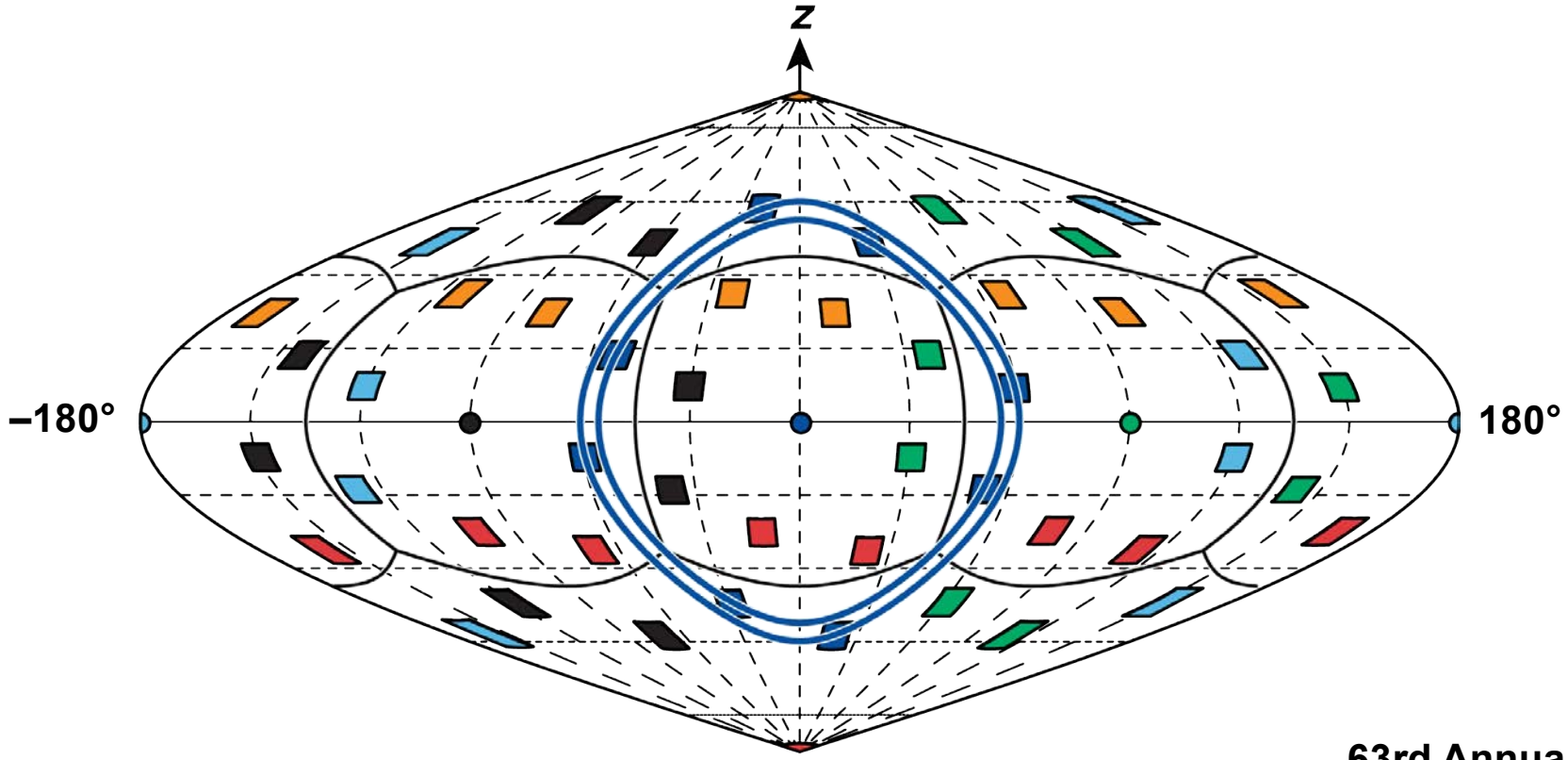
A Dual Laser-Beam Configuration Compatible with Both Symmetric Direct Drive and Spherical Hohlraums



Proposed design

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American Physical Society
Division of Plasma Physics
Pittsburgh, PA
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Summary

A laser-beam configuration is proposed that allows both symmetric direct drive and spherical indirect drive to be carried out on the same facility

UR LLE

- The proposed configuration is a modified version of the Lan design* for octahedral hohlraums
- The proposed configuration gives direct-drive uniformity much better than 1% with modest beam repointings chosen to match the cubic Russian laser system**
- All configurations can give indirect-drive uniformity much better than 1% but some of this should be traded off for a lower case-to-capsule ratio

*K. Lan *et al.*, Phys. Plasmas 21, 010704 (2014).
**S. A. Bel'kov *et al.*, J. Exp. Theor. Phys. 121, 686 (2015).

Collaborators

W. Y. Wang,* M. A. Marangola,* and E. M. Campbell

University of Rochester
Laboratory for Laser Energetics

***also LLE Summer High School Research Program**

Outline

- Description of the three configurations
- Direct-drive performance
- Indirect-drive performance

Lan proposed a design for six-hole spherical ("octahedral") hohlraums*

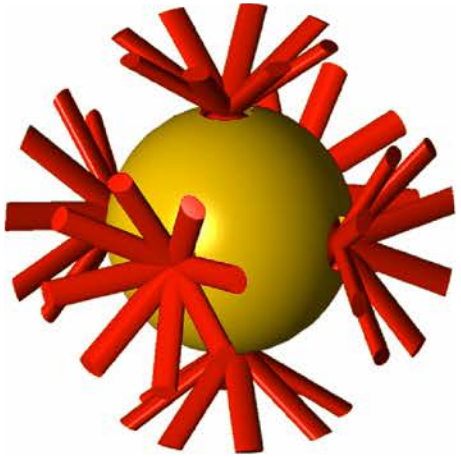
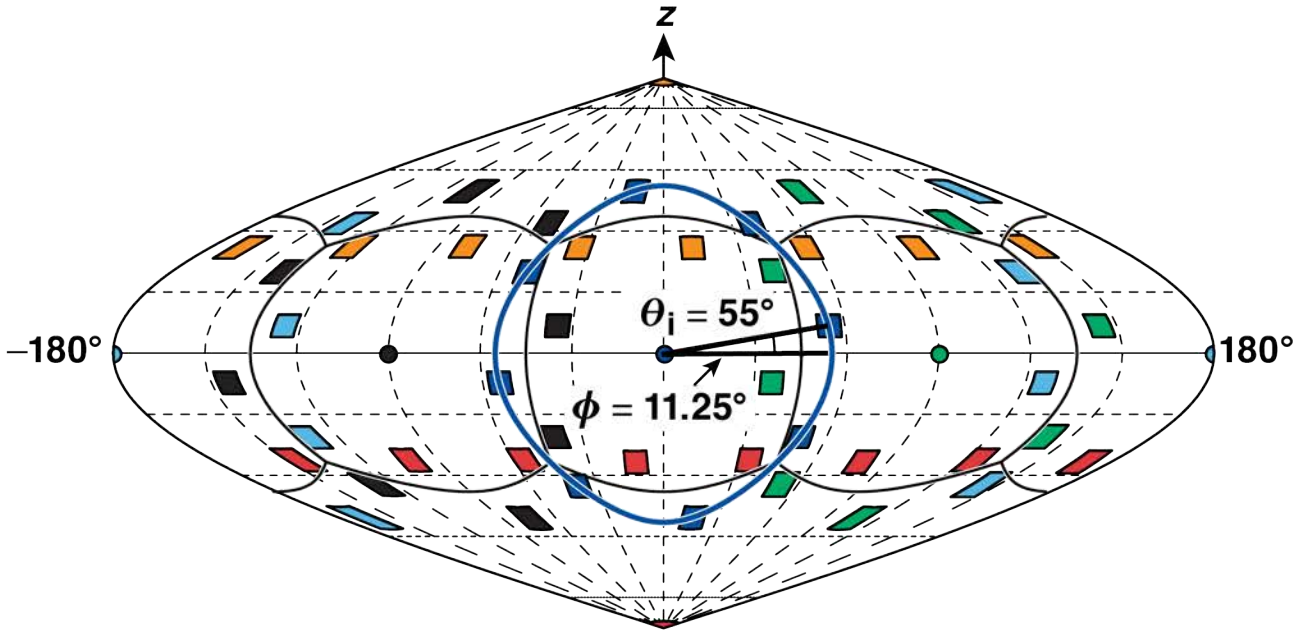


Figure from Jing**

TC15481



- All beams enter the laser entrance holes (LEH's) at 55°

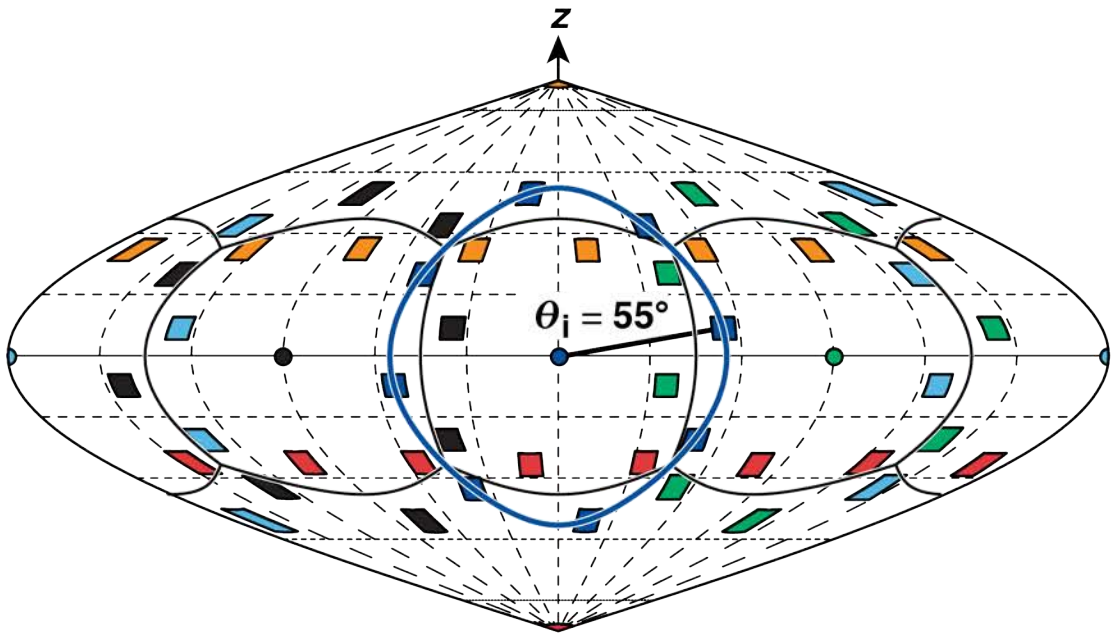
- Port map is based on NIF quad size (100 cm) and focal length (7.7 m)
- $\phi = 11.25°$ allows for in-tank beam dumps

NIF: National ignition facility

* K. Lan *et al.*, Phys. Plasmas 21, 010704 (2014).

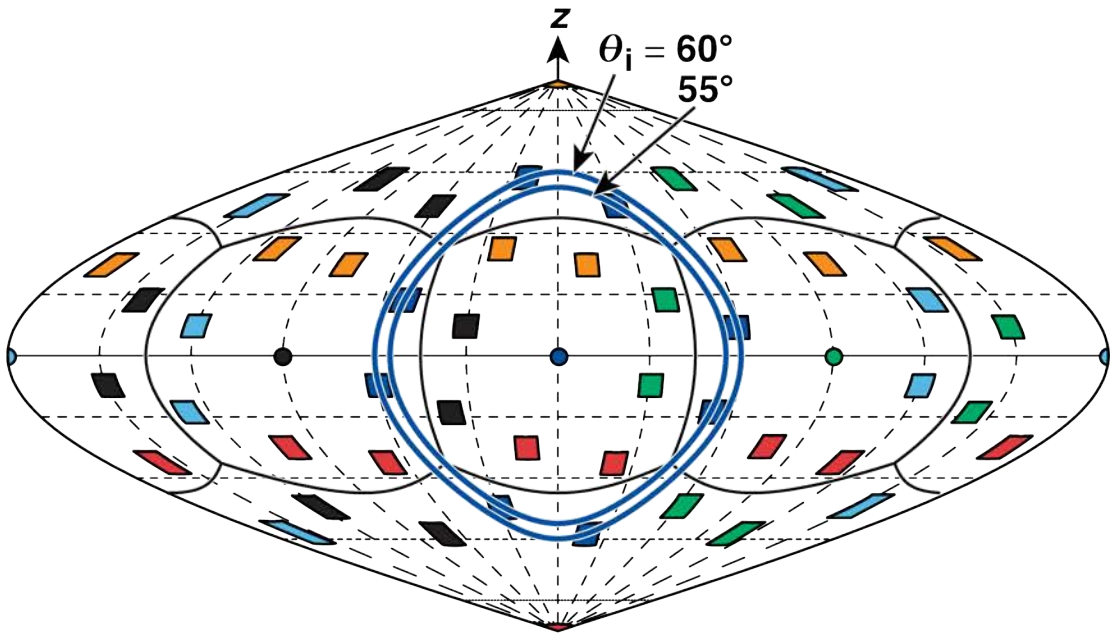
** L. Jing *et al.*, Nucl. Fusion 57, 046020 (2017).

The proposed design also accommodates direct drive



TC15485a

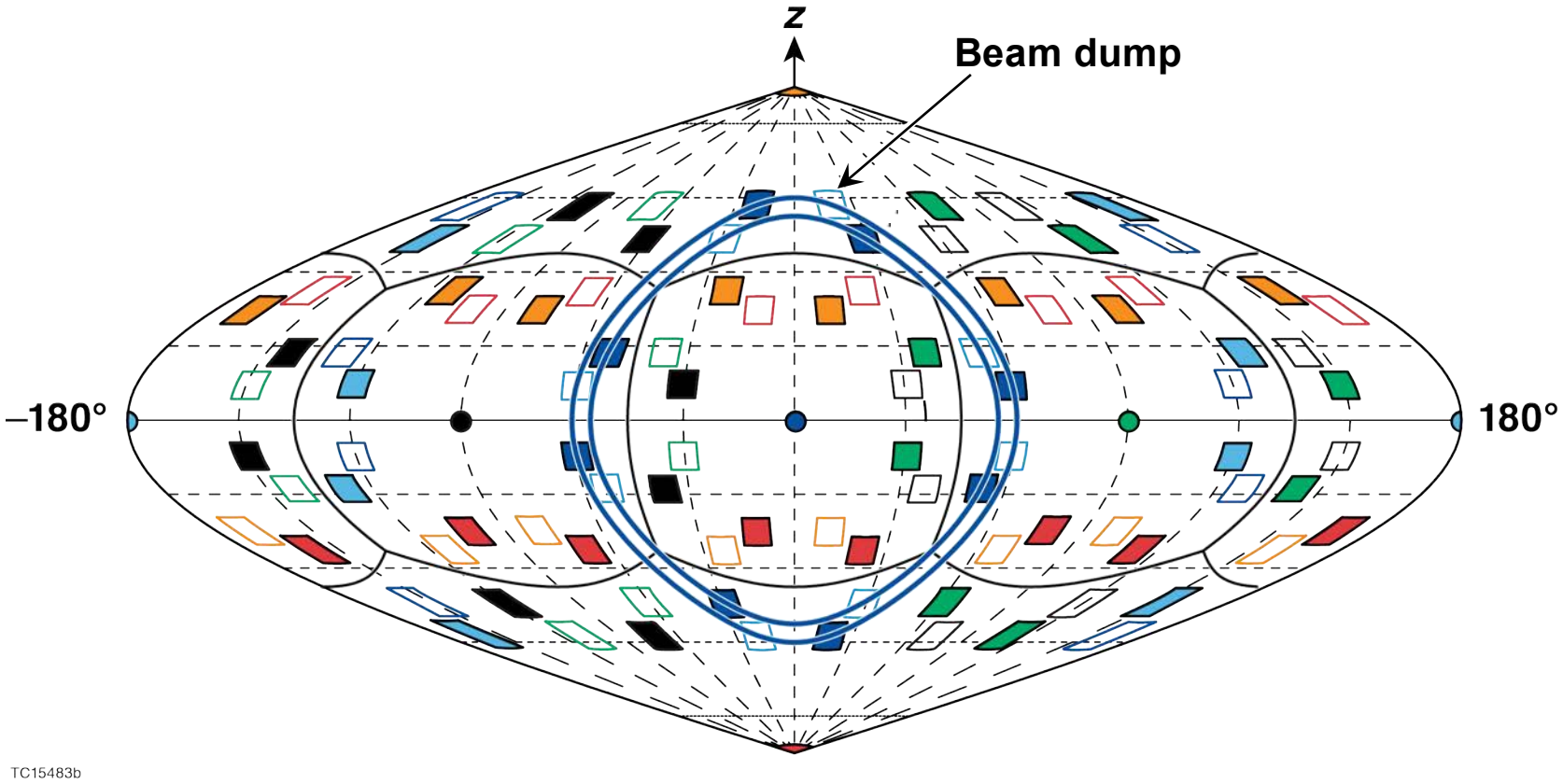
Lan design



Proposed design

- The beams are better spread out
- Crowding near the corners is avoided

The proposed design has non-opposed beam ports (like the Lan design and the NIF)

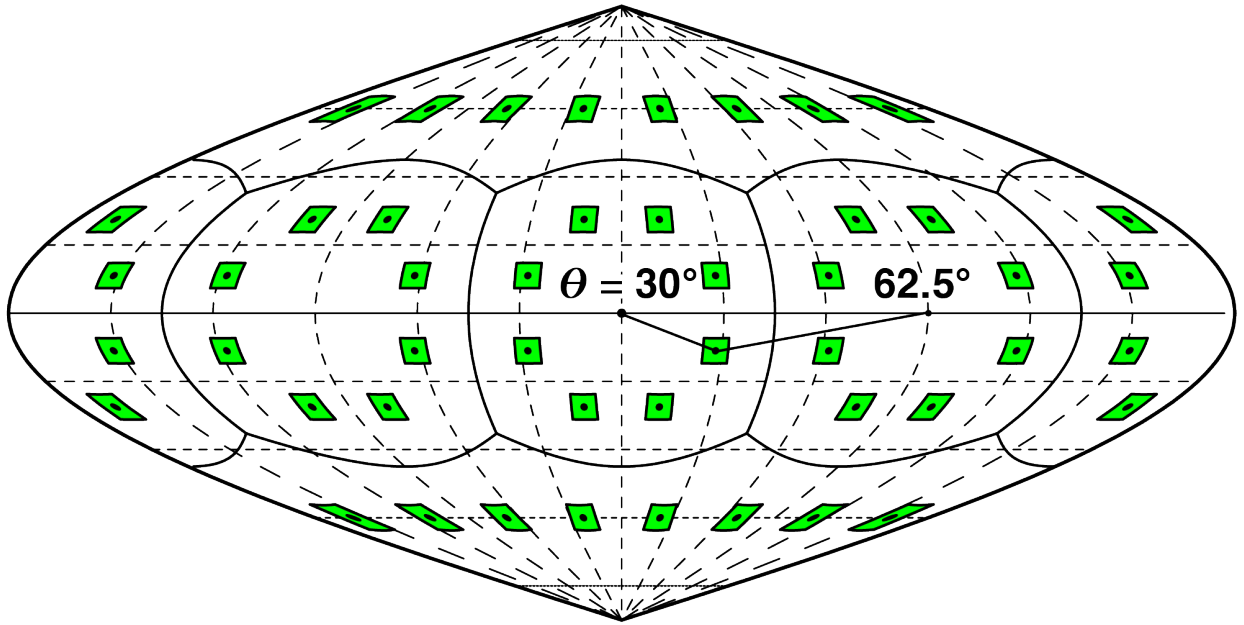


- The geometry also allows good diagnostic access

The Russian laser system also accommodates both direct and indirect drive

TC15485b

- The system has opposed beam ports



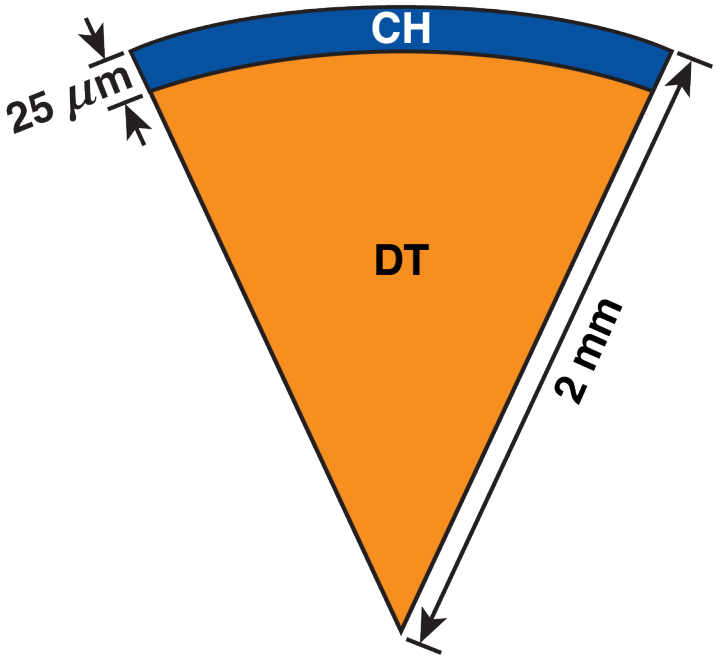
$\theta_{LEH} = 62.5°$

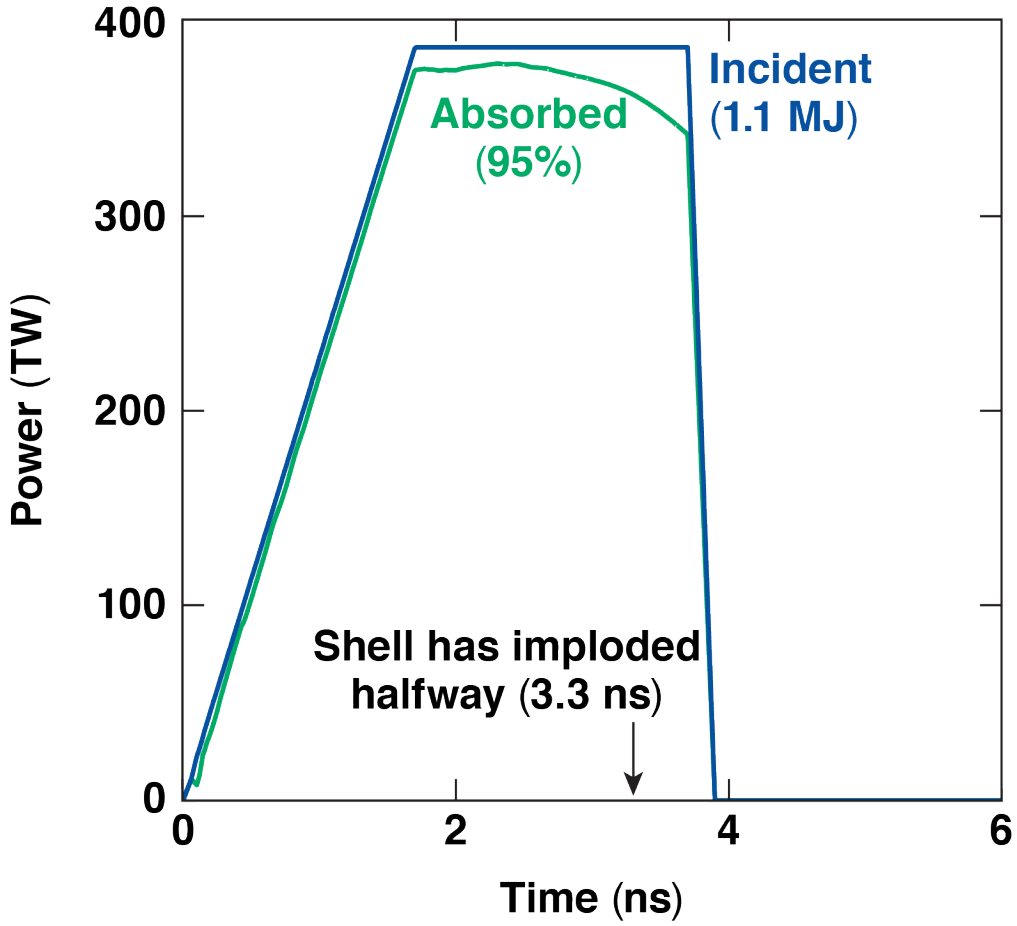
* VNIIEF—Russian Federal Nuclear Center

NIF shot N190227-001 (“Orange”) was chosen to compare the NIF and proposed octahedral geometries for direct drive

- The 1.1-MJ exploding pusher* produced 1.1 × 10^{16} neutrons

“Orange” target*

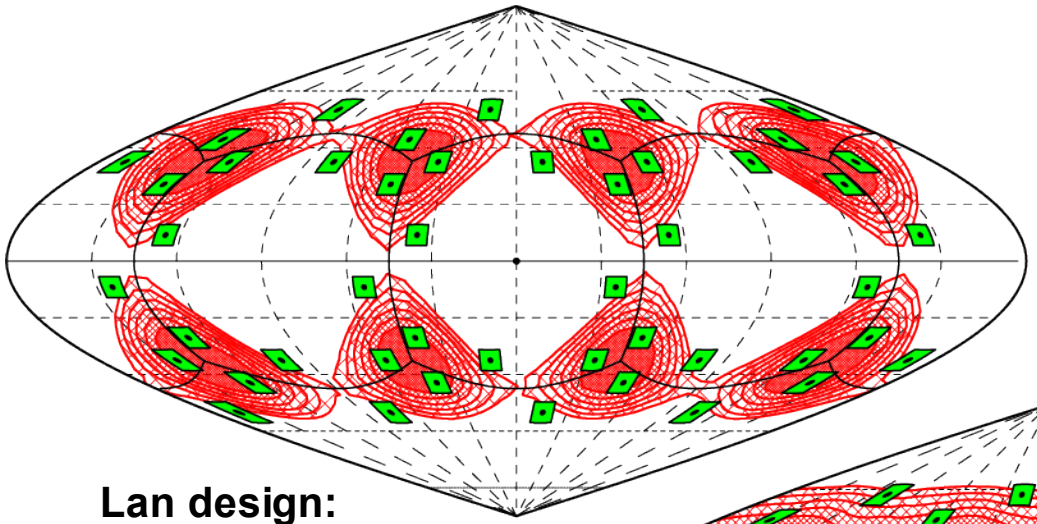




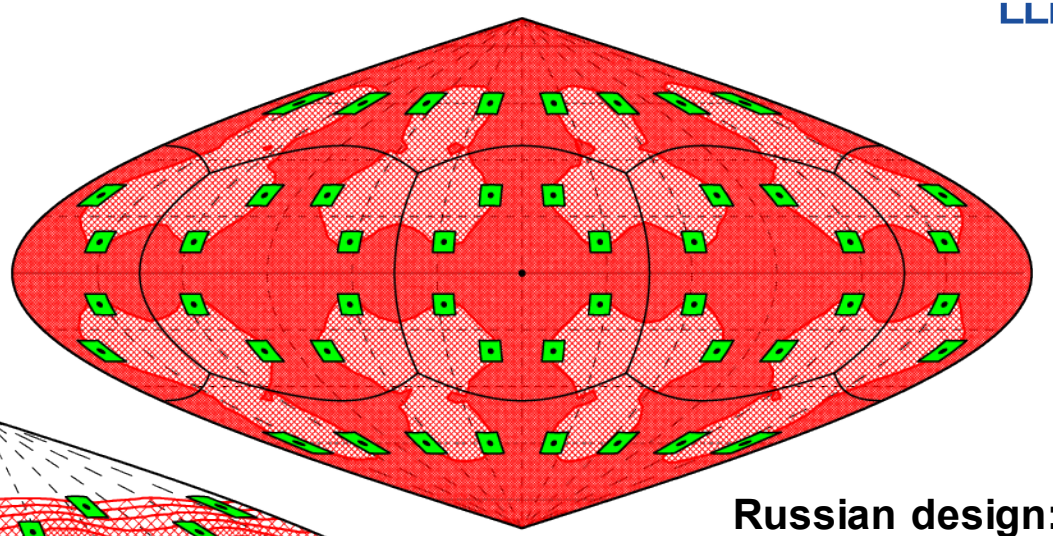
Run 6958
TC15489

*C. B. Yeamans *et al.*, Nucl. Fusion 61, 046031 (2021).

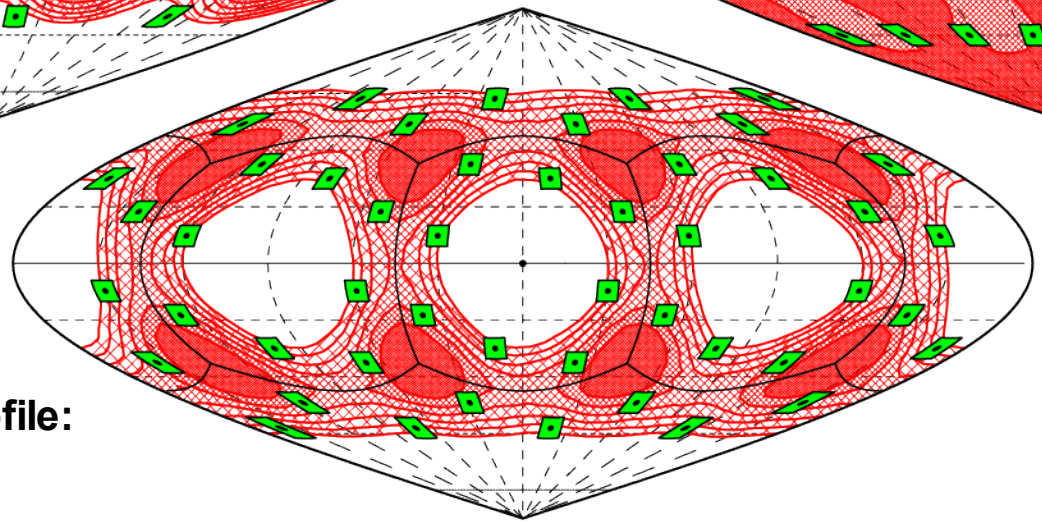
When all three geometries were compared with center pointing, the Russian system had the best uniformity of time-integrated deposited energy



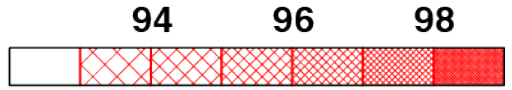
Lan design:
rms = 7.78%



Russian design:
rms = 0.60%



Proposed design:
rms = 4.33%

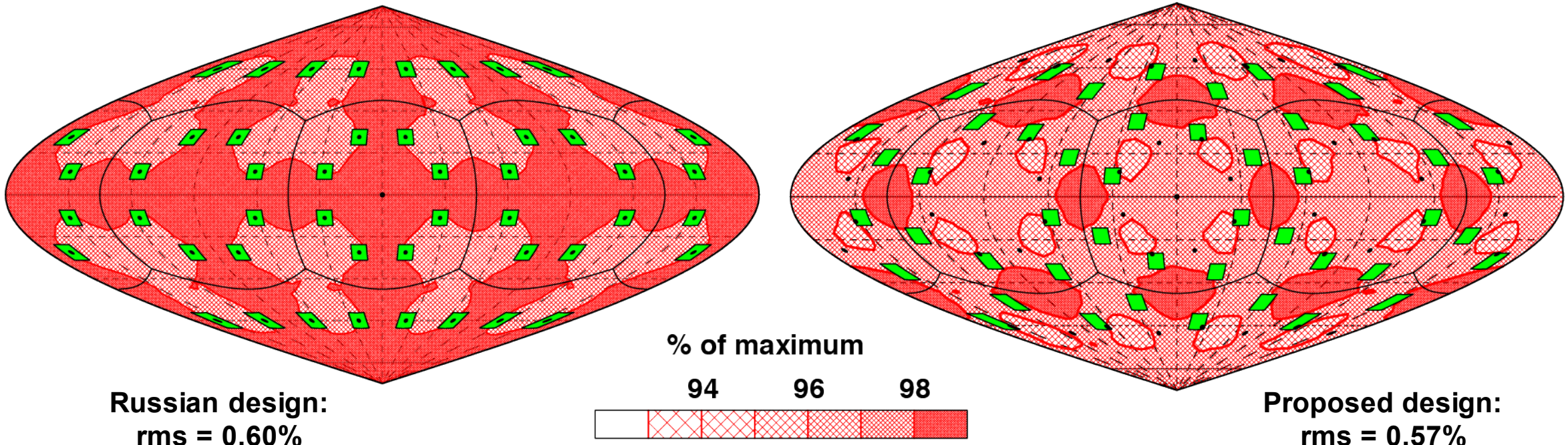


Super-Gaussian spatial profile:
r_0 = 1500 μm, n = 2.7
r_{tgt} = 2000 μm

TC15832

Runs 1342, 1343, 1341

When the beams were repointed toward the Russian system, equally good uniformity was obtained



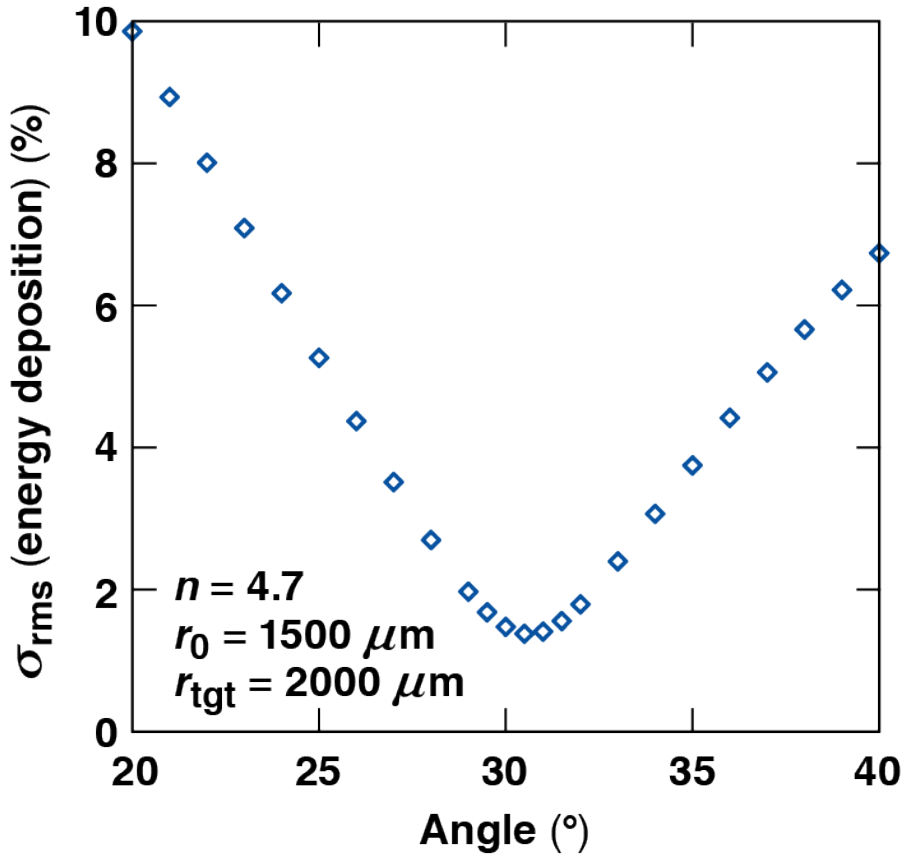
Russian design:
rms = 0.60%

Proposed design:
rms = 0.57%

TC15832a

Runs 1341, 1325

The Russian design was optimally chosen with an angle θ of 30°

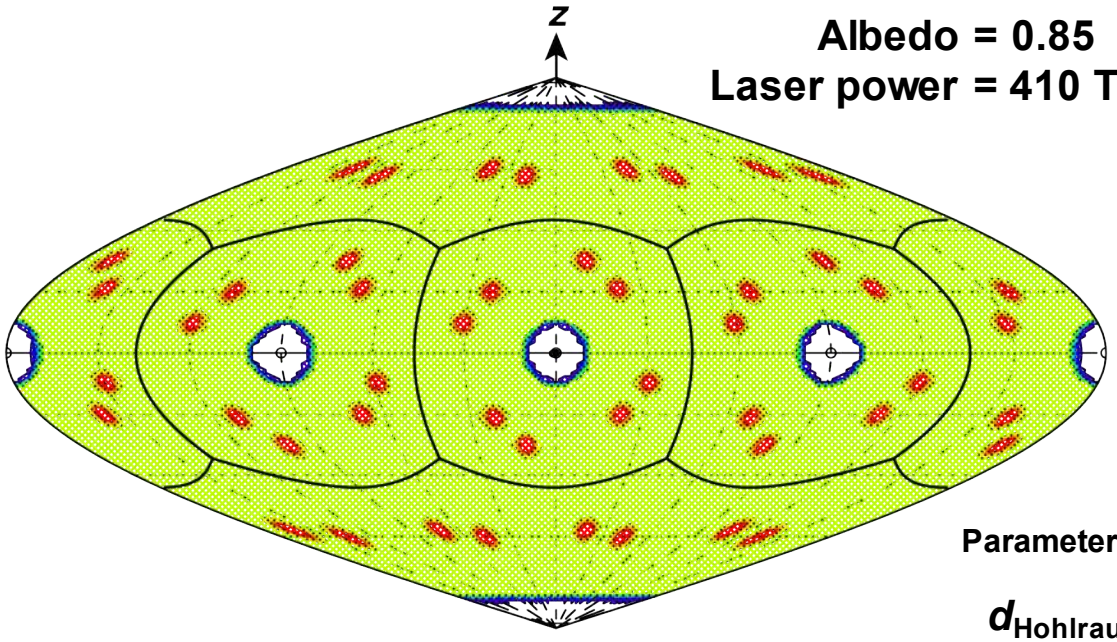


TC15833

Sub 66
Runs 7045–7068

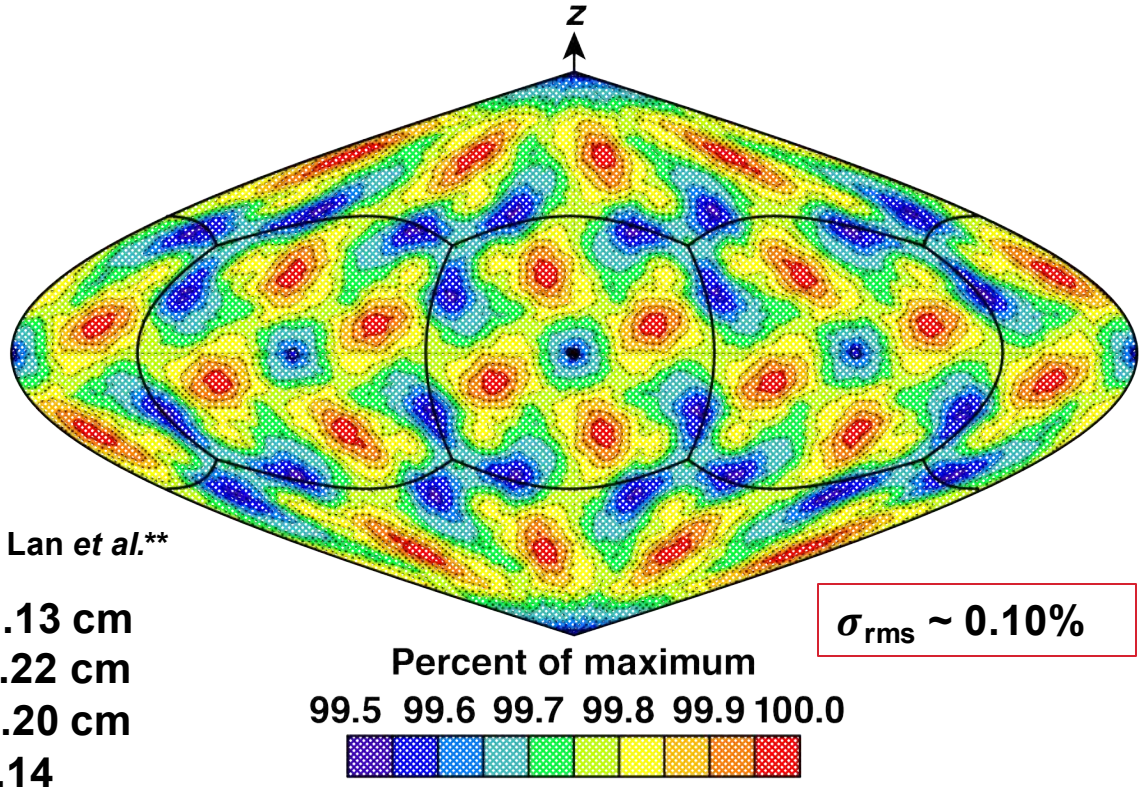
The view-factor code *LORE** obtains a capsule drive nonuniformity of only 0.1% for the proposed configuration

- Emission temperature on hohlraum wall
- Radiation flux on capsule



Parameters from Lan *et al.***

$d_{Hohlraum}$ = 1.13 cm
$d_{capsule}$ = 0.22 cm
d_{LEH} = 0.20 cm
CCR = 5.14

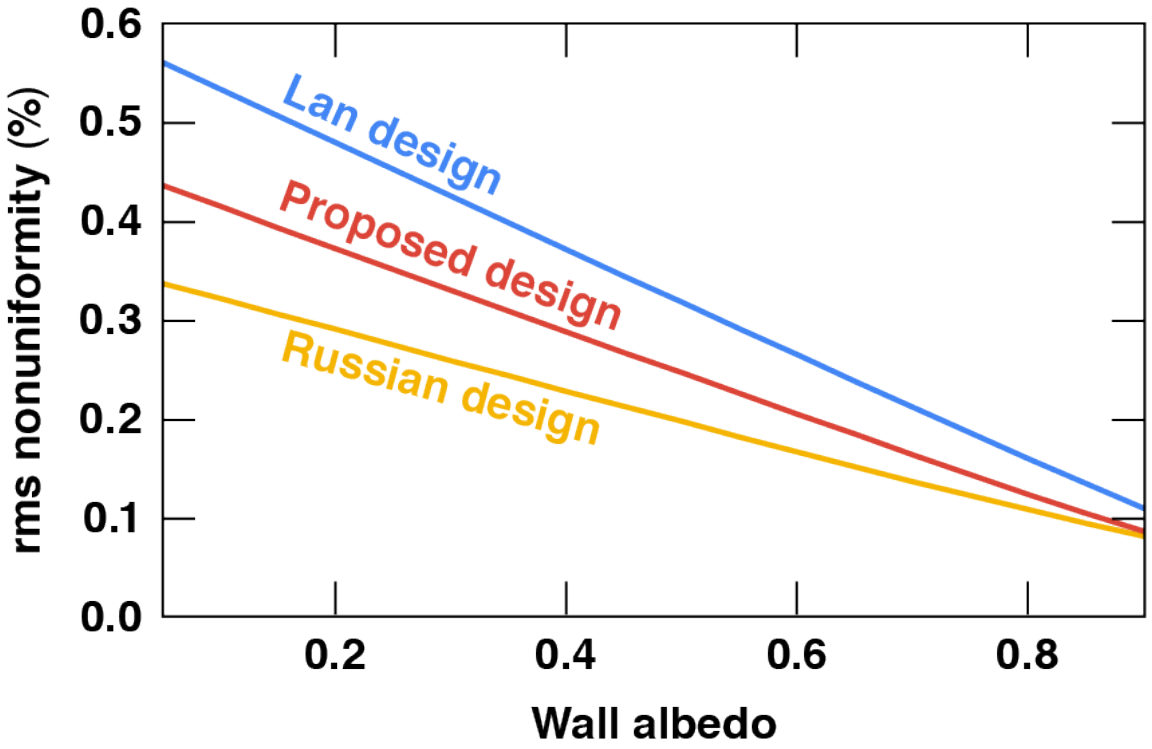


σ_{rms} ~ 0.10%

TC15484a

CCR: case-to-capsule ratio
* W. Y. Wang and R. S. Craxton, Phys. Plasmas 28, 062703 (2021).
** K. Lan *et al.*, Phys. Plasmas 21, 010704 (2014).

All three designs perform comparably well for all albedos



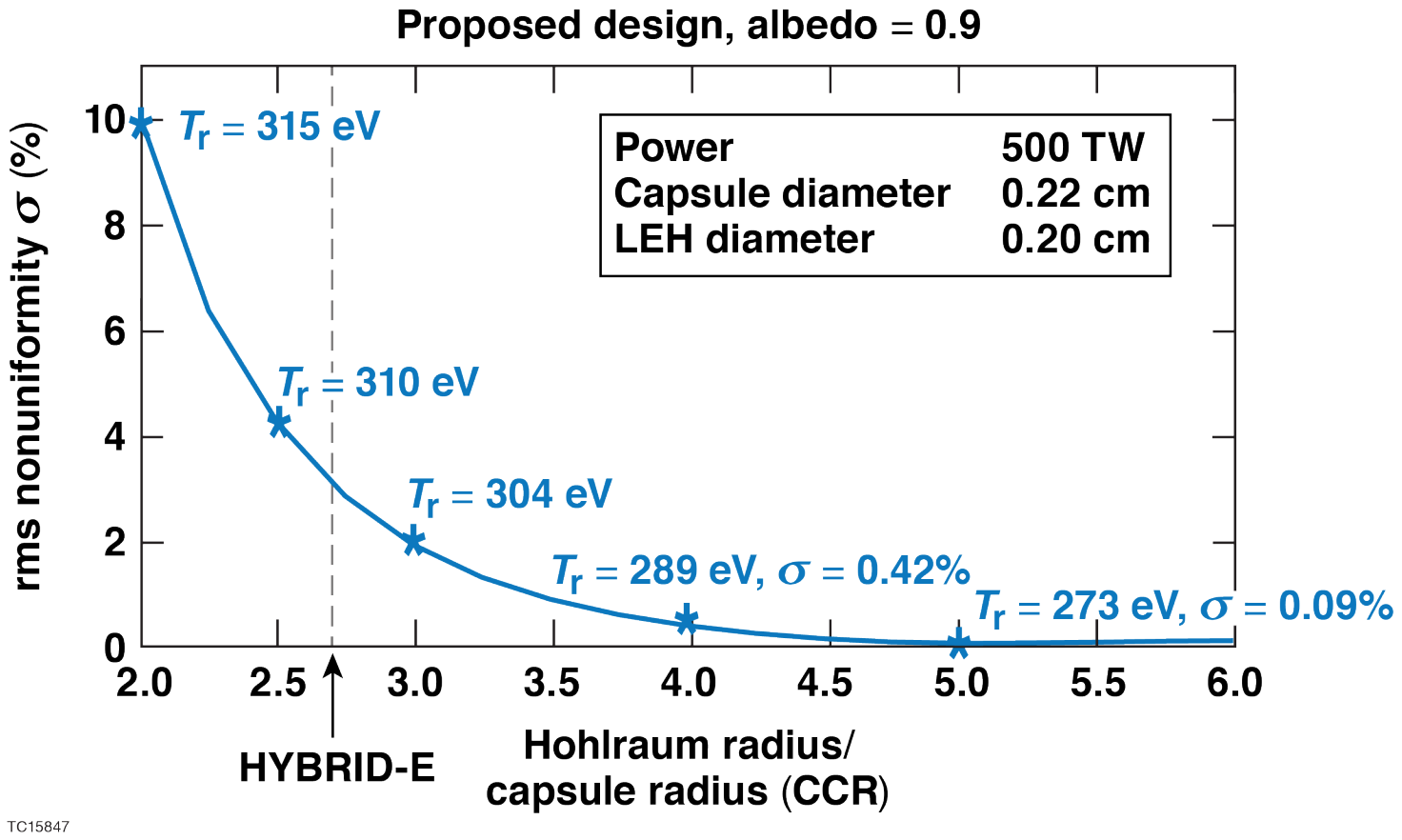
TC15834

Parameters from Lan *et al.

- **Hohlraum diameter** **1.13 cm**
- **Capsule diameter** **0.22 cm**
- **LEH diameter** **0.20 cm**
- **Case-to-capsule ratio (CCR)** **5.14**

*K. Lan *et al.*, Phys. Plasmas 21, 010704 (2014).

The case-to-capsule ratio (CCR) can be varied to trade off radiation temperature (T_r) against uniformity



Summary/Conclusions

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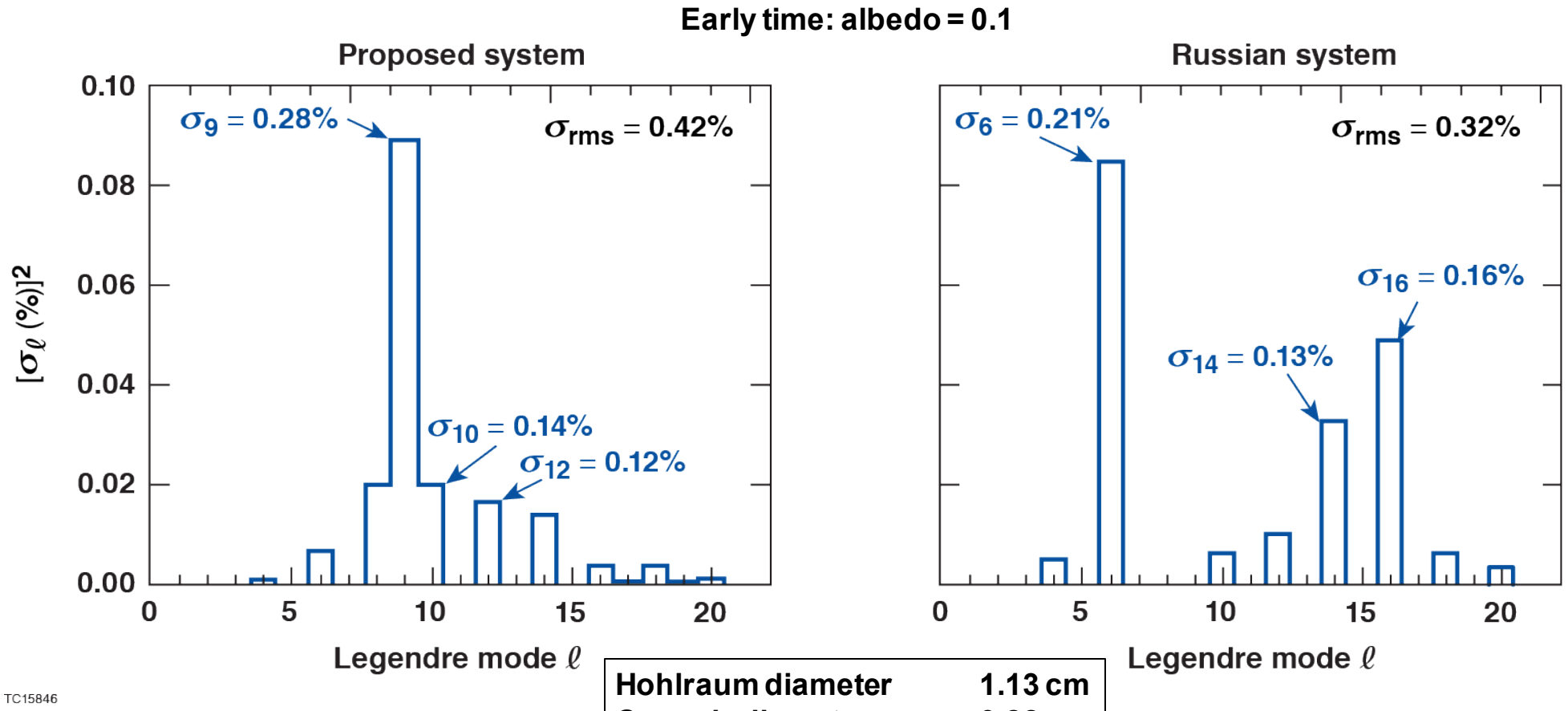
**S. A. Bel'kov *et al.*, J. Exp. Theor. Phys. 121, 686 (2015).

Mode $\ell = 9$ dominates for the proposed system but all odd modes vanish for the Russian system



Hohlraum diameter	1.13 cm
Capsule diameter	0.22 cm
LEH diameter	0.20 cm
Case-to-capsule ratio	5.14