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Developing the Science and Technology for the Material Plasma Exposure eXperiment (MPEX)

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Linear plasma generators are cost effective facilities to simulate divertor plasma conditions of present and future fusion reactors. They are used to address important R&D gaps in the science of plasma material interactions and towards viable plasma facing components for fusion reactors.
Next generation plasma generators have to be able to access the plasma conditions expected on the divertor targets in ITER and future devices. The steady-state linear plasma device MPEX will address this regime with electron temperatures of 1 –10 eV and electron densities of 10^{21} –10^{20} m^{-3}. The resulting heat fluxes are about 10 MW/m2. MPEX is designed to deliver those plasma conditions with a novel Radio Frequency plasma source able to produce high density plasmas and heat electron and ions separately with Electron Bernstein Wave (EBW) heating and Ion Cyclotron Resonance Heating (ICRH) with a total installed power of 800 kW.
The linear device Proto-MPEX, forerunner of MPEX consisting of 12 water-cooled copper coils, is operational since May 2014. Its helicon antenna (100 kW, 13.56 MHz) and EC heating systems (200 kW, 28 GHz) have been commissioned. The operational space was expanded in the last year considerably. 12 MW/m^2 was delivered on target. Electron temperatures of about 20 eV have been achieved in combined helicon and ECH/EBW heating schemes at low electron densities. Overdense heating with Electron Bernstein Waves was achieved at low heating powers. The operational space of the density production by the helicon antenna was pushed to 2 x 10^{19} m^{-3} at relatively high magnetic fields of 0.7 T, which would allow ECH absorption for 2nd harmonic X-mode overdense heating schemes. Proto-MPEX has been prepared to allow for first material sample exposures. The experimental results from Proto-MPEX will be used for code validation (B2-Eirene, COMSOL, VORPAL, AORSA, GENRAY) to enable predictions of the source and heating performance for MPEX.
MPEX, in its last phase, will be capable to expose neutron-irradiated samples. In this concept, targets will be irradiated in ORNL's High Flux Isotope Reactor and then subsequently exposed to fusion reactor relevant plasmas in MPEX.
The current state of the MPEX pre-conceptual design and unique technologies already developed, including the concept of handling irradiated samples, will be presented.

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