Progress towards liquid metal plasma compression at General Fusion

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General Fusion (GF) is working to build a magnetized target fusion (MTF) power plant based on compression of magnetically-confined plasma by liquid metal [1]. This effort is being supported by experiments on SPECTOR (R=12 cm, a=9 cm), construction and commissioning of PI3 (R=60 cm, a=40 cm), and design of an integrated prototype (R=95 cm, a=70 cm). All are spherical tokamak devices in which a compact toroid is formed by direct coaxial helicity injection and sustained by driving shaft current to maintain toroidal magnetic field. SPECTOR and PI3 have solid Al flux conservers that are gettered with Li. The integrated prototype will have a liquid Li flux conserver that will be pressurized to compress the plasma on a 1 ms timescale.

There have been 4 machines with the SPECTOR design geometry. SPECTOR-1 is a laboratory-based machine used to develop diagnostics, such as edge Mirnov coils, soft X-ray electron thermometers, CO_2 interferometers, spectrometers, scintillators, a six-point Thomson scattering laser system, and a Faraday rotation polarimeter. Measurements correlated between the soft X-ray and Thomson systems indicate 300 eV electron temperatures can be maintained in excess of 500 μs. SPECTOR-2, -3, and -4 were field machines designed to compress the plasma by imploding their Al flux conserver to observe the effect on confinement physics. Heating in these tests was measured by soft X-ray, ion Doppler, and neutron diagnostics. These results and their comparison to simulations will be presented. Confinement performance in the SPECTOR compression experiments and scaling laws from operating the larger PI3 will inform the design of the integrated prototype.

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