TOKAMAK COMPRESSION EXPERIMENTS AT GENERAL FUSION

Michel Laberge – CAP Congress 2017

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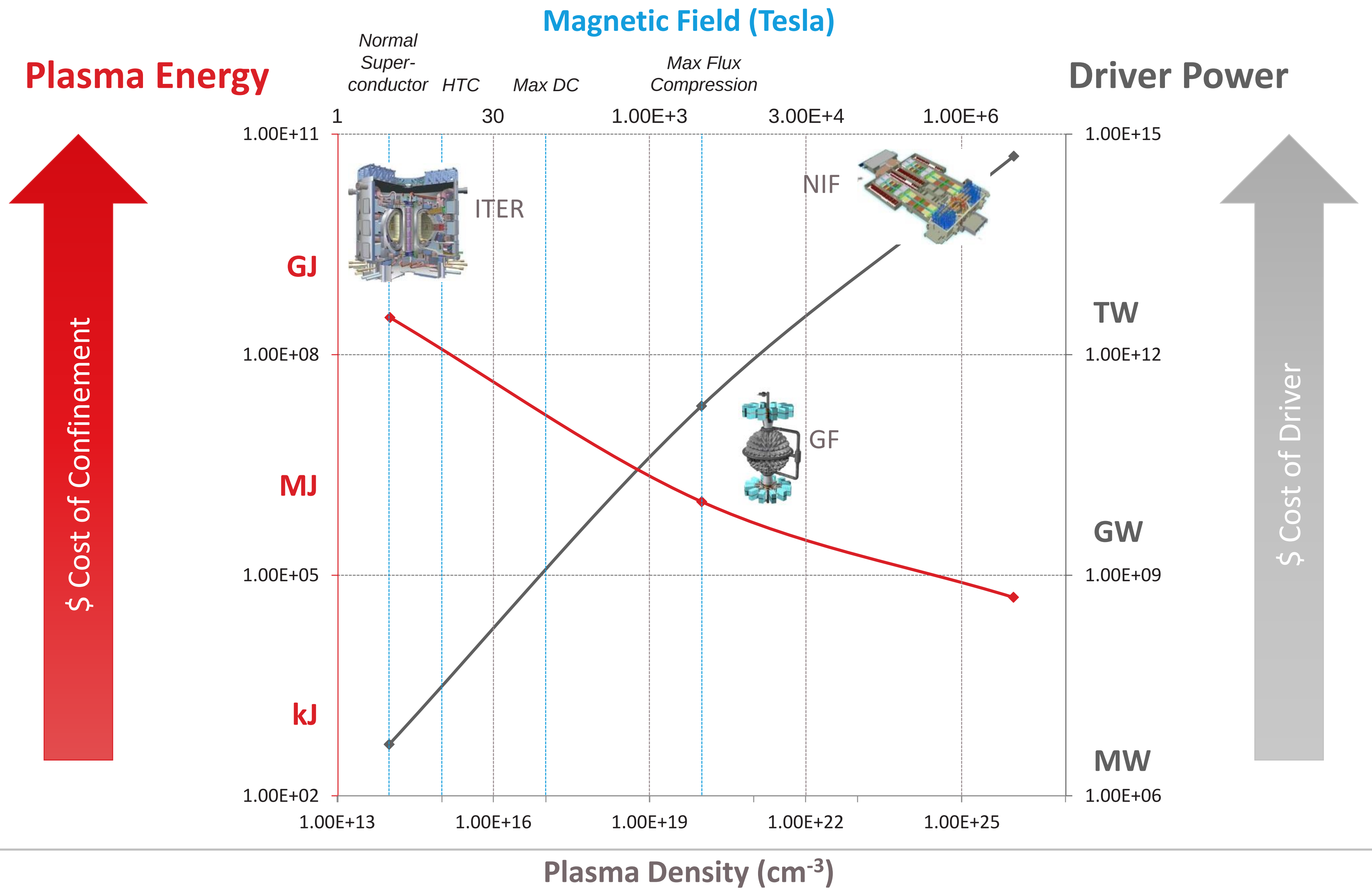
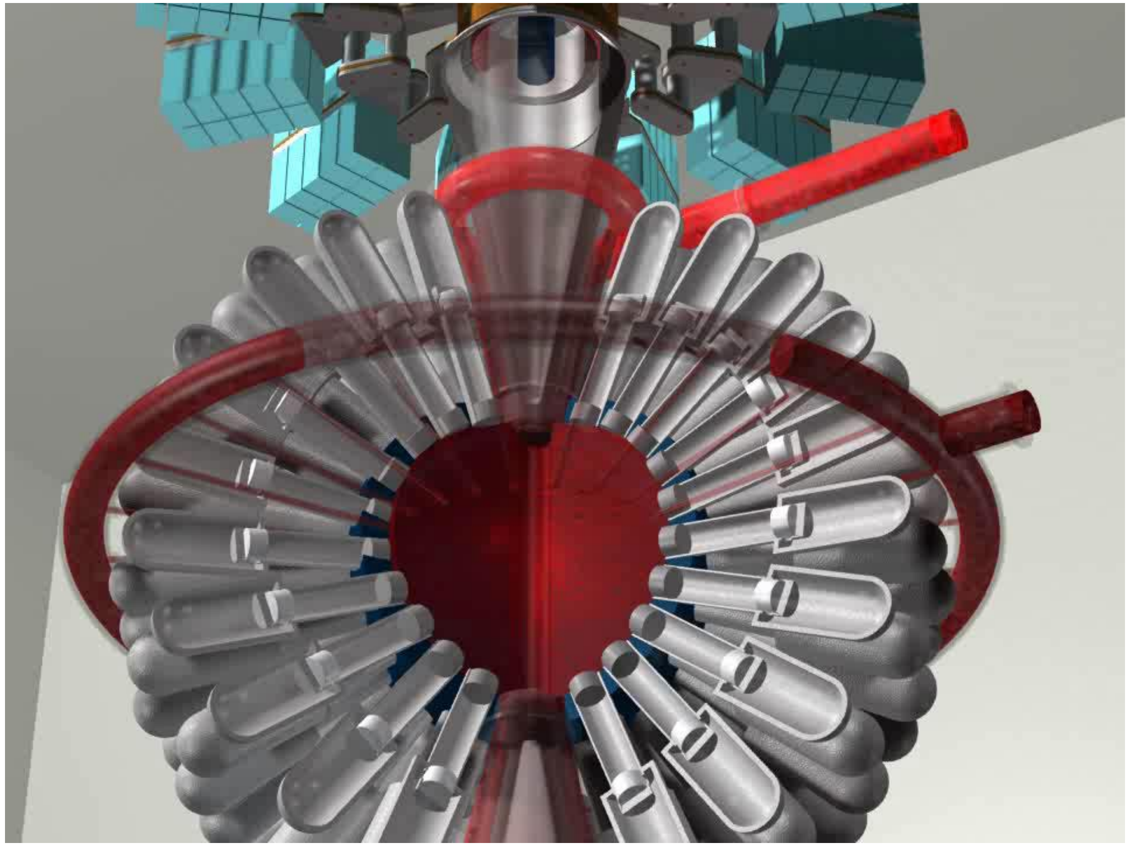
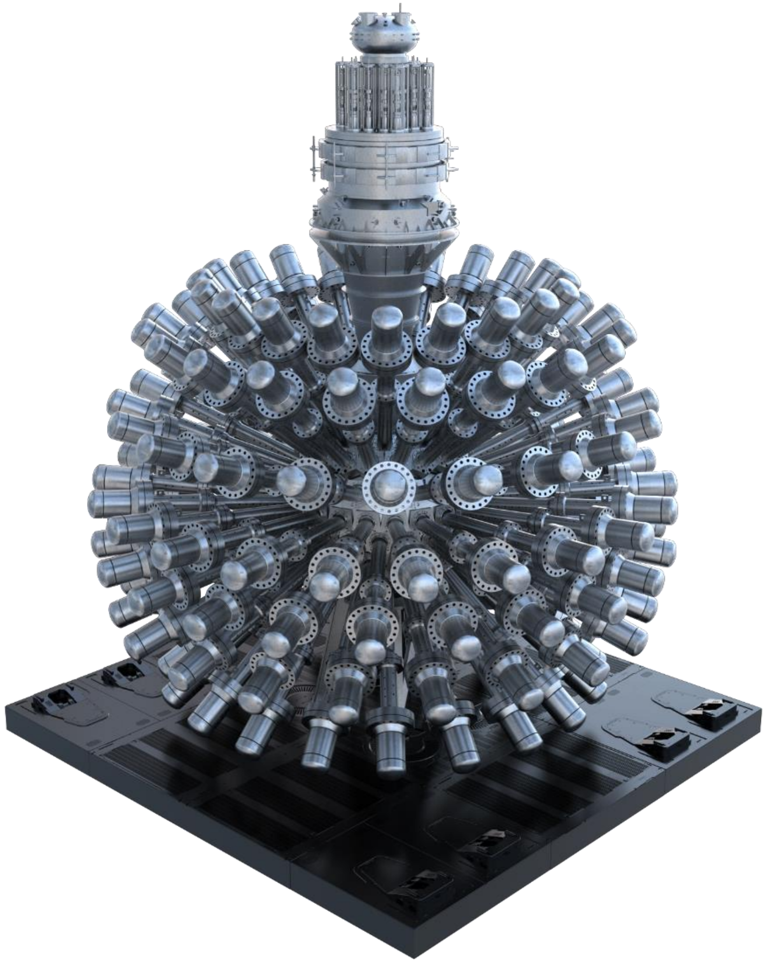
Fusion Technology Comparison

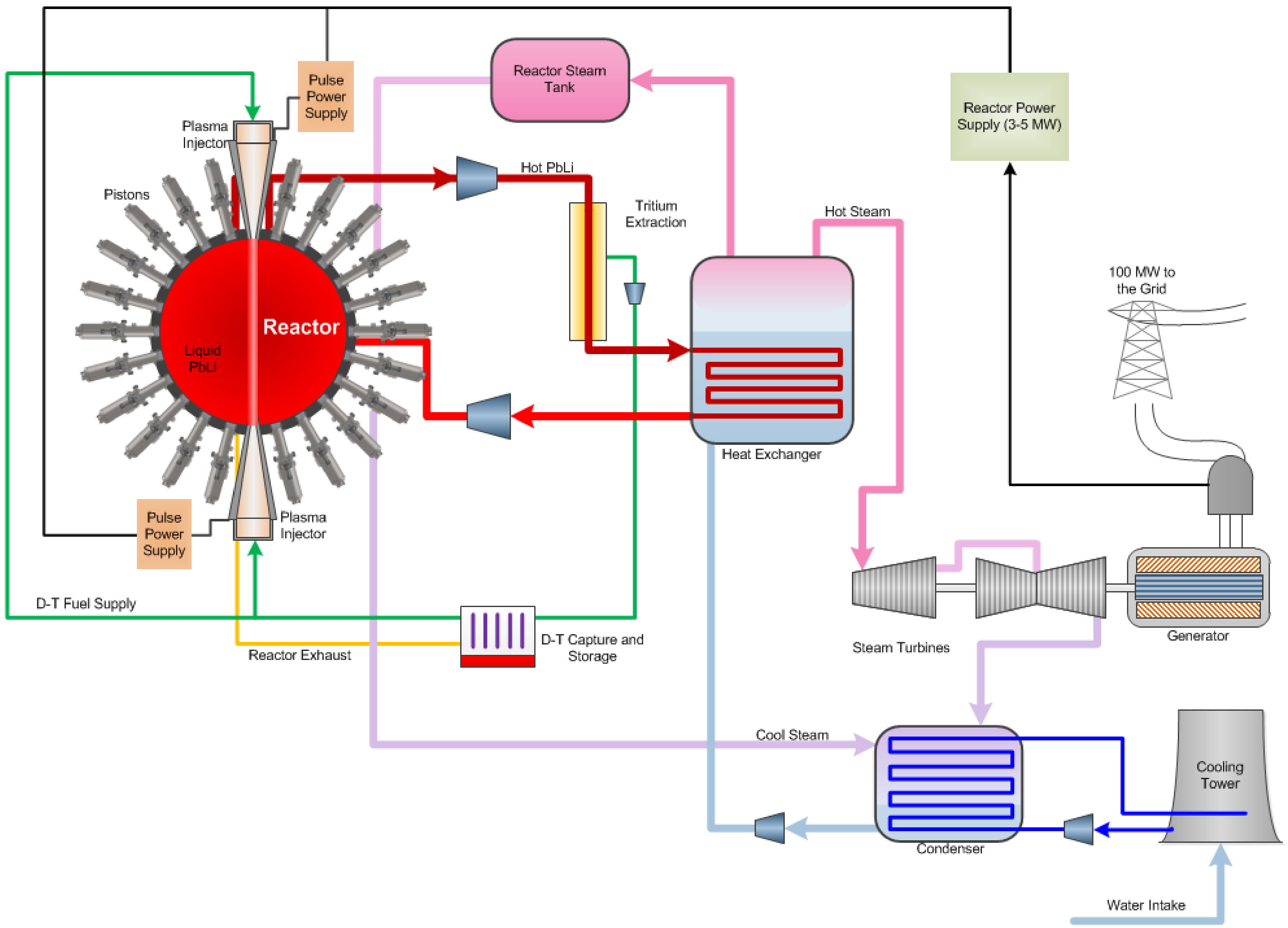


General Fusion's Acoustically Driven MTF





Power Plant Schematic

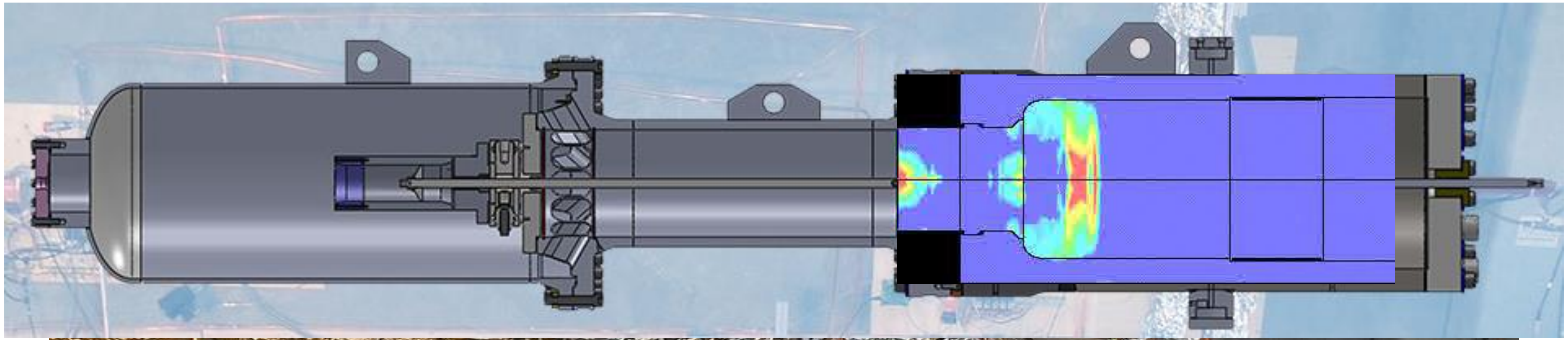


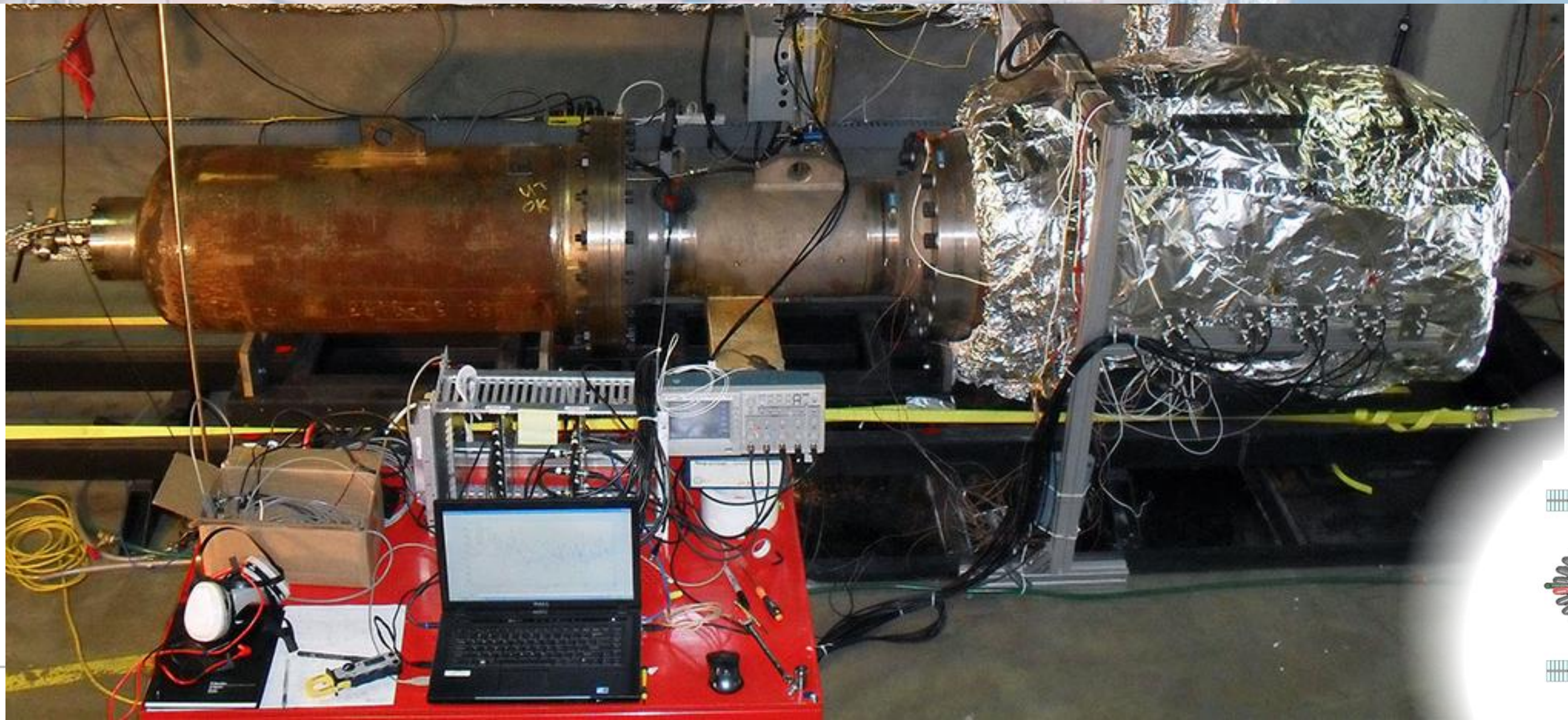
Advantages of MTF

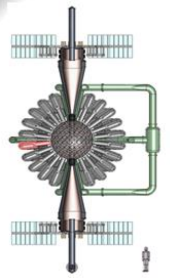
- Less confinement required then MF
- Bohm good enough
- Slower compression (ms vs ns) than ICF
- Less compression ratio (7 vs 40) than ICF
- Rotation stabilized RT instability
- No target destroyed, cost effective

- 4 pi coverage 1.5 m PbLi
- Tritium breeding ratio 1.6 with natural Li
- 10^{-5} high energy neutrons at the metal wall
- Low DPA, long life reactor walls
- Natural way to move the heat out with the liquid PbLi
- Low cost gas driver from the thermal cycle gas

Acoustic Driver



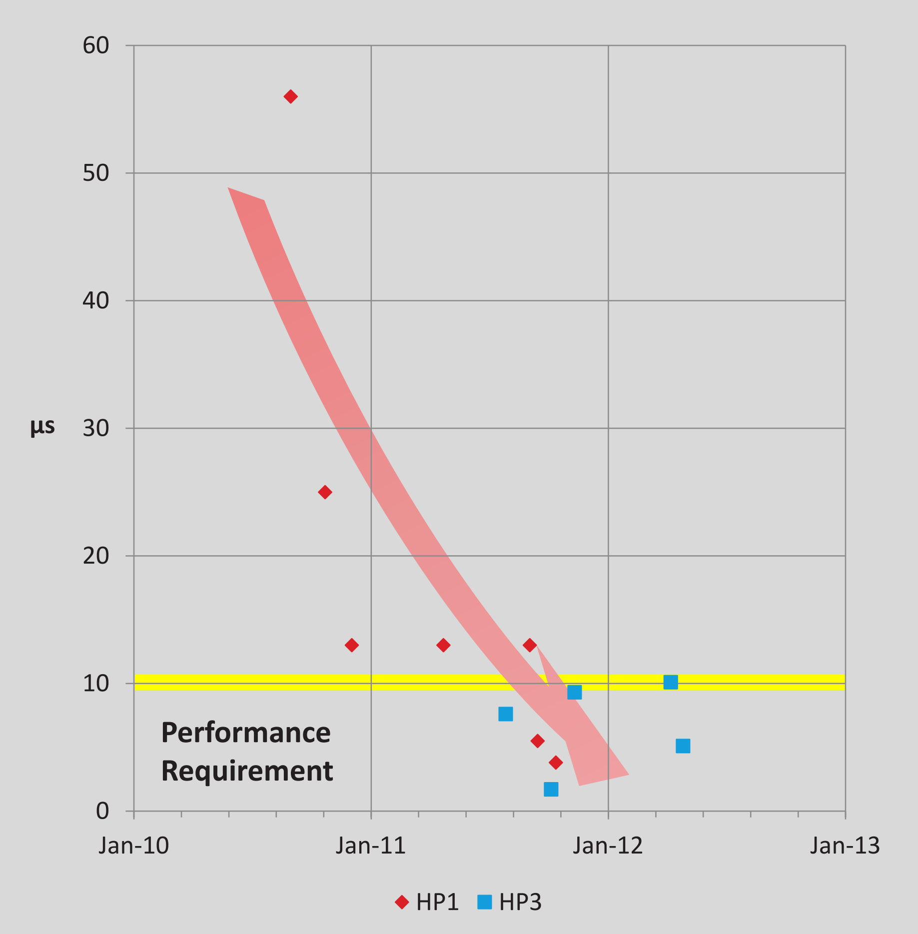


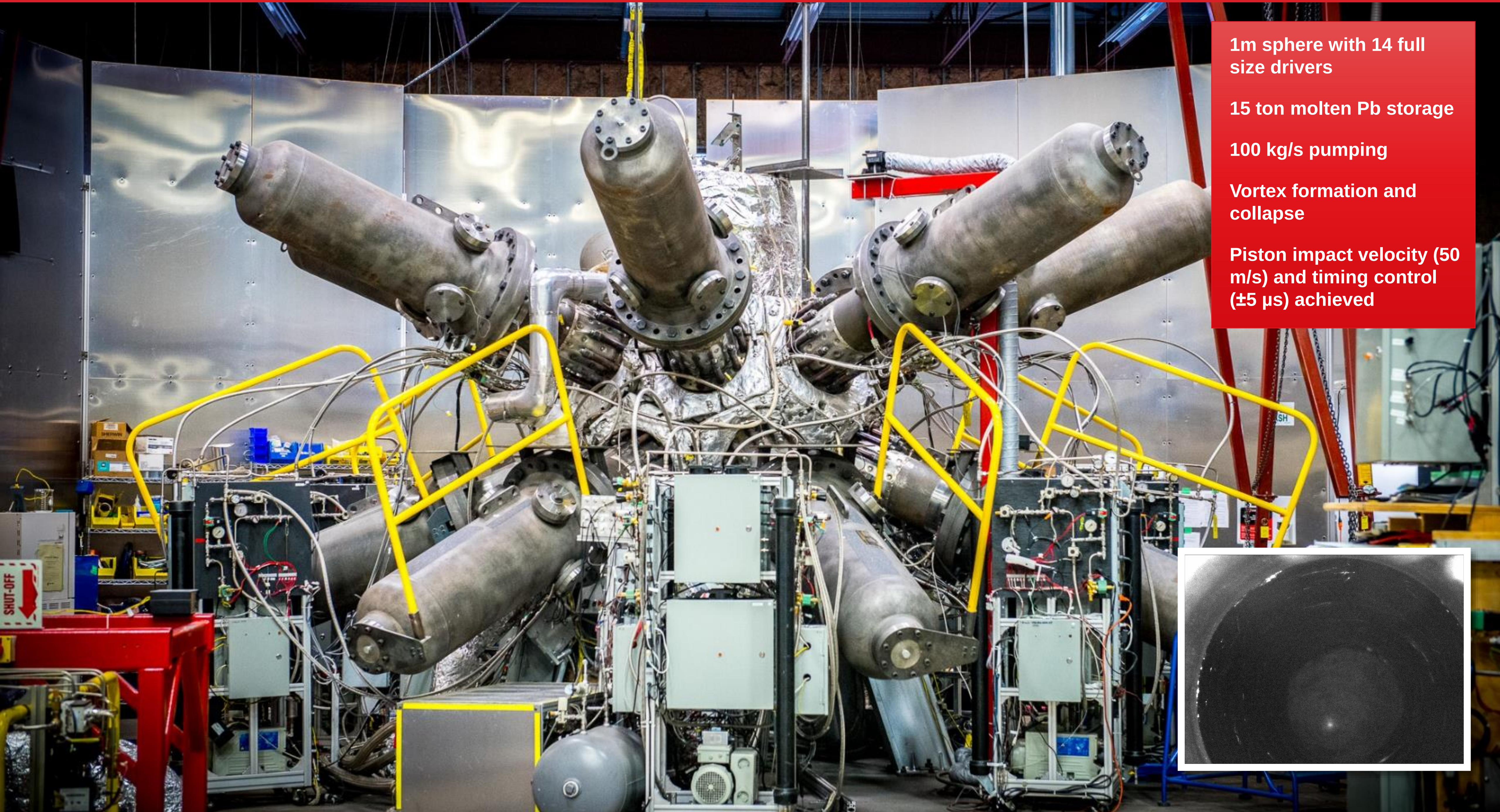


Acoustic Driver Milestones Met

Piston Impact Timing Control (5 sequential shots)

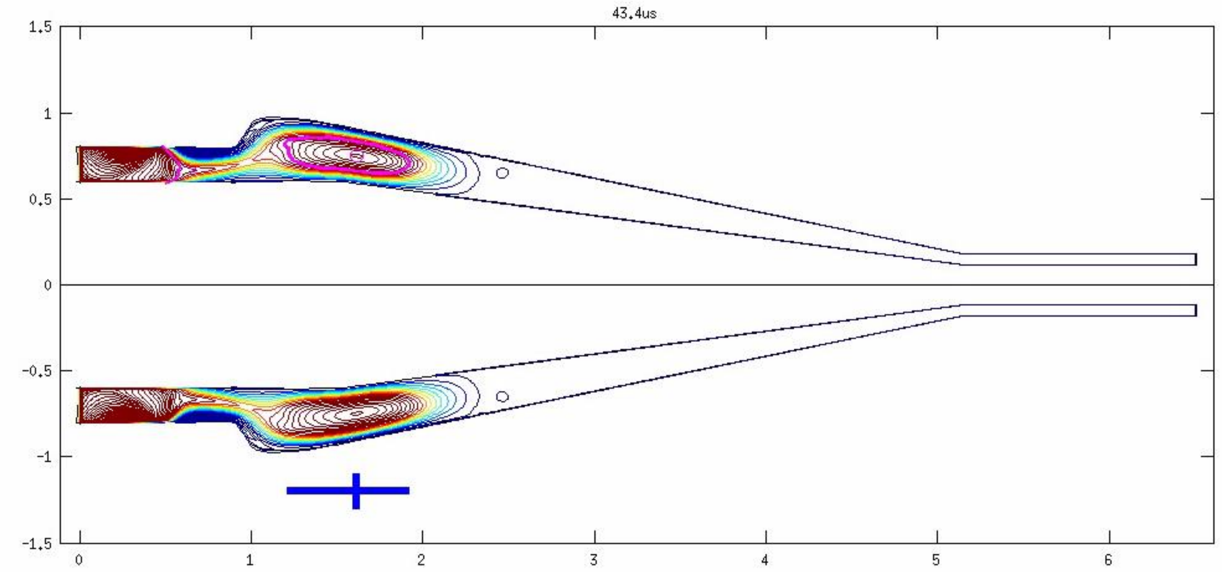
Piston Impact Velocity

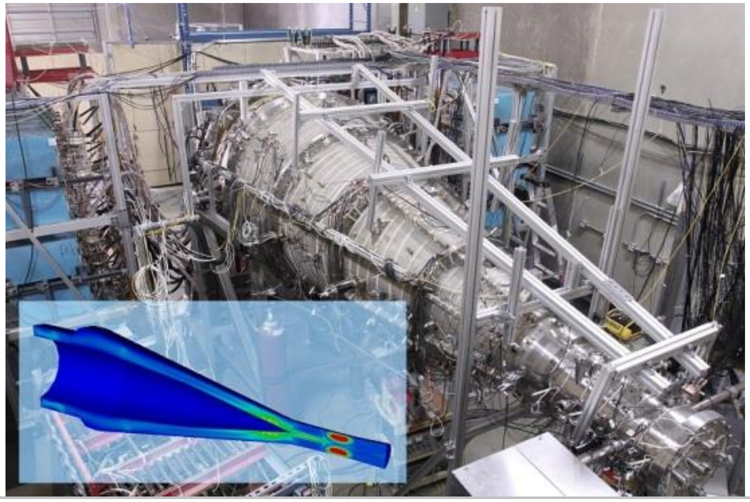




- 1m sphere with 14 full size drivers
- 15 ton molten Pb storage
- 100 kg/s pumping
- Vortex formation and collapse
- Piston impact velocity (50 m/s) and timing control (±5 μs) achieved

Plasma Injector Simulation





Large Plasma Injector

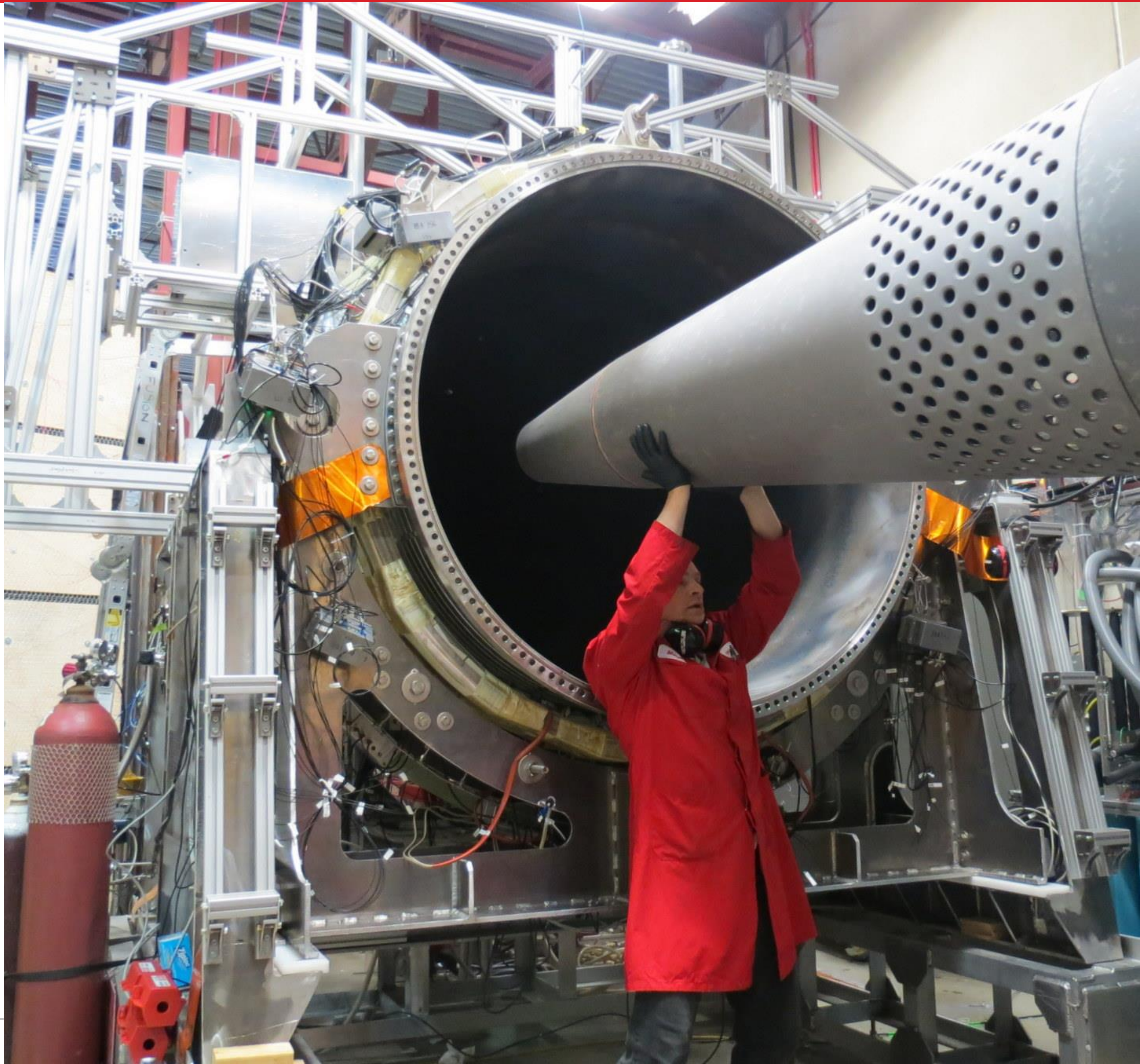
$5 \times 10^{16}\ cm^{-3}$

300 eV

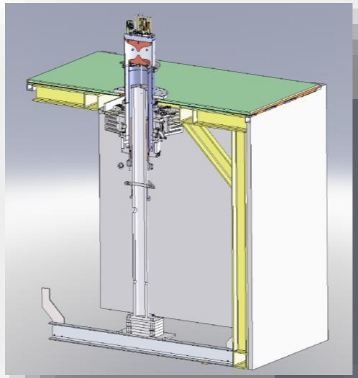
20 µs

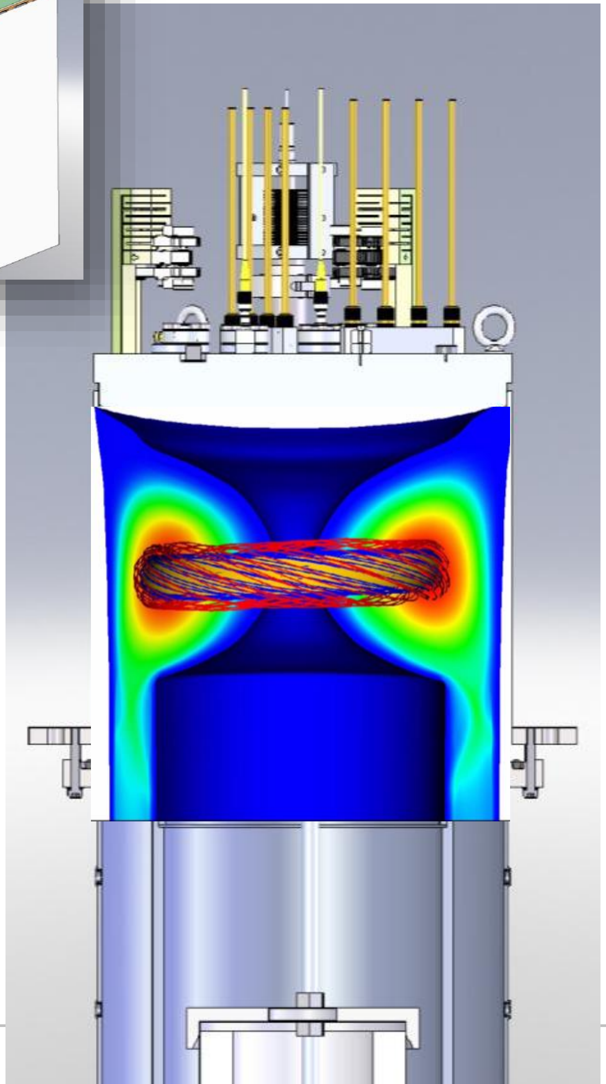
3 T

Accelerator current damages plasma magnetic structure



Small Plasma Injector

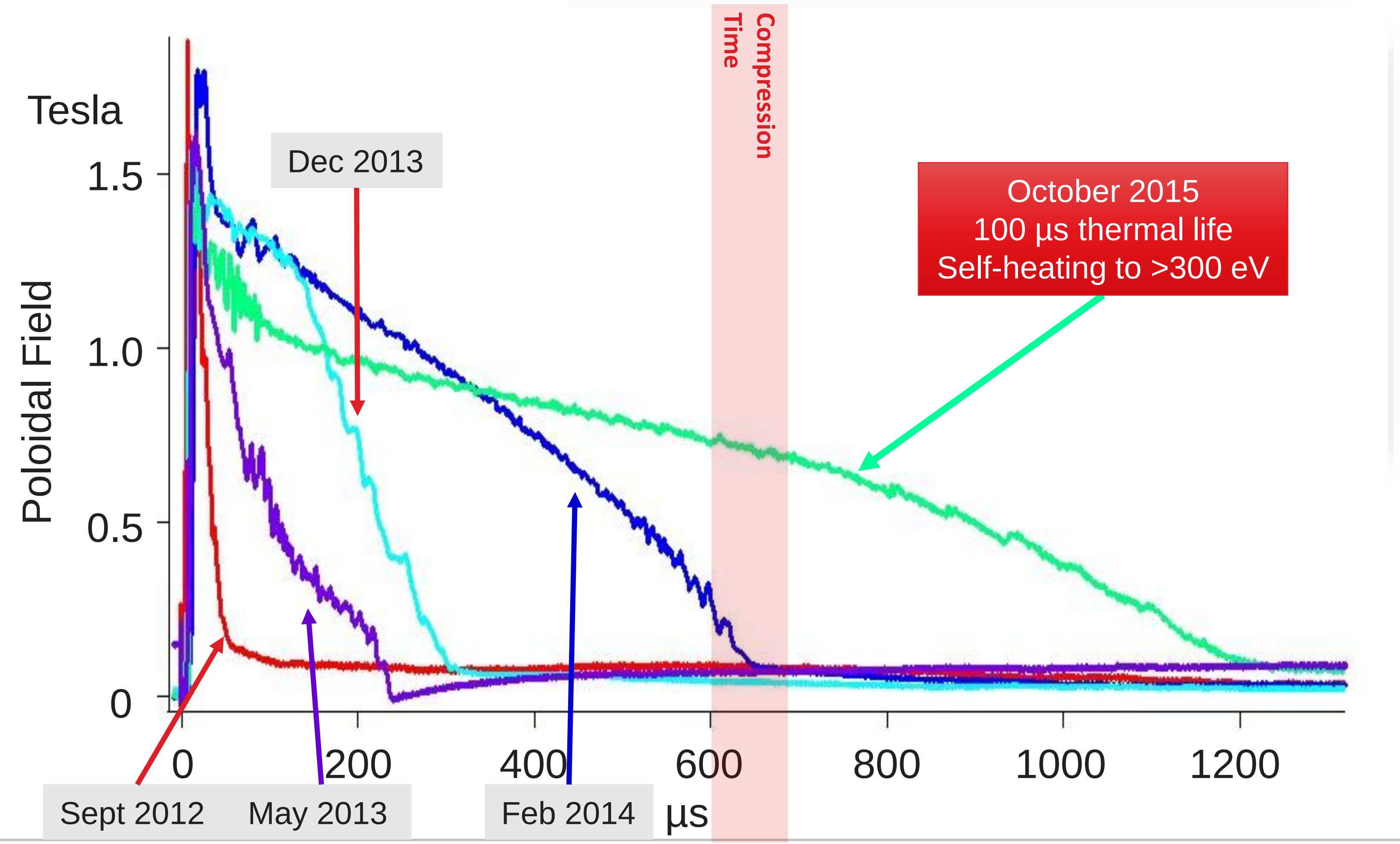




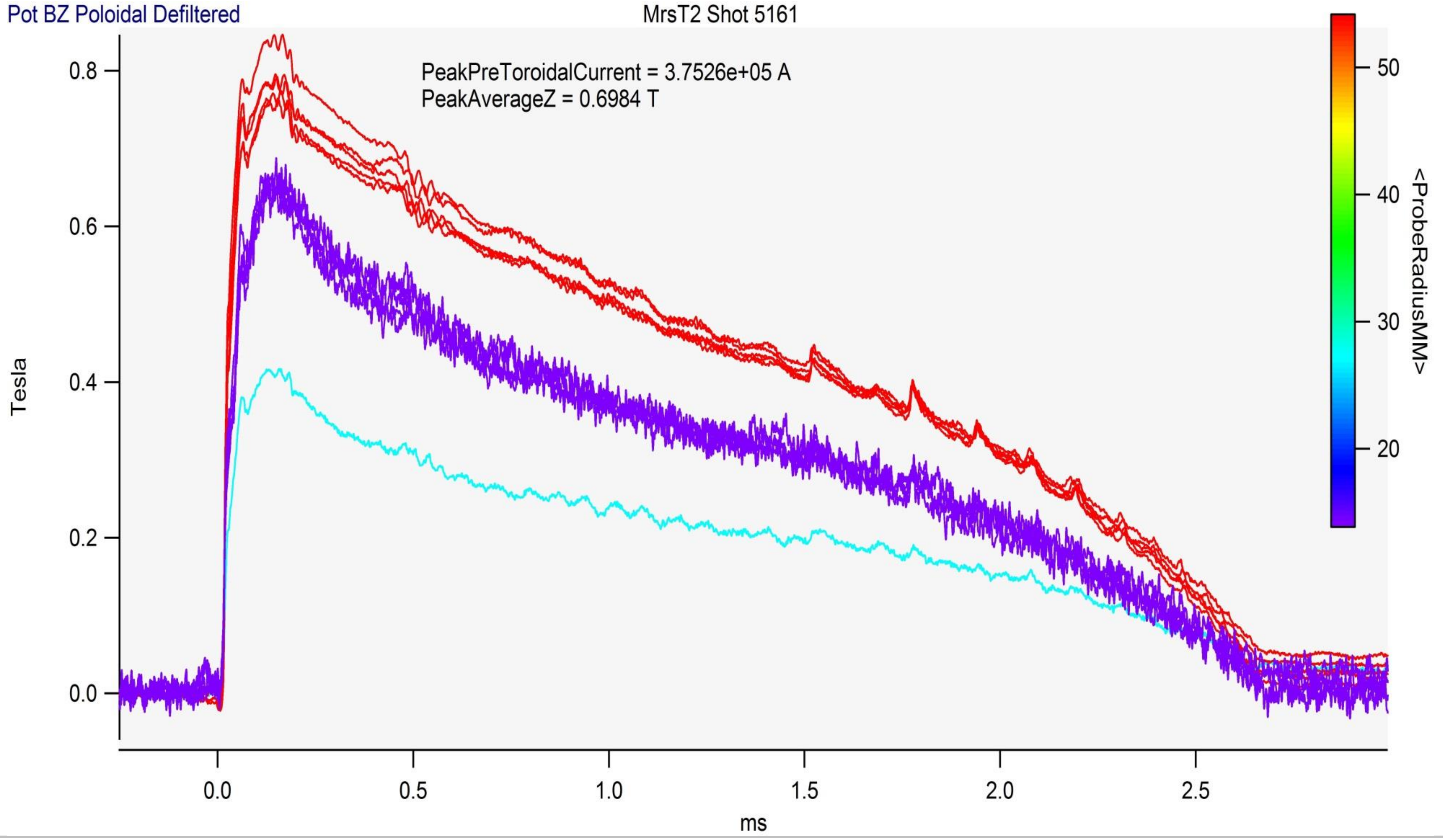
- Direct formation: no acceleration stage.
- Comparable to CTX and SSPX designs
- Lower maximum plasma density than large injectors
- Faster design iteration
- Designed for use in plasma compression experiments

Plasma Lifetime Progress

General Fusion has created a long-lived plasma that we believe is good enough to compress.



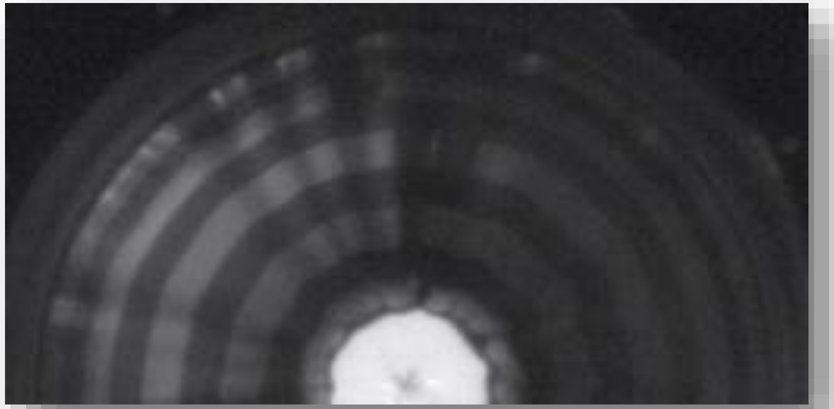
Spherical tokamak 500 eV from TS

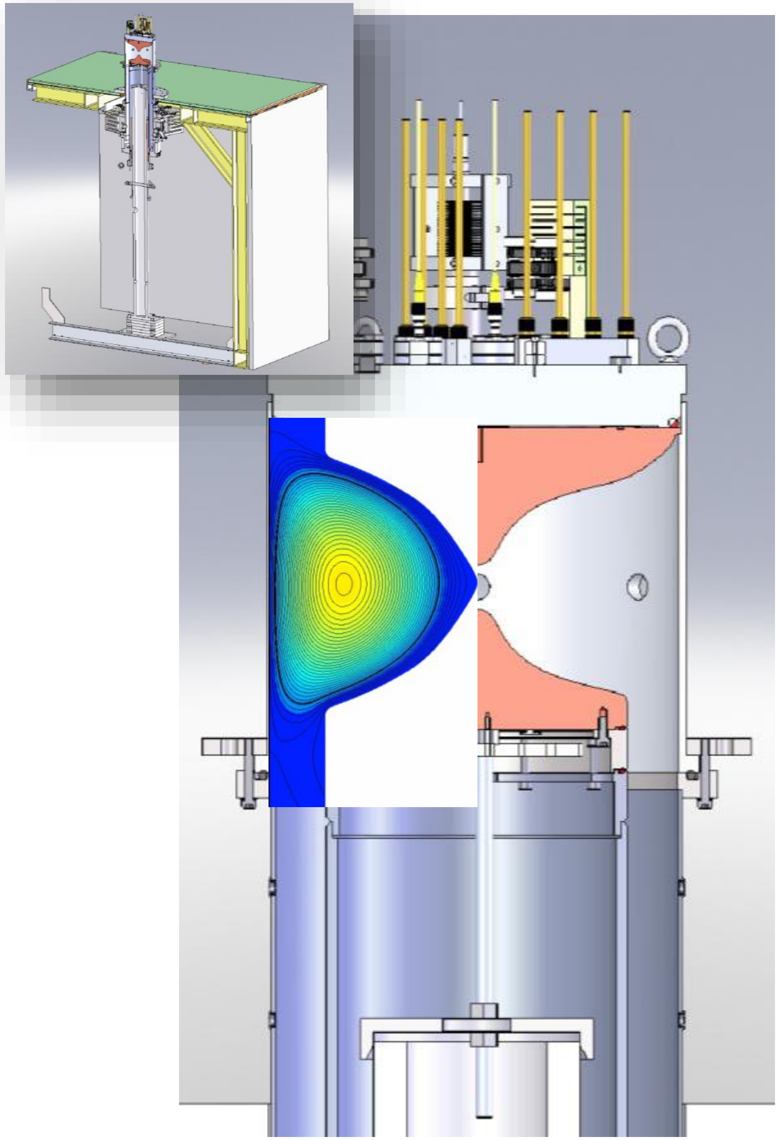


2017

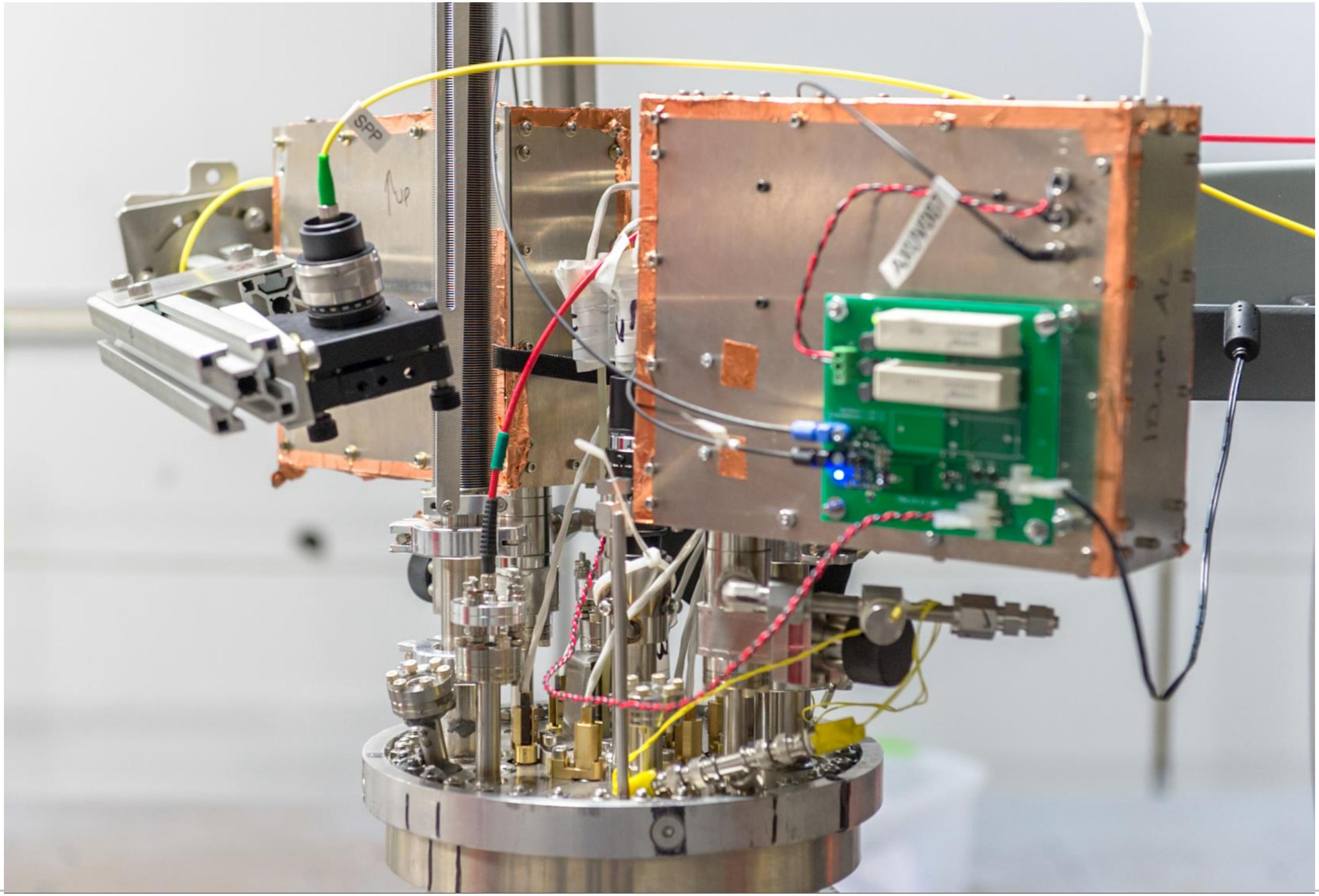
- 2500 µs lifetimes
- 500 eV

Plasma Compression Testing

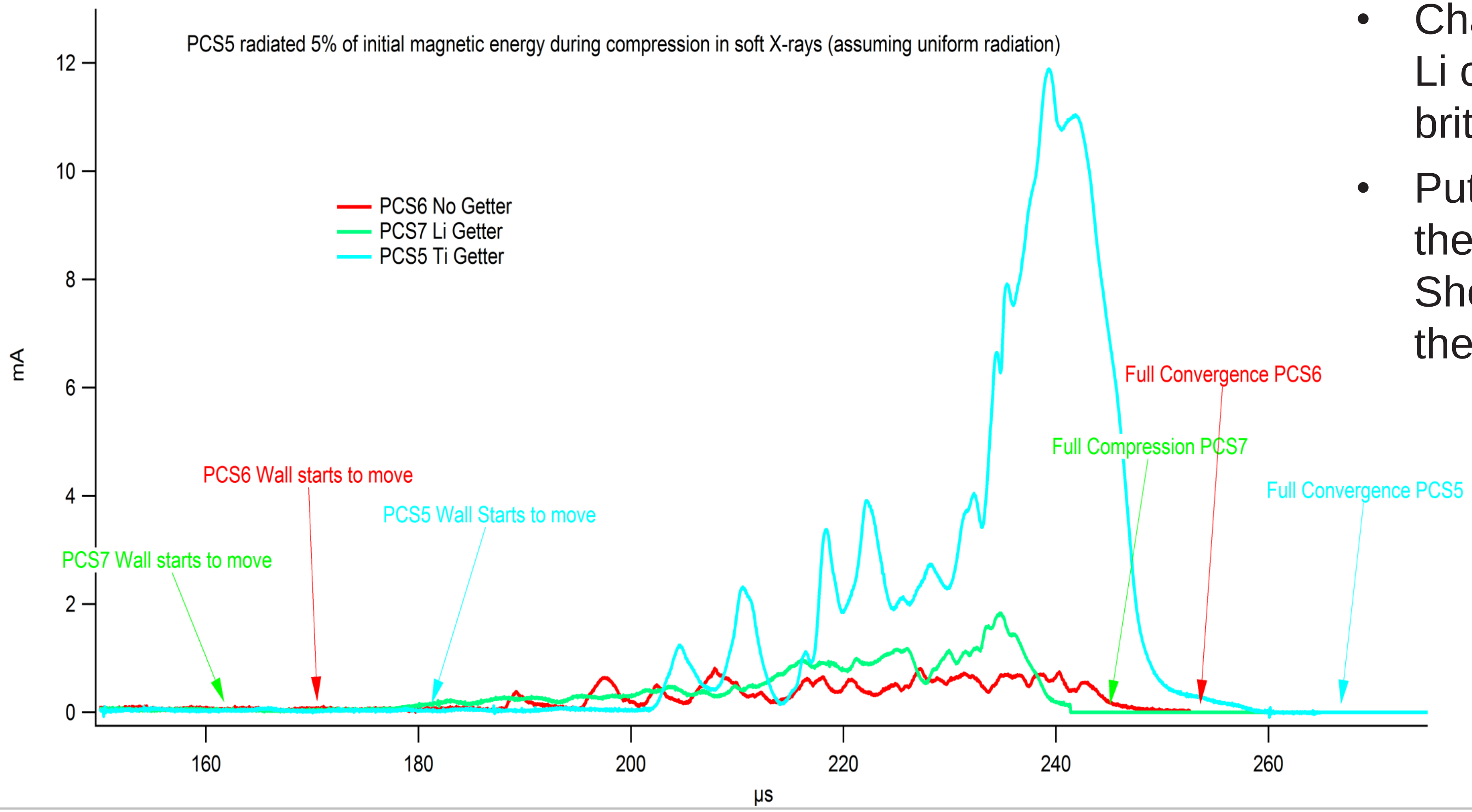




Diagnostics



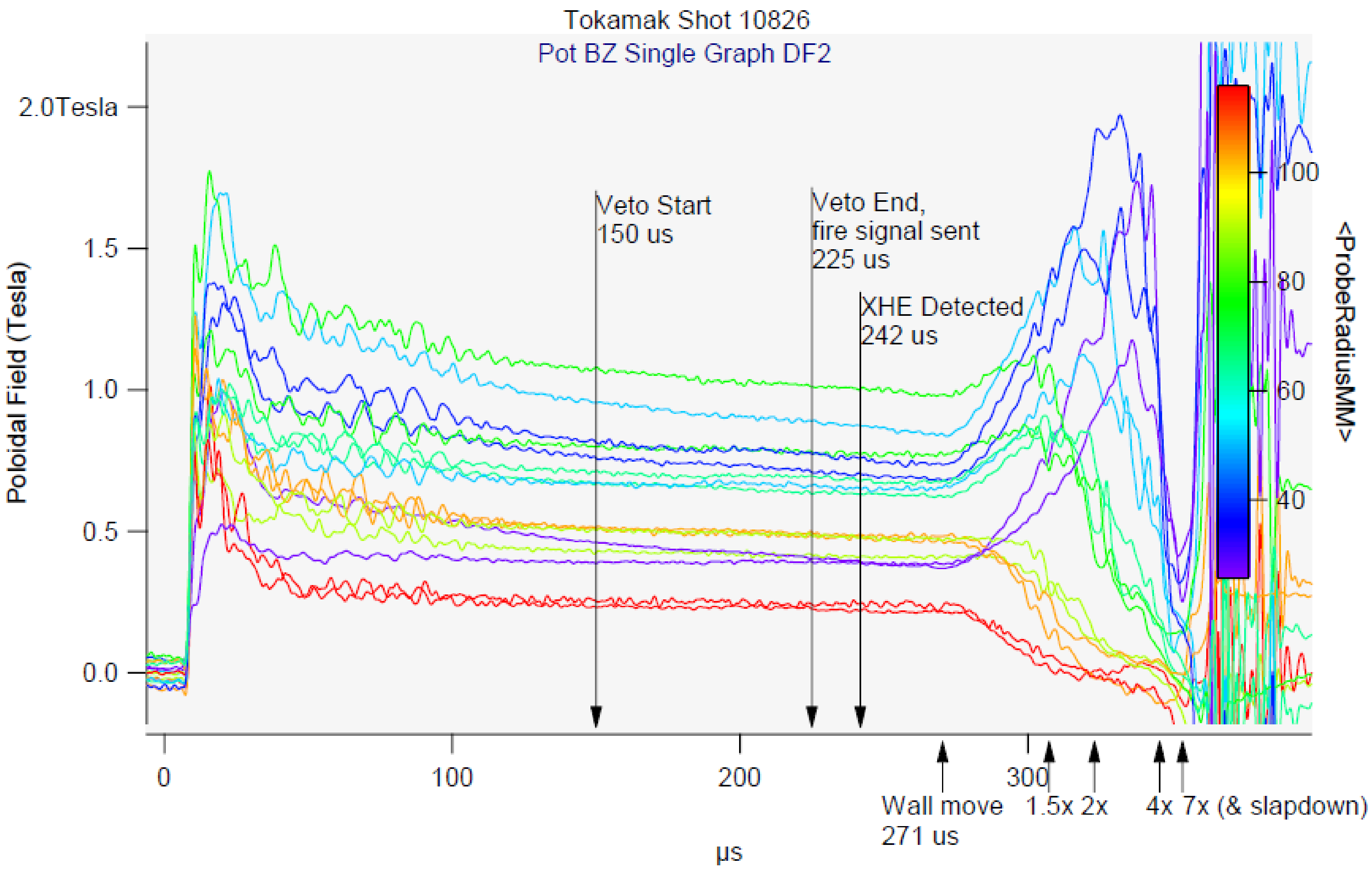
Fixed Radiation Death



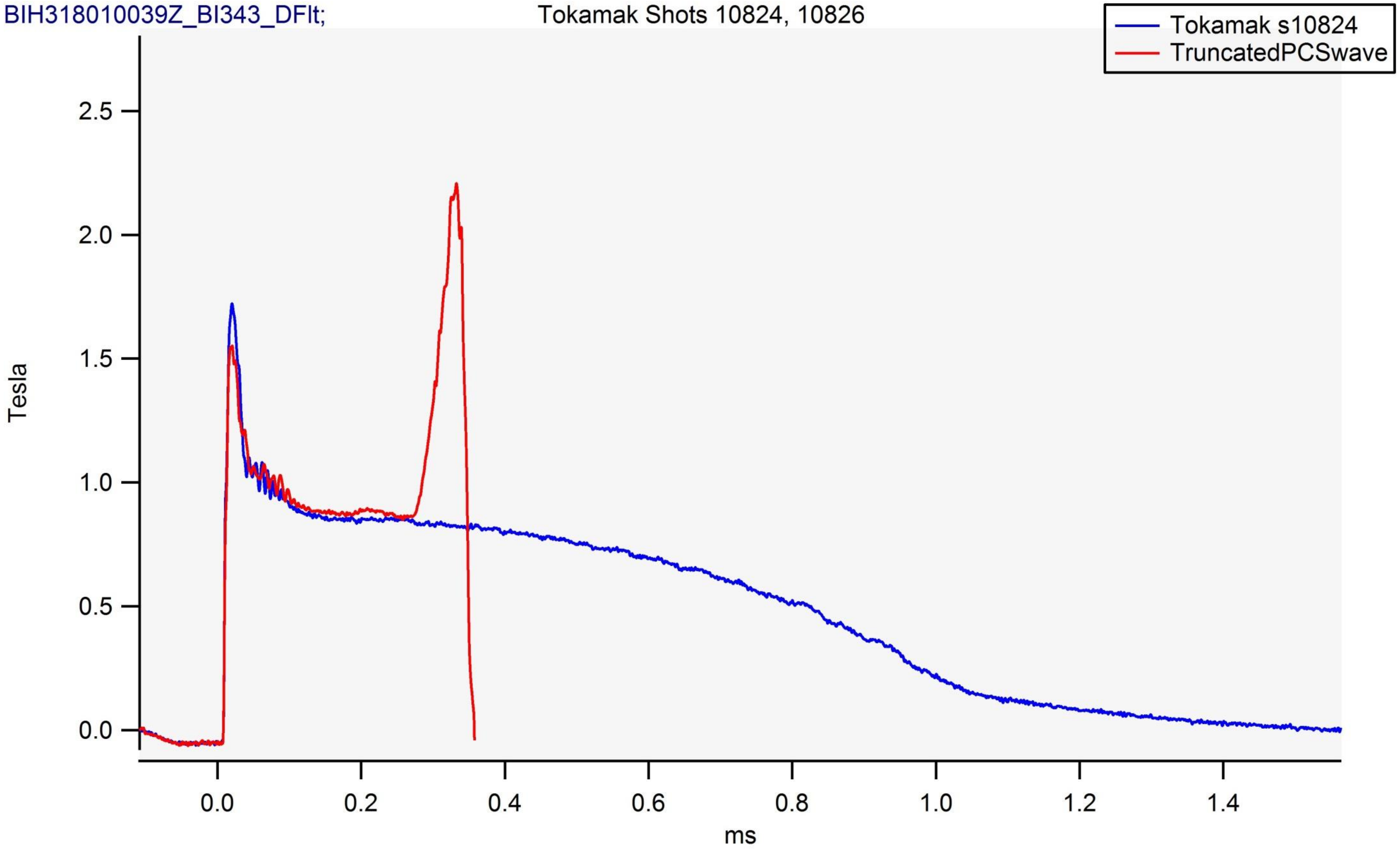
- Changed from Ti coating to Li coating. Lower Z. Less brittle coating
- Put a vacuum gap between the driver and the liner. Shockless acceleration of the liner

Poloidal Field Compression: Compression Test #12

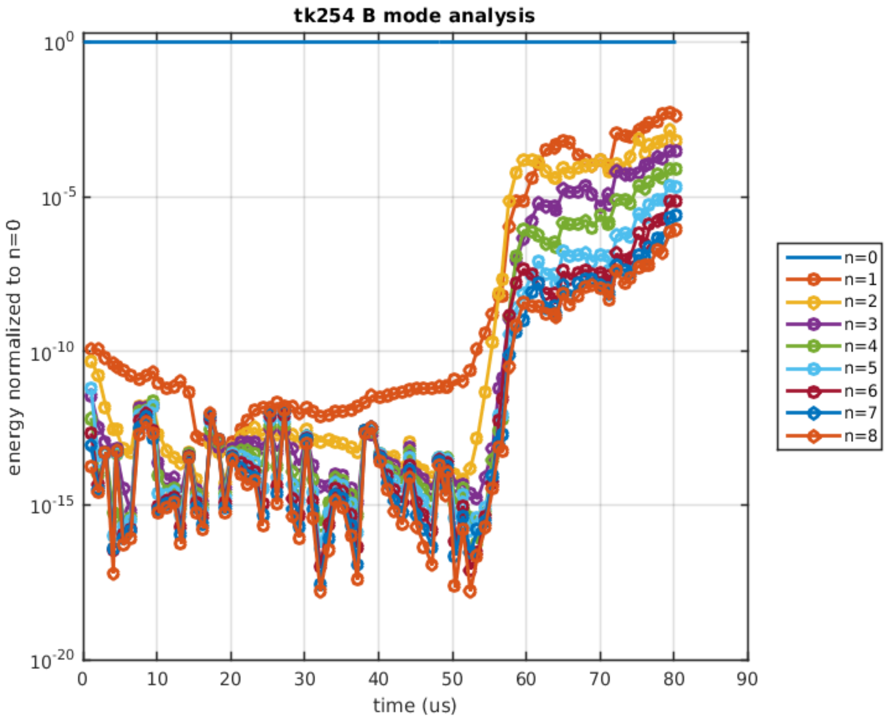
Chart of increase in magnetic field during compression

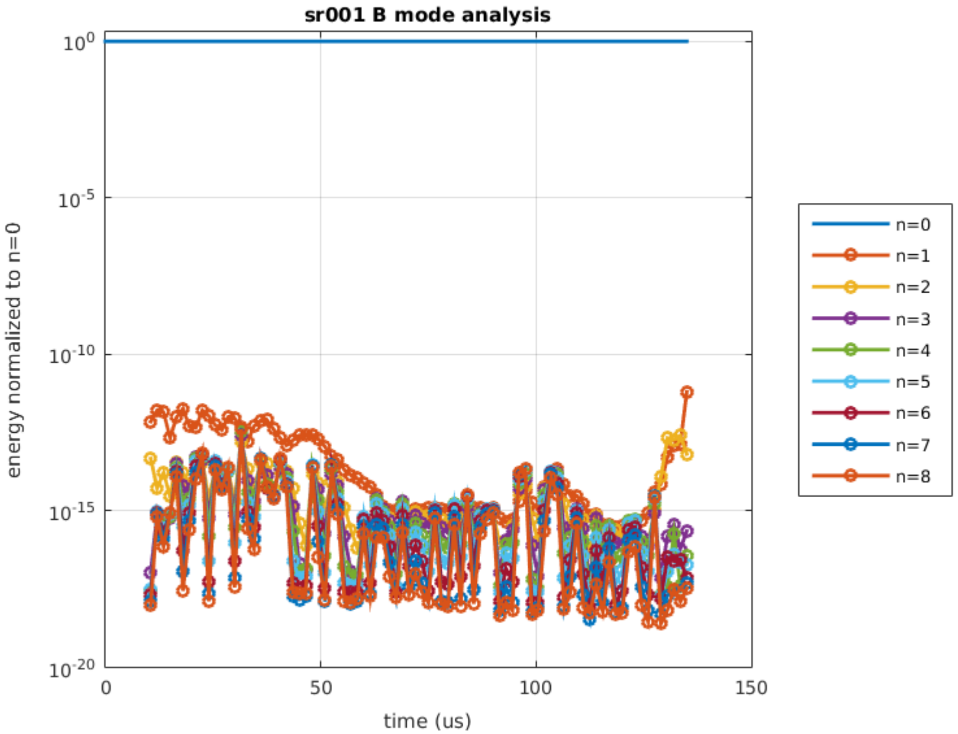


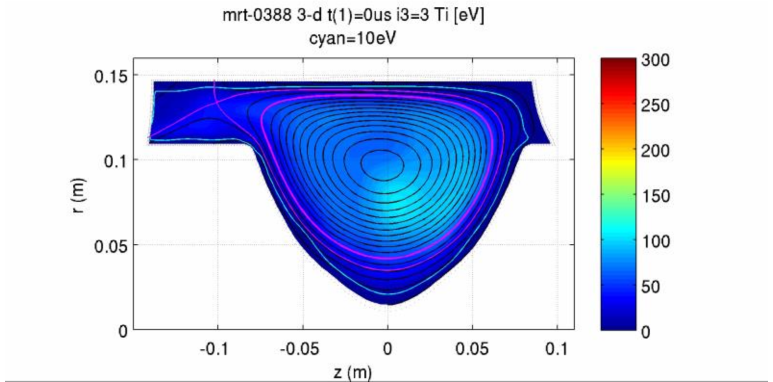
Uncompressed (blue) compared to compressed (red)

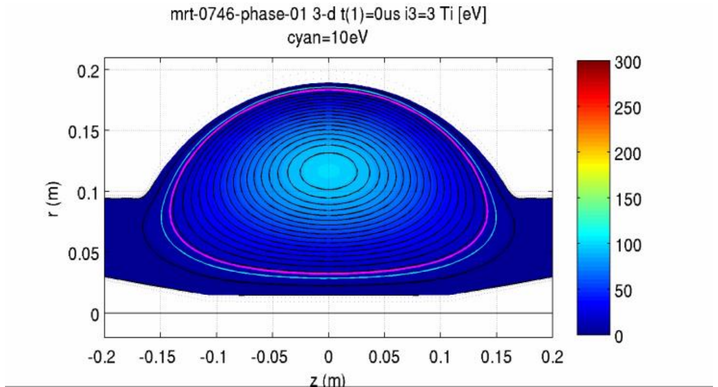


Change in Compression Geometry

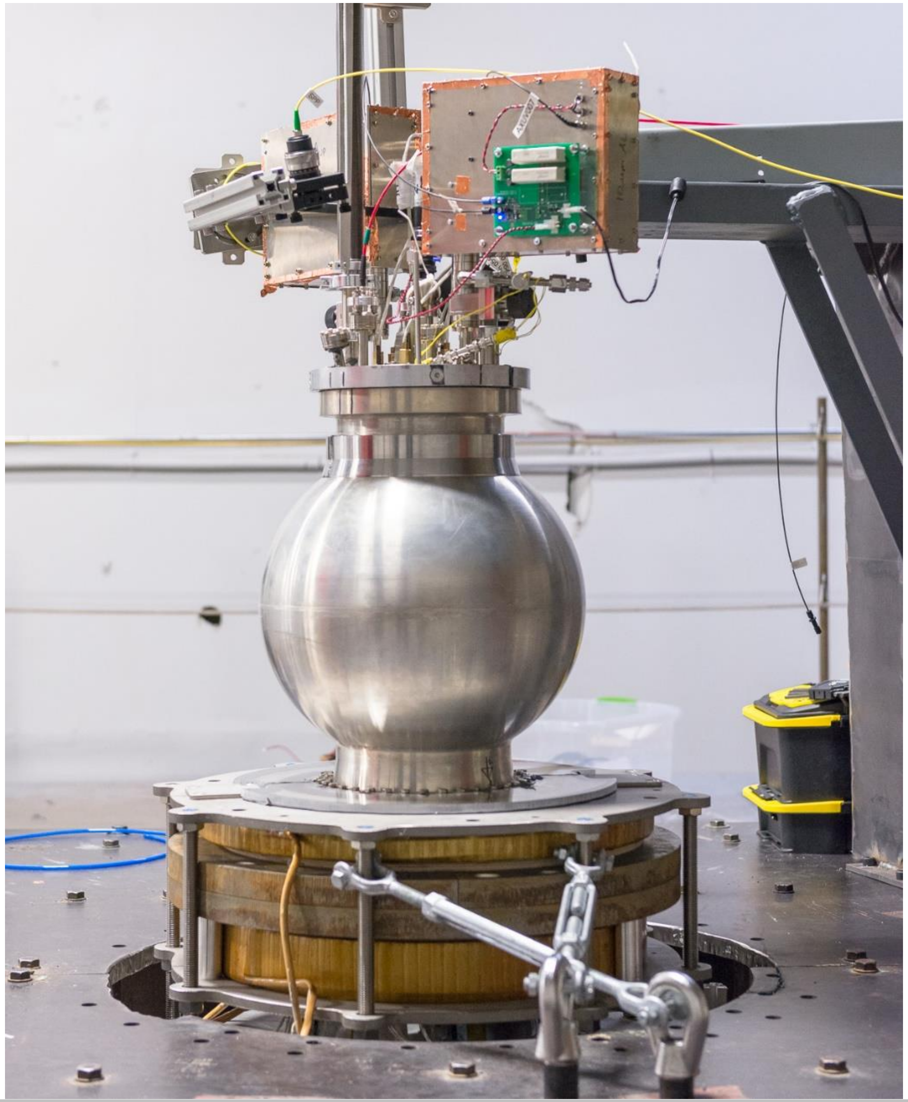




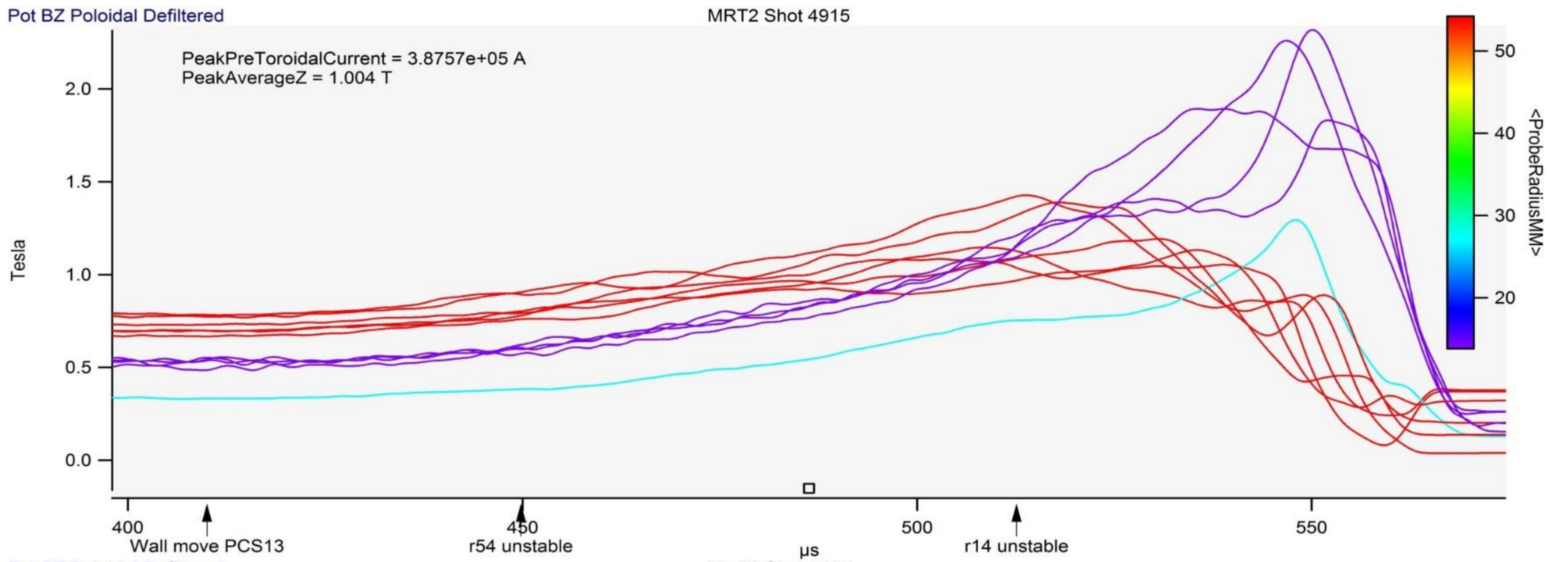


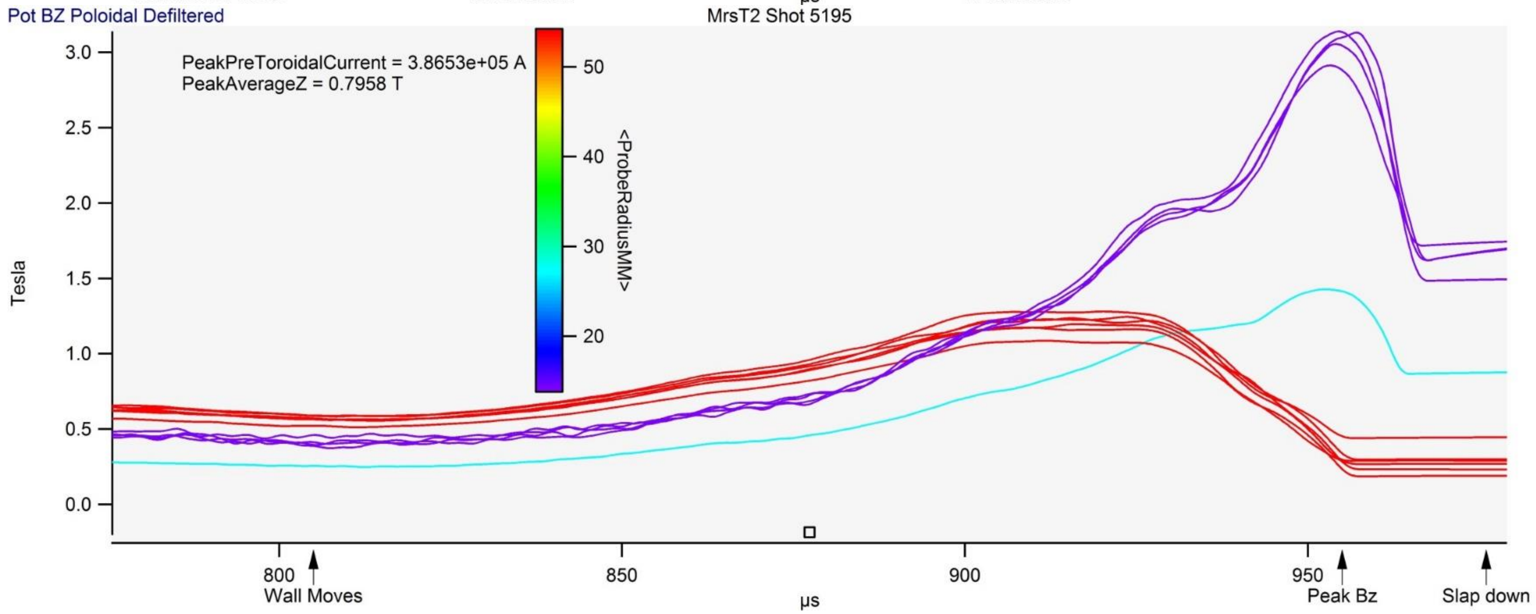


New Spherical Shape

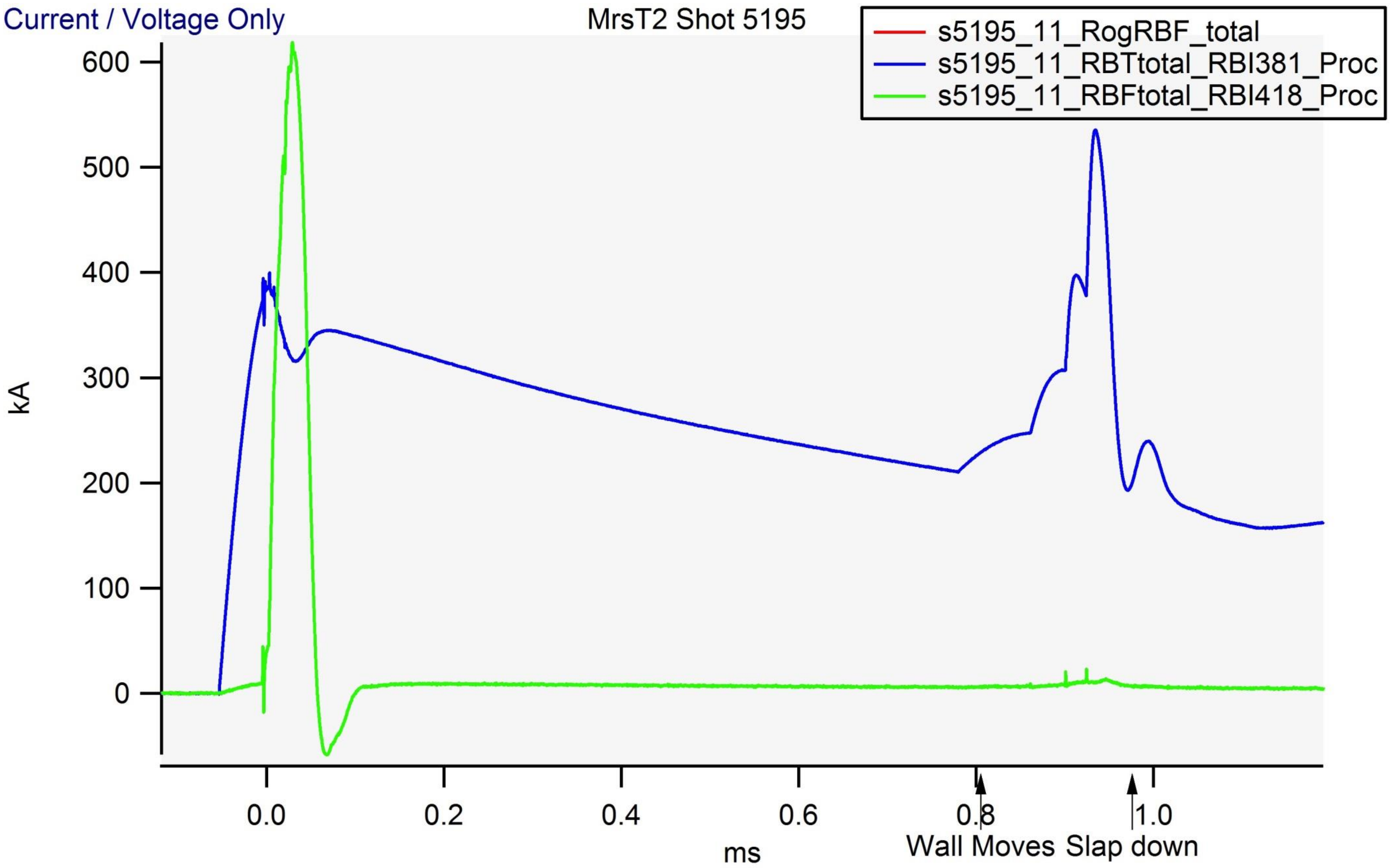


Magnetic Field During Compression

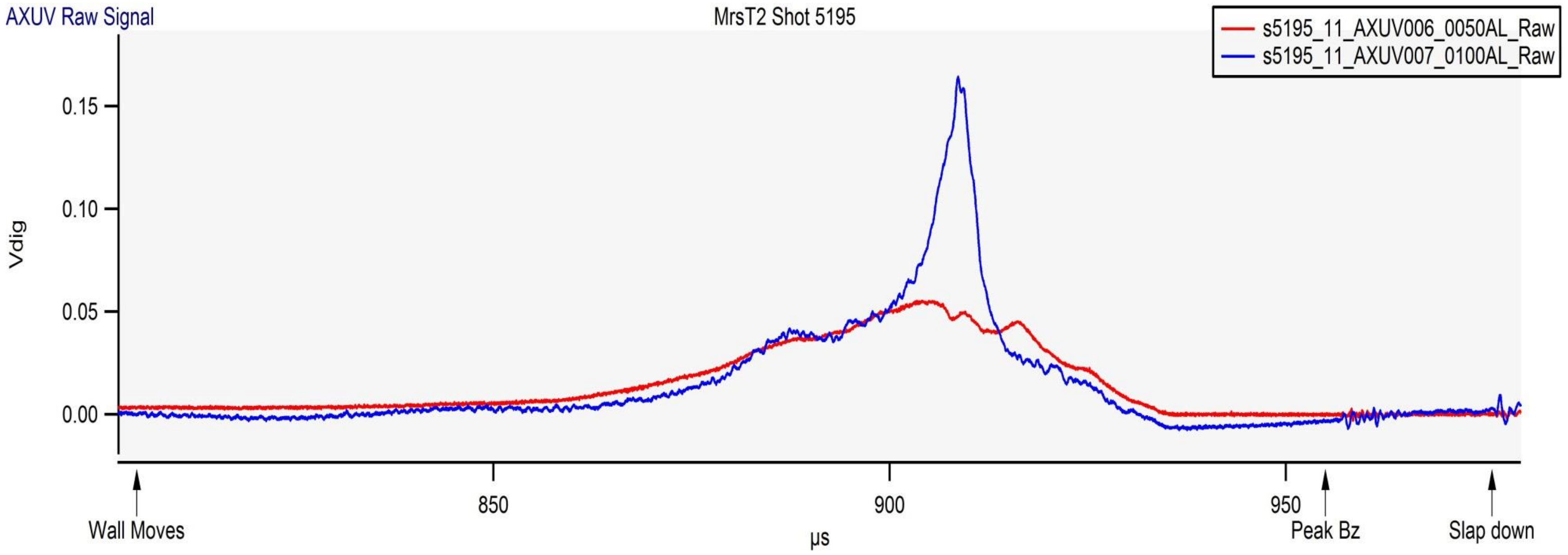


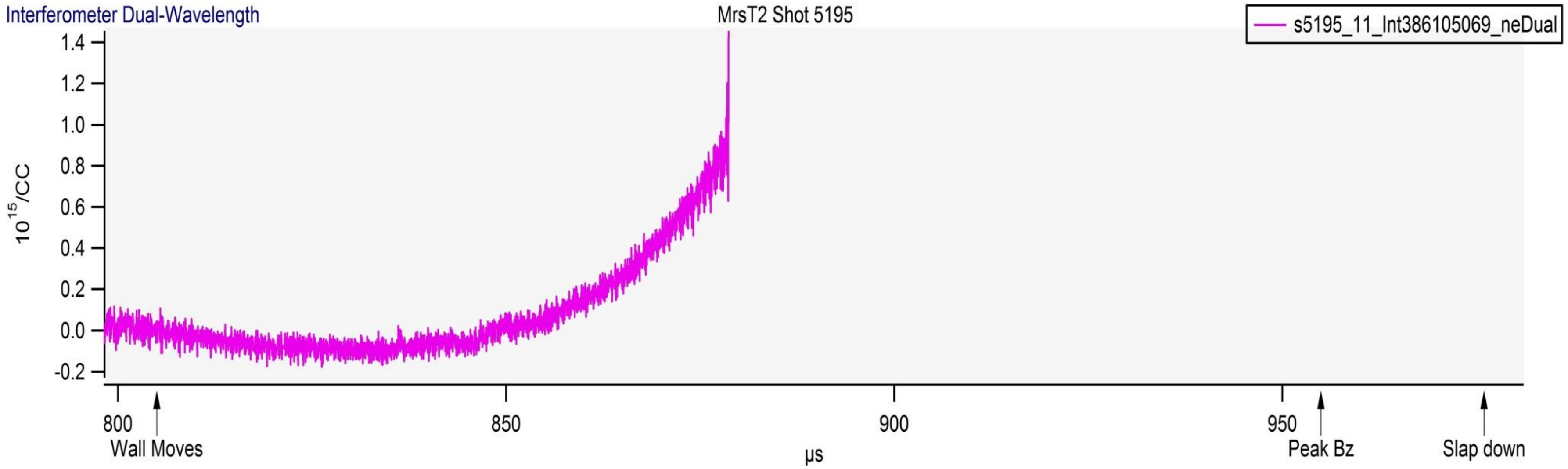


Shaft Current And Formation Current



X-Ray and Density





Conclusion

- We can make plasma with sufficient confinement before compression
- We fix radiation losses and now maintain stability during compression
- Some evidence of heating during compression
- We will try to get better heating and higher temperature in future shots

CLEAN ENERGY. EVERYWHERE. FOREVER.

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