VA 1: ITER - The new international fusion reactor

Time: Monday 10:30–12:10 Location: HSZ 101

Invited Talk VA 1.1 Mon 10:30 HSZ 101

ITER, the next step to clean energy by fusion - Size matters — •Christian Day — Forschungszentrum Karlsruhe, Institut für Technische Physik, Postfach 3640, 76021 Karlsruhe

Fusion is the energy source of our sun which keeps our earth alive. Fusion research is aimed at using this energy source with abundant fuel resources to produce electricity in a safe, environmentally benign way without CO2-emission, to meet the needs of a growing world population.

ITER is a joint research and development project that aims to demonstrate the scientific and technical feasibility of thermonuclear fusion power. With seven parties participating in the project (European Union, Japan, China, Korea, the Russian Federation, India, and the USA), ITER constitutes one of the largest international scientific projects of its kind and brings together countries representing over one-half of the world's population. ITER will be built at Cadarache in the South of France.

The ITER mission is the next large step to develop nuclear fusion from the plasma physics level towards a technology with the potential and technical availability to act as future energy source. Hence, engineering is the core element of the ITER project. ITER will generate some 500 MW of fusion power, with a tenfold energy output/input ratio under conditions similar to those expected in an electricity-generating fusion power plant. The talk will present the ITER project, address major technical challenges and outline the impressive ITER vacuum systems.

VA 1.2 Mon 11:10 HSZ 101

Strömungsberechnung in großen Vakuumsystemen — •Volker Hauer und Christian Day — Institut für Technische Physik, Forschungszentrum Karlsruhe GmbH, Postfach 3640, 76021 Karlsruhe,

Die Berechnung von Masseströmen und Leitwerten in großen Vakuumsystemen ist ohne die Verwendung spezialisierter Software kaum möglich. Neben der großen Anzahl der Bauelemente können Asymmetrien und das gleichzeitige Auftreten unterschiedlicher Strömungsbereiche die Berechnung erschweren. Am Beispiel des ITER-Torusvakuumsystems unter Verwendung des Simulationsprogramms ITERVAC soll die Berechnung eines großen Vakuumsystems demonstriert werden.

Die Software ITERVAC simuliert ein Vakuumsystem als ein Netz von Kanälen. Jeder Kanal hat eine definierte Form, Querschnittsfläche und Länge. ITERVAC berechnet auf Basis der geometrischen Daten, der Gasart, der Temperatur und der Druckdifferenz den Massenstrom in jedem einzelnen Kanal. In einem weiteren Simulationsschritt können die Drücke am Ein- und Ausgang der einzelnen Kanäle bestimmt werden. Für das ITER-Torusvakuumsystem wurde ein Modell erstellt und für verschiedene Gase die Massenströme und Drücke ermittelt.

Parallel zu den Berechnungen wurde die verwendete Simulationssoftware validiert. Dazu wurden Messungen an langen und kurzen Kanälen unterschiedlicher Form durchgeführt und mit den Simulationsergebnissen verglichen. Die erreichte Übereinstimmung liegt innerhalb der Messungenauigkeiten.

VA 1.3 Mon 11:30 HSZ 101

The Novel Cryopump for the Neutral Beam Injection Systems of ITER — •Stefan Hanke, Christian Day, and Matthias Dremel — Institut für Technische Physik, Forschungszentrum Karlsruhe GmbH, Postfach 3640, 76021 Karlsruhe

The Neutral Beam Injection Systems (NBI) for ITER induce extraordinary high demands on the supporting vacuum system. The Beam Line Components of the NBI are considerable sources of gas and thermal radiation.

A cryopump design was developed to fulfil the two main operational tasks: a pumping speed of several 10^3 m^3/s and high gas loads of protium and deuterium to be pumped. The design was driven by two competing requirements: The high thermal heat loads ask for a closed pump, the need of a high pumping speed ask for an open structure. To combine both objectives in an optimized geometry the Test Particle Monte Carlo code MOVAK 3D was used.

The talk will give an overview of the NBI, the implications for the vacuum system, the approaches to solve and optimize various aspects and the resulting features of the actual cryopump design.

VA 1.4 Mon 11:50 HSZ 101

ProVac3D and Application to the Neutral Beam Injection System of ITER — •Xueli Luo, Christian Day, and Matthias Dremel — Institut für Technische Physik, Forschungszentrum Karlsruhe GmbH, Postfach 3640, 76021 Karlsruhe

We have developed ProVac3D (3D density Profiles in Vacuum systems), a Monte Carlo simulation code, to calculate gas dynamics and the density profiles in a complex vacuum system characterized by distributed gas sources and pumps. The Neutral Beam Injection System of ITER is a good example of such a system, for which Forschungszentrum Karlsruhe is responsible to design the state-of-the-art cryogenic pump. By using ProVac3D, we can intensively study volumes of interest inside NBI and get the information about the pumping speed in order to provide the required density profile along the beamline. The advantage of ProVac3D is that it is flexible with modular structures and very fast to achieve precise statistics by large simulation numbers even with a current desktop computer. To extend ProVac3D beyond the free molecular regime, the collision of the probe molecule with the gas background has been included. We are going to present some preliminary results as well.