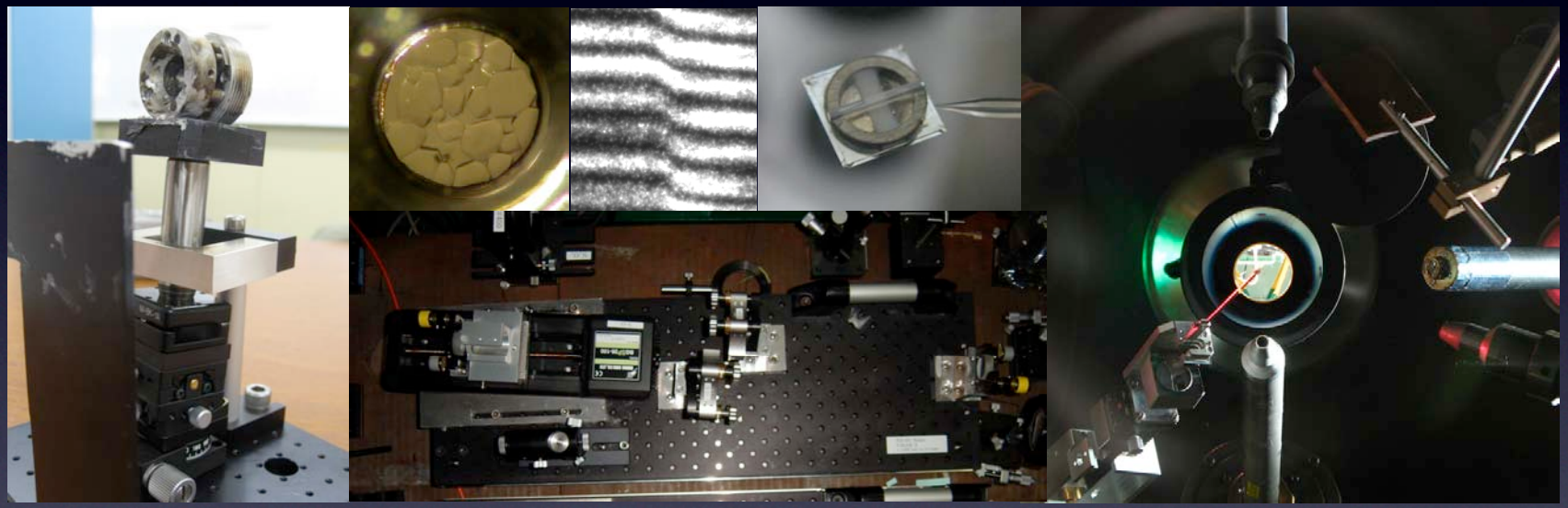
Recent activities of the research unit for exploration of new materials toward innovative electrons devices (Ozaki IDER)



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Acknowledgment

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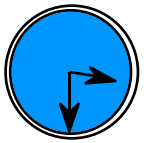
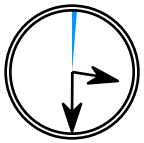
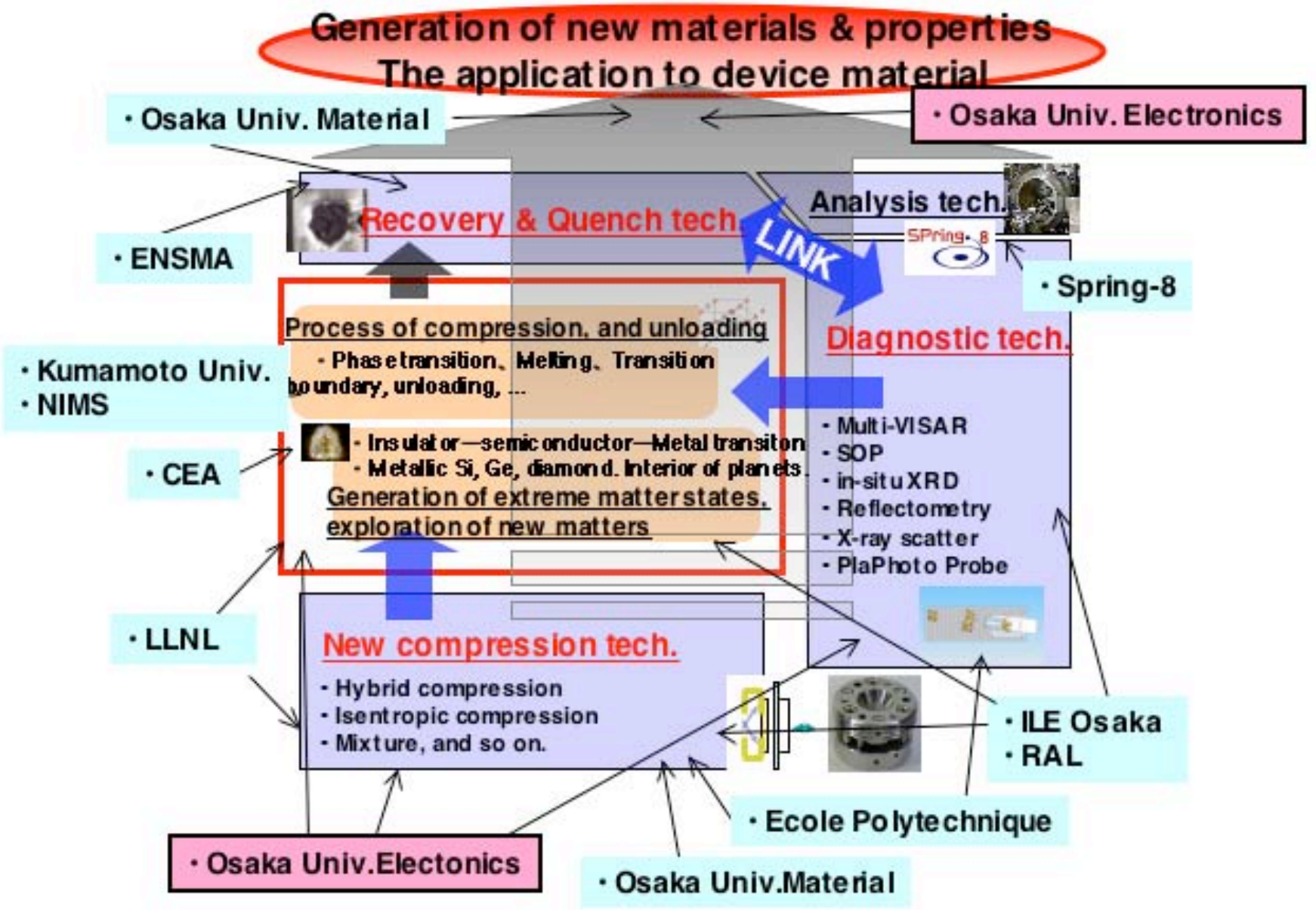
[13]*Commissariata l'Energie Atomique (CEA), France*

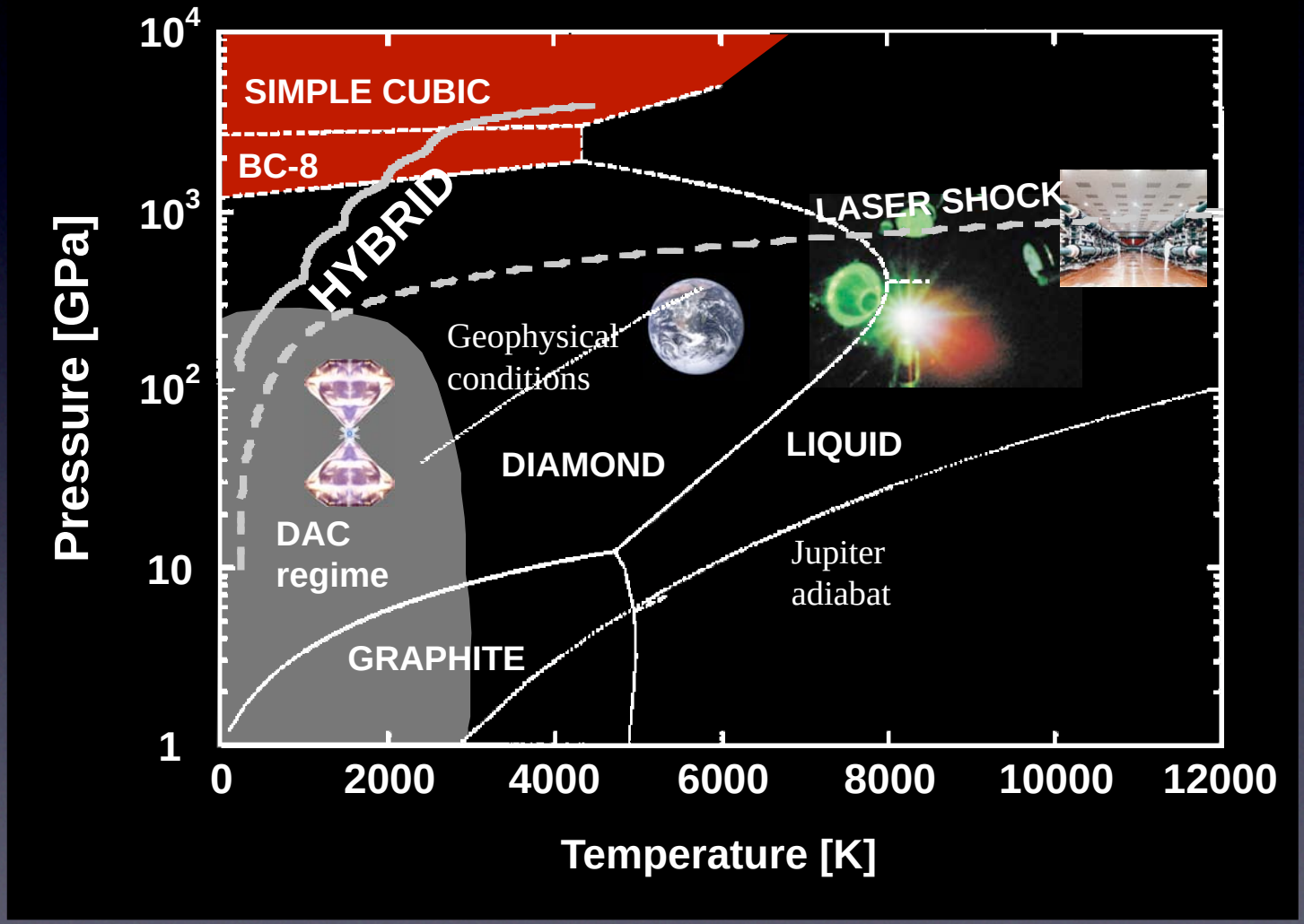
What is the purpose of the unit?

- Creating novel materials applicable to innovative electronic devices not found in STP condition

	Gun	Laser
Spatial scales	 10 mm	1 mm
Time scales	 1 μs	 10 ns
Pressure	 0.5 TPa	 50 TPa


Generation of new materials & properties
The application to device material
・Osaka Univ. Material
・Osaka Univ. Electronics
・ENSMA
Recovery & Quench tech.
LINK
Analysis tech.
SPring-8
・Spring-8
Process of compression, and unloading
・Phase transition、Melting、Transition boundary, unloading, ...
Diagnostic tech.
・Kumamoto Univ.
・NIMS
・Multi-VISAR
・SOP
・in-situ XRD
・Reflectometry
・X-ray scatter
・PlaPhoto Probe
・CEA
・Insulator—semiconductor—Metal transiton
・Metallic Si, Ge, diamond. Interior of planets.
Generation of extreme matter states, exploration of new matters
・LLNL
New compression tech.
・Hybrid compression
・Isentropic compression
・Mixture, and so on.
・ILE Osaka
・RAL
・Ecole Polytechnique
・Osaka Univ.Electonics
・Osaka Univ.Material

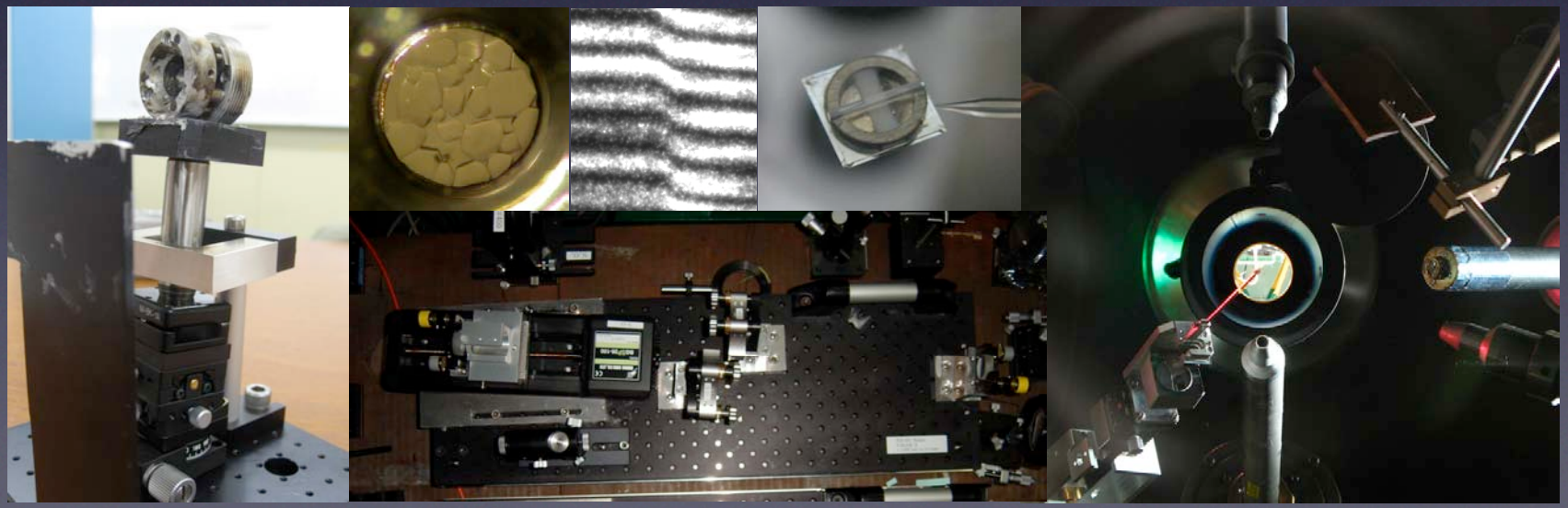
In order to investigate “Off-Hugoniot” states, new approaches are required



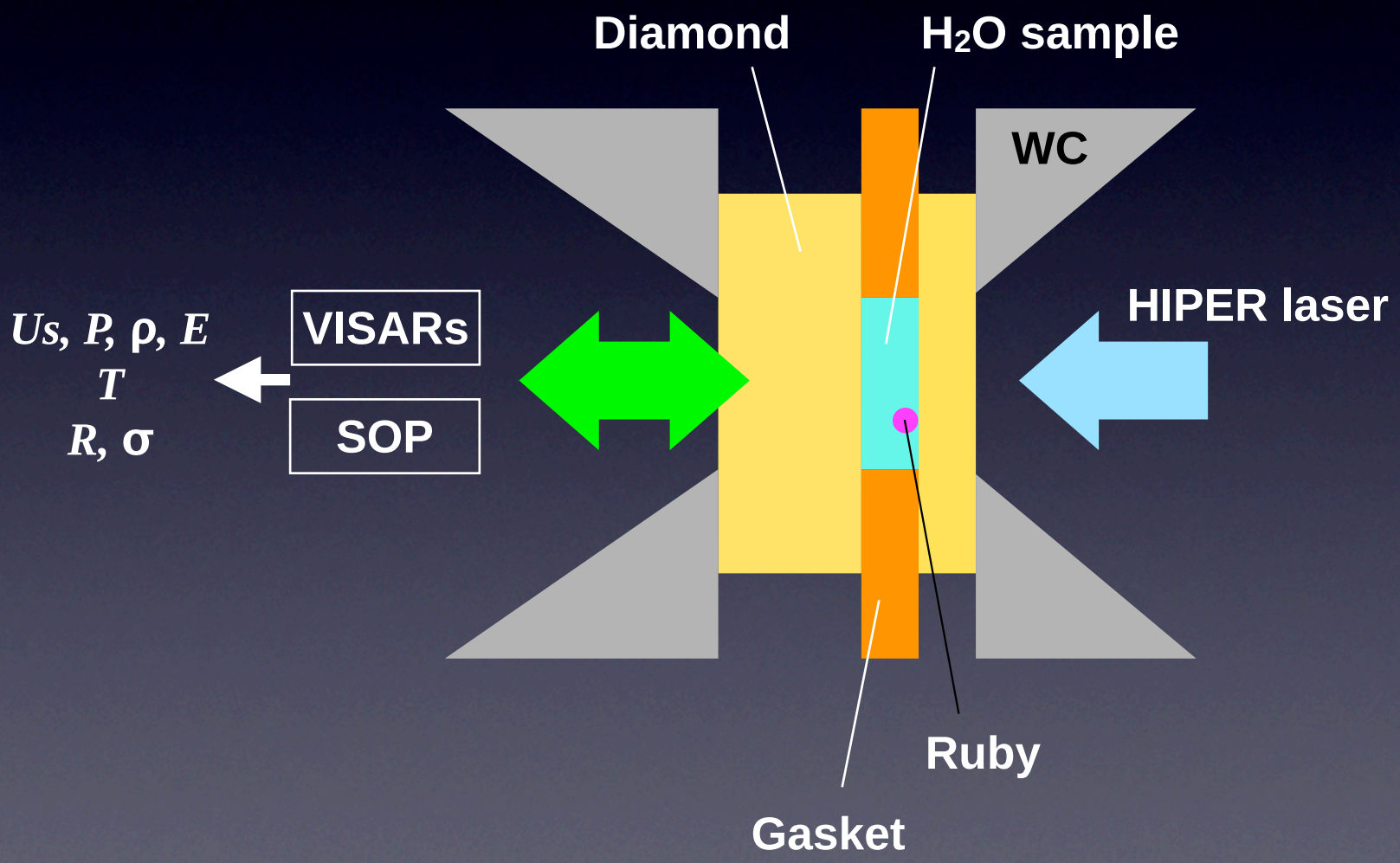
P. Grumbach *et al.*, Phys Rev. B (1996).

Some new approaches are under development in Osaka University to access Off-Hugoniot material states

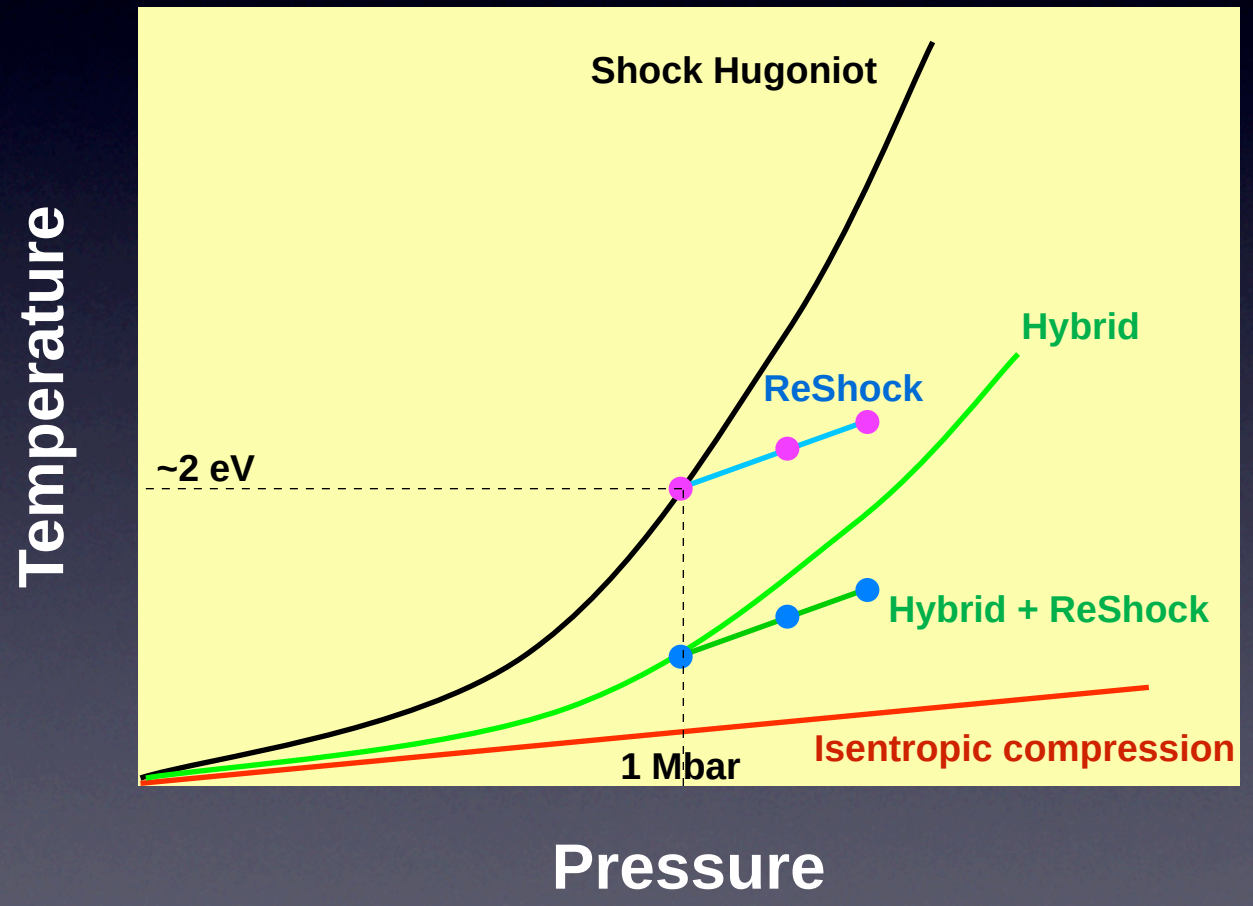
- Static and dynamic “hybrid” compression
- Reflecting shocks
- Isentropic compression



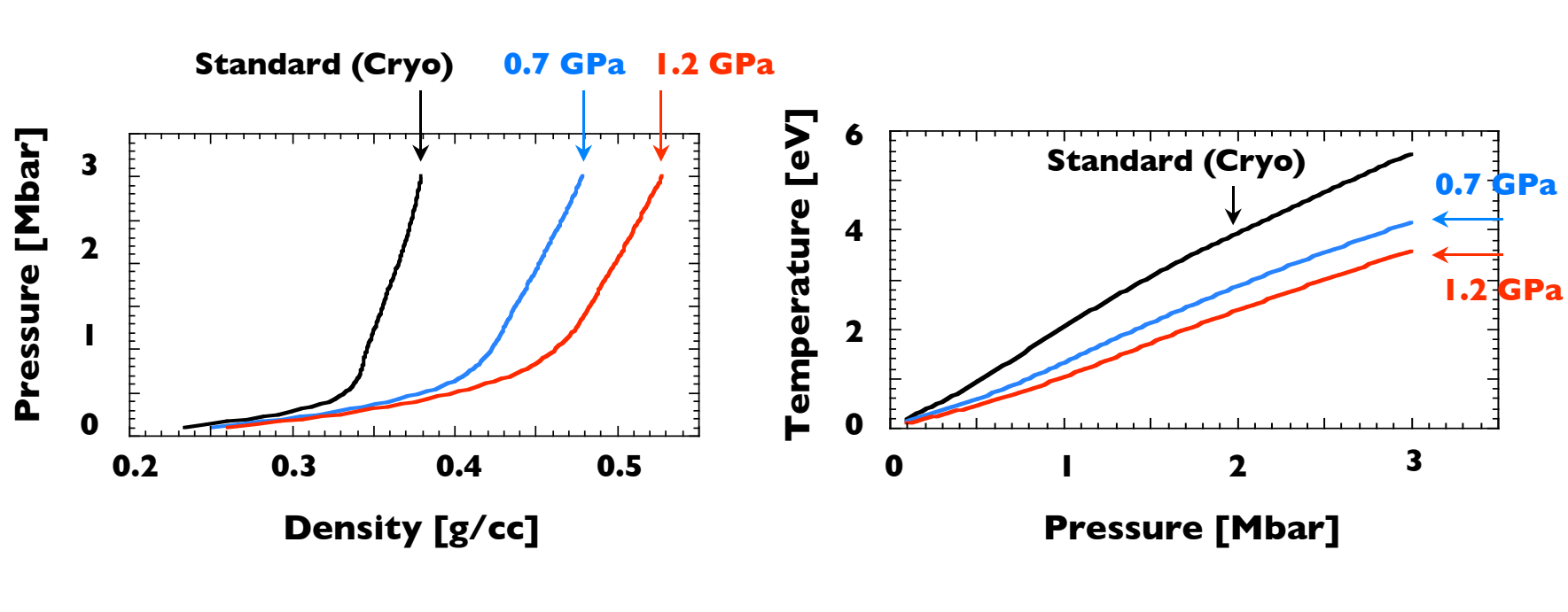
Laser shock experiments on the pre-compressed H_2O target have been performed at GEKKO/HIPER facility



Wide range off-Hugoniot conditions are available for e.g., hydrogen using these techniques



Comparison of Hugoniots between cryogenic and pre-compressed H_2 targets

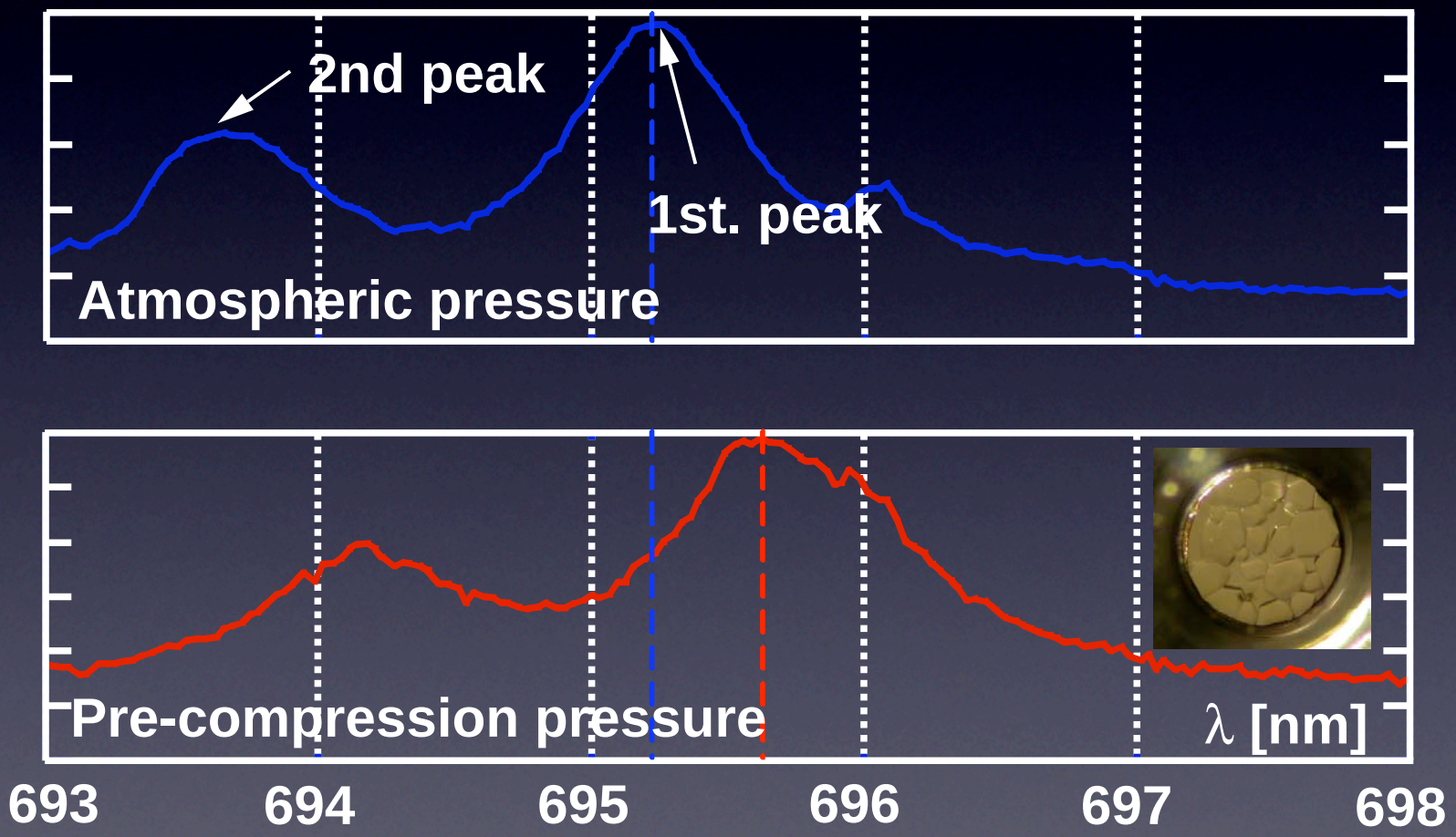


0.088 g/cc, 20 K (cryogenic liquid H2)

0.122 g/cc, 300 K (0.7 GPa pre-compress)

0.142 g/cc, 300 K (1.2 GPa pre-compress)

Precompression pressures more than 1 GPa have been achieved using even thin flat diamond plates



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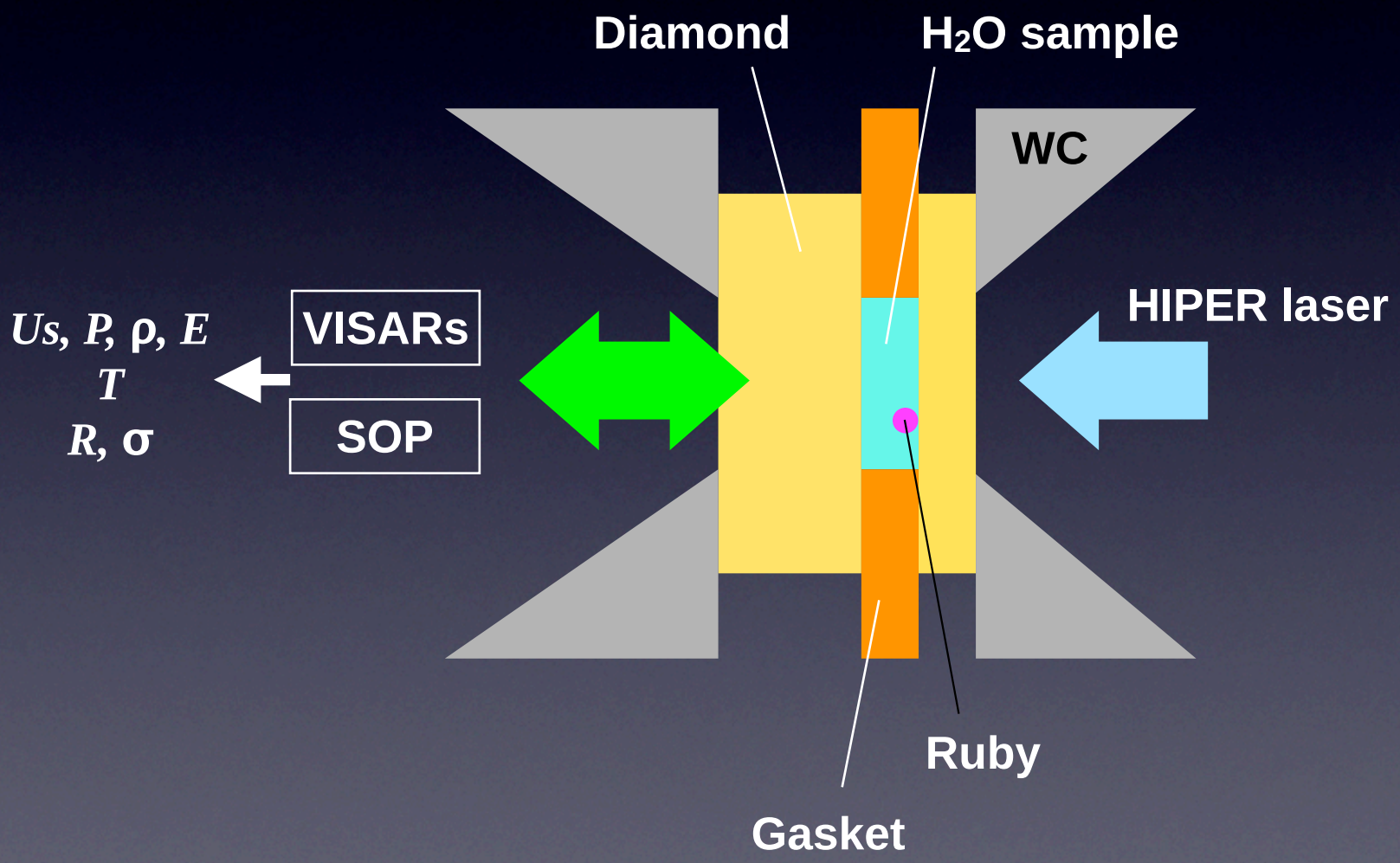
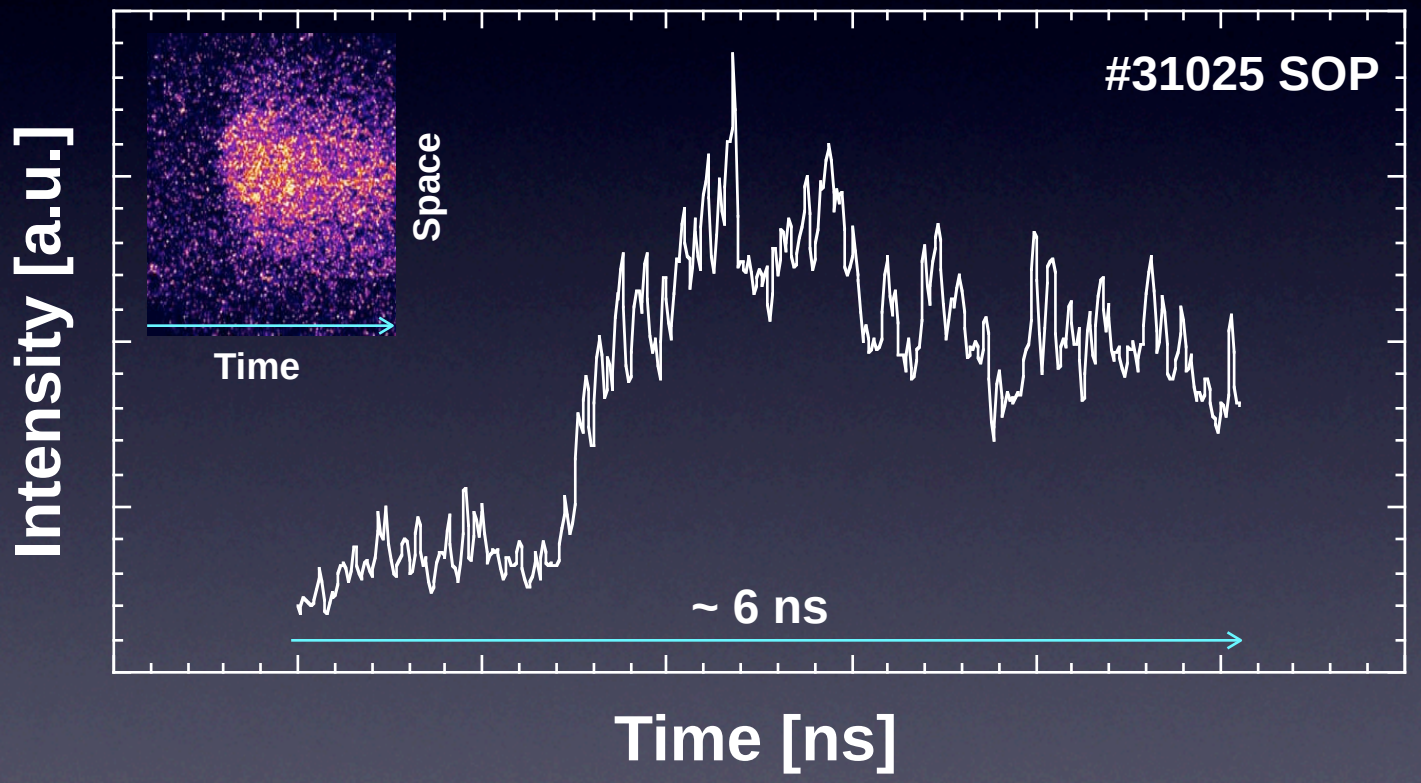
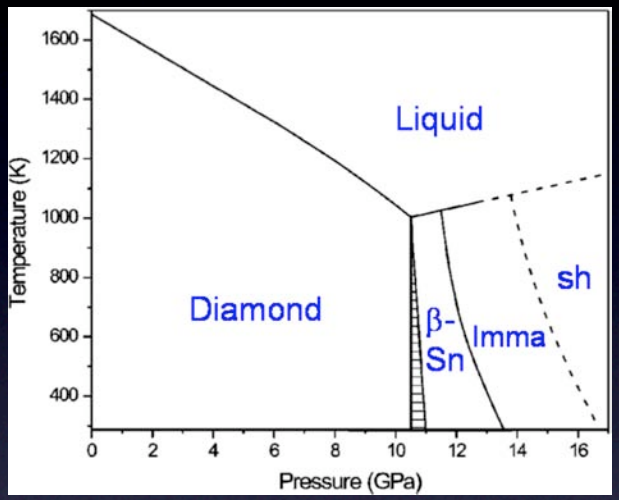
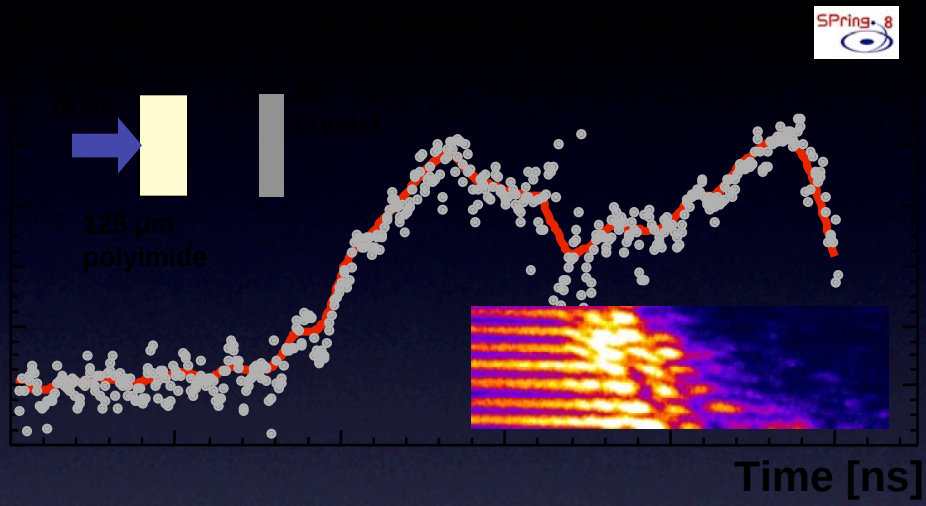


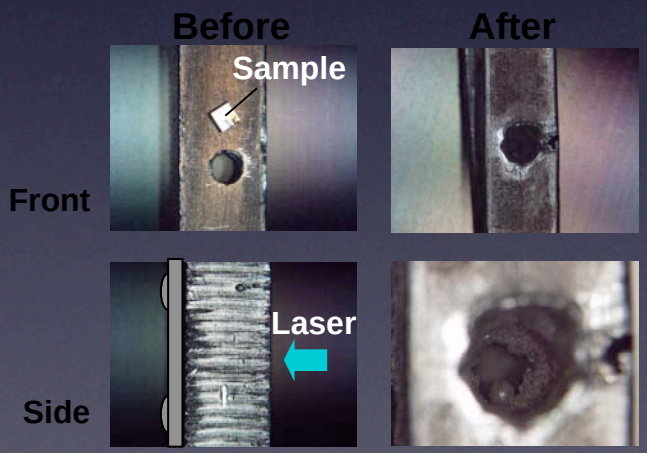
Few eV temperature, which is much lower than principle Hugoniot one, is measured

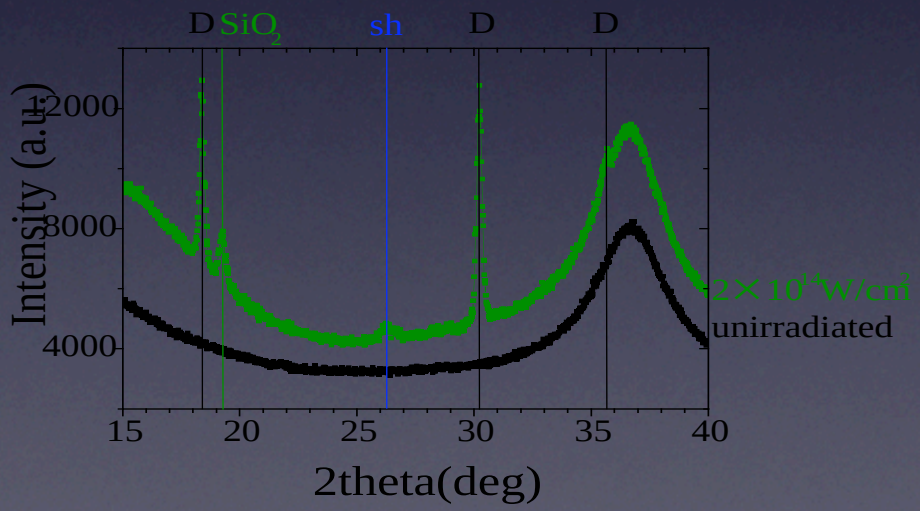


We have recovered shocklessly compressed silicon









Voronin *et al.*, Phys. Rev. B (2003).

Conclusions

Experimental investigations for Off-Hugoniot with high pressure but low temperature have been started using new techniques

- Precompression pressures more than 1 GPa have been achieved using diamond anvil cell technique.
  - Laser-shock experiments were also performed at HIPER laser facility.
- Simultaneous measurements with rear VISAR/SOP and monochromatic x-ray diagnostics have been developed.
  - Shock reflection by sapphire anvil has been observed with VISARs.
  - New anvil materials have been investigated up to TPa pressures.
- Ramp wave generations have been confirmed.
  - Al sample is isentropically compressed up to ~ 20 GPa.
  - We are improving the planarity of laser irradiation pattern.