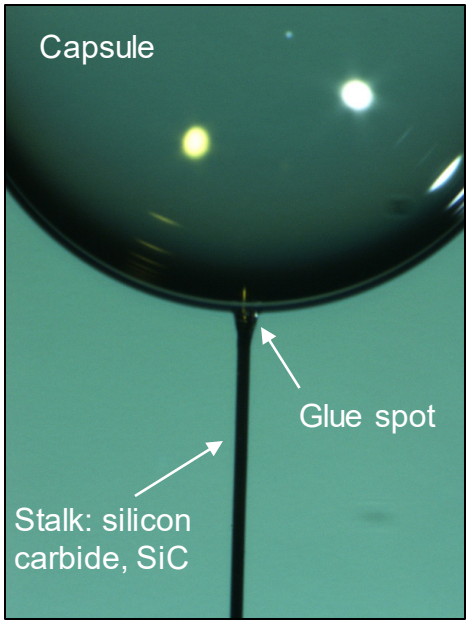
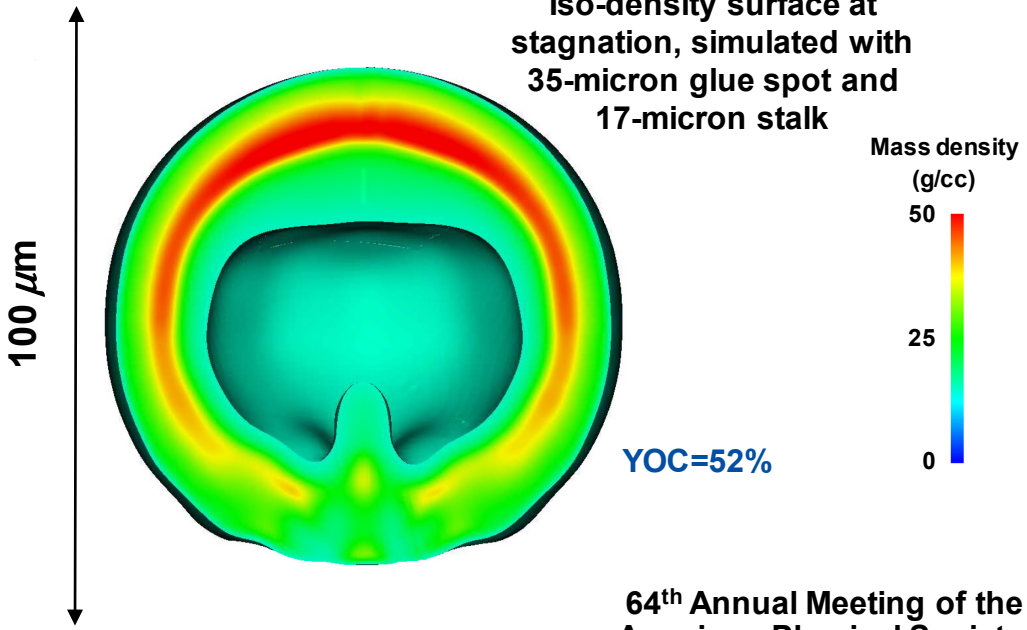
Computational Studies of the Mounting Stalk in Direct-drive Implosions





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Summary

Glue spots degrade yield more than stalk effects in 3-D *HYDRA** simulations, similar to what has been seen in 2-D stalk simulations**

- A platform previously developed in 3-D *HYDRA* is being used to model the mounting stalk and glue spot in full 4π geometry
- The stalk perturbs the primary shock as well as the ablation pressure on the shell, leading to a jet of material perturbing the hot spot
- The glue spot attaching the stalk to the capsule exacerbates each of these elements leading to a large $\ell = 1$ perturbation on the hot spot.

OMEGA cryogenic experiments in Q2FY23 will determine the effect of mounting stalk diameter on implosion performance

*M. M. Marinak *et al.*, Phys. Plasmas 8, 2275 (2001).
**Igumenshchev *et al.*, Phys. Plasmas 16, 082701 (2009).

Collaborators

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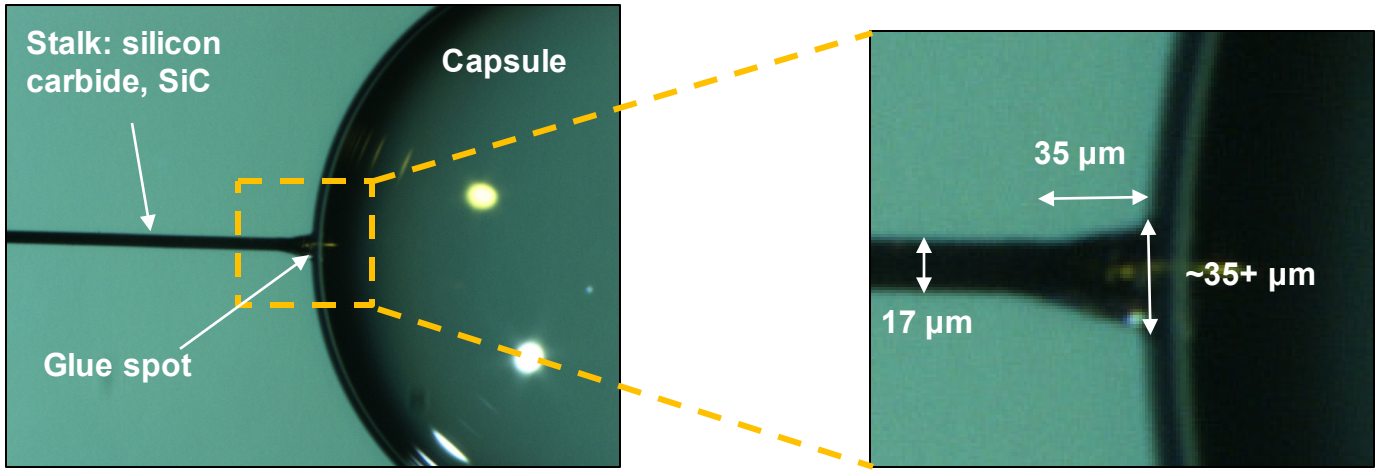
Directly-driven cryogenic targets are positioned and held in place using a target mounting stalk



Capsule radius for OMEGA cryo targets is typically ~430 to 510 μm

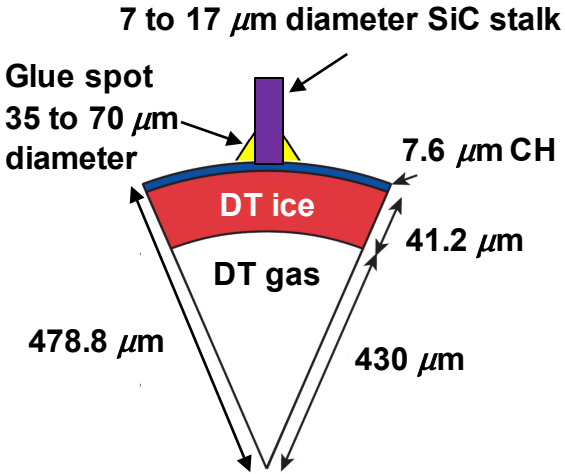
*Image courtesy D. Harding, M. Bonino, and D. Wasilewski

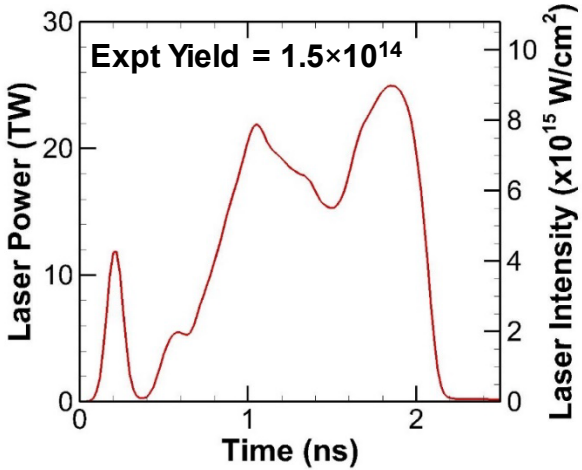
HYDRA has been used to perform 3-D integrated modeling of OMEGA cryogenic implosions with the stalk and glue spot

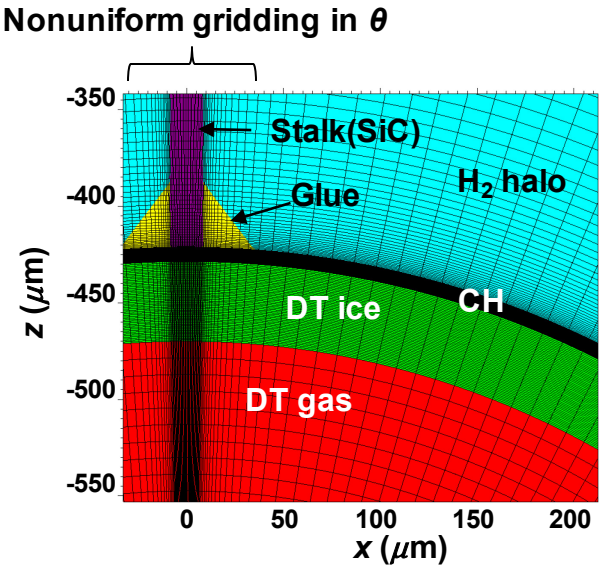
- 4π solid-angle simulation with no symmetry assumptions will allow the addition of other 3-D perturbations
- The 3-D laser ray trace models all beams individually, using an inverse projection noise reduction algorithm†
- Flux-limited Spitzer thermal conduction is used with a variable flux limiter tuned to match 1-D LILAC simulations, which included CBET and non-local thermal conduction.
- Simulations include:
  - LEOS equation of state.
  - Multi-group diffusion radiation transport.
  - Interface tracker for subzonal resolution of material interfaces.
  - Full mounting stalk, including the glue spot modeled as a cone.

† J. A. Marozas *et al.*, APS-DPP 2006.

The effects of the mounting stalk and glue were simulated in 3-D for the high-performing OMEGA cryogenic implosion 90288





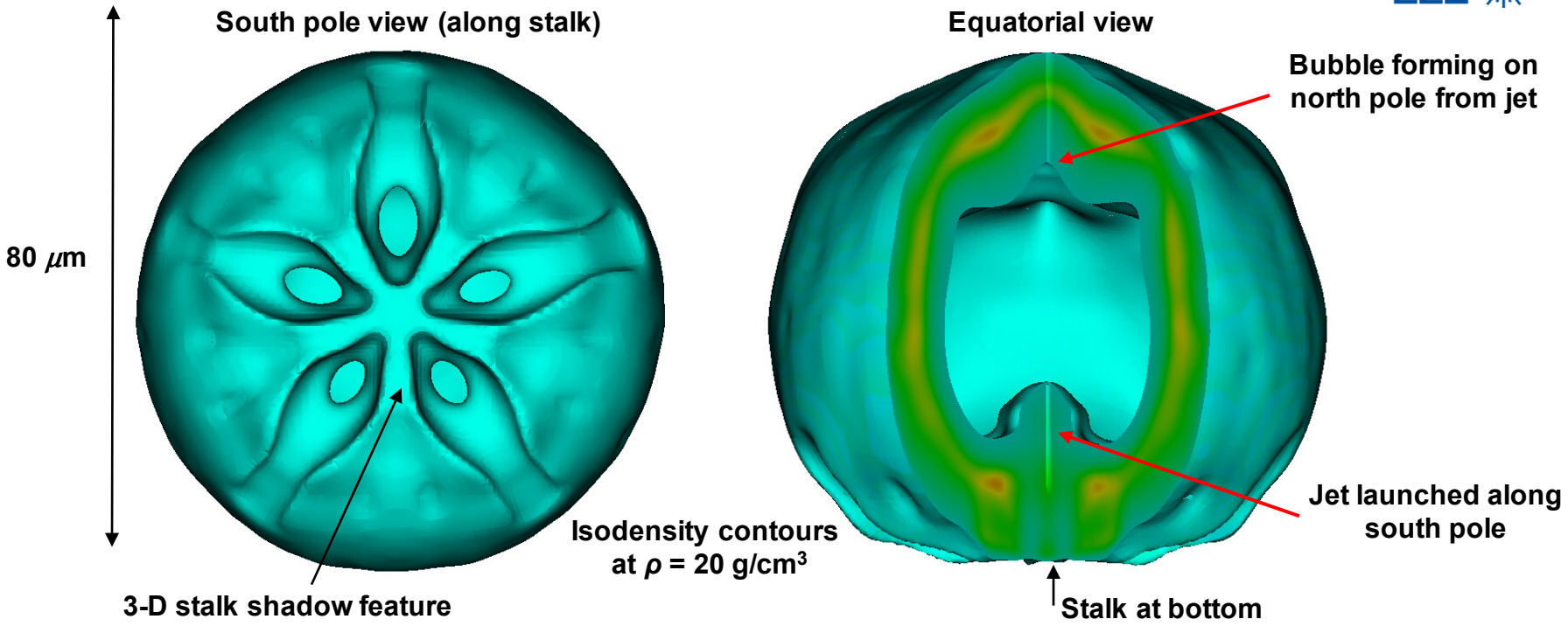


- The glue composition was determined via an inductively coupled plasma technique to be:

  7% H; 58% C; 25% O; 3% Si

- Simulations are being used to explore effects of both glue spot size and stalk diameter

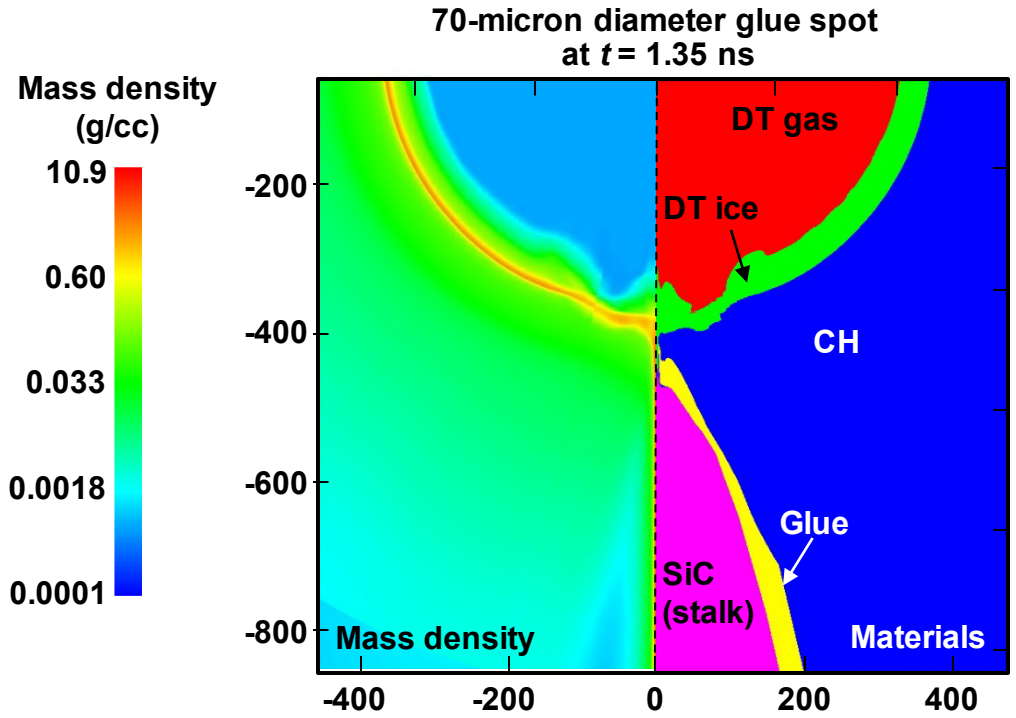
Previous simulations† with only a 17-μm diameter stalk and no glue spot found ~15% reduction in yield

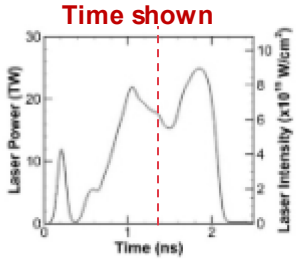


Stalk shadowing did not significantly degrade target performance

† K. S. Anderson *et al.*, APS-DPP 2021.

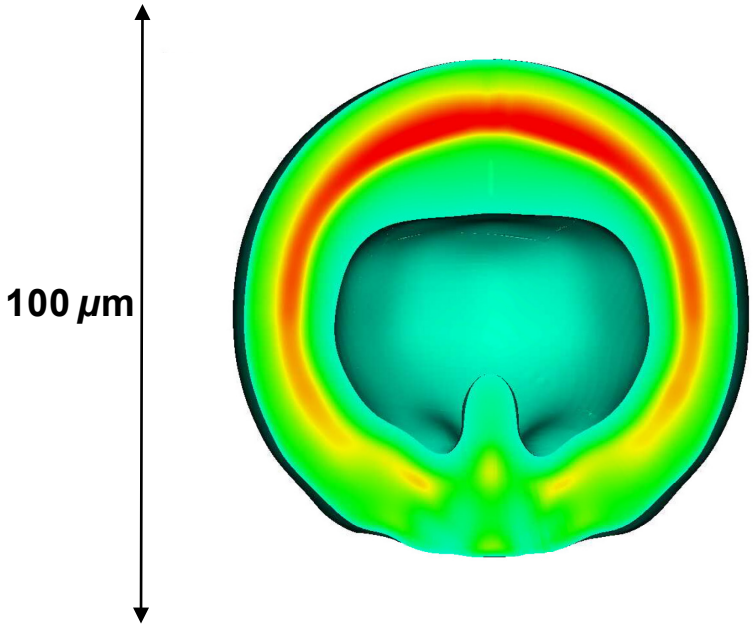
Neither stalk nor glue material is predicted to be entrained into the capsule or hotspot, even for large glue spots



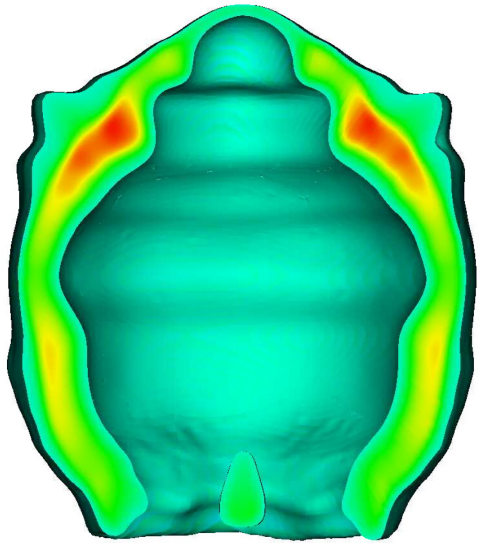


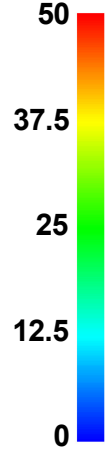
No jetting of stalk material into the capsule is evident

The perturbation from the glue spot can lead to large hot spot distortions and yield degradation



Isodensity contours at ρ = 15 g/cm^3





35-micron glue spot:
Significant ℓ = 1 perturbation of the hot spot coupled with south-polar jet

70-micron glue spot:
Increased hot-spot volume, more prominent perturbation from the polar jet, and greater reduction in overall areal density

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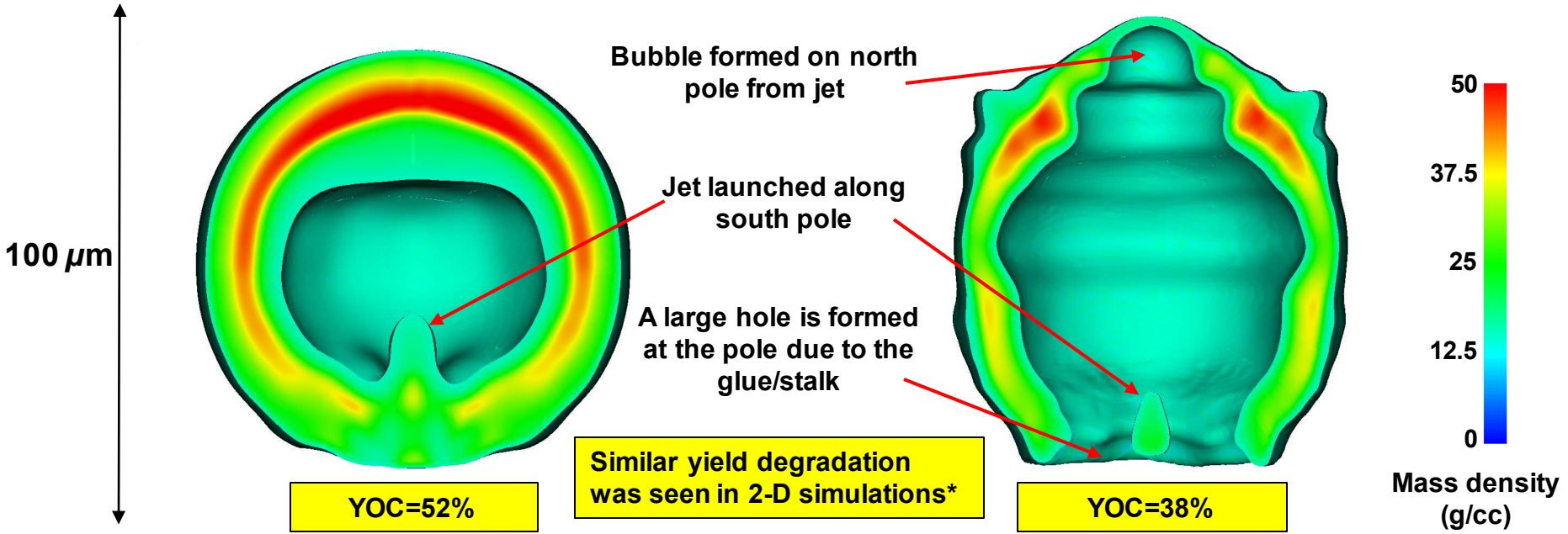

Contribution to yield degradation by glue and stalk may be significantly less when other perturbations sources are included

*Igumenshchev *et al*., Phys. Plasmas 16, 082701 (2009).

Future work will explore interaction of 3-D effects

- **A scans on stalk thickness is underway**
- **Interaction of target offset and other low-mode perturbations with the stalk will be investigated to determine the moderating effect of unaligned perturbations**
- **The stalk serves as a heat source, causing a perturbation in the ice layer, an effect which will also be investigated**
- ***HYDRA's* 2-vector *k*-local model for CBET has been tested on this shot without the stalk, and will be used to explore the impact of the stalk on absorption**

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Upcoming OMEGA cryogenic experiments will determine the effect of mounting stalk diameter on implosion performance

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