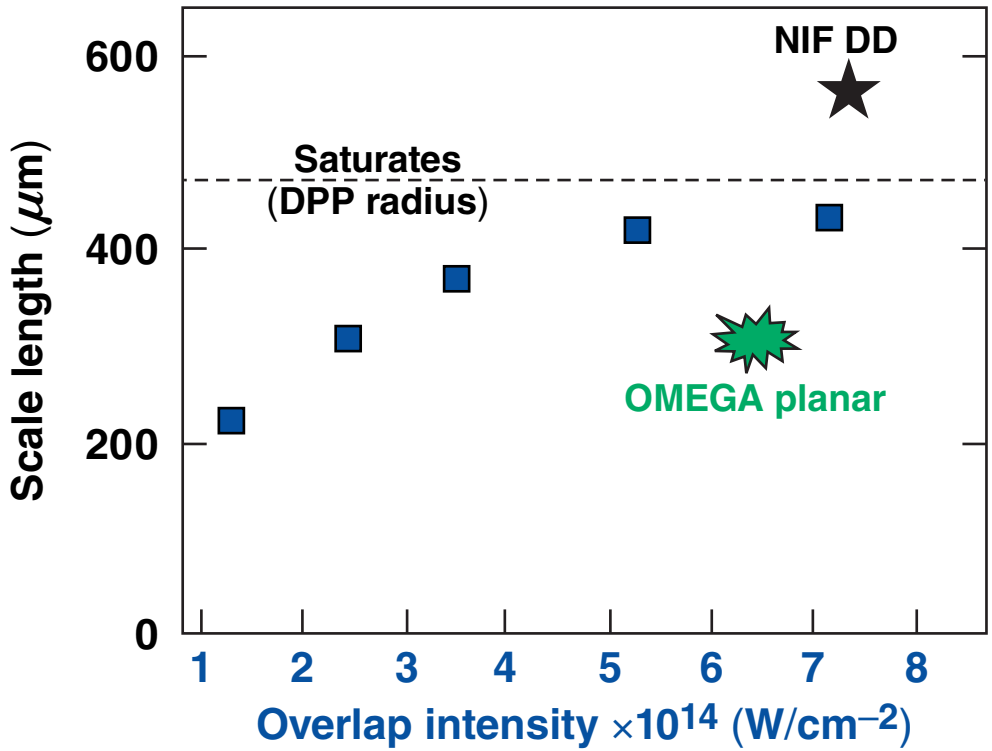
Simulation and Analysis of Long-Scale-Length Plasma Experiments at the Omega EP Laser Facility



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Summary

DRACO simulations show long-scale-length plasmas created on OMEGA EP approach NIF conditions

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- To study LPI processes in NIF-scale plasmas, planar-target experiments are performed using large distributed phase plates at the Omega EP Laser Facility
- Long-scale-length plasmas of L_n ~ 300 to 400 μm, close to direct-drive NIF conditions, have been created with beam energies currently available on OMEGA EP
- Two-dimensional *DRACO* simulations predict the hydro-evolution of such long-scale-length plasmas
- Temporal evolution of fast-electron generation from two-plasmon-decay (TPD) instability is characterized with the TPD threshold parameter

Collaborators

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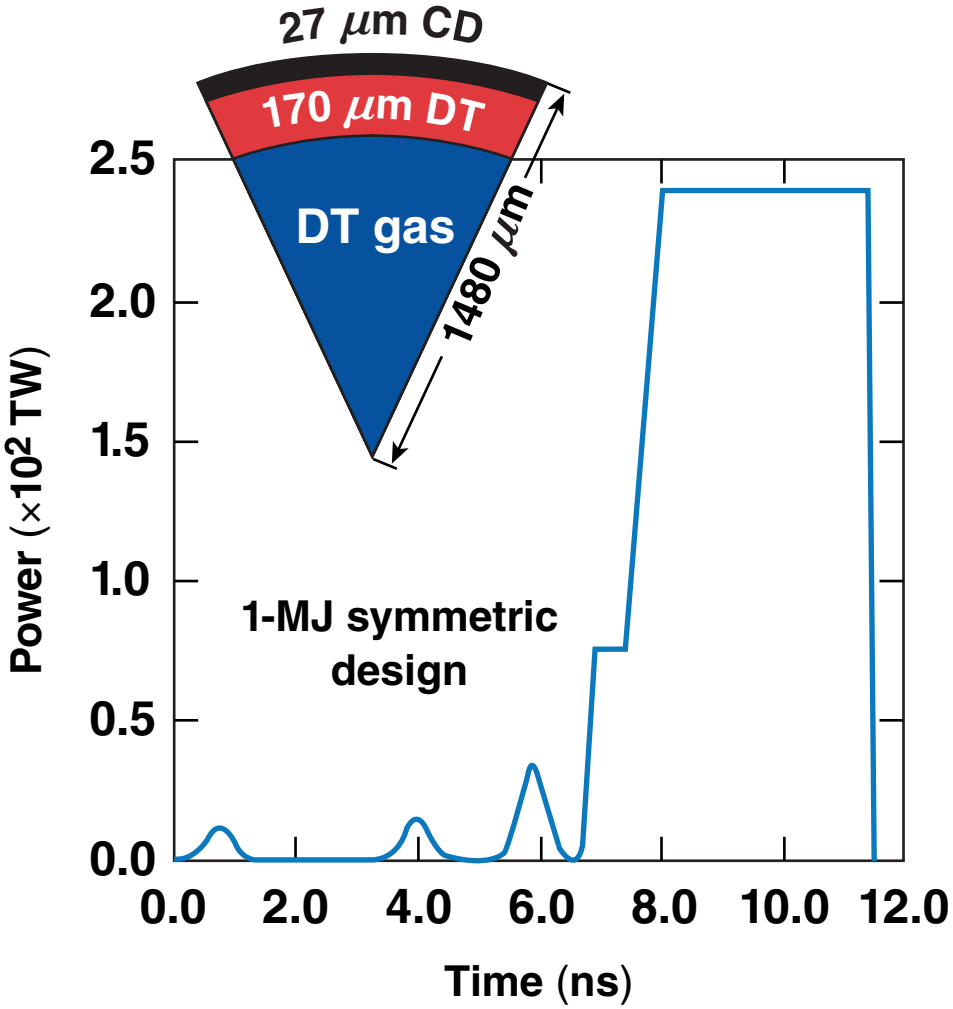
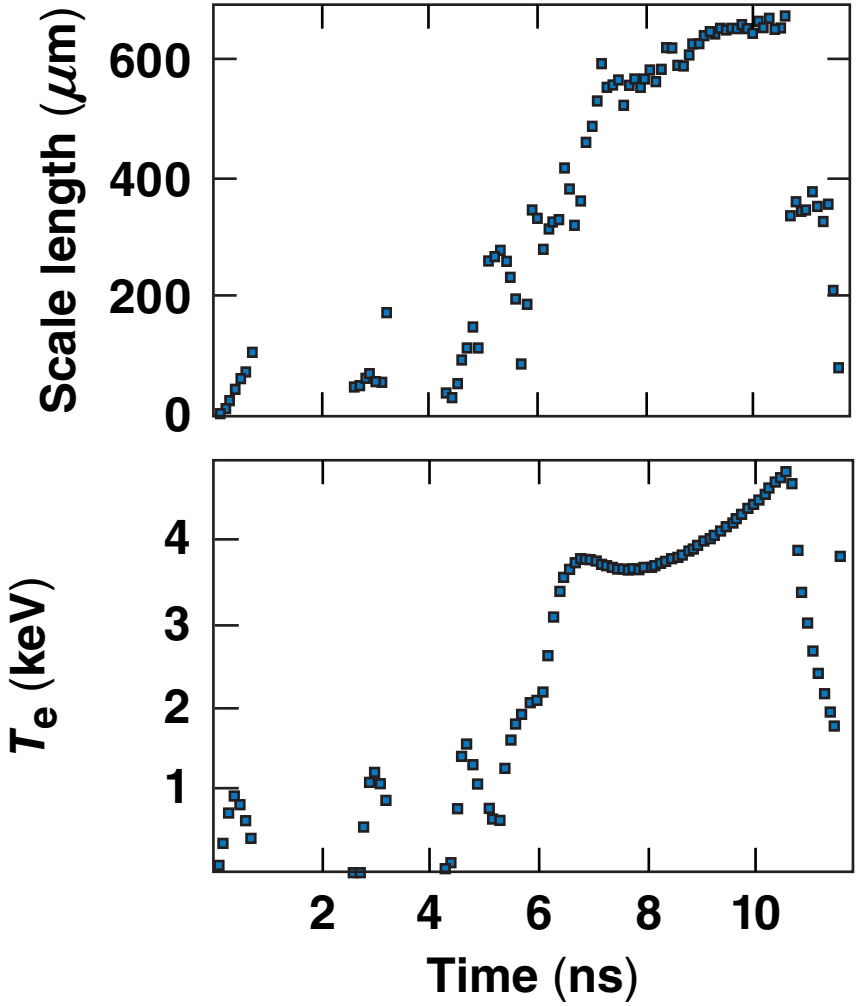
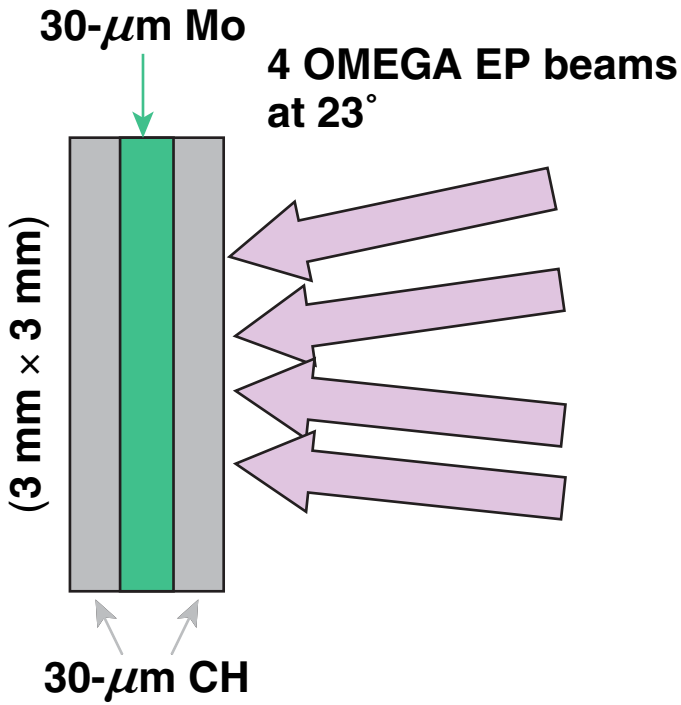
Direct-drive NIF designs require accurate assessments of LPI processes in long-scale-length plasmas



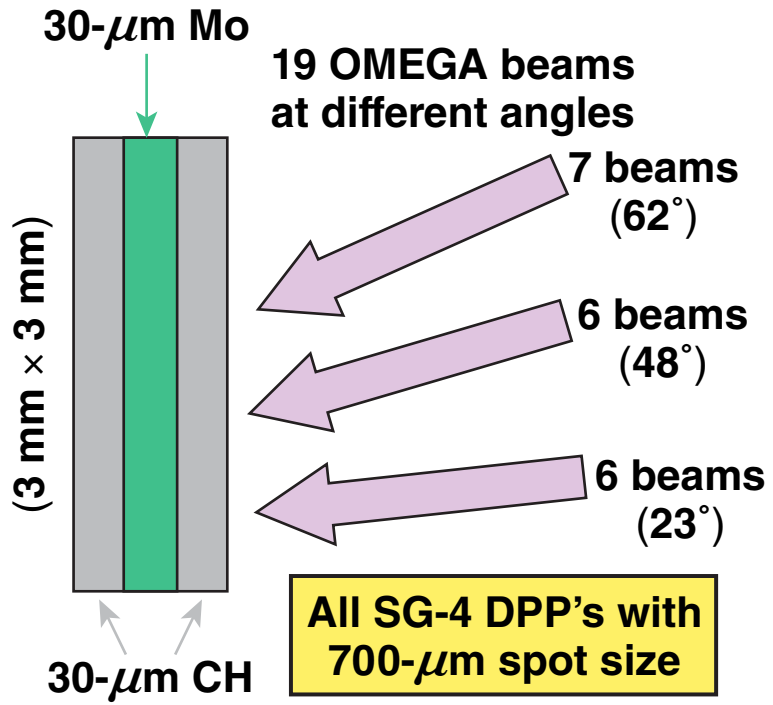


TC9392

Planar-target experiments have been performed on both OMEGA and OMEGA EP using large distributed phase plates (DPP's)



2 DPP's at 1100-μm spot size
2 DPP's at 750-μm spot size



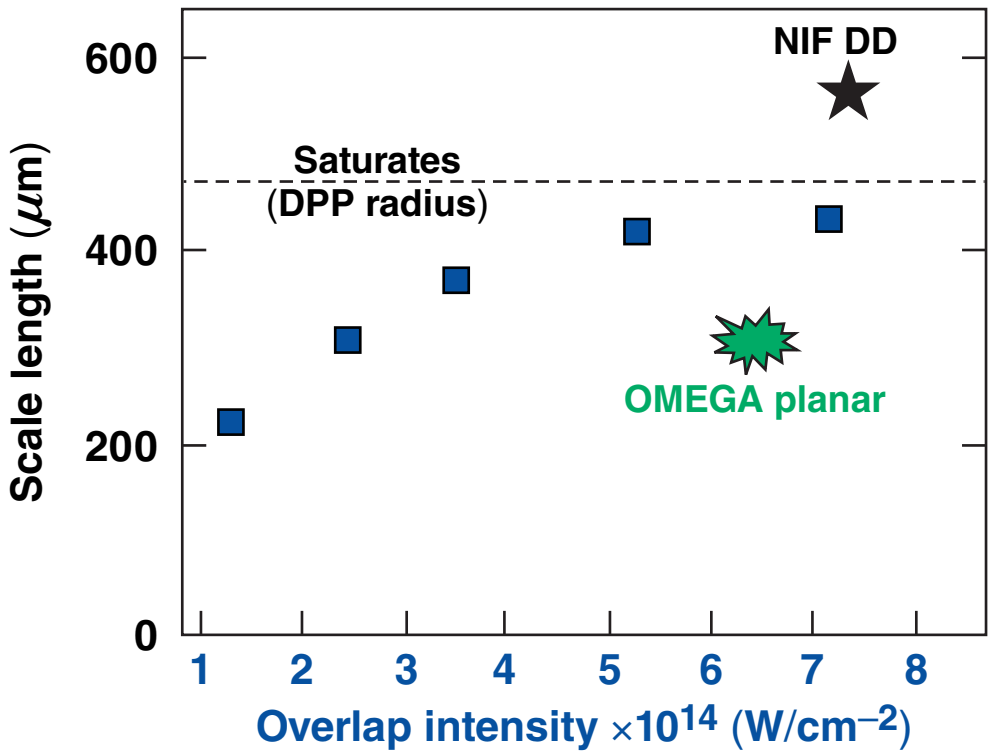
All SG-4 DPP's with 700-μm spot size

Hard x-ray detector and Mo-K_α are used to infer the amount and temperature of fast electrons generated.

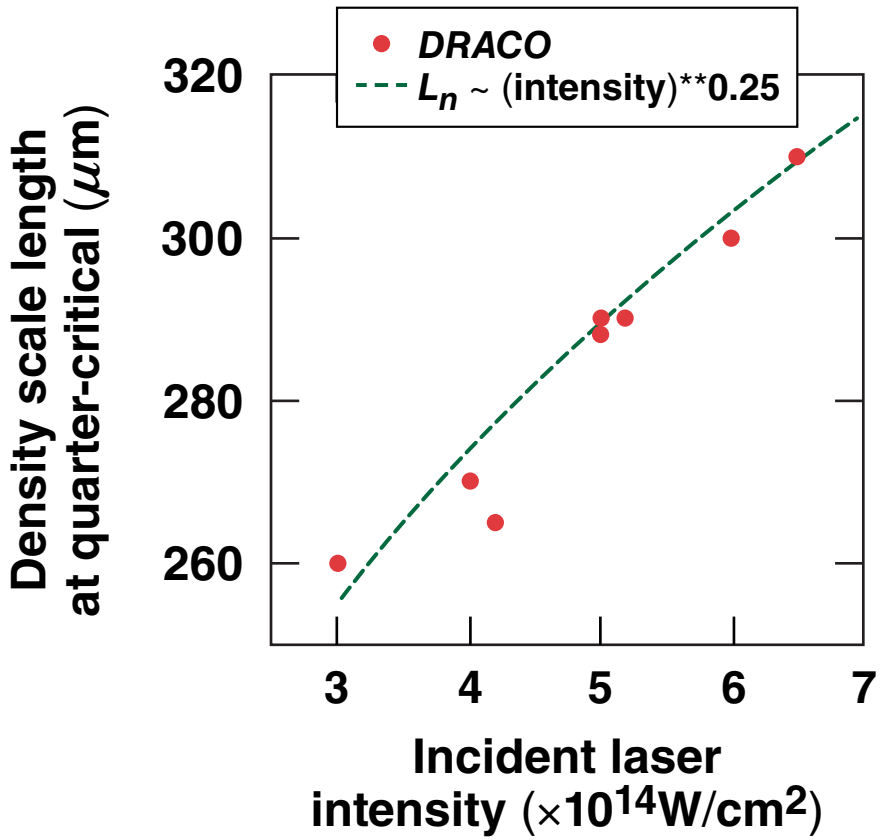
NIF-scale plasmas can be created on OMEGA EP for LPI studies

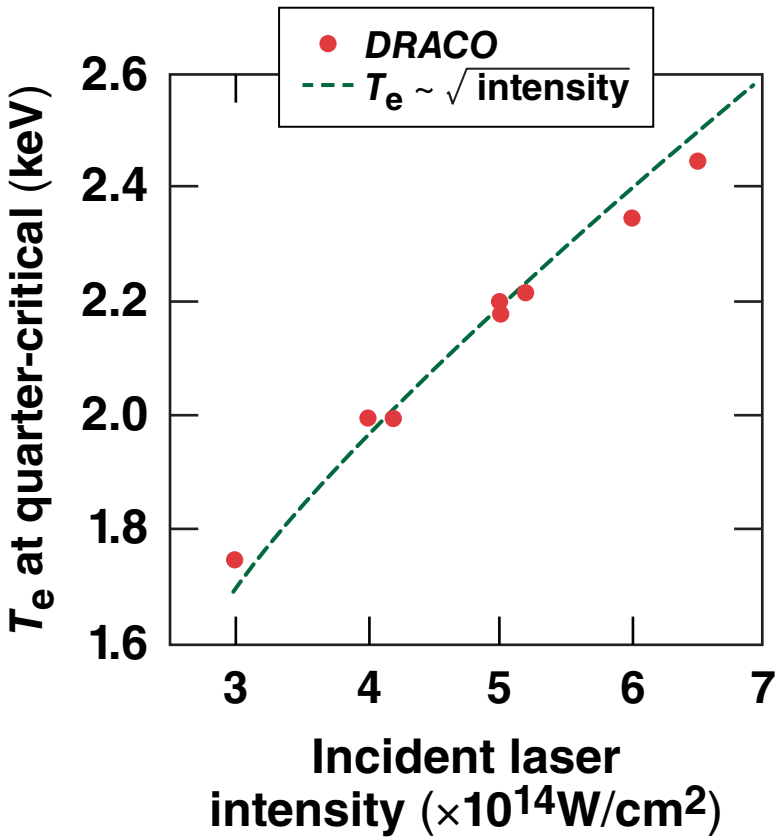
- By varying the beam energy and DPP size, long-scale-length plasmas of $L_n \sim 450\ \mu$m can be created on OMEGA EP
- Simulations indicate 2-ns square pulses produce better NIF-condition plasmas, while longer pulses do not increase the density scale length
- Due to the spot-size restriction (SG-4/SG-8) and large beam angles, the plasma scale length can reach to only $L_n \sim 300\ \mu$m on OMEGA

Pre-shot simulations indicate that long-scale-length (L_n ~ 340 to 440 μm) plasmas can be created on OMEGA EP



The intensity dependence of coronal conditions predicted by *DRACO* is consistent with analytic model predictions*

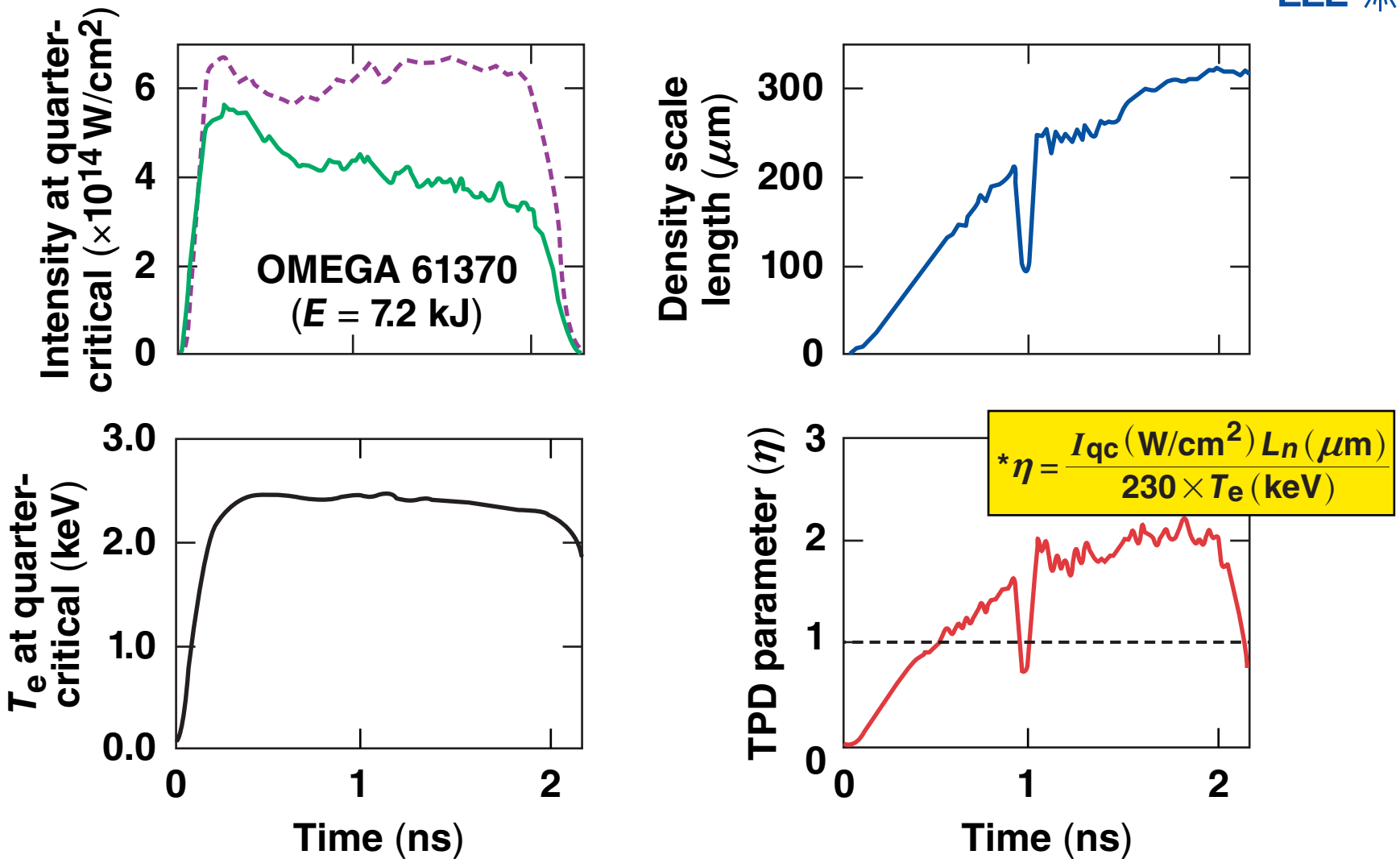




*Eq. (7.67), Atzeni and Meyer-ter-Vehn, "The Physics of Inertial Fusion" (Oxford, 2004).

TC9398

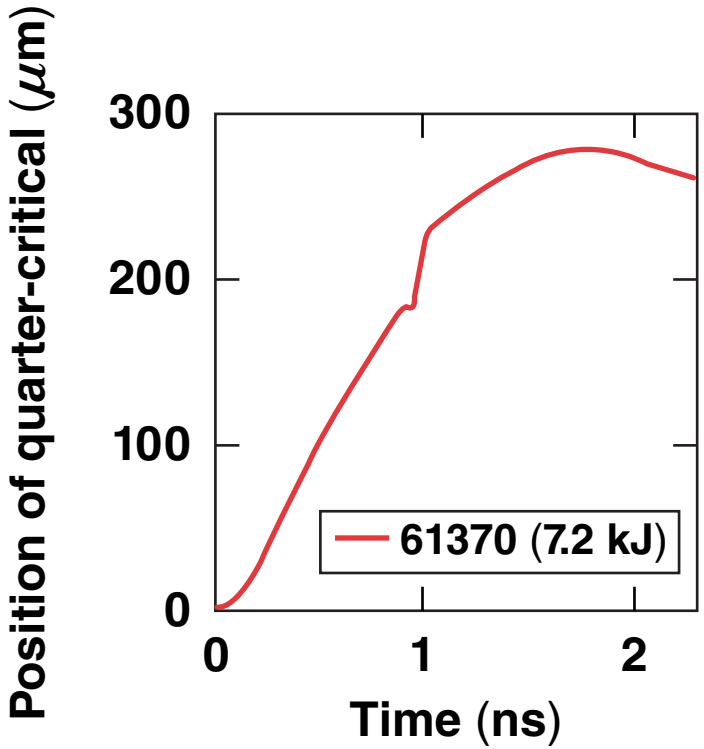
Long-scale-length (L_n ~ 300 μm) plasmas have been produced on OMEGA planar experiments

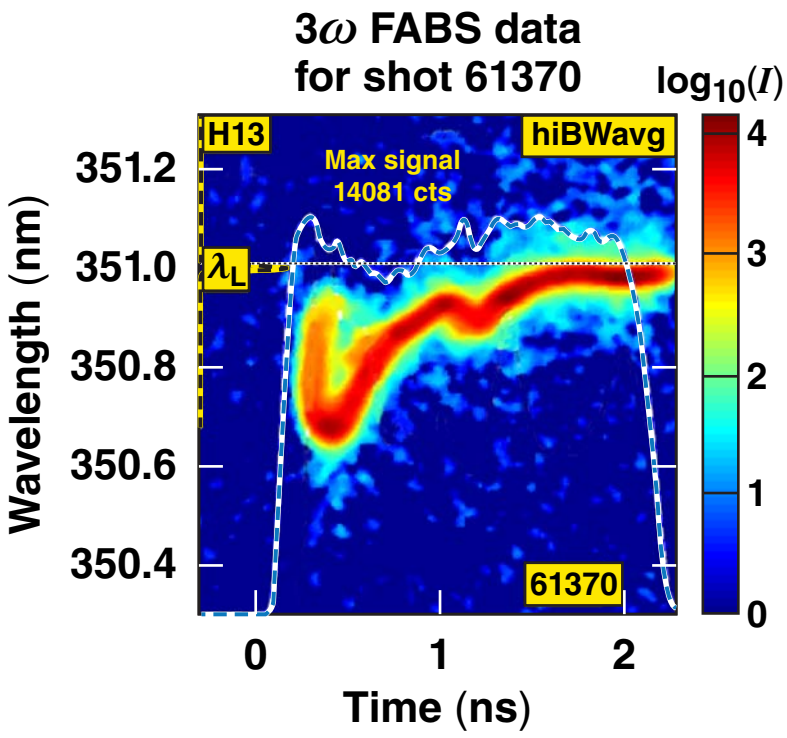


TC9397

*A. Simon *et al.*, Phys. Fluids 26, 3107 (1983).

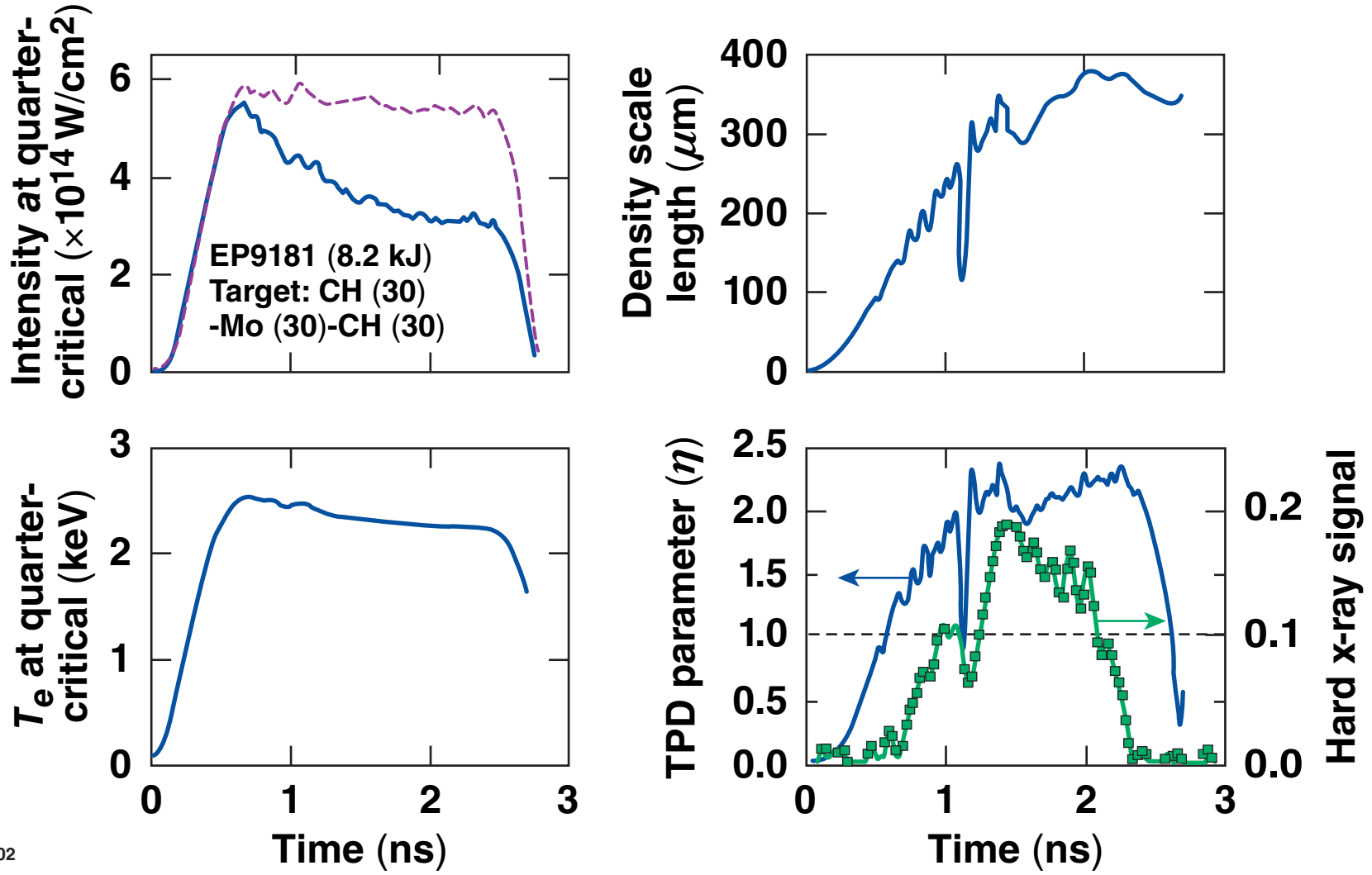
When the rarefaction wave "sweeps" the quarter-critical regime, the scattered light catches that signal





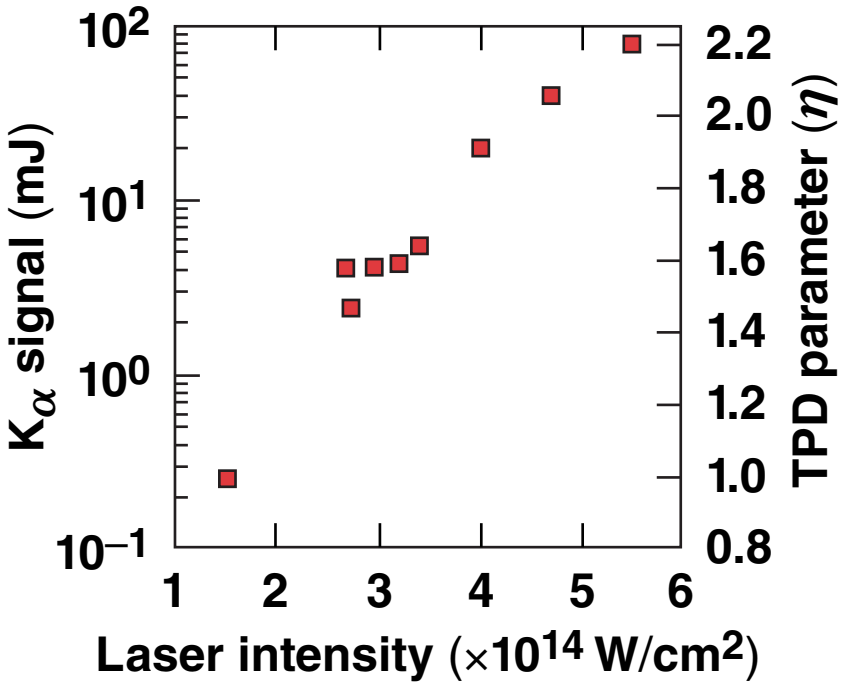
TC9396

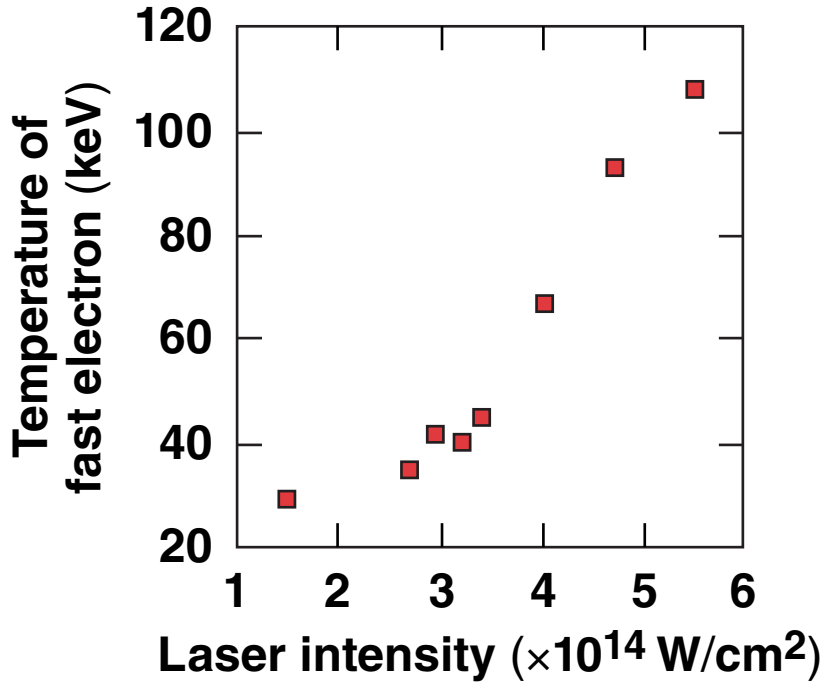
The time-resolved hard x-ray signals from OMEGA EP experiments are well characterized by the hydro-predicted η



TC9402

The time-integrated Mo-K_α signal and fast-electron temperature depend nonlinearly on η





2-ns square pulse

TC9403

TPD experiments with varied ablator material have been scheduled in August on OMEGA EP

Material	ρ (g/cc)	$\langle Z \rangle$	L_n (μm)	T_e (keV)	$I_{qc} \times 10^{14}$ (W/cm^2)	TPD–η
CH	1.044	3.0	350	2.10	2.6	1.8
Parylene	1.42	5.5	290	2.30	2.3	1.3
Saran	1.70	8.0	300	2.35	2.2	1.2
SiO_2	2.33	10.0	300	2.45	2.0	1.1
Al	2.70	13.0	250	2.55	1.8	0.8

Parylene: $C_8H_6Cl_2$
Saran: $C_2H_2Cl_2$

OMEGA EP: pulse: EP9165
Energy: 7.1 kJ; 2-ns square

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