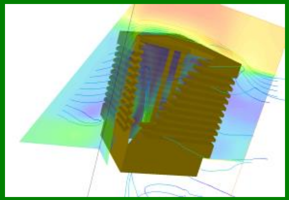

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PHOENICS

An Overview

Overview

- This presentation is intended to be a general overview of PHOENICS, its applications, and how to use it.

PHOENICS Overview

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- PHOENICS is a general-purpose CFD code
- The name PHOENICS is an acronym standing for:

P arabolic
H yperbolic
O r
E lliptic
N umerical
I ntegration
C ode
S eries

PHOENICS Overview

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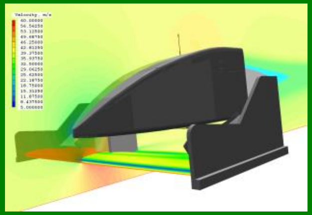
- PHOENICS is based on the finite volume method.
- Domain is discretized into a finite set of control volumes or cells.
- General conservation (transport) equations for mass, momentum, energy, etc. – inflows and outflows in each cell must balance.
- Values of pressure, three velocity components, temperature etc in all the cells are computed by an iterative procedure.
- The distributions of these variables can then be displayed graphically.



Main Features of PHOENICS

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- Cartesian, Polar and Body-Fitted Coordinates
- Cut-cell technique for complex geometry
- Conjugate Heat Transfer
- Single or Multi-Phase Flow
- Particle Tracking
- Chemical reaction
- Radiation
- Non-Newtonian Flow
- Choice of equation solvers and differencing schemes
- “InForm” user programmability
- Automatic convergence control

Main Features of PHOENICS

PHOENICS predicts quantitatively:-

- how fluids (air, water, steam, oil, etc) flow in and around:
  - engines,
  - process equipment,
  - buildings,
  - lakes, river and oceans,
  - and so on;
- the associated changes of chemical and physical composition

PHOENICS Structure

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PHOENICS consists of several modules:

- Pre-processor for setting up problems,
- Solver for solving the problem,
- Post-processor for visualising results; and
- POLIS for providing information.

PHOENICS Structure

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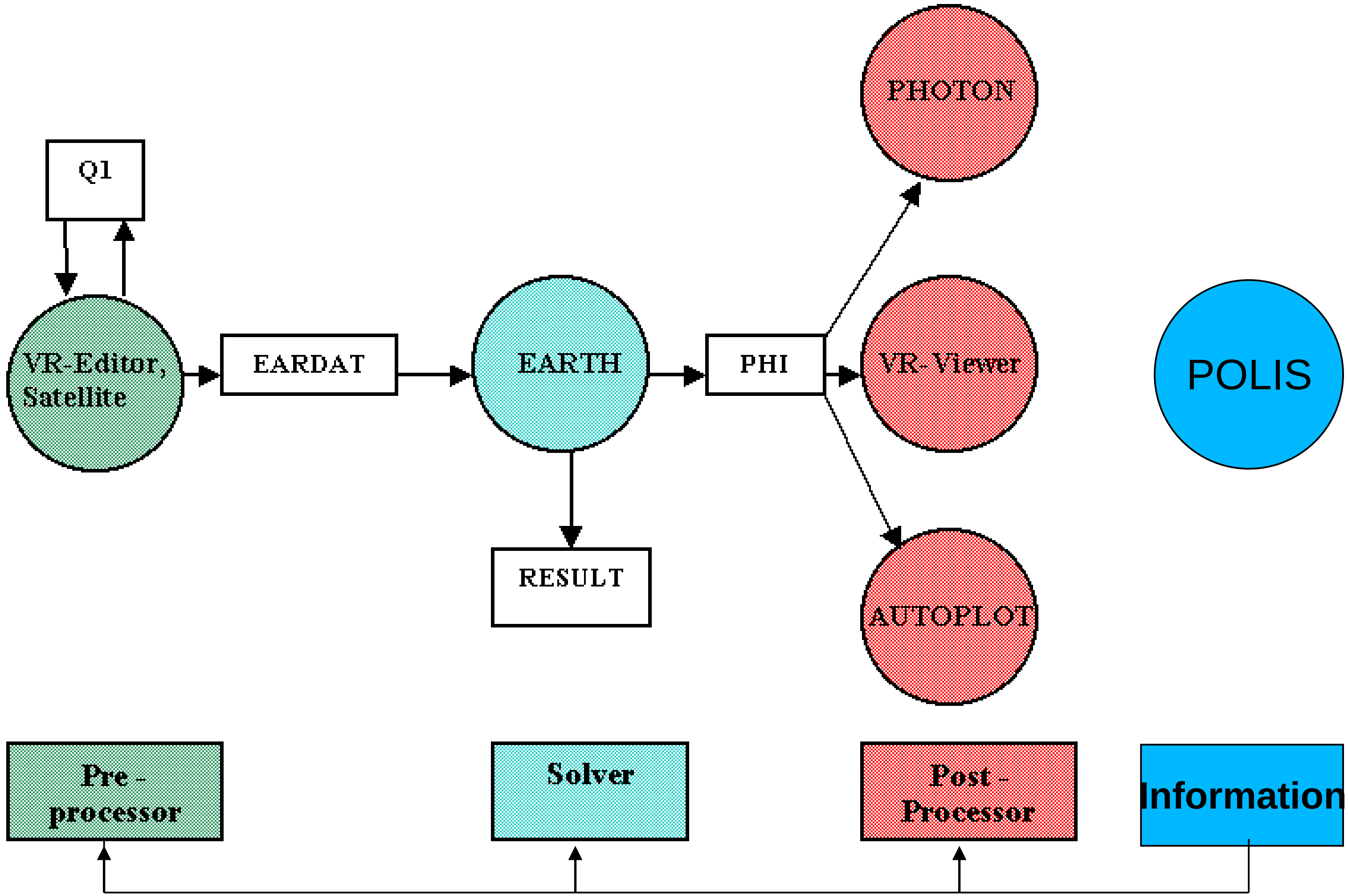


How the model is defined

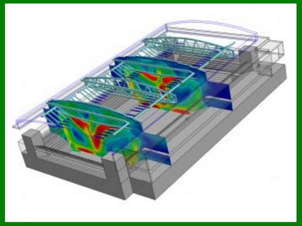
Problem definition normally involves making statements about:

- **geometry**, ie shapes, sizes and positions of objects and intervening spaces;
- **grid**, ie the manner and fineness of the sub-division of space and time;
- **processes**, for example:- whether the heat transfer is to be calculated; whether materials are inert or reactive; whether turbulence is to be simulated and if so by what model

How the model is defined

- **materials**, i.e. thermodynamic, transport and other properties of the fluids and solids involved;
- **environmental or boundary conditions**; and
- **numerical parameters** (i.e. non-physical) affecting the speed, accuracy and economy of the simulation.

The “Virtual-Reality” Interface



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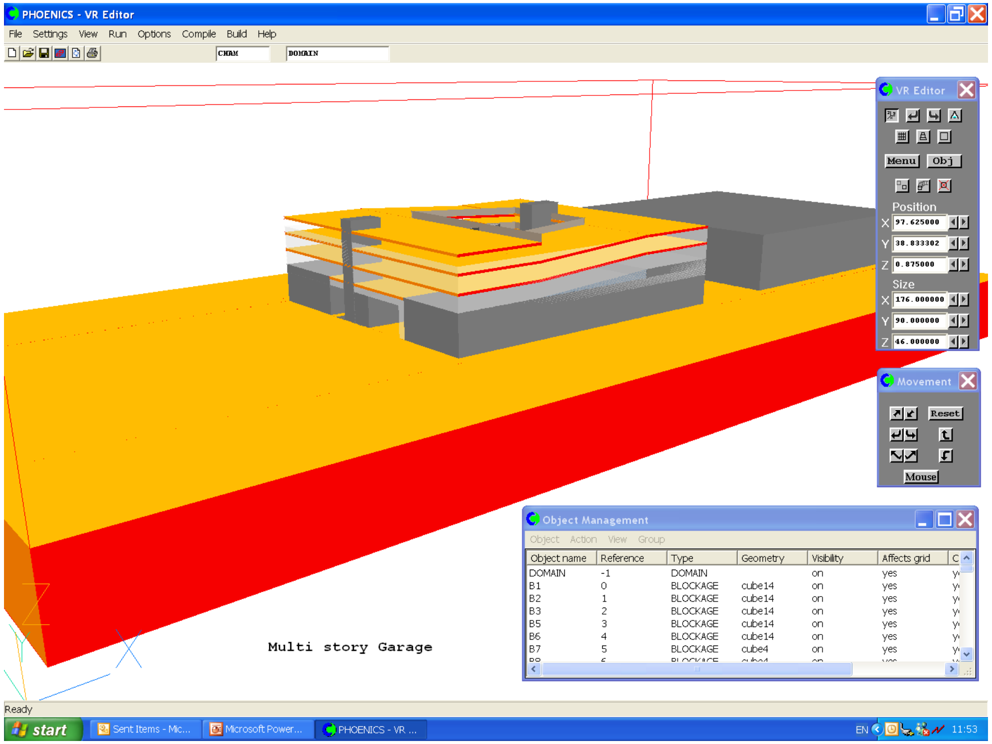
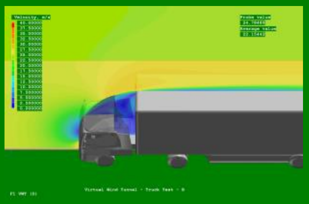
Model setup – VR Editor

- The model is defined as a set of “objects”.
- Clicking on an object brings a dialogue box onto the screen.
- This enables the information about the object to be edited.



The Virtual-Reality Interface
Import a CAD file



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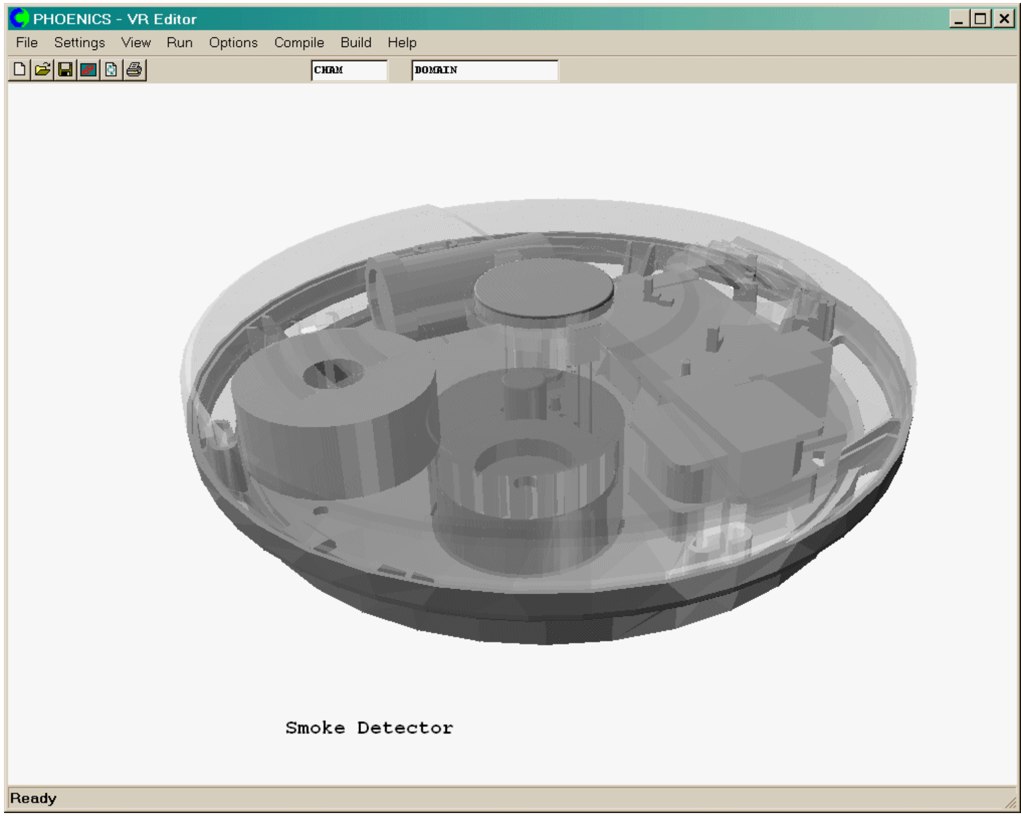
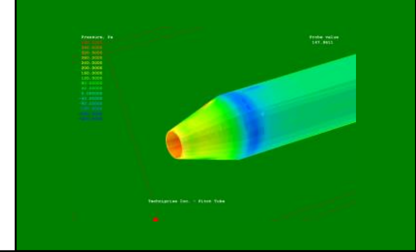
Model setup – VR Editor

- The object geometry can be taken from a library of shapes, or loaded from a CAD file.
- CAD geometry formats include STL, DXF, 3DS and many others.



Setting Up Problems: PHOENICS-VR main menu



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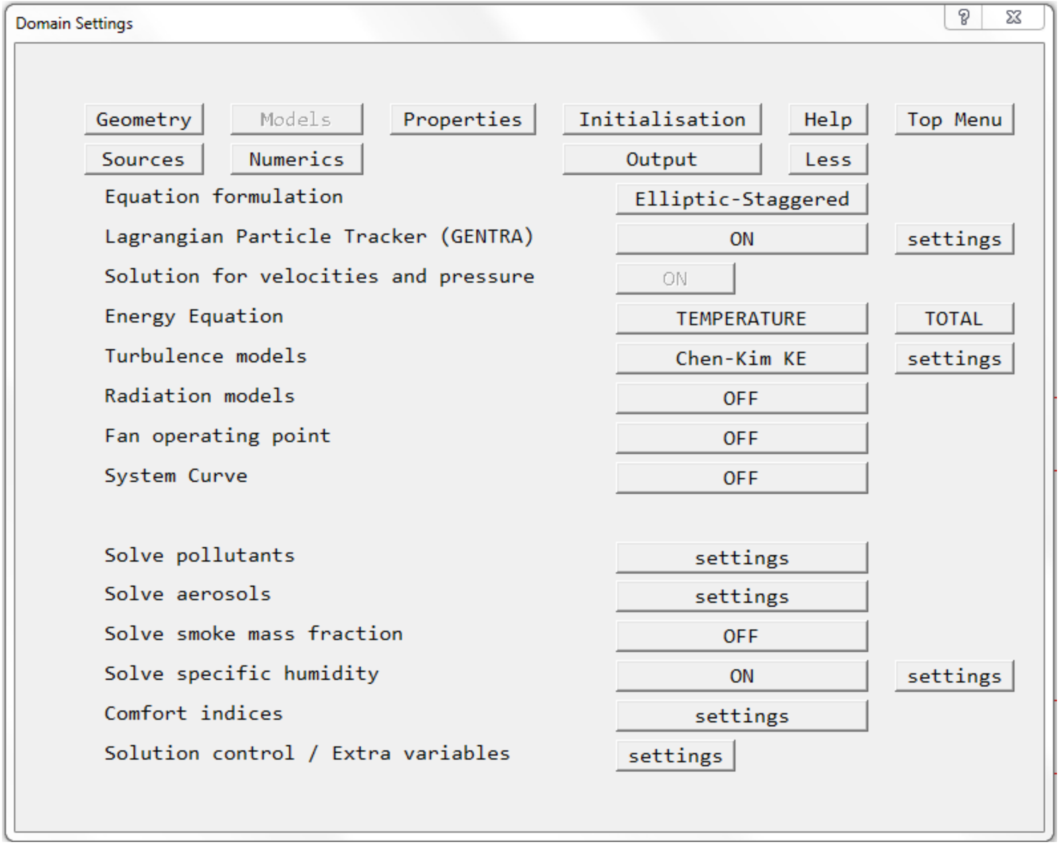
The PHOENICS-VR Main menu allows you to make all the settings required for a problem, including:

- Geometry
- Variables to be solved (models)
- Fluid properties
- Initial values
- Boundary conditions
- Numerical controls
- Printout options



A Typical EARTH Convergence Monitor Plot

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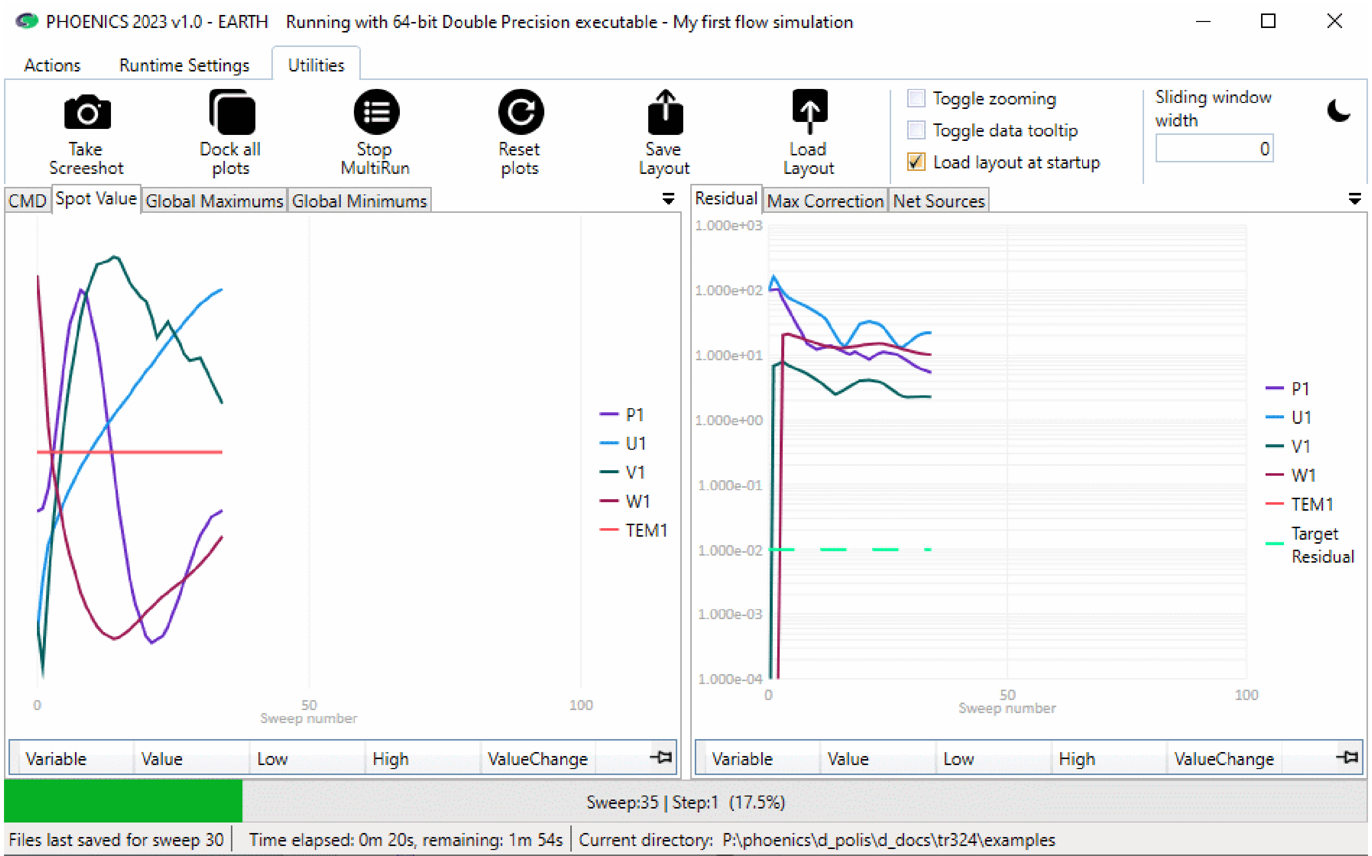
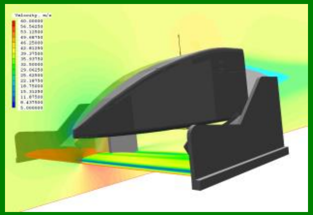
- EARTH is the program that performs the simulation.
- The graphical monitor shows the converging solution.





Solver-Graphics Monitoring

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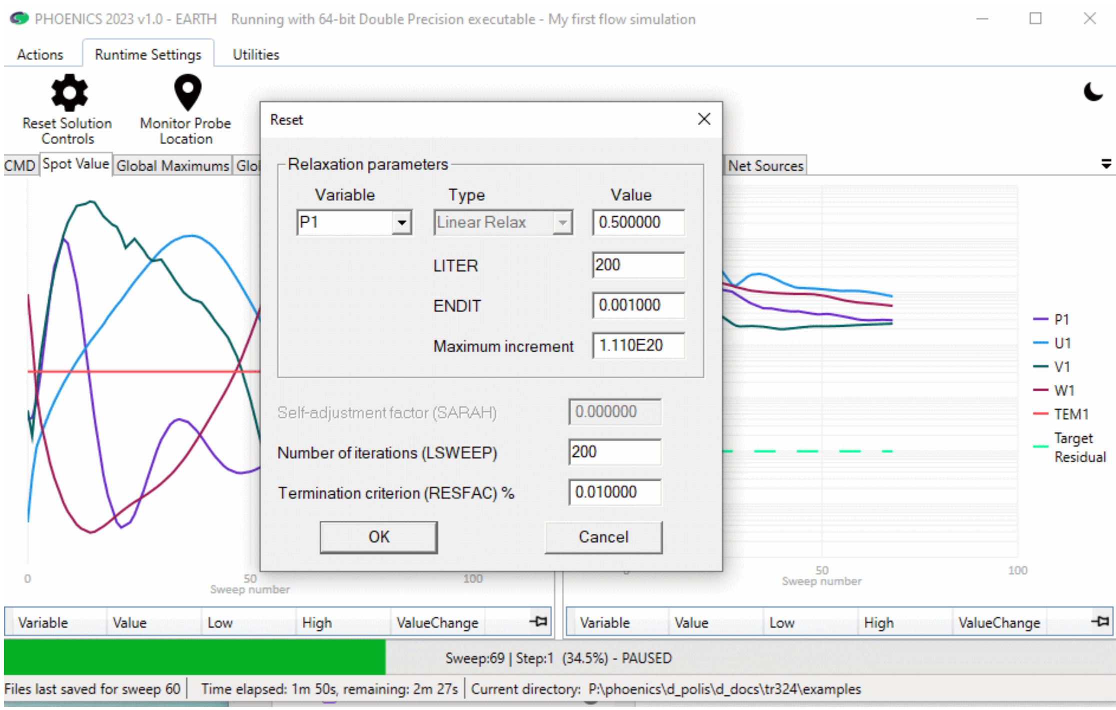
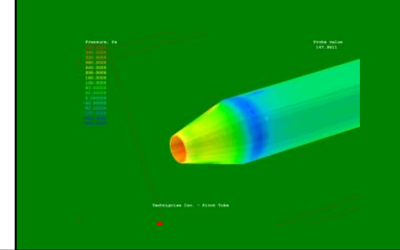
The EARTH run can be interrupted to change several parameters:

- Monitoring position
- Relaxation factors
- Graphical monitor settings
- Intermediate result files can also be dumped





Analysis of Results - VR Viewer

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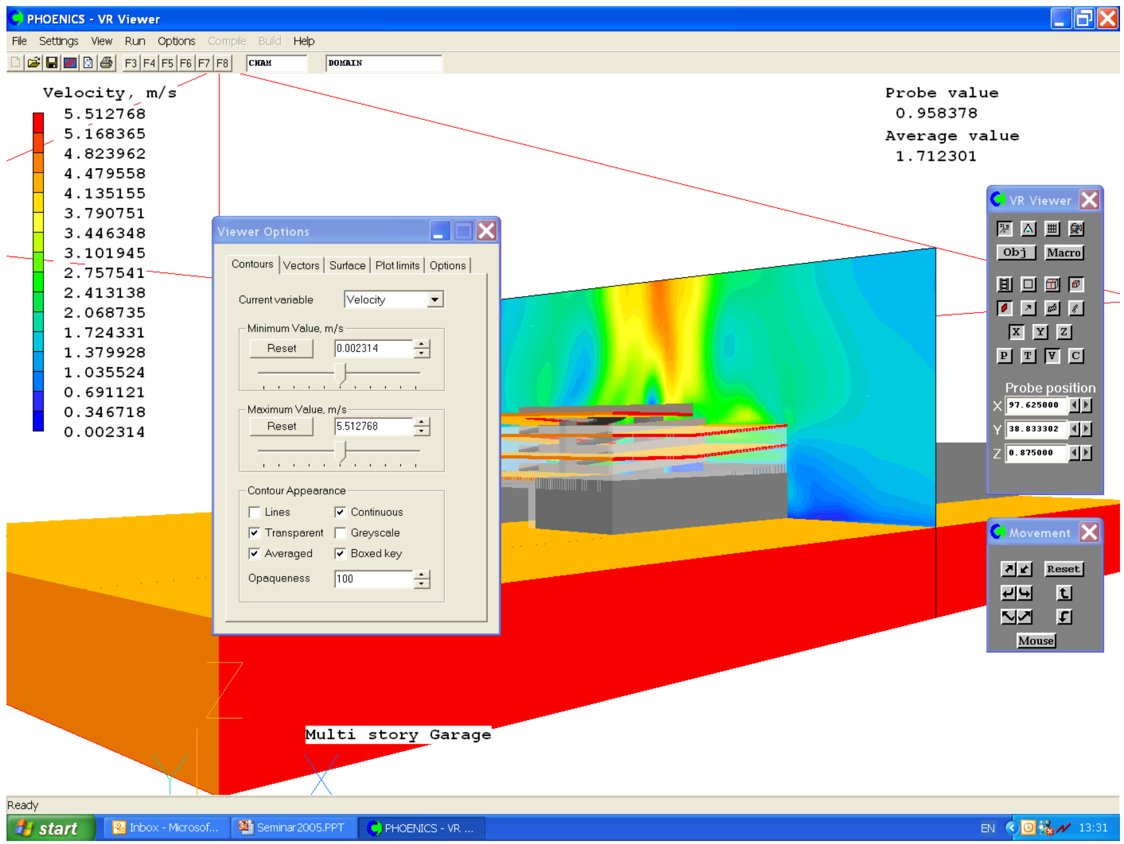
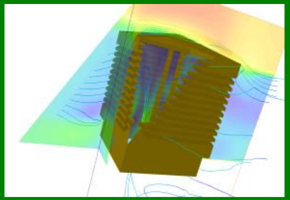
The VR Viewer allows users to see their results in a number of different ways:



Analysis of Results - VR Viewer



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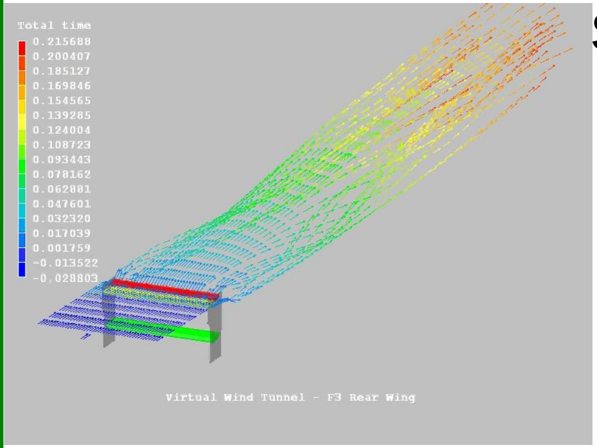
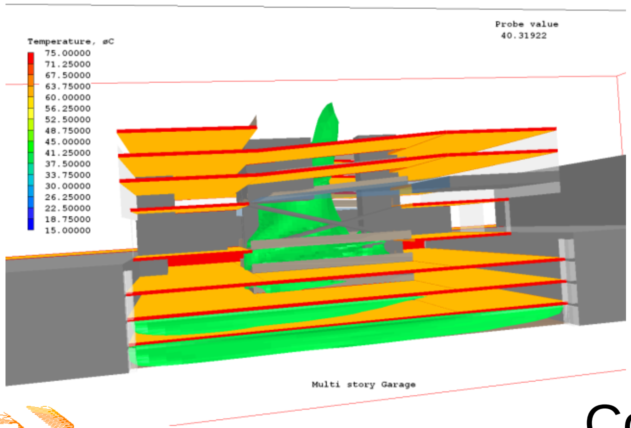
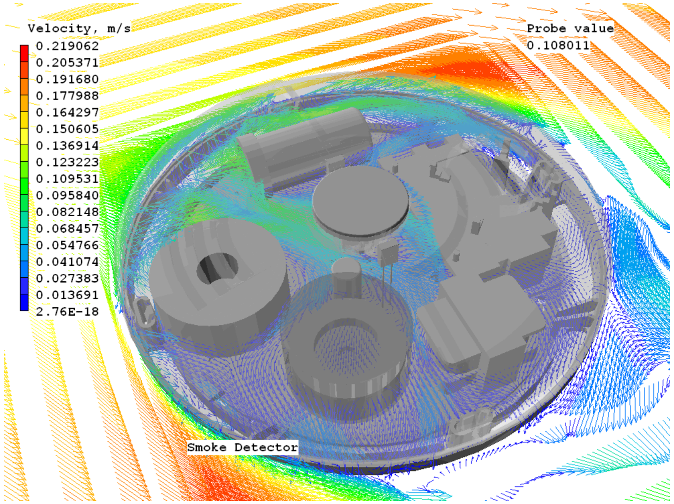


Streamlines, static or animated

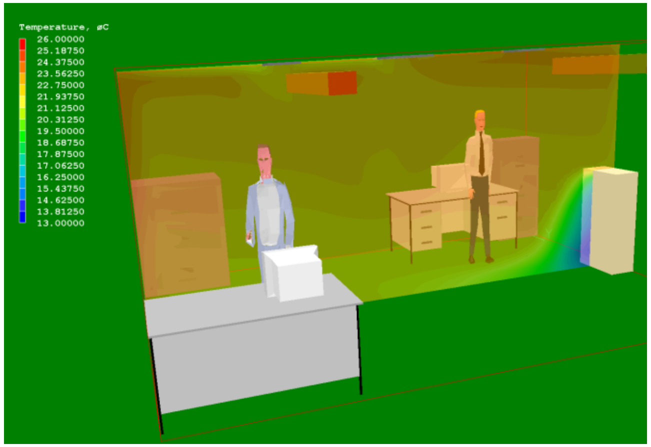


Iso-surfaces

Contours



Vectors



User Programmability

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- **In-Form** enables users of PHOENICS to greatly extend its capabilities, without any need to write FORTRAN coding.
- Users are enabled to express their requirements by way of formulae.
- These are read by the Input Module (Satellite), which transmits them to the Solver Module (EARTH); this then interprets them and performs the implied computations.
- In-Form does **not** require use of a re-compilable version of PHOENICS.

In-Form Capabilities

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- In-Form can be used to:
  - Set sources
  - Set initial values
  - Set physical properties
  - Define and calculate new derived quantities
  - Calculate total or average values and print them
  - Generate additional monitoring tables
  - Many others...

Big Ass Ceiling Fan

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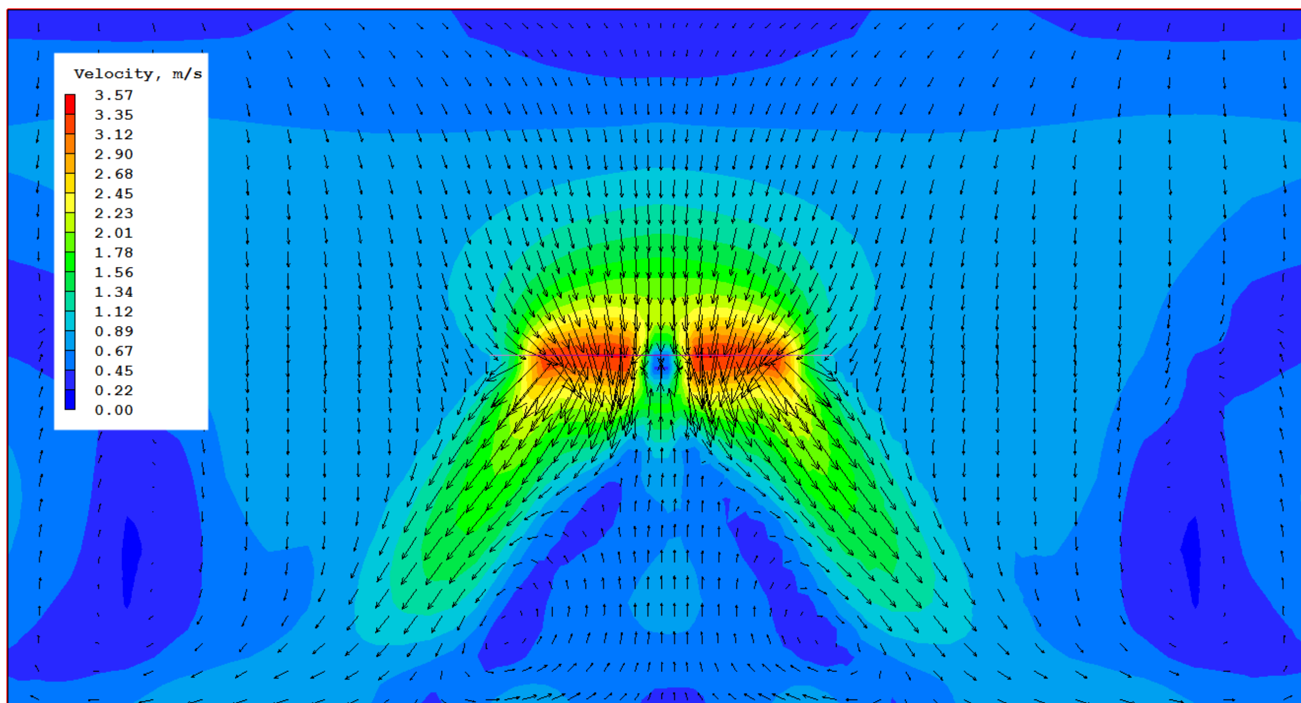

Pollutant release

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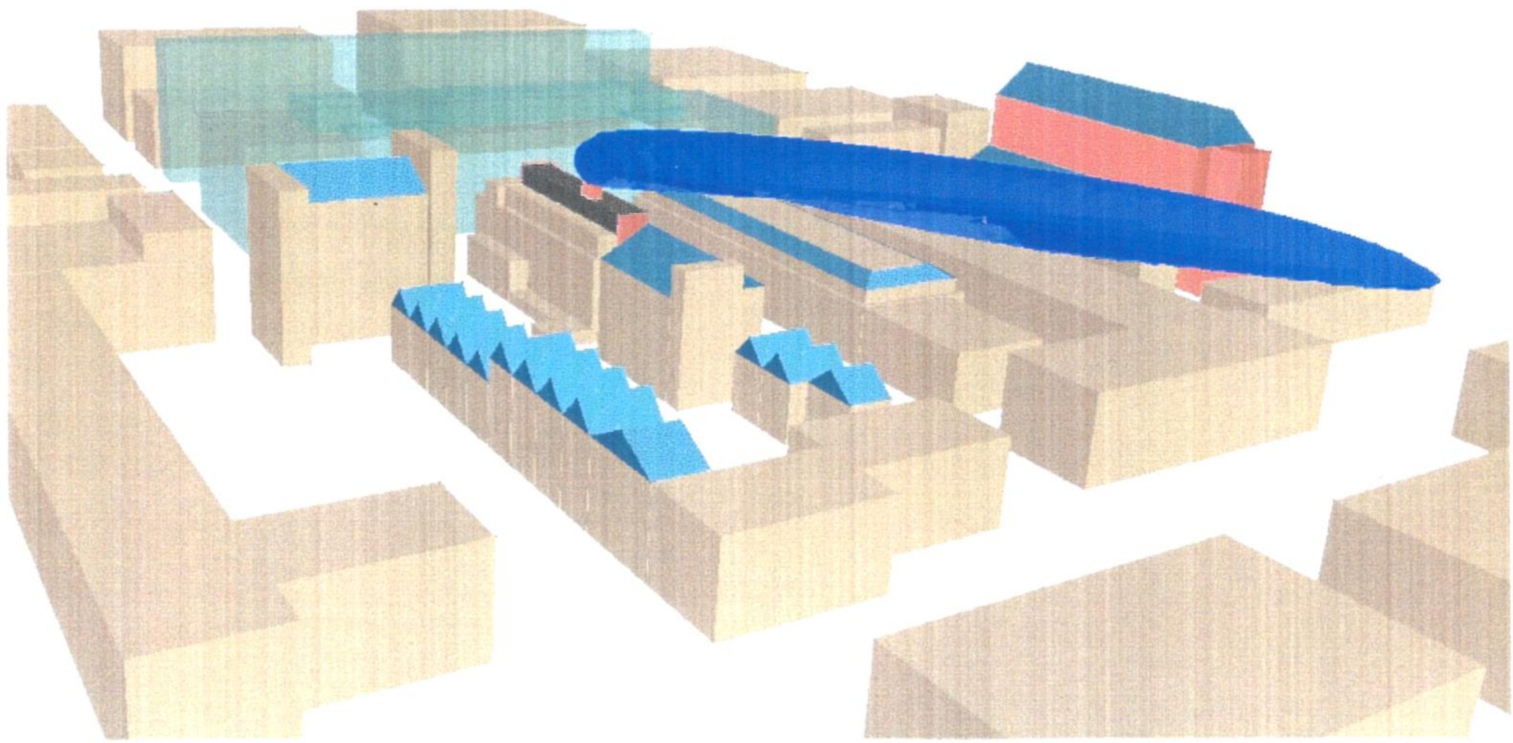
- Animal house in an urban environment
- Isosurface of odour concentration



Wind

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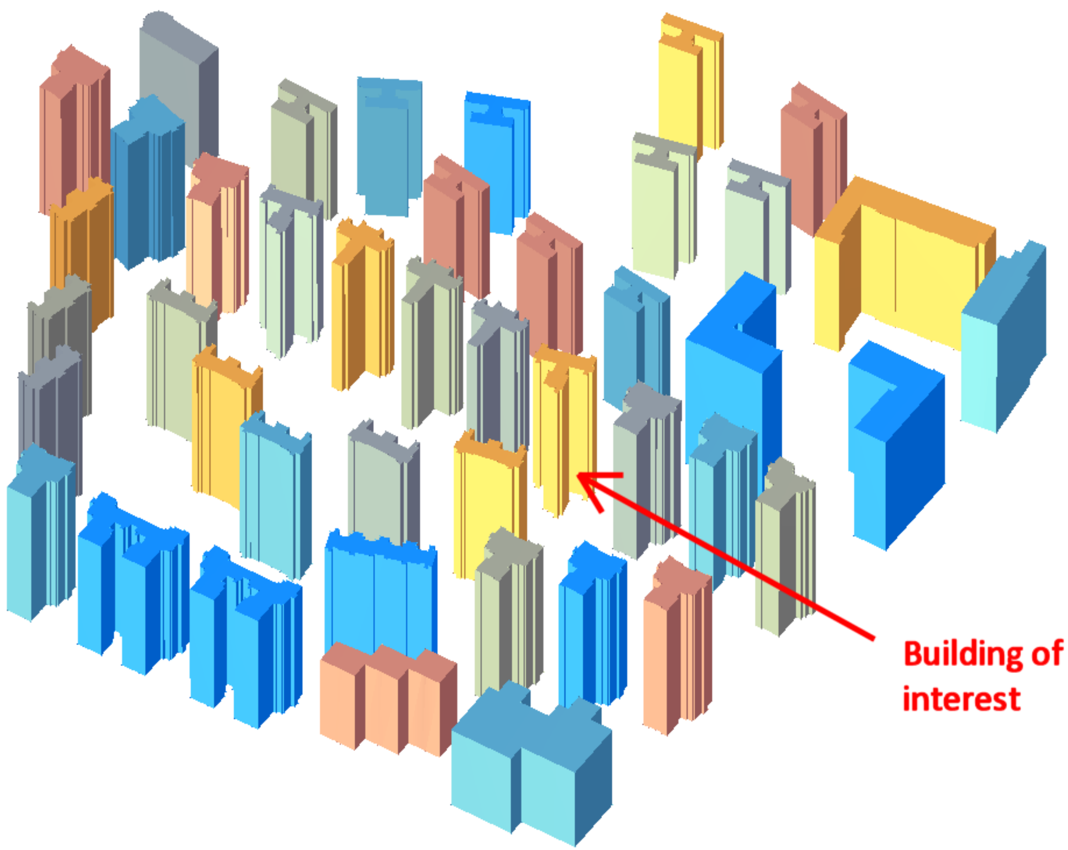
- Wind around a building development
- Wind 5 m/s from SW, log-law profile, roughness height 0.03m



Typical Wind Case

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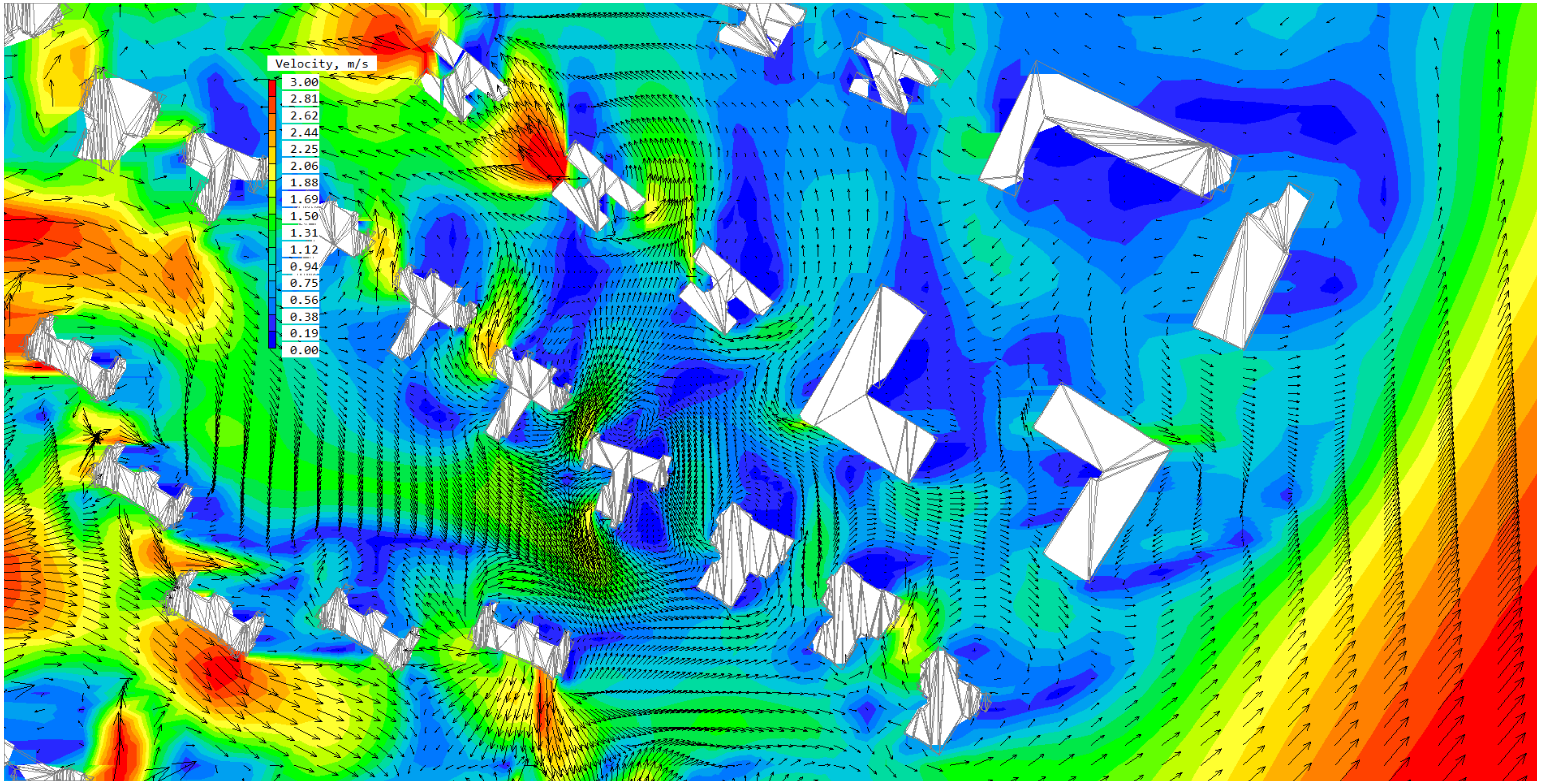
- Wind 1.5m above ground, around building of interest



Fire in a Train

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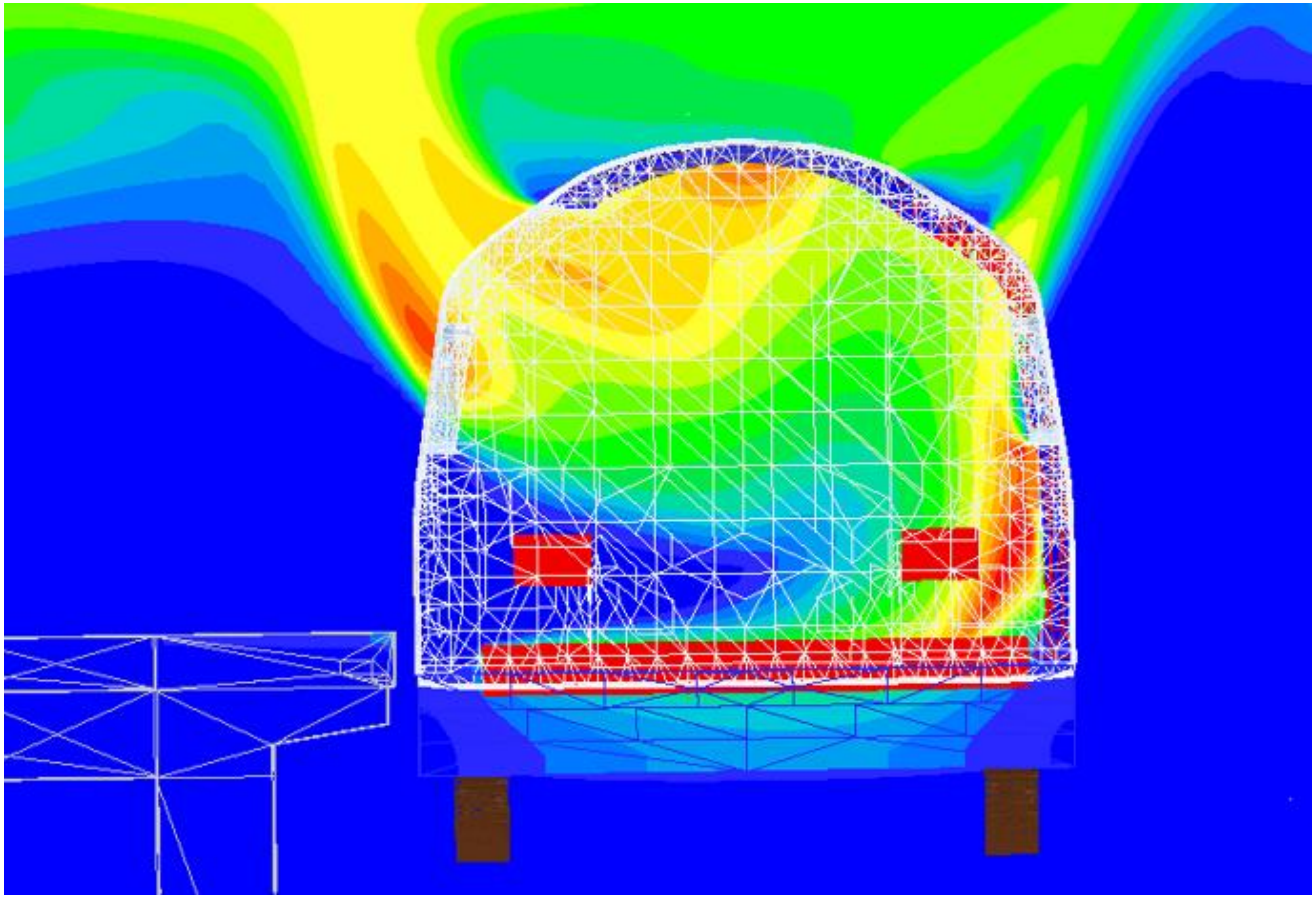

Luggage Fire in an Air Terminal

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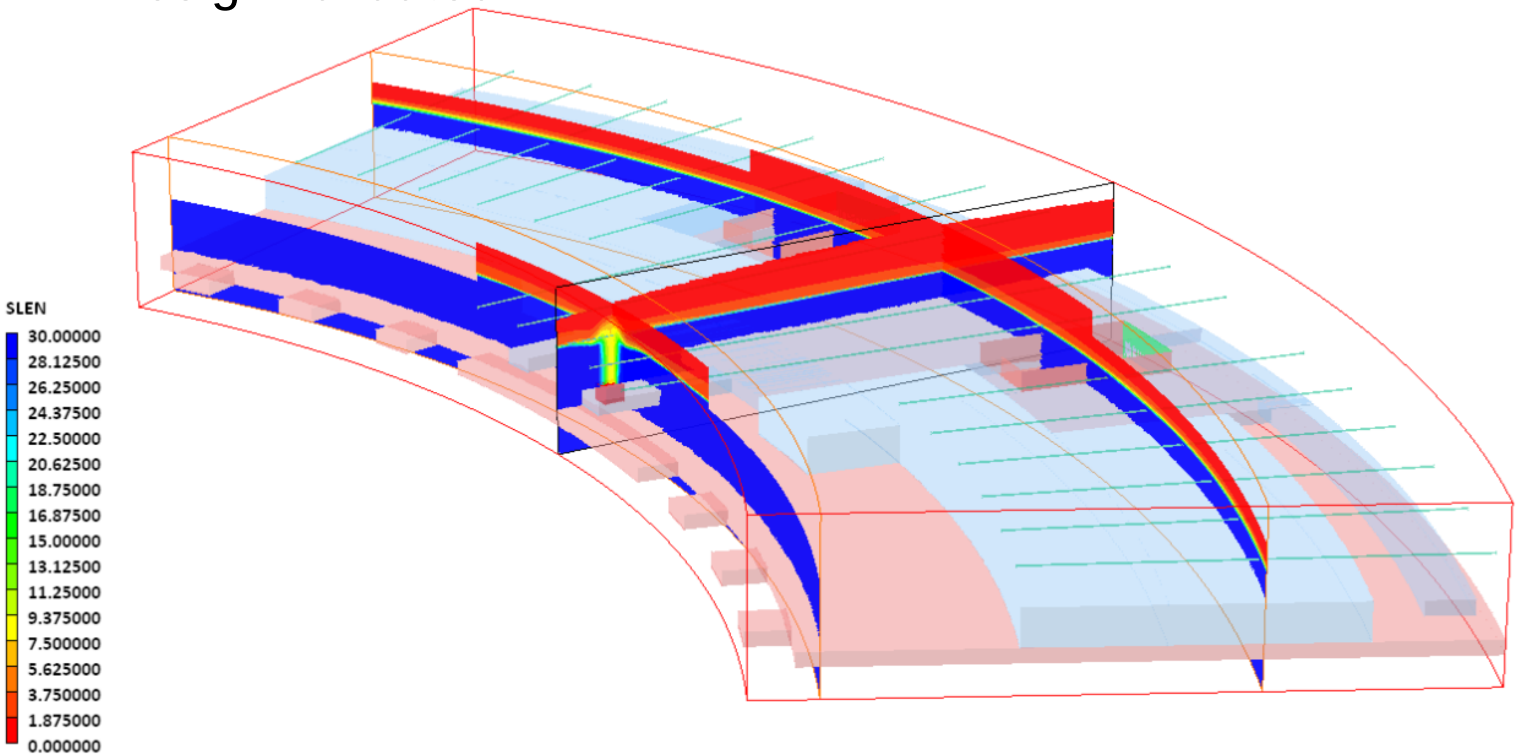
- Plot of visibility length – colours reversed, smoke is red
- High smoke concentrations near ceiling only
- Green lines show the smoke extracts (at bottom of smoke layer)
- Design validated



Transonic Flow around an Aerofoil

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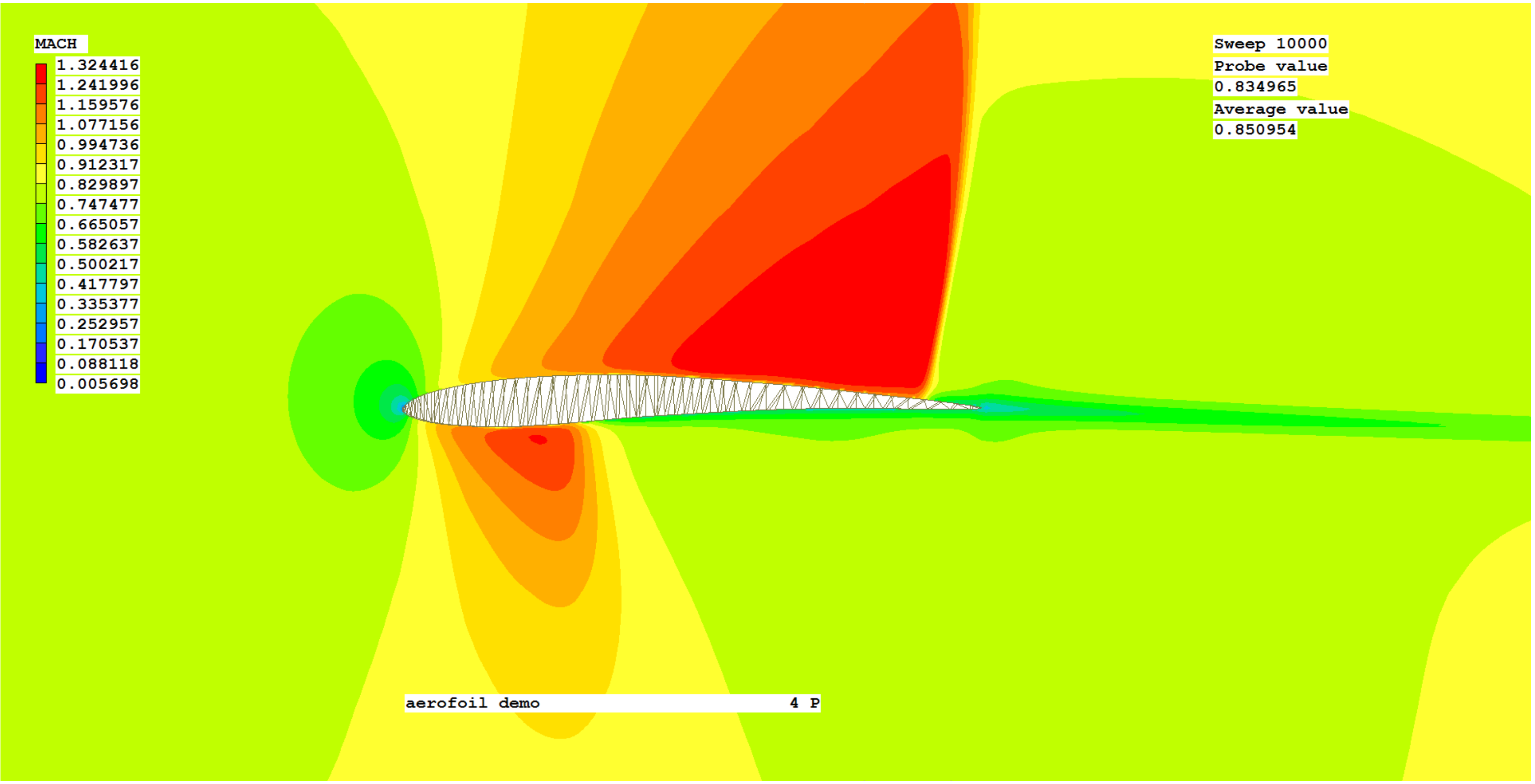

Features Added in Recent Years

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- "Hypre" solvers
- Improved geometry detection (Parsol / Sparsol)
- New convergence monitor
- VOF method for free surface models
- Pollutants menu and other FLAIR developments
- New comfort indices
- Wind comfort – Lawson Criteria
- Buildings treatment for UHI problems
- Extended range of non-Newtonian fluids
- New fluidised bed model
- Superior VBO graphics