PROGRESS REPORT

CONTRACT N° : IST-2000-29266

PROJECT N° : 29266

ACRONYM : VIRTUALFIRES

TITLE : Virtual Real Time Fire Emergency Simulator

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1 Table of contents

2 Executive publishable summary

A Virtual Reality Real Time Fire Emergency Simulator (VIRTUALFIRES) will be developed using techniques of virtual reality. In the simulator, the observer will be able to visualise the fire and smoke development and the transport of heat and toxic combustion products inside a tunnel and walk or run through the virtual structure in the same way as through a real tunnel. The simulator will use and access a database, which contains the results of three-dimensional transient combustion (Computational Fluid Dynamics - CFD) simulations for particular tunnel geometries with associated safety installations, particular fire hazard scenarios, etc.

It is planned to develop the system as a fixed installation in a CAVE virtual environment and as a portable installation using a PC and a head-mounted display (HMD). Two systems are planned: one where the CFD simulation is pre-calculated, stored into a data base and then displayed another where it is carried out in parallel to the visualisation. In the first system the user will be able to move through the data but will not be able to change the characteristics of the simulation, for example the ventilation characteristics. In the second system the user may change the properties of the simulation while the data are displayed.

The VIRTUALFIRES system will be a unique system that can be used for assessing the fire safety of tunnels and aircraft, for training of rescue personnel and for planning rescue scenarios and will be able to replace or supplement real fire tests. The end users of this system will be rescue organisations such as the fire brigade and police, tunnel operators and government organisations concerned about tunnel safety. The system can be used for making an objective assessment of the fire safety of existing European tunnels. It can also be used for training drivers on how to behave in the case of a fire emergency in a tunnel.

3 Objectives and strategic aspects

We propose to apply the method of virtual reality to develop a simulator for assessing the fire safety of tunnels and for training rescue personnel. In a virtual computer-simulation-based environment all data about the structure, the safety equipment, ventilation, the fire and smoke development and vehicles/passengers exist in computer memory only. These data are displayed in such a way that the user has the possibility to study all the hazardous effects of a real fire emergency. The project therefore aims to contribute to efforts by the Community to increase the fire safety of European tunnels. It also aims to extend the range of application of virtual reality techniques.

The objective is to develop and implement a Virtual Reality Real Time Fire Emergency Simulator (VIRTUALFIRES). In the simulator, the observer will be able to visualise the fire and smoke development and the transport of heat and toxic combustion products inside a tunnel and walk or run through the virtual structure in the same way as through a real tunnel.

By the end of this project a prototype of the VIRTUALFIRES simulator will have been developed which can be used by government authorities, tunnel operators and rescue personal. Currently the only method available to assess the fire safety of tunnels is to perform real fire tests. The advantages of virtual reality based simulations are that they offer virtually unlimited scope, are economical (the only expense being the computer time) and are environmentally friendly because no toxic waste is produced. As a result of the project's activity, through the availability of VIRTUALFIRES, the fire safety of tunnels will be increased because all European tunnels can be tested for fire safety and virtual fire tests can be made obligatory for new tunnels.

The work plan is to develop computer software, which together with specialised hardware can be used to display in a virtual reality environment the geometry of a tunnel with all its structural elements and safety installations together with the results of computer simulations of fires. The simulator will use and access a database, which contains the results of three-dimensional transient combustion (Computational Fluid Dynamics - CFD) simulations for particular geometries, hazard scenarios, etc. It is planned to develop the system as a fixed installation in a CAVE virtual environment and as a portable installation using a PC and a head-mounted display (HMD) although emphasis will be placed on the development of the CAVE installation.

The applications on which we will concentrate the development include:

Training of rescue personnel. Currently this can be only done with real fire test, which are expensive and produce toxic material.

Objective assessment of the fire safety of tunnels. This is currently either done using a list of rather arbitrary rules or by performing real fire/smoke tests (i.e. Mont Blanc Tunnel).

The simulator can also be used for:

Training of drivers. Using the simulator truck and other drivers can be trained on how to behave in a case of a fire accident.

Intervention management. The tunnel operators will be able to train the intervention procedures in order to mitigate the effects of a fire emergency.

4 Scientific and technical performance

4.1 Objective summary

4.1.1 Workpackage 3

The objective is to specify the database for geometrical input data for the VR-System and the CFD-Calculation, which should be done in Task 1. The work of task 2 is to specify the format of data, which are necessary for visualisation (i.e. display of smoke and fire). In task 3 the existing data compression and optimisation techniques are evaluated to provide a real time visualisation with a given I/O rate. After specification the work must be done in task 4 and be tested in task 5. Task 6 closes WP3 by writing the documentation.

4.1.2 Workpackage 4

The objective is to implement the VIRTUALFIRES functionality specified in WP2 in the VR environment. The same software will run both in the CAVE environment and in a Head Mounted Display (HMD) system with some modifications. The HMD-version of VIRTUALFIRES is designed to run on a well-equipped graphics workstation or PC. To display CFD data requires many optimisations because of the size of the data and is also demanding from a user interface perspective. The coupling of real-time generation of CFD-data to the VR-environment is highly innovative and raises many unsolved problems.

4.1.3 Workpackage 5

The objective is to develop advanced, efficient and user-friendly simulation tools for the computer aided analysis of tunnel fire hazards and embedding them into the VR environments (CAVE and HMD) of the other partners. Two approaches have been followed during the past period concerning the development of these tools. The first one was the a-priori generation of CFD data for various anticipated tunnel fire hazards (MontBlanc and Gleinalm tunnel) using the commercial CFD package FLUENT™, whose underlying numerical algorithms are based on implicit time integration schemes and body fitted computational meshes. The results of these computations have been stored in the central VIRTUALFIRES database and can now be accessed by the different VR systems for the visualisation of flame front and smoke movement.

Whilst the above approach represents a standard way to display data in a VR environment, the second solution strategy pursue is much more challenging and definitely contained some technical risk. Here it was envisaged to run the CFD simulations in real time embedded in the VR systems. The numerical methodology is based on the Lattice-Boltzmann method and utilizes explicit time integration schemes. Initial tests, which have been already performed, proved the feasibility of the proposed solution strategy. However, it is obvious that this approach requires significant computing resources and it will not be feasible to compute in a concurrent fashion the fire hazard taking place in the entire tunnel geometry. It is therefore planned to solve the full three dimensional conservation equations only in regions of interest (an extended area around the user). The remote areas of the tunnel will be treated using one dimensional transport equations for the hydrodynamic quantities. The boundary conditions at the interface between the 1D/3D areas are adopted continuously. Already available results are very promising.

4.2 Technical progress

Fig.1 shows the layout of the integration of VIRTUALFIRES. A detailed description of the different modules is given in the following sections. The optimised visualization methods are integrated as plug-ins to the Cover Renderer in Covise as well as the User Interface Controller, which handles the communication with the User Interface.

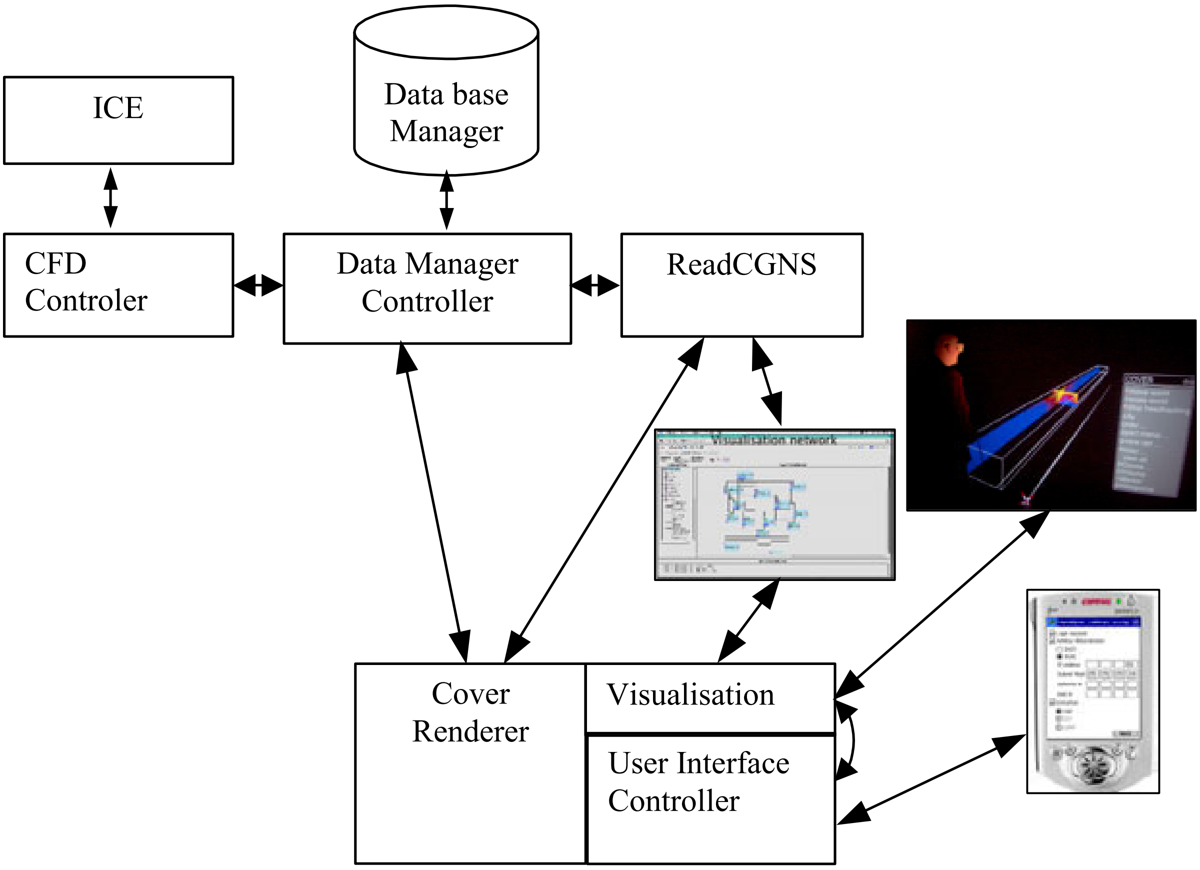


Fig.1: Layout of the VirtualFires Simulator

4.2.1 Workpackage 2

4.2.1.1 WP 2.4a: "Updated system specification"

As decided by the consortium the first update of the system specification (WP 2.4a) was made. on 14.03.03. The main modification was the description of a clear system layout and how the several modules coming from the developing partners will be arranged and communicate with each other. The developers responsible for each of these modules were determined. It was also clarified how the whole Virtualfires System will be adapted to the Covise VR Environment.

4.2.2 Workpackage 3

4.2.2.1 Datamanager and Database

The DM module provides the connection to the remote SQL database server and maintains the integrity of the stored data. It provides an API for data access and manipulation and is independent from the Covise VR environment.

The database server is based on the MySQL 4.0.12max SQL-server from MySQL AB, Sweden. The communication between the DM and database server was realised by using the C++ API mysql++ from MySQL AB, which is, besides the MySQL-client libs, the only SW infrastructure that is required by the DM.

4.2.2.2 Communication ICE – DM – Visualisation(DMC)

The modules ICE and CFDController are outside the Covise VR Environment and were developed by SiTu for the first prototype. The CFDController is responsible to receive messages from the DMC (DataManagerController) such as starting new computation, changing boundary conditions during a running computation etc. The communication was implemented by using ACE (ADAPTIVE Communication Environment). ACE provides safe communication and is platform independent and therefore it fits the specification defined in D2.4.

The CFDController is able to connect to the DM (DataManager) to receive input data for ICE and upload computed CFD-Results. These results are currently in CGNS file format, which is platform independent and specified in D2.4.

The CFD Controller is working as acceptor which is able to receive connections from more than one DMC and can start more than one ICE computation. It also can run on more than one computer as a service, so that the DMC can choose between some CFD Controller to compute CFD results of missions.

The DMC provides all information from the DM needed by the User Interface Controller (UIC). This information is transmitted by using Covise internal communication methods.

All message protocols have the functionality that was needed for the review meeting, but can easily be extended for the next releases.

4.2.3 Workpackage 4

4.2.3.1 Research and implementation work at FIGD

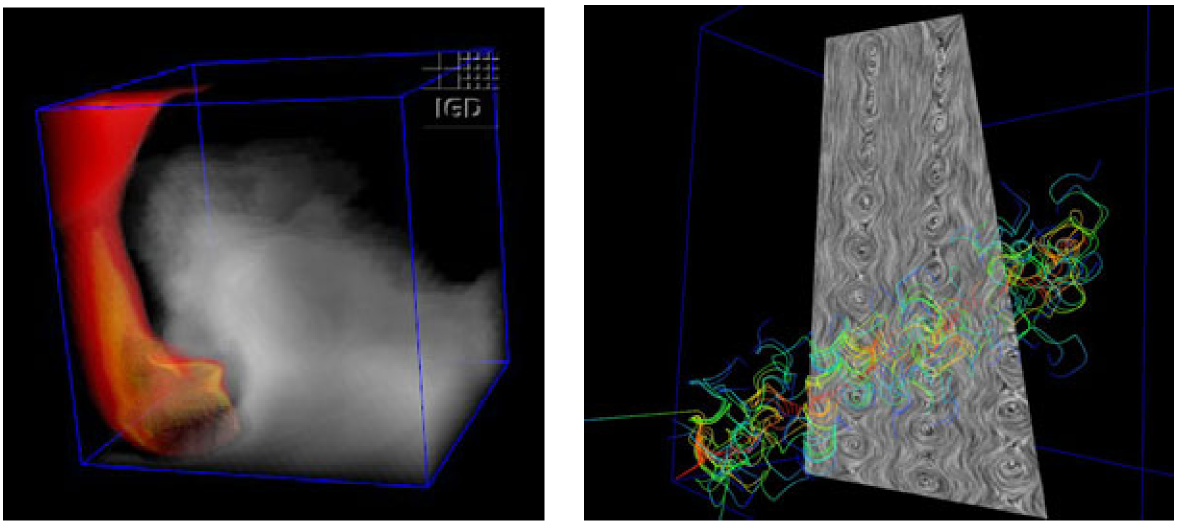


Fig.2: Left: Shaded Volume Rendering
Right: Combined visualization: LIC (Line Integral Convolution) and Stream Lines

FIGD realized the parallel visualization kernel as planned. The implemented prototypes of the integrated visualization methods were further tested, developed and specialized. Several improvements regarding the user navigation, the visualization method administration and the prototype handling were made. Until now the parallel visualization kernel was adapted to Inventor/Coin3D and OpenSG scenegraphs during the prototyping and testing phase. For the integration of the kernel into the Covise system, it is now necessary to adjust the visualization to Performer (because Covise finally will not support OpenSG as it was announced by Vircinty at the beginning of the last year).

Furthermore FIGD developed a specialized data format type which was necessary to support the display of the upcoming amounts of CFD data at interactive rates: The Progressive Grids. This format was implemented and tested in several prototypes regarding its usability and the necessary features for interacting with the data. These first experiences and improvements will join during the integration of this format into the parallelized visualization kernel, which is one of the upcoming tasks at FIGD for the next period.

4.2.3.2 Implementation of reading CGNS-Files in Covise

The Covise module ReadCGNS reads the CFD result files generated by ICE and stored in the DM. This data will be send to the visualisation plugin developed by FIGD or to the built in visualisation methods of Covise.

4.2.3.3 Integration HMD system and Spacemouse

The integration of the HMD using stereo mode was shown at the review meeting in February. The stereo mode is working quite well, but there is a bug in the Linux driver of the Nvidia driver. This bug causes some flickering and is reported in the documentation of the driver and will be fixed in one of the next releases. The integration of the Spacemouse is now completed. Therefore it was necessary to develop an own module (TRACKERD) to read Spacemouse data. This data will be sent to COVER by using UDP-Packets. The integration of the built in tracker of the HMD is in progress. As Vircinity has not implemented any HMD tracker system by now it requires some adaptations in Covise to support tracking of moving projection walls (LCD of HMD). The TRACKERD is already able to read the data from the tracker. This data will be sent to COVER in the same way as before by sending UDP-Packets.

4.2.3.4 Communication inside Covise and communication with User Interface

A COVISE visualisation network consists of *modules*, these are computational processes that perform some transformation on data. These are represented as boxes in the graphical map editor. Modules pass data from one to another via connections, represented as lines. Data always flows from "upstream" modules to "downstream" modules. The final, sink, module in a visualisation network is a *renderer* module. There are different types of these, depending on if rendering is directed to a workstation desktop or an immersive display, if data are to be shown as 2D plots or as 3D graphics.

The VFS system uses the COVER renderer for immersive 3D display. Normally the parameters for the modules are set by a control panel in conjunction with the map editor, but for immersive interaction it is more convenient to be able to steer the modules from within the immersive environment. Therefore modules can communicate with COVER by attaching *feedback* objects to the data going downstream.

The functionality of COVER can be extended through the use of *plugins*, library functions adhering to a certain protocol. These plugins can catch feedback objects arriving at the COVER module and, through the reference in these, send feedback messages to the originating module.

This module can then, if needed, recompute its output values to reflect any changes in its parameters suggested by the message from the plugin.

Plugins can also communicate amongst themselves through a set of inter-plugin messaging functions. A given plugin can send a message to either a named plugin or to all plugins currently loaded by COVER.

Finally, it is possible to use out-of-band socket messaging. Modules have convenience methods that allow them to react to incoming message events, whereas plugins have to implement socket polling on their own.

VFS uses all these methods for its internal communication. Refer to fig 1 for the connections between the different units.

In principle, all actions are initiated through the GUI. While the GUI is intended to run on a PDA, it can be executed anywhere. It will contact the UIC on a pre-agreed socket and the two will exchange UDP datagram packets. The UIC will then forward requests from the GUI to the appropriate receivers, i.e. the DMC and the HVR visualisation plugin, and in turn forward their responses to the GUI.

DMC and ReadCGNS both send feedback objects that are captured by UIC. (HVR also receives the reference to ReadCGNS in order to short-circuit the data passing route.)

UIC and HVR communicate through the plugin communication mechanism.

All messages passed through these mechanisms are simple text strings according to a predefined protocol.

4.2.3.5 User Interface

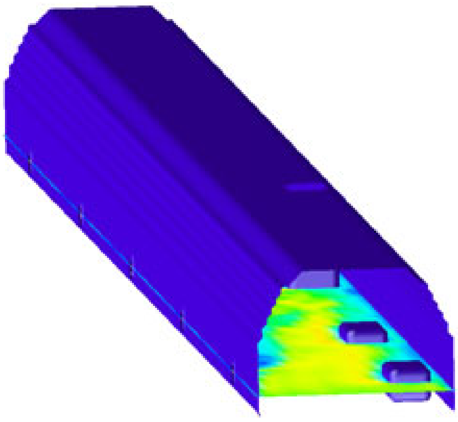
A simple prototype of the User Interface was developed in Java with the awt library. This user interface was demonstrated at the review. It can run on the PDA that will be used in the Cave environment or on a PC as is planned for the HMD environment.

4.2.4 Workpackage 5

4.2.4.1 Preparation of test cases for the review meeting

Case A

The first test case consists of 651 000 computational cells and represents a tunnel section of about 100 [m]. Fig. 3 & 4 show images of the tunnel structure and the velocity magnitude in a cutting plane.



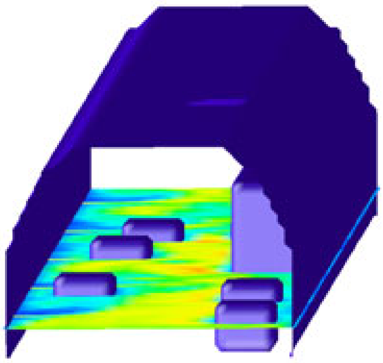


Fig. 3& Fig. 4 Case A : Tunnel structure and velocity magnitude

Five fresh air inlets are located at the bottom of the left side and one exhaust air outlet is situated at the ceiling of the opposite side of the tunnel. A number of passenger cars and a HGV are placed within the tunnel.

For the review meeting a data set containing the results of a certain period of time (in the range of about 20 minutes) will be pre-calculated. The ventilation characteristic is fixed in beforehand.

Case B

The second test case consists of a very coarse grid containing 37 500 cells. This small number of cells allows acceptable CPU times even on note books for the demonstration of interactive steering of the computations. The ventilation system consists of one fresh air inlet and two smaller exhaust air outlets located at the ceiling of the tunnel.

Fig. 5 shows the temperature isosurface of 400 [K]. The only driving force is the pressure difference along the tunnel axis.

The same isosurface (400 [K]) is depicted in Fig. 6, but in this situation the ventilation is activated.

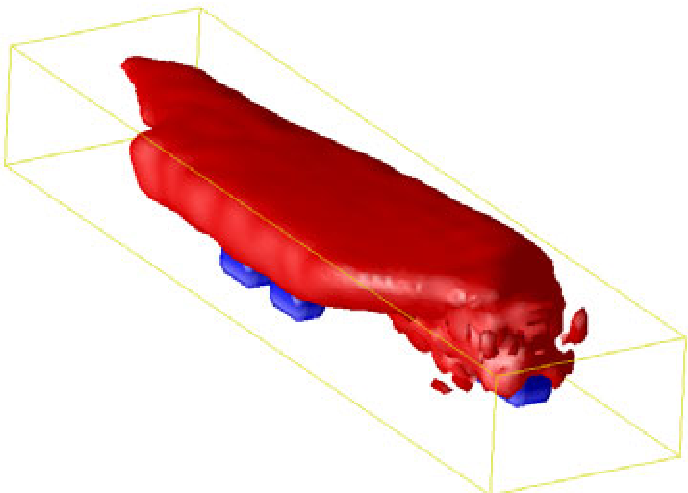


Fig. 5: Natural ventilation (T = 400 [K])

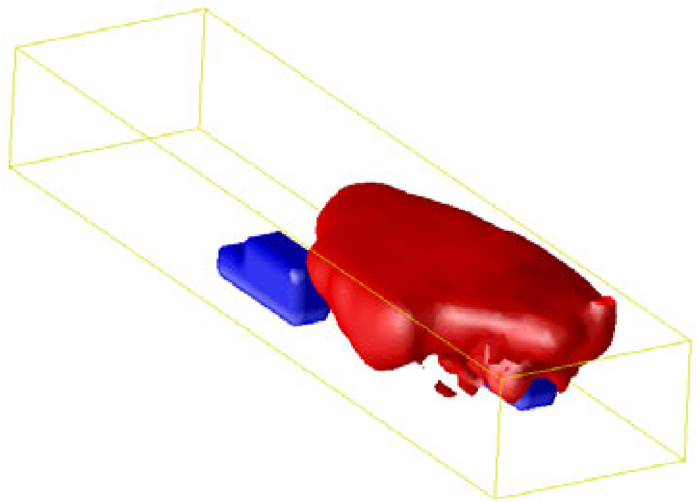


Fig. 6: Ventilation system active (T = 400 [K])

4.2.4.2 Linking of CGNS library

The routines for the data IO in CGNS format have been implemented successfully. No serious problems occurred. The files are organized in the following way :

A file with grid information is written at the beginning of the simulation (`<ICEBASENAME>_Grid.cgns`).

The required flow solutions are written in a separate file for each output time step (`<ICEBASENAME>_<TSID>.cgns`).

For Case A prepared for the review meeting the file size for one time step is about 25 MB.

4.2.4.3 Testing of MRT model

The MRT (multiple relaxation time) model has been implemented and is currently subject to extensive testing. As expected (according to literature) it shows better numerical properties and stability and allows the use of coarser grid to achieve reliable results. Especially for 3D problems the influence of the mesh resolution on the flow solution should not be underestimated. The use of very coarse grids such as for the real time simulation in the VirtualFires project results in a strong damping and smoothing of the unsteady, turbulent motions. The results of the already completed examination of two-dimensional test cases showed that the MRT model is able to capture the high frequency motions much better than the standard LBGK model.

It must be pointed out that the first MRT model for 3D was published not earlier than in March 2002 and a first publication of a MRT simulation including turbulence modelling was presented at the end of 2002.

4.2.4.4 Parallelisation

The parallelisation is proceeding well and it is to be expected that first performance data can be delivered in June 2003. No major problems appeared so far apart from usual difficulties in developing parallel programs. It must be stressed that the debugging of code parallelised using MPI can be very time consuming.

To achieve an optimal performance a substantial change in the cell indexing scheme of ICE was necessary.

A typical result of a domain decomposition can be seen in Fig. 7.

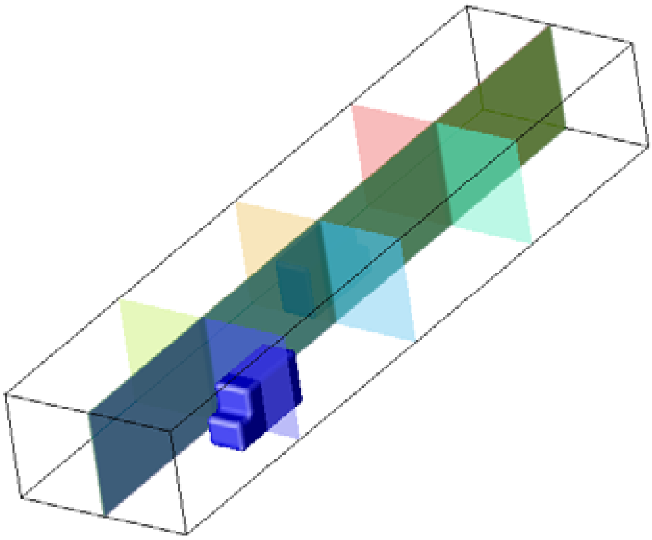


Fig. 7: Domain decomposition for 8 processors

4.2.4.5 Implementation of wall functions

Fig. 8 shows a typical velocity profile for a turbulent boundary layer.

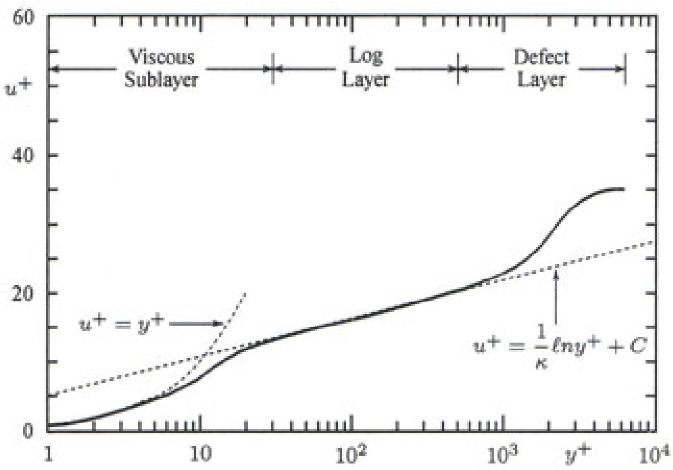


Fig. 8: Velocity profile for the turbulent boundary layer

The graph display the dimensionless velocity and distance :

$$u^+ \equiv \frac{U}{u_\tau} \qquad y^+ \equiv \frac{u_\tau y}{\nu}$$

where the friction velocity is given as:

$$u_\tau \equiv \sqrt{\frac{\tau_w}{\rho}}$$

In above equation τ_w is denoting the surface shear stress.

In the log layer the velocity profile matches the law of the wall

$$\frac{U}{u_\tau} = \frac{1}{\kappa} \ln \frac{u_\tau y}{\nu} + C$$

where C ~ 5.0 and κ ~ 0.41.

The Smagorinsky sub grid scale model used in ICE is somehow akin to a mixing length model with the mixing length determined by the Smagorinsky constant and the filter width. As algebraic mixing length models a large eddy simulation (LES) requires some modifications near walls to agree with the universal velocity profile in fig. 6.

The most often used approach is the introduction of the Van Driest damping function near wall which is given by

$$l_{mix} = C_s \Delta \left(1 - \exp\left(-\frac{y^+}{A^+} \right) \right)$$

where A^+ is a model constant and assumed to be 26.

4.2.4.6 Linking of ICE-Steering library

A first version of the ICE steering library (provided by SiTu) has been linked to the CFD code.

The major problem is that there are no uniform standards for linking Fortran90 (ICE) and C++ (steering library) programs. Programs mixing both languages are usually not portable but this point is very essential for VirtualFires as the software is expected to run on various platforms. To achieve maximum portability the C++ functionality is called with a C-style interface.

4.2.4.7 Implementation of ICE-Steering library

The communication between ICE and the CFDController also uses the same communication library as used for the communication between CFDController and DMC. The necessary functions, which have to be called during an ICE simulation, are provided as a library to integrate the steering mechanism into the ICE-Code written in Fortran. The communication runs in an own thread so all messages can be sent and received, while an ICE simulation is running.

4.2.4.8 Coupling of 3D/2D models to 1D model

A one-dimensional model of Navier-Stokes equations is developed in order to compute the flow in the tunnel far from the fire. This model is then coupled to the 2D model (a simple version of the 3D model used for the test purposes), which is used near the fire. The coupling between these two models is obtained by using interpolation of the characteristic values of the flow. Tests are performed where the coupled 2D/1D model is compared to the 2D model. The difference between the two models are computed at different times, both with the model of heat source included and without it. The results obtained in these tests seem promising.

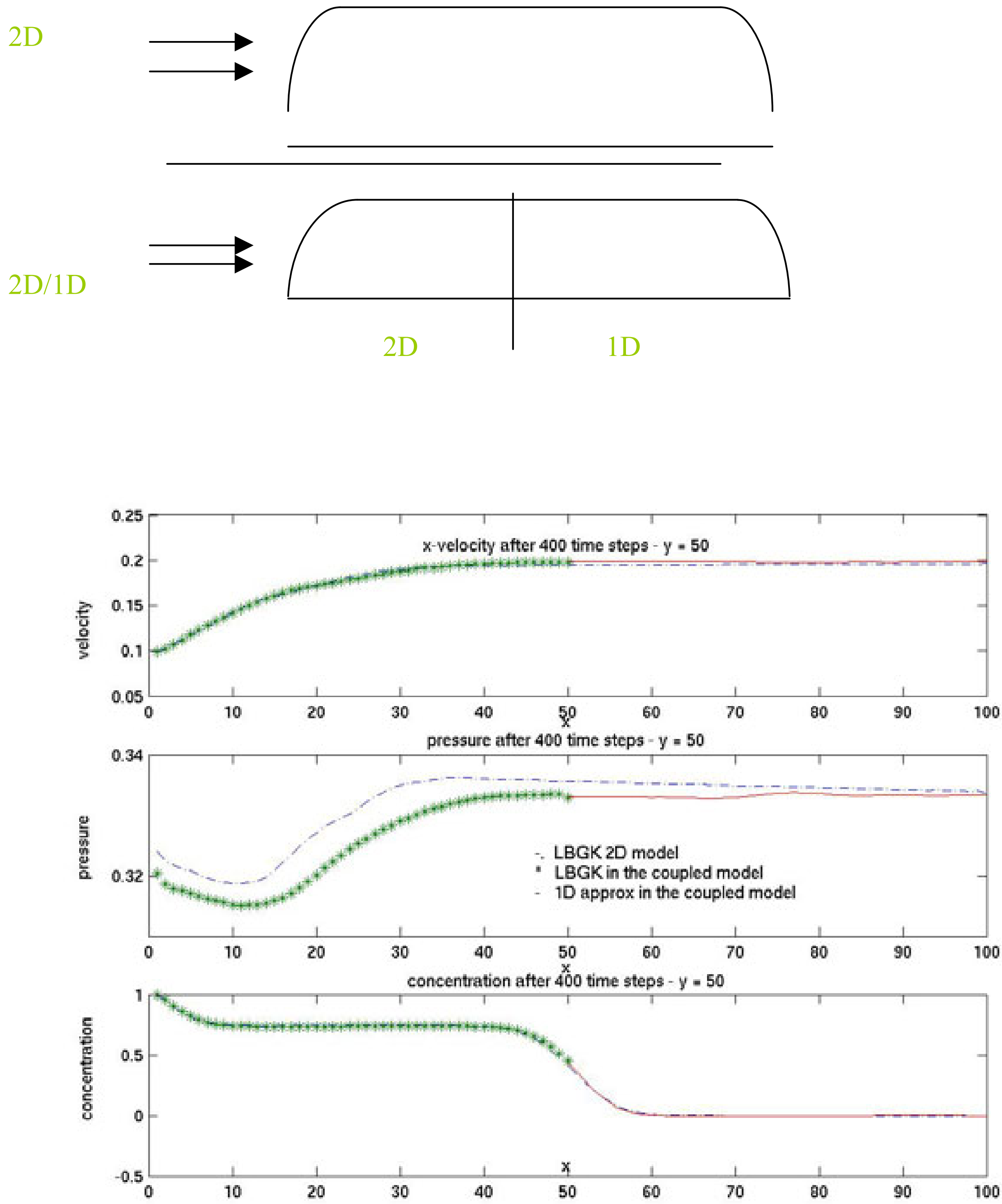


Fig. 9: simple test of the 2D LBGK model and the coupled model (no "heat source" in the tunnel)

4.3 *Comparison planned activities and actual work*

4.3.1 Reports

A number of deliverable reports were produced, which are listed in Table 2. In general all the planned activities were carried out successfully. The completion of some reports was delayed for a short time because information was not available in time. The rejected deliverable D2 has been updated in response to the reviewers suggestions. Rejected deliverable D7.1 is expected to be updated in July 2003.

Delive rable	Title	Planned Closing date	Achieved closing date	Reason for delay
D2	Dissemination and use plan	2002-04-30	2003-06-15	Rejected at last review
D2.4a	Updated System Specification (II)	not planned from the beginning	2003-03-14	D2.4a was not planned from the begin of the project
D3.4	Beta version of data management for first prototype	2003-01-31	2003-01-31	
M3.1	Beta testing of software completed successfully	2003-02-28	2003-02-28	
D4.4	Integration of HMD system completed	2003-02-28	2003-02-28	
M5.2	Software release V1.0	2003-03-31	2003-03-31	
D4.5	VR implementation with limited functionality and speed	2003-04-30	2003-06-04	Unforeseen limitations in Covise
D5.4	Software User Guide V1.0	2002-12-31	2003-01-16	
D7.1	Accurate definition of use cases	2002-06-31		Rejected at last review

Table 2: Planned activities and actual work done

4.4 *State of the art review*

4.4.1 CFD Display methods

There are many tools on the market for displaying CFD datasets. Most of them operate sequentially and/or are limited to certain data input formats. Dealing with large datasets, as they are the contents of the VIRTUALFIRES project, these already available tools run into non-negligible performance problems. They cannot handle the corresponding amounts of simulation data in real time or interactively. For that reason a development of massive parallel visualization methods was initiated. These methods, which utilize partly sophisticated hardware capabilities of new graphic cards available on the market, are integrated in a state of the art visualization system (parallel visualization kernel / Covise).

4.5 *Planned activities for the next period*

4.5.1 Workpackage 2

Review system specifications and change as required.

4.5.2 Workpackage 3

Following activities are planned for the next period:

- Add additional functionality of DataManager
- Implementation of an administration tool for the DB-Server
- Generation of a single STL file for the whole scene geometry defined in the scenario description

4.5.3 Workpackage 4

There are several activities planned for the next period at FIGD. At the moment FIGD is working on

- Port and integration of the central parallelized visualization kernel from the prototype [Coin/OpenSG] (in)to Covise [Performer]
- Completion of the interfaces between visualization, UIC (user interface controller) and data management (i.e. the corresponding Covise module)
- Integration of Progressive Grids for faster visualization
- Realization of a converter from the proprietary CFD simulation data format to the format needed by the visualization
- Realization of a management for time varying data on the visualization side

These points have to be realized until the end of the next period i.e. the end of the project. The following points are of interest as well but are not required to be realized until the end of the project:

- Integration of further visualization methods
- Investigation to expand the system to a cluster
- Integration of an intelligent buffering
- Realization of a kind of automated system check which is able to adapt and scale the system capabilities to the found hardware resources

The planned activities for the next period at SiTu are as follows:

- Extension of the communication protocol of DMC providing additional functionality such as defining scenarios, missions, activating/deactivating ventilations in running simulations.
- Close cooperation with Vircinity to integrate the HMD Tracker into Covise.
- Porting the software to the CAVE environment at KTH.

The planned activities for the next period at KTH are as follows:

- Enhancing the communication protocol between the user interface and the UIC plugin to resolve stability issues regarding message passing.

- Step by step restructuring of user interface to provide a more intuitive interface as functionality of components is verified.

- Extension of the interaction methods in the user interface and communication protocols as the need arises based on e.g. new visualisation methods implemented.

- Implementation of PDA software to enable PDA to function as an interaction device in CAVE environment.

- Implementation of a readGeometry module to enable loading and interaction with graphical representations of tunnels, cars, road signs and such.

4.5.4 Workpackage 5

The major issues to be done within the next reporting period are the following :

Parallelisation

The parallelisation of the CFD software will be finished within the next months. From the current state of development there are no major problems in sight, which can endanger the successful completion of this task. After an extensive testing phase to achieve the optimal parallel performance on the 4 processor DEC Alpha ES 40 at CD the software will be transferred to KTH IBM Strindberg (or possibly the new HP Intel Linux cluster).

Integration of CFD steering

The final integration of the CFD steering will be done in close cooperation with SiTu. Some problems regarding portability on operating systems other than Linux are to be expected. Due to the chosen strategy to provide C functions to match the Fortran naming conventions these problems should be solved within a short period of time.

Generation of CAS file

ICE defines the behaviour of boundaries such as ventilation, sprinkler system, etc. in the CAS file. This file has to be created automatically from the mission description.

Code development

If the testing delivers convincing results the MRT model will be implemented as standard solver model. Some options regarding the user input and additional output information will be added on user's request.

Coupling of 3D/2D models to 1D model

The first version of the coupled model is developed and will be tested with the 3D model to see if it behaves as well as expected. Next version will even include adaptive switching between 1D and 3D models. In the area where the flow is nearly one-dimensional it will be computed with the 1D model. Zonal models will also be studied such that the 1D model will be extended to a model with two 1D flow fields, one hot 1D flow near the ceiling of the tunnel, and one cold 1D flow near the floor of the tunnel.

5 List of deliverables (Month 13 – 18)

No.	Deliverable (D) or Milestone (M) name	WP no.	Lead Particip ant	Estimated person-months	Del. type*	Delivery (proj. month)	Delivered (proj. month)
D3.4	Beta version of data management for first prototype	3	SITU	6	Prototype	16	15
M3.1	Beta testing of software completed successfully	3	SITU		Demonstration	17	16
D4.4	Integration of HMD system completed	4	KTH	6	Prototype	18	16
M5.2	Software release V1.0	5	CD		Dem.	18	17
D4.5	VR implementation with limited functionality and speed	4	KTH	13	Prototype	19	18
D5.4	Software User Guide V1.0	5	CD	5,5	User guide	15	14

* A short, self-evident description e.g. report, demonstration, conference, specification.

6 Exploitation and dissemination of results

6.1 Exploitation

At a combined PCC/TCC meeting on May 13, 2003 in Dortmund Dr. Andreas WIERSE, managing director of the company Vircinity was invited. A short description of the project and its aims was given to him by the coordinator. He was asked if the company Vircinity would be interested in marketing the VIRTUALFIRES product. He expressed strong interest and a meeting will be arranged in the near future to discuss details. Dr. Wirse gave a commitment of full cooperation with resolving any problems associated with COVISE, which is used as the rendering system for VIRTUALFIRES and which is being developed, maintained and marketed by Vircinity.

Rene Faure of CETU pointed out an opportunity for a demonstration of VIRTUALFIRES. Apparently there will be an announcement for a study initiated by LTF, which will be published soon in the European Official Newspaper. Some details are given below:

“ For the project of the Bussoleno tunnel LTF will be seeking the services of a consultant for the study of the ventilation system. The study should identify constructive measures to be adopted for the Bussoleno tunnel and should consider two scenarios: One without forced ventilation the other with forced ventilation. If a forced ventilation is identified alternative proposals for a ventilation shaft in Foresto will be asked for.

The study will consist of two parts:

1. Ventilation study (without fire)

   Study on the effect of air current and the piston effect (effect of traffic) at different locations.

2. Ventilation study (with 3 hypotheses of fire)
   Car/lorry train fire (> 100 MW)
   Passenger train fire (< 15 MW)
   Freight train fire (> 15 MW)

Study on the chimney effect
Analysis of the spread of smoke (time dependent)
- Without ventilation
- With forced ventilation

Realization of a numerical model for smoke spread. Identification of the costs required to keep the safety zones free of smoke”.

Dr. Brandstätter of CD expressed strong interest in performing the necessary CFD calculations and a VIRTUALFIRES prototype could be used to display the results.

6.2 Dissemination

At the combined TCC/PCC meeting in Dortmund members of the consortium had the opportunity to see a real fire exercise of the Dortmund fire brigade in a disused part of the Dortmund underground. The exercise attracted publicity with TV and press were present. The coordinator of VIRTUALFIRES attended a press conference, where he presented the aims of the project. Some articles appeared in the local press and a short excerpt from the interview appeared on TV.

The coordinator is also preparing a paper on the project for a conference in South Africa in July 2004. It is planned to present a VIRTUALFIRES prototype at the 1. International Symposium on Safe and Reliable Tunnels organised by the EC Projects DARTS (Integrated design of tunnels regarding safety, durability and environmental and socio-economic aspects), UPTUN (Upgrading of existing tunnels on fire safety) and the thematic network FIT (Fire in Tunnels). This conference is to be held in Prague on February 4-6, 2004.

7 Management and coordination aspects

No major problems were encountered with the management of the project. The rejection of the prototype at the last review meeting resulted in an increased activity and cooperation between partners. Several meetings were organised. At a combined PCC/TCC meeting the general manager of Vircinity was invited, so that some problems with COVISE that hampered the development of VIRTUALFIRES could be resolved. Dr. Andreas WIERSE appeared extremely cooperative and not only gave answers directly to detailed questions but also offered that members of the consortium could at any time approach the software developers or make appointments to see them personally. It seems that most of the problems were resolved, others were noted pending a resolution.

It was agreed at that meeting that the rejected report “Accurate definition of cases” will be updated in cooperation with CETU, LTF, EUVE and FDDO taking into consideration the reviewers’ request. Unfortunately the preparation of the report has been delayed and it is now scheduled to be finished in July.

The work effort in the project appears on target and as predicted. However, travel costs appear to have been underestimated and have increased due to the increased meeting activity after the rejection of the first prototype. SiTu has already requested a transfer of funds from the hardware budget to the travel budget. KTH pointed out that they were using up manpower faster than estimated. At the meeting in Dortmund it was agreed to review the situation at the next PCC/TCC meeting.

The long delay experienced in the transfer of progress payments by the Commission is causing some problems with partners which are small institutes with their own accounting system (i.e. CD and SiTu). At the time of writing this progress report (for period 3) we are still waiting for the progress payment from period 2 (this is a delay of more than 6 months). Also the receipt of progress reports (sent to the responsible project officer by courier) is not automatically acknowledged nor did we receive an official acknowledgement (by letter) of the acceptance of the report by the Commission for the last two reports submitted.

In order to make sure that the prototype to be demonstrated at the next review meeting in Stockholm is working correctly a roadmap has been prepared.

Draft of the Roadmap to the Stockholm meeting:

Problems faced during integration:

CFD-Data:

- The CFD-Results shown at the review did not show realistic flow vectors

GUI:

- limited capabilities of the GUI: no sliders, no graphics
- stability problems

HMD + Tracker:

- impossibility to change camera viewing angles whole system:
- only playback capabilities at the moment
- missing scene geometry display
- no closed loop working: it is not possible to modify the scene within the VR environment, generate the domain for the CFD automatically, define missions, generate the steering files for the CFD automatically, invoke the computation and view the results

Work to be done:

Vircinity:

- support for changing camera viewing angles by tracking system

CD:

- verification of the CFD results especially vectorial data
- specification of mission parameters and values according to the test cases provided by FDDo
- selection of mission parameters for demonstration purposes

KTH:

- extend GUI: 3D placement of objects, mission editing, info display inside VR-environment, slider for some numerical values
- stabilize UIC-GUI communication

SiTu+KTH:

- extend/modify DMC-UIC protocol for scene modification, mission definition, steering

SiTu+KTH+CD+FDDO:

- define mission parameters, range of values

SiTu:

- adapt DM for mission-handling
- finish head tracker integration
- administration tool for DB-Server
- automatic generation of 1 STL-file for whole scene

SiTu+CD:

- ICE-Steering: automatic generation of CAS-files from mission descriptions, extension of interaction mechanism

CD:

- fully automatic generation of computational domain from scene-geometry (provided as STL file)

FIGD:

- implement missing visualization methods
- adapt plug-ins

FIGD+KTH:

- adapt communication UIC-viz plugins

SiTu/KTH/FIGD/CD:

- check/port/modify software for use at KTH's CAVE + Cluster

8 Glossary

SiTu	Institute for structural analysis, Graz University of Technology, Austria
CD	Christian-Doppler-Laboratory for Applied Computational Thermofluiddynamics, Austria
FIGD	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung, Germany
KTH	Kungl. Tekniska Högskolan, Sweden
LTF	Lyon-Turin Ferroviaire
METL	Ministere del'Equipment des Transport et du Logement, Centre d'Etudes de Tunnel, France
FDDO	Stadt Dortmund, Feuerwehr (fire brigade), Germany
EUVE	European virtual engineering, Spain

9 Annexes

9.1 Deliverable and major milestone list

No.	Deliverable (D) or Milestone (M) name	WP no.	Lead Participant	Estimated person-months	Del. type*	Security**	Delivery (proj. month)
D2.1	Report on available developer tools	2	FIGD	1,5	Report	Int.	2
D2.2	Selection of developer tools	2	FIGD	1,4	Spec.	Int.	2,5
D2.3	Report on available system capabilities (hardware)	2	FIGD	1,8	Report	Int.	2
D2.4	Specification of planed system capabilities (software)	2	FIGD	7,5	Spec.	Int.	2,5
D2.4a	Update System Specification	2	FIGD		Spec.	Int.	
D2.5	Report on existing VR-systems, Adaptability to VIRTUALFIRES	2	FIGD	1,1	Report	Int.	3,5
D2.6	Specification of selected VR System & required extensions	2	FIGD	2,2	Spec.	Int.	4
D1	Project presentation	1	SITU		Publicity	Ext.	3
D2	Dissemination and use plan	7	METL		Report	IST	6
Total		**WP2**		**15,5**			
D3.1	Report on geometrical data base	3	SITU	3	Report	Rest.	5
D3.2	Report on CFD data base	3	SITU	2,5	Report	Rest.	5
M1	CFD computation of fire reference simulations completed	1-5	CD		Demonstration	IST	6
D3.3	Report on compression/ optimisation	3	SITU	3,5	Report	Rest.	6
M5.1	Release of VIRTUALFIRES a-priori results database	5	CD		Dem.	IST	11
D3.4	Beta version of data management for first prototype	3	SITU	6	Prototype	Rest.	15
D3.5	Beta version of data management for second prototype	3	SITU	5	Prototype	Rest.	20
M3.1	Beta testing of software completed successfully	3	SITU		Demonstration	Rest.	16
D3.6	Release version of data management	3	SITU	4	Serial	Rest.	26
Total		**WP3**		**24**			
D4.1	Specification on methods of displaying CFD data	4	KTH	4	Report	Rest.	12
D4.2	Specification of user interface in VR-environment	4	KTH	4	Report	Rest.	12
D4.3	Report on hardware HMD specification	4	KTH	2	Report	Rest.	13
D4.4	Integration of HMD system completed	4	KTH	6	Prototype	Rest.	16
M5.2	Software release V1.0	5	CD		Dem.	IST	17
D4.5	VR implementation with limited functionality and speed	4	KTH	13	Prototype	Int.	18

No.	Deliverable (D) or Milestone (M) name	WP no.	Lead Participant	Estimated person-months	Del. type*	Security**	Delivery (proj. month)
D4.6	VR implementation with full functionality optimised for speed	4	KTH	8	Prototype	Int	25
D4.7	VR integration with real-time CFD data generation	4	KTH	8	Prototype	Int	25
D4.8	VIRTUALFIRES users manual	4	KTH	4	Report	Int.	26
Total		**WP4**		**49**			
D5.1	CFD database containing results of 6 computational studies	5	CD	30	Database	Int.	11
D5.2	Report: Interactive Field Simulation Techniques; Solver and Data Flow Parallelization	5	CD	37	Report	Int.	11
D5.3	Parallelisation efficiency report	5	CD	1,5	Report	Int.	24
D5.4	Software User Guide V1.0	5	CD	5,5	User guide	Int.	14
M5.3	Software release V2.0	5	CD		Demonstr ation	IST	26
D5.5	Software User Guide V2.0	5	CD	5,5	User guide	Int.	26
Total		**WP5**		**79,5**			
D6.1	Report on CAVE/ HMD installation	6	EUVE	12	Report	Int.	26
M4.1	Beta testing of software completing successfully	4	KTH		Demonstr ation	Rest.	27
M6.1	Requirements accomplishment	6	EUVE		Demonstr ation	IST	27
D6.2	VIRTUALFIRES results report	6	EUVE	6,5	Report	Int.	28
Total		**WP6**		**18,5**			
D7.1	Definition of cases	7	METL	2	Report	Int.	8
D7.2	Journal articles	7	METL	2	Report	Ext.	28
D7.3	Conference papers and exhibition at conferences	7	METL	2	Report	Ext.	28
D7.4	Webpage	7	METL	3	Website	Ext.	6
Total		**WP7**		**9**			

* *A short, self-evident description e.g. report, demonstration, conference, specification.*

** *Int.* *Internal circulation within project (and Commission Project Officer if requested)*

Rest. *Restricted circulation list (specify in footnote) and Commission PO only*

IST *Circulation within IST Programme participants*

FP5 *Circulation within Framework Programme participants*

Table 1 Man power use plan

		- - - - - - - - - Man-Month - - - - - - - - - - -									- - - - - - - Technical Progress % -- - - - -		
Task/Subtask (N°/title)	Partner (Name/ abbrev.)	Planned efforts - at start of period (MM)				Actual effort (MM)	Forecast effort (MM)			*Devia-tion (MM)*	Planned (%)	Assessed (%)	*Devia-Tion* (%)
		Year 1	Year 2	Year 3	Total	Y 1+1/2	Year 2	Year 3	Total	*Totals*	Year 1	Year 1	*Year (now)*
		a	b	c	d	a1	b1	c1	d1	d1-d			
1. Management	SiTu	9	7	4	**20**	13,49	2,5	4	**20**	***-0,01***	45%	67%	*22%*
	CD			1	**1**			1	**1**				
	FIGD	0,34	0,33	0,33	**1**	0,34	0,33	0,33	**1**			34%	*34%*
	KTH	0,4	0,4	0,2	**1**	0,55	0,3	0,2	**1,05**	***0,05***		52%	*52%*
	ALPE/LTF	0,4	0,4	0,2	**1**	0,54	0,23	0,23	**1**			54%	*54%*
	METL	0,5	0,3	0,2	**1**	0,76	0,36	0,36	**1,48**	***0,48***		51%	*51%*
	FDDo	0,1	0,2	0,2	**0,5**	0,28	0,22	0,2	**0,7**	***0,2***	20%	40%	*20%*
	EUVE	0,4	0,4	0,2	**1**	0,6	0,2	0,2	**1**				
	Total	**11,1**	**9,03**	**6,33**	**26,5**	**16,6**	**4,14**	**6,52**	**27,2**	***0,72***	**42%**	**62%**	***20%***
2. System Specification	SiTu	3			**3**	5,23			**5,23**	***2,23***	100%	100%	
	CD	1,5			**1,5**	1,5			**1,5**		100%	100%	
	FIGD	3			**3**	6			**6**	***3***	100%	100%	
	KTH	2,5			**2,5**	2,36			**2,36**	***-0,14***	100%	100%	
	ALPE/LTF	1,5			**1,5**	0,17			**0,17**	***-1,33***	100%	100%	
	METL	1			**1**	0,5			**0,5**	***-0,5***	100%	100%	
	FDDo	3,5			**3,5**	2,93	0,37		**3,3**	***-0,2***	100%	89%	*-11%*
	EUVE	1,5			**1,5**	0,75			**0,75**	***-0,75***	100%	100%	
	Total	**17,5**			**17,5**	**19,4**	**0,37**		**19,8**	***2,31***	**100%**	**111%**	***11%***
3. Data Processing	SiTu	11	5		**16**	20,13	9		**29,1**	***13,13***	69%	69%	*0%*
	CD	1,5			**1,5**	1,5			**1,5**		100%	100%	
	FIGD		1,5		**1,5**	0,75	0,75		**1,5**			50%	*50%*
	KTH	0,3	1	0,2	**1,5**	0,08	1	0,2	**1,28**	***-0,22***	20%	6%	*-14%*
	ALPE/LTF	0,2	0,8	0,5	**1,5**	0,23	0,36	0,36	**0,95**	***-0,55***	13%	24%	*11%*
	METL	0,25	0,25		**0,5**	0,37	0,12	0,12	**0,61**	***0,11***	50%	61%	*11%*
	FDDo	0,5	4		**4,5**	3,27	1,23		**4,5**		11%	73%	*62%*
	EUVE	0,8	0,2		**1**	1			**1**				
	Total	**14,6**	**12,8**	**0,7**	**28**	**27,3**	**12,5**	**0,68**	**40,5**	***12,47***	**52%**	**98%**	***46%***
4. VR Implementation	SiTu	1	15	4	**20**	3,01	3	4	**10**	***-9,99***	5%	30%	*25%*
	CD	1	1		**2**	1	1		**2**		50%	50%	
	FIGD	3	7,5	1	**11,5**	9,75	1,75		**11,5**		26%	85%	*59%*
	KTH	4	4	1,5	**9,5**	9,58	5	2,5	**17,1**	***7,58***	42%	56%	*14%*
	ALPE/LTF		0,8	0,7	**1,5**		0,57	0,57	**1,14**	***-0,36***			
	METL		0,8	0,2	**1**		0,57	0,57	**1,14**	***0,14***			
	FDDo	1	2		**3**	1,55	1,45		**3**		33%	52%	*18%*
	EUVE	0,5	1,3	0,2	**2**	1,1	0,7	0,2	**2**				
	Total	**10,5**	**32,4**	**7,6**	**50,5**	**26**	**14**	**7,84**	**47,9**	***-2,63***	**21%**	**51%**	***31%***
5. CFD Data Generation	SiTu		10	2	**12**	0,97	3,5	2	**6,47**	***-5,53***		15%	*15%*
	CD	12,5	18	18	**48,5**	23,5	10	15	**48,5**		26%	48%	*23%*
	FIGD												
	KTH	3	7	4	**14**	3,65	6	2	**11,7**	***-2,35***	21%	31%	*10%*
	ALPE/LTF	0,2	0,4	0,4	**1**	0,11	0,44	0,45	**1**		20%	11%	*-9%*
	METL	0,2	0,8	0,5	**1,5**	0,46	0,57	0,57	**1,6**	***0,1***	13%	29%	*15%*
	FDDo		0,5	0,5	**1**	0,1	0,4	0,5	**1**			10%	*10%*
	EUVE		1,5	0,5	**2**	0,4	1,1	0,5	**2**				
	Total	**15,9**	**38,2**	**25,9**	**80**	**29,2**	**22**	**21**	**72,2**	***-7,78***	**20%**	**36%**	***17%***
6. Evaluation/Validation	SiTu			3	**3**			3	**3**				
	CD			2	**2**			2	**2**				
	FIGD			1,5	**1,5**			1,5	**1,5**				
	KTH			1,5	**1,5**			1,5	**1,5**				
	ALPE/LTF			2	**2**		1	1	**2**				
	METL			1,5	**1,5**		0,72	0,86	**1,58**	***0,08***			
	FDDo			3,5	**3,5**			3,5	**3,5**				
	EUVE			5	**5**		0,75	5	**5,75**	***0,75***			
	Total			**20**	**20**		**2,47**	**18,4**	**20,8**	***0,83***			
7. Dissemination	SiTu	0,5			**0,5**	0,66			**0,66**	***0,16***	100%	100%	
	CD			0,5	**0,5**			0,5	**0,5**				
	FIGD			0,5	**0,5**	0,11		0,39	**0,5**			22%	*22%*
	KTH	0,1	0,1	0,3	**0,5**	0,15	0,1	0,3	**0,55**	***0,05***	20%	27%	*7%*
	ALPE/LTF	0,2	0,4	0,4	**1**	0,34	0,4	0,4	**1,14**	***0,14***	20%	30%	*10%*
	METL	1,5	0,9	0,6	**3**	1,43	0,72	1,43	**3,58**	***0,58***	50%	40%	*-10%*
	FDDo		1	1	**2**	0,2	0,8	1	**2**			10%	*10%*
	EUVE	0,7	0,9	0,4	**2**	0,7	0,9	0,4	**2**		35%	35%	
	Total	**3**	**3,3**	**3,7**	**10**	**3,59**	**2,92**	**4,42**	**10,9**	***0,93***	**30%**	**36%**	***6%***
TOTALS	SiTu	24,5	37	13	**74,5**	43,49	18	13	**74,5**	***-0,01***	33%	58%	*63%*
	CD	16,5	19	21,5	**57**	27,5	11	18,5	**57**		29%	48%	*23%*
	FIGD	6,34	9,33	3,33	**19**	16,95	2,83	2,22	**22**	***3***	33%	89%	*165%*
	KTH	10,3	12,5	7,7	**30,5**	16,37	12,4	6,7	**35,5**	***4,97***	34%	54%	*70%*
	ALPE/LTF	2,5	2,8	4,2	**9,5**	1,39	3	3,01	**7,4**	***-2,1***	26%	15%	*66%*
	METL	3,45	3,05	3	**9,5**	3,52	3,06	3,91	**10,5**	***0,99***	36%	37%	*67%*
	FDDo	5,1	7,7	5,2	**18**	8,33	4,47	5,2	**18**	***0,00***	28%	46%	*109%*
	EUVE	3,9	4,3	6,3	**14,5**	4,55	3,65	6,3	**14,5**		27%	31%	
	TOTAL	**72,6**	**95,7**	**64,2**	**233**	**122**	**58,4**	**58,8**	**239**	***6,85***	**31%**	**53%**	

**) Please note that the actual technical progress percentage and the updated remaining efforts must reflect the physically assessed status of the work.*

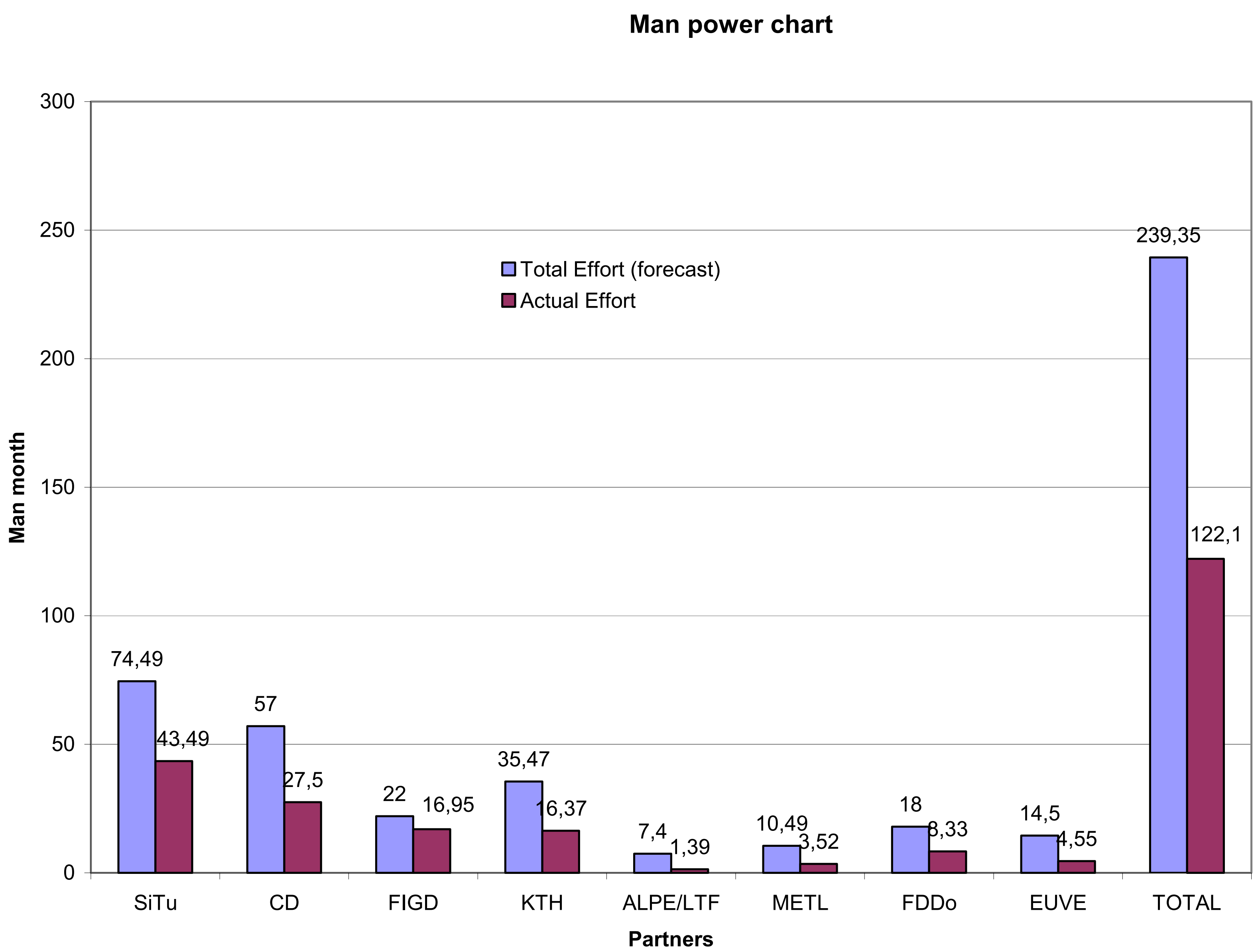
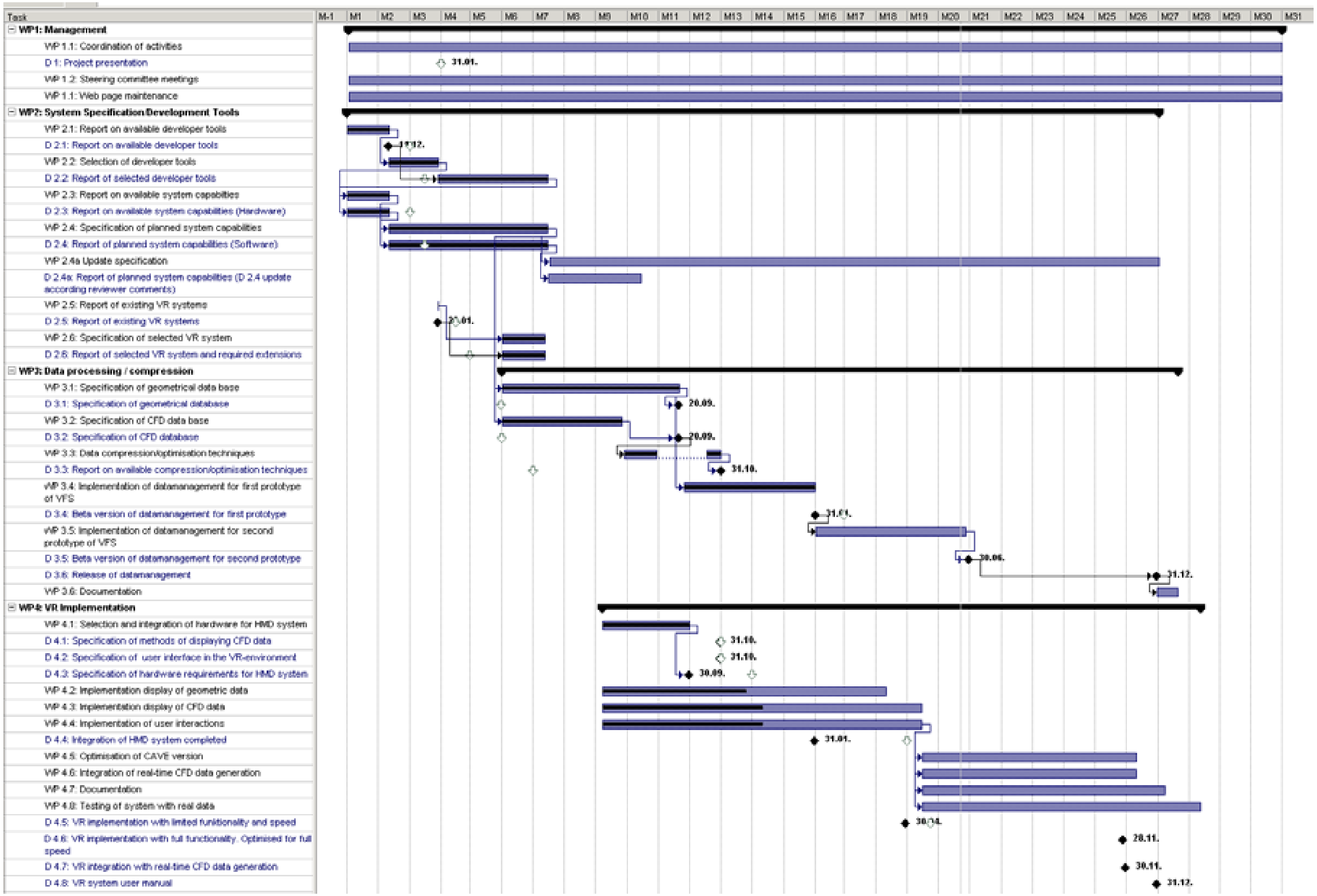
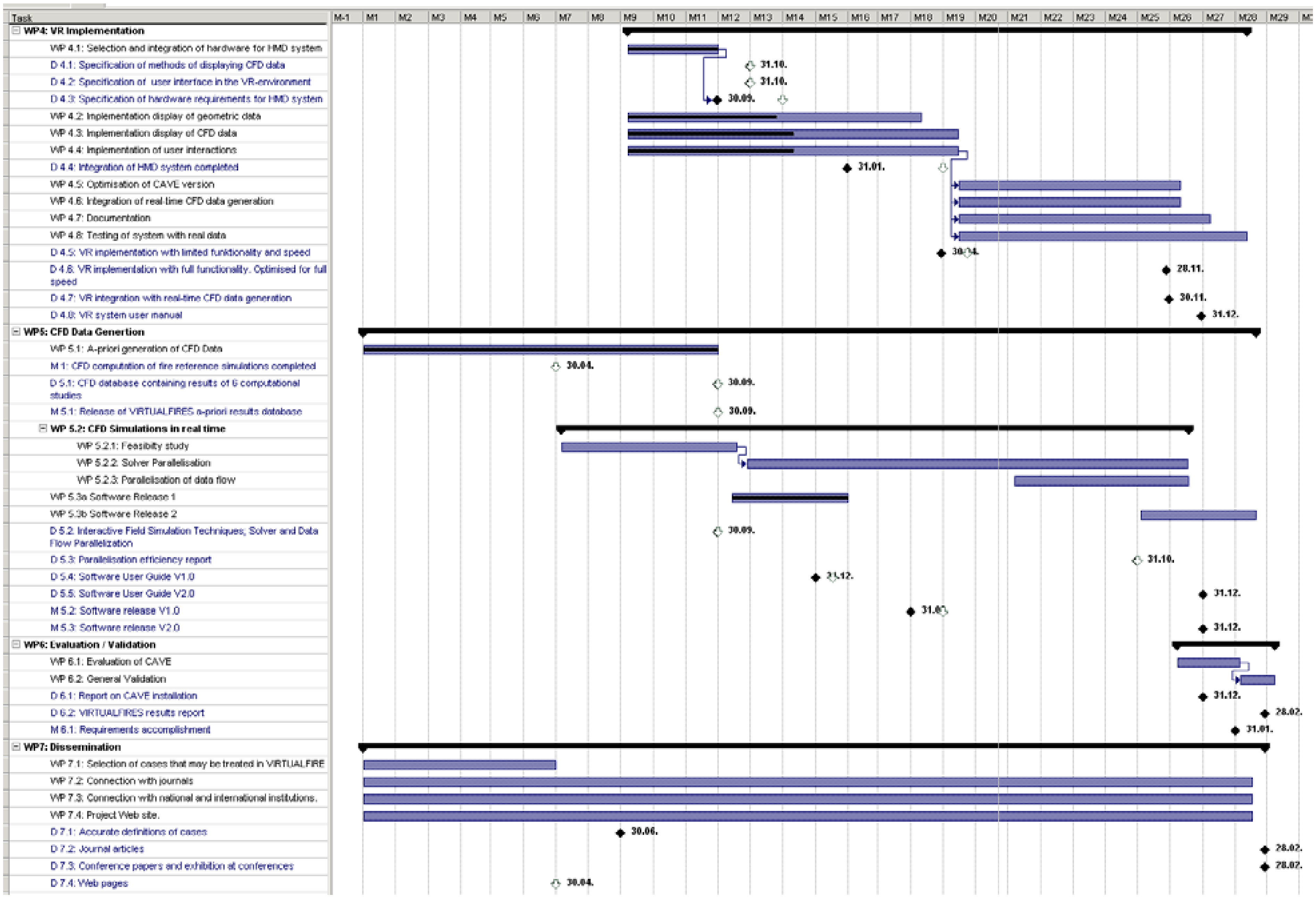

Man power chart
Man month
300
250
200
150
100
50
0
Total Effort (forecast)
Actual Effort
74,49
43,49
57
27,5
22
16,95
35,47
16,37
7,4
1,39
10,49
3,52
18
8,33
14,5
4,55
239,35
122,1
SiTu
CD
FIGD
KTH
ALPE/LTF
METL
FDDo
EUVE
TOTAL
Partners

Table 2: Project plan




Task
WP4: VR Implementation
WP 4.1: Selection and integration of hardware for HMD system
D 4.1: Specification of methods of displaying CFD data
D 4.2: Specification of user interface in the VR-environment
D 4.3: Specification of hardware requirements for HMD system
WP 4.2: Implementation display of geometric data
WP 4.3: Implementation display of CFD data
WP 4.4: Implementation of user interactions
D 4.4: Integration of HMD system completed
WP 4.5: Optimisation of CAVE version
WP 4.6: Integration of real-time CFD data generation
WP 4.7: Documentation
WP 4.8: Testing of system with real data
D 4.5: VR implementation with limited funktionality and speed
D 4.6: VR implementation with full functionality. Optimised for full speed
D 4.7: VR integration with real-time CFD data generation
D 4.8: VR system user manual
WP5: CFD Data Genertion
WP 5.1: A-priori generation of CFD Data
M 1: CFD computation of fire reference simulations completed
D 5.1: CFD database containing results of 6 computational studies
M 5.1: Release of VIRTUALFIRES a-priori results database
WP 5.2: CFD Simulations in real time
WP 5.2.1: Feasibity study
WP 5.2.2: Solver Parallelisation
WP 5.2.3: Parallelisation of data flow
WP 5.3a Software Release 1
WP 5.3b Software Release 2
D 5.2: Interactive Field Simulation Techniques, Solver and Data Flow Parallelization
D 5.3: Parallelisation efficiency report
D 5.4: Software User Guide V1.0
D 5.5: Software User Guide V2.0
M 5.2: Software release V1.0
M 5.3: Software release V2.0
WP6: Evaluation / Validation
WP 6.1: Evaluation of CAVE
WP 6.2: General Validation
D 6.1: Report on CAVE installation
D 6.2: VIRTUALFIRES results report
M 6.1: Requirements accomplishment
WP7: Dissemination
WP 7.1: Selection of cases that may be treated in VIRTUALFIRE
WP 7.2: Connection with journals
WP 7.3: Connection with national and international institutions.
WP 7.4: Project Web site.
D 7.1: Accurate definitions of cases
D 7.2: Journal articles
D 7.3: Conference papers and exhibition at conferences
D 7.4: Web pages
M-1
M1
M2
M3
M4
M5
M6
M7
M8
M9
M10
M11
M12
M13
M14
M15
M16
M17
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31.10.
31.10.
30.09.
31.01.
28.11.
30.11.
31.12.
30.04.
30.09.
30.09.
30.09.
31.10.
31.12.
31.12.
31.12.
31.12.
28.02.
31.01.
30.06.
28.02.
28.02.
30.04.

Table 3: Budget plan

PARTNER	Cost Category	BUDGET (EUR)	ACTUAL COSTS (EUR)									Total Pct. Spent (%)
			Year 1	M13-18	Year 3	Year 4	Total	Year 1	M13-18	Year 3	Year 4	
		e	a1	b1	c1	d1	e1	a1/e	a1+b1/e	a1+b1+c1/e	a1+b1+c1+d1/e	e-e1
Partner 1 SiTu	Labour	332443	111267,67	74491,08			185758,75	33%	56%			146684,25
	Overheads	83658	26843,82	16897,03			43740,85	32%	52%			39917,15
	Labour+Overheads	416101	138111,49	91388,11			229499,60	33%	55%			186601,40
	Travel	25000	13122,11	7044,13			20166,24	52%	81%			4833,76
	Durable Eqmt.	57501	4470,86	2903,49			7374,35	8%	13%			50126,65
	Consumables	3340	5358,49	46,46			5404,95	160%	162%			-2064,95
	External Assistance	4766	200,00				200,00	4%	4%			4566,00
	Other											
	..											
	Total	506708	161262,95	101382,19			262645,14	32%	52%			244062,86
Partner 2 CD	Labour	206126	91339,17	24900,66			116239,83	44%	56%			
	Overheads	56109	24757,95	7521,96			32279,91	44%	58%			23829,09
	Labour+Overheads	262235	116097,12	32422,62			148519,74	44%	57%			113715,26
	Travel	10000	8989,07	2888,52			11877,59	90%	119%			-1877,59
	Durable Eqmt.	50421	19641,24	9820,62			29461,86	39%	58%			20959,14
	Consumables	14000	3820,28				3820,28	27%	27%			10179,72
	External Assistance											
	Other											
	..											
	Total	336656	148547,71	45131,76			193679,47	44%	58%			142976,53
Partner 3 FIGD	Labour	160334	95612,62	26597,40			122210,02	60%	76%			38123,98
	Overheads	153976	112689,89	52003,29			164693,18	73%	107%			-10717,18
	Labour+Overheads	314310	208302,51	78600,69			286903,20	66%	91%			27406,80
	Travel	15000	5218,39	3084,29			8302,68	35%	55%			6697,32
	Durable Eqmt.											
	Consumables	5000	1600,00	450,18			2050,18	32%	41%			2949,82
	External Assistance											
	Other											
	...											
	Total	334310	215120,90	82135,16			297256,06	64%	89%			37053,94
Partner 4 KTH	Labour	163065	32983,86	28056,19			61040,05	20%	37%			102024,95
	Overheads	44240	8450,37	7314,39			15764,76	19%	36%			28475,24
	Labour+Overheads	207305	41434,23	35370,58			76804,81	20%	37%			130500,19
	Travel	24138	6308,64	3433,77			9742,41	26%	40%			14395,59
	Durable Eqmt.	5000										5000,00
	Consumables	4000	1636,17	43,92			1680,09	41%	42%			2319,91
	External Assistance											
	Other											
	Computing	25000	1321,09	5038,06			6359,15	5%	25%			18640,85
	Total	265443	50700,13	43886,33			94586,46	19%	36%			170856,54
Partner 5 ALPE/LTF	Labour	48713	5313,00	1214,40			6527,40	11%	13%			42185,60
	Overheads	9742	1062,60	242,88			1305,48	11%	13%			8436,52
	Labour+Overheads	58455	6375,60	1457,28			7832,88	11%	13%			50622,12
	Travel	15000	1565,92	1928,65			3494,57	10%	23%			11505,43
	Durable Eqmt.											
	Consumables											
	External Assistance											
	Other											
	..											
	Total	73455	7941,52	3385,93			11327,45	11%	15%			62127,55
Partner 6 METL	Labour	48713	14041,40	4605,80			18647,20	29%	38%			30065,80
	Overheads	9742	2808,28	912,20			3720,48	29%	38%			6021,52
	Labour+Overheads	58455	16849,68	5518,00			22367,68	29%	38%			36087,32
	Travel	15000	2761,20	1656,00			4417,20	18%	29%			10582,80
	Durable Eqmt.											
	Consumables											
	External Assistance											
	Other											
	..											
	Total	73455	19610,88	7174,00			26784,88	27%	36%			46670,12
Partner 7 FDDo	Labour	45021	13347,90	7041,00			20388,90	30%	45%			24632,10
	Overheads	12004	2669,58	1408,20			4077,78	22%	34%			7926,22
	Labour+Overheads	57025	16017,48	8449,20			24466,68	28%	43%			32558,32
	Travel		4185,76	1464,00			5649,76					-5649,76
	Durable Eqmt.											
	Consumables											
	External Assistance	52500	15000,00				15000,00	29%	29%			37500,00
	Other											
	Computing	15000										15000,00
	Total	124525	35203,24	9913,20			45116,44	28%	36%			79408,56

PARTNER	Cost Category	BUDGET (EUR)	ACTUAL COSTS (EUR)									Total Pct. Spent (%)
			Year 1	M13-18	Year 3	Year 4	Total	Year 1	M13-18	Year 3	Year 4	
		e	a1	b1	c1	d1	e1	a1/e	a1+b1/e	a1+b1+c1/e	a1+b1+c1+d1/e	e-e1
Partner 8 EUVE	Labour	54648	11187,36	8774,40			19961,76	20%	37%			34686,24
	Overheads		8949,89	7019,52			15969,41					-15969,41
	Labour+Overheads	54648	20137,25	15793,92			35931,17	37%	66%			18716,83
	Travel	15000	4827,88	2749,06			7576,94	32%	51%			7423,06
	Durable Eqmt.											
	Consumables	2000										2000,00
	External Assistance											
	Other		1600,00				1600,00					-1600,00
	..											
	Total	71648	26565,13	18542,98			45108,11	37%	63%			26539,89
TOTAL	Labour	1059063	375092,98	175680,93			550773,91	35%	52%			508289,09
	Overheads	369471	188232,38	93319,47			281551,85	51%	76%			87919,16
	Labour+Overheads	1428534	563325,36	269000,40			832325,76	39%	58%			596208,24
	Travel	119138	46978,97	24248,42			71227,39	39%	60%			47910,61
	Durable Eqmt.	112922	24112,10	12724,11			36836,21	21%	33%			76085,79
	Consumables	28340	12414,94	540,56			12955,50	44%	46%			15384,50
	External Assistance	57266	15200,00				15200,00	27%	27%			42066,00
	Other		1600,00				1600,00					-1600,00
	Computing	40000	1321,09	5038,06			6359,15	3%	16%			33640,85
	Total	1786200	664952,46	311551,55			976504,01	37%	55%			809695,99

Literature/Links

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