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Book of abstracts

Plasma Physics (WP_ENR, EP-CD, WP-MST1)

TRANSPORT COEFFICIENTS INDUCED BY DRIFT TYPE TURBULENCE IN ITER SIZE PLASMAS

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Massive numerical simulations have shown that heat transport evolves from Bohm to gyro-Bohm scaling when plasma size increases, and they have predicted that ITER plasmas would be close to the gyro-Bohm regime. We have obtained similar results in a theoretical study based on a semi-analytical method, the decorrelation trajectory method (DTM). We have studied both ion and electron transport including the complex case of multi-scale turbulence and the effects of the zonal flows. These studies were enabled by an important development of the DTM, which leads to the decrease of the calculation time with a factor of the order 50.
The physical processes that are characteristic to each regime have been identified. We have shown that the gyro-Bohm regime corresponds to the nonlinear transport process for which ion trapping or eddying in the structure of the stochastic potential is statistically relevant. We have also studied the radial spreading of the turbulence, which is considered in the literature to provide the explanation for the transition to gyro-Bohm regime.
The conclusion of this work is that ion transport in plasmas of ITER size is a complex nonlinear process close to gyro-Bohm scaling, which is essentially determined by particle trapping or eddying in the potential structure.

THE EFFECT ON PLASMA CONFINEMENT OF THE ROTATION INDUCED AT IONIZATION OF NEUTRALS

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We investigate a unifying connection within a wide class of regimes in which it has been noted a correlation between the change of density and the improvement of the confinement. The practical objective is to determine to what extent the transient phase of the external control of density can modify the confinement. There are two mechanisms that we consider responsible for this connection:
(1) the change of density via ionization (of a pellet of gas-puff) means that a fraction of the newly created ions is going to be trapped and is moving radially, from the point of their creation, to occupy the positions (the centers) which are the averages of the banana orbits. The first part, when the ion moves from the place where it has been created to the center of the banana is a net radial current, a single and unrepeatable event for each new ion. The collectivity of such events is very large (comparable with the increase of the density) and produces a torque.
(2) every trapping and detrapping event of ions is accompanied by a substantial change of the neoclassical ion radial drift. As in (1), this is manifested as a unique, unrepeatable, spatially small and short-lived, radial current (for every event of transition trapped/untrapped), and produces a torque that may sustain sheared poloidal rotation.
These two mechanisms reveal the existence of a (volume) source of torque and injection of vorticity that has been ignored until now. They are involved in the Pellet Enhanced Performance (JET), higher confinement with increase

of density (DIII-D), spontaneous rotation (Alcator C-Mod), etc. We also show that these mechanisms provide a coupling between poloidal and toroidal rotation.

Dust dynamics and transport in SOL turbulence. Transport of particles in stochastic electro-magnetic fields in tokamak plasma. Extrapolation of the results to dust in SOL

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We developed a model for impurity transport in SOL, using two alternative methods: DCT method (similar with Negrea *et al.,* PPCF **53** (2011)) and Direct Numerical Simulation using TURBO code. The particle (i.e. ions or dust impurities) transport depends on the level of turbulence and on the inhomogeneity of the magnetic field. We analysed some statistical features of particle dynamics. The specific autocorrelations for the electrostatic fluctuations have been implemented in the TURBO code and we have calculated and interpreted the radial and poloidal MSD, kurtosis and skewness. For another model, we have evaluated the acceleration and the transport of the dust grain assuming the presence of a weakly inhomogeneous sheared magnetic field and of a pedestal radial plasma pressure and considering a typical radial shape of the electric field at the edge of plasma [A.H. Bekheit, Energy and Power Engineering, 39-45 (2010)].
Also, a generalized transport equation for particles was proposed and studied. This model includes local effects (through Fokker-Planck equation) and non-local spatial effects (Levy flights modelled using fractional derivatives). External perturbations are introduced in the model as source term in the fractional equation. A specific code based on matrix approach was built in order to study the one-dimensional model. The 1D specific algorithm was extended for the study of 2D fractional transport equations. Numerical simulations were performed for various source terms and initial conditions. The results were compared with those obtained from classical transport equation in order to observe the influence of non-local spatial effects and of memory effects on the dynamics of the system. A particular attention was paid to the use of asymmetric fractional Riesz derivative (in space) and to the study of this asymmetry's impact on the transport characteristics (for example occurrence of uphill transport).

NUMERICAL METHODS FOR APPROXIMATION OF SOLUTIONS OF FOKKER-PLANCK EQUATIONS BY OPTIMISED REFERENCE DISTRIBUTION FUNCTIONS. CLASSICAL AND GENERALIZED MAXIMUM ENTROPY METHODS.

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The problem of selection by Maximal Entropy principles, of the class of reference distribution functions that are candidates for the optimal approximation of the stationary solutions of the Fokker-Planck equation that describe the statistical properties of the tokamak plasma, is exposed. Maximal entropy principles with scale invariant linear restrictions based on classical Shannon as well as its generalization, that include the extension of the A. Rényi entropy to the case of anisotropic phase spaces are presented. Aspects related to the numerical stability, mathematical consistence of the generalized entropies are discussed. The mathematical foundation of the optimisation principles and algorithms and their realization as FORTRAN 90 programmes are presented.

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DEVELOPING OF PHYSICAL AND NUMERICAL MODELS TO DESCRIBE HALO CURRENT FORMATION AND ASYMMETRIES IN TOKAMAK PLASMAS

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The halo currents represent the major player in plasma-wall interactions during disruptions. A deep understanding of the disruption phenomenon became now a highest priority topic in tokamak plasma physics. The plasma wall touching kink mode, discovered on JET in 1995, is frequently excited during the vertical displacement event (VDE) and causes big sideways forces on the vacuum vessel which are difficult to confront. In VDE the sharing of electric current between the plasma and the wall structure plays an important role in plasma dynamics and determines amplitude and localization of the sideways force. The thin wall approximation is the simplest model for describing the effect of a conducting shell on the plasma dynamics. This model replaces the real current distribution in the bulk of the structure by a sheet current along the plasma facing surface. A wall model and numerical code to describe halo currents in a thin wall has been developed. We have started with the determination in a unitary manner of both current density components: the divergence-free component of the surface current (corresponding to the eddy currents) and the curl-free component (corresponding to the current shearing between the plasma and the wall). Next, a Green's function numerical scheme for the triangle based electromagnetic model of in-vessel components has been formulated and tested. Two energy functional (Lagrangian) for both surface current components have been defined. Extension of STARWALL-JOREK code to consider halo currents is under work and will continue in 2015 and 2016.

WPCD Portal for Fusion and Complementary Research

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The Portal software developed in the context of the ITM-TF (Integrated Tokamak Modeling Task Force) was adapted to the needs of the WPCD ("Code development for integrated modelling" EUROfusion Work Package) project. Thus, it continues to represent one of the key entry points for users accessing the computing resources, both hardware and software, available to project members. New tools were developed and made available through the web interface, as well as updates to existing ones.

INFLPR being member of the ADAS international project, the present project has consolidated the link with ADAS as well as helped to improve the precision and completeness of the atomic database used for simulations with the suite of codes developed within WPCD which are aimed to be applied to the present fusion experiments, validated against plasma spectroscopy and furnish predictions for ITER.

NTM DYNAMICS AND EXTERNAL MAGNETIC PERTURBATIONS

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We have participated to the AUG14-1.4-4 "NTM dynamics and external magnetic perturbations" experimental campaign within the frame of the Medium-Size Tokamak 1 Campaign (WPMST1 2014). 17 shots have been performed in order to gain information regarding the integration of the MHD control into plasma scenarios. The experimental campaign main goals were to improve the understanding of the interaction of NTMs with the magnetic perturbations (MPs), to study the NTM onset mechanism in NTM free discharges using rotating $n=1$ MPs, to validate existing NTM onset and saturation models and develop new models where necessary. As primary deliverables the following are to be fulfilled: obtaining the parametric dependence of the MP penetration threshold, characterizing the physics of NTM onset and probing NTM destabilization by polarization current effect. Basically, the full scenario for the *(2,1)* NTM is to establish.
Our objective within the project structure was to develop a 3D linear multimode model to provide the description of the tearing mode dynamics in the so-called linear regime (FKR regime). The theoretical objective was to match the expected experimental results. We have solved the plasma/vacuum/external conductors system of linearized perturbed equations in order to obtain a time dependent solution to show the mode dynamics. The influence of the resistive wall and the effect of the coupled (N)TM-RWM have been calculated. The derived solution of the above mentioned equations exhibits an analytic dependence on all the external conductors surrounding the plasma column as well as on the plasma toroidal rotation and on the amplitudes and rotation frequencies of the error field spectrum components. The plasma rotation and the static / rotating error field effects on the (N)TM dynamics have been calculated.
Our scientific proposals have already been approved and our work will continue within the frame of the further MST1 experimental campaigns for the AUG and TCV devices, during 2015 and the first half of 2016.

Materials (WP-MAT)

W-metal laminates: using W paradox to develop W based structural materials by FAST

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FAST has been successfully used to create W-laminates with Cu, V, Ti, Pd and W. Multi-layered composites with different rectangular and disc shapes have been produced and investigated (morphology and thermal properties) . The effect of long term (up to 1000 hours) exposure to high temperature (1000 °C) has been assessed for the first laminates batches.

Thermal barriers: materials and components design

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Thermal barriers are a promising route to control the heat flow through the heat sink components of the DEMO divertor. To achieve this goal a concerted design effort for both components and materials is needed. The key points of this work are presented together with the results obtained for thermal properties of some candidate materials.

SURFACE MODIFICATION AND HEATING OF FUSION COMPATIBLE MATERIALS EXPOSED TO A FEW MEV ELECTRON BEAM AND PLASMA JET

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Materials compatible with fusion technology have to withstand high heat fluxes and resist to bombardment of ionized particles, neutrons and photons. Tungsten and carbon are already used for building the first wall or the divertor of tokamaks. The need to understand the behavior of these materials under extreme conditions of temperatures and particle fluxes is of paramount importance for designing and building the future large fusion machines such as ITER. Testing of these materials has been conducted at several facilities by recreating at best the conditions present in a fusion plasma [1]. Small samples of about 1 cm^3 made of C and W were exposed to a relativistic electron beam with an energy of 6.2 MeV produced in a LINAC. The heating of these samples induced by the energy deposited by the electron beam was evaluated experimentally and semi-analitically during the irradiation and an extrapolation has been made for the parameters of a tokamak [2,3]. Thin films with different widths, from 80 nm to 70 microns were exposed to plasma jets created in a coaxial plasma gun powered by a capacitor bank with a maximum stored energy of 2 kJ. Heating by the plasma jet induced cracks and local melting on the surface of the films.

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Magnets (WP-MAG)

Accurate 3D modeling of Cable in Conduit Conductor type superconductors by X-ray microtomography

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Operation and data acquisition of an X-ray micro-tomograph developed at INFLPR are optimized to produce stacks of 2-D high-resolution tomographic sections of Cable in Conduit Conductor (CICC) type superconductors demanded in major fusion projects. High-resolution images for CCIC samples (486 NbTi&Cu strands of 0.81 mm diameter, jacketed in rectangular stainless steel pipes of 22x26 mm2) are obtained by a combination of high energy/ high intensity and small focus spot X-ray source and high resolution /efficiency detector array. The stack of reconstructed slices is the input data for quantitative analysis consisting of accurate strands positioning, determination of the local and global void fraction and 3D strand trajectory assignment for relevant fragments of cable (~300 mm). The strand positioning algorithm is based on the application of Gabor Annular filtering followed by local maxima detection. The local void fraction is extensively mapped by employing local segmentation methods at a space resolution of about 50 sub-cells sized to be relevant to triplet of triplet twisting pattern.

For the strand trajectory assignment we developed a global algorithm of the linear programing type which typically provides the vast majority of correct strand trajectories. For carefully manufactured benchmark CCIC samples over 99% of the trajectories are correctly assigned. For production samples the efficiency of the algorithm is around 90%. Trajectory assignment of a high proportion of the strands is a crucial result for the derivation of statistical properties of the cable such as twisting pattern, cos(θ) or void fraction.

Plasma facing components (WP-JET2, WP-PFC)

ITER related mixed reference coatings preparation and characterization

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Beryllium containing samples, having D and N gaseous inclusions were obtained using TVA and HiPIMS techniques. The two types of layers were compared in the frame of the working plan in NILPRP Bucharest and UAIC Iasi. Also, a set of samples were sent for characterization to the partners laboratories, namely: VTT-Finland, IST - Portugal, Juelich - Germany, CEA - France.

A study concerning W erosion evolution and surface change at high temperatures for samples exposed to H containing plasmas was performed. The layersobtained by CMSII were heated to 4000C and 8000C respectively, in vacuum pressure or heated to the same temperature and exposed to hydrogen plasma. The exposing plasma parameters were: RF power supply, 100 sccm hydrogen flux, 9E-3 mbar pressure, 11 cm distance between plasma source and surface of W samples and & hours exposing time. AFM measurement showed a 31 nm value of the RMS.

Erosion process of a W sample in a HiPIMS discharge under the action of Ar and N ions Was also performed. Erosion profile and re-deposition process were highlighted through profilers measurements. Nitrogen radial distribution embedded in the W sample is very well correlated with the erosion profile. The sputtered W atoms were studied using laser absorption spectroscopy and laser induced fluorescence.

Post mortem analysis of the JET HFGC and WPL tiles

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The JET campaign carried out between Aug. 2011-July 2012 demonstrated that the ILW (ITER like Wall) configuration meet and exceeded the expectations concerning power and energy handling capabilities. An extensive program aimed to analyze and assess the results of the ILW JET operation was launched in 2014 under EUROfusion framework. Within the present project samples cored from tiles exposed in campaigns 2011-2012 have been analyzed. These samples retrieved from JET wall were characterized by X-ray micro-tomography (XCT), high energy X-ray fluorescence (HEXRF), glow discharge optical emission spectrometry (GDOES), X-ray diffraction (XRD) and thermo-desorption spectrometry (TDS). Another important task performed within this project was the cutting of 13 Be tiles exposed to JET plasma.

The HEXRF investigations indicated that W particles can penetrate up to a depth of 0.25 μm. The measurements indicated that no erosion of W coatings occurs after the exposure in JET. The measured thickness was about 9.5 μm, similar with the initial coating thickness. GDOES analysis revealed a relatively thick Be deposit of 20÷25 μm on top of a specific tile (HFGC). The analysis showed also the presence of Be at large depth, up to about 100 μm. The penetration of Be through the W/Mo coating should be investigated in more details. SEM investigations and EDX (Energy Dispersive X-ray spectroscopy) confirmed the GDOES results. XRD measurements were performed on Be IWGL tile ASSY, tile CARRIER ASSY and dump plate. Ni and BeNi compounds have been identified on some samples. In specific areas some small amounts of W have been identified by using EDX and XPS investigations. TDS analysis was used to assess the deuterium release from IWGL tile ASSY and dump plate. It has been found a desorbed quantity in the range of $1.55x10^{18}$ - $6.56x10^{18}$ D/cm^2. In order to analyze the deuterium profile across the W coatings exposed to JET plasma, the GDOES equipment was upgraded with a monochromator. A cutting technology for Be tiles, able to keep the temperature below 70°C was developed. A number of 163 Be samples have been cut from 14 tiles and were sent to JET to be distributed to other laboratories for analyses.

D2+He plasma influence on Be-W mixed films prepared by TVA technology

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In the next generation fusion reactor (ITER), a W divertor will be subjected to low-energy high flux particles consisting of hydrogen isotopes (D, T), helium (He) beryllium (Be) and other impurities. The presence of Be as a first wall component will likely generate Be-W mixed surfaces due to the sputtering process followed by re-deposition during plasma operation. In previous work, the retention properties and effects caused by deuterium plasma on deposited layers of Be-W of varying composition were examined. This current work extends that study and reports on the retention properties, and morphological and structural changes of varied compositions of Be-W layers, when exposed to D2 + He mixed plasmas in PISCES-B. Mixed material layers consisting of beryllium (Be) and tungsten (W) with well controlled atomic composition were produced using thermionic vacuum arc technique (TVA). 2 µm thick Be-W mixed deposited films were exposed to high ion flux (5.7–7.5×1022 ions m-2s-1) D2+He mixed plasma at two temperatures regimes of 473 K and 1073 K respectively. Structural and morphological studies were carried out prior and post plasma exposure. Regardless of the exposing temperature and elemental composition of each studied sample, results show a strong depletion of Be in the near surface and in coating depth respectively. For the case of 473K exposure, Thermal Desorption Spectrometry (TDS) showed a decreased level of D retention in W rich layers as compared with pure deuterium exposure. High temperature exposure, namely 1073K, leads to surface enhancement in tungsten which, in turn, results in He induced W “fuzz” structures whatever of the initial Be-W elemental ratio.

STUDY OF W AND WN LAYERS MODIFICATION UNDER EXPOSURE TO H OR D CONTAINING RF PLASMAS

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We study the influence of a thin layer of tungsten nitride (WN) on the plasma deuteration of W thin films prepared by magnetron sputtering. Two types of samples were prepared on silicon substrates: *i)* thin (300nm) layers of W denoted with W_{AR} and *ii)* sandwich structures (denoted WNW), containing a 5nm thin layer of WN in between two layers of W (the bottom and top W layer being 300nm, respective 30nm thick) [1]. W_{AR} and WNW samples were simultaneously exposed to a D_2 glow discharge until first sign of film deterioration appears. Top view and cross section SEM investigations show that deterioration of the samples is produced due to blistering. Such as, blisters were observed to develop at the interfaces (Si substrate for W_{AR} samples, respective WN interlayer for the WNW structure). Exfoliation of W_{AR} sample is produced by the cracks appearing at the edges of the blisters. For WNW samples only the top W layer is affected by blistering; still, no cracks were observed at the edges of the blisters. Moreover, the top W exfoliated layer presents a continuous and corrugated shape. NRA and ERDA investigations performed on the undamaged zones of the samples exposed to plasma reveal that the WN interlayer substantially reduced the diffusion of Deuterium in the bottom layer. These results are in agreement with other results [2], proving that even a very thin layer of WN might be able to act as D diffusion barrier.

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Thin layers of W/Mg/C obtained by laser ablation: preparation and properties

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Thin films of Mg/W and C/W have been prepared by sequential Pulsed Laser Deposition (PLD) and Pulsed Laser Deposition assisted by a radiofrequency plasma (RF-PLD) in argon atmosphere. The gas pressure during deposition, the substrate temperature and the number of pulses on each target during a sequence have been varied in order to establish the appropiate set of values that produces the best composite layers.
An alternative ablation method, using two lasers, with different wavelengths for different ablation targets has been implemented. The thin films have been characterized by Atomic Force Microscopy (AFM), X-Ray Diffraction (XRD), Spectral ellipsometry (SE) and Secondary Ions Mass Spectrometry (SIMS).
The thin layers have been exposed to deuterium plasma and the effects have been analyzed by the same techniques.

Fe BASED INTERMETALLIC COMPOUNDS WITH Cr, Mo AND W ALLOYING ELEMENTS

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Fe-based intermetallics, specific to PFCs, with alloying elements from the Cr group (Cr, Mo or W), in form of ribbons and thin films were envisaged. Details on processing conditions, local configurations around the Fe atoms, structural thermal stability and effect of light element penetration in such structures are reported. In this respect, $Fe_{1-x}Mo_x$ and $Fe_{1-x}Cr_x$ ribbons, with x = 0.05, 0.1 and 0.15, have been prepared by melt spinning, annealed in Ar atmosphere at 600 and 700°C or in He atmosphere at 800, 1100 and 1300 °C have been prepared and further characterized by means of Differential Scanning Calorimetry, X-ray diffraction and transmission Mössbauer spectroscopy. Solid solutions with the bcc structure in the as-quenched state were evidenced by XRD. The structural stability of the solid solutions is excellent, over passing the stability of the usual structure of individual elements. The local configurations (type of neighbours) of the Fe atoms in the bcc structure are directly influenced by annealing conditions and type of protecting atmosphere (e.g. He against Ar). On the other hand, $Fe_{1-x}Mo_x$ and $Fe_{1-x}Cr_x$ thin films have been prepared by rf sputtering whereas Fe-Cr-W films have been obtained by thermo-ionic vacuum arc methods. The films were characterized by Granzing Incidence XRD, Reflectometry and Energy Dispersive X ray spectroscopy as well as by Conversion Electron Mossbauer spectroscopy. The rf sputtered films are amorphous and present a good structural stability under thermal treatments. The effect of the hydrogenation process was also analyzed for some compositions.

Participation at JET experiments and enhancements (WP-JET1, WP-JET4)

JET GAMMA-RAY SPECTROMETER UPGRADE

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§ See the Appendix of F. Romanelli et al., Proceedings of the 25th IAEA Fusion Energy Conference 2014, Saint Petersburg, Russia

The α-particles produced by the nuclear fusion reactions between deuterons and tritons will provide the power for self-sustained DT-plasma burn by transferring their energy to the thermal plasma during their slowing down. Therefore the adequate confinement of α-particles will be essential to provide efficient heating of the bulk plasma and steady-state burning of reactor plasma. Consequently, the investigation of α-particles behaviour for deciphering the main mechanisms of their slowing down, redistribution and losses, appear as priority task for the planned deuterium- tritium experiments on JET in order to develop optimal plasma scenario.

The GSU project addresses the upgrade of the KM6T spectrometric system in order to bring it at the desired level of compatibility with the future DT campaign. This project is running in the EUROfusion WPJET4 Work Package. IAP-INFLPR-INOE (Institute of Atomic Physics which is an EUROfusion member and its linked-third-parties the Institute for Laser, Plasma and Radiation Physics and the Institute for Optoelectronics) is leading the Project Consortium which includes the following partners: CCFE UK, ÖAW Austria, CNR Italy, IPPLM Poland, IST Portugal, SFA Slovenia.

The project comprises the development of a radiation field components assembly (RFCA) which will allow for the definition of the spectrometer Field-of–View (FoV) across the DT plasma and will provide adequate shielding of the gamma-ray detector from parasitic neutron and gamma-ray sources. For proper gamma-ray measurements, the necessary reduction of the neutron flux of 14 MeV neutrons reaching the detectors will be achieved by the manufacturing and installation of a set of LiH neutron attenuators. The upscale of the prototype LiH neutron attenuator to a cross-section close to that needed for the KM6T neutron attenuators is the second IAP-INFLPR-INOE milestone completed in 2014.

JET Lost Alpha Gamma Rays Monitor

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The confinement of alpha particles represents a critical issue for the successful development of the tokamak fusion reactor. A method to measure the local fluxes of lost alpha particles in a tokamak (a Lost Alpha Monitor, LAM) has been proposed recently [1] and it is to be applied on JET within the "Lost Alpha Gamma Rays Monitor (LRM)" EUROfusion project. The LAM implementation on JET turned out to be far from a straightforward upgrade of an existing diagnostics as it was initially estimated. Although simple in principle, the application of the LAM technique on JET has run into severe technical complications due to the particular structure of the machine. Consequently, in its initial phases, the LRM project is planned to go through two gate reviews aimed at assessing the feasibility of the proposed solutions.

The activities performed so far within a first phase of the "Feasibility Study and Conceptual Design" have included numerical calculations for alpha particle losses, gamma-ray emission from the LAM beryllium target, gamma-ray detector response and transport of radiations (neutrons and photons) emitted by large volume sources. Pre-conceptual designs have been developed for two different locations on JET for the LAM diagnostics.

The main technical issue for the LRM project is the presence of strong parasitic gamma radiation from large quantities of carbon (divertor CFC tiles) falling within the detector field-of-view for at least one of the design alternatives. Means to deal with the large ratio of parasitic-to-useful radiation levels have been investigated as well as alternatives for some of the diagnostics components (target, detector, data acquisition).

A design solution that avoids or mitigates this issue and which could be developed within the allocated project budget is still to be found.

[1] Kiptily V.G. et al., Fusion Alpha-Particle Diagnostics for DT Experiments on the Joint European Torus, International Conference on Fusion Reactor Diagnostics, Villa Monastero, Varenna (Italy), September 2013.

NEW DEVELOPMENTS IN JET GAMMA EMISSION TOMOGRAPHY

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§ See the Appendix of F. Romanelli et al., Proceedings of the 25th IAEA Fusion Energy Conference 2014, Saint Petersburg, Russia

JET neutron profile monitor ensures 2D coverage of the gamma and neutron emissive region that enables tomographic reconstruction. Due to the availability of only two projection angles and to the coarse sampling, tomographic inversion is a limited data set problem. Several techniques have been developed for tomographic reconstruction of the 2-D gamma and neutron emissivity on JET, but the problem of evaluating the errors associated with the reconstructed emissivity profile is still open. The reconstruction technique based on the maximum likelihood principle, that proved already to be a powerful tool for JET tomography, has been used to develop a method for the numerical evaluation of the statistical properties of the uncertainties in gamma and neutron emissivity reconstructions. The image covariance calculation takes into account the additional techniques introduced in the reconstruction process for tackling with the limited data set (projection resampling, smoothness regularization depending on magnetic field). The method has been validated by numerically simulations and applied to JET data. Different sources of artefacts that may significantly influence the quality of reconstructions and the accuracy of variance calculation have been identified.

Thermal emissivity at 4 µm for W coated CFC tiles determined with a Single Pixel scanning IR Camera

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The emissivity value is a key parameter for determination of the real temperature with the IR cameras. For a correct evaluation of the heat loads on different components of the ILW (ITER Like Wall), the right values of the emissivity for those components should be introduced in the software programs. Previous experiments carried out at 1064 nm in the framework of JET Enhancements ACIR project revealed a significant influence of the substrate structure on the emissivity of W coatings. Since the ILW contains about 1300 CFC (Carbon Fibre Composite) tiles coated with 10 µm and 20 µm of tungsten, determination of emissivity at 4 µm is important for interpretation of the results associated with the surface temperature obtained during the JET campaigns.

The present project is a continuation of ACIR and aims the determination of thermal emissivity for W coatings at a wavelength of 4 µm. This is the wavelength where the scientific cameras from JET operate. The previous experiments performed with IR camera operating at 1064 nm revealed that the substrate structure affects the emissivity of W coatings. A significant difference between the emissivity values of W coatings and bulk W measured in the framework of ACIR project was found. The issues related to the substrate material and structure affects in the same extent the emissivity at 4 µm too.

In order to achieve the project goal as a first stage the procurement of single pixel IR detector and other IR components was performed. The design and the manufacturing of the experimental setup were the next step. The data acquisition and the control of the movement of the IR detector will be performed by using a software program particularly developed. The emissivity measurements will be performed on W coatings (10 µm and 20µm) deposited on CFC and FGG (Fine Grain Graphite) substrates.