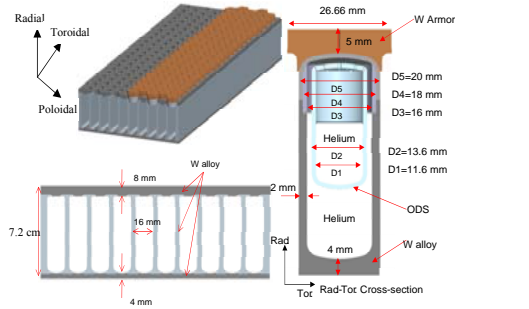


W-Based Alloys for Advanced Divertor Designs: Detailed Activation and Radiation Damage Analyses

A. Robinson, L. El-Guebaly, D. Henderson and the ARIES Team

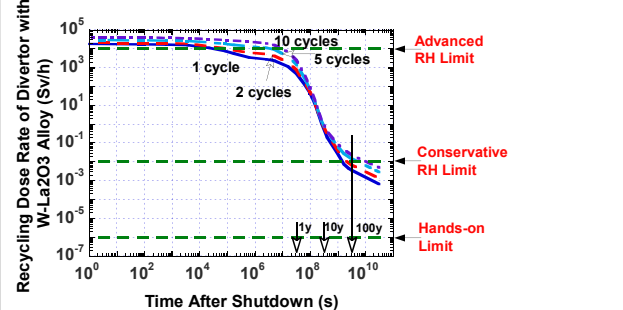
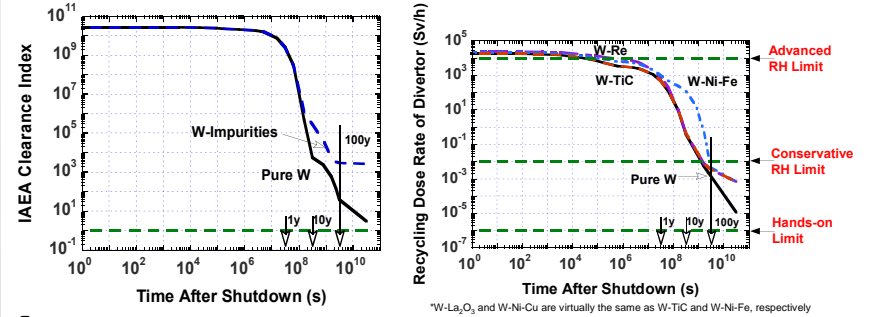
ARIES-ACT Divertor Design



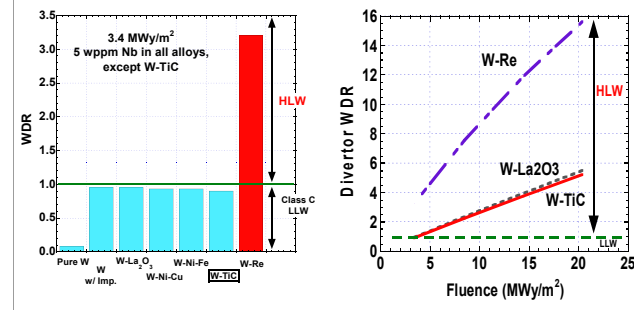
Design Constrains:
1. Withstand >10 MW/m²
2. Operate at 800-1200 °C

- Recent analyses have shown that previous divertor designs were inefficient in dealing with high thermal loads from the plasma
- Coolant has been switched from water to He – increased operating temps, increased thermal conversion efficiency
- He cooled divertor with W alloy structure is judged as an innovative and credible concept for dealing with advanced plasma conditions
- W armor has been deemed mandatory to protect divertor surface during operation
- Cooling channel consists of 30% W-alloy, 3% W, 11% ODS-MF82H, and 56% He coolant, by volume

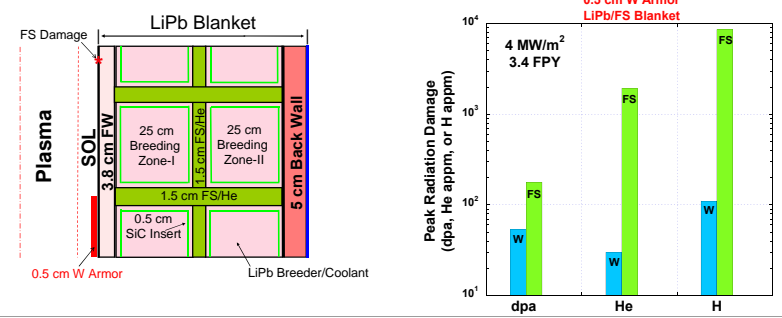
Divertor Clearance, Recycling, Multiple Reuse



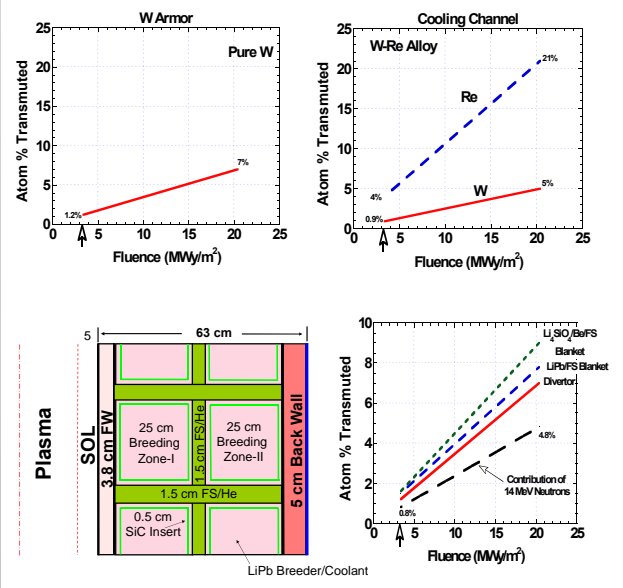
Divertor Disposal



W Exhibits Lower Radiation Damage Compared to FS



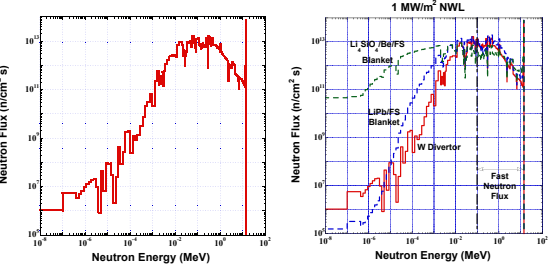
Divertor Transmutation



Conclusions

- W-based divertor, along with all PFC, is not clearable
- W-1.1TiC and W-La₂O₃ are the most promising alloys for generating LLW and being recyclable:
 - Recycling Option: all alloys do not have to cool very long before being refabricated
 - Disposal Option: divertor with any alloy (expect W-Re) would classify as LLW after 100 years of NRC control
 - W-26Re alloy generates HLW – avoid W-Re in divertor
- For same neutron environment, radiation damage level in W is low compared to ferritic steel:
 - He to dpa ratio is only 0.6 in W vs. 11 in ferritic steel.
- For ARIES neutron environment, W transmutation does not appear to be significant
- Significant Re transmutation in W-26Re, Re transmutation expected to adversely affect the bulk material properties – avoid W-Re divertor
- For softer neutron spectrum (at ceramic breeder blanket surface), transmutation of W in W armor attached to the first wall is larger than at the divertor.

ARIES-ACT Neutron Spectrum



- Analysis conducted for ARIES-ACT – newest ARIES design under development
- Results apply to any device with a similar neutron spectrum at divertor and/or W armor