Contribution ID: **587** Type: **not specified**

P2.014 Design and mock-up tests of the RING photoneutralizer concept for an efficient DEMO NBI

Tuesday, 18 September 2018 11:00 (2 hours)

High energy (800 keV) Neutral Beam Injection (NBI) is one of the methods being considered to heat EU DEMO plasma [1]. A major issue of present NBI systems is the limited efficiency of the gas neutralizer (for ITER NBI ~55%), which impacts on the overall system efficiency. An attractive method, but still undemonstrated at full performances, is the photo-neutralization of the negative D-ion beam. In this process the energetic ions pass through an optical cavity where they impact on laser photons with a frequency chosen to maximize the neutralization cross section. The expected neutralization efficiency can be up to 70-90%.
A possible scheme for photoneutralization is named RING (Recirculation Injection by Nonlinear Gating) [2] where the second harmonic of a Nd:YAG laser is extracted and trapped within a non-resonant optical cavity. A mock-up of the optical cavity has been built in Consorzio RFX to study its performances in order to demonstrate the feasibility of the RING concept and its potentiality for a full-scale NBI photoneutralizer. The mock-up has been operated with a low repetition rate (10 Hz) Nd:YAG laser (λ=1064 nm). The optical alignment of the cavity appears not to be critical and first operations are aimed to achieve the 2nd harmonic generation (SHG) saturation regime. The measurements of the SHG efficiency using a Lithium Triborate (LBO) crystal confirm the non-linearity of the process with the crystal thickness. The optical properties of the recirculating light are described by measuring the beam envelope profile with a laser-triggered CCD camera and the trapped beam pulse decay time with a fast photodiode. Operations with the mock-up are fundamental to assess the optical cavity performance and estimate the loss channels affecting the beam recirculation.

[1] P. Sonato, Nucl. Fusion 57 (2017) 056026
[2] A. Fassina, Rev. of Sci. Instrum. 87 (2016) 02B318

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Session Classification: P2