



simufact welding

# Version 2020

## What's new?

Hamburg, January 2020

# What's new? - Highlights

- New process module “Direct energy deposition”
- Python scripting functionalities
- Extended postprocessing capabilities
- Further improvements in resistance spot welding
- GUI support for metallurgical models
- Processing of G-Code for model generation
- Improved UNV export and compatibility with 3<sup>rd</sup> party software
- Many further improvements in usability & stability
  - Implemented 246 new features

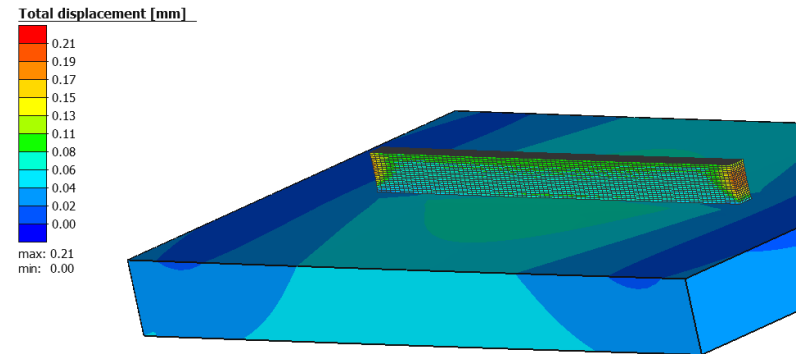
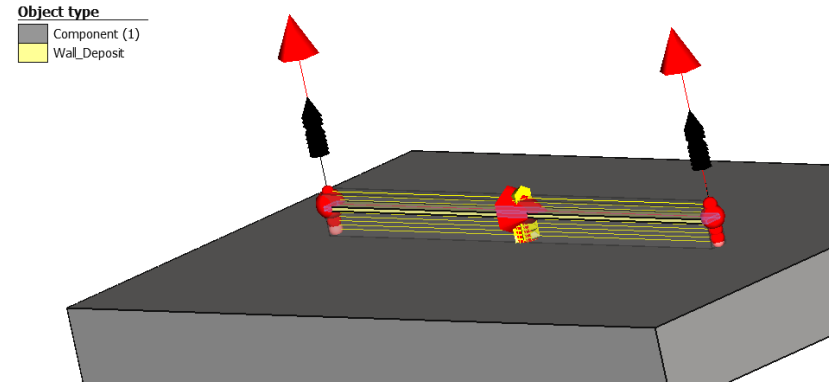
# New version numbering

- The names of the versions will change starting with the currently shipped version of Simufact Welding
- Simufact Welding 9.0 → Simufact Welding 2020
- Simufact Welding 9.1 → Simufact Welding 2020FP1 (Feature pack 1)
- Simufact Welding 9.0.1 → Simufact Welding 2020SP1 (Service pack 1)

# **New process module “Direct energy deposition”**

# • New process module “Direct energy deposition”

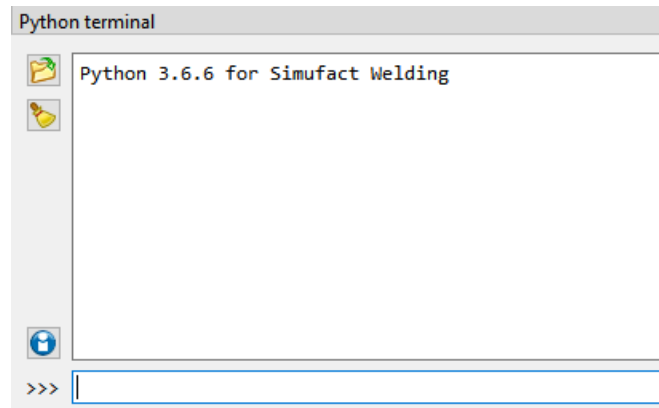
- Added “Direct energy deposition” (DED) process type
- Added license check to solver and GUI. GUI is able to show a process or results without an existing license feature.
- The model is based on a single deposit body instead of several distinct “weld fillers” as required before
- An advanced element activation technology is used in order to speed up the calculation and improve result quality
- Number of active robots is limited to one
- Fast mode (single shot) and element refinement are deactivated for DED processes
- Needed element sets can be gathered from the GUI
- New contact settings are used
- New material definition approach is used
- It is possible to define preheating of deposit material



# Python scripting functionalities

# Python scripting functionalities

- Added a Python interface allowing manipulation of tools and welding sequences in existing models
- The interface can be used
  - Internally, by using certain commands in the terminal
  - By running scripts in the terminal
- Offers integrated html based documentation in addition to tutorial
- Additional packages can be installed and used
- A script can also be used for result import and rescanning of result folder

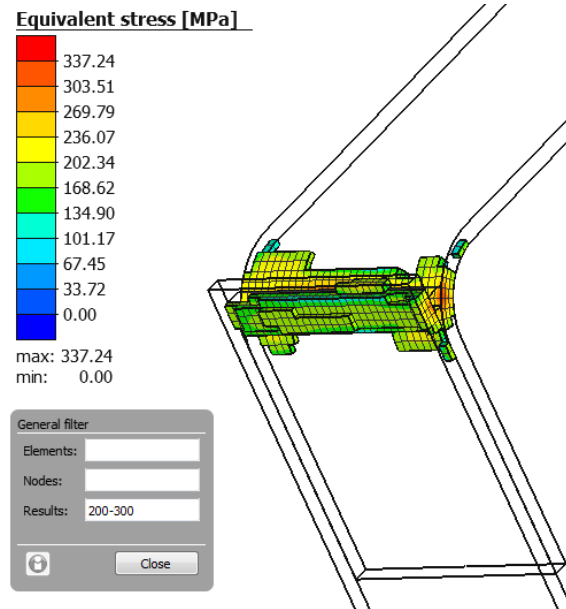


# Extended postprocessing capabilities



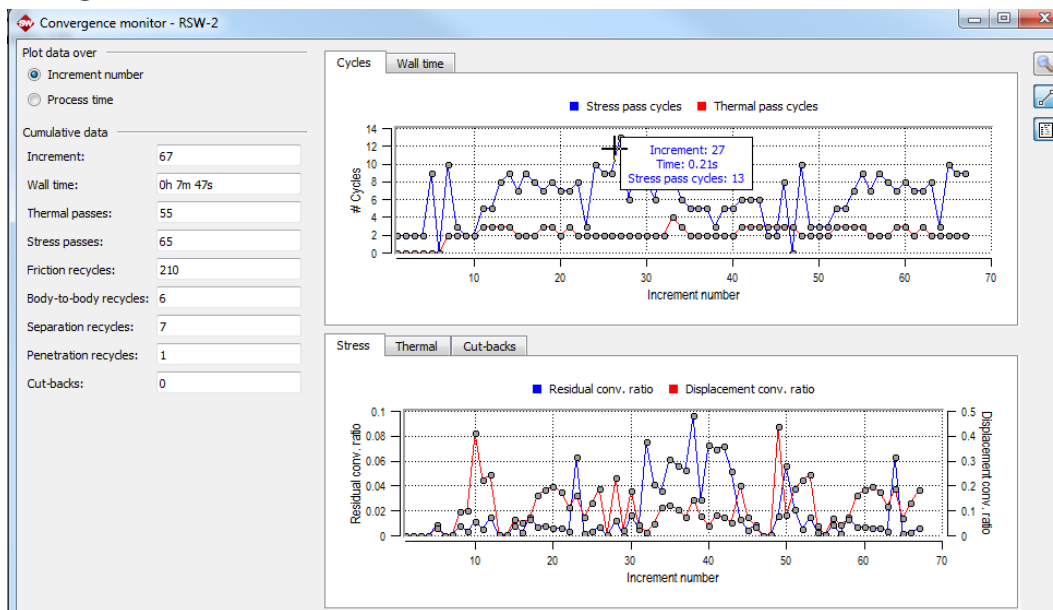
# Postprocessing capabilities

- Added a general filter to result view, allowing to
  - Show nodes and elements with a certain number
  - Show nodes and elements within a certain number range
  - Show results
    - Smaller or larger than a certain value
    - Within a certain value range



# Postprocessing capabilities

- Added a convergence monitor, allowing to evaluate the convergence behavior of the solver (on the fly or after a calculation is finished) . It can help to improve the calculation time by providing deeper insight on solver behavior and events in the simulation process leading to slow, instable or aborted solutions.



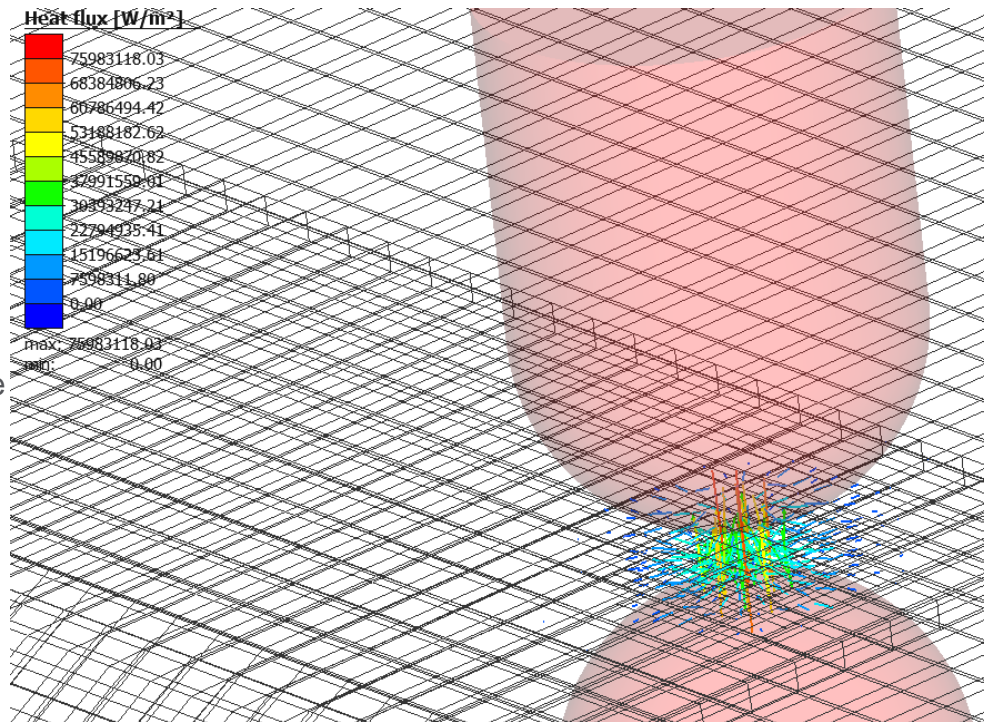
# Postprocessing capabilities

- Results

- Displacements
- Principal stress
- Stress vector
- Heat flux
- Temperature gradient

can be represented as vectors in model view

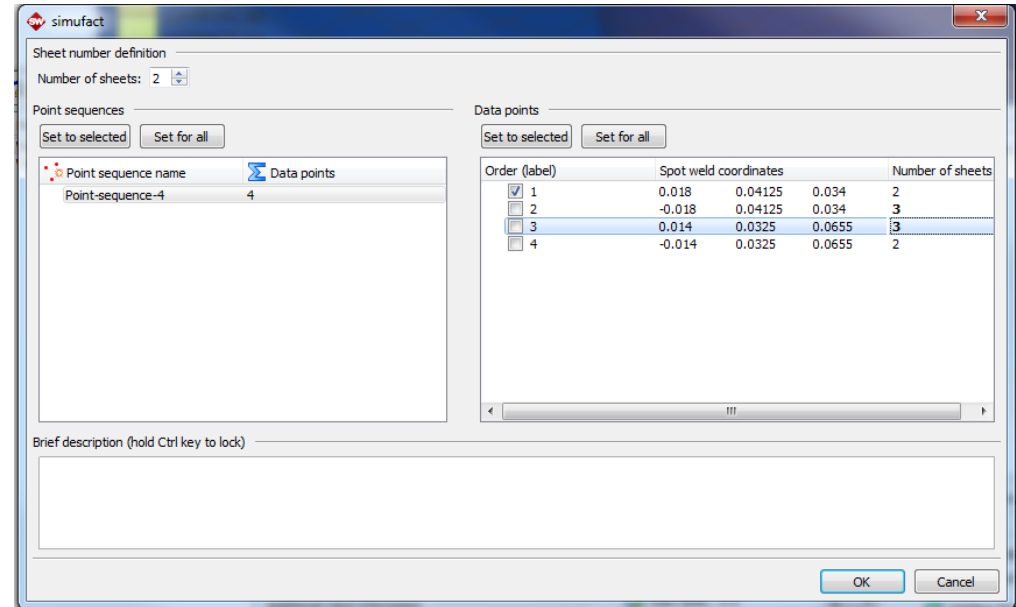
- Full mesh outline can be shown if vector results are used with clipping planes



# Improvements in resistance spot welding

# Resistance spot welding

- More than 2 sheets can be used for resistance spot welding with thermal cycle
  - It is possible to define the number of sheets either for the complete point sequence or for the given spot
  - Depending on the number of sheets the GUI calculates the position of weld nugget



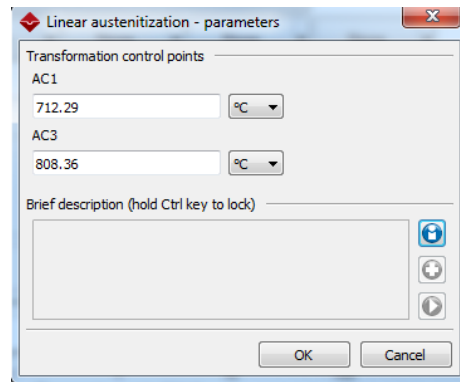
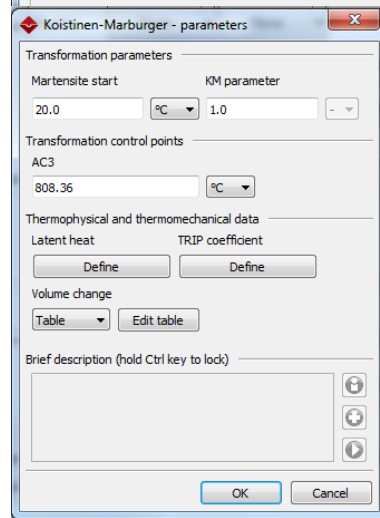
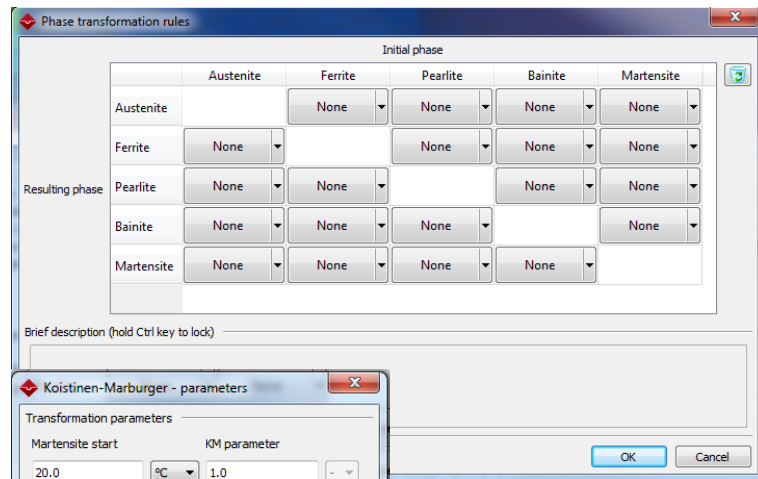
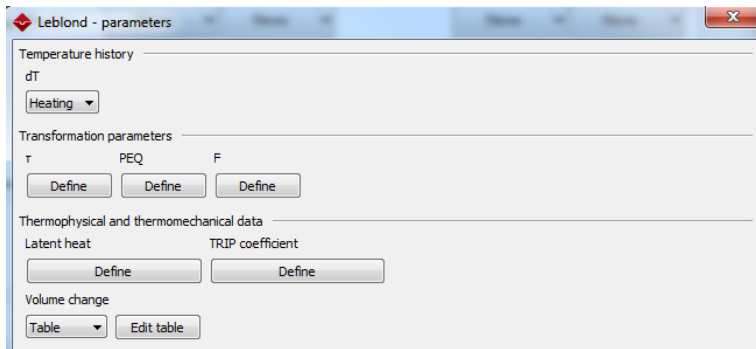
# Resistance spot welding

- Default contact type between components set to “advanced glue on peak”
- A component can be marked as “adhesive”. This can be used to define a layer of glue between sheets that will be welded. Glue is removed during welding in the spot area.
- New corrected X-gun kinematics
- Added control of the number of time steps during cooling pause between spots
- Spots in a resistance spot welding model can now be grouped if thermal cycle is used for heat source description
- For resistance spot welding processes, plastic strain is now reset in the molten volume
- It is possible to define number of sheets for thermal cycle type heat sources and also to use two robots at the same time in this case

# GUI support for metallurgical models

# GUI support for metallurgical models

- Added GUI support for following types of models:
  - Linear austenitization (for formation of austenite)
  - Koistinen-Marburger model (for formation of Martensite)
  - Leblond model (for general diffusion controlled transformation)
- This types of models can be added to already existing multiphase material data set or used in a new material definition





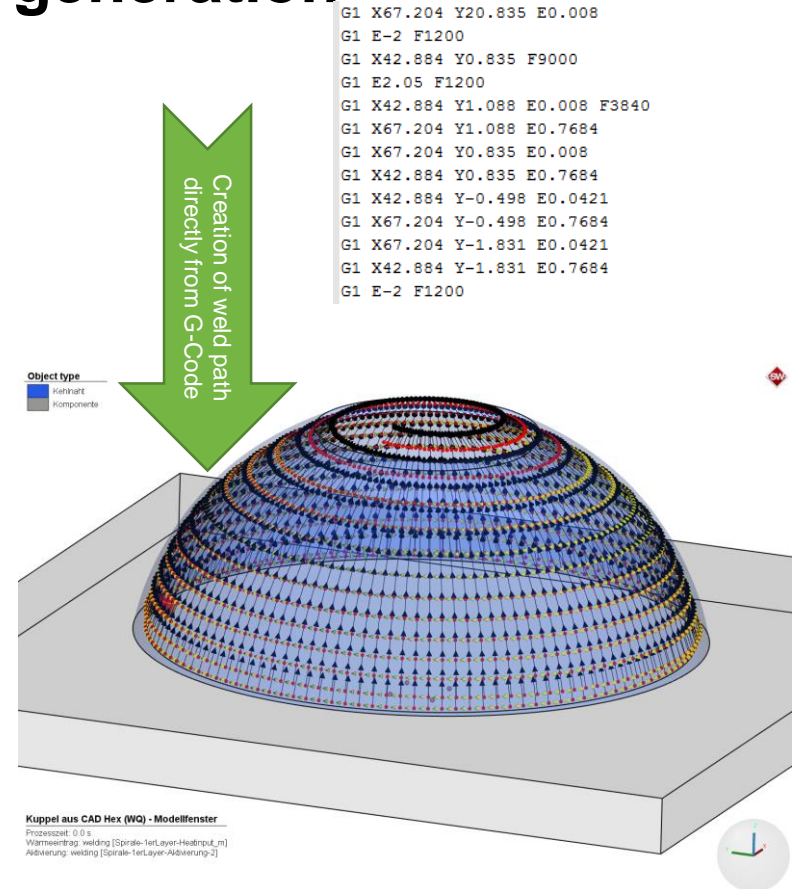
# GUI support for metallurgical models

- Martensite finish temperature is calculated from martensite start temperature and Koistinen-Marburger parameter
- All required model parameters can be entered manually
- Solver is prepared to handle more than five phases (no GUI support yet)
- If not all transformations are defined (thus, there are phases in the definition that cannot be created), those phases are completely ignored during the calculation
- If the transformation model is defined for an already existing multiphase material, data for volume change, transformation enthalpy and TRIP coefficient are transferred from existing model to the new one
- Volume change can be defined as table or scalar value
- Created CCT diagrams can be visualized in the GUI

# Processing of G-Code for model generation

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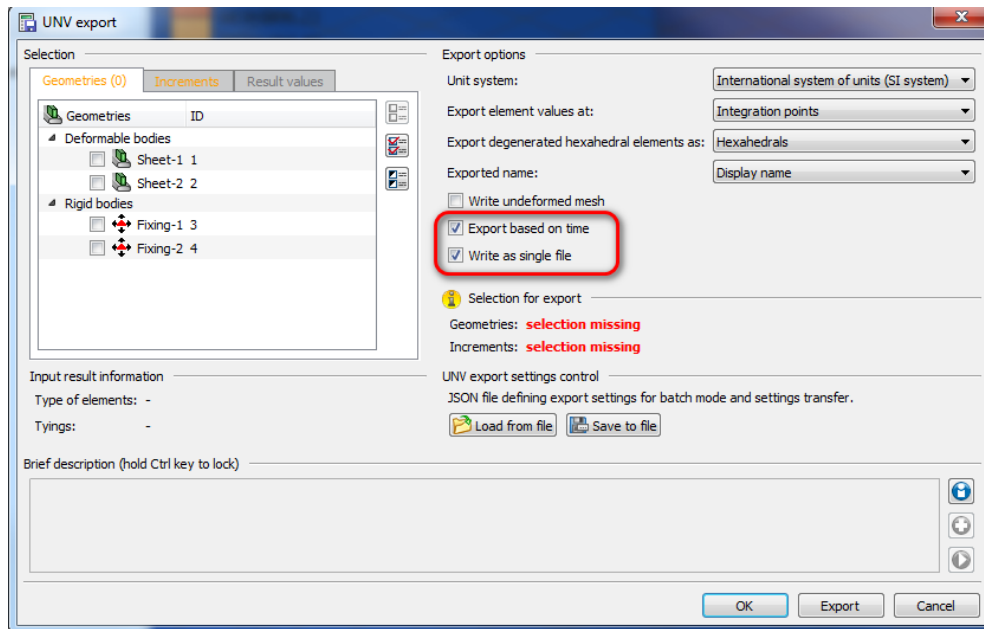
- Certain G-Code data can be used during model generation
- G-Code files containing robot positions and velocities can be imported – due to wide variety of possible G-Codes, not all versions can be imported
- If imported from object catalog, the GUI tries to distinguish between welding and repositioning and created a trajectory for each welding line recognized
- If imported from process tree (Deposition type of process only), the GUI evaluates velocities, creates and attaches trajectories to welding robot object and also creates and attaches a dummy heat source with proper velocity data
- IF, FOR and WHILE commands can be processed



# **Improved UNV export and compatibility with 3<sup>rd</sup> party software**

# Improved UNV export and compatibility with 3<sup>rd</sup> party software

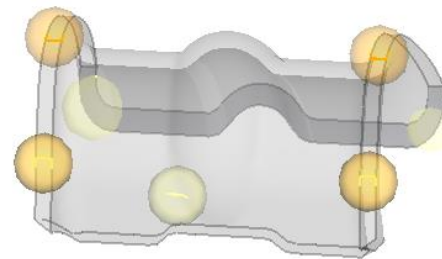
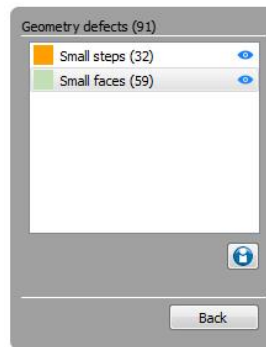
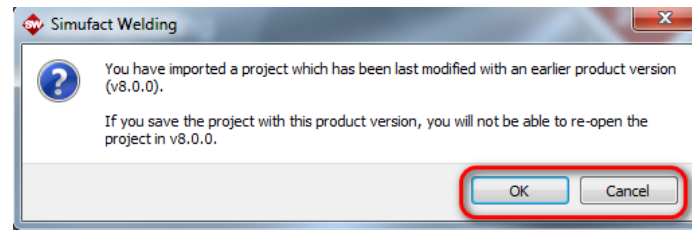
- UNV export supports output based on times in addition to export based on increments:
  - If same export settings will be applied to different processes with different number of increments, it is possible to enforce export at certain time points. If those time points do not exist, the nearest possible time point will be used
- All selected bodies can be included into a single UNV file. This is needed for an interface with MpCCI mapper, which allows transfer of results to certain 3<sup>rd</sup> party tools.
  - Body IDs as well as geometry names are also processed during export or import of such files



# Further improvements

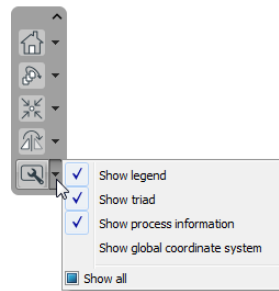
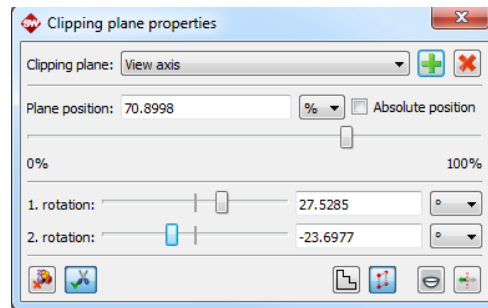
# Further improvements – General usability

- Added the possibility to cancel import of projects created with older releases
- New icons are used for camera toolbar
- Added geometry test for surface STL files and imported geometries
- Information about position and size of message boxes are moved to *welding\_windows.ini* file. If something goes wrong (due to some changes in display settings), this file can be removed to go back to default values.
- “sfMarc solver executable” is renamed to “Finite element solver” in general settings
- Comment fields use timestamps and have word wrapping always active



# Further improvements – General usability

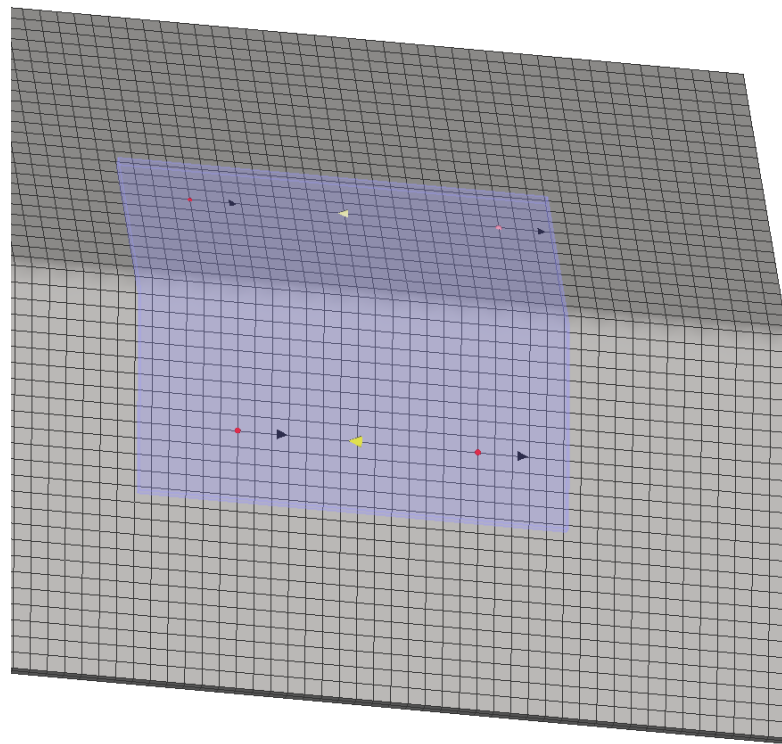
- Added several new functions to clipping plane definition
  - Rotation
  - Definition using two selected points
  - New (more distinct) buttons and icons are used
- Project name can be edited
- Changed several dialog titles
- The triad can be also scaled in model and result view
- “Zoom to region” was added to the middle mouse button
- Removed “Synchronize all” from view control menu
- View elements are now controlled with one toolbutton and allow more control possibilities
- Removed several unused units from unit settings, renamed several result values





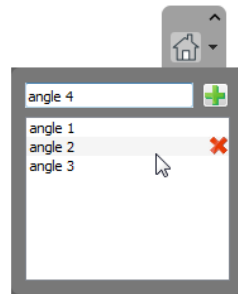
# Further improvements – General usability

- Hidden geometries are highlighted in the view if selected in the process tree. Also, it is possible to center the view on selected geometry.
- Change location of memory dumps to %LOCALAPPDATA%\Crashdumps according to Windows default directory setting
- Reworked settings for utilities (Simufact Material and Simufact Monitor)
- Improved control in Simufact Monitor and increased performance if many processes are queued
- When zooming using mouse wheel in model or result view, the zoom is centered at the mouse pointer
- Unified project loading screen with other Simufact products
- Navigation via arrow keys was enabled in some tables



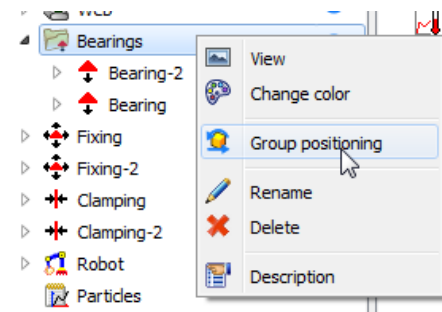
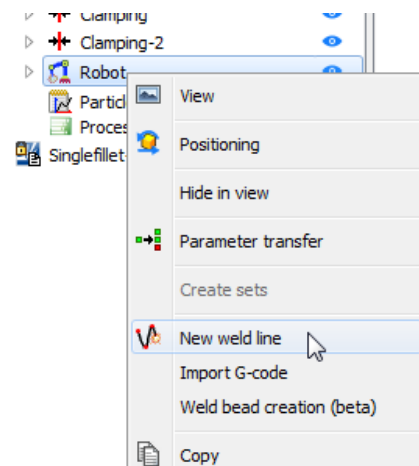
# Further improvements – General usability

- Views (angle, zoom) can be saved for model and result view. View settings can be then used globally for all models
- If a project is closed with one or several views (model or result view) open, view settings are saved and are reopened automatically if the project is reopened.
- Corrected links to tutorial chapters in Simufact Demos
- Cut outline can be shown during clipping
- Positions and sizes of selected message boxes are saved and can be controlled from the GUI settings window.



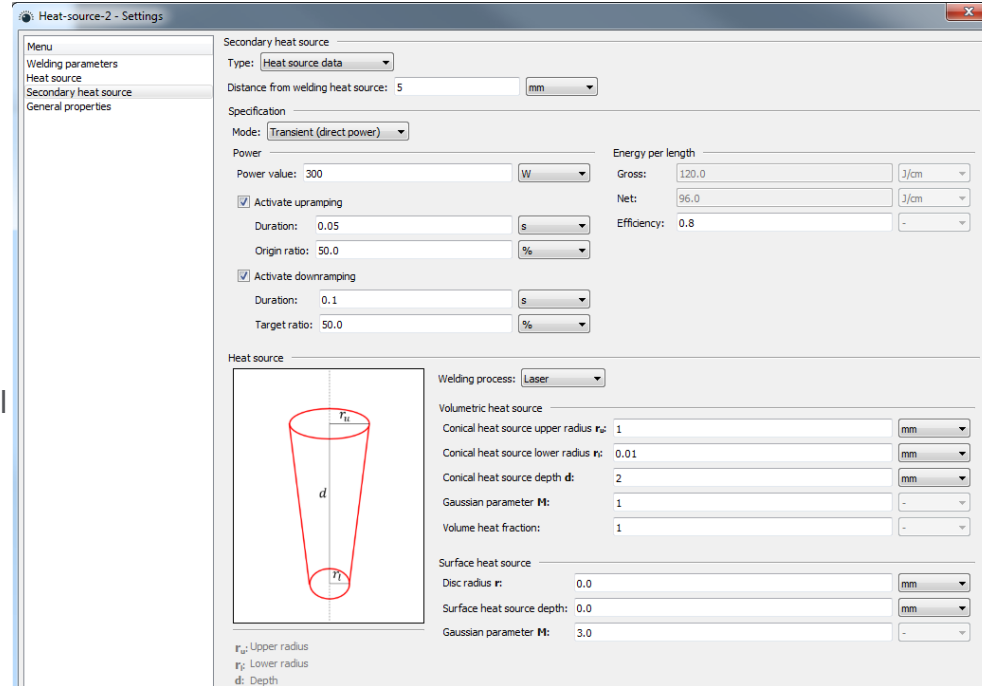
# Further improvements – Model definition, preprocessing

- Added to model check: valid values for Poisson's ratio
- If Parasolid files are imported and used by internal meshers, the meshing happens directly on Parasolid data instead of generated STL
- Added “new weld line” entry to robot context menu, allowing to automatically assign this weld line to a robot
- Similar objects in process tree can be attached to a group. This group can be positioned as one object.
- Groups are considered during parameter transfer
- If a component is positioned and the mesh is removed, the positioning information is kept
- Geometries and trajectories can be assigned to a process using multiselection in object catalog. Depending on the type of mesh, entities in process tree are created automatically.



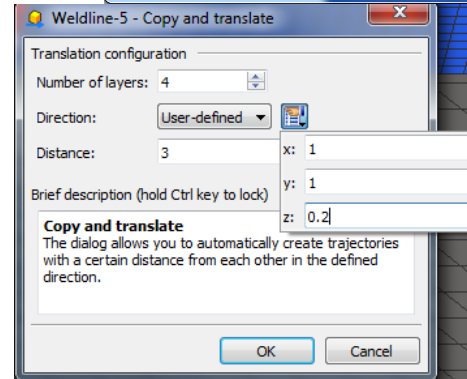
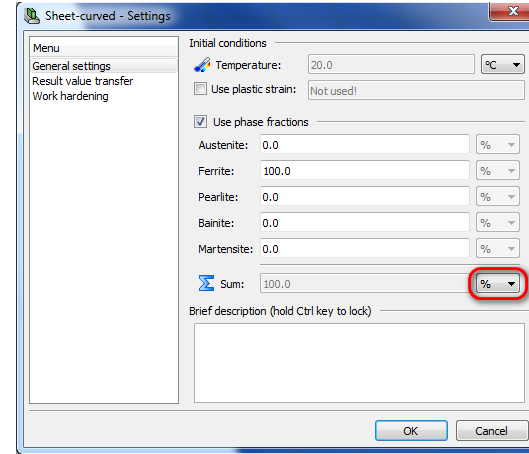
# Further improvements – Model definition, preprocessing

- Added a possibility to define a secondary heat source. With this function it is possible to define a second heat source (either for a hybrid process or pre- or post-heating), that
  - Allows definition of position relative to the main heat source
  - Allows definition of prescribed temperature of weld filler material
- Secondary heat source cannot be used with lead in and/or follow up times. Time control is handled by model check



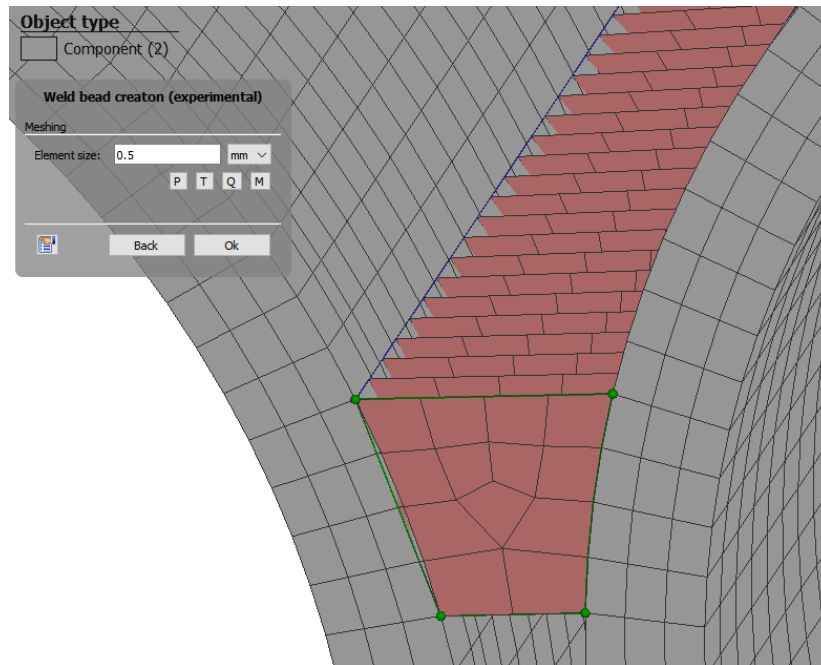
# Further improvements – Model definition, preprocessing

- Unit selector for phase proportion settings is now synchronized
- Object catalog filter can be hidden and shown again if needed using a button in the object catalog header line
- It is possible to interact with model view if trajectory definition window is open
- Number of filtered items in object catalog is shown
- General GUI speed up when working with very large models
- Trajectories can be copied and shifted with some given distance increment in arbitrary directions



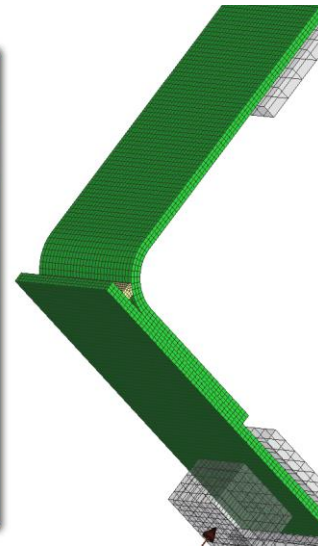
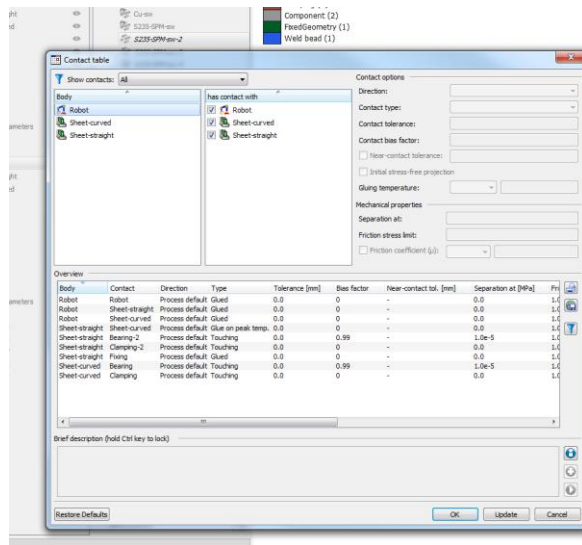
# Further improvements – Model definition, preprocessing

- Existing trajectories can be repositioned in model view using general positioning tool
- Positioning window can be called from process tree in addition to the call from view
- Gravity and contact positioner can operate on multiple meshes, allowing positioning of assemblies. It also considers assemblies that are already welded or have glue information defined.
- Manual positioning allows rotation around a user defined axis
- Positioning allows direct selection of nodes as center of rotation
- Added a new experimental fillet creator which allows manual definition of fillet cross-sections and element edge length in the generated mesh







# Further improvements – Model definition, preprocessing

- Contact pairs defined in the contact table can be visualized in the model view
- Contact overview can be filtered for selected bodies only
- List of bodies is extended and also shows bodies that are too far away from the currently selected body (in *italic*). This allows definition of contact pairs for bodies that are not in contact initially but will come into contact later during the simulation run.
- Trajectories can be separated into several subtrajectories. Those are assigned to the robot in the correct sequence.
- Removed several obsolete options in parameter transfer window for trajectories
- Model update (especially for calculation of timings) can be triggered manually, if needed



# Further improvements – Model definition, preprocessing

- Fillet generator is renamed to Weld bead generator
- Significant speed up of DAT file writing, especially in large models with a high number of trajectories and/or thermal cycle heat sources
- “Exchange with copy” in the process tree was renamed to “Copy and replace” and automatically opens the properties window of the copied object
- If a process is copied when automatic orientation calculation was used, the GUI makes a test if the orientation in the copy differs from the orientation in the original process. The user can select if he wants to keep the original orientation or recalculate it.
- In the model view, the number of objects inside a group is shown

Object type	
	Component (1)
	Sheet-02
	Electrode (2)
	FixedGeometry (2)



# Further improvements – Model definition, preprocessing

- Improved visibility of geometries and meshes during meshing
- Mesh coarsening is possible for tetmesher
- Added more informative messages if mesh cannot be converted from hexahedral element type to solid shell
- During positioning, selected axis or rotation circles are highlighted in the view
- Wizards (assignment wizards for trajectories, tools and robots) are renamed to “Assistant”
- Ringmesher now supports segments with arbitrary angles
- Added some model check warnings regarding incompatibility between selected time step and upramping time of a heat source

# Further improvements – Process settings

- Added control for number of contact separations
- Initial stress free projection can be activated globally for certain contact pairs in the *pre-processing\_settings.ini*
- Direction of activation box for filler elements can be controlled from the GUI
- Process parameters can be exported and imported
- Redesigned time settings page of process settings
- The frequency for writing of SPR files can be defined directly (every n increments)
- Changed defaults tolerance value for iterative solver
- Several brief descriptions were updated in the process settings window
- Added an option to disable friction globally in a given model

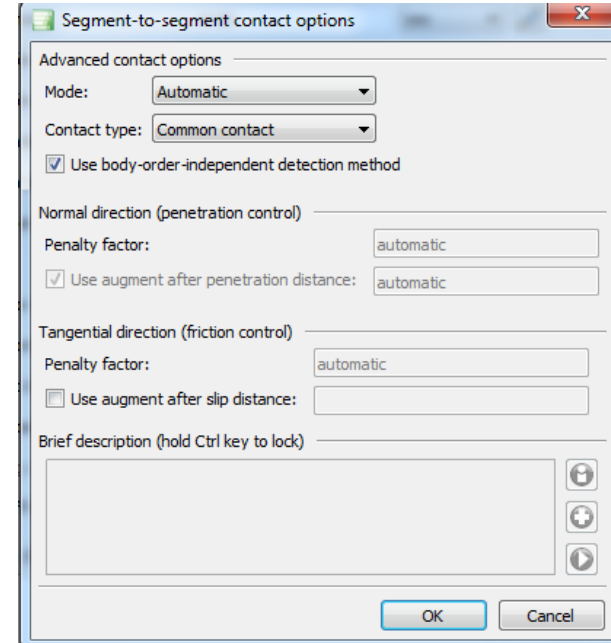
```
[General]
local_contact_tolerance_factor=0.25
contact_method=3
contact_tolerance_method=0
friction_force_tolerance=0.05
loadcase_max_temperature_change_factor=1.1
loadcase_refinement_adaption_factor=1.3
loadcase_cooling_adaption_factor=0.25
material_property_scaling_factor=0.001
smallest_time_interval=0.001
fixed_time_steps_welding=0.05
fixed_time_steps_cooling=1
fixed_time_steps_welding_resistance_spot_welding=0.01
fixed_time_steps_stress_relief_heat_treatment=100
result_time_steps_cooling=5

[WeldGun]
second_point_orientation_z=1
third_point_orientation_x=1
approach_distance_to_reference_point=0.005
initial_weld_gun_opening_angle=45
initial_weld_gun_opening_distance=0.05

[InitialStressFreeProjection]
is_component_to_boundary_enabled=true
is_component_to_component_enabled=false
is_component_to_robot_enabled=true
is_robot_to_robot_enabled=true
```

# Further improvements – Process settings

- Contact tolerance can be entered as negative value, preventing recalculation of contact tolerance during simulation
- Analysis settings window was subdivided into “Filler properties” and “Advanced settings” windows for better overview
- Changed contact direction default settings
- Changed default value for “Largest ratio between time steps” to 2 for cooling loadcases
- Process settings are now reset if the process type is changed into an incompatible process type (i.e. from welding to cooling or heat treatment)
- Added additional settings for segment to segment contact
- Added fast, normal and precision mode to process settings

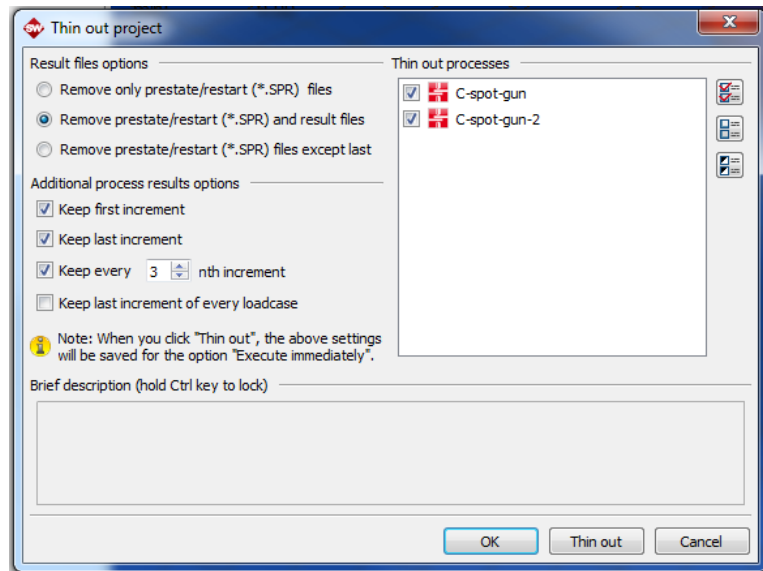


# Further improvements – Results and postprocessing

- Renamed some result values:
  - Effective strain rate → Effective plastic strain rate
  - Effective stress → Equivalent stress
  - Effective total strain → Equivalent total strain
  - Strains XX → X strain
- Result tree was removed from the toolbar. It is accessible directly in the result view
- Changed the context menu of results for more similarity with other products
- Camera button for screenshots can now be applied for history plots and allows selection of preferred resolution
- Added a “Show results” entry to process context menu
- THS and particle plots are now shown “always on top”
- Measuring transformation has been reworked and unified with shape comparison

# Further improvements – Results and postprocessing

- User defined result values are saved and transferred if the software is updated
- Result management window shows an additional column about existing SPR files in given increments
- Unified messages during result removal with other products
- Particle plot can differ between pre and post particles
- All results of all processes inside a project can be thinned out (partially deleted) at once
- Results from a process inside a project can be imported to the object catalog (for further use in following calculation steps) without copying the process
- Particle import and export from or to CSV file stores recently used directory



# Further improvements – Calculation procedure

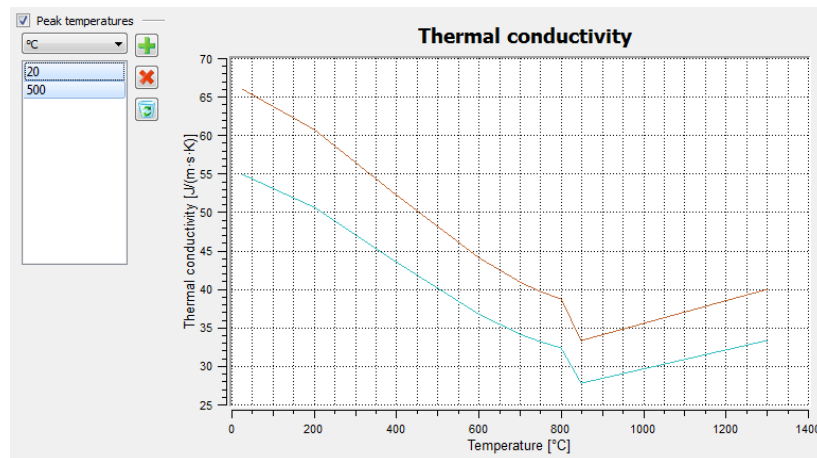
- Replaced AUTO CREEP with AUTO STEP in processes that involve creep calculation
- Solver supports temperature controlled heat input
- IDs of nodes and elements in ARC files are now correspond with IDs in t16 files
- Prevented usage of non-symmetric friction matrix due to its incompatibility with DDM
- Decoupling is now controlled using COUPLE CONTROL card
- Control of result output frequency is now performed via POST INCREMENT instead of ARC card
- Reduced number of loadcases if velocity or power of heat source changes
- If velocity or power of heat source changes, additional result output at this particular time is enforced

# Further improvements – Calculation procedure

- Reduced the number of elements affected by a heat source in a thermal joining process, leading to general speed up of thermal calculation
- Changed run.bat files for better compatibility with other Simufact products
- Solver supports full decoupling between thermal and mechanical pass (without DDM or GUI support)
- Added a warning if iterative solver is used with SMP parallelization
- Time stepping in decoupled calculations relates to coupled increments
- New CUR file design helps to avoid issues with progress bar during calculation

# Further improvements – Material data and management

- If evaporation enthalpy is defined in material data, the thermal energy is removed from the model after evaporation temperature is achieved
- Added new S235-SPM definition to material database
- Added X5CrNi18-9 to material database
- Added new TiAl6V4 definition to material database
- Added Inconel 625 to material database
- Added ER-NiCr3 (Inconel 82) to material database
- Peak temperature dependency can be defined for all material properties
- Material data sheet removed from Simufact Material
- Volume change during phase transformation can be defined as constant value in addition to temperature dependent table



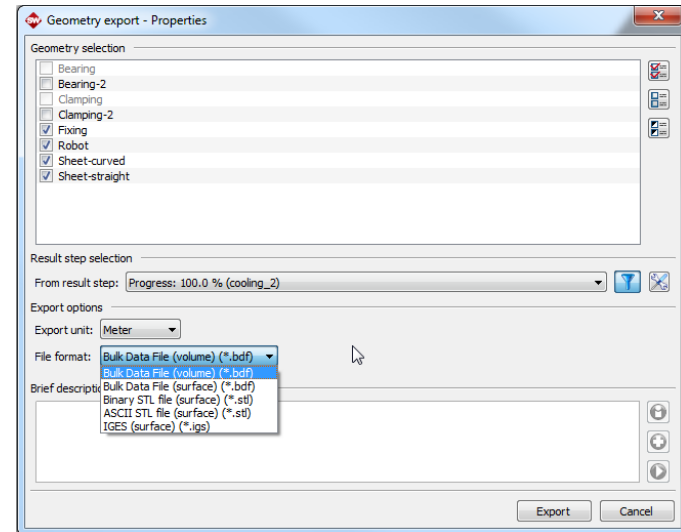
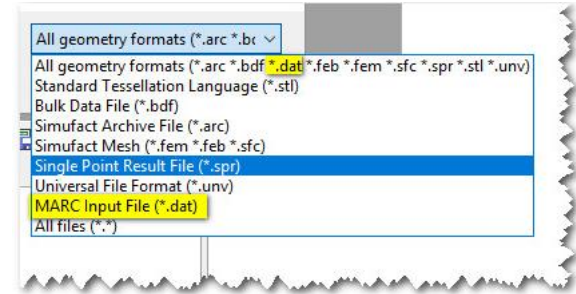


# Further improvements – Material data and management

- Better strategy for legend update in the flow curve definition window
- Reworked general design of several pages in Simufact Material
- Removed “Export overview” from Simufact Material
- Added Chinese norm (GB) to Simufact Material
- Added diffusion, creep, powder properties and electrical resistivity to filters in Simufact Material
- Added plasticity model to filter in Simufact Material

# Further improvements – Data import and export

- Added the possibility to import DAT files containing mesh directly into the GUI
- Stress relief heat treatment objects can be exported and imported
- During import of multiple CSV files, the settings can be applied to all files to be imported
- If BDF files contain component or mesh names, those can be processed during import. Search settings can be configured via *simufact\_user.ini* file
- Deformed meshes can be exported in several formats at all existing increments
- Local joint export now can process display and internal names
- If constant thickness of shell mesh is provided in the BDF file, this information is used for extrusion during import



# Further improvements – Data import and export

- It is possible to import CSV files containing trajectory points that do not include any orientation information
- Updated CAD import library
- Several data import and export paths are now saved and can be reused
- Unified file extensions and wording in several import dialogs with other Simufact products
- Reworked CSV file export settings
- New upper boundary for grade factor during CAD import

# Further improvements – Setup, licensing, utilities

- A list of blocking programs is shown during installation
- New testjobFE input file added to setup, allowing quick test of solver installation
- Moved ArcTool installation directory to .../sfTools/sfArctool for more similarity with other Simufact products
- Reworked GUI behavior if a resistance spot welding process is opened and no license for RSW is present. In this case it is possible to view the model and results, no changes in the model and no calculation is possible.
- Added license feature and license check for new Direct Energy Deposition module.
- Customer entitlement ID is shown in solver log and out files
- Improved representation of existing solver licenses in the GUI

# Further improvements – Setup, licensing, utilities

- Reworked messages appearing if the license is going to expire soon
- Improved the message about the progress and result of license checks in the GUI
- Improved performance of Simufact Monitor

# Further improvements – Documentation

- Updated the description how to use restart in the DAT file

**Thank You**