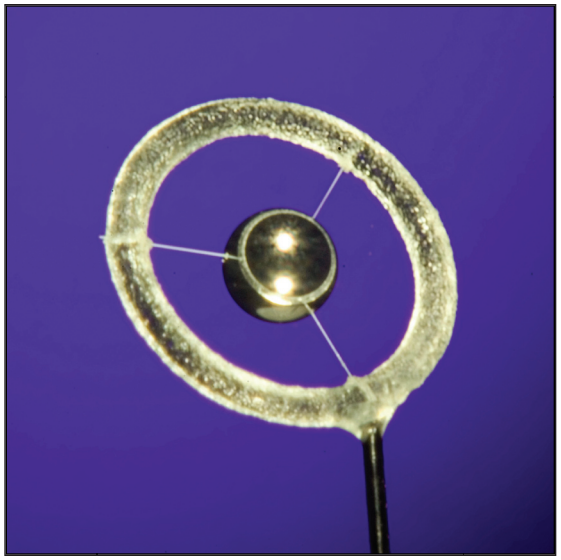
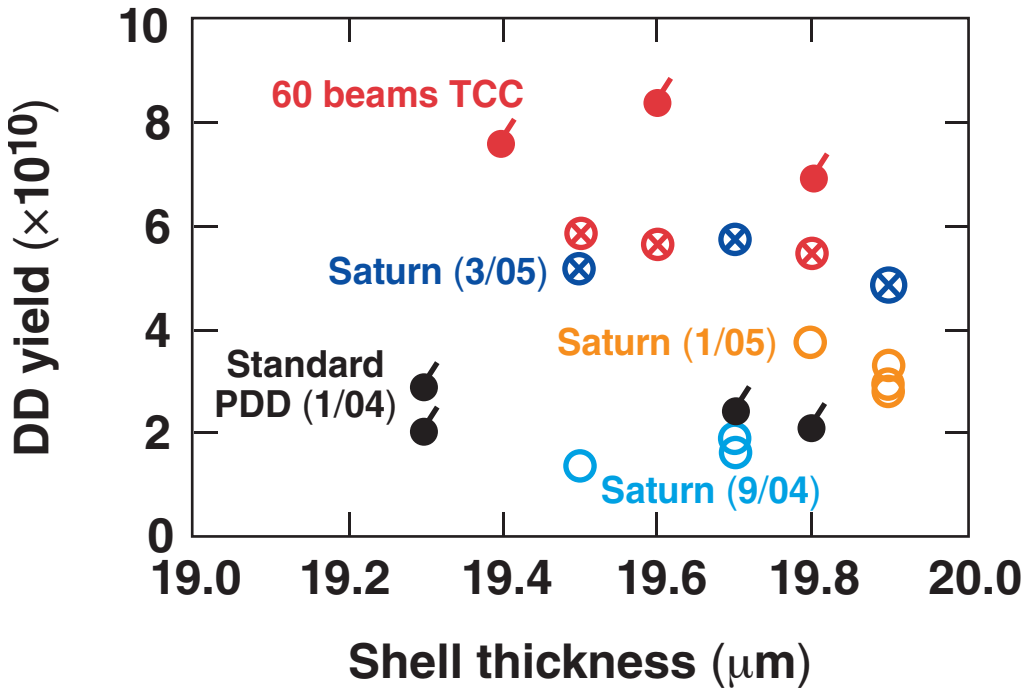
Polar-Direct-Drive Experiments on OMEGA Using Saturn Targets





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Contributors

UR LLE

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Summary

Saturn targets on OMEGA perform almost as well as symmetrically irradiated targets

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- The initial experiments suffered from excessive drive on the equator.
- A new radiation model in *SAGE* shows that this was due to x rays from the ring being absorbed in the capsule.
- Yields up to ~75% of symmetric have been obtained with
  - adjusted beam pointings
  - spoke mounts rather than web mounts

Outline

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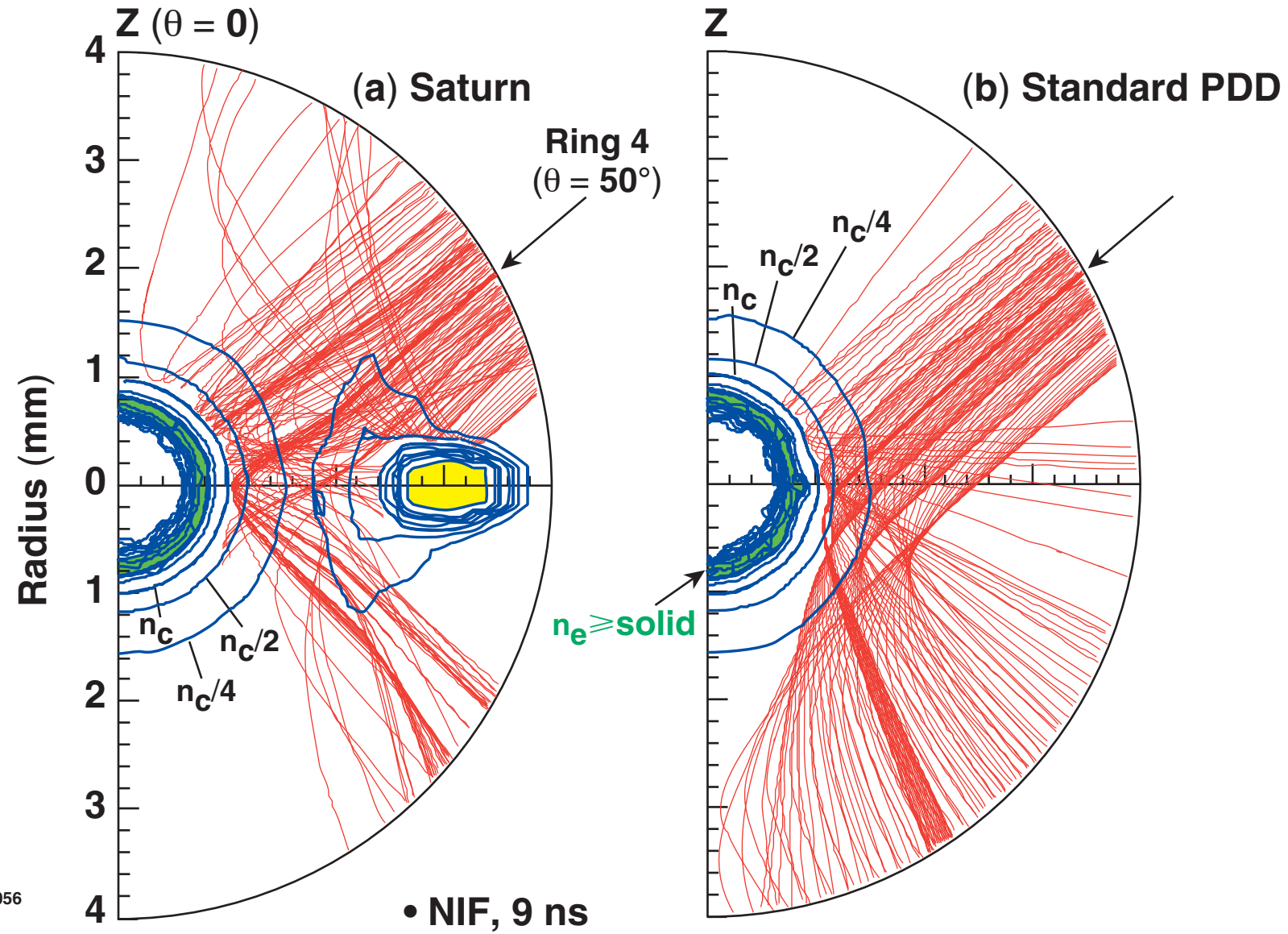
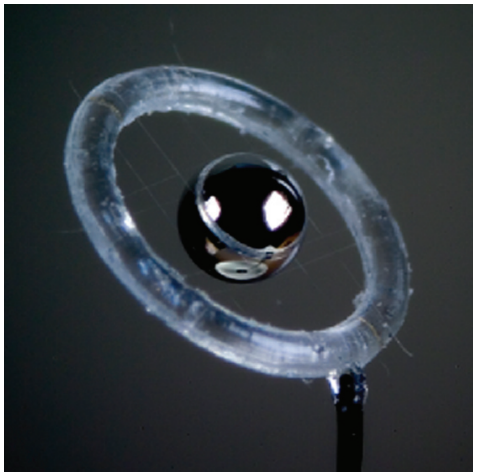
- Saturn targets
- Experimental results for original beam pointings
- Radiation model in *SAGE*
- Experimental results for adjusted beam pointings
  - uniformity of drive
  - uniformity of the imploded core
  - neutron yield

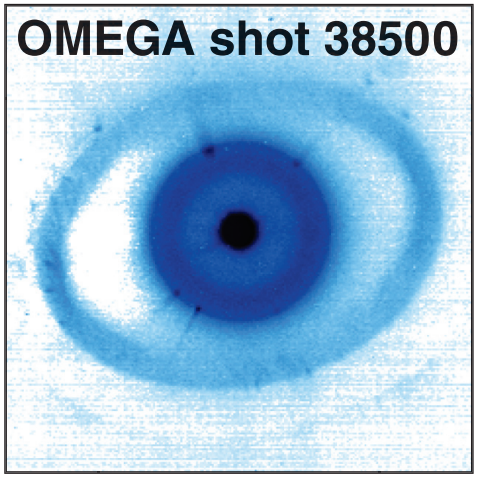
As the critical surface moves in, the ring of the Saturn target refracts rays back toward the equator



Runs 4341, 4056
TC6636

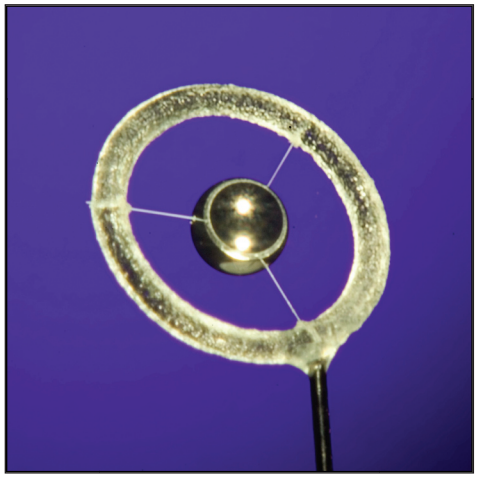
Silk-mounted and spoke-mounted Saturn targets have been shot on OMEGA

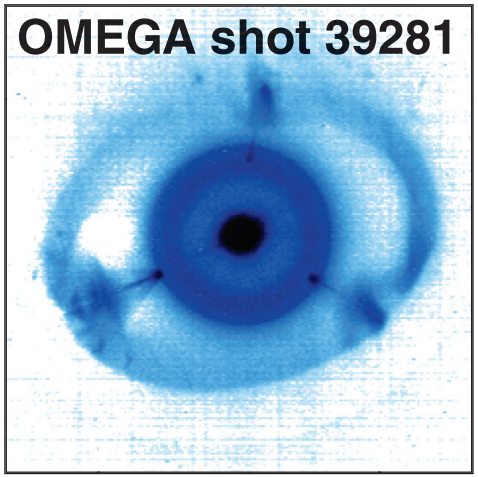




Time-integrated pinhole camera (2 to 5 keV)

"Silk" mount





"Spoke" mount

Framing-camera backlit images of the original experiment showed increased drive on the equator

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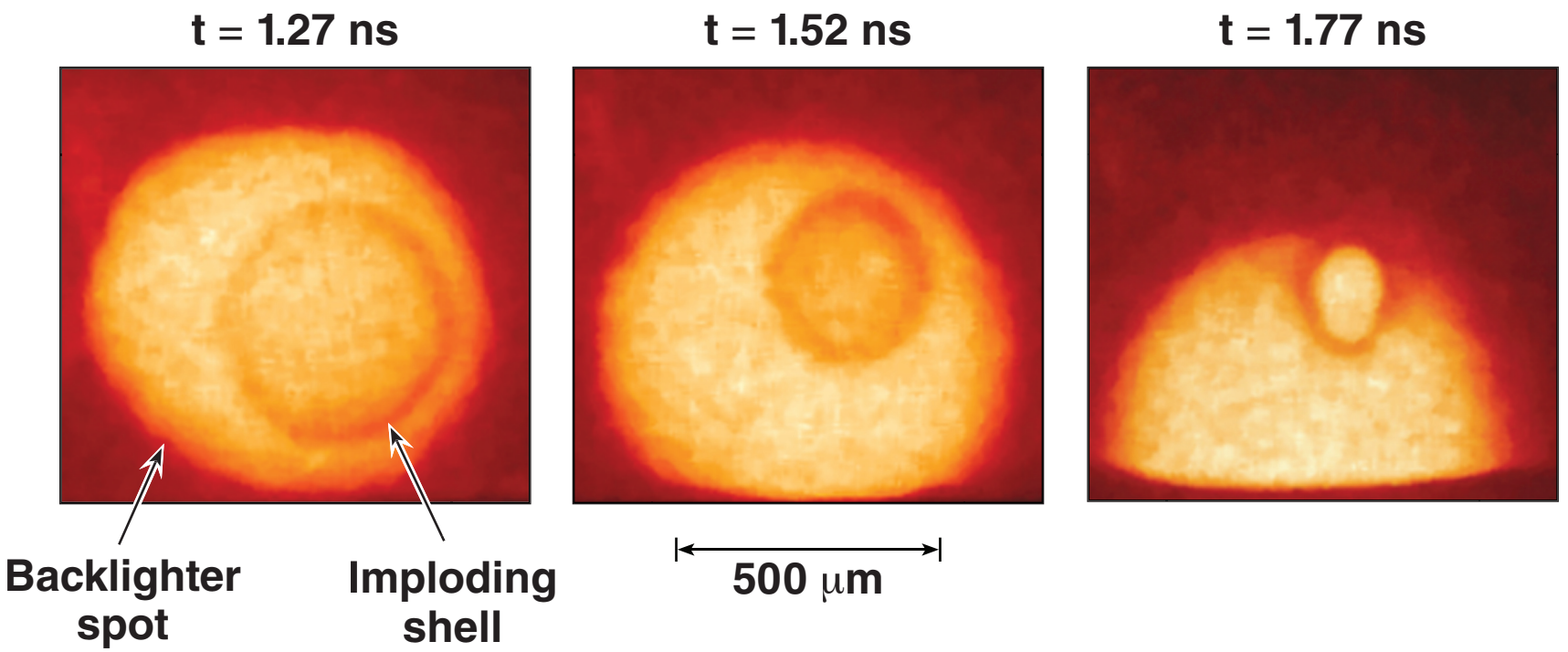
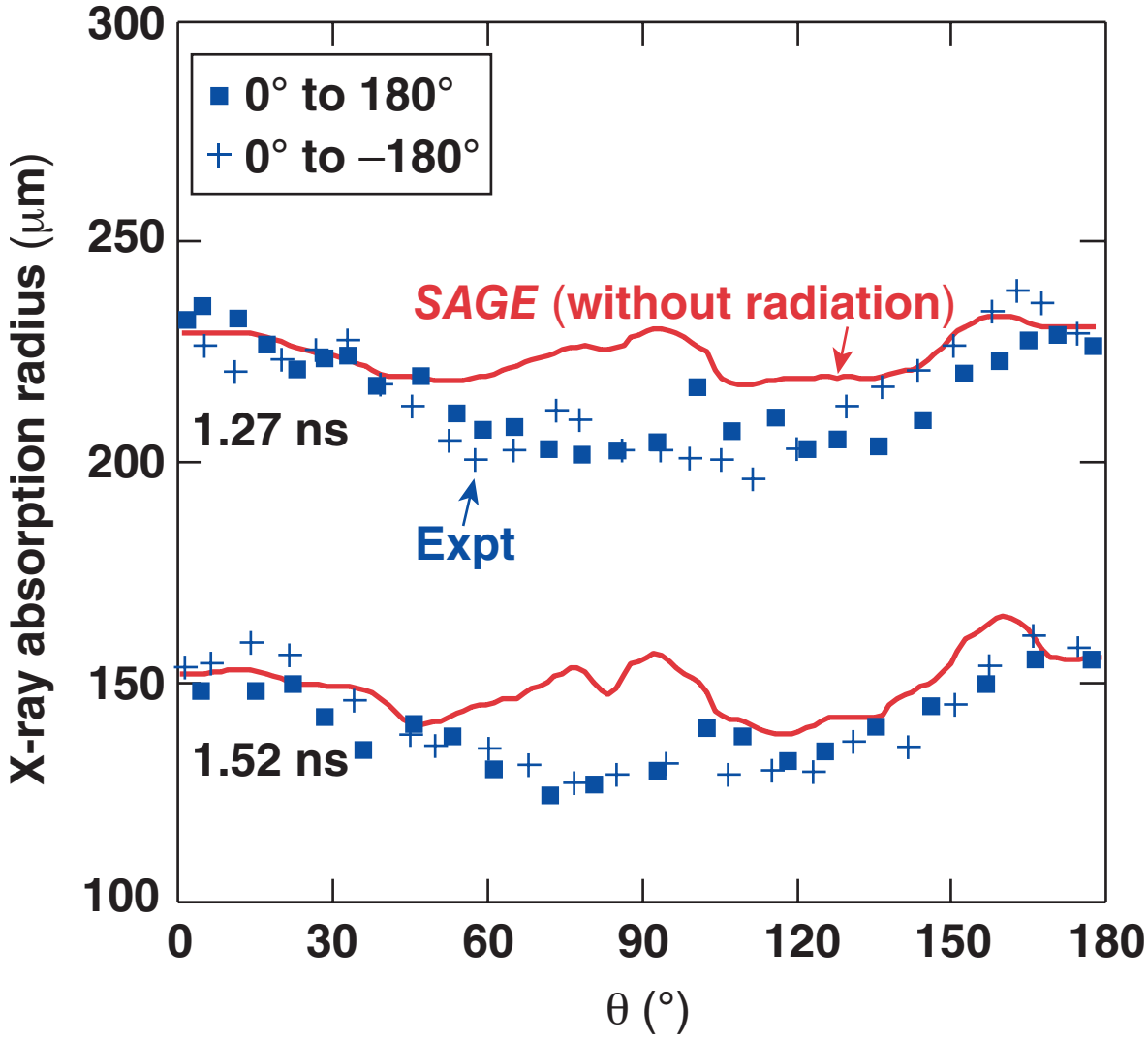
P6 view (26.6° above equator)



Shot 37428-7,11,15
TC6662a

The additional drive at the equator for the Saturn target was greater than predicted without radiation



Shot 37428
Run 4488
TC6860a

SAGE models the radiation from the ring plasma to the capsule using a new model

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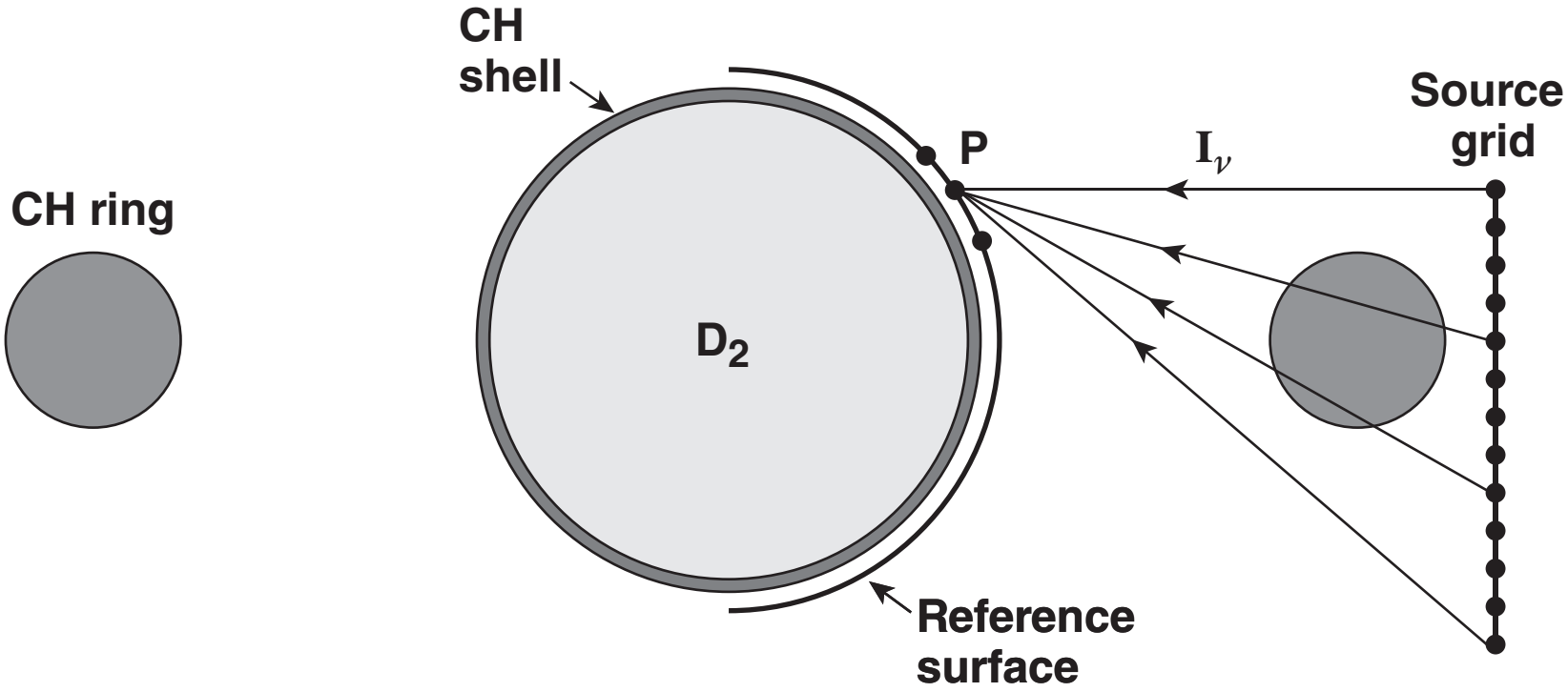
- The model is similar to "view-factor" models.
- Full directional and spectral information is retained.
- The model is implemented within the *SAGE* optical ray-tracing package.
- The algorithm is divided into two stages:
  - transport
  - deposition

In the "transport" stage, the incident spectral intensity is calculated as a function of angle and wavelength

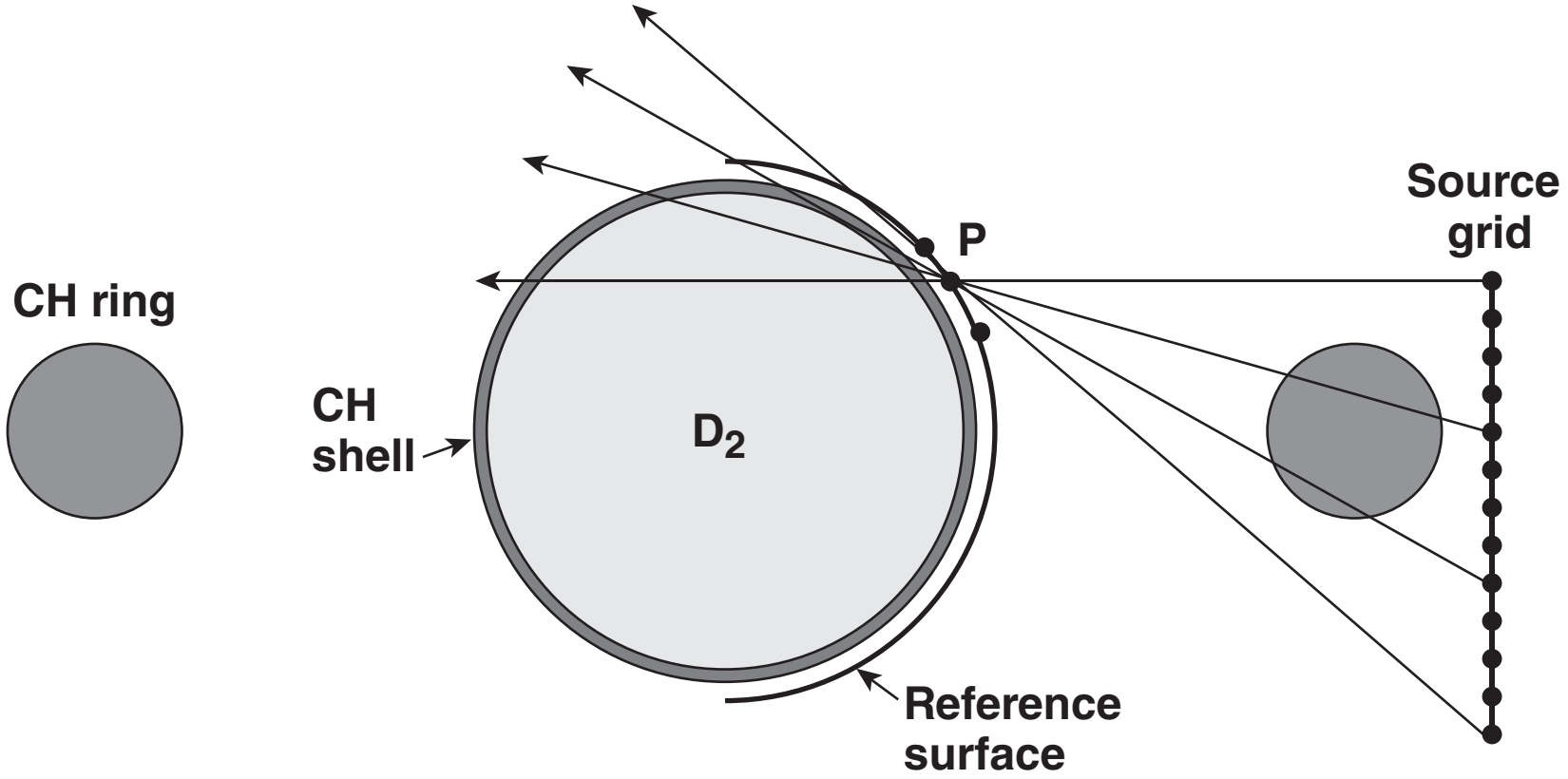


$$\frac{dI_\nu}{ds} = \kappa_\nu (B_\nu - I_\nu)$$

Opacity Blackbody

TC6964

In the "deposition" stage, rays with known incident energy are propagated into the capsule and attenuated

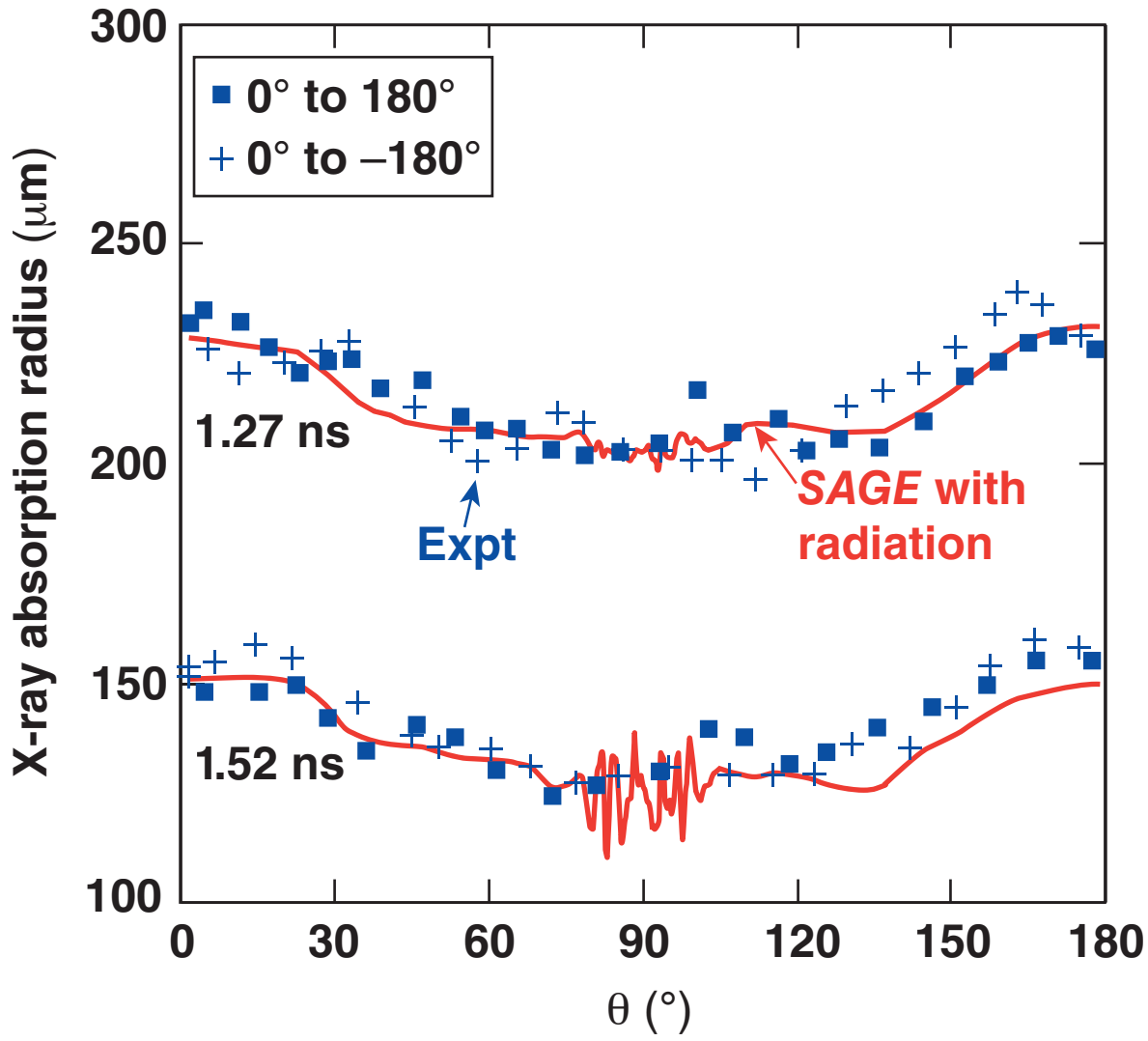


Ray energy: $\delta \mathbf{E} = \mathbf{I}_\nu \, \mathbf{dt} \times \mathbf{dS} \times \mathbf{d}\Omega \times \mathbf{d}\nu$

Along ray: $\dfrac{\mathbf{d}}{\mathbf{ds}} \delta \mathbf{E} = -\kappa_\nu \, \delta \mathbf{E}$

TC6965

The additional drive at the equator for the Saturn target is due to radiation

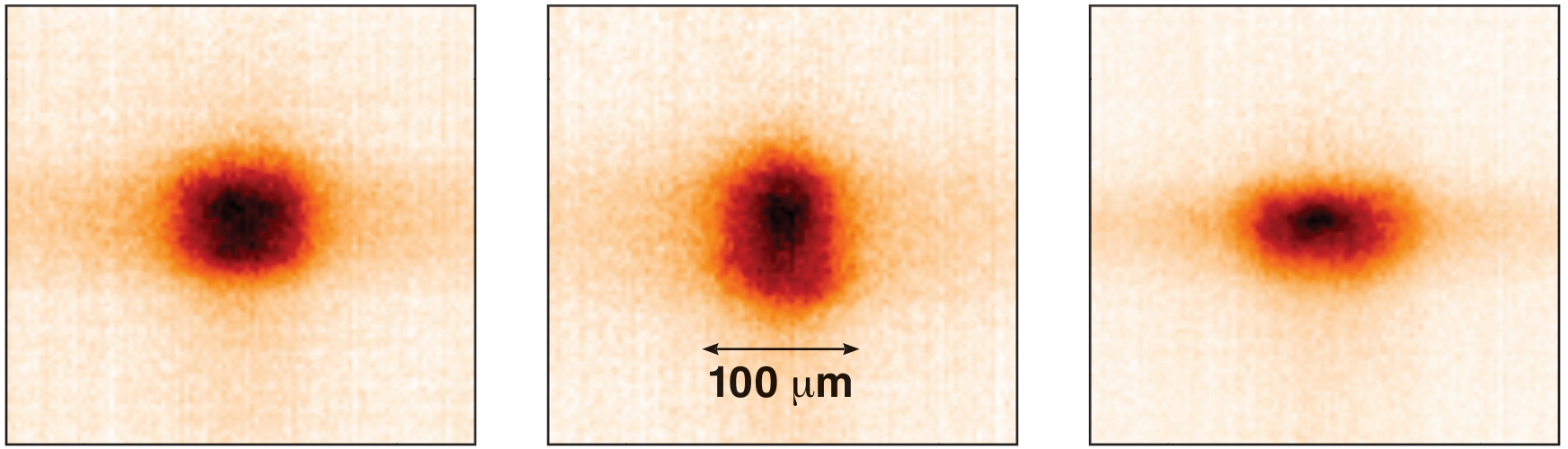


Shot 37428
Run 4673
TC6935

X-ray microscope images show that Saturn targets can be tuned by changing the laser beam pointings

UR LLE

"Corrected"	"Undercorrected"	"Overcorrected"
$Y_n = 3.7 \times 10^{10}$	$Y_n = 2.9 \times 10^{10}$	$Y_n = 2.2 \times 10^{10}$

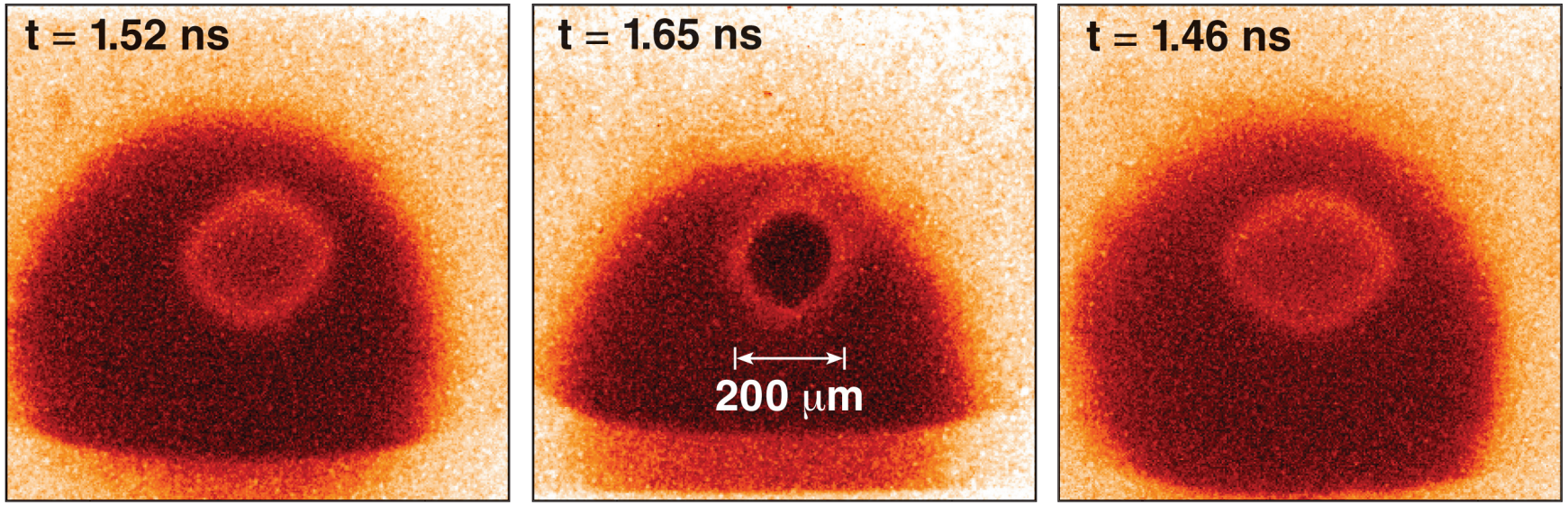


Shot 38500	Shot 38507	Shot 38512

Framing camera images also show that Saturn targets can be tuned

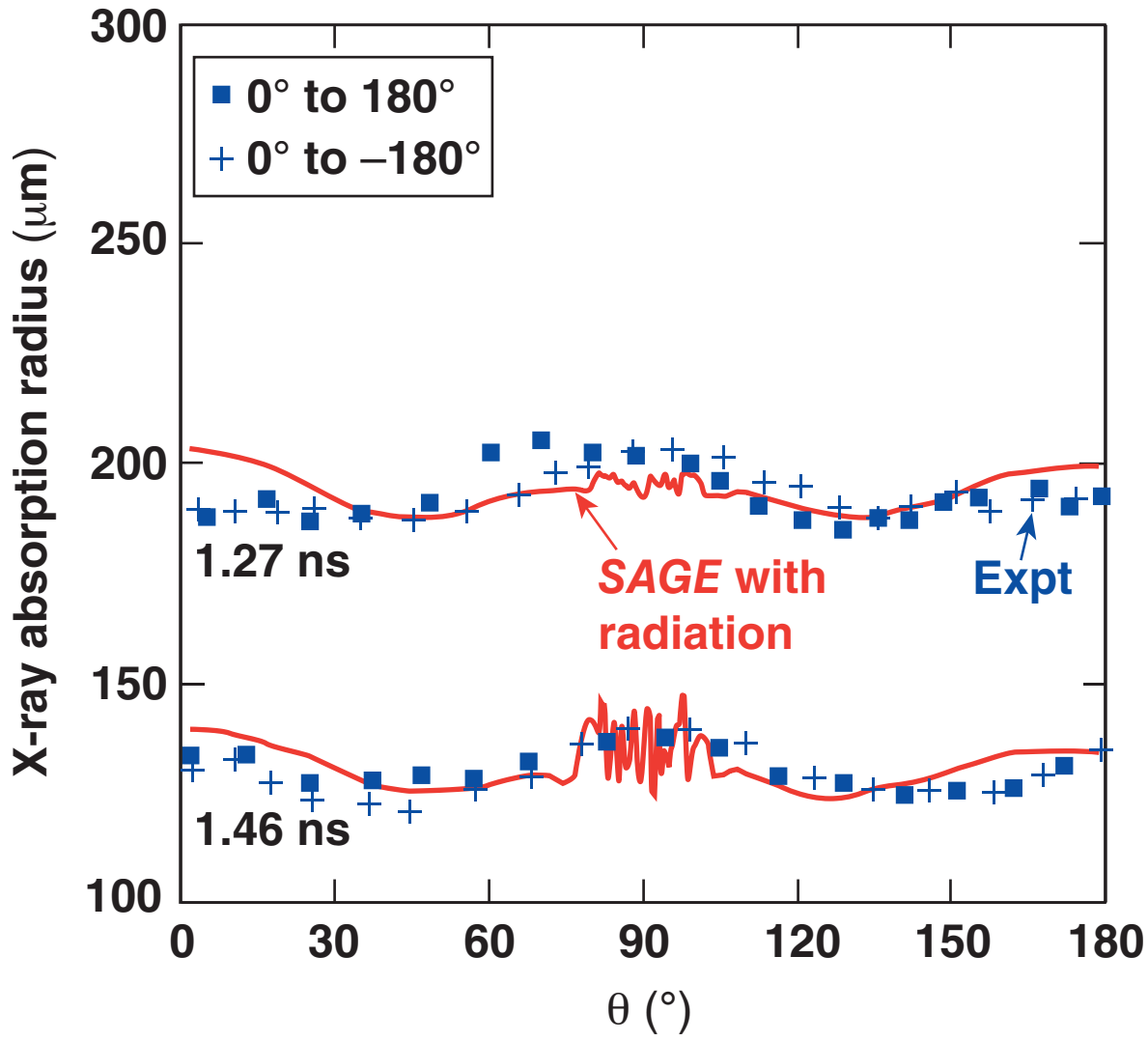
UR LLE

"Corrected"	"Undercorrected"	"Overcorrected"
$Y_n = 2.8 \times 10^{10}$	$Y_n = 3.3 \times 10^{10}$	$Y_n = 2.2 \times 10^{10}$



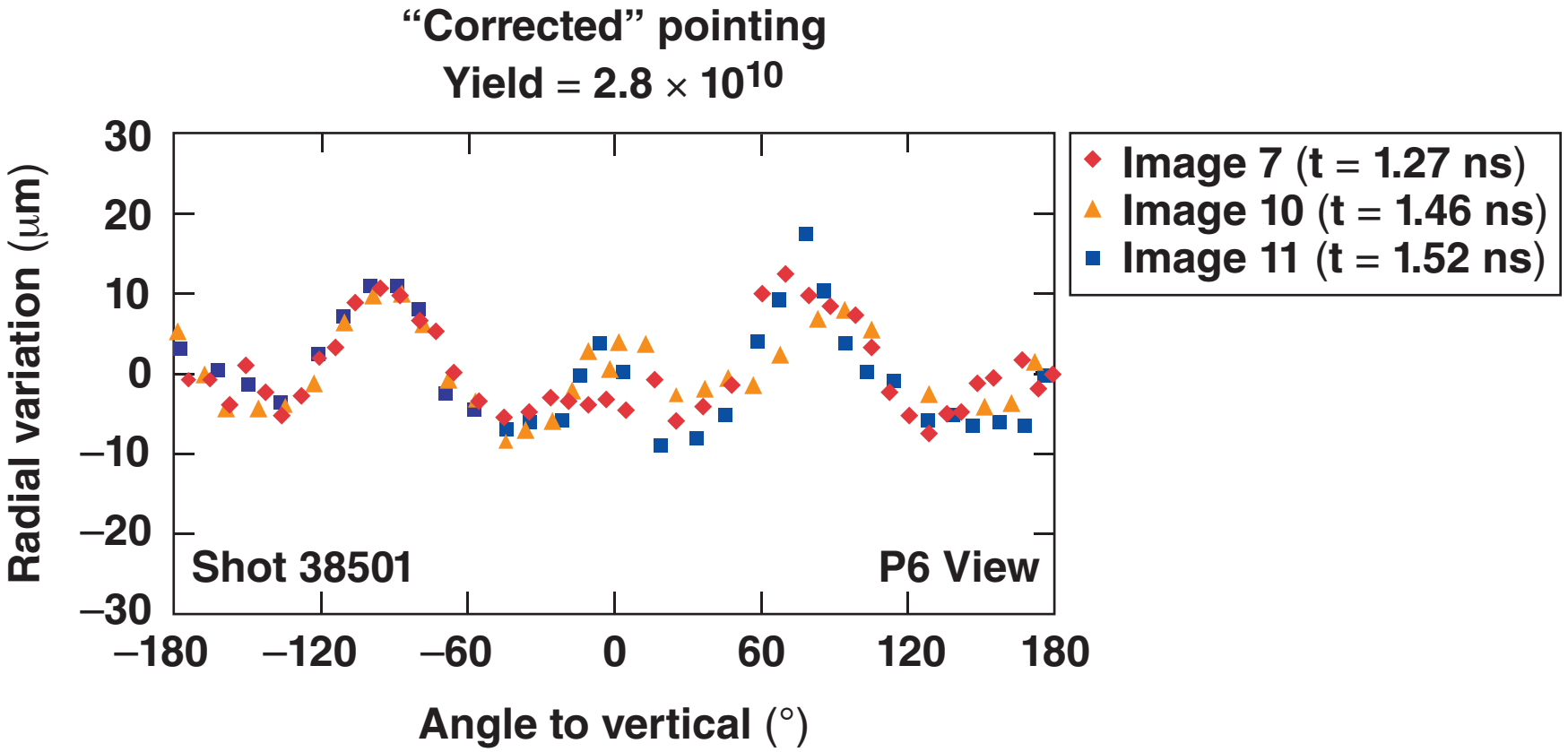
Shot 38501	Shot 38508	Shot 38512

The corrected pointing results in a more uniform drive



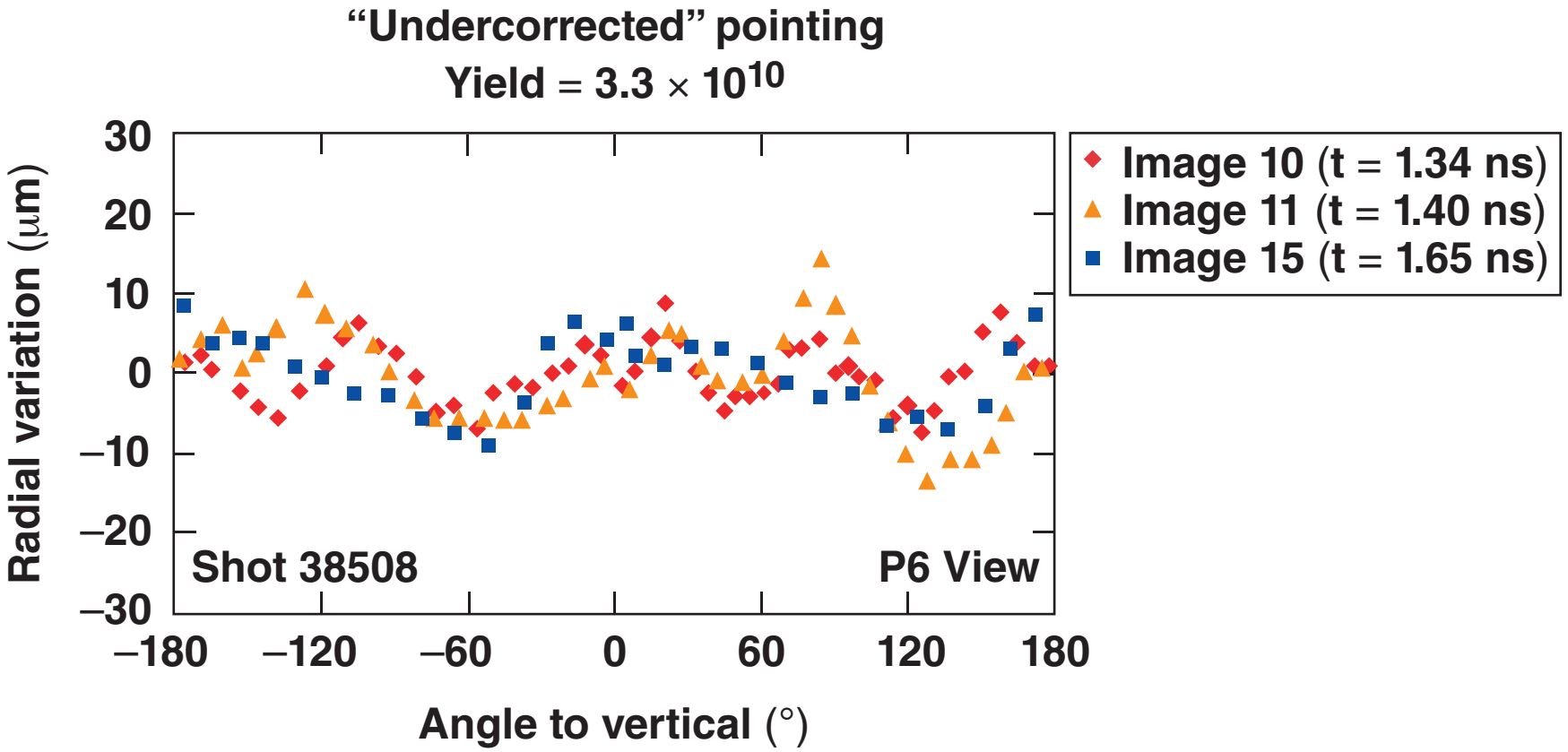
Shot 38501
Run 4686
TC6966

The observed mode pattern is consistent at different times



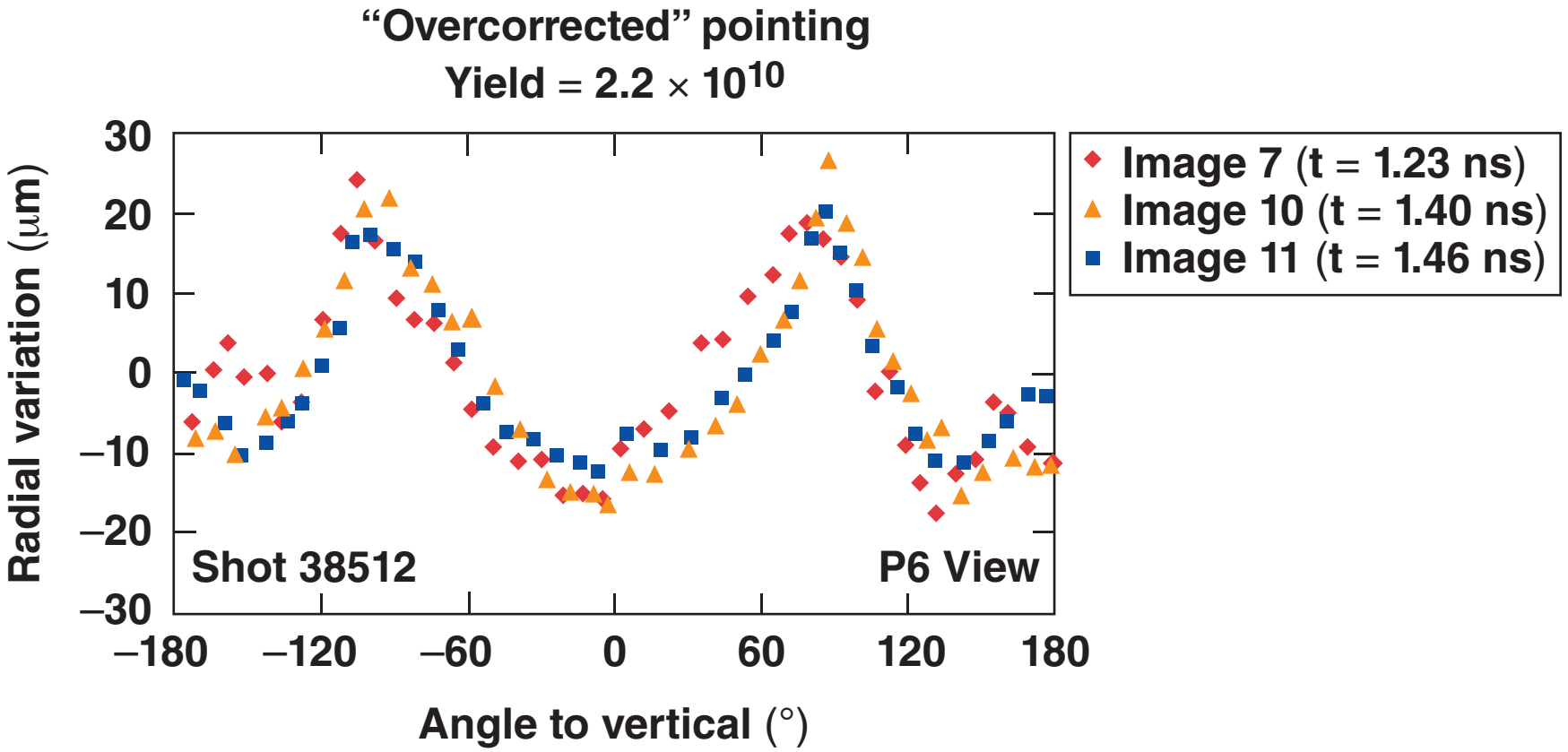
TC6924

The observed mode pattern is consistent at different times



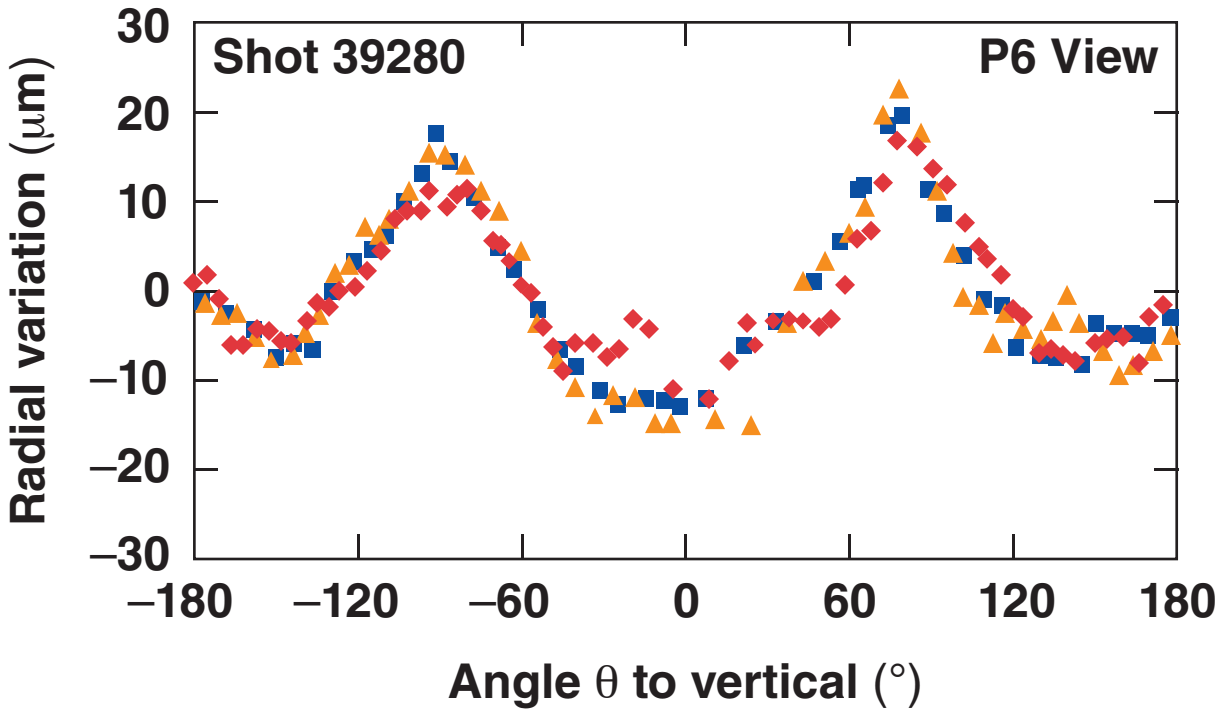
TC6925

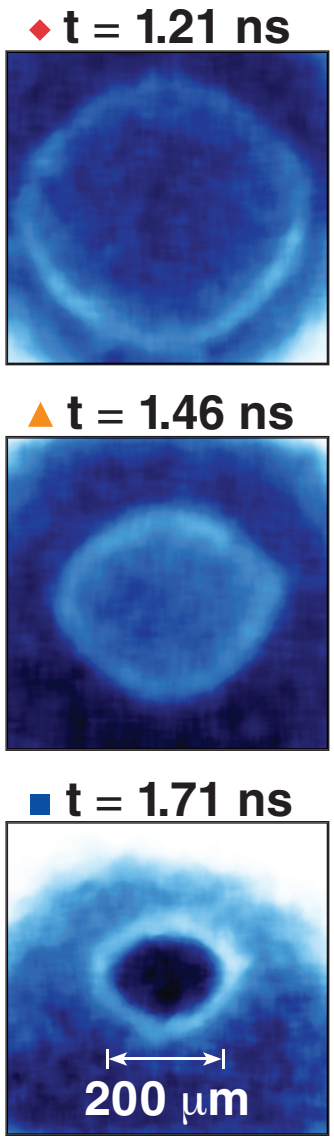
Beams pointed too much toward the poles resulted in an oblate implosion



TC6926

The Saturn ring diameter was varied at the "corrected" pointing configuration using spoke-mounted targets

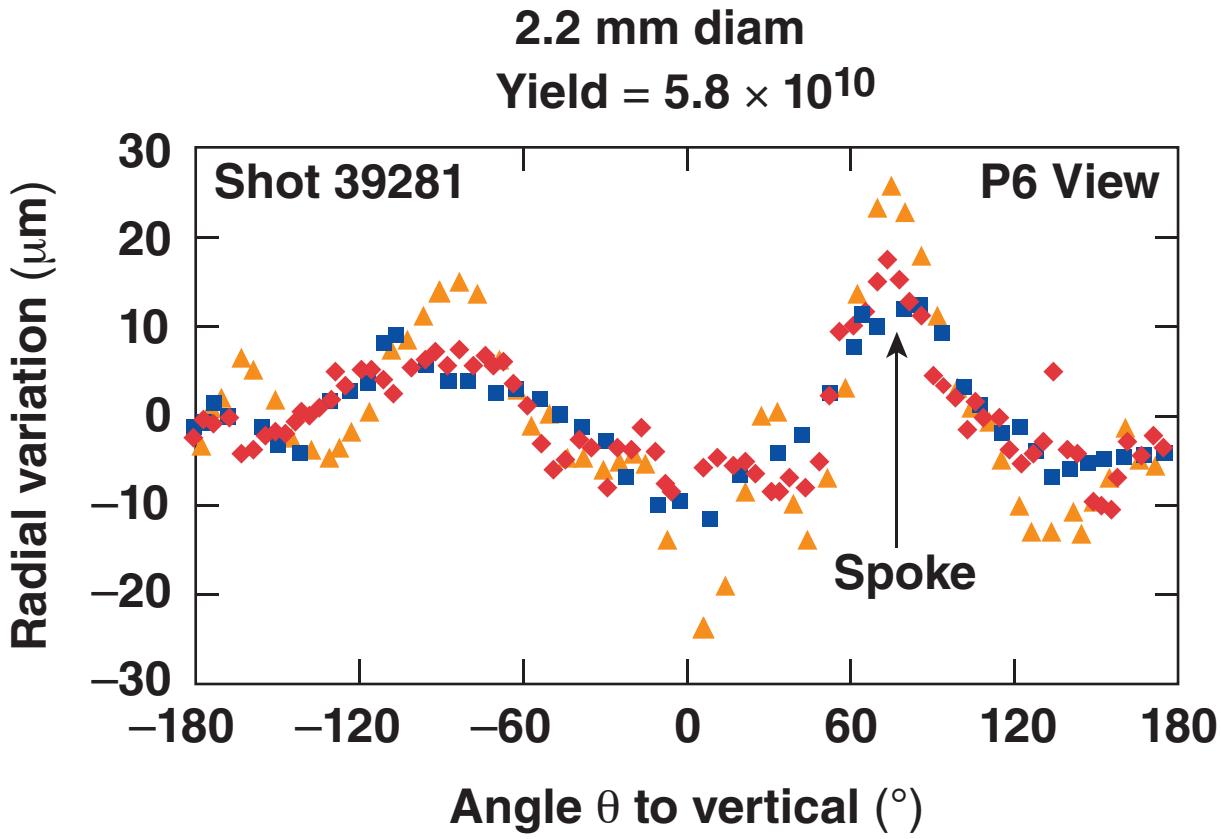


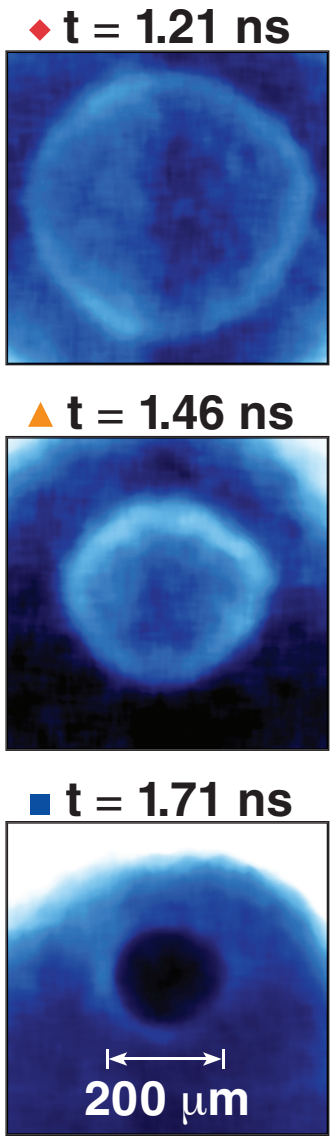


TC6967

The Saturn ring diameter was varied at the "corrected" pointing configuration using spoke-mounted targets

UR LLE

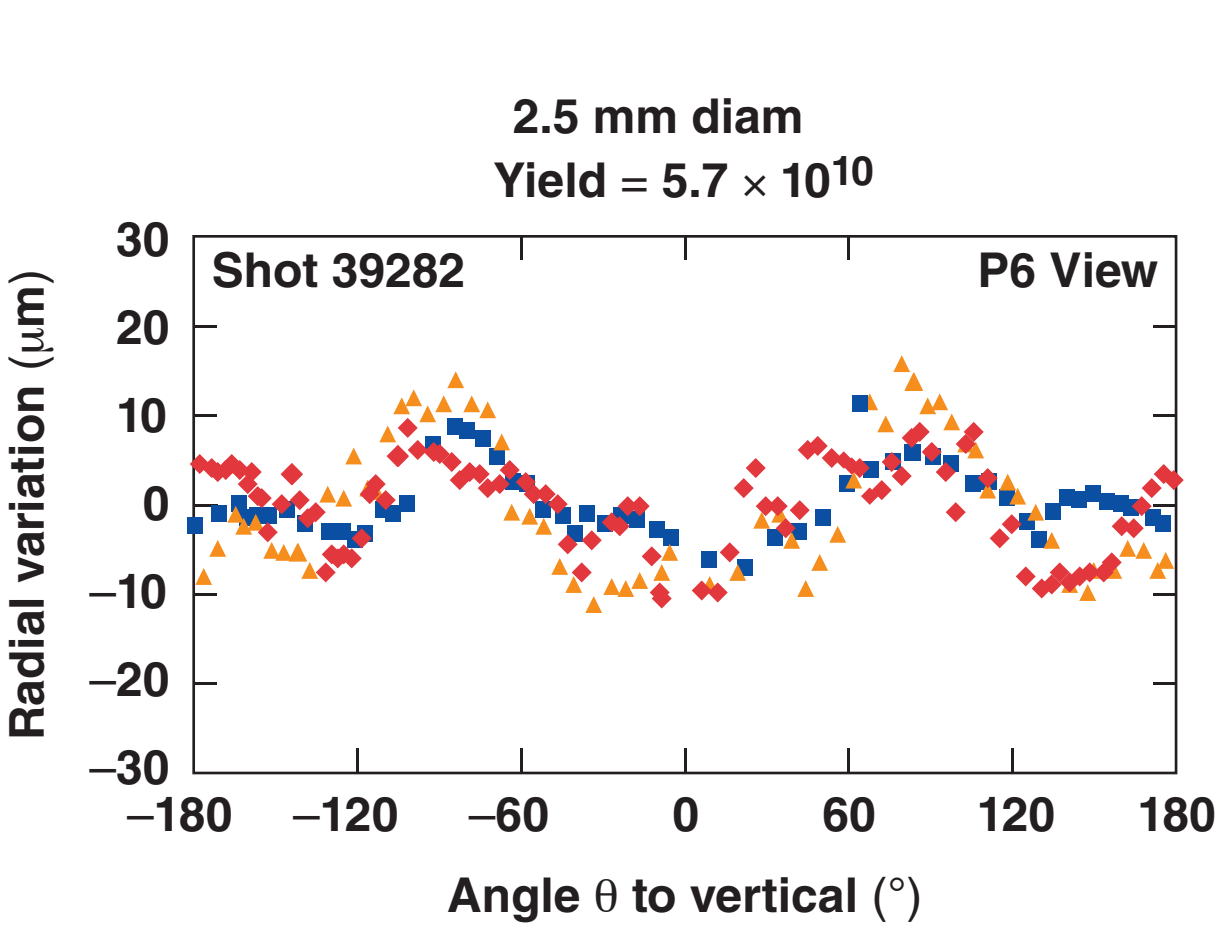


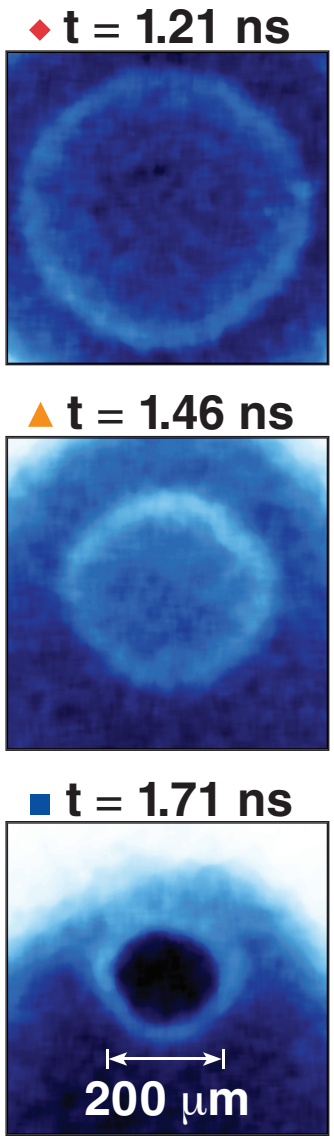


TC6968

The Saturn ring diameter was varied at the "corrected" pointing configuration using spoke-mounted targets

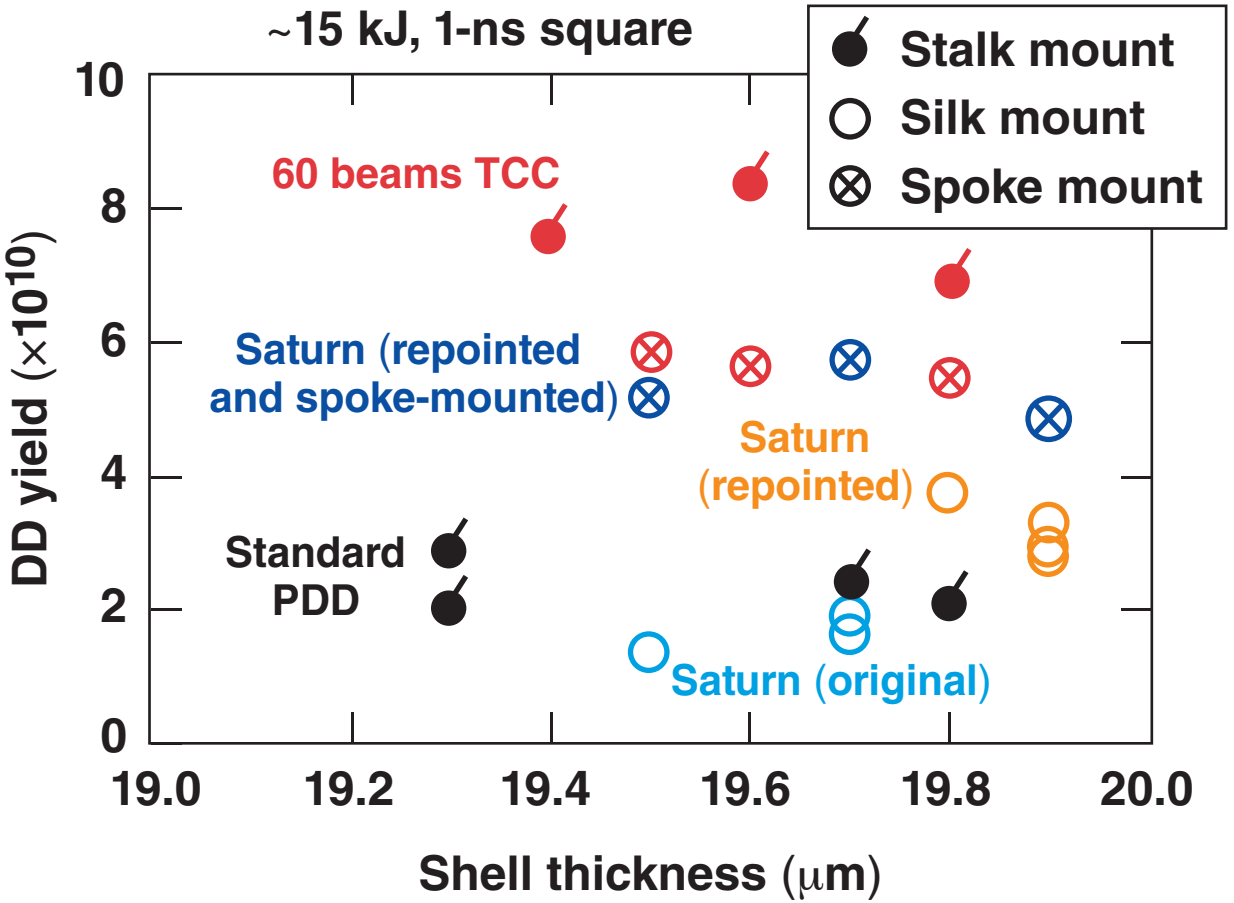
UR LLE





TC6969

The best Saturn targets perform almost as well as symmetrically irradiated targets



TC6971

Summary/Conclusions

Saturn targets on OMEGA perform almost as well as symmetrically irradiated targets

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- The initial experiments suffered from excessive drive on the equator.
- A new radiation model in *SAGE* shows that this was due to x rays from the ring being absorbed in the capsule.
- Yields up to ~75% of symmetric have been obtained with
  - adjusted beam pointings
  - spoke mounts rather than web mounts

These results improve the prospects for direct-drive ignition on the NIF.