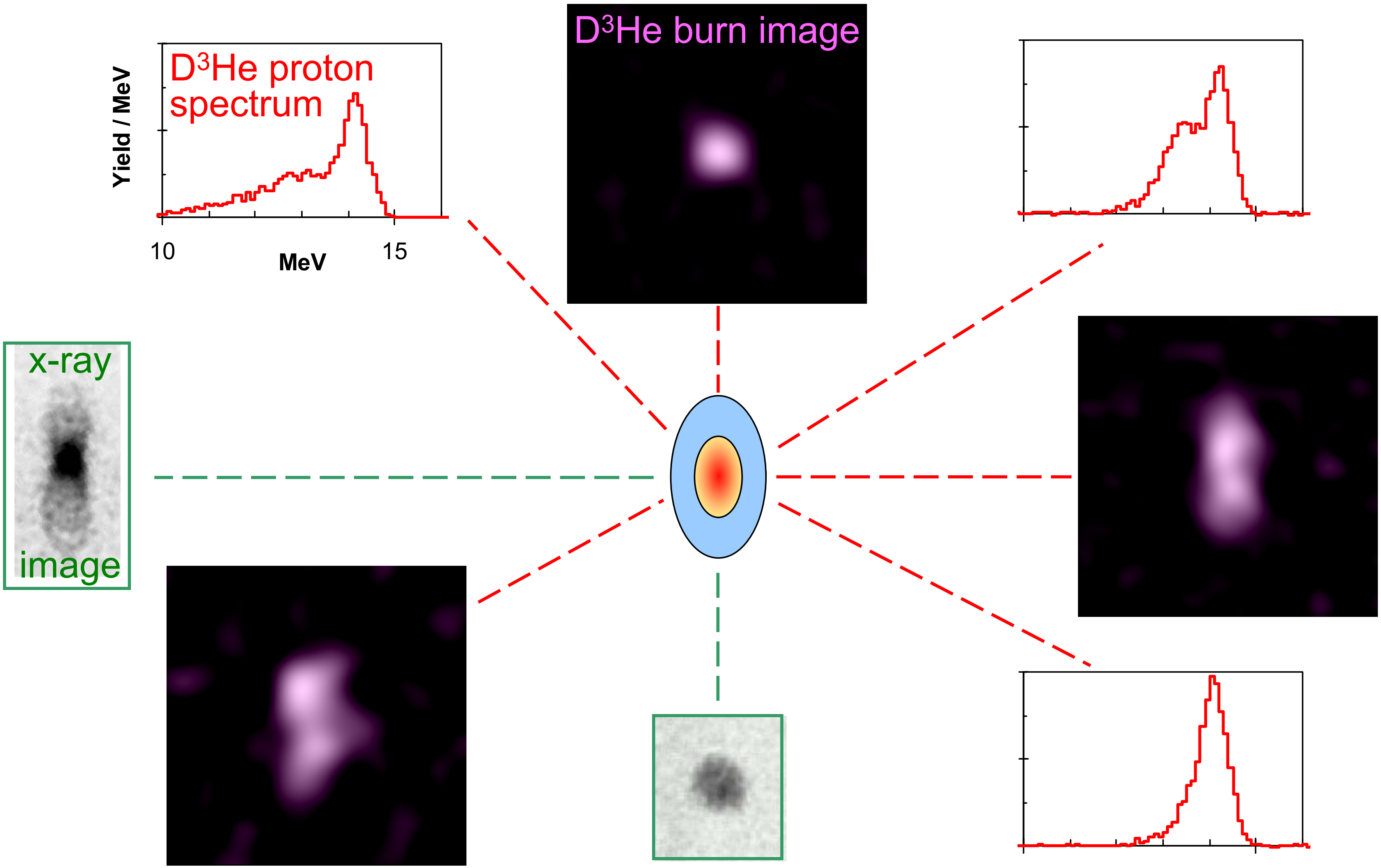
# Studying effects of drive asymmetry on burn asymmetry with proton emission imaging




**Fredrick H. Séguin *et al*., M.I.T.**

46th APS DPP Meeting, 2004

# Summary:

## Low-mode asymmetry in the 3-D burn distribution directly reflects drive asymmetry

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- **Burn asymmetry amplitude is proportional to drive asymmetry**

- **Burn images, proton spectra, and x-ray images can provide a self-consistent picture of asymmetric capsule structure at burn time**

# Collaborators

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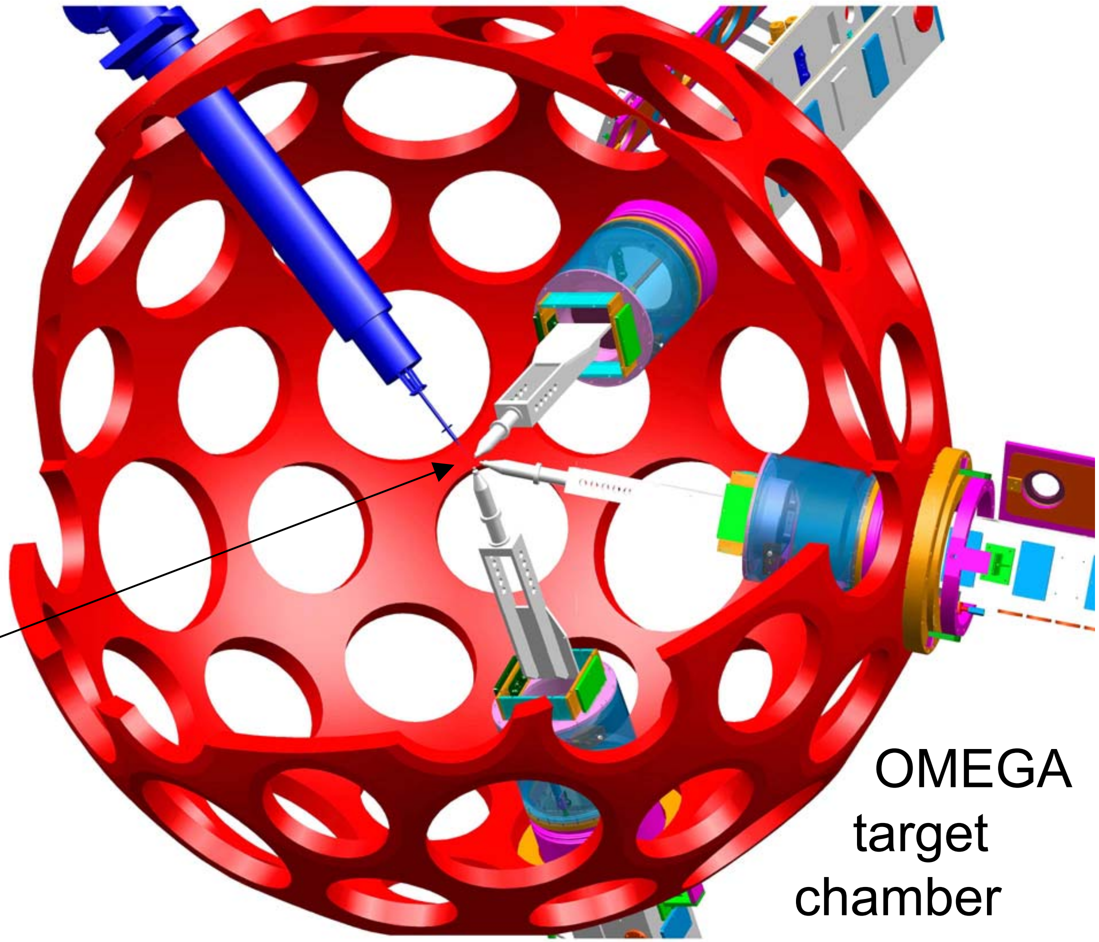
# Three orthogonal proton imaging cameras are used at OMEGA

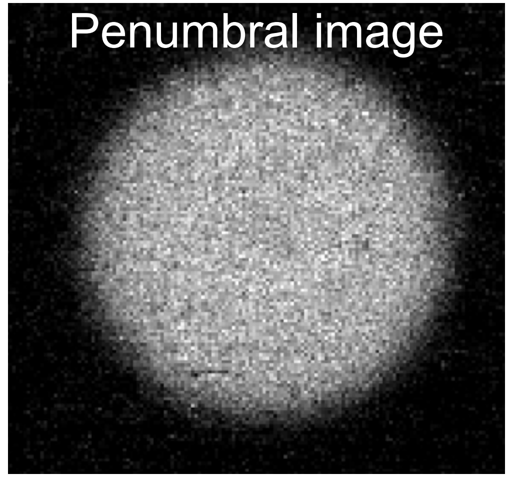


Target capsule

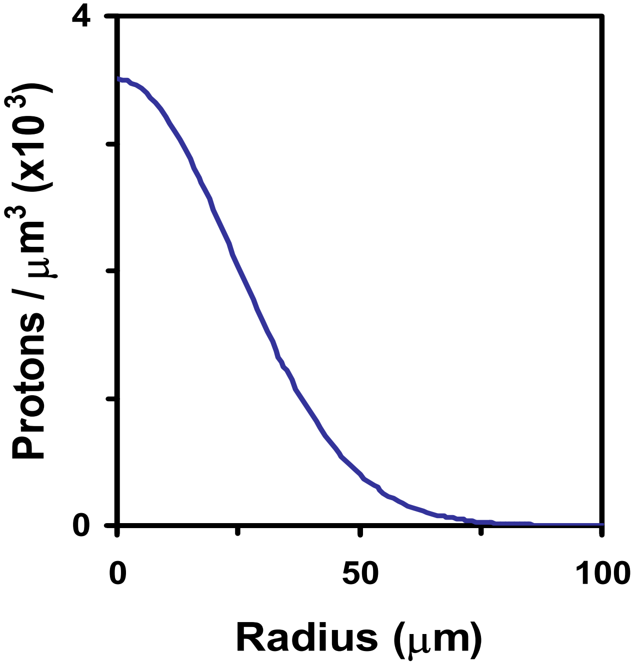
OMEGA target chamber

~ 320 cm

# Information about the spatial distribution of burn is extracted from penumbral images in two ways*

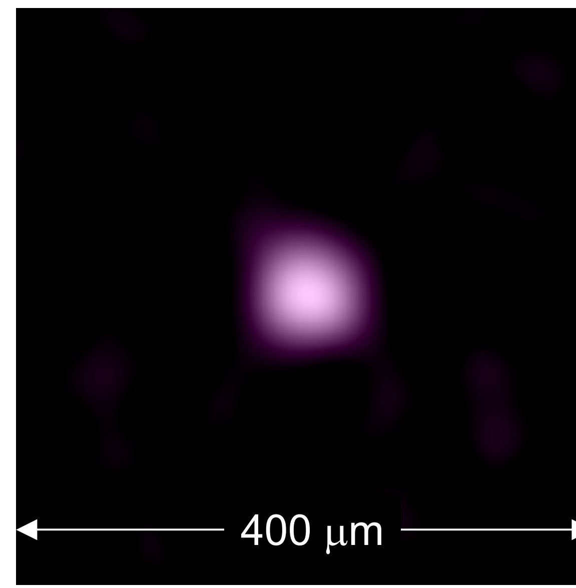



**1-D reconstruction:**




spatial-
domain
deconvolution

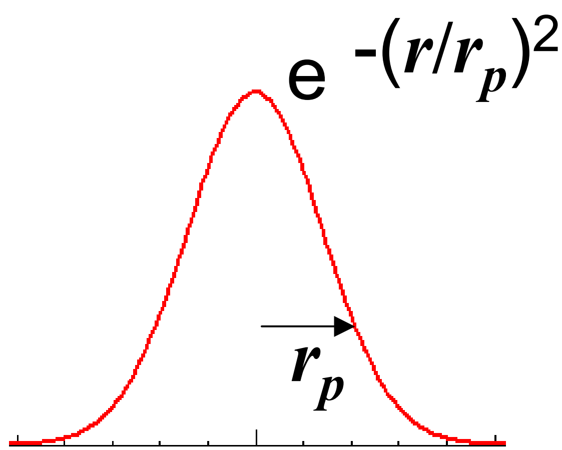
**2-D reconstruction:**

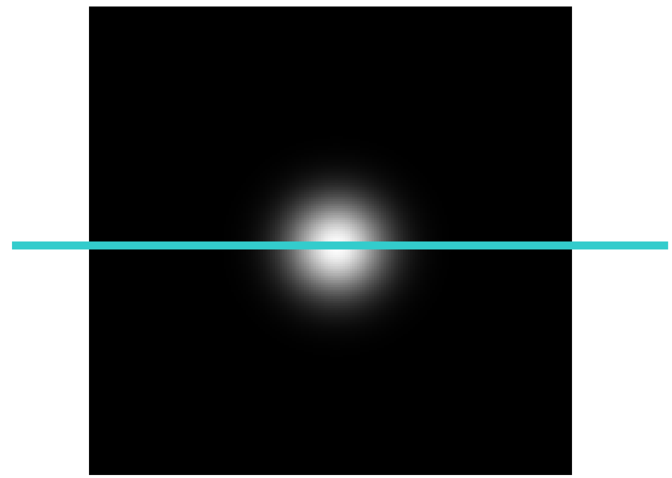



* Séguin *et al.*, RSI **75**, 3520 (2004)

# Spatial resolution in 2-D reconstructions is limited by noise filtering

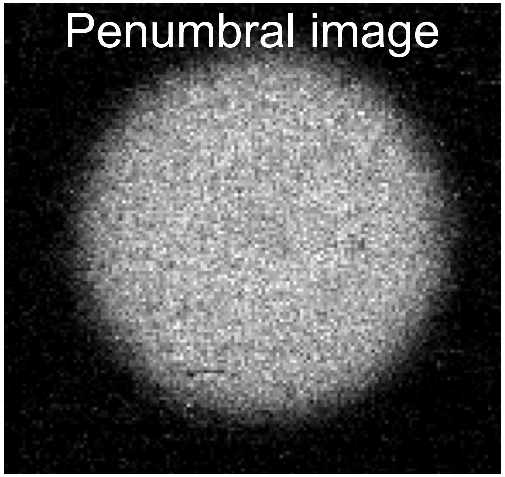
**The noise filtering used here results in a Gaussian point-response function parameterized by a radius $r_p$ :**



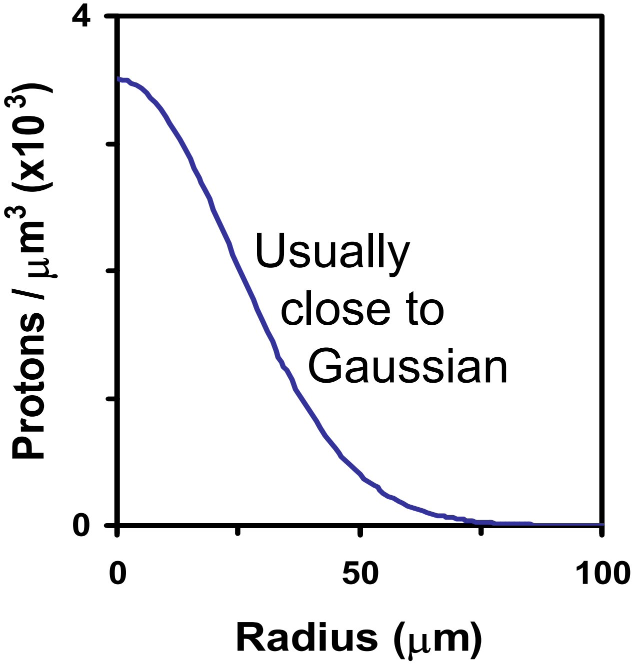
$$r_p \approx 15\,\mu m \left(\frac{r_s}{30\,\mu m}\right)^{4/5} \left(\frac{Y_s}{10^9}\right)^{-1/5}$$

# The 2-D point-response function broadens the true structure



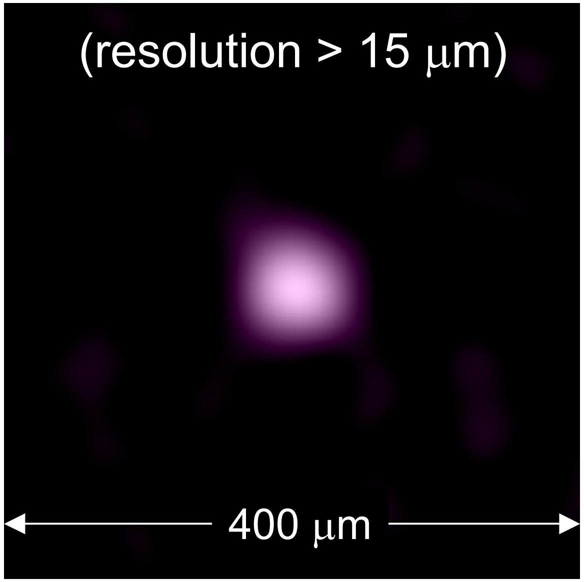

**Constrained in shape:**

**1-D reconstruction:**




**Unconstrained:**

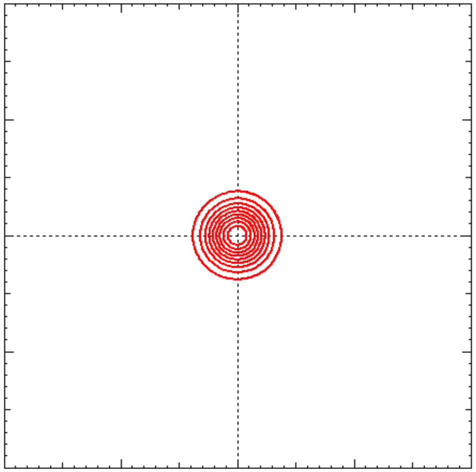
**2-D reconstruction:**



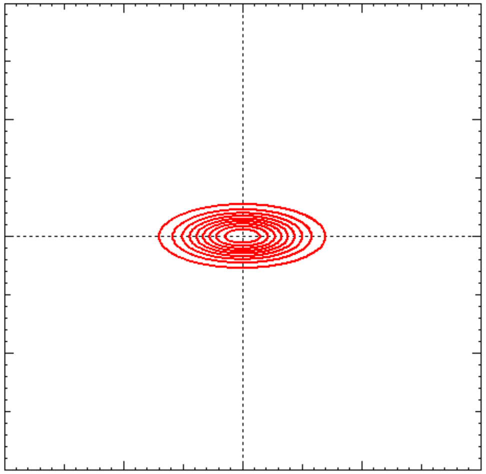
# A modified 2-D algorithm produces more accurate estimates of source sizes

## by constraining the source to belong to a family of functions

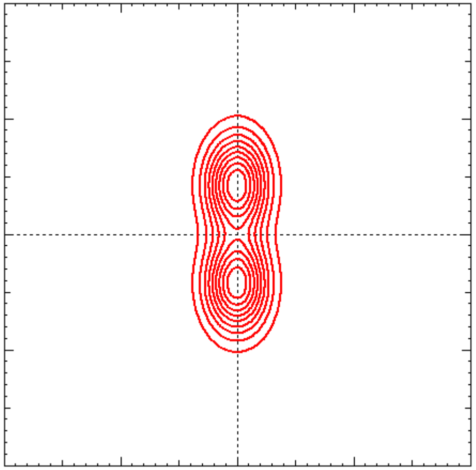
Circular, with Gaussian radial profile



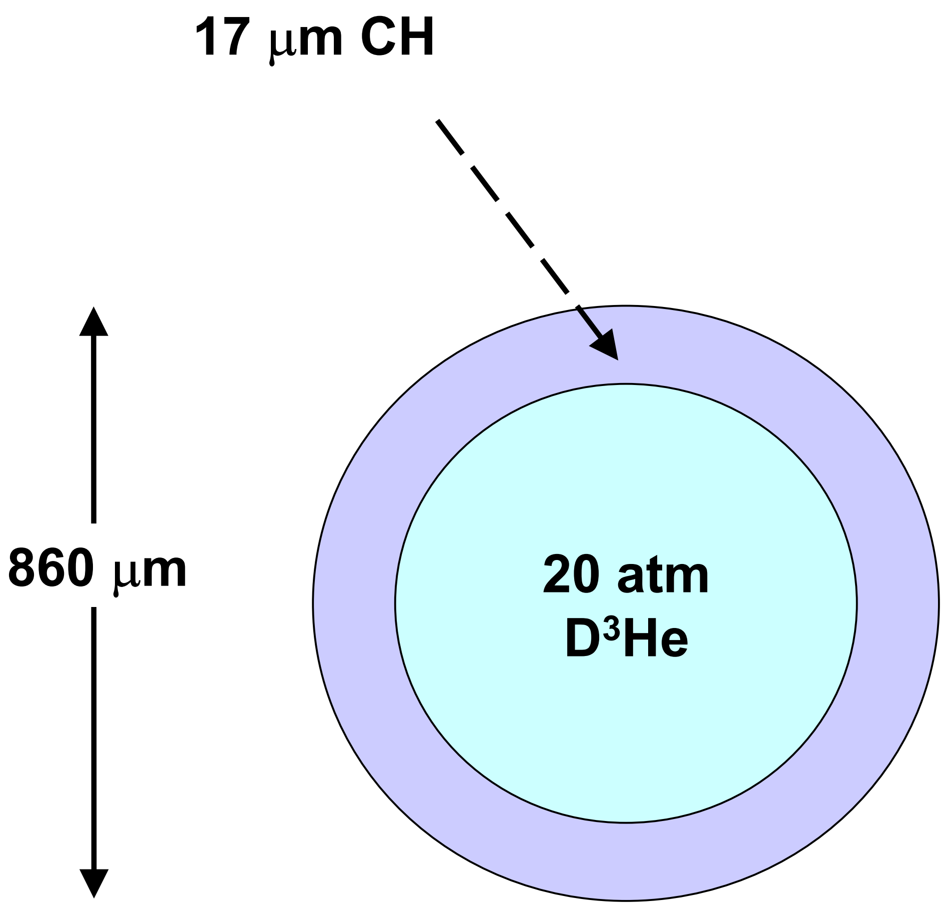
Elliptical, with Gaussian radial profiles



2 ellipses, with Gaussian radial profiles



# The cameras were used to study burn asymmetry resulting from imposed laser drive asymmetry at OMEGA

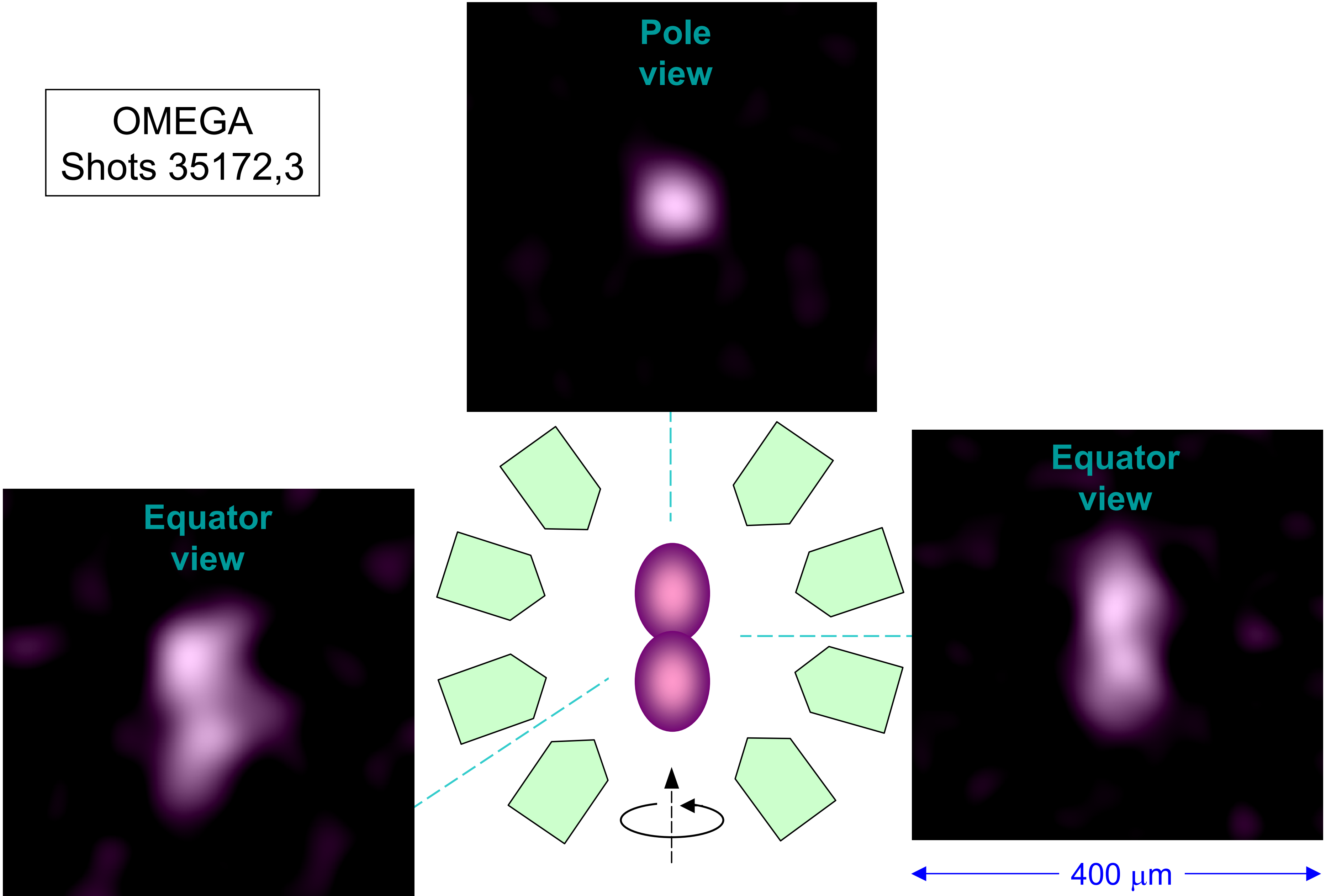



18 kJ laser light

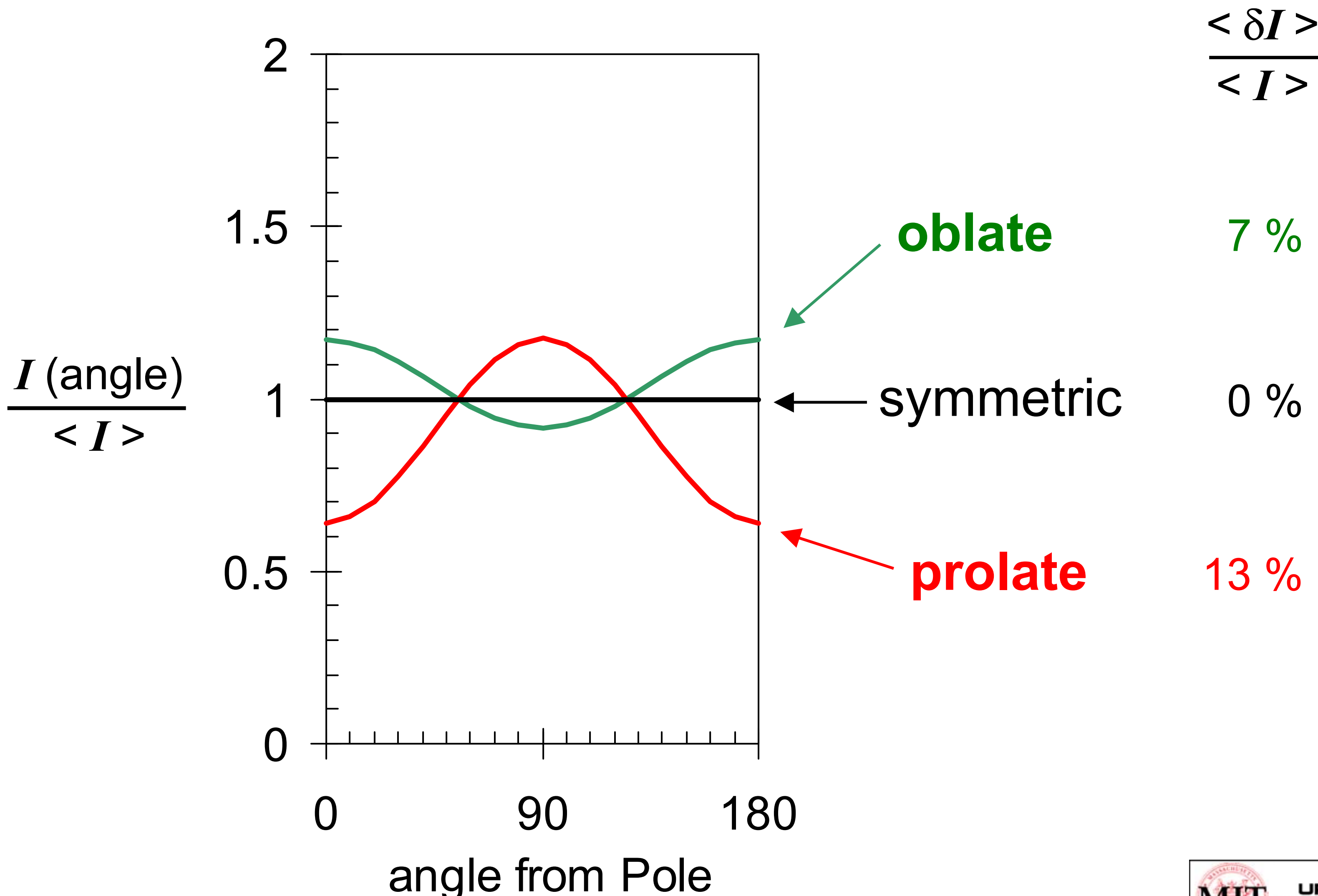
1-ns square pulse

# Prolate drive

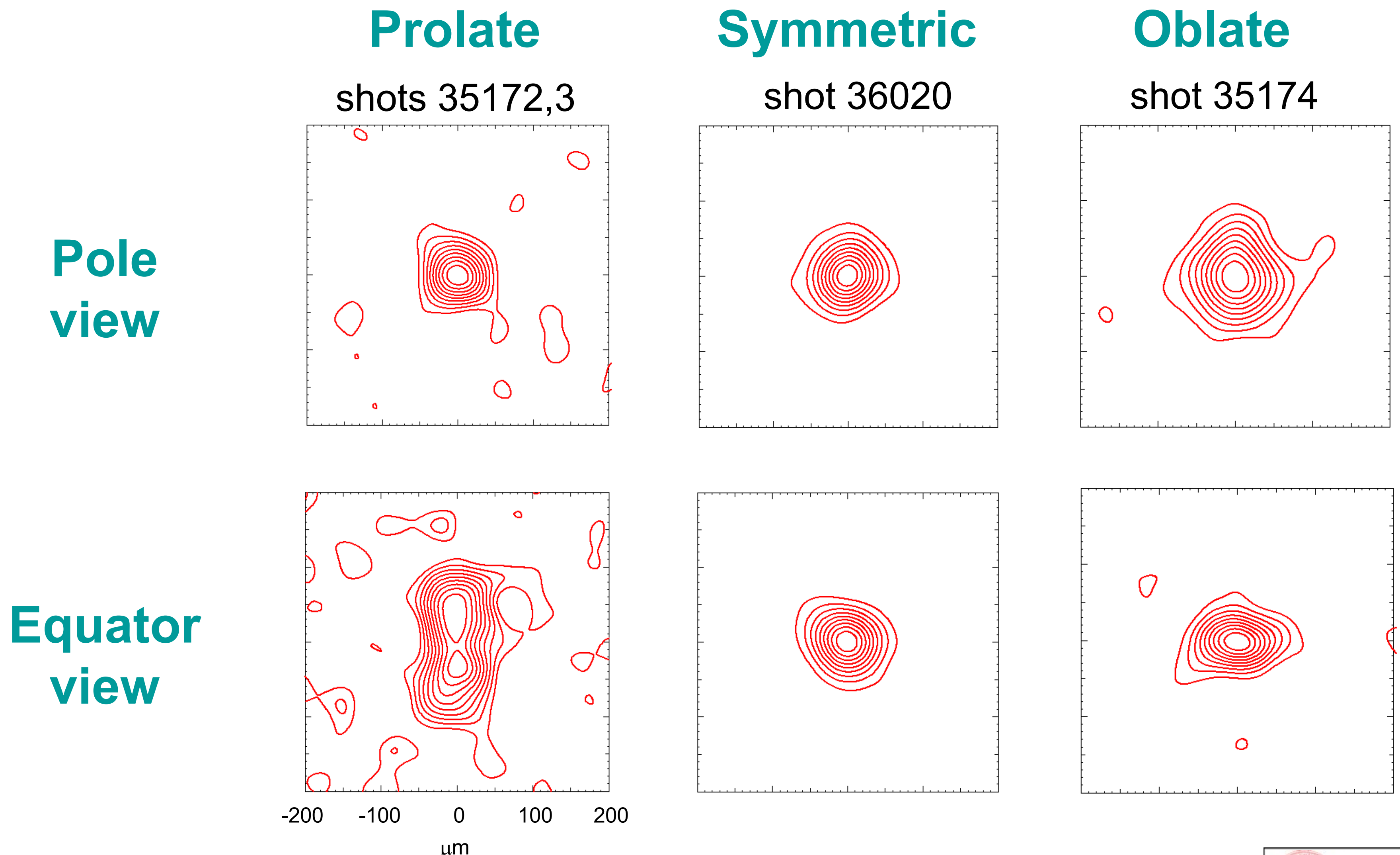
OMEGA
Shots 35172,3



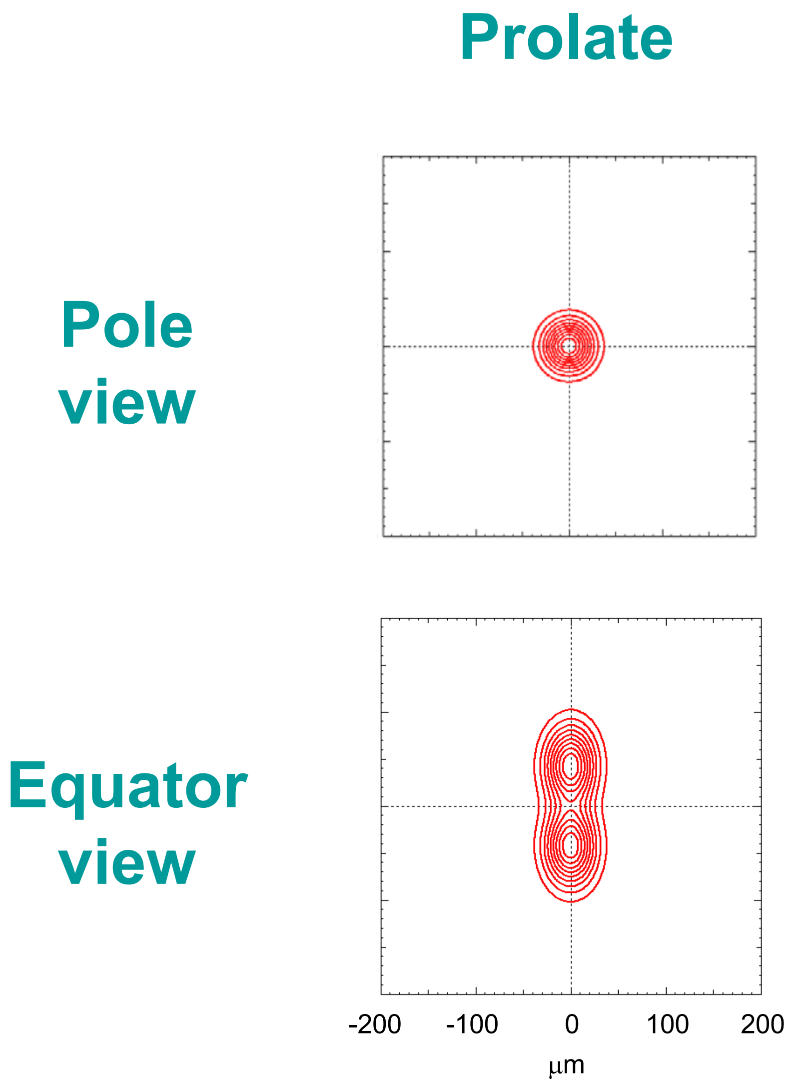
# Three different axially-symmetric laser drive schemes have been compared



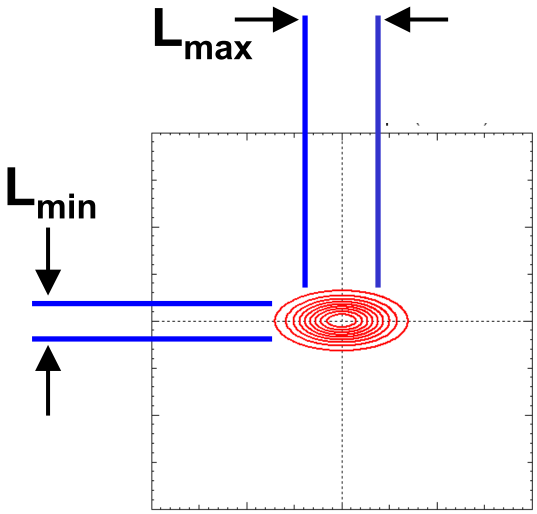
# Different drive asymmetries generate different burn asymmetries



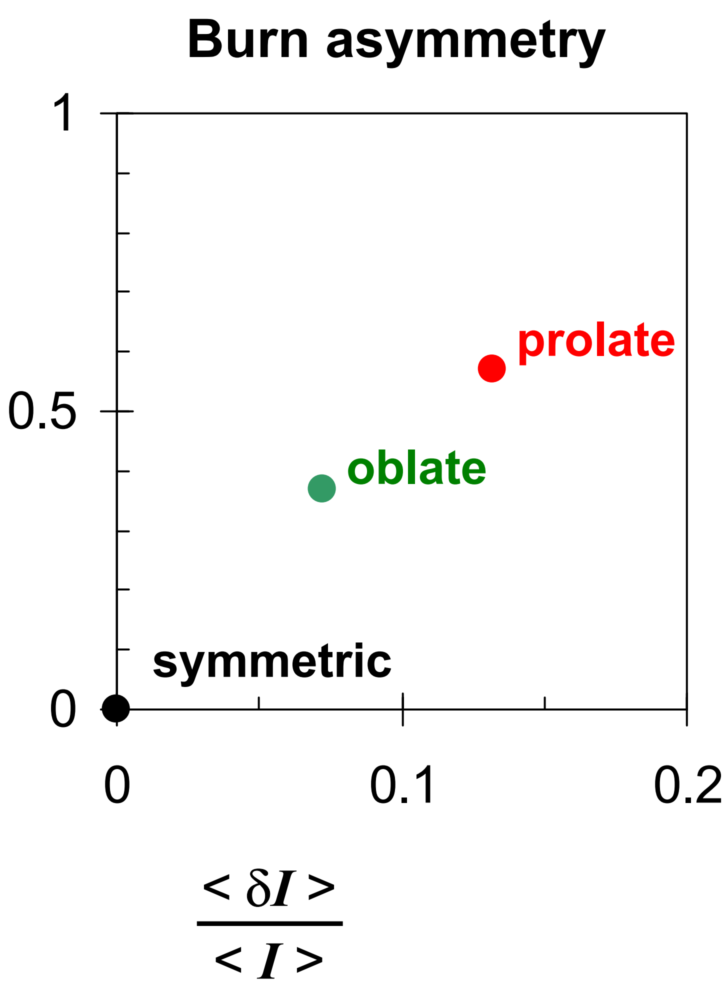
# Constrained reconstructions result in better estimates of actual sizes

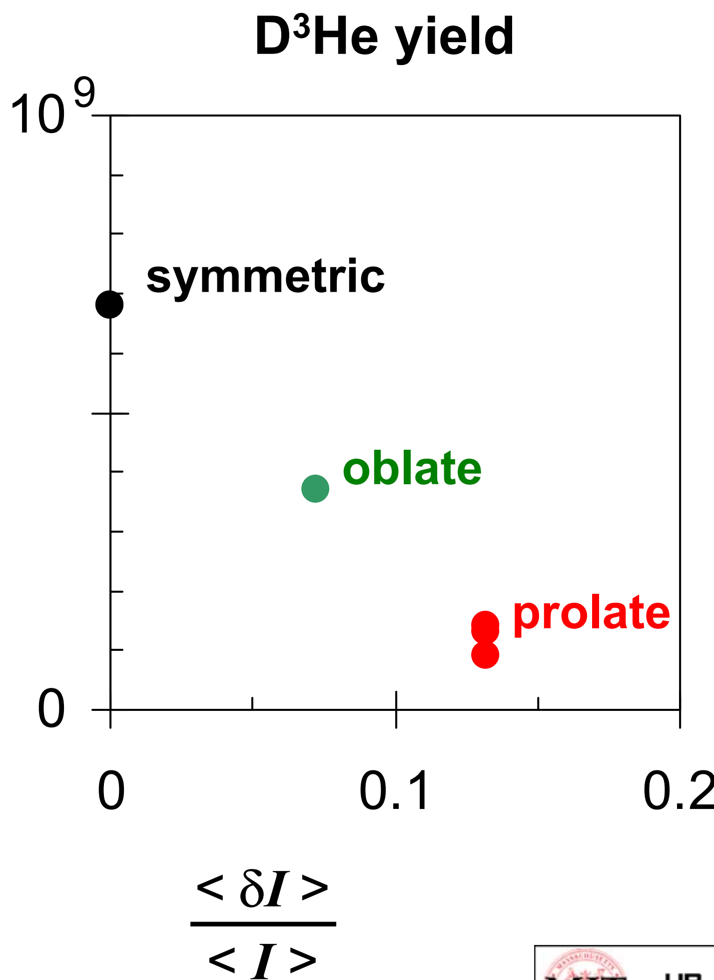


$$\textbf{Burn asymmetry} \equiv \frac{L_{max} - L_{min}}{L_{max} + L_{min}}$$

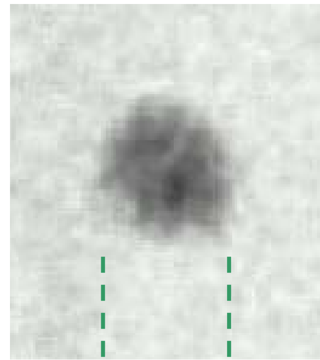


## Increasing drive asymmetry → increasing burn asymmetry
## → decreasing yield



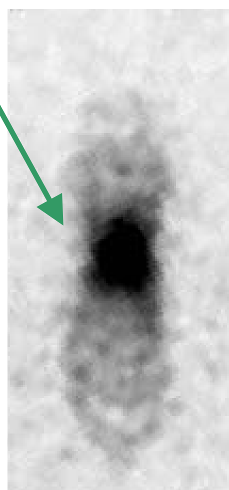



# Burn image structure is roughly consistent with x-ray-image-implied fuel-shell interface

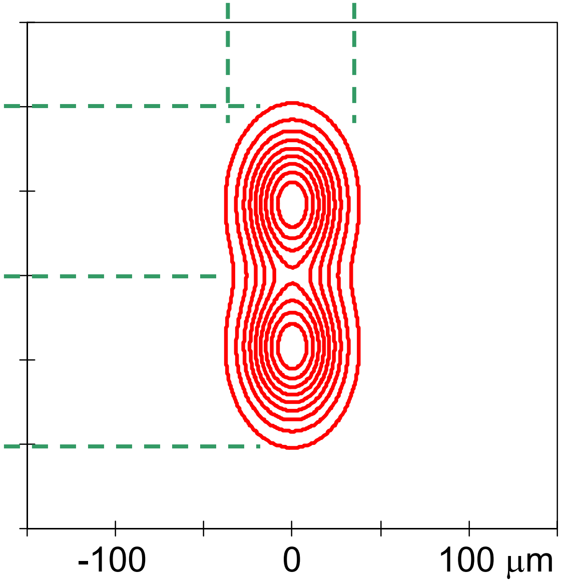


See
Reuben Epstein *et al.*,
H01.013,
x-ray image simulation

Large emission peak shows hot shell material near axis

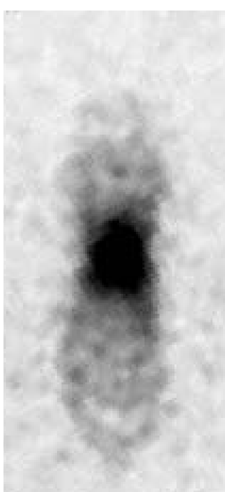


xrfc at peak burn
( ~ 4 – 5 keV )
shot 35173

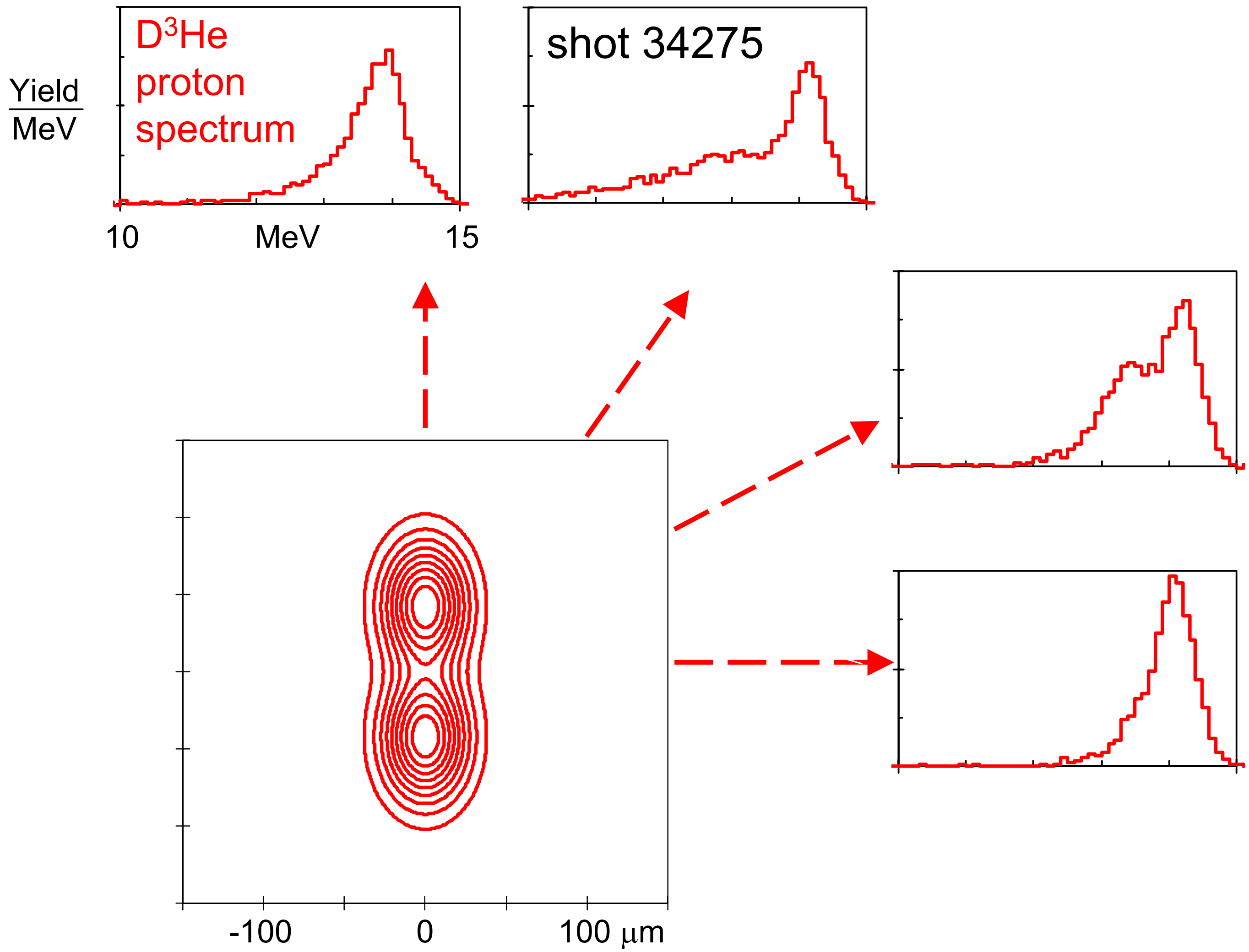



$D^3He$ burn
shots 35172,3

# Proton spectra provide additional information and strong constraints on capsule structure

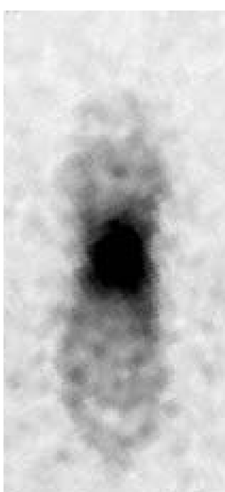


xrfc at peak burn
shot 35173

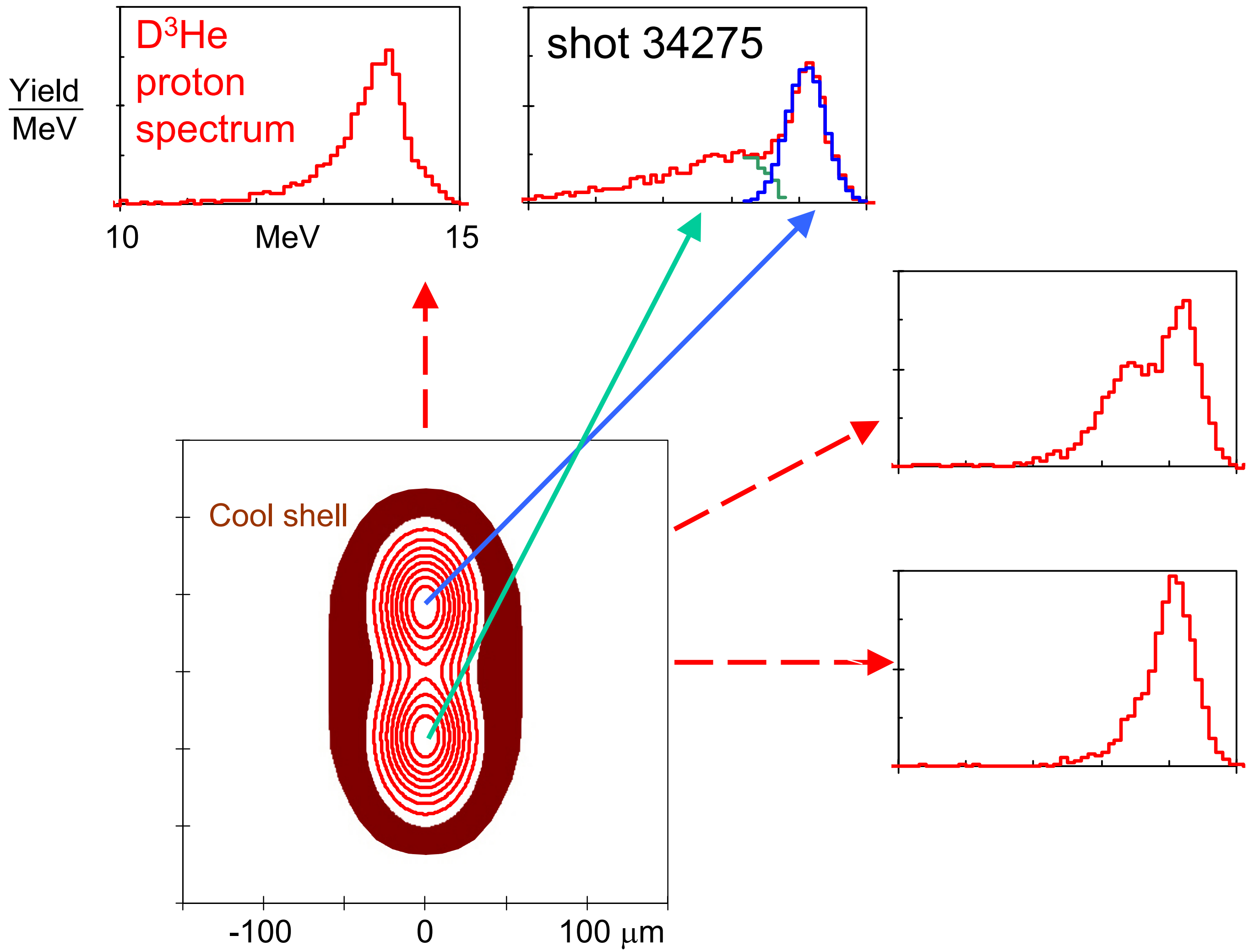



$D^3He$ burn
shots 35172,3

# A self-consistent interpretation of structure involves two emission sources and cool material around the waist



xrfc at peak burn
shot 35173




$D^3He$ burn
shots 35172,3

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