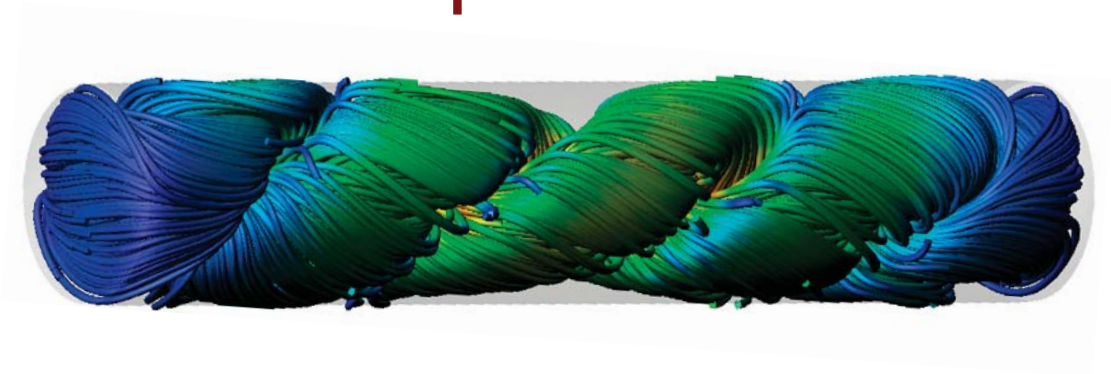
Plasma Accelerator on the Swarthmore Spheromak Experiment



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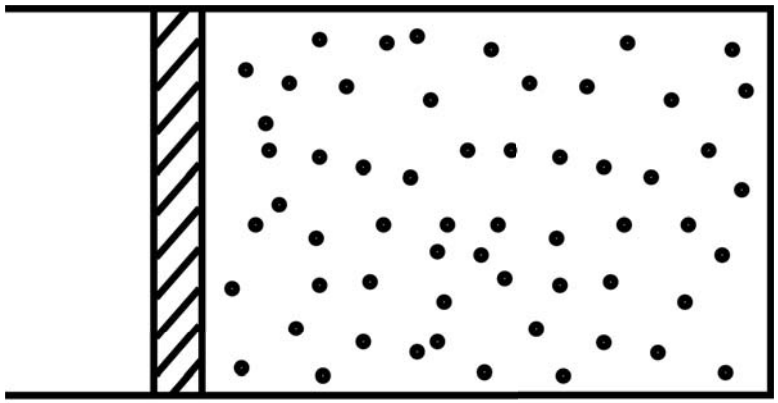
Objective

The twisted Taylor state is the minimum energy state in MHD, and was observed in the SSX lab in 2013 (Gray, *et al.*, PRL).

- Our main goal is to **accelerate** a Taylor state to higher velocity, then stagnate and to **compress** it to higher density. A Taylor state is an ideal MIF target (stability, aspect ratio, spring).
- We have been studying **magneto-thermodynamics** on these compressed Taylor states (manuscript submitted). Our focus now is on optimizing acceleration.

Adiabatic compression of a gas



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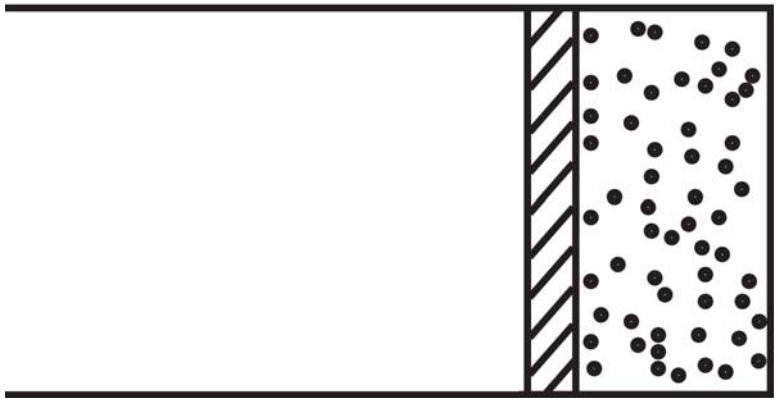
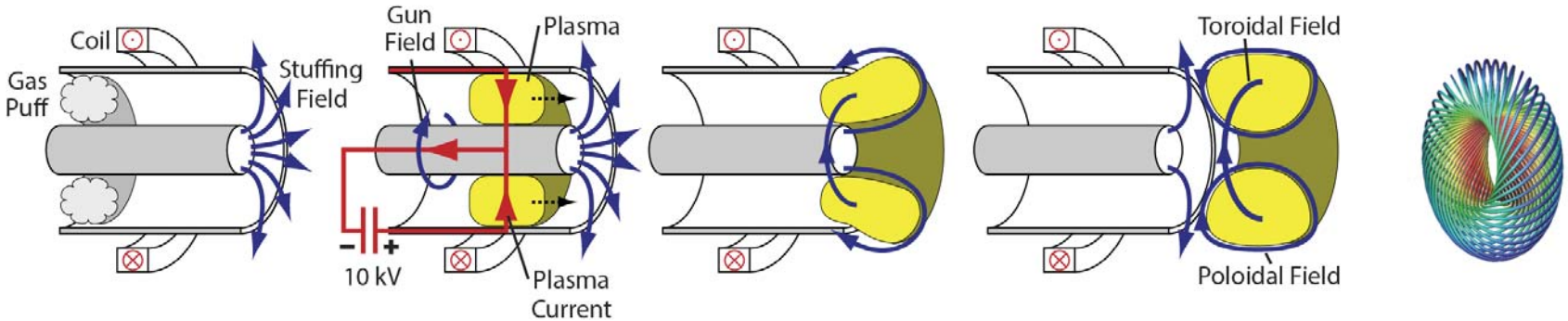
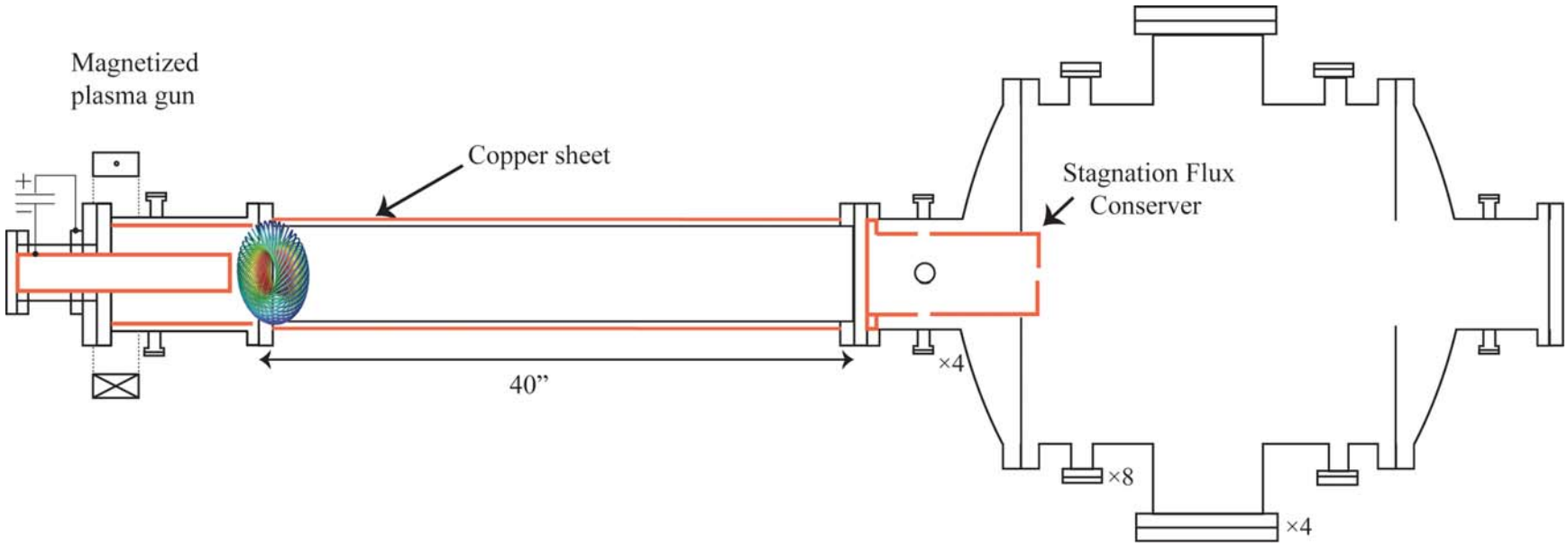


$$PV^{\gamma} = \text{constant}$$

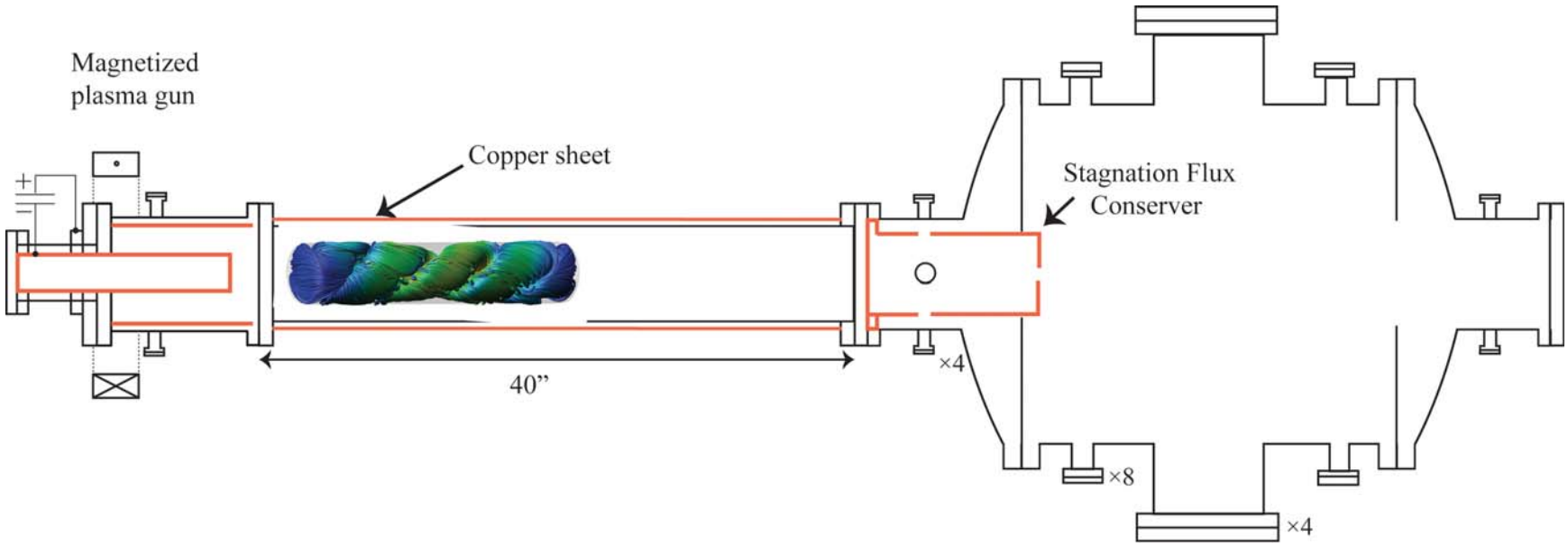
Magnetized plasma production



Experimental Set-up schematic



Sequence of events



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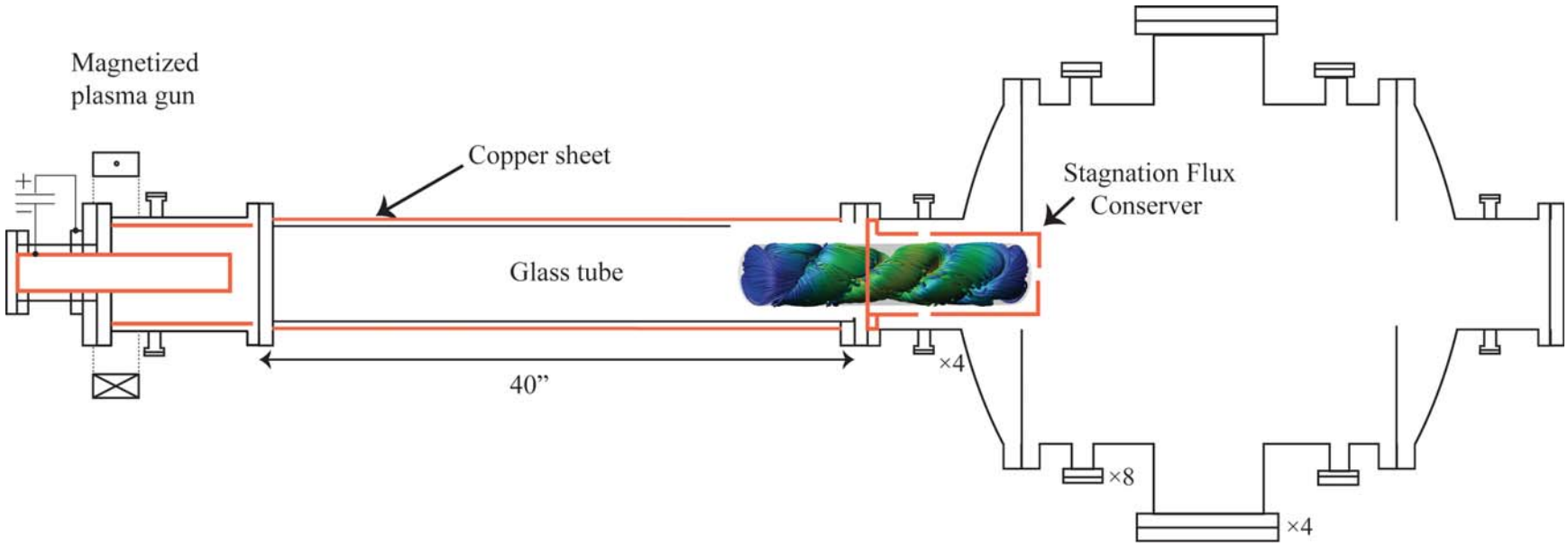

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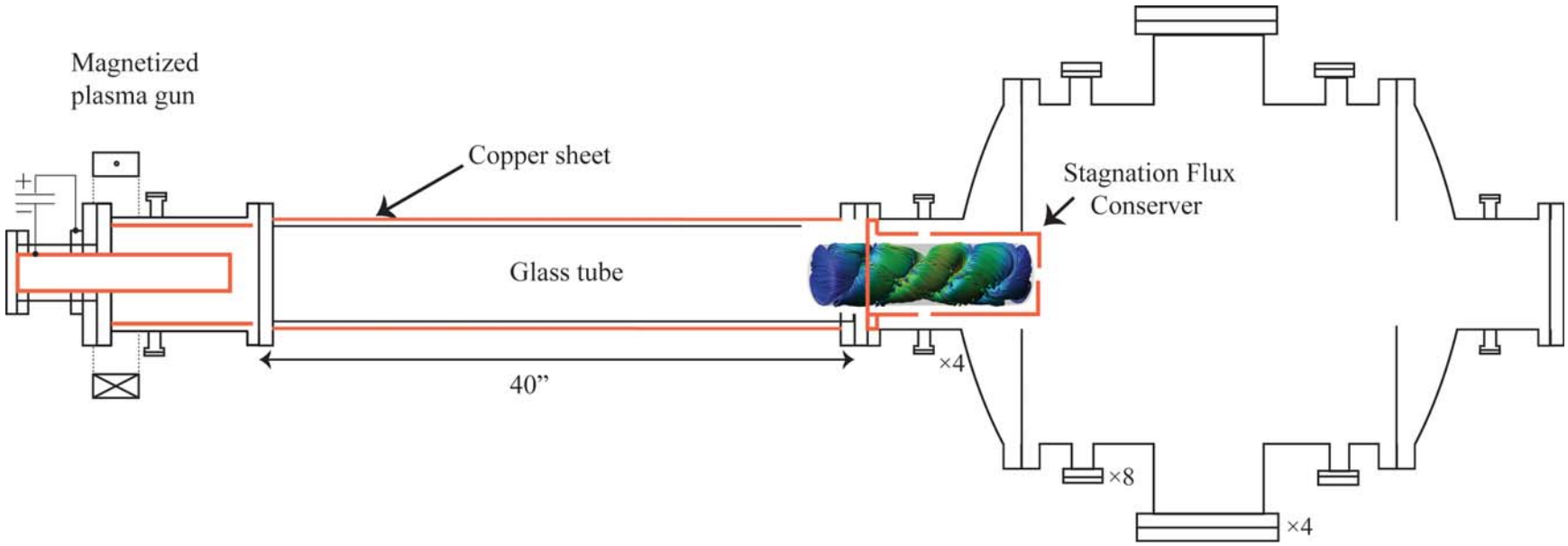
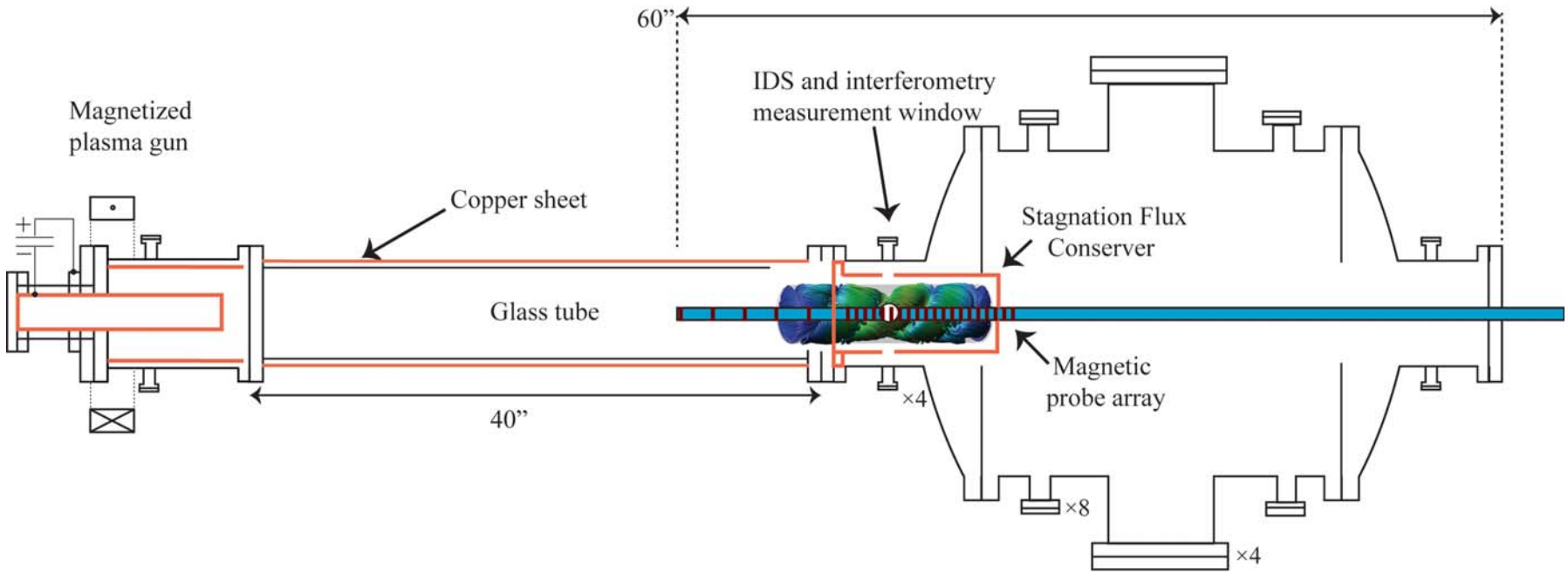


Diagnostics of compressed plasma



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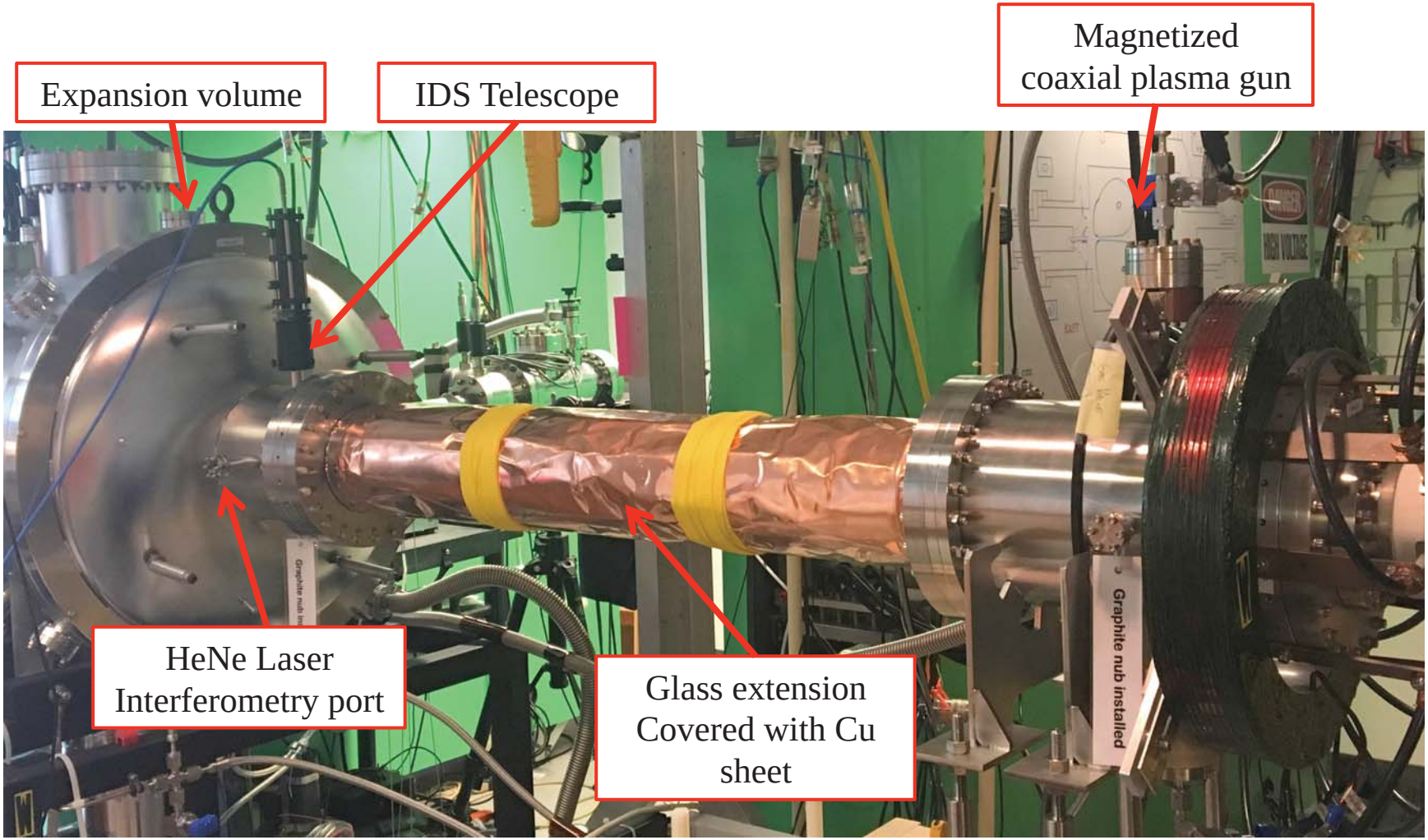
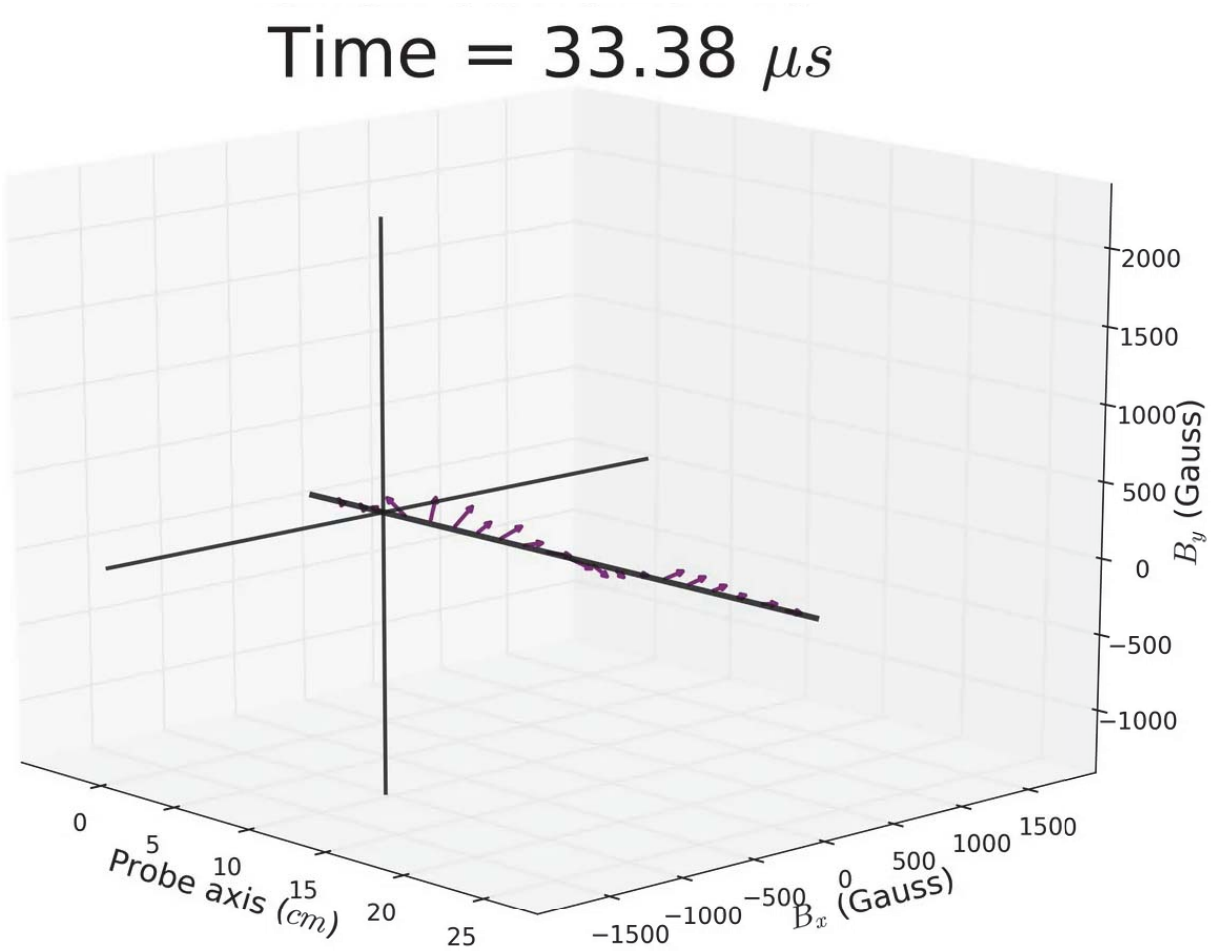


Measurement of magnetic field vectors



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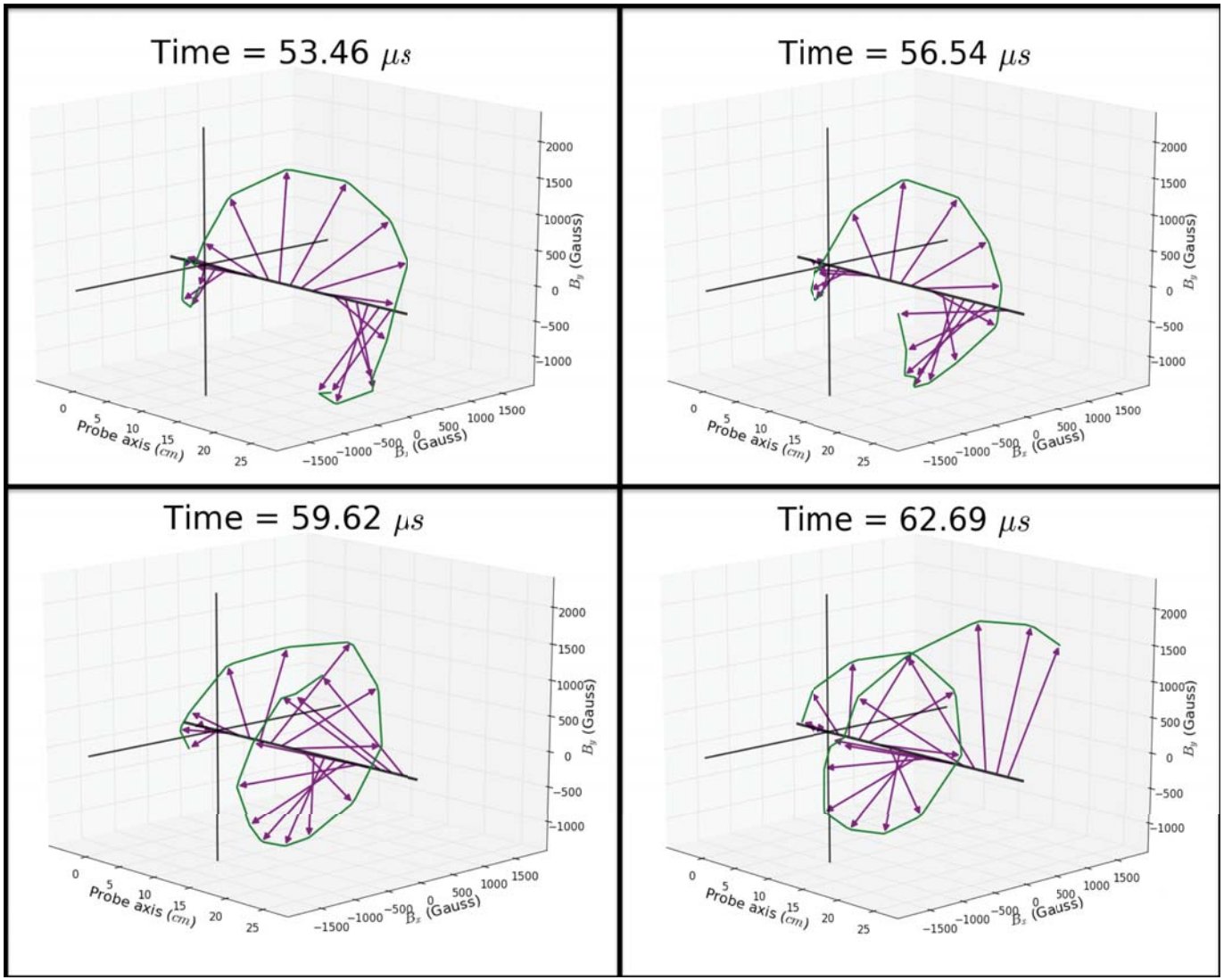
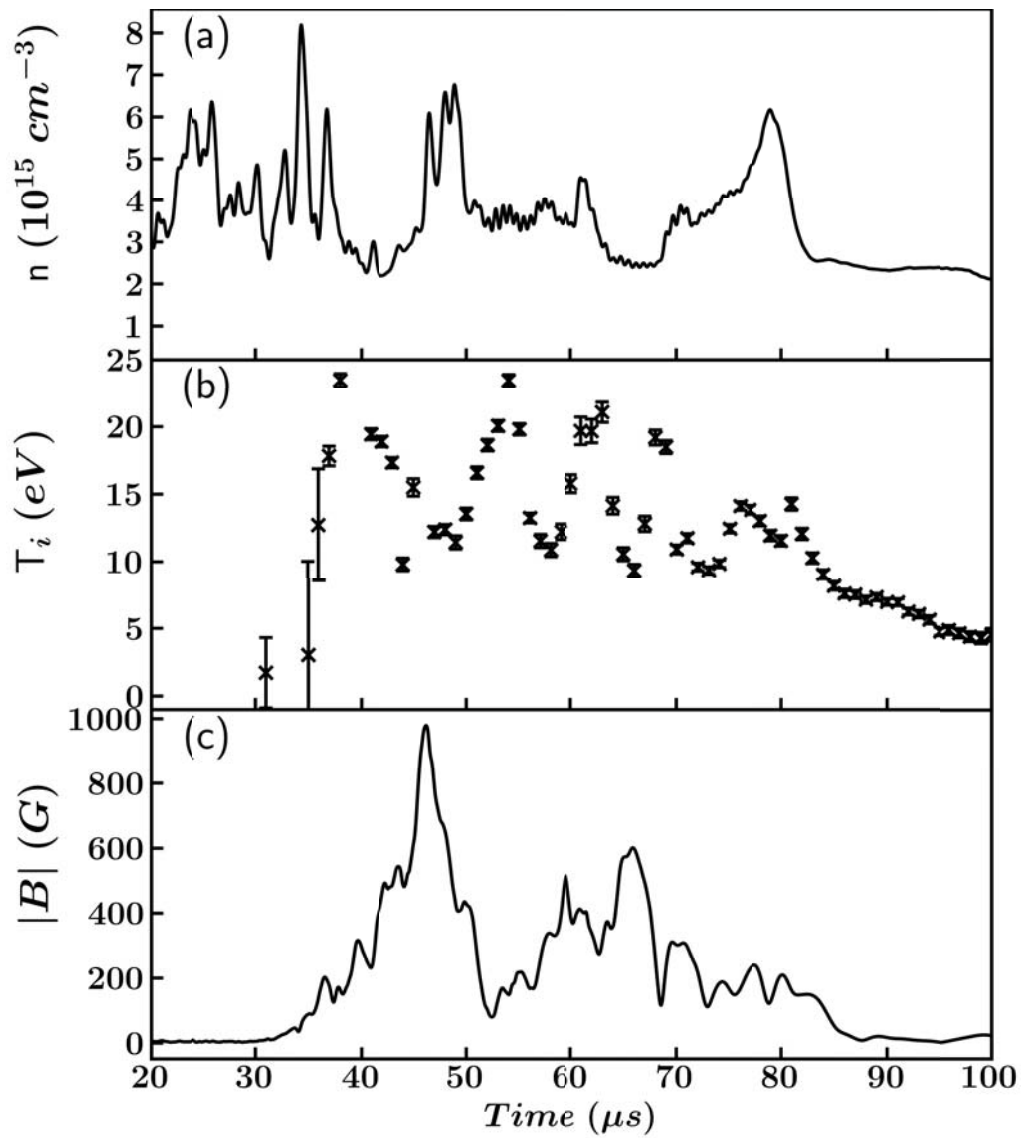
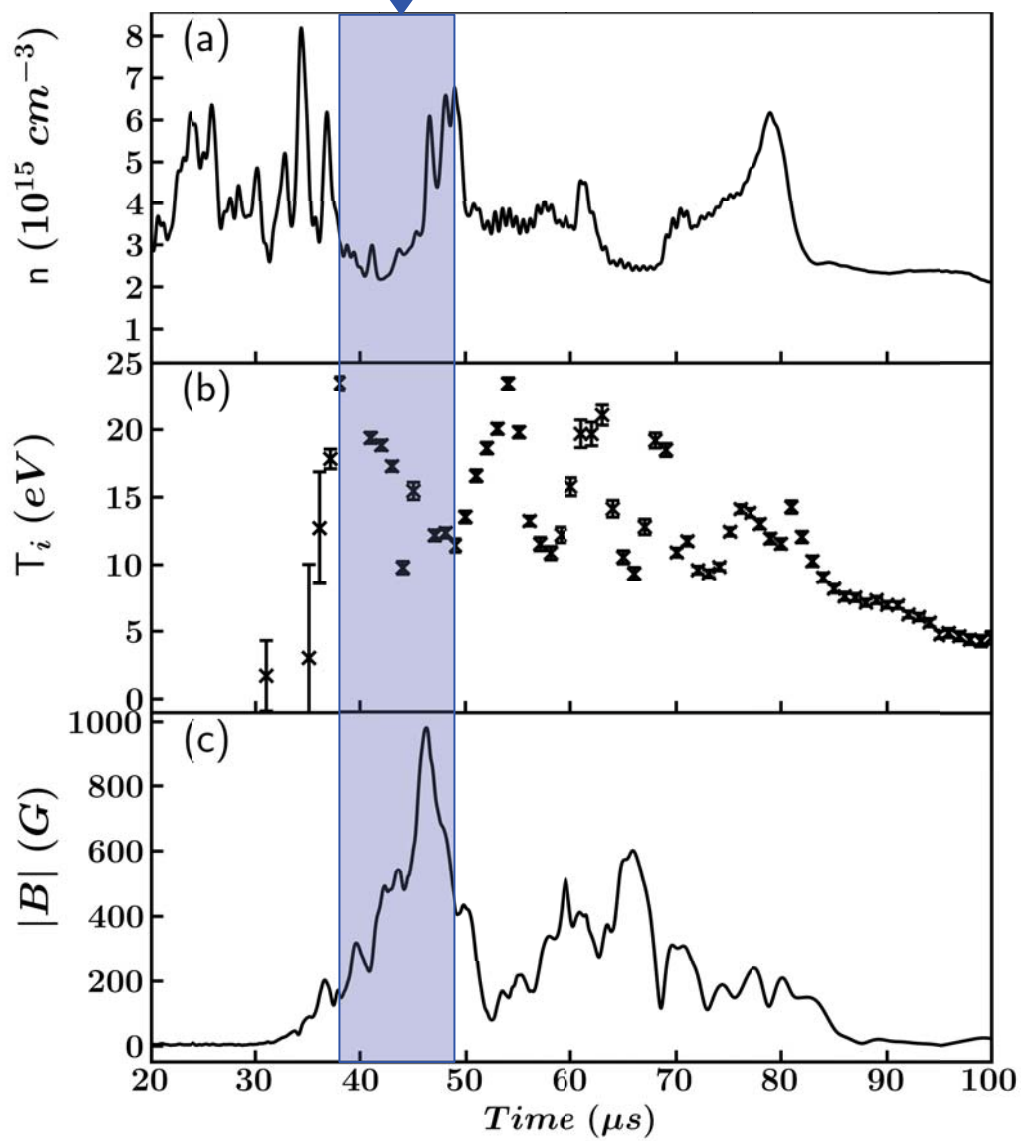


Taylor state in stagnation flux conserver



Taylor state in stagnation flux conserver

Taylor state enters the stagnation flux conserver



Taylor state in stagnation flux conserver

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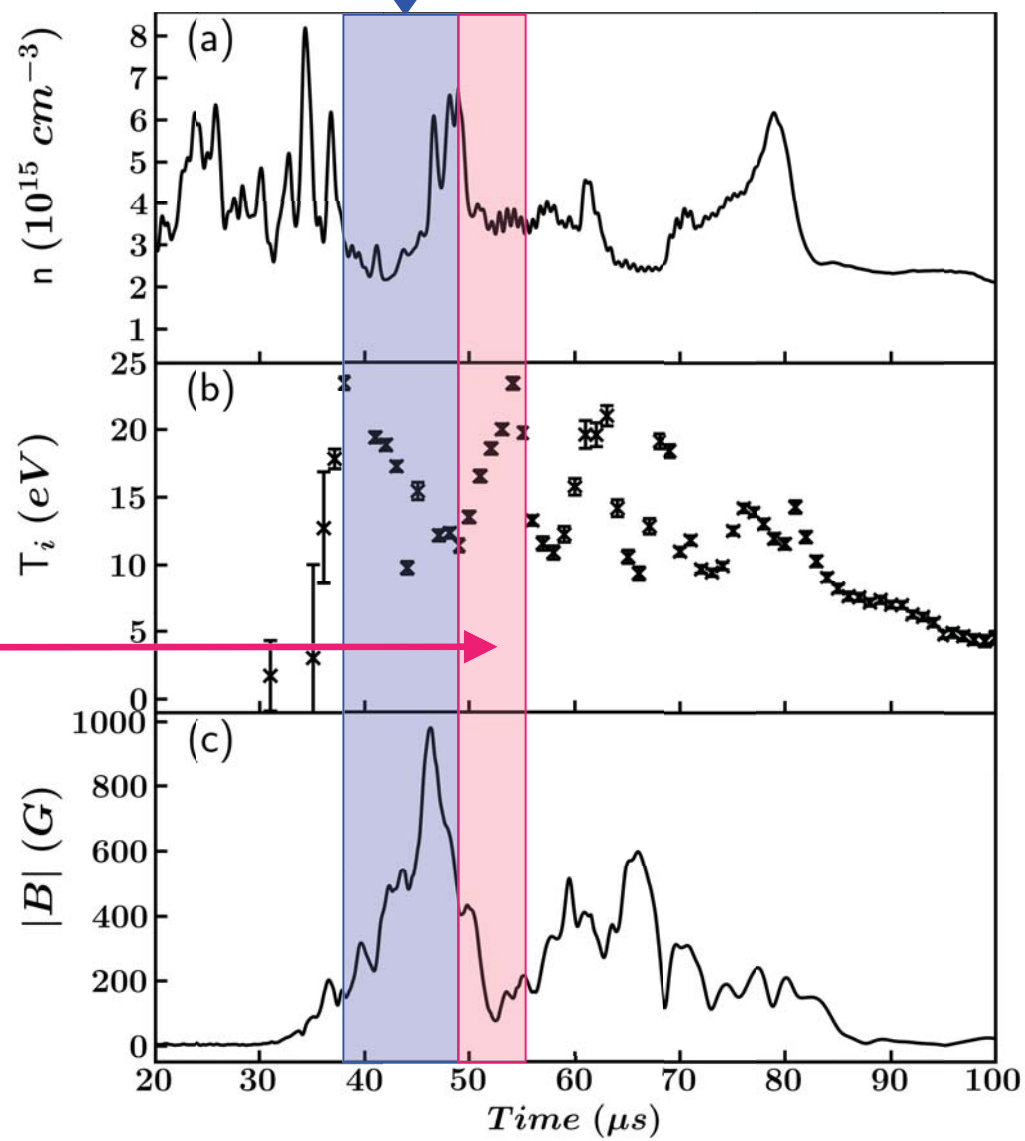
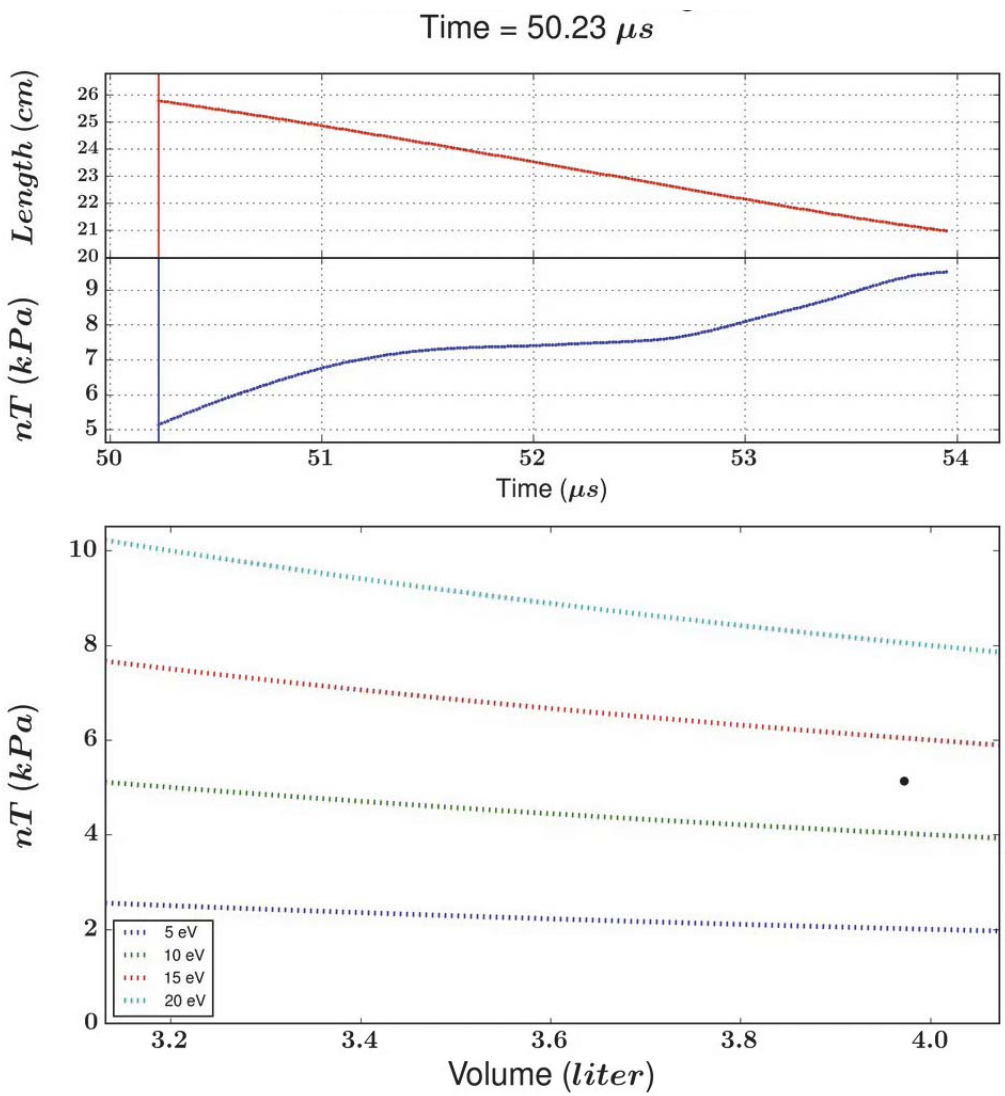
Taylor state compression & heating



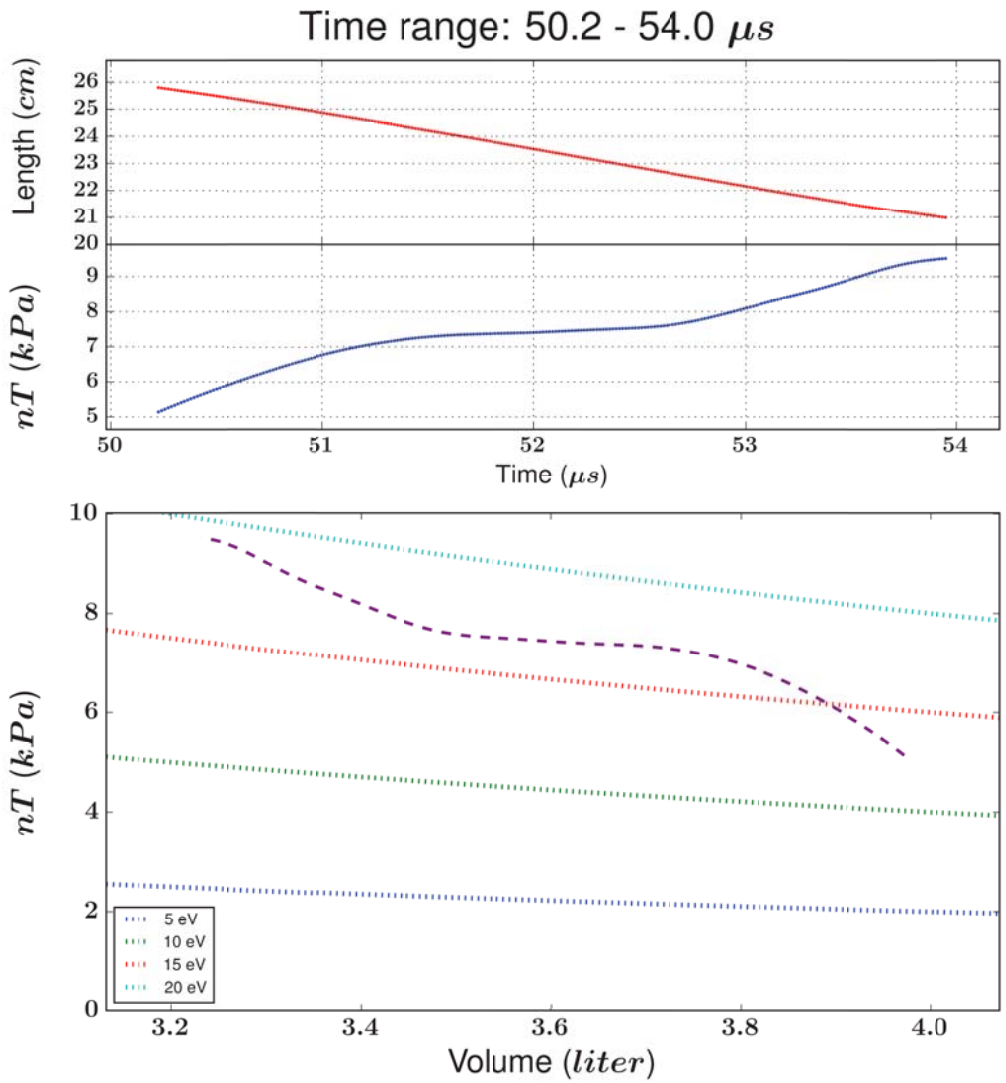
PV diagram



PV diagram helps in identifying Compressive heating events → Taylor state compression accompanied by ion heating.

Length reduces by 20%
Pressure increases by 80%

PV diagram



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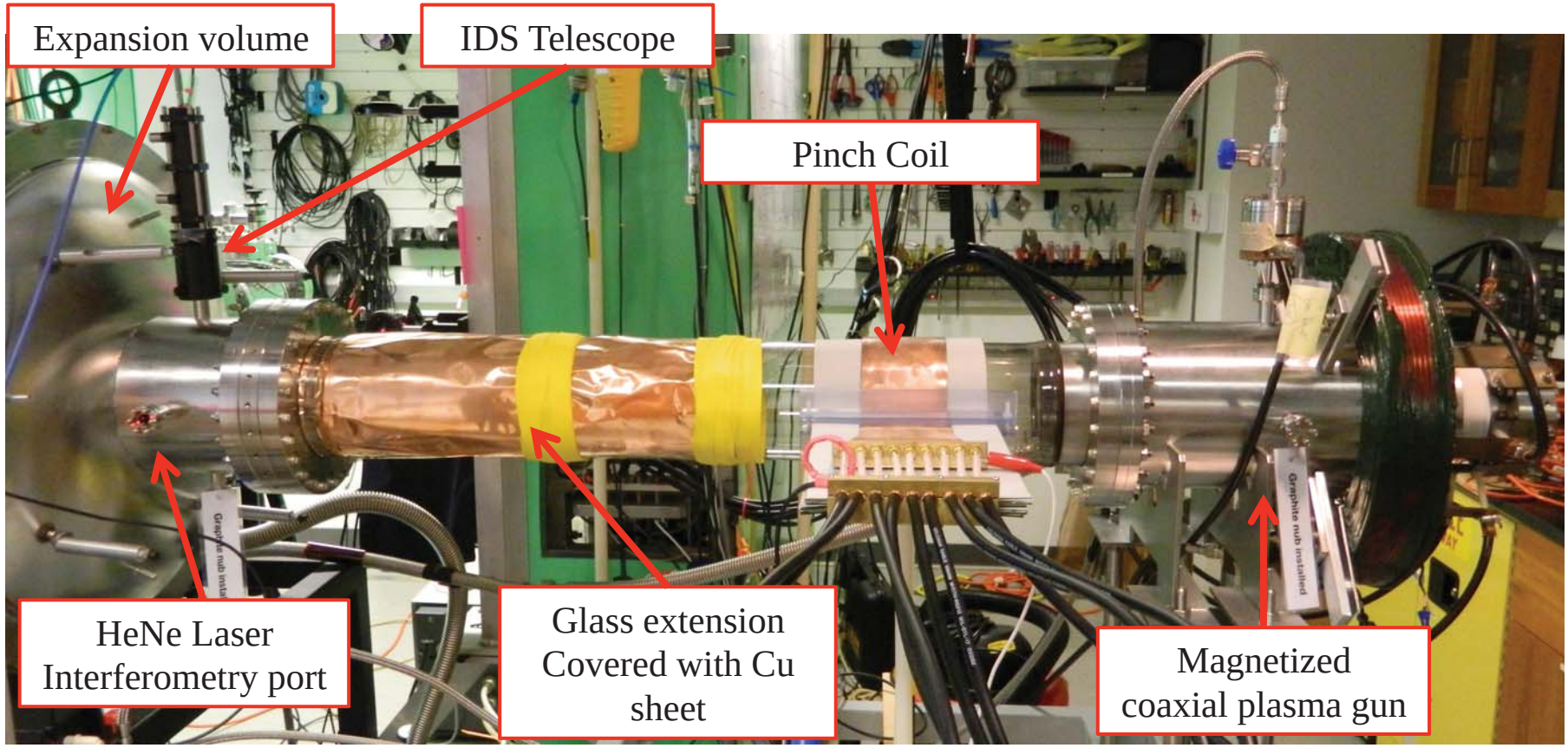
Pressure increases by 80%

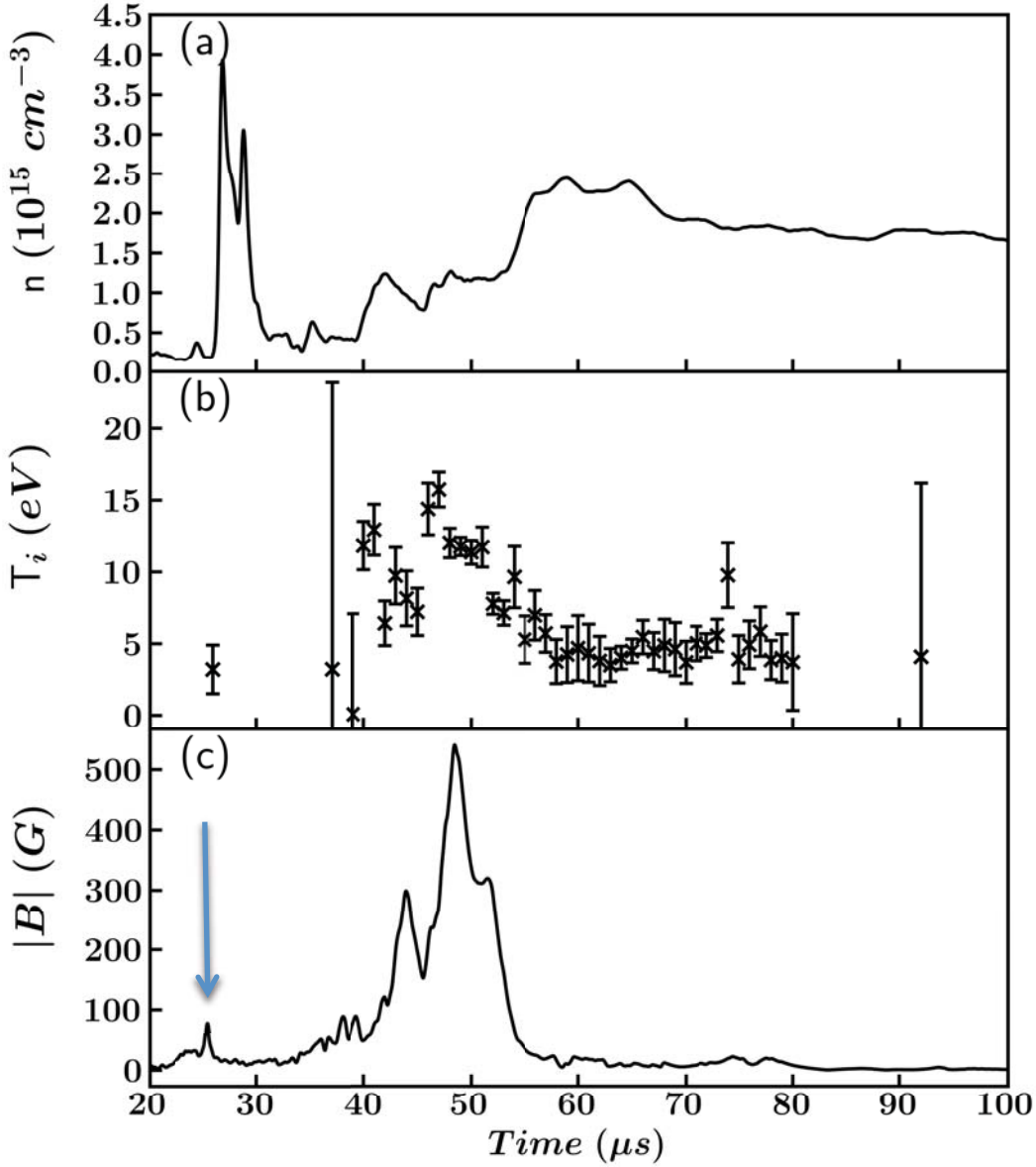
Compression conclusion

- Our results show **compressive heating events**.
- During compression events, the **volume reduces by** 10-30%
- The events last for 1-4 μs.
- We are comparing various equations of state (see poster).

Present status



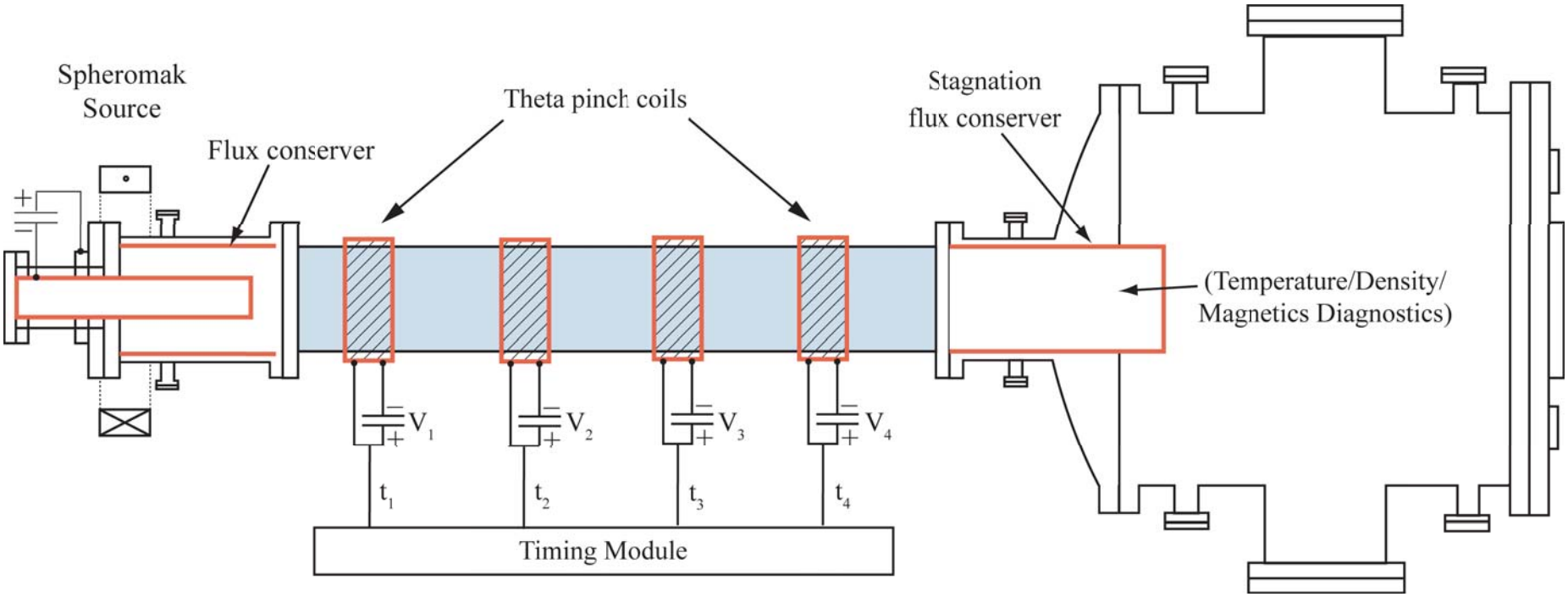
Accelerated Taylor state



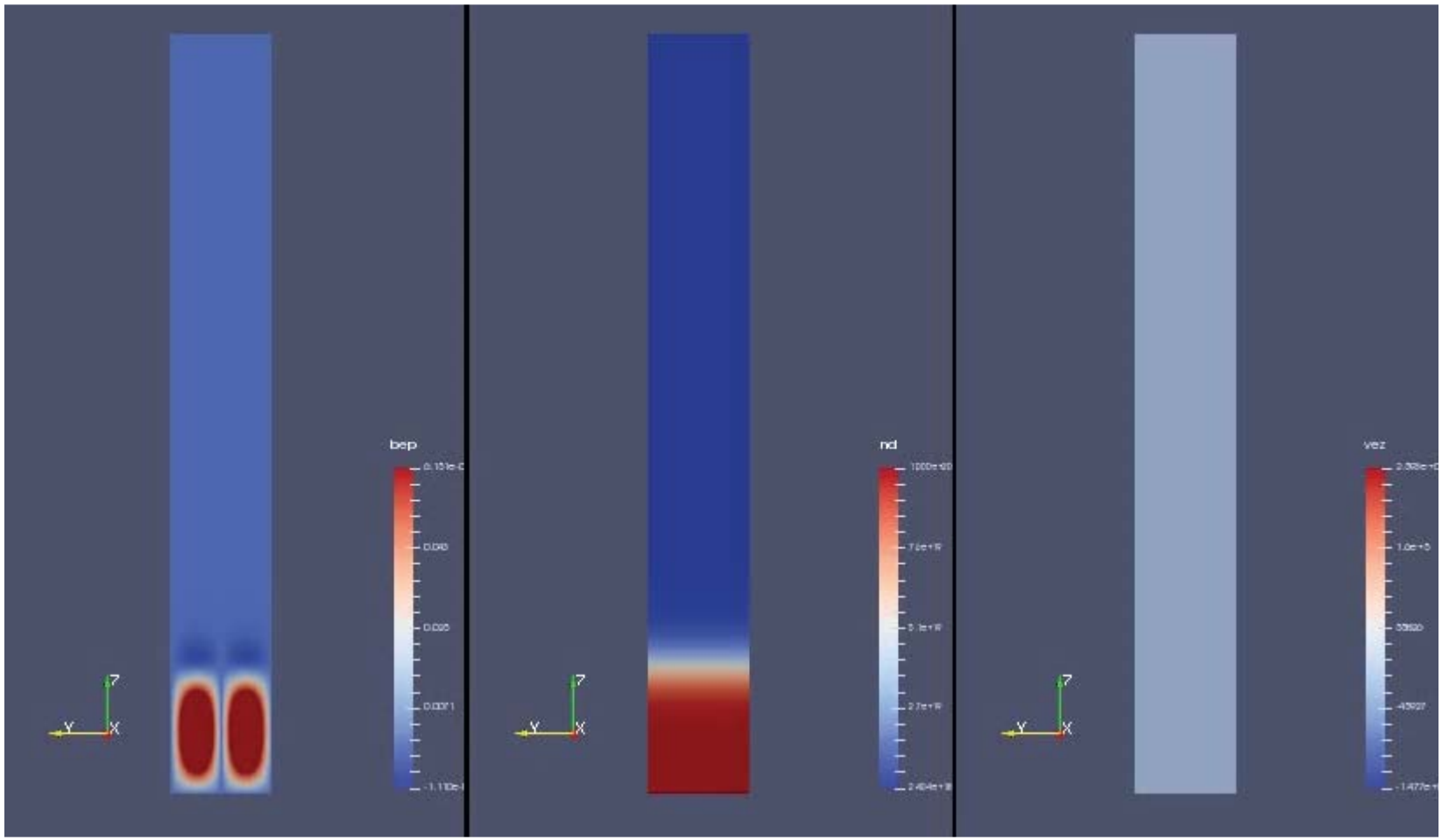
Accelerated Taylor state

Ultimate goal

Four theta pinch coils will be triggered separately and sequentially to accelerate plasma to velocities over 200 km/s. Compression should increase density to over 10^{16} cm^{-3} and ion temperature to over 100 eV.



Thank you

3D MHD simulation of coil compression

NIMROD with full 3D continuity equation, initial conditions for v_z and n_e as $f(z)$, and BC for E_φ for coil compression