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Performance of the plasma source and heating concept for the Prototype-Material Plasma Exposure eXperiment (Proto-MPEX)

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The Material Plasma Exposure eXperiment (MPEX) is a planned linear plasma device to address plasma-material interactions for future fusion reactors. Its concept does foresee the capability to expose apriori neutron irradiated material samples to fusion reactor grade divertor plasmas. This new capability will be unique world-wide addressing important research needs in the area of fusion nuclear science. It will be an evolution to current operating steady-state linear plasma devices, which are limited either in plasma fluxes they can deliver to the material targets or plasma temperatures (for ions and electrons) they can reach in front of the material targets. The concept of MPEX does foresee a combination of a high-power helicon plasma source with microwave electron heating and ion cyclotron resonance heating. This source and heating concept is being tested on the Prototype-Material Plasma Exposure eXperiment (Proto-MPEX). With 100 kW helicon power a plasma density of 8e19 m-3 was achieved, which is about a factor 2 more than required for MPEX. Electon heating was pursued with a 28 GHz gyrotron. A maximum power of 50 kW was delivered to the plasma, which is produced by the helicon. At this frequency, the plasma is overdense in the plasma center (> 1e19 m-3). Maximum electron temperatures of 20 eV have been achieved under those overdense plasma conditions with Electron Bernstein Wave EBW) heating. This is almost the electron temperature required for MPEX (25-30 eV). Ion cyclotron heating (ICH) was performed in the frequency range of 6 - 12 MHz with a low power ICH antenna able to launch about 25-30 kW of power. Without ICH, the ion temperature is about 2-4 eV. With ICH ion temperatures of 8-12 eV were measured. The ion fluxes to the target are about 5e23 m-2s-1. The plasmas produced by the helicon antenna have been modeled extensively with a fluid plasma code, coupled to a Monte-Carlo neutral code (B2-Eirene). The plasma transport can be well explained by this fluid approach and a radial diffusion coefficient consistent with Bohm-like transport. The transport of auxiliary heated plasmas (ECH/EBW and ICH) is currently being investigated and experimental results of this investigation will be presented.

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