Appendix J

OHB System
Thermal Result Viewer

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(OHB System, Germany)

Abstract

Driven by mission demands for improved performance, more precise prediction etc. a trend is observed to bigger thermal models simulated with a high transient resolution. The built-in post- processing capabilities of commercial software codes often cannot cope with the model and result file sizes. Further the necessary post-processing is split over multiple tools which are often not easy to handle.
Over the last couple of years an integral thermal post-processing tool has been developed at OHB Munich, which combined the necessary capabilities and offers a convenient and fast user I/F. The Thermal Result Viewer (TRV) has among others the following main features:

- Import of result files in different formats:
  - *.TMD
  - *.out
  - *.csv
- Import of the model structure from different sources:
  - GMM model (*.erg)
  - TMM result file (*.TMD)
  - Excel list (*.xlsx)
  - Manual setting in the program
- Simultaneous visualization of 3-D and 2-D temperature and heat flux maps and plots for selected groups
- Transient group based visualization of the internal hat fluxes in a model (conductive and radiative) – without the necessity to program it into the TMM beforehand.
- Easy and intuitive graphical user Interface (GUI)

A Demonstration of the TRV functionality will be presented and discussed in the presentation.

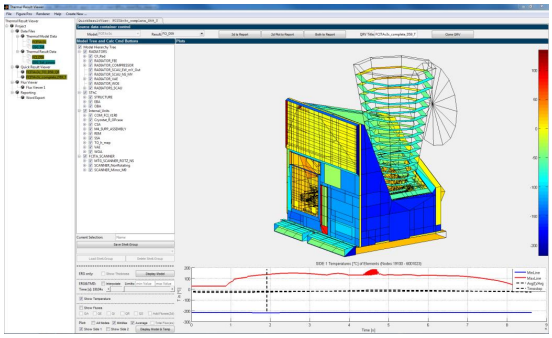

Figure J.1: Example Temperatures Visualization in TRV

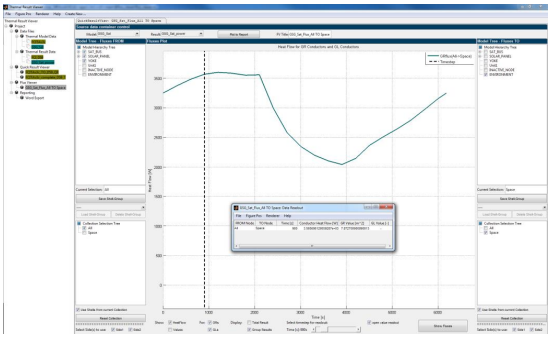

Figure J.2: Example Heat Flux Visualization in TRV

OHB System AG
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03.11.2015

SPACE SYSTEMS

OHB System – Thermal Result Viewer

We. Create. Space.

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- Thermal Result Viewer (TRV)
  - Rationale
  - Tool modules
    - Data Files
    - Quick Result Viewer
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      - Environmental Fluxes
    - Flux Viewer
    - Reporting
  - Future Work
- Summary

Thermal Result Viewer - Rationale

- Need to quickly and efficiently post-process and visualize:
  - Temperatures:
    - transient evolutions
    - 3-D maps
  - Fluxes:
    - Environmental (QS, QA, QE, etc.)
    - Heat flows between parts (conductive, radiative) → establish heat flux budgets in post-processing
- Be able to work with or without GMM
- Allow easy grouping
  - re-using of available model structure
  - customized groups from excel
  - Manual group setup in GUI
- All is also possible with other tools (in ESATAN-TMS, Excel, Therm-NV etc.) but with significant effort.

→ **Efficiency increase and ease of use were and are the main targets for the TRV**

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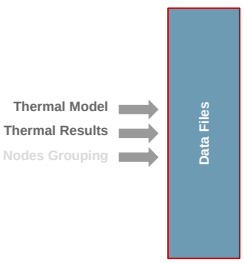
Thermal Result Viewer – Modules

- TRV is setup in a modular object oriented fashion
- Development is centralized on a server accessible to all OHB colleagues
- The TRV modules are:
  - **Data files** → import of data and sorting (optional)



Seite 4 OHB System AG

Thermal Result Viewer – Modules

- TRV is setup in a modular object oriented fashion
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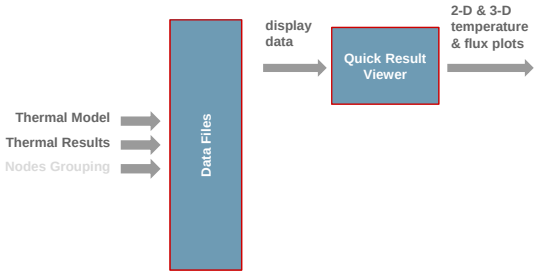
  - **Quick Result Viewer** → temperature and environmental fluxes visualization



Seite 5 OHB System AG

Thermal Result Viewer – Modules

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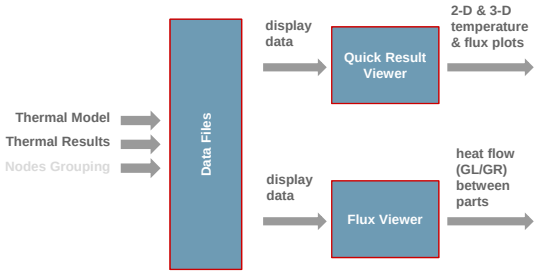
  - **Flux viewer** → heat flow visualization



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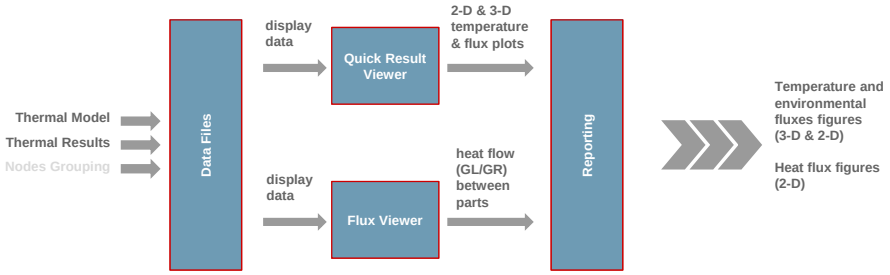
Thermal Result Viewer – Modules

- TRV is setup in a modular object oriented fashion
- Development is centralized on a server accessible to all OHB colleagues
- The TRV modules are:
  - **Data files** → import of data and sorting (optional)
  - **Quick Result Viewer** → temperature and environmental fluxes visualization
  - **Flux viewer** → heat flow visualization
  - **Reporting** → fine post-processing of figures and export



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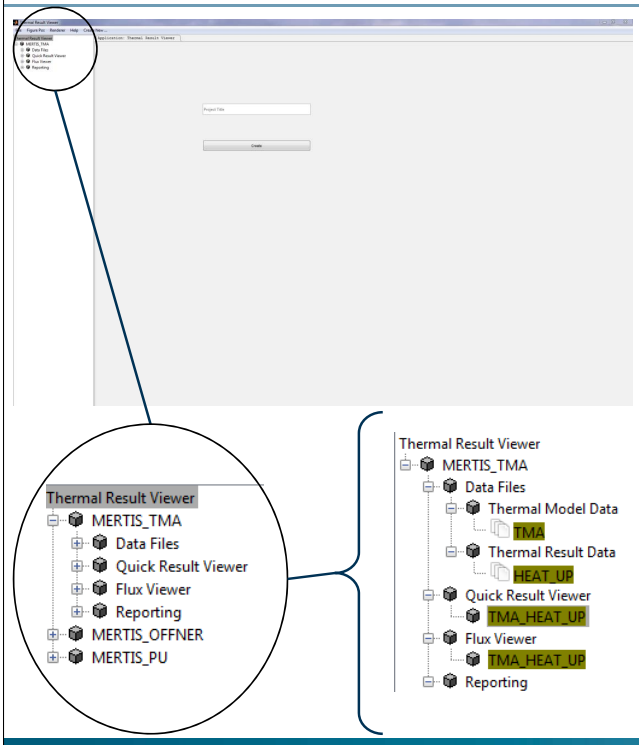
Thermal Result Viewer – Modules



- To start a project/session name is requested
- Multiple projects/sessions can be started in parallel
- Each project/session contains the following modules
  - Date Files
  - Quick Result Viewer
  - Flux Viewer
  - Reporting

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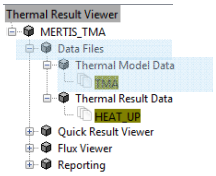
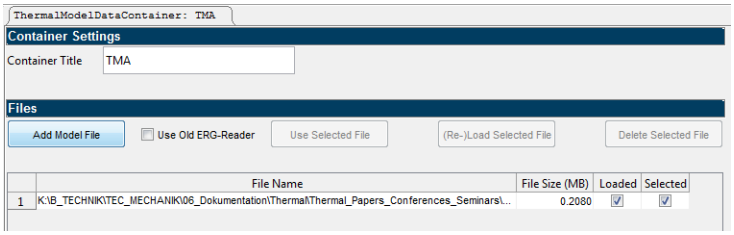
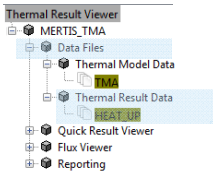
Thermal Result Viewer – Data Files



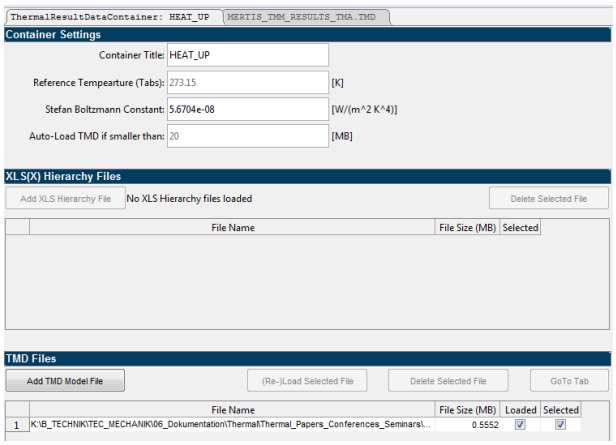
- **Thermal Model Data:**
  - Loading of GMMs in *.erg format
  - Multiple GMMs can be loaded simultaneously
  - GMMs can be named



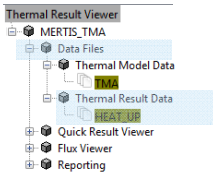
Thermal Result Viewer – Data Files



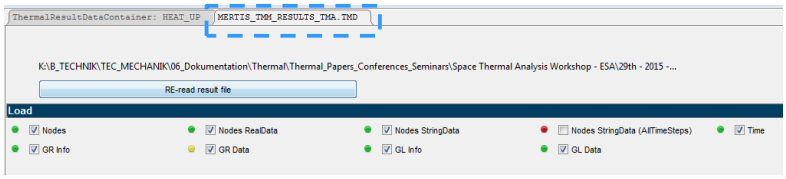
- **Thermal Result Data:**
  - Loading of temperature and flux results in *.TMD format
  - Loading of custom node hierarchies
  - Multiple results can be loaded simultaneously
  - Results can be named



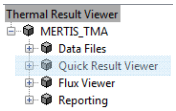
Thermal Result Viewer – Data Files



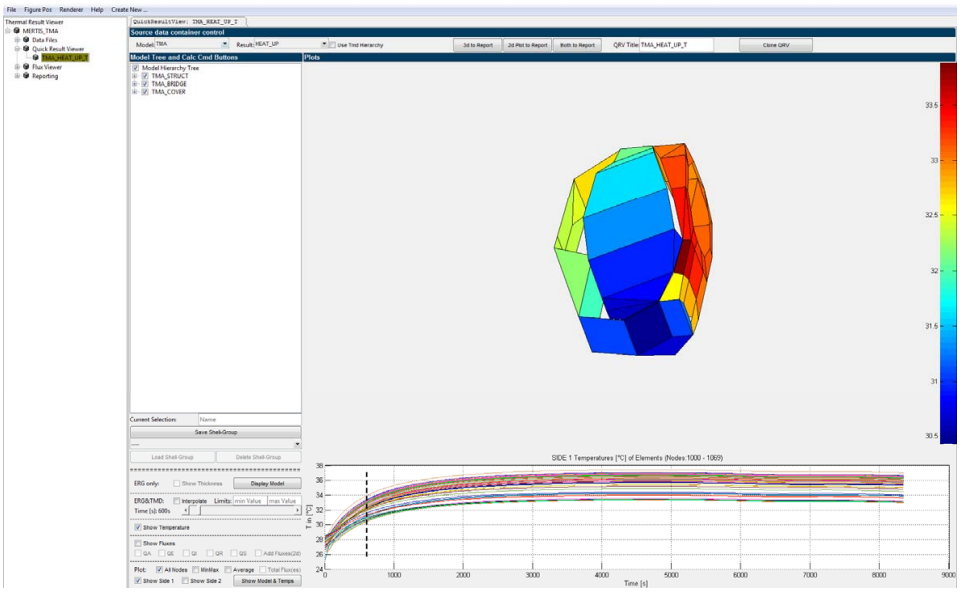
- **Thermal Result Data:**
  - Loading of TMDs in *.erg format
  - Loading of custom node hierarchies
  - Multiple results can be loaded simultaneously
  - Results can be named
  - Parts of results to be loaded and used can be selected (important for big files sizes)
  - Check is possible if needed data is available



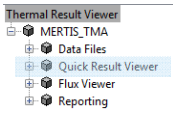
Thermal Result Viewer – Quick Result Viewer

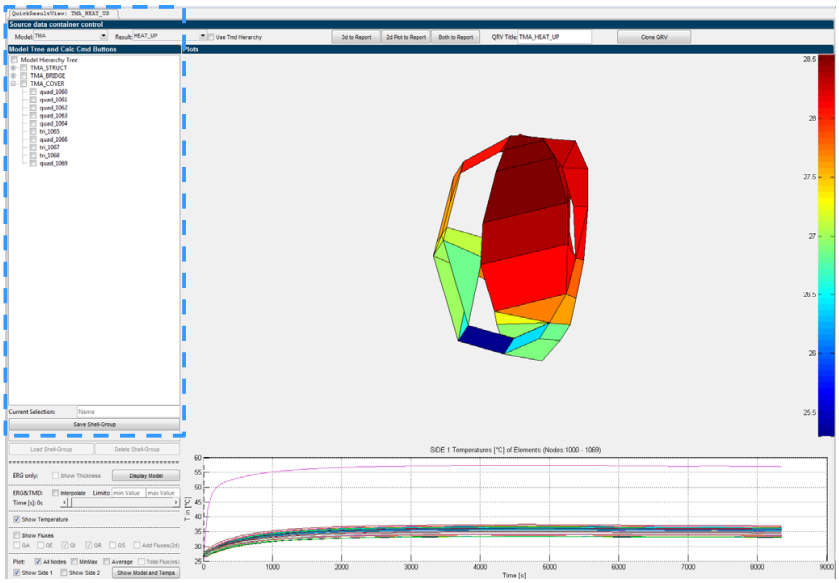


- Used model and used result file must be selected
- Views can be named and multiple can be created



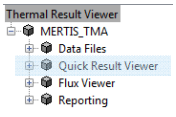
Thermal Result Viewer – Quick Result Viewer

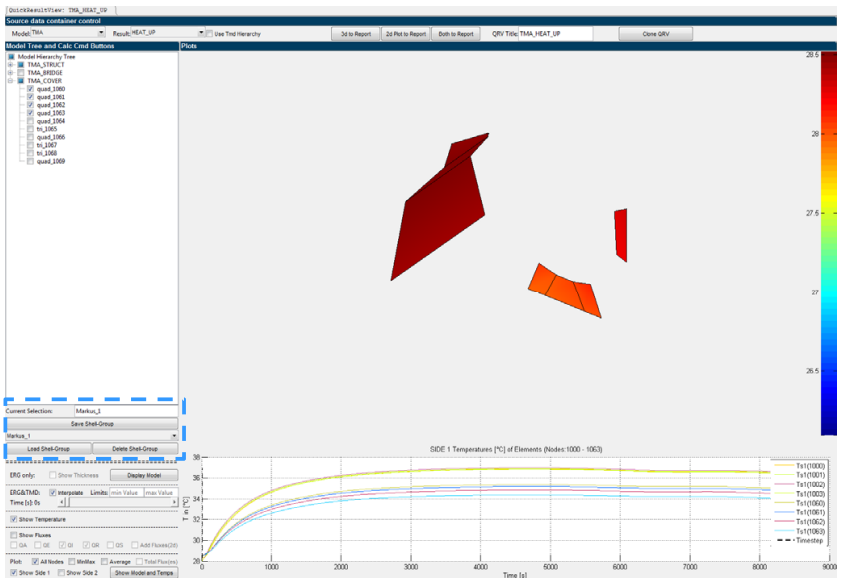




- **Model hierarchy:**
  - Imported from GMM or TMD or customized external files
  - Displayed as foldable tree
  - Shells with no temperatures are greyed out
  - Temperatures with no shells are combined in an “from_TMD” nodes group

Thermal Result Viewer – Quick Result Viewer

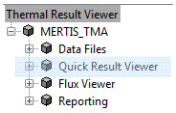


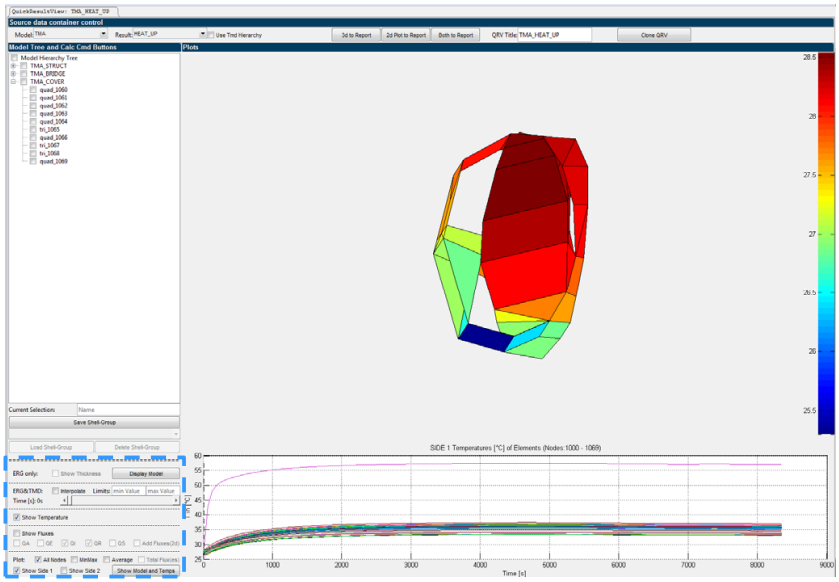


- **Model hierarchy:**
  - Imported from GMM or TMD or customized external files
  - Displayed as foldable tree
  - Shells with no temperatures are greyed out
  - Temperatures with no shells are combined in an “unassigned nodes” group
  - Shells/nodes can be grouped manually an become selectable
  - The manual section is detached from the loaded and valid model structure

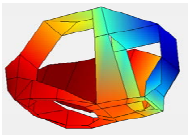
    → the model itself cannot be re-structured

Thermal Result Viewer – Quick Result Viewer



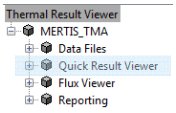


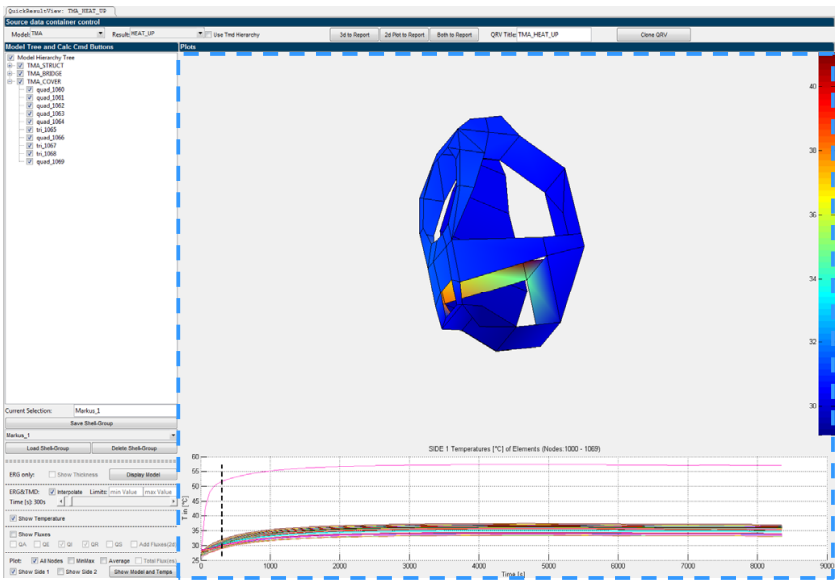
- **Data selection:**
  - Allows selection of items/data to be displayed
  - Model can be displayed stand-alone to visualize the shell thicknesses
  - Color map can be “flat” or “interpolated”



  - Shown time point for 3-D color map can be selected
  - Type of results can be selected (Temperatures, Fluxes)
  - min/max values and/or average values can be displayed
  - Sides of GMM are selectable (e.g. to show MLI)

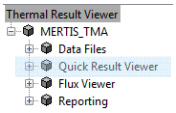
Thermal Result Viewer – Quick Result Viewer

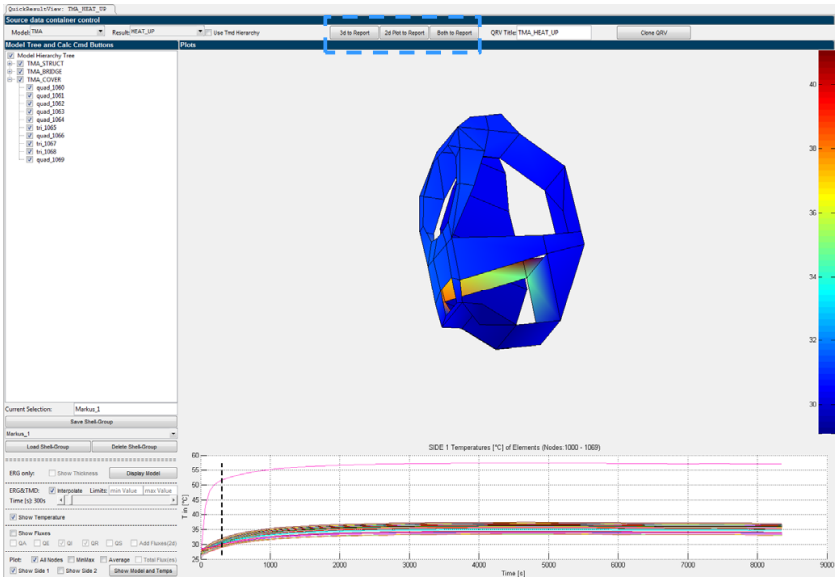




- **Views 3-D/2-D:**
  - 3-D color map and 2-D are displayed simultaneously
  - Shown time point for 3-D color map can be selected and is indicated in the 2-D plot
  - 3-D view can be rotated, zoomed, and paned

Thermal Result Viewer – Quick Result Viewer





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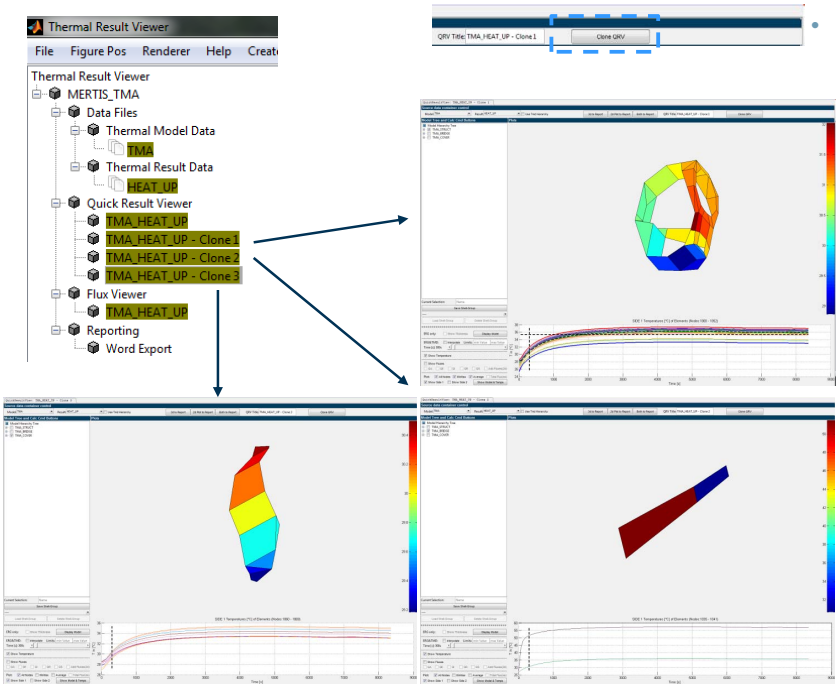
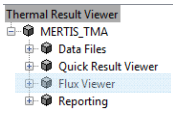
  - Plots can be “sent” to the report where thy can be further post processed

Thermal Result Viewer – Quick Result Viewer

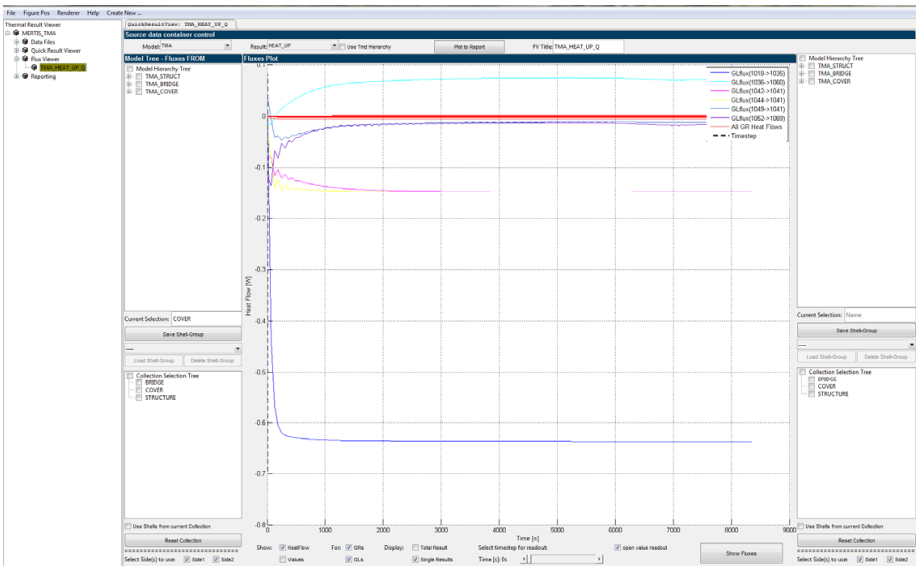


- **Views 3-D/2-D:**
  - 3-D color map and 2-D are displayed simultaneously
  - Shown time point for 3-D color map can be selected and is indicated in the 2-D plot
  - 3-D view can be rotated, zoomed, and paned
  - Plots can be “sent” to the report where thy can be further post processed
  - QRV can be “cloned” to generate multiple views of the same
  - Each view is fully independent of the others
  - Each view can be accessed from the data selection tree

Thermal Result Viewer – Flux Viewer



- Allows to visualize the exchanged **heat flows between model parts in the POST-PROCESSING** without the need to program it into the solver a priori
- Used model and used result file must be selected
- Based on Temperatures, GLs and GRs from TMD



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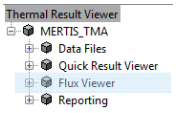
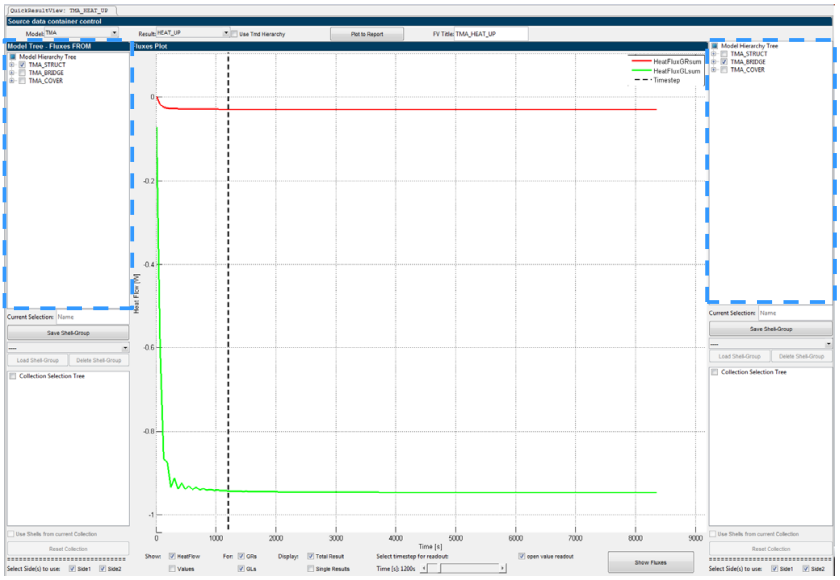


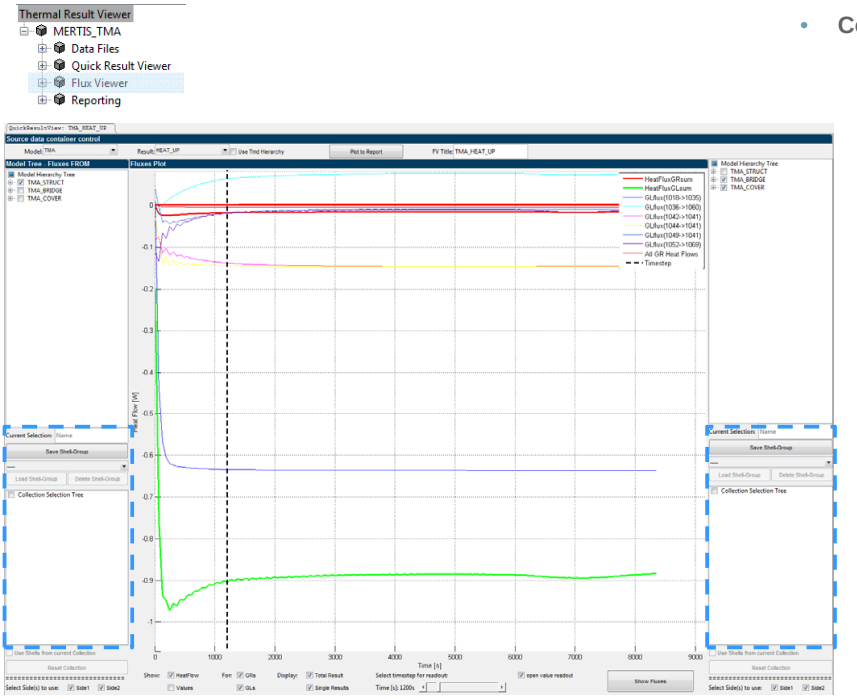


- **Model Hierarchy:**
  - Imported from GMM or TMD
  - Displayed as foldable trees **ON BOTH SIDES**
  - Allows easy selection of flux groups
    - Fluxes FROM → TO

Thermal Result Viewer – Flux Viewer

- **Collectors:**
  - Custom node groups can be set up
  - Displayed in separate selection boxes
  - Allows to plot fluxes from one group to multiple groups in one plot
    - The top tree gives either a sum of **all fluxes** or single fluxes from all nodes

Thermal Result Viewer – Flux Viewer



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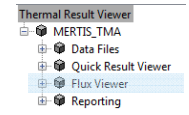
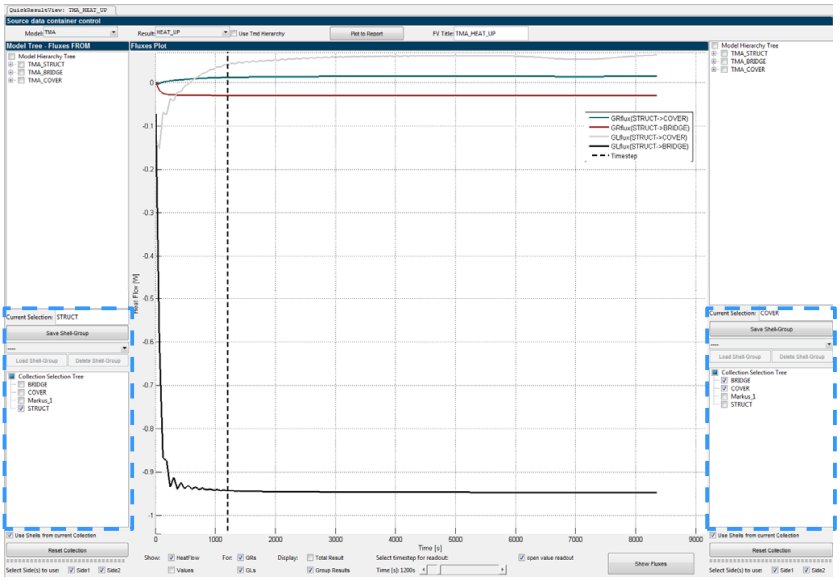
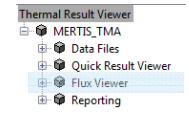
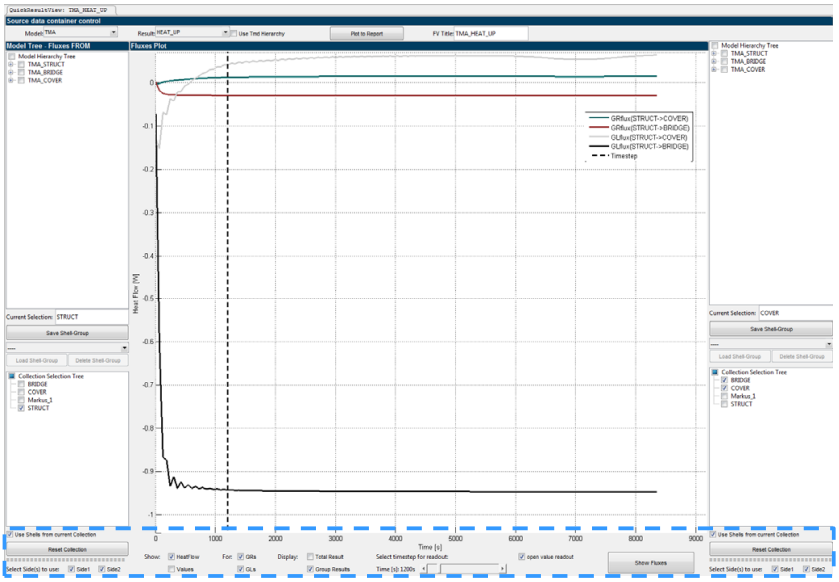




- **Collectors:**
  - Custom node groups can be set up
  - Displayed in separate selection boxes
  - Allows to plot fluxes from one group to multiple groups in one plot
    - The top tree gives either a sum of all fluxes or **single fluxes** from all nodes
    - Sub-groups are needed to allow visualization of partial flux totals

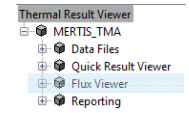
Thermal Result Viewer – Flux Viewer

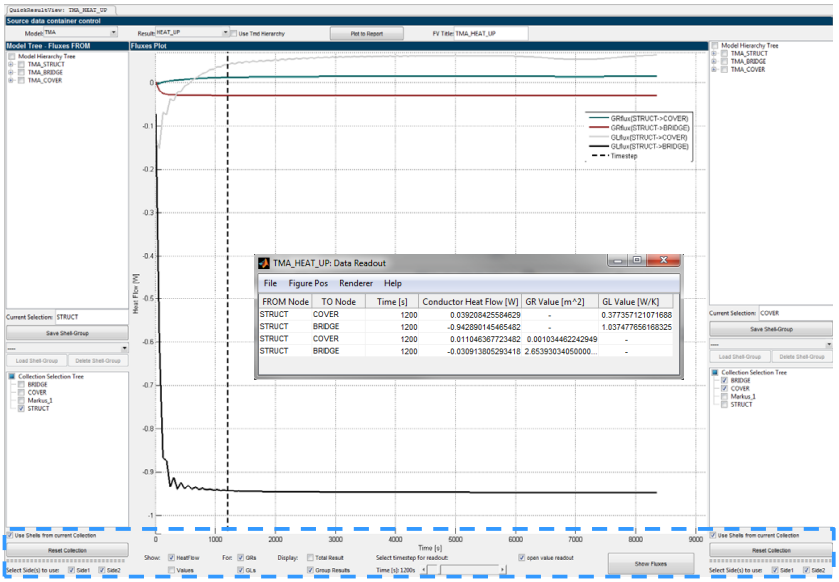




- **Data selection:**
  - Allows selection of items/data to be displayed
  - Heat flows or GL/GR values between groups can be displayed
  - GL and/or GR values/fluxes
  - Total and/or single results can be displayed
  - Shown time point can be selected

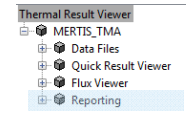
Thermal Result Viewer – Flux Viewer



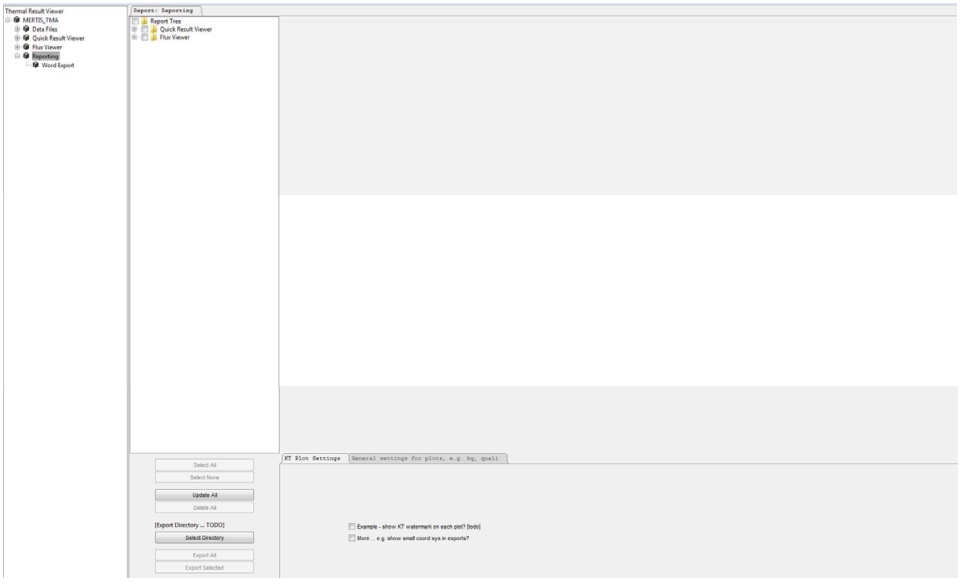


- **Data selection:**
  - Allows selection of items/data to be displayed
  - Heat flows or GL/GR values between groups can be displayed
  - GL and/or GR values/fluxes
  - Total and/or single results can be displayed
  - Shown time point can be selected
  - Precise values for selected time point are displayed as a pop-up table
  - Side 1 and/or side 2 of shells can be selected

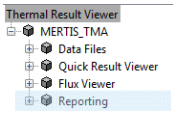
Thermal Result Viewer – Reporting

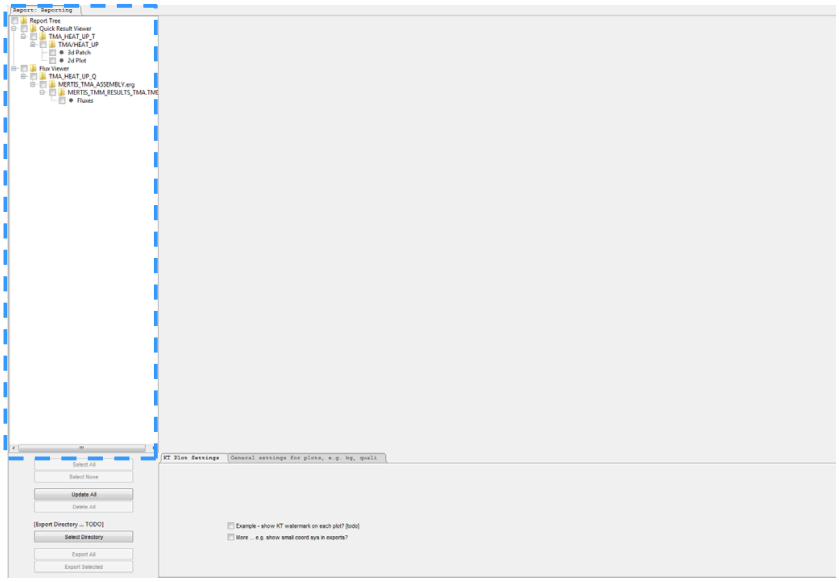


- Allows fine-tuning of selected figures (e.g. annotations)
- Allows export to figures
- Allows export to word (under development)



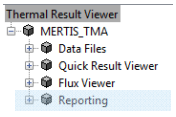
Thermal Result Viewer – Reporting

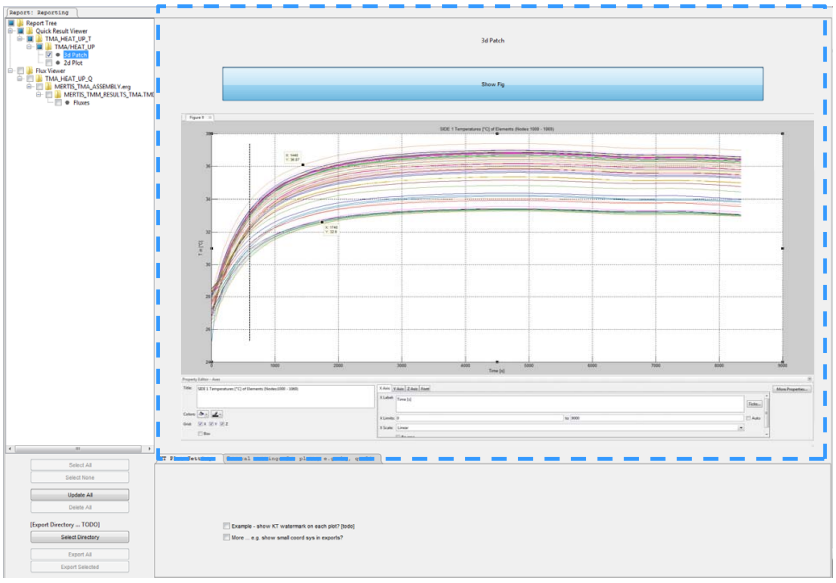




- **Selection Tree:**
  - Allows selection of plots which were sent to the report from quick result viewer or flux viewer
  - Each view can be accessed separately (2-D or 3-D)
  - Each view can be post treated with MATLAB functionalities (e.g. add legend, change axis, annotate, etc.)

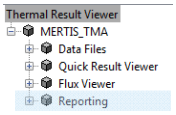
Thermal Result Viewer – Reporting

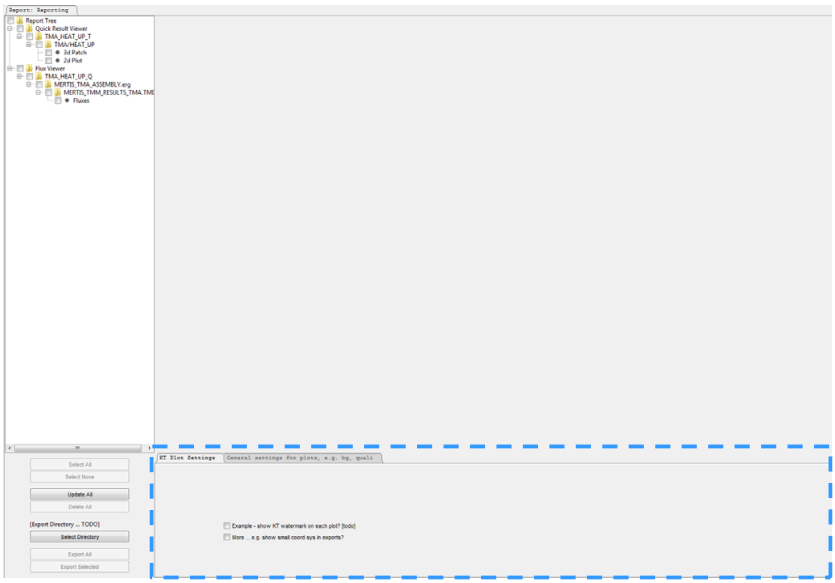




- **Work area:**
  - Each view can be post treated with MATLAB functionalities (e.g. add legend, change axis, annotate, etc.)

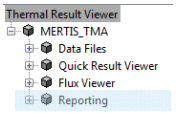
Thermal Result Viewer – Reporting

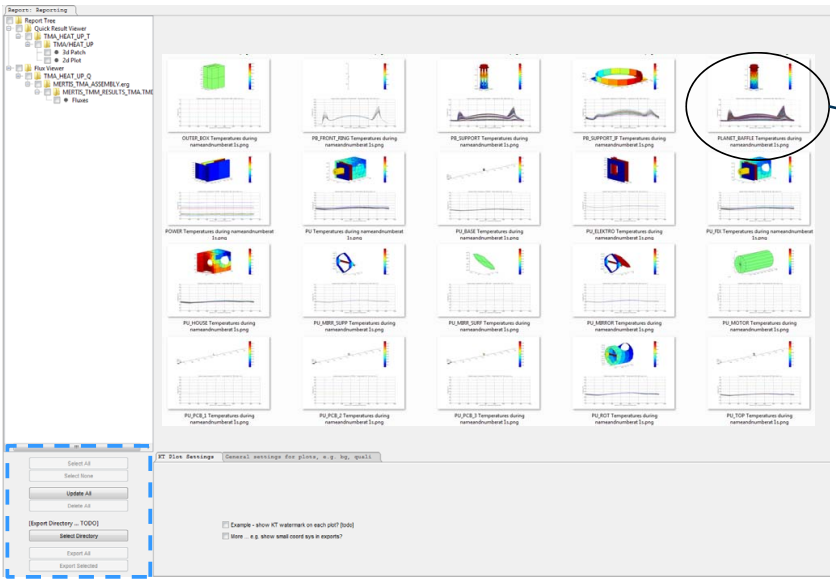


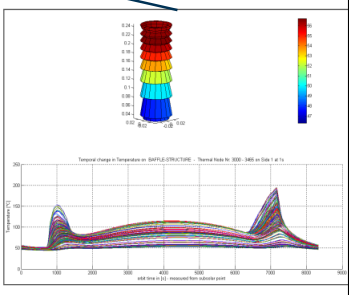


- **Plot settings:**
  - Allows to add watermark
  - Allows to set quality of plots
  - Allows to change font size globally

Thermal Result Viewer – Reporting







- **Export section:**
  - allows export to picture file formats into dedicated folders

Thermal Result Viewer – Future Work

- **Batch mode:**
  - Re-use of post-processing templates for:
    - other cases
    - model versions
  - Enable an a priori creation of post-processing templates outside of GUI:
    - Pre-set which parameters of which nodes are to be displayed together in a figure
    - Import setting
    - Export figures
- **Automated Reporting:**
  - Auto export all crated figures
- **Movies:**
  - Enable TRV to show movies of the temperature evolution
- **Model Comparison:**
  - Side by side views of different models or model versions
- **Miscellaneous:**
  - Allow node identification in the plots
    - 3-D → shell picking → highlight node in tree and curve in 2-D
    - 2-D → curve picking → highlight node in tree and in 3-D

Thermal Result Viewer – summary

- A **T**hermal **R**esult **V**iewer has been developed at OHB
- **It allows:**
  - Quick review of thermal models and thermal results in an integrated environment
    - temperatures → 3-D and 2-D
    - environmental Fluxes → 3-D and 2-D
  - Quick and efficient review of heat flows between parts in a thermal model
    - purely in POST-PROCESSING
    - easy selection and collection options
    - conductive and radiative fluxes can be visualized
  - Automated export of plots into picture files

→ the efficiency of thermal result post-processing has been significantly increased compared to standard state-of the tool combinations