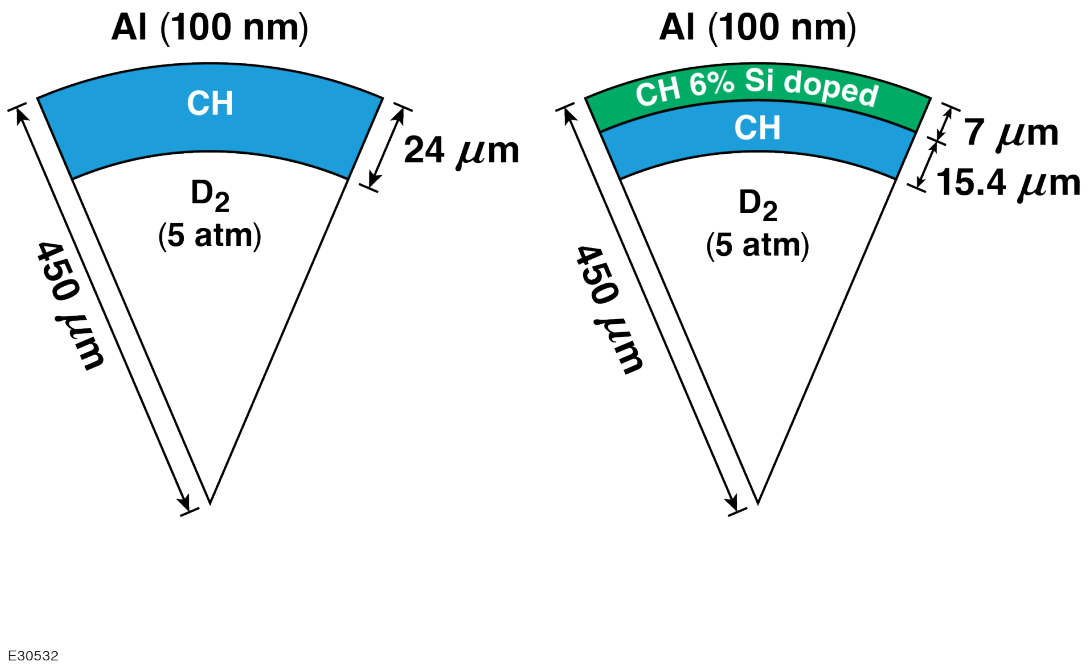
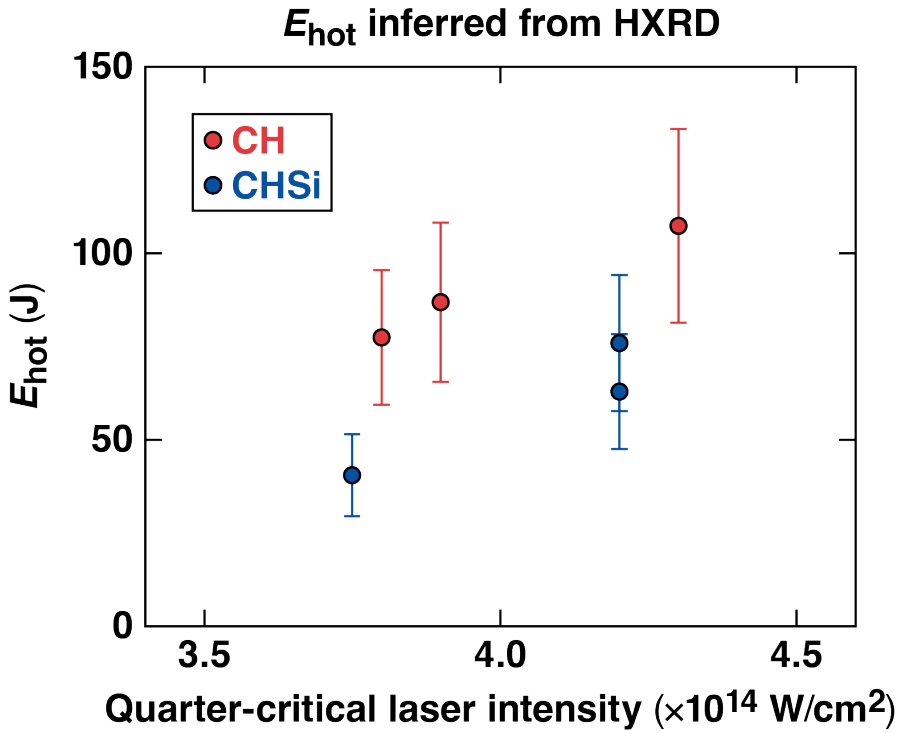
Hot-Electron–Preheat Mitigation Using Silicon-Doped Layer Shells on OMEGA





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64th Annual Meeting of the APS
Division of Plasma Physics
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17–21 October 2022

Summary

OMEGA direct-drive experiments using targets with Si-doped CH ablators show a reduction in hot-electron preheat by a factor of 2 compared to pure-CH ablators

- Implosions of D_2-gas-filled targets with pure-CH shells were compared with the performance of mass-equivalent 6% Si-doped CH layer shells
  - tight-focused phase plates increase energy coupling and increase hot-electron production*
  - implosion adiabat was kept constant by adjusting the laser pulse shape to compensate for radiative preheat
- Hot-electron temperature, T_{hot}, and total hot-electron energy, E_{hot}, were inferred from the signal of an absolutely calibrated hard x-ray detector (HXRD)**,†
- Implosions with the Si-doped layer shells achieved higher areal densities and higher yields than the pure-CH shell implosions‡

* W. Theobald *et al.,* Phys. Plasmas 29, 012705 (2022).
** C. Stoeckl *et al.*, Rev. Sci. Instrum. 72, 1197 (2001).
† A. Christopherson *et al.,* Phys. Rev. Lett. 127, 055001 (2021).
‡ P. S. Farmakis *et al.*, CO04.00003, this conference.

Collaborators

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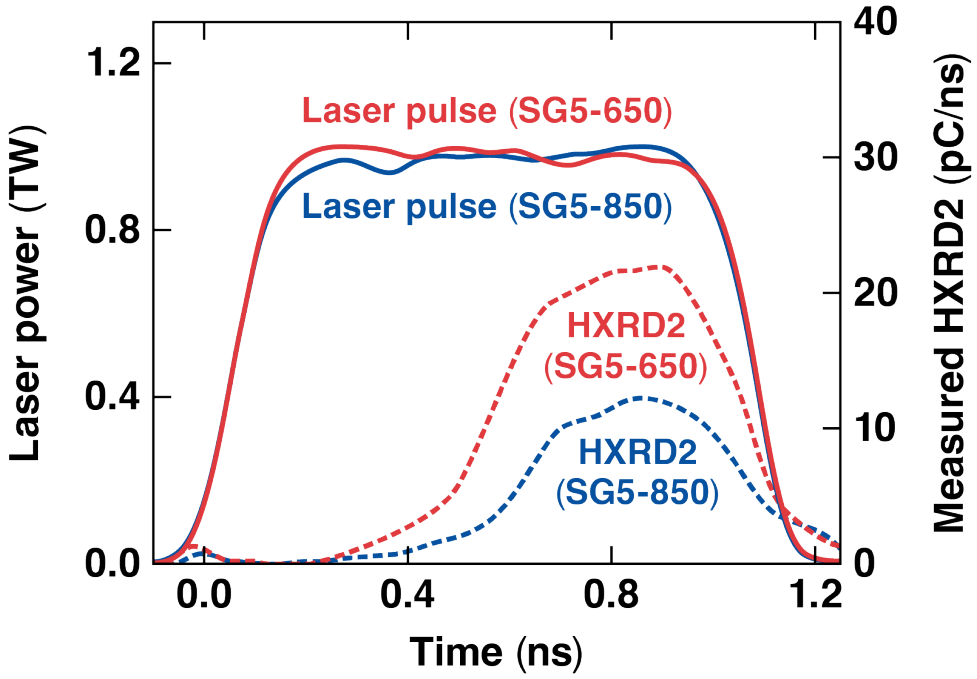
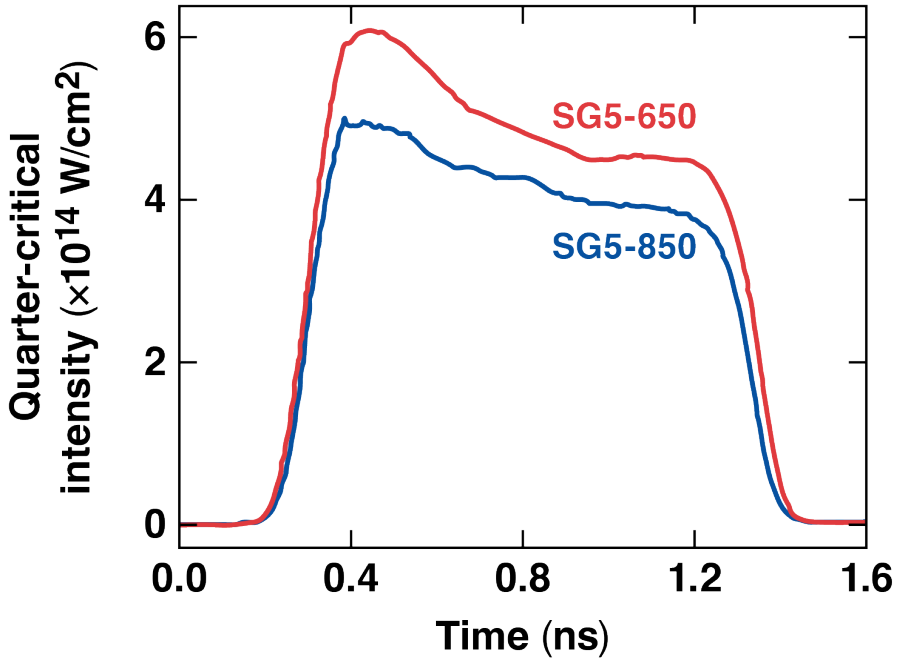
Tight-focused phase plates increase energy coupling and increase hot-electron production*,**



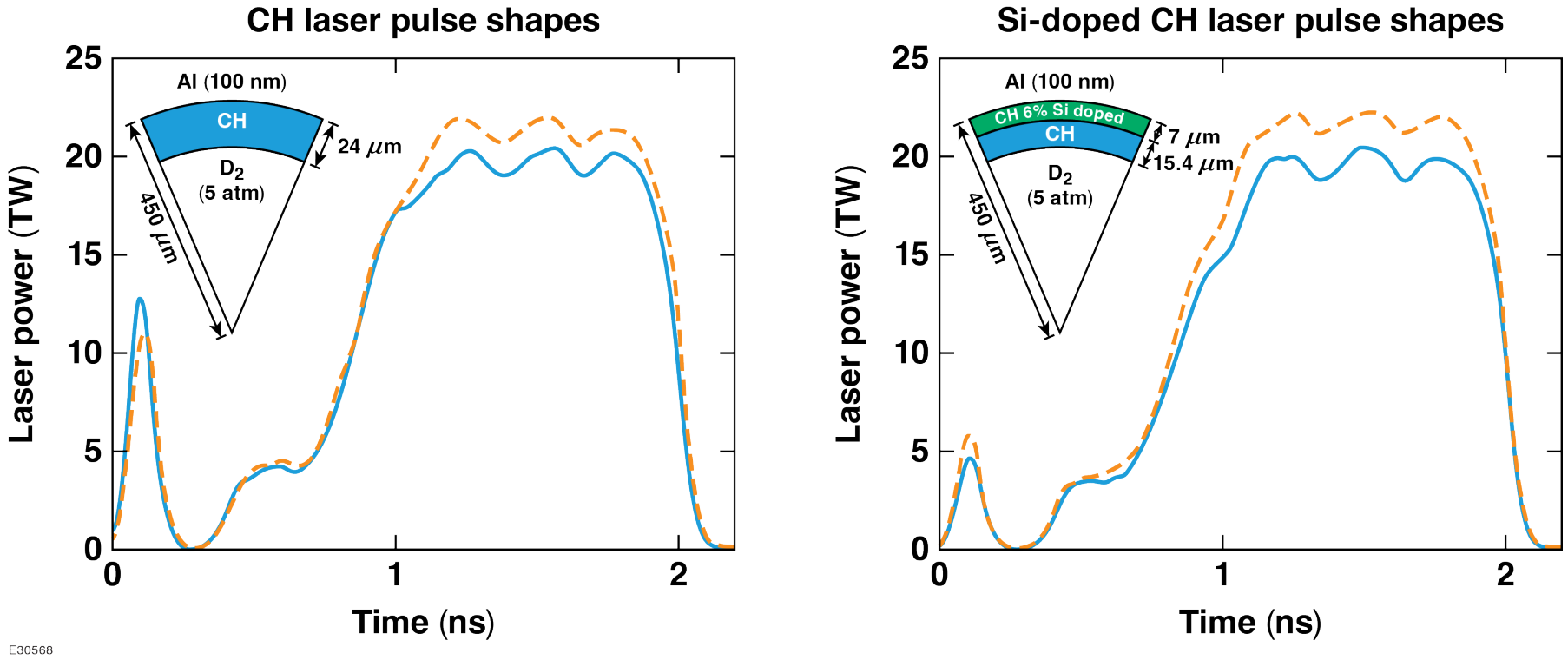


E30557

Tight-focused phase plates have a higher intensity at the quarter critical density and generate more hot-electron preheat than the SG5-850 phase plates.

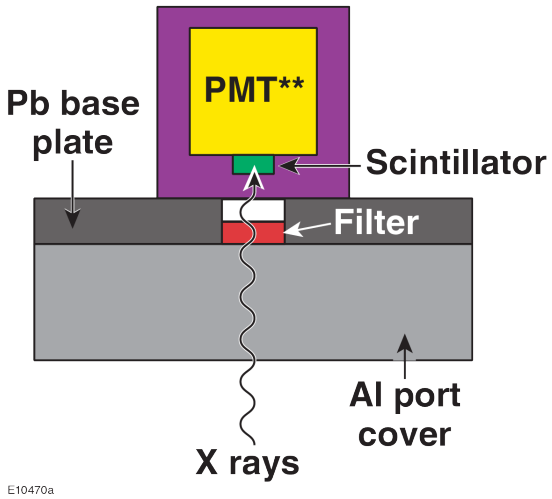
* W. Theobald *et al.*, Phys. Plasmas 29, 012705 (2022).
**D. Cao *et al.*, presented at the 61st Annual Meeting of the APS Division of Plasma Physics, Fort Lauderdale, FL, 21–25 October 2019 (NO5.00010).

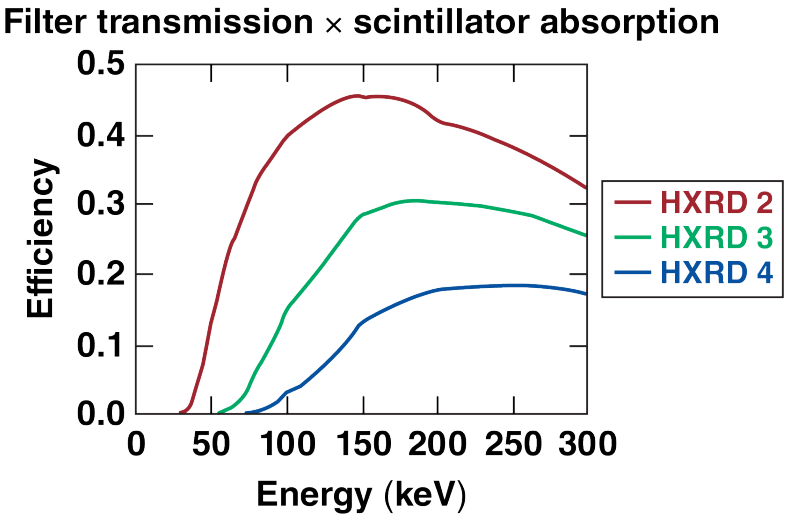
Experiments were performed using D_2-gas-filled pure-CH shells and mass-equivalent 6% Si-doped CH layer shells

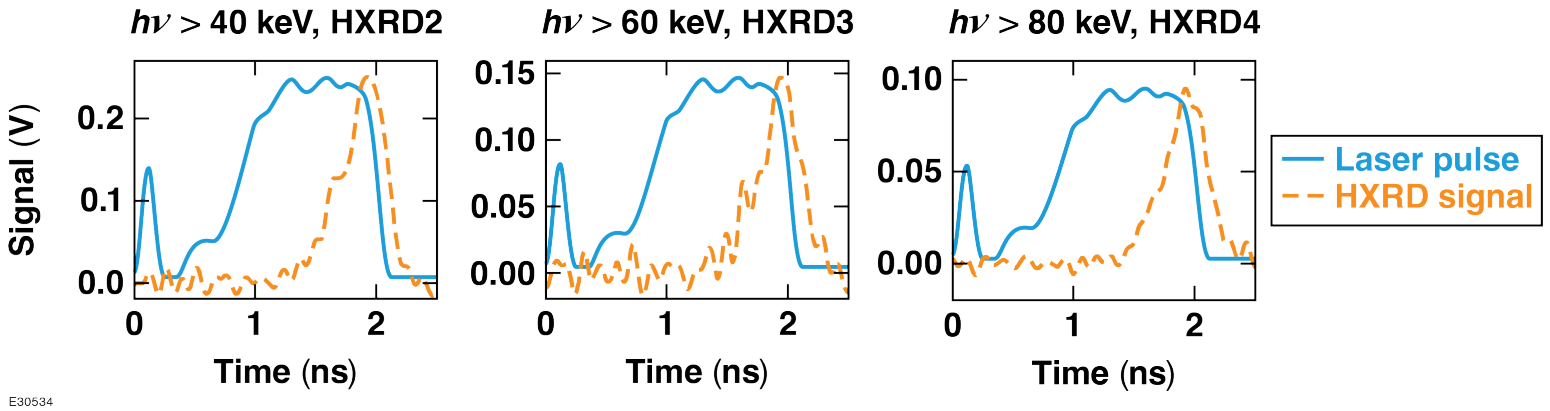


The implosion adiabat was kept constant by adjusting the laser pulse shape to compensate for radiative preheat.

The hot electron temperature, T_{hot}, and total hot electron energy, E_{hot}, were inferred from the signal of an absolutely calibrated hard x-ray detector (HXRD)*



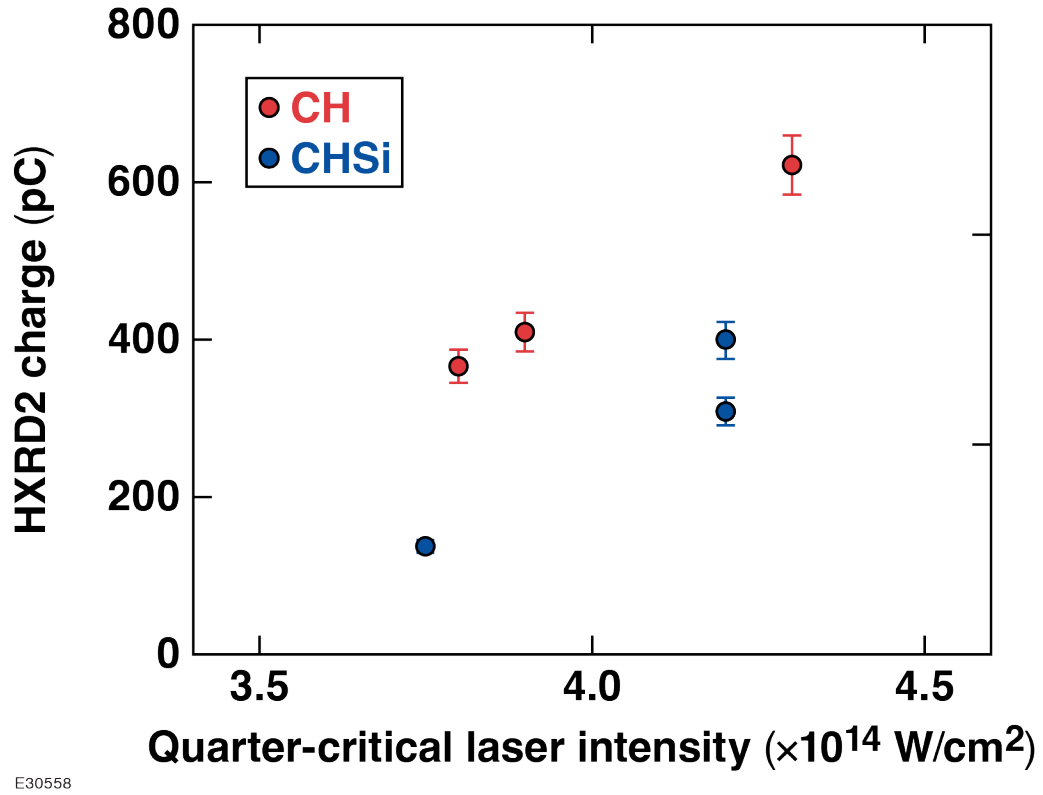




*C. Stoeckl *et al.*, Rev. Sci. Instrum. 72, 1197 (2001).

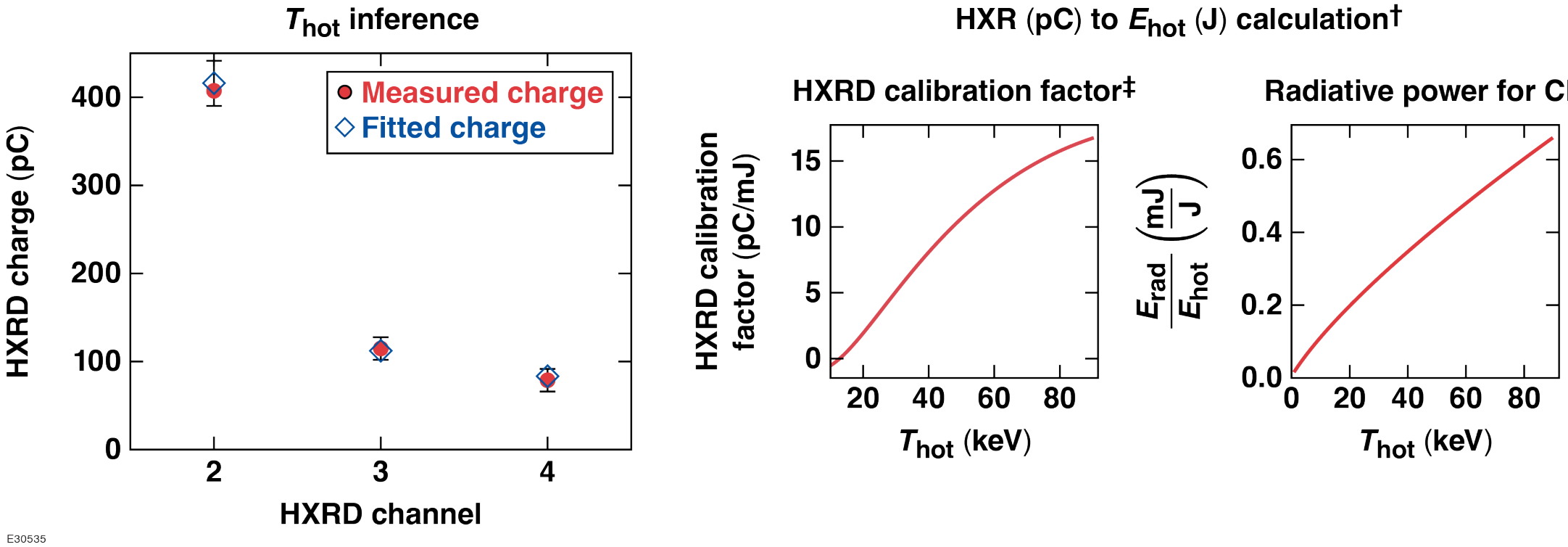
**PMT: photomultiplier tube

Si-doped CH targets produced fewer hard x-rays than pure-CH shells



Si-doped CH targets showed a factor of 2 lower HXR signal compared to pure CH targets at all intensities.

Hard x-ray measurements were used to infer hot-electron energy E_{hot}*,**



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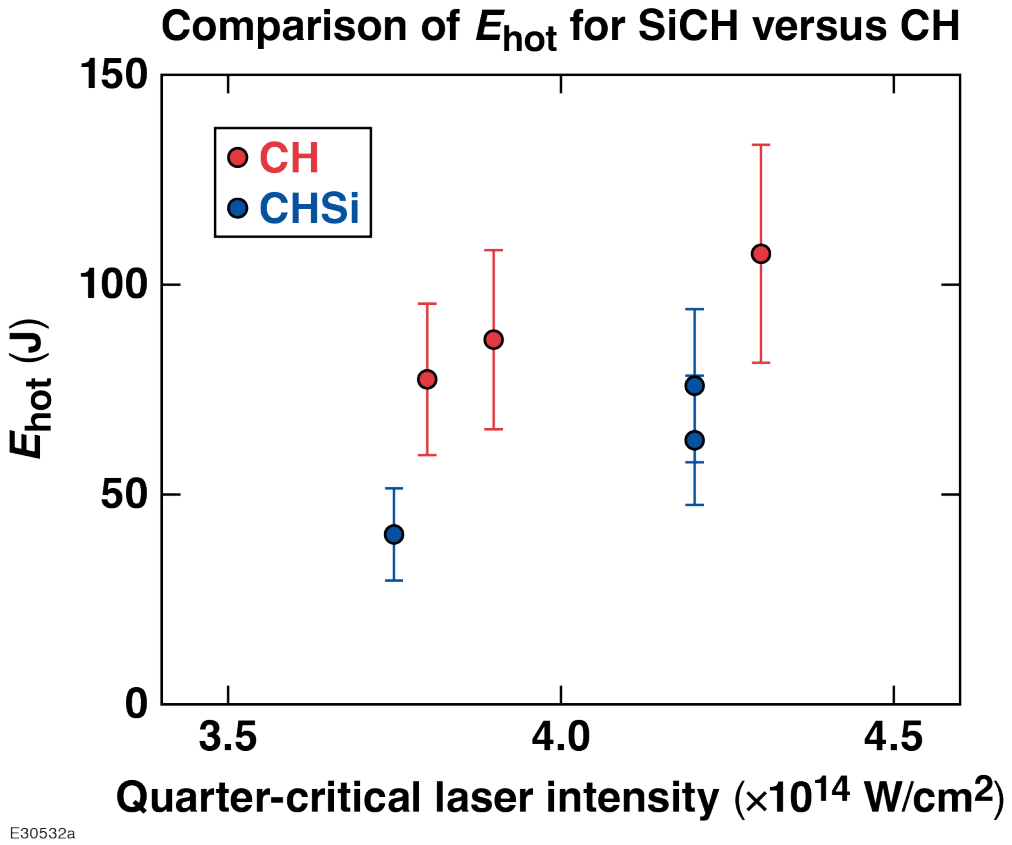
Current analysis assumes radiative power of CHSi equal to CH, which gives a conservative estimate of E_{hot} reduction.

* C. Stoeckl *et al.*, Rev. Sci. Instrum. 72, 1197 (2001).
**A. Christopherson *et al.*, Phys. Rev. Lett. 127, 055001 (2021).

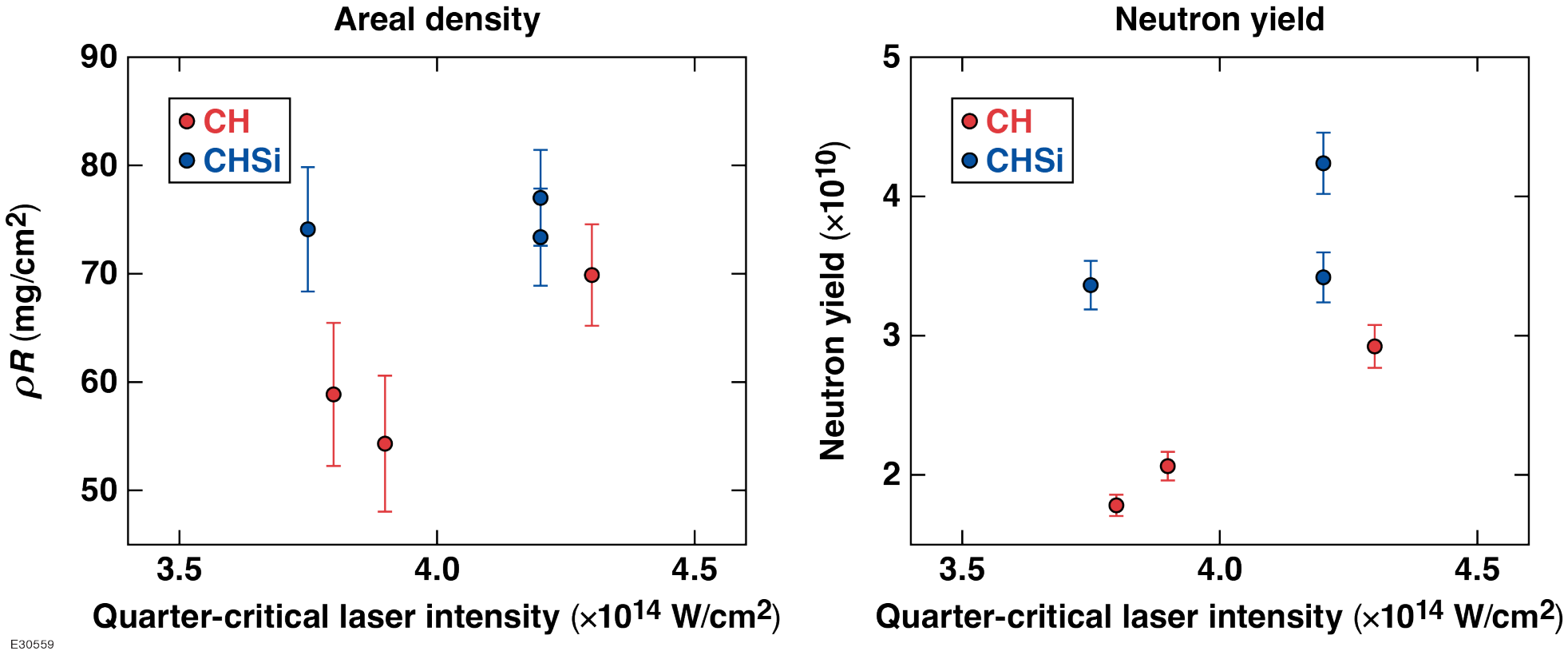
† A. Christopherson, Ph.D. thesis, University of Rochester, 2020.
‡ C. Stoeckl *et al.*, Rev. Sci. Instrum. 87, 11E323 (2016).

The inferred E_{hot} is lower by a factor of 2 for Si-doped CH targets compared to pure-CH targets



E_{hot} is reduced with Si-doped CH shells at all intensities, indicating the reduction of hot-electron preheat.

Implosions with the Si-doped layer shells achieved higher performance compared to the pure-CH shell implosions*



E30559

*P. Farmakis *et al.*, CO04.00003, this session.

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A follow-up campaign with fully Si-doped CH shells is scheduled for FY23 to understand the individual contributions to the HXR signal from the corona and payload.

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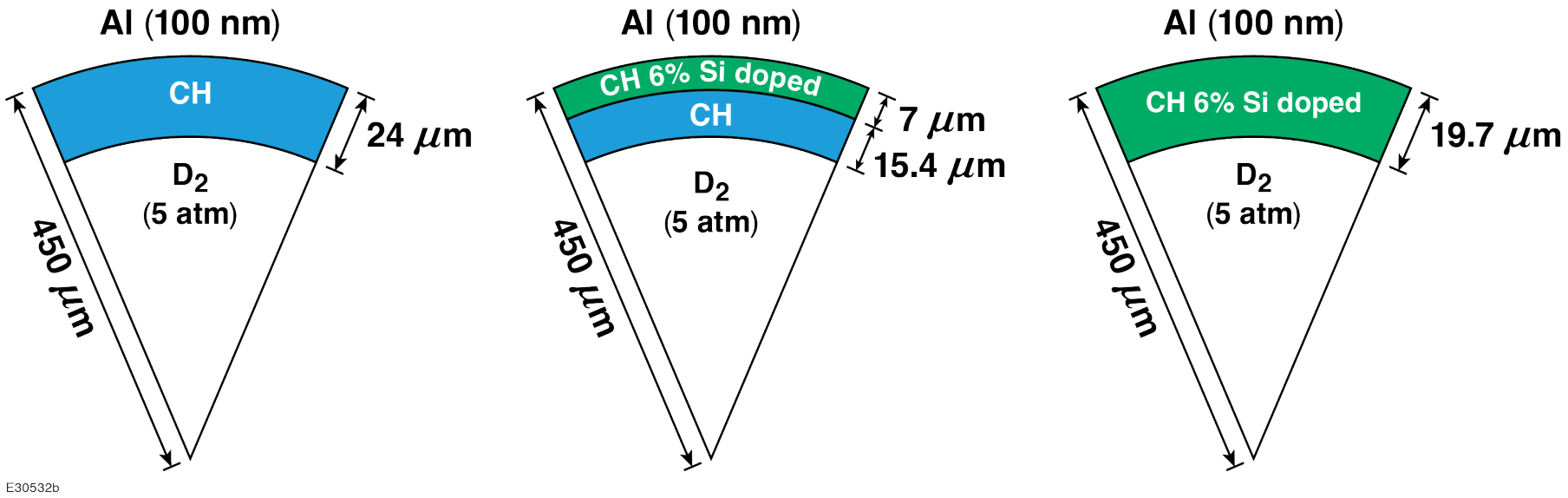
Back up slides

A follow up campaign is scheduled to get more accurate estimate of preheat reduction with CHSi ablators using single-layer Si-doped CH shells



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