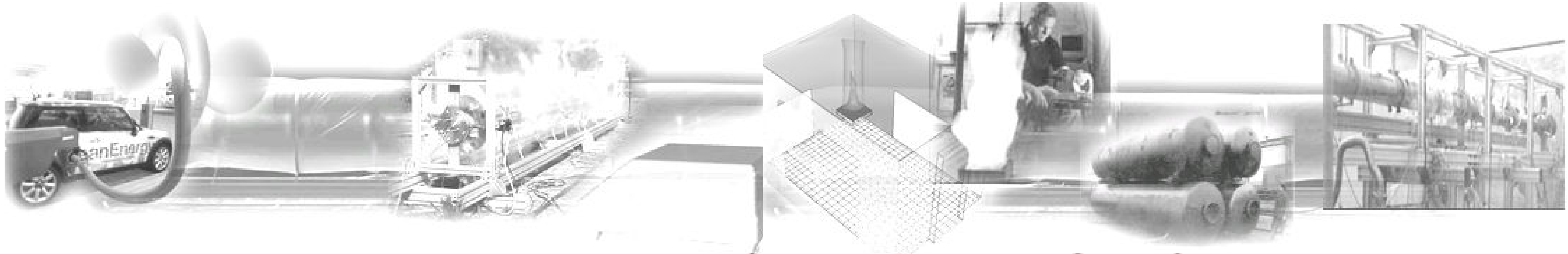

Results of the HySafe CFD Validation Benchmark SBEPV5

T. Jordan[1], J.García[3], O. Hansen[4], A. Huser[7], S. Ledin[8], P. Middha[4], V. Molkov[5], J. Travis[2], A.G. Venetsanos[6], F. Verbecke[5],J. Xiao[1]

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[3]Universidad Politecnica de Madrid Spain,[4]GexCon AS Norway,
[5]University of Ulster United Kingdom,
[6]National Center for Scientific Research Demokritos Greece,
[7]Det Norsk Veritas Norway, [8]HSE/HSL United Kingdom

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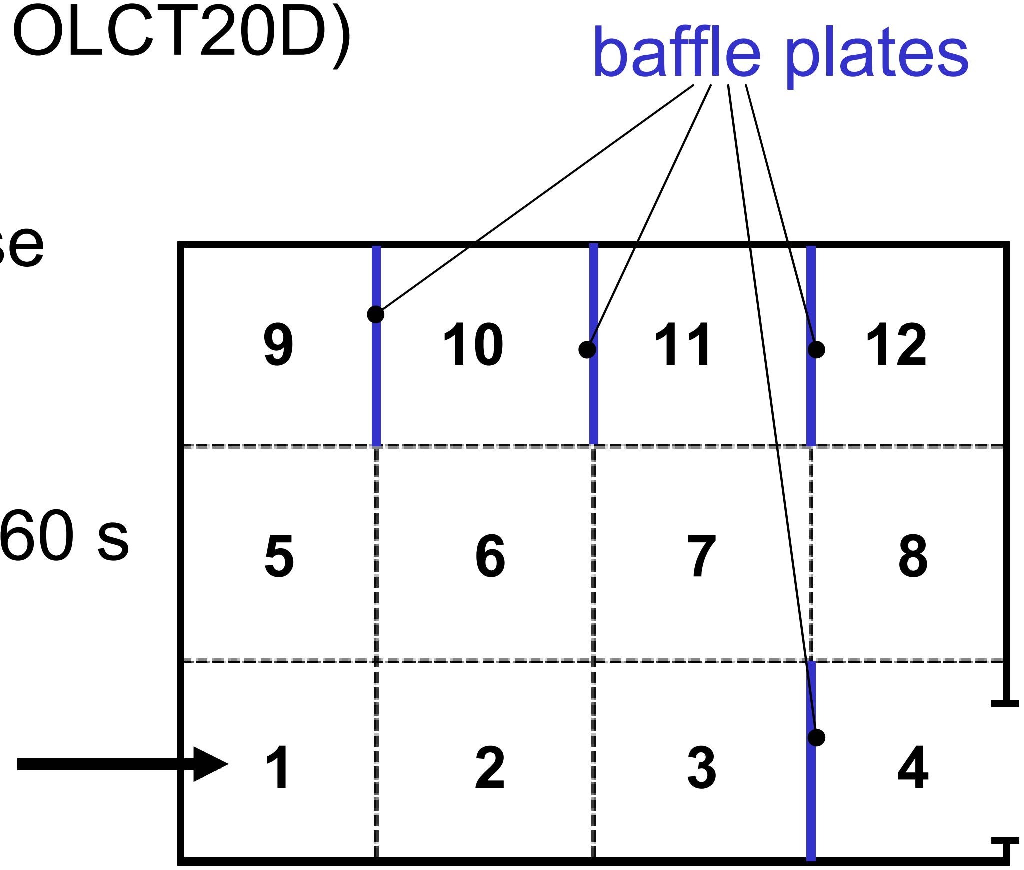
SBEPV5 Benchmark description

1.20m×0.90m×0.20m

- Dispersion experiments in 2003
- Partial to full confinement
- Internal structures
- DNV and GexCon (HySafe partners) & Statoil
- Sub-set of results shared with HySafe

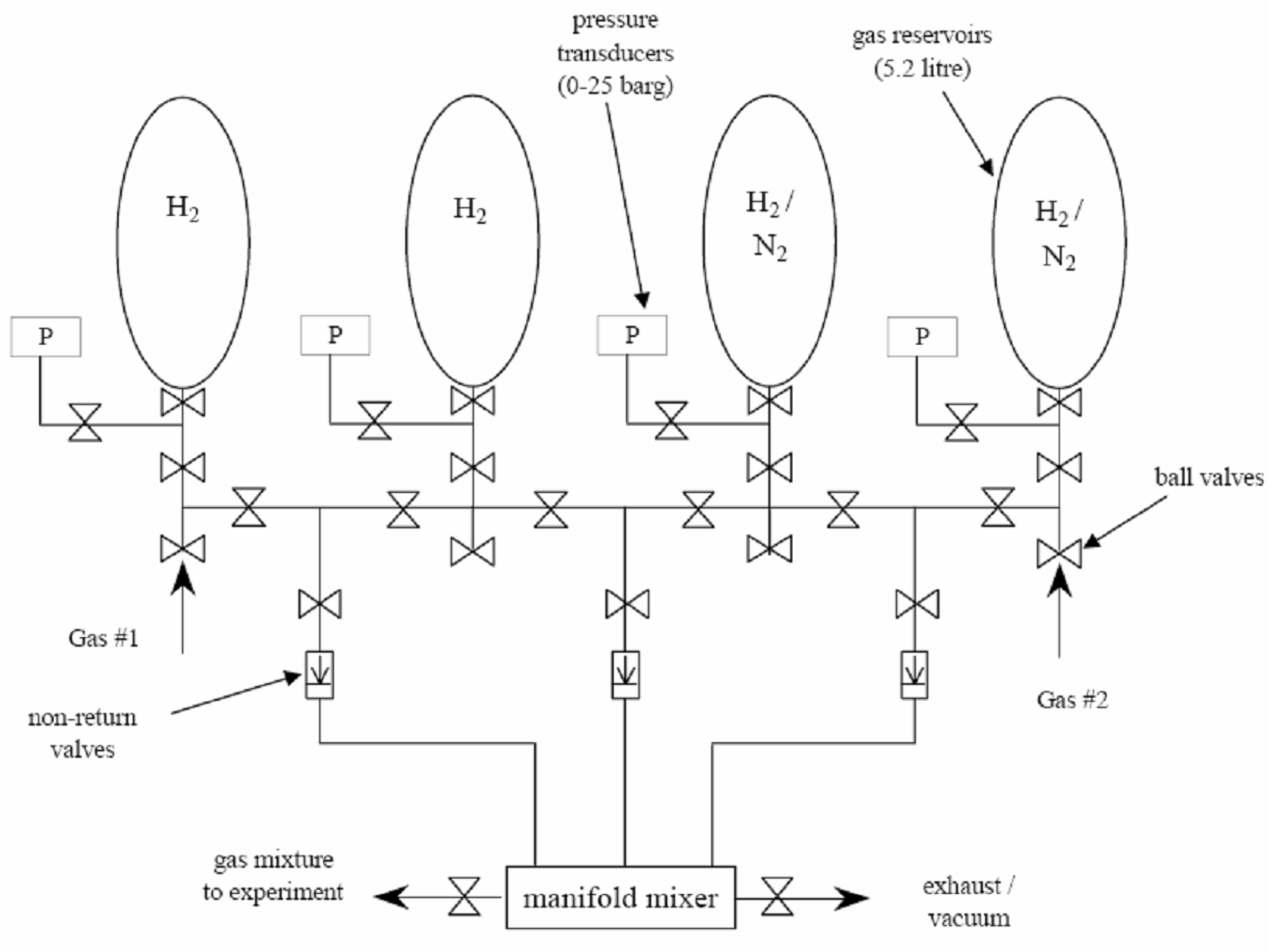
D27 - Experiment description

- H2 concentration measurement
  (12 Oldham sensors type OLCT20D)
- Central sensor location
  in each compartment close
  to the rear wall



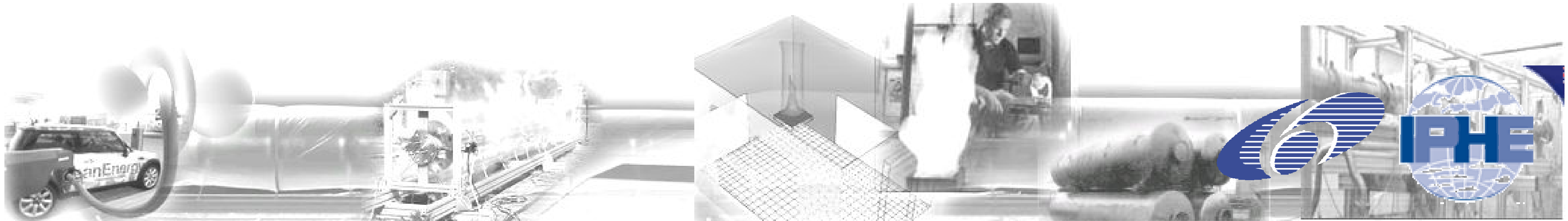
- Hydrogen release period: 60 s
- Nozzle diameter: 12 mm
- Exit velocity: 10.17 m/s
- Release rate: 1.15 l/s

Gas preparation



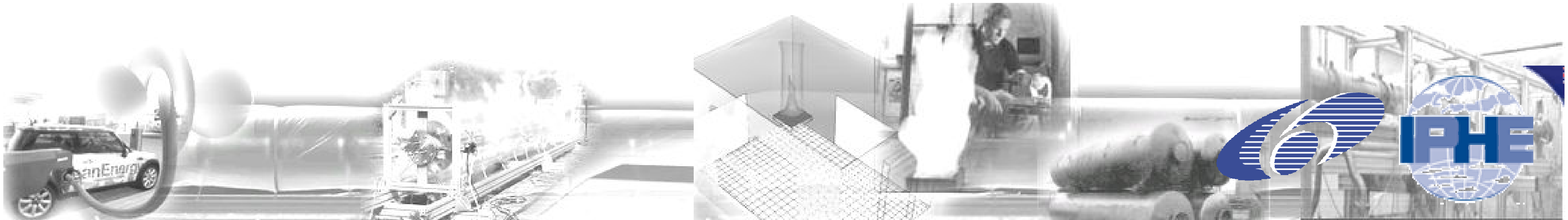
Sensor OLDHAM OLCT 20D

- Catharometre (thermal conductivity) type for H_2
- 0-100% vol H_2
- Accuracy 1% vol H_2
- -20 to 50 C; 10 to 95% RH
- IP66



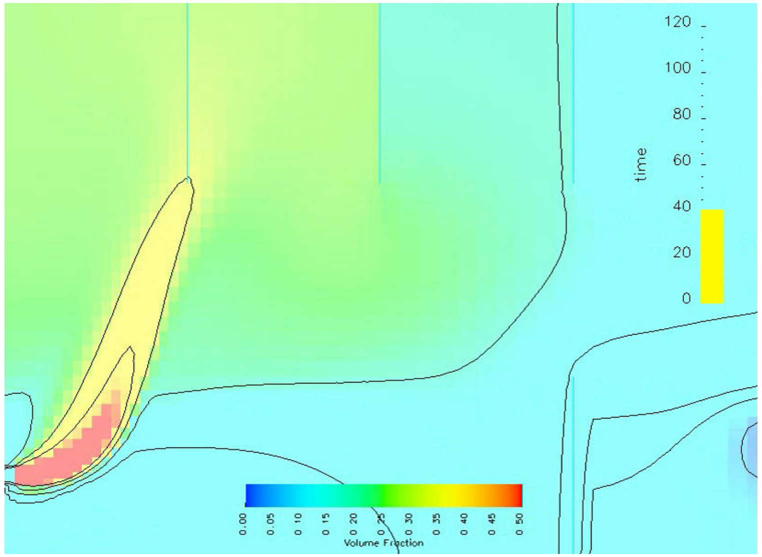
Simulations

CODE (Partner)	N cells	Min-max cell dim	Turbulence model	CPU time
ADREA (NCSRD)	141.466	12 mm	standard k-ε	
FLACS (GexCon)	38.318	11 mm	-	64 h
KFX (DNV)	15.444	11-30 mm	standard k-ε	
FLACS (DNV)	15.444	15 mm	-	
FLUENT (UPM)	71.561		standard k-ε	48 h
FLUENT (UU)	261.506	1,3 mm	LES	
CFX (HSE/HSL)		0,5-2 mm	SST	
GASFLOW (FZK)	23.100	15 mm	k-ε	

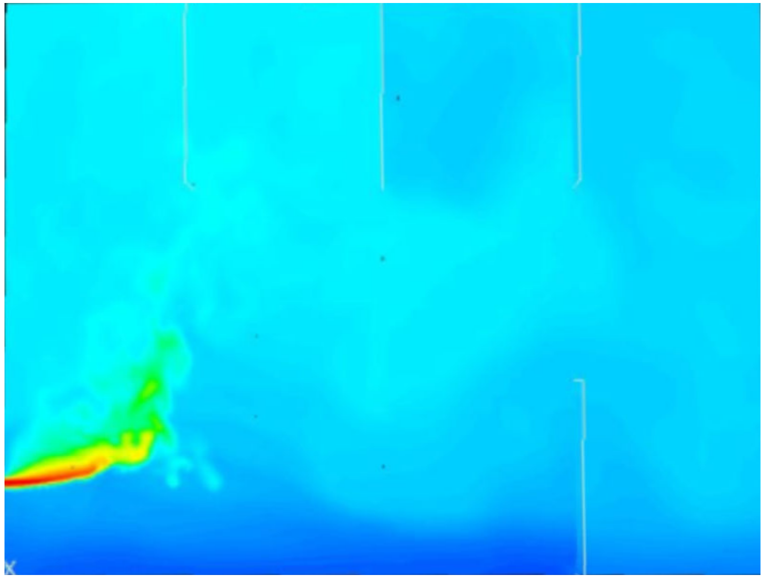


Some movies…

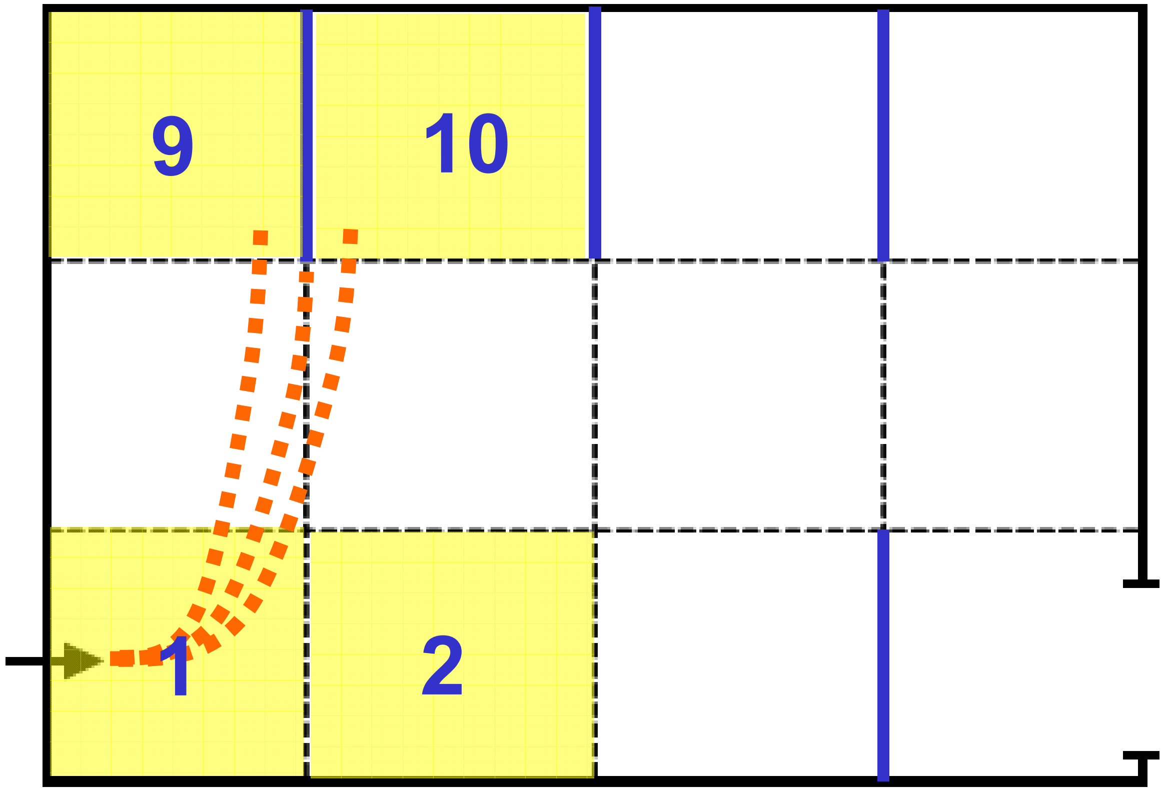
[GASFLOW (FZK) $k\varepsilon$]



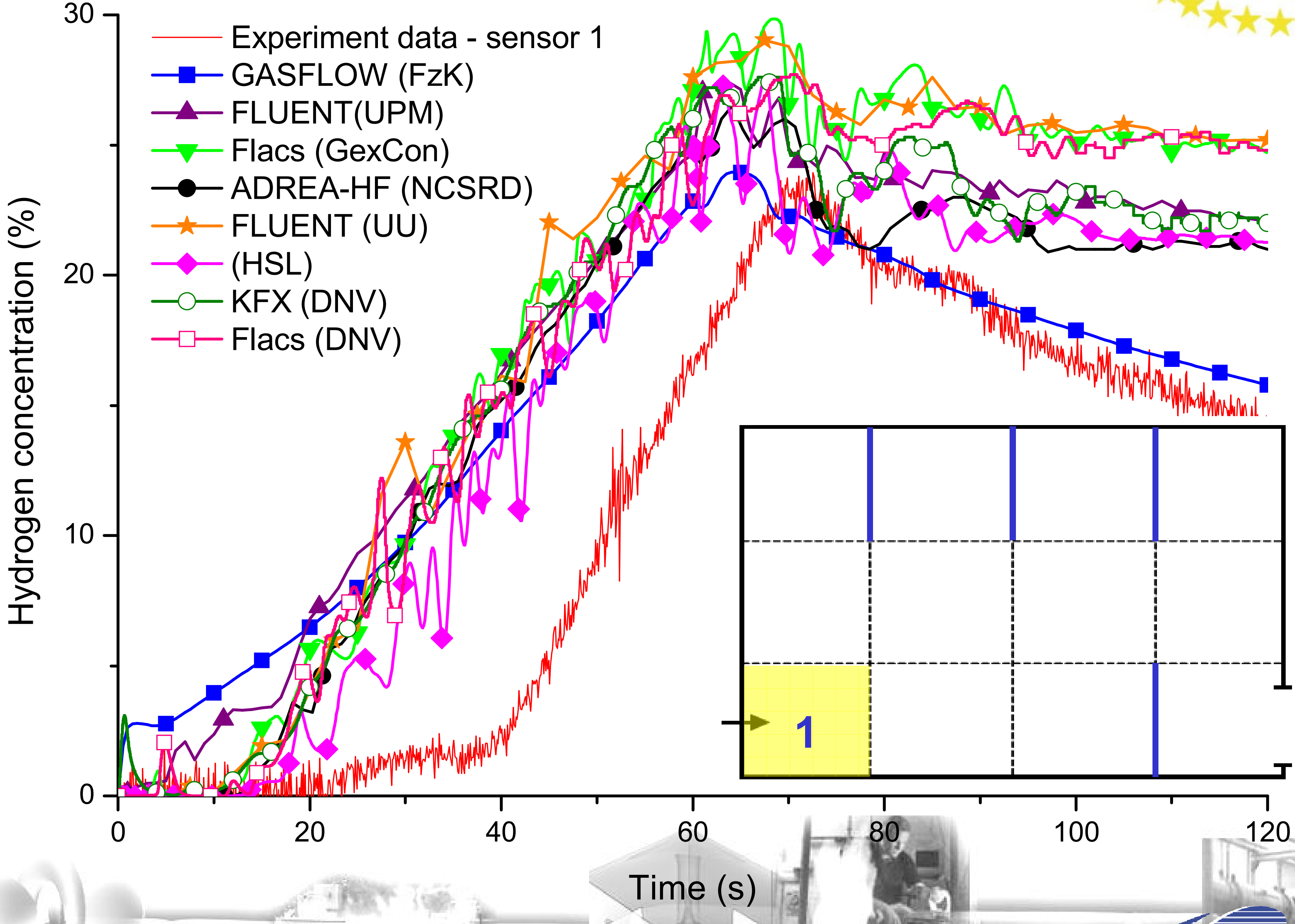
[Fluent (UU) LES]



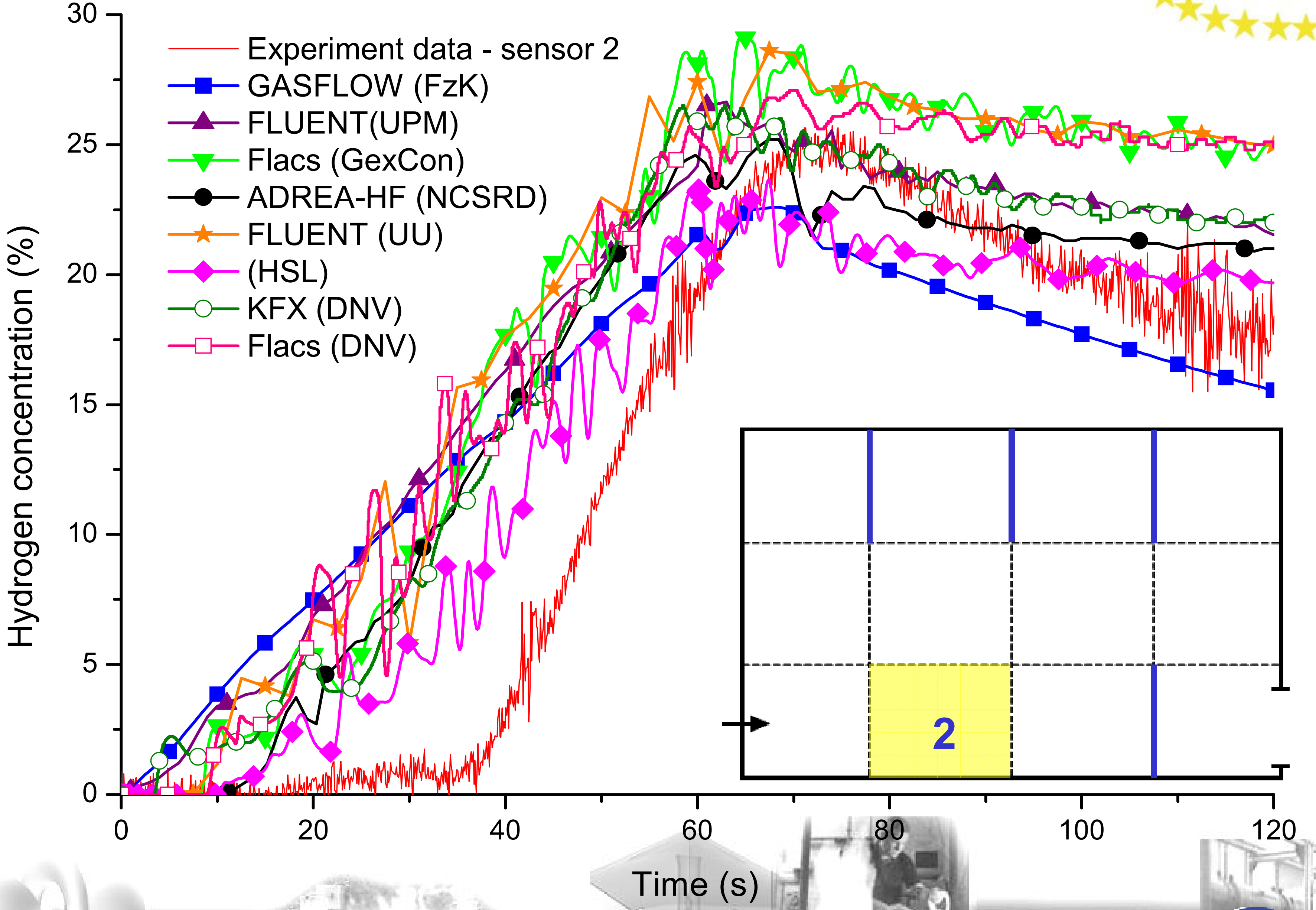
Comparison of Results at the sensitive sensor locations



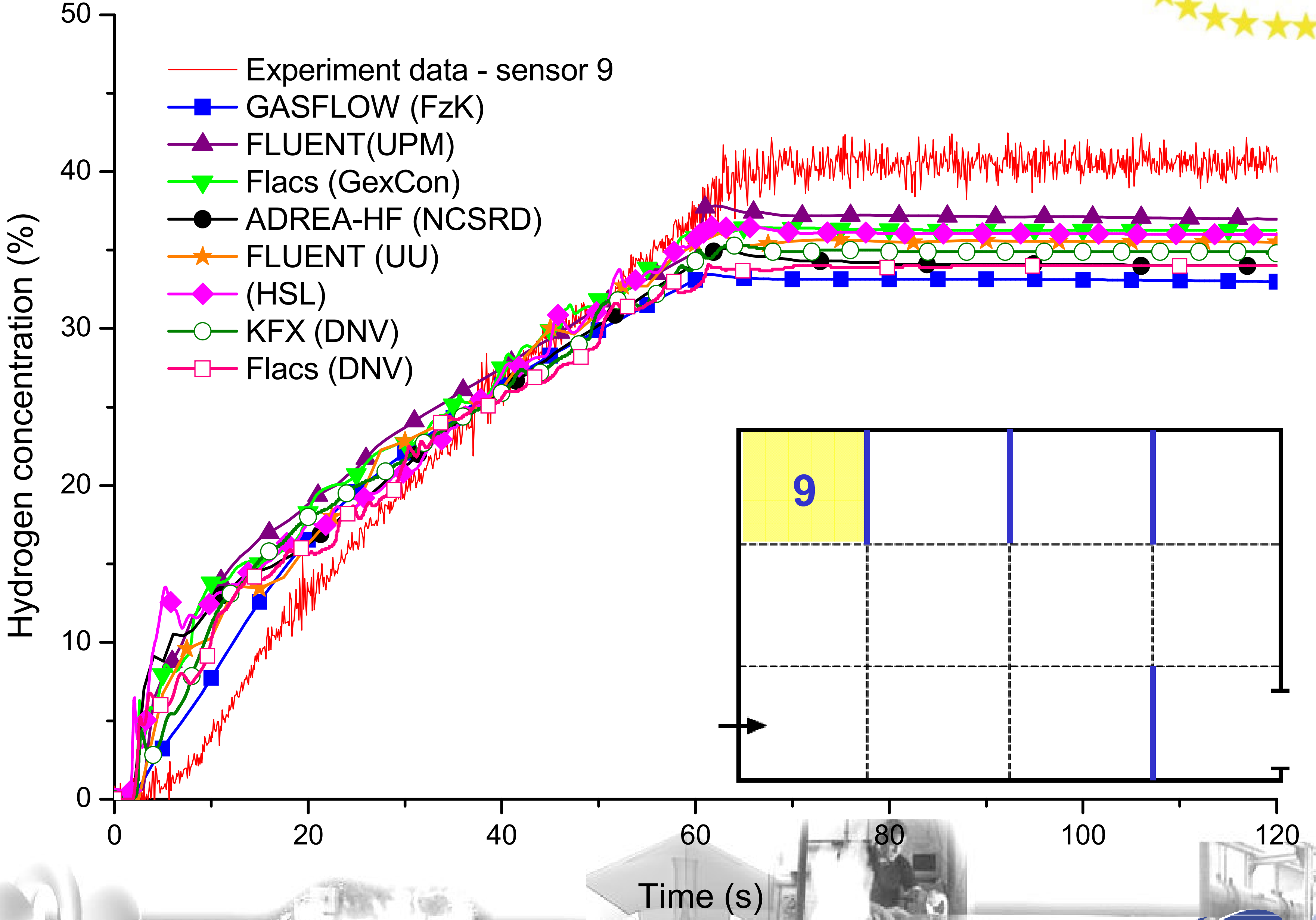
Results at Sensor 1



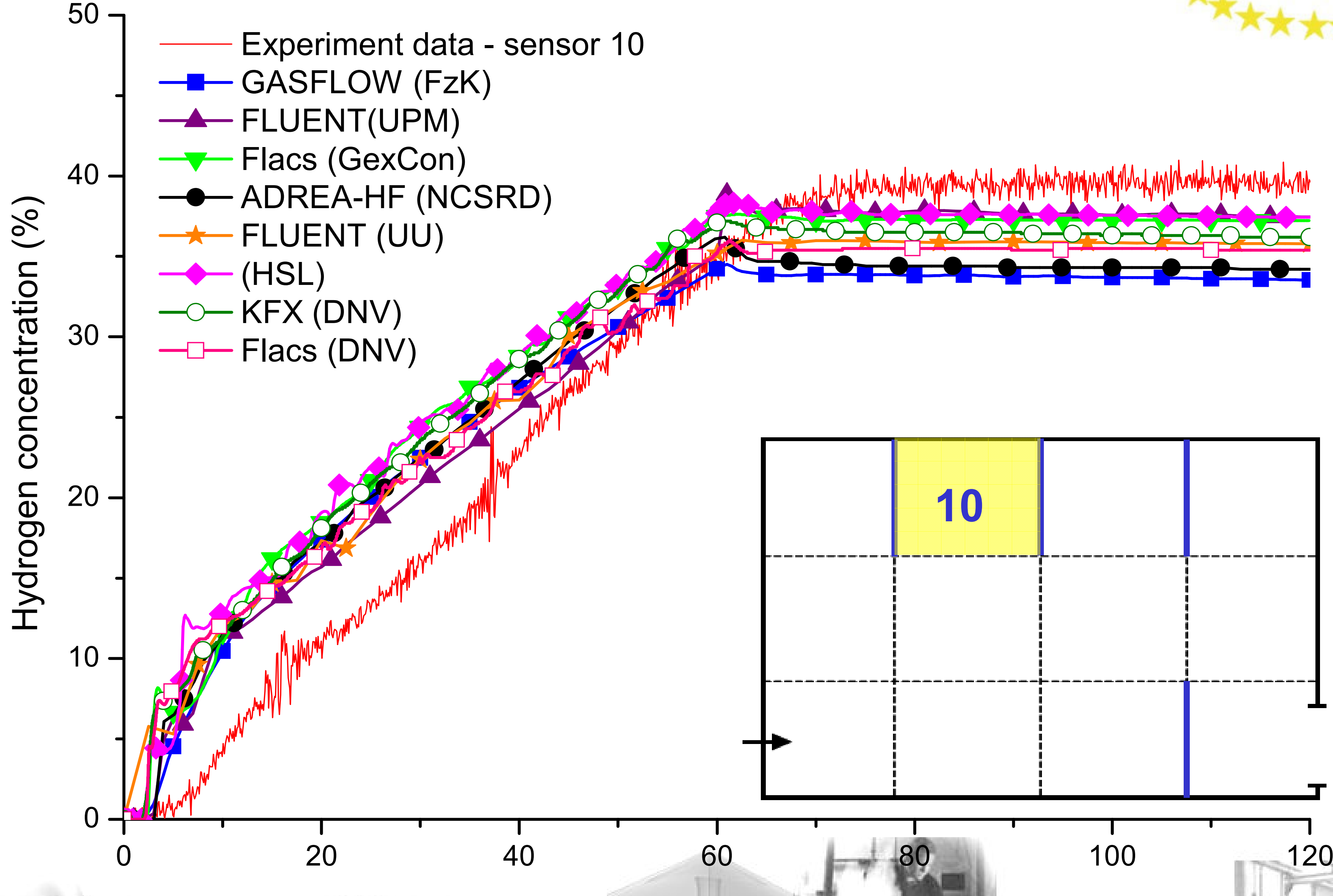
Results at Sensor 2



Results at Sensor 9



Results at Sensor 10

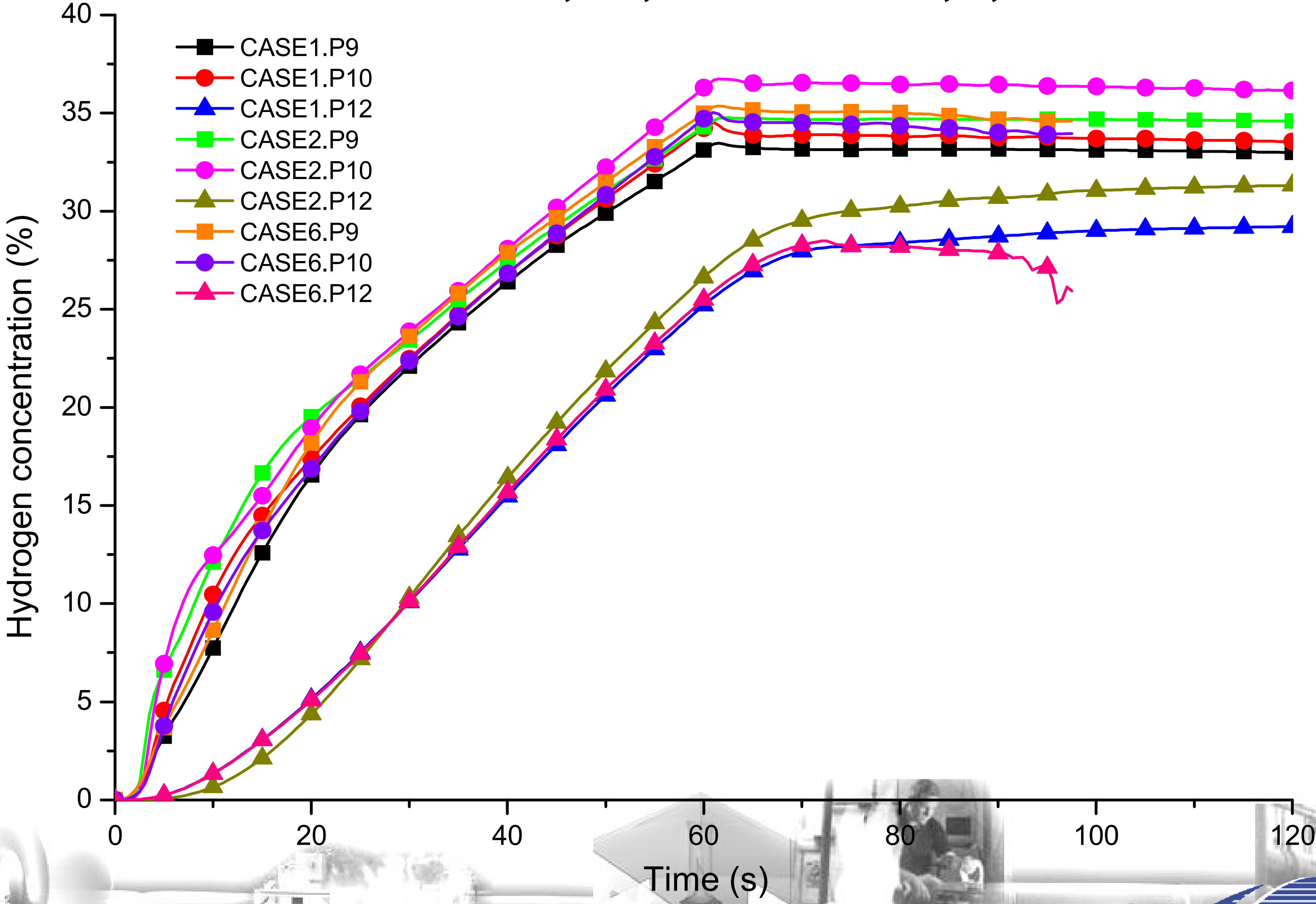


Parametric Study (GASFLOW)

Case	Inflow H2-T (° C)	Turb. Schmidt	Heat Transfer	Mesh	Comments and Effects
1 Ref.	20	0.85	No	Coarse 55x42x10 = 23100	1. Uses GASFLOW default values 2. Steady State #9 & #10 between 33% & 34%, respectively. 3. #10 slightly higher than #9 in contrast with data.
2	20	**1.50**	No	Coarse	1. Increases #9 to 35%, & #10 to 36% 2. #10 slightly higher than #9 in contrast with data.
3	**0**	0.85	No	Coarse	1. Increases #9 to 34%, & #10 to 35% 2. #10 slightly higher than #9 in contrast with data.
4	**0**	**1.00**	No	Coarse	1. Increases #9 to 35%, & #10 to 36% 2. #10 slightly higher than #9 in contrast with data.
5	0	0.85	**Yes**	Coarse	1. Increases #9 to 34%, & #10 to 36% 2. #10 slightly higher than #9 in contrast with data.
6	20	0.85	No	**Fine 80x63x15 = 75600**	1. Same as reference Case 1 with finer spatial resolution 2. Steady State #9 & #10 between 35% & 34%, respectively. 3. #9 slightly higher than #10 in agreement with data.

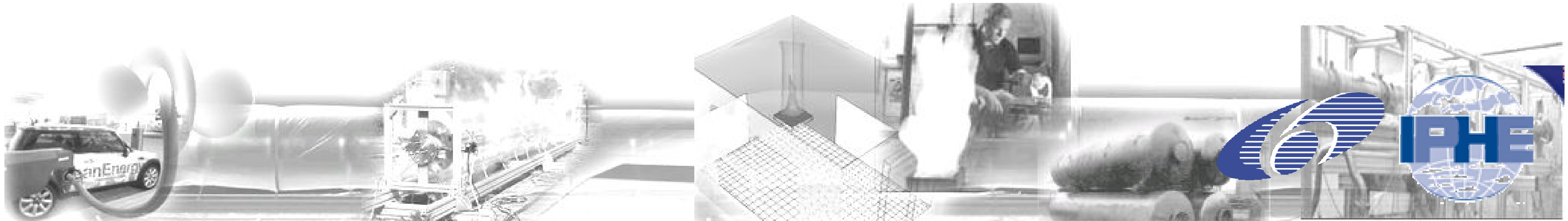
Parametric Study (GASFLOW)

Sensor 9,10,12 –case 1,2,6



Conclusions
of the parametric study

- H2 Inflow Temperature between 0° and 20° C
  → positive, but small effect
- 2 x turbulent Schmidt Number → positive, but small effect
- Including structural heat transfer → a positive, but small effect.
- Increasing mesh resolution by 50% in all dimensions
  → higher hydrogen concentration for measurement position #9 than position #10



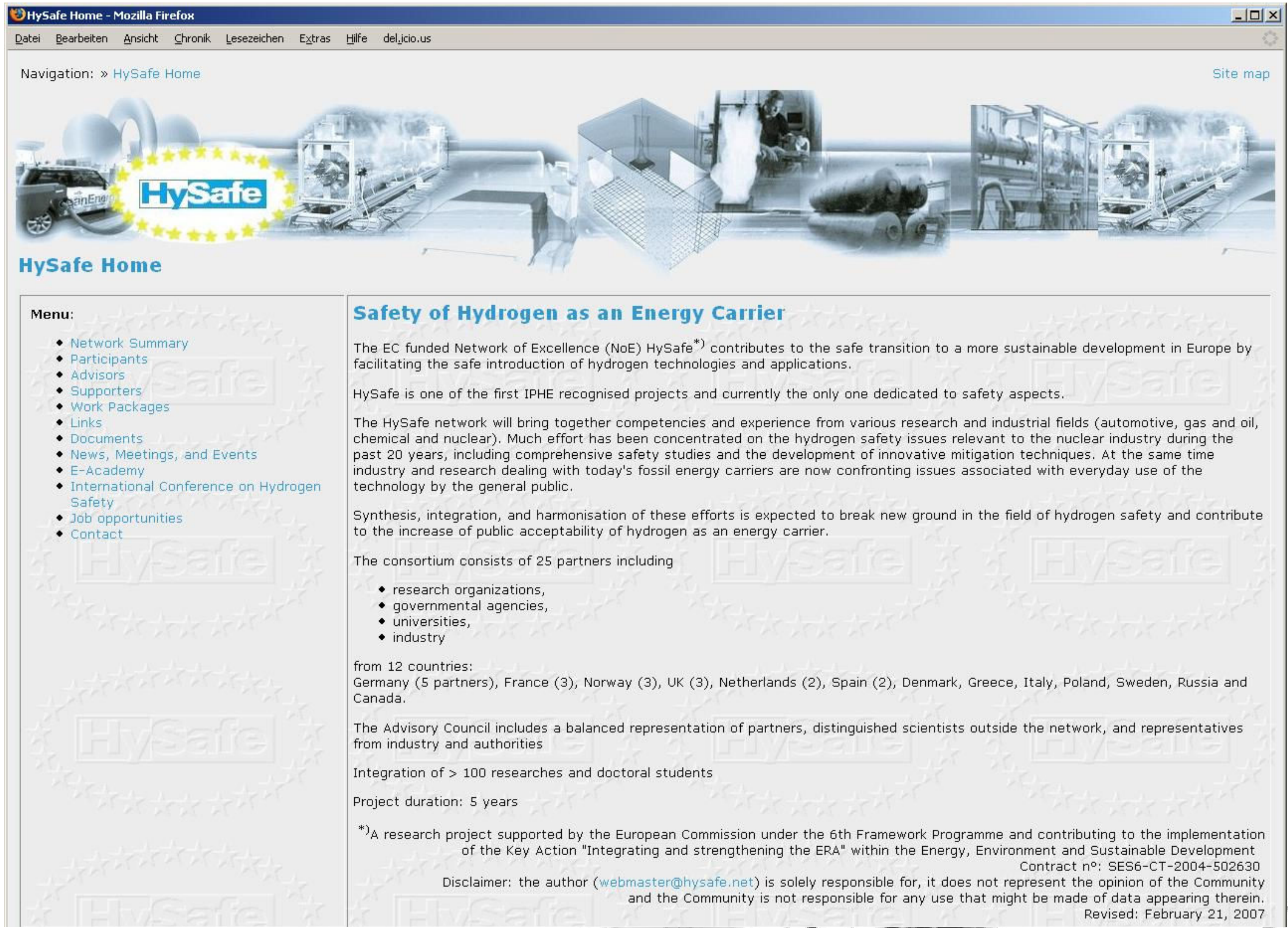
Conclusions

Simple but relevant dispersion H2 dispersion experiment, well instrumented besides some sensor failures and unknown characteristics modeled by 8 expert groups with 5 different CFD packages

- **CFD results** show only **small scatter**
- may be **explained** by different settings and model assumptions
- Some deviation compared to experimental data might be attributed to unknown sensor performance
- k ε and LES produce similiar results
- Further attention should be payed to the source and jet modeling

Further information

→ www.hysafe.net


HysSafe Home - Mozilla Firefox

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Safety of Hydrogen as an Energy Carrier

The EC funded Network of Excellence (NoE) HySafe*) contributes to the safe transition to a more sustainable development in Europe by facilitating the safe introduction of hydrogen technologies and applications.

HySafe is one of the first IPHE recognised projects and currently the only one dedicated to safety aspects.

The HySafe network will bring together competencies and experience from various research and industrial fields (automotive, gas and oil, chemical and nuclear). Much effort has been concentrated on the hydrogen safety issues relevant to the nuclear industry during the past 20 years, including comprehensive safety studies and the development of innovative mitigation techniques. At the same time industry and research dealing with today's fossil energy carriers are now confronting issues associated with everyday use of the technology by the general public.

Synthesis, integration, and harmonisation of these efforts is expected to break new ground in the field of hydrogen safety and contribute to the increase of public acceptability of hydrogen as an energy carrier.

The consortium consists of 25 partners including

- research organizations,
- governmental agencies,
- universities,
- industry

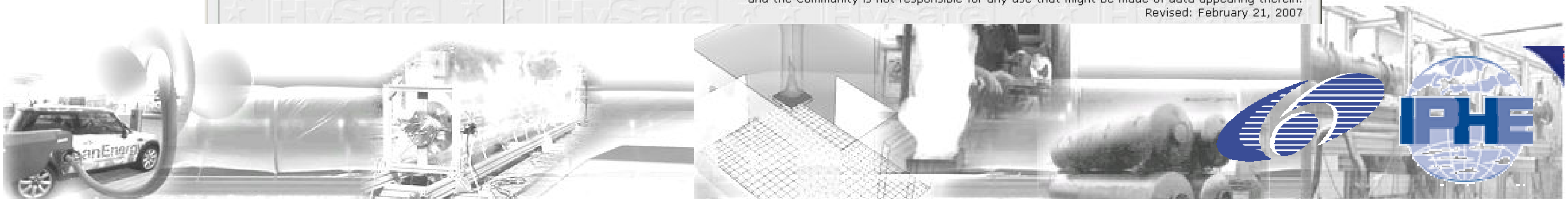
from 12 countries:
Germany (5 partners), France (3), Norway (3), UK (3), Netherlands (2), Spain (2), Denmark, Greece, Italy, Poland, Sweden, Russia and Canada.

The Advisory Council includes a balanced representation of partners, distinguished scientists outside the network, and representatives from industry and authorities

Integration of > 100 researches and doctoral students

Project duration: 5 years

*) A research project supported by the European Commission under the 6th Framework Programme and contributing to the implementation of the Key Action "Integrating and strengthening the ERA" within the Energy, Environment and Sustainable Development
Contract n°: SES6-CT-2004-502630
Disclaimer: the author (webmaster@hysafe.net) is solely responsible for, it does not represent the opinion of the Community and the Community is not responsible for any use that might be made of data appearing therein.
Revised: February 21, 2007



Acknowledgment

NoE HySafe is co-funded by the European Commission within the 6th Framework Programme (2002-2006); Contract n° : SES6-CT-2004-502630.

The network is contributing to the implementation of the Key Action "Integrating and strengthening the ERA" within the Energy, Environment and Sustainable Development.

Thanks to all HySafe colleagues…

… and thank you for your attention.