Ambience14 & 10i3m
Tampere, Finland

NEWTON MANIKIN SOFTWARE FOR EVALUATION OF THERMAL COMFORT USING ISO 14505-2

Pokorný Jan, Fišer Jan, Jícha Miroslav

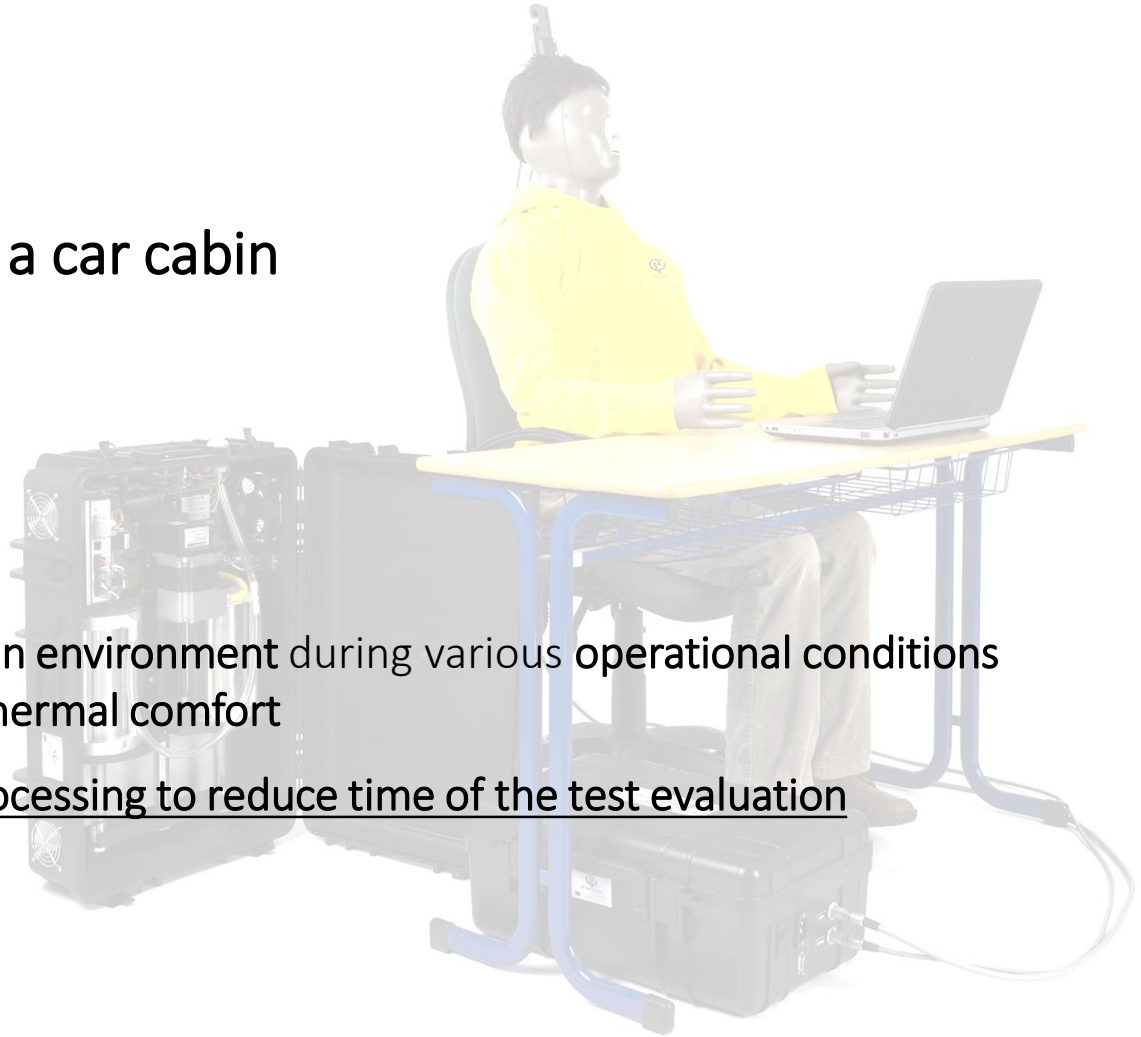
University of Technology Brno, Faculty of Mechanical Engineering
Department of Thermodynamics and Environmental Engineering
NETME Centre

Content

1 Introduction | Motivation

Why?

- Thermal comfort inside a car cabin
- HVAC system efficiency



How?

- Investigate behavior of **car cabin environment** during various **operational conditions** and its impact on the **human thermal comfort**
- Software for measured data processing to reduce time of the test evaluation

2 Thermal Manikin Newton | Overview

Technical parameters:

- "Average human" , 34 segments
- Heat flux, temperature regulation
- Breathing mechanism with the filter
- ThermDac control software
- "Working conditions": -20 – 50 °C
- Ambient sensors:
  - 2x Air temperature
  - 1x RH
  - 1x air velocity

www.energetickeforum.cz/fsi-vut-v-brne/pristrojove-vybaveni/tepelny-mankyn-newton

3 ISO 14505-2 Algorithm

Table 1 Comfort zones diagrams MTV scale

PPD [%]	Not acceptable	< 20 %, acceptable	< 10 %, comfort	< 20 %, acceptable	Not acceptable
MTV scale	MTV < -1.5	-1.5 ≤ MTV < - 0.5	-0.5 ≤ MTV ≤ + 0.5	+0.5 < MTV ≤ +1.5	MTV > +1.5
	too cold	cold but comfort	Neutral	warm but comfort	too warm

(thermal manikin measurement)

$$T_{eq} = T_s - \frac{\dot{q}_T}{h_{cal}} = T_s - R_T \cdot \dot{q}_T \quad [°C]$$

(thermal manikin calibration)

$$h_{cal} = \frac{\dot{q}_{cal}}{T_s - T_a} = \frac{\dot{q}_{cal}}{34 - 24} \quad [Wm^{-2}K^{-1}]$$

(comfort zone diagram thresholds)

$$T_{eq} = T_s - R_T \cdot (a + b \cdot MTV) \quad [°C]$$

4 Thermal Comfort Analyzer | Overview

Applications

- Newton manikin data processing
- Calibration, Post-processing and Real-time mode
- Automates routines for evaluation of thermal comfort using ISO 14505-2

Technical parameters

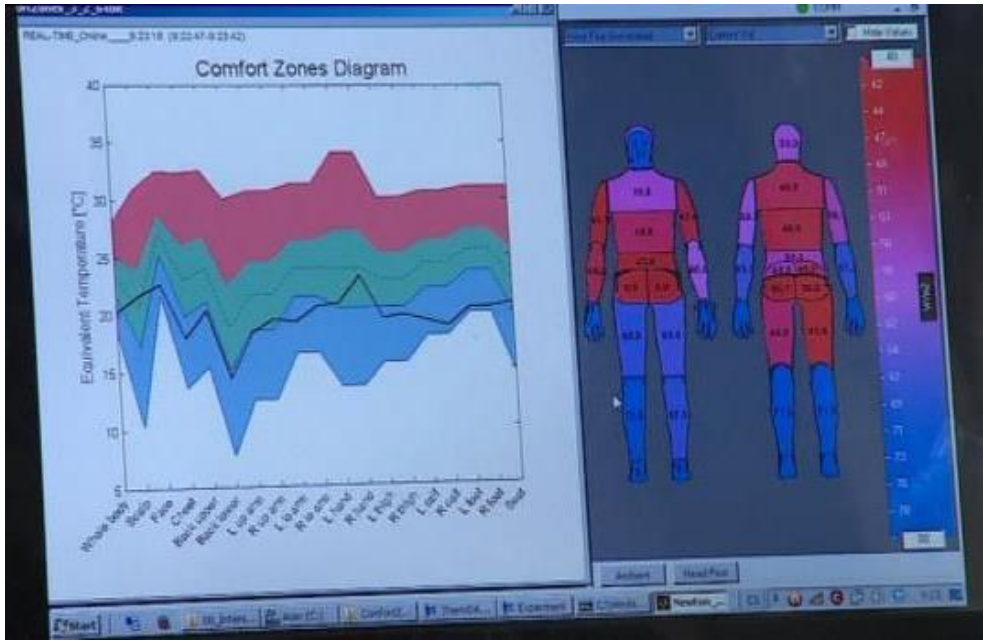
- Standalone executable application

Download: www.energetickeforum.cz/fsi-vut-v-brne/vysledky-vyzkumu/thermal-comfort-analyzer

- Matlab Compiler Runtime 2012b

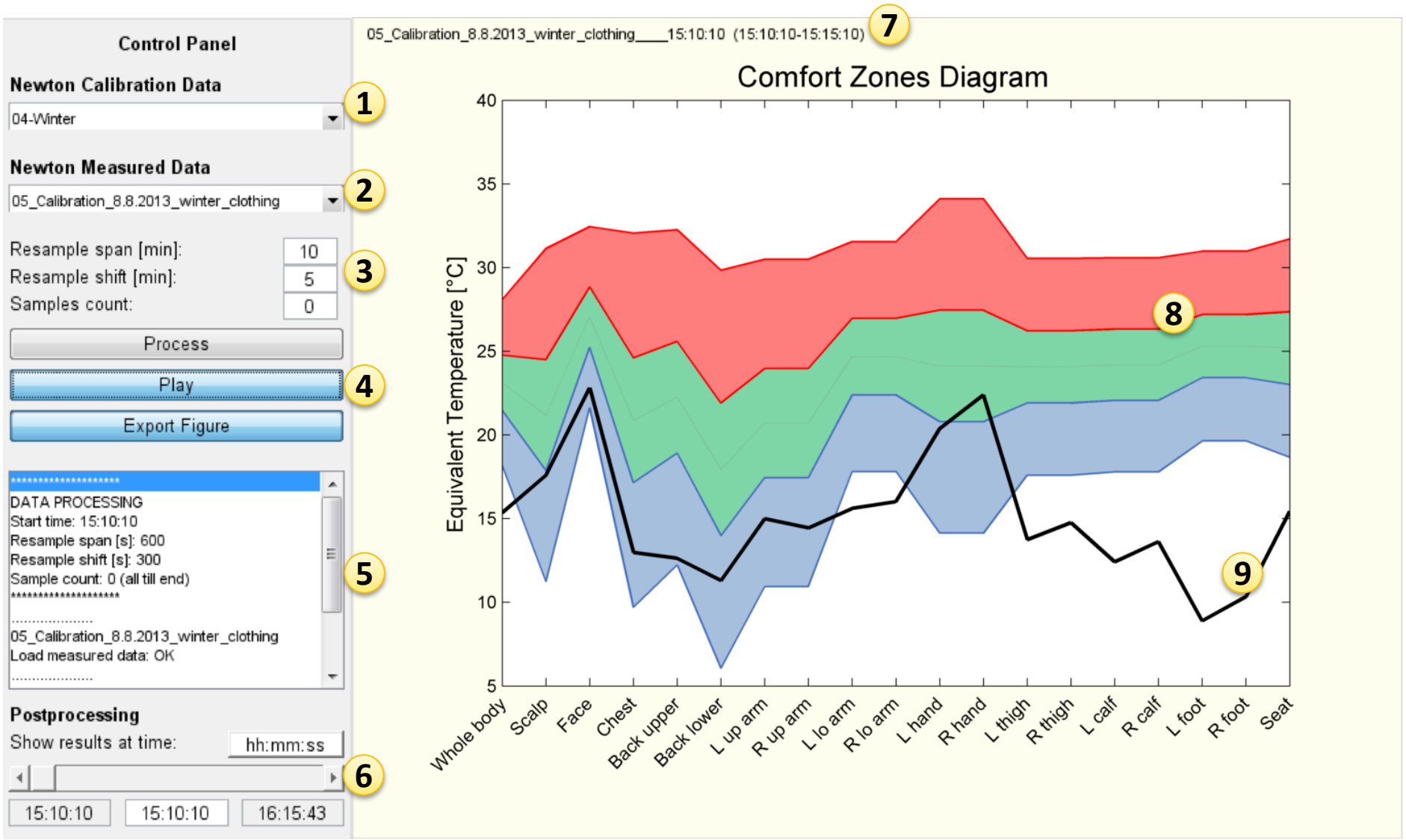
www.mathworks.com/products/compiler/mcr/.

- 32 bit and 64 bit version



Print screen: Thermal Comfort Analyzer (TCA) and Thermdac 8 in real time

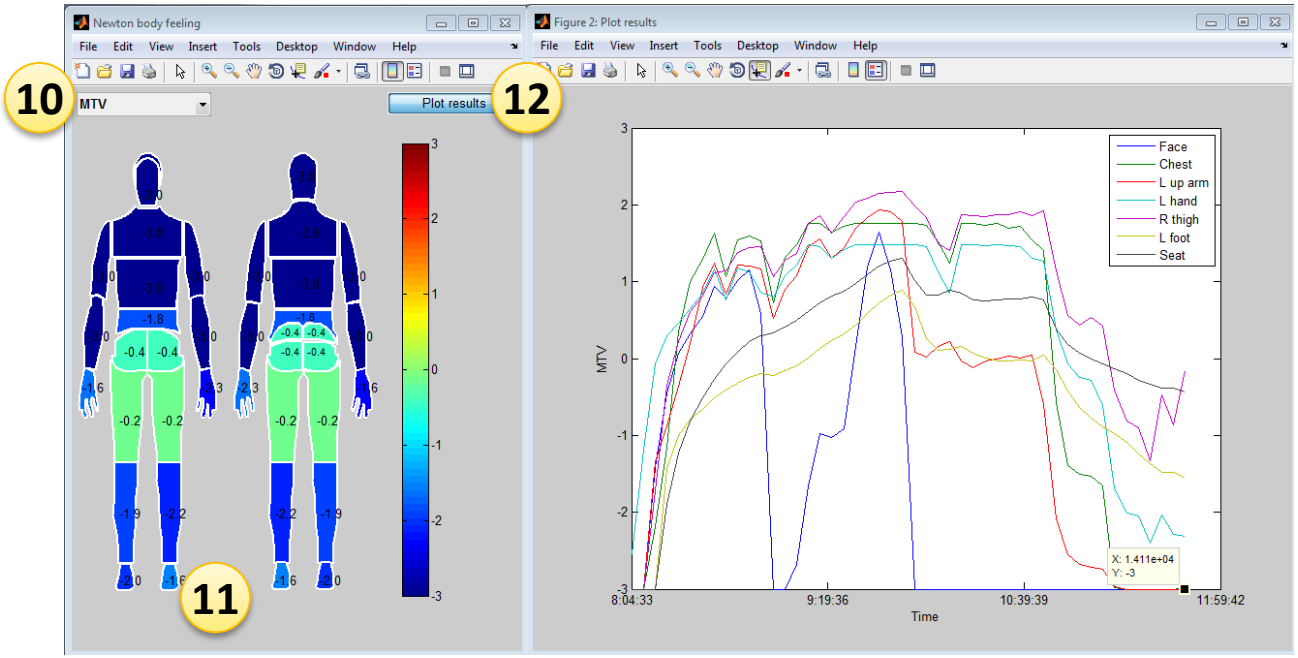
4 Thermal Comfort Analyzer GUI



4 Thermal Comfort Analyzer | Setup

Table 2 Most important options in the Setup.csv

Value	Label	Recommended values and other remarks
10	DefaultSpan	RealTime =1, Calibration = 30 (in minutes)
5	DefaultShift	RealTime =0.1 Calibration = 10 (in minutes)
0	DefaultSamplesCount	RealTime =0 (not used), Calibration = 1
1	TeqPartsAveraging	Averaging of local eq. temp. for dual parts (L, R) – i.e. legs
C:\Online.csv	RealTimePathDefault	default path to the real-time csv test file
0	RealTime	0-off, 1-on
0	hcal	0-off, 1-on , calibration (only for offline mode). Hint: 30,10,1 → Process
0	Figurine	0-off, 1-on , visualization of data on the figurine

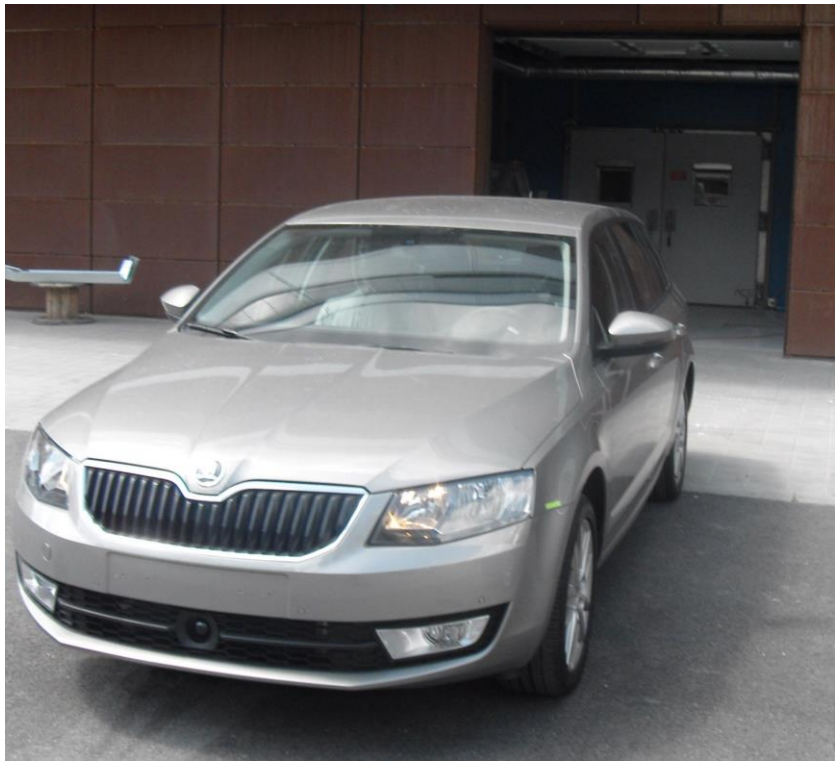


5 Experimental tests

Summer HVAC test

Table 3 Time schedule of the summer test 12.7.2013, Brno

Real time	Action	Diagram for the specific time
8:04	Start test, manikin start heat up	**Figure 1** - 8:59:39
9:00	Engine run, A/C off, ventilation 3/6	**Figure 2** - 9:59:38
10:00	A/C on - set temp. 22 °C, ventilation 3/6	**Figure 3,4** - 10:04:38, 10:59:40
11:00	A/C on - max. power, ventilation 6/6	**Figure 5,6** - 11:04:40, 11:59:42



5 Experimental tests

Summer HVAC test

Figure 1
No air-conditioning
8:59:39 ($T_{air,IN}$=27 °C)

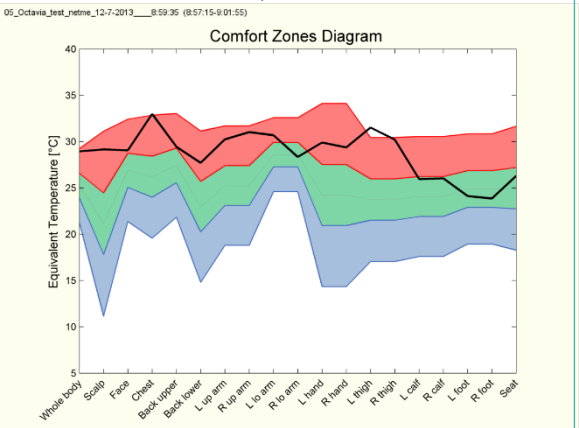


Figure 2
9:59:38 ($T_{air,IN}$=30.9 °C)

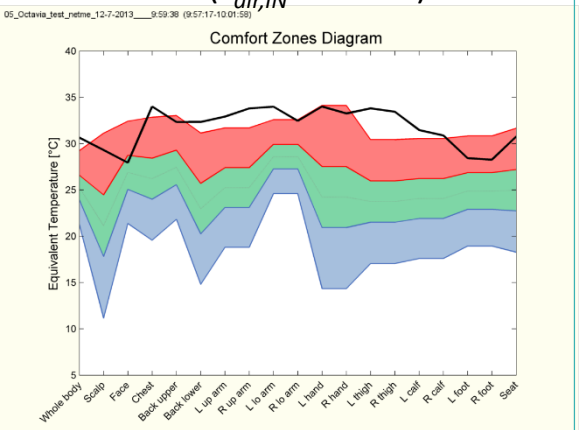


Figure 3
Air conditioning to set point 22 °C
10:04:38

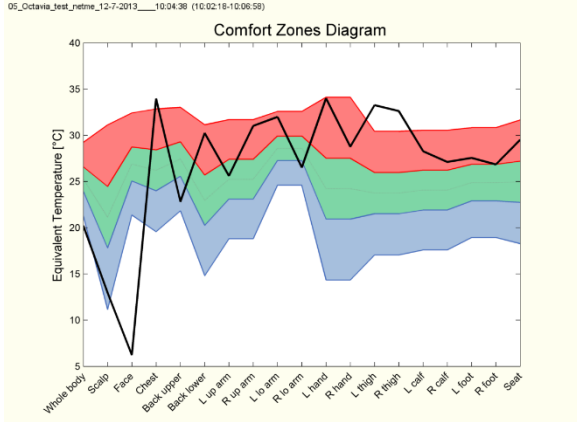


Figure 4
10:59:40 ($T_{air,IN}$=25.5 °C)

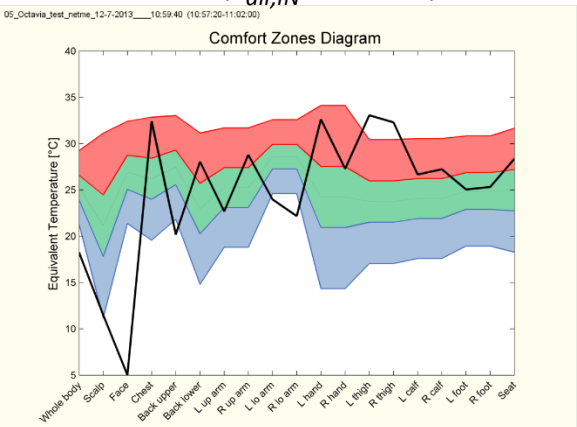


Figure 5
Air conditioning by full power
11:04:40

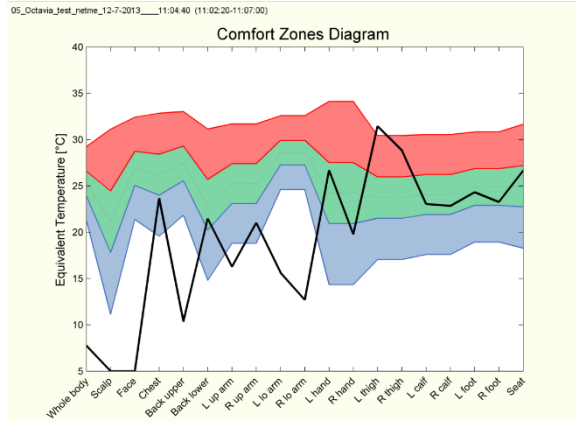
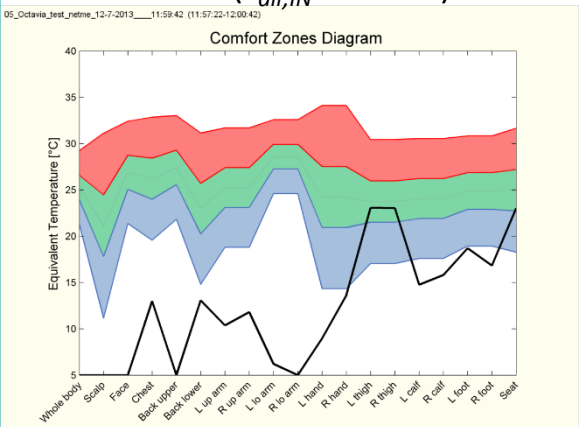
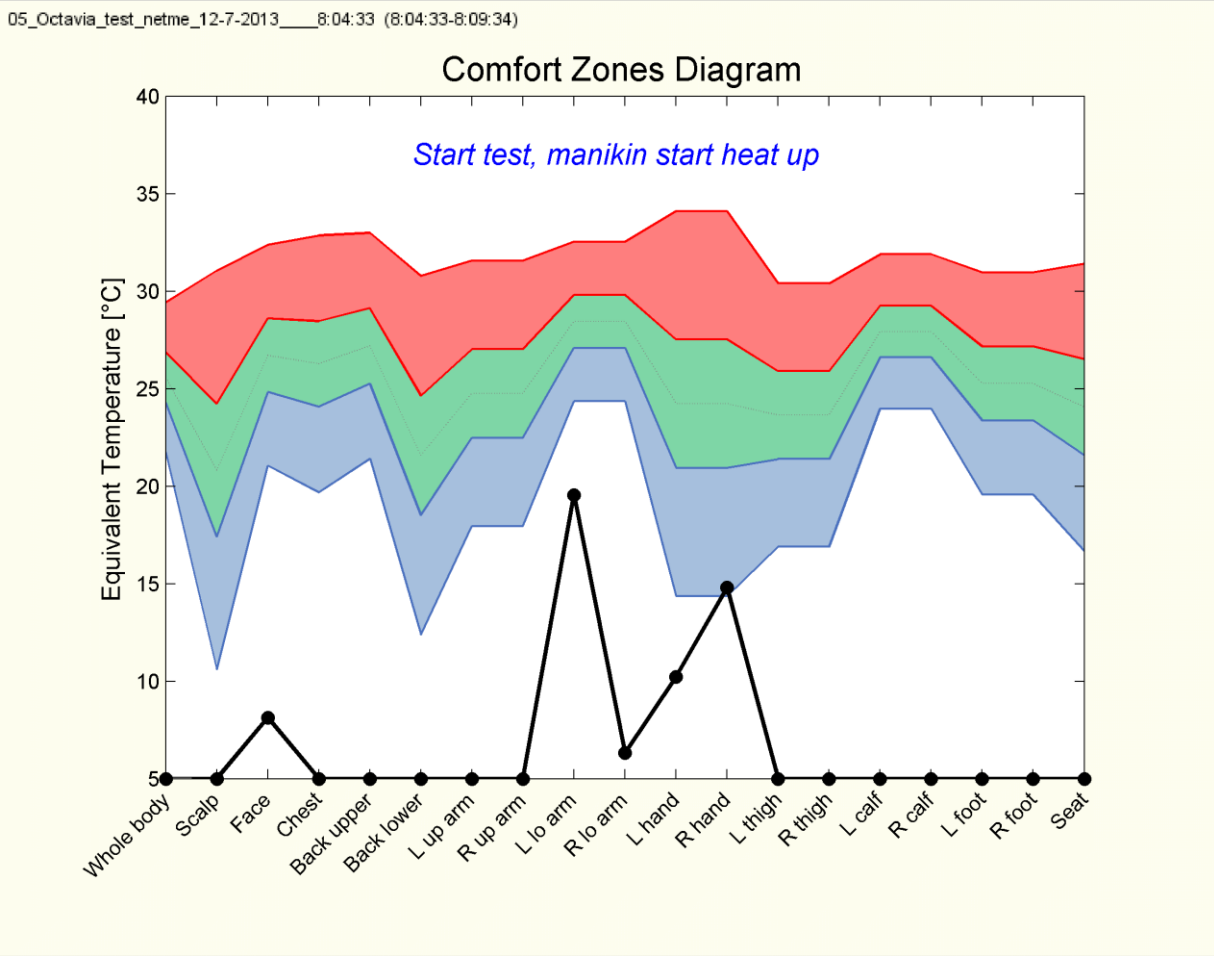


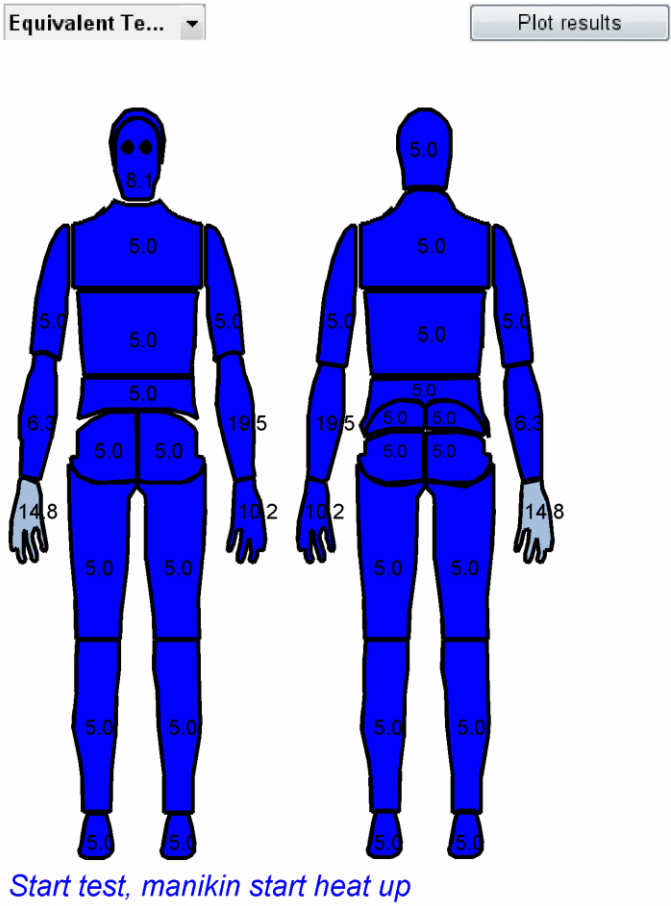
Figure 6
11:59:42 ($T_{air,IN}$=14.6 °C)



5 Experimental tests

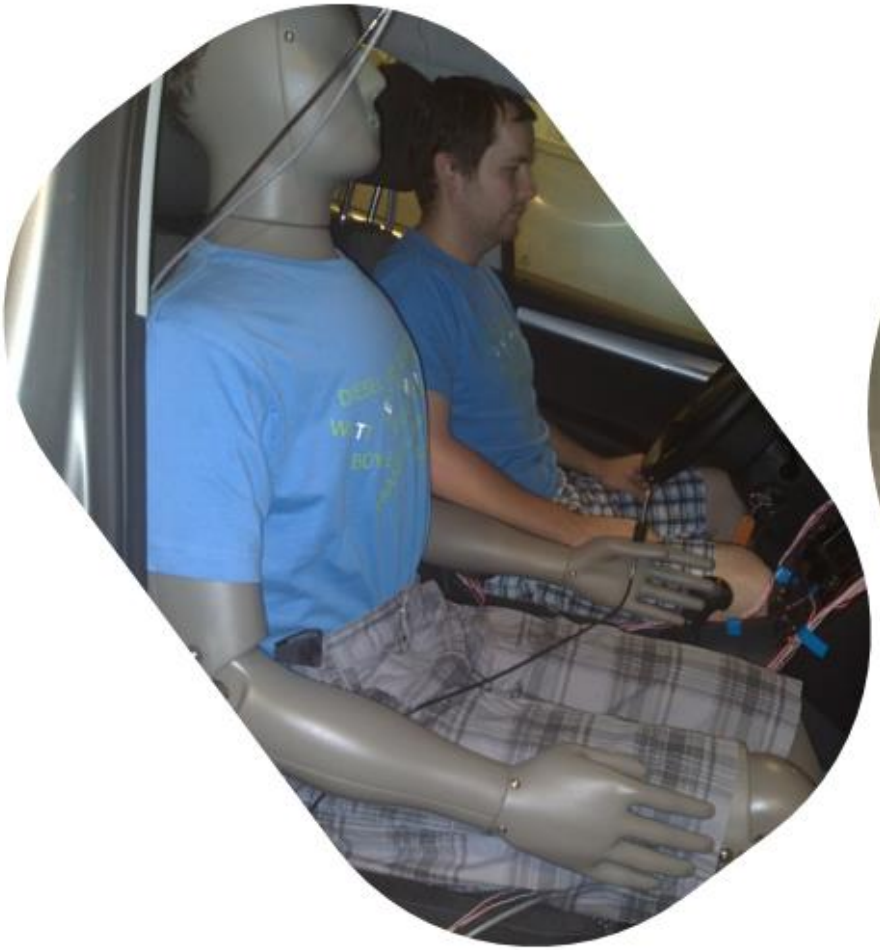
Summer HVAC test





5 Experimental tests

Climatic chamber tests



5 Experimental tests

Climatic chamber tests

Preliminary tests on the human subjects

Newton **real time** thermal comfort using ISO 14505-5

We know „right now“ what is the difference

6 Conclusion

- It was developed a **stand-alone application** in Matlab allowing to proccessed Newton manikin data
- The application is possible to run in the post-processing , calibration and **real time** mode
- The application reduce a post-processing time and it helps in the analysis of the results and presentation of the experiments

Plan to future

Revision of the ISO 14505-2 using the human subject tests

- Identify overall thermal comfort
- Climate chamber measurements
- Thermal comfort evaluation

Thank you for your attention!

Contact: pokorny.j@fme.vutbr.cz
Brno University of Technology
Faculty of Mechanical Engineering
Department of Thermodynamics and Environmental Engineering
Technická 2896/2
616 69 Brno, Czech Republic

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