Wendelstein 7-X

NEWSLETTER

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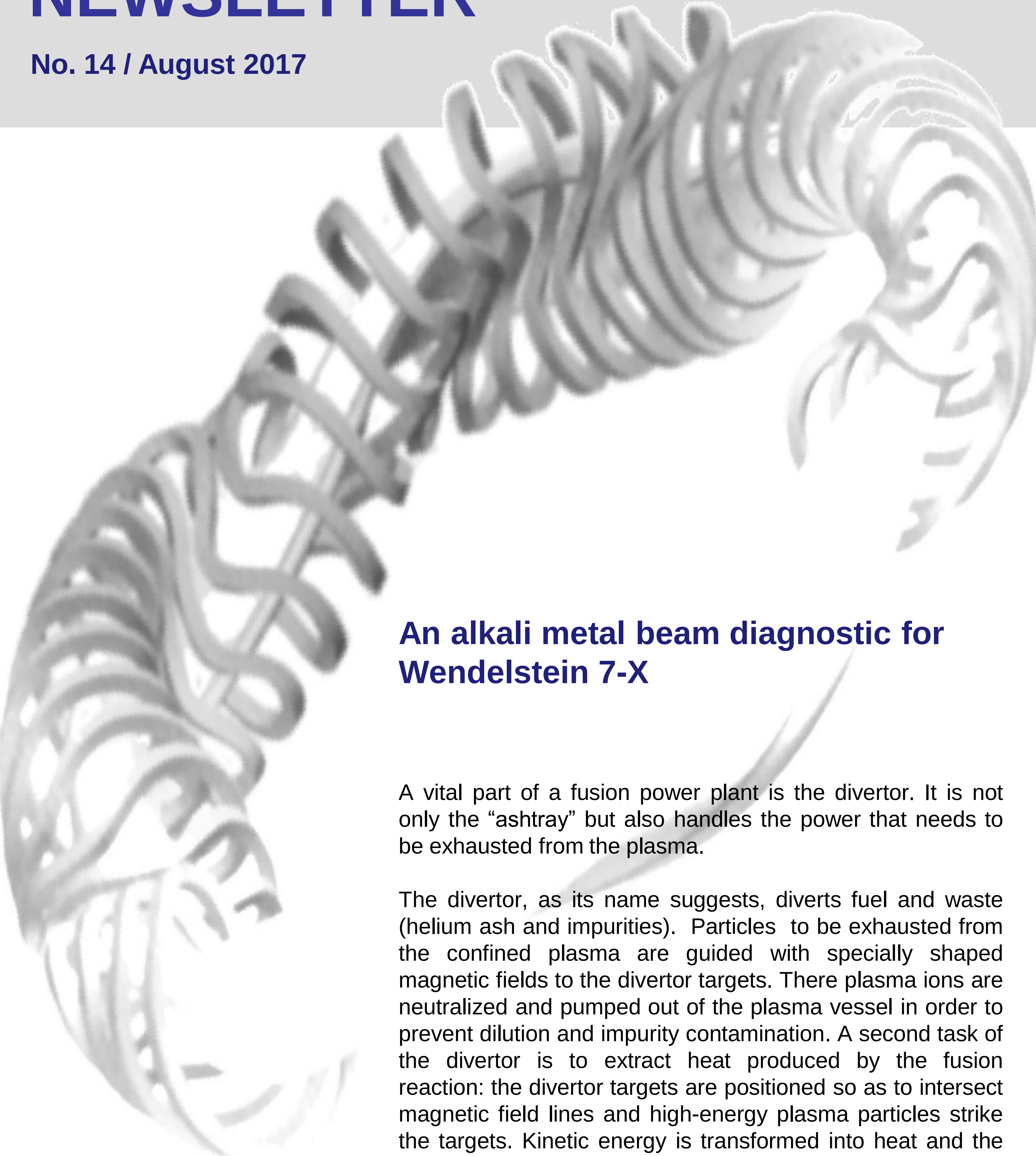


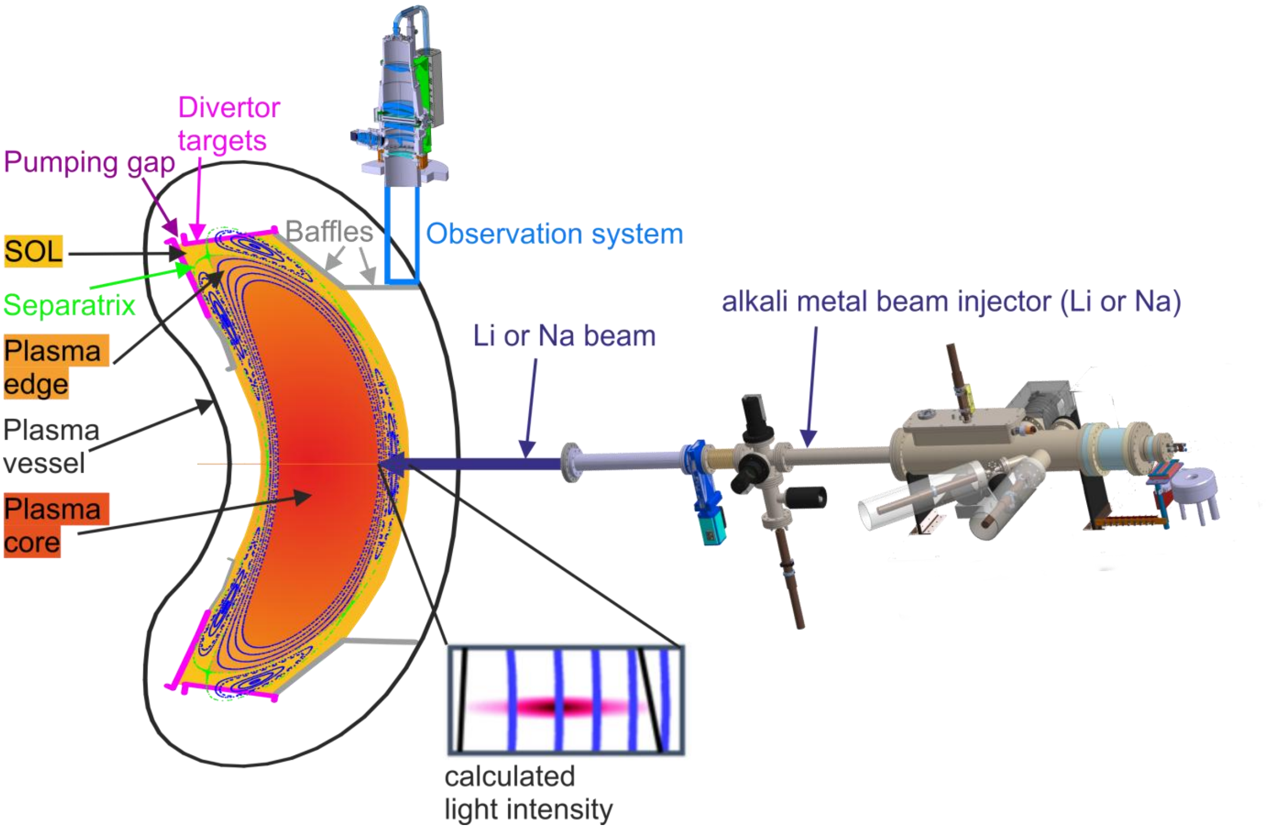
An alkali metal beam diagnostic for Wendelstein 7-X

A vital part of a fusion power plant is the divertor. It is not only the “ashtray” but also handles the power that needs to be exhausted from the plasma.

The divertor, as its name suggests, diverts fuel and waste (helium ash and impurities). Particles to be exhausted from the confined plasma are guided with specially shaped magnetic fields to the divertor targets. There plasma ions are neutralized and pumped out of the plasma vessel in order to prevent dilution and impurity contamination. A second task of the divertor is to extract heat produced by the fusion reaction: the divertor targets are positioned so as to intersect magnetic field lines and high-energy plasma particles strike the targets. Kinetic energy is transformed into heat and the heat is removed by a cooling system to eventually drive a turbine in a future fusion power plant.
Hence, it is very important to improve scientific understanding of the divertor and develop an advanced divertor concept for application in such a power plant.

Since Wendelstein 7-X is designed for steady-state operation, its divertor has been designed to withstand quasi-continuous heat fluxes of up to 10 MW/m^2 and a maximum total load of 10 MW is to be handled for about 30 minutes. For safe operation of the divertor and to learn how to reduce impurity content and power loads, diagnostics have been installed to measure important plasma quantities.

One of these diagnostics is an alkali metal beam designed and manufactured for Wendelstein 7-X in collaboration between Wigner RCP Budapest and IPP Greifswald within the framework of the EUROfusion programme. The primary objective of the diagnostic is to measure density profiles, island structures, turbulence and turbulence flow properties in the plasma edge region including the scrape-off layer (SOL) at the W7-X outer midplane.



Graphic: IPP/Wigner RCP

<u>Scrape-Off Layer (SOL)</u> refers to the plasma region outside the separatrix and is characterized by open field lines commencing or ending on the divertor or the plasma vessel wall.
<u>Separatrix</u> is the boundary between closed and open field lines, separating the toroidally confined region from the region where field lines connect to material surfaces.
The <u>plasma edge</u> region is bounded by the separatrix signalling the transition from the confined plasma with closed field lines to the Scrape-Off Layer (SOL) with open field lines.

The diagnostic is based on the interaction of a probing energetic lithium or sodium beam which penetrates the plasma edge. The atoms with an energy of 60 keV and an intensity corresponding to an electrical current of 1 mA are propagated into the plasma edge where they are successively excited and ionized. Characteristic light in the visible range is emitted by the spontaneous de-excitation of the excited species and can be detected by an optical observation system.

The alkali metal beam injector and its observation system were designed and built at the Wigner RCP. After successful tests the injector and the control system were sent to IPP. After reassembling and testing, the injector was installed in the torus hall on a platform between the two neutral beam injectors which will be used for heating the plasma. The figure below shows the tight space between the injector boxes where the alkali metal beam injector is placed.

The Hungarian and German team :
Dr. Gábor Anda, (project manager), Tibor Krizsanóczi, Sándor Hegedűs, Domonkos Nagy and Dr. Matthias Otte, Stefan Freundt
photo: G. Wurden

Next, the observation system will be installed including a conventional 2D camera and a fast avalanche photo diode array with high radial (1 cm) and temporal (1 µs) resolution. The whole diagnostic will be ready for commissioning with the start of the OP 1.2a plasma operation phase, half a year ahead of the original schedule.

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