

## Towards viable nuclear fusion reactors 2

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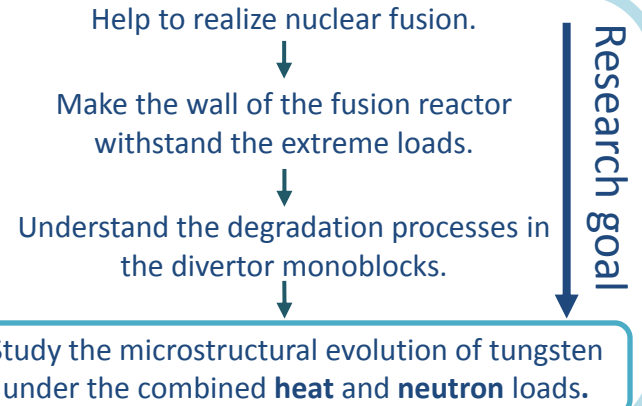
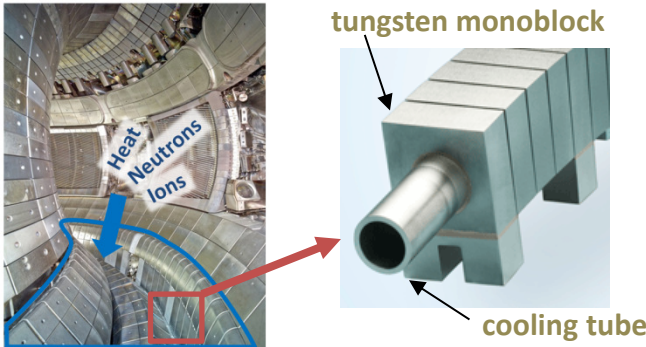
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# Towards viable nuclear fusion reactors

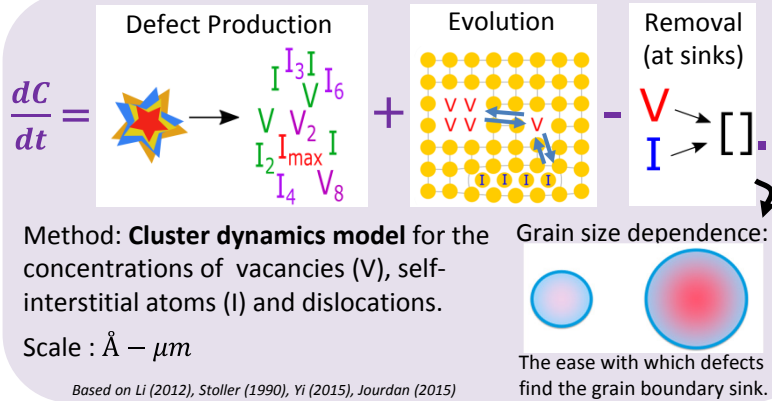
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**Research goal:** Can the heat extractor (divertor) withstand the extreme loads in a future fusion reactor for a sufficient amount of time?



## Method 1 Grain level: neutron damage



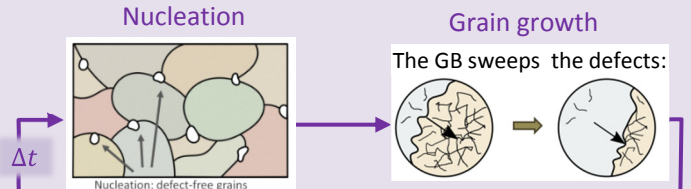
## 2 Polycrystal level: recrystallization

### Mean-field model (Scale 1-100 $\mu\text{m}$ )

Microstructure: a set of representative grains.

- Radius  $r$
- Defect densities  $\rho, C_I^m, C_V^n$
- # of represented grains  $N$

Each grain interacts with the average microstructure medium.



Nucleation depends on:

- GB (grain boundary) mobility
- Defect density: **stored energy**
- GB surface area

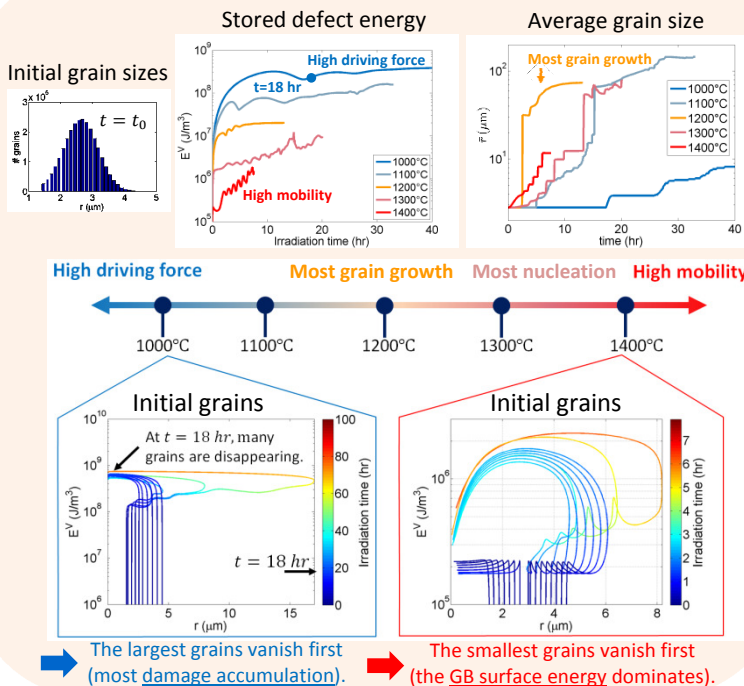
Grain growth is based on the velocity of the grain boundaries:

$$v = m(T) \Delta E_{\text{average}} / \text{grain}$$

GB mobility  $\swarrow$  Defect density  $\searrow$

Based on Bernard (2011), Lopez (2015)

## Results Microstructural evolution



## 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**.