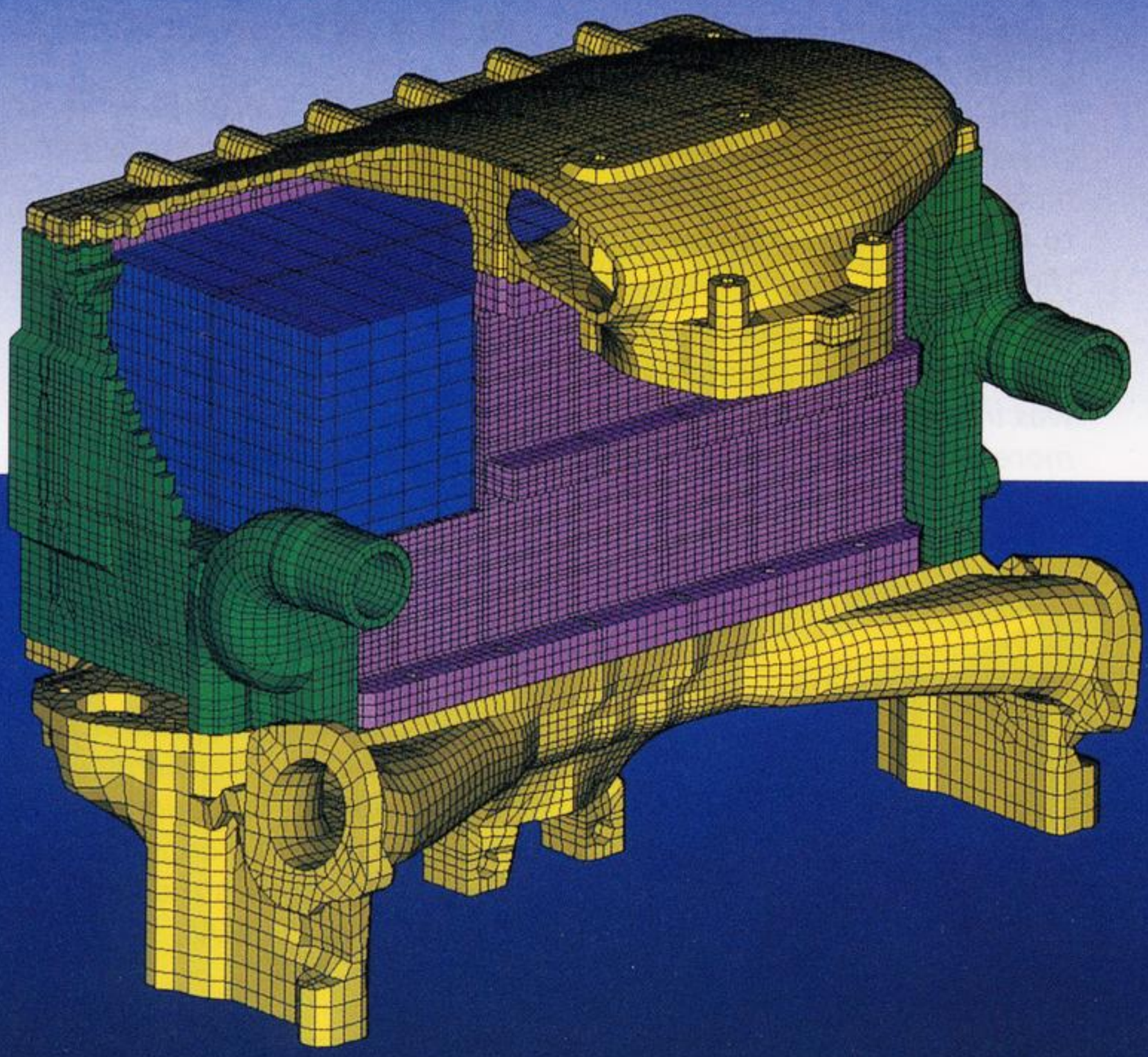
PERMAS
IN USE AT BEHR

Analysis of a Charge Air Cooler:

- TRANSIENT TEMPERATURE FIELDS
- COUPLED THERMAL STRESSES
- WITH CONTACT



At Behr GmbH & Co., Stuttgart, a supplier of engine cooling and air conditioning for the automotive industry, complex structures are analyzed with PERMAS. The model parameters of this charge air cooler of BEHR Industrietechnik are impressive:

103,000 nodes
101,000 elements
4,500 contacts
277,000 static degrees of freedom
91,500 temperature degrees of freedom

The more complex a modern construction is, the more important is the consideration of all relevant physical effects for an efficient numerical analysis.

The charge air cooler presented here is subject to time and temperature dependent loads requiring a detailed modelling and calculation of the whole structure.

Time for PERMAS!

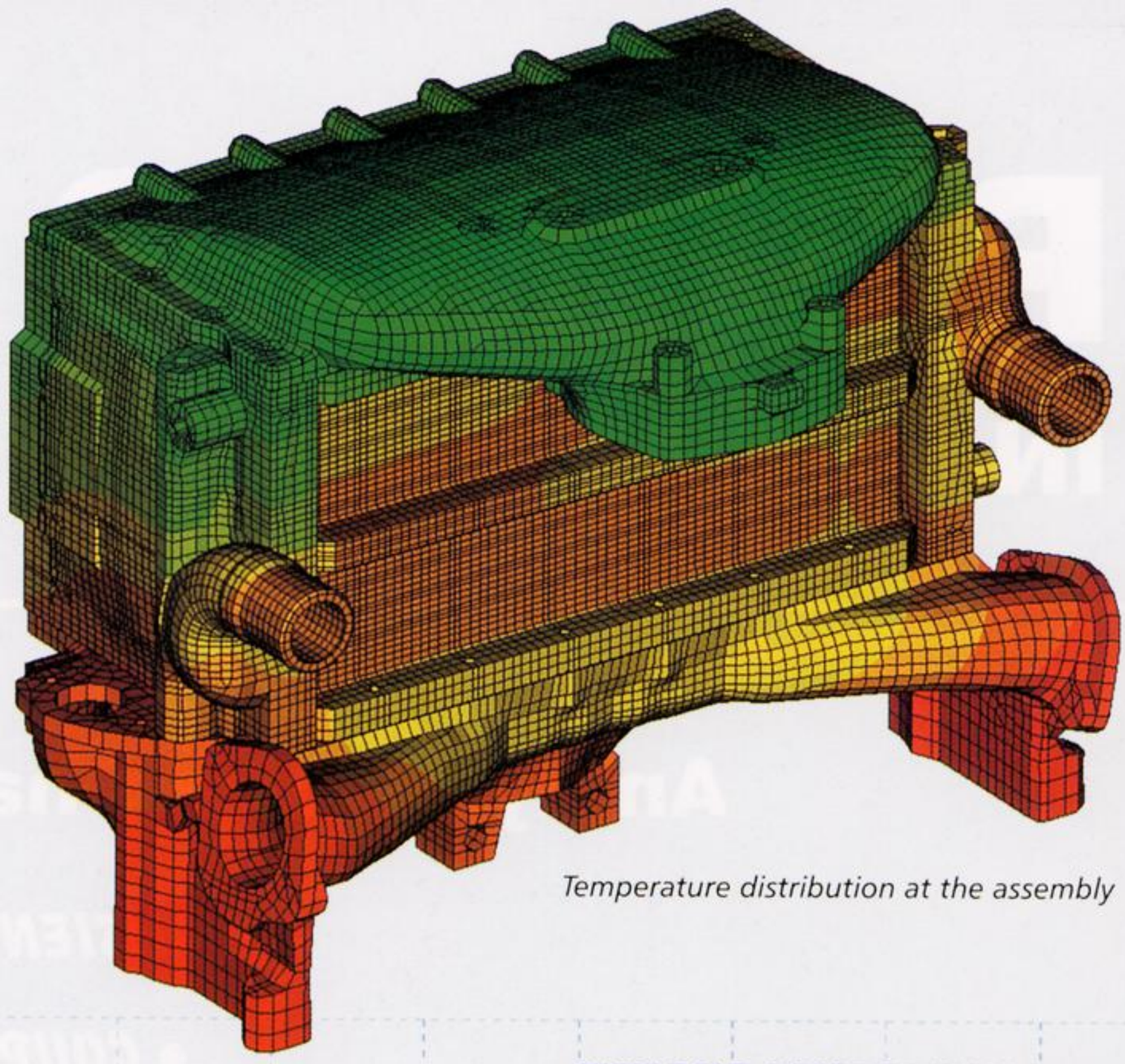
TEMPERATURE FIELD CALCULATION

The temperatures were calculated in one second increments for a period of 600 seconds. Points of interest were the effects of load changes due to shifting on full load and shifting into neutral in a realistic chronological succession.

Prescribed temperature profiles for air and water had to be considered. Also loading cases with and without water throughput were examined.

Here the core was simplified and modelled in a homogenized form with corresponding material data.

The global behaviour of the cooler was determined by an overall balance of heat fluxes.



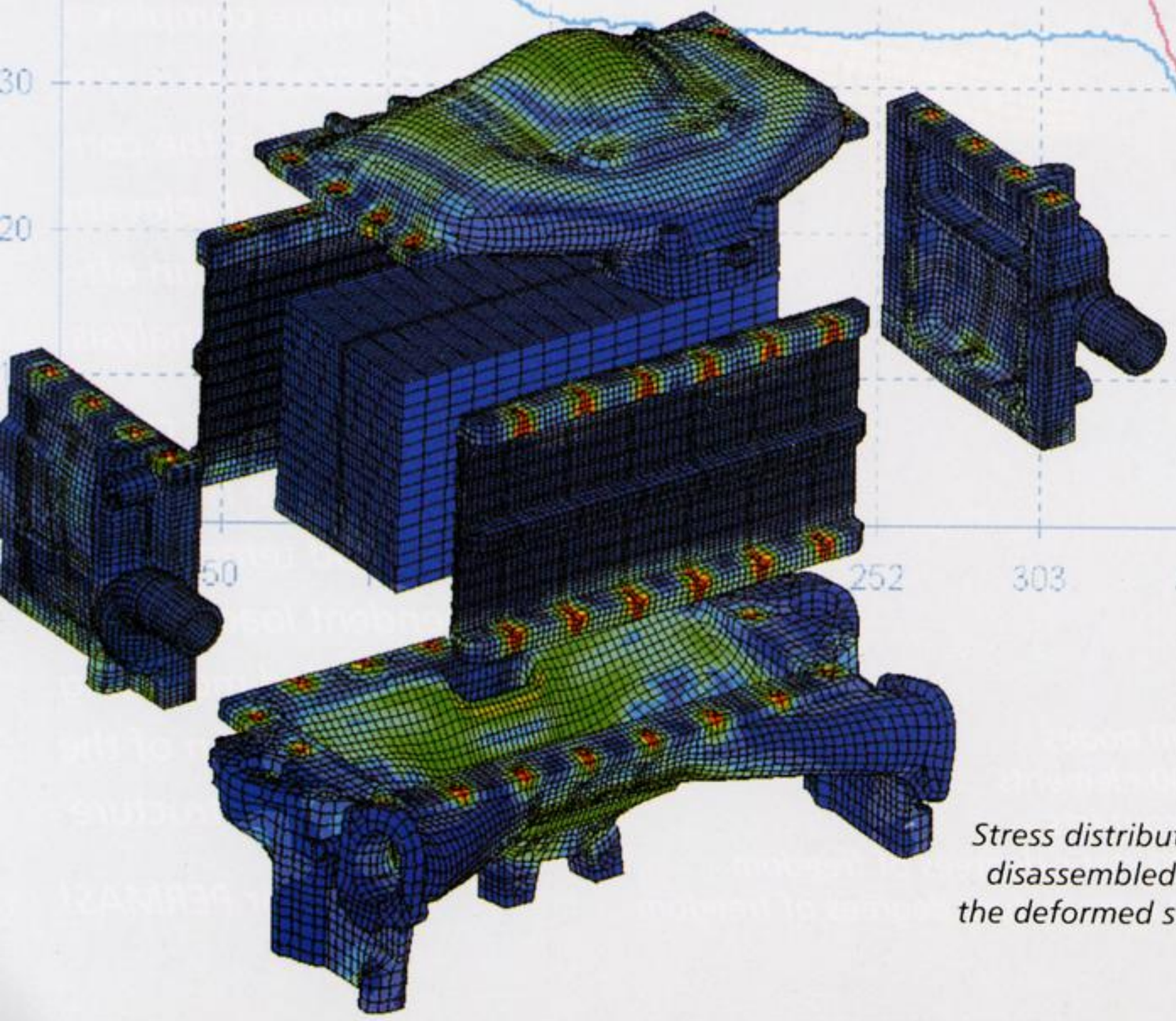
Temperature distribution at the assembly

THERMAL STRESSES WITH CONTACT

The temperature results from the preceding field calculation were directly taken as loads for the thermal stress calculation in the same analysis.

Contact definitions were first used to fix the top of the cooler to the case. Secondly, the prestresses of the screws were modelled correctly with contacts to represent the extensions of the bolts.

As an additional load, the internal pressure from air and water was introduced. Altogether, more than twenty different loading cases and loading case combinations were examined.



Stress distribution in a disassembled view of the deformed structure

SYNCHRONIZATION WITH MEASUREMENTS

Parallel to the calculations, temperature profiles and stresses were measured and used to match the calculation.

Here the complex reality turned out to be well described in the calculation model, with all relevant physical effects being successfully considered.

PERMAS

The combination of a considerable model size, transient calculation and determination of thermal stresses with contact conditions demonstrates the high capability of PERMAS.

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