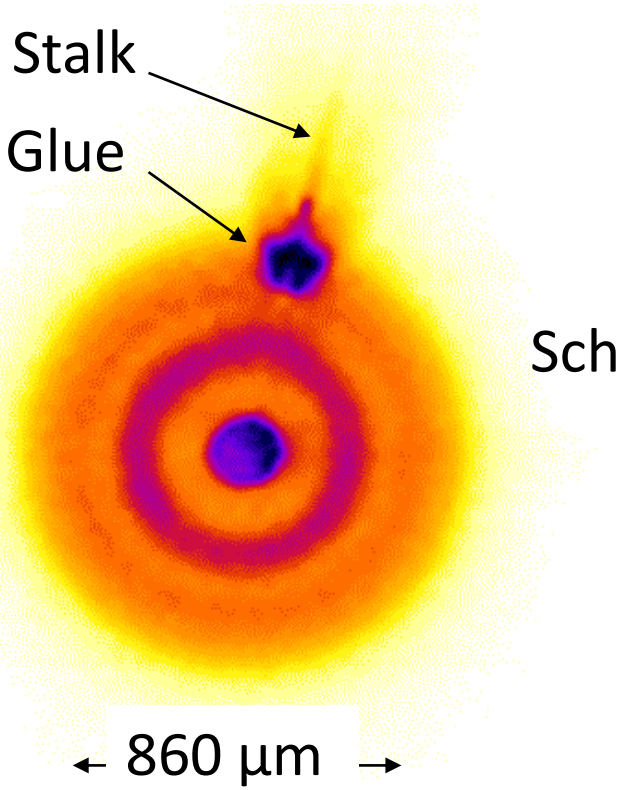
Experimental work related to IFE and UPLiFT



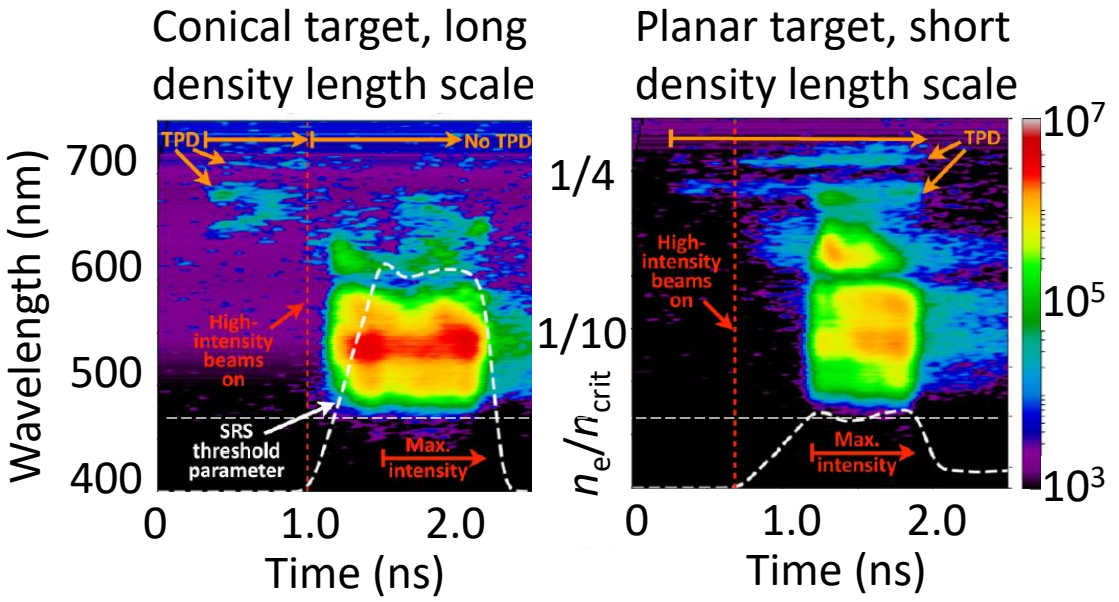
Nigel Woolsey
York Plasma Institute
School of Physics, Engineering and Technology
University of York

UK IFE Meeting
Imperial College London, 26-27 March 2024

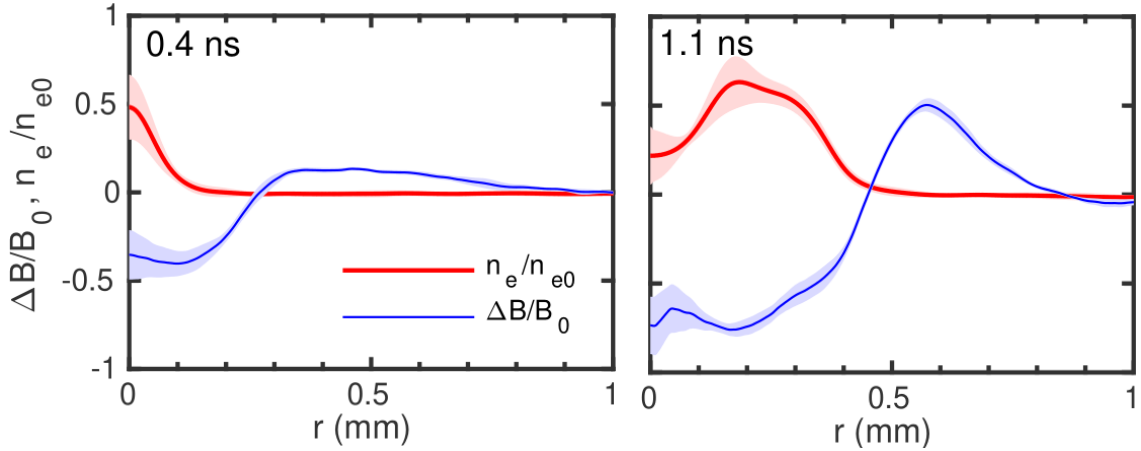
Four principal areas

- Laser-plasma instabilities
  - OMEGA, Vulcan, ELI-beams
- Heat transport
  - Vulcan, OMEGA, (short pulse?)
- Laser-drive imprint
  - EuroXFEL, LCLS-II (high rep)
- Implosion & hot spot energetics
  - OMEGA

+ Diagnostic developments
  Phase contrast imaging
  Hot electron characterisation



Scott et al, PRL 127, 065001 (2021)

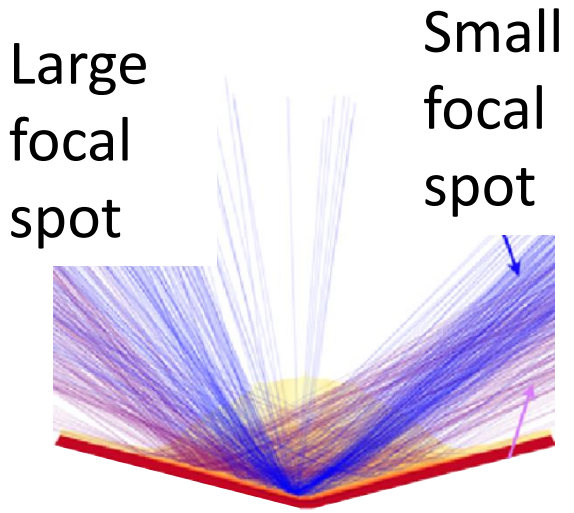


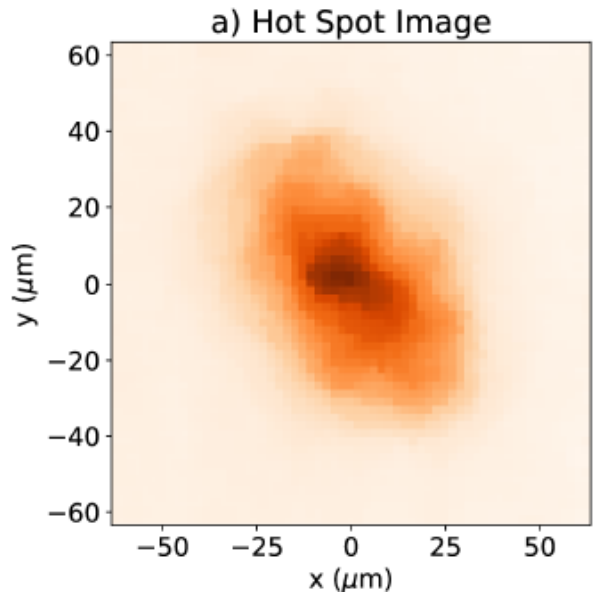
Arran et al., PRL 131, 015101 (2023)

Physics specific & integrated experiments

- Physics specific experiments
  - Access many more facilities – test models but not necessarily in ICF conditions
    - Examples: Nernst, laser imprint
  - Some physics does not readily scale down
    - Examples: Laser-plasma instabilities, CBET etc

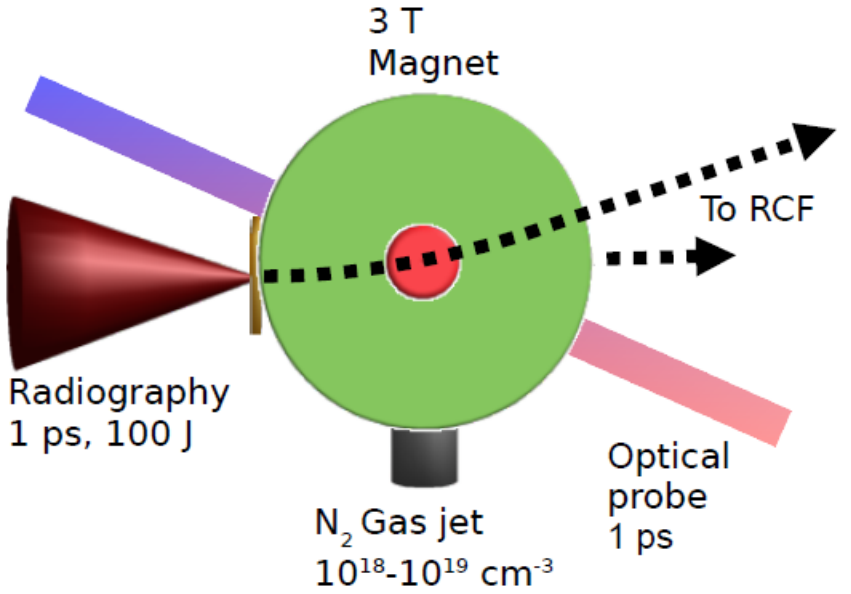
- Integrated experiments – i.e., implosions
  - Primarily using OMEGA
  - Tuning new pulse shape concepts – shock augmented ignition (SAI)
  - Hot spot energetics

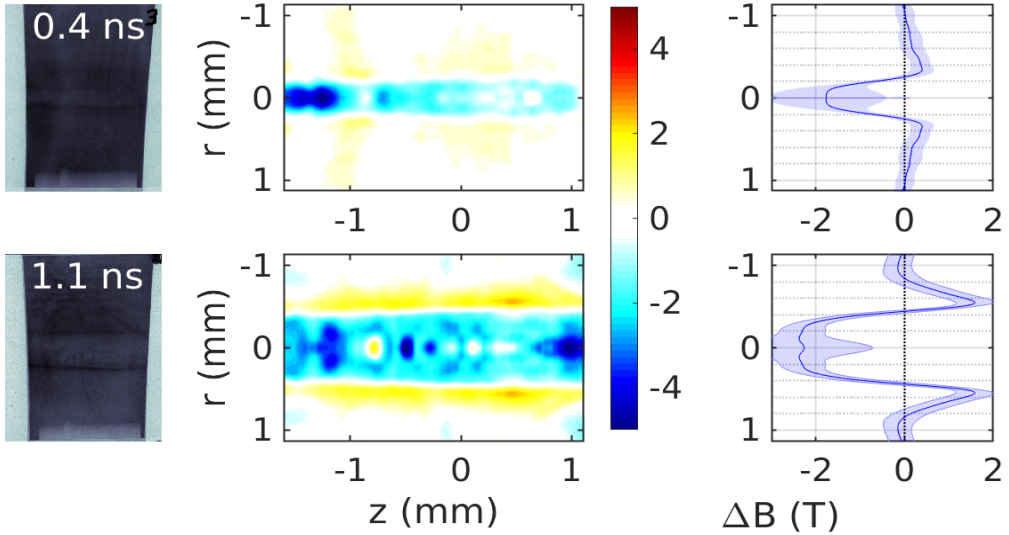




Isolating Nernst at HED

- Tests of extended MHD in rad-hydro
  - Close to single physics study
- Under-dense plasma in cylindrical geometry
  - Average along the cylinder & Abel invert
- Requires multiple measurements
  - Electron density (interferometry)
  - Electron temperature (Thomson scatter)
  - Magnetic field (proton imaging)





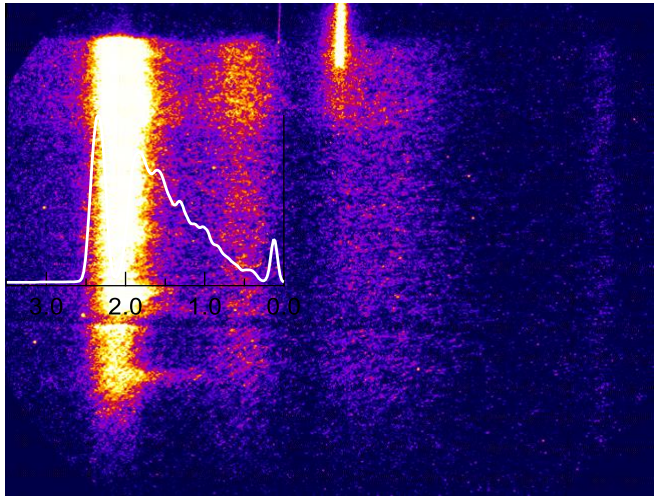
Arran et al., PRL (2023); https://doi.org/10.1103/PhysRevLett.131.015101

Spatially reconstruct hotspot electron temperature and density structure in time

- Monochromatic imaging of hot spot
  - Ideally spatial & temporal resolution 5 μm, 10 ps
  - Currently 15 μm and 60 ps

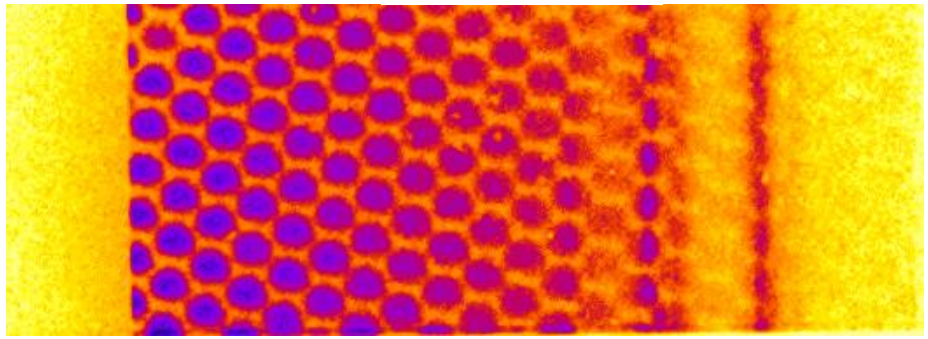
- Temperature extracted from ratio maps at two photon energies, say 3 and 6 keV

- Density inferred from absolute emissivity
  - Extracted from an absolutely calibrated (time integrated) spectrometer and streak spectrum



Photon energy

Time (ns)

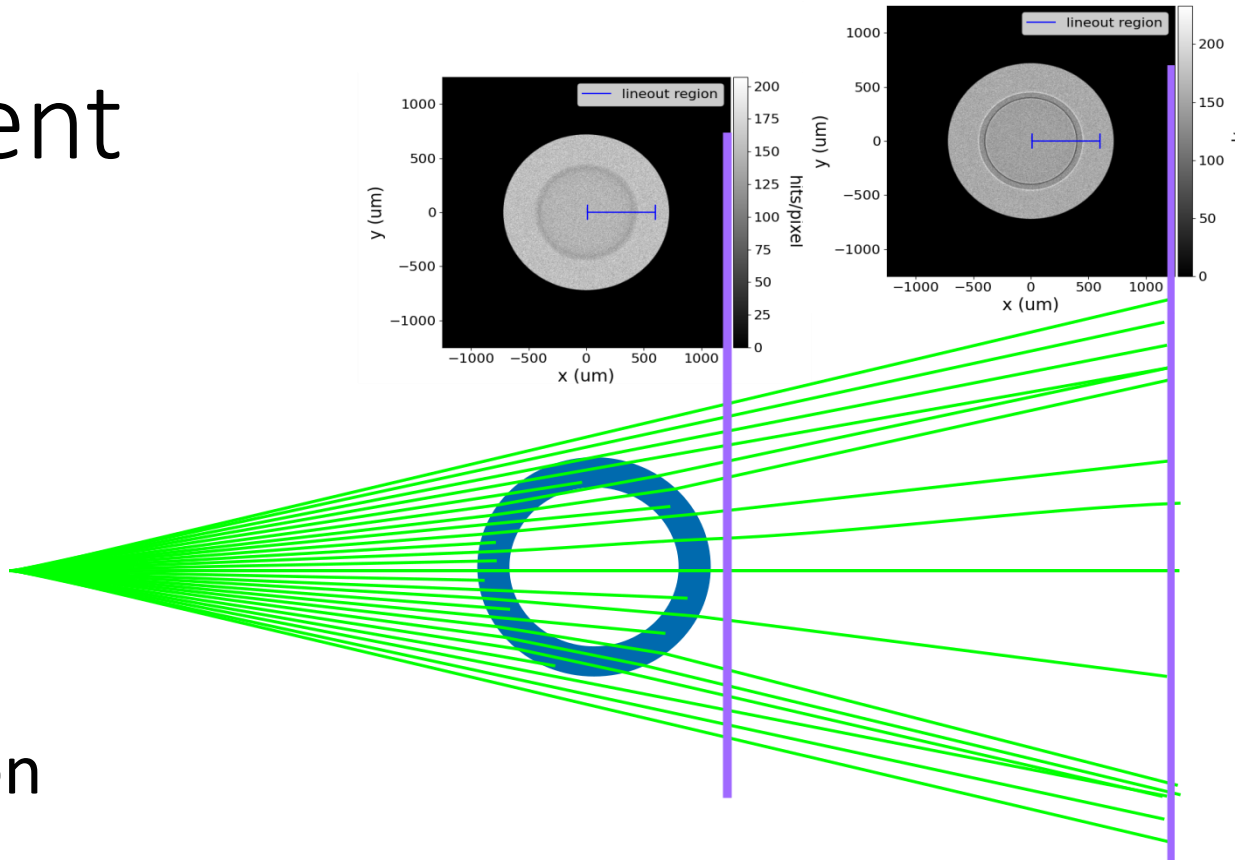


Photon energy

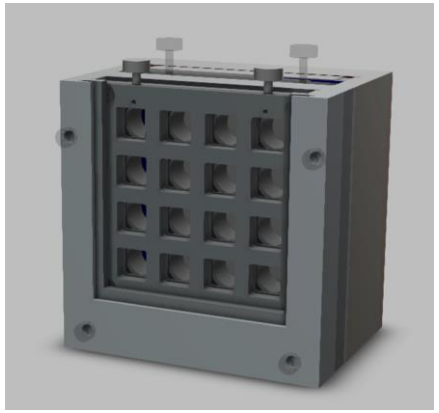
Diagnostic development

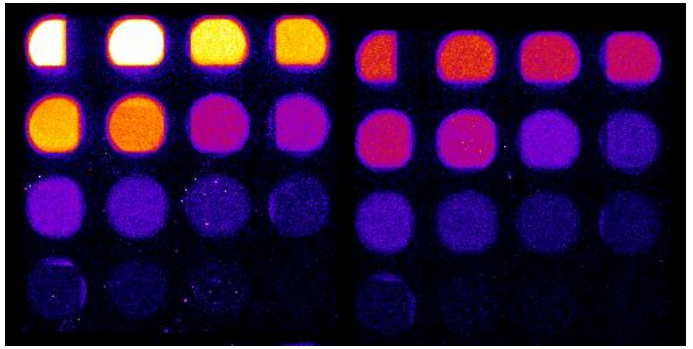
- X-ray phase contrast imaging

X-ray Source:
XFEL,Betatron,
bremss, Kα



- Sub-MeV bremsstrahlung cannon
  - Development of a standard MeV cannon with multiple apertures & in-front filters





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  - Bordeaux (CELIA)
  - Rochester (LLE)
  - *Pisa*
  - *Oxford*
  - *First Light Fusion*

PHYSICAL REVIEW LETTERS **131,** 015101 (2023)

Measurement of Magnetic Cavitation Driven by Heat Flow in a Plasma

C. Arran,[1,*] P. Bradford,[1,†] A. Dearling,[1] G. S. Hicks,[2] S. Al-Atabi,[2] L. Antonelli,[3] O. C. Ettlinger,[2] M. Khan,[1] M. P. Read,[3] K. Glize,[4,‡] M. Notley,[4] C. A. Walsh,[5] R. J. Kingham,[6] Z. Najmudin,[2] C. P. Ridgers,[1] and N. C. Woolsey[1]

PHYSICAL REVIEW LETTERS **129,** 195001 (2022)

Shock-Augmented Ignition Approach to Laser Inertial Fusion

R. H. H. Scott,[1,*] D. Barlow,[1] W. Trickey,[2] A. Ruocco,[1] K. Glize,[1] L. Antonelli,[2] M. Khan,[2] and N. C. Woolsey[2]

PHYSICAL REVIEW LETTERS **127,** 065001 (2021)

Shock Ignition Laser-Plasma Interactions in Ignition-Scale Plasmas

R. H. H. Scott,[1,*] K. Glize,[1] L. Antonelli,[2] M. Khan,[2] W. Theobald,[3] M. Wei,[3] R. Betti,[3] C. Stoeckl,[3] A. G. Seaton,[4] T. D. Arber,[5] D. Barlow,[5] T. Goffrey,[5] K. Bennett,[5] W. Garbett,[6] S. Atzeni,[7] A. Casner,[8] D. Batani,[8] C. Li,[9] and N. Woolsey[2]