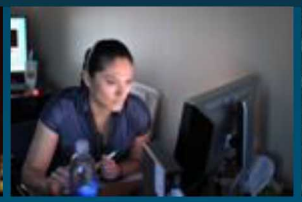
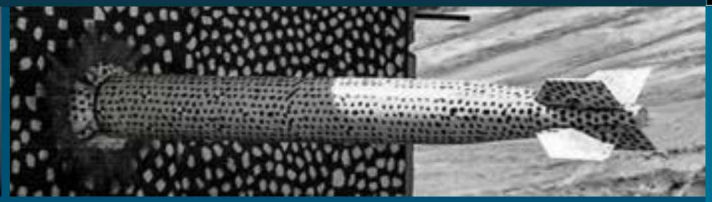
SAND2019-6863C

Sandia National Laboratories

Shock Compression of Iridium





PRESENTED BY

Chris Seagle, Bill Reinhart, Scott Alexander, Justin Brown and Jean-Paul Davis

U.S. DEPARTMENT OF ENERGY NNSA

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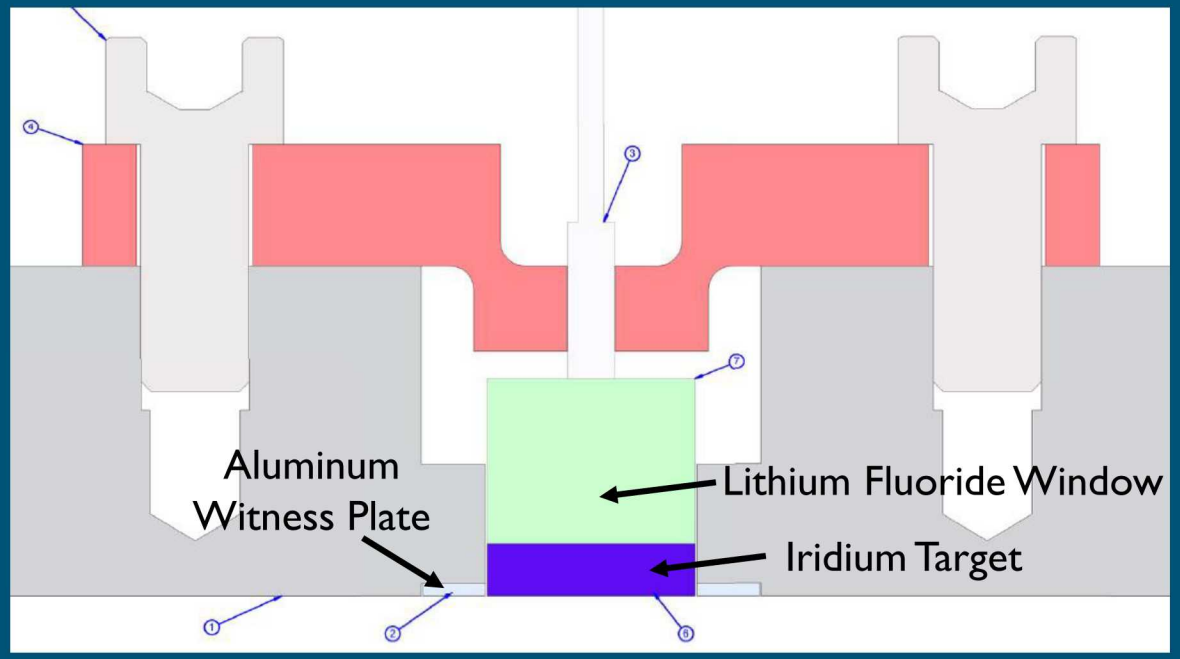
Iridium is one of the highest shock impedance elements

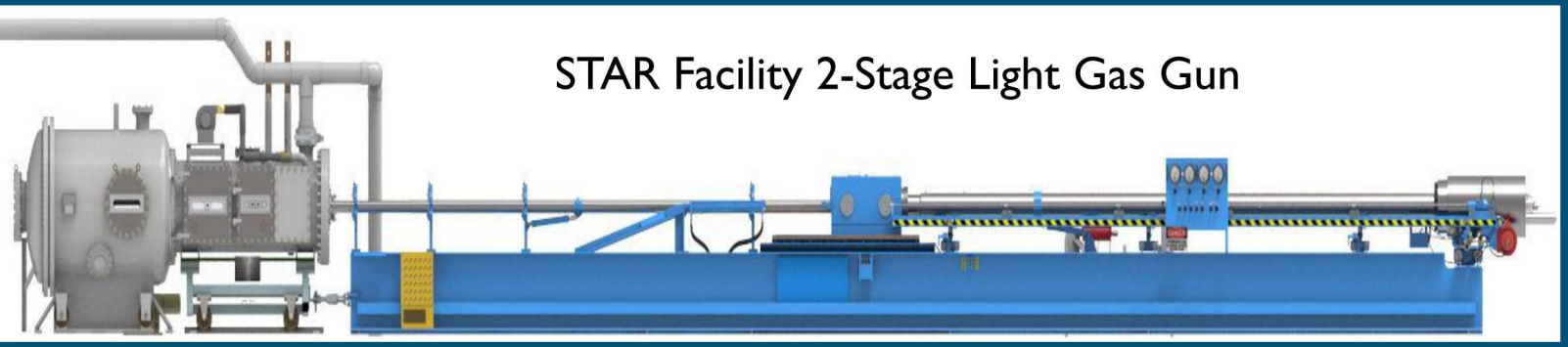
Iridium has several desirable characteristics for flyers or an equation of state standard in dynamic compression studies:

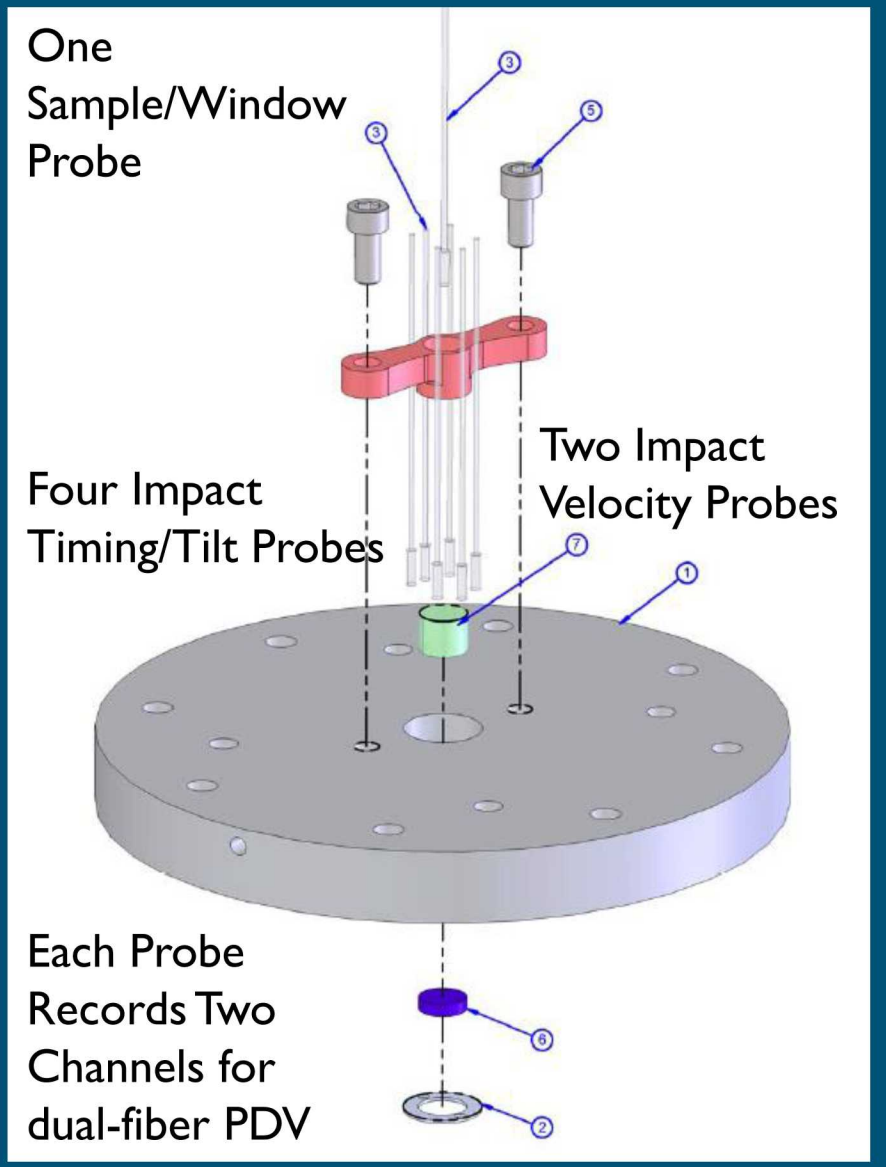
- 22.5 g/cc Density
- 3.7 km/s Sound Velocity
- 320 GPa Bulk Modulus
- Low Reactivity (noble metal)
- High melting temperature (2739 K)

Relatively few dynamic compression studies have been carried out previously.

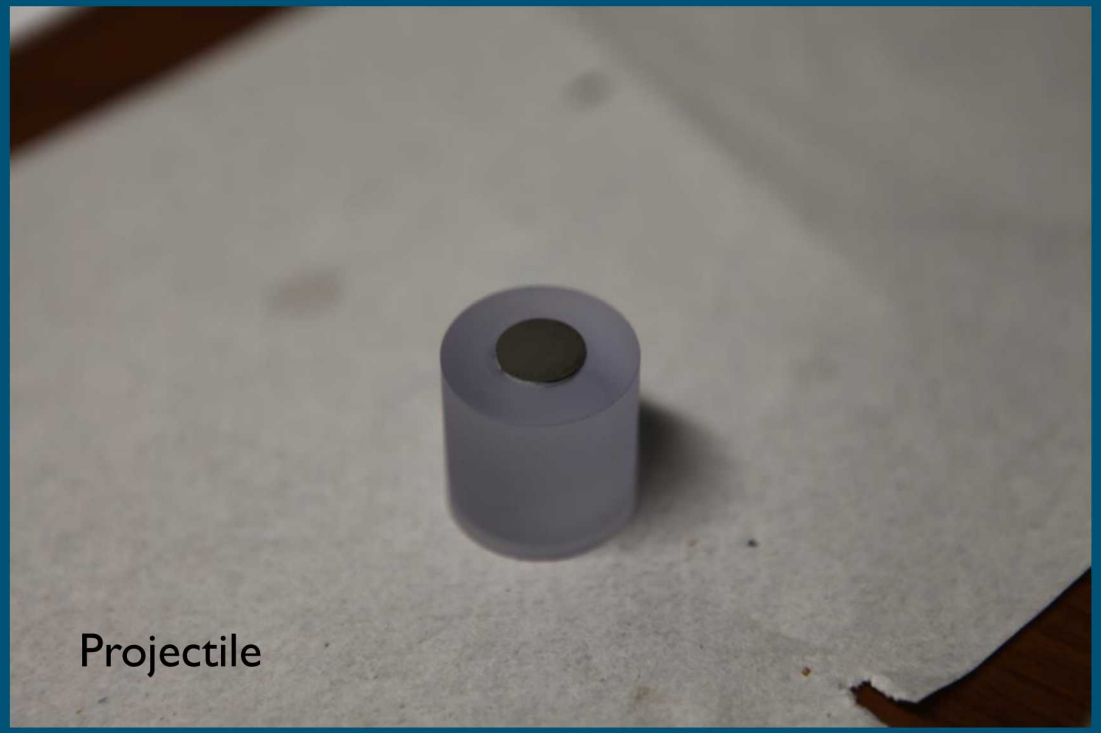
Symmetric Impact Experiments on 2-Stage Light Gas Gun





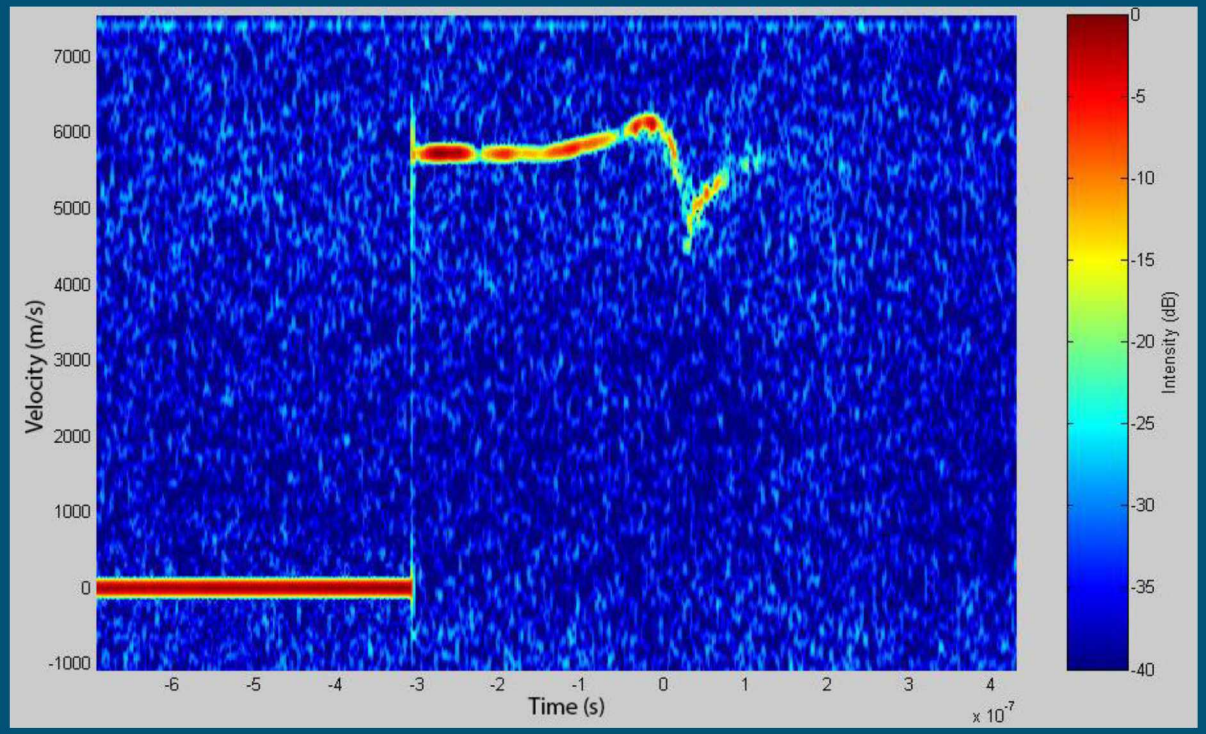


Symmetric Impact Experiments on 2-Stage Light Gas Gun



Impactor: 2 mm thick x 12 mm diameter
Sample: 2 mm thick x 8 mm diameter
Iridium: 99.95% with 2.386 g/cc density

Hugoniot Results



Representative apparent Ir/LiF velocity on Shot #4 (5.39 km/s Ir Impactor)

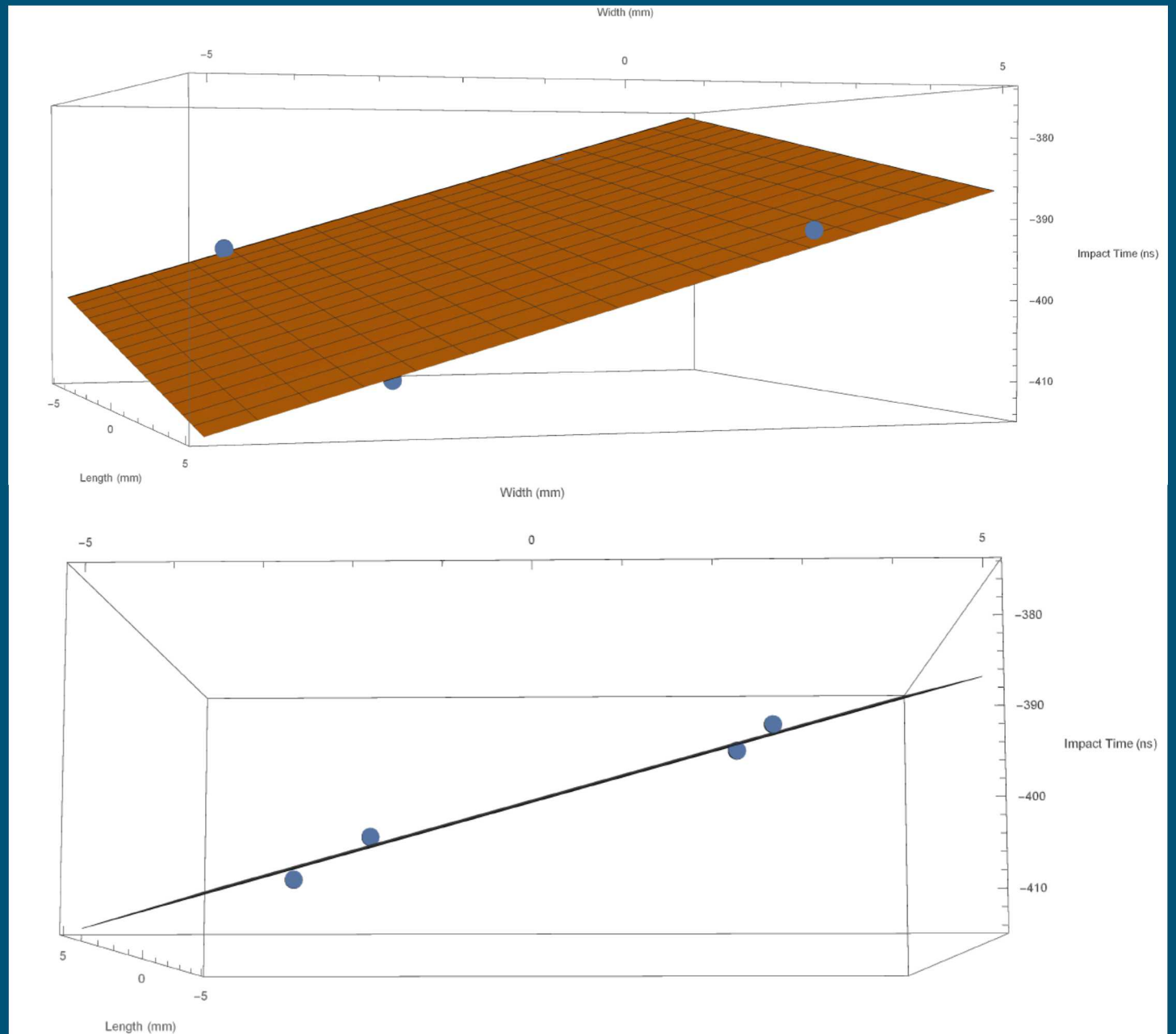
Hugoniot Results

Measured tilt was ~5-20 mrad

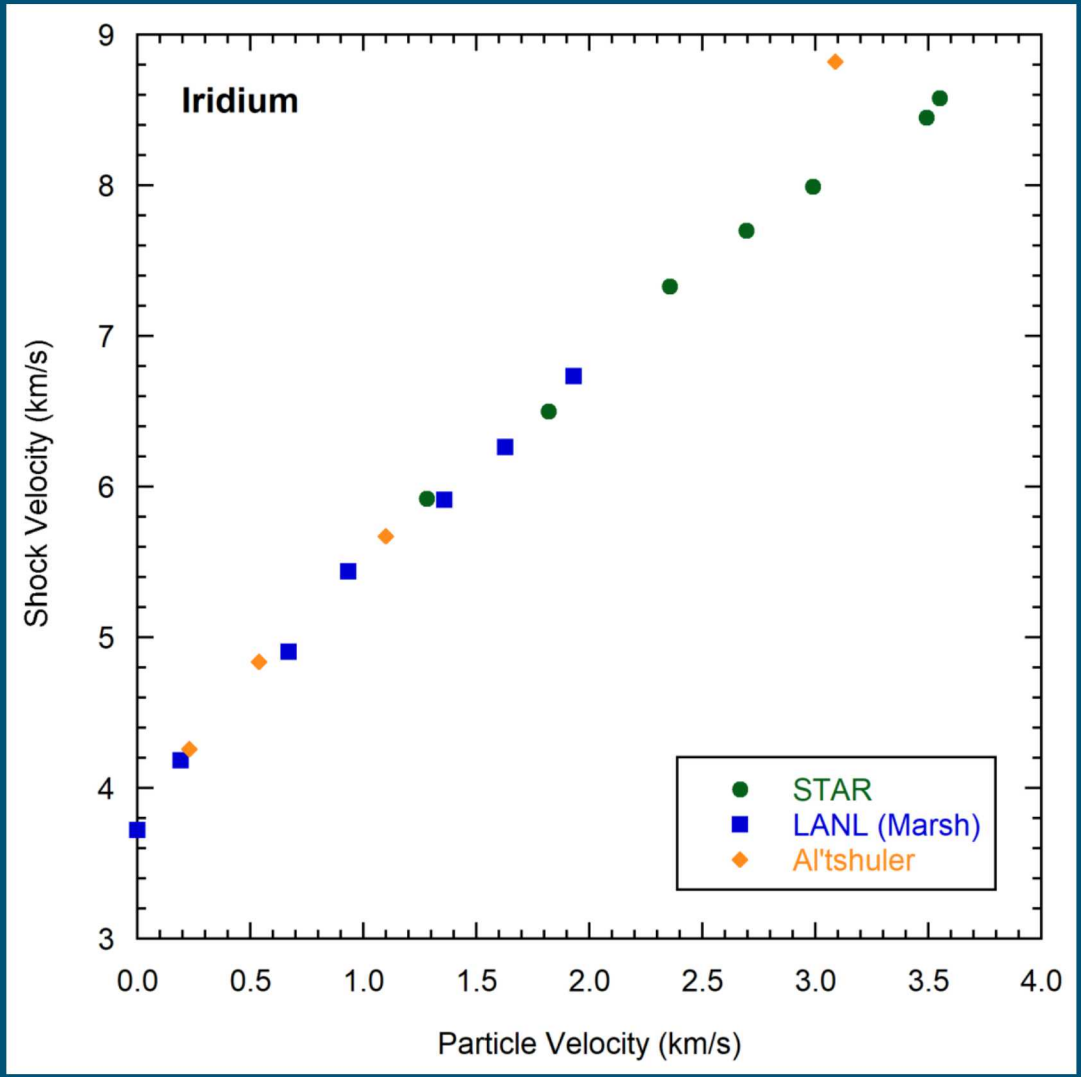
Plane fit to impact times on aluminum witness plate to infer impact time on center

Typical mis-fit plane fiducials of ~1 ns

Note: The Ir Hugoniot must be known to infer the impact time on the witness plate from the measure witness plate breakout time. The entire data set is iterated upon to bring the Ir EoS into convergence.

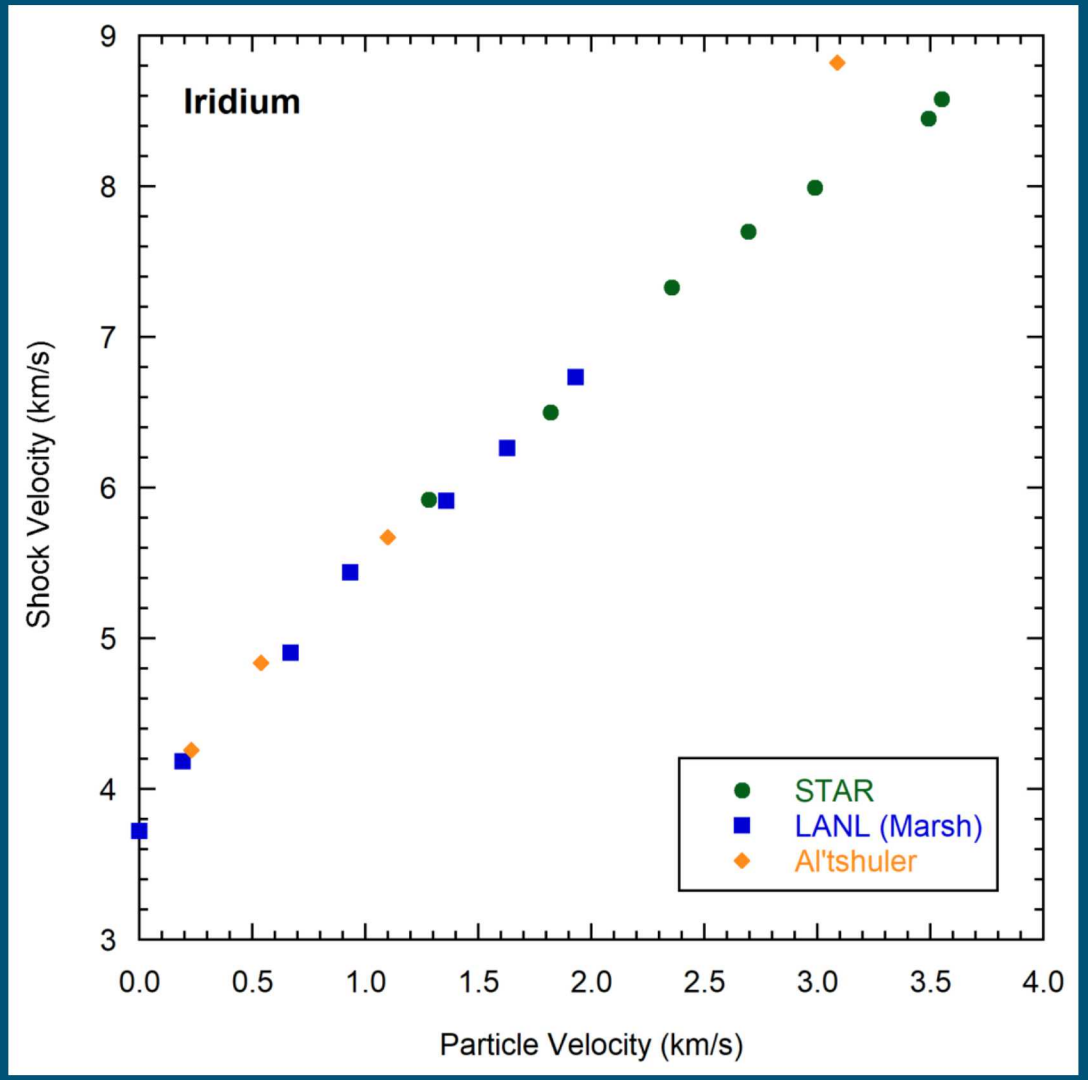


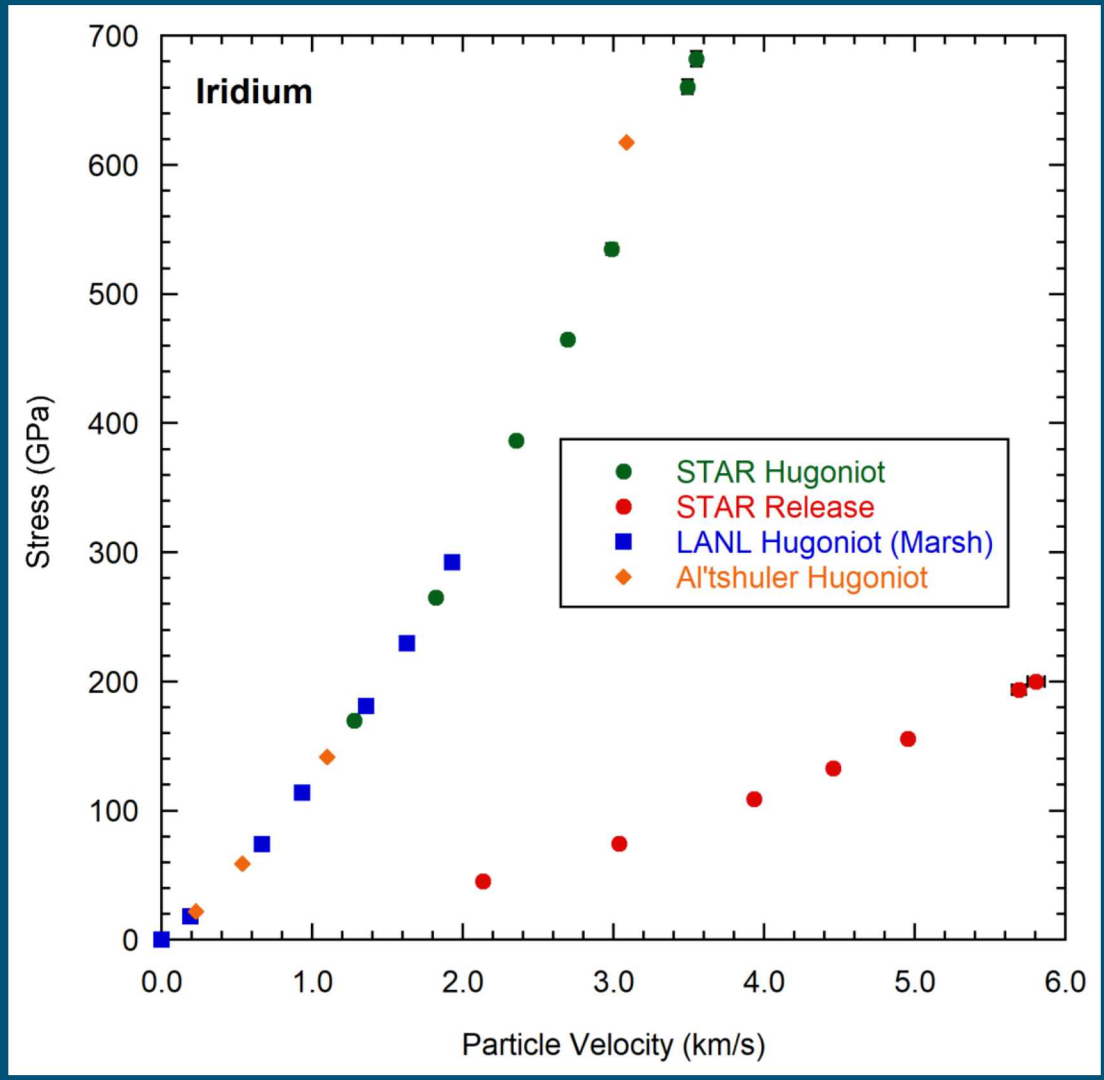
Hugoniot Results



Errors smaller than symbols for STAR data (no error reported for Marsh or Al'tshuler)

Hugoniot Results





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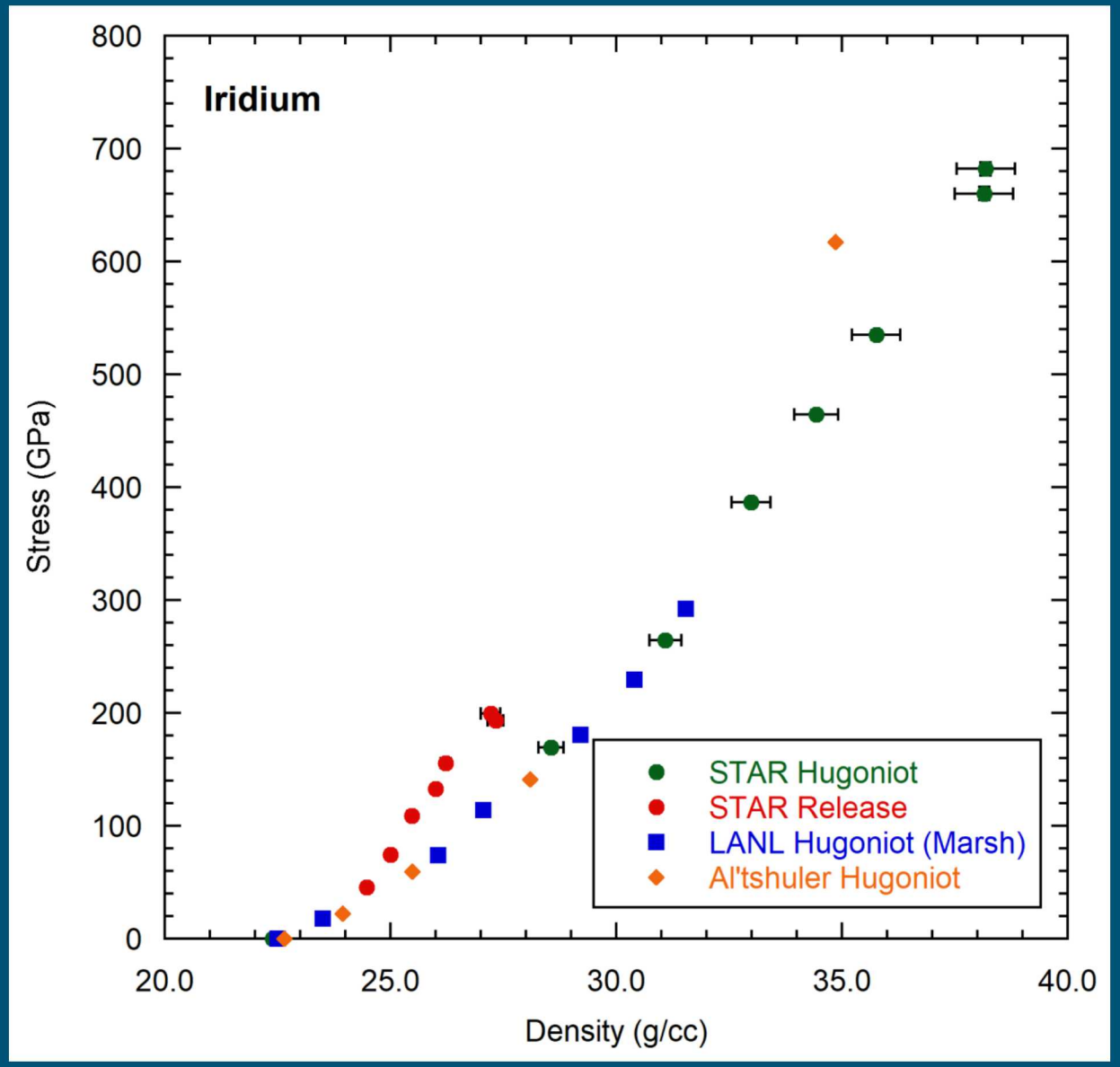
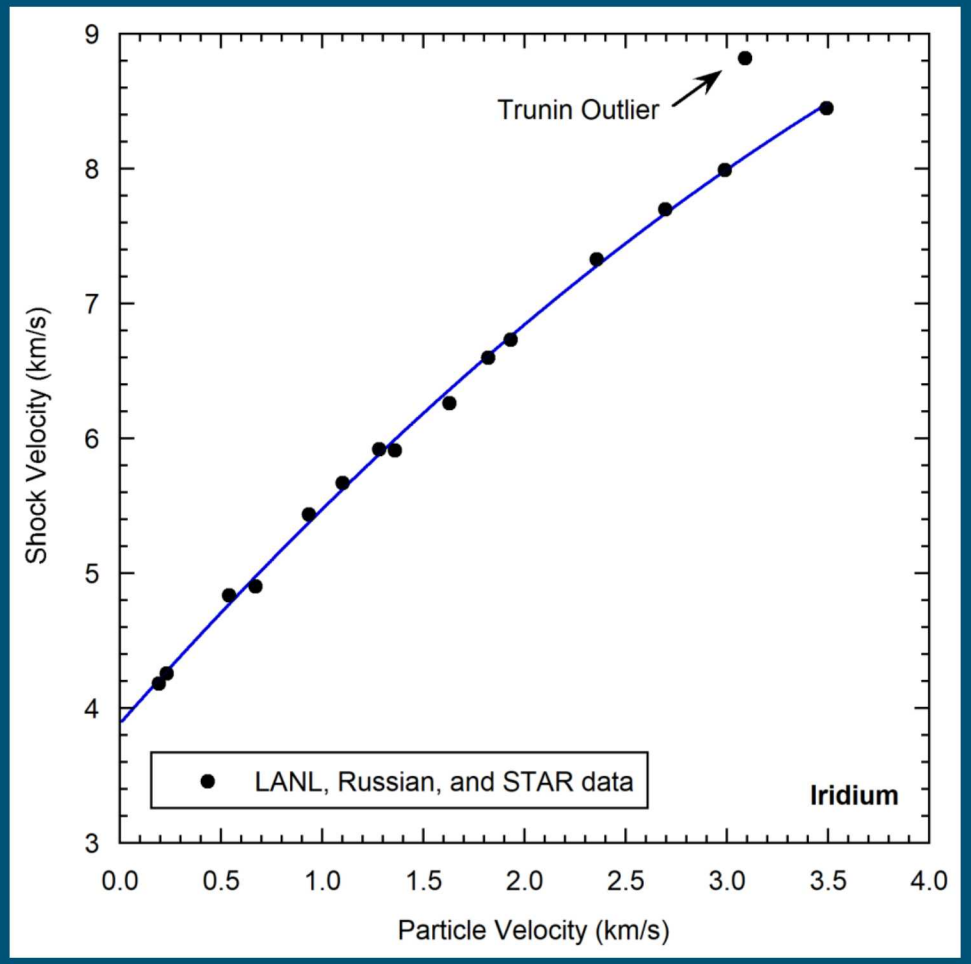
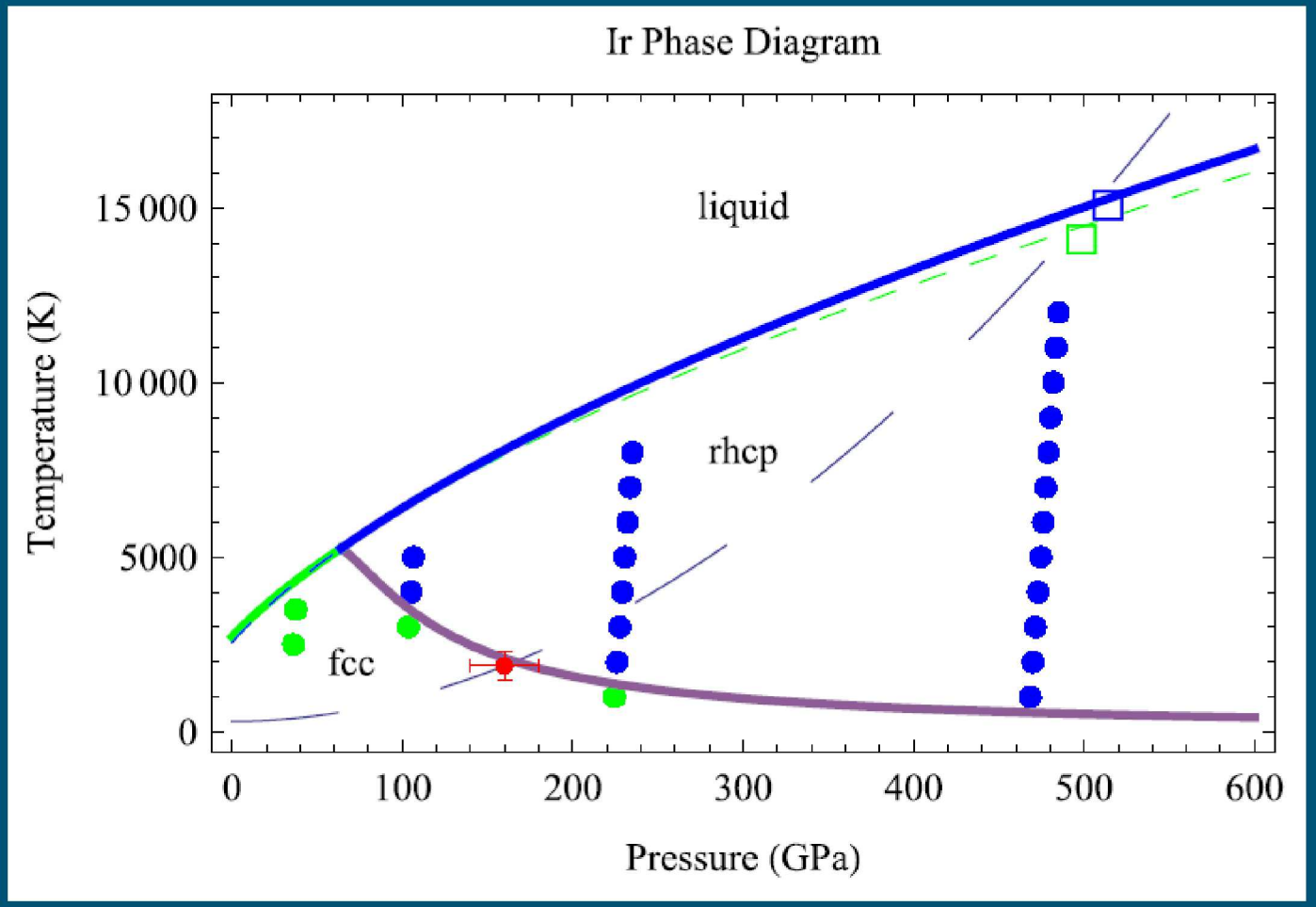
Hugoniot Results



Possible Phase Transition on the Hugoniot

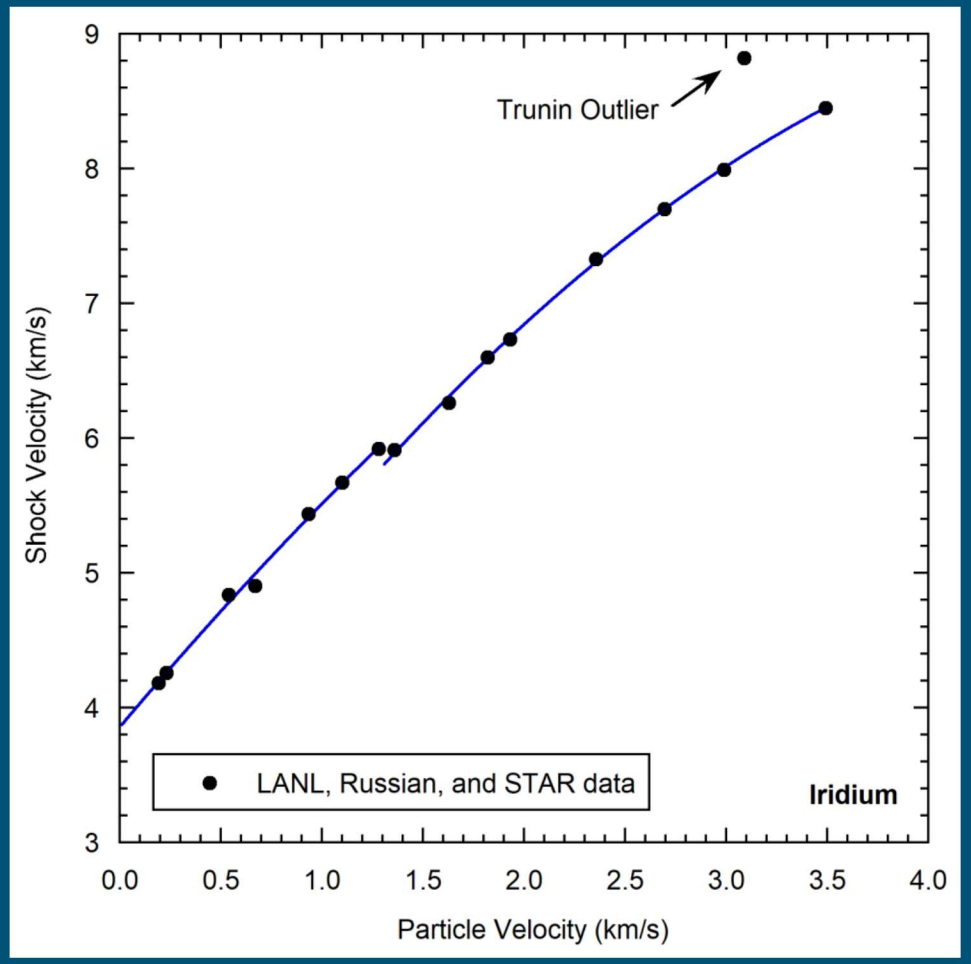


Single function fit, ignoring outlier

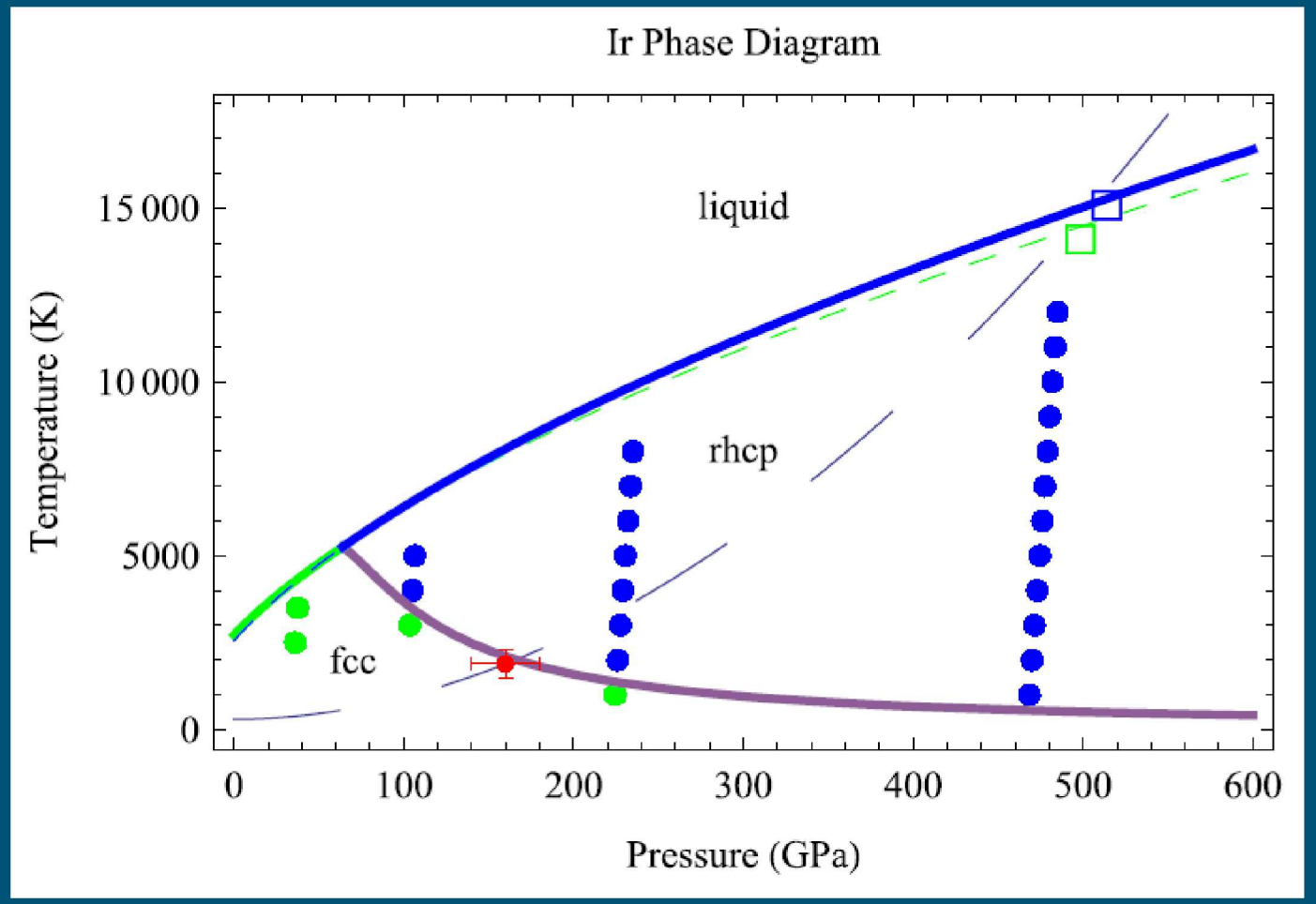


Predicted Ir phase diagram (Burakowski et al., 2016)

Possible Phase Transition on the Hugoniot



Piece-wise fit with phase transition at ~1.3 km/s particle velocity (~170 GPa)



Predicted Ir phase diagram (Burakowski et al., 2016)

Conclusions

High precision Hugoniot data was obtained with symmetric impact on the STAR 2-stage light gas gun up to 6.8 Mbar.

A possible solid-solid phase transition was detected – more experiments planned to target this region of phase space.

The shock-particle velocity relationship is non-linear. The shock-response of iridium is well characterized for use as an impactor on 2-stage gun studies.

Special Thanks To:

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