Summary from 16th CWGM (January 2017): Joint proposals for impurity transport

IT.1 Z dependence of impurity transport and impurity accumulation.

(Task Leaders: Tamura, Langenberg)

- **Goal: Develop an understanding of impurity transport and accumulation in stellarator plasmas.**
- Map out the regimes of Er shielding, impurity accumulation and impurity screening across multiple machines.
- Compare experimental impurity transport results to theoretical models.
- Benchmark multi-species neoclassical codes.
- Utilize different injection methods (Gas Puff, LBO, TESPEL and Probe Tip) to provide wide range of impurity species and to help isolate injection effects from impurity transport.

Progress:

- The theoretical considerations of neoclassical impurity transport for high Z impurities have been advanced though the utilization of SPHINCS and EUTERPE (Mollén, ISHW 2017).
- A comprehensive set of experiments to explore the Z dependence have been proposed for the current W7-X experimental campaign. **These experiments are planned for the upcoming weeks!**
- Commissioning of the LBO injection and Probe Tip systems at W7-X is complete.
- A extensive suite of impurity diagnostics on W7-X is complete (HR-XIS, PHA, HEXOS, bolometer, XICS). **This diagnostic set will allow cross machine comparisons with other well diagnosed stellarator/heliotron experiments such as LHD, TJ-II, etc.**

SUMMARY FROM 16TH CWGM (JANUARY 2017): JOINT PROPOSALS FOR IMPURITY TRANSPORT

IT.2 Investigation of impurity hole.

(Task Leaders: Velasco, Nakata)

- **Goal: Develop an understanding of the physics underlying the impurity hole regime.**
- Look for an impurity hole regime on W7-X.
- Search the parameter space in LHD where the impurity hole is observed for conditions that are accessible on W7-X.
- Continue neoclassical and GK modeling efforts to develop a physics understanding.

Progress:

- Efforts continue to model **neoclassical and gyro kinetic impurity transport** with a specific effort to understand the impurity hole.
- Diagnostic set on W7-X ready to observe impurity hole!

Summary from 16th CWGM (January 2017): Joint proposals for impurity transport

IT.3 Investigation of potential asymmetries (ϕ_1) on impurity transport.

(Task Leaders: Regaña, Mollén)

- **Goal: Understand the effect of potential asymmetries on impurity transport (neoclassical).**
- Compare predicted ϕ_1 with experimental measurements across multiple machines.
- Utilize capabilities of mid-size machines to develop and validate predictions for ϕ_1 and apply to large-size machine that are more difficult to diagnose.
- Measure high-z impurity density distribution on multiple machines in regimes where large ϕ_1 is expected.
- Search for impurity density oscillations which are indicative of impurity density asymmetries caused by ϕ_1.

Progress:

- Both **modeling** and **experimental** efforts in characterization of the potential asymmetries have made significant progress (Regaña, ISHW 2017; Mollén, ISHW 2017, Velasco ISHW 2017, H. Smith ISHW 2017).
  - SFINCS multispecies simulations have predicted potential variations of up to 200 V in LHD impurity hole plasmas.
  - Inclusion of the effect of NBI ions/torque on the on the variation-driven impurity fluxes.
  - Doppler reflectometry asymmetries compared with EUTERPE in TJ-II.
- Development of the **KNOSOS code** is underway at CIEMAT which can include effects not currently considered in other codes (EUTERPE, SFINCS). (Velasco, ISHW 2017)
- The **necessary experimental conditions** that favor high potential variations have been identified. Validate of neoclassical predications **across the range of stellarator experiments underway** (much of this validation has already been completed at TJ-II).

Summary from 16th CWGM (January 2017): Joint proposals for impurity transport

IT.4 Development of general purpose 3D stellarator impurity deposition/ionization/transport tools.

(Task Leaders: Pablant, Zhang)

- **Goal: (a) Predict charge resolved impurity density after injection using Gas Puff, LBO, TESPEL or Probe.**
  (b) Interpret diagnostic signals in the context of impurity injection experiments.
- Allow easier comparison of impurity transport experiments across devices.
- Utilize unique diagnostics on various devices to validate codes.
- Identify what is needed that is not captured through current 1D impurity transport tools such as STRAHL.

Progress:

- A program to **train research scientists** and **students** in the use of STRAHL is underway at W7-X (D. Zhang).
- Planned and recently executed experiments at LHD and W7-X will provide **well diagnosed scenarios** for modeling of both impurity injection and pellet fueling.