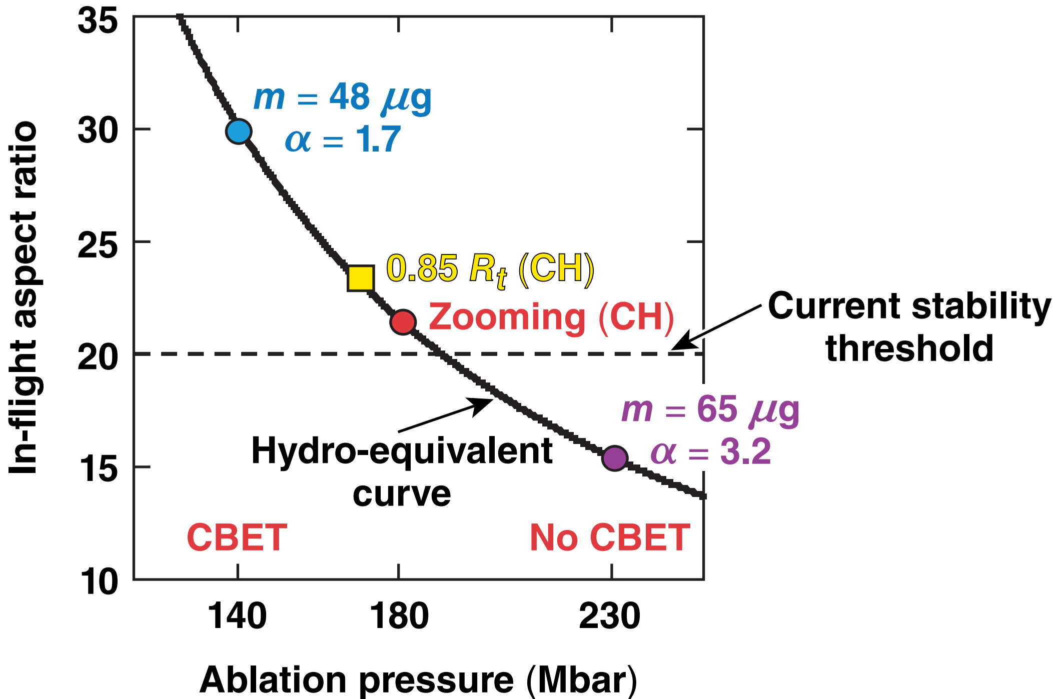
Mitigation of Cross-Beam Energy Transfer in Direct-Drive Implosions on OMEGA

OMEGA cryogenic ignition hydro-equivalent design
ρR = 300 mg/cm^2, V_{imp} = 3.7 × 10^7 cm/s



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55th Annual Meeting of the American Physical Society Division of Plasma Physics
Denver, CO
11–15 November 2013

Summary

Reducing cross-beam energy transfer (CBET) on OMEGA will allow for more stable ignition-relevant implosions

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- CBET can be mitigated by reducing the diameter of the laser beams
- Mitigating CBET increases the ablation pressure, allowing for thicker shelled targets and higher adiabats
- Two approaches are being investigated on OMEGA to reduce the laser beams
  - smaller laser spots—reduced beam-to-beam overlap
  - two-state zooming—increased single-beam imprint

Experiments to validate these schemes are underway.

Collaborators

T. J. Kessler, I. V. Igumenshchev, V. N. Goncharov, H. Huang, S. X. Hu, E. Hill, J. H. Kelly, D. T. Michel, D. D. Meyerhofer, A. Shvydky, J. D. Zuegel, and R. Epstein

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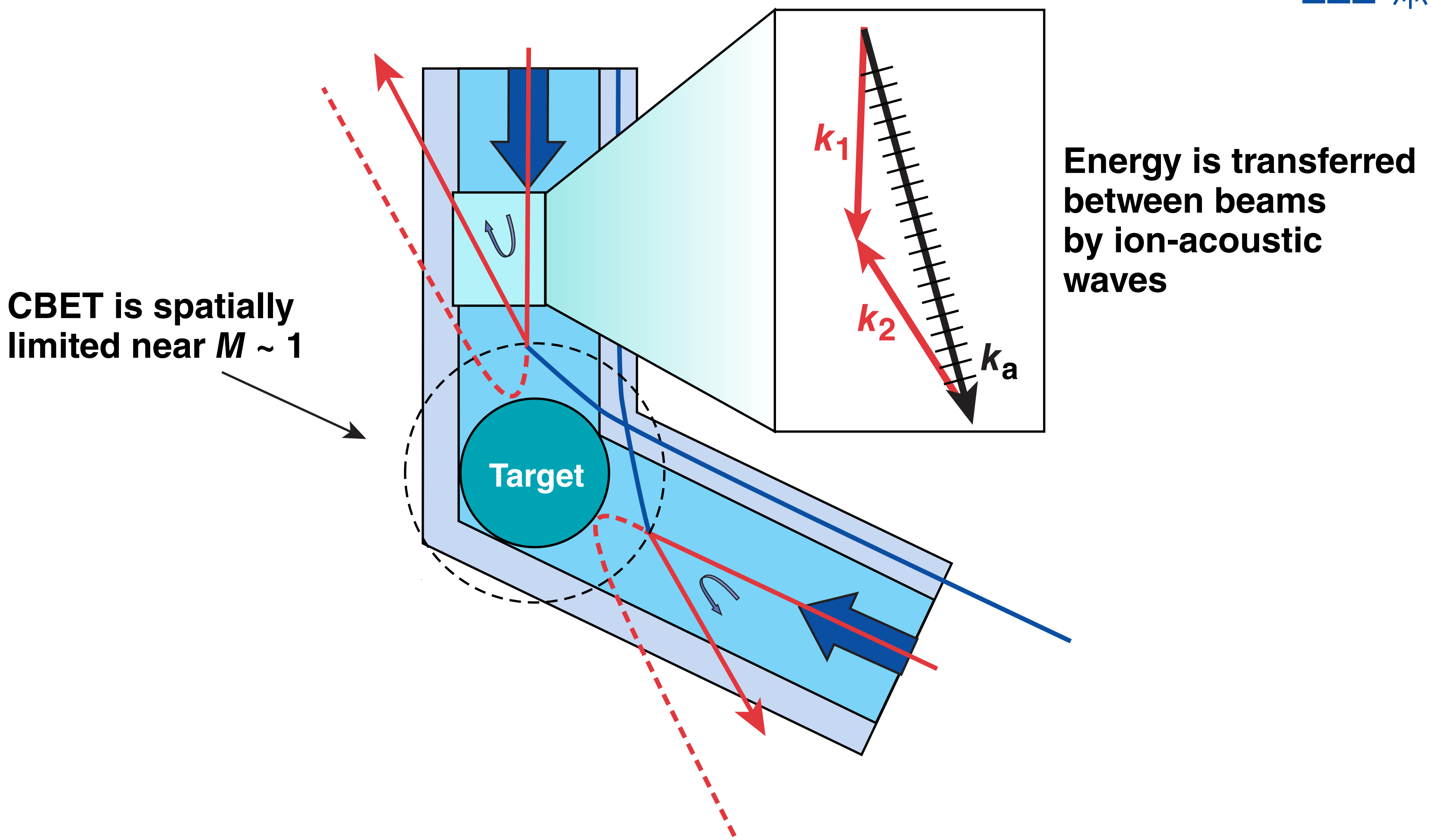
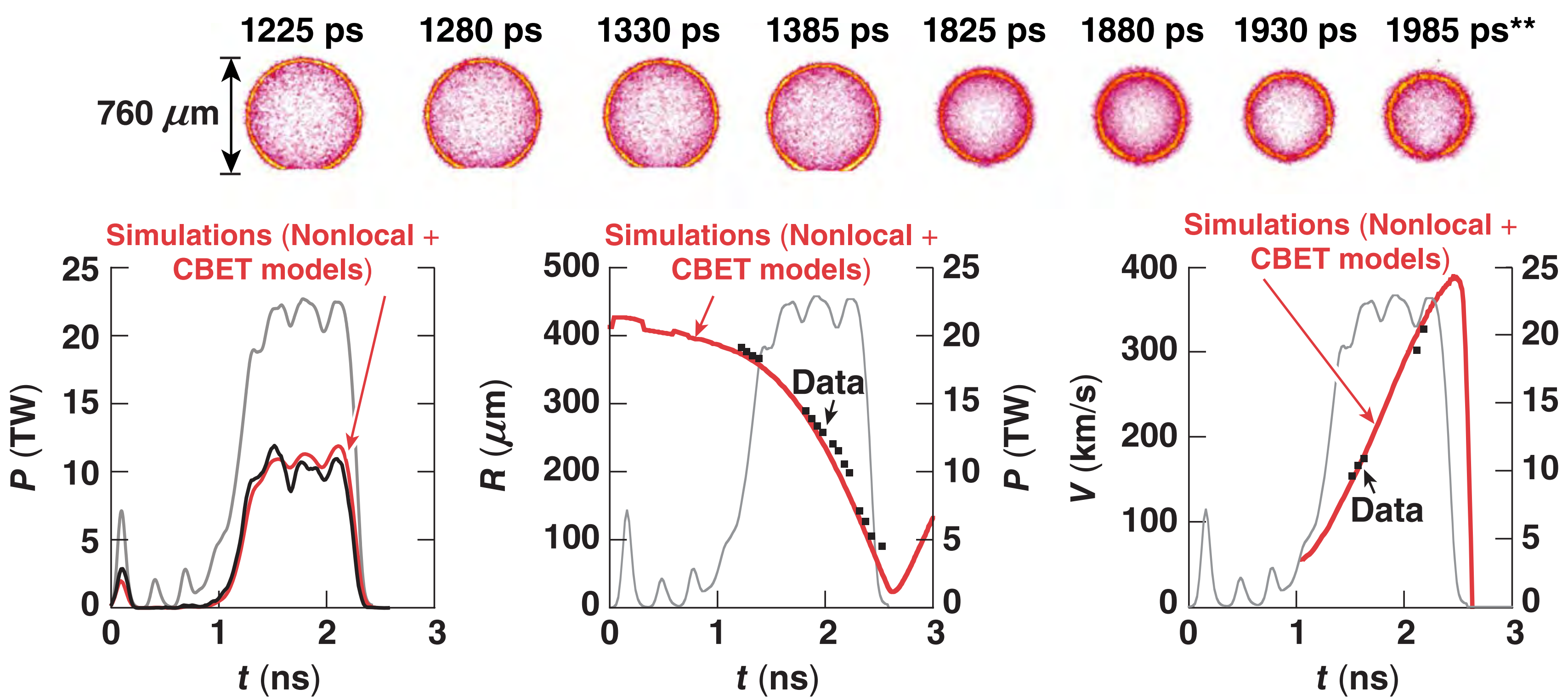
CBET reduces the energy coupled to the fusion capsule



CBET reduces the most hydrodynamically efficient portion of the incident laser beams.

E19971d

CBET modeling is required to match the experimental observables (scattered light, implosion velocity, and bang time)*

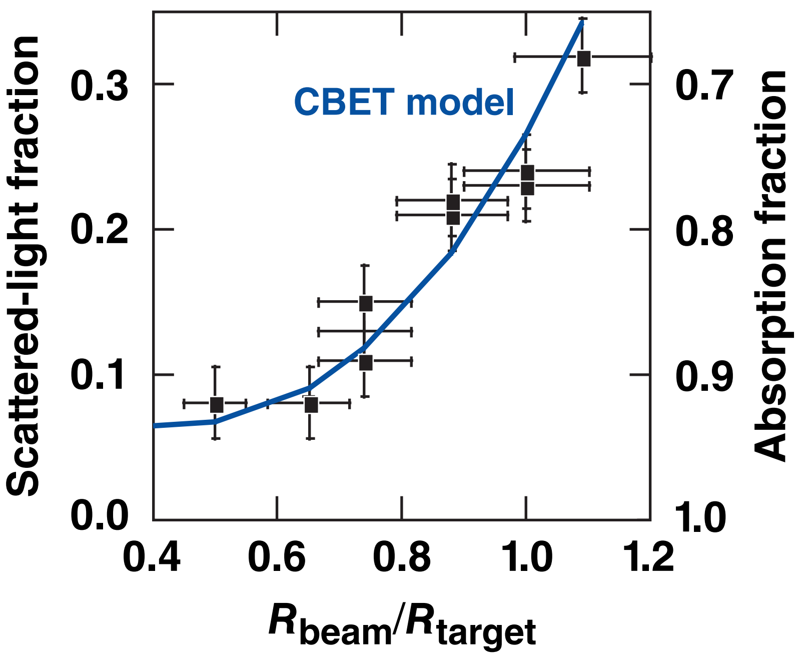


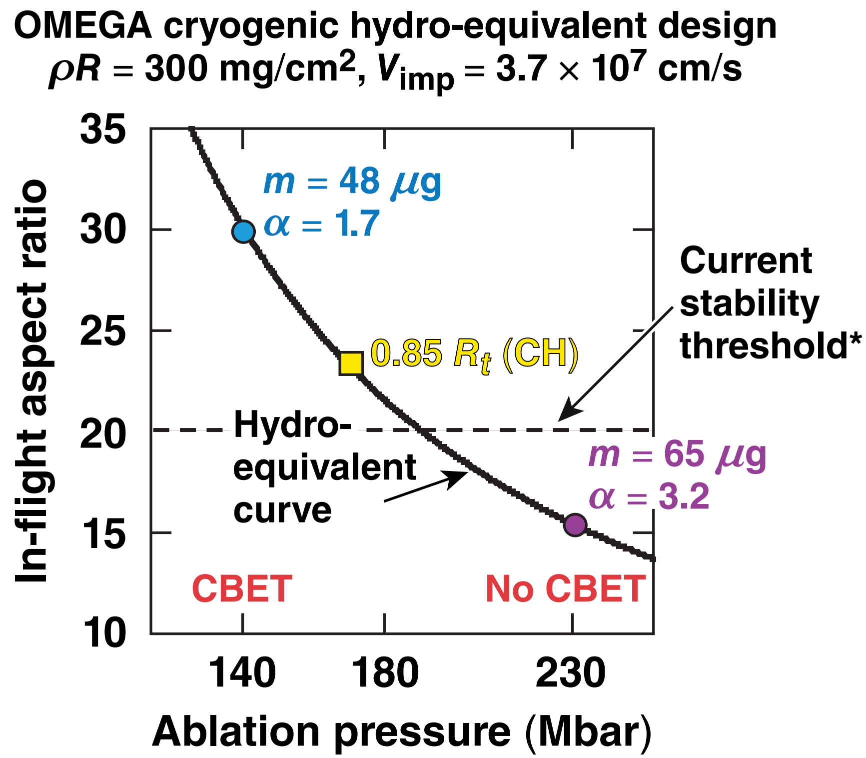
CBET reduces the ablation pressure by ~45%.

*I. V. Igumenshchev *et al*., Phys. Plasmas 19, 056314 (2012).
**D. T. Michel *et al*., Rev. Sci. Instrum. 83, 10E530 (2012).

E22473a

Experiments have demonstrated that CBET can be mitigated by reducing the radius of laser beams





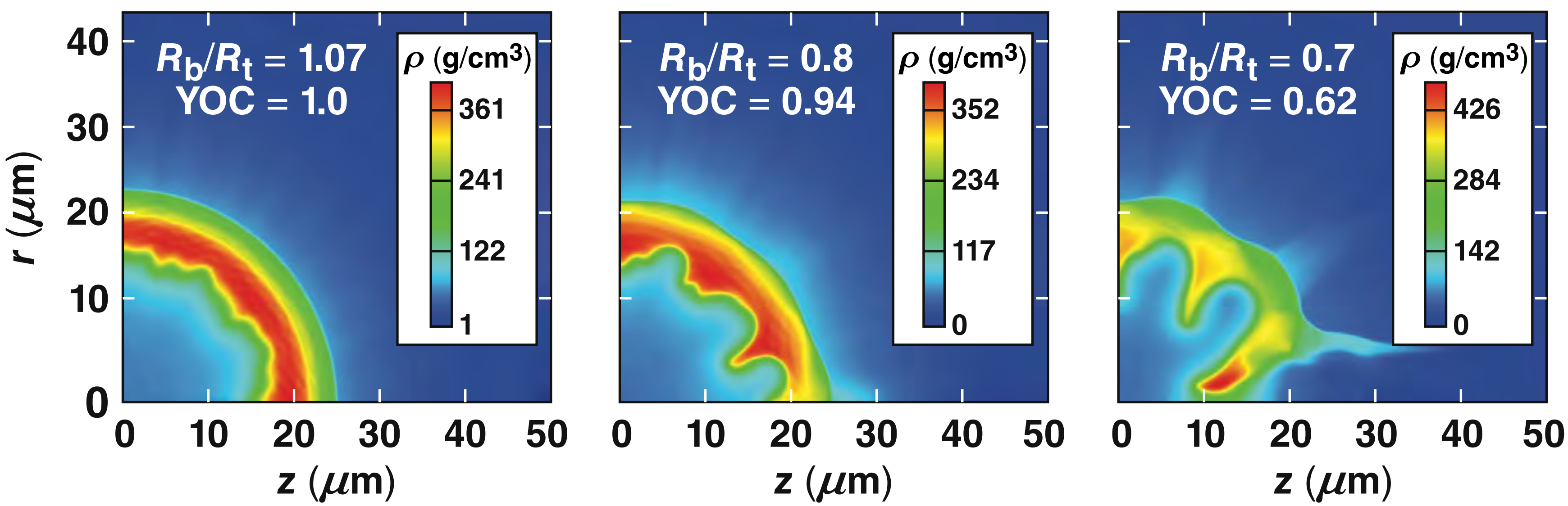
Reducing the radius of the beams will allow the thickness of the shell and the adiabat to be increased in a hydro-equivalent design but the reduced overlap uniformity may increase the imprint.

D. H. Froula *et al*., Phys. Rev. Lett. 108, 125003 (2012).
*V. N. Goncharov, GI3.00001, this conference (invited).

E20145g

Simulations suggest that reducing the beam diameters by 20% ($R_b/R_t = 0.8$) will have minimal impact on the hot-spot symmetry

2-D *DRACO* simulations
(low-order nonuniformities only)

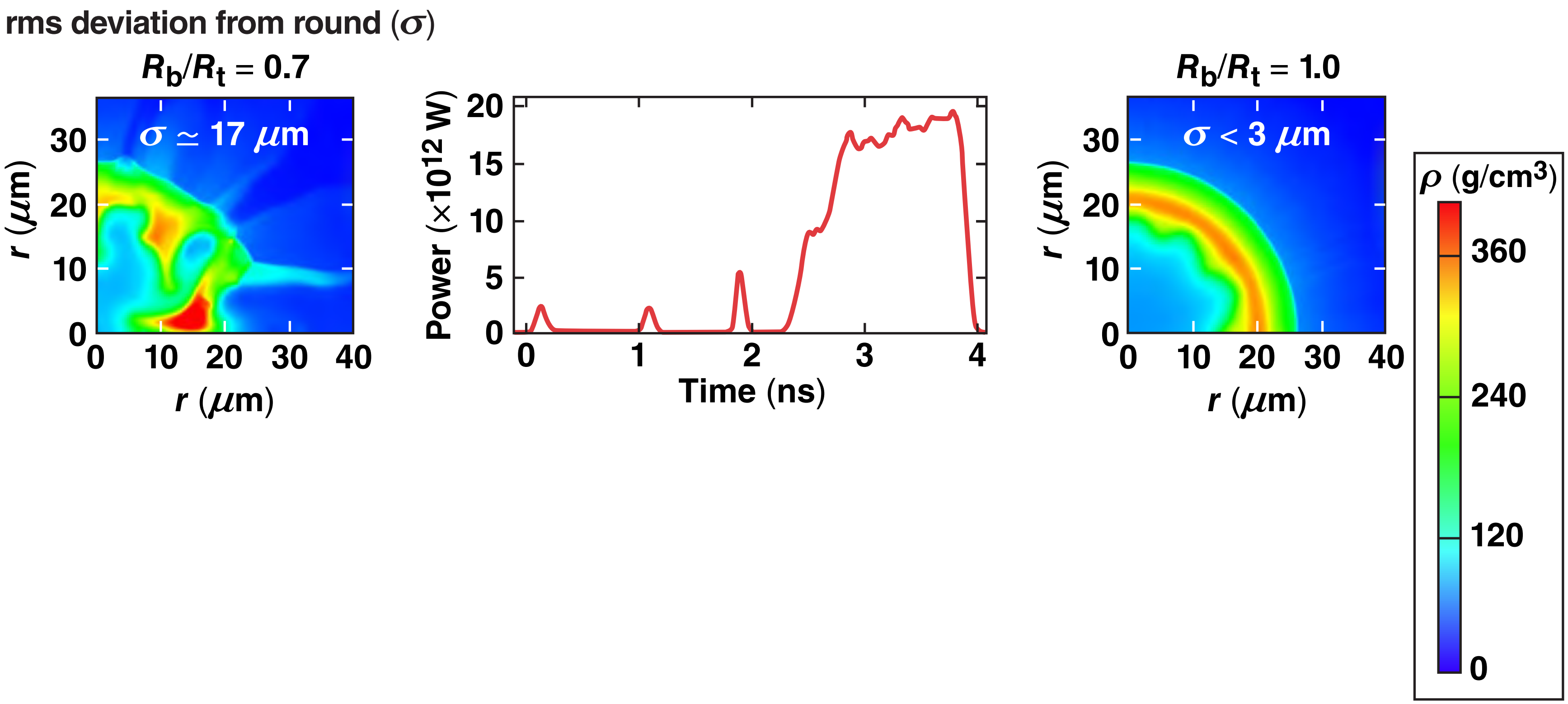


Reducing the beam diameters by more than 20% significantly degrades the target performance.

TC9894

I. V. Igumenshchev *et.al.*, Phys. Plasmas 19, 056314 (2012).

Reducing the diameter of the laser beams beyond 20% after a sufficient conduction zone is generated ("zooming") is predicted to maintain good low-mode uniformity



E21317l

*I. V. Igumenshchev *et al.*, Phys. Rev. Lett. 110, 145001 (2013).

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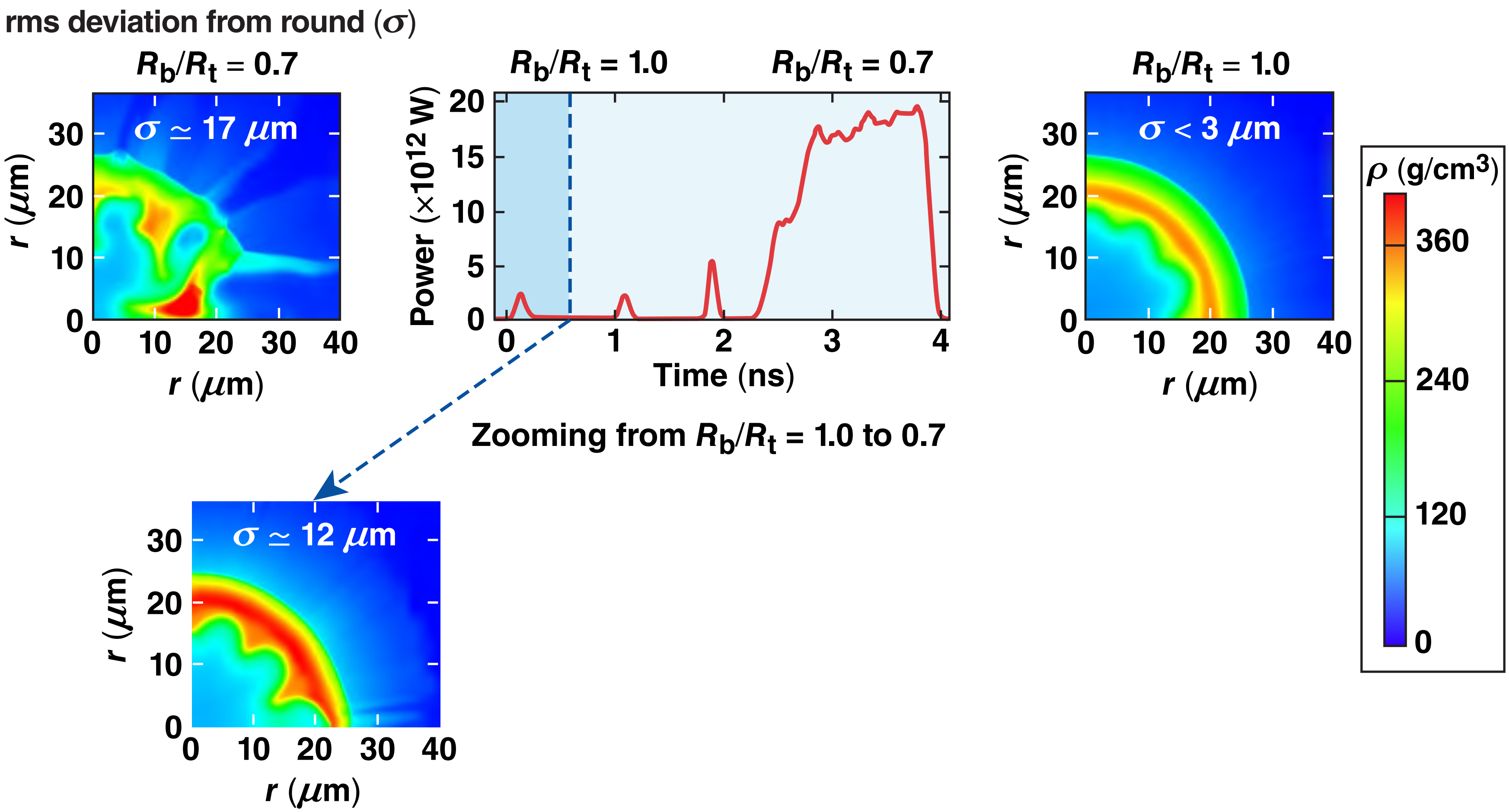
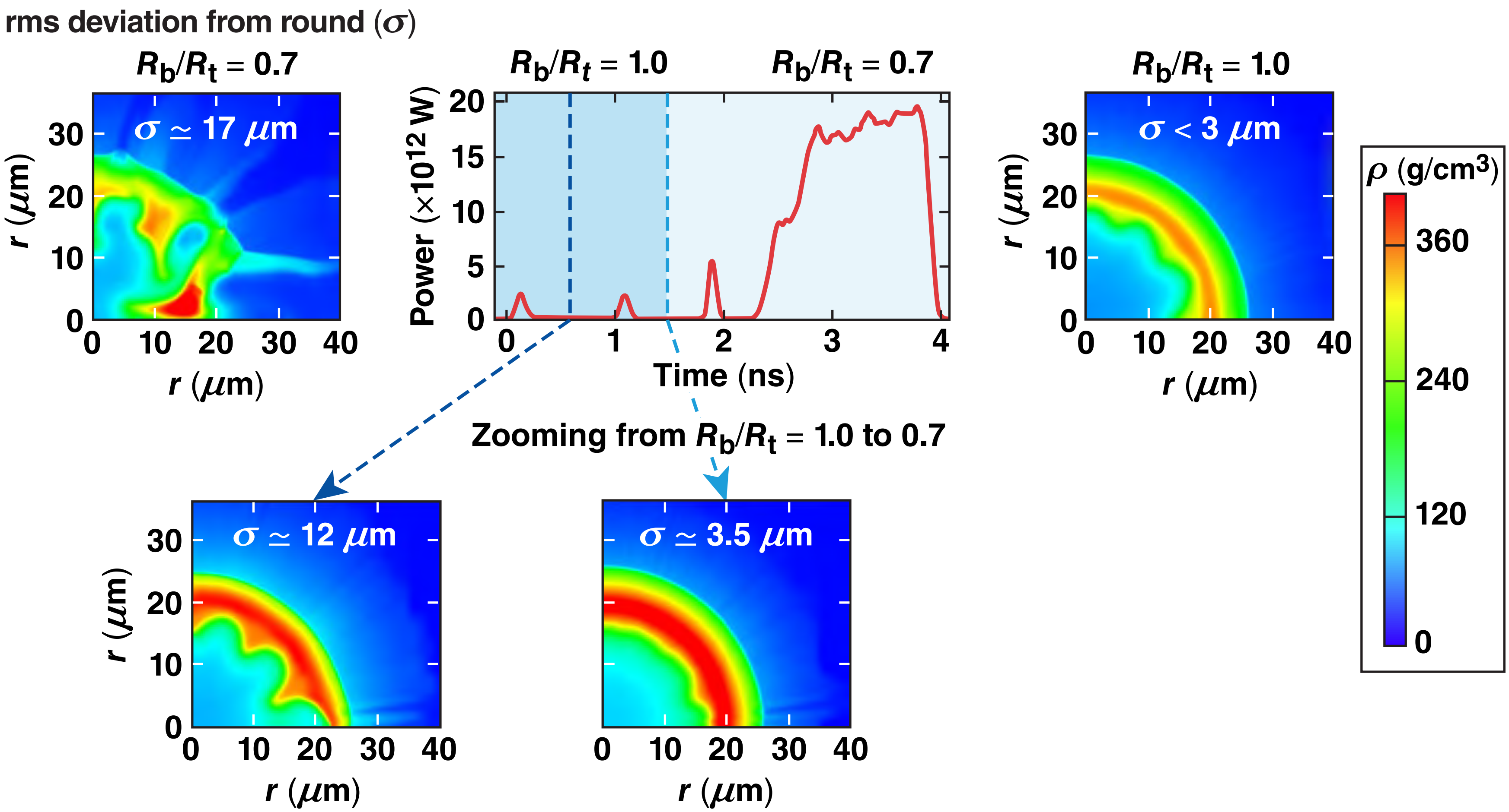


E21317m

*I. V. Igumenshchev *et al.*, Phys. Rev. Lett. 110, 145001 (2013).

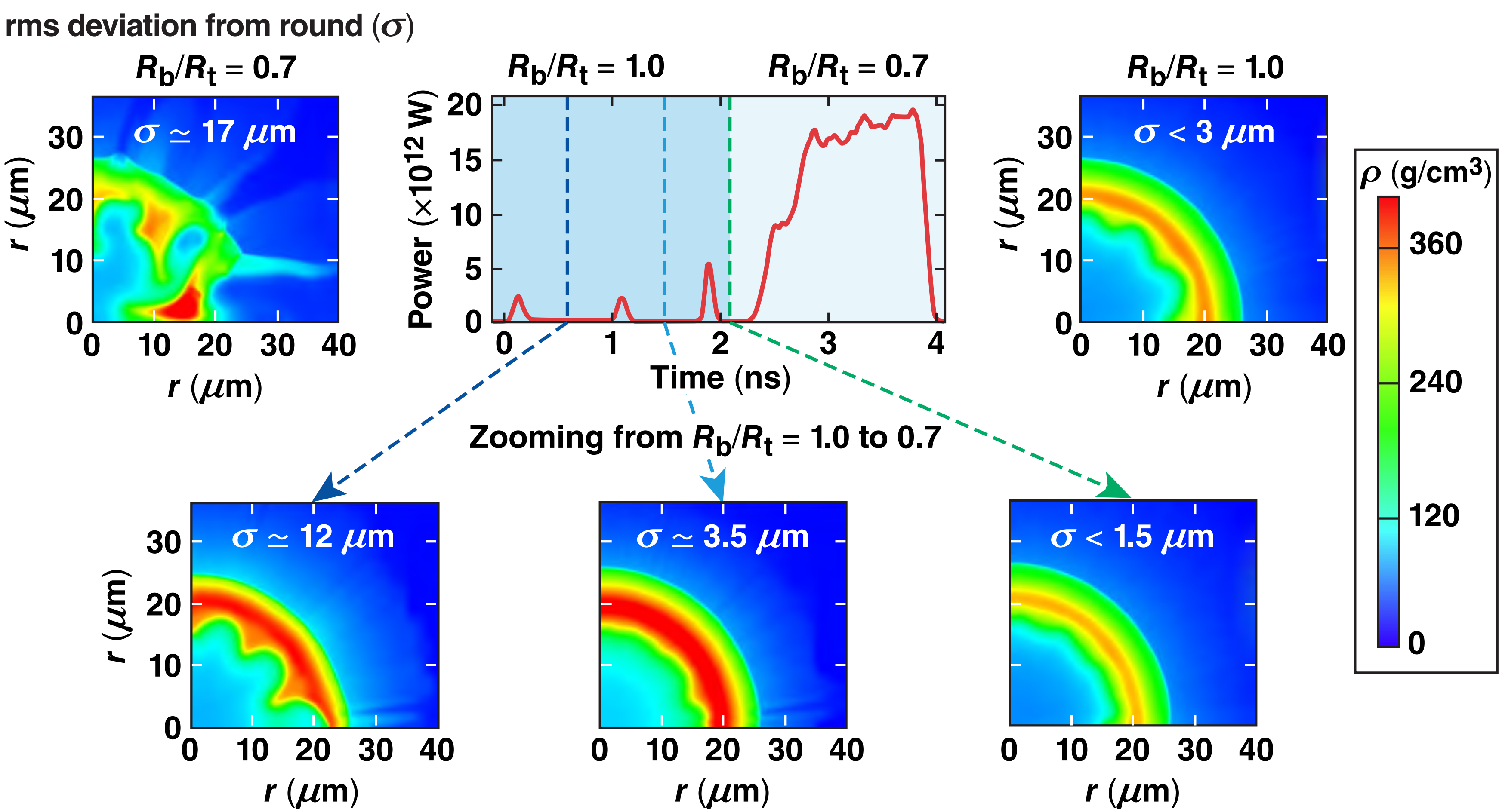
Reducing the diameter of the laser beams beyond 20% after a sufficient conduction zone is generated (“zooming”) is predicted to maintain good low-mode uniformity



E21317n

*I. V. Igumenshchev *et al*., Phys. Rev. Lett. 110, 145001 (2013).

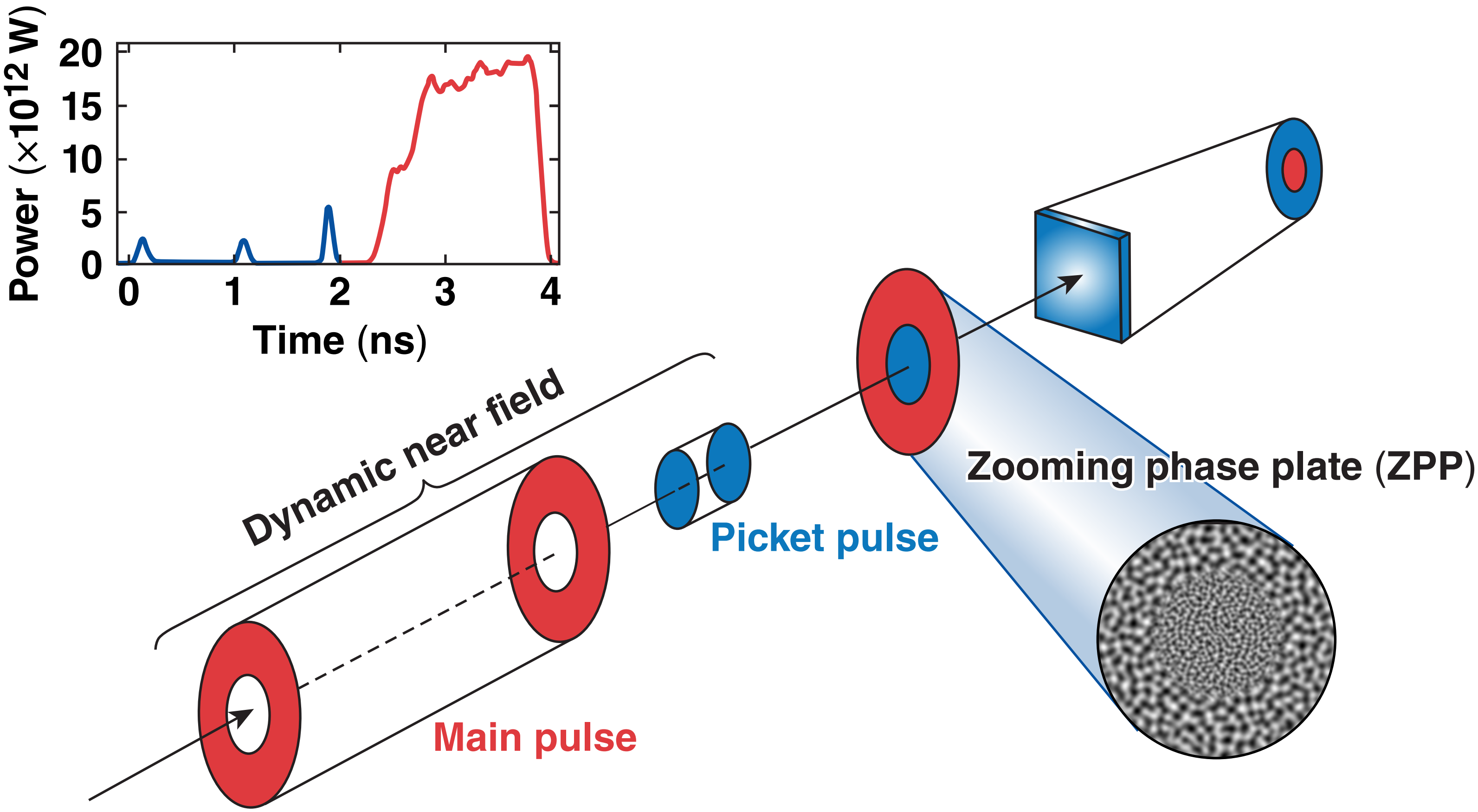
Reducing the diameter of the laser beams beyond 20% after a sufficient conduction zone is generated (“zooming”) is predicted to maintain good low-mode uniformity



E21317o

*I. V. Igumenshchev *et al*., Phys. Rev. Lett. 110, 145001 (2013).

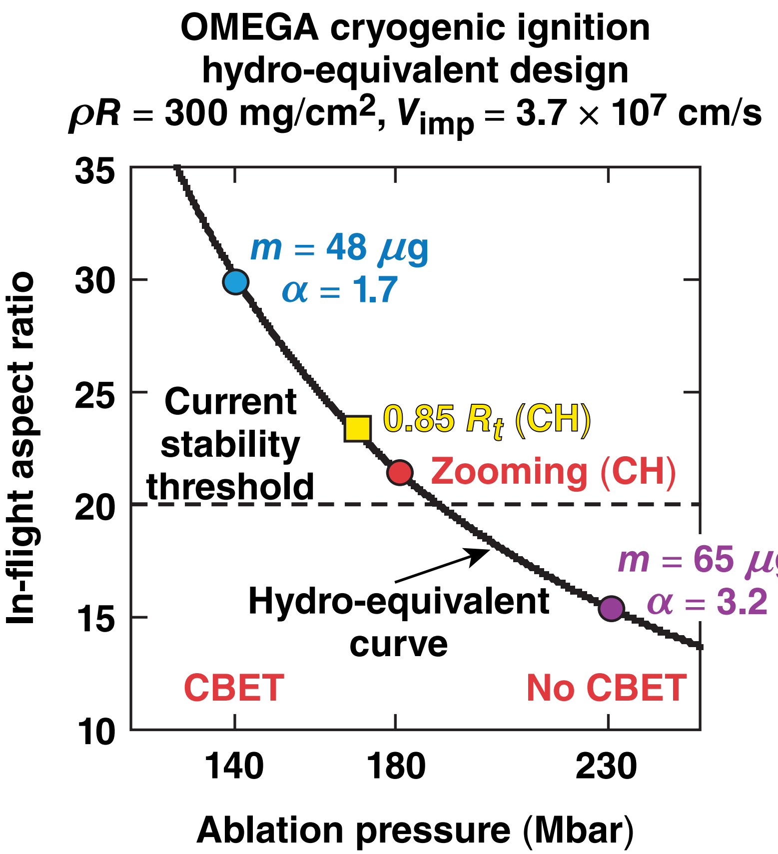
Zooming can be implemented on OMEGA using a radially varying phase plate and a dynamic near field

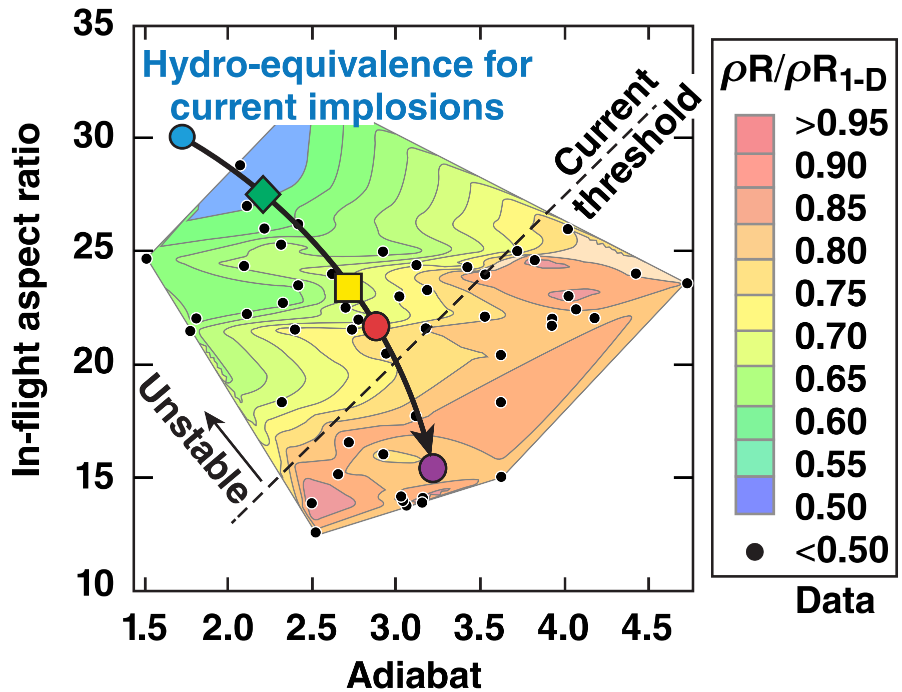


E22039b

D. H. Froula *et al*., Phys. Plasmas 20, 082704 (2013).

Implementing zooming on OMEGA will provide a more-robust implosion to hydrodynamic instabilities





Both CBET mitigation strategies on OMEGA will allow the mass of the shell and the adiabat to be increased while maintaining ignition-relevant conditions.

E22229b

T. C. Sangster *et al.*, Phys. Plasmas 20, 056317 (2013).

Summary/Conclusions

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