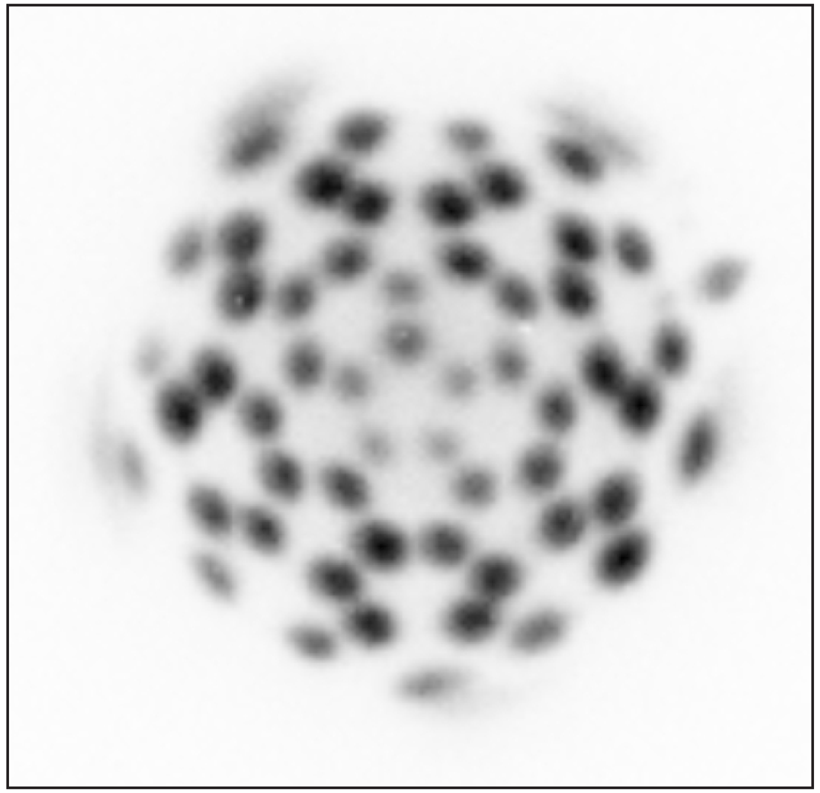
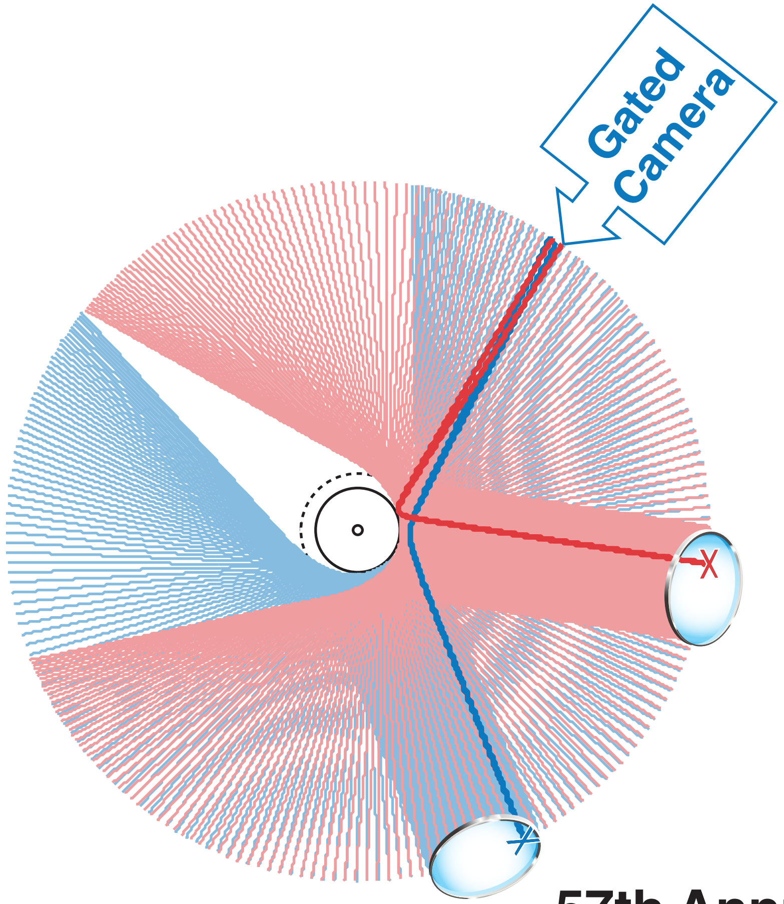
Diagnosing Cross-Beam Energy Transfer Using Beamlets of Unabsorbed Light from Direct-Drive Implosions

Image of 351-nm light
from OMEGA implosions





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Summary

The unabsorbed light from individual beamlets is a powerful tool to diagnose cross-beam energy transfer (CBET)

- Images of 351-nm light from OMEGA implosions show a unique and distinct "spot" corresponding to each drive beam
- Each spot is a record of the unabsorbed light from a single "beamlet" originating from a particular location (impact parameter, polar angle) in the beam profile
- This can be used to diagnose how CBET affects different parts of the beam profile and provide benchmarking for hydrodynamics codes
- A strong variation in the intensity of each spot because of the effect of beam polarization on CBET has been observed

Collaborators

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A 351-nm camera records the unabsorbed light of a beamlet from each OMEGA beam

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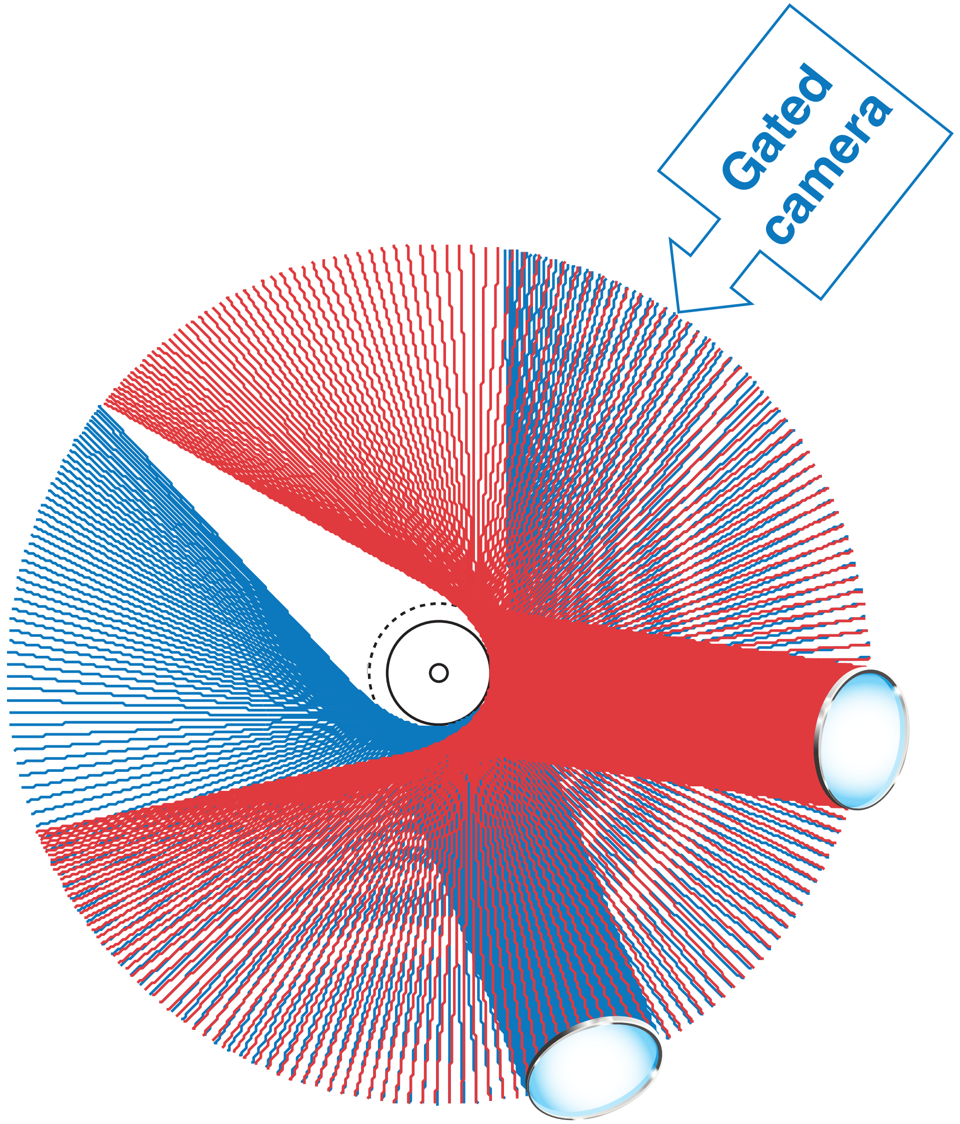
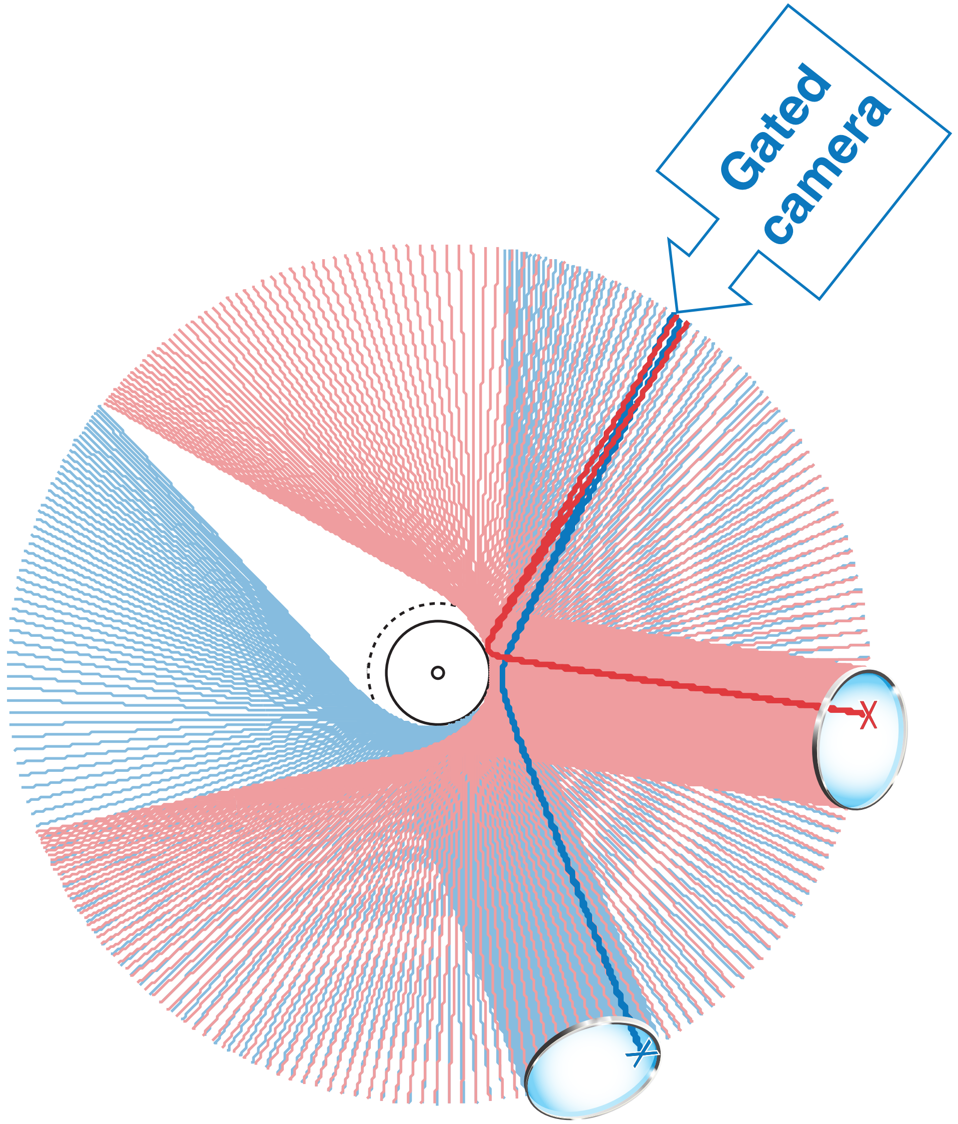
- **Light reaches a scattered-light detector originating from each beam**



E24108a

A 351-nm camera records the unabsorbed light of a beamlet from each OMEGA beam

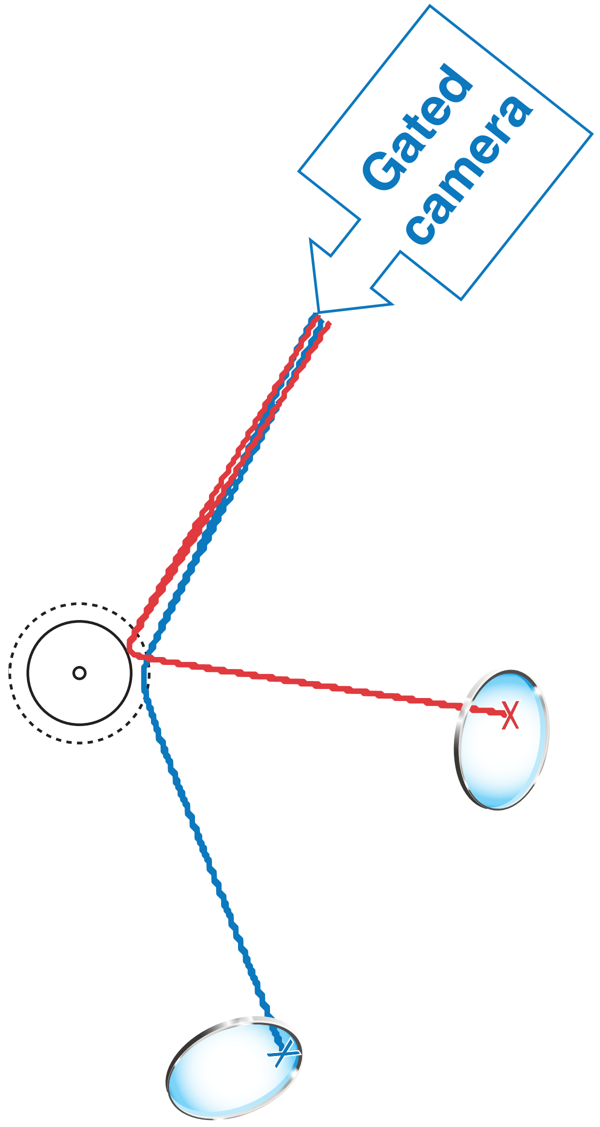
- Light reaches a scattered-light detector originating from each beam
- Recorded light originates from a determinable point in a beam profile
  - – impact parameter
  - – polar angle



E24109a

A 351-nm camera records the unabsorbed light of a beamlet from each OMEGA beam

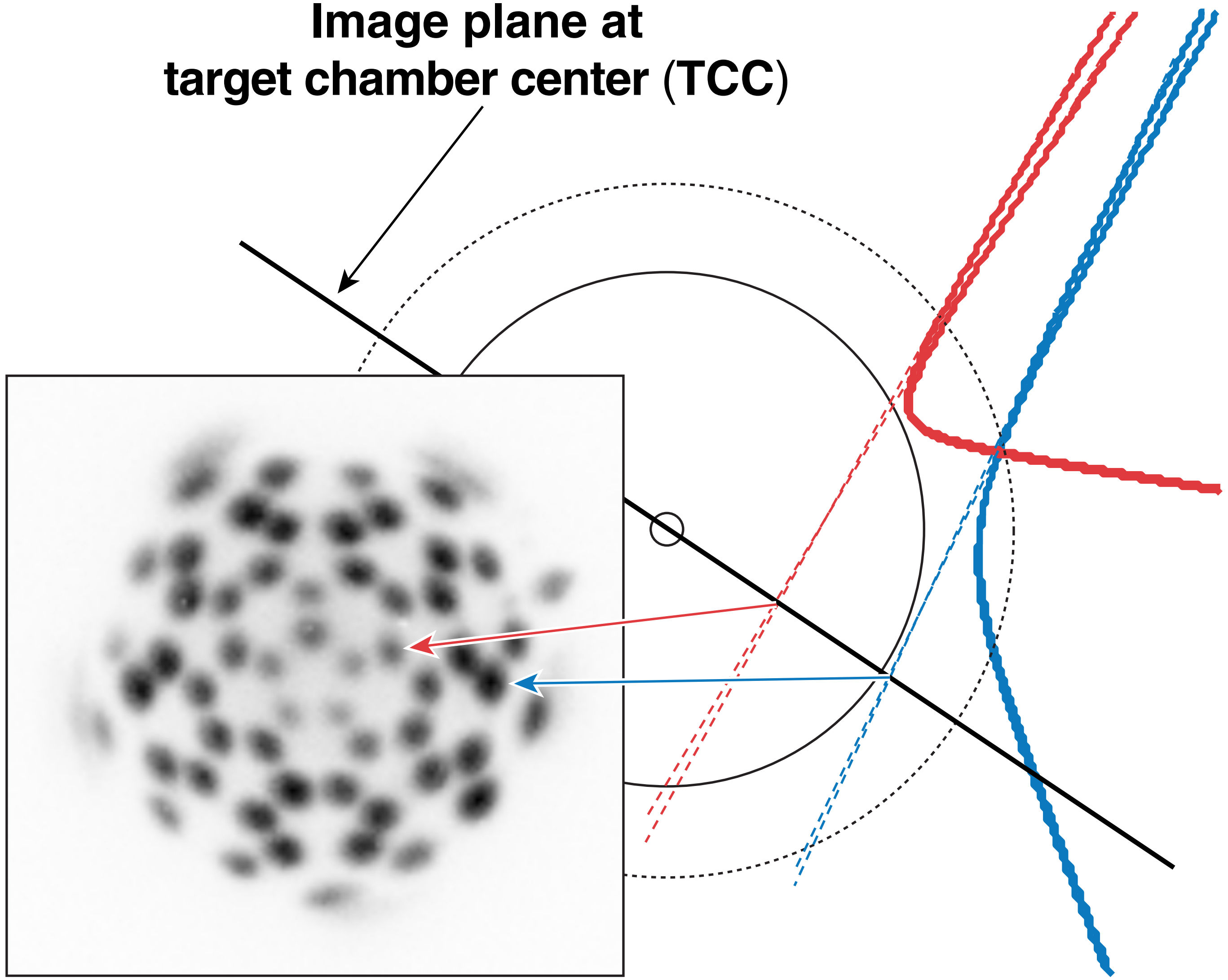
- Light reaches a scattered-light detector originating from each beam
- Recorded light originates from a determinable point in a beam profile
  - – impact parameter
  - – polar angle
- This light can be considered as sampled from a small component of the incident beam
  - – a "beamlet"



E24236a

A 351-nm camera records the unabsorbed light of a beamlet from each OMEGA beam

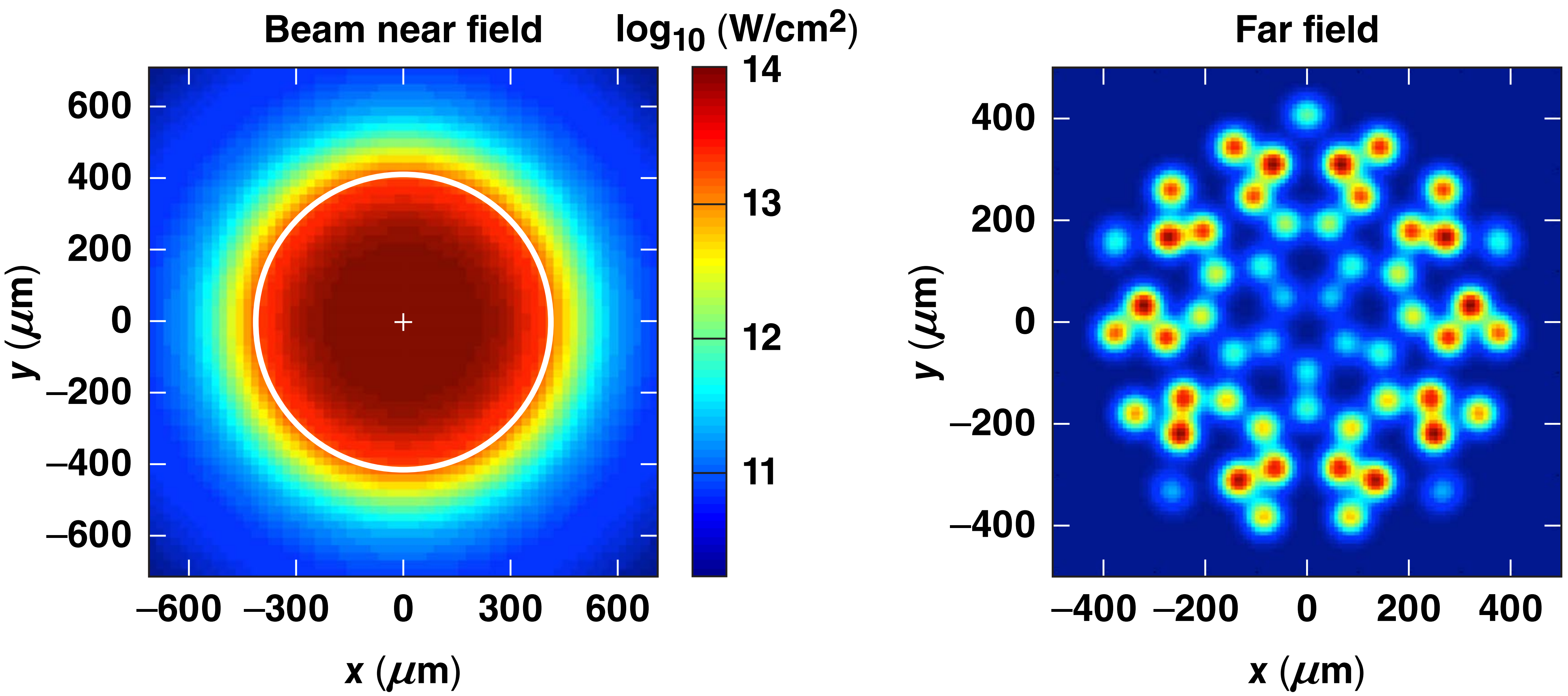
- Light reaches a scattered-light detector originating from each beam
- Recorded light originates from a determinable point in a beam profile
  - – impact parameter
  - – polar angle
- This light can be considered as sampled from a small component of the incident beam
  - – a "beamlet"
- Unabsorbed light from this beam appears as a spot in the image plane



E24237a

Each beamlet originates from a specific location in its beam's profile

Simulated images



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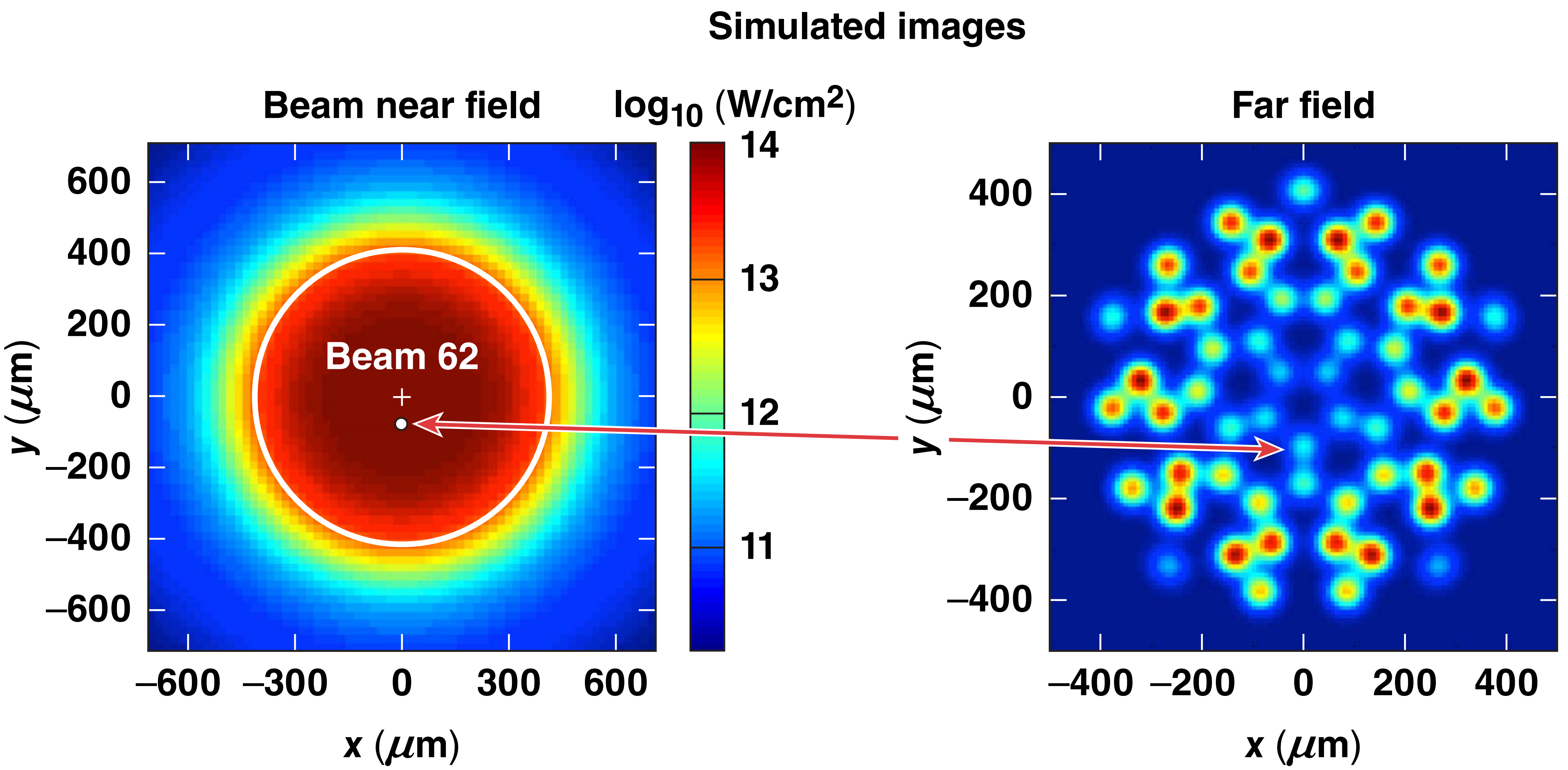
Each beamlet originates from a specific location in its beam's profile



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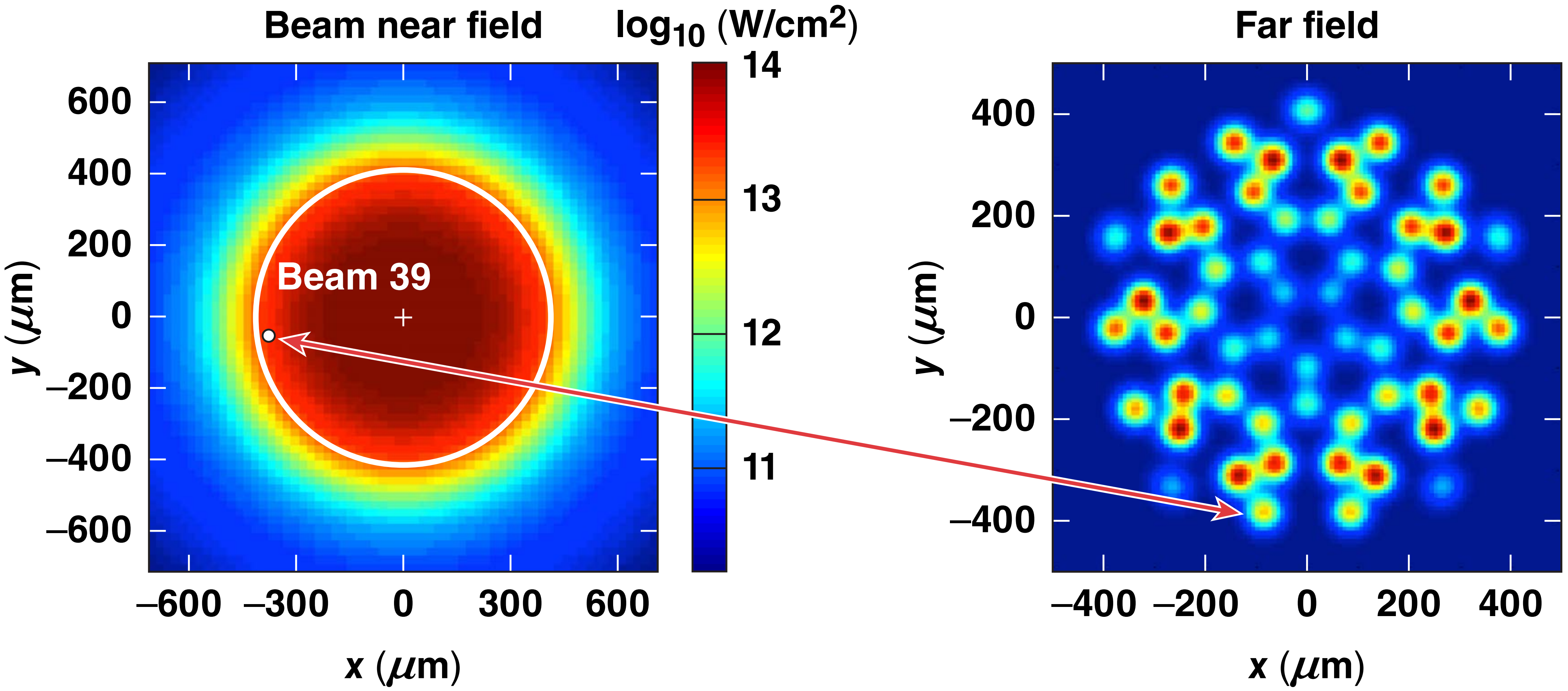
Each beamlet originates from a specific location in its beam's profile

Simulated images



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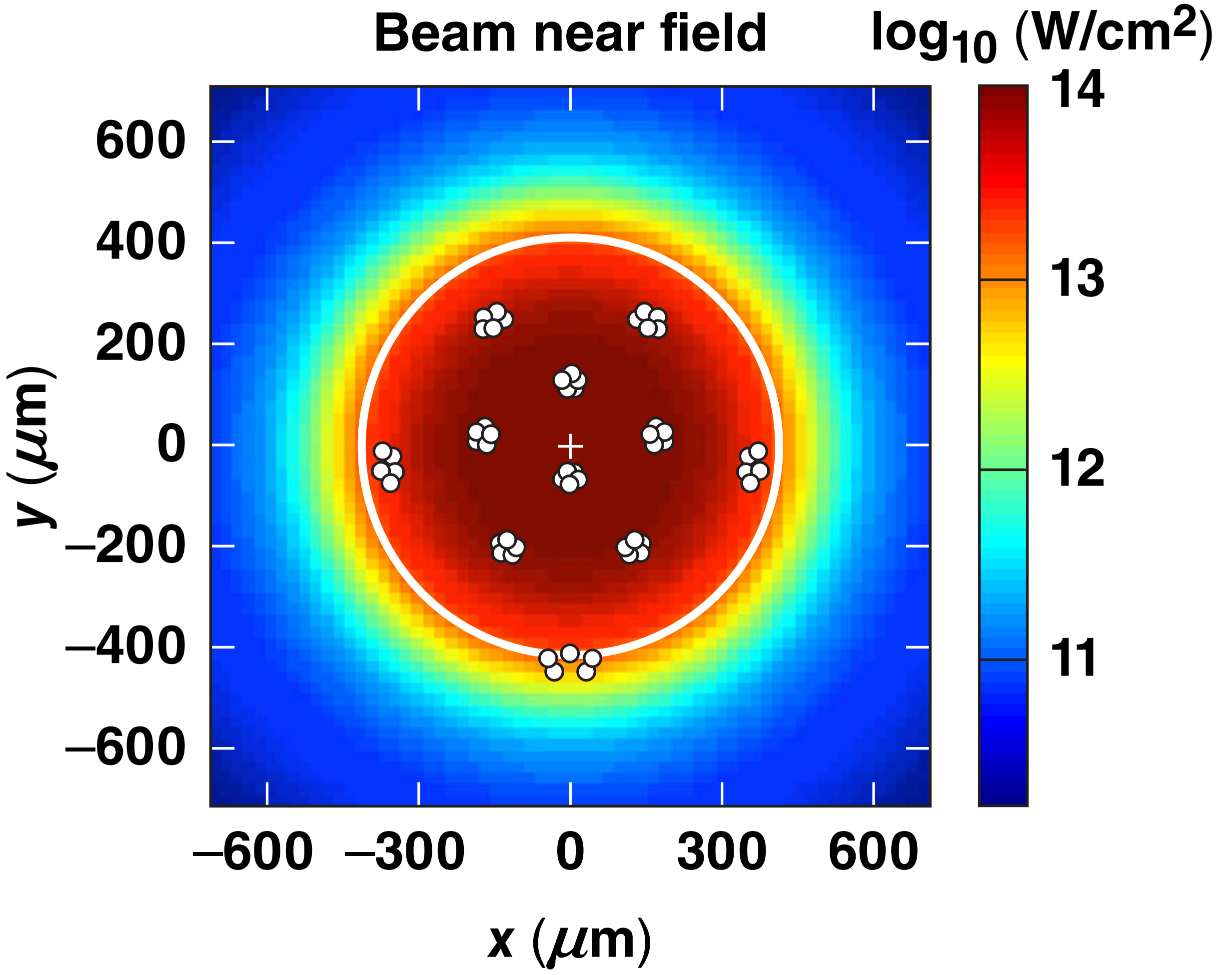
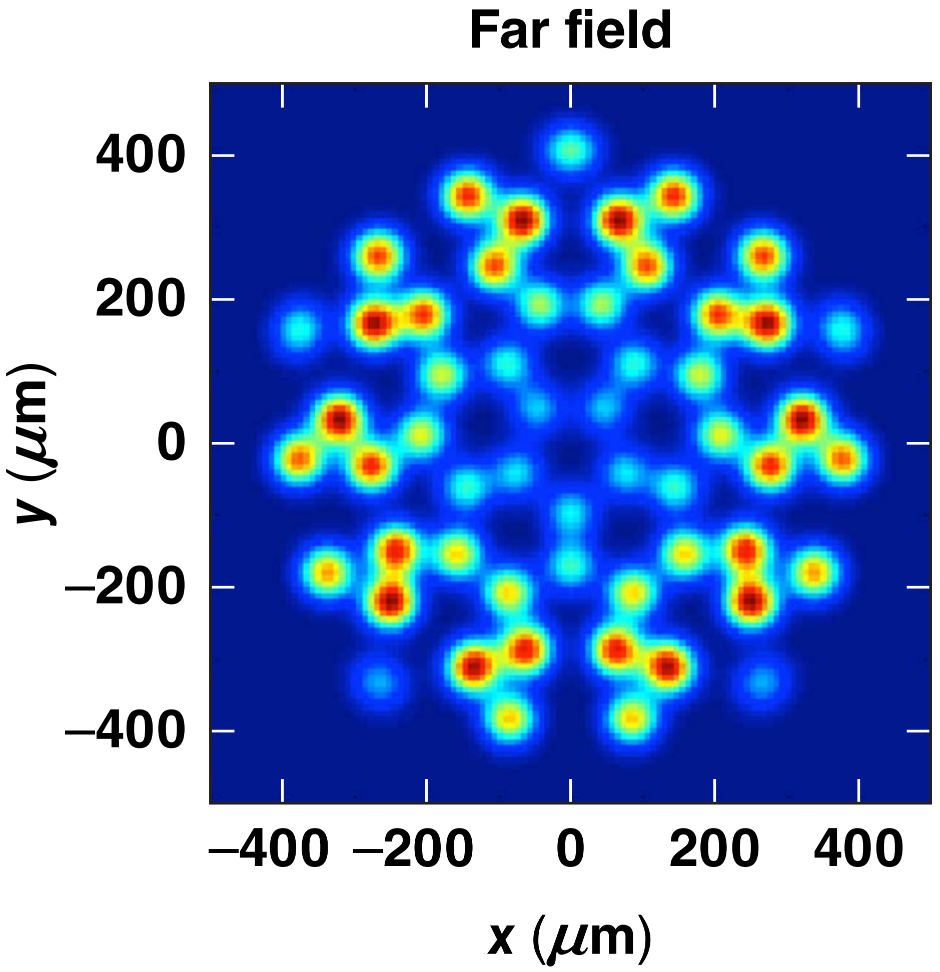
Each beamlet originates from a specific location in its beam's profile

Simulated images





60 identical beams sample CBET along many unique paths in a beam.

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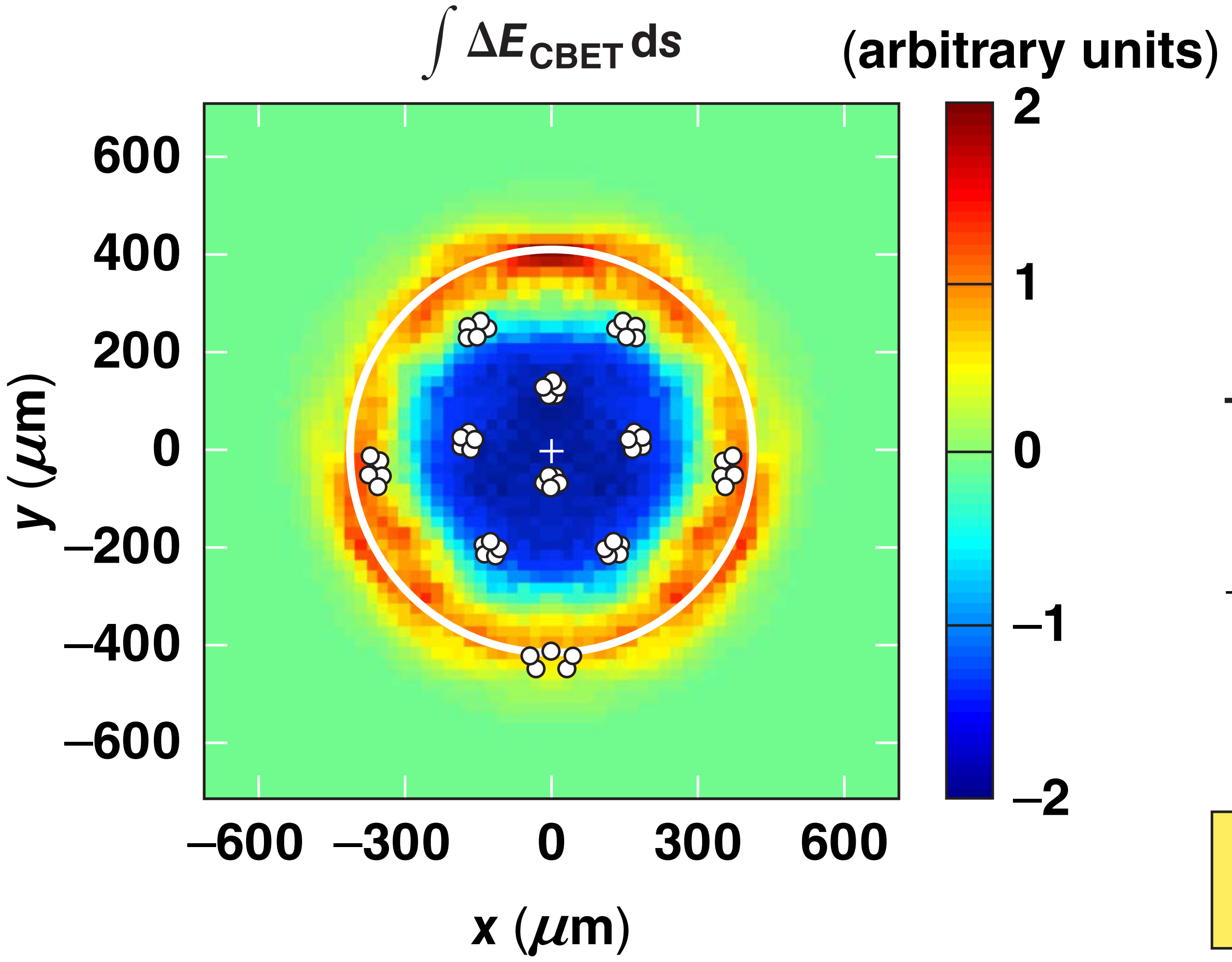
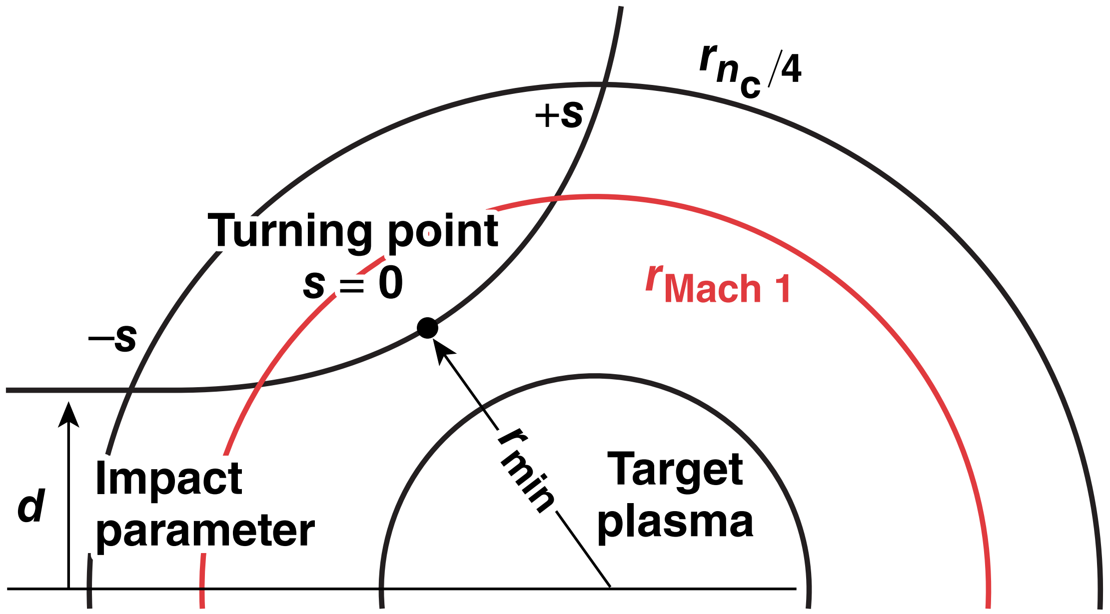
The beamlet spots can be used to diagnose the variation in CBET over a beam profile

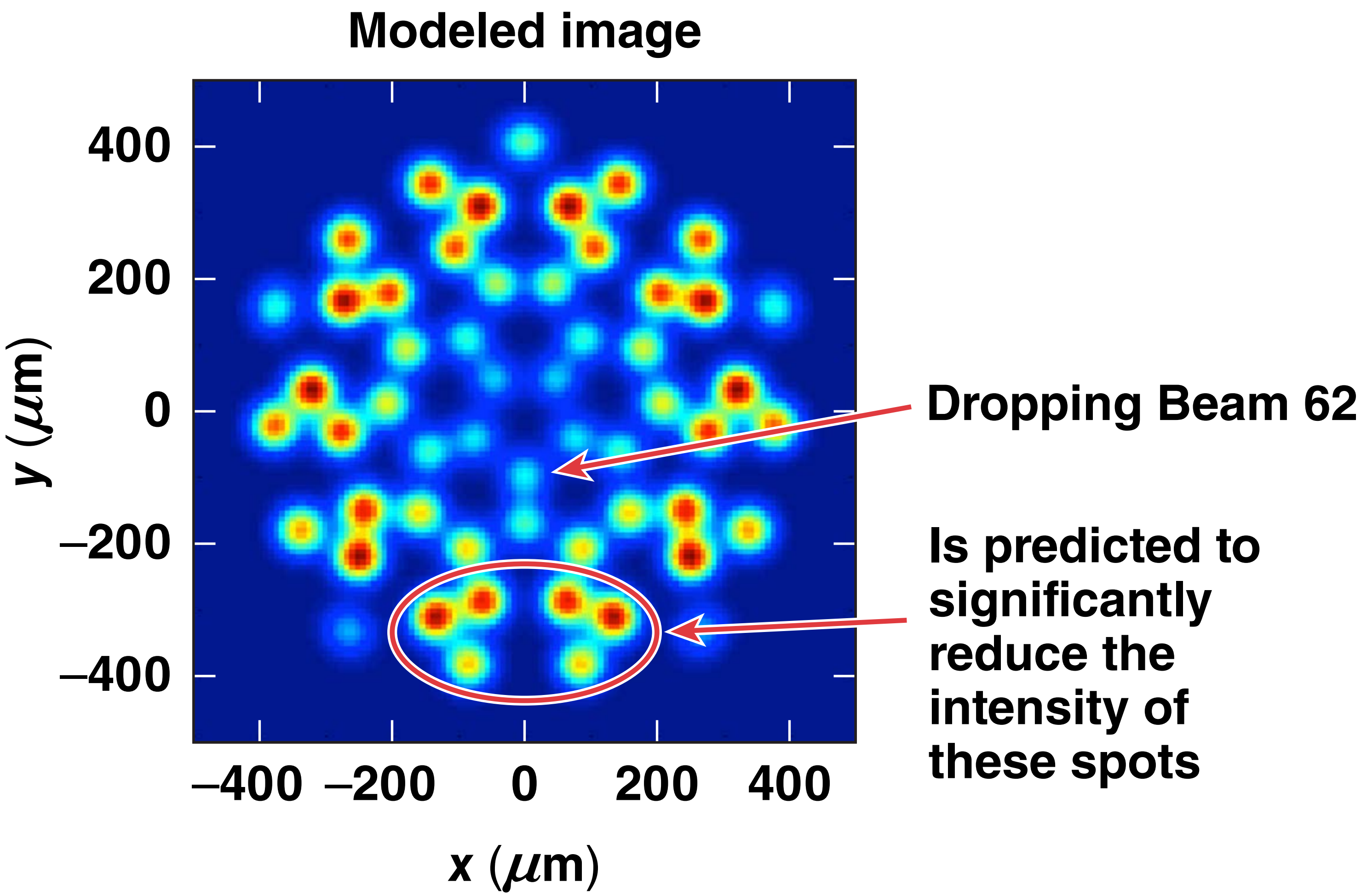


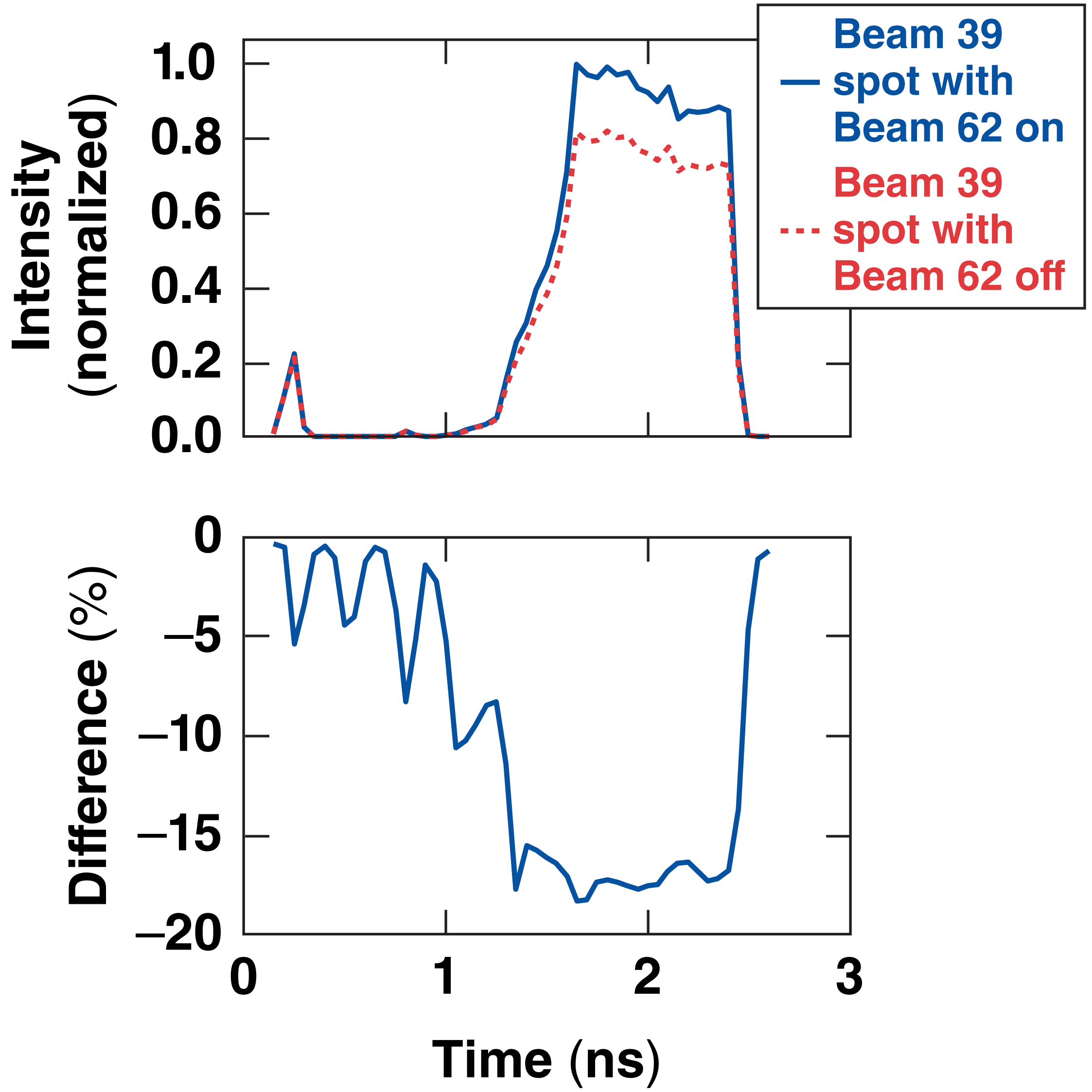


Some of the recorded beamlets experience net loss because of CBET while others a net gain.

E17999b

Three-dimensional CBET modeling predicts that turning off one beam can reduce the intensity of some other spots by over 15%





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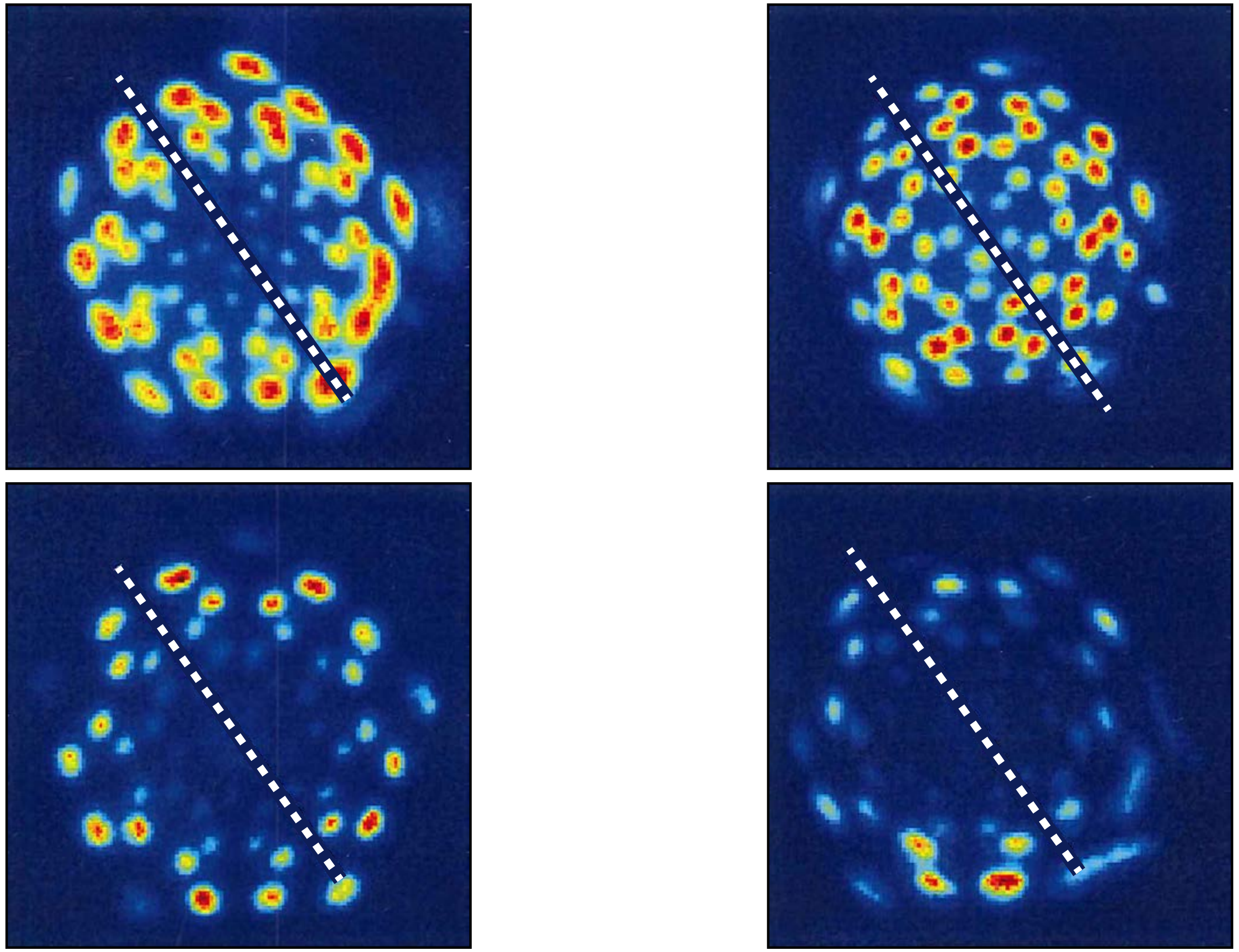
A strong variation in the intensity of each spot caused by the effect of beam polarization on CBET has been observed

- CBET is strongly affected by the relative polarization of crossing beams*
- Without distributed polarization rotators (DPR's) each beam has a different specific polarization
- This destroys the symmetry of the beamlet intensities when CBET is strong as each crosses different beam polarizations

Without polarization smoothing | With polarization smoothing



Early time little CBET

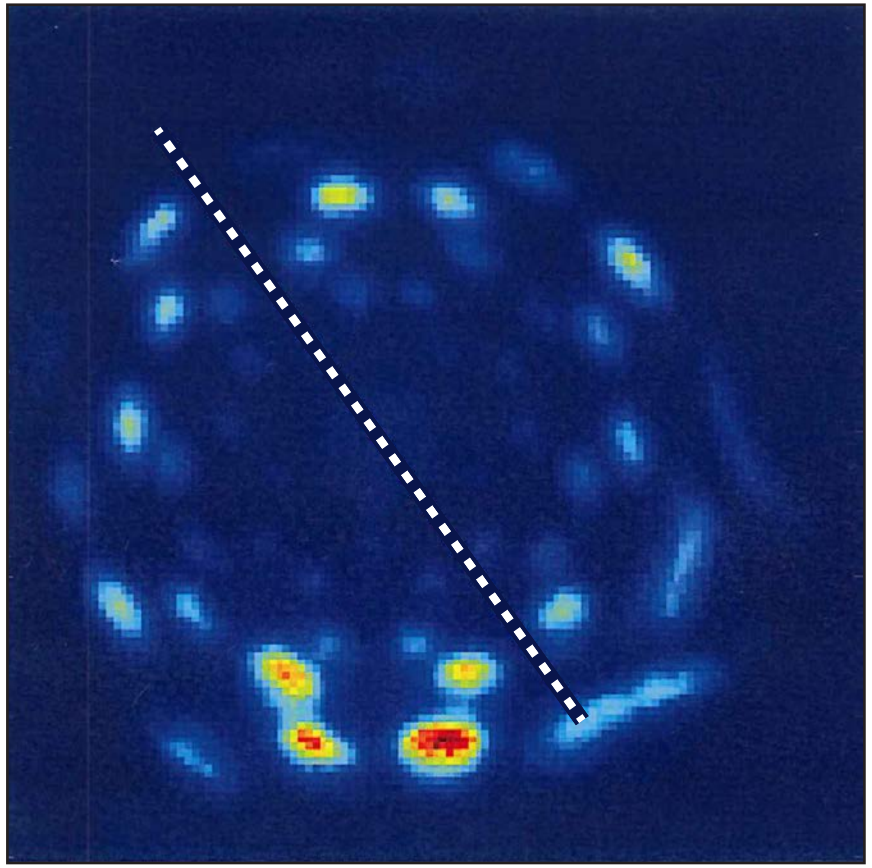
Late time strong CBET

*P. Michel *et al*., Phys. Rev. Lett. 113, 205001 (2014).

E24744

The effect of polarization should be included in CBET modeling

- When a polarized beamlet undergoes CBET with a beamlet of a different polarization, the polarization of both beamlets will be altered*
  - only the shared component of polarization gains/loses energy
- As a result the polarization and intensity of a single beam will vary asymmetrically over its beam profile
- Even with polarization smoothing, some asymmetric variations are expected since polarization will be altered when CBET occurs



This source of implosion nonuniformity must be studied to determine its impact.

*D. Turnbull *et al.*, Rev. Sci. Instrum. 85, 11E603 (2014).

E24745

The unabsorbed light from individual beamlets is a powerful tool to diagnose implosions

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