COMPASS
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CarMa0NL Modelling of Plasma Disruptions on COMPASS-U for Scenarios with Positive and Negative Triangularity

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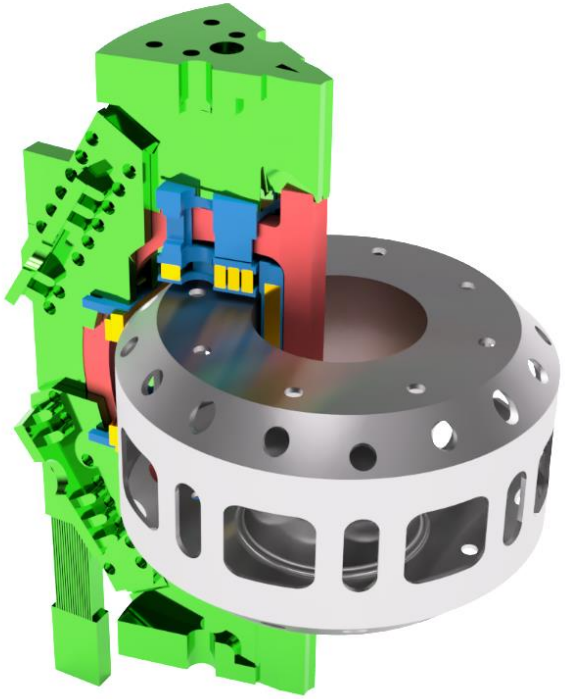
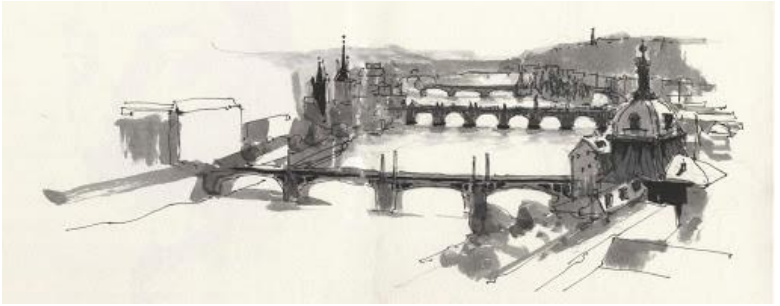
COMPASS-U: Compact High-Field Tokamak

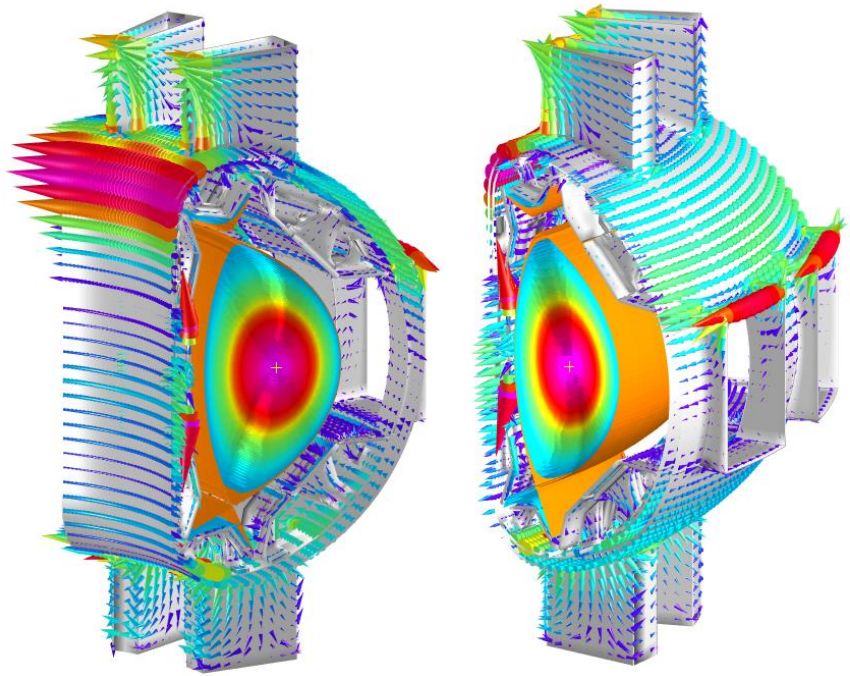


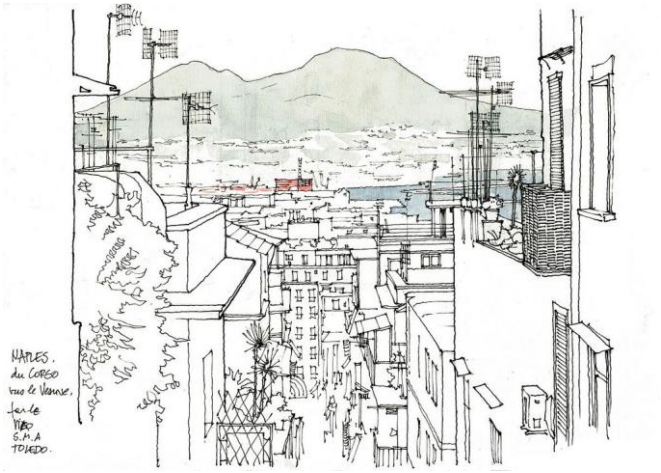


- Magnetic field 5 T
- Plasma current 2 MA
- Major radius 0.9 m
- First plasma 2023

*tokamak's image is a courtesy of Ondrej Ficker

CarMa0NL: 2D plasma + 3D conductors

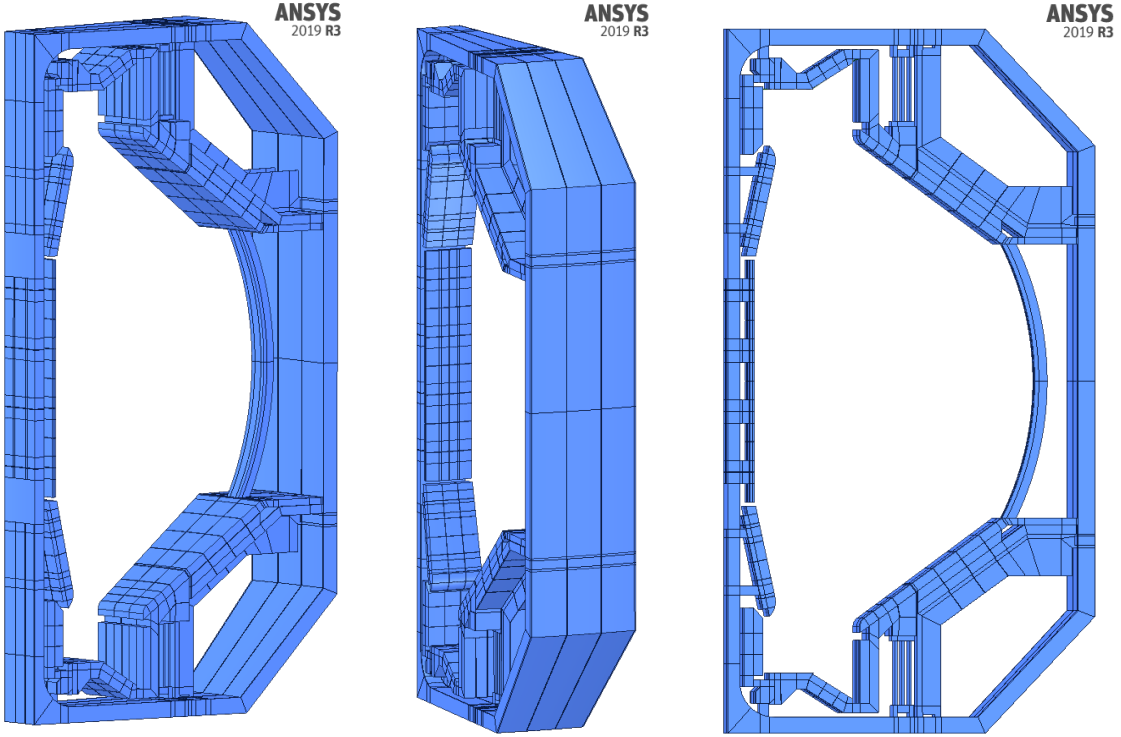




- CarMa0NL describes the evolutionary equilibrium of axisymmetric plasmas in presence of 3D volumetric conducting structures

*F. Villone et al., Plasma Phys. Control. Fusion 55 095008 (2013)
**S. L. Chen, Nucl. Fusion 59 (2019) 106039

COMPASS-U VV with PSPs and PFCs



- Vacuum Vessel (VV): Inconel 625
- Passive Stabilizing Plates (PSPs): Glidcop
- Plasma Facing Components (PFCs): Inconel 718 / W

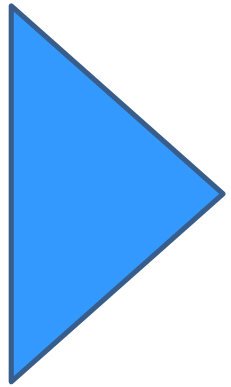
Case 1 with positive triangularity

- Baseline equilibrium #6400

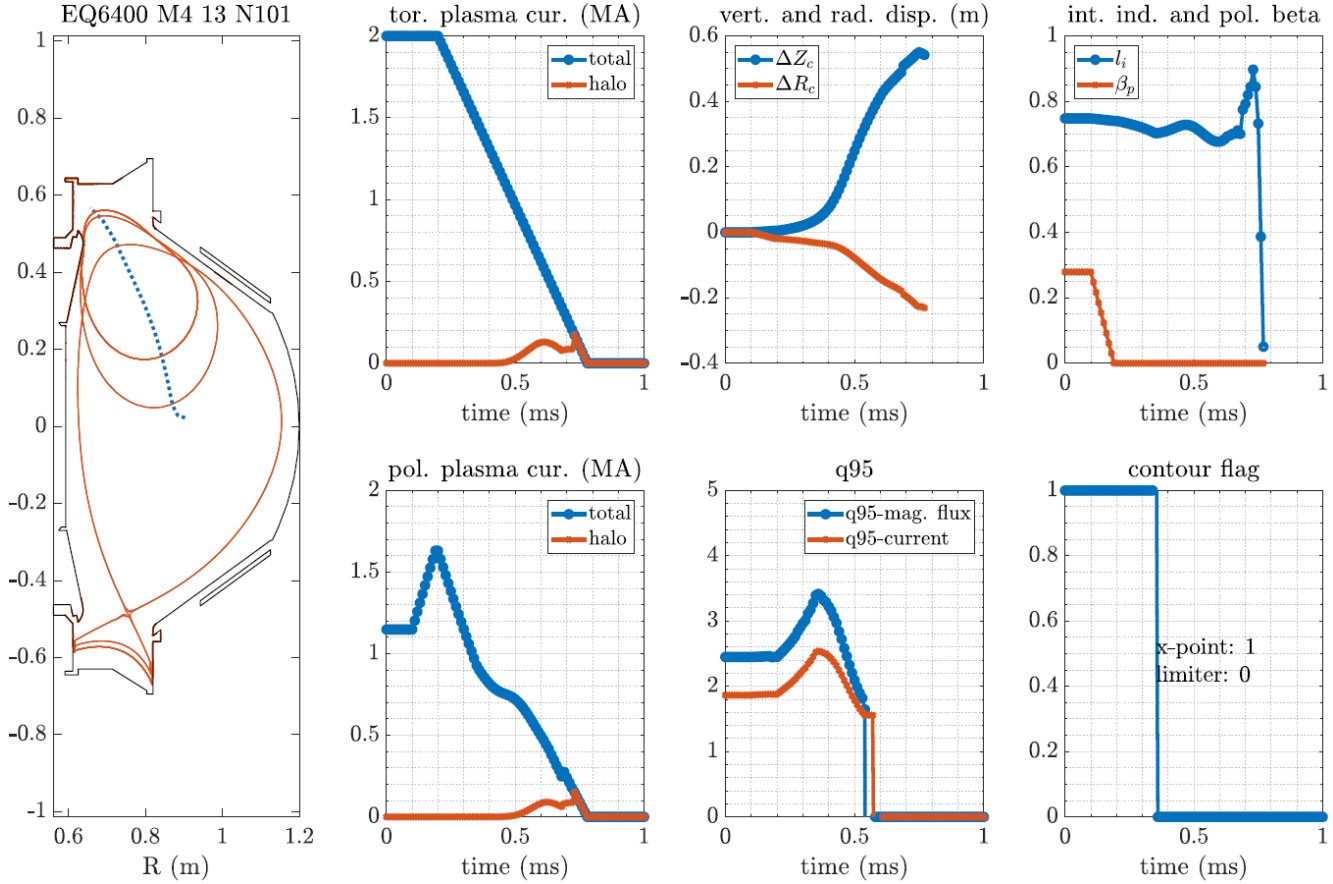
Disruption scenario #13:

- 0.1 ms stable
- 0.1 ms long TQ
- 0.6 ms long 2 MA CQ at the fastest rate 0.33 MA/ms

- VDE trajectory: Upwards + Inwards (HFS)



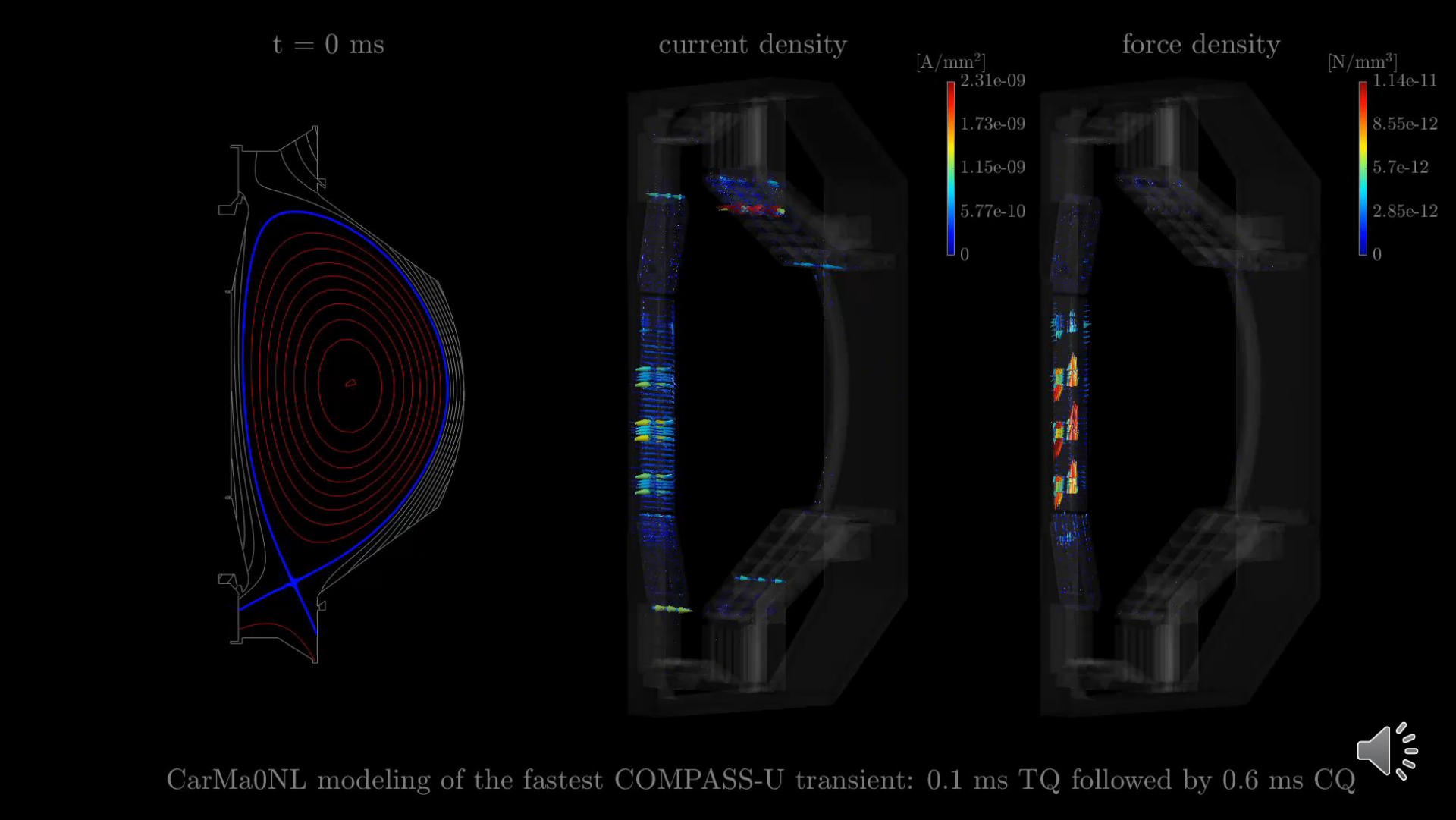
The fastest transient with positive triangularity



- Equilibrium #6400
- Disruption #13

- 0.1 ms stable
- 0.1 ms long TQ
- 0.6 ms long CQ at the fastest rate 0.33 MA/ms

- VDE trajectory: Upwards + Inwards (HFS)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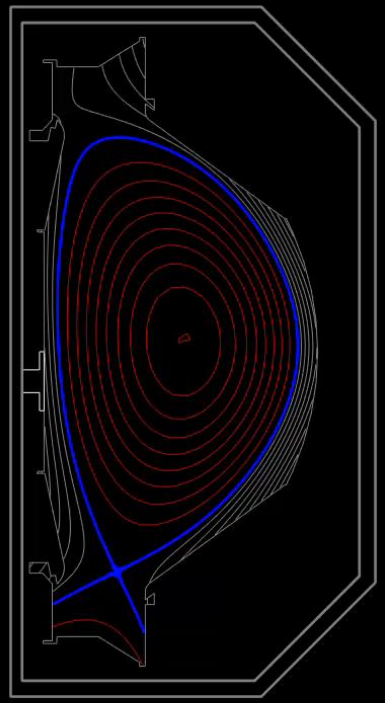
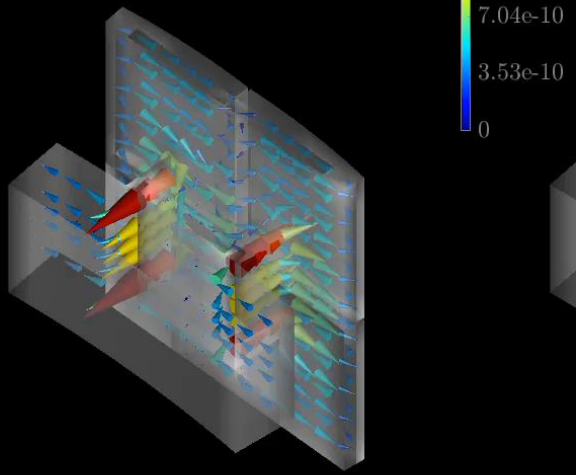
1.73e-09
1.15e-09
5.77e-10
0
force density
[N/mm³]
1.14e-11
8.55e-12
5.7e-12
2.85e-12
0
CarMa0NL modeling of the fastest COMPASS-U transient: 0.1 ms TQ followed by 0.6 ms CQ

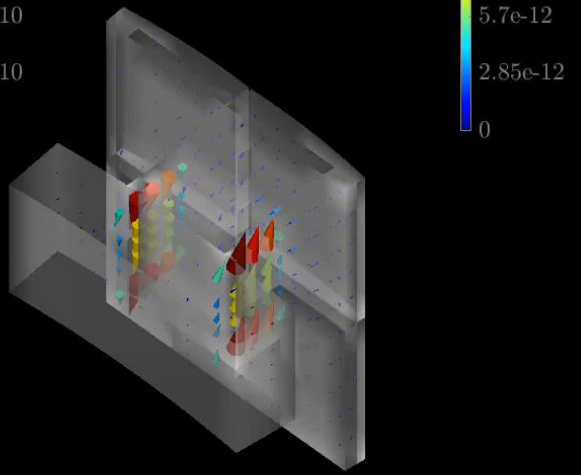
t = 0 ms



current density



force density



CarMa0NL modeling of the fastest COMPASS-U transient: 0.1 ms TQ followed by 0.6 ms CQ

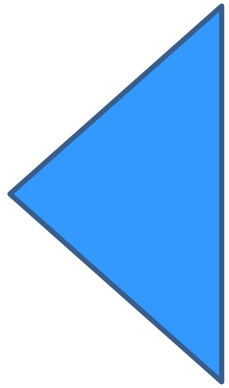
Case 2 with negative triangularity

- Equilibrium #11000

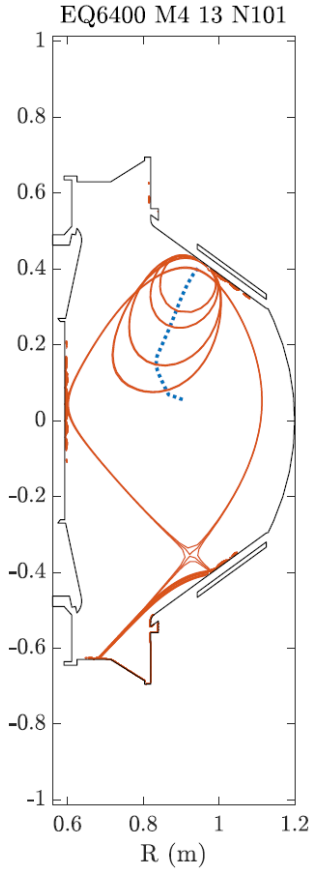
Disruption scenario #13:

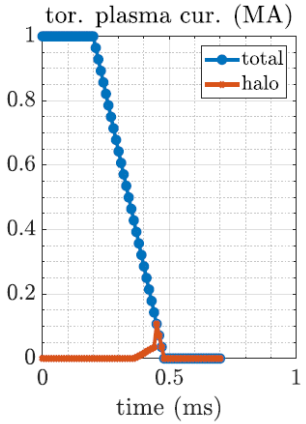
- 0.1 ms stable
- 0.1 ms long TQ
- 0.3 ms long 1 MA CQ at the fastest rate 0.33 MA/ms

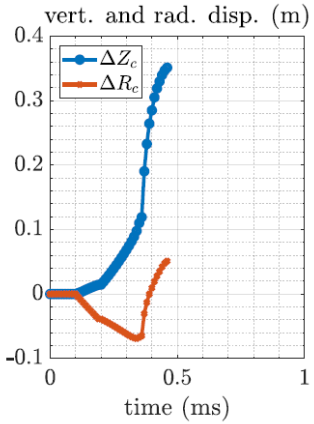
- VDE trajectory: Upwards + Outwards (LFS)

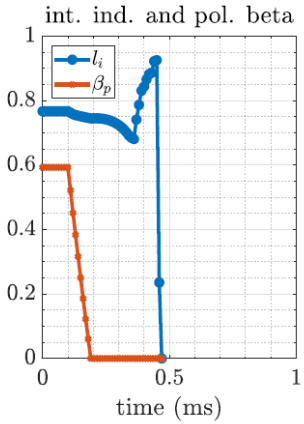


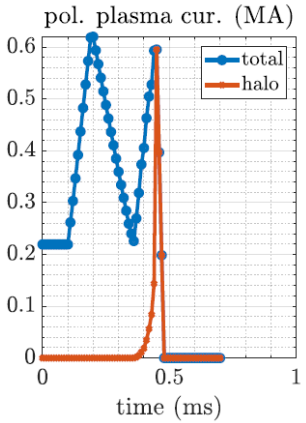
The fastest transient with negative triangularity

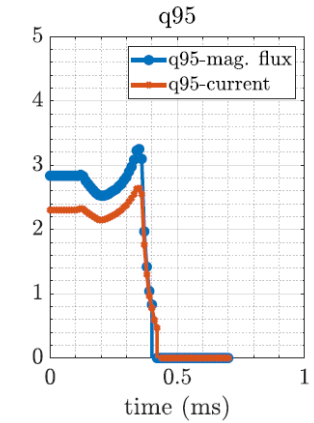


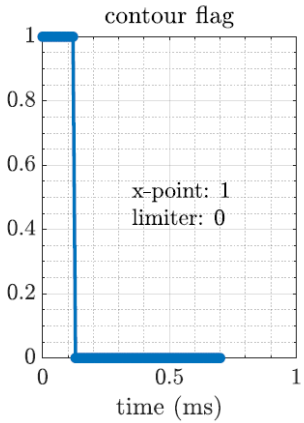










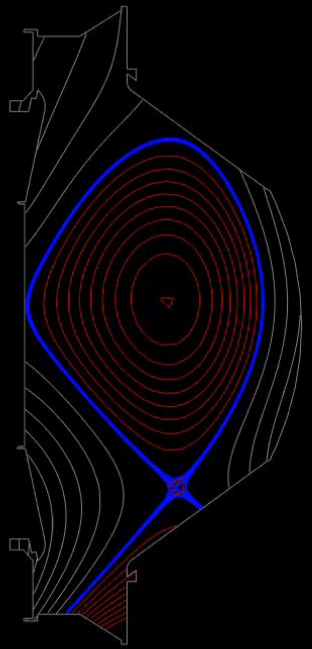


- Equilibrium #11000
- Disruption #13

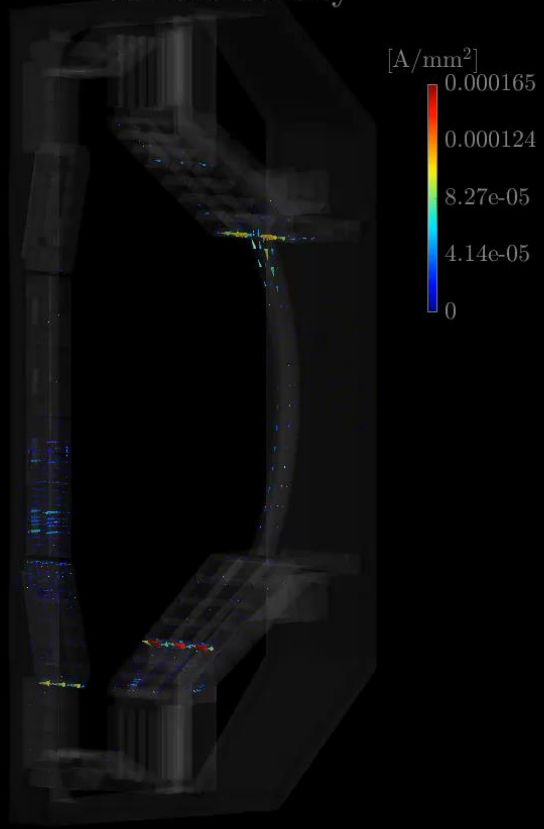
- 0.1 ms stable
- 0.1 ms long TQ
- 0.3 ms long 1 MA CQ at the fastest rate 0.33 MA/ms

- VDE trajectory: Upwards + Outwards (LFS)

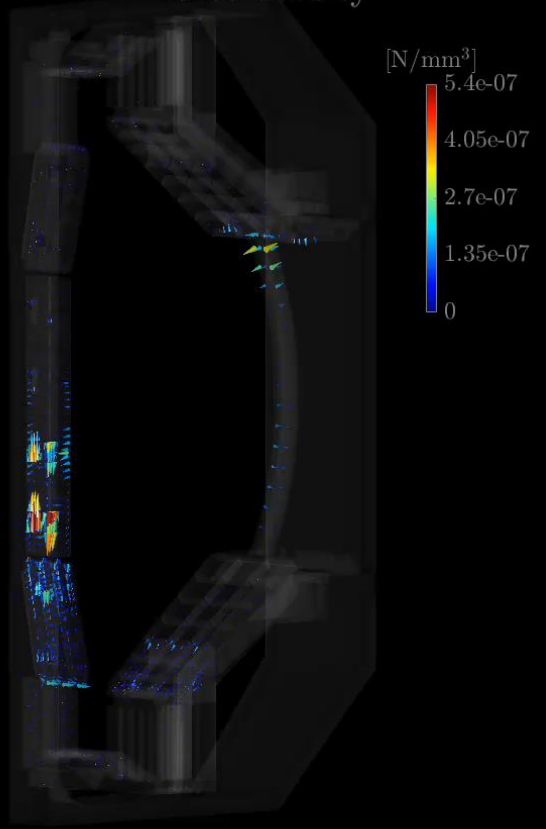
t = 0 ms



current density

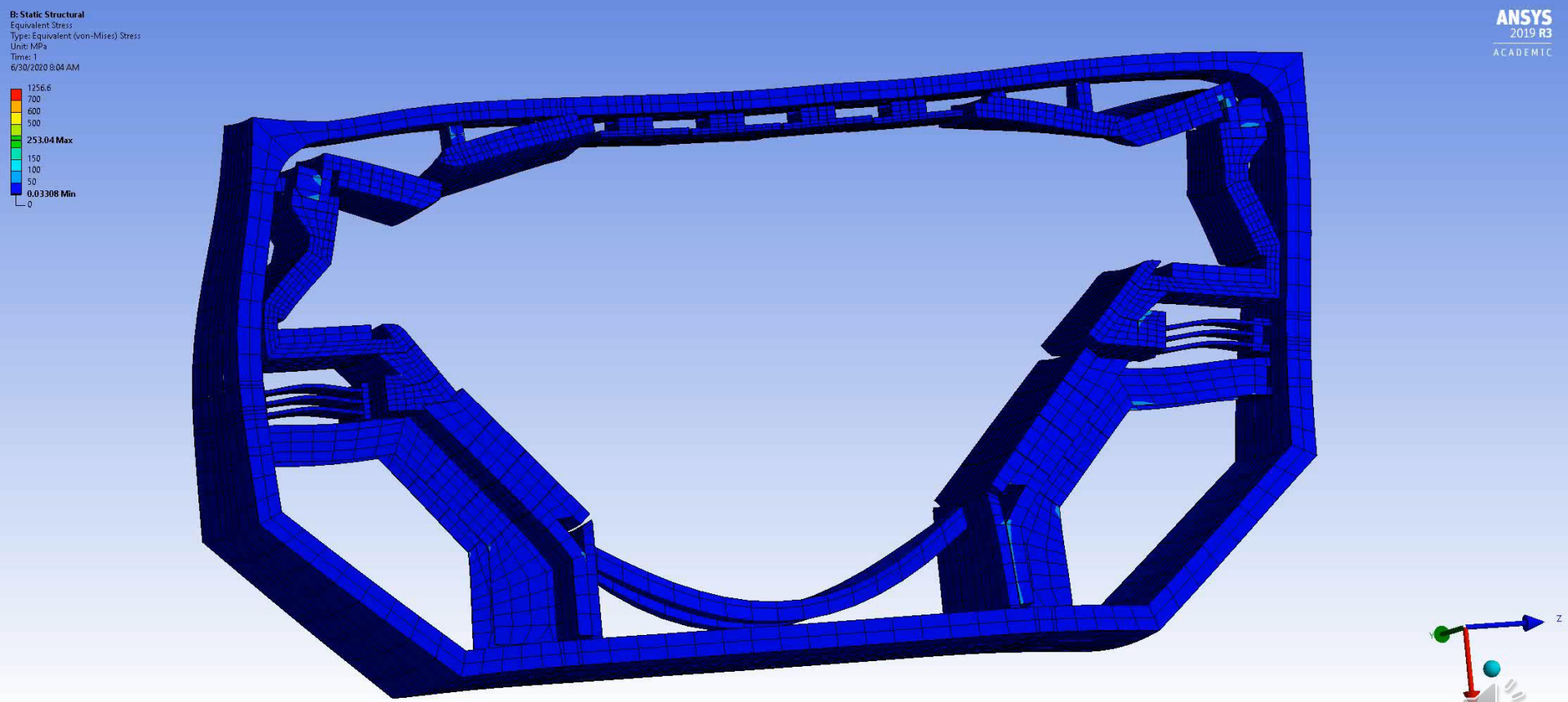


force density



CarMa0NL modeling of the fastest COMPASS-U transient: 0.1 ms TQ followed by 0.3 ms CQ

Structural analysis for positive triangularity



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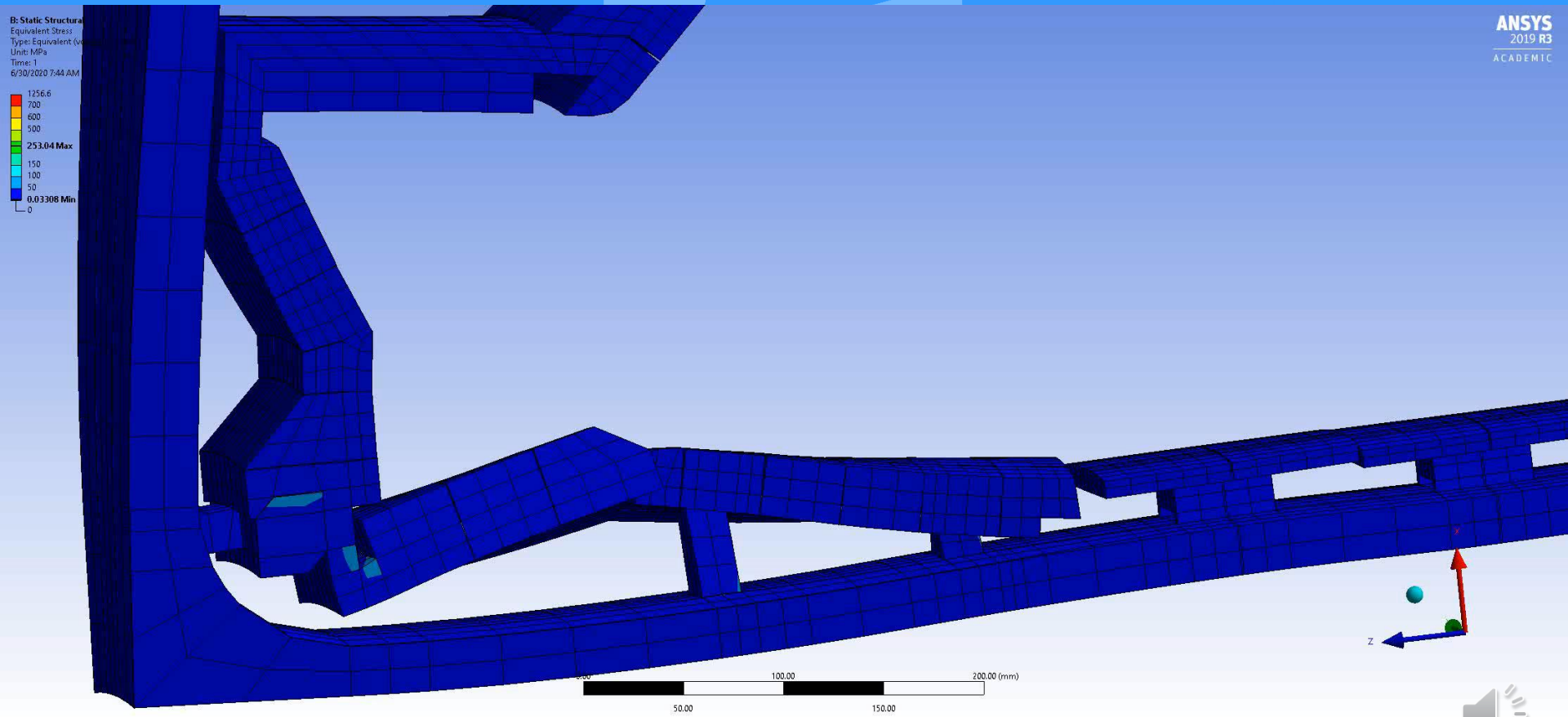

Summary

- The fastest transients with positive and negative triangularities have been analyzed with CarMa0NL.
- It has been shown that the force distribution in the wall strongly depends on the pre-disruption plasma equilibrium.
- The results are being currently used to optimize the mechanical design of the COMPASS-U wall.
- At the moment halo currents are considered only for evolutionary equilibrium modeling. But future work will include also calculation of the forces related to the halo current.

* CarMa0NL modeling for positive triangularity has been already validated on COMPASS, EAST, JET and TCV. To increase the credibility of modeling for negative triangularity, it might be of interest to perform benchmarking with experimental data.