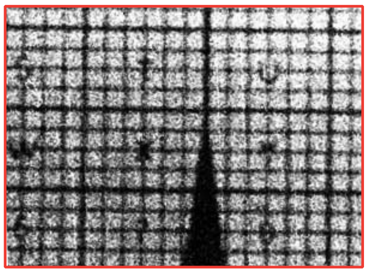
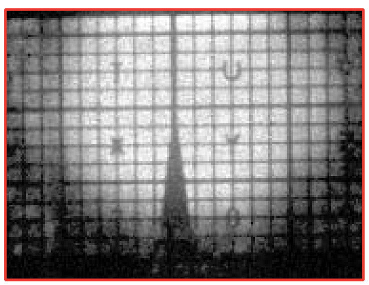
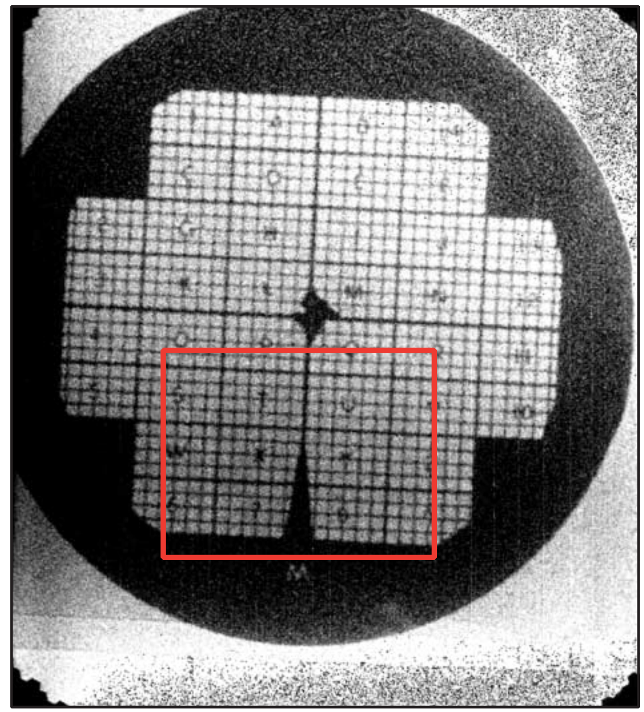
Development of Point-Projection Backlighting for Laboratory Astrophysics Experiments on OMEGA







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cf. Jim Knauer's talk GM1.006 Laboratory Astrophysics session this afternoon.

Summary

Point-projection backlighters are being developed on OMEGA for large fields of view and high resolution

- Point-projection backlighting provides a 3 $\times$ 3-mm FOV.
- 10-μm resolution was achieved. Features of that size will be discernible in large laboratory astrophysics targets.
- Spectral analysis of step targets shows a spectral peak at a higher energy than expected.

We study shock-driven jet morphologies

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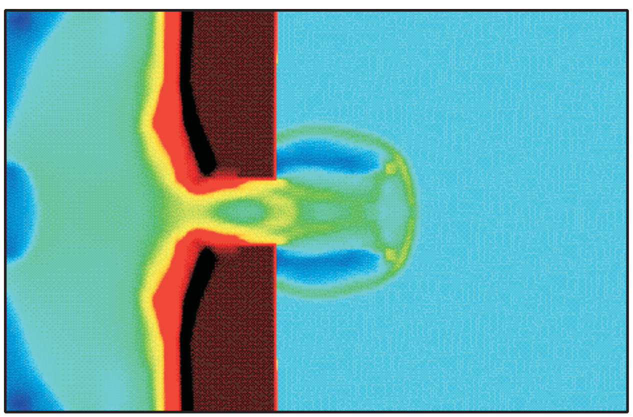
- Astrophysical experiments on OMEGA can help bridge the gap between astrophysical theories, simulations, and observations.
- The scale of the jet evolution defines the FOV.
- Jet structure sets the minimum resolution criterion.



Density contour from Igumenshchev's PPM simulation of one of our astrophysical targets

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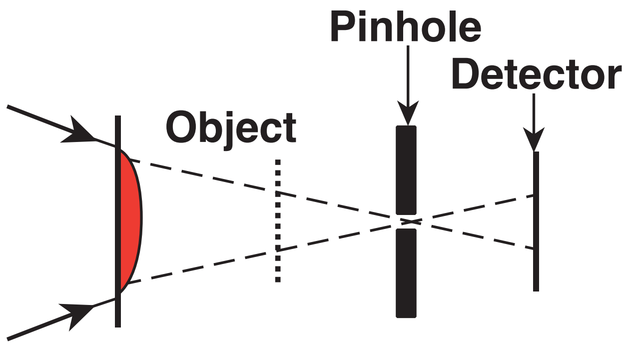
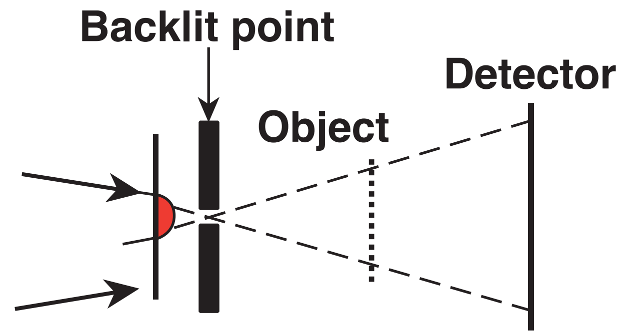
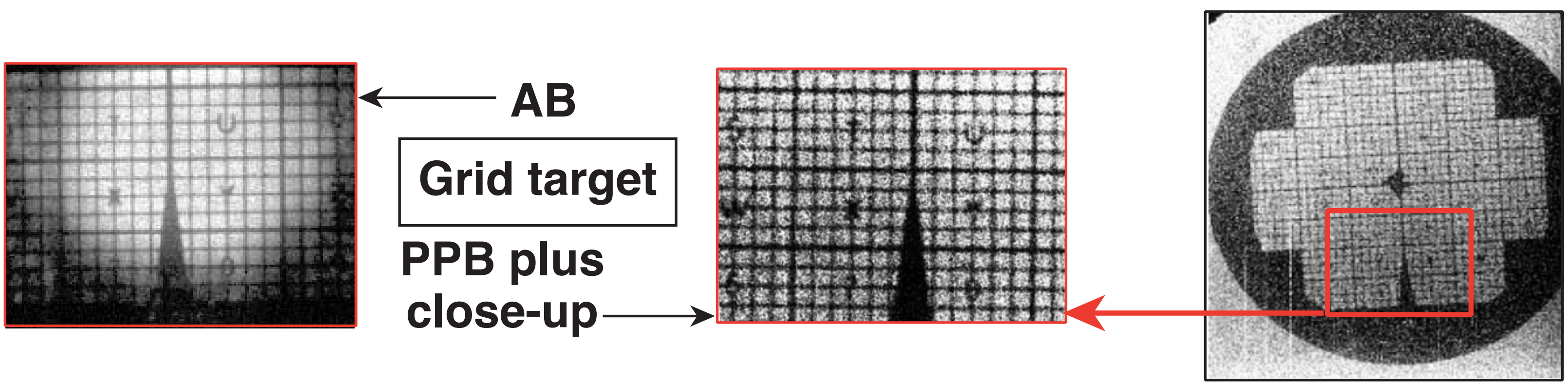
Point-projection radiography has advantages over area backlighting

Area Backlighting (AB)



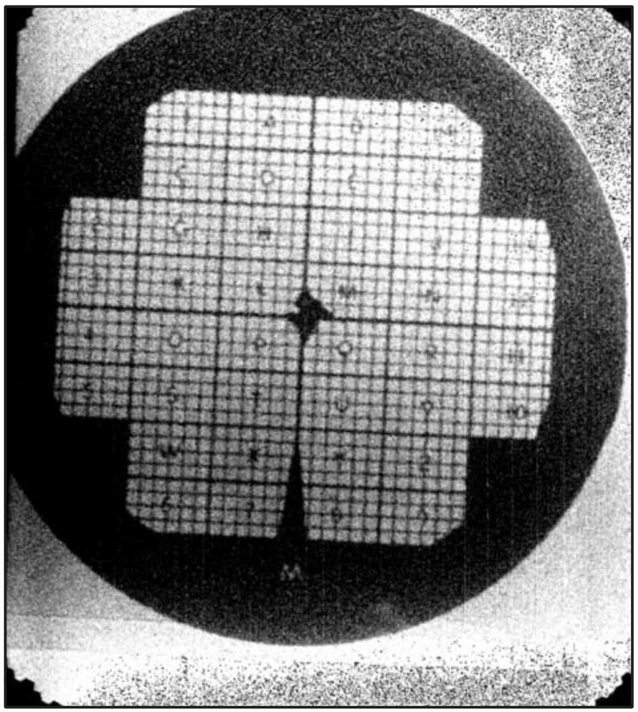
Point-Projection Backlighting (PPB)



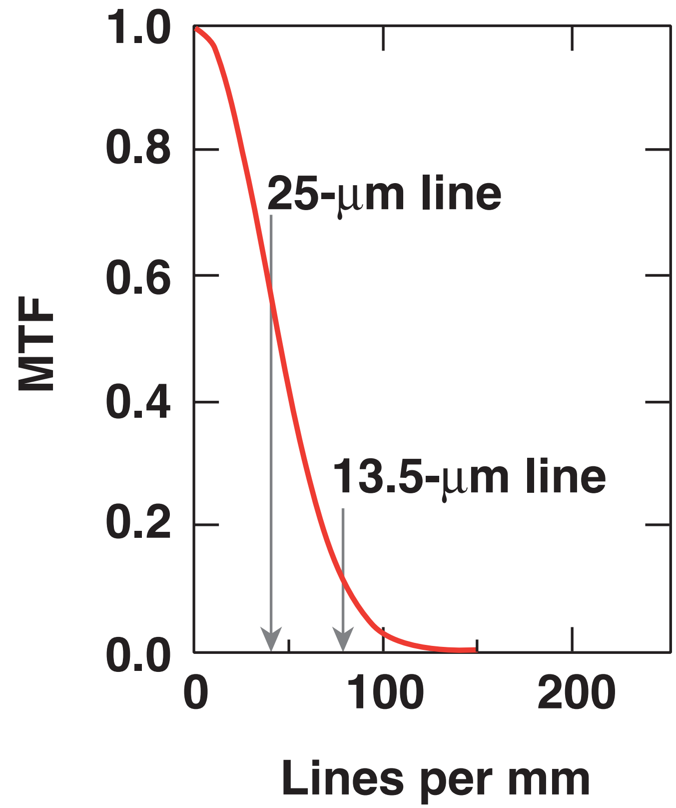


- PPB has a resolution comparable to AB over a large FOV.

Backlit grid targets are used to measure MTF and FOV



- Grid circle: 3 mm
- Thick lines: 25 μm
- Thin lines: 13.5 μm



- MTF from grid lines gives ~10-μm resolution.

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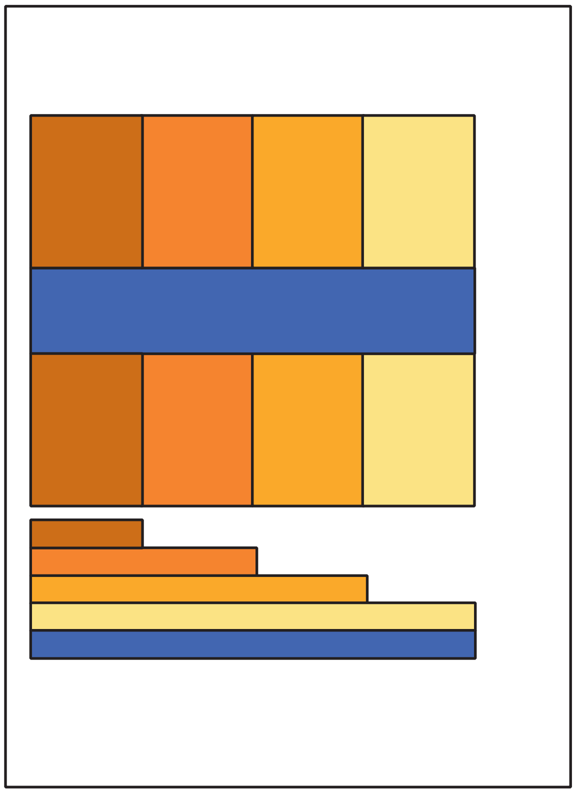
Step targets were used to determine sensitivity, x-ray spectrum, and spatial resolution



Material	*K* abs. edge	Step thickness
CH	(0.28 keV)	50 μm
Si	(1.84 keV)	20 μm
Ti	(4.97 keV)	10 μm
Ni	(8.33 keV)	12.5 μm

- Targets: 3 mm × 3 mm
- A 500-μm-wide, 10-μm-thick Pt strip down the center of the target is used to measure the edge resolution.

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Measuring spectral content of our Ti backlighter requires several step targets

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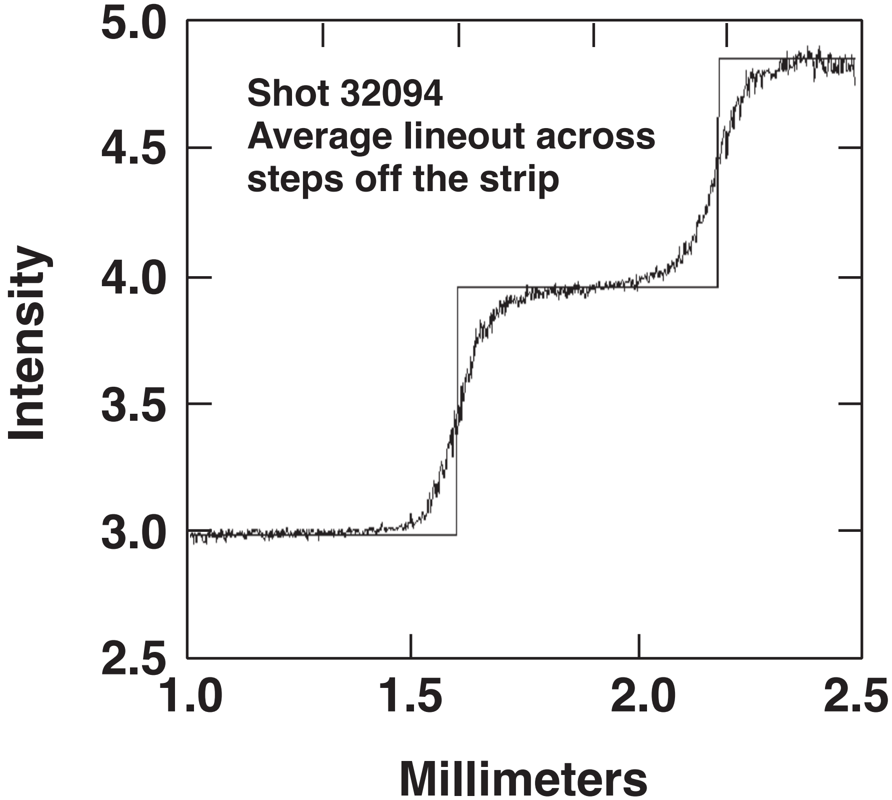
Si step target averaged intensities



- The step intensity ratios depend on the backlighter spectrum.
- The step intensity ratios from several materials are used to determine an emission spectrum.

Using image intensities and system response, we can back out the spectrum of our Ti backlighter

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$$I_m = C \cdot \sum_n R_{mn} \cdot \left\langle \frac{dS}{dE} \right\rangle_n$$

$$\left\langle \frac{dS}{dE} \right\rangle_n = \frac{\int_{\text{low } E_n}^{\text{high } E_n} \frac{dS}{dE} \, dE}{\text{high } E_n - \text{low } E_n}$$

$$R_{mn} = \int_{\text{low } E_n}^{\text{high } E_n} \eta e^{-\mu_m \rho_m \ell_m} dE$$

$$\left\langle \frac{dS}{dE} \right\rangle_n = C^{-1} \cdot \sum_m R_{mn}^{-1} \cdot I_m$$

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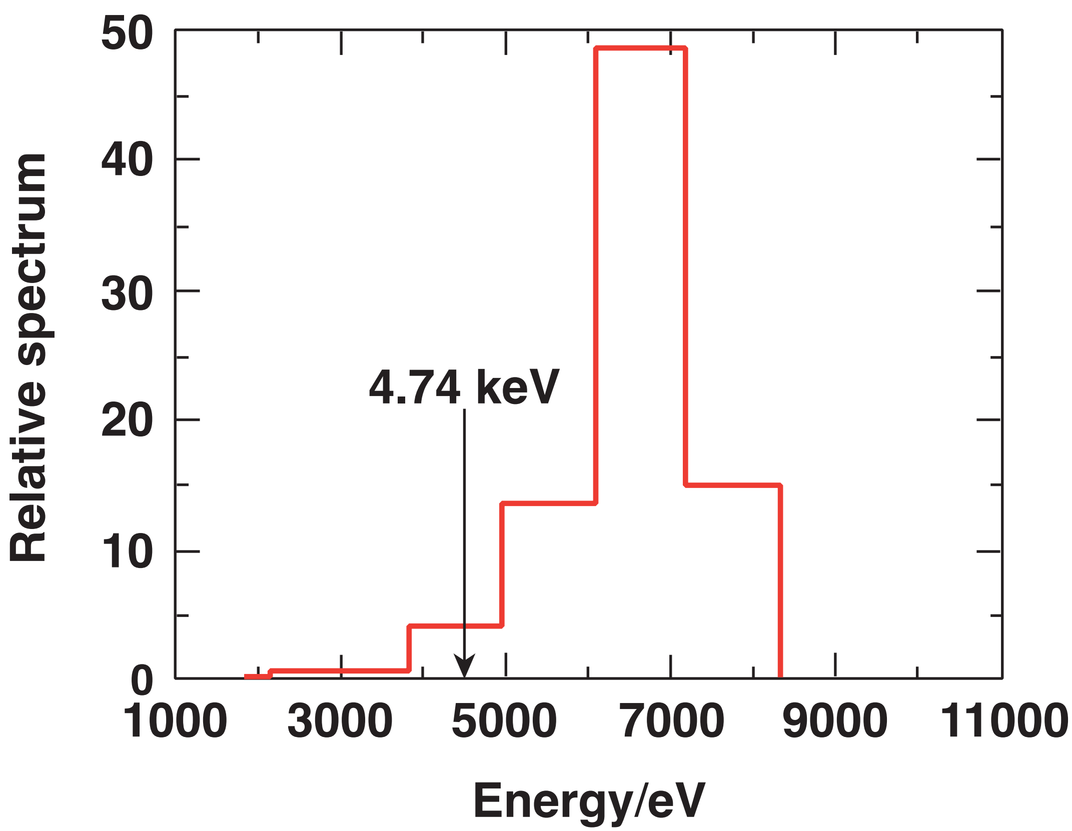
Spectral of Ti backlighter peaks near 6.5 keV



- 6.5-keV peak observed
- Expected: 4.7-keV He-α peak (seen in crystal spectrograph) high-energy continuum contributes to the x-ray spectrum.
- Fe BL spectrum in progress

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Summary/Conclusions

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