Flood Risk Management Research Consortium - II

CFD modelling

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- to better understand the local interactions
- to identify governing parameters
- to provide series of algorithms
- enhancements of FRMRC1 models
- to establish a better design criteria for gully inlets

```
/ ******************************************* //
Info<< "\nStarting time loop\n" << endl;
for (runTime++; !runTime.end(); runTime++)
{
Info<< "Time = " << runTime.timeName() << nl << endl;
# include "readPISOControls.H"
# include "CourantNo.H"
{
fvVectorMatrix Ueqn
(
fvm::ddt(U)
+ fvm::div(phi, U)
+ turbulence->divDevReff(U);
if (momentumPredictor)
{
solve(UEqn == -fvc::grad(p));
}
```

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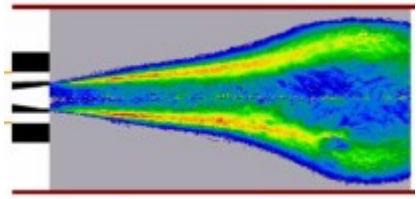
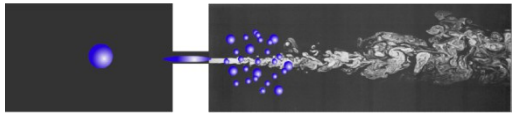
OpenFOAM (Open Field Operation And Manipulation)

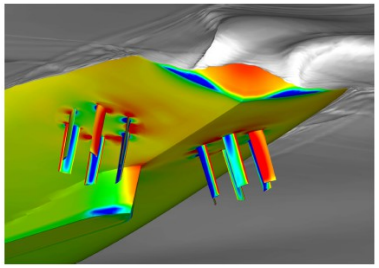
- CFD Toolbox
- Finite Volume Method
- Uses wide range of mesh type
- New solvers and utilities can be created easily
- Robust and flexible



Fluent – most popular commercial CFD

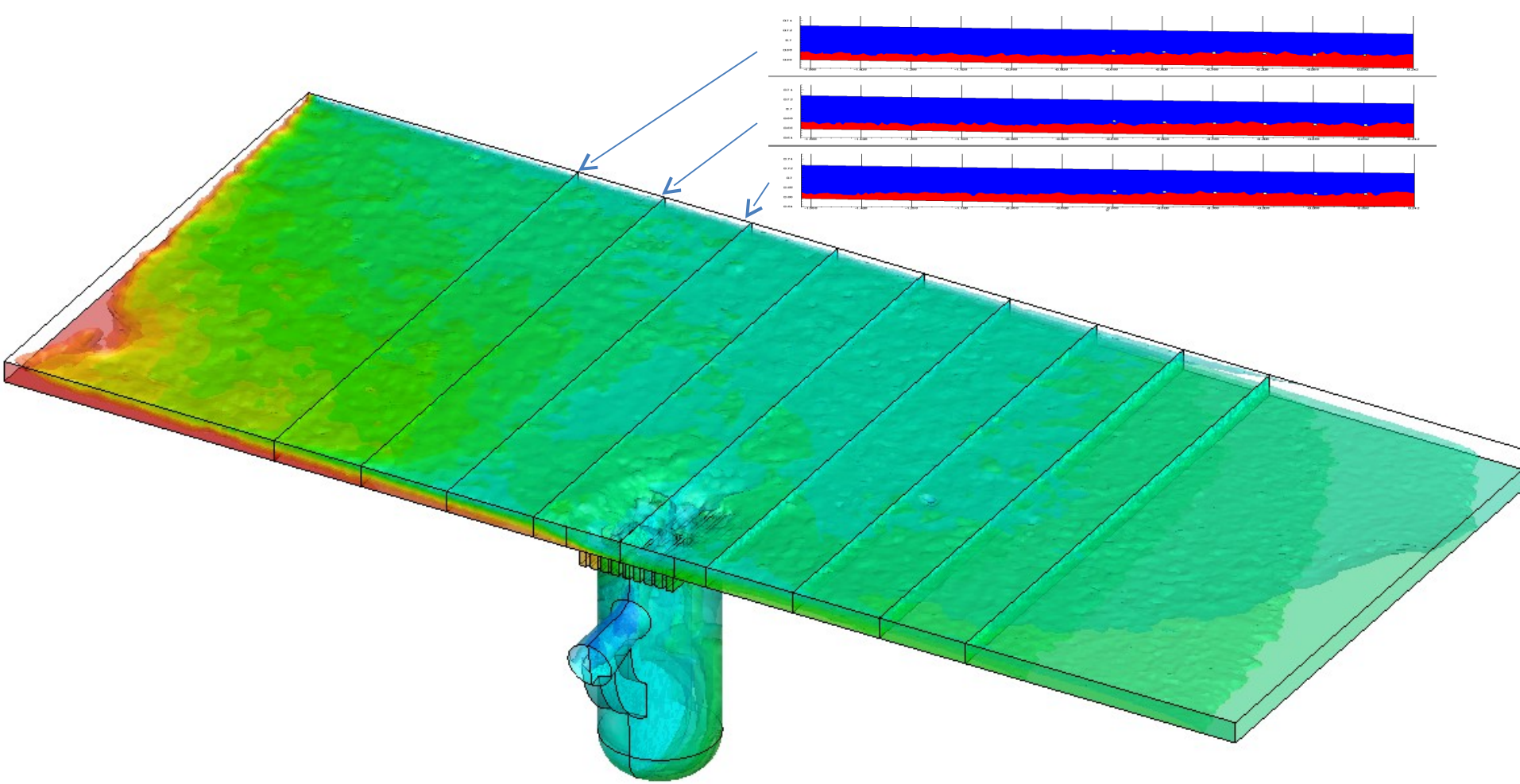
- High quality mesh generation (GAMBIT)
- Sophisticated numerics and robust solvers
- User friendly pre- and post-processing





- *Solver*: Implicit Pressure Based
- *Multiphase Model*: Implicit Volume of Fluid, Level Set
- *Pressure Velocity Coupling*: PISO
- *Pressure Discretization*: PRESTO
- *Turbulence closure*: k-ω
- *Momentum Discretization*: First & Second Order Upwind
- *Volume Fraction Discretization*: First & Second Order Upwind
- *Time*: Unsteady, Steady

FRMRC flood risk management research consortium



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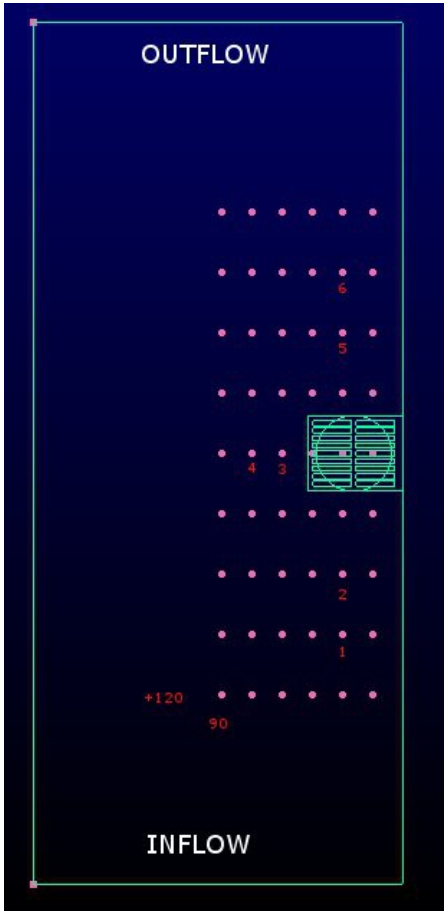
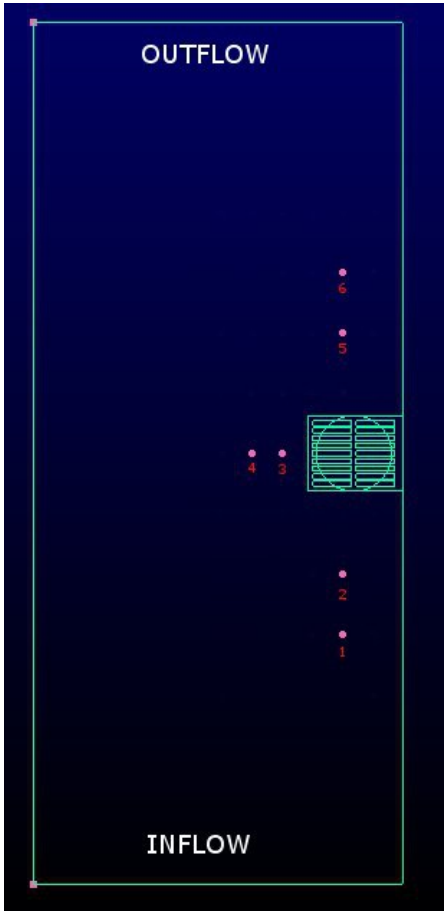
Improved understanding of interaction between surface and underground drainage system





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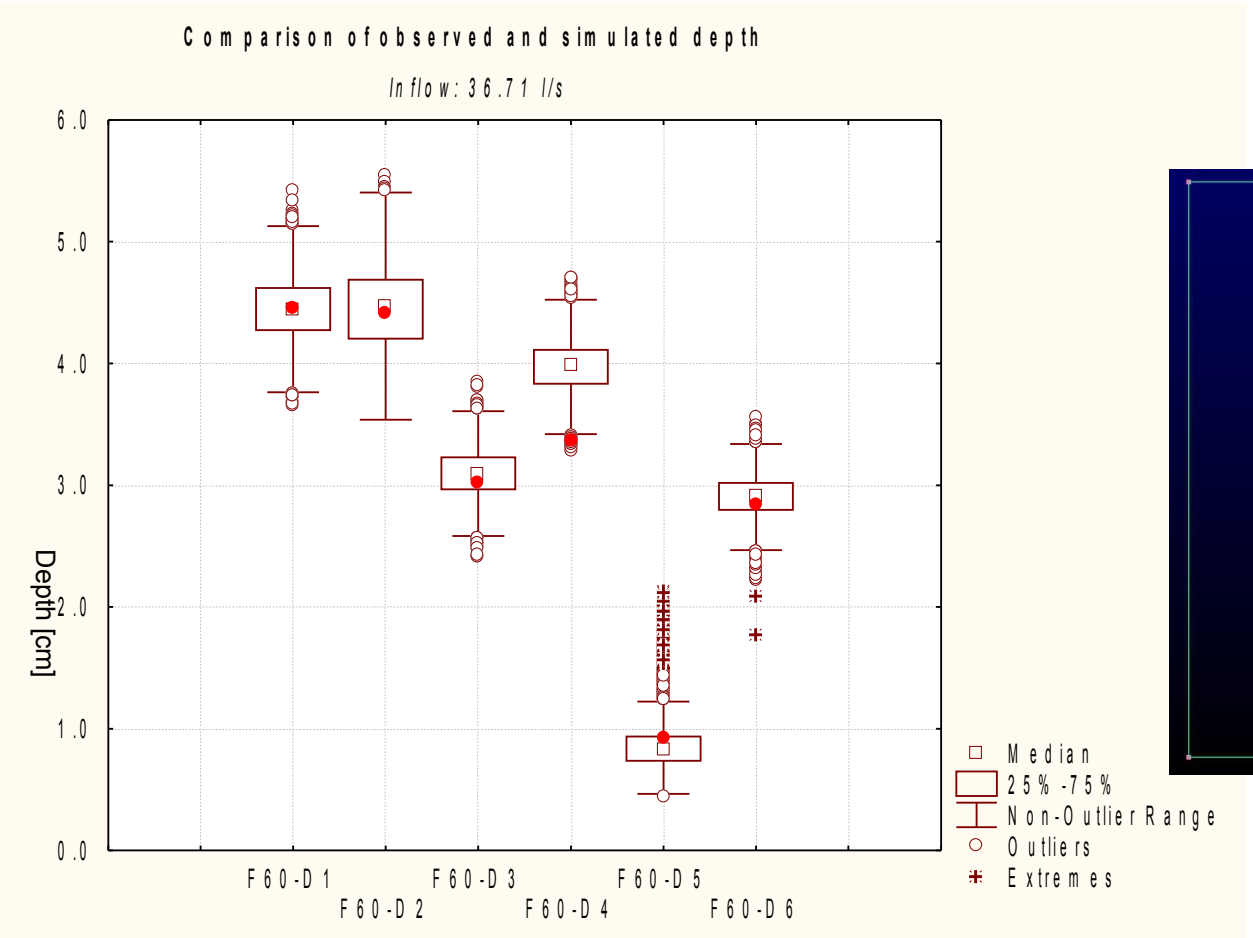

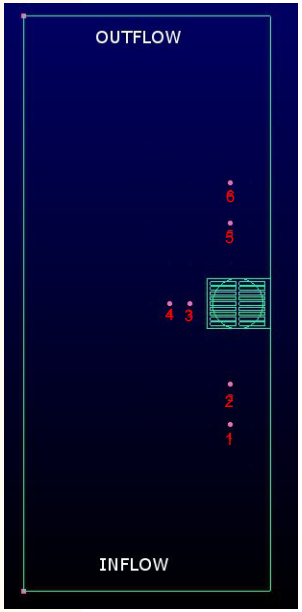

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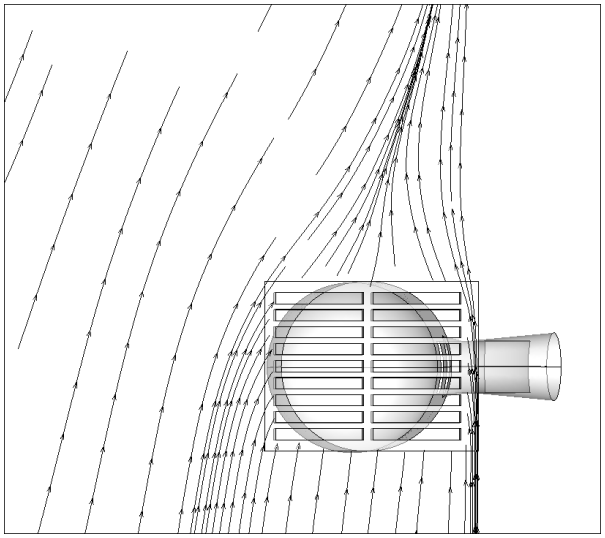

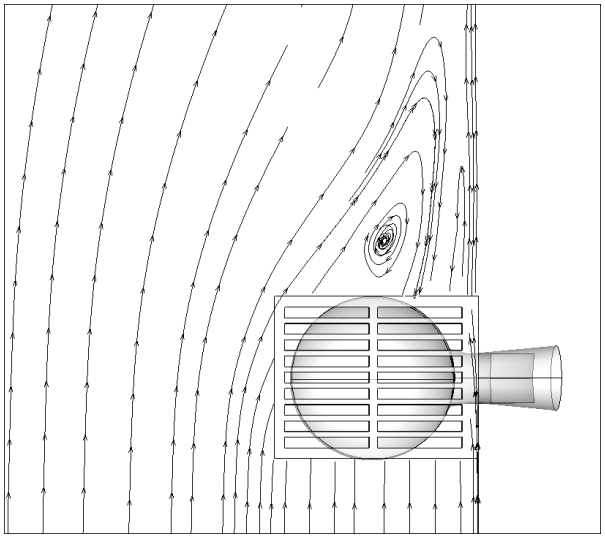

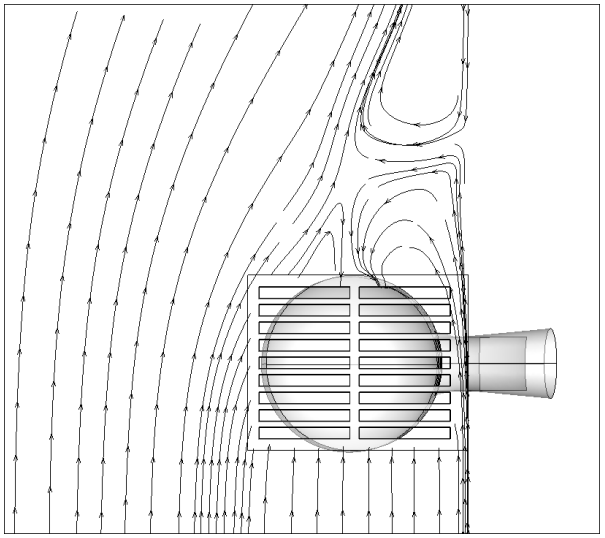

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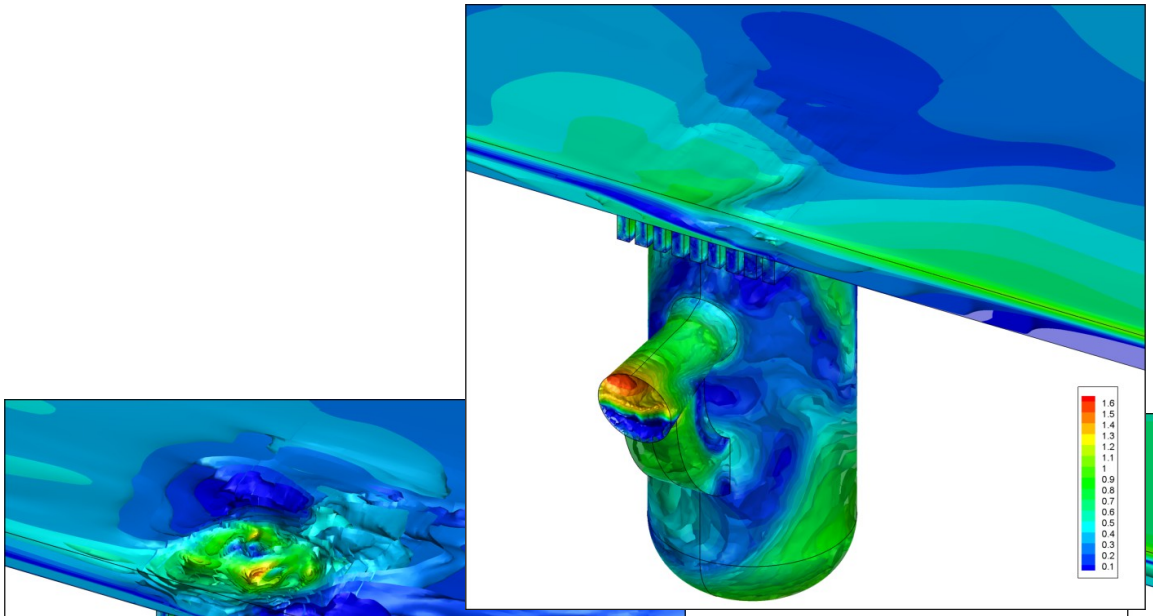

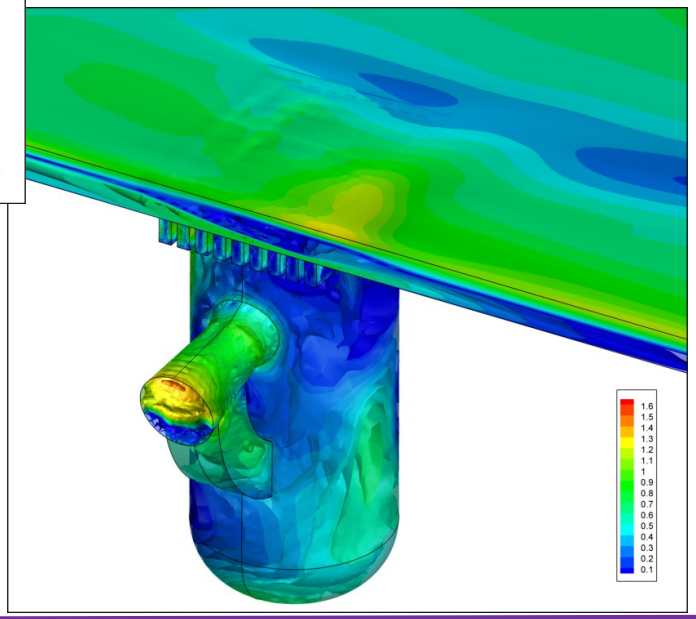

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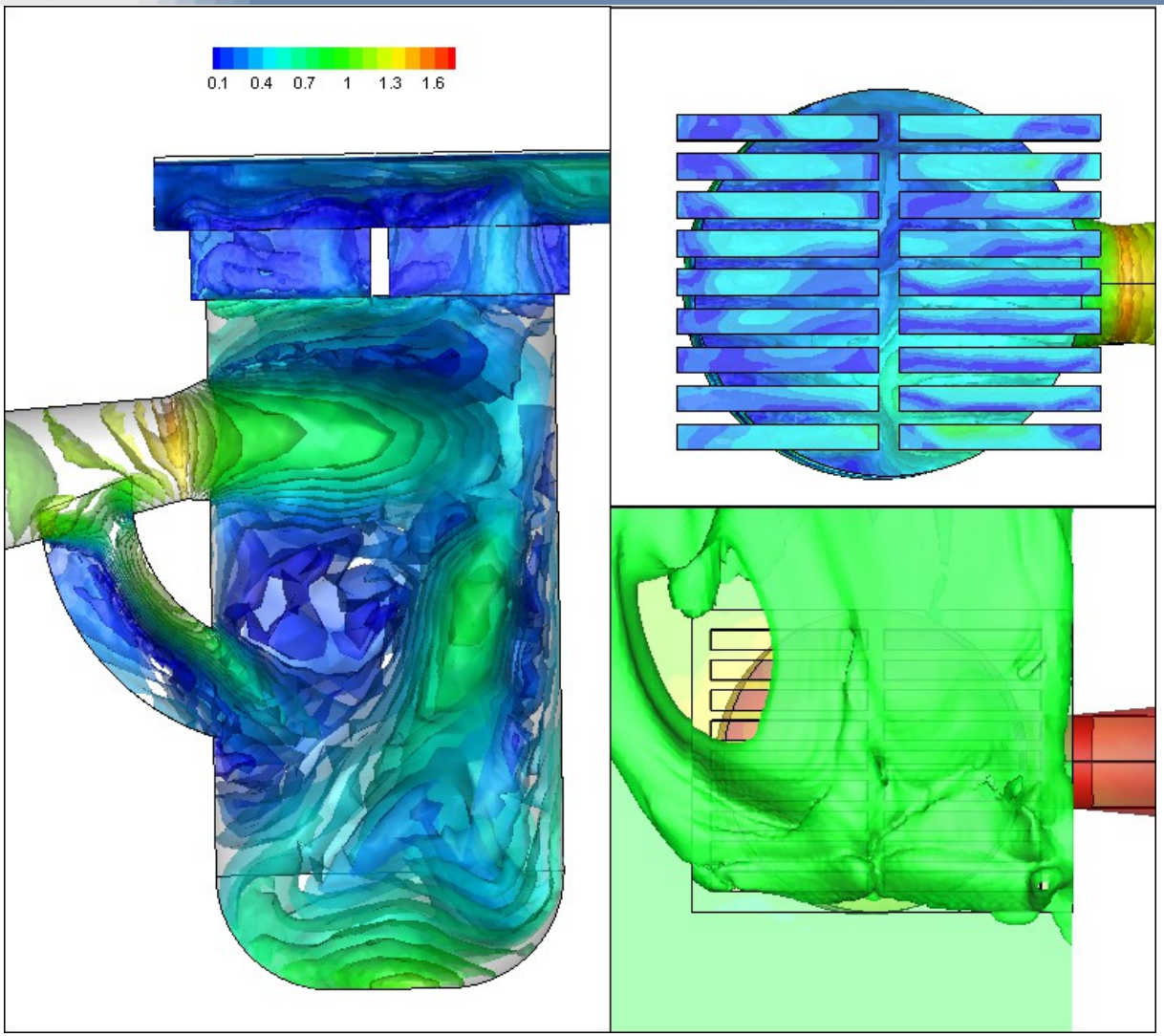

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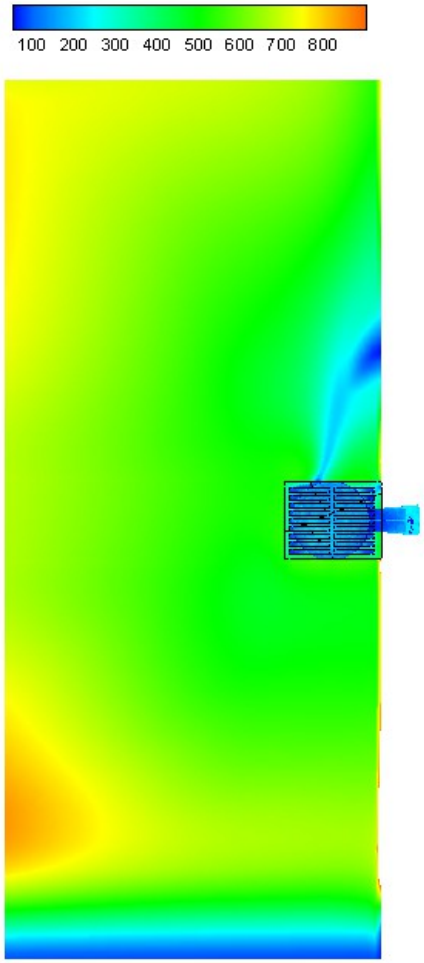

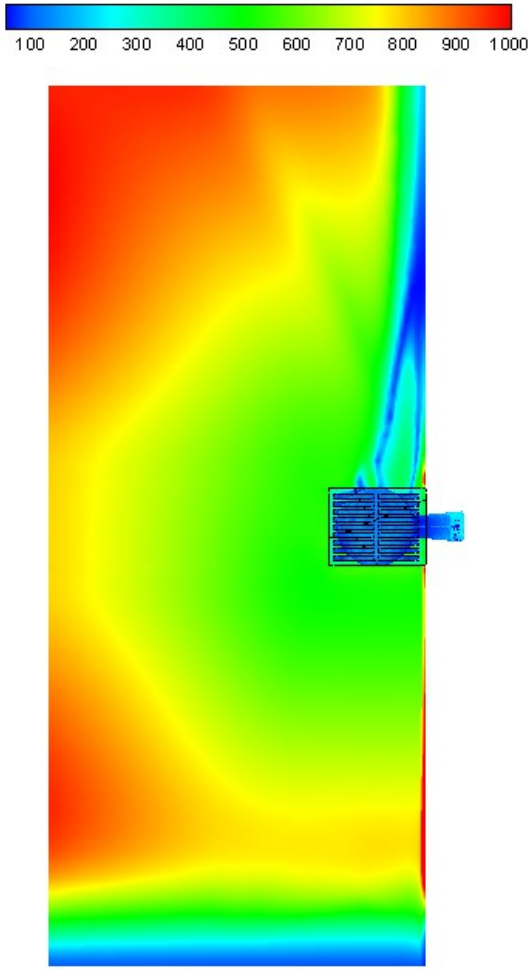

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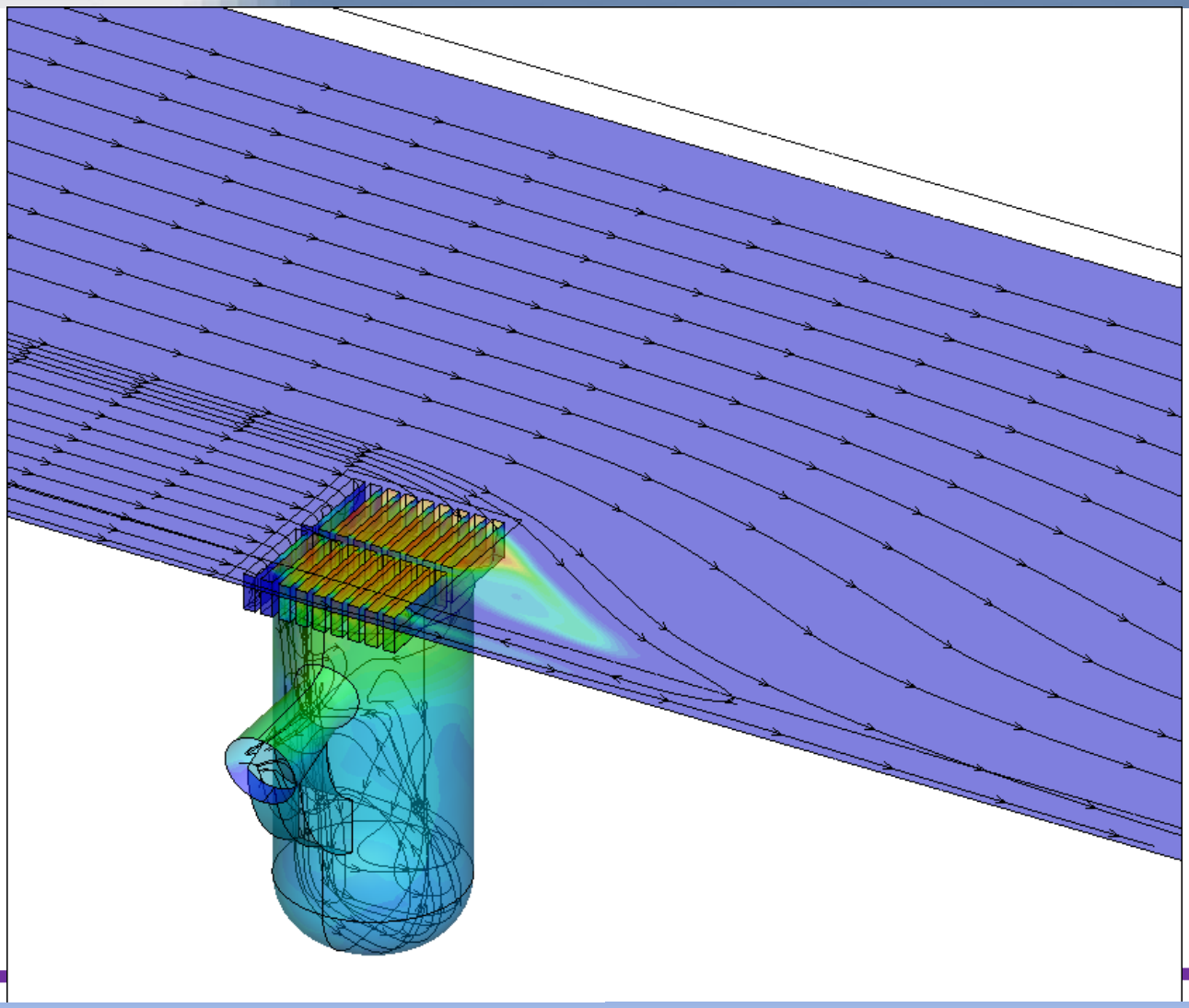

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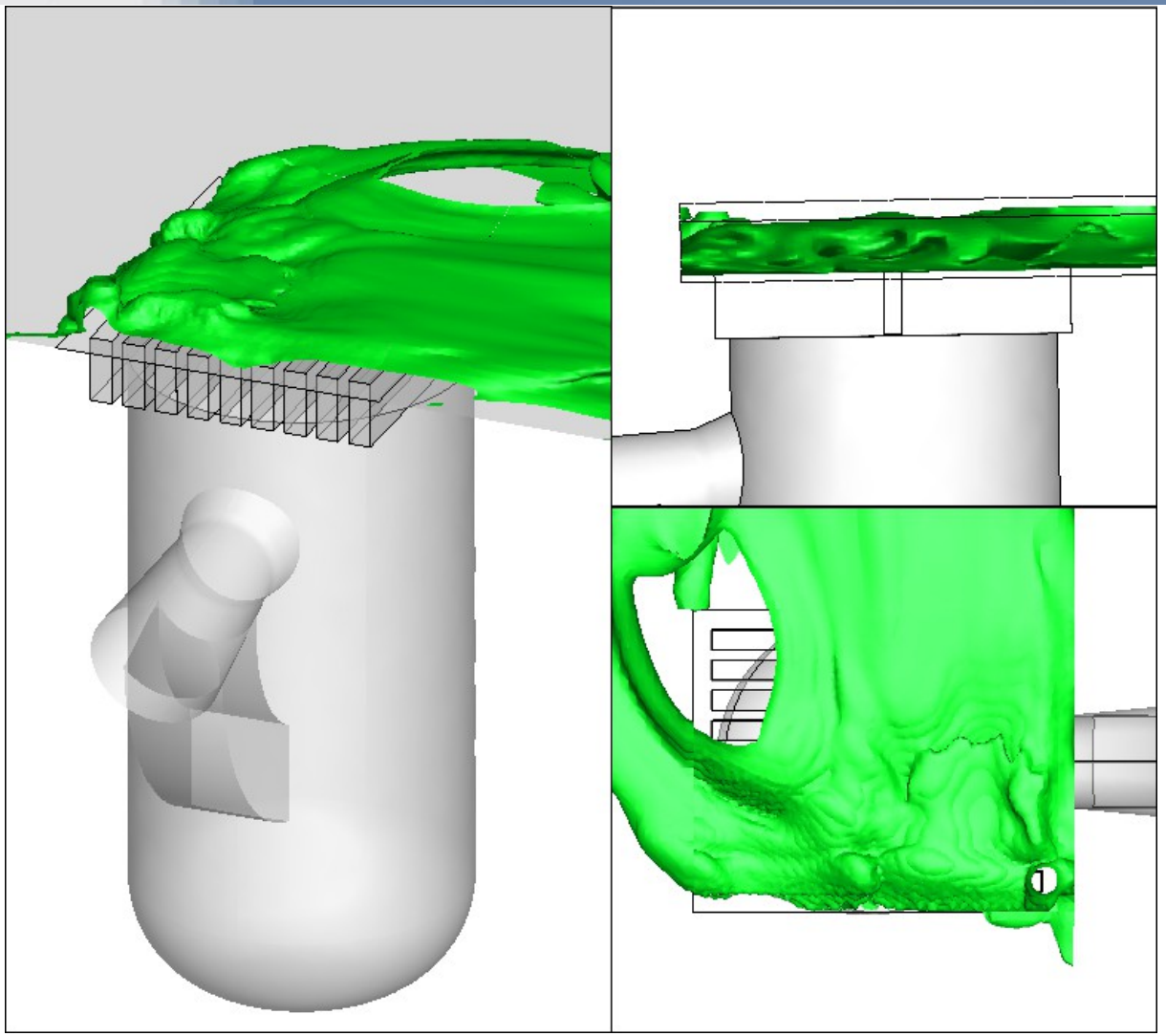

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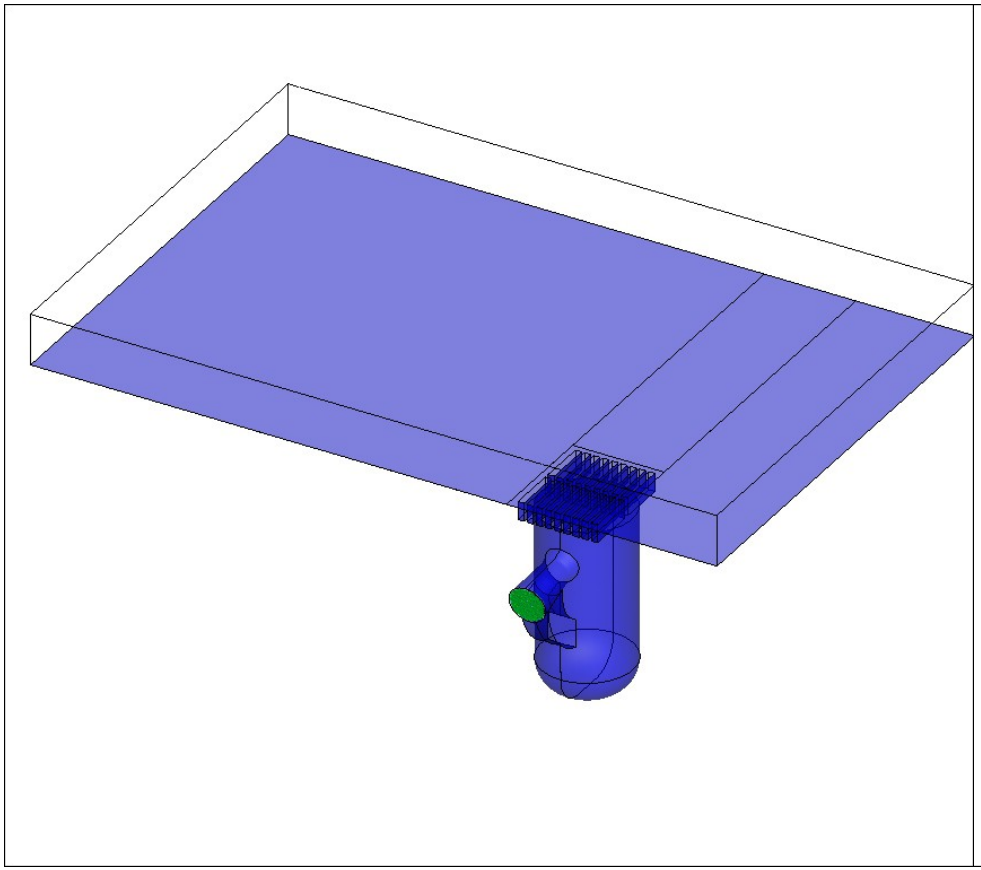

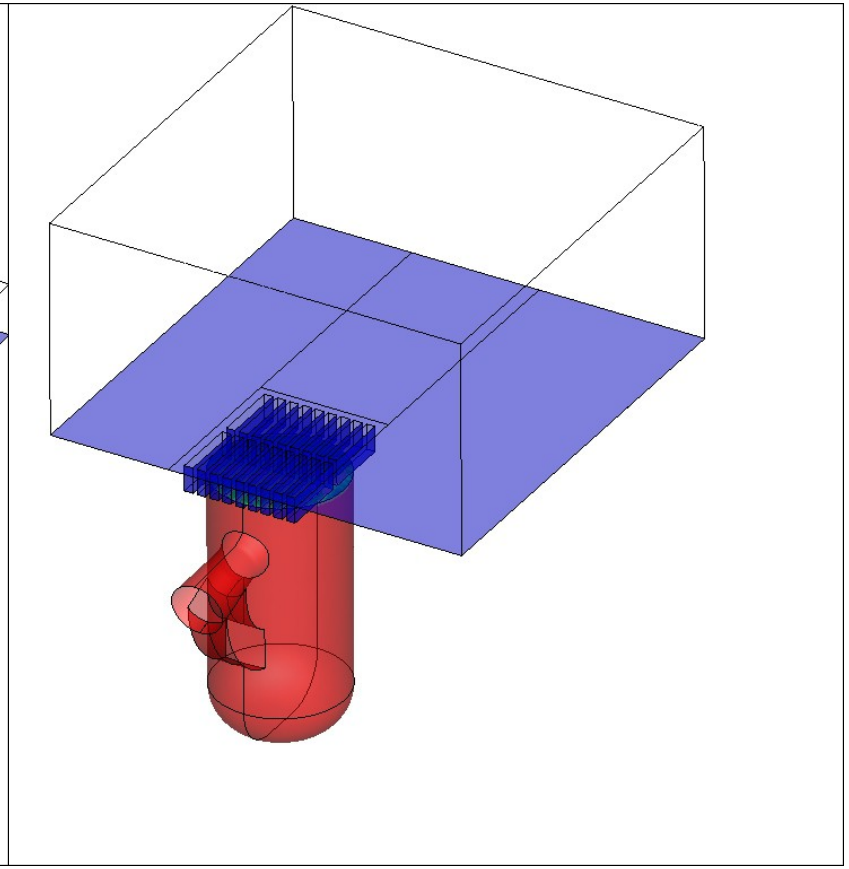

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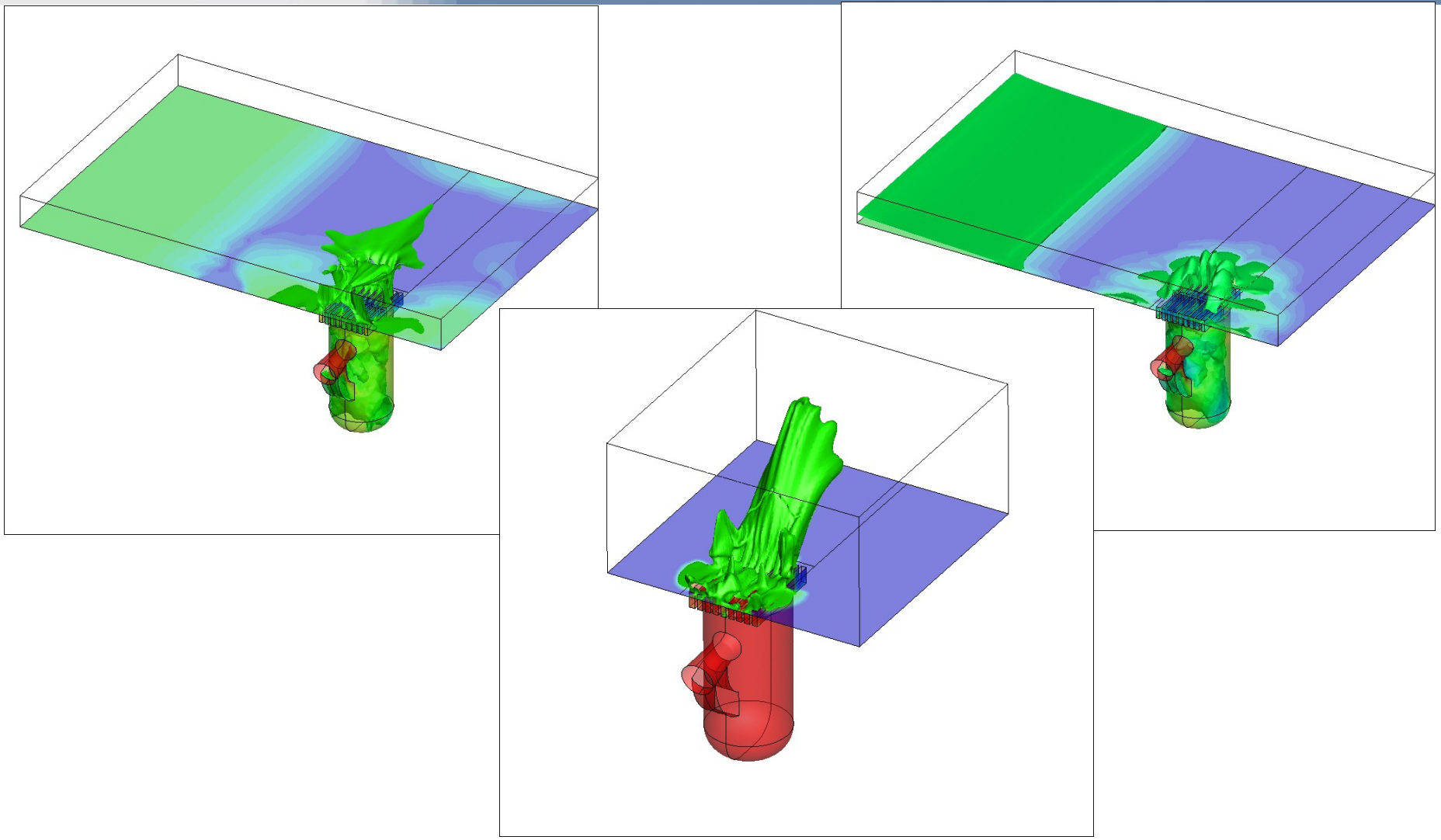

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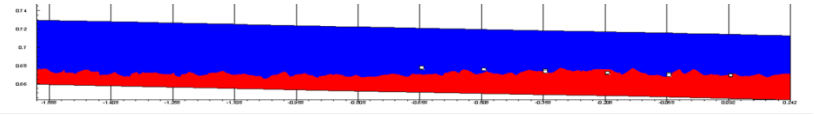
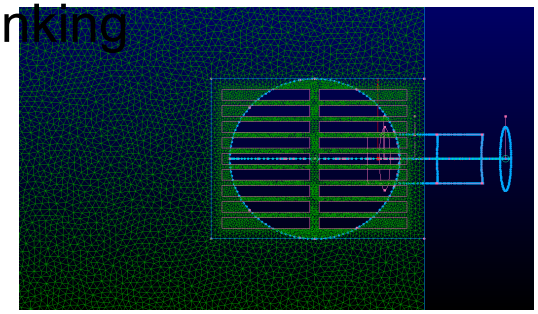
Thank you for your attention !

- Sharp interface tracking



- Decrease the number of control volumes – 2D/3D linking



➡ Level Set Method instead of VOF

using signed distance function instead of Heaviside marker function,

distance function does not obey conservation law

➡ Film Flow + interFoam

replacing finite volume mesh with finite area one,

modelling assumptions

Level set vs. VOF

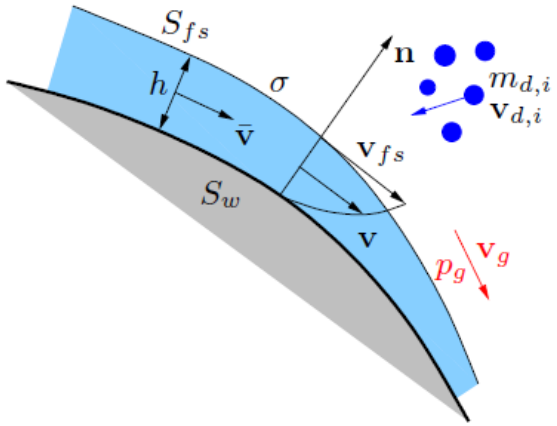
- Volume of Fluid method use a **discontinuous function** (1 and 0)
- Level set method represent the interface by a certain contour of a **smooth function**
- **VOF** can suffer **poor accuracy** in determination of the position of the interface and the curvature
- **VOF conserve the mass** of each fluid
- **Level set** has **good accuracy** in determination of interface position and surface curvature
- **Mass is not conserved** in Level Set Method

Dependent variables: h and v

$$\bar{\mathbf{v}} = \frac{1}{h}\int_0^h \mathbf{v}\, dh$$

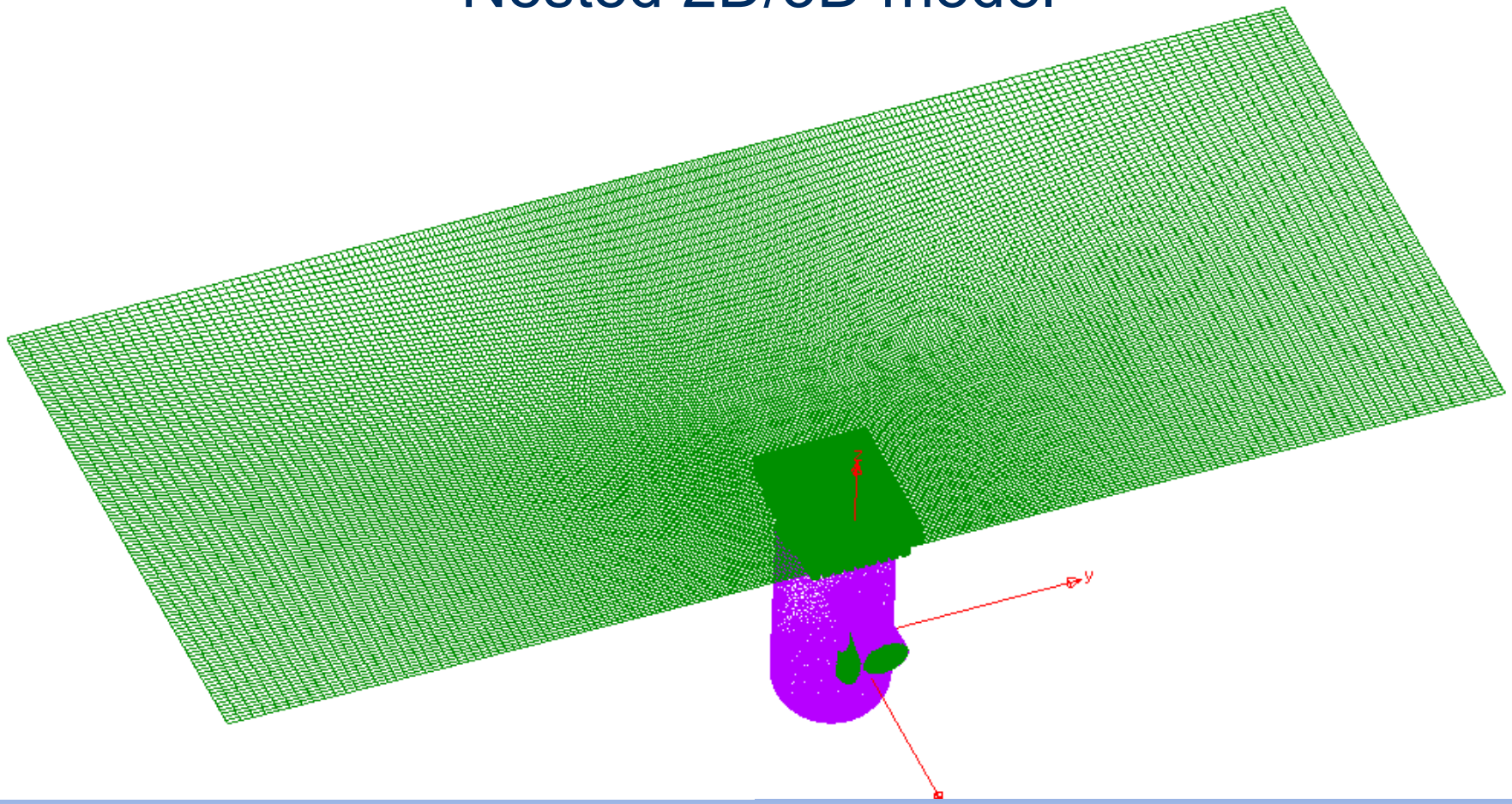
$$\mathbf{v}(\eta) = \mathbf{v}_{fs}.diag\,(\mathbf{a}\eta + \mathbf{b}\eta^2 + \mathbf{c}\eta^3)$$

$$\eta = \frac{n}{h}, \quad 0 \le n \le h$$



1. Depth of water (h) derived from mass conservation and handling pressure;
2. Mean velocity;
3. Gravity, surface tension and surface curvature are taken into account;
4. Shear stress as area-based term.

Nested 2D/3D model



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- **Northern Ireland Rivers Agency**

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