



FloEFD v17 What's New

Mechanical Analysis

Alexey Kharitonovich, Product Manager

GENERAL

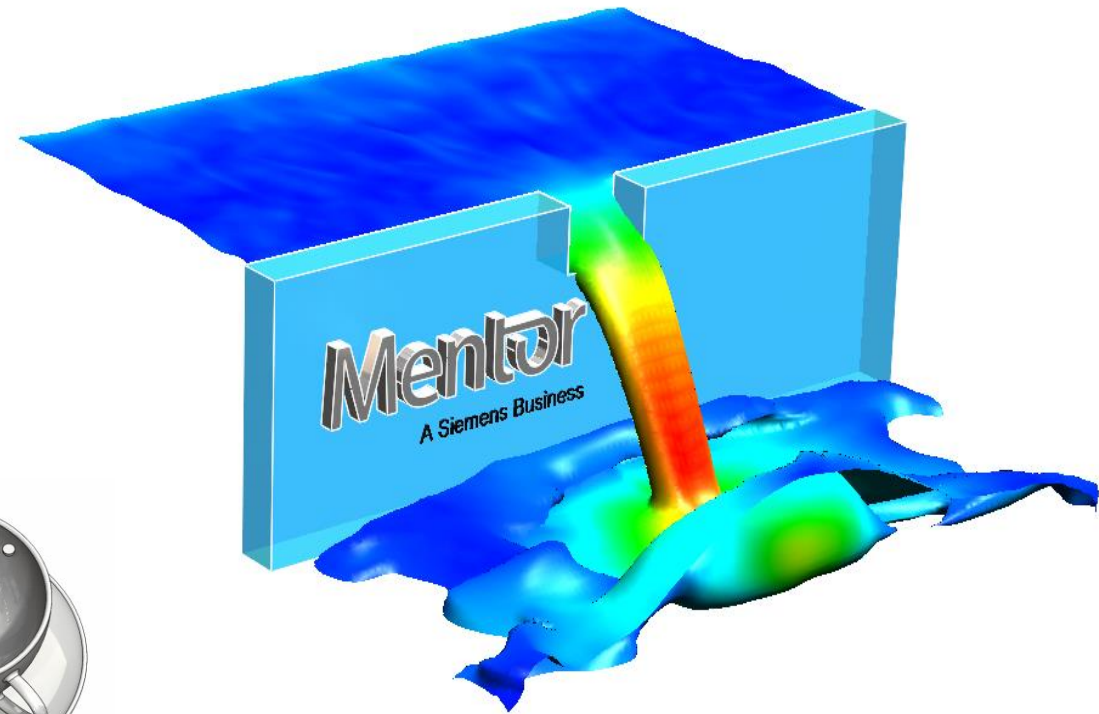




Free Surface

Robust and general enough method (Volume-Of-Fluid) to simulate a moving interface between immiscible fluids with densities ratio up to 10^4 .

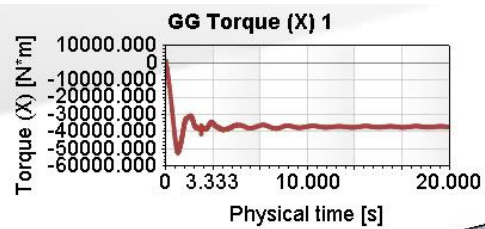
- Two fluid mixture
- Gas – Liquid, Liquid – Liquid
- Gas – Non-Newtonian (ADVANCED module)
- Incompressible solver only (valid for Mach < 0.3)
- Many drops, bubbles or complex topology of free surface lead to large mesh for accurate representation of the surface
- Surface tension is not modelled
- No Boundary Layer model on free surface
- No condensation, evaporation, cavitation
- No rotation



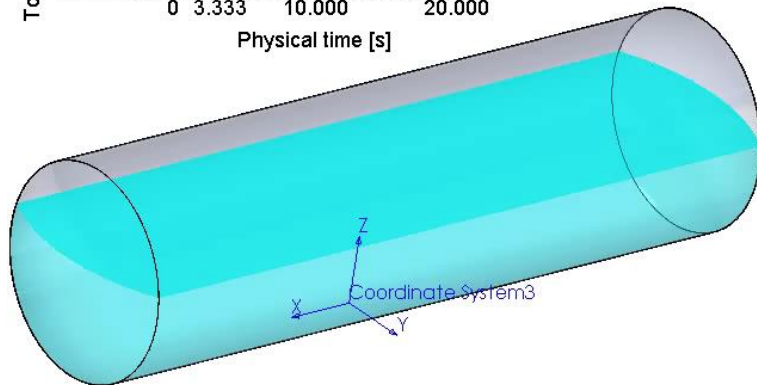


Free Surface - Applications

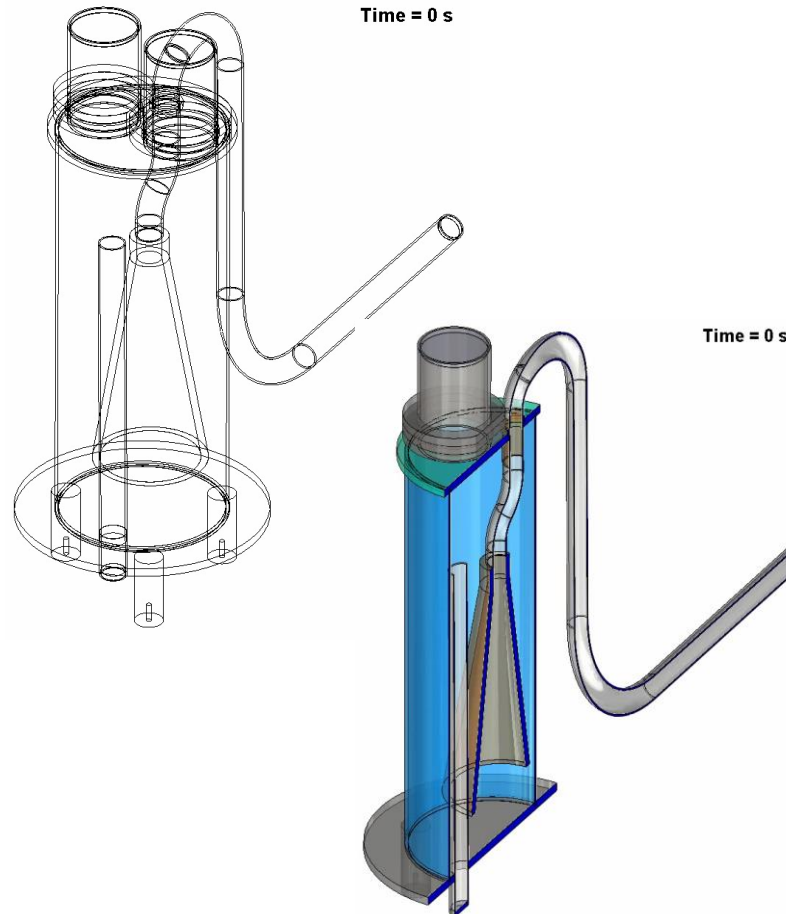
Sloshing



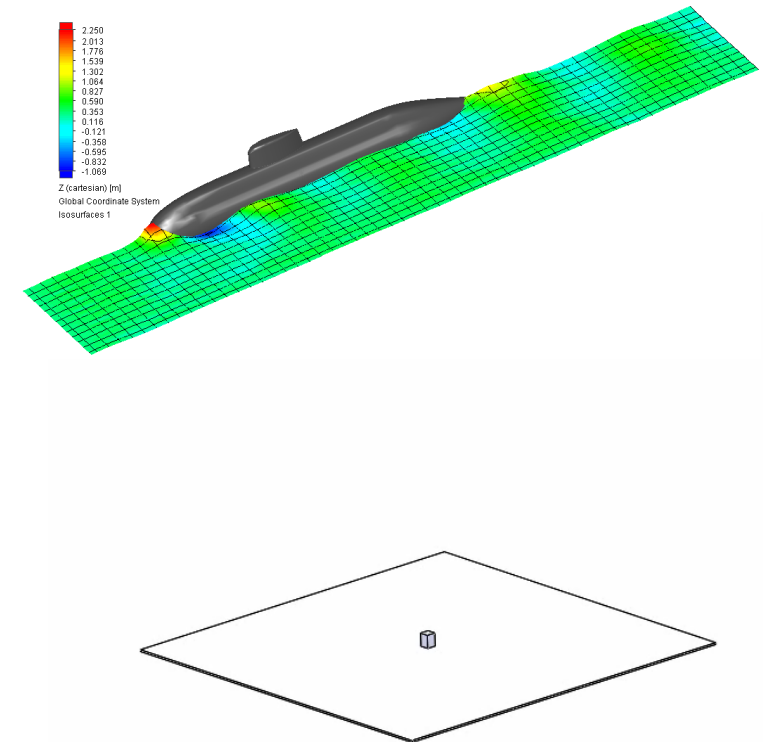
Time = 0 s



Filling/Evacuation



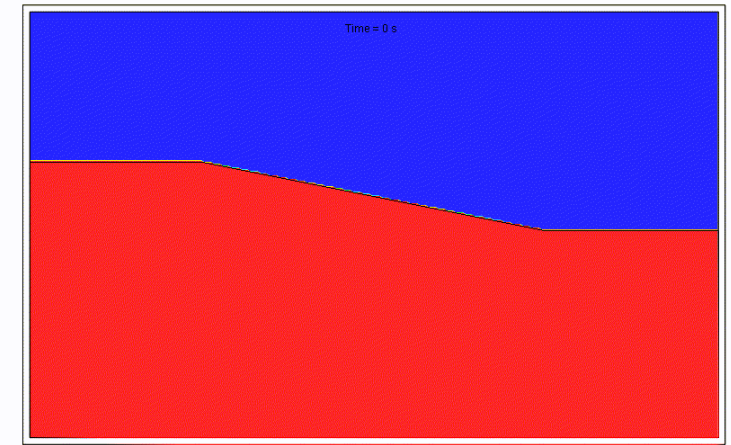
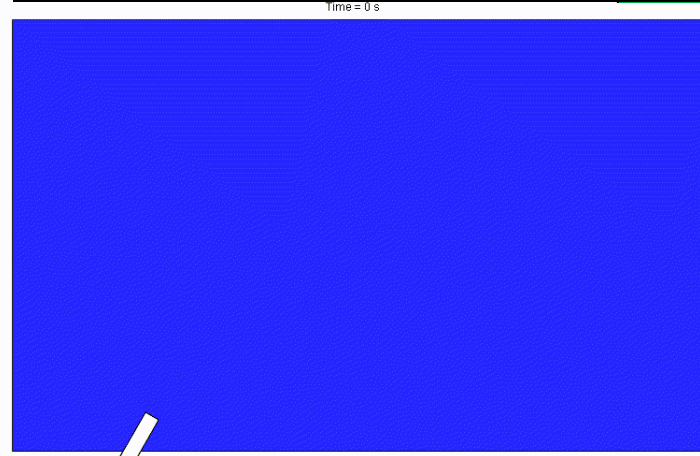
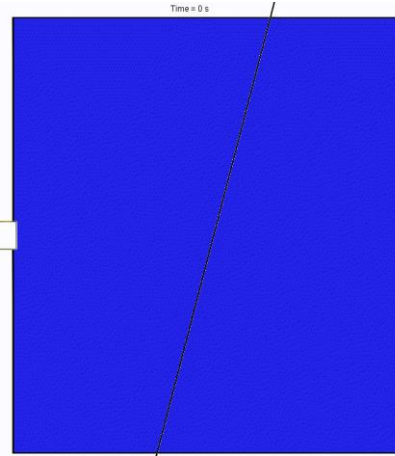
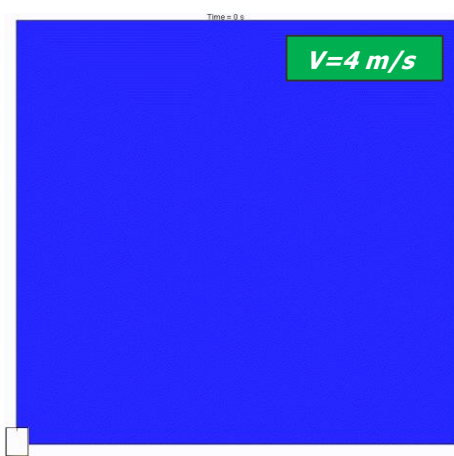
Jet/Open water



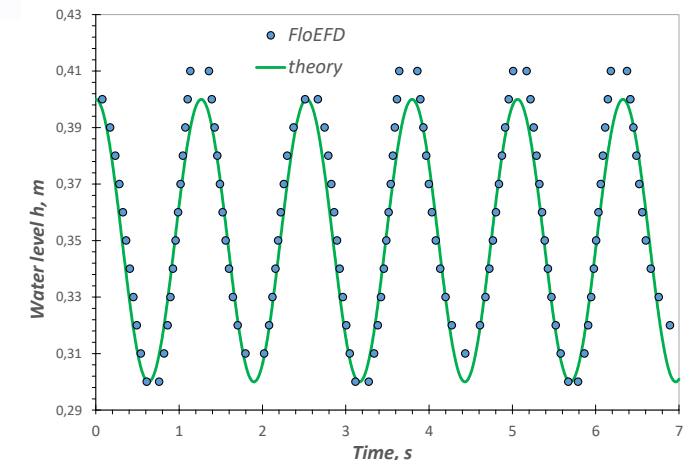
Free Surface - Validations

Goal Name	Unit	V=3 m/s			V=4 m/s		
		Value	Reference	Error, %	Value	Reference	Error, %
Fountain Height (VOF)	[m]	0,477	0,459	3,95	0,834	0,815	2,32
Fountain Height (Velocity)	[m]	0,478	0,459	4,20	0,835	0,815	2,44

Goal Name	Unit	V=4m/s		
		Value	Reference	Error, %
Jet lift height	[m]	0,6303249	0,612	2,95
Jet width of flight	[m]	1,4176308	1,414	0,26

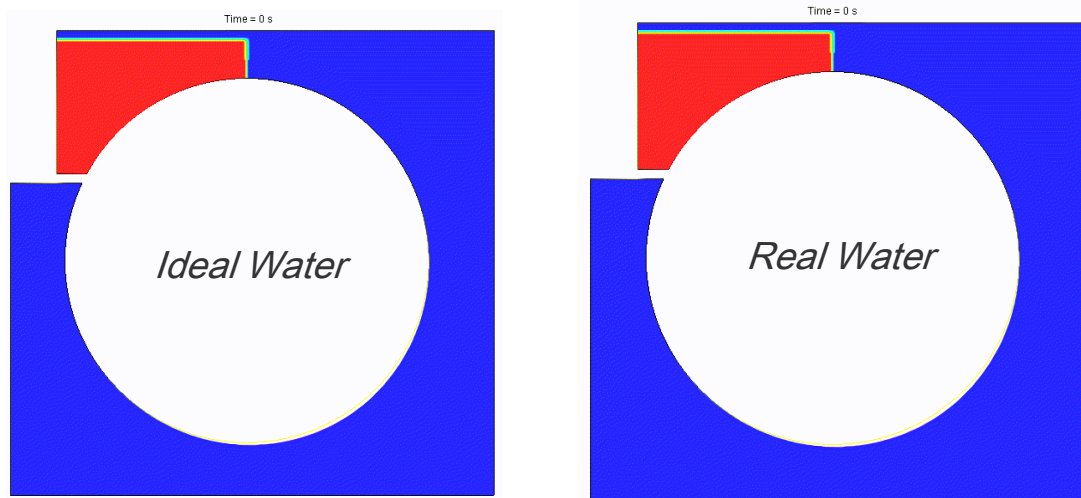
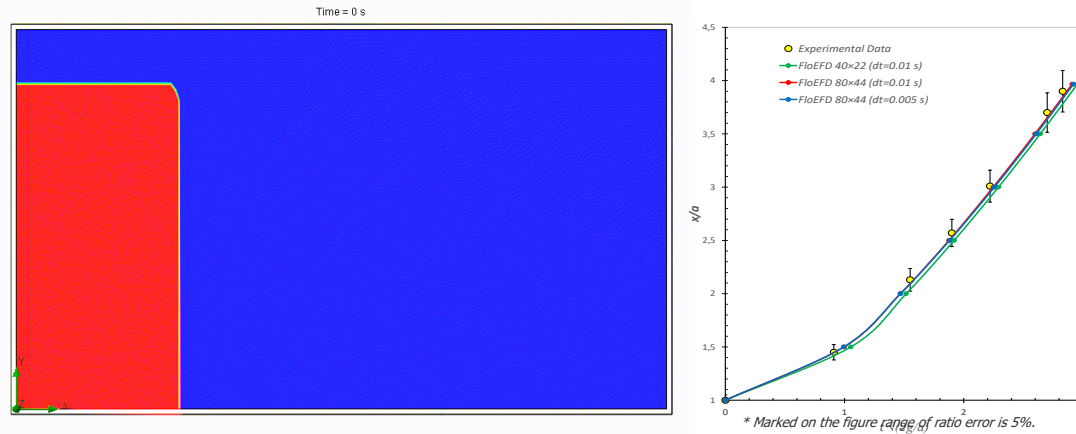


Goal Name	Unit	45 degree			60 degree			75 degree		
		Value	Reference	Error, %	Value	Reference	Error, %	Value	Reference	Error, %
SG Normal Force 1	[N]	7,068	7,072	0,05	8,672	8,661	0,13	9,688	9,659	0,29
SG Normal Force (X) 1	[N]	4,989	5,001	0,25	7,502	7,501	0,02	9,360	9,330	0,32
SG Normal Force (Y) 1	[N]	-5,007	-5,000	0,15	-4,349	-4,330	0,45	-2,498	-2,500	0,08
SG Force 1	[N]	7,068	7,072	0,05	8,672	8,661	0,13	9,688	9,659	0,29
SG Force (X) 1	[N]	4,989	5,001	0,25	7,502	7,501	0,02	9,360	9,330	0,32
SG Force (Y) 1	[N]	-5,007	-5,000	0,15	-4,349	-4,330	0,45	-2,498	-2,500	0,08
SG Torque (Z) 1	[N*m]	0,357	0,354	0,88	0,252	0,250	1,00	0,133	0,129	2,71
V top jet (Vtj)	[m/s]	1,00212	1,00000	0,21	1,00315	1,00000	0,31	0,99600	1,00000	0,40
V bottom jet (Vbj)	[m/s]	0,96735	1,00000	3,27	0,97739	1,00000	2,26	0,98165	1,00000	1,83
B top jet (Btj)	[m]	0,08528	0,08535	0,07	0,07471	0,07500	0,29	0,06274	0,06294	0,20
B bottom jet (Bbj)	[m]	0,01433	0,01465	0,32	0,02403	0,02500	0,97	0,03841	0,03706	1,35

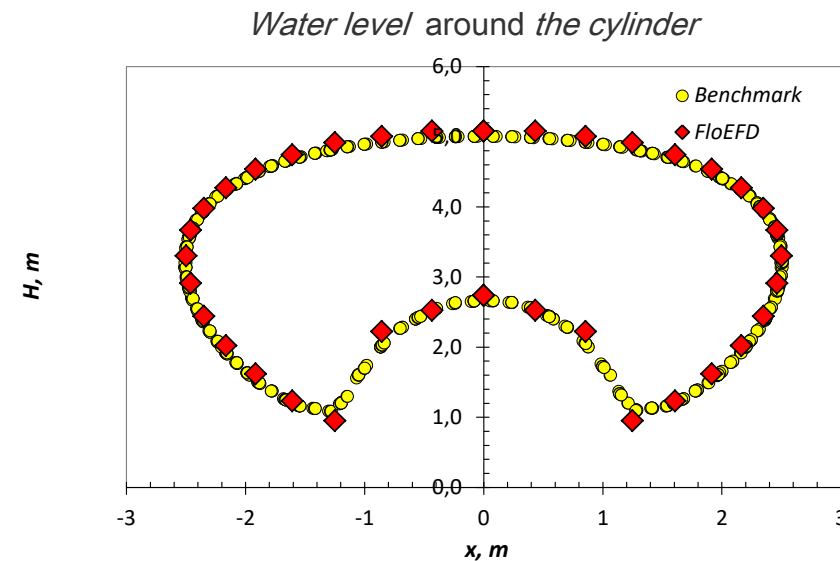
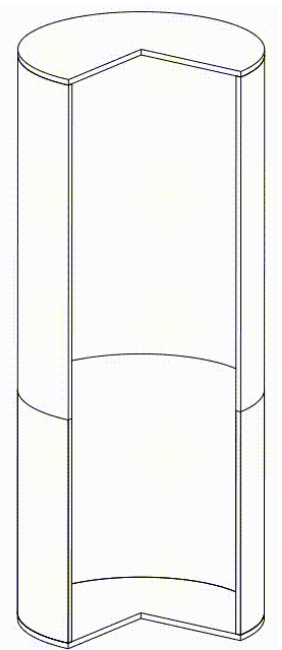
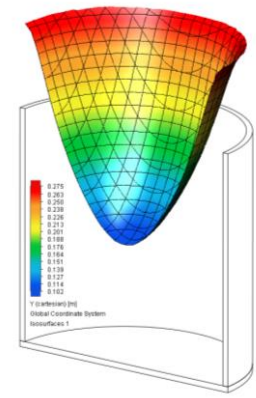
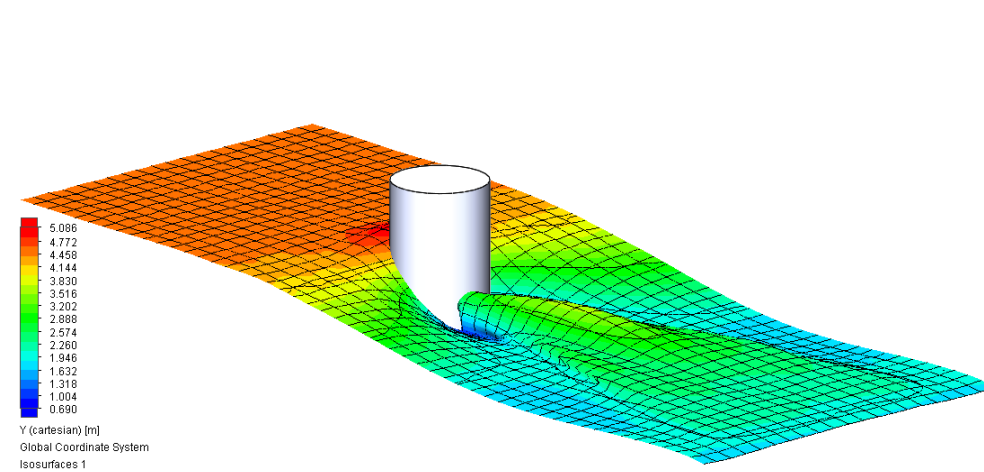




Free Surface - Validations



Coanda effect





Molecular formula • — — — — — •

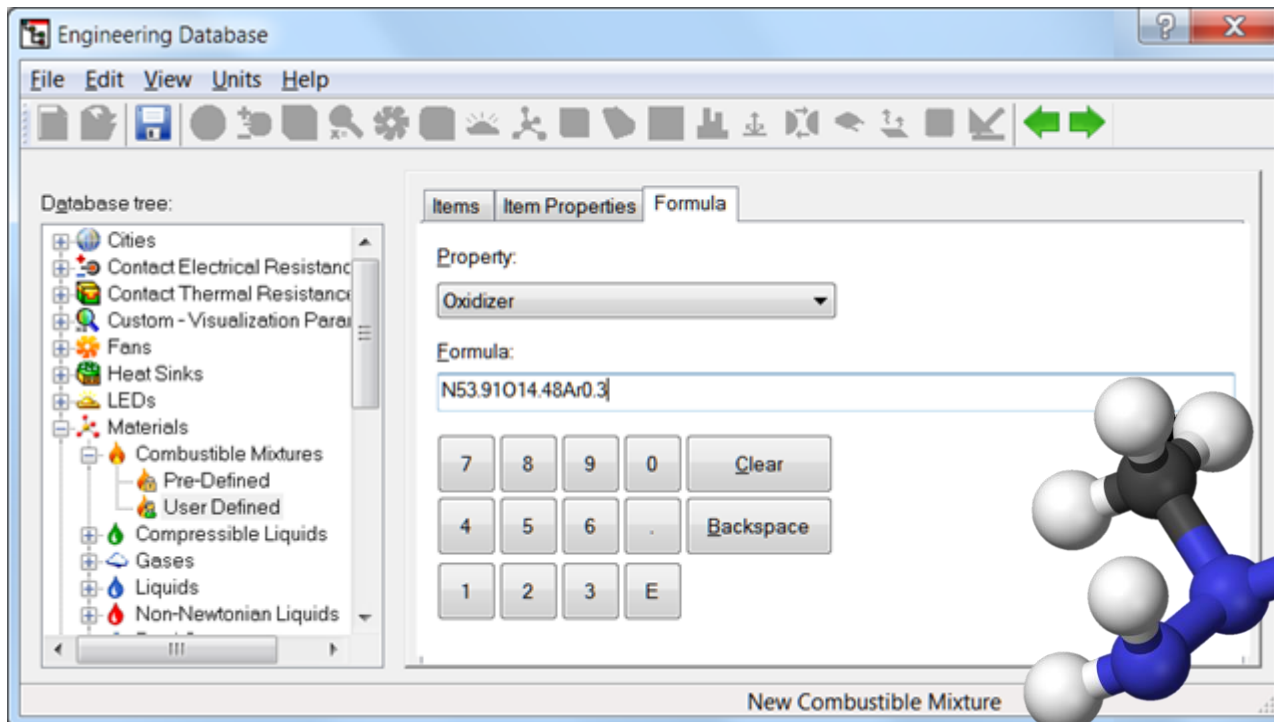




Combustion

Possibility to set Fuel or Oxidizer as a molecular formula (such as C₂H₈N₂).

You can choose to set input Temperature as Temperature of initial components or Temperature of combustion products.



<u>Name</u>	<u>Empirical formula</u>	<u>Molecular formula</u>	<u>Structural formula</u>
Benzene	CH	C ₆ H ₆	

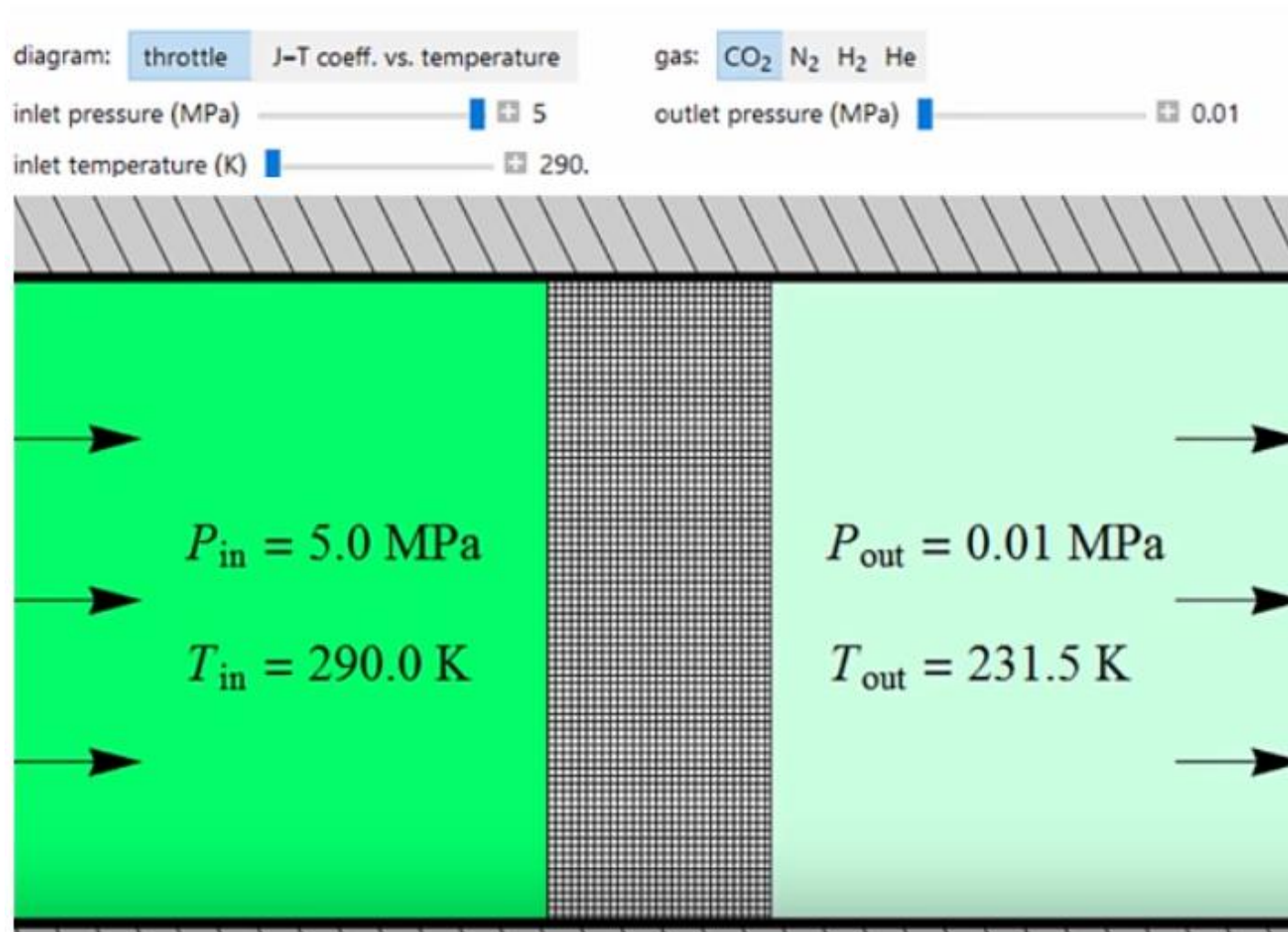
Thermodynamic Parameters

P 101325 Pa f_{∞}

☒ Temperature of initial component
☐ Temperature of combustion product

T 20.05 °C f_{∞}

☒ Pressure potential
☐ Refer to the origin

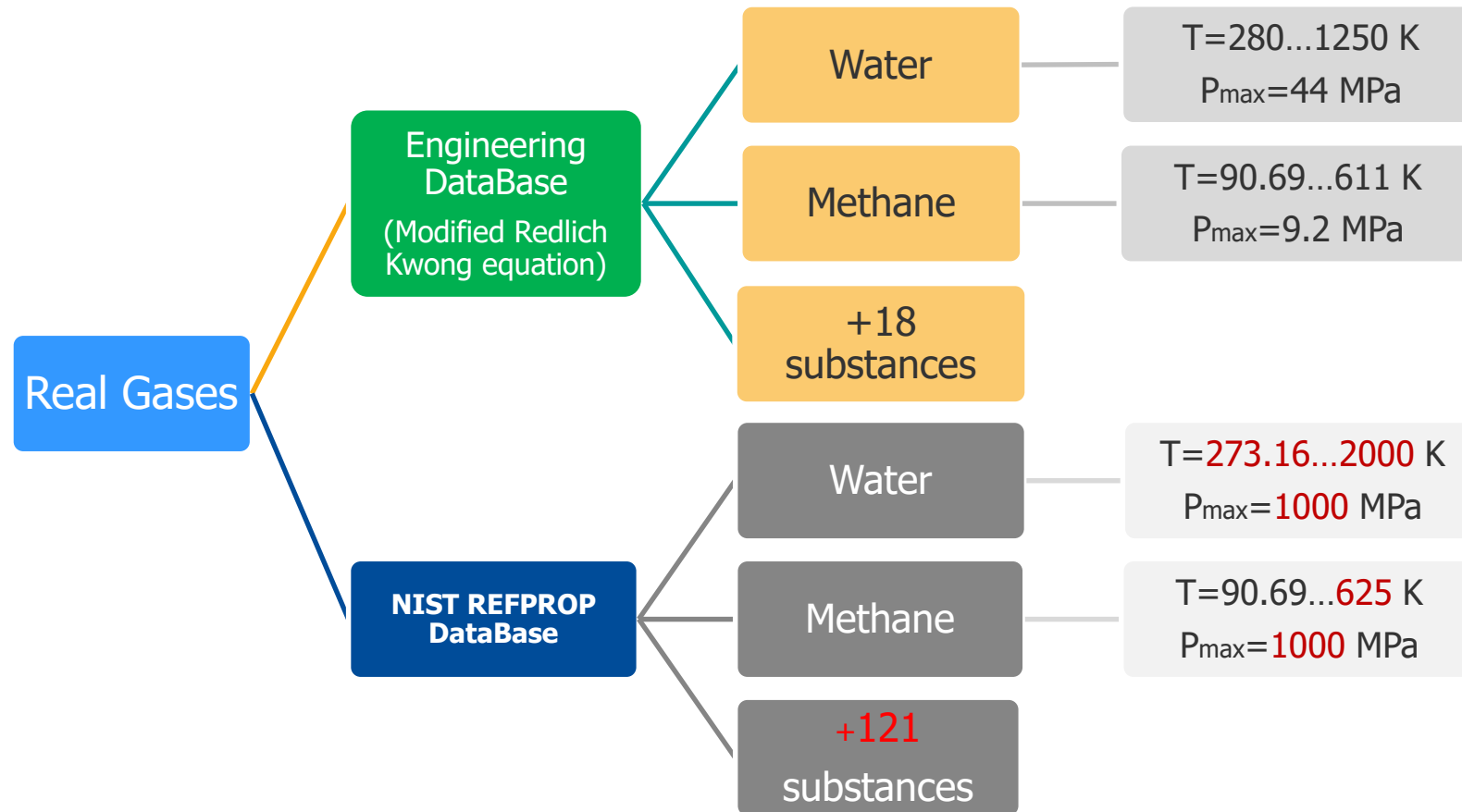


The throttling process is commonly exploited in thermal machines such as generators, air conditioners, heat pumps, and liquefiers.

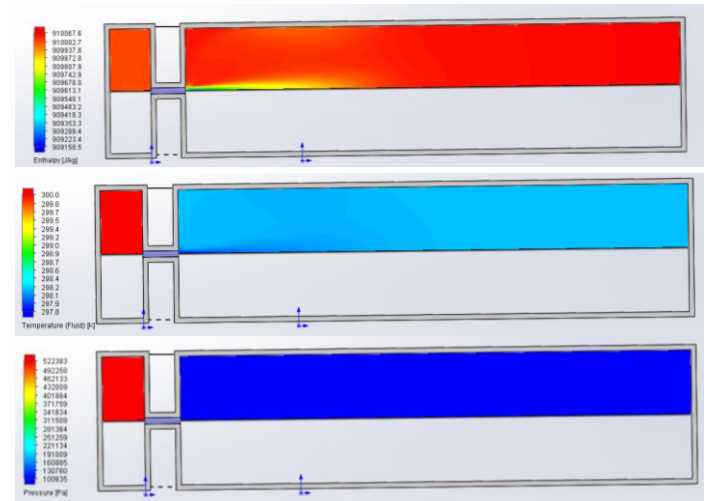


Extended Real Gas Properties

NIST Database with extended properties of Real Gases is included (available for Advanced license).



Joule–Thomson effect describes the temperature change of a *real* gas when it is forced through a [porous plug](#) while kept insulated so that no heat is exchanged with the environment.



Relative error in Joule-Thomson Coefficient calculation:

	EDB	NIST REFPROP
Water	2,49%	1%
Methane	18,11%	1.21%

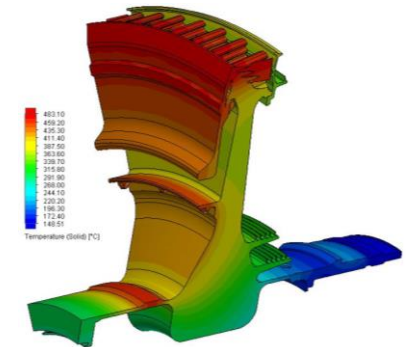
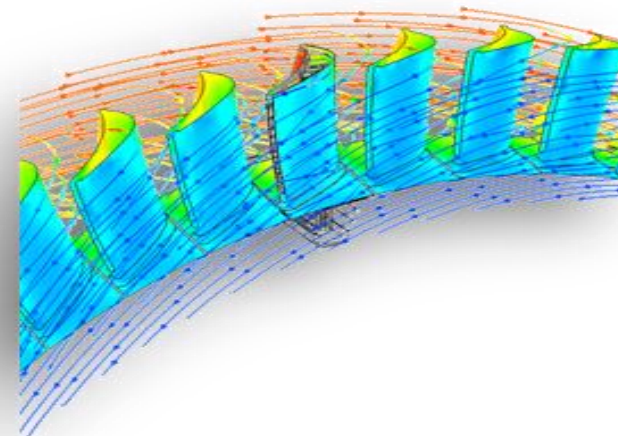
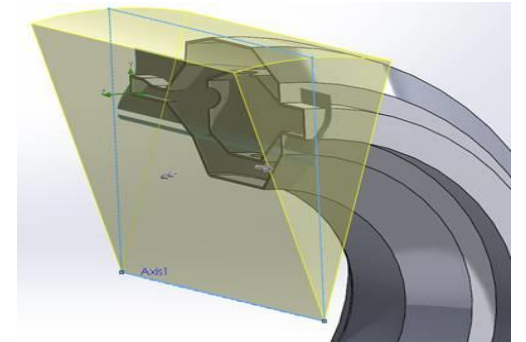
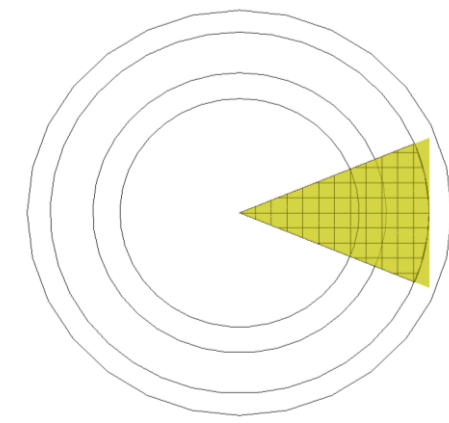


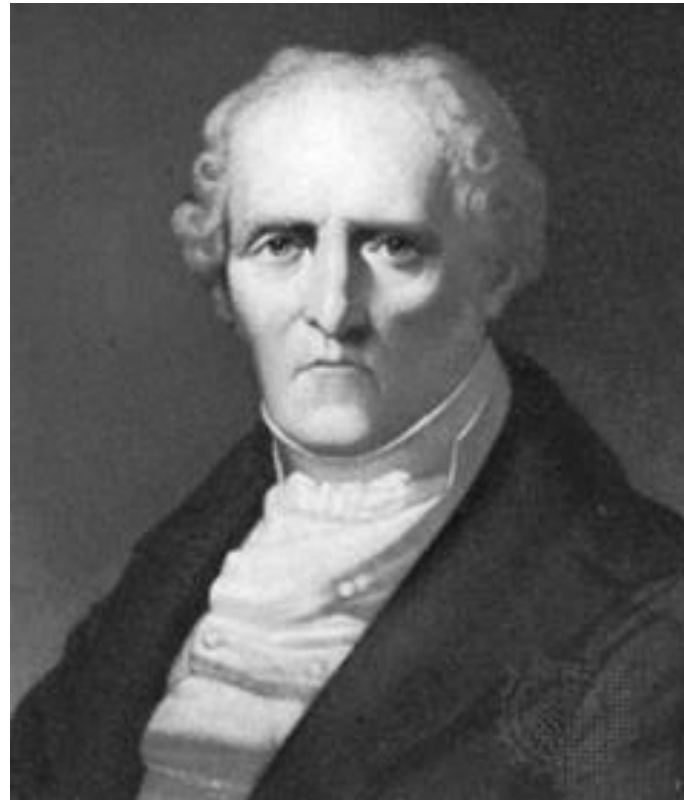


Sector Periodicity

Sector periodicity allows to decrease mesh size in case of sector periodic tasks (nozzle guide vanes for example). Periodic boundary can be plane.

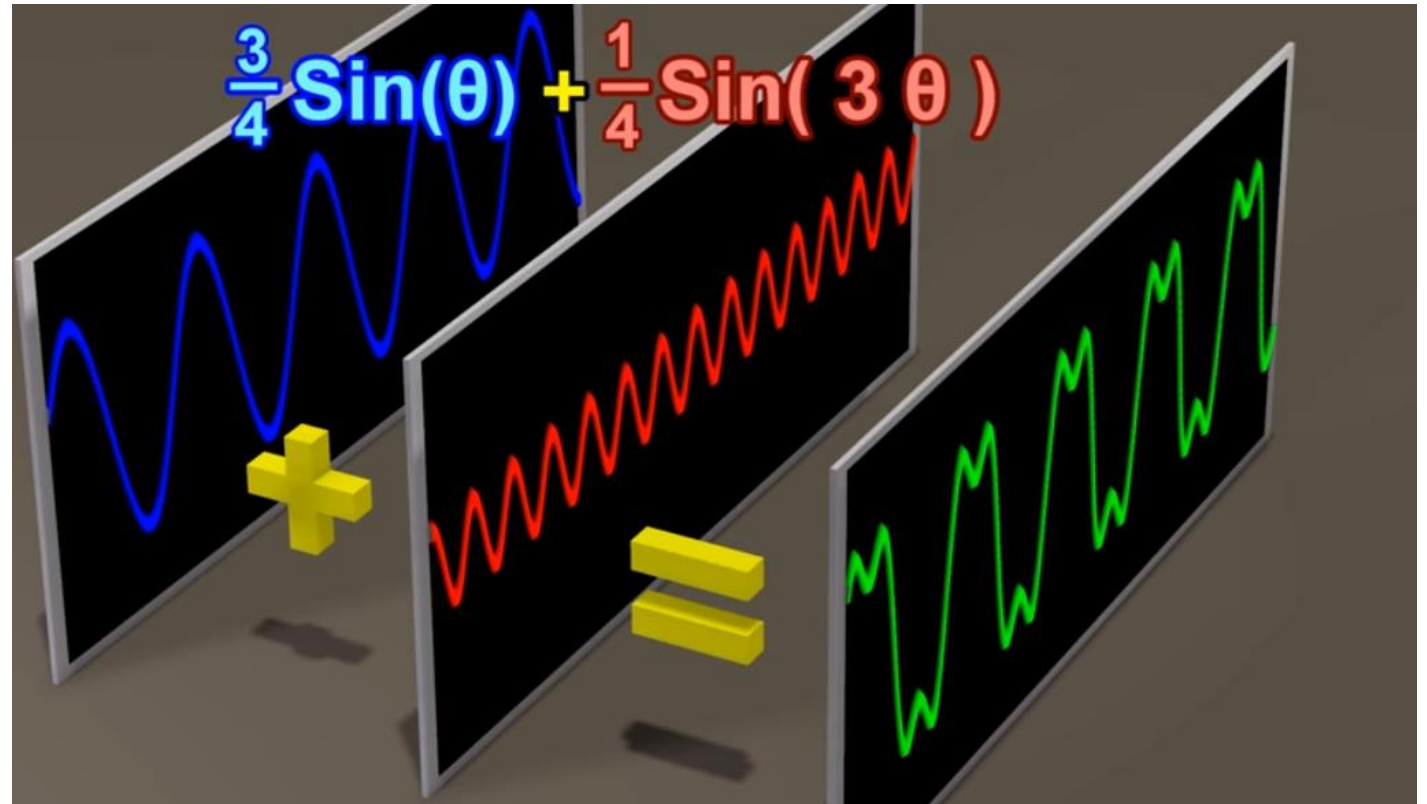
- Single periodic domain only
- Not supported:
 - Porous Media
 - High Mach Number
 - Radiation
 - Rotating is local region (Averaging)
 - Cavitation
 - Fluid Film, Sorption.







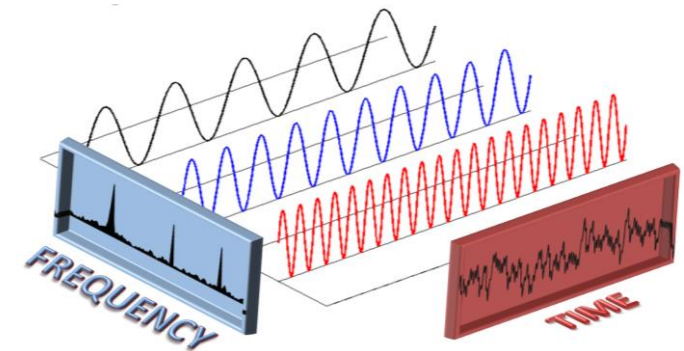
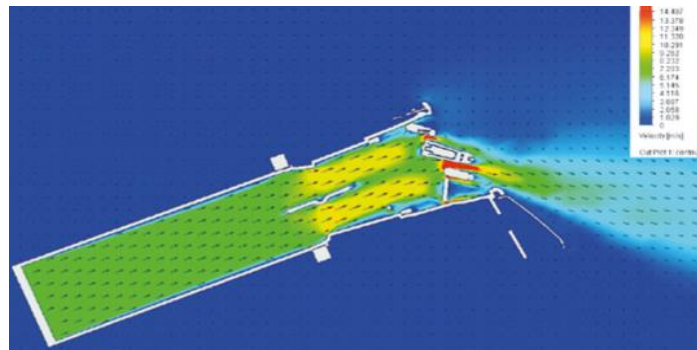
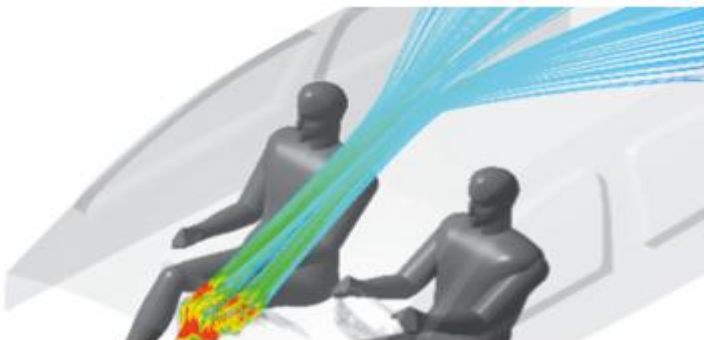
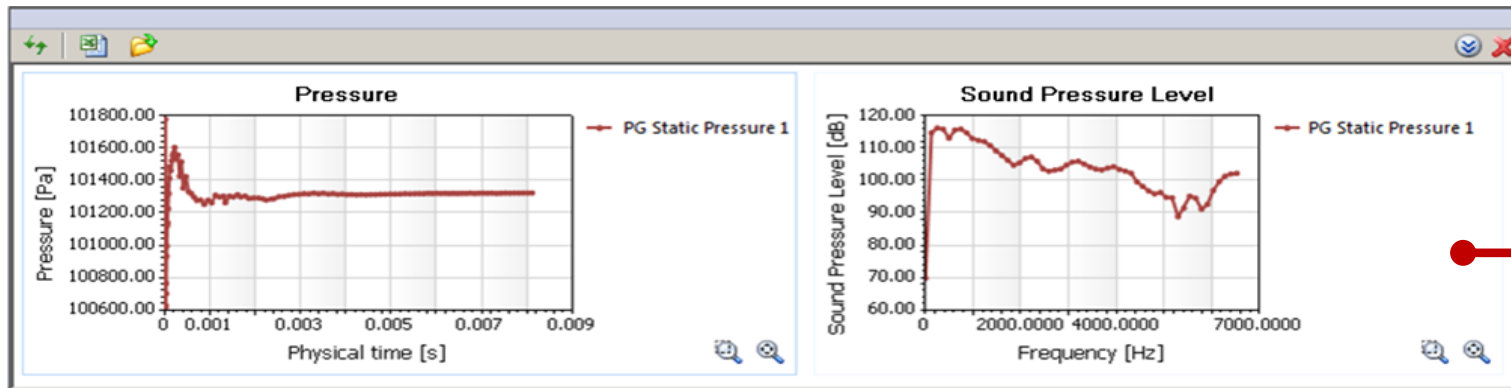
Fast Fourier Transform





Noise Estimation: Fast Fourier Transform

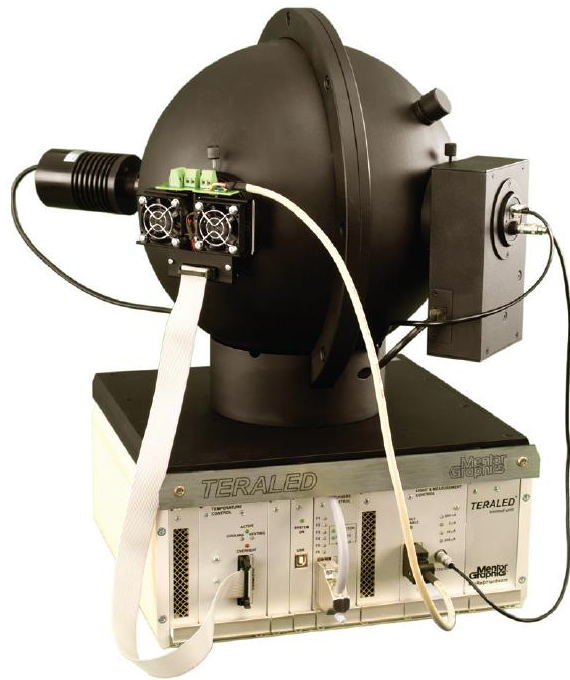
Fast Fourier Transform allows to convert a time signal to the complex frequency domain.
A parameter oscillation (e.g. Pressure) can be represented as Sound Pressure Level [dB]-Frequency plot.



**LIGHTING
RADIATION
WATER FILM**

FloEFD TeraLED Interface

Import non-linear LED characteristics from TeraLED as a raw table instead of coefficients of linearity (sensitivities).



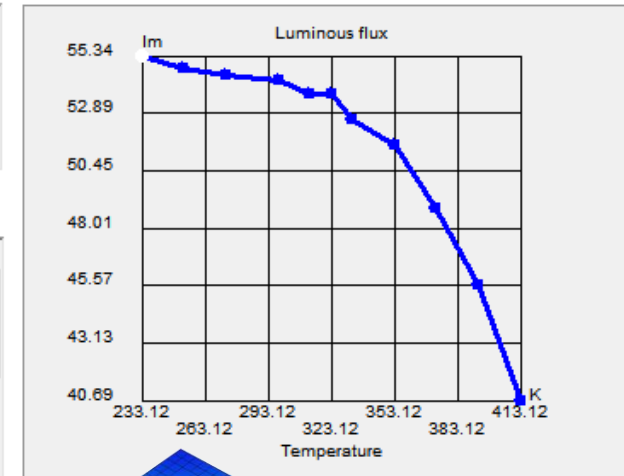
Property:
Luminous flux

Current

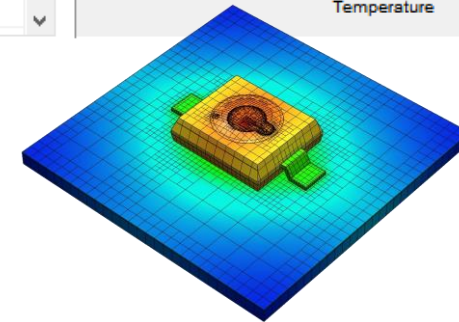
- 0.15 A
- 0.42 A
- 0.7 A
- 0.8 A

Current: 0.15 A

Temperature	Luminous flux
233.12 K	55.335 lm
253.12 K	54.7925 lm
273.12 K	54.52125 lm
298.12 K	54.25 lm
313.12 K	53.7075 lm
323.12 K	53.7075 lm
333.12 K	52.6225 lm



Import from T3Ster TeraLED...



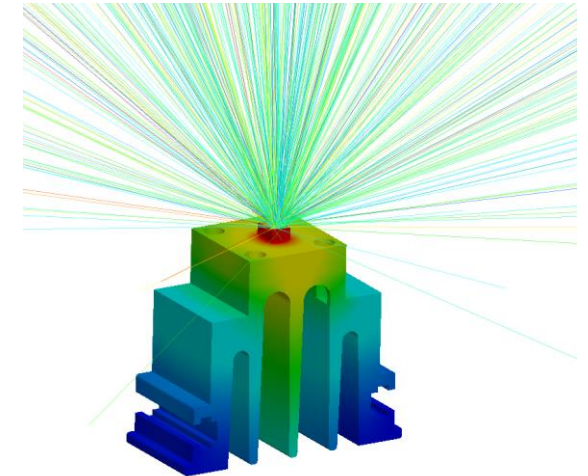
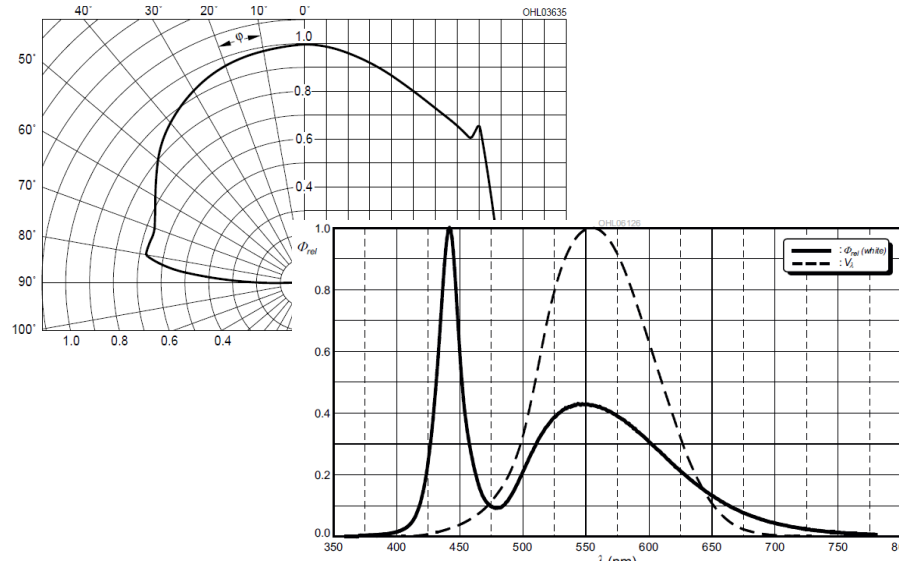


Radiation Pattern and Spectrum for LED

Radiation pattern (power dependency on angle) **and spectrum** are added to the definition of **LED Thermal-Optical** compact model.

Adding radiation pattern and spectrum automatically **enables radiation source** on LED's top surface.

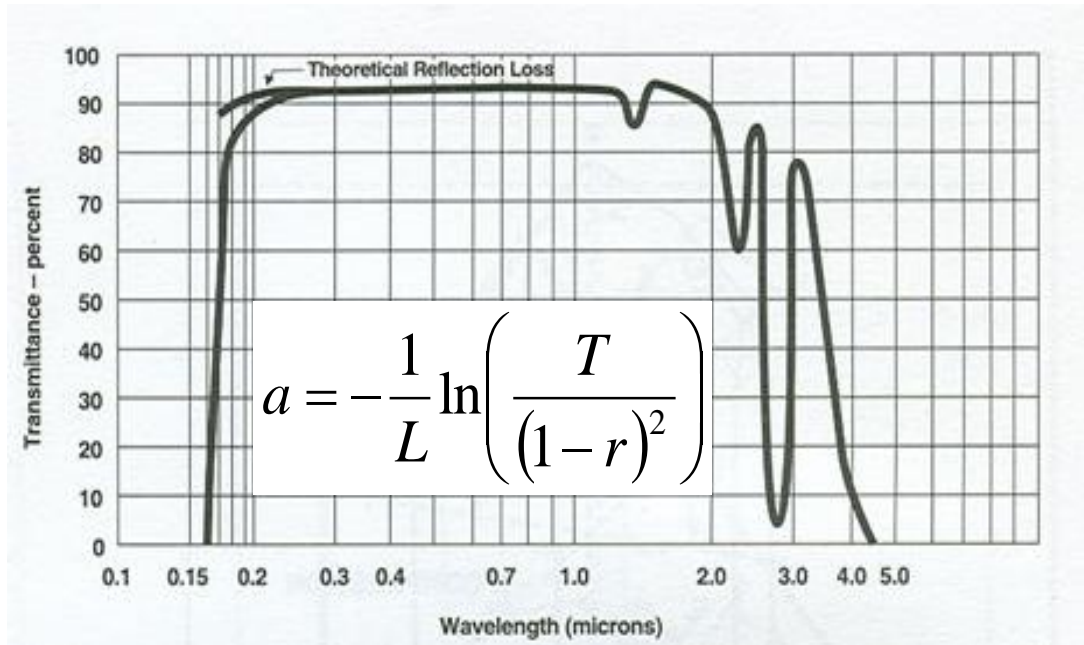
Property	Value
Name	New LED
Comments	
Thermal resistance	Two resistor model
Junction to bottom, R _{jb}	1 K/W
Junction to top	<input type="checkbox"/>
Temperature dependence	Temperature table
Voltage	[Table]
Radiant flux	[Table]
Luminous flux	[Table]
<input checked="" type="checkbox"/> Radiation properties	<input checked="" type="checkbox"/>
Radiation spectrum	[Table]
Radiation pattern	[Table]





Transmission Curve

Possibility to add **transmission curve** instead of absorption curve as a radiation characteristic for semi-transparent solid materials.



Transmission curve

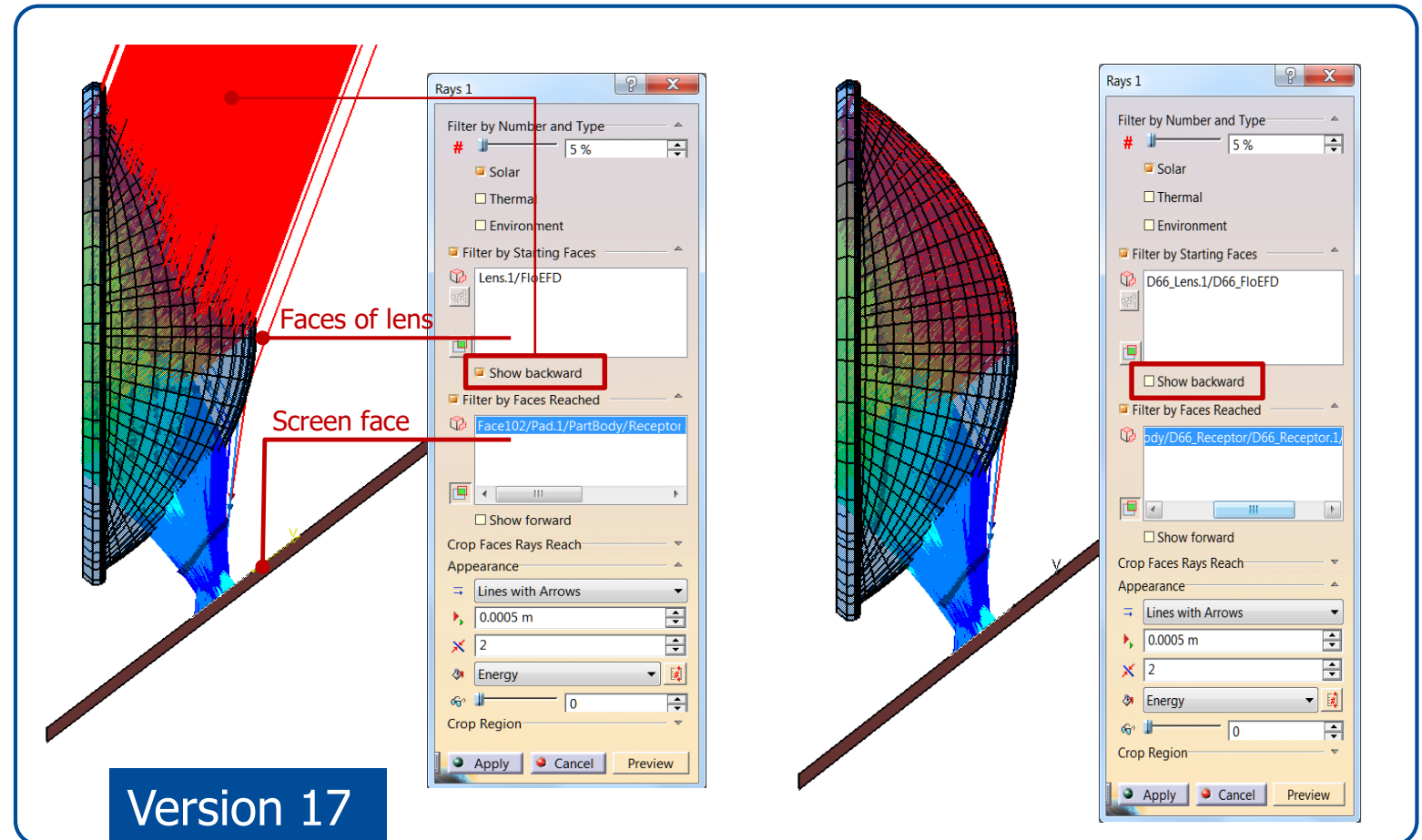
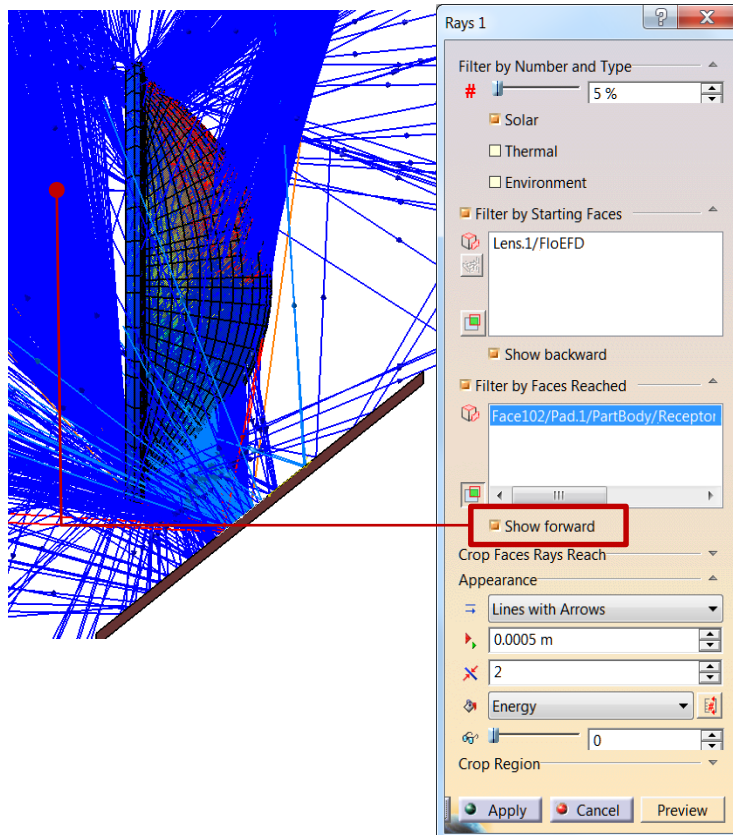
<input checked="" type="checkbox"/> Radiation properties	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Set absorption properties as	Absorption coefficient
Absorption coefficient	(Table)
Refractive index	(Table)

<input checked="" type="checkbox"/> Radiation properties	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Set absorption properties as	Transmission
Transmission	(Table)
Reference thickness	1 mm
Absorption coefficient cut-off	1 1/mm
Refractive index	(Table)



Improved Ray Visualization

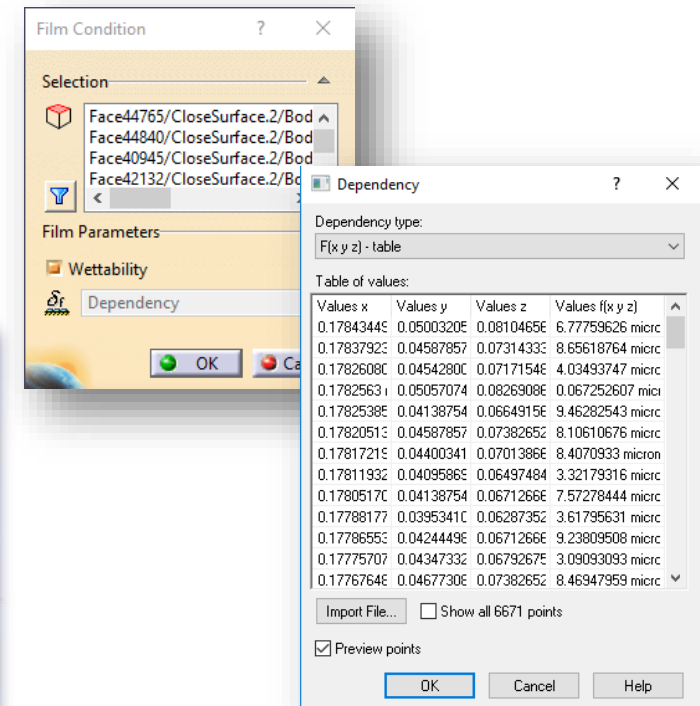
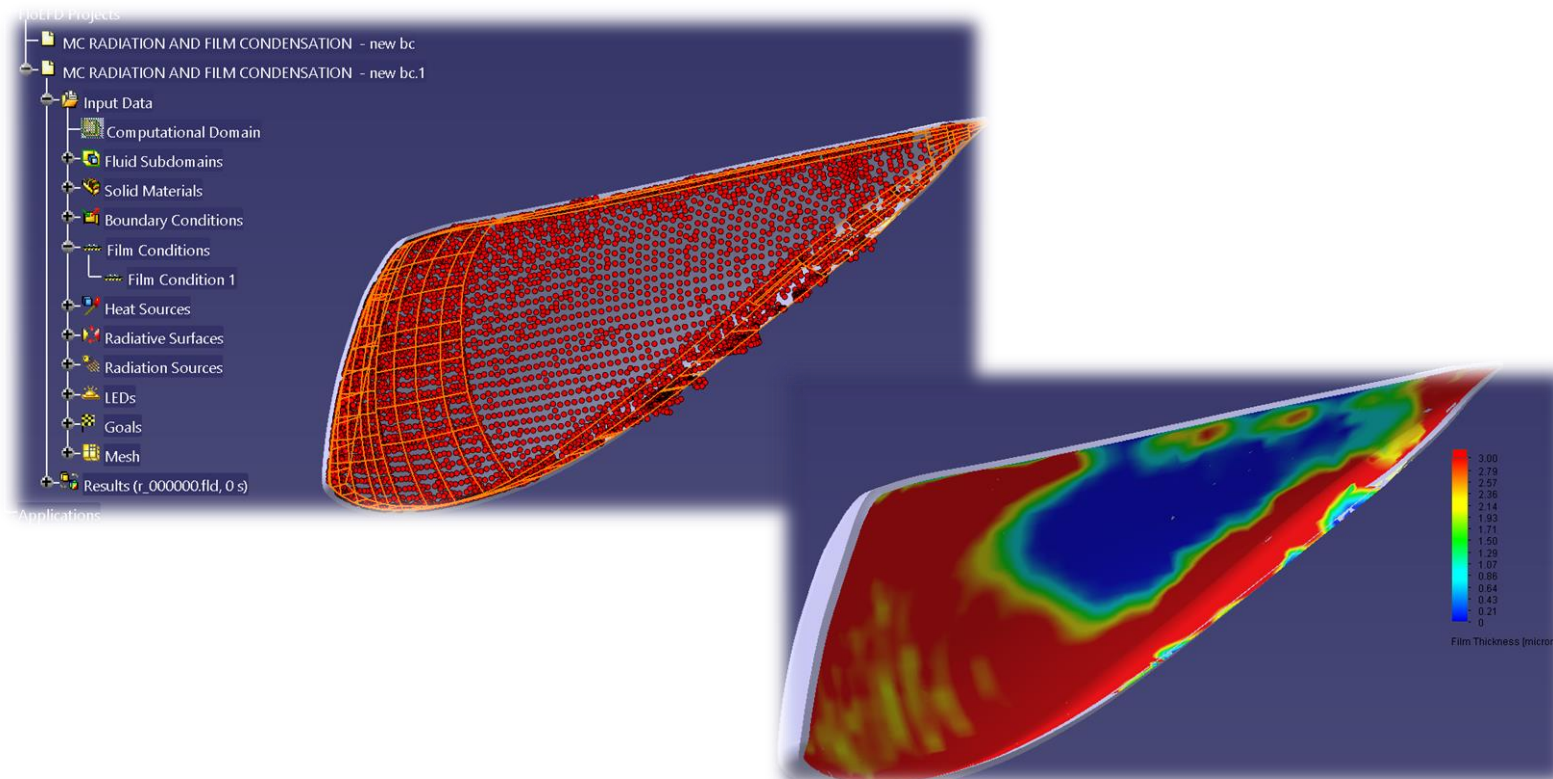
You can now display rays between two selected surfaces, including those which go through a selected semi-transparent surface.





Film Thickness Import

Film thickness mapping - Import film thickness as a table of points. Used for transferring results of film condensation to other simulation.



PCB MODELING ELECTRONICS

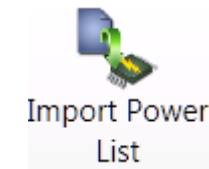
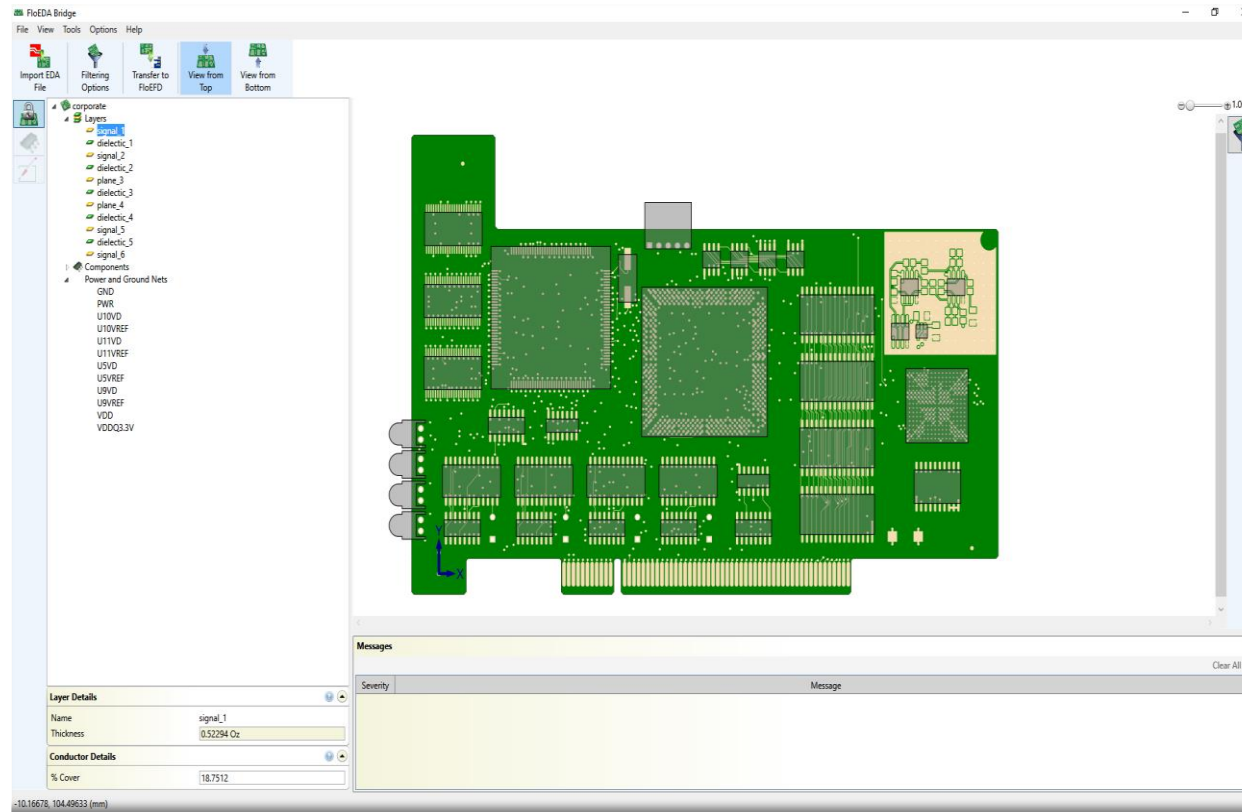
EDA Bridge: Import Power List

Create CSV file with power map: [ComponentName;Power].

Import it into EDA bridge (or you can change power manually).

The screenshot shows a spreadsheet application with a list of resistors and their values. The spreadsheet has columns A, B, and C. Column A lists resistor identifiers (FID1, FID2, FID3, FID4, FL1, J3, J4, J20, J21, J22, J23, J25, L5, L6, MP1, Q3, U2, U3, U4, U5, U6, U7, U8, U9, U21, U22, U23). Column B contains numerical values (1, 2, 3, 4, 1, 1.3, 1.4, 1.2, 1.21, 1.22, 1.23, 1.25, 0.5, 0.6, 1, 3, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.21, 2.22, 2.23). The status bar at the bottom shows 'resistors' and '85%' zoom.

	A	B	C
3	FID1	1	
4	FID2	2	
5	FID3	3	
6	FID4	4	
7	FL1	1	
8	J3	1.3	
9	J4	1.4	
10	J20	1.2	
11	J21	1.21	
12	J22	1.22	
13	J23	1.23	
14	J25	1.25	
15	L5	0.5	
16	L6	0.6	
17	MP1	1	
18	Q3	3	
19	U2	2.2	
20	U3	2.3	
21	U4	2.4	
22	U5	2.5	
23	U6	2.6	
24	U7	2.7	
25	U8	2.8	
26	U9	2.9	
27	U21	2.21	
28	U22	2.22	
29	U23	2.23	



The screenshot displays the FloEDA Bridge application window. The top menu bar contains 'File', 'Edit', 'View', 'Tools', 'Options', and 'Help'. Below the menu are five icons with labels: 'Import EDA File', 'Import Power List', 'Filtering Options', 'Transfer to FloEFD', and 'Export Power List'. The main area features a table with the following data:

Component	Power
U5 [B000051029U5, B000	2.5 W
U6 [B000055417U6, B000	2.6 W
U8 [B000022477U8, B000	2.8 W
U9 [B000022477U9, B000	2.9 W
U11 [B000037679U11, B1	0 W
U12 [B000027618U12, B1	0 W
U14 [B000027618U14, B1	0 W
U15 [B000027618U15, B1	0 W
U21 [B000055402U21, B1	2.21 W
U22 [B000055545U22, B1	2.22 W
U23 [B000055391U23, B1	2.23 W
U52 [B000027655U52, B1	2.52 W
Y1 [B000032783Y1, B000	0 W
Y2 [B000051842Y2, B000	0 W
Y3 [B000053482Y3, B000	3.3 W
Y4 [B000051591Y4, B000	3.4 W

Below the table is a 'Power and Ground Nets' icon. At the bottom, there is a 'Component' dropdown menu with 'Thermal' and 'Thermal Territory' options. The 'Component Details' section includes the following fields:

- Reference Designator: U21
- Package Name: B00005540
- Part Number: B00005540
- Board side: Bottom
- X Location: 39.4 mm
- Y Location: 31.2 mm
- Z Offset: 0 mm
- Rotation: 100.00

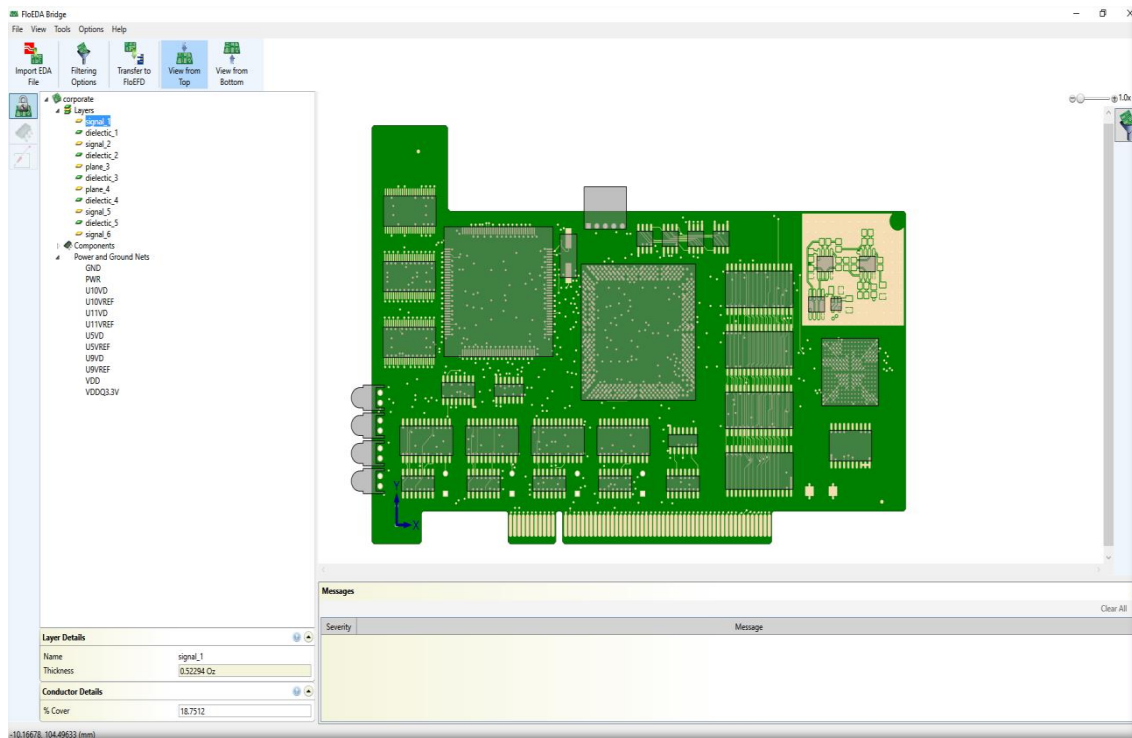


EDA Bridge: Material Properties for Layers

Copper content is calculated for layers.

Material for dielectric can be: FR4, FR4(24% Fibre) or Polyamide.

Material for conductor can be: Copper or Copper Tungsten.



Layer Details	
Name	top
Thickness	1.00774 Oz
Dielectric Material	FR4
Conducting Material	Copper
% Cover	71.48322



EDA Bridge: Material Properties for Components

Component can be defined as a solid material or 2Resistor.

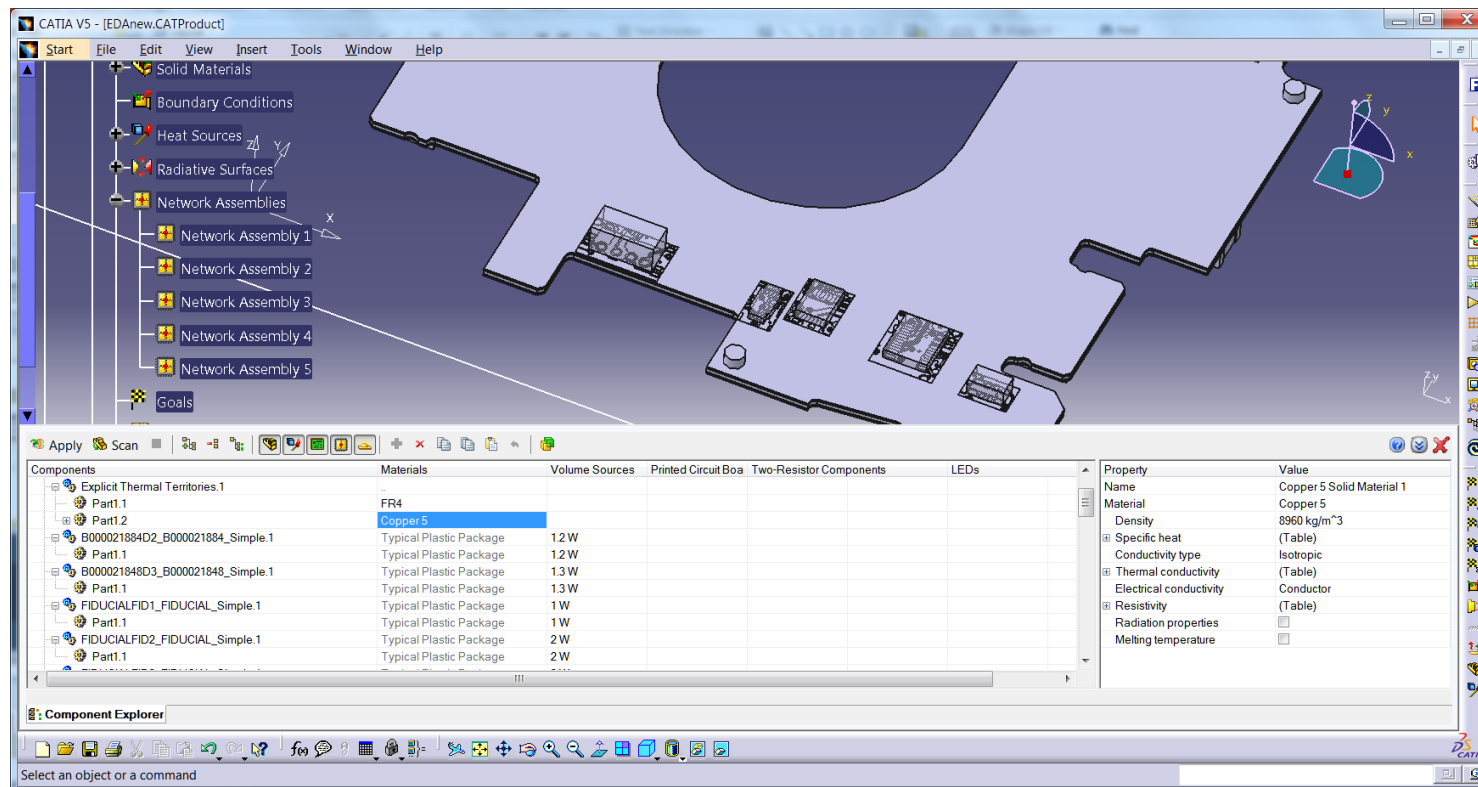
The left screenshot shows a component list on the left and a dropdown menu on the right. The dropdown menu lists various package types, with 'Typical Plastic Package' selected. Below the dropdown is a 'Thermal Details' section with fields for Model Type, Power, Max. T_{Junction}, Max. T_{Case}, and Material.

The right screenshot shows the 'Thermal Details' section for a selected component (J25 [B000055560]J25, B00). The 'Model Type' is set to '2Resistor'. The 'Power' is 1.25 W. The 'Max. T_{Junction}' is 90 degC. The 'Max. T_{Case}' is 75 degC. The 'Resistance J/B' is 1.7 K/W. The 'Resistance J/C' is 3.1 K/W.



EDA Bridge: Material Properties for Components

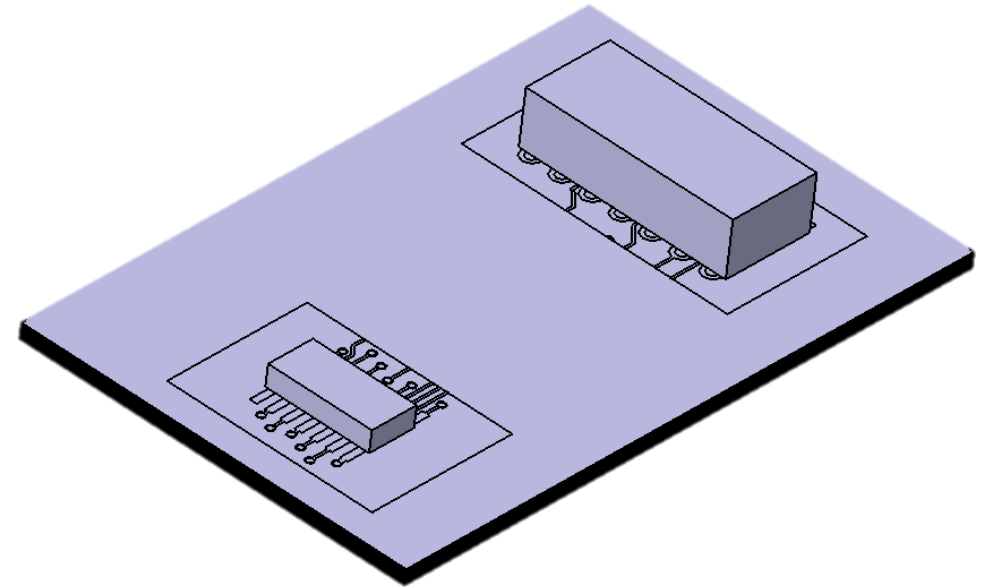
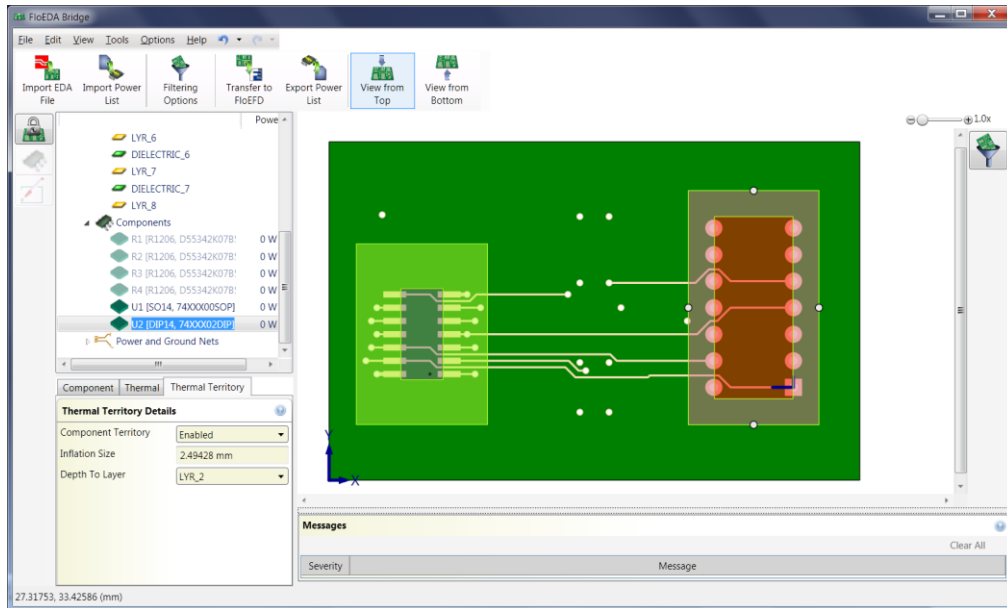
After importing the corresponding **Material** and **Boundary Conditions** (Heat Sources, Network Assembly, Radiative Surfaces) are **automatically** created.





EDA Bridge: Thermal Territory

Thermal Territory is ability to explicitly model only a selected area under a component.





Edit from Component Explorer

- Create/edit sources, 2R, LED, PCB and materials from the table.
- Display total power applied.

The screenshot shows the 'Component Explorer' window with a table of components. The table has four columns: Component, Material, Volume Source, and Printed Circuit Board. A 'Total power:' row shows '33 W'. A 'Properties' panel on the right shows 'Name: VS Heat 1' and 'Heat generation rate: 1 W'. A status bar at the bottom says 'Scan completed.'

Component	Material	Volume Source	Printed Circuit Board
Total power:		33 W	
epic pc			
EPIC PCB-1	Solid Material 1		
PC104 ISA Connector-1	Solid Material 1		
PC104 PCI Connector-1	Solid Material 1		
SODIMM Connector-1	Solid Material 1		
SODIMM-1			
SODIMM PCB-1			4s2p PCB
ram chip-1	Steel (Mild) (Default Solid Material)		
ram chip-3	Default Solid Material (Steel (Mild))		
ram chip-4	Default Solid Material (Steel (Mild))		
ram chip-5	Default Solid Material (Steel (Mild))		
Heatsink-5	Copper	5 W	
CPU Heat Pipe-1	Default Solid Material (Steel (Mild))		
Northbridge Heat Pipe-1	Default Solid Material (Steel (Mild))		
Case-1	Default Solid Material (Steel (Mild))		

Properties

Property	Value
Name	VS Heat 1
Heat generation rate	1 W

Scan completed.



Feature Goals for LED, 2R, Network Assembly. Display Junction T.

- Create Goals for the nodes of compact models (LED, 2R, NA) in definition dialog.
- Select a node (Junction, Bottom, or Top) to display as **Temperature (Active Node)**.

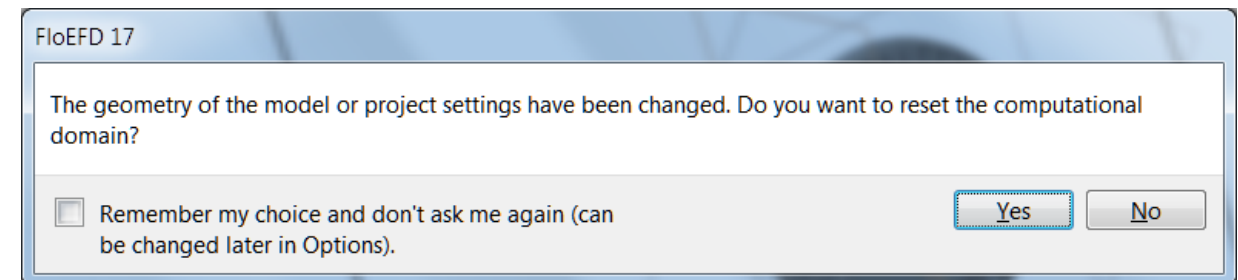
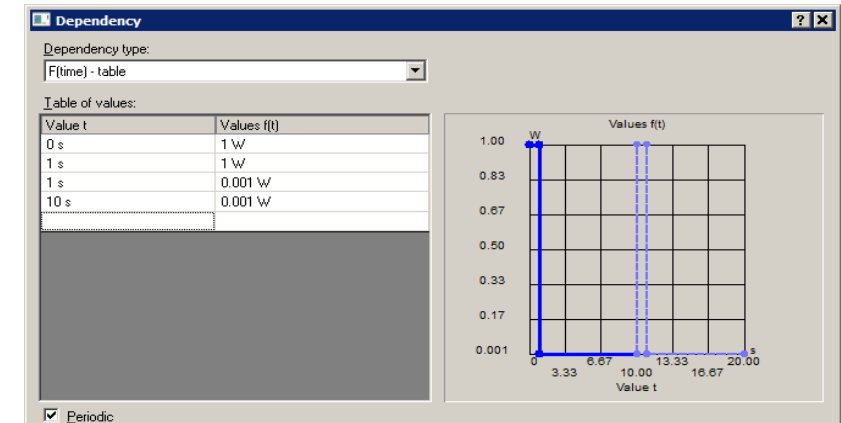
The screenshot illustrates the workflow for defining and displaying temperature goals in the simulation software. It is divided into four main sections:

- Left Panel (Two-Resistor Component-SmallBGA):** This panel shows the component selection and definition process. Under the 'Selection' tab, 'Face<29>SMALLBGACASE-2379' is selected. Under the 'Component' tab, 'PBGAFC_35x35mm' is chosen from a list of various package types. The 'Source' is set to '20 W', and the 'Displayed Temperature' is set to 'Temperature (Junction)'. The 'Goals' section at the bottom is highlighted with a blue box, showing a table with columns for 'Parameter' and 'Us'. The table contains three rows: 'Temperature (Case)', 'Temperature (Junction)', and 'Temperature (Board)', all with checkboxes in the 'Us' column.
- Center Panel (Tree View):** This panel shows the hierarchical structure of the simulation model. The 'Goals' folder is expanded, showing two sub-items: 'Two-Resistor Component-SmallBGA Temperature (Case)' and 'Two-Resistor Component-SmallBGA Temperature (Junction)'. The 'Junction' goal is highlighted with a blue box, and a blue arrow points from this box to the 'Goals' section in the left panel.
- Right Panel (Surface Plot 1):** This panel shows the 'Surface Plot 1' dialog. The 'Selection' tab shows 'Face<2053>VCS_COM_BOARD-CAD-'. The 'Display' section is expanded, showing 'Contours' selected. The 'Contours' section is highlighted with a blue box, showing 'Temperature (Active Node)' as the selected display option. The 'Options' and 'Crop Region' sections are also visible.
- Right Panel (3D Model):** This panel shows a 3D model of the component. The component is a circular package with a green top surface and a grey base. The top surface is highlighted with a blue box, and a blue arrow points from this box to the 'Surface Plot 1' dialog. A label 'Temperature (Active Node) 59.1 °C' is shown next to the model.

USABILITY

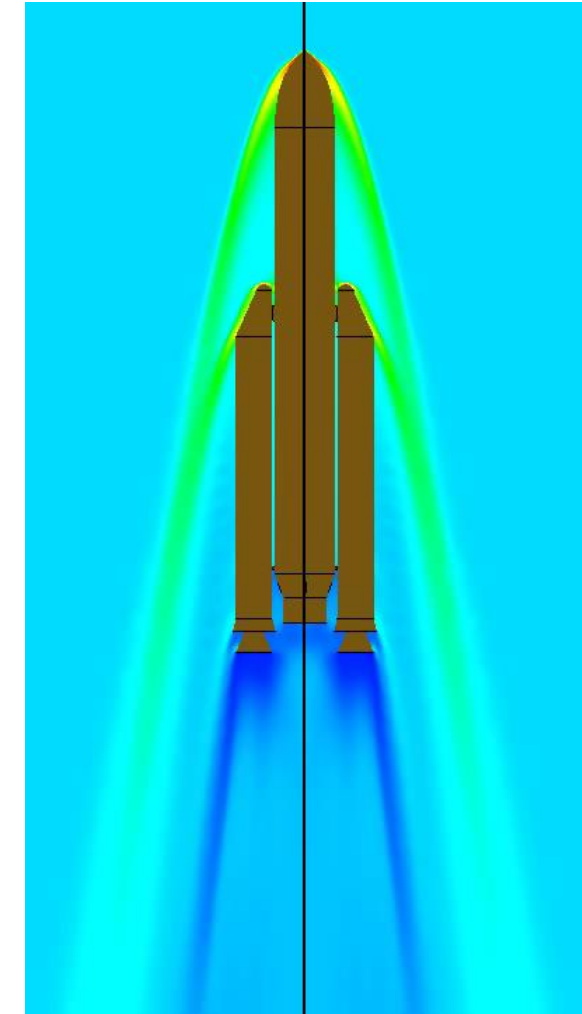
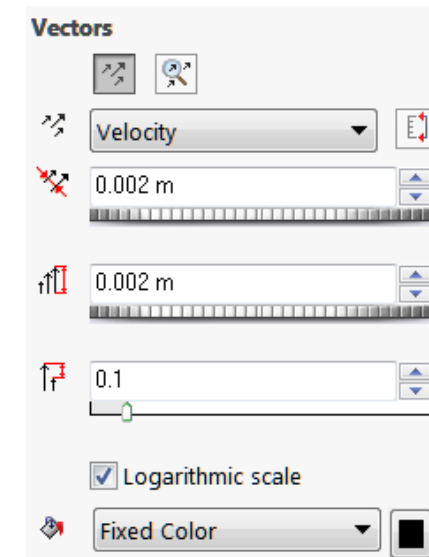
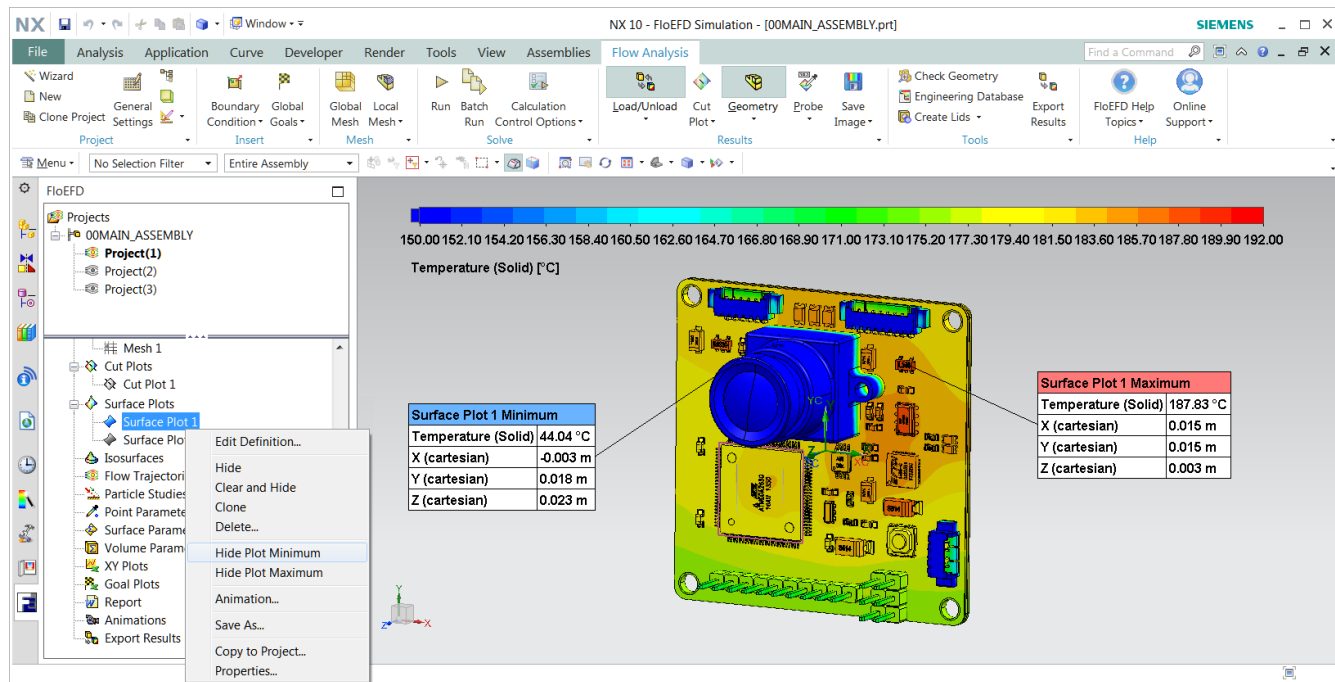
Usability: Preprocessing

- “Don’t ask me again” for reset mesh and reset computational domain
- Full Template: all data is now saved in template
- Rebuild Error don’t block boundary condition creating
- Toggle to set periodic (cycling) time dependence
- Display used cores in Monitor and logs incl. for Linux
- BC name is displayed in the caption of dialog
- TEC driving current as a function of Goal
- Display linked condition in the main project tree
- Dynamic Viscosity is added into point goal
- Inlet Mass Flux



Usability: Postprocessing

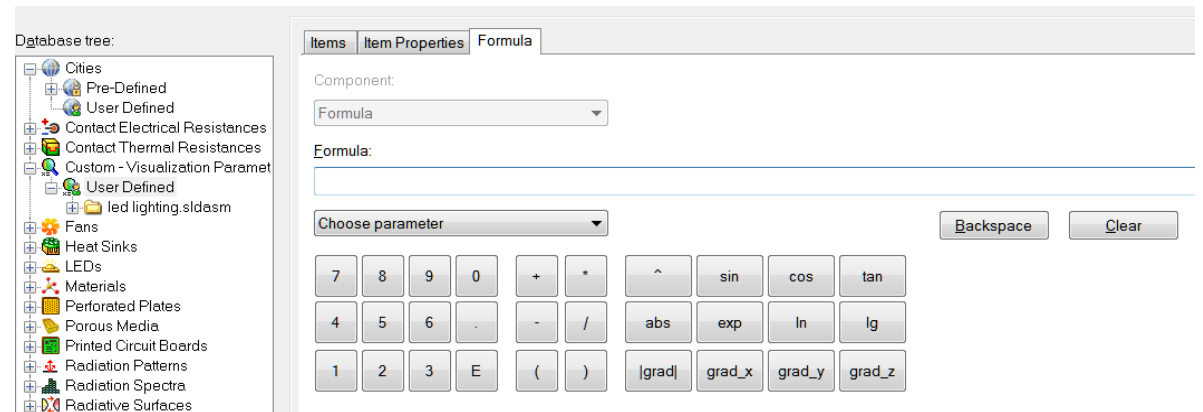
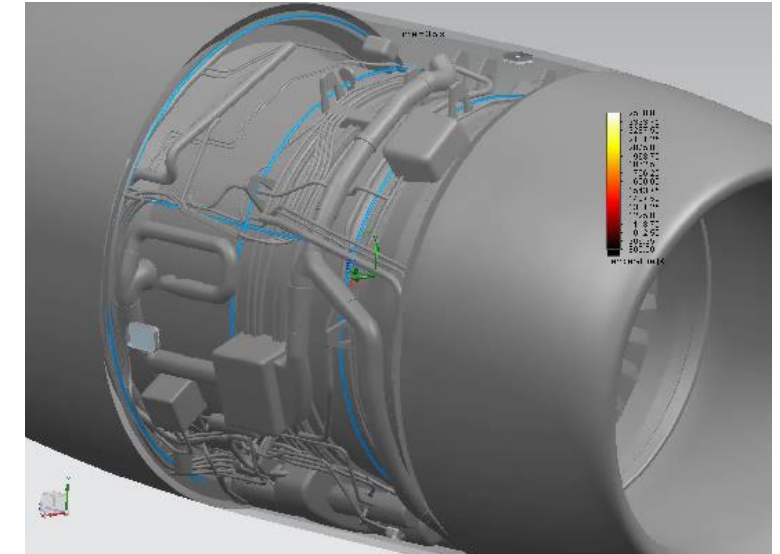
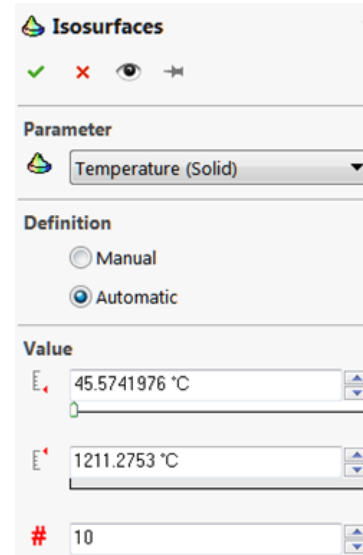
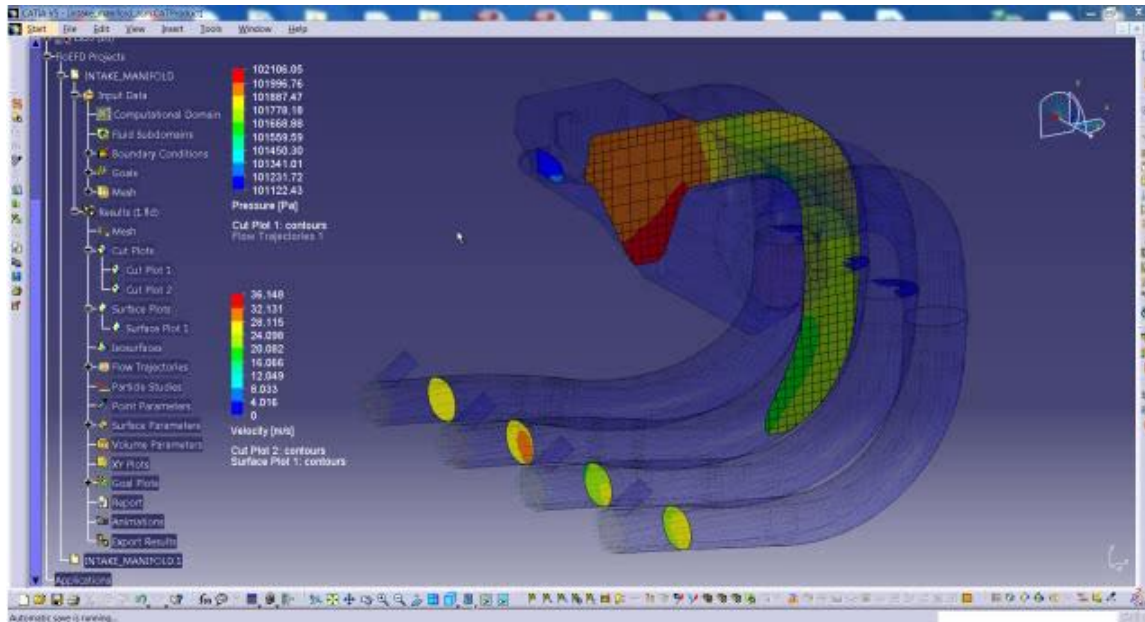
- Logarithmic scale for contours and vectors
- Horizontal legend
- Min Max callouts on plot optionally with coordinates





Usability: Postprocessing

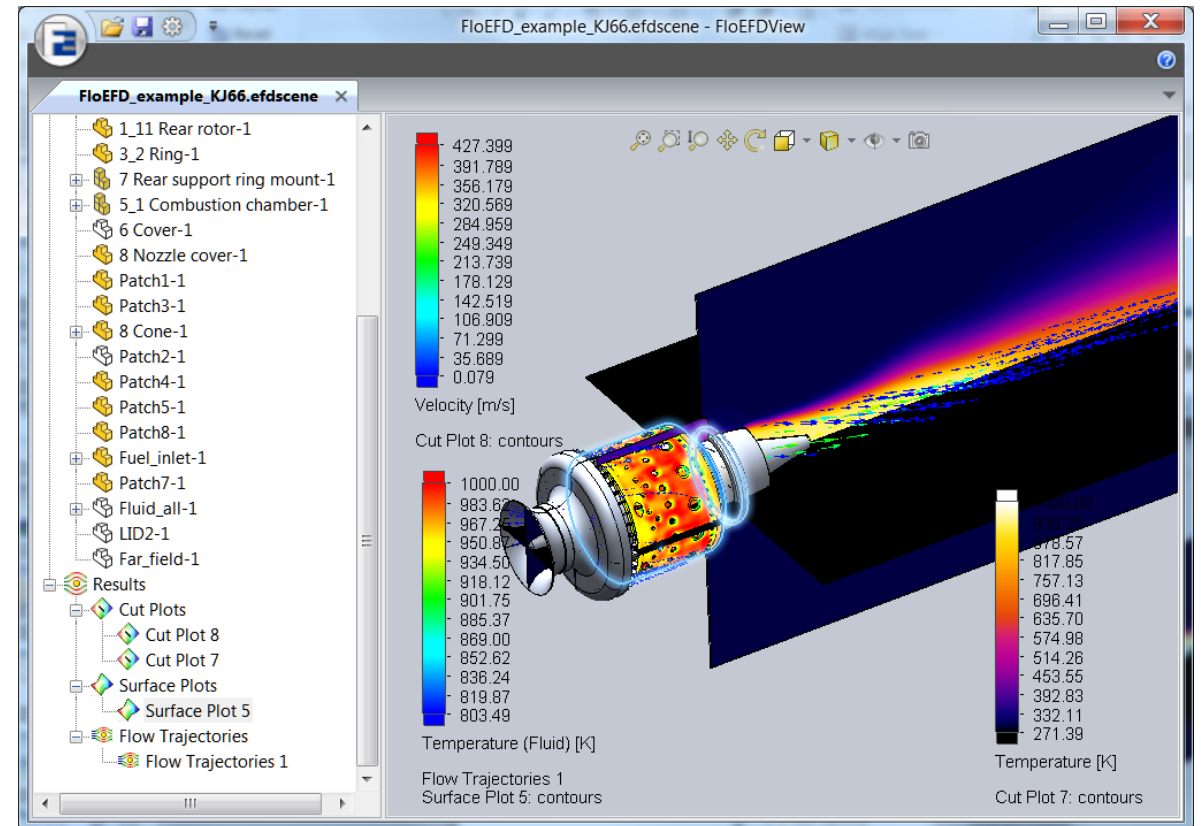
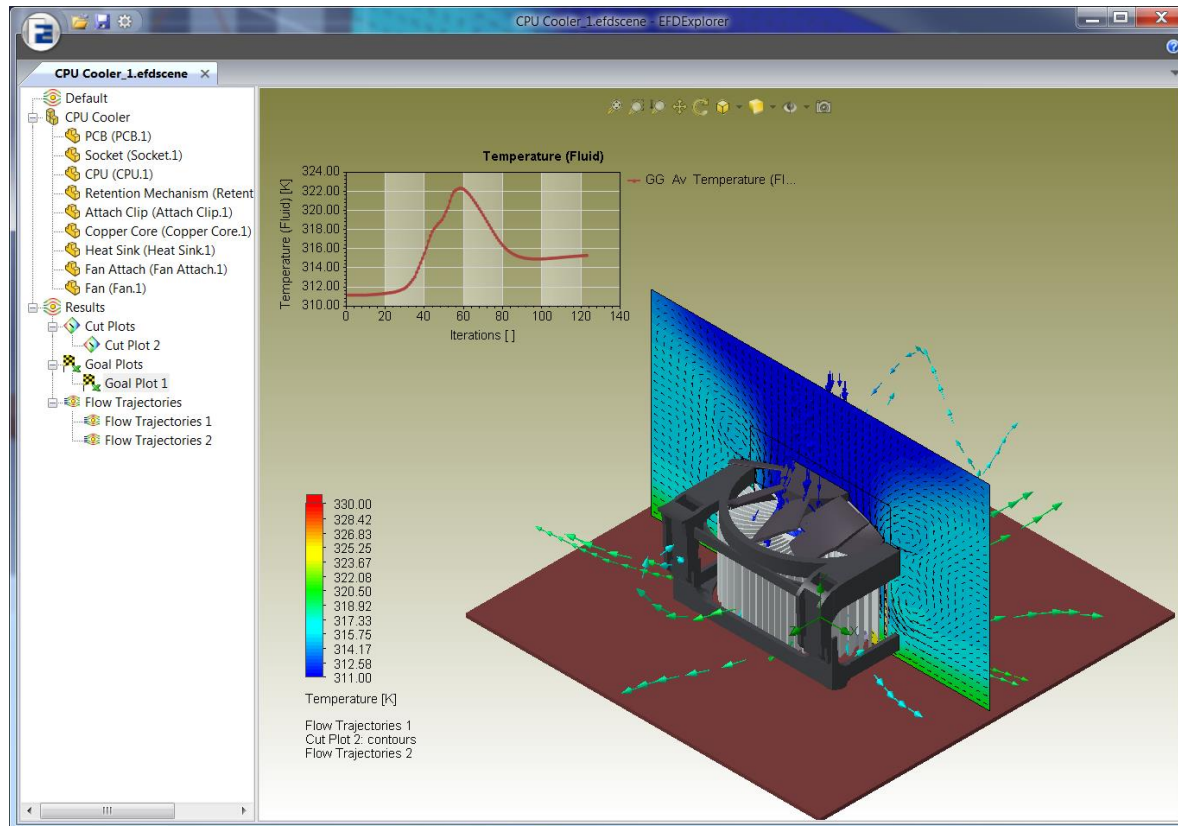
- Isosurface: number of values in a range
- Cut plots: Orient the plot parallel to the screen
- Parameters: Specific and Absolute Humidity
- Parameters: Custom Gradient parameter





FloEFDView

Standalone **FREE** viewer to explore FloEFD results optionally including original CAD geometry.

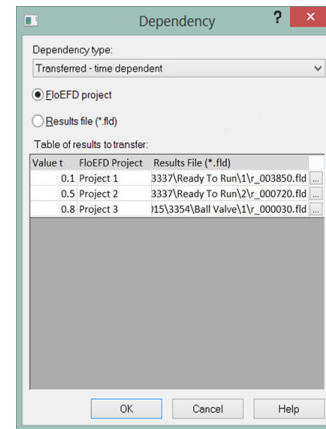
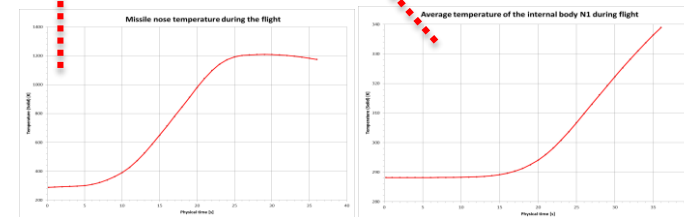
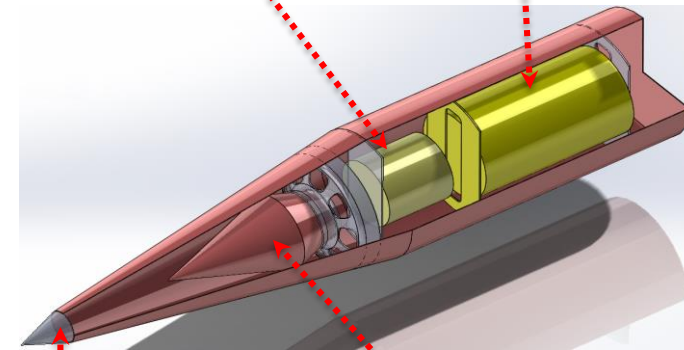
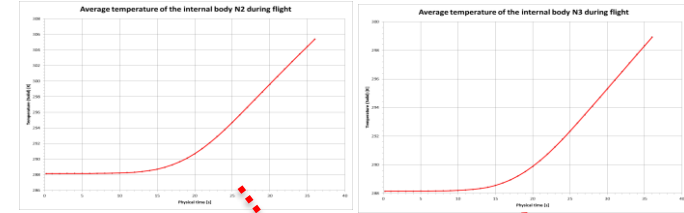
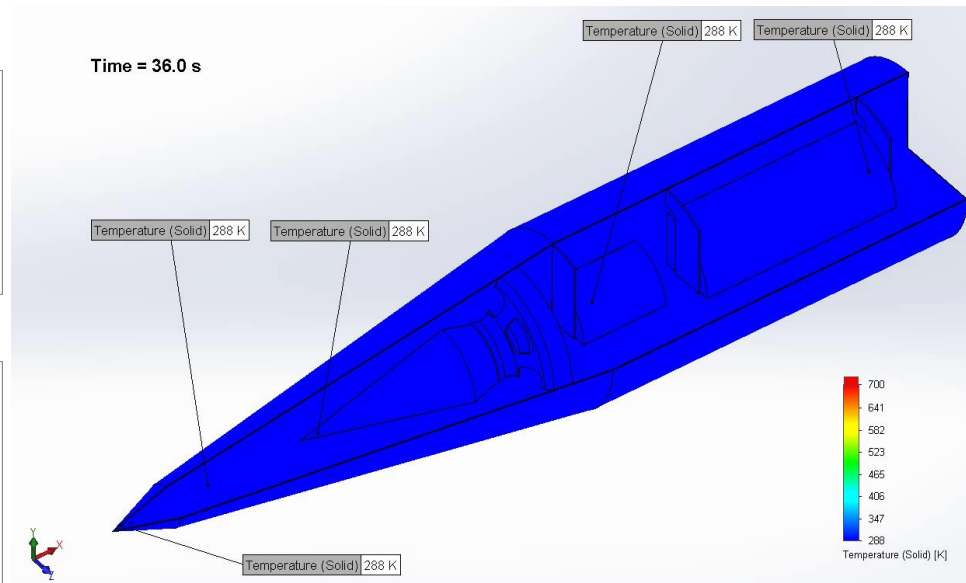
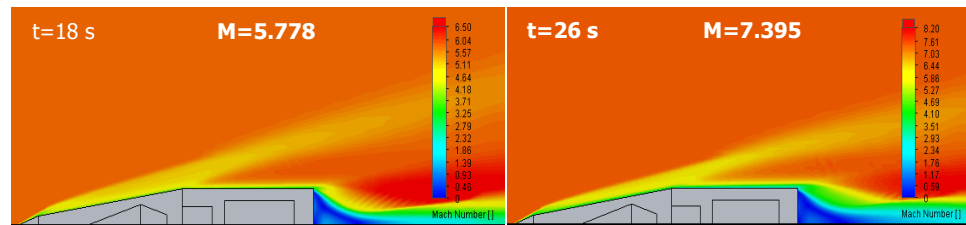
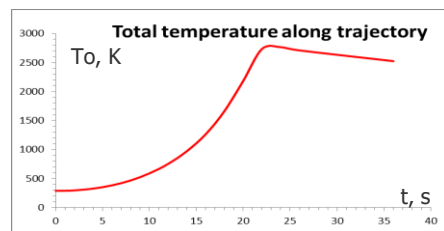
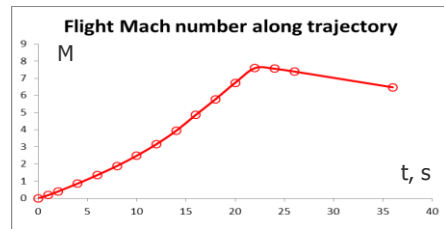
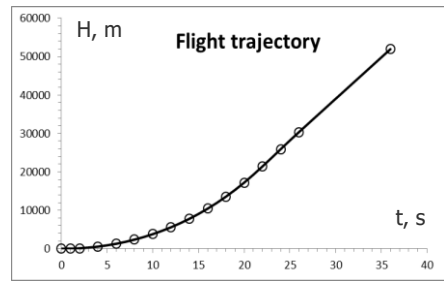


PERFORMANCE



Transferred HTC

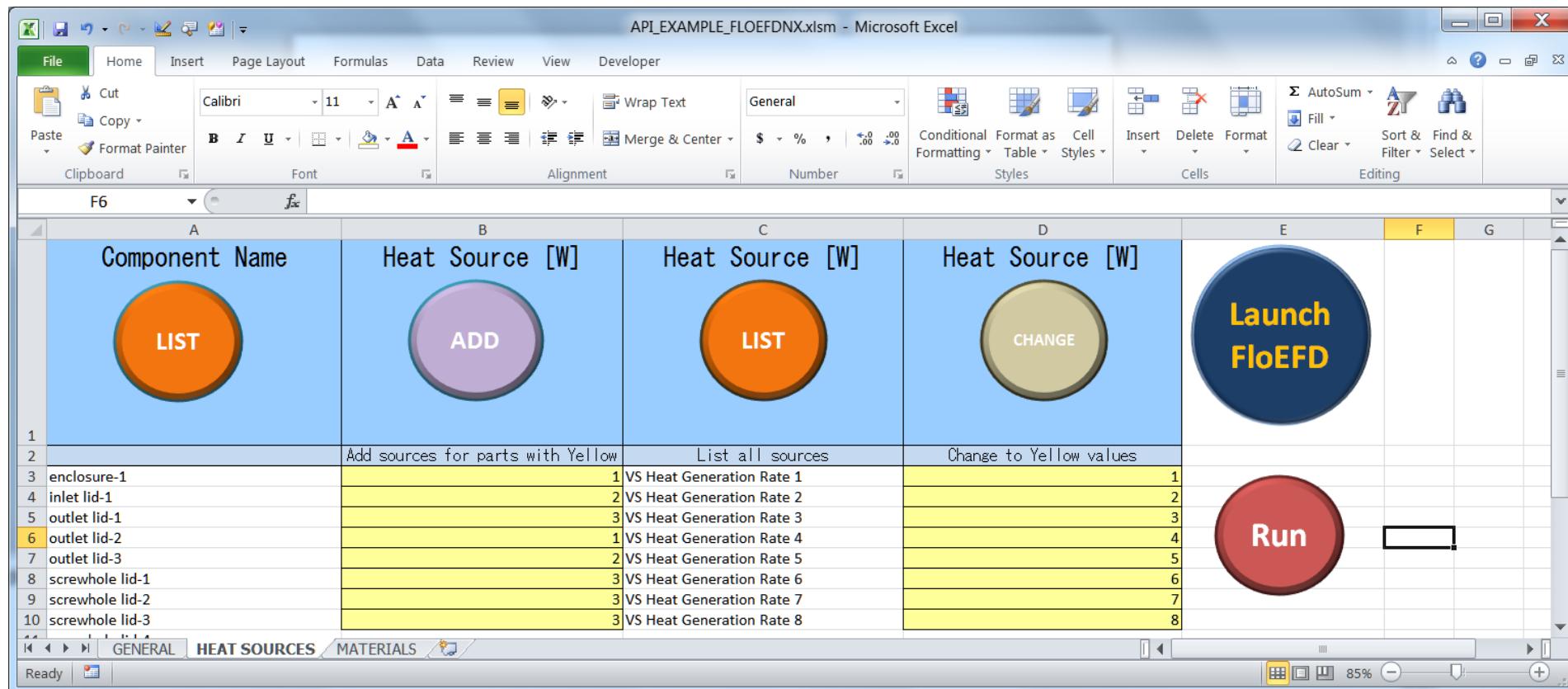
Heat Transfer Coefficient can be transferred from other results (fld) file, or set of files (in case of transient simulation).





API: Now You Can Create Conditions

Possibility to add heat sources and solid material to a component by name or pre-selection (also available for face conditions like mass flow rate, electrical current), delete condition using API (VBA, VBS, C++).

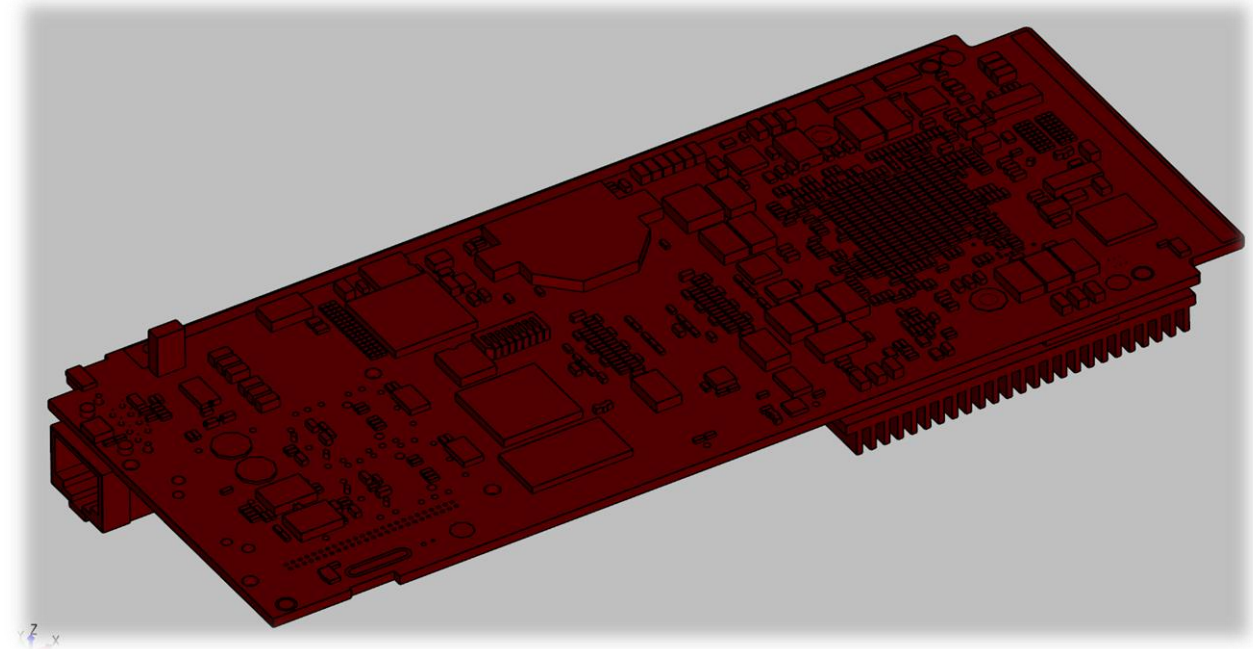




Improved Geometry Handling with Own Boolean

Own Boolean Kernel is designed to automatically heal geometry and significantly speedup CAD geometry extraction.

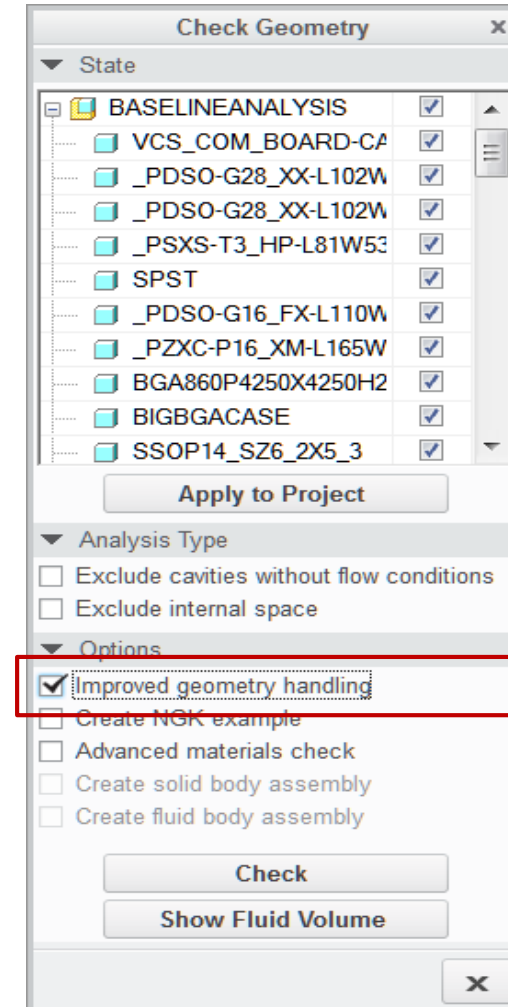
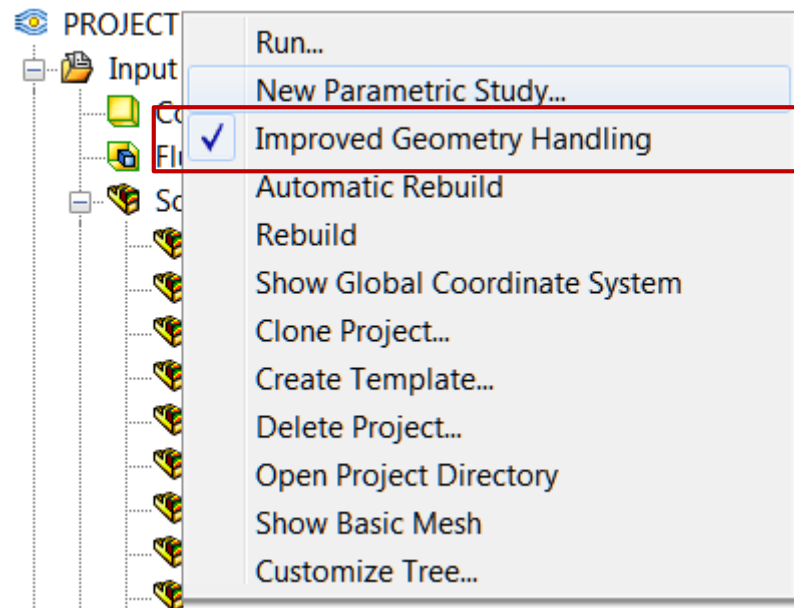
- The current procedure is based on CAD Boolean operations which are slow and not parallelized (use 1 core).
- The new Geometry Handling procedure assumes creating solid and fluid bodies using topology information by means of FloEFD internal mathematical kernel = FloEFD Boolean operations.
- As a result the preparation process can be shared among many cores.
- The new algorithm will coexist with the current version for a few years.





Improved Geometry Handling

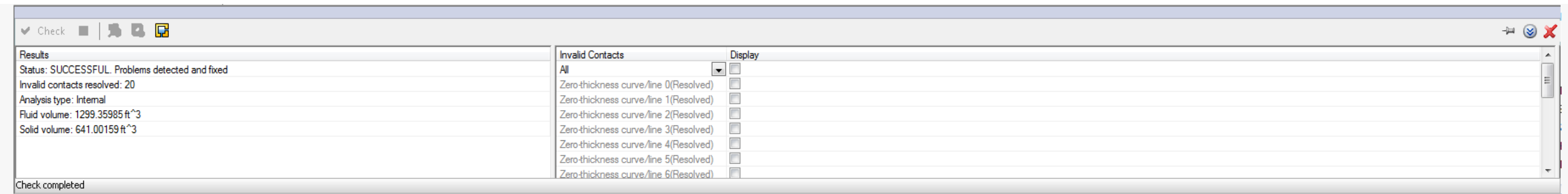
Activated for the project as **Improved Geometry Handling**.
Can be activated in **Check Geometry** for diagnostic.



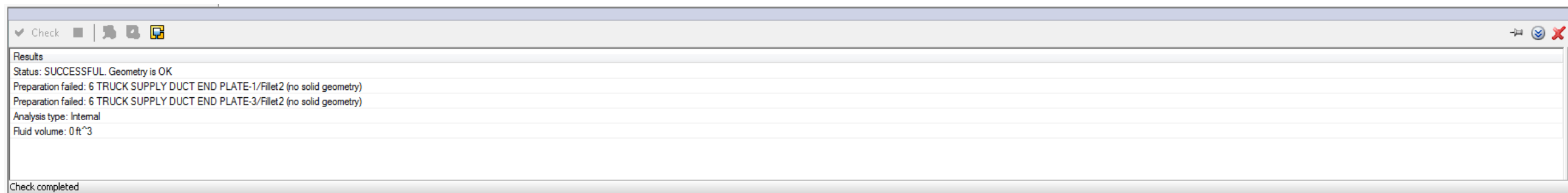


Better Diagnostic and auto Healing, Speed up

- CAD Boolean: Successful geometry check but stopped at preparing



- FloEFD Boolean: Detected problem geometry

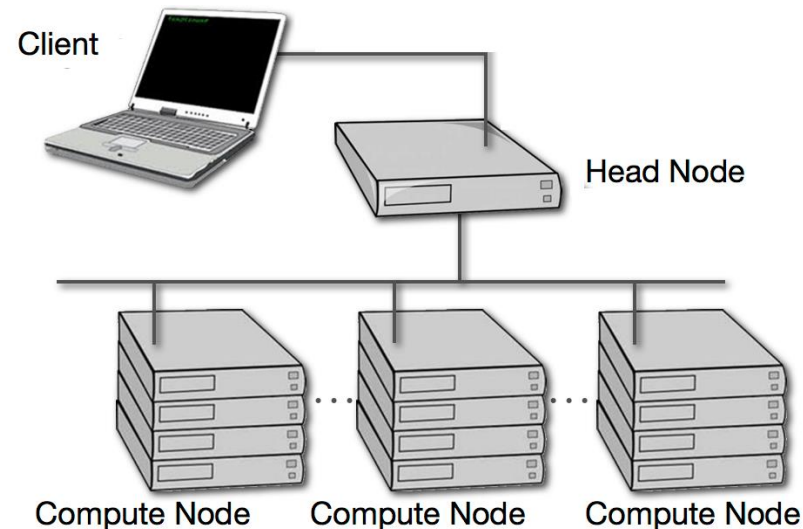
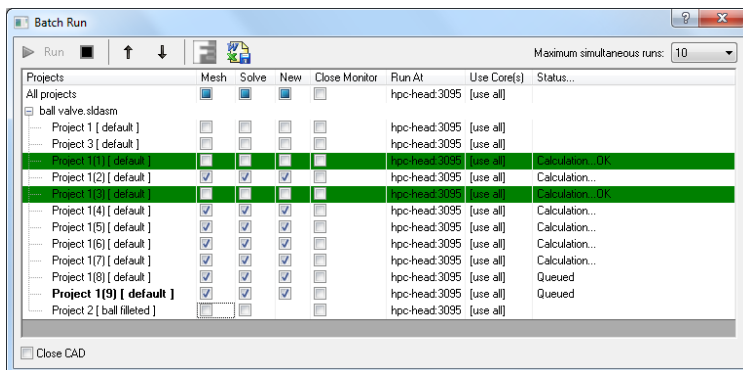
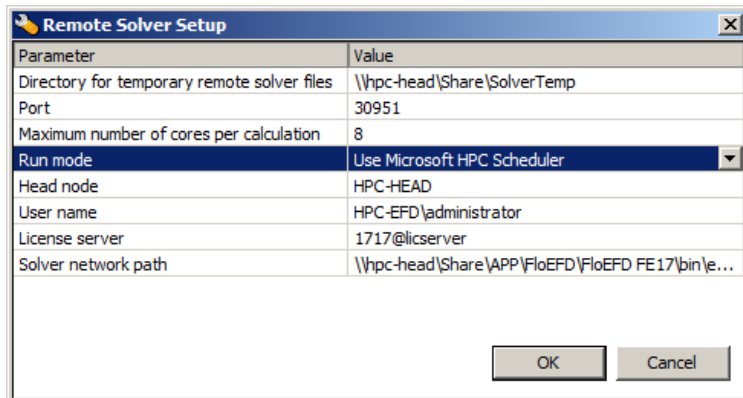


- Customer example: **7 hours** (FloEFD Boolean) compared to **72+ hours** (CAD Boolean)



Microsoft HPC Job Scheduler

- The new **Use Microsoft Windows Job Scheduler** mode to manage calculations on the server.
- HPC Scheduler automatically distributes tasks to computer nodes of the HPC.

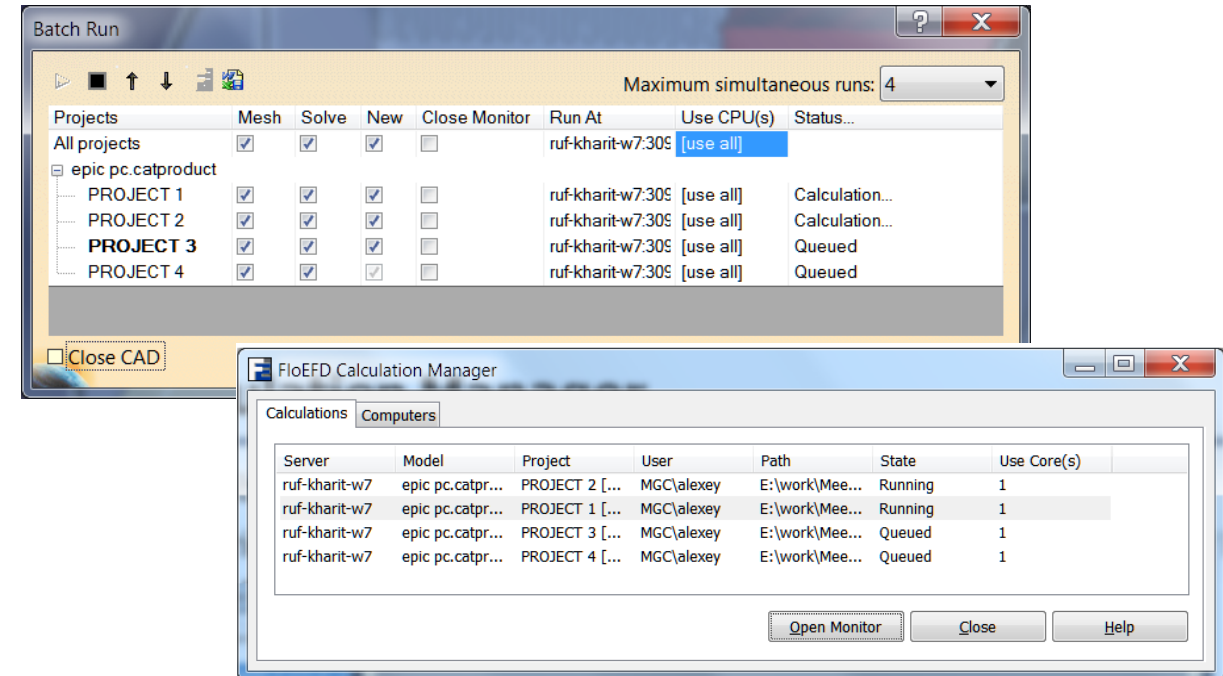
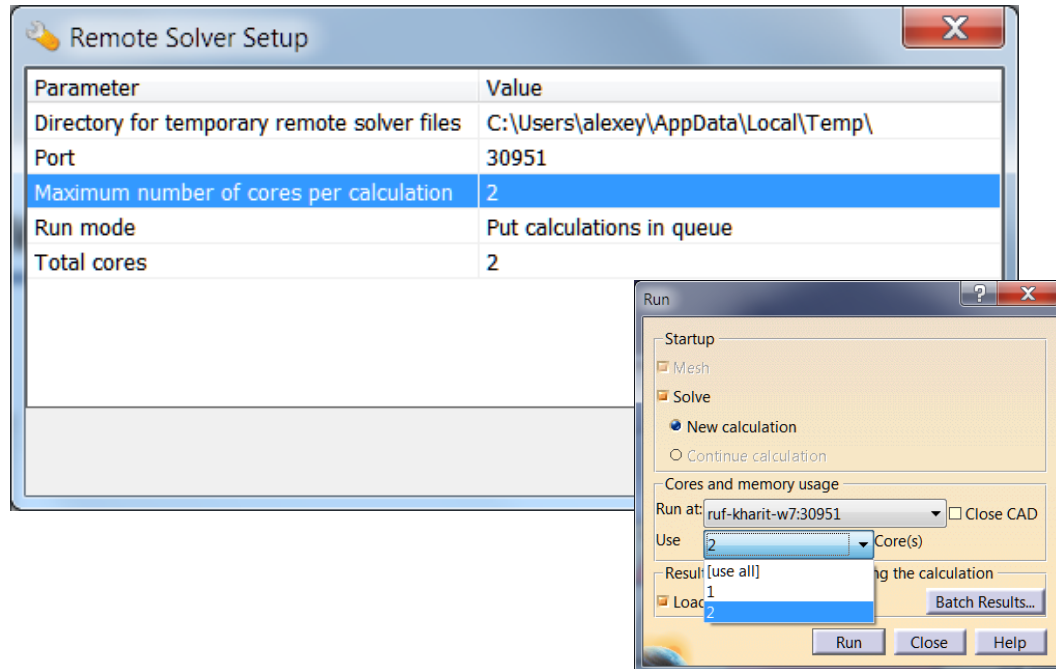


Job Management					
	Job ID	Job Name	State	Owner	Progress
All Jobs	54	FloEFD [HPC-EF...	Queued	HPC-EFD\Administrator	0%
	53	FloEFD [HPC-EF...	Queued	HPC-EFD\Administrator	0%
	52	FloEFD [HPC-EF...	Queued	HPC-EFD\Administrator	0%
	51	FloEFD [HPC-EF...	Queued	HPC-EFD\Administrator	0%
My Jobs	50	FloEFD [HPC-EF...	Queued	HPC-EFD\Administrator	0%
	49	FloEFD [HPC-EF...	Queued	HPC-EFD\Administrator	0%
	48	FloEFD [HPC-EF...	Running	HPC-EFD\Administrator	0%
	47	FloEFD [HPC-EF...	Running	HPC-EFD\Administrator	0%
By Job Template	46	FloEFD [HPC-EF...	Running	HPC-EFD\Administrator	0%
	45	FloEFD [HPC-EF...	Finished	HPC-EFD\Administrator	100%
	44	FloEFD [HPC-EF...	Finished	HPC-EFD\Administrator	100%
	43	FloEFD [HPC-EF...	Finished	HPC-EFD\Administrator	100%
Default	42	FloEFD [HPC-EF...	Finished	HPC-EFD\Administrator	100%
	41	FloEFD [HPC-EF...	Finished	HPC-EFD\Administrator	100%



Remote Solver Queueing

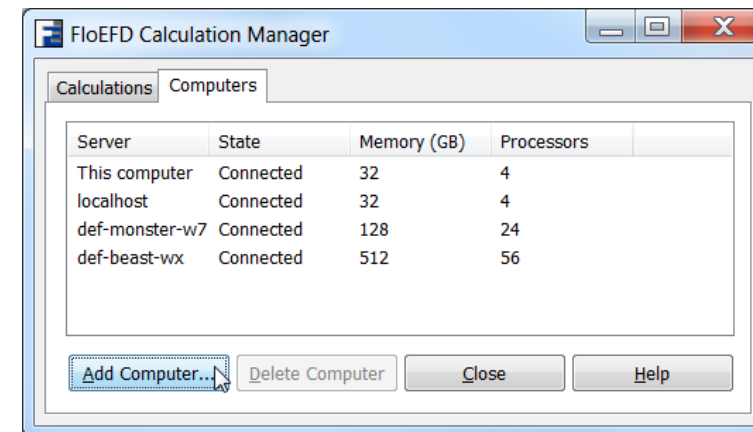
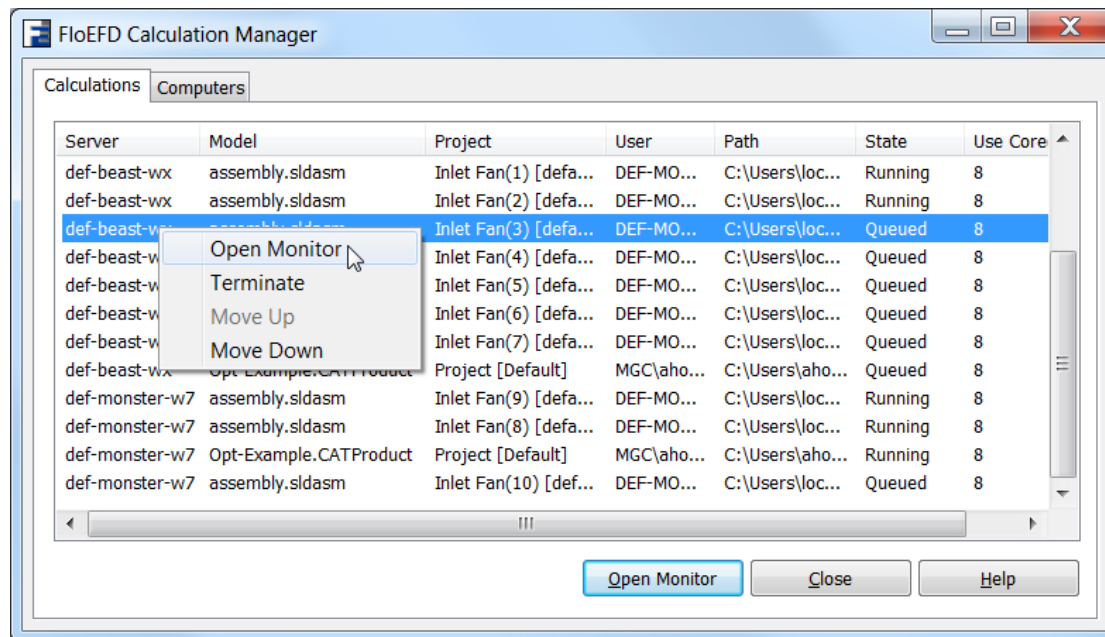
- Possibility to define a queue of calculations on FloEFD server.
- Restrict maximum number of server's cores used per a calculation. Restrict total number of server's cores to be used by FloEFD. Additional analysis tasks will be put into a queue for later calculation.





Calculation Manager

- The Calculation Manager was enhanced to view and control solving and queued FloEFD projects on any configured Remote Solver.
- Normal users can only terminate their tasks. A FloEFD Administrator (a user added to the global domain group “FloEFDAdministrators”) can Open the Solver Monitor, Terminate any project or Adjust the position of queued projects.

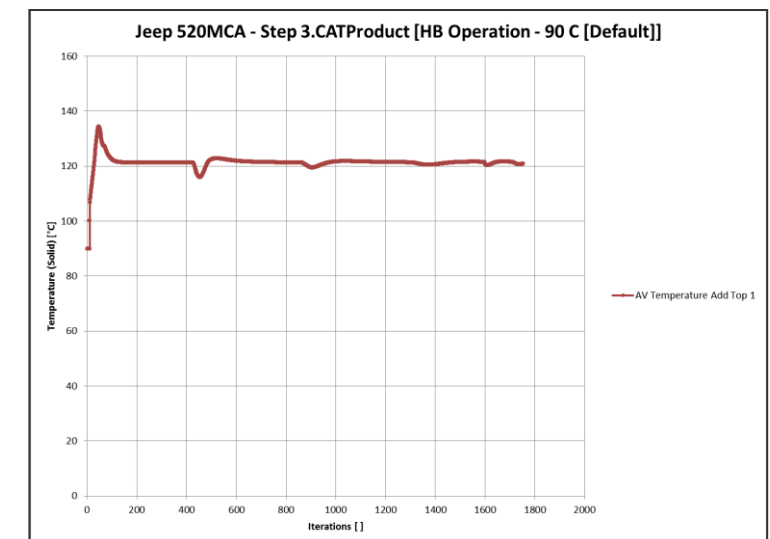
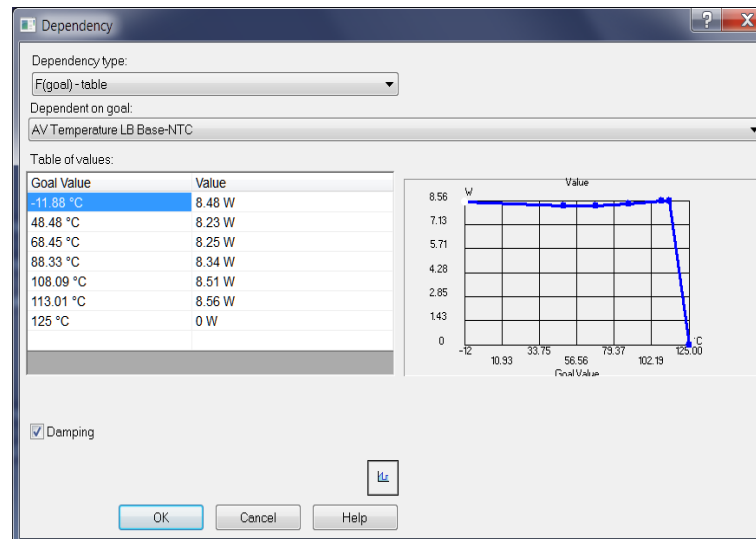
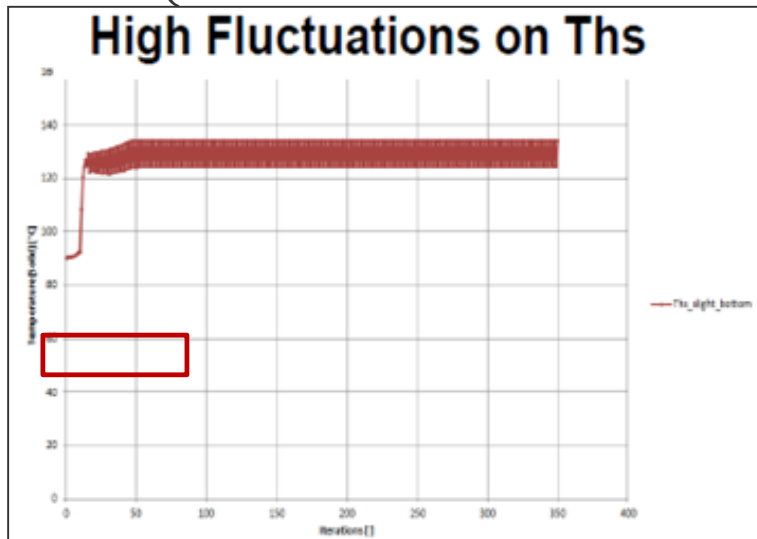




Damping for goal dependency in steady-state

- Damping factor for goal dependent parameters to avoid oscillations or relaxation of an extreme change of dependent parameters in steady-state.
- Damping: the actual value of the goal is replaced by the value averaged on the $\frac{1}{4}$ of analysis interval ($4 * T_a$ = Analysis interval specified for Goal convergence, by default $T_a = 0.125$ Travel).

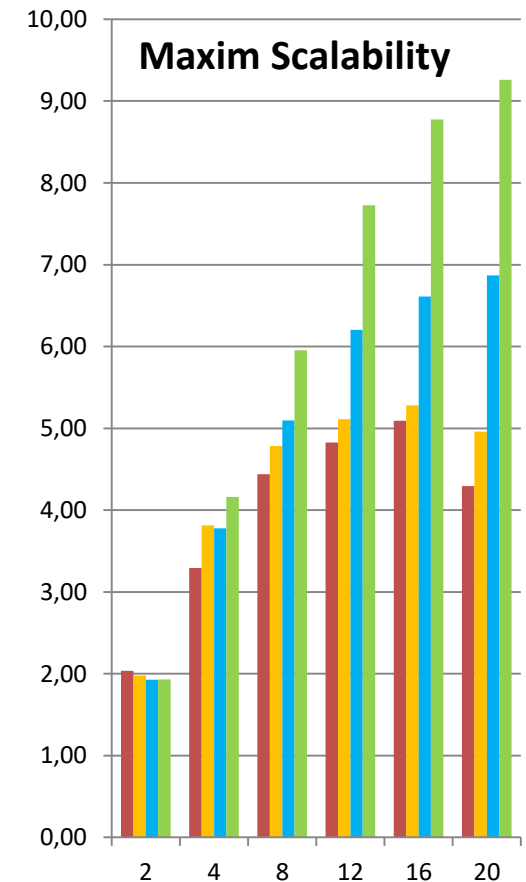
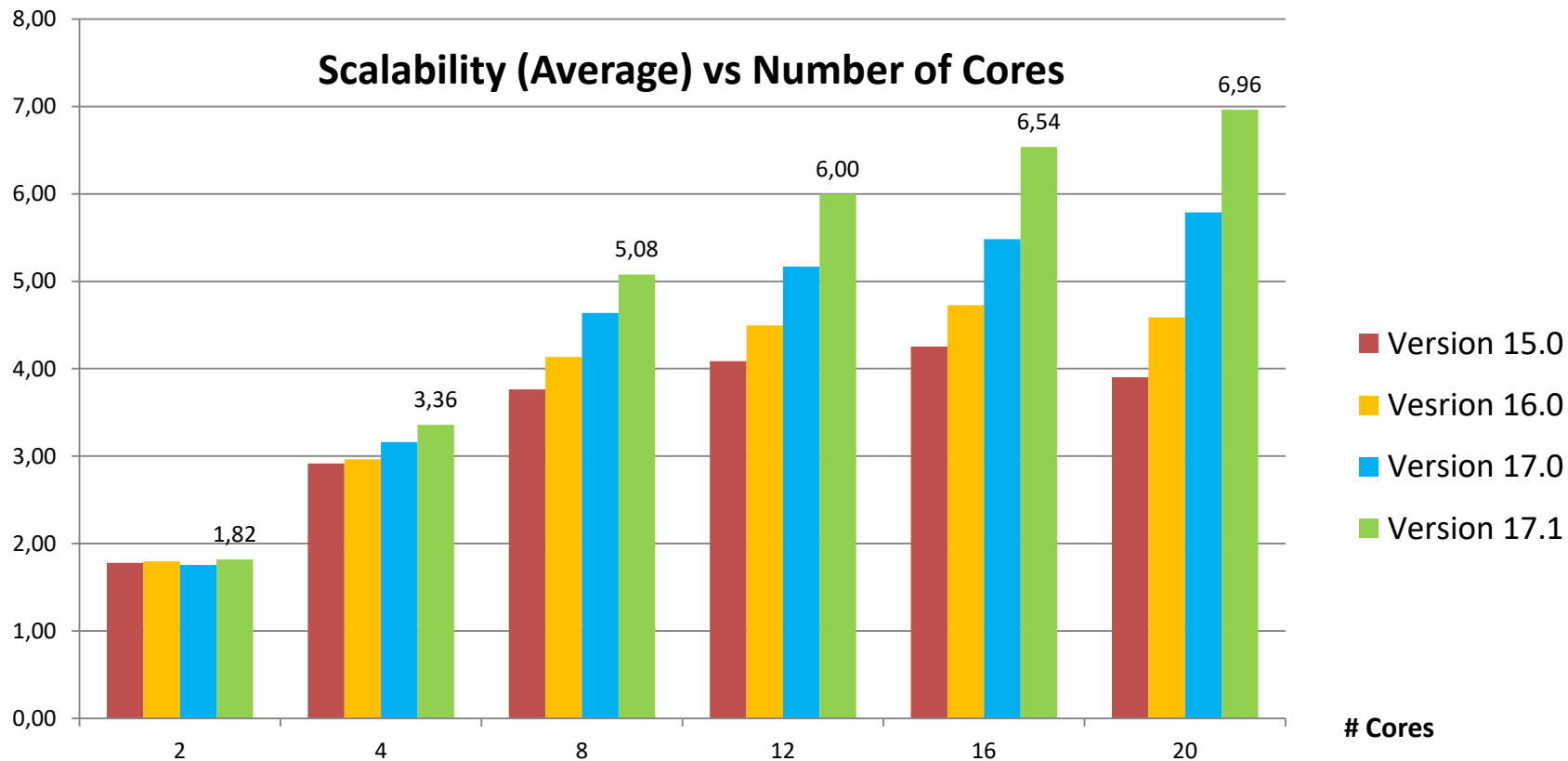
$$f_i = \begin{cases} f_0 \frac{T - t_i}{T} + \bar{f}_{i-1} \frac{t_i}{T} & , \text{ for } t_i < T_a \\ \bar{f} & , \text{ for } t_i \geq T_a \end{cases}$$





Scalability (shared memory)

Scalability is the ratio of calculation time to the time obtained with only one core.
The chart shows average and maximum scalability obtained from a number of cases.



Scalability = Average scalability for a number of cases representing FloEFD capabilities (excl. High Mach Number flow)
1 core calculation uses Intel Turbo BOOST technology which can automatically run the processor core faster than the noted frequency.

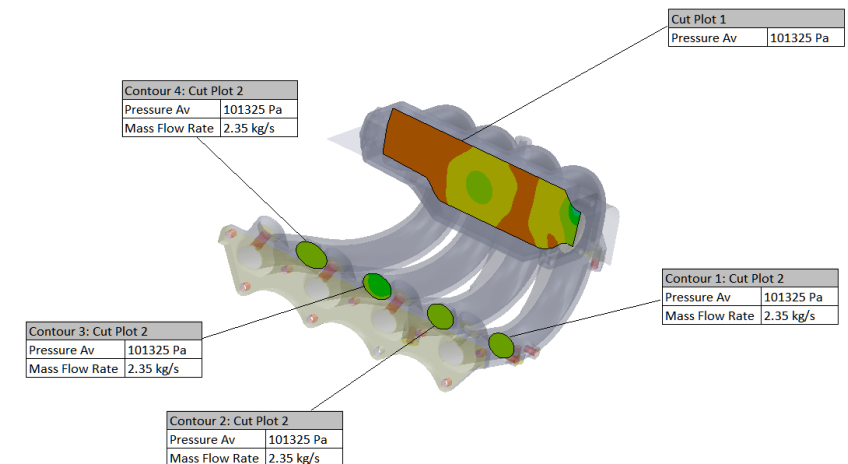
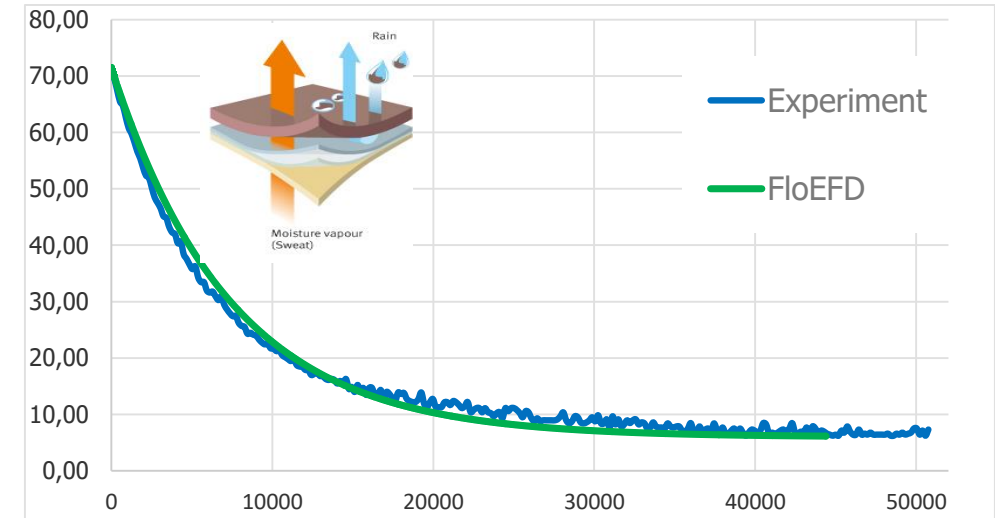


$$\sqrt{292.41} = 17.1$$

FLOEFD 17.1

FloEFD 17.1

- Membrane
- Improved solver scalability
- GIF Animation: select transparent color
- Mirror Results for Sector Periodicity
- FloEFDView: Support Section View
- Support 4K monitors
- Isosurface in Transient Explorer (cool for Free Surface)
- Free surface parameter for plots
- Uniformity Index Goal
- Creo 4.0 support
- Siemens NX12 support
- ...



HOEFD

Thank you!

