FCC Fire Safety Engineering Collaboration

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Interface to the FCC study

In the framework of the Future Circular Collider study (FCC) a fire safety engineering collaboration (FCC-FSEC) has been established. It is dedicated to improve all aspects of fire protection in (particle) physics research facilities, providing cutting-edge safety solutions.

Members of this group come from institutes worldwide:

- CERN, Switzerland
- DESY, Germany
- ESS, Sweden
- FNAL, United States
- MAX IV, Sweden
- University of Lund, Sweden
- University of Wuppertal, Germany

Principal collaboration topics

Four major research topics have been selected by the collaboration:

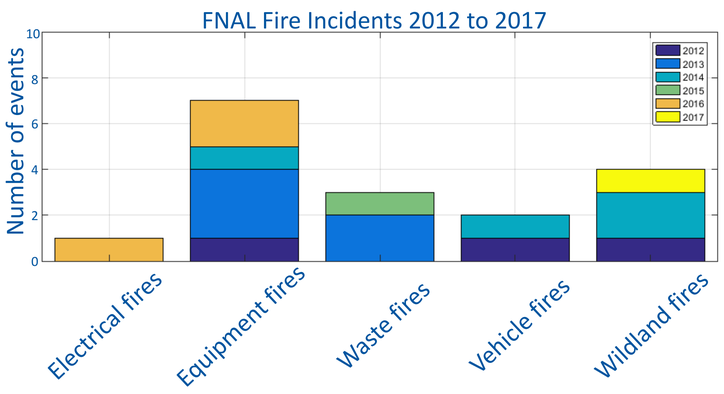
1. Fire statistics
2. Fire detection and extinguishing
3. Fire propagation and its limitation
4. Evacuation

Thus, all aspects of a fire incident in physics research facilities are covered. Each collaborator is contributing on one or multiple subjects, depending on local existing knowledge and experience. Besides monthly video conferences, the collaboration meets twice per year at different locations to discuss the ongoing work and set future goal and objectives.

Contribution example: FNAL fire incident data

Fire incidents at FNAL are reported to the US Department of Energy (DoE), storing all available data in a dedicated database. Its content helps the collaboration to understand the frequency of occurrence of certain events, possibly deriving likelihoods for future events.

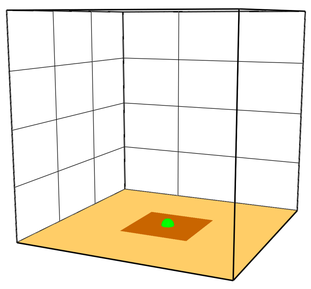
Similar data has been made available e.g. by CERN and DESY.



Contribution example: Parameter optimization for fire modeling

During the CHRISTIFIRE project experiments were conducted to investigate the fire behavior and development of cables in tray configurations. Experiments have been performed on different scales, from benchscale to real scale. The gained data is used to generate material parameter sets to conduct fire simulations and predict the fire development and spread in cable trays. As a final goal, a pipeline to create material parameter sets for fire simulations has to be established.

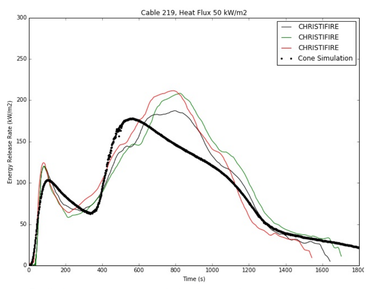
A simplified three dimensional model of a standardized Cone Calorimeter test is used, in conjunction with a Shuffled Complex Evolutionary algorithm, to determine the material parameter sets. The cables are represented as a layered material to account for different plastics (jacket, insulator). Up to 35 model parameters, such as density, specific heat and heat of combustion are taken into account for the optimization process.



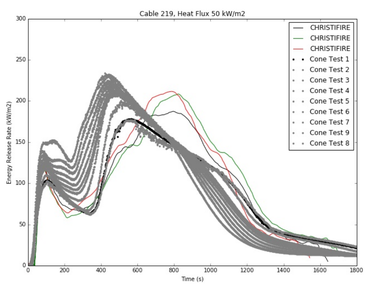
Simplified Cone Calorimeter model

Cone Calorimeter Sample

Typical Cone Calorimetry test results are shown below. Therein, the black dotted plot represents the simulation results from the optimization process.

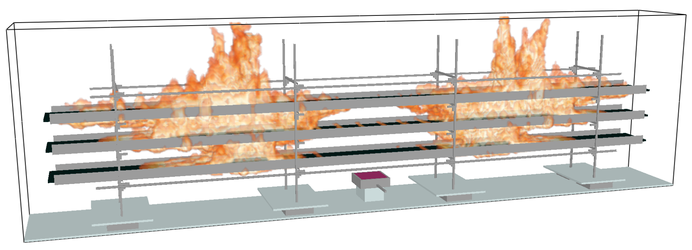


Preliminary parameter optimization results



Grid resolution sensitivity test

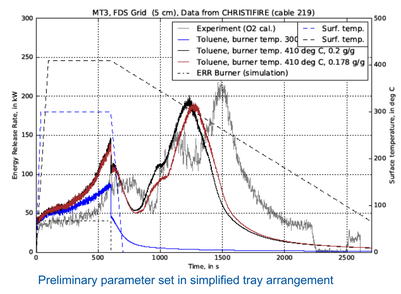
The established preliminary parameter set yielded reasonable results at a grid resolution of 10 cm. However, it could be shown that the solution is grid dependent. Nevertheless, it has been used to test the general behaviour of higher fidelity to be applied later on.



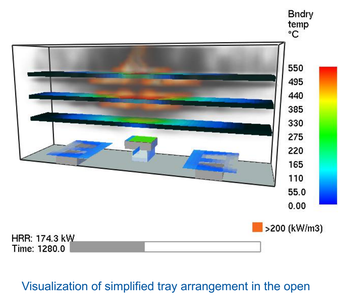
Higher fidelity cable tray

Contribution example: Research on fire propagation in cable trays

A open cable tray setup was used to demonstrate that the simulation of fire propagation could be performed. Furthermore, a corridor model was used to investigate its behaviour and computational demands.

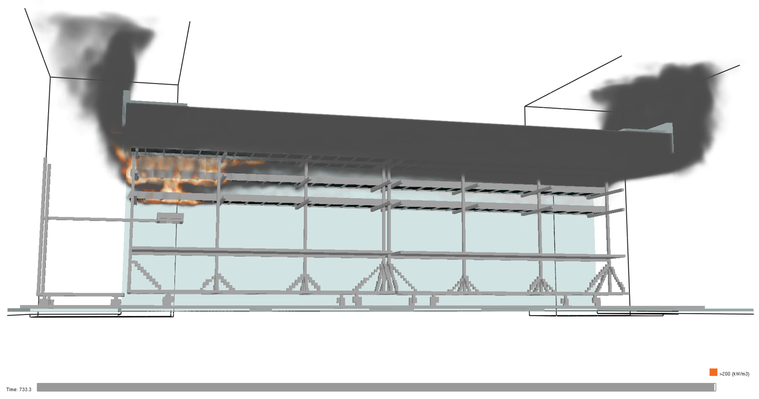


Preliminary parameter set in simplified tray arrangement



Visualization of simplified tray arrangement in the open

It could be successfully demonstrated that the simulation of fire propagation in cable trays is possible. Now, the overall process will be refined and multiple cables from CHRISTIFIRE are to be processed to validate the approach. Furthermore, tests with CERN-specific cables will be carried out in June 2017, so that this data can then be used for design fires for CERN infrastructures, like the FCC accelerator.



Visualization of CHRISTIFIRE corridor setup

Outlook

Since 2015 the fire safety collaboration, established in the framework of the FCC study, carries out research on fire safety related subjects dedicated to physics research facilities, especially for the FCC particle accelerator tunnel.

Here, only a few examples of the ongoing regular and lively exchange of knowledge, experience and data taking place could be shown. Its benefits is already visible to all co-operating institutes and academic partners. It is in the utmost interest of all collaborators to continue – even beyond the current scope.

Works cited

- CHRISTIFIRE Phase 1, NUREG/CR-7010, Vol. 1, July 2012
- FDS User's Guide Sixth Edition, NIST, http://dx.doi.org/10.6028/NIST.SP.1019, November 18, 2015

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http://cern.ch/gentner