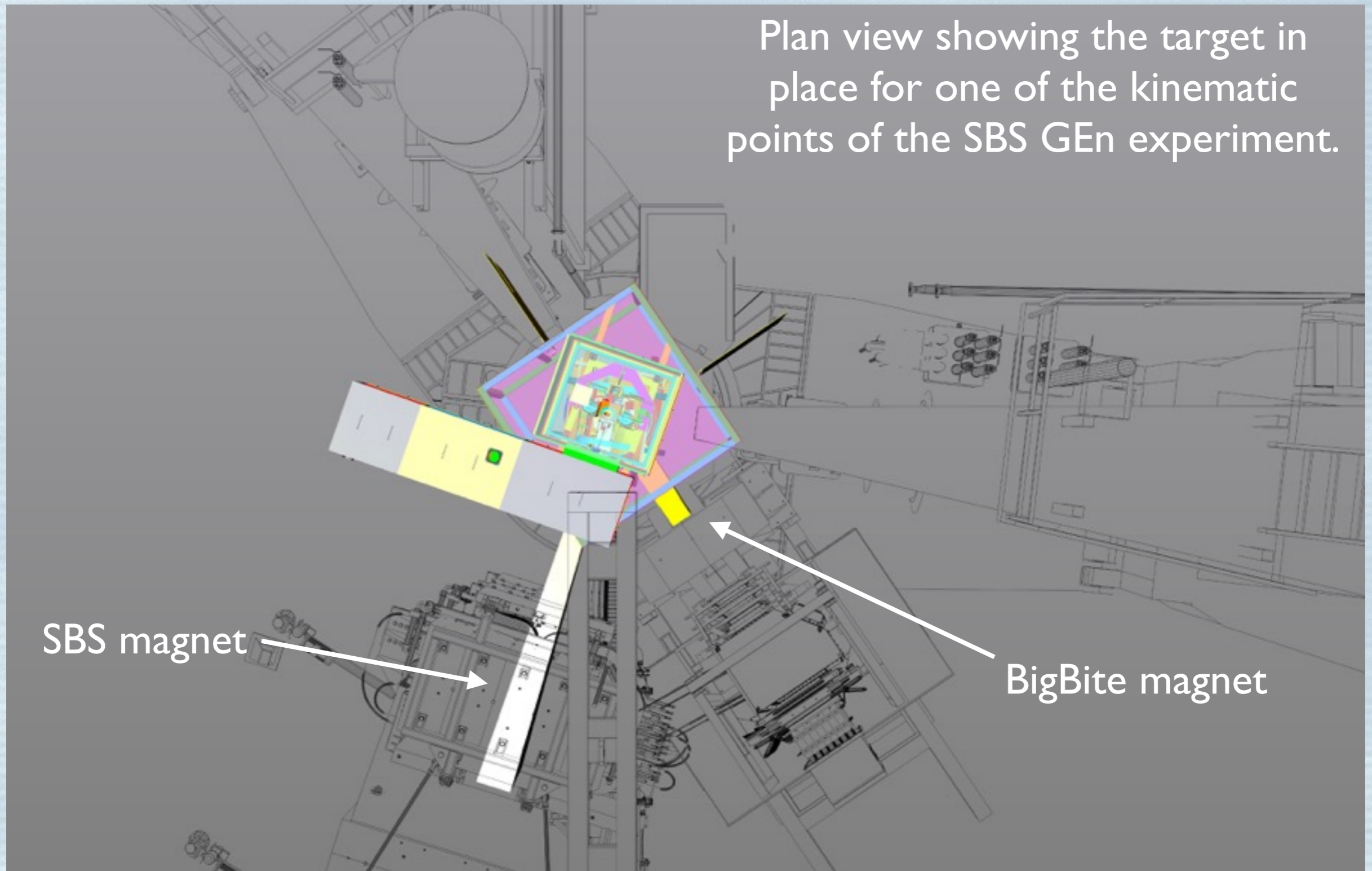
***** Target milestones *****

*** Selection of target cell design	Nov 2014	(Complete)
Conceptual design document complete	January 2016	(Complete)
Conceptual design review	March 2016	(Complete)
Start bench test of 3 liter glass conv. target	April 2016	(Complete)
Conceptual design frozen	June 2016	(Complete)
Test of glass/metal technology complete	June 2016	(Complete)
Begin engineering and design	July 2016	(Complete)
Bench test of 3 liter glass/metal target	January 2017	
*** Simulated beam test (bench test) (full scale 6 liter cell)	September 2017	
Begin production of full-scale cells	November 2017	
End of engineering	January 2018	
*** Design complete of target hardware and Instrumentation	June 2018	
*** Target is ready	January 2019	

Engineering

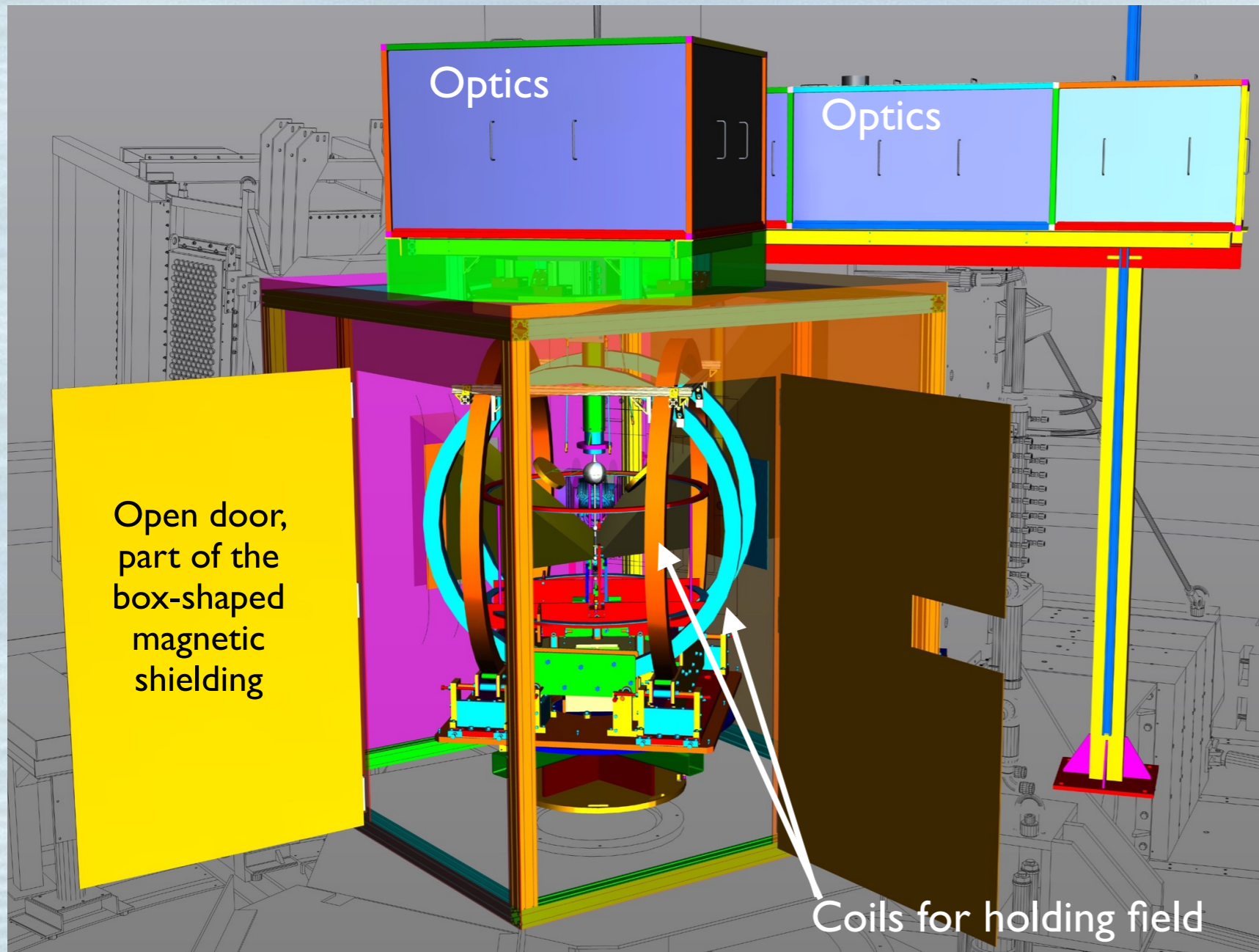
Engineering model for G_E^n target

Plan view showing the target in place for one of the kinematic points of the SBS G_E^n experiment.

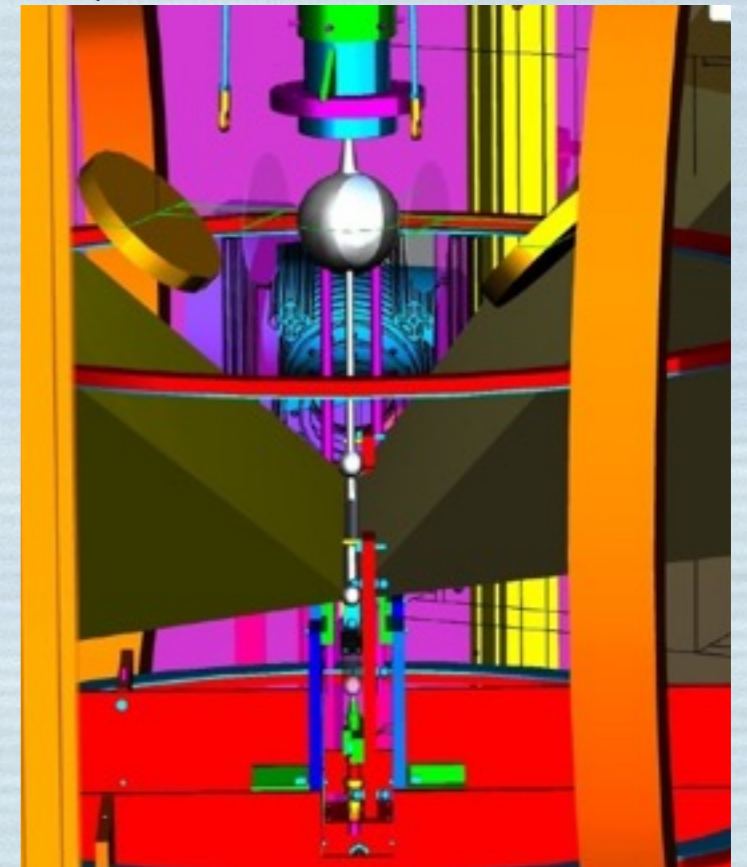


The target system is nestled very close to the BigBite and SBS magnets.

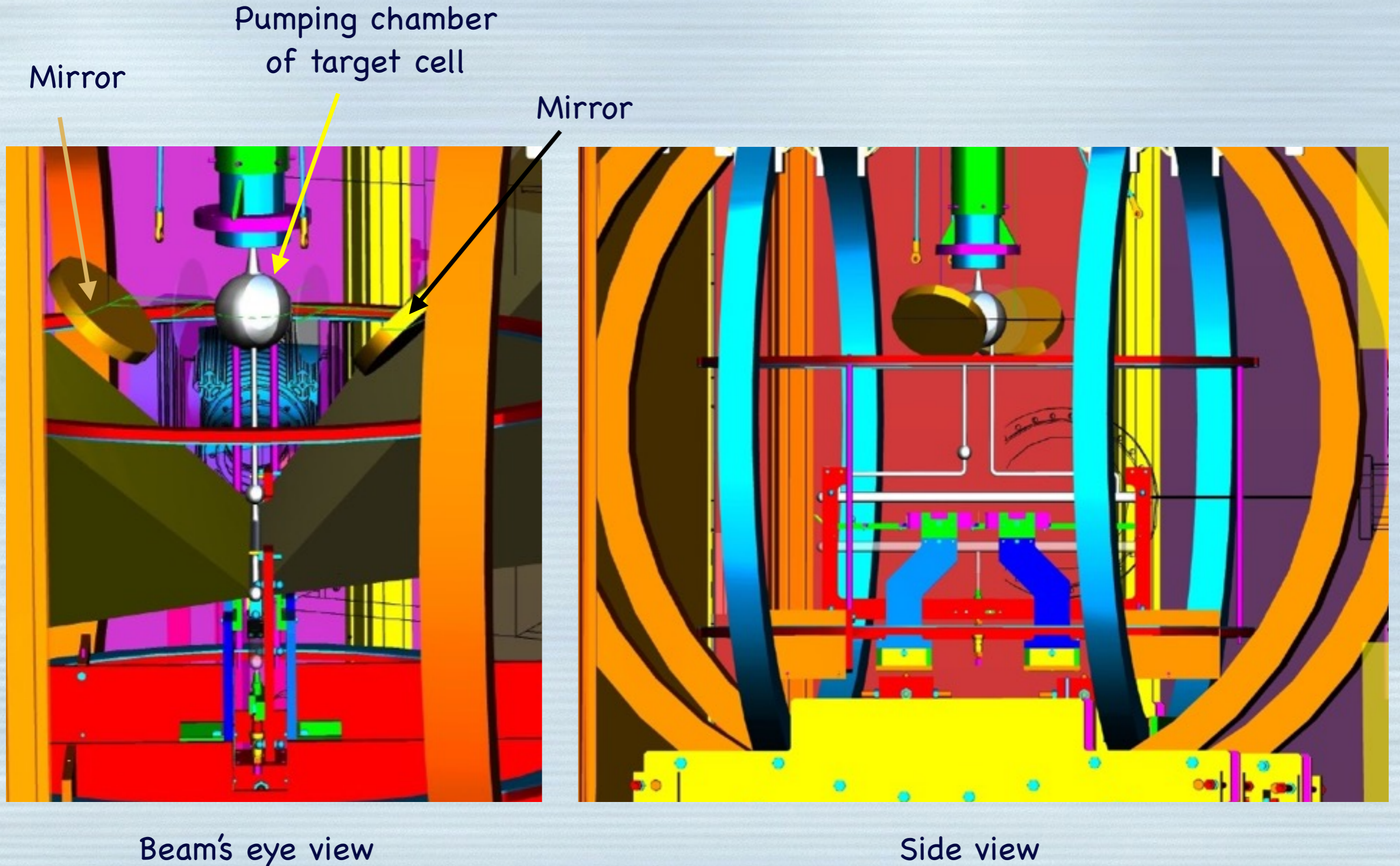
Engineering model for G_E^n target



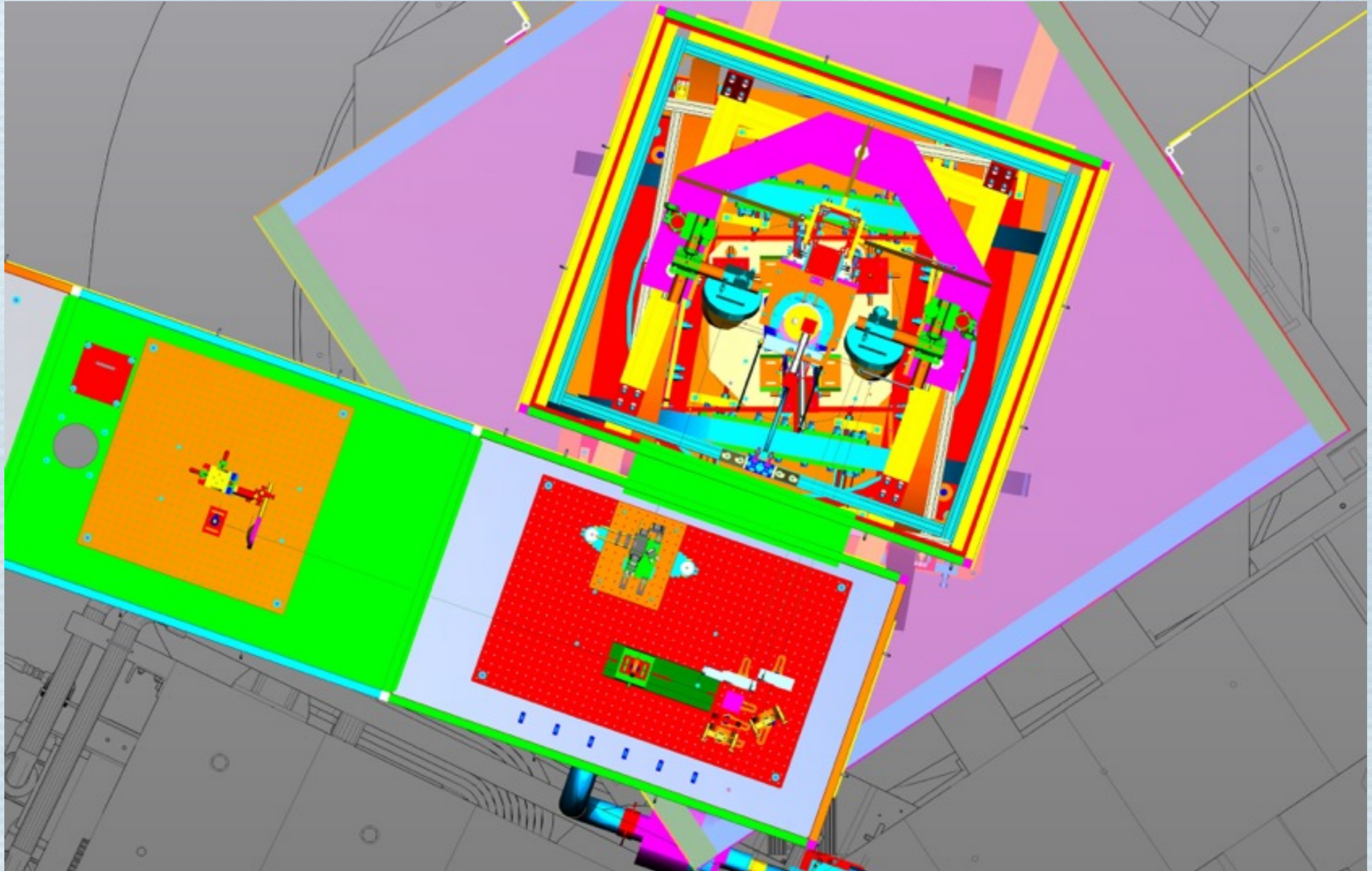
- Temple/Transversity coils provide holding field.
- Shielding from SBS and BigBite magnet fringe fields by iron box.
- Optical pumping from two directions.
- One-inch-optics modules help simplify laser and optics system.



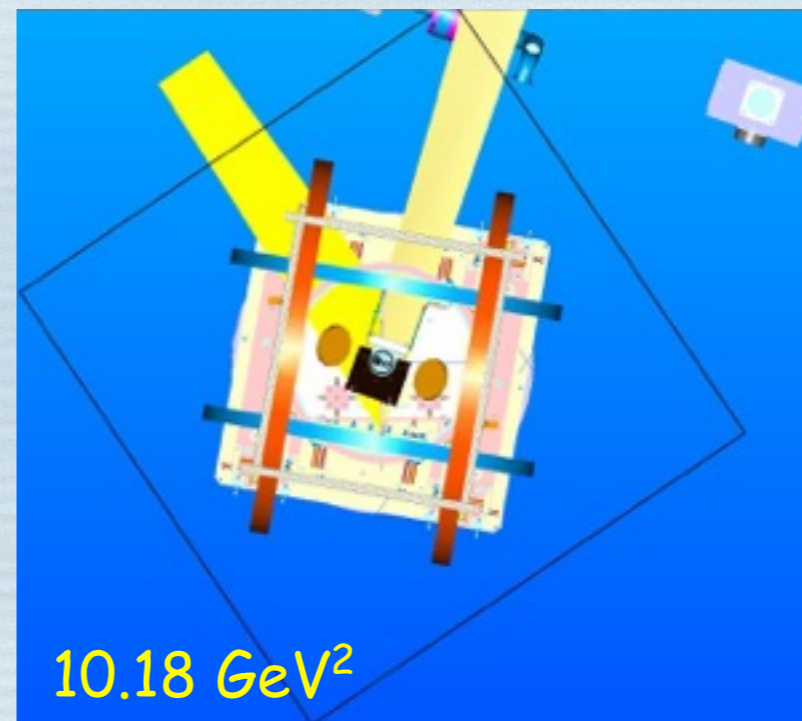
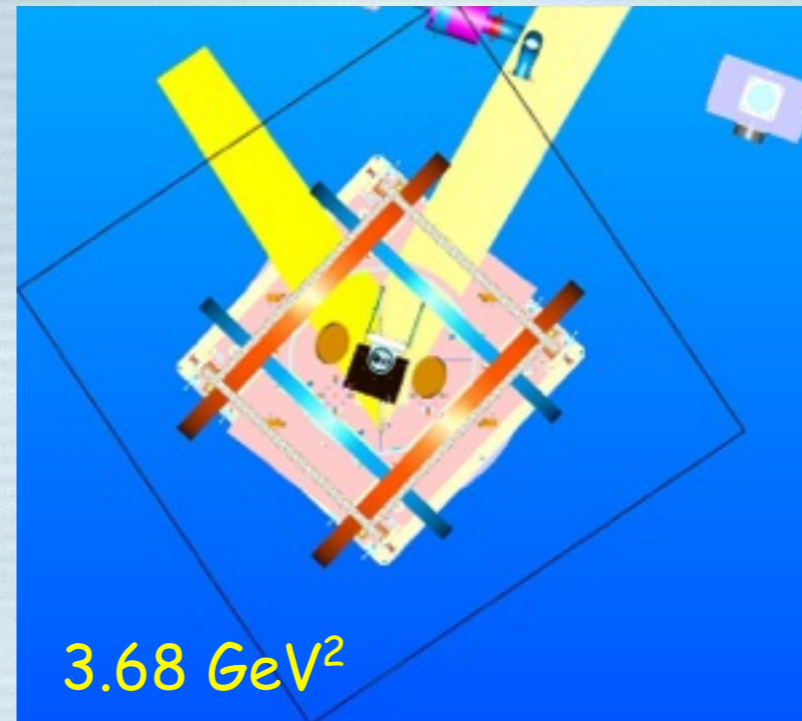
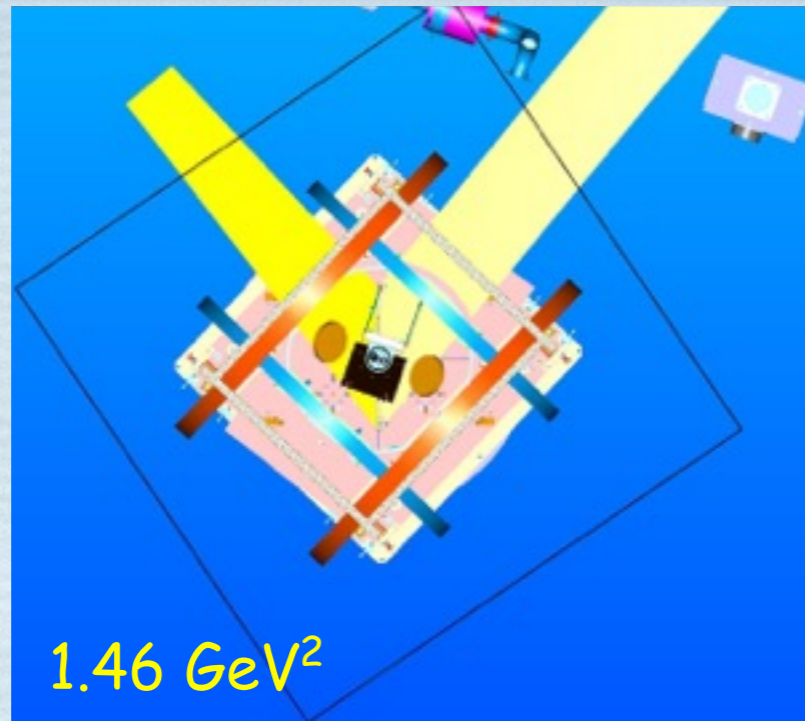
Engineering model for G_E^n target



Engineering model for G_E^n target

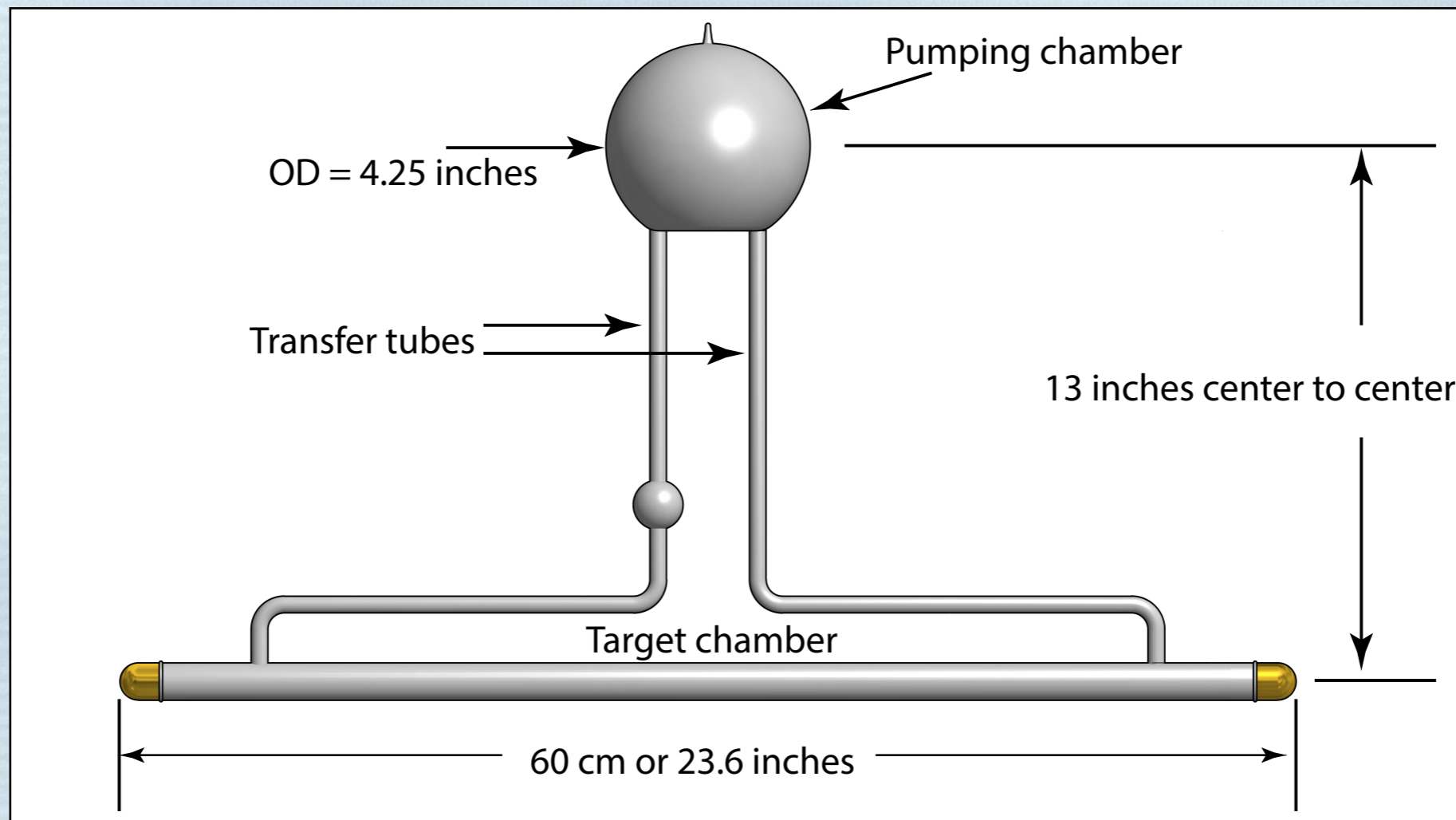


Kinematic settings for SBS G_E^n target



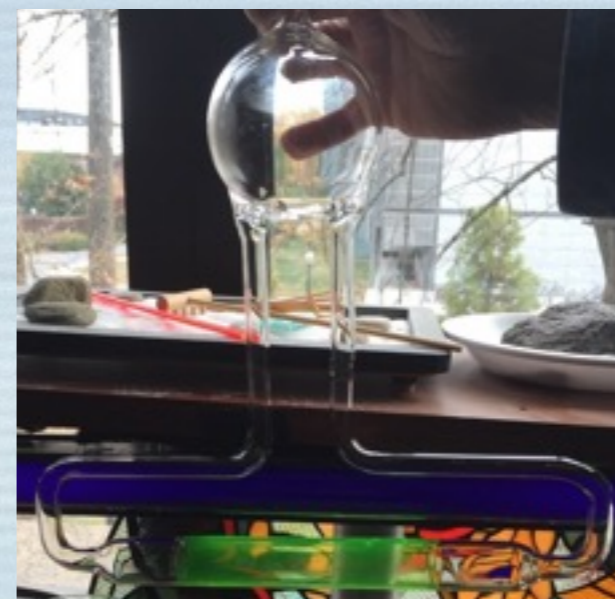
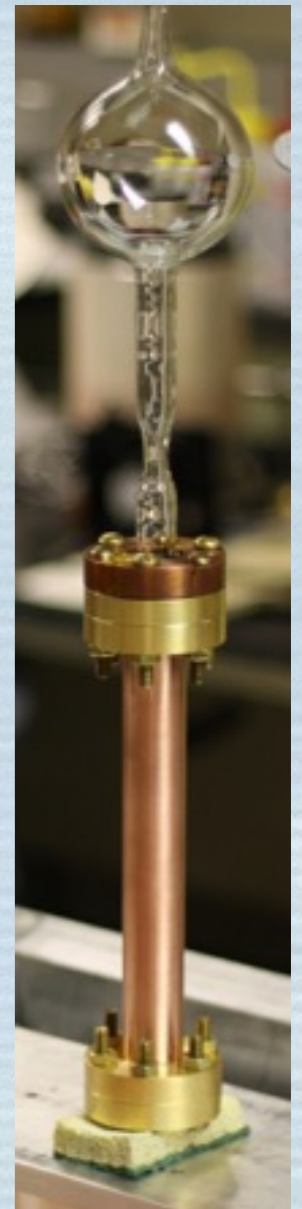
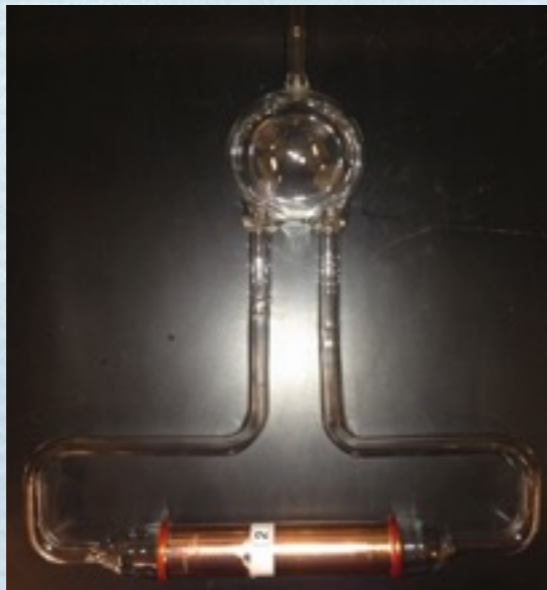
Design accommodates the acceptance for all kinematic points.

Target cell work



Shown is the GEn target-cell design as it appears in the Target Conceptual Design Report

Development of glass-and-metal cell technology - complete!



Shown are all the principle geometries studied, but NOT all of the cells tested.

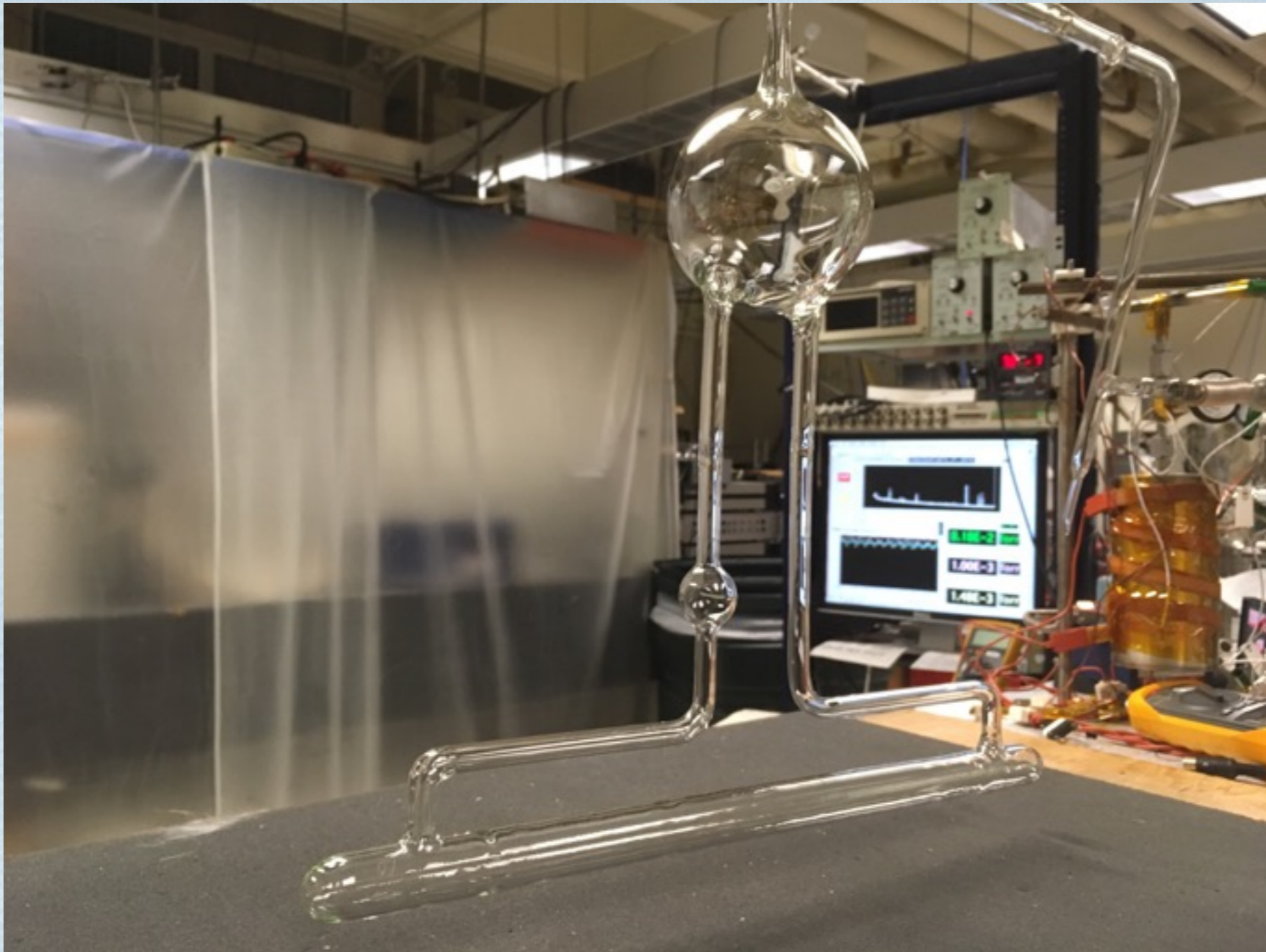
Development of glass-and-metal cell technology - complete

Cell Name	Fill Type	Geometry	Glass	Metal	Max Lifetime (hr)	Fill Date
Tyrion	NGP	Sphere	GE180	Gold on glass	1.21	6/18/09
Gold Maiden1	NGP	Flange	Pyrex	Gold on Copper	2.14	6/18/10
Gold Maiden2	NGP	Flange	Pyrex	Gold on Copper	None	8/14/10
Gold Maiden3	NGP	Flange	Pyrex	Gold on Copper	6.49	11/11/10
Goldfinger	NGP	Vertical	Pyrex	Gold on Copper	3.59	4/28/13
Cupid	NGP	Vertical	Pyrex	Bare Copper	3.13	6/15/13
Goldeneye	NGP	Vertical with Valve	Pyrex	Gold on Copper	13.94	10/2/13
GoldRush	NGP	Vertical	Pyrex	Gold on Copper	14.81 [†]	11/8/13
Pyrah	NGP	Vertical	Pyrex	None	26.52 [†]	2/1/14
GoldenVec	NGP	Horizontal	Pyrex	Gold on Copper	10.6	10/18/14
TitanVec	NGP	Horizontal	Pyrex	Gold on Titanium	0.52	12/15/14
GoldenVec2	Cryogenic	Horizontal	Pyrex	Gold on Copper	15.6	2/14/15
Titan	NGP	Vertical	Pyrex	Bare Titanium	None	3/11/15
GoldenVec180	Cryogenic	Horizontal	GE180	Gold on Copper	4.43	6/17/15
GolderVec360	Cryogenic	Horizontal	GE180	Gold on Copper	3.01	7/11/15
Tweety	Cryogenic	Vertical	Pyrex	Canary Glass	22.7	9/22/15
Sylvester	Cryogenic	Horizontal	GE180	Canary Glass	6.39	11/20/15
Kappa1	Cryogenic	Sphere	GE180	None	72.17	2/6/16
Goldfinger180	Cryogenic	Vertical	GE180	Gold on Copper	12.4 [†]	5/19/16

Glass-and-metal cell technology: Lessons Learned

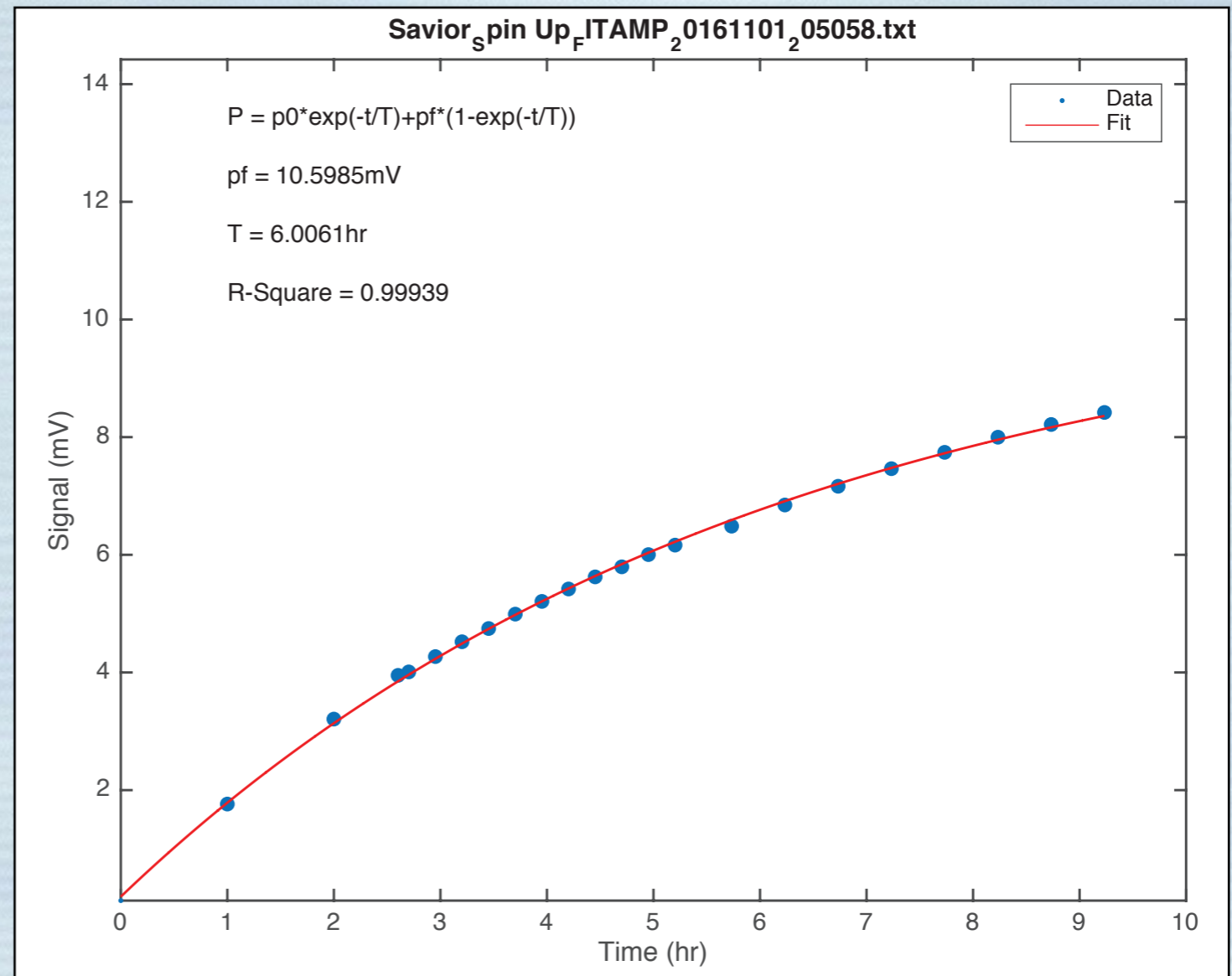
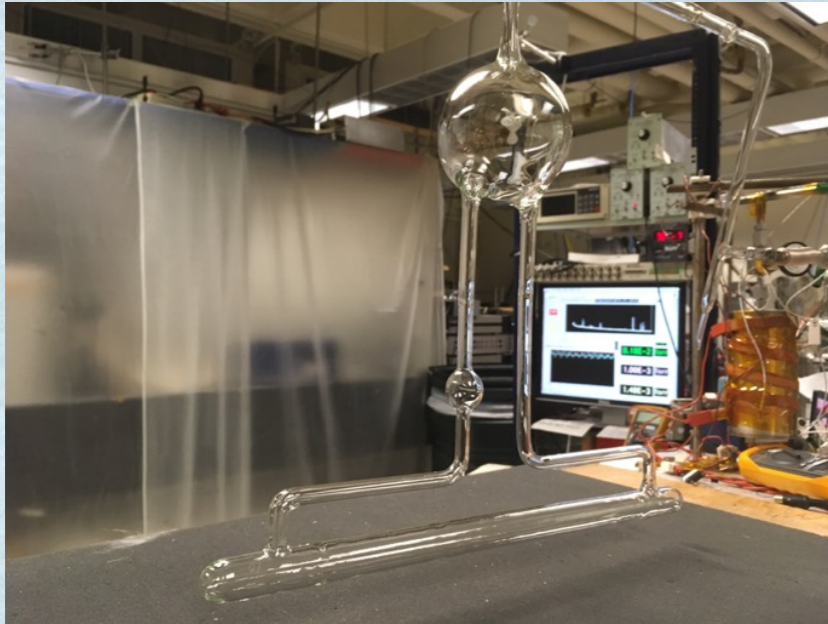
- Housekeeper seals provide excellent transition for going from glass to metal, with good integrity with regards to both pressure and contamination.
- OFHC copper, mechanically polished and electropolished, subsequently electroplated with gold, provides good spin-relaxation properties.
- Surprise #1 - We have more flexibility in our choice of transition glasses than we thought at the outset. Specifically, uranium or canary glass works in addition to Corning 7056.
- Surprise #2 - annealing affects spin-relaxation far more strongly than anticipated. This may also have affected target cells in the past.

Stage I target production underway



Shown is a "stage-I" target cell, 3 liters instead of 6 liters, on the UVa gas-handling system prior to being filled.

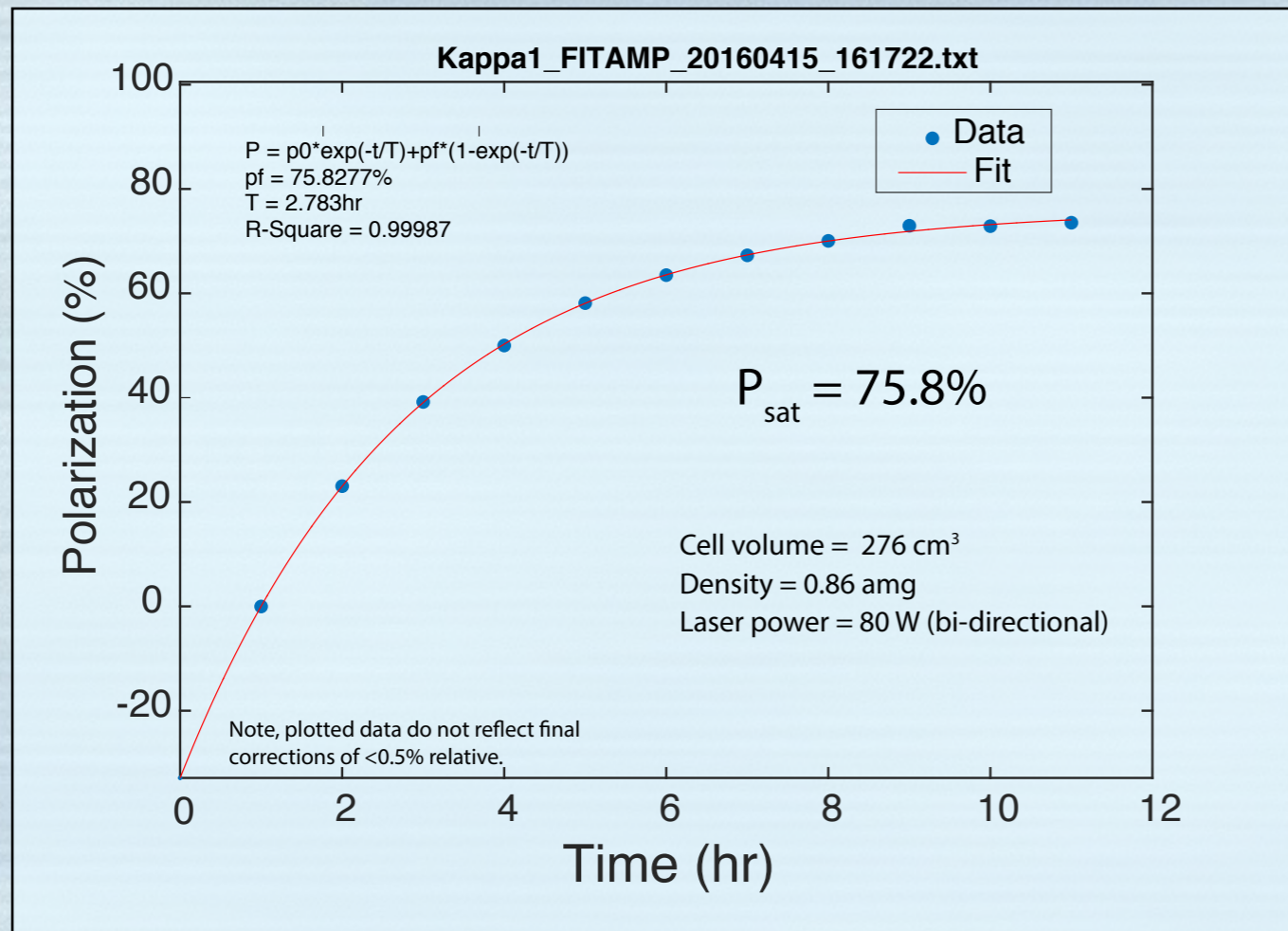
Stage I target production underway



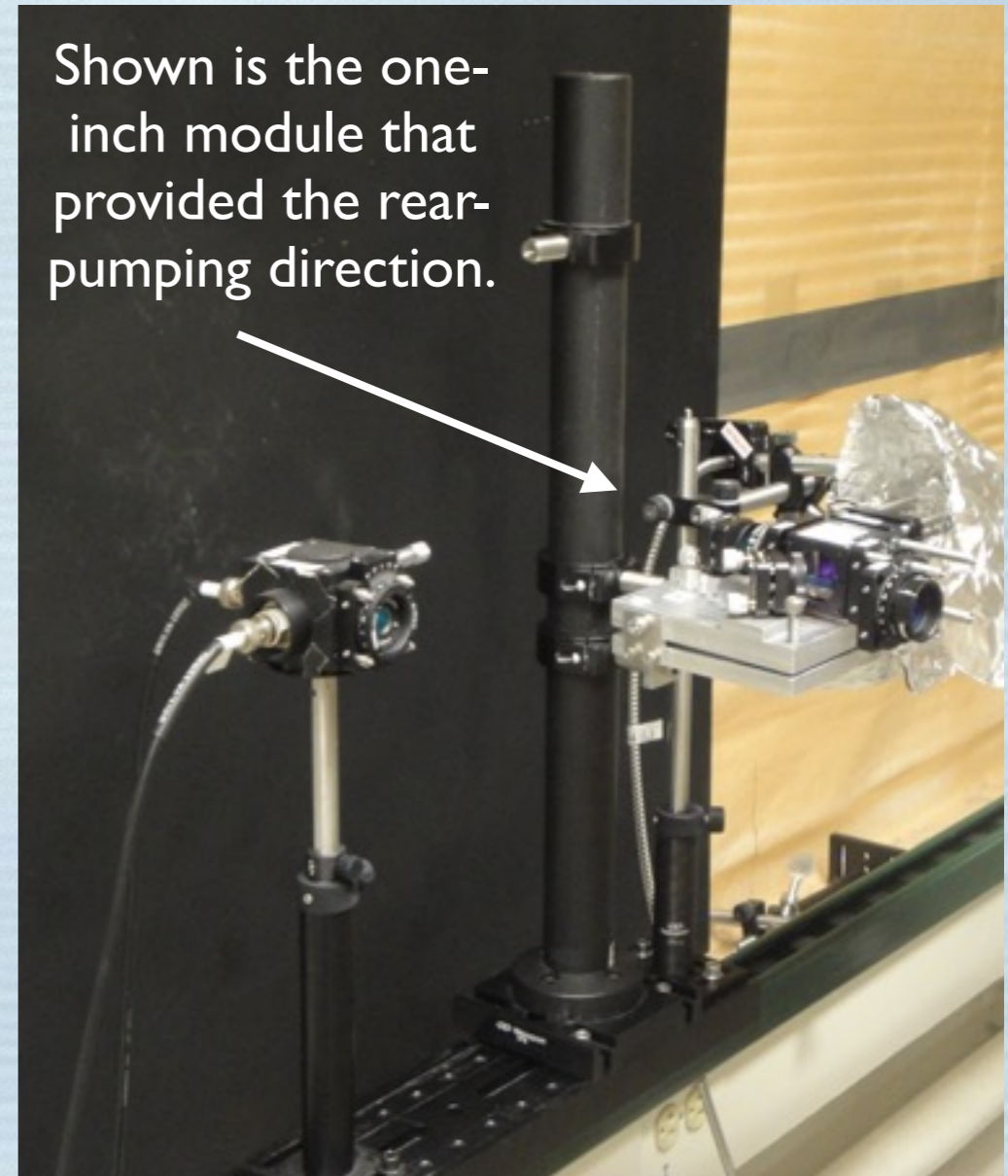
Shown is a "stage-I" target cell, 3 liters instead of 6 liters, on the UVa gas-handling system prior to being filled.

Other highlights

First test of dual-direction pumping



Shown is the one-inch module that provided the rear-pumping direction.



- Spherical cell, 3.25 inches outside diameter.
- Pressure just under one atmosphere.
- 40 Watts from three lasers combined with five-to-one combiner from the "front" pumping direction.
- 40 Watts from single one-inch module from the "back" pumping direction.

Apparatus for K_0 measurement

Shown at Nov. 2015 review

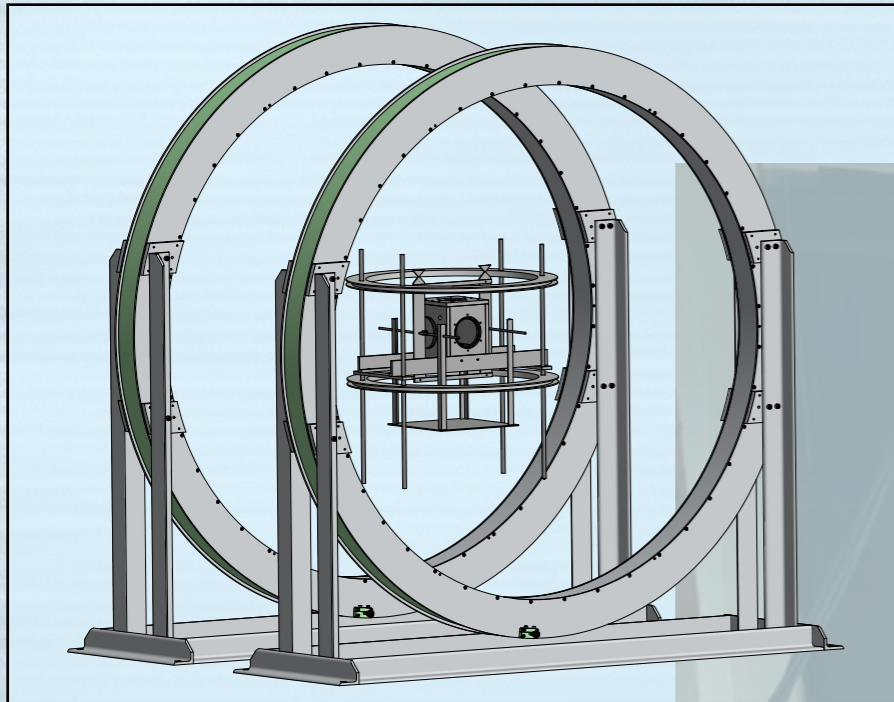
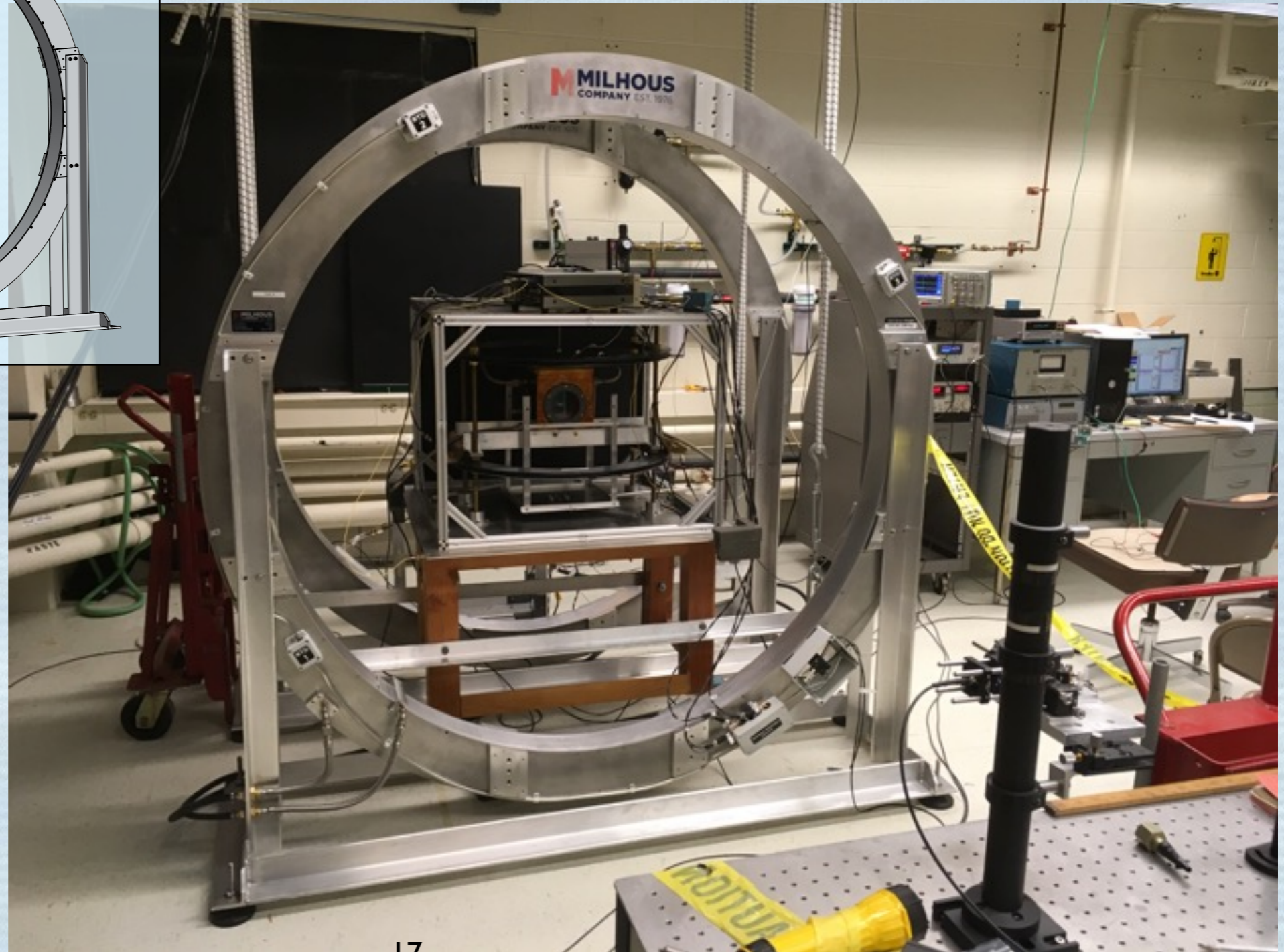


Photo taken 26 October 2016



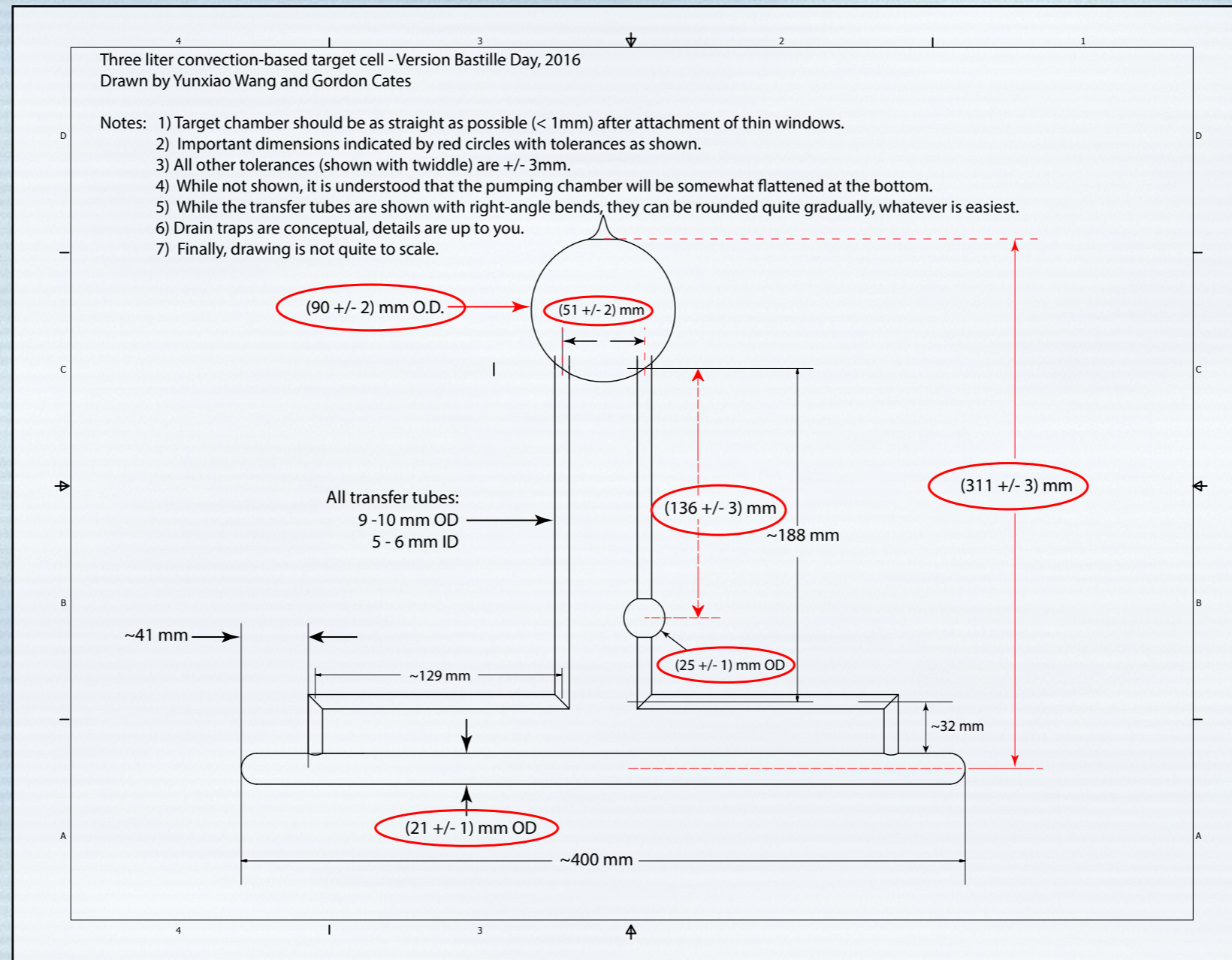
Summary

- All milestones up to present time are complete.
- Target's conceptual design is frozen, and engineering is underway.
- A plan is (still) in place to have the target system ready by January 2019.
- Early results suggest that dual-direction pumping will indeed deliver the hoped-for boost in performance.

Backup slides

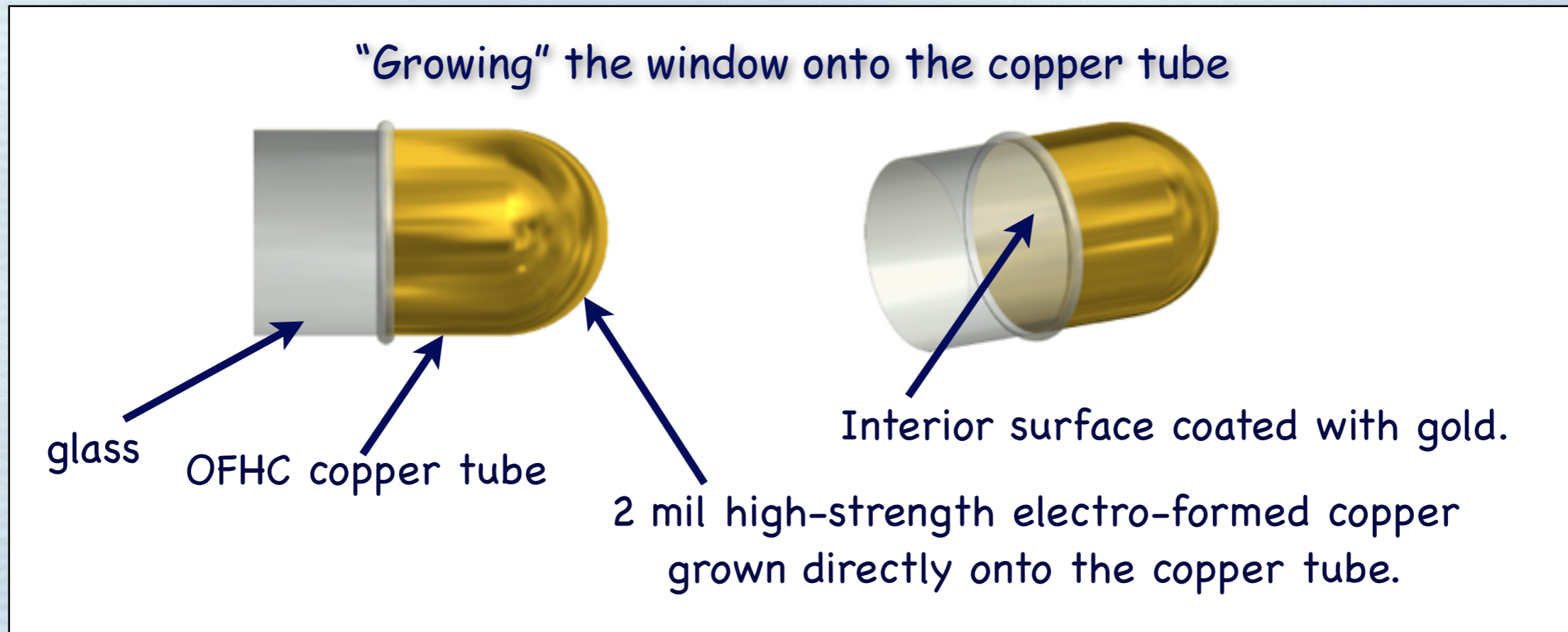
Production of 3-liter target cells is beginning

Bastille Day Design (below) released to glass blower on July 14th



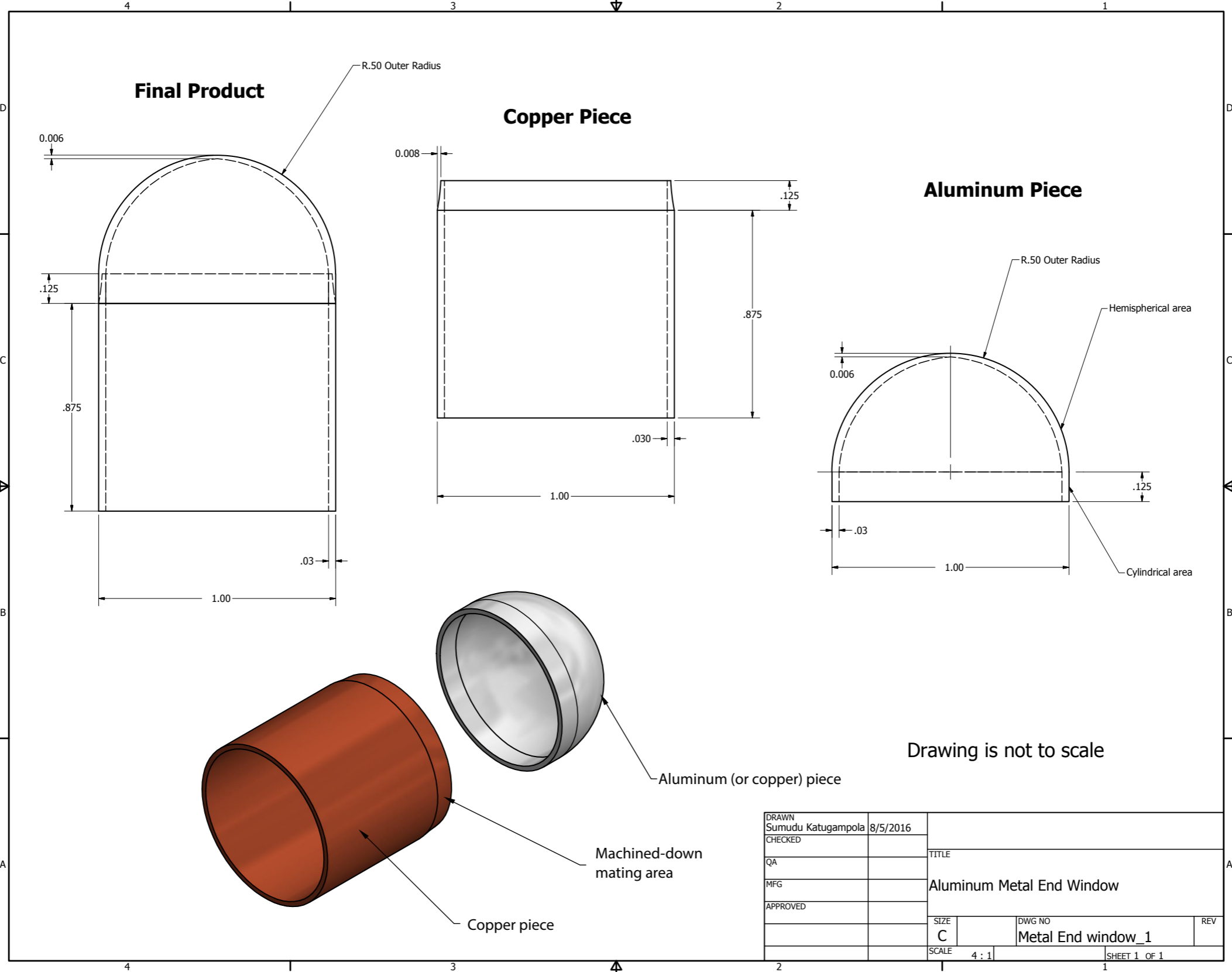
Mike Souza, the glass blower, expects to finish the first cell on Monday, July 25th.

Developing and incorporating a sufficiently thin window



- Thus far, only copper substrates have given us gold coatings with sufficiently slow spin relaxations.
- To limit scattering from the window to the level currently achieved with glass windows, we need a very thin (< 2 mil) thick copper window.
- We have located a company (A. J. Tuck Co.) that has developed a process for electro-forming very-high-strength copper, and it can be "grown" directly onto the OFHC copper tube.
- The finished glass-and-metal end window will then have its interior surface coated with gold.

Thin window development



Final Product

Copper Piece

Aluminum Piece

Drawing is not to scale

DRAWN	Sumudu Katugampola	8/5/2016		
CHECKED			TITLE	
QA			Aluminum Metal End Window	
MFG			SIZE	DWG NO
APPROVED			C	Metal End window_1
			SCALE	REV
			4 : 1	
				SHEET 1 OF 1

Thin window development

