

EXPERIMENTAL AND NUMERICAL ANALYSIS OF THERMAL COMFORT IN A RESIDENTIAL BUILDING

Berec Gabor

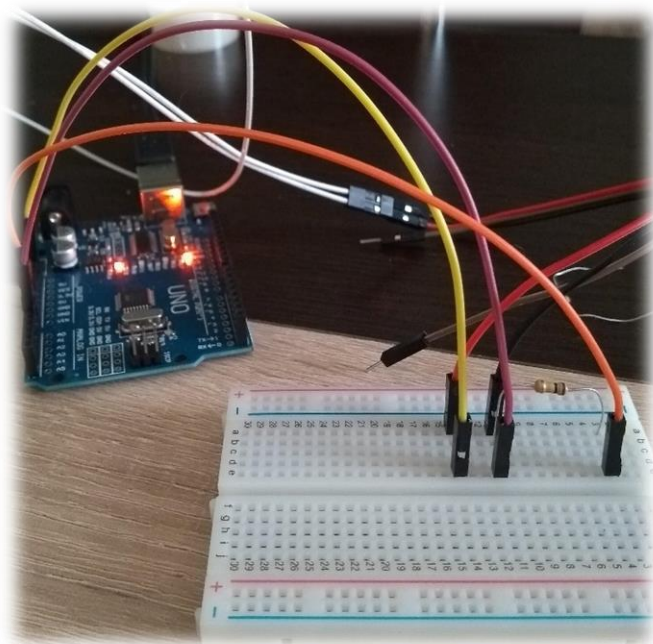
Thursday, Dec. 3. 2020.



- Practical measurements of the thermal comfort conditions according to the ASHRAE 55 from 2017
- Other standards (Well V2 2018, EN16798 2019)
- Numerical (CFD) analysis with Design Builder software.
- Results presented by graphs and numbers.
- Conclusions

Devices

Arduino
UNO



Testo 435



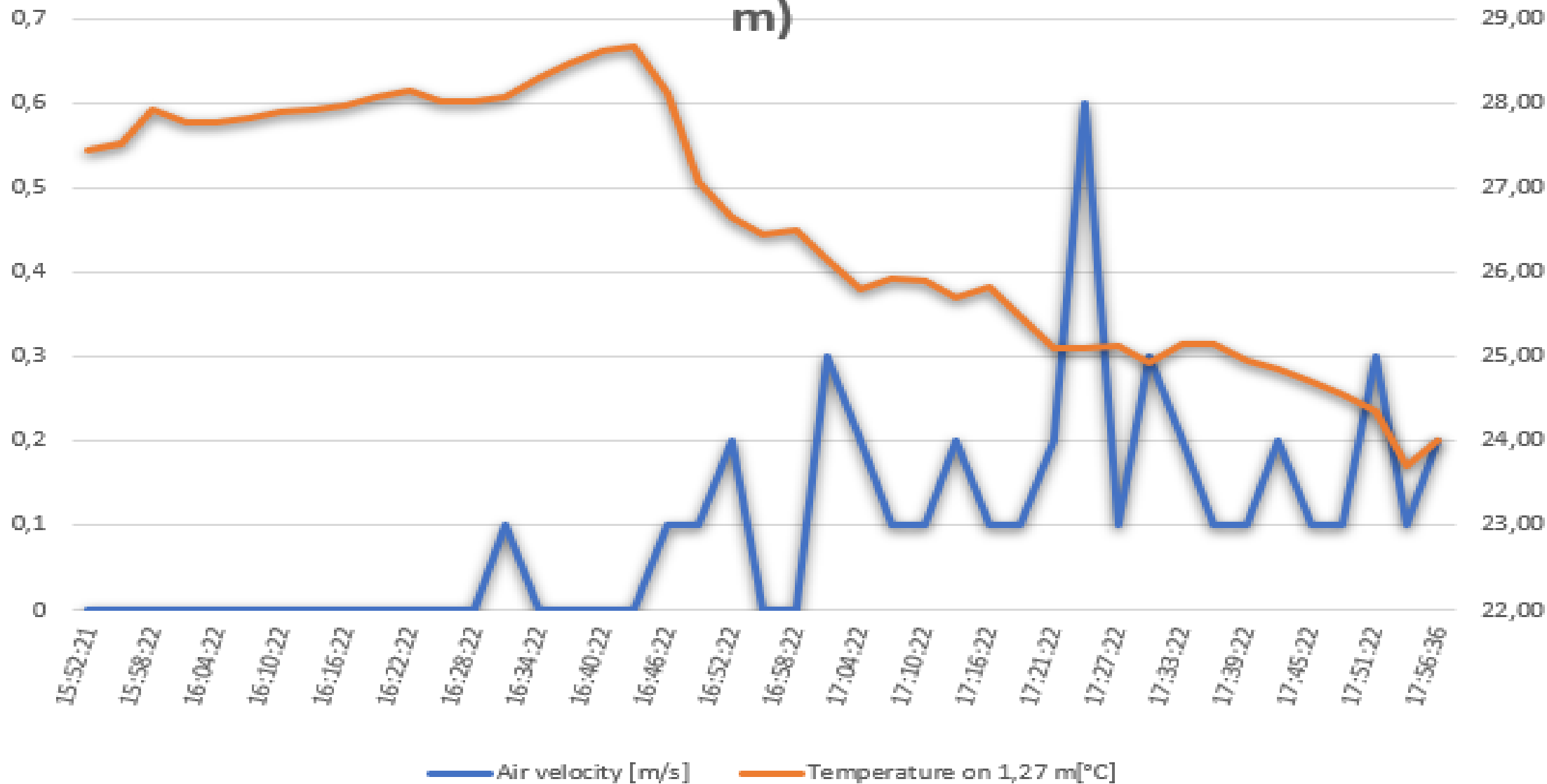
Trotec
BP15



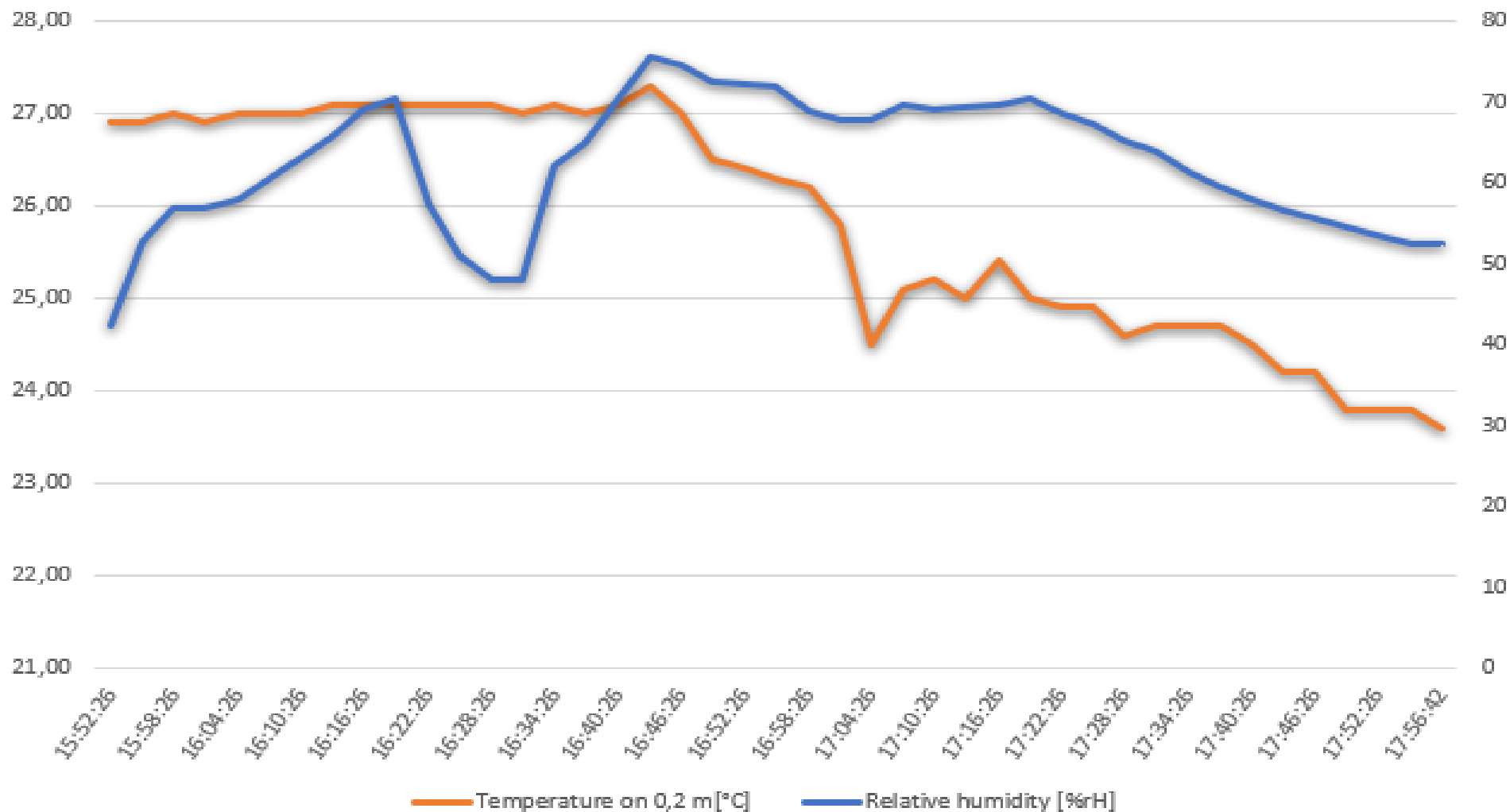
Testo
177H¹



Temperature and air velocity (Time=2 hours, h= 1,27 m)



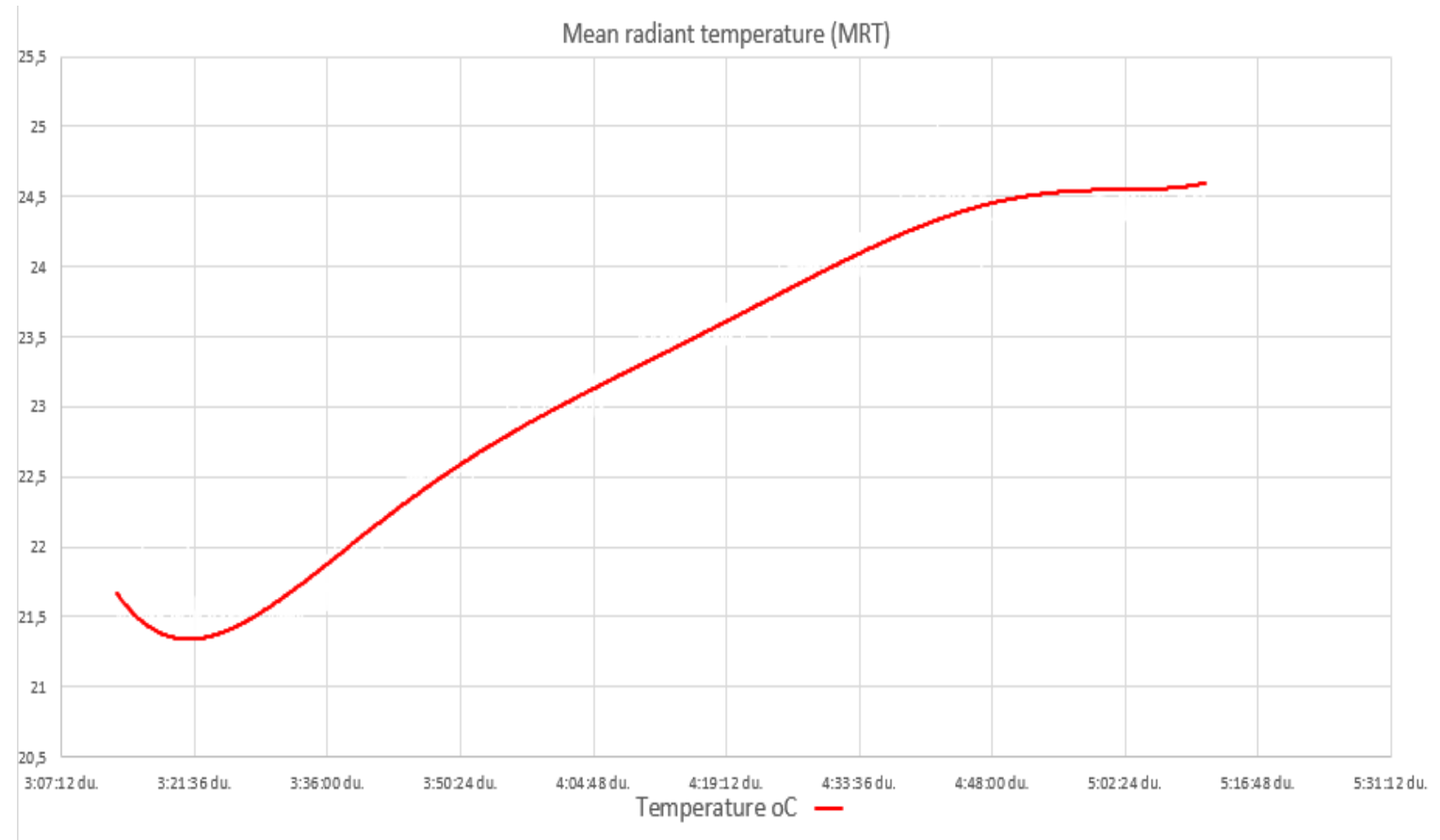
Temperature and relative humidity (Time= 2 hours, h= 0,2 m)





Measuring the mean radiant temperature

- Mean Radiant Temperature:
MRT=24,53 °C
- Room temperature:
t=25,3 °C
- Outside temperature:
T=25,6 °C
- Relative humidity:
rH=65%



Thermal comfort – according to the measured values

Acceptable values are from -0,5 to +0,5 PMV and up to 10% PPD, according to the standard Ashrae 55 from 2017. The same applies to EN15251 from 2006 too.

Select method: PMV method

Air temperature: 25,3 °C

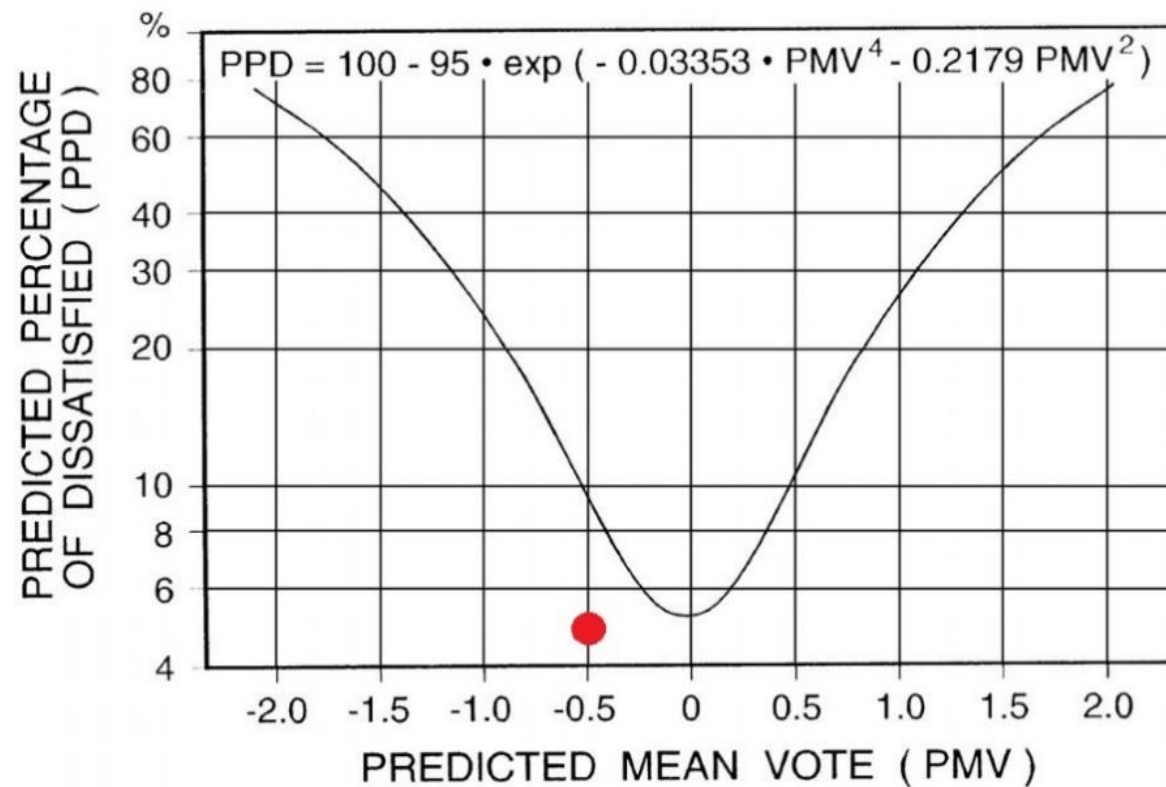
Mean radiant temperature: 24,53 °C

Air speed: 0,1 m/s No local air speed control

Humidity: 65 % Relative humidity

Metabolic rate: 1 met Seated, quiet: 1.0

Clothing level: 0.61 clo Trousers, long-sleeve





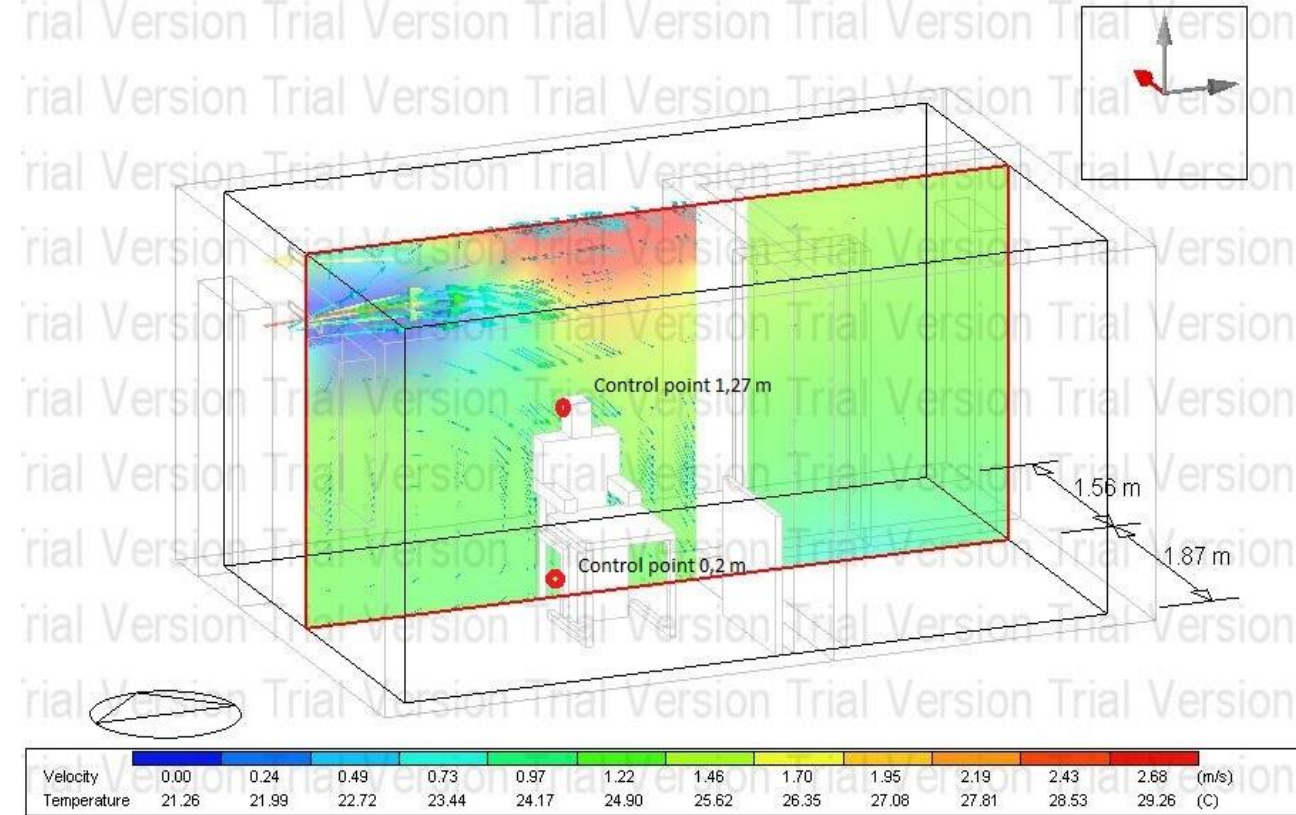
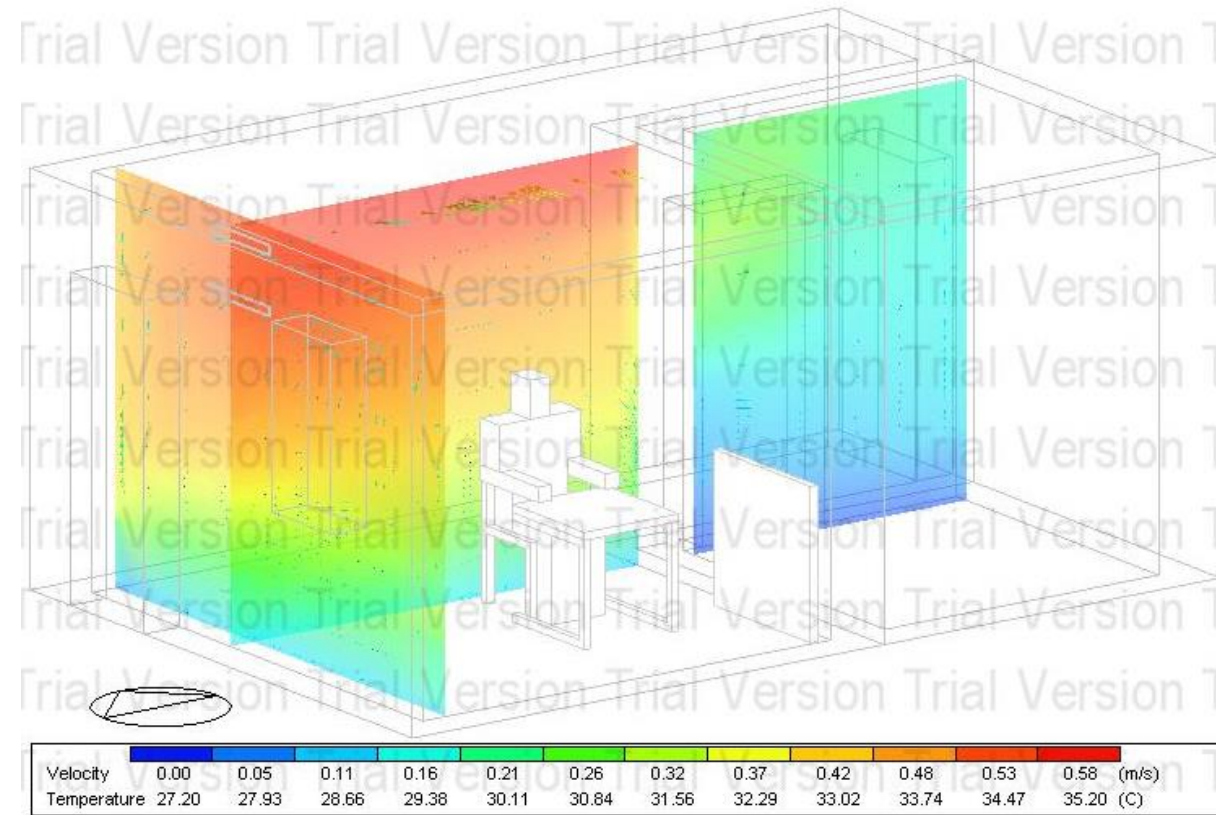
ON-LINE

51. MEĐUNARODNI KONGRES I IZLOŽBA O KGH | 51ST INTERNATIONAL HVAC&R CONGRESS AND EXHIBITION

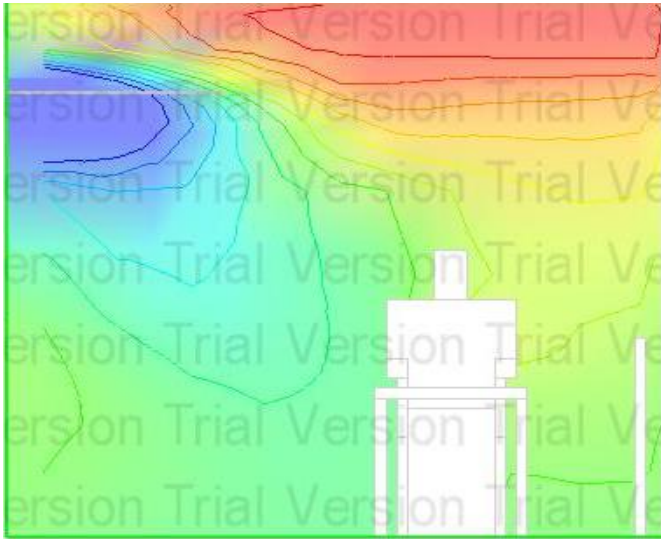
Beograd, 2-4.12.2020 ■ Belgrade, Dec. 2-4, 2020



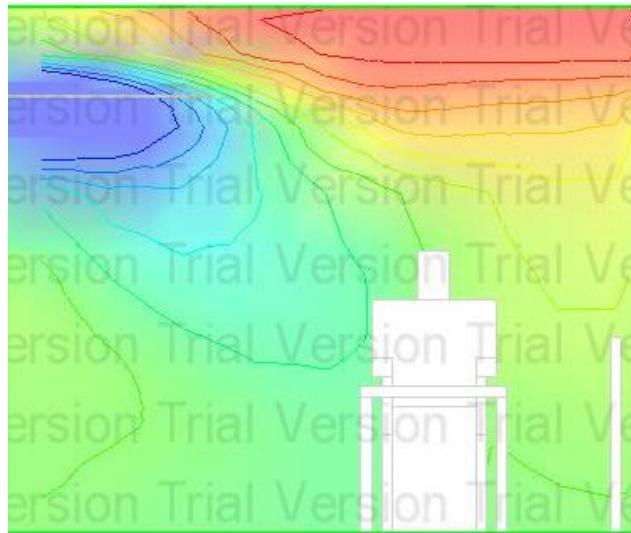
Results of the CFD



Results of the CFD



300 m³/h, 7,3 °C

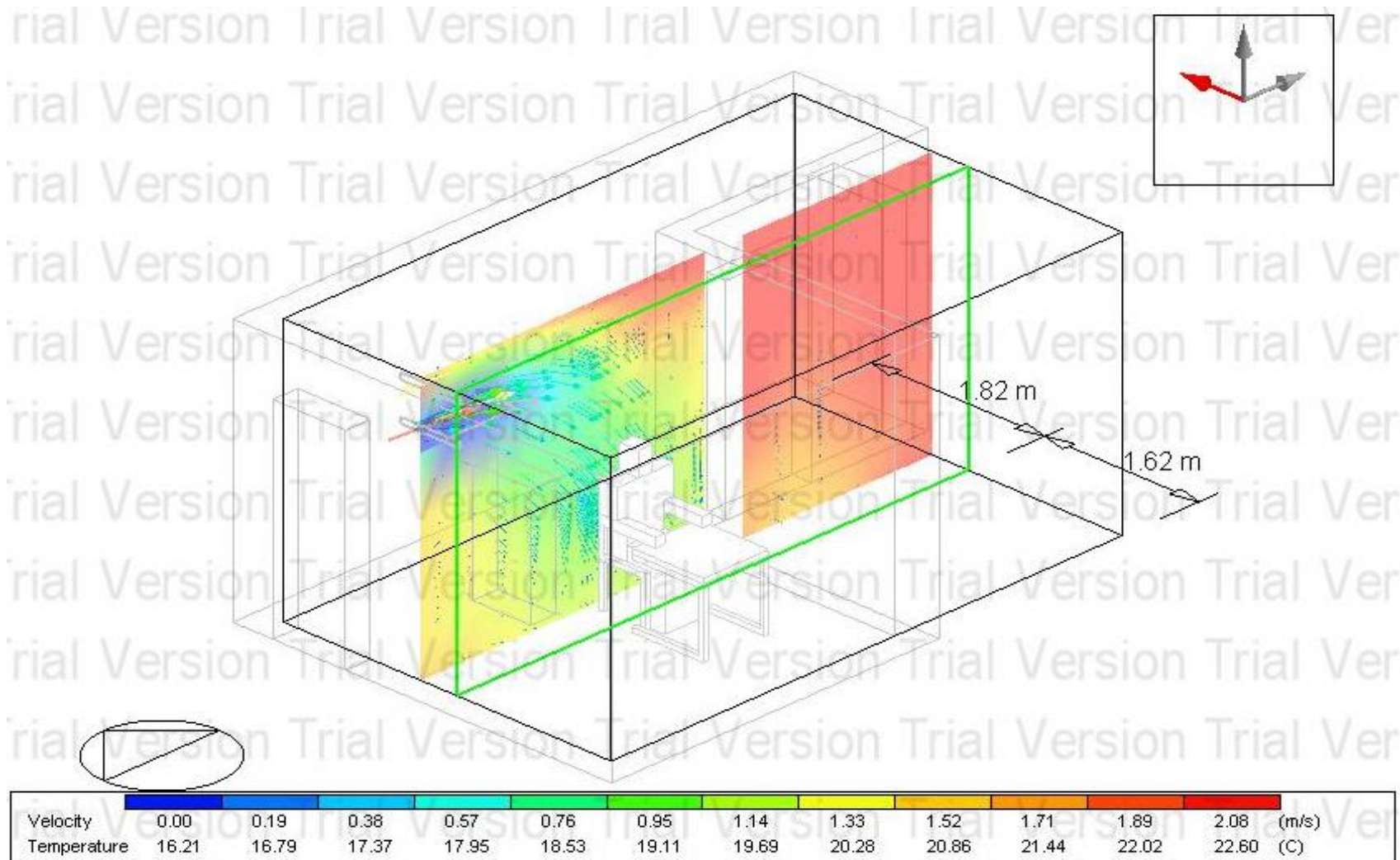


360 m³/h, 9 °C



460 m³/h, 10,7 °C

Results of the CFD

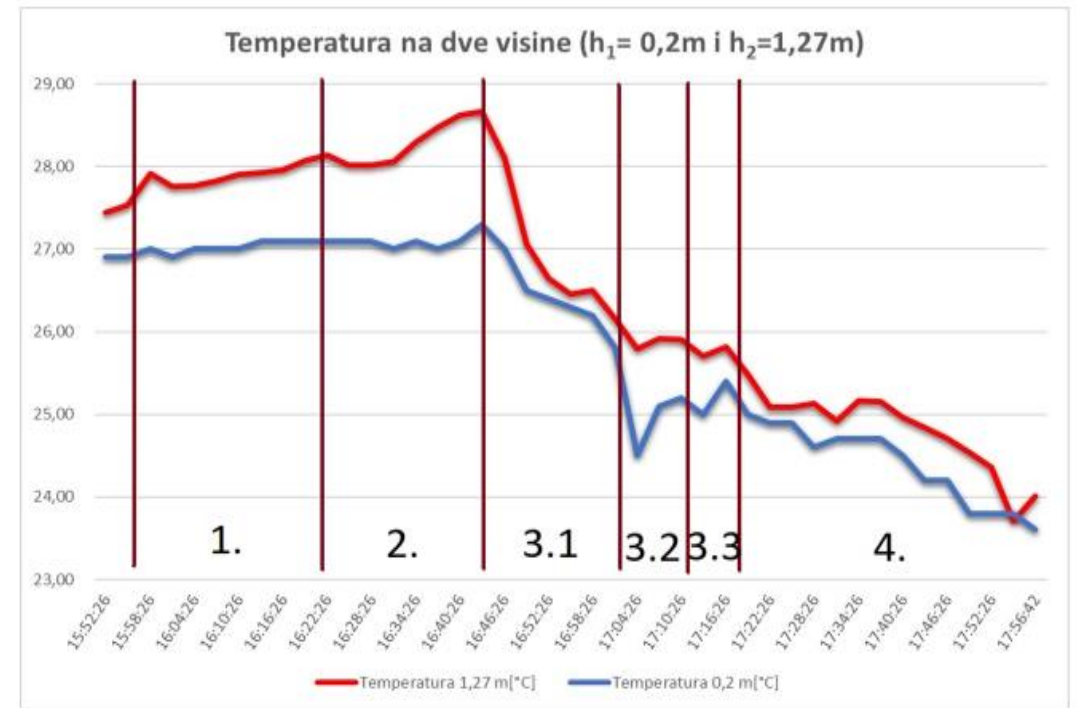


Comparison of the results

- One analysis for is needed for all the changes of the inside conditions (window closing and opening, AC turn on and off etc.)
- Parameters were not established because of the accumulated heat in the walls and furniture
- Influence of the accumulated heat was not taken into account in the software.

Comparison of the results

Beleške	Vreme	V[m/s]	T _{1,27m} [°C]	CFD: Temperatura i brzina
Uključeno hlad. – vent. Min. ↓	16:43:22	0	28,67	3. <u>T_{1,27m}=24,8 °C</u> <u>T_{0,2m}=24,6 °C</u>
	16:46:22	0,1	28,11	
	16:49:22	0,1	27,06	
	16:52:22	0,2	26,65	
	16:55:22	0	26,46	
	16:58:22	0	26,50	
	17:01:22	0,3	26,15	
	17:04:22	0,2	25,79	
Ventilator srednja brzina ↓	17:07:22	0,1	25,92	Napomena: brzina je zanemarljiva, maksimalna vrednost: v=0,3 m/s
	17:10:22	0,1	25,91	
	17:13:22	0,2	25,70	
Ventilator maks. brzina ↓	17:16:22	0,1	25,82	
	17:19:22	0,1	25,48	



Conclusions:

- The numerical model in Design Builder can't follow the condition changes in time .
- On the pictures and graphs there are significant changes and there is a parallel with the measured values.
- Air distribution is according to the expectations
- Temperature is different in the model and in the measurements