

Understanding strength and texture in Fe at planetary core pressures and temperatures: insights from laser compression experiments

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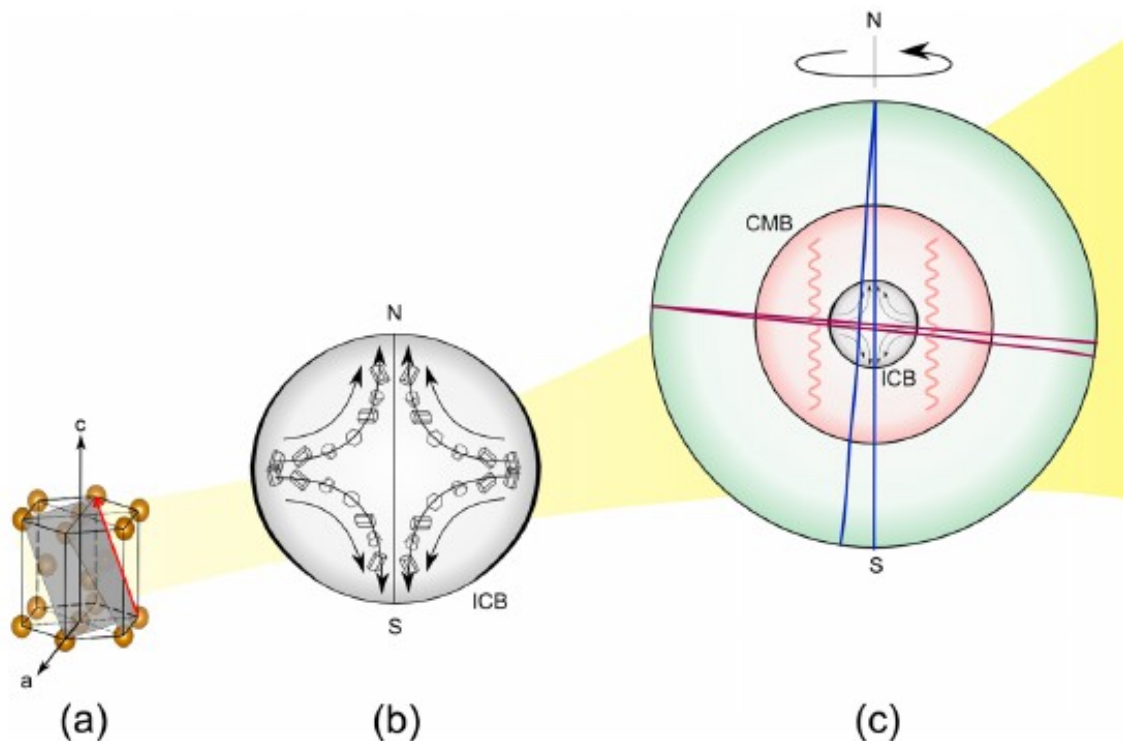


RESEARCH LETTER

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Multiscale model of global inner-core anisotropy induced by hcp alloy plasticity

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Multiscale model of inner core formation and dynamics

Constraints from observations
seismic anisotropy

Input

- Fe plasticity at inner core conditions
- Fe elasticity at inner core conditions
- Formation model

Goals

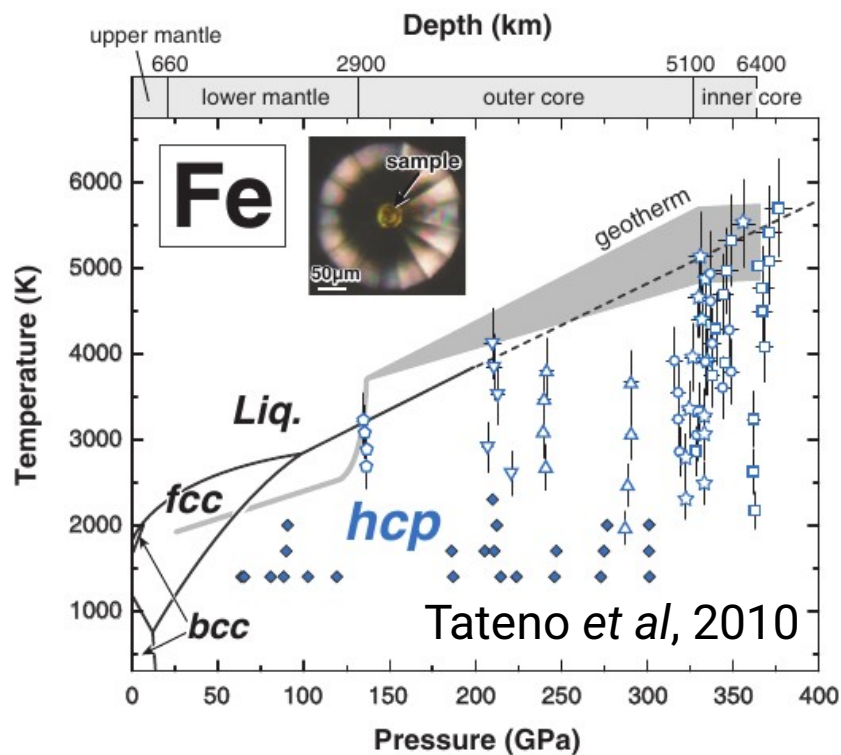
- Constrain formation model

Limitations

- Properties of Fe at inner core pressures

Static experiment

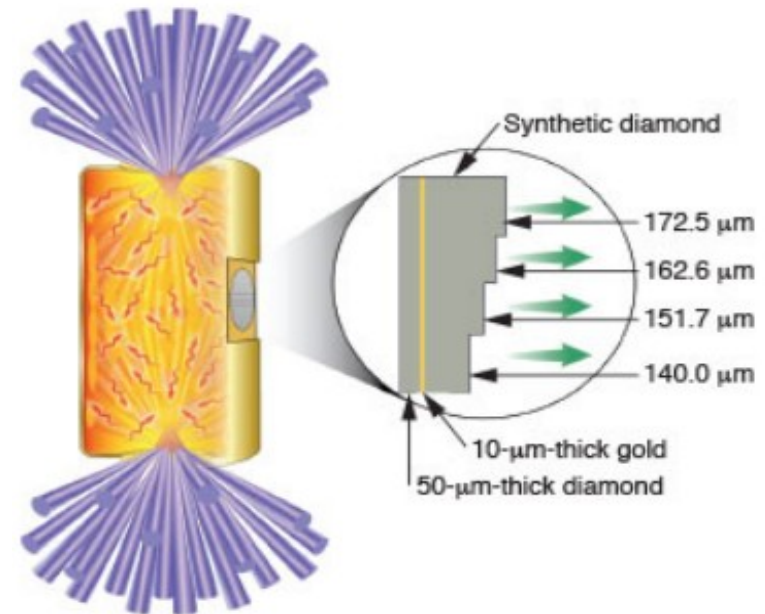
Laser heated diamond anvil cell



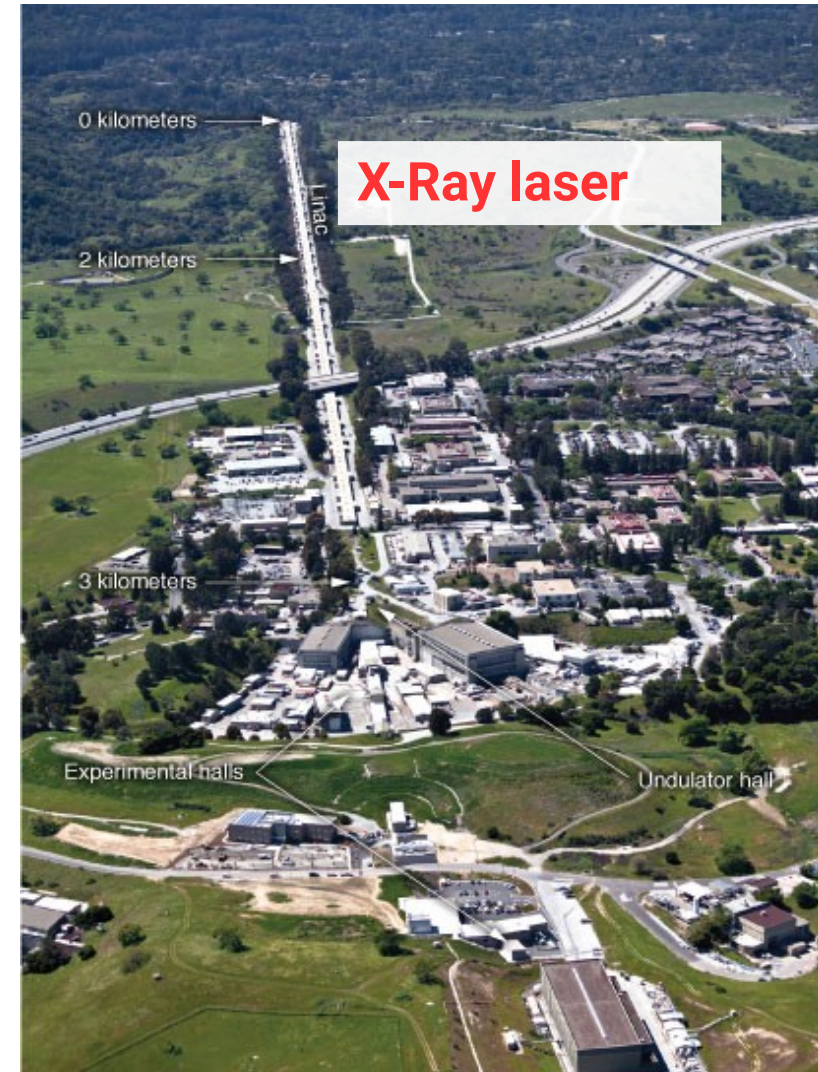
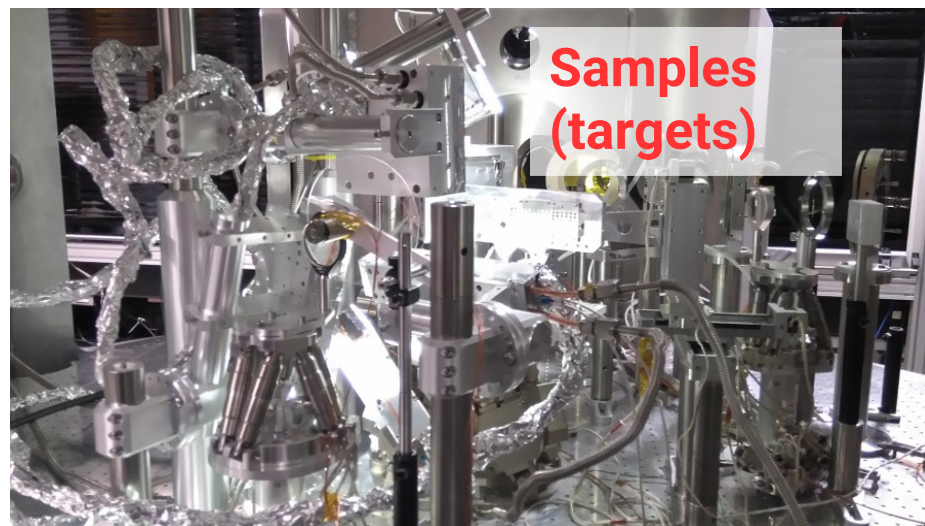
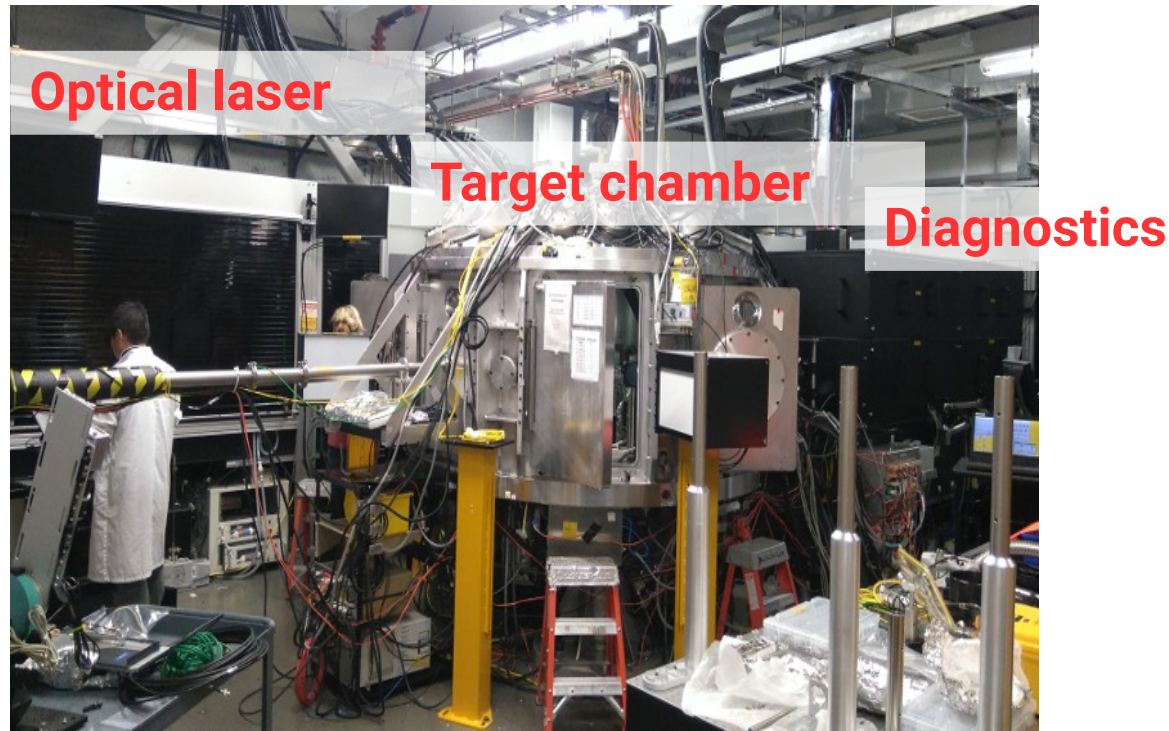
- Inner core conditions within reach
- **Issues: no deformation at inner-core conditions**

Dynamic compression

Laser driven shock compression



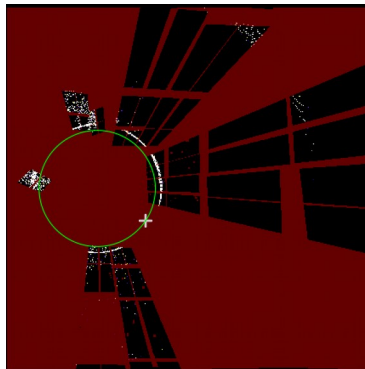
- Inner core core compression well within reach
- Sample deformation
- **Issue: duration of experiment 10 ns (10^{-8} s)!**



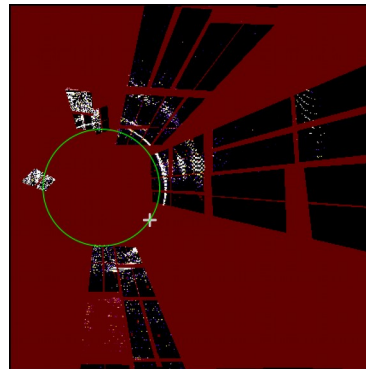
MEC beamline at
LCLS/SLAC, Stanford



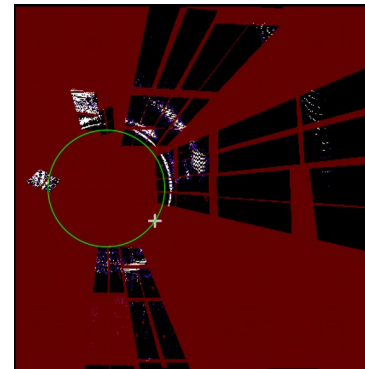
0 ns.
Impact!



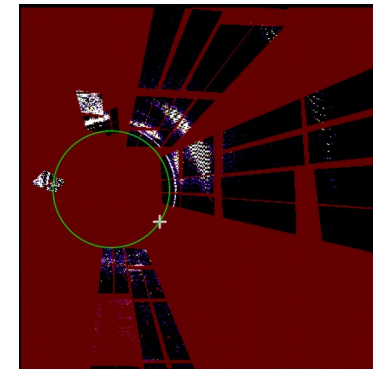
3 ns.
bcc to hcp
transition



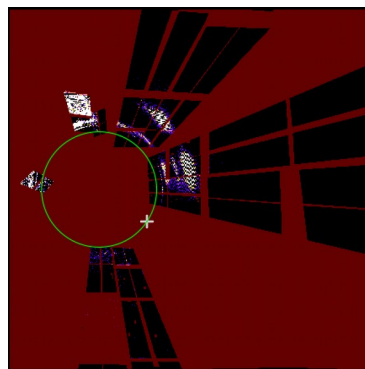
3.5 ns.
more hcp



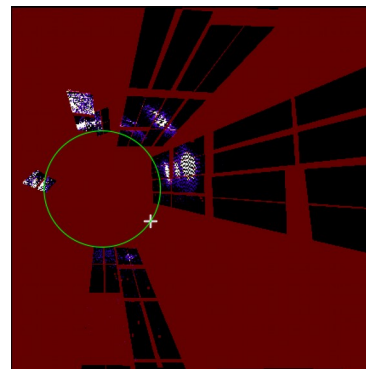
4.0 ns.
hcp



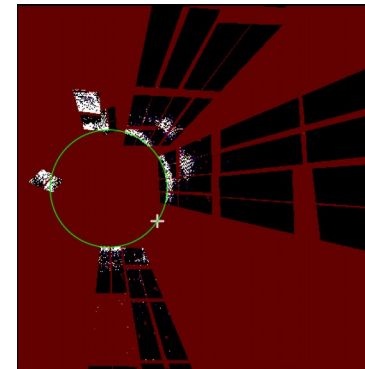
5.0 ns.
hcp



6.0 ns.
hcp



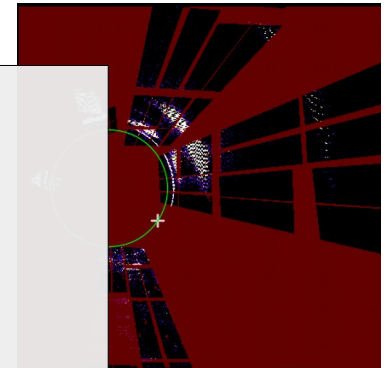
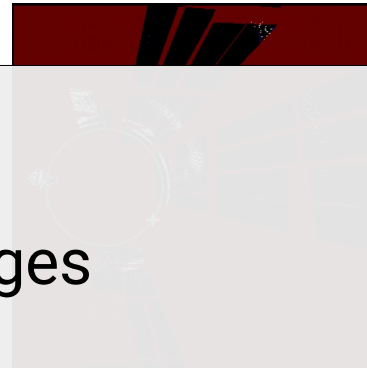
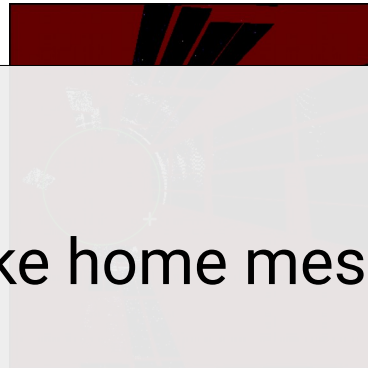
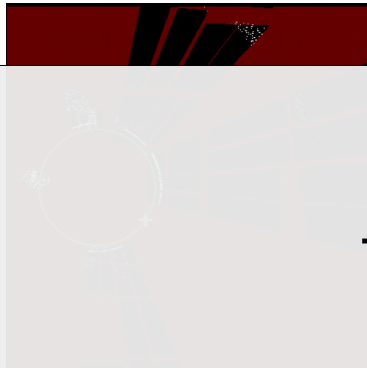
7.0 ns.
hcp



8.0 ns.
ambient
pressure
experiment
terminated!



0 ns.
Impact



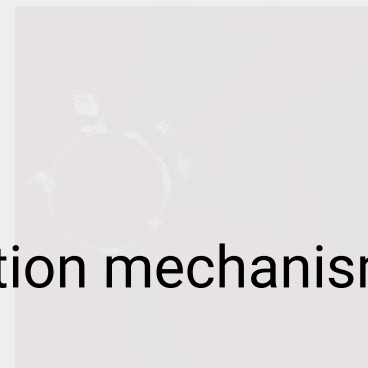
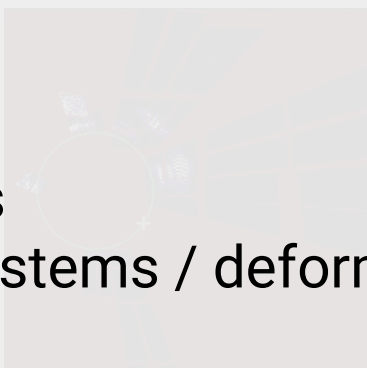
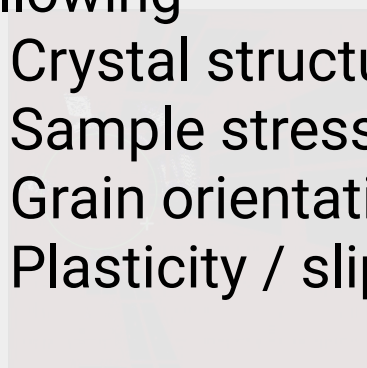
Take home messages

Laser driven shock waves
 In-situ x-ray diffraction at ~ 190 GPa and ~ 4000 K
 Sub-ns timescale resolution

Following

- Crystal structure
- Sample stress
- Grain orientations
- Plasticity / slip systems / deformation mechanisms

5.0 ns.
hcp



8.0 ns.
ambient
pressure
experiment
terminated!

6.0 ns.

hcp

7.0 ns.

hcp