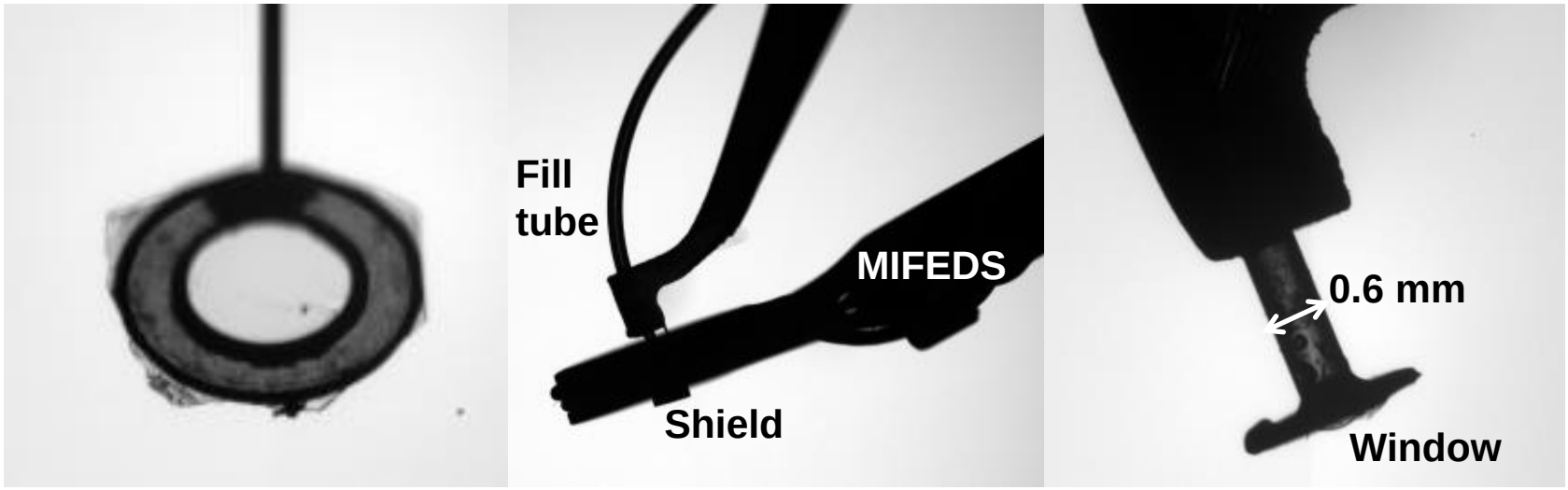
Preheating Studies for Laser-Driven MagLIF on OMEGA

1.84 μm polyimide foil (Entrance window)

Cylinder (Shown with coil)

Cylinder (Without shield)



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Summary

Preliminary analysis of experiments on OMEGA indicate that adequate preheating is achieved

- Transmission through entrance window foils along the original beam path exceeds 50%
- Backscatter from foil-only and cylinders is similar, lasts around 0.5 ns and accounts for less than 1% of the laser energy
- Just under 10% of the laser energy is side scattered as the foil starts to transmit
- Optical and soft X-ray emission indicate that the gas is heated along the full length of the target to at least 100 eV

Collaborators

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An OMEGA beam with 60 to 200 J in 2.5 ns and a phase plate giving a 96 μm FWHM Gaussian spot was used giving peak laser intensities of 2.3 to 7.6 × 10^{14} W cm^{-2}

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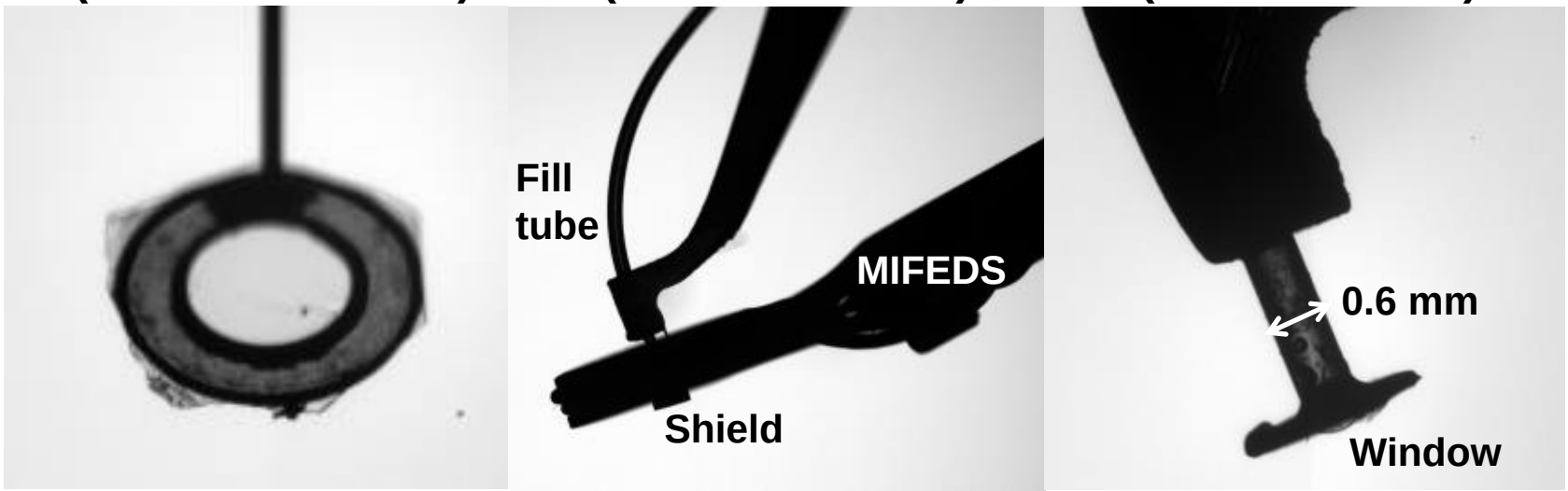
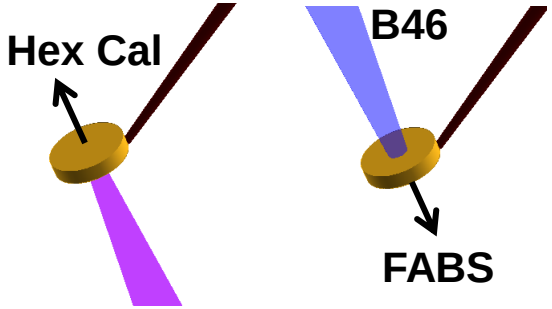
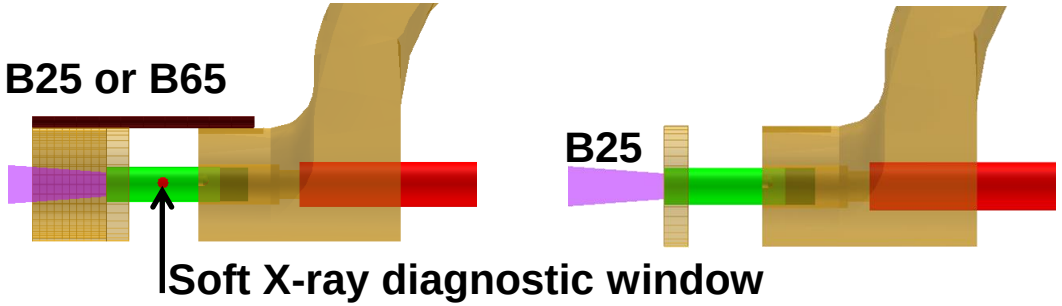
Cylinder (Shown with coil)

Cylinder (Without shield)

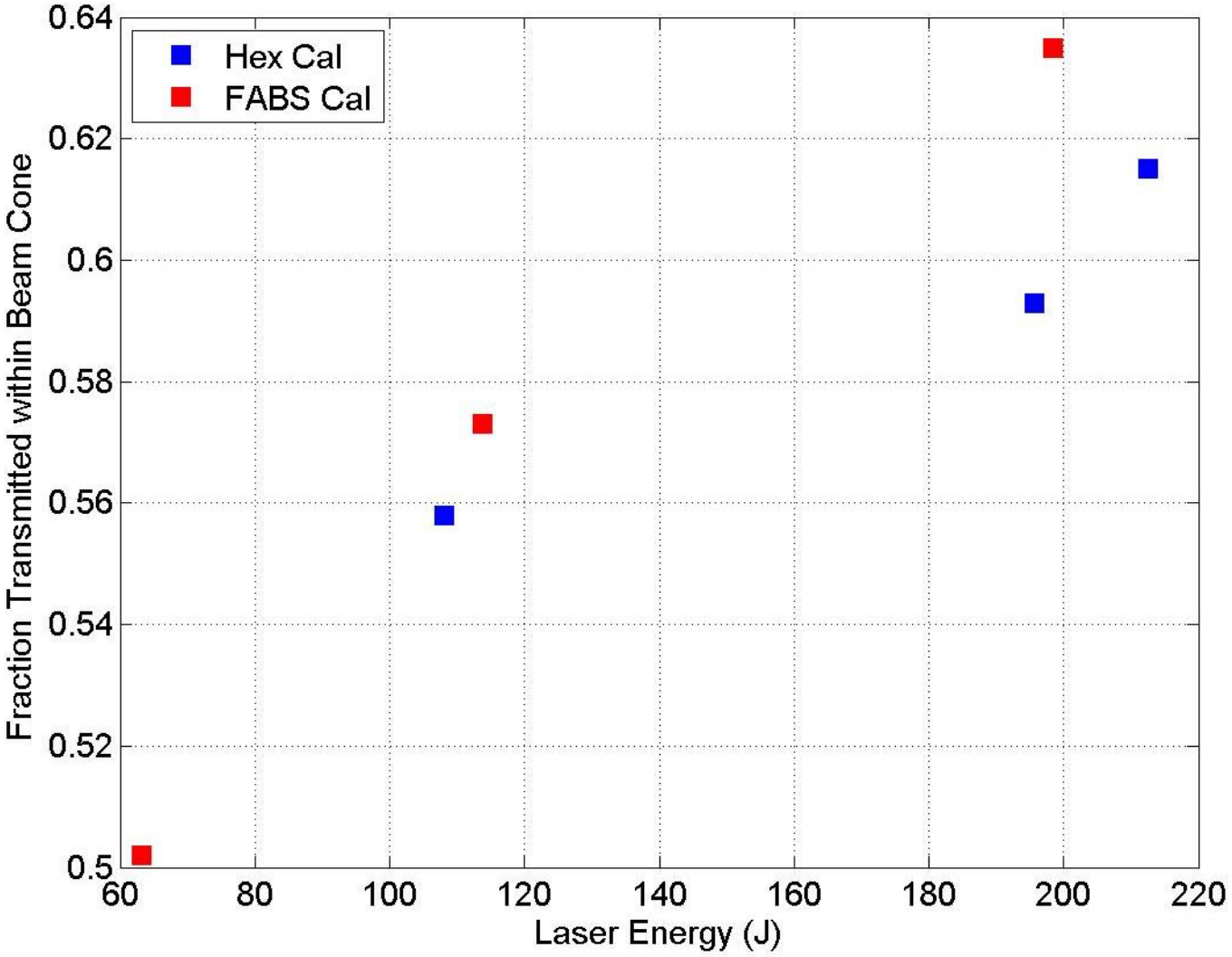




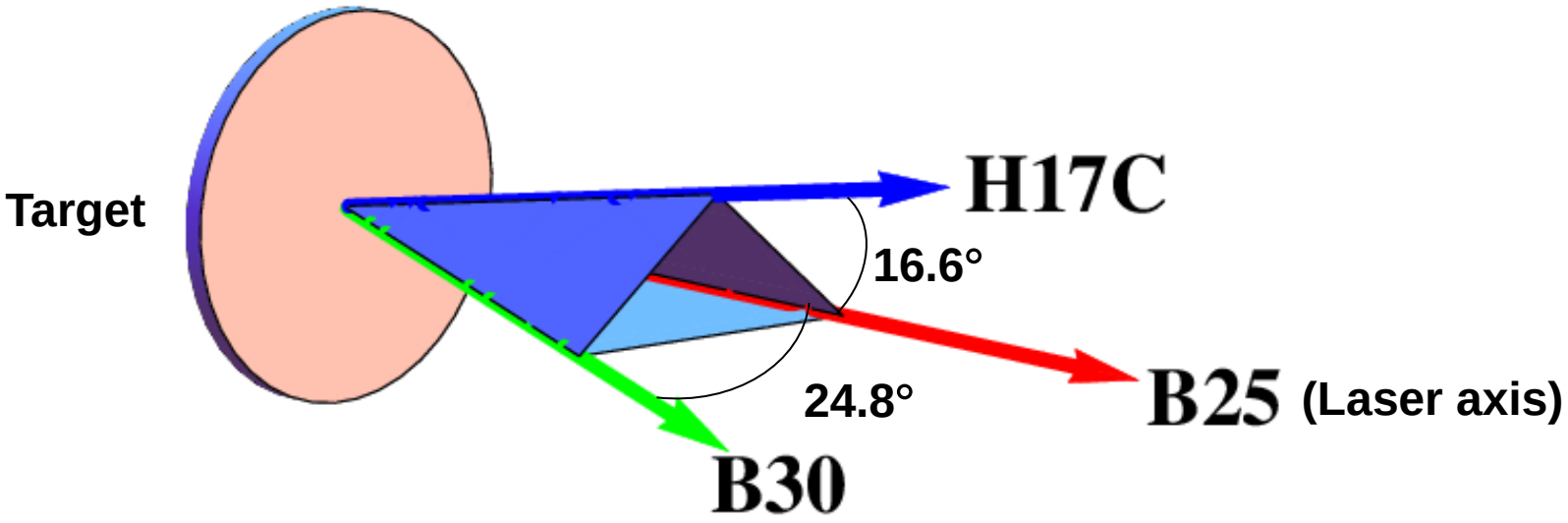


600 μm outer diameter, 30 μm thick parylene-AF4 cylinders filled with 1.6 mg/cc 2%at Ne doped D_2

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



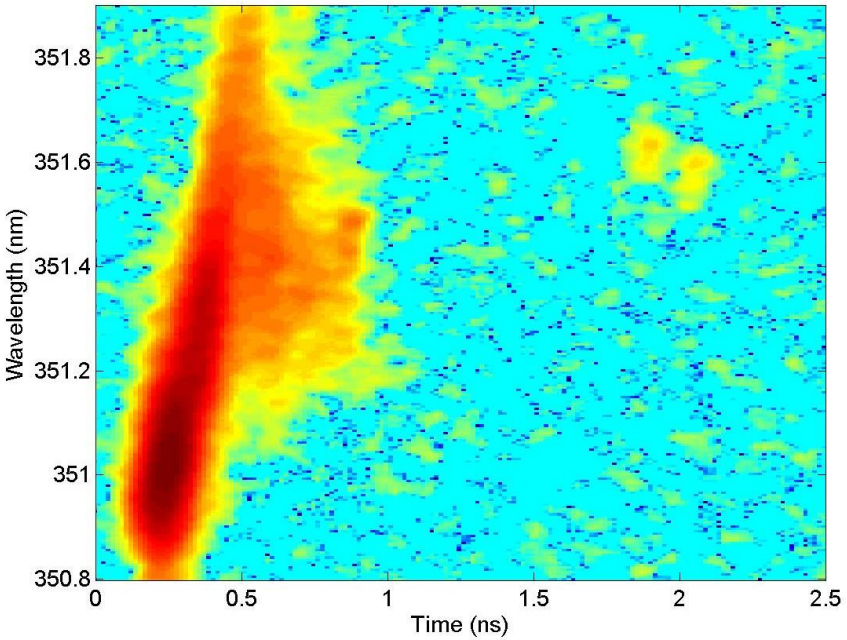
Time resolved spectra of backscattered or transmitted light were measured at three angles



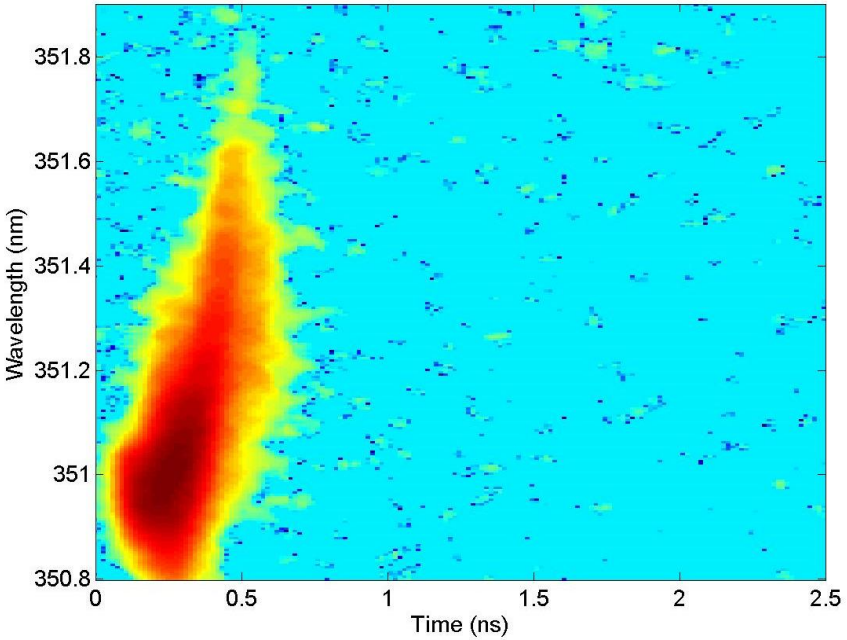
Backscatter from foils and cylinders was similar and lasted around 0.5 ns

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

Cylinder 203.3 J



Foil 195.6 J



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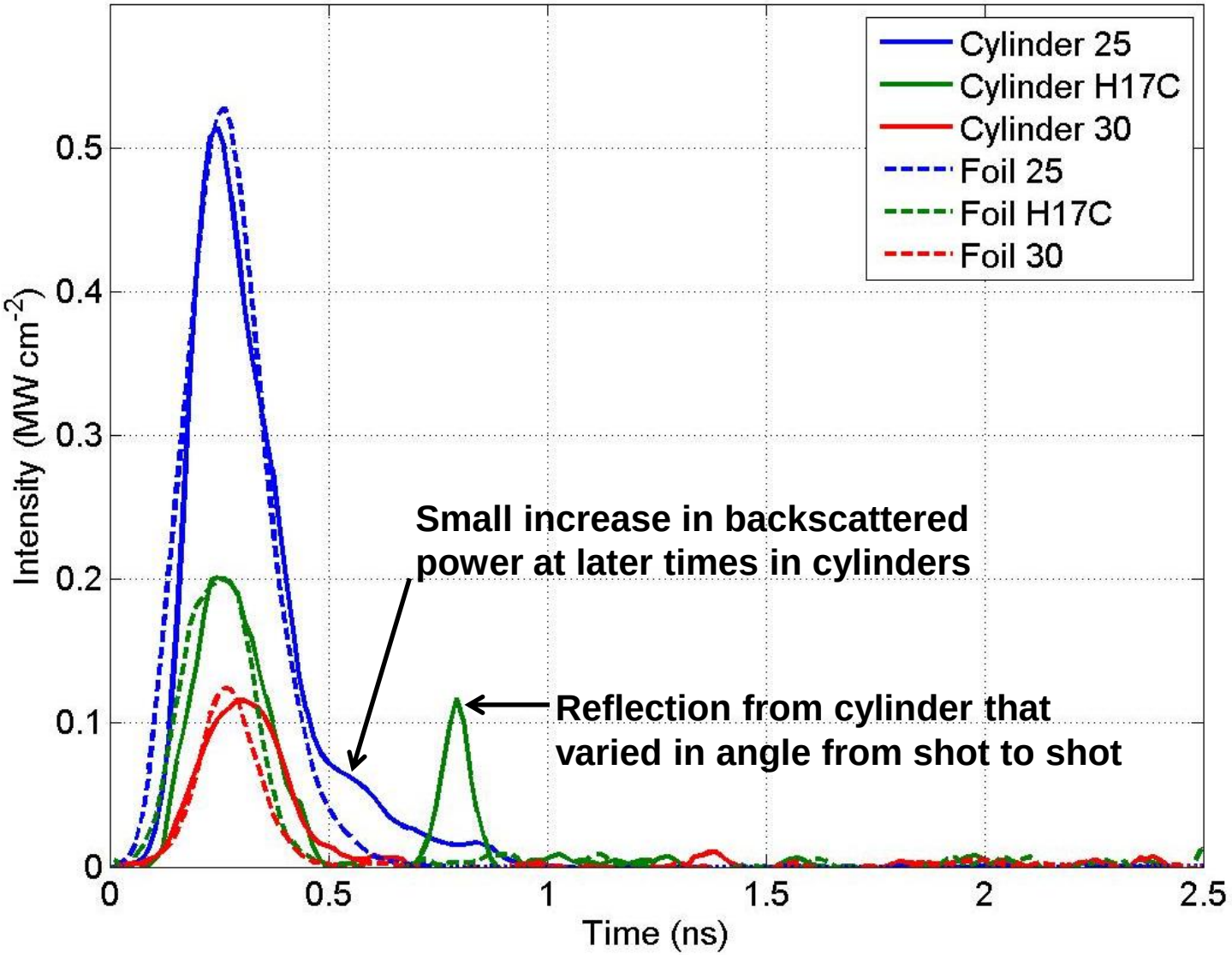
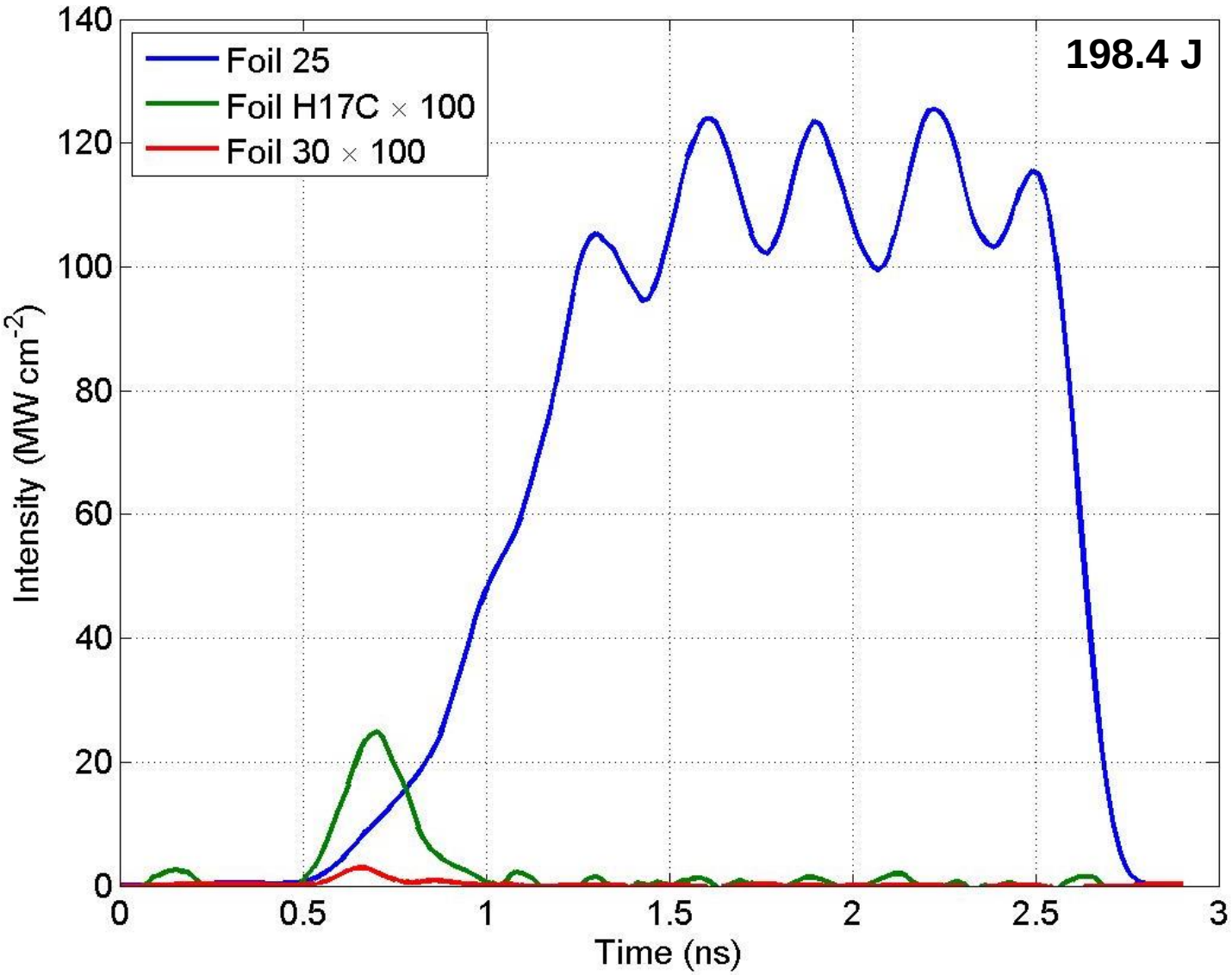
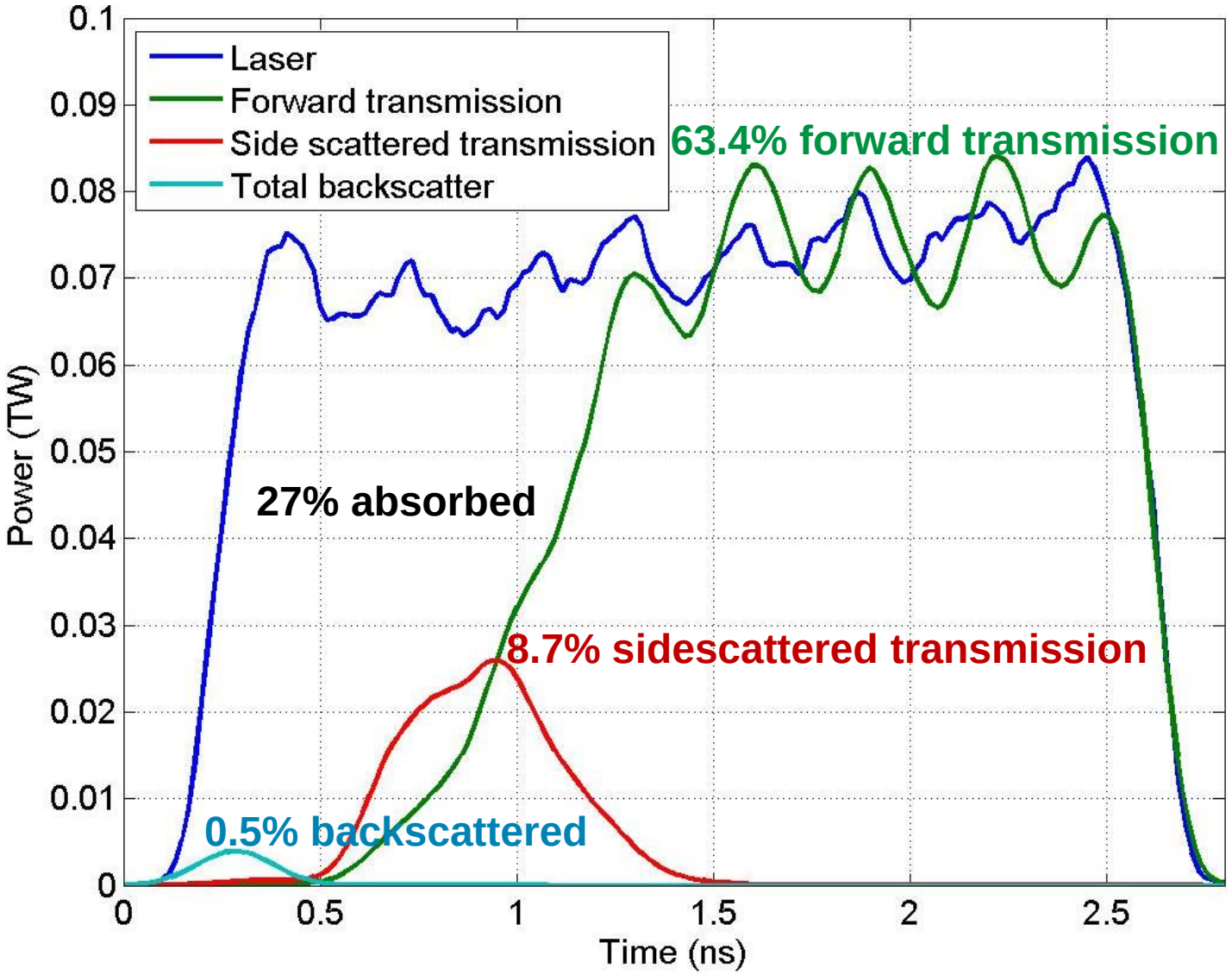


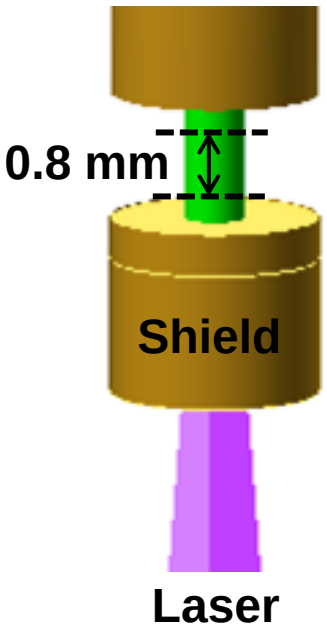
Foil transmission measurements showed side scattering lasting less than 0.5 ns

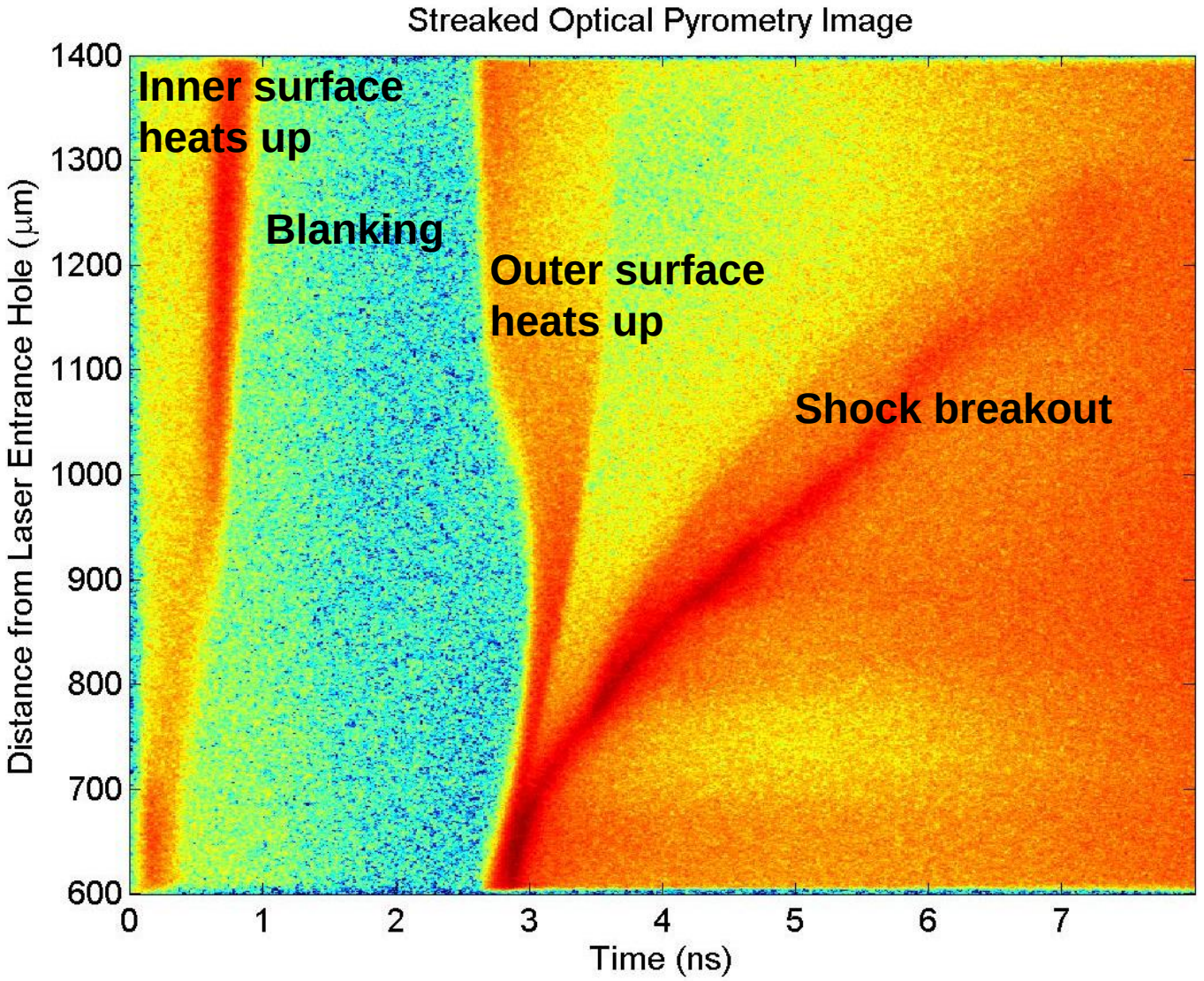


Total backscatter and transmission for foils at 200 J was obtained by fitting data from 2 shots with a Gaussian radial intensity profile

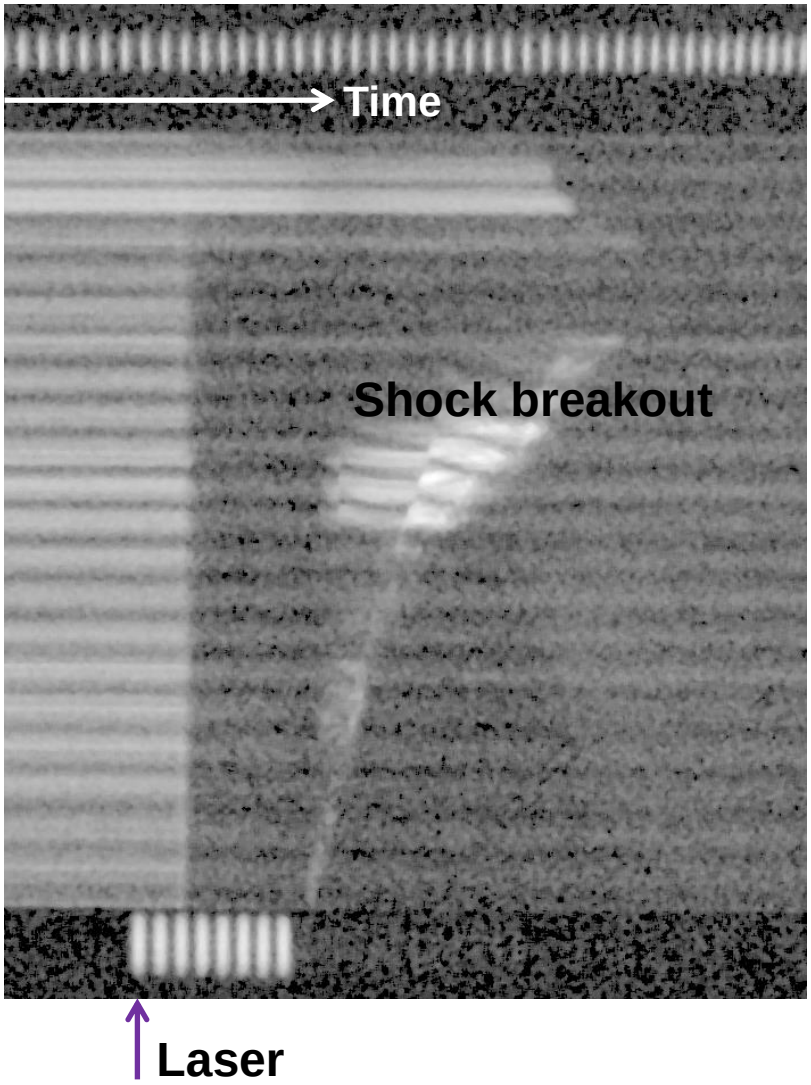


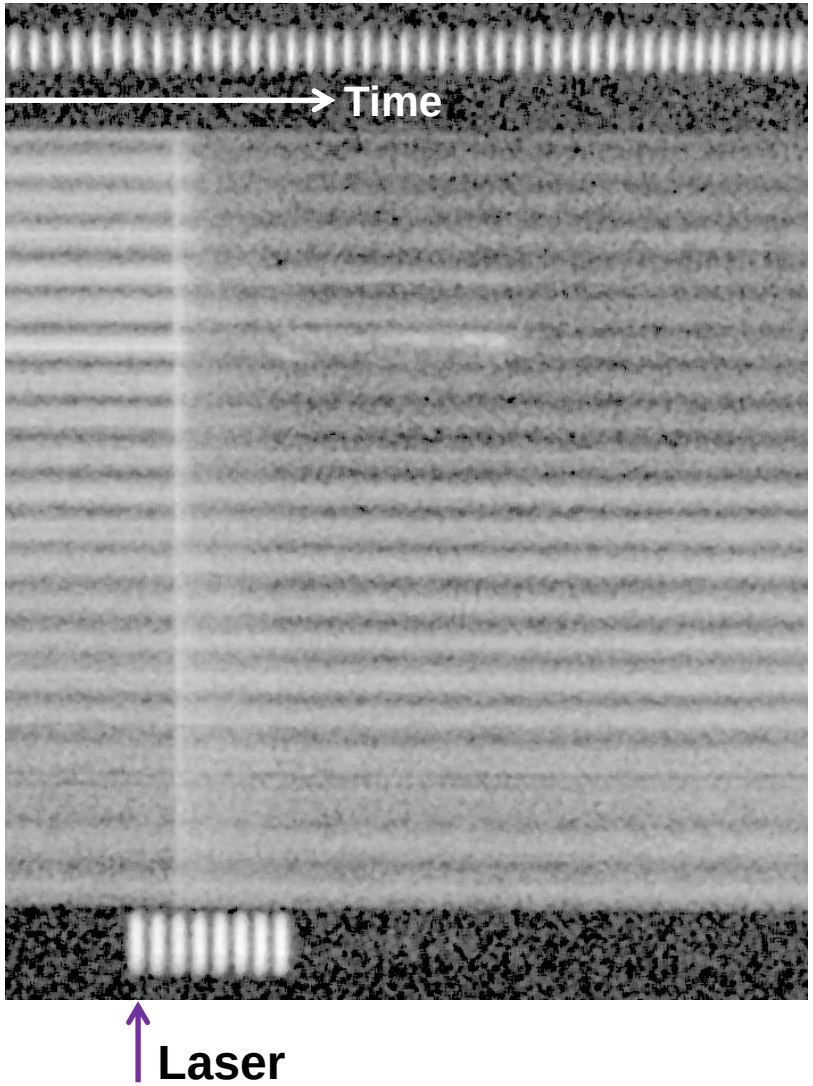
Streaked optical pyrometery of the cylinder surface demonstrates energy coupling along the central 0.8 mm



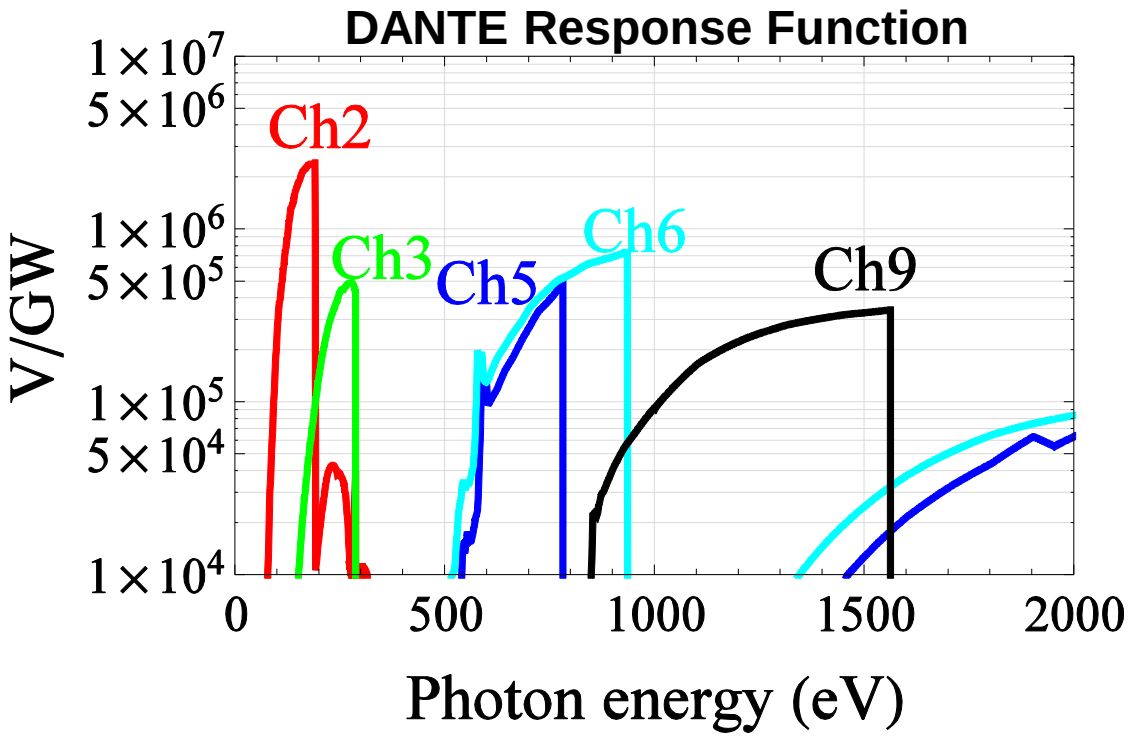


VISAR confirmed shock breakout but in some shots there was no shock seen in either SOP or VISAR

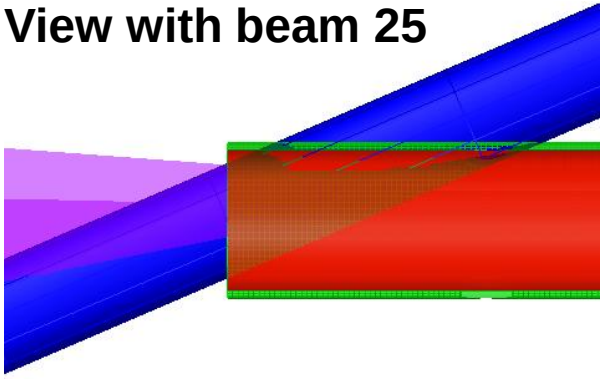




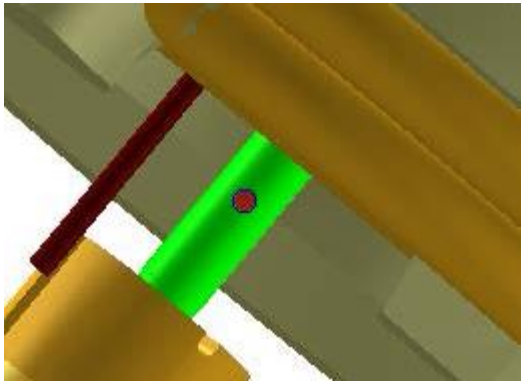
The time resolved X-ray spectrometer DANTE was used to measure emission from the entrance window or from the side diagnostic window



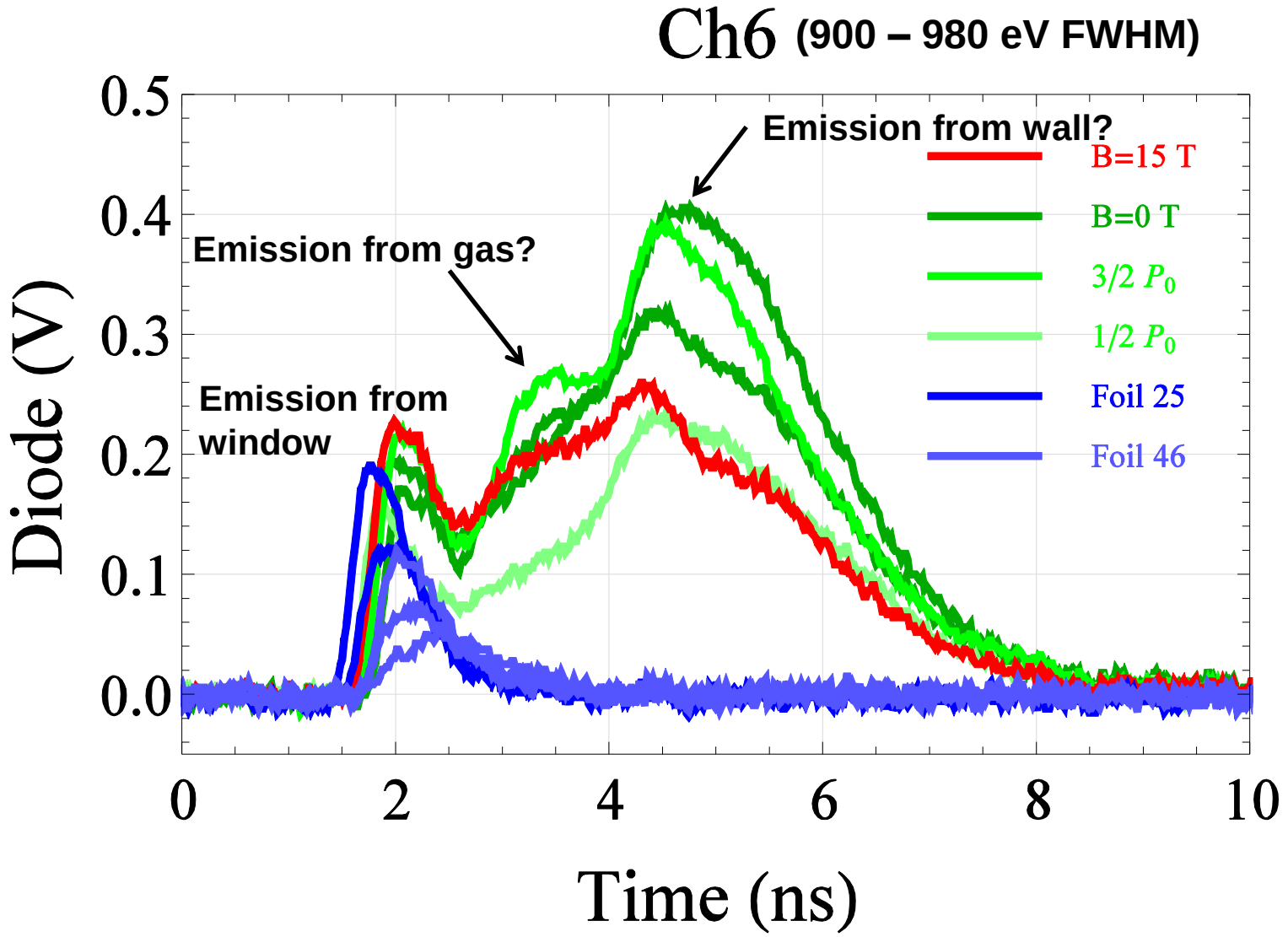
View with beam 25



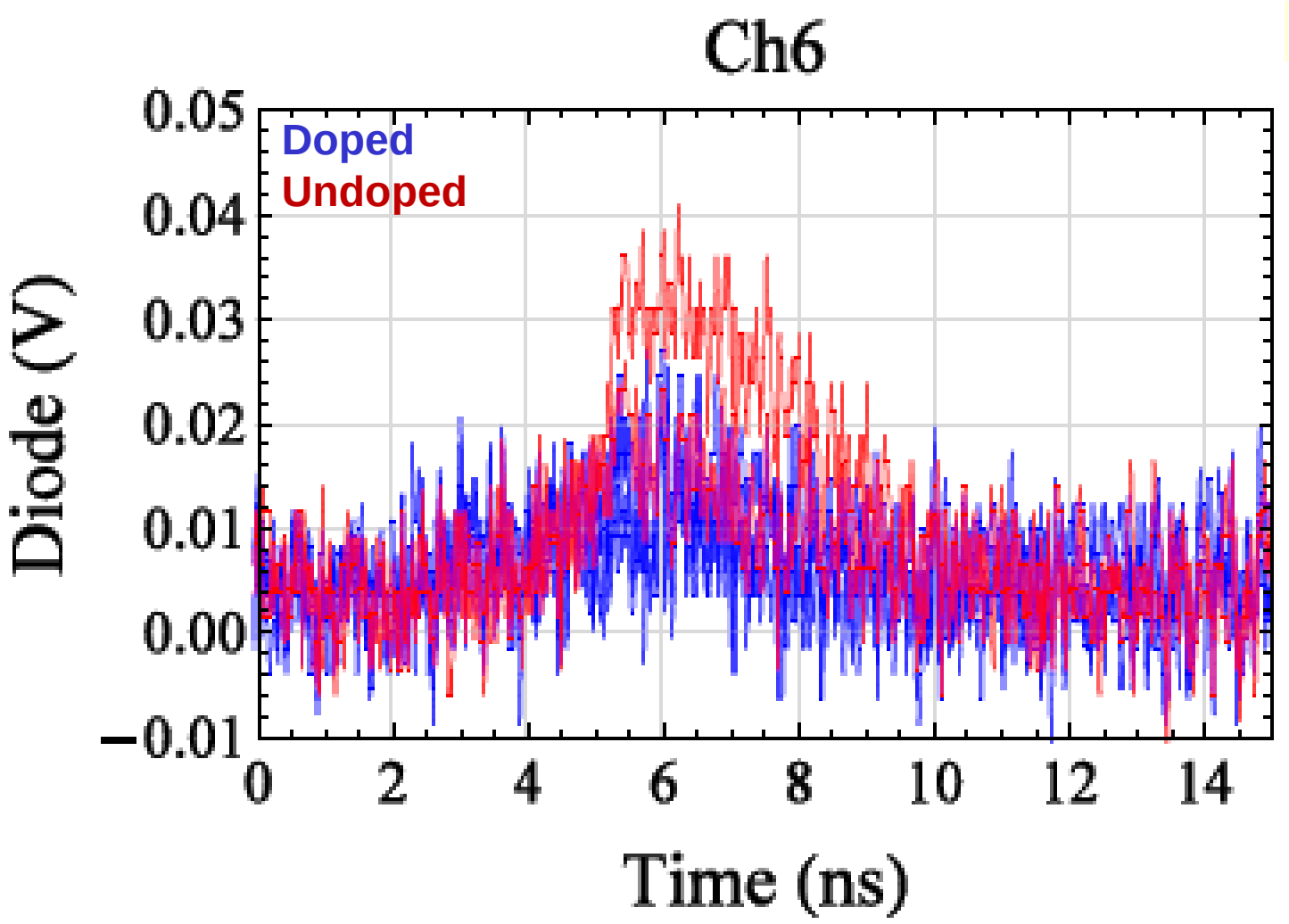
View with beam 65



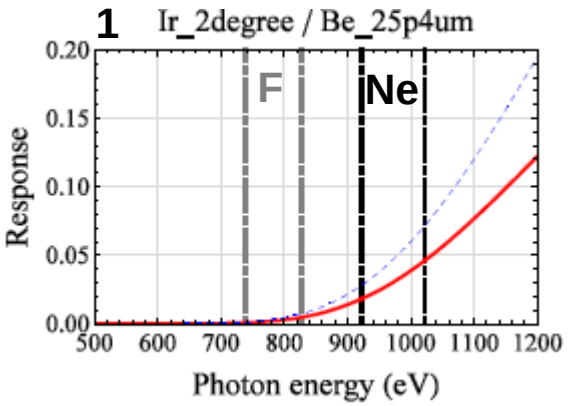
Signal was obtained on 5 channels from the entrance window that appears to contain signal from the gas

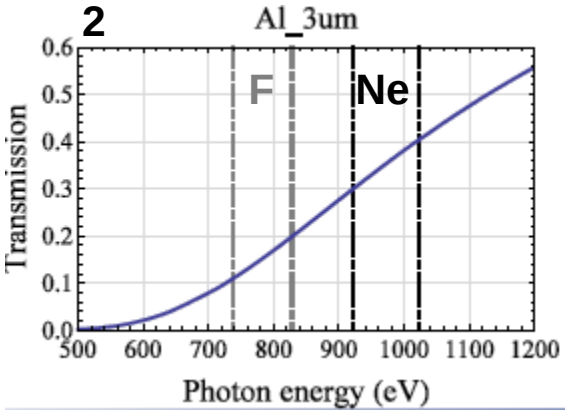


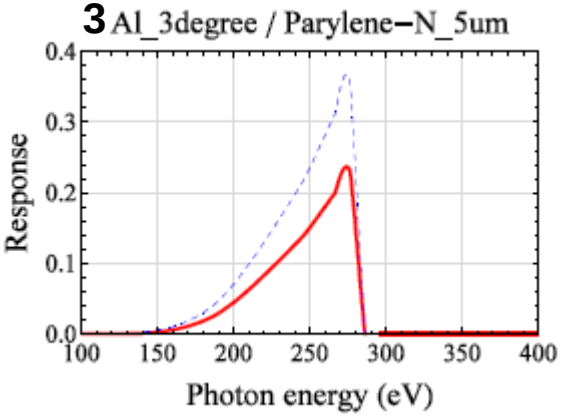
The signal from the side diagnostic window was barely above the noise level in only 2 channels

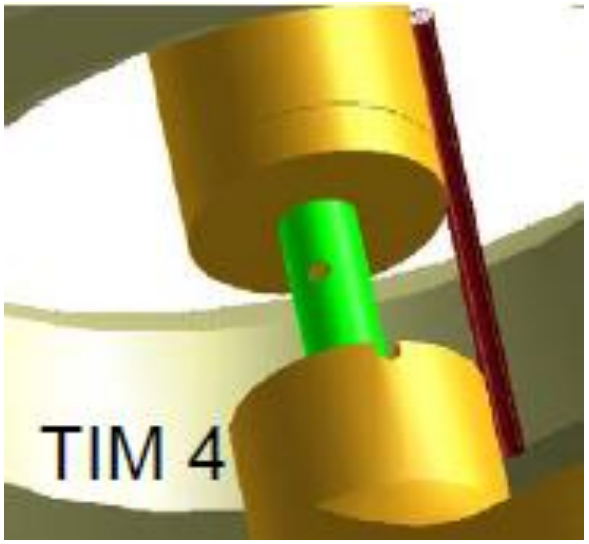


Mirror-filter pairs coupled to X-ray framing cameras gave 3-channel, time resolved X-ray spectrometers (SXR)







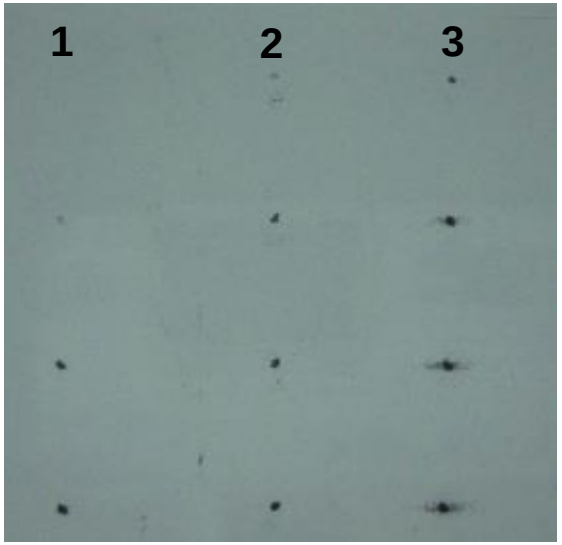


1.3 ns

1.9 ns

2.5 ns

3.1 ns



DANTE and SXR data are being modeled with Spect3D to infer the gas temperature

- **The data is insufficient to give a unique solution**
- **The best that can be achieved is placing bounds on the gas and wall temperatures**
- **Preliminary results indicate that the gas temperature at the center exceeded the goal of 100 eV**
- **Spect3D will be used to post-process hydrocode results to allow a direct comparison with the soft X-ray measurements**

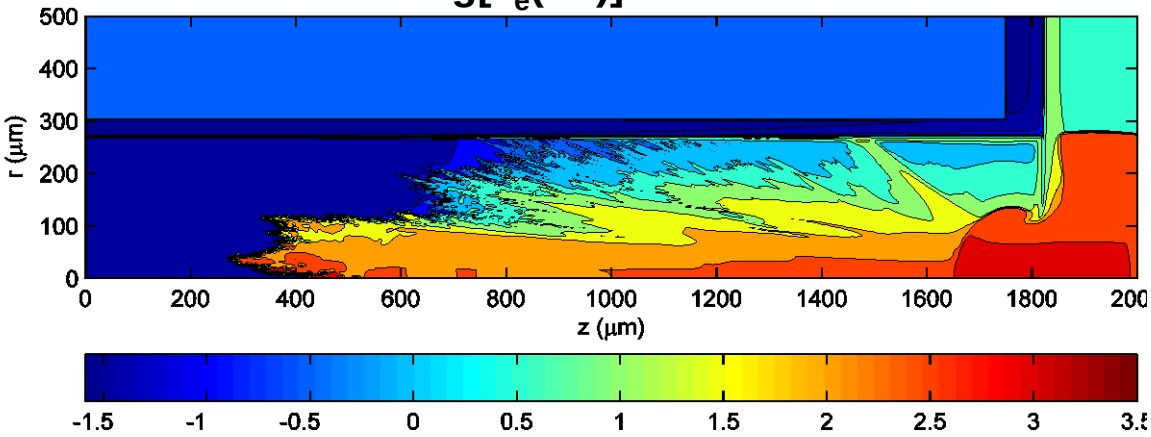
Hard X-ray, 3ω/2, Raman scattered light and neutron detectors were also fielded

- **No detectable hard X-ray or 3ω/2 emission**
  - **Two plasmon decay is not significant**
- **A weak Raman scattered signal was detected in some cylinder shots**
  - **Brief emission at early times that has yet to be analyzed**
- **The neutron scintillator detected from 2 to 4 DD fusion neutrons**
  - **Total yields ~ 10^5 neutrons**
  - **Yields appear to be higher for magnetized shots**

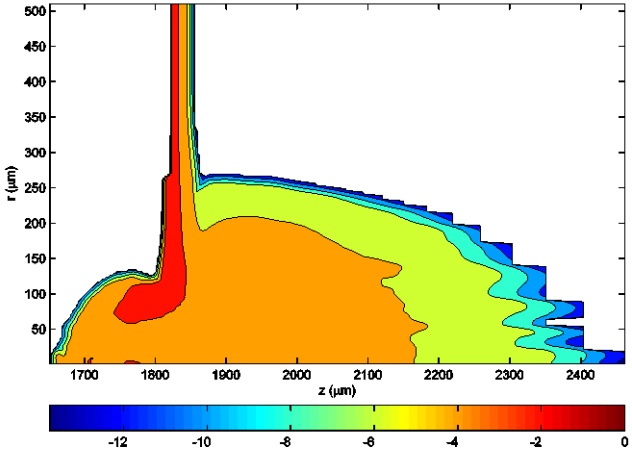
The experiments are being modeled in 2D with Draco and Flash

- **Sample results from Draco for a cylindrical target**

Log[T_e(eV)] at 0.4 ns



Log[ρ(g/cc)] at 0.4 ns



  - **Burn through time is consistent with experiment**
  - **Sidescattering of transmitted light is seen due to refraction near the edge of the expanding hole in the window**

- **Draco and Flash will be used to model SOP, soft X-ray emission and the streaked, back scattered spectrum**

Summary

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- Backscatter from foil-only and cylinders is similar, lasts around 0.5 ns and accounts for less than 1% of the laser energy
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Six shots were taken on just the entrance window foils

Shot #	E (J)	Diagnostics
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 #	E(J)	P(atm)	Ne	B(T)	Front diagnostics	Side diagnostics
76673	203.3	10	Y	15	FABS, DANTE	Nothing
76674	202.0	10	Y	15	FABS, DANTE	Nothing
76675	198.9	10	Y	0	FABS, DANTE	SOP (over filtered)
76678	191.6	10	Y	0	FABS, DANTE	SOP
76682	209.3	5	Y	0	FABS, DANTE	SOP
76683	201.7	7.5	Y	0	FABS, DANTE	SOP
76966	228.6	10	Y	0	SXR	SXR, SOP-VISAR, DANTE
76967	200.8	10	Y	0	SXR	SXR, SOP-VISAR, DANTE
76968	202.4	10	Y	0	SXR	SXR, SOP-VISAR, DANTE
76969	196.4	10	N	0	SXR	SXR, SOP-VISAR, DANTE
76970	198.8	10	Y	0	SXR	SXR, SOP-VISAR⊥, DANTE
76971	198.7	10	N	0	SXR	SXR, SOP-VISAR⊥, DANTE