Where does laser melting start in polycrystalline metals?

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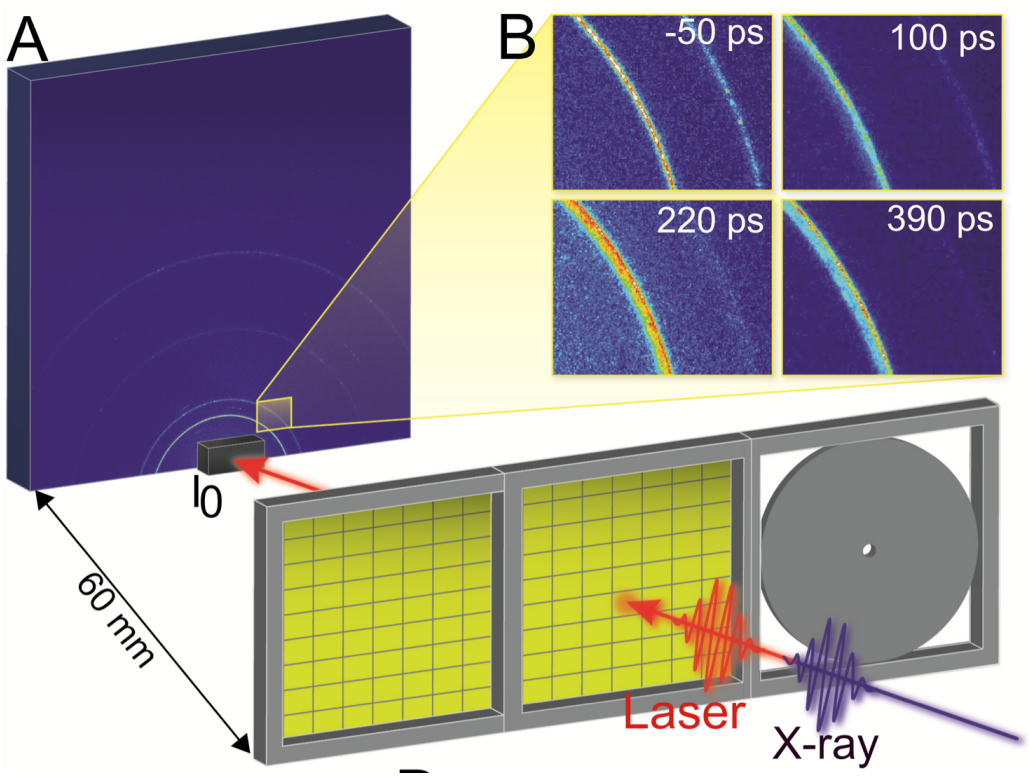
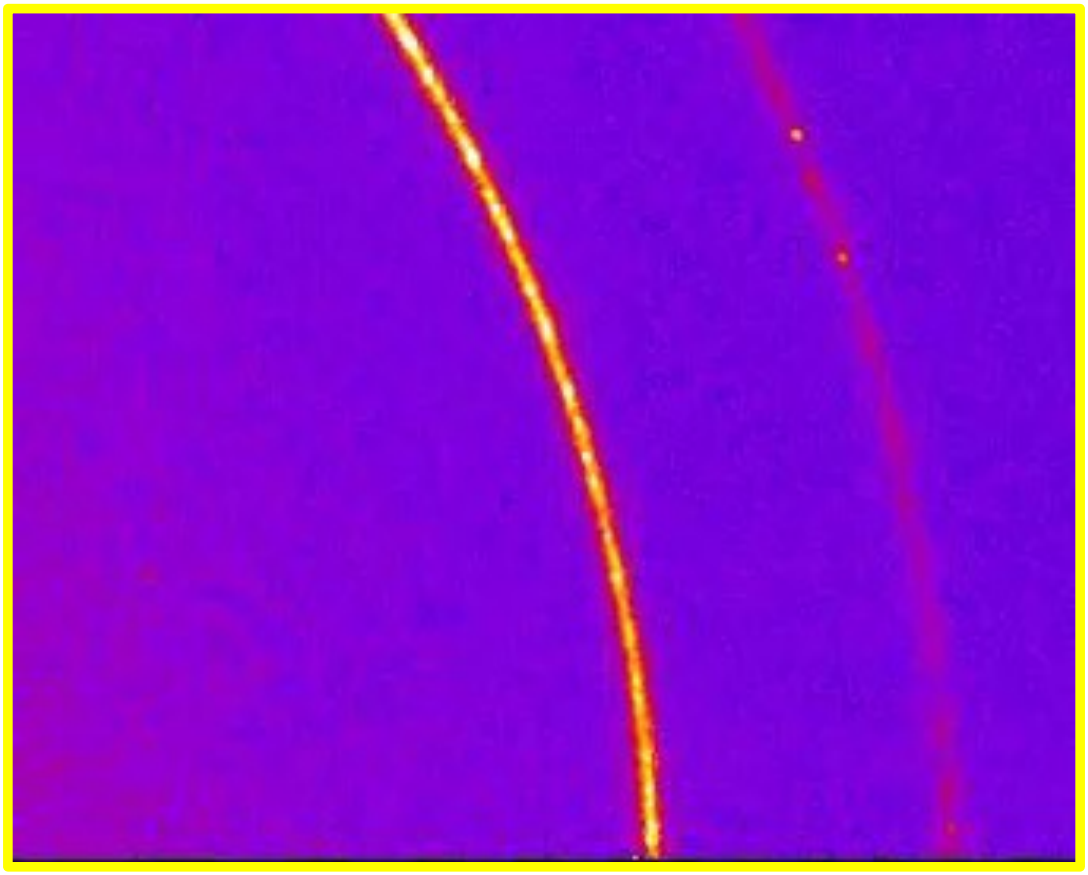
Questions about Melting

- Can we see the liquid phase?
- Are there transient liquid structures (water)?
- How fast does melting take place?
- Where does the melting start?
- How does the 2TM couple to the lattice?
- Role of sample geometry?

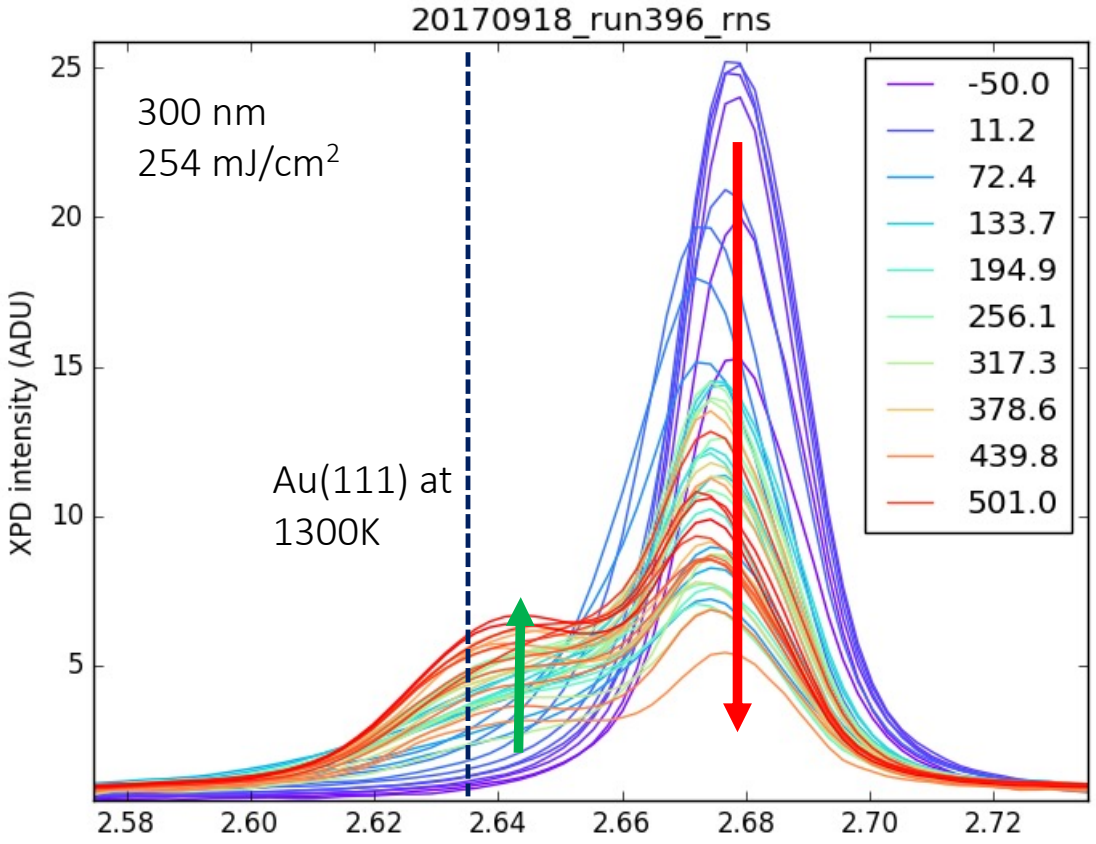
Powder Diffraction Geometry



Raw data #396 300nm film, 254 mJ/cm^2



PyFAI integration around ring

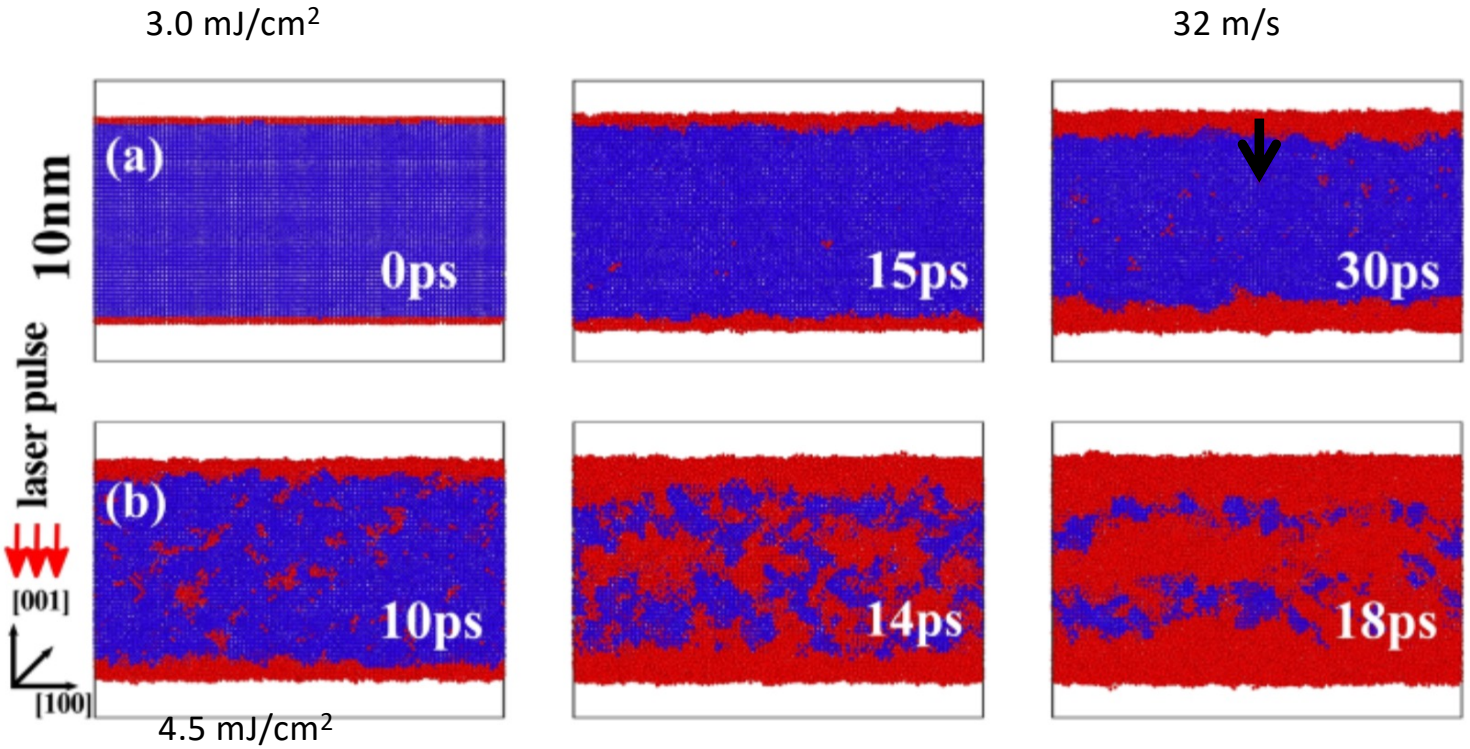


Average grain size ≥ 30nm

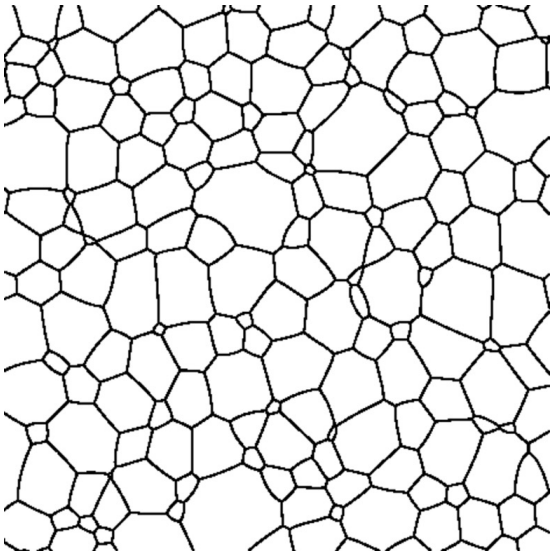
New peak ~3x broader

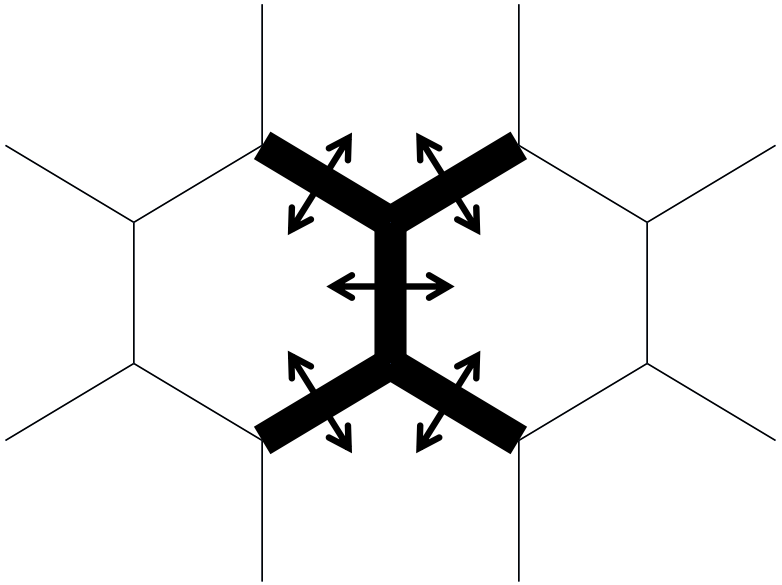
2TM-MD (EAM) simulation Au slab

Giret et al, APL **103** 253107 (2013)

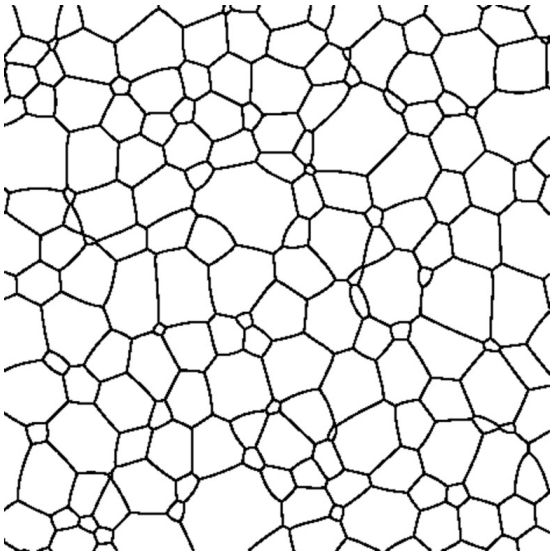


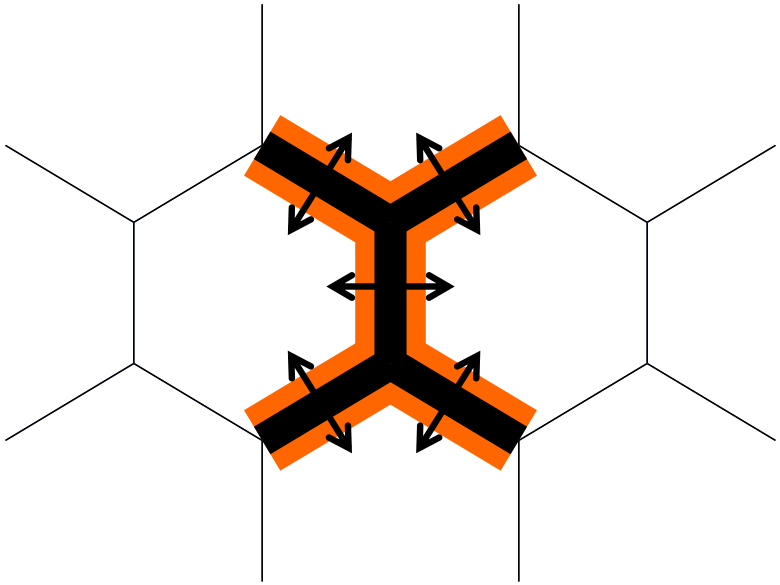
Grain Boundary Melting





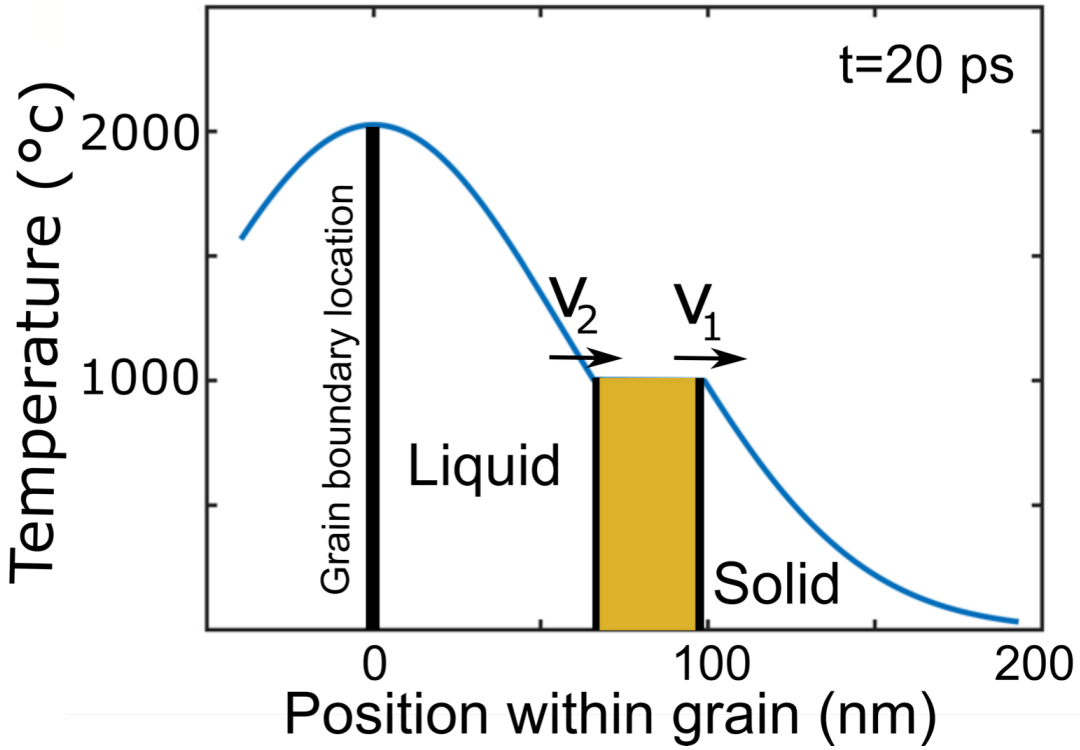
Grain Boundary Melting





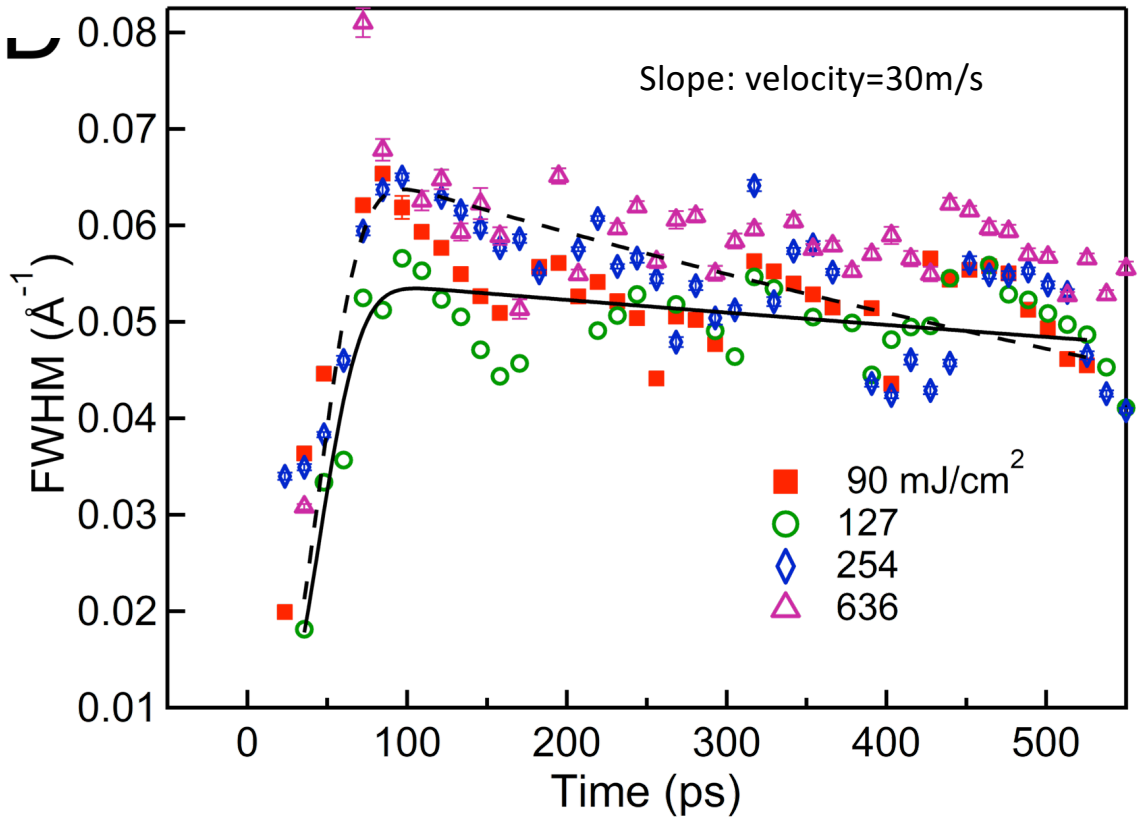
Grain Boundary Induced Melting

T. A. Assefa et al Science Advances 6 eaax2445 (2020)

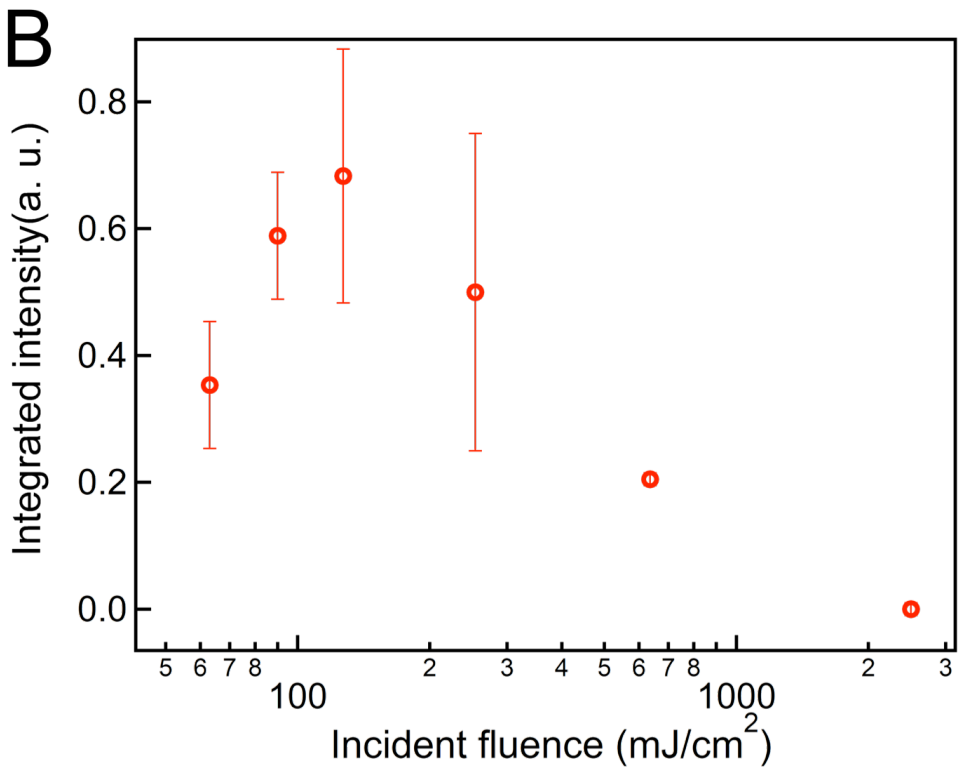


Width of new “Melt-Front” Peak

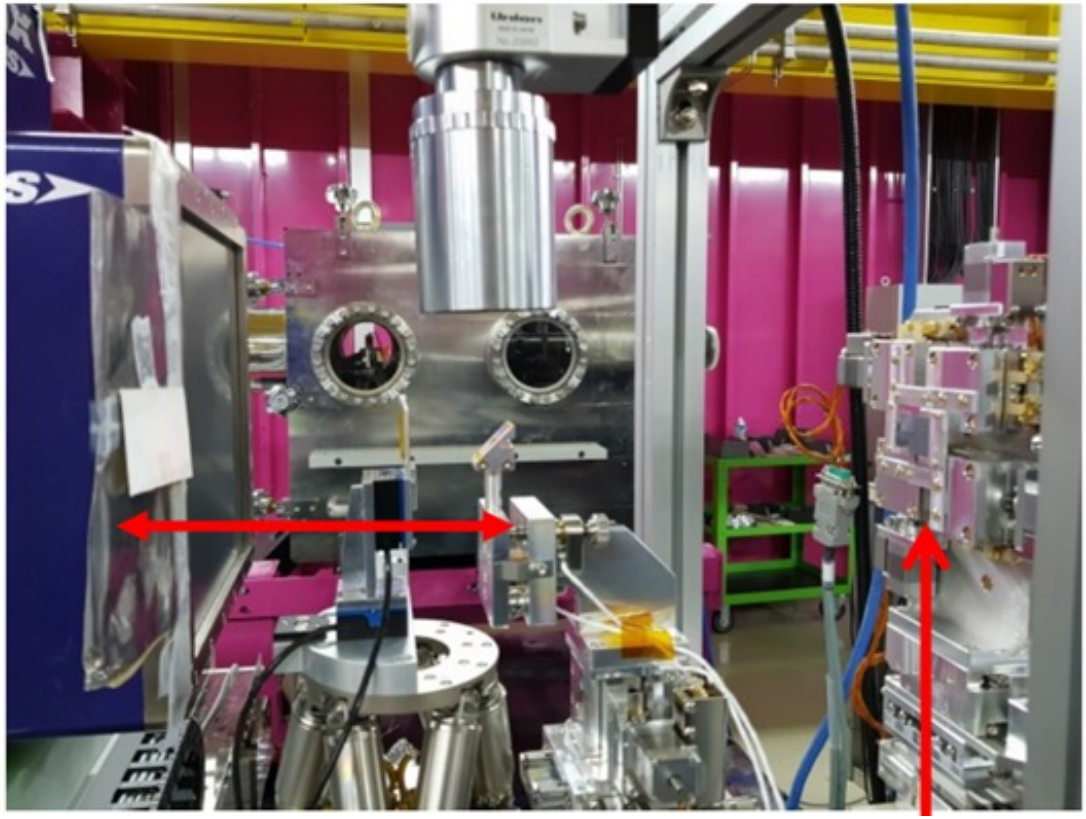
T. A. Assefa et al Science Advances 6 eaax2445 (2020)



Fluence dependence of New Peak

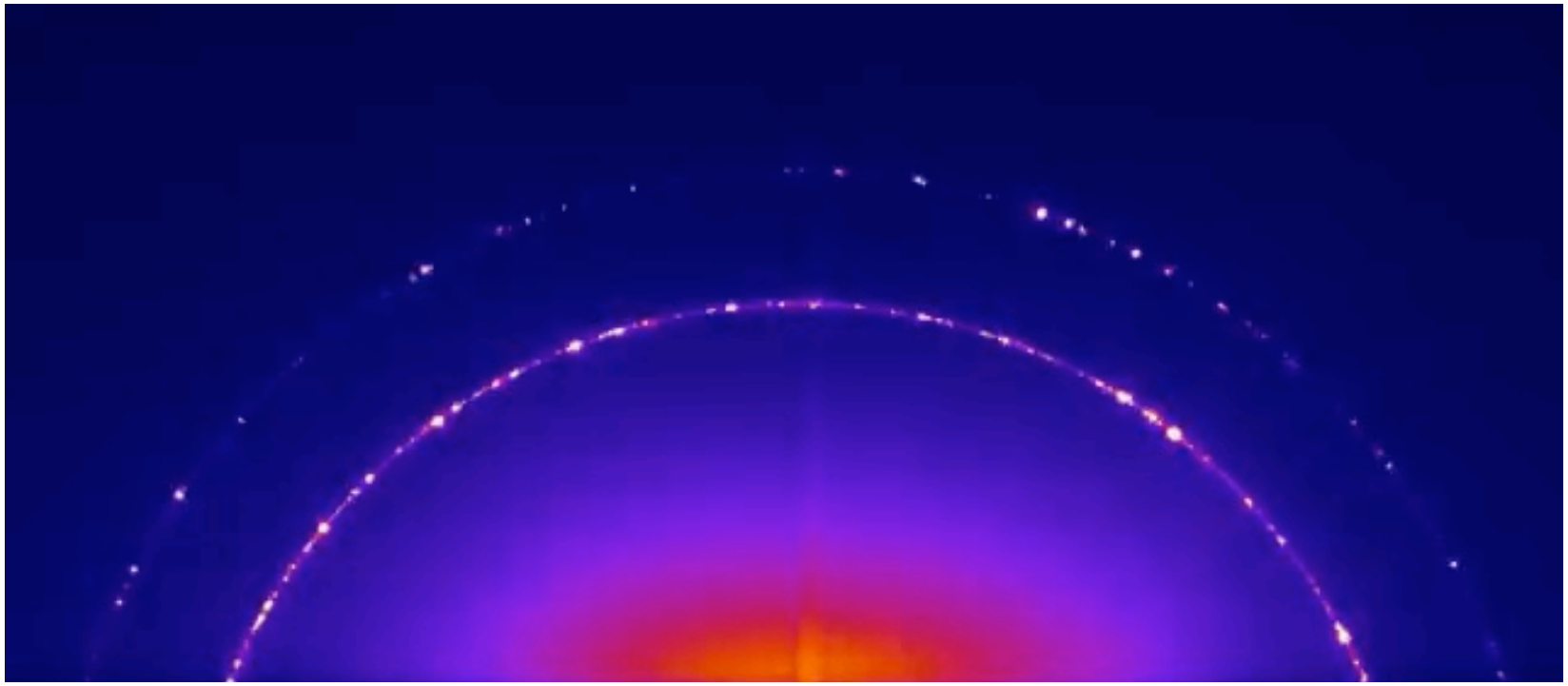


April 8-12, 2021 Experiment in EH2 PAL-XFEL

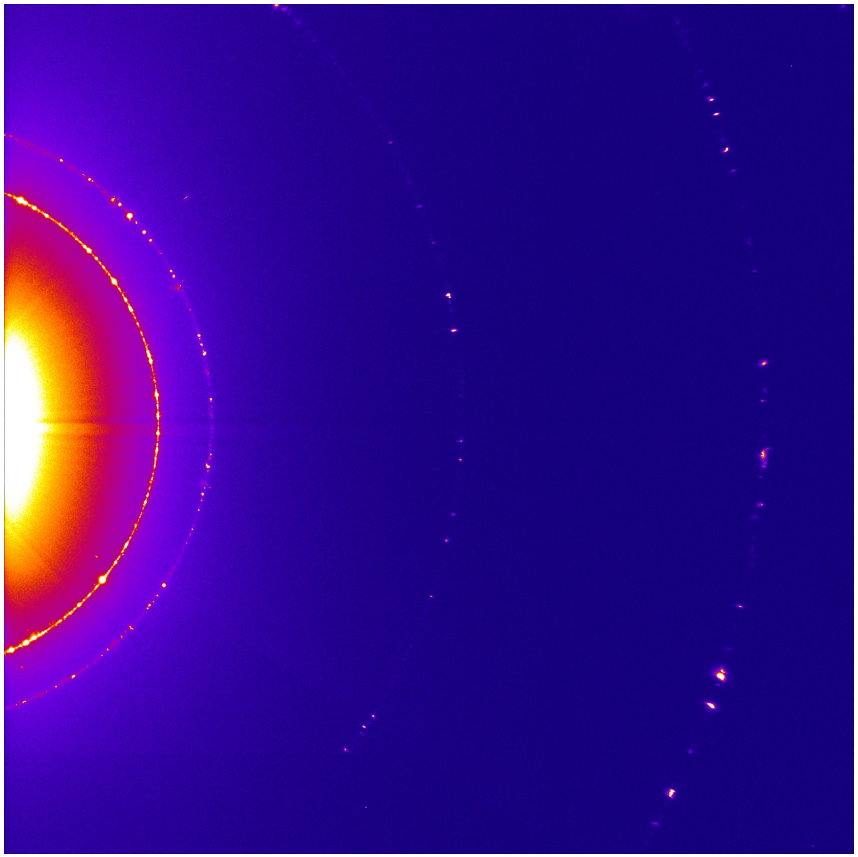


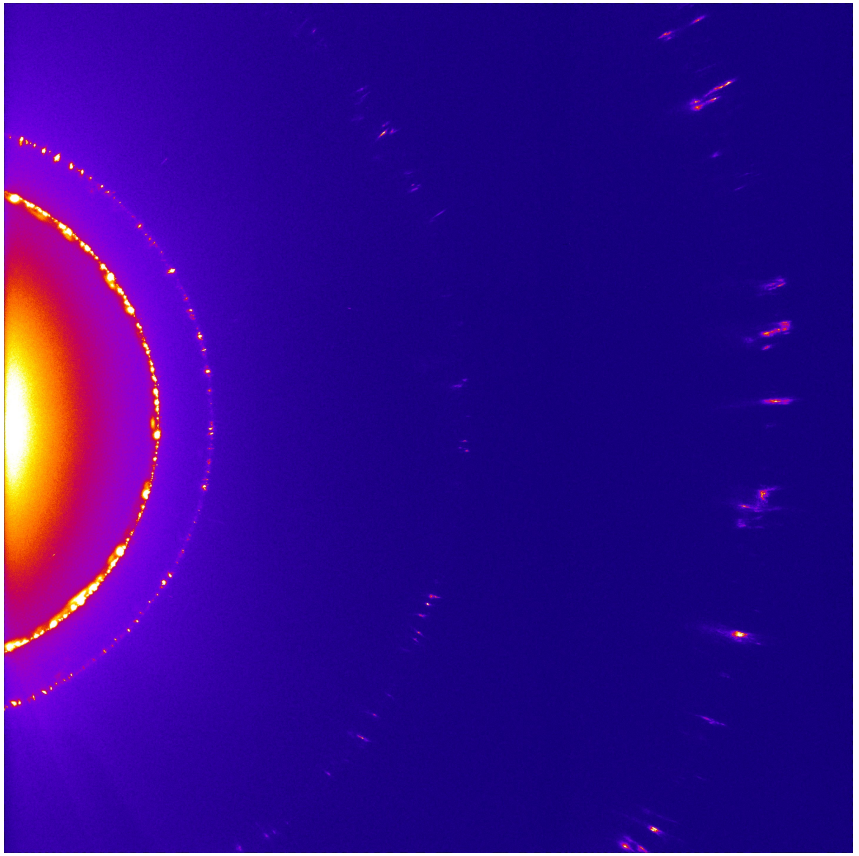
Self-seeded beam: single shots on 300nm Pd

36% laser ~150mJ/cm^2 Run 138-194 -5-200ps (5ps steps)



Single shots on 300nm Pd, 150mJ, 0ps and 100ps

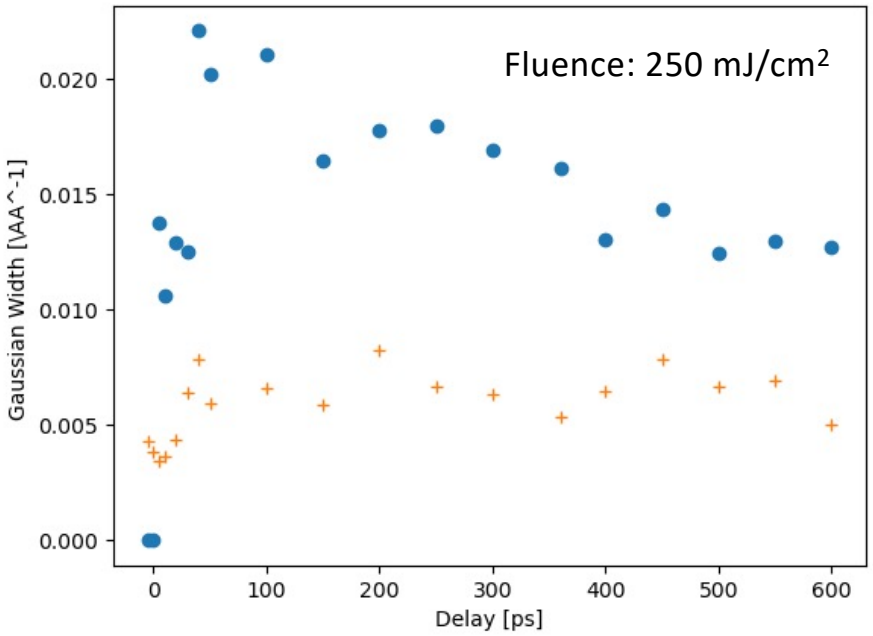


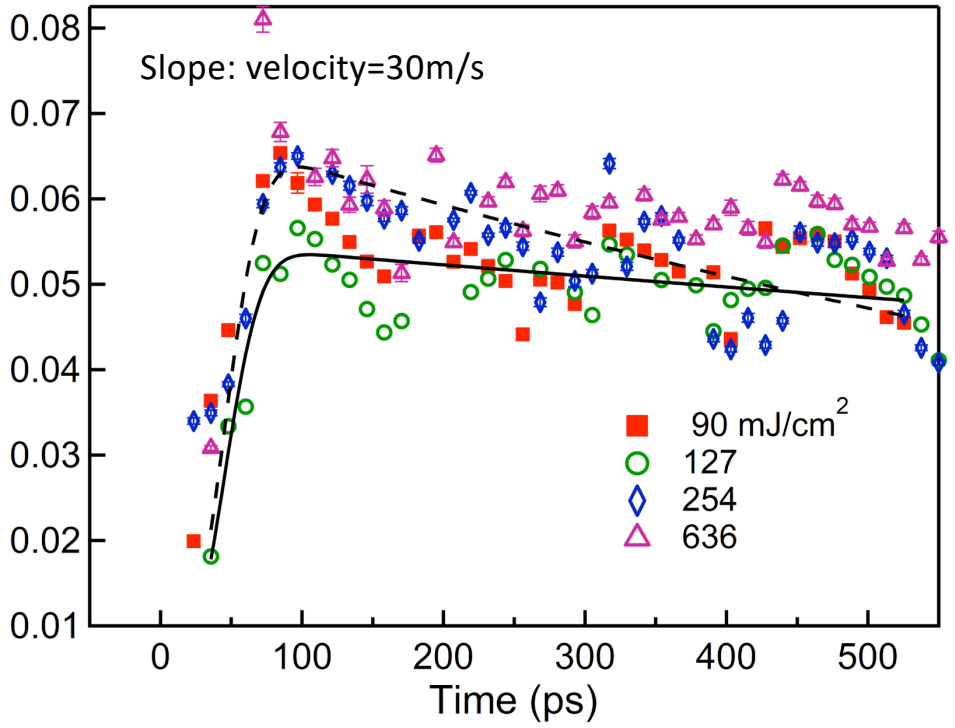


Width of new “Melt-Front” Peak

T. A. Assefa et al Science Advances 6 eaax2445 (2020)

A. F. Suzana et al, to be published

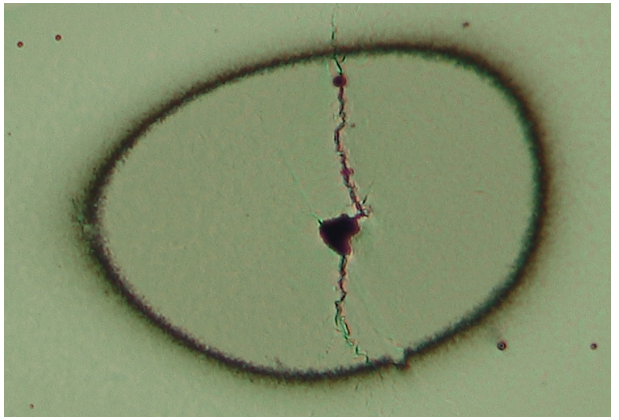


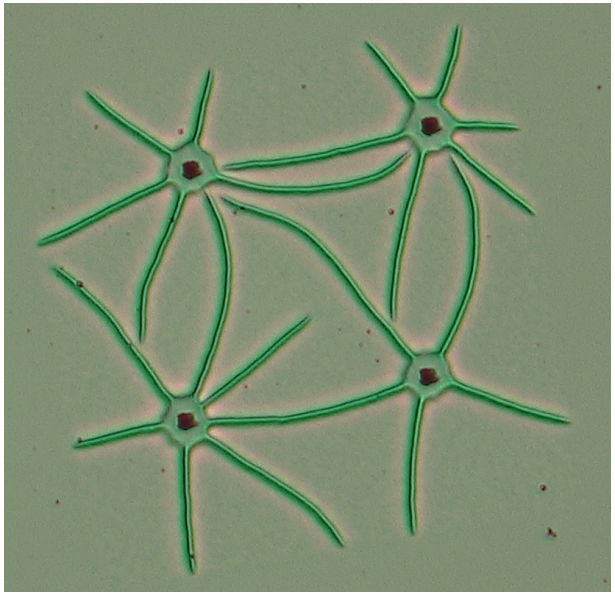


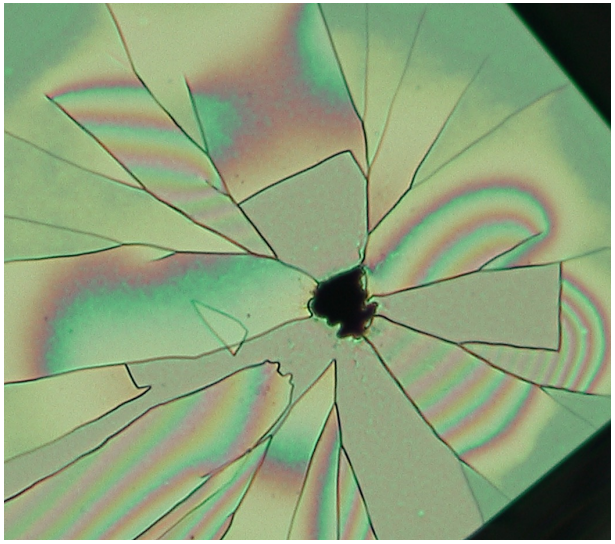
Where does laser melting start in polycrystalline metals?

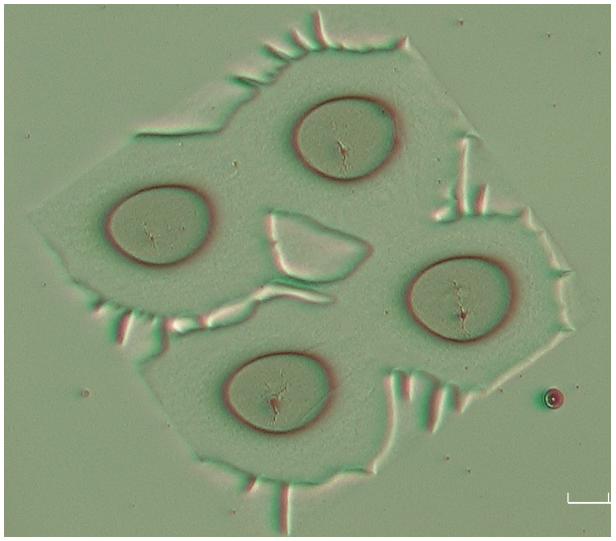
- Laser induced disorder
- Three phases: liquid, solid, melt
- 2-phase inhomogeneous melting
- Energy transfer at Grain Boundaries
- Interface melting like nanoparticles
- Measured structure of Melt Front

Laser and X-ray damage

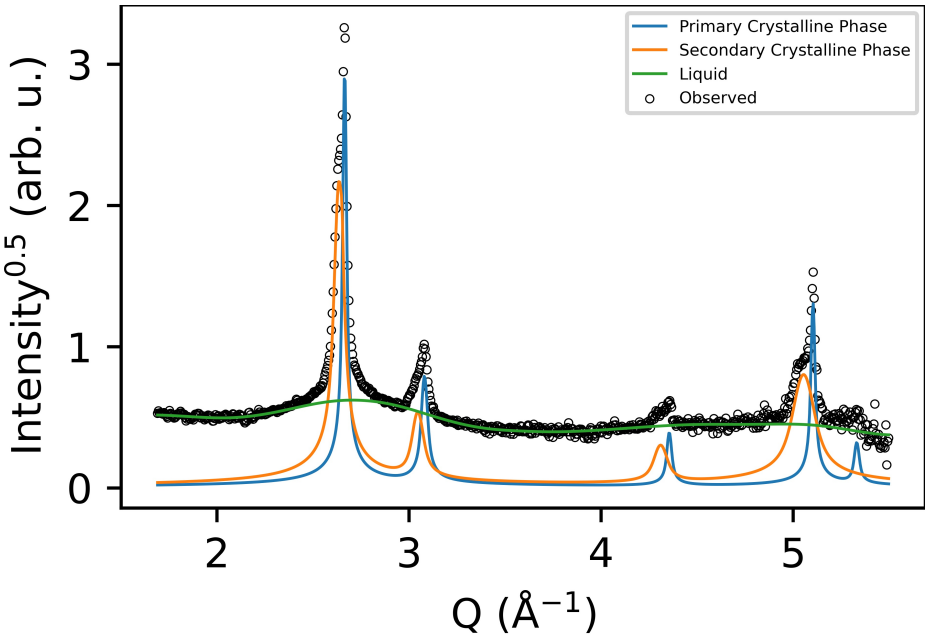








Extracting the diffuse signal

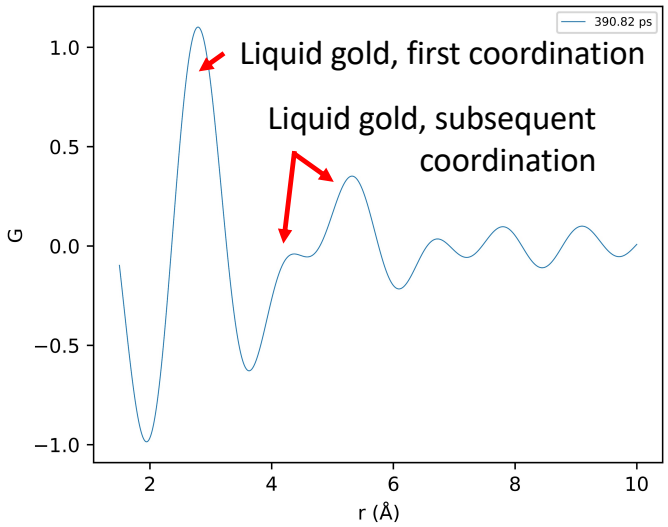


- Raw data plotted, 231 ps, square root intensity scale
- Unconstrained peak fitting approach
- Remove Bragg components

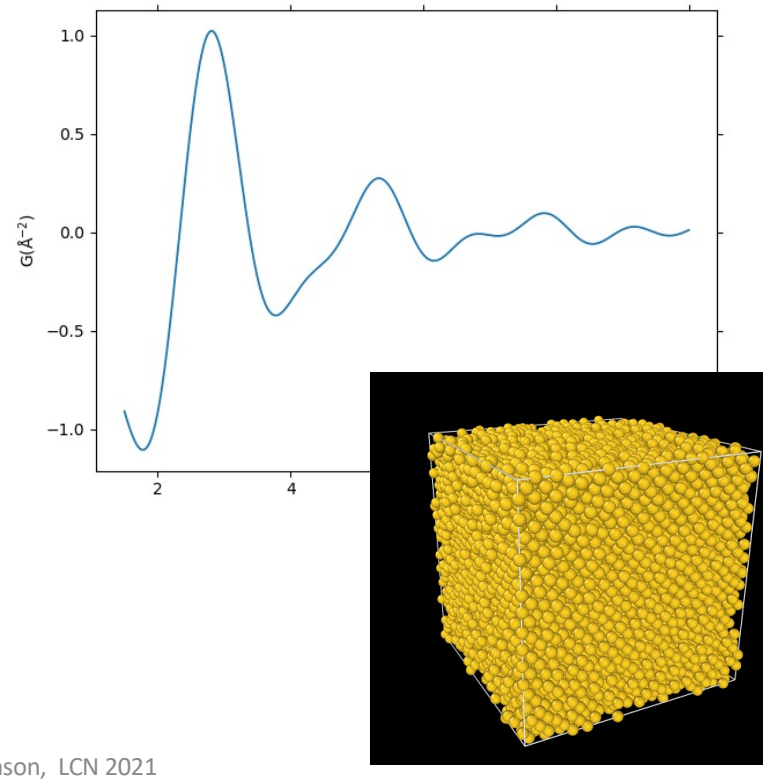
Is this liquid gold PDF ?

R. Koch unpublished

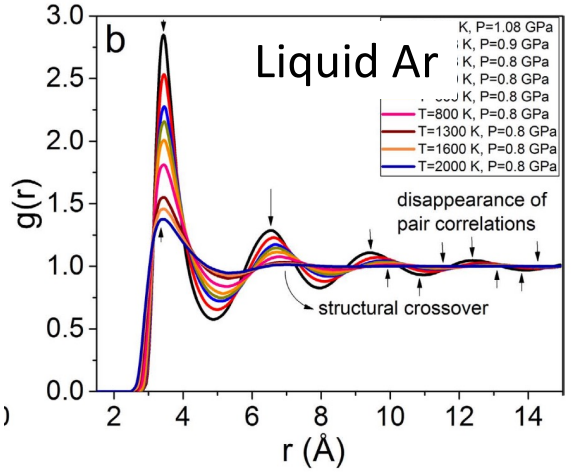
Observed

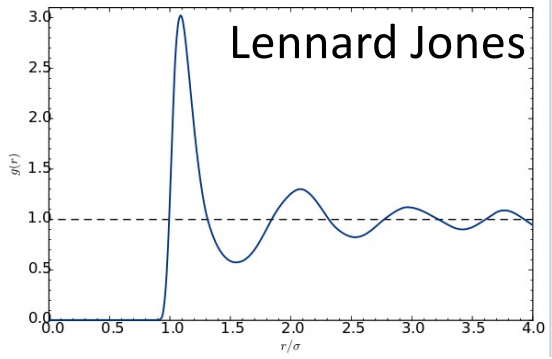


Simulated



Other Liquid RDFs





Au-Ge alloy