PROGRESS AND PLANS

FUSION POWER ASSOCIATES 2017 ANNUAL MEETING

generalfusion®

2017 Highlights

Improved performance on small SPECTOR series injectors

- New benchmarks for plasma life, temperatures

2 field plasma compression tests completed

- Big improvement in plasma stability during compression

New, scalable driver servo control system developed

New large injector, PI3, constructed

Launch of integrated prototype program

General Fusion

Founded in 2002 by Dr. Michel Laberge

Based in Vancouver, Canada

75 employees

Focused on building a practical, commercially viable path to fusion energy

Approaches to Fusion

Magnetic Confinement

Plasma confinement using large magnetic coils

Low density:

~10^{14} ions/cm^3

Continuous operation

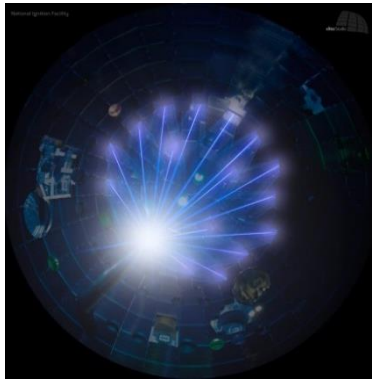
Magnetized Target Fusion

Combination of compression and magnetic confinement

Medium density:

~10^{17} ions/cm^3

Pulsed: ~1 ms



Inertial Confinement

Very fast compression using high power lasers or ion beams

Very high density:

~10^{26} ions/cm^3

Pulsed: <1 ns

Plasma formed by CHI into liquid metal cavity

- Temperature: ~500 eV
- Density: ~1E20 m^{-3}

Piston array compression

- ~10:1 radial compression
- 20 ms compression time

Liquid Metal Liner serves as:

- First Wall
- Neutron Blanket
- Tritium Breeding
- System Coolant
- Radiation Shielding

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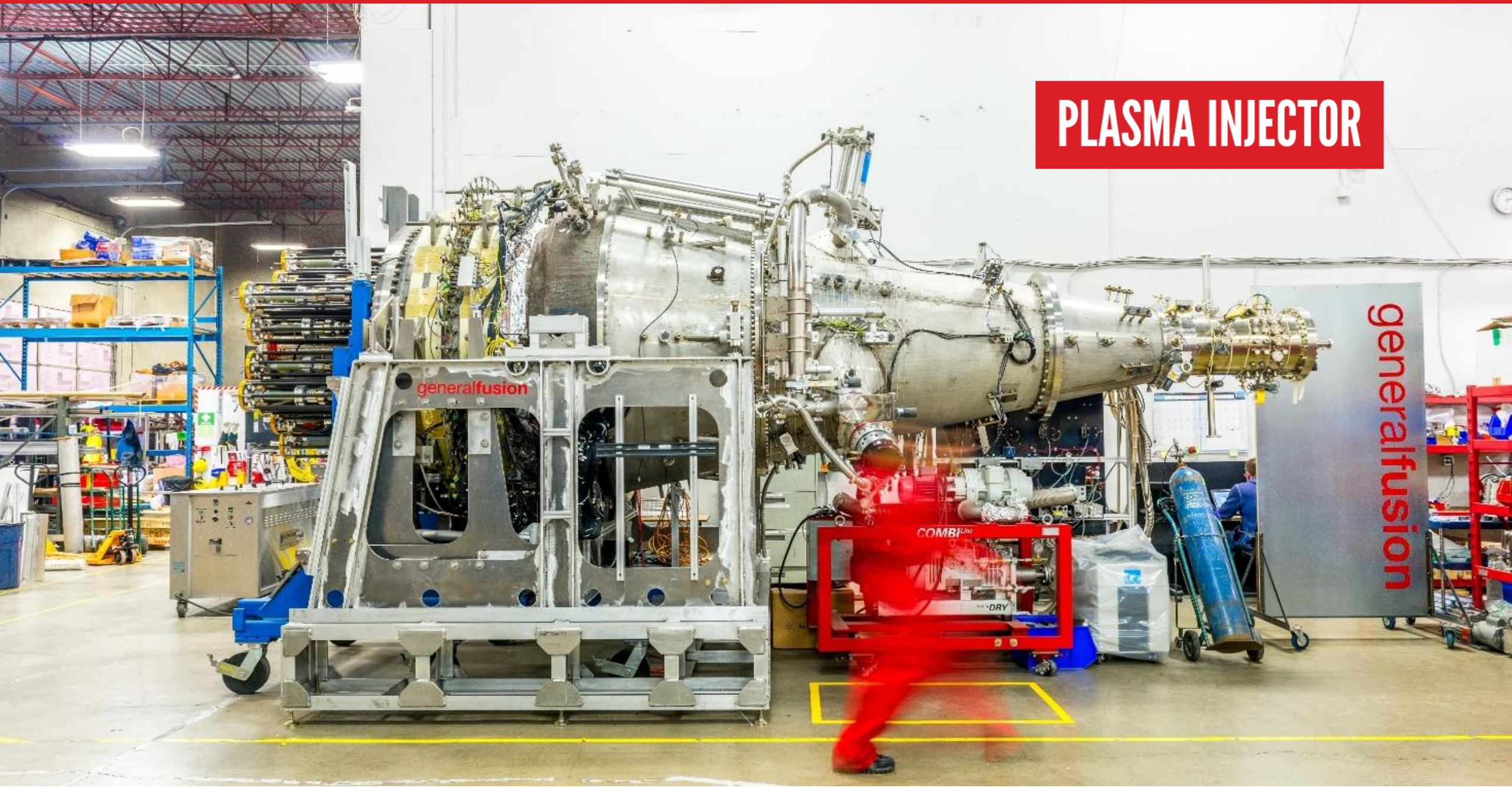
PLASMA INJECTOR
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COMBI

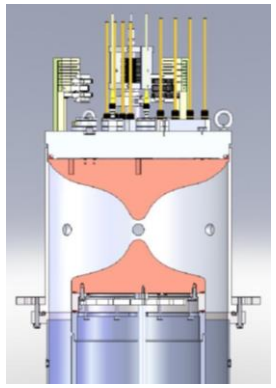
Small Plasma Injectors

Built on a reduced scale to reduce iteration time and expense

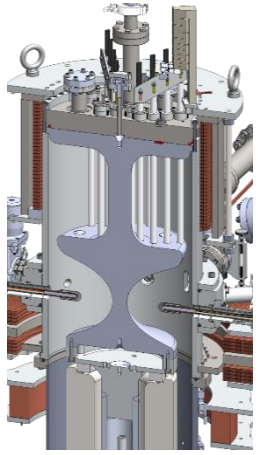
Used in plasma compression experiments

16 small injectors constructed in 8 years

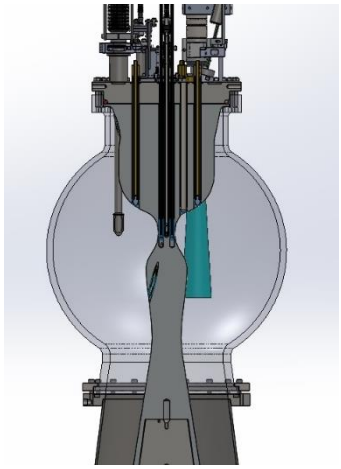
Allow a variety of geometries and overall safety factor (q) to be explored



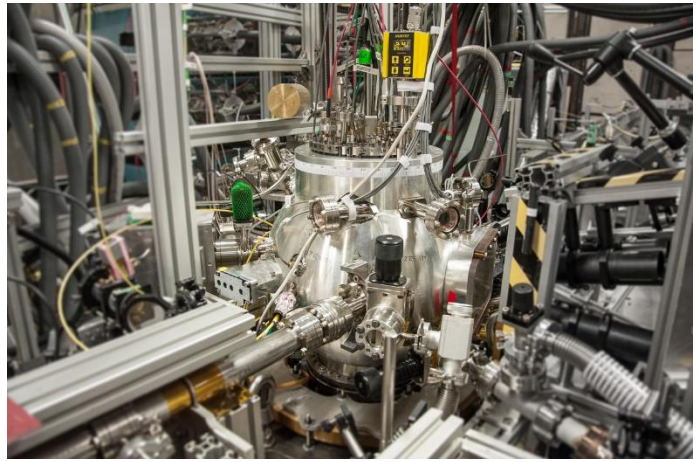
MRT



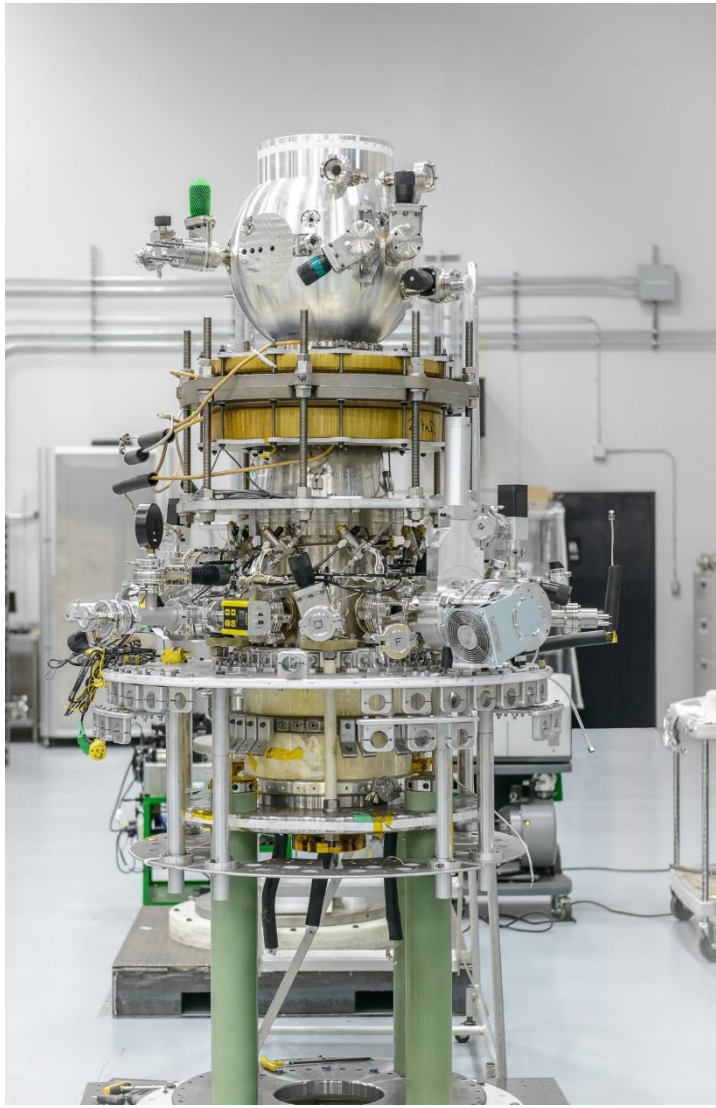
PROSPECTOR



SPECTOR
Spherical **C**ompact
Toroid



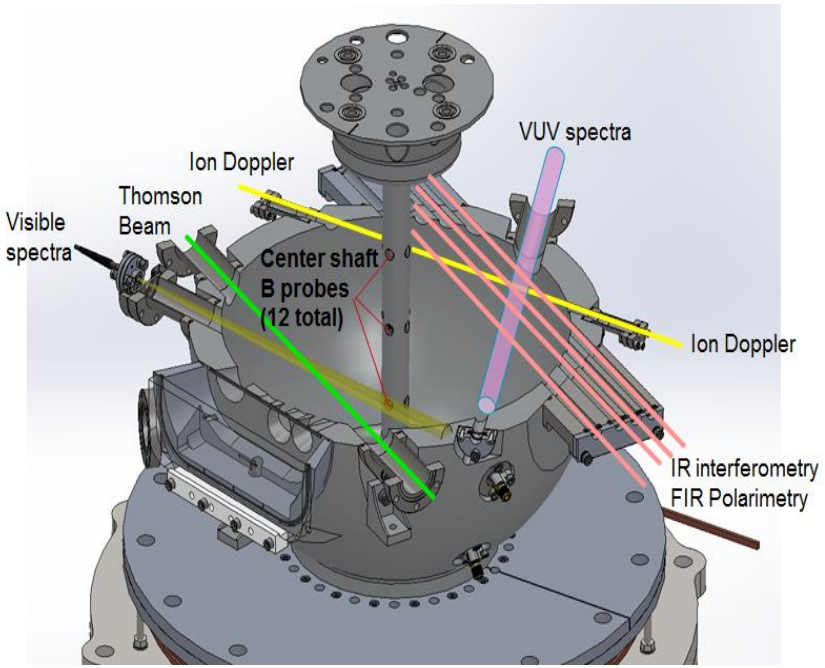
SPECTOR in lab with diagnostics

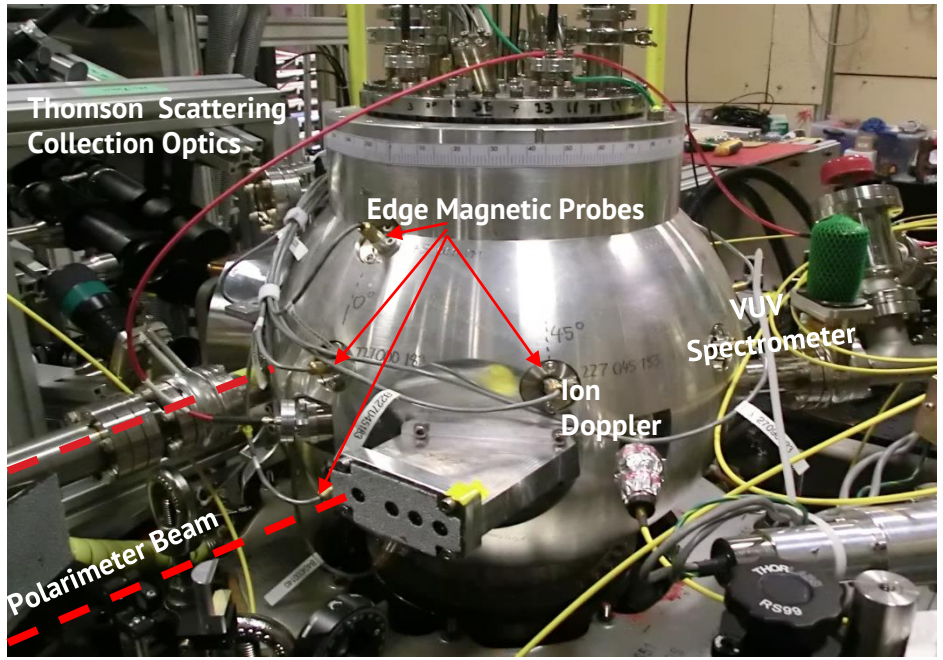


SPECTOR injector

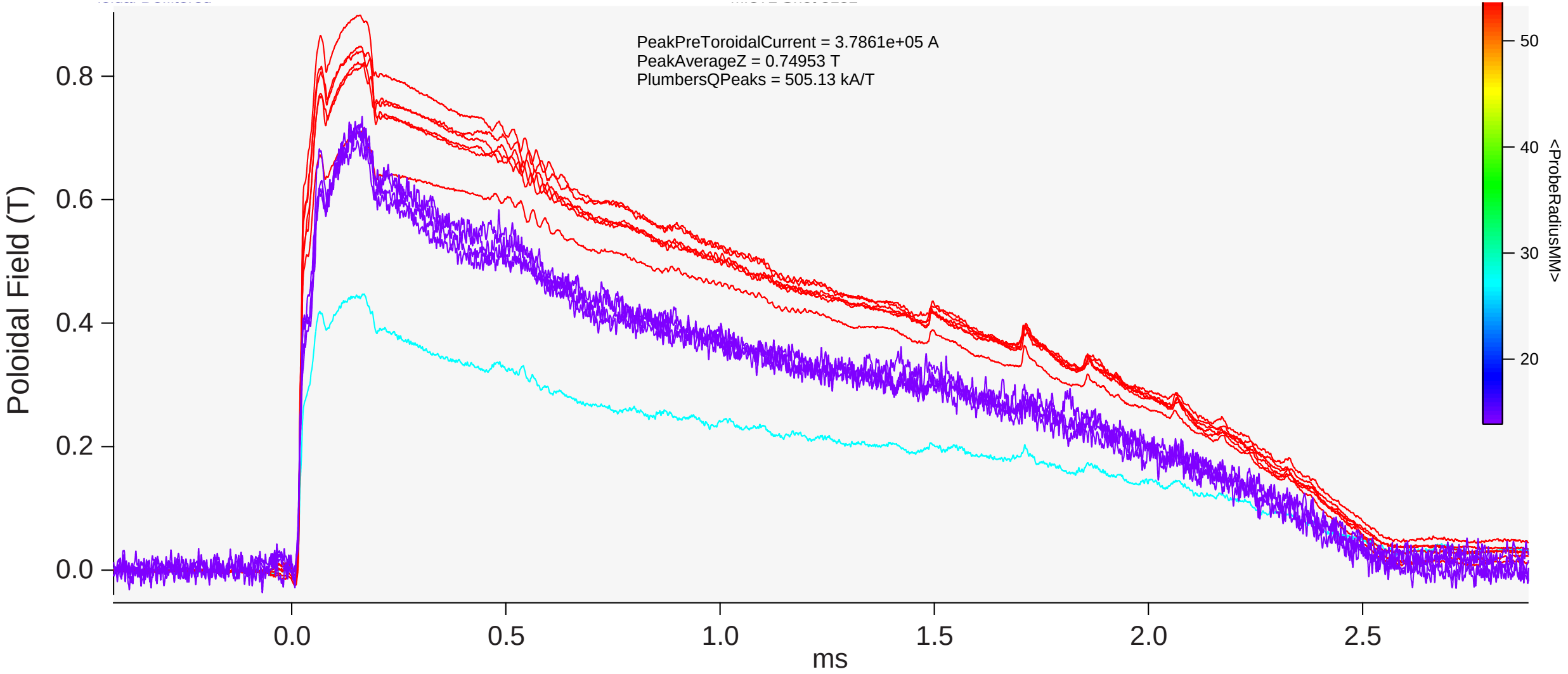
Laboratory SPECTOR System

- Magnetic pick-up probes
- Interferometers
- Visible light photodiodes
- X-ray photodiodes
- X-ray phosphor camera
- Visible Spectrometers
- Multi-point Thomson scattering
- Multi-chord FIR Polarimeter
- VUV Spectrometer



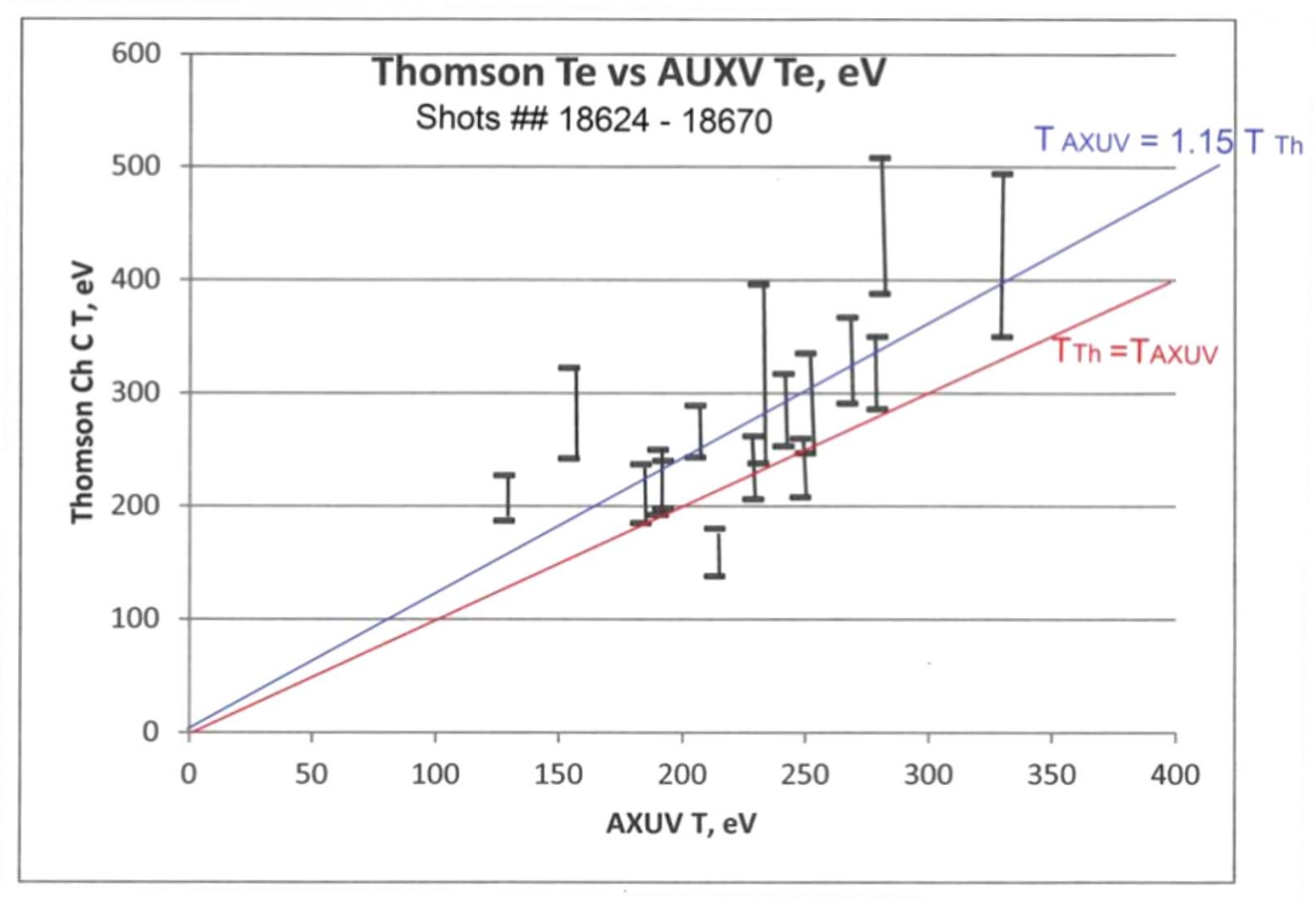


2017 SPECTOR Performance Benchmark



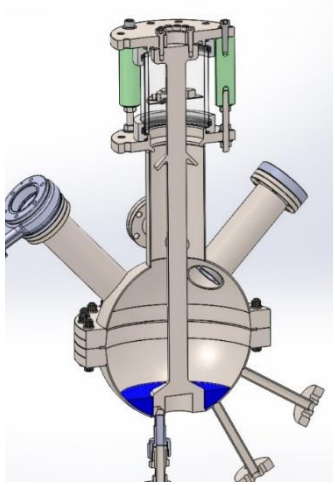
SPECTOR Electron Temperature

Thomson scattering and AXUV photodiode array indicate electron temperatures ~300 eV

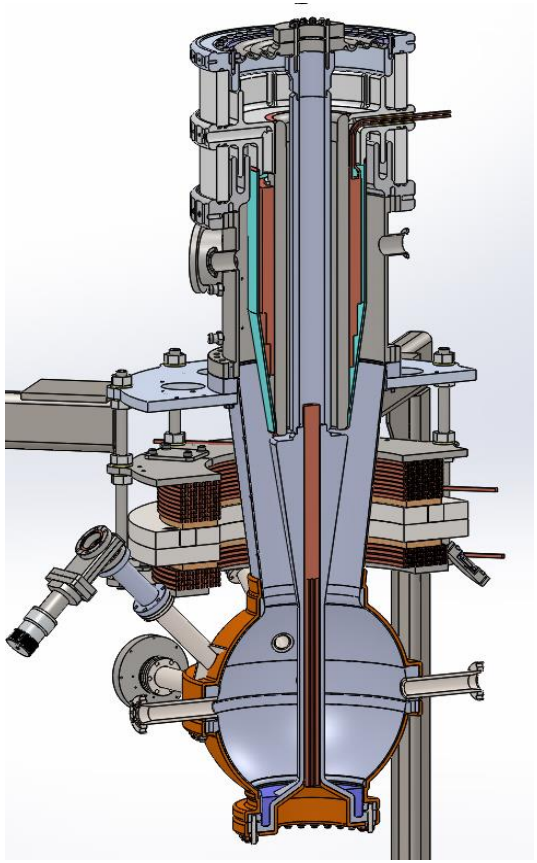


Plasma Formation onto Liquid Metal

MiniSL!C: Operating Now
No Plasma
Pulsed Current
Pulsed Magnetic Field
Liquid Lithium Free Surface

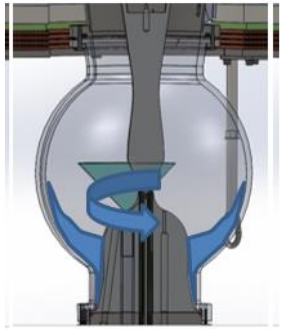


SL!C: 2018
CHI Plasma Formation
Liquid Lithium Free Surface



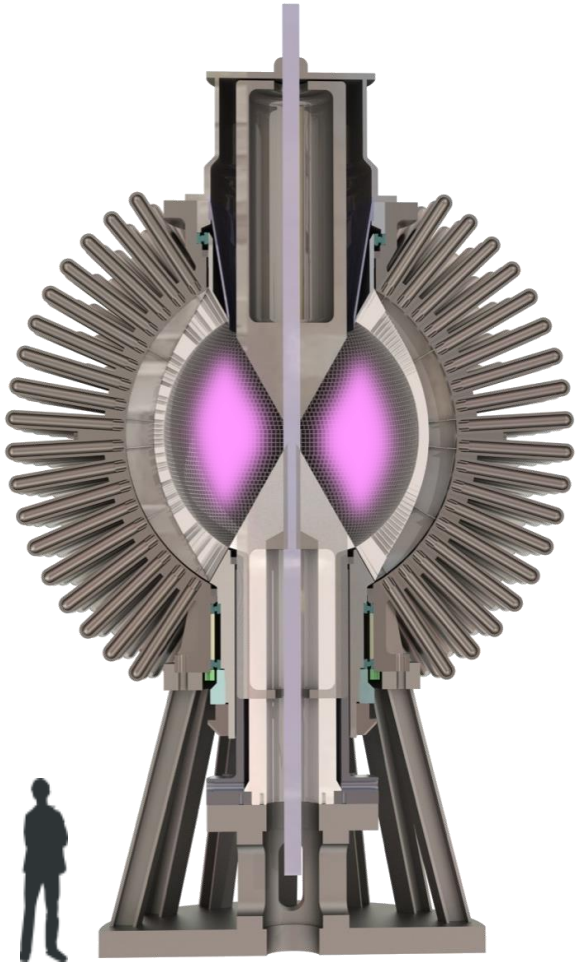
Static “Puddle”

Diagnostics:
Fast Camera
Rogowski Coils
Mirnov Coils
X-ray spectroscopy
Thomson Scattering
Interferometer



Rotation to Equator

GF Prototype: *2021*

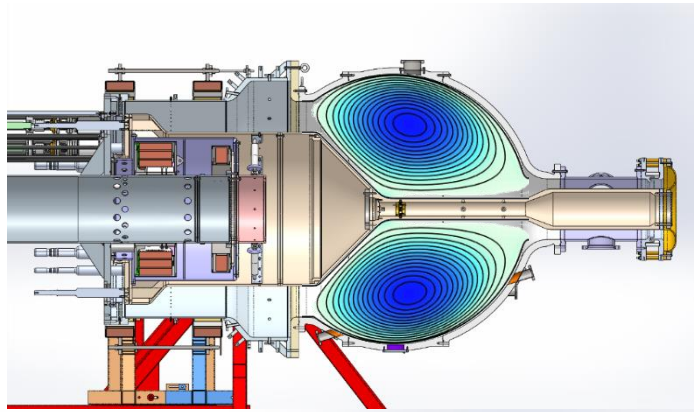


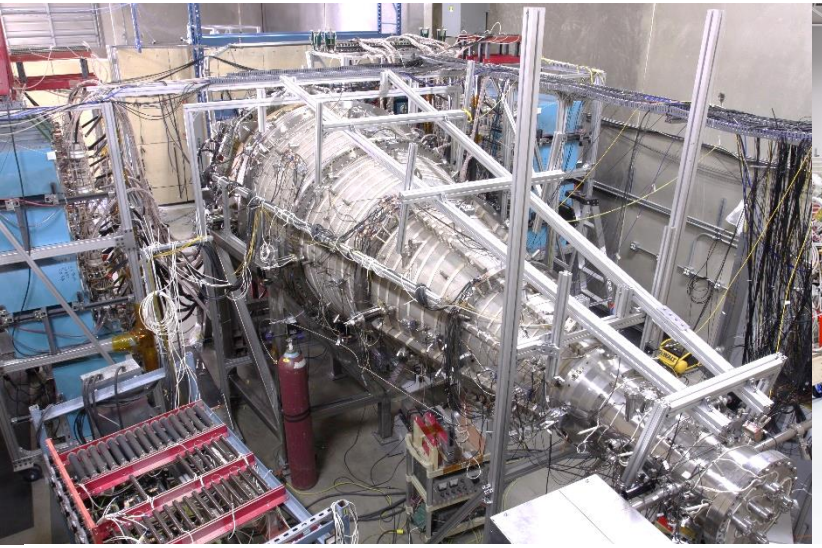
Large Plasma Injectors

Injectors built to a similar scale as expected for power plant

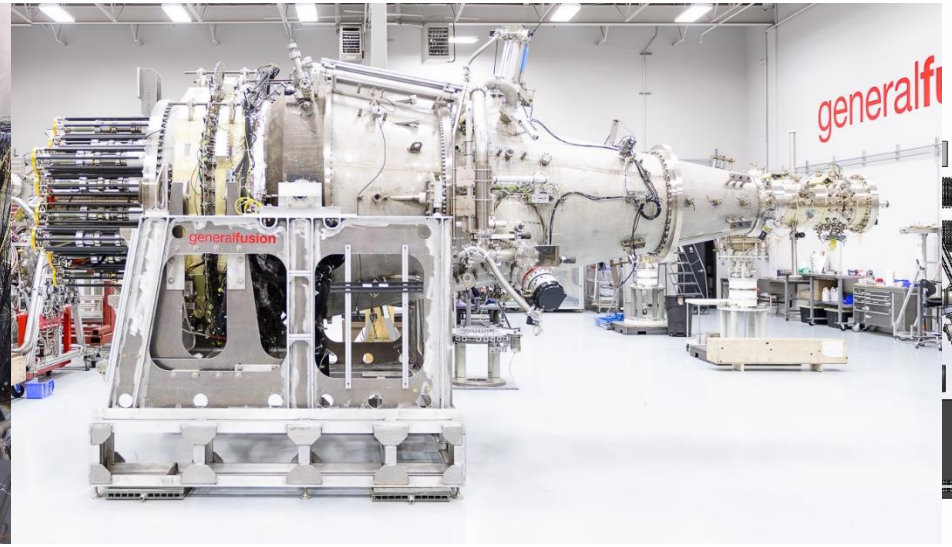
PI1 and PI2 demonstrated magnetic compression heating of a spheromak to over 300 eV and 3.2T magnetic fields

PI3 first plasma last week

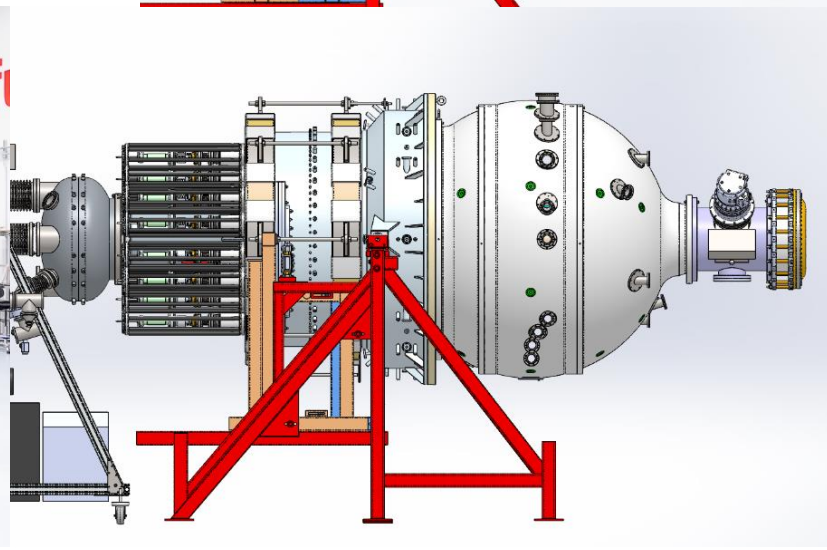




PI1



PI2



PI3

PI3 large injector

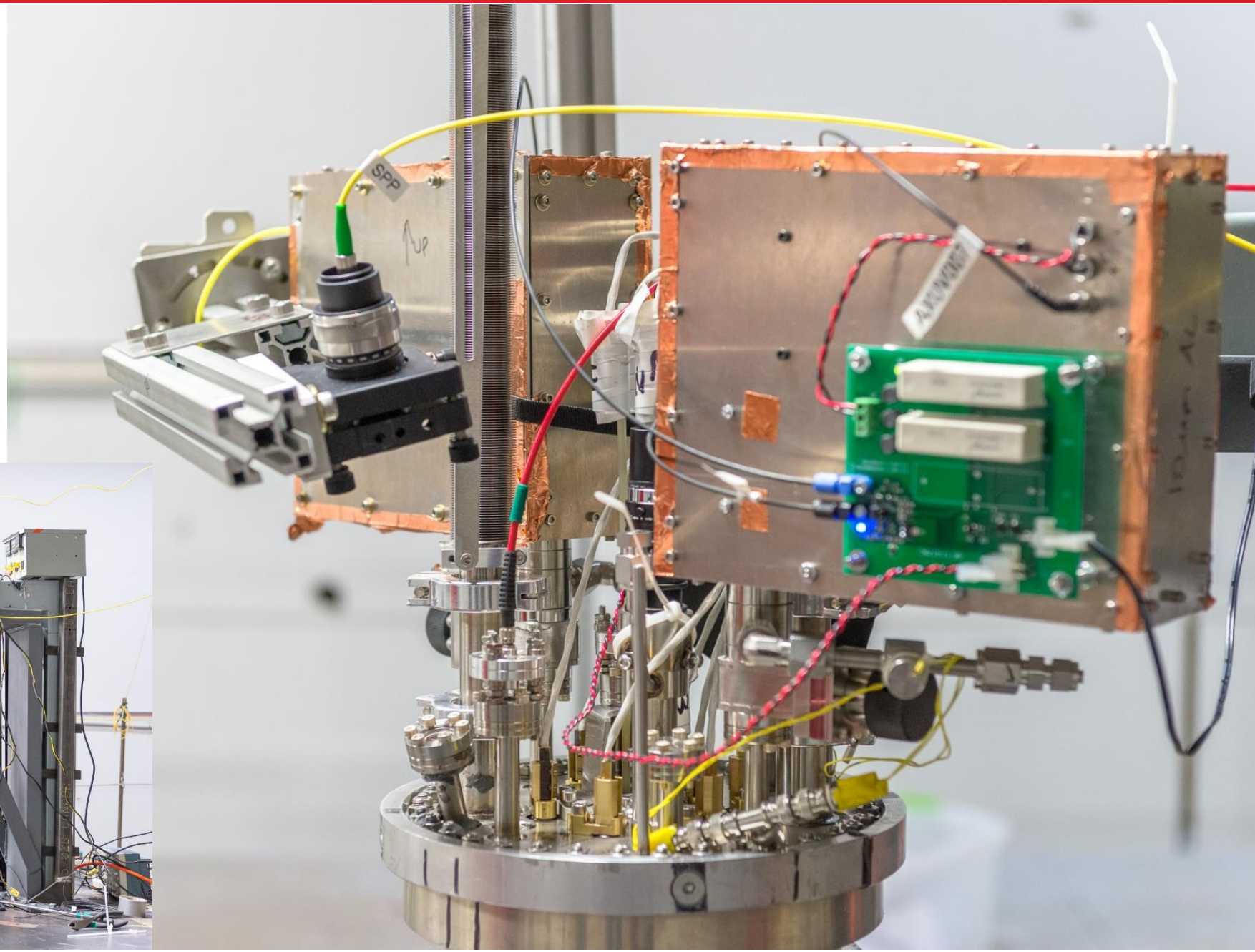
Spherical tokamak plasma target

10 MJ pulsed power supply

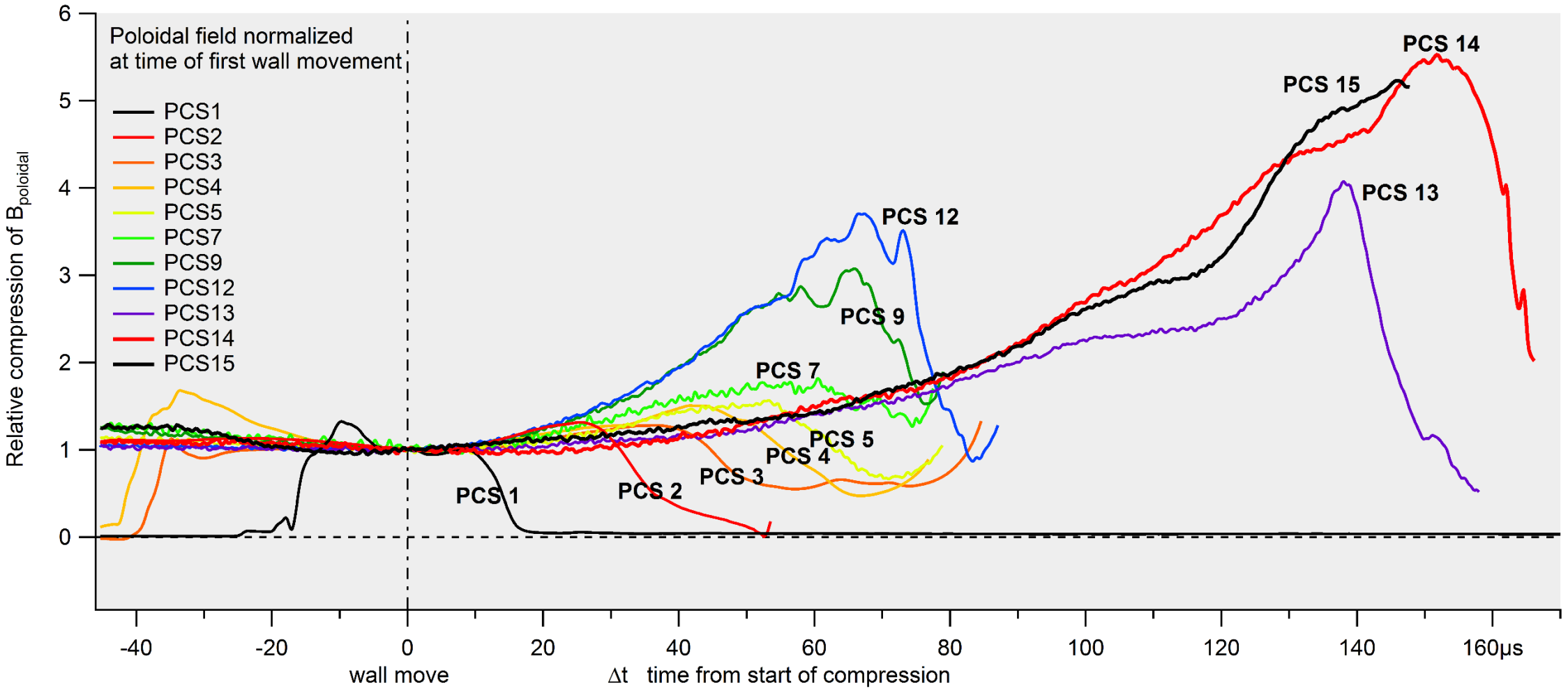
Vessel inner radius		1 m
Major radius	R	0.6 – 0.7 m
Minor radius	a	0.3 – 0.4 m
Poloidal flux	Ψ_{CT}	0.15 – 0.3 Wb
Plasma current	I_p	0.3 – 0.6 MA
Shaft current	I_s	1.0 – 1.3 MA
Plasma density	n_e	$2x10^{19} – 2x10^{20}$ m^{-3}
Temperature	$T_e \sim T_i$	100 – 500 eV
Beta	β	2% - 8 %

COMPRESSION TESTING

Diagnostics



All PCS Shots Normalized to B_z at Wall Move

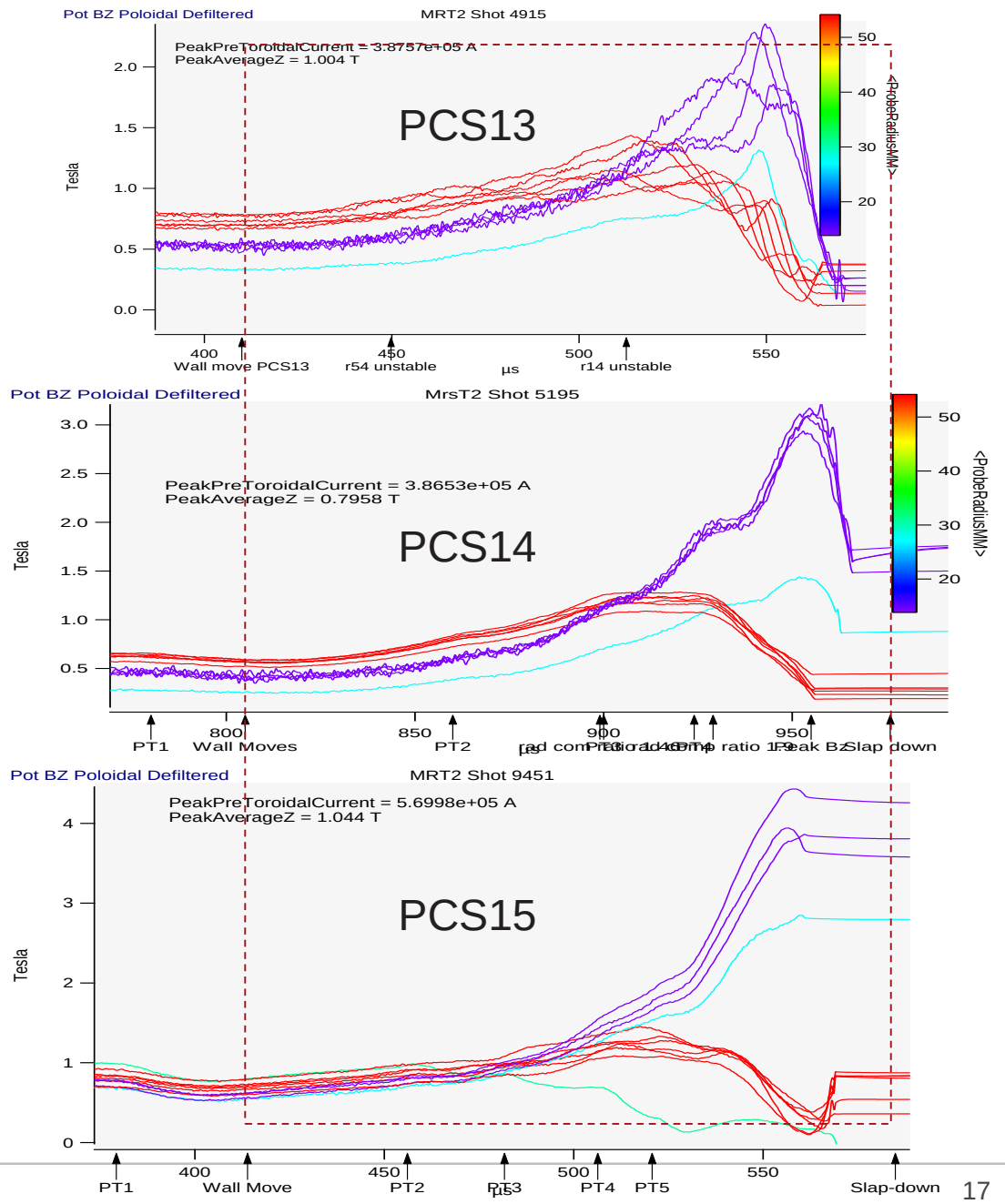


Summary of recent PCS shots:

PCS13: first shot with new spherical geometry.

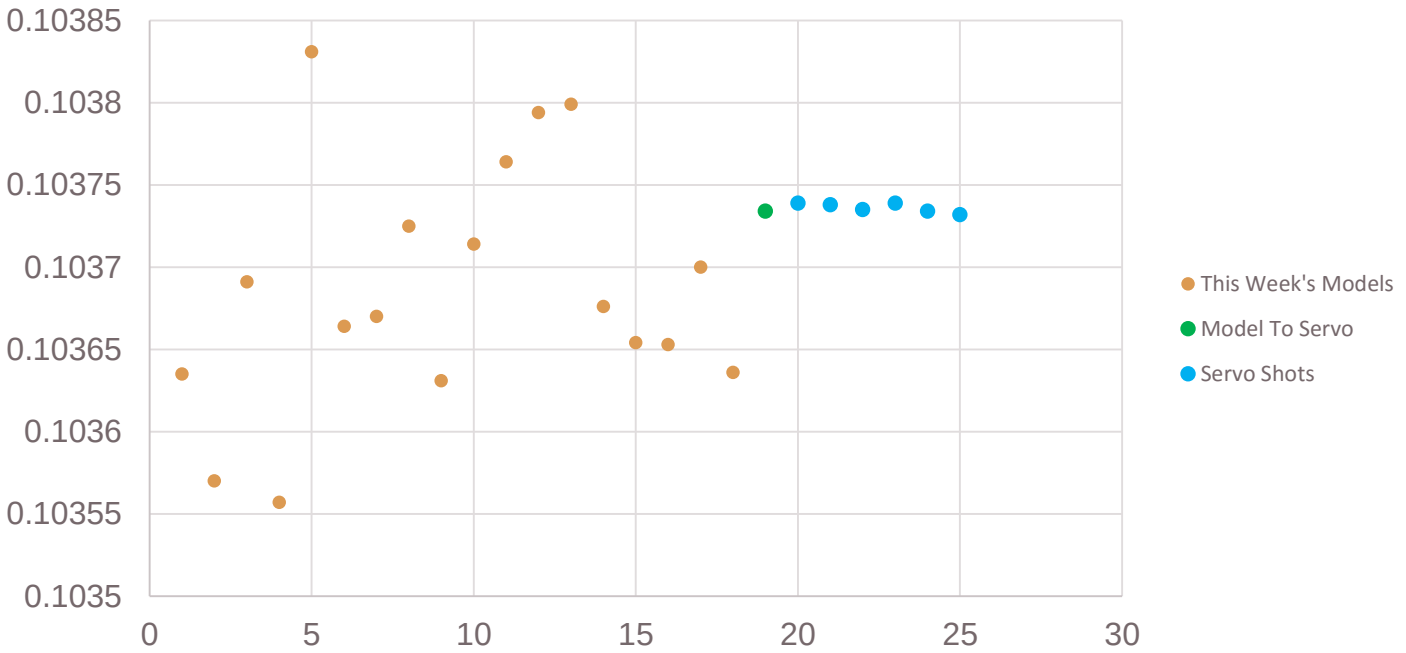
PCS14: Higher q, ramped shaft current, shot later to achieve a peaked lambda profile:

PCS15: Even higher q, shot earlier (motivated by hot ions), higher formation power.



COMPRESSION SYSTEM

Piston Driver Scalable Servo



All of the models we shot had a range of 274 µs

The Servo shots had a range of +5.0/-2.0 µs from their model

Integrated Prototype

Goals

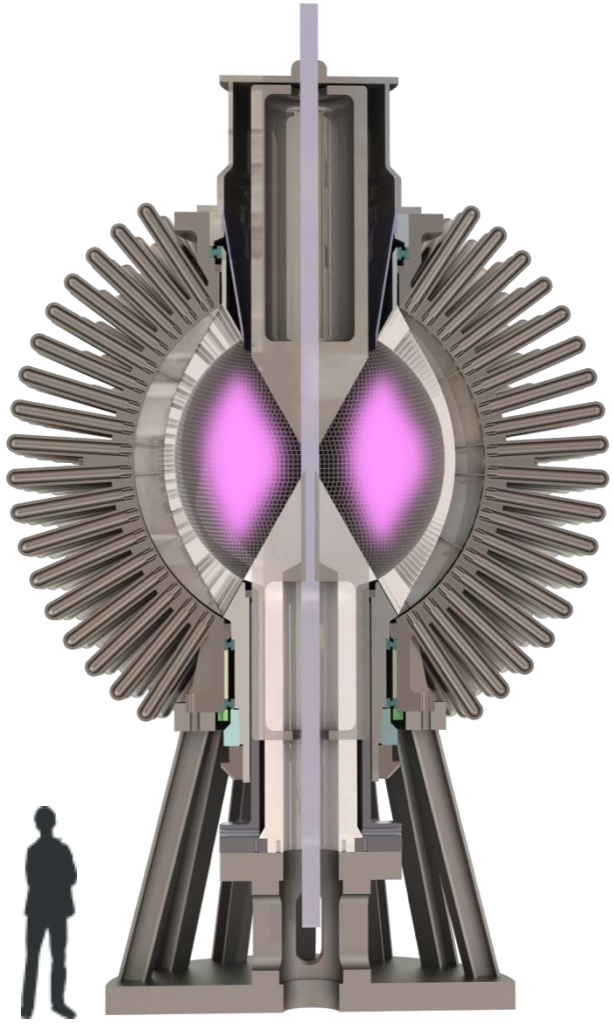
Demonstrate, at scale, that fusion conditions can be achieved using General Fusion's MTF technology

Strategy:

- Optimize performance with flexible operating envelope
- Modularize systems to permit rapid innovation

Key Features and Specifications:

- 3 meter diameter plasma
- 15-25 MJ of plasma formation bank
- Liquid lithium
- 3.5 ms compression time
- Up to 10:1 radial compression ratio
- 1 compression shot/day operating rate



QUESTIONS?

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