SIMULATING CAR THEFT WITH AIRBAG MODEL

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AGENDA

- **Background**
  - Load case description
  - Need of new CAE method
  - Physical testing

- **Demonstrating new method**
  - Comparison to test results
  - New capabilities

- **Future work**

BACKGROUND – CAE CLOSURES, INTERIOR AND EXTERIOR

- Strength and Endurance CAE evaluation for closures and trim on system level
  - Major part implicit non-linear FE analysis
  - LS Dyna Explicit for quasi-static analysis with large displacements

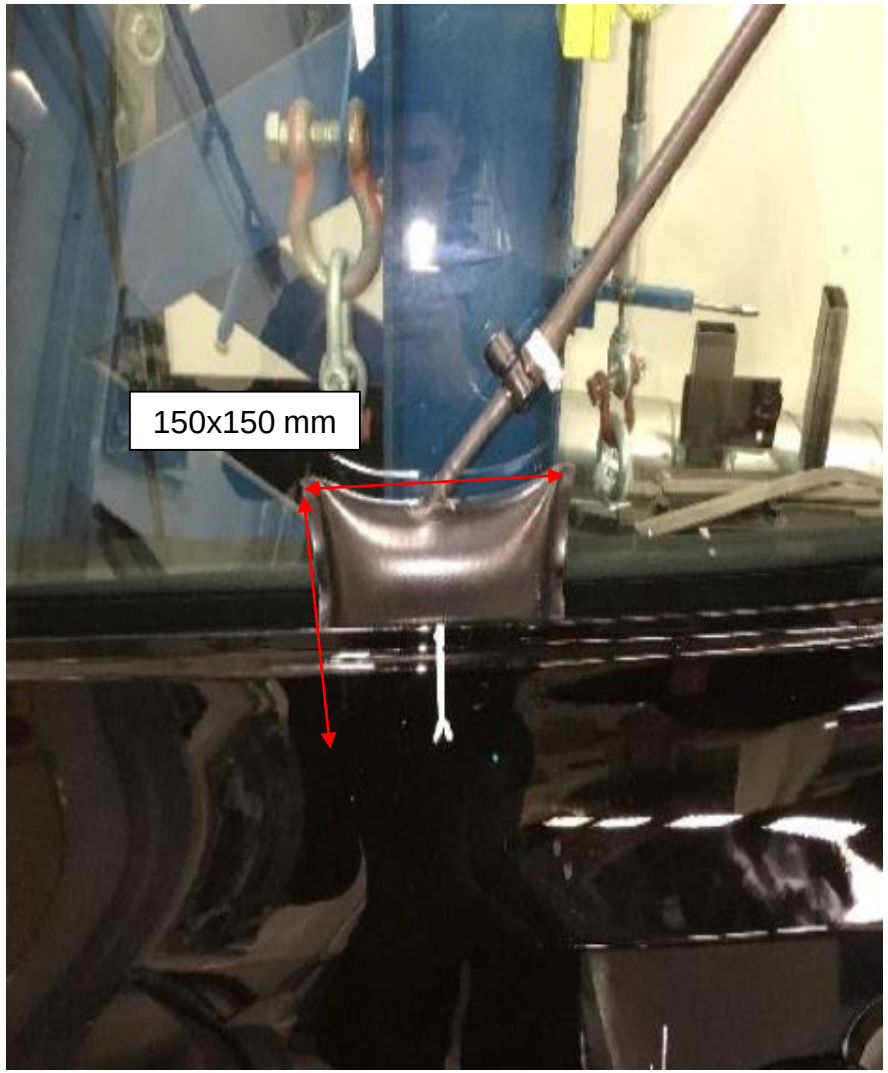
- Creep analysis regarding interior and exterior trim parts

- 17 CAE engineers

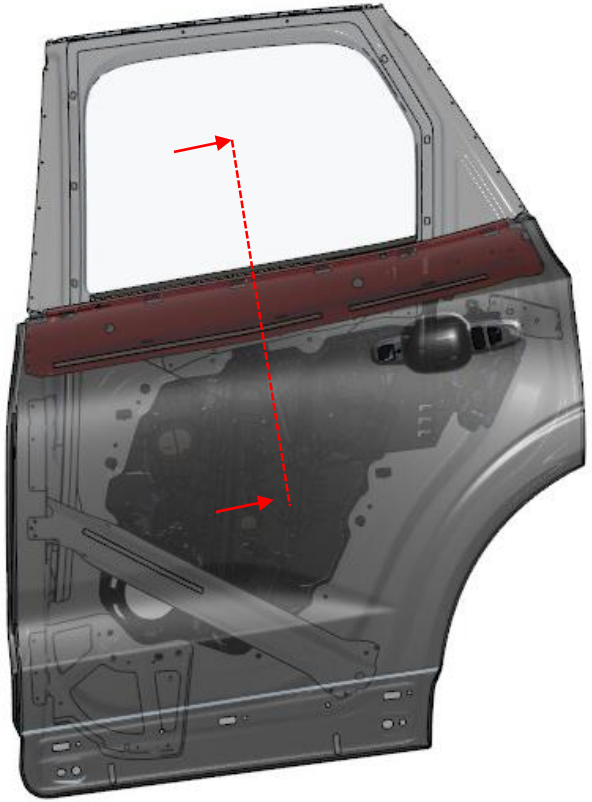
BACKGROUND – LOADCASE SECURITY BELT

Security Belt Loadcase

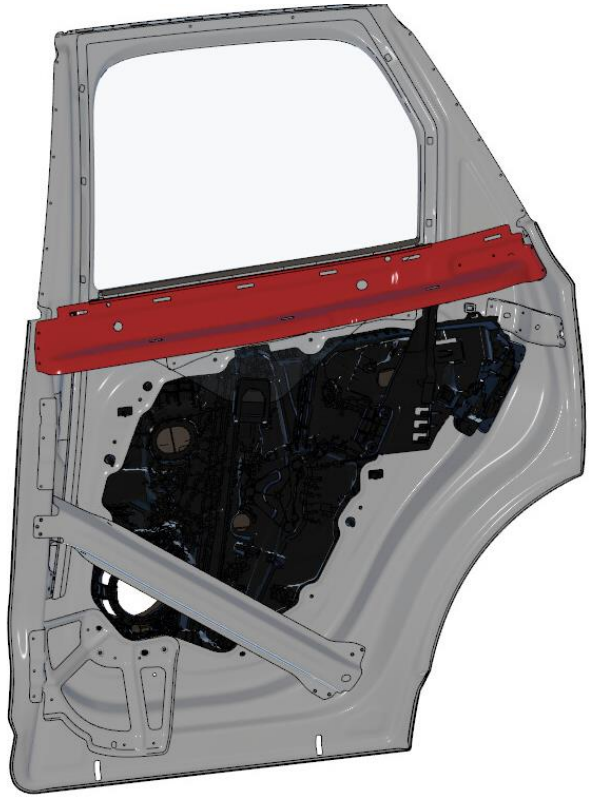
- Inflatable cushion to separate window and door structure
- Front and rear door
- Minimizing size of opened gap is critical to prevent theft
- Pressure = 1,8 [bar]



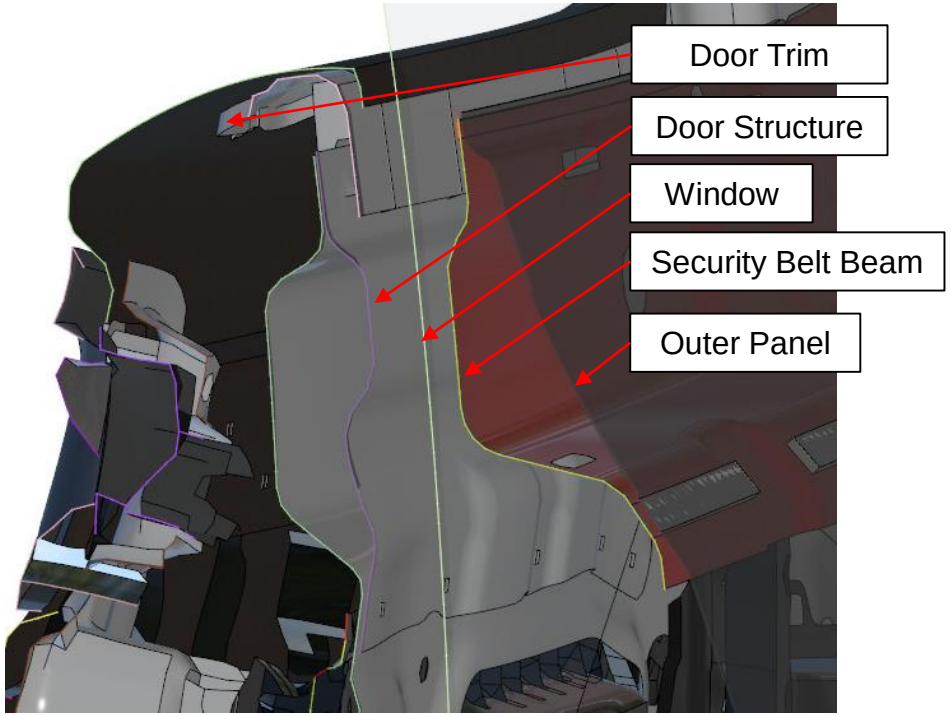
BACKGROUND - VOLVO XC60 REAR DOOR GEOMETRY



Volvo XC60 Rear Door Geometry



Security Belt highlighted



Section of door

BACKGROUND - IMPLICIT METHOD

Method work in Volvo V40

Correlated cascaded load to enable CAE

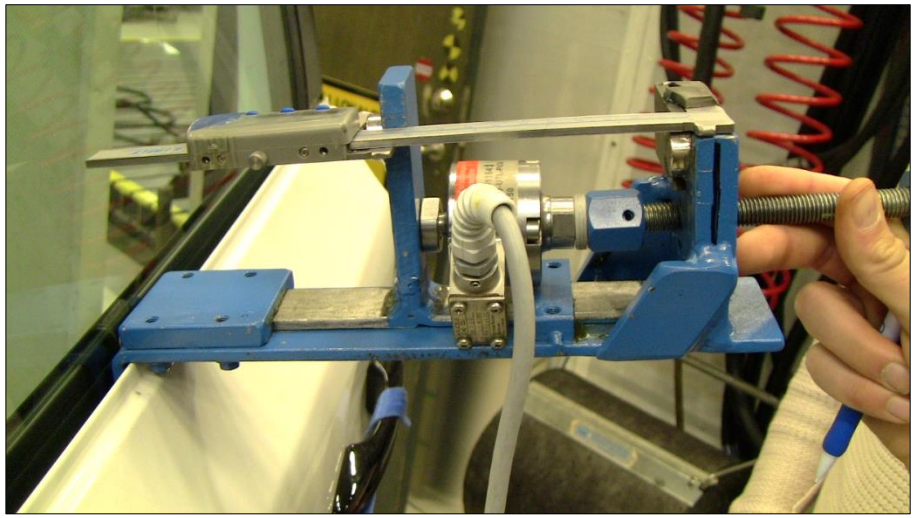
- Load applied as force via pliers, force transducer
- Analysis gap correlated with gap achieved with pliers

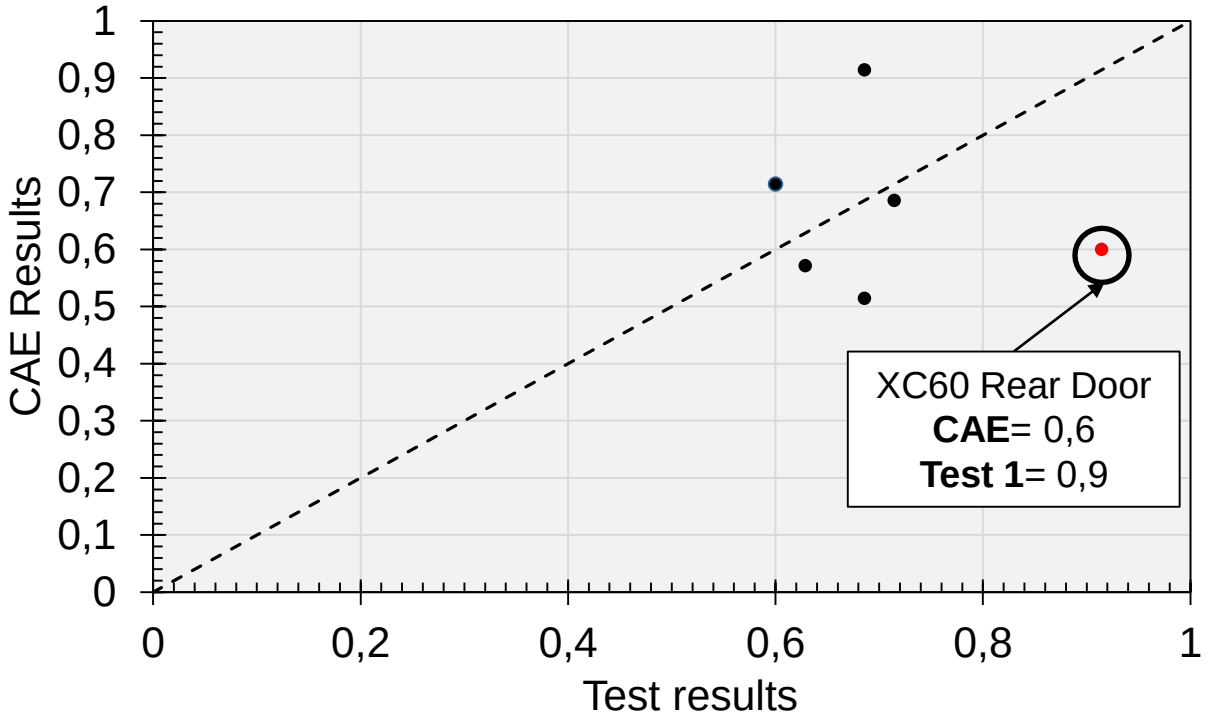
Gap with pliers ⟷ Gap with airwedge

- Same load independent of door structure
- Un-robust method

CAE test vs Physical test

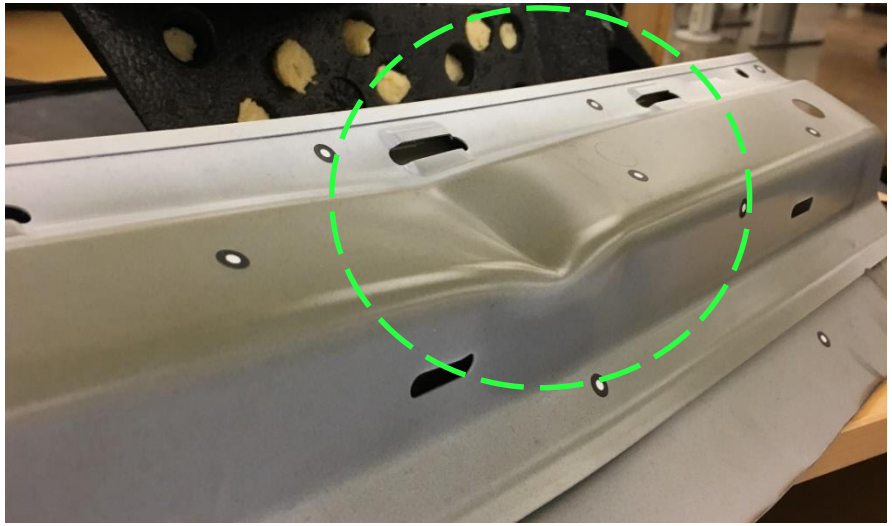
- Load via pliers in CAE, load via pressure in test
- Discrepancy



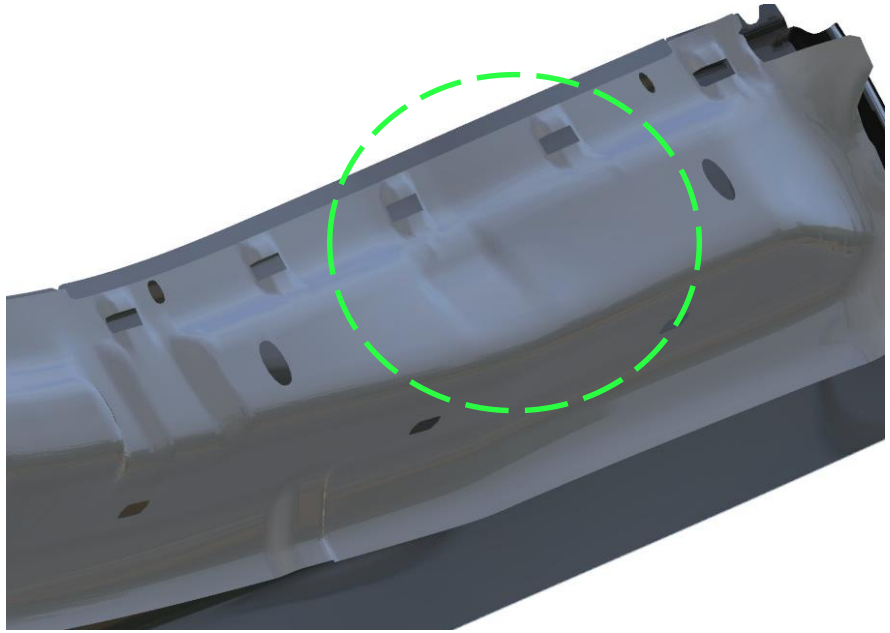


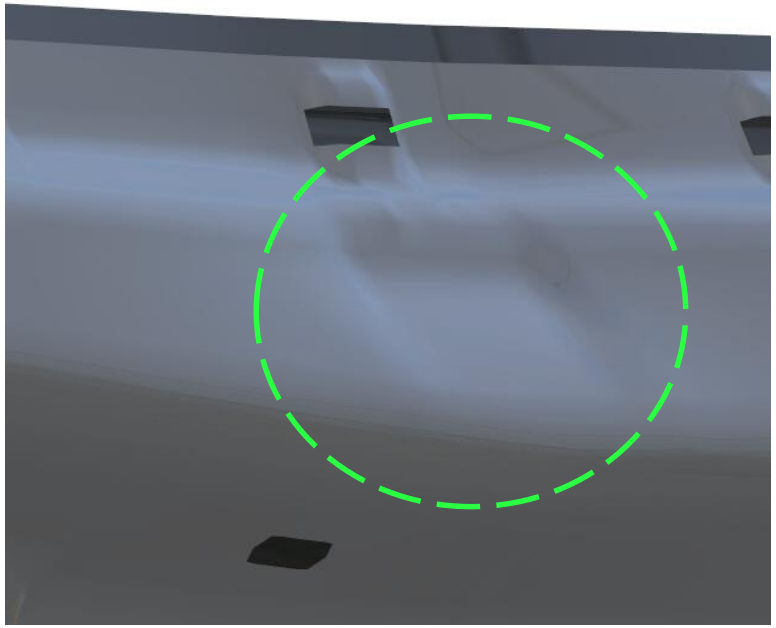
BACKGROUND - VOLVO XC60 RESIDUAL DEFORMATION OF BELT BEAM

TEST



CAE





BACKGROUND - WANTED FEATURES IN NEW METHOD

Key features

- Predict gap with accuracy
- Robust method, independent of geometry
- Predict local large deformations for understanding

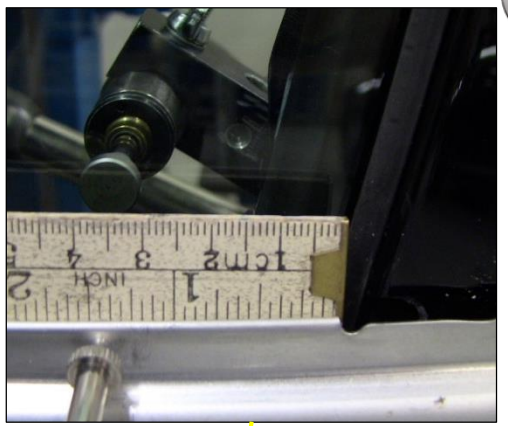
Optional features

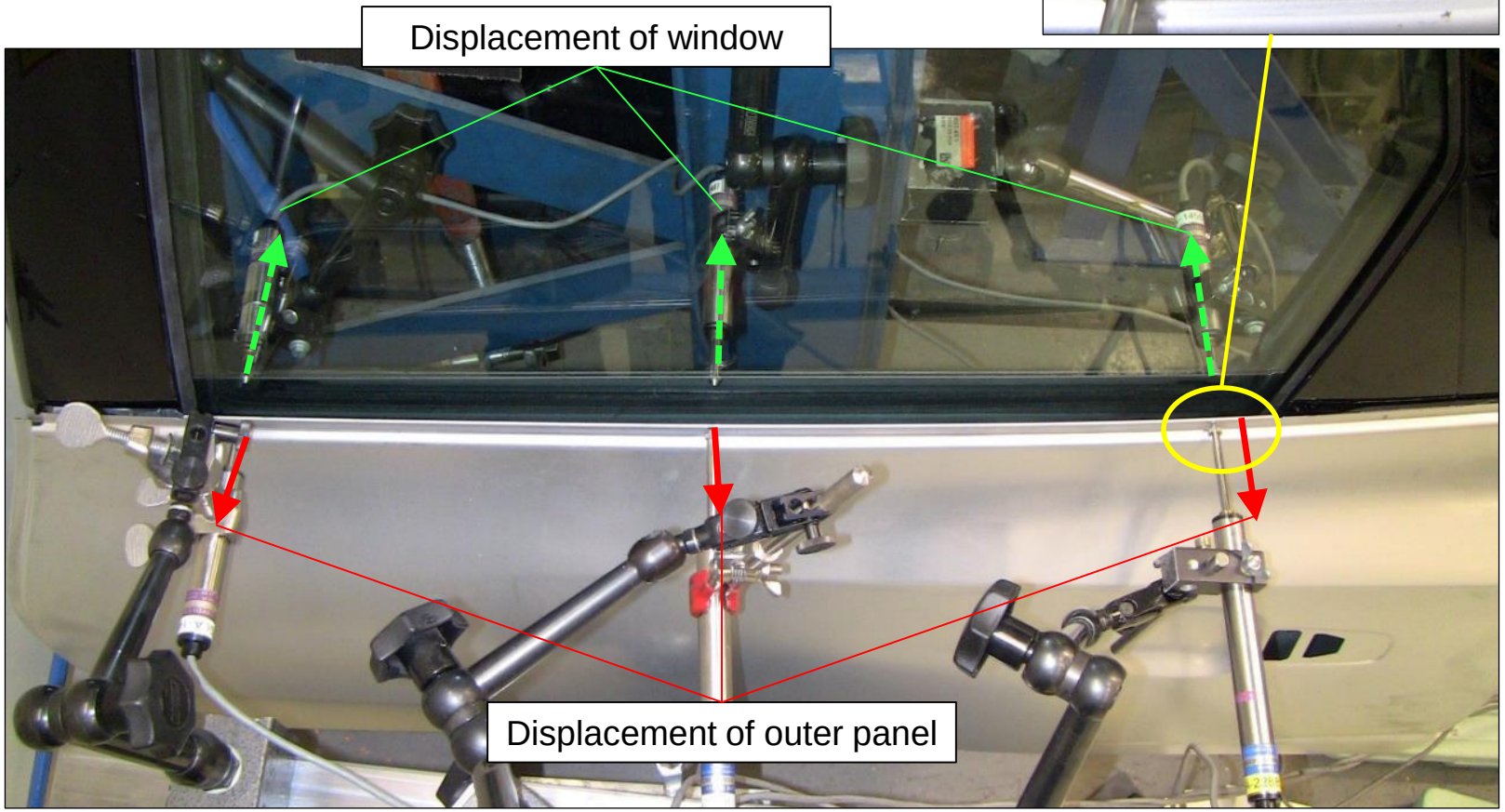
- CAE to represent physical test in procedure

BACKGROUND - PHYSICAL TESTING

Volvo XC60 new rear door test

- Extra measurements for CAE correlation
- Displacement of outer panel
- Displacement of window
- Increase of pressure with small increments





NEW EXPLICIT METHOD

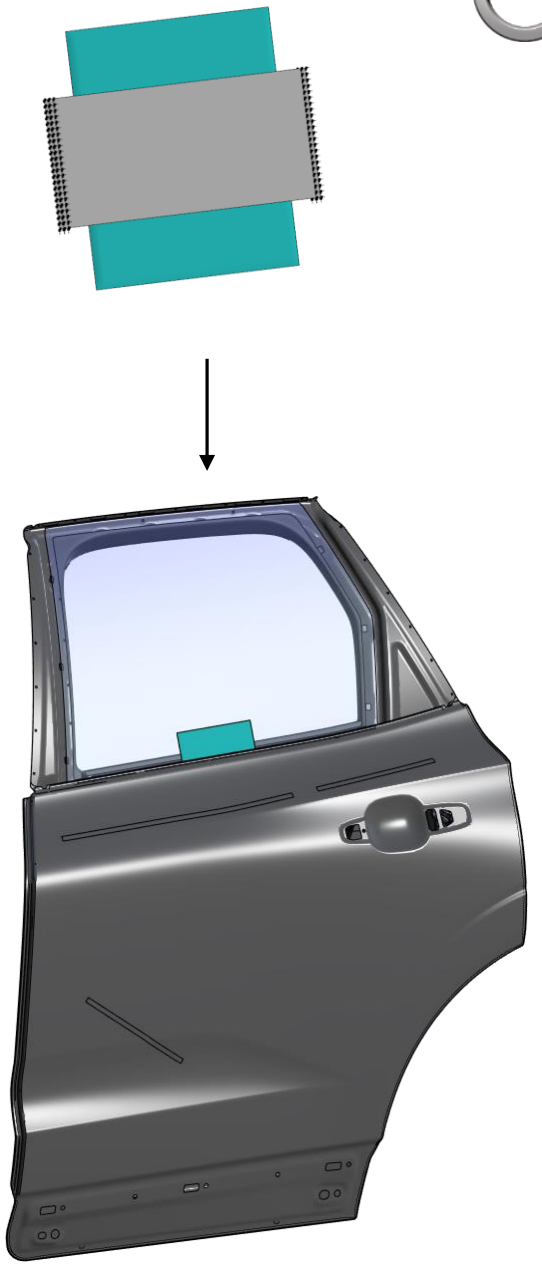
CAE analysis

- Solver: LS Dyna (Explicit Code)
- Quasi - static conditions
- Airwedge modelled as airbag with *AIRBAG_LOAD_CURVE
  (Ideal gas law and thermodynamic behaviour of gas flow)

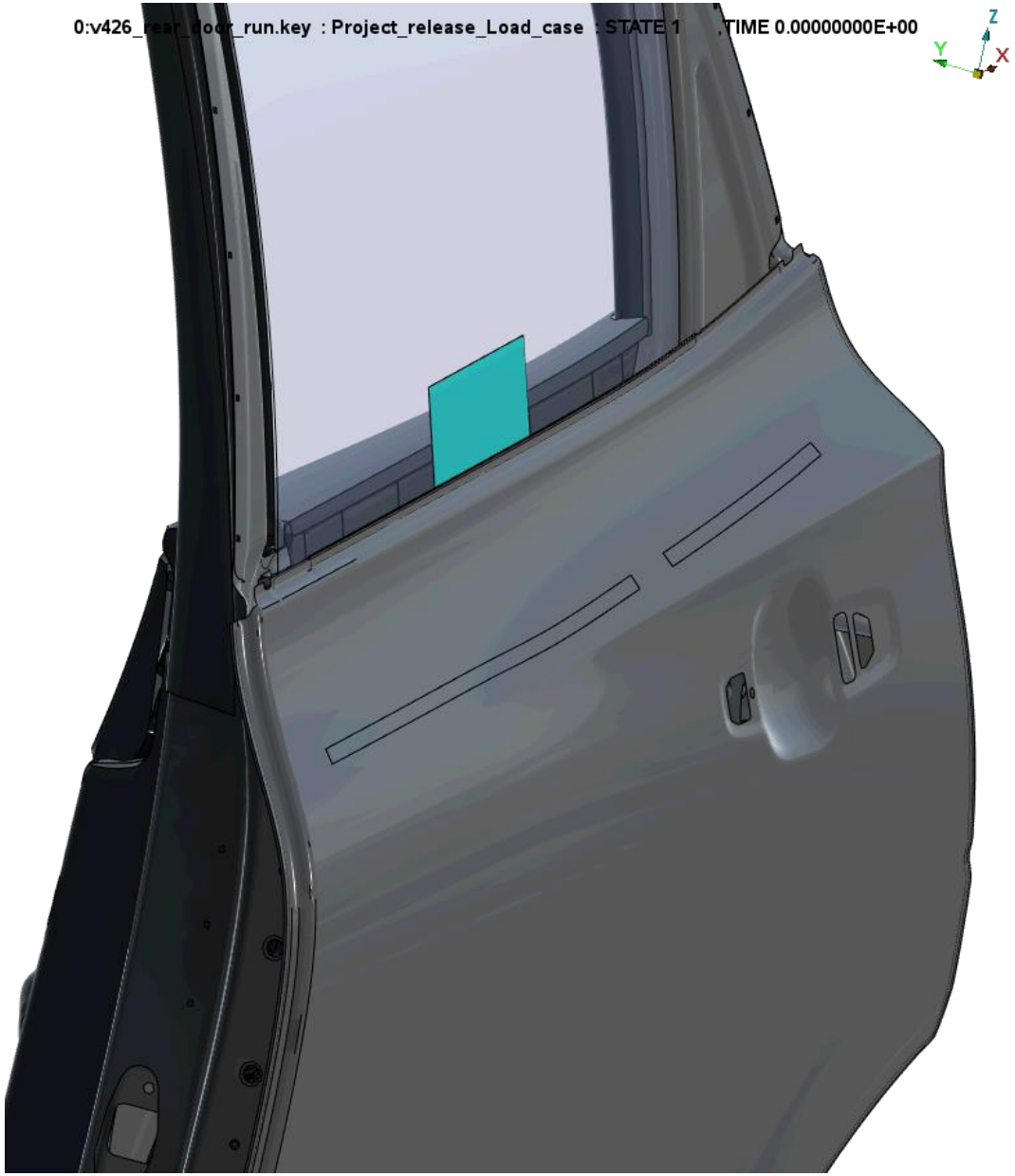
Challenges with new method

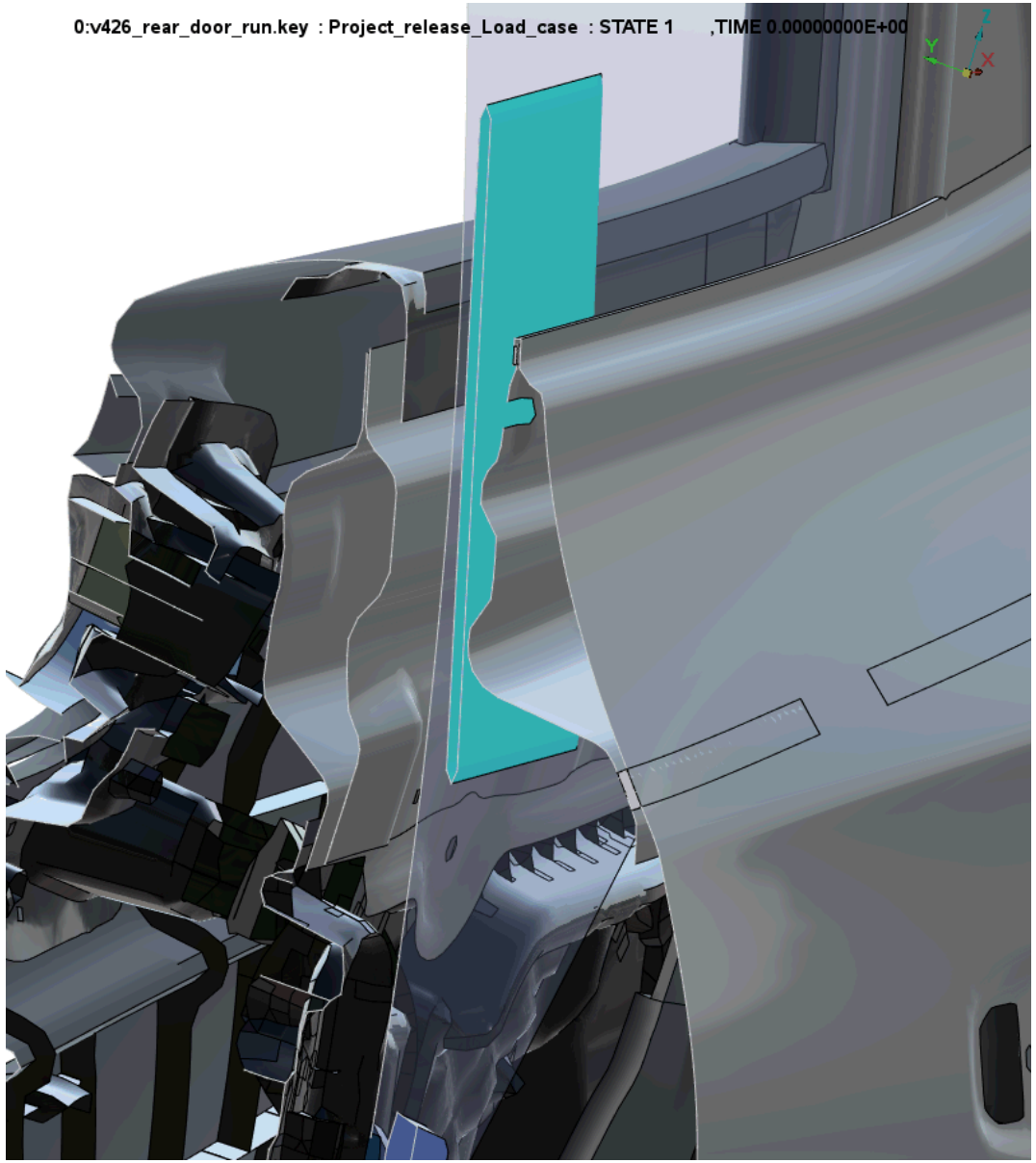
- Tuning of parameters in simplified model:
  - Material of airwedge: MAT34 MAT_FABRIC (only in-plane properties)
  - Pressure distribution
  - Contact interaction

- Introduce tuned airbag model in door structure, tuning parameters to test results
  - Friction properties
  - Contact damping settings
  - Robust positioning of airwedge
  - Load rate dependency

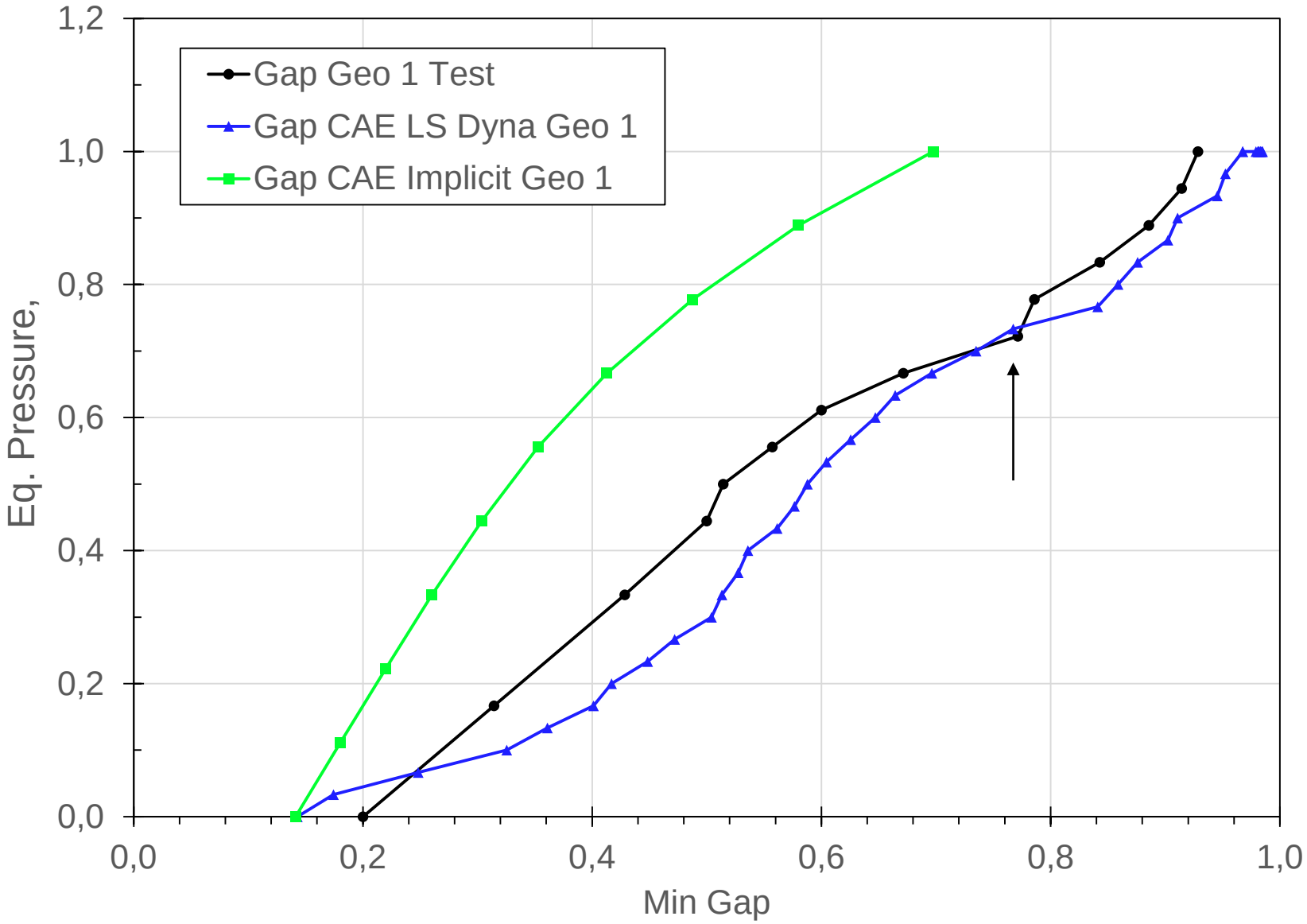


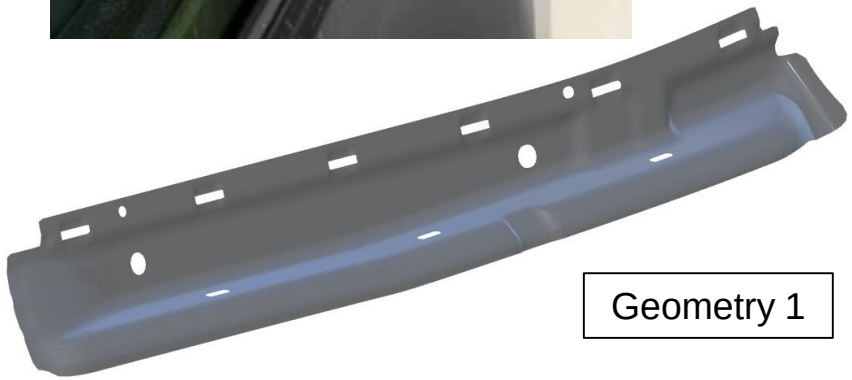
EXPLICIT METHOD – ANIMATION





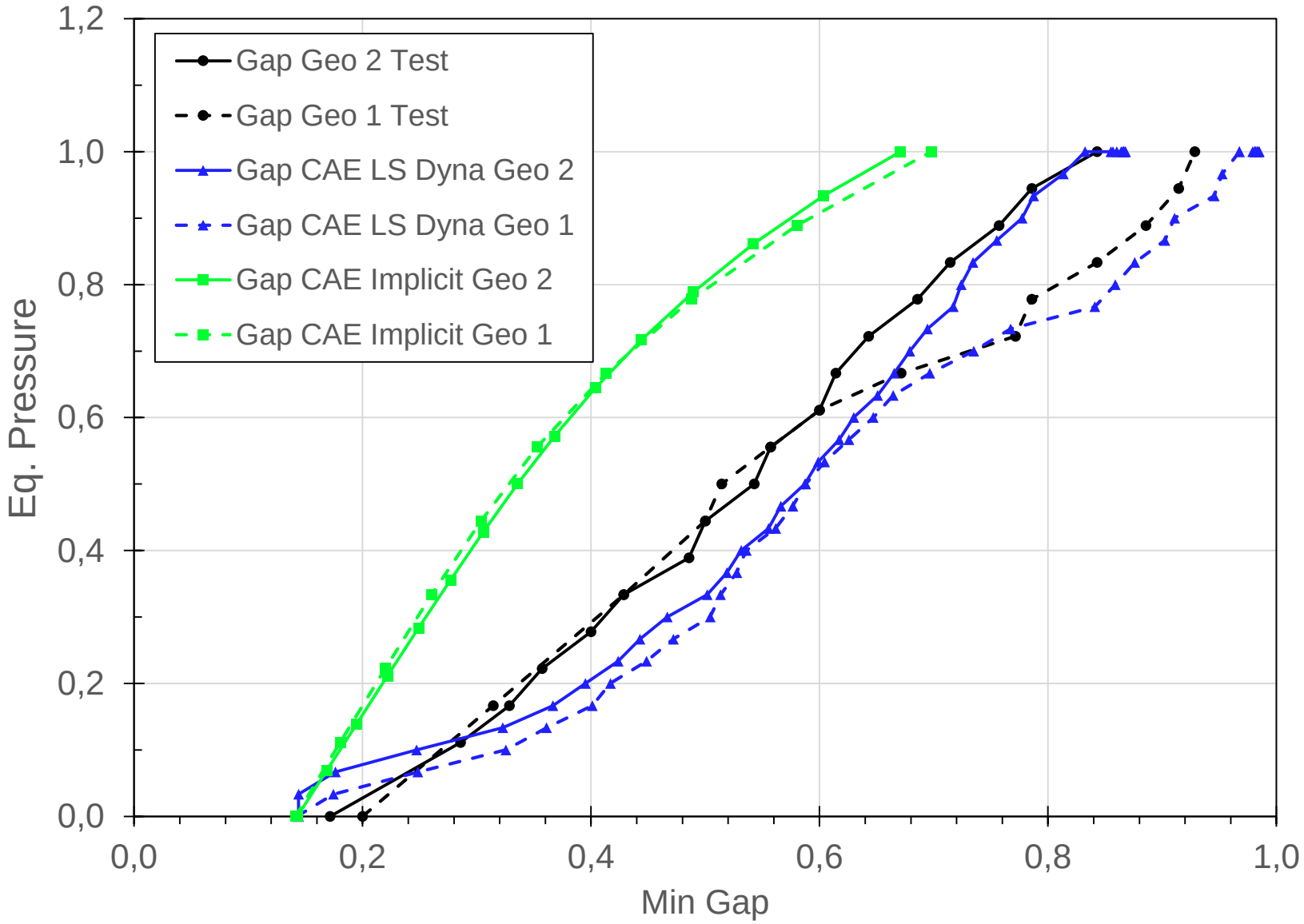
GAP RESULTS

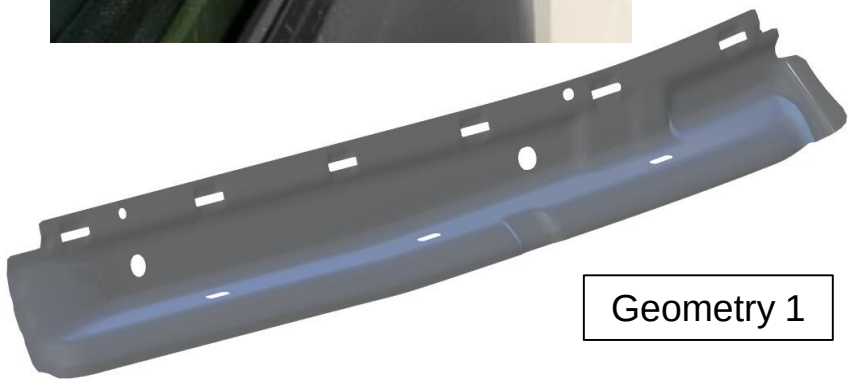




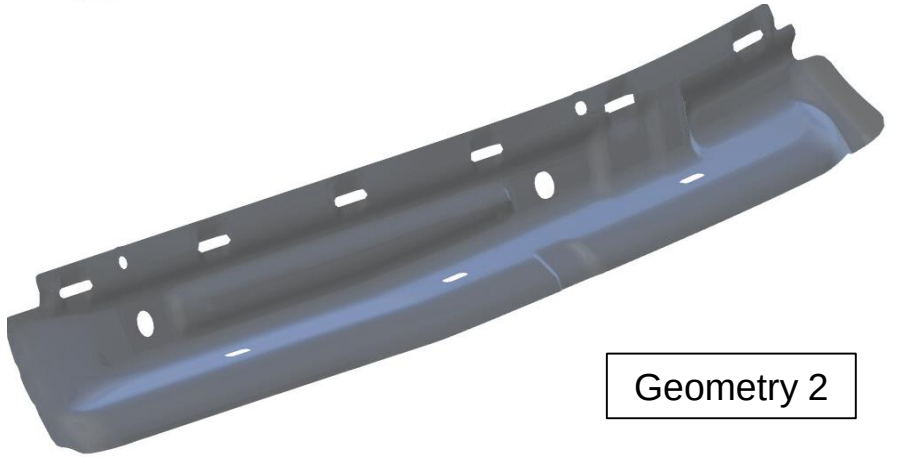
Geometry 1

GAP RESULTS



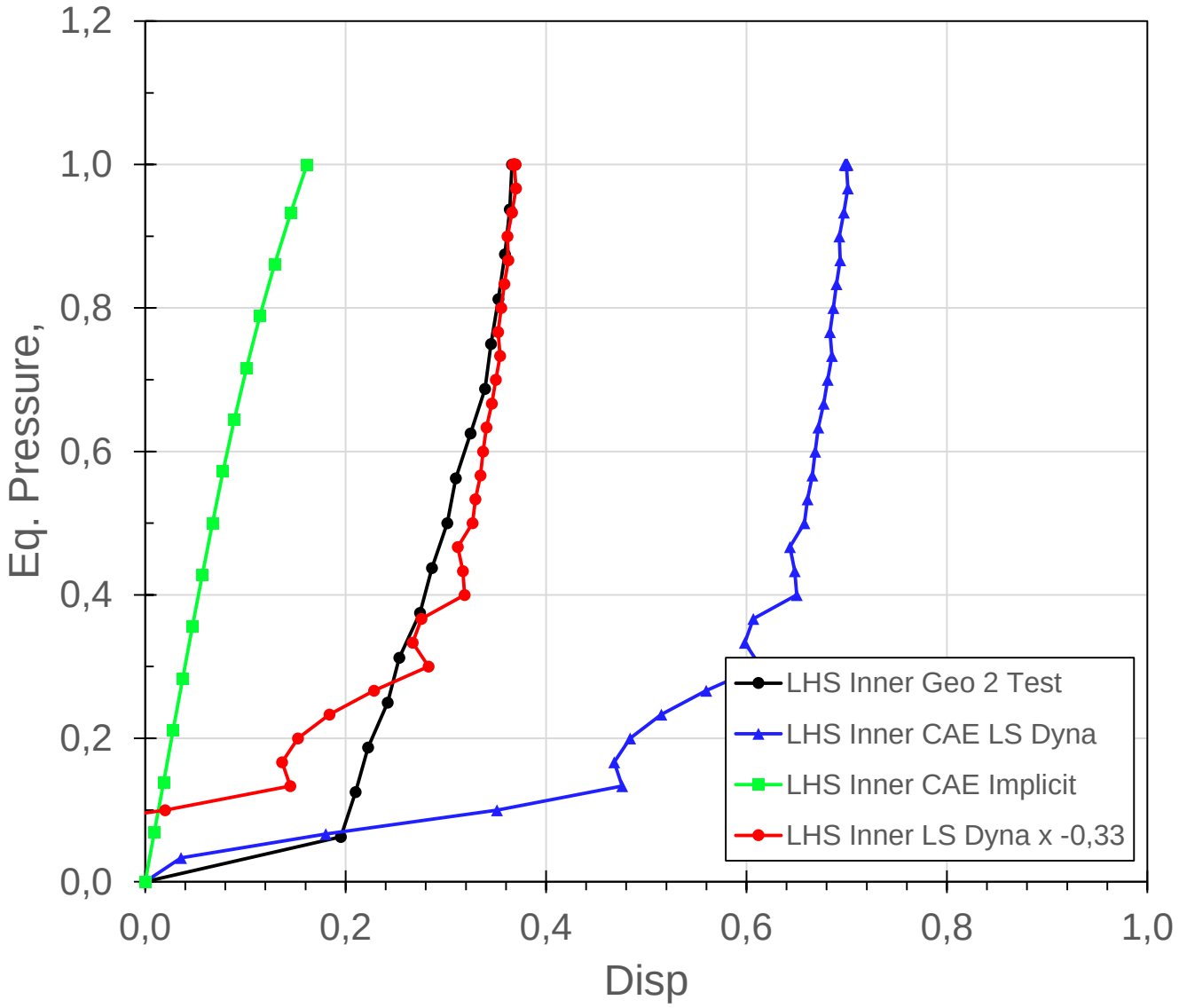


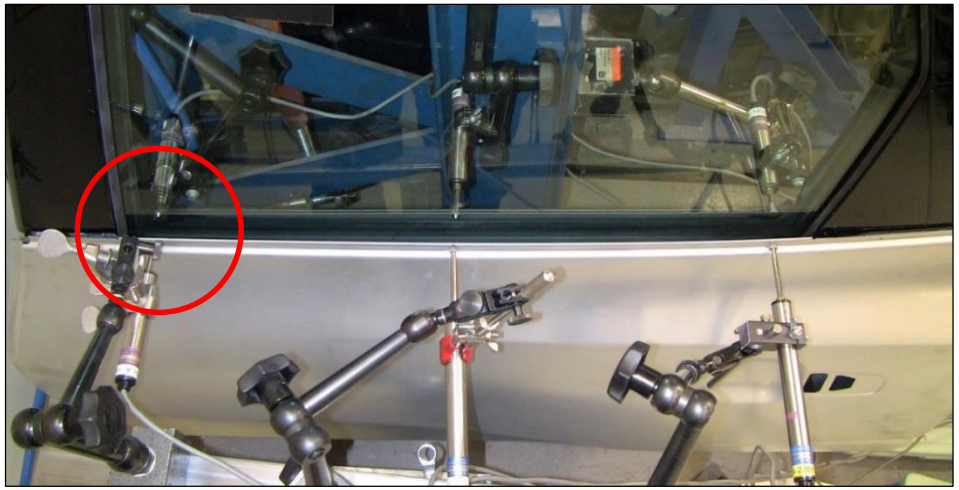
Geometry 1



Geometry 2

WINDOW DISPLACEMENTS





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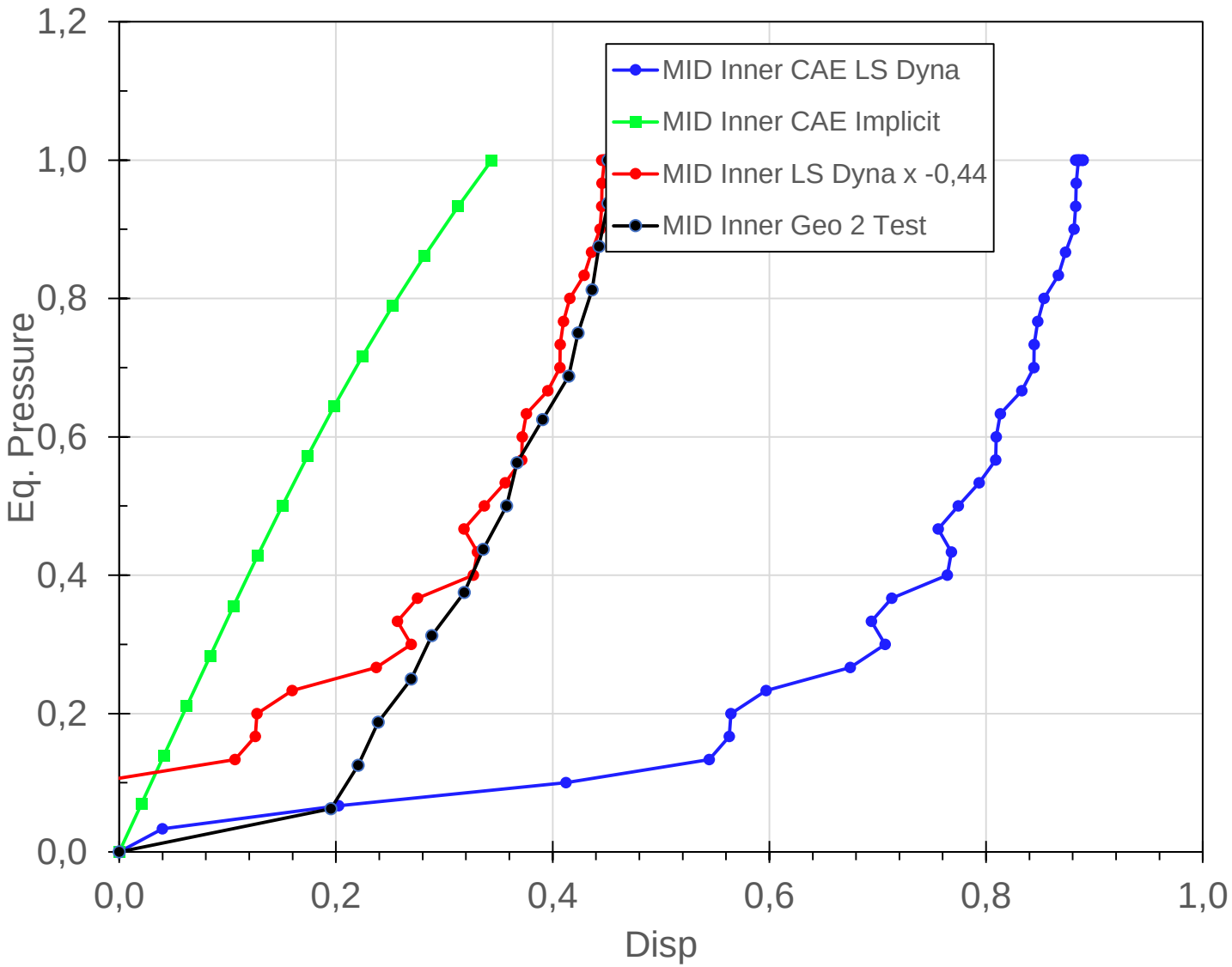

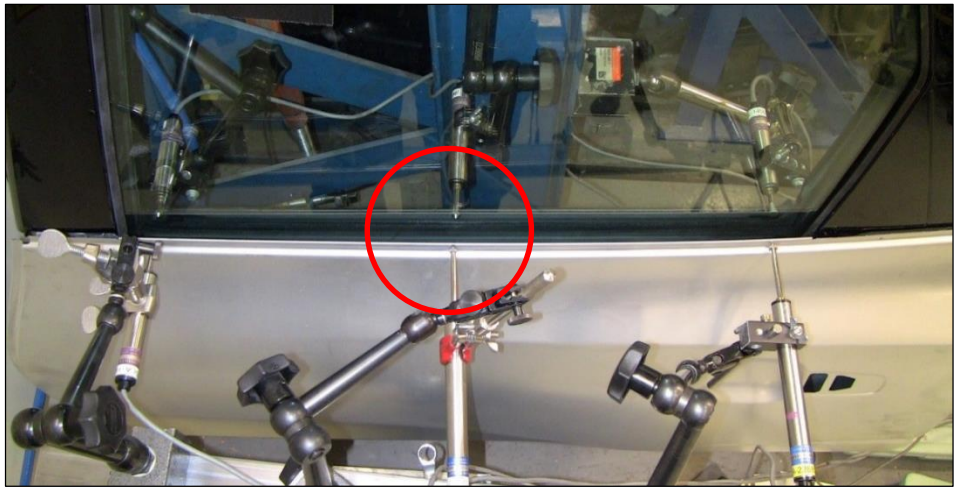

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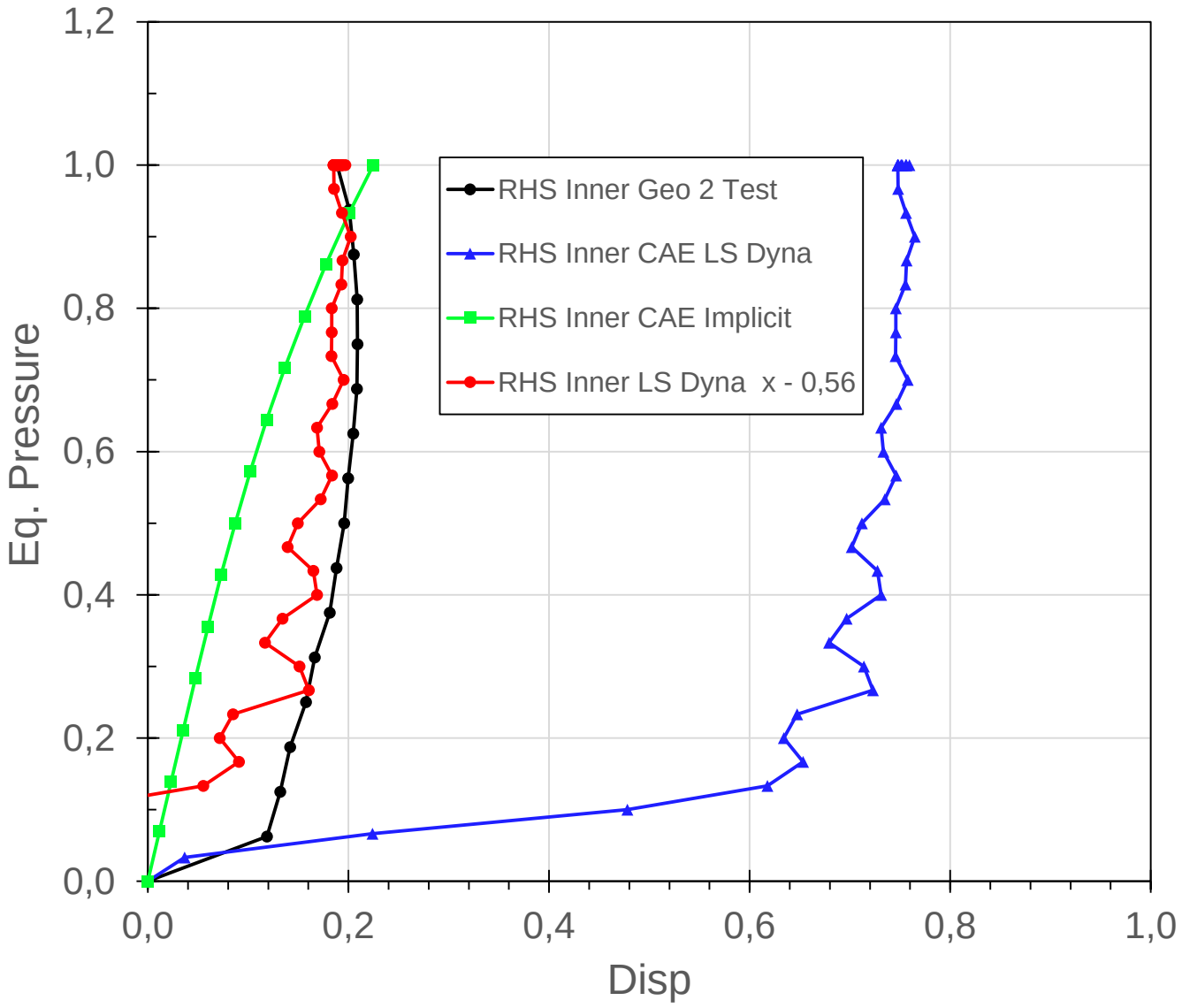
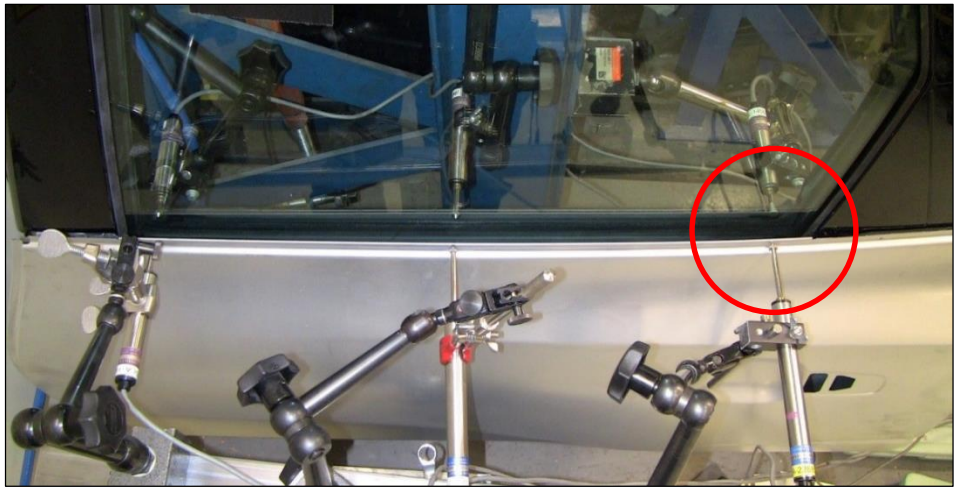
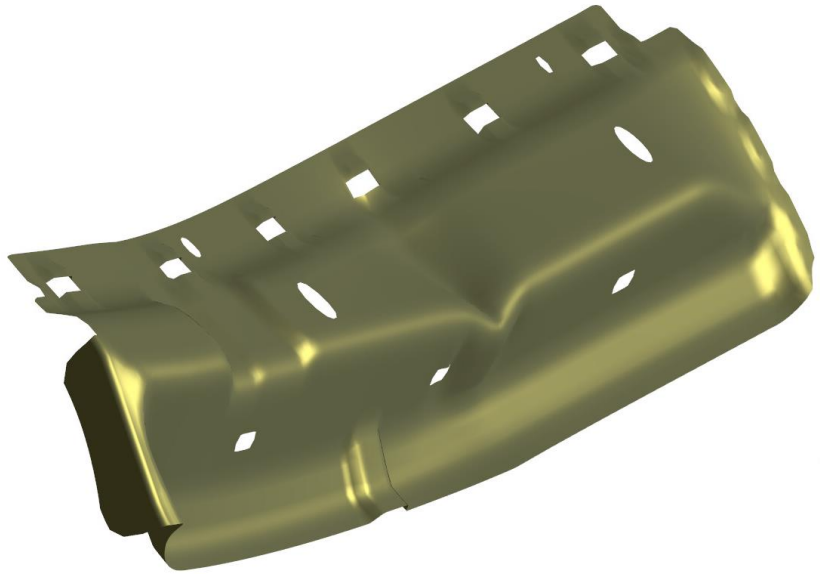


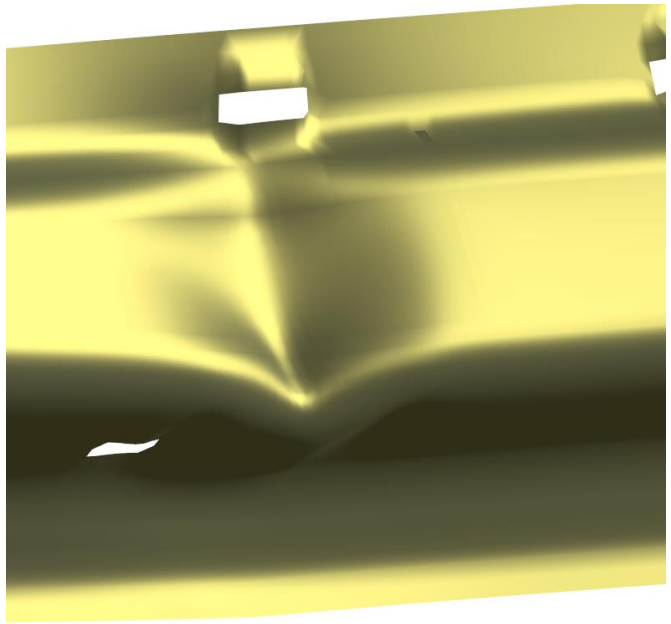


TEST VS NEW METHOD - RESIDUAL DEFORMATION OF BELT BEAM

TEST

CAE

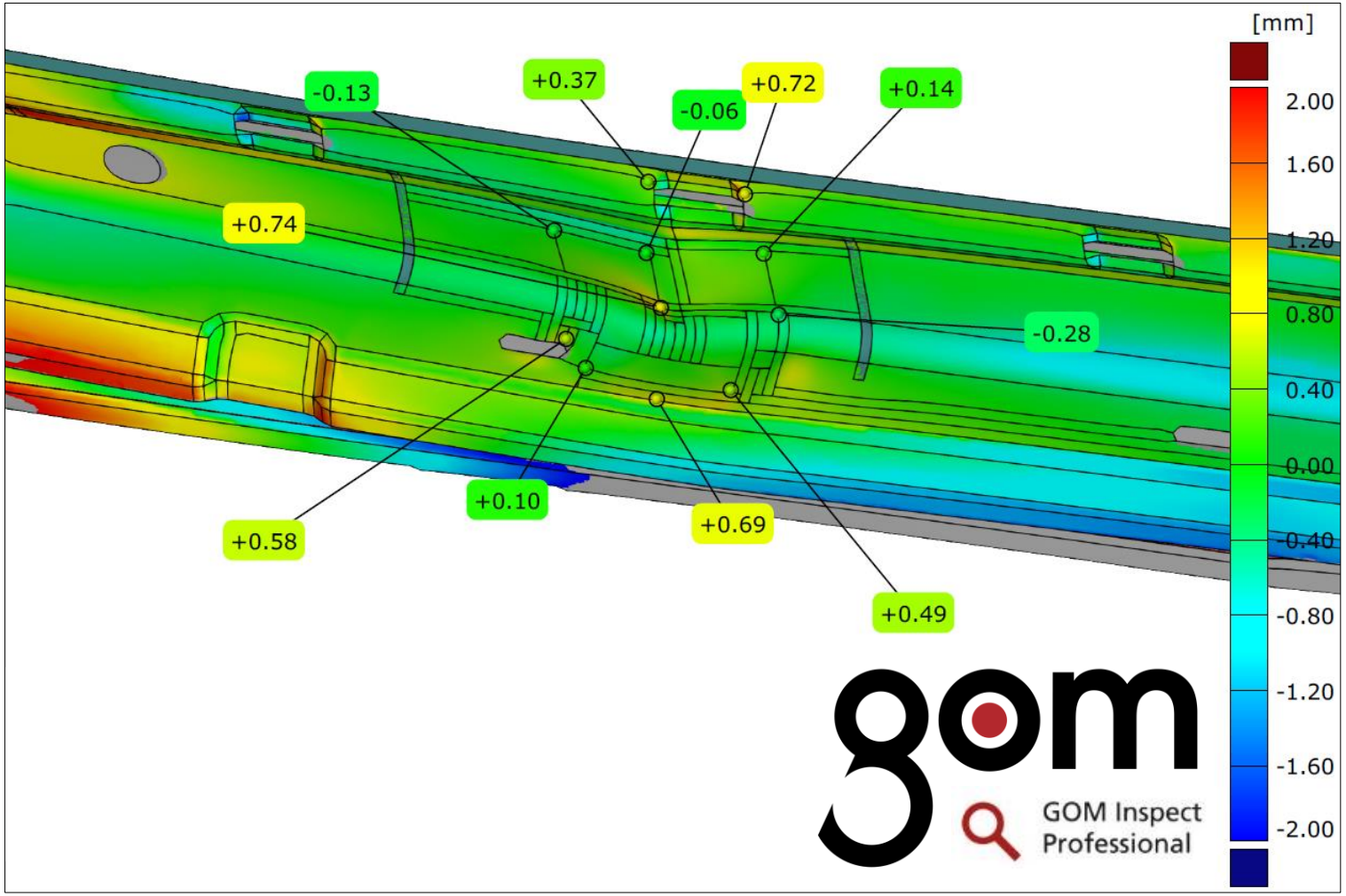




TEST VS NEW METHOD - RESIDUAL DEFORMATION OF BEAM

Residual deformation study

- 3D scan of cut out belt section
- New method capable of capturing correct residual deformation
- Minor difference between CAE and test in loading area



SUMMARY

New method

- New CAE method is simulating test method and not a cascaded requirement
- Correct deformation mode captured in new method
- Displacement during loading shows correct behaviour
- New method is used in project

Future work

- Modelling of window sealing
- Improve mehtod with further physical testing (ongoing)


THANK YOU
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QUESTIONS