

Supply & Demand of Tungsten in a Fleet of Fusion Power Plants

E. Day-San¹, G. Blackett^{1,*}, M. Dornhofer², A.K. Manduku¹,
M.D. Anderton¹, L. Tanure¹, T.P. Davis^{1,3}

¹ Oxford Sigma, Summertown Pavilion, 18-24 Middle Way, Summertown, Oxford OX2 7LG

² Independent Supply Business Partner, Bluetengasse 9, A-8010, Graz, Austria

³ Nuclear Futures Institute, Bangor University, Bangor, Gwynedd, LL57 2DG, UK

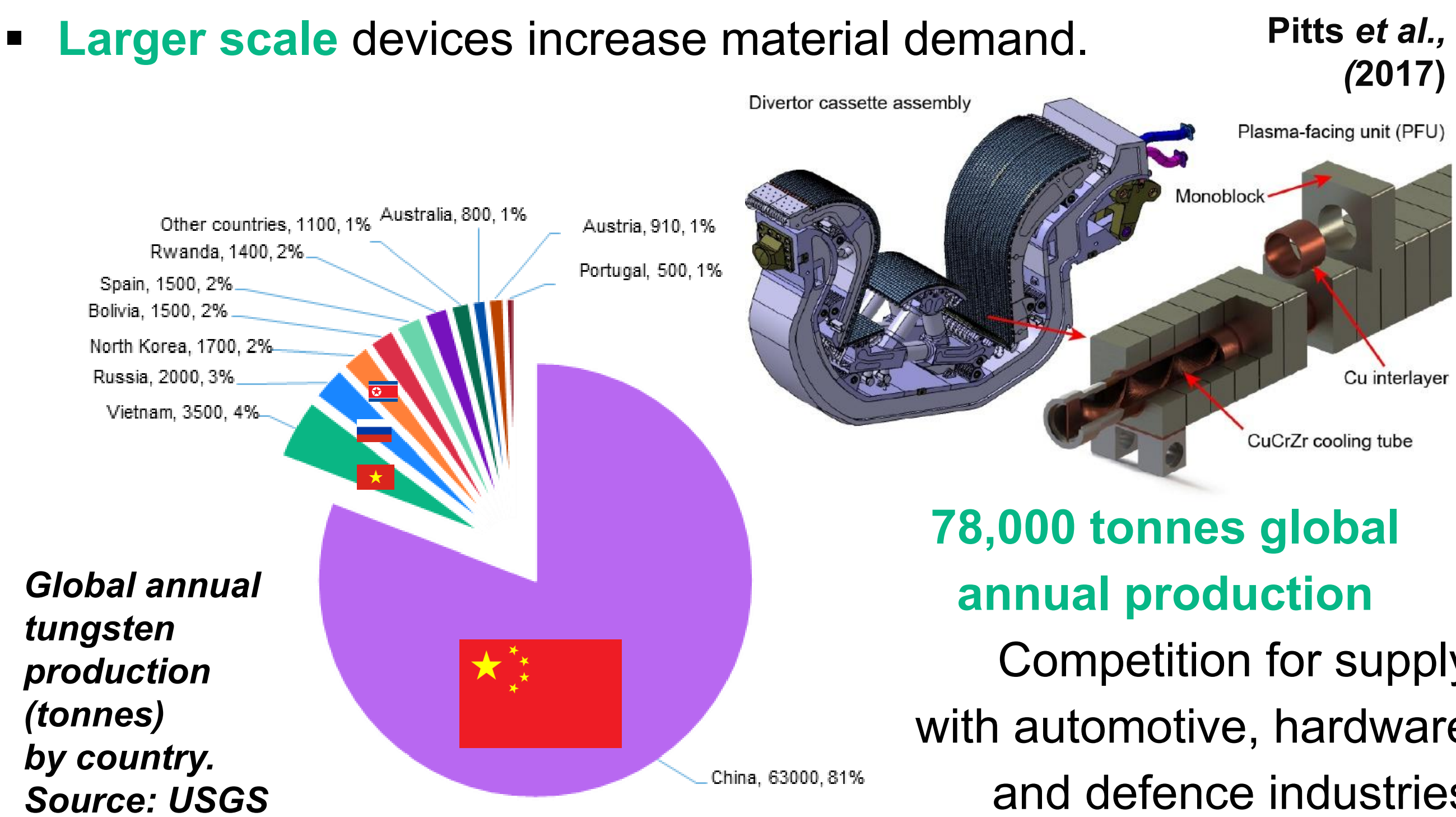
*gabriel.blackett@oxfordsigma.com

TUNGSTEN WEST
GUARDIAN
METAL RESOURCES

OXFORD
SIGMA

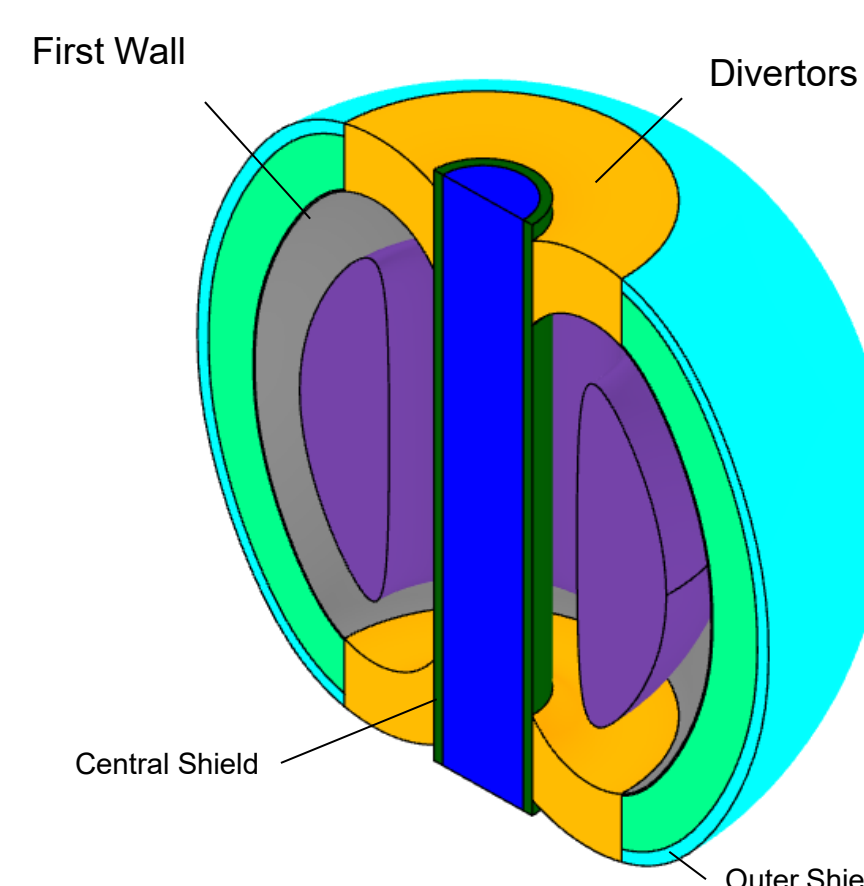
1. Tungsten for Fusion Energy

- Tungsten is essential for the **manufacturing of plasma facing and shielding components**.
- Neutron irradiation degradation **limits lifetime** with **limited experimental data** in fusion conditions.
- Larger scale** devices increase material demand.

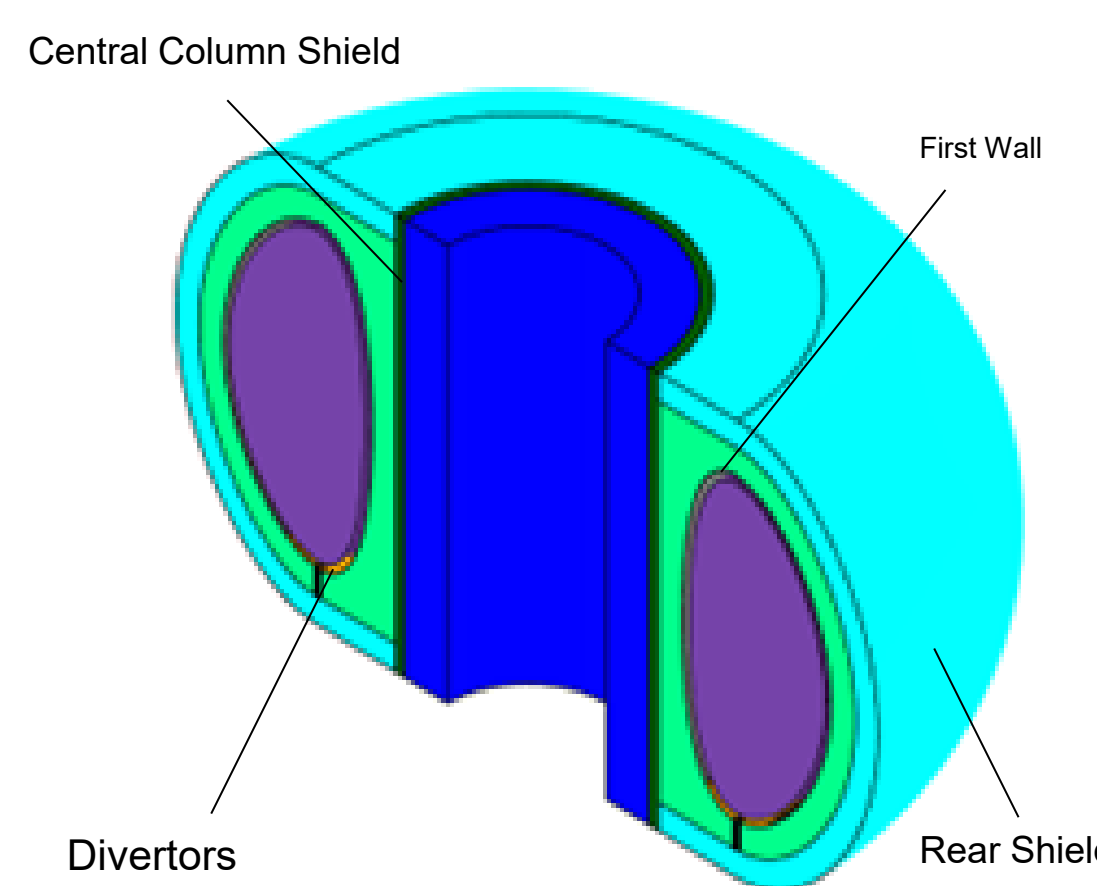


2. Benchmark Reactor Designs

ARIES-ST (USA)
Najamabadi et al., (2006)



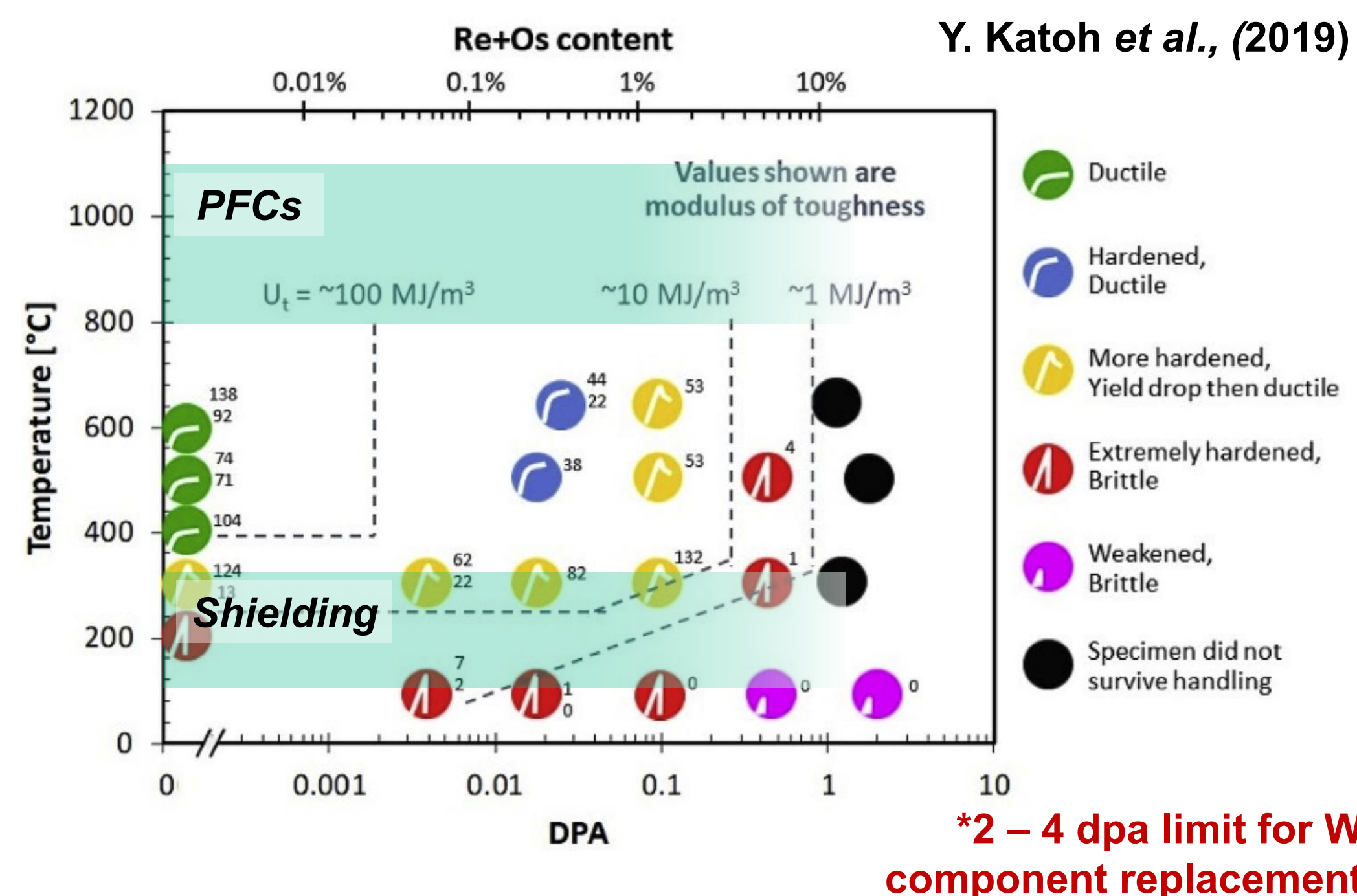
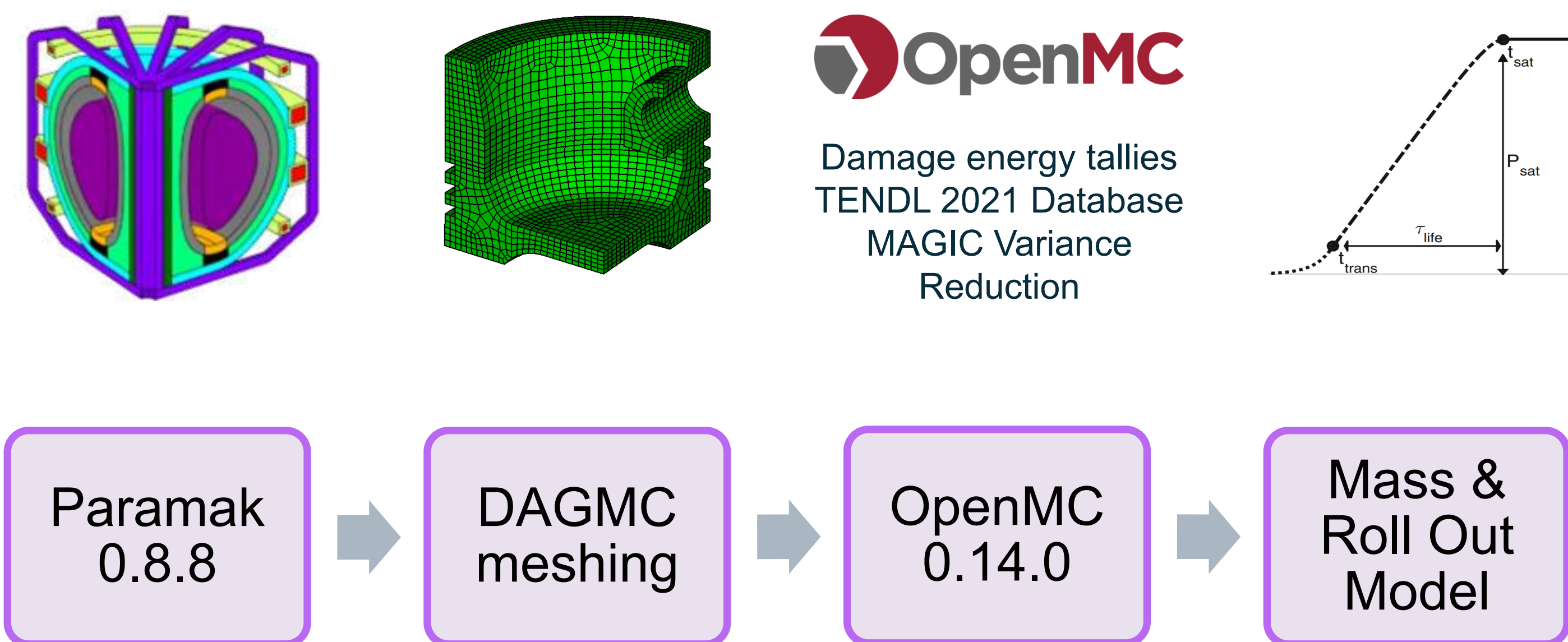
EU-DEMO
Bachmann et al., (2015)



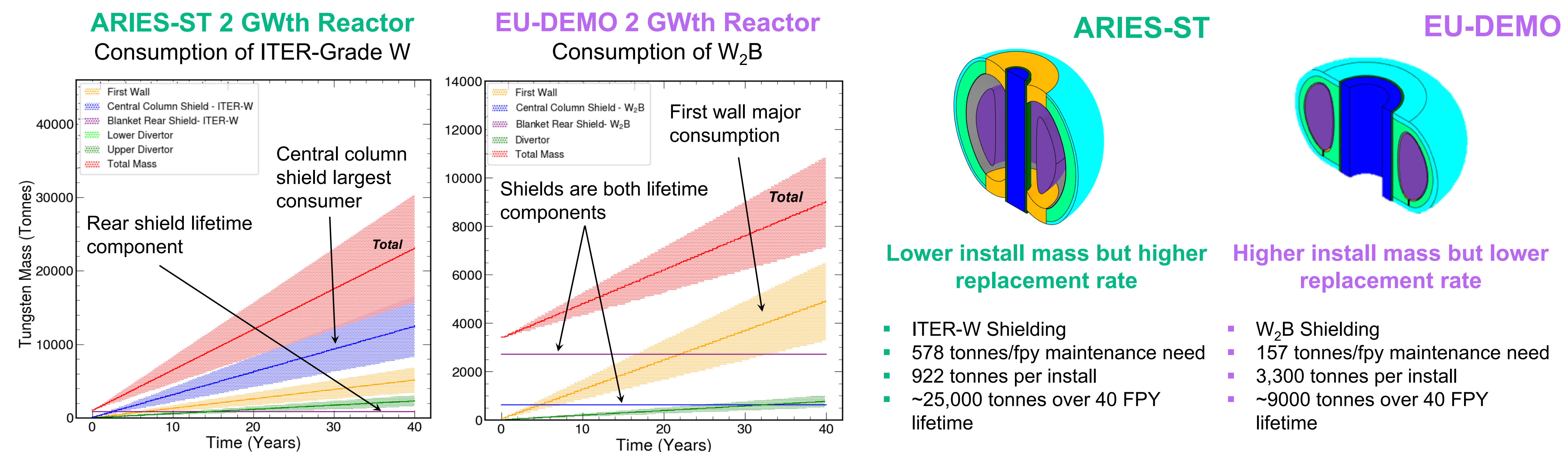
Tungsten Components:
First Wall, Central Column Shield, Divertors, Rear Blanket Shield

Candidate shielding materials:
ITER-Grade W; tungsten carbide (WC);
tungsten boride (W₂B)

3. Computational Approach



4. Component Consumption Rate

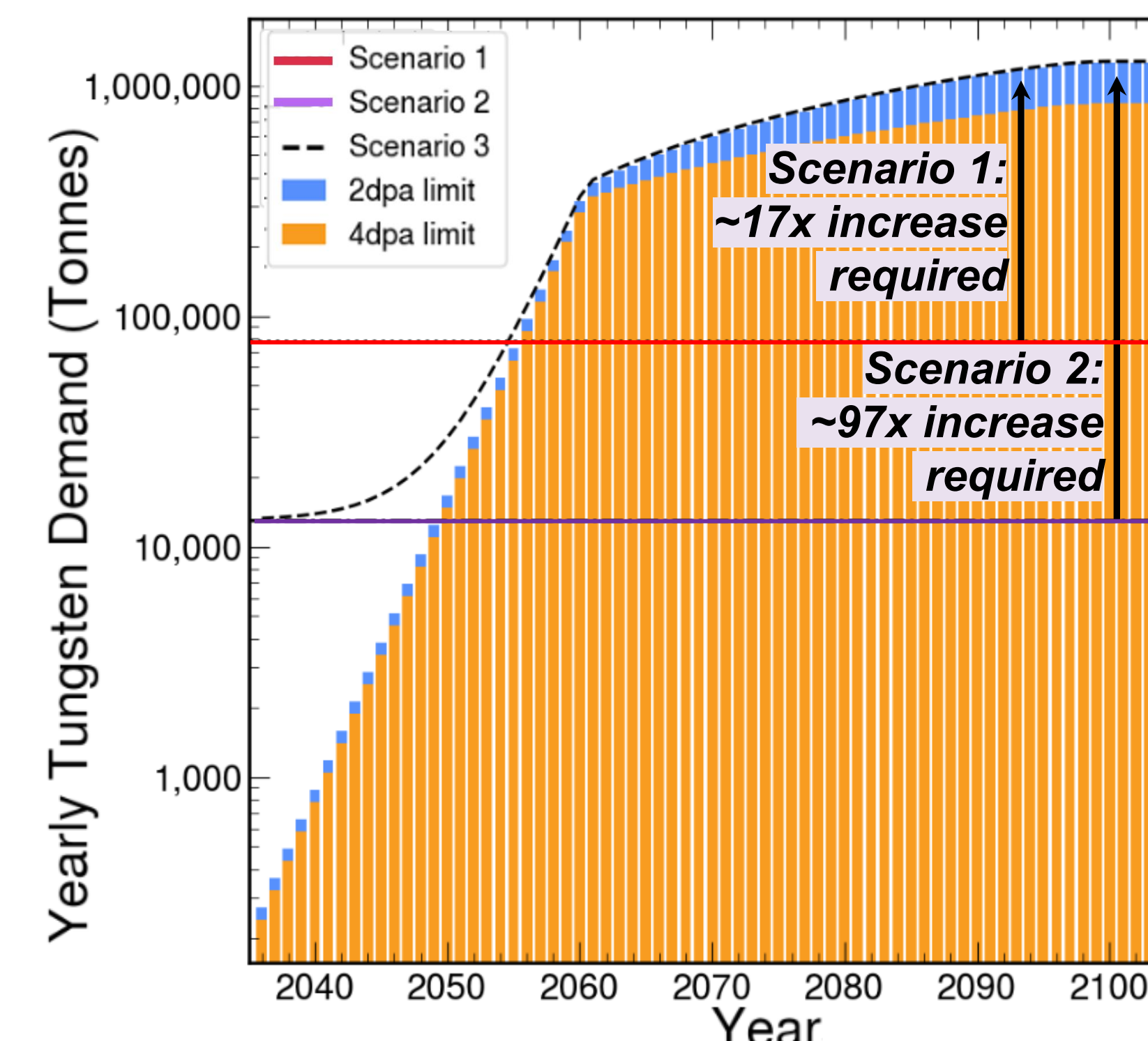


5. Reactor Roll-Out Model

- Reactor roll-out model based on N.J. Lopes Cardozo et al., 2015 market adoption model.
- Adoption anticipated **up to 3 TW** (10% of global power supply).
- Supplied by a fleet of **1 GWe** power plants.
- Based on **current fission market** penetration.

Example Scenarios:

- Stagnant current production levels:**
→ Demand forecast to exceed supply in ~2050
- Excluding Chinese and Russian supply**
→ Demand forecast to exceed supply mid 2050s
- Active involvement to increase western extraction**
→ >400k tonnes per year increase needed by 2060



Estimated demand in 2100

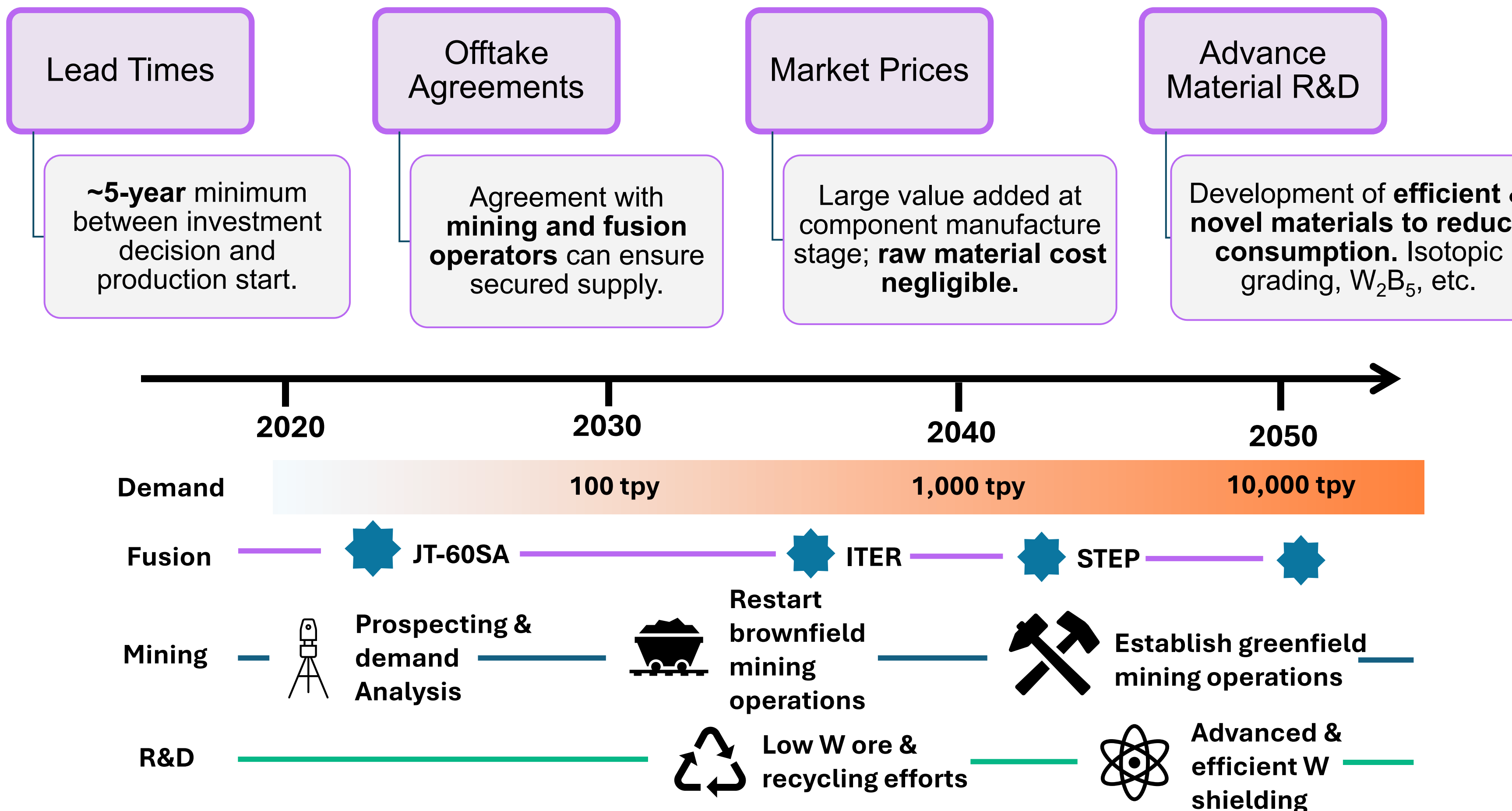
4 dpa service limit

840,000 tonnes per year

2 dpa service limit

1,260,000 tonnes per year

6. Fusion Timeline Context: Key Challenges & Considerations



7. Key Findings

- Tungsten demand for tokamaks estimated, accounting for upfront needs and component replacement:
 - ARIES-ST: ~25,000 tonnes (40 FPY, Pure W shield)
 - EU-DEMO: ~9,000 tonnes (40 FPY, W₂B shield)
- DEMO reactor roll-out tungsten demand peak of ~840k-1,200k tonnes per year.
 - Tungsten demand would be an order of magnitude greater than current supply (~78,000 tonnes per year)
- Tungsten supply chain investment required to facilitate fusion energy roll-out.

Published: E. Day-San et al., 'Supply and demand of tungsten in a fleet of fusion power plants', *Fusion Engineering and Design*, vol. 214, p. 114881, May 2025, [10.1016/j.fusengdes.2025.114881](https://doi.org/10.1016/j.fusengdes.2025.114881)