# T/HIS 22.0

Oasys
LS-DYNA Environment

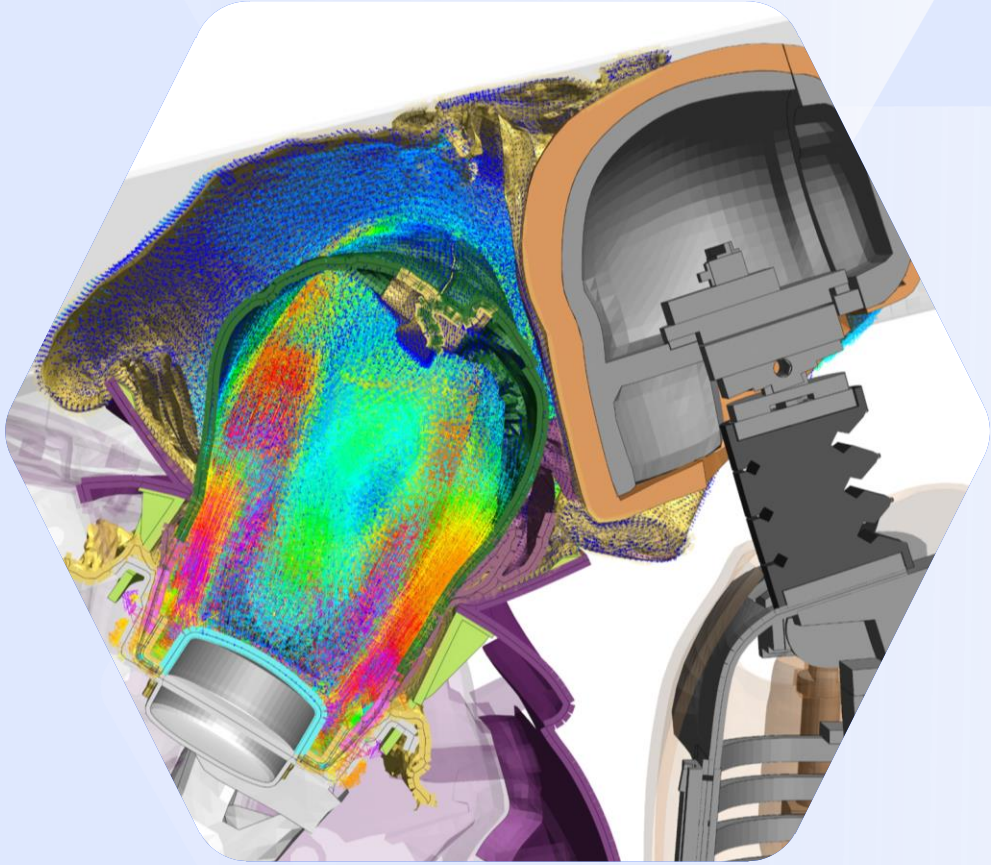
# T/HIS 22.0 – Contents


Complete Ansys LS-DYNA Support

# Airbags

# Support for *AIRBAG_CPG

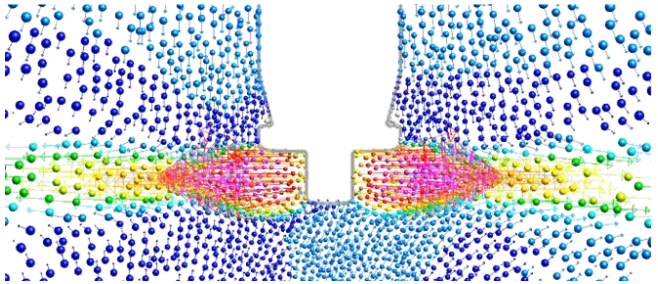
A New Airbag Gas Solver



Oasys LS-DYNA Environment

# Support for Continuum-based Particle Gas (CPG)

- CPG is a new continuum-based particle approach for airbag simulations, available from Ansys LS-DYNA 2025R1 (R16).
- As a fully functional fluid solver, CPG is more effective at simulating gas flow than the corpuscular particle method (CPM), and more capable at internal fluid-structure interaction than ALE.
- Key features:
  - Compressible Navier-Stokes solver coupled with an ideal gas equation of state.
  - Meshless by design, based on a generalized finite-difference scheme.
  - Particle cloud fills airbag volume, gas passes from particle to particle (Eulerian approach).
  - Particles added or removed only when necessary.
  - Excellent accuracy, robustness & scalability to hundreds of cores.

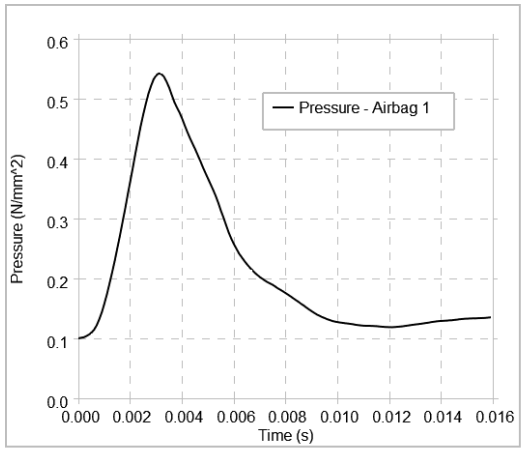


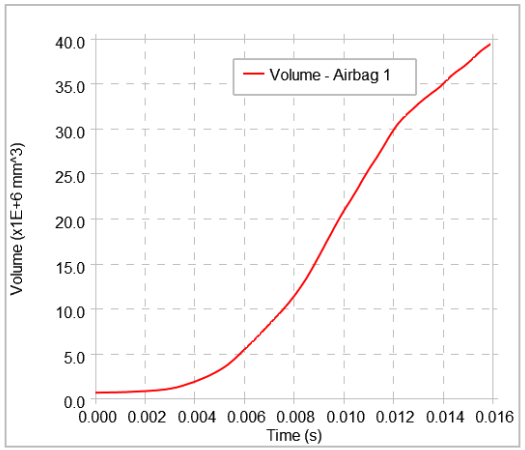
- Designed for airbag simulation, validated by airbag CAE engineers:
  - Simple *AIRBAG_CPG keyword format that copies other *AIRBAG_ types. Same input data for inflators, fabric, etc.
  - First release supports internal structures, simple venting, fabric porosity, multiple gases/orifices/inflators, moving environment, local particle refinement, and more.
  - Inviscid with free-slip boundary by default, although viscosity and wall friction available.
- CPG is destined to take airbag simulation to the next level required for virtual testing, however accurate input data and well folded models are also vital to achieve useful results.

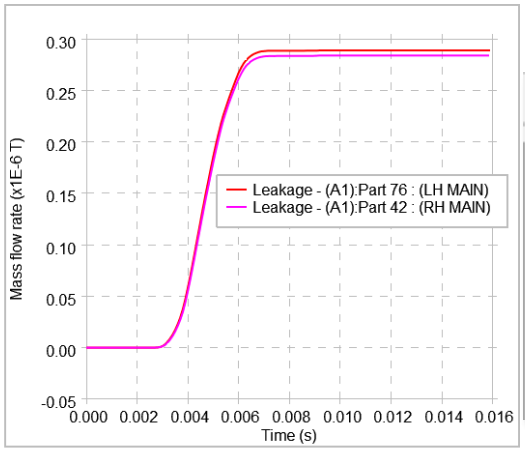
# Support for CPG Results in T/HIS

We work closely with Ansys to ensure that the Oasys LS-DYNA Environment is the leading choice for CPG workflows

- T/HIS 22.0 supports all R16 CPG data in the binout file:

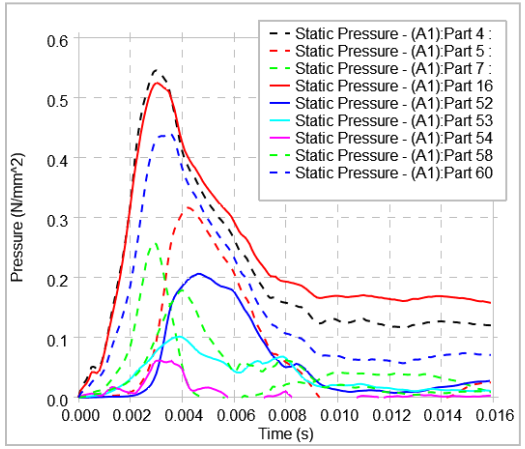


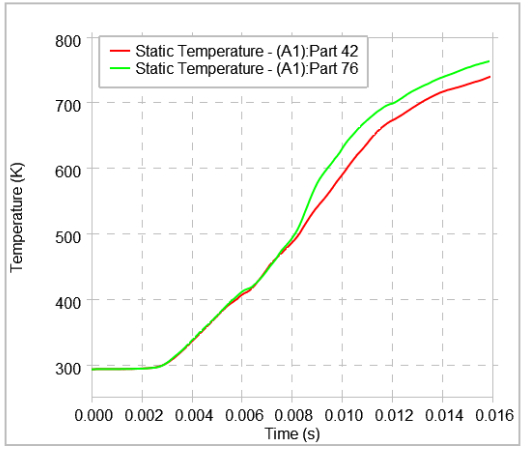



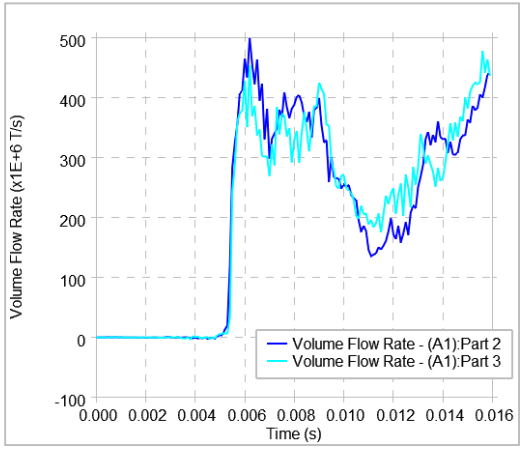




Per airbag

PR - Pressure
VO - Volume
IE - Internal energy
IN - Mass flow rate in
OU - Mass flow rate out
MIN - Mass in
MOU - Mass out
TM - Total mass

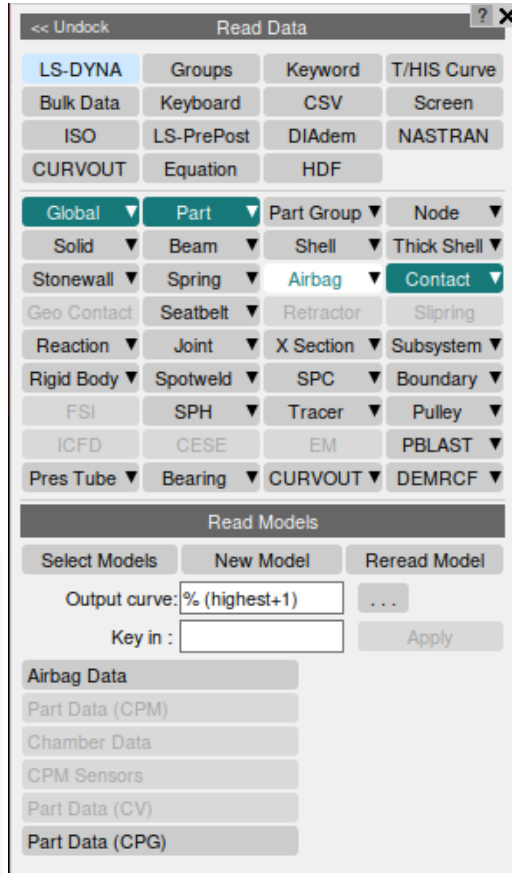



Per part

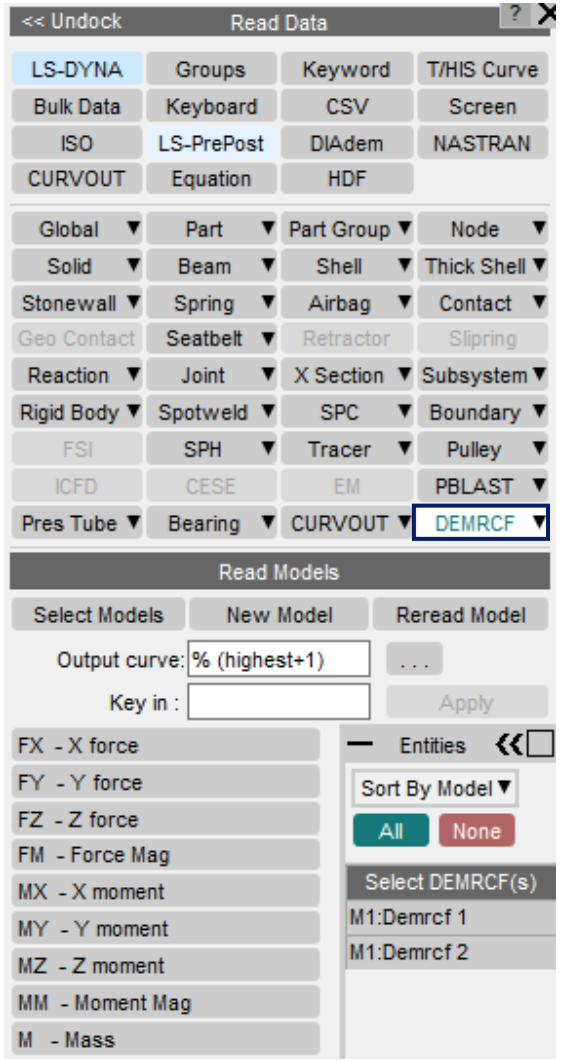
AR - Area
FX - X Force
FY - Y Force
FZ - Z Force
LK - Leakage
SPR - Static Pressure
TPR - Total Pressure
STE - Static Temperature
TTE - Total Temperature
VFR - Volume Flow Rate



# DEMRCF

# DEMRCF

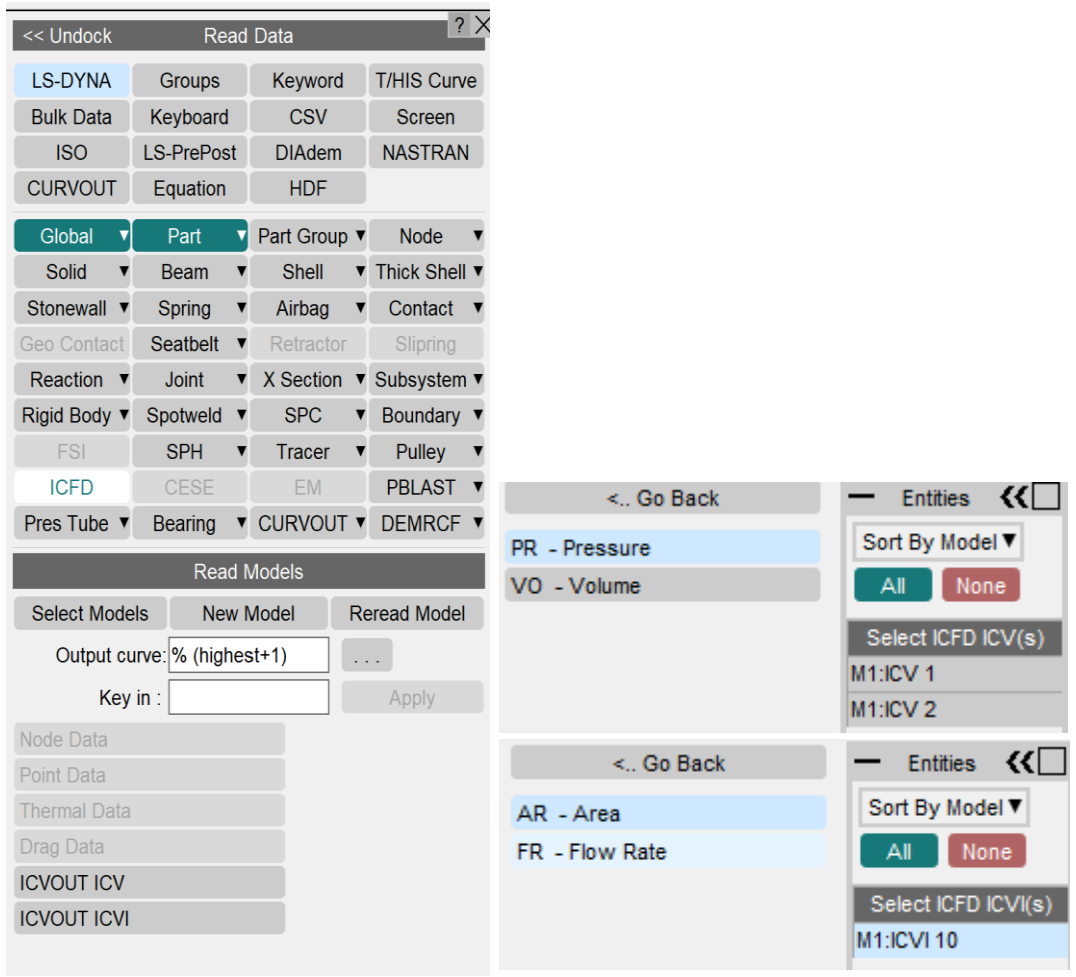
- A new ASCII output file *demrcf* has been introduced. This output reports the non-tied coupling between discrete element spheres (DES) and surfaces that are part of either shell parts or solid parts.
- The demrcf output file allows the plotting of contact forces, moments, and the corresponding mass from the contact surface to the DES element, provided this data is available.
- To output relevant data:
  - Define the necessary contacts using the *DEFINE_DE_TO_SURFACE_COUPLING keyword in PRIMER.
  - The output frequency of the coupling forces within the DEM interface force file is controlled by the *DATABASE_BINARY_DEMFOR keyword.
  - To record this information in the *demrcf* output file, enable the RCFORC field within the DATABASE → (ASCII)_OPTION menu.



# ICVOUT

# ICVOUT

- A new ASCII output file *icvout* (incompressible control volume) is now supported by T/HIS. The icvout output file allows the plotting of pressure, volume, flow rate and area of control volumes, provided the data is available.
- BINOUT file containing icvout data can now be read into T/HIS and plotted for its components.
- Volume and Pressure are output as ICV (Incompressible Control Volume) components of the control volumes.
- Flow rate and Area are output as ICVI (Incompressible Control Volume Interaction) components of the control volumes.
- To output relevant data:
  - Define the control volumes using *DEFINE_CONTROL_VOLUME in PRIMER, that output the pressure and volume components.
  - The flow area between the interacting control volumes is defined using *DEFINE_CONTROL_VOLUME_FLOW_AREA.
  - The interaction between the interacting control volumes is defined using *DEFINE_CONTROL_VOLUME_INTERACTION.

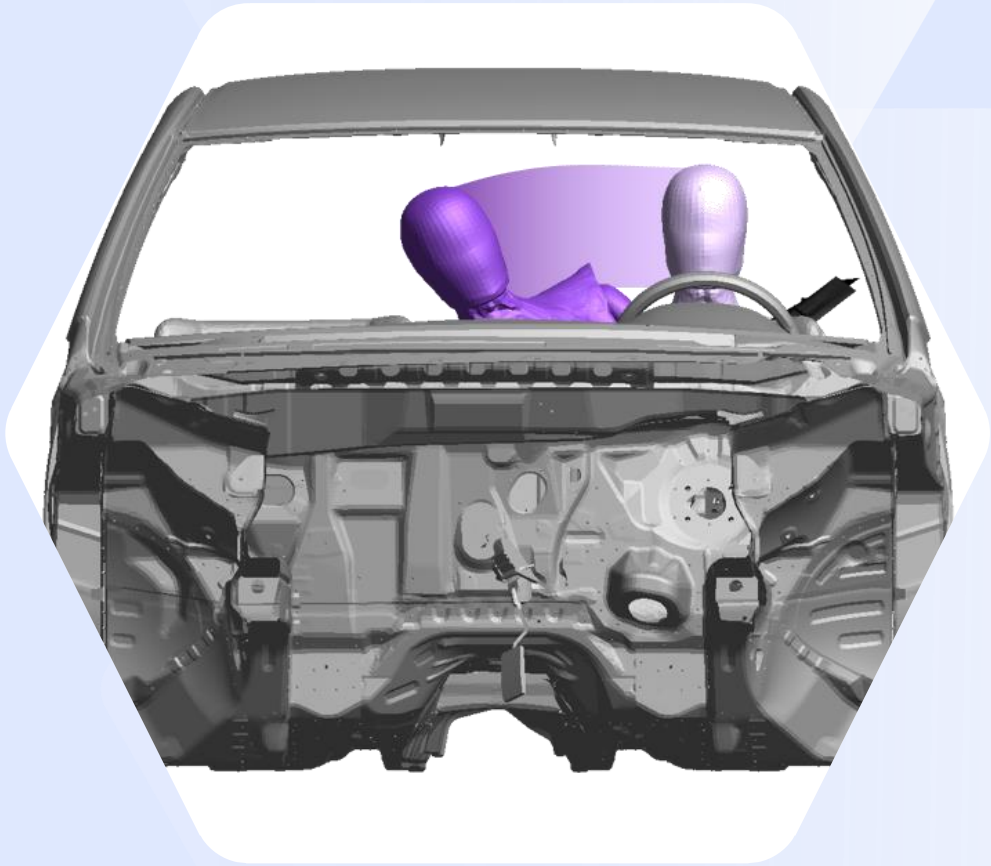



Efficient End-to-End Workflows

# Virtual Testing

- C-NCAP Management Regulation
- Working with Test Data
- Automotive Assessments Improvements
- SimVT Graph Options
- VTC Quality Criteria Workflows
- VTC Videos File Size

# C-NCAP Management Regulation

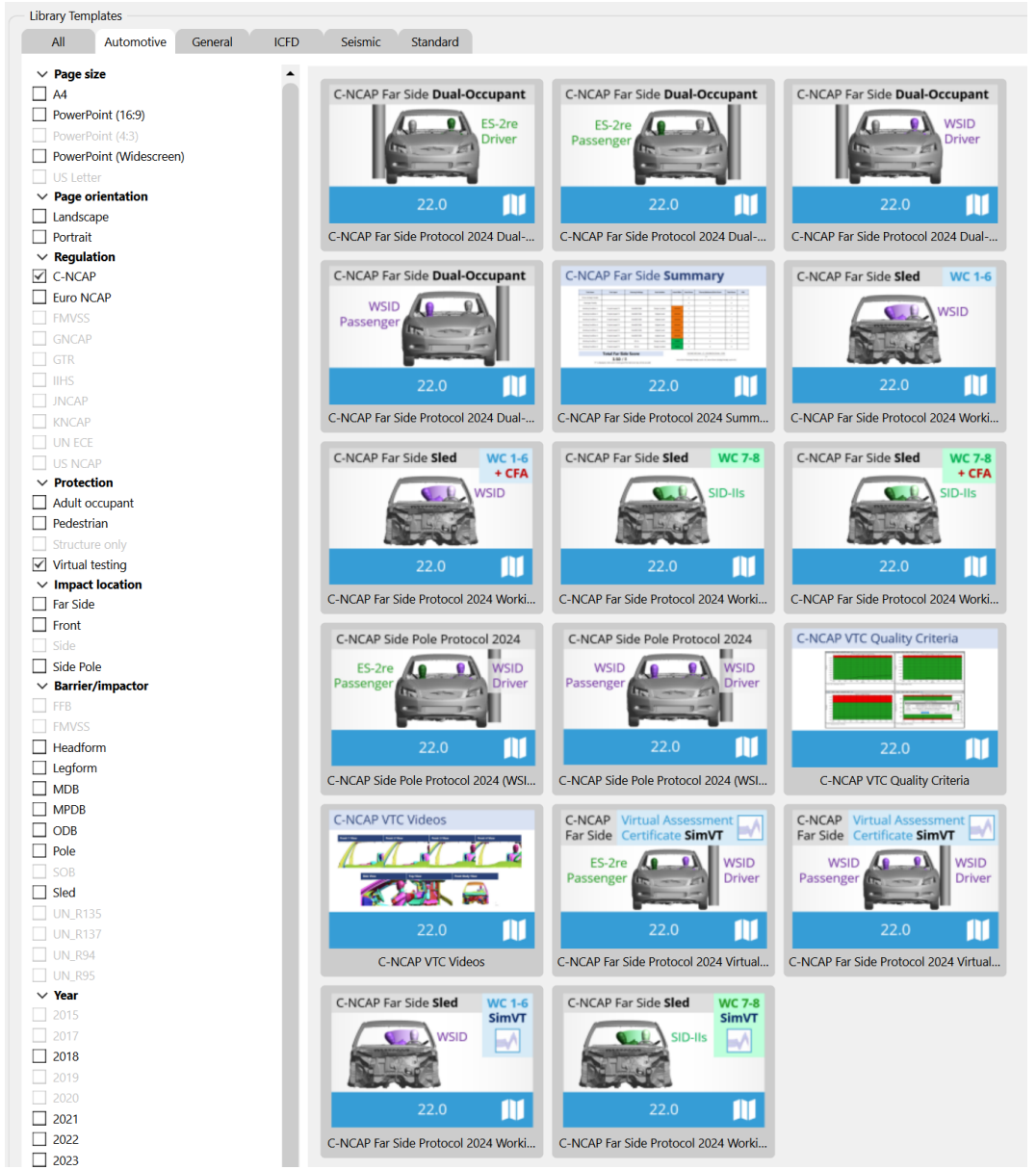


# C-NCAP Management Regulation (2024 Edition)

Since Oasys 21.1, there has been support for the various requirements of the C-NCAP Far Side Occupant Protection Protocol, including:

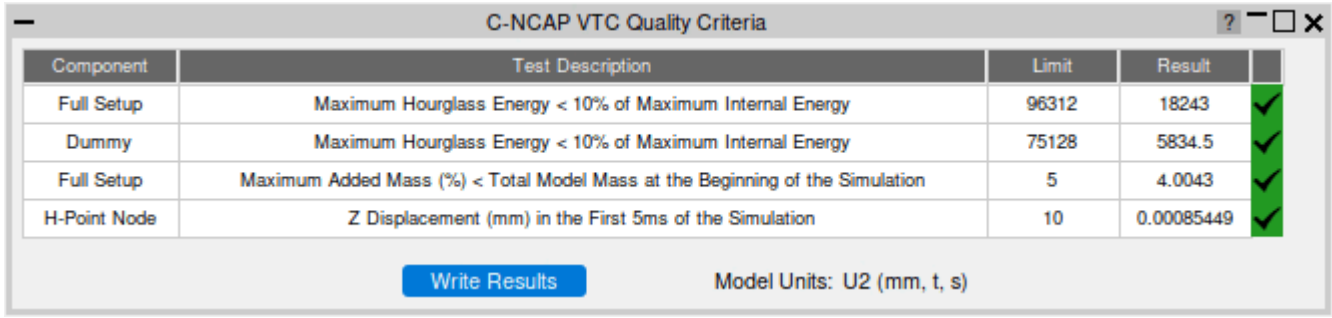
- For each of the eight Working Conditions:
  - Occupant injury assessment
  - ISO Correlation Fitting indices
  - Correction Factor A
- Dual-Occupant Penalty calculation
- ISO correlation fitting indices for the Virtual Assessment Certificate (prerequisite for the symmetry of far side occupant protection airbags)
- Overall score calculation

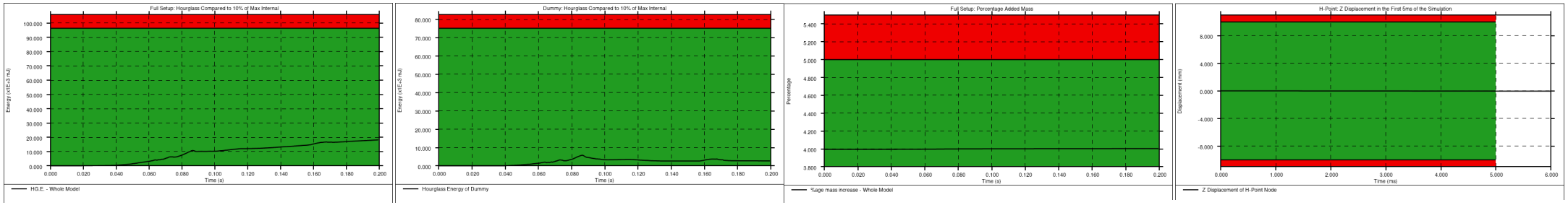
Read the documentation to learn more



# C-NCAP VTC Quality Criteria

- The C-NCAP VTC Quality Criteria Workflow tool follows the same principals as the Euro NCAP version but assesses the quality criteria specified in section H.1.1(f) of the C-NCAP Far Side Simulation & Assessment Protocol.
- The tool can be automated using the REPORTER template provided.

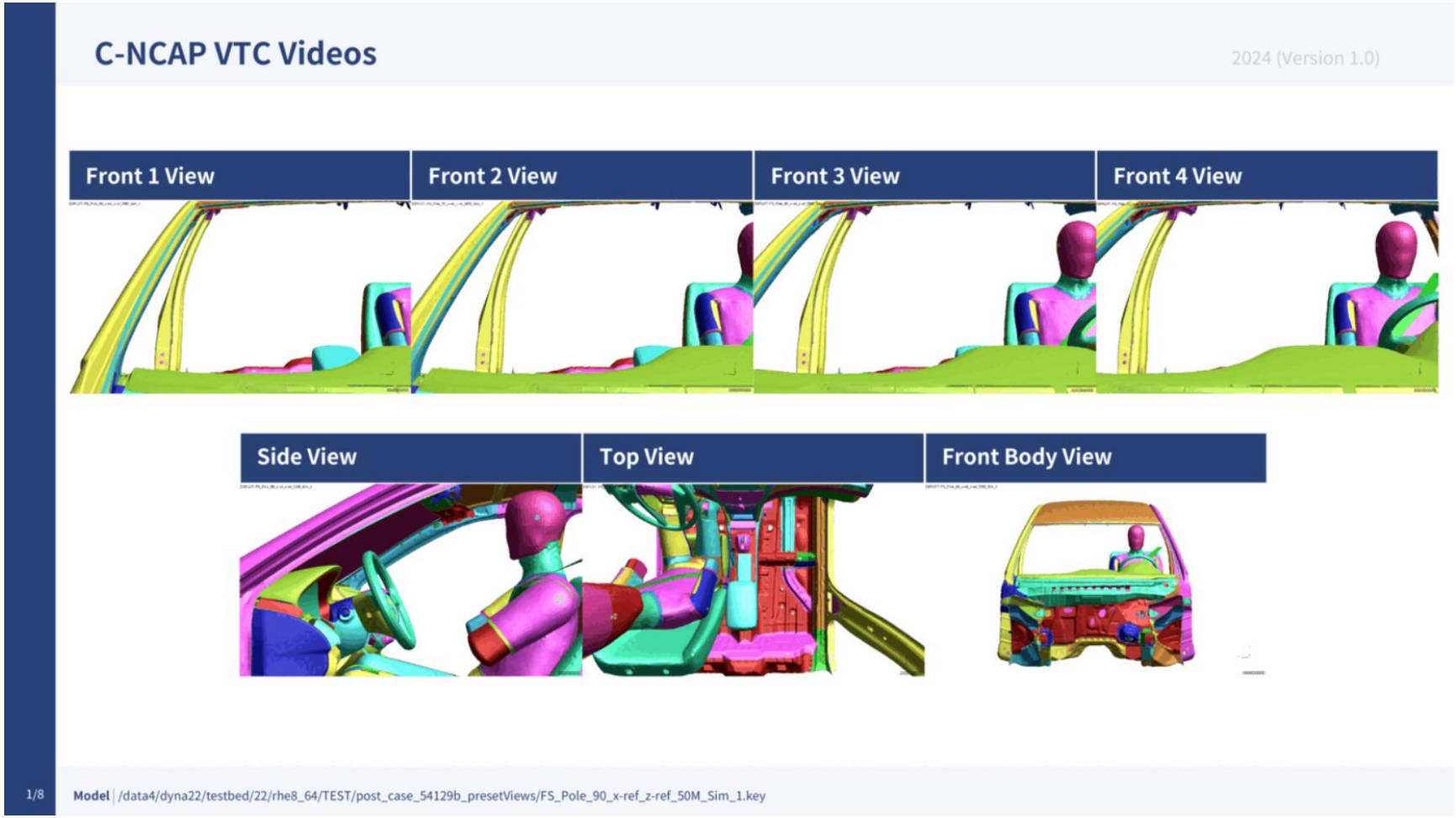


# C-NCAP VTC Videos

- The **C-NCAP VTC Videos** Workflow tool follows the same principles as the Euro NCAP version but helps you calculate the views and export the videos specified in section H.2.8 of the C-NCAP Far Side Occupant Protection Protocol (2024 Edition).

- Use the standard Workflow method in **PRIMER** and **D3PLOT** or the whole process can be automated using the **REPORTER** template provided.

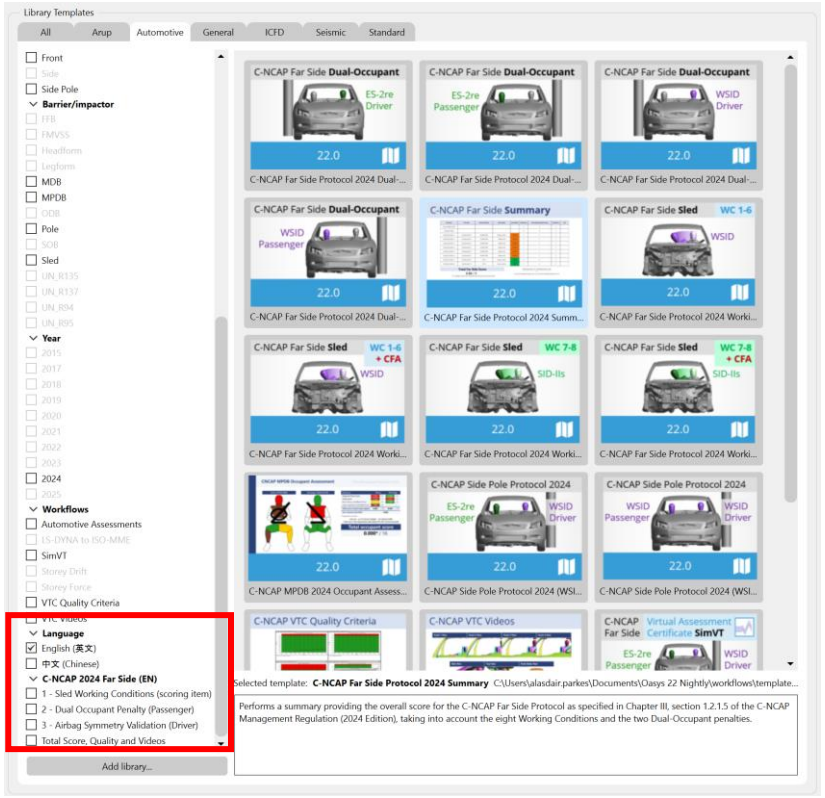


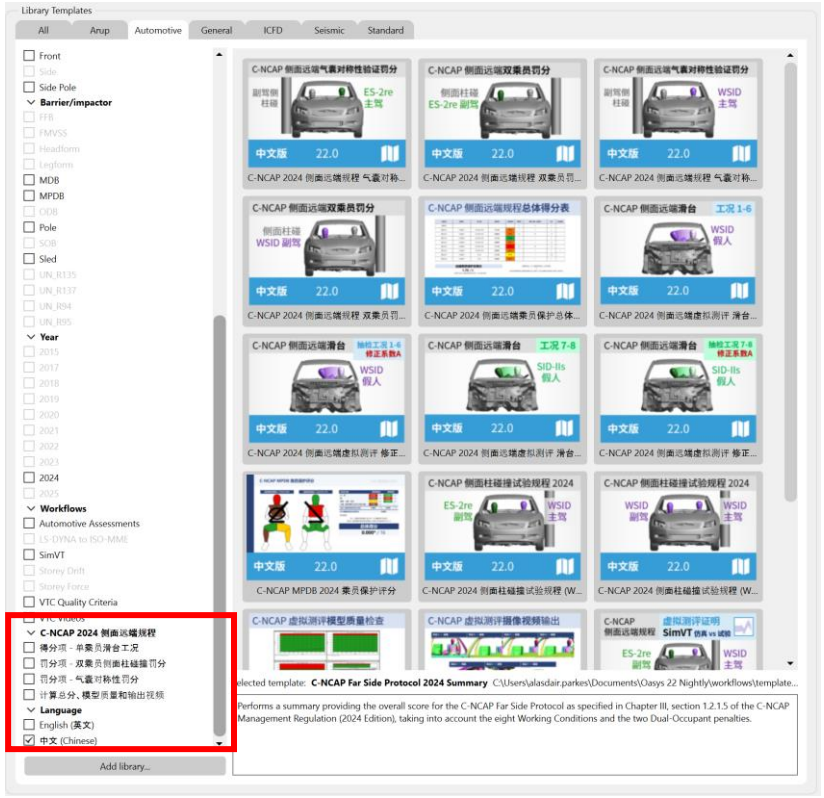
# Chinese Language Reports

# 中文版报告模板

- You now have access to all the C-NCAP REPORTER templates in both English and Chinese, for ease of communication with your teams, partners, suppliers, and C-NCAP.

- 所有 C-NCAP REPORTER 模板都同时提供英文和中文版供您使用，方便您与团队、合作伙伴、供应商，和 C-NCAP 沟通。



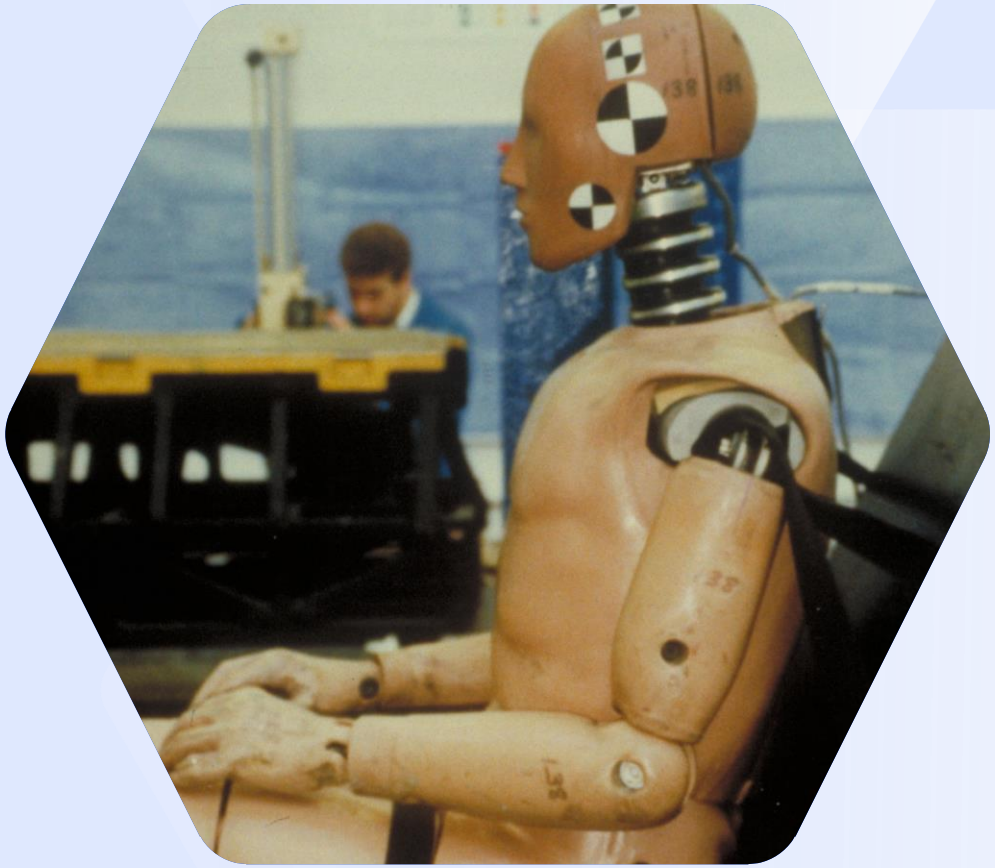
# Chinese Language Reports

# 中文版报告模板

- Example reports generated by C-NCAP REPORTER templates, in English (left) and Chinese (right):

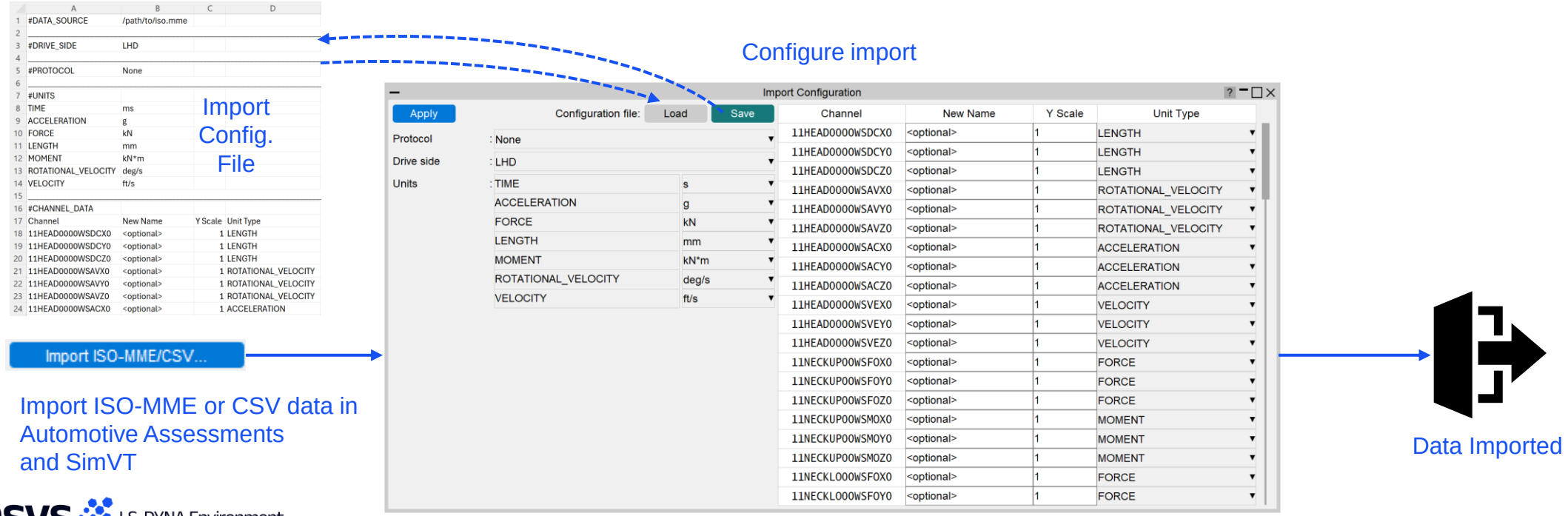
- 下方展示了由 C-NCAP REPORTER 模板自动生成的英文版（左侧）和中文版（右侧）报告示例。


# Working with Test Data



# Improved unit handling and configuration for imported data

- Previously, imported ISO-MME data was assumed to be in SI units. This assumption was not always valid and data with non-standard units (e.g. accelerations in ‘g’ or rotations in ‘degrees’) needed to be manually scaled.
- Additionally, the vehicle drive side was inferred from the position code of the first occupant channel, which was assumed to be the driver.
- Now, when importing ISO-MME channel data, T/HIS attempts to automatically determine the units from the unit header in each channel file and the drive side from the “Driver position object 1” header in the MME file. However, it is not always possible to correctly infer this information.
- The new Import Configuration window (and Import Config. file) gives you the option to correct any issues with the channel units, polarity, scale and naming before importing ISO-MME or CSV data.



# Time of first sample

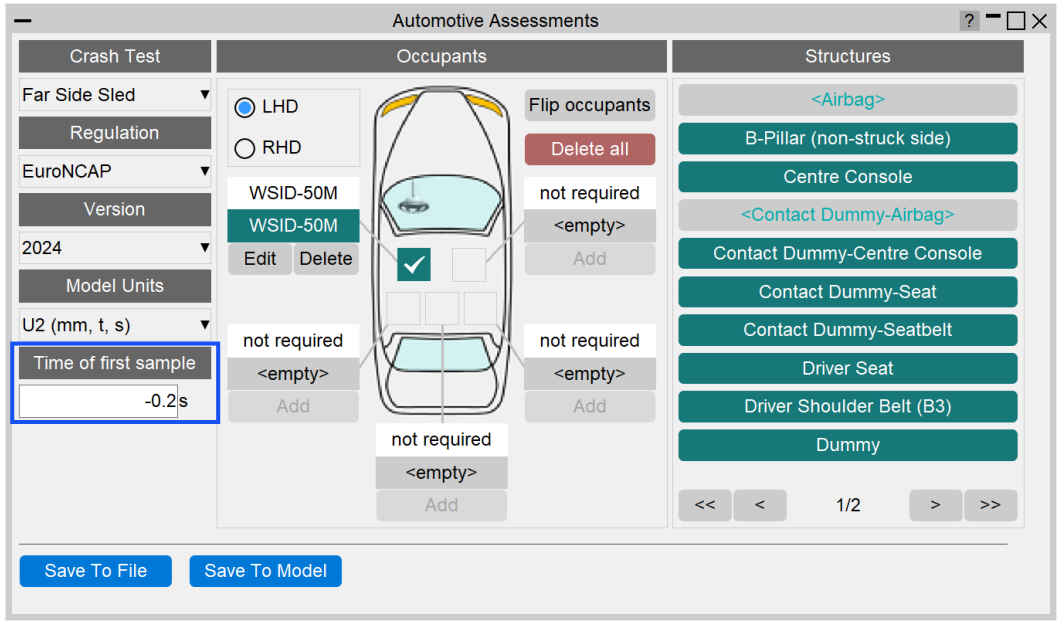
To accommodate the pre-crash (settling) phase in a simulation, a new “Time of first sample” input has been added to the Automotive Assessments workflow set-up in PRIMER.

**Automotive Assessments and SimVT**

- In accordance with ISO-MME convention a **negative** time value is used to shift the start time of the output curves when post-processing using the Automotive Assessments or SimVT workflows in T/HIS.
- For example, if your analysis begins with 200 milliseconds of set-up (e.g. seat squash etc.) before the crash test load case commences then you would enter -0.2 in the “Time of first sample” input to shift the curves so that the crash test will effectively start at t=0.
- Any data before t=0 is automatically discarded.

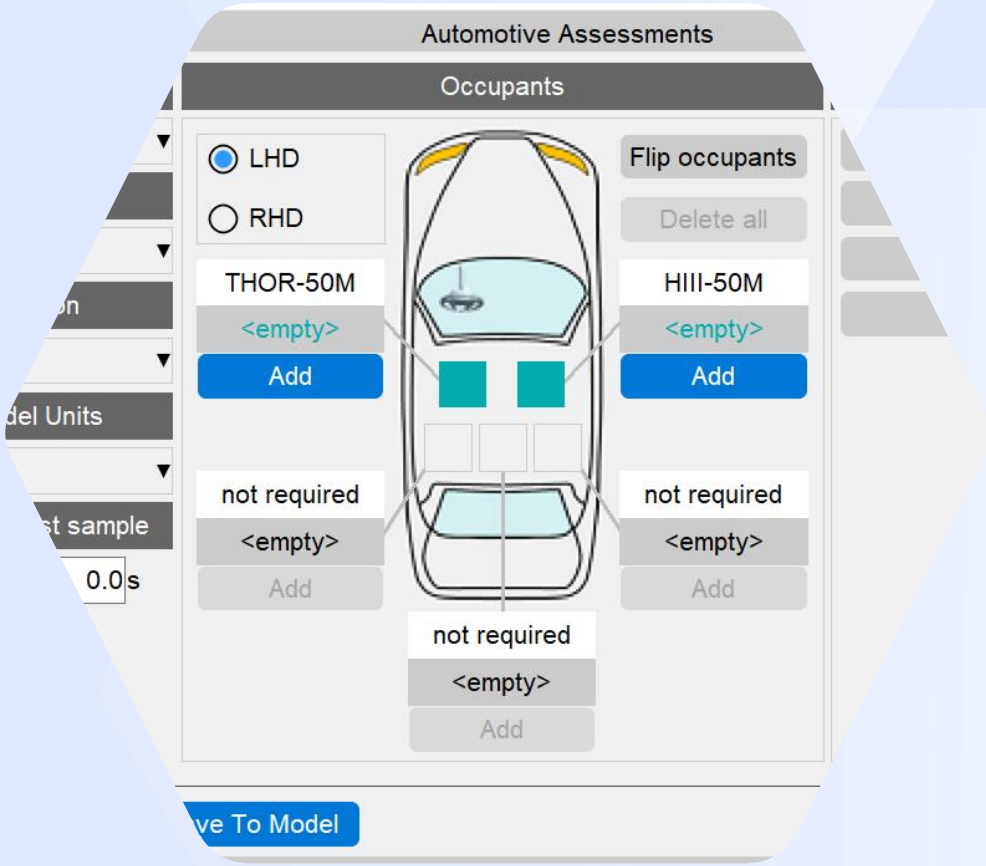
**LSDYNA to ISO-MME**

- The “Time of first sample” value is also used by the LS-DYNA to ISO-MME workflow.
- If it is defined, then the “Time of first sample” header value will automatically be set in the channel files.
- Note that in this instance the samples which are shifted to time < 0 will not be discarded as this only happens when the ISO-MME data is processed.



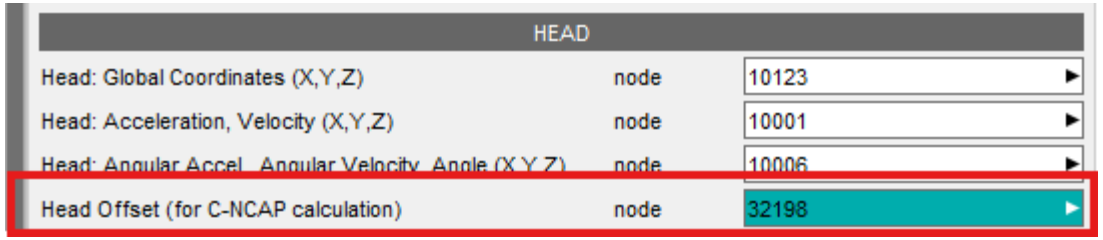

```
Test object number          :1
Name of the channel         :Accel x - Node 10001 : ( HEAD0000WSAC) (Reg 0.100E-03)
Laboratory channel code     :NOVALUE
Customer channel code       :NOVALUE
Channel code                :11HEAD0000WSACX0
Unit                        :m/(s*s)
Reference system            :NOVALUE
Pre-filter type             :NOVALUE
Cut off frequency           :NOVALUE
Channel amplitude class     :NOVALUE
Sampling interval           :0.0001
Bit resolution              :NOVALUE
Time of first sample        :-0.02
Number of samples           :2000
0
-2.86178e-08
-5.19904e-09
```

# Automotive Assessments Improvements

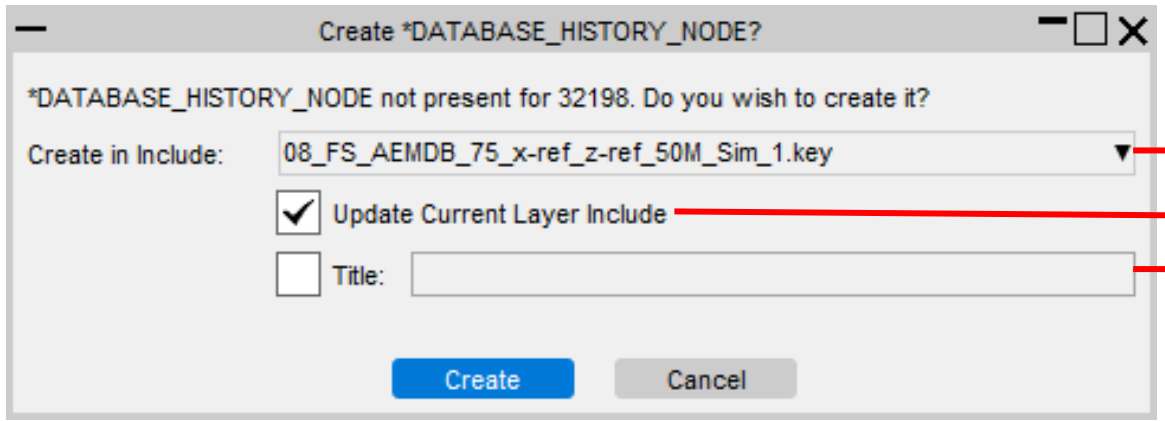


# Automotive Assessments Improvements

- Entity IDs that are defined but don't have corresponding *DATABASE_HISTORY_XXXX keyword defined are now shown with a latent cyan-coloured textbox background:




- A window is now mapped when such entity IDs are selected or typed into the text box, giving you the option to create the corresponding *DATABASE_HISTORY_XXXX keyword for them. It also provides an option to select the include file to which the keyword will be added. **Note:** you have to save the include and re(run) the analysis to obtain results for the corresponding entity.




Dropdown to select the include file

If ticked, then the current layer include will be updated to the one selected in the dropdown above

Option to provide optional Title

# Automotive Assessments Improvements

- The ISO channel codes have been updated for several channels in the Far Side VTC v1.1 draft protocol. The necessary changes have been incorporated in Automotive Assessments workflows tool, and backward compatibility support has been added for the older ISO codes. The channels whose ISO codes have changed are:

  - LAP Belt (SEBE00**03**B6FO00 to SEBE00**00**B6FO00)

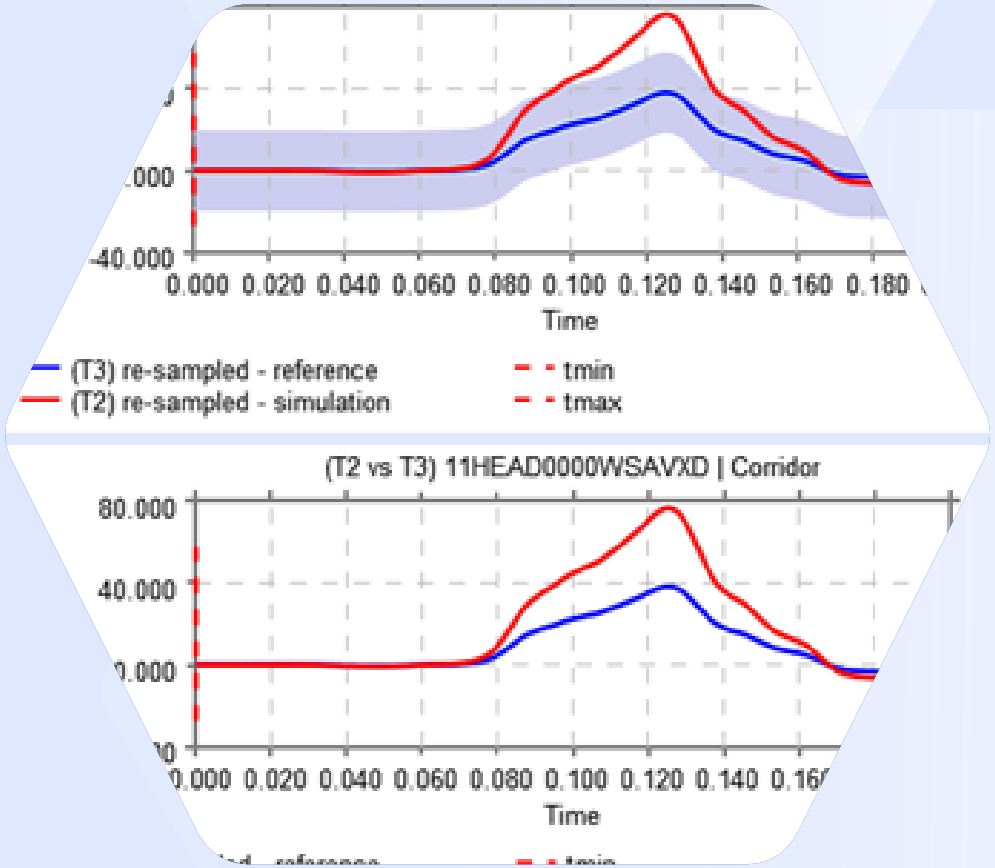
  - Shoulder Belt (SEBE00**03**B3FO00 to SEBE00**00**B3FO00)

  - Contact Dummy-Airbag (**ARBG**0000WSFOX/Y/Z to **AIRB**0000WSFOX/Y/Z)

  - Thoracic Spine 04 and 12 Displacements (THSP04/1200**00**DCX/Y/Z0 to THSP04/1200**WS**DCX/Y/Z0).

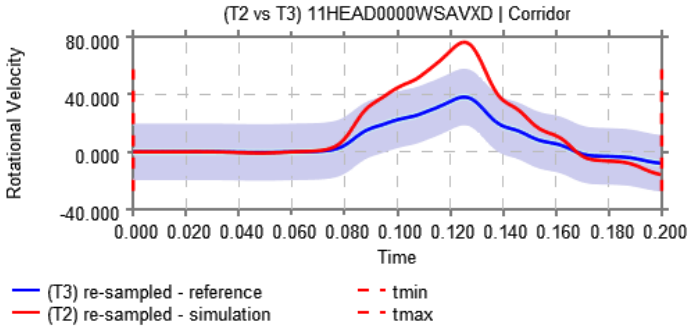
- The 'Far Side + VTC' and 'Far Side' crash tests have been renamed to 'Far Side Sled' for consistency across the tools. The version for the former 'Far Side + VTC' is now 2024, while the version for the former 'Far Side' crash test is 2022. Support for backward compatibility has also been added.
- The term Physiology has been renamed to Anthropometry and support for backward compatibility has also been added.
- Users can now select multiple contacts for contact structures (Contact  Dummy – Airbag, Contact Dummy – Centre Console, Contact Dummy –Seat and Contact Dummy - Seatbelt) via SELECT option.

# SimVT Graph Options

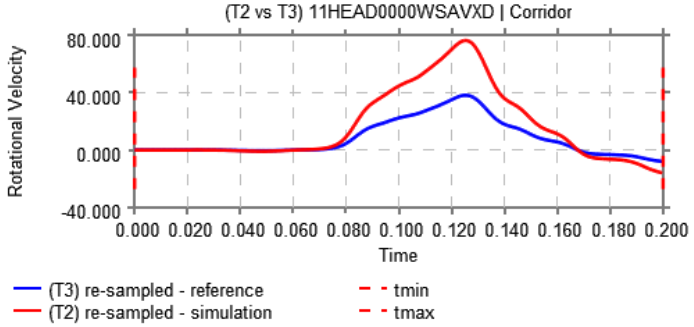


# SimVT Graph Options – Show Corridors

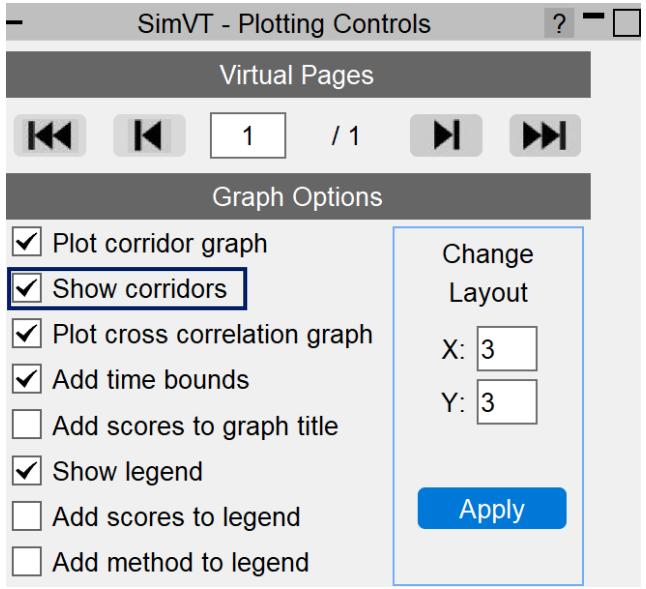
- A new graph option “Show corridors” has been added to SimVT plotting controls. This determines whether the inner and outer corridors are plotted along with the reference and simulation curves.
- Deselecting show corridors can help reduce clutter on the graphs.



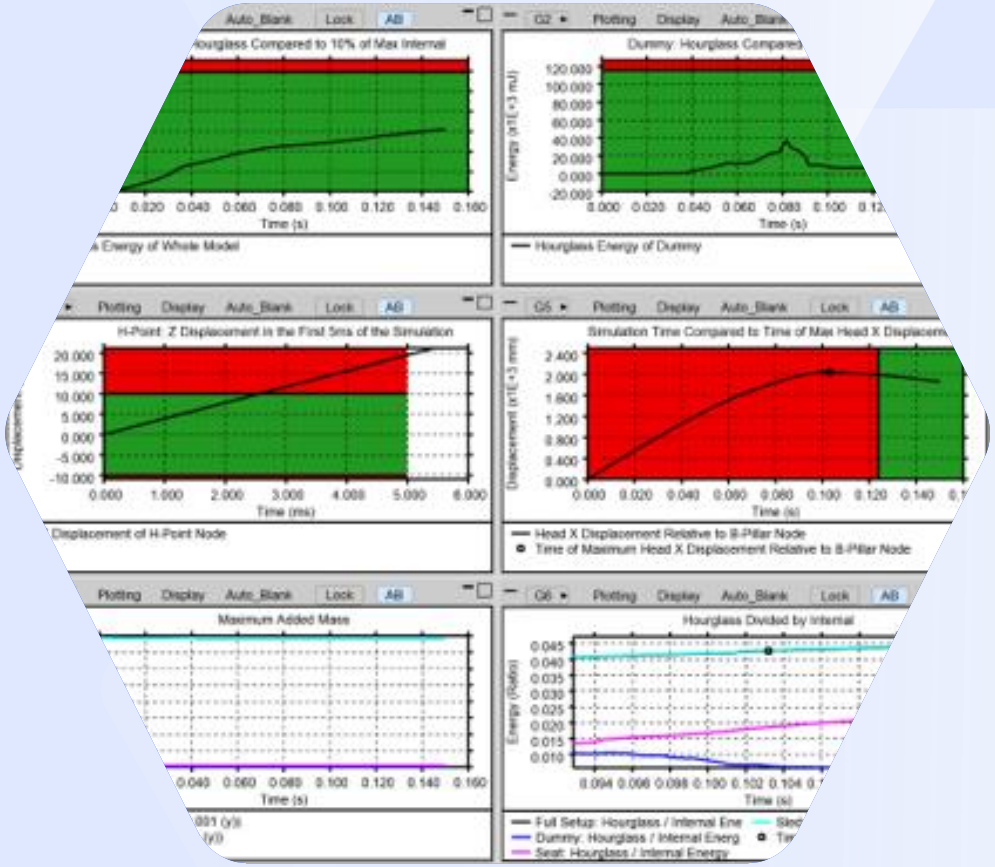

Corridors turned on




Corridors turned off

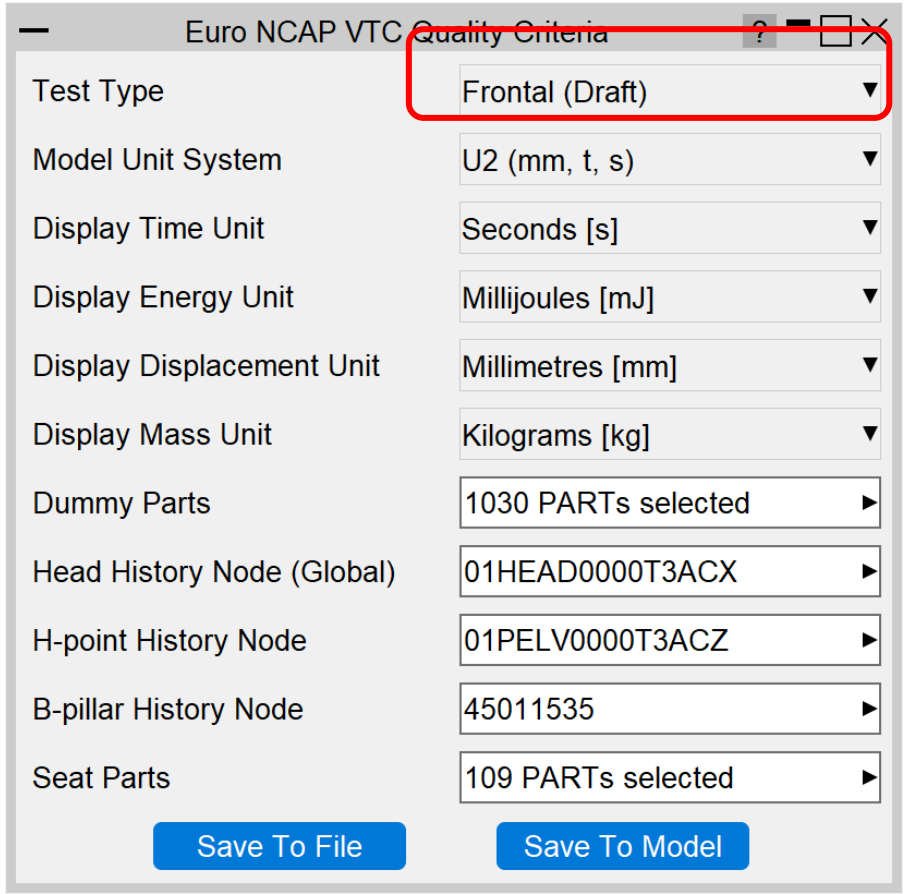


# VTC Quality Criteria Workflows



# Quality Criteria – Euro NCAP Frontal

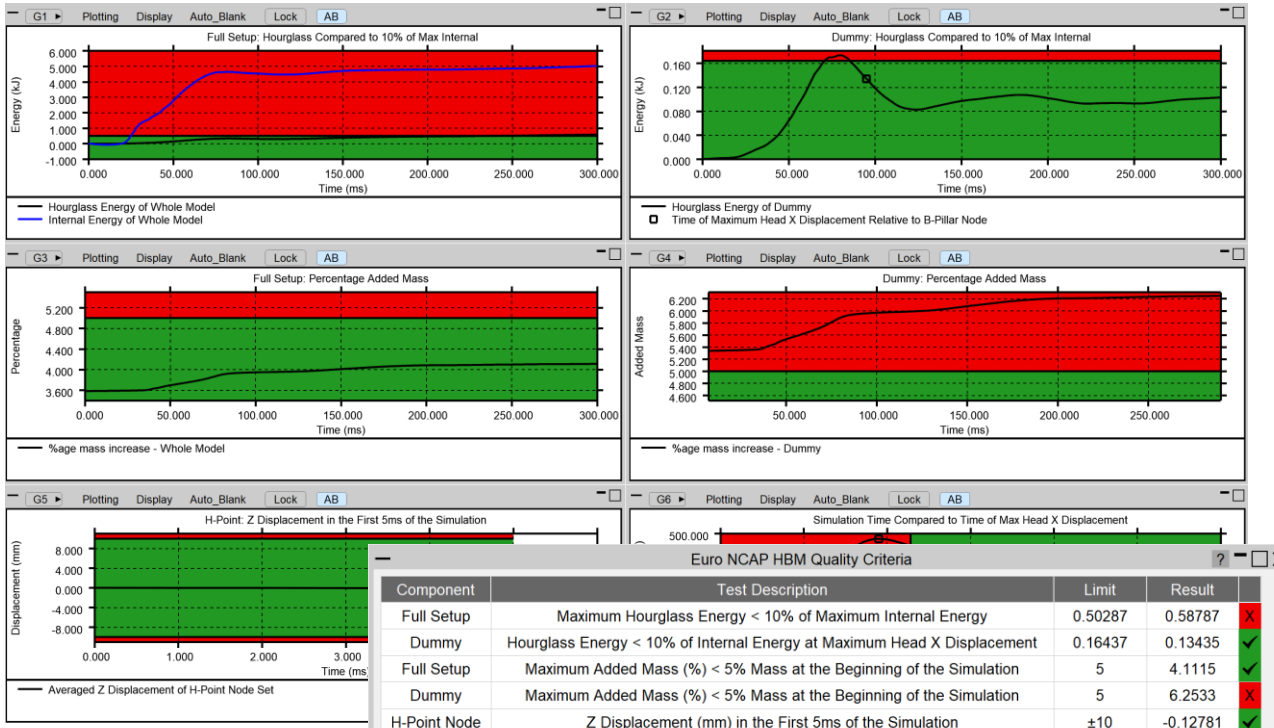
- The Euro NCAP VTC Quality Criteria Workflows tool and associated REPORTER Template are now capable of assessing the Euro NCAP Virtual Frontal Simulation & Assessment Protocol (draft) as well as the existing Far Side protocol.


Oasys LS-DYNA Environment

# Quality Criteria – Euro NCAP HBM

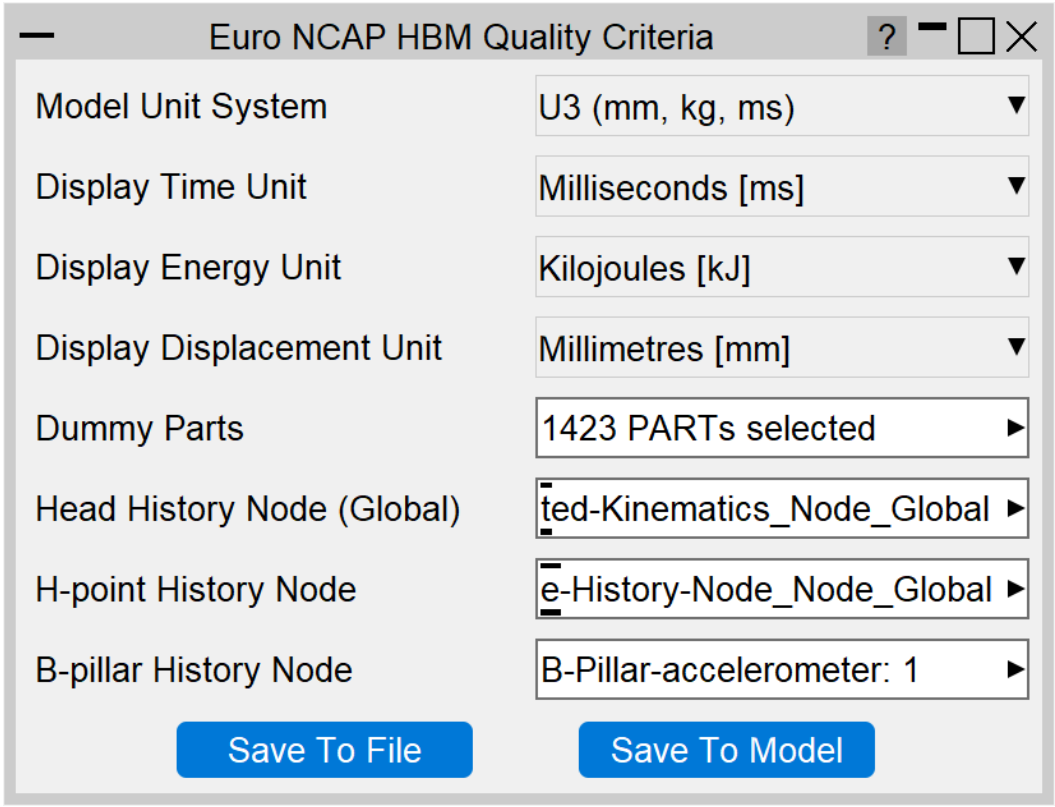
- The Euro NCAP HBM Quality Criteria Workflows tool and associated REPORTER Template allow you to perform the quality checks outlined in Section 7.1 of the Euro NCAP VTC HBM Frontal Protocol (draft) relating to energy, added mass and displacements.



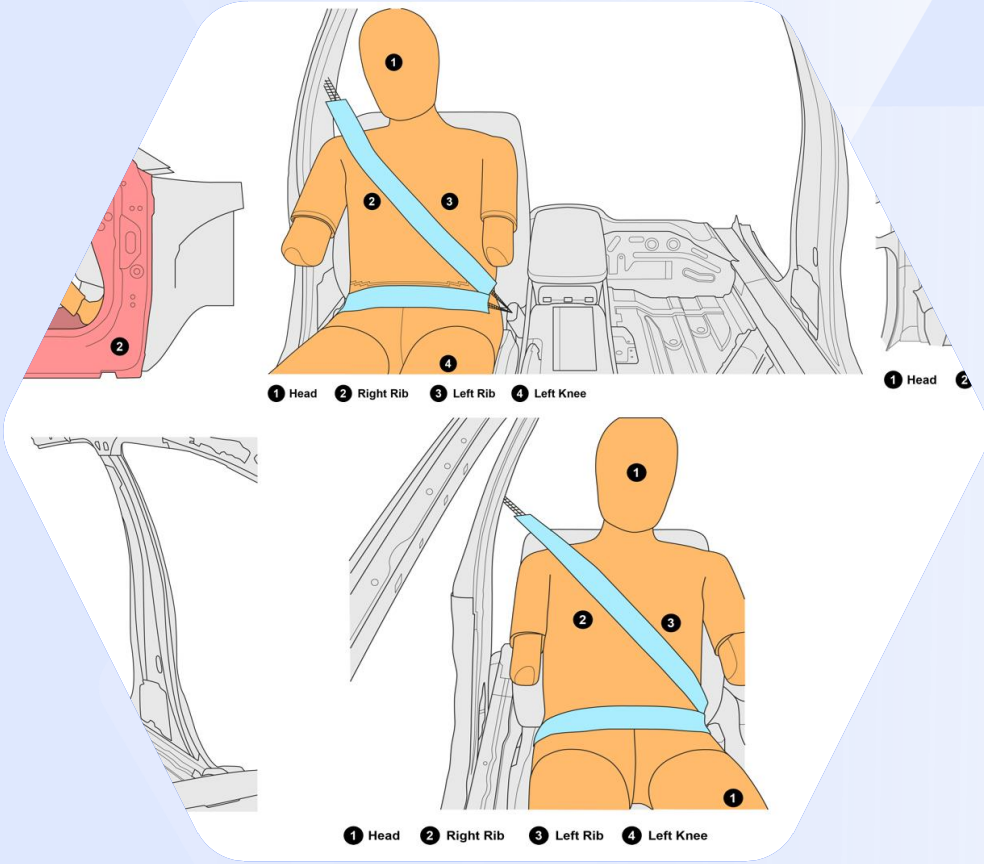

Euro NCAP HBM Quality Criteria

| Component | Test Description | Limit | Result | |
|---|---|---|---|---|
| Full Setup | Maximum Hourglass Energy < 10% of Maximum Internal Energy | 0.50287 | 0.58787 | X |
| Dummy | Hourglass Energy < 10% of Internal Energy at Maximum Head X Displacement | 0.16437 | 0.13435 | ✓ |
| Full Setup | Maximum Added Mass (%) < 5% Mass at the Beginning of the Simulation | 5 | 4.1115 | ✓ |
| Dummy | Maximum Added Mass (%) < 5% Mass at the Beginning of the Simulation | 5 | 6.2533 | X |
| H-Point Node | Z Displacement (mm) in the First 5ms of the Simulation | ±10 | -0.12781 | ✓ |
| Full Setup | Maximum Head X Displacement + 20% < Simulation Time | 114.00 | 300.00 | ✓ |

Write Results  Model Units: U3 (mm, kg, ms)

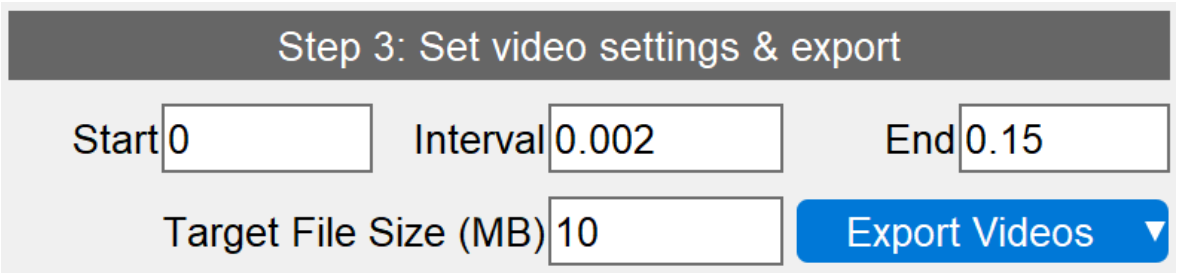


# VTC Videos File Size



# VTC Videos Settings Improvements

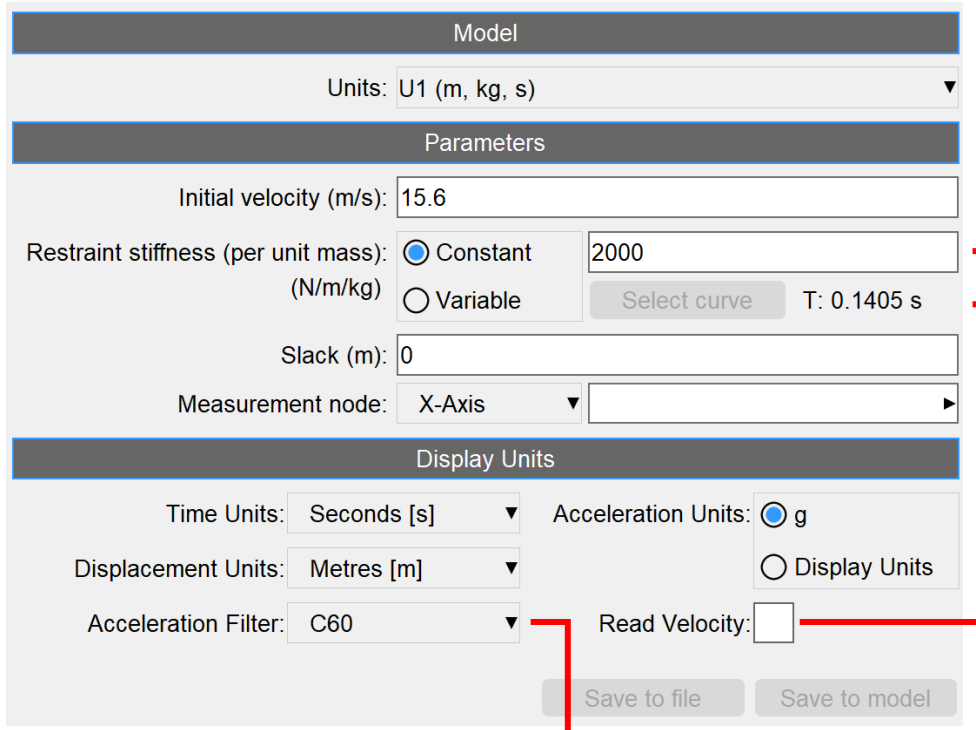
- The displayed End time is now determined by model simulation end time rounded down to three decimal places rather than model simulation end time minus 1 interval step (which had caused issues with video capture previously).
- For the Euro NCAP version, the Video Quality slider has been replaced with a target file size option to allow users to satisfy the 1-10 MB video requirement.



# Pulse Index

# Pulse Index (PI)

- The Pulse Index Workflow allows you to estimate the acceleration that would be experienced by a vehicle occupant in a crash test scenario.
- Pulse Index has been updated following user feedback. The occupant mass input has been removed with stiffness now being taken per unit mass. Based on the stiffness input, the time period of the system is now displayed to serve as a sense check. The acceleration curve filter can now be chosen from three options: C60, C180, and C600. A differentiated velocity curve can now be used in place of the acceleration curve.




Stiffness now per unit mass

Time period relating to current stiffness

Take acceleration as a differentiated velocity curve

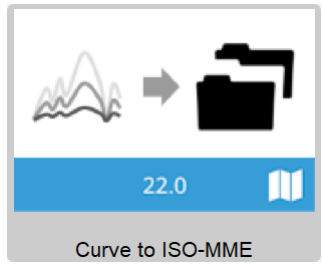
Select filter applied to the acceleration curve

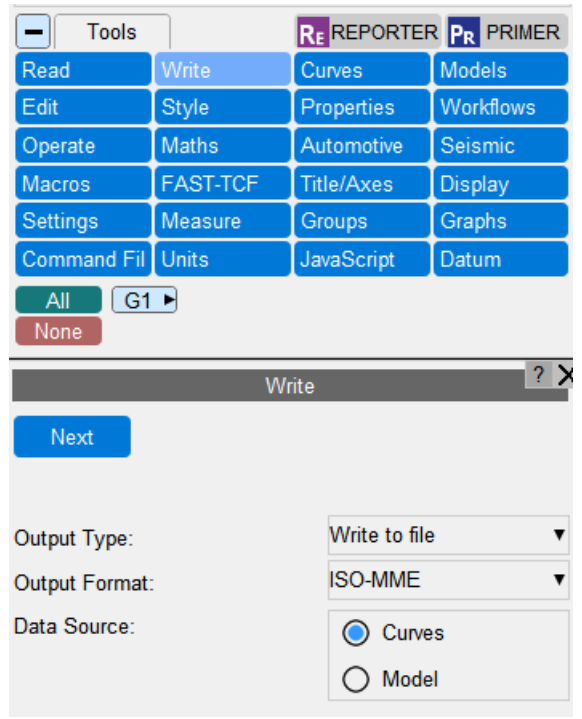
# Curve to ISO-MME

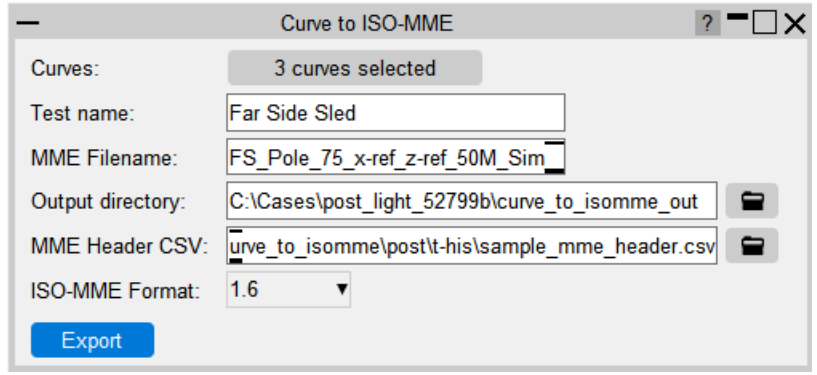
# Curve to ISO-MME

- A new Workflows tool “Curve to ISO-MME” allows you to write any curves from your T/HIS session directly to ISO-MME format without the need of a configuration file.

- You can access the tool from either the **Tools** → **Workflows** menu or from:
  1. Select **Tools** → **Write**
  2. Select output format as ISO-MME
  3. Select Data source **Curves**
  4. Click **Next**




Human-Safe Design

# Automotive Protocols

# New Protocols and Regulations

- Automotive Assessments and REPORTER now support the following new protocols and regulations:

| Regulation | Loadcase |
|---|---|
| C-NCAP | Far Side Occupant Protection |
| Global NCAP | MDB, ODB, Side Pole |
| JNCAP | FFB, MDB, ODB |
| KNCAP | FFB, MDB, Side Pole |
| UN ECE | R94, R95, R135, R137 |

# Upgraded Protocols

- The following protocols have been updated:

| Regulation | Loadcase | Update |
|---|---|---|
| Euro NCAP | MPDB Occupant Assessment | • 2024 (Follows Adult Occupant Protocol v9.3)<br>• Includes DAMAGE assessment |
| IIHS | Front SOB | • 2024 (Version VII)<br>• New fuel modifier |
| IIHS | Side MDB | • 2024 (Version IV)<br>• New fuel modifier and updated head protection rating system |

# Latest Protocol Support

Automotive Assessments Workflow

● Available for some time
● New in version 21.1
● New in version 22.0

| Regulation | Year | Loadcase/Workflow | PRIMER | T/HIS | D3PLOT | REPORTER (migrated to workflows) | REPORTER (standard template) |
|---|---|---|---|---|---|---|---|
| C-NCAP | 2018 | ODB | ● | ● | | | ● |
| | 2021 | Head Impact | | | | | ● |
| | | Leg Impact | | | | | ● |
| | 2022 | MPDB Occupant | ● | ● | | ● | |
| | 2023 | MPDB Compatibility | | | | | ● |
| | 2024 | Side Pole | ● | ● | | ● | |
| | | Far Side Pole | ● | ● | | ● | |
| | | Far Side Sled | ● | ● | | ● | |
| | | VTC Quality Criteria | ● | ● | | ● | |
| | | VTC Videos | ● | | ● | ● | |
| | | LS-DYNA to ISO-MME | ● | ● | | ● | |
| | | SimVT | | ● | | ● | |

# Latest Protocol Support

Automotive Assessments Workflow

- ● Available for some time
- ● New in version 21.1
- ● New in version 22.0

| Regulation | Year | Loadcase/Workflow | PRIMER | T/HIS | D3PLOT | REPORTER (migrated to workflows) | REPORTER (standard template) |
|---|---|---|---|---|---|---|---|
| Euro NCAP | 2017 | FFB | ● | ● | | ● | |
| | | ODB | ● | ● | | ● | |
| | 2020 | MPDB Occupant | ● | ● | | ● | |
| | | Side Pole | ● | ● | | | |
| | | MDB | ● | ● | ● | | |
| | 2022 | Far Side | ● | ● | ● | | |
| | | MDB | ● | ● | ● | ● | |
| | | Side Pole | ● | ● | | ● | |
| | 2023 | MPDB Compatibility | | | | | ● |
| | | Head Impact | | | | | ● |
| | | Leg Impact | | | | | ● |
| | **Continued…** | | | | | | |

# Latest Protocol Support

Automotive Assessments Workflow

- ● Available for some time
- ● New in version 21.1
- ● New in version 22.0

| Regulation | Year | Loadcase/Workflow | PRIMER | T/HIS | D3PLOT | REPORTER (migrated to workflows) | REPORTER (standard template) |
|---|---|---|---|---|---|---|---|
| Euro NCAP | 2024 | Far Side Sled | ● | ● | | ● | |
| | | MPDB Occupant | ● | ● | | ● | |
| | | VTC Quality Criteria | ● | ● | | ● | |
| | | VTC Videos | ● | | ● | ● | |
| | | LS-DYNA to ISO-MME | ● | ● | | ● | |
| | | SimVT | | ● | | ● | |
| | 2026 (Draft) | Front Sled | Early access – available on request | | | | |
| | | FWDB Full Vehicle | | | | | |
| | | VTC Quality Criteria | ● | ● | | ● | |
| | | VTC HBM Quality Criteria | ● | ● | | ● | |
| | | SimVT | Early access – available on request | | | | |

# Latest Protocol Support

Automotive Assessments Workflow

- ● Available for some time
- ● New in version 21.1
- ● New in version 22.0

| Regulation | Year | Loadcase/Workflow | PRIMER | T/HIS | D3PLOT | REPORTER (migrated to workflows) | REPORTER (standard template) |
|---|---|---|---|---|---|---|---|
| **Global NCAP** | 2022 | MDB | ● | ● | | ● | |
| | 2023 | ODB | ● | ● | | ● | |
| | 2024 | Side Pole | ● | ● | | ● | |
| **GTR** | 2019 | Leg Impact | | | | | ● |
| | 2020 | Head Impact | | | | | ● |
| **IIHS** | 2017 | MDB | ● | ● | ● | | |
| | | ODB | ● | ● | | | |
| | | SOB | ● | ● | | | |
| | **Continued…** | | | | | | |

# Latest Protocol Support

Automotive Assessments Workflow

- ● Available for some time
- ● New in version 21.1
- ● New in version 22.0

| Regulation | Year | Loadcase/Workflow | PRIMER | T/HIS | D3PLOT | REPORTER (migrated to workflows) | REPORTER (standard template) |
|---|---|---|---|---|---|---|---|
| IIHS | 2021 | MDB | ● | ● | ● | ● | |
| | | MDB Structure Only | | | | ● | |
| | | ODB | ● | ● | | ● | |
| | | ODB Structure Only | | | | ● | |
| | | SOB | ● | ● | | ● | |
| | | SOB Structure Only | | | | ● | |
| | 2024 | MDB | ● | ● | | ● | |
| | | MDB Structure Only | | | | ● | |
| | | SOB | ● | ● | | ● | |
| | | SOB Structure Only | | | | ● | |

# Latest Protocol Support

Automotive Assessments Workflow

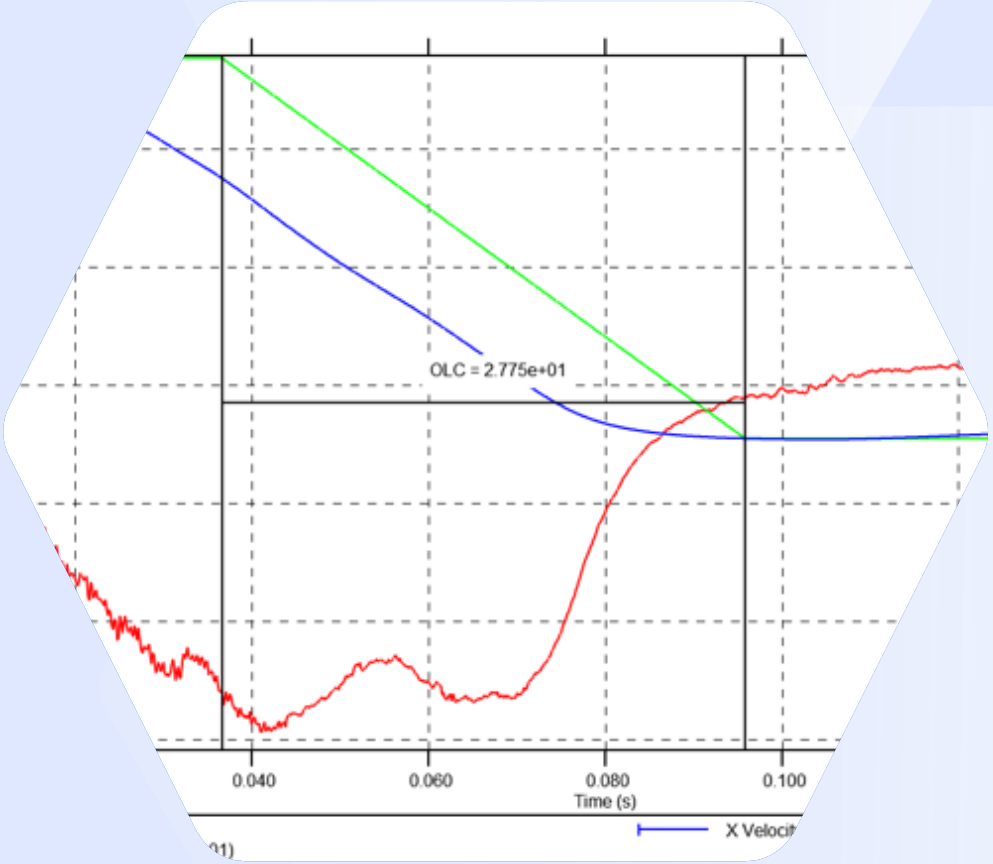
● Available for some time
● New in version 21.1
● New in version 22.0

| Regulation | Year | Loadcase/Workflow | PRIMER | T/HIS | D3PLOT | REPORTER (migrated to workflows) | REPORTER (standard template) |
|---|---|---|---|---|---|---|---|
| JNCAP | 2018 | Leg Impact | | | | | ● |
| | 2023 | FFB | ● | ● | | ● | |
| | | MDB | ● | ● | | ● | |
| | | ODB | ● | ● | | ● | |
| KNCAP | 2019 | Leg Impact | | | | | ● |
| | 2024 | FFB | ● | ● | | ● | |
| | | MDB | ● | ● | | ● | |
| | | Side Pole | ● | ● | | ● | |
| UN ECE | 2015 | R135 (Side Pole) | ● | ● | | ● | |
| | 2022 | R94 (ODB) | ● | ● | | ● | |
| | 2023 | R95 (Side MDB) | ● | ● | | ● | |
| | | R137 (FFB) | ● | ● | | ● | |

# New Automotive Operations

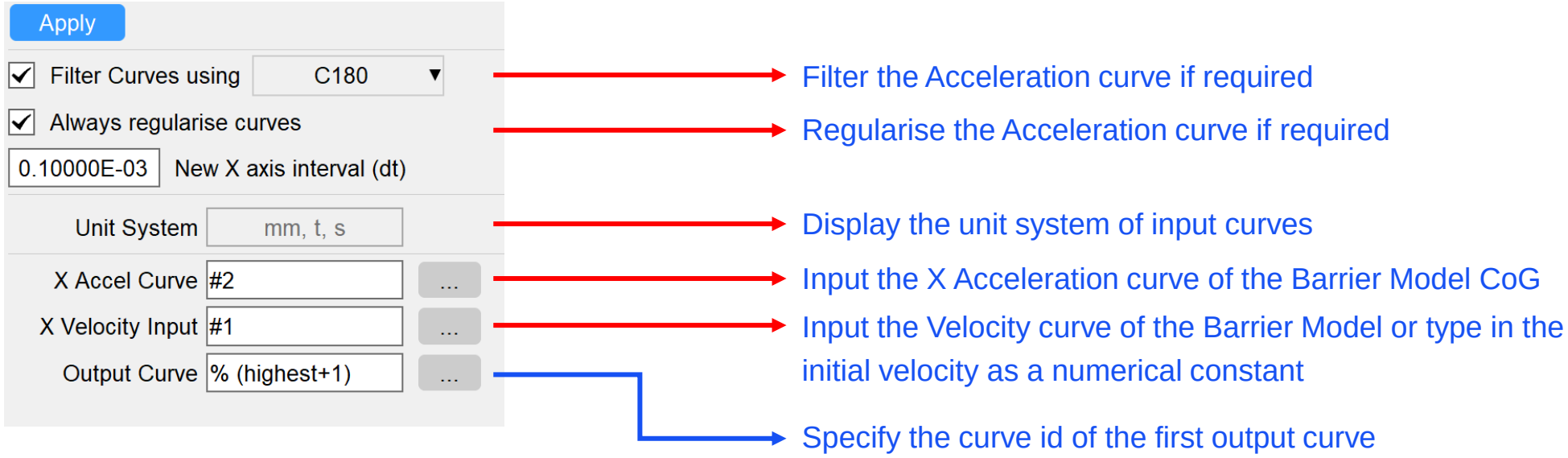
- Occupant Load Criterion (OLC)
- Tibia Index (TI)
- DAMAGE (DMG)

# Occupant Load Criterion (OLC)



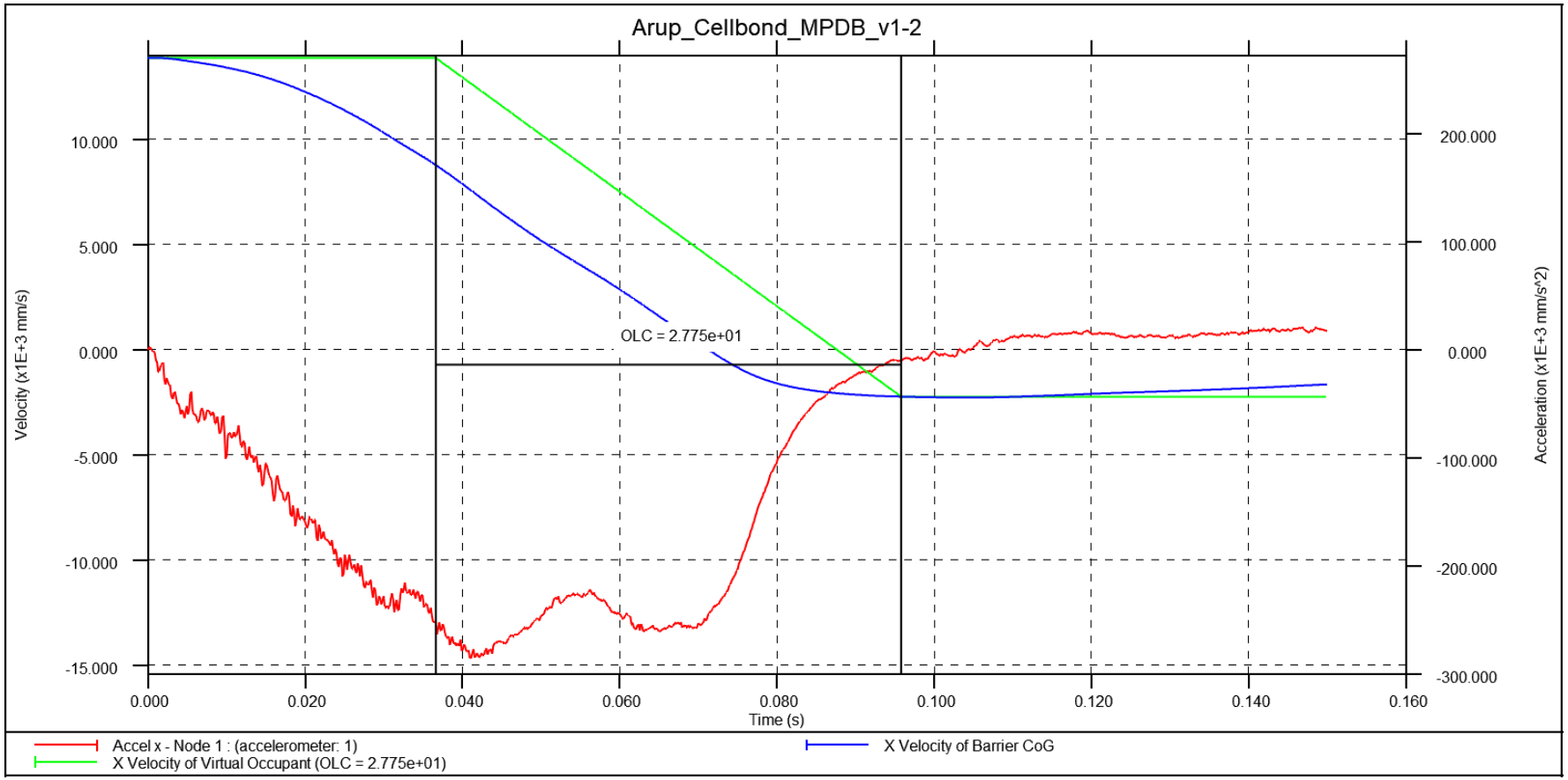
# Occupant Load Criterion (OLC)

- T/HIS can now calculate OLC and generate velocity and displacement curves for MPDB Compatibility Assessment. The calculation follows the method specified in Euro NCAP Technical Bulletin (TB 027) v1.1.1, which is intended to be used with Adult Occupant Protection Assessment Protocol v9.1.1.
- The OLC Operation requires an X Acceleration Curve of the Barrier CoG as its first input and requires the Initial Velocity of the Barrier CoG either as a Velocity Curve or as a Numerical Value.



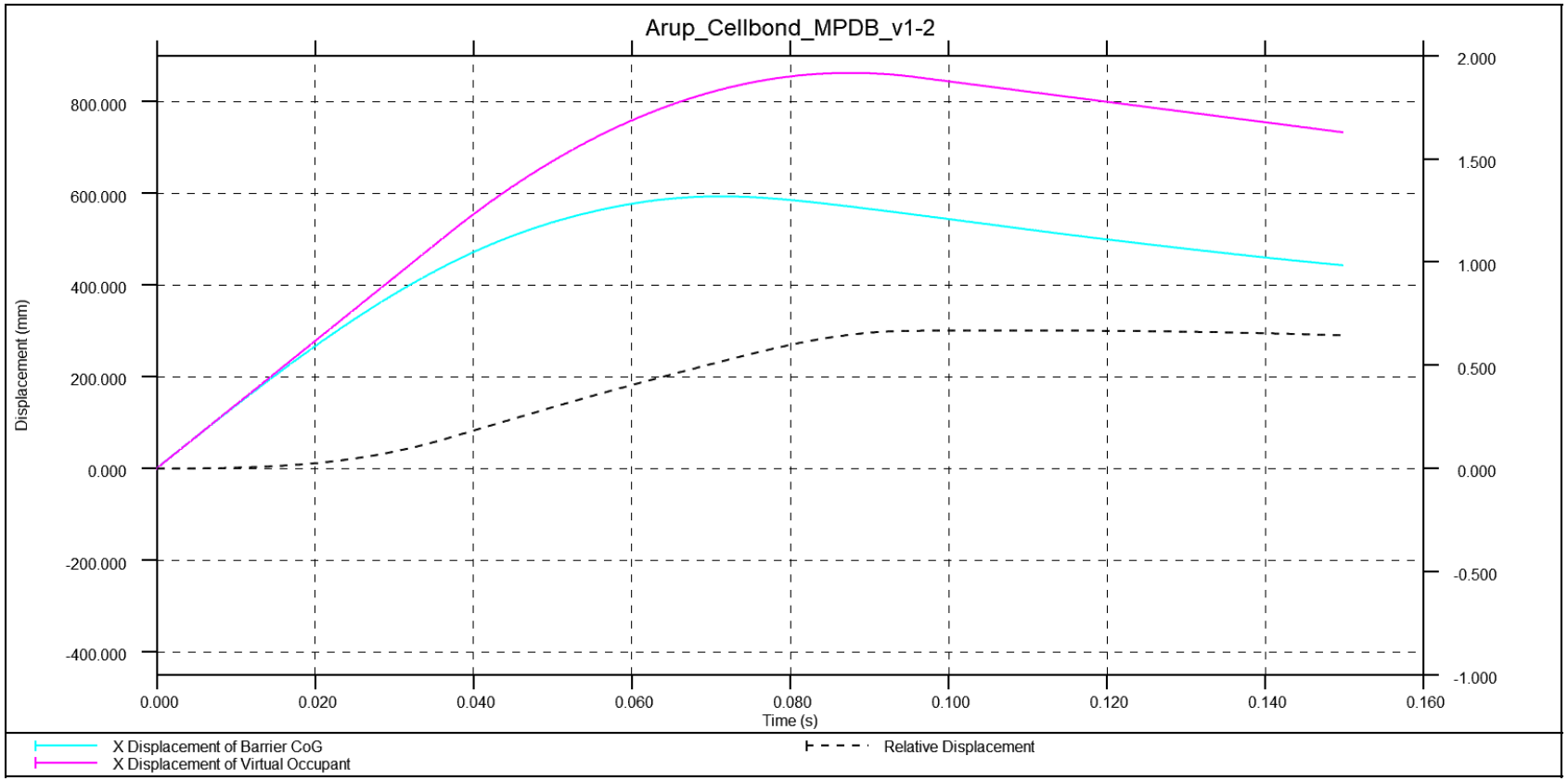
# Occupant Load Criterion (OLC)

- The OLC operation generates two velocity curves:

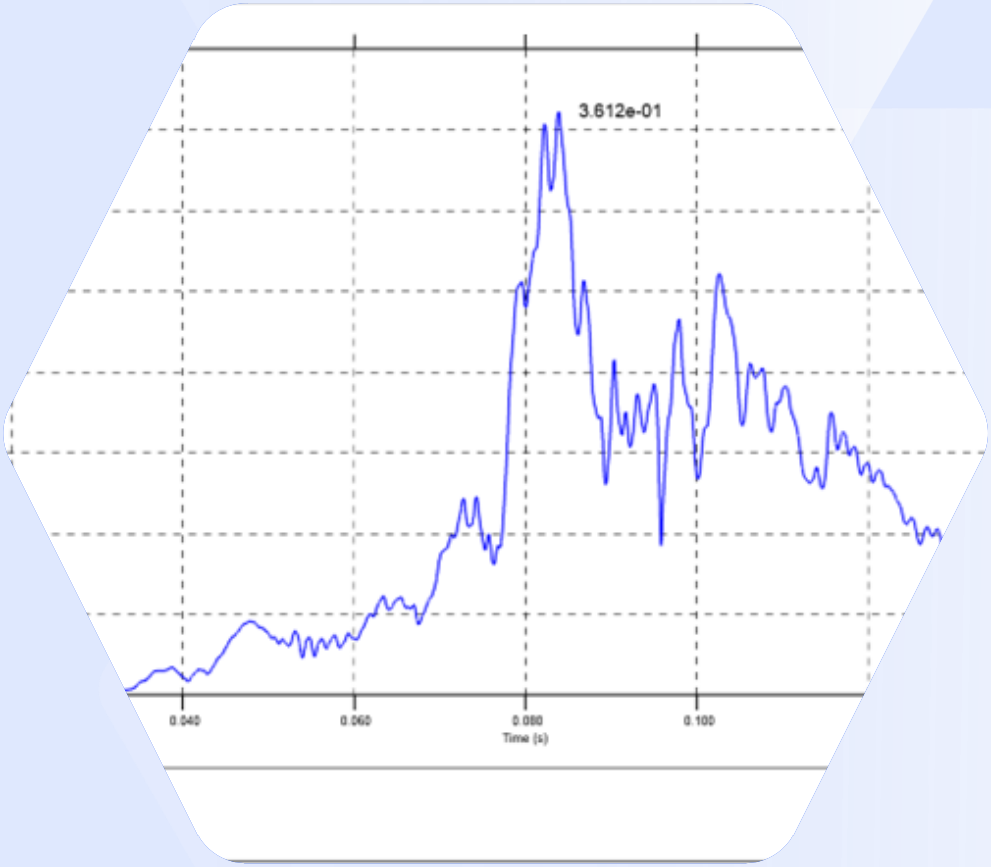


# Occupant Load Criterion (OLC)

- It also generates three displacement curves:



# Tibia Index (TI)



# Tibia Index (TI)

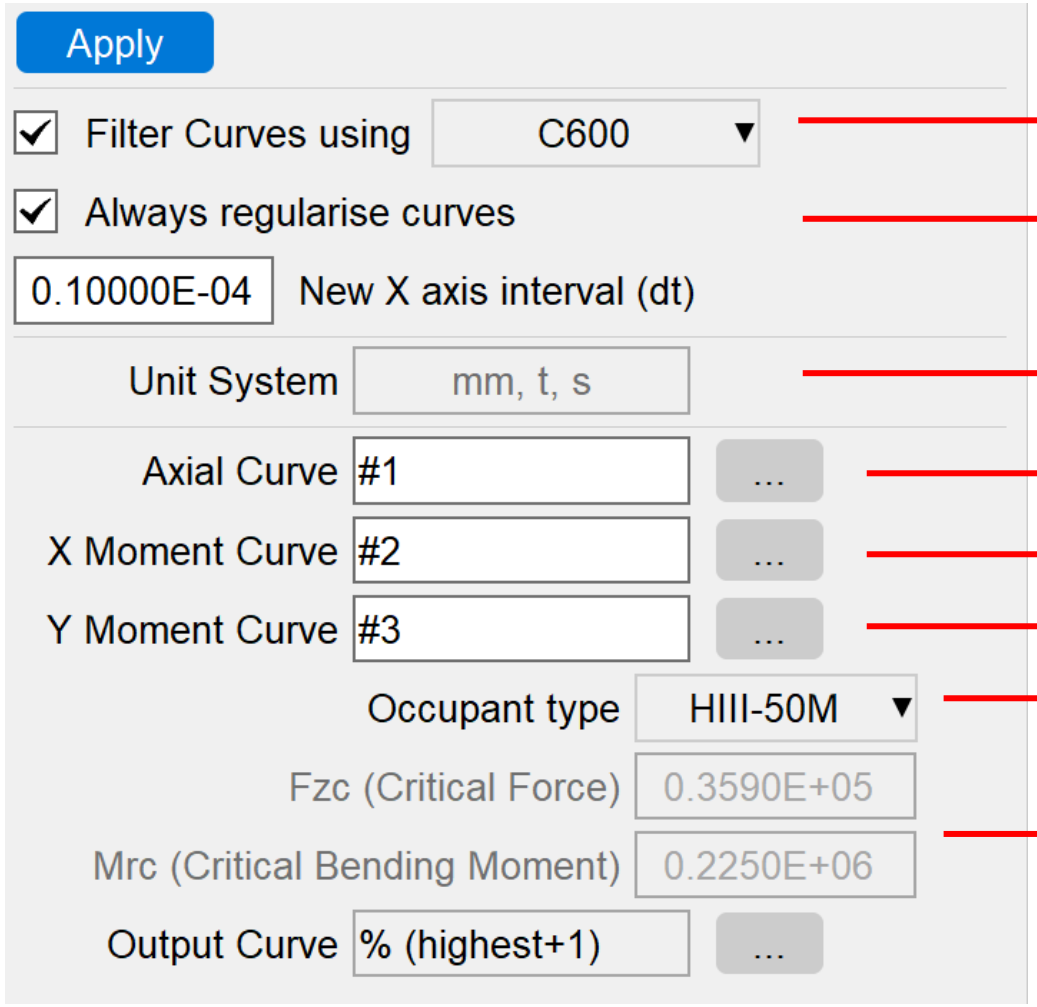
- T/HIS can now calculate the Tibia Index (TI) injury criterion and generate the Tibia Index curve, based on the following interaction formula specified in Euro NCAP Technical Bulletin (TB 021) v4.1:

$$TI(t) = \left|\frac{M_R(t)}{(M_R)_c}\right| + \left|\frac{F_z(t)}{(F_z)_c}\right|$$

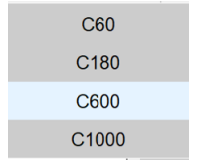
Where, $M_R(t) = \sqrt{M_x(t)^2 + M_y(t)^2}$

- The TI operation requires three input curves $F_z(t)$, $M_x(t)$ and $M_y(t)$ and two critical constant input values $(M_R)_c$ and $(F_z)_c$.

# Tibia Index (TI)




Select to filter the input curves before calculating TI, and select the filter class




Select to regularise the input curves using the new X axis interval

Displays the unit system of the input curves

Input the Axial Curve ID

Input the X Moment Curve ID

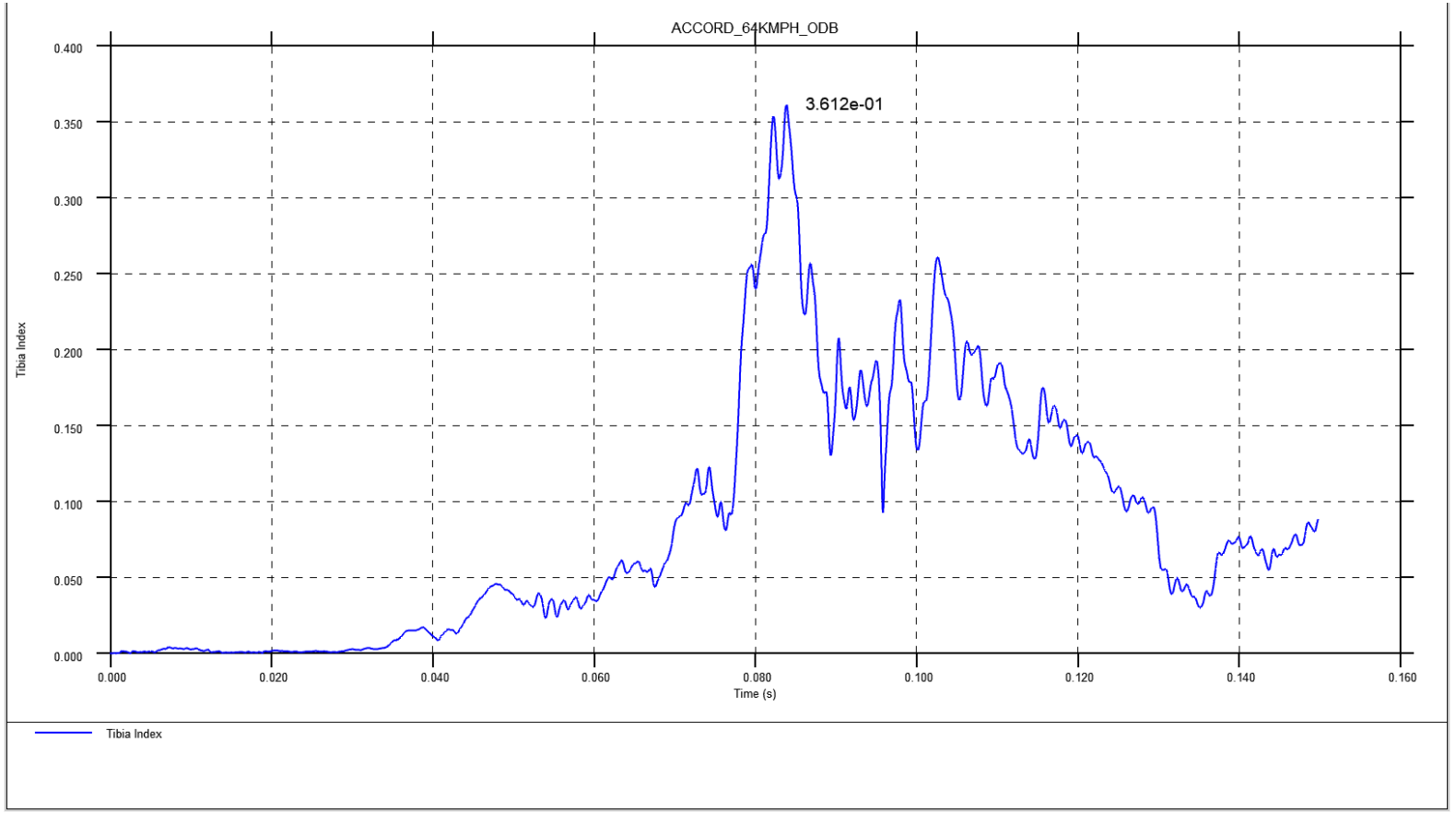
Input the Y Moment Curve ID

Select the Occupant type

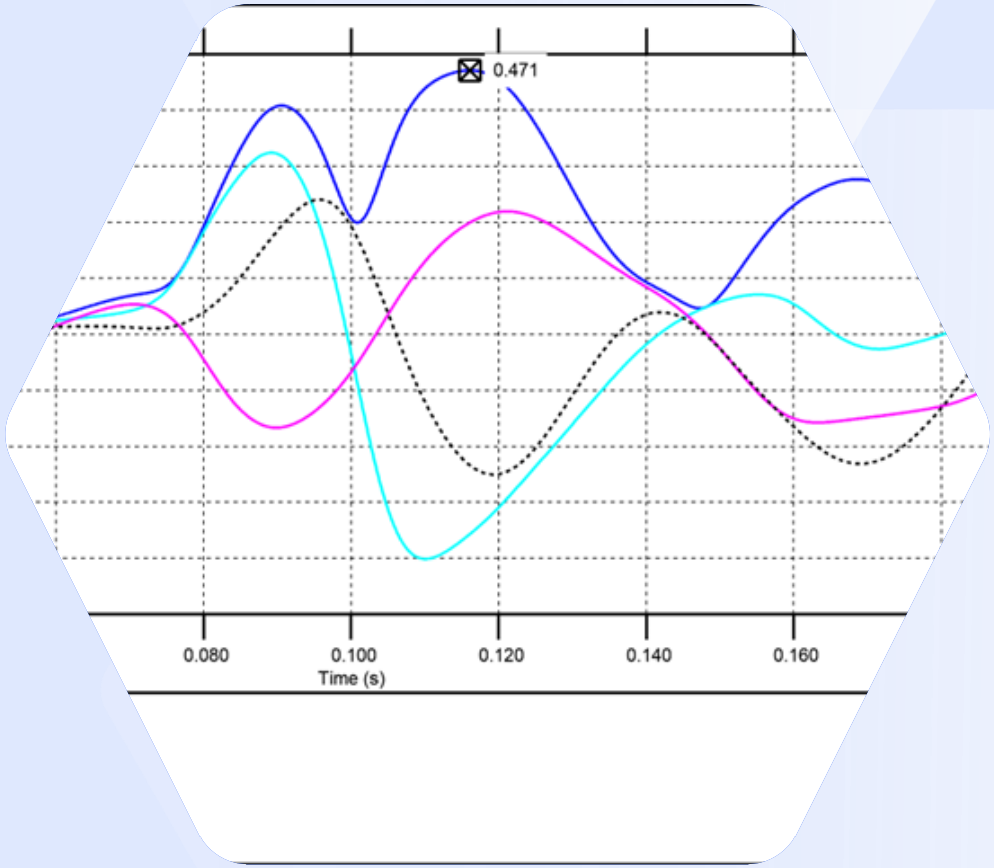

For the standard occupant types, $(F_z)_c$ and $(M_R)_c$ values are updated automatically. Otherwise, input suitable Critical force and Critical Bending Moment values.

# Tibia Index (TI)

- The TI operation generates a Tibia Index output curve.
- The Tibia Index value can be displayed on the graph by turning on the “Show Max Value” property of the Tibia Index curve.



# DAMAGE Criterion (DMG)



# Damage Criterion (DMG)

- The DAMAGE Criterion is a brain injury metric which is based on deformation output from a second-order system of equations.
- T/HIS can now calculate Damage Criterion (DMG) and generate the Damage curve, based on the interaction formula specified in the Euro NCAP Technical Bulletin (TB 035) v1.0 (right).
- DMG requires three input curves: Head Rotation Velocity X, Head Rotation Velocity Y, Head Rotation Velocity Z.
- You can also select the calculation method used to perform the Damage operation. The available methods are:
  - RK4: Runge Kutta 4
  - RKF45: Runge Kutta 45
  - NBM: Newmark Beta method

$$\begin{bmatrix} m_x & 0 & 0 \\ 0 & m_y & 0 \\ 0 & 0 & m_z \end{bmatrix} \begin{Bmatrix} \ddot{\delta}_x \\ \ddot{\delta}_y \\ \ddot{\delta}_z \end{Bmatrix} + \begin{bmatrix} c_{xx}+c_{xy}+c_{xz} & -c_{xy} & -c_{xz} \\ -c_{xy} & c_{xy}+c_{yy}+c_{yz} & -c_{yz} \\ -c_{xz} & -c_{yz} & c_{xz}+c_{yz}+c_{zz} \end{bmatrix} \begin{Bmatrix} \dot{\delta}_x \\ \dot{\delta}_y \\ \dot{\delta}_z \end{Bmatrix} + \begin{bmatrix} k_{xx}+k_{xy}+k_{xz} & -k_{xy} & -k_{xz} \\ -k_{xy} & k_{xy}+k_{yy}+k_{yz} & -k_{yz} \\ -k_{xz} & -k_{yz} & k_{xz}+k_{yz}+k_{zz} \end{bmatrix} \begin{Bmatrix} \delta_x \\ \delta_y \\ \delta_z \end{Bmatrix} = \begin{bmatrix} m_x & 0 & 0 \\ 0 & m_y & 0 \\ 0 & 0 & m_z \end{bmatrix} \begin{Bmatrix} \ddot{u}_x \\ \ddot{u}_y \\ \ddot{u}_z \end{Bmatrix}$$

$DAMAGE = \beta max\,\{|\vec{\delta}(t)|\}$

$\vec{\delta}(t) = [\delta x(t)\ \delta y(t)\ \delta z(t)]^T$

β = scale factor, m = mass, $cij$ = damping, $kij$ = stiffness

$\delta$“, $\delta$’, $\delta$ = $acceleration, velocity, displacement$

$\ddot{u}$= $applied\ angular\ acceleration$

$mx$ = 1 $kg$, $my$ = 1 $kg$, $mz$ = 1 $kg$

$kxx$ = 32142 N/m, $kyy$ = 23493 $N/m$, $kzz$ = 16935 $N/m$,

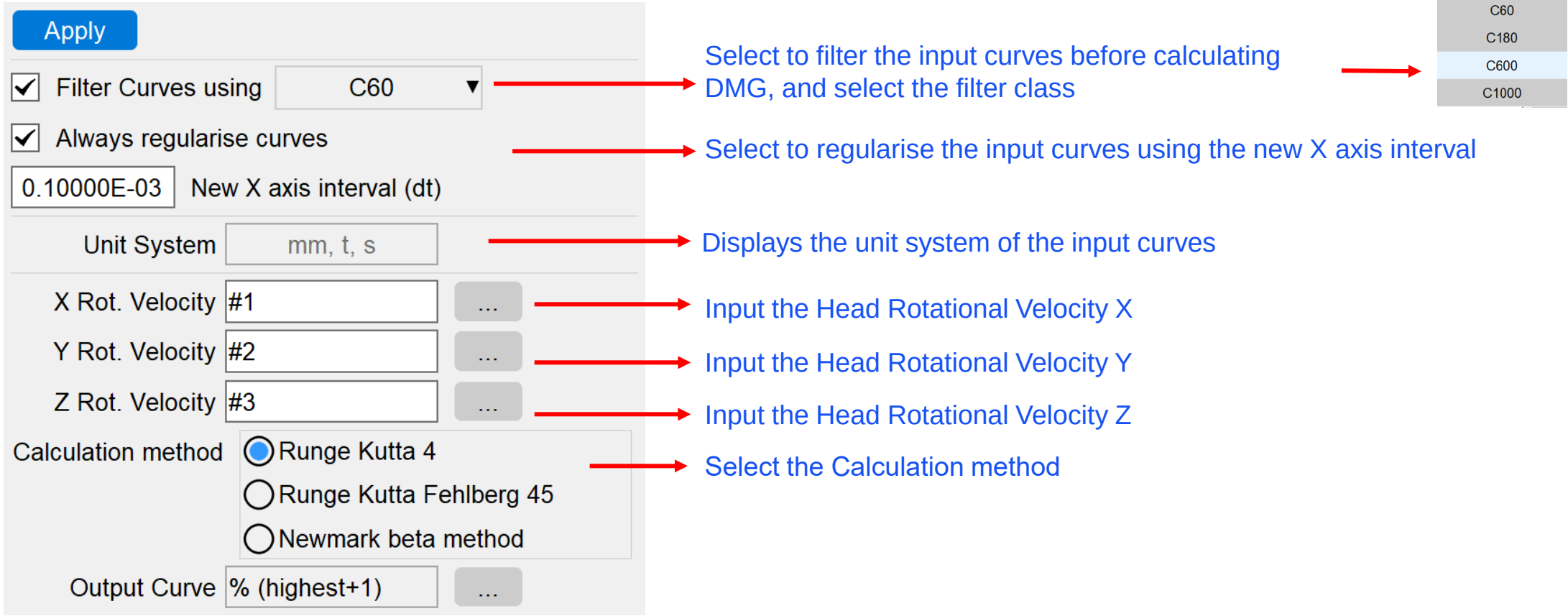
$kxy$ = 0 $N/m$, $kyz$ = 0 $N/m$, $kxz$ = 1636.3 N/m,

a1=5.9148 ms,

$\beta$=2.9903 1/m

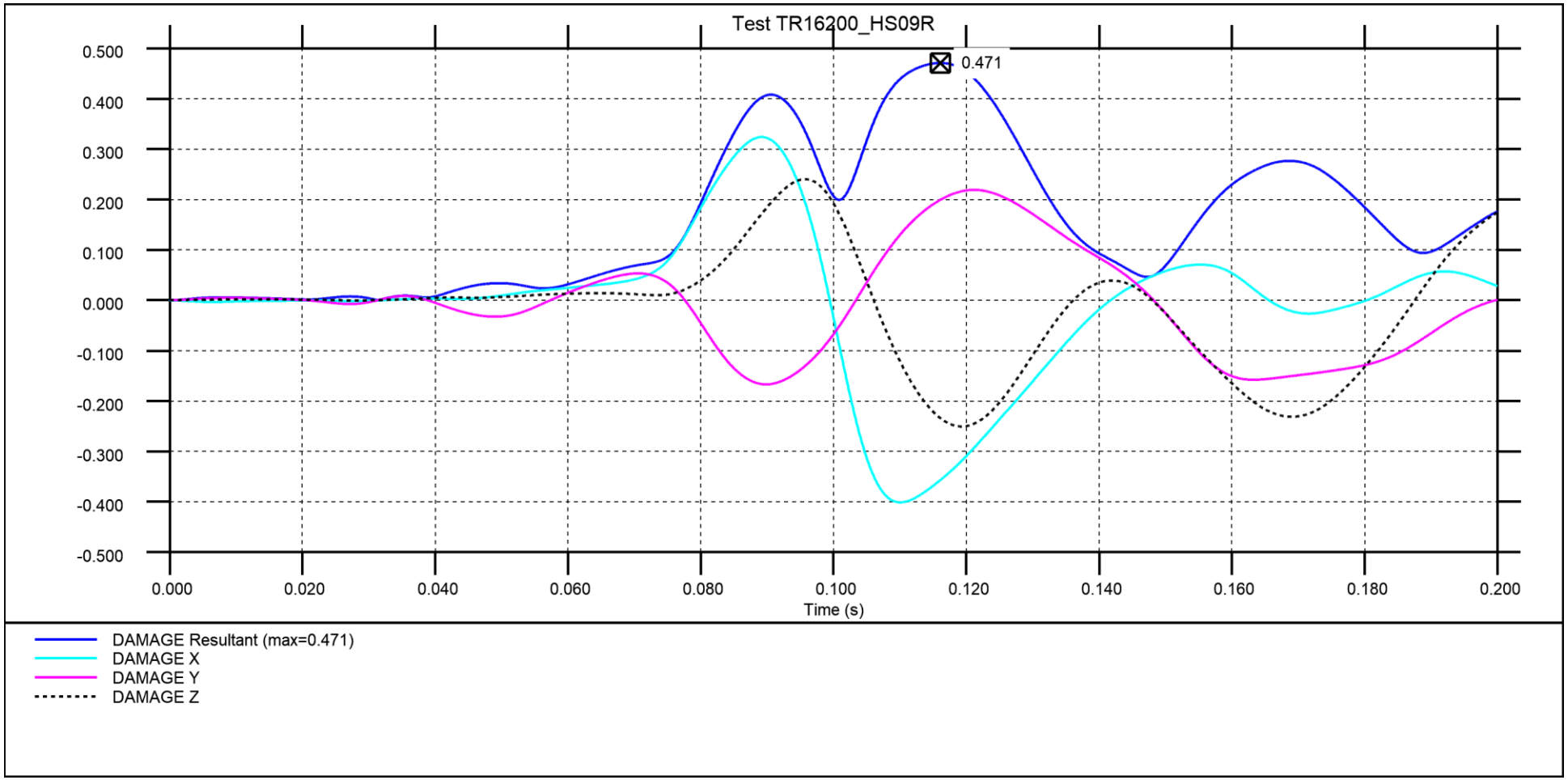
$[c]$ = a1 × $[k]$

# Damage Criterion (DMG)



# Damage Criterion (DMG)

- The DMG operation generates four DAMAGE curves:



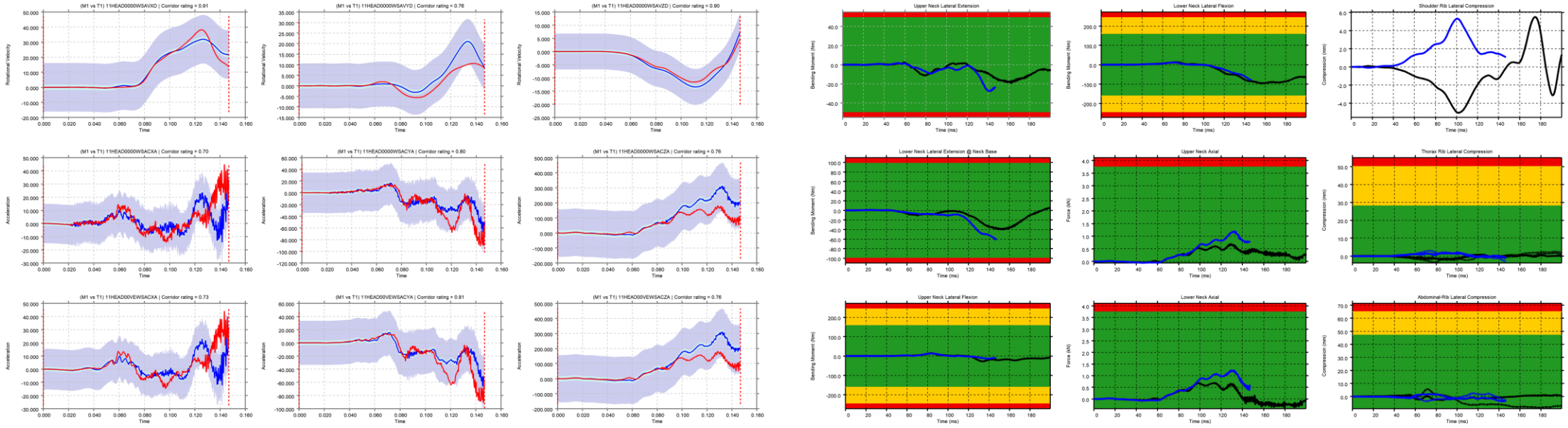

Speed and Performance

# Datums

# Datums

- The previous hard-wired limit of 256 for datums has now been removed from T/HIS. Any number of datums can now be created with machine specifications being the limiting factor.

Many constant and points datums in a single session:



# Write ISO-MME Files

# Write ISO-MME Files

New variables have been added to ISO-MME configuration files:

- **mandatoryHeaders:** Controls the inclusion of mandatory headers in MME files. When set to true, all mandatory headers are automatically included. When set to false, mandatory headers are omitted, allowing headers to be rearranged using the descriptor functionality. The default value for this variable is true.
- **testObjectHeaderNumber:** Specifies the test object header number required in MMD files. By default, this value corresponds to the first letter of the curve ISO code. This variable is used when a different test object number is required instead of the default behaviour.

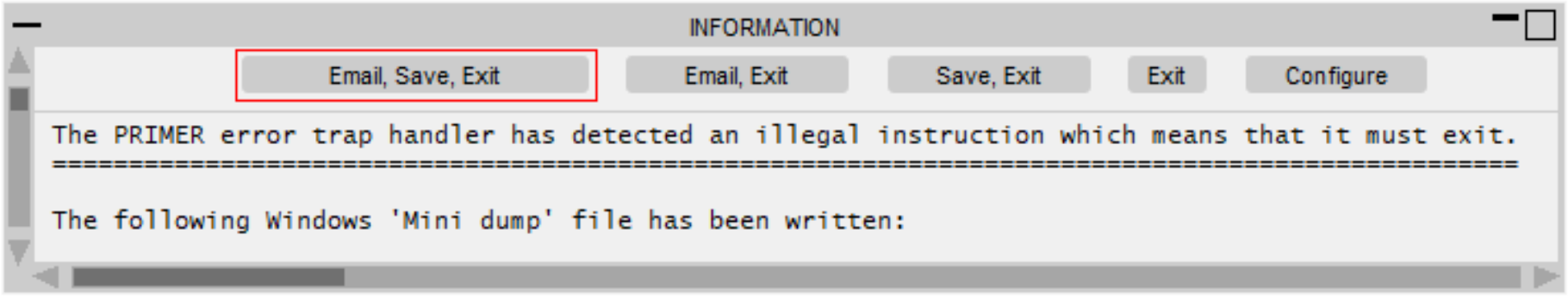
It is also now possible to write ISO-MME files directly from curves, without configuration, using the new Curve to ISO-MME Workflow.

# Email Minidump Files

# Windows Minidump files can now be emailed

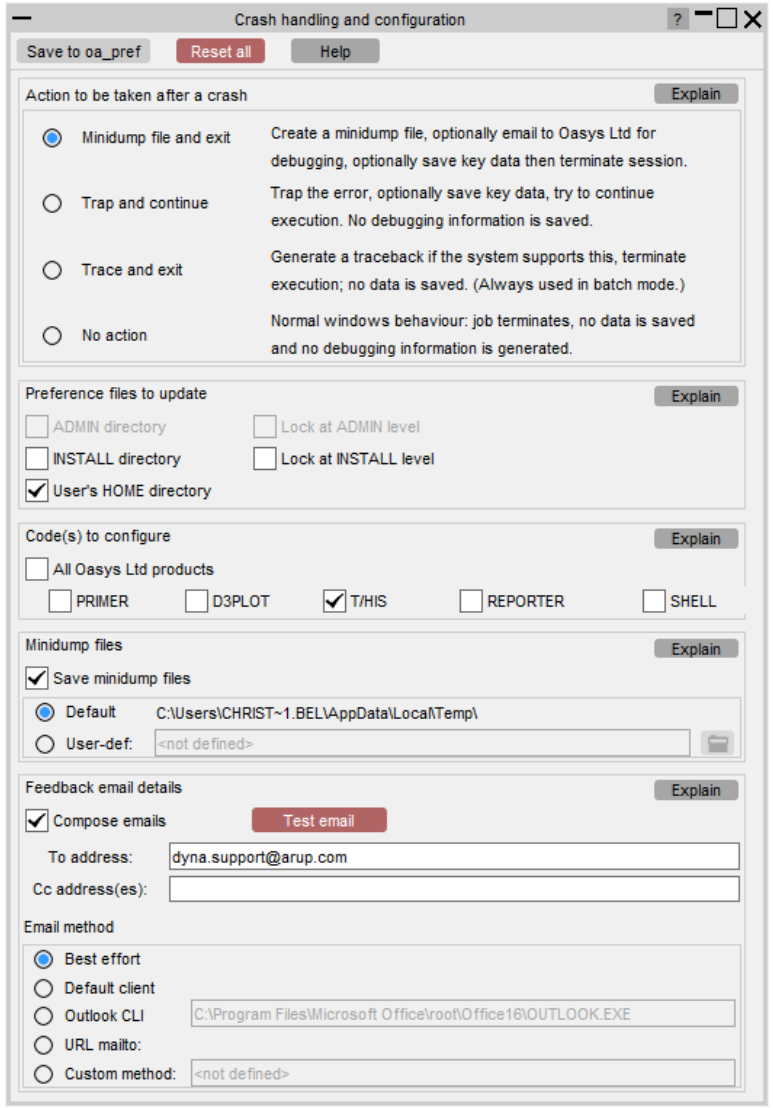
- Following a crash on Windows a “minidump” file is created which, if sent, can sometimes enable us to diagnose the cause of the crash, suggest workarounds and fix the bug. Historically this file has been written to an obscure temporary directory making it laborious to extract and send it.
- T/HIS can now:
  - Compose an email automatically, attaching the minidump file.
  - Include further information about the crash (stack trace) in that email.
  - Launch the default email handler on the system so that you can add further information if you wish.

- This email is ***not*** sent automatically, you can choose to send it or not.
- Composition of these emails is optional; they can be turned off.



# Windows Minidump files can now be emailed (continued)

- Minidump files and crash handling generally can be configured by preferences, but to make this easier there is now an interactive GUI which can be used to control this behaviour:

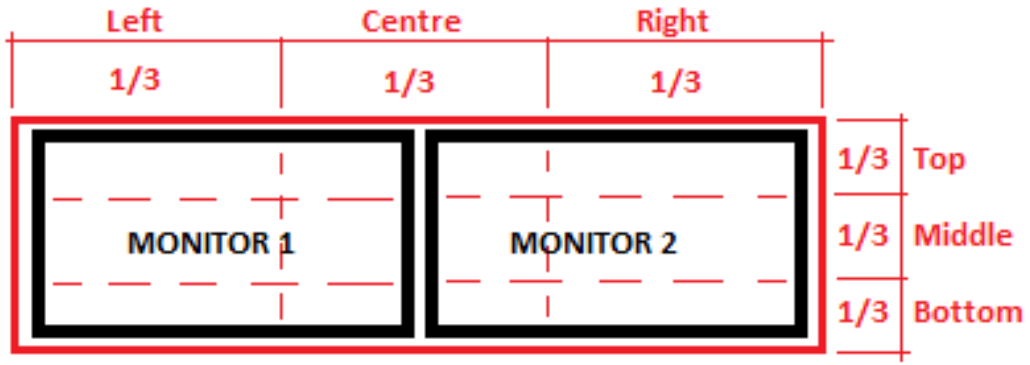



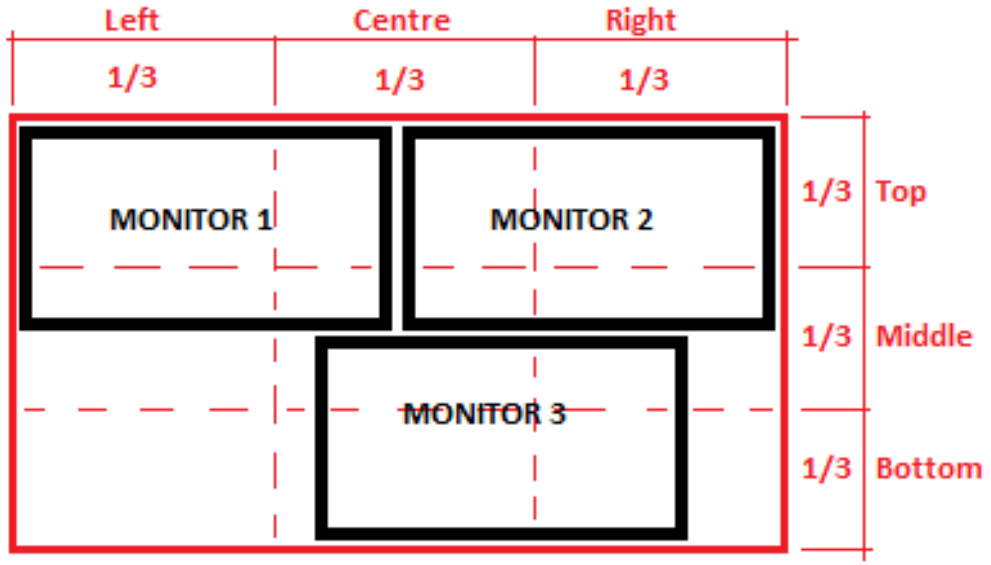

- Crash dump behaviour can also be configured at the “admin” or “installation” levels during software installation, configuring it for all users.

# Initial Window Placement

# Master T/HIS window can start on a selected monitor.

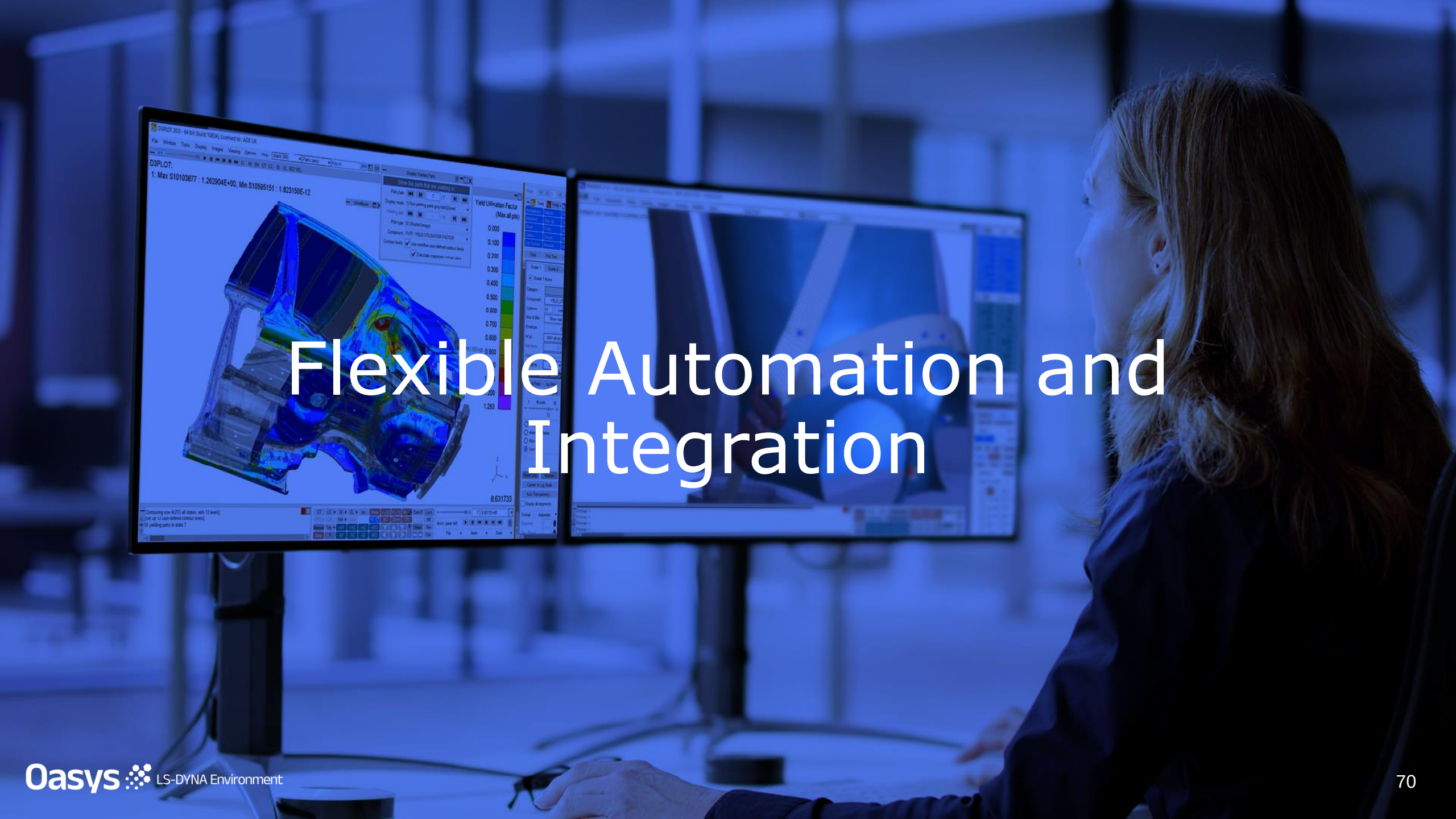
- On a multi-monitor desktop the “placement” preference can be used to select which of multiple monitors on a desktop the master T/HIS window starts in. Previously this was always the main display window.  The bounding box (red) around the monitors (black) that make up the desktop in pixel space which is divided into 1/3rds. For example:




The preference value may be a combination of
**LEFT | CENTRE | RIGHT**
and / or
**TOP | MIDDLE | BOTTOM**

The monitor nearest to the centre of that 1/3rd sub-area is used.


Flexible Automation and Integration

# JavaScript API

# JavaScript API

- It is no longer necessary to specify the memory required when running a script.
  The memory is now automatically increased as required.
- The function assigned to the Window onClose event can now return false to prevent the window closing if required.

# JavaScript API

- Functionalities to set and query the Model and Display Units have been added.
- The GetModelUnits and SetModelUnits methods can be accessed from the Model Class, using the model instance.
- The GetDisplayUnits and SetDisplayUnits methods can be accessed from the Units Class.

# JavaScript API

- New Automotive operations added to the Operate Class:

| Class function | Required Inputs | Optional Inputs | Output | Example |
|---|---|---|---|---|
| **Operate.Olc()** | • Acceleration Curve<br>• Velocity Curve or Initial Velocity as a constant | • X axis Interval for regularization<br>• Filter type as a string | Returns an array of 5 curves | `Operate.Olc(curve1, curve2, 0.001, 'C180');`<br>or<br>`Operate.Olc(curve1, 13888, 0.001, 'C180');` |
| **Operate.Ti()** | • Axial Curve<br>• X Moment Curve<br>• Y Moment Curve<br>• Critical Force value<br>• Critical Bending Moment value | • X axis Interval for regularization<br>• Filter type as a string | Returns a curve object | `Operate.Ti(curve1, curve2, curve3, 35.9, 225, 0.0001, 'C600');` |
| **Operate.Dmg()** | • X Rot. Velocity Curve<br>• Y Rot. Velocity Curve<br>• Z Rot. Velocity Curve<br>• Calculation method string:'rk4','rkf45','nbm' | • X axis Interval for regularization<br>• Filter type as a string | Returns an array of 5 curves | `Operate.Dmg(curve1,curve2,curve3, 'rk4',0.001, 'C60');` |

# JavaScript API

- New methods added to the Model Class:

| Member function | Required Inputs | Output | Example |
|---|---|---|---|
| **model.GetModelUnits()** | No Input | Returns Model Unit System | `let model = Model.GetFromID(1);`<br>`model.GetModelUnits();` |
| **model.SetModelUnits()** | Model Unit System | True if Model units are set, else False | `let model = Model.GetFromID(1);`<br>`model.SetModelUnits("U2");` |

# JavaScript API

- New methods added to the Units Class:

| Class function | Required Inputs | Output | Example |
|---|---|---|---|
| **`Units.GetDisplayUnits()`** | No Input | Returns Display Unit System | `Units.GetDisplayUnits();` |
| **`Units.SetDisplayUnits()`** | Display Unit System | True if Display units are set, else False | `Units.SetDisplayUnits(“U2”);` |

# JavaScript API

- New property added to the Graph Class:

| Member property | Output | Example |
|---|---|---|
| **graph.show_y2axis** | Gets / sets the display of the Y2 axis | `let graph = Graph.GetFromID(1);`<br>`graph.show_y2axis = Graph.ON;` |

# JavaScript API

- New property added to the Curve Class:

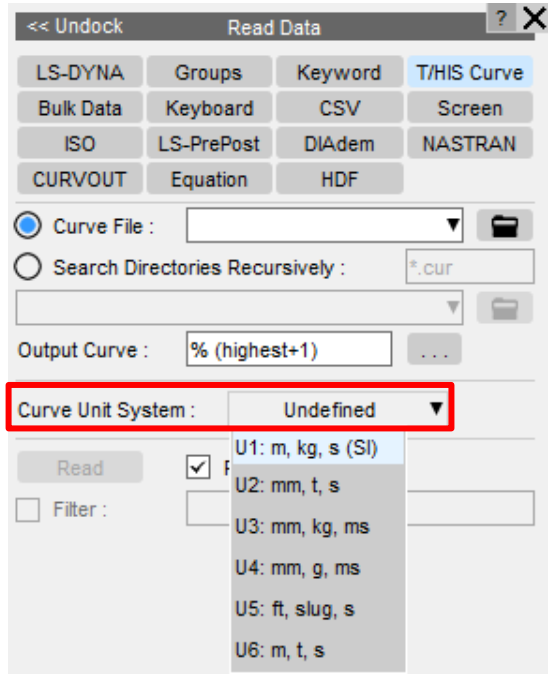
| Member property | Output | Example |
| --- | --- | --- |
| `curve.y_axis` | Gets / sets the Y axis the curve is plotted on | `let curve = Curve.GetFromID(1);`<br>`curve.y_axis = Curve.Y2_AXIS;` |

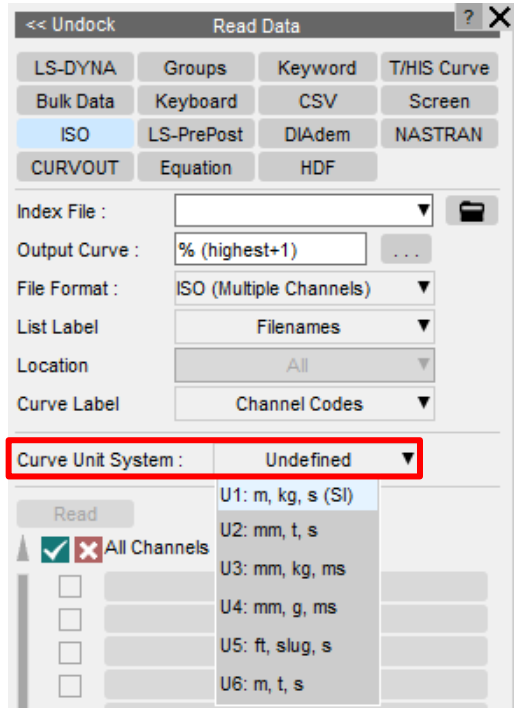

Other Developments and Preferences

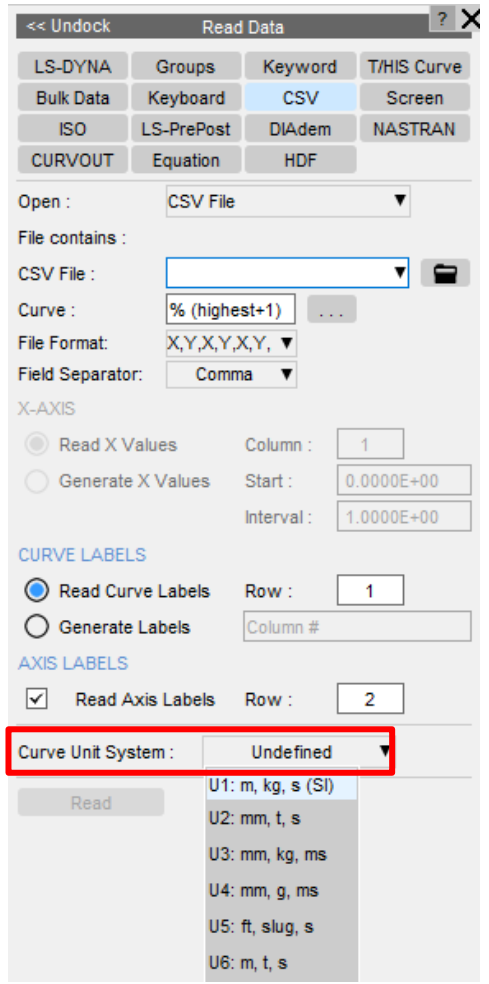
# Units

# Curve Unit System

- The **Curve Unit System** dropdown has been introduced in the Read Data panels of **T/HIS Curve**, **CSV** and **ISO**.
- If a unit system is not defined for the curves in the input file, then the unit system selected from this dropdown is applied to the curves read in from the input file.
- Once units are defined for input curves, T/HIS automatically displays units on graphs (even after subsequent curve operations) and knows what scale factor to apply to any constants in Automotive functions (such as OLC and Tibia Index).

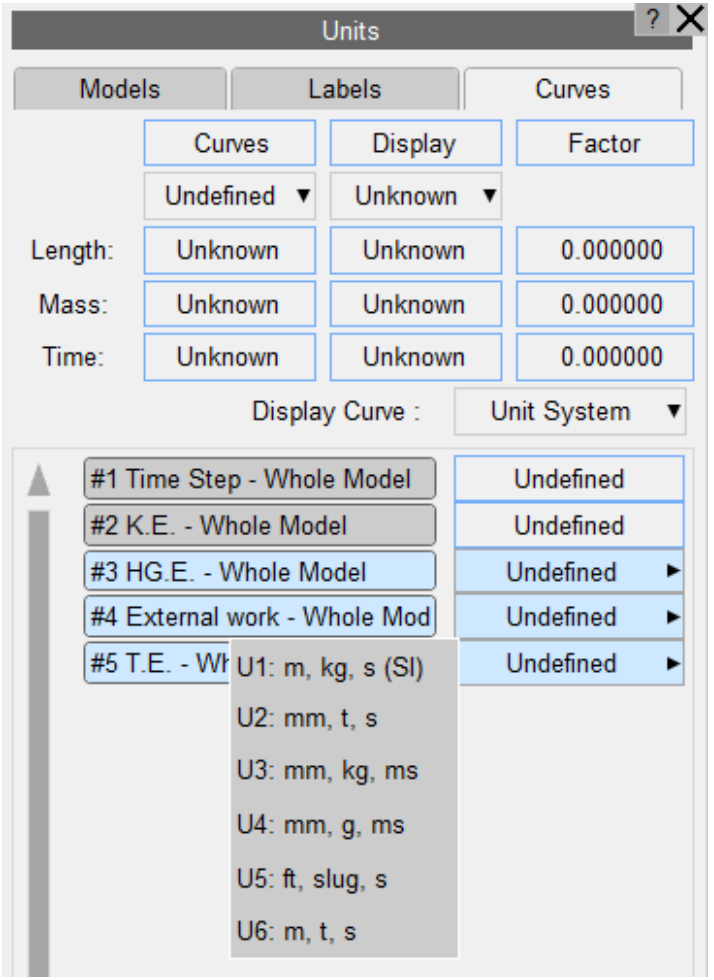


# Curve Unit System

- Multi-selection of curves is now possible using the curves toggle button, allowing the Unit System or X-Y Units to be modified for multiple curves simultaneously.
- Display Units can also be viewed and adjusted directly from the curves panel.



# New Preferences

# New preferences

| Preference | Description |
|---|---|
| `oasys*javascript_maximum_memory_size` | Maximum memory allocated for garbage collection (MB) |
| `oasys*cd_compose_email`<br>`this*cd_compose_email` | Whether or not to offer to compose an email for sending minidump files. |
| `oasys*cd_email_address`<br>`this*cd_email_address` | Email address in To: field of crash dump emails. |
| `oasys*cd_cc_addresses`<br>`this*cd_cc_addresses` | Email address(es) in Cc: field of crash dump emails. |
| `oasys*cd_custom_email`<br>`this*cd_custom_email` | Custom method of sending emails. |
| `oasys*cd_dump_directory`<br>`this*cd_dump_directory` | Directory in which to save crash dump files |
| `oasys*cd_email_method`<br>`this*cd_email_method` | Method used to create crash dump emails. |
| `oasys*cd_minidump_file`<br>`this*cd_minidump_file` | Whether or not to create minidump files, and what to do with them. |

# New preferences

| Preference | Description |
|---|---|
| this*ctable_show_olc | Display OLC value |
| this*s_to_ms_conversion_time | Time threshold for seconds to milliseconds conversion |
| this*show_olc_value | Display OLC value |
| this*damage_method | Calculation method for calculating Damage injury metric |
| this*automotive_constant_unit_system | Unit system of the constants in DMG, OLC and TI Operation |
| this*auto_filter | Automatically filter curves |
| this*auto_filter_class | Filter class for automatic filtering of curves |

# Contact us

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