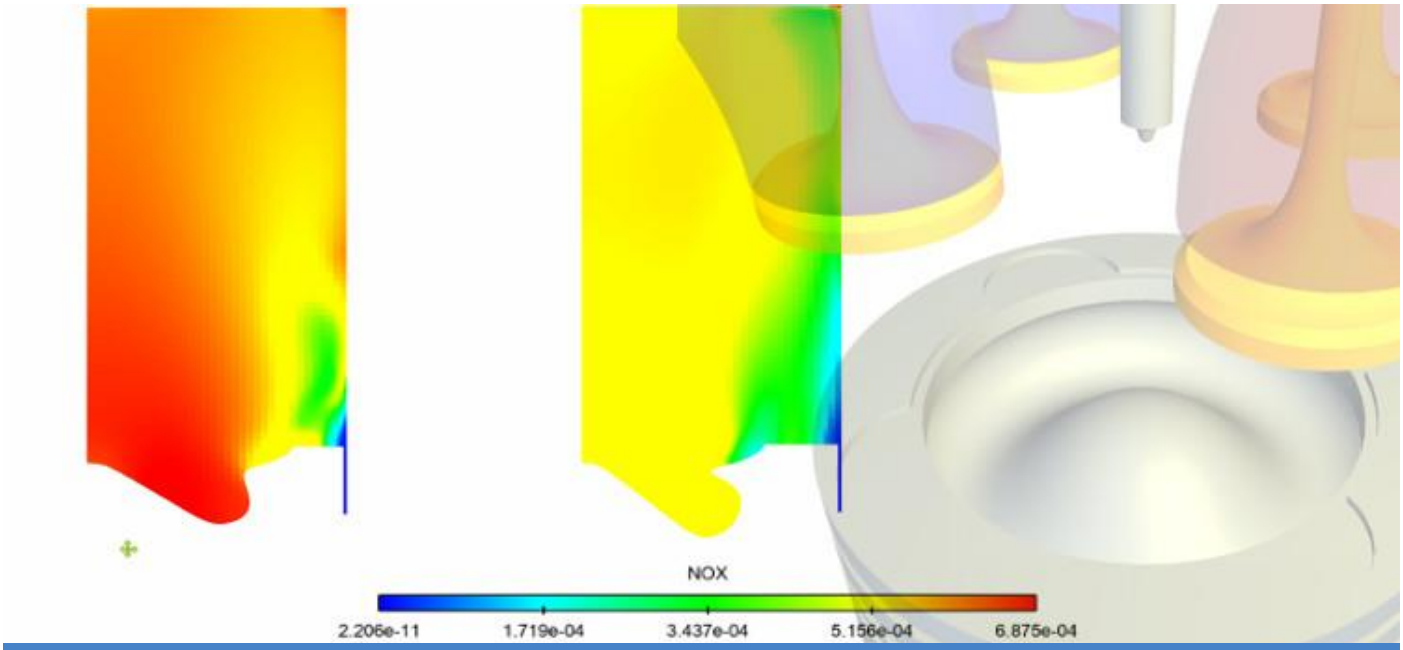
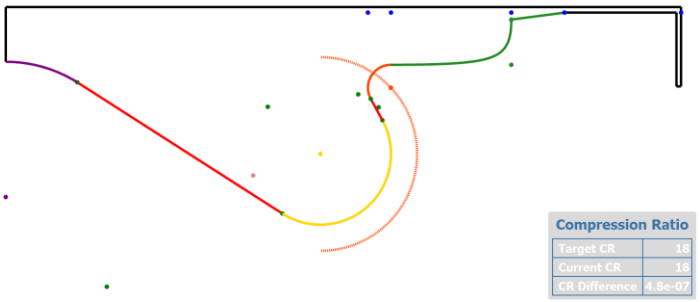



**TECH BRIEF**

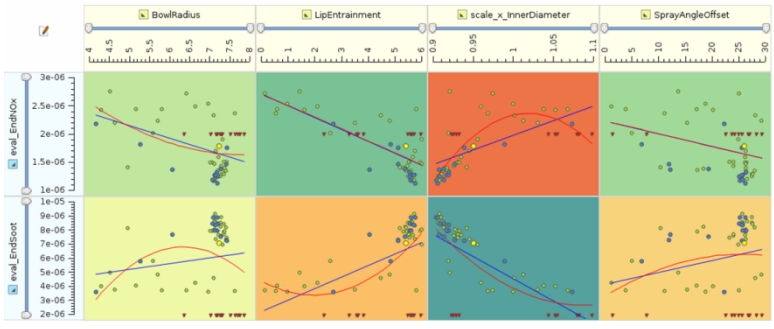
# PISTON BOWL DESIGN WITH CONVERGE CFD

A piston bowl is a recess in the piston crown primarily used in (direct injection) Diesel engines, where it basically forms the combustion chamber. The shape of the piston bowl influences the movement of air and fuel during the compression stroke, thereby affecting the air/fuel mixture. A good mixture leads to a more efficient combustion, resulting in more power or better fuel economy. Additionally, using an effective piston bowl shape can reduce the in-cylinder emissions (like NOx and soot) and the cost for after-treatment.




*Parametric 2D contour of piston bowl in CAESES:*
*The compression ratio is kept constant automatically for each new design*

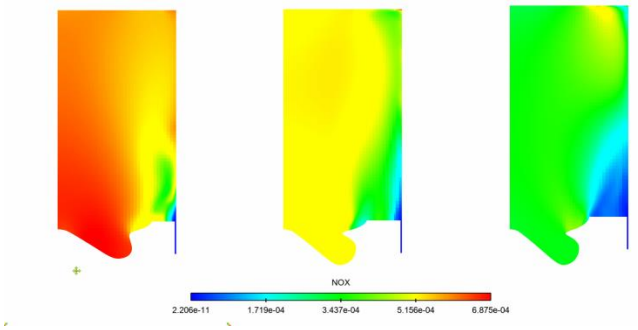
CAESES® has been effectively used to design and optimize state-of-the-art piston bowls.
It brings along several key capabilities for this specific task.




*Conduct piston bowl optimizations in CAESES*

## COUPLING TO CONVERGE CFD

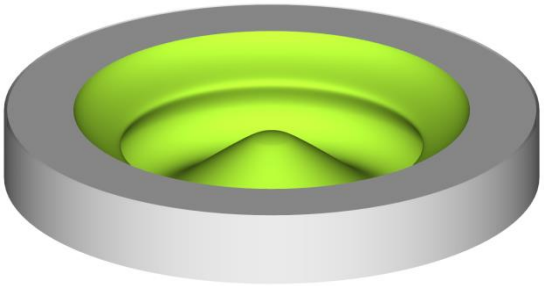
CONVERGE can be coupled to CAESES® and automated using the integrated software connector. A sector of the geometry is usually cut according to the number of nozzles and exported in a special format for CONVERGE CFD ("surface.dat"), including individual IDs for the identification of the different patches.




*Corresponding NOx distributions for different piston bowl designs*

## FEATURES IN CAESES® FOR PISTON BOWL DESIGN

- Arbitrary profile parameterizations can be used. The design of your specific piston bowl is not limited to certain pre-defined templates, but you are free to model your own custom parameterization. Any curve type can be used, e.g. linear and circular segments and splines.
- The bowl profile can be varied in circumferential direction, allowing for, e.g. "wavy" bowl shapes.
- Robust variation of the bowl geometry is possible with no failed variants. As for other geometries, one of the most important targets of our software is 100% robust geometry variation, obtained by smart parameterization and dependency-based models.



*3D model in CAESES*

- The compression ratio can be automatically adjusted for each geometry variant. This is crucial for making sure that every generated variant has the same compression ratio and not wasting time on infeasible designs. It is done with an internal optimization loop, where the variables for the adjustment can be chosen freely. It is even possible to define an order of precedence, so that the automated adjustment first tries to match the compression ratio with the first given variable. If that doesn't suffice, the next variable is added, and so on.
- Other automated adjustments can be carried out as well, like adjustment of the spray angle in relation to the changing bowl shape.
- The geometry can be exported in several different formats suitable for your CFD/meshing tools. Many of the formats support patch naming, so that the downstream tool can correctly identify surface patches for the assignment of individual mesh settings or boundary conditions.
- A design study on the piston bowl geometry can be combined with an investigation of the injection strategy, or other process parameters (such as fuel composition, EGR amount, etc.). In the software connector interface, users can parameterize and modify any value that goes into the input files or scripts for the CFD solver.