Migration of a post-processing process

From manual Medina to automatic Meta post-processing

Rheinmetall Automotive AG is a global player in developing and delivering a multitude of products for the automotive Industry. One of our core competencies over more than 100 years is the development and production of pistons for any kind of combustion engine from a few grams to several hundred kilograms of weight. Worldwide local presence of the simulation department in all significant markets requires a standardized process for simulation in order to cope with the high level of detailing and to ensure an equal high level of simulation quality worldwide. The challenge, to come from a longtime and global well established process with the appropriate status of data, to build up and to improve existing work flows within a very short time, has been accepted at Kolbenschmidt by using Beta products. We will present the current status of the development of a mostly automatized process to produce Visualizations of the results and allow the simulation specialist to see, verify, evaluate and assess them before they are automatically transferred to Reports. What were the challenges and how do we convince and teach our colleagues worldwide to utilize the new process?

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Existing post-processing process

The process that is used worldwide includes the following manual steps. They are automated as far as possible, but still the whole process usually takes days.

- Review the results in the Postprocessor to verify the calculation
- Manually generate the pictures and descriptions for the result
- Transfer the pictures and texts to PowerPoint using in-house software feeding a PowerPoint Macro
- Manually prepare the report.
  - Positioning, resizing, duplicating and moving of pictures. Especially a comparison with a previous result is fully manual.
  - Assess critical / uncritical regions with graphical elements
  - Manually collect the assessed results in a summary table
- Report the results to Project Database / Report Database
  - Manually enter the project data / summary table into the report database
  - Manually link the report in the Project database

In case of a follow-up calculation (which is the most common case) all this effort has to be repeated.

Current status post-processing with Meta Post

We achieved a lot of the project goals already. The standard process is automatized to a high level. By now even visualizations that were just not created / possible in the previous process can be automatically generated, enabling a quicker and deeper analysis and verification of the calculation. Templates for different types of analysis are available to allow complex visualizations by editing just a few parameters.

Currently the standard process consists of the following tasks:

- Create CSV file specifying each picture (templates for standard and special cases available)
- Batch process creates pictures in PNG format that can be directly used
  - Views that will be needed for the report
  - Views that are necessary / helpful to verify / assess the results
- Reporting:
  - The user has to verify, modify and select the pictures for the report
  - Assessment of the results inside Meta Post
- Transfer of the pictures to PowerPoint using a Python script in Meta Post feeding a PPT Macro

- Manual preparation of the Report
    - Comparisons of FEAs are automatically generated
    - Assess critical / uncritical regions with graphical elements
    - Summary table is automatically generated with the assessments from Meta Post
- Report the result to Project Database / Report Database
    - Manually enter the project data / summary table into the report database

In case of a follow-up calculation the existing CSV file allows very quick turnaround in the verification and assessment, and also very easy comparison with the previous calculation, as the process generates the necessary PowerPoint slides automatically.

Additionally to the fully automatic process with a CSV file we created a series of buttons to bring functionality the colleagues experienced in Medina are used to into Meta Post.

- Viewing angles
- Min/Max in screen box
- Annotation by node picking
- Annotation for each node in a set
- Create a full model from a half model (including all results and settings)
- Display visible parts of the model deformed / un-deformed at the same time
- A grid that is applied to Annotations to enforce alignment in row/column
- Buttons for the general setup of the session
    - Lighting
    - Fringe Bar (Temperature or Safety factors)
    - Displayed part of the model
    - Viewing angle
- Fringe Bar settings for all possible situations with one button click
- Fringe Bar color table automatically calculated from min/max/step

As well as functionalities that are just not possible in Medina:

- Annotations are automatically arranged around the model and rearranged every time a new annotation is created or deleted. Collisions of connection lines are automatically resolved.
- Automatic search for local Min/Max of the whole foreground of the visible model
- Safety factor annotations that include the Temperature, Mean Stress and Stress Amplitude (loading the results if necessary)
- To create normed wear pattern, the user picks the annotation with the max. value and the wear pattern result is automatically scaled down to max. 1, including Fringe Bar.
- Stress results including all components of the stress tensor (loading the results if necessary)
- Display rear/front/left/right/top/bottom part of the model only without need for Sets/properties
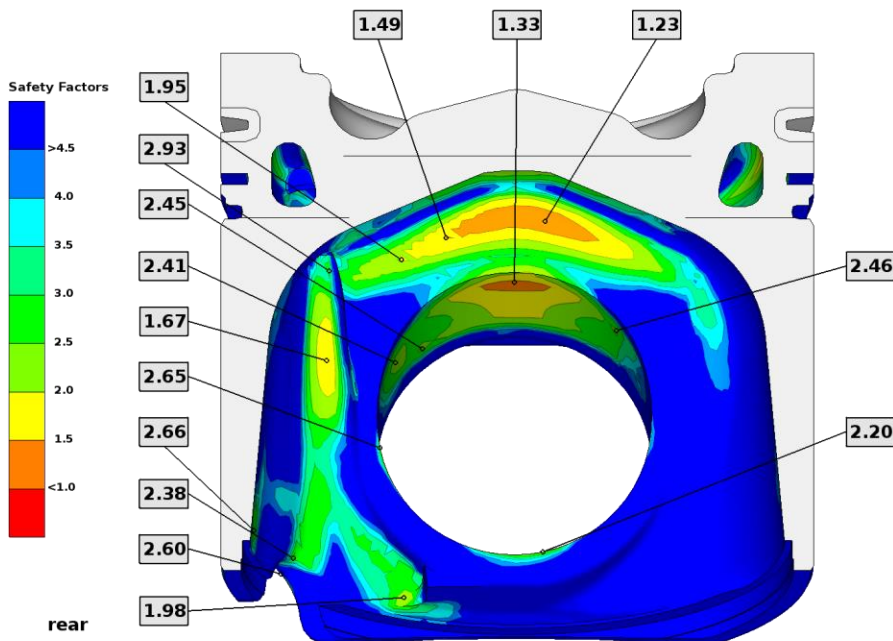
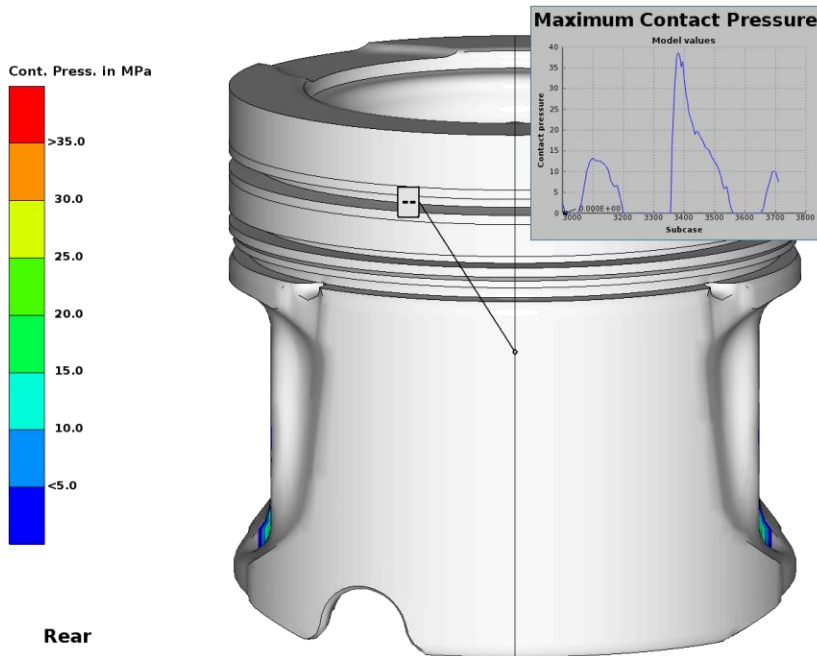# Examples (unchanged after automatic process)

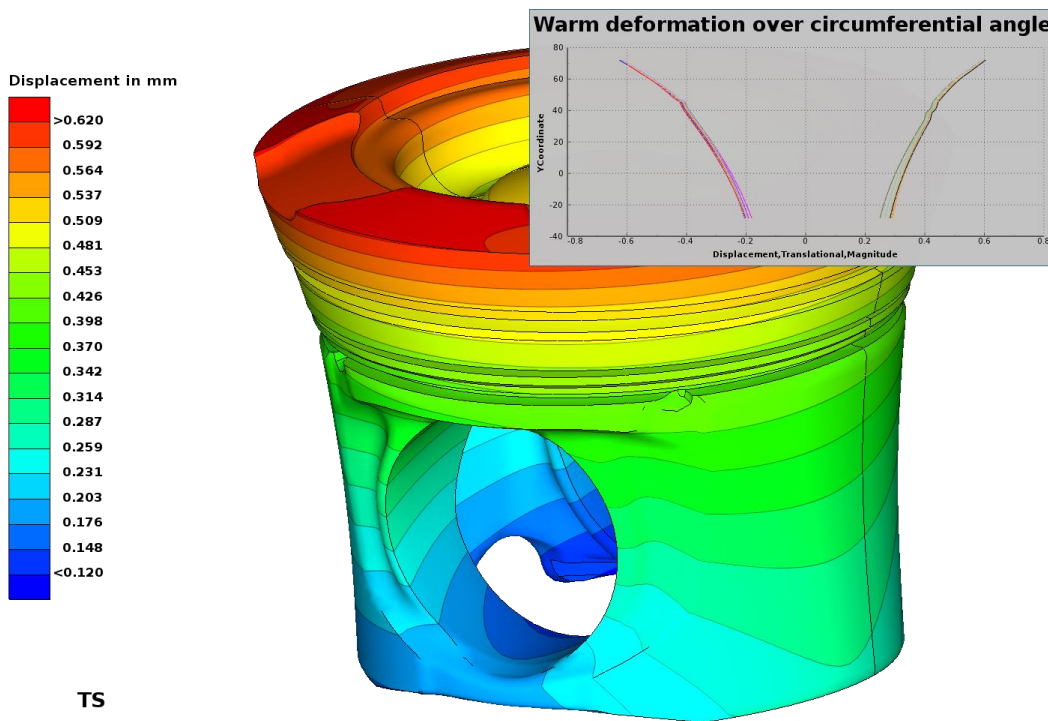## Temperature distribution
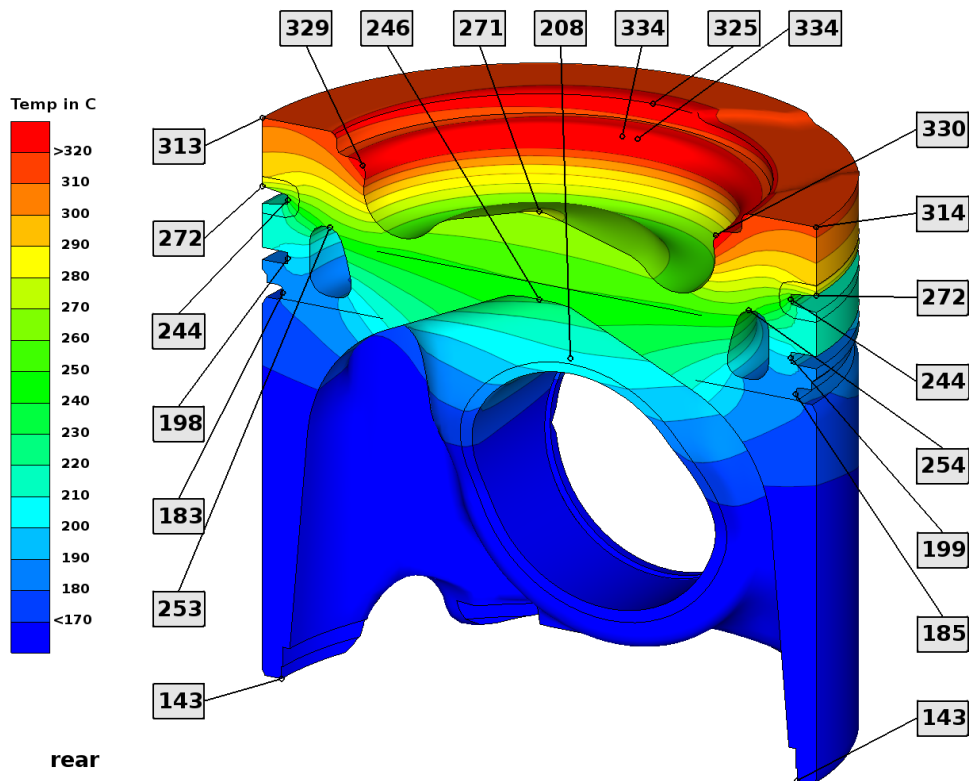
Safety factor

Contact pressure over crank angle

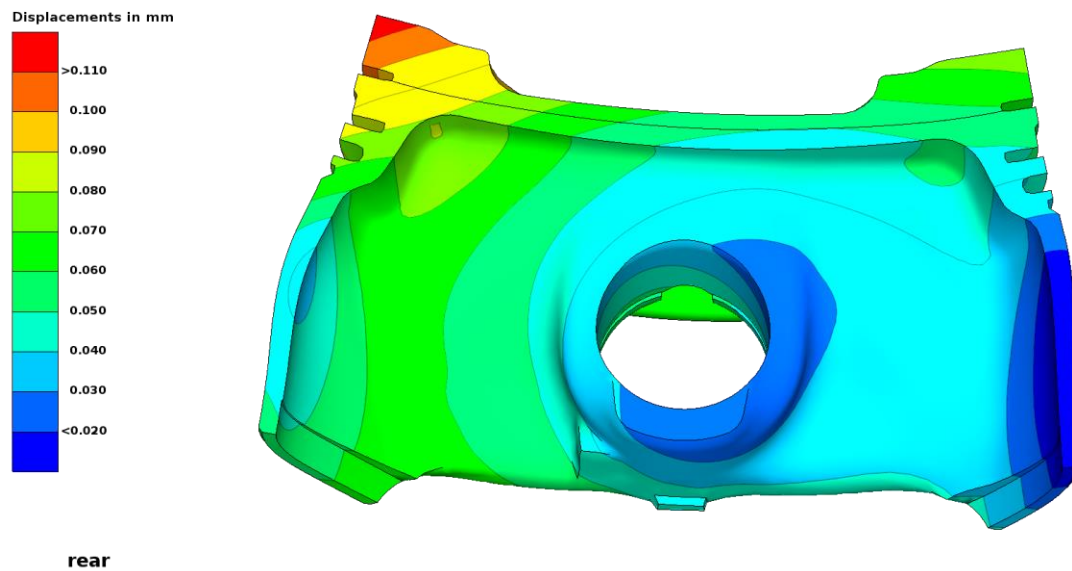Warm deformation of the piston (including CSV export of the curves)

Temperature difference
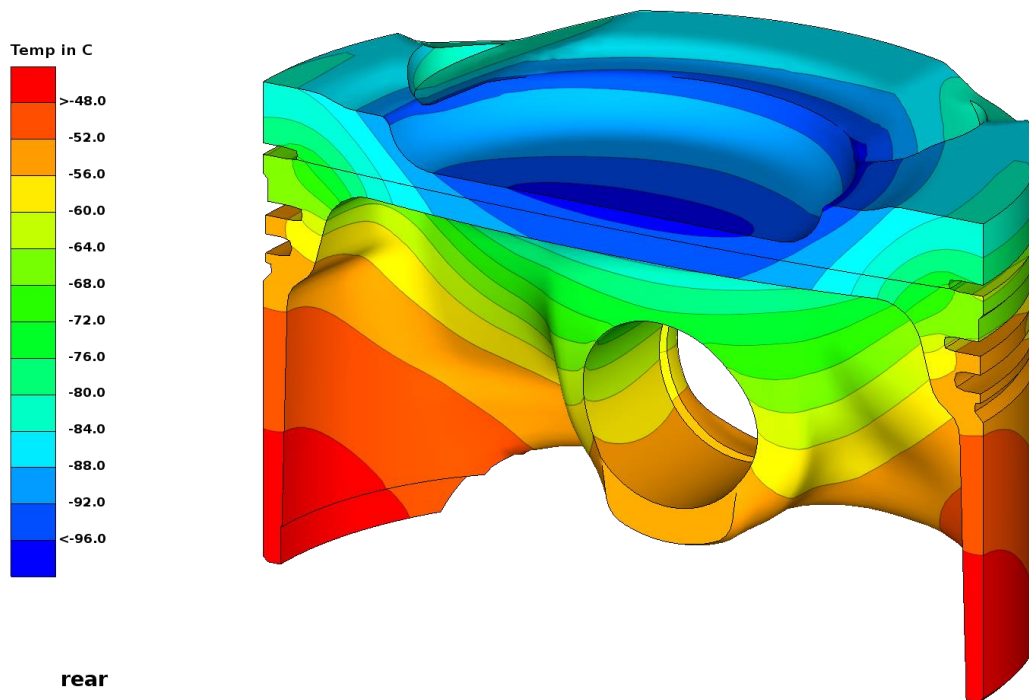
Displacement difference

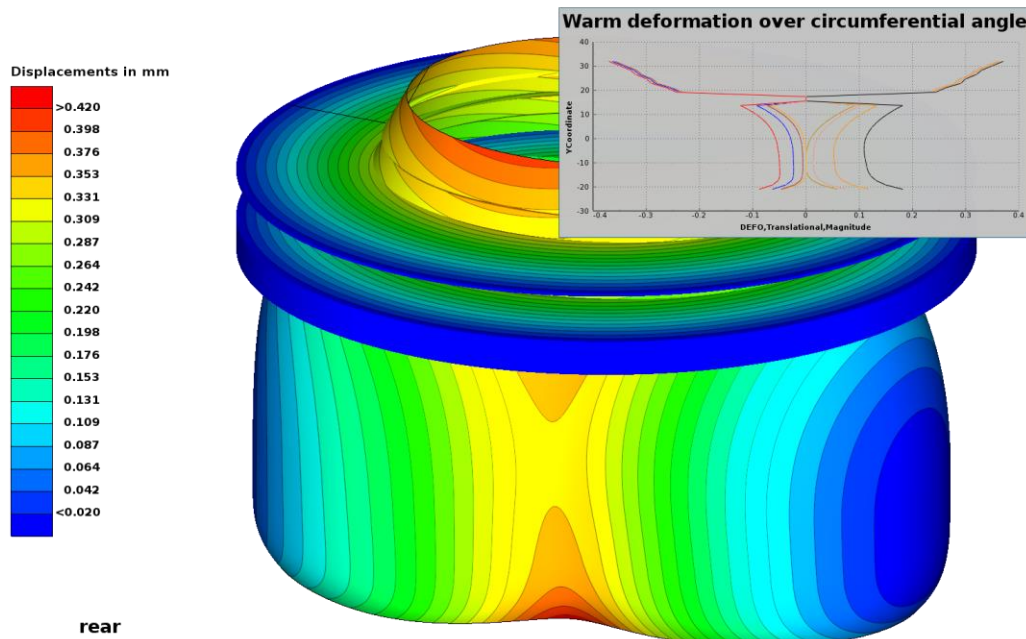## Stress Difference
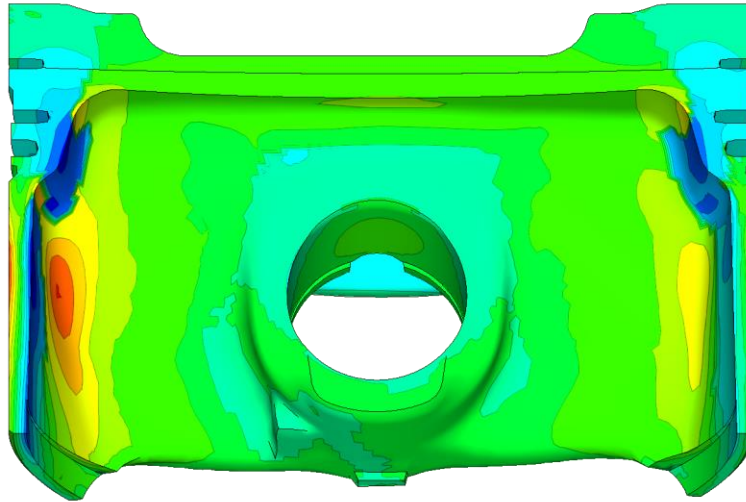
Full stress tensor Annotations
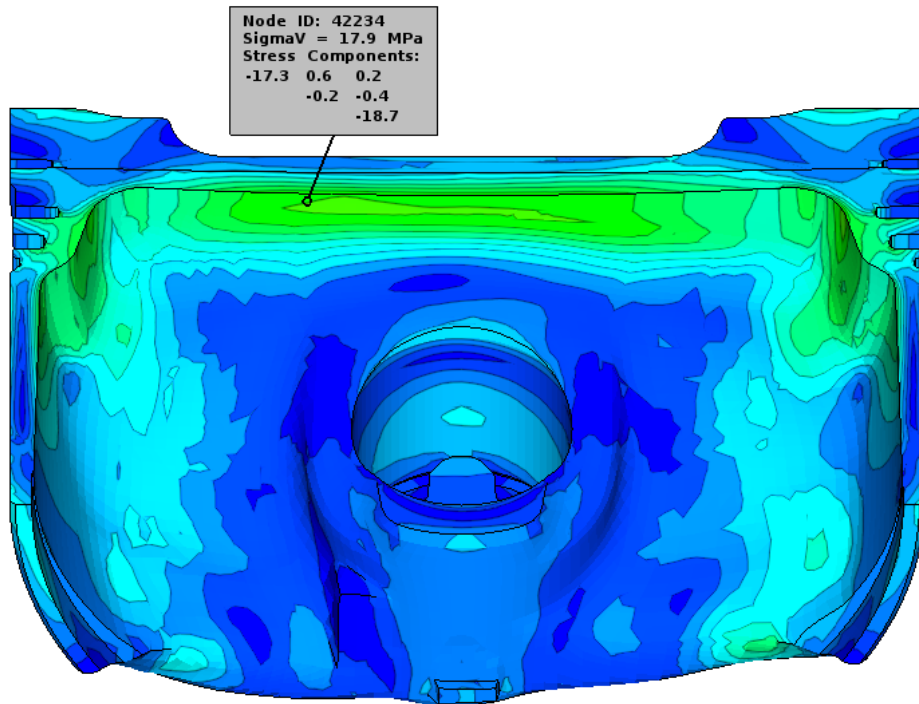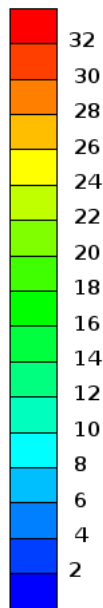
Microgeometry

Future Developments

Integration into solver processes

The Batch process will be integrated into the normal calculation process. This way the user will find a full set of pictures already available once the calculation is finished. This will allow a quick and because of the available templates also more thorough examination of the calculation, as visualizations that are very time consuming to create – and therefore are only created when there is already the suspicion that there is a problem but it was just not found yet – are just there automatically right from the beginning.

Connectivity with in-house databases

We have project data in a Project database. And we have to enter Project data into the report database. Until now these data are transferred manually from one to the other.

Also we need to report the calculation result into the Project database and the Report database, in case of the report including the Assessed critical/uncritical locations of the product that are inside the Summary table.

The goal is to have these databases pulled into the process and read and write them automatically.

Expansion of the Batch Macro language

Currently the Macro language in the CSV file can handle our standard evaluations and some evaluations that were just not possible with the previous tools. But it is concentrating on results of static calculations, mostly. There is support for static pictures and simple animations of time dependent results, but the full feature set to visualize TMF, EHD, CFD, … results has yet to be defined and developed.

Also, even if we have implemented almost anything we could dream about for static results – thanks to no small amount to the excellent support of the team at Beta Systems and the fast reaction to any bug report - there is always something coming up.