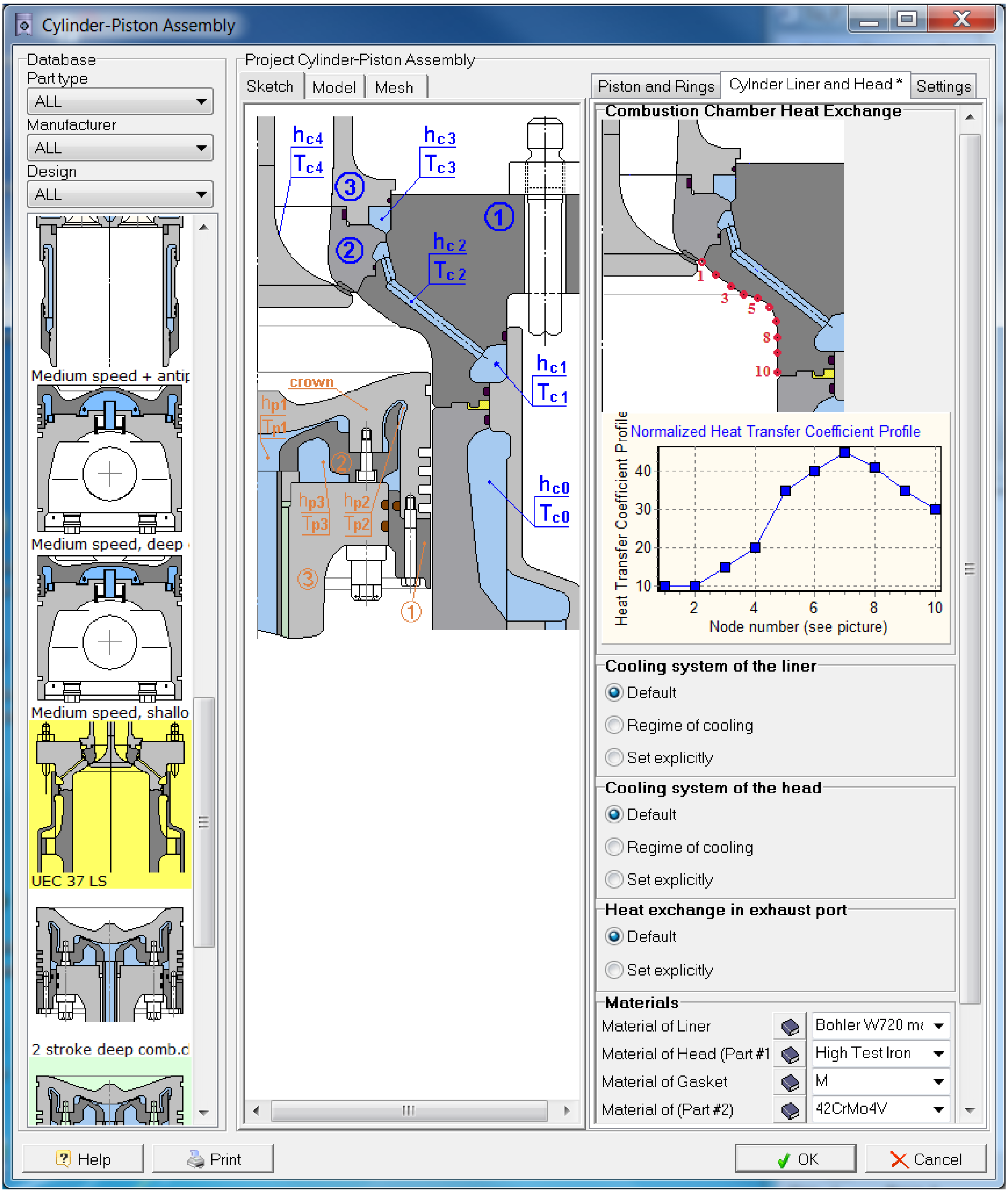
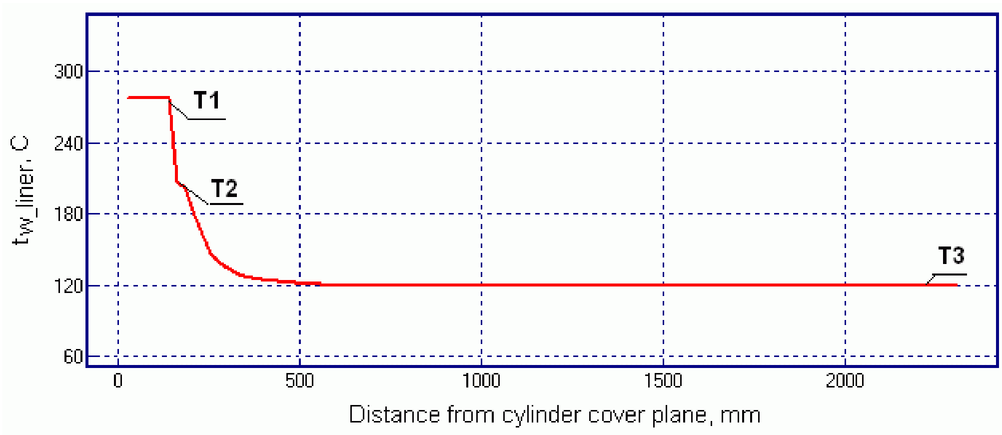
Newest capabilities of DIESEL-RK
(2017)

1. Parallel simulation of engine working processes (turbocharging, gasexchange, mixture formation, combustion, emissions formation) and Finite Element Analysis (FEA) of temperature state of engine parts. FEA analysis has advanced interface: user can select design of cylinder liner, head and piston from data bases, combine them using easy drag'n'drop technique and assign materials of main parts in assembly (see figures below).

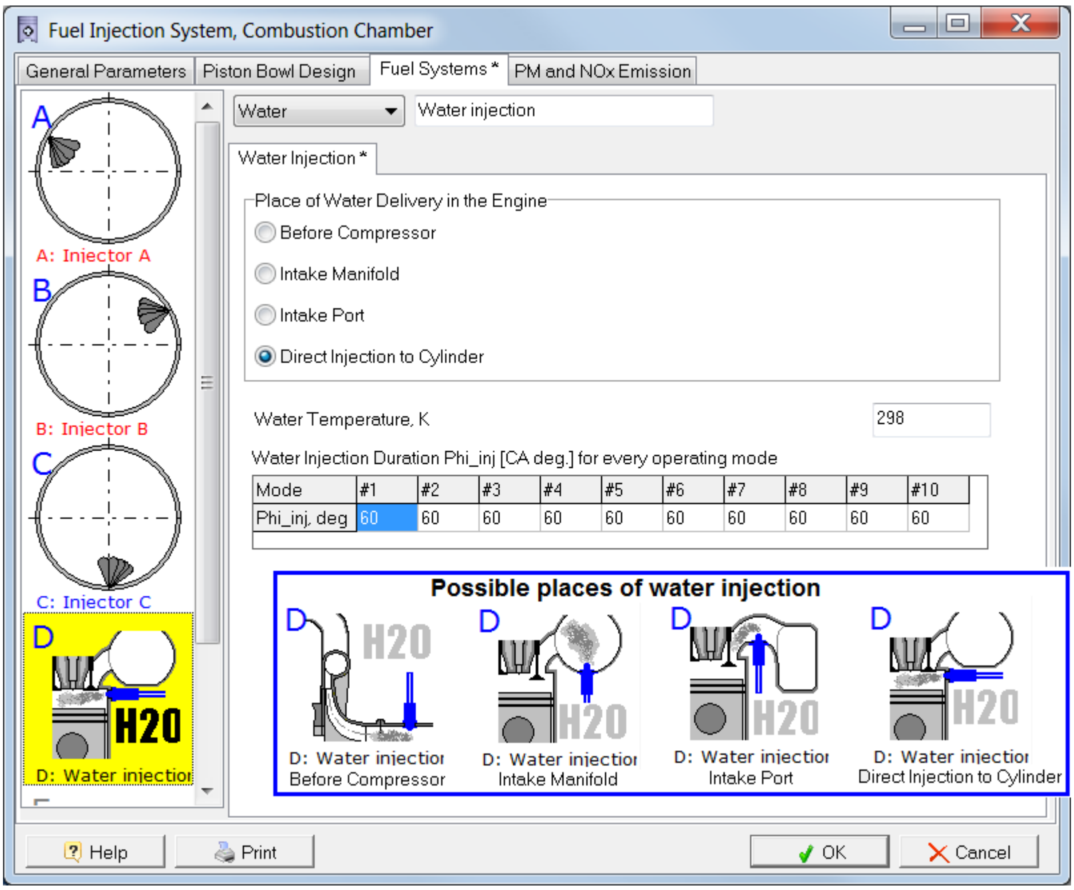


This function allows accurate simulation of heat exchange during intake and scavenging because allows prediction temperature field of long cylinder liner and place where piston is in TDC.
The typical approximation of the Cylinder Liner Temperature obtained for large marine two-stroke engine is presented below.

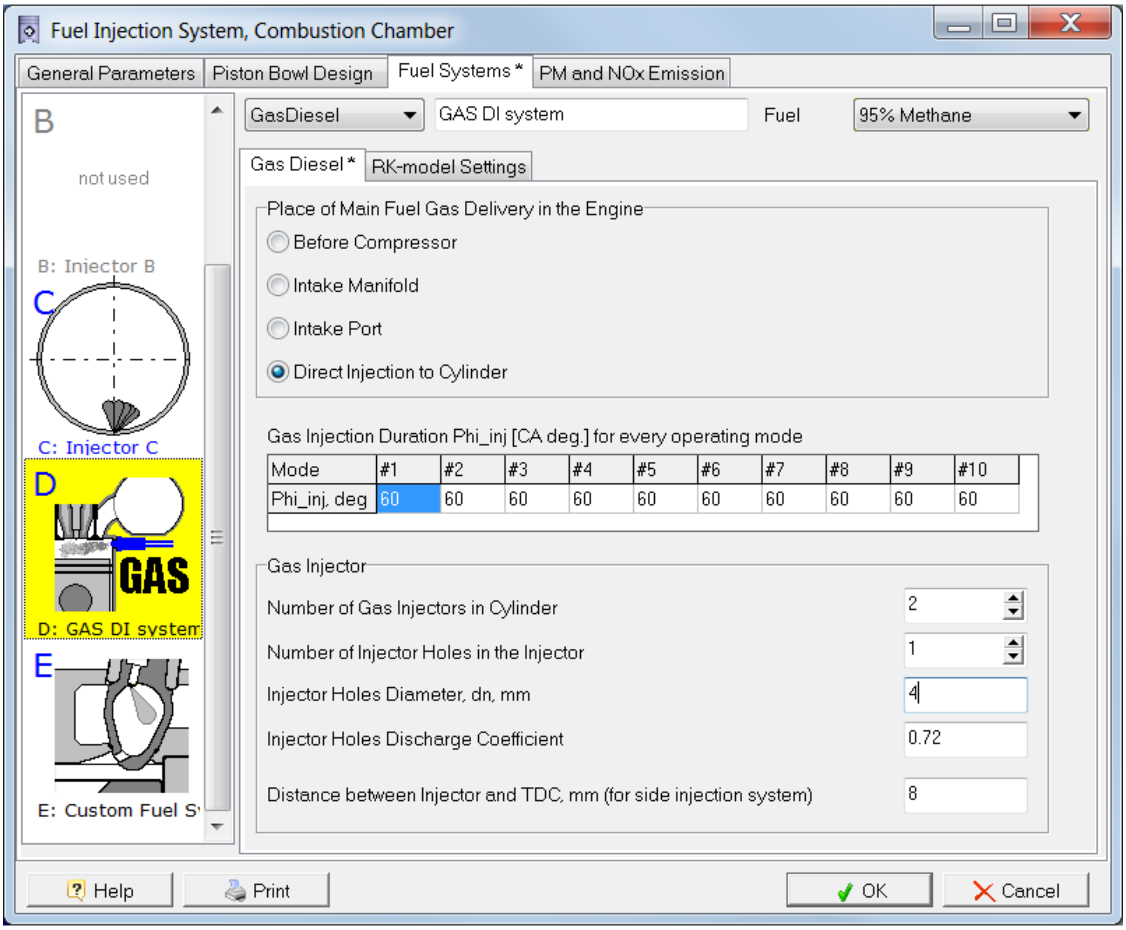


Correct temperature field of engine parts allows right simulation of gas flow at gasexchange and evaporation in the zones where the fuel spray impinges the wall. Program will scale the assembly for actual engine D/S, implement the actual piston bowl into piston crown, make a grid and will perform simulation – everything automatically.
In result, together with engine cycle parameters there temperature fields and critical temperatures of piston rings and all surfaces are outputted.

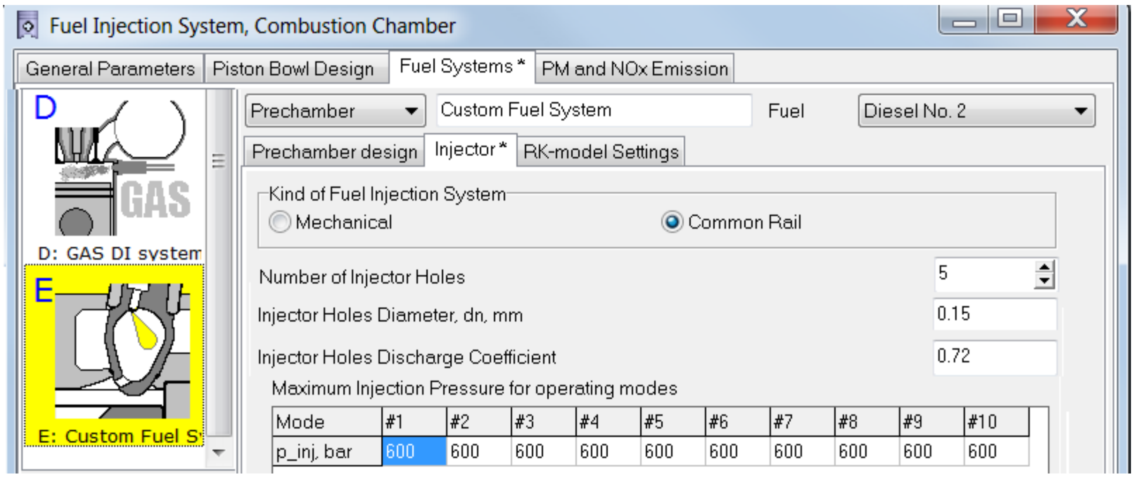
2. Simulation of engine with few (up to 5) independent fuel injection systems including Gas and Water injection system. Injection systems are marked by indexes A, B, C, D and E. Any system may be intended for delivery Liquid fuel, Gas or Water. Gas and Water may be injected into different places. Condensation of water from ambient air is accounted as well.

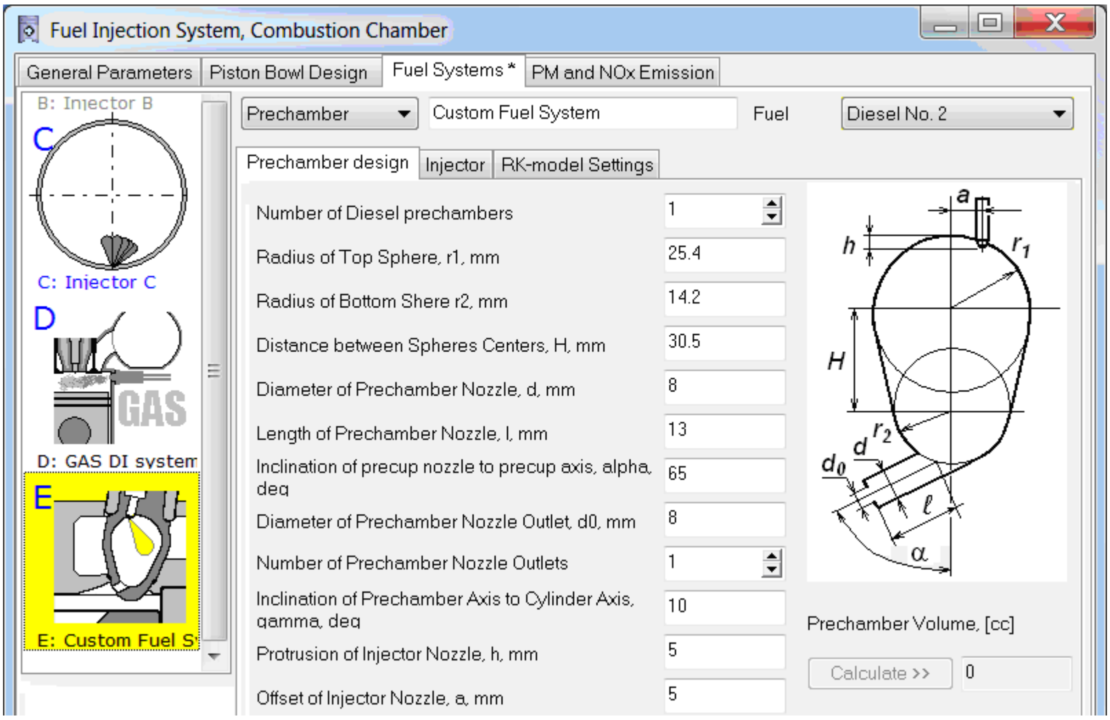


In the Gas engine with ignition by diesel oil the delivery of Gas is possible to be simulated in: Intake Manifold; Intake Port; before Compressor and Directly into Cylinder, as injection of water in above picture. Ignition of Gas is possible to be simulated as by DI of diesel oil, as by diesel injection into Pre-chamber.

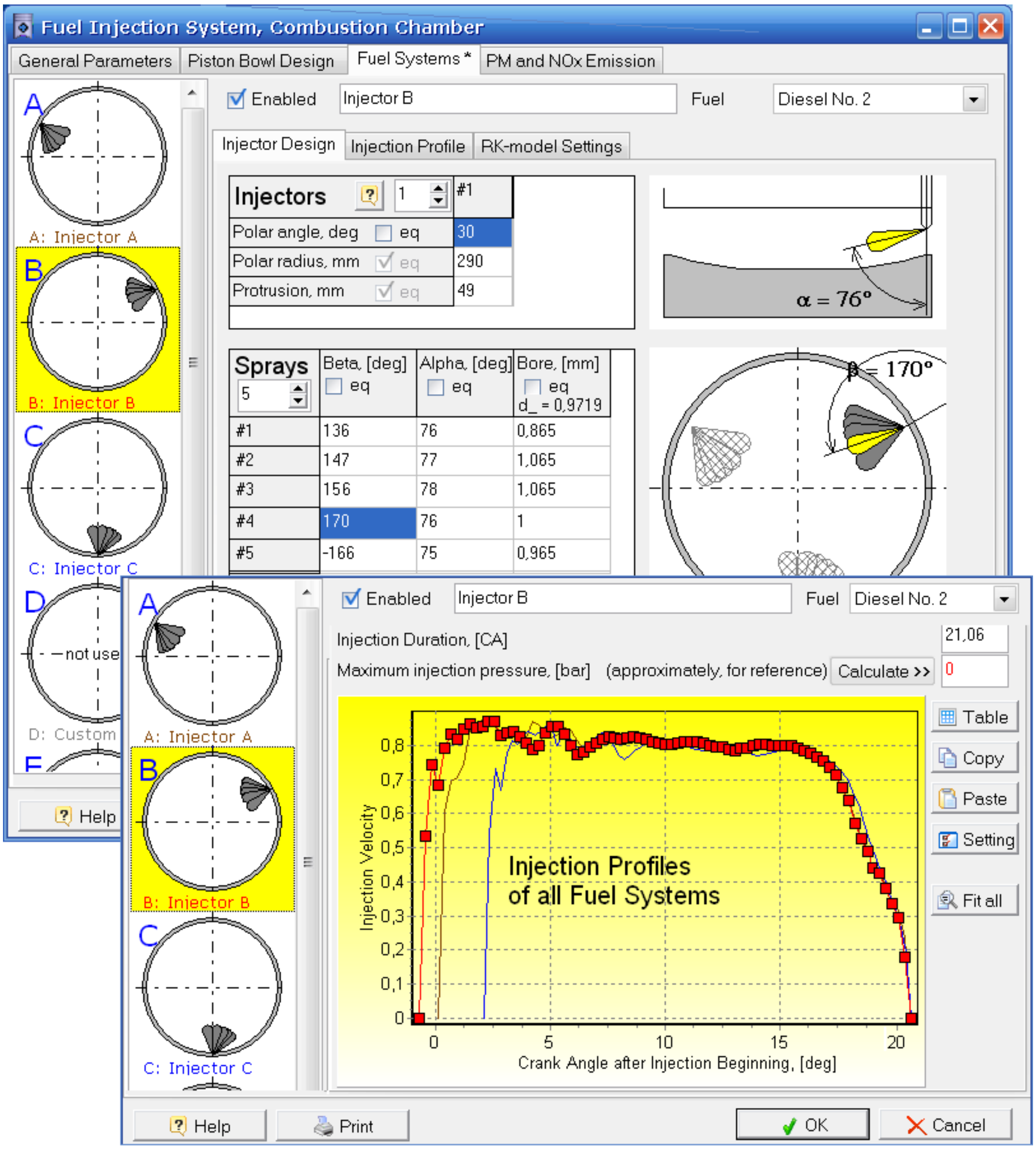


If the engine has Pre-chamber, then it is necessary to set it geometry and specification of diesel oil injection system (pictures below). Cycle fuel mass of gas, diesel oil and water and their injection timing are specified in general table of engine regime parameters.

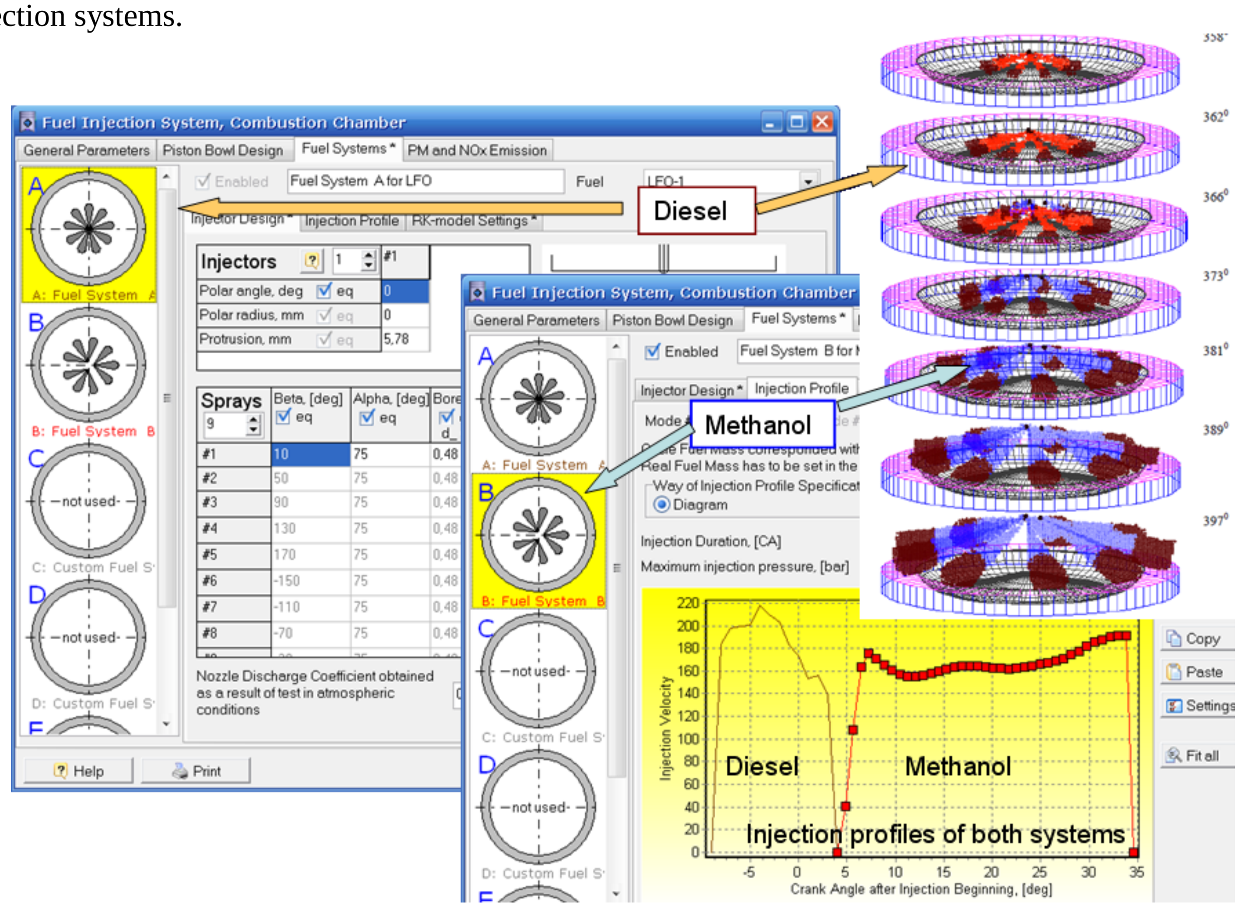




If the engine has few DI diesel system it is possible to set own design and own injection profile for every system.

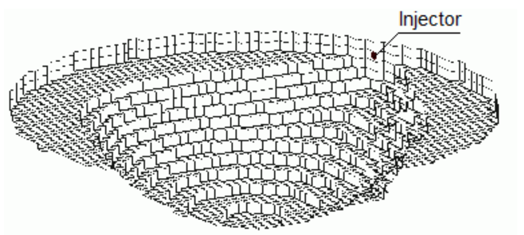


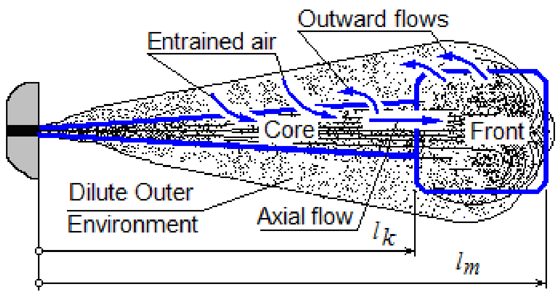
3. Simulation of Dual Fuel engine. This feature is realized if different fuels are specified for fuel injection systems.



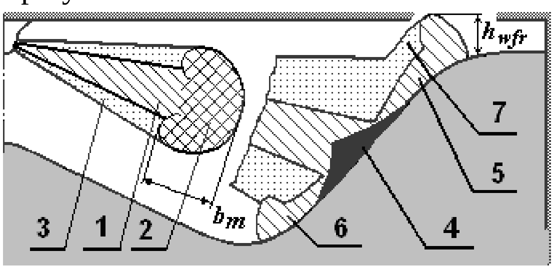
4. Simulation of spatial fuel sprays intersection. 3D mesh is used for sprays shape interpretation and piston bowl shape interpretation. Gas flows inside and around of the sprays are simulated using equation of momentum conservation. It is non-CFD simulation: balance equations are resolved for clusters of cells but not in each cell. <u>Computational time is 1 … 2 min</u> on conventional PC.

In cylinder 3D mesh of OP engine at TDC





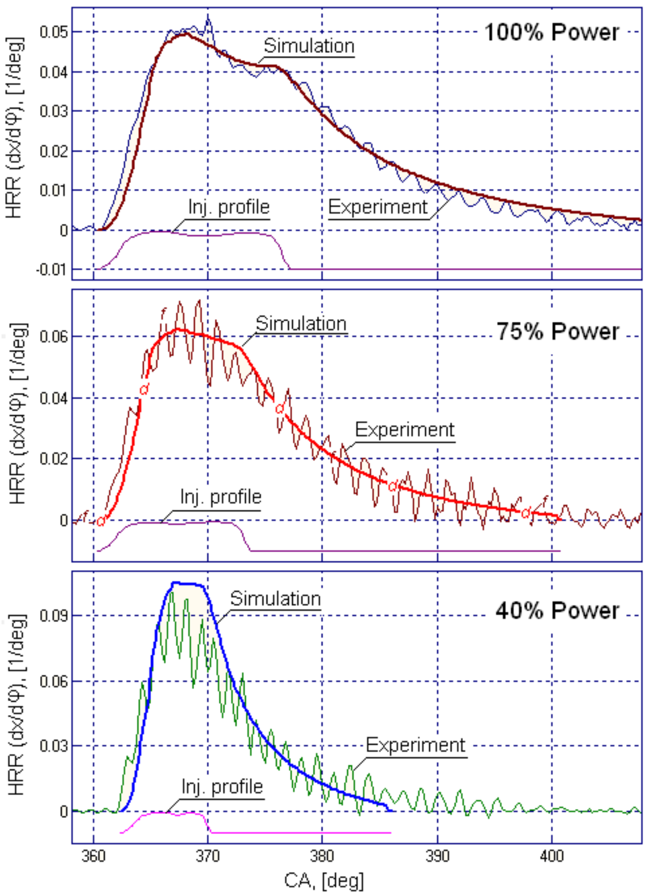
Sprays are divided into 11 characteristic zones.

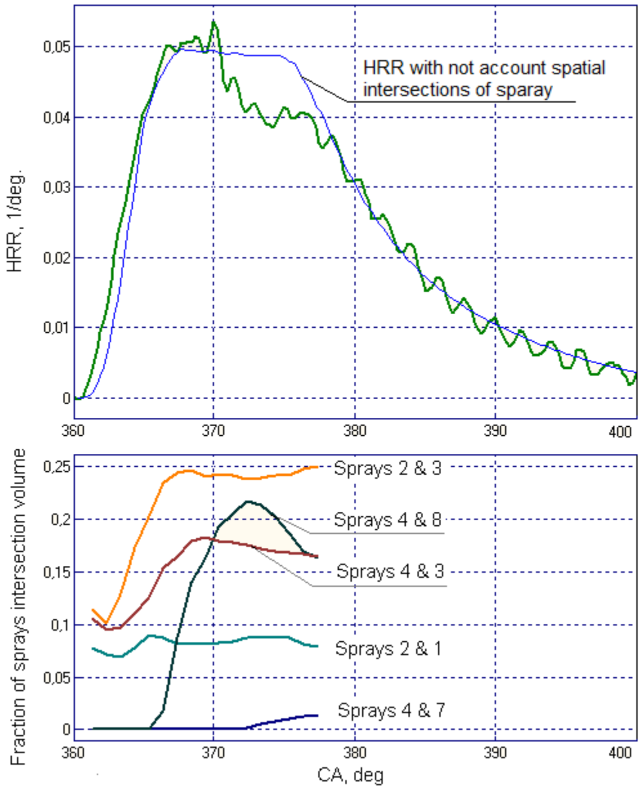


1. The dense conical core of free spray;
2. The dense forward front of free spray;
3. The dilute outer sleeve of free spray.
4. The axial conical core of the Near Wall Flow;
5. The dense core of the Near Wall Flow on the piston bowl surface;
6. The dense forward front of the Near Wall Flow;
7. The dilute outer zone of the Near Wall Flow;
8. Zone on the cylinder liner surface if fuel reaches it.
9. Zone on the cylinder head if fuel reaches it.
10. Zone of Near Wall Flow overlap.
11. Zone of sprays spatial overlap.

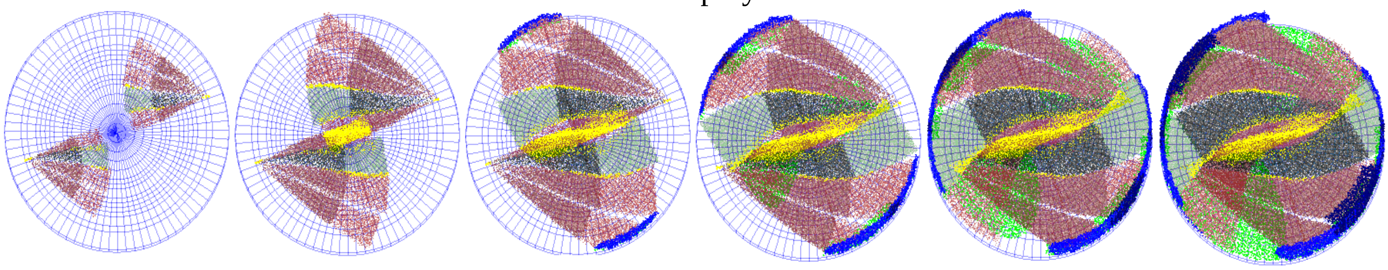
Each zone has own character temperatures dependent on time and own conditions of evaporation.

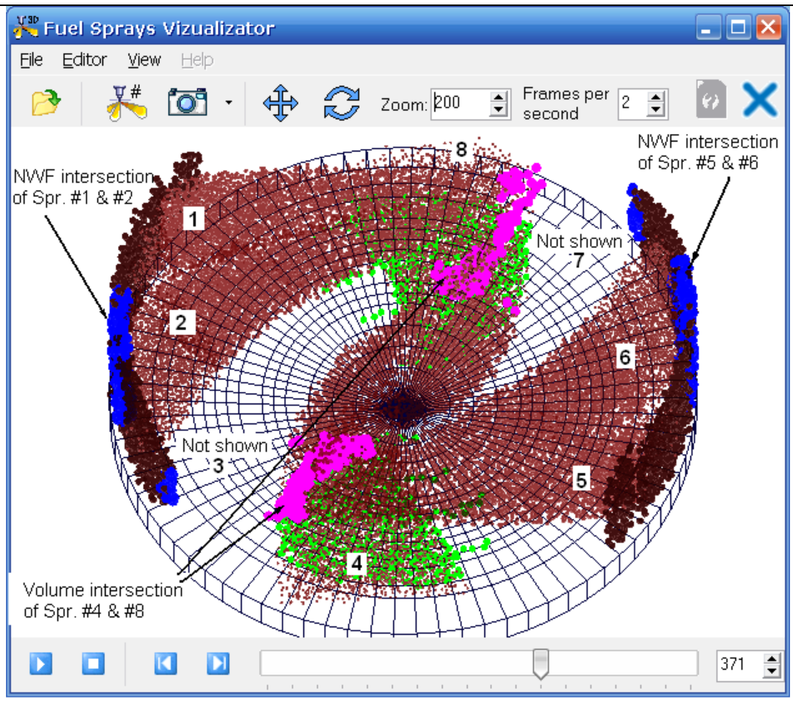
Account of spatial sprays intersection allows simulation of character decrease of heat release rate after middle of injection at large load.





The diagrams show most massive overlap of sprays





Evolution of sprays from 2 injectors in cylinder of 2 stroke large marine engine with side injection system. (One inner spray is marked by green bullets to separate inner and outer sprays. Light Green bullets are Near Wall Flow (NWF) on piston; Blue bullets are NWF on cylinder wall. Dark Blue bullets are NWF overlap.) Yellow bullets on figure indicate zones of sprays spatial intersections. The intersections lead to local decrease of HRR.

Program for 3D Fuel Spray Visualization allows marking of sprays and their zones to analyze sprays overlap and search for solutions to minimize the overlapping.