MAX-PLANCK-INSTITUT
FÜR PLASMAPHYSIK

Modifications to TM5h/ TM6h/ TM7h area to avoid hotspots at TM7h/TM6h in high iota configuration

Jasper Dettmar

This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

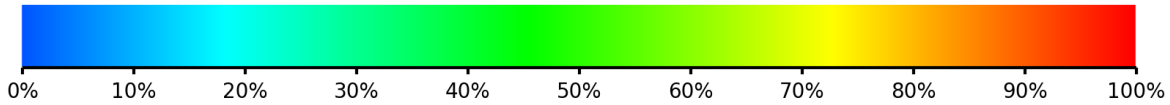
Simulation specifications

- **EMC3-lite was used for simulation, settings as follows:**

```
------------ Transport parameters ------------
PSOL(W)  ne_aver(cm**3) Te_aver(eV)  Chi(cm**2/s)
1.0000E+07  1.0000E+13  1.0000E+02  2.0000E+04
```

- **Number of particles used was 100 000, as samples with 1 000 000 particles brought very similar/ same results**

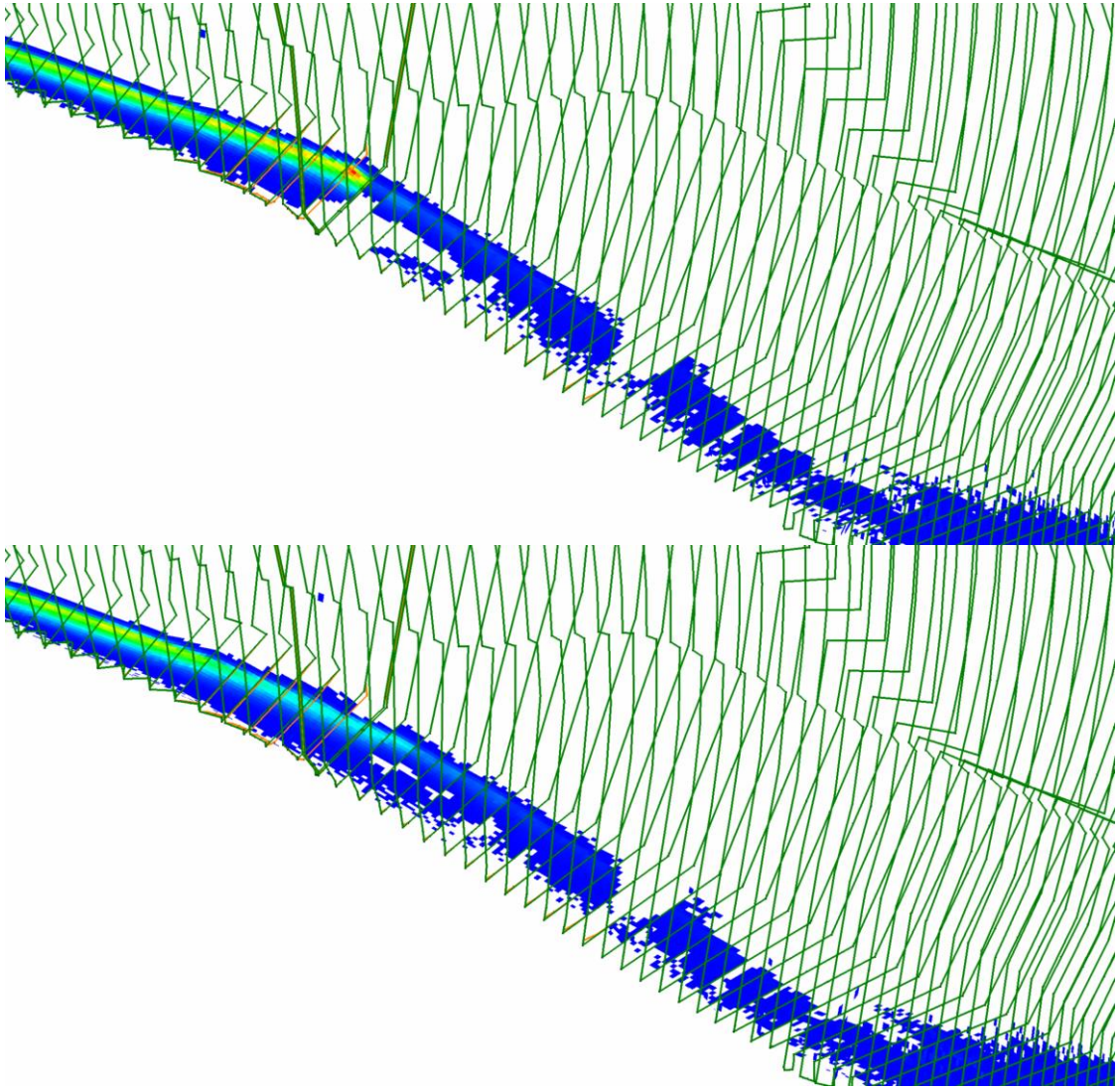
- **For better break-up of critical heat loads the colour-scale spans from 0 to 20 MW/m²:**

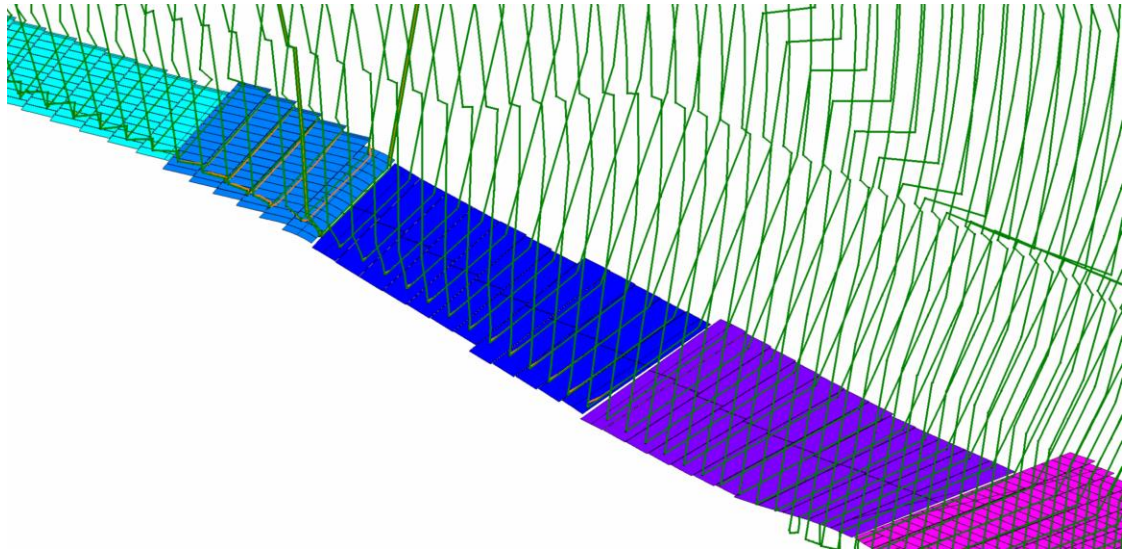


Change 1 to the divertor shape

- The transition in height from TM6h to TM7h was stretched across a larger phi-section. From an original curvature between phi = 11,92 to 12,35 degree to a linear transition between phi = 15 and 11,5 degree
- This means a change to the shape of TM7h module

planed vs. original geometry at TM6h/TM7h, beta = 0 %





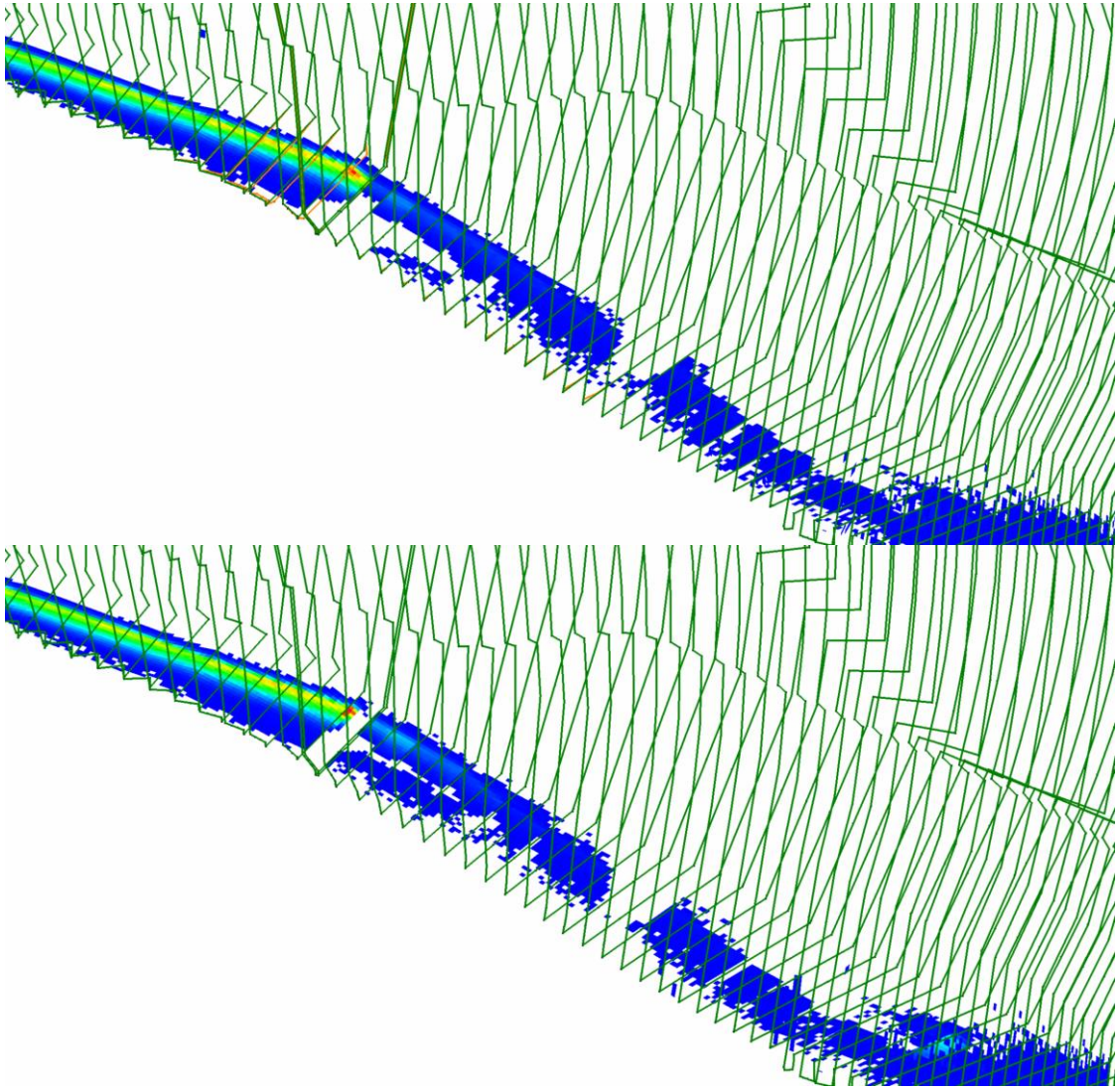
- Above right: for orientation: current divertor shape. Modules (from left to right) TM7h, TM6h, TM5h
- Above left: Simulated heat load on current divertor shape
- Left: Simulated heat load with planed divertor shape

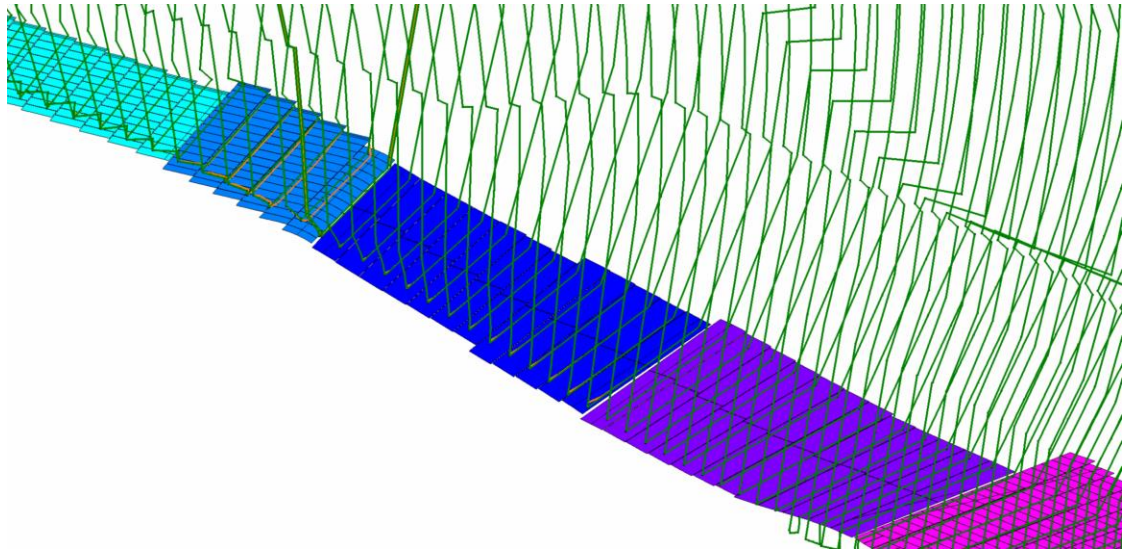
Green lines: original grid, orange lines: changed grid

Change 2 to the divertor shape

- **TM6h and TM5h lifted either 5, 10 and 15 mm along z-axis**
- **This means no change to the shape of any module**

Lifted 5 mm vs. original geometry at TM6h/TM7h, beta = 0 %

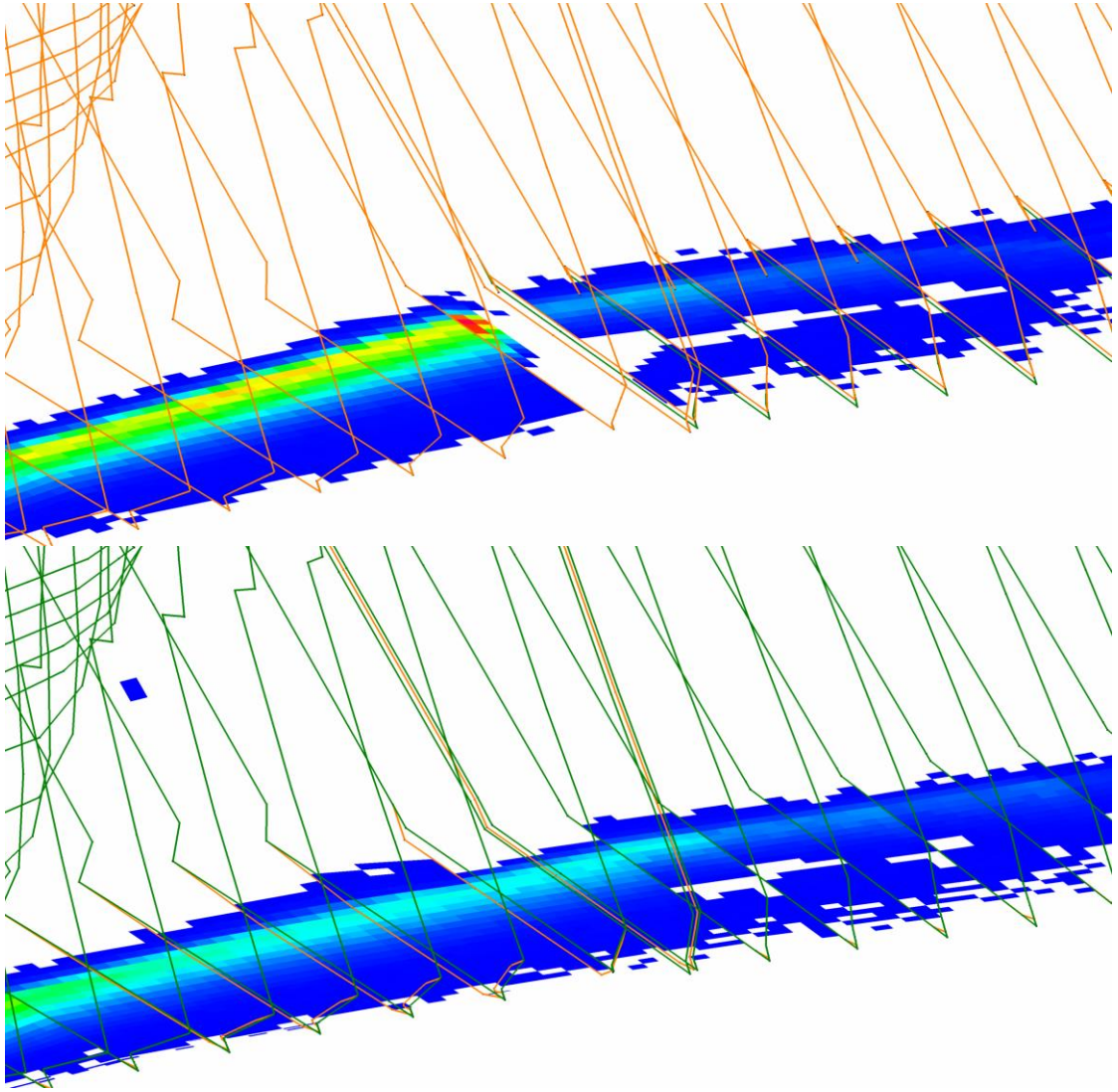


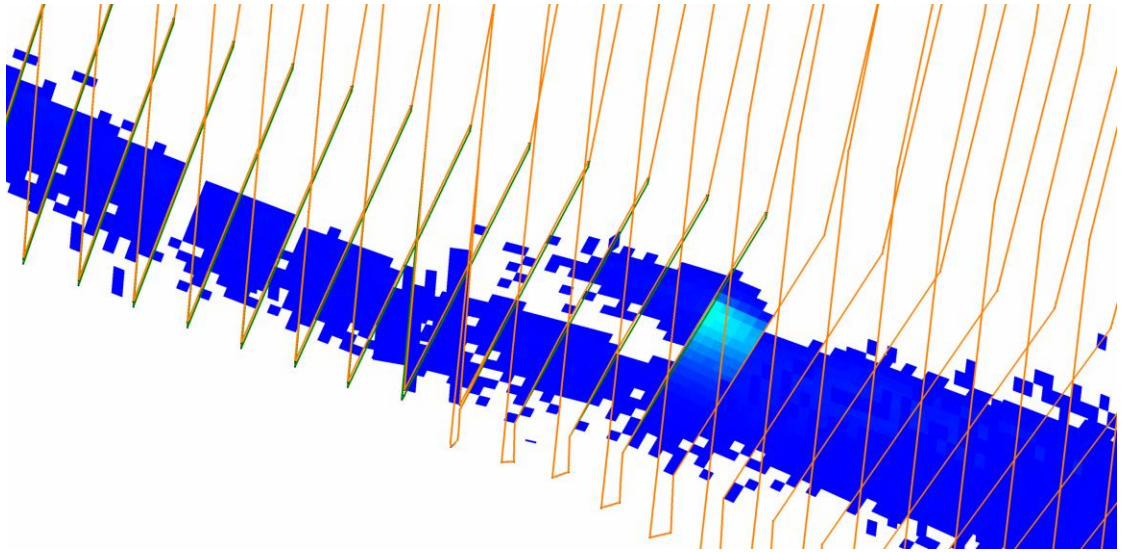


- Above right: for orientation: current divertor shape. Modules (from left to right) TM7h, TM6h, TM5h
- Above left: Simulated heat load on current divertor shape
- Left: Simulated heat load with 5 mm lifted divertor shape

Green lines: original grid, orange lines: changed grid

Lifted 5 mm vs. original geometry at TM6h/TM7h, beta = 0 %

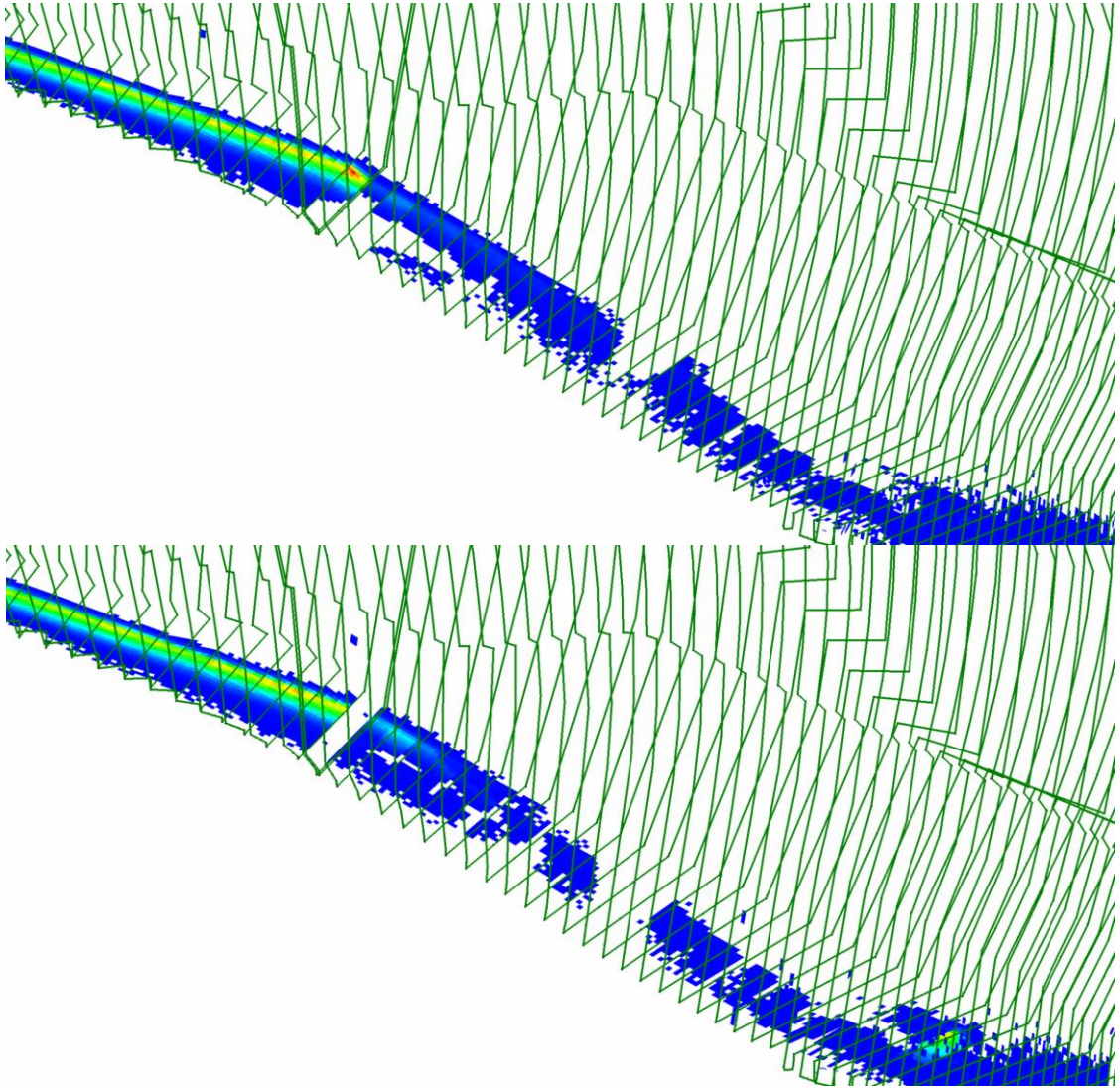


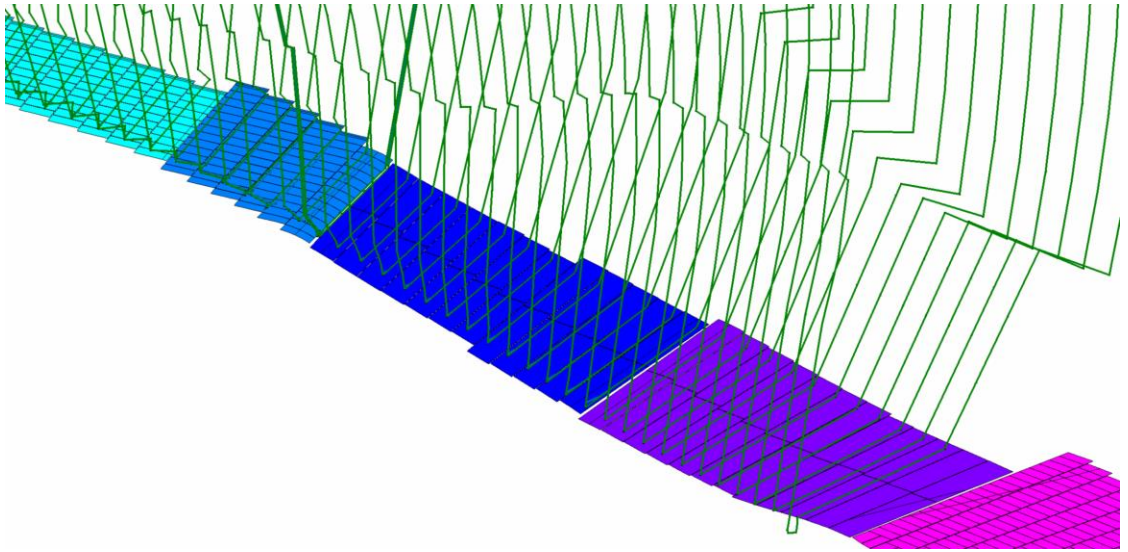


- Above right: TM5h/TM4h transition with lifted divertor shape
- Above left: TM6h/TM7h transition with 5 mm lifted divertor shown from the other side
- Left: TM6h/TM7h transition with planed divertor shown from the other side

Green lines: original grid, orange lines: changed grid

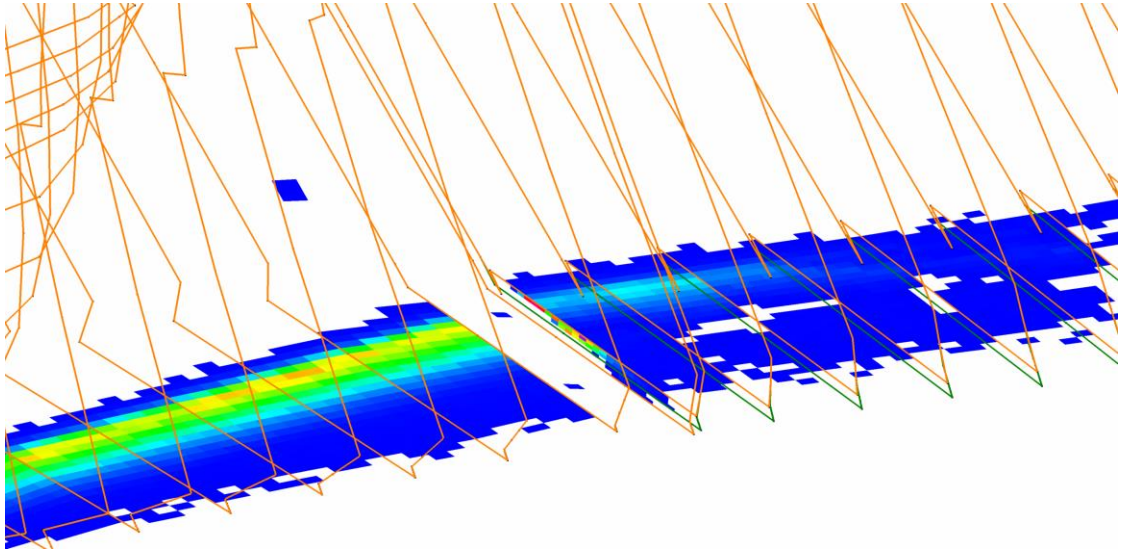
lifted 10 mm vs. original geometry at TM6h/TM7h, beta = 0 %

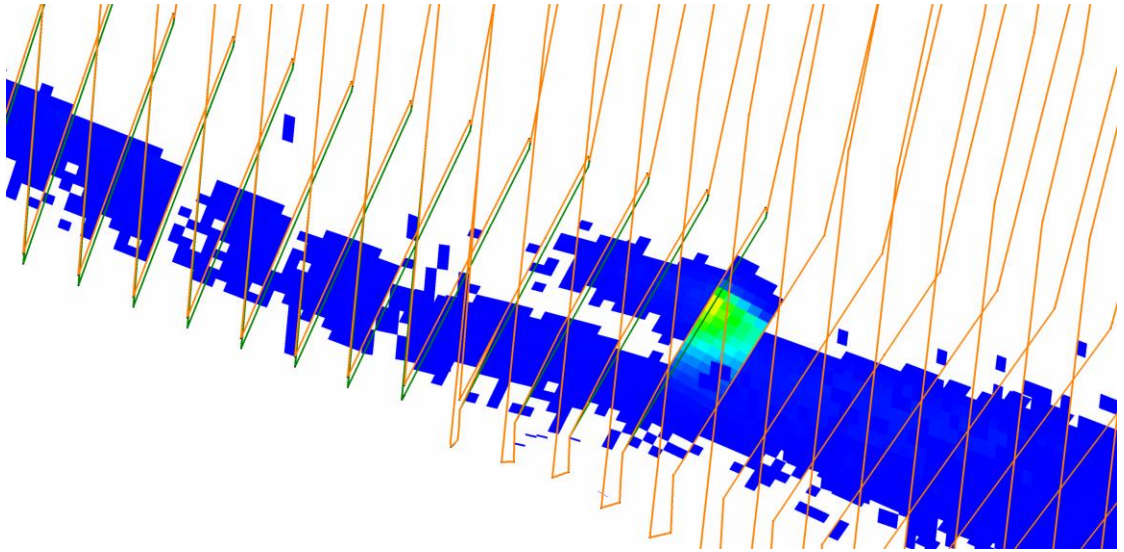




- Above right: Current divertor shape. Modules (from left to right) TM7h, TM6h, TM5h
- Above left: Simulated heat load on current divertor shape
- Left: Simulated heat load on 10 mm lifted divertor shape

lifted 10 mm vs. original geometry at TM6h/TM7h, beta = 0 %

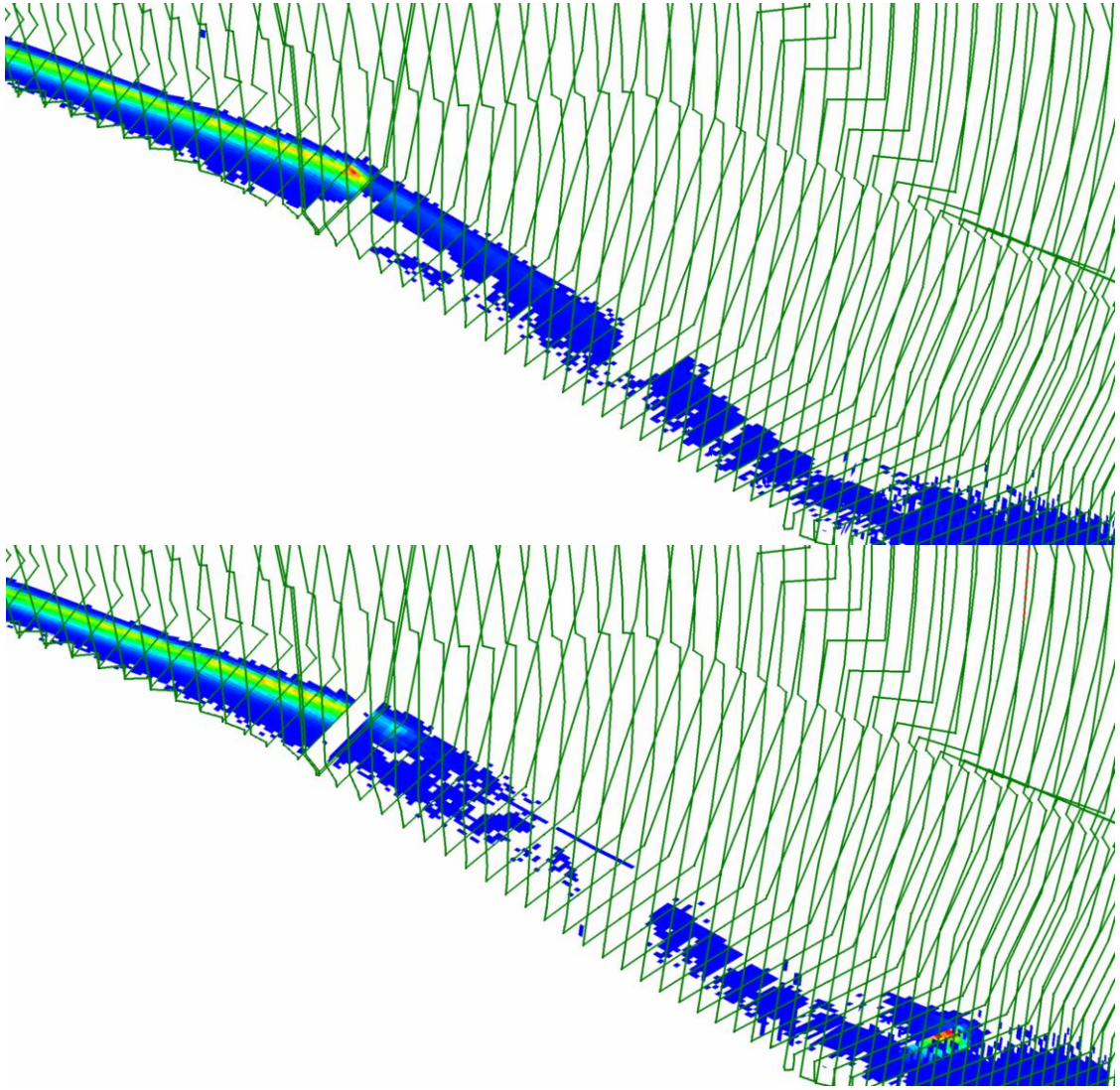


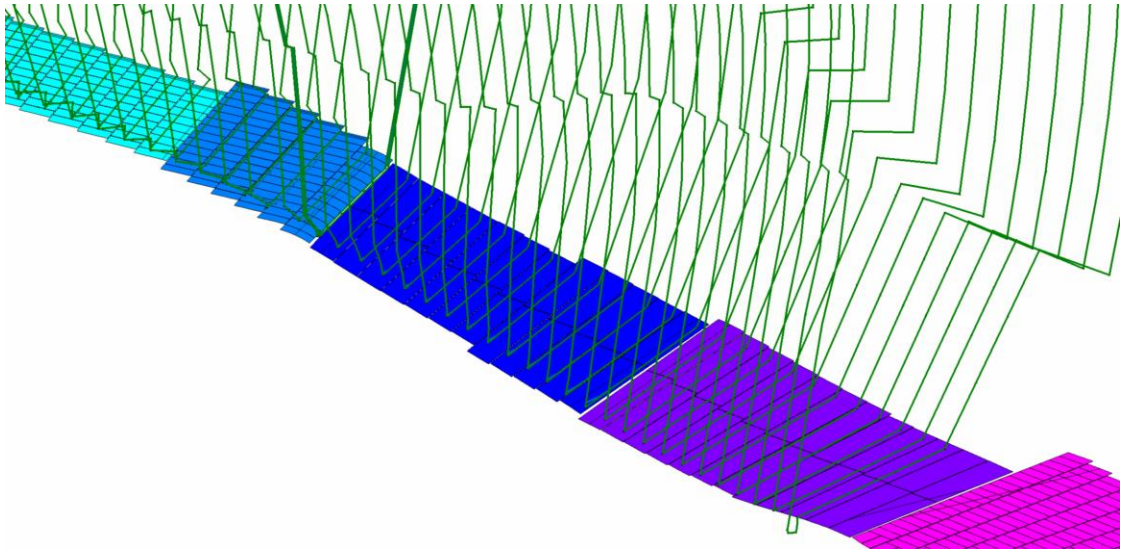


- Above right: TM5h/TM4h transition with lifted divertor shape
- Above left: TM6h/TM7h transition with 10 mm lifted divertor shown from the other side

Green lines: original grid, orange lines: changed grid

lifted 15 mm vs. original geometry at TM6h/TM7h, beta = 0 %

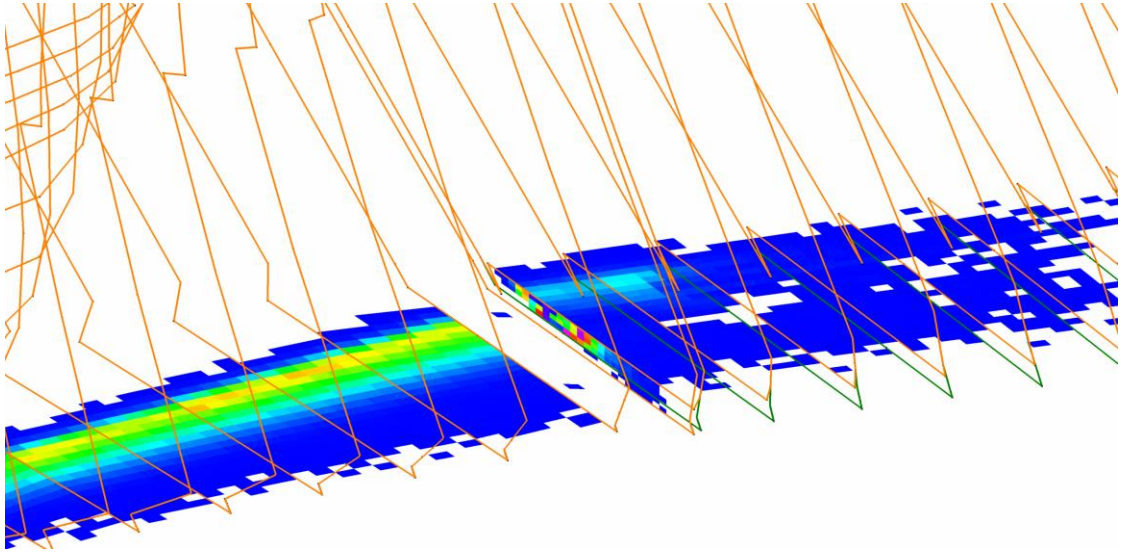


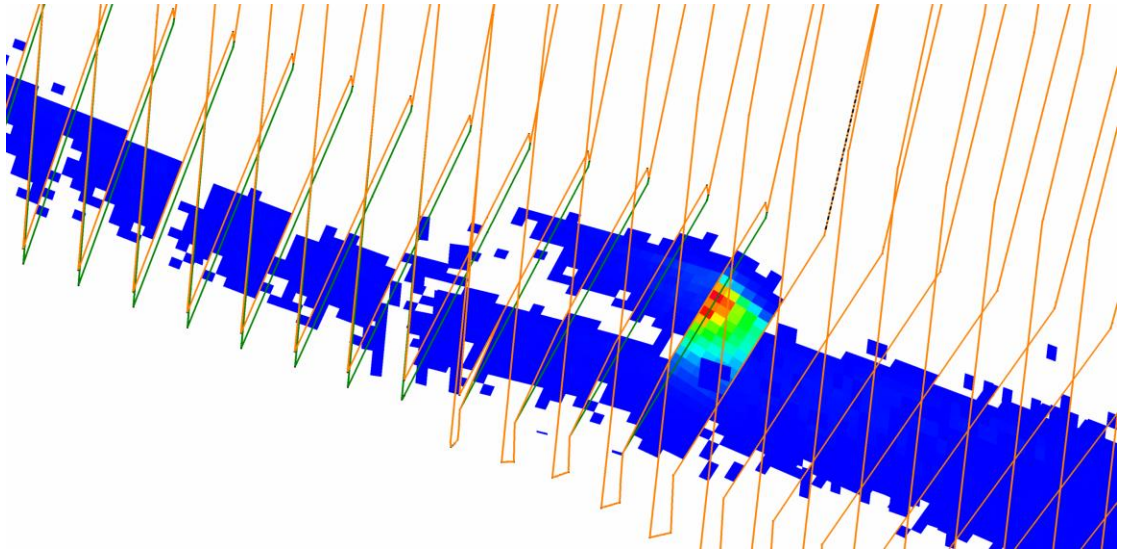


- Above right: Current divertor shape. Modules (from left to right) TM7h, TM6h, TM5h
- Above left: Simulated heat load on current divertor shape
- Left: Simulated heat load on 15 mm lifted divertor shape

Only original grid shown

Lifted 15 mm vs. original geometry at TM6h/TM7h, beta = 0 %





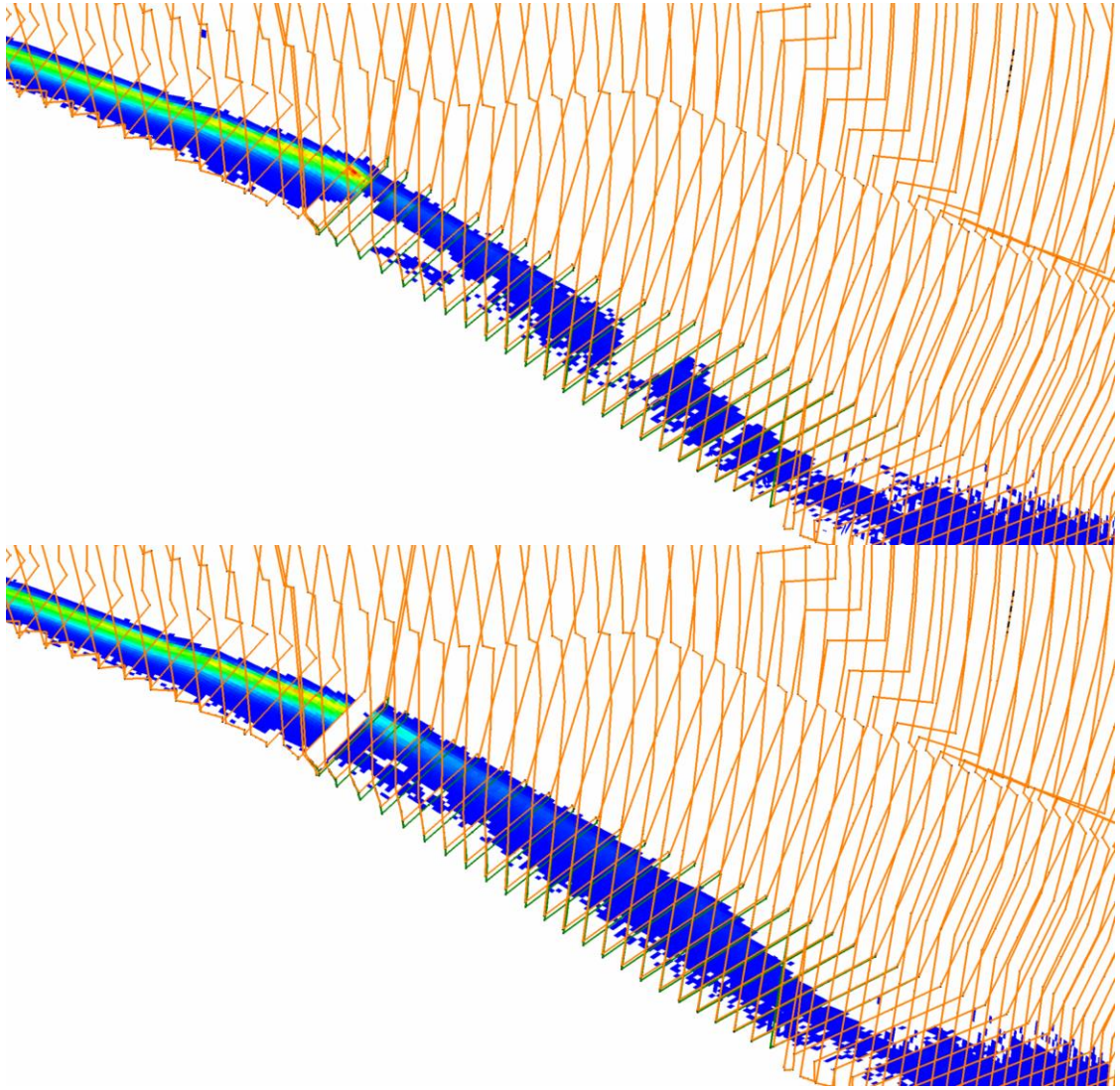
- Above right: TM5h/TM4h transition with lifted divertor shape
- Above left: TM6h/TM7h transition with 15 mm lifted divertor shown from the other side

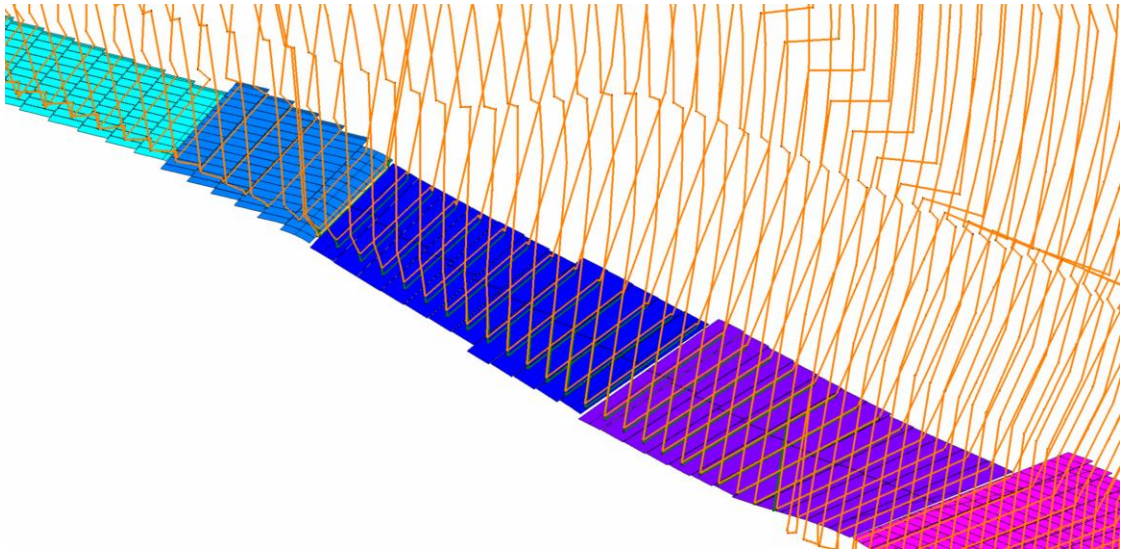
Green lines: original grid, orange lines: changed grid

Change 3 to the divertor shape

- **TM6h and TM5h tilted, starting at either 5, 10 and 15 mm at the TM6h/ TM7h transition**
- **This means a slight change to the shape of module TM6h and a change to the shape of TM5h**

tilted from 15 mm vs. original geometry at TM6h/TM7h, beta = 0 %

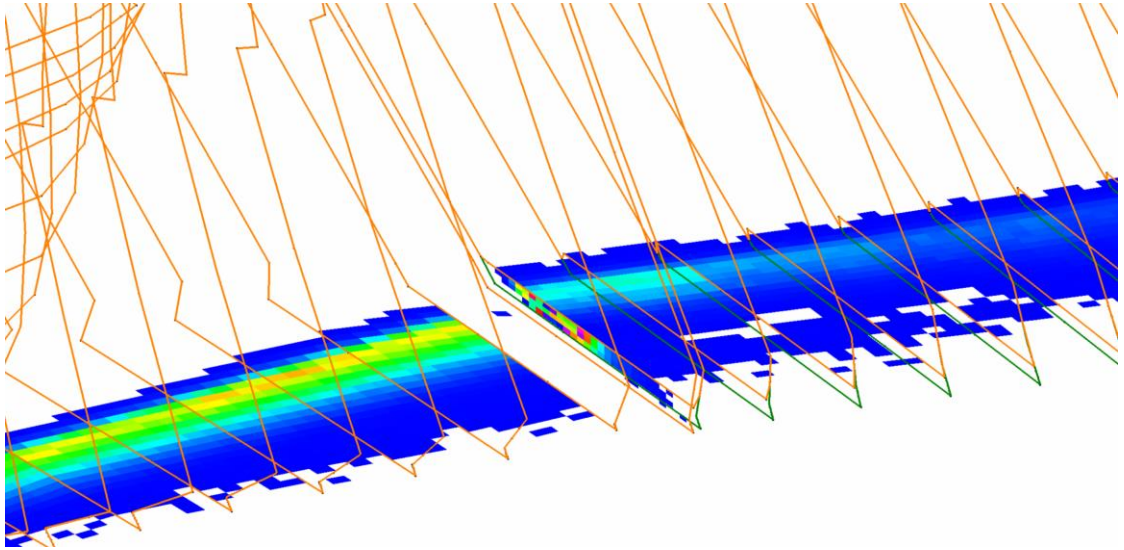


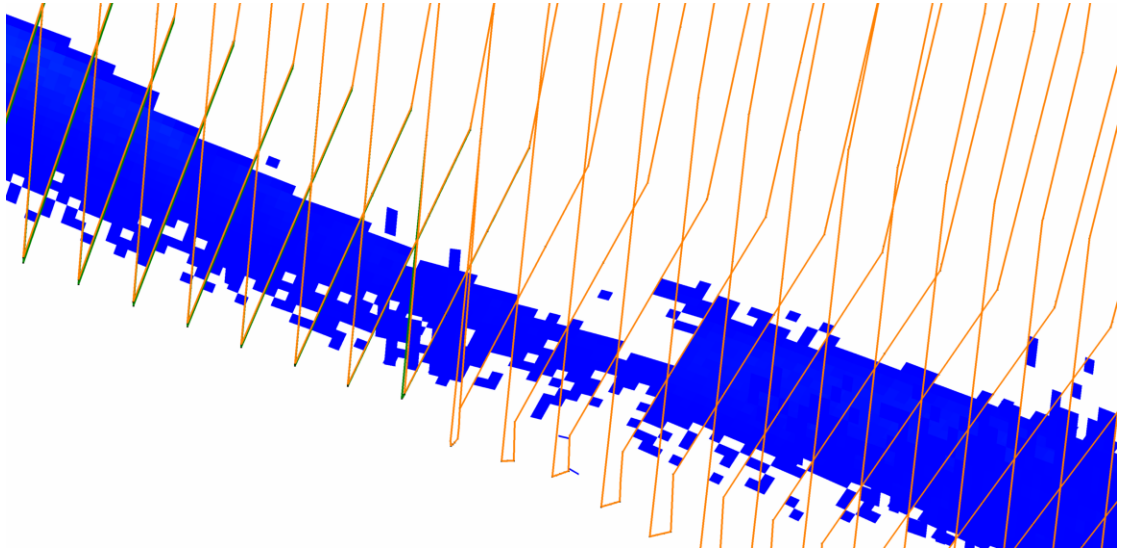


- Above right: Current Divertor shape. Modules (from left to right) TM7h, TM6h, TM5h
- Above left: Simulated heat load on current divertor shape
- Left: Simulated heat load on tilted divertor shape

Green lines: original grid, orange lines: changed grid

tilted 15 mm at TM6h/TM7h, beta = 0 %

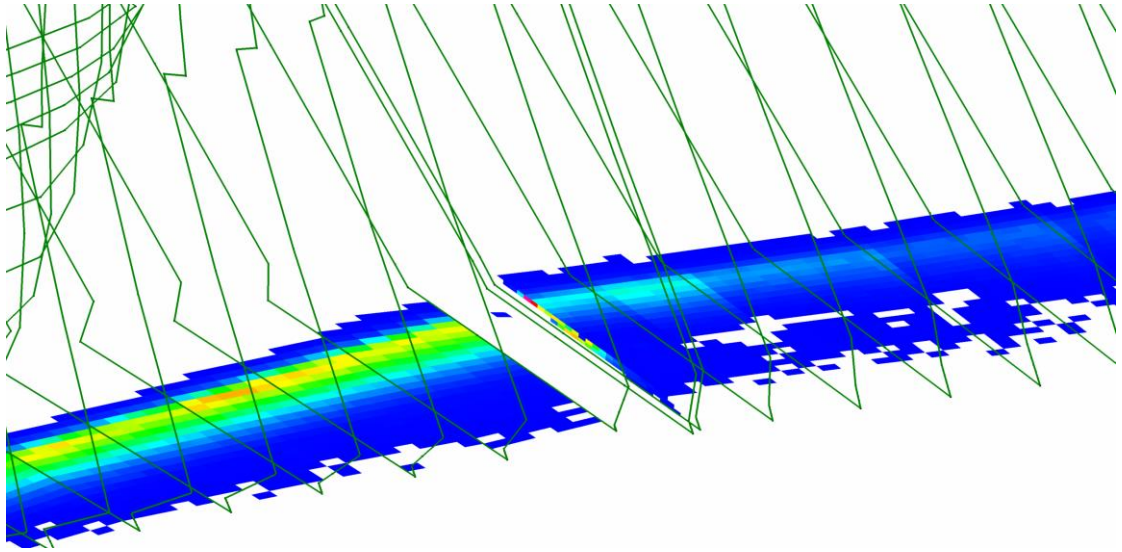


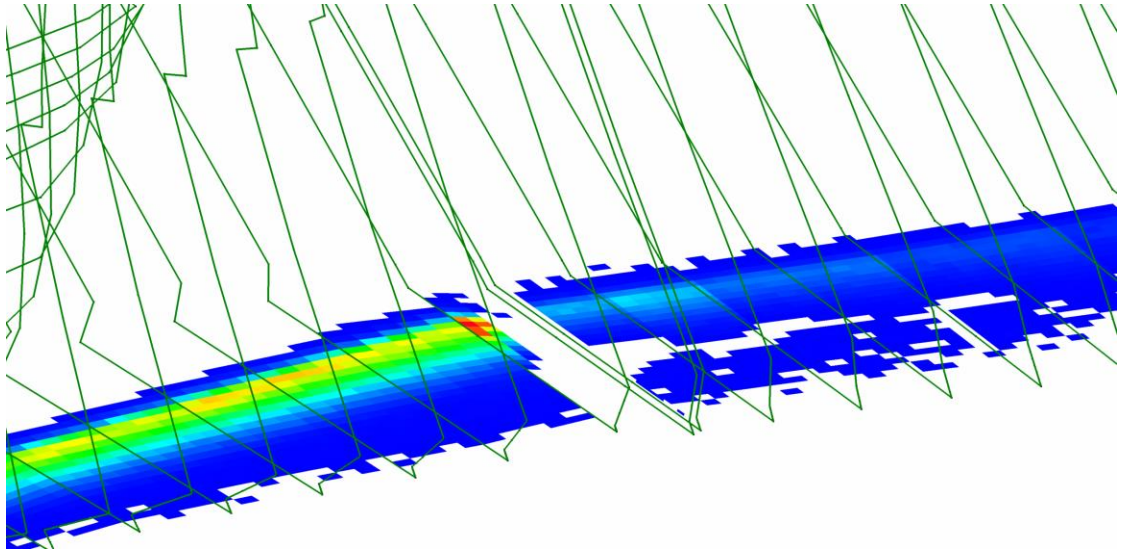


- Above right: TM5h/TM4h transition with tilted divertor shape
- Above left: TM6h/TM7h transition with tilted divertor shown from the other side

Green lines: original grid, orange lines: changed grid

for comparison: tilted 5 mm and 10mm at TM6h/TM7h, beta = 0 %





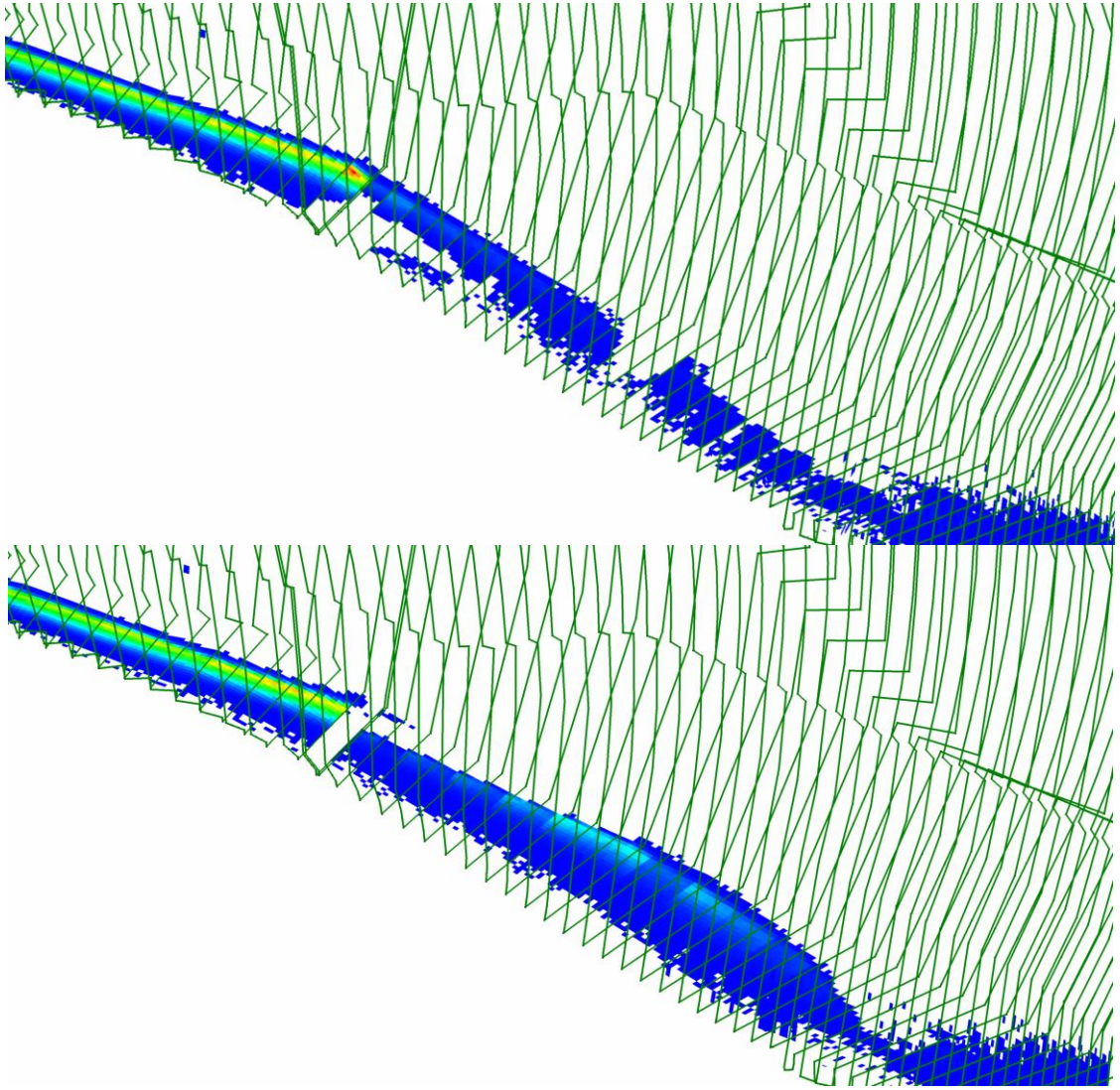
- Above right: TM6h/TM7h transition with 5 mm tilted divertor shown from the other side
- Above left: TM6h/TM7h transition with 10 mm tilted divertor shown from the other side

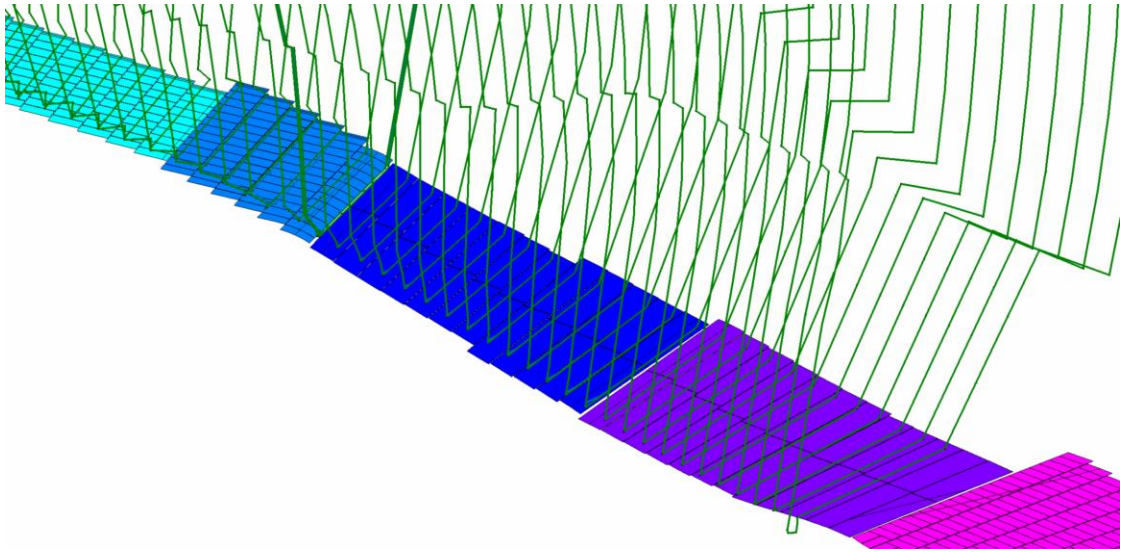
Only original grid shown

Change 4 to the divertor shape

- **TM6h and TM5h tilted, starting at either 5, 7 or 9 mm (*start value*) at the TM6h/ TM7h transition, increasing to *start value* + 5, 10 or 15 mm at phi = 6°, then decreasing to 0 at the end of TM5h**
- **This means a slight change to the shape of modules TM6h/ TM5h**
- **Only the 7_15_0 version is shown in the following**

roof-shaped vs. original geometry at TM6h/TM7h, beta = 0 %

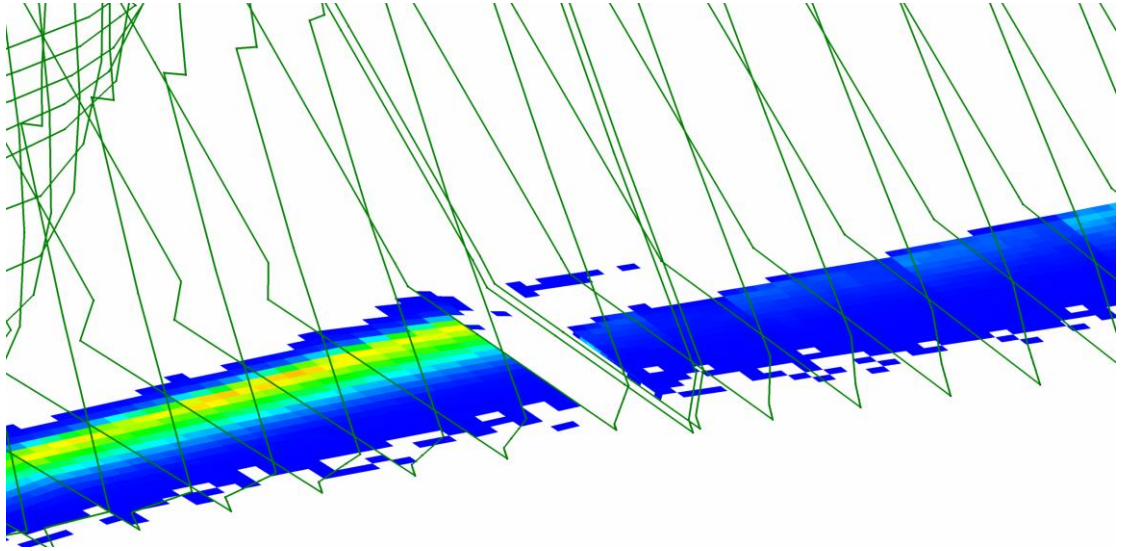


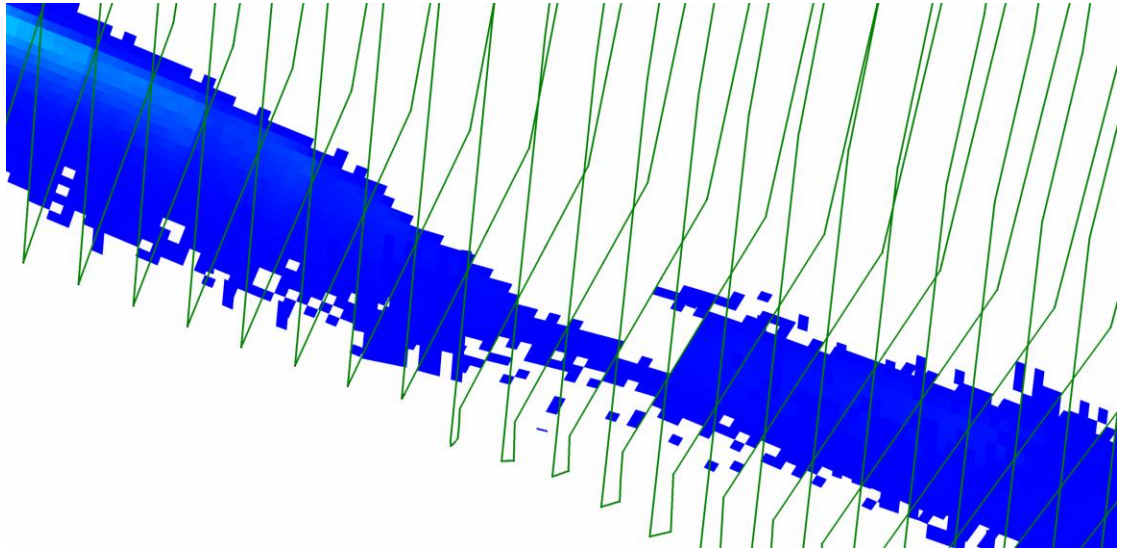


- Above right: Current divertor shape. Modules (from left to right) TM7h, TM6h, TM5h
- Above left: Simulated heat load on current divertor shape
- Left: Simulated heat load on roof-shaped divertor (7_15_0 as described on previous slide)

Only original grid shown

Roof-shape 7-15-0 mm at TM6h/TM7h, beta = 0 %





- Above right: TM5h/TM4h transition with roof-shaped divertor
- Above left: TM6h/TM7h transition with roof-shaped divertor shown from the other side

Only original grid shown

Summary

- Planing the TM7h/TM6h transition brings the smoothest heat load distribution but makes a rebuild of TM7h and TM6h necessary

- Only lifting modules TM6h and TM5h doesn’t bring the need to reshape any module but would create a leading edge at the TM5h/TM4h transition

- Tilting modulesTM6h and TM5h either creates a load on a new emerging TM6h leading edge or doesn’t take heat load off the exiting edge, depending on tilting-value. However, a redesigned leading edge on TM6h might mitigate that.
- Creating a roof-shaped geometry for TM6h/TM5h avoids excess heat load on any module