SECURE WITH STEEL

Development of an FDS – SAFIR Interface

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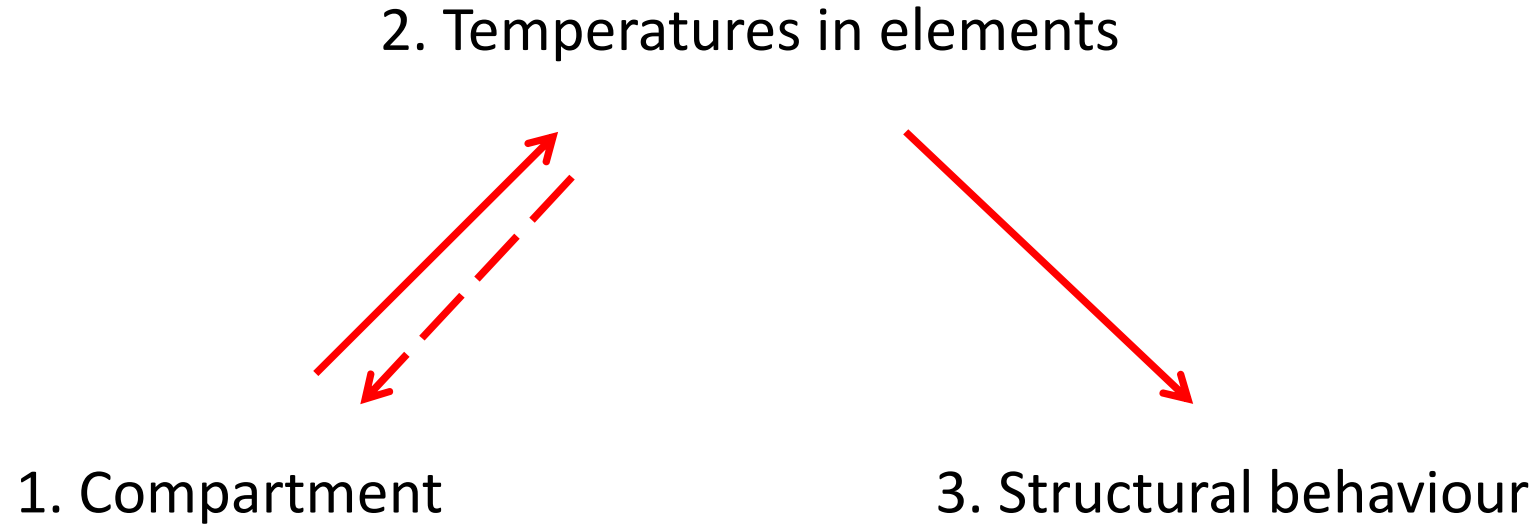
OVERVIEW

3 problems have to be solved. Each of them is governed by different equations.

1. Fire development => Temperatures and flows in the compartment. It requires a 3D model.
2. Thermal response => Temperatures in the structural elements. A 2D model is generally sufficient.
   - Elements across the compartment.
   - Elements on the boundaries of the compartment.
3. Mechanical response => Behaviour of the structural elements.

WEAK COUPLING STRATEGY



NOTE: Interaction 2 to 1

- It is complete if step 2 is performed by the CFD
- It is limited to the boundary of the compartment if step 2 is performed by the FE.

WEAK COUPLING STRATEGY

ESSENTIAL FEATURES

1) The structural elements are not present in the CFD analysis, except for the boundaries of the compartment, possibly in an approximated manner.

2) The temperatures in the boundaries of the compartment are calculated by the CFD software.

3) The temperatures in load bearing elements are calculated by the FE software.

WEAK COUPLING STRATEGY

FDS

- Simulation of the fire development in the compartment

TRANSFER FILE

INFORMATION:

- Temperatures
- Convection factors
- Radiant intensities

SAFIR

- Thermal response
- Mechanical response

WEAK COUPLING STRATEGY

ADVANTAGES

- The CFD calculation can be performed before and separately of the FE analysis.
- Can be used with different combinations of CFD and FE software.
- Less demanding in terms of CPU and hardware.
- If p structures must be evaluated under q fire scenarios, only q CFD analyses must be performed, compared to $p \cdot q$ coupled analyses in a two-way coupling approach.

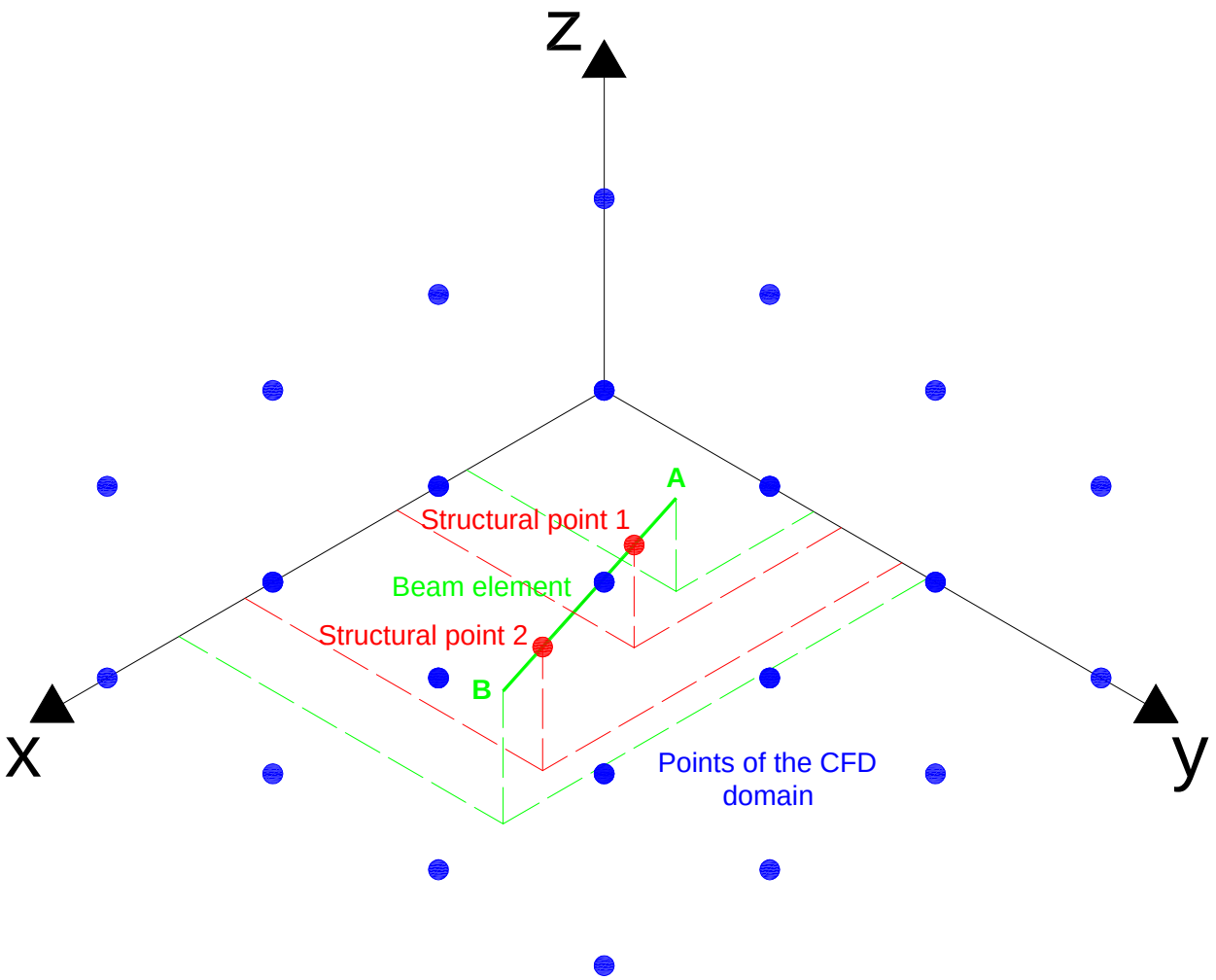
ISSUES

- How to judge whether the interactions between 1 and 3 are really negligible?

INTERPOLATION

A three level interpolation must be performed.

1. A Cartesian interpolation in space to have the information at the locations that are relevant for the structure.



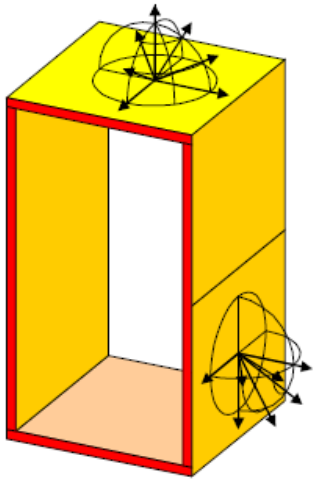
INTERPOLATION

2. An Interpolation in time to have the information at the time step that are relevant for the structure.
3. An Interpolation in spherical coordinates to have the radiant intensities in the appropriate directions on the surface of the structure.

INTEGRATION OF RADIANT INTENSITIES TO GET THE IMPINGING FLUX

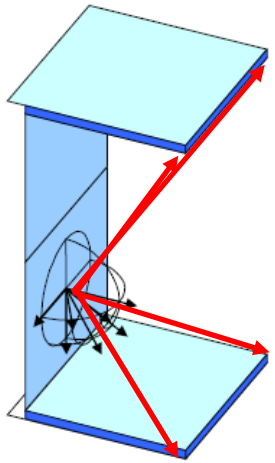
CONVEX ELEMENT

Integration on the whole hemisphere

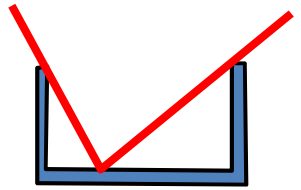


CONCAVE ELEMENT

Integration on “clear sky”

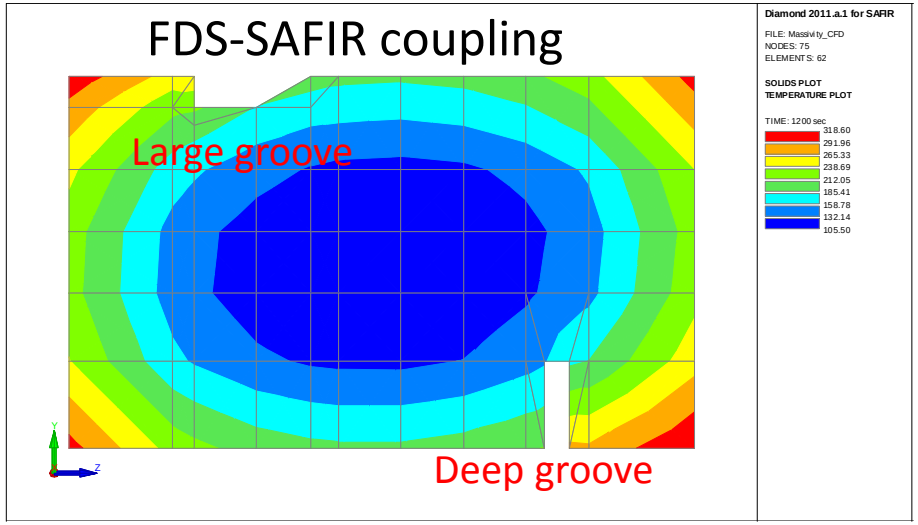


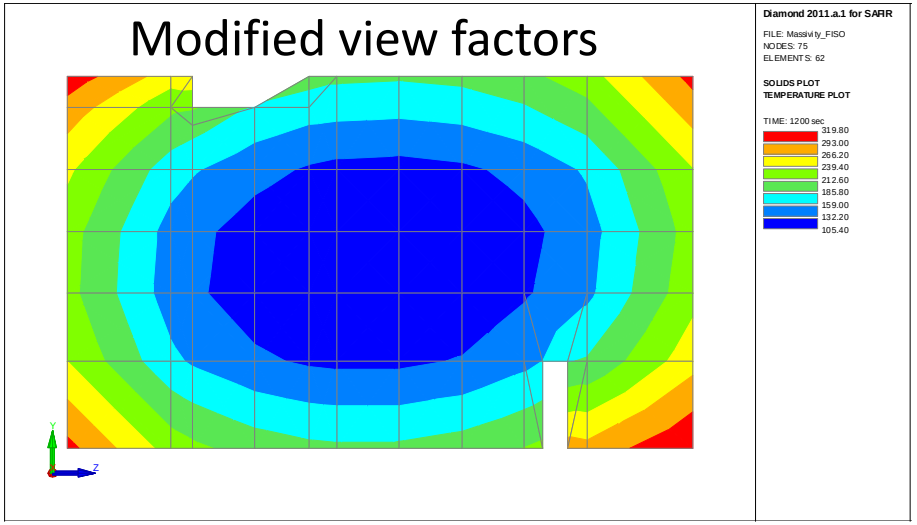
View angle

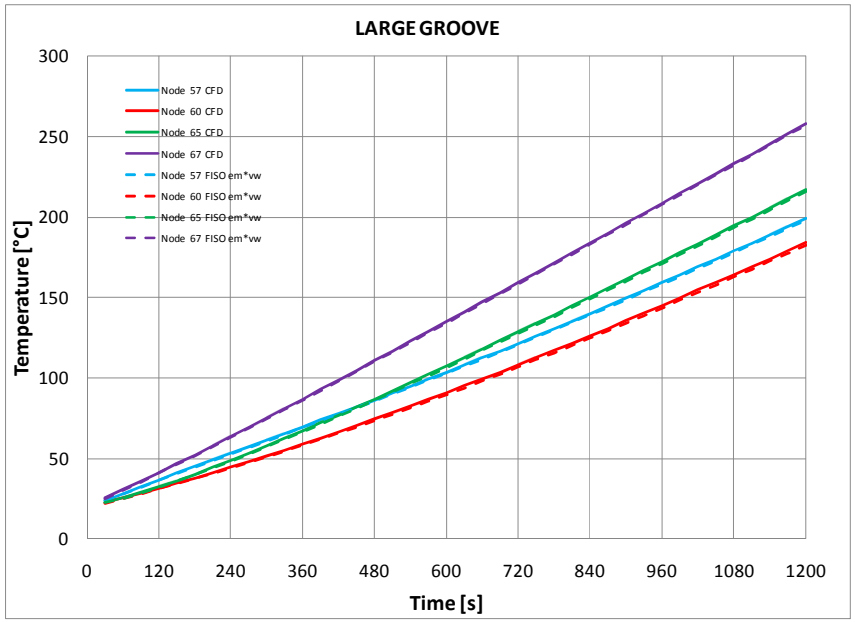


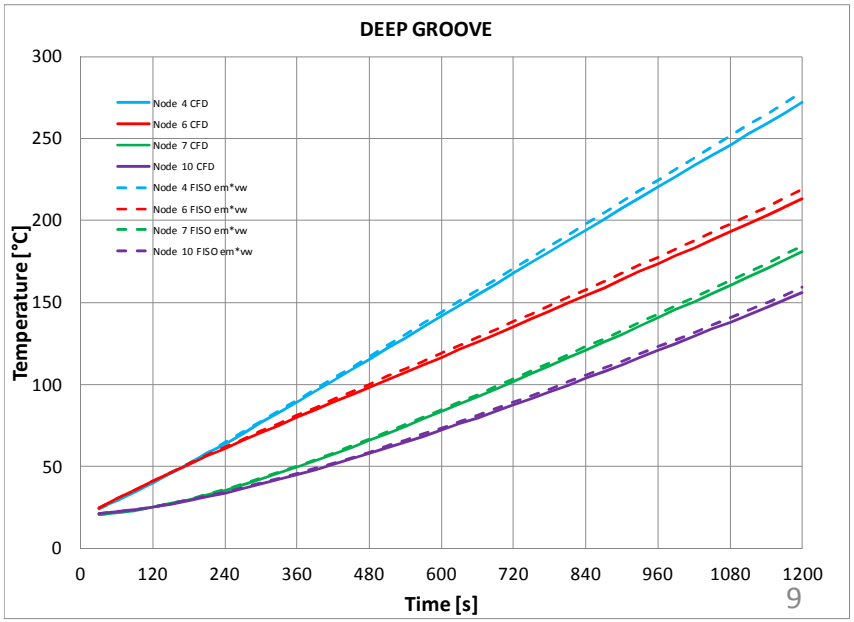
EXAMPLES: Uniform radiation

Standard fire ISO 834: spherical integration vs. view factors



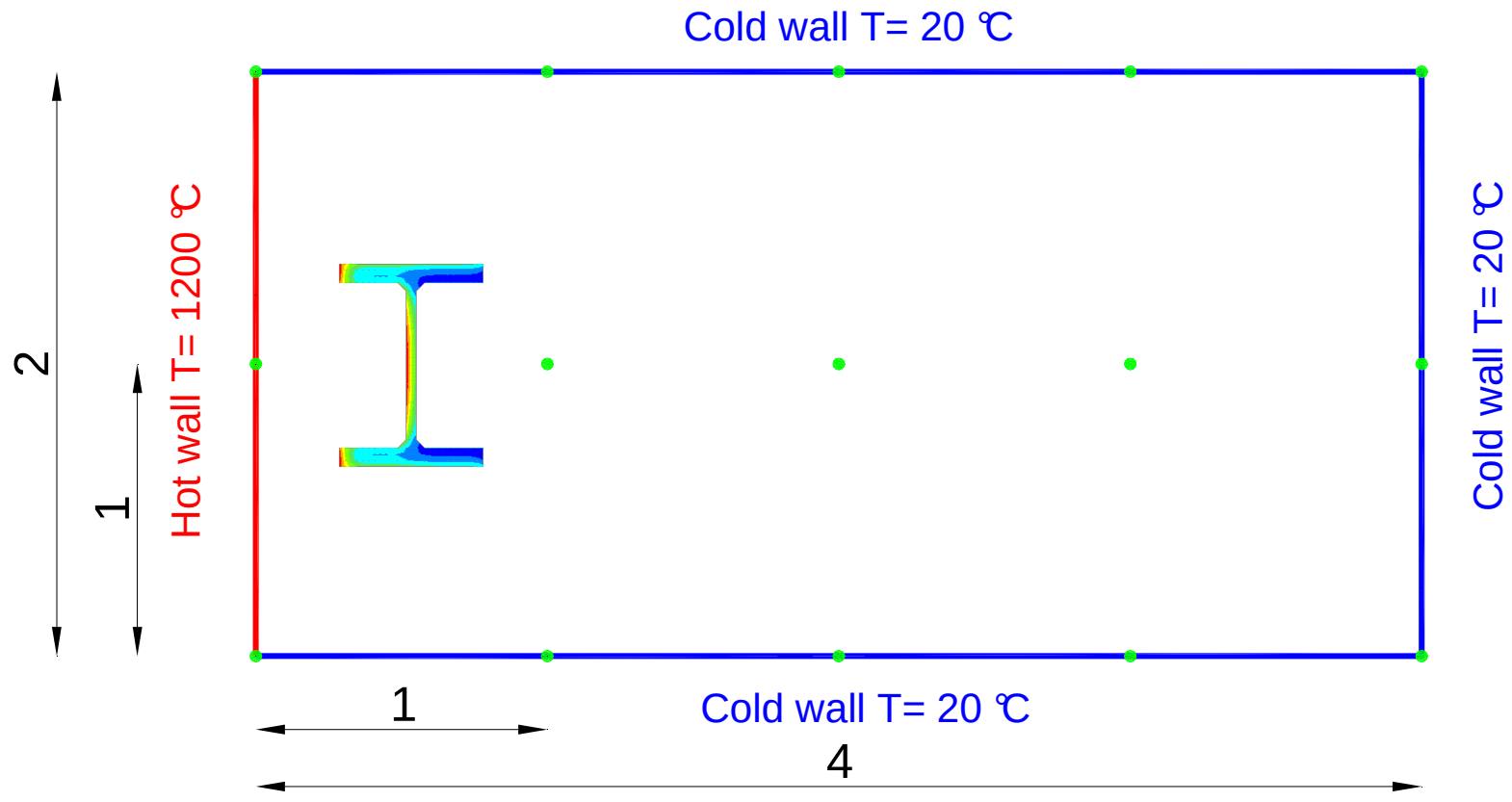






EXAMPLES: Non-uniform radiation

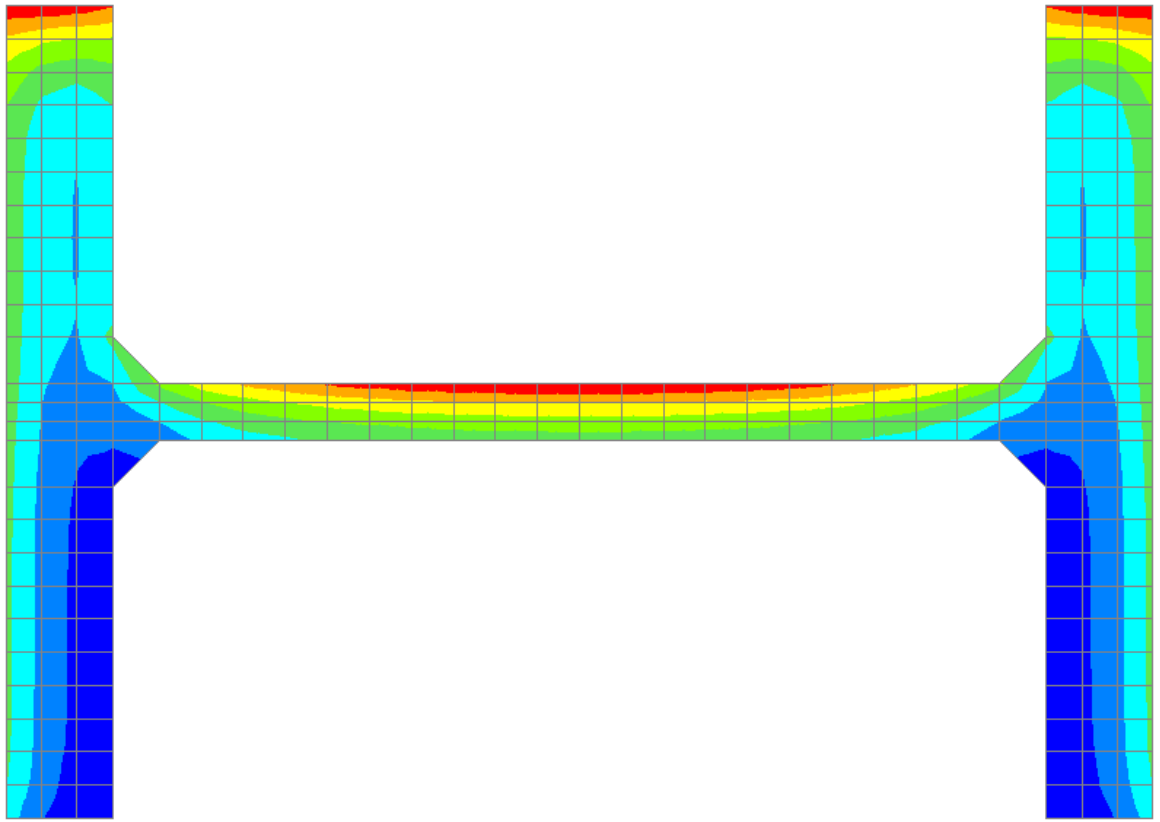
Compartment with one hot wall and a HE400M section



EXAMPLES: Non-uniform radiation

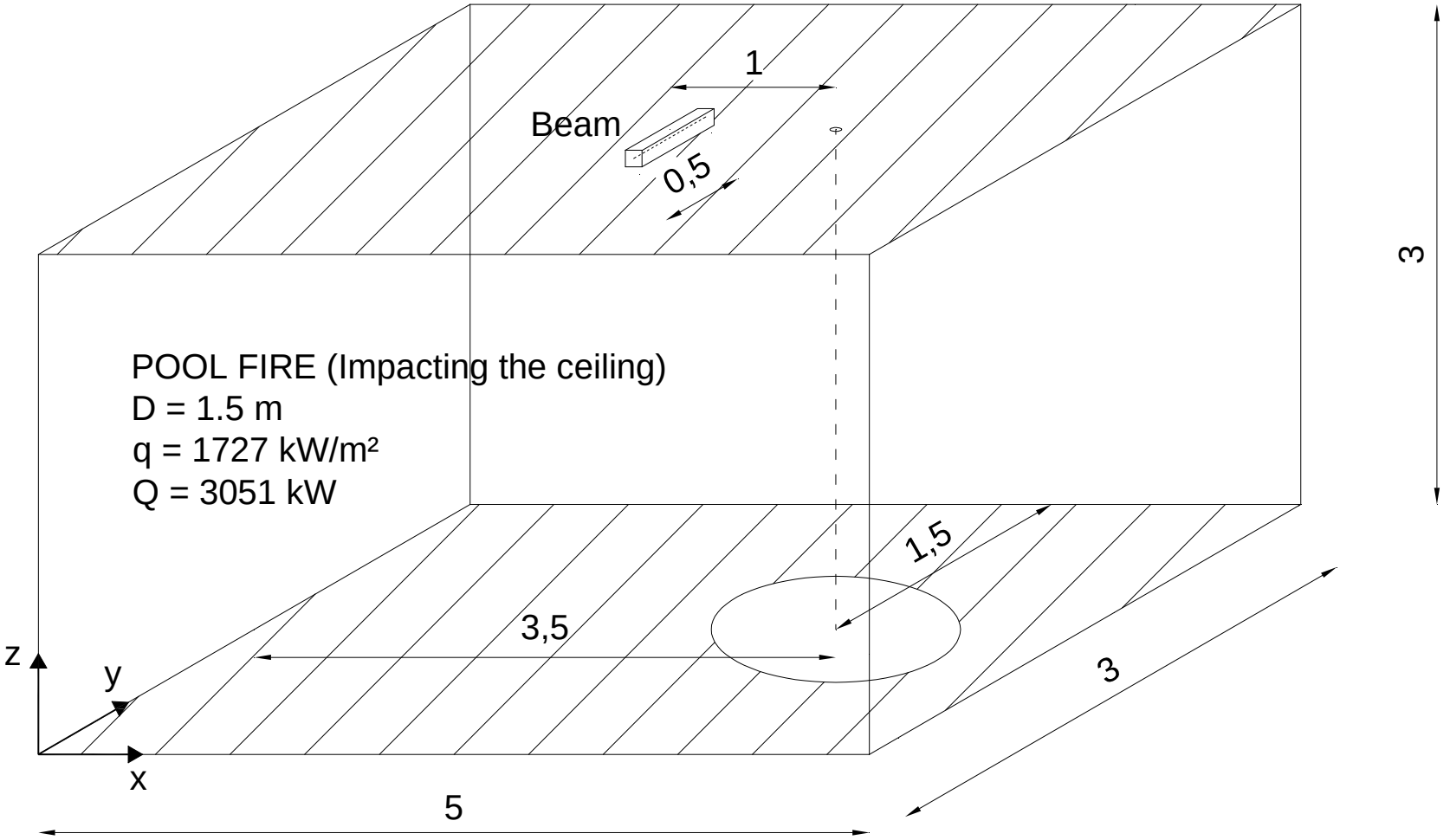
Temperature development in the section

Hot wall



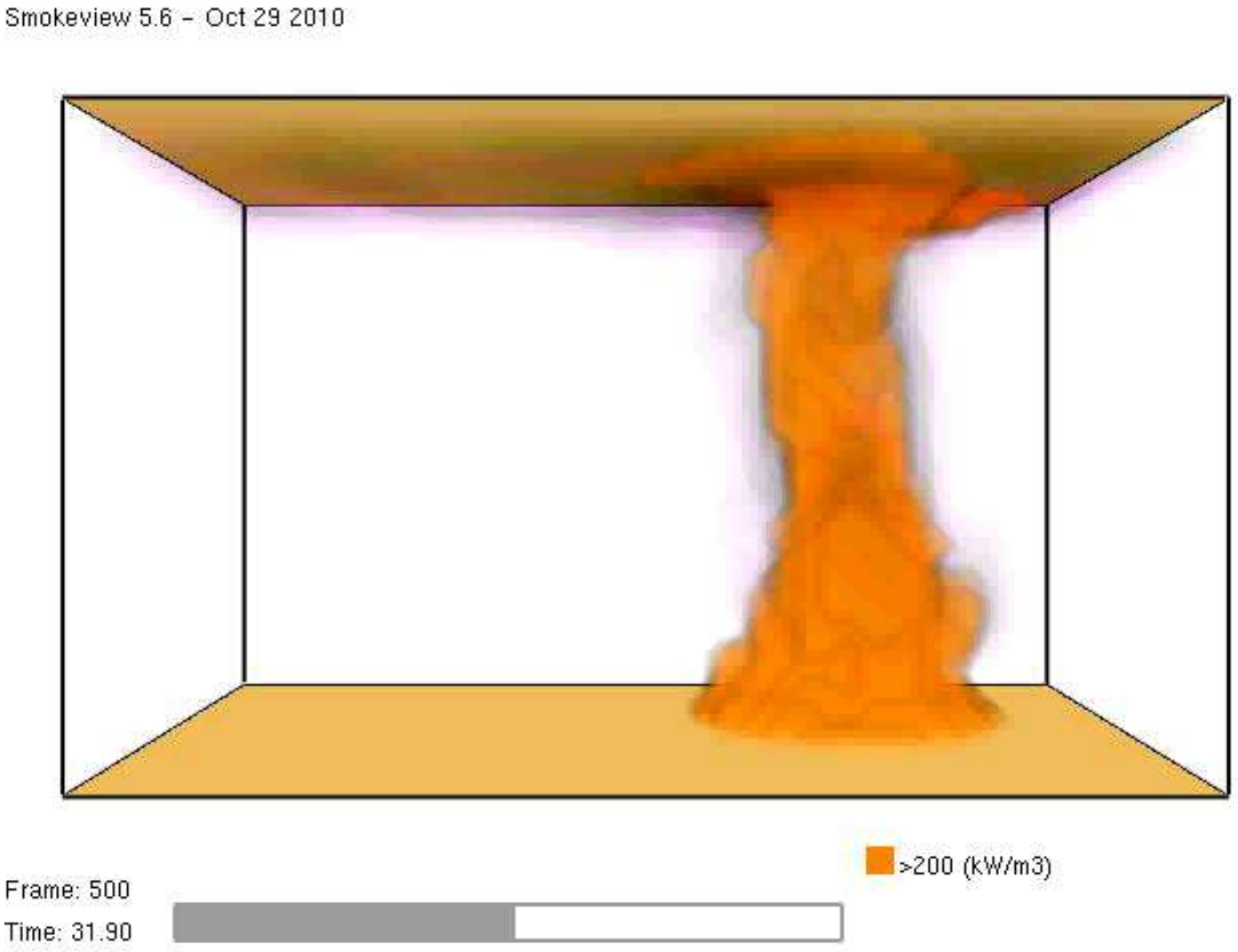
EXAMPLES: Compartment pool fire (FDS vs. HASEMI)

Geometry of the compartment



EXAMPLES: Compartment pool fire (FDS vs. HASEMI)

Simulation with FDS



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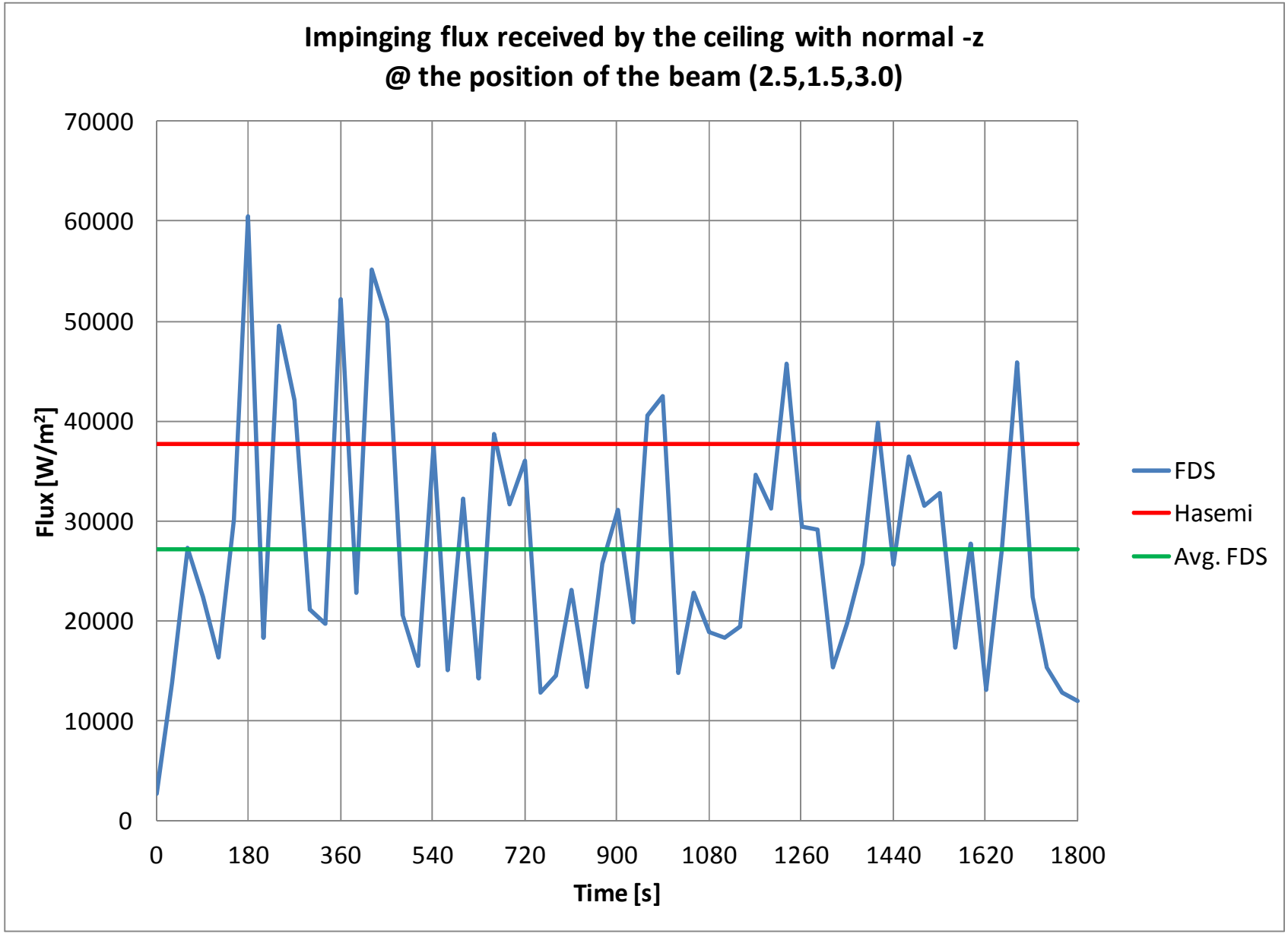
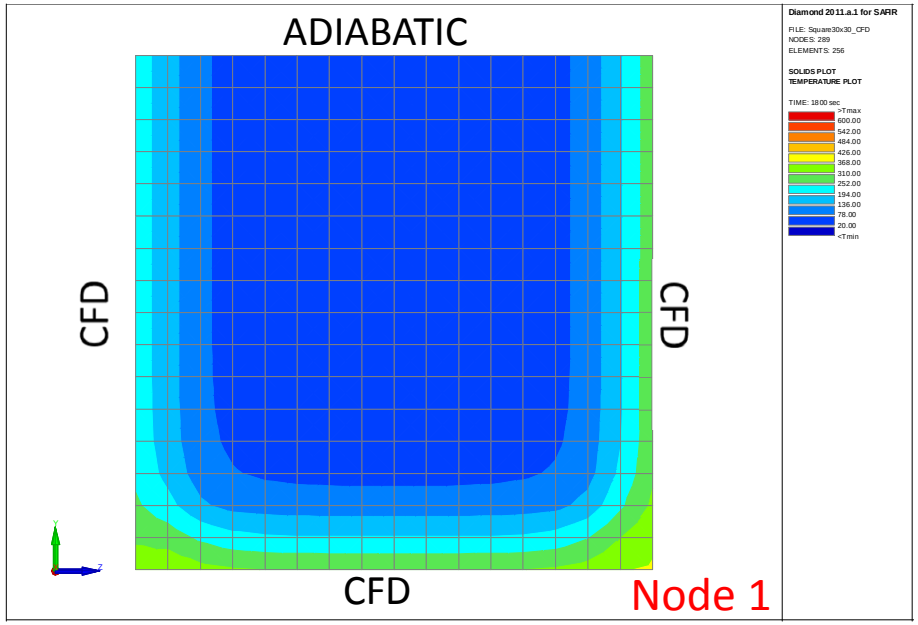


EXAMPLES: Compartment pool fire (FDS vs. HASEMI)

FDS @ t = 1800 s



HASEMI @ t = 1800 s