High Intensity D-T Neutron Source HINEG and Its Applications

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

Neutron sources are the important experimental platform for the R&D of advanced nuclear energy systems, especially for the development for fusion systems. Series High Intensity D-T Steady Neutron Sources (HINEG) have been developed in China for different missions including neutronics design validation, materials & components irradiation test, nuclear waste burning and nuclear technology applications, etc. HINEG includes three phases: HINEG-I, HINEG-II and HINEG-III.

HINEG-II is a new D-T neutron source based on a high-voltage electrostatic accelerator, which is constructed in Chongqing and achieves an excellent neutron yield of 1.3×10^{13} n/s. Its outstanding performance is supported by three key core technologies: high-efficiency beam transport technology, which ensures stable extraction and transmission of high-current deuterium beams; a large, ultra-high-speed rotating target that can stably operate at 5000 rpm, combined with dynamic disturbance-enhanced heat dissipation technology to solve the problem of ultra-high heat flux density; and gradient nano crystallization epitaxial growth technology with a T/Ti ratio of 1.9, which improves tritium storage capacity and reaction efficiency. The device provides multi-type neutron spectra, including fusion-like ones, serving as a crucial experimental platform for fusion-related technical verifications, radiation damage mechanism research, and advanced reactor technology validation. Series experiments have been successfully completed on HINEG, including neutronics performance test of TBM blanket, measurement of leakage spectra from Pb and Pb-Bi, irradiation damage testing for laser crystal, etc.

Besides, the FDS Consortium has also developed a series of neutron sources for various uses, such as the Mini Neutron Generator (MINEG), Small Neutron Generator (SNEG), Compact Neutron Source (CONEG) and Volumetric Neutron Source (VNEG). Among them, SNEG is a D-D/D-T neutron source featuring with high neutron yield, compact design, and mobility. Its main body occupies an area of less than 1 m2, with a D-D source strength of 10^{10} n/s and a D-T source strength of 10^{12} n/s. Due to its small size and portability, the SNEG neutron source is highly suitable for on-site calibration of detectors. VNEG is a Gas-dynamic Trap (GDT) based volumetric fusion neutron source with a neutron flux higher than 10^{15} $n\cdot cm^{-2}\cdot s^{-1}$, it is an optimal platform for research on tritium breeding blankets of fusion reactors and material irradiation testing.

FDS provides an open platform that invites global research and applications in neutron source and fusion technology.

#12705

Water Activation Experiment in the JET DTE3 campaign: Recovery of Saturated Gamma Signals in Support of ITER

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

Water activation by high-energy DT fusion neutrons is a key radiological and diagnostic issue for current and future tokamaks, particularly for ITER, where water-cooled systems will operate under unprecedented neutron fluxes. To support ITER design and operation, a dedicated Water Activation Experiment (WACT) was conducted at the Joint European Torus (JET) during the 2023 DD and DT campaigns.

The experimental setup employed a BGO scintillation spectrometer installed beneath the neutral beam injector cooling pipe in the basement of JET Octant 4. Detection efficiencies at the characteristic N-16 gamma-ray energy (6.13 MeV) were determined using a combined experimental and Monte Carlo approach, coupling low-energy calibration measurements with MCNP simulations of the full detector–pipe geometry and a volumetric gamma source.

For pulses within the linear operating regime of the detector (up to approximately 1.3e16 DT neutrons), the measured N-16 activity concentration increased linearly with neutron yield. At higher neutron yields, however, the BGO detector became saturated, resulting in a temporary loss of the gamma signal and preventing direct activity determination. A key outcome of this work is the development of a recovery methodology based on a boundary-case JET pulse, number 104225, located at the transition between unsaturated and saturated regimes. By comparing a fully recorded low-rate signal with the partially recovered post-saturation signal from this pulse, a scaling factor between saturated and unsaturated signal components was determined.

This scaling factor enables the reconstruction of N-16 activity for medium-yield pulses that would otherwise be unusable, effectively extending the dynamic range of the diagnostic beyond its hardware limits. The reconstructed activities align with the extrapolated linear trend from unsaturated measurements, providing experimental constraints for neutron yields approaching ITER-relevant regimes.

These measurements represent the only available experimental dataset of neutron-induced water activation obtained in a DT tokamak cooling circuit, providing unique benchmark data for validating predictive modelling methodologies in support of ITER commissioning.

Integrated Commissioning of Fusion Facilities: Experience from JET and MAST-U

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The integrated commissioning of the Joint European Torus (JET) represents one of the most demanding commissioning exercises performed on a large-scale fusion facility, providing a unique reference for the preparation of ITER and future fusion devices. This contribution presents an overview of the JET integrated commissioning, structured around two tightly coupled stages: Integrated Commissioning of sub-systems and Plasma Commissioning. The first stage focuses on the coordinated activation, verification, and synchronization of plant systems, while the second stage establishes reliable plasma initiation, optimizing machine conditioning, and the validation of control, diagnostics, and auxiliary heating systems in preparation for experimental campaigns, including deuterium–tritium operation. This contribution outlines the organisational framework, planning tools, and procedures developed at JET to manage hundreds of interdependent commissioning activities, ensuring traceability, risk mitigation, and efficient progress against agreed Restart targets.

Beyond JET, the same integrated commissioning principles and processes have been successfully adapted and implemented on the MAST Upgrade (MAST-U) spherical tokamak, which has been operating since 2020. The transfer of this framework to MAST-U demonstrates its flexibility and scalability across devices. The experience from both machines confirms that a clear structured commissioning approach is essential for reducing risk, improving efficiency, and supporting the timely delivery of advanced plasma operations in next-generation fusion devices.

Measuring the reaction rate between hydrogen isotopologues with a spinning rotor gauge

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The isotopic exchange reaction H + T ↔ HT influences tritium inventory and plasma-fuel recycling in fusion devices because it governs the formation and release of molecular tritium in the cold edge and pumping regions. A precise, temperature-dependent rate constant is therefore required to optimize fuel-cycle management, minimize the tritium inventory, and improve the predictive capability of plasma-performance models. Established diagnostics such as mass spectrometry or Laser-Raman systems are currently not capable of measuring at temperatures of 70 K and lower.

The spinning-rotor gauge (SRG) provides an alternative by measuring the dynamic viscosity of the gas mixture and cross-calibrate these measurements at room temperature with a Laser-Raman-system (μRa-system) developed at TLK. The gas mixture is transferred directly after production to the SRG through an inline measurement of its composition with such a μRa-system, giving its composition at the beginning of the measurement and at the end when the gas mixture is evacuated from the SRG. The normalized deceleration rate (DCR) of the SRG rotor is measured over a long time-period of up to two weeks. During this time small samples of the mixture are extracted and re-measured with the μRa-system to validate the progress of the exchange-reaction between the hydrogen isotopologues. As the DCR changes with the gas-mixture composition, and the μRa-system shows the exact composition for different times during the reaction, the reaction-rate can be extracted.

Preliminary measurements already show a clear correlation between increasing HT concentration and the observed deceleration. Provided that the exact functional dependence of deceleration on mixture composition is fully validated SRG-based viscosity monitoring will constitute a high-bandwidth, non-destructive diagnostic for H–T exchange kinetics. Such a capability will aid the development of robust tritium-handling strategies, contribute to safety assessments, and support the design of next-generation fusion reactors.

Experimental characterization of the irradiation cavity of the GENeuSIS Neutron Assembly

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The existing neutron irradiation facilities are not able to fully reproduce the spectral complexity of the radiation fields foreseen in fusion tokamaks as ITER. As a result, experimental qualification of components under fully representative ITER conditions is still not achievable with conventional test infrastructures.
To fill this gap, GENeuSIS (General Experimental Neutron System Irradiation Station) has been developed as a modular, flexible, and transportable neutron irradiation setup, made of layers of different materials. Its purpose is to tailor target neutron energy spectra within a dedicated test cavity in order to reproduce radiation environments relevant to specific ITER locations. At the moment, the assembly relies on the 14 MeV neutrons produced by the Frascati Neutron Generator (FNG).
Previous designs and simulations made with MCNP demonstrated the feasibility of the GENeuSIS concept and have led to the definition of two configurations: GENeuSIS-I, representative of the ITER Port Interspace, and GENeuSIS-II, designed to reproduce the radiation field expected in the Port Cell of the Equatorial Port #12.
GENeuSIS-II has now been assembled and is fully operational at the FNG facility. This work presents the experimental characterization of the GENeuSIS-II irradiation cavity employing different kind of active and passive neutron detectors. Measurements will include neutron flux measurements and validation of the achieved spectral conditions.

DIII-D: A Public Facility's Role in Pioneering Fusion Technology

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The US Fusion Roadmap envisages the first fusion power plants to be delivered by the private sector. This requires major advances not only in the plasma core, which must be demonstrated with higher energy confinement, better control and handling of more heat than demonstrated today, but also in a range of even more challenging technology innovations. And the compatibility between these techniques, which interact with and constrain each other, must be resolved, as well as their projection to the reactor scale. The strength of publicly funded facilities is that they have broad capabilities to experiment, learn what works, and understand how to project and integrate solutions; to discover the path.

DIII-D has pivoted its program to address this agenda, with an aggressive program of technology development. First, 61 novel wall materials have been tested in the last 2 years, ranging from advanced tungsten alloys to high temperature ceramics, and even pebble and liquid metal structures. Equally critical is power exhaust handling to protect the first wall, where the facility is pursuing a modular series of divertors to isolate and enhance detachment of a cold plasma edge through magnetic shaping, closure and radiative impurity techniques. Three new current drive technologies have been pioneered: high field side lower-hybrid current drive (CD), helicon ultrahigh harmonic fast wave, and top launch electron-cyclotron CD. Pellet innovations have been developed to fuel and safely quench fusion plasmas. Pioneering diagnostic technologies have facilitated a spin-out of a private company, Nusenics, and tests for several other companies. And DIII D is now pioneering AI digital twin technology to accelerate research and close the loop on plasma control.

To assess these new technologies, DIII-D is upgrading its heating, current drive and shaping to provide relevant conditions in collisionality, opacity, beta, rotation, plasma equilibration and current distribution. This enables key tests of interactions such as heat dissipation, flows, impurity dynamics, pellet ablation, RF deposition, 3D fields, or measurement and control, to understand a range of technologies. It also enables determination of which core solutions are most compatible and advantageous, from high current pulsed to 'steady state' noninductive, peaked to broad current profile, and positive to negative triangularity. These elements combine with an opening up of the facility to private sector engagement with 19 private-sector companies now exploiting DIII-D to test critical elements of their approach. DIII D is thus providing unique and critically needed data for the fusion commercialization agenda.

Fluid-Structural Analysis of IFMIF-DONES Li-Target Assembly

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The IFMIF-DONES (International Fusion Materials Irradiation Facility and DEMO-Oriented Neutron Source) facility relies on a single accelerator line to deliver 125 mA of deuteron at 40 MeV to a flowing liquid Lithium (Li) target, where the deuteron beam interacts with a free surface. The high-speed Li jet, reaching up to 15 m/s, must keep a specific thickness to achieve the desired neutron flux and effectively dissipate heat. The performance of this jet is critical for designing key components, including the target assembly (TAA), nozzle, liquid Li channel, and quench tank (QT).
This work analyses the dynamic characteristics of the TAA channel with outflowing liquid Li, using fluid-structure interaction simulations to understand and mitigate these oscillations. Continuing the earlier simulations, the focus of this activity is analysis of vibration of the outlet channel of TAA inside of QT, propagation of vibrations towards the TAA and their impact on the target structure and Li- jet stability. The fluid-structural analyses were performed using the commercial software packages Siemens Star-CCM+ and ANSYS 2023 R2.
The simulation results indicate that channel vibrations propagate through the target structure. Fast Fourier Transform (FFT) analysis reveals that vibration frequencies are consistent across all measurement points. Thermal expansion of the channel slightly increases vibration amplitudes, with the maximum observed amplitude in the target region not exceeding 0.2 mm. This value is of the same order of magnitude as experimentally measured dynamic Li-jet-surface waves induced by turbulence. The superposition of these two instability sources may affect the lithium flow behaviour and, consequently, the neutron generation performance of the target.
The analyses further indicate that temporal temperature variations throughout the TAA structure can significantly influence both structural stability and Li-jet behaviour. Fatigue analysis shows that the oscillation amplitude is mainly constrained by the bellow design and by introducing suitable geometry modifications, the fatigue

#12843

Maintenance of Fusion Equipment Over Decades: The JET Experience

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

JET was successfully operated over 4 decades and during those years the nature of the machine changed considerably. The period from 1983-2023 saw enormous changes in technology, in particular computing and related areas. In order to continue reliable operation, the maintenance of ageing and obsolete systems was key.
Over time different strategies were developed on JET to ensure machine availability was as high as possible. Retaining sufficient spares of older components helped to ensure any down time was minimal, however as technology changed, suppliers became unavailable or spare parts also became unserviceable other strategies were required. On many occasions the JET team adapted to this by re-designing components with more modern components but to the original (or improved) specifications. The decision to re-design components requires balancing the risk of the new design being inadequate, the downtime to replace and re-commission and the expert staff time required against the risk of the older equipment failing and the difficulty in retaining the appropriate skills for obsolete equipment. A number of case studies from the neutral beam power supplies and the Control and Data Acquisition System (CODAS) will be used to demonstrate the path followed on JET.
As fusion progress towards reactor concepts the topic of machine availability has become a key factor, in particular in the feasibility of the economics of those concepts. Appropriate and targeted ongoing maintenance to avoid large amounts of downtime will be an essential part of achieving that availability. The experience on JET in the area of upgrading and modernising equipment as necessary can help those future projects develop their own maintenance strategy.

IFMIF-DONES status and experimental programme

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Topics

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Communication type

Oral

Abstract

IFMIF-DONES (International Fusion Materials Irradiation Facility, DEMO-Oriented NEutron Source) is a cutting-edge neutron irradiation facility designed to simulate the high-energy neutron environment of future fusion reactors. It also contributes to the development of tritium and breeding blanket technologies. As part of the European roadmap to fusion electricity, its primary objective is to create a comprehensive database of material properties under intense neutron irradiation conditions, similar to those encountered in a fusion reactor. The neutron source is generated by an accelerated deuteron beam striking a liquid lithium curtain, producing neutrons with an energy spectrum and flux comparable to those experienced by the first wall of a fusion reactor.

The IFMIF-DONES facility construction phase, part of the DONES Programme, has progressed from preliminary to detailed design, with some parts already in manufacturing process. Construction officially started after the first DONES Steering Committee met on 16 March 2023, facilitating the transfer of design authority to the DONES Programme Team. The Multilateral International DONES Agreement, signed on 21 November 2025, secured contributions for the construction phase. This paper reviews the current progress of the DONES Programme and the IFMIF-DONES Facility.

This contribution will focus on the design status of the Facility, the progress of facility construction, anticipated performance, including a summary of its experimental features and programs.

#13030

Operating Experience from JET

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

JET was a very successful experiment mainly due to its flexibility and resilience on diagnostics. Over its 40 year life, JET has seen 3 internationally collaborative DT campaigns amongst numerous other fusion experiments and set fusion records. It has not only provided huge learning on our journey to sustainable fusion energy but also provided the operational, engineering and safety teams with lessons that can be carried forwards to a future Fusion Power Plant.

The talk will detail the main facilities that comprise JET, emphasising the huge array of supporting facilities that are required beyond the tokamak. JET's limitations offer oppertunities to understand the challenges between batch vs. continuous operation - something that is of relevance in Future Power Plants (FPPs). The lessons learned in each area will be discussed including aspects on ageing which are highly relevant to FPP. Whole facility operational learning and ways of working constructs are highlighted as exemplars and where additional learning can be made to improve efficiency when problem solving. The talk will conclude with lessons that can be directly applied to FPP will be presented along with lessons where scale of a larger FPP need to be considered but are still applicable.

#13066

Current status of the control system development for the ITER EC gyrotrons

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

The employment of 80 gyrotrons is foreseen in the latest baseline for the Electron Cyclotron Heating system in ITER. The planned reliability and performances of the gyrotrons during plasma operation lead to challenging objectives for the control system of the plant and the tubes. Gyrotrons are expected to be available on demand at all times during operation and to provide 1~MW of continuous radiofrequency wave for extended experiments. In this framework, two activities are currently undergoing: i) the development of a thermal model for the electron gun of the gyrotron to provide a tool for controller anesthetization and integration, and ii) the development of data-driven mode loss detection methods for the emitted radiofrequency beam to make up for the lack of detectors. In this work, the current status of both research topics is shown, the latest advances are described, and the prospect of a future implementation is outlined.

Pre-conceptual design of the Compact Accelerator-driven Neutron Source Karlsruhe

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

In future fusion reactors based on DT-fusion, in-vessel components like the breeding blanket, divertor and limiter will be subjected to extreme conditions regarding the 14 MeV neutron flux, heat and γ-radiation of the burning plasma. In particular the breeding blanket has a key role. It dissipates the heat generated from fusion, breeds the fusion fuel tritium and serves as radiation shield. For the nuclear qualification of breeding blanket materials and components, fusion relevant neutron sources are necessary.
A prominent example is the International Fusion Materials Irradiation Facility – DEMO Oriented Neutron Source (IFMIF-DONES), which is currently under construction. The main objective of IFMIF-DONES is to provide a database for structural materials. For the qualification of breeding blankets, integrated tests of mock-ups under a relevant nuclear environment become increasingly important. This requires one or more complementary irradiation facilities. The Compact Accelerator-driven Neutron Source KArlsruhe (CANSKA) is projected to address this qualification gap. The baseline of the CANSKA project aims at a linear accelerator, accelerating protons and/or deuterons on a target producing high energy neutrons with a neutron flux density in the order of 10^13 n/cm^2/s in the test volume immediately behind the target delivering typically 3-5 dpa within few years of high-availability operation. As such, CANSKA focuses on early irradiation effects and a pre-selection of the most attractive designs for subsequent full qualification experiments at other facilities.
To evaluate the neutron flux density in the test volume for different beam energies, accelerated particles and target materials, MCNP simulations were conducted. The results show that a proton accelerator with 30 MeV and 10 mA on a liquid Lithium or Gallium-Indium target can reach the requirements for the nuclear environment. Different configurations of the linear accelerator line were investigated and compared with regard to power consumption, cost and reliability. Based on the selected accelerator design a concept for the liquid metal target and building layout will be presented.

#13126

Enhancement of Time-Averaged Fe Ion Beam Current and dpa Rate at KAHIF through Molflow-Based Vacuum Optimization of a MIVOC System

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

A vacuum-dynamics-based redesign of the MIVOC system at KAHIF has been carried out to enhance the time-averaged Fe ion beam current and the corresponding dpa generation rate for fusion structural materials irradiation studies. In fusion materials research, rapid accumulation of high displacement per atom (dpa) is essential to evaluate irradiation-induced microstructural evolution and mechanical degradation within practical experimental time scales. Therefore, sustained time-averaged beam current, rather than peak beam performance, determines the efficiency of ion irradiation campaigns. KAHIF employs an Electron Cyclotron Resonance (ECR) ion source with a Metal Ions from Volatile Compounds (MIVOC) system using ferrocene precursor to generate Fe ion beams relevant to fusion-relevant alloy compositions. Although peak Fe beam currents exceeding 1 μA were achieved, long-duration operation revealed a significant reduction in time-averaged beam current. Time-resolved pressure measurements showed a transient downstream pressure spike upon opening the MIVOC–ECR valve, followed by decay to a lower steady-state level. This behavior indicates that ferrocene delivery to the plasma is governed by molecular-flow-limited transport, reservoir buffering capacity, and condensation losses, rather than solely by saturation vapor pressure.

To identify the dominant mechanisms, molecular-flow simulations were performed using Molflow. The effects of MIVOC chamber volume, effective ferrocene evaporation surface area, and connecting line conductance on transmission probability and steady-state partial pressure delivery were systematically evaluated. The analysis revealed that insufficient buffering volume and high surface-to-volume ratio reduce the time-averaged ferrocene flux reaching the plasma. Based on these findings, a redesigned MIVOC configuration was developed with increased reservoir volume, reduced surface-to-volume ratio, minimized cold-spot formation, and optimized flow-limiting control. The upgraded system and quantitative improvements in time-averaged Fe beam current and dpa accumulation rate will be presented at this presentation

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Development of Wire-Scanner Monitor for High-Current Beam Profile Measurements of Accelerator Based Fusion Neutron Sources.

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

Beam profile measurements are essential for characterizing beam properties including beam intensity and spatial distribution. In general, there are two methods to measure the beam profile: directly interceptive or indirectly non-interceptive beam profile monitors. The Linear IFMIF Prototype Accelerator (LIPAc) employs an interceptive secondary electron emission monitor (SEM grid) to measure the deuteron beam profile. Although the SEM grid is one of the most reliable ways to obtain beam information, wire breakage remains a problem due to the beam intensity and vacuum conditions. Therefore, accelerator operation during beam measurements is performed under constraints, such as low-duty cycle. We are developing a novel interceptive rotating wire-scanner monitor that enables beam profile measurements at a high-duty cycle.

The developed profile monitor employs tungsten as the wire material and measures the beam by rotating the wire at high speed to reduce the thermal load. One advantage of the rotating mechanism is that the tip speed can be easily increased by enlarging the rotation radius. A thermal analysis was performed to estimate the thermal load on the wire during movement within the beam, and the rotation speed required for beam profile measurements was investigated. As a result, a rotation speed of 8,100 rpm was found to be required to mitigate the effect of thermionic emission from the heated tungsten wire on the measurement. In addition, the effect of wire deflection on the measurement was evaluated as a function of rotation speed and wire diameter.

A prototype device was fabricated to demonstrate the actuation mechanism of the rotating wire-scanner monitor. The prototype employs a gear-based acceleration system and was designed to reach 2,300 rpm during start/stop operation within two revolutions. This presentation reports the results of performance tests conducted with the prototype, including evaluations of rotation speed and wire deflection, and compares the experimental results with previously calculated values.

60Co Irradiation Tests on Individual IFMIF-DONES STUMM Detectors

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The materials that will be used to build the walls of fusion reactors must be validated; this is the objective of IFMIF-DONES (International Fusion Material Irradiation Facility- DEMO Oriented Neutron Source), a research infrastructure where a neutron spectrum closely matching that expected in the DEMO reactor will be generated.

The first module that will be irradiated at the IFMIF-DONES facility will be the monitoring system known as STUMM (Start-Up Monitoring Module). It is a system that will characterize the neutron and gamma-ray fields during the commissioning of the facility. Many of the critical operating conditions, such as Helium pressure, high temperature and electrical configuration that will exist in the STUMM can be replicated in the STUMM-PROTO, a 1:1 scale PROTOtype of the STUMM. It is currently located in the UGR-DONES building in Granada, Spain. The main purpose of this prototype is to evaluate the behaviour of different particle detectors and sensors under representative conditions before the installation of the final STUMM in the accelerator facility.

The prototype includes several types of radiation detectors, such as Micro Ionization Chambers (MIC), Micro Fission Chambers (MFC) based on 235U and 238U, and Self-Powered Neutron Detectors (SPNDs. The characterization of these particle detectors under irradiation operation, will enable the study of the radiation-induced currents and associated non-idealities, such as EM noise or crosstalk between detectors. The results obtained with STUMM-PROTO will contribute to the validation and optimization of the monitoring system that will be implemented in the final STUMM module.

In this study, one detector of each type, outside of the prototype, will be irradiated at the National Accelerator Center (CNA) in Seville using a 60Co gamma source. These detectors are planned to be placed on a specific support fabricated of the same material as the prototype (stainless steel 316L) and with an internal geometry that replicates the distance at which the detectors will be located inside the STUMM-PROTO container. This will allow their response and generated current to be evaluated under representative conditions. If these tests demonstrate stable and measurable currents, the final objective is to irradiate the entire STUMM-PROTO with 60Co at the CNA in order to replicate the boundary conditions imposed by the prototype on the detectors. The aim is to study how these variables influence the detectors output signal.

This work presents the development, preparation and results of the 60Co irradiation tests on the single particle detectors at the CNA.

Conditioning of Wendelstein 7-X vacuum vessel

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

Before each new experimental campaign, the vacuum vessel of the Wendelstein 7-X (W7-X) is conditioned. This process includes baking at 150°C, cleaning with glow discharges in helium and hydrogen, and boronisation.
This paper compares the last three baking processes on the W7-X, focusing particularly on the pressure variation in the vacuum vessel, the mass spectra of the residual gas, and the final pressure in the vessel after cooling down. It also discusses the dependence of the final pressure in the vessel (design value: 1×10^{-6} Pa) on the length of the baking process and the temperature variation during baking. The reduction of the water peak in the mass spectrum and the proportion of higher masses are also described.
After baking, the vessel undergoes further conditioning using glow discharges in helium and hydrogen. The W7-X features ten graphite electrodes, which are evenly distributed across the torus, for cleaning discharges. These discharges operate in helium and hydrogen within a pressure range of approximately 0.3-1 Pa, with discharge voltages of approximately 210 V (helium) and 300 V (hydrogen), respectively. The discharge is ignited at approximately 10 times the gas pressure and 3–10 times the voltage compared to subsequent discharges. The ignition process is monitored visually using cameras to detect any deviations from the desired diffuse glow discharge, and to enable the implementation of countermeasures if necessary. This paper describes how the discharge voltage depends on the discharge current and gas pressure, and specifies the resulting stability window for current and pressure in the W7-X. It presents and describes the development of the discharge voltage over several discharges. The effect of vessel cleaning is described using mass spectra obtained before and after glowing.
In addition to cleaning with glow discharges, the W7-X vacuum vessel is boronised before each experimental campaign and after approximately 3–5 weeks of operation. Boronisation on the W7-X is performed using a glow discharge in B_2H_6. The same glow electrode system used for cleaning discharges is employed for this purpose. This paper describes the boronisation system setup in detail. Approximately 60 liters of a helium (90%) and B_2H_6 (10%) gas mixture are processed per boronisation cycle. The process control during boronisation and its influence on the plasma experiments are discussed.

#13248

The Lawson Machine 26 (LM26) Program: Fusion Technology Development and Operational Processes

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

The Lawson Machine 26 (LM26) program at General Fusion aims to demonstrate a viable pathway to commercial fusion energy using Magnetized Target Fusion. The three key program milestones are reaching plasma temperatures of 1 keV, 10 keV, and the Lawson triple product conditions. This poster will lay out the technological roadmap for the LM26 program, the machine designs for each stage of the program, the operational cycle for a plasma compression campaign, and the plasma compression sequence.

LM26 compression system development started with testing electromagnetically driven compression of thin-walled solid tin and lithium rings and spinning liquid gallium–indium–tin . The results from these ring compression experiments supported the selection of solid, hollow lithium cylinders for LM26, significantly simplifying both mechanical design and operational complexity. Quarter-scale thin-walled, hollow lithium cylinders were manufactured and compressed as part of the Prototype Zero (P0) test stage to further inform the engineering design and operational sequences needed for LM26 plasma compression tests.

Alongside compression system development, a plasma target improvement campaign was underway in General Fusion's Plasma Injector 3 (PI3). The Marshall gun from PI3 has been retained for LM26. Other new designs for other plasma injector components, like the centre shaft and vessel, were required to be compatible with compression operations.
The lithium cylinders for LM26 are approximately 300 kg, with an outer diameter of 1.8 m and a wall thickness of around 70 mm. They are cast, machined, and transported to the plasma injector in an inert environment to preserve surface quality and prevent contamination.

Plasma compression is driven by a 17 MJ capacitor bank that discharges into 2.5 m diameter coils surrounding the target chamber, generating the magnetic fields required to theta-pinch the lithium cylinder. This radial compression increases plasma temperature and density. An additional power system ramps the toroidal magnetic field during compression to maintain plasma stability.

The LM26 program works because General Fusion's engineering team has applied its ingenuity and creativity to design systems that enable a high repetition rate of integrated plasma compression experiments.

Operation of the enhanced impurity powder dropper at ASDEX Upgrade

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

The impurity powder dropper (IPD) is a device to inject powder (especially boron) into discharges for wall conditioning and to produce radiation for special plasma scenarios. It was developed by the Princeton Plasma Physics Laboratory (PPPL) and installed at ASDEX Upgrade (AUG) in 2017.
In 2022/24 a new upper divertor including in-vessel coils was installed at AUG. For this reason, the outlet of the dropper at the upper divertor had to be adopted. Additionally, new extensions to optimize the reliability of the instrument were installed. During the injection of the boron powder into the vessel some of the boron powder settled on the disc of the torus inlet valve. The result was, that the gate valve didn't close properly because of the powder, which lead to a delay of the operation process at AUG. To avoid this problem PPPL enhanced the boron dropper and installed the so-called TIV protector (torus inlet valve protector). It is a tube, that can be extended through the open torus inlet valve, before the boron is dropped. The lower end of the TIV protector is funnel-shaped and fits exactly in the flange of the new installed drop tube. This ensures, that the boron powder has no contact to the disc of the gate valve anymore.
Because of the enhancement it was necessary to adapt the control system, to make sure that the process follows the correct order and to prevent, that the torus gate valve can be closed, while the TIV protector is inserted.
During the 2024/25 campaign the IPD allows plasma experiments for 3 different plasma scenarios. The new upper divertor allows to drop directly into the high density divertor plasma. This was used for investigation of x-point radiation stability studies using boron and boron nitride powder.

Design and technology of the Volumetric Neutron Source

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The Volumetric Neutron Source (VNS) is designed as a compact beam-driven tokamak with D–T plasma to generate a high neutron flux as achieved in recent T-rich JET DT campaigns. This is targeted, primarily, for the testing and qualification of fusion nuclear components up to a reactor relevant neutron fluence. Furthermore, VNS could demonstrate the operation of a nuclear fusion facility including essential functions and processes such as the continuous operation of the tritium processing systems, contamination control, remote maintenance and nuclear waste management. The superconducting tokamak has a major radius of 2.67 m at a relatively high aspect ratio of 4.25, which provides sufficient space in the machine center for massive neutron shielding structures and magnet coils providing a high field of 5.6 T on the plasma axis. It operates a plasma with a current of 2.5 MA that is driven by the tangential neutral beams, hence the device can be operated in continuous mode. The feasibility of the facility had been confirmed in 2024 by a EUROfusion expert panel.

This article provides, firstly, an overview of the basic design and the technologies foreseen for the main components. Secondly, the results of selected engineering activities that were carried out to de-risk the facility resolving main integration challenges are described: (i) adjustment of the neutral beam configuration following updated results of integrated plasma physics simulations, (ii) integration concept and remote maintenance strategy of the divertor, (iii) mechanical integration concept of the blankets, (vi) initial integration concepts for in-vessel diagnostics, and (v) a machine assembly concept adapted to the small machine size and the space constraints inside the bioshield.

#13390

Neutroni studies on the building penetrations of the Divertor Tokamak Test (DTT) facility

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The Divertor Tokamak Test facility (DTT) is a new fusion experiment under construction at the ENEA Frascati Research Center to study plasma exhaust issues in DEMO relevant conditions and to explore alternative solutions for the extraction of the heat generated by the fusion process with different divertor configurations. During high-performance operations, DTT is expected to reach a D-D neutron emission rate of 1.5 x 10^17 and in addition, a non-negligible rate of 14 MeV neutrons from D-T reactions, due to the triton burn-up.
As a nuclear installation, the Torus Hall Building (THB) that will host the DTT facility must provide adequate radiation shielding to protect workers and the public from neutron and gamma radiation, according to the rigorous requirements imposed by the national regulatory authority. Neutronics and radiation transport studies are essential for the design and the assessment of the shielding properties of the torus building, and to design effective shielding solutions for the building penetrations.
Such discontinuities in the radiation shield are necessary to connect the tokamak to the many auxiliary systems for the operation of the device but also represent a potential pathway for radiation streaming outside the THB.
This work presents an extensive 3D neutron and gamma transport analyses conducted with the MCNP5 Monte Carlo code using variance reduction techniques (i.e., weight windows) to improve the efficiency of the calculations of the neutron and gamma fluxes and dose rates to the public outside the building and other relevant radiation quantities during the plasma operation of the machine.
All the analyses are performed with the 360° model, which includes a simplified representation of the tokamak, where the internal cryostat components are modeled with reduced geometrical detail to reduce the computational cost, without affecting the attenuation of the particles relevant for the analysis. The 360° model also includes the main features of the THB building, such as the wall penetrations and the external structures. The main outcomes of the study are presented and discussed with the objective of contributing to the optimization of the shielding capabilities of the building.

Challenges and Adaptive Engineering in the Manufacturing of the COMPASS-U Tokamak Support Structure

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

COMPASS Upgrade (COMPASS-U) [1] is a compact, high-field tokamak currently under construction at the Institute of Plasma Physics in Prague. Designed to operate with a toroidal magnetic field of 5 T and a plasma current of 2 MA, the device relies on a compact, cryogenically cooled copper coil system. The structural integrity of this magnet system is maintained by a massive stainless steel Support Structure, which must react to immense vertical forces totaling approximately 70 MN. However, the primary structural challenge is not merely the vertical load but the severe torsional moments induced by the interaction of the poloidal field with the toroidal field (TF) coil current. The specific geometry of the COMPASS-U Toroidal Field coil makes it uniquely vulnerable to these torsional forces due to the presence of a Sliding Joint connecting the outer parts of the coil (TF “limbs”) with the inner part (TF “core”). The design must ensure that this global twisting does not translate into local misalignment; specifically, the differential toroidal deformation between the inner and outer sliding joint fingers is limited to ~0.6 mm to ensure electrical continuity and prevent mechanical damage.

This contribution summarizes the manufacturing process of the Support Structure and lessons learned. The support structure consists of 16 heavy C-frames manufactured from forged 316LN stainless steel. Particular focus is given to the engineering adaptations implemented during the manufacturing phase to meet these strict stiffness requirements. These adaptations include the reinforcement of the vertical webs, shifting from a standard bolted connection to a high-preload configuration using BUMAX Nitro 109 fasteners. Furthermore, the contribution details the integration of a radial TF coil preload system into the existing forging designs, a process that required additional machining and introducing new load paths into the already-procured components without compromising the structural integrity and timeline.

With manufacturing completed and test assembly nearing completion, the contribution discusses the strategy for the full Support Structure assembly. Key technical solutions to reach required tolerances are highlighted, including the use of adjustable wedge systems to compensate for machining deviations

Keywords: Support structure, design, adaptation, manufacturing, tokamak, test assembly

[1] P. Vondracek, et al., Fusion Engineering and Design 169 (2021)

Experimental Characterization of PbLi/Water Interaction in the LIFUS5/Mod3 Separate Effect Test Facility for Nuclear Fusion Applications

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

The LIFUS5/Mod3 facility is a separate-effect test facility dedicated to the experimental investigation of lithium-lead and water interaction under representative operating conditions of the Water Cooled Lithium Lead (WCLL) Breeding Blanket. The facility has been designed, constructed and operated at ENEA Brasimone Research Centre to generate high-quality experimental data for the validation of numerical codes and to support the understanding of the physical and chemical phenomena occurring during a postulated in-box Loss of Coolant Accident (LOCA) scenario.

Such transients represent a key safety issue for the WCLL Breeding Blanket, as the interaction between lithium lead and water can produce pressure and temperature transients that may affect the structural integrity of the component and, consequently, the safe operation of the DEMO reactor. In addition, the chemical reaction between lithium lead and water leads to hydrogen production, which constitutes an additional safety concern.

The LIFUS5/Mod3 facility is designed to operate under high-pressure and high-temperature conditions (up to 200 bar and 500 °C) and is equipped with a dedicated instrumentation system enabling detailed experimental characterization of the interaction phenomena. The instrumentation allows the measurement of pressure wave propagation generated by the thermodynamic and chemical interaction between the two fluids, the mapping of temperature evolution within the reaction vessel, and the quantification of hydrogen production resulting from the exothermic reaction.

This paper presents the experimental capabilities of the LIFUS5/Mod3 facility and summarizes the main outcomes of the experimental campaigns performed within the Nuclear Fusion Programme. Particular attention is devoted to the test matrix definition, the experimental methodology and the resulting dataset supporting the characterization of lithium lead/water interaction phenomena and used for numerical codes validation.

#13560

TRACE-Based Thermal-Hydraulic Model for coupling HELOKA-US and HELOKA-HP Facilities

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

Within the European Demonstration Fusion Power Plant (EU-DEMO) several Breeding Blanket (BB) and Balance of Plant (BoP) concepts are currently under assessment, with particular attention to their integration, efficiency, and capability to cope with the intrinsic pulsed nature of tokamak operation. In this context, the Helium-Cooled Pebble Bed (HCPB) concept adopts an Indirect Coupling Design (ICD), where the Primary Heat Transfer System (PHTS) is decoupled from the Power Conversion System (PCS) through a molten salt–based Intermediate Heat Transport and Storage System (IHTS). The integration of thermal energy storage within the intermediate loop allows smoothing of the pulse-dwell power oscillations, thus enabling more stable conditions at the turbine interface.

The experimental investigation of the IHTS architecture is carried out at the Karlsruhe Institute of Technology (KIT) within the HELOKA-Upgrade-Storage (US) facility. It consists of a molten salt loop (200 °C - 465 °C; 7 bar) representing a two-tank thermal energy storage system with a 260 KW electrical heater acting as a controllable heat source. The molten salt loop is thermally connected via a molten salt/water heat exchanger to a high-temperature, high-pressure water loop (160 °C - 220 °C; 45 bar) acting as controllable heat sink. To experimentally investigate advanced heat exchanger designs under fusion-relevant thermohydraulic boundary conditions, qualify system-level simulation tools, and further develop and evaluate the performance of an IHTS for fusion reactor power plants, the coupling of the HELOKA-US facility with the HELOKA-High-Pressure (HP) facility (300 °C - 520 °C; 80 bar) is envisioned in a future expansion stage. For this purpose, the electrical heater would be bypassed by a helium/molten salt heat exchanger and the thermal power is supplied by HELOKA-HP.

This paper presents the development of detailed, system-level, thermal-hydraulic models of the HELOKA-US and HELOKA-HP facilities using the TRACE code. The molten salt loop model is validated by experimental measurements obtained during steady-state and pulsed operation. Models of several helium loop components, such as the heater and economizer, are evaluated by using experimental operating data. A coupled simulation framework is established by replacing the electrical heater of the molten salt loop with a helium/molten salt heat exchanger, which interconnects the two validated models. This work provides a coherent numerical foundation for future integrated analyses and supports ongoing experimental activities within the HELOKA infrastructure.

#13638

Exploring LTS and HTS Superconducting joint concepts with the SELFIE facility

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

Superconducting joints are critical components of tokamak magnet systems, ensuring electrical and mechanical continuity between superconducting conductors while limiting resistive losses. Their performance directly determines magnet reliability under high-current cryogenic operating conditions. Once the machine is assembled and cooled down, joint inspection or repair becomes impractical, imposing stringent requirements on joint design, manufacturing, assembly and prior qualification1. The SELFIE test station2 (ITER SELf-FIEld joint test facility), developed at CEA Cadarache, was designed to test superconducting joint prototypes under representative current and cryogenic conditions, enabling resistance measurements and concept validation prior to integration.
An experimental campaign3 was carried out on the SELFIE facility to evaluate the electrical and thermal performance of several joint prototypes. This paper presents the results obtained and demonstrates the stability and reproducibility of joint performance over the test series. In parallel, tests on intentionally degraded joints were performed to assess the impact of representative defects and to evaluate design robustness margins. Finally, in the context of the laboratory's recent orientation towards high-temperature superconducting (HTS) conductors, this paper reports the first SELFIE test of an HTS joint designed at CEA, paving the way for the qualification of HTS joint concepts for future fusion magnet systems.

1 C. Nguyen Thanh Dao et al., "Development of Coax Compacted Joint Assembly Process for the ITER Central Solenoid," in IEEE Transactions on Applied Superconductivity, vol. 31, no. 5, pp. 1-5, Aug. 2021, Art no. 4202405, doi: 10.1109/TASC.2021.3068275.

2 S. Girard et al., "SELFIE: ITER superconducting joint test facility", Fusion Engineering and Design, Volume 188, 2023, 113434, ISSN 0920-3796, https://doi.org/10.1016/j.fusengdes.2023.113434.

3 C. Nguyen Thanh Dao et al., "ITER Magnets Superconducting Joints Prototype Tests in the CEA SELFIE Facility for Operators Qualification," in IEEE Transactions on Applied Superconductivity, vol. 34, no. 5, pp. 1-5, Aug. 2024, Art no. 4204705, doi: 10.1109/TASC.2024.3365095

Lawson Machine 26 – Results from the large-scale Magnetized Target Fusion Demonstration

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

Lawson Machine 26 (LM26) is a large-scale magnetized target fusion (MTF) machine built to demonstrate that compressional heating of a spherical tokamak plasma can achieve fusion conditions. A coaxial helicity injector forms a magnetized plasma inside a hollow lithium cylinder, which is inside a composite vacuum vessel. A surrounding 36-turn theta-pinch coil generates a strong magnetic field to symmetrically compress the liner and the deuterium plasma it contains in less than 4 milliseconds. The compression of the liner occurs without damaging any major structures, allowing the device to be rapidly restored for further experiments. Recent compression results from LM26 will be presented.

OSCAR-Fusion analysis of the first Copper dust campaign in the FNG ACP hydraulic loop

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

Corrosion Products (CP) arise from the combined effects of metallic cation corrosion-release, particle formation, dissolution–precipitation, surface deposition phenomena, and fluid-dynamic transport within process fluids. When exposed to neutron irradiation, they become Activated Corrosion Products (ACP), representing a significant radiological source term in nuclear facilities. While ACP assessment in fission reactors relies on well-established codes (e.g., OSCAR from CEA) and extensive validation datasets coming from operational experience in Pressurized Water Reactors, the ITER ACP study is based on the OSCAR-Fusion version, which still requires thorough validation. To address this need, an experimental water loop dedicated to investigating ACP mechanisms under ITER-relevant conditions was designed and commissioned at ENEA Frascati, employing the FNG (Frascati Neutron Generator) as source of 14 MeV neutrons. This ACP loop aims at reproducing thermo-hydraulic regimes as closely as possible to the ITER water cooling systems, allowing the study of materials of interest in fusion, such as copper. Specifically, the current loop configuration enables a scaled reproduction of the flow and temperature conditions of the Integrated Blanket ELM/VS Coils and Divertor (IBED) cooling loop during plasma operation, where copper-containing components are foreseen.
The first experimental campaign focused on the injection of 1 μm granulometry copper dust previously activated at FNG, into the ACP loop operating at 140°C and 6 bar. This campaign investigated the transport and deposition of the short-lived activation

products, notably Cu-64, through gamma activity measurements in specific points along the hydraulic path of the water in the loop. The corresponding surface activity, measured through gamma spectrometry, was compared to OSCAR-Fusion predictions to benchmark the code and provide guidelines for further improvements.

The present study shows the modeling of the FNG ACP water loop implemented in OSCAR-Fusion and the analysis of the main quantities of interest from the first copper campaign. In particular, the activity concentration of Cu-64 in the coolant and in the surface deposits along selected sections of the loop, and the corresponding gamma dose-relevant source terms are evaluated. The initial radionuclide inventory and activity of the injected copper dust were assessed with the FISPACT-II code, whereas activated particle transport and surface deposition were simulated using OSCAR-Fusion. The comparison between measured and calculated activity distributions provides an experimental benchmark for ACP predictive models under ITER-relevant thermo-hydraulic conditions, providing significant insights into radiological source term characterization for ITER and future fusion applications.

#13720

Design Concepts for Solenoid-free Plasma Startup using Transient CHI

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

Compact, low-aspect-ratio tokamaks have the advantage of lower cost and would be suitable test facilities for developing technologies needed for fully sustained operation, such as core fueling consistent with high bootstrap current operation and reliable disruption mitigation systems consistent with the avoidance of runaway current generation. Such facilities may not be able to accommodate a full-sized solenoid without compromising net power generation [1]. The scaling of plasma current generation for the solenoid-free plasma startup method known as Transient Coaxial Helicity Injection is relatively well understood. Transient CHI has successfully generated closed-flux currents on three low-aspect-ratio tokamaks of vastly different sizes and CHI injector configurations [2]. These are HIT-II [3], NSTX [4], and QUEST [5]. Studies for ST40 suggest a 0.5 MA current-generation potential. On NSTX, when induction is applied to a 0.2 MA CHI startup target, the discharge ramps to 1 MA with substantial solenoid-flux savings, and, with neutral-beam application, it transitions to an H-mode discharge. A transient CHI discharge is generated by driving a short pulse current (a few ms in duration) from an external power supply along magnetic field lines connecting divertor plates on one end of the tokamak, which are electrically separated from each other. As the injected magnetic field lines expand into the vessel, the externally driven current is rapidly reduced to zero. This results in a large-scale global reconnection of the injected field lines in the divertor region, thereby generating a closed flux configuration. The amount of generated current is proportional to the current driven in the divertor coil to generate the injector flux, and for the same injector flux, the externally driven current is inversely proportional to the magnitude of the toroidal field. This scaling strongly favors high-field tokamaks. Compared to inductive startup, transient CHI plasmas naturally have much lower normalized plasma internal inductance, higher plasma elongation [4], and can form with a naturally diverted plasma configuration, all of which are desirable for advanced tokamak operations. Progress in transient CHI startup and CHI electrode design concepts for emerging tokamak concepts will be discussed.

[1] J.E. Menard et al., Nuclear Fusion 56 (2016) 106023
[2] R. Raman, et al., Plas. Phys. Control. Fusion 67 (2025) 095007
[3] R. Raman, T.R. Jarboe, et al., Nuclear Fusion 45 (2005) L15-L19
[4] R. Raman, D. Mueller, T.R. Jarboe, et al., Phys. Plasmas 18, (2011) 092504
[5] K. Kuroda, R. Raman, et al., Phys. Plasmas 32, (2025) 042506

Establishment of Standardized Vacuum Conditioning Procedures Preparing for the Transition to a Full Tungsten Wall Environment

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

Following the installation of the actively cooled tungsten (W) lower divertor in 2023, KSTAR has completed four experimental campaigns under a partially metallic wall configuration. The consecutive 2025–2026 campaigns provided a unique opportunity to establish and systematically validate standardized vacuum conditioning procedures in preparation for the full metal wall upgrade scheduled for 2027.

The conditioning protocol encompasses vessel baking, helium leak verification, residual gas analyzer (RGA) monitoring, optimization of turbo-molecular and cryogenic pumping, glow discharge cleaning (GDC), and periodic in-vessel boronization. The efficacy of these procedures was evaluated by analyzing key engineering parameters, including base pressure evolution, partial pressure trends of dominant impurities (H_2O, CO, CO_2, hydrocarbons), pumping efficiency, and outgassing rate reduction.

Notably, periodic in-vessel boronization was implemented as a core step of the conditioning routine. As a full tungsten environment can pose significant challenges for reliable plasma start-up, the boronization is now recognized as a critical procedure to ensure robust breakdown. The operational impact of boronization was assessed in terms of vacuum recovery time, impurity suppression efficiency, and the reproducibility of plasma start-up. Results indicate that post-boronization phases significantly enhance breakdown reliability and facilitate stable current ramp-up, even within the tungsten divertor configuration. Especially, it has been confirmed that the break-down voltage requirement is lowered and radiative losses during the initiation phase is reduced due to the suppressed oxygen influx.

This paper details the preparation, implementation, and validation of vacuum conditioning protocols following the KSTAR metal wall upgrade, providing practical guidelines and operational insights essential for reliable plasma performance in future full tungsten environments.

#13736

Experimental Validation of Activated Water Source Terms at KATANA: Quantitative Comparison of Calculations and Measurements

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

Activated cooling water represents a spatially and temporally varying radiation source in water-cooled fusion reactors. Accurate prediction of dose fields from short-lived radionuclides such as ^{16}N (6–7 MeV γ) and ^{17}N (delayed neutrons 0.3 MeV – 1.7 MeV) requires coupled neutronics, activation, radioactive decay and CFD transport modelling. Within the EUROfusion WP PrIO programme, the KATANA closed-loop water activation facility at the JSI TRIGA reactor provides a controlled experimental benchmark for validation of such tools.

Between 2024 and 2025, five experimental campaigns (>200 reactor operating hours, 26 test days, 15 diagnostic systems) generated an extensive dataset of time-resolved neutron and gamma measurements under steady-state and pulse operation. Gamma spectrometry (HPGe, $LaBr_3$), $^3He/BF_3$ counters, Li-glass detectors, activation foils (Au, In, Ni) and TLD dosimetry were deployed over a wide range of flow rates (0.05 l/s – 0.68 l/s) and reactor powers (1 kW – 250 kW in steady state and up to 150 MW in pulse mode).

This contribution presents the first quantitative code-to-experiment comparisons at KATANA. In pulse-mode experiments, the time evolution of ^{17}N activity was tracked via ^3He detectors and compared with a simplified activation–transport model. The calculated and measured peak timing and shapes agree within experimental uncertainty. The loop volume derived from activation-peak separation (12.80 ± 0.04 l) matches the directly measured volume (12.80 ± 0.15) l, validating geometric and transport assumptions. The measured ^{17}N half-life (4.1 ± 0.3) s is consistent with the literature value, confirming the temporal fidelity of the model.

Independent neutron-activation measurements using indium foils yielded emission rates of (2.3–3.3) $\times 10^5$ s^{-1} and local fluxes of ~(2–3)$\times 10^2$ $cm^{-2}s^{-1}$, consistent with modelling (MCNP-based) predictions. Li-glass measurements indicate delayed-neutron fluxes of ~10 $cm^{-2}s^{-1}$ at 250 kW, in agreement with parallel detector systems. For high-energy gamma measurements, preliminary detector-response simulations reproduce spectral trends but overestimate full-energy peak areas by 20 % – 30 %, highlighting areas requiring refinement in coupled transport modelling.

These results establish KATANA as a fusion-relevant experimental benchmark for validation of FLUNED, RSTM, ActiFlow and GammaFlow tools and provide a quantified basis for improving predictive capability of activated-water source terms in ITER and DEMO cooling circuits.

#13755

Overview on the Structural Design and Manufacturing of the ITER MCTB Cryostat

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The ITER Magnet Cold Test Bench (MCTB) cryostat, the largest single component delivered to the ITER Organization to date, encompassing a volume exceeding 1000 m3 (21.2 m × 10.5 m × 6 m). It provides the essential high-vacuum (

Design of a WCLL Breeding Blanket First Wall test section to be tested in the Water Loop facility and integration in the W-HYDRA platform

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

The Water-thermalHYDRAulic (W-HYDRA) platform, under construction at the ENEA Brasimone research centre, will support the experimental qualification of key components and auxiliary systems for the DEMO Water Cooled Lead Lithium (WCLL) Breeding Blanket (BB). Experimental tests are necessary to assess the thermal-hydraulic and thermomechanical performances of the BB components and their potential showstoppers, as well as to validate the computational methodologies adopted for the DEMO design. To this purpose, a test section of the WCLL BB First Wall (FW) will be tested in the Water Loop facility of the W-HYDRA infrastructure, aimed at the assessment of the DEMO FW behaviour under relevant operating conditions. In particular, the FW test section will be tested in a Vacuum Chamber (VC) under high heat fluxes, delivered by and electron beam gun, and it will be cooled by water in PWR conditions provided by the Water Loop circuit.
Within this framework, the design of the FW test section has been set up and is reported in this work, along with its integration in the Water Loop facility and its auxiliary systems interacting with the test section. Particular attention was paid to the thermal-hydraulic assessment and optimization of the VC cooling circuit, which is one of the critical components interfacing the test section, subjected to the reflected electron flux.
Finally, a dedicated instrumentation layout was also developed to enable accurate monitoring and control of the main operating parameters and to support the experimental campaign, collecting data for the assessment and validation of the FW test section behaviour.

Advanced Variance Reduction Schemes for Dose Assessment Toward Licensing of 9 MeV Deuteron Operation in LIPAc

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

Linear IFMIF Prototype Accelerator (LIPAc) is designed to demonstrate the performance of a high-current deuteron accelerator for fusion materials irradiation. Following successful high-duty operation of 5 MeV, 125 mA deuterons with the RFQ in 2024, preparations are underway for continuous 9 MeV operation using the SRF linac. It is required to update the radiation regulatory licensing process in Japan, since the operating conditions will be shifted to higher-energy deuteron operation. The conventional MCNP Weight Window Generator had demanded considerable human and computational resources to acheive the precision requried for the regulatory licensing we applied so far. Thus, it has been introduced the ADVANTG code to generate optimized variance reduction parameters for MCNP dose assessments as a more advanced method. For instance, compared with the WWG, which typically required several days of iterations, ADVANTG produced region specific weight window parameters within approximately two hours while maintaining or improving the statistical quality of neutron induced dose results (fsd≤0.1). An internally developed post-processing module was also implemented to automatically extract peak dose values from mesh tally data calculated, enabling systematic preparation of licensing relevant quantities. For the gamma induced dose component, the revised variance reduction configuration has shown potential for reducing the long standing large uncertainties in deep shielding regions such as cable pits, and further refinement is ongoing. These developments support the efficiency and reliability of dose evaluations required for the upcoming LIPAc radiation regulatory licensing process.

#13803

Engineering System Integration and Experimental Progress of the Spherical Tokamak EXL-50U

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

EXL-50U, a hydrogen-boron plasma spherical tokamak device designed and built by ENN, achieved first plasma in December 2023 and has completed over 18,000 shots since January 2024. The device has demonstrated high plasma performance with parameters including R0=0.6~0.8m, A=1.85~1.6, Ip=1.0MA, Bt=1.2T, κ=2.0 , and a flat-top duration of 1.6s.

The low aspect ratio of the spherical tokamak necessitates compact arrangement of components in the inboard high-field-side central region and within the vacuum vessel, while the elongated plasma control requires integration and coupling of the magnet coils, vacuum vessel, and support structures. High-parameter operation demands that various heating, diagnostic, and auxiliary systems have as many access ports as possible without interference or mutual impact. These requirements pose significant challenges to the device design.

In the design, the vacuum vessel integrates a double-null divertor, poloidal field coils, resonant magnetic perturbation coils, passive plates, and toroidal cryopumps. In the external systems, auxiliary heating is provided by three neutral beam injection (NBI) systems (2.5MW total power at 25/50/80 keV), five electron cyclotron resonance heating (ECRH) systems (1.5MW total power at 28/50GHz), and one ion cyclotron resonance heating (ICRH) system (1 MW power at 22–50 MHz).Additionally, the system integrates diagnostic systems including a Thomson scattering system, an HCN interferometer microwave diagnostic, a bending crystal spectrometer, vacuum ultraviolet and extreme ultraviolet (VUV&EUV) spectroscopy, and electrostatic probes. Auxiliary systems such as vacuum pumping, pneumatic pellet injection, and boron powder injection are also incorporated.

EXL-50U adopts an integrated design approach for the toroidal field coils, flexible joints, central solenoid, coil leads, vacuum vessel, support structures, and in-vessel components, enabling MA-level discharges and withstanding plasma disruptions and vertical displacement events. Standardized ports and rational pre-layout planning facilitate the upgrade and adjustment of heating, diagnostic, and auxiliary systems. The application of collaborative design tools and virtual reality tools has improved design efficiency and minimized interference risks. The major systems have now been upgraded and commissioned.

These systems have enabled the attainment of ion and electron temperatures up to 4 keV and 10 keV, respectively, an energy confinement time of 70ms, and H-mode operation in hydrogen-boron plasma, with the fusion triple product expected to reach 1×10^19 keV·s·m^−3 by the end of 2026.

#13815

Development of a Muon Catalyzed DT Neutron Source

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

Multiple technolgy facilities are required to qualify materials and components for use in fusion power plants. The development of a Fusion Pilot Plant (FPP) without verification of materials and components that can survive the integrated fusion environment carries significant risk. This is a partricularly urgent issue for the fusion breeding blanket, and essential component for breeding fusion fuel and extracting heat for plant operation which is at a low technical readiness. A Volumetric Neutron Source is necessary in order to test components at scale in a DT neutron environment. the U.S. Department of Energy Fusion Science and Technology Roadmap state, "In the next 3-5 years, DOE will aggressively pursue the closure of near-term $&D gaps of D-Li stripping approaches, spallation and true-fusion approaches. This strategy allows for simultaneous development of volumetric neutron sources (VNSs) and novel fusion neutron sources supporting a path for an FPNS." One potential concept for the development of a high fluence volumetric neutron source would be the reaction from a muon beam interacting with a DT target. Muon-catalyzed fusion takes advantage of the inherently smaller nuclei of muon-carrying atoms of deuterium and tritium to enable closer approach and increased tunneling probability to overcome the Coulomb barrier, leading to an enhanced fusion reaction rate without the need for thermonuclear temperatures of magnetic or inertial confinement. This can produce >100 fusion reactions per muon, thus is the most energy-efficient process for the accelerator driven production of neutrons and can operate in steady state. The ideal driving source for a muon beam is a GeV proton beam, thus ORNL and Acceleron are pursuing the possibility coupling excess proton beam power from teh ORNL Spallation Neutron Source with Acceleron's muon beam technology to creat a muon-catalyzed VNS. This builds on the success of an ARPA-E BETHE project that demonstrated the production of fusion neutrons through this process. Preliminary calculations indicate that neutron rates on the order of 10E16 n/s are possible, and fluxes could exceed 10E14 n/cm^2-s over a 0.5m surface. Early stage calculations and facility plans will be presented.

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The FUSERO Program Advancing In-Pile Fusion Materials Testing Under Neutron Irradiation

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The FUSERO programme is a joint UKAEA–CEA initiative to justify and develop fusion-relevant irradiation experiments inside material test reactors (MTR), such as the Jules Horowitz Reactor (JHR) under construction at Cadarache, CEA. This technical presentation reports progress across three workstreams: subcritical crack growth (SCCG) in brittle functional materials (FUSERO-A), in-pile thermo-mechanical fatigue of structural metals (FUSERO-C), and reactor-based tritium production in ceramic breeder materials (FUSERO-D). All three target in-situ observation of dynamic material properties under irradiation.

FUSERO-A examines SCCG in brittle materials and the influence of neutron and gamma damage on fracture behaviour, with direct application to window materials in fusion reactors. We present a ball-on-ring test rig that has been designed, manufactured, and is now operational for controlled loading of disc specimens. First data are presented here.

FUSERO-C addresses structural materials under thermo-mechanical fatigue and creep, requiring independent control of temperature and mechanical stress during irradiation. Observation of synergistic irradiation and thermo-mechanical fatigue demands in-situ measurement that post-irradiation examination cannot provide. Specifications for a highly instrumented in-pile rig are established, defining an experiment with both independently programmable temperature (150–700 °C) and stress (0–100 MPa). We present neutronic performance estimation that establishes the baseline irradiation environment: neutron flux spectrum, heating rates, and displacement damage within the design constraints of the host reactor. These baseline predictions define the operating envelope against which active thermal and mechanical control systems will be designed.

FUSERO-D provides a reactor-based platform for high-fluence breeder material qualification and engineering development. Accelerator-driven neutron sources deliver the fusion-relevant 14 MeV spectrum in a genuine multi-physics environment, essential for nuclear data validation and early irradiation characterisation, but are fundamentally flux-limited and cannot accumulate the fluence needed to reach engineering-relevant burn-up. MTR irradiation is complementary: it reproduces the coupled environment of simultaneous displacement damage and transmutation over sustained fluences at which lifetime-limiting phenomena, including tritium release kinetics against burn-up, gas build-up effects on pellet integrity, and breeder/structure compatibility under prototypic thermochemical conditions, can be observed to saturation. Neutronic calculations establish breeder material performance under JHR conditions for the given design constraints, alongside a comparison with expected fusion blanket conditions. This identifies where the experiment faithfully models the fusion environment and where scaling arguments or supplementary data are required.

Dynamic mechanical failure of structural materials and tritium production are among the most consequential open challenges facing the fusion industry. FUSERO pursues a practical, actionable approach to addressing both.

The engineering and physics challenges of high-performance long-pulse plasmas in Wendelstein 7-X

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The Wendelstein 7-X (W7-X) stellarator is the world's largest superconducting optimized stellarator designed to demonstrate the viability of the stellarator concept for steady-state fusion power. Unlike tokamaks, W7-X employs a complex, three-dimensional magnetic configuration engineered to minimize neoclassical transport and enable very good plasma confinement without relying on large internal plasma currents. The device is specifically designed to achieve long-pulse, high-performance plasmas: up to 1800 seconds at 10 MW electron cyclotron resonance heating (ECRH). This mission is enabled by a suite of technically demanding and fully qualified systems, including a superconducting magnet system with robust quench protection, an actively water-cooled first wall, divertor, ports, and plasma vessel, and a low-loss quasi-optical ECRH beam line.

Recent operational campaigns have successfully validated the design principles of W7-X. The machine has achieved a record energy turnaround of 1.8 GJ in a 350-second pulse (5 MW ECRH), and demonstrated high-performance plasmas with tokamak-like H-mode characteristics ($T_i \approx T_e \approx 2.8$ keV) for up to 10 seconds under combined neutral beam and ECRH heating. Furthermore, W7-X has reached record stellarator values of the plasma triple product ($n\tau T$), approaching modern tokamak performance, and has realized high-beta scenarios with a volume-averaged β of 3% and a peak core β of 10%, underlining the stability and efficiency of the optimized magnetic configuration under significant thermal pressure. The recent successful deployment of a steady-state-capable extruder pellet injector extends the operational envelope significantly.

However, the transition to the final step of the long-pulse, high-performance plasma program reveals further engineering challenges. Increasing heating power leads to escalating heat loads on plasma-facing components (PFCs), demanding enhanced thermal management, power transfer throughput and structural integrity. Other challenges include integrated operation experience, investigation and selection of suitable magnetic field configurations and the development of feedback schemes for detached divertor operation.

To overcome the hurdles a systematic development strategy has been implemented, based on stepwise system hardening, failure mode and effects analysis (FMEA), and non-conformity management as well as advanced modeling via finite-element calculations. This paper presents the comprehensive technical and operational roadmap for the transition to the full design envelope of W7-X, detailing the current performance status, and the development of its core building blocks.

LEAPS: Upgrades and upcoming experimental programme of high-field spherical tokamak ST40

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

At the end of 2025, ST40 embarked on a major upgrade, funded primarily by a cross-governmental public-private partnership between Tokamak Energy Ltd., the U.S. Department of Energy, and UK Department for Energy Security and Net Zero [1,2]. The upgrade prepares ST40 for the upcoming LEAPS (Lithium Evaporations to Advance PFCs in ST40) Campaign with the objective to study the use of lithium, a potential future liquid metal plasma-facing material, by evaporatively coating its plasma-facing components (PFCs) with solid lithium. In addition to installation of two lithium evaporators, the following improvements will be made to increase the relevance of ST40 results for the next generation of STs: (i) transitioning from graphite to molybdenum PFCs, (ii) introduction of a 1 MW dual-frequency (104/137GHz) gyrotron to provide radiofrequency (RF) heating and current drive, (iii) enabling core fuelling via a four-barrel D pellet injector, and (iv) increasing the toroidal magnetic field of ST40 to 2.4 T. To make the most of plasma operations after these improvements, ST40 diagnostic suite will be improved by both adding a host of new diagnostic systems and refining many of the existing ones. Along with adding new features, robustness and reliability of ST40 will be improved by, e.g., installing a new centre column, and replacing and updating some of the PF coil and neutral beam injector power supplies.

After the upgrade, the first experimental Campaign will explore scenarios with RF start-up, heating, and current drive in a device with all-metal PFCs, whereas the second Campaign will centre on studying the effect of lithium PFCs on plasma performance. Throughout both Campaigns, the focus areas of ST40 research programme will continue to include topics such as energy confinement, validation of transport models, impact of impurities on transport, scrape-off-layer transport, plasma material interactions, power handling, and development of high-performance and advanced operating scenarios utilising pellet injection and electron cyclotron heating and current drive.

[1] U.S. DEPARTMENT OF ENERGY OFFICE OF SCIENCE, “DOE Partners with UK’s DESNZ and Tokamak Energy Ltd. to Accelerate Fusion Energy Development through a $52M Upgrade to the Privately Owned ST40 Facility“, https://www.energy.gov/science/articles/doe-partners-uks-desnz-and-tokamak-energy-ltd-accelerate-fusion-energy-development

[2] GOV.UK, ”UK and US announce first joint project in fusion energy innovation” https://www.gov.uk/government/news/uk-and-us-announce-first-joint-project-in-fusion-energy-innovation

#13855

Performance Evaluation of Hydrogen Isotope Permeation Sensors for Gas-Phase and Static LiPb in the TRI?PRISM Project

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

Monitoring tritium in fusion reactors is crucial from both safety and fuel management perspectives. Within this context, Hydrogen isotope Permeation Sensors (HPS) for tritium monitoring in liquid lithium-lead (LiPb, 15.7 at.% Li) currently represent the reference technology for the Water-Cooled Lithium-Lead Test Blanket System (WCLL-TBS) of ITER and one of the most promising technologies for different liquid metal blankets including the WCLL of the European DEMO reactor and the Kyoto Fusioneering's (KF) Self-Cooled Yuryo Lithium-Lead Advanced (SCYLLA©) blanket as an application to spherical tokamaks.
Kyoto Fusioneering UK has been developing HPS under UKAEA's LIBRTI programme within the TRItium Permeation Real Time In line Sensor for Monitoring (TRI PRISM) project. As part of this effort, a dedicated experimental campaign was carried out to further advance sensor characterisation and qualification.
In this work, a permeation sensor based on a pure alpha-iron membrane was installed and tested under controlled conditions in both gas-phase deuterium and static LiPb within HyPer-QuarCh II device located at ENEA C.R. Brasimone. The experimental campaigns aimed to investigate the sensor behaviour over a wide range of hydrogen isotope partial pressures relevant to breeder blanket applications. The isotopic effect was also assessed through dedicated tests with both protium and deuterium.
A comprehensive analysis was performed to determine the sensor calibration function under different transport regimes. In addition, key performance indicators, including response time, accuracy and limit of detection, were experimentally evaluated. The transport properties of the membrane, with particular emphasis on surface parameters, were also characterized.
These results represent a significant step forward in the qualification of permeation-based sensors for tritium monitoring in liquid metal breeder systems.

#13909

UNITY?3: Launching the Next?Generation Integrated Blanket Test Facility with a Fusion?Prototypic Neutron Field

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

UNITY-3 is a is a beam-target device proposed as an intense 14 MeV neutron source using the D-T reaction. The neutron facility designed to close the long-standing neutronics validation gap for fusion blanket development. The facility combines a stable, 14 MeV neutron source with a modular, reactor-relevant blanket test bed, enabling experimental validation of tritium breeding, neutron transport, and shielding in realistic three-dimensional geometries. A combination of fusion-prototypic neutron energy spectrum and planar-to-volumetric source geometry reproduces key neutronic conditions expected in fusion power plant blankets. A 100 to 150 keV, 1 MW deuteron beam on a tritiated metal target produces fusion-prototypic neutron fields with large volumes exposed to a flux of order 10^{11} n/cm^2/s, a regime only accessible over small volumes with previous neutron sources. The target is designed to produce 10^{18} neutrons, which results in tritium quantities that can be detected easily.

We describe the UNITY-3 facility concept and experimental scope and explain the class of experiments uniquely enabled at this flux level, including measurements of global TBR > 1, 3D-mapped spectrum and breeding, and online tritium transport. UNITY-3 is conceived as a collaborative experimental platform supporting fusion blanket development for both public and private fusion programs.

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#13918

Feasibility study of the response of the STUMM-DONES detection systems

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The Start-Up Monitoring Module (STUMM) is being developed as a calibration and diagnostic module for the commissioning phase of IFMIF-DONES (International Fusion Materials Irradiation Facility – DEMO-Oriented Neutron Source). It will be installed close to the neutron source within the irradiation volume dedicated to material testing, with the primary objective of characterizing the neutron source parameters and irradiation conditions.
STUMM is foreseen to host approximately 240 detectors arranged in dedicated rigs. The diagnostic suite includes eight Rabbit Systems (RS) for the thermal, epithermal, and fast neutron fluxes measurements; 66 pairs of Micro-Fission Chambers (MFC with U-238) and ionization chambers (132 detectors in total) for fast neutron flux monitoring; 36 Micro-Fission Chambers (MFC with U-235) or Self-Powered Neutron Detectors (SPND) for thermal and epithermal neutron flux measurements, 28 gamma thermometers for nuclear heating assessment, and 44 thermocouples for temperature monitoring.
The detectors' requirements are dictated by the extreme operating conditions, including very high neutron fluxes and mixed radiation fields. Sensors must therefore ensure high radiation resistance while maintaining sufficiently low response per unit flux to avoid signal saturation. Although most systems are commercially available, IFMIF-DONES conditions require adaptation and, in selected cases, dedicated design modifications.
This contribution presents studies aimed at estimating the response of the STUMM diagnostic system under representative irradiation conditions. Active detectors such as MFCs (U-235 and U-238), ionization chambers, and gamma thermometers are analysed, together with the Rabbit System, treated as a semi-passive diagnostic tool. The selection of suitable activation materials for the Rabbit System detectors and optimization of the activation detectors and positioning spheres arrangement are discussed. The presented results support validation of the proposed diagnostics concept and contribute to reliable neutron source characterization during the IFMIF-DONES commissioning.

Acknowledgements:

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Progress on the COMPASS Upgrade Construction

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

COMPASS Upgrade (COMPASS-U) is a new medium-sized (R = 0.9 m) tokamak under construction at the Institute of Plasma Physics in Prague [1]. Designed to address some of the key challenges in next step fusion devices, COMPASS-U features a unique combination of hot metallic first wall operating up to 500 °C and cryogenically cooled copper coils. The latter provides a high magnetic field (Bt = 5 T) and high plasma current (Ip = 2 MA), yielding, e.g. a very narrow power flux decay length (

#13950

Design and operation of JT-60SA divertor gas-puffing system considering in-pipe gas flow

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

JT-60SA is one of the world's largest tokamak devices for fusion research and achieved first plasma in 2023. Although, at that time only a limited set of in-vessel components were installed. For the next experimental campaign, aimed at producing and controlling high-performance plasmas, additional components are being installed, including heating systems such as neutral beam injectors, diagnostics and the lower divertor.

To mitigate the heat load on the lower divertor targets, a divertor gas-puffing system is designed and injection nozzles are installed on seven toroidal sections. The expected flow-rate range is approximately 0.5–16 Pa·m^3/s for H2 gas. In the diverter plasma experiment, it is required to control the piezoelectric valve opening, so that flow rate at the injection nozzle varies in multiple stages while ensuring plateau regions. The gas released from the valve propagates through the pipe while filling the internal volume. A time delay between valve opening and the gas outflow at the nozzle tips is expected. Quantifying this delay is needed to estimate the actual injected flow rate during divertor gas injection experiments.

In this flow-rate range, main flow regime in the piping is viscous regime, where the conductance is not solely determined by geometry but depends on pressure. Therefore, analyzing the time evolution of the pressure distribution along the piping network is required.

In this presentation, we report an overview of the JT-60SA divertor gas-puffing piping system and gas-flow analyses that incorporate in-pipe flow effects, focusing on the transient behavior.

Japanese Achievements in R&D for Lithium Target System Performed under the IFMIF/EVEDA Project during BA Phase II

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

For the early realization of fusion neutron sources (FNSs) such as A-FNS and IFMIF-DONES, R&D for the lithium target facility (LF) for FNSs have been conducted under EU-JA collaborative framework of the IFMIF/EVEDA project in BA phase II from 2021 to 2026. As the common issues of A-FNS and IFMIF-DONES under discussion in the IFMIF/EVEDA project team based on the achievements of BA phase I conducted until 2016, 6 tasks had been addressed on the Japanese side, namely, 1) validation of lithium purification system, 2) validation of lithium target diagnostic system, 3) erosion/corrosion analysis of ELTL materials, 4) R&D on stabilization method of lithium, 5) lithium fire, and 6) R&D on analysis methods for impurities in lithium. As topical results from these tasks, 1) lithium purification system could be experimentally validated with the use of LIPSE which is a newly designed and fabricated pilot lithium purification system, 2) lithium target surface diagnostic system with the use of opt-comb laser distance meter was validated with less than 1 mm error from 10 m away from the target, 3) It was considered from the measurements and estimation of erosion/corrosion thicknesses of inner surface of pipes and nozzle of target assembly of ELTL that LF would be operatable even without nitrogen trap, while cavitation gave obvious damage to the materials, which might give harm to the sound operation of LF, 4) it was found that a few microns of lithium on surface could be chemically stabilized to lithium carbonate by sequential exposure of humidified argon and carbon dioxide gases, 5) it was found from a series of lithium ignition experiments that lithium hardly ignites under dry air with the humidity of 0.15v% or less, and that ignited lithium can be distinguished by argon flow from bottom-ward, and 6) adoptability of plugging gauge to lithium system, which has been developed and used in Na system, was validated, and hydrogen (protium) concentration measurement method was developed, as well as those for the other hydrogen isotopes. This paper presents an overview of these achievements including discussions about the next steps and prospects toward the realization of LF for FNSs.

The linear plasma device JULE-PSI: update on plasma operation and integration into a nuclear hot cell

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

Plasma-material interaction significantly determines the lifetime of the first wall and, consequently, the performance, safety, reliability, and ultimately the cost of electricity generation of future fusion power plants. Irradiation and damage caused by fusion neutrons profoundly affect the material properties of wall materials. Various material concepts and systems proposed for plasma facing components have been extensively investigated using non-irradiated samples under steady state plasma exposure. Nevertheless, current findings [1] reveal considerable limitations regarding the extrapolation of these studies to real reactors.
Therefore, it is essential to test neutron-damaged samples after direct plasma exposure. However presently no facility worldwide exists where highly activated samples can be exposed to plasma. The JULE-PSI facility [2], currently under construction, closes this critical research gap and will facilitate the investigation of neutron-damaged materials under reactor relevant plasma fluxes and thus facilitates the study of synergistic effects of radiation damage and plasma-wall interaction in controlled experiments.
JULE-PSI will be placed and operated within a hot cell [3] and therefore device operation, sample exposure control and plasma characterisation will be done remotely. Laser based diagnostics, namely laser induced desorption spectroscopy (LID-QMS), laser induced breakdown spectroscopy (LIBS) coupled with a mass-spectrometer (LIA-QMS) will be used as in situ hydrogen sensitive techniques. This allows thereby assessment of dynamic hydrogen retention directly after plasma exposure and eliminates any hydrogen isotope exchange with ambient air or humidity. In addition, these laser based methods are generally compatible with more detailed studies regarding evolution of mechanical properties or surface roughness in ex-situ analysis stations.

This contribution reports on the archived plasma parameters during prolonged operation of JULE-PSI in noble gasses and gives an outlook towards its integration into the new hot cells. It reviews past engineering decisions, provides an overview of performed cooling upgrades necessary for steady-state operation and presents first results from the characterization of hydrogen plasma. Furthermore, the design of the sample transfer system and exposure manipulator, as well as solutions for coupling high-intensity ps-lasers into the hot-cell, will be discussed.

[1] M. J. Lloyd et al. 2024 Materialia 33
[2] B. Unterberg et al. 2011 Fusion Eng. And Design 86
[3] L. Scheibl et al. 2015 Fusion Eng. And Design 98-99

Cyclotron-driven fast neutron sources at NPI CAS providing support irradiations for IFMIF-DONES preparatory activities

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

The IFMIF-DONES facility requires extensive preparatory work to qualify materials, validate diagnostic systems, and develop operational workflows prior to commissioning. Within the EUROfusion Work Package Early Neutron Source (WPENS), the Nuclear Physics Institute (NPI) of the Czech Academy of Sciences contributes to these efforts by providing cyclotron-driven fast neutron irradiation platforms and the associated simulation infrastructure. This work presents an overview of the neutronics simulation activities and support irradiation experiments conducted at NPI in the framework of several interconnected WPENS subtasks.

NPI operates two complementary p+Be neutron sources. The U-120M isochronous cyclotron generates a continuous neutron spectrum with characteristics overlapping substantially with the fusion-relevant energy range of the IFMIF-DONES field. The recently commissioned High Power Neutron Generator (HPNG) at the TR-24 cyclotron provides approximately one order of magnitude higher fluence rates, enabling shorter irradiation times and higher activation levels.

MCNP6 neutron transport models were developed for both facilities. At the TR-24 HPNG, a simulation of the IFMIF-DONES High Flux Test Module (HFTM) irradiation capsule was established with material specimens, activation foils, and a rhodium Self-Powered Neutron Detector (SPND). The expected SPND signal was estimated using a two-stage methodology, and activation inventory calculations using FISPACT were performed in collaboration with colleagues at UKAEA to support the development of sample reloading workflows. At the U-120M facility, a model of the STUMM-proto module — a prototype of the Start-up Monitoring Module for IFMIF-DONES — was developed through CAD-to-MCNP conversion and integrated into the experiment hall geometry to assess the feasibility of the planned irradiation campaign.
In parallel, in collaboration with KIT colleagues, EUROFER97 steel samples were irradiated at the U-120M NG-2 neutron generator and the measured activation product activities were compared against MCNP predictions, yielding satisfactory agreement and demonstrating the reliability of the simulation framework.

This work discusses the complementary roles of the two NPI sources within the IFMIF-DONES preparatory program and presents details of current status and outlook for ongoing experimental campaigns.

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First operational experience with the new upper divertor in ASDEX Upgrade

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Oral

Abstract

Power and particle exhaust is one of the major challenges for the development of a fusion power plant. An efficient divertor design, combining a high radiative fraction, detachment and helium exhaust is required. Alternative divertor configurations (ADC) such as Snowflake or X-Divertor have been proposed, aiming to outperform conventional single null divertors. In a major two year long effort, ASDEX Upgrade has been equipped with a new upper divertor. The divertor includes two in-vessel divertor coils and a charcoal coated cryo pump capable of pumping helium. The plasma facing components are toroidally symmetric allowing operation in both helicities with a total injected energy of up to 110 MJ. With its size and high auxiliary heating power ASDEX Upgrade is now capable to study these configurations at reactor relevant Scrape-Off Layer (SOL) heat fluxes in an all tungsten environment.
This contribution presents the experience gained from the first operational campaign of ASDEX Upgrade with the new upper divertor. It will highlight the achievement of the different envisioned ADC configurations, such as X-Divertor with a large poloidal flux expansion and Snowflake with an additional X-Point in the divertor region. Challenges encountered during commissioning and scenario development will be discussed, including both technical and operational solutions applied to overcome them. Special care has been taken during scenario development to achieve good diagnostic coverage of both the divertor as well as the upstream region. This is more challenging for operation in the upper divertor compared to the lower divertor since the contour of the plasma facing components on the low field side are not up down symmetric and favor operation in the lower divertor. Nevertheless, the desired ADCs have been achieved up to 1 MA of plasma current and auxiliary heating of over 20 MW, enabling the study of these divertor configuration in reactor relevant conditions. An overview of the technical changes implemented for the second campaign with the new upper divertor is given.

THE SORGENTINA-RF NEUTRON SOURCE: NUCLEAR ANALYSES IN SUPPORT OF ITS DESIGN DEVELOPMENT

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

The SORGENTINA-RF project aims at the design and commissioning of an intense 250 kW accelerator-driven neutron source capable of producing 14 MeV fusion neutrons. A 300 keV positive ion beam of deuterons and tritons impinges onto a rotating target covered with a 3 μm titanium coating, where ions implant and remain stable in the form of titanium hydride, thus producing neutrons via D–T, D–D, and T–T fusion reactions, with an expected neutron yield of approximately $1.3 \times 10^{1}4$ n s^{-1}. While primarly funded for the generation of the radiopharmaceutical ^{99}Mo as precursor of 99mTc, through irradiation of natural molybdenum via the 100Mo(n,2n)99Mo reaction, such an intense neutron source is s also highly valuable for fusion-related research, including materials testing, neutron activation studies, and validation of nuclear data for fusion applications.

The present work provides an overview of the neutronics activities carried out in support of the SORGENTINA-RF design development. The analyses address several key aspects, including the optimization of its performances, the design of the bioshield to mitigate radiation streaming and ensure the protection of personnel and environment, the evaluation of nuclear loads on structural and sensitive components, and radioactive waste assessments aimed at determining the inventory of activated materials during operation and at the end of the facility lifetime.

As mentioned above, the neutron source developed within the SORGENTINA-RF project represents a valuable platform for scientific and industrial applications. In this context, the feasibility of implementing neutron extraction lines for both 14 MeV and thermalized neutrons is baing investigated, with the objective of providing dedicated beamlines for fusion technology studies, materials characterization, and fundamental neutron physics.

#14055

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Topics

B. Experimental Devices and Facilities for Fusion Research

Communication type

Poster

Abstract

The realisation of viable fusion energy plants will require the use of increasingly more capable test facilities for research into component behaviour under fusion-relevant loads and for qualification-type testing to increase technology readiness. The Combined Heating and Magnetic Research Apparatus, known as CHIMERA, will be capable of testing relatively large component modules under near-representative conditions for fusion. CHIMERA is under construction in the UK, and we here give an update on the build status as well as outlining current plans for commissioning and first testing. At the core of CHIMERA is the magnet system, a relatively large split-pair superconducting magnet enabling testing of roughly metre-cubed test modules under static magnetic field of up to 4 Tesla. In parallel, an orthogonal axis pulsed magnet will deliver a transient field at the sample volume of up to 12.5 Tesla/s, enabling testing of transient field effects. The assembly of this magnet is entering final stages involving welding of the two halves of the stainless steel cryostat. First commissioning will focus on bringing online and characterising this magnet system, followed by early testing exploiting this unique setup to build confidence in electromagnetic simulations of fusion components and thereby bringing immediate risk mitigation to fusion programmes. We also give an update on parallel facilities, which can be operated standalone or integrated with CHIMERA, and will deliver installation of a high power continuous laser for component high heat flux heating, and installation of a lithium-lead circulation loop to enable testing of fusion liquid metal blanket mock-ups.