Negative hydrogen ion sources: a challenge to sustain the fire in ITER

Ursel Fantz
Max-Planck-Institut für Plasmaphysik, Garching and Universität Augsburg

The international fusion project ITER requires for heating and current drive neutral beam injection systems based on large and powerful negative hydrogen ion sources. The challenge to extract a negative hydrogen ion current of 40 A from a low temperature plasma at low pressure (0.3 Pa) is accompanied by the challenge to accelerate the beam to 1 MeV. Large RF sources with the size of a door operating at a power of up to 800 kW must deliver a uniform and stable negative hydrogen ion current with a density larger than 200 A/m^2 for one hour. Simultaneously, the amount of co-extracted electrons must be kept lower than the extracted ion current in order to avoid severe damages of the extraction system.

The ITER requirements incorporate several challenges which can be met only by combining the disciplines of low temperature plasma physics, plasma surface interaction, ion beam optics, beam physics, and mechanical and electrical engineering. In order to fulfil these requirements an ambitious development program has been initiated in Europe and is carried out at IPP at three test facilities in parallel. The state of the art and prospects of the negative hydrogen ion source development will be discussed with emphasis on the physical aspects.