# Overview of Swarthmore/Bryn Mawr project: Plasma accelerator on SSX

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with contributions from

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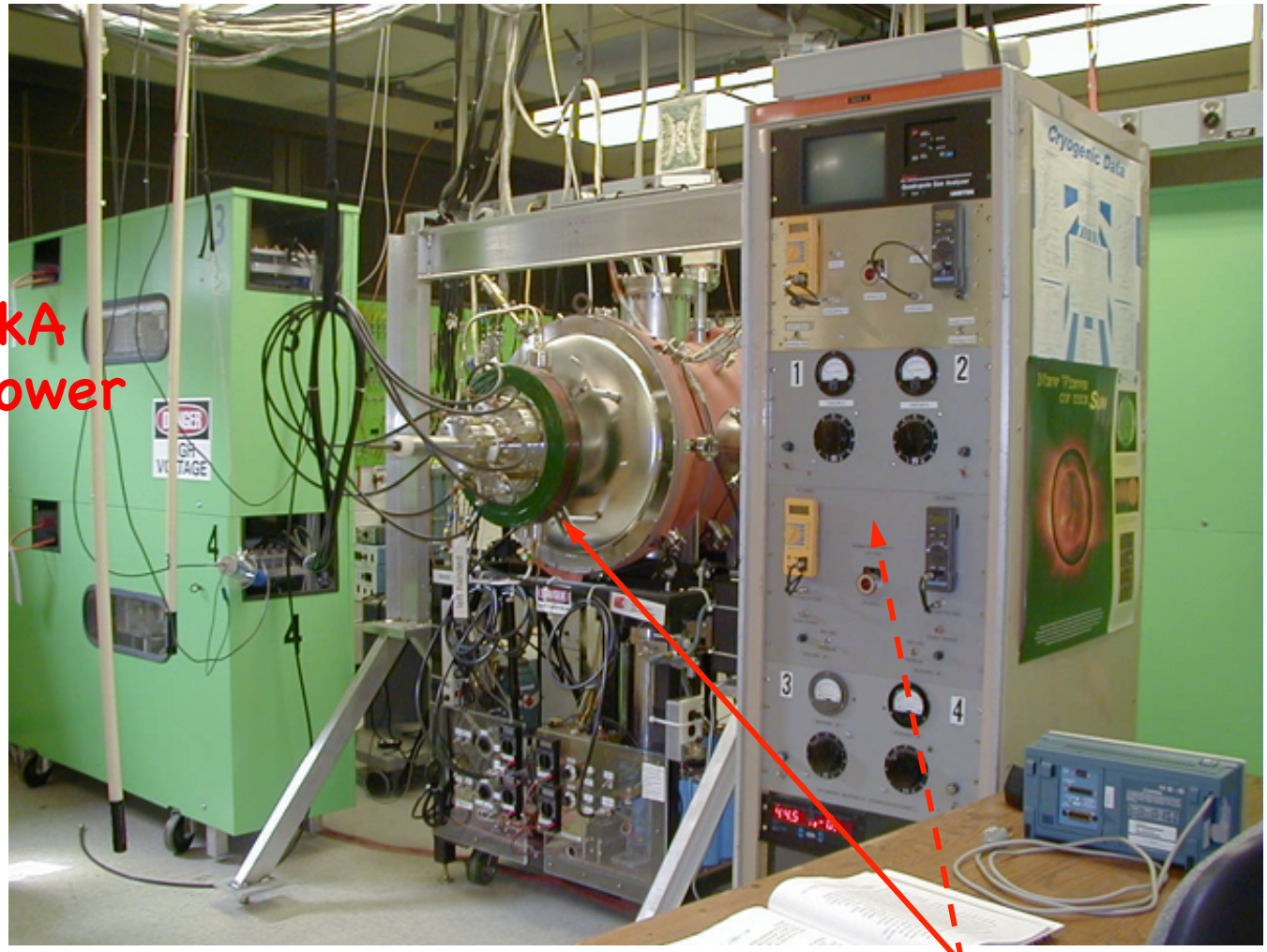
Day 1 ALPHA kick-off meeting
October 14, 2015

Research supported by ARPA-E, DOE-OFES

# The SSX Laboratory (20 years)

10kV/100kA
Pulsed power



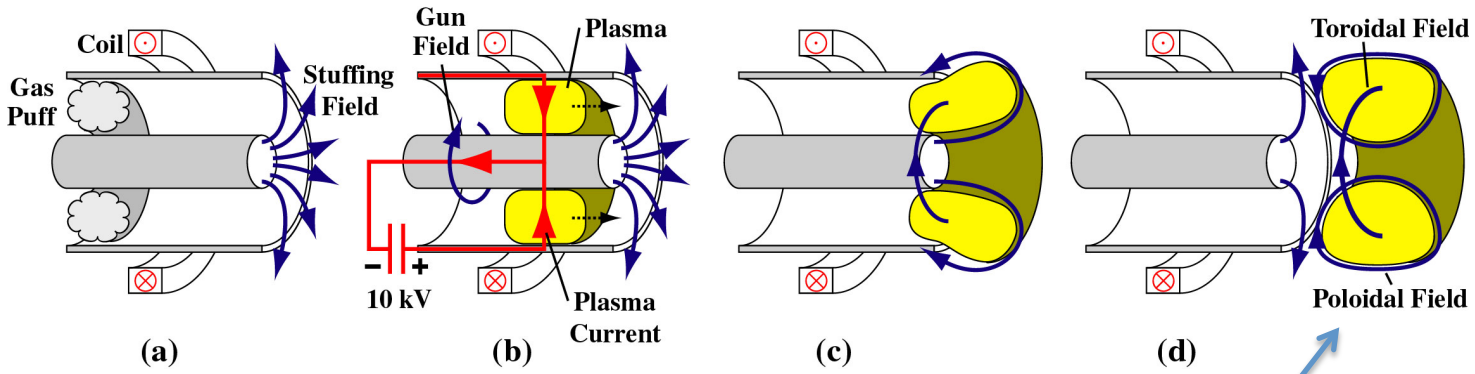

Cylindrical vacuum chamber
(D = 0.5 m, L = 1 m)

High voltage plasma
guns on each end

# Baseline SSX parameters

| | |
|---|---|
| Ion Density (protons) | $10^{15}$ cm$^{-3}$ |
| Temperature ($T_e$,$T_i$) | 20 - 60 eV |
| Magnetic Field | < 0.5 Tesla |
| Ion gyroradius | < 5 mm |
| Alfvén speed | 100 km/s |
| S (Lundquist number) | > 1000 |
| Plasma β | 0.1-1 |

# Spheromak formation

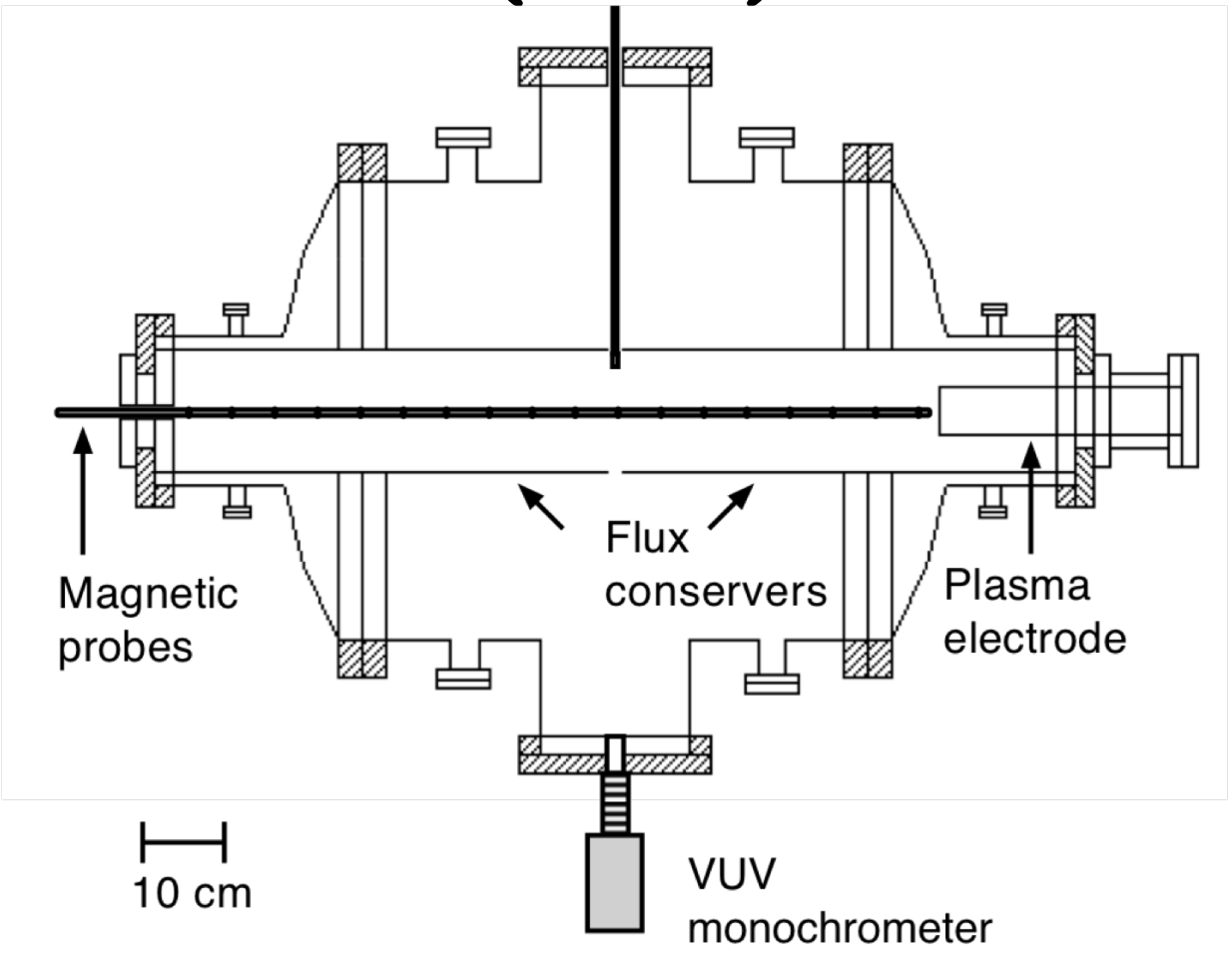



Spheromak

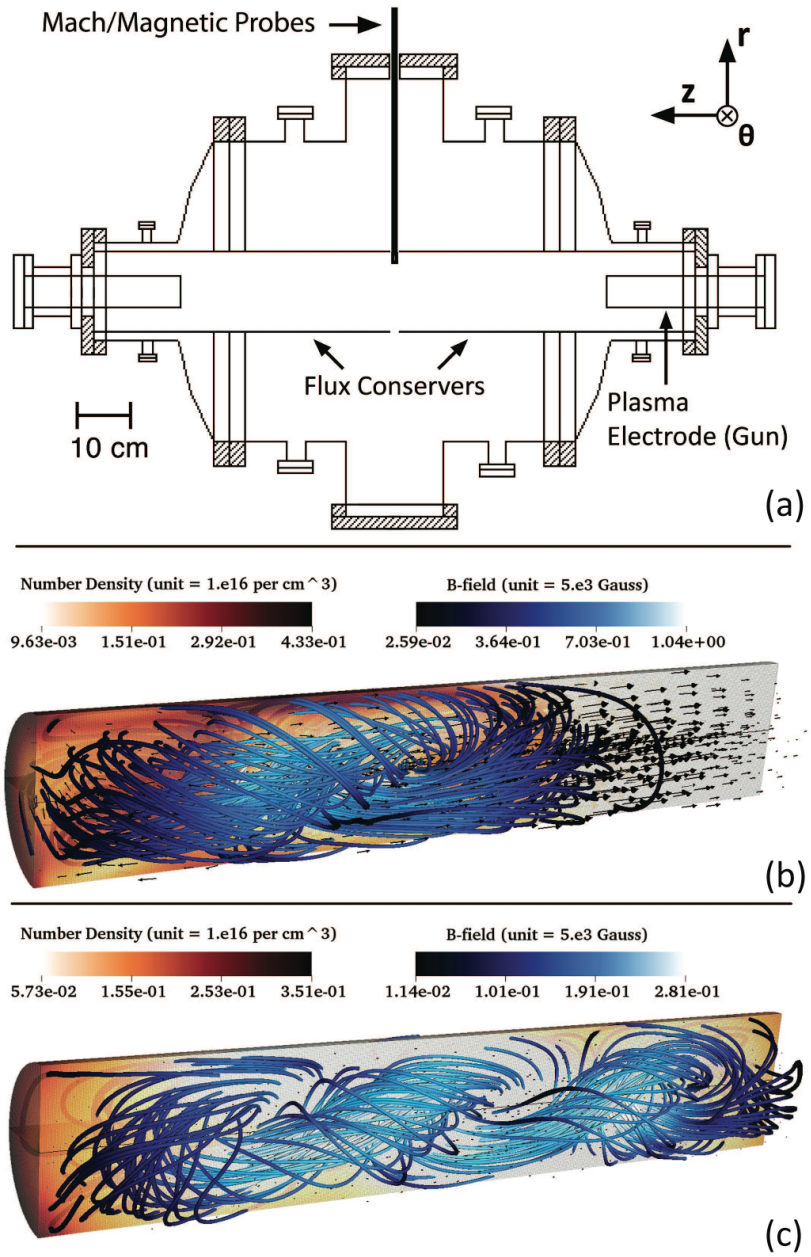
# MHD wind tunnel configuration

- 50 km/s flows, fully ionized and magnetized
- Kinetic, magnetic, thermal energies comparable
- Single plume (>5 kJ), merging (>10 kJ)
- High $\beta$ and large flows
- Merged or stagnated plumes as MIF target

# Prototype SSX MHD wind tunnel (2010)



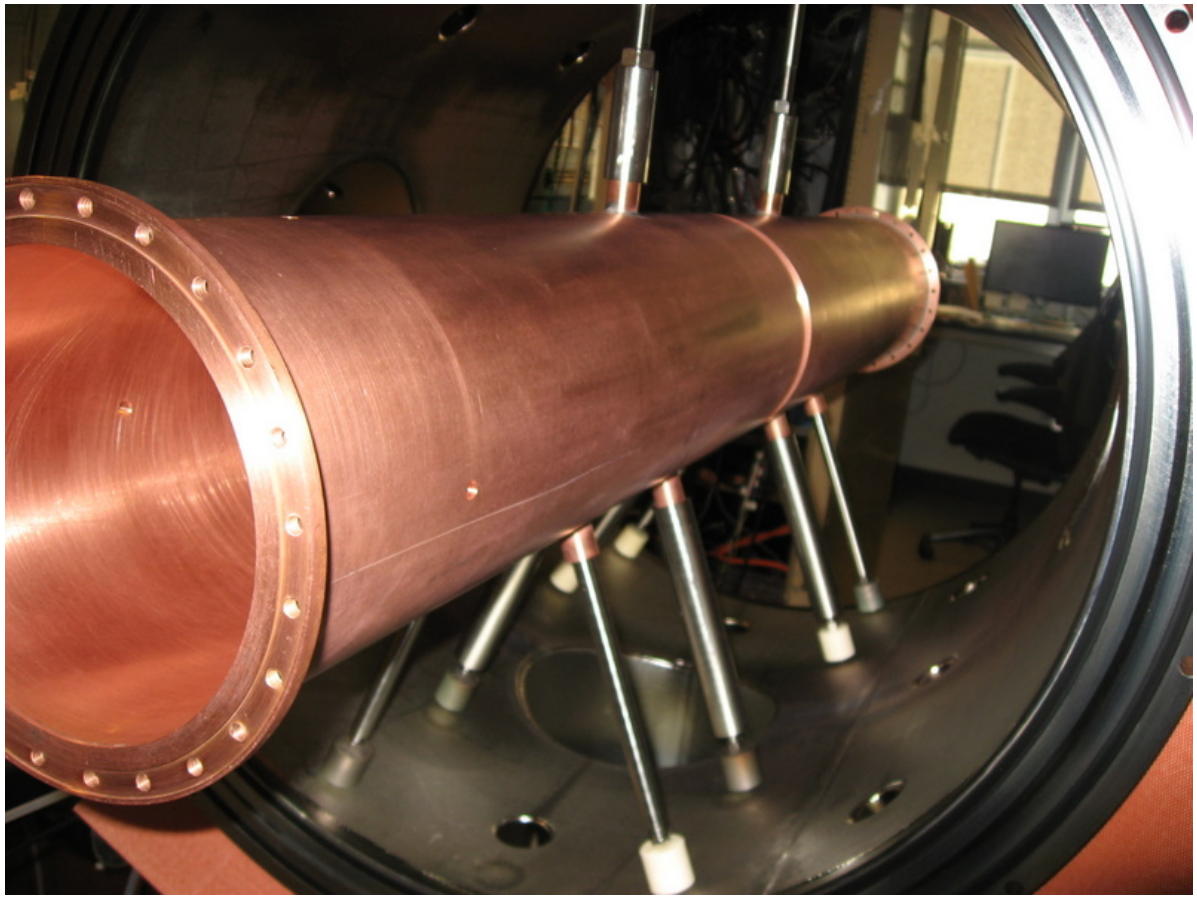

Chamber is baked and glow discharge cleaned, P = $10^{-8}$ torr




Merging configuration

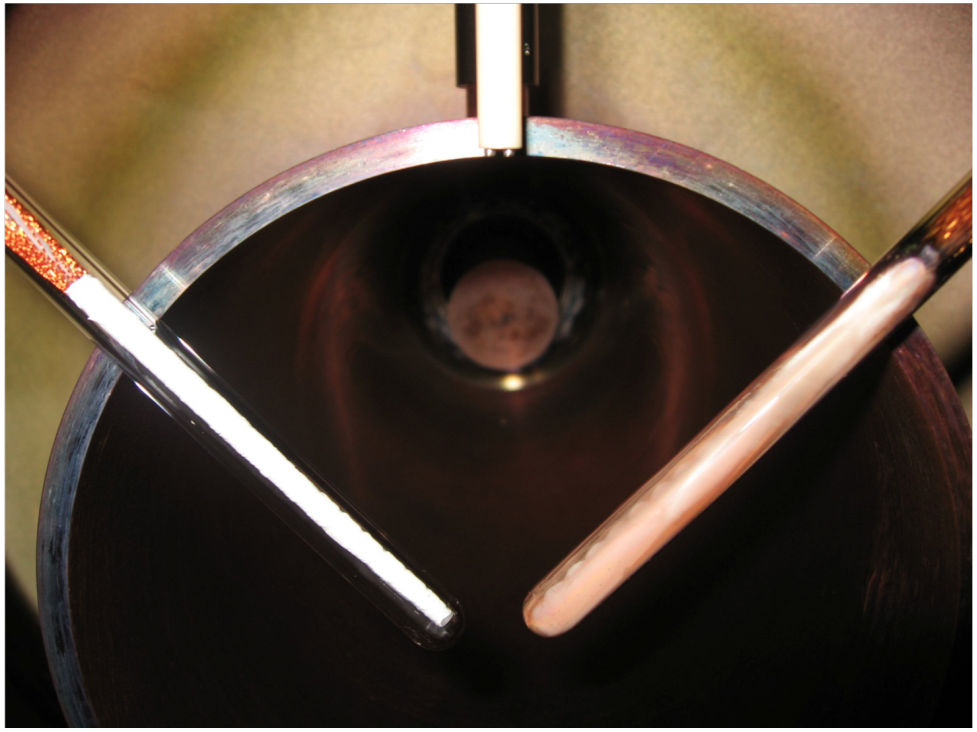
HiFi simulation

# SSX MHD wind tunnel
# 50 km/s, magnetic and fluid turbulence



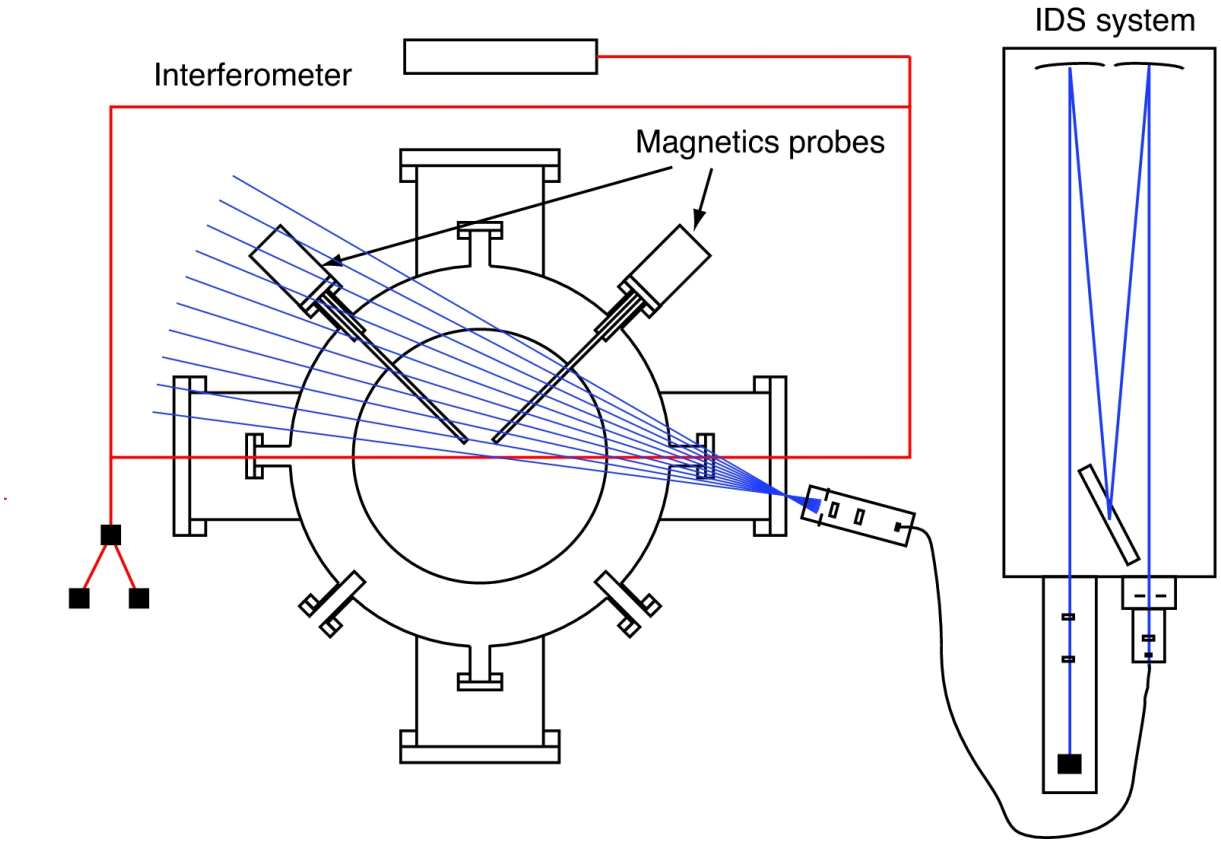
Diagnose with arrays of magnetic and velocity probes

# Diagnostics at midplane (B and $n_e$)



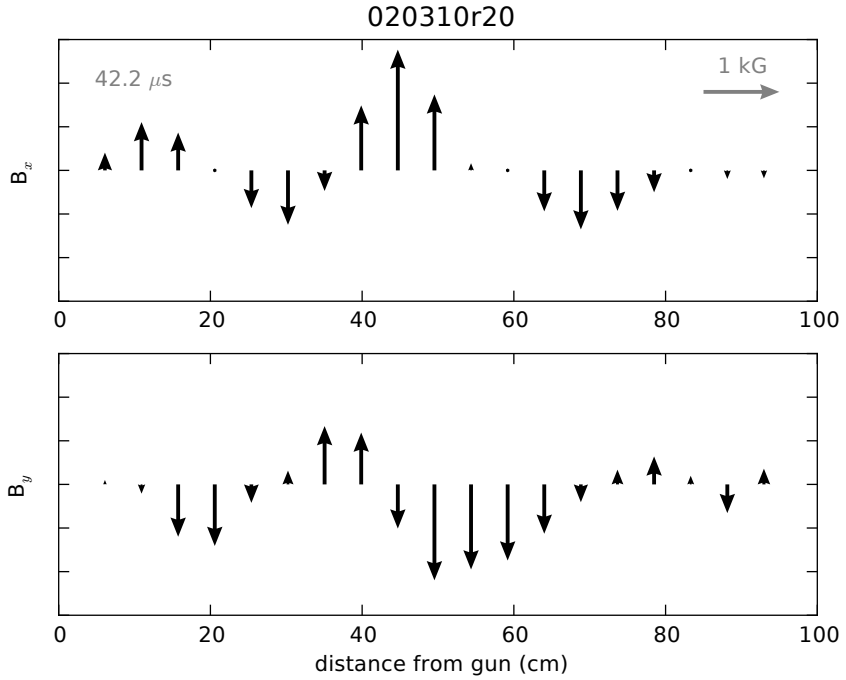
Line-averaged density with He-Ne, temperature from IDS

# Ion Doppler spectrometer on SSX

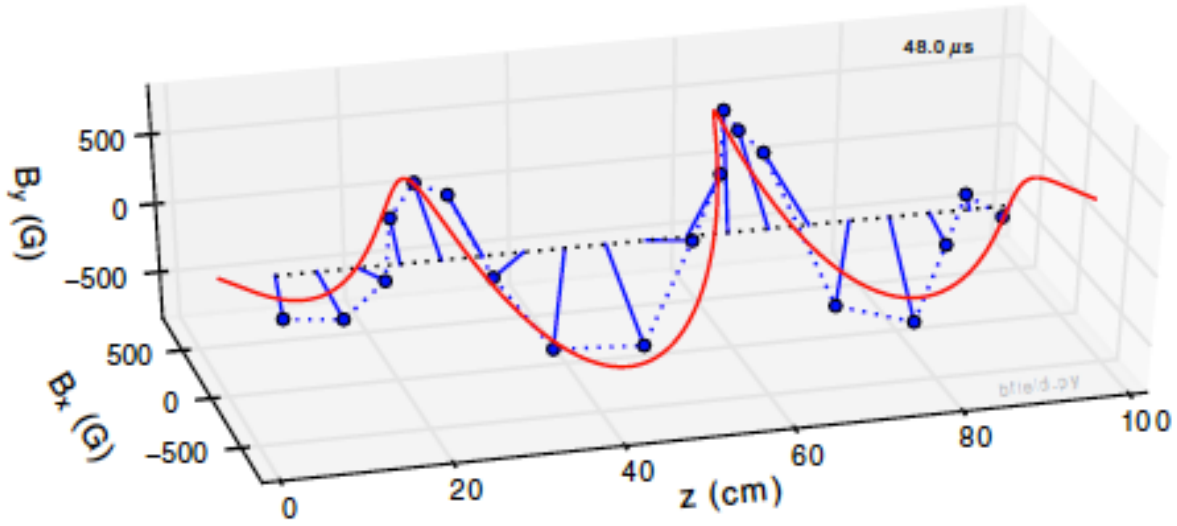



Interferometer chord and two magnetic probes also shown

# Measured Taylor state (42 μs)

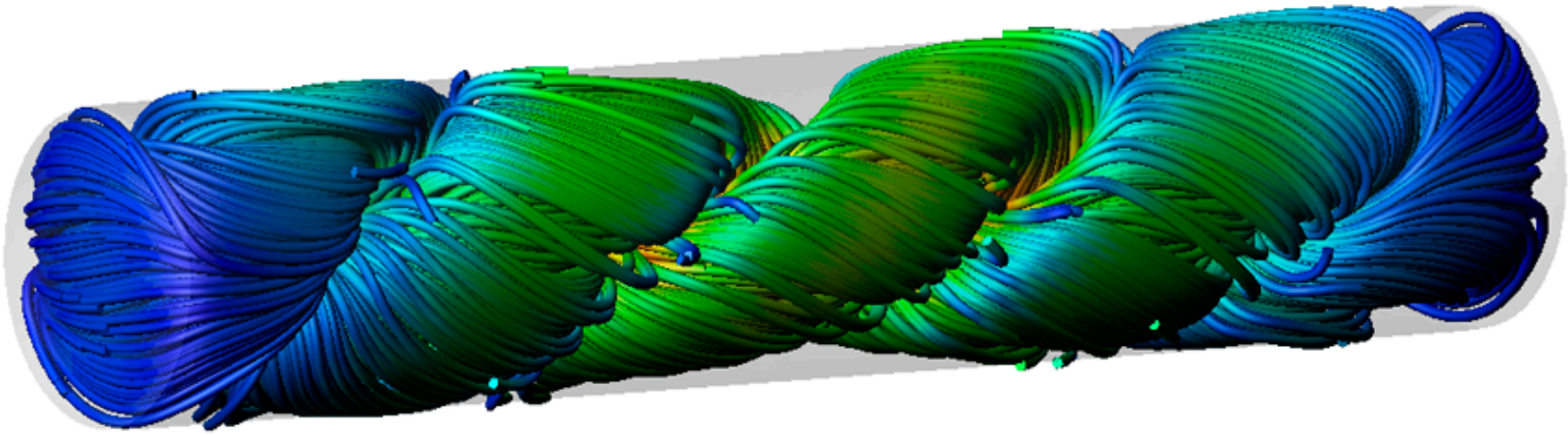


# Measured Taylor state (48 μs)



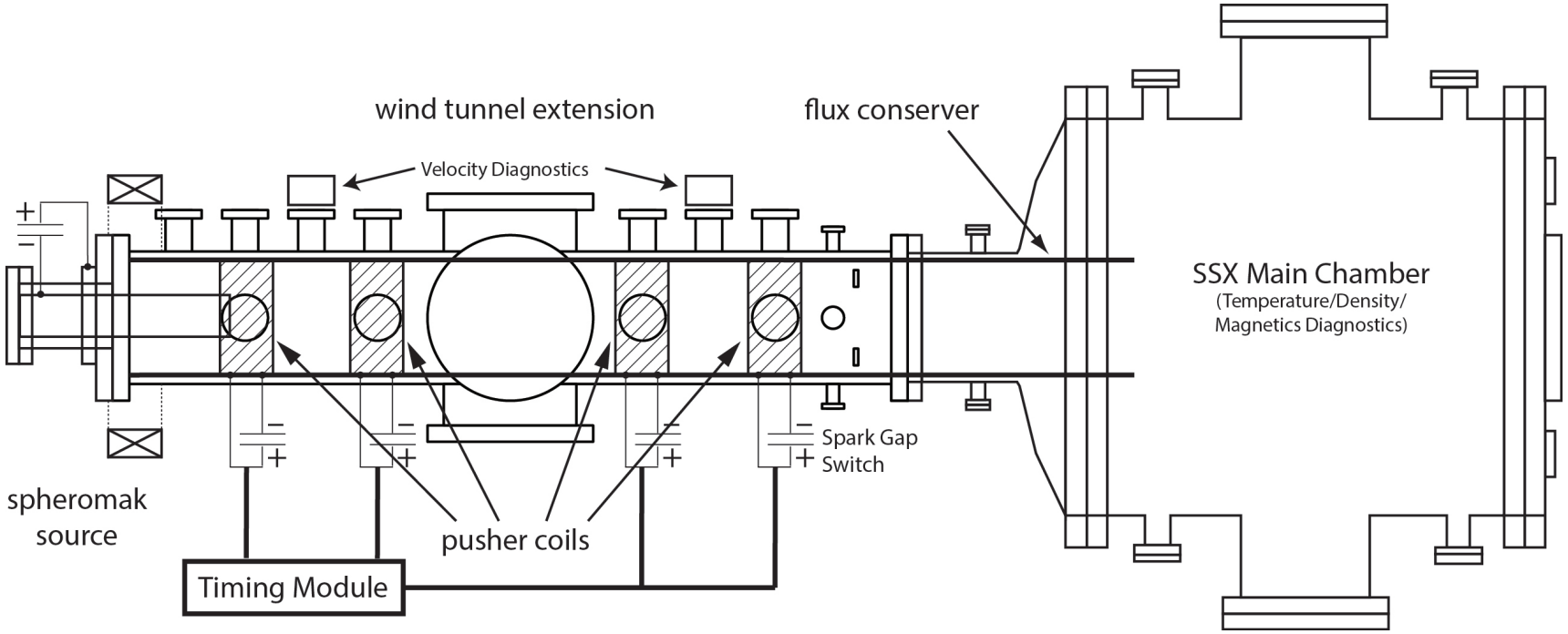

Gray, et al, PRL 2013

# Comparison with predicted helical state



State with the minimum magnetic energy
(subject to certain constraints)
Originally predicted by J. B. Taylor

# Extension and accelerator, ALPHA plan




Accelerate to v > 200 km/s, M > 4… fast camera, probes in chamber

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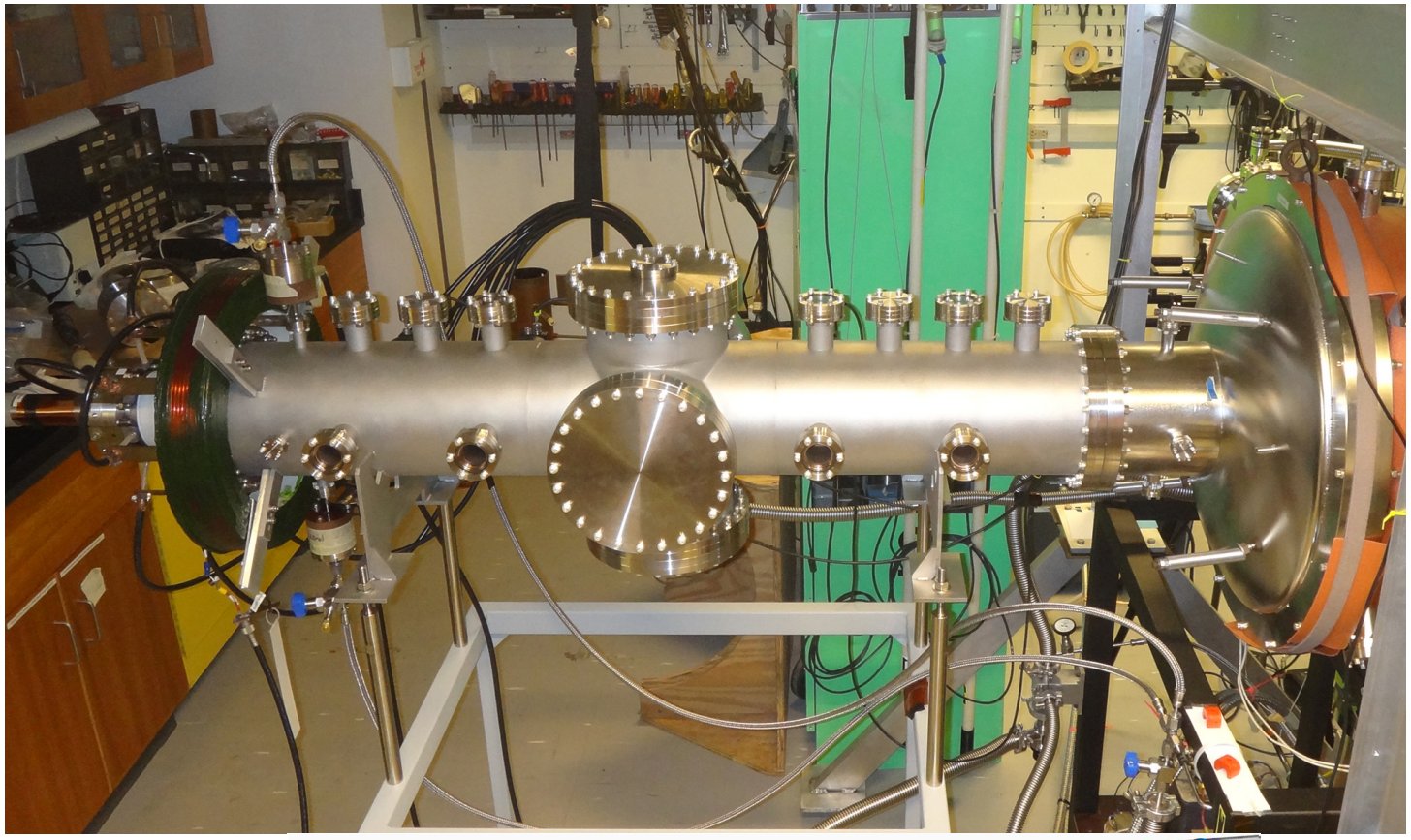

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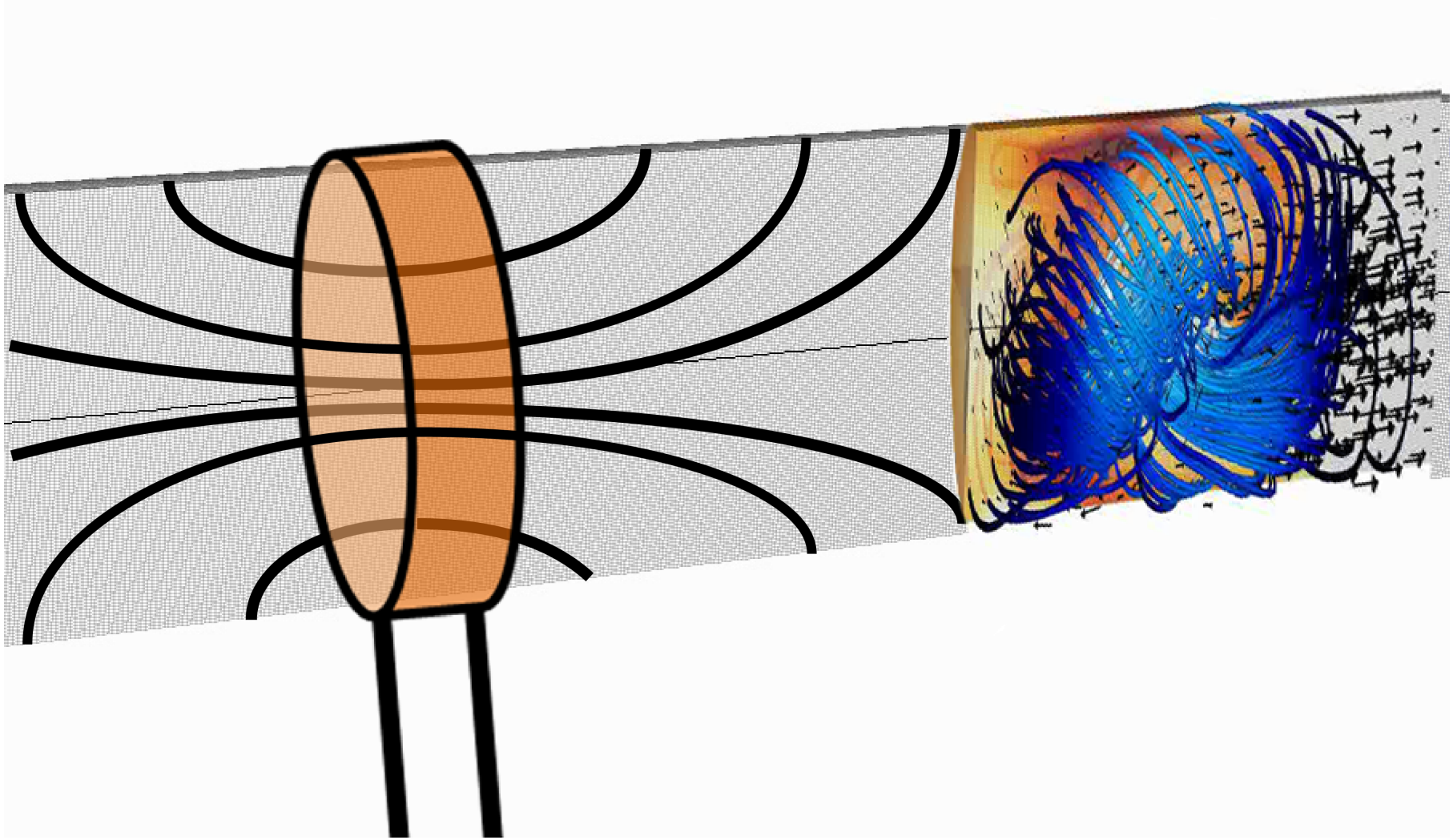

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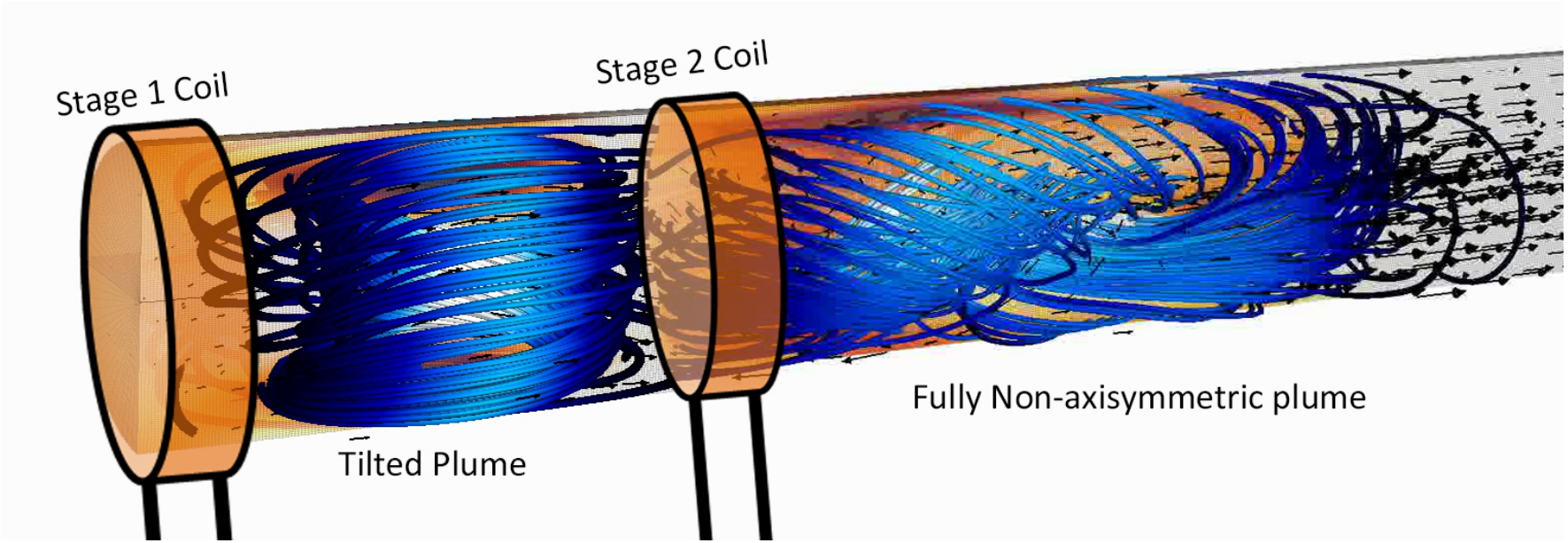
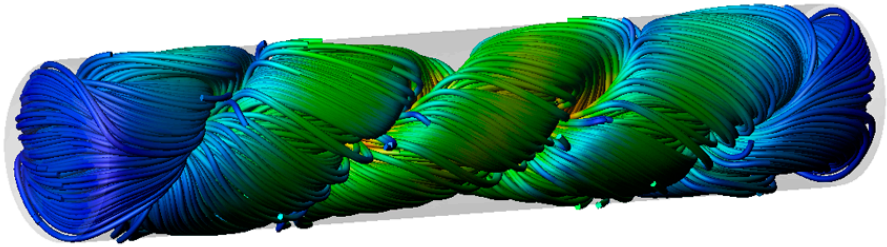
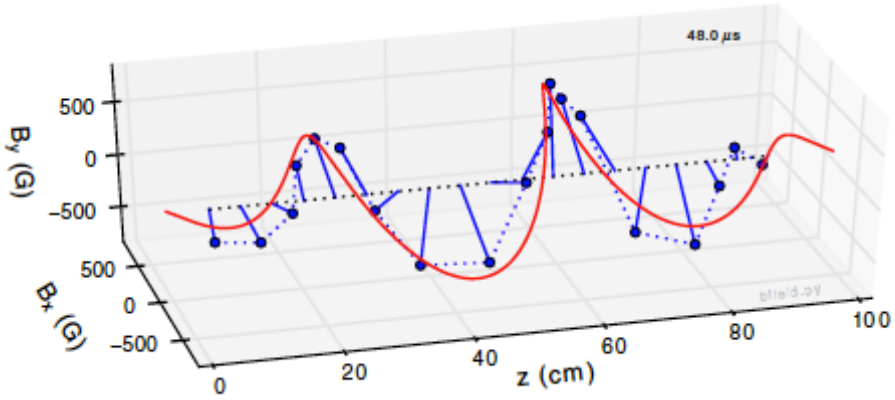



Initial experiments in glass extension

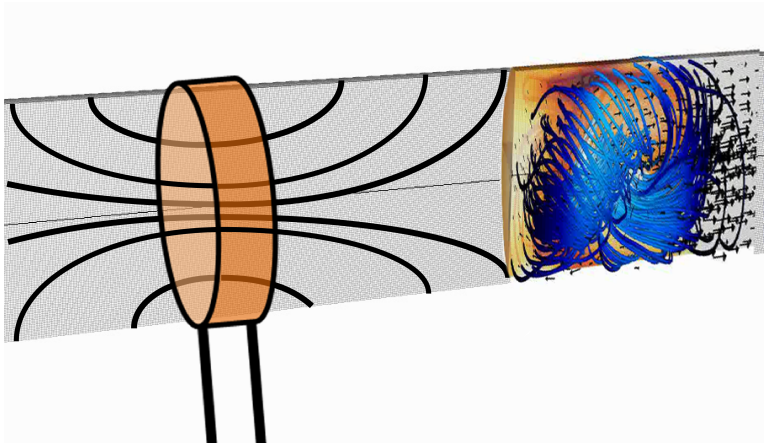
# Summary



Double helix Taylor state (predicted 1986)




Measured at SSX (2013)



Accelerate, stagnate, merge for MIF target