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Title: Preshot Summary for Coax-14A OMEGA Experiments on January 28th, 2014

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Preshot Summary for Coax-14A OMEGA Experiments on January 28th, 2014

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Goals of the Coax Campaign

Implement an experiment with a highly anisotropic radiation source to benchmark the performance of CASSIO in a regime where radiation transport modeling requires an implicit Monte Carlo treatment instead of the standard diffusion treatment. The system is created by driving an Au half-hohlraum (halfraum) with a foam package mounted on the end opposite of the halfraum LEH. Different types of Ta apertures are inserted at the foam/halfraum interface to make the radiation drive incident on the foam anisotropic.

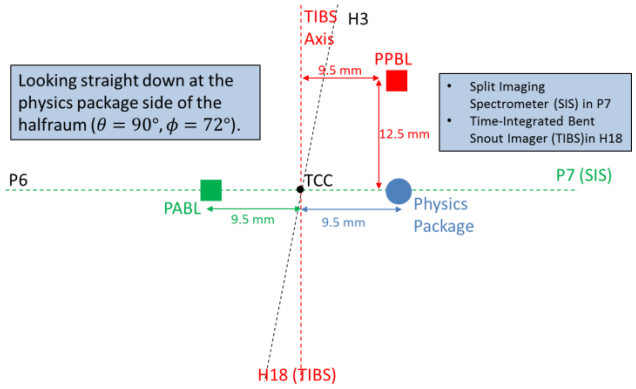
Goals of Coax14A

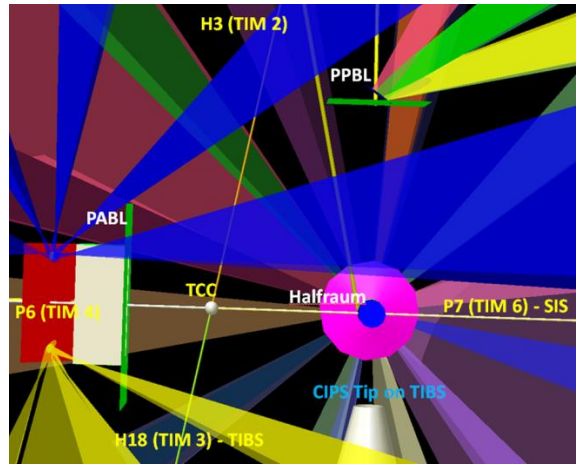
- Demonstrate absorption spectroscopy of a Ti-doped foam to constrain the energy transferred into the foam package using a new instrument, the split imaging spectrometer (SIS).
- Measure the Marhshak wave in the foam at different times to constrain the energy transferred into the foam package using point-projection x-ray imaging.
- (Pending) Use a time resolved x-ray spectrometer to characterize the radiation temperature in the halfraum.
    - Major difference from previous shotday: Pure SiO_2 foams have been replaced by SiO_2 foams with 5:1 Si:Ti foam inserts in the foam to introduce Ti to the problem for absorption spectroscopy. A new diagnostic (SIS) will be used to make this measurement.

History of the Campaign

- Coax13B (07/03/13): Good x-ray imaging data of the Marshak wave for bullseye and annulus Ta aperture targets with pure SiO_2 foams was taken using the CIPS STD tip on the LAPC. DANTE data is inconclusive. SXS (time resolved spectrometer) on the SSCA was also used to help characterize the radiation drive.
    - Major difference from previous shotday: Radiation drive was generated using a half-hohlraum instead of a full hohlraum.
- Coax13A (02/21/13): X-ray imaging data of the Marshak wave was obtained using a full hohlraum with a foam physics package located on the side of the hohlraum. Annulus and bullseye Ta aperatures were placed between the foam and the hohlraum wall.
    - Major difference from previous shotday: This is the first Coax shotday.

Experimental Configuration



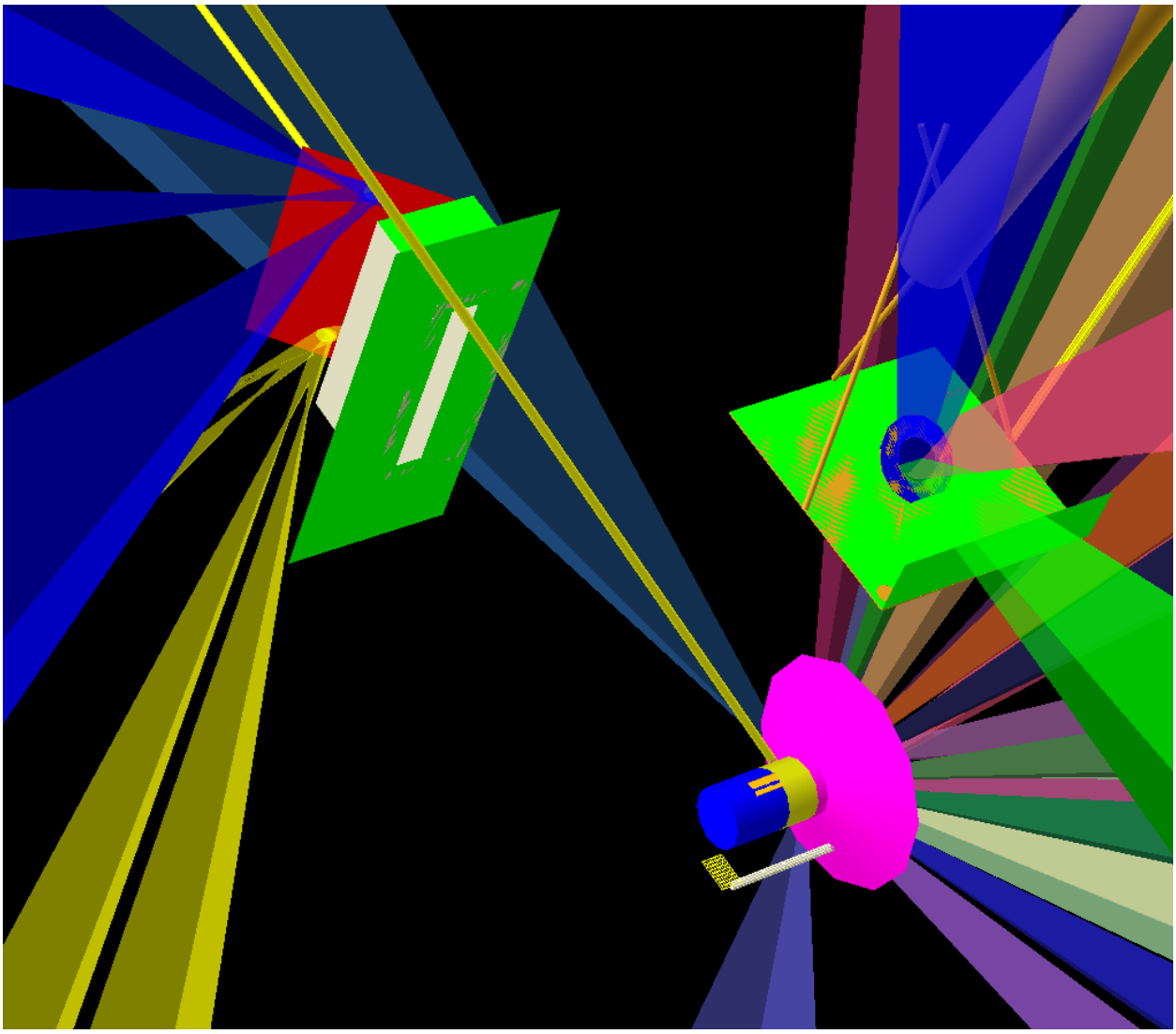


A halfraum with the foam package on the end is located 9.5-mm towards TIM 6. A pinhole apertured backlighter (PABL) is located 9.5-mm towards TIM 4 and produces 2 broadband x-ray spots that are absorbed by the foam and spectrally, spatially, and temporally resolved on the SIS in TIM 6. A point projection backlighter is located 9.5 mm towards (TIM 6) and 12.5 mm towards (TIM 2) and creates an x-ray source that images the Marshak wave on a tilted snout x-ray imager (LANL TIBS or LLNL SPCA on a 10.8S15 Frame).

TIM Diagnostic Summary:

TIM 1: Available

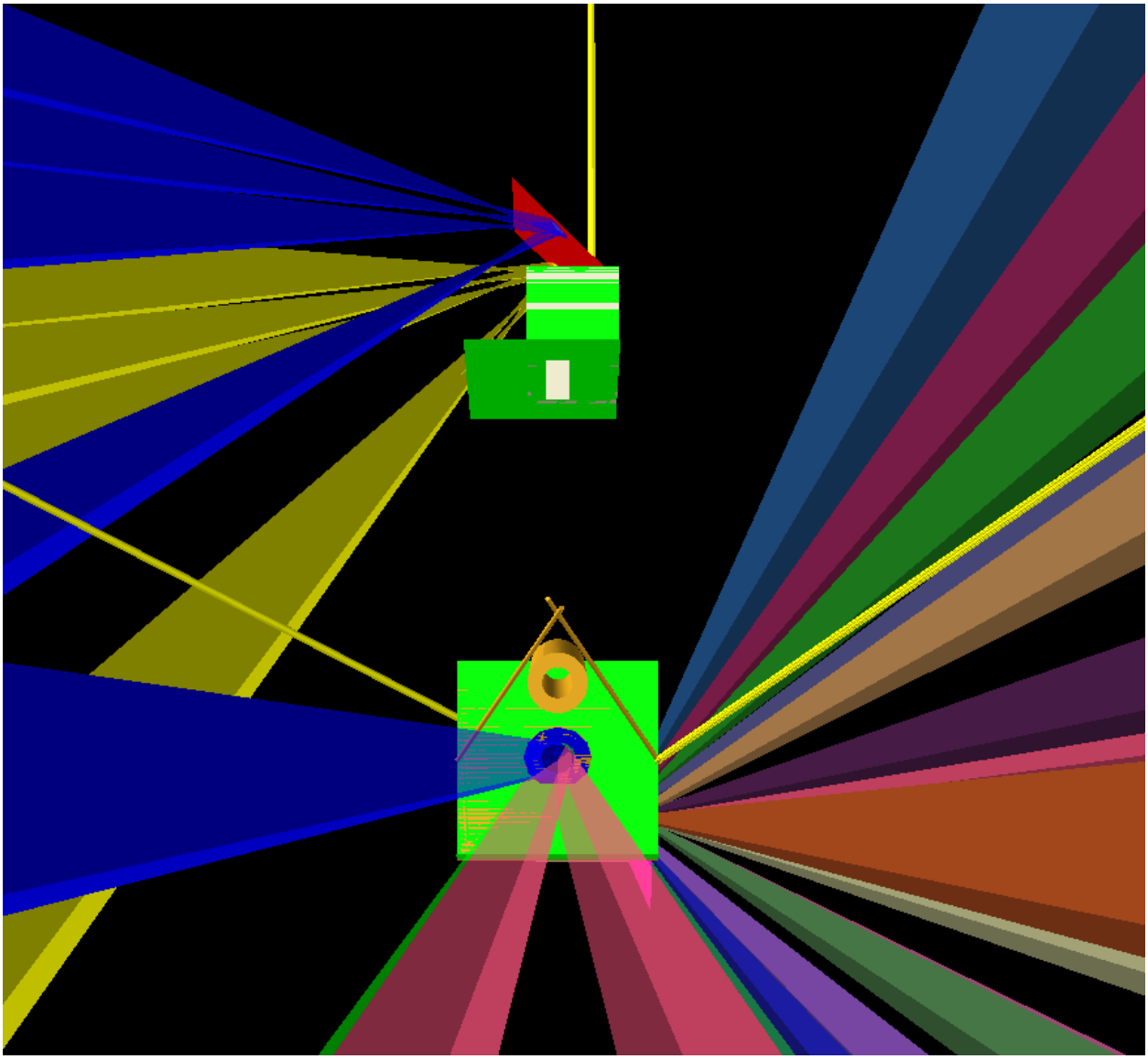
Diagnostic	Available
Setup	
Pointing	
Details	



View from TIM 1

TIM 2: TTPS2

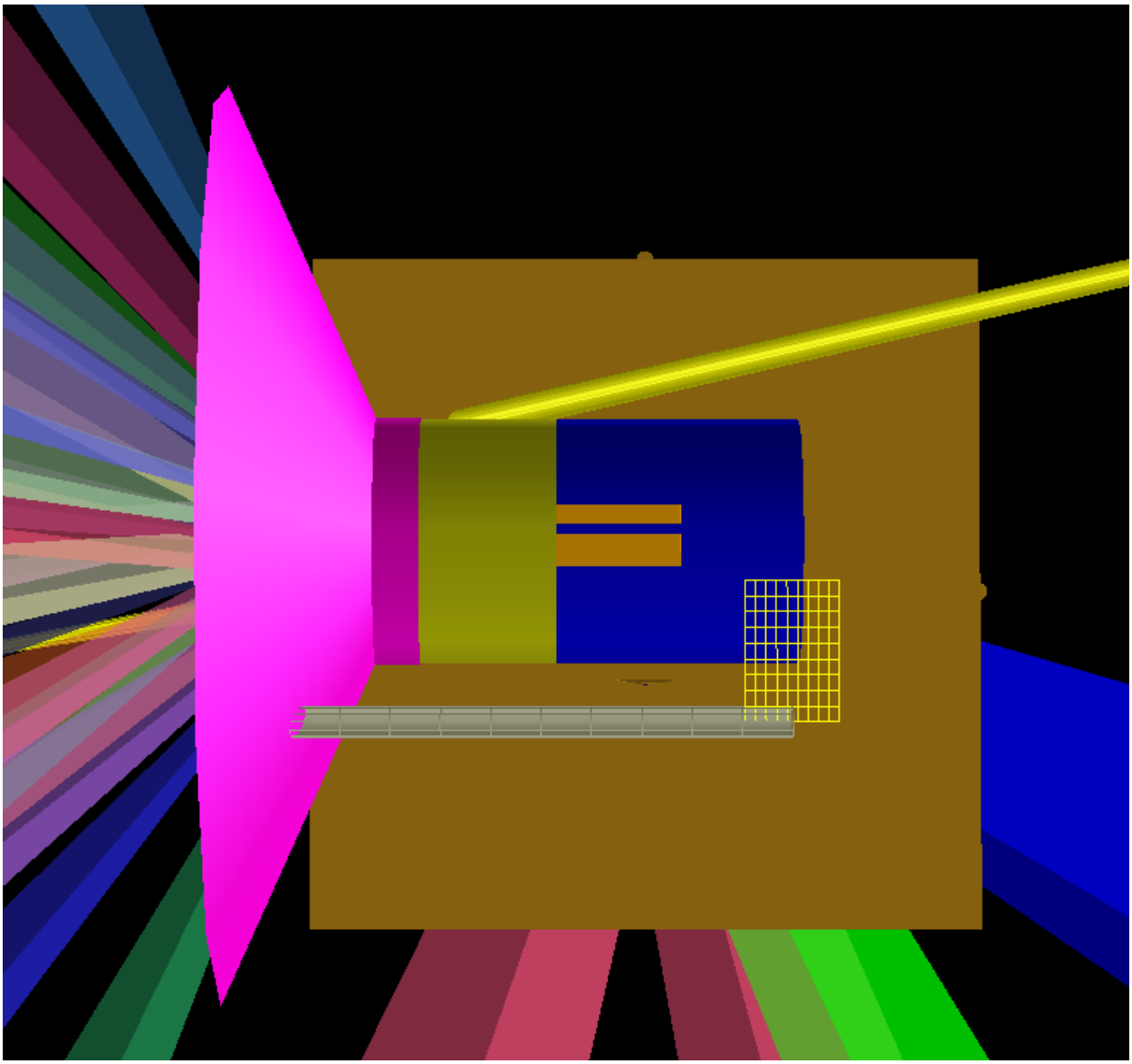
Diagnostic	TIM Target Positioner 2 (TTP)
Setup	
Pointing	
Details	Positions the point-projection backlighter (PPBL)



View from TIM 2

TIM 3: SPCA

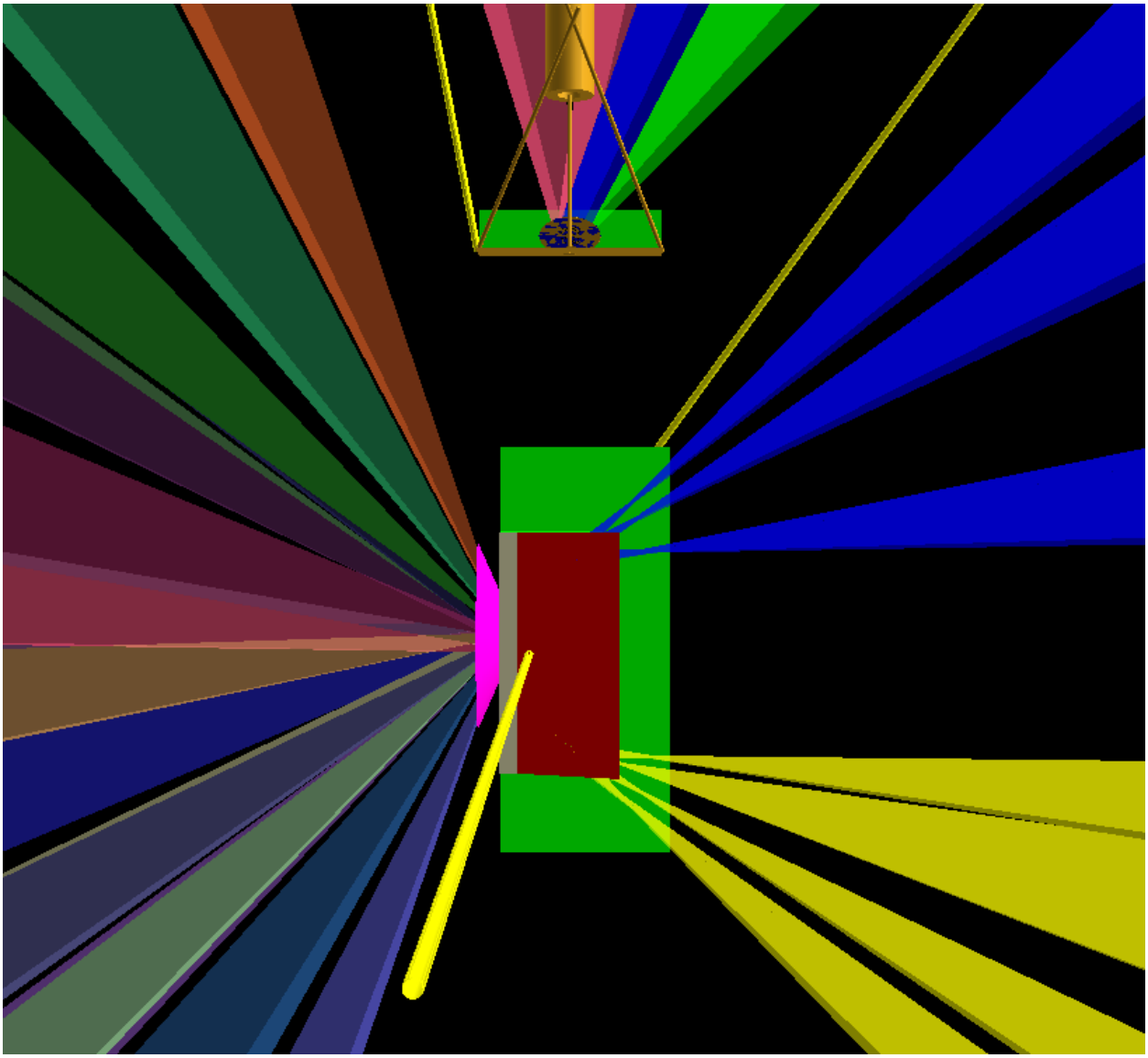
Diagnostic	Static Pinhole Camera A (SPCA)
Setup	P10.8S15 Bent Frame; LLE 12X Snout; CIPS Tip (STD and -6 mm); 1 mm Be blast shield with ¼ mil Ti filter
Pointing	STD: $\mathbf{r}$=$\mathbf{10.145}$ $\boldsymbol{mm}$, $\boldsymbol{\theta}$=$\mathbf{136.75}$°, $\boldsymbol{\phi}$=$\mathbf{162}$° (3.5 mm from foam) -6 mm: $\mathbf{r}$=$\mathbf{18.659}$ $\boldsymbol{mm}$, $\boldsymbol{\theta}$=$\mathbf{175.6}$°, $\boldsymbol{\phi}$=$\mathbf{162}$° (16 mm from foam)
Details	CIPS STD has 1.4 mm field of view; CIPS -6 mm has 1.75 mm field of view



View from TIM 3

TIM 4: TTP

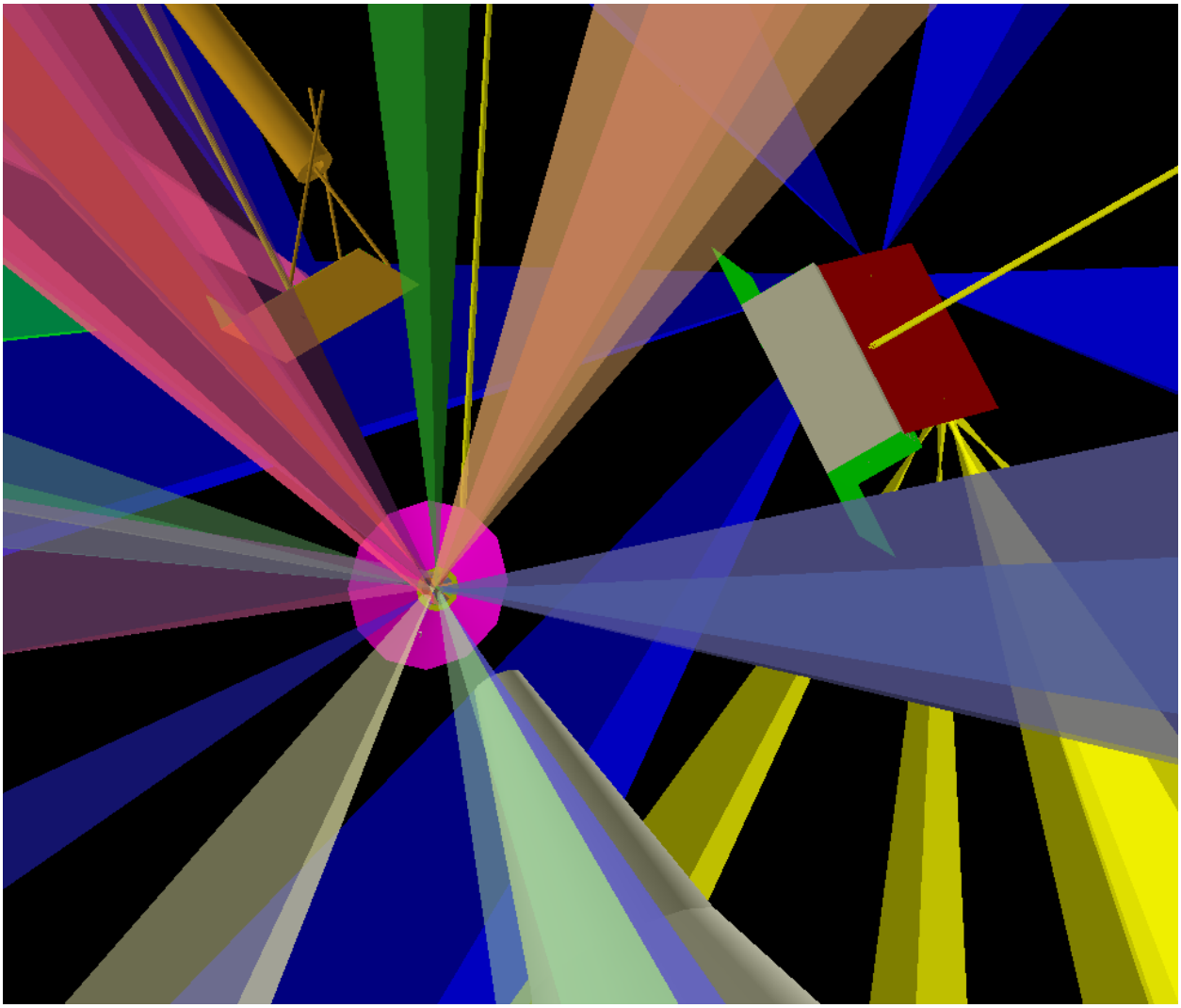
Diagnostic	TIM Target Positioner 4 (TTP)
Setup	
Pointing	
Details	Used to position the Pinhole Apertured Backlighter (PABL)



View from TIM 4

TIM 5: Available

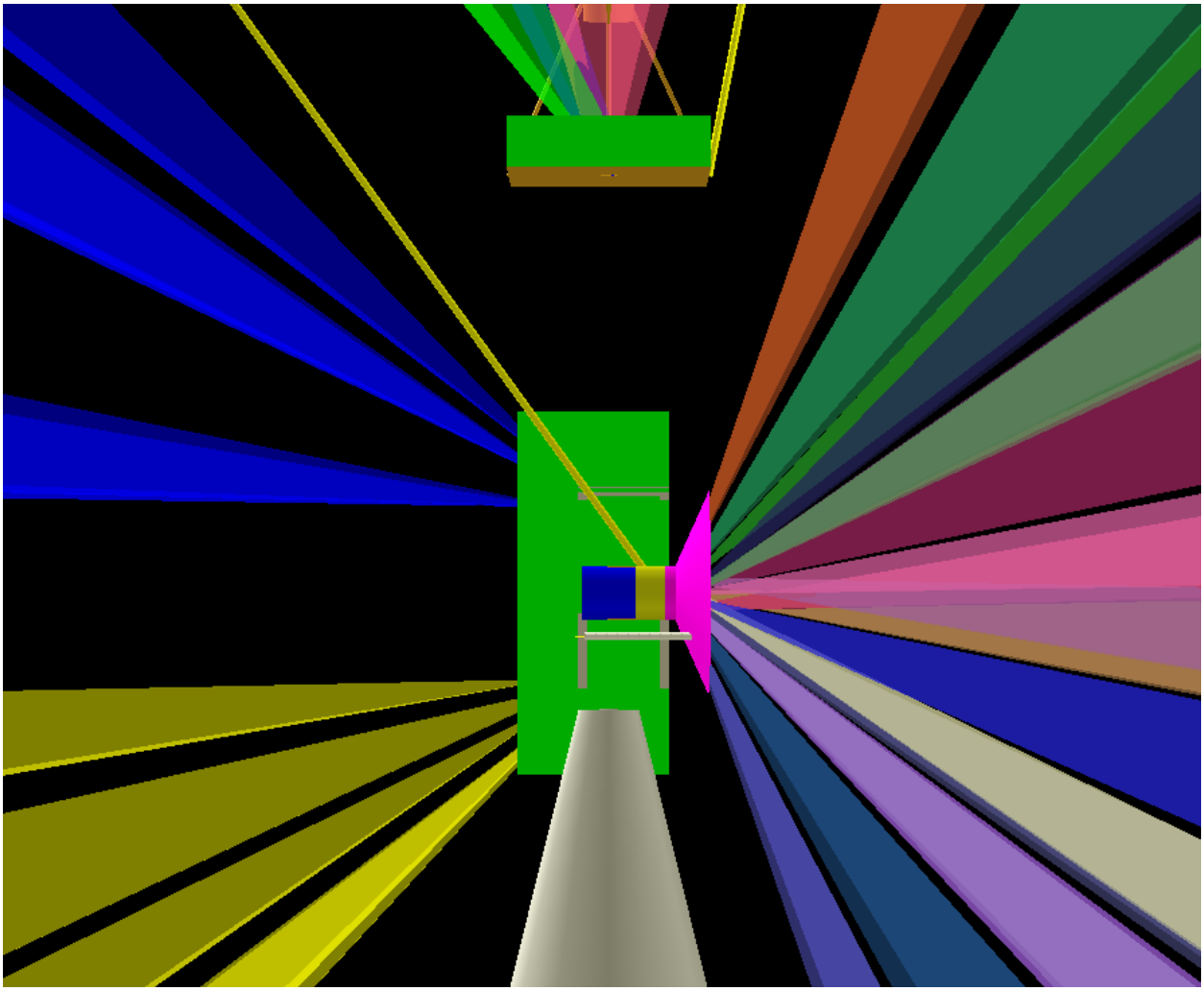
Diagnostic	Available
Setup	
Pointing	
Details	



View from TIM 5

TIM 6: XRFC3 w/ SIS

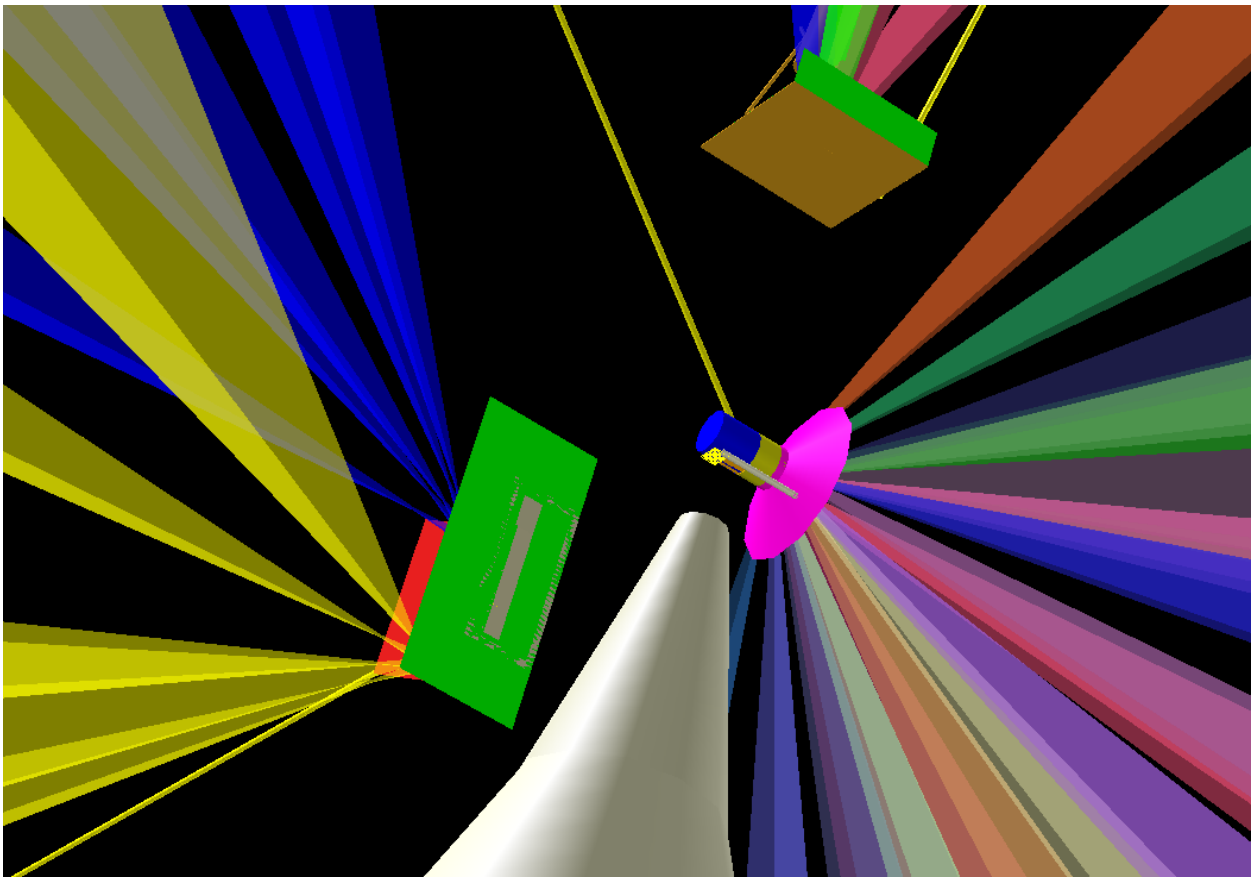
Diagnostic	Split Imaging Spectrometer on XRFC3 w/ 2-Strip MCP
Setup	1 mil Be + 1 mil Kapton blast shield, 1 mil Black Kapton Middle Filter; 400 ps MCP PFM
Pointing	9.5 mm Towards P7
Details	1-Strip MCP is available as well as SPCA for optional backends.



View from TIM 6

Relevant Fixed Diagnostics

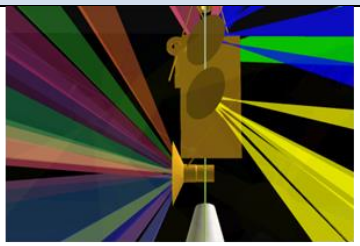
Diagnostic	DANTE
Setup	
Pointing	
Details	No line-of-sight to LEH



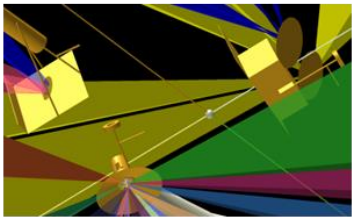
View from DANTE

Diagnostic	Pinhole Cameras
Setup	
Pointing	
Details	No line-of-sight to LEH

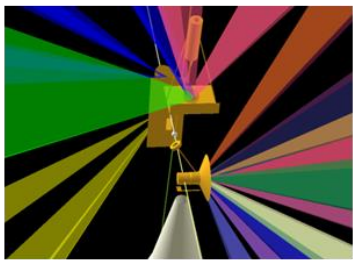
H12



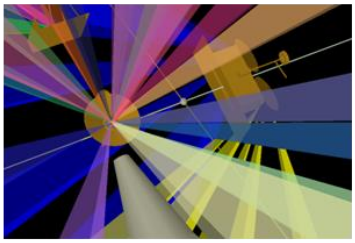
H13



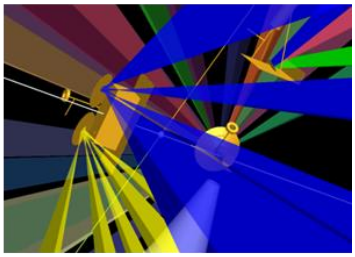
H4



H8



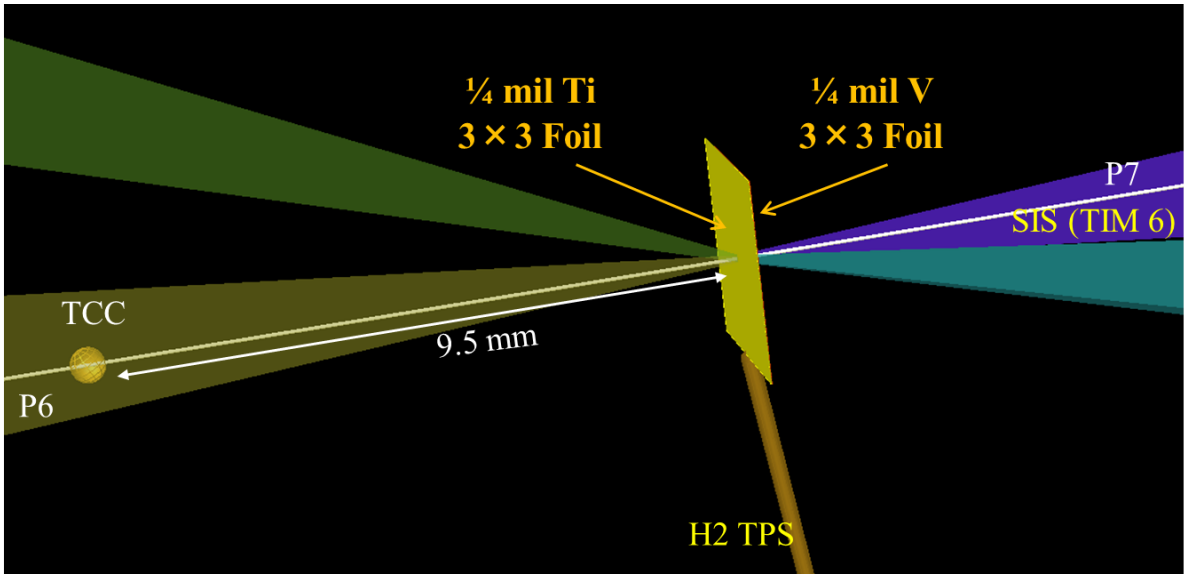
P11

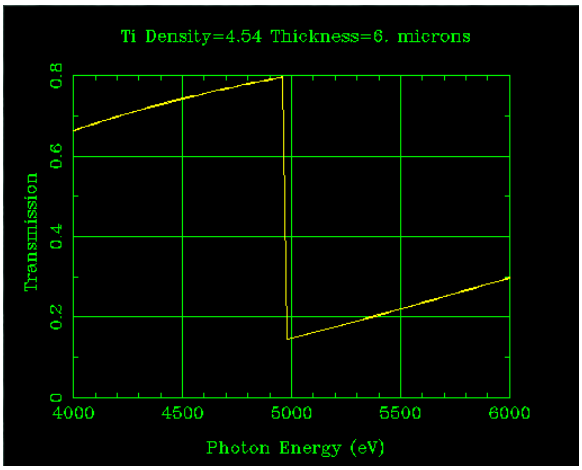


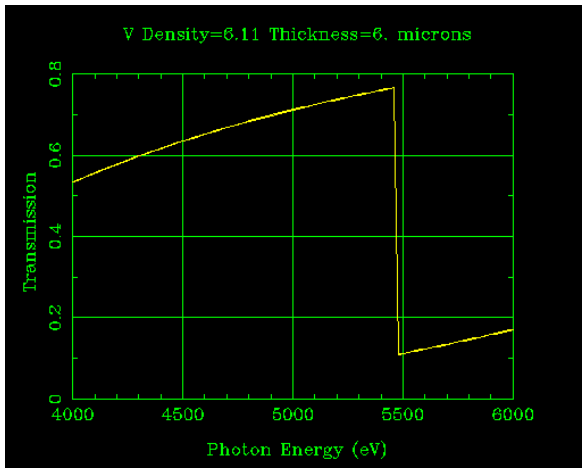
P2

Secondary Experimental Configuration:

A Titanium/Vanadium foil located at the focal spot of the SIS will be used to characterize the instrument's spectral performance. **The V foil must face the SIS (TIM 6)!**

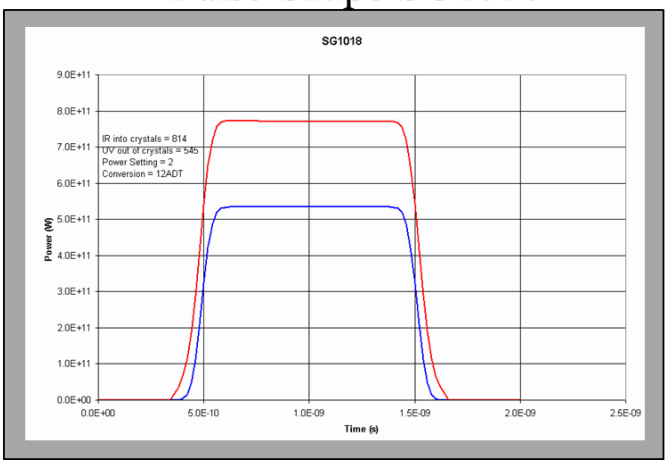






Laser Configuration:

Pulse Shape SG1018



- **Laser**
  - **No DPP, No DPR**
  - **SSD off**
  - **All beam Max Power [1ns, 500 J]**

Coax14A	SIS - Straight	Pointing					
Group	Beam #	r (µm)	θ (deg)	ϕ (deg)	Focus (mm)	Timing (ns)	Spot Size (µm)
Halfraum_1	48, 52, 60, 63	9823	115.6	178.4	0	-1	100
Halfraum_2	26, 51, 55	9708	116	175.2	-1	-1	100
Halfraum_3	33, 34, 38, 54	9708	116	175.2	0	-1	100
Halfraum_4	16, 29	9708	116	175.2	-1	-1	100
Halfraum_5	41	9961	118.8	175.2	0	-1	100
Halfraum_6	49	9404	113.3	175.4	0	-1	100
Halfraum_7	40	9708	116	175.2	-1	-1	100
Halfraum_8	36, 43	9823	115.6	178.4	0.6	-1	100
PABL_1_S	14, 18, 23, 50, 69	9887	79.53	342	-2.5	2	100
PABL_2_S	13, 24, 59, 66, 67	9887	47.35	342	-2.5	2	100
PPBL	47, 58, 65, 68	16050	62.5	162	0	2	900

Coax14A	Ti-V	Pointing					
Group	Beam #	r (µm)	θ (deg)	ϕ (deg)	Focus (mm)	Timing (ns)	Spot Size (µm)
Ti_V Foil Drive	10, 31, 44, 57	9500	toward	P7	0	2	100

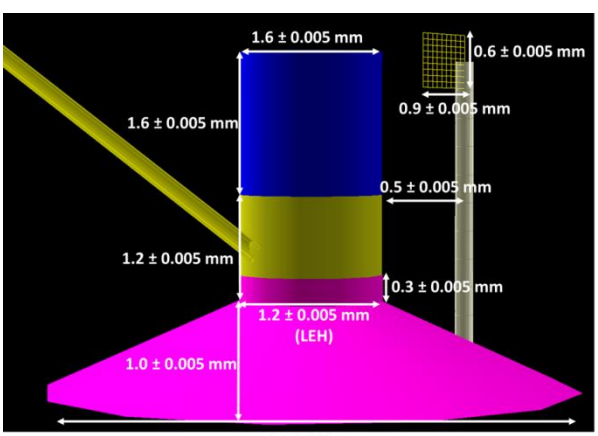
Target Summary:

Target Name	Type	Quantity Requested	Notes
Coax14A_Halfraum_A	Main Target w/ Annulus	7	
Coax14A_Halfraum_B	Main Target w/ Bullseye	4	
Coax14A_PPBL	Point Projection Backlighter	12	
Coax14A_PABL_S1_250	Pinhole-Apertured Backlighter	4	
Coax14A_PABL_S1_100	Pinhole-Apertured Backlighter	2	
Coax14A_PABL_S2	CsI Backligher w/o Pinhole	0	
Coax14A_PABL_R1_250	Pinhole-Apertured Backlighter	6	
Coax14A_PABL_R1_100	Pinhole-Apertured Backlighter	2	
Coax14A_PABL_R2	CsI Backligher w/o Pinhole	4	
Coax14A_Ti_V_Foil	Ti/V Foil	3	

Target Details (excerpt from Memo):

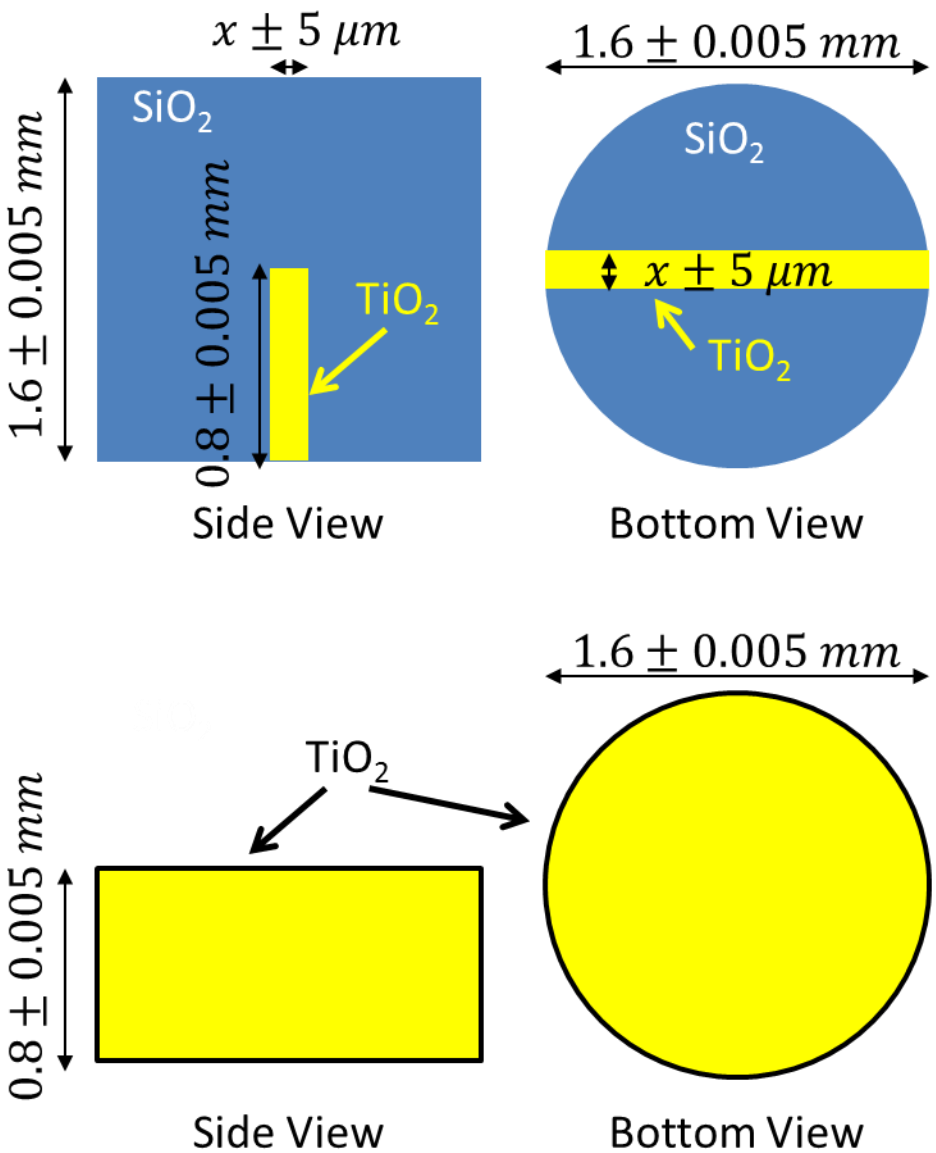
Main Target

The primary target will be inserted using the H2 target positioner and will consist of an Au half-hohlraum with the LEH axis along θ = 90°, φ = 252°; ~21° off of H14 (θ = 100.81°, φ = 270.00°). The half-hohlraum will be 1.2±.005 mm in length by 1.6±0.005 mm in diameter and laser entrance hole sizes of 1.2 ±.005 mm in diameter. The physics package hole will be 1.2±0.005 mm in diameter. The wall thickness will be 25±2 um. The hohlraum will have a conical LEH shield 1.0±.005 mm long with a diameter of 1.6±.005 mm at one end and a 6.0±0.005 mm diameter at the other end. The shield will be mounted with a 300±5 µm tall collar fitting over the hohlraum. A physics package will be placed over the hole on the end of the hohlraum. The physics package will be comprised of a foam piece and an aperture plug. A 900 um x 600 um 400 lines per inch fiducial grid should be mounted 500-um from the hohlraum normal to $\theta = 26.214°, \phi = 162°$. The bottom edge of the grid is located 1.1 mm from the end of the hohlraum and the edge closest to the center of the foam is 0.7 mm away from the edge of the foam. Figure 2 shows the hohlraum with the shield and physics package. Figure 3 shows the hohlraum drawing. Glue spots for attaching the the foam to the halfraum should be on the P6/P7 axis (90° away from the TiO_2 slab).



Foam Physics Package

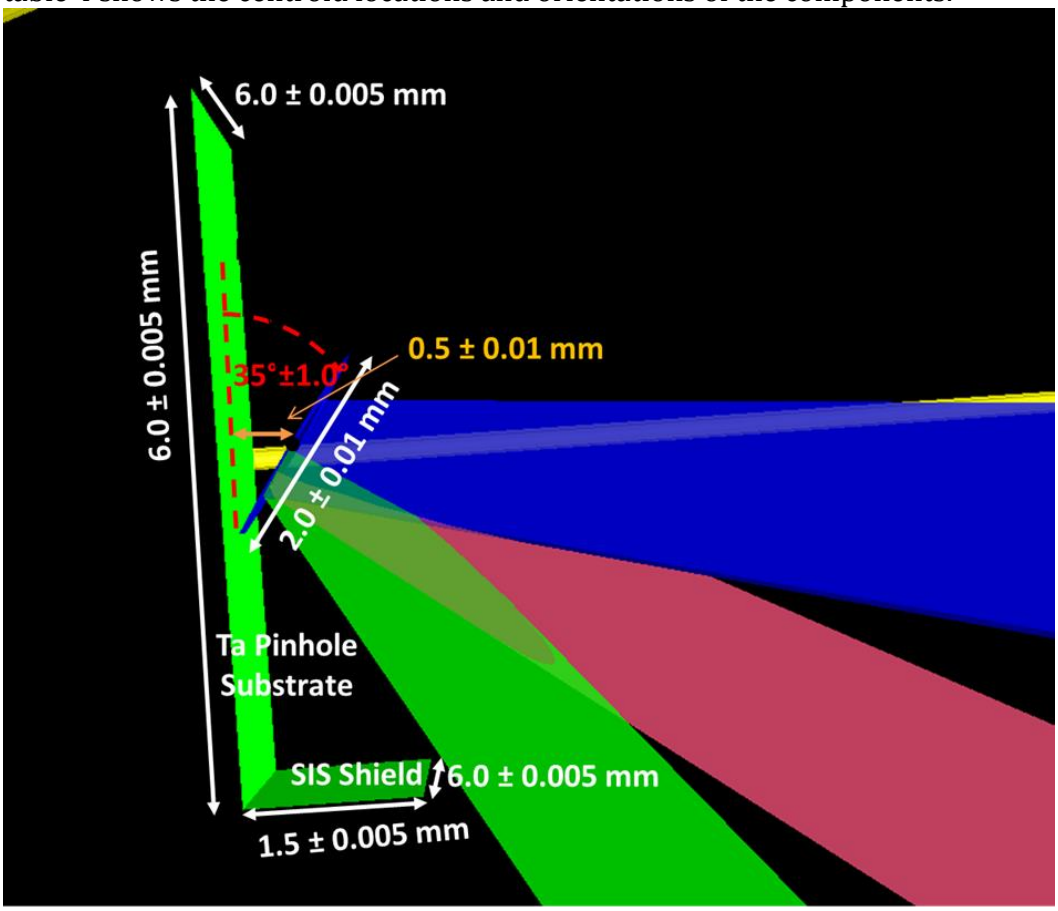
A SiO_2 foam physics package will be placed on the end of the hohlraum. The foam package will be 1.6 ± 0.005 mm in diameter by 1.6± 0.005 mm long with an $x \pm 5\ \mu m$ thick Si-TiO_2 foam vertically through the center of the package (Figure 4) and a solid Si-TiO_2 foam. The densities of the foams should be in the 50 – 80 mg/cc range. The thickness of the foam (x) will be 200- and 400-µm. The foam package will be glued to the outside of the hohlraum, with the glue spot locations TBD. The TiO_2 foam layer must be aligned with its surface normal pointing towards P7 (θ = 116.57°, φ = 162°), the direction of the line of sight from the split imaging spectrometer (SIS) at P7 to the physics package.



PPBL

The point-projection backlighter will be mounted using the TIM target positioner and inserted in TIM 2. The pinhole substrate will be 6 mm x 6 mm square, 50-µm-thick tantalum with a 20-µm diameter circular pinhole that is **TAPERED** located at the center of the foil. Both sides of the pinhole substrate should be coated with 5-10 µm of plastic. An additional 50-um-thick, 6 mm x 1.5 mm tantalum shield should be mounted at the edge of the foil perpendicular to the pinhole substrate. The seam between the pinhole substrate and the addition Ta shield should be sealed with Ag epoxy.

The backlighter material should be 1/4 mil (6.3 microns) thick. The dimensions of the foils should be ***at least*** 2.0-mm in diameter with their centers located 500-µm away from the pinhole resulting in a mounting angle of ~ 35° wrt the pinhole substrate. Figure 6 shows the VisRad image of the PPBL target. Table 3 shows the summary of the target components and table 4 shows the centroid locations and orientations of the components.



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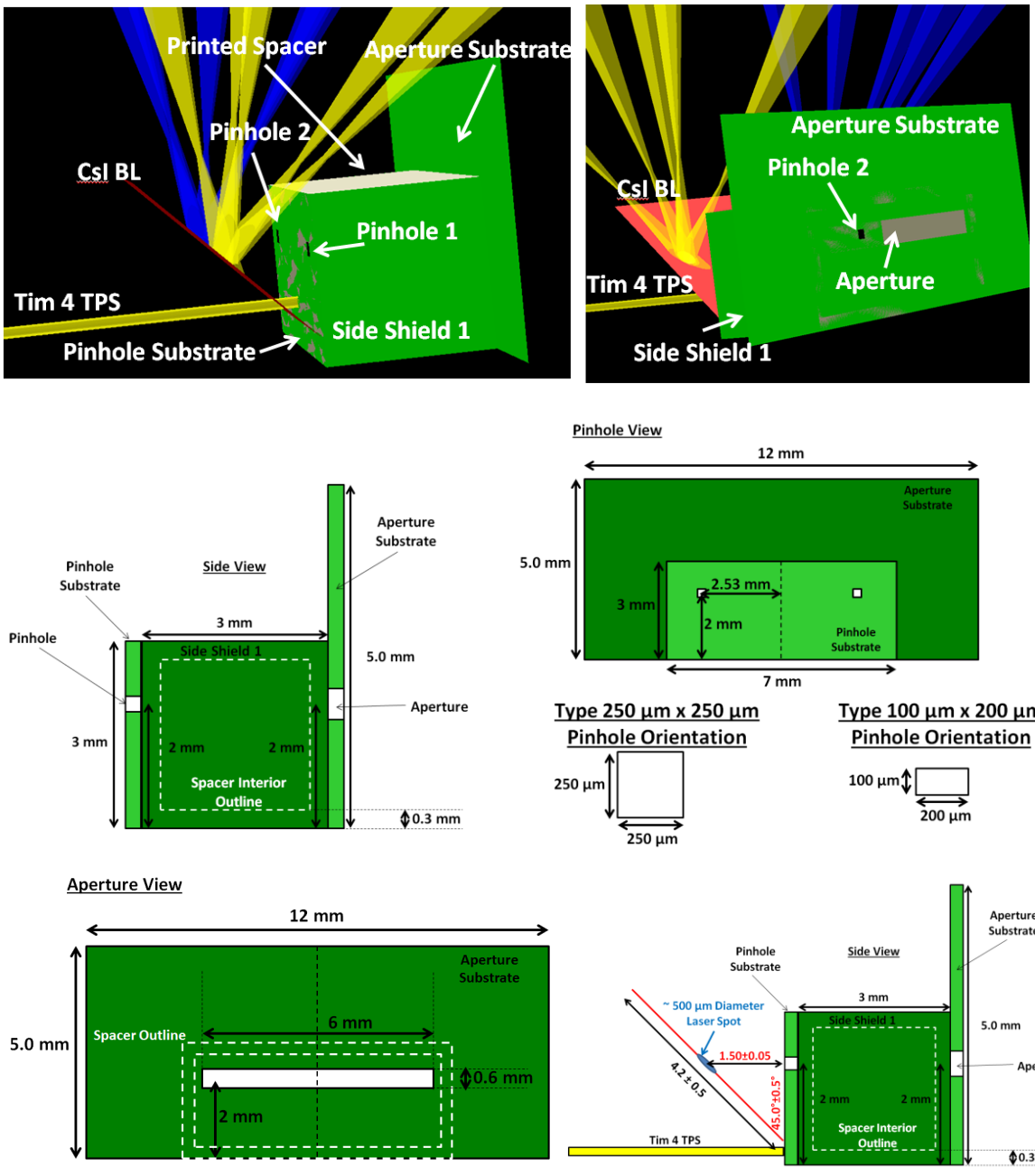
PABL

The Coax14A_PABL_S1_XXX backlighter is a pinhole apertured backlighter designed to be used with the split imaging spectrometer in its straight configuration ("S"). The target consists of 6 components:

- 1 Rectangular CsI coated Be backlighter
- 1 Ta Pinhole Substrate
- 1 Ta Aperture Substrate

- 2 Ta Side Shields
- 1 Printed Spacer

The backlighter is designed such that x-rays generated off of the laser irradiated side of the backlighter travel through the pinhole and to the diagnostic (unlike the PPBL from the previous section). Figure 7 shows the VisRad schematic of the PABL.



Shot Plan:

RID	Shotnum	Description	Primary Diagnostics	Notes
46197	1	Ti_V_Foil Only	XRFC w/ SIS	No PPBL or Main Target
46198	2	CsI w/ Pinhole Only	XRFC w/ SIS, SPCA w/ CIPS STD	SIS Straight - 250x250 pinhole; No PPBL or Main Target
46199	3	CsI w/o Pinhole	"	No PPBL or Main Target
45242	4	Physics Package	"	SIS Straight - 250x250 pinhole
47147	5	“	"	SIS Straight - 250 x 250 pinhole
47148	6	“	"	SIS Straight - 250x250 pinhole
47149	7	“	"	SIS Straight - 250 x 250 pinhole
47150	8	“	"	SIS Straight - 250x250 pinhole
47151	9	“	"	SIS Straight - 250 x 250 pinhole
47152	10	“	"	SIS Straight - 250x250 pinhole
47153	11	“	"	SIS Straight - 250x250 pinhole
47154	12	“	"	SIS Straight - 250x250 pinhole
47155	13	“	"	SIS Straight - 100x200 pinhole
47156	14	“	“	SIS Straight – 100x200 pinhole
47145	Backup	Physics Package	SPCA w/ SIS, SPCA w/ CIPS STD	SIS Straight – 250x250 pinhole
45283	Backup	Physics Package	XRFC w/ SIS, SPCA w/ CIPS -6mm	SIS Straight - 250x250 pinhole

Calculations:

Be Mass Calc

```
ρbe = 1.85 ;(* density in g/cc *)
t = 25.4; (* um *)
r = 4500 / 2.; (* um radius *)
vbe = 2 * π * r ^ 2 * t; (* volume in um^3 *)
vbe = vbe * (100. / 10. ^ 6) ^ 3 ;(* volume in cm^3 *)
mbe = ρbe * vbe
```

```
0.00149469
```

CIPS -6mm Field of View

```
(*ycips=0.9 ;(* radius of the STD CIPS TIP in mm *)*)
ycips = 2.0 ;(* radius of the -6 mm CIPS TIP in mm *)
xbf = 12.5;(* distance from backlighter pinhole to foam in mm *)
xfc = 16.0;(* distance from the foam to the cips tip for -6 CIPS*)
(*xfc=3.5;(* distance from the foam to the cips tip for STD CIPS*)*)
ypr = 10 / 1000; (* radius of the backlighter pinhole in mm *)
xpoint = (xbf + xfc) / ycips * (1 / ypr - 1 / ycips) ^ -1 ;
(* distance from pinhole substrate to the point of the point-
 projection in mm *)
yf = ycips / (xpoint + xfc + xbf) * (xpoint + xbf) * 2
  (* Field of view at the center of the foam in mm *)
```

```
1.76561
```

CIPS STD Field of View

```
ycips = 0.9 ; (* radius of the STD CIPS TIP in mm *)
(*ycips=2.0 ;(* radius of the -6 mm CIPS TIP in mm *)*)
xbf = 12.5;(* distance from backlighter pinhole to foam in mm *)
(*xfc=16.0;(* distance from the foam to the cips tip for -6 CIPS*)*)
xfc = 3.5; (* distance from the foam to the cips tip for STD CIPS*)
ypr = 10 / 1000; (* radius of the backlighter pinhole in mm *)
xpoint = (xbf + xfc) / ycips * (1 / ypr - 1 / ycips) ^ -1 ;
(* distance from pinhole substrate to the point of the point-
 projection in mm *)
yf = ycips / (xpoint + xfc + xbf) * (xpoint + xbf) * 2
  (* Field of view at the center of the foam in mm *)
```

```
1.41062
```

SIS Imaging Field of View

```
ps = 0.100;(* pinhole size in mm *)
pbl = 1.5;(* pinole to BL Spot distance in mm *)
pf = 19 - pbl ;(* pinhole to foam distance in mm *)
fc = 446.4; (* foam to crystal distance in mm *)
cd = 220.8 ;(* crystal to detector distance in mm *)
dy = 34.29;(* MCP length in imaging direction *)
apx = 3.0; (* Distance from Pinhole to Aperture *)
```

$$ppx = \frac{ps}{2} * \frac{pf + fc + cd}{(dy - ps)/2}$$

(* x-distance from PPBL point to pinhole in mm*)

$$fy = (ppx + pf) * \frac{dy}{ppx + pf + fc + cd}$$

(* field of view of the foam in mm *)

$$bs = (ppx - pbl) * \frac{ps}{ppx}$$ (* Required spot on BL in mm *)

$$apy = (ppx + apx) * \frac{ps}{ppx}$$ (* Required Imaging Aperture Height *)

2.00263

0.97385

0.0250986

0.249803

```
ps = 0.250; (* pinhole size in mm *)
pbl = 1.5; (* pinole to BL Spot distance in mm *)
pf = 19 - pbl ; (* pinhole to foam distance in mm *)
fc = 446.4; (* foam to crystal distance in mm *)
cd = 220.8 ; (* crystal to detector distance in mm *)
dy = 34.29; (* MCP length in imaging direction *)
apx = 3.0; (* Distance from Pinhole to Aperture *)
```

$$ppx = \frac{ps}{2} * \frac{pf + fc + cd}{(dy - ps)/2}$$

(* x-distance from PPBL point to pinhole in mm*)

$$fy = (ppx + pf) * \frac{dy}{ppx + pf + fc + cd}$$

(* field of view of the foam in mm *)

$$bs = (ppx - pbl) * \frac{ps}{ppx}$$ (* Required spot on BL in mm *)

$$apy = (ppx + apx) * \frac{ps}{ppx}$$ (* Required Imaging Aperture Height *)

5.02864

1.12002

0.175427

0.399146

SIS Pinhole and Beam Spot Calc

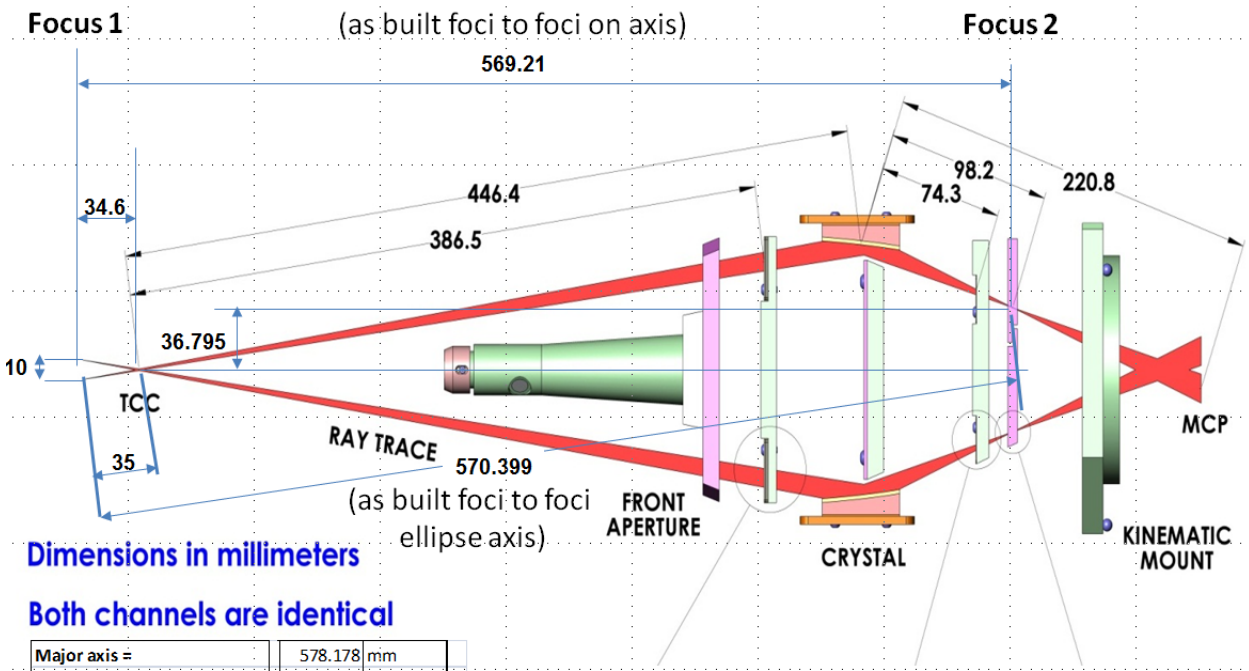
```
y = 5;
h = 35;
θ = ArcSin[y/h]
xspot = 19;
yspot = N[xspot * Tan[θ]]
xpinhole = 17.5;
ypinhole = N[xpinhole * Tan[θ]]
```

$$\text{ArcSin}\left[\frac{1}{7}\right]$$

2.74241

2.52591

SIS As Built Dimensions



Dimensions in millimeters

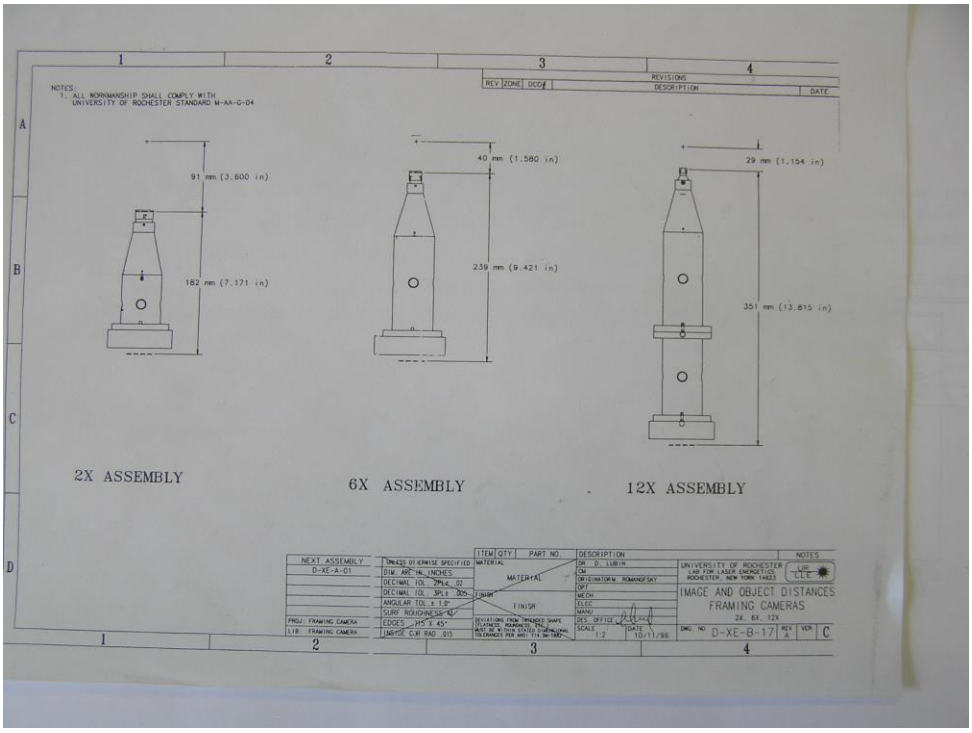
Both channels are identical

Major axis =	578.178	mm
Minor axis =	101.83	mm
left focus	x=-34.64	y=-5.02
right focus	x=522.29	y=31.93
angle between ellipses	6.18	deg
Max Bragg angle	15.06	deg
Min Bragg angle	12.47	deg
foci to foci =	569.1401	569.13
	calc.	model

CIPS Tips Dimensions

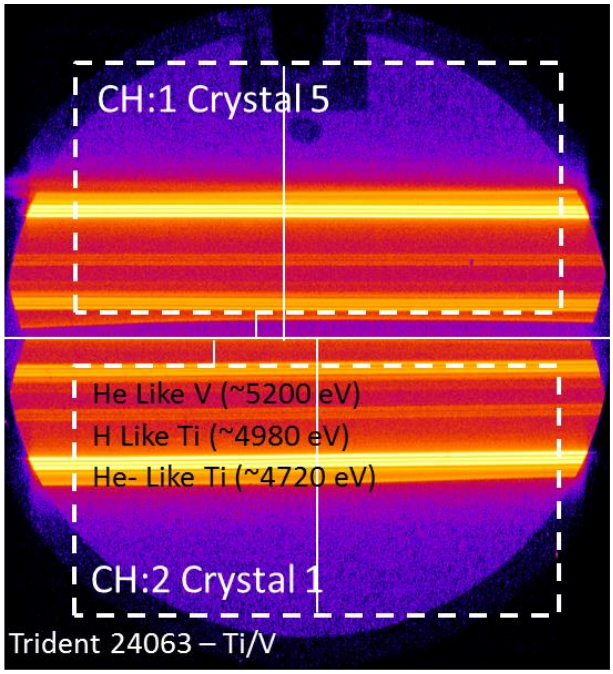
CIPS Nose tip's	Length of Tip	ID Of Tip (Hole)	Comments
Original Old Tip	1.290 or 32.6mm	.119 or 3mm	
Standard Tip	1.285 or 32.6mm	.074 or 1.8mm	
Modified Tip	1.050 or 26.6mm	.158 or 4mm	Tip was shorten by 6mm
37x Tip same as the CIPS TIP	1.350 or 34.2 mm	.050 or 1.2mm	

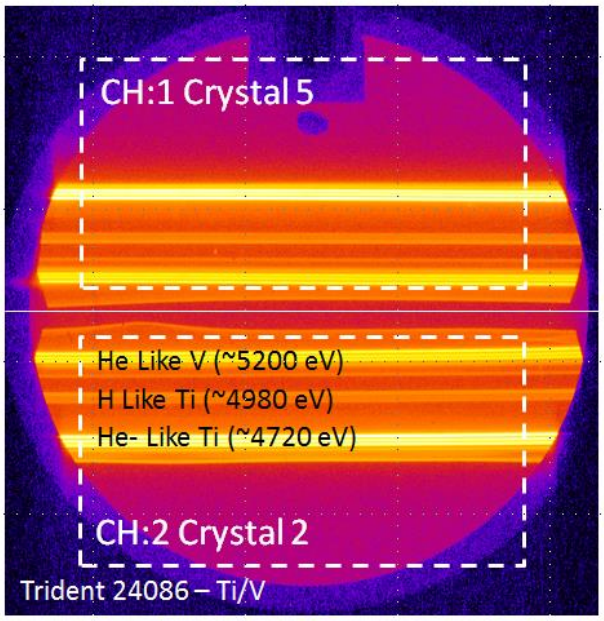
LLE Nosecone Dimensions

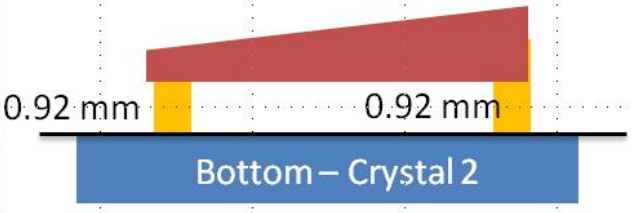


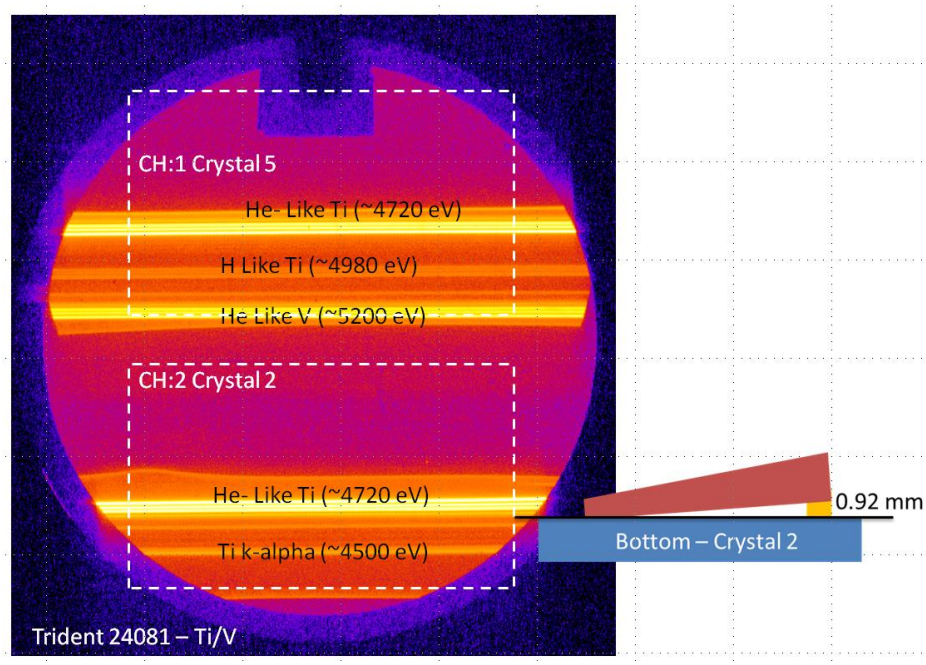
SIS Data

Shimming

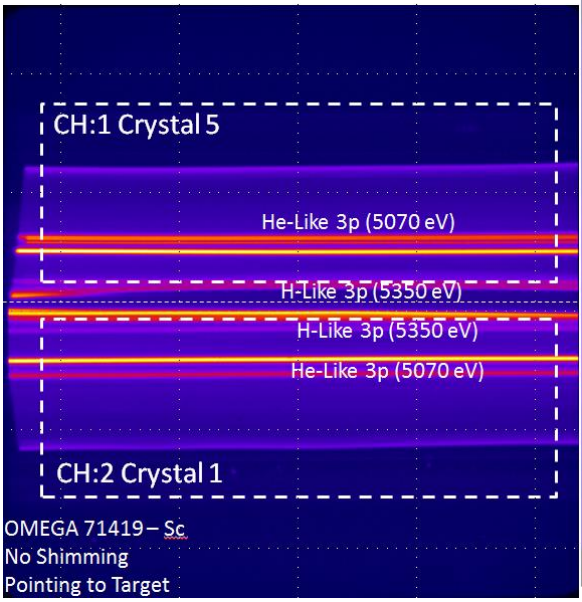


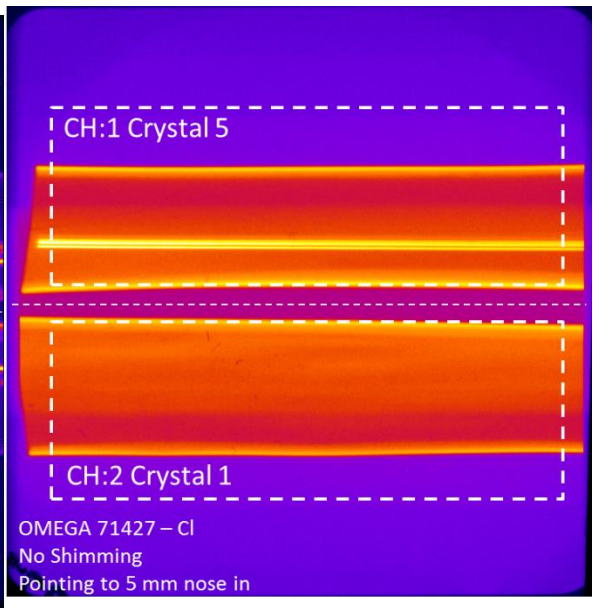


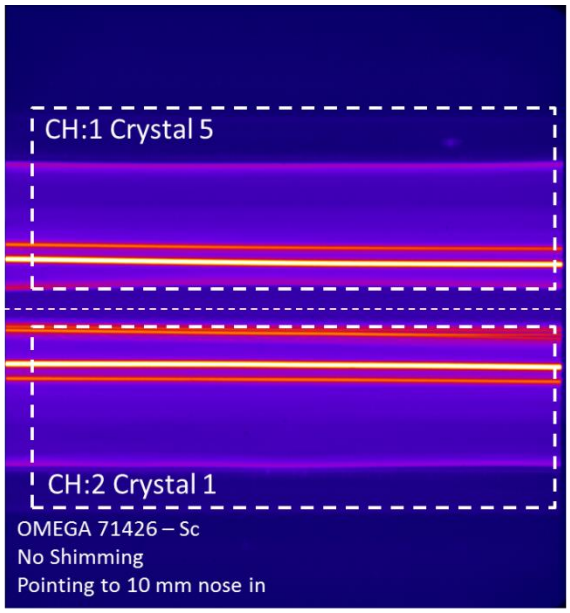



CH:1 Crystal 5
He- Like Ti (~4720 eV)
H Like Ti (~4980 eV)
He Like V (~5200 eV)
CH:2 Crystal 2
He- Like Ti (~4720 eV)
Ti k-alpha (~4500 eV)
Trident 24081 – Ti/V
0.92 mm
Bottom – Crystal 2

Pointing


CH:1 Crystal 5
He-Like 3p (5070 eV)
H-Like 3p (5350 eV)
H-Like 3p (5350 eV)
He-Like 3p (5070 eV)
CH:2 Crystal 1
OMEGA 71419 – Sc
No Shimming
Pointing to Target


CH:1 Crystal 5
CH:2 Crystal 1
OMEGA 71427 – Cl
No Shimming
Pointing to 5 mm nose in


CH:1 Crystal 5
CH:2 Crystal 1
OMEGA 71426 – Sc
No Shimming
Pointing to 10 mm nose in

Relevant X-Ray Data

Element	Ionization	Type	Energy (eV)
Ti	H-Like	1s-2p	4977.29
Ti	H-Like	1s-2p	4956.33
Ti	H-Like	1s-3p	5889.98
Ti	He-Like	1s^2-1s2s	4701.71
Ti	He-Like	1s^2-1s2p	4726.99
Ti	He-Like	1s^2-1s2p	4750.17
Ti	He-Like	1s2s-2s2p	4925.87
Ti	He-Like	1s2p-2p^2	4933.71
Ti	He-Like	1s2s-2s2p	4939.61
Ti	He-Like	1s2s-2s2p	4945.52
Ti	He-Like	1s^2-1s3p	5582.36
V	H-Like	1s-2p	5442.68
V	He-Like	1s^2-1s2s	5155.27
V	He-Like	1s^2-1s2p	5180.9
V	He-Like	1s^2-1s2p	5205.7
Sc	H-Like	1s-2p	4531.59
Sc	H-Like	1s-3p	5362.64
Sc	H-Like	1s-3p	5364.96
Sc	H-Like	1s-4p	5656.21
Sc	He-Like	1s^2-1s2s	4270.9
Sc	He-Like	1s^2-1s2p	4295.01
Sc	He-Like	1s^2-1s3p	5070.93
Sc	He-Like	1s^2-1s4p	5334.95
Sc	He-Like	1s^2-1s5p	5457.05
Sc	He-Like	1s^2-1s6p	5522.68
Ti	None	k-alpha1	4510.84
Ti	None	k-alpha2	4504.86
Ti	None	k-beta1	4931.81
V	None	k-alpha1	4952.2
V	None	k-alplha2	4944.64
V	None	k-beta1	5427.29
Sc	None	k-beta1	4460.5

	Ti Absoprtion Lines (eV)
2p	4530
	4570
	4600
3p	5180
	5120
	5150