GENERAL FUSION

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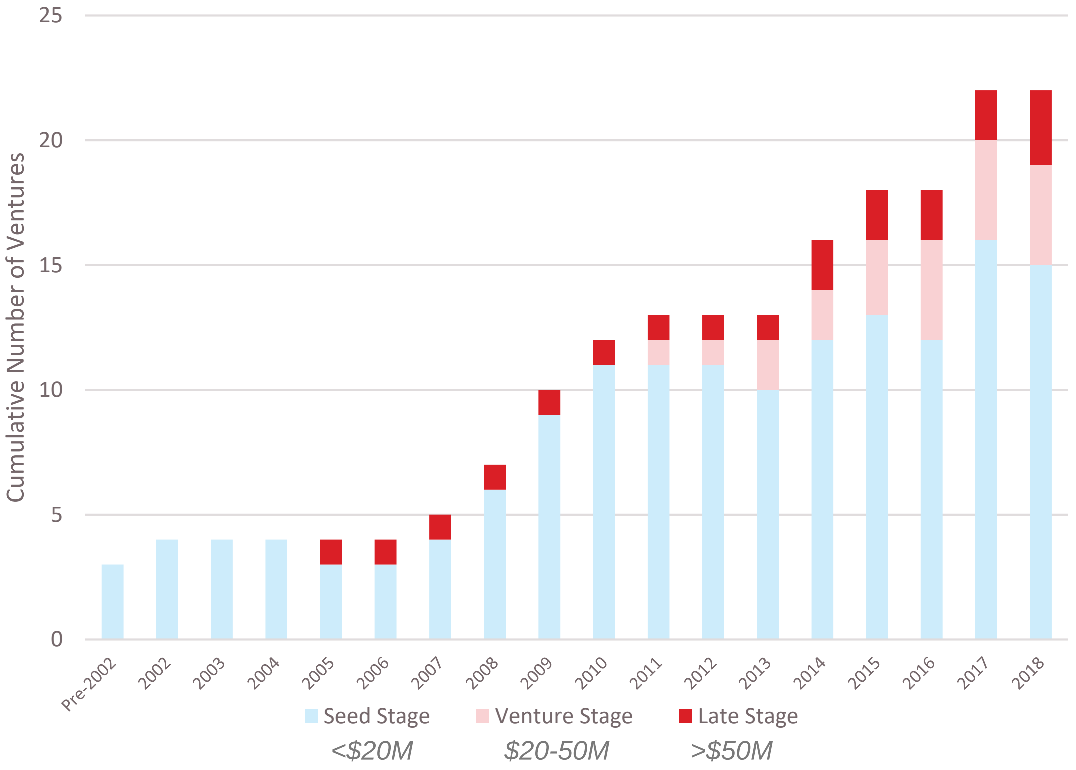
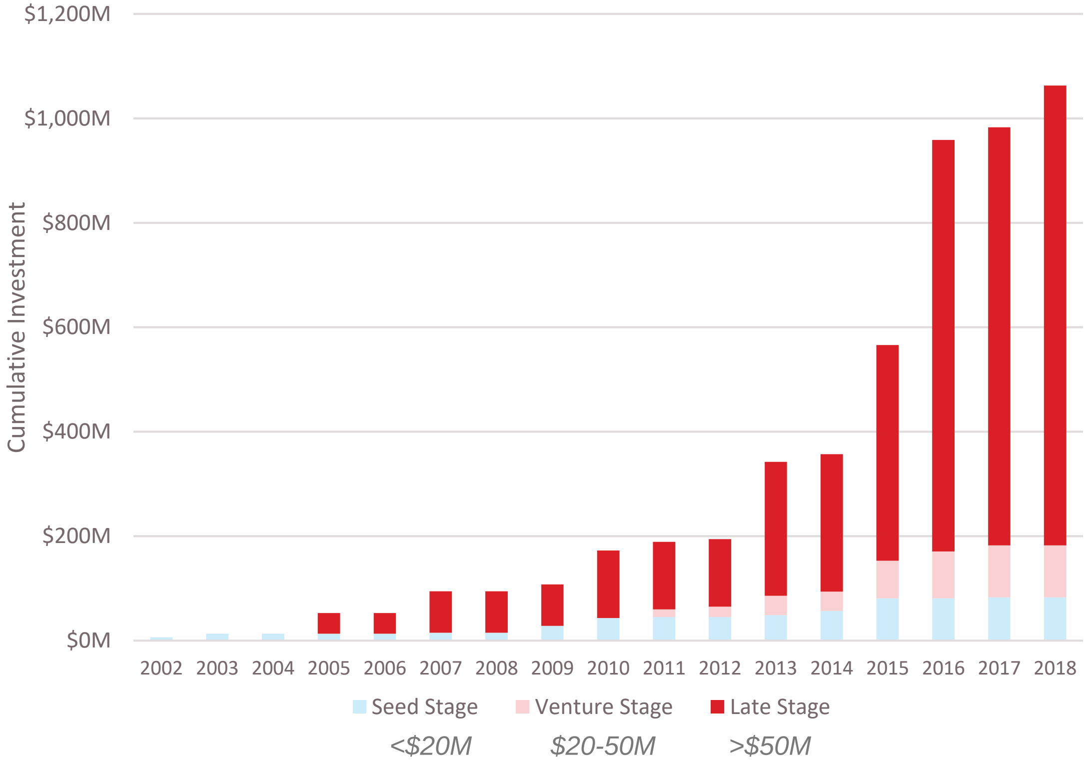
The rise of the private fusion company continues

Private Fusion Ventures

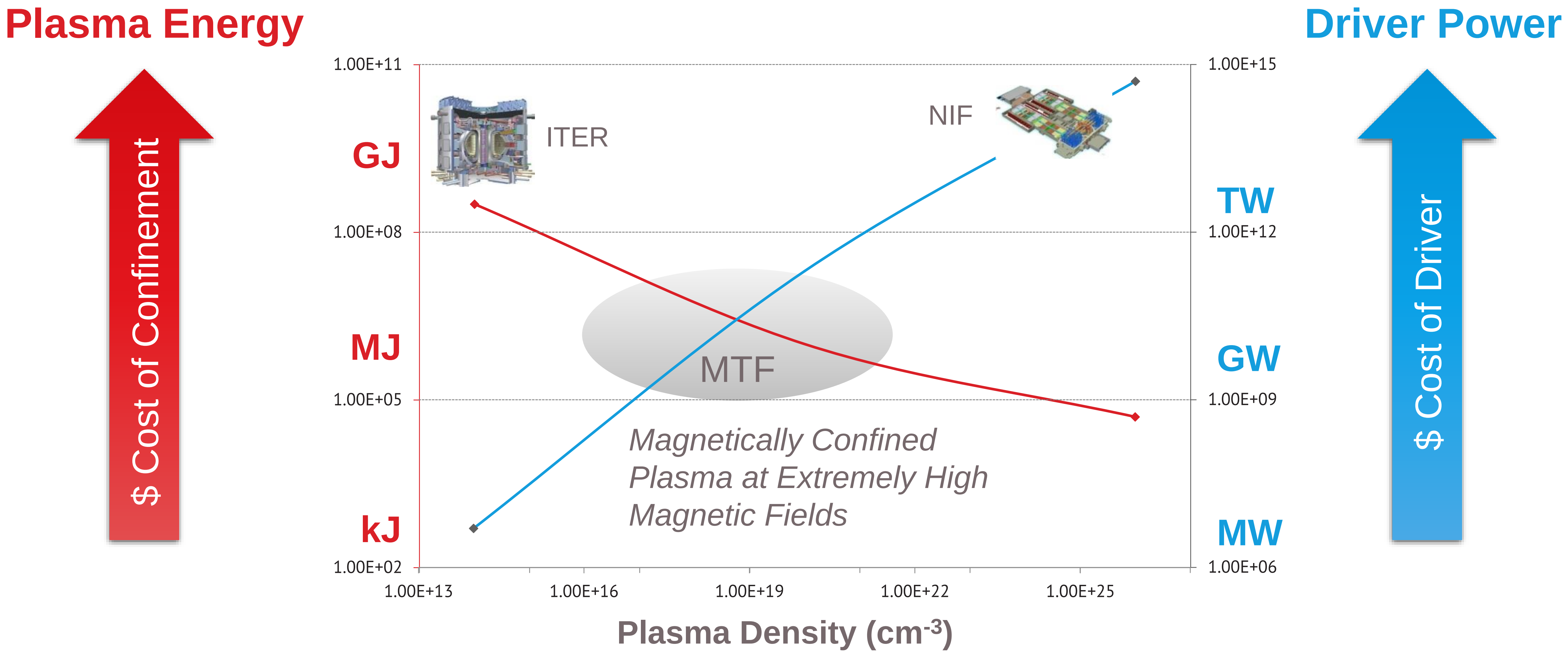


Investment in Private Fusion Ventures



Source: PitchBook, Crunchbase.

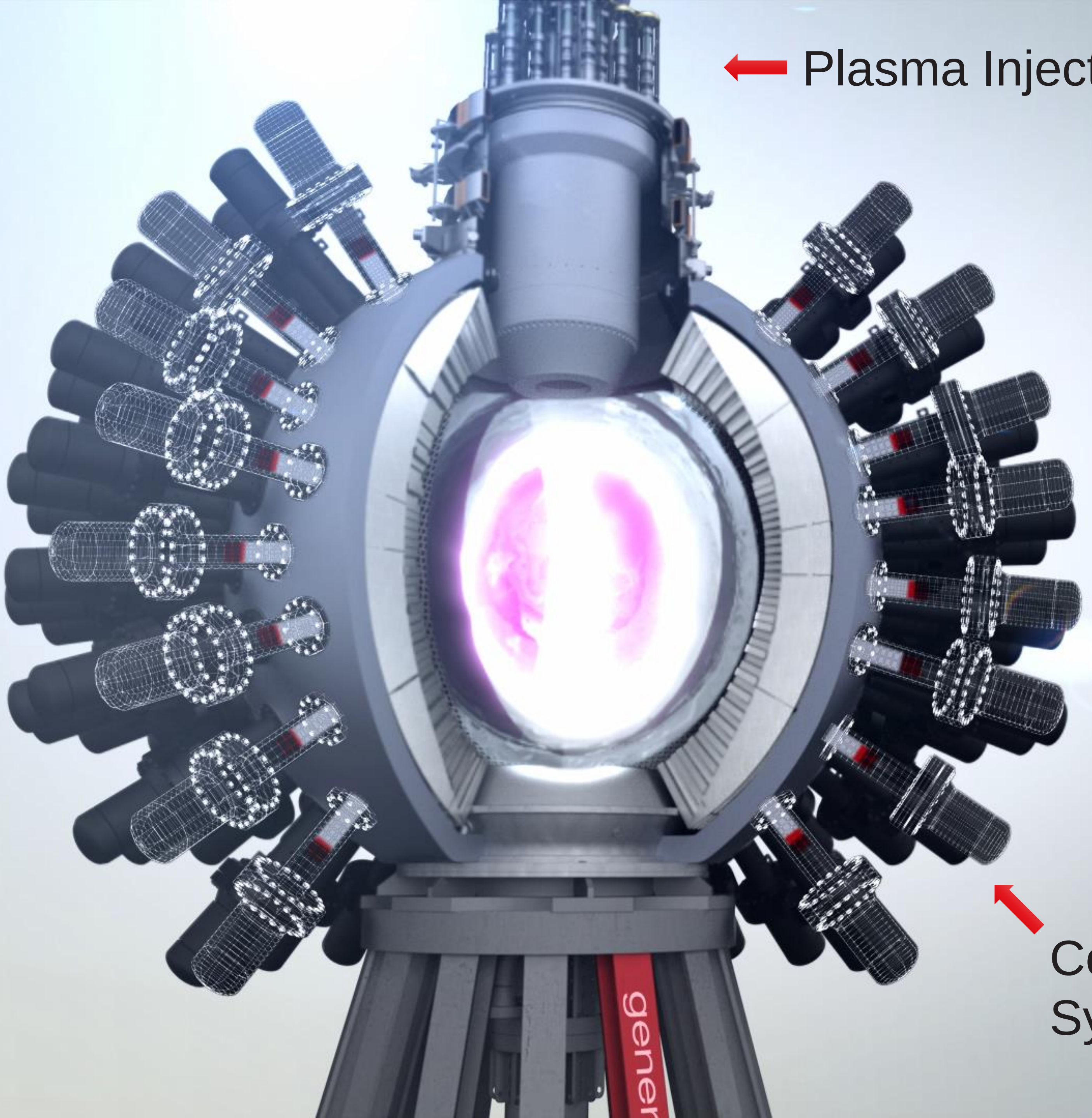
Many companies exploring density regime between MF and ICF



Background on General Fusion

Investors

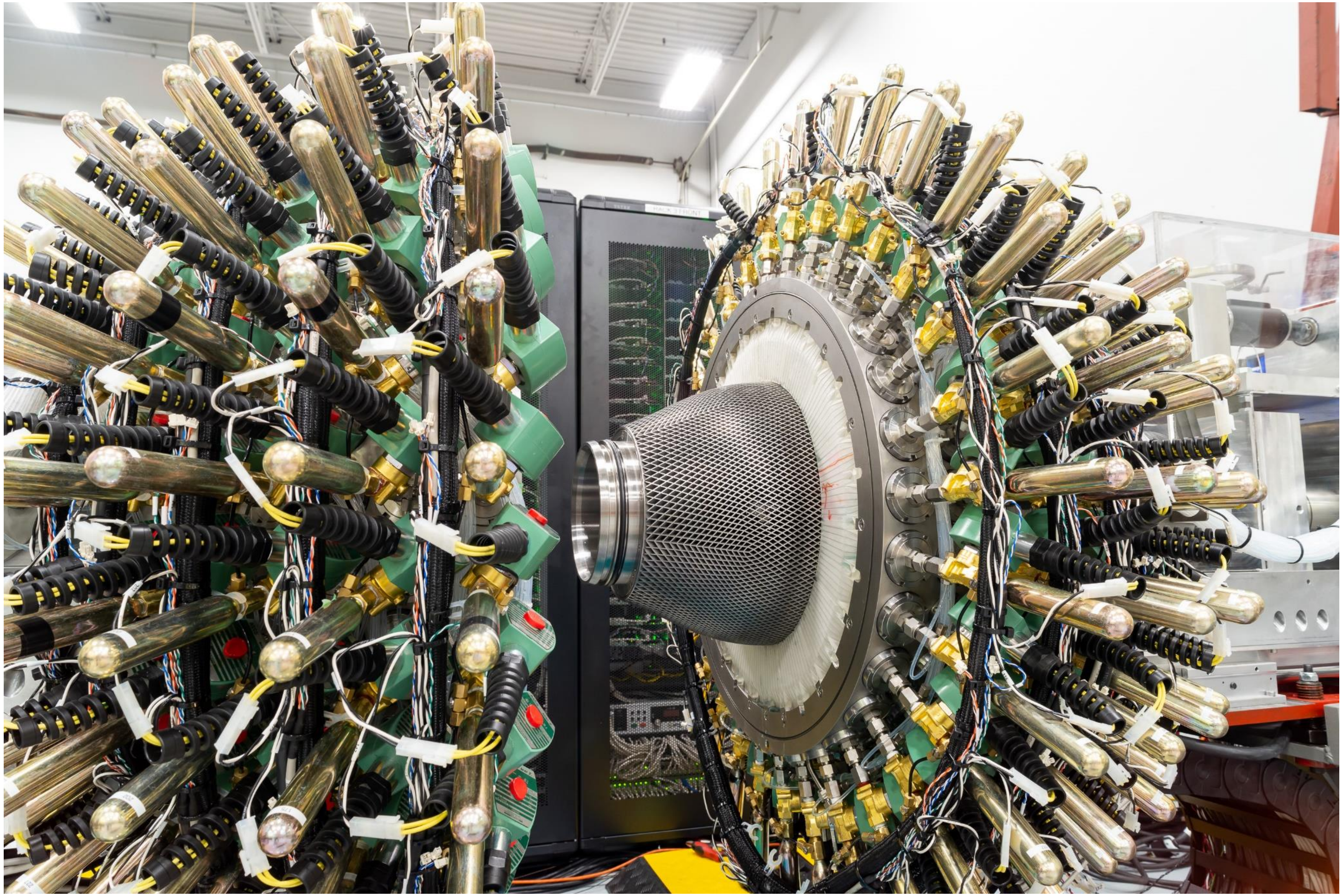
- Total invested capital of $110 million USD
- 20% funded by Canadian government
- 80 employees


Plasma Injector
Compression System

Parameter	Initial	Final
Plasma Density (n)	2e^{20} m^{-3}	6.5e^{22} m^{-3}
Plasma Temperature (T)	1.3 keV	38 keV
Compression Ratio	1	6.5
Outside Radius of Liquid Metal Flux Conserver	2.2 m	0.34 m
Aspect Ratio (A) = R/a	1.6	2.4
Plasma Current (I_p)	4.7 MA	47 MA
Center Shaft Current (I_s)	7 MA	76 MA
Magnetic Field on Axis (B_0)	1 T	63 T
Magnetic Field on shaft surface (B_{shaft})	2.8 T	100 T
Beta (b)	15%	40%
Thermal Energy (E_{th})	4 MJ	133 MJ
Magnetic Energy (E_m)	28 MJ	378 MJ
Confinement required (c)	4 m^2/s	4 m^2/s
Fusion Yield	0	488 MJ

Advantages

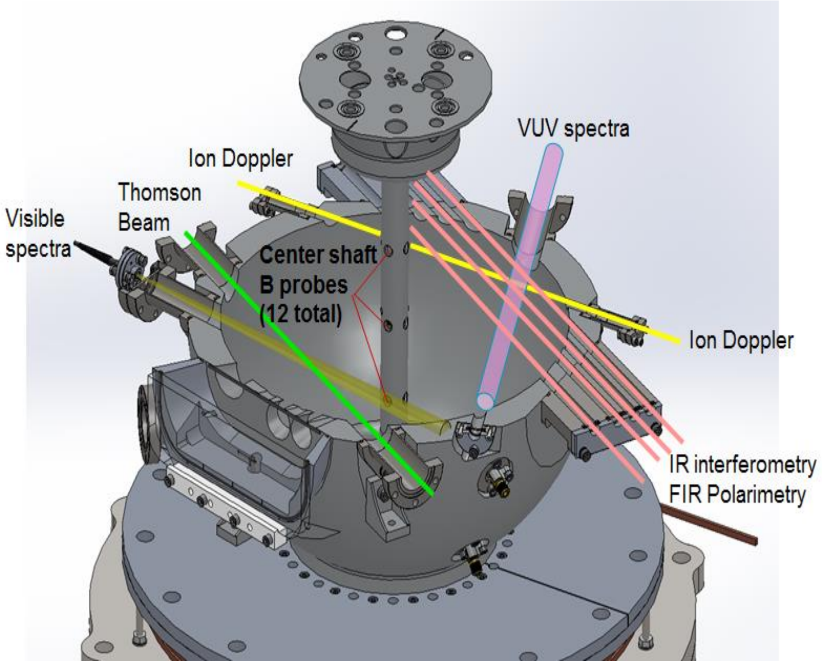
- Full coverage by 2 m of PbLi shields all solid structure, no neutron damage problems to structure
- Tritium Breeding ratio of 1.4 with natural Li
- No heat load issues on divertor or any metal surface, only liquid sees high energy plasma
- Straightforward energy extraction from the hot liquid liner through a heat exchanger
- Energy from inexpensive gas pistons leading to attractive economic
- No poloidal or toroidal superconductor coils
- No RF or neutral beam auxiliary heating
- No laser or particle beams
- No expensive target to replace

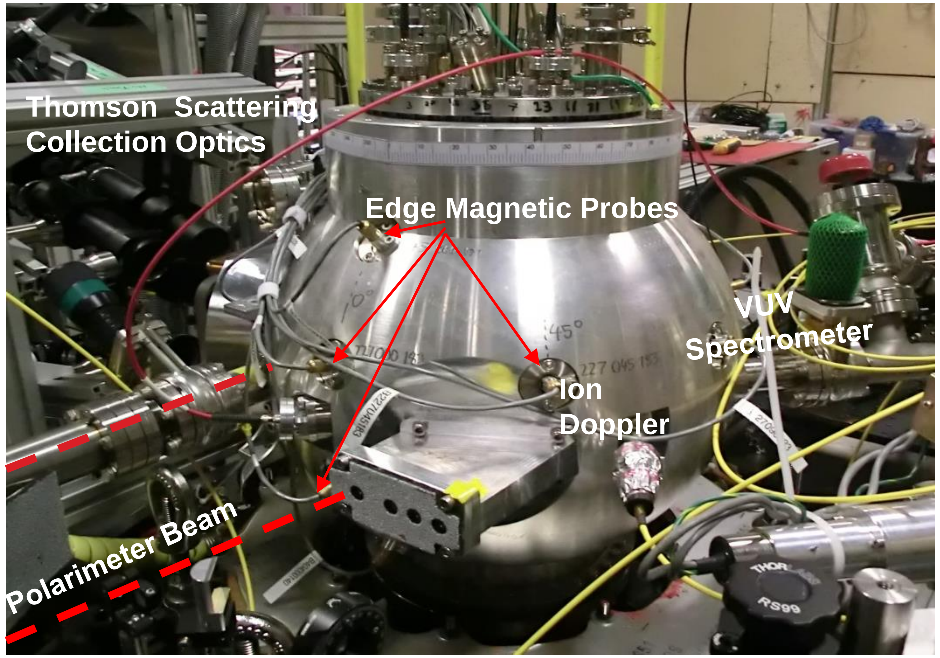


Spherical liquid compression experiment with 3D printed rotor and stator

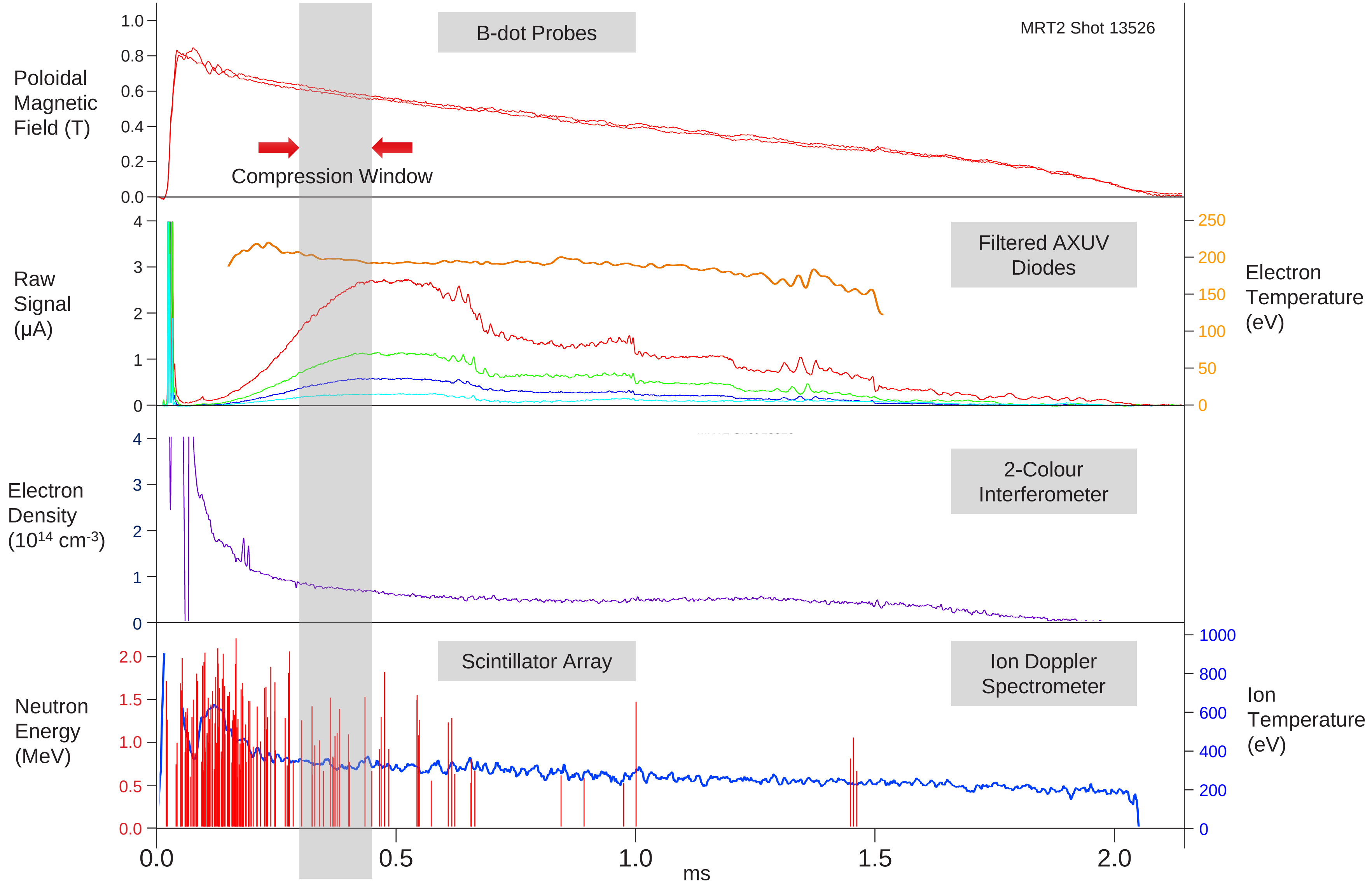
Well-Diagnosed Laboratory Small Spherical Tokamak
100 % CHI

- 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





Achieving Target Performance Within Compression Window

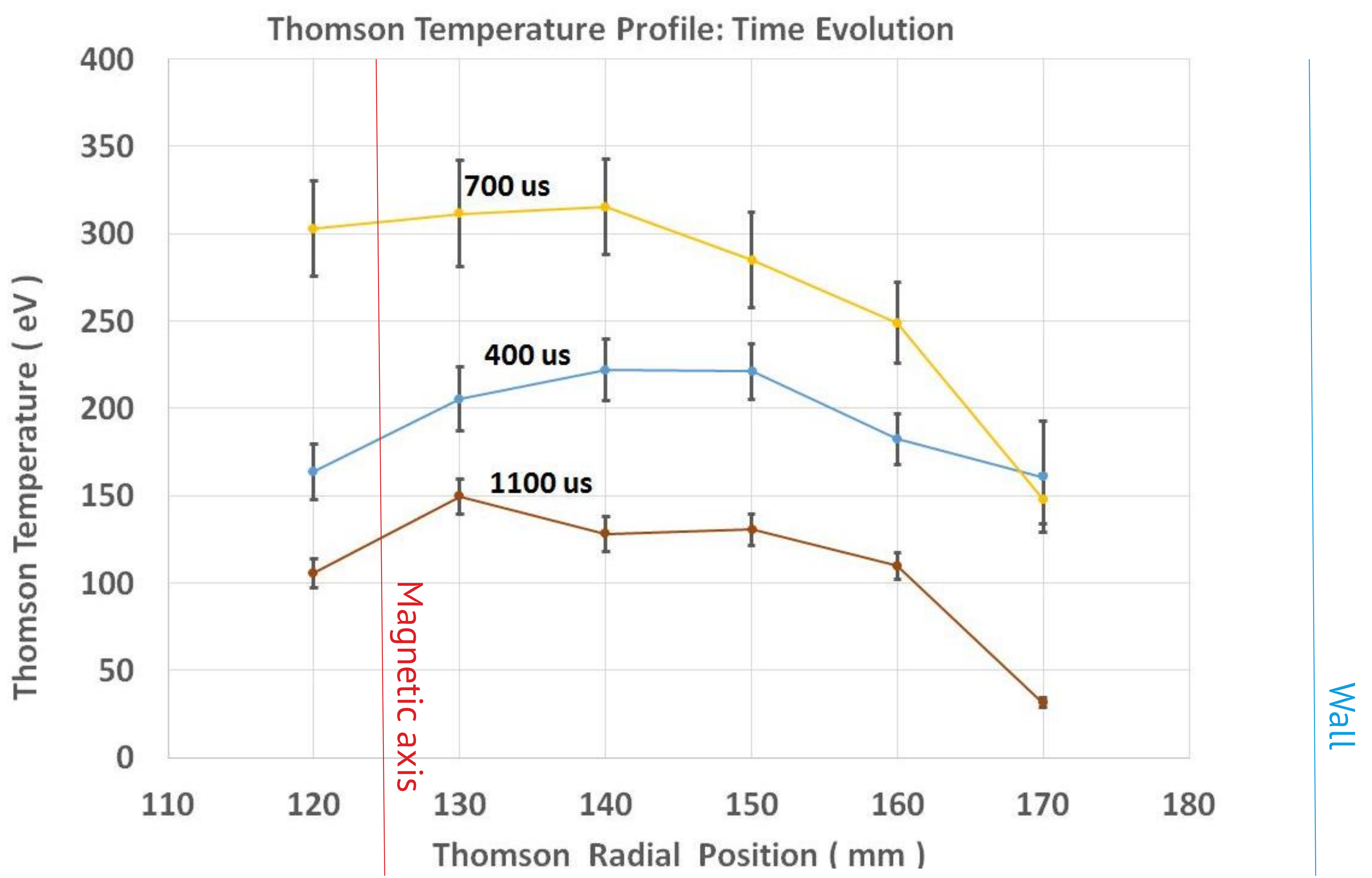


Self-organized plasmas evolve continuously after formation

General Fusion experience with injector design and operation enables tuning of desired plasma properties within a selected compression window

Example:

- MHD stability
- Ion, electron temperatures >200 eV
- Density 0.7×10^{14} cm^{-3}
- Strong AXUV, scintillator signals
- q profile, lambda profile (not shown)



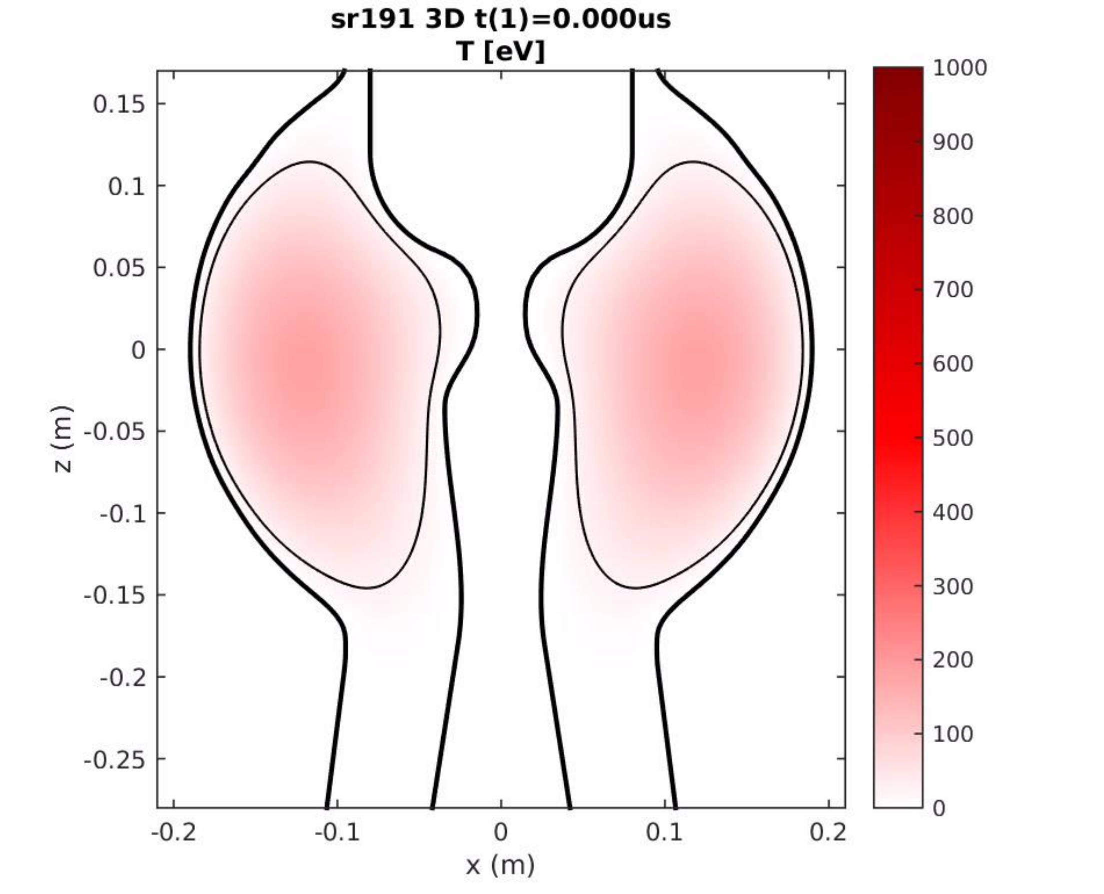
Thomson Temperature Profile: Time Evolution
Thomson Temperature (eV)
Thomson Radial Position (mm)
400
350
300
250
200
150
100
50
0
110
120
130
140
150
160
170
180
700 us
400 us
1100 us
Magnetic axis
Wall

Plasma Compression Science: Field Tests Explore Key Physics

Chemical driver compresses a magnetized plasma with an aluminum liner

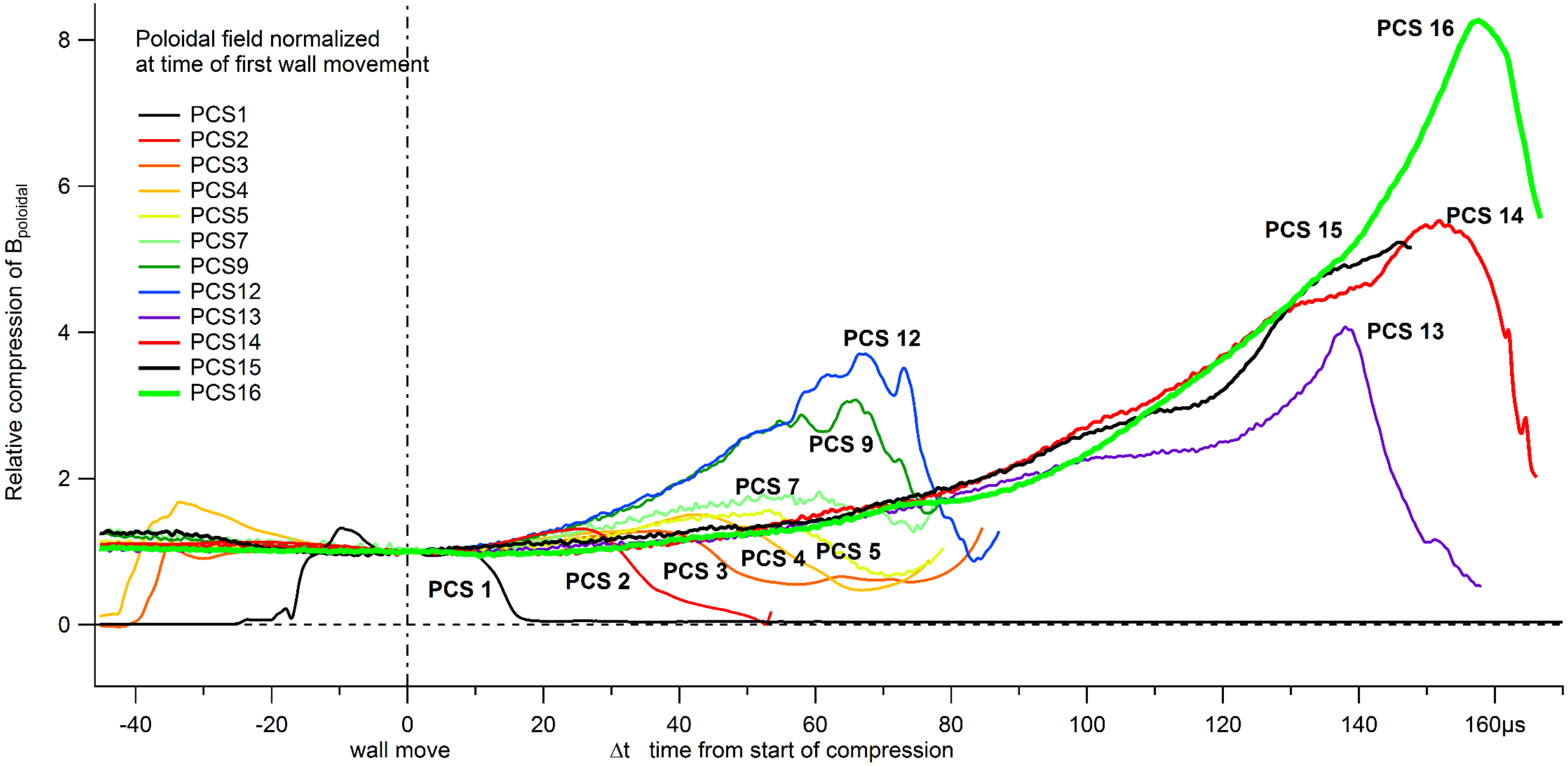
Goals:

- Demonstrate plasma MHD stability in compression
- Demonstrate compression heating



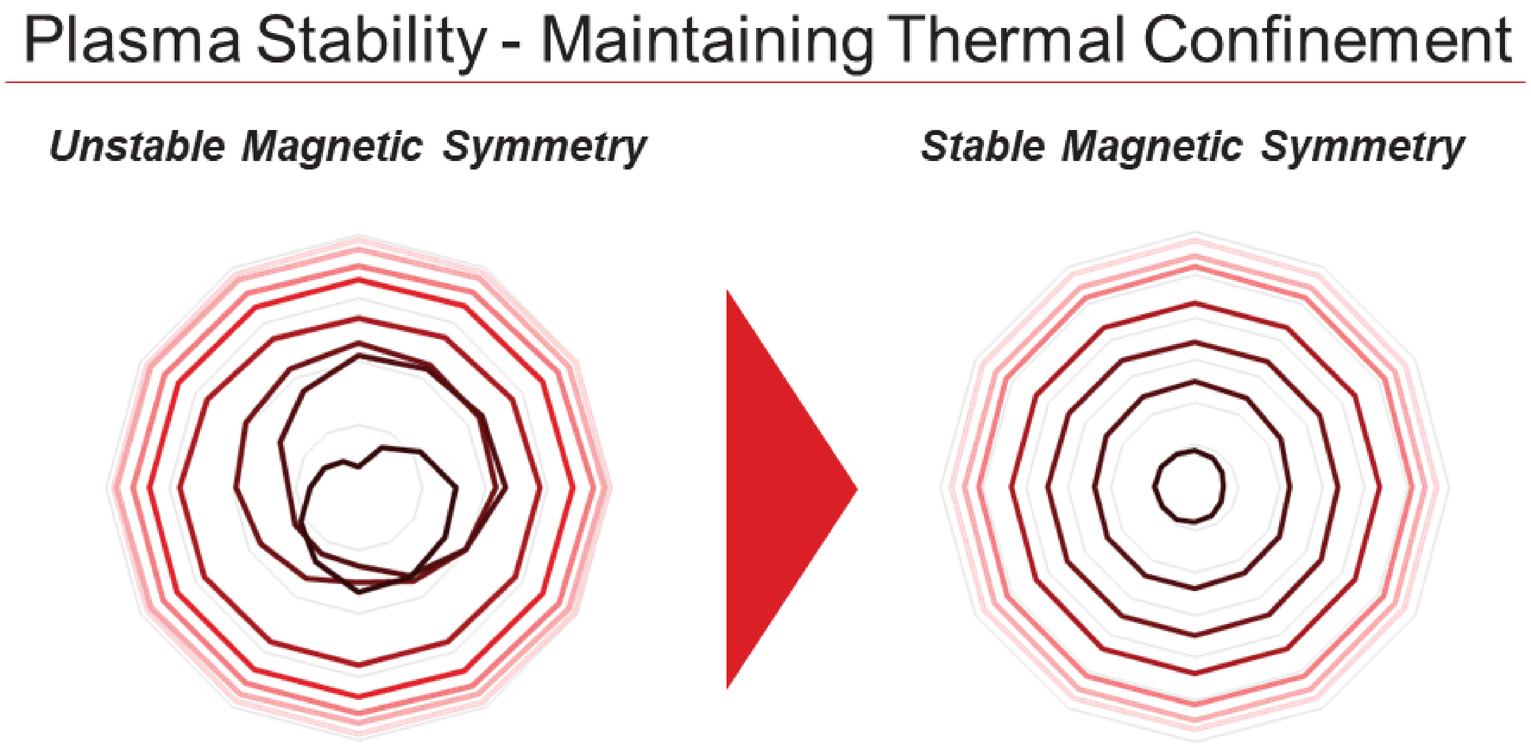
Consistent Progress in Magnetic Compression

16 PCS Shots, 2012-2018



Plasma Compression

- Mechanical compression of magnetized plasma
- Recent experiments show good magnetic stability



PI3 Large Injector: Prototype Relevant Design, Performance

Goals, at Prototype-relevant scale:

- Validate plasma performance
- Develop and demonstrate technology

Spherical tokamak plasma target

500% increase in radius from our small spherical tokamak

10 MJ pulsed power supply

Presently commissioning

Vessel inner diameter		2 m
Major radius	R	0.6 – 0.7 m
Minor radius	a	0.3 – 0.4 m
Plasma current	I_p	0.8 MA
Shaft current	I_s	1.6 MA
Plasma density	n_e	$2 \times 10^{19} – 2 \times 10^{20}$ m^{-3}
Temperature	$T_e \sim T_i$	100 – 500 eV

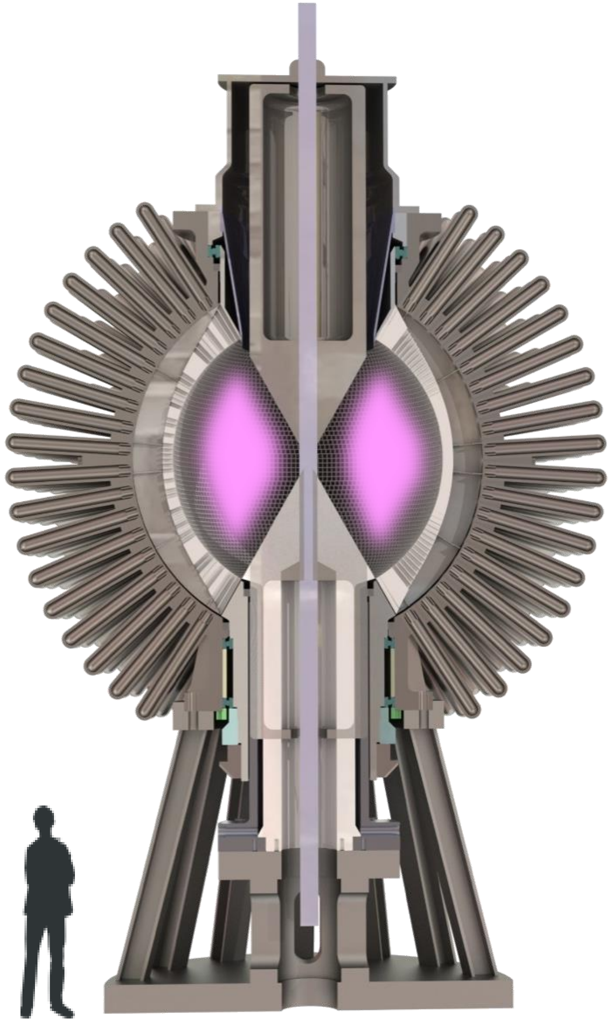
Next Prototype

Strategy

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

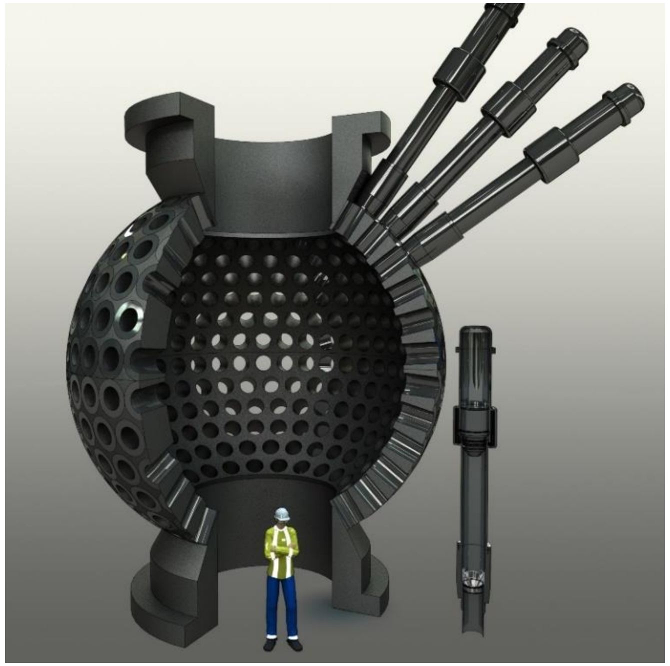
Key Features and Specifications

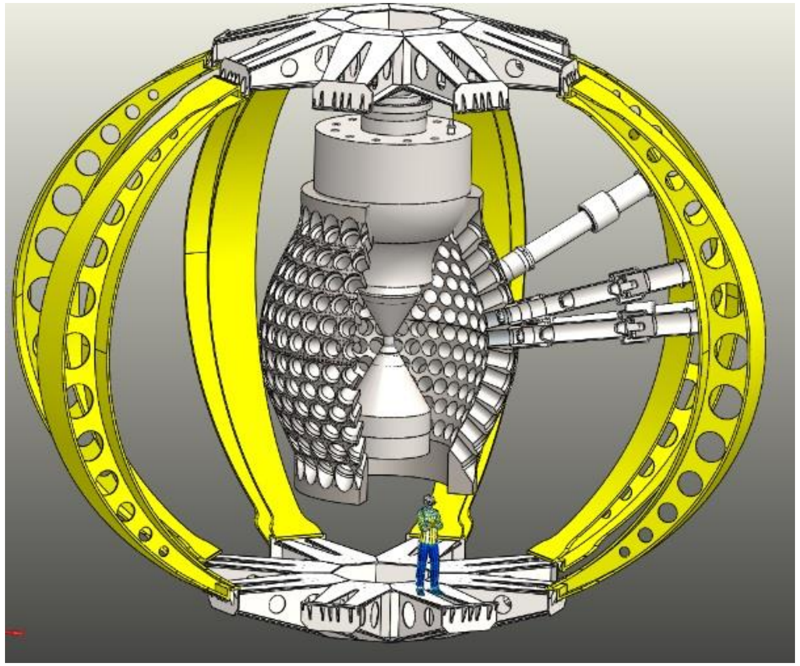
- 3 meter Diameter Plasma (~70% power plant scale)
- 15 - 25 MJ Plasma Formation Bank
- MAST, SSPX equivalent starting plasma
- Liquid Lithium
- D-D
- 3.5 - 4 ms Compression Time
- Up to 10:1 Radial Compression Ratio
- Designed for 1 Compression Shot / Day Operating Rate
- 10 KeV, 10% of Lawson



Compression Systems

- 346 drivers (pistons)
- Lithium liquid metal (~9 tons)
- Superstructure supports center shaft, cones, plasma injector





Vessel Inner Radius: 1.95 m

Liquid Lithium Temperature: 350 ºC

Liquid Lithium Volume: 17 m^3

Pressure Pulse: 30 MPa over 2 ms

Conclusion

- Sufficient plasma formation performance has been achieved
- Piston and servo control systems are working fine
- Plasma compressions tests are producing good results
- We are planning to build a large integrated liquid metal prototype, aiming for temperatures of 10 keV and 10% of Lawson
- MAST, NSTX class initial plasma, compressed 10X linear
- 5 ½ years design, build ,operate

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