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ITER周辺トムソン散乱計測装置の開発の現状
Recent progress in development of the edge Thomson scattering in ITER

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The edge Thomson scattering system (ETS) is one of the primary diagnostic systems for measuring electron temperature T_e and electron density n_e profiles in ITER. The requirements for the edge plasma measurement are a spatial resolution of 5 mm within $r/a > 0.85$, a temporal resolution of 10 ms and a T_e accuracy of 10% and an n_e accuracy of 5% within the ranges of 0.05−10 keV and 5×10^{18}–3×10^{20} m^{-3} [1]. Recently, the conceptual design for the ETS has been completed. Fig. 1 shows a schematic of the ETS. This paper presents conceptual design of ETS and related prototyping.

With the present collection optics design, the coverage area is $7.8 < R < 8.36$ m. A normalized minor radius range of $0.8 < r/a < 1.08$ for the nominal plasma can be measured [2]. Main design issues of the collection optics are (1) compatibility of optical performance and neutron shielding, (2) using of reflecting optics (i.e. metal mirrors) in port plug (vacuum environment) for reliability against harsh radiation environment, thermal and electromagnetic loads. Fig 2 shows optical layout of collection optics. In this design, six mirrors (flat and concave mirrors) are used as the reflecting optics in the port plug, arranged on a labyrinthine optical path for neutron shielding. Collected light passed through double vacuum windows enters refraction optics to image on surfaces of fiber-optic bundles. As a result, we have obtained a design satisfying both optical performance and neutron shielding targets. Regarding optical performance, the requirement of the spatial resolution of 5 mm can be satisfied for almost the whole viewing field of the collection optics. From a preliminary analysis, neutron flux is effectively attenuated by the shield module labyrinth, and shut-down dose rate of less than 100 μSv/h, the required value in ITER, is obtained.

A new beam dump, the so-called “Chevron beam dump” has also been designed to absorb the laser beam in the vacuum vessel [3]. The chevron beam dump is expected to withstand thermal loads due to nuclear heating, radiation from the plasma, and numerous incident laser pulses throughout the entire ITER project with a reasonable margin for the peaking factor of the beam profile.

A prototype of Nd:YAG laser is being developed. Currently an output energy of 7.66 J per pulse with a repetition rate of 100 Hz and the pulse duration of approximately 30 ns have been achieved against a requirement of 5 J/100 Hz/<10 ns for the ITER laser set [4].

[1] ITER Organization, *Project Requirements ver. 4.6* (2010).
[2] E. Yatsuka, et al., “Progress in development of the ITER Edge Thomson Scattering System” submitted to JINST (2013).
[3] E. Yatsuka, et al., Rev. Sci. Insrum. **84**, 103503 (2013). E. Yatsuka, et al., 05pE13P in this meeting.
[4] T. Hatae. Et al., Rev. Sci. Instrum. 83, 10E344 (2012).

The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.

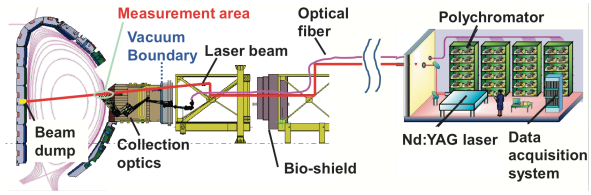

Fig.1. Schematic of the edge Thomson scattering system in ITER

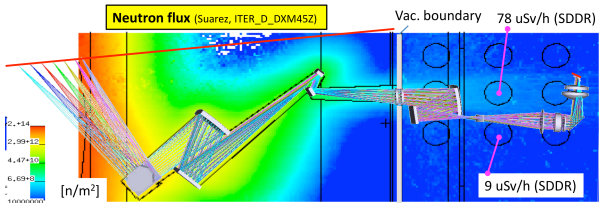

Fig.2. Optical layout of collection optics on the distribution of neutron flux and values of shut-down dose rate.