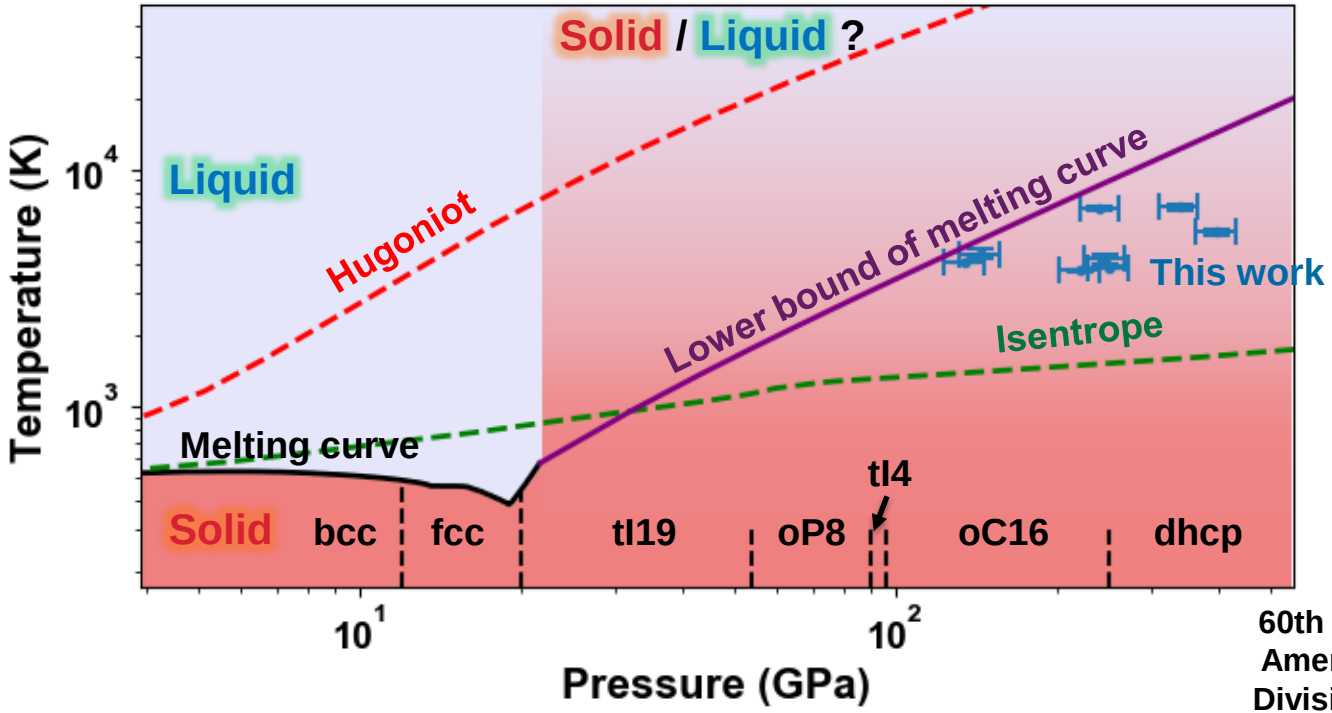
X-Ray Diffraction of Ramp-Compressed Potassium



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Summary

Solid phases of potassium are observed at pressures up to 400 GPa

- **Potassium (K), like other alkali metals, is predicted to transform into complex structures at extreme pressures**
- **The melting temperature has been previously observed to increase sharply with pressure up to 22 GPa**
- ***In-situ* x-ray diffraction on ramp-compressed K constrains the crystal structure and melting curve up to 400 GPa**

Collaborators

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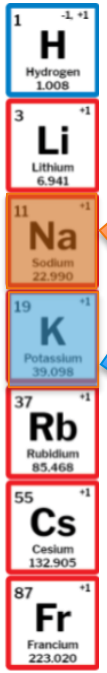
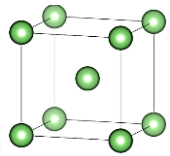
Lawrence Livermore National Laboratory

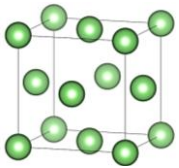
M. I. McMahon
University of Edinburgh

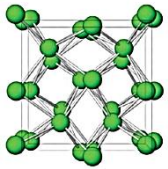
Core electrons influence structures of alkali metals at high pressures

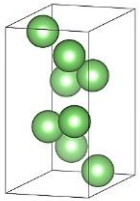
For Na, see D. Polsin's talk at session UM9

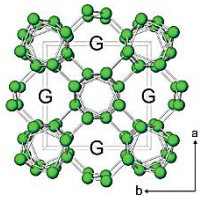



0 GPa
bcc

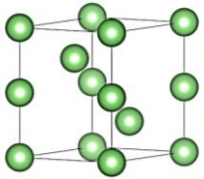

65 GPa
fcc

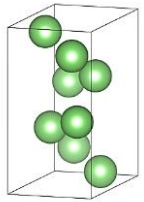

103 GPa
cI16


117 GPa
oP8

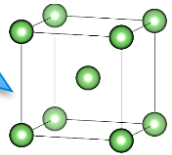


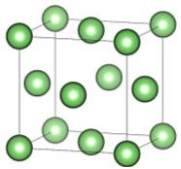
125 GPa
tI19

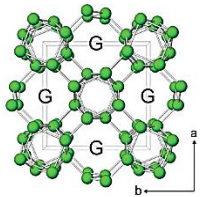

200 GPa
hP4


1.75 TPa (?)
oP8

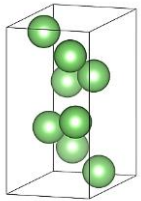
Increasing Structural Complexity

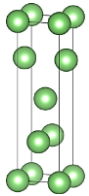

0 GPa
bcc

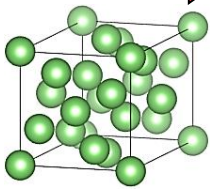

12 GPa
fcc

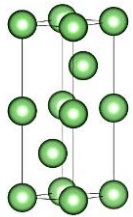


20 GPa
tI19


54 GPa
oP8

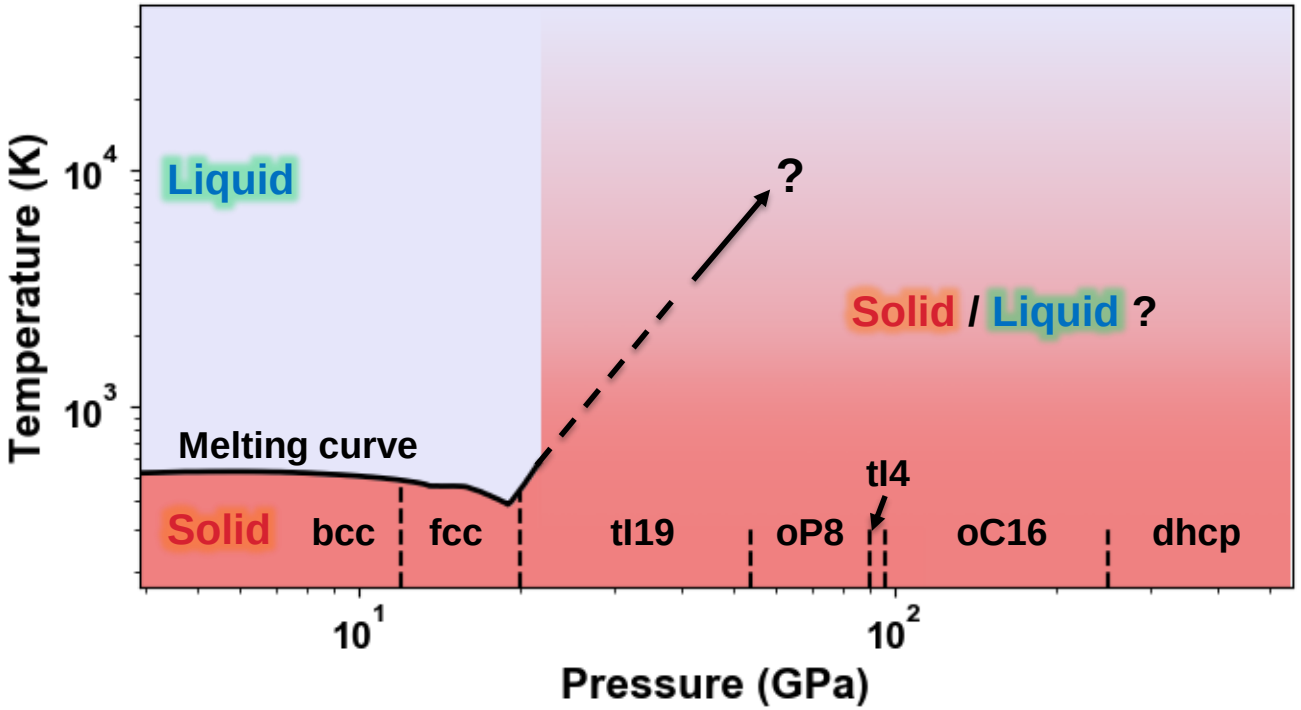

90 GPa
tI4


96 GPa
oC16


250 GPa (?)
dhcp

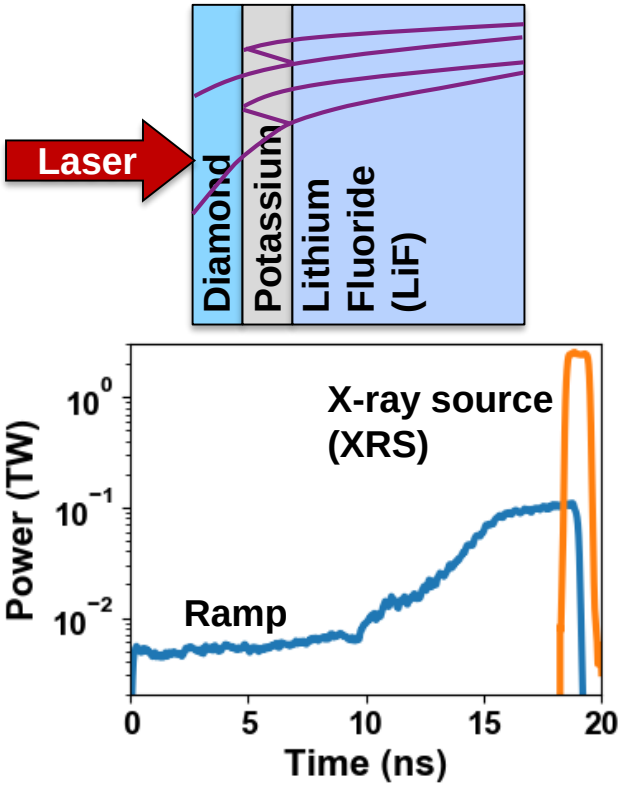
Na: Y. Ma *et al.*, Nature 458, 182 (2009).
K: L. F. Lundegaard *et al.*, Physical Review B 80, 020101 (2009).

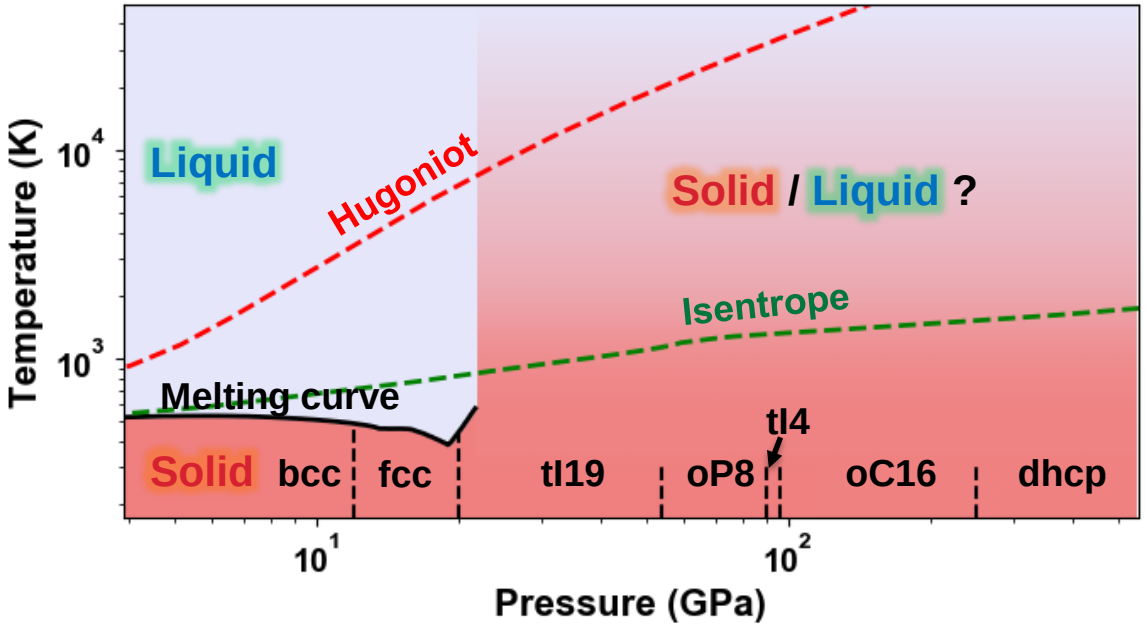
The phase diagram of K is unknown above 112* GPa and 550 K**



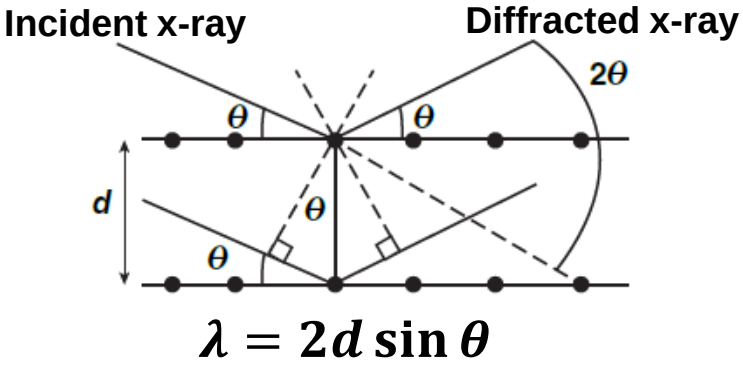
* L. F. Lundegaard *et al.*, Physical Review B 80, 020101 (2009).
** O. Narygina *et al.*, Physical Review B 84, 054111 (2011).

K was ramp compressed to high pressures near the isentrope



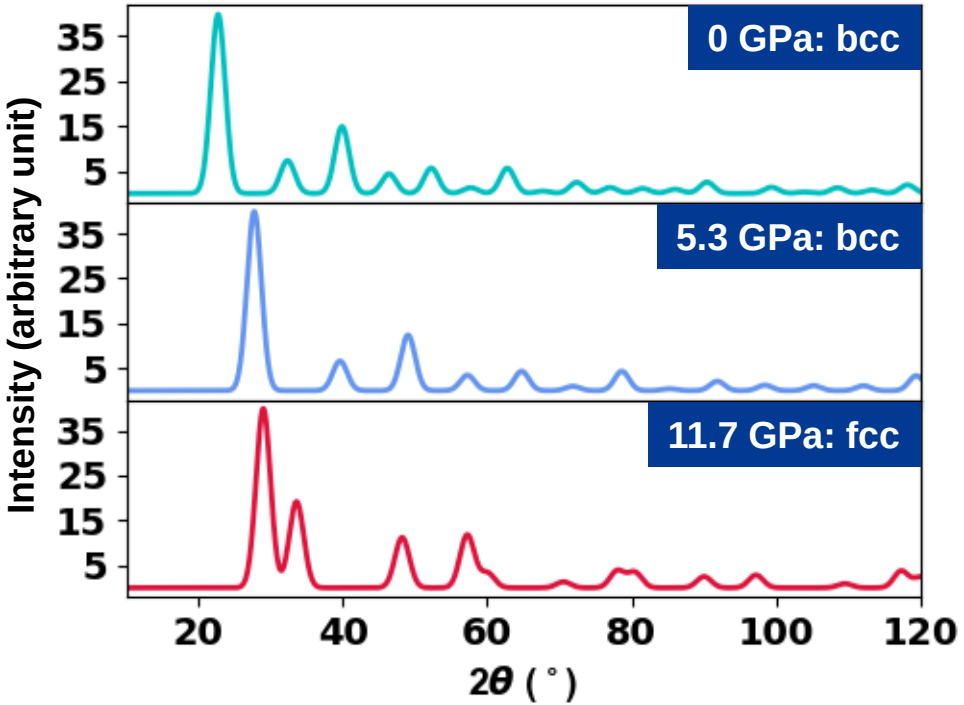


The x-ray diffraction pattern encodes information about the crystal structure

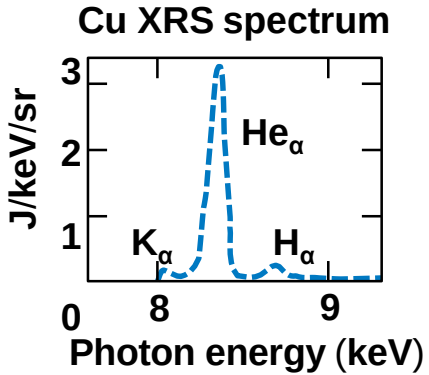


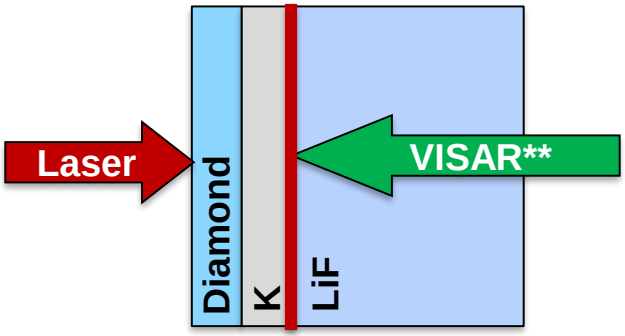
$$\lambda = 2d \sin\theta$$

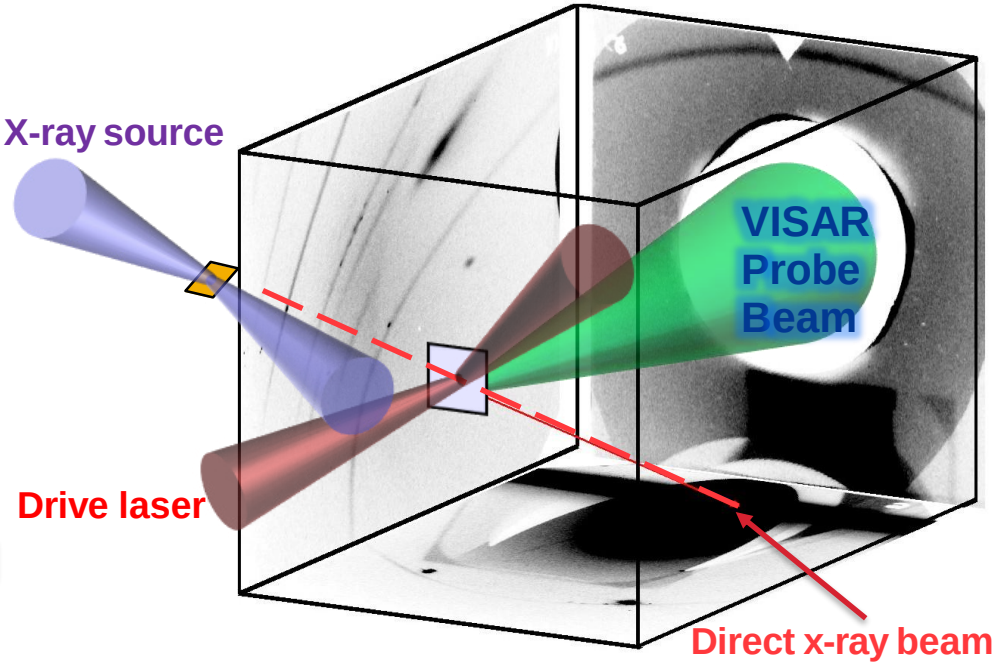
- Compression changes d-spacing between lattice planes
- Compression causes phase transformations, leading to different diffraction patterns.



The powder x-ray diffraction image plate (PXRDIP)* platform is deployed on OMEGA EP to record the diffraction patterns

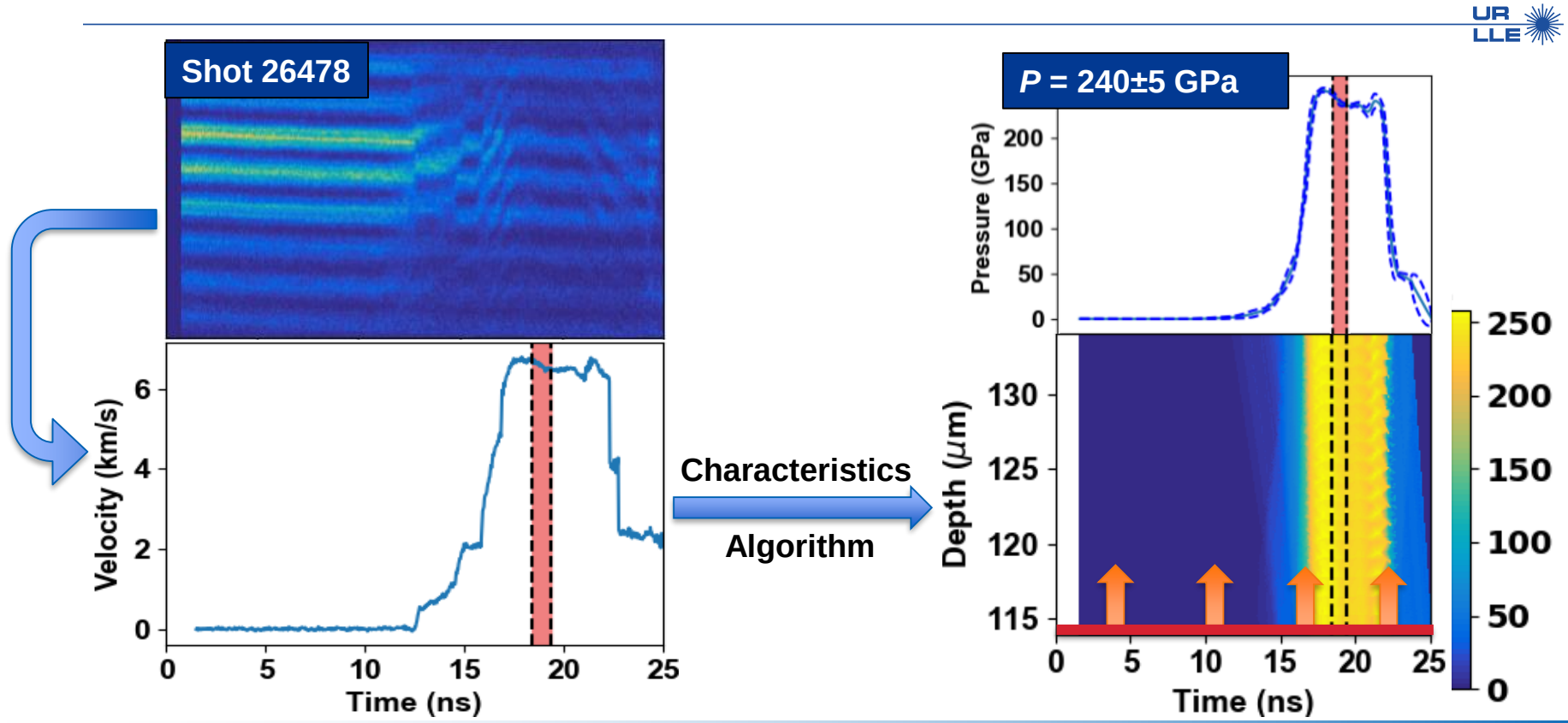




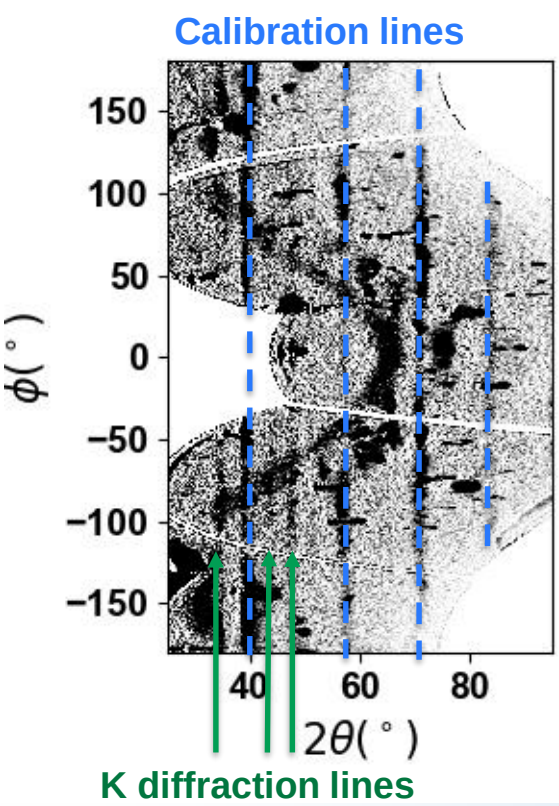


* J. R. Rygg *et al*., Rev. Sci. Instrum. 83, 113904 (2012).
** VISAR: Velocity interferometer system for any reflector.

Pressure in the K sample is inferred using velocimetry measurements



Solid phases are observed at pressures up to 400 GPa, and not consistent with expected candidate structures



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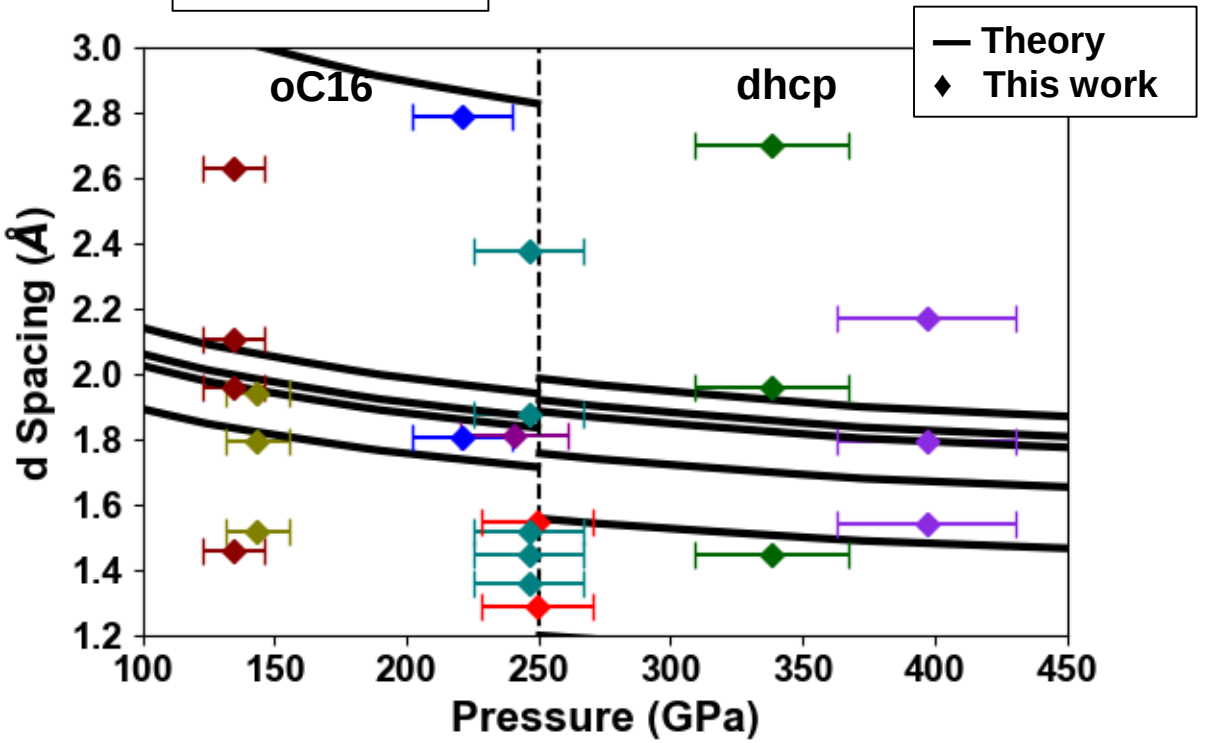
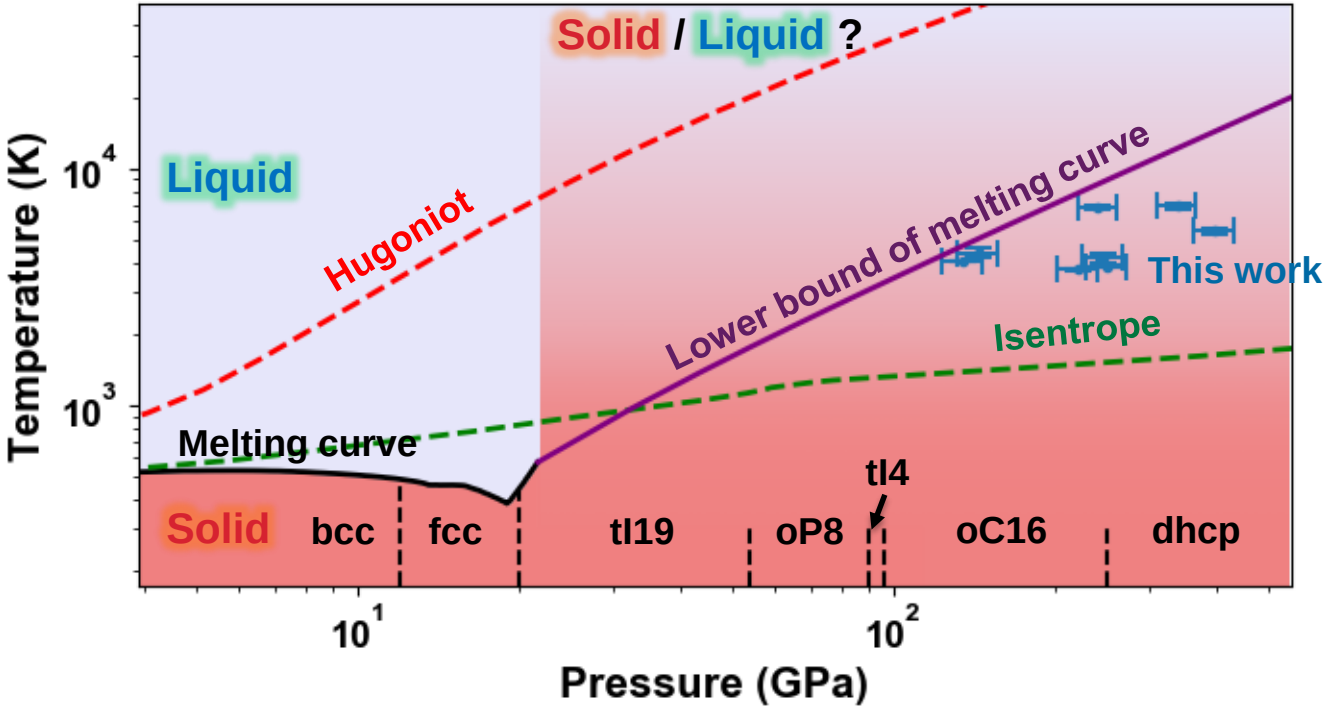


Solid diffraction observations up to 400 GPa put a new constraint on the melting curve



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