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Title: Multi-Probe 24A Pre-Shot report

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Multi-Probe 24A
Pre-Shot report

Omega EP
November 28, 2023

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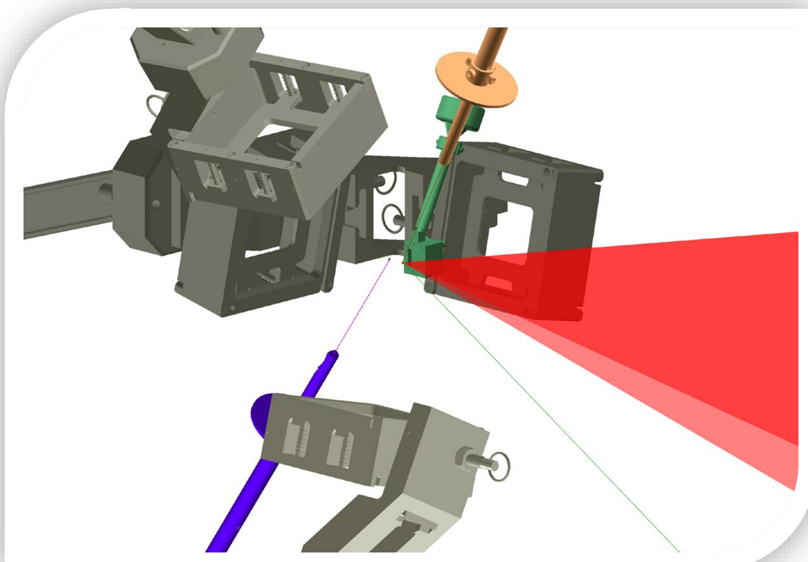

Abstract

The Multi-Probe Radiography campaign will field a full day of experiments at the Omega EP laser facility. The day consists of shots alternating between Omega EP's two short-pulse laser beams. The Backlighter beam will generate proton and deuteron beams from 500-800nm CH/CD film targets, and the Sidelighter beam will accelerate electrons to generate x-rays from 0.5mm x 25-50µm ⌀ Ta wire targets attached to Compound Parabolic Concentrator (CPC) cones. The ion beams shots will optimize CD foil thickness (maximizing ion energy/yield) for the transparency regime for use as the pitcher in a pitcher-catcher neutron-generation platform. Several shots will include a LiF catcher within the NTA and this feeds into future neutron radiography work. X-ray shots will be used to characterize the platform established in FY2020B via measurement of electron spectra with and without the Ta wire, and radiography will be conducted at varying laser energies. This will validate PIC electron acceleration modeling while also demonstrating potential for using the x-ray platform for imaging of thicker objects.

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Goals:

Multi-probe radiography: build up capability for generating independent <u>*x-ray*</u>, <u>*proton*</u>, and <u>*neutron*</u> radiographs, and then generate simultaneous radiographs with some combination of beams.

Two independent goals by alternating shots between **sidelighter** & **backlighter**

− **X-ray source characterization (SL)**

- Characterization of proven *x-ray platform* (CPC cone+wire) incl. *electrons driving Bremsstrahlung*
- **Goals**: validate modeling by directly measuring electron spectra, measure x-ray energy and resolution scaling with laser energy

− **Pitcher Series (BL)**

- Optimizing CD film thickness for *pitcher* in *pitcher-catcher* neutron source
- **Goal**: develop deuteron-proton source for FY24B pitcher-catcher neutron generation concept
- Primary metric of pitcher performance is TPIE spectra, neutron activation and nTOF are secondary

− **Both (SL/BL)**

- Demonstrate x-ray shield (XBLK) 1 cm from target to block crosstalk between perpendicular beams
- *Note XBLK-1 is for use on SL shots, XBLK-2 is for use on BL shots.*

Shot Plan for Nov. 28, 2023

Shot #	Beam/Config.	Energy (J)	RID	Pulse (ps)	Target description	Static object	MIFEDS	Shield*	TPIE setting/filter
1	BL/1 (no LiF)	250	94568	0.7	CD film (500nm)				*Measure D^+ 5-20 MeV,* P1/'Graeme' filter
2	SL/1	20	94630	5	CPC+wire (0.5mm × 25µm ⌀)				
3	BL/1 (no LiF)	500	94633	0.7	CD film (500nm)				P1/'Graeme' filter
4	SL/1	20	94631	5	CPC+glue (no wire)				
5	BL/1 (with LiF)	500	94644	0.7	CH film (500nm)			**XBLK-2**	*Measure H^+ >100 MeV,* P2/1.5um mylar
6	SL/1	80	93537	5	CPC+wire (0.5mm × 25µm ⌀)			**XBLK-1**	
7	BL/2 (with LiF)	500	94645	0.7	CD film (700nm)			**XBLK-2**	P1/'Graeme' filter
8	SL/2 (no MIFEDS)	20	94632	5	CPC+wire (0.5mm × 25µm ⌀)	**Yes**		**XBLK-1**	
9	BL/2 (with LiF)	500	94646	0.7	CD Film (800nm)			**XBLK-2**	P1/'Graeme' filter
10	SL/2 (with MIFEDS)	20	94011	5	CPC+wire (0.5mm × 25µm ⌀)	**Yes**	**Yes**		
11	BL/2 (with LiF)	500	94647	0.7	CD Film (best thickness)			**XBLK-2**	*Measure D^+ up to 40 MeV,* P2/'LANL2023' filter
12	SL/2	80	94634	5	CPC+wire (0.5mm × 25µm ⌀)	**Yes**	**Yes**		
					alternative shots				
13	BL/2 (with LiF)	500	94648	0.7	CD Film (600nm)			**XBLK-2**	P1/'Graeme' filter
14	SL/2	40	94637	5	CPC+wire (0.5mm × 50µm ⌀)	**Yes**	**Yes**		
14	SL/2	80	94639	5	CPC+wire (0.5mm × 50µm ⌀)	**Yes**		**XBLK-1**	

***XBLK filters notionally set to 6 mm Al and will be revised through the day.**

Laser conditions

We will alternate between the backlighter and sidelighter for all shots through the day to maximize the number of shots. Beam parameters for both will remain the same for the entire shot day, besides the first backlighter shot, which will be at half power.

The **backlighter** is focused at TCC, operated at best conditions, best compression, and best spot size (0.7 ps, maximum energy, nominally 15-micron diameter containing 80% of laser energy). Maximum energy is expected to be 500 J.

The **sidelighter** is focused at 9.5 mm (θ= 90deg, ϕ = 270deg) relative to TCC, i.e. -9.5 mm relative to the direction of laser propagation. The sidelighter will be operated between 20-160 J, 5 ps pulse length, and best spot size (nominally 15-micron diameter containing 80% of laser energy). Maximum energy is 80 J.

Target designs and descriptions

3 main types of targets will be shot during the day, with variations of each.
There will also be one type of static object used on x-ray radiography shots.

The foil targets position within casing during transport to LLE is as follows,
[Box ID][Position ID][thickness], Box is A-C, Position is A-K

1. CH foil: BL shots only
    a. 500nm (position within case: AA500, BA500, AB500, BB500)
2. CD foil: BL shots only
    a. 300nm (position: CA300, CB300, CC300)
    b. 500nm (position: AC500, BC500, AD500, BD500, AE500, BE500, CE500, CF500)
    c. 600nm (position: AF600, BF600, AG600, BG600)
    d. 700nm (position: AH700, BH700, AI700, BI700)
    e. 800nm (position: AJ800, BJ800, AK800, BK800)
    f. 1000nm (position: CG1000, CH1000, CI1000, CJ500+500, CK500+500)

Note that the CD film targets are mounted onto washers by floating in water. This may be an additional source of O & H contaminates.

3. CPC cone + glue: SL shots only
    a. Two targets
4. CPC cone + 25um diameter x 0.5mm Ta wire
    a. Seven targets
5. Static radiography objects
    a. Eight static objects

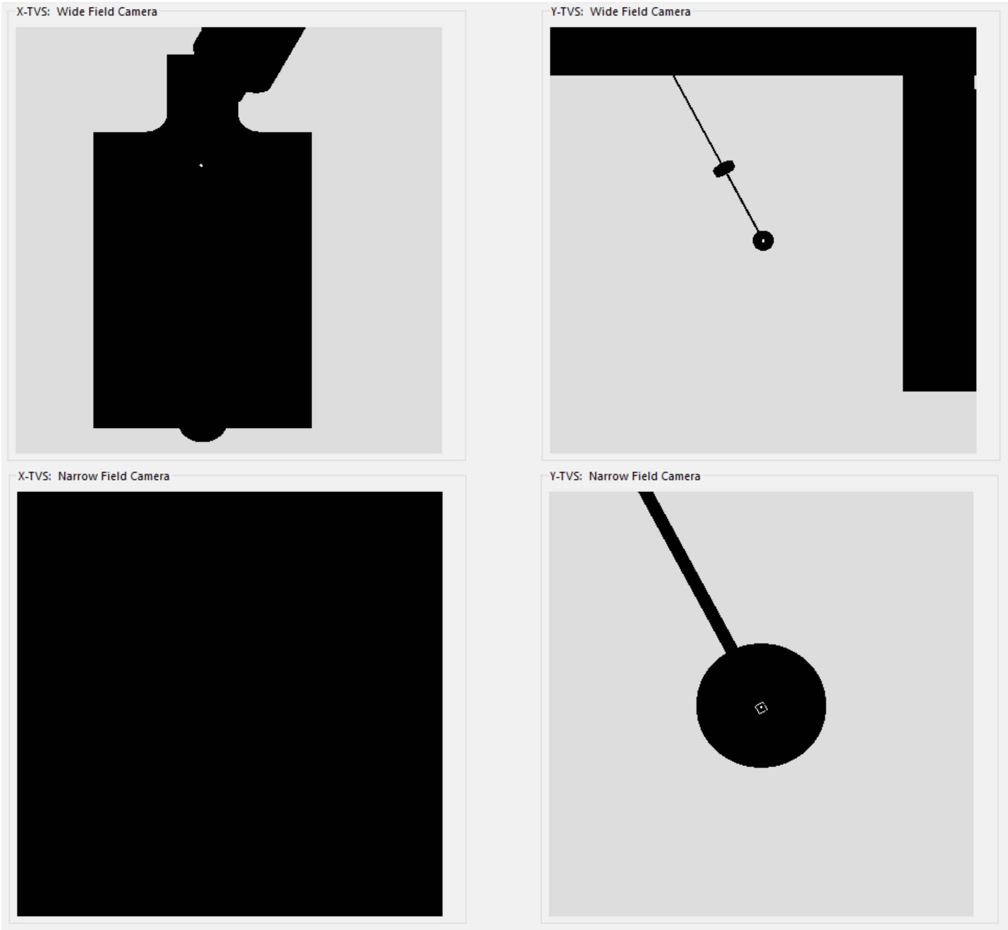
CD film and CH film targets

The CD film and CH film targets were built by Ann Junghans

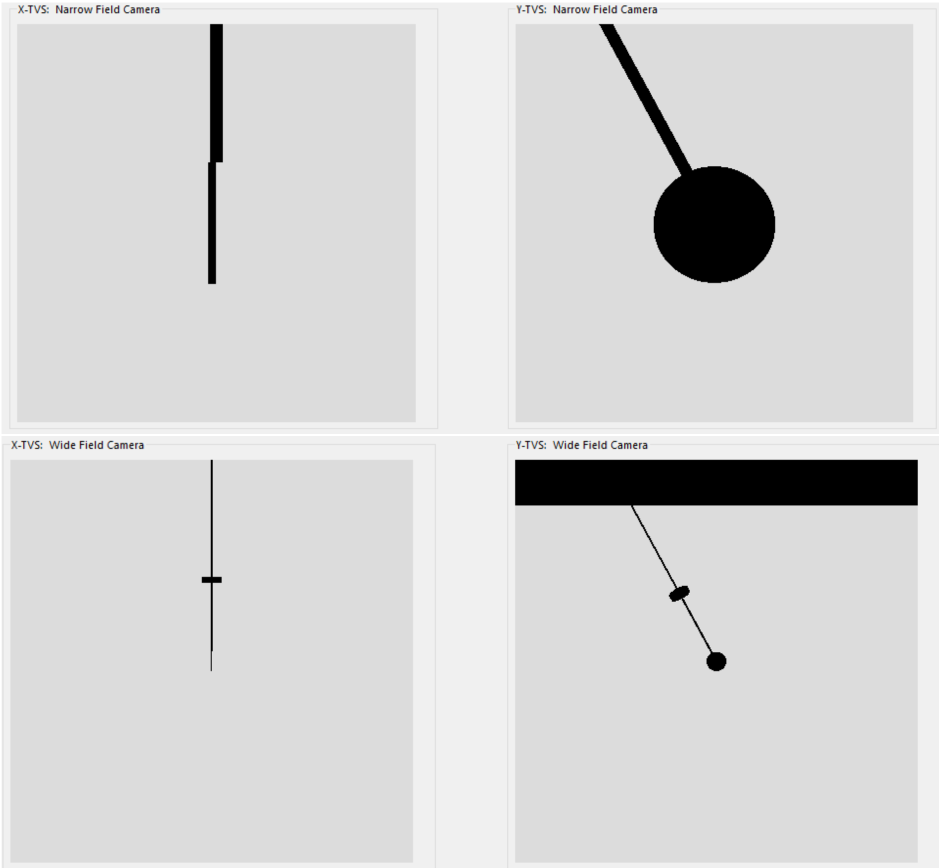
- Sallee Klein provided polyimide washers mounted to stalks (all on TPS 7 facing BL)
    - Washer dimensions: OD 1.5 mm, ID 0.5 mm, thickness 25 micron
- Ann Junghans mounted CH and CD films ranging 300 nm to 1000 nm on the washers

TVS-view

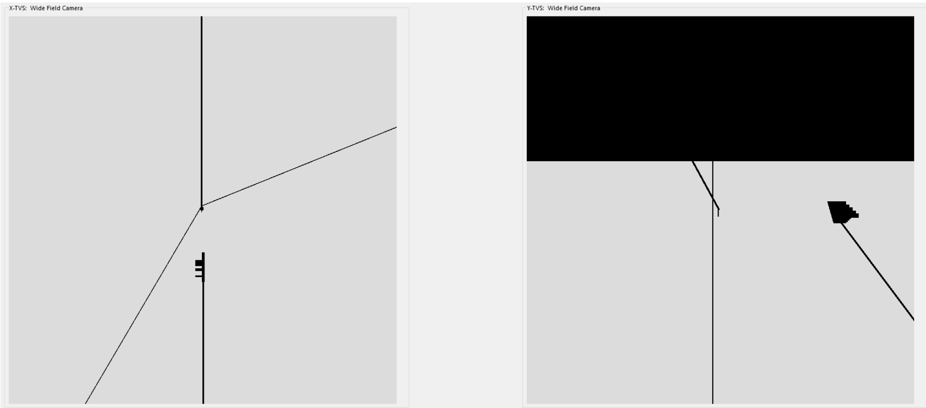
Pitcher CD/CH film (with XBLK)



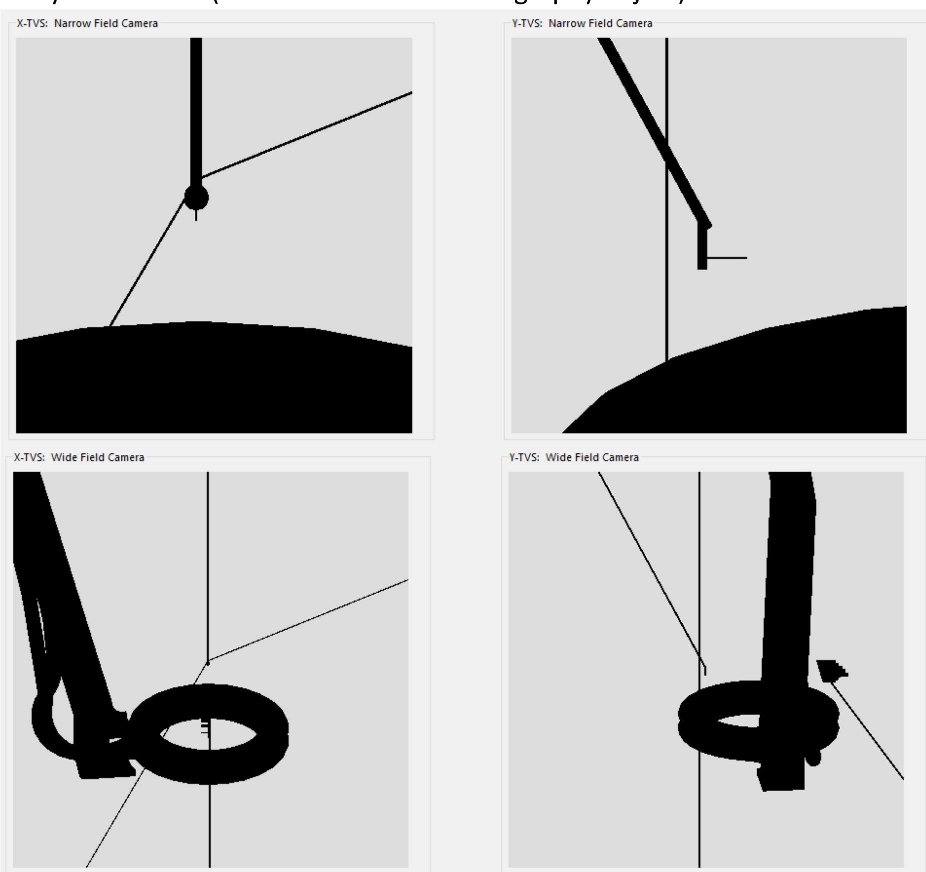
Pitcher CD/CH film (without XBLK)



X-ray – CPC+wire (no MIFEDS - with radiography object)



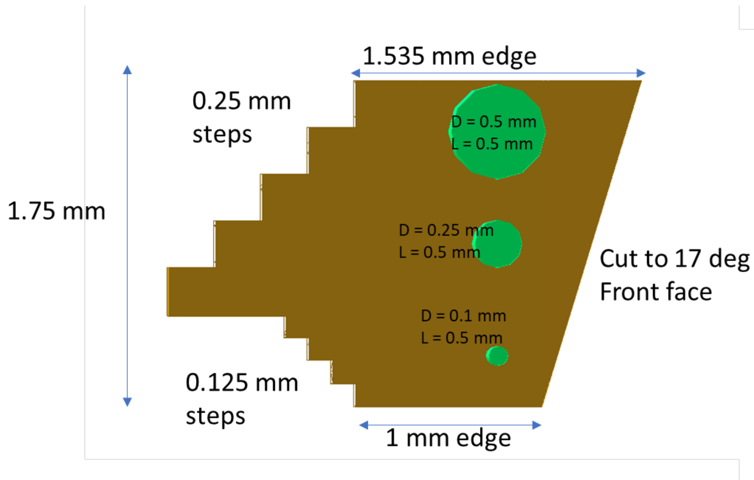
X-ray – CPC+wire (with MIFEDS - with radiography object)

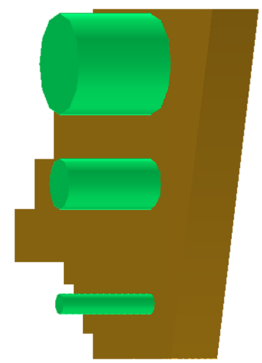


Static objects

The static objects (4) are being built by Michigan

- Ta block (100 um width) with 3 W wires glued to the side
- The block has steps as shown in figure, the wires are 0.5 mm long with diameters of 0.5 mm, 0.25 mm and 0.1 mm
- The Ta edge facing the Sidelighter is tilted 17 degrees down
- Held by TPS 83 to face Sidelighter

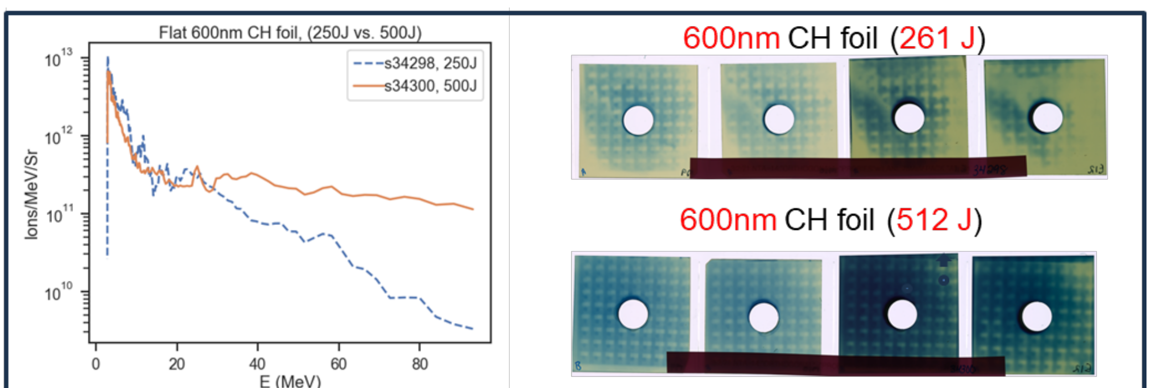




Pre-Shot reasoning for the backlighter series

Increasing energy from *250J to 500J* for CH foil appears to shift proton acceleration from *TNSA regime* into the *relativistic transparency + TNSA regime* (both 0.7ps, ~18µm R_{80}).
This transition *significantly increases both ion yield and maximum energy* – also applies to CD foils.

- TPIE measurements of ion spectra from CD targets 500, 600, 700, 800nm thick will be used to optimize transparency regime for maximizing D^+ and H^+ yields and energies for EP laser conditions
- During these shots, LiF catcher in NTA will generate neutrons for diagnostic testing/simulation validation

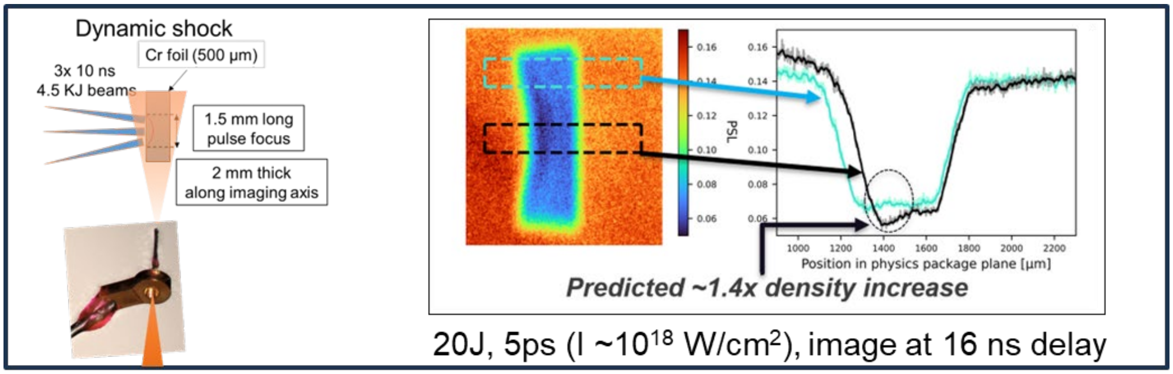


Thompson parabola data indicates high energy plateau

Corresponding increase in RCF dose deeper in stack

Pre-Shot reasoning for the backlighter series

FY20 Multi-Probe campaign developed x-ray platform for imaging shocked Cr foil



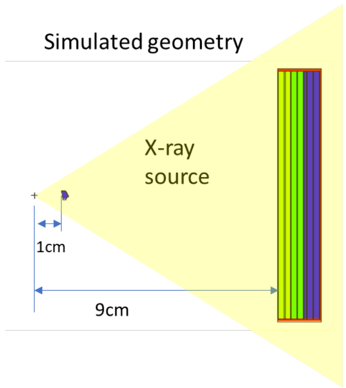
To assess potential for scaling to imaging of larger shockwaves we will assess image quality and spectrum at variable laser energies (20-80J) at 5ps pulse length for Ta wires (0.5mm × 25-50µm ⌀).

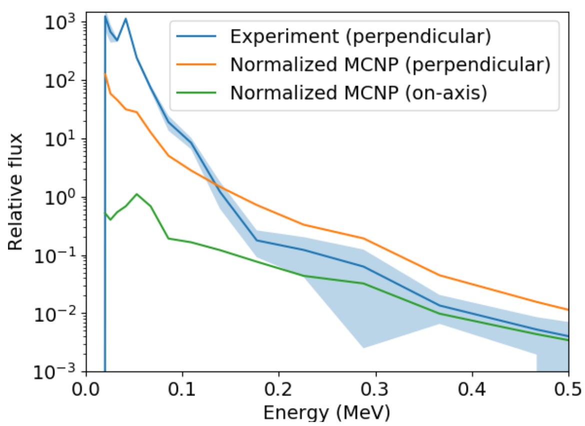
- LOS EPPS-3 will validate PIC and provide input for radiation transport modeling
    - Shooting CPC cone both with *glue + wire* and with *only glue* provides e^- source measurement
- Shots with vs. without MIFEDS definitively answers the question of electron background signal

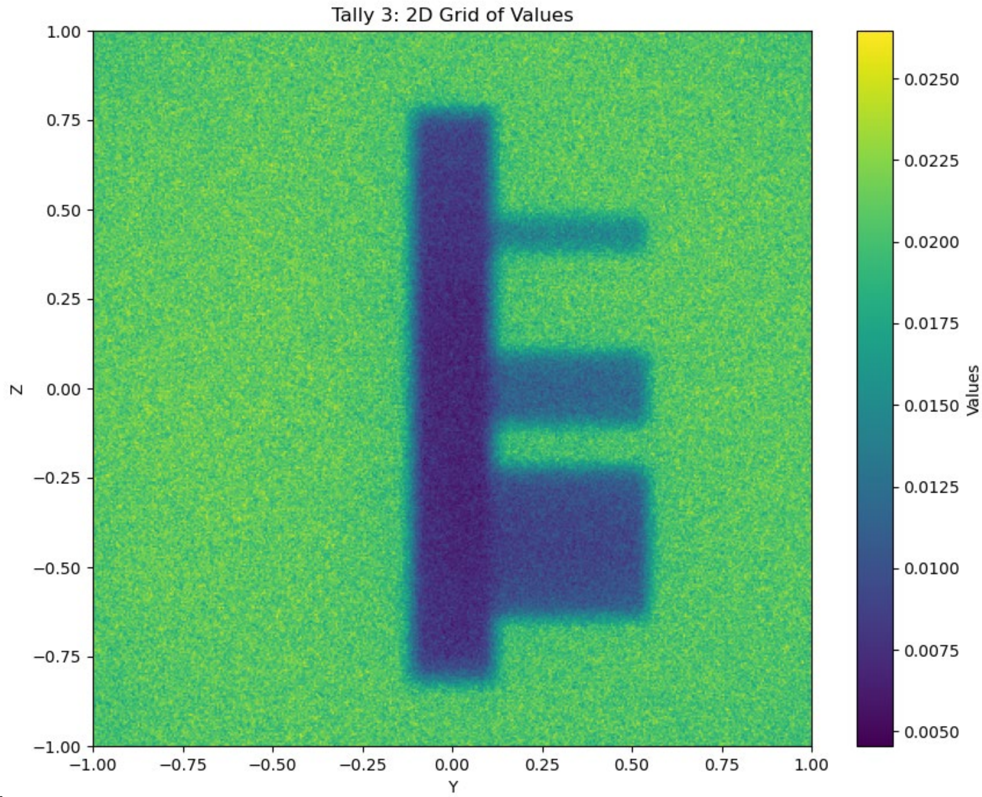
Pre-Shot simulations for the sidelighter series

Radiographs of the static object were simulated with MCNP6.3 with the green spectrum in the figure below.

The x-ray source was simulated as a disc with 100um diameter (*this is a conservatively large spot size*).

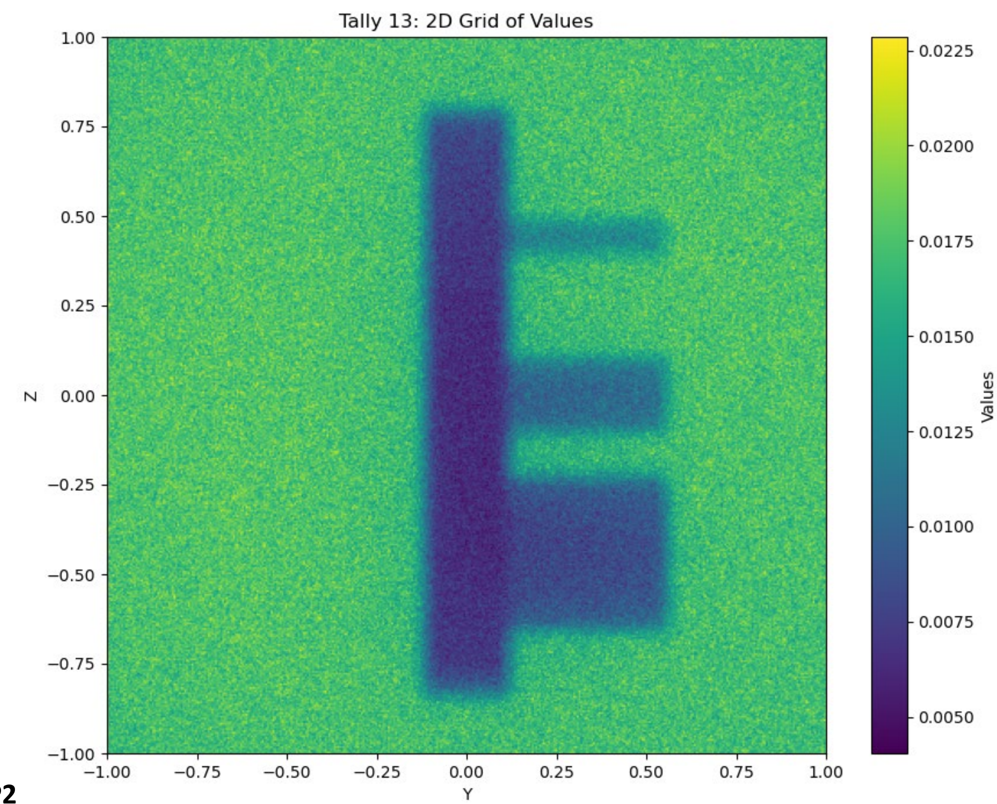






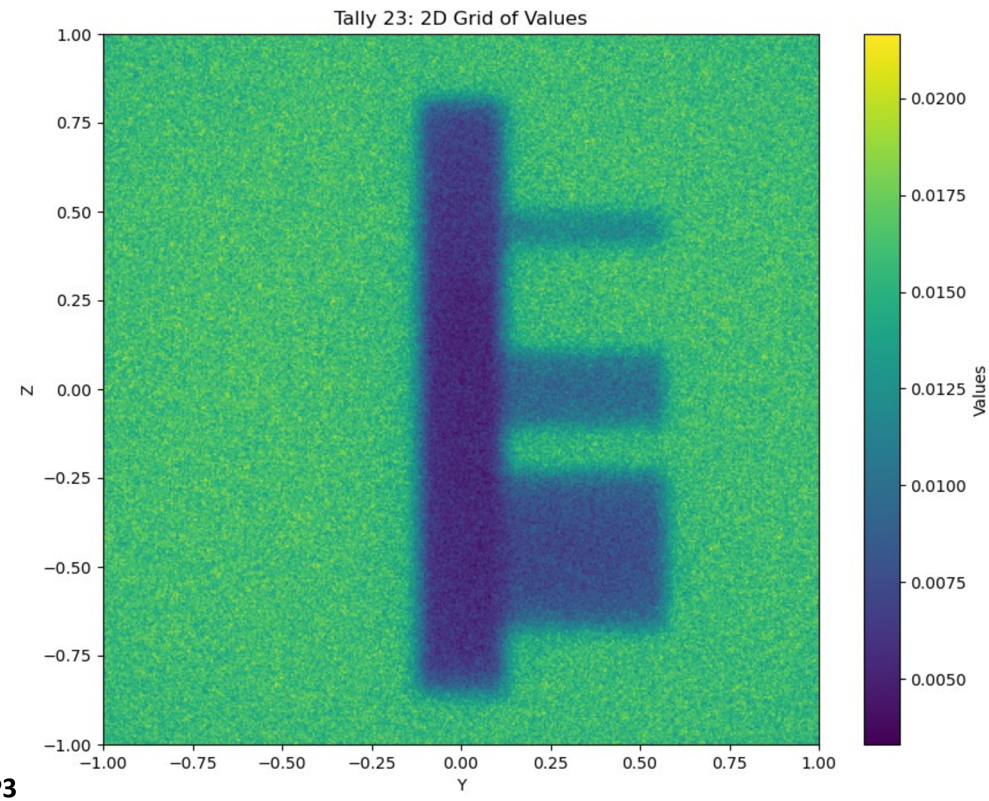
Tally 3: 2D Grid of Values
Z
Y
Values
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050

IP1

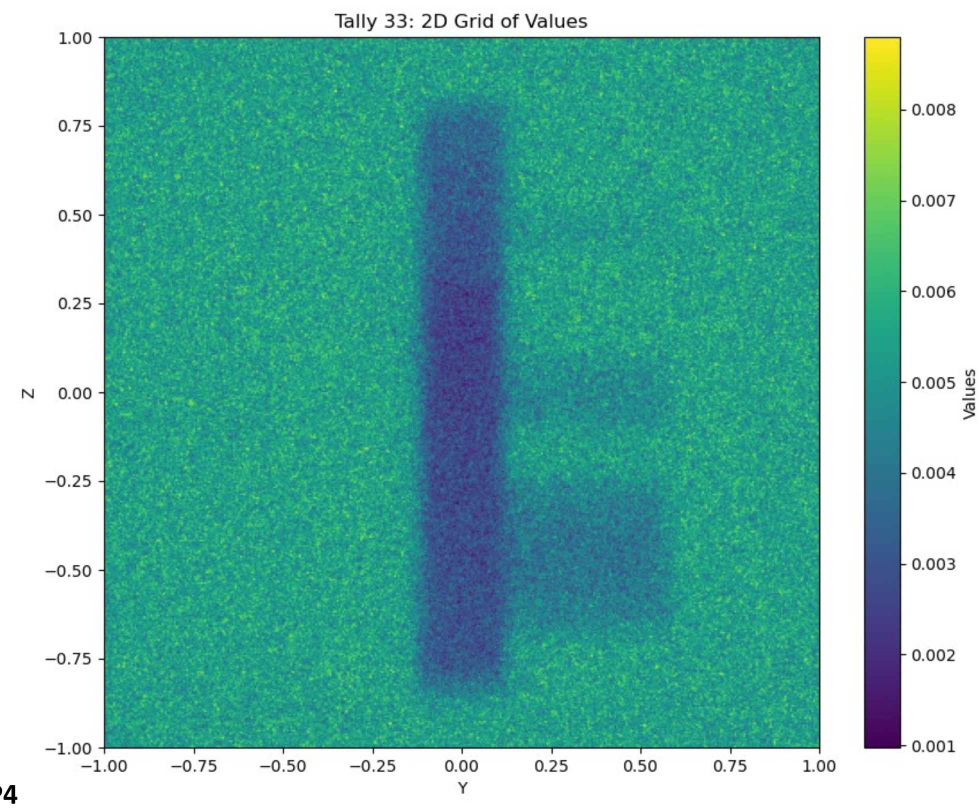


Tally 13: 2D Grid of Values
Z
Y
Values
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050

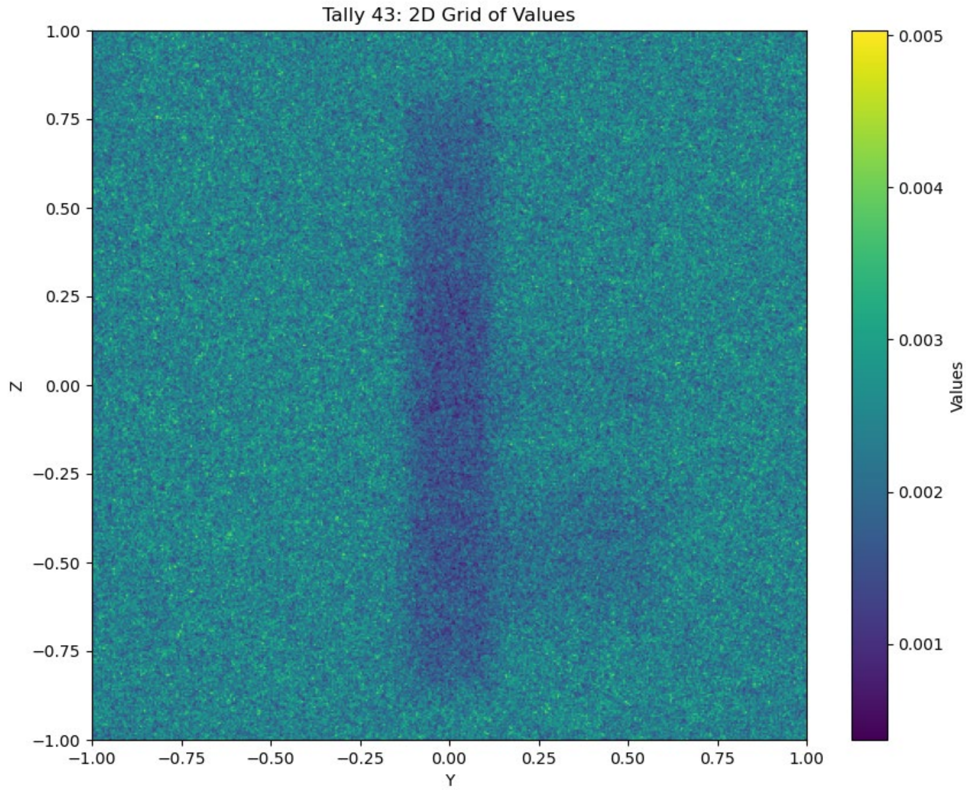
IP2


Tally 23: 2D Grid of Values
Z
Y
Values
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050

IP3


Tally 33: 2D Grid of Values
Z
Y
Values
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001

IP4


Tally 43: 2D Grid of Values
Z
Y
Values
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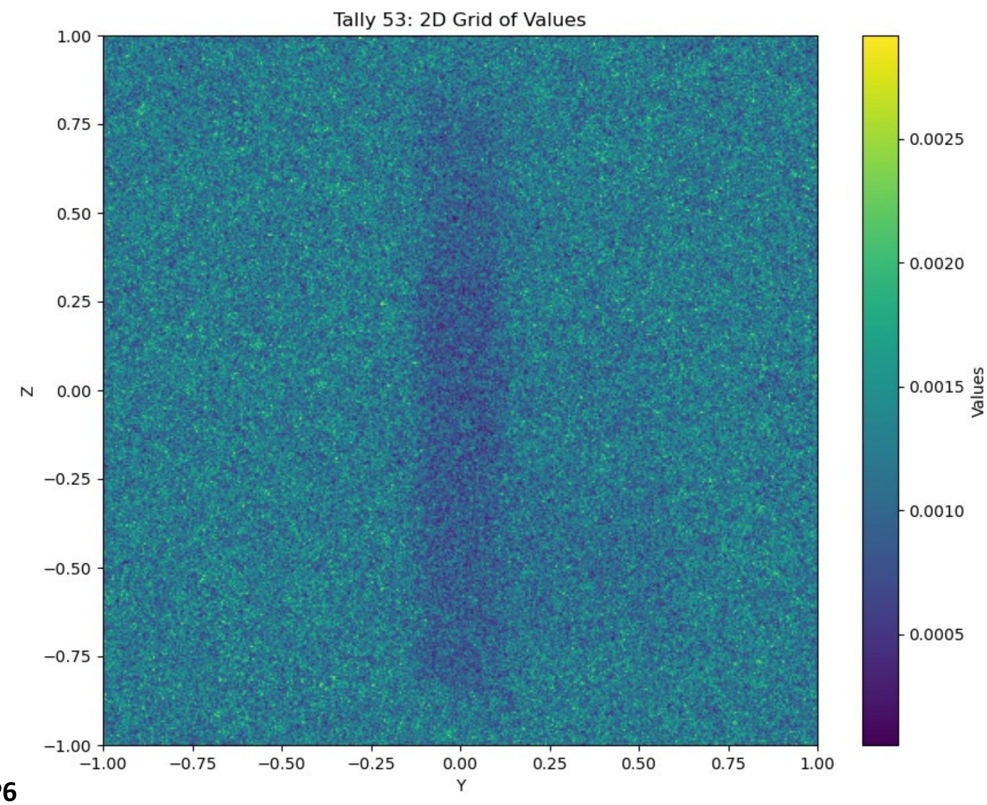
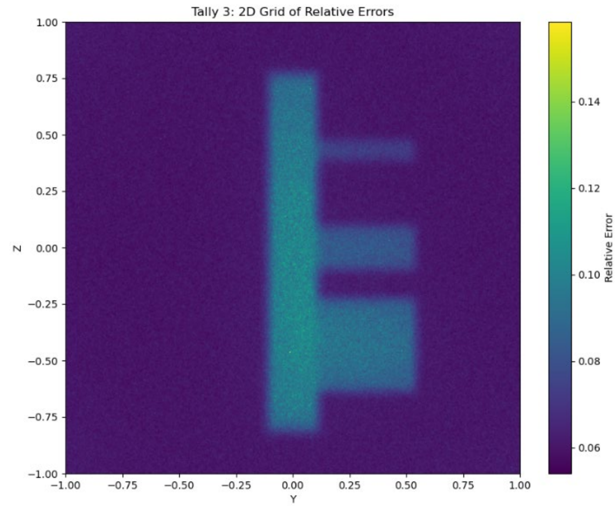
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0.005
0.004
0.003
0.002
0.001

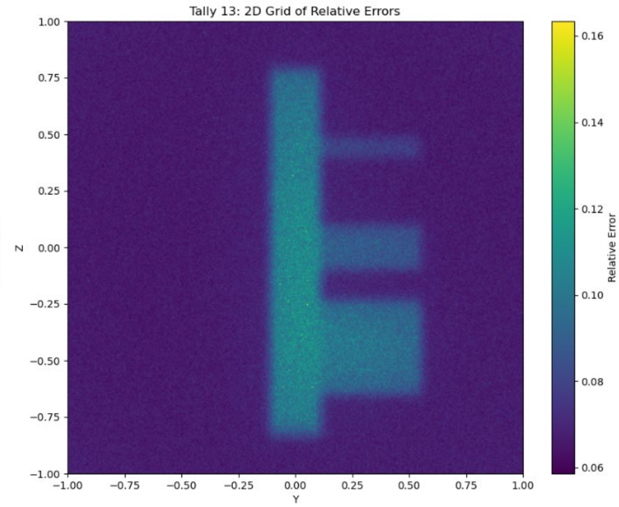
IP5

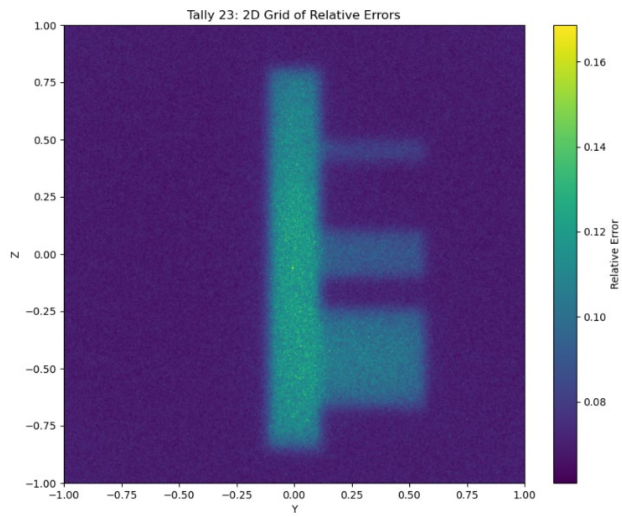

Tally 53: 2D Grid of Values
Z
Y
Values
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0.0025
0.0020
0.0015
0.0010
0.0005

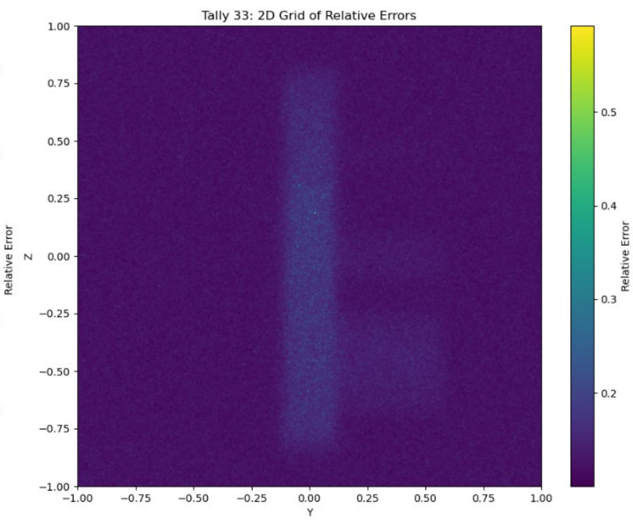
IP6

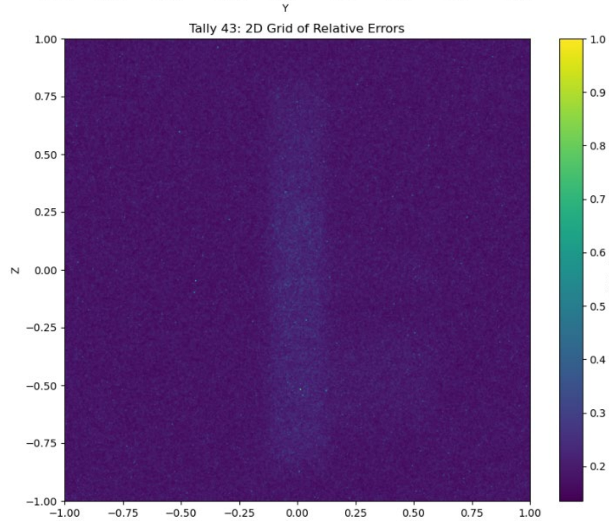
Below are the corresponding relative error for each of the above radiographs (<10-15%)

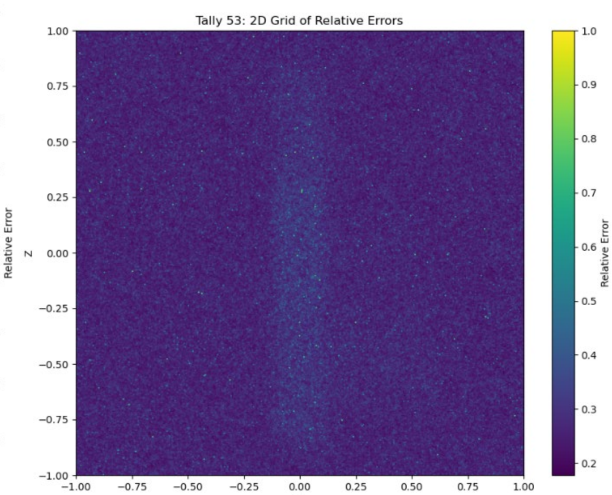


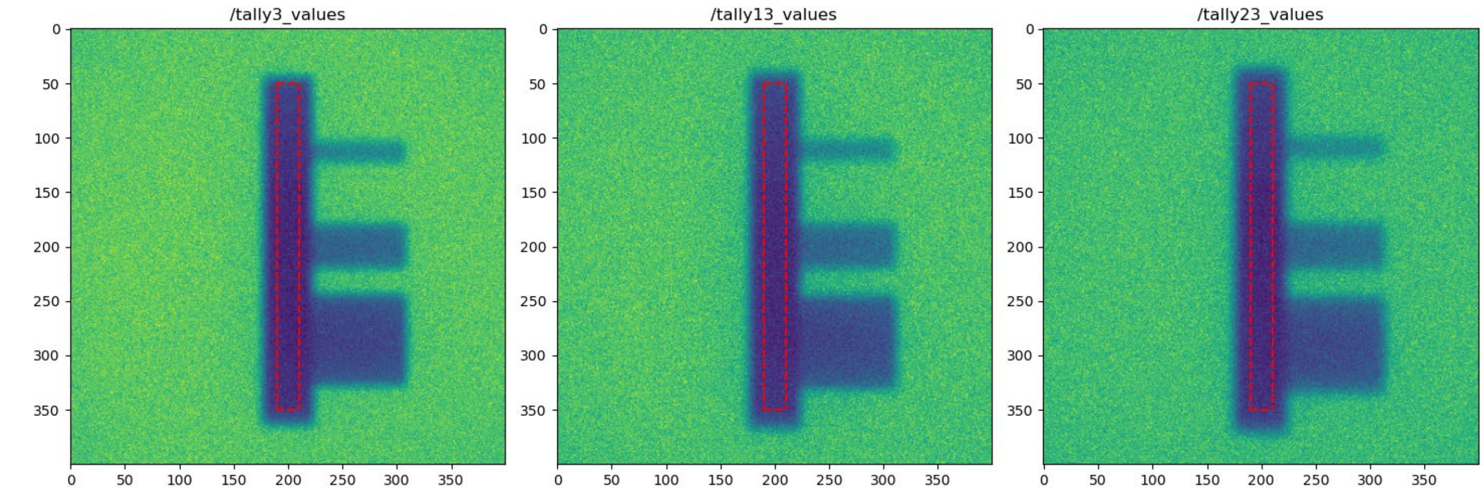


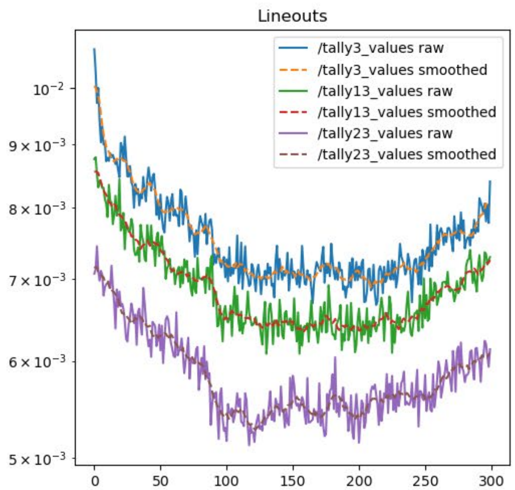








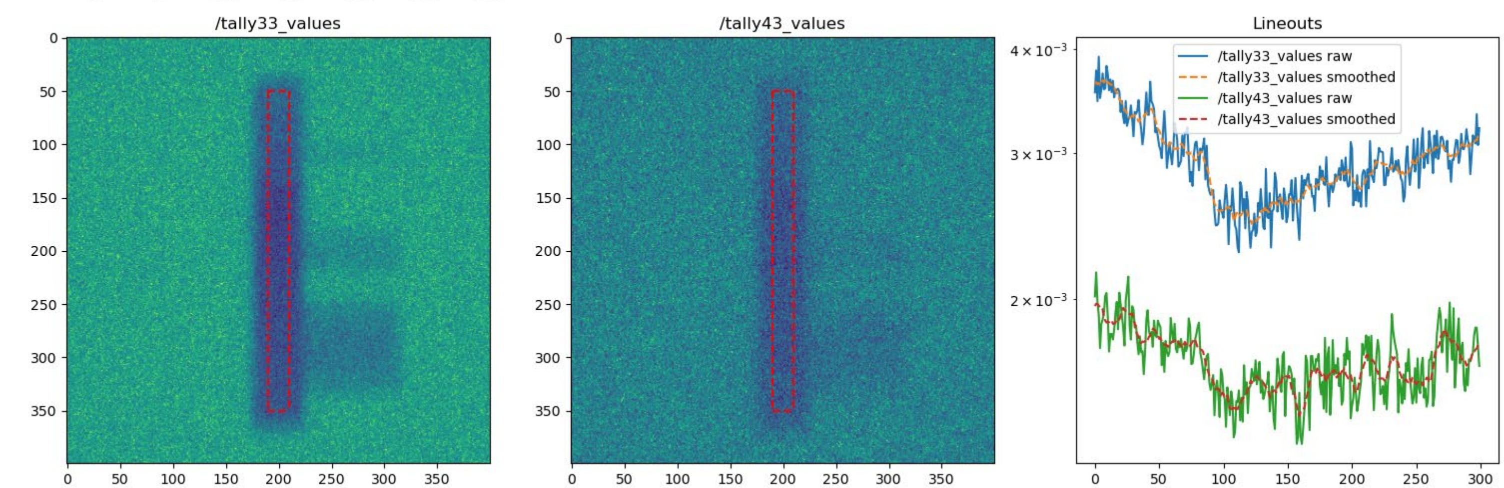




Lineouts are 20 pixels wide in the center of the object.

Lineout smoothing is done using a moving average with 10pixel window (alternative methods should be tested, this was simply to demonstrate the feature are visible within the noise).

Is there a way to normalize IP response to account for variations in object thickness due to the 17-degree slant on the front face of the step-wedge?



Diagnostics

For the **pitcher series**, we will measure ion spectra with TPIE as the primary diagnostic.

- Neutron diagnostics will be nTOF and Neutron Activation PAck (NAPA).
- After initially measuring neutron signal without a LiF converter in the TPIE NTA, we will measure signal with the LiF converter in front of the NAPA.
- X-ray diagnostics include the IP packs either in behind EPPS-3 or in TIM14-NTA (the EPPS-3 will be swapped for an NTA after several shots) – these will have XBLK between the CD/CH film and the IP pack, and BMXS-25 will be used to measure the unshielded x-ray spectrum.
- EPPS-3 and EPPS-1 will be used to measure the electron spectrum with and without shielding, respectively.

For the **x-ray series**, at the start of the day EPPS-3 will along the laser axis to measure the electron spectrum with an IP stack behind.

- Additional x-ray diagnostics are BMXS-25 for spectrum, an IP filter stack within the TPIE NTA to measure the crosstalk signal behind XBLK.
- After the electron spectra data is obtained EPPS-3 will be swapped for an NTA in TIM14 so that higher fidelity radiography can be conducted.

	X-ray series			**Pitcher series**	
Configuration	***xray-SL-1***	***xray-SL-MIFEDS***	***xray-SL-2***	**pitcher-catcher-BL-1**	**pitcher-catcher-BL-2**
SRF RID	93537	94011	94556	94568	93586
Beam	SL (5ps, 20-80J)	SL (5ps, 20-80J)	SL (5ps, 20-80J)	BL (0.7ps, 500J)	BL (0.7ps, 500J)
TIM10	XBLK-1	-	-	XBLK-2	XBLK-2
TIM11	-	MIFEDS	-	-	-
TIM12	TPIE w/NTA (filter stack)	TPIE w/NTA (filter stack)	TPIE w/NTA (filter stack)	TPIE w/NTA (LiF+NAPA)	TPIE w/NTA (LiF+NAPA)
TIM13	EPPS-1	EPPS-1	EPPS-1	EPPS-1	EPPS-1
TIM14	EPPS-3 (radiography)	NTA (IP filter stack)	NTA (IP filter stack)	EPPS-3 (radiography)	NTA (IP filter stack)
Fixed diags	BMXS-25	BMXS-25	BMXS-25	RADMON-BL+SL	RADMON-BL+SL
	RADMON-BL+SL	RADMON-BL+SL	RADMON-BL+SL	Visible camera	Visible camera
Neutronics	-	-	-	nTOF (all 4)	nTOF (all 4)

Primary
Secondary
Ride-along

X-ray IP stacks

X-ray diagnostics will be fielded through a combination of IP stacks on TIM NTAs and on BMXS-25.

For **BMXS-25**, we will use the LLE Standard MeV Pack. Note that the BMXS diagnostic does have a set of magnets included. (2x magnets with 3723 G surface field. 2”x1”x0.5” about 0.5 to 1” apart”).

BMXS IP Cartridge MeV Filter List		
Layer	Filter Thickness (mm)	Filter Material
1	5	Teflon
2	5	Teflon
3	0.1	Al
4	0.5	IP-1
5	0.1	Ti
6	0.5	IP-2
7	0.1	Fe
8	0.5	IP-3
9	0.1	Cu
10	0.5	IP-4
11	0.1	Mo
12	0.5	IP-5
13	0.15	Ag
14	0.5	IP-6
15	0.5	Sn
16	0.5	IP-7
17	0.5	Ta
18	0.5	IP-8
19	1.56	Au
20	0.5	IP-9
21	1	Pb
22	0.5	IP-10
23	2	Pb
24	0.5	IP-11
25	3	Pb
26	0.5	IP-12
27	4	Pb
28	0.5	IP-13
29	6.4	Pb
30	0.5	IP-14
31	6.4	Pb
32	0.5	IP-15

Additional IP packs specifications are summarized below, and then followed by simulated response functions.

Specifications for diagnostics that use with film/IP (*starting configuration* – with EPPS-3 installed)

Backlighter	Sidelighter
TIM14: EPPS-3 with EPPS rad stack (1.3 cm max)	TIM14: EPPS-3 with EPPS rad stack (1.3 cm max)
TIM12: *if room, 1 RCF film between LiF and NAPA*	TIM12: NTA LANL_X_Talk_stack (held by TPIE)
	BMXS-25: standard MeV stack

LANL_EPPS_rad_stack

Layer	IP #	Material	Thickness (mm)	Total Thickness (mm)
1		Al	0.1	0.1
2	1	MS-IP	0.5	0.6
3		Al	1	1.6
4	2	MS-IP	0.5	2.1
5		Al	2	4.1
6	3	MS-IP	0.5	4.6
7		Cu	0.5	5.1
8	4	MS-IP	0.5	5.6
9		Cu	1	6.6
10	5	MS-IP	0.5	7.1
11		Ta	0.5	7.6
12	6	MS-IP	0.5	8.1
13		Ta	1	9.1
14	7	MS-IP	0.5	9.6
15		Ta	2	11.6
16	8	MS-IP	0.5	12.1
17		Cu	0.5	12.6

LANL_X_Talk_stack

Layer	IP #	Material	Thickness (mm)	Total Thickness (mm)	Notes
1		Al	0.1	0.1	
2		Mylar	4	4.1	Mylar cut in half laterally (or vertically)
3	1	MS-IP	0.5	4.6	
4		Al	1	5.6	
5	2	MS-IP	0.5	6.1	
6		Al	2	8.1	
7	3	MS-IP	0.5	8.6	
8		Cu	0.25	8.85	
9	4	MS-IP	0.5	9.35	
10		Cu	1	10.35	
11	5	MS-IP	0.5	10.85	
12		Cu	2	12.85	
13	6	MS-IP	0.5	13.35	
14		Ta	1	14.35	
15	7	MS-IP	0.5	14.85	
16		Ta	2	16.85	
17	8	MS-IP	0.5	17.35	
18		Cu	0.5	17.85	Wrap sides in 0.5 mm Cu too

Specifications for diagnostics that use with film/IP (*second configuration* – EPPS-3 swapped out for NTA)

Backlighter	Sidelighter
TIM14: NTA LANL_X_Talk_stack	TIM14: NTA LANL_radiography_stack
TIM12: *if room, 1 RCF film between LiF and NAPA*	TIM12: NTA LANL_X_Talk_stack (held by TPIE)
	BMXS-25: standard MeV stack

LANL_radiography_stack

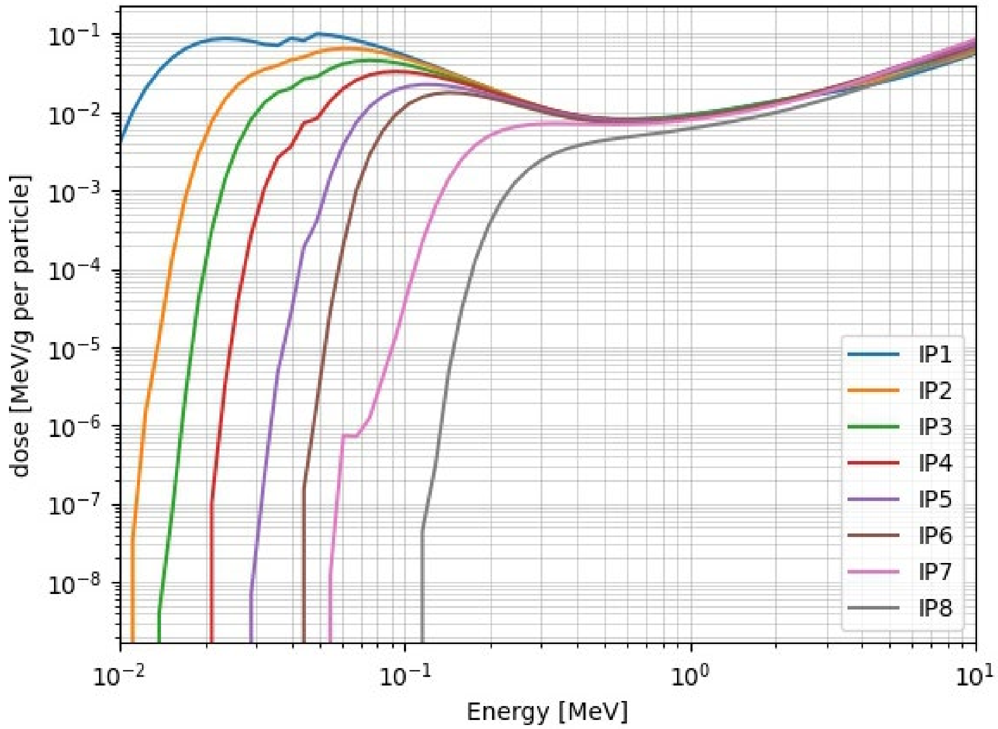
Layer	IP #	Material	Thickness (mm)	Total Thickness (mm)	Notes
1		Al	0.1	0.1	
2	1	MS-IP	0.5	0.6	
3		Mylar	2	2.6	
4	2	MS-IP	0.5	3.1	
5		Mylar	2	5.1	
6	3	MS-IP	0.5	5.6	
7		Al	2	7.6	
8	4	MS-IP	0.5	8.1	
9		Al	2	10.1	
10	5	MS-IP	0.5	10.6	
11		Al	2	12.6	
12	6	MS-IP	0.5	13.1	
13		Ta	1	14.1	
14	7	MS-IP	0.5	14.6	
15		Ta	2	16.6	
16	8	MS-IP	0.5	17.1	
17		Cu	0.5	17.6	Wrap sides in 0.5 mm Cu too

LANL_X_Talk_stack

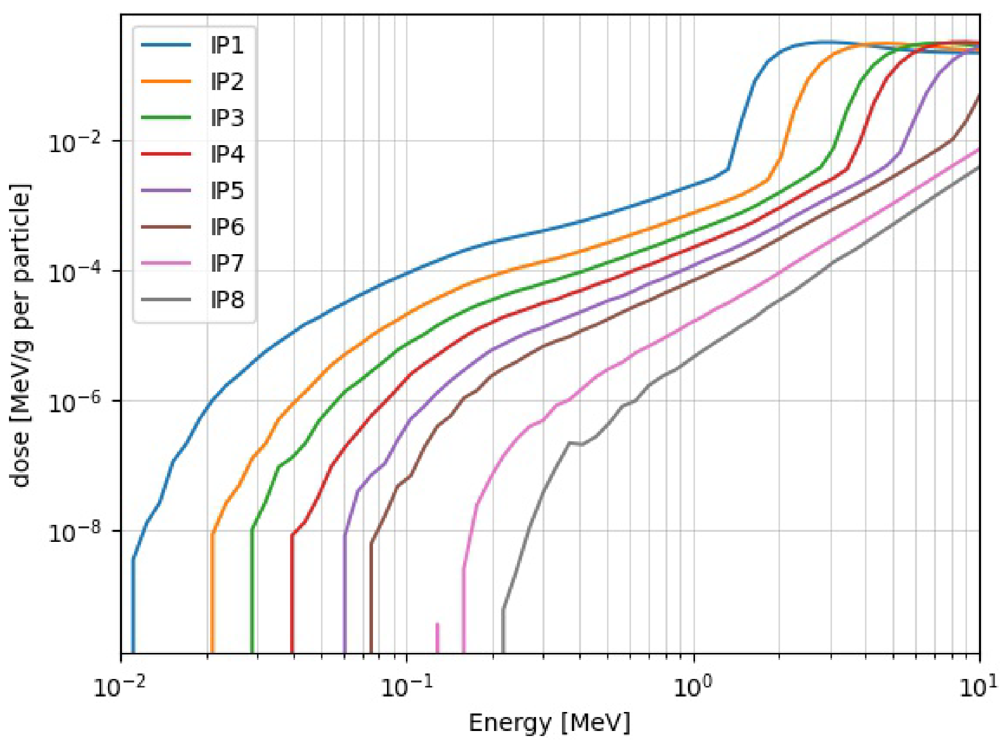
Layer	IP #	Material	Thickness (mm)	Total Thickness (mm)	Notes
1		Al	0.1	0.1	
2		Mylar	4	4.1	Mylar cut in half laterally (or vertically)
3	1	MS-IP	0.5	4.6	
4		Al	1	5.6	
5	2	MS-IP	0.5	6.1	
6		Al	2	8.1	
7	3	MS-IP	0.5	8.6	
8		Cu	0.25	8.85	
9	4	MS-IP	0.5	9.35	
10		Cu	1	10.35	
11	5	MS-IP	0.5	10.85	
12		Cu	2	12.85	
13	6	MS-IP	0.5	13.35	
14		Ta	1	14.35	
15	7	MS-IP	0.5	14.85	
16		Ta	2	16.85	
17	8	MS-IP	0.5	17.35	
18		Cu	0.5	17.85	Wrap sides in 0.5 mm Cu too

X-ray energy deposition vs x-ray energy for each MS-IP stack as simulated in MCNP6.3.

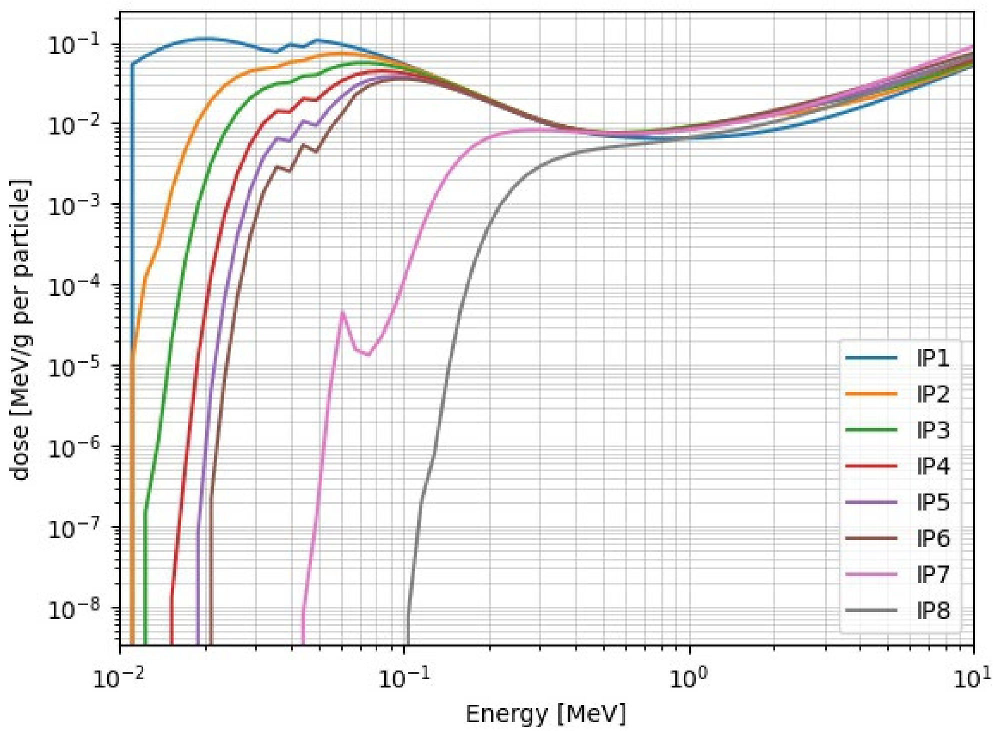
Photon response for LANL_X_Talk_stack:



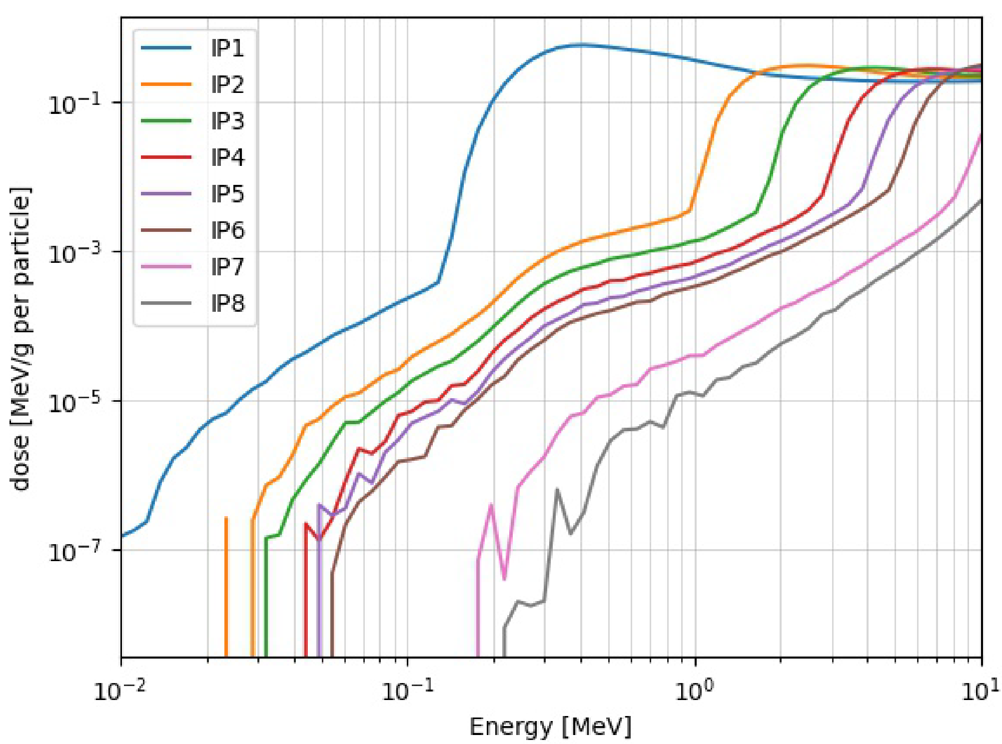
Electron response for LANL_X_Talk_stack:



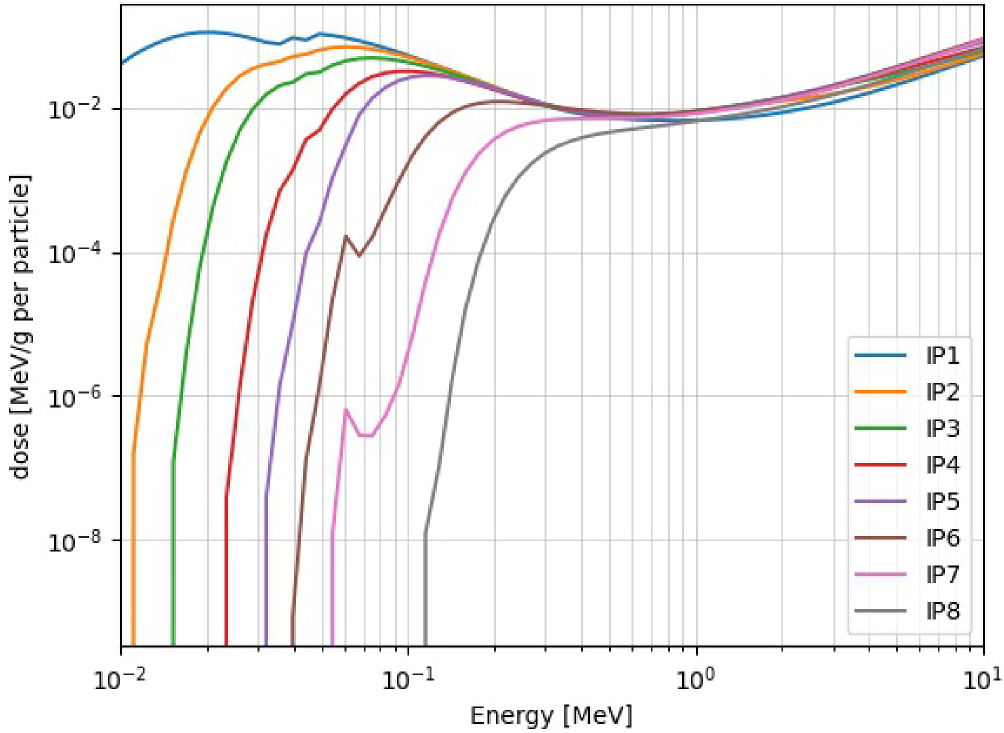
Photon response to LANL_radiography_stack:



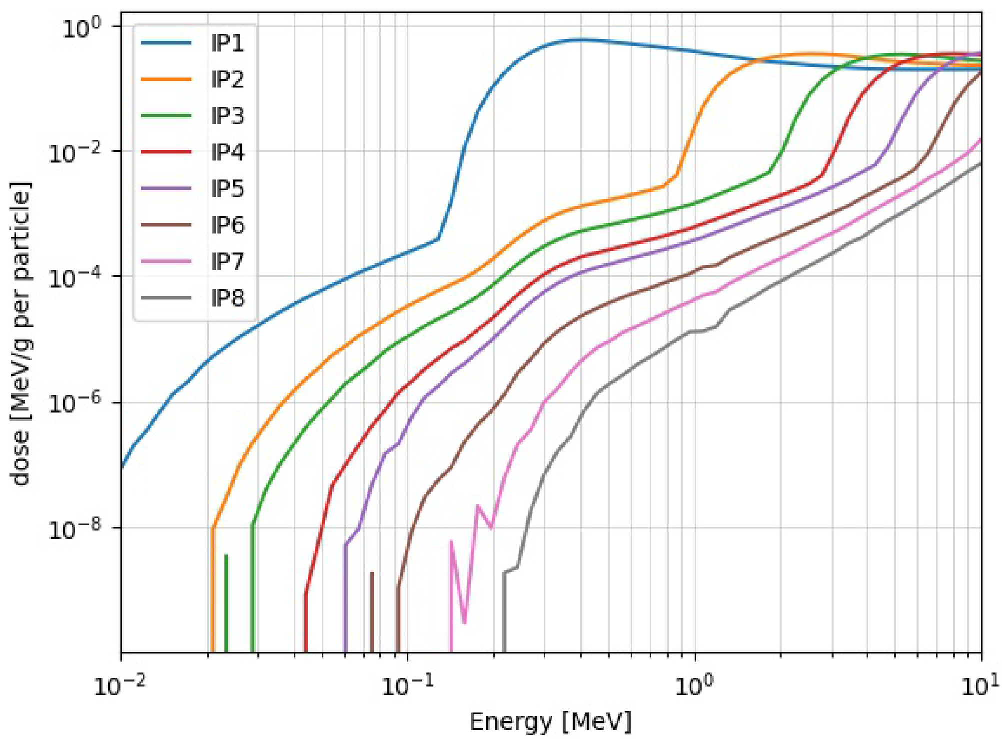
Electron response to LANL_radiography_stack:



Photon response LANL_EPPS_rad_stack:



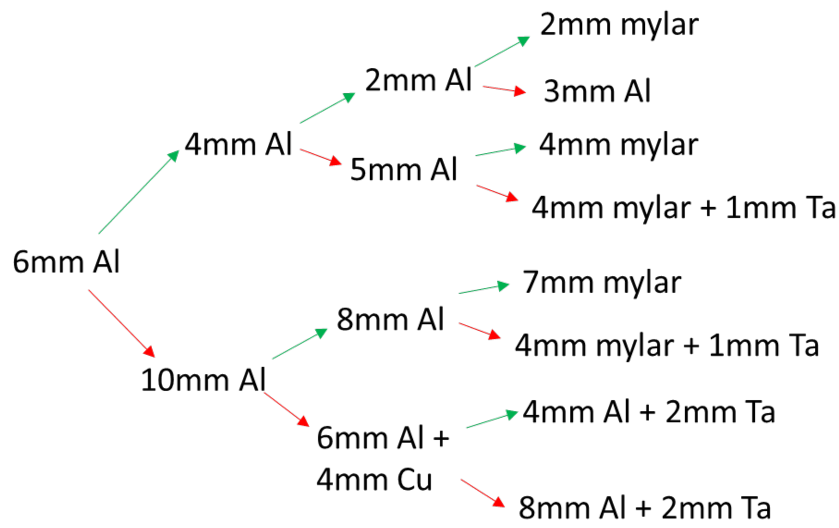
Electron response LANL_EPPS_rad_stack:



XBLK: Crosstalk shield

Notional XBLK plan

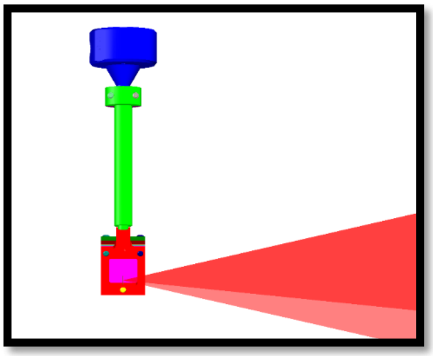
There are four full energy CD/CH foils to be shot with XBLK-2. The following outlines one potential sequence of shots. The evaluation will be semi-qualitative, however PSL values for the x-ray shots can be used to inform what a high background is.

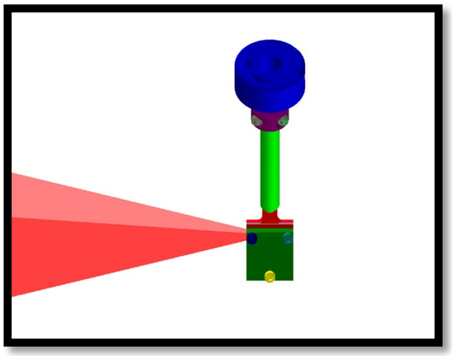


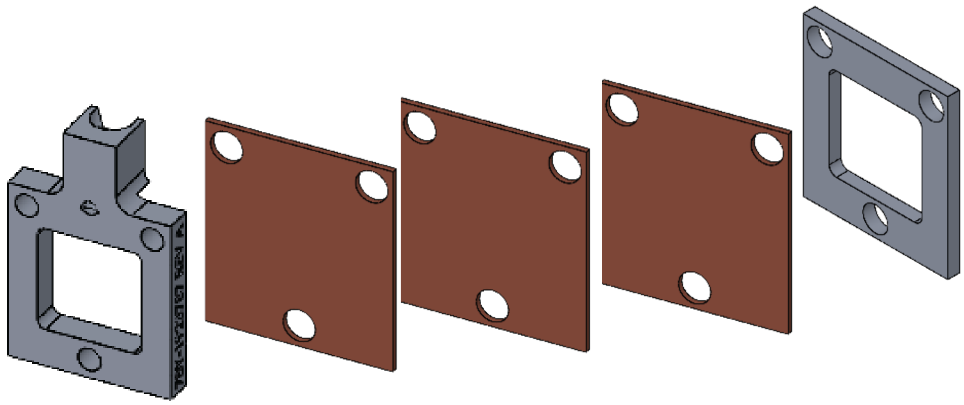
We will field **XBLK** a shield intended to filter crosstalk between perpendicular lasers.

- XBLK-1 is fielded on Sidelighter shots to prevent exposure of Backlighter imaging diagnostics
- XBLK-2 is fielded on Backlighter shots to prevent exposure of the Sidelighter imaging diagnostics

Both XBLK-1 and -2 (designed by J. Jorgenson) are mounted on **TIM-10** using the NOVA mount. The design (front on the left, back on the right) allows for filter pieces from 1 mm to 10 mm in thickness to be easily added or removed from the front plate by three screws. The filters have a 15.6 by 17.1 mm lateral dimension. Technical drawings for XBLK and the filters are provided in the Appendix. The only difference between XBLK-1 and -2 is the orientation.



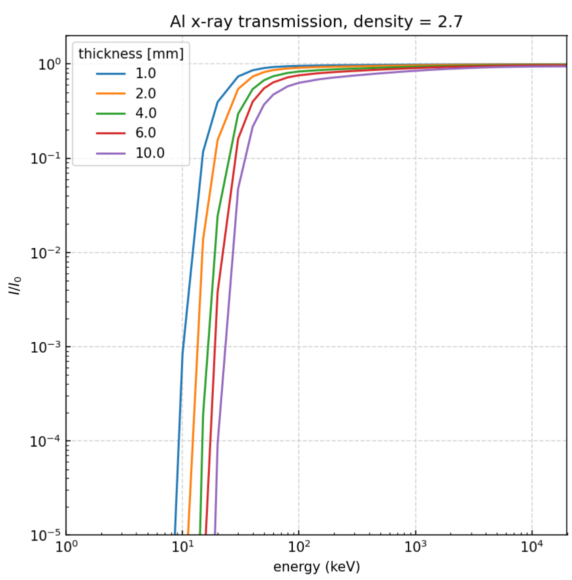


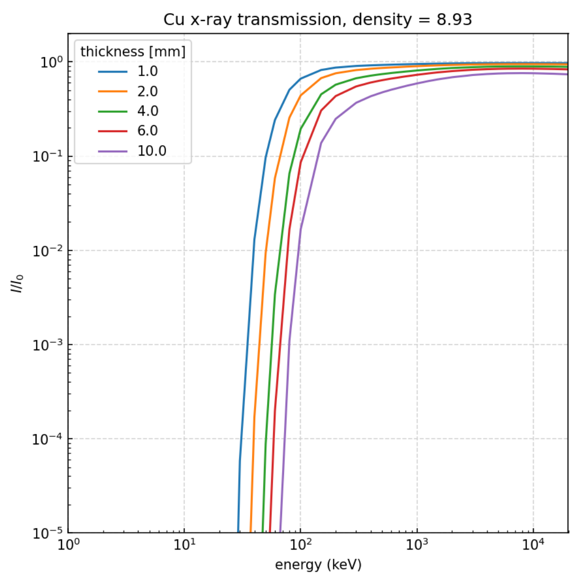


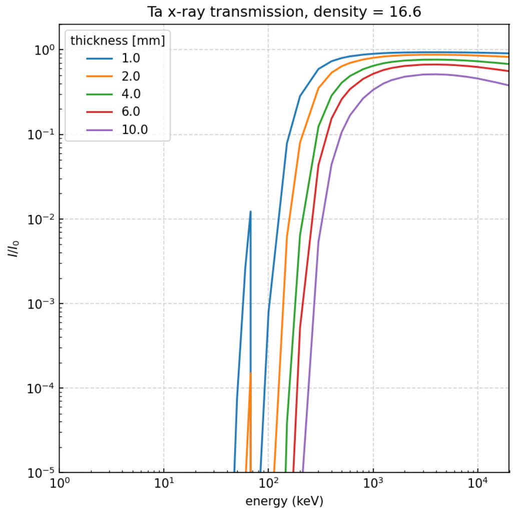
The filter thicknesses and quantities we had fabricated out of Cu, Ta, Al, and Mylar are given next.

Material	Thickness	Quantity
Copper	0.5mm	4
	1mm	16
	2mm	8
Tantalum	1mm	4
	2mm	8
Aluminum	0.5mm	2
	1mm	4
Mylar	2mm	6

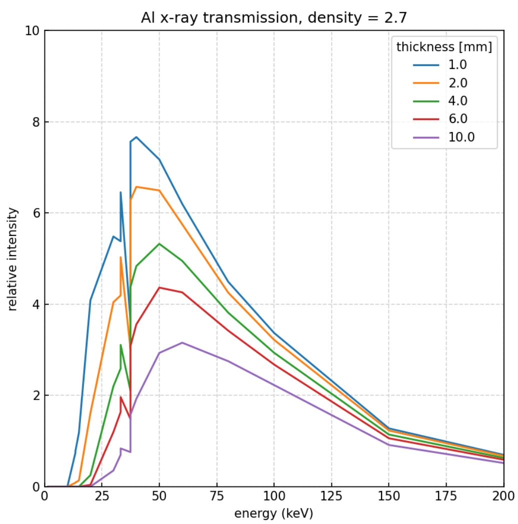
Below are transmission curves for Al, Cu, Ta of various thicknesses.

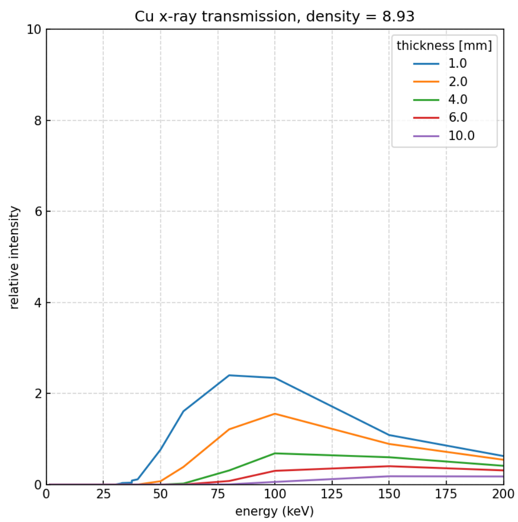


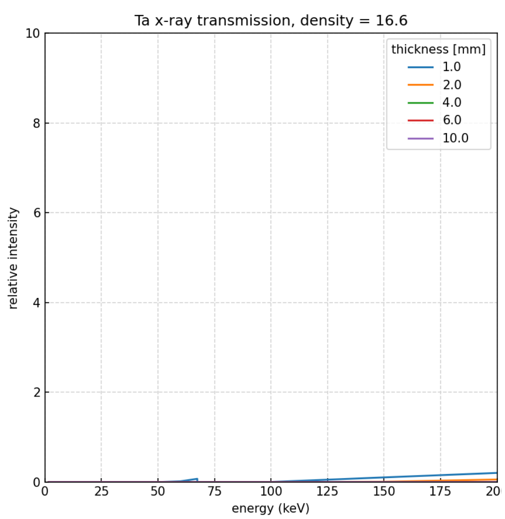




Below are predicted image plate responses for a flat x-ray spectrum.







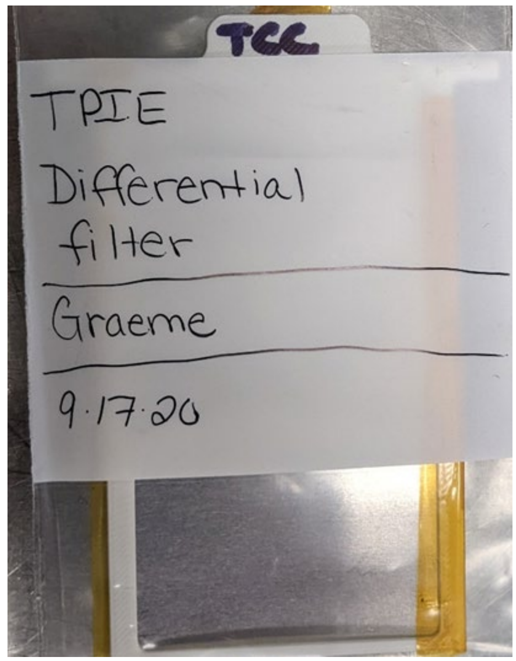
Ion/Neutron Diagnostics

Backlighter

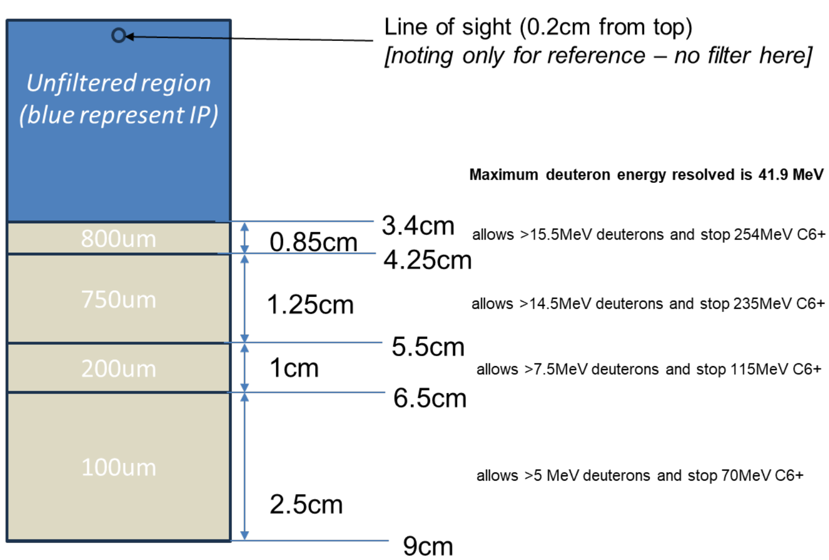
For the backlighter shots (pitcher series), we will use TPIE (TIM-12) with a LiF converter and NAPA (within TIM-14 orthogonal NTA with LOS hole).

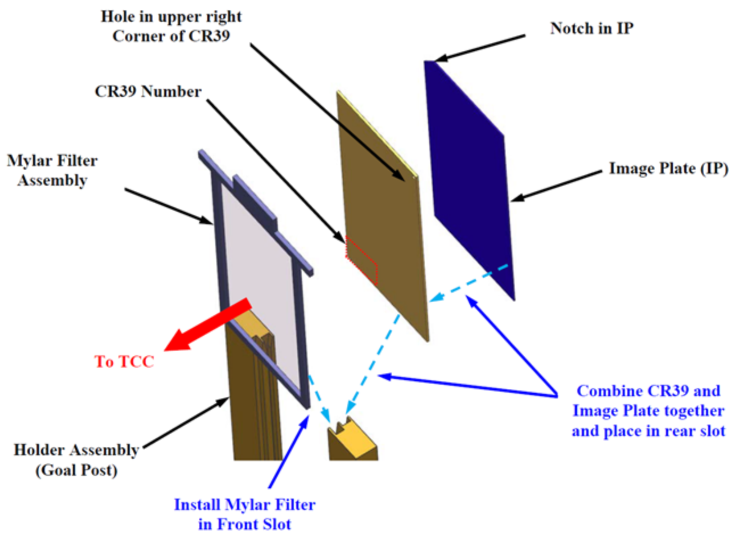
For TPIE, we will use the differential step filter below to stop C^{6+} but allow D^{+} to go through. We will have an SR image plate in back to detect the ions.

The following filter is used for P1 (up to ~20 MeV deuterons).



The following is used for P2 to measure high energy deuterons, up to ~42 MeV.





The **TPIE** parameters are as follows:

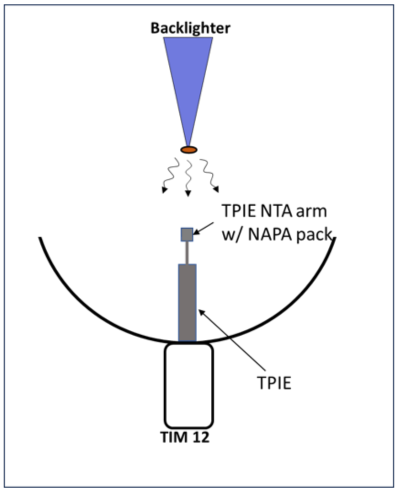
- Pinhole (Ø) 250 um
- IP in P1 (10 cm)*
- 5.6 kG magnet
- 10 kV/cm electric field (electrodes set to -5 kV and +5 kV)
- Pixel size: 50 microns
- Differential filter for CD films**

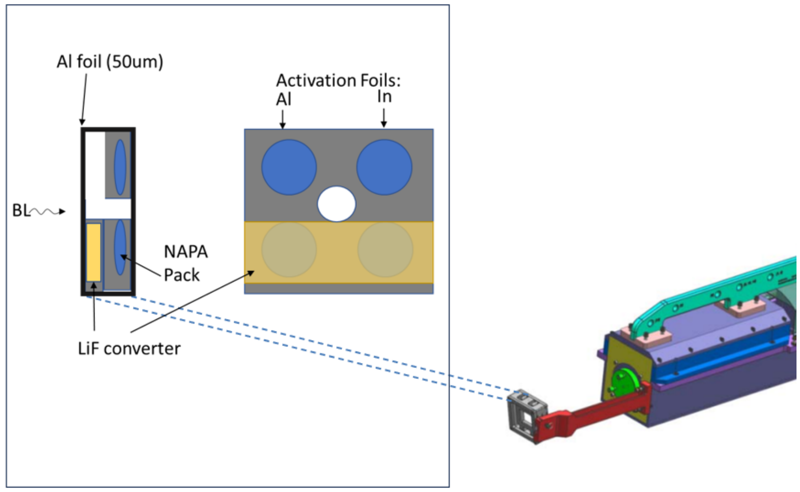
* Shot 5 (500nm CH film) use P2 without differential filter to measure maximum proton energy
** Shots 1,3,7,9 (CD film thickness scan) use P1 with Graeme's differential filter (shown above) to measure low energy D^+ spectra
* and ** Shot 11 (best CD film) use P2 with 'LANL2023' differential filter (shown above) to clearly see high energy portion of D^+ spectrum

LiF and NAPA with TPIE-NTA arm

The TPIE NTA arm will be used to hold a pack containing a LiF converter and four activation foils. The purpose of this is to generate neutrons and measure the difference between the signal immediately beside the LiF source and the signal at a slightly increased distance (to gauge that we have some localized production above background). This pack is a secondary diagnostic and the line-of-sight hole allows ions to enter TPIE for higher precision spectrometry.

TPIE with NTA arm for LiF and neutron activation foils





- **23mm diameter by 3mm thick foils**.
- Centered 10mm diam aperture
- Pack designed to infer neutron distribution with a thru-hole for joint use with TPIE

Below are cross section plots illustrating energy dependence of neutron yield in Lithium from protons and deuterons.

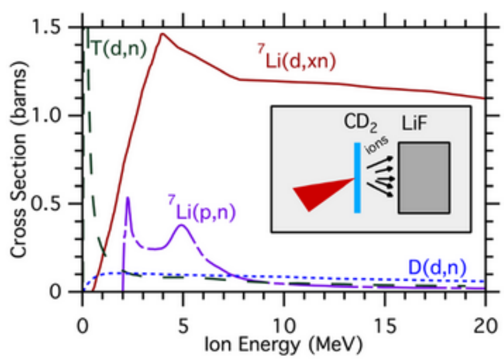
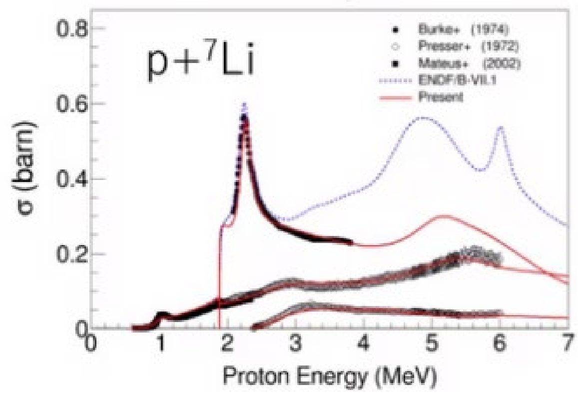
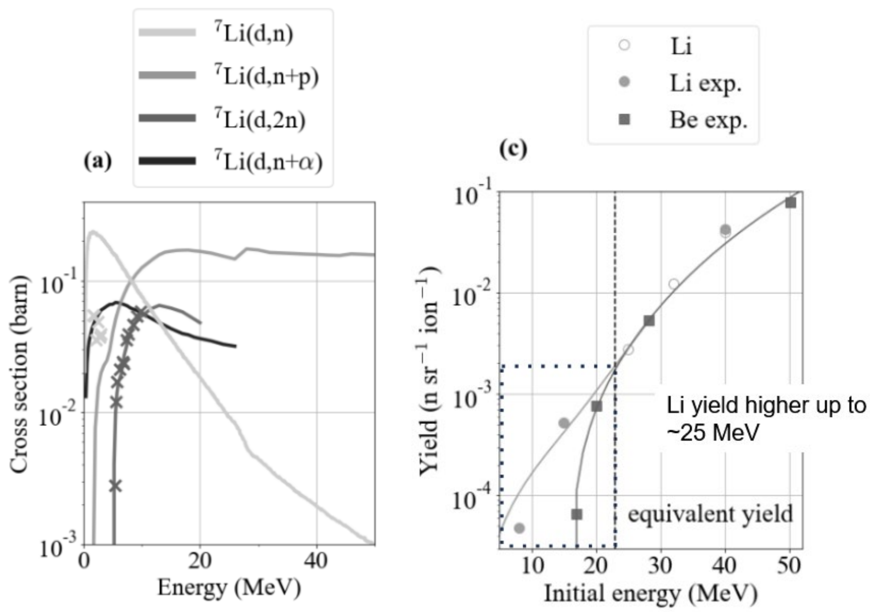


FIG. 1. (Color online) Cross sections of nuclear reactions that have potential for neutron generation using ions. Above 1 MeV the ^{7}Li(d,xn) reaction is the highest by far. The inset shows the target setup used in this experiment, where ions accelerated from a CD_2 foil are incident on a LiF slab.

https://doi.org/10.1063/1.3654040 Higginson et al 2011

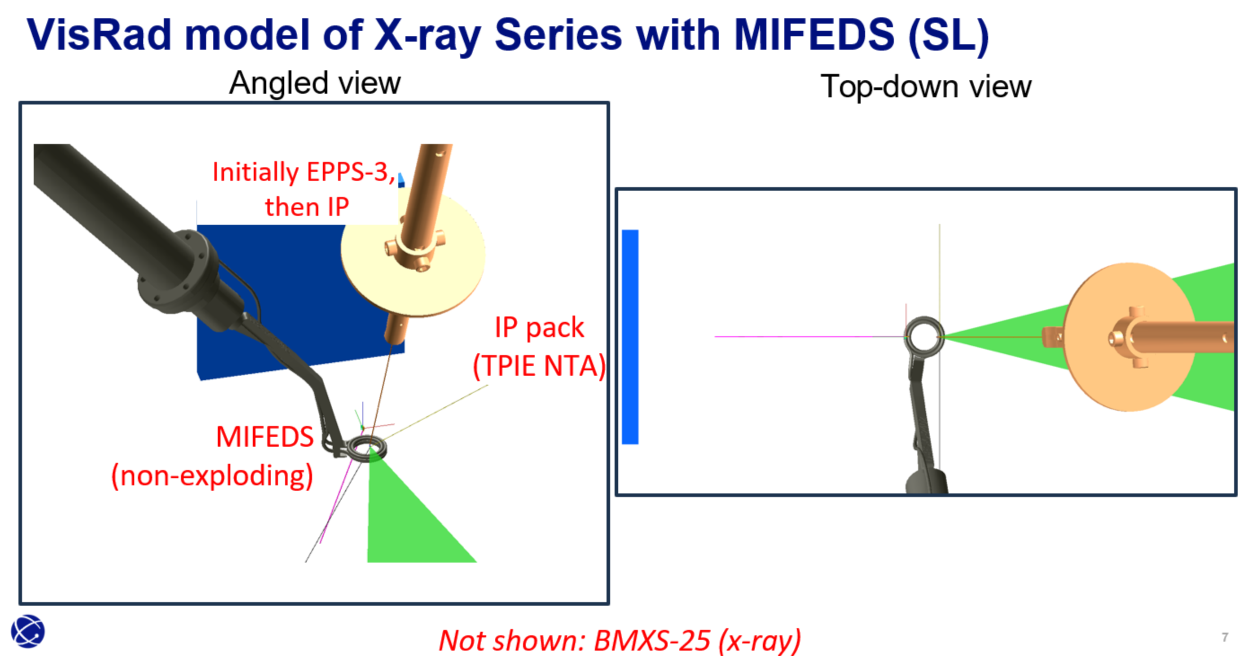


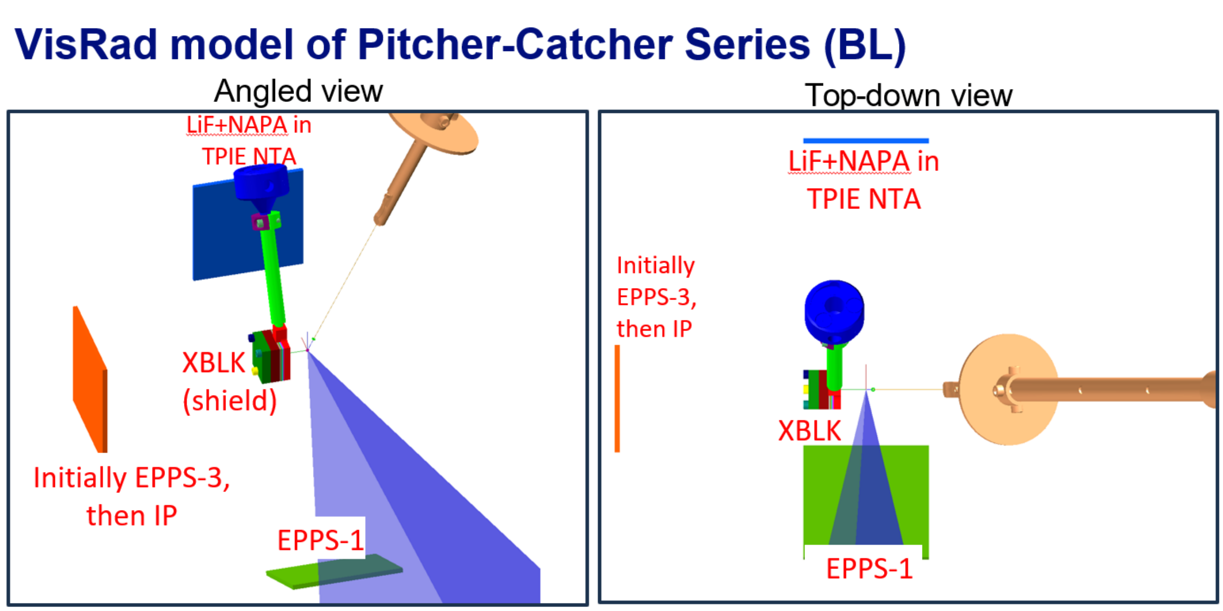
Illustrating energy dependent of neutron production from protons on Lithium (JENDL-4.0/HE)

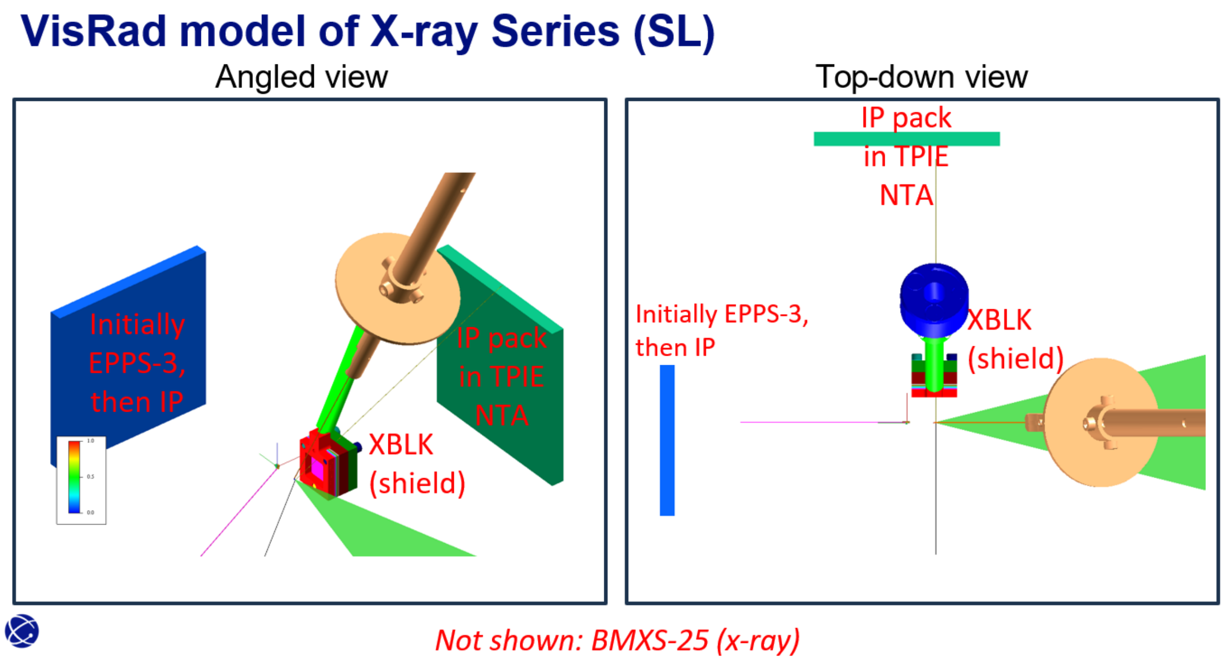


Above, **(a)** shows reaction probability for neutron production from deuterons, **(c)** shows neutron yield from deuterons. https://doi.org/10.3390/instruments5040038

Shot configurations







Appendix

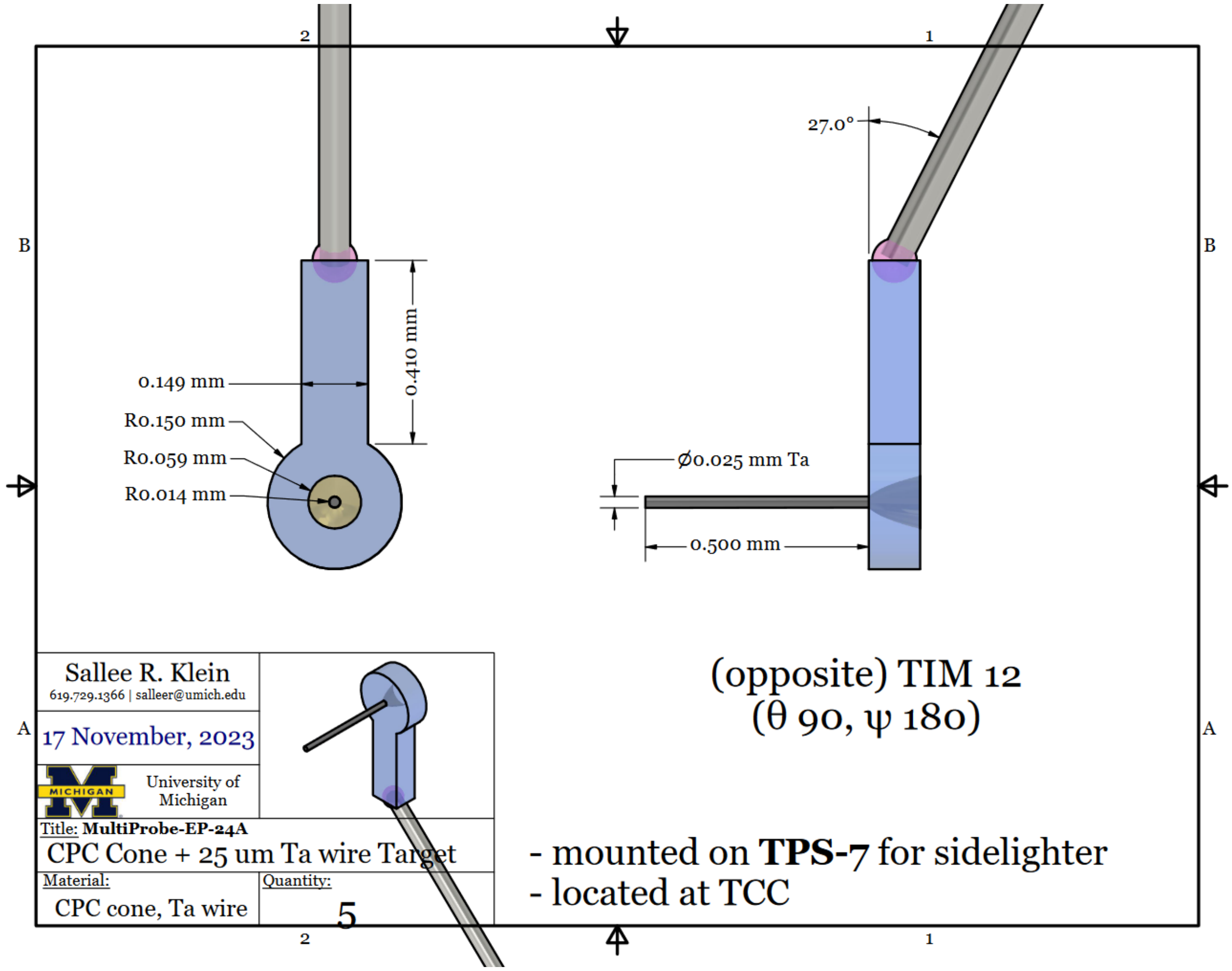
Material properties

Material	Chemical Formula	nominal density (g/cc)	AMU	Z
Ta	Ta	16.6	180.9	73
Cu	Cu	8.93	63.546	29
Al	Al	2.7	26.98	13
Mylar (polyethelene terephthalate)	$C_{10}H_8O_4$	1.63	---	---
Kapton	$C_{22}H_{10}N_2O_5$	1.43	---	---
MS-IP	8 um mylar + 124 um $BaFBr_{0.85}I_{0.15}$ +~220 um mylar	3.18	---	---

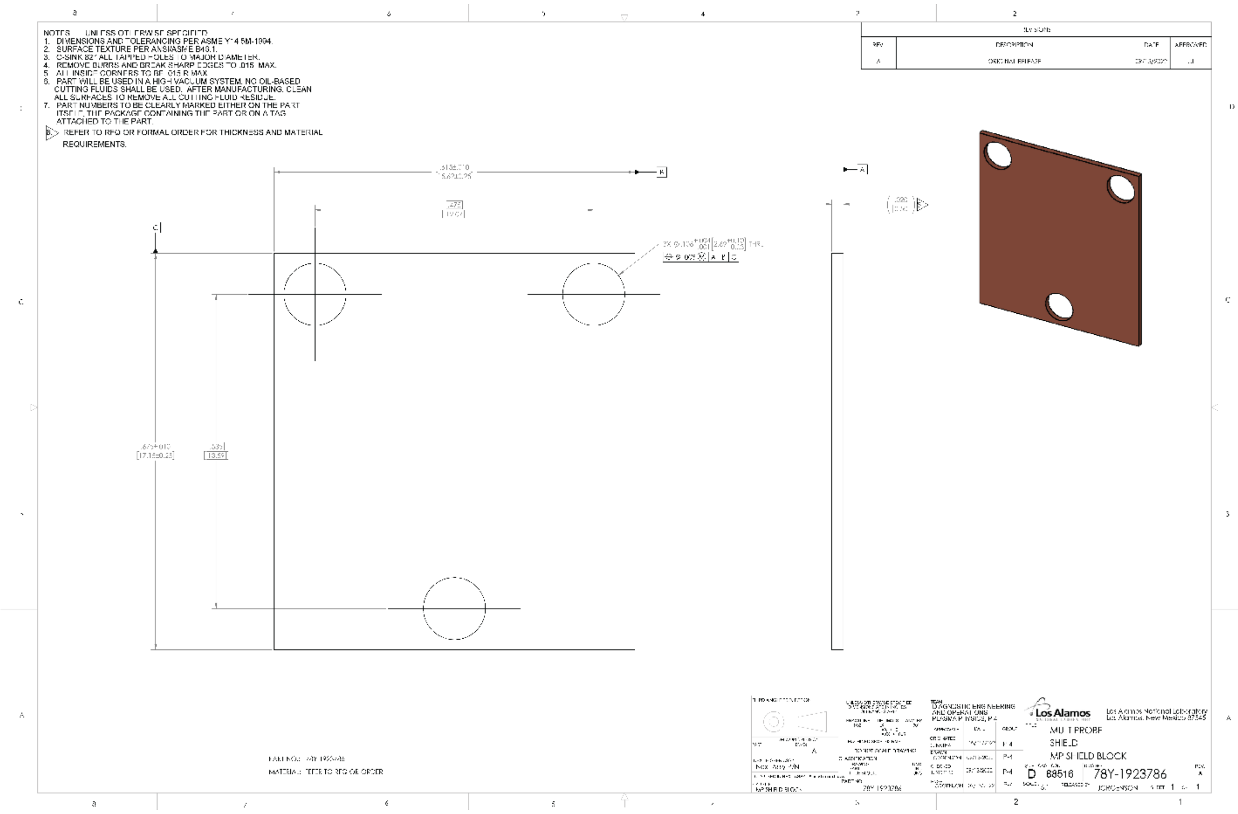
Relative angles in Omega EP chamber between targets & ports/diagnostics (CSW)

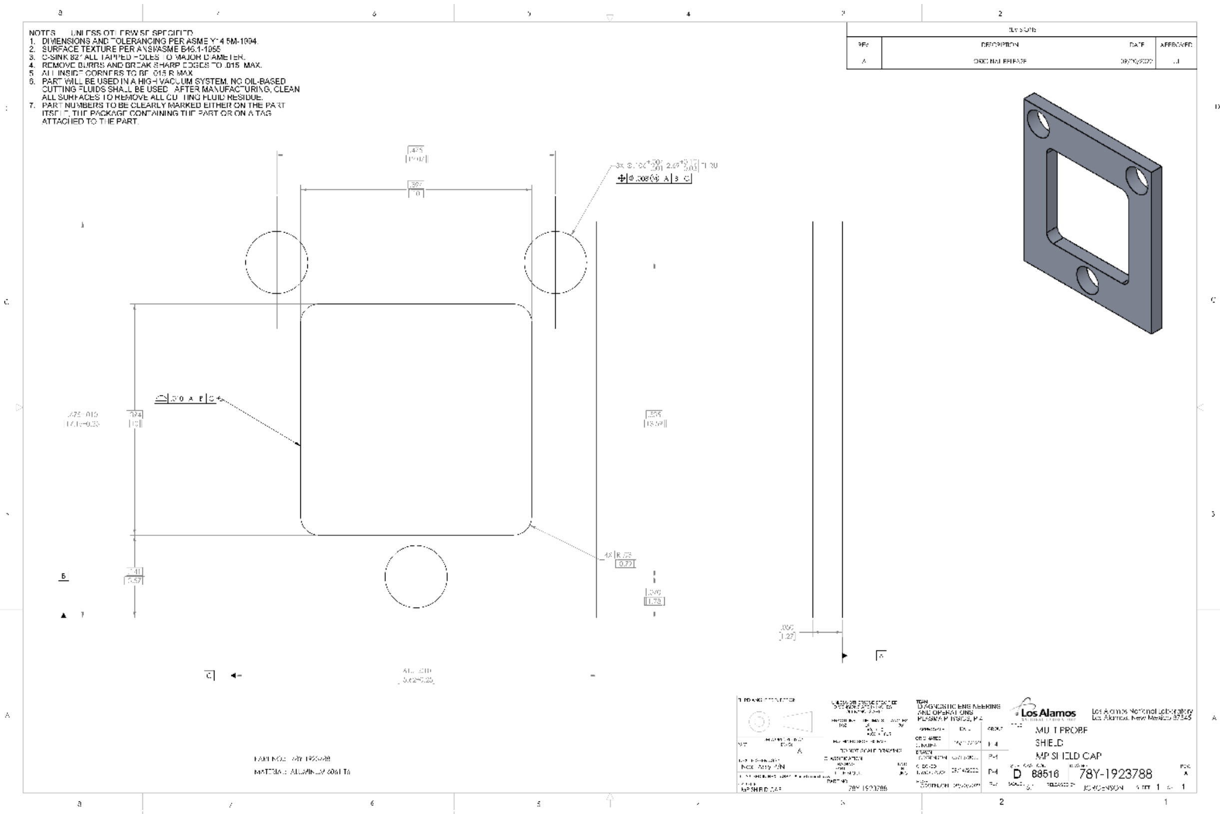
	Initialization		units: cm, deg							
	Chamber radius	75								
PORT	**targets**	**r**	**theta (0 to 180)**	**phi (0 to 360)**	**x**	**y**	**z**			
51	backlighter: port 51	0	90	180	*0.00*	*0.00*	*0.00*			
54	sidelighter	1	90	270	*0.00*	*-1.00*	*0.00*			
	Calculation								OUTPUT: angles relative to beam direction	
PORT	**TIM/Diagnostic name**	**r**	**theta (0 to 180)**	**phi (0 to 360)**	**x**	**y**	**z**		**angle to backlighter**	**angle to sidelighter**
63	Beam 3	75	106	163	*-68.94*	*21.08*	*-20.67*		**156.82**	**72.95**
38	Beam 4	75	74	197	*-68.94*	*-21.08*	*20.67*		**156.82**	**105.59**
37	Beam 1	75	74	160.00	*-67.75*	*24.66*	*20.67*		**154.59**	**70.09**
64	Beam 2	75	106	197.00	*-68.94*	*-21.08*	*-20.67*		**156.82**	**105.59**
2	TIM 10	8	27	0.00	*3.63*	*0.00*	*7.13*		**63.00**	**82.87**
9A	TIM 11	8	39	189.00	*-4.97*	*-0.79*	*6.22*		**128.43**	**88.47**
45	TIM 12/TPIE/PROBIES	8	90	0.00	*8.00*	*0.00*	*0.00*		**0.00**	**82.87**
87	TIM 13 - NTA	8	153	180.00	*-3.63*	*0.00*	*-7.13*		**117.00**	**82.87**
48	TIM 14 NORMAL	8	90	90	*0.00*	*8.00*	*0.00*		**90.00**	**0.00**
	TIM 14 ORTHGONAL	8	90	0	*8.00*	*0.00*	*0.00*		**0.00**	**82.87**
7	TPS-7 X-ray package	75	27	270	*0.00*	*-34.05*	*66.83*		**90.00**	**116.32**
83	TPS-83 test object	75	145	90	*0.00*	*43.02*	*-61.44*		**90.00**	**54.38**
75	TVS-X	75	120	270	*0.00*	*-64.95*	*-37.50*		**90.00**	**149.61**
68	TVS-Y	75	111	0	*70.02*	*0.00*	*-26.88*		**21.00**	**89.24**
25	BMSX-25	75	60	0	*64.95*	*0.00*	*37.50*		**30.00**	**89.24**
55	BMSX-55	75	90	300	*37.50*	*-64.95*	*0.00*		**60.00**	**149.61**
56C	nTOF	75	90	325.75	*61.99*	*-42.21*	*0.00*		**34.25**	**123.61**
73	nTOF	75	120	180	*-64.95*	*0.00*	*-37.50*		**150.00**	**89.24**
82	nTOF	75	139	0	*49.20*	*0.00*	*-56.60*		**49.00**	**89.24**
90	nTOF	75	270	0	*-75.00*	*0.00*	*0.00*		**180.00**	**89.24**
71	4w Diagnostic Assembly	75	120	90	*0.00*	*64.95*	*-37.50*		**90.00**	**29.62**
30	4w Diagnostic Assembly	75	60	270	*0.00*	*-64.95*	*37.50*		**90.00**	**149.61**

Target drawings:



XBLK technical drawings (JJ):

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2. SURFACE TEXTURE PER ANSI/ASME B46.1-1985
3. C-SINK 82° ALL TAPPED HOLES TO MAJOR DIAMETER.
4. REMOVE BURRS AND BREAK SHARP EDGES TO .015 MAX.
5. ALL INSIDE CORNERS TO BE .015 R MAX.
6. PART WILL BE USED IN A HIGH VACUUM SYSTEM. NO OIL-BASED CUTTING FLUIDS SHALL BE USED. AFTER MANUFACTURING, CLEAN ALL SURFACES TO REMOVE ALL CUTTING FLUID RESIDUE.
7. PART NUMBERS TO BE CLEARLY MARKED EITHER ON THE PART ITSELF, THE PACKAGE CONTAINING THE PART OR ON A TAG ATTACHED TO THE PART.
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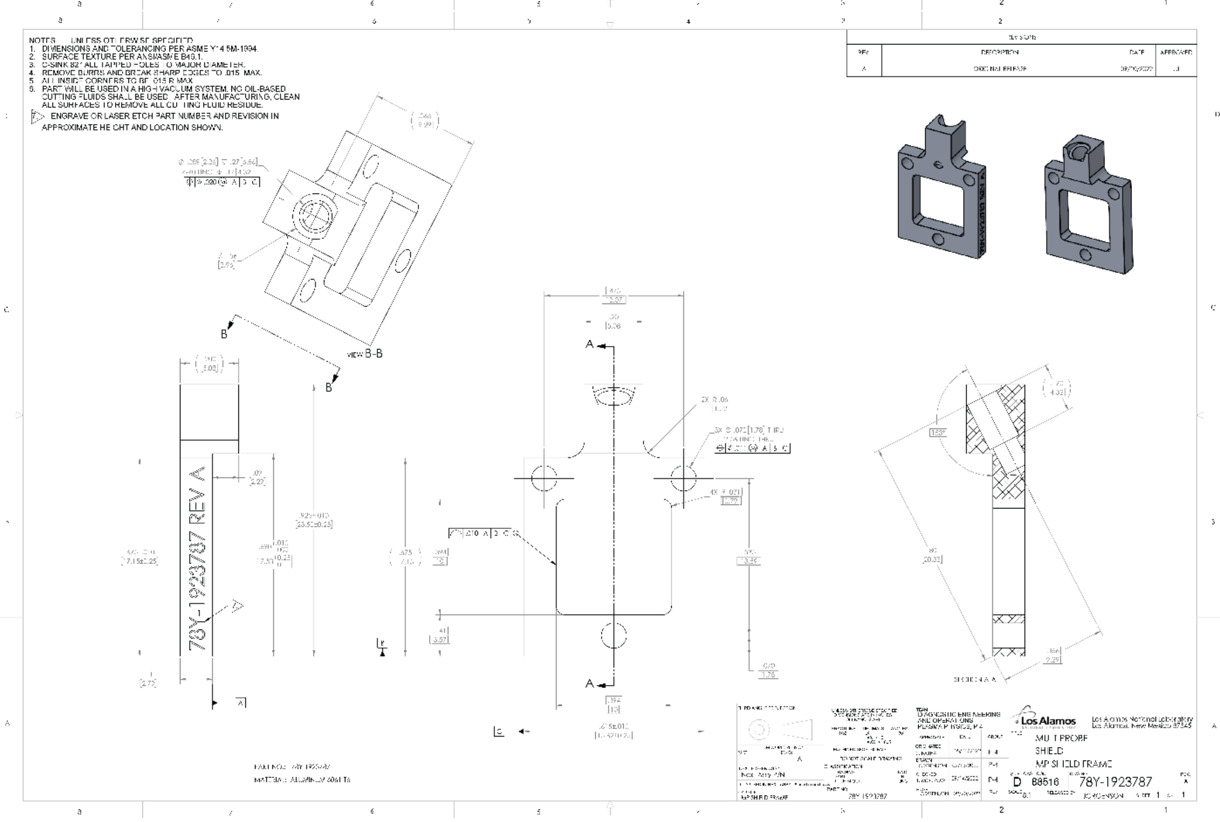
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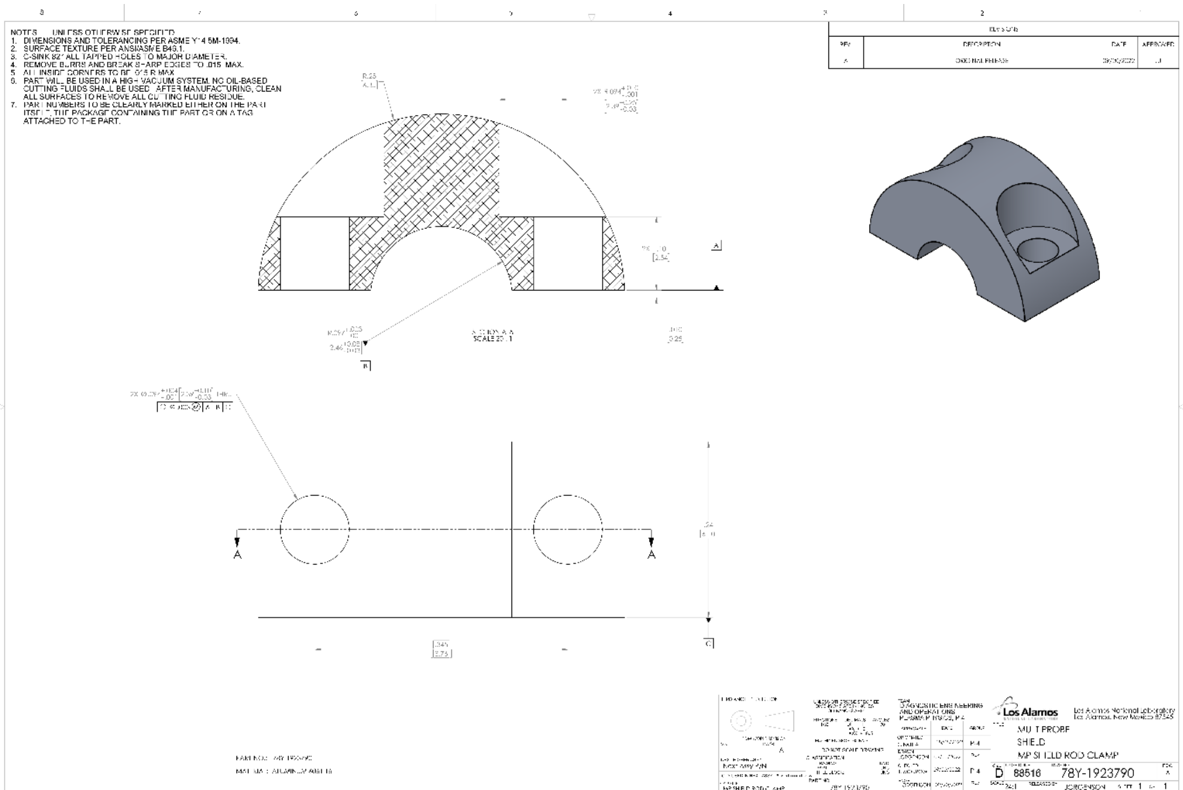
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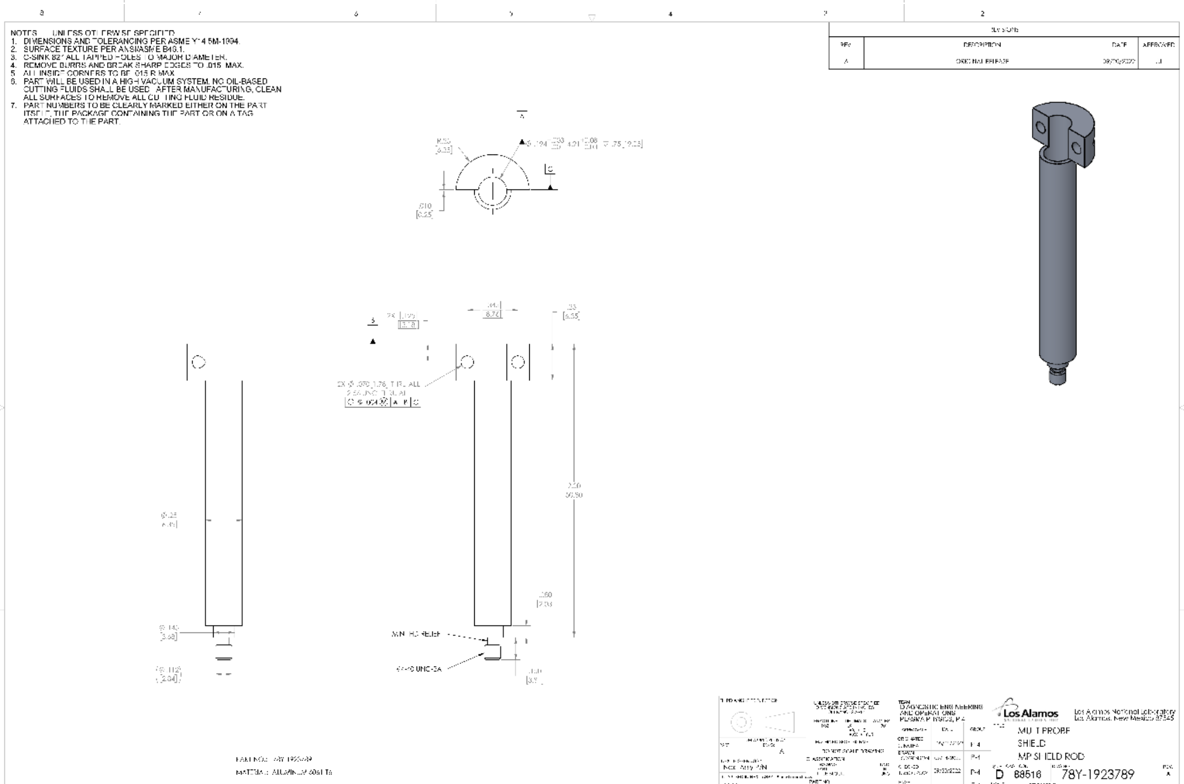
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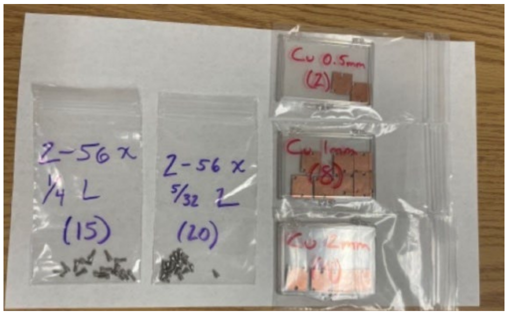
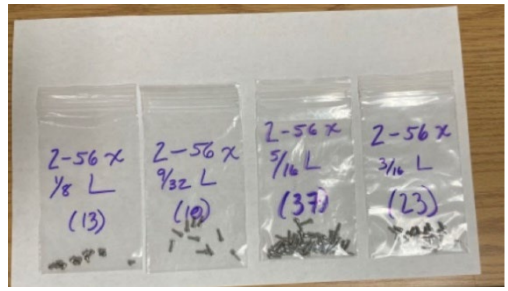
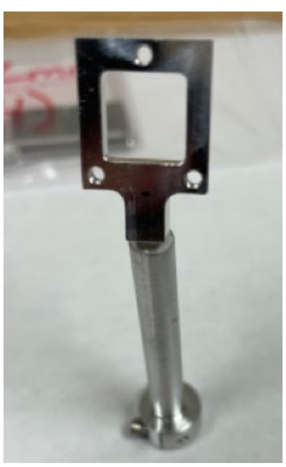
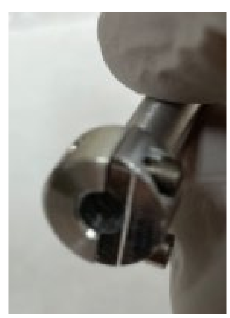
JORGENSON
SHEET 1 OF 1

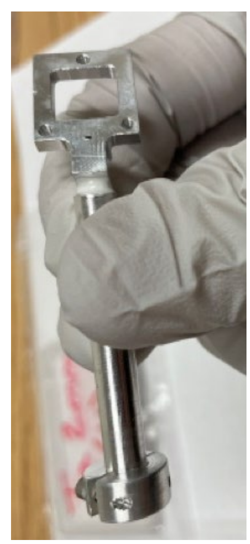
XBLK photos (Matthias Hochanadel):











To: Sallee Klein
From: Steven Batha, David Broughton, Tim Wong
Date: Sept. 22, 2023

Memorandum

P-4 Thermonuclear Plasma Physics

Subject: MultiProbe-EP-24A Target Request: Michigan (Rev. 0)

MultiProbe-EP-24A is scheduled for **November 28th, 2023,** on OMEGA EP.

For the backlighter shots, we request 30 washers mounted on stalks. These will be held on TPS-7 facing the backlighter beam.

Type	Outer diameter	Inner diameter	Thickness	material	Quantity
Washers	1.5mm	0.5mm	25 micron	polymide	30

For two polymide washers with the same description as above and mounted for the same backlighter configuration, we request a 500 nm thick Kapton foil to be mounted (same target as in MultiProbe FY23).

For the sidelighter shots, we request a total of 10 CPC cone + Ta wire targets (2 of them without Ta wires) in addition to several static objects.

- The CPC cone + Ta wire targets were used in previous campaigns for the MultiProbe project. The CPC cone + Ta wire targets will all have the same Au-coated CPC cone, but we will vary the Ta wire diameter and would like the Ta wires to be coated with plastic. The CPC cone + Ta wire targets will be held in TPS-7 and the cone opening will face the sidelighter while the wire will face TIM-14.

- The static test objects can be cut from 0.250 mm thick Ta foil. The front side (facing laser) will be cut to a >17 degree (or larger) edge. The back side (away from laser) will have a series of 0.25 mm and 0.125 mm steps cut into them. W wires of different thicknesses will be glued to the side of the foil. The static object will be held in TPS-83.

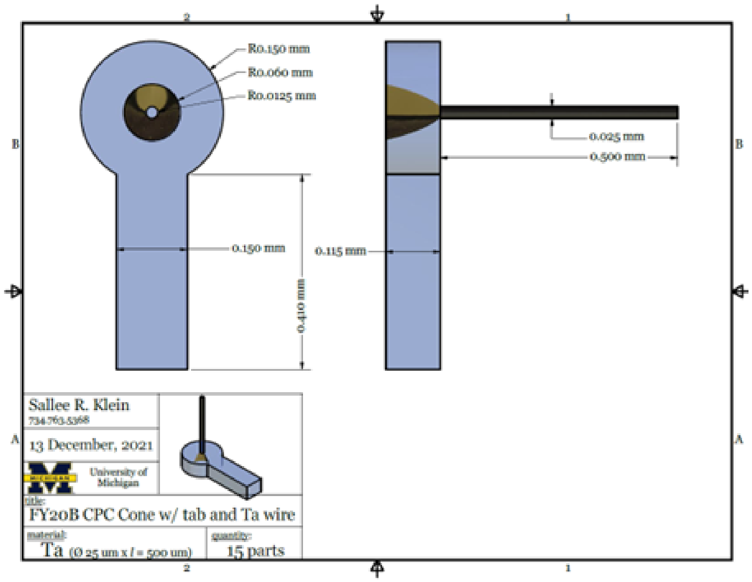
Target quantities

Type	Ta Wire length	Ta Wire Diameter	Ta wire comments	Quantity
CPC + wire	0.5 mm	25 micron	Coated in plastic	5
	0.5 mm	50 micron	Coated in plastic	2
OBJ	0.5 mm	125 micron	Coated in plastic	1
	close opening with glue	N/A	no wire	2

Type	Quantity
Static object	4

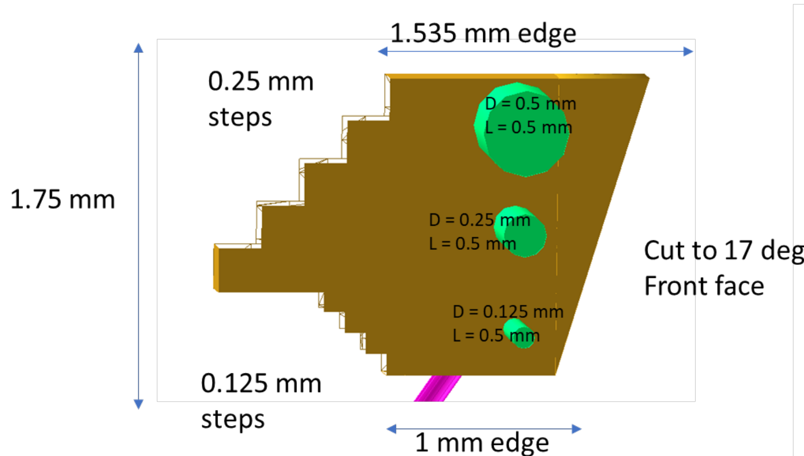
1. **CPC cone + Ta wire targets**
    1. Target held in TPS-7 for sidelighter [see VisRad]
    2. Same CPC cone as in MultiProbe FY22 and FY20B shot days.
        1. "cone with tab" design
        2. Cone geometry provided in image below
        3. Coated with 5 nm of Au
        4. 25 micron diameter hole at tip
    3. Ta wire
        1. Wire placed at hole at end of CPC cone
        2. Length: 0.5 mm
        3. Diameter: 25 micron (qty: 5), 50 micron (qty: 2), 125 micron (qty: 1)
        4. If possible (not required), coat the length of the Ta wire with plastic (> few microns)
        5. 2 targets requested with glue covering hole, but no wire
2. **Static Objects**
    1. Mounted on TPS83 with 17 deg edge facing sidelighter [see VisRad]
        1. Located at TCC
        2. 1.75 mm tall, ~2.0-2.535 mm deep, 0.25 mm thick Ta foil
        3. Regular steps cut into side of foil (0.25 mm steps and 0.125 mm steps)
    2. 3 W wires of different thicknesses glued to the side
        1. Diameters of 0.5 mm, 0.25 mm, 0.125 mm.

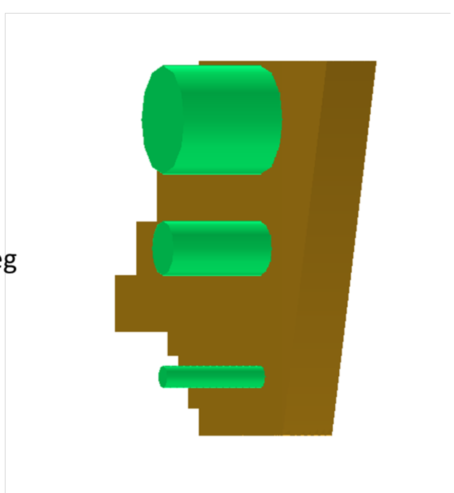
CPC cone geometry (Same as before):



Static objects

Made from Ta, with W wires





NEN-1 target request

The following is the email request:
The idea was to scan a range of CD thicknesses, from 500-800nm, and then do a last shot with the 'best' thickness (as well as an initial warm-up shot at 500nm). The following are the number of "good" targets we would want, so having at least 1-2 extra at each thickness would be helpful.

CD foils: 500nm x 3, 600nm x 2, 700nm x 2, 800nm x 2
CH foils: 500nm x 1

The washers to float these onto will be provided already mounted to stalks.