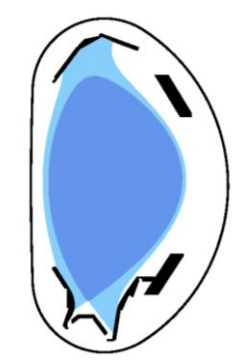




ASCOT-RFOF modelling of ion cyclotron heated fast ion loads on AUG antenna limiters

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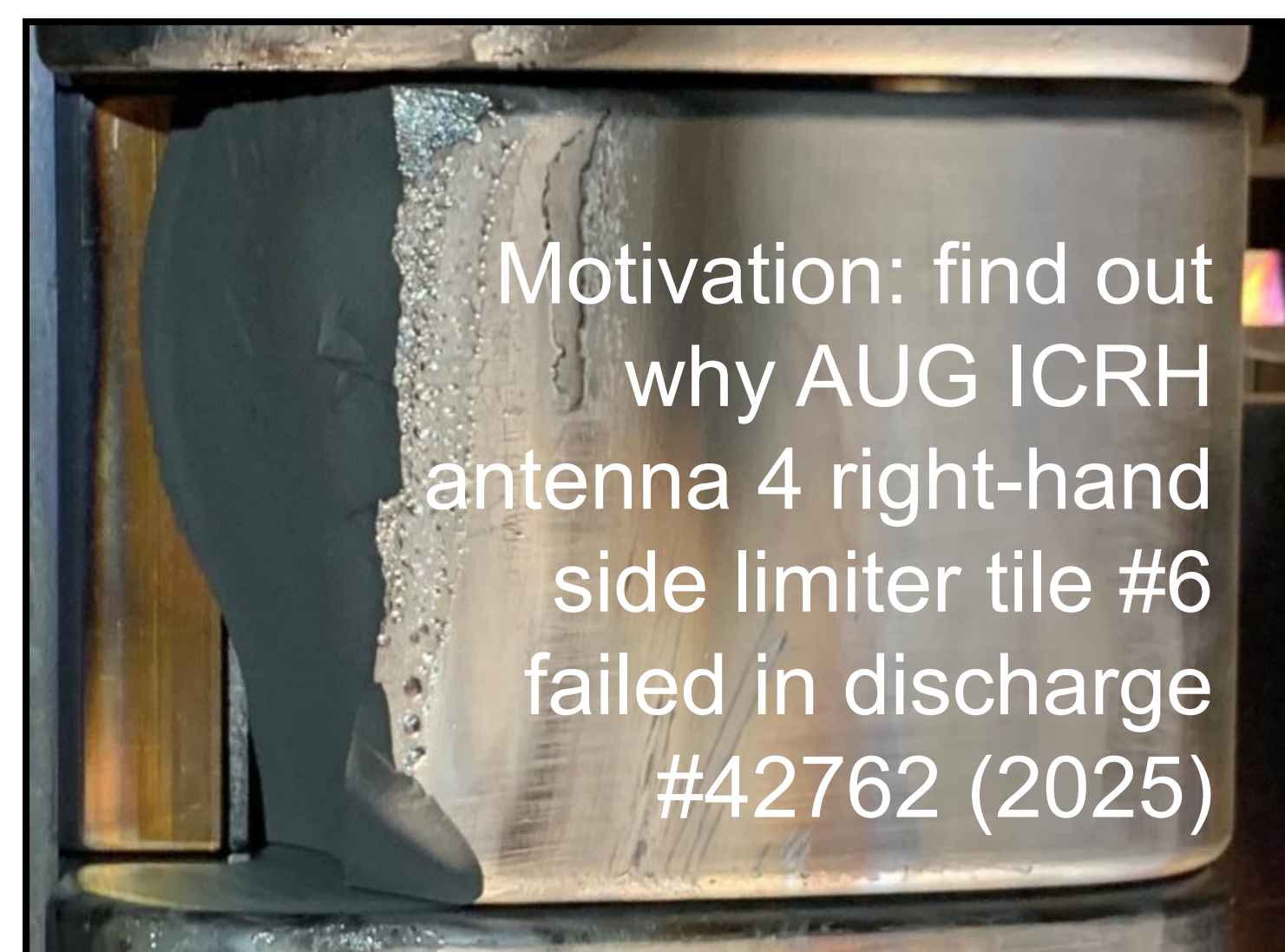
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⁴ See the author list of T. Pütterich et al., 2026 Nucl. Fusion **66** 116002

⁵ See the author list of N. Vianello et al., 2026 Nucl. Fusion **66** 116010

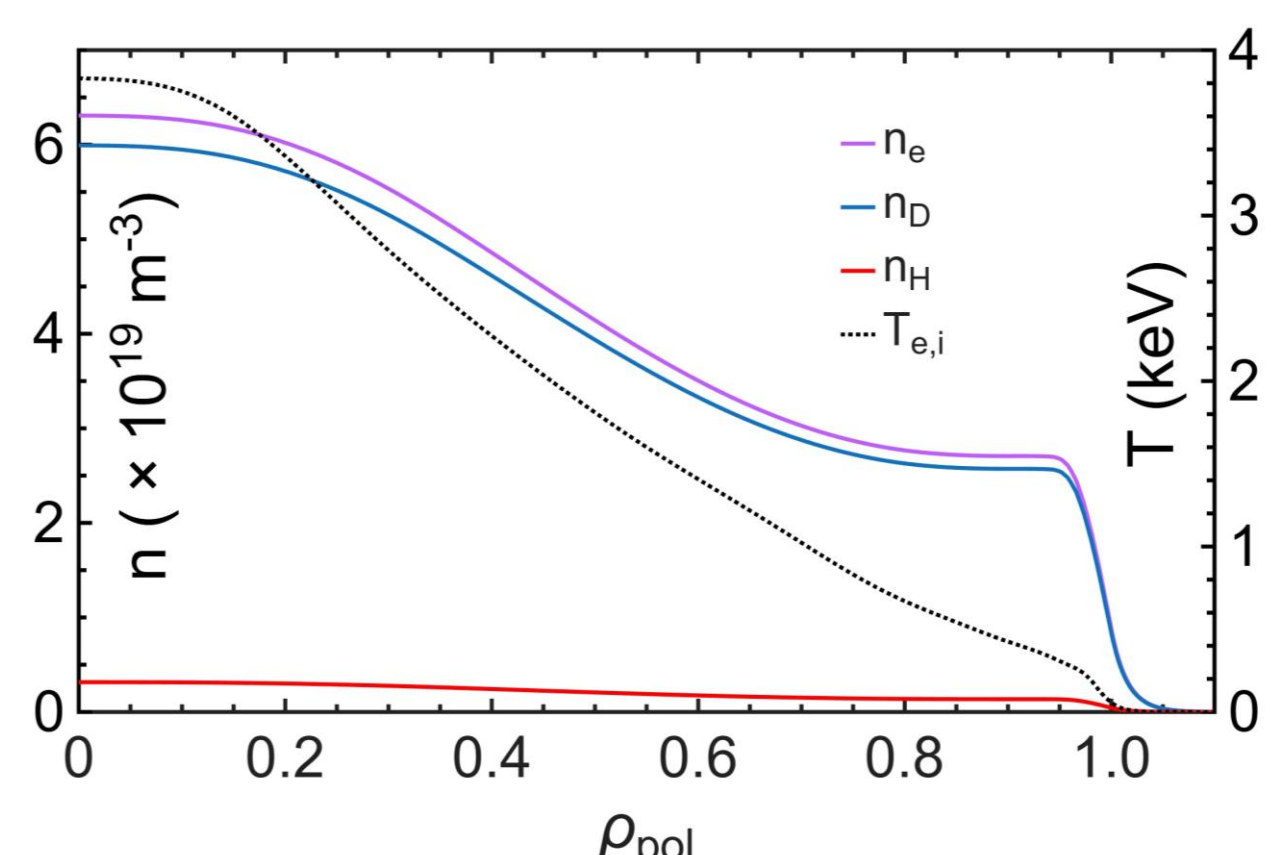
Introduction

A new analysis chain based on the orbit-following Monte Carlo code ASCOT-RFOF^{1,2} is presented for detailed studies of fast ion heat load patterns on plasma-facing components.



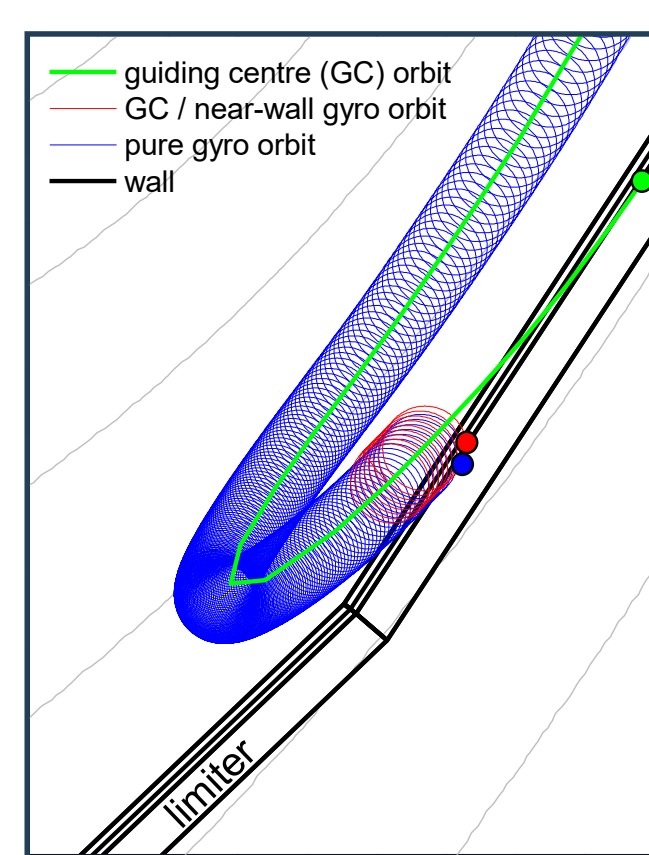
Orbit-following simulations

- AUG #42762@7.75s ($B_T = 2.52T$, $I_p = 0.35MA$, 5% H)
- AUG 3D magnetic data with ripple, CAD wall model
- hydrogen ICRH at $f = 36.5$ MHz and $P_{ICRF} = 3.00$ MW

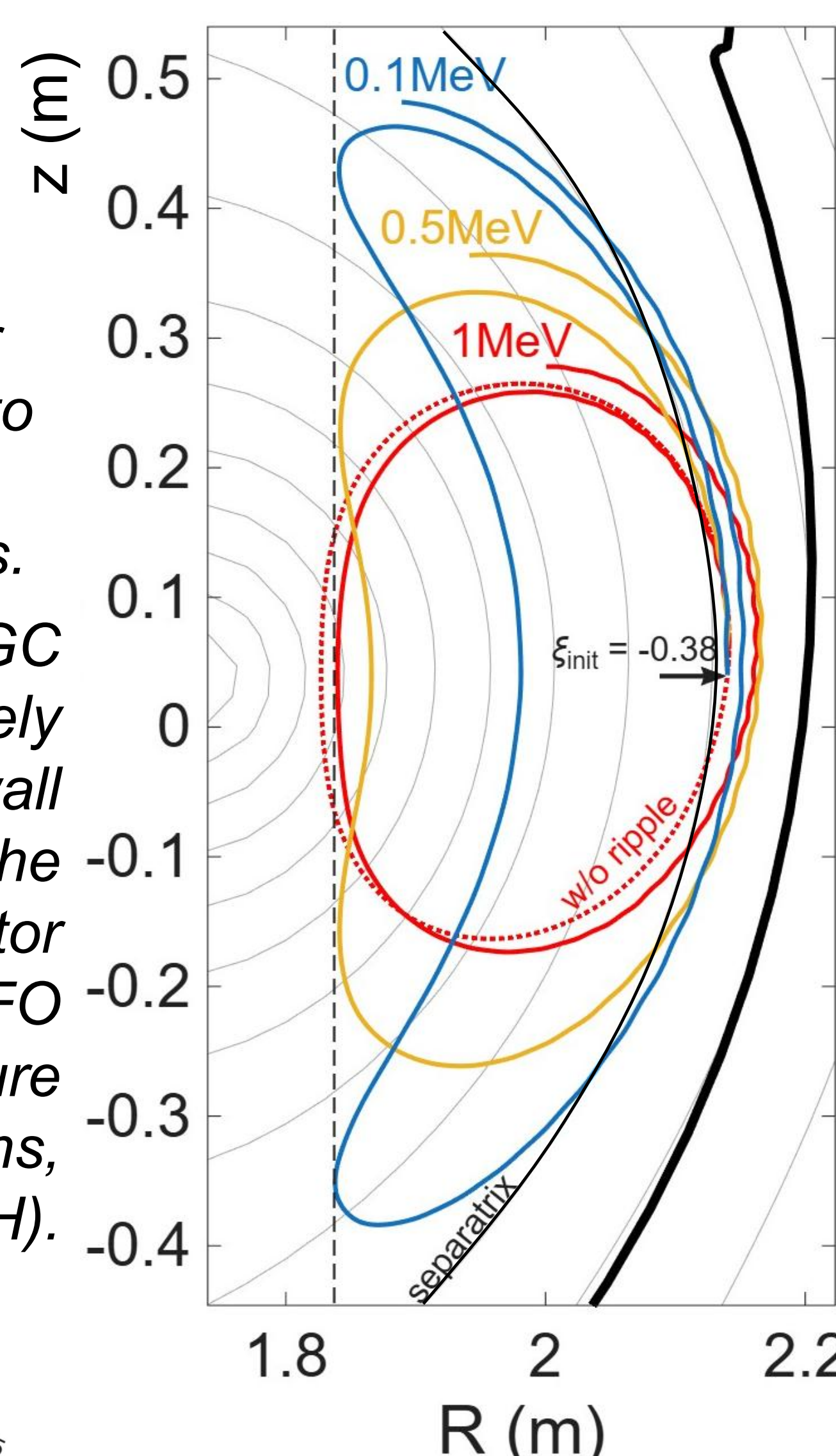


Stage 1: ~1.5M H markers were initialized with random (R, ϕ, z), random pitch ξ and local Maxwellian energy E and followed with ICRH and Coulomb collisions on background plasma for 100ms or until lost, evaluating the steady-state hot tail distribution $f(R, z, \xi, E)$. (~9.5h@8192 cores)

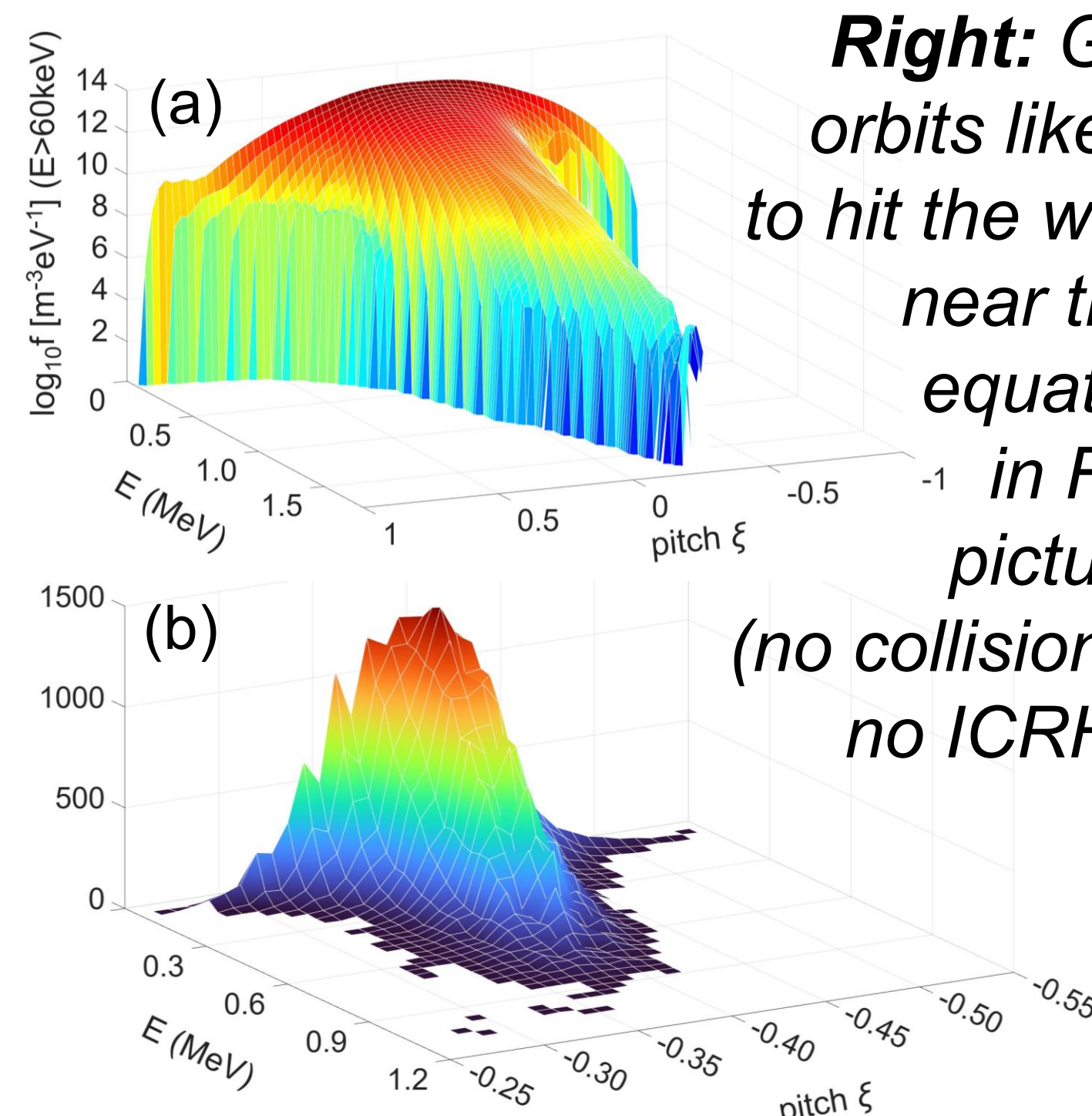
Stage 2: Fast hydrogen markers ($E > 60keV$), continuously sampled from the recorded hot tail distribution, were followed on collisionless orbits and without ICRH for 10ms, recording wall collisions in (R, ϕ, z, ξ, E), until a statistically adequate heat load pattern emerges. (~13h, 1.2B markers)



Left: ASCOT switches from guiding centre (GC) to full orbit (FO) picture near the wall in order to produce realistic wall load patterns.



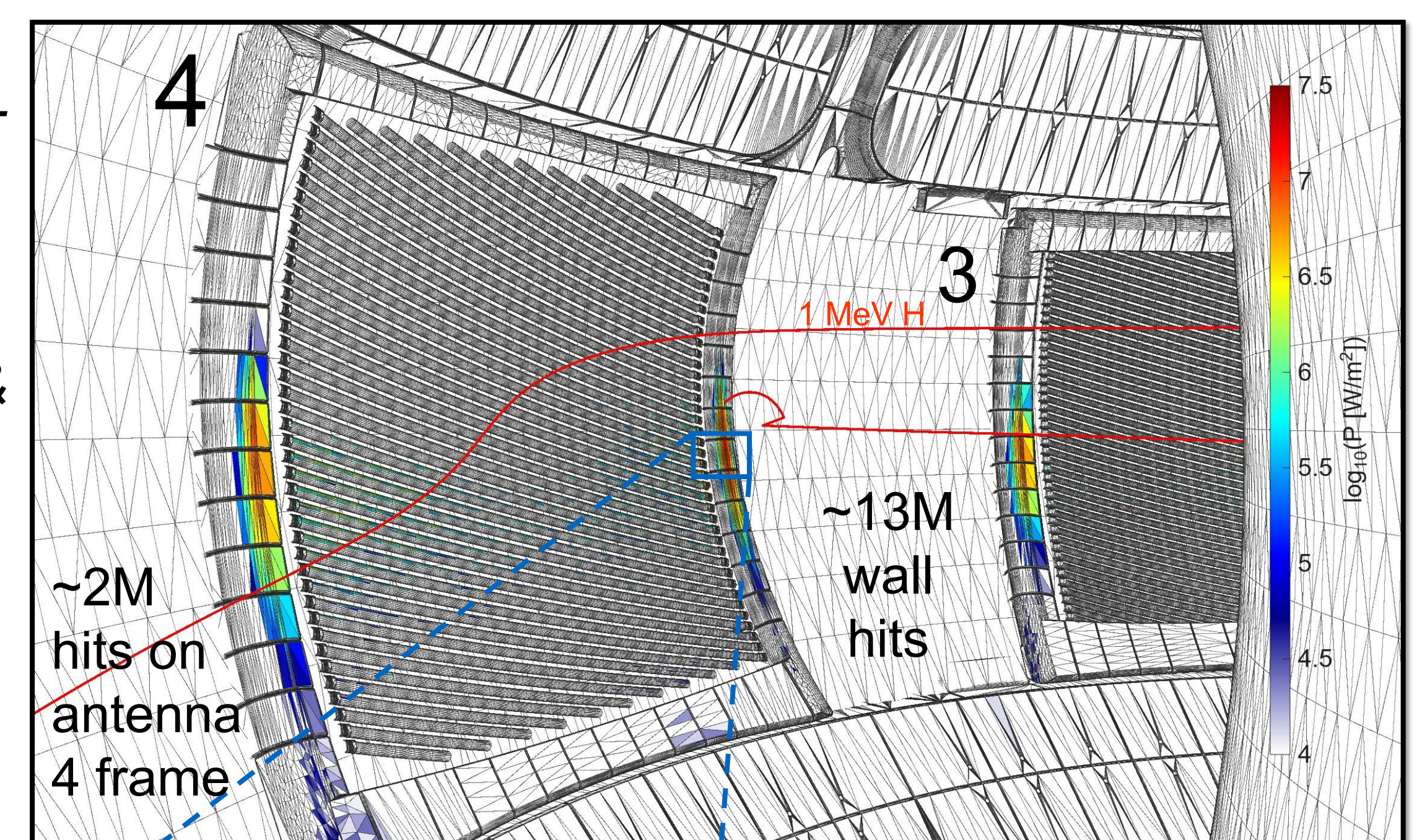
Right: GC orbits likely to hit the wall near the equator in FO picture (no collisions, no ICRH).



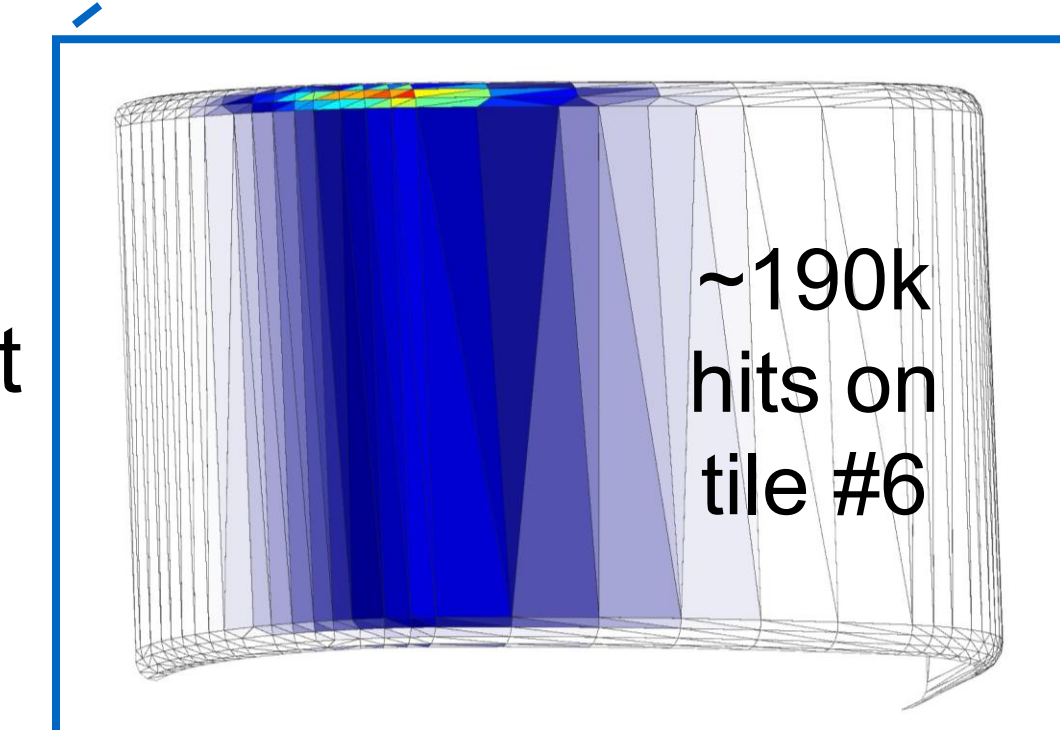
Above: a) steady-state tail from 1st stage ICRH simulation.
b) ξ -E histogram of H marker hits on tile #6 from 2nd stage.

Analysis of heat load pattern on tile #6

Right: simulated IC-heated fast ion heat load pattern on antennas 3 & 4 from the 2nd stage simulation.

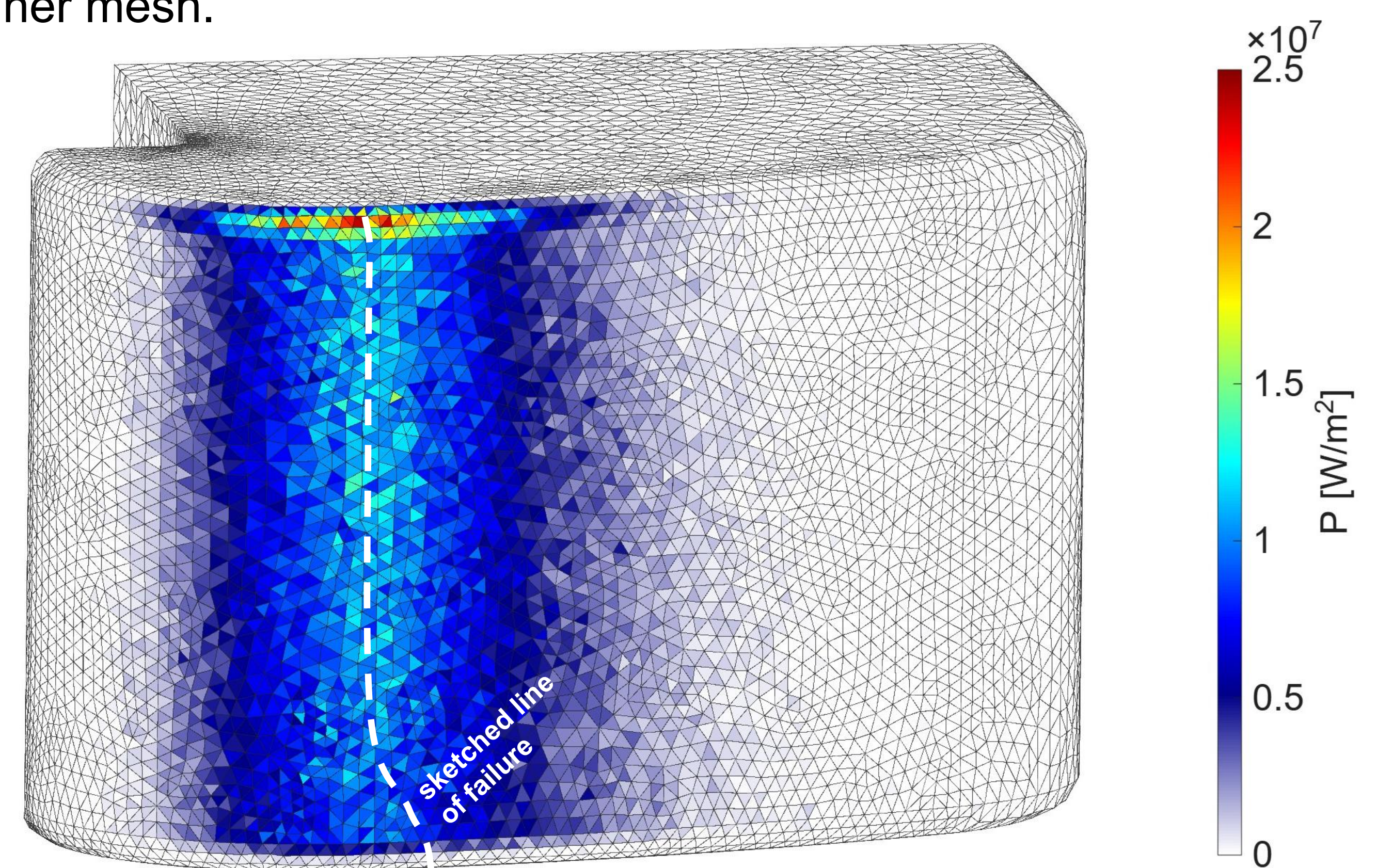


The surface mesh of the wall CAD model is inadequate for pinpointing hot spots, but the wall hit data can be projected on a finer mesh.



Left: Heat load projected on the original CAD model of tile #6.

Below: Heat load projected on the remeshed tile surface from ANSYS.



Conclusions

- The new analysis chain facilitates detailed simulations of fast ion heat load patterns on plasma-facing components
- Computing resources permitting, heat load patterns on arbitrarily detailed components can be modelled
- Load patterns can readily be mapped onto a more refined surface mesh for further analysis (e.g. ANSYS)
- A likely contributing factor to the antenna 4 limiter tile failure was found.

[1] E. Hirvijoki et al., Computer Physics Communications 185 (2014) 1310.

[2] T. Johnson et al., AIP Conference Proceedings 1406 (2011) 373.

The simulations were carried out using the Pitagora cluster at CINECA, Bologna, Italy.



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