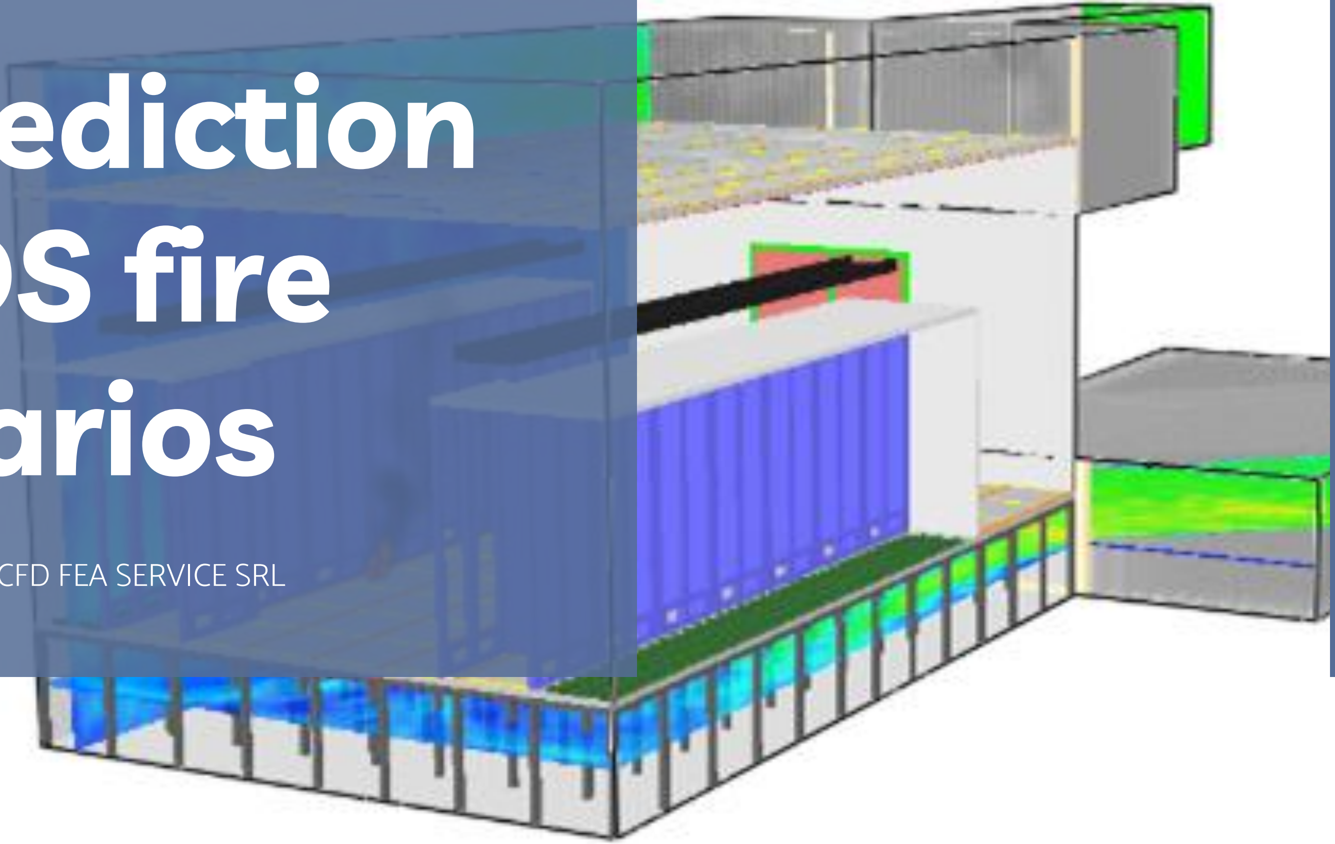
AI prediction of FDS fire scenarios



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INTRODUCTION

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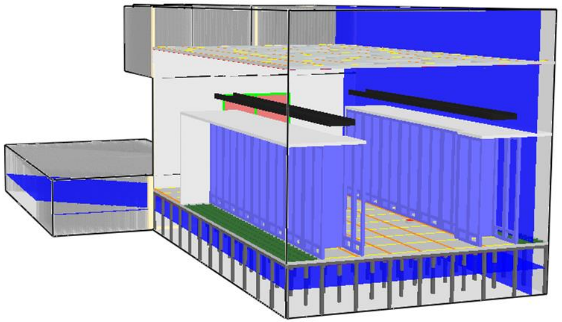
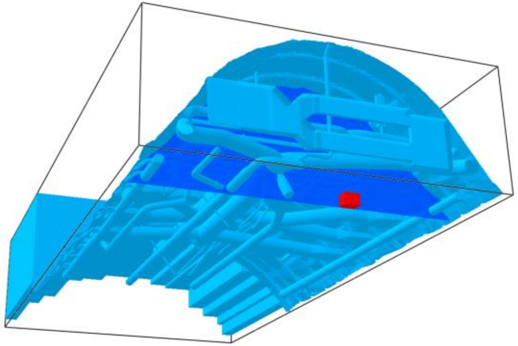
FDS SIMULATIONS





FDS - CFD

Standard approach for fire safety. It allows engineering predictions for fire scenarios and provide guidance to users and designers

HARDWARE

FDS simulations can be really expensive in terms of hardware resources. Cloud HPC can help but sometimes simulations can be high demanding/costly

SCENARIOS

Often designers are required to identify the “WORST CASE SCENARIO” which in theory it would require running several scenarios just to identify it

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AI PROJECT GOALS

PREDICTIONS

The main goal is generating an instrument that is able to predict the results of a simulations in a matter of seconds instead of hours/days

GUIDELINES

Identification of the worst locations for a fire scenarios inside a building

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HYPOTHESIS AND REQUIREMENTS

- Some results transient behaviour
- Localized fire
- Only smokeView and temperature
- Prediction accuracy report
- Qualitative results only

TRAINING

- Generation of an input database of simulations results to provide to the AI
- The input database defines the boundaries where AI can operate
- The more results are provided for a training the more accurate the prediction can be
- Training process is highly demanding of hardware resources (in our case, 1h per each simulations provided)

PREDICTION

- It is basically instantaneous
- Input data for the prediction: FDS input file ".fds"

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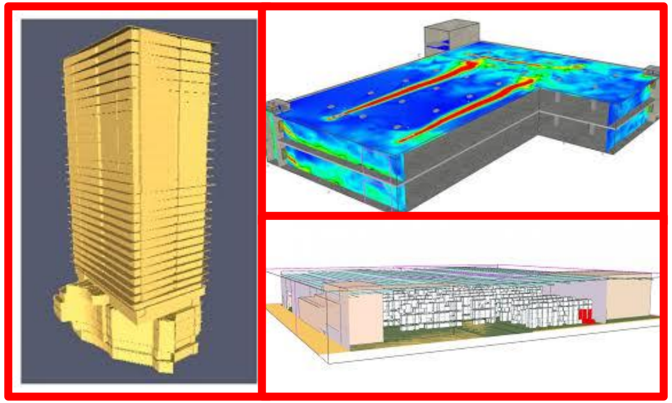
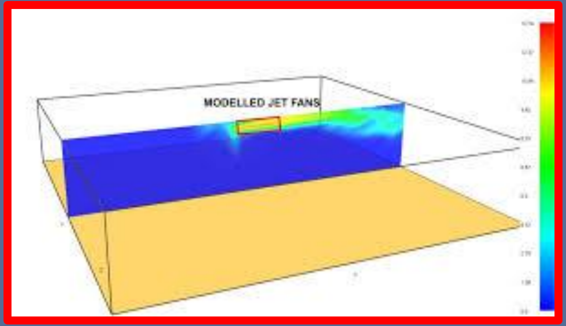
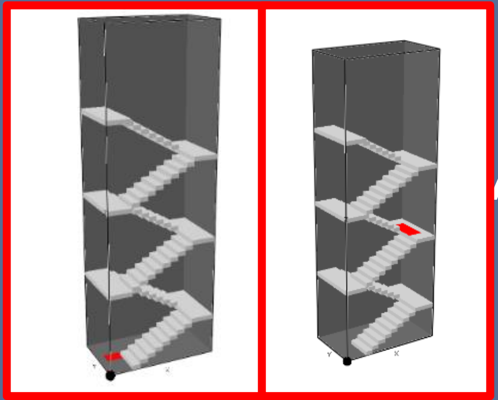
DATABASE OF SIMULATIONS







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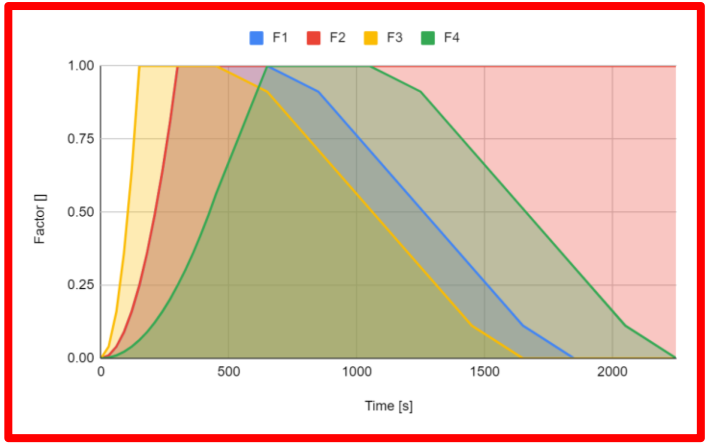

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OTHER PHYSICAL VARIATIONS

- ➢ Sprinkler
- ➢ Fire propagation
- ➢ Chemical reaction (SOOT/CO YIELD)
- ➢ Geometry variations in time (door opens/closes)
- ➢ ...

OTHER NUMERICAL VARIATIONS

- ➢ FDS versions
- ➢ Time steps
- ➢ Turbulence model
- ➢ Wall representation
- ➢ Mesh resolution
- ➢ ...

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TRAINING

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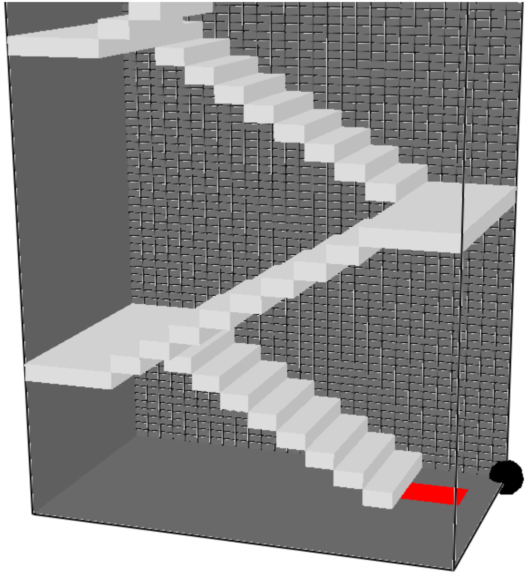
CHOSEN GEOMETRY



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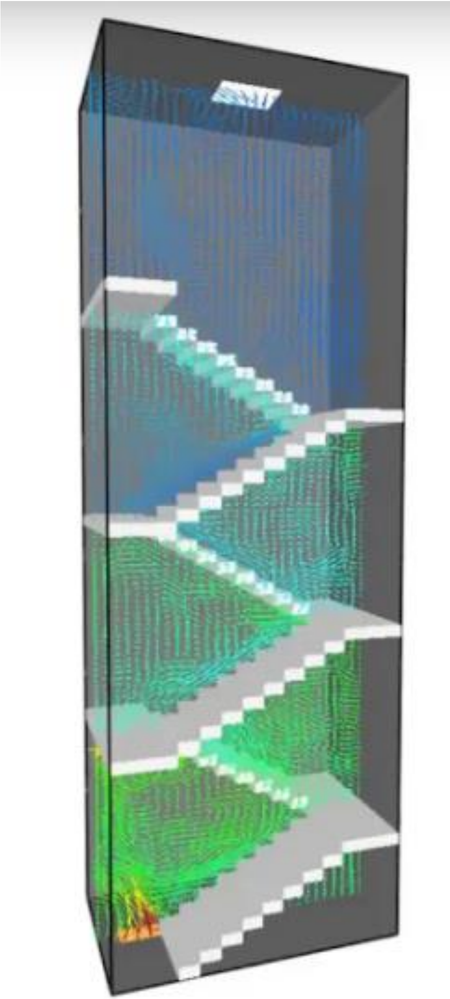

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SIMULATION FEATURES

GEOMETRY
Staircase example
provided by FDS Tutorial

SLICES
Set of horizontal slices at 1.5, 1.7, 1.8 and 2.0 metres from the ground. Two vertical slices at the centre of the domain normal to X and Y axes

VENTILATION
No ventilation considered

MESH
8 MESH with 8,000 cells each

TIME
T_END = 1800s
Results monitored at 300s, 600s, 900s, 1200s, 1500s and 1800s

DATA
VTK data conversion generated to allow communications

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R&D ACTIVITY

NAVASTO aerodynamic solutions

- Proprietary AI software
- Developed AI to perform pseudo-transient predictions

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- FDS cases and results setup
- Computing power provider
- Developed a converter from FDS to VTK file format

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GEOM RY

Geometry of the nsidered: from car parks to uses, partments to industrie

VENTIL TIO

Jet fans, supply/e natural ventilation (gr dows, gs)

FIRE LOC TION/AREA

Prescribed e t fire location is considered. F plied as a heat surface placed in specific area of the building.

HRR CURV

Shape of the ed assigned to the fire. Variation in ter otal HRRPUA can be indirectly depend the input of the HRR curve through the RAMP option.

APPLIED VARIABILITY

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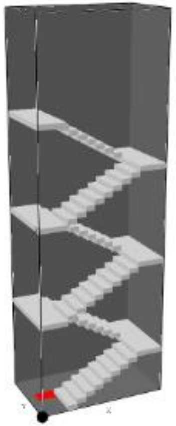
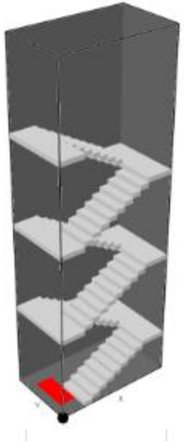
FIRE LOCATION/AREA

LB

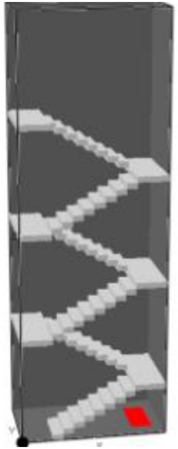


LBW



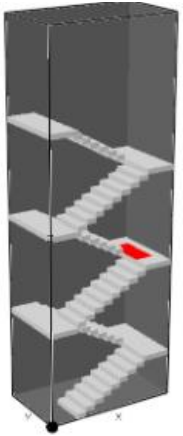
RB

RBW



LR

RRW



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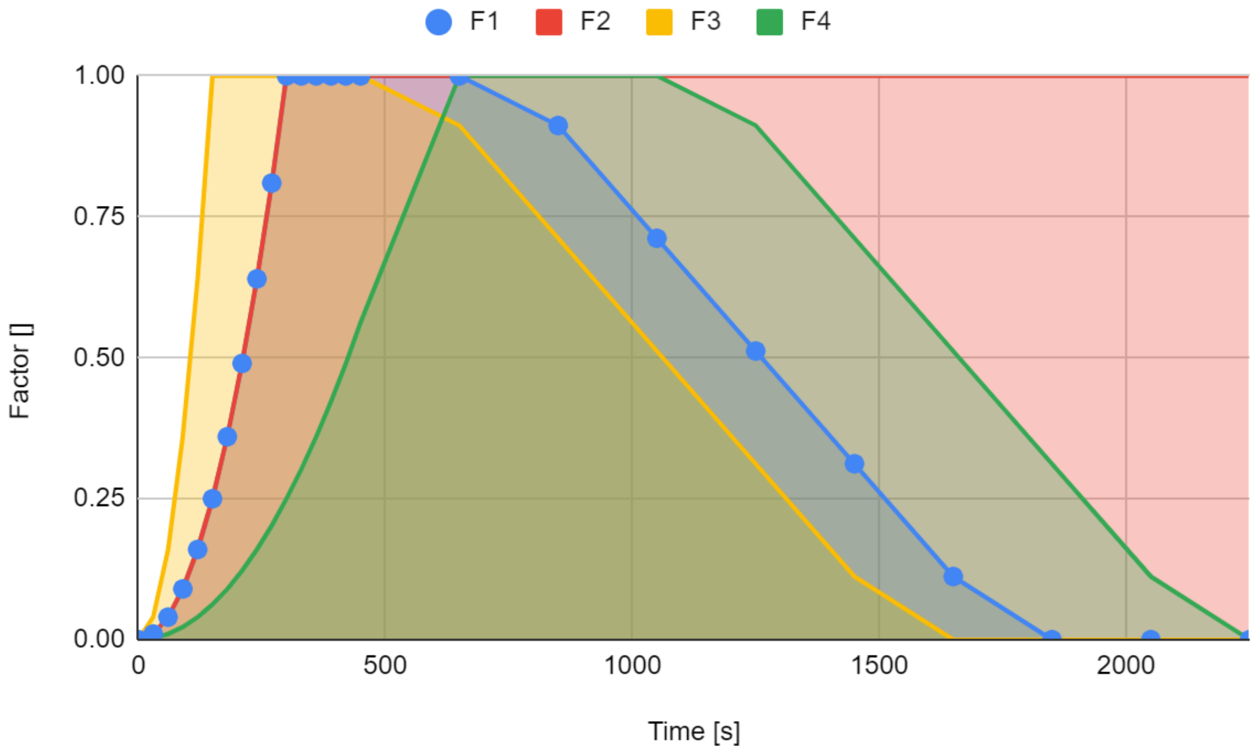
HRR CURVE



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AI TRAINING CASES

LOCATIONS	LB	LBW	RB	RBW	LR	RRW
F1	✓	✓	✓	✓	✓	✓
F2	✓	✓	✓	✓	✓	✓
F3	✓	✓	✓	✓	✓	✓
F4	✓	✓	✓	✓	✓	✓

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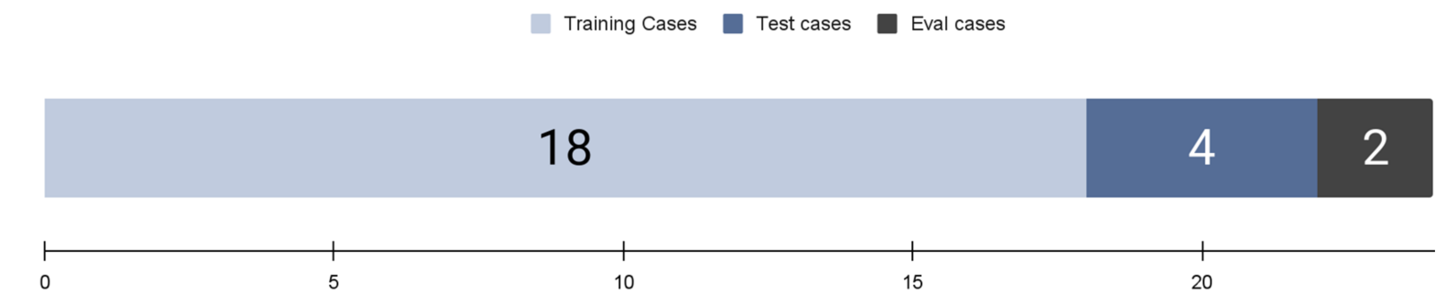
PREPROCESSING



TRAIN **75%**

TEST **16.5%**

EVAL **8.5%**

From the cases defined a total of 22 cases have been used to train the AI - 4 cases are used for testing the training. 2 more cases remained unseen by the AI and were used to test the predictions against real FDS analyses results.

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PREDICTIONS

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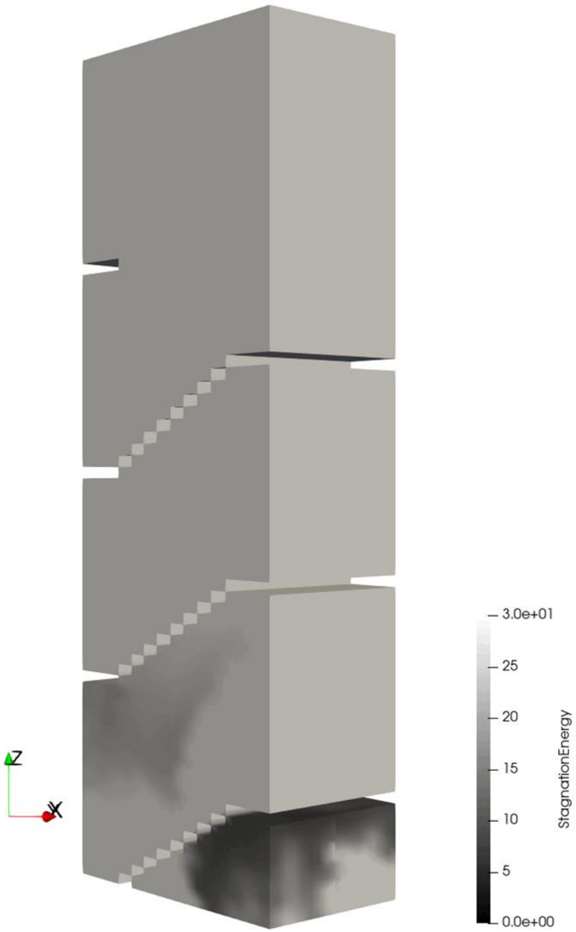
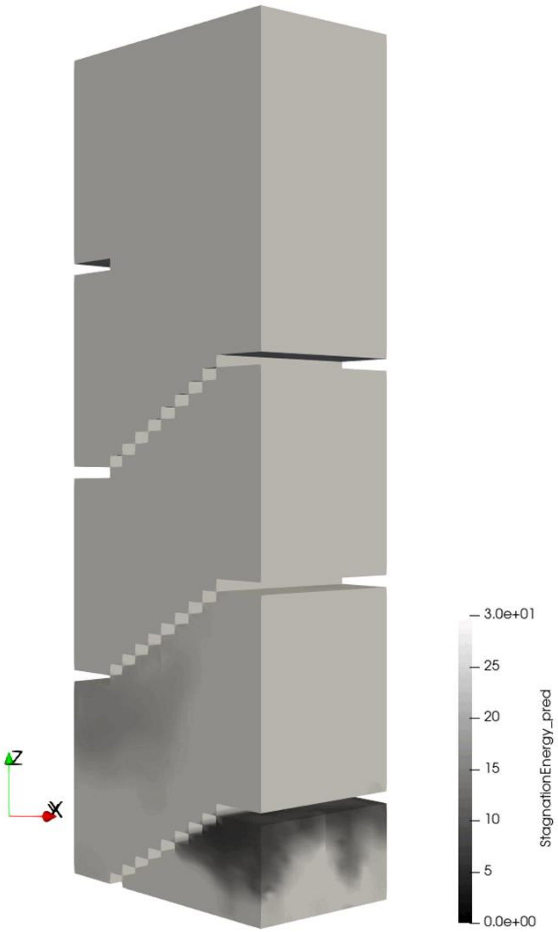


PREDICTION



SMOKE VISIBILITY

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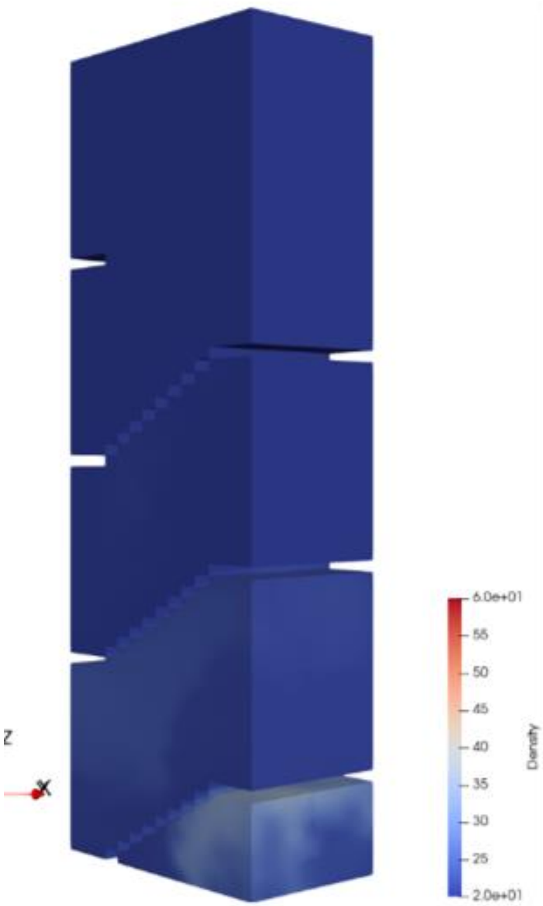
TEMPERATURE

FDS



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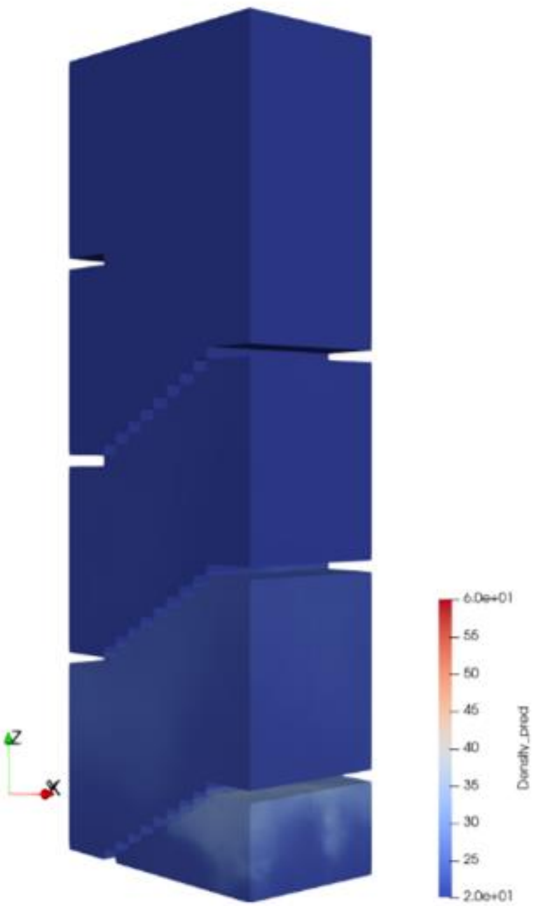

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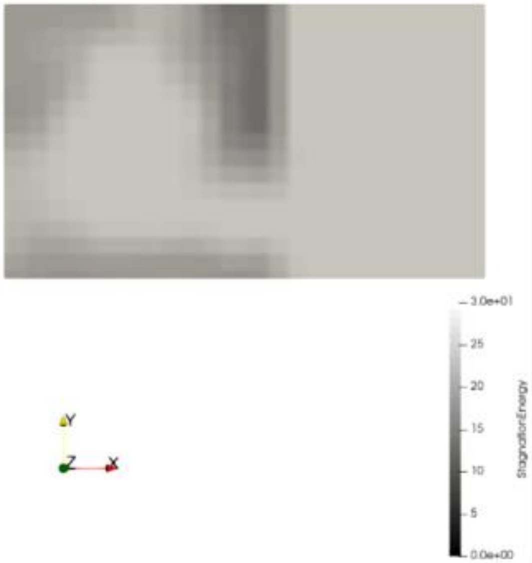
SMOKE VISIBILITY SLICE

FDS



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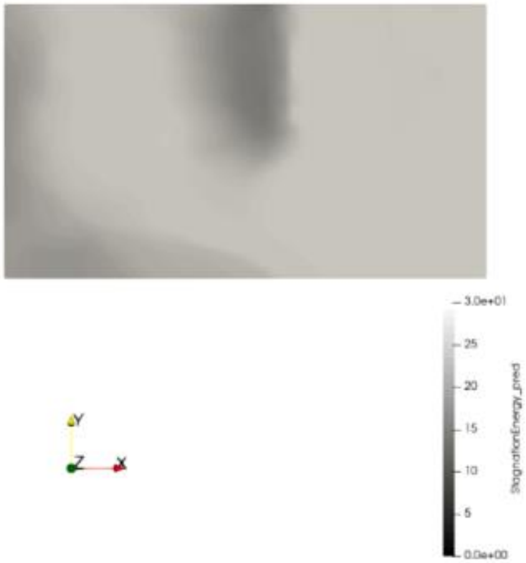

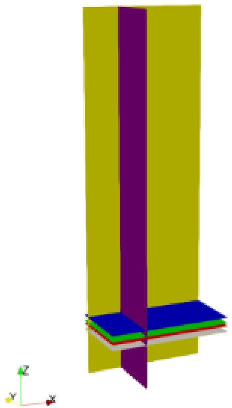

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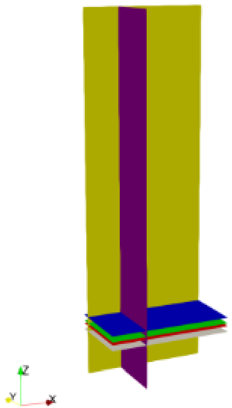
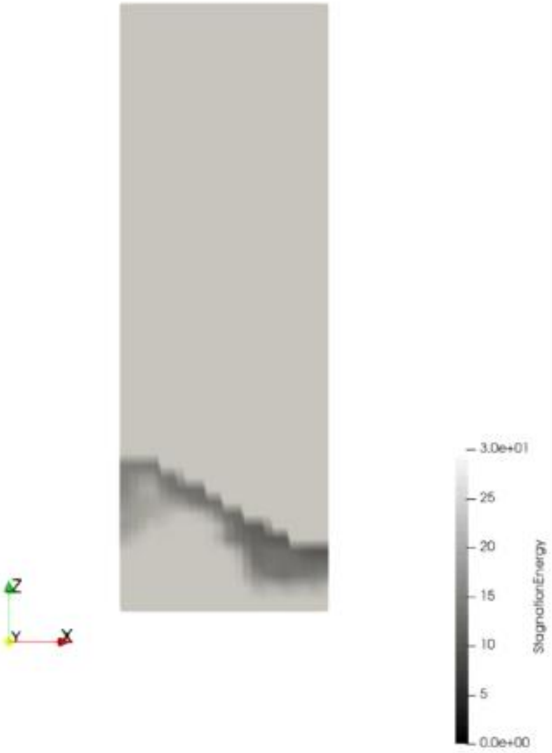
SMOKE VISIBILITY VERTICAL SLICE



FDS



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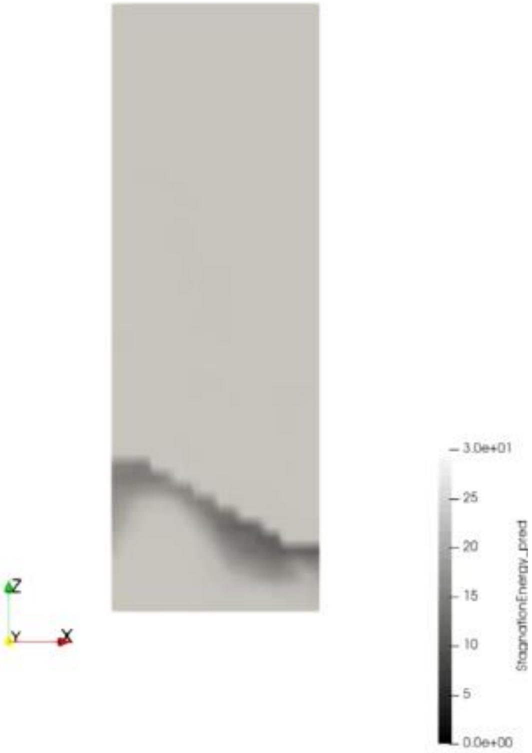

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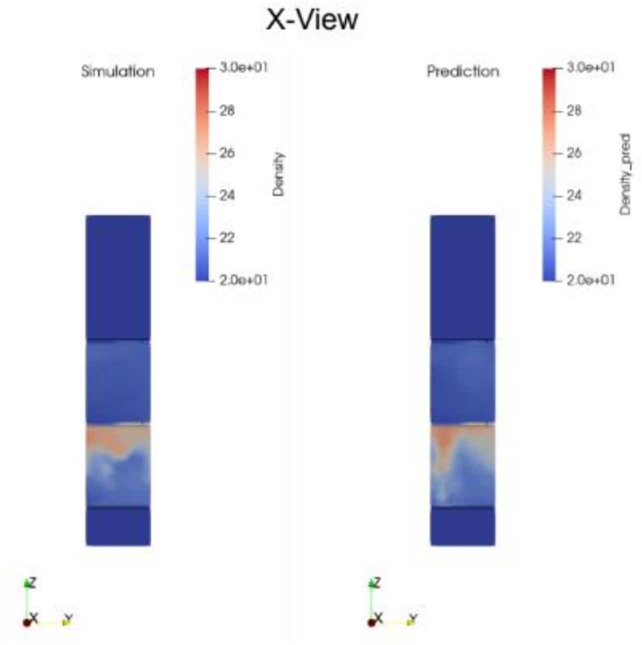
TEMPERATURE SLICES - T=600s

FDS PREDICTION



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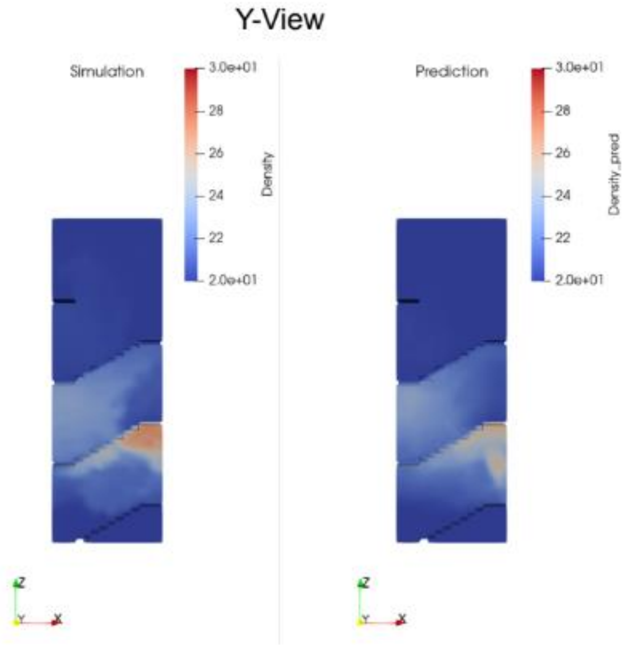

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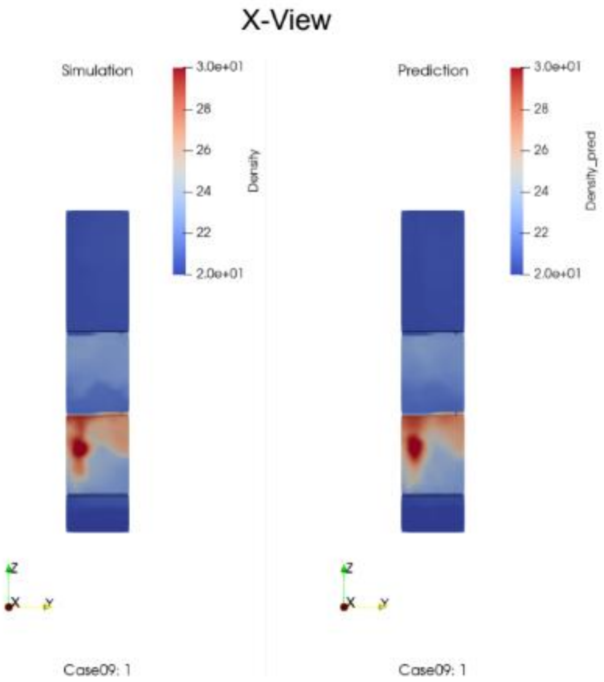
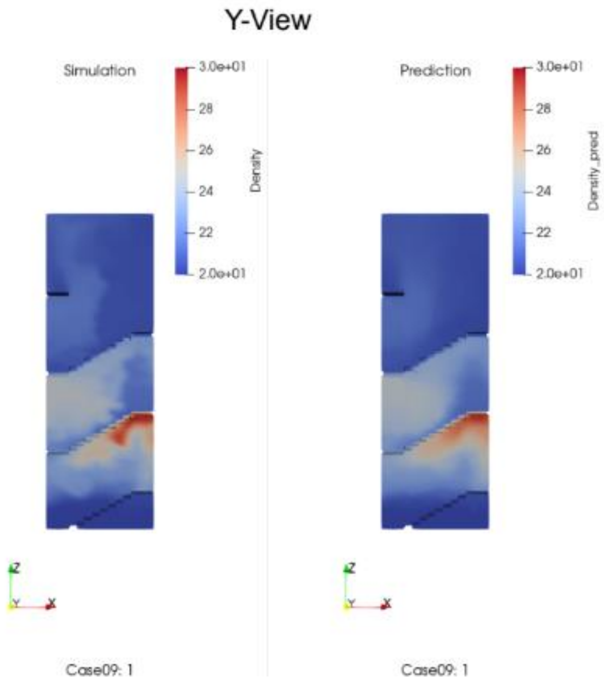
TEMPERATURE SLICES - T=1200s

FDS **PREDICTION**



FDS **PREDICTION**



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CONCLUSIONS

- ➔ AI can predict the main features of the FDS simulations
- ➔ Generation of a wide database of simulations is fundamental
- ➔ Once predictions are working it can be easily expanded to generate guidelines to choose the worst case scenario

WORK TO DO

- Managing bigger mesh size (higher cells number)
- Inclusion geometry variation
- Inclusion ventilation variation
- Accuracy report definition
- Actual output to provide

  Reduce the output to slice only
    - **Which slices?**

  Provide the output in format easy to read:
    - VTK allows interaction but requires ParaView [**Pyrosim**?!?!]
    - JPG would allow more flexibility but less interaction

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THANKS

Does anyone have any questions?
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