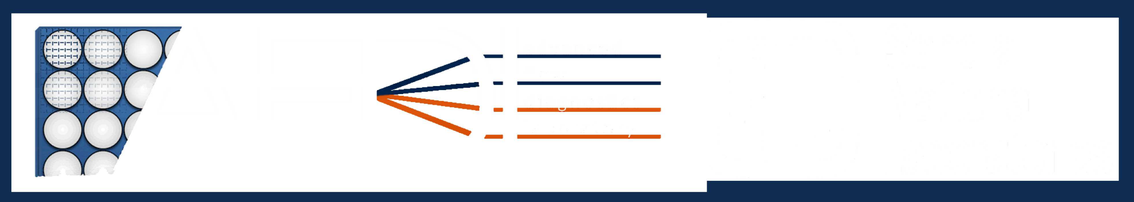
SAND2018-11648D

3D fragment location and sizing from perspective shifted plenoptic images

Elise M. Hall[1,2], Daniel R. Guildenbecher[2], Brian S. Thurow[1]

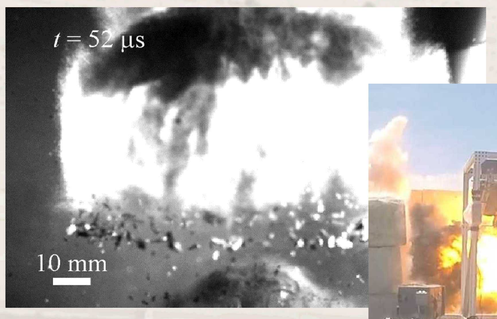
[1]Auburn University, [2]Sandia National Laboratories



Plenoptic imaging

- Microlens array between the main lens and image sensor collects angular and spatial information in a single snapshot
- Post processing enables refocusing and changes in perspective
- Applications: consumer imaging, wind tunnel experiments, multiphase sprays, medical imaging, natural flow analysis, ***explosion analysis***

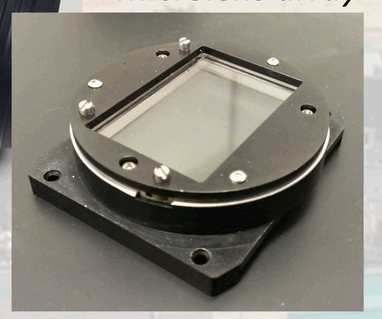
RP-80 detonator



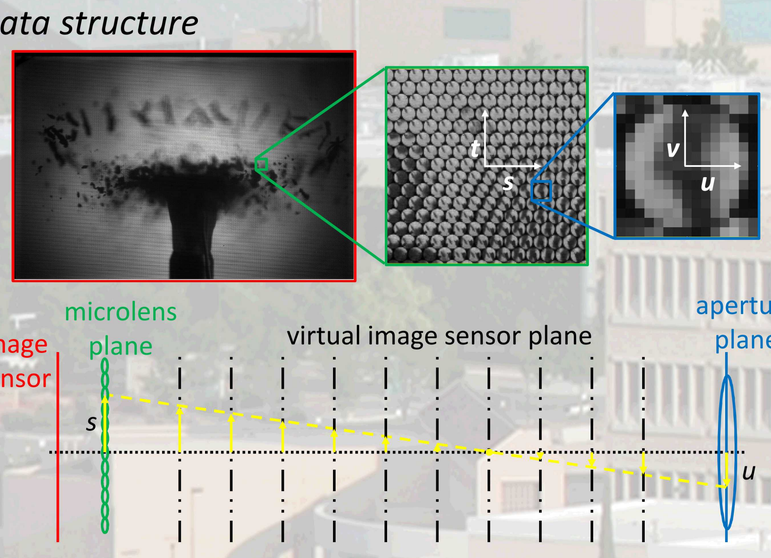
Large scale explosion

Plenoptic camera

Microlens array

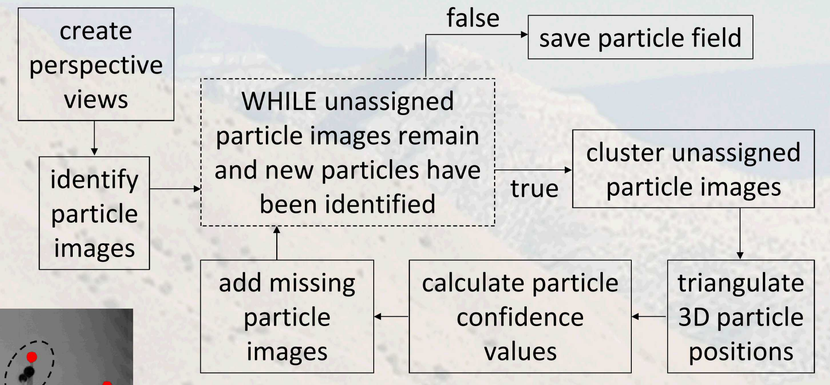


Data structure

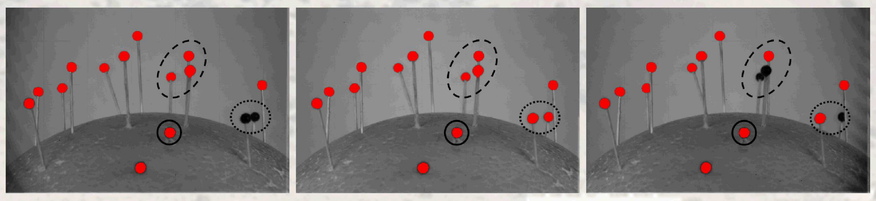


Algorithm development

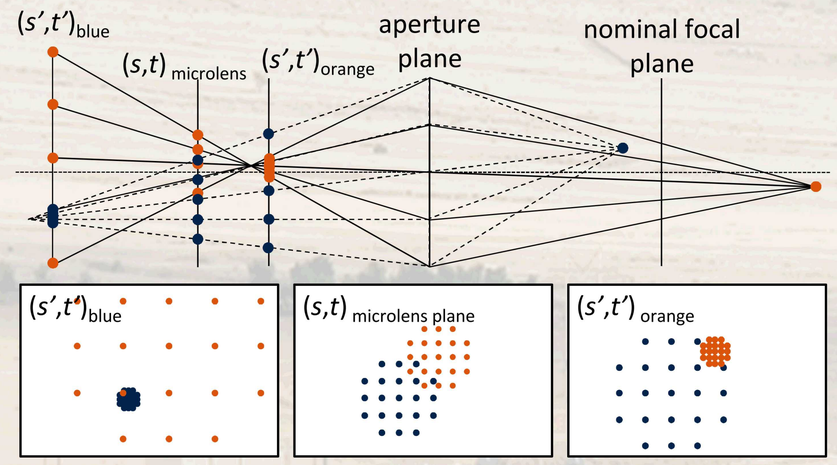
- 3D location from discrepancy between views
- Processing time improvement of 2 orders of magnitude over refocusing



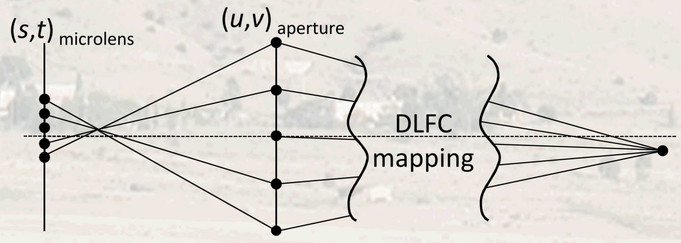
Perspective views/particle images



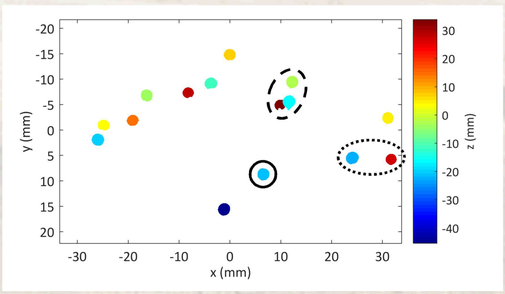
Projection plane clustering



3D triangulation



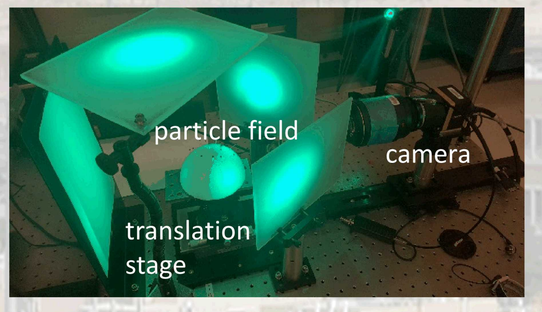
Final 3D locations



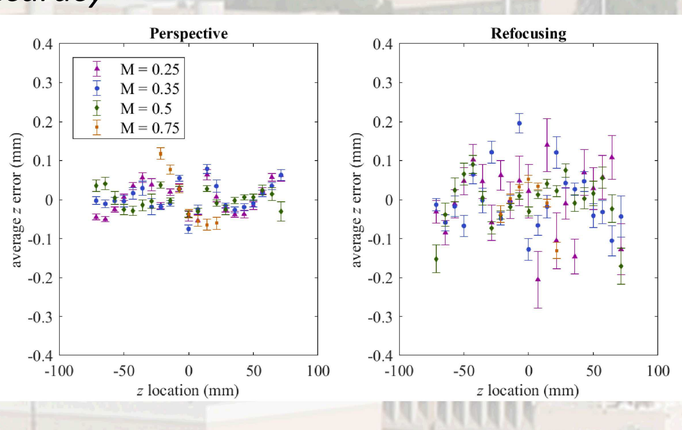
Uncertainty quantification

- Static particle field translated known displacements
- Improved accuracy and precision of depth displacement error over refocusing based method
- ***Accuracy within 0.1 mm, precision within 0.4 mm over a depth of 50 mm***

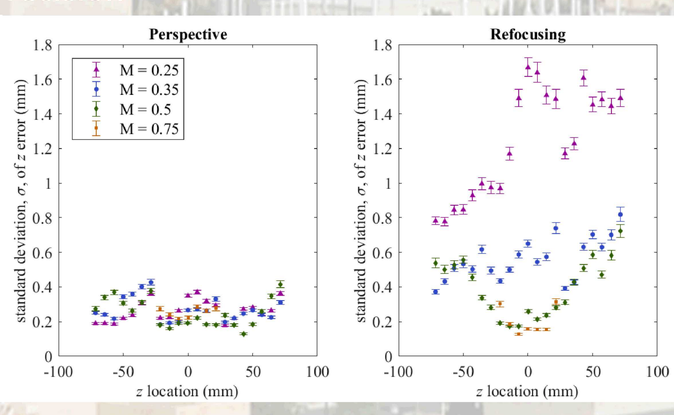
Experimental configuration



Accuracy



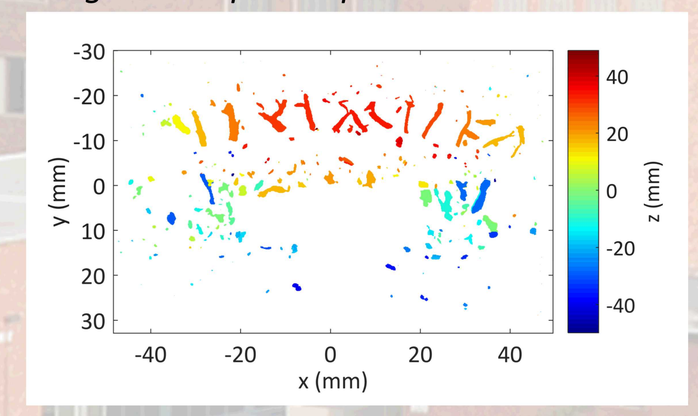
Precision



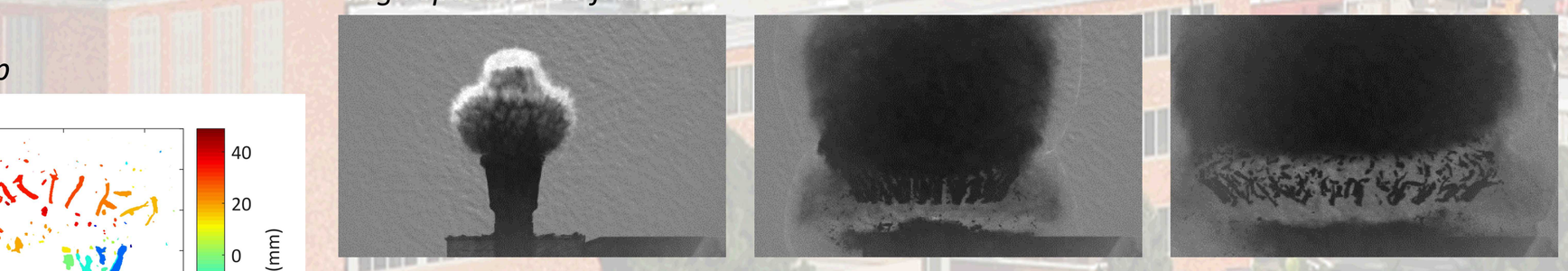
Detonator fragment location

- RP-80 detonator for a lab-scale explosion
- Simultaneous high-speed and plenoptic data collection
- Verification of arbitrary shape measurement

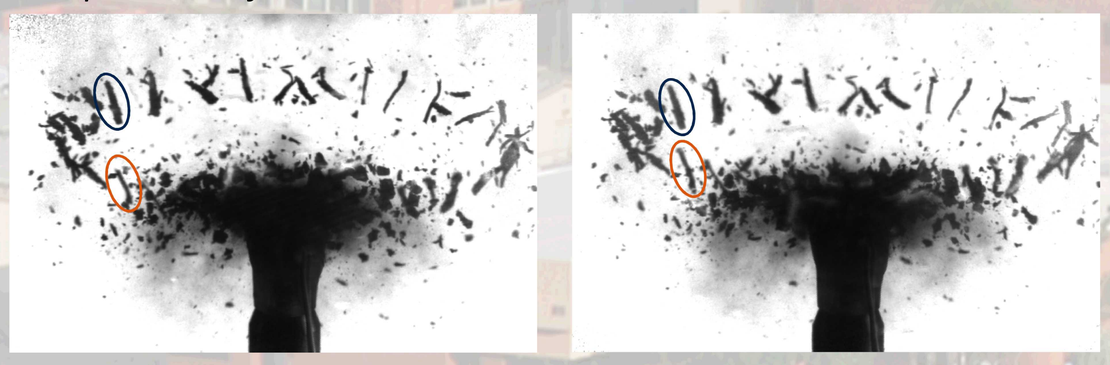
Fragment depth map



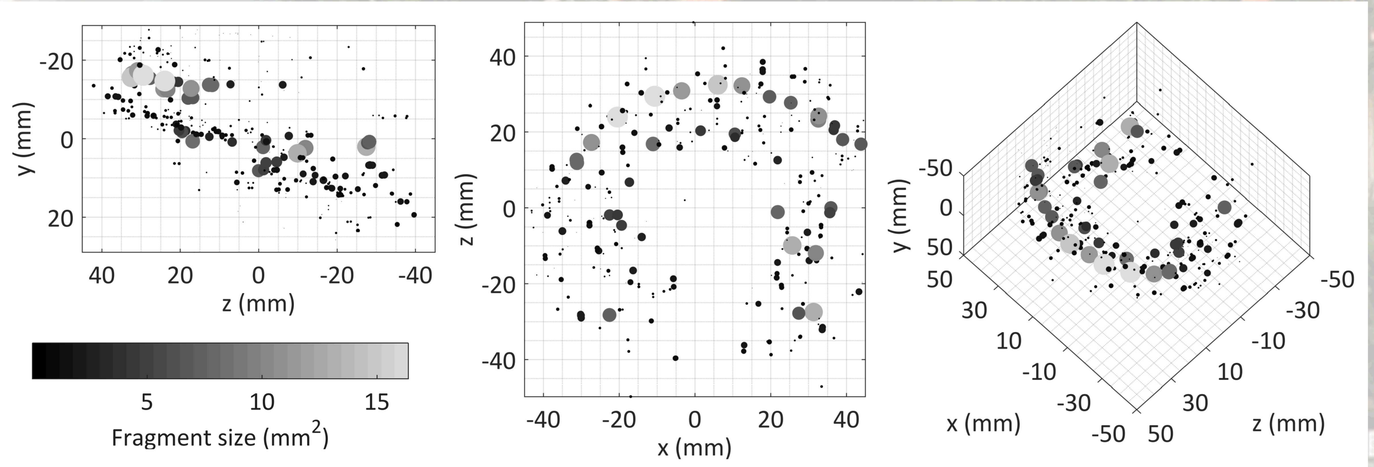
High speed video frames



Perspective-shifts



Fragment size & location



U.S. DEPARTMENT OF ENERGY
National Nuclear Security Administration

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.