Accelerated Taylor State Plumes on SSX

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The typical plasma parameters of the Taylor plumes* in the SSX plasma wind tunnel are as follows: density $\approx 10^{15}\ cm^{-3}$, ion temperature $\approx 20\ eV$ and velocity $\approx 30 - 100\ km/s$. For producing a high velocity dense plasma, the Taylor plumes will be accelerated to over 100 km/s using pulsed theta pinch coils and will further be compressed to $10^{16}\ cm^{-3}$ using a stagnation flux conserver. For accommodating the pulsed theta pinch coils, the SSX device is modified by the addition of a 1 m long glass extension. In this configuration, the Taylor plumes are launched from a magnetized plasma gun and are allowed to flow to the main expansion volume downstream of the glass extension tube. The time of flight (TOF) measurements of these plumes are carried out during their passage through glass tube using a linear array of $\dot{B}$ probes (separated by 10 cm). With the glass boundary, the typical velocity of the unaccelerated Taylor plumes from TOF is found to be 25 km/s, accompanied by a fast plasma (50 km/s) at the leading edge. Magnetic field of the Taylor plumes in the expansion chamber is measured using a three-dimensional array of $\dot{B}$ probes and is found to be 700 G. The proton density of the plumes is measured in the expansion volume using a precision quadrature HeNe laser interferrometer and is found to be $\approx 6 \times 10^{14}\ cm^{-3}$. Ion temperature will be measured using a fast time response high resolution spectrograph which makes use of an echelle grading and a 32-channel photomultiplier tube to analyse the line shape of C III (impurity) ion at 229.687 nm. Some flux conservation of the Taylor plumes is provided by using a resistive liner (soak time = 3 μs) and a mesh flux conserver(soak time = 170 μs > discharge time) around the glass tube for improving the downstream Taylor state velocity, density and magnetic field. The results from all these different boundary conditions will be presented.

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