

# LA-UR-22-22451

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**Title:** MeVXRy-23A: We aim to increase the laser-driven MeV x-ray yield to ~ 4-6 Rads/shot (~2-3X increase) using novel target designs suitable for weapons radiography

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**Intended for:** Slides submitted to the HED council requesting shot day at OMEGA EP laser facility

**Issued:** 2022-03-15



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# MeVXRy-23A: We aim to increase the laser-driven MeV x-ray yield to $\sim 4\text{-}6$ Rads/shot ( $\sim 2\text{-}3\times$ increase) using novel target designs suitable for weapons radiography

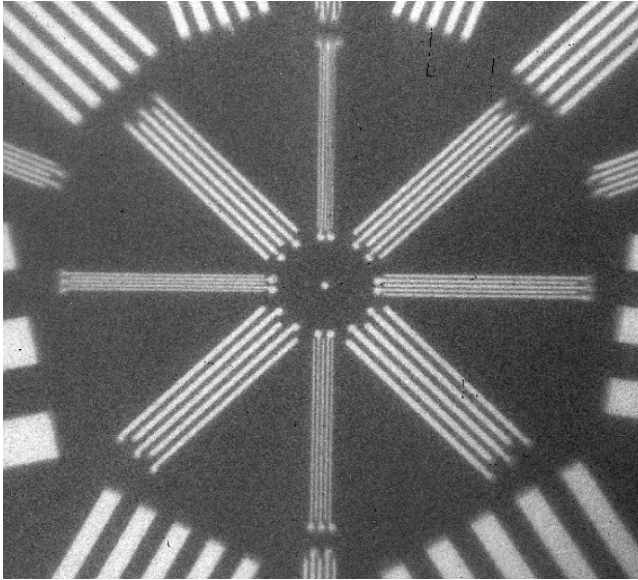
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- **Purpose:** Evaluate enhanced laser-plasma coupling using near-critical foam padded tungsten cube targets and its effect on the laser-driven MeV x-ray dose
- **Motivation:** Compact MeV x-ray sources with  $<200\mu\text{m}$  source size in the several Rads/shot are needed for weapons radiography.
- **Goal:** Increase laser-driven MeV x-ray dose by  $\sim 2\text{-}3\times$
- **PI/Designer:** S. Palaniyappan, D. C. Gautier, J. Strehlow, B. J. Albright, L. Yin, J. Hunter

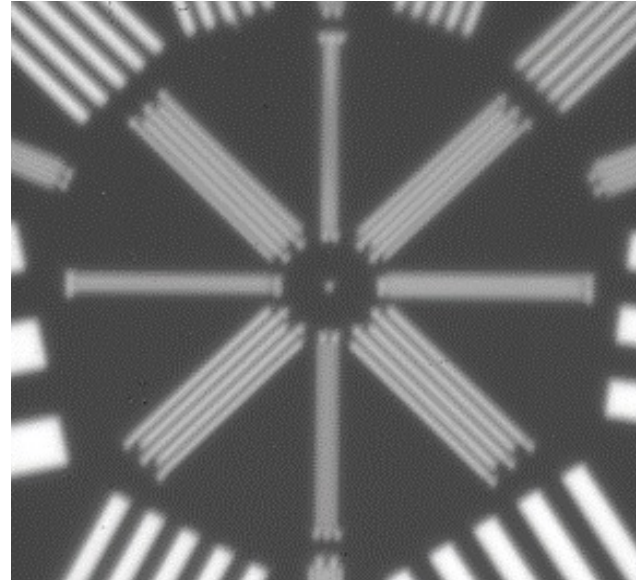
Summary Shot Table	Q1FY23	Q2FY23	Q3FY23	Q4FY23
Total shots			12	

# Motivation: We are developing laser-driven MeV x-ray radiography for LANL weapons applications

## Radiograph of high-resolution test object



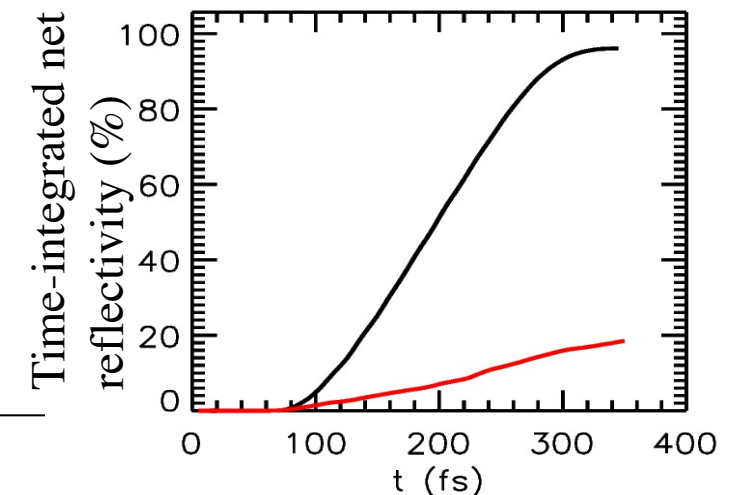
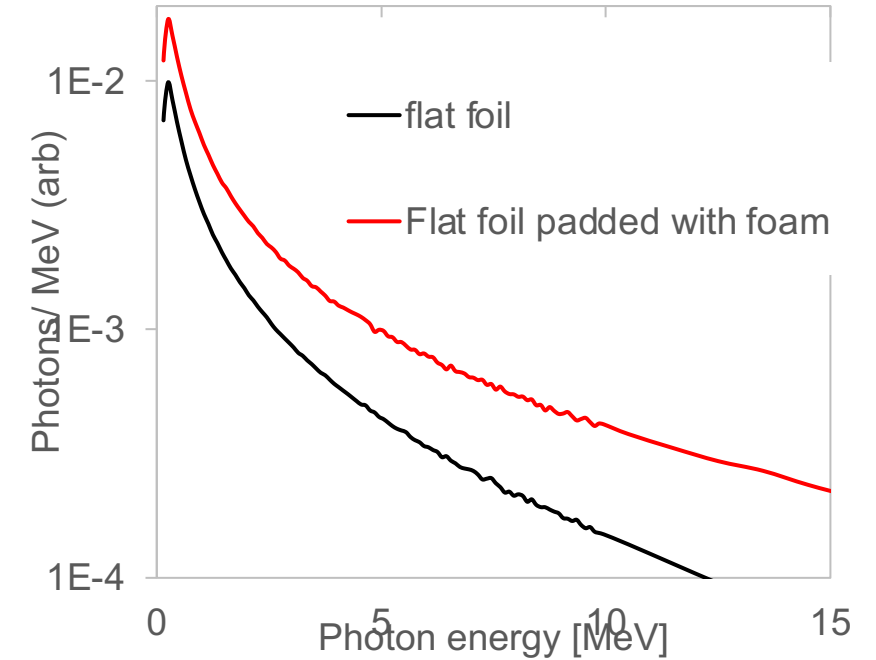
Trident Laser-driven source  
(source size  $<100\ \mu\text{m}$ )



Microtron (source size  $\sim\text{mm}$ )

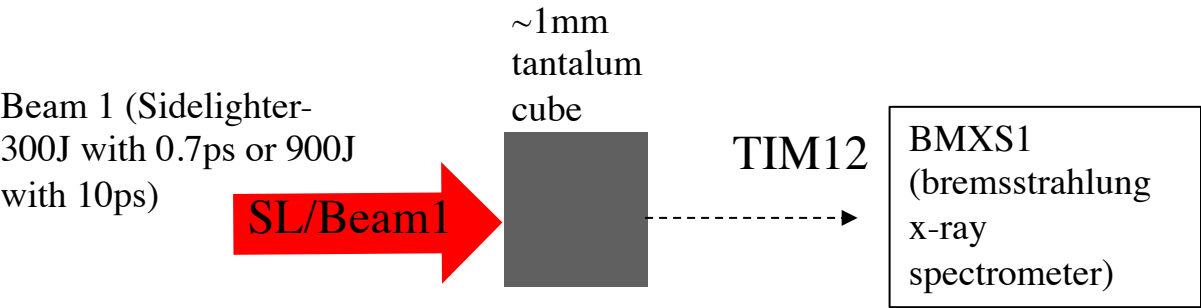
Simulations indicate that MeV x-ray yield can be significantly enhanced by padding the  $\sim\text{mm}$  thick tungsten cube with near-critical foam on the laser interaction side that increases the laser-plasma coupling by 16X (5% coupling in bare foil Vs 80% coupling with foam padding).

## X-ray spectra (PIC/MCNP)



# Expt Configuration: We will alternate between the sidelighter and the backlighter beams repeating shots every 45 minutes to increase the shot rate

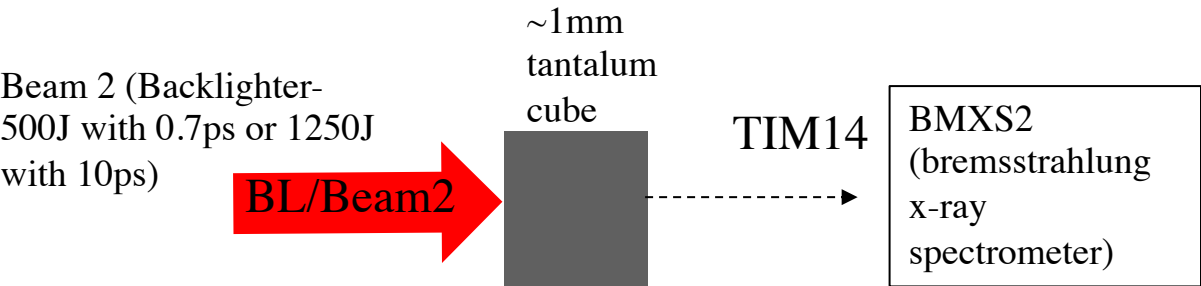
## Configuration #1



## Laser configuration

Beams	Pulse	Energy	Debris shield	DPP
Beam1 (SL)	0.7-10ps	MAX	None	None
Beam2 (BL)	0.7 -10ps	MAX	None	None

## Configuration #2



Diagnostic	TIM	priority
BMXS	TIM12	1
BMXS	TIM14	1
4ω Probe Diagnostic (4WPD)	Fixed	1

# Research Approach: Systematically vary the foam density and thickness to optimize the x-ray yield

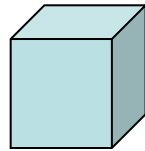
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- The x-ray spectra/dose from flat foil will serve as the baseline measurement
- We will vary the foam density from 15 mg/cc to 60 mg/cc (i.e.,  $\sim 5 n_{critical}$  to  $20 n_{critical}$ ) and thickness from 25  $\mu\text{m}$  to 300  $\mu\text{m}$ ) to optimize the x-ray source.
- We believe the density plays a major role than thickness. This parameter space will be further narrowed down before our experiment using integrated x-ray models using xRAGE/PIC/MCNP codes.
- We will also leverage on our upcoming Texas Petawatt experiment (Spring 2022) to narrow down this parameter space to increase the likelihood of success of the proposed OMEGA EP experiment.
- As a stretch goal, we will also explore the possibility of padding the flat foil with nanostructures which can also increase the laser-plasma coupling.

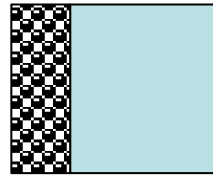
# Target Section: The targets are type 'c'

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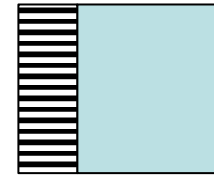
## Main target: Type C



~ bare 1mm<sup>3</sup>  
tungsten cube



Foam padded  
tungsten cube



Nanostructure  
padded  
tungsten cube

- Type A: Developmental e.g. never been made before
- Type B: Complex e.g. produced before but has some schedule risk due to complex processes involved
- Type C: Routine/Simple e.g. hohlraums, witness plates, backlighter disks,...