

# Annual Report of ITPA Topical Group on Scrape off Layer and Divertor

For the period July 2009 to June 2010

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## Executive Summary

The DivSOL Topical Group held one meeting during the reporting period, in San Diego, USA, December 14-17, 2009. In even years, the International Conference on Plasma Surface Interactions (PSI) always takes place in Spring and is a natural place in which DivSOL TG activities are extensively reported, with all TG members usually in attendance. The DivSOL group did not therefore hold a Spring meeting this year.

The new organisation, with the DivSOL research plan structured in 5 task groups (fuel retention and removal, tungsten R&D, dust, heat loads and material migration) is now fully operational. The research plan is revised periodically, with sub-tasks within the Task Groups oriented/closed/created to address the ITER IO priorities. The 12<sup>th</sup> ITPA meeting (Amsterdam, May 2009) was the first to structure itself around the Task Group reports, and this was repeated successfully for the 13<sup>th</sup> meeting (San Diego, December 2009).

This new organisation allows the combination of very targeted tasks directly driven by ITER IO requests (like for detachment modelling or fuel removal from beryllium codeposits) with more long term physics oriented activities (such as the scaling of SOL power widths or understanding material migration). Progress in the different research areas is reported in Section 2 of this document, with reference to the status provided in the 2009 CC report. Specific ITER IO activities (status of the PFC design, ITER heat load specifications ...) are regularly presented, providing up to date information to the TG experts.

Selected scientific highlights over the reporting period are given below in the five areas. Much of this work related papers presented at the PSI conference are also indicated. More details can be found in the summary of the meeting in Section 1, or in the table compiling the progress on the research plan in Section 2.

- Fuel retention and removal (leaders R. Doerner, J. Roth)
  - The summary of the work of the DivSOL group for predictions of the tritium (T) inventory for ITER is now available as a MIT internal report. A comparison of experimental retention rates in view of establishing a multi-machine scaling has begun for carbon dominated machines as a first step (paper at PSI 2010).
  - Fuel removal from beryllium (Be) deposits has been extensively studied to assess the efficiency of the ITER first wall (FW) and divertor bakeout temperatures (nominal 240°C for FW and divertor, 350°C possible during high temperature gas bakeout for the divertor). Fuel release is satisfactory for pure Be layers but degrades if codeposition takes place at high temperature. It becomes marginal for mixed materials (Be-W or Be-C). (oral paper at PSI2010, IAEA 2010)
  - Coordinated experiments have been performed on Ion Cyclotron Wall Conditioning (ICWC) on a large number of devices, showing isotopic exchange can be achieved with pulsed operation, but with a high consumption of the cleaning isotope (oral paper at PSI 2010).
- Tungsten R&D (leaders A. Kallenbach, Y. Ueda)

- Tungsten melting experiments have been reported from AUG and TEXTOR, the latter showing that the melt layer motion is dominated by  $j \times B$  forces. Different regimes have been found, from continuous W spraying to large droplet ejection, eventually leading to a disruption.
  - The impact of neutron damage on fuel retention in tungsten has been studied, using heavy ion bombardment as a tool to induce damage sites. The enhancement of retention due to damage induced trap creation decreases with increased temperature and is also affected by simultaneous He ion bombardment. Conservative extrapolation to ITER indicates a small impact (7 g of T inventory trapped in the damage sites of a full W divertor at end of life).
- Dust (leaders : N. Ashikawa, D. Rudakov)
  - Coordinated dust injection experiments have been performed in a number of devices (LHD, DIII-D, MAST, TEXTOR, NSTX), providing input on dust particle trajectories and velocities for modelling.
  - Discussions during the San Diego meeting between experimentalists and the DUSTT modeller (Smirnov) led to a number of suggestions for improved measurements as input to models. If successful such efforts would provide better benchmarking and predictions.
- Heat loads (leaders : M. Lehnen, A. Leonard)
  - New data are available on divertor wetted surface area during ELMs, showing ELM broadening with ELM size. This is a favourable trend with respect to the ITER Heat Load Specifications, which assume no broadening compared with the inter-ELM heat flux profile. The effect does not eliminate the need for ELM control on ITER but would, if it can be confidently extrapolated to ITER, significantly improve tolerance to imperfect control.
  - Radiation asymmetries have been assessed during mitigated and unmitigated disruptions (C-Mod, JET, AUG, DIII-D). Due to the localized nature of the gas injection, poloidal and toroidal peaking factors of 1.5-2 have been found. Simplified extrapolation to ITER, particularly on the basis of JET results, indicates that the asymmetries would be insufficiently strong to induce local melting of the Be wall.
  - Dedicated experiments have been performed to compare SOL power widths during limiter ramp-up with the adopted ITER scaling, showing a reasonable agreement within the data scatter.
- Material migration (leaders : V. Philipps, P. Stangeby)
  - A review of Be erosion yields and the associated codeposition (which will determine the lifetime of ITER FW panels in areas of high expected main chamber ion flux and the expected main wall T-retention) has been performed, based on laboratory and tokamak experiments. Results show a significant scatter in the data, and a need to investigate further the erosion mechanisms.
  - Impurity migration tracer experiments (e.g.  $^{13}\text{C}$ ) have been reviewed (invited paper at PSI2010). New  $^{13}\text{C}$  injection experiments have been performed in DIII-D to test ITER concerns about erosion/redeposition in the vicinity of the 2<sup>nd</sup> X point, showing that most of the  $^{13}\text{C}$  injected is locally redeposited in this case confirming the expectation that main chamber retention could be an issue. Tungsten migration analysis has been extended from JT-60U to C-Mod confirming low erosion rates.

The status of collaborative DSOL experiments is reviewed in Section 1.2. 7 DSOL proposals are running, 4 were proposed for closure, with 1 new proposal (divertor detachment modeling) launched.

The next meeting of the Div/SOL Topical Group will take place in Seoul, Korea, October 2010, coordinated with the timing and location of the IAEA Conference. It will include joint sessions with other TGs (Pedestal, MHD, Energetic Particles).

Finally, thanks to the efforts at the IO all presentations given at DivSOL TG meetings since the first meeting in 2002 are now available on the ITER hosted ITPA Sharepoint website (<https://portal.iter.org/departments/FST/ITPA/SD/Pages/default.aspx>),.

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# 1. Meetings and reports

The summary report and all presentations given at the 13<sup>th</sup> meeting of the ITPA Div/SOL TG, can be found at <https://portal.iter.org/departments/FST/ITPA/SD/SD/default.aspx?InstanceID=1> and only the executive summary is repeated here. A summary of results on IEA/ITPA co-ordinated experiments was also presented at the December 2009 planning meeting for these experiments and will not be repeated here.

## 1.1 Report on the 13<sup>th</sup> Meeting of the ITPA SOL and divertor physics Topical Group, San Diego, USA

*The meeting was held over the period December 14-17, 2009 in San Diego. The local coordinator was Russell Doerner of the PISCES laboratory at UCSD. The meeting lasted 4 days and was split between discussions on the SOL/div R&D plans in support of ITER urgent needs and several research topics. There were over 50 participants.*

In previous meetings we have examined the effect of substrate temperature on the fuel retention in co-deposits. At this meeting we shifted the emphasis to what fuel can be removed when one heats the substrate **after co-deposition**. While the various possibilities for the substrate condition before baking are numerous (varying mixes of materials and in different ratios, varying temperatures at co-deposition) when one examines H/Be co-deposition with low C fractions (below a few %) the co-deposits act like pure Be in that ~90% of the H can be desorbed at bakes of 350C. However, for higher C concentrations in the co-deposits carbides form which both means less initial retention in the co-deposit but also almost none of the retained H is removed up to 1000C. Oxygen baking at 350°C results in C and H removal from co-deposits but no removal of Be. Heating of surfaces to high temperatures (1000°C) may be feasible by moving the plasma wetted surface around the chamber, strike point sweeping and heating during disruptions (planned and unplanned). Oxygen-radicals produced by ECR discharges appear to be efficient at removing C from gaps (as opposed to surfaces where O bake is more efficient).

At this meeting we also reviewed the many results obtained from the studies of the trajectories of injected dust based on DSOL-21. Similar, or the same, dust was injected on a number of tokamaks (e.g. MAST, DIII-D, TEXTOR) and the results indicate a dependence of the trajectory on the mass/Z of the material. Initial modelling studies reproduce a number of the dust trajectory characteristics but apparently there are still too many unknowns. It was agreed that for proper comparison with modeling more effort is needed to develop injection at a known velocity/direction and to make sure a 3D trajectory can be followed by appropriate stereoscopic views. The study of the mechanisms for dust generation is in much poorer state due to lack of diagnostics. Some simple experiments

involving a gridded analyzer being developed by C. Skinner or even using simple quartz micro-balances to collect dust under tile gaps would make sense; In either case examining how the dust collected correlates with events in the plasma is the direction to go in.

At this meeting we reviewed all available information in Be erosion in tokamaks and laboratories. The results were in poor agreement which means predicting the lifetime of the Be wall in ITER and its role in co-deposition has very large uncertainties. It was agreed that further laboratory studies are needed together with the upcoming work in JET ILW. An informal (non-DSOL) collaboration was initiated between UCSD, Sandia-Livermore and FOM to investigate Be (and possible Be surrogate materials such as Al and Mg) erosion mechanisms. In addition, the experiments planned for EAST (driven by the IO) should help bring new information on material migration to benchmark code calculations.

ITER has decided that a fully-tungsten divertor will be utilized before the DT phase. Because W will then be in the strike point region where melting is very likely the question of melt layer dynamics and effect of eroded W on the core plasma has received more emphasis recently. Modelling of melted W surfaces observed in TEXTOR are consistent with thermal emission current moving the melted W up the tile against gravity as observed. The poloidal movement of the W is consistent with  $J \times B$  motion with no bridging of gaps. The re-solidified W exhibits poor structure (e.g. holes inside). Laboratory studies carried out on neutron-irradiated W and C show that the material performance is reduced compared to un-irradiated material such that the ITER specification for ELMs should probably be reduced further. Initial experiments on the effect of a divertor-localized W source (ASDEX-Upgrade) show minimal effects on the core plasma but there is no way at present to scale this small source to a melted tile in ITER. More experiments are needed both in melt layer dynamics and effect on the core with the latter requiring code development to follow all the W charge states. A number of new W materials (alloys, or specially prepared W) were discussed and more work is needed there - a long-term research area. In terms of W nano structure induced by He ions, studies on formation and erosion in lab. experiments are progressing. Their behaviors in tokamak edge plasma are still under discussion, but it may not grow in the tokamak environment due to erosion by ions, deposition of low Z wall materials, or high plasma pressure.

We spent some time reviewing the current knowledge of power flows during disruptions. Even though several tokamaks have added main chamber IR views the results are sparse. In addition the variation of power and energy deposition can be large even within one machine; DIII-D reported a range of  $\times 1000$  for divertor power loads during the thermal quench for different kinds of disruptions with beta limit disruptions being the worst. The new IR system on JET indicates that first-wall energy deposition during a disruption can approach that of the divertor as that the power flow profile in the SOL broadens. In all cases more work is needed. Coordination with the MHD group would enhance the amount of information available.

With regard to disruption mitigation there has been a significant enhancement of diagnostic capability over the last year resulting in studies of toroidal and poloidal asymmetries in the induced radiation following massive gas injection (MGI). Although there are some small discrepancies between the experiments, there is an overall agreement that MGI gives a significant reduction of localized, conducted heat loads to the first wall and divertor. AUG, JET, and DIII-D all report that the injected impurities are swept by poloidal drifts over the top (crown) of the plasma toward the inner wall. This raises the concern that a repeatable "hot spot" may form. However, C-Mod presented results that the toroidal asymmetry of the thermal quench radiation flash is quite variable suggesting that repeated radiation flash heating of a single wall location during the TQ is unlikely. Overall, there was a consensus that more fast bolometry of MGI shots should be done. Also, it was recommended to try simultaneous MGI at two different toroidal locations - this has not yet been

done and would help ITER verify that radiation flash heat loads can be broadened by going to more than one MGI port.

The study of the effect of RMP on heat loads and the SOL profiles is only in its infancy. The little information we have garnered so far seems to indicate the SOL is not strongly affected - that the SOL profiles are L-mode like. More data is needed from the various experiments.

We also reviewed the current dataset for limiter plasma SOL profiles. While the data is consistent with models one could easily argue that the consistency is poor - the implication being that either a first-principles model is needed or better data from a range of tokamaks. Certainly better measurements of Ti are needed to pin down that power flow channel. With regard to the question of the effect of species (H, D, He) on SOL profiles the answer is minimal with some broadening reported for He JET plasmas. Lastly, the scaling power flows to the main chamber surfaces was examined as a function of  $dW/W$ , the ELM size in JET. Since larger ELMs carried a bigger fraction of their energy farther out in the SOL more data is needed on a number of machines and better modeling in order to determine how this effect would scale to ITER.

## 1.2 IEA/ITPA multi-machine collaborations

The status of the DSOL experiments is summarized below (red : closed DSOL, blue : ongoing DSOL, green : new DSOL).

- **DSOL-2** Chemical erosion under ITER-like divertor conditions (semi-detached) (S. Brezinsek)

Proposal: **TEXTOR, JET, AUG, DIII-D, Magnum PSI**

- **DSOL-8** ICRF Conditioning for hydrogen removal (N. Ashikawa)

Proposal: **LHD, HT-7, EAST, AUG, TEXTOR, TORE SUPRA, JET**

- **DSOL-9** Tracer injection experiments to understand material migration (V. Philipps)

Proposal: **JET, DIII-D, TEXTOR, AUG**

- **DSOL-11** Disruption mitigation experiments (D. Whyte) **Moved to MDC-11**
- **DSOL-12** Reactive gas wall cleaning (P. Stangeby)

Proposal: **TEXTOR, HT-7, EAST, DIII-D**

- **DSOL-13** Deuterium codeposition with carbon in gaps of plasma facing components (K. Krieger)

Proposal: data from **AUG, TEXTOR, MAST, DIII-D, TORE SUPRA, C-MOD**

- **DSOL-14** Multi-code, multi-machine edge modelling and code benchmarking (Coster) **Closed**
- **DSOL-15** Inter-machine comparison of blob characteristics (J. Terry) **Closed**
- **DSOL-16**: Determination of the poloidal fueling profile (M. Groth) **Closed**
- **DSOL-17**: Cross-machine Comparisons of Pulse-by-Pulse Deposition (C. Skinner) **Closed**
- **DSOL-20**: Transient divertor reattachment (R. Pitts)

Proposal : **DIII-D, ASDEX-Upgrade**

- **DSOL-21**: Introduction of pre-characterized dust for dust transport studies in divertor and SOL (D. Rudakov)

Proposal: **DIID, TEXTOR, MAST, NSTX, LHD**

- **DSOL-22** Multi code validation against experiment for improved detachment modelling (M. Wischmeier)

Proposal: **AUG, JET, JT60U, IO**

Ongoing DSOL, with new experiments planned, include : DSOL2 on chemical erosion, DSOL8 on ICWC (TS, TEXTOR, AUG, JET), DSOL9 on material migration (<sup>13</sup>C tracer experiments in TEXTOR, AUG, JET and associated modelling), DSOL12 on O cleaning (lab experiments + TEXTOR, DIII-D), DSOL13 on gaps (TEXTOR, AUG, TS).

DSOL14, 15, 16, 17 have been closed.

Recently launched DSOL (DSOL20 on divertor reattachment and DSOL21 on dust injection) have started (DSOL21 : experiments performed in MAST, TEXTOR, LHD, NSTX; DSOL20 : data mining performed, experiments under definition)

The new DSOL 22 (multi code validation against experiment for improved detachment modelling) will replace the closed DSOL14 (Multi-code, multi-machine edge modelling and code benchmarking) with a strong focus on the physics of divertor detachment, the reference case for the ITER scenario.

## 2. High Priority Research Areas

As mentioned in the executive summary, the strategy adopted by the SOL/Divertor TG to address urgent ITER R&D needs in the plasma-wall interaction area, has been to establish a set of high priority R&D areas which parallel those identified by ITER IO. Leaders have been identified to drive the overall research activity in each topical area. They have selected a number of subtasks, for which further coordinators have been appointed if required.

The table below compiles the five targeted R&D areas, summarising the subtasks which have been identified to constitute a work plan in each area. This table was already included in the 2009 CC report but is now updated to indicate which subtasks have been successfully completed, which are proceeding well but are not yet considered complete and which have only achieved moderate progress. This is indicated in the “Timescale” column by a cell colour with green corresponding to areas where significant progress has been achieved since the Task Groups were established, orange to areas in need of re-energising or re-orientation and grey to subtasks whose objectives have been reached and the task is proposed for closure. As before, the priority indicator in the final column remains unchanged from the 2009 report and is derived from the priorities set in the IO PWI research plan on which the R&D tasks are based.

The text in blue very briefly summarizes the progress achieved in the subtasks. Detailed scientific results and participating laboratories can be found in the presentations of the TG meetings on the ITER Sharepoint website as well as at the Plasma-Surface Interactions Conference website (<https://fusion.gat.com/conferences/psi2010/talks.php>). A few new subtasks have been proposed, with yellow backgrounds across all columns in the table. They are still under discussion amongst the TG members.

R&D Topic Area	Subtask	Timescale	Priority
<b>Tritium retention and removal</b> <i>Leaders:</i> R. Doerner J. Roth	1. Refine predictions for expected retention on ITER <b>report made available → closed.</b>	1-2 years	High
	2. Constitute multi-machine fuel retention database <b>(report)</b> <b>First step performed for carbon dominated machines (TS, TEXTOR, AUG, JET : PSI 2010 paper).</b>	2-4 years	High
	3. Pursue development (multi-machine) of ion cyclotron wall cleaning (ICWC) to establish feasibility for ITER wall conditioning, explore potential for T-removal and determine compatibility with planned ICRH system <b>(DSOL8)</b> <b>Significant effort on a number of devices, summarised in oral papers at PSI2010, IAEA 2010, EPS 2010 → closed – will re-orient to more specific comparison of HF-GDC and ICWC with regard to isotopic exchange (development of HF-GDC in general).</b>	2-4 years	High
	New subtask: Comparison between ICWC and HF GDC, especially wrt isotopic exchange but including also a general comparison of the two techniques.	1-2 years	High

	4. T-removal by outgassing to 350°C – the baseline ITER divertor bakeout temperature ( <b>collaboration</b> ) Extensive studies done for Be → closed. Oral paper PSI and IAEA 2010 – re-open specific task to investigate what is the “optimum” combination for the ITER operating temperature and bakeout + actual co-deposition of D into Be layer (in TVA apparatus) simultaneously	1-2 years	High
	5. Influence of mixed impacting species on fuel retention ( <b>collaboration</b> ) Studies performed for Be+ on W and Be+ on C as well as He ions on W → closed. Oral paper PSI and IAEA 2010	1-2 years	High
	6. T-removal potential of disruption heating Data for unmitigated disruptions available (3 PSI 2010 papers). Need for mitigated disruption data but particle balance difficult to perform.	1-2 years	Medium
	7. Fuel retention in gaps ( <b>DSOL-13,9 – with material migration R&amp;D Topic Area</b> ) New data available from TS and TEXTOR. Modelling ongoing (PSI2010 papers)	2-4 years	Medium
	8. Isotope exchange/tailoring using plasma discharges ( <b>new DSOL under discussion</b> ) New data from JET (oral paper PSI2010)	1-2 years	Medium
	9. Carbon removal capability and associated risks ( <b>report</b> ) Oxygen baking performed in DIII-D, data still under analysis (post deadline PSI2010, IAEA 2010)	1-2 years	Medium
<b>R&amp;D Topic Area</b>	<b>Subtask</b>	<b>Timescale</b>	<b>Priority</b>
<b>Tungsten</b> <i>Leaders:</i> A. Kallenbach Y. Ueda	1. Impurity generation due to ICRH operation ( <b>modelling, design, report</b> ) New diagnostics and antennas to come in C-Mod & AUG	2-4 years	High
	2. Melt layer behaviour and effect of divertor target damage on subsequent operation ( <b>tokamak experiments, report</b> ) Experiments performed in TEXTOR, AUG and C-Mod. Negotiations ongoing with JET for ILW expts in 2011/2012.	1-2 years	High
	3. Balance between ELM driven impurity sources and outflux due to ELM flushing ( <b>tokamak experiments, report</b> ) Detailed work performed for AUG (oral paper at PSI2010). To be driven by Pedestal TG and IO contract	1-2 years	High
	4. Material mixing, cracks, surface morphology changes, blistering ( <b>report</b> ) Good progress: operational window for formation of surface changes identified. Role of impacting He+	1-2 years	High

	elucidated → closed		
	5. Tritium permeability and retention in neutron damaged W (lab experiments, report) Significant progress on measurement as a function of material temperature and He flux: should not be an issue for T inventory in ITER → closed	2-4 years	Medium
	6. Power load control by low Z extrinsic seeding (tokamak experiments, report) Experiments in C-Mod, JET and AUG (papers PSI 2010). Joint effort with IOS TG. Task extended	2-4 years	Medium
	7. Edge modelling including W and W/Be (code development) Some progress (DIVIMP and EDGE2D on JET, trace W in Eirene) but still needs a significant effort	2-4 years	Medium
	8. Effect of mixed impacting species on T-retention in W (lab experiments, report) Experiments performed on Be-W (see R&D on fuel retention) → closed	1-2 years	Medium
<b>R&amp;D Topic Area</b>	<b>Subtask</b>	<b>Timescale</b>	<b>Priority</b>
<b>Dust</b> <i>Leaders:</i> N. Ashikawa D. Rudakov  Replace one with Greg. De T.?	1. Characterisation of dust production rates, conversion factors from erosion and damage to dust production (collaboration) No new results, awaiting new diagnostics and dust measurements (JET).	2-4 years	High
	2. Cross-machine studies of dust injection including benchmarking of dust modelling tools (DSOL-21) Good progress, experiments performed in DIII-D, MAST, TEXTOR, LHD, NSTX	1-2 years	High
	3. Quantification of dust character under high loads: ejection velocities, dust sizes/morphology (IO coordinated work) Awaiting for new results with Be from QSPA + Magnum PSI in the future	1-2 years	High
	4. Study the role of T-removal techniques in dust generation (laboratory collaboration) No new results reported	2-4 years	Medium
	5. Contribution to development of dust measurements (in collaboration with ITPA Diagnostics TG) Progress for dust particle tracking (fast cameras) and detection, as well as modelling. Difficult area.	2-4 years	Medium
<b>R&amp;D Topic Area</b>	<b>Subtask</b>	<b>Timescale</b>	<b>Priority</b>
<b>Heat fluxes to plasma-facing surfaces</b> <i>Leaders:</i> A. Leonard M. Lehnen	1. Disruption heat loads (ongoing discussion within ITPA) Good progress for radiation and plasma loads during disruptions but scarce data on runaway electrons. Modelling needs significant effort.	1-2 years	High
	2. Cross-machine characterisation of ELM statistics (DSOL-15, PEP-10, 21) No new results reported.	2-4 years	High

	3. Heat loads during ramp-up/ramp-down ( <b>tokamak experiments, report</b> ) Data from DIII-D and TS reported. Awaiting new JET experiments	1-2 years	High
	4. Transient divertor reattachment ( <b>DSOL-20</b> ) Good initial session on data mining in the Amsterdam meeting but slow progress since.	2-4 years	High
	5. Modelling detachment ( <b>new coordinated effort within the TG, re-focus of DSOL-14</b> ) Effort started, task leader appointed, good initial progress but problem of manpower.	2-4 years	Medium
	6. Far SOL heat and particle fluxes ( <b>US comparison, extend to ITPA</b> ) US study underway (not reported yet). Secondary divertor heat loads reported (DIII-D, TCV). More data needed for ITER heat loads specs.	1-2 years	Medium
	7. Divertor and SOL ELM heat fluxes – characterisation of power footprints and parallel heat flux widths ( <b>ongoing ITPA meeting, reports</b> ) Good recent progress with data from JET and the US devices (part of the ReNew process) exploring new physics on footprint with RMP etc	1-2 years	Medium
	New subtask: Machine size scaling of ELM footprint with ELM size for controlled and uncontrolled ELMs		
<b>R&amp;D Topic Area</b>	<b>Subtask</b>	<b>Timescale</b>	<b>Priority</b>
<b>Material migration</b> <i>Leaders:</i> P. C. Stangeby V. Philipps	1. Cross-machine comparisons of main wall erosion and local redeposition ( <b>modification of existing DSOL-9</b> ) Mainly <sup>13</sup> C injection. Review of past experiments performed. New results from DIII-D and experiments performed in JET awaiting for analysis.	2-4 years	High
	2. Development (and benchmarking) of local models accounting for surface shaping to predict erosion and subsequent deposition in shadowed regions during steady state and limiter start-up/ramp-down phases ( <b>study, tokamak experiments, code development</b> ) IO modelling ongoing, as well as gap related modelling (TEXTOR)	1-2 years	High
	3. Characterise outer and inner divertor erosion and movement of impurities between divertors and from main chamber to divertor ( <b>new DSOL under discussion</b> ) C-Mod tiles analyzed for W migration (PSI 2010). Be erosion yield reviewed (Div/SOL meeting, San Diego, PSI 2010).	2-4 years	Medium
	4. Understand the driver of fuel retention in tile gaps - dependence on material, flux, temp. ( <b>DSOL-13</b> ) See subtask 7 in fuel retention and removal R&D → <a href="#">close here ?</a>	1-2 years	Medium

### **3. Future meetings**

The next meeting of the DivSOL Topical Group will take place in Seoul, Korea, October 18-21, coordinated with the timing and location of the IAEA Conference. At the moment Professor K.S. Chung is kindly taking care of the local organisation. Benefitting from the extensive gathering of other ITPA Topical Groups around the IAEA Conference, the meeting will feature an entire day of joint sessions addressing some of the most pressing areas of concern for ITER. A half day session will be held jointly with DivSOL and Pedestal TGs addressing ELM physics and ELM divertor target heat loads. In a second half-day session DivSOL, MHD and Energetic Particle TGs will discuss heat loads in mitigated and non-mitigated disruptions. A final, shorter joint session will bring together DivSOL, Pedestal and Transport TGs to discuss which joint efforts can be brought to bear on the critical issue of ITER fuelling.