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: \( \sim 10^{14} \text{ ions/cm}^3 \)
- Continuous operation

### Magnetized Target Fusion
Combination of compression and magnetic confinement
- Medium density: \( \sim 10^{17} \text{ ions/cm}^3 \)
- Pulsed: \( \sim 1 \text{ ms} \)

### Inertial Confinement
Very fast compression using high power lasers or ion beams
- Very high density: \( \sim 10^{26} \text{ ions/cm}^3 \)
- Pulsed: \( <1 \text{ ns} \)
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
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
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

PeakPreToroidalCurrent = 3.7861e+05 A
PeakAverageZ = 0.74953 T
PlumbersQPeaks = 505.13 kA/T
SPECTOR Electron Temperature

Thomson scattering and AXUV photodiode array indicate electron temperatures ~300 eV
Plasma Formation onto Liquid Metal

**MiniSLIC**: Operating Now
- No Plasma
- Pulsed Current
- Pulsed Magnetic Field
- Liquid Lithium Free Surface

**SLIC**: 2018
- CHI Plasma Formation
- Liquid Lithium Free Surface

**GF Prototype**: 2021

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

Static “Puddle”

Rotation to Equator
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
## PI3 large injector

Spherical tokamak plasma target

10 MJ pulsed power supply

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel inner radius</td>
<td>1 m</td>
</tr>
<tr>
<td>Major radius</td>
<td>R 0.6 – 0.7 m</td>
</tr>
<tr>
<td>Minor radius</td>
<td>a 0.3 – 0.4 m</td>
</tr>
<tr>
<td>Poloidal flux</td>
<td>$\Psi_{CT}$ 0.15 – 0.3 Wb</td>
</tr>
<tr>
<td>Plasma current</td>
<td>$I_p$ 0.3 – 0.6 MA</td>
</tr>
<tr>
<td>Shaft current</td>
<td>$I_s$ 1.0 – 1.3 MA</td>
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<tr>
<td>Plasma density</td>
<td>$n_e$ $2\times10^{19}$ – $2\times10^{20}$ m$^{-3}$</td>
</tr>
<tr>
<td>Temperature</td>
<td>$T_e \sim T_i$ 100 – 500 eV</td>
</tr>
<tr>
<td>Beta</td>
<td>$\beta$ 2% - 8%</td>
</tr>
</tbody>
</table>
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.
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
CLEAN ENERGY. EVERYWHERE. FOREVER.