Progress in the New ECRH System for ASDEX Upgrade

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The new ECRH system which is currently under construction at ASDEX Upgrade is aimed for a total power of 4 MW, generated by 4 gyrotrons, and a pulse length of 10 sec. A particular feature is the use of multifrequency gyrotrons, where the gyrotrons will work either at two frequencies (105/140 GHz) or will be step-tunable in the range of 105-140 GHz. The system should allow for central heating at different magnetic fields. It will also give more flexibility for the stabilization of neoclassical tearing modes (NTM) through the possibility of current drive on the high field side without changing the magnetic field and very localized feedback controlled power deposition with a narrow beamwidth by using a fast steerable launcher. The transmission line components are especially designed to cope for the large bandwidth of the system. The system will be constructed in several steps. The first gyrotron to be installed can work at 105 GHz and at 140 GHz. The operating modes are $TE_{17.6}$ and $TE_{22.8}$. Here we make use of the $3\lambda/2$ and $4\lambda/2$ resonances of the single disk synthetic diamond vacuum window at these frequencies. A second gyrotron will be step-tunable, i.e. it can work at several frequencies within the same frequency range. For each frequency the gyrotron oscillates in a different cavity mode. Short pulse test gyrotrons at FZK and IAP have demonstrated efficient generation of power in excess of 1 MW at all these frequencies. The frequency can be changed between two ASDEX Upgrade pulses and requires a resetting of the cryomagnetic field at the cavity, the gun magnetic field and the collector magnetic field. There is one complicating feature with such a gyrotron: the output beam leaves the gyrotron window at slightly different angles and positions so that mirror adjustment in the matching optics unit is necessary. In order to limit the number of required phase correcting mirror sets we will choose 4 frequencies as our main operating modes. The torus window required for the step-tunable gyrotron should be in principle broadband, e.g. a Brewster window. To avoid constraints in the polarization and the quasi-optical design, a tunable double-disk window with a remote controlled adjustment of the distance between the disks will be used. For the two-frequency gyrotrons a single-disk window is sufficient.

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