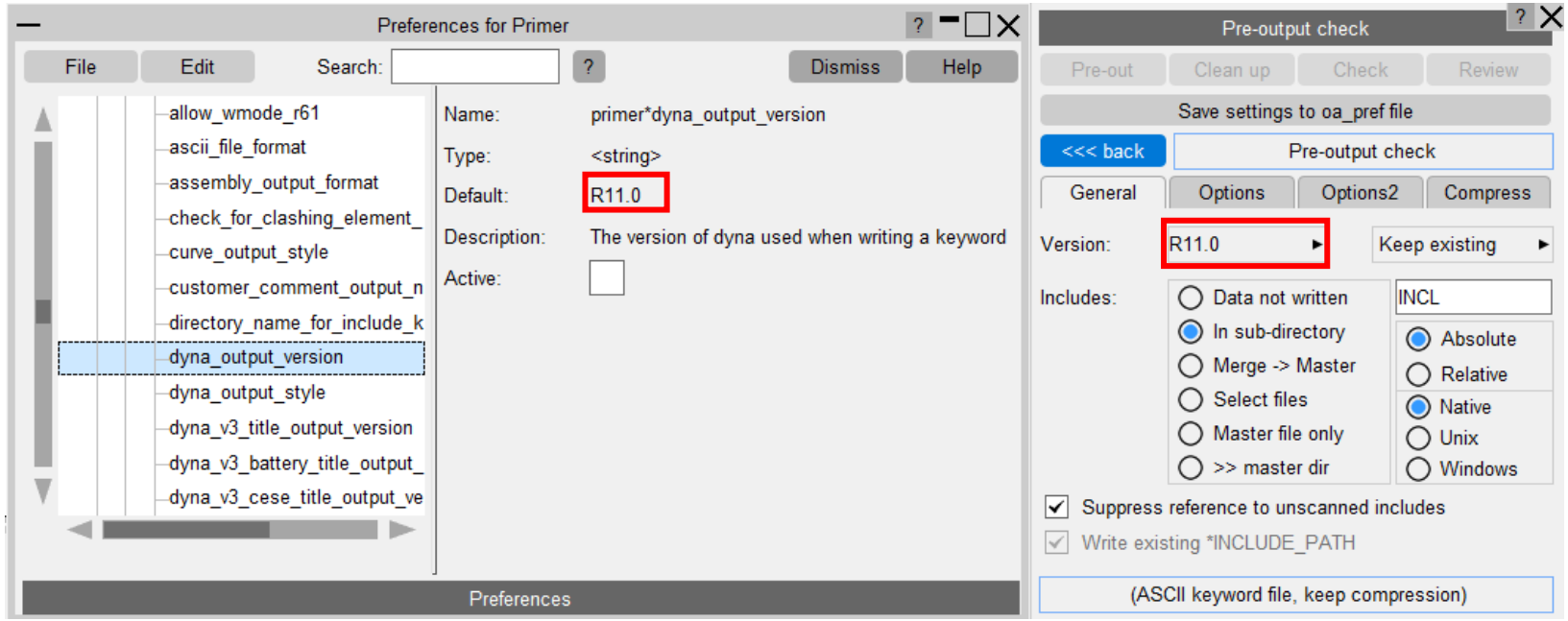
PRIMER 19.0

PRIMER 19.0 – Contents

Changes to Input and Output

LS-DYNA Keyword Support

- PRIMER 19.0 keywords:
  - LS-DYNA up to and including R12 fully supported.
  - LS-DYNA R13.0 mostly supported (outstanding keywords mainly ACOUSTIC related).
- Default output version updated from R9.0 to R11.0.



*SENSOR Keyout Pattern

- New preference ‘sensor_keyout_pattern’ can be used to handle the way PRIMER writes out *SENSOR data.
- ‘Coupled’ pattern groups related *SENSOR cards.
  - This method used in previous versions of PRIMER can result in LS-DYNA errors.
- ‘Normal’ pattern lists all *SENSOR cards together of the same type.
  - This new (default) more robust method is less likely to result in LS-DYNA errors.

Coupled Output

```
$ ============
$ SENSOR cards
$ ============
$
$
$ ================================
$ Sensor_Control and associated Sensor_switch and Sensor_Define cards
$ ================================
*SENSOR_CONTROL
         1     AIRBAG         0         0         0
        ON         1         2         0         0         0         0         0
*SENSOR_SWITCH
         1    SENSOR         1        LT       0.0         0       0.0       0.0
         2    SENSOR         2        GT       0.0         0       0.0       0.0
*SENSOR_DEFINE_FORCE
         1     AIRBAG         1         X         0
*SENSOR_DEFINE_FORCE
         2     AIRBAG         1         X         0
$
$ ================================
$ Sensor_Control and associated Sensor_switch and Sensor_Define cards
$ ================================
*SENSOR_CONTROL
         2     AIRBAG         0         0         0
        ON         3         4         5         0         0         0         0
*SENSOR_SWITCH
         3    SENSOR         5        LT       0.0         0       0.0       0.0
*SENSOR_SWITCH_CALC-LOGIC
         4         1         2
*SENSOR_SWITCH
         5      TIME         0        LT       0.0         0       0.0       0.0
*SENSOR_DEFINE_CALC-MATH
         5       MAX         1         2         0         0         0         0
$
$ ================================
$ Remaining Sensor_switch and Sensor_Define cards
$ ================================
*SENSOR_SWITCH
         6    SENSOR         0        GT       0.0         0       0.0       0.0
         7      TIME         0        GT       0.0         0       0.0       0.0
         8    SENSOR         0        GT       0.0         0       0.0       0.0
*SENSOR_DEFINE_MISC
         3     ANGLE                   0         0         0         0
*SENSOR_DEFINE_MISC
         4     ANGLE                   0         0         0         0
*SENSOR_DEFINE_NODE
         6         1         2         0                  VEL
*SENSOR_DEFINE_NODE
         7         1         2         0                  VEL
*SENSOR_DEFINE_ELEMENT
         8      BEAM         1     AXIAL     FORCE                 0.0       0.0
$
```

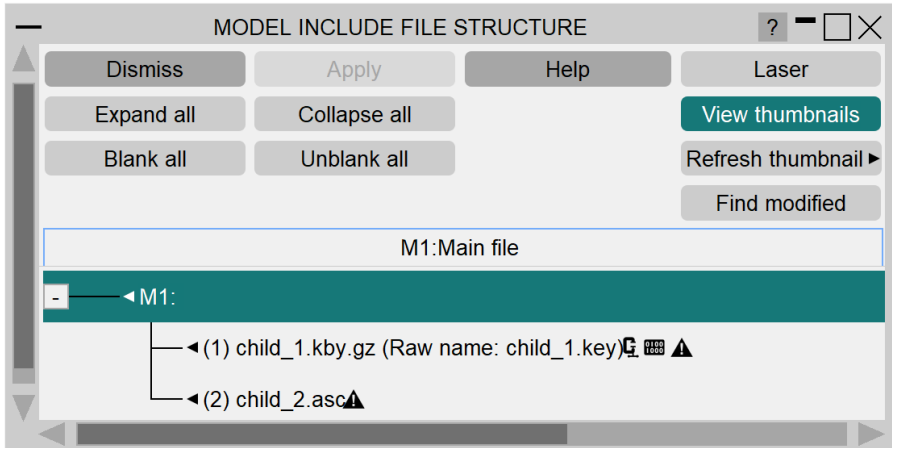
Normal Output

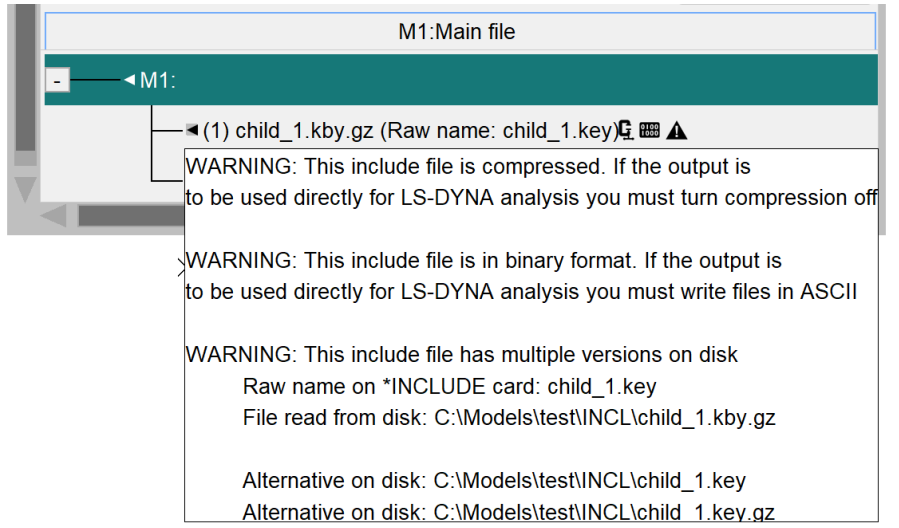
```
$ ============
$ SENSOR cards
$ ============
$
$
$ ================================
$ SENSOR_DEFINE cards
$ ================================
*SENSOR_DEFINE_FORCE
         1     AIRBAG         1         X         0
*SENSOR_DEFINE_FORCE
         2     AIRBAG         1         X         0
*SENSOR_DEFINE_MISC
         3     ANGLE                   0         0         0         0
*SENSOR_DEFINE_MISC
         4     ANGLE                   0         0         0         0
*SENSOR_DEFINE_NODE
         6         1         2         0                  VEL
*SENSOR_DEFINE_NODE
         7         1         2         0                  VEL
*SENSOR_DEFINE_ELEMENT
         8      BEAM         1     AXIAL     FORCE                 0.0       0.0
$
$ ================================
$ SENSOR_DEFINE_CALC-MATH cards
$ ================================
*SENSOR_DEFINE_CALC-MATH
         5       MAX         1         2         0         0         0         0
$
$ ================================
$ SENSOR_SWITCH cards
$ ================================
*SENSOR_SWITCH
         1    SENSOR         1        LT       0.0         0       0.0       0.0
         2    SENSOR         2        GT       0.0         0       0.0       0.0
         3    SENSOR         5        LT       0.0         0       0.0       0.0
         5      TIME         0        LT       0.0         0       0.0       0.0
         6    SENSOR         0        GT       0.0         0       0.0       0.0
         7      TIME         0        GT       0.0         0       0.0       0.0
         8    SENSOR         0        GT       0.0         0       0.0       0.0
$
$ ================================
$ SENSOR_SWITCH_CALC-LOGIC cards
$ ================================
*SENSOR_SWITCH_CALC-LOGIC
         4         1         2
$
$ ================================
$ SENSOR_CONTROL cards
$ ================================
*SENSOR_CONTROL
         1     AIRBAG         0         0         0
        ON         1         2         0         0         0         0         0
*SENSOR_CONTROL
         2     AIRBAG         0         0         0
        ON         3         4         5         0         0         0         0
$
```

Warnings and feedback for compressed/doppelganger input files

Warnings and feedback for compressed/doppelganger input files

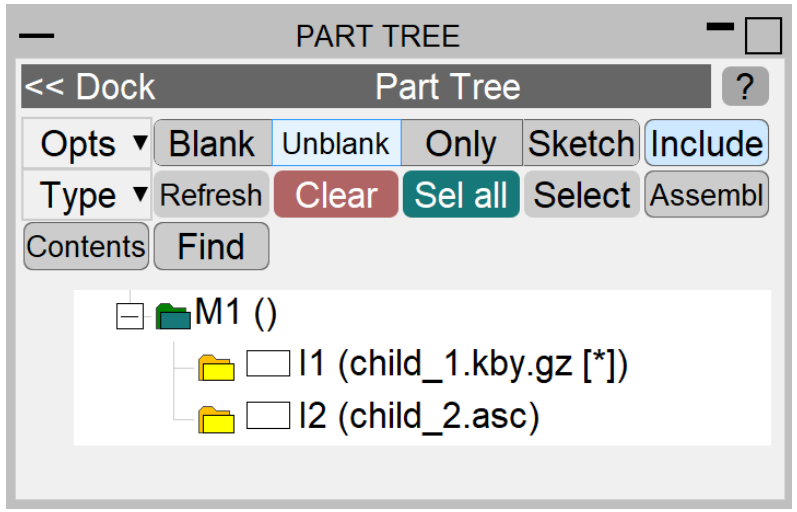
- The GUI now provides warnings and feedback in four places when a filename with multiple variants has been read.
- (1) In the INCLUDE tree, the actual file read (e.g. child_1.key.gz) is listed first with the raw name (e.g. child_1.key) appended. There are symbols to denote compression and binary, and a warning symbol if the file read is not the raw name in the include statement or there were multiple doppelganger candidate filenames. Hovering over such a row gives details of the differences.

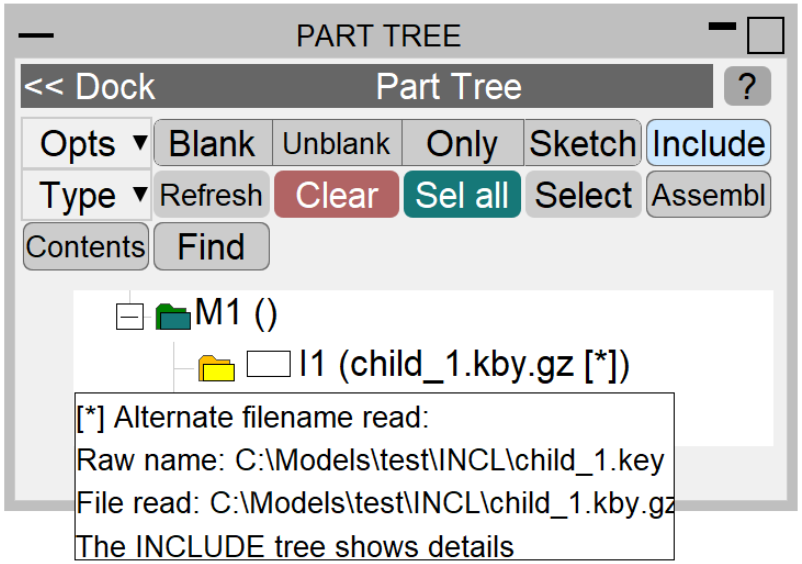




Warnings and feedback for compressed/doppelganger input files

- (2) In the PART tree, the actual file read rather than the raw name is reported with a [*] after it to act as a warning and hovering over that row gives details.

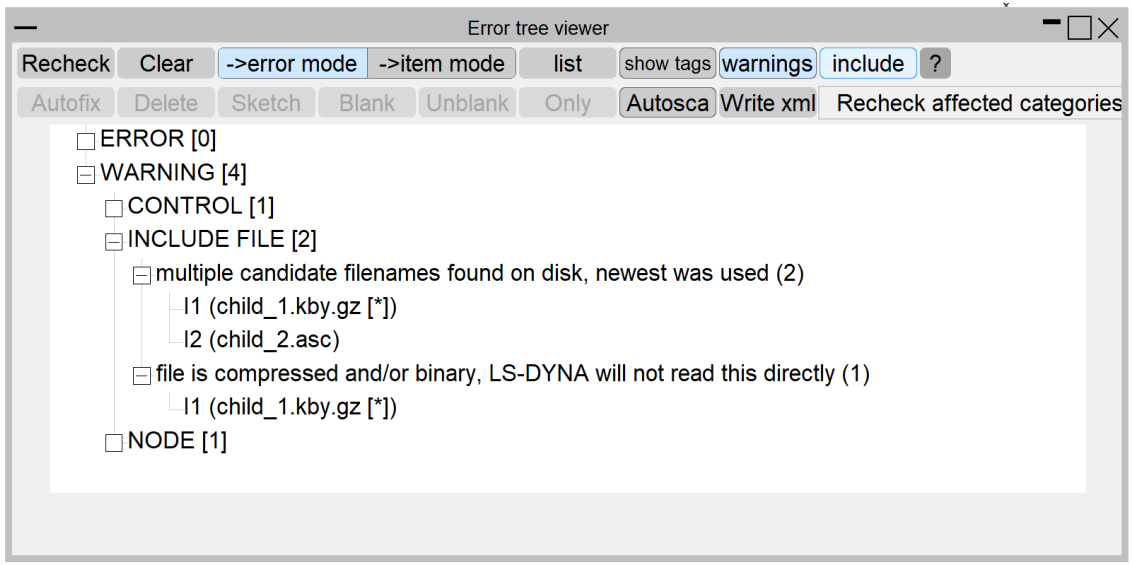




Warnings and feedback for compressed/doppelganger input files

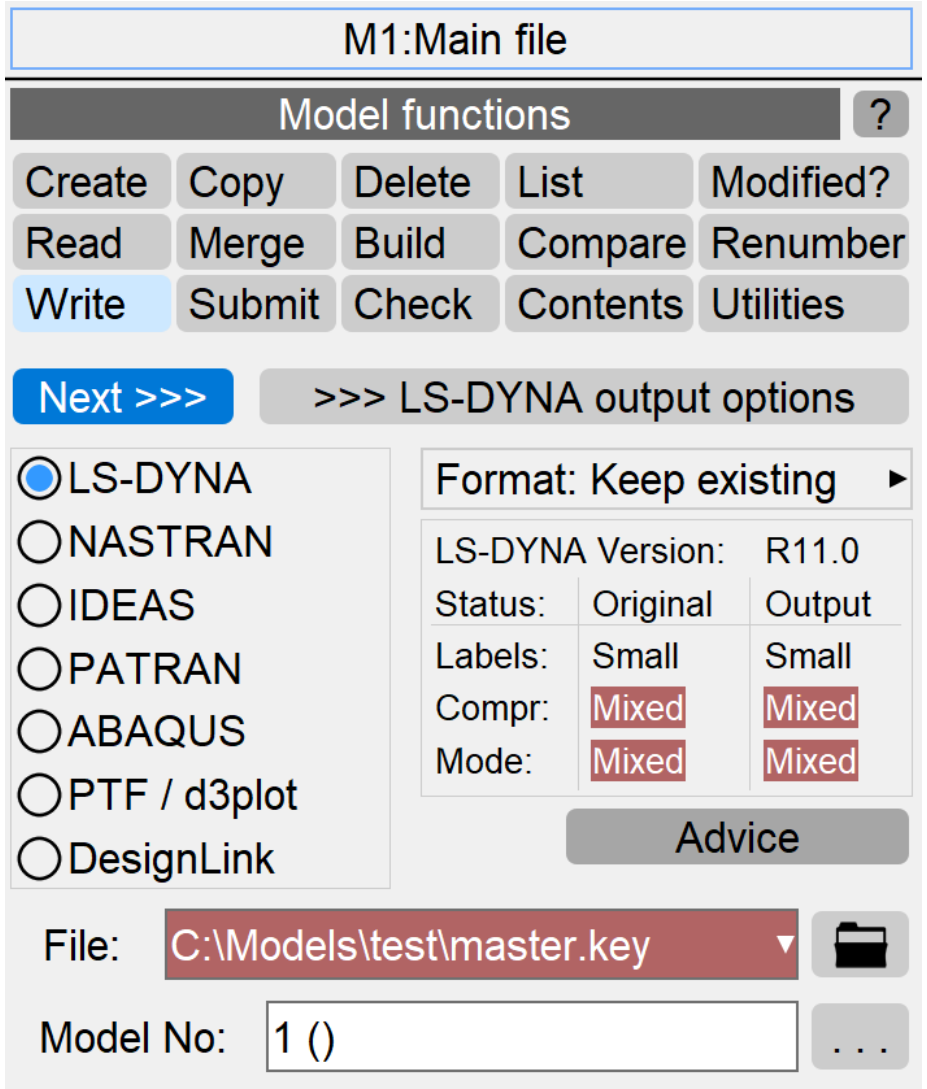
- (3) In Model Check, there are three new categories of warning for include files:
  - If the file is compressed/binary and therefore would not be directly readable into LS-DYNA.
  - If the raw filename could not be found but a single alternative filename, found by fuzzy-matching the name, has been read instead.
  - If there were multiple variations of the filename.

- In all cases, 'details' (or 'explain') will list the various filenames in detail explaining what was actually read.



Warnings and feedback for compressed/doppelganger input files

- (4) In the pre-output check panel, a model which will not read into LS-DYNA because of compression/binary is highlighted in red, hovering over gives details. (This is also included in V18).



Multiply anchored *COMMENTs

Multiply anchored comments

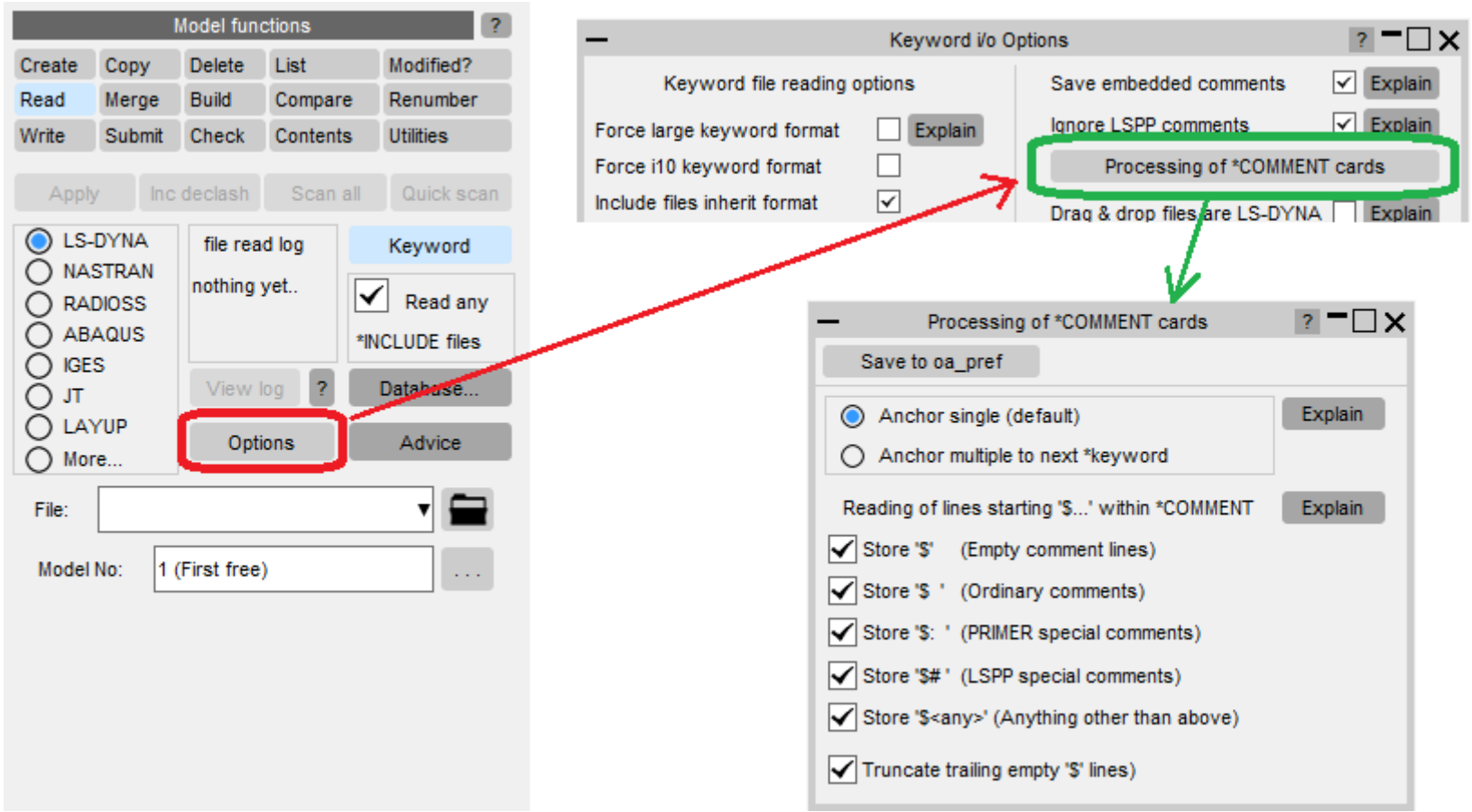
- *COMMENT can now be ‘anchored’ to multiple items between the two following keywords. Allows comments/meta-data to be associated with ‘blocks’ of keywords.

```
*COMMENT
comment line 1
comment line 2
$
*NODE
       10       710.09998      -100.00000      -125.00000       0       0
       12       710.09998      -100.00000      -100.00000       0       0
       14              0.0             0.0       140.00000       0       0
$
*NODE
       11              0.0             0.0       130.80508       0       0
       13              0.0      -1.1061331       121.86359       0       0
       15              0.0      -9.7319727       120.00057       0       0
       16              0.0      -18.926884       120.00091       0       0
          etc
```

Comment lines ("$...") within *COMMENT blocks

- PRIMER can now store comment lines starting "$..." within *COMMENT blocks, and provides fine control over which types of "$..." comment line are read.

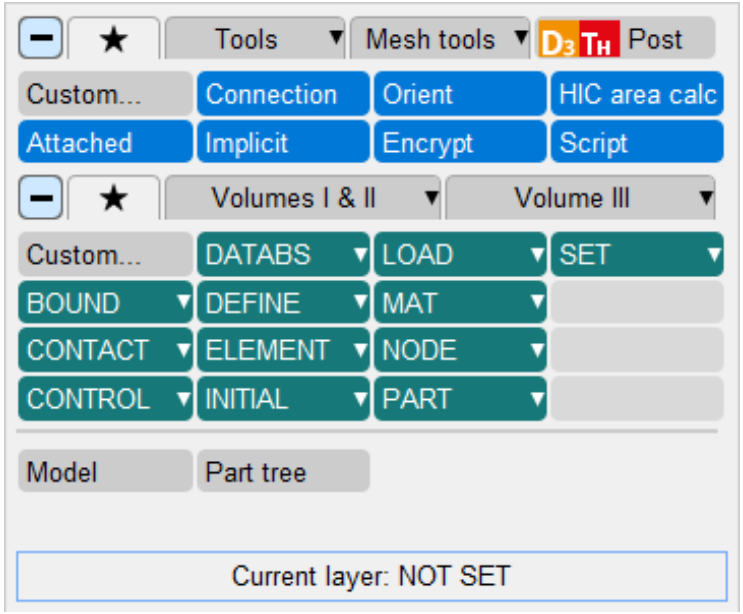
- This is controlled in [Model] Read, options.
- The settings can be saved as preferences.



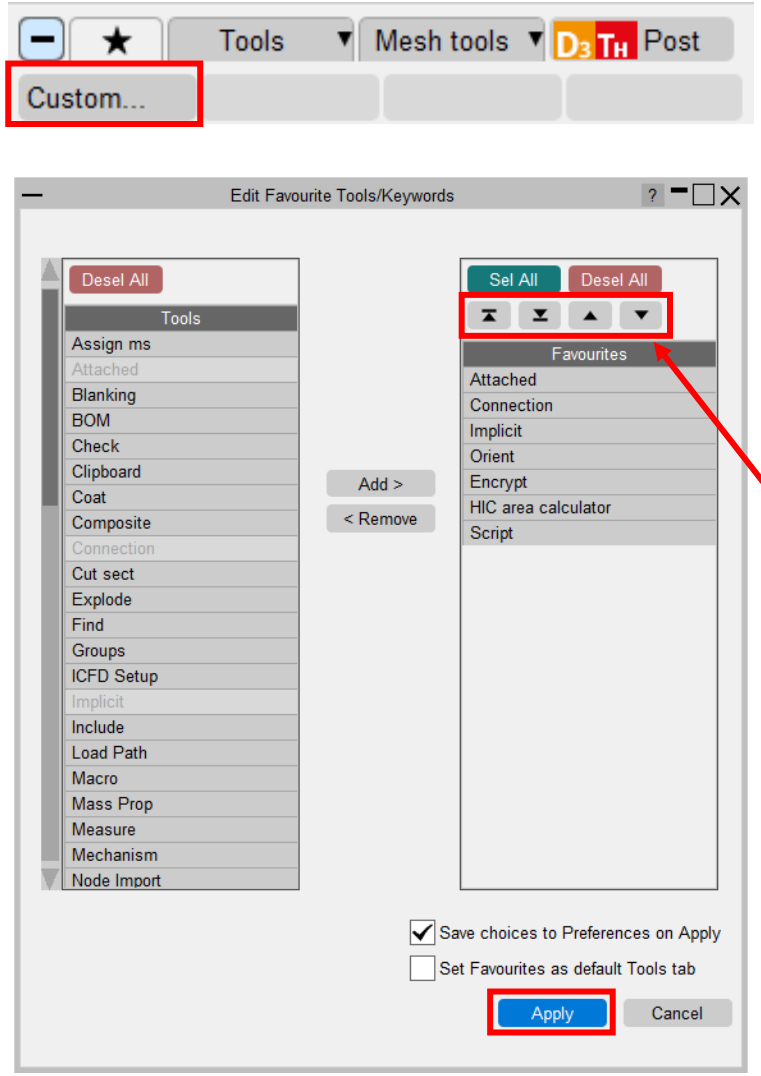
Favourite Tools & Keywords

Favourite Tools & Keywords

- Users now have the ability to create their own Favourite Tools or Favourite Keywords menus.
- This saves vertical space in the right-hand menu panel and makes it easier to find the Tools and Keywords that you use regularly.



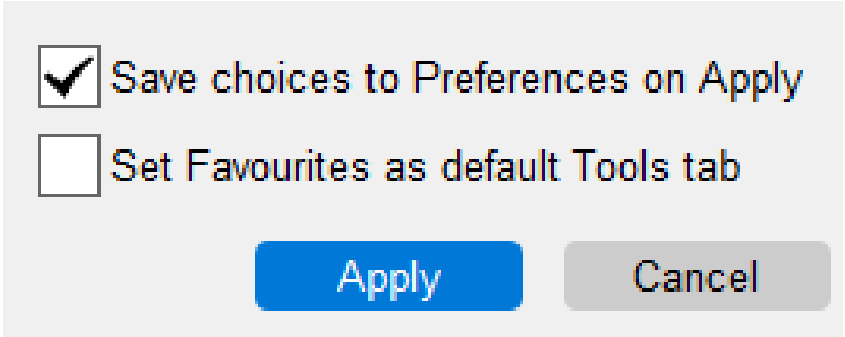
Favourite Tools & Keywords



- Clicking “Custom...” on the Favourites menu will launch the Edit Favourite Tools/Keywords panel.
- All available Tools or Keywords are listed on the left where they can be selected and added to the list of Favourites on the right.
- Buttons at the top of the list can be used to order the items.
- Pressing “Apply” updates the Favourites menu to show buttons in the order they are listed.

Favourite Tools & Keywords

- If you wish, the contents and layout of each Favourites menu can be saved to your oa_pref file, so your choices are remembered for subsequent PRIMER sessions.
- You can also set your Favourites menu as the default tab to be open when you next launch PRIMER.
- Thanks to this, you can easily copy your setup to different devices with all your other preferences!

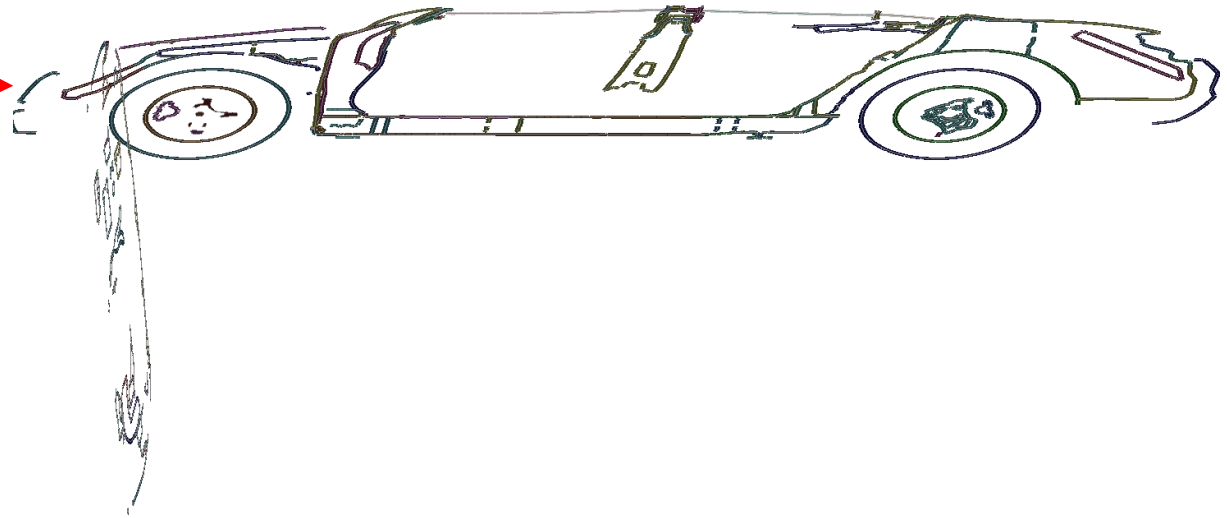


Cut Sections

Multiple Cut plane directions

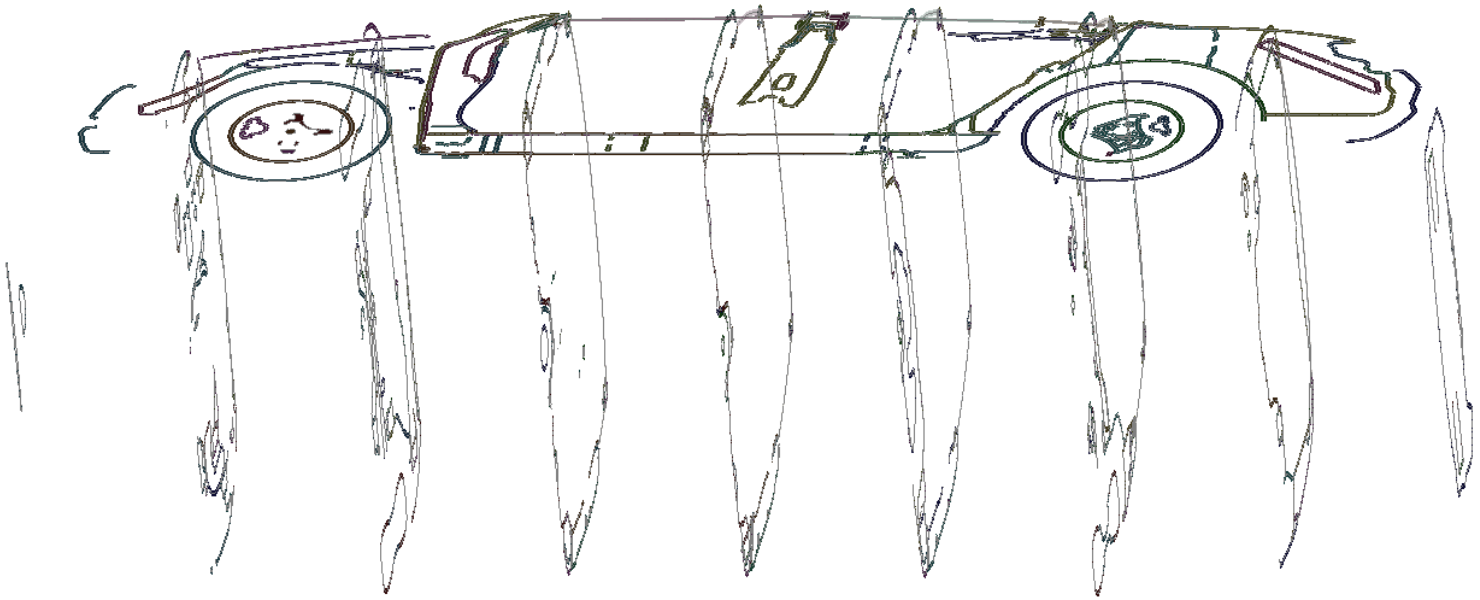
- Cut planes can now be defined in up to 3 non-parallel directions.

- The example shown on the right shows two orthogonal planes intersecting a car model.



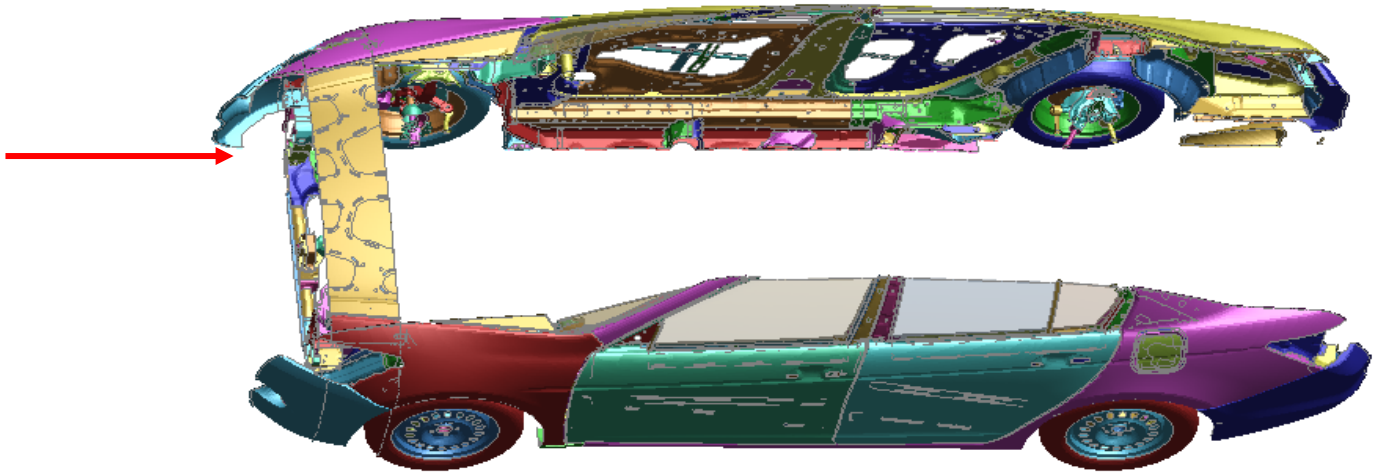
Parallel cuts with multiple directions

- Multiple directions can be combined with multiple parallel planes in one or more directions.

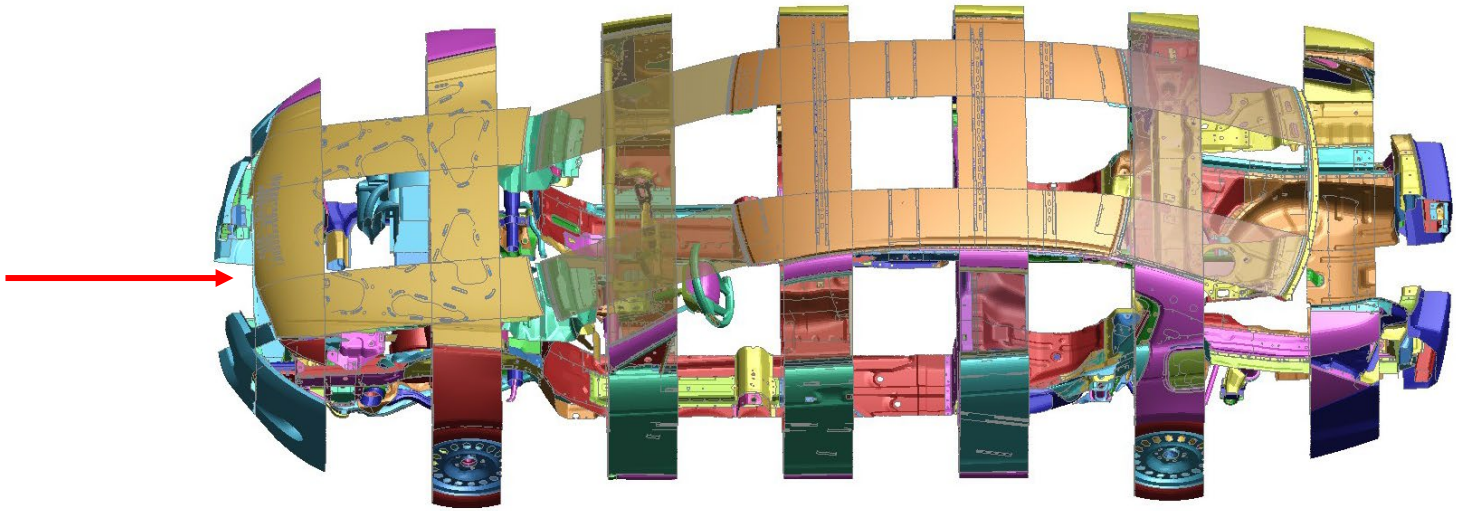


Combination of thick cuts and multiple parallel cuts

- This example shows a thick cut in one plane and multiple thick parallel cuts in another.



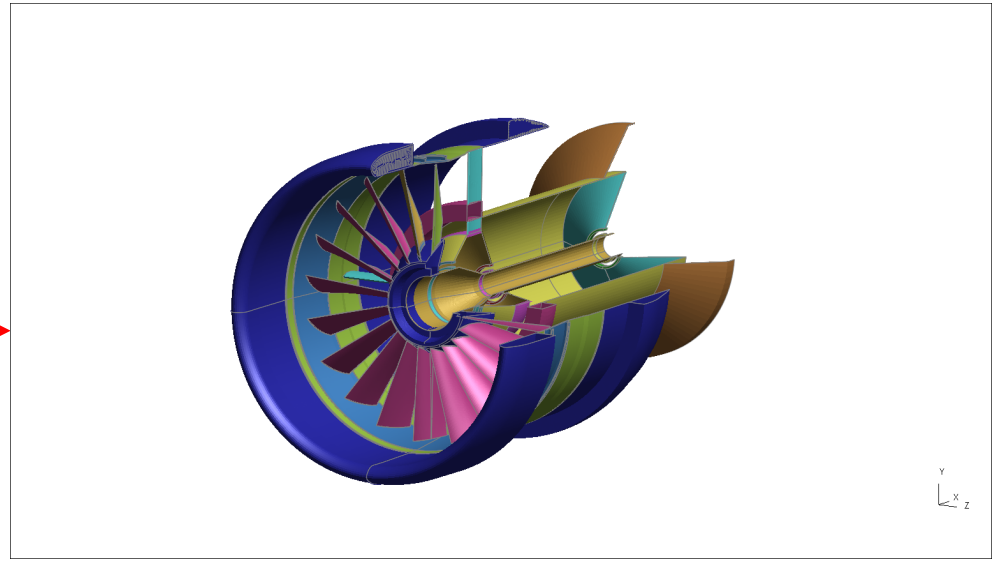
- This example shows multiple thick parallel cuts in two directions.



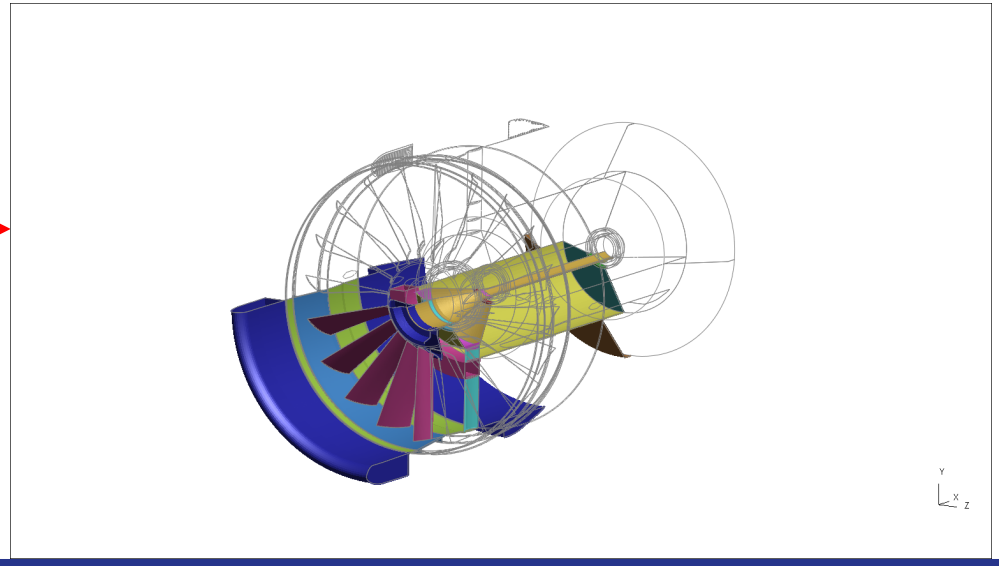
Union Vs Intersection

One can choose between Union and Intersection of multiple planes.

- **Union** of constant Z cut plane and constant Y cut plane with positive action as Omit and negative action as Normal.



- **Intersection** of constant Z cut plane and constant Y cut plane with positive action as Outline and negative action as Normal.

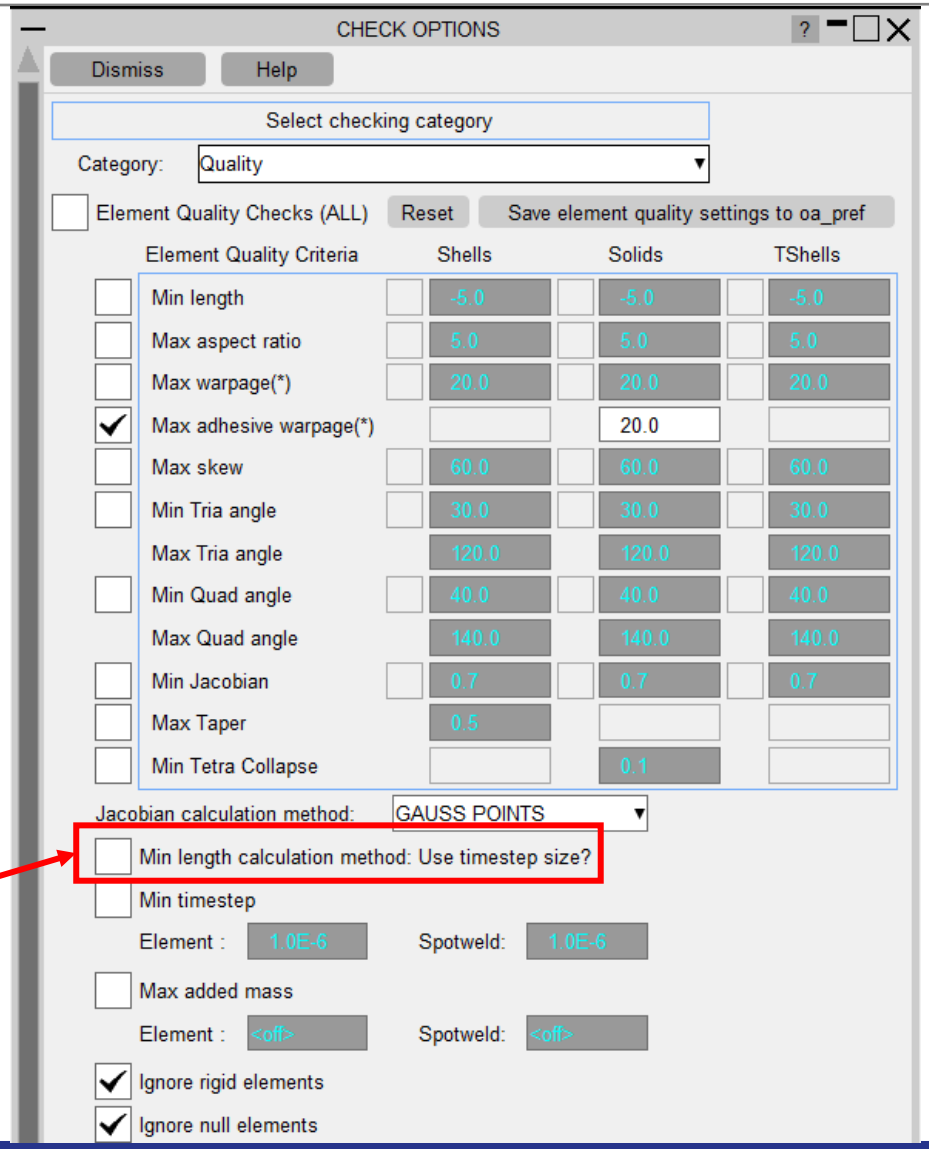


Images from LS-DYNA Aerospace Working Group

Element Length Check

Element Length Check – New Preference/Option

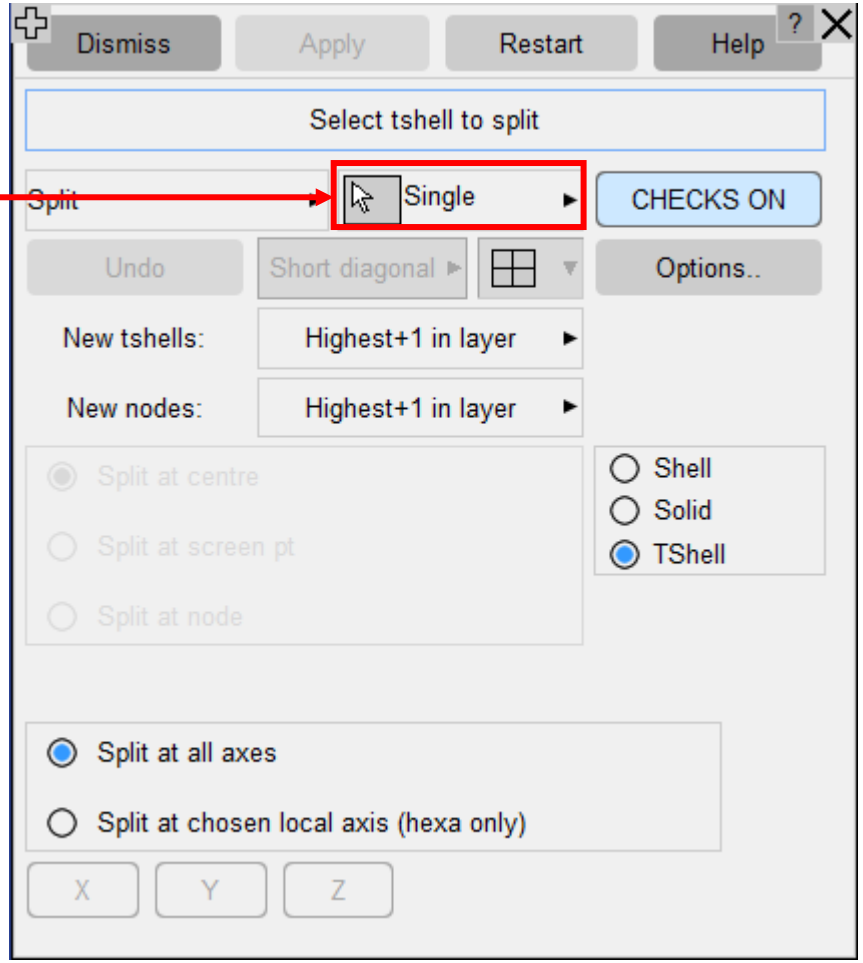
- `primer*check_min_length_timestep`: Use timestep size of elements while checking minimum length
- When this preference is set to TRUE, PRIMER will use the timestep size instead of the actual minimum length of elements while doing minimum length checks.
  - For shells, the timestep size depends on the *CONTROL_TIMESTEP <ISDO> field
- This option is also available in the CHECK OPTIONS panel.



Meshing Enhancements

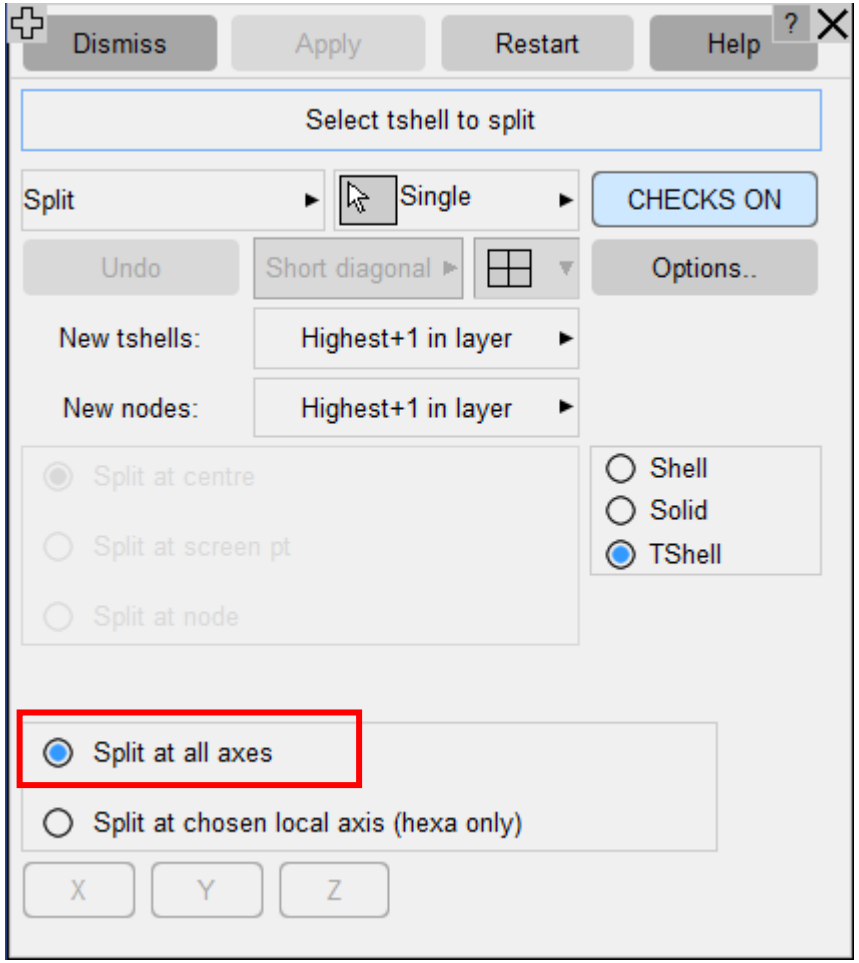
Support for splitting of thick shells

- Thick shells can now be split in a similar way to solids.
- In **Single** mode, clicking on a thick shell will split it.
- In **Multiple** mode, multiple thick shells can be selected and split using the object menu and pressing Apply.
- There are two modes of splitting thick shells.



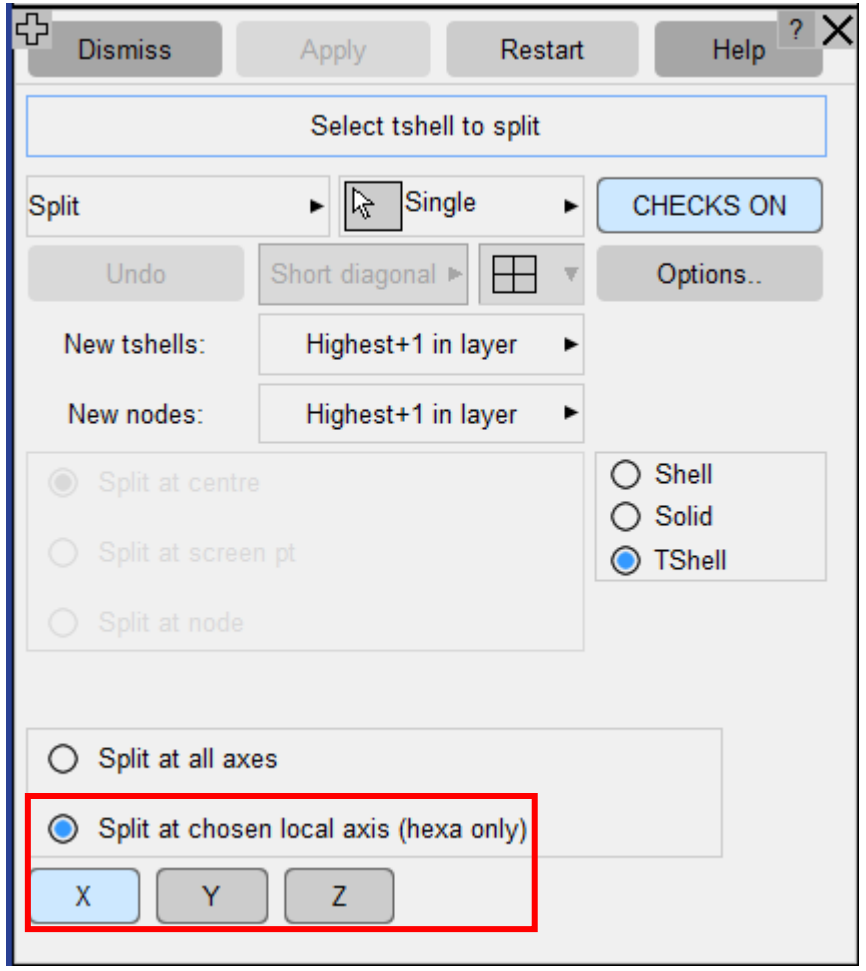
Support for splitting of thick shells: All Axes

- Thick shell elements can be split at all axes.
- Both **hexahedral** and **pentahedral** thick shell elements can be split in this mode.

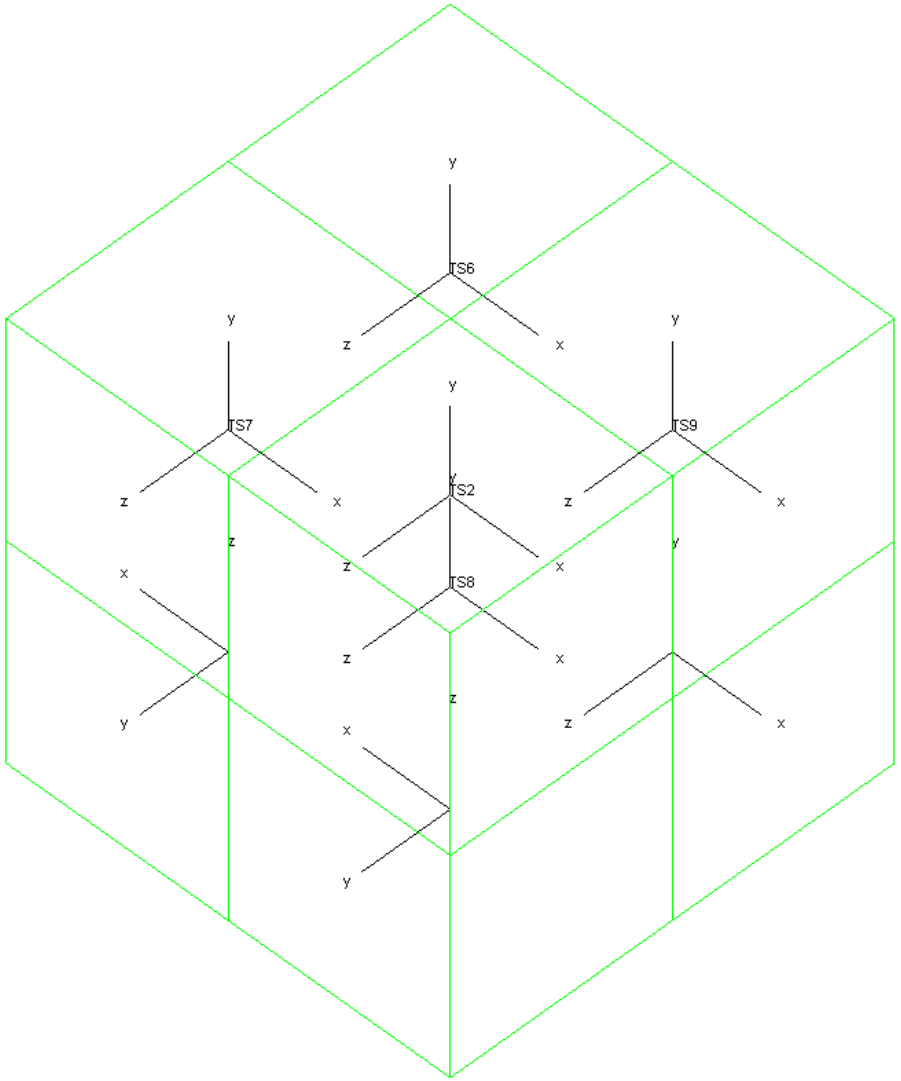


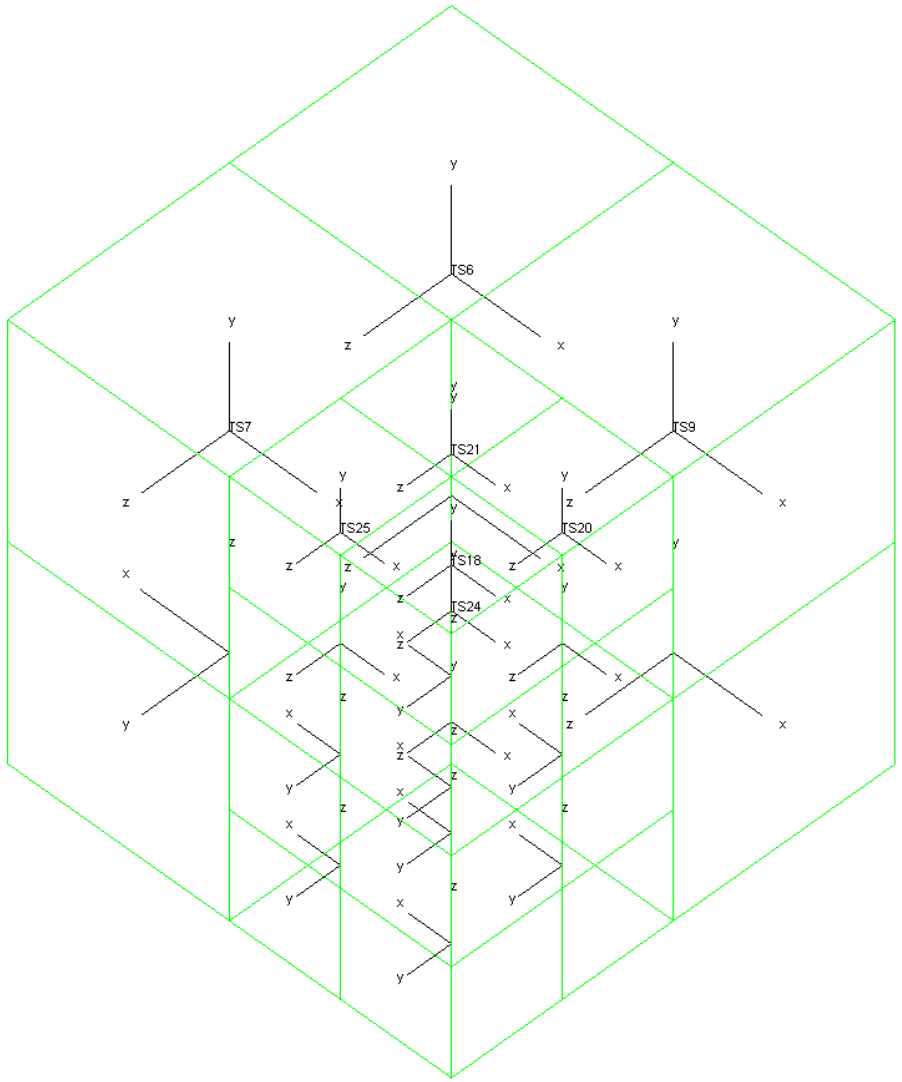
Support for splitting of thick shells: Local axis

- The thick shell elements can be split at any single axis or a combination of axes. For example, a thick shell can be split at only X or Y or Z axis or it can be split at XY or YZ or XZ.
- In this mode splitting is restricted to **hexahedral** thick shell elements only.
- In this mode splitting is with respect to the local coordinate system.

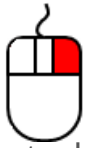


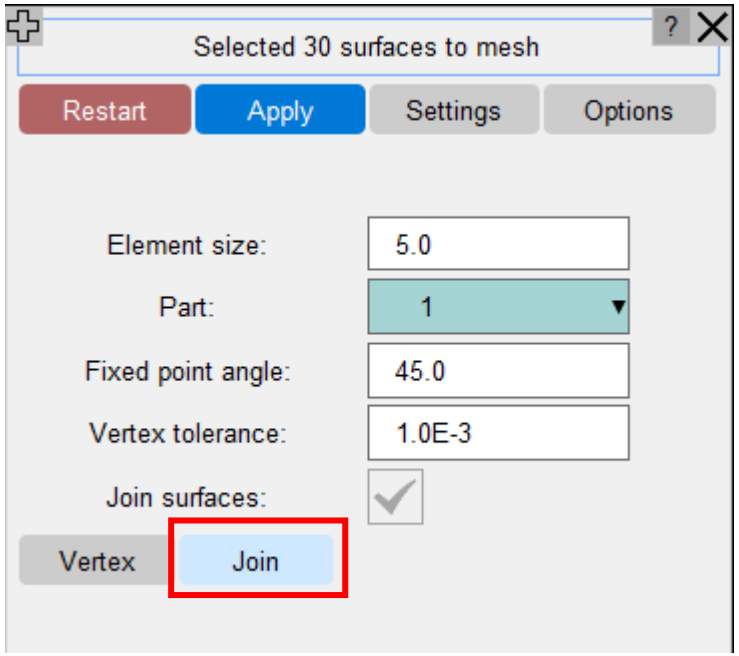
Support for splitting of thick shells: Before and after split

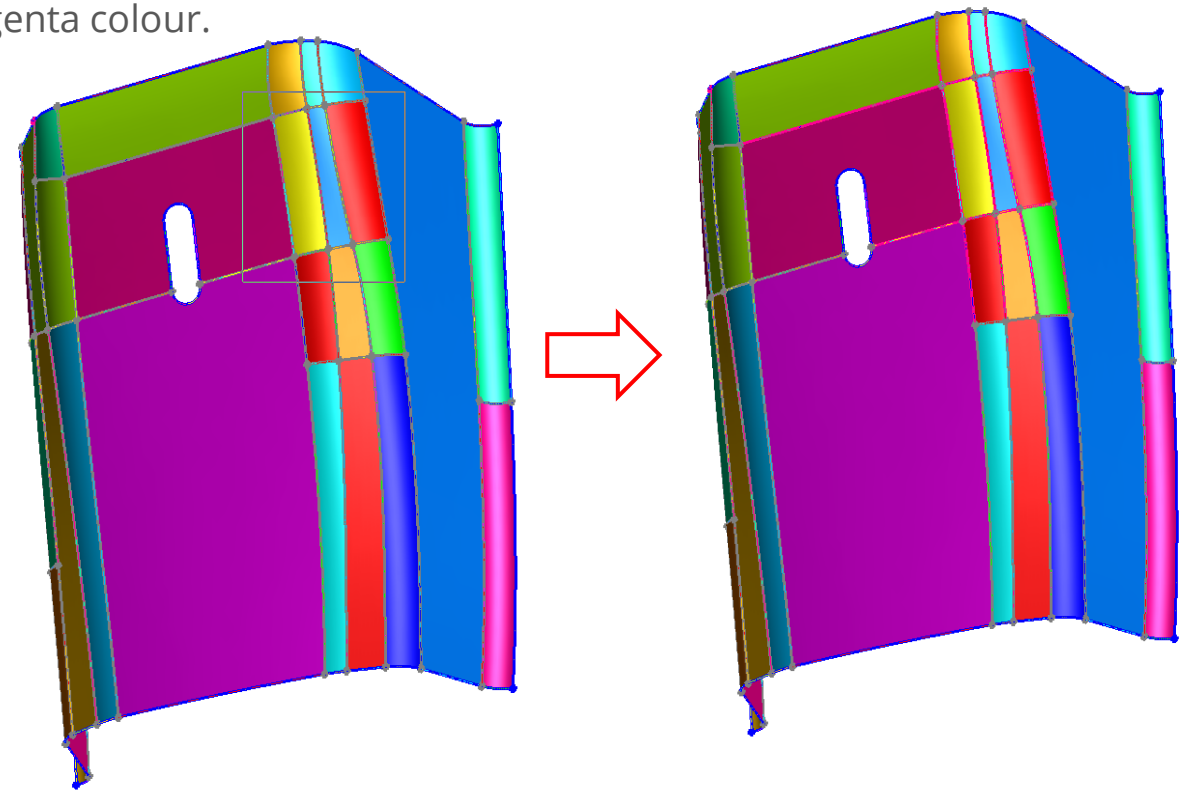




Drag a box to select/deselect during geometry meshing

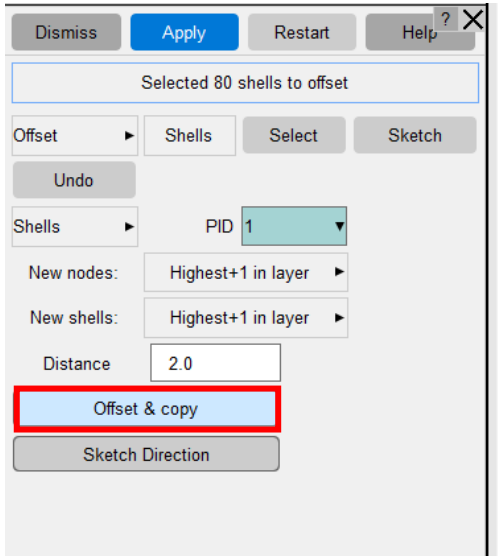
- In the mesh geometry panel, after selecting the surfaces to remesh, you can draw a box in the graphics area using  left mouse click to select feature line and nodes.
- Use  right mouse click in graphics area to deselect feature line and nodes.
- Selected feature lines and nodes are displayed in a magenta colour.

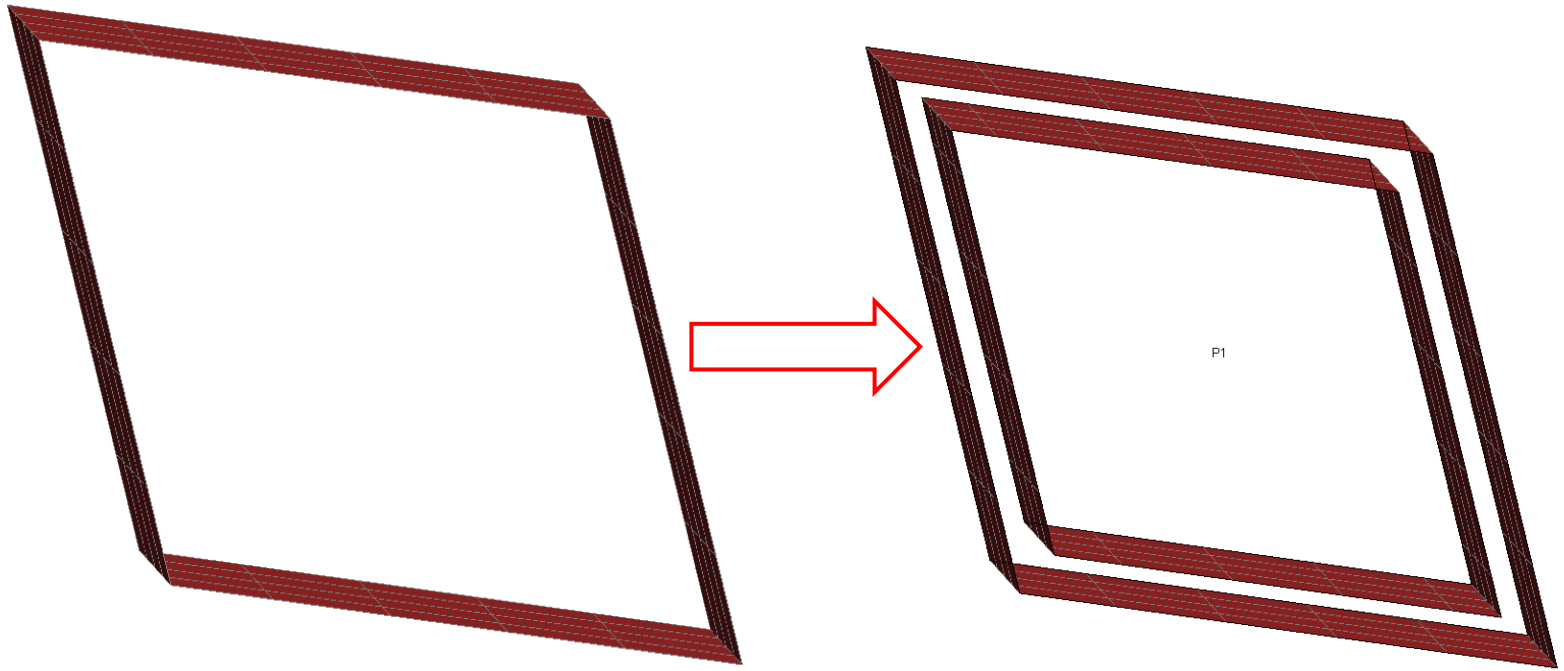




Mesh offset at corners

- In previous versions, the mesh offset command caused skewness/roundness at corners.
- Now applying an offset preserves the corner correctly.

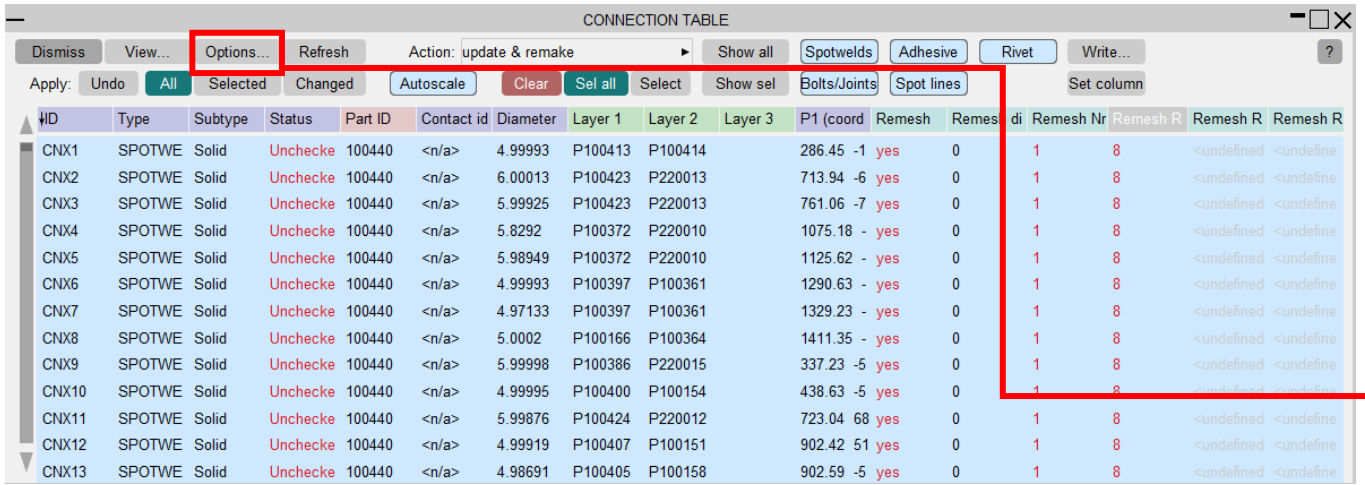


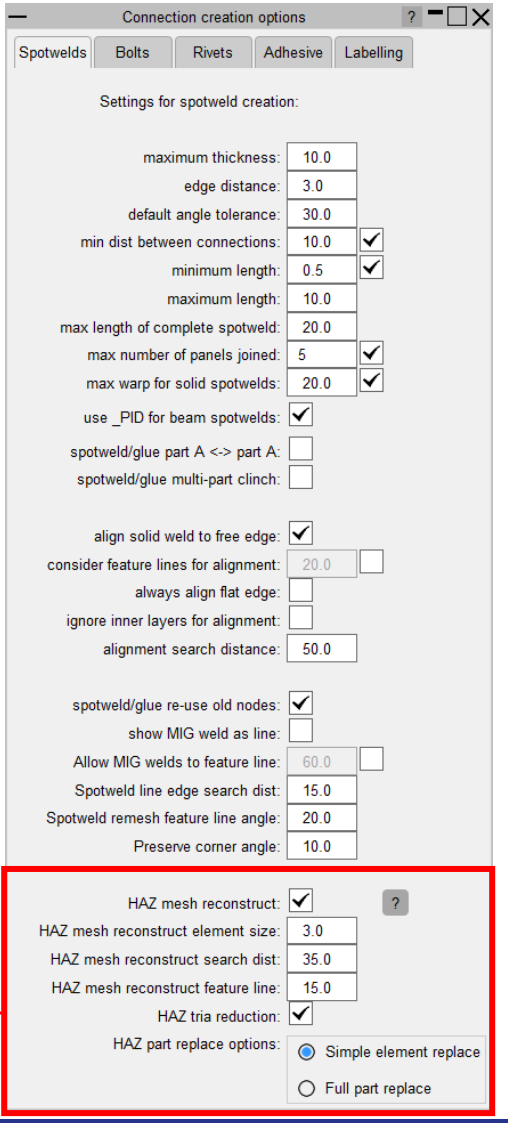


HAZ Mesh Enhancements

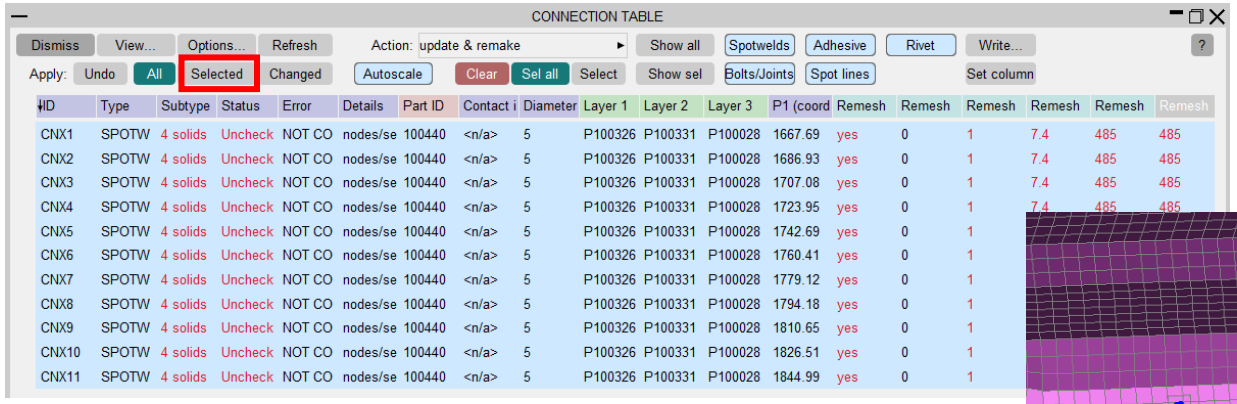
Settings to improve mesh around HAZ spotwelds

- Added “HAZ mesh reconstruct” and “HAZ tria reduction” options to improve mesh quality by reducing the tria density around spotwelds after creating HAZ spotwelds.
- HAZ mesh reconstruct: If turned ON, PRIMER will remesh the elements around all the selected spotwelds simultaneously to improve mesh quality by reducing the number of trias.
- HAZ tria reduction: This is a second option to reduce tria density. In this method, PRIMER loops through all the elements and tries to merge trias to further reduce their number.



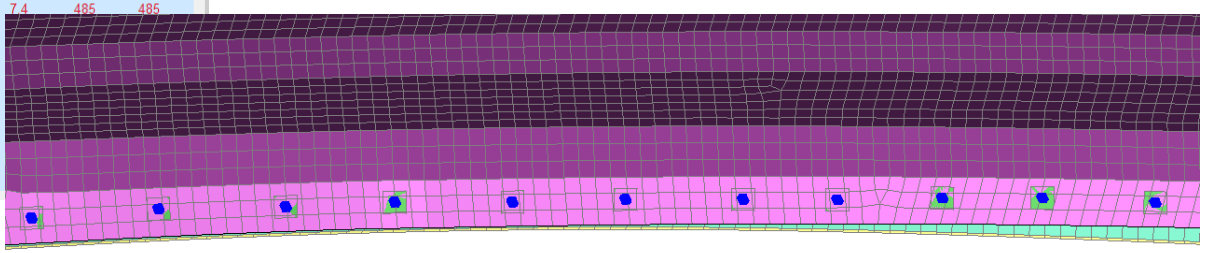


Settings to improve mesh around HAZ spotwelds

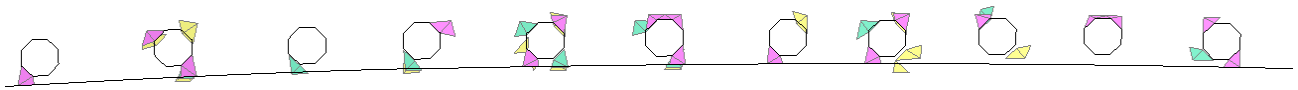


ID	Type	Subtype	Status	Error	Details	Part ID	Contact i	Diameter	Layer 1	Layer 2	Layer 3	P1 (coord	Remesh	Remesh	Remesh	Remesh	Remesh	Remesh
CNX1	SPOTW	4 solids	Uncheck	NOT CO	nodes/se	100440	<n/a>	5	P100326	P100331	P100028	1667.69	yes	0	1	7.4	485	485
CNX2	SPOTW	4 solids	Uncheck	NOT CO	nodes/se	100440	<n/a>	5	P100326	P100331	P100028	1686.93	yes	0	1	7.4	485	485
CNX3	SPOTW	4 solids	Uncheck	NOT CO	nodes/se	100440	<n/a>	5	P100326	P100331	P100028	1707.08	yes	0	1	7.4	485	485
CNX4	SPOTW	4 solids	Uncheck	NOT CO	nodes/se	100440	<n/a>	5	P100326	P100331	P100028	1723.95	yes	0	1	7.4	485	485
CNX5	SPOTW	4 solids	Uncheck	NOT CO	nodes/se	100440	<n/a>	5	P100326	P100331	P100028	1742.69	yes	0	1			
CNX6	SPOTW	4 solids	Uncheck	NOT CO	nodes/se	100440	<n/a>	5	P100326	P100331	P100028	1760.41	yes	0	1			
CNX7	SPOTW	4 solids	Uncheck	NOT CO	nodes/se	100440	<n/a>	5	P100326	P100331	P100028	1779.12	yes	0	1			
CNX8	SPOTW	4 solids	Uncheck	NOT CO	nodes/se	100440	<n/a>	5	P100326	P100331	P100028	1794.18	yes	0	1			
CNX9	SPOTW	4 solids	Uncheck	NOT CO	nodes/se	100440	<n/a>	5	P100326	P100331	P100028	1810.65	yes	0	1			
CNX10	SPOTW	4 solids	Uncheck	NOT CO	nodes/se	100440	<n/a>	5	P100326	P100331	P100028	1826.51	yes	0	1			
CNX11	SPOTW	4 solids	Uncheck	NOT CO	nodes/se	100440	<n/a>	5	P100326	P100331	P100028	1844.99	yes	0	1			

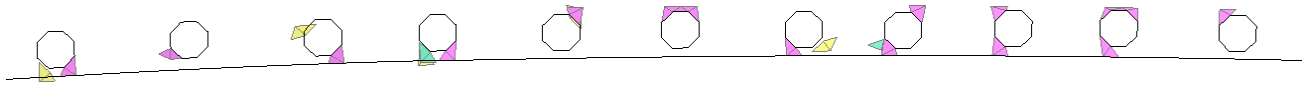
Input spotweld model.



Output HAZ spotweld without settings: 36 trias.



Output HAZ spotweld with settings: 19 trias.



IGA Enhancements

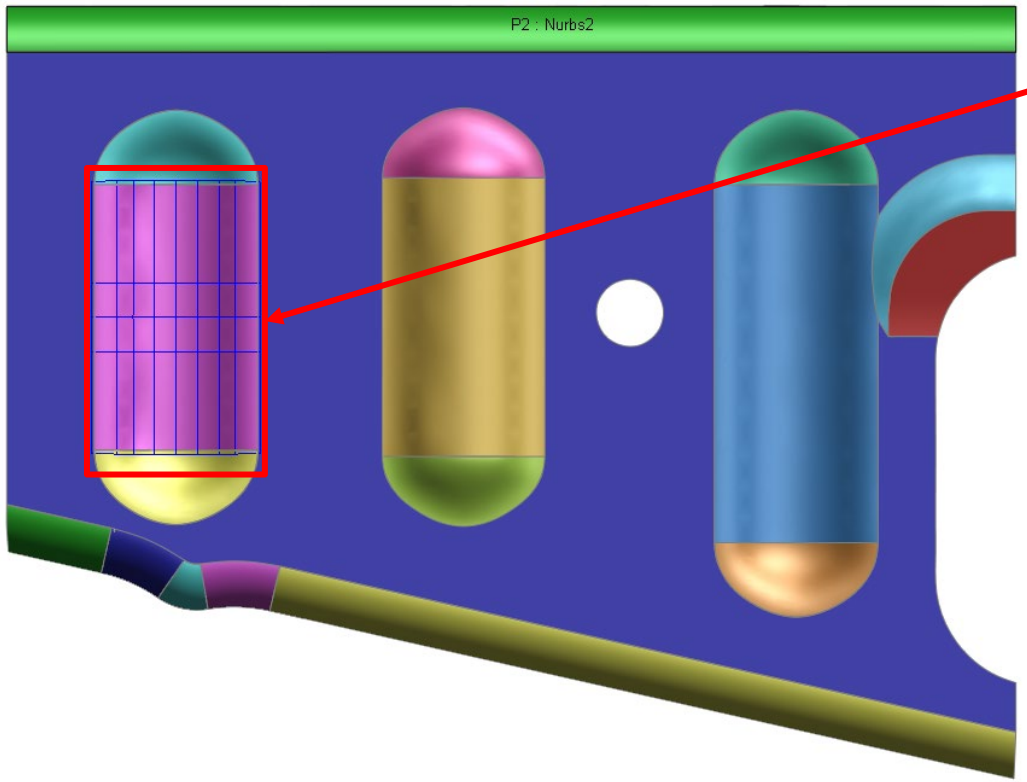
IGA images are courtesy of JSOL

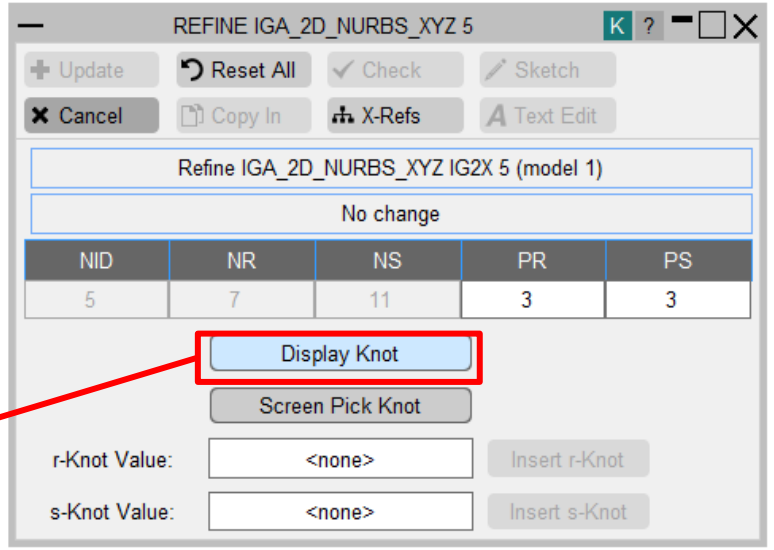
IGA Enhancements

- Visualisation and interactive manipulation of *IGA keywords is now possible.
- A new IGA refine panel has been added. It can be accessed from IGA_SHELL, IGA_FACE_XYZ or IGA_2D_NURBS_XYZ.
- The refine panel allows you to manipulate and visualize the IGA_SHELL. You can:
  - Visualise knot grids;
  - Insert knot values;
  - Change the curve degree.
- It is now also possible to sketch IGA trimming curves
- IGA capability is further improved with the ability to check contacts and make connections with IGA entities.

IGA Refine panel: Visualise knot grids

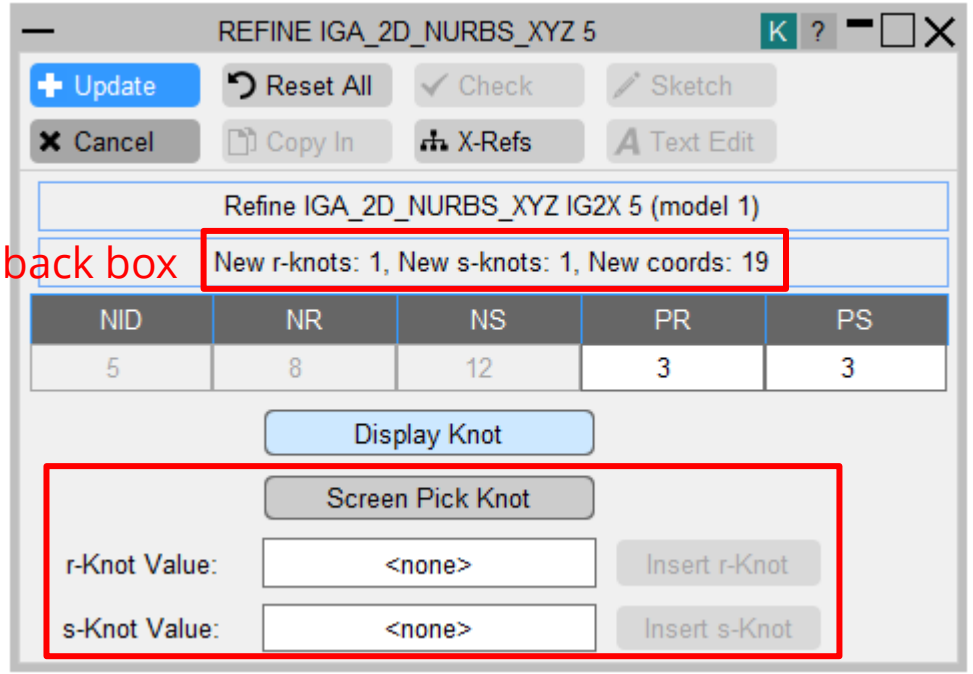
- The NURBS elements (or knot segments) can be visualised by enabling the Display Knot toggle button.





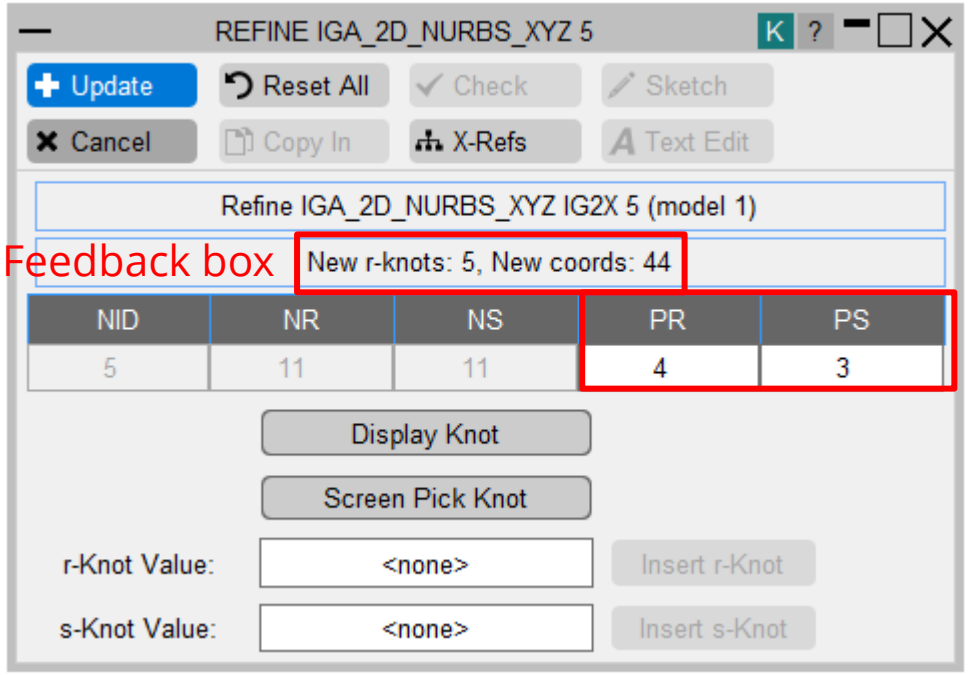
IGA Refine panel: Insert knot values (h-refinement)

- Allows user to add knots by screen pick on knot grid edges or directly by typing in the textbox.
- Feedback regarding how many new knots and coordinates will be added is given in the panel in feedback box above NID, NR, NS, etc. fields.



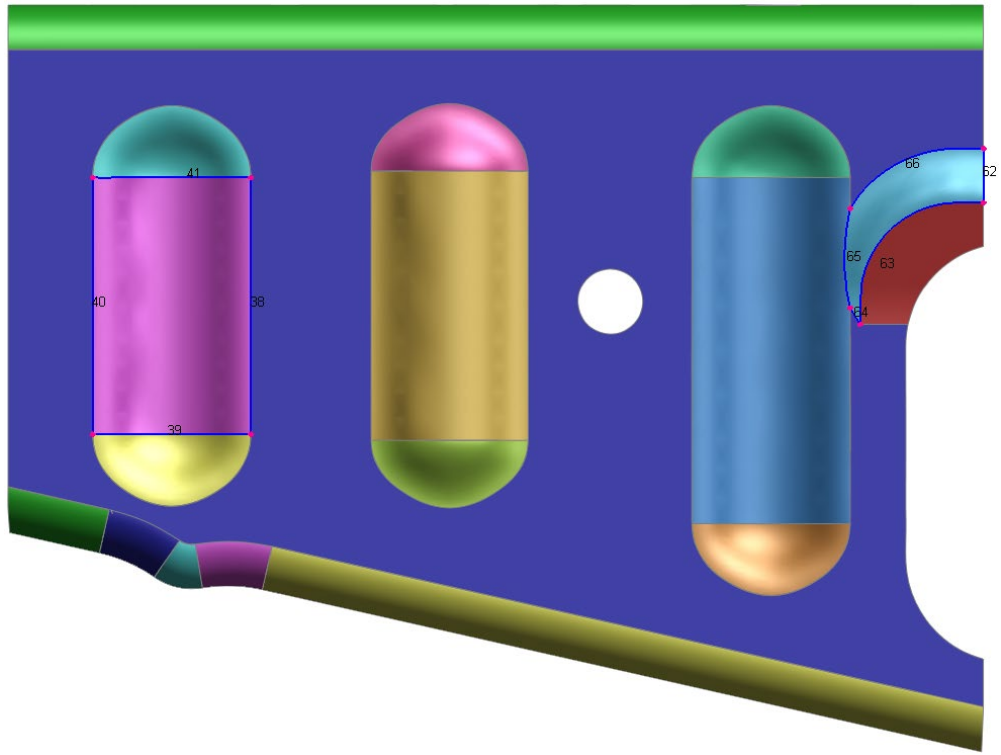
IGA Refine panel: Change the curve degree (p-refinement)

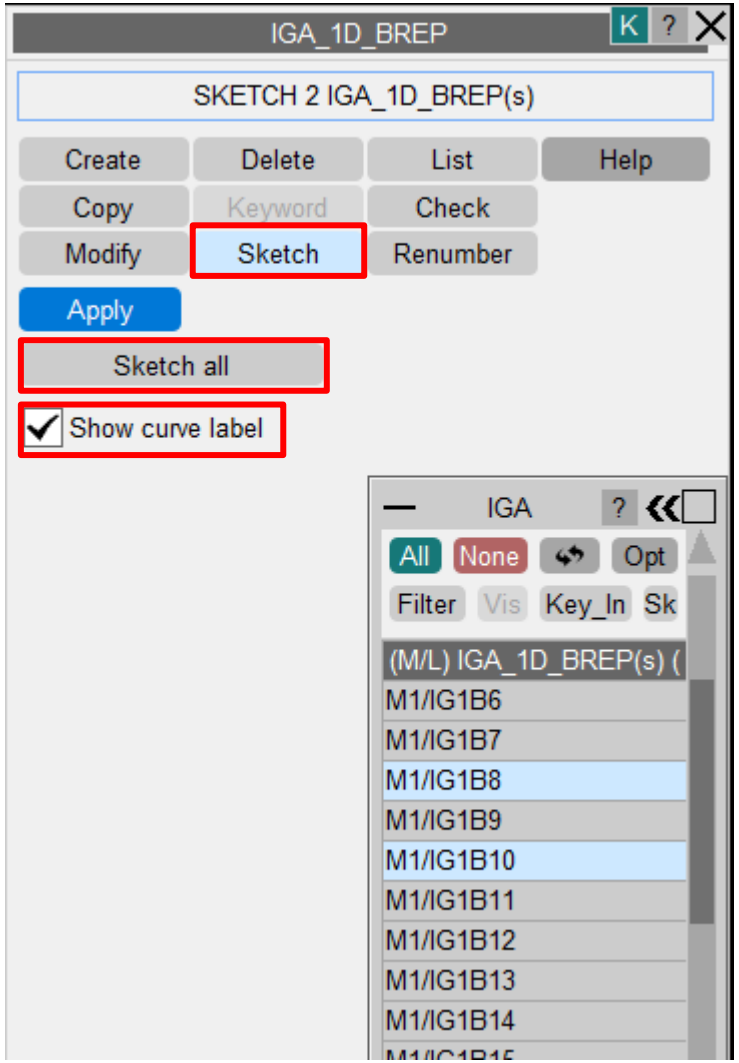
- Allows user to change degree of IGA definition. User can increase/decrease degree.
- Feedback regarding how many new knots and coordinates will be added is given in the panel in feedback box above NID, NR, NS, etc. fields.



Sketching trimming loop

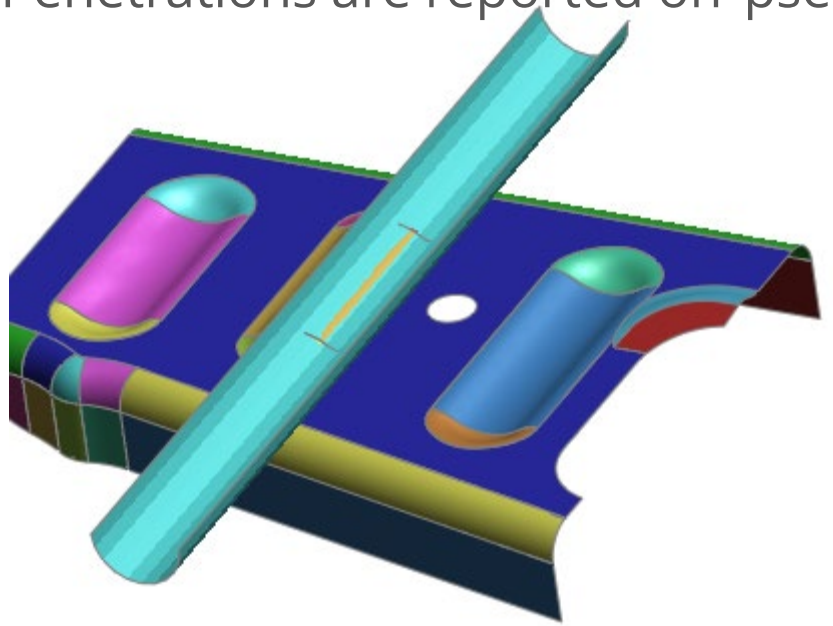
- It is now possible to sketch trimming loops for the new IGA keyword, *IGA_1D_BREP.
- Enable or disable curve labels by checking ‘Show curve label’.

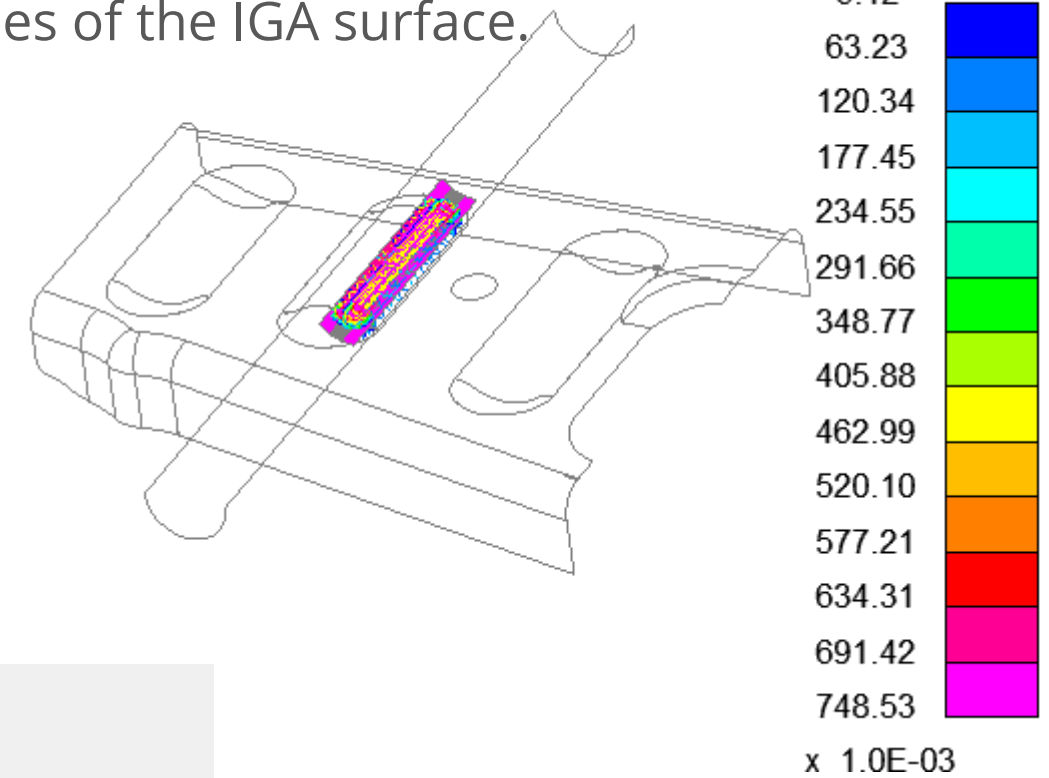




*CONTACT check with IGA surface

- PRIMER analyses IGA contacts using a heavily discretized tria mesh.
- Penetrations are reported on ’pseudo’ nodes of the IGA surface.





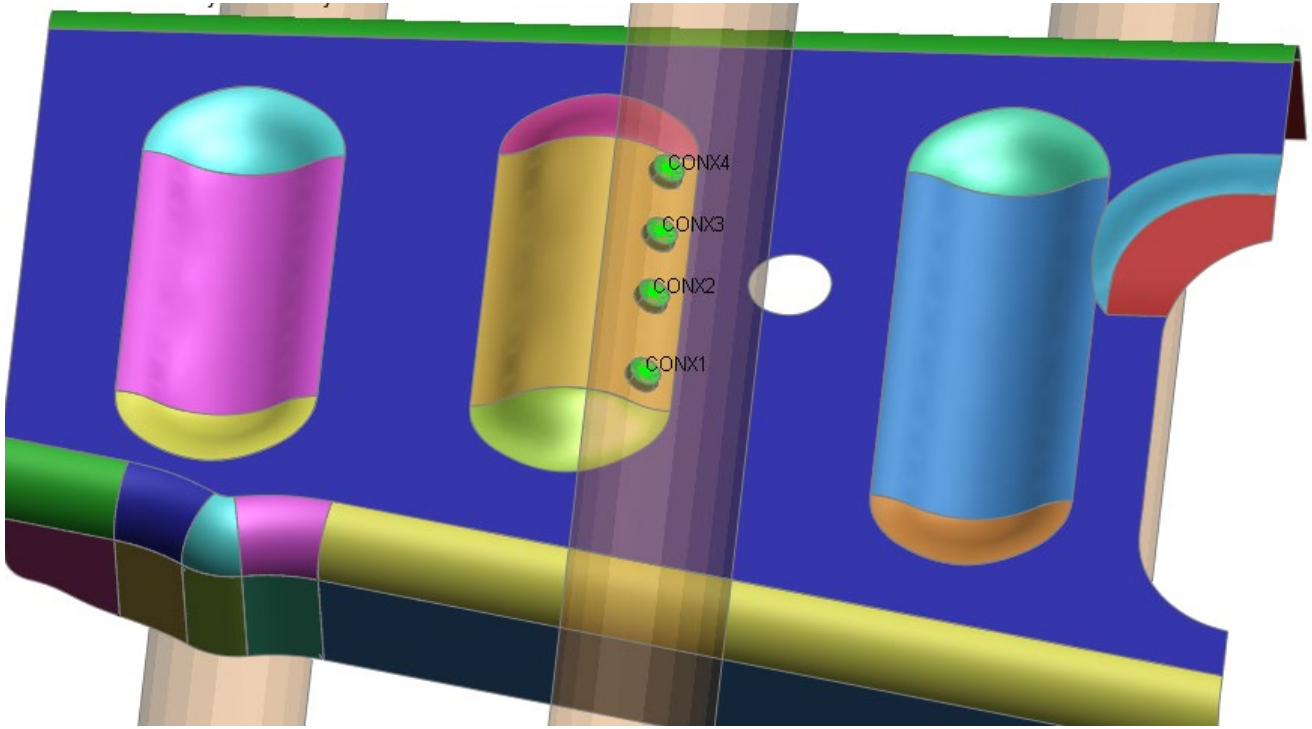

```
Nodal Penetration Summary.
--------------------------


Penetrations >= 0

N:36       on IGSH:8        penetrates S:503     . Penetration:    3.646e-02
N:37       on IGSH:8        penetrates S:503     . Penetration:    4.567e-02
```

*CONNECTION weld/adhesive onto IGA surface

- Connections can be made to an IGA surface



Performance improvements

Keyword editor “Go to label”

- Keyword editors have been made easier to use when there are many rows.
- Using this menu, you can automatically jump the scroll bar to the entity row of the given (or nearest) label value.
- This is available in keyword editors for entities with label fields.

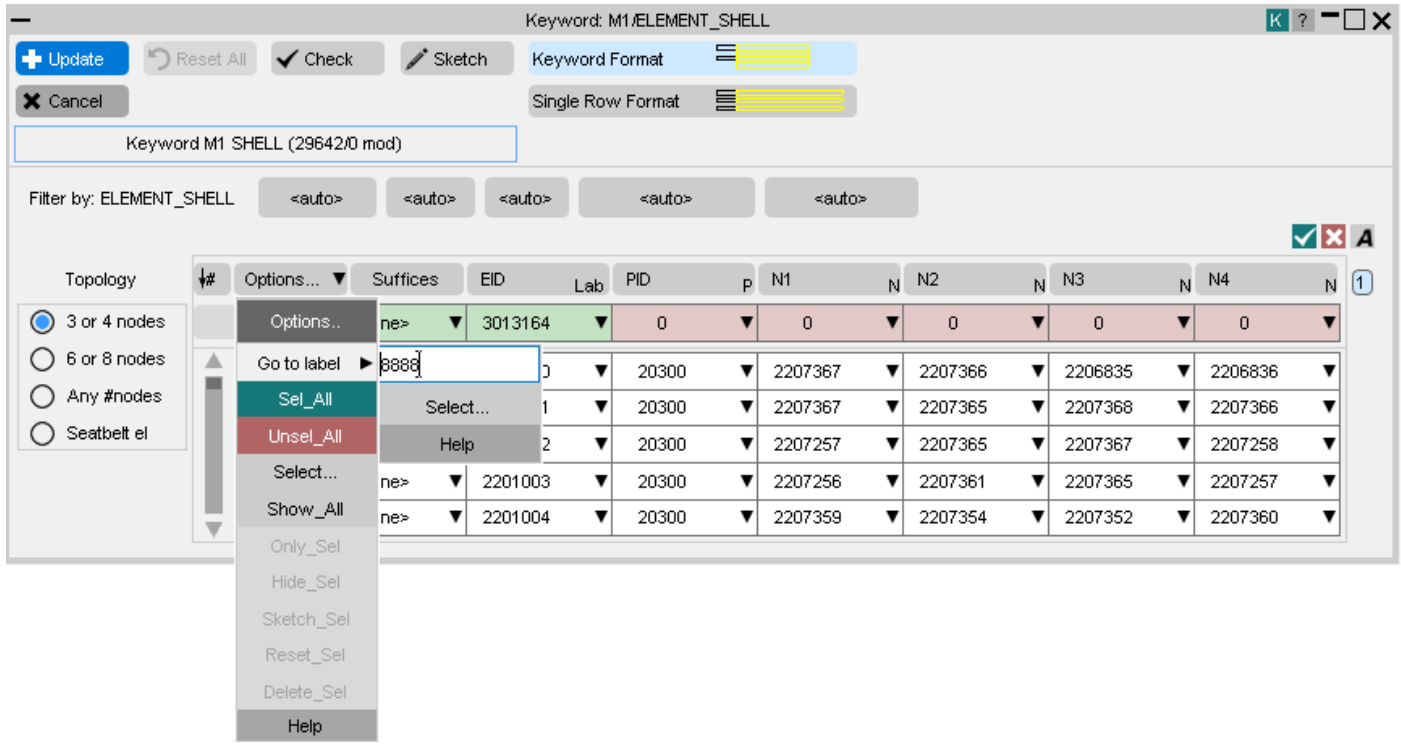
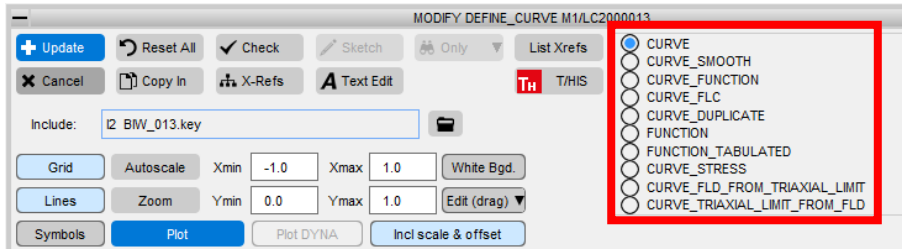
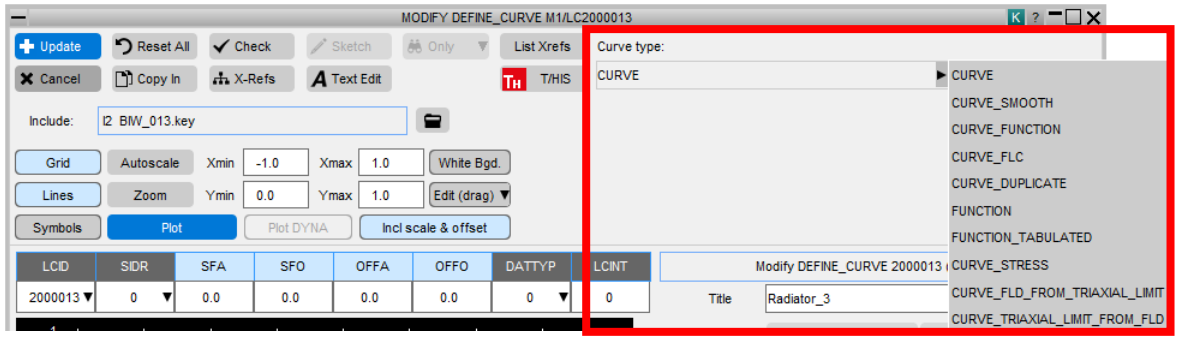


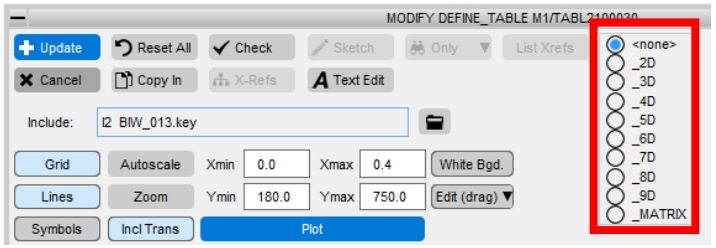
Table and Curve editor improvements

- Tall radio buttons used in v18 to define curve and table types have been replaced by more user-friendly drop-downs.

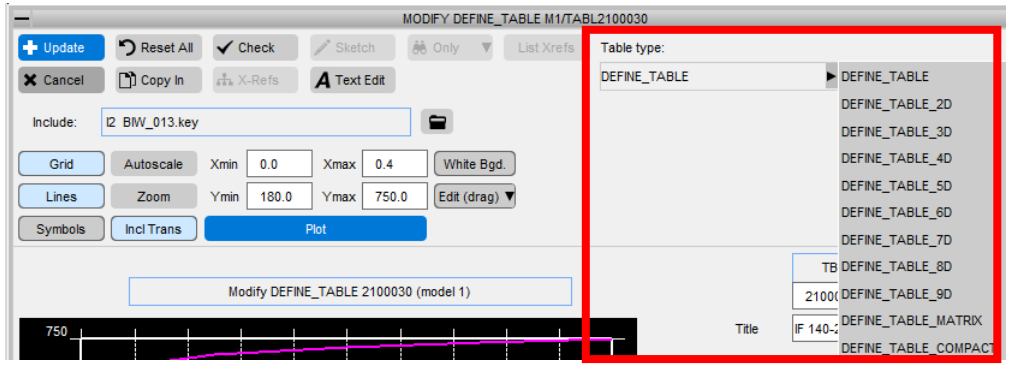




v18



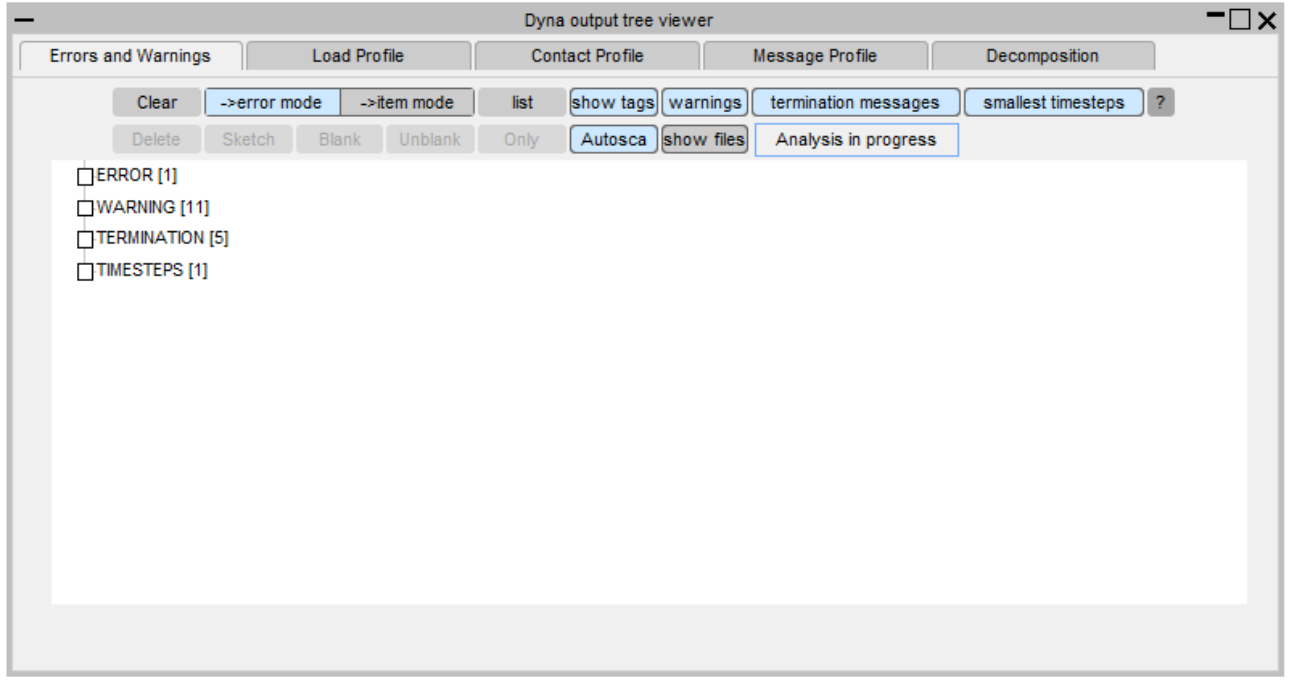
v19

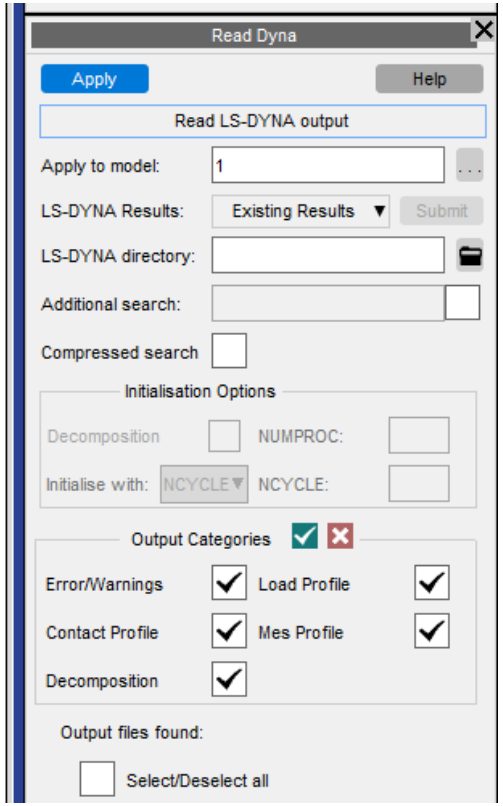


- The graph area in the table editor now also expands as the window is made bigger.

LS-DYNA output reader

- It is no longer necessary to re-read LS-DYNA output files every time the tree viewer is launched, improving the performance of this utility.
- If none of the files have been modified the tree viewer is mapped instantaneously.

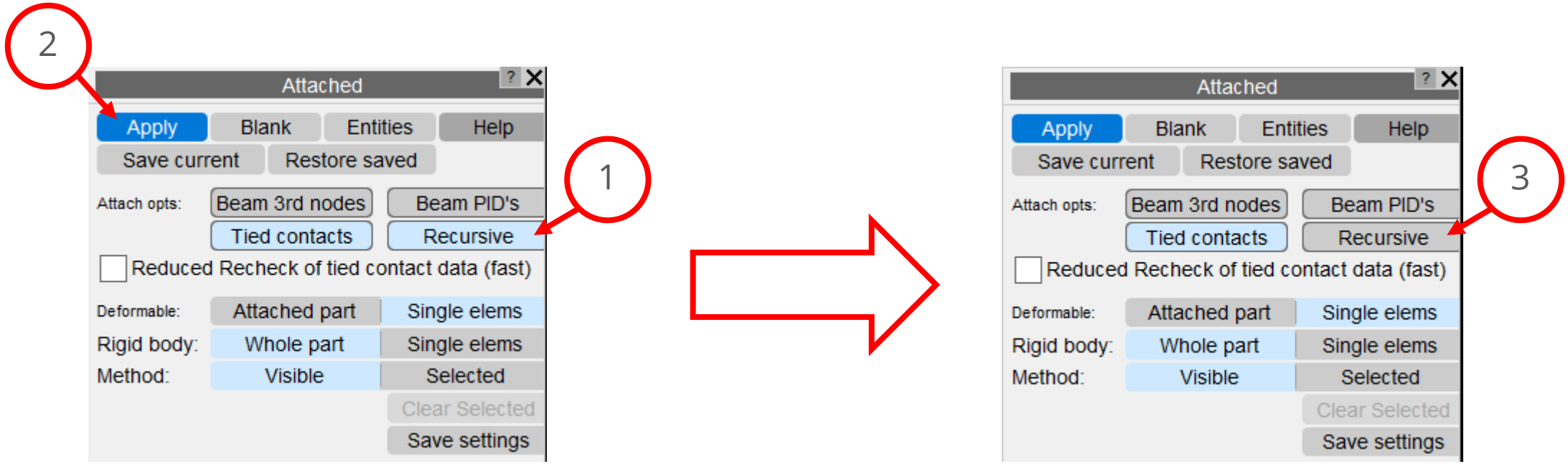




Attached – Recursive option

If set, the **Recursive** option in **Tools** → **Attached** will now be switched off automatically at the completion of an Attached operation.

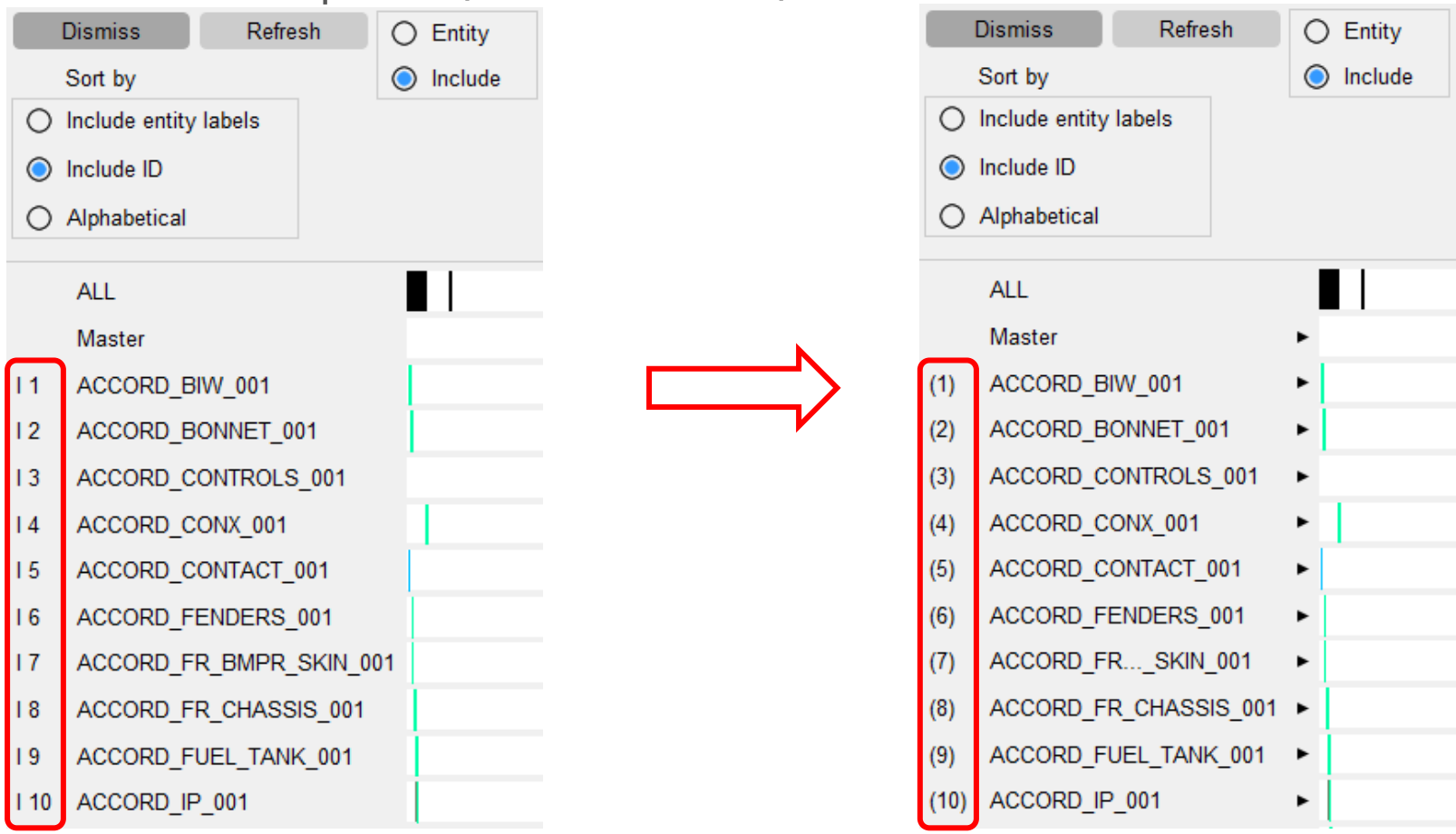
This improves performance by preventing accidental, time intensive, recursive operations being initiated.



Renumber Panels

Renumber Panels – Include IDs for Visualise panel

- For greater clarity and consistency the include ID format has been changed from 'I xx' to '(xx)' on the visualise panel (include mode).



Renumber Panels – Renumber Includes panel: “File name”

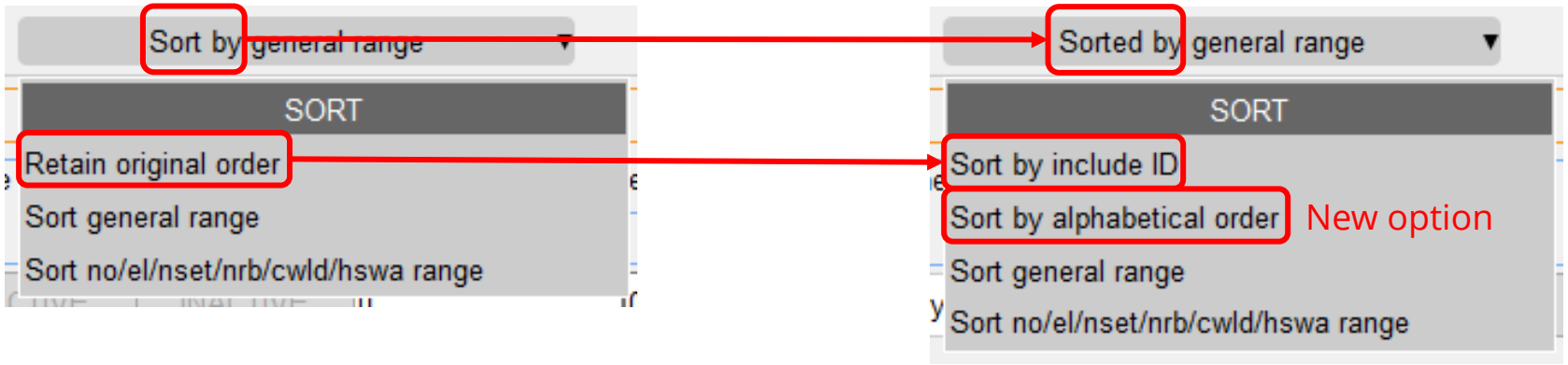
- To maintain consistency with the Visualise panel (include model):
  - Added include ID '(xx)' before file name for each include file;
  - Left justify the “File name” column.
- “File name” column width is now:
  - Extended to contain the longest file name;
  - If file names are too long, they are truncated to fit the column.
- Add visualisation (“Blank”, “Unblank” & “Only”) popup for master & include files

Renumber Panels – Visualise panel (include mode)

- Visualise panel (include mode):
  - If file names of include files are too long, they are truncated to fit the column.
    - Improved to deal with non-default fonts & font sizes.
  - Add visualisation (“Blank”, “Unblank” & “Only”) popup for master & include files

Renumber Panels – Renumber Includes panel improvements

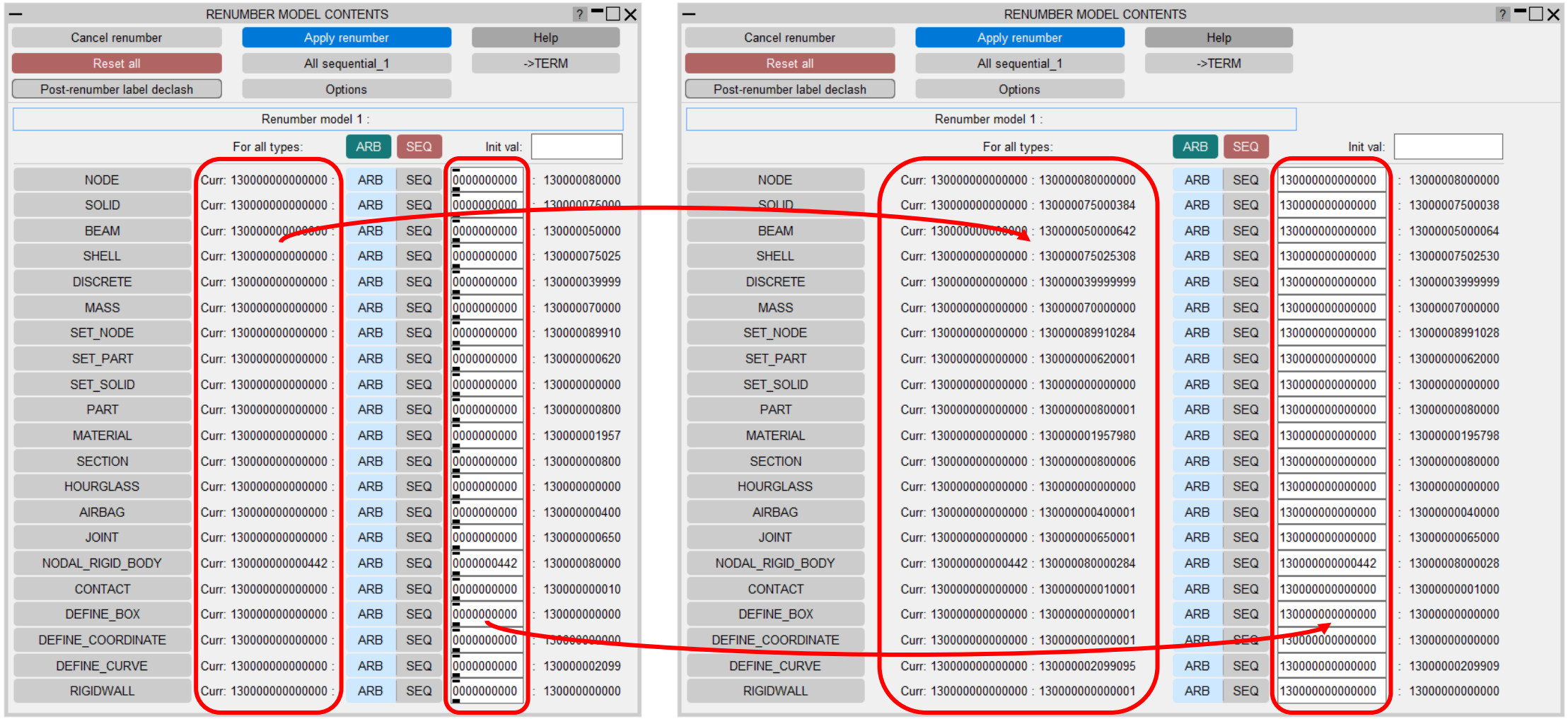
- Sort options:
  - Changed the sort text displayed from 'Sort by ...' to 'Sorted by ...' for clarity;
  - Changed 'Retain original order' to 'Sort by include ID';
  - Added 'Sort by alphabetical order'.



- Removed 10-row limit so we can see as many in the list as the panel will allow on panel resize.

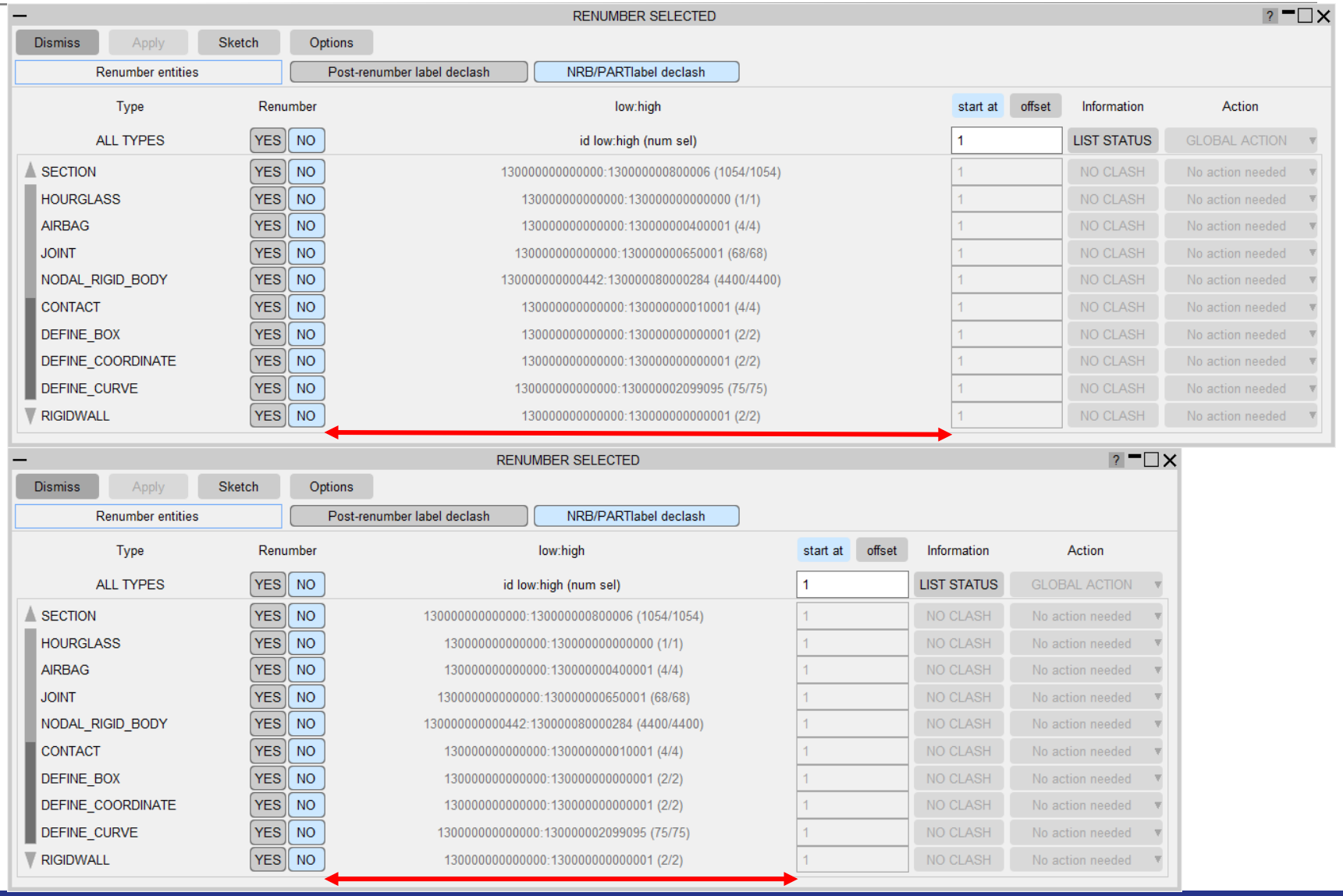
Renumber Panels – Renumber Contents panel: Large Labels

- Increased width of columns to accommodate large labels



Renumber Panels – Renumber selection panel: Large labels

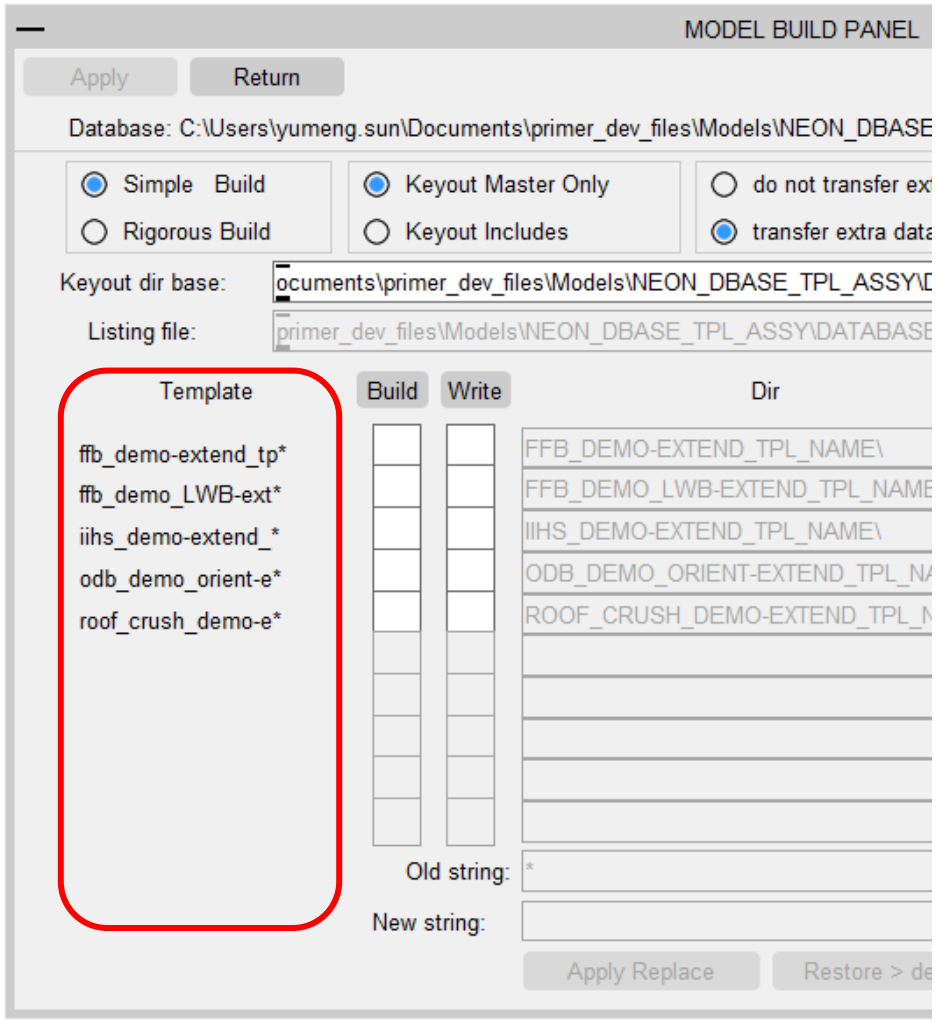
- Renumber selection panel: In PRIMER 18, the width of the 2nd column will increase when large labels are detected. Decrease the increment slightly to reduce waste of space.



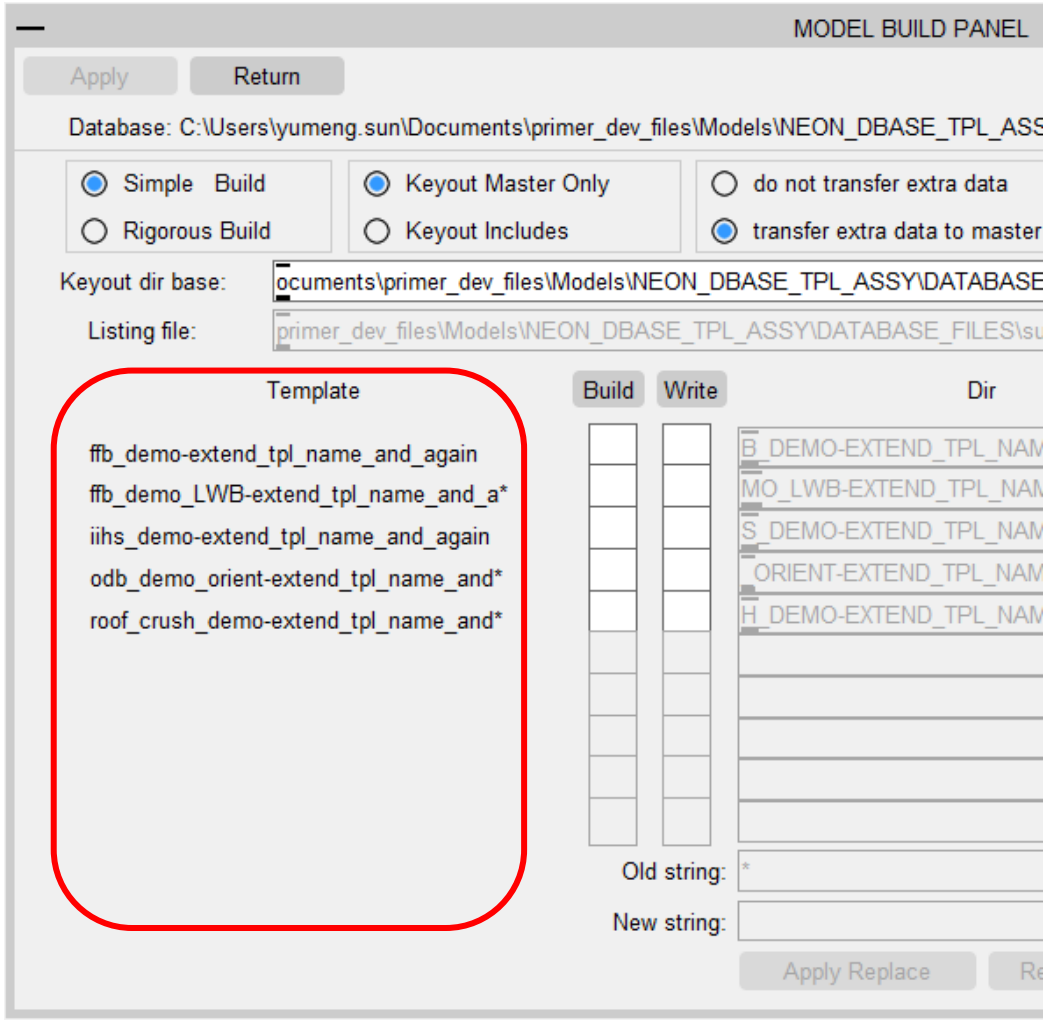
Model Build Panel

Model Build panel: Template column width increased

v18



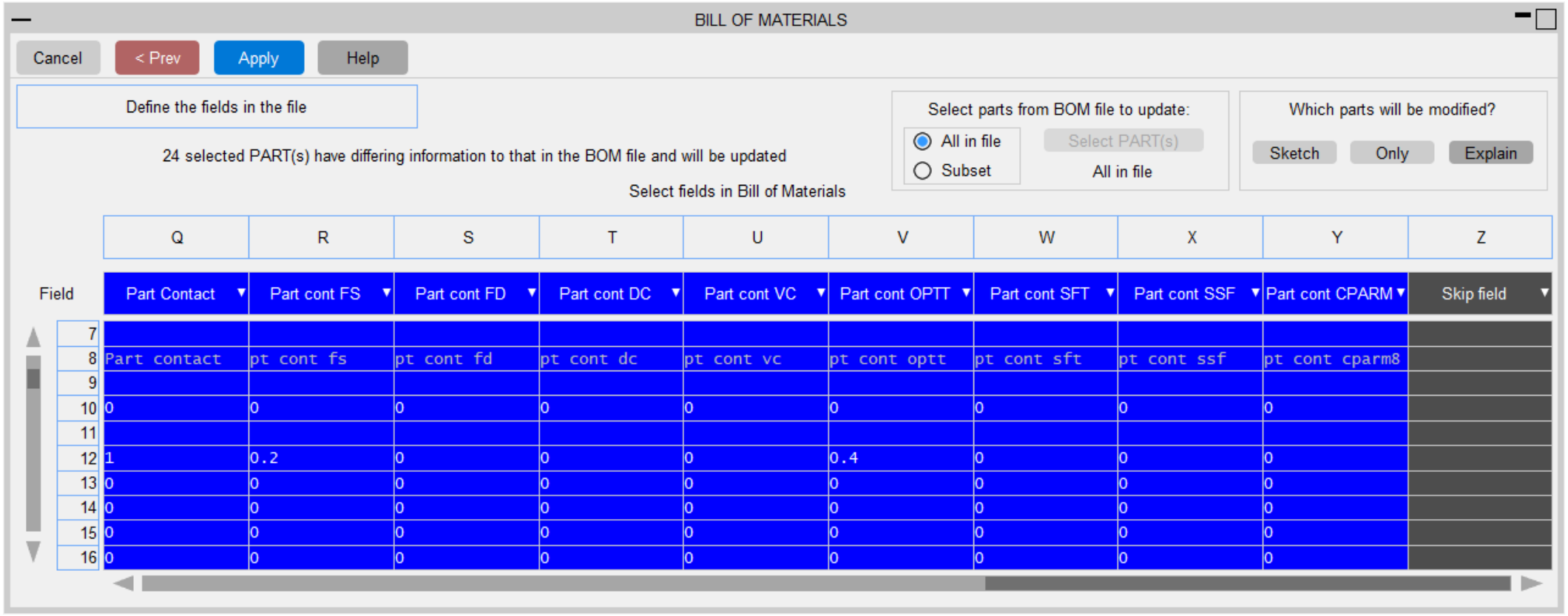
v19



Bill of Materials

Bill of Materials

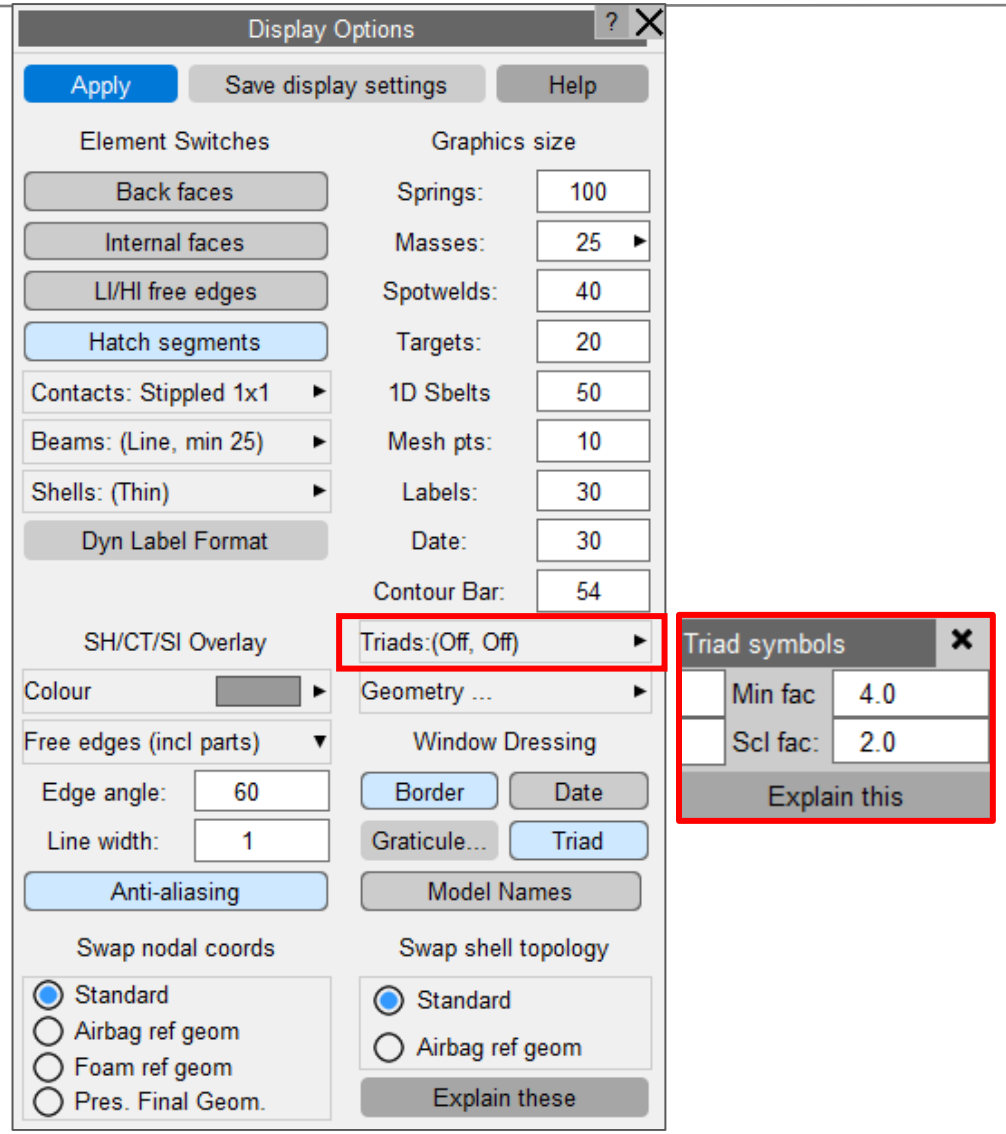
- It is now possible to read/write *PART_CONTACT options and fields to Bill of Materials
  - Makes it easier to specify *PART_CONTACT information on a part by part basis



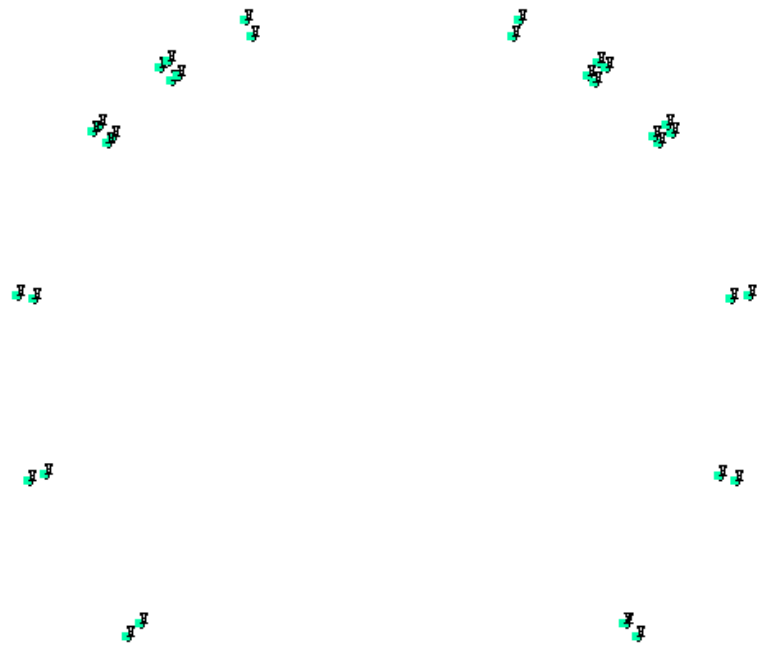
Triad Size

Display Options – Triad Size

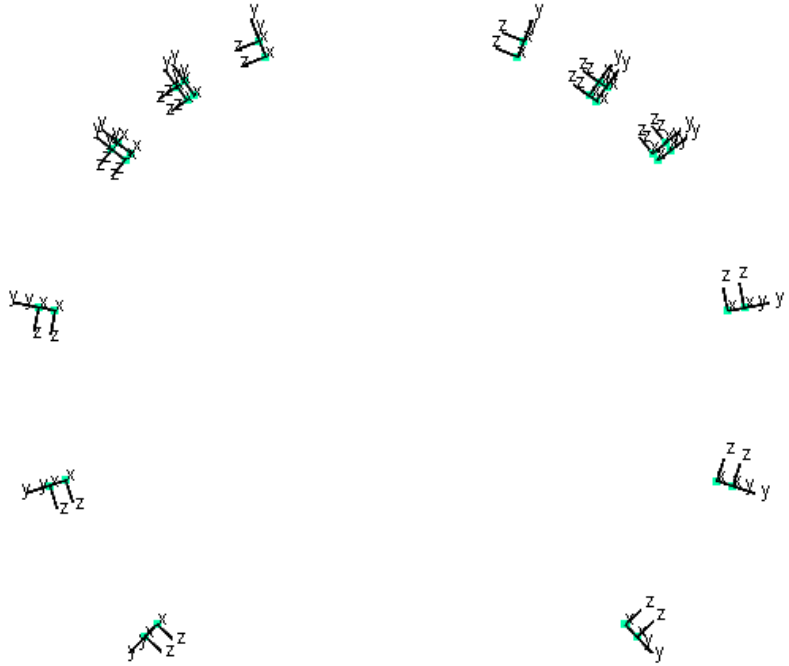
- New options have been added to improve visibility of triads.
- These new triad size options are found in the Display Options panel:
  - The **minimum factor** controls the minimum size of triads;
  - The **scale factor** scales the triad size.



Triad Symbols – Minimum Factor

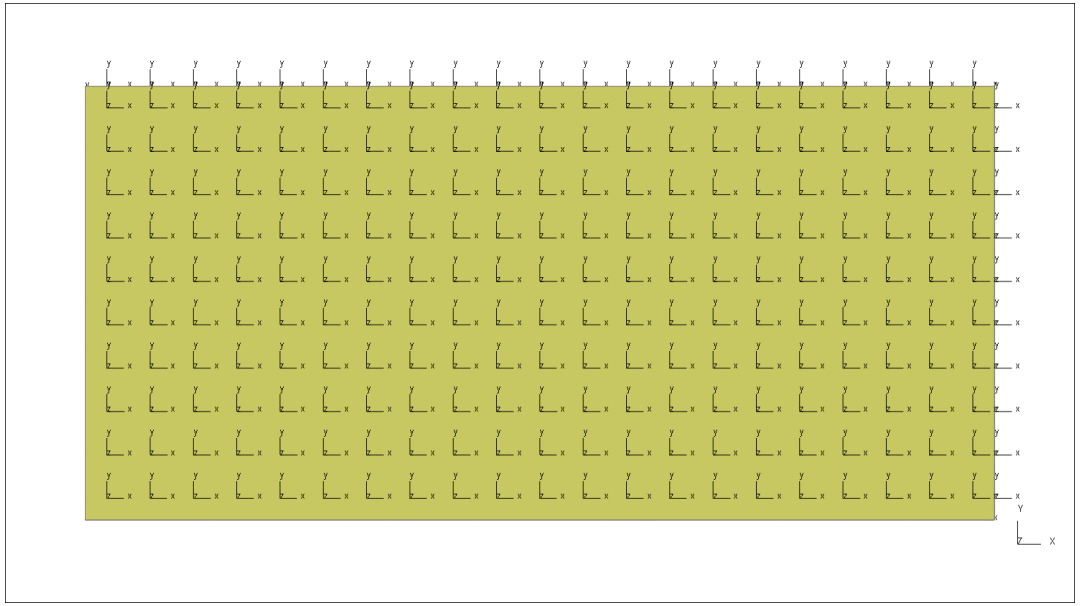


Minimum Factor: Off

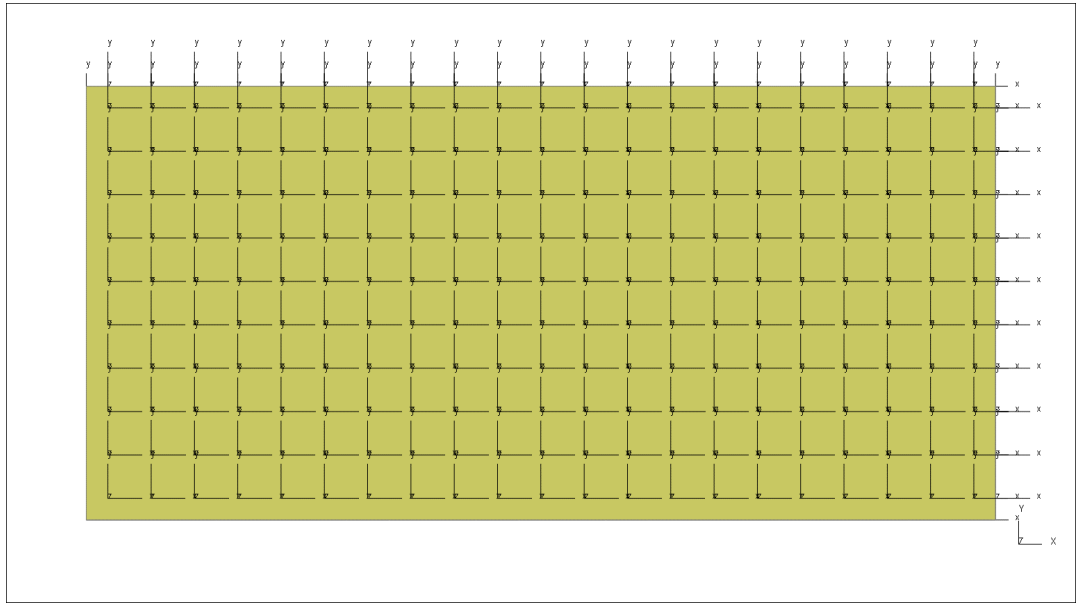


Minimum Factor: 4.0

Triad Symbols – Scale Factor (Off)



Scale Factor: Off

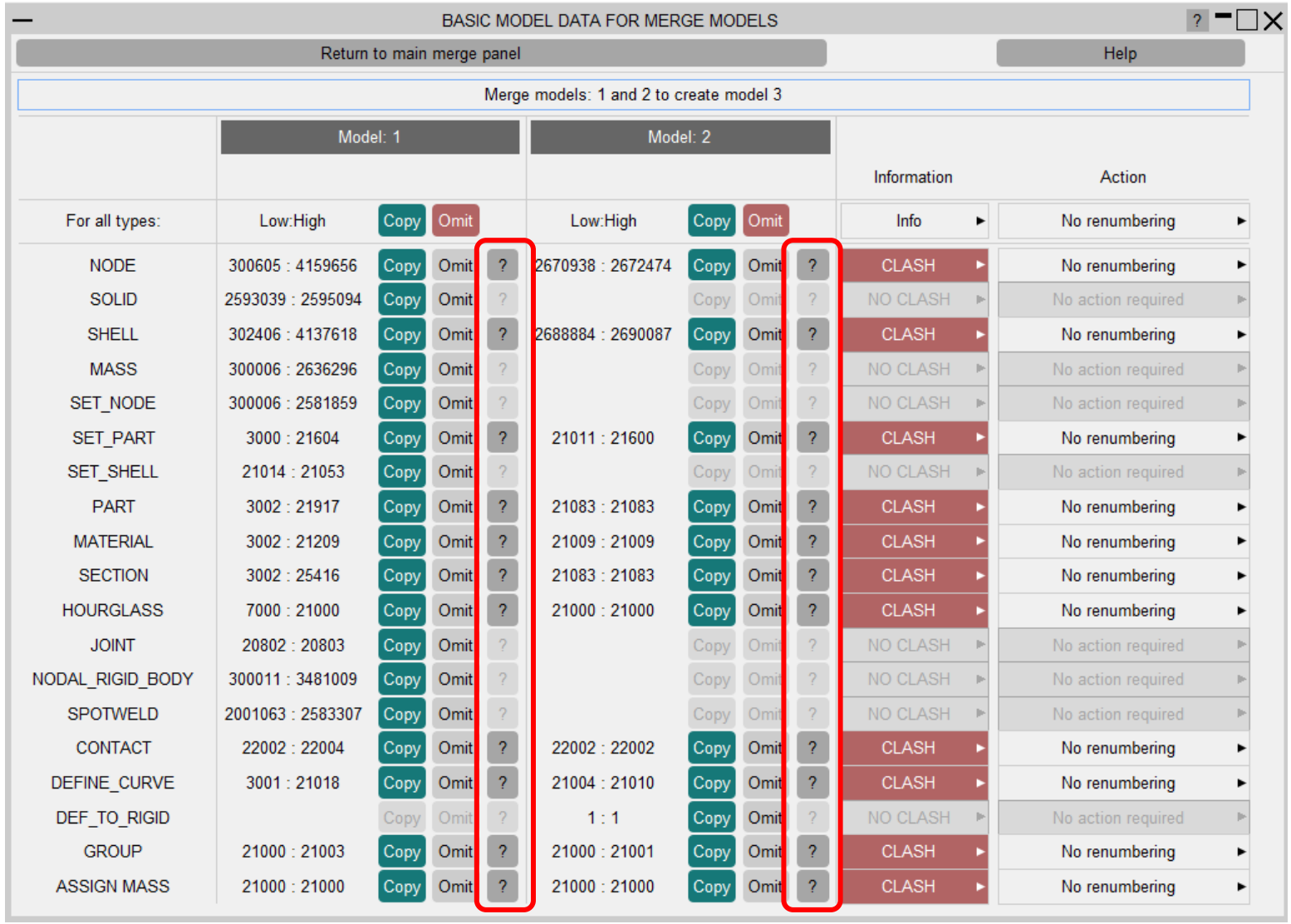


Scale Factor: 2.0

Merge Basic Model Data

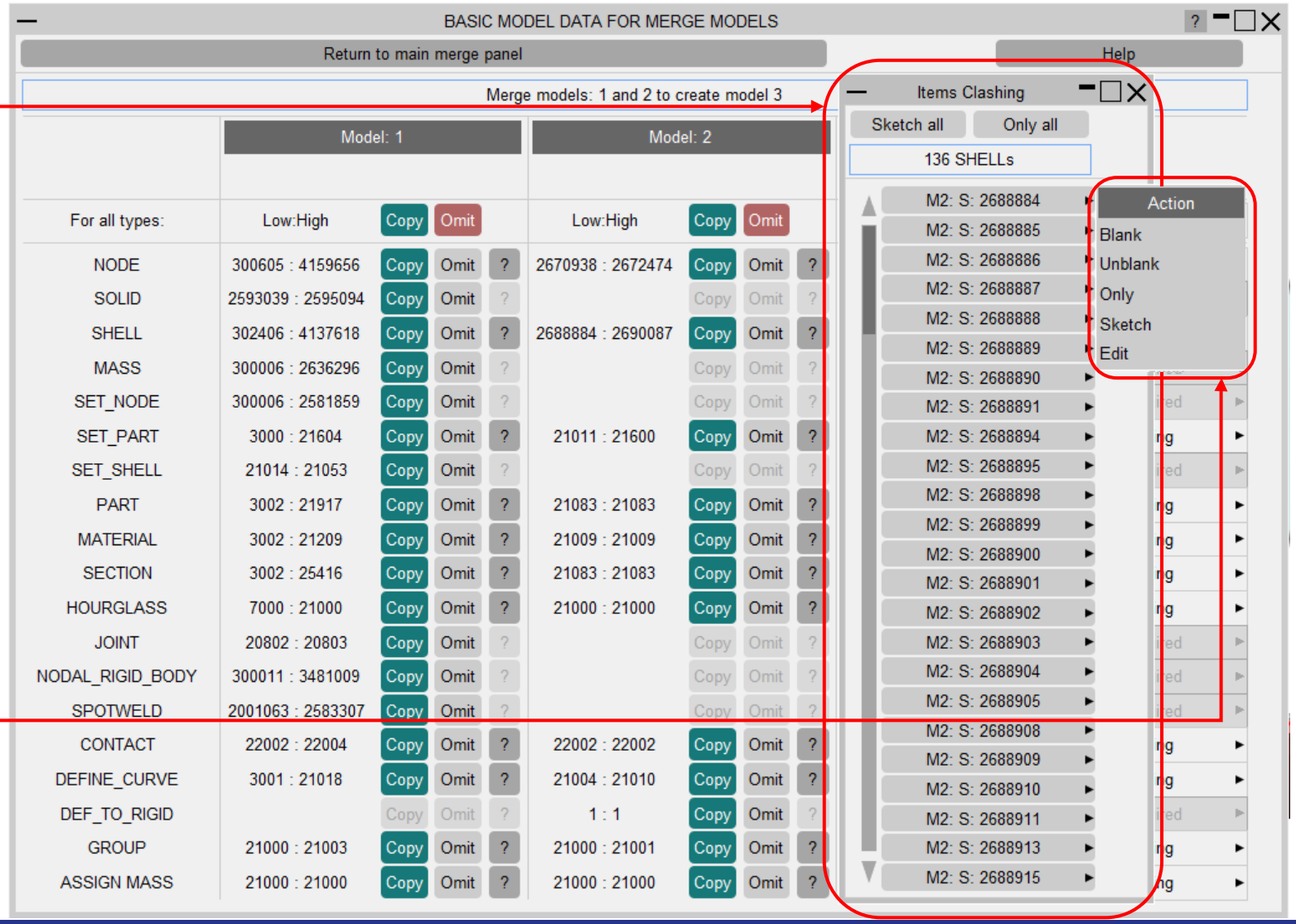
Merge Basic Model Data – new [?] button added

- In PRIMER 19, a new [?] button is added for each type.
- Note that it is only available when the relevant type has clashing items.



Merge Basic Model Data – new [?] button added

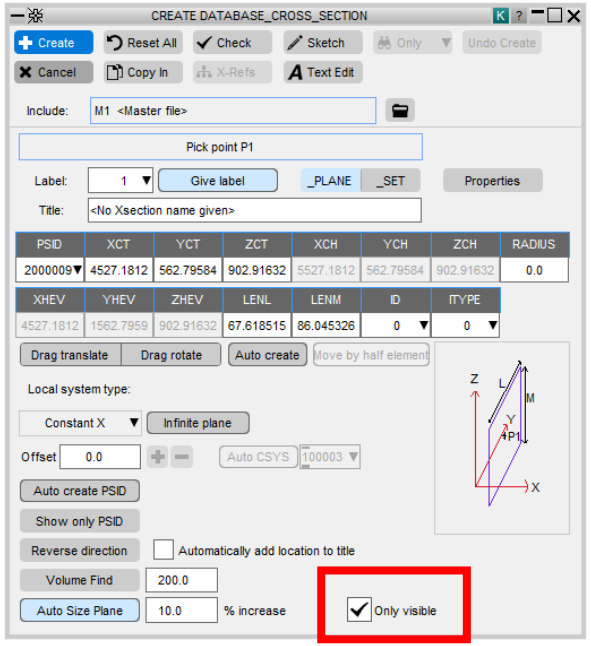
- Clicking on [?] will bring up a new popup.
- This allows users to 'Sketch all' & 'Only all' clashing items of the relevant type.
- From the list of all clashing items of the relevant type, a further popup has 'Blank', 'Unblank', 'Only', 'Sketch' & 'Edit' options for each individual item.



DATABASE_CROSS_SECTION

*DATABASE_CROSS_SECTION - only visible items

- Previous versions of PRIMER were inconsistent about the inclusion (or exclusion) of blanked entities in cross section definitions.
- This has been rationalised using a new ‘Only Visible’ option that will control the handling of blanked entities in a consistent manner.



v18

v19

Tie-break contact

*CONTACT_AUTOMATIC_SURFACE_TO_SURFACE_TIEBREAK

- Analysis of tie-break contacts has been improved.
- Tie distance as defined in LS-DYNA manual:

  MPP: 0.5*(SST+MST) + 0.01*sqrt(2*master segment area)

  SMP: 0.9*(SST+MST)

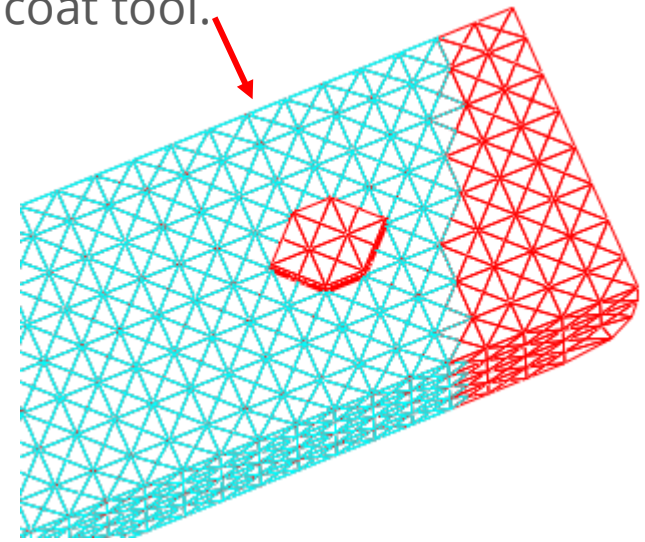
  where SST=slave segment thickness, MST= master segment thickness.
- Contact surface offset (CNTCO=1) applied to slave side of surface_to_surface, but not nodes_to_surface.
- Model check warning if CNTCO=0 and NLOC or _OFFSET in use on shells.

Making Patch Adhesive on Solids

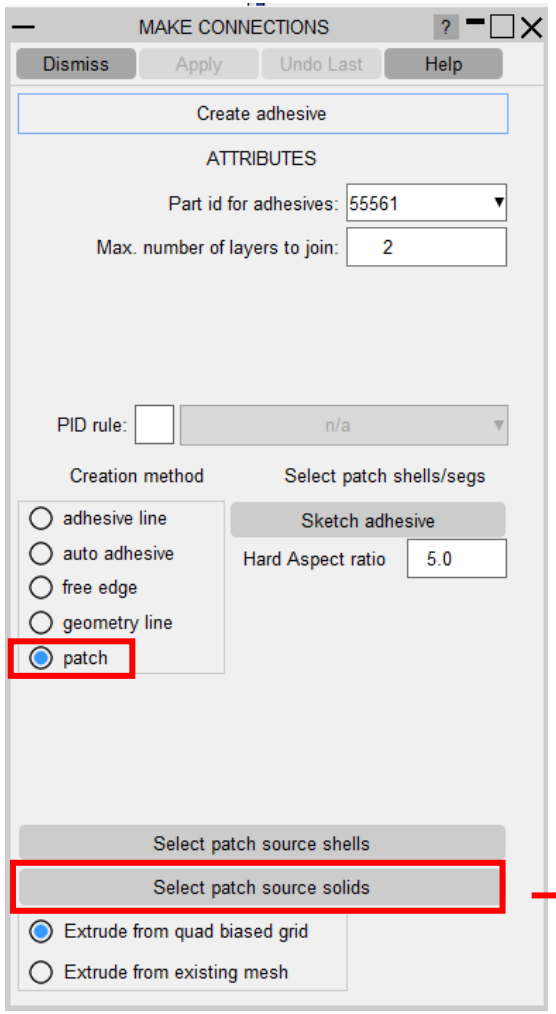
Adhesive Patch on Solids

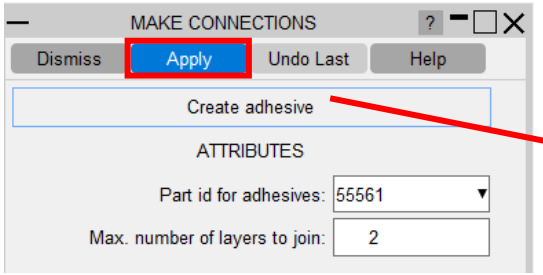
Select patch source shells

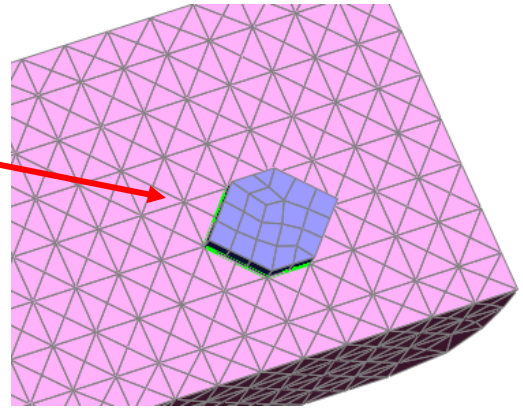
- In V18 **Select patch source shells** was the only option for patch adhesive.
- Required creation of shells on solid face using coat tool.
- Adhesive then created from selected shells.
- Adhesive extruded directly from mesh.
- Coating shells require deletion.
- V19 allows creation directly from solids.



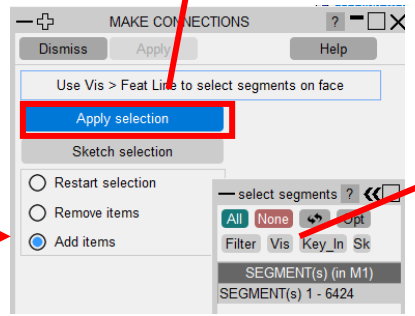
Adhesive patch made directly from solid surface

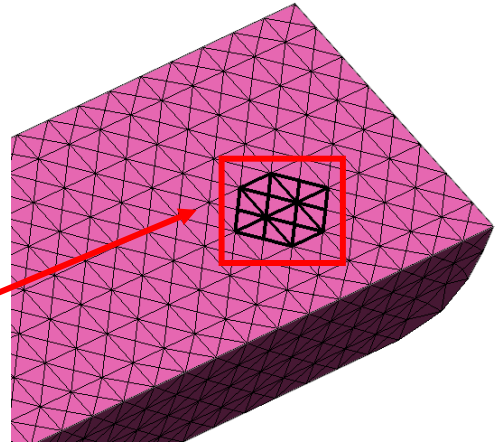






Default is to extrude from a quad-biased grid



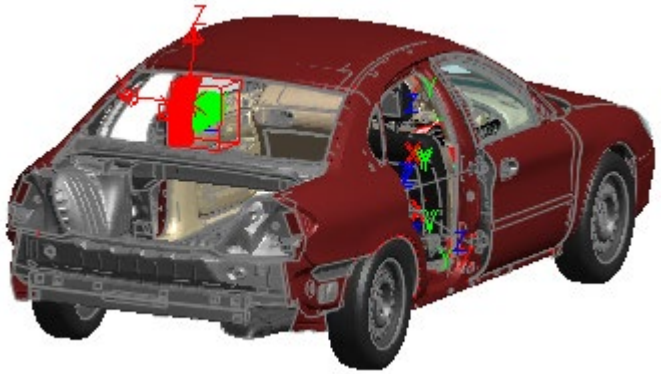


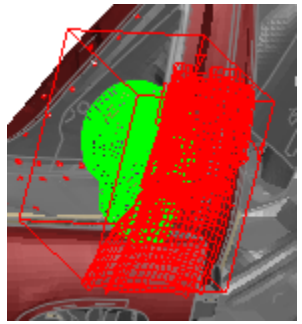
Segments selected by picking, by area or by face [feat line]

Speedup of multi-model build

Speedup for multi-model build contact positioning

- Contact often defined on whole body excepting impactor (SSTYP = 6).
- Model Build created segments on entire body side contact.
- In most cases impactor initial position is close to impacted body.
- Box limited segment generation saves CPU time and memory.
- Preference ‘model_build_generate_contact_boxes_for_depenetration’.
- Default is AUTOMATIC – limits body (red) segments to box formed around impactor.

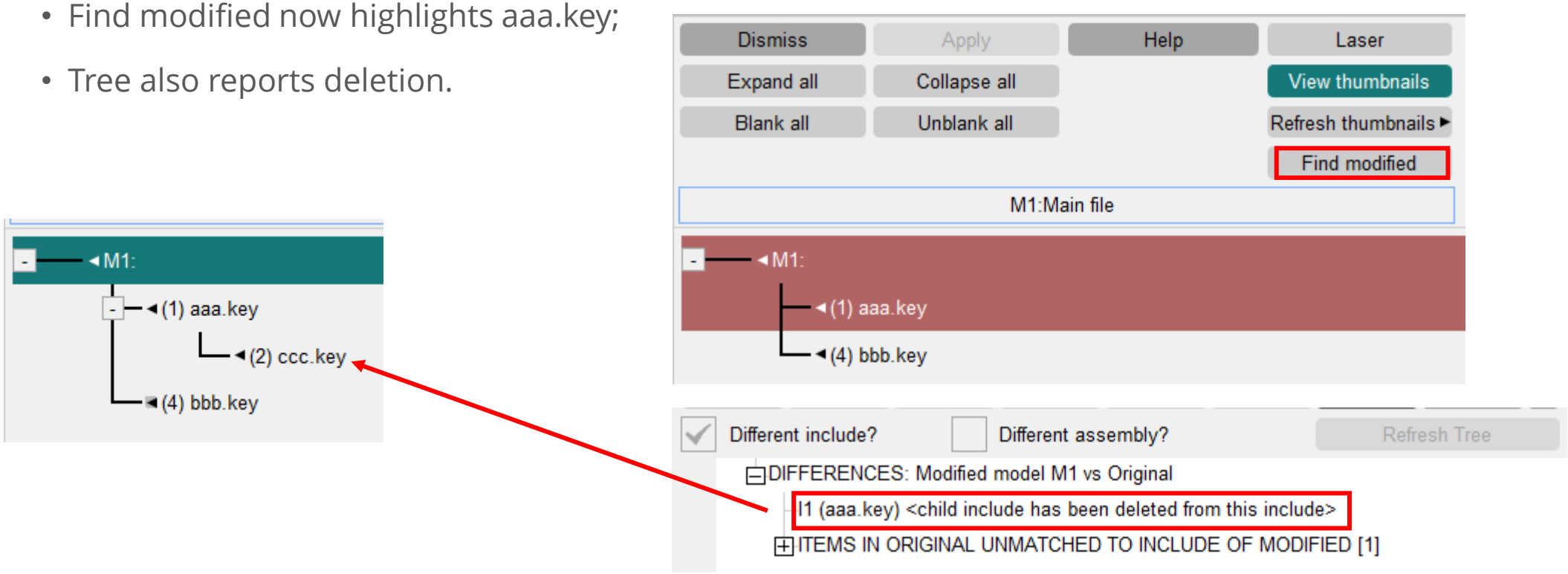




Finding Modified Includes

Finding Modified Includes

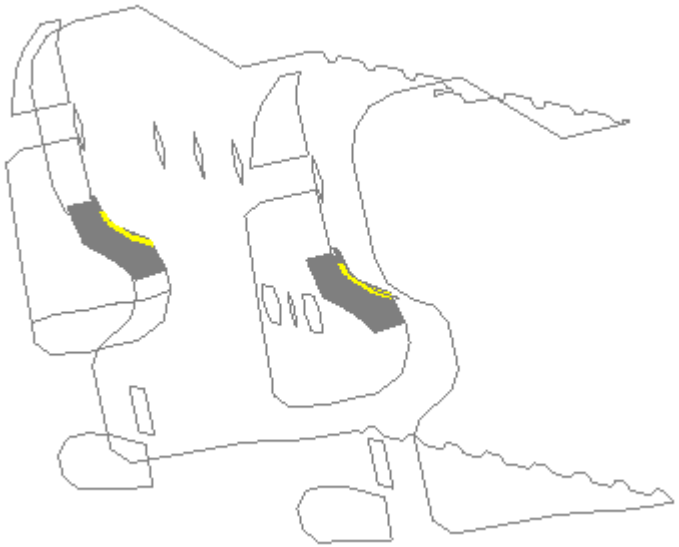
- Modification/deletion of an include now highlights the parent files in red.
- For example, consider the deletion of include ccc.key:
  - Find modified now highlights aaa.key;
  - Tree also reports deletion.

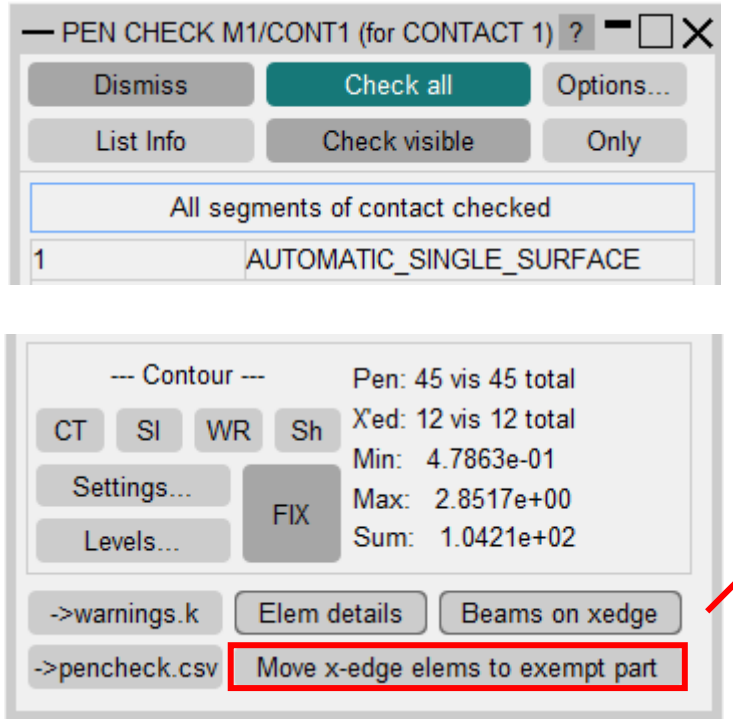


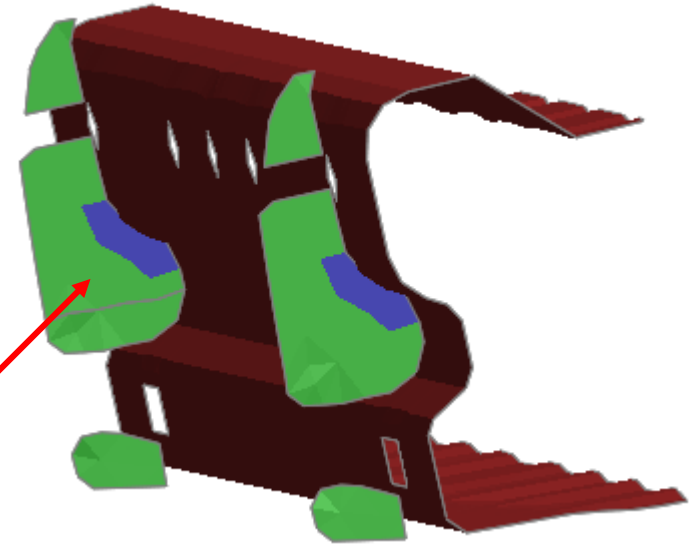
Fixing crossed edges

Fixing crossed edges

- CONTACT_AUTOMATIC_SINGLE_SURFACE using SSTYP=6 exempt part set.
- New tool to fix crossed edges by moving shells to new part in the exempt set.



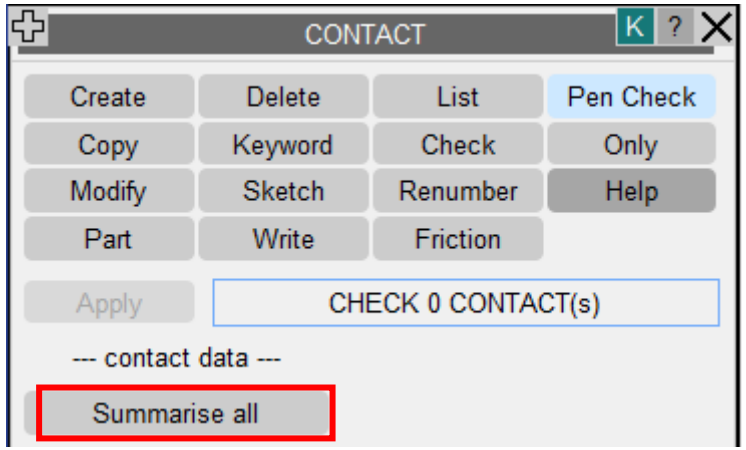




Contact Pen Check

All Contact Pen Check

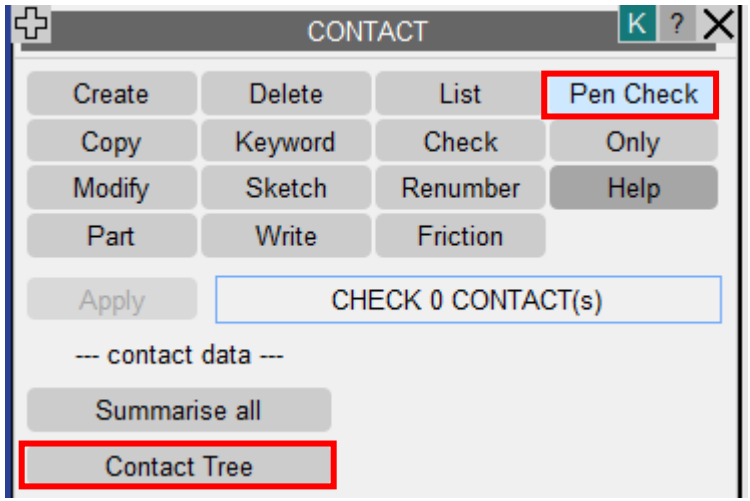
- Previously **Summarise all** gave text information only for sliding/tied contacts.
- This does not allow selection of contact for further PenCheck analysis.

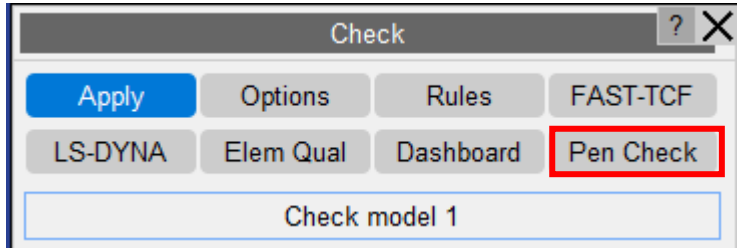


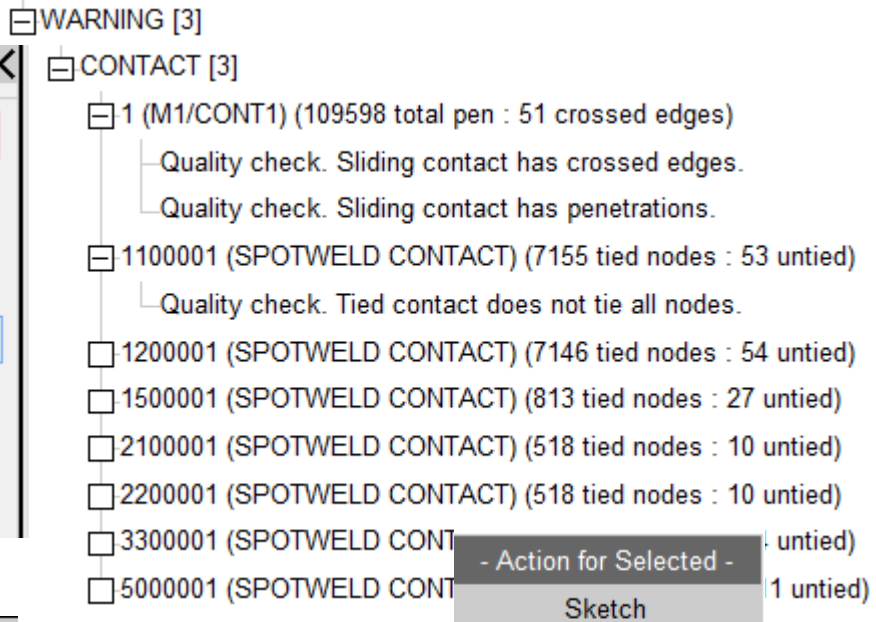

```
Surface M1/CONT1        has        0 penetrating nodes,        0 crossed edges (*CONTACT_AUTOMATIC_SINGLE_SURFACE)
Surface M1/CONT2        has        0 penetrating nodes,        0 crossed edges (*CONTACT_AUTOMATIC_SURFACE_TO_SURFACE)
Surface M1/CONT3        has        0 penetrating nodes,        0 crossed edges (*CONTACT_AUTOMATIC_SURFACE_TO_SURFACE)
Surface M1/CONT4        has        0 penetrating nodes,        0 crossed edges (*CONTACT_AUTOMATIC_SURFACE_TO_SURFACE)
Surface M1/CONT5        has        0 penetrating nodes,        0 crossed edges (*CONTACT_AUTOMATIC_SINGLE_SURFACE)
Surface M1/CONT6        has        0 penetrating nodes,        0 crossed edges (*CONTACT_AUTOMATIC_SINGLE_SURFACE)
Surface M1/CONT7        has     2736 penetrating nodes,        0 crossed edges (*CONTACT_AUTOMATIC_NODES_TO_SURFACE)
Surface M1/CONT8        has        0 penetrating nodes,        0 crossed edges (*CONTACT_AUTOMATIC_SURFACE_TO_SURFACE)
Surface M1/CONT9        has        5 penetrating nodes,        0 crossed edges (*CONTACT_AUTOMATIC_SURFACE_TO_SURFACE)
Surface M1/CONT53001    has      724 tied nodes,         0 untied nodes (*CONTACT_SPOTWELD)
Surface M1/CONT53002    has   380590 tied nodes,         4 untied nodes (*CONTACT_TIED_SHELL_EDGE_TO_SURFACE)
Surface M1/CONT200002   has    91798 penetrating nodes,    12358 crossed edges (*CONTACT_AUTOMATIC_SINGLE_SURFACE)
Surface M1/CONT919002   has        0 penetrating nodes,        0 crossed edges (*CONTACT_FORCE_TRANSDUCER_PENALTY)
Surface M1/CONT919003   has        0 penetrating nodes,        0 crossed edges (*CONTACT_FORCE_TRANSDUCER_PENALTY)
```

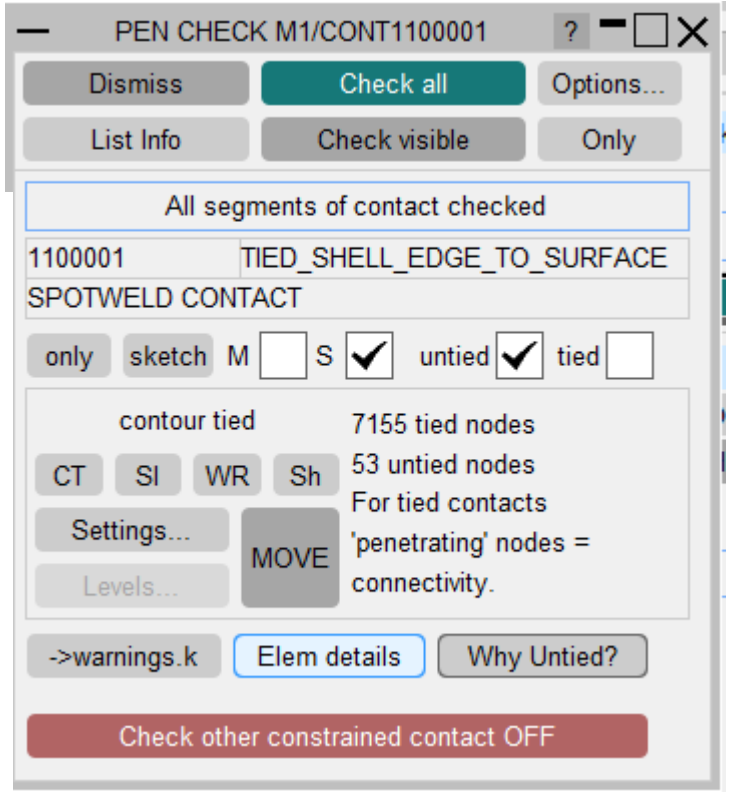
Contact Tree for Pen Check

- New Contact Tree tests all sliding/tied contacts and displays tree
- Tree drop-down **PenCheck** accesses detailed check panel directly





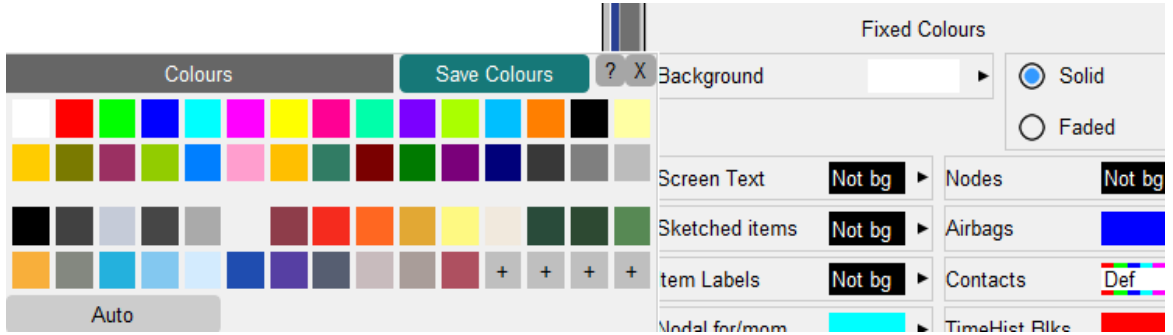




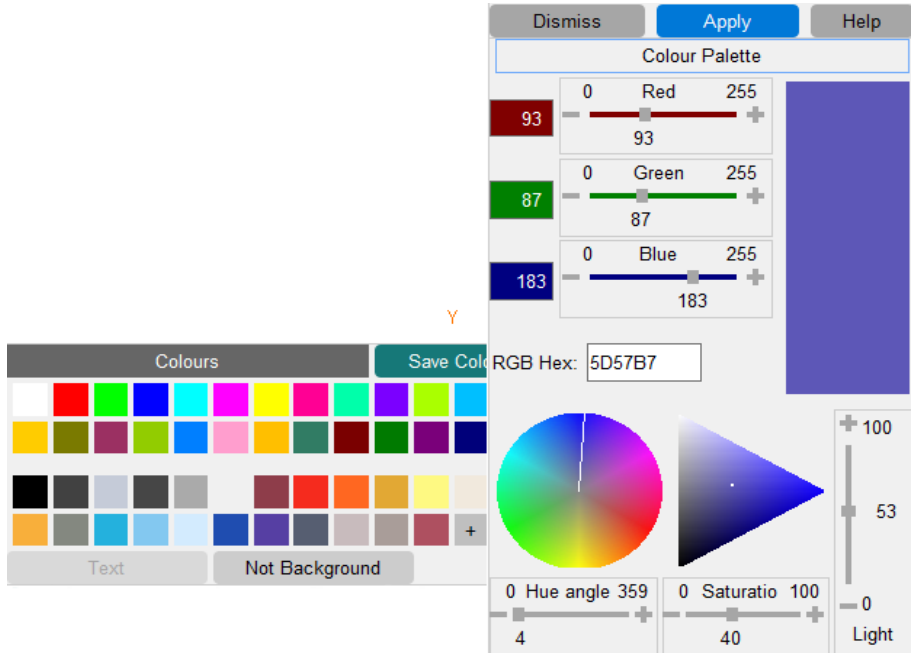
Updated Colour Popup

Colour Popup

- The colour popup in PRIMER has now been updated at all places and is consistent with D3PLOT and T/HIS.
- Users can now either choose one of the 30 core colours or create a colour from the palette in the popup by clicking on ‘+’ button.
- The created user colours can also be saved by clicking on the ‘Save Colours’ button. They are automatically loaded into the palette when the next session is opened.

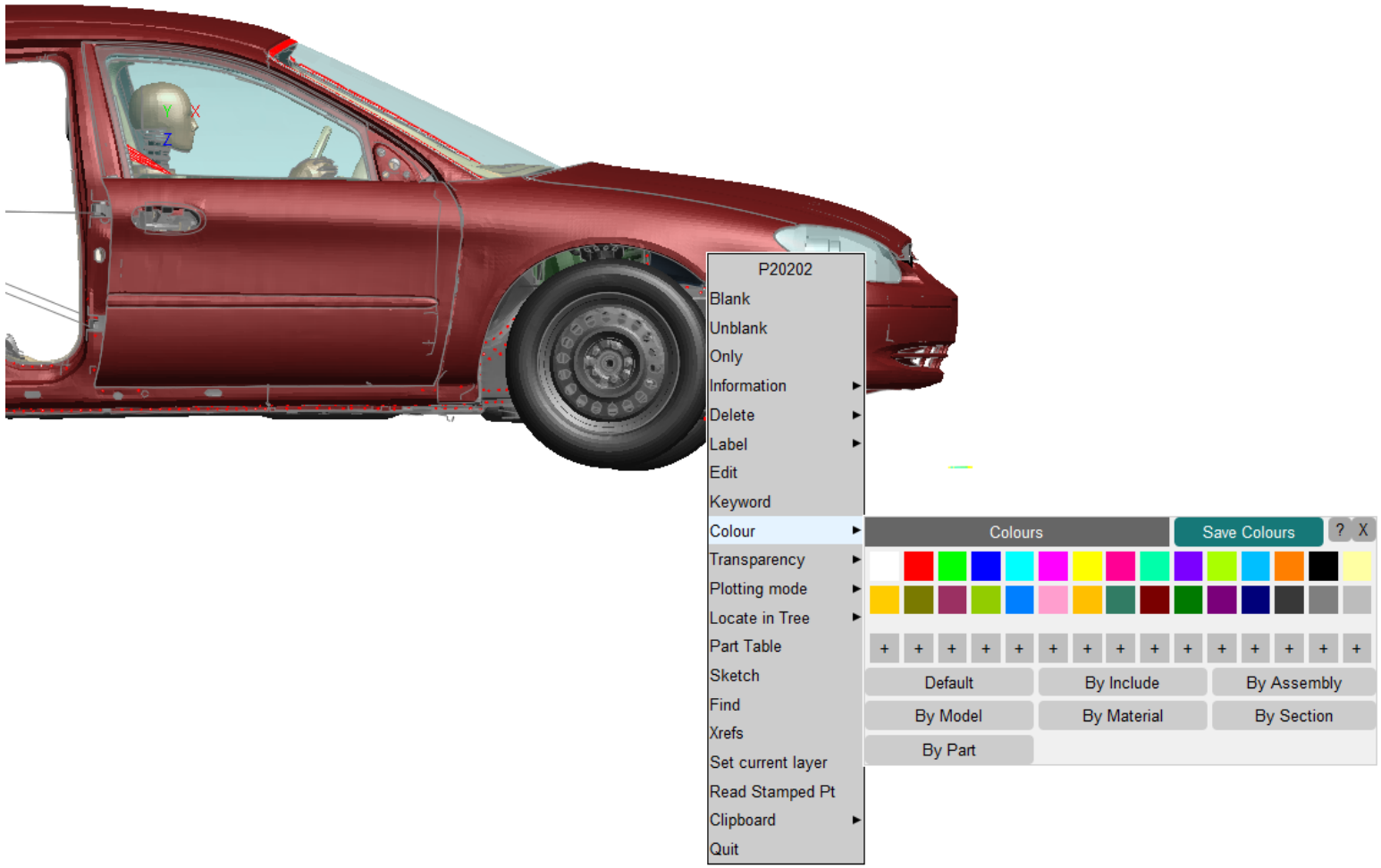


Updated colour popup



Colour Popup

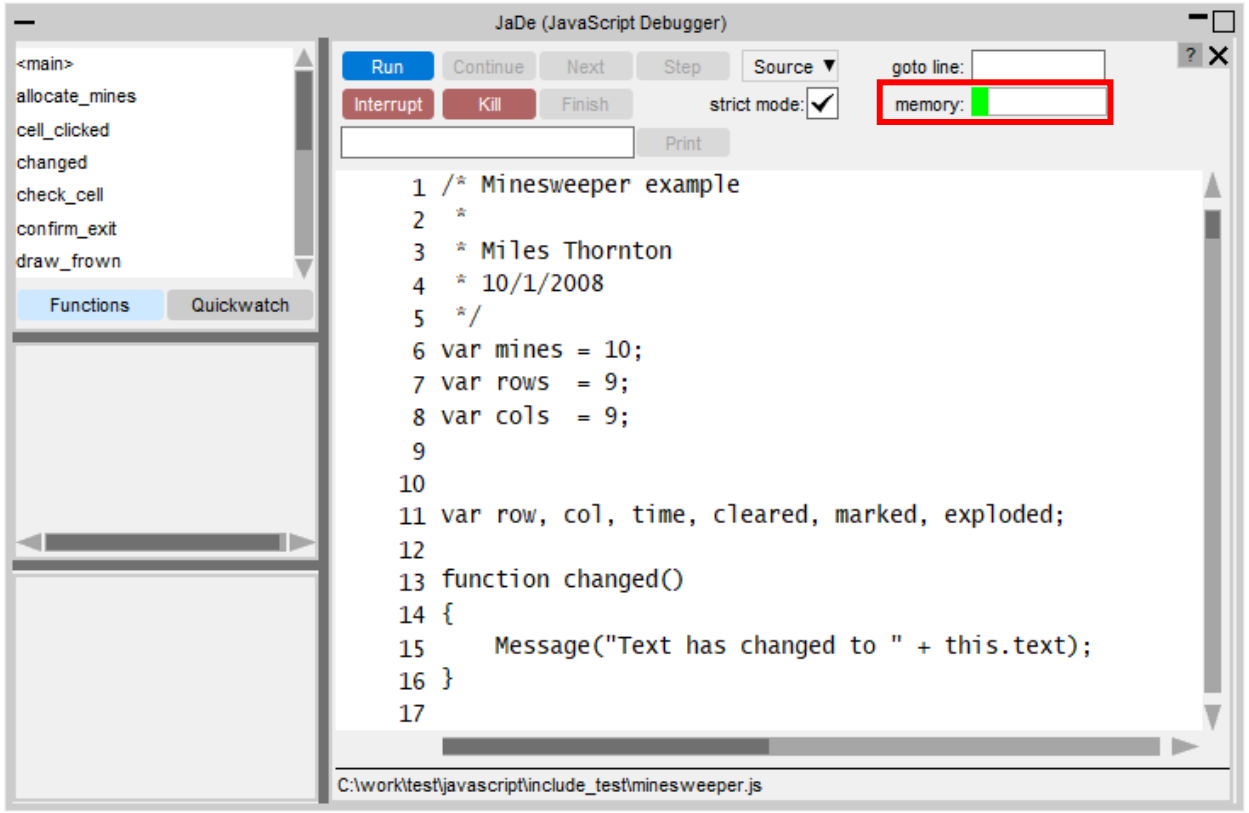
All the buttons that were previously present like colour ‘By Model’ , ‘By Include’ etc., are still present for the user to choose.



JavaScript

Memory use in JaDe

- The JavaScript debugger now shows how much garbage collection memory is being used by a script.



console API

- The JavaScript engine now implements the console API (as specified in https://console.spec.whatwg.org) so functions such as console.log(), console.warn() etc are now usable.
- Output is sent to the console window on Windows and the terminal window on Linux

Other JS API changes

- The JavaScript engine has been upgraded to the latest Extended Support Release version (Spidermonkey ESR91).
- ECMAScript 6 Modules are now supported in PRIMER. Both static and dynamic imports are supported.
- The special encoding comment at the beginning of a script now supports Shift-JIS.
- Chinese, Japanese and Korean fonts now display correctly in comboboxes, listboxes and in the tree view for custom JavaScript checks.
- A new Evaluate method has been added to the Parameter class to be able to evaluate parameter expressions in a script.
- SaveAll and UpdateAll methods have also been added to the Parameter class to enable multiple parameters to be changed before PRIMER updates the model.

Other JS API changes

- A new property addKeywords has been added to the Material class to obtain the number of *MAT_ADD cards that are defined for a material. The Keyword and KeywordCard methods in the Material class can now take an optional integer argument to return the *MAT_ADD data.
- Methods and properties to create and edit the following keywords have been added to the relevant JS-API classes:
  - *COMMENT
  - *CONTROL_MPP_DECOMPOSITION_TRANSFORMATION
  - *DEFINE_CURVE_SMOOTH
  - *DEFINE_HEX_SPOTWELD_ASSEMBLY
- A new function Colour.GetFromName has been added to return a colour value (integer) for a core colour or user colour from its name.

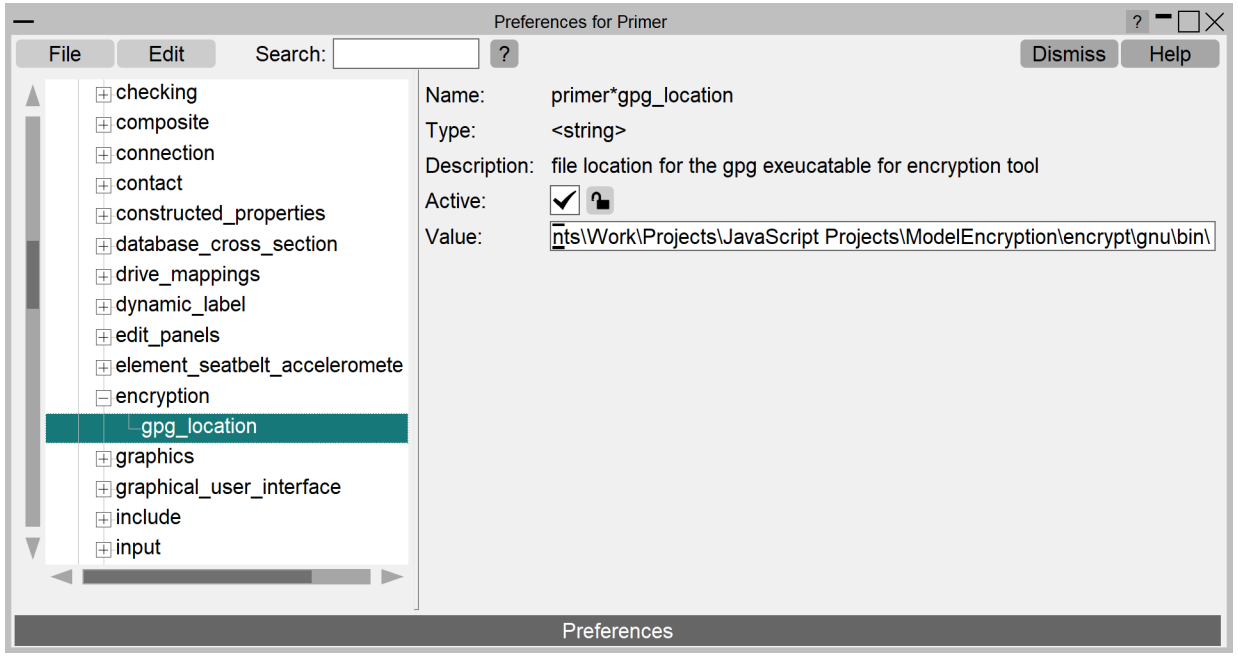
Encryption Tool Improvements

Encryption Tool Improvements – GPG Location Preference

- To prevent the user having to specify the location of the gpg.exe each time the tool is run, a preference has been set up.
- When the user first finds the location of the GPG through the file finder, the preference is automatically updated to that location.

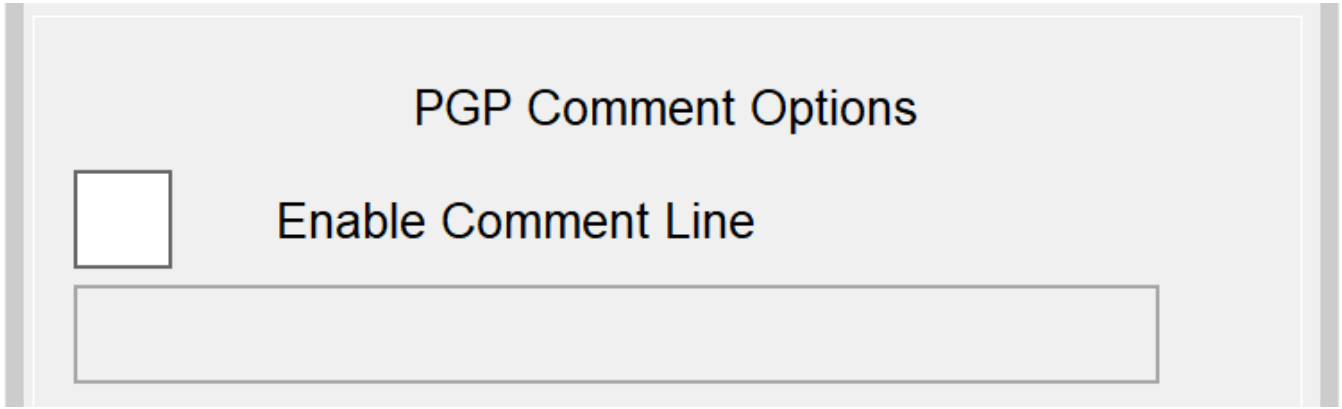
Edit Preference Manually:

- Options → Edit Preferences → PRIMER → Encryption → gpg_location
- Make sure to enter the file location (without “gpg.exe” ending)



Encryption Tool Improvements - Comments

- It is now possible to write a comment line into the Encryption tool from the 'Options' GUI.



- The Comment Line will now also print PRIMER Full/Partial Encrypt

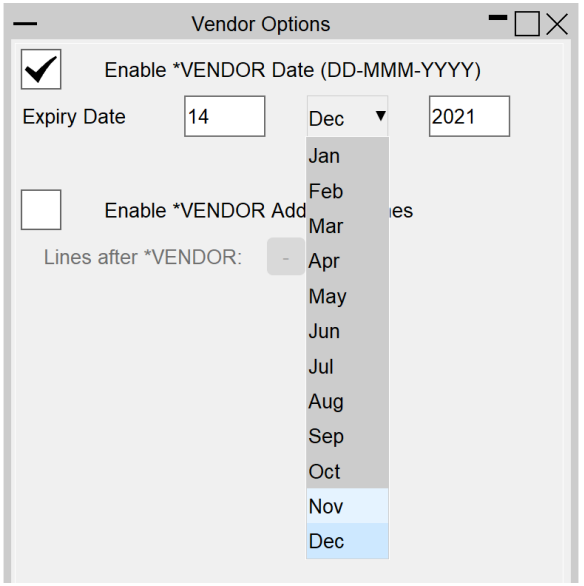
- Example output in the keyword file with Enable Comment Line

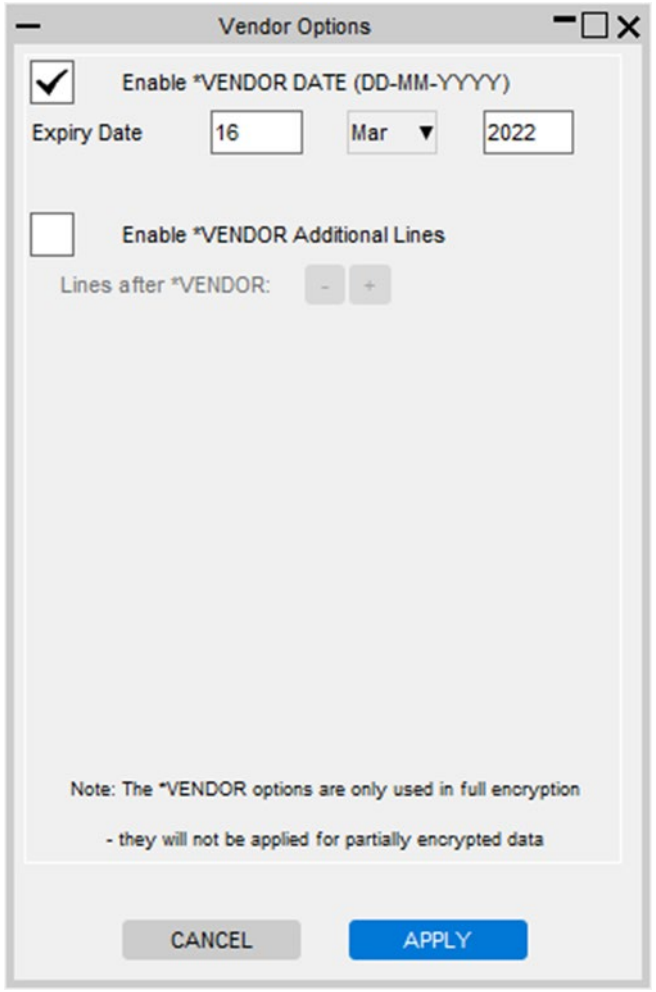
```
-----BEGIN PGP MESSAGE-----
Comment: PRIMER Full Encrypt | hi

hQEOAx24cNFeERoiEAP/SQLeOUqGHG3+5qUIhc0OFqeaBr+vz2avuYasF+em9KIw
I+OeKvayWuuibgGem0kCBE/aLxQYhPG9GltTldb95V0JKBbCk7vgcxAZYaNVdwlW
```

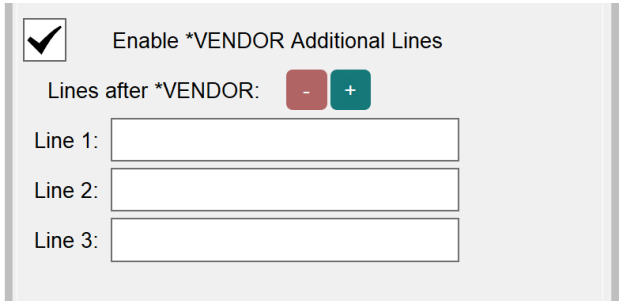
Encryption Tool Improvements – Vendor Options

- New Vendor Options GUI. Located from the Main Encryption Menu → Options → Vendor Options.
- All data from this GUI is written into the PGP Encrypted text.
- Specifying an Expiry Date:





- Additional Vendor Lines can be added/removed by pressing the green/red +/- buttons



Encryption Tool Improvements – Partial Encryption Start Line

- The Partial Encryption Start Line can now be specified from the Options GUI giving more control over encryption

- Encryption Start Line 2 is the default value and is per normal Partial Encryption where the title and first line are not encrypted and all lines that follow are encrypted

```
*MAT_PLASTICITY_COMPRESSION_TENSION_TITLE
Title Test
         1   7.85E-9     210.0       0.3       0.0       0.0       0.0       0.0
$
-----BEGIN PGP MESSAGE-----
```

- If the Encryption Start Line was specified to be at 7 for example then the title and first six lines are not encrypted and all lines that follow are encrypted

```
*MAT_PLASTICITY_COMPRESSION_TENSION_TITLE
Title Test
         1   7.85E-9     210.0       0.3       0.0       0.0       0.0       0.0
         0         0         0         0       0.0         0       0.0       0.0
       0.0       0.0       0.0       0.0       0.0
      0.03
       5.0       5.0
       6.0       6.0
$
-----BEGIN PGP MESSAGE-----
```

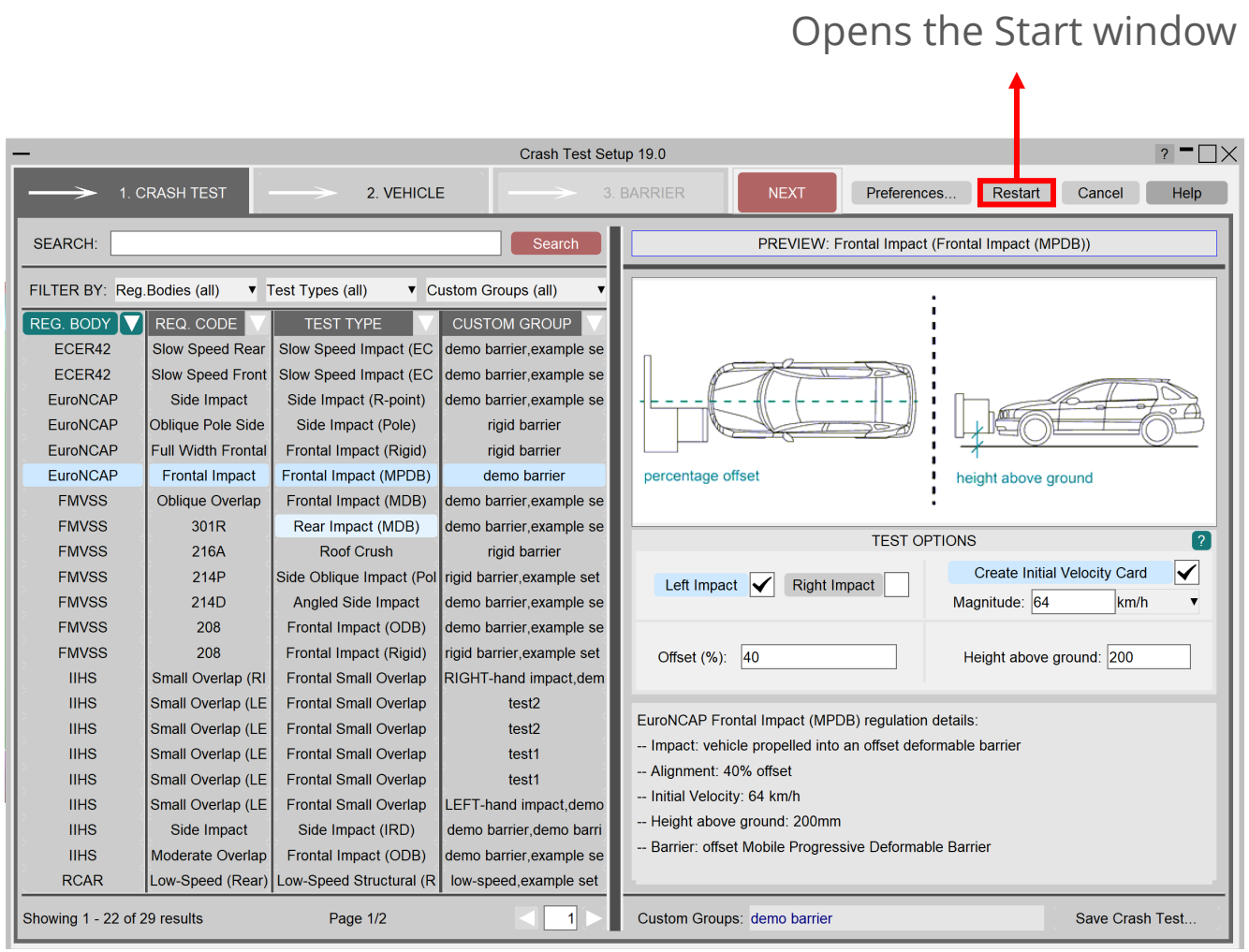
Crash Test Setup Improvements

Most recent regulations/commercial test specs

- New test added: EuroNCAP full width frontal impact.
- EuroNCAP oblique pole side impact test: test settings and barrier alignment updated according to the latest protocol.
- UN-ECE R32 rear impact rigid test: name and display image corrections.
- EuroNCAP Frontal Impact: Default barrier changed to a simplified Mobile Progressive Deformable Barrier (MPDB).
- IIHS Side Impact: Impact velocity updated to 60km/h and IRD calculations updated according to the latest protocol.

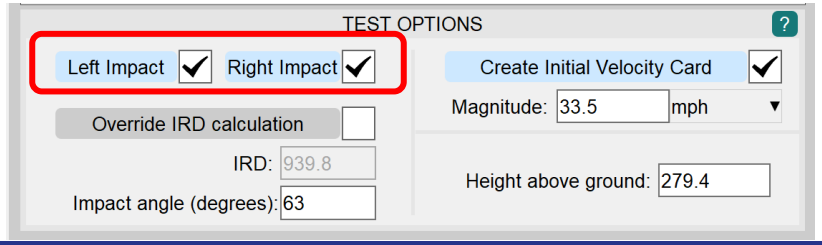
Option to rescan the model

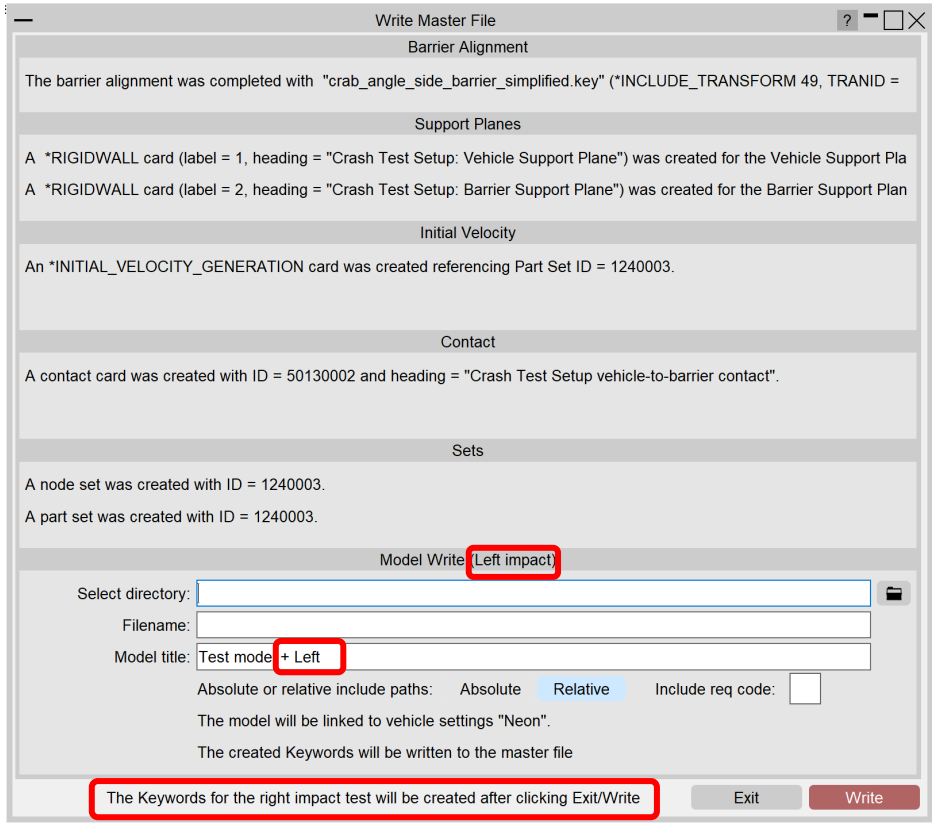
- The ‘Restart’ button allows the user to rescan the vehicle model while resetting all default parameters, without the need to exit and restart.

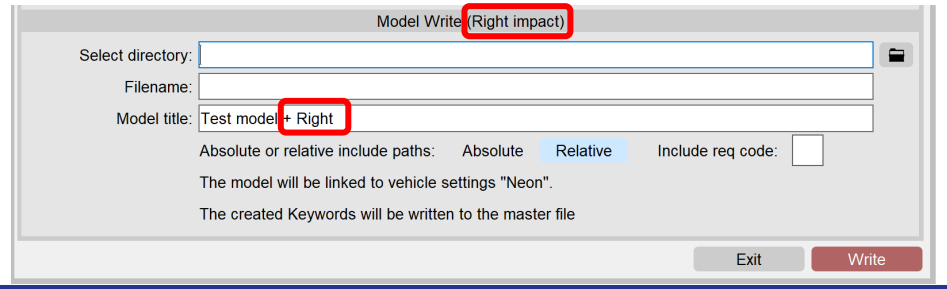


Option to create ‘Left’ and ‘Right’ impact setups simultaneously

- It is now possible to create left and right impact setups simultaneously.
- This will create a copy of the selected model resulting in two models with similar keywords/labels, one for each side.
- When the user clicks on the ‘Go’ button, the keywords are created/saved in the following order:
  - *Left side impact keywords created;*
  - *‘Write Master File’ window for left side impact;*
  - *Right side impact keywords created;*
  - *‘Write Master File’ window for right side impact.*
- Both models contain the same labels for all selected/created elements except the vehicle contact part set which can be different for each side.
- The ‘Model Write’ panel in the ‘Write Master File’ window will indicate which impact side test is being written.

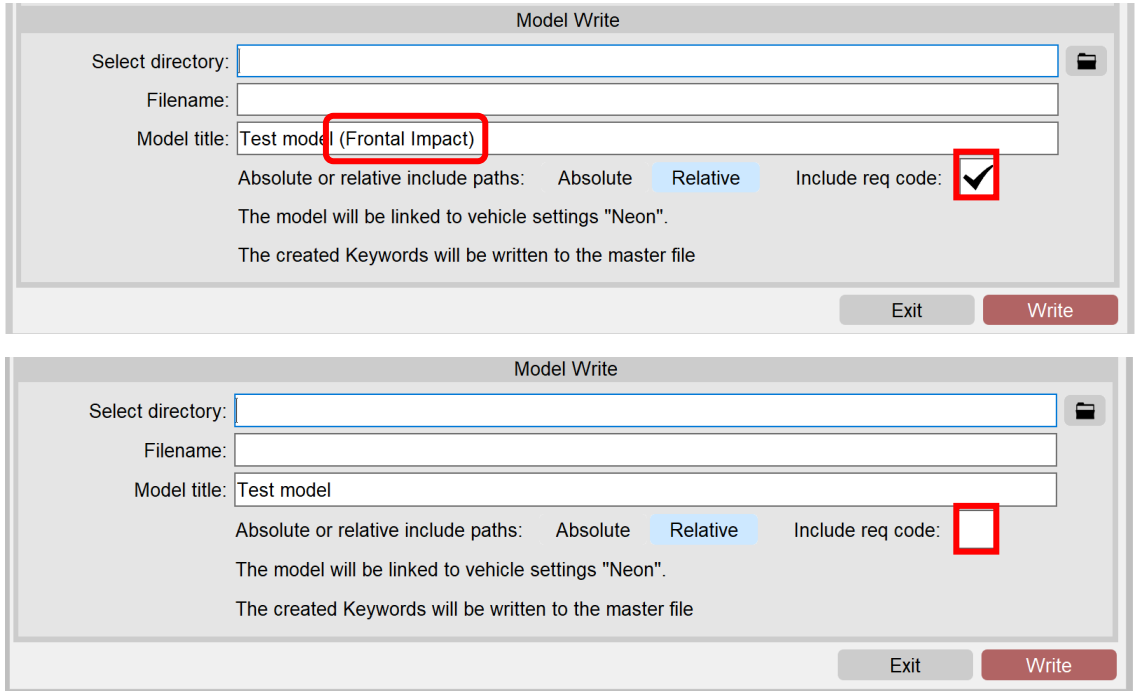






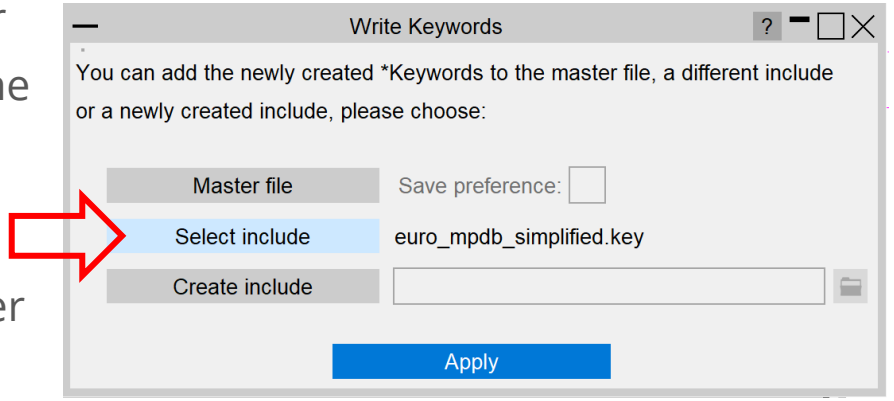
Option to include req code in the model name

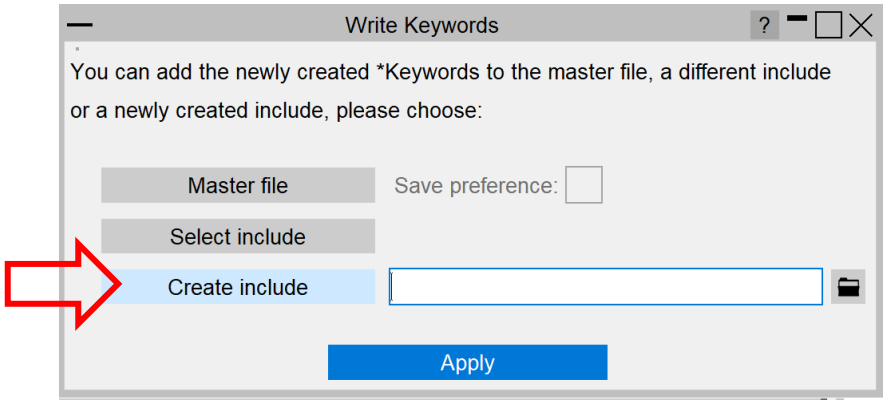
- The ‘Include req code’ checkbox in the ‘Write Master File’ window adds the requirement code of the corresponding test setup (as shown in the crash test settings) to the master model title.

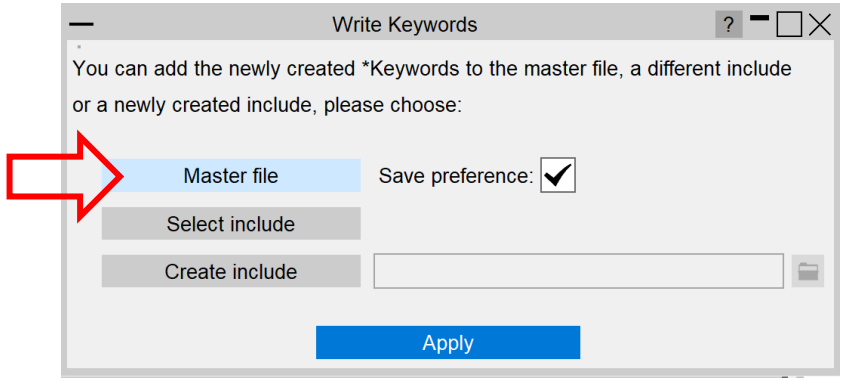


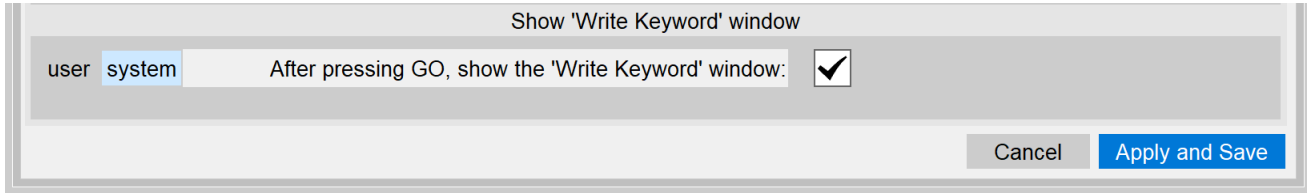
Write the created crash test setup *keywords to a different include

- A new pop-up window is now displayed before the ‘Write Master File’ window allowing created keywords to be written to either the Master file, an existing include or a new include file.
- The ‘Save preference’ checkbox can be used to save a user preference so that the keywords are always written to the master file, which will skip the ‘Write Keywords’ pop-up window.
- If both ‘Left’ and ‘Right’ impact sides are selected, a similar pop-up window will be displayed for each side and the user has the option to select a different option for each.





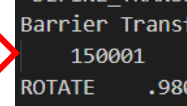




Write Transformation card on one line

- All the rotations and translations of the barrier are combined to result in only one line for rotations and one line for translations in the *DEFINE_TRANSFORMATION_TITLE card.
- Note that in some cases more than one line for the rotations will be required when rotations are around different points.

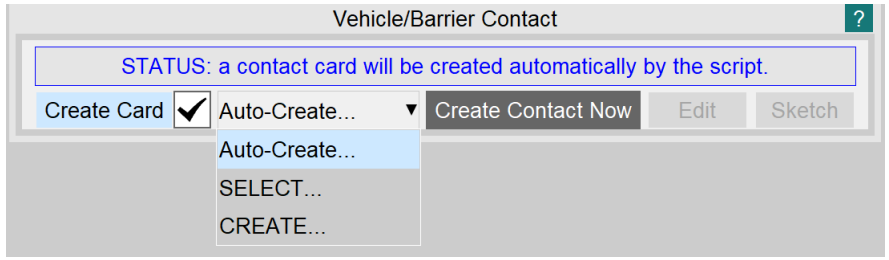
```
*DEFINE_TRANSFORMATION_TITLE
Barrier Transformation
    150001
ROTATE          1.0       0.0       0.0     914.5     381.0       0.0      25.0
ROTATE          0.0       1.0       0.0     914.5     381.0       0.0       5.0
TRANSL    1242.45055-1289.43022322.10357
TRANSL    -77.238495 411.67514-882.84003
```

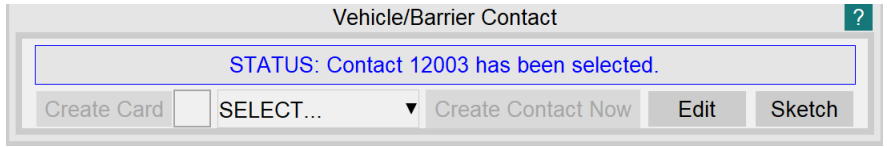


```
*DEFINE_TRANSFORMATION_TITLE
Barrier Transformation
    150001
ROTATE    .980254444.193053061-.04279883     914.5     381.0       0.025.4872919
TRANSL    1165.21205-877.755091439.26354
*
```

Option to select/create a contact card

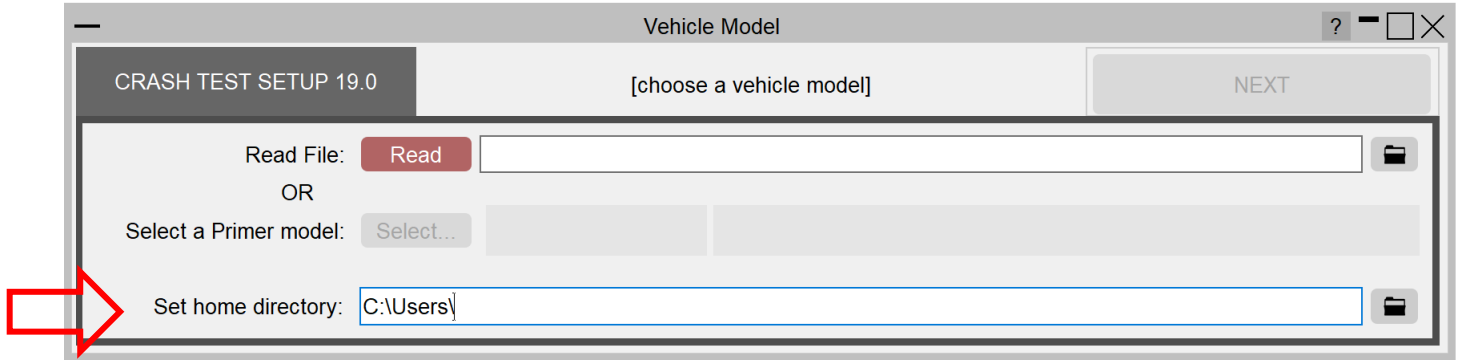
- The user can SELECT/CREATE a contact card in the barrier settings.
- The ‘Create Contact Now’ and ‘Edit’ buttons are separate now, where ‘Create Contact Now’ allows the user to check the values of the automatically created card with the option to do any changes.
- The ‘Edit’ button applies to all three options.
- Once a card is selected/created or the parameters in the automatically created card are changed, the default imported parameters cannot be retrieved.





File/Folder directory related changes

- Changed default file path from generic home to model location when writing.
- Removed the default ‘Read file’ location on start up.
- User defined 'Home' directory in Start window.



Other changes

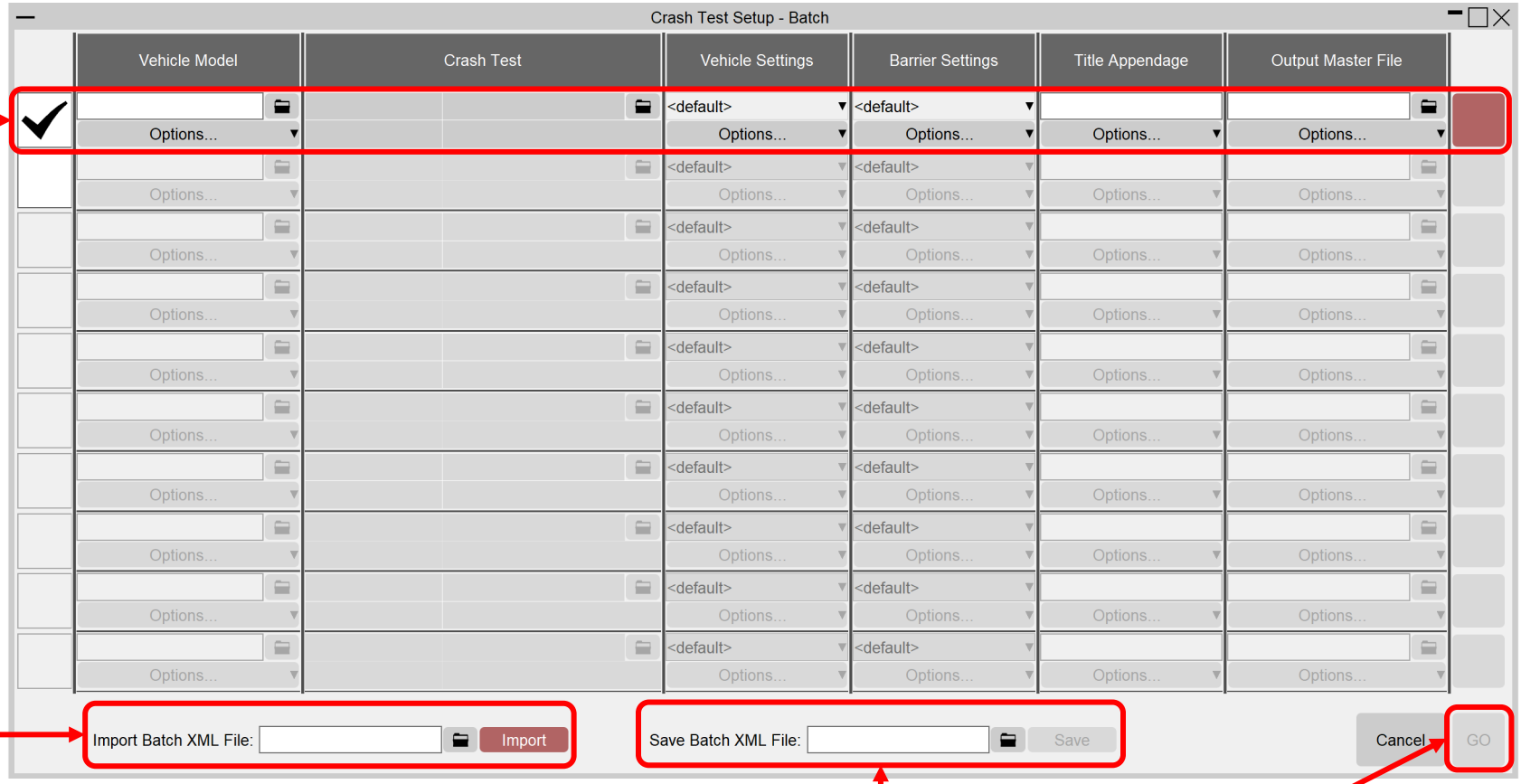
- Images now appearing in full size on 4K monitors.
- Previously imported barriers in current session are automatically deleted when the user imports/selects a new barrier include file.
- A different barrier include file can be selected multiple times in a given session.
- Default barrier settings are automatically added when importing a default barrier more than once.
- The barrier settings window gets reset when a different test is selected.
- Added user warning when selecting a home path which is not valid.
- Various GUI corrections.

Batch crash test setup scripts

- The BATCH crash test setup scripts can be used to set up multiple different crash tests at once. This automates the setup process and makes it easier to generate many load cases.
- Two scripts are available, one with a user interface to help the user generate/modify the test setups. A second script, with no UI can be used to set up the cases straight from the saved batch XML files.
- The batch test setups can be saved as XML files so they can be reused and modified later using the scripts.
- The batch scripts can run all the predefined load cases, as well as user modified tests and barriers. It also allows for different vehicle settings to be used.

Batch crash test setup UI

Select input vehicle, crash test type, vehicle/barrier settings and name/location of the generated master file. The red light on the right indicates that the setup on this line is invalid.



Previously generated batch test setups can be imported and modified.

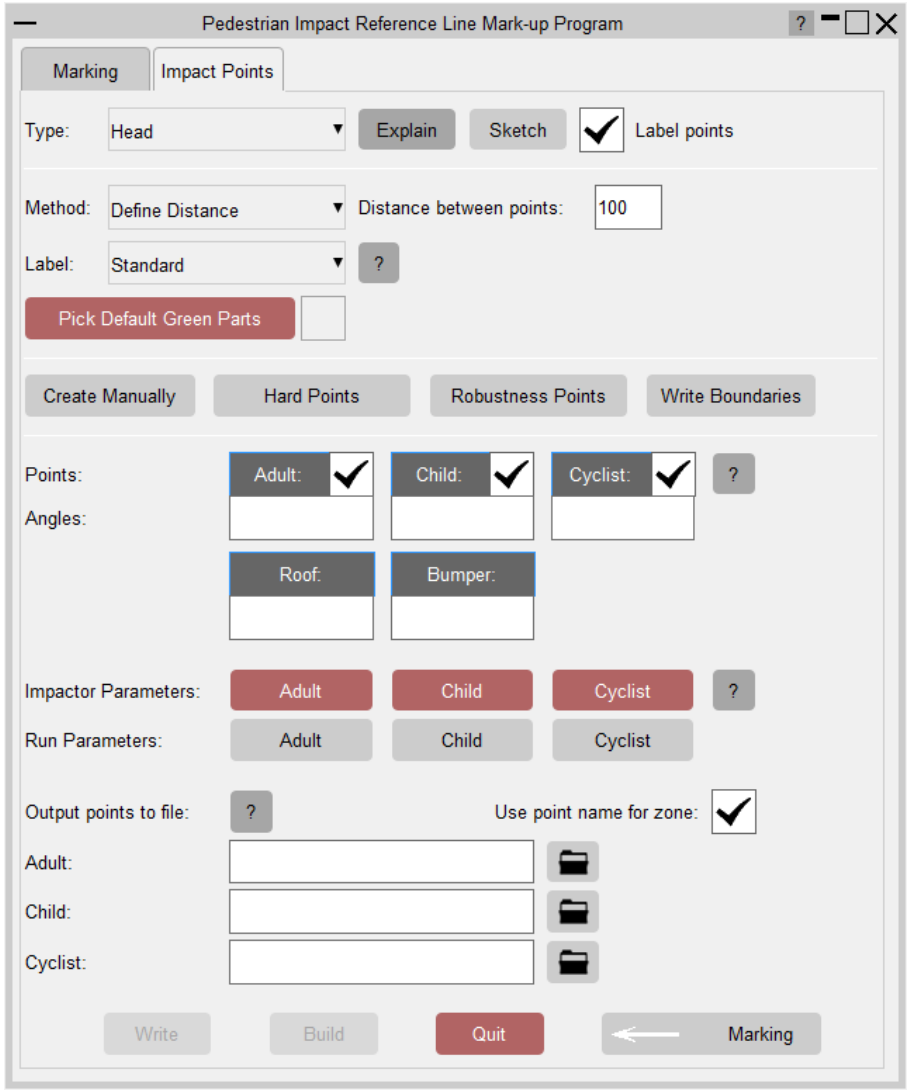
The batch test setup can be saved as XML file.

The crash tests can be generated if the batch tests are valid

Pedestrian Impact Markup Tool

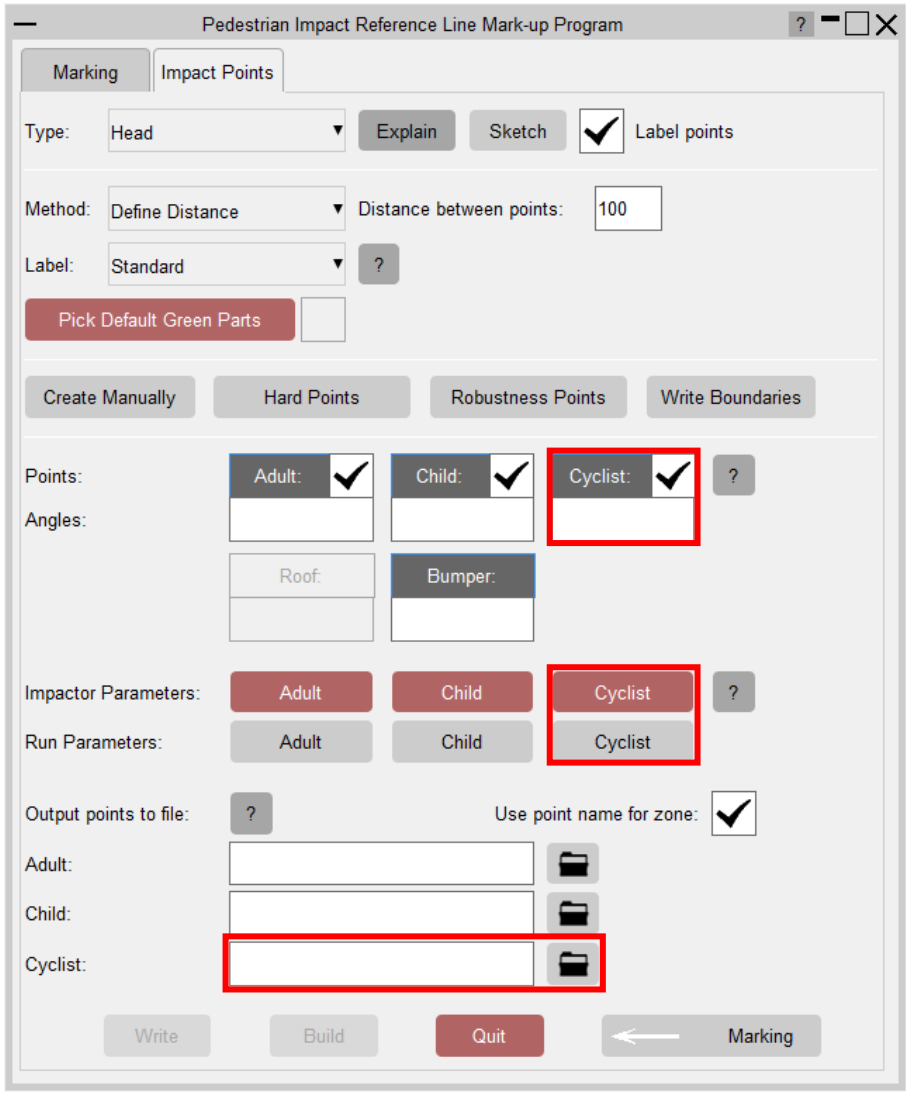
Updated head impact GUI layout

- To account for some additional textboxes and widgets (to support the latest protocols), the head impact GUI has been updated.
- The GUI still follows the same rough layout: with the desired impact types and their corresponding orientation angles given at the top, followed by their respective Impactor/Run parameter options, and finally their output filepaths given at the bottom.



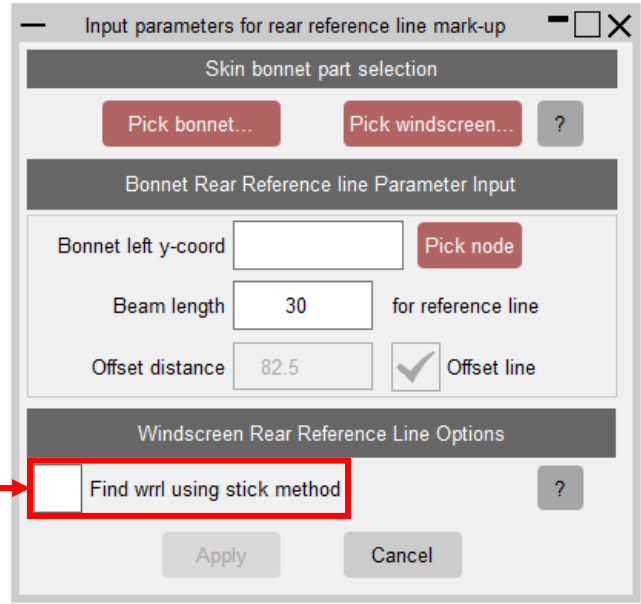
Support for the latest CNCAP (2021) protocol

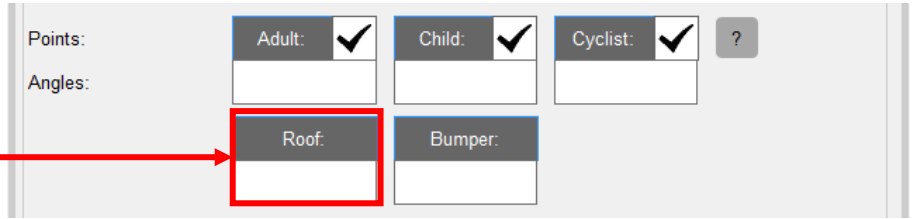
- The CNCAP 2021 pedestrian impact protocol has been added to the markup tool.
- Settings for impact points between WAD 2100 – 2300 can be specified via the **Cyclist** options.



Support for the latest EuroNCAP (v9.0) testing protocol

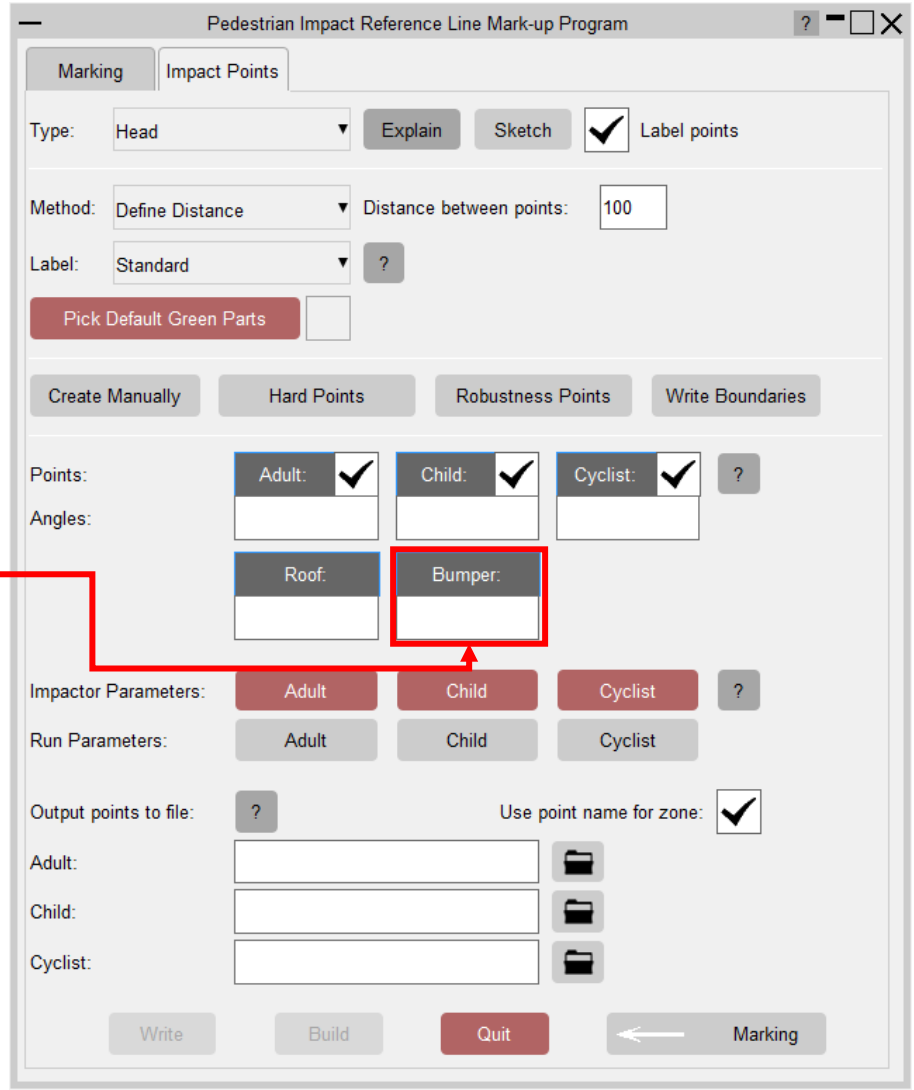
- The EuroNCAP Testing Protocol v9.0 has been added to the markup tool.
- The windscreen rear reference line (WRRL) can be calculated by determining the rearmost free edge of the windscreen part (default), or by determining where a vertical stick rotated 45 degrees rearwards touches the windscreen.
- The Impactor orientation angle for adult/cyclist head impact points behind the WRRL can be specified via the **Roof** textbox.





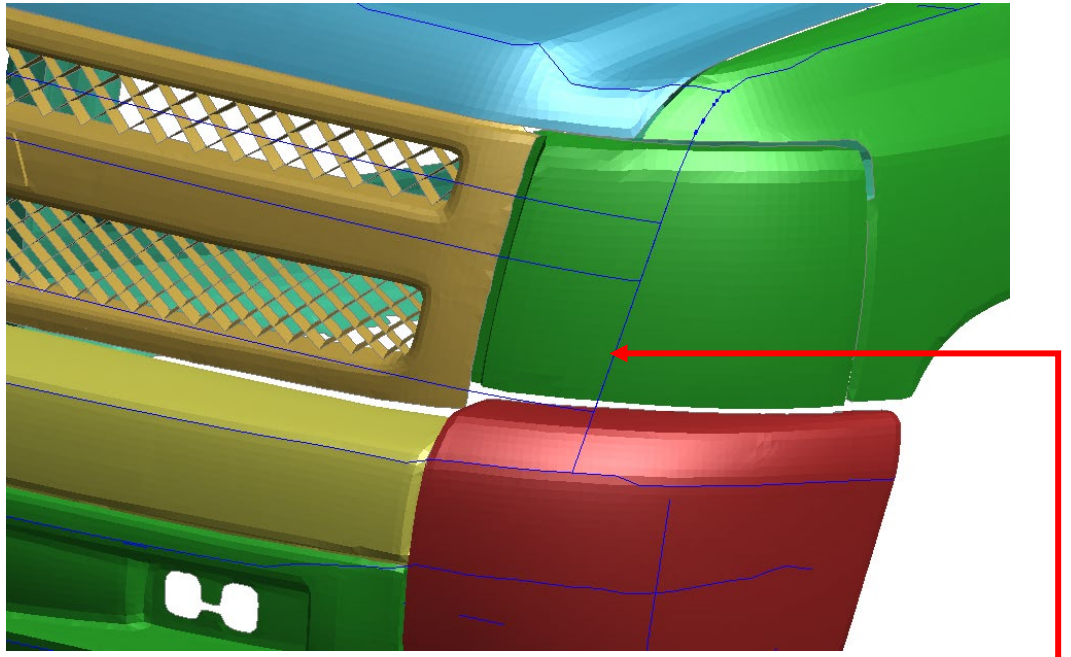
Additional child impactor orientation angle

- For EuroNCAP 8.0 and CNCAP 2018 onwards, an alternative impact angle is used for Child head impact points on/in front of the bonnet leading edge.
- A new textbox, **Bumper** (angle), has been added to set the impactor rotation angle for these impact points.



Projected line for corner reference point

- Section 3.6.1 of EuroNCAP V8.0 (onwards) describes how the corner reference point will be projected forward to the WAD 775 line.
- This is now supported in the markup tool.
- A line joining the corner reference point and its projected point is drawn for ease of visibility.



Line joining the Corner Reference Point and its projected point.

New Preferences/Command line arguments

Preferences:

- `primer*pm_cyclist_head_template`: Impactor template file for cyclist head impacts

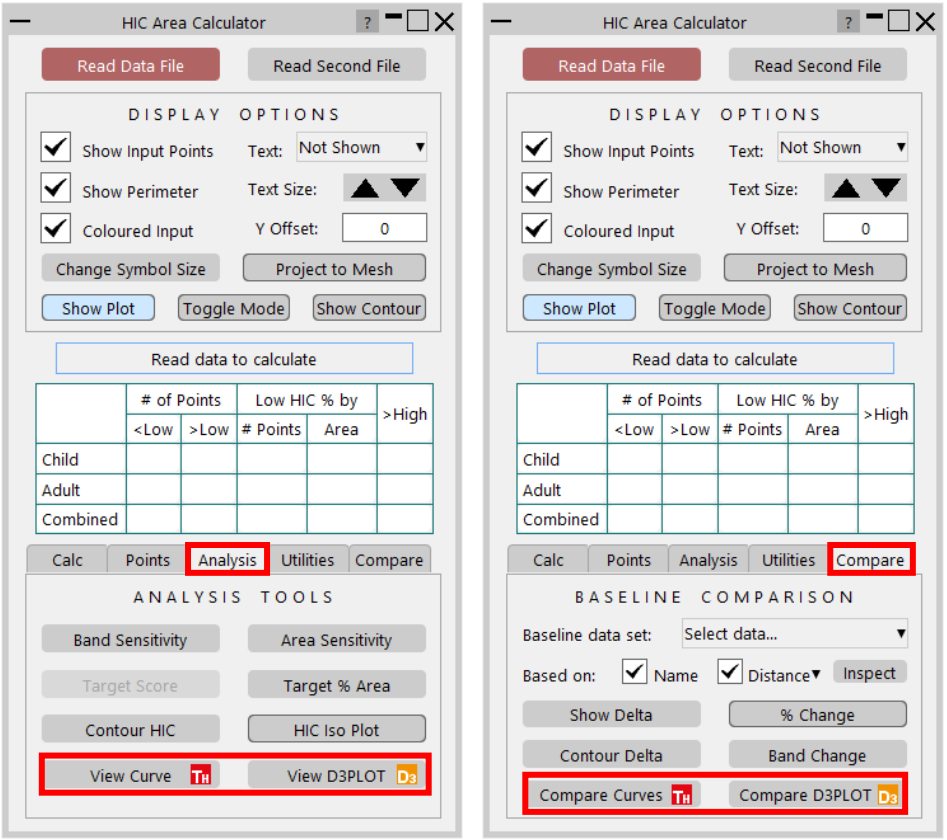
Command line arguments:

- `bumper_head_angle`: Impactor orientation angle for child head impact points on/in front of the bonnet leading edge
- `cyclist_head_angle`: Impactor orientation angle for cyclist head impact points
- `cyclist_head_csv_filename`: CSV filename for cyclist head impacts
- `cyclist_head_impactor`: Filename of cyclist head impactor to use in the model build
- `cyclist_head_template_filename`: Template filename for cyclist head impacts
- `roof_head_angle`: Impactor orientation angle for adult/cyclist head impact points behind the windscreen rear reference line
- `wad7`: 7th WAD value
- `wrrl_angle`: Windscreen rear reference line stick angle when calculating the wrrl using the stick method
- `wrrl_stick_method`: Use the stick method to calculate the windscreen rear reference line

HIC Area Calculator

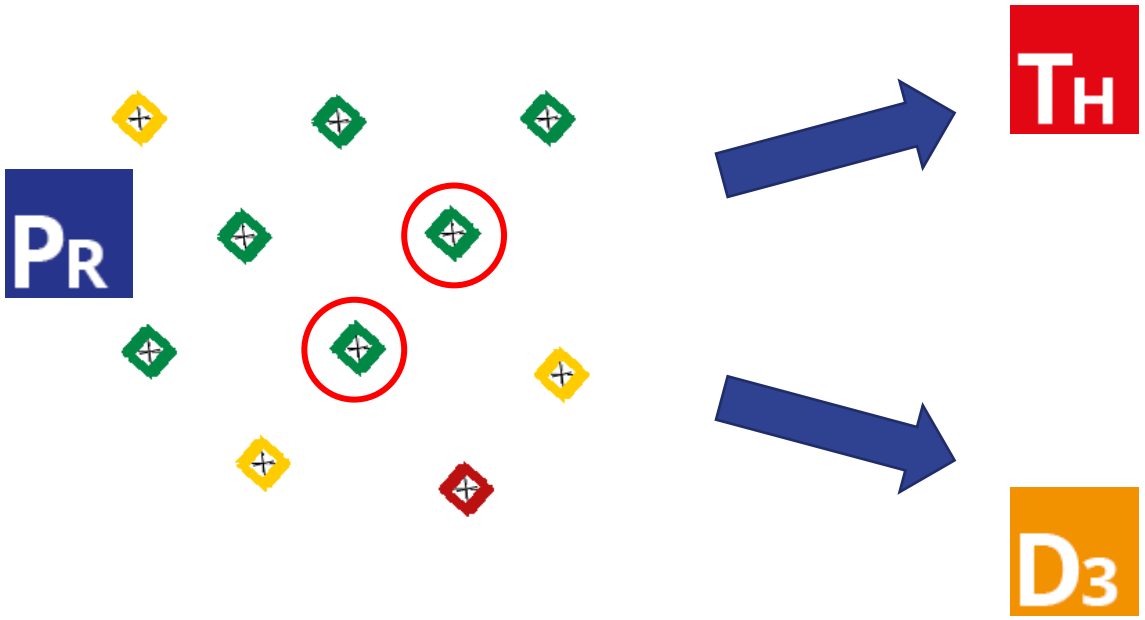
D3PLOT and T-HIS Integration

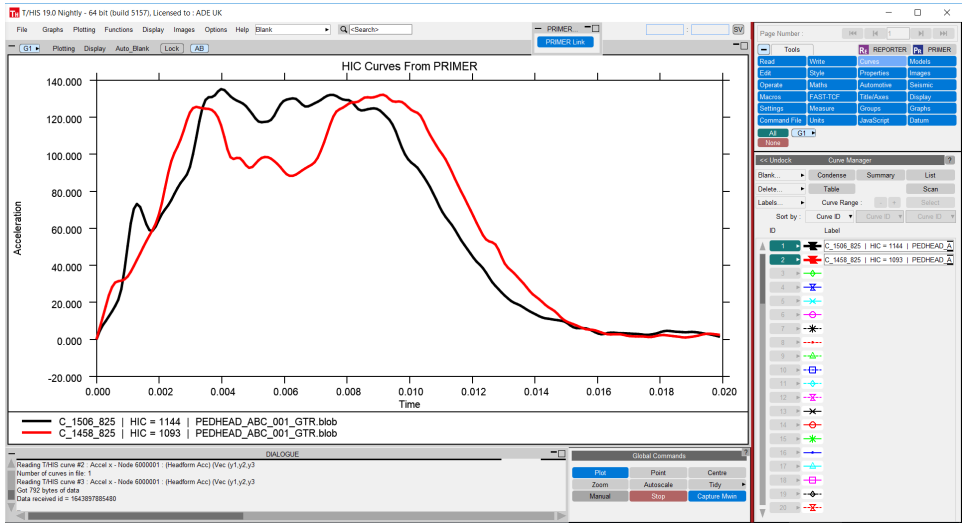
- Using the HIC Area Calculator, it is now possible to view head impact results in D3PLOT, and HIC curves in T-HIS, by simply selecting blobs from within PRIMER.
- Users can do this via new buttons located on the 'Analysis' and 'Compare' tabs.
- From within 'Analysis' users select blobs and can load their respective results into D3PLOT and T-HIS.
- From within 'Compare' users select matched pairs of blobs and can load their results into D3PLOT and T-HIS.

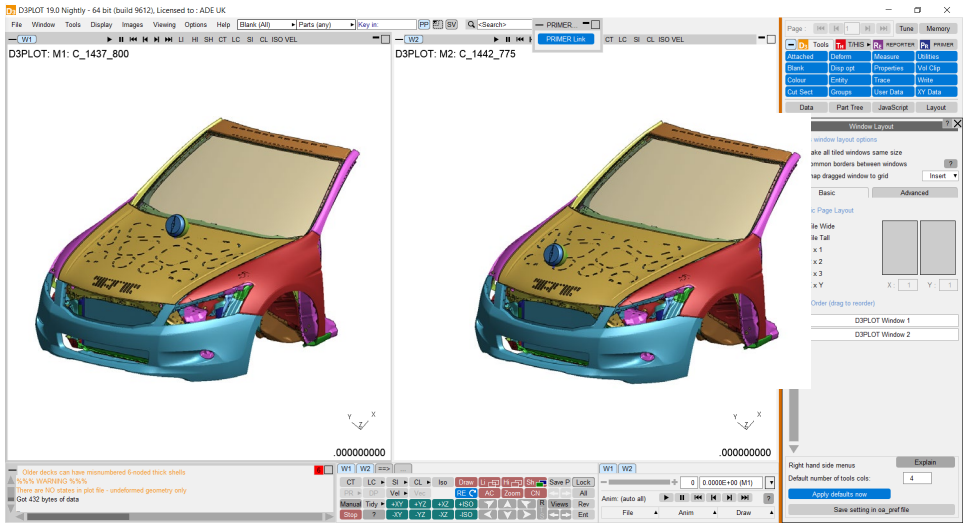


D3PLOT and T-HIS Integration

- The new buttons allow users to select blobs on screen and have the data load in the chosen software.







- When selecting multiple points for D3PLOT, users have the option to combine models into a single window.

D3PLOT and T-HIS Integration – New Path Input

- This is possible using additional information stored in the blob plot text file.
- The core format for HIC Area Tool blob plots is now*:

`data X_coord Y_coord Z_coord HIC_value` *`Name`* ***`Path`***

- Where the new input, ***`Path`***, is the full file path to the head impact keyword, for example:

	X	Y	Z	HIC	Name	Path
data	1466.9	-909.2	949.7	852.8	C_1467_909	C:\PEDHEAD_ABC_001_GTR\C_1467_909\c_1467_909.key
data	1426.9	-875.0	961.4	727.6	C_1427_875	C:\PEDHEAD_ABC_001_GTR\C_1427_875\c_1427_875.key
data	1469.8	-893.5	960.3	877.4	C_1470_894	C:\PEDHEAD_ABC_001_GTR\C_1470_894\c_1470_894.key
data	1492.0	-909.5	955.9	898.9	C_1492_910	C:\PEDHEAD_ABC_001_GTR\C_1492_910\c_1492_910.key
data	1450.6	-875.0	969.2	892.5	C_1451_875	C:\PEDHEAD_ABC_001_GTR\C_1451_875\c_1451_875.key

*older formats are still supported.

D3PLOT and T-HIS Integration – Special Comments & Variables

- The path information is used with two new comment lines that can be included at the top of the file:

  `$cur_file` and `$d3plot_file`.

- These comments are text strings that provide additional info to PRIMER when searching for results data.
- For example, a valid comment would be: `$cur_file hic_output.cur`

  which in turn would tell PRIMER that the HIC curves for points are named 'HIC_output.cur'.
- Two special variables can be included to provide additional flexibility, they are:
  - $$NAME$ - This is the name field defined for an individual blob.
  - $$KEYWORD$ - This is the base filename as used by the submitted keyword.
- So for the example below:

```
$cur_file $$NAME$_hic.cur
data 1466.9 -909.2 949.7 852.8 C_1467_909 C:\PEDHEAD_ABC_001_GTR\C_1467_909\c_1467_909.key
```

- PRIMER would look for the curve data: C:\PEDHEAD_ABC_001_GTR\C_1467_909\C_1467_909_hic.cur

D3PLOT and T-HIS Integration – Results File Search Logic

- The logic PRIMER follows to locate results data is described using the example below:

```
$cur_file CURVES\$$NAME$_hic.cur
$d3plot_file $$KEYWORD$.ptf
data 1466.9 -909.2 949.7 852.8 C_1467_909 C:\PEDHEAD_ABC_001_GTR\C_1467_909\c_1467_909.key
```

- First the path is broken into directory and base filename components:

  C:\PEDHEAD_ABC_001_GTR\C_1467_909\c_1467_909.key

- Then:

D3PLOT results become:	T-HIS results become
directory + $d3plot_file	directory + $cur_file
directory + c_1467_909 + .ptf	directory + CURVES\ + C_1467_909 + _hic.cur

- So:

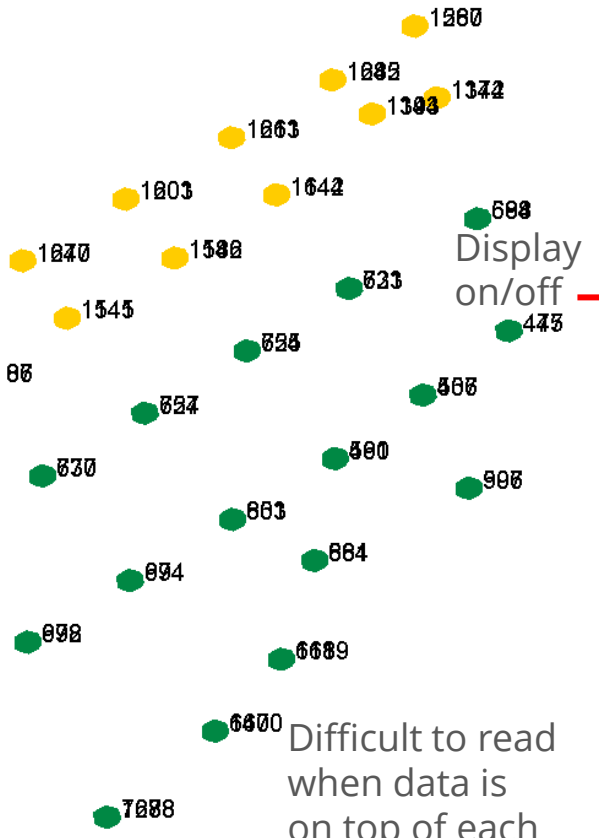
C:\PEDHEAD_ABC_001_GTR\C_1467_909\c_1467_909.ptf	C:\PEDHEAD_ABC_001_GTR\C_1467_909\CURVES\C_1467_909_hic.cur

- Additionally, if PRIMER cannot detect D3PLOT data using the above logic, the following will also be checked:
- directory + “d3plot” followed by: directory + filename.ptf

The latter being the same result as the example, so in this case the $d3plot_file comment could have been omitted and the data still located.

Keyboard toggling between plots

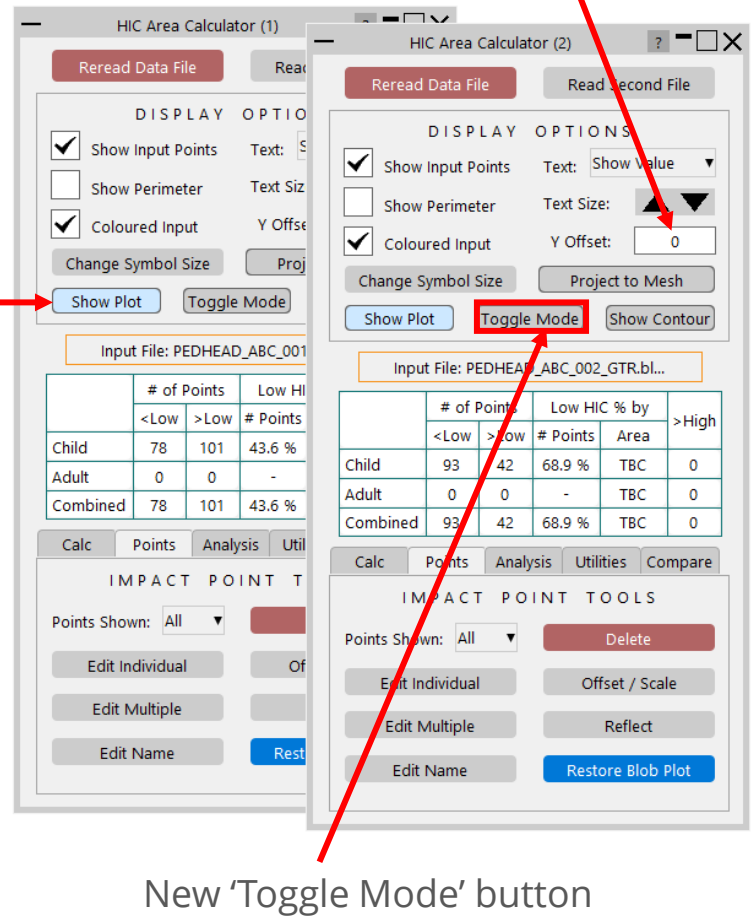
- When plotting multiple sets of data it can be difficult to keep track of what is being displayed on the screen.
- Previous versions of the HIC area calculator provided options to help with this by offsetting the points in the *y*-axis as well as quickly turning on/off the display.
- PRIMER 19.0 introduces a new method that allows users to toggle the display of blob plots via the left and right arrow keys on the keyboard.



Difficult to read when data is on top of each other

Display on/off

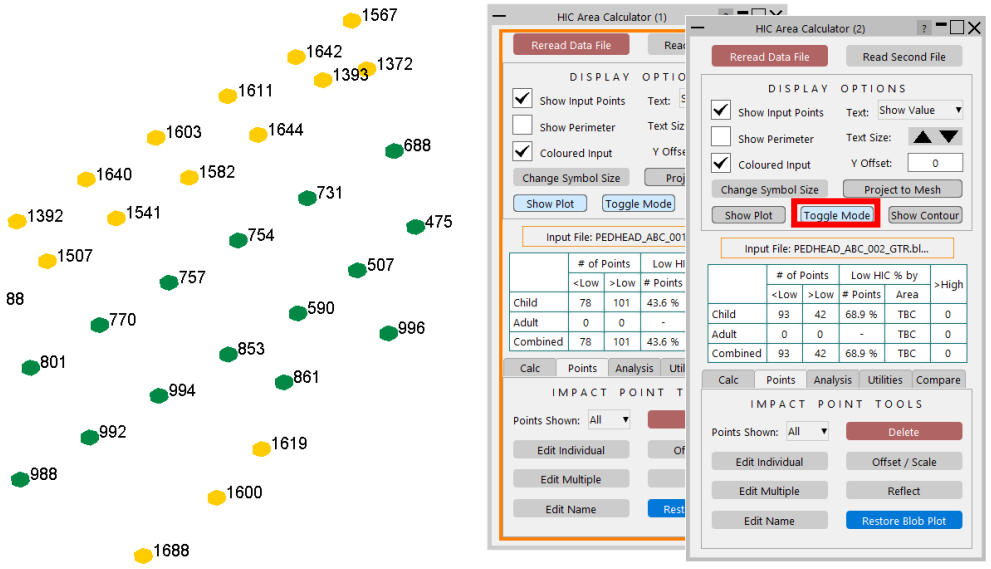
y-offset



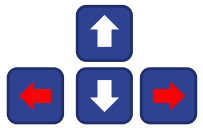
New 'Toggle Mode' button

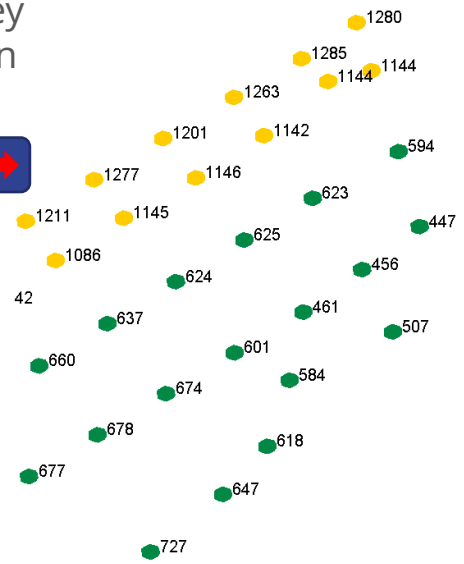
Keyboard toggling between plots

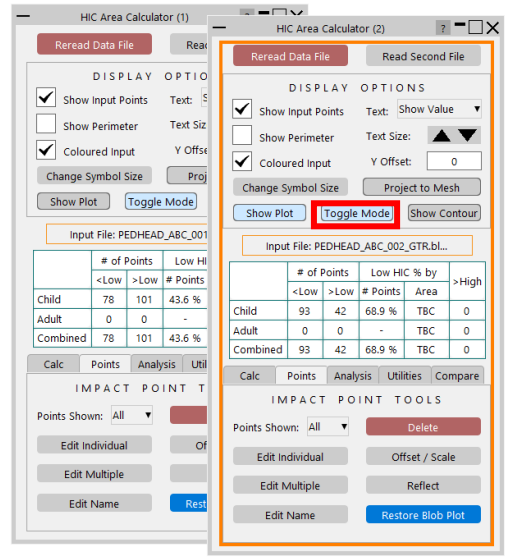
- When active, the Toggle Mode button will display only the data from the session from which the button is pressed.
- The user can then cycle through data using the left and right arrow keys.
- The current displayed session is highlighted using the orange border.
- Additionally, the display options (text visibility, font size, perimeter etc) from the first session are synced to the other displays.



Keyboard arrow key selection



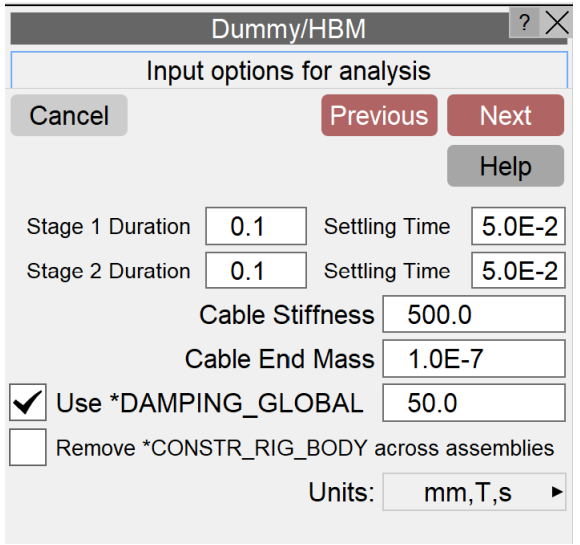




HBM Parameter Update Script

HBM Parameter Update Script

- A script has been added (‘HBM Parameter Update’) under the Scripts tool which allows users to update the values in Dummy/HBM setup automatically.
- Users can edit the values ‘Stage 1 duration’, ‘Stage 1 settling’, ‘Stage 2 duration’ and ‘Stage 2 settling’ by running this script, which in turn updates all the relevant keywords associated with these values.
- The user should not edit the value of the ‘HBMstage’ parameter and should not delete any of these parameters if this script is wanted to be used in the future: HBMstage, s1dur, s1set, s2dur, s2set. If a model cleanup is done, this may automatically delete the parameters.



Write Hook Script

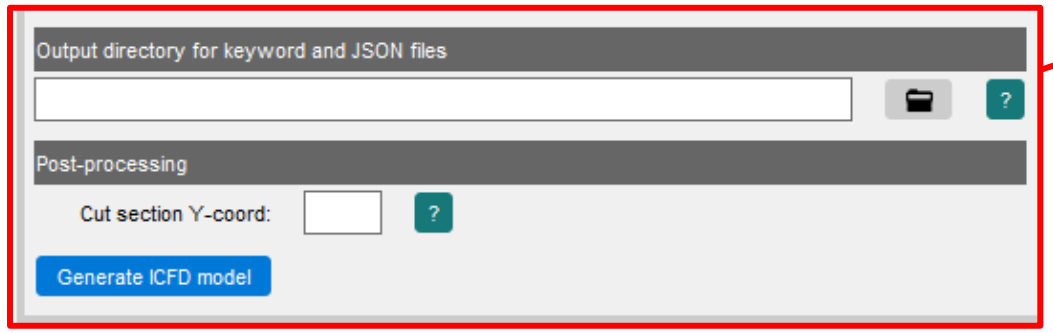
Write Hook Script

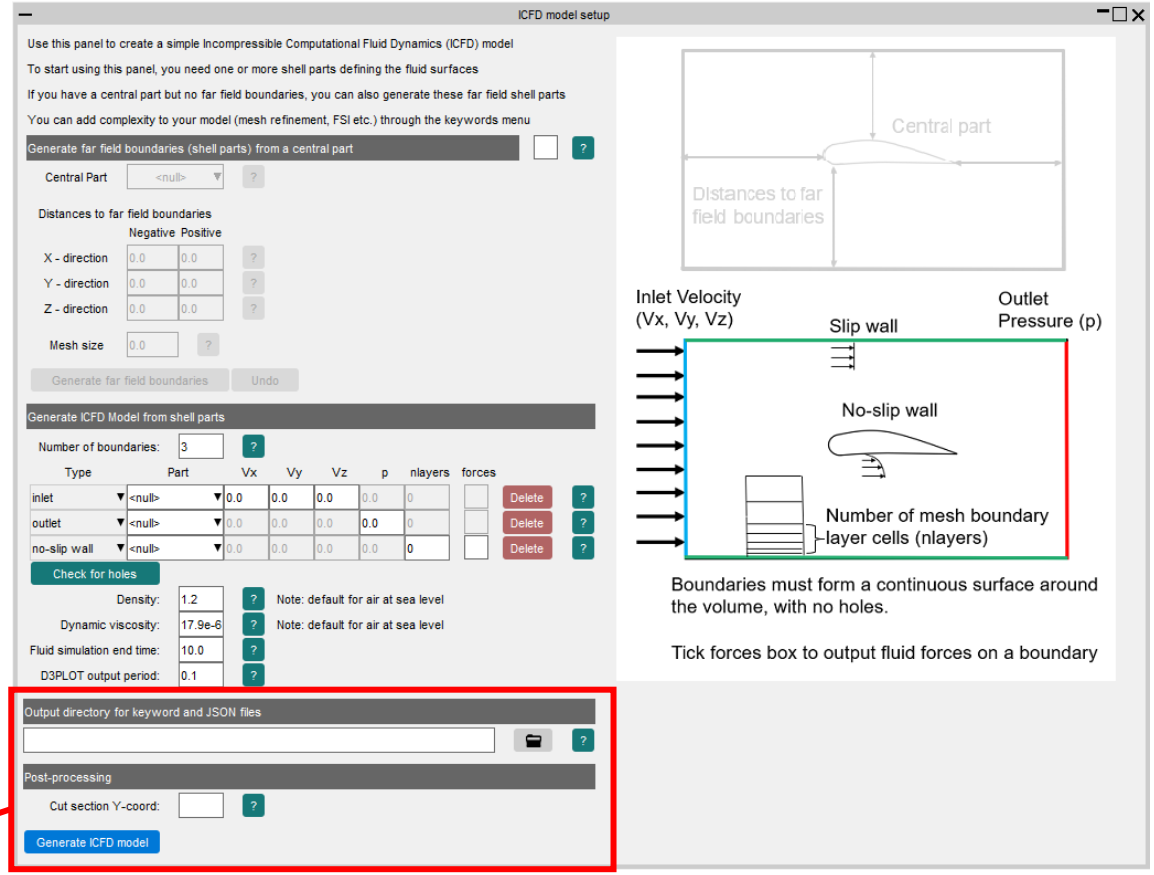
- Users can now trigger a hook script on writing out:
  - A full model in the Model Tab;
  - A single include file from the Include Tool;
  - A full model from the Dialogue Box;
  - Selected include files from the Select Include Files panel.
- This is intended to allow users to check files being written out and even set up a script to record a changelog for each model iteration.
- To enable this, users must put a JavaScript file named “write_hook.js” into their primer_library/scripts/hooks directory. An example is included in the install directory.
- The arguments passed to the JavaScript file carry data about the script file path, model, hook trigger instance, include file numbers and their file names. (See PRIMER manual *Section 10.1.9 Write hook* for full details and explanation.)

ICFD Setup and Post-processing

ICFD Setup

To help you get to grips with LS-DYNA's Incompressible Computational Fluid Dynamics (ICFD) solver, PRIMER comes with an **ICFD Setup** tool. From PRIMER 19.0, the tool lets you specify an output directory for the keyword file. A JSON file is now also written, containing inputs required for post-processing in **REPORTER**. These include a cut section that will be taken through the centre of your model.



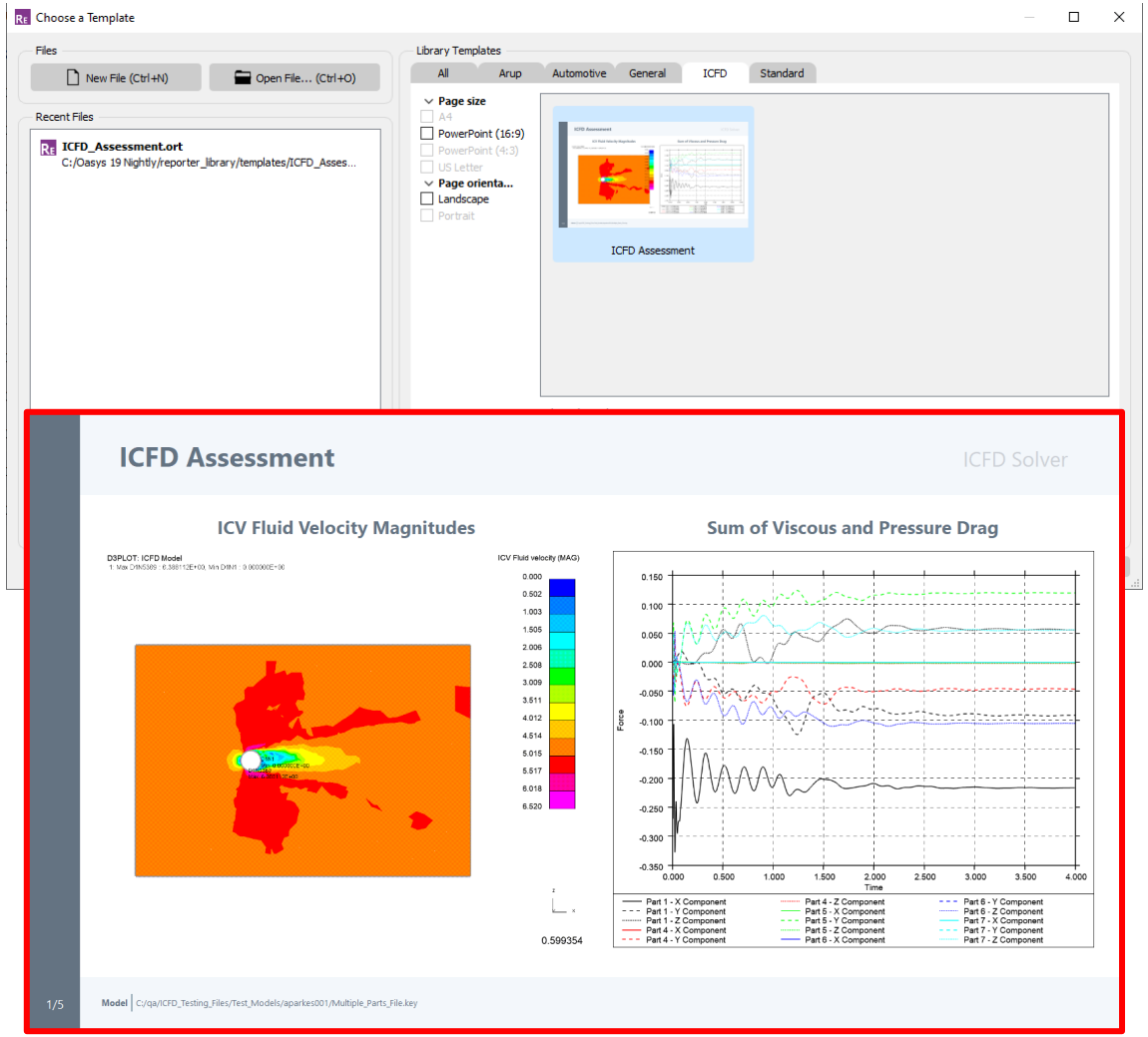


ICFD Assessment

REPORTER 19.0 comes with an **ICFD Assessment** library template, which can be found in the new **ICFD** tab.

Designed to be used with the **ICFD Setup** tool in **PRIMER**, the template includes:

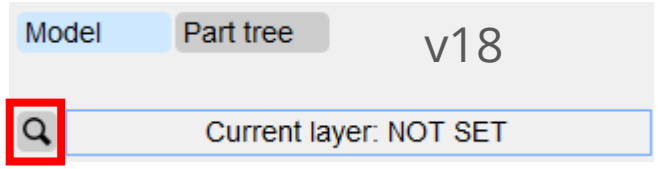
- An animated contour plot of ICV Fluid Velocity magnitudes on a cut section through the model
- A graph of viscous and pressure drag forces
- A summary table listing the input parameters for reference purposes



Miscellaneous

Search Box

- Previous versions of PRIMER included a Quick Find button which has now been made more prominent in the form of a search box located on the top bar. The existing keyboard shortcut (#) can still be used.



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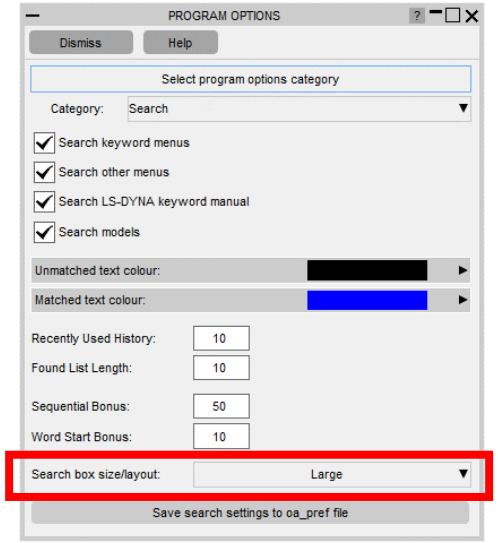
- The size of the search box and other search options can be controlled from Options → Program Options → Search.



Shell thickness in QP info

- Added ‘Shell Thickness’ to QP >Info pop-up for SHELL as this could be different than the ‘Section Thickness’ if _SHELL_THICKNESS card is used.
- Added ‘Min Shell Thickness’ and ‘Max Shell Thickness’ to QP >Info pop-up for PART when the part contains shells with _SHELL_THICKNESS cards.

Miscellaneous

- Added volume to Part Table (only compatible for SHELL, TSHELL, SOLID or BEAM).
- Added ability to not associate encrypted data to a material when it is written just after the material card.

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