Towards viable nuclear fusion reactors

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**Research goal:** Can the heat extractor (divertor) withstand the extreme loads in a future fusion reactor for a sufficient amount of time?

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**Method**

1. **Grain level: neutron damage**

   \[
   \frac{dC}{dt} = \text{Defect Production} + \text{Evolution} - \text{Removal (at sinks)}
   \]

   Method: **Cluster dynamics model** for the concentrations of vacancies (V), self-interstitial atoms (I), and dislocations.

   Scale: \( \Lambda - \mu m \)

   Based on Li (2012), Stoller (1990), Yi (2015), Jourdan (2015)

   - Defect Production
   - Evolution
   - Removal (at sinks)

   Grain size dependence:

   The ease with which defects find the grain boundary sink.

   **Results**

   **Microstructural evolution**

   - Stored defect energy
   - Average grain size

   **Damage accumulation vs. recovery**

   - Defect accumulation / GB mobility / point defect mobility / nucleation rate / individual grain behavior can all be studied with this model.
   - Pace of renewal of the microstructure.

   **Conclusions/Outlook**

   - The multi-scale model for the microstructural evolution of tungsten under heat and neutrons shows to be a versatile tool to study the temperature dependent stability of the original microstructure and the competition between the various processes for damage and recovery.
   - In future, lifetime of the divertor monoblocks will be studied by combining the (stress-dependent) microstructural model with a mechanical FE analysis.

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Figure 1: the divertor in the JET reactor ([www.iter.org](http://www.iter.org), left) consists of many tungsten monoblocks (on the right).