# 9–1 Lifetime Extension of Beam Dump by Dispersing the Deposition of Laser Energy

## — A High Laser Energy-Resistant Beam Dump for Thomson Scattering in ITER —

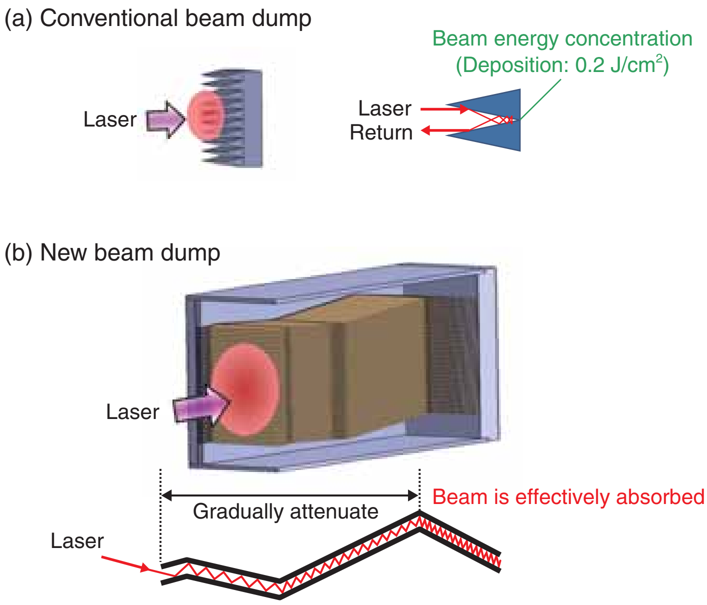


**Fig.9-2 Beam dump structures**
(a) The conventional beam dump has a relatively small area for beam absorption, which induces damage; (b) the new beam dump has a number of sheets aligned parallel to one another which can gradually absorb the beam energy.

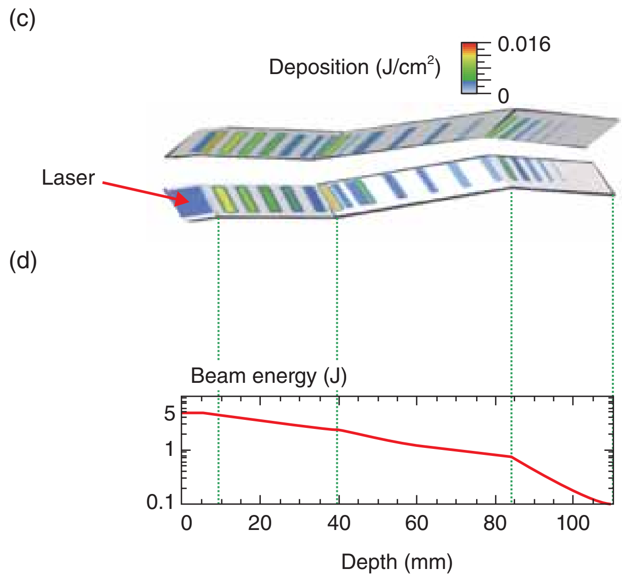


**Fig.9-3 Beam energy deposition profile**
(c) Beam energy deposition profile on two of the sheets; (d) to use the limited depth effectively, beam energy attenuation of the latter sections is larger than that of the front sections.

When a laser beam is injected into plasma, a very small fraction of the light is scattered by electrons in the plasma. This phenomenon is called Thomson scattering. The electron temperature and density of the ITER plasma are measured from the spectrum and intensity of the scattered light, respectively. Since the proportion of incident photons that are scattered and detected as a signal in ITER is $10^{-14}$, it is very important to inject intense laser beams, to collect the scattered light effectively and to reduce the stray light of the laser beam in the Thomson scattering measurement, so that the electron temperature and density can be accurately measured with a high signal to noise ratio (S/N).

Laser beam dumps are designed to terminate intense laser beams and reduce the stray light of the laser beams. Since $10^9$ laser pulses with a 5-J energy are to be injected throughout the 20 year operation of ITER, the concentrated laser energy in the valley of a conventional beam dump will cause serious damages to the surface (Fig.9-2(a)). The accuracy of the Thomson scattering measurement significantly degrades if the laser beam dump is damaged, since the stray light from the damaged surface of the beam dump increases. A key concept of the new beam dump is to reduce laser energy absorption per unit area on the surface and to gradually absorb the energy of the laser beam, so that the stray light will be reduced at the same time.

We have applied the idea that the absorption ratio depends on the angle of incidence and the polarization of the laser beam to the design of a new beam dump. Fig.9-2(b) shows the schematic of the newly proposed beam dump. To gradually absorb the beam energy, the laser beam is injected into the beam dump with a large angle of incidence and is polarized parallel to the beam-exposed area (S-polarization). In general, the depth should be sufficiently large to gradually absorb the beam energy. However, the allocated depth for the beam dump in ITER is up to 125 mm. The new beam dump has a number of thin molybdenum sheets with thicknesses of 0.5 mm, which are aligned parallel to each other with a separation of 1 mm. We optimized the angle and position of bending on the sheets to disperse the deposition of the beam energy (Fig.9-3).

While conventional beam dump cannot withstand more than $10^4$ laser pulses, the new beam dump would withstand more than $10^9$ pulses. In addition, compatibility with ITER's thermal and electromagnetic loads was confirmed through thermo-structural analysis. We have proposed the first detailed beam dump structure in the world that complies with the severe conditions of use, installation environment, and space limitations of ITER.

**Reference**

Yatsuka, E., Hatae, T. et al., Chevron Beam Dump for ITER Edge Thomson Scattering System, Review of Scientific Instruments, vol.84, no.10, 2013, p.103503-1-103503-6.