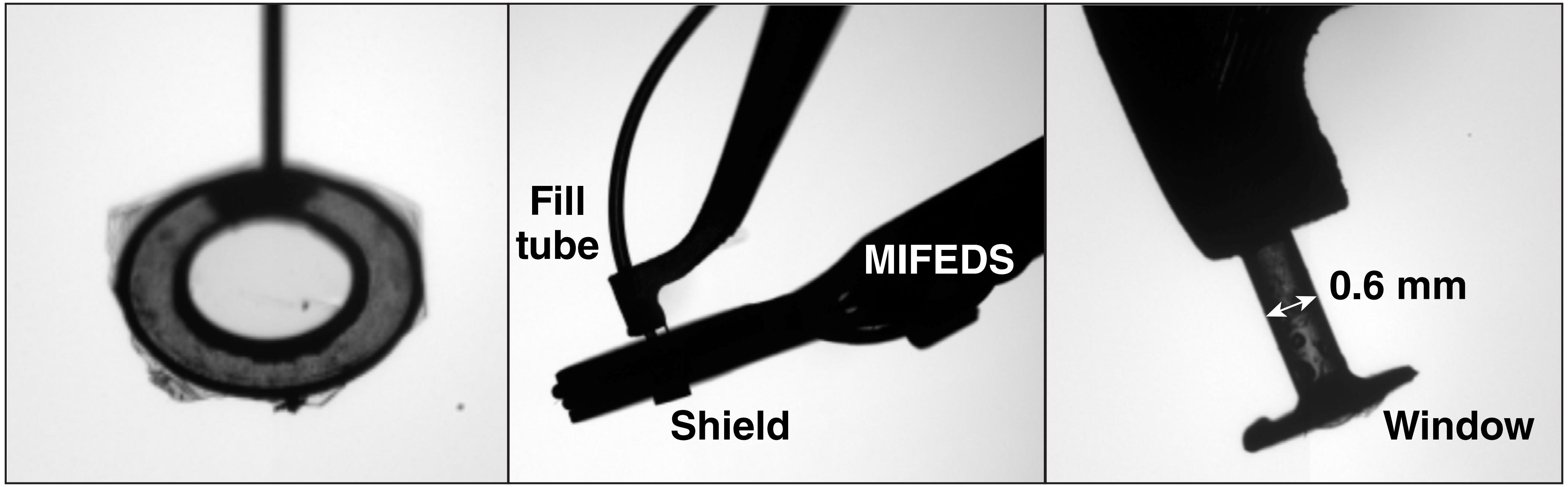
First Results from Laser-Driven MagLIF Experiments on OMEGA: Backscatter and Transmission Measurements of Laser Preheating

1.84-μm polyimide foil (entrance window)

Cylinder (shown with coil)

Cylinder (without shield)



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Summary

Laser preheating has been studied as the first phase in the development of laser-driven magnetized liner inertial fusion (MagLIF) on OMEGA

- Transmission through entrance window foils along the original beam path exceeded 50%
- Backscatter from foil-only and cylinders was similar, lasted ~0.5 ns, and accounted for less than 1% of the laser energy
- Less than 10% of the laser energy was sidescattered as the foils started to transmit
- Hydrocode modeling is in reasonable agreement with experiment

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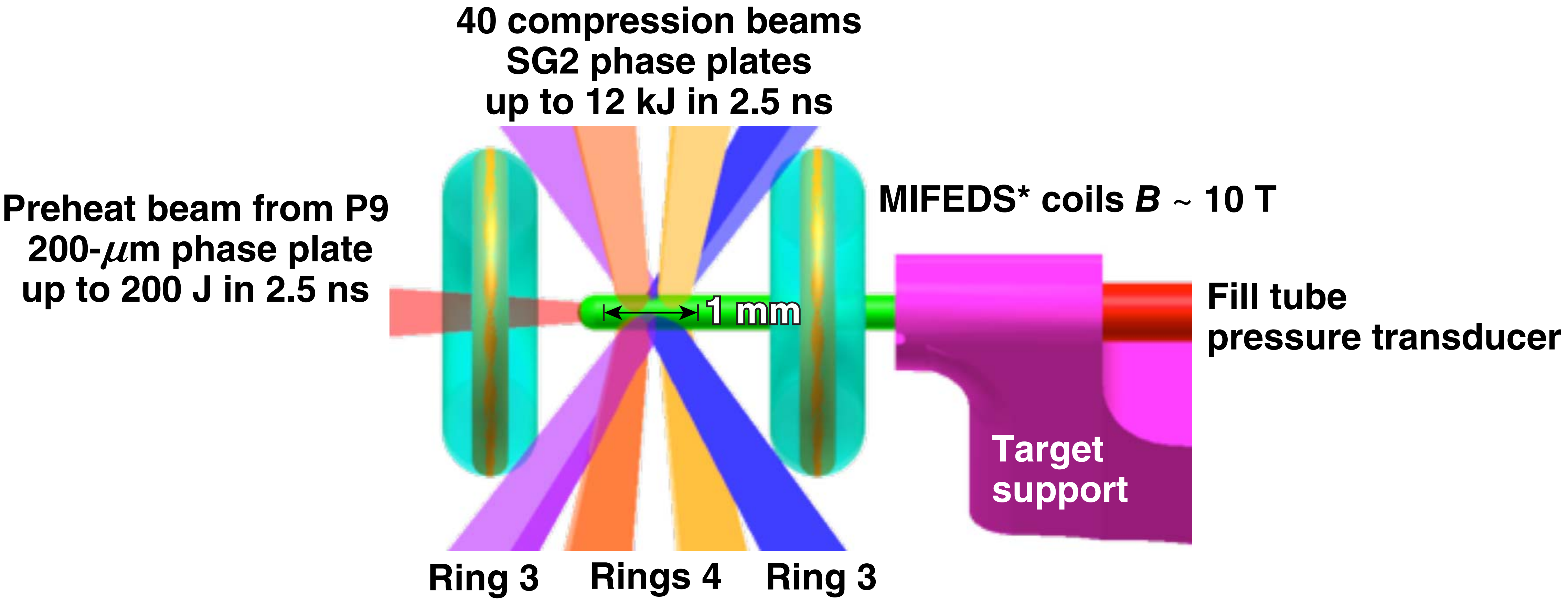
A point design for laser-driven MagLIF on OMEGA has been developed and will be tested in a series of experiments



Parylene-N Target

Outer diameter:	600 μm
Shell thickness:	30 μm
Compressed length:	600 to 700 μm
D_2 fill density:	1 to 2.1 mg/cm^3
Preheat temperature:	$\geq$100 eV

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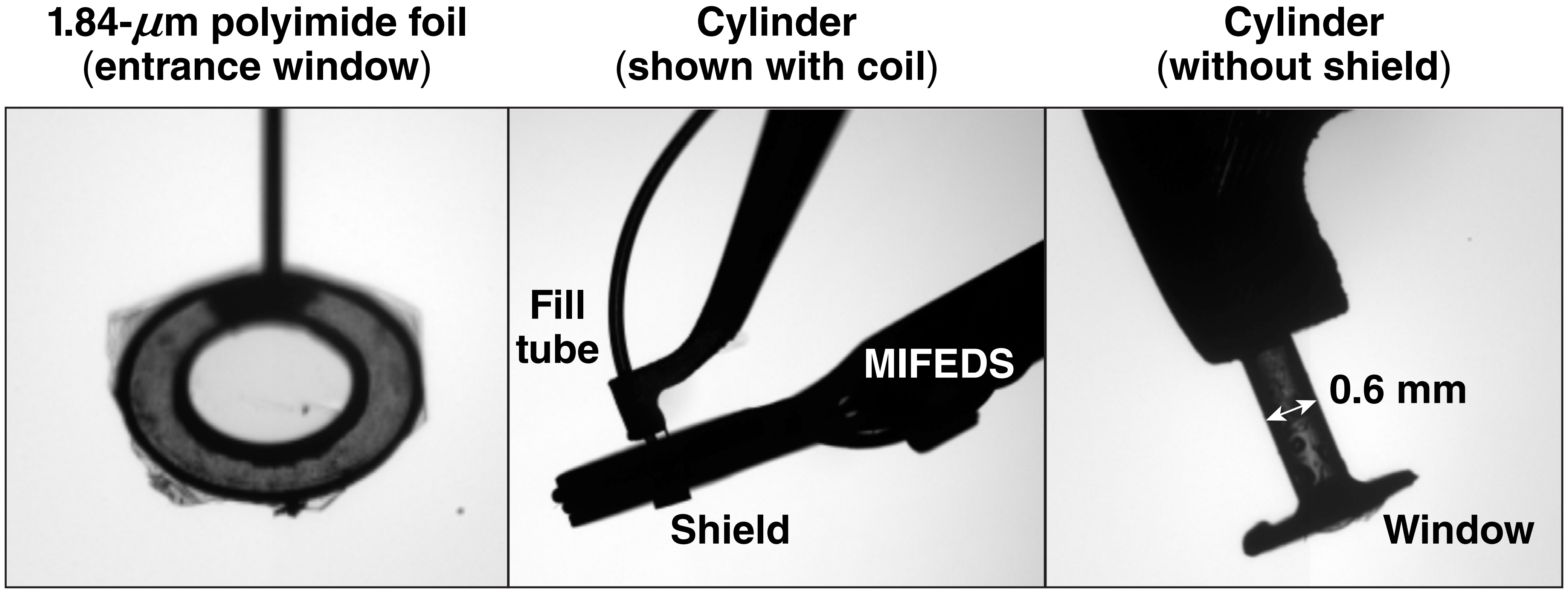
*MIFEDS: magneto-inertial fusion electrical discharge system

The first experiments studied preheat using entrance window foils and complete targets with and without magnetic field



Target fill: 10-atm D_2 doped 2%$_{at}$ Ne (1.6 mg/cm^3)

Laser: Energy on target 60 to 200 J
2.5-ns square temporal profile
218-μm FWHM* Gaussian radial profile
Peak intensity 0.44 to 1.5 × 10^{14} W/cm^2

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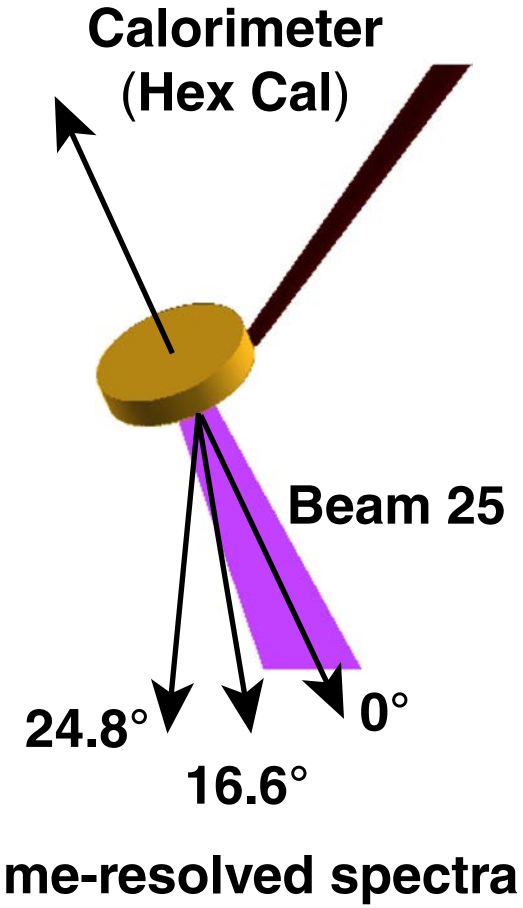
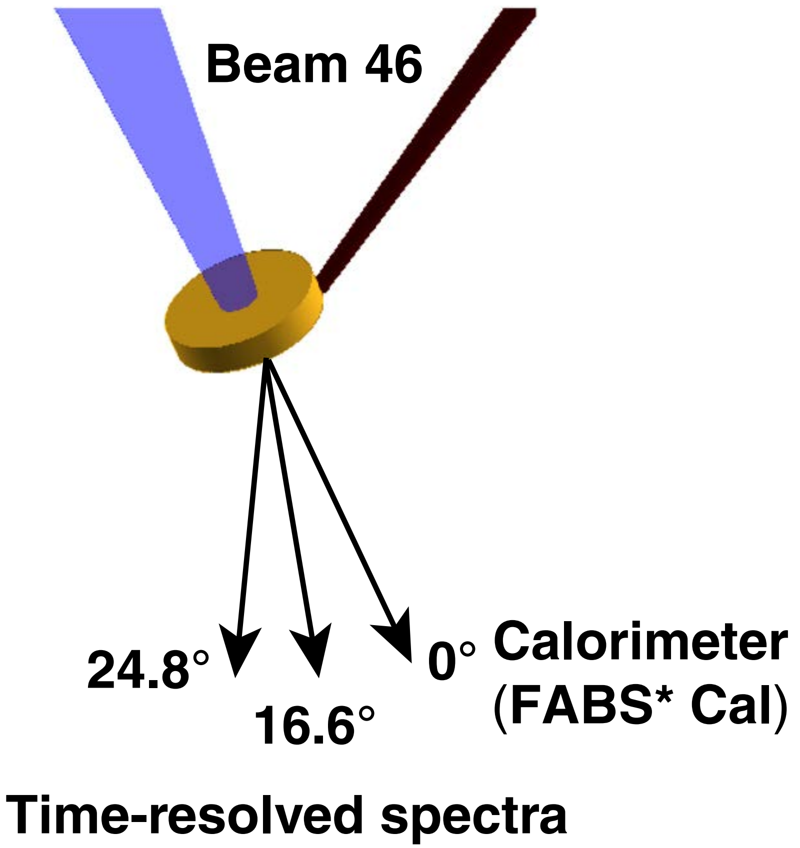
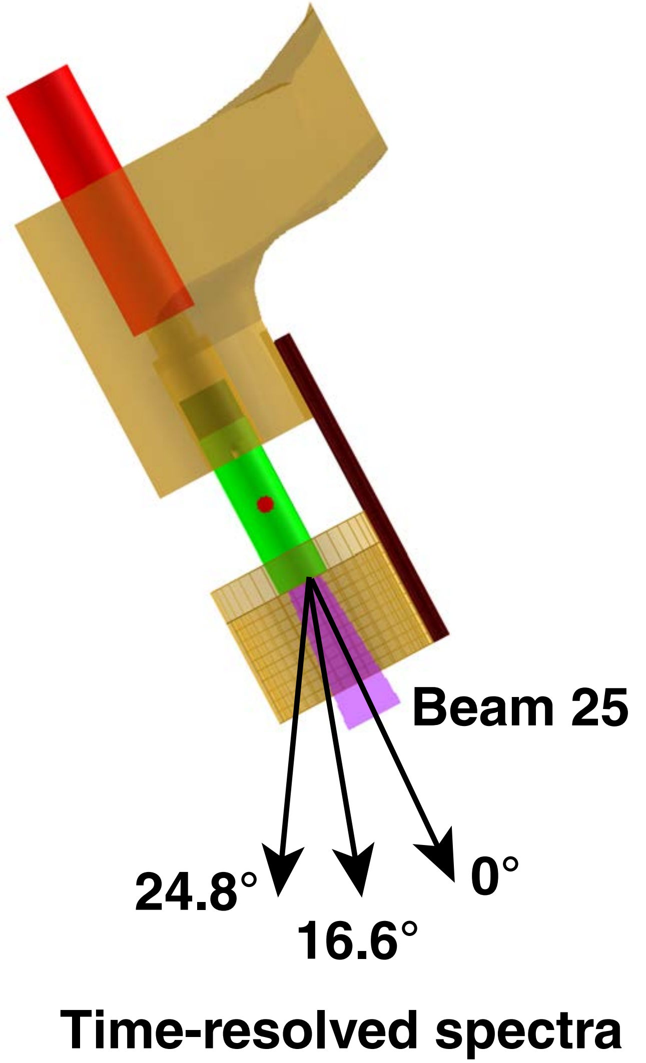
*FWHM: full-width at half-maximum

Time-resolved spectra of scattered light were measured at 0°, 16.6°, and 24.8° to the laser axis; foil transmission was measured with a calorimeter







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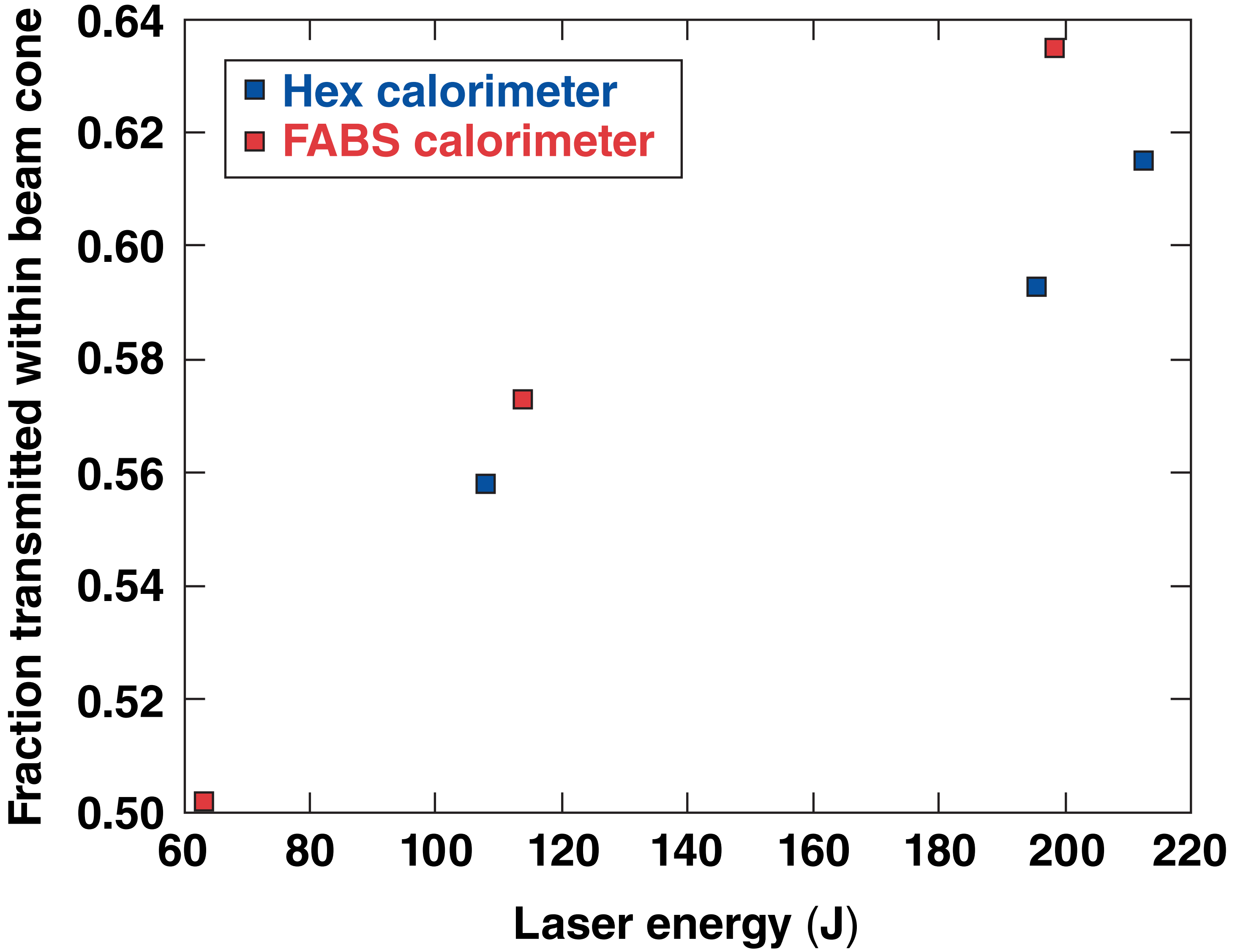
*FABS: full-aperture backscatter station

Foil transmission along the original beam path exceeded 50% and increased with laser energy



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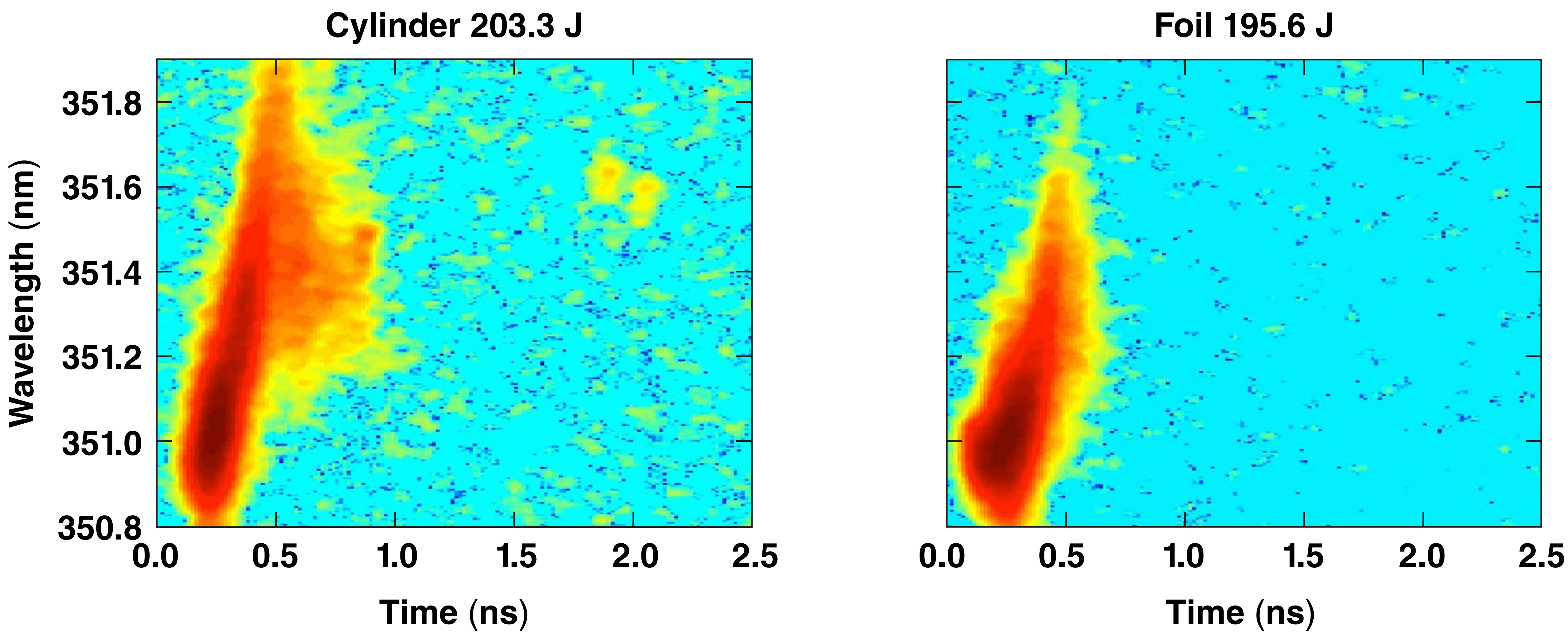
Backscatter from foils and cylinders was similar at all angles and laser energies, with and without a magnetic field, lasting ~0.5 ns

Time-resolved spectra through the laser beam port 25 (log scale)



There was no backscatter from the gas.

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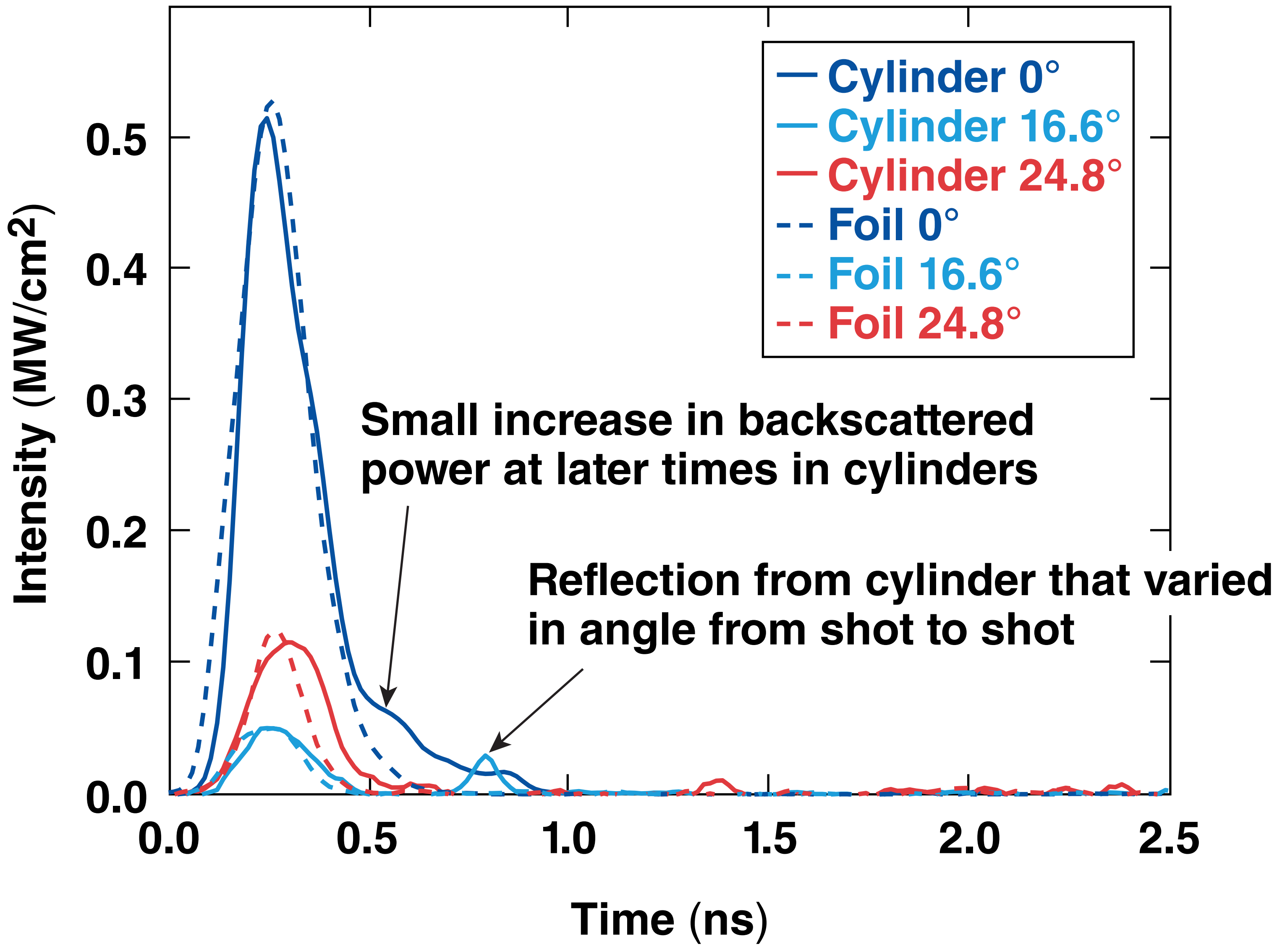
Laser light was backscattered outside the original beam path



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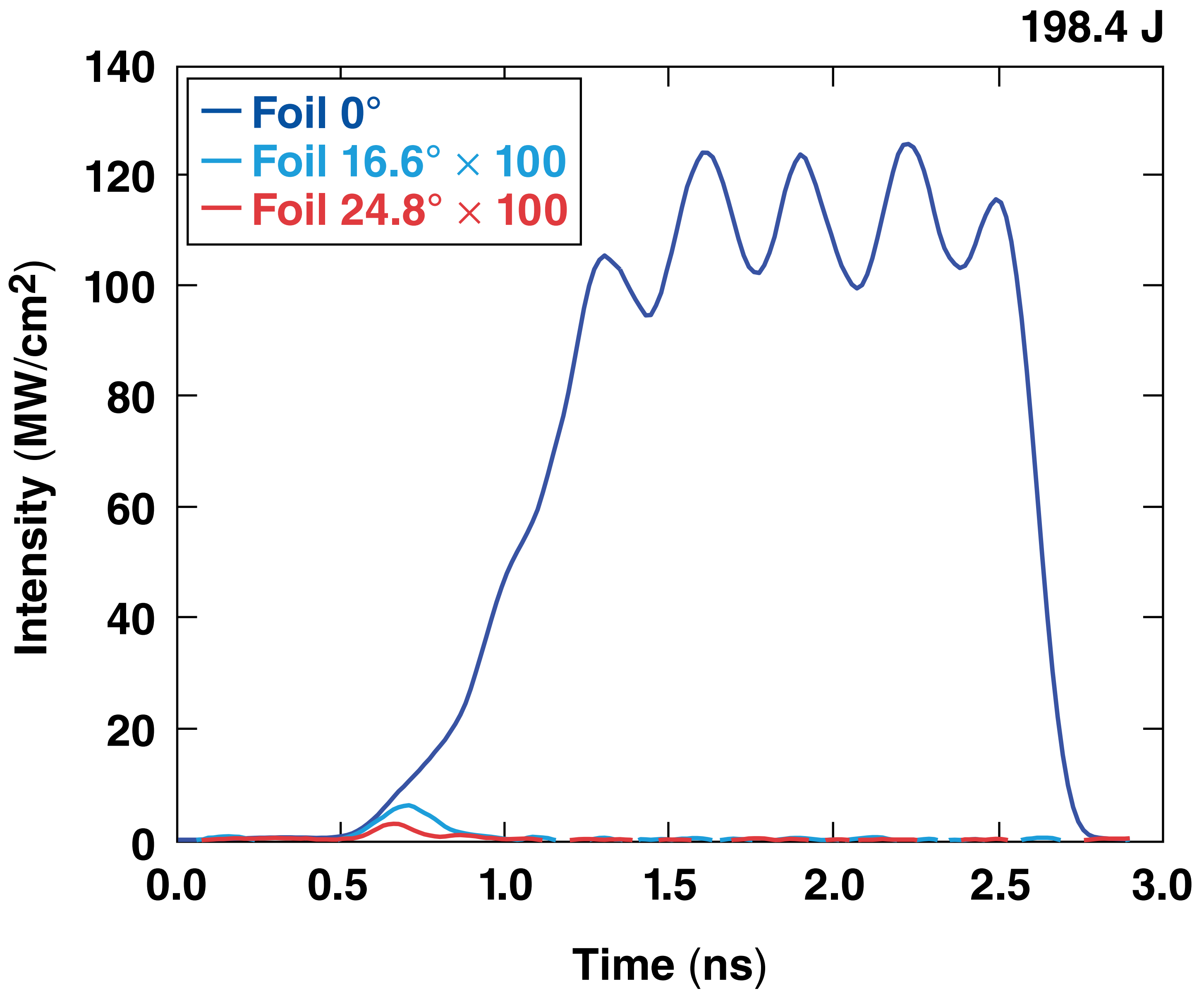
Foil-transmission measurements showed sidescattering lasting less than 0.5 ns



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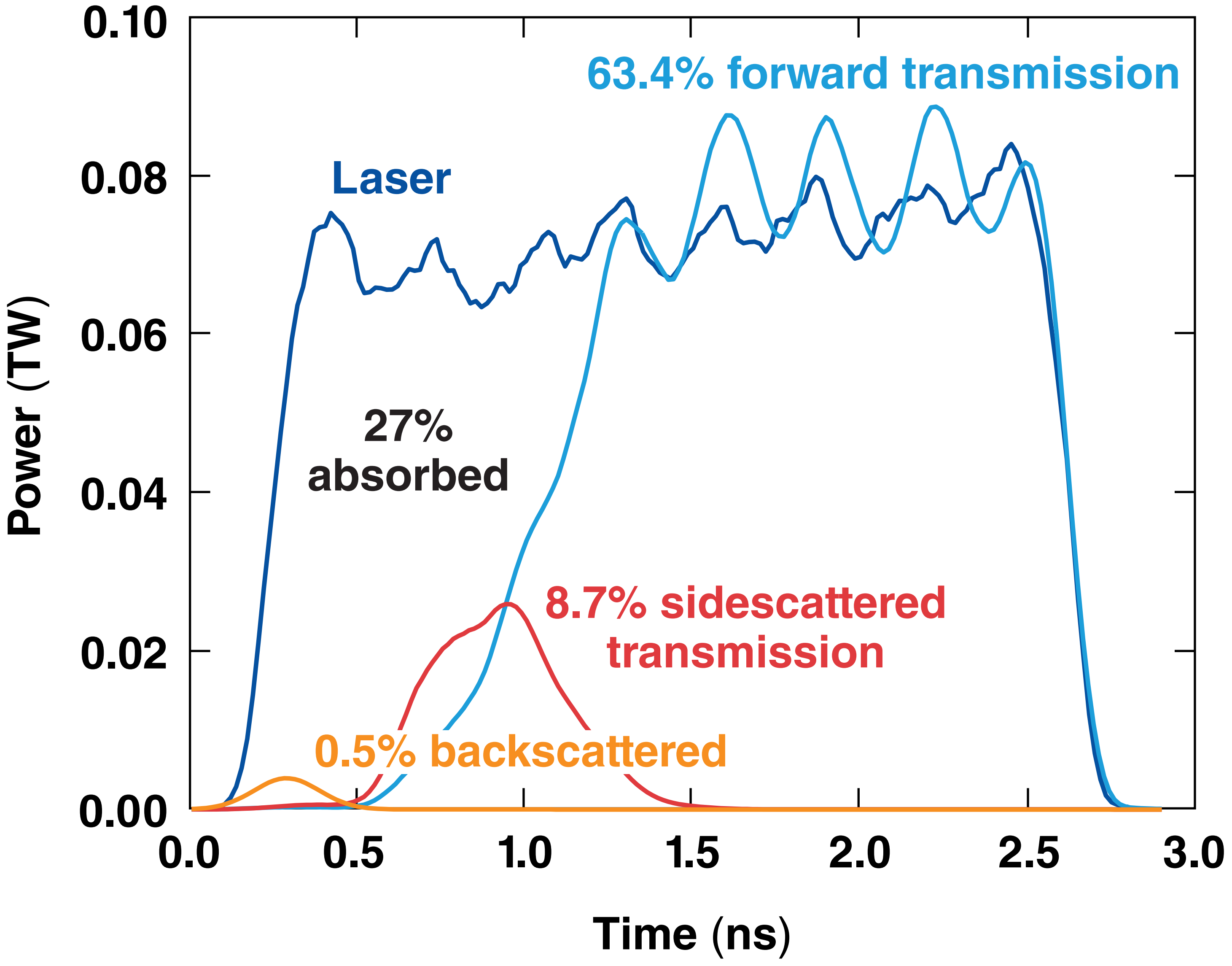
Total backscatter and total transmission for foils at 200 J were obtained by fitting backscatter and transmission measurements from two separate shots



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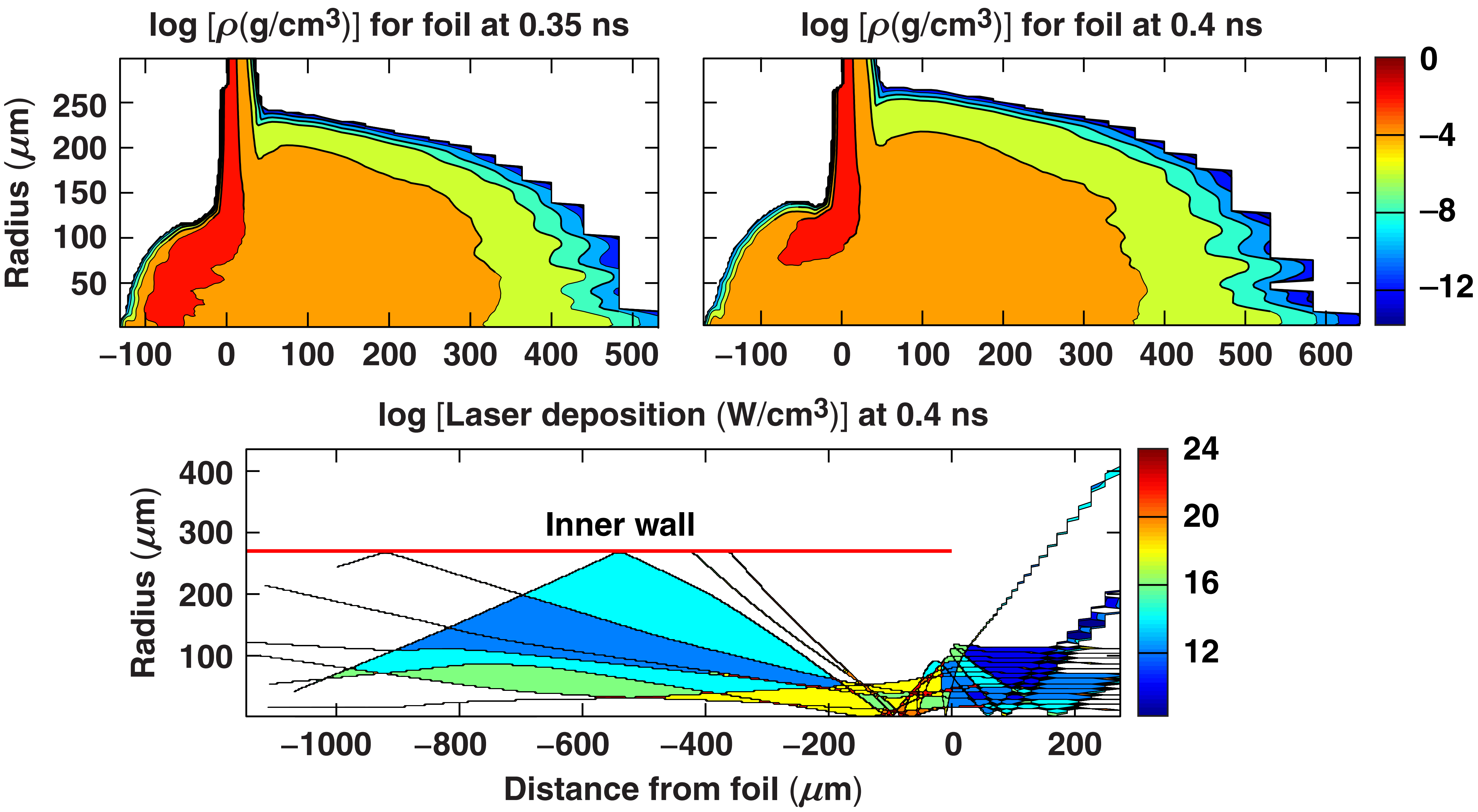
The hydrocode *DRACO* reproduces foil breakthrough time and sidescatter but overestimates absorption by the foil at 36.4%



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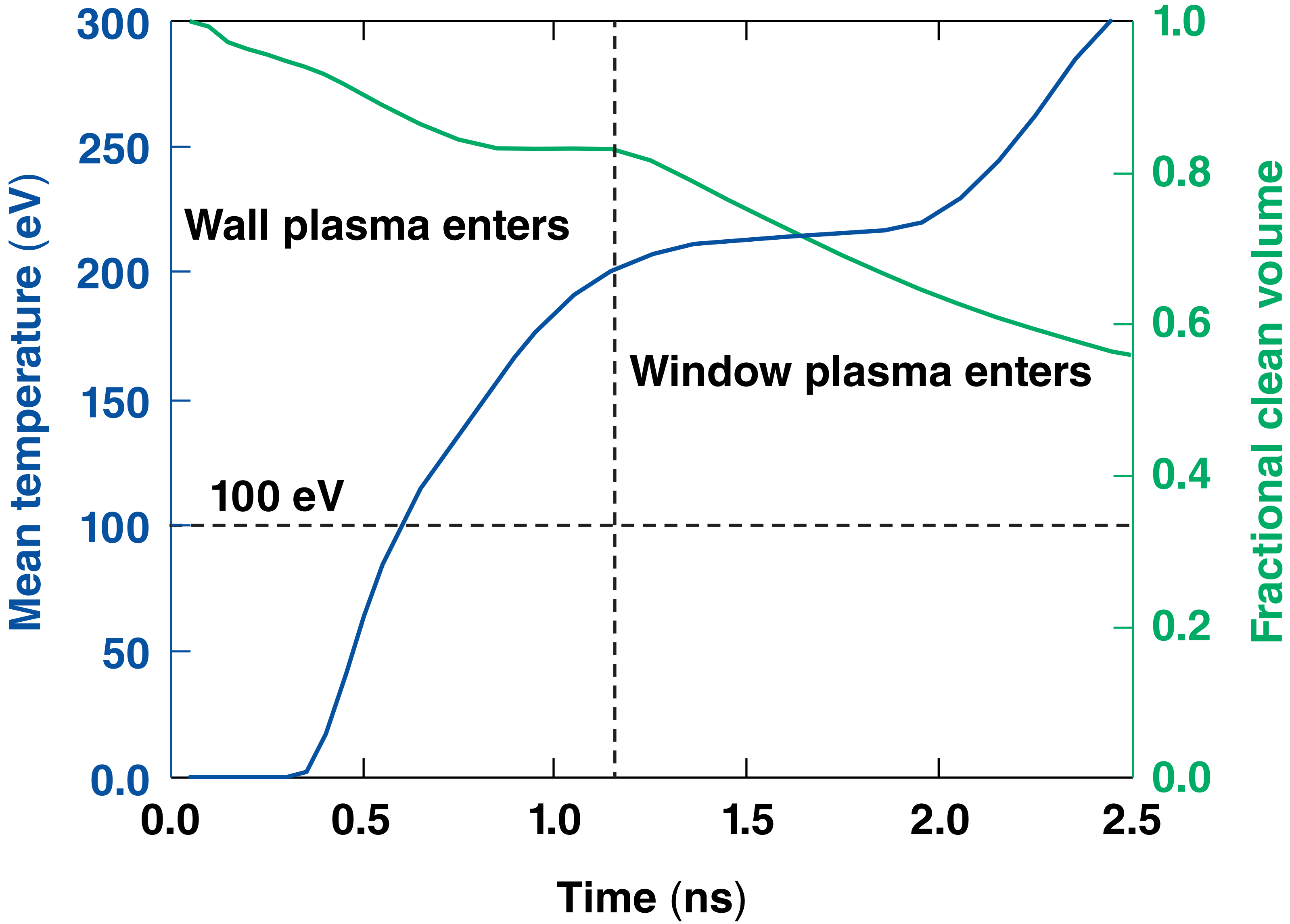
DRACO predicts up to 200-eV mean preheat temperature in the volume to be compressed before the window plasma enters



TC12458a

Laser preheating has been studied as the first phase in the development of laser-driven magnetized liner inertial fusion (MagLIF) on OMEGA

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Six shots were taken on just the entrance window foils

Shot number	*E* (J)	Diagnostic
76671	212.6	FABS backscatter, Hex Cal transmission, Dante
76676	195.6	FABS backscatter, Hex Cal transmission, Dante
76677	108.1	FABS backscatter, Hex Cal transmission, Dante
76679	198.4	FABS transmission, Dante
76680	113.8	FABS transmission, Dante
76681	63.1	FABS transmission, Dante

Twelve shots were taken on gas-filled cylinders

Shot number	*E* (J)	*P* (atm)	Ne	*B* (T)	Front diagnostic	Side diagnostics
76673	203.3	10.0	Y	15	FABS, Dante	Nothing
76674	202.0	10.0	Y	15	FABS, Dante	Nothing
76675	198.9	10.0	Y	0	FABS, Dante	SOP* (overfiltered)
76678	191.6	10.0	Y	0	FABS, Dante	SOP
76682	209.3	5.0	Y	0	FABS, Dante	SOP
76683	201.7	7.5	Y	0	FABS, Dante	SOP
76966	228.6	10.0	Y	0	SXR**	SXR, SOP-VISAR†, Dante
76967	200.8	10.0	Y	0	SXR	SXR, SOP-VISAR, Dante
76968	202.4	10.0	Y	0	SXR	SXR, SOP-VISAR, Dante
76969	196.4	10.0	N	0	SXR	SXR, SOP-VISAR, Dante
76970	198.8	10.0	Y	0	SXR	SXR, $\text{SOP-VISAR}_{\perp}$, Dante
76971	198.7	10.0	N	0	SXR	SXR, $\text{SOP-VISAR}_{\perp}$, Dante

*SOP: streaked optical pyrometry
**SXR: soft x ray
†VISAR: velocity interferometer system for any reflector

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