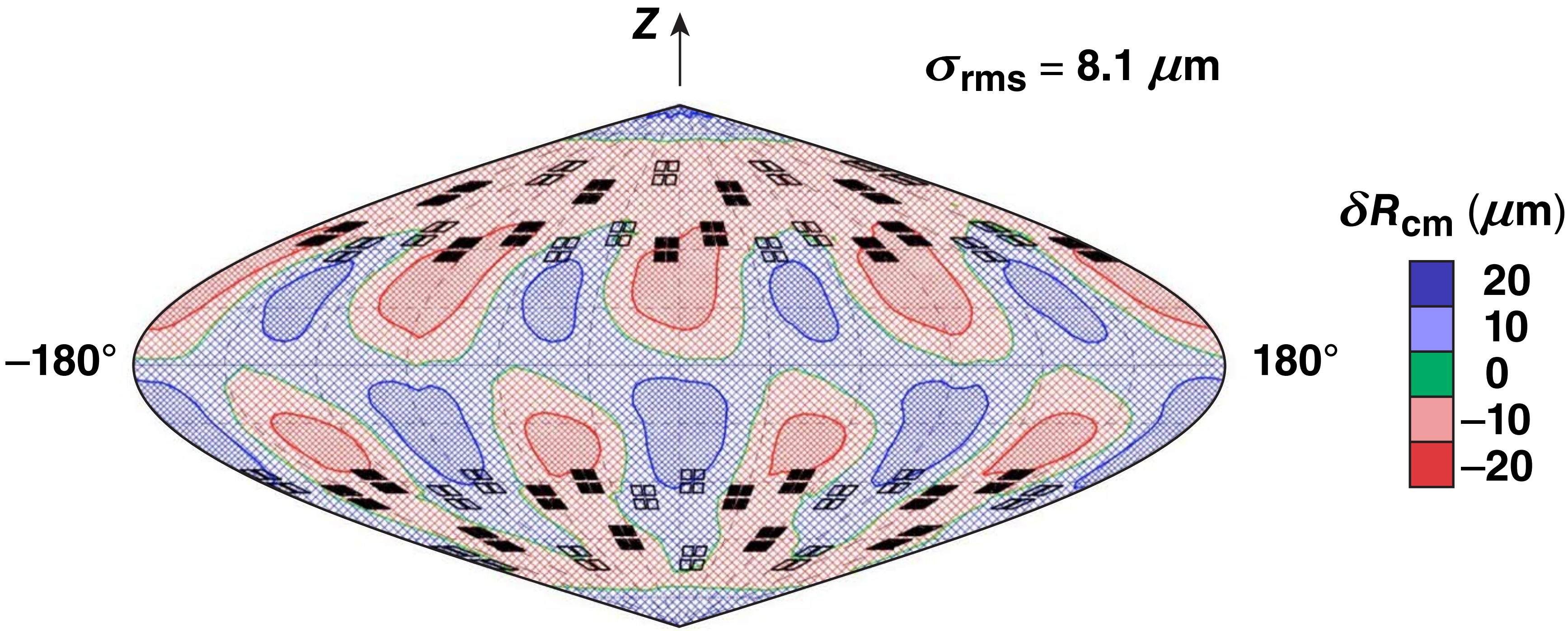
Three-Dimensional Design of a 96-Beam NIF Target to Test the Compression Phase of Shock Ignition



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ICF Shock Ignition
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Summary

A polar-drive design has been developed for the compression phase of a NIF shock-ignition target

- A surrogate CH target will be imploded with 24 quads in the proposed initial experiment
- The polar-drive design includes horizontal beam shifts to optimize the uniformity in 3-D
- The imploded shell radius is uniform to 8-μm rms (averaged over the sphere) when the target has moved 400 μm
- Framed x-ray backlighting is proposed to diagnose the implosion uniformity

Collaborators

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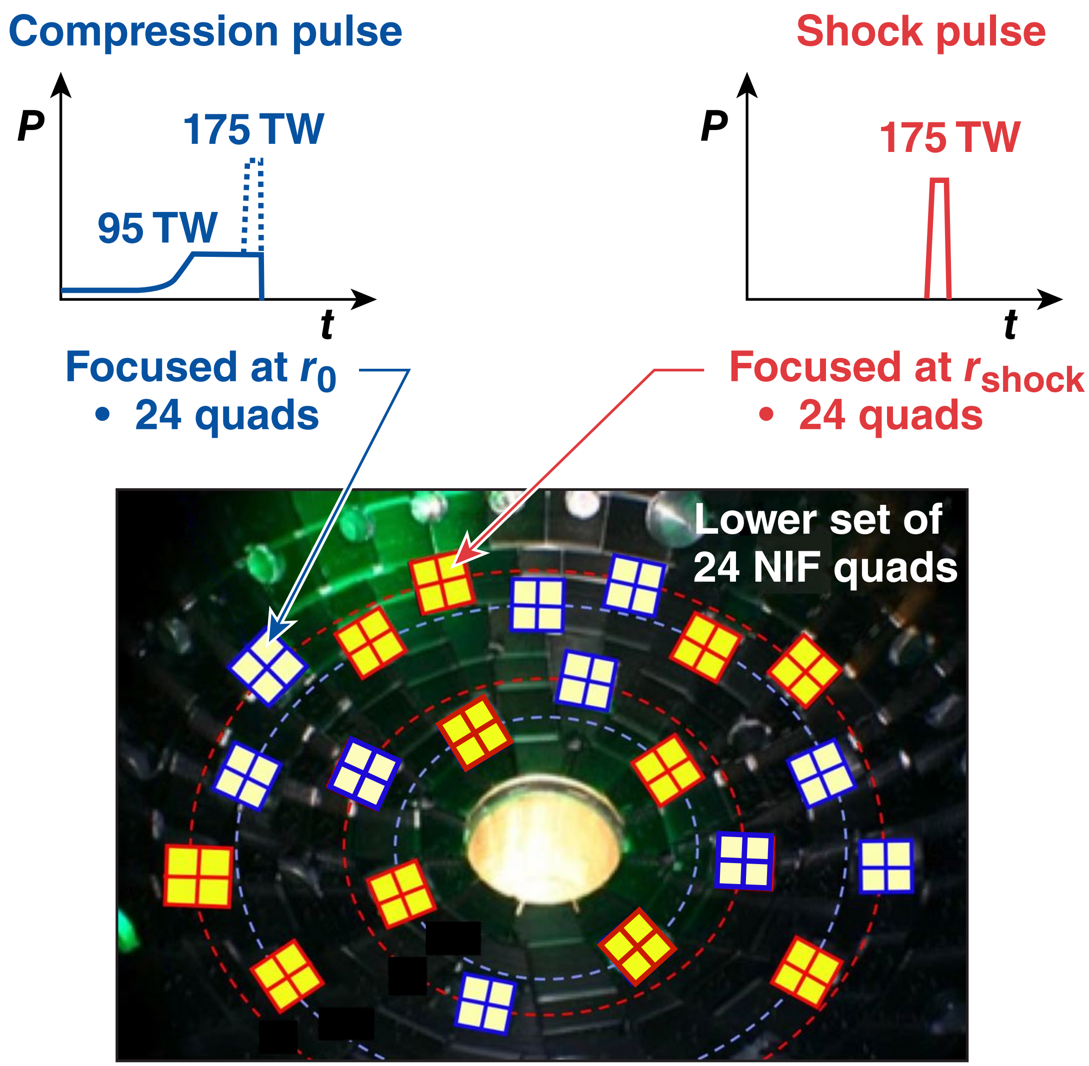
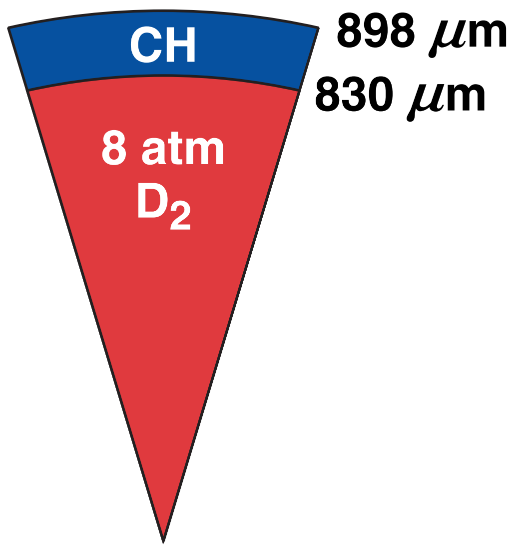
CELIA

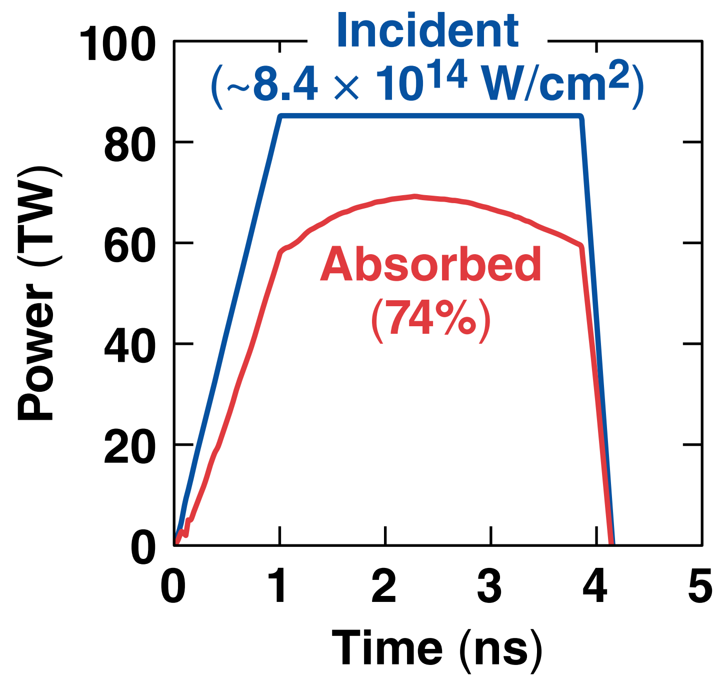
Two independent pulse shapes are used with separate parameters for Polar-Drive Shock Ignition



TC8792a

A surrogate CH target is proposed to test the 24-quad compression phase



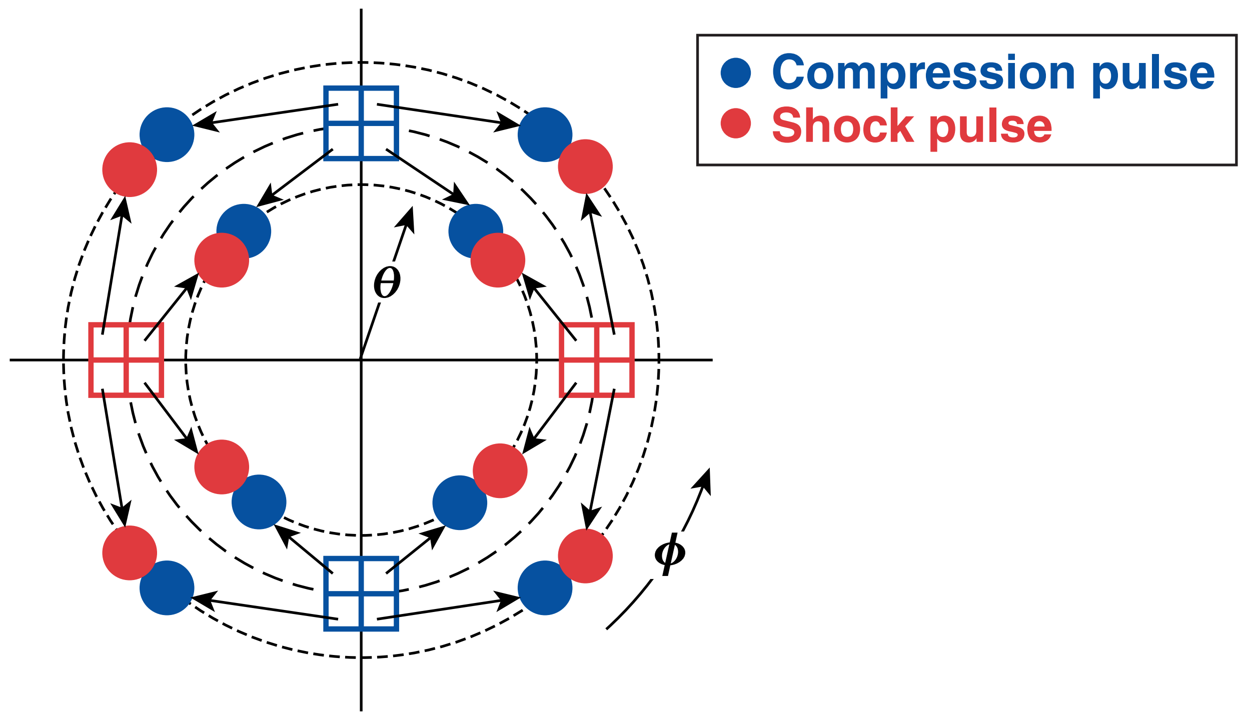


- Objectives of the initial experiment
  - diagnose the implosion uniformity
  - measure the speed of the imploding shell
  - diagnose any hot electrons from the two-plasmon instability

Run 1266
TC9030

The use of alternating quads in a ring with horizontal (ϕ) as well as the usual vertical (θ) repointings can improve the irradiation uniformity

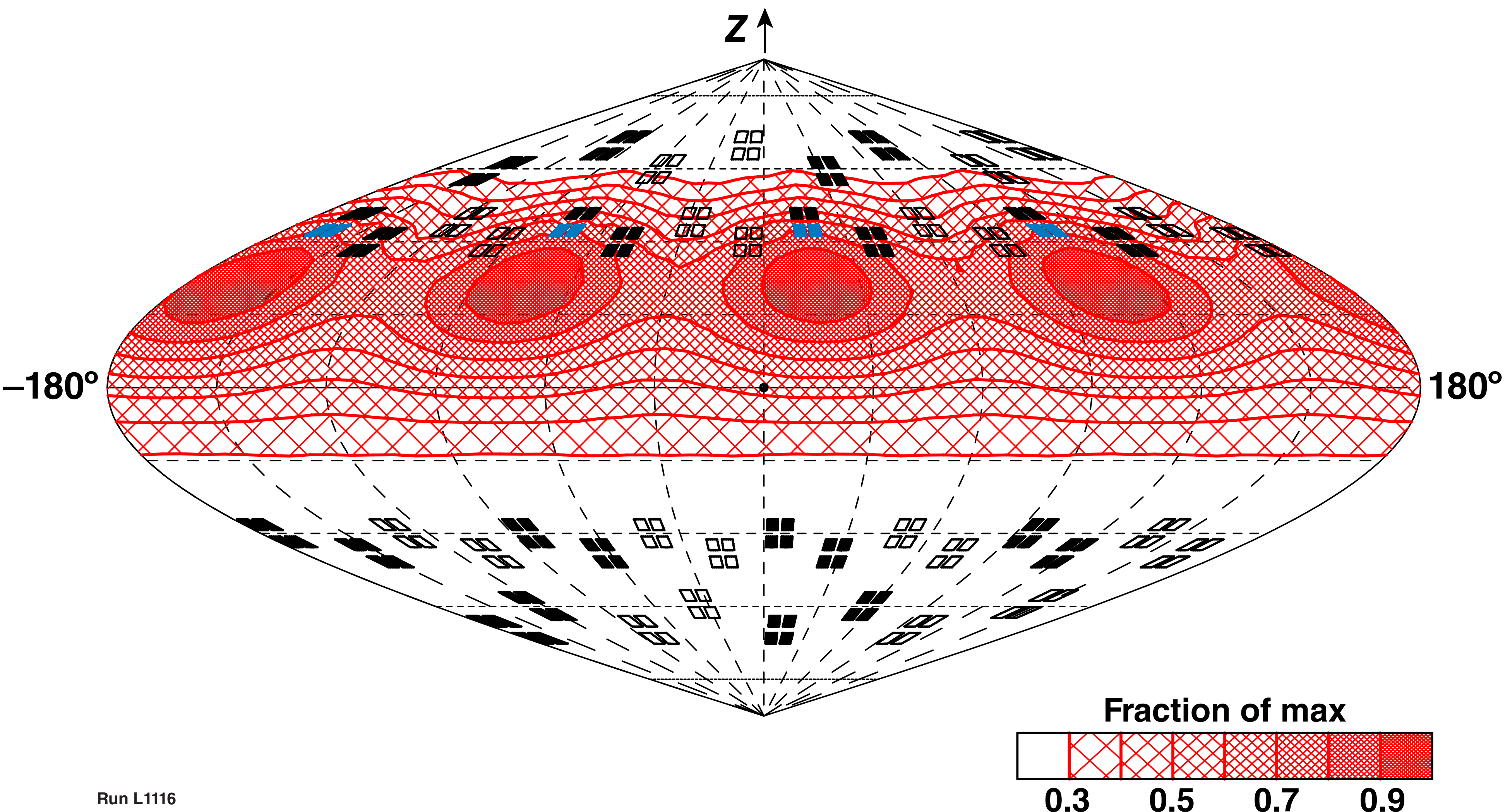
View from top



- This does not work well for the 23.5° and 30° rings
- This works for the 44.5° and 50° rings

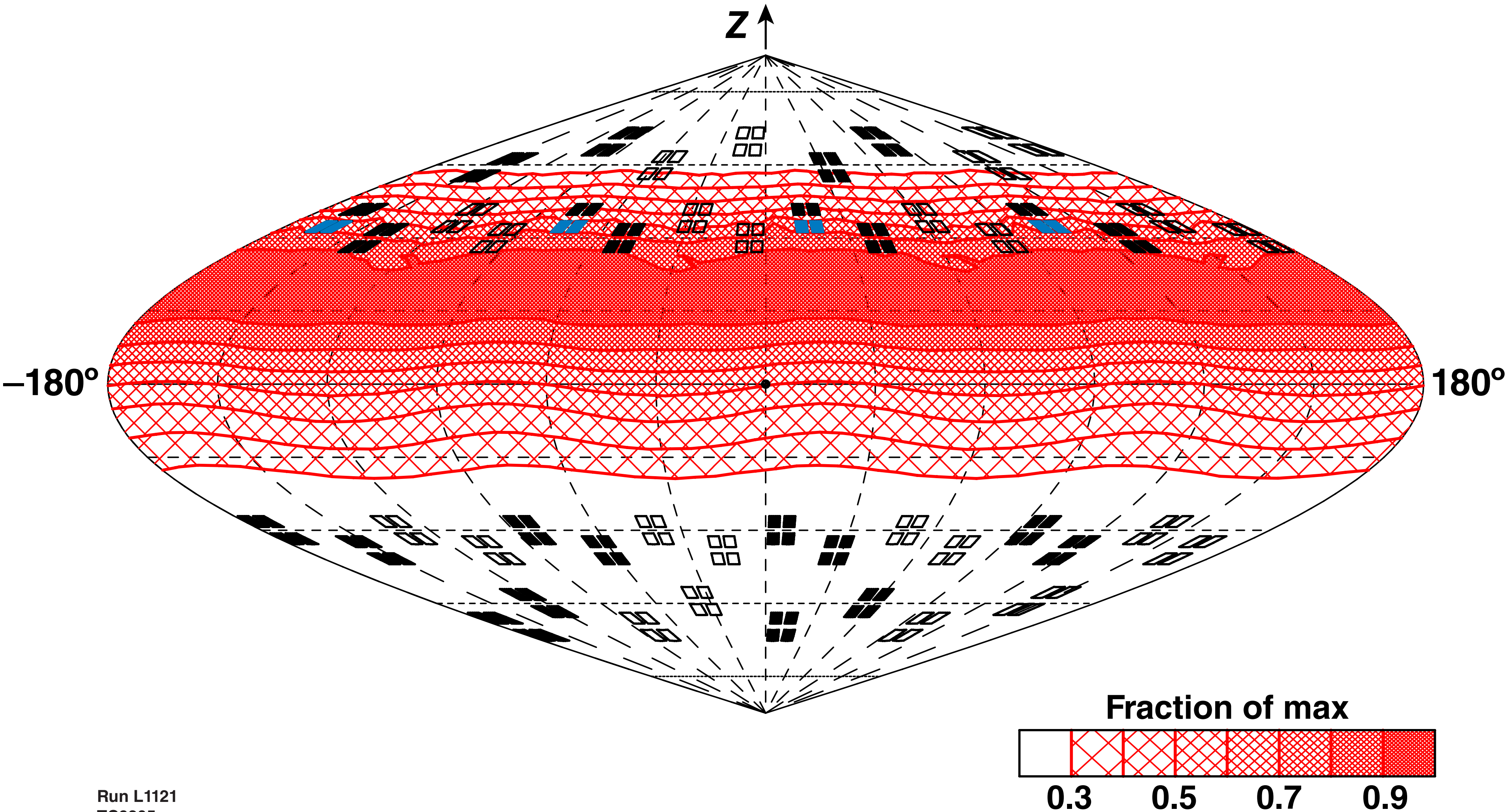
TC9031

For a small horizontal shift (210 μm), the deposition pattern of Ring 3B matches the beam pattern azimuthally



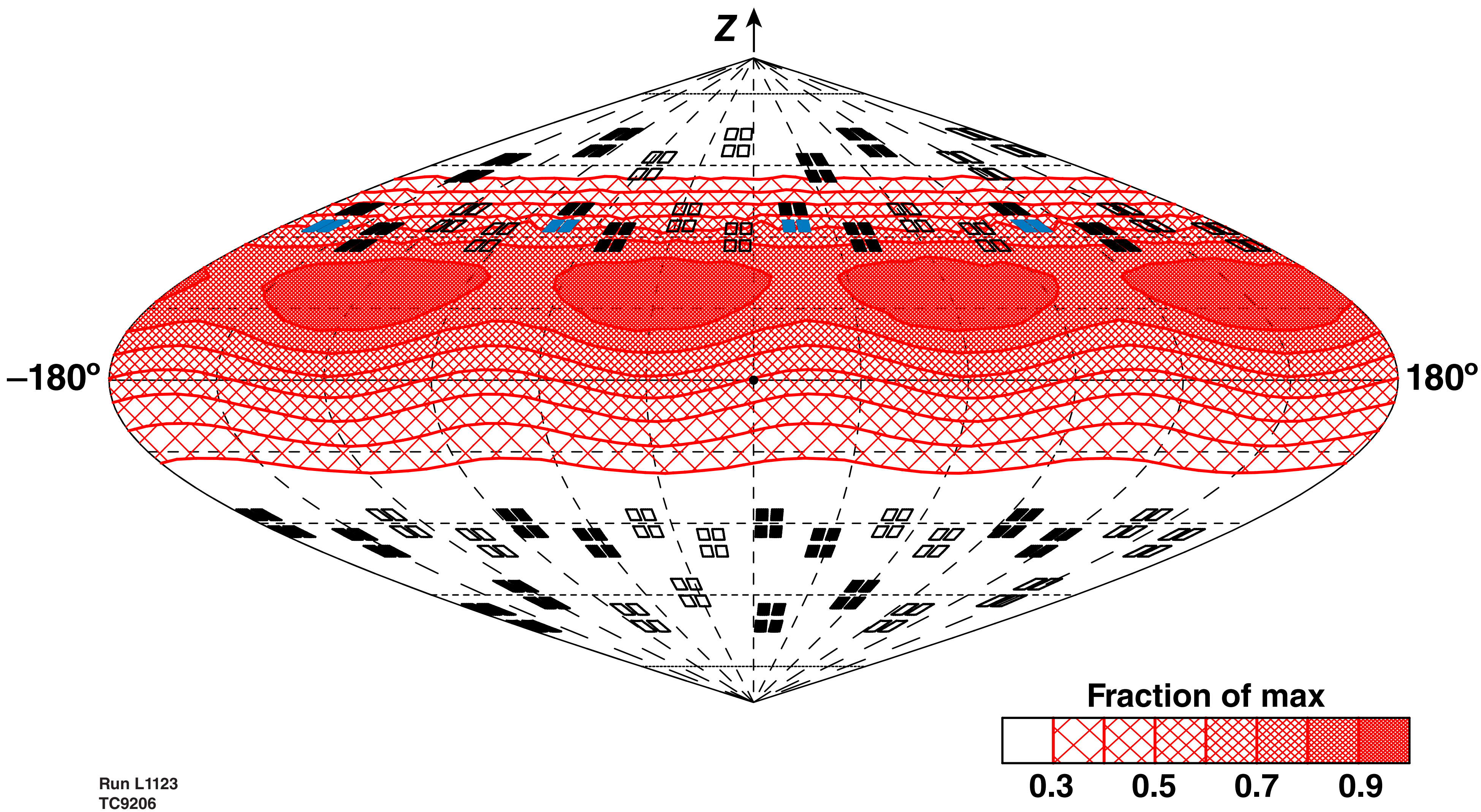
Run L1116
TC9204

An optimum Ring 3B deposition is found at a horizontal shift of 410 μm



Run L1121
TC9205

For a larger horizontal shift (490 μm) the phase of the deposition pattern reverses



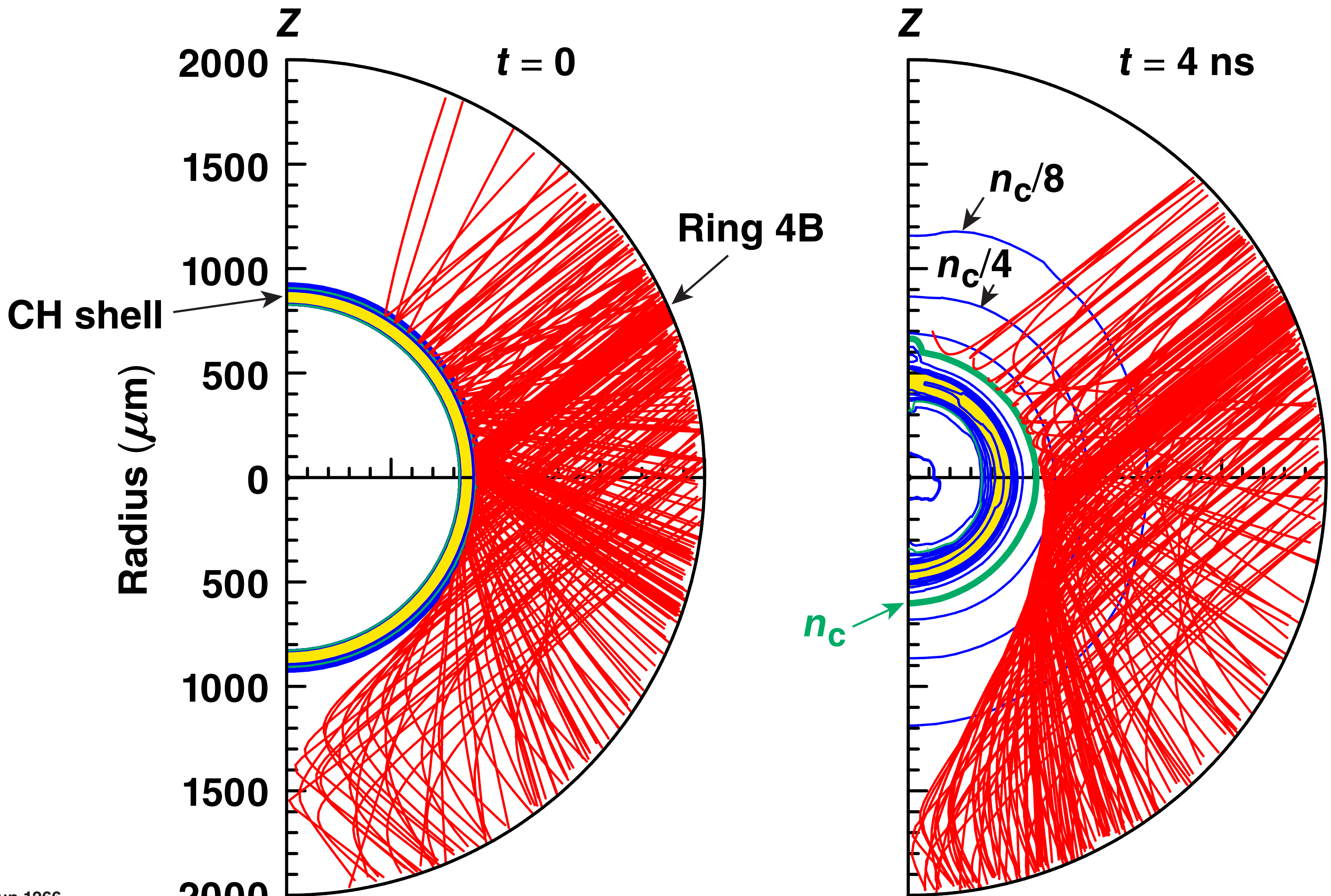
Run L1123
TC9206

The polar-drive compression-pulse design uses existing NIF hardware

Ring	θ	*a*, *b* (μm)	Defocus cm	Vert. PT (μm)	Horiz. PT (μm)
1A	21.24	882, 631	–	–	–
1B	25.93	882, 631	–	–	–
2A	28.01	824, 590	2.2	–70	0
2B	32.70	824, 590	2.2	–70	0
3A	42.19	635, 367	2.0	160	±250
3B	46.89	635, 367	1.7	–340	±380
4A	47.68	593, 343	1.2	–520	±420
4B	52.38	593, 343	1.0	–500	±450

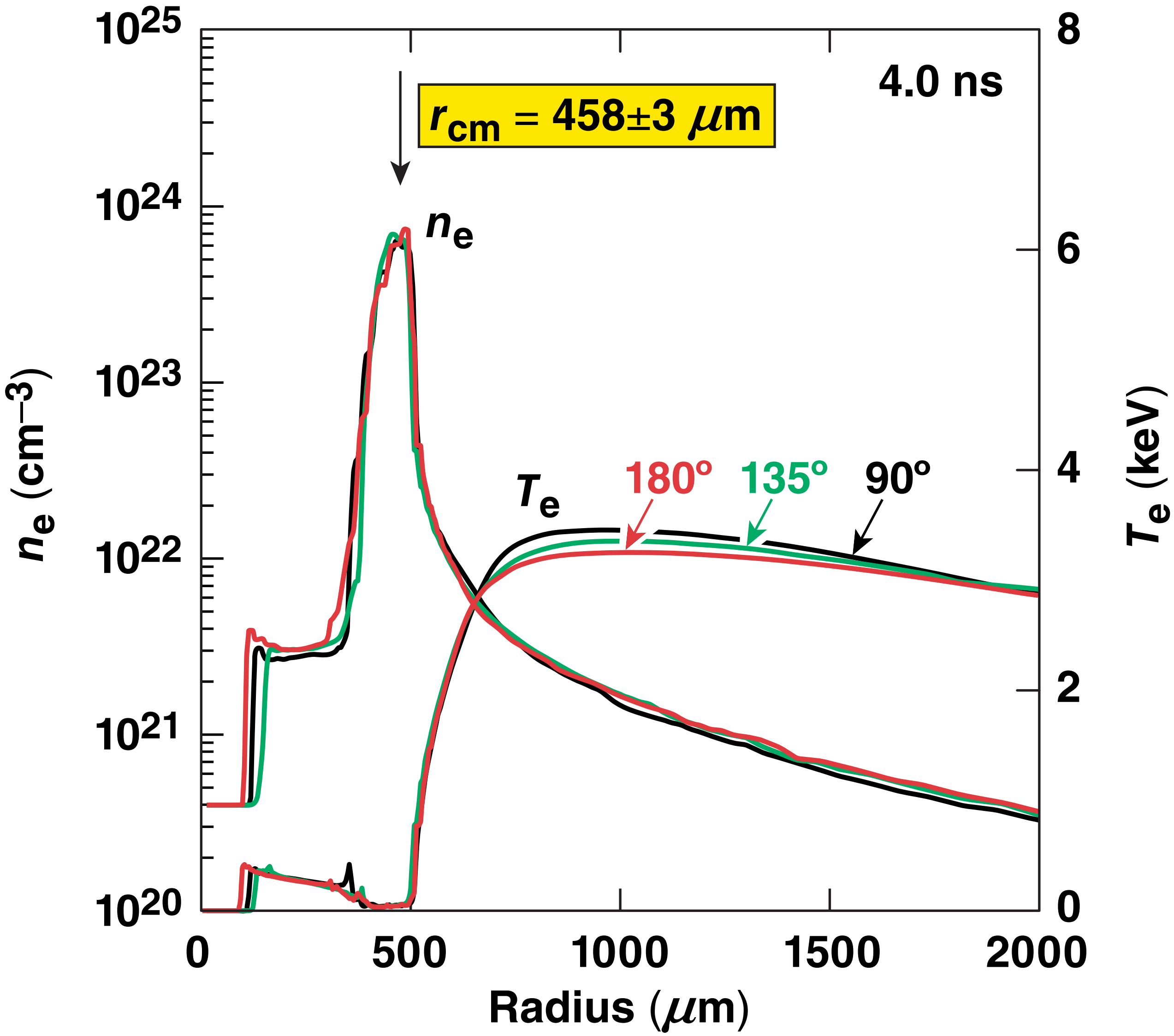
- Ring 1 is unused
- Ring 4 has 20% additional energy

The CH shell implodes uniformly throughout the 4-ns laser pulse



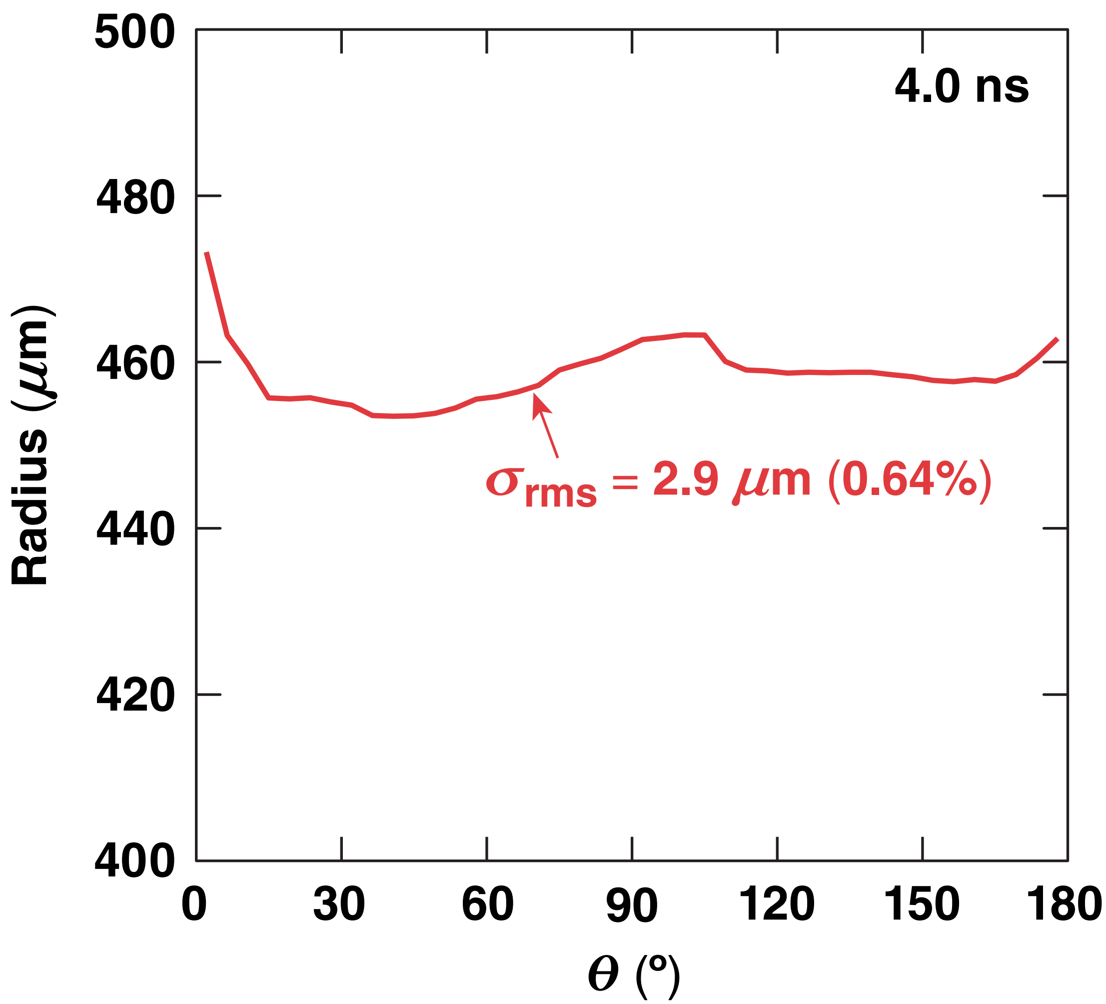
Run 1266
TC9032

Radial density lineouts at different θ are almost identical at the end of the laser pulse



Run 1266
TC9033

The azimuthally averaged center of mass is uniform to 2.9 μm (rms) after implosion through ~400 μm



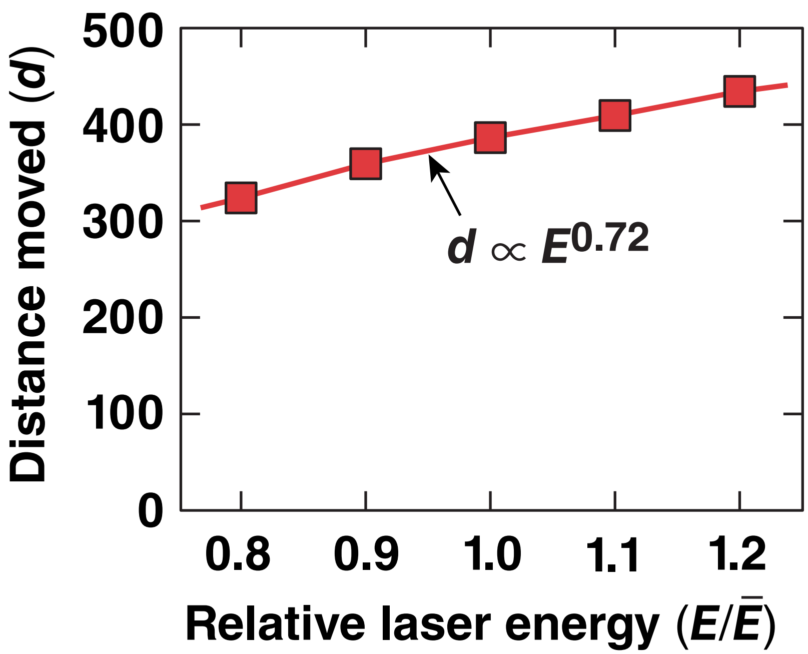
Run 1266
TC9034

The 3-D distance of shell motion, $d(\theta,\phi)$, is estimated from the 3-D deposited energy $E(\theta,\phi)$

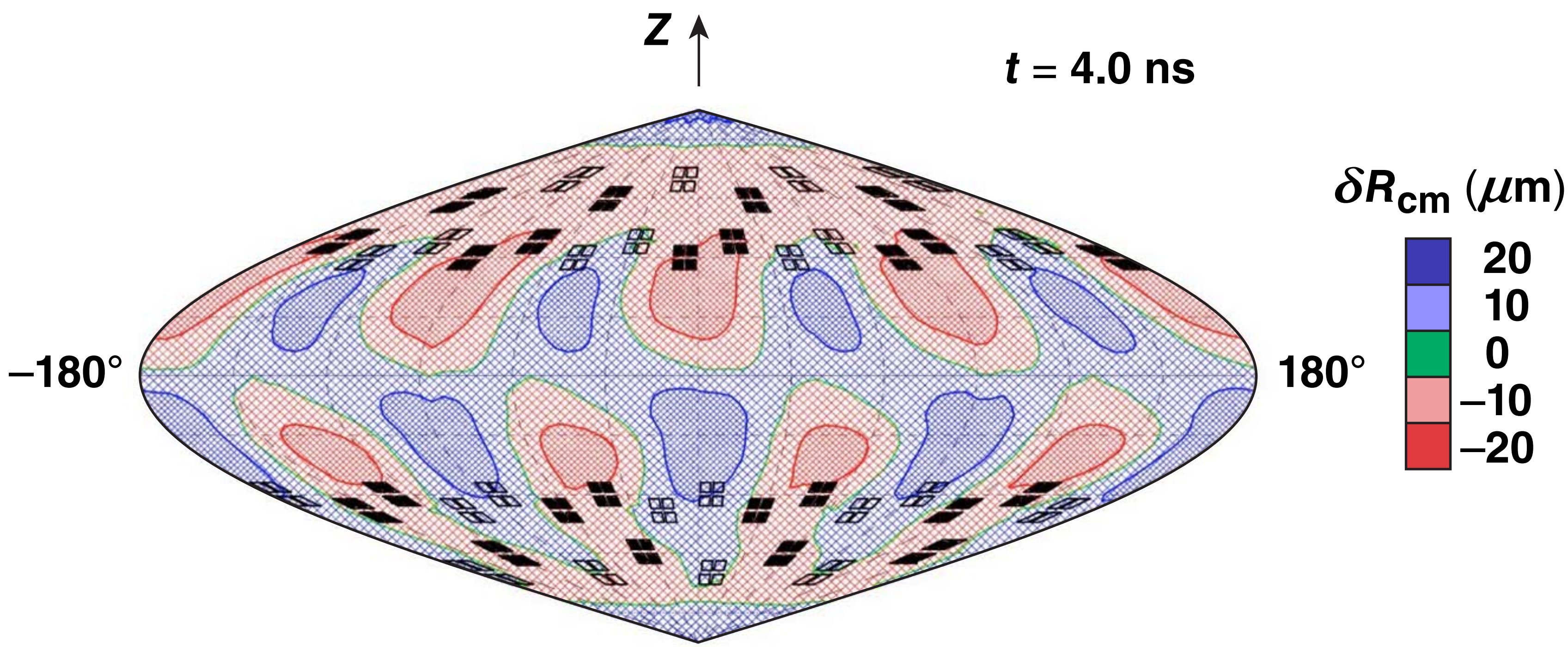
- The 3-D deposited energy $E(\theta,\phi)$ is obtained from *SAGE* by summing over all 96 beams

- At each θ, the azimuthal variations in the center of mass *d* are obtained using

$$d(\theta,\phi) \propto E(\theta,\phi)^{0.72}$$

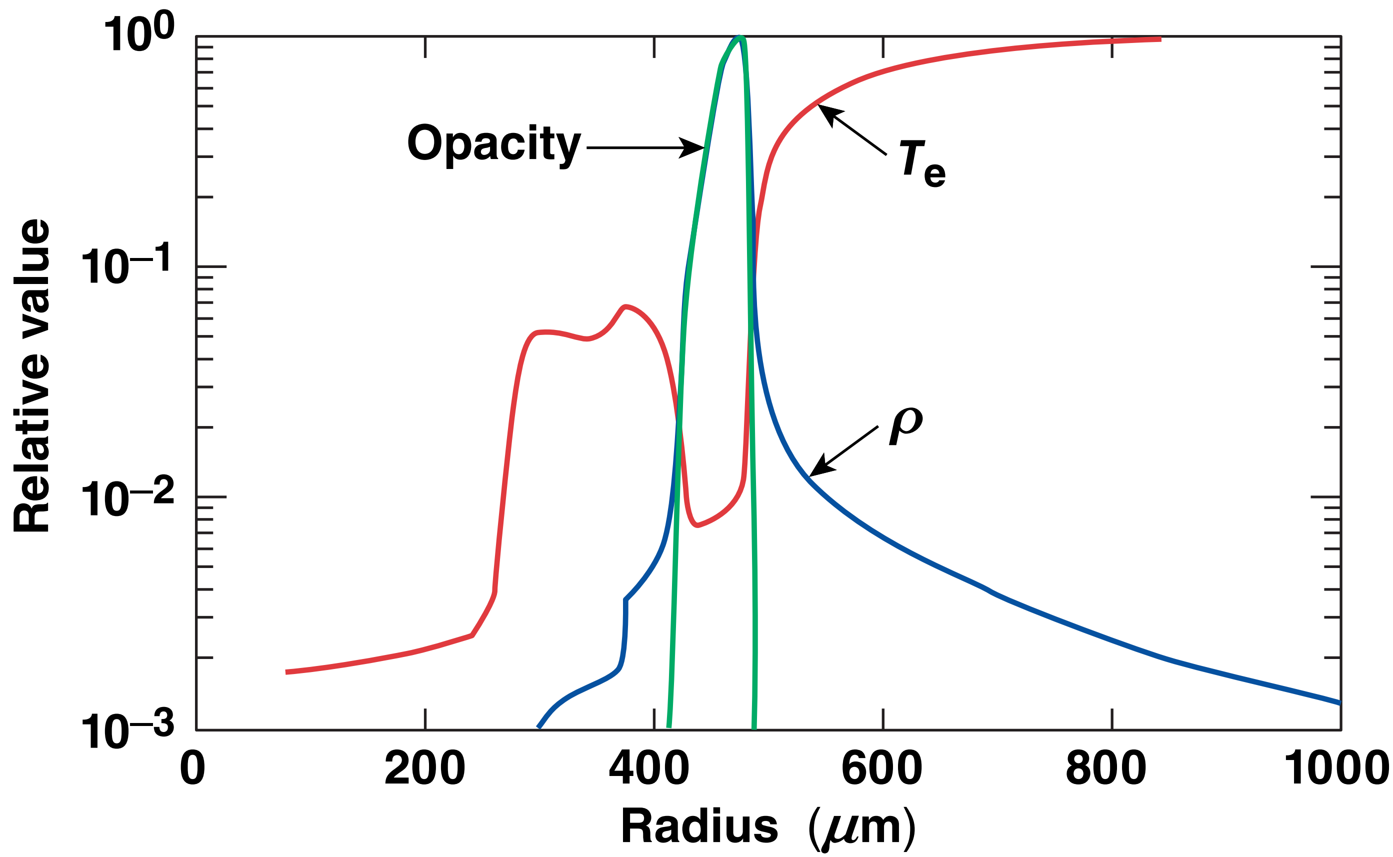


The center of mass radius is uniform to 8.1 μm (rms) when averaged over the sphere



Run 1266
TC9036

3-D density/opacity profiles are formed from 1-D *LILAC* profiles shifted by the 3-D *SAGE* center-of-mass perturbations

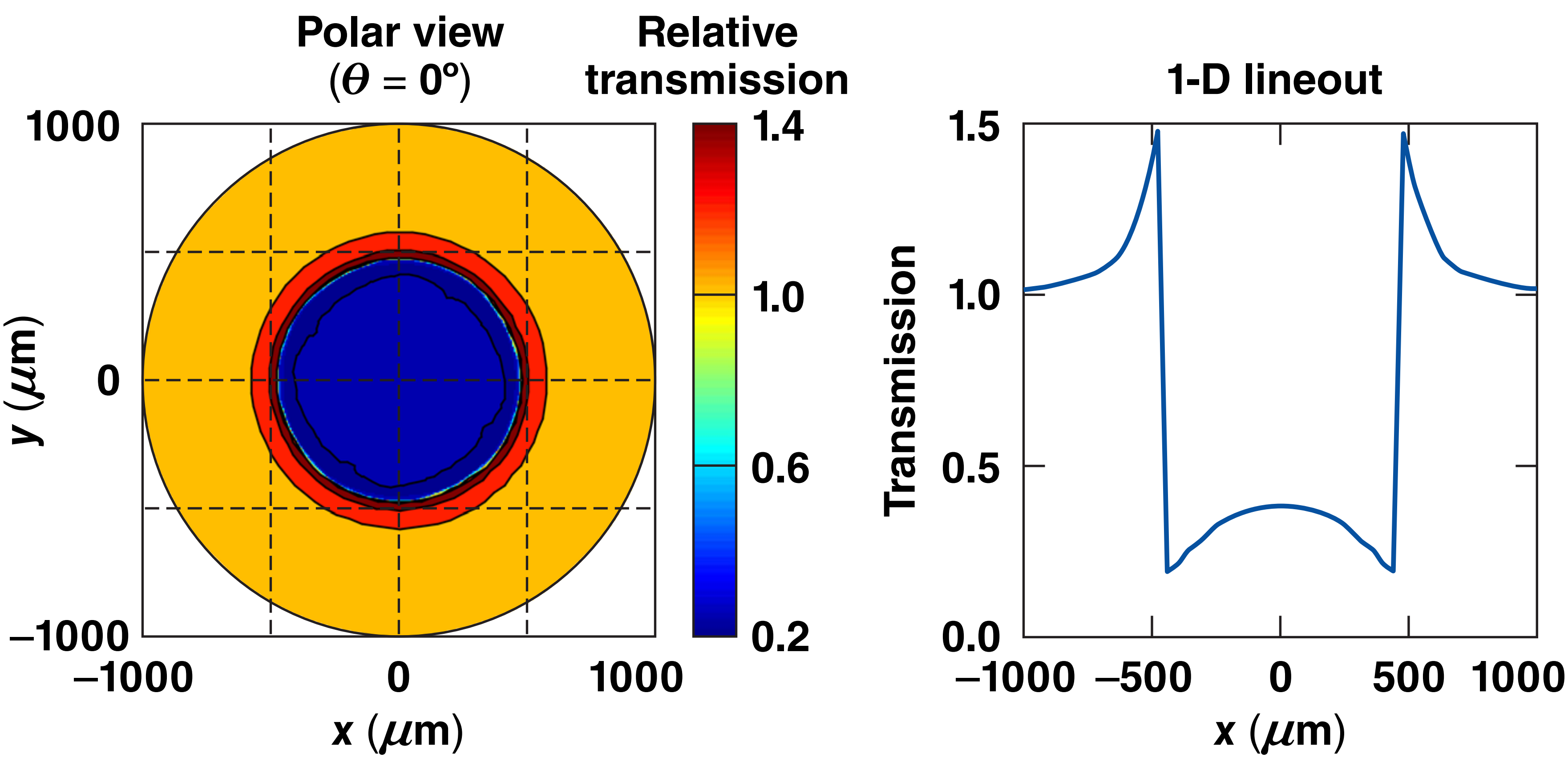


Center on R_{cm} (θ, ϕ)

- The resultant 3-D profiles are used for backlighting

TC9037

Framed x-ray backlighting can be used to diagnose the uniformity of the imploding target



t = 4.0 ns
$h\nu$ = 3.5 keV
T_{XR} = 300 eV

Run 1266
TC9038a

Summary/Conclusions

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