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P3.056 Measurement of edge plasma parameters at W7-X using Alkali Beam Emission Spectroscopy

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A 60 keV neutral Alkali beam system was designed, built and installed for beam emission spectroscopy measurement of edge plasma on W7-X.

The injector consists of three parts: a recently developed thermionic (lithium or sodium) ion source ($j \geq 2.5 \text{ mA/cm}^2$), a high focusing efficiency ion optic (~50% of the extracted current can be found in the plasma) and a newly developed recirculating neutralizer; it gives the possibility to measure continuously even at long (<100s) discharges.

The observation system consists of two parts: a 40 channel avalanche photo diode (APD) camera unit and a CMOS camera which run in parallel: 95 % of the collected light goes to the APD unit which is digitized with 2MHz sampling rate while the CCD camera is operated in the 100 Hz range.

As the decay length of the Sodium first excited state is much shorter than Lithium it was selected as beam species. This way the steep density gradient at the bean shaped cross section of the Wendelstein 7-X plasma can be resolved.

The diagnostic beam can be removed from the plasma using deflection plates driven by a fast high voltage switch. This beam chopper can be operated up to 250 kHz giving a possibility to monitor the background on the time scale of the turbulence.

Unexpectedly a thermal sodium beam was also observed in the far Scrape Off Layer in the W7X plasma during the first measurements. It was found to originate from the recirculating neutralizer. Its light signal is at least one magnitude higher than the local accelerated beam signal, although its penetration is limited to the far SOL. To resolve this issue potassium filled neutralization experiments are being performed.

In this paper the main improvements of the sodium beam system and the first measurement results are described.

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