High Resolution Phase Contrast Imaging of Strong Shock-Cloud Interactions

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FUSION CDT

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EPSRC

X-Ray Phase Contrast Imaging (XPCI)

- Conventional x-ray absorption imaging is limited by it’s need for significant differences in target absorption characteristics.
- In contrast XPCI is sensitive to phase shifts introduced by, for example, the steep density gradients produced by strong shocks and material interfaces.
- This allows for the use of low atomic number targets with greater sensitivity to density gradients, as well as working well with polychromatic sources.

Experimental Setup

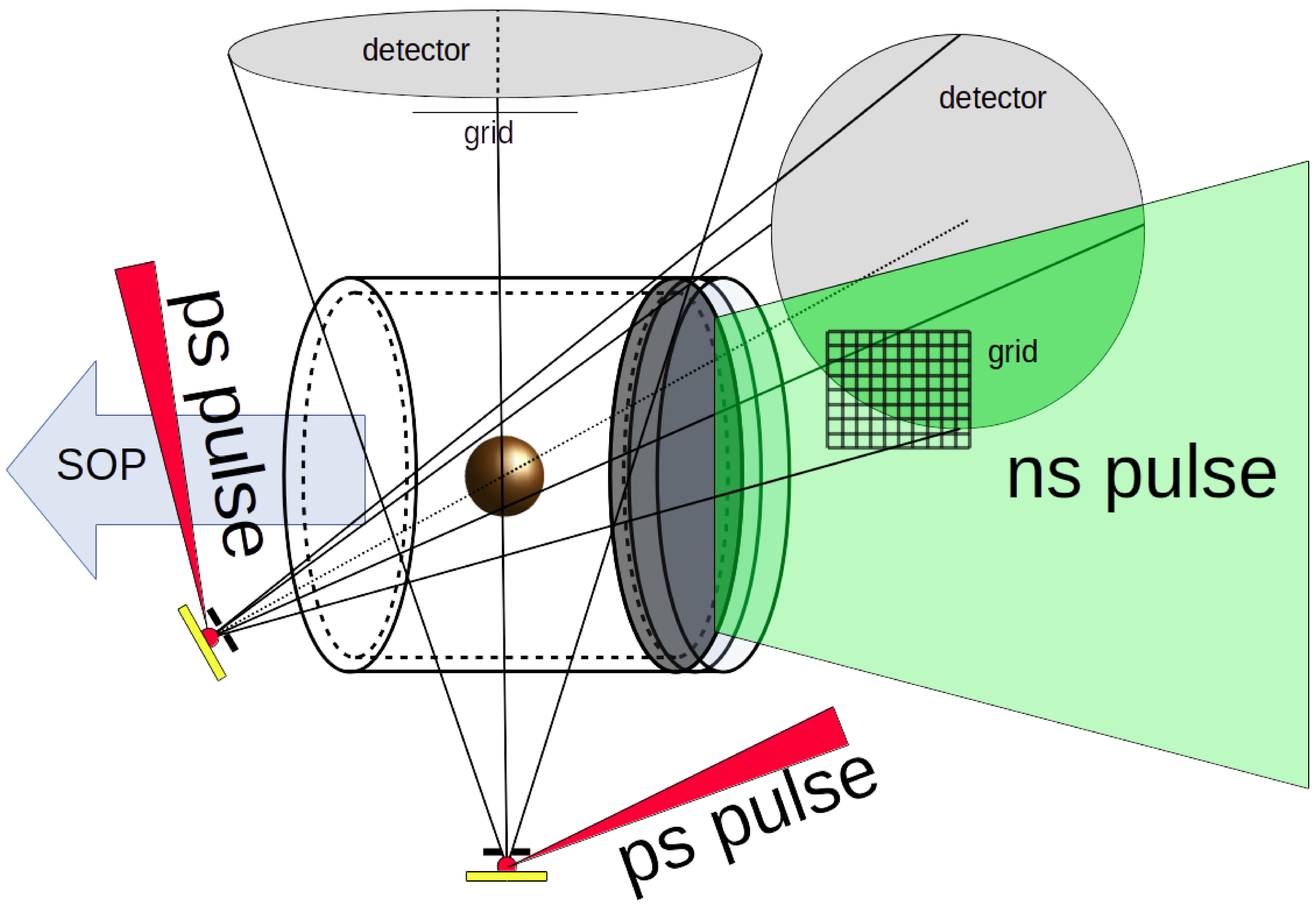

Figure 1: Schematic of possible experimental setup

- The target consisted of a plastic ‘cloud’ of density 1g/cm^3 inserted into a low density foam (200 mg/cm^3).
- Long-pulse beamlines will generate shocks, distort the cloud and initiate Hydrodynamic instabilities.
- Using two XPCI backlighters enables measurements along and transverse to the shock axis.

Target and Beams

Foam cylinders: density 50 -200mg/cm^3 300μm in length with 150μm radius inserted into 25μm thick walled sleeve, plastic ablator and molybdenum radiation shield.
Plastic sphere: polystyrene sphere, 25μm to 75μm radius. This gives a density contrast of 5 to 20.

- Long-pulse beams of nanosecond duration at 2 omega will drive the shock. The pulse duration and energy will be varied throughout the experiment to observe the different responses of the target.
- Two backlighter source size will be minimised with the use of 5μm pin-hole.

DUED Simulations

- Hydrodynamic simulations were performed using the DUED code.
- The output was then fed into x-ray phase contrast and absorption simulation models.

Figure 2a: 0ns into simulation

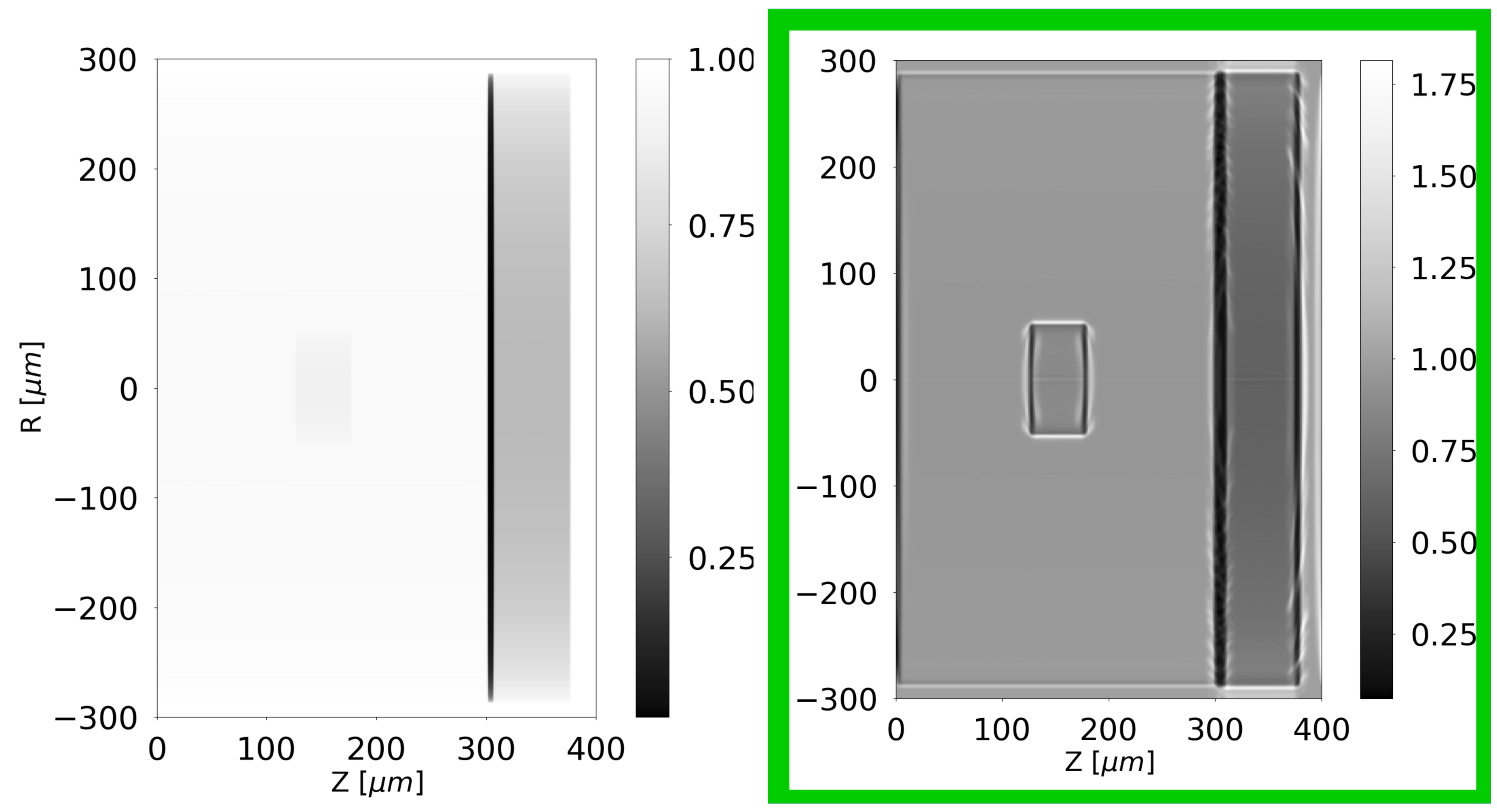

Figure 2b: 5ns after laser firing

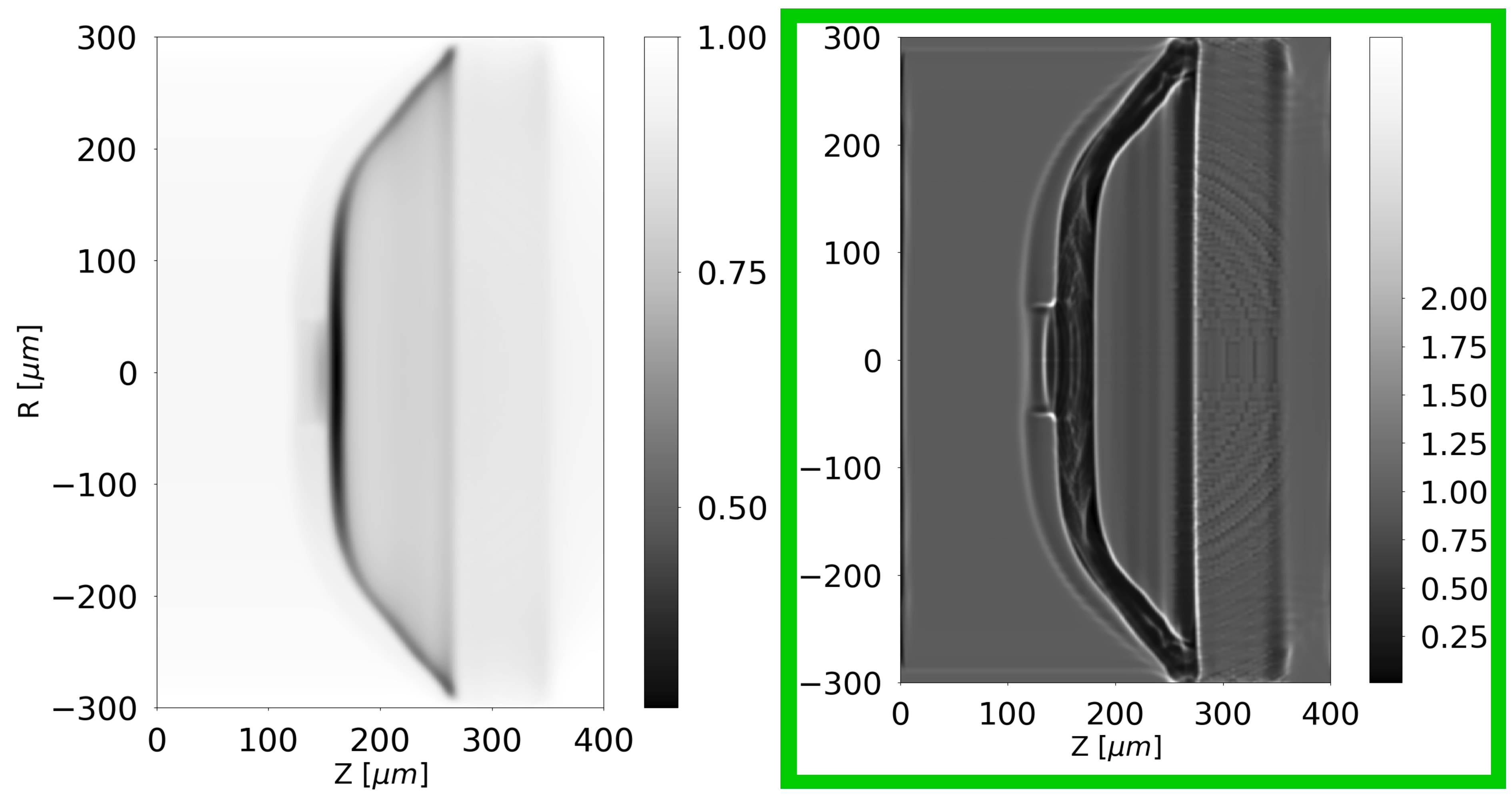

Figure 2c: 7ns after laser firing

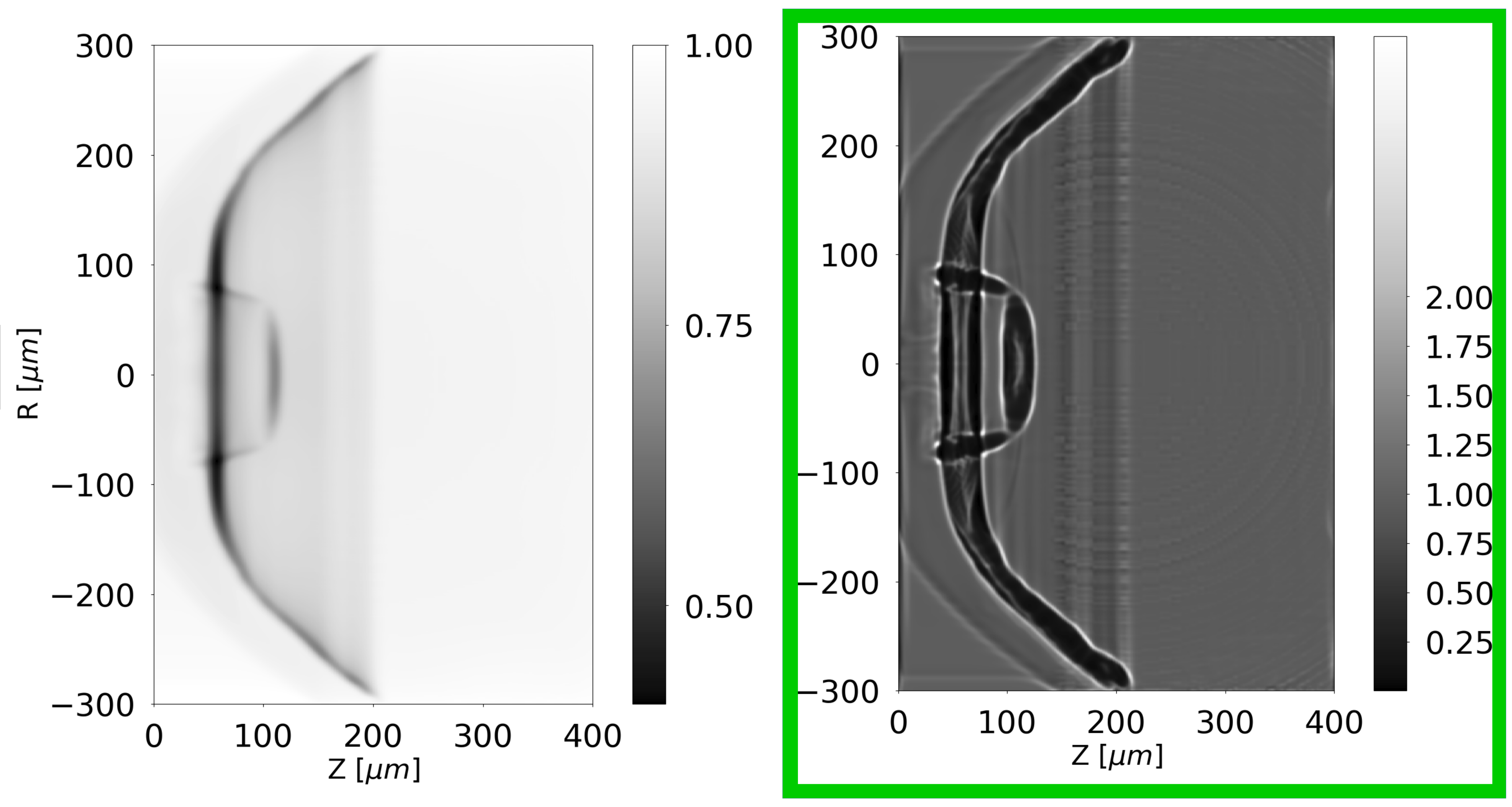

Figure 2: A comparison of simulated images from a shock wave.
Left: X-ray absorption, Right (green): XCPI images
Distance from source to object was 10cm and from object to detector was 40cm. Backlighter had a 5μm source size

References

[1] H.F. Robey, et al., Phys. Rev. Lett., 89, (2002)
[2] J.M. Pittard, et al., Astron. Astrophys., 401, (2003)