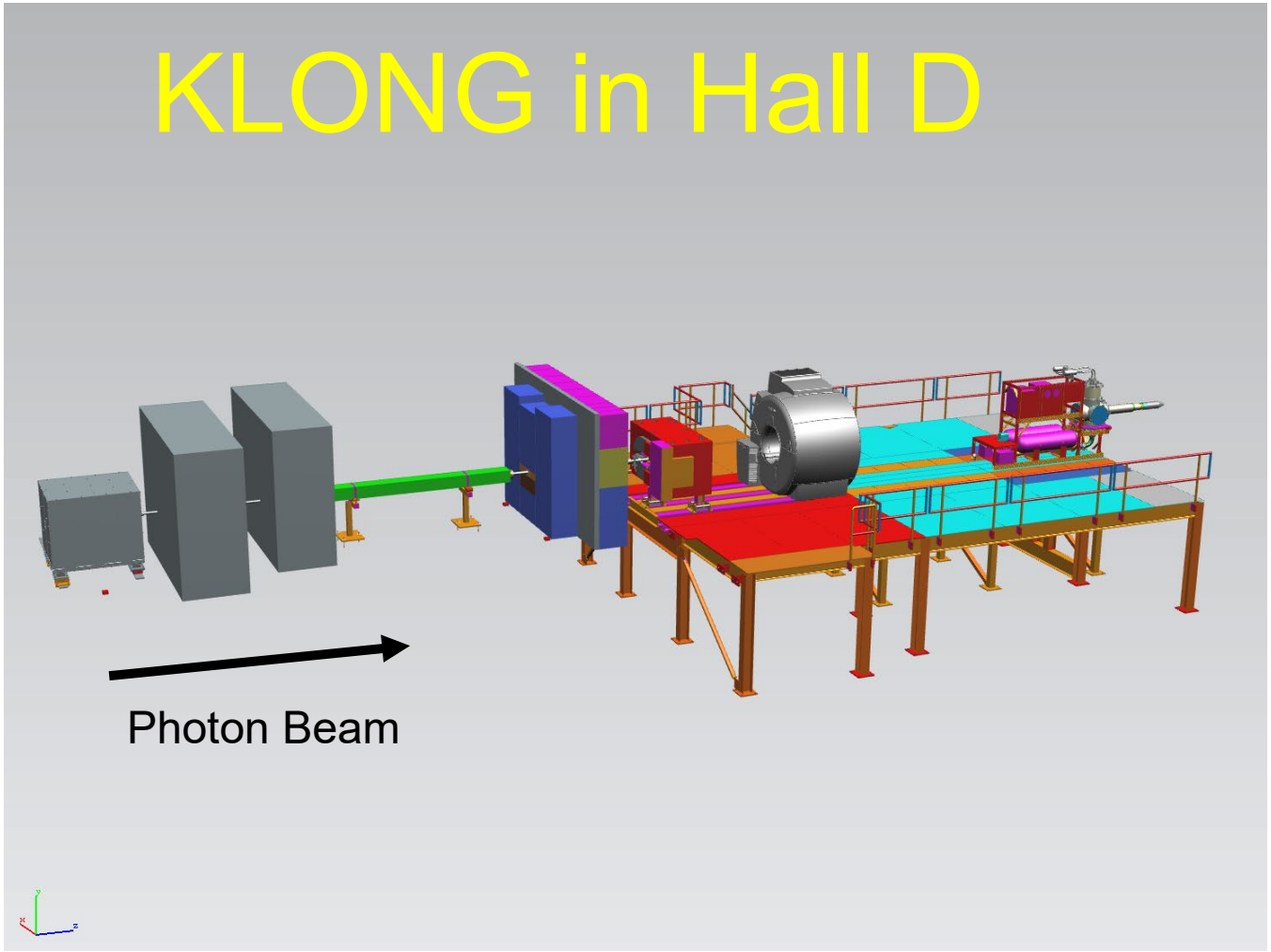
Engineering Update



3 Overall Components

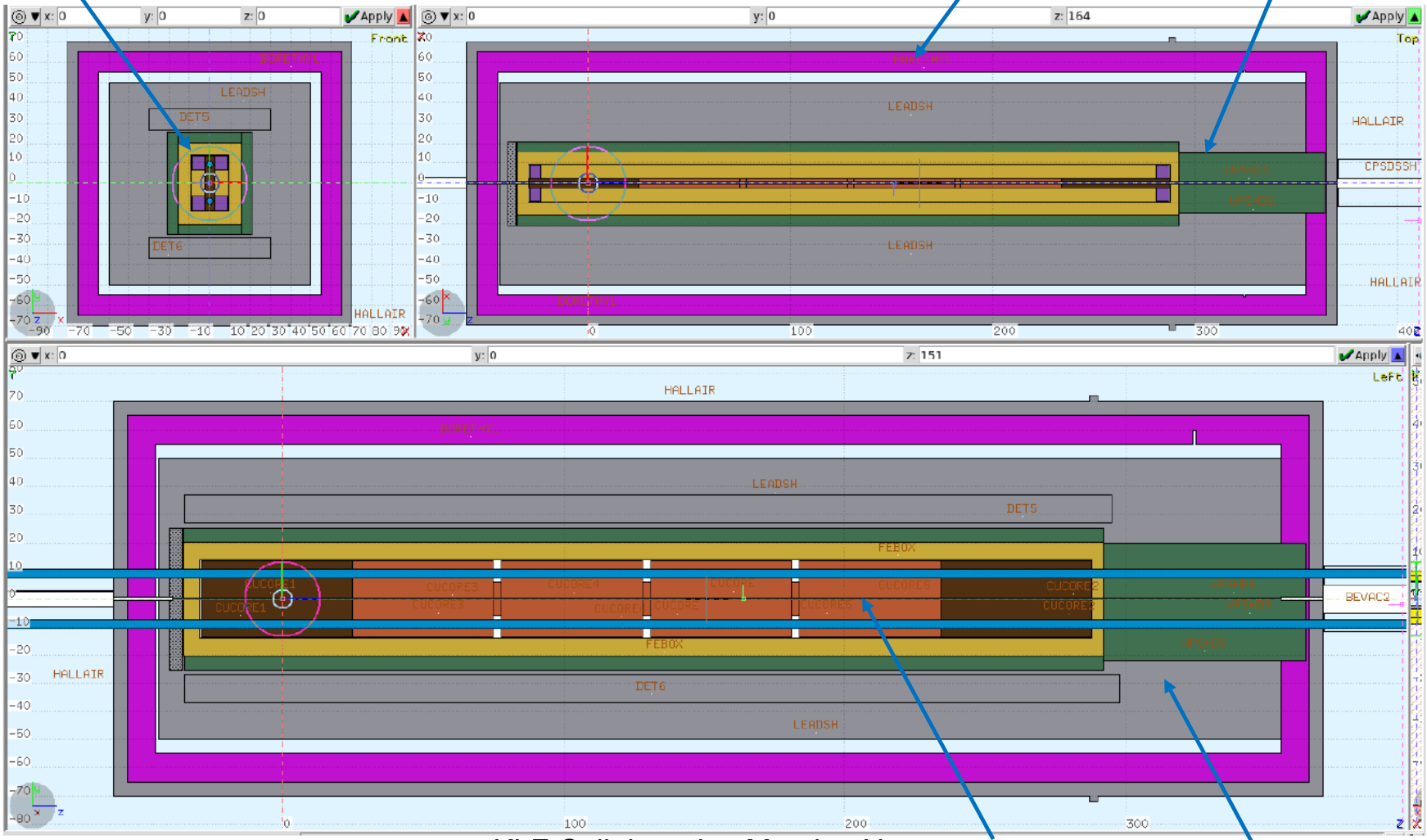
- CPS Engineering Design Status
- Target/Beamline Engineering Status
- Flux Monitor Infrastructure status

KLONG CPS Concept (Vitaly)

Magnet steel and coils

Borated Poly

Tungsten

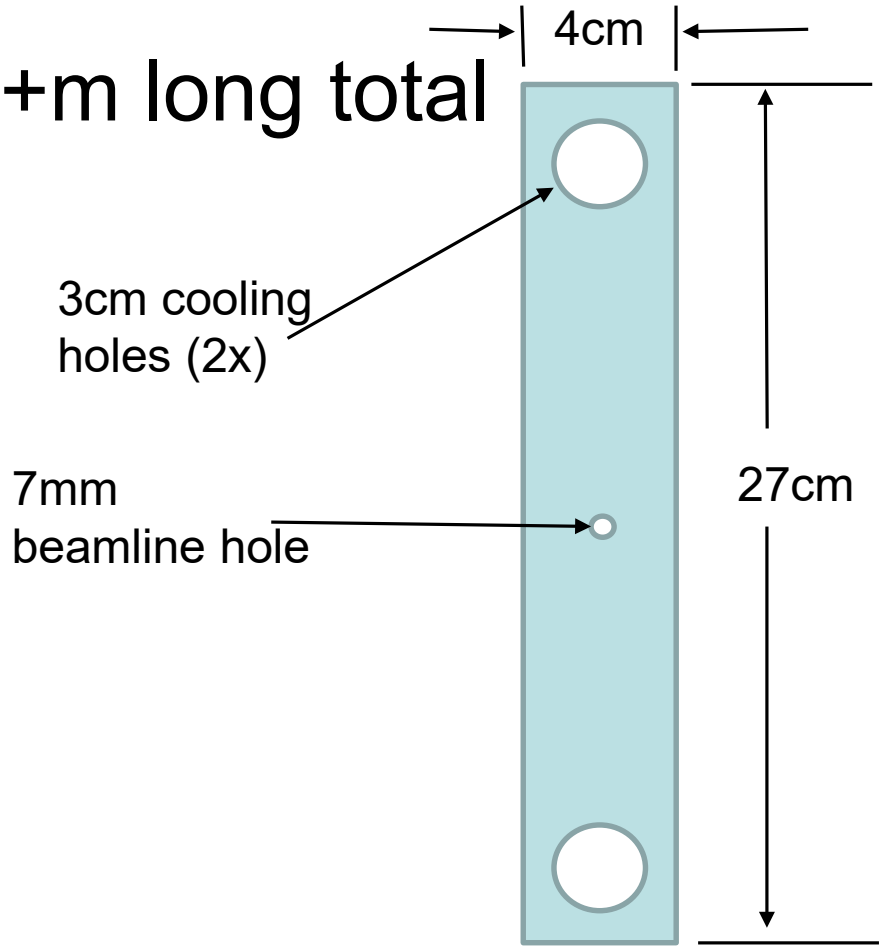


4x Copper Absorber

Lead

CPS Copper Absorber

- 2+m long total



CPS Water cooling

CPS Absorber cooling water_v1 - tanabe [Compatibility Mode] - Excel

File Home Insert Page Layout Formulas Data Review View Acrobat Tell me what you want to do... Timothy Whitlatch Share

A29 20

1	Kl…ng CPS 45KW total, 2 circuits LCW															
2			Units		Units		Units									
3	d			30	mm	0.098425	ft	0.03	M	ID of tube						
4	L	3	m	3000	mm											
5	epsilon					0.000005	ft	e/d =	5.08E-05							
6	nu	0.00000929	ft^2/sec	at 37°C												
7	…ail Power	45	kW	4500…	W											
8																
9																
10																
11																
12																
13																
14																
15																
16										P=mCpdeltaT						
17										3.8 factor=	1kg/s=15.83gpm					
18											Cp =	4.18	KJ/Kg*K			
19										KW=KJ/s=(kg/s)(kj/kg*C)C						
20																
21																
22																
23																
24																
25																
26	DeltaP				f	v	Re	q	DT		V	DP		h		
27	(psi)	(ft/sec)	(no units)	(no units)		(ft/sec)		(gpm)	(deg.C)							
28	0.14	0.45631317	0.000533	6.546688	0.023332	2.98734	31650.11	10.20016002	16.76444							
29	20	5.45398555	5.72E-05	8.485699	0.013888	46.28088	490334.2	158.0243164	1.082112							
30	0.04	0.24390965	0.000985	6.0131	0.027657	1.466653	15538.82	5.00783143	34.14652		1.466653	0.04				
31	20	5.45398555	5.72E-05	8.485699	0.013888	46.28088	490334.2	158.0243164	1.082112		46.28088	20				
32	40	7.71310034	4.44E-05	8.704354	0.013199	67.13756	711305.4	229.2386574	0.745947		67.13756	40				
33	45	8.18097833	4.27E-05	8.739381	0.013093	71.49669	757489.3	244.1227395	0.700467		71.49669	45				
34	50	8.62350834	4.12E-05	8.770157	0.013001	75.62952	801275.7	258.2341515	0.66219		75.62952	50				
35	55	9.04441185	3.99E-05	8.797536	0.01292	79.56854	843008.6	271.6837828	0.629408		79.56854	55				
36	60	9.44658008	3.88E-05	8.822143	0.012848	83.33908	882956.5	284.5581496	0.600932							
37	65	9.83231229	3.78E-05	8.844448	0.012784	86.96137	921333.7	296.9263142	0.5759							
38	70	10.2034727	3.69E-05	8.864811	0.012725	90.45186	958314.6	308.8444628	0.553677							
39	75	10.5615976	3.62E-05	8.88352	0.012672	93.82416	994043.2	320.3590438	0.533776							
40	80	10.9079711	3.54E-05	8.900799	0.012622	97.08966	1028640	331.5089849	0.515823							
41	85	11.2436793	3.48E-05	8.916836	0.012577	100.258	1062209	342.3272993	0.499522							
42	90	11.5696505	3.42E-05	8.931781	0.012535	103.3376	1094836	352.8422756	0.484636							

Heat Exchange with wate… at DP row 28

Twater =	40.38222144	C	average
N_{ud} =	223		From Oliver &
K =	0.623	W/MK	From White
Pr =	4.84	extrapolate fr…	m White ap
f =	0.023334503	friction factor	
h =	Nud K/D	W/M^2 K	
h =	4630.966667		
q =	hA(Tw-Twall)	=	m…CpdeltaT =
A =	piDL	use L for are…	inside cool
Twall =	91.93341443		

$$v = -2\sqrt{\frac{2g\Delta P}{0.433}\frac{d}{L}}\log_{10}\left(\frac{\varepsilon}{3.7d}+\frac{2.51}{\frac{d}{v}\sqrt{\frac{2g\Delta P}{0.433}\frac{d}{L}}}\right)$$

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{\varepsilon}{3.7d}+\frac{2.51}{\frac{d}{v}\sqrt{\frac{2g\Delta P}{0.433}\frac{d}{L}}}\right)$$

$$q\left(\frac{gpm}{circuit}\right) = v\frac{\pi d^2}{4} = v\left(\frac{ft}{sec}\right)\frac{\pi d^2}{4}\left(ft^2\right)\times\frac{gal}{0.1337\ ft^3}\times 60\frac{sec}{min}$$

$$\left(\frac{\varepsilon}{3.7d}+\frac{2.51}{\frac{d}{v}\sqrt{\frac{2g\Delta P}{0.433}\frac{d}{L}}}\right)$$

$$\sqrt{\frac{2g\Delta P}{0.433}\frac{d}{L}}$$

$$\mathrm{Re} = \frac{vd}{\upsilon}$$

$$\Delta T = \frac{3.8P}{q}$$

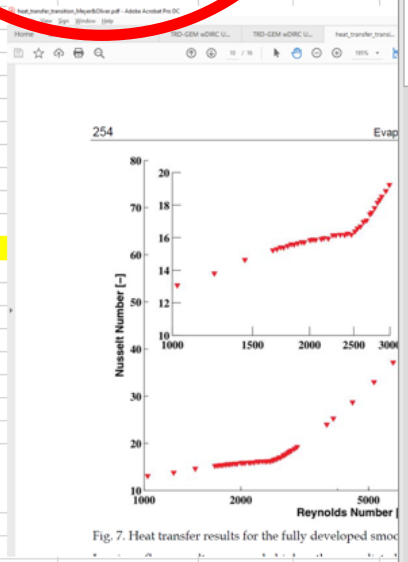
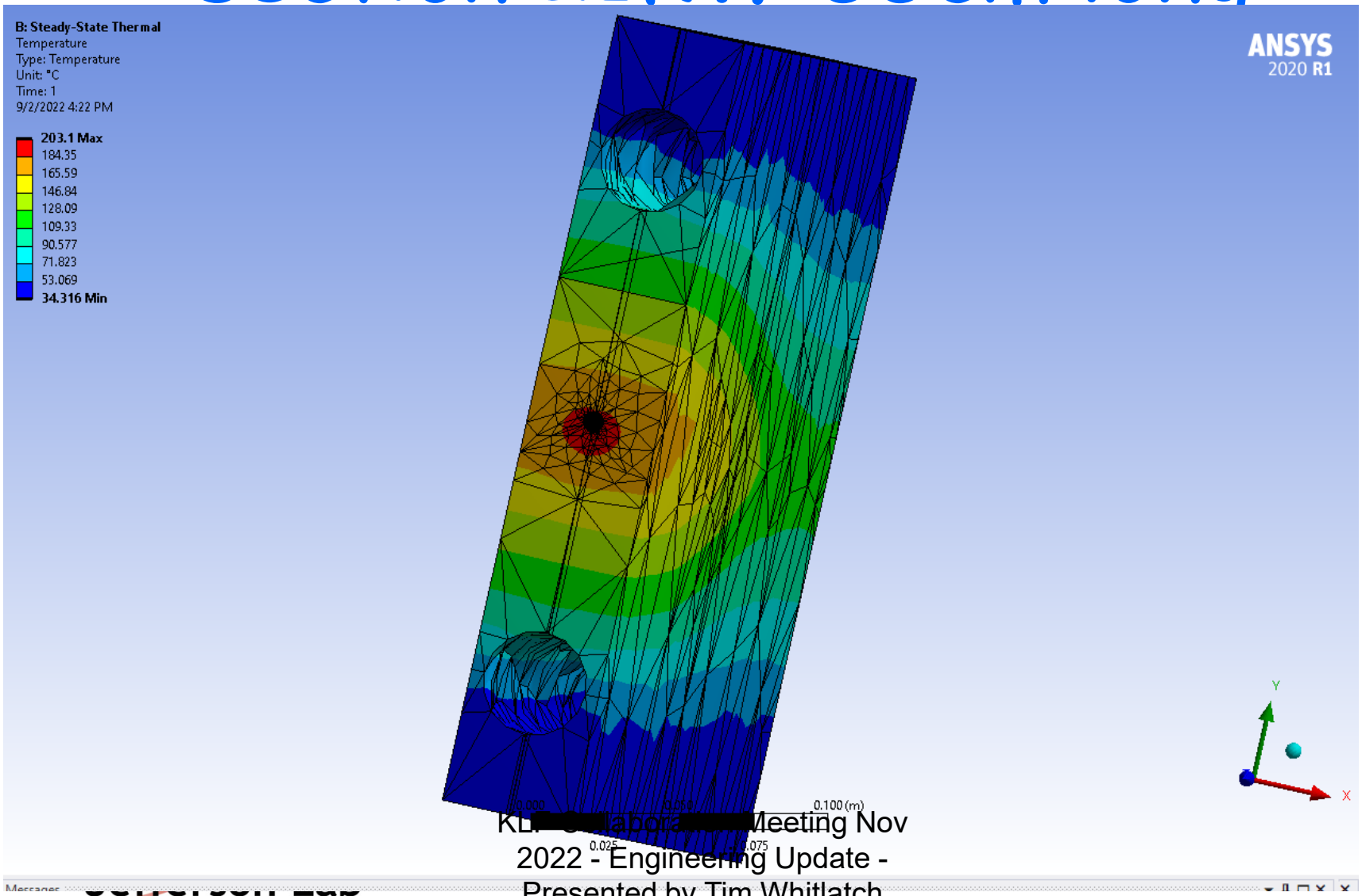


Fig. 7. Heat transfer results for the fully developed smoo

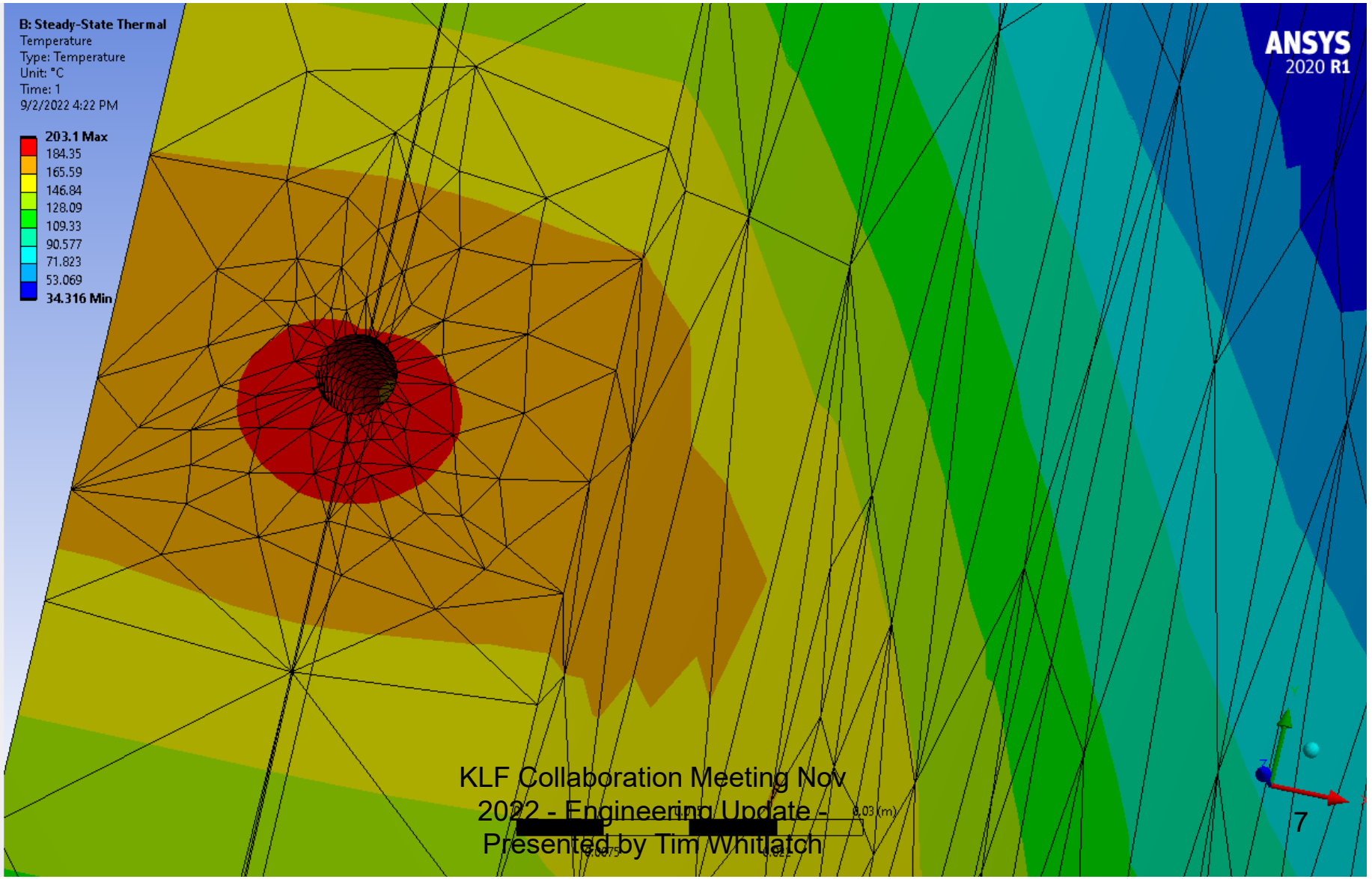
2 paral circuits | air-n2 Hx

Ready 100%

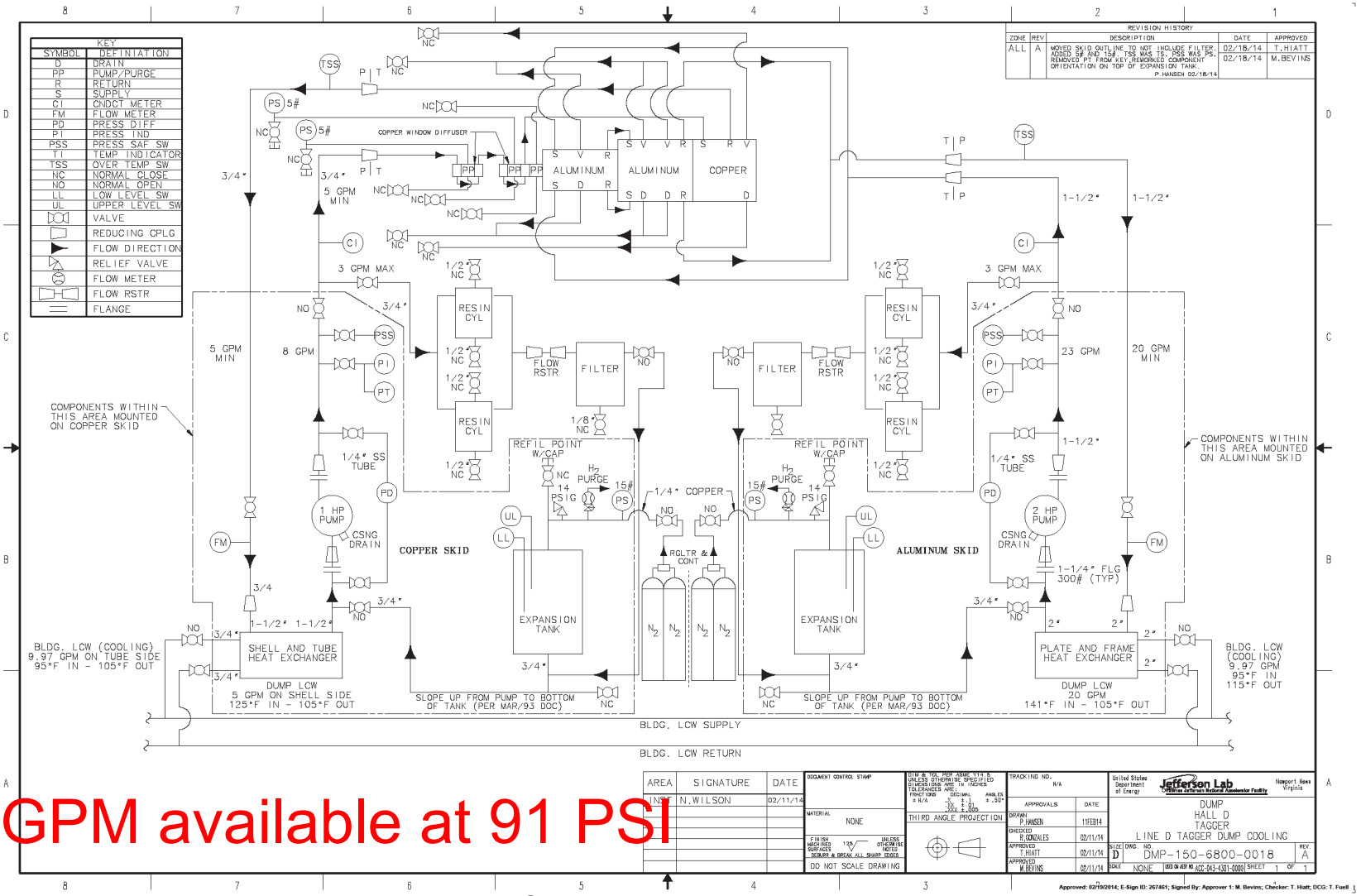
Latest segmented hot section 21KW 55cm long



Fine Mesh 7mm hole

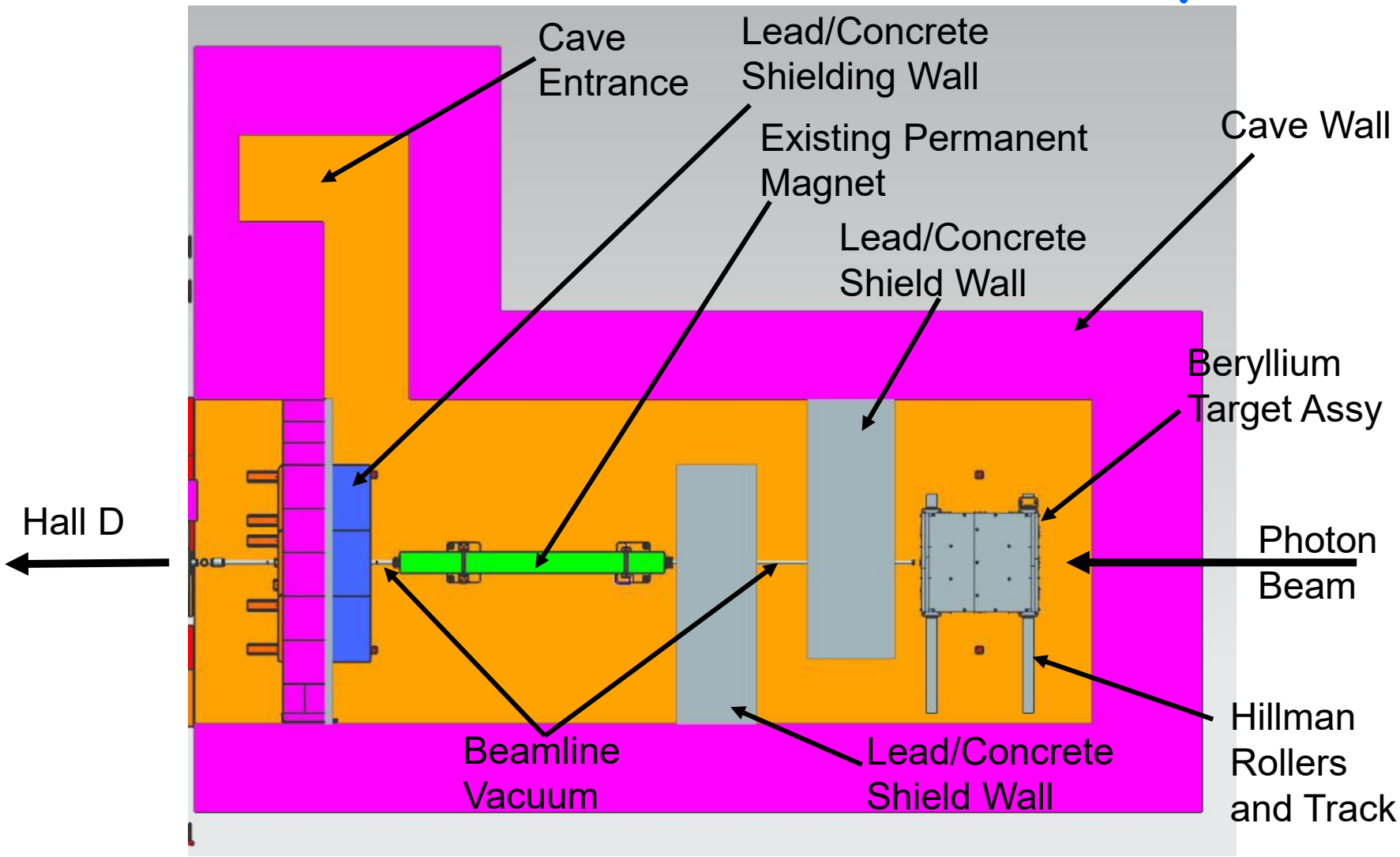


Existing Tagger Dump P&ID

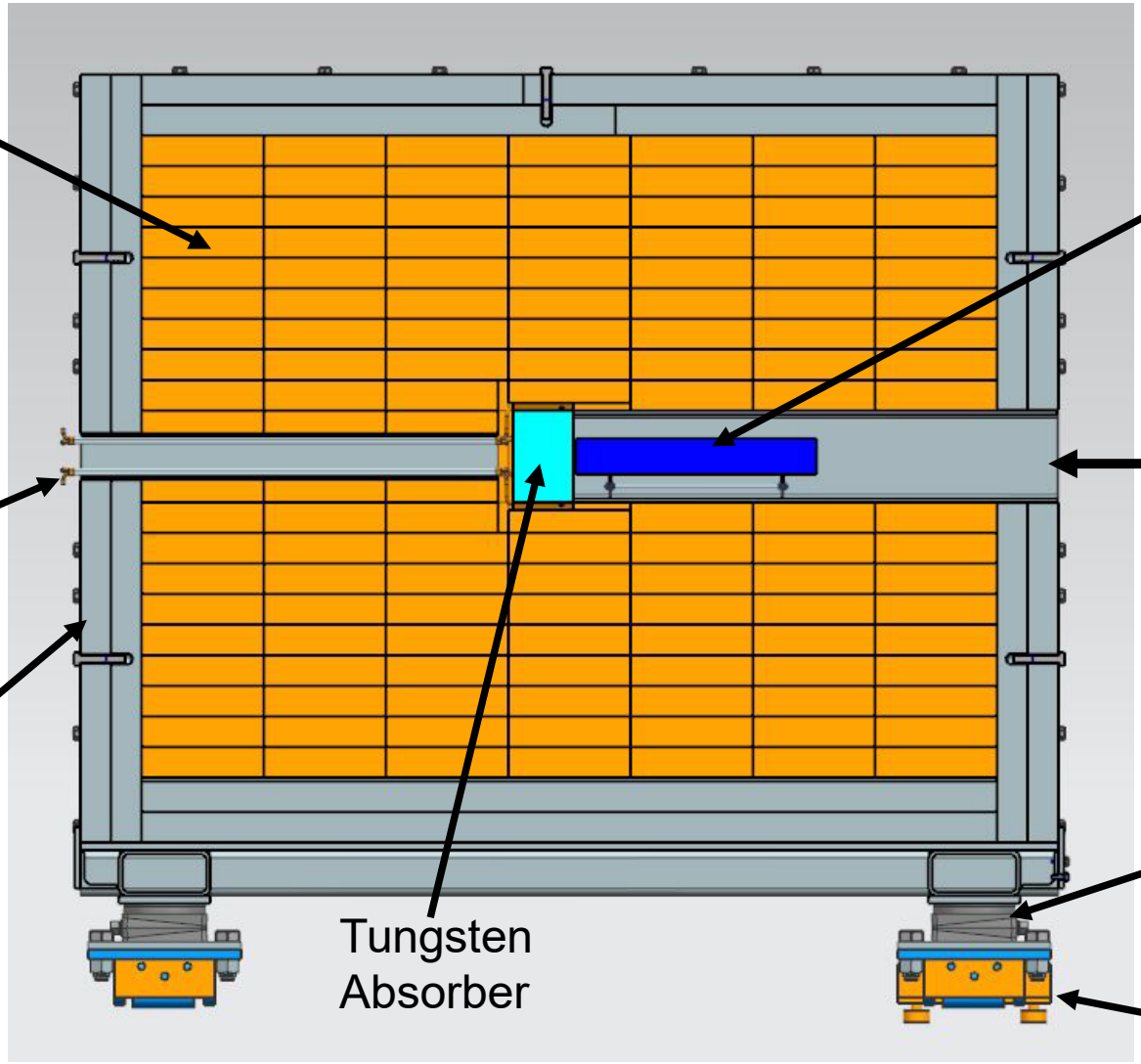


25 GPM available at 91 PSI

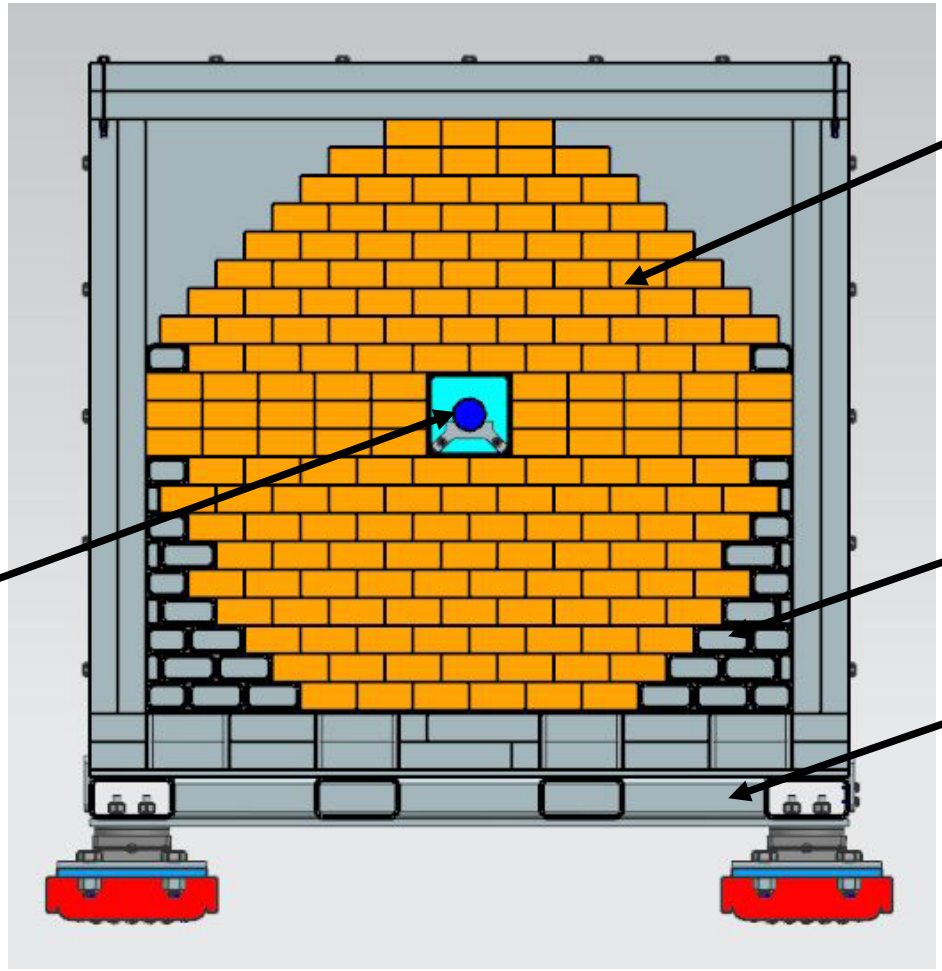
Hall D Collimator Cave Layout



Beryllium Target Assy



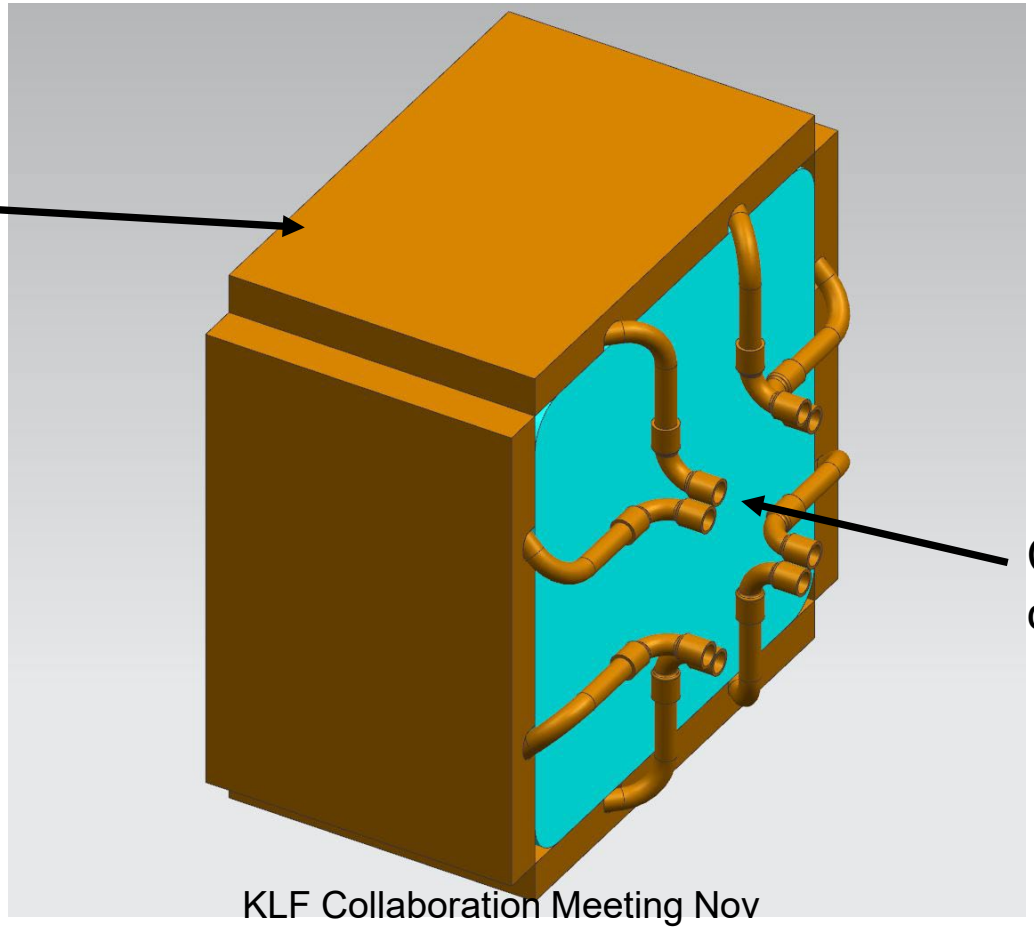
Beryllium Target Section



Target Design Requirements/Specs

- Berylium Target
  - 6cm diameter
  - 40 cm length
  - 187W power absorption
  - Max Temperature 400C (factor of 3 to melting)
  - Water cooled – local system required
- Tungsten absorber
  - 15cm square
  - 10cm length
  - 5.2KW power absorption
  - Max Temperature inside 1000C (factor of 3 to melting)
  - Water cooled – separate local system required

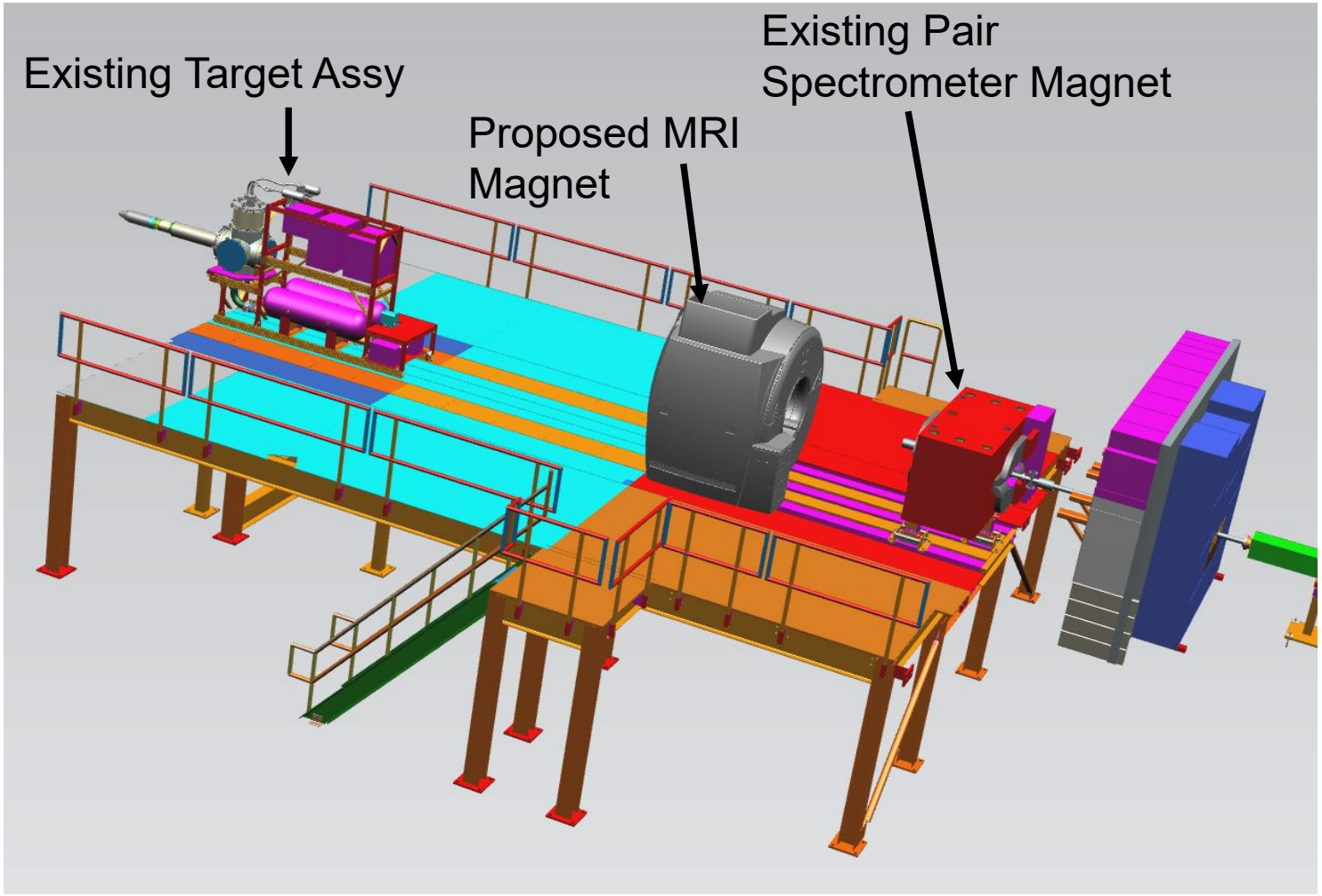
3D Rendering – cooling plates on 4 sides – Max water temp less than 100C



Tungsten Absorber Thermal Analysis

- Power absorption data provided by Vitaly Baturin
- Modelled in ANSYS Static Thermal
- Shows maximum delta T of 216C
- Outer Surface cooled with water under 100C
- Maximum Tungsten Temp 316C

Flux Monitor Conceptual Setup in Hall D



Solenoid Magnet

- Use existing MRI magnet from industry
  - Is it available?
  - What does it take to integrate?
  - It does fit in available space
  - Has own refrigerator
- Use existing solenoid magnet from JLAB
  - Is it available?
  - Do we have enough refrigerator to handle additional load?

Overall Status

- Collimator Cave Final Drawings in Final Check
- Thermal Analysis needed on Berylium water cooling
- Full Installation Plan Needed for collimator cave
- Flux Monitor in Conceptual Phase
  - Proposed MRI will fit
  - Need to check availability and integration
  - Separate meetings required for MRI Integration
- CPS in Conceptual Design
  - Need to perform Thermal analysis on Vitaly's geometry
  - Need to perform thermal analysis on Pavel's proposal
  - Use existing dump cooling skid
  - Magnets will need to be designed or modify existing (if available)
- Ready for procurement of Target assy Jan 2023

Backup

Cave Layout Elevation