Institute of Atomic Physics www.ifa-mg.ro
407 Atomistilor St., Magurele, ILFOV, 077125, P.O.Box MG-3, ROMANIA, Phone/Fax: (+4021) 457 44 93, 457 44 56

Asociatia EURATOM-MEdC Romania

pentru fuziune termonucleara controlata

Romania a aderat la EURATOM in 1999, si a creat Asociatia EURATOM-MEdC, fiind acceptata ca participant la realizarea programului European de cercetari in fuziunea termonucleara controlata in plasma confinata magnetic. Obligatiile generate de aceasta participare sunt stipulate in documente incheiate intre Comisia Europeana si Ministerul Educatiei, Cercetarii si Inovarii:

- Contract of Asssociation between the European Atomic Energy Community and the Ministry of Education and Research of Romania
- European Fusion Development Agreement (EFDA)
- JET Implementing Agreement (JET = Joint European Torus, instalatia Tokamak Europeana)
- European Joint Undertaking for ITER, Fusion for Energy (ITER = International Thermonuclear Experimental Reactor)
- Mobility Agreement

Unitatea de Cercetare a Asociatiei isi stabileste programul de lucru exclusiv pe baza cerintelor formulate de EFDA si acest program este aprobat direct de Comisia Europeana Directoratul J – Energy (EURATOM). Evaluarea rezultatelor se face exclusiv de catre experti EFDA prin Topical Groups si Task Force.

In prezent exista 15 Task Agreements cu EFDA si EFDA-JET si inca 8 Task Agreements propuse si aflate in examinarea EFDA.

Exista doua participari la “Consortia of Associations” pentru realizarea de obiective legate de ITER, lansate de Fusion for Energy (F4E): ITER Tritium Plant si Date Nucleare de fuziune.

Realizari notabile:

- Asociatia EURATOM – MEdC Romania a castigat competitia internationala pentru realizarea operatiunii de protejare a camerei de reactie a JET (pentru regimul de reactor termonuclear) prin oferirea singurei solutii viabile de depunere de Wolfram pe peretele interior (10 competitori constand in Asociatii din alte state europene precum si intreprinderi comerciale). A fost realizata o instalatie industriala de acoperire cu straturi subtiri prin pulverizare magnetron combinata cu implantare ionica.

- Asociatia EURATOM – MEdC a fost nominalizata pentru realizarea de depuneri de Beryllium pe celulele superioare ale camerei JET

- Asociatia EURATOM – MEdC perfectioneaza diagnostica instalatiei europene JET: Gamma Ray Cameras Neutron Attenuators, Gamma Ray Spectroscopy. Peste 70% din efortul Asociatiei este destinat JET.

- Associatia EURATOM-MEdC a realizat dispozitive pentru examinarea structurii interne a dispozitivelor, componentelor, etc. legate de instalatia de fuziune, prin tomografie computerizata cu raze X. Succesul unui numar extrem de mare de aplicatii a fost apreciat si constituie baza unor propuneri de colaborare.

- In fizica fuziunii termonucleare Asociatia are contributii importante in: statistica particulelor incarcate, instabilitati si turbulenta, magnetohidrodinamica, date atomice si nucleare, etc. Peste 100 de lucrari stiintifice in reviste ISI. Primele doua pozitii in lista pentru Plasma in Ad-Astra.

- Preferential Support din partea EFDA pentru Asociatie in : (1) Integrated Tokamak Modeling (2) Plasma-wall interaction

Activitatile sunt sustinute de ANCS si co-finantate de Comisia Europeana conform cu Contract of Association.

Tungsten coating of CFC (Carbon Fiber Composite) tiles for the JET (Joint European Torus) first wall

A number of 10 technologies to produce 10µm W coatings have been developed and applied on identical CFC samples.

After tests **all the coatings proposed by several EURATOM Associations and Industrial Companies experienced delaminations except the one developed by MEdC**. **As a result of this tough competition, this technology was selected for coating about 1000 tiles** of various shapes and dimensions for the JET wall.

This is the object of the following Task Agreements with the European Commission:

1. EFDA Task Agreement Code: JW5-TA-EP-BEW-02 Task Agreement Name: R&D on W coating on CFC and bulk W tiles development in support of the ITER-like Wall project (BEW) (2005 – 2006)

2. EFDA Task Agreement Code: JW6-TA-EP2-ILC-04. Task Agreement Name: Manufacturing and testing of W-coated CFC tiles for installation in JET for the ITER-like Wall project (2007 – 2009)

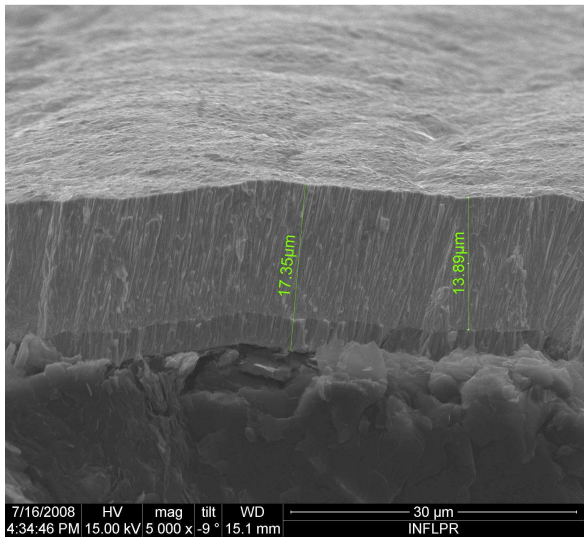


Fig. 1 Scanning Electron Microscopy micrograph of the W coating deposited on CFC substrate by CMSII technology (Combined Magnetron Sputtering and Ion Implantation)

Fig.2 CMSII Industrial Coating Unit developed under EURATOM program

Fig.3 Inner Wall Cladding W coated prototypes tiles for JET

Contact address: Dr. Cristian Ruset, EURATOM MEdC Association, National Institute for Laser, Plasma and Radiation Physics, Plasma Physics and Nuclear Fusion Department

High Resolution X-ray Tomography in Nuclear Energy Research

Contribution to EURATOM FUSION

- Assessment of the Structural Integrity of a Prototypical Instrumented IFMIF High Flux Test Module Rig by Fully 3D X-ray Microtomography

- 3D X-ray Micro-Tomography for Modeling of Nb3Sn Multifilamentary Superconducting Wires

- Neutron emission tomography for limited data set at JET tokamak

Contribution to EURATOM FISSION

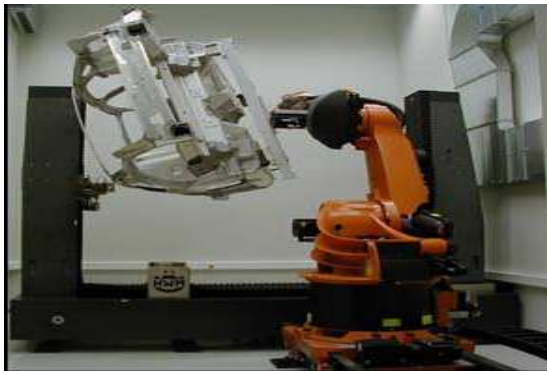
- Nuclear waste management: X-ray micro-tomography for crystalline host rock analysis

  - X-ray Tomography for Nuclear Applications and Research

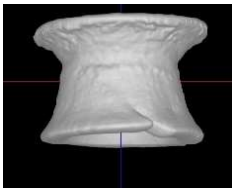
- Ultra fast X-Ray Computed Tomography for Transient Phenomena

  - Gamma Emission Tomography

INFLPR UPGRADED X-RAY subMICROTOMOGRAPHY FACILITY

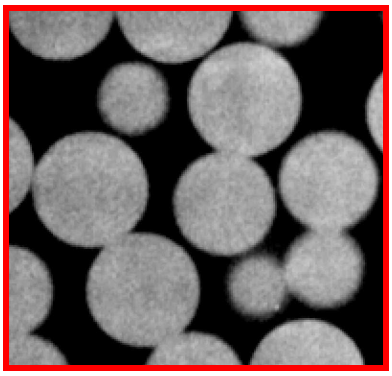


Advanced Computed Tomography System for the Inspection of Large Aluminium Car Bodies



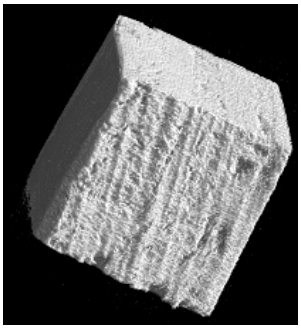
High resolution tomography for ITER

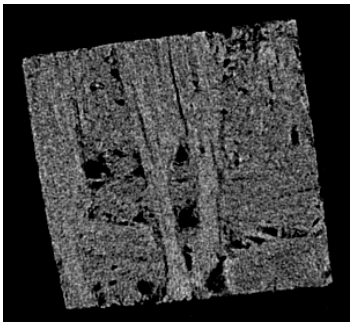
(International Thermonuclear Experimental Reactor)

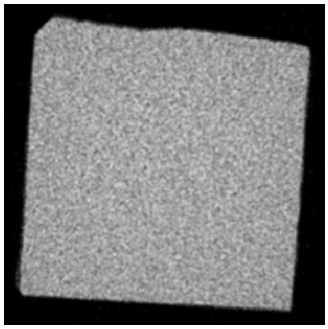


CFC JET/ITER

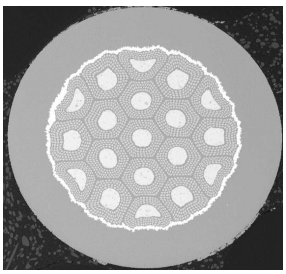
Sample sectioned to about 4 x4x4 mm^3: 3D tomography reconstruction and axial cross section Space resolution 18 microns/ image pixel, minimum detectable feature 15-20 micro

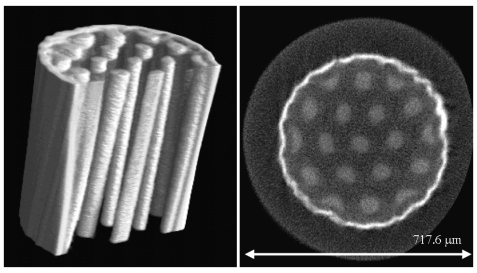




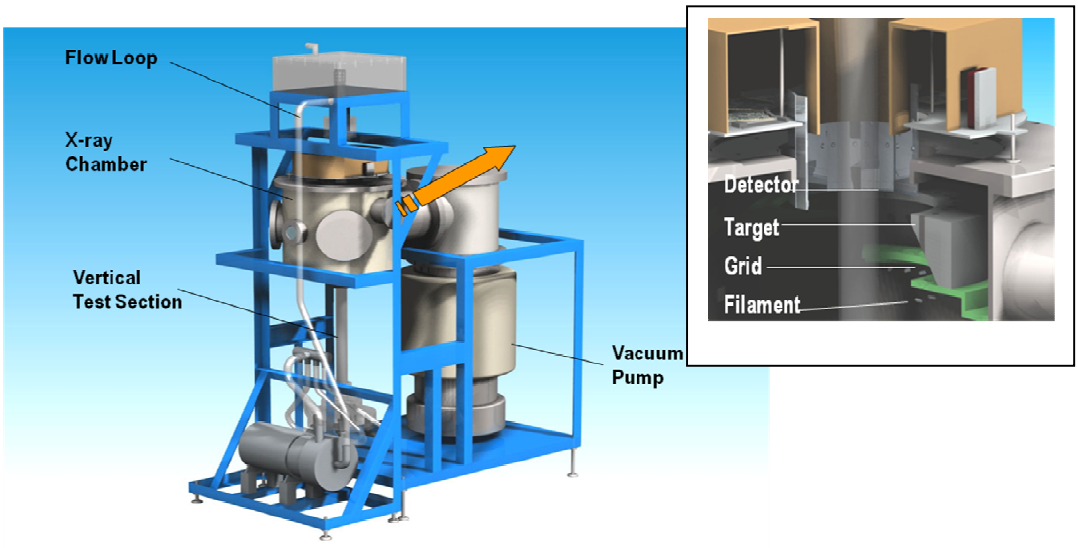


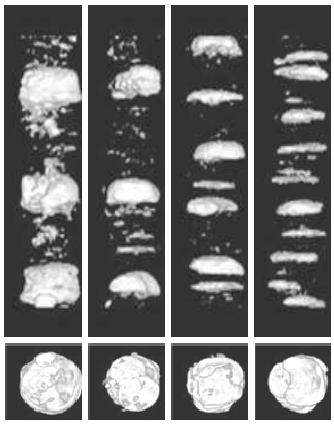
X-ray tomography on ITER Type Nb3Sn superconducting wires





Fast X-ray computer-tomography for transient phenomena





Instantaneous bubble interface visualized by fast X-ray computer tomography

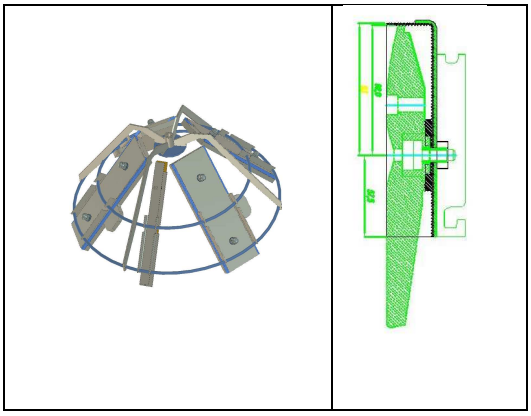
Contact address: Dr. Ion Tiseanu, Dr. Teddy Craciunescu

EURATOM MEdC Association, National Institute for Laser, Plasma and Radiation Physics, Plasma Physics and Nuclear Fusion Department

Production of Beryllium Coatings for Inconel Cladding and Beryllium tile Markers for the ITER-like Wall project

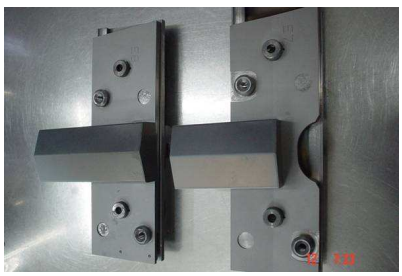
The primary material choice in the ITER fusion device is beryllium (Be) for the entire main chamber wall, carbon fiber composite (CFC) at the divertor strike points and tungsten (W) on the baffles and dome.

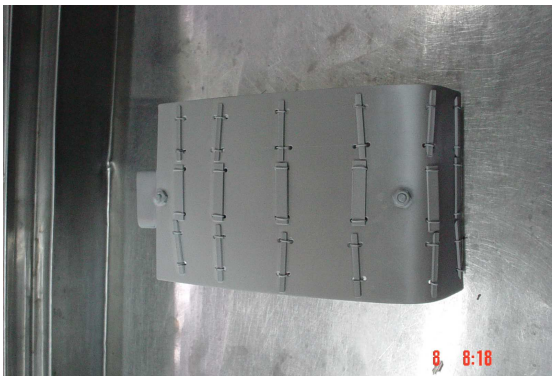
INFLPR has developed a technology for coating tiles of JET wall with a 8–9µm thick film deposited by Be evaporation. Thermal evaporation of Be (1287^{o}C melting point) was performed by using a sintered beryllia crucible (BeO, melting point at 2530^{o}C) that was heated by a molybdenum resistor.

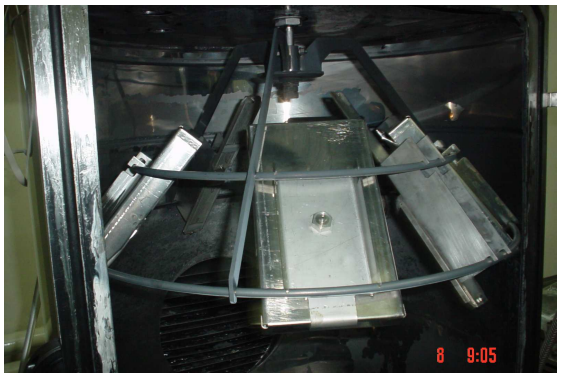


The new cupola device for Inconel tiles deposition and the jigging device for the inconel tile

Thermal evaporation system dedicated for Inconel tiles coating. Below: Inconel IGWL and IWC tiles coated with Be by thermal evaporation, Inconel DPC tiles coated with Be by thermal evaporation







IWGL tiles and zyrkonium alloy samples installed in the cupola, and (right) The zirconium alloy test samples after coating. IWC, DPC tiles and zirconium alloy test samples settled on the cupola device. The zirconium alloy test samples after coating (right).

Diploma for antifriction layer and deposition method

Contact address: Dr. Cristian Lungu

EURATOM MEdC Association, National Institute for Laser, Plasma and Radiation Physics

Contributions of the Institute of Cryogenic and Isotope Technology

To the EURATOM programme

1. Technologies for separation of the hydrogen isotopes in Heavy Water Detritiation Systems (TWO-TRIT/REM)

2. Optimisation of the ratio of filling substance/catalyser for the simultaneous transfer of the deuterium and tritium in detritiation systems (EFDA-JET Task Agreement No. JW0-FT-2.1)

3. Endurance test for the mixture of the filling substance/catalyser proposed for the detritiation system of JET (EFDA-JET task Agreement No. JW – FT – 2.20)

4. Tritium permeation in materials (NUC – INT – UT 4)

5. Design of the equipment of tritium processing for JET and ITER; (EFDA-JET Task Agreement Nos. TW2-TI-TR39, TW5-TTFD-TPI-51 and TW6-TTFD-TPI-55)

6. Research Training Network - „Preparing the ITER Fuel Cycle“

7. JET Gamma-Ray Cameras Upgrade Neutron Attenuator (GRC_KN3_NA)

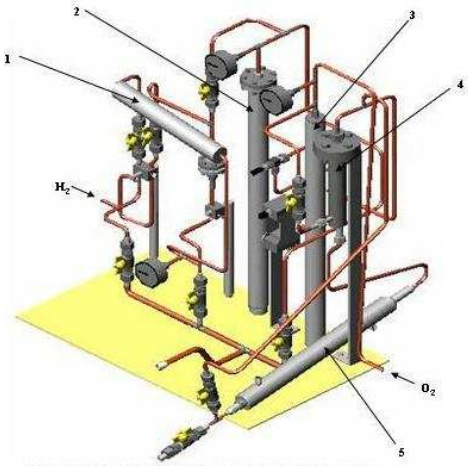
8. Tests of endurance of the components of the systems for water detritiation

Test of endurence of the mixture of the filling substance/catalyser proposed for the system of detritiation of JET

Instalatie experimentala

Amestec catalizator/umplutura

Permeability of tritium in metallic metarials



The experimental stand for tritium permeation
1 - permeation membrane flanges;
2 – hydrogen/tritium stocking vessel;
3 – oxygen stocking vessel;
4 - catalyst burner;
5 - cooler

Stand experimental

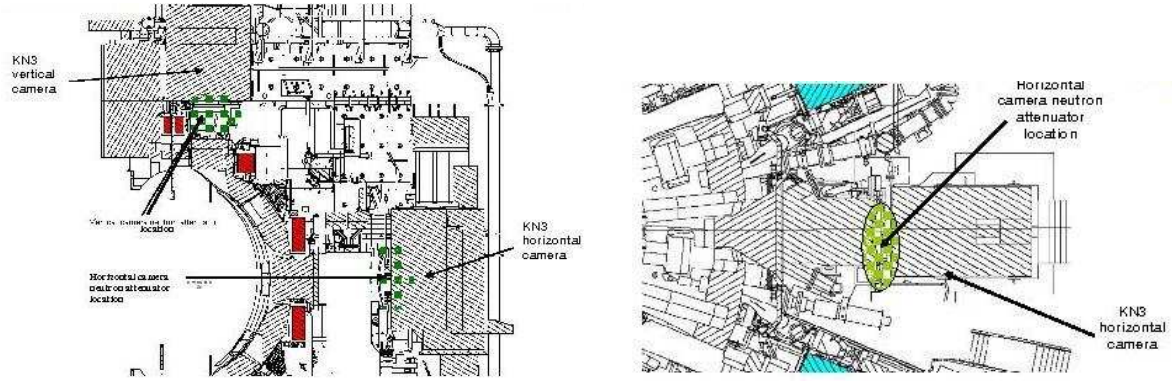
Contact address: Professor Dr. Ioan Stefanescu,

EURATOM MEdC Association, Institute for Cryogenics and Isotope Technology, Rm. Valcea

Upgrade of the neutron and gamma ray dignostics at JET:

Gamma ray cameras neutron-attenuators

Neutron attenuators have been designed in order to improve the accuracy of the gamma ray spectroscopy at JET (Joint European Torus).



Positions of the gamma ray spectroscopic line of sight (for vertical and horizontal components) relative to the JET reaction chamber

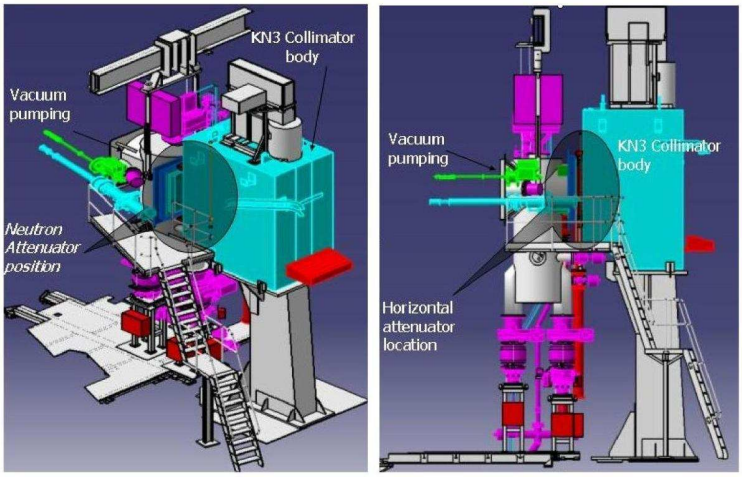


Figure 4.4 Isometric and side view of horizontal neutron camera showing the neutron attenuator location

Contact address: EURATOM MEdC Association, V. Zoita, INFLPR Bucharest, M. Curuia, ICSI Rm. Valcea

Inside-Gap Plasma Generator for wall cleaning applications

Development of a technology, of a device and of the experimental procedures for cleaning the fuel and impurity retentions on the surface of the reactor chamber in a tokamak

Inside-Gap Plasma Generator (IGPG) tool at laboratory scale.
Task Agreement No.: *JW6-FT-JET-A*

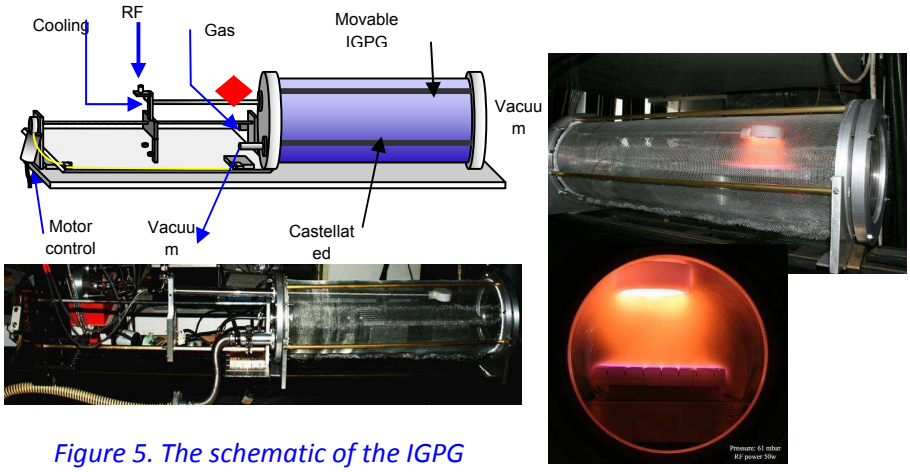


Figure 5. The schematic of the IGPG setup (top) and its image (bottom)

Applications for Tritium retention on surfaces of the ITER-like wall.

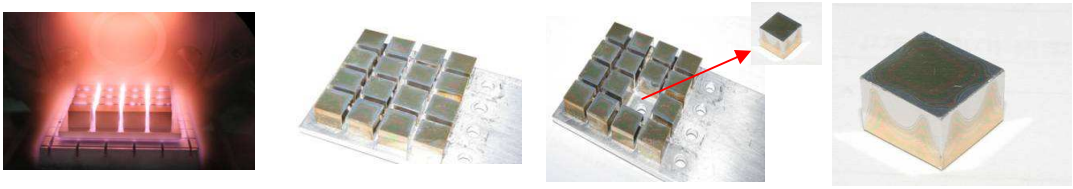
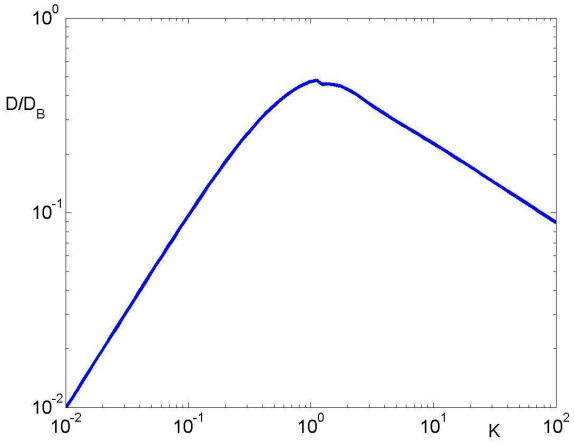


Figure 10. Image of the cleaning process and image of partial cleaned assembled and disassembled castellated piece

Contact address: Dr. Ghe. Dinescu
Association EURATOM-MEdC , Institute of Laser, Plasma and Radiation Physics, Bucharest

Physics studies for thermonuclear plasma
Understanding of the ExB drift nonlinear effects on transport and structure generation in turbulent tokamak plasmas

The statistics of test particles in turbulence was studied and it was shown that the ExB stochastic drift produces strong non-linear effects in the regime characterized by ***trajectory trapping.*** There is memory in the motion, which determines a class of anomalous diffusion regimes. Trajectory quasi-coherent structures are produced, which determine the decrease of the diffusion coefficients. These effects have been found by means of original semi-analytical statistical methods: the decorrelation trajectory method and the nested subensemble approach.



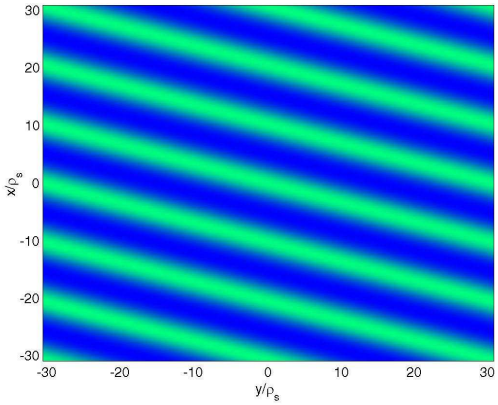
The normalized diffusion coefficient as function of the nonlinearity parameter, the Kubo number K. Trajectory structures appear for K>1 and produce the decay of the diffusive losses of energy and particles.

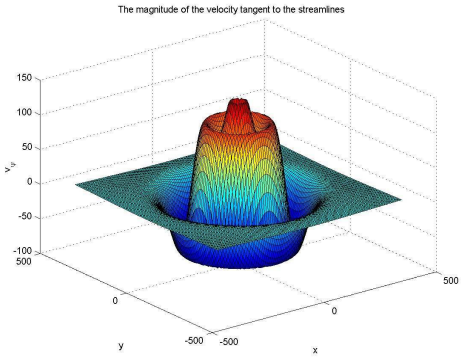
Recent results have shown that trajectory trapping determines a strong and complex influence on turbulence evolution in the nonlinear regime, producing large scale potential cells and zonal flows

Contact address: Dr. Madalina Vlad, Association EURATOM-MEdC , Institute of Laser, Plasma and Radiation Physics, Bucharest

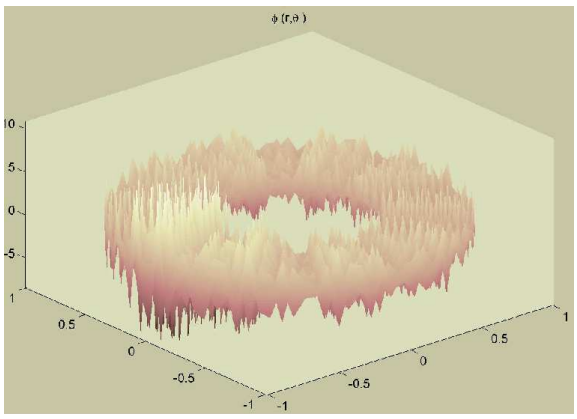
Physics studies for thermonuclear plasma
Equilibrium flows and and threshold conditions for accessing high confinement regimes

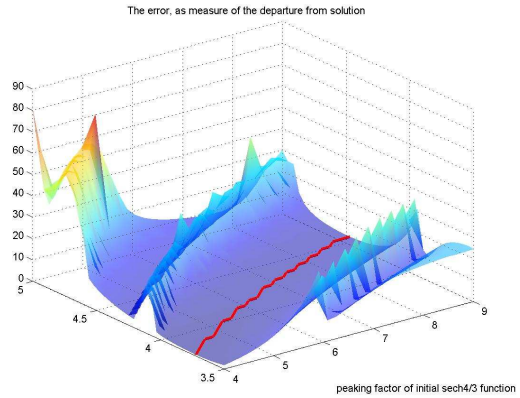
Physics of the quasi-stable structures developing in high confinement regimes in tokamak. Predictive models have been elaborated for the distribution of plasma parameters (temperatures, density, vorticity, current density) in tokamak.





LEFT: Exact solution for sheared flows (reduction of the radial correlation length of the turbulence);
RIGHT: Radial distribution of poloidal rotation velocity in High Confinement regimes, derived from an original field-theoretical formulation of the 2D tokamak plasma



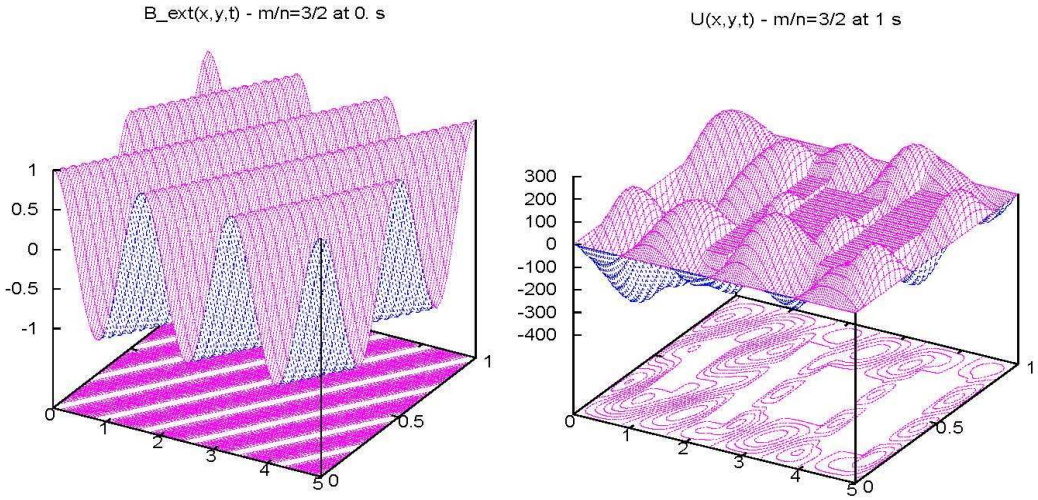


LEFT: Poloidal asymmetry of the envelope of the drift wave turbulence in tokamak. RIGHT: approach of a structured poloidal flow, characterized by the departure of a functional from its extremum

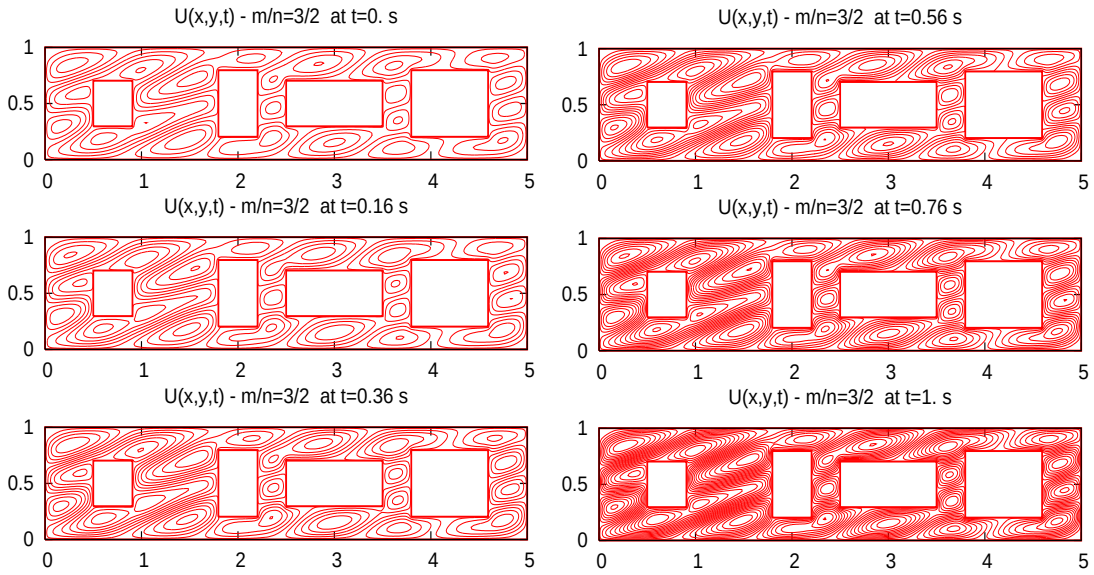
Contact address: Dr. F. Spineanu, Head of Reasearch Unit, Institute of Atomic Physics, Bucharest

Physics studies for thermonuclear plasma
Interpretation and control of helical perturbation in tokamak

Numerical studies, based on original computer codes, of the Resistive Wall Modes in tokamak.
Analytical studies of magnetohydrodynamic instabilities



Perturbed magnetic field and stream function U of the induced eddy currents given by an External Kink Mode



The eddy current stream function U(x, y, t) at different time, excited by an m/n =3/2 external kink mode in a thin wall with arbitrary holes

Contact address: Dr. C. Atanasiu, Association EURATOM-MEdC , Institute of Laser, Plasma and Radiation Physics, Bucharest