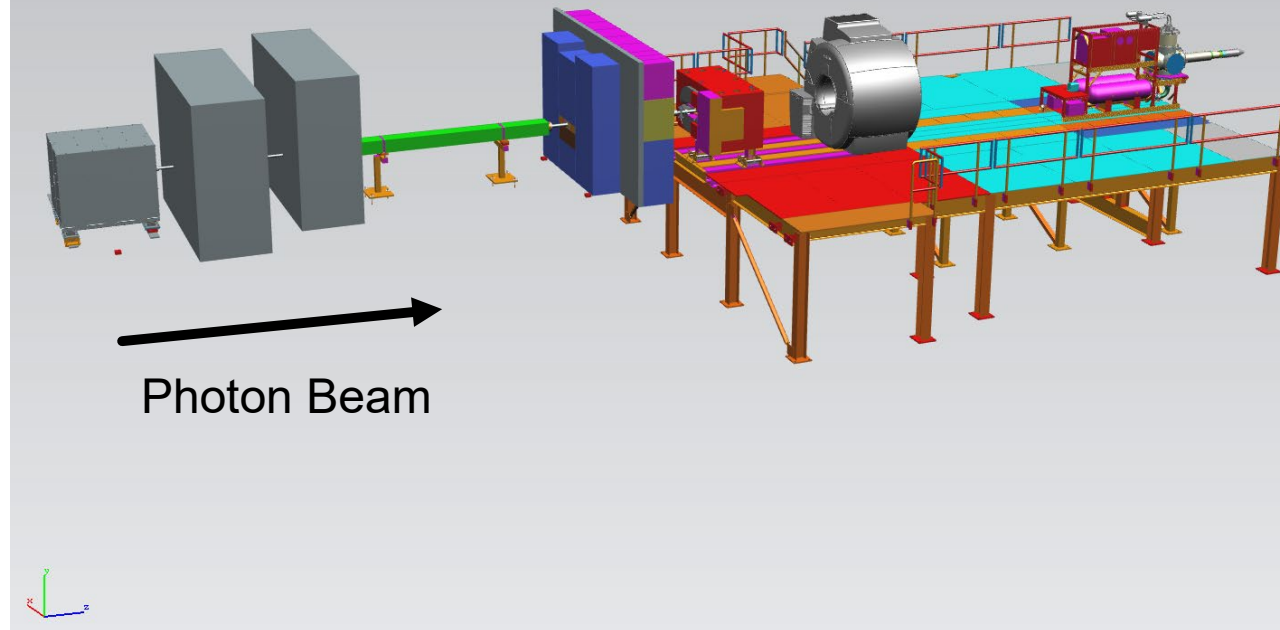


Engineering Status

K-Long in Hall D

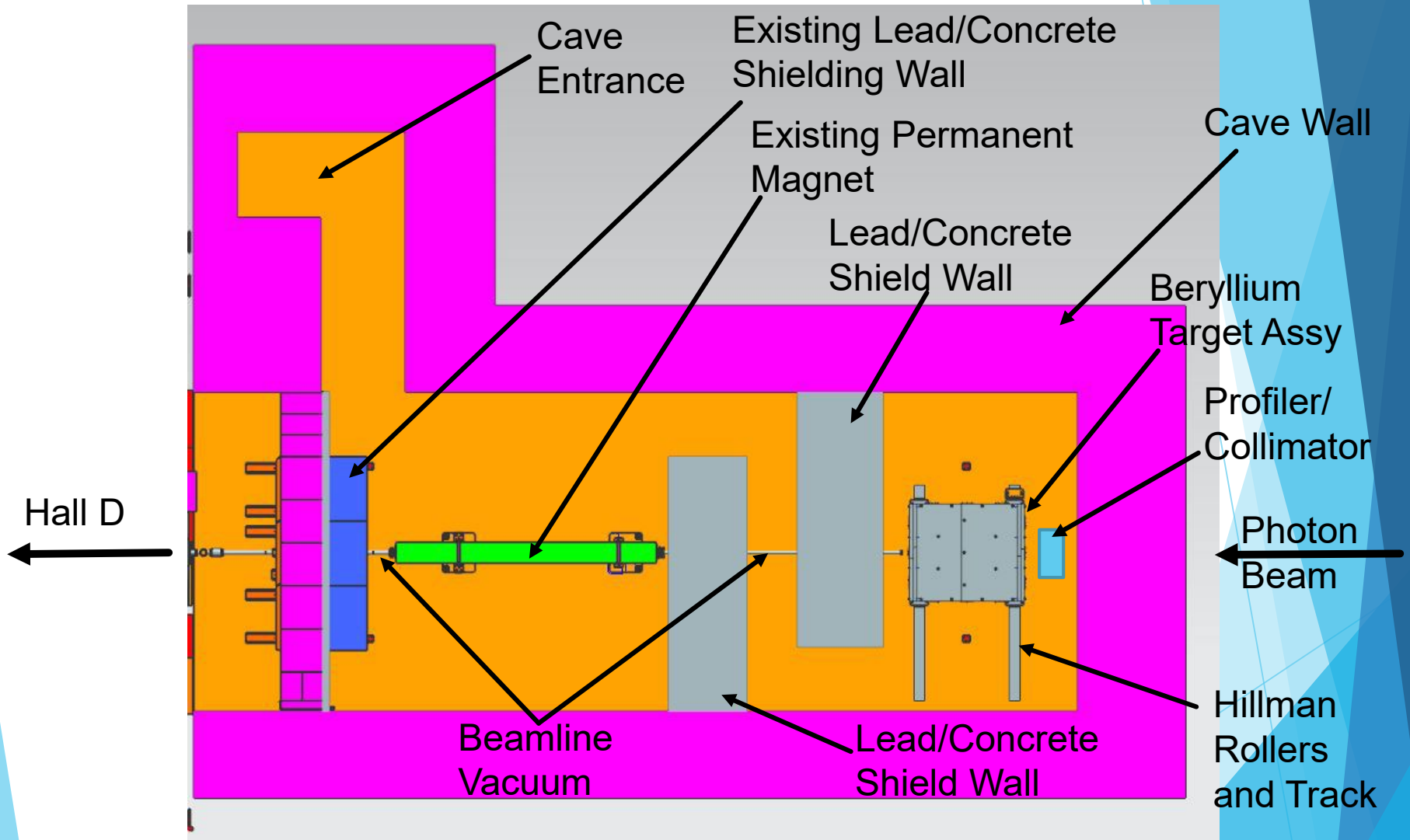


Topics

- ▶ KPT
 - ▶ Design Status
 - ▶ Cooling and Contamination
 - ▶ Civil Construction Requirements
 - ▶ Cost and Schedule
 - ▶ Decommissioning Plan
- ▶ CPS
 - ▶ Design Status
 - ▶ Cooling and Contamination
 - ▶ Civil Construction Requirements
 - ▶ Cost and Schedule
 - ▶ Decommissioning Plan
- ▶ Flux Monitor
 - ▶ Design Status

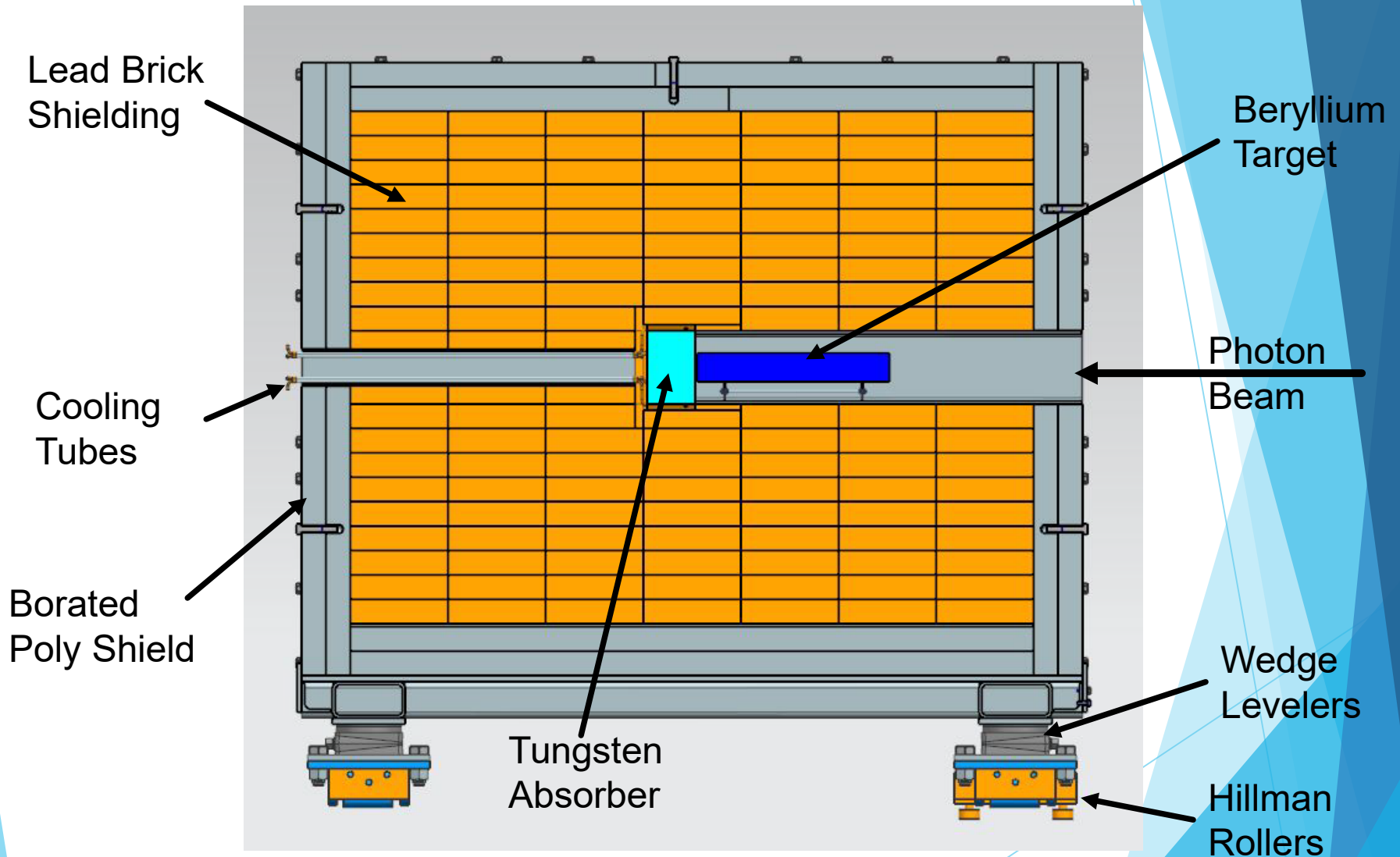
Hall D K-Long Facility ERR August 2023 - Presented
by Tim Whitlatch

Hall D Collimator Cave Layout

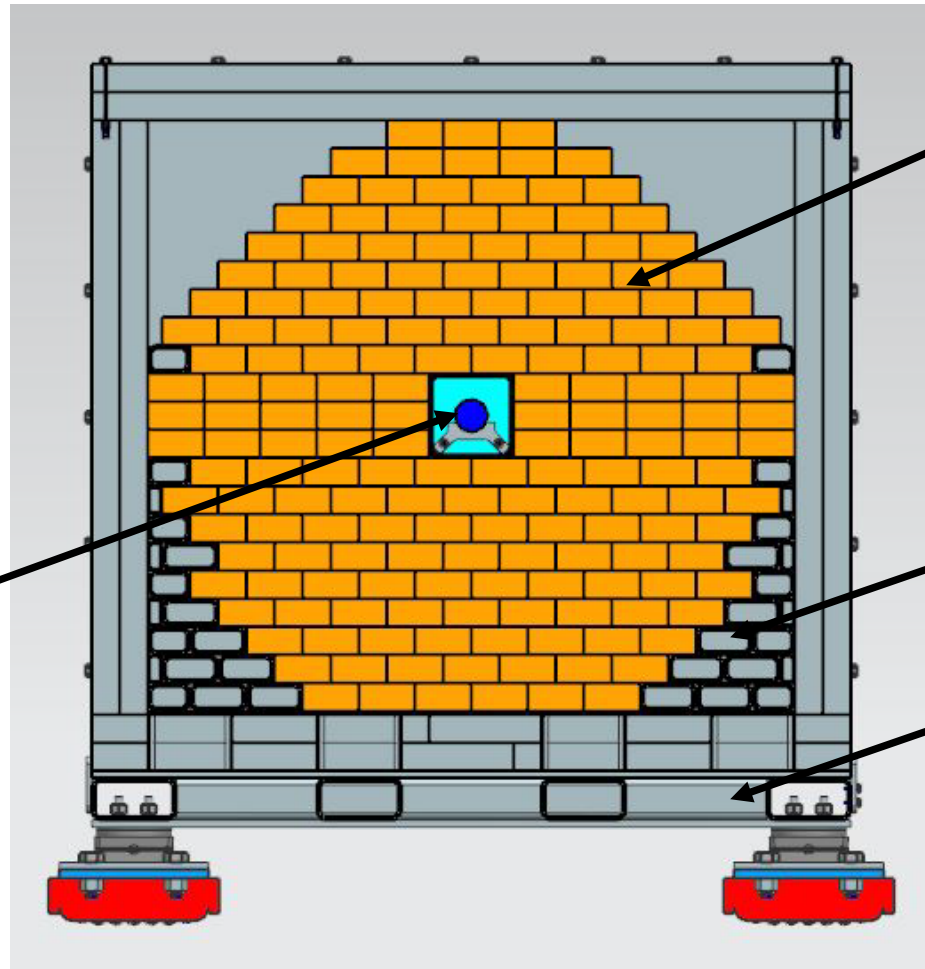


Hall D K-Long Facility ERR August 2023 -
Presented by Tim Whitlatch

Beryllium Target Assy



Beryllium Target Section



Beryllium
Target

Lead
Shielding

Steel Tube
Fillers

Steel
Support
Structure

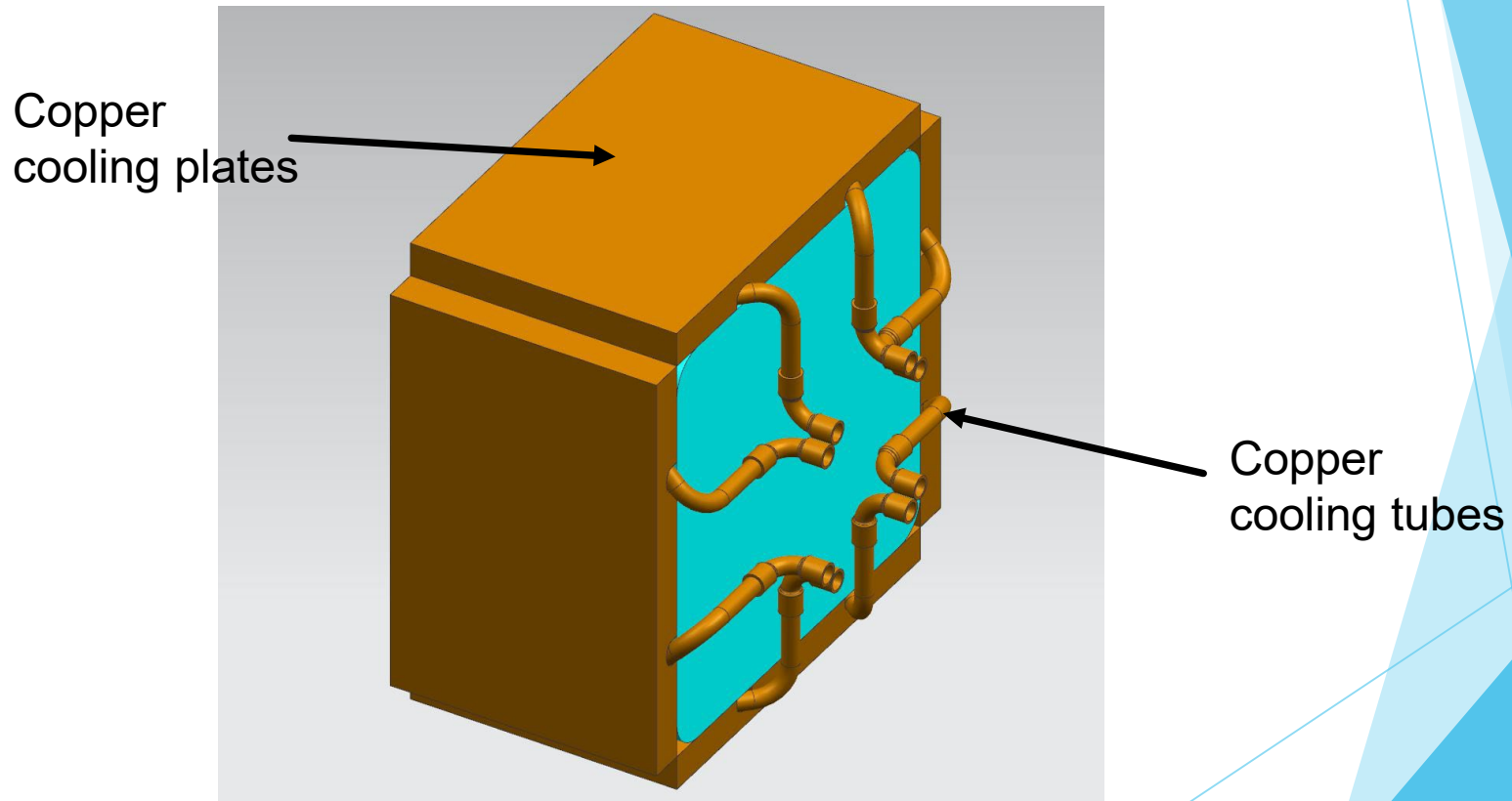
Design Requirements/Specs

- Beryllium Target
 - 6cm diameter
 - 40 cm length
 - 300W power absorption
 - Max Temperature 66C
 - Water cooled
- Tungsten absorber
 - 15.24 cm square
 - 10cm length
 - 5.2KW power absorption
 - Max Temperature inside 1000C (factor of 3 to melting)
 - Water cooled - separate Chiller system required

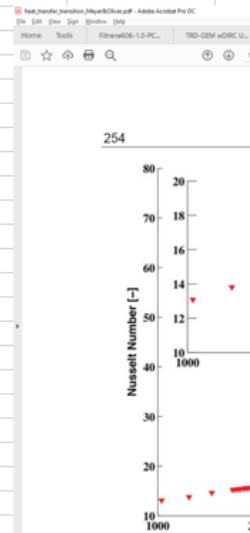
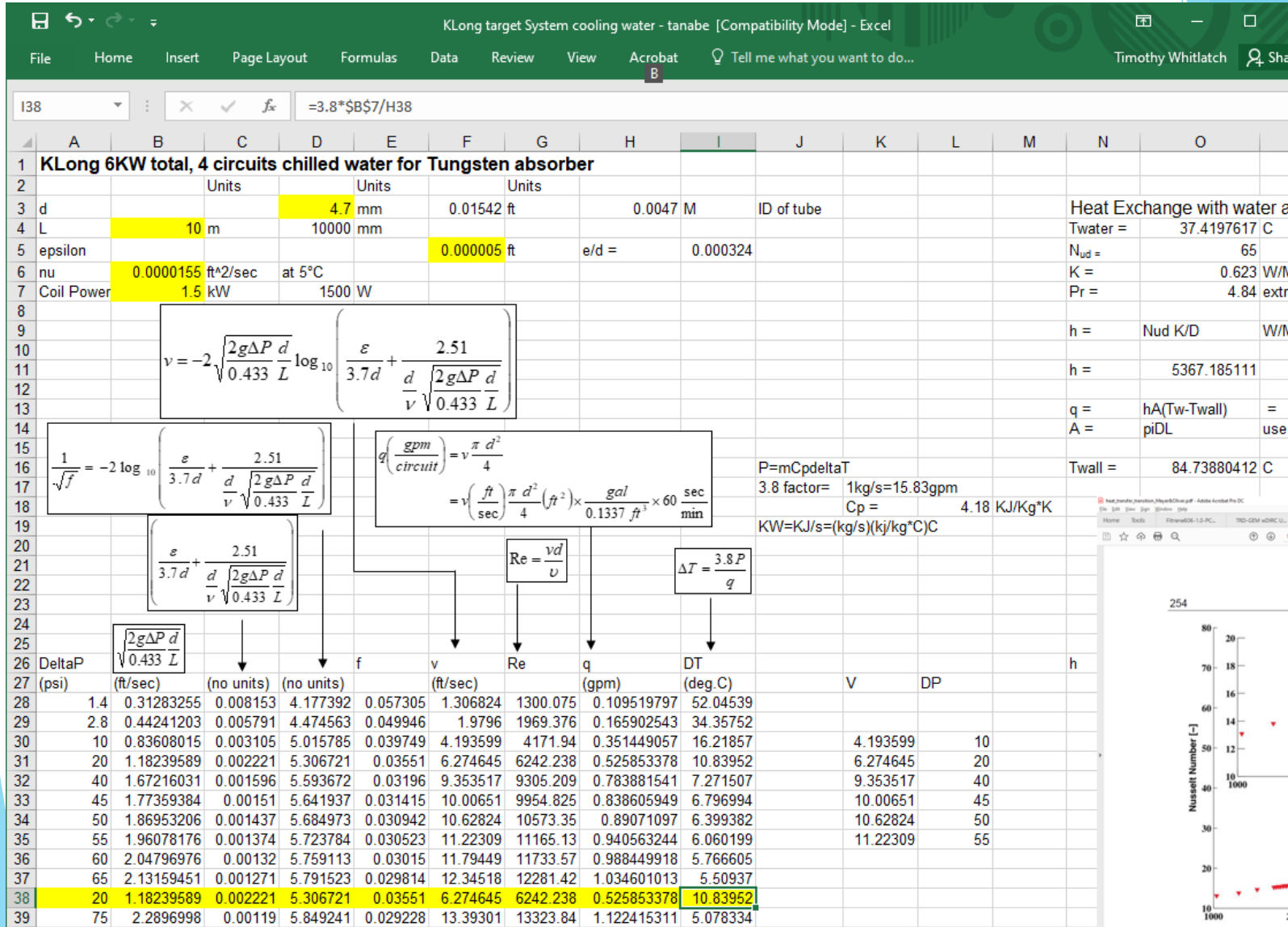
Tungsten Absorber Thermal Analysis

- ▶ Power absorption data provided by Vitaly Baturin
- ▶ Modelled in ANSYS Static Thermal
- ▶ Shows maximum delta T of 117C
- ▶ Outer Surface cooled with water under 100C
- ▶ Maximum Tungsten Temp 216C

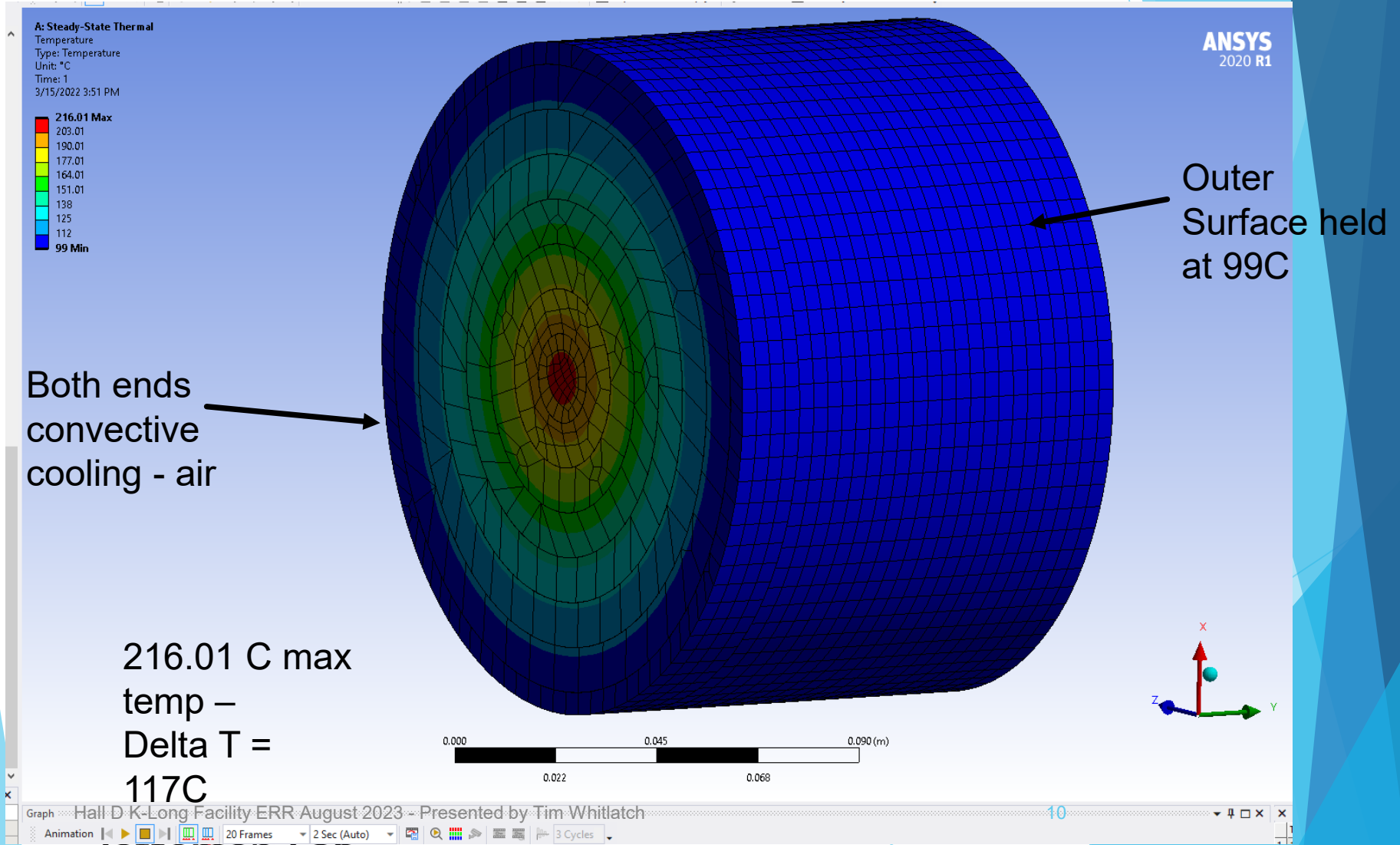
3D Rendering - cooling plates on 4 sides - Max water temp less than 50C - 4 circuits



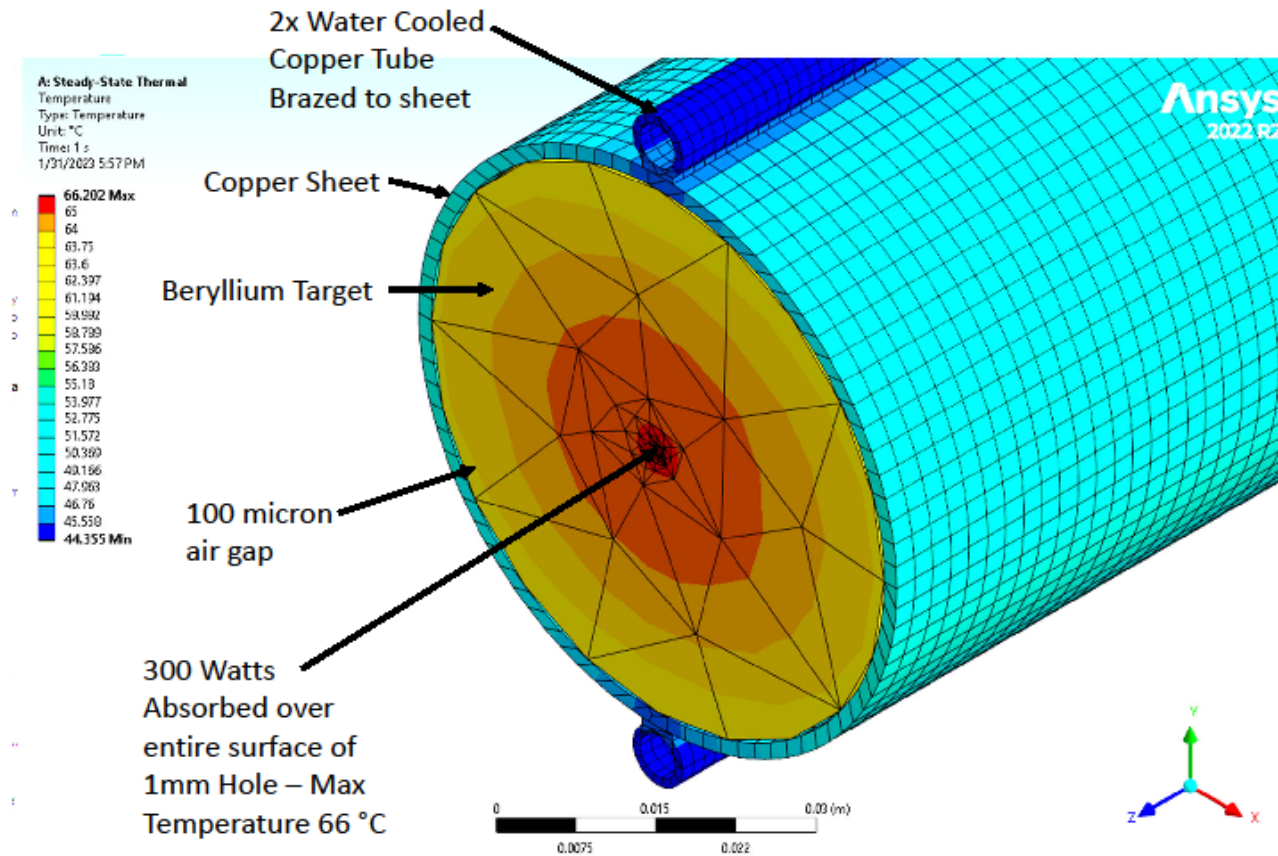
Cooling Water removing 6KW from Tungsten



Tungsten Absorber 5.2 KW total input - 2 W/m² convection US face - 80C air temp



Beryllium Target Water Cooled

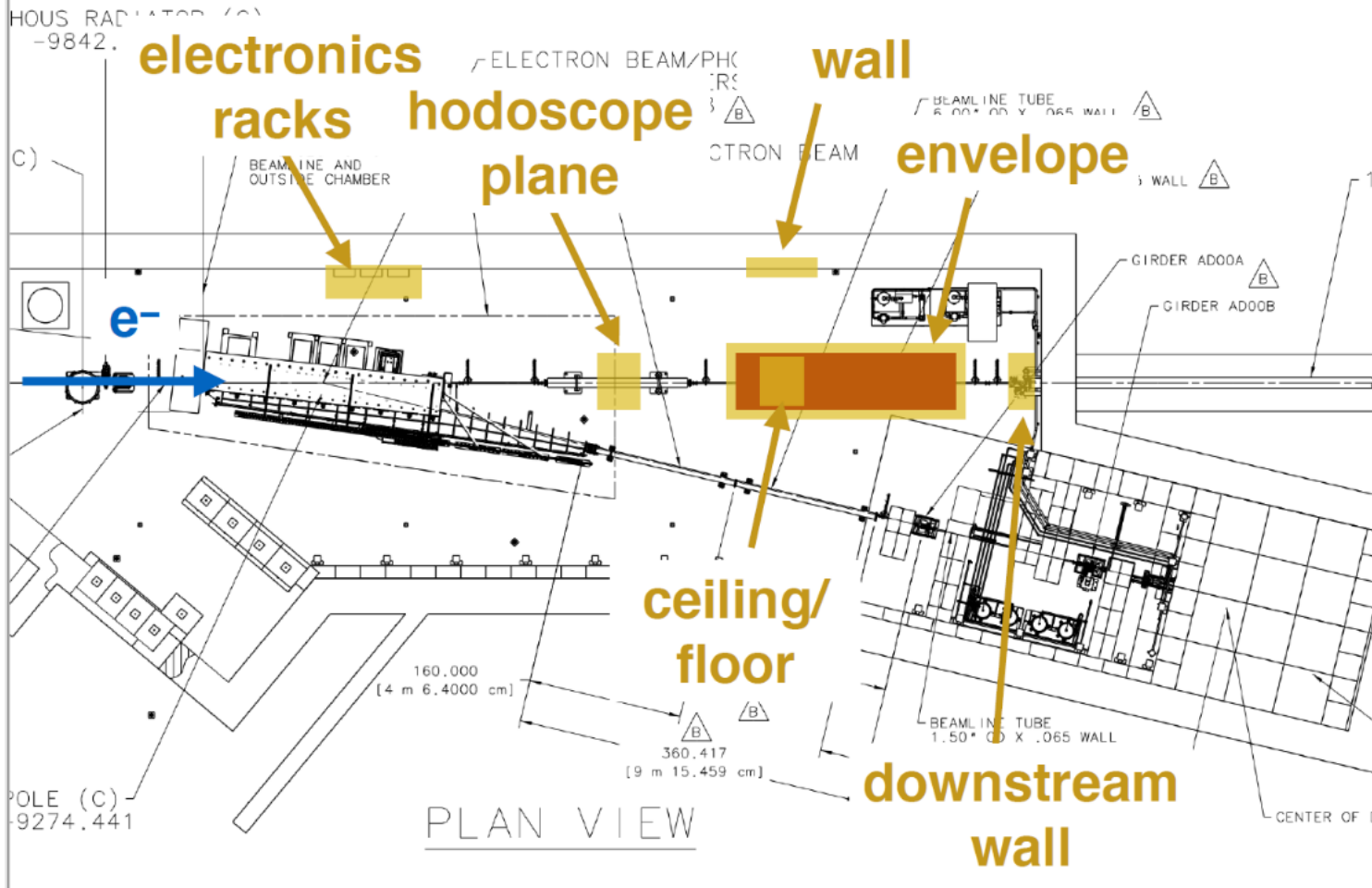


KPT Status

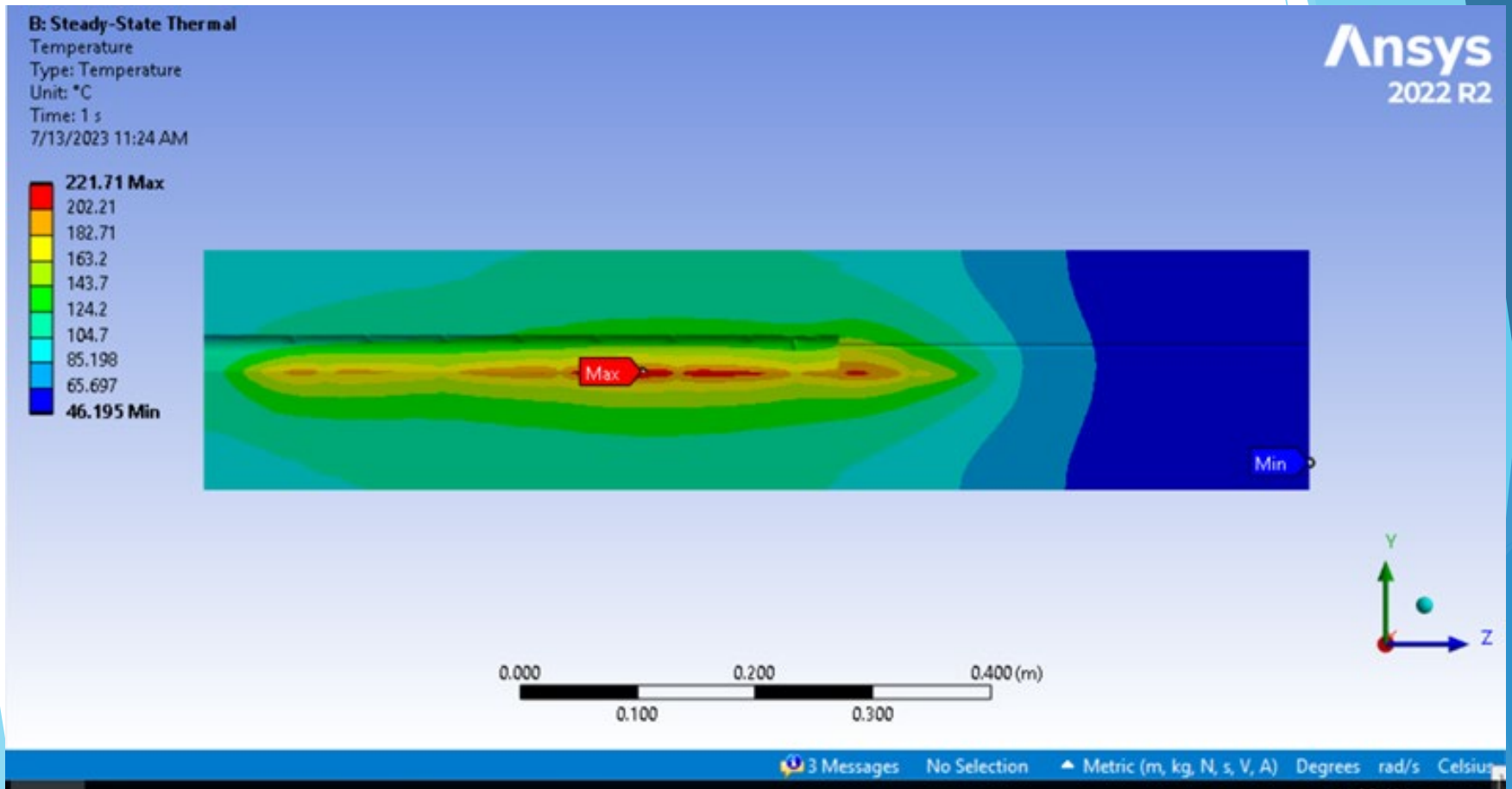
- ▶ **Cooling System**
 - ▶ Separate Local 6 Kw chiller to be purchased
 - ▶ Manifold with 5 circuits (4x tungsten absorber, 1x beryllium target)
- ▶ **95% Complete Final Design Drawings**

CPS in Tagger Hall

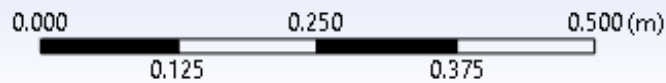
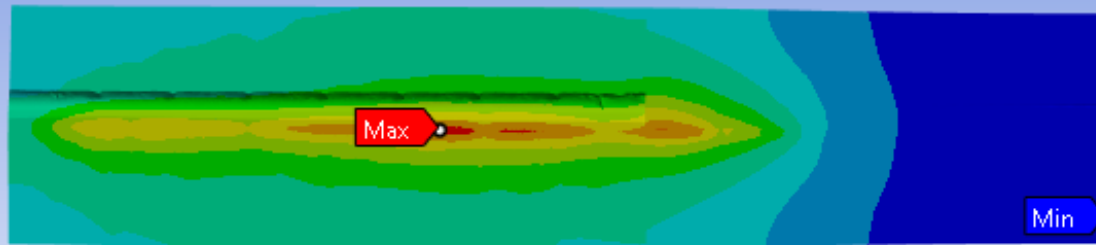
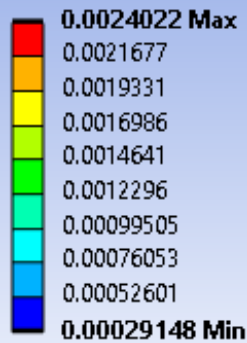
Hall D Tagger Hall



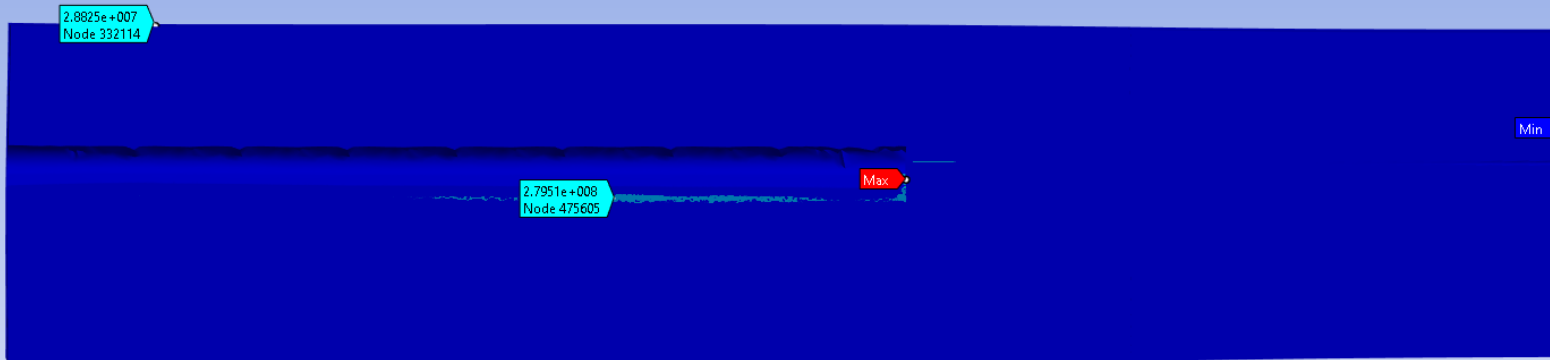
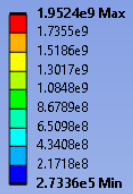
Pavel 64 Keyhole Model 52Kw



C: Static Structural
Thermal Strain
Type: Thermal Strain(X Axis)
Unit: m/m
Global Coordinate System
Time: 1 s
7/16/2023 1:39 PM



C: Static Structural
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: Pa
Time: 1 s
7/16/2023 1:51 PM



CPS Cooling Spreadsheet

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...

O11 : X ✓ fx =U5*O6/(D3/1000)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	F
1	KLong CPS 52KW total, 2 circuits LCW															
2		Units			Units			Units								
3	d			30	mm	0.098425	ft		0.03	M	ID of tube	Heat Exchange with water at				
4	L	2	m	2000	mm						Twater = 35.34604143 C					
5	epsilon					0.000005	ft	e/d =	5.08E-05						Nud = 62	
6	nu	0.00000929	ft ² /sec	at 37°C								K = 0.623 W/MK				
7	Coil Power	26	kW	26000 W								Pr = 4.84 extrap				
8																
9																
10	$v = -2 \sqrt{\frac{2g\Delta P d}{0.433 L}} \log_{10} \left(\frac{\epsilon}{3.7d} + \frac{2.51}{\frac{d}{v} \sqrt{\frac{2g\Delta P d}{0.433 L}}} \right)$															
11																
12																
13																
14																
15	$\frac{1}{\sqrt{f}} = -2 \log_{10} \left(\frac{\epsilon}{3.7d} + \frac{2.51}{\frac{d}{v} \sqrt{\frac{2g\Delta P d}{0.433 L}}} \right)$															
16																
17	$q \left(\frac{\text{gpm}}{\text{circuit}} \right) = v \frac{\pi d^2}{4}$															
18	$= v \left(\frac{\text{ft}}{\text{sec}} \right) \frac{\pi d^2 (\text{ft}^2)}{4} \times \frac{\text{gal}}{0.1337 \text{ ft}^3} \times 60 \frac{\text{sec}}{\text{min}}$															
19	$P = mCp\Delta T$															
20	$3.8 \text{ factor} = 1 \text{ kg/s} = 15.83 \text{ gpm}$															
21	$Cp = 4.18 \text{ KJ/Kg}^\circ\text{K}$															
22	$KW = KJ/s = (kg/s)(kJ/kg^\circ\text{C})$															
23																
24																
25																
26	DeltaP	$\frac{2g\Delta P d}{0.433 L}$			f	v	Re	q	DT							
27	(psi)	(ft/sec)	(no units)	(no units)		(ft/sec)		(gpm)	(deg.C)		V	DP				
28	0.18	0.63369586	0.000388	6.823268	0.021479	4.323877	45810.38	14.76371438	6.692083							
29	2.8	2.49933016	0.000109	7.928988	0.015906	19.81716	209957.8	67.66493856	1.460136							
30	8	4.22463904	6.98E-05	8.312191	0.014473	35.11601	372045.2	119.902282	0.824004		35.11601	8				
31	20	6.67974084	4.92E-05	8.616129	0.01347	57.55351	609764.8	196.5142767	0.502762		57.55351	20				

h = 4806.222762

hA(Tw-Twall) = use L

piDL = use L

Twall = 64.04507772

Thermal Stress - copper absorber C101 Full Hard

- ▶ Strain = Alpha * delta T
- ▶ Stress = Youngs Modulus * Strain
- ▶ Strain = $1.674 \times 10^{-5} / \text{C} * 175 \text{C} = .0029$
- ▶ Stress = $1.26 \times 10^{11} \text{ Pa} * .0029 = 365 \text{ MPa}$
- ▶ Allowable yield stress = 283 Mpa
- ▶ Model Shows a little lower

CPS Cost Estimates

Klong Compact Photon Source - Pavel							
Component	qty	Lbs	Kg	cost ea \$	Fab cost \$	Total cost \$	
Copper absorber	1	3194	1450.1	33000	0	33,000	
WCu absorbers	20.4	510	231.54	1,400		28,560	
Lead Bricks	3421.73	88965	40390	52	2000	179,930	
borated poly sheets	71.5875	11454	5200.1	800	28635	85,905	
Iron core	1	3436	1559.9	17180	0	17,180	
Iron shield	1	38678	17560	193390	0	193,390	
Barite concrete (CPS and beamline)	2045.71	126167	57280	10	10,000	30,457	
Adjustment components	3			2800		8,400	
Support Structure	1			30000		30,000	
Rail System	1			4000		4,000	
Water Cooling System	1			5000		5,000	
Beamline Plus girder	1			10000		10,000	
Radiator (3 position remotely)	1			15000		15,000	
Magnet	1	2202.7	1000	110000		110,000	
Power Supply	1			100000		100,000	
Machining of shielding components	1			15000		15,000	
Concrete pier	1			20000		20,000	
Temperature sensors and wires	20			200		4,000	
Vacuum Pump and controllers	1			20000		20,000	
PLC modules and shielding	5			1500		7,500	
Total Materials		274607	124671			917,322	678,422

CPS Required Design Manpower

KLONG CPS Design						
Task	Days	#	#	FTE	FTE	FTE
	Duration	Eng	Des	Eng	Des	Facilities
Design new beamline						
Beamline layout	10	0.1	1	0	0.04	
Perm Magnet setup	2	0.1	1	0	0.01	
Vacuum pump setup	2	0.1	1	0	0.01	
Final Beamline drawings	25	0.2	1	0.02	0.1	
Component procurement	200	0.05	0.05	0.04	0.04	
Design CPS						
Design Concrete Base	30	0.2	1	0.02	0.12	0.12
Design rails	15	0.3	1	0.02	0.06	
Design support structure/strongback	25	0.4	1	0.04	0.1	
Design adjustment system	25	0.1	1	0.01	0.1	
Design magnets	65	0.4	1	0.1	0.26	
Procure Magnets and Power Supplies	250	0.1	0.1	0.1	0.1	
Design radiator	25	0.1	1	0.01	0.1	
Design shielding	120	0.2	1	0.1	0.48	
Test Magnets	5	0.2	2	0	0.04	
Design alignment system	45	0.2	1	0.04	0.18	
Design cooling system	30	0.4	1	0.05	0.12	
Procure all shielding components	200	0.1	0.05	0.08	0.04	
Procure rails, strongback and cooling	200	0.1	0.05	0.08	0.04	
Procure radiator components	80	0.1	0.05	0.03	0.02	
Installation Drawings	40	0.1	1	0.02	0.16	
Totals	424			0.76	2.11	0.12
Duration in months	21.2					
Des required for duration (ave)	1.20					
Eng required for duration (ave)	0.43					

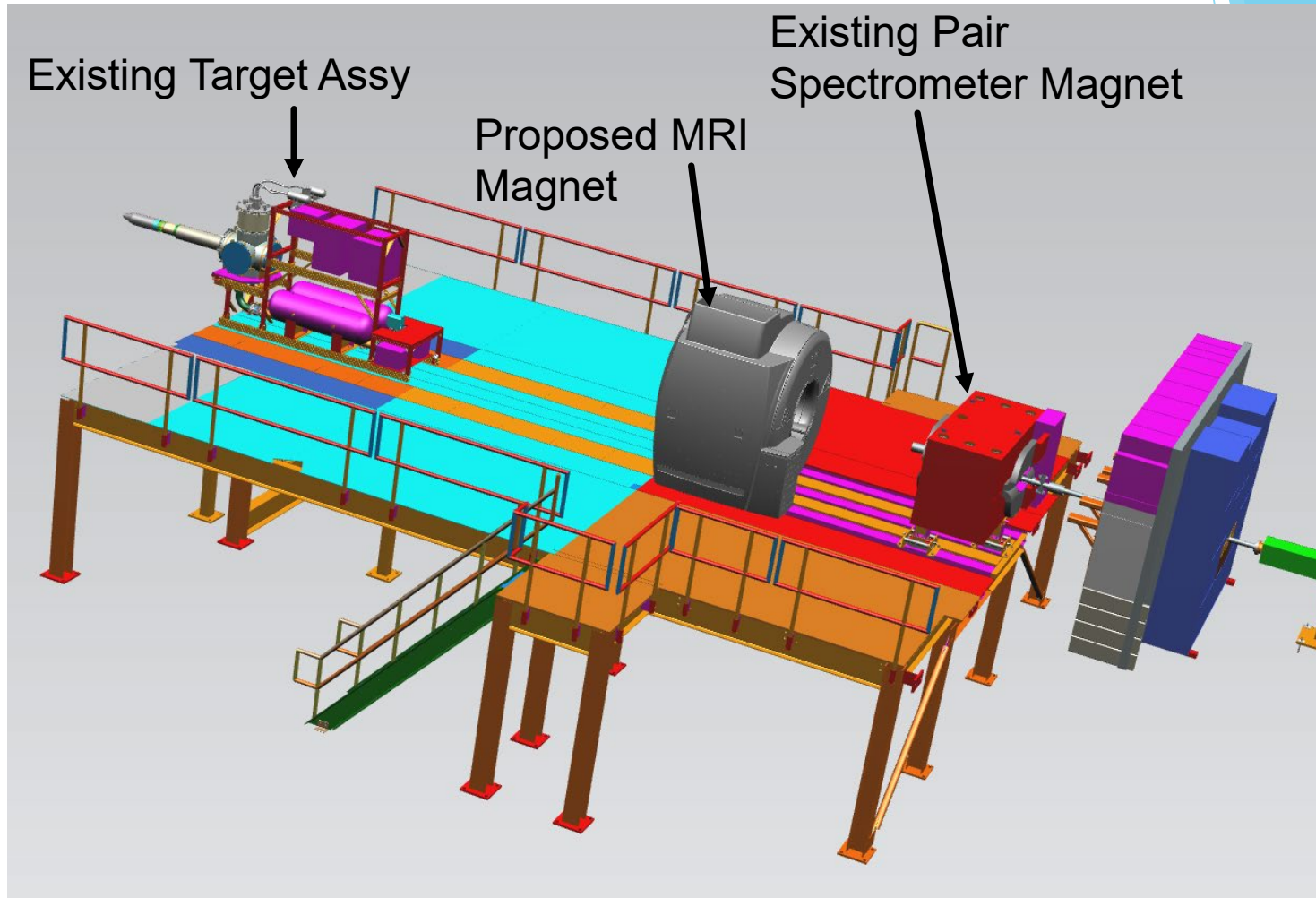
CPS Installation

KLONG CPS Installation							
	Days	#	#	FTE	FTE	FTE	FTE
Task	Duration	Eng	Tech	Eng	Tech	Facilities	S&A
Remove old equipment							
Crates		5	0.1	3	0.002	0.06	
microscope		3	0.1	3	0.0012	0.04	
Hodoscope		3	0.1	2	0.0012	0.02	
Beamline		5	0.2	3	0.004	0.06	
Install CPS							
Install Concrete Base		10	0.1	1	0.004	0.04	0.12
Install rails		4	0.3	3	0.0048	0.05	0.01
Install support structure		10	0.3	3	0.012	0.12	0.02
Install magnets		10	0.2	3	0.008	0.12	
Install Power Supplies		5	0.1	3	0.002	0.06	
Survey and alignment		2	0.2	1	0.0016	0.01	0.01
Install radiator		2	0.3	2	0.0024	0.02	0.01
Install partial shielding		20	0.2	4	0.016	0.32	
Test Magnets		5	0.2	2	0.004	0.04	
Survey and Alignment		2	0.2	1	0.0016	0.01	0.01
Install remaining shielding		20	0.2	4	0.016	0.32	
Install cooling system		10	0.4	3	0.016	0.12	
Install Perm Magnet		4	0.2	3	0.0032	0.05	0.01
Install beamline & windows		5	0.2	3	0.004	0.06	
Install New Girder		3	0.1	3	0.0012	0.04	0.01
Setup and test controls		20	0.1	1	0.008	0.08	
Final Survey		2	0.1	1	0.0008	0.01	0.01
Totals		150			0.114	1.63	0.12
Duration in months		7.5					
Techs required for duration (ave)		2.61					
Eng required for duration (ave)		0.18					
Techs with overhead for safety and training		3.13					

Civil requirements

- ▶ Collimator Floor Capable of supporting additional 100+ Tons
- ▶ Tagger Hall Floor Capable of supporting additional 120+ Tons
 - ▶ Facilities will re-evaluate when final weight is determined
 - ▶ Facilities to install concrete pier

Conceptual Flux Monitor Setup in Hall D



Status

- ▶ Collimator Cave Final Drawings 95% Complete
- ▶ Preliminary Thermal Analysis Complete for CPS
- ▶ Integrated Installation Plan Needed
- ▶ Beamline Requirements set
- ▶ Flux Monitor in Conceptual Phase - Proposed MRI will fit
- ▶ CPS Design Work to start Following ERR Approval

Backup

Cave Layout Elevation

