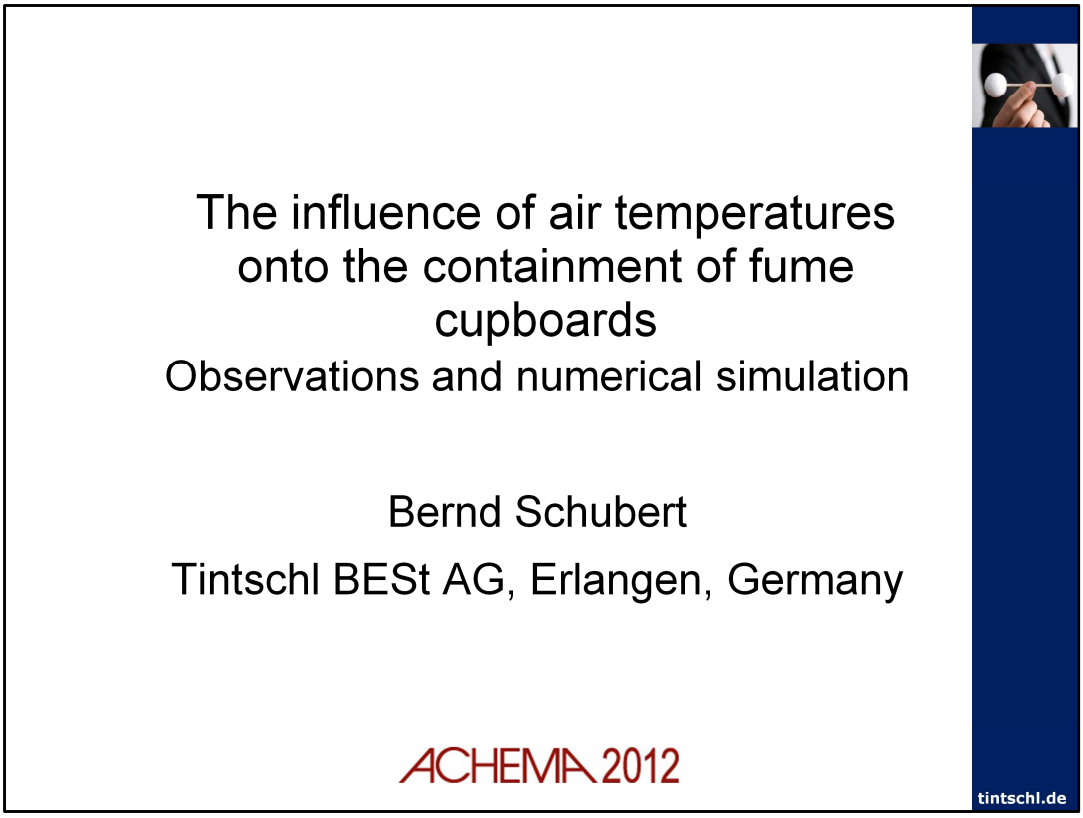

Good Morning Ladies and Gentlemen,

The next twenty minutes I am going to present you some interesting results from our work: the testing of fume cupboards – and - the numerical investigation of flow fields

Basics

- Fume cupboard:
  airborne substances taken away by exhausted air
- Modern fume hoods:
  less air to save energy

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The fume cupboard shall be the preferred working place for scientists who are working with potential harmful substances. To protect them from breathing them air is exhausted through the hood. But as the extracted air has to be costly prepared before entering the room new fume cupboards are developed consuming less air and therefore saving energy and costs.

Test according to EN 14175 - 3

- Bench top fume cupboard
- Test condition:
  - Room air temperature: 22.3±0.5°C
  - Input air: 21 – 23°C
- Static test outer grid 300 s

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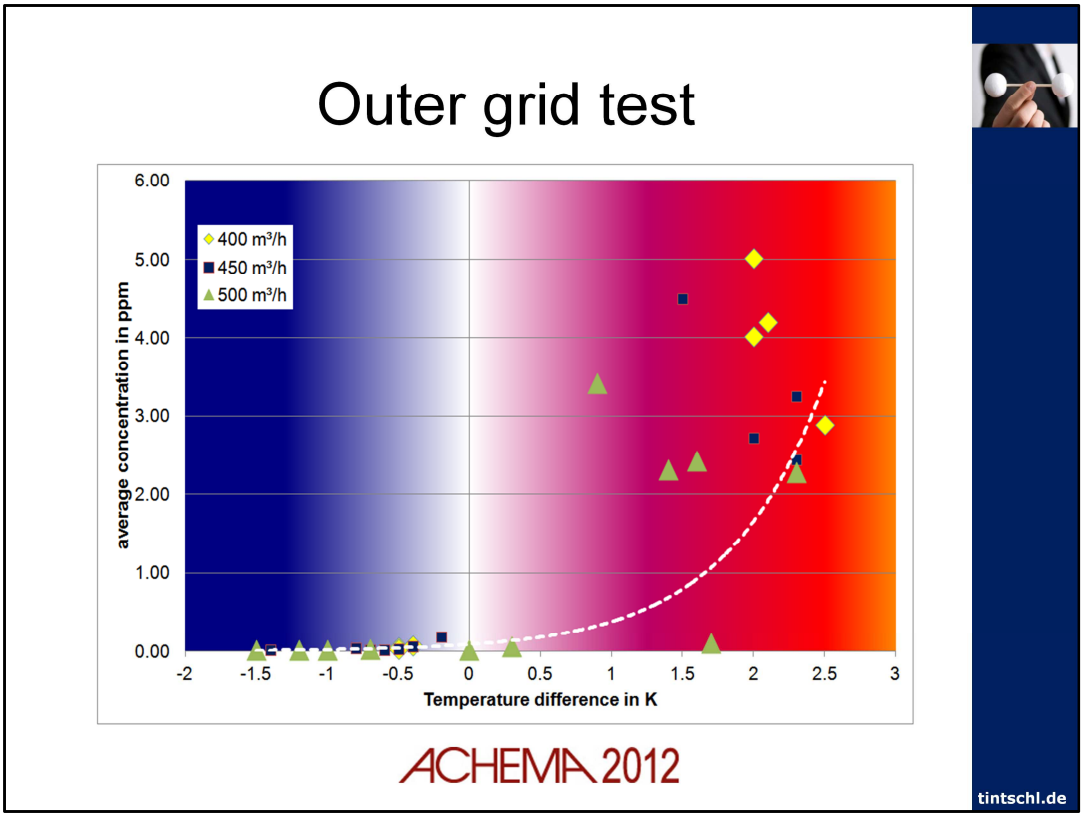
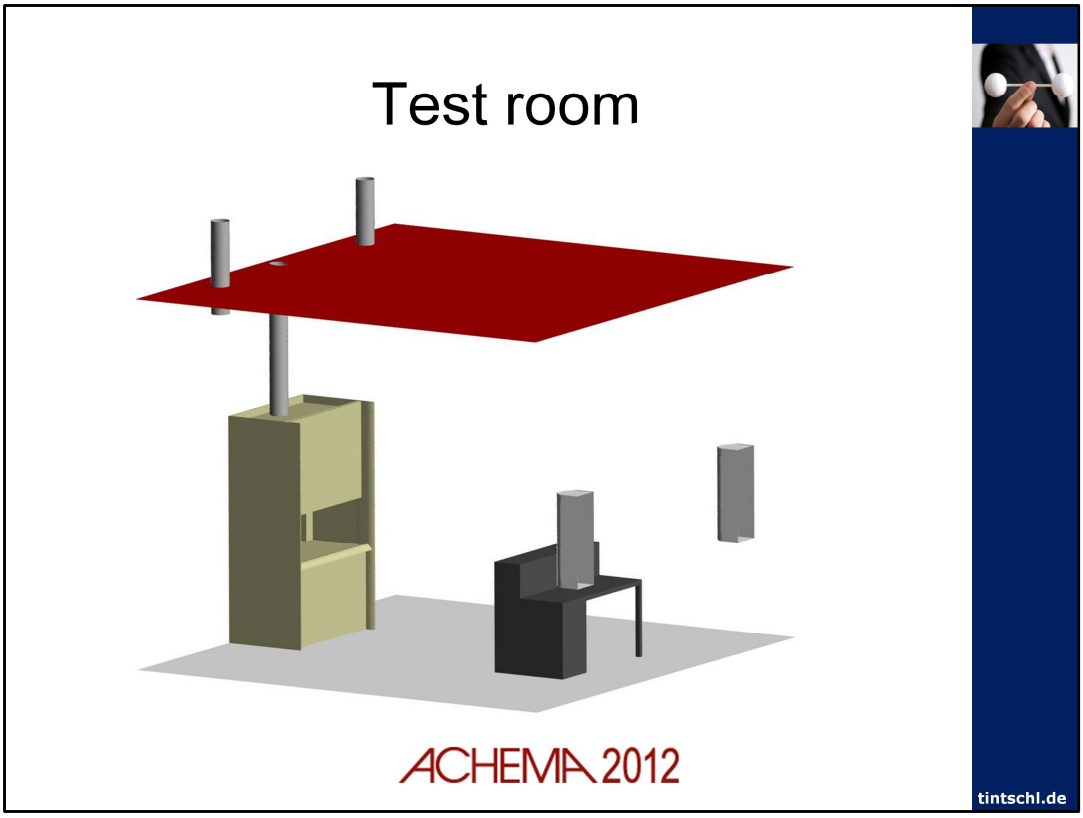
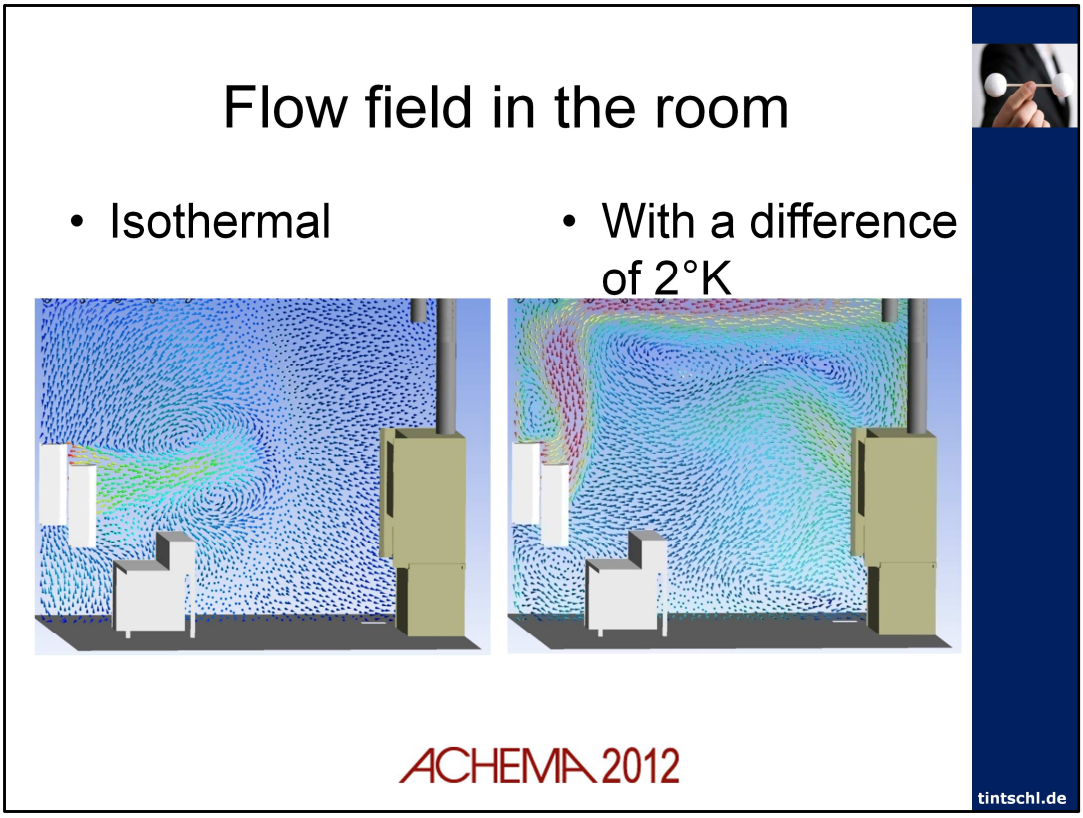
Such a new kind of fume cupboard was now tested in our special test room according to the EN 14175-3 , type test. This not commercial available unit was 1.5m wide and running at constant volume flow rate. The fume cupboard had some aerodynamic add-ons which should allow to run it with a low volume flow rate.
The intended test conditions had been according to the prescription of the standard, does mean around 22 Degree C plus minus 1 Kelvin



So we started with the tests and reduced the air more and more. But we found some values not following the rules. Do to some extreme outside conditions the input air temperature did not meet the specifications according the EN 14175 – 3 rules and differ more than 1 degree from the room temperature. So we get this set of data. It shows the influence of the temperature difference onto the containment for one and the same fume cupboard and various volume flow rates.



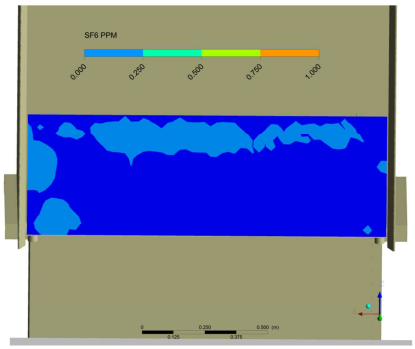
As I was not able to identify the mechanism immediately I asked my colleagues for support. They put the dimensions of the room, the objects and the conditions into their computer and let their CFD-software run. Here you see the electronic copy of our test room with fume cupboard on the left side at the wall, two additional room air outlets left and right of the hood, the two air inlet opposite the test opening at the other wall and finally a small desk of the operator.

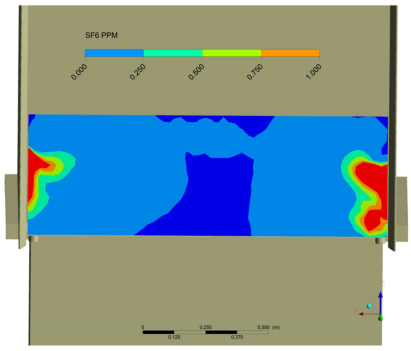


The result of the numerical simulation were amazing: In the isothermal situation the room air flow was as designed and expected: a smooth flow through the room direct into the test opening of the investigated fume cupboard.
But with a difference of only 2 Kelvin suddenly a total different flow field is created which gives room air velocities in the surrounding of the fume cupboard, which are within the limits..

SF_6 concentration at the grid

- Isothermal
- With difference of 2°K





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This difference in the flow fields has a tremendous influence onto the investigated fume cupboard with the low volume flow rate: While in the isothermal situation only concentrations of maximum 0.2ppm are found in the outer gird surface, with the temperature difference of 2 Kelvin the fume cupboards starts leaking and spots with concentration of 1ppm and above can be found in a distance of 50 mm of the opening.

Reality example 1

- Nights cold - days hot
- Rooms with several fume cupboards
- Room temperature 23°C – full climate control
- Containment test outer grid accordning to EN 14175-4

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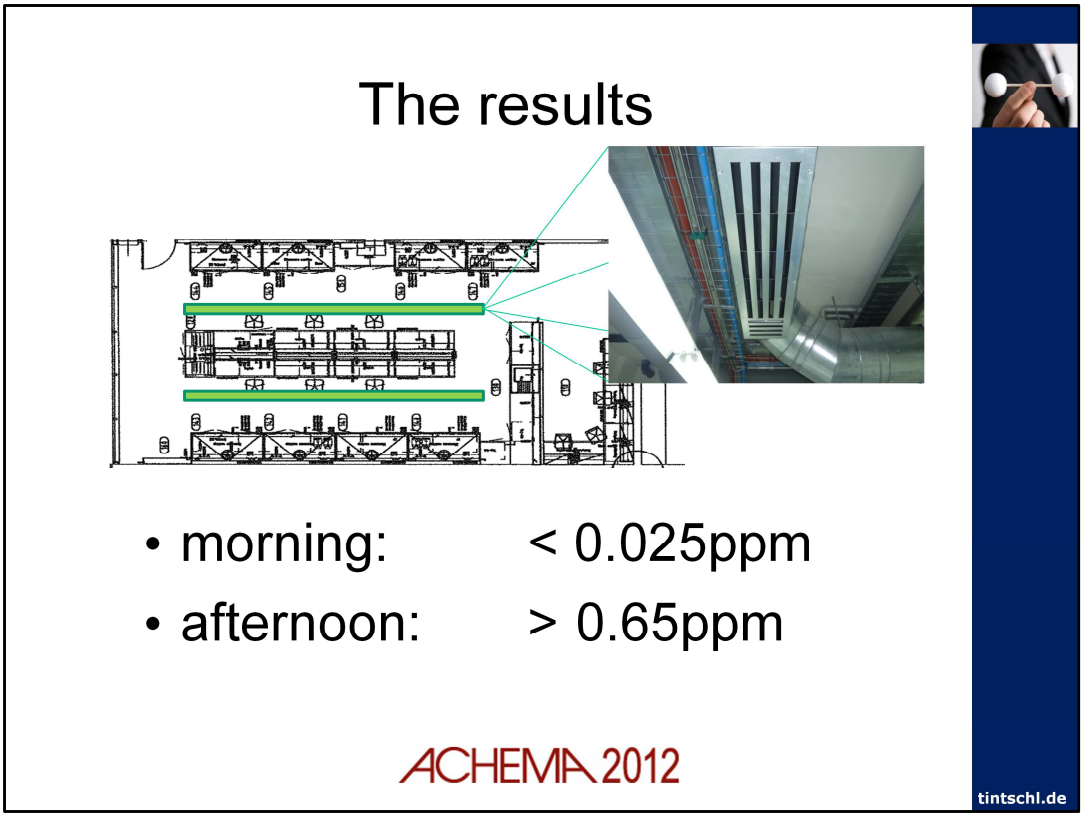
That is reason why the test room conditions are defined so tight.

But what happens in the real world - the real laboratories ?

It was in a southern country were the nights had been cold and during the day the temperature went up to 35°C and more.

We were asked to perform tests in a brand new building with a lot of fume cupboards and fully automatic climate control system.



Just – to make it more comparable – here are only the result of the outer grid test:

In the morning values below the detection limit of the used instrument – in the afternoon values above 0.65ppm.

The origin was soon identified: With the found adjustment of the air outlet system the warm air was well distributed in the room and no drafts in the working area were detectable. But the cold air, used in the afternoon to keep the room air temperature reasonable, creates heavy drafts just in front of the fume cupboards. The solution was a slight increase of the exhaust rates and mainly , the readjustment of the outlets. This causes some loss of comfort in the heating situation, but it guarantees a stable working condition for the fume cupboards.

Example 2

- Many fume cupboards
- Special air intake system
- Containment test: Different results for the same type

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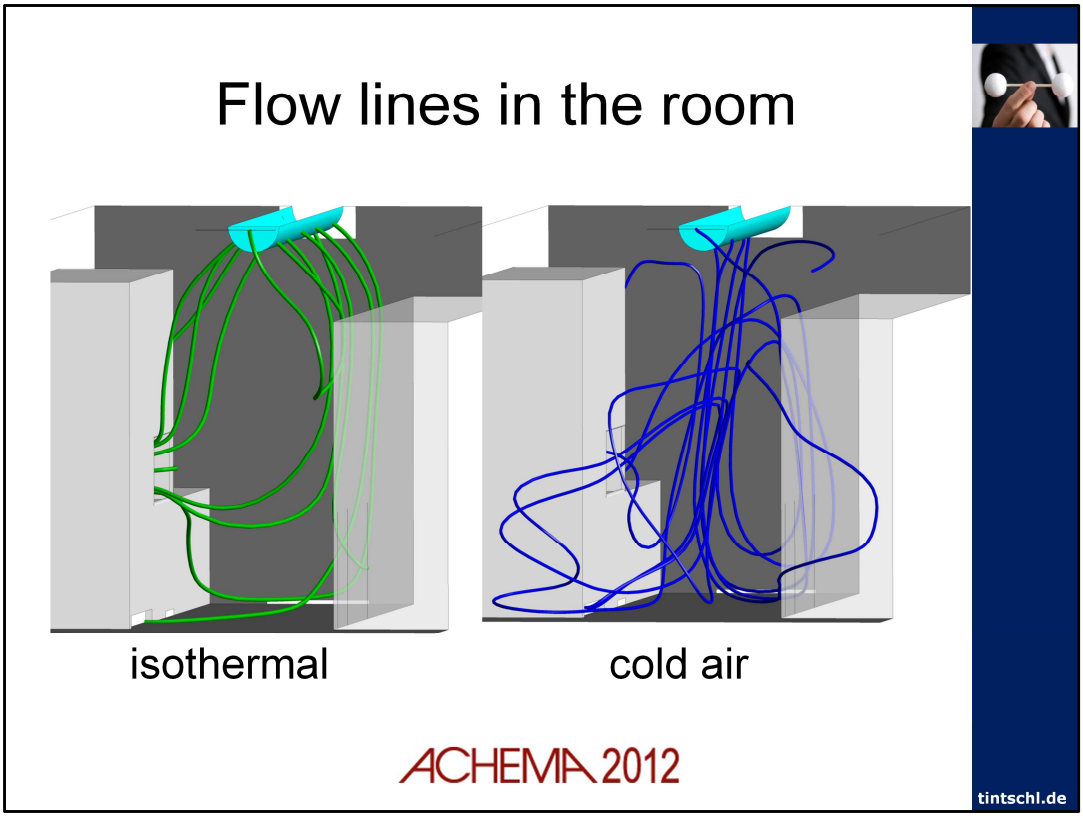
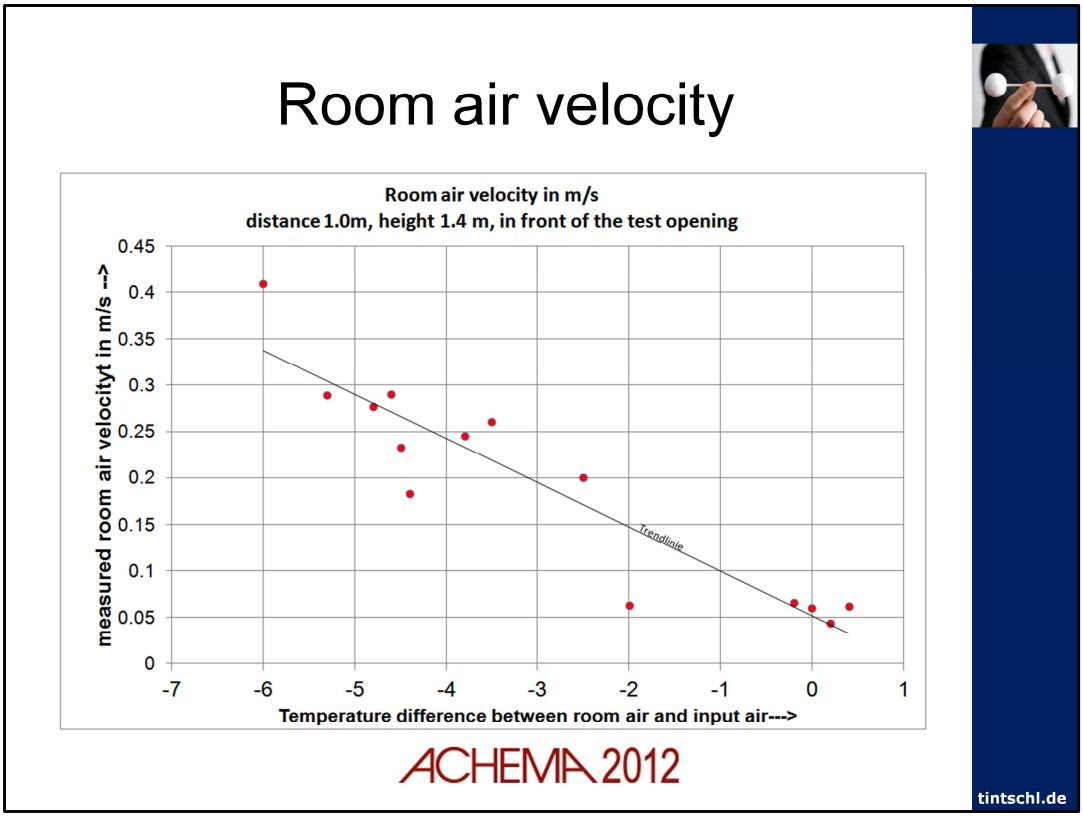
I would like to show you another example which was investigated in more detail: A new laboratory with modern fume cupboards and textile filter air outlet system for the room air. But again – the containment tests according EN 14175-4 showed different results, although it had been the same type of fume cupboard and they were running with the same volume flow rate.

So our numerical team was asked whether they can identify the reason



They copied all relevant details like furniture, walls, air outlets and , of course, the fume cupboards into the computer and started the calculation of the flow field. The most interesting result was, that even with the very efficient distribution system the cold air creates strong turbulences which causes the low volume flow fume cupboards to leak.

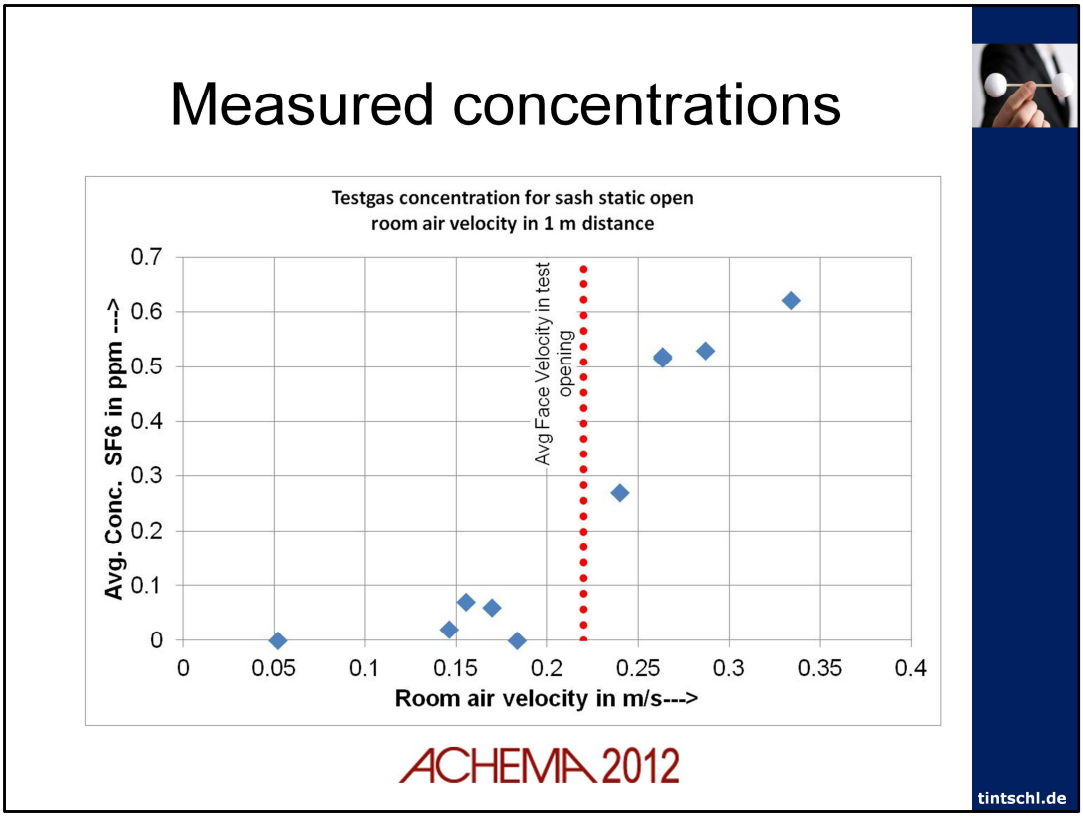
To validate these results we went back into the laboratories.



Here we measured the room air velocities as described in EN14175-4 while the HVAC people changed the temperature conditions.

And as predicted in the numerical simulation did we find higher velocities in the room the colder the input air was related to the room air.

But although the distance of the measurement point was one meter away from the front opening the influence onto the containment was measurable.

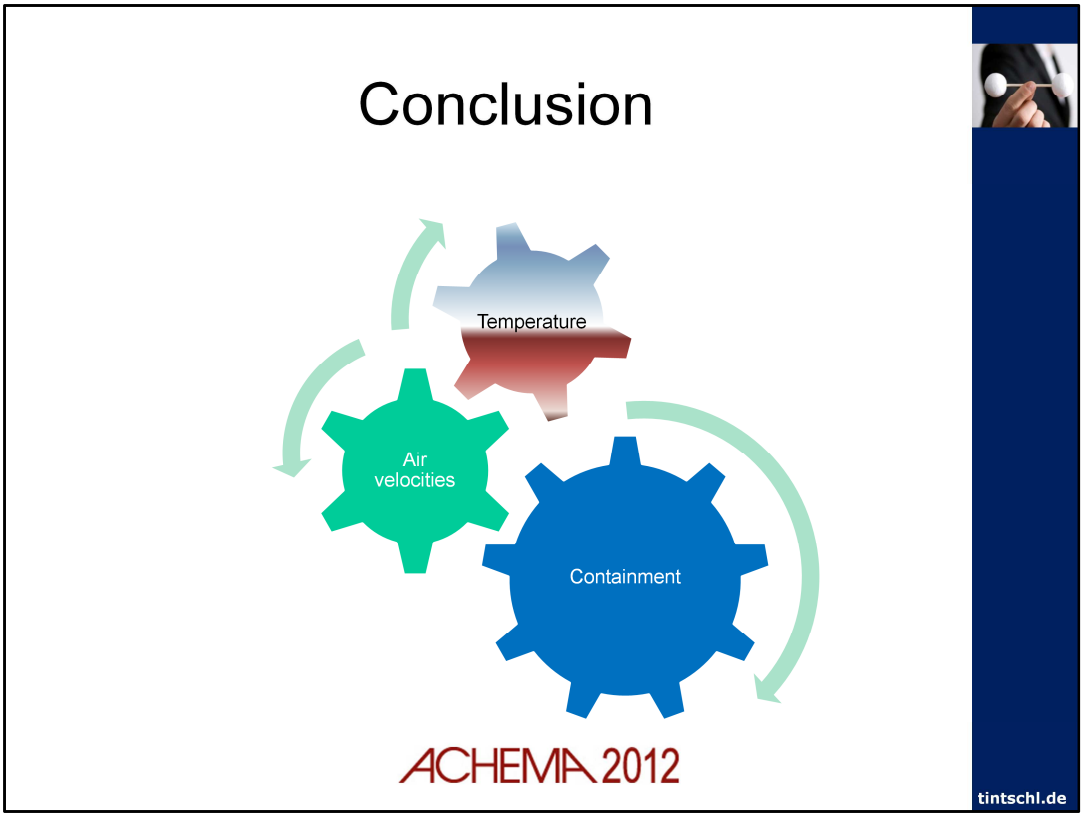


The correlation between room air velocity and the containment of the fume cupboard turns out like this.

Not surprising, but every time astonishing, if the line for the face velocity in the sash opening is added:

Room air velocity higher than the face velocity: - higher concentration outside

Room air velocity below the face velocity: - low concentrations



This led me to a simple conclusion:
Containment, the major task of a fume cupboard is mainly influenced by velocities: Room air velocity as well as face velocity in the opening. And both are influenced by temperature differences, which get's more relevant the lower the velocities are.
And so was the solution for the last case as shown before: the face velocity was increased and the temperature difference between room and input air was limited to 3 DegreeC.

I am now at the end of my short presentation and I thank you for taking the time to listen to me. Now I am available to answer your questions.