The coordinated activities of the Topical Group on Diagnostics were continued over the period of July 2010 to December 2011, with an emphasis being placed on d

measurements, total current, and position and shape of the runaway channel. These changes will be iterated within the Topical group and with the IO PCS working group. In addition, potential measurement techniques have been assembled and will be evaluated against the requirements after they are reviewed. This will be part of the contribution to Charge 5 of STAC 10. Additional discussions will include avoidance scenarios and measurement requirements, and any special need associated with disruption mitigation.

The report of the Specialist Working Group on First Mirrors gave an overview of all activities in the field of first mirrors. Much ITER-diagnostic specific research is in progress at many laboratories worldwide, but in general more solution-oriented research is needed and should be supported. More refined geometries are continuously being introduced for predictive modelling, although gas/plasma background conditions need considerable refinements. The effort in this field should be intensified and accelerated to serve the rising needs. Further progress was reported in the field of deposition mitigation (e.g. by flowing gas in front of the mirror) and mirror cleaning, coated mirrors, mirror manufacturing and irradiation testing of mirrors. With mirrors exposed in tokamaks: softer carbon films formed on the surfaces of the mirrors exposed in the divertor of DIII-D were cleaned completely and the reflectivity was restored, whereas harder films originating from TEXTOR were largely removed leading to the significant increase of the mirror reflectivity. Results from laser cleaning were reported from many laboratories was used to remove deposits. Important results were recently obtained in mirror cleaning techniques using laser irradiation. Significant improvement of optical reflectivity of treated mirrors was reported. However, in some cases the laser cleaning resulted in additional damage to the mirror surface. Applicability of these techniques for ITER conditions should be fully assessed.

Set of new molybdenum- and rhodium- coated mirrors were produced by evaporation and magnetron sputtering techniques at the University of Basel was exposed under erosion-dominated conditions in TEXTOR tokamak. Surface and optical characterizations revealed acceptable performance of all exposed mirrors: the reflectivity decreased insignificantly. Recently, the new experiment was carried out at higher fluence of eroding particles. Molybdenum mirrors withstood the erosion, the moderate decrease of the reflectivity was noticed for the Mo-coated mirrors. On a contrast, the Rh-coated mirror was severely sputtered by the plasma. This activity is being performed in the frame of collaboration program between FZJ and the University of Basel.

Single crystal molybdenum mirrors demonstrate an excellent performance under erosion-dominated in predictions and to reveal the mitigation effect of fins. These tests are presently being designed and implemented at various devices (TEXTOR, EAST, LHD, DIII-D). These dedicated experiments, made with various geometries of diagnostic ducts exposed under well-diagnosed plasma conditions, are important in validating these predictive models.

A few options for corrective mitigation of deposition have been described. These include laser cleaning, cascaded-arc source and microwave source particle flux cleaning. Each presents some challenges and R&D is presently being pursued at many laboratories.

The properties of several ITER-candidate mirror materials under erosion conditions were reported. Two exposures were performed in TEXTOR with single-crystal, Mo-nanostructure coated molybdenum mirrors along with Rh-coated mirror deposited by evaporation technique. The mirrors were kept under the same plasma conditions allowing for a direct comparison of the change of optical benchmarked versus the tritium and dust recovered during the replacement of the divertor cassettes. The first benchmarking will be done in the hydrogen phase. Following these findings, the HP item was refocused on the remaining issue of hot dust, e.g. dust can be found on hot surfaces, that if exposed to steam could lead to an explosive situation.

An evaluation of the requirements on the presence of dust on hot surfaces (i.e. hot dust) has been formulated. It was found that a maximum of ~18kg of hot dust can be tolerated within the vacuum vessel. Separately, if one accounts for the total amount of dust that could be found within the vacuum vessel, it is estimated that up to ~40kg of dust could be uniformly distributed on hot surfaces, which would represent a factor of 2 above the safety limit derived above. With these estimations and constraints beam could significantly pollute the core signals for upper port viewing systems. The situation appears less severe for the equatorial systems. The software is readily available and permits the quick importation of 3D CATIA models as well as scans of Bidirectional Reflectance Distribution Function (BRDF) effects. Such packages would be a powerful tool for simulating and qualifying diagnostic performance on many existing devices. They are also being used successfully to simulate plasma radiation loads on in-vessel components.

Extensive R&D efforts are ongoing at W7-X to quantify and study the effects of stray microwave radiations onto diagnostics and other in-vessel components. The research plans were presented alongside with initial results, indicating the importance of understanding these effects in W7-X, and likely in ITER

Active Spectroscopy First Mirrors	N. Hawkes (EU)	S. Tugarinov (RF)	M. von Hellermann

Spokes person:

Key persons:

Devices:

Mirrors will be used in all optical and laser diagnostics in ITER to observe the plasma radiation. The performance of respective diagnostics will rely on the characteristics of mirrors outlining the need in high-performance robust mirror solutions for ITER. Recently, the prioritized work plan (WP) of the R&D on diagnostic mirrors was developed. The aim of the WP is to provide the set of measures to be fulfilled to ensure the maximum lifetime of the high-performance mirrors in ITER – to enable the so-called baseline mirror solution. The WP consists from six main directions – tasks:

In auxiliary heated high-temperature plasmas in JET and TFTR, clear discrepancies (up to several tens of %) have been measured between the electron temperatures measured by electron cyclotron emission (ECE) and Thomson scattering (TS). The discrepancy (in plasmas without ECCD or LHCD) has been seen in JET with ICRF plasmas, above electron temperatures of ~5 keV, and at TFTR in ICRF+NBI plasmas above 7 keV. No discrepancy has been found at C-Mod for ICRF plasmas up to ~8.5 keV. No evidence of deviations from a maxwellian distribution of the bulk electrons has been seen at DIII-D in NBI+FW plasmas up to 9.5 keV, or in ECRH +NBI plasmas up to 15 keV.

Spokes person:	E. Veshchev (previously P. Andrew)
Key persons:	S. H. Hong (KSTAR), A. Herrmann (AUG).
Devices:	KSTAR, AUG

The ITER dust strategy includes monitoring local dust levels in the bottom of the machine (under divertor targets). The aim is to correlate local levels with dust removal activities in early phases of operation to get some indication of dust inventory during operation.

A microbalance based on a capacitive diaphragm principle has been investigated as a diagnostic method, and has the advantage of measuring directly measuring the weight of the dust. Although this technique has shown promise in controlled laboratory tests, it has never been tested in a tokamak environment where thermal cycling and a noisy electromagnetic environment can affect the measurement.

Local dust monitors have been proposed for ITER and these are nominally expected to be of the capacitive diaphragm microbalance type.

The object of this joint experiment would be to demonstrate the operational functionality of a capacitance diaphragm gauge in existing devices.

Spokes person:	G. Bonheure
Key persons:	
Devices:	NEW

Measurement of energetic ion losses (e.g. alphas) remains difficult, and alternatives are sought for ITER. A number of techniques have been proposed and are being considered. The performance and reliability of the standard ion loss measurement techniques based on direct particle detection are questionable as the detectors will have to operate in the harsh ITER first wall environment. New and more robust techniques need to be developed in order to minimize risks and increase measurements' reliability.

Recent experimental studies on JET [1] have shown that a technique based on charged particle in-vessel activation is able to generate absolute measurements of fusion proton loss. The same technique could be developed and used for measuring the loss of alpha particles in ITER.