EX-C 3070

RFX-MOD2 AND THE NEFERTARI PROJECT: A diffuse infrastructure for the study of magnetically confined plasmas for fusion

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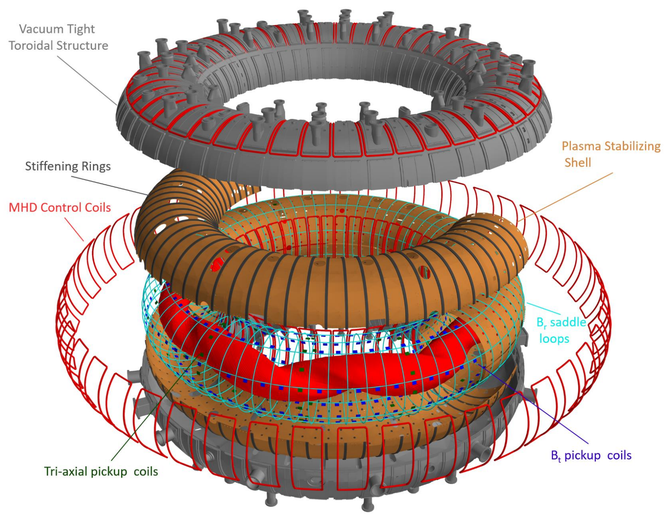
ABSTRACT

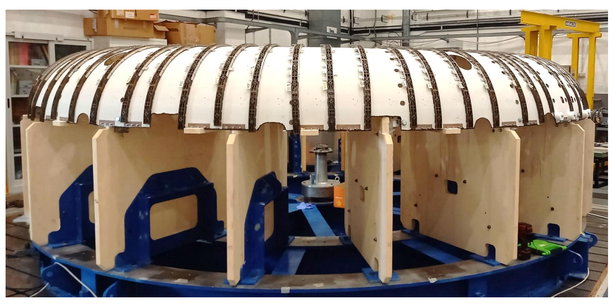
- RFX-mod2 is the upgrade of RFX-mod Reversed Field Pinch device
- RFX-mod2 can operate as high current RFP and 0,5T ohmic tokamak tokamak with active control
- Plasma magnetic boundary is upgraded
  - Reduced tearing modes, reduced error fields, improved equilibrium control, fast rotating mode regimes, improved transport are expected
- Diagnostics are significantly upgraded, thanks to National Recovery and Resilience Plan
- The RFX-mod2 goals are to study:
  - Regimes of RFP with rotating tearing modes
  - Role of upgraded boundary on helical improved confinement regimes in RFP plasmas
  - Transport in RFP and tokamak with higher space and time resolution
  - 3D effects with active coils in RFP and tokamak

RFX-MOD2

- The RFX-mod Inconel vacuum vessel has been removed
- Vacuum is ensured by the Vacuum Tight Toroidal Structure which holds the same diagnostic accesses



- 3 mm copper shell in vacuum
- Electrical insulation coating (0.2 mm Al_2O_3)
- Machining completed in 2022
- Insulation tests ongoing



Copper shell with alumina coating and stiffening rings for sustaining the graphite tiles of the first wall.

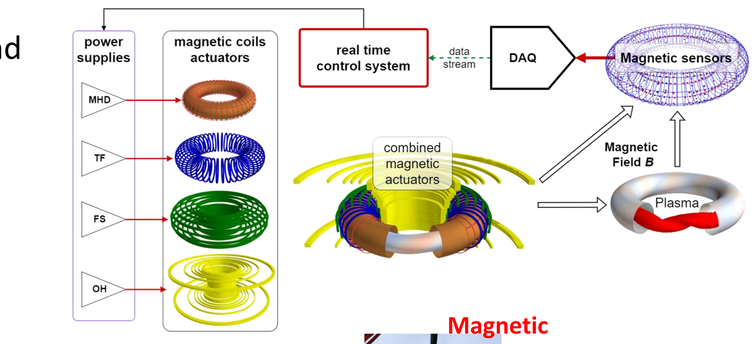
2216 in-vessel sensors just behind the graphite tiles

1736 magnetic

480 electrostatic

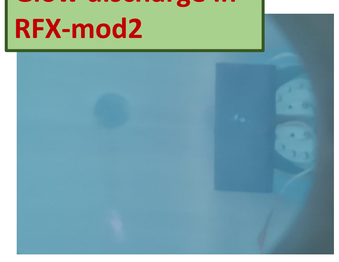
Custom developed acquisition:

- 20 bit ADC - 1 MSample/s
- Galvanic isolation up to 2.5 kV
- Digital integration
- Real time streaming
- Transient recorder
- Timing decoding



- Real time control of equilibrium and modes
- 3D reconstruction of magnetic and electrostatic structures of the plasma

Glow discharge in RFX-mod2

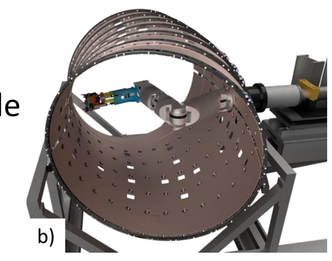


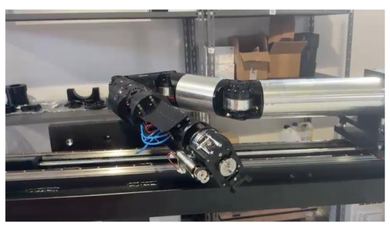
Wall conditioning

- Pulse Discharge Cleaning + Glow discharge Cleaning
- 8 fixed air-cooled electrodes only DC provide better plasma uniformity and inter-shot glows
- **Boronization**: new independent movable electrodes
- Better density control

Manipulator

- Maintenance of internal tiles without disassembling the whole machine
- Mock-up facility for test and training



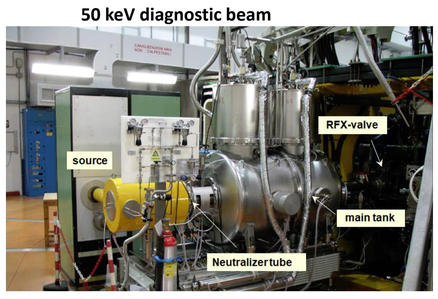


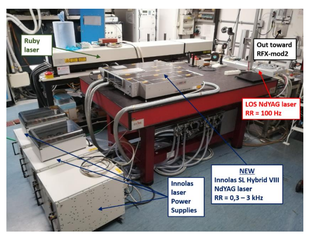
PLASMA CORE STUDIES

- At high plasma current (Ip >1MA) in RFP plasma a single magnetic mode dominates the other causing a 3D magnetic core, with helical electron transport barriers
- Fast spatial and temporal characterization of this regime is fundamental to understand the physics and compare the experimental results with transport codes
- Thomson Scattering, DNBI, SXR tomography and GEM, Neutron and Gamma detectors

DNBI

- Ion density and Temperature (Charge exchange)
- Magnet field (Motional Stark Effect)
- CRXS: Czerny-Turner spectrograph 750 mm focal length, 1200gr/mm grating
- MSE: ISOPLANE SCT-320 spectrograph 320 mm focal length, 1800 and 2400 gr/mm gratings

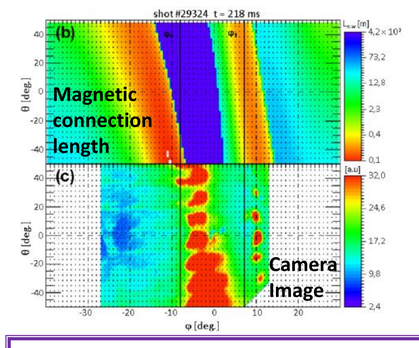




New Thomson Scattering

- 2 Nd:YAG lasers. One can operate up to 3 kHz
- The two coaxial lasers provide high temporal and spatial resolution: 84 radial points of 5mm diameter
- Double pass optical configuration for measuring also low density tokamak plasmas

PLASMA EDGE STUDIES



- High current RFP shows a 3D magnetic topology at the edge
- It influences the PWI and the kinetic properties: profiles, gradients, turbulent transport
- Similar behaviour of tokamak plasma with magnetic perturbation

New system of 7 visible cameras (CI emission)

+

MANTIS: H_α, H_γ, HeI, CII emission

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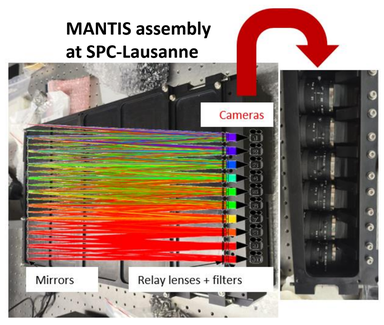
- Coverage of greatest part of the outboard first wall
- 3D reconstruction of the emission from the first wall
- Characterization of the interaction between plasma and 3D magnetic field



Complete characterization of the plasma edge with:

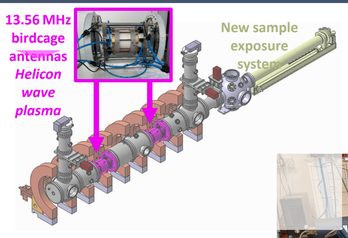
- Gas Puff Imaging: edge turbulence
- 4 THB: n_e T_e at 4 poloidal angle
- Reciprocating Probe (FARM): edge turbulence and E_r
- LIT: poloidal distribution of emissivity
- Electrostatic probes array: turbulence along ϕ and θ
- Reflectometer: n_e profiles
- GBS: turbulence simulations
- ORBIT: magnetic topology simulations

Fast reciprocating probe

SUPPORTING FACILITIES

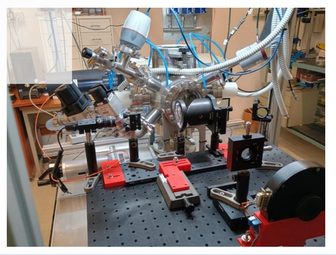
BiGyM for to study plasma-wall interaction

- 10 kW RF source @ 13.56MHz
- $n_e \leq 10^{19}$ m^{-3} and $\Gamma \leq 10^{23}$ m^{-2}s^{-1}
- Conditions as edge/SOL plasma



Optical diagnostics laboratory

- LIBS spectroscopy for the analysis of the surfaces
- Emission spectroscopy for high density discharges
- Spectroscopy models



CONCLUSIONS

- ❑ The assembly of the RFX-mod2 device is ongoing together with mechanical and electrical tests
- ❑ Revamping of power plants and vacuum system is ongoing
- ❑ New diagnostics are in assembly and testing phase and will complete the ones of RFX-mod
- ❑ Complete rebuilding of the machine expected in 2026
- ❑ Plasma operation expected in 2027

ACKNOWLEDGEMENTS

This work has been carried out within the framework of Italian National Recovery and Resilience Plan (NRRP), funded by the European Union—NextGenerationEU (Mission 4, Component 2, Investment 3.1—Area ESFRI Energy—Call for tender No. 3264 of 28-12-2021 of Italian University and Research Ministry (MUR), Project ID IR0000007, MUR Concession Decree No. 243 of 04/08/2022, CUP B53C22003070006, 'NEFERTARI- New Equipment for Fusion Experimental Research and Technological Advancements with Rfx Infrastructure'). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.