Hohlraum Energetics with a Plastic-Lined Laser Entrance Hole (LEH)

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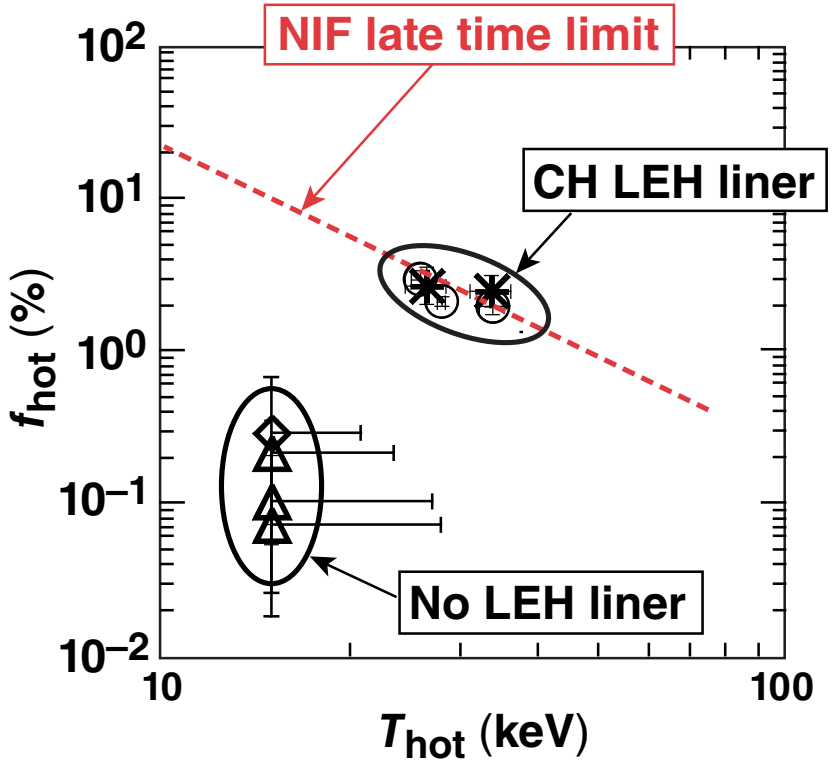
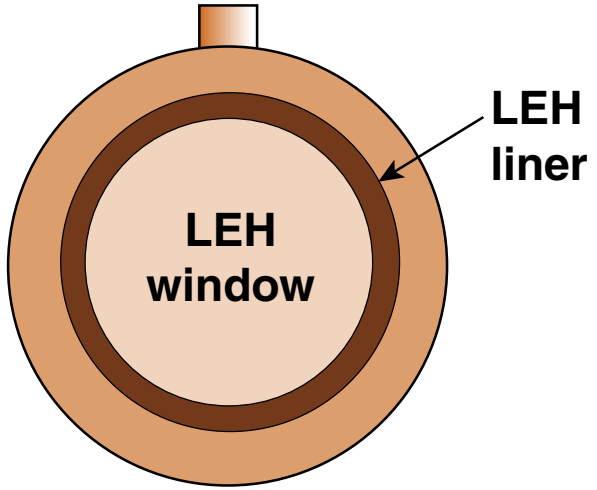
LEH liner hot electrons f_{hot} versus T_{hot}



Axial view of gas-filled Au hohlraum



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Summary

Liners do delay LEH closure of gas-filled Au hohlraums on OMEGA

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- LEH liners (CH, CF, Ge-doped CH) generate hot electrons on axis in the cooling, stagnating liner plasma.
- The hard x rays produced by the hot electrons correlate with the stimulated Raman scattering.
- Fewer hot electrons are produced with CF liners or Ge-doped CH liners or when using a larger LEH diameter with no LEH liner.
- A drop in the peak radiation temperature with liners, as seen in modeling, is observed (T_r = 195 eV → T_r = 185 to 190 eV).

The level of hot electrons produced with CH LEH liners on OMEGA approaches the NIF late-time capsule preheat limit.

Collaborators

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The hohlraum energetics of gas-filled Au hohlraums with and without LEH liners were investigated

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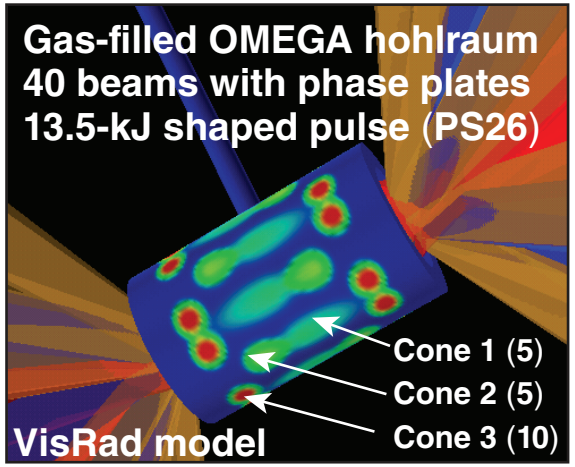
Hohlraum plasma density
Vacuum, $n_e = 0.04\ n_{cr}$

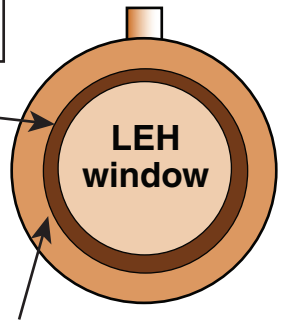
Thin-walled, scale-1 hohlraum
Au thickness = 5 μm
i.d. = 1.6 mm
L = 2.55 mm
LEH = 1.07 mm
Polyimide window 0.6-μm thick

Primary diagnostics
HXRD,* DANTE, XRPHC,
3ω/2 spectrometer,
FABS, and NBI

LEH liners (δr = 100 μm)
CH (10 μm thick)
Ge-doped CH (10 μm)
CF (6 μm)

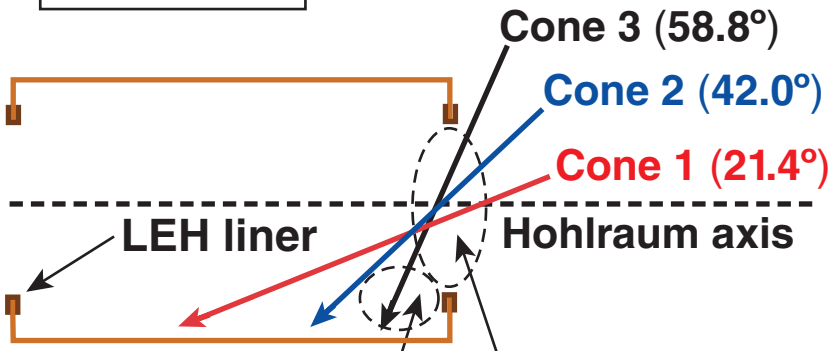


Axial view



Gas-filled, Au hohlraum

Radial view



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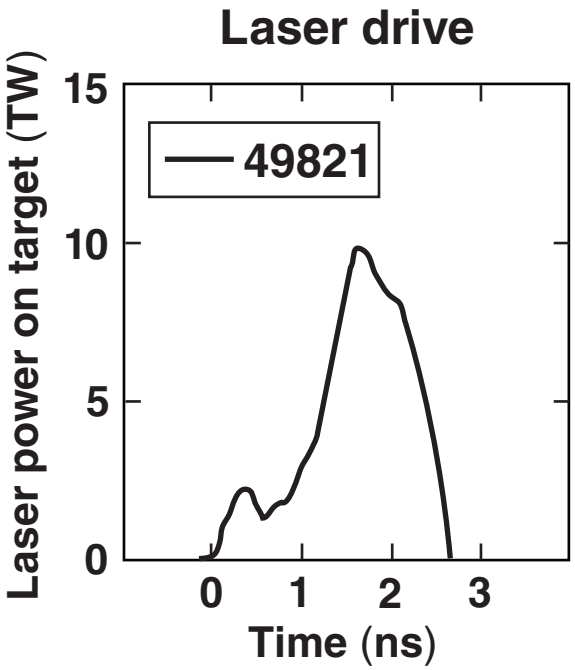
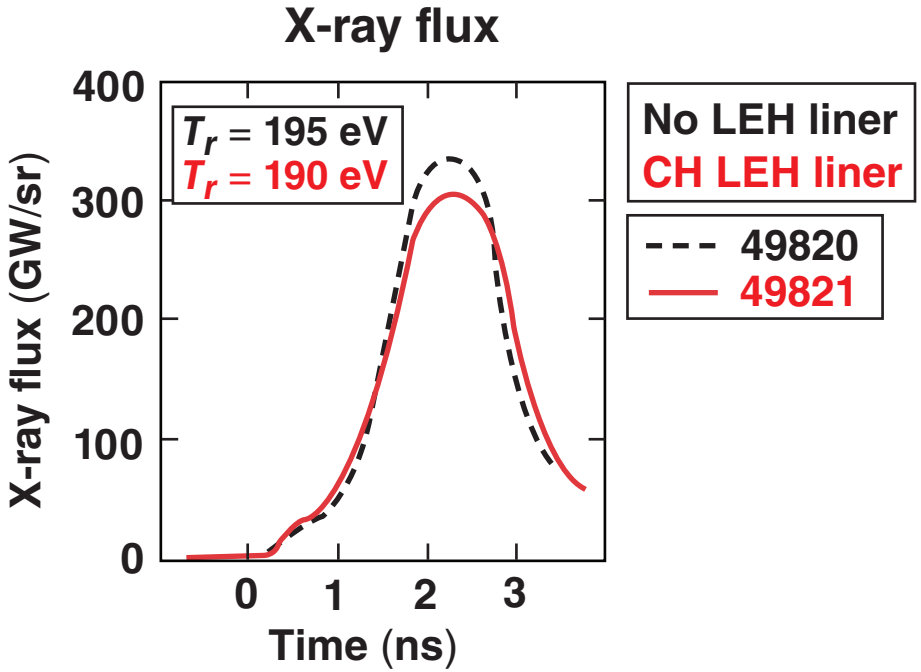
*C. Stoeckl, Rev. Sci. Instrum. 72, 1197 (2001).

LEH liners reduce the peak radiation temperatures





Greater reductions in the peak radiation temperatures for CF and Ge-doped CH liners are observed (~10 eV).

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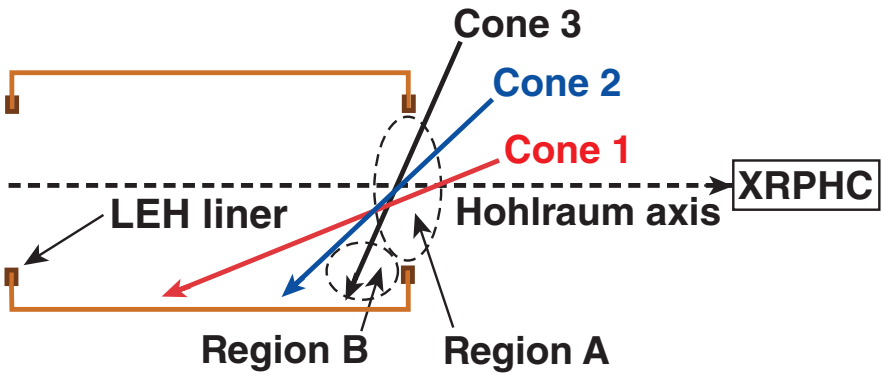
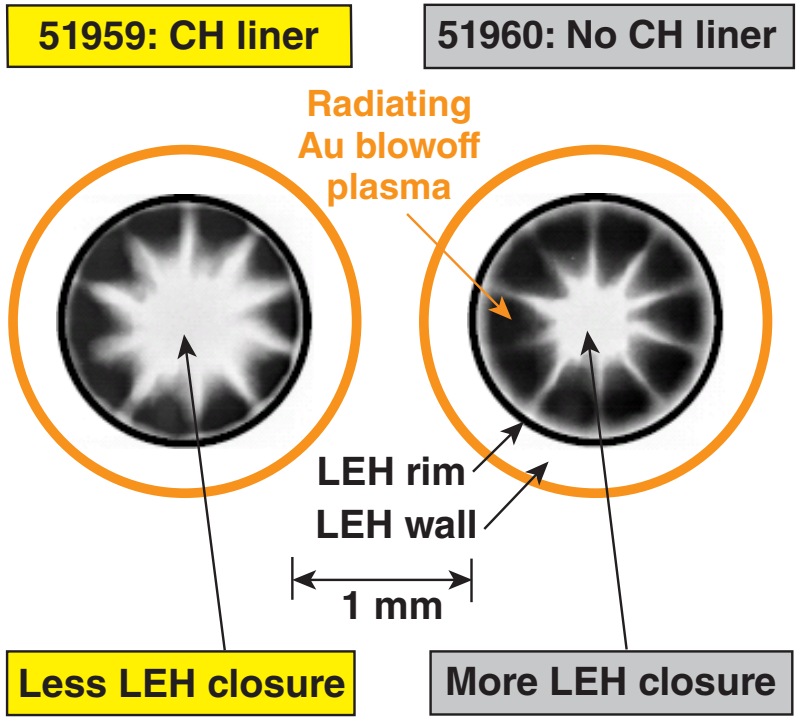


Axial, time-integrated x-ray pinhole camera (XRPHC) images of Au M-band emission



The LEH liner tamps the expansion of Au blowoff from the LEH rim (Region A) and the cone-3 laser-deposition region (Region B).

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Substantial increases in the late time hard x-ray production are observed with the LEH liners

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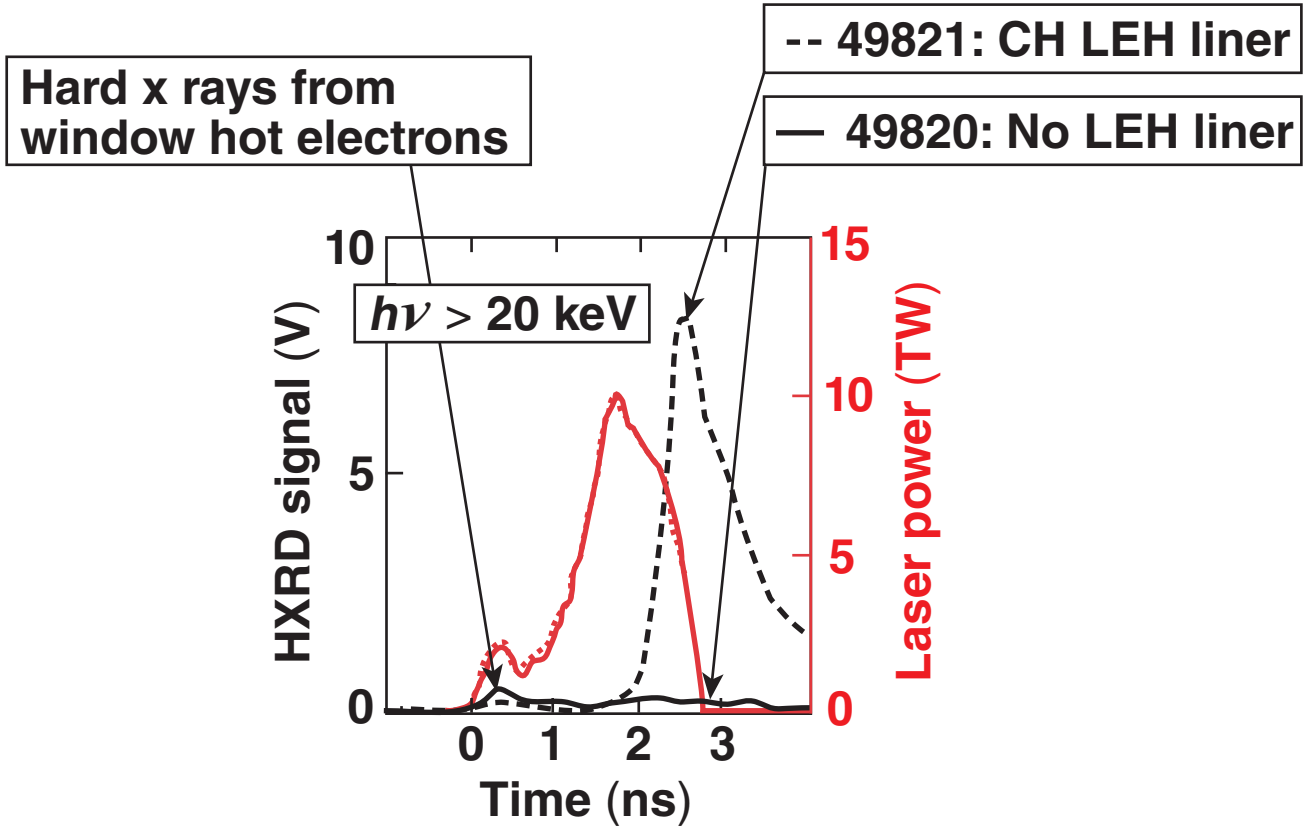

Similar behavior is observed in higher-energy hard x-ray channels with $h\nu > 40$ keV, $h\nu > 60$ keV, and $h\nu > 80$ keV.

LEH liner hot electrons correlate with SRS measured on a cone-3 beam

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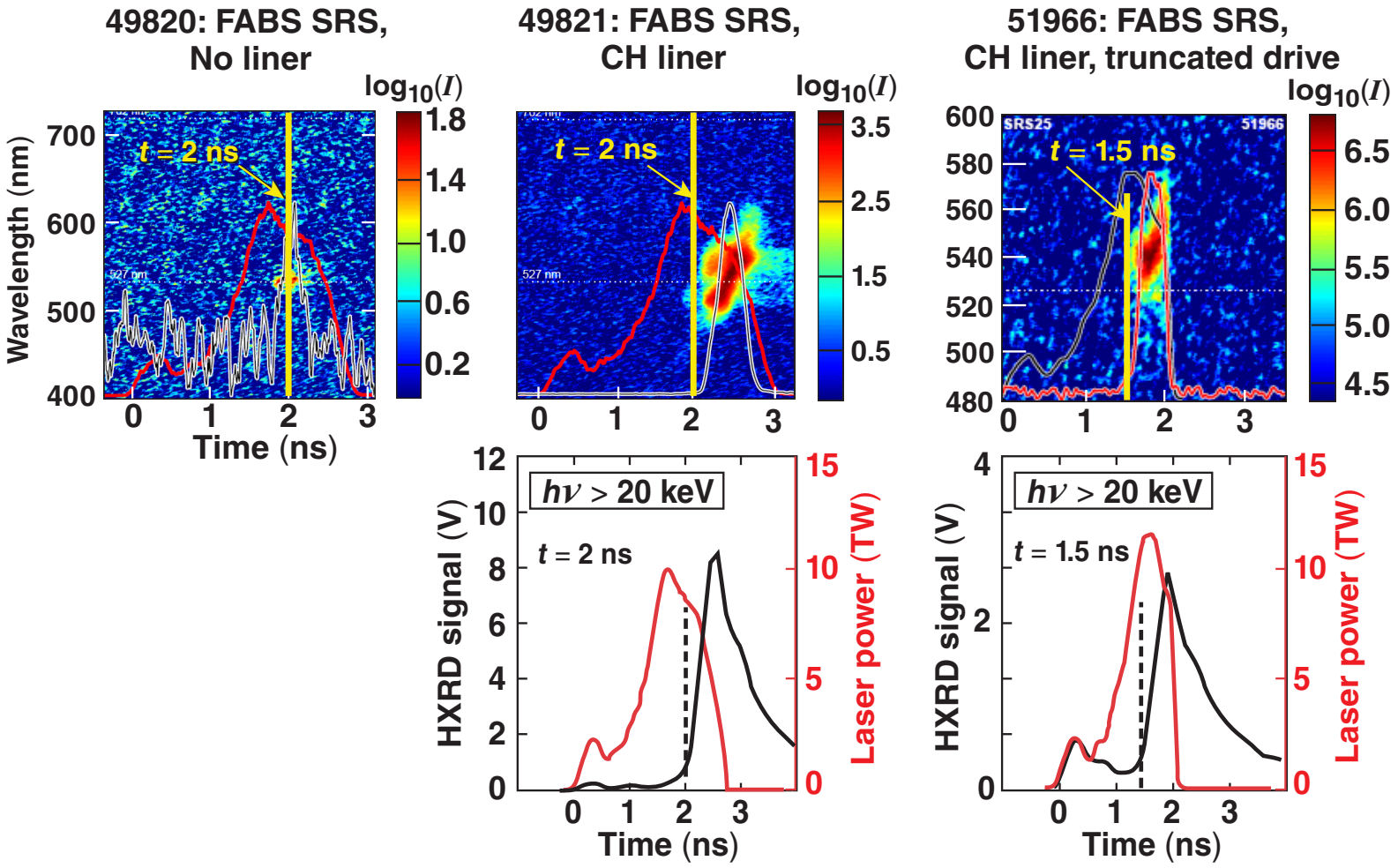

Optimal conditions for SRS and LEH liner hot-electron production are created in cooling LEH plasma (i.e., on the falling edge of the laser drive).

E17415

Hot-electron production for CH LEH liners on OMEGA are at the NIF limit for target preheat

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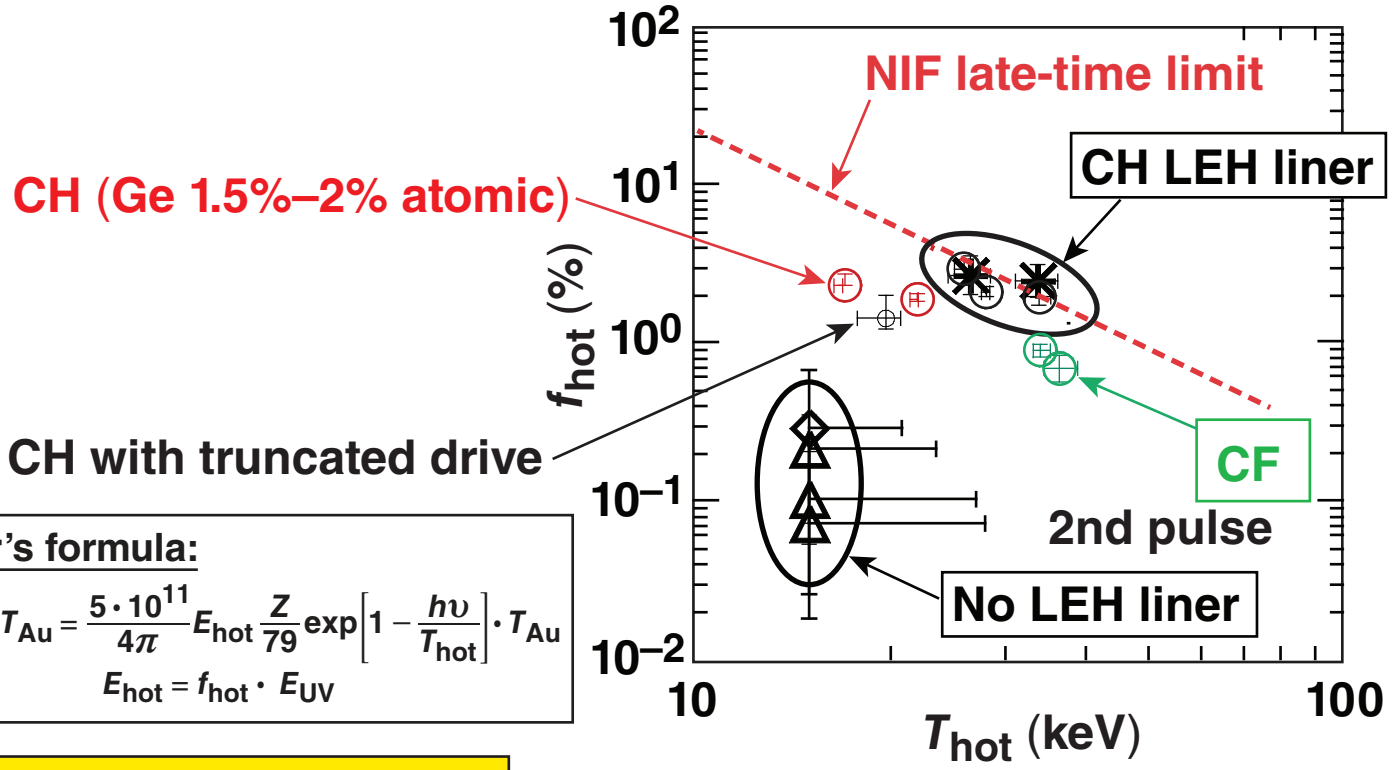
Gas-filled (n_e = 0.04 n_{cr}) Au hohlraums with and without LEH liners, NO implosion capsules



Kruer's formula:

$$\frac{dI}{d\upsilon d\Omega}\cdot T_{Au} = \frac{5\cdot 10^{11}}{4\pi} E_{hot}\frac{Z}{79}\exp\left[1-\frac{h\upsilon}{T_{hot}}\right]\cdot T_{Au}$$

$$E_{hot} = f_{hot}\cdot E_{UV}$$

Three mitigation strategies

1. CF liners
2. CH + mid-Z dopant
3. No liner, but increase diameter of LEH

While this does not prove that the NIF will have liner-generated hot electrons near the limit, it does suggest that we should be prepared to mitigate the possibility.

E17418

LEH liner hot electrons appear to be generated on-axis in the stagnating CH LEH liner plasma (region A)

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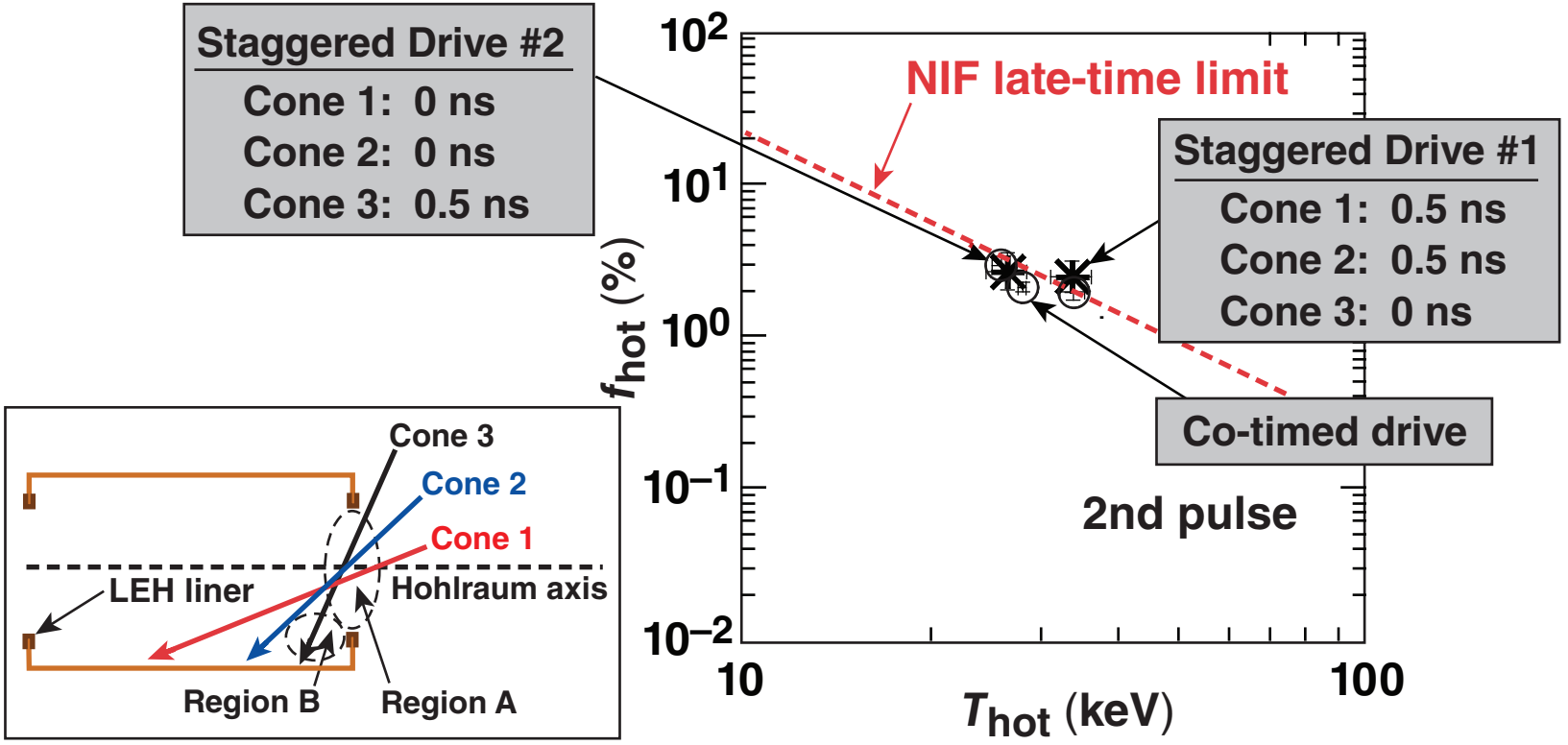

The late time density in region A is predicted to be higher on OMEGA than on the NIF; consequently, the LEH liner hot-electron production could be higher on OMEGA.

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Summary/Conclusions

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