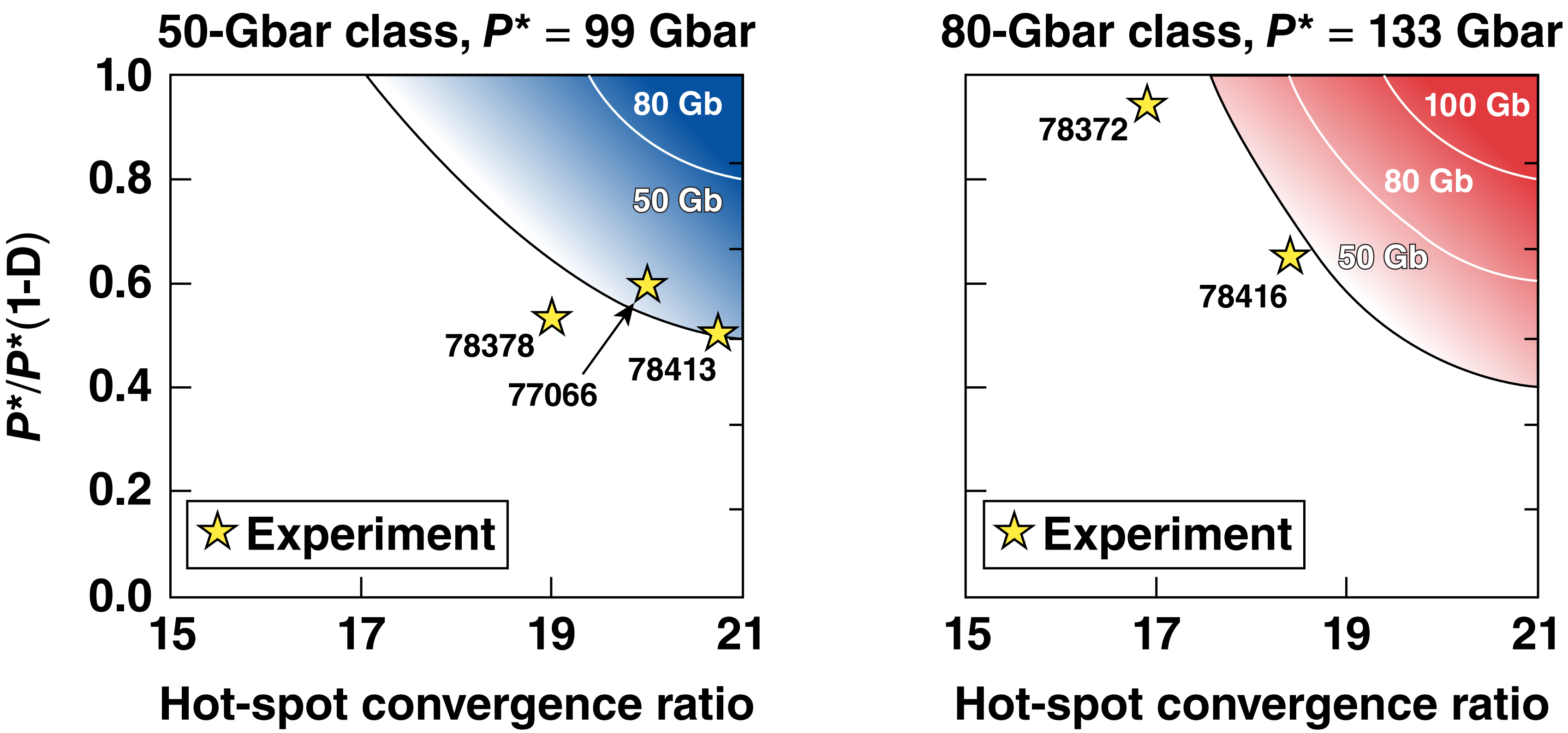
Evaluation of Long-Wavelength Perturbations in OMEGA 80-Gbar Cryogenic Implosions



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Summary

Long-wavelength perturbations represent a significant challenge in the pursuit of 80-Gbar implosions on OMEGA

- Ignition-class, direct-drive implosions with cross-beam energy transfer (CBET) mitigation require burn-averaged hot-spot pressures (*P**) in excess of 120 Gbar
- One can compare the experimentally inferred *P** and hot-spot convergence ratio to simulations as a metric of target performance
- Simulations indicate that improving power imbalance does not significantly alter 80-Gbar target performance
- Target offset and inner ice roughness are equivalent in reducing target performance and are critical in achieving 80 Gbar

The effect of long-wavelength perturbations on 80-Gbar performance is consistent between all LLE multidimensional codes.

Collaborators

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Ignition-class, direct-drive (DD) implosions with CBET mitigation require burn-averaged hot-spot pressures (*P**) in excess of 120 Gbar

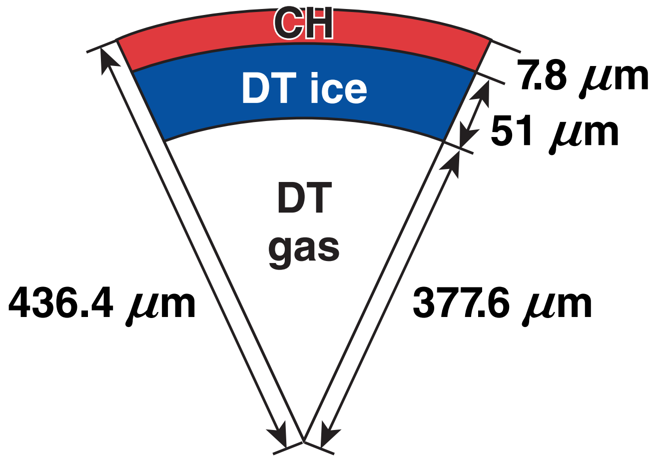
- The hot-spot pressure in an ignition design must exceed a threshold value given by $P_{th} \sim 1 / \sqrt{E_{hs}}$ *
- Current OMEGA data indicates that we have achieved ~56 Gbar without any CBET mitigation**
- Scaling the OMEGA results to NIF and applying CBET mitigation techniques† points to a threshold pressure of ~120 Gbar for direct-drive designs
- LLE has set a milestone of achieving 100-Gbar implosions on OMEGA by 2020, with an intermediate goal of 80 Gbar in the coming years

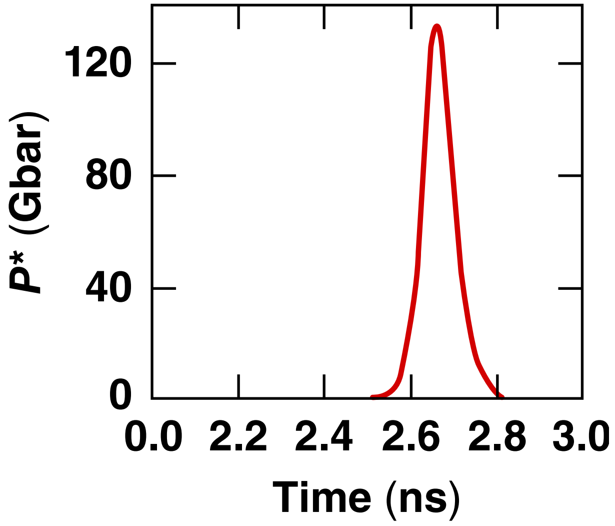
*V. N. Goncharov *et al*., Phys. Plasmas 21, 056315 (2014).
**S. P. Regan *et al*., Phys. Rev. Lett. 117, 025001 (2016).
†P. B. Radha *et al*., NO5.00005, this conference;
J. A. Marozas *et al*., NO5.00009, this conference;
J. F. Myatt *et al*., UI3.00004, this conference;
D. H. Froula *et al*., UO9.00008, this conference;
M. Hohenberger *et al*., UO9.00009, this conference;
R. K. Follett *et al*., UO9.00010, this conference;
D. H. Edgell *et al*., UO9.00011, this conference.

TC13111

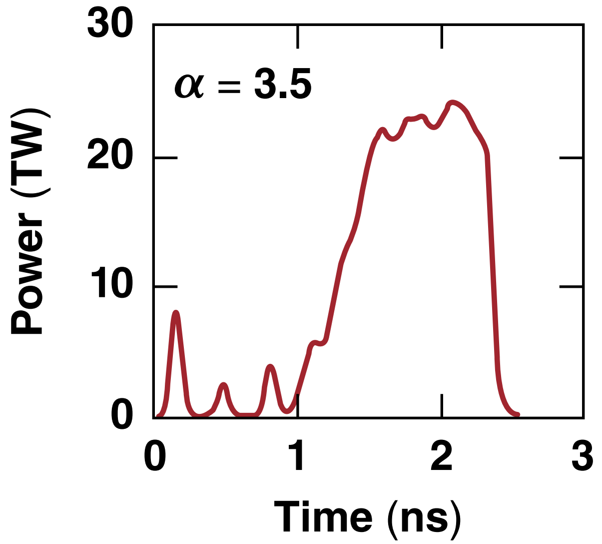
The 80-Gbar target design achieves a 1-D *P** value of 130 at a hot-spot convergence ratio (HSCR) of 23

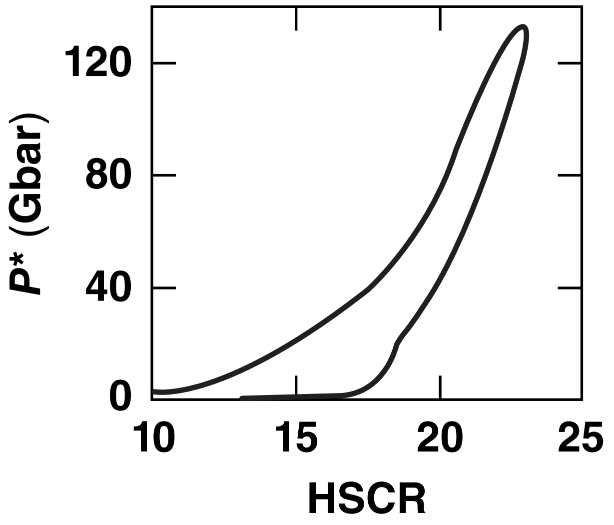
$P^* \equiv P_{hs}(t)$
HSCR = R_0/R_{hs}
No CBET mitigation





- Low-mode requirements for 80 Gbar
  - <10%-rms (beam-to-beam) power balance (PB)
  - <10%-μm target offset
  - 1-μm inner ice roughness

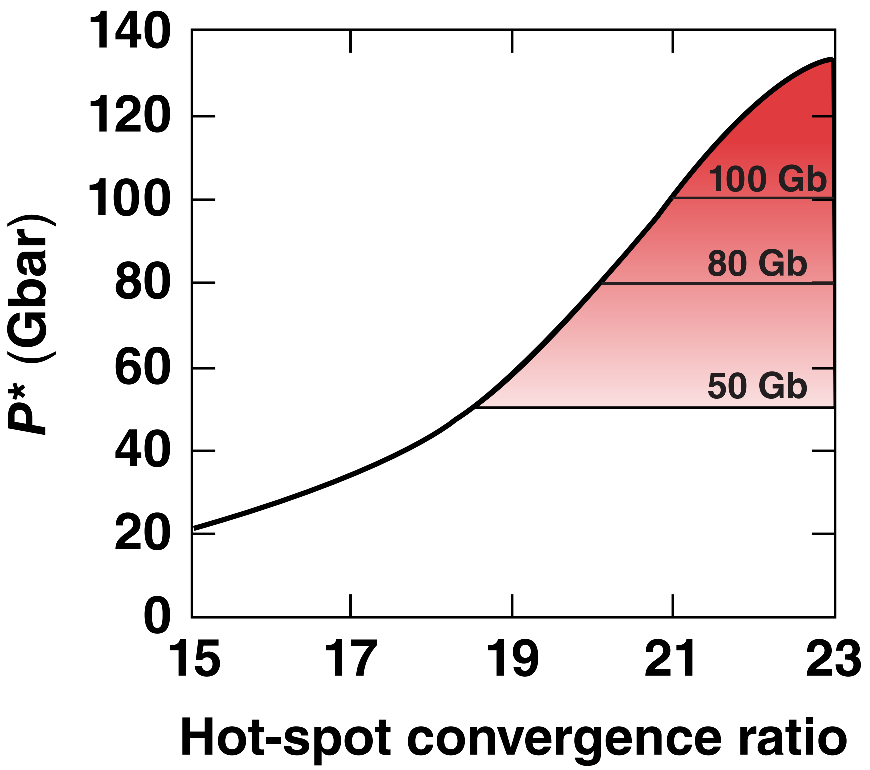


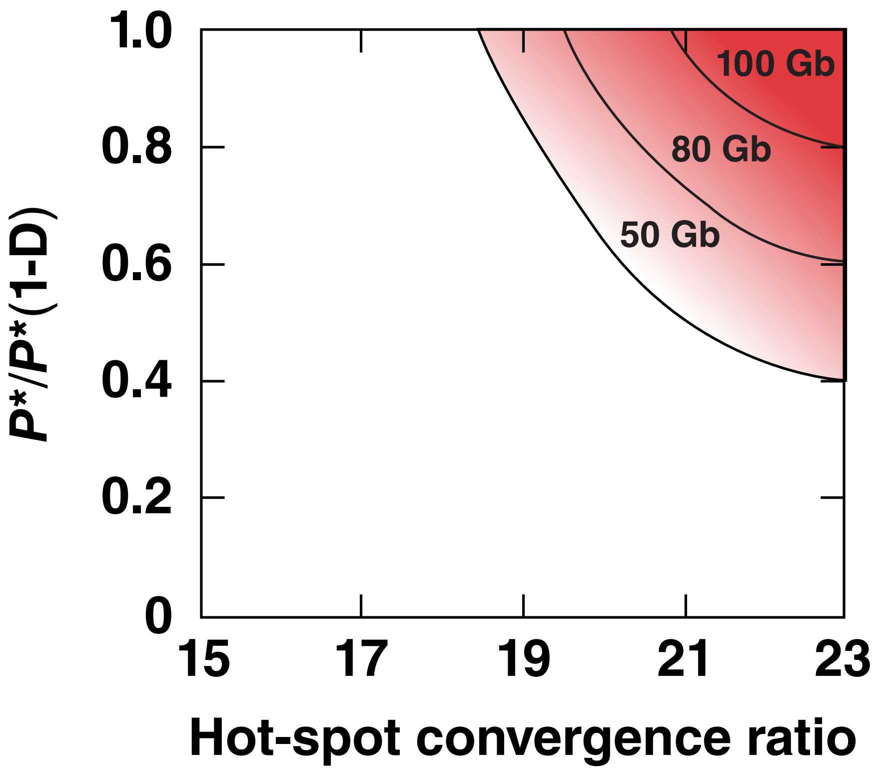


TC13103

Casting the one-dimensional (1-D), *P** history with HSCR, one can construct performance regimes to evaluate perturbed capsule behavior

80-Gbar class, *P** = 133 Gbar

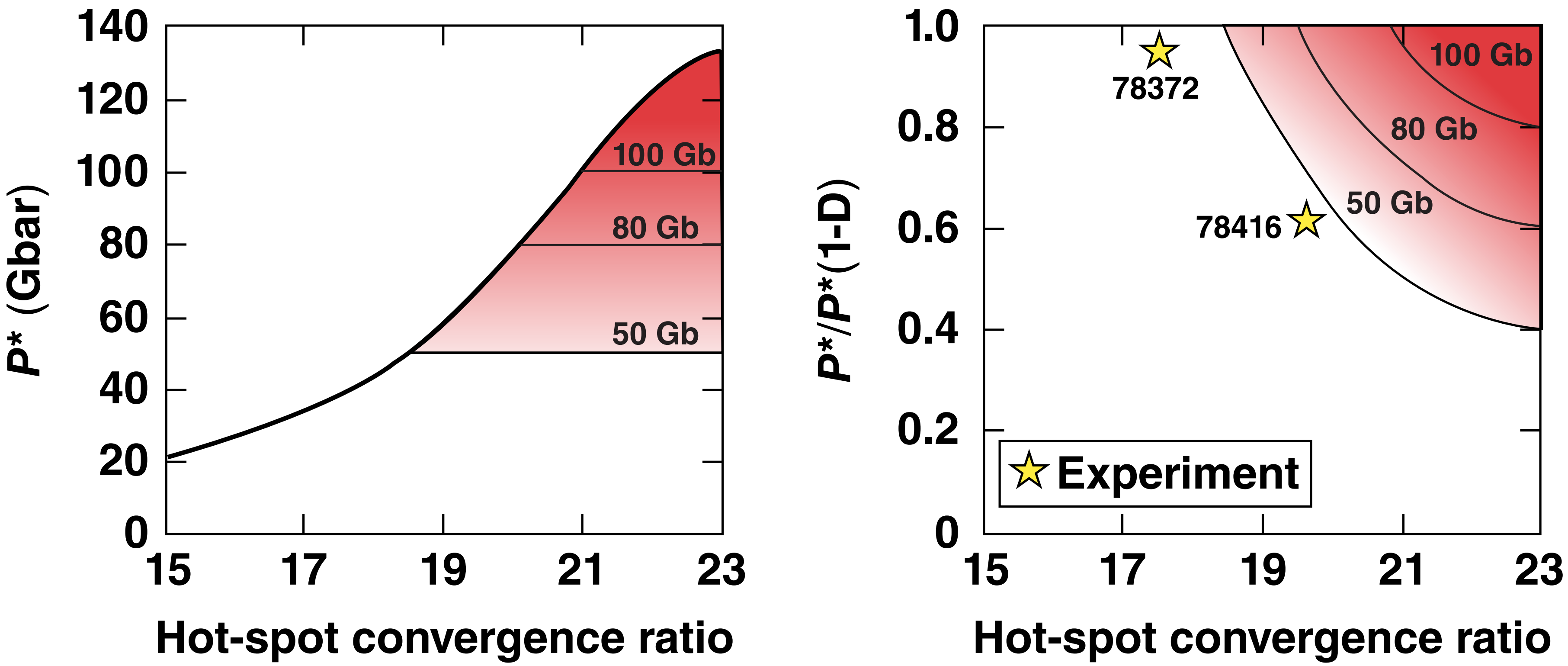




TC13104

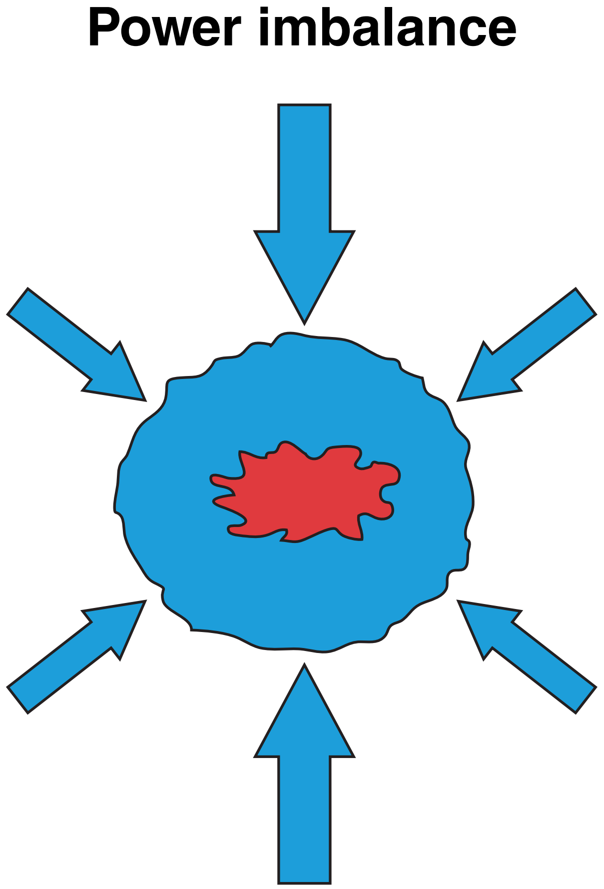
Casting the 1-D, *P** history with HSCR, one can construct target performance to evaluate perturbed capsule behavior

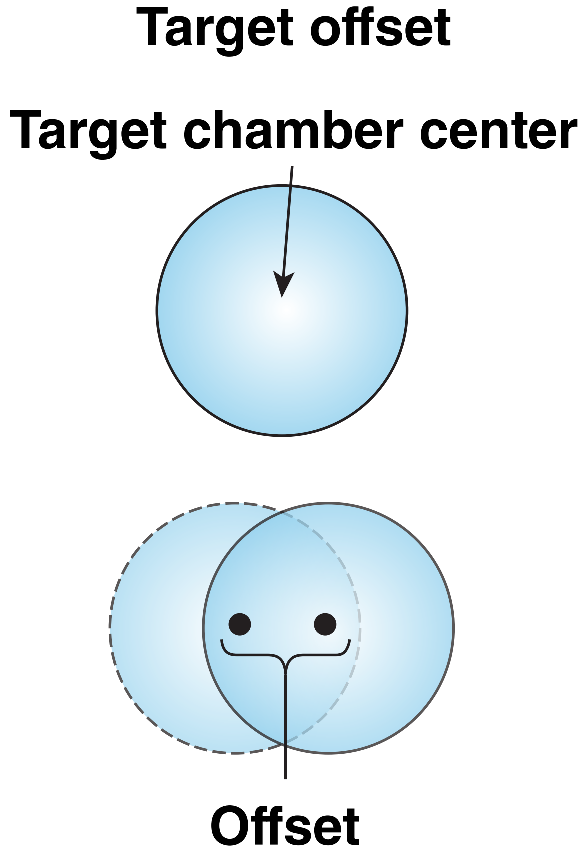
80-Gbar class, *P = 133 Gbar**

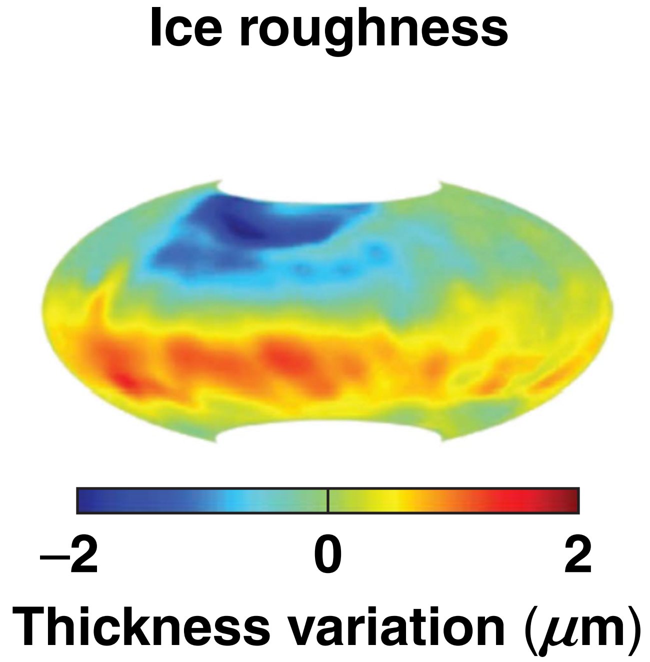


TC13104a

Sources of long-wavelength perturbations include power imbalance, target offset, and inner ice roughness

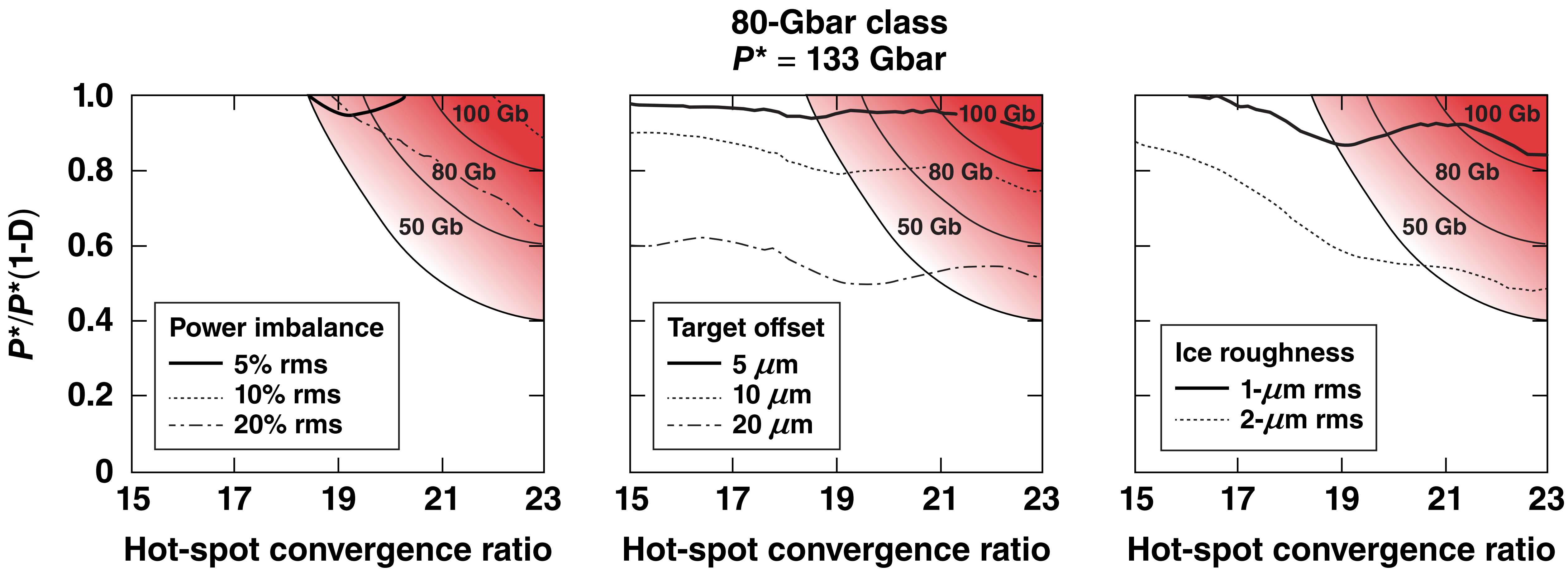






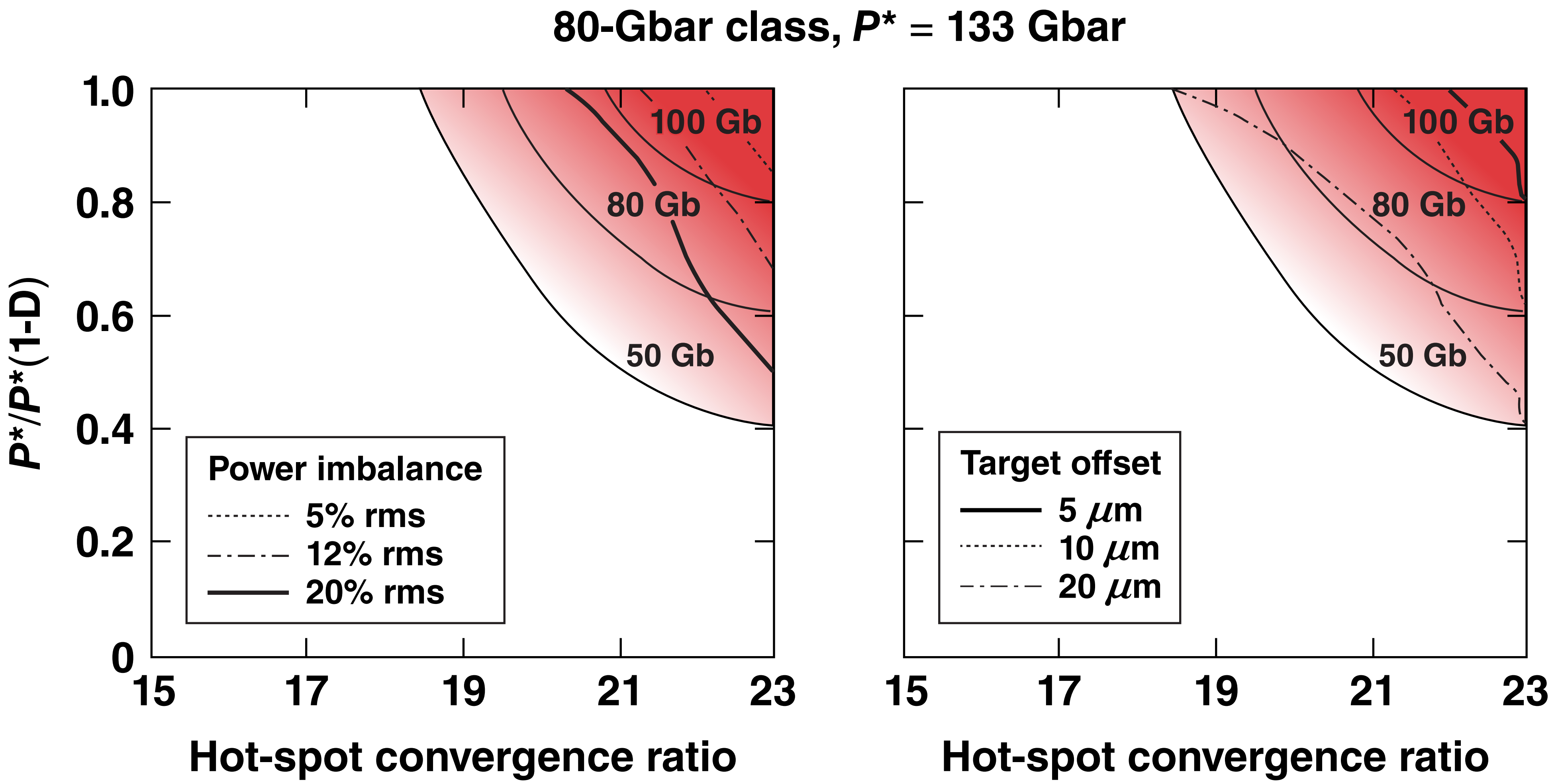
TC13105

The 80-Gbar design can withstand relatively high levels of power imbalance, but is susceptible to target offset and ice roughness



TC13106

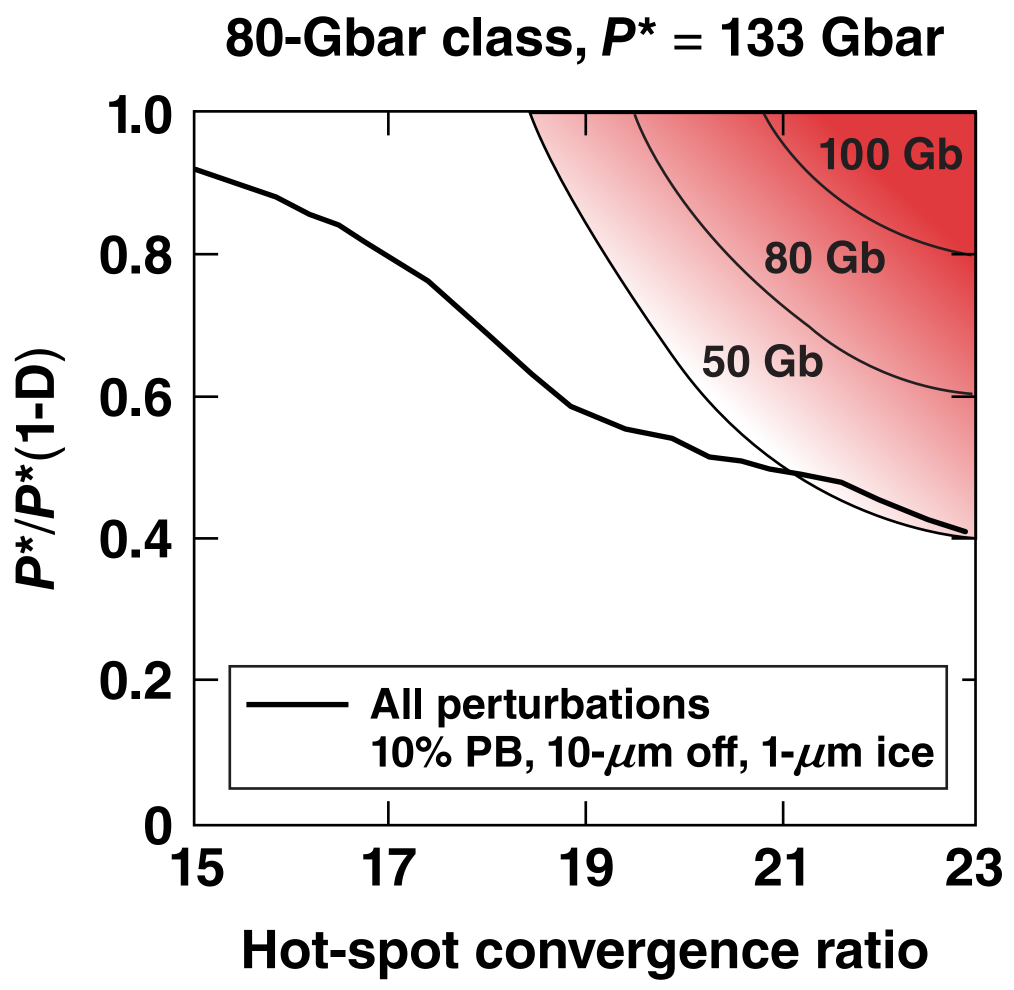
Three-dimensional *HYDRA* calculations are in qualitative agreement with *DRACO* low-mode asymmetry calculations



K. S. Anderson *et al.*, NO5.00011, this conference.

TC13107

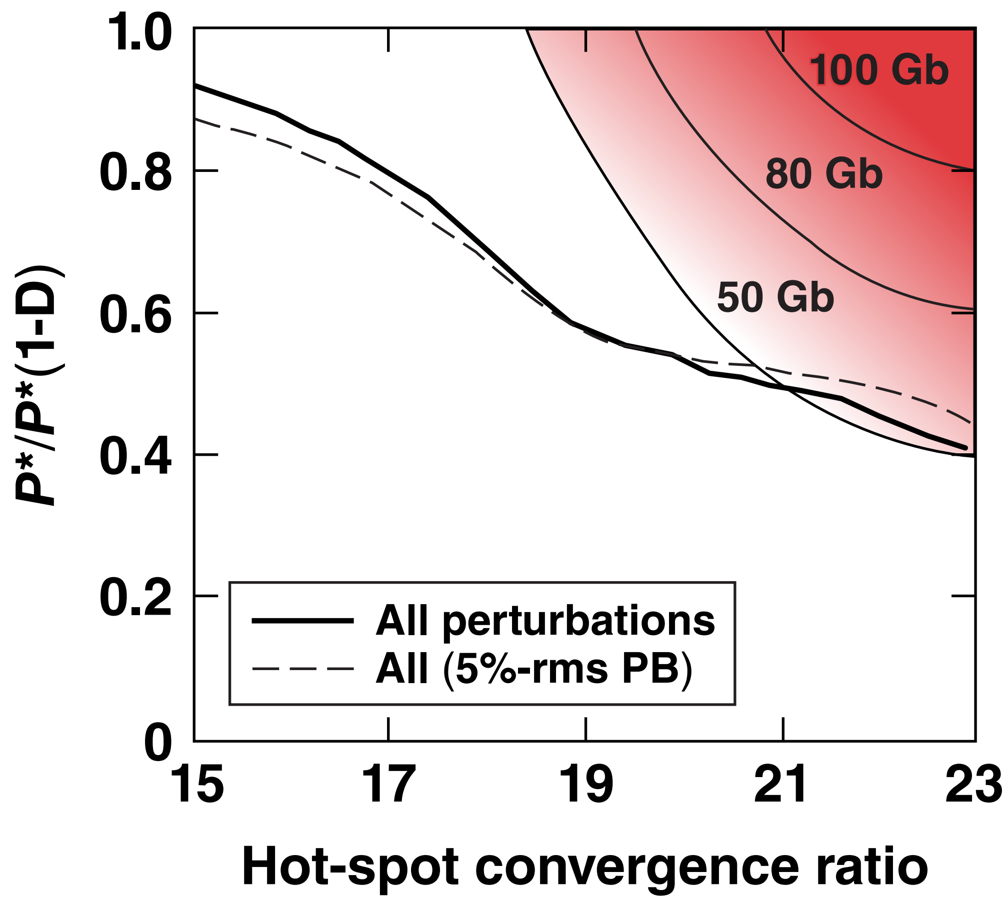
Implementing all long-wavelength peak specifications together prevents the implosion from reaching the 80-Gbar goal



TC13108

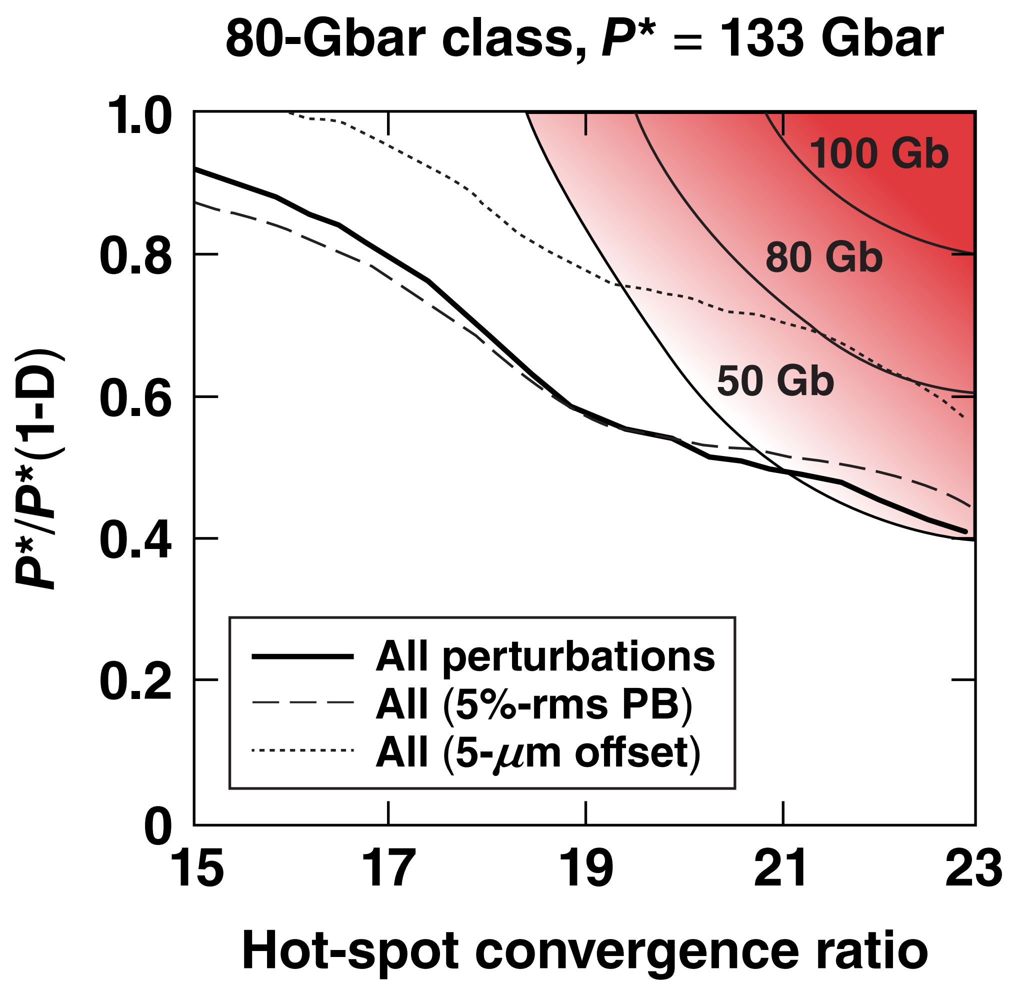
Calculations indicate that improving laser power imbalance does little to affect achieving 80 Gbar

80-Gbar class, P^* = 133 Gbar



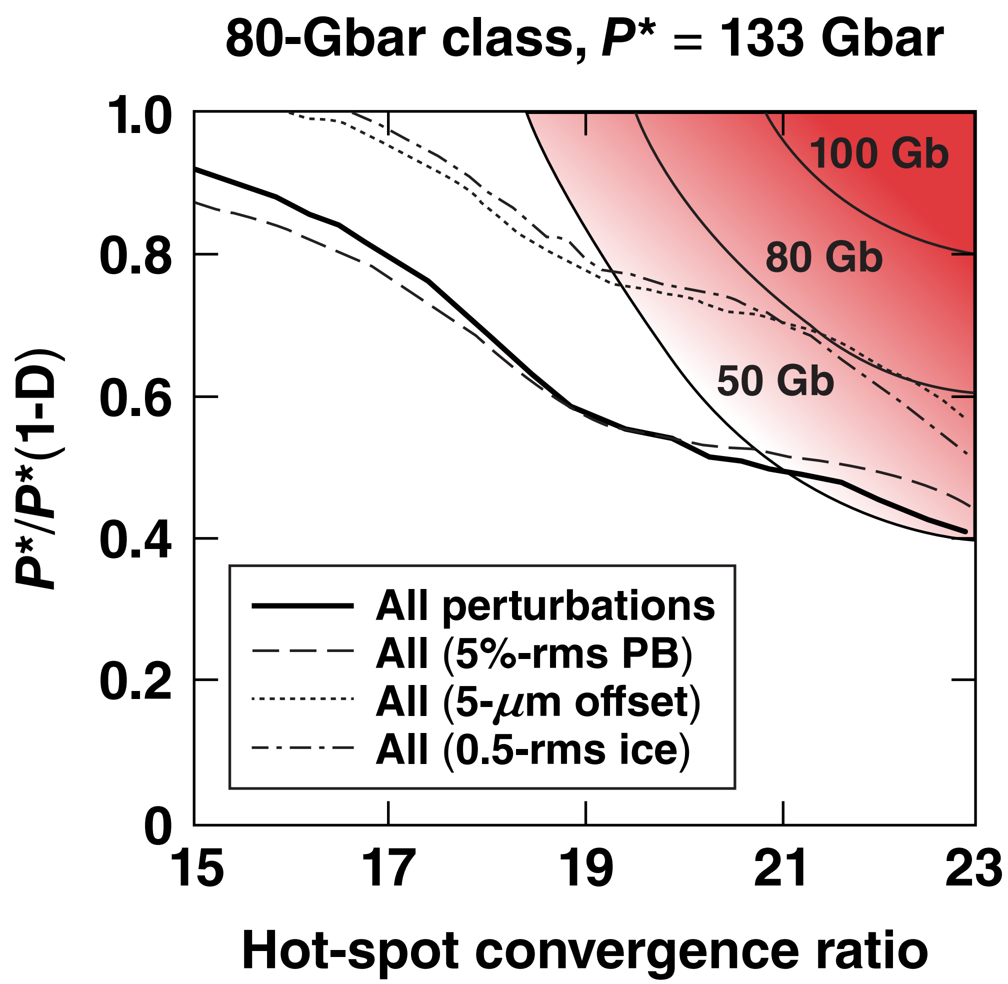
TC13108a

Decreasing target offset plays a significant role in target performance and provides a path to 80 Gbar



TC13108b

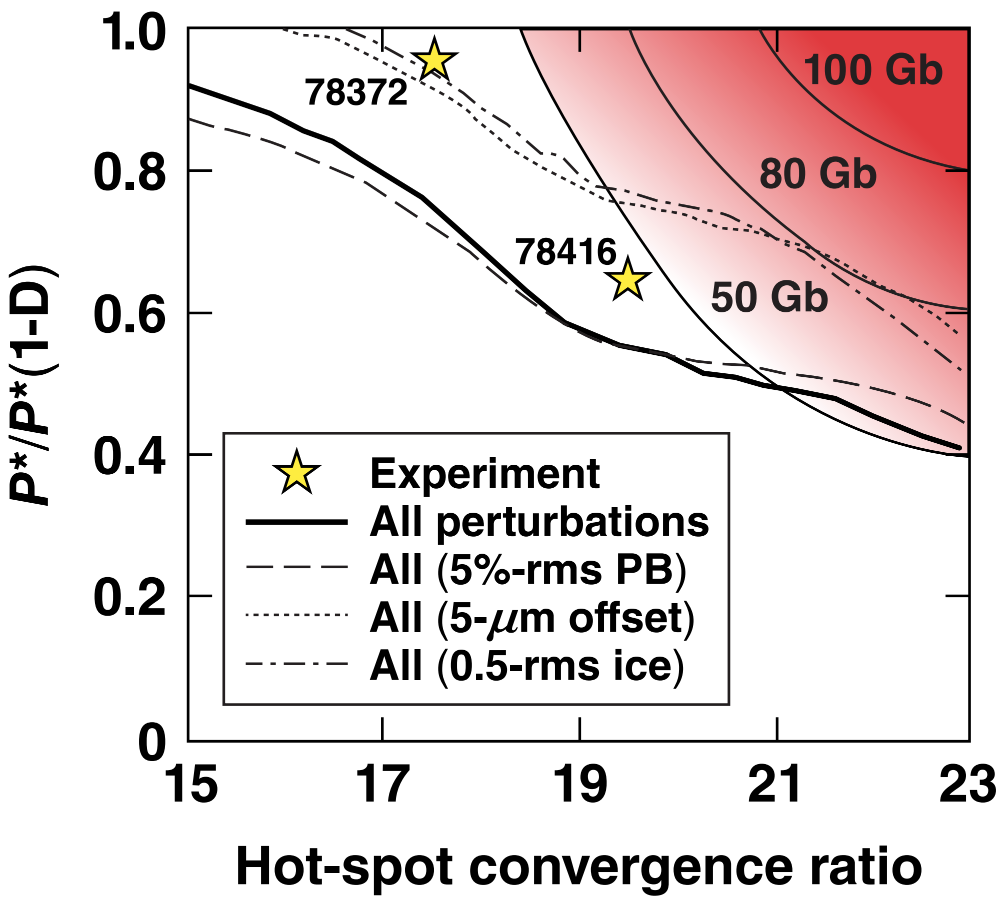
The role of ice roughness is comparable to target offset in obtaining 80-Gbar implosions on OMEGA



TC13108c

The role of ice roughness is comparable to target offset in obtaining 80-Gbar implosions on OMEGA

80-Gbar class, $P^* = 133$ Gbar



TC13108d

D. Cao, TO5.00012

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