

Modeling fast particle losses in three dimensional equilibrium

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MAX PLANCK
GESELLSCHAFT



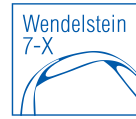
EUROfusion



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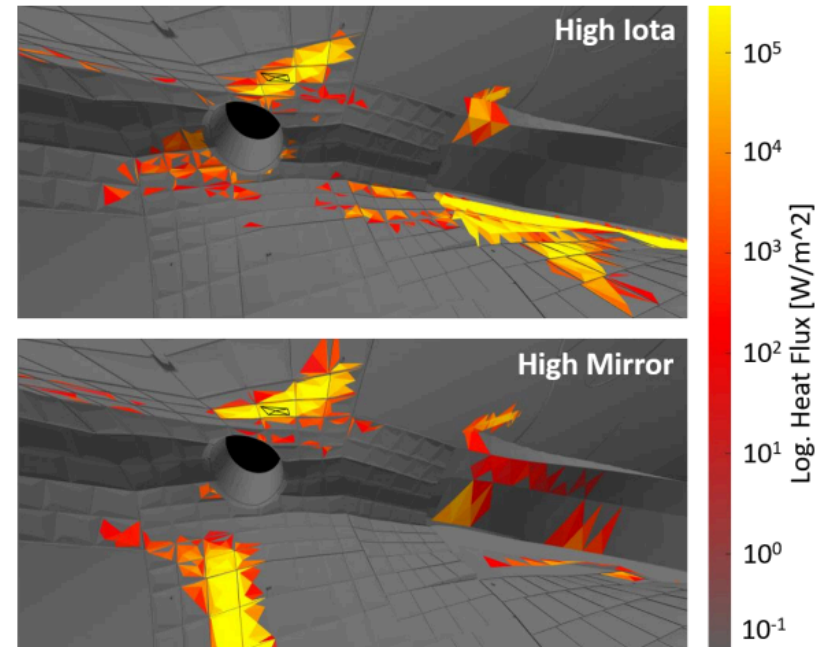
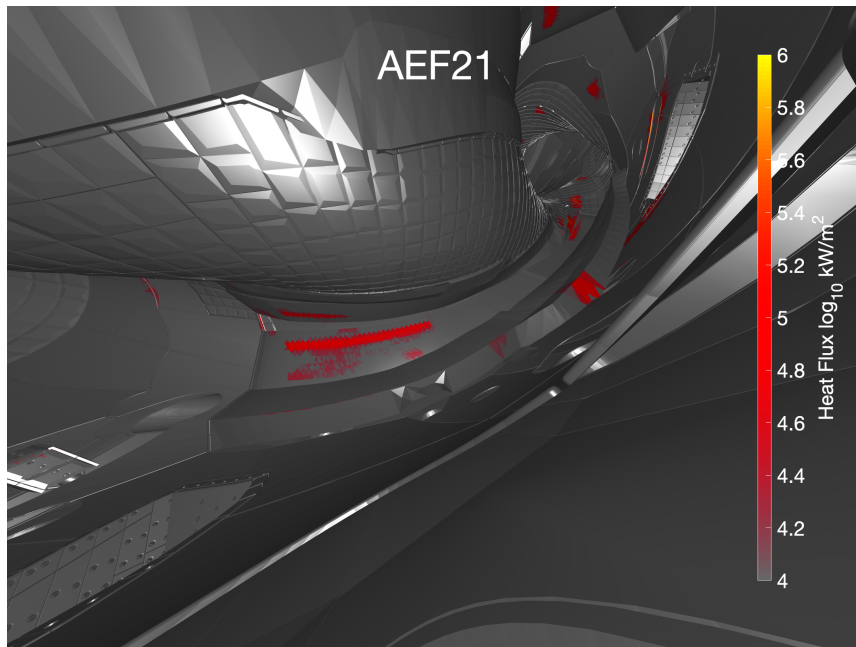
VMEC provides 3D equilibria for fast ion modeling



- Three dimensional equilibria codes
 - Ideal 3D MHD: VMEC, NSTAB, GVEC, DESC
 - 3D resistive MHD: HINT, SPEC, PIES, SIESTA, M3D-C1S
- BEAMS3D
 - Monte-Carlo NBI gyrocenter code interfaced to VMEC
- VENUS-LEVIS (SCENIC)
 - ICRH (NBI) Monte-Carlo code interfaced to VMEC (Boozer)
- ASCOT4/5
 - Monte-Carlo gyrocenter and full orbit code
- Japanese codes also exist (HFREYA...)

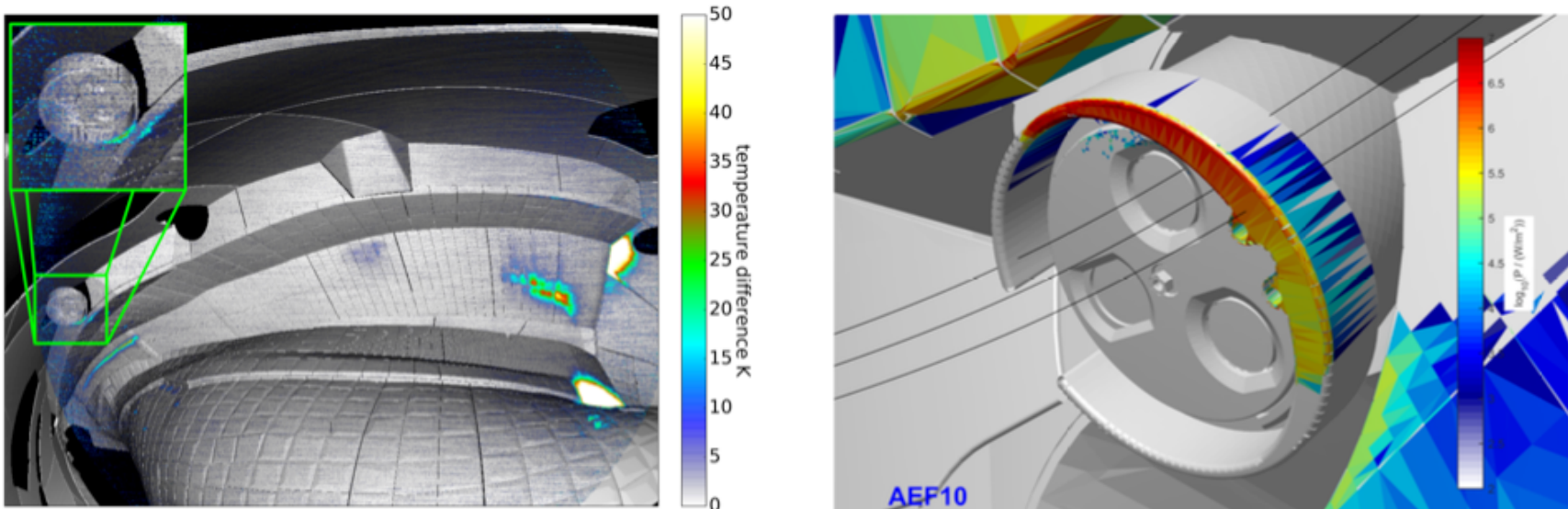
Modeling of FI losses plays an operational role in W7-X

- Early work suggested high first wall heat fluxes in W7-X from NBI lost ions
- Subsequent experiments show no such loads
- This is attributed to no CX in simulations



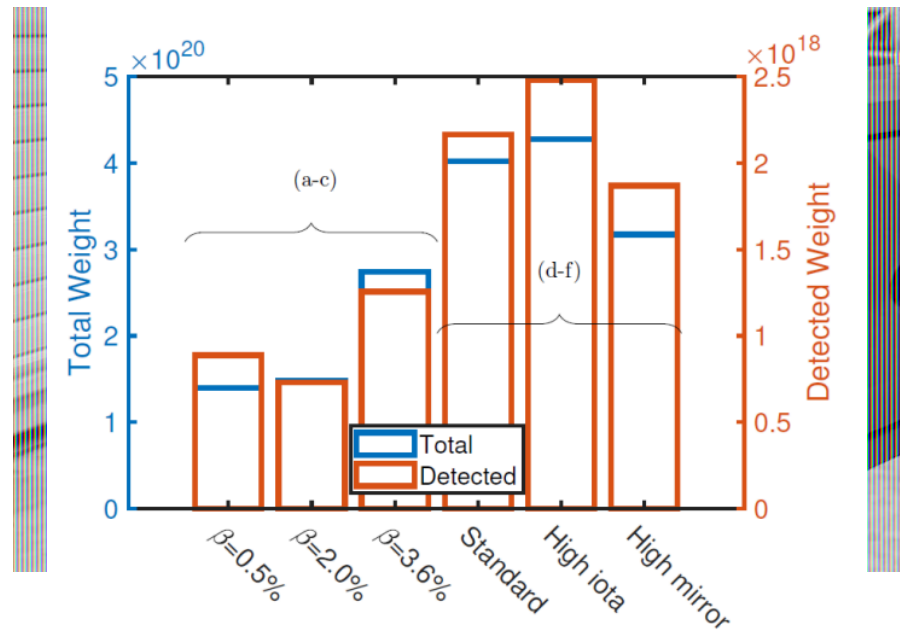
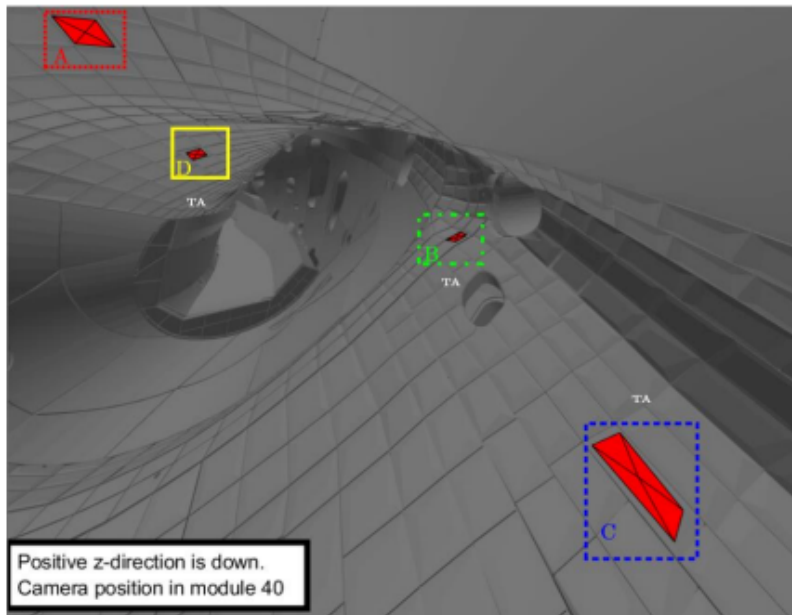
However qualitative agreement is present in some cases

- Predicted loads on immersion tubes were present
- Amplitude of loads was lower than expected
- Challenge is to go from heat flux to temperature rise on non-carbon surfaces with complex geometry.



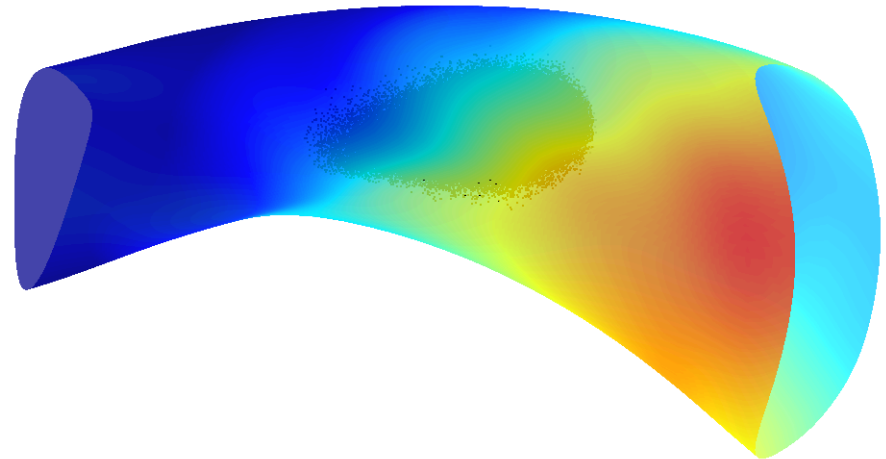
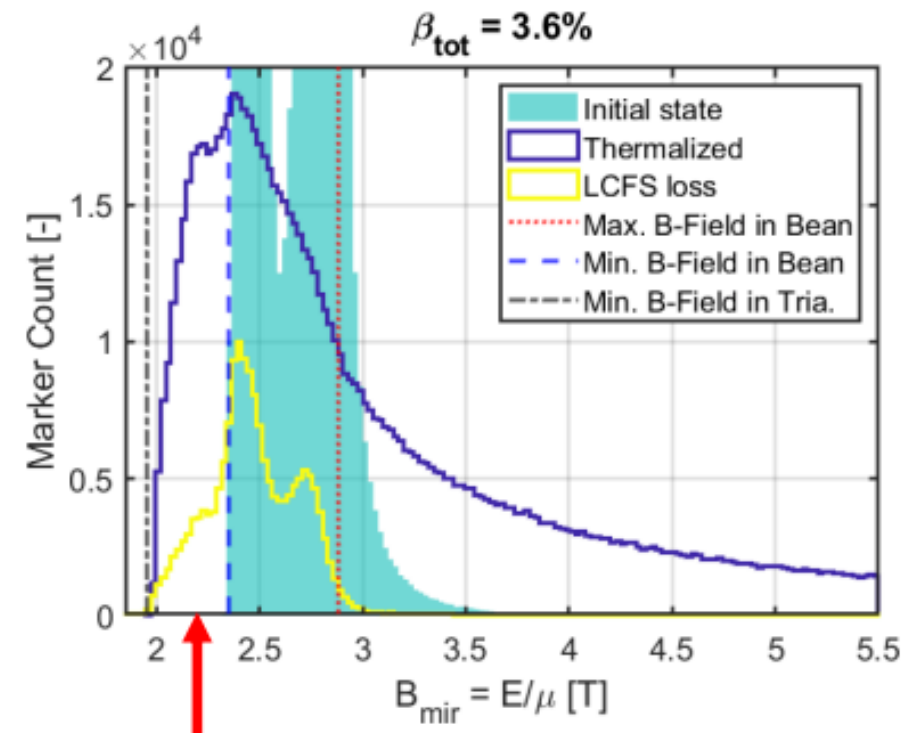
Simulations inform placement of novel FC-FILDs

- Solid state Faraday Cup Fast Ion Loss Detectors allow for in-wall tile placement.
- Coupled BEAMS3D/ASCOT5 simulations are helping to inform placement in W7-X.

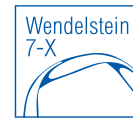


In three dimensions High/low field paradigm can be broken

- W7-X optimization predicts improvement in confinement of deeply trapped particles as beta increases
- W7-X NBI simulations do not show this effect
- W7-X has high field injection.



Work is underway to improve and extend codes



- **BEAMS3D upgraded to simulation fusion alphas**
 - Lazerson et al. PPCF 2021
- **BEASM3D being interfaced to HINT, SIESTA, SPEC, and M3D-C1S**
 - Experiments being proposed to investigate role of core island on W7-X
- **BEAMS3D being interfaced to FIDASIM (ENR)**
- **ASCOT5 being accelerated with GPU's (TSVV-12)**
- **AORSA code being investigated for stellarator applications**
- **VENUS-LEVIS providing ICRH and coupled ICRH/NBI studies.**