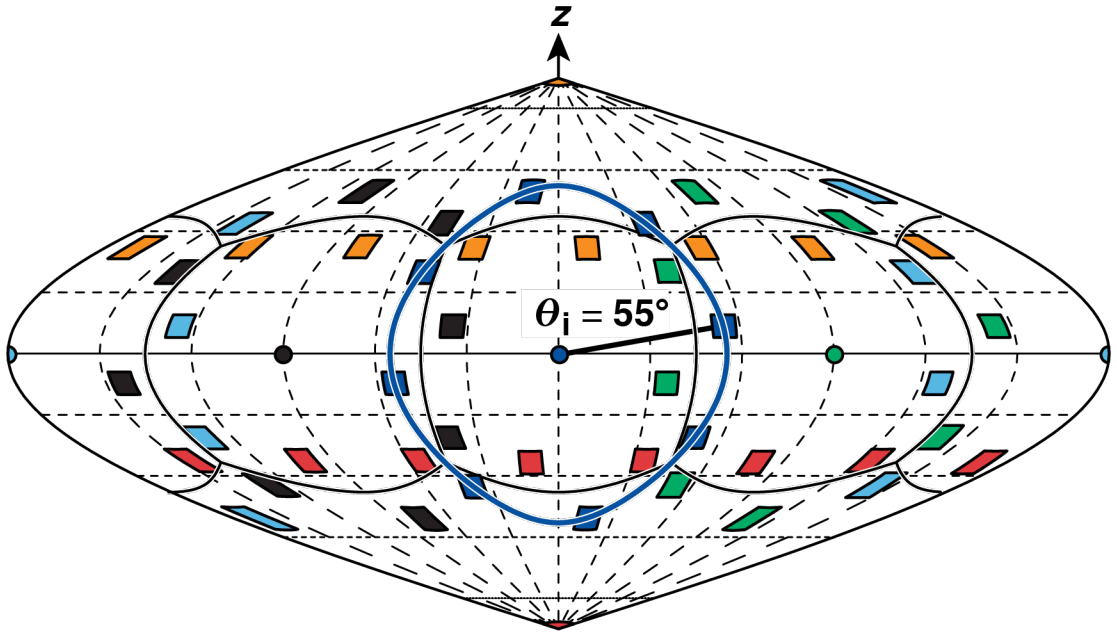
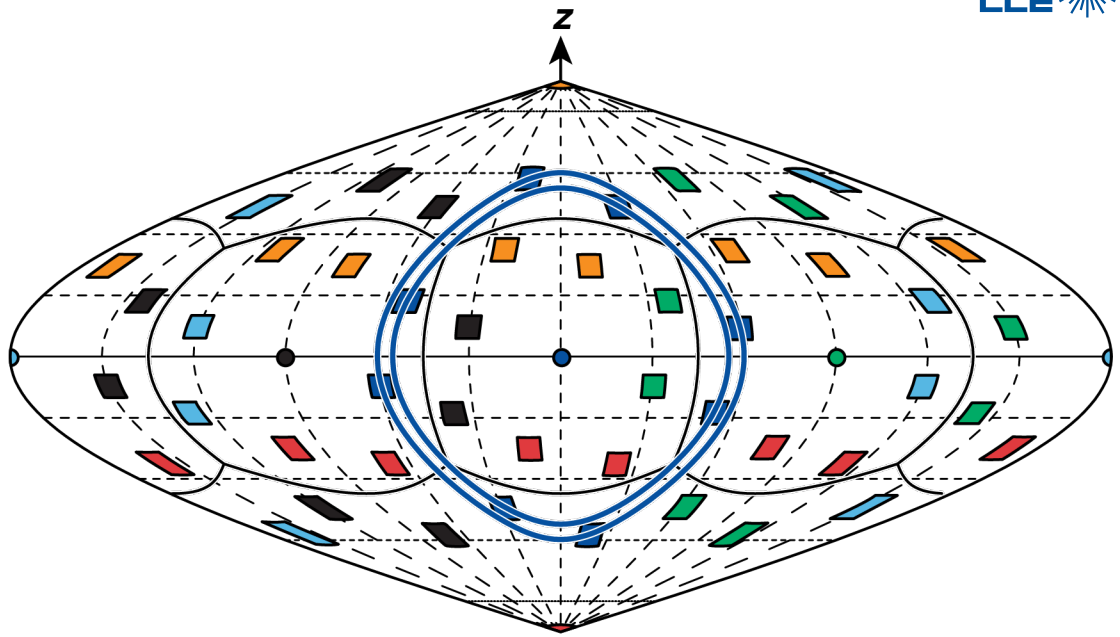
A New Beam Configuration to Support Both Spherical Hohlraums and Symmetric Direct Drive



Baseline: Designed for 6-LEH spherical hohlraum



Proposed: Also accommodates spherical direct drive

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Division of Plasma Physics
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Summary

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

- This is demonstrated for a minor modification to the Lan design* for octahedral hohlraums
- The uniformity for both direct drive and indirect drive is better than 1%
- The repointing needed for direct drive requires angle shifts of <10°, compared with close to 40° on the National Ignition Facility (NIF); this avoids problems currently experienced with polar drive

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

Collaborators

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University of Rochester
Laboratory for Laser Energetics
***also LLE Summer High School Research Program**

Outline

- Proposed port modifications to the Lan design
- Indirect-drive uniformity
  - use *LORE* viewfactor code
- Direct-drive uniformity
  - use *SAGE* hydrodynamics code

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

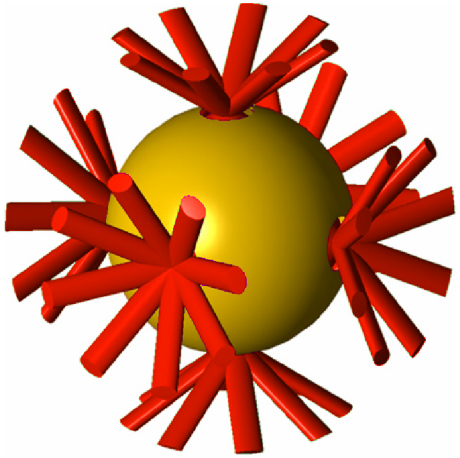
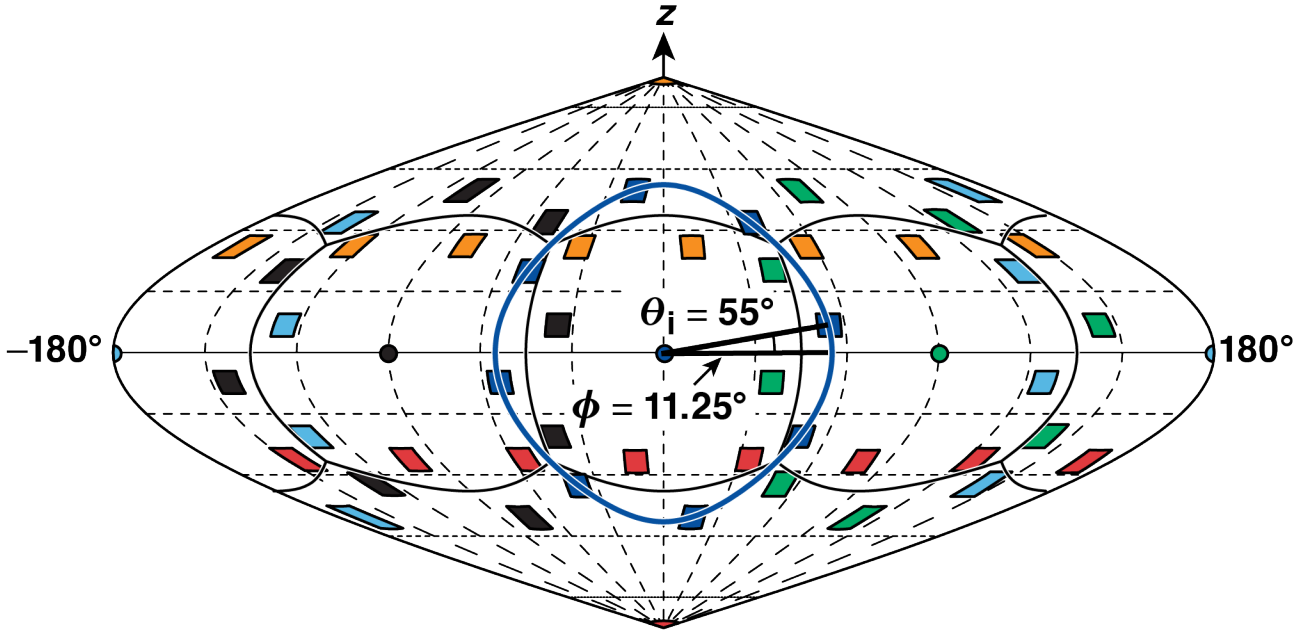


Figure from Jing**

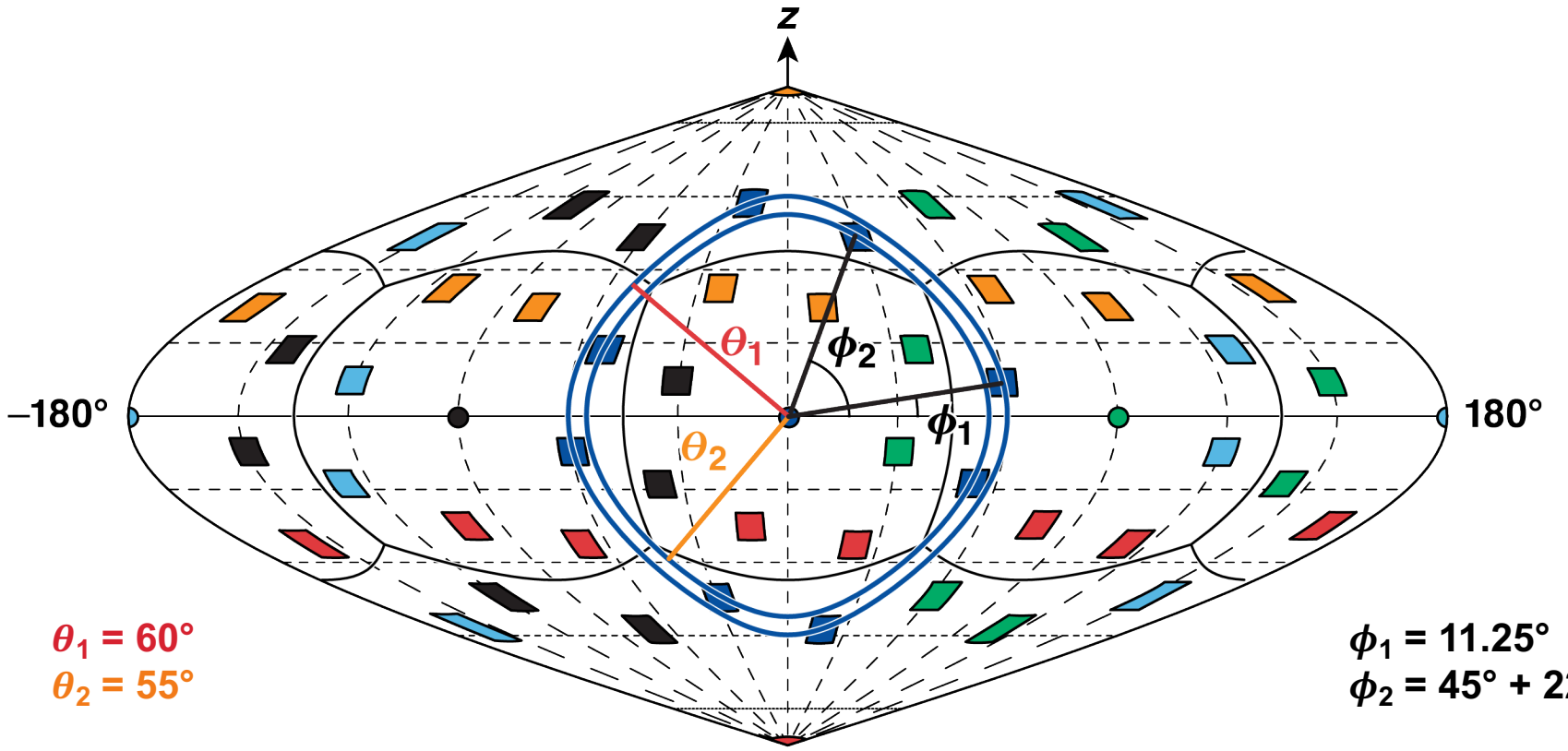
TC15481



- All beams enter the laser entrance holes (LEH's) at 55°
- Port map is based on NIF quad size (100 cm) and target chamber diameter (5 m)
- ϕ = 11.25° allows for in-tank beam dumps

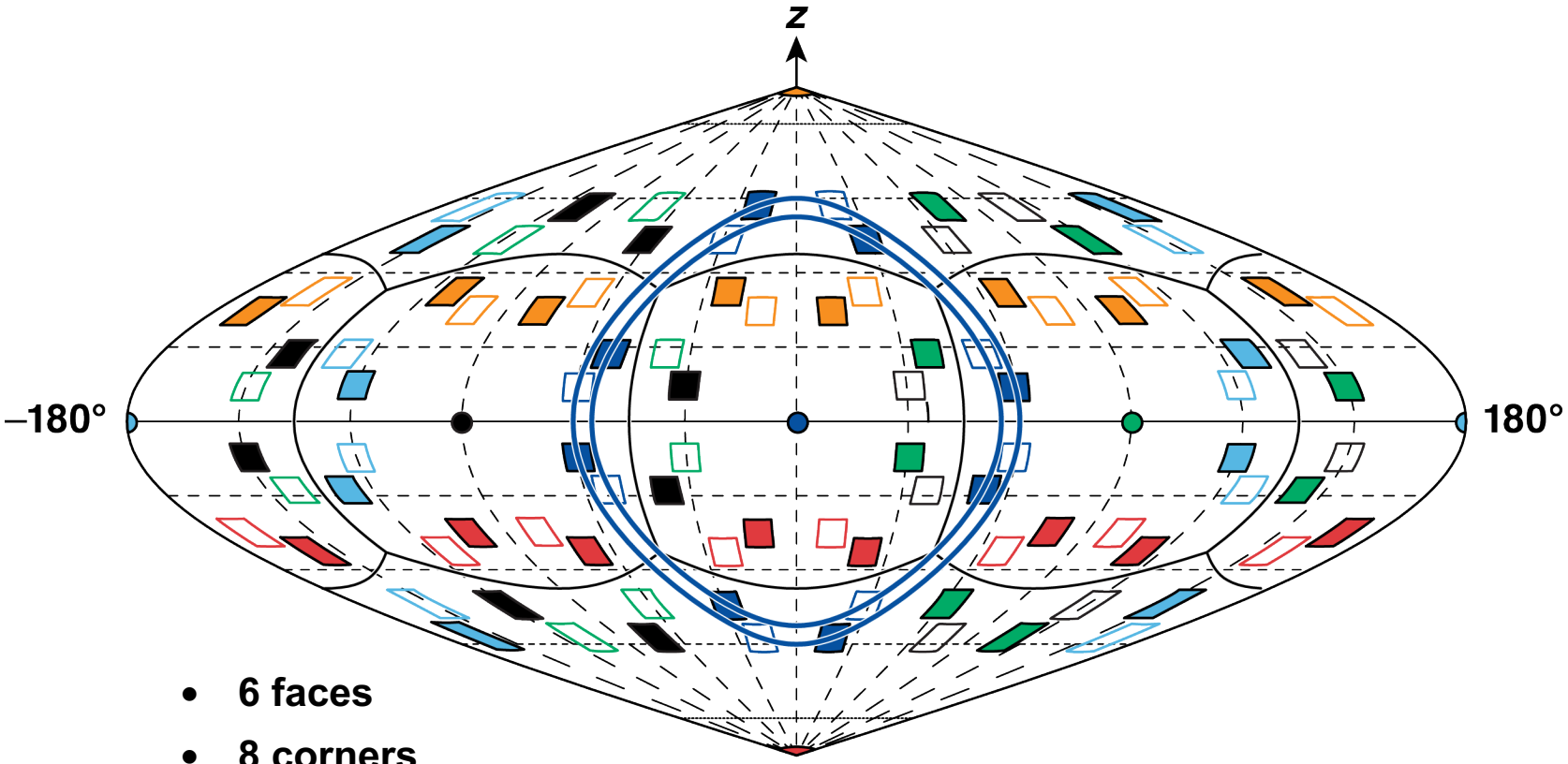
* K. Lan *et al.*, Phys. Plasmas 21, 010704 (2014).
** L. Jing *et al.*, Nucl. Fusion 57, 046020 (2017).

The proposed design has half the beams entering the LEH's at 60°



- The beams are better spread out for direct drive
- Nonuniform spacing of the eight quads in ϕ avoids crowding near the corners of the cube

The port design allows space for in-tank beam dumps and good diagnostic access

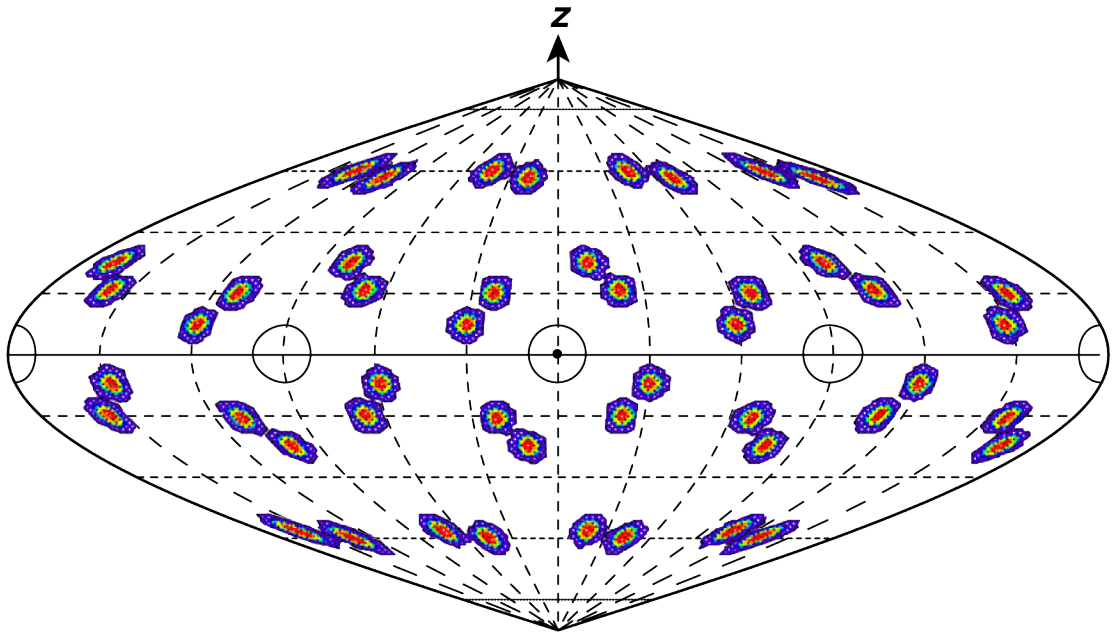


TC15483

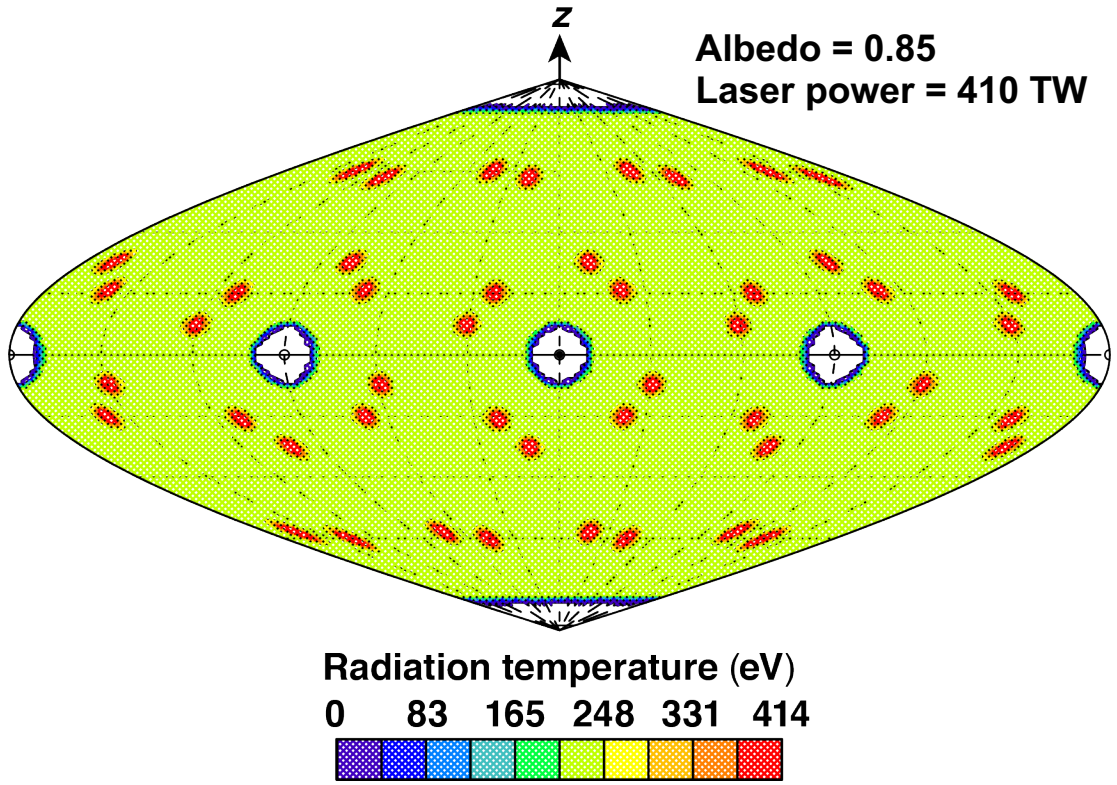
- 6 faces
- 8 corners
- 12 edges

The new view-factor code *LORE* models the octahedral hohlraum in three steps

1. **Calculate the deposited energy**



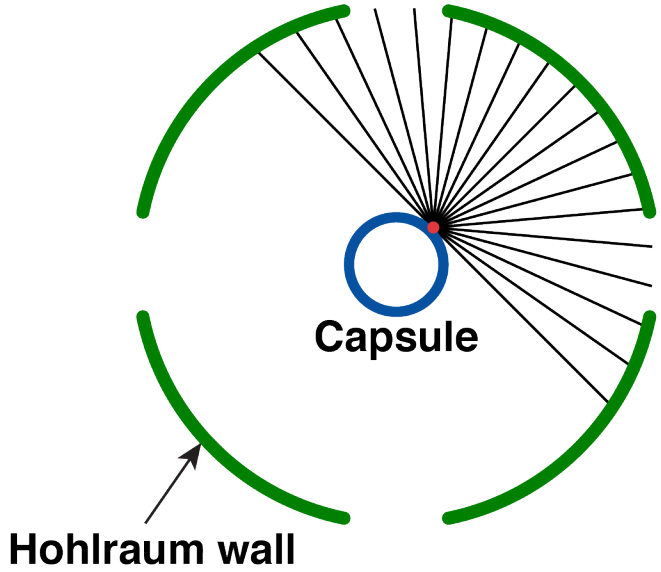
2. **Calculate the effective radiation temperature T_e**



TC15484

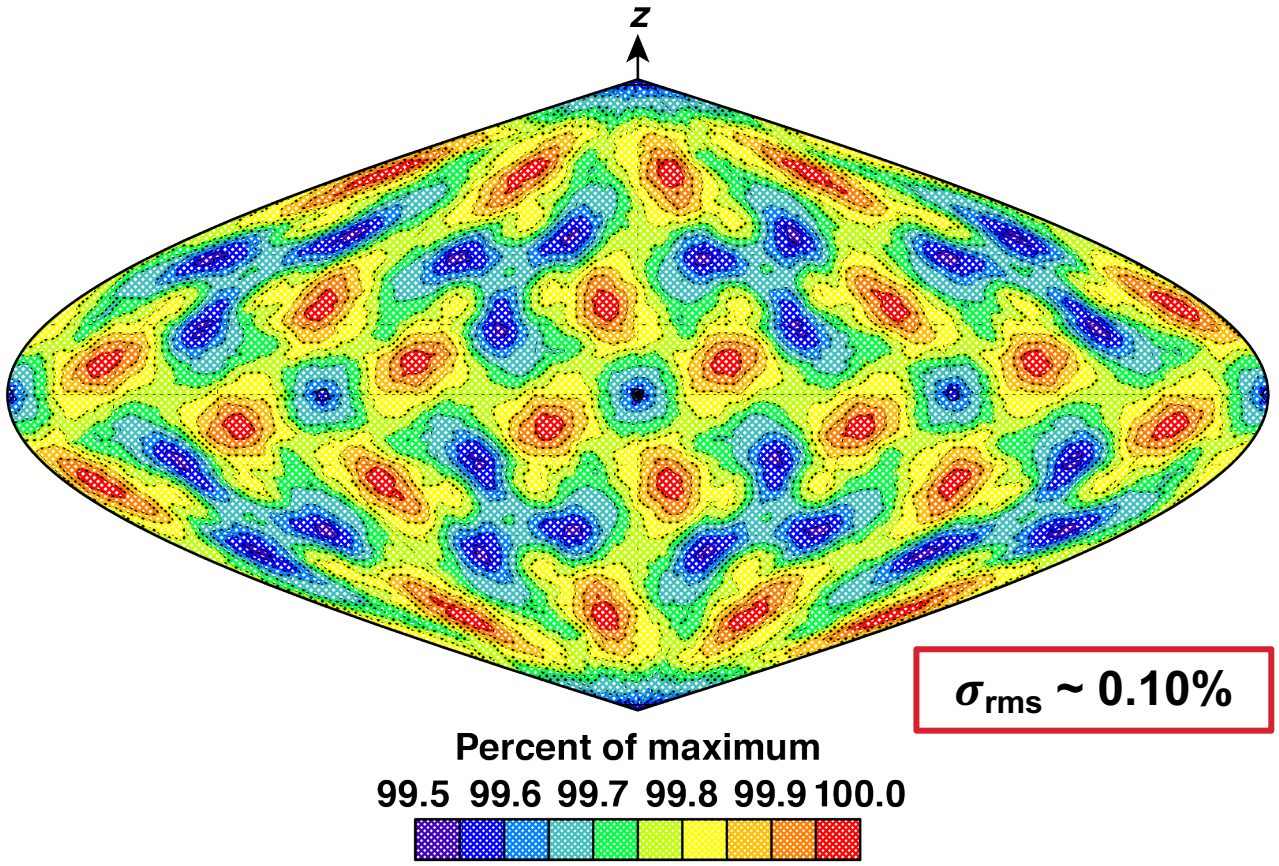
- **Obtain a global radiation temperature T_R (~244 eV)**

In Step 3, *LORE* integrates over all directions to calculate the x-ray flux at each point on the capsule



- 60,000 points
- 100,000 directions

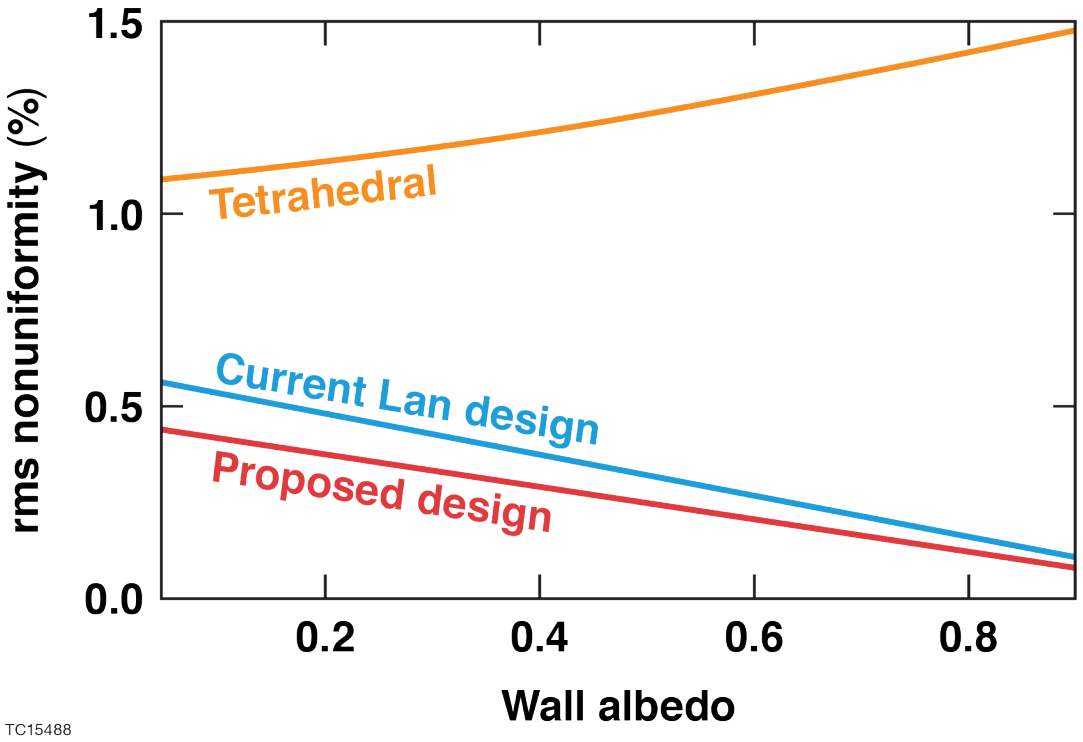
- X-ray flux on capsule (for albedo = 0.85)



σ_{rms} ~ 0.10%

TC15486

The uniformity is better than 0.5% rms for all albedos



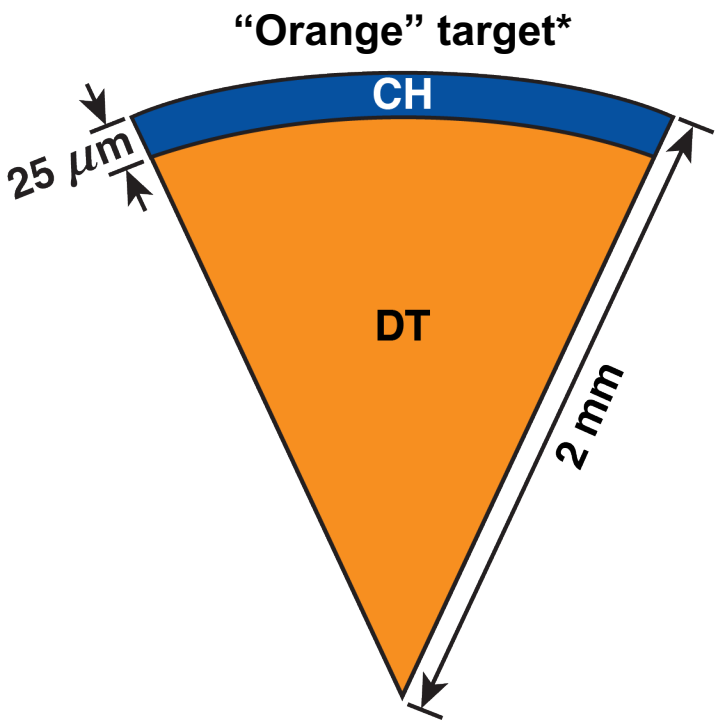
Parameters from Lan *et al.

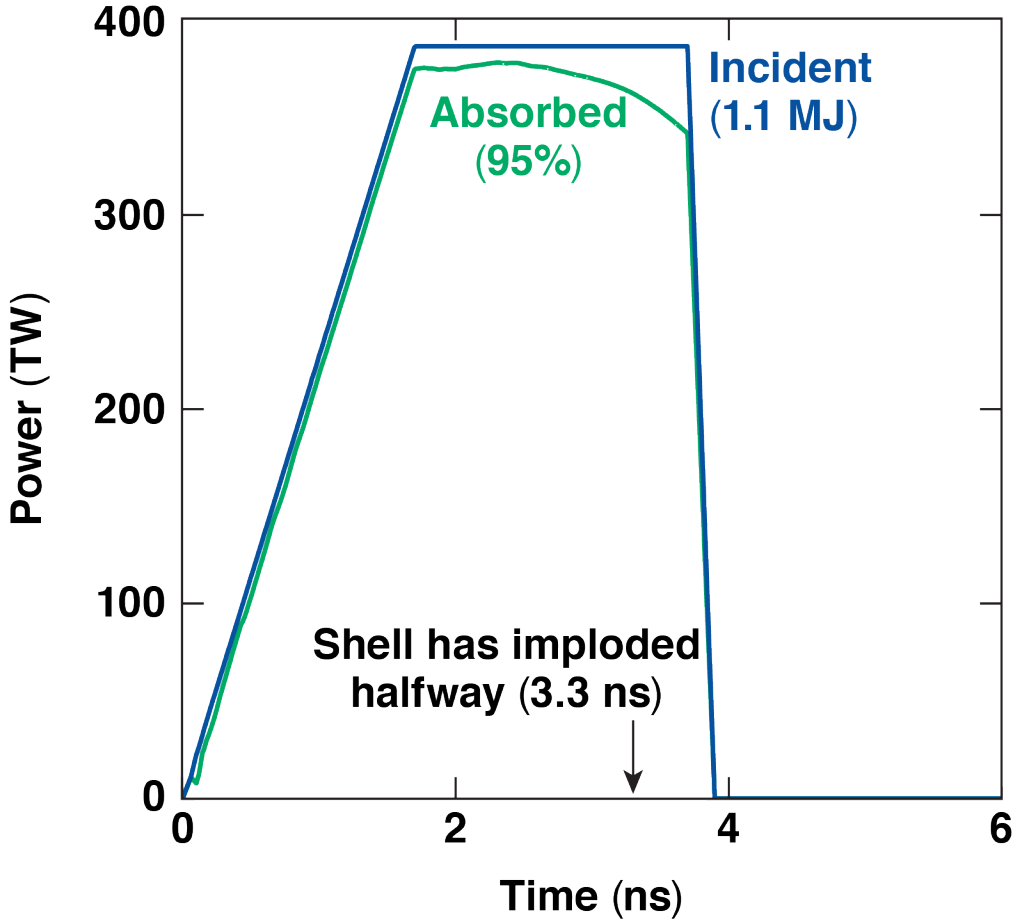
- **Hohlraum diameter 1.13 cm**
- **Capsule diameter 0.22 cm**
- **LEH diameter 0.20 cm**
- **Case-to-capsule ratio 5.14**

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

NIF shot N190227-001 was chosen to compare the NIF and proposed octahedral geometries for direct drive

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

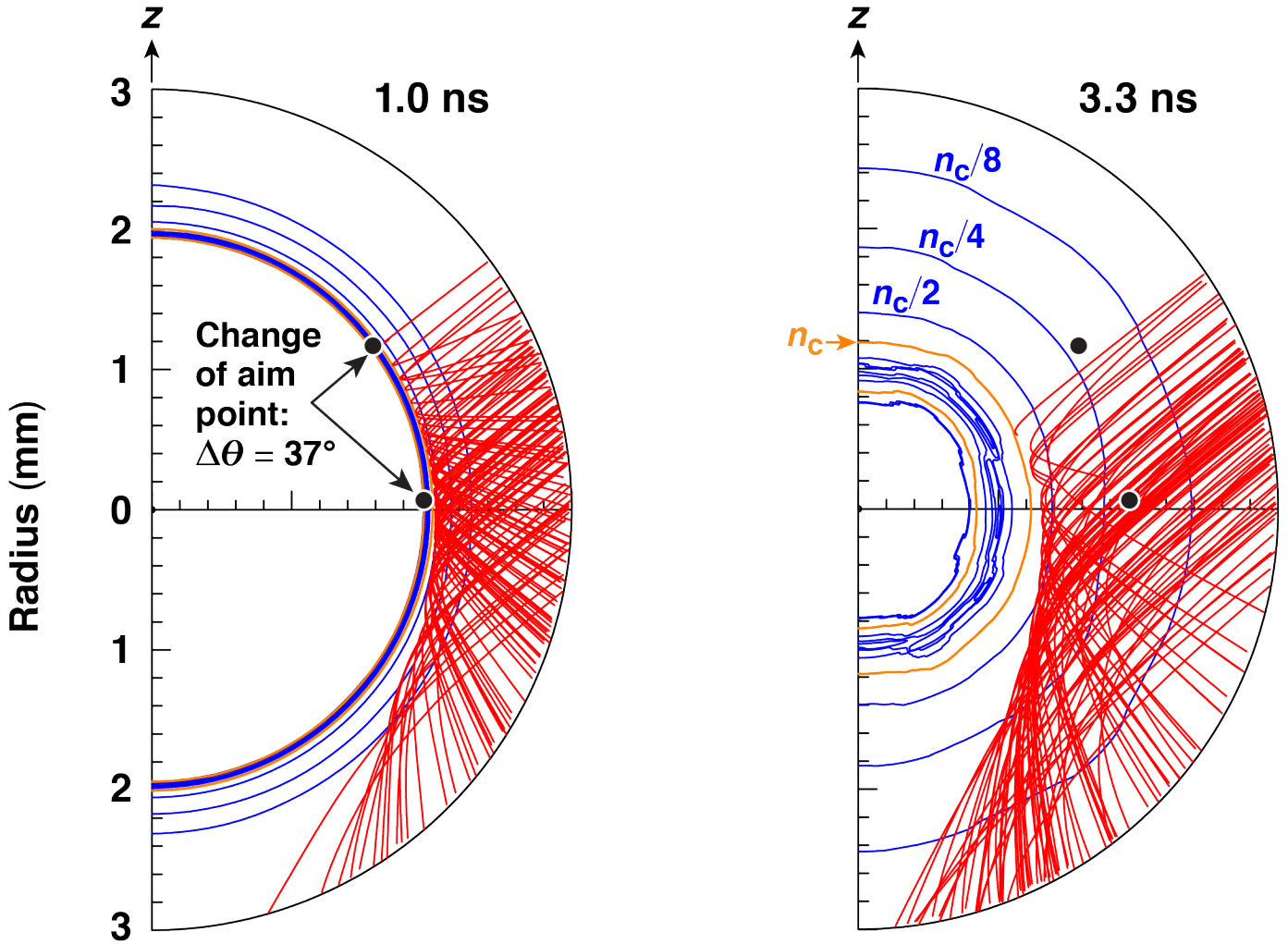




Run 6958
TC15489

* C. B. Yeamans *et al.*, "High Yield Polar Direct Drive Fusion Neutron Sources at the National Ignition Facility," submitted to Nuclear Fusion.

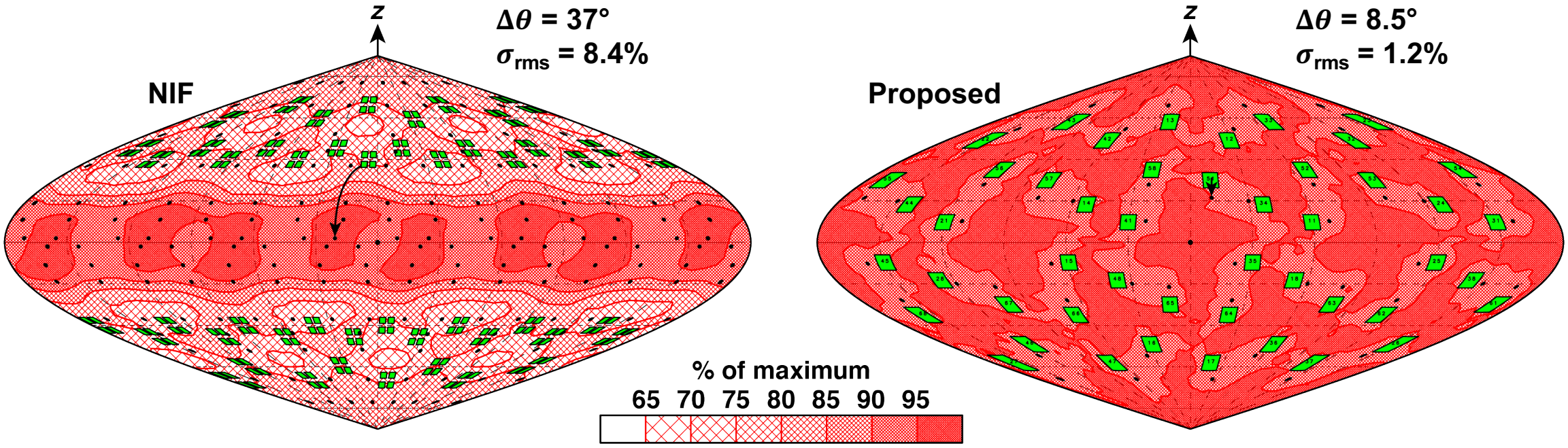
The NIF polar-drive geometry exhibits significant issues as the target implodes



Run 6958
TC15490

The deposited energy on the NIF needs to be strongly enhanced on the equator to provide adequate drive in this region

- Time-integrated deposited energy up to 3.3 ns

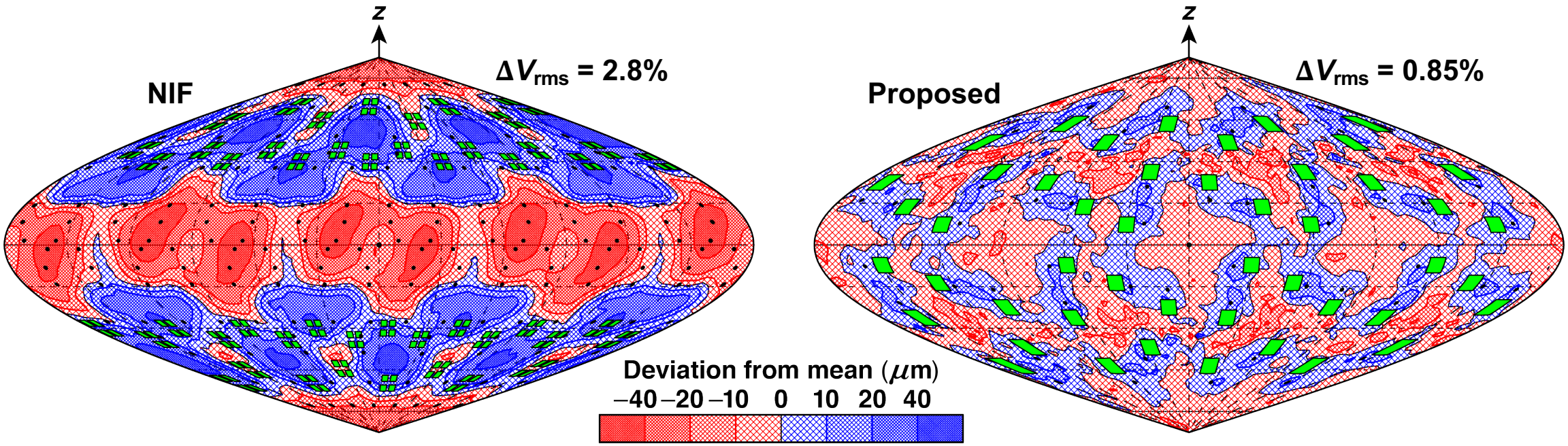


Runs 6958, D1118
TC15491

- All beams have equal energies

Variations in average center-of-mass velocity are below 1% for the proposed configuration

- Deviations from mean of the center of mass radius at 3.3 ns



- Uniformity is expected to improve with
  - optimization of parameters
  - use of 192 beams

Runs 6958, D1118
TC15492

Summary/Conclusions

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

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- The uniformity for both direct drive and indirect drive is better than 1%
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Further direct-drive uniformity improvements can be expected.