# DIAG-2 Environmental tests on diagnostic first mirrors

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| **TG priority:** Critical | **Start date:** | **Status:**  On-going | **Personnel exchange:**  Yes |
| **IO priority:** | **End date:** | **Motivation:**  helping to solve critical problems of the mirror-based optical diagnostics in ITER | |

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| --- | --- | --- | --- | --- | --- | --- |
| **Device /**  **Association** | **Contact**  **Person** | **2016 TG Request** | **Activity (from JEX/JA spreadsheet)** | | | |
| **2012** | **2013** | **2014** | **2015** |
| TEXTOR | A. Litnovsky | Analysis | Committed | Committed | Committed |  |
| T-10 | I. Orlovskiy | Desirable |  |  |  |  |
| Tore Supra | M. Joanny | Desirable | Committed | Not doing | Not doing |  |
| JET | M. Rubel | Desirable | Committed | Committed | Committed | Committed |
| DIII-D | D. Rudakov | Desirable | Analysis | Considering | Considering | Considering |
| EAST,HT-7 | J. Chen | Desirable | Committed | Committed | Committed | Considering |
| AUG | A. Herrmann | Desirable | Analysis | Committed | Committed | Committed |
| LHD | N. Ashikawa T. Akiyama | Desirable |  | Analysis | Analysis |  |
| NSTX-U | C. Skinner | Desirable |  | Analysis | Done |  |
| HL-2A | Y. Zhou | Desirable |  |  | Committed |  |
| Aditya | V. Kumar | Desirable |  |  |  |  |
| FTU | G. Maddaluno | Desirable | Committed | Committed | Committed |  |
| KSTAR | S.-G. Oh | Desirable |  |  |  |  |
| ITER | G. De Temmerman | Desirable |  |  |  |  |

**Purpose:** All optical and laser-based diagnostics In ITER will be using mirrors to transmit the radiation from plasma towards respective detectors. The first, plasma-viewing mirror is the most sensitive optical component largely defining an overall performance of respective diagnostics. Therefore, attaining the maximum lifetime of the diagnostic mirrors represents a crucial topic for ITER diagnostics and operation of the machine. The prioritized work plan (WP) of the R&D on diagnostic mirrors was developed to provide a set of measures to ensure the maximum lifetime of mirrors in ITER.

The WP consists from five main directions – tasks:

1. Performance under erosion- and deposition- dominated conditions: material choice;
2. Modeling of the impact of plasma, neutral and neutron environment on optical properties of diagnostic mirrors;
3. Mirror Surface Recovery (MSR) comprising mitigation of deposition, mirror cleaning and in-situ mirror calibration
4. Tests under neutron, gamma and X-Ray environment;
5. Engineering and manufacturing of ITER first mirrors

Based on the assessment of the progress in the fulfilment of the WP within ITPA, the task C on mirror surface recovery was recognized as the most critical one. Therefore, the task C was on the focus of multi-machine activities and on accompanying supporting activities within other tasks.

**Results for 2015**

* Duct mirror systems, the so-called Mirror Stations comprising cylindrical ducts of different length with diagnostic mirrors at the end of ducts were exposed in ASDEX Upgrade, in TEXTOR and in DIII-D. The aim of these investigations was to validate modeling predictions on the suppression of undesirable impurity deposition in the long diagnostic ducts and in the ducts with apertures (fins). The aim of fins is to trap impurities before they reach the mirror surface. Smooth ducts and the ducts with fins of the same length were exposed side by side to allow for a direct comparison of different duct interior. Mirror Station for TEXTOR was equipped with conical ducts in addition to cylindrical ones. The modified mirror cassette with smooth cylindrical ducts and ducts with fins has been exposed in JET.
* The Mirror Station from TEXTOR was analyzed after exposure. The deposition was found on all mirrors exposed in cylindrical ducts both with and without fins. Neither deposition nor degradation of the reflectivity was detected on the mirrors exposed in conical ducts, outlining advantages of conical geometry. Dedicated modeling and analyses of wall conditioning clearly demonstrated that the deposition in the ducts was by no means caused by the regular plasma operation. The maximum fluence of charge exchange neutrals during plasma operation was 4800-fold weaker than that during the plasma conditioning. Therefore, the decisive contribution to the deposition was due to RF-stimulated glow discharge conditioning.
* Mirrors in the modified mirror cassette featuring optical ducts with and without fins/baffles were exposed in JET during the campaign 2014-2015. Visual observations show less deposition on the mirrors exposed in the ducts with baffles.
* Studies of gas protection of the mirrors were performed in KSTAR. The evolution of impurity deposition with time measured on quartz crystal monitor installed in mirror box was analyzed. 10 sccm of He blown into KSTAR plasma for one second did not show any detectable photo emission.
* Evolution of net erosion and deposition patterns in the cylindrical smooth ducts depending of their proximity to plasma was studied in EAST. For ducts located far away from scrape-off layer (SOL) the deposition was gradually decreasing with the distance from the plasma. For ducts located close to SOL, deposition pattern exhibited the maximum at some distance from plasma. The observed dependencies call for urgent analyses of underlying physical processes.
* The deposit on the surface of the FMs used in FIR system in EAST was detected to be over 30 micrometer in thickness, mainly consisting of C, O and Li – which are the elements of the wall conditioning material and the graphite divertor material.

**Plans for 2016**

* Analyses of exposed modified mirror cassette in JET;
* Continuation of experimental activity with diagnostic ducts in LHD;
* Experiments with modified ducts, mirror cleaning and studies of mitigation of impurity deposition on mirrors by heating in EAST
* Studies of mirror protection inside the diagnostics ducts in KSTAR.