Edge-plasma characteristics for ITER*

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and discussions with M. Kotschenreuther

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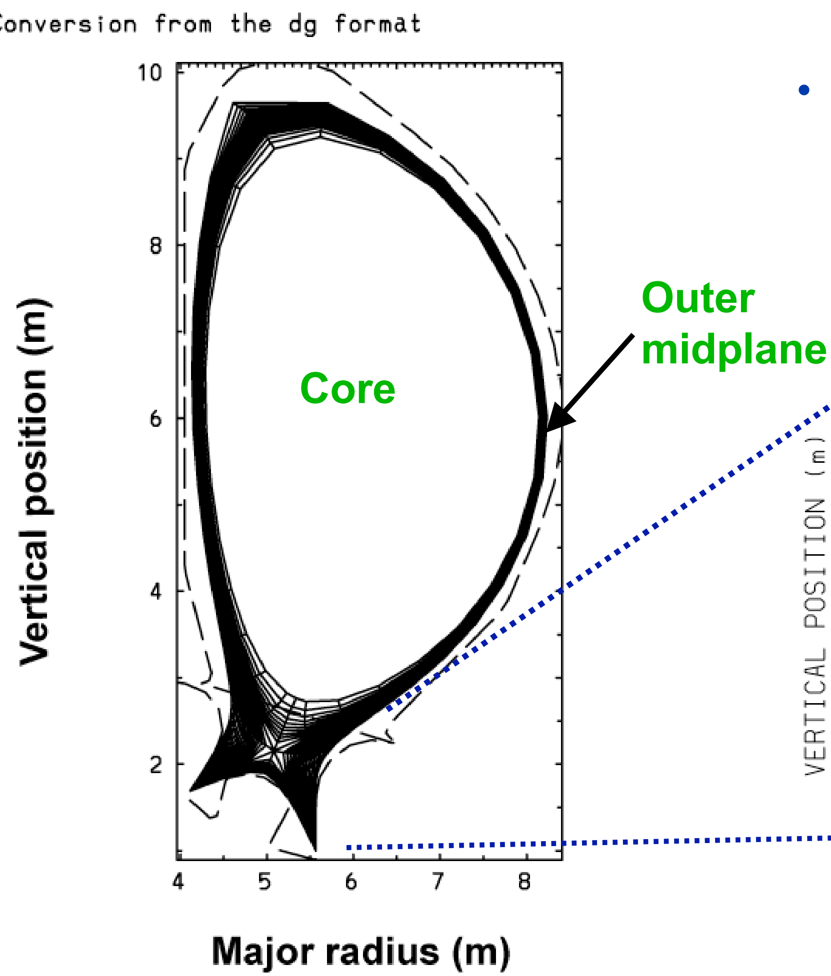
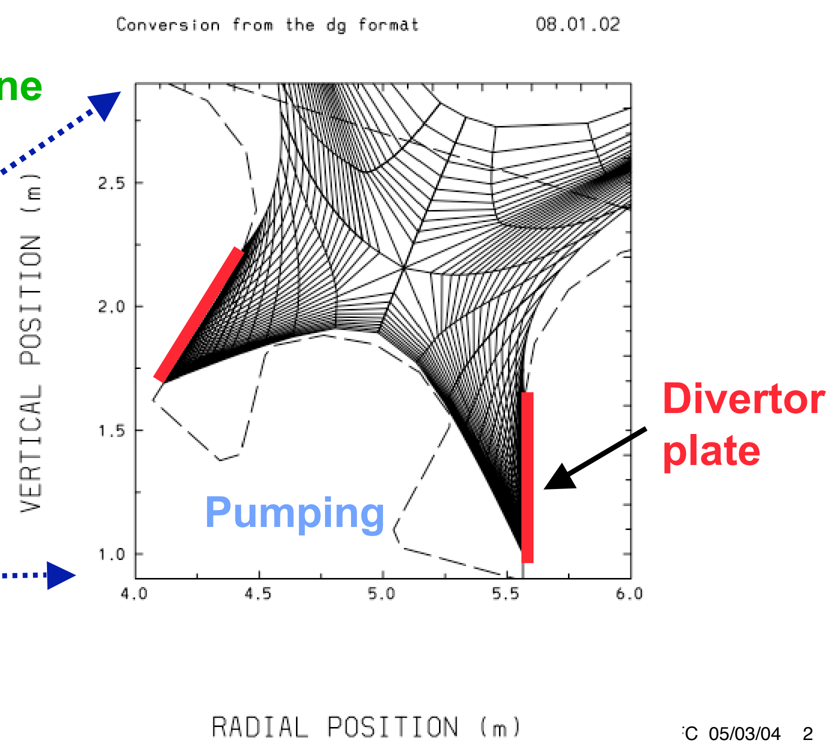
ITER utilizes a single-null divertor with steeply-inclined divertor plates

Poloidal cross-section showing edge-plasma region

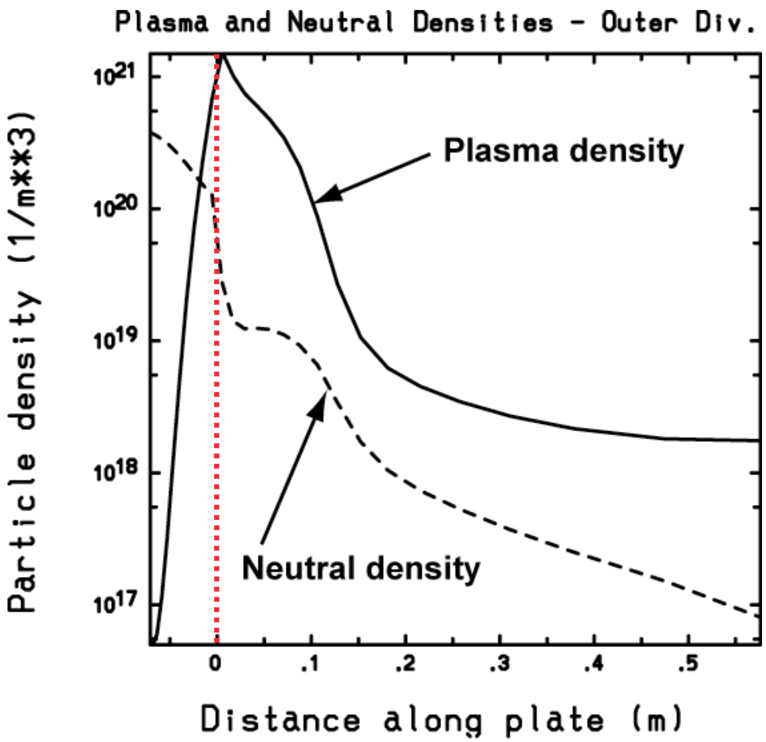


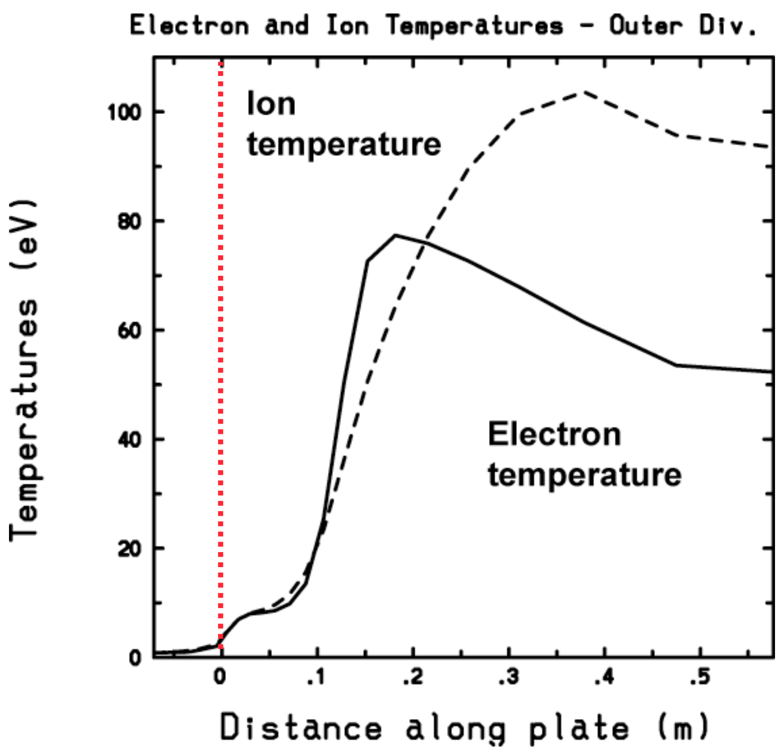
- **Nearly vertical plates reduce heat flux & facilitate plasma detachment**
- **Carbon radiation helps reduce T_e near strike point to allow He pumping**



ITER divertor plasma modeling has assumed standard diffusive radial transport

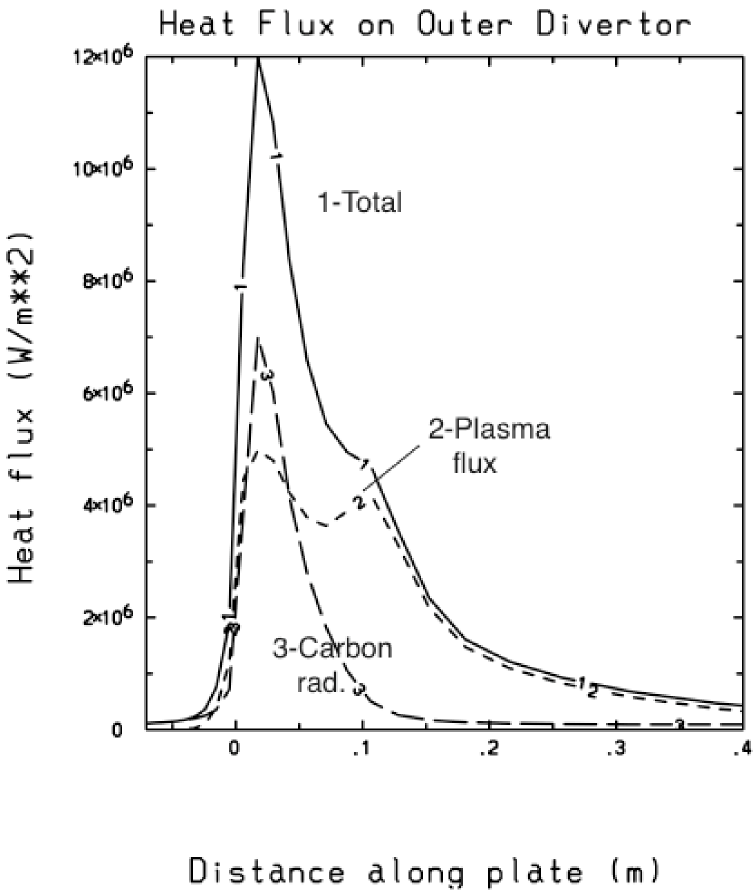
- ITER assumes 100 MW power input to SOL
- Here carbon modeled as a 3% concentration
- Anomalous radial diffusion set at D = 0.3 m^2/s, $\chi_{e,I}$ = 1 m^2/s





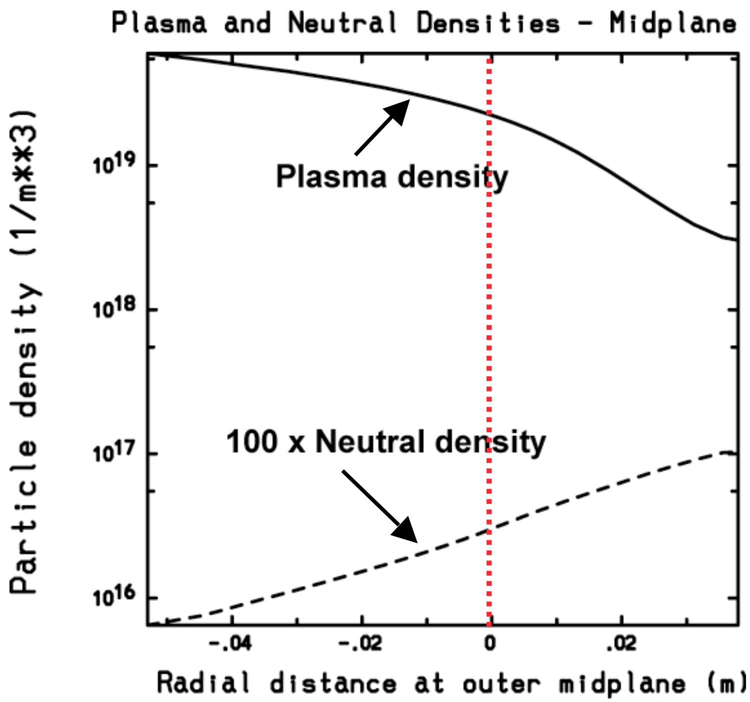
Divertor heat-flux is kept within allowable limits

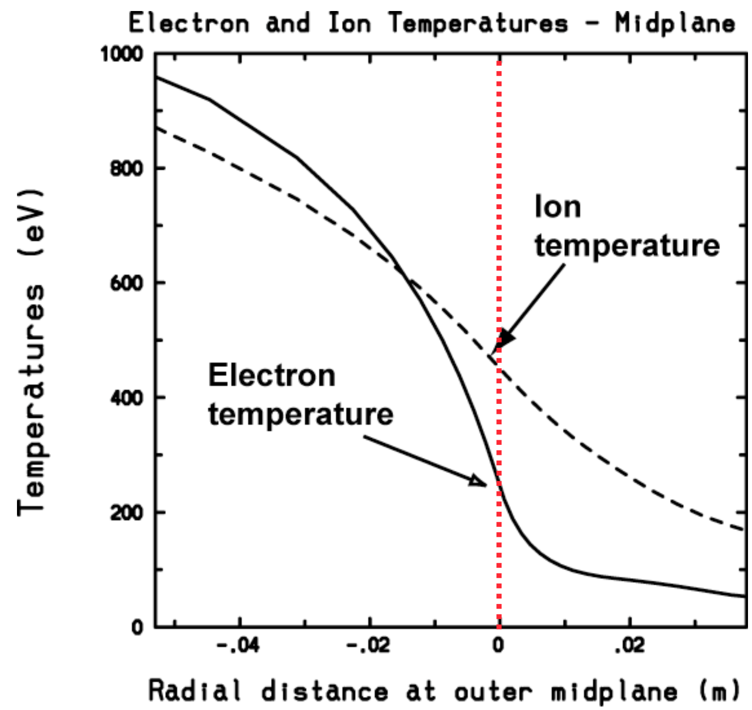
- **Wetted area is increased by strong tilting (similar, but more extreme than Alcator C-Mod)**
- **Sputtered carbon yields a further necessary heat-flux reduction via line radiation**
- **Addition impurity seeding with neon sometimes considered**



Outer midplane profiles yield low neutral density and $T_i > T_e$ near the outer wall

- **Plasma recycling in the divertor is dominant; low wall density**
- **Ion temperatures outside separatrix in 200-400 eV range**





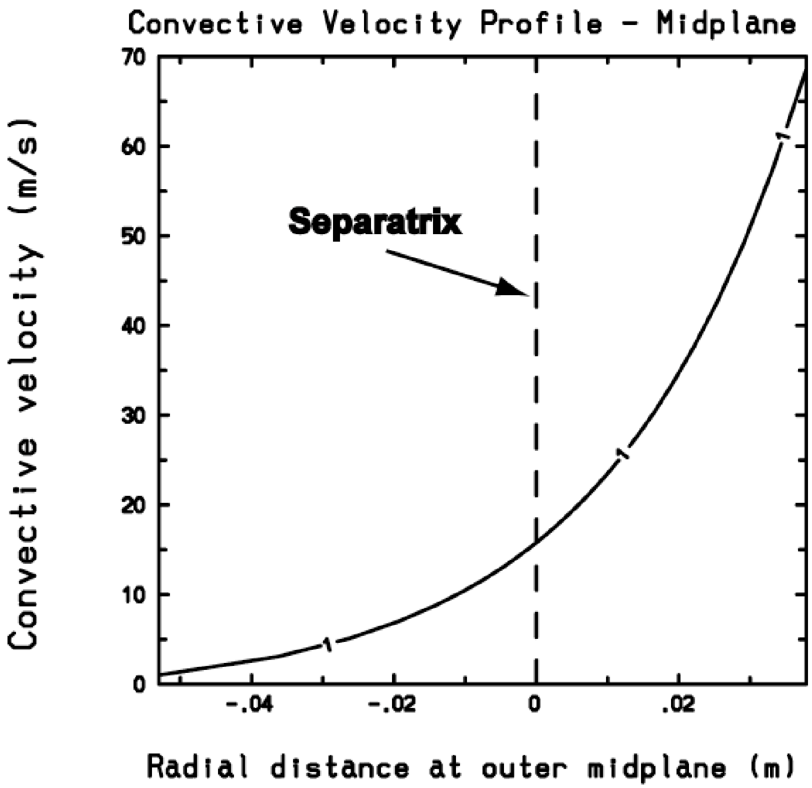
Experiments and turbulence simulations indicate SOL transport can have strong outward component

- **Gas-puff imaging and H-alpha light show outward moving filaments ("blobs") (Zweben et al.)**

- **Probes see outward moving perturbations (Boedo, Rudakov)**

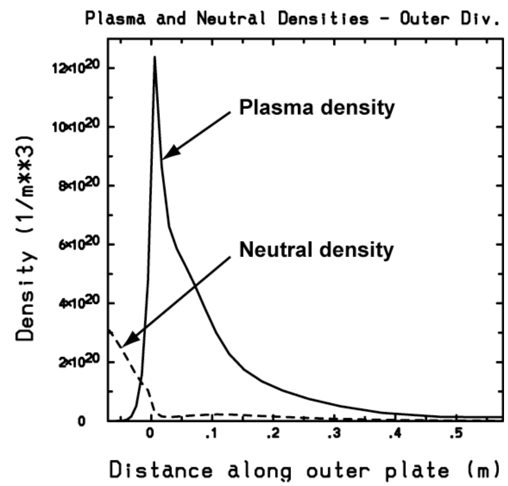
- **Ionization balance from H-alpha (Lipschultz, Whyte)**

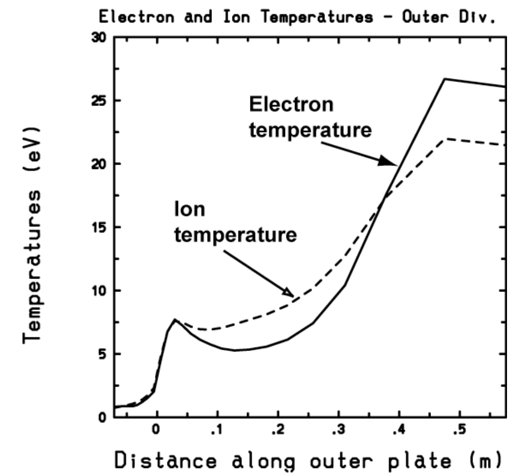
- **Transport modeling indicates that some features of the SOL can be explained by outward convection (Pigarov et al.)**



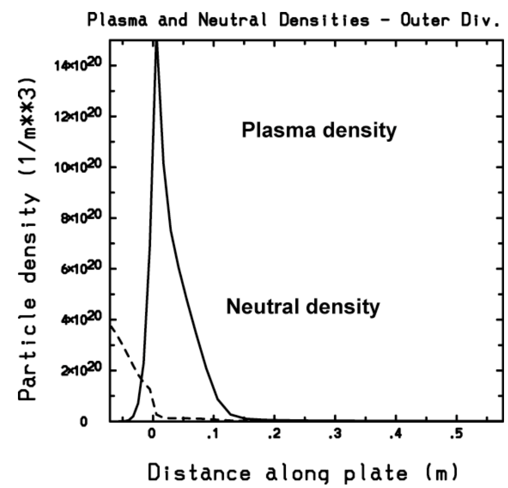
Convection applied to ITER shows some radial broadening of profiles at the divertor

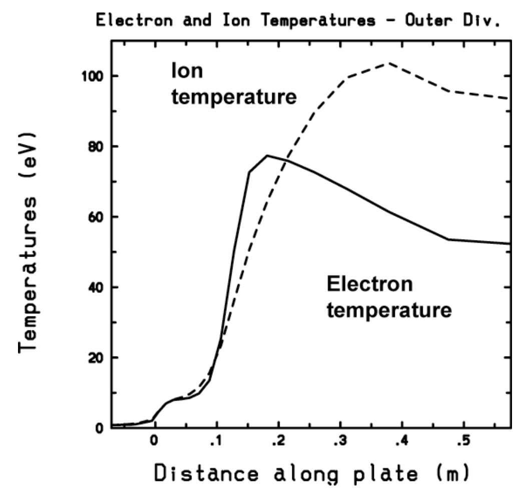
With convection →





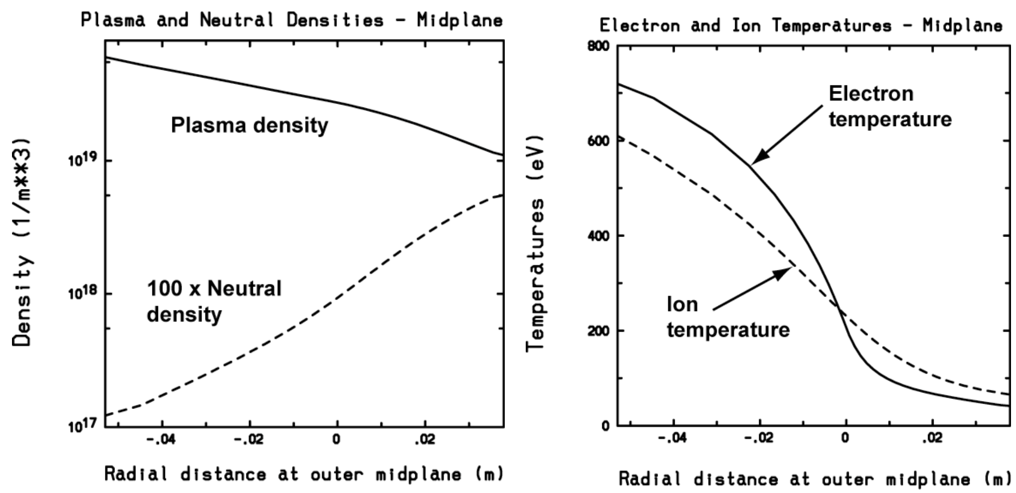
Without convection →



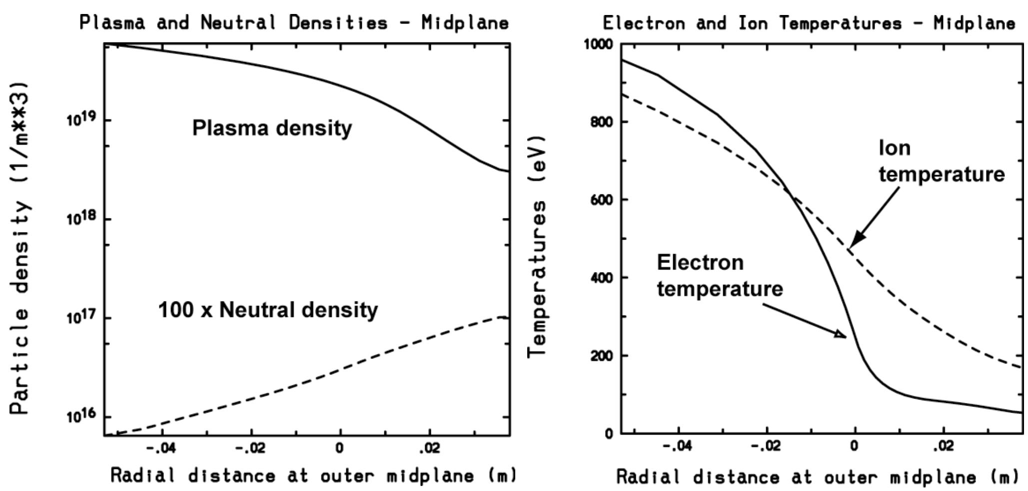


Neutral density at the outer midplane increases a factor of 50 with convection

With convection →



Without convection →



Increased neutral density caused by convective loss poses a potential wall erosion problem

- Neutrals from the close chamber wall can penetrate to a sufficiently high T_i region that charge-exchange neutrals are well above the sputtering threshold
- Related modeling by Kotchenreuther, Rognlien, and Valanju for an ARIES tokamak show that such loss can cause severe erosion
- These ITER cases need to be more completely evaluated, including CX flux back to the wall

There are many problems relating to ITER edge-plasma behavior that should be addressed

- Impact of possible strong convective radial transport
- Effect of ExB drifts on transport
- Tritium co-deposition modeling needs plasma/neutral properties, including carbon sputtering, surface evolution, and plasma chemistry
- ELMs induced heat-flux on divertor and walls