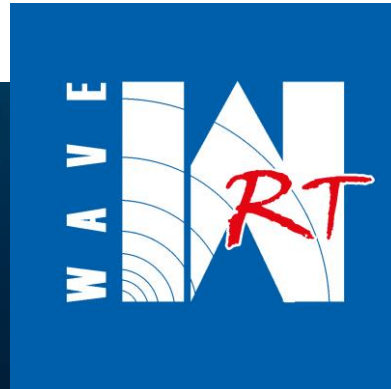
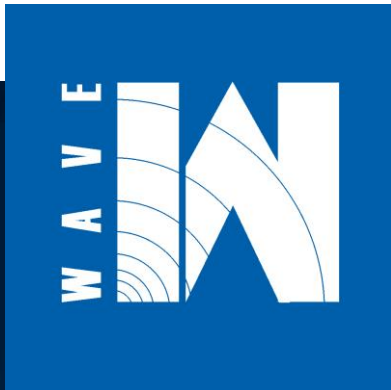


WAVE 2017.1 New Features



What is WAVE?

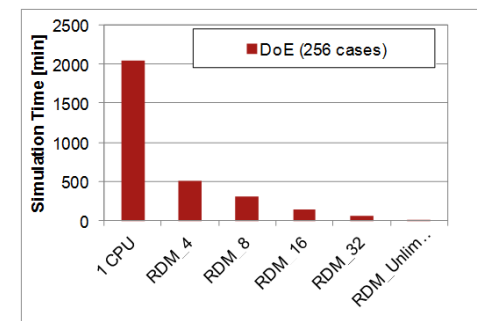
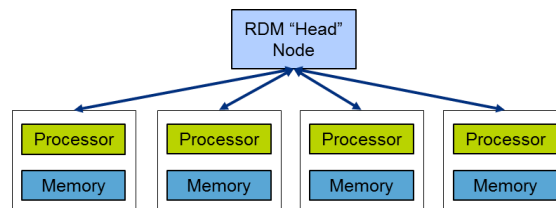


WAVE is a one-dimensional gas dynamics program for the design and analysis of internal combustion engines

- Includes tools that can be utilized effectively across an organization by multiple departments to optimize price/performance benefit



- Run more design points faster than any other tool to make better design decisions, sooner



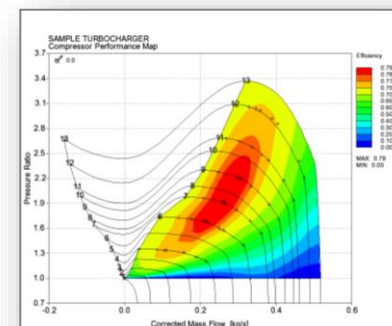
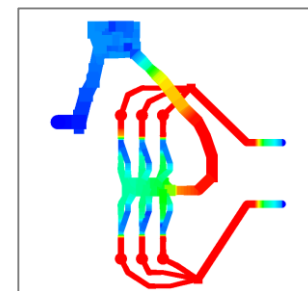
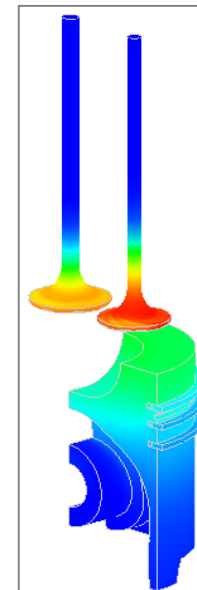
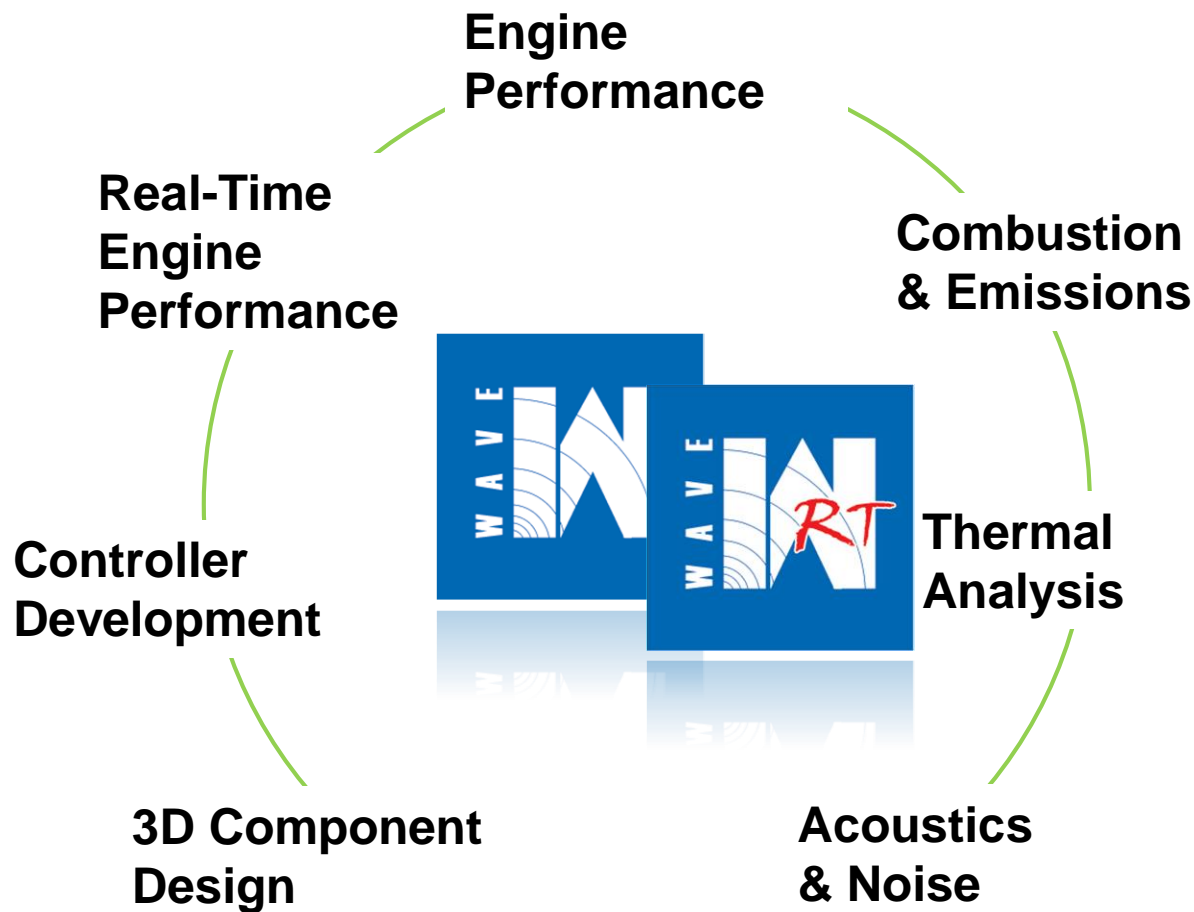
Complete Tool Chain

Speed

Real-time Technology Like No Other

Class-leading Acoustics

WAVE and WAVE-RT are 1D CFD analysis tools supporting engine performance and acoustic/NVH development



New WAVE Plug in



WAVE 2017.1 - 0_6L_Motorbike_Supersport

0_6L_Motorbike_Supersport

Case Cases - Case 1

Rotation 0.0

Scale 1.00

Motorbike Supersport 600cm³

Library

Search...

- WAVE
 - Flow Elements
 - Ambient
 - Component
 - Compressor
 - Crankcase
 - Cylinder
 - Duct
 - End Cap
 - Injector
 - Orifice
 - Speaker
 - Throttle
 - Turbine
 - Valve
 - Yjunction
 - Mechanical Elements
 - Engine Block
 - Turbo Shaft
 - Control Elements
 - Sensor
 - Actuator
 - Compressor Stall Cont...
 - Signal Processing
 - Delay

Library Active Libraries

Session

Search...

- THROTTLE_ANGLE
 - Actuators
 - BDUR_act
 - CAS0_act
 - CYL_HEAD_HTC_act
 - CYL_LIN_HTC_act
 - PIS_OIL_HTC_act
 - Ambients
 - AMB_in_1
 - AMB_in_2
 - AMB_out
 - Components
 - airbox_CBR1
 - Muffler
 - Cylinders
 - cyl1
 - cyl2

Help

Engine Cylinder

Cylinder elements are typically used to model the cylinders of a standard IC engine, however they can be used to model piston compressors if motored (no combustion selected). Additionally, cylinder elements can be used to model non-standard combustion chambers (e.g. rotary engines, opposed-piston engines) given that they are 0-dimensional and simply represent a volume changing with time.

Cylinders connect to multiple flow elements via valves and usually require numerous sub-models in order to correctly represent the desired system.

This element represents a basic piston engine cylinder of an IC engine.

Help Output

Edit

Label cyl1

Cylinder Data **Submodels** **Outputs**

Ports

Valve intakes count **2**

1: Valve_1

2: Valve_2

Valve exhausts count **2**

1: Valve_3

2: Valve_4

Geometry

Bore **67** mm

Crank Stroke **42.5** mm

Clearance height **0.6** mm

Head area multiplier **1.6**

Piston area multiplier **1**

☐ Sinusoidal Movement

Connecting rod length **109** mm

Wrist pin offset **0.8** mm

Compression ratio **12**

☐ Swirl Prediction

Boundary Conditions

Piston **PISTON_TEMP**

Liner **LINER_TEMP**

Head **HEAD_TEMP**

Intake valve **IV_TEMP** K

Exhaust valve **EV_TEMP** K

Initial Conditions

Swirl ratio **0**

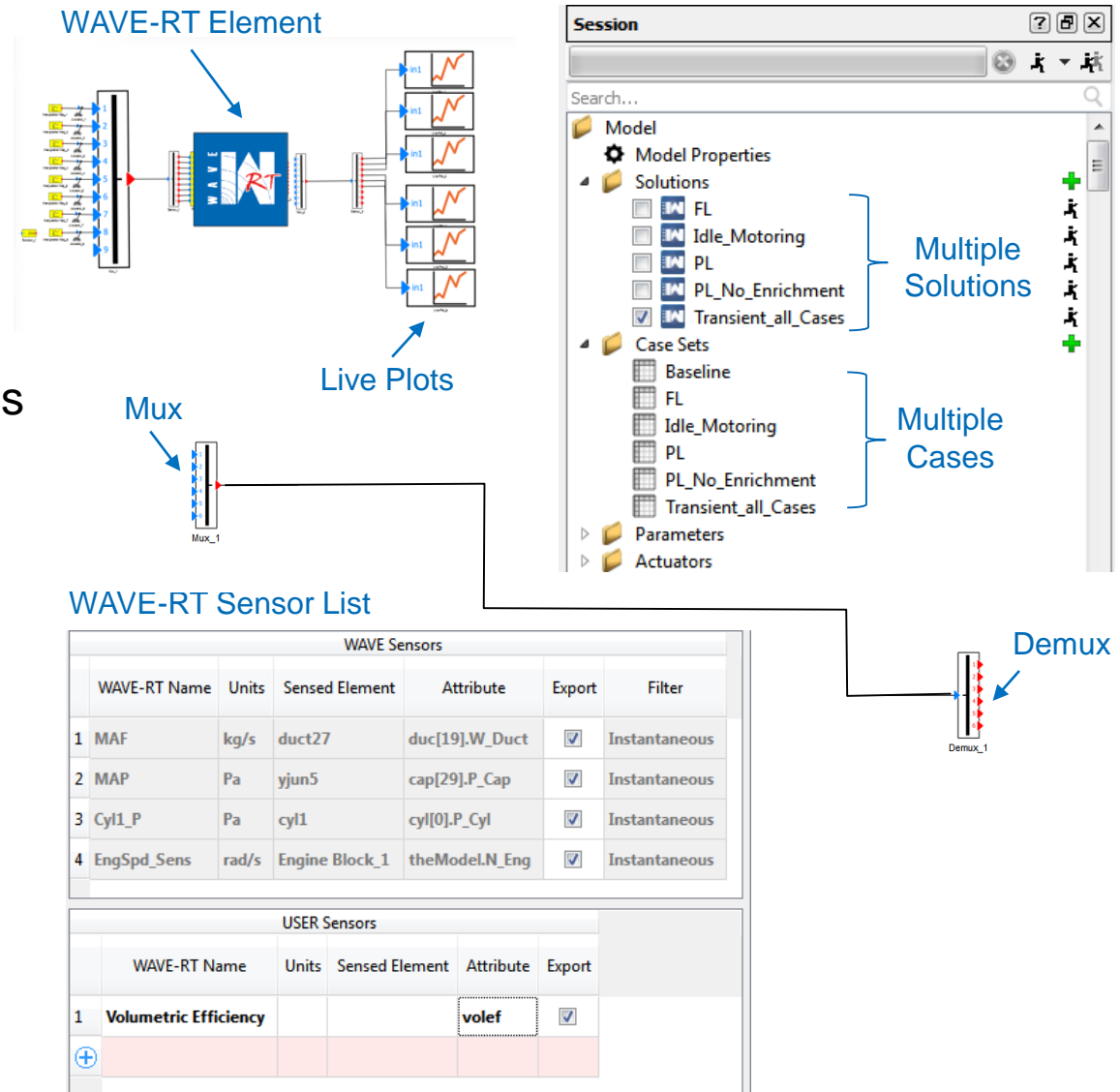
Fluid state **Default Fluid State**

Fluid composition **Default Air**

New Key Features



- New Fresh Look
- User Friendly
- 2-Button Mouse Supported
- Multi-Monitor Support
- Multiple Cases and Solutions
- Reference Objects
- Live Plots
- Valve Elements
- New WAVE-RT Export
- WAVE-RT Element
- Direct GT-Power Import
- Seamless IGNITE Element

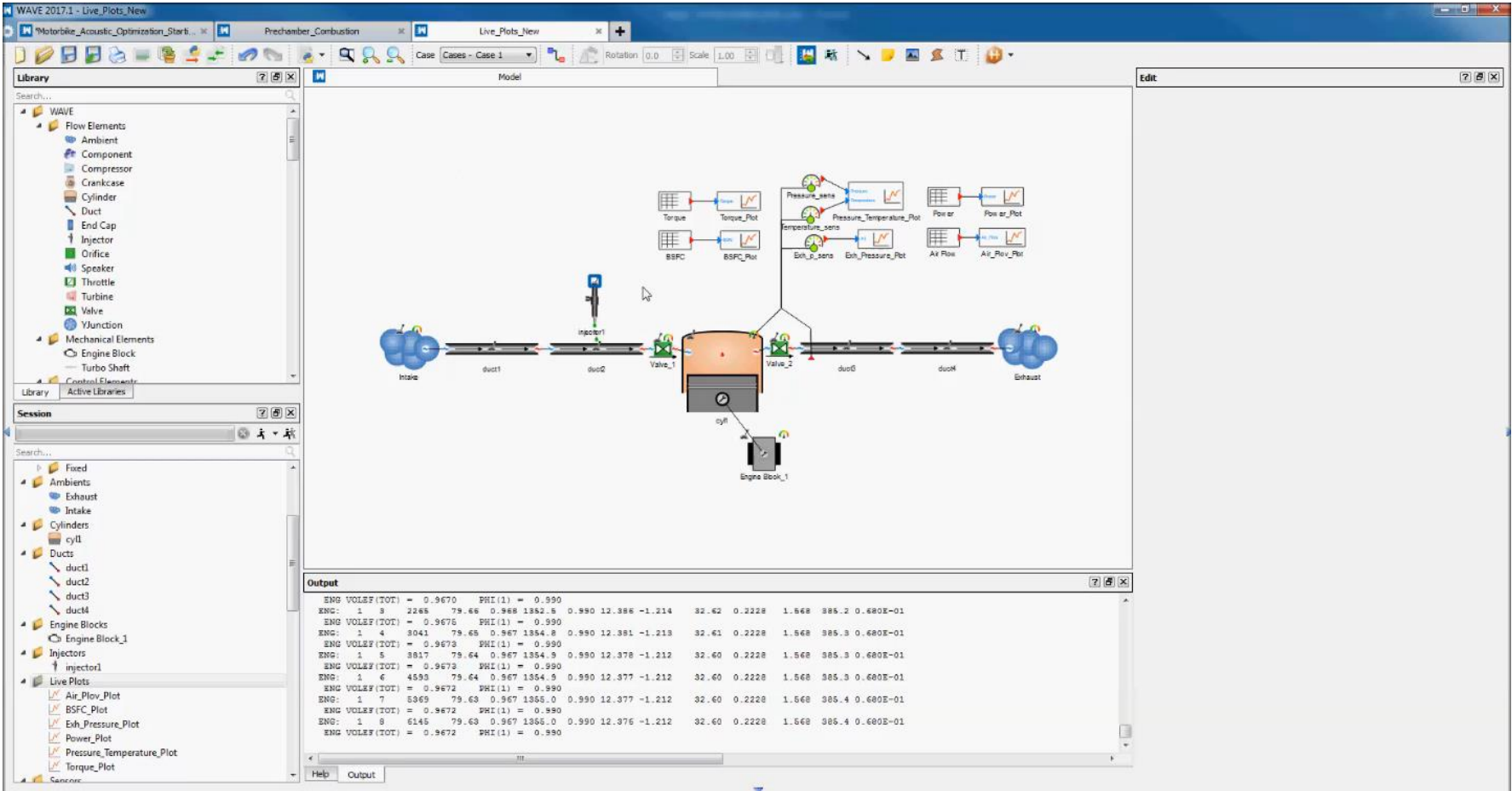


Live Plots

usability

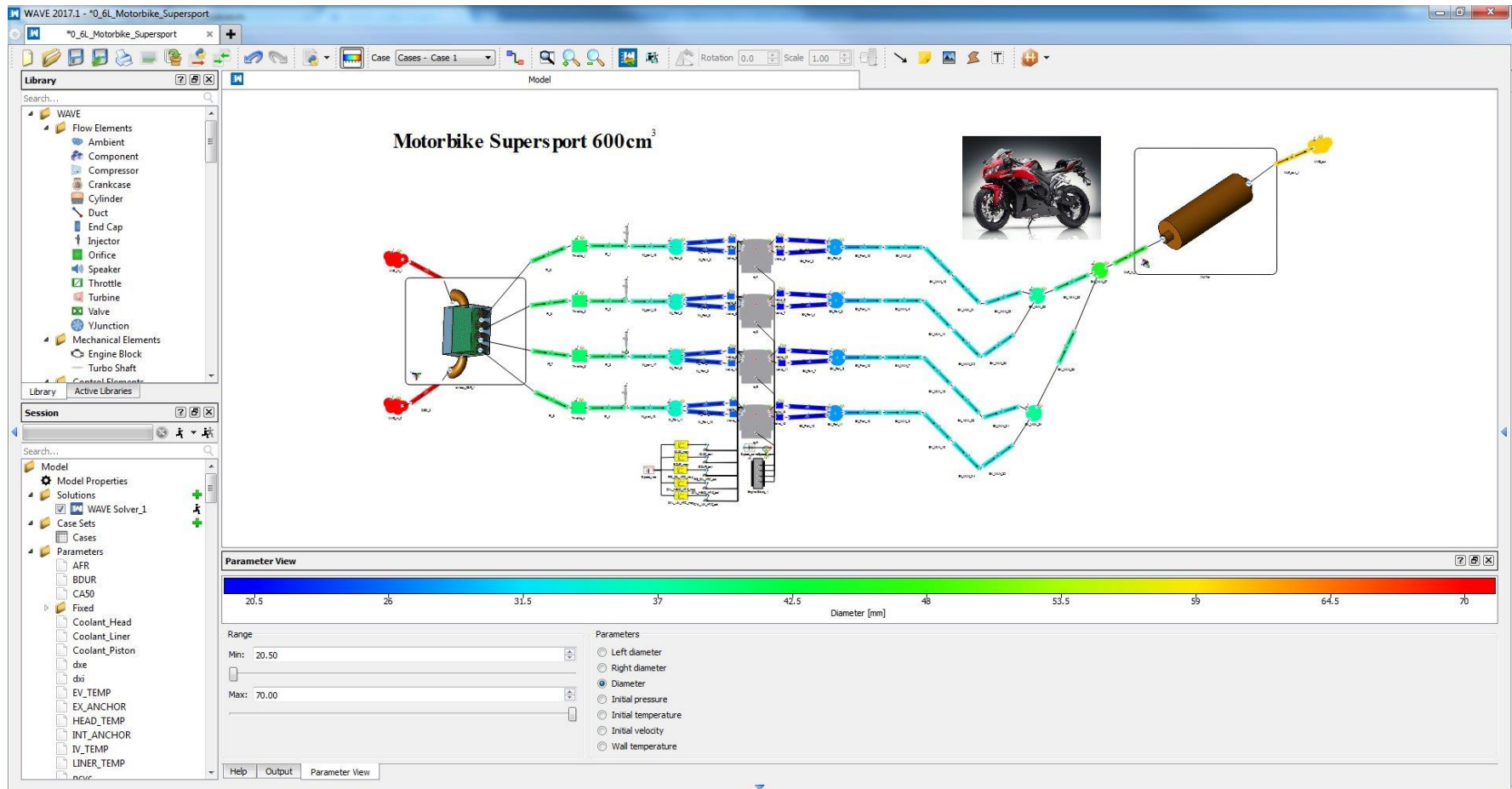


Click on the picture to Play



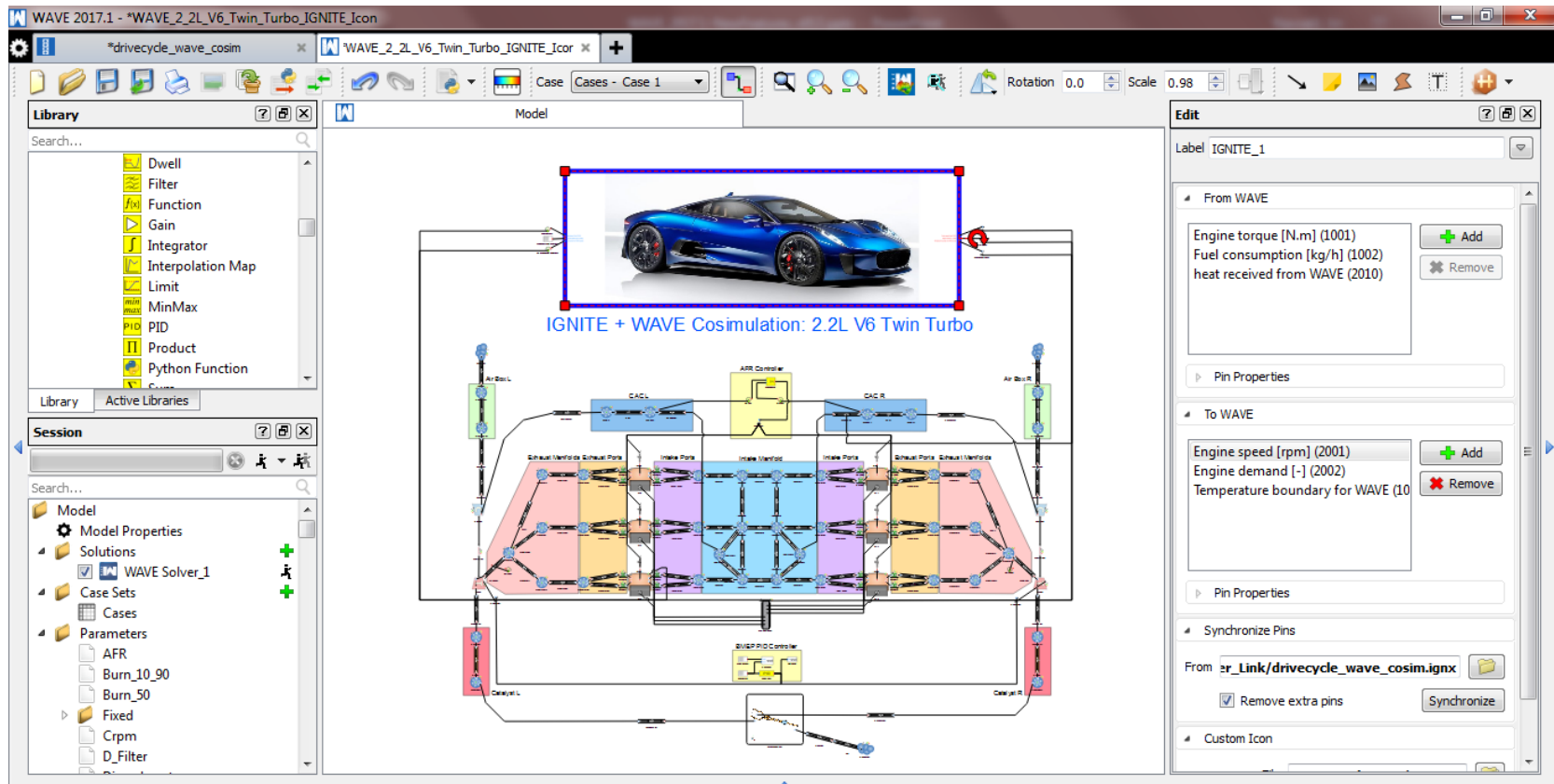
Parameter View with Gradient Scale

usability





-



Real-Time SI Predictive Combustion Model

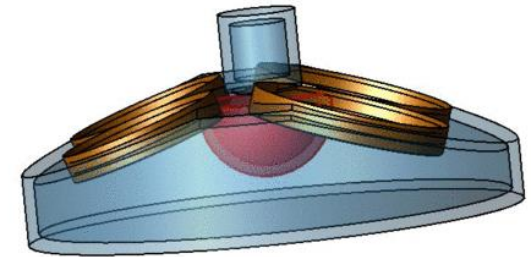
usability and capability



- **Real-Time SI Predictive Combustion Model in WAVE-RT**

- 2-zone Combustion
- Laminar and Turbulent flame front propagation
- Sensitivity to in-cylinder state
 - Pressure, Temperature
 - Lambda
 - Residuals (EGR)
 - Fuel type

Flame Propagation

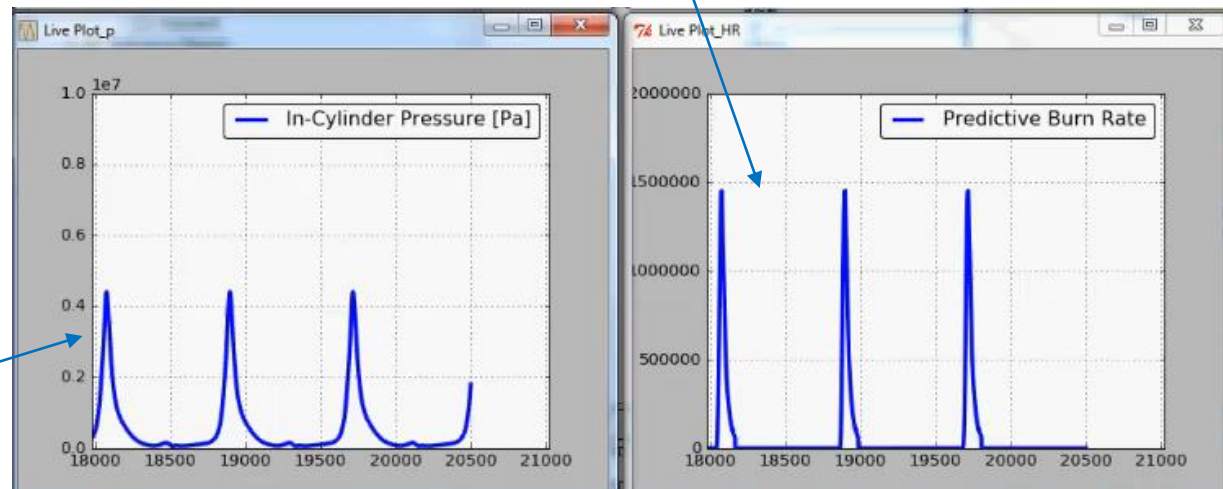


- **Knocking Model**

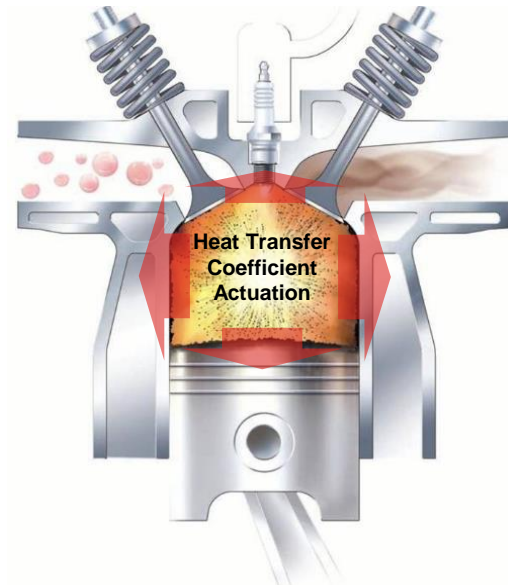
- Octane Number

Predictive Combustion

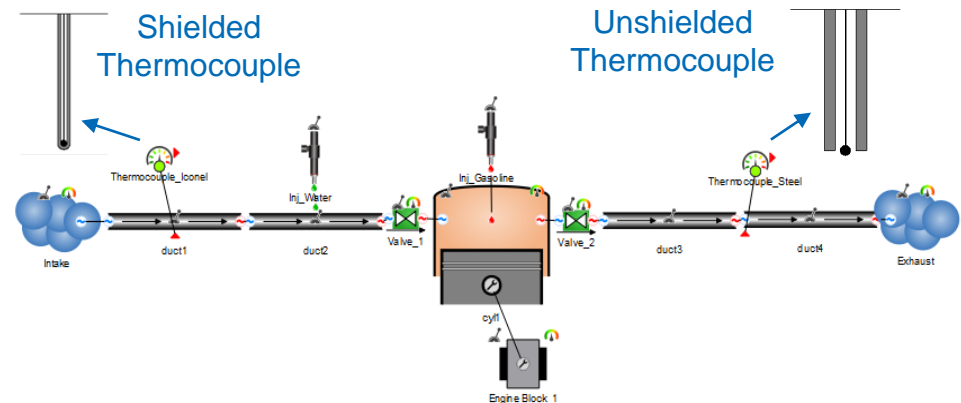
In-Cylinder Pressure



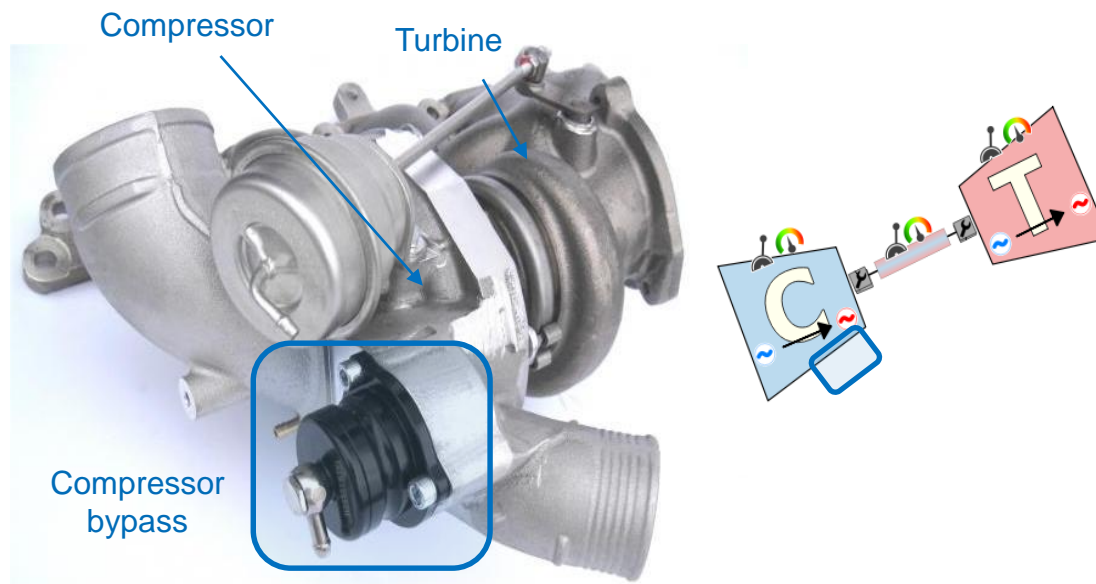
- Heat Transfer Coefficient Actuator
 - Available for Cylinders and Crankcase



- Multiple Thermocouples Types



- Integrated Compressor Bypass
 - Both WAVE and WAVE-RT



- New Compressor Surge model for Twin Turbochargers

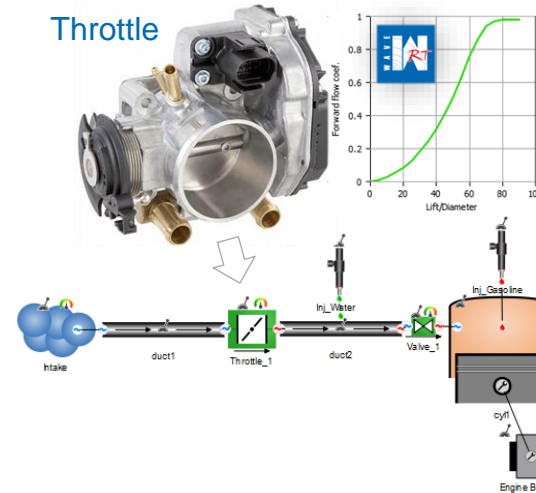
WAVE-RT Enhancements

usability and capability



- Throttle Support
- Multiple Thermocouples Types
- New Sensors and Actuators
 - Instantaneous
 - Summary Sensors

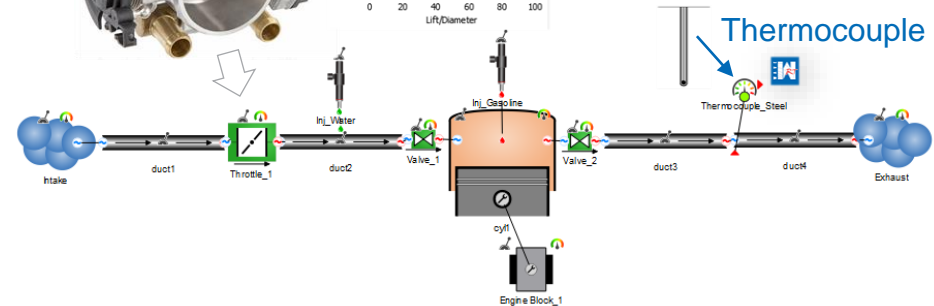
Throttle



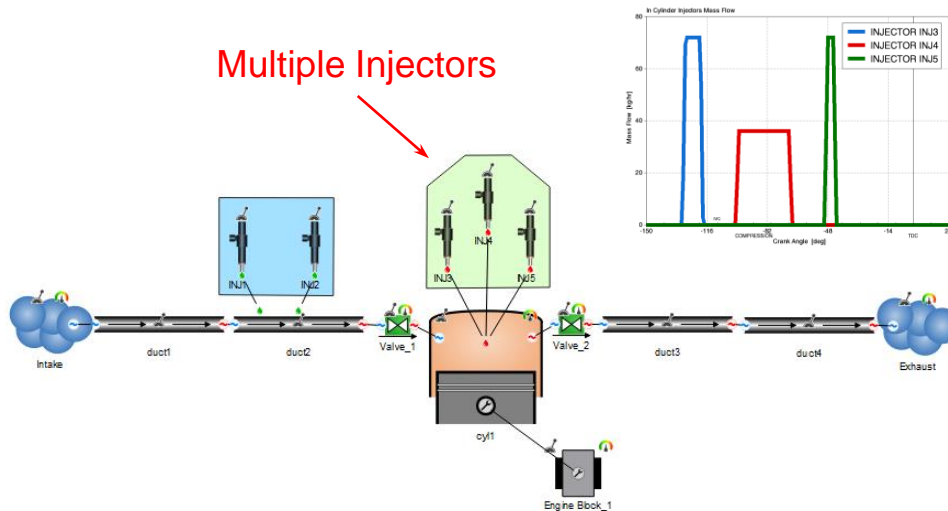
WAVE-RT Throttle:

- Geometry
- Flow Coefficients

Thermocouple



Multiple Injectors

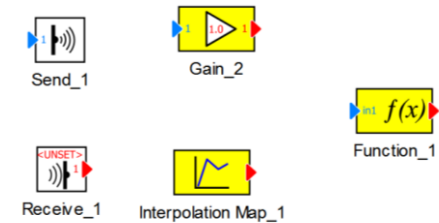
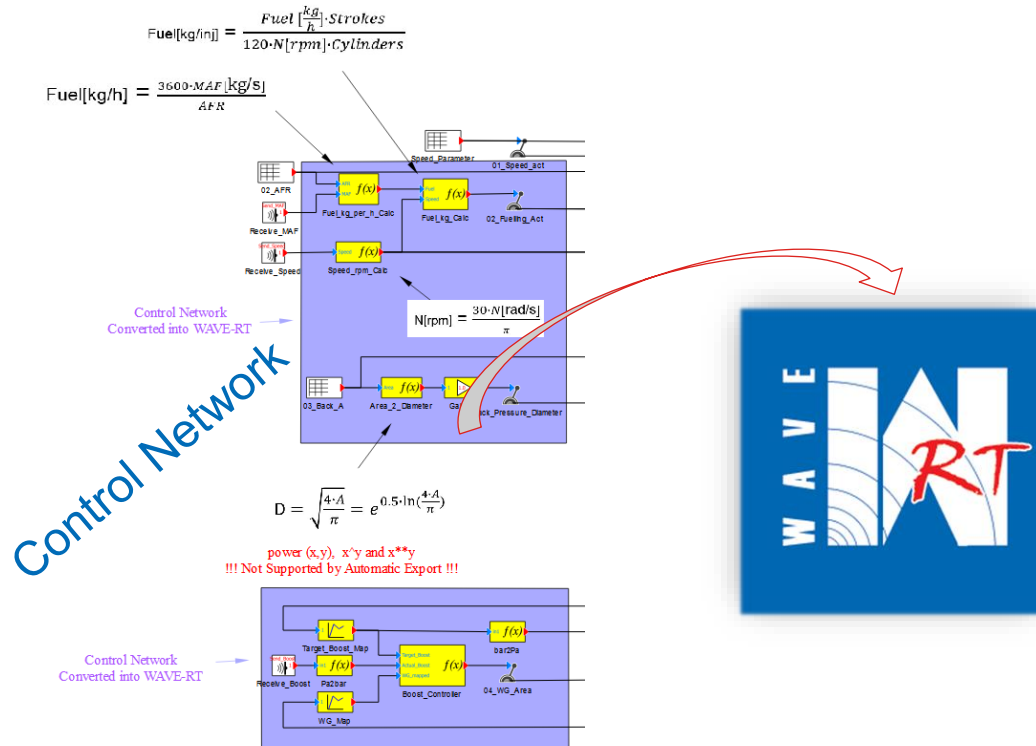


- Multiple Injectors per cylinder
- State of Art Direct Gas Property calculation
- Python script Model Export / Import of models

usability



- Automatic Control Network Export



- More Control Elements Exported

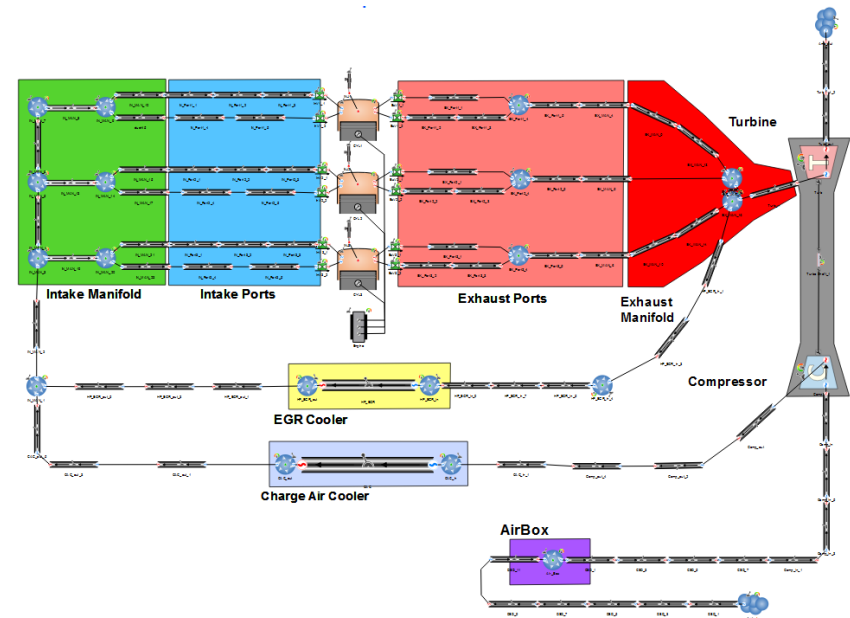
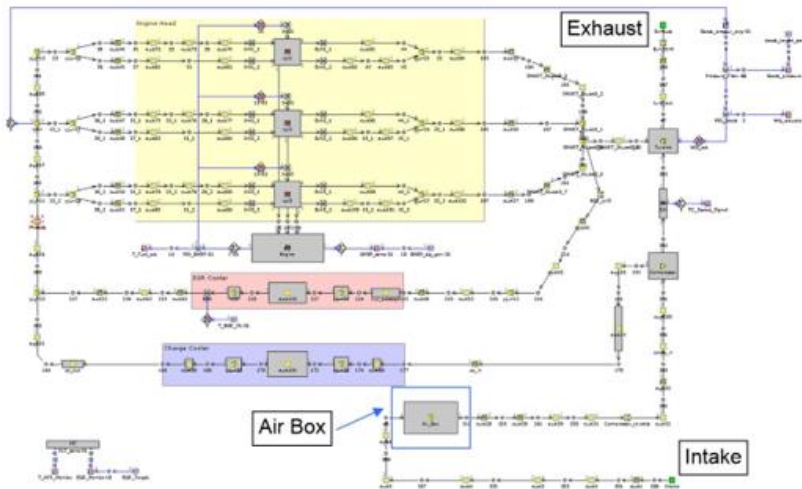
- Function, Gain
- Interpolation Map
- Send, Receive

GT-Power Interface

usability and flexibility



- New GT-Power Importer
 - Fuel files
 - TC maps
 - Interpolation maps
 - Structure Conduction
 - Profiles



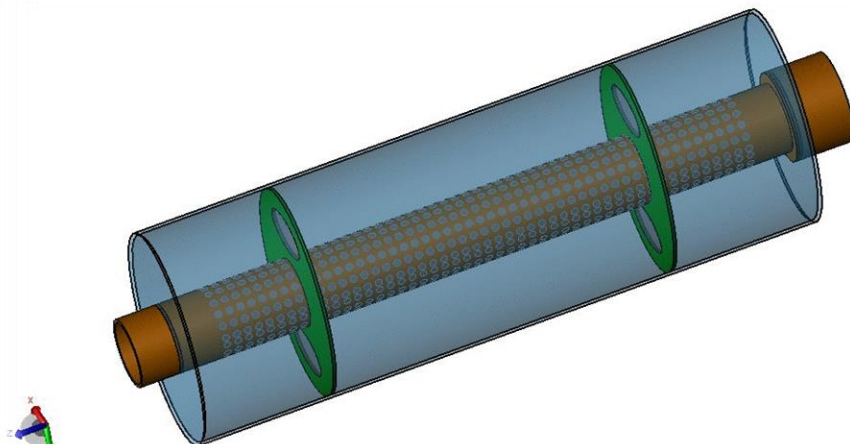
- WavePost reads GTP summary results file

Acoustic Optimization

usability

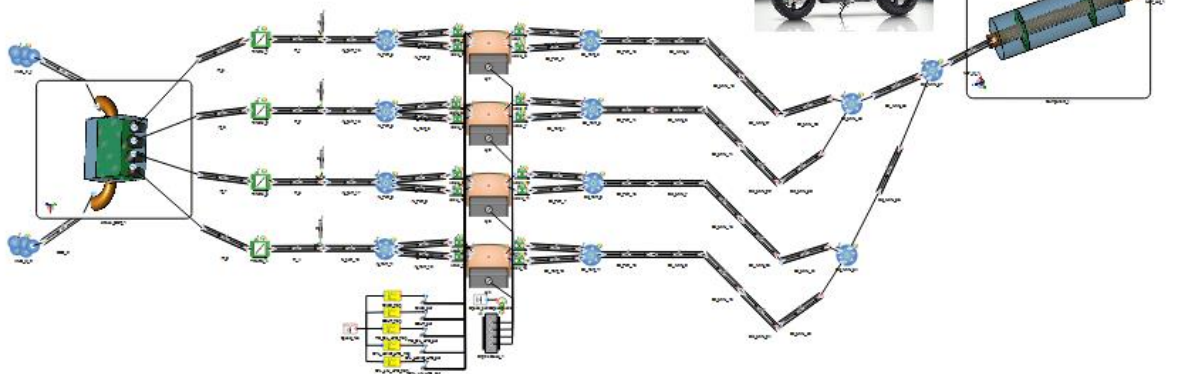


- WaveBuild3D Components Parameterization
- Automatic Export to HEEDS



Motorbike Supersport 600cm³

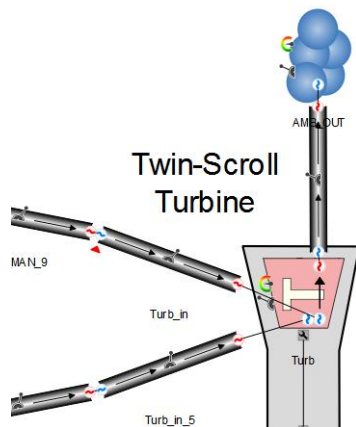
Acoustic optimization of the rear muffler using HEEDS Plugin



Run Slide Show to perform an animation

Twin Scroll Turbine

- 3 Maps
 - Scroll 1
 - Scroll 2
 - Cross Flow



usability



Turbine Data Outputs

General

Turbine type Twin scroll

Configuration

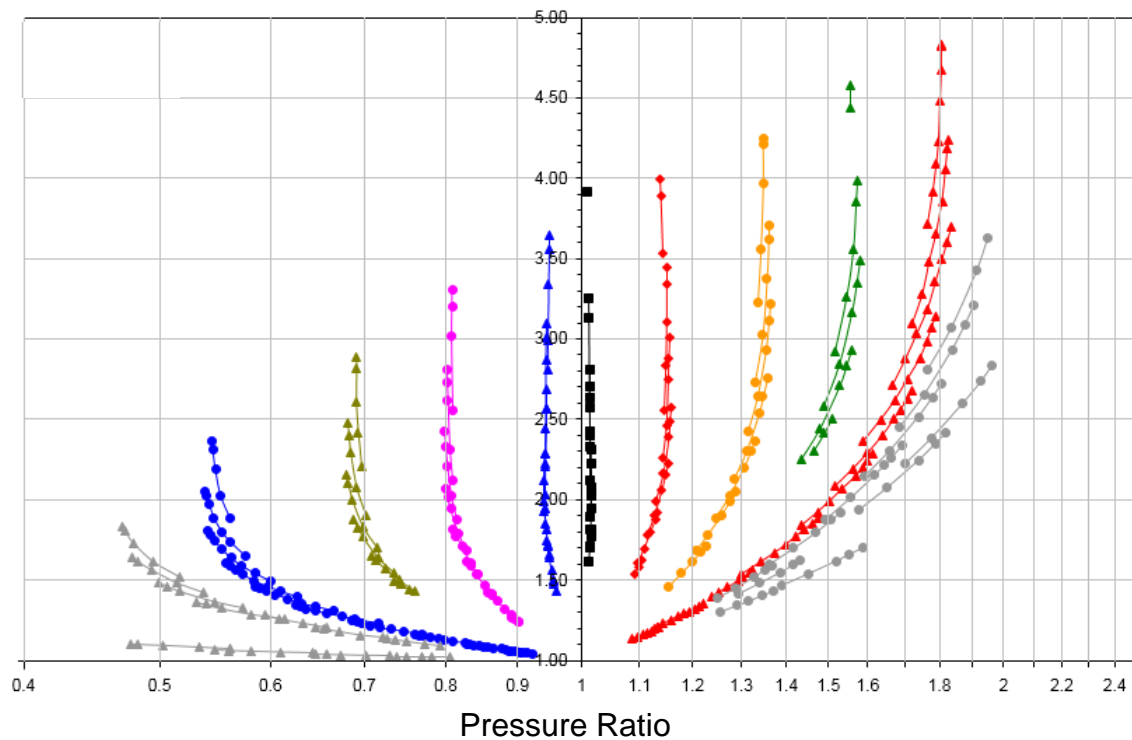
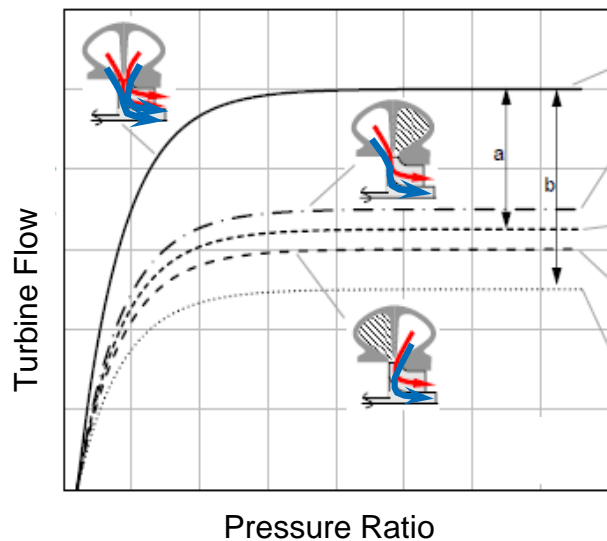
Wastegate ☒

Wastegate open area awaste

Scroll 1 Map file scroll1.trb

Scroll 2 Map file scroll2.trb

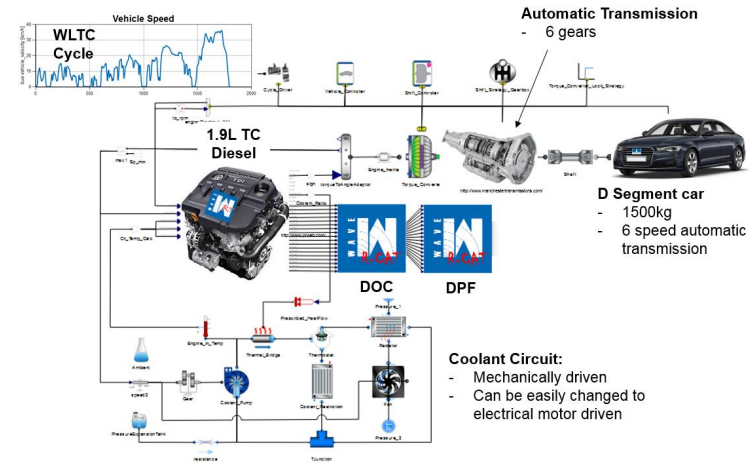
Flow Interaction Map file interaction_map.trb



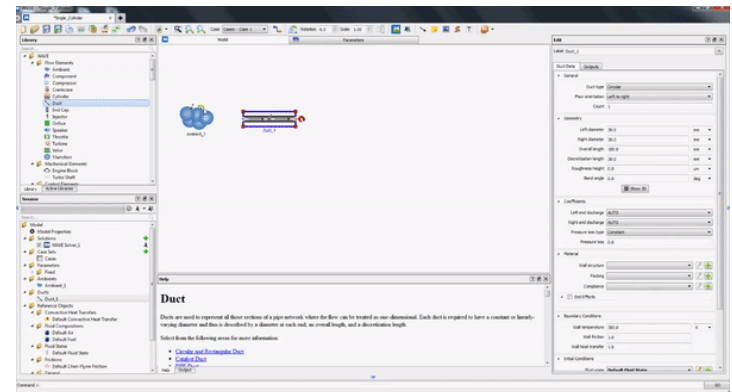
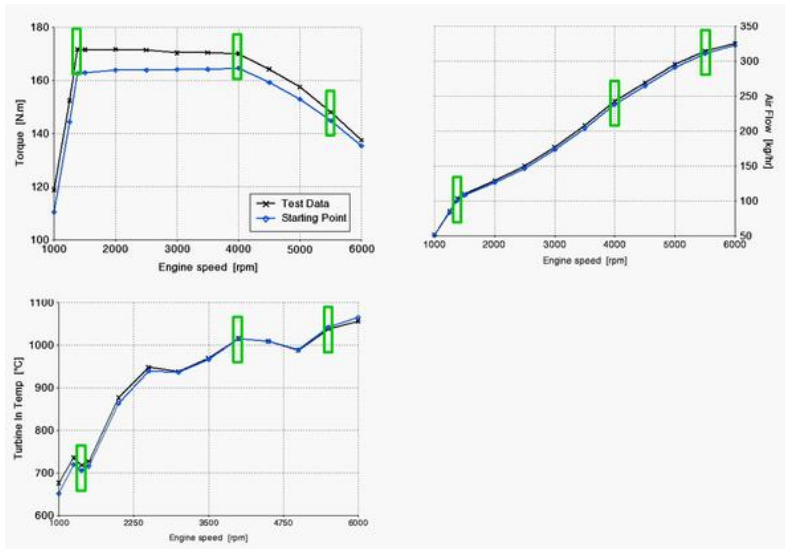
New Tutorials

- Acoustic Optimization of WB3D Components
- WAVE-VALDYN stop-start co-simulation
- Python Script Model Export & Import
- Ideal Y-Junctions Connections modelling study
- GT-Power Geometry Model Import

documentation

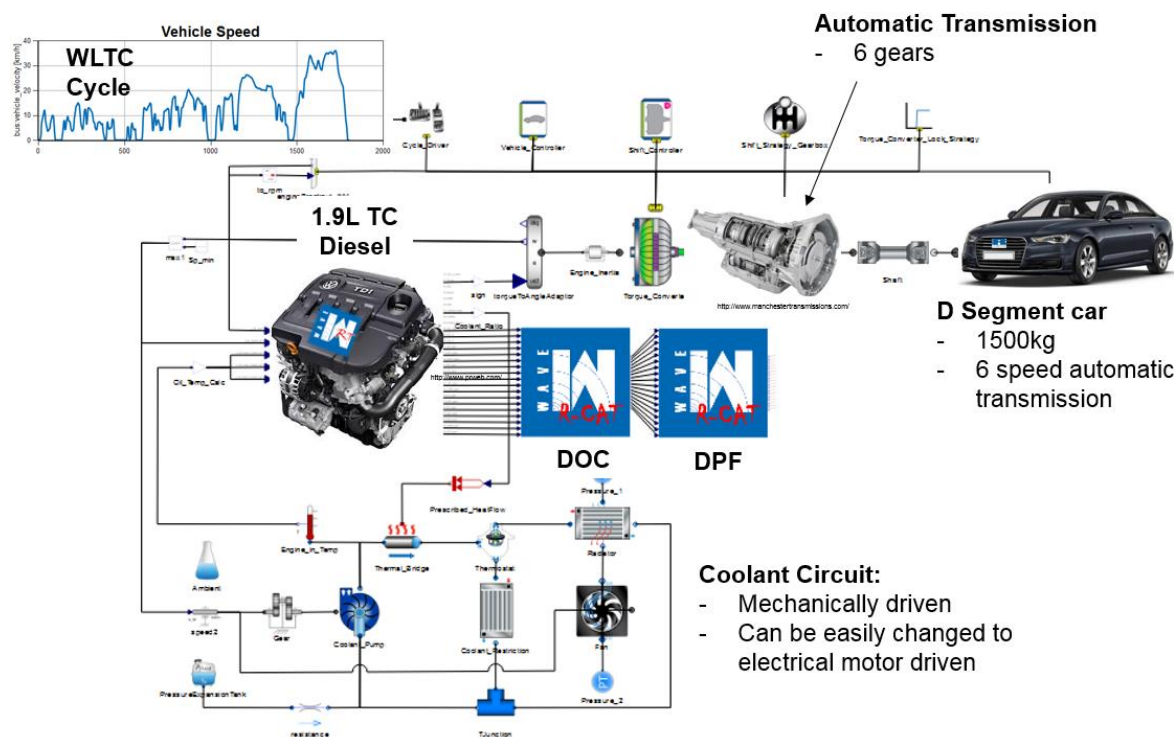


- Model Calibration - Curve Fitting
- Gasoline Engine Model in R-Desk Video Tutorial

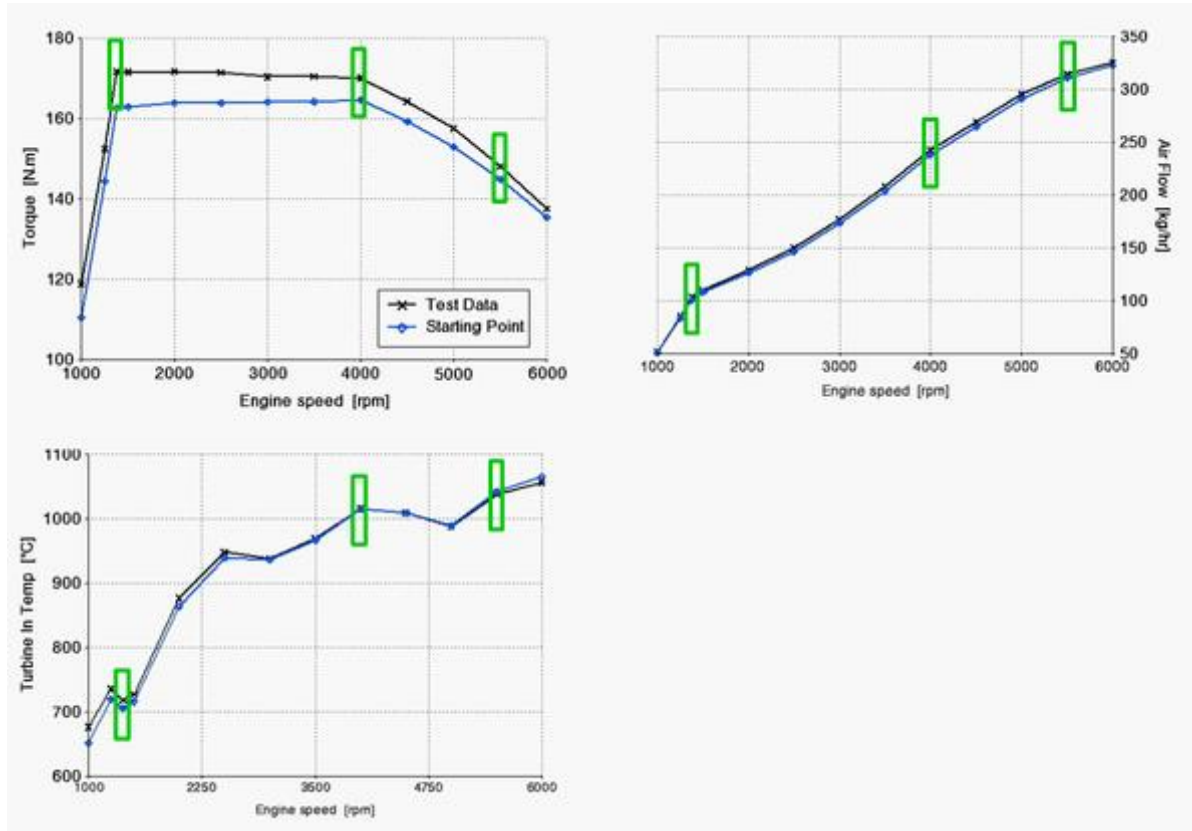


- Cold Start Example
 - IGNITE
 - WAVE-RT
 - R-CAT Chemical Kinetics Aftertreatment

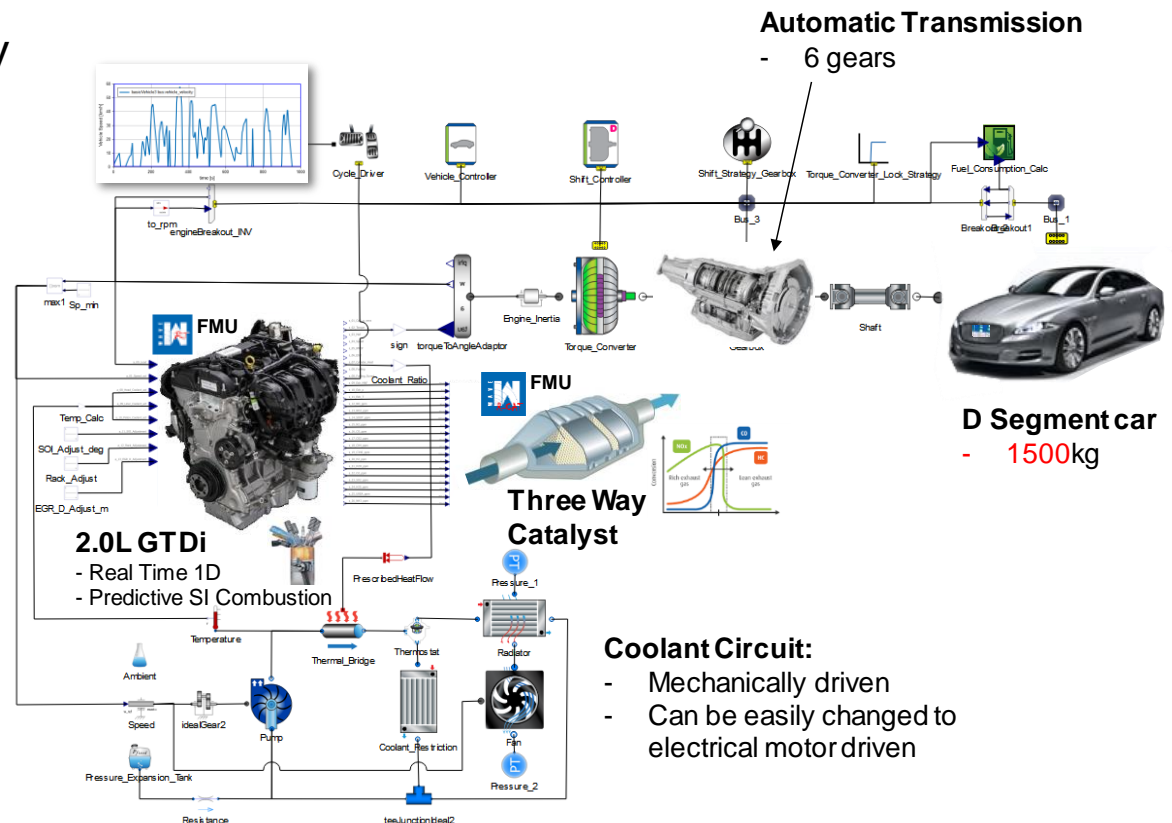
!! Runs Real-Time !!



- Model Calibration Example
 - Automatic Curve Fitting
 - Using HEEDS Plugin



-

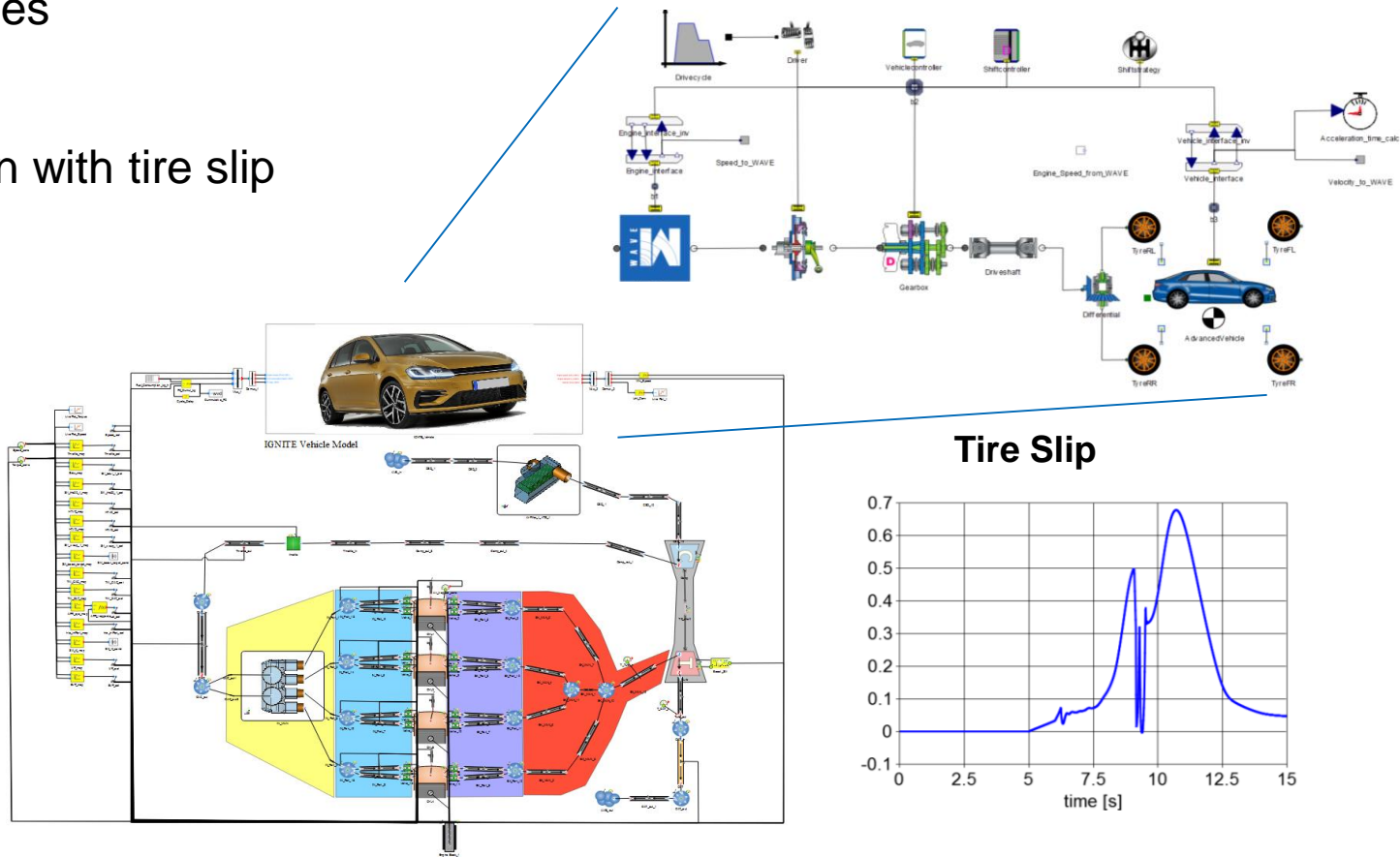


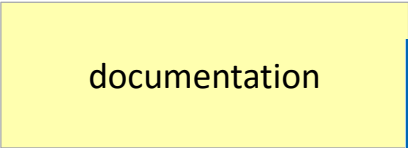
WAVE: Driveline Examples

documentation



- WAVE + IGNITE
- Driving cycles
- Acceleration with tire slip





documentation



- WAVE
 - Blow-by with Crank Case Ventilation controlled by PCV Valve
 - Minimum and Maximum sensor value using Python Function
 - Transient acoustic model with Exhaust Speaker allowing to produce user defined sounds within model geometry

- WAVE-RT
 - WAVE-RT & IGNITE Diesel Engine Cold Start with Chemical Kinetics DOC and DPF model
 - WAVE-RT SiL (Software in the Loop) of Diesel and SI with knocking turbocharged engines
 - User Defined EGR Sensor
 - WAVE-RT Duct Length and Volume Actuation
 - Simple Heat Exchanger Model in both WAVE and WAVE-RT
 - Intake Sound Generator model allowing cabin sound prediction and development