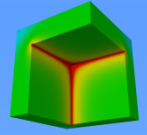

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AnTherm

the software system for
Analysis of **Therm**al
behaviour of building constructions
with thermal bridges

http://antherm.eu/

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Avoiding thermal bridges in passive houses supported by the three dimensional analysis of heat flux and vapour transport

in building components

Calculation and visualization

of thermal heat bridges by

tracing the heat- and vapour stream.
Examples and capabilities available for such calculations by using the three dimensional simulation software AnTherm

T.Kornicki, Vienna

…?…

- Why there are only few who know how to calculate thermal bridges quickly, efficiently, easily and precisely?
- Why only few manage to do that successfully?
- Do you want to be adept at thermal bridge calculation?
- Do you want to discover secrets and mysteries of the easy and rapid thermal bridge analysis with AnTherm?

…cause with AnTherm…

- The building envelope as thermal- and vapour diffusion bridge
- The development history of stable and practical tool commonly evolving in parallel to European standards
- Three dimensional visualization – the added value to building physics
- Modelling examples
  - Renovation of brick wall towards the passive house standard and estimating its vapour diffusion behaviour
  - Mounting holder on roof construction and the risk of surface condensation
  - Foundation in contact with ground – path of the heat stream
  - Thermal renovation of a balcony – searching for the optimal solution
  - Not insulated garage slab – core condensation and damage due to freezing caused by extensive vapour diffusion
  - Slab over carport – three dimensional effects and localizing thermal bridges
  - Basement deep in ground – dynamic transient problem, harmonic coupling coefficients and the phase lag
- Discussion and conclusio

Tomasz Kornicki

- Physicist and computer scientist
- “IT Services” in Vienna, 23°
- Scientific and Management Consultancy since more then 25 years
- Software Tools for Building Physics
- Reliable partner for high performance simulation, supercomputing and (not only scientific) visualisation
- Lecturer at TU-Vienna, Danube-Univ. ,…
- International Building Performance Simulation Association

AnTherm

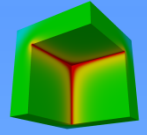
- AnTherm = the hymn (anthem)

  In memoriam of **Dr. Walter Heindl** (†1994), author of the concept of **Base Solutions** and the **Thermal Coupling Coefficients (Leitwerte)**

- The kernel of these theoretical concepts have been directly adopted into the „**Thermal Bridge Standards“ EN ISO 10211**, thus stringent **conformity to the standard** is easily and automatically provided by **AnTherm**!

Visualisation

- "**Making visible**" of heat flow processes within the interior of a building component thanks to **employing progressive visualisation thechnologies**, finally now deployed into the **building physics** in its **precious quality**.
- The **thermal bridge** can be **analysed and developed** like the game.
- **„Pictures speak louder than words..."**
- Results are **meaningful** to "non physicists" and can be **easily understood** by non professionals!



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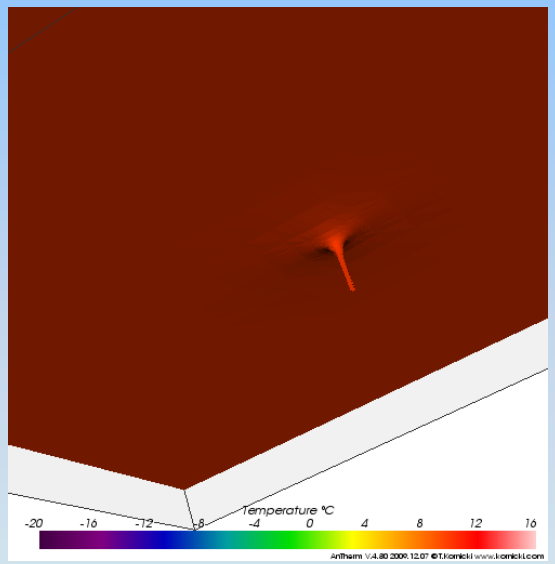
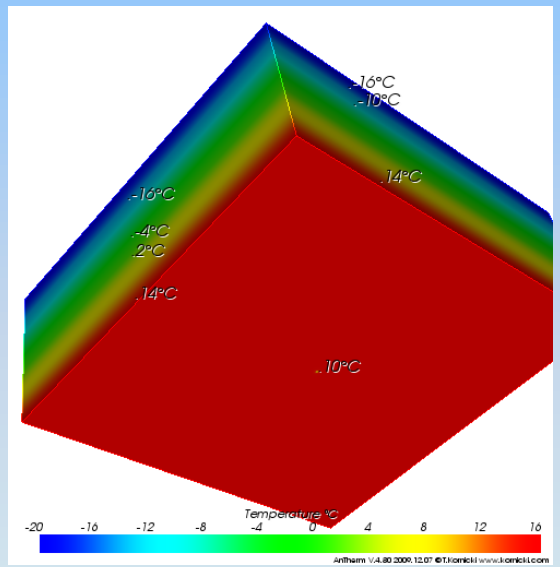
Short presentation

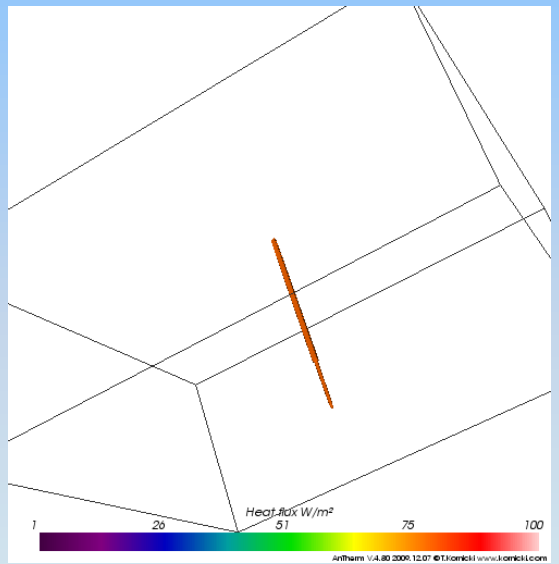
Thermal Bridge Simulation
and
Visualisation in 2D and 3D
with
AnTherm

Mounting of roof insulation

Simulation in 3D
with
AnTherm

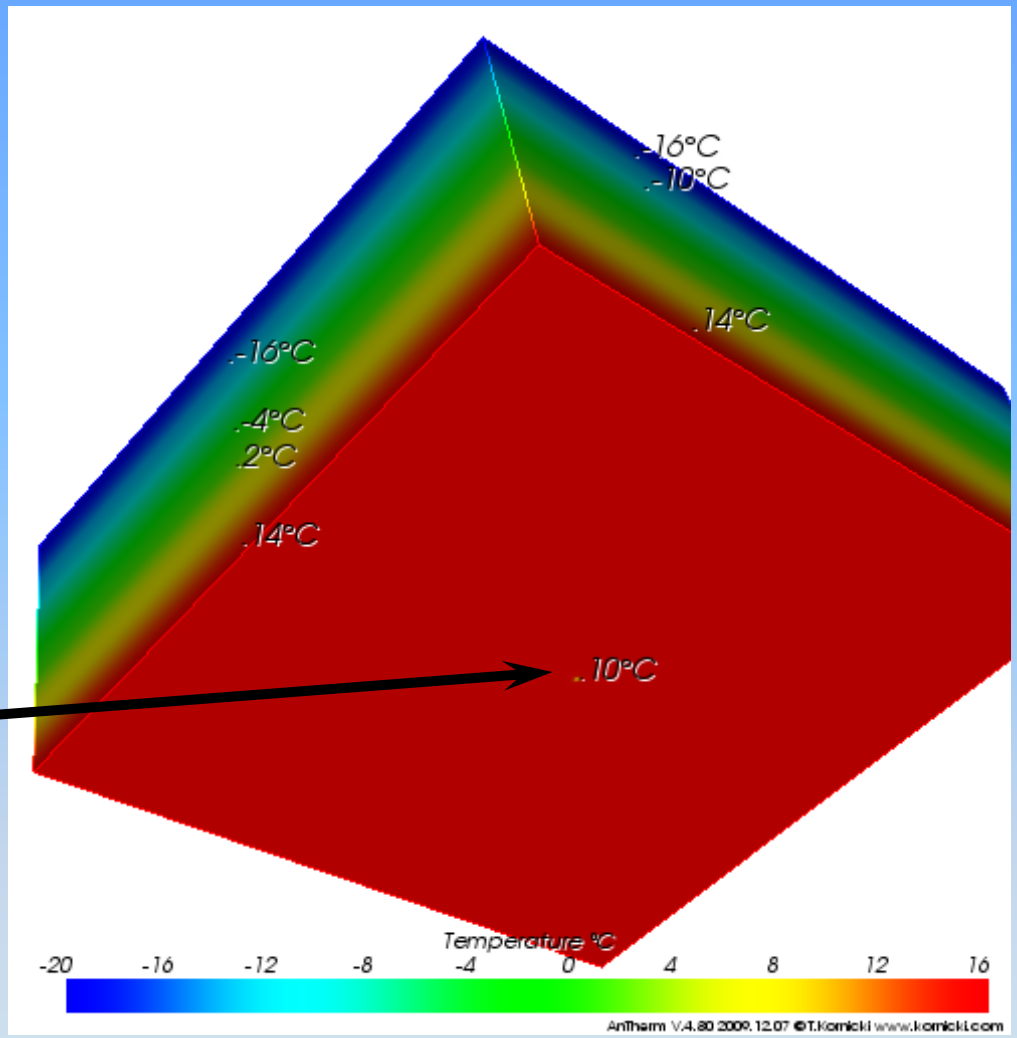






Roof with a central holder
Model 1000x1000mm

U	= 0,0813 W/m²K
$L^{3D}_{1000x1000}$	= 0,0817 W/K
U_{mittel}	**= 0,0817 W/m²K**
X	= 0,0004 W/K
$T^*_{16°C/-20°C}$	**= 9,69 °C**
f_{Rsi}	**= 0,82**



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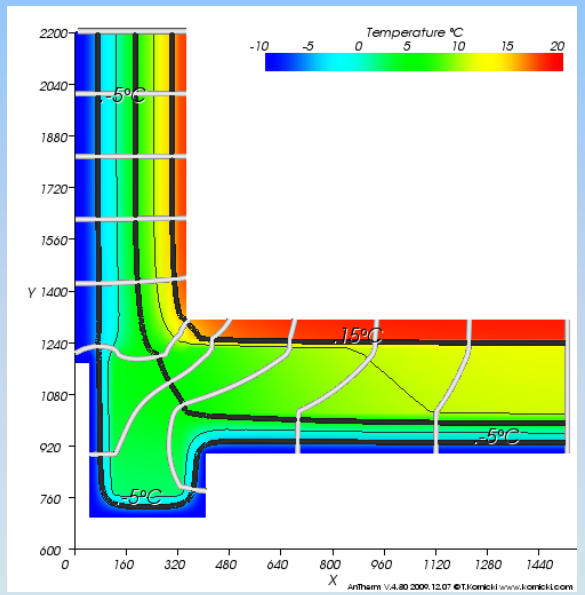
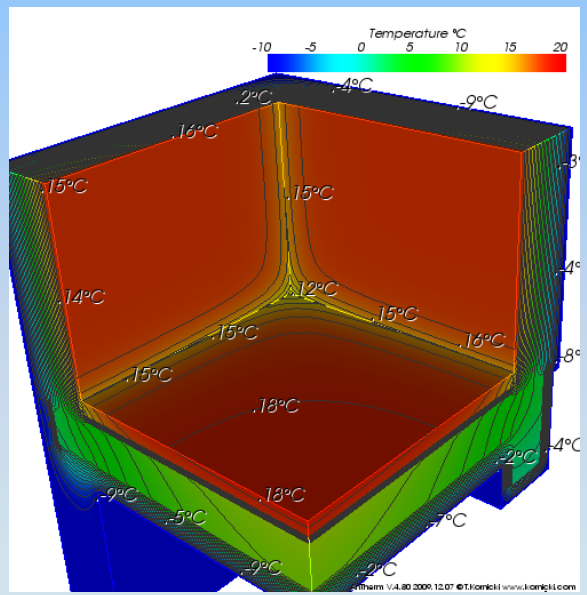
Slab over carport
Localising thermal bridges
Simulation in 2D and 3D
with
AnTherm





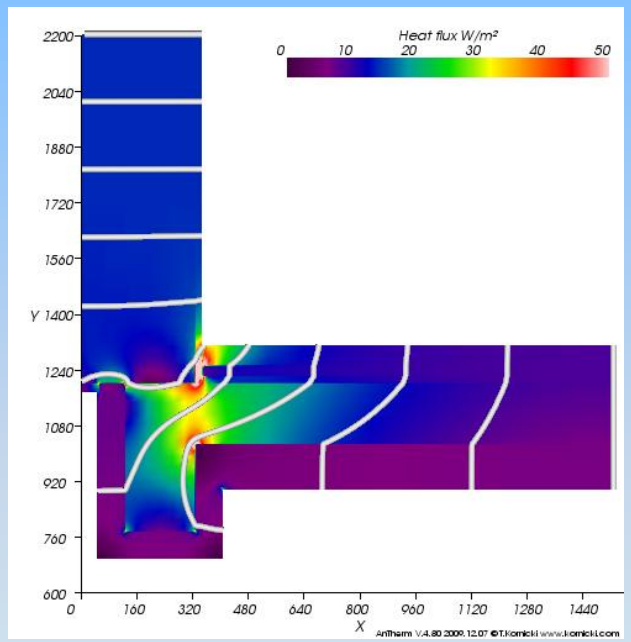
- 2D calculated result :

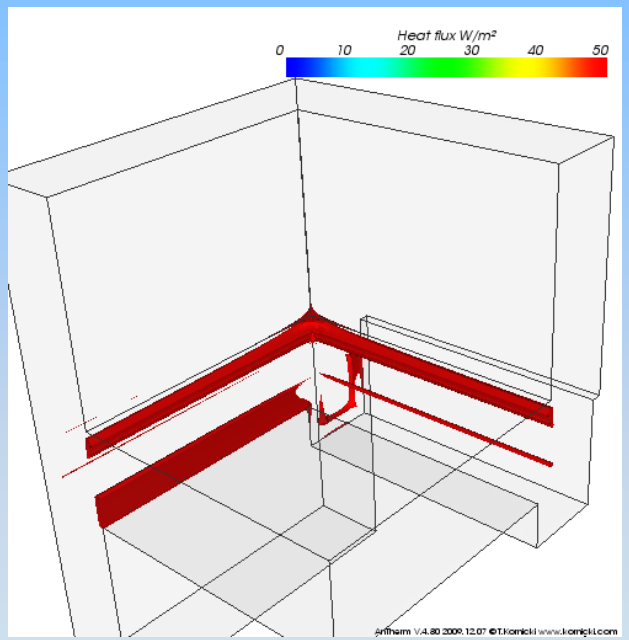
  T* = 15,22°C, fRsi = 0.84

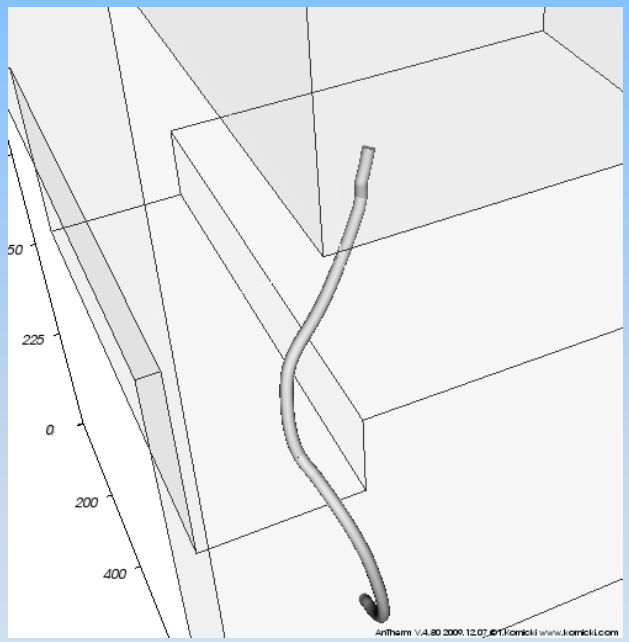
but

- 3D calculation leads to :

  T* = 11.08°C, fRsi = 0,70 !

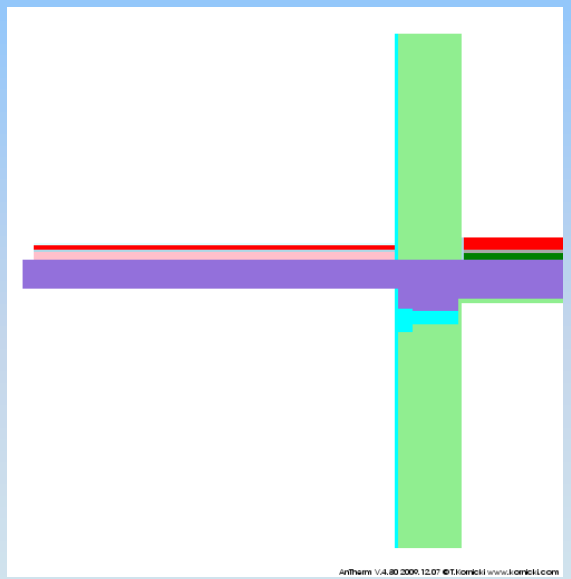


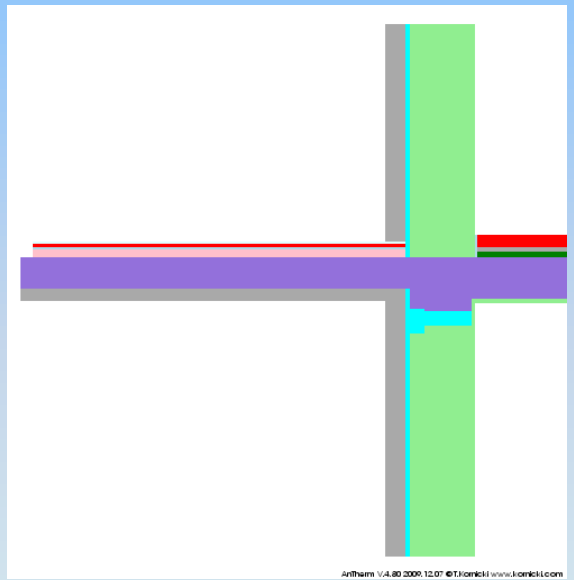


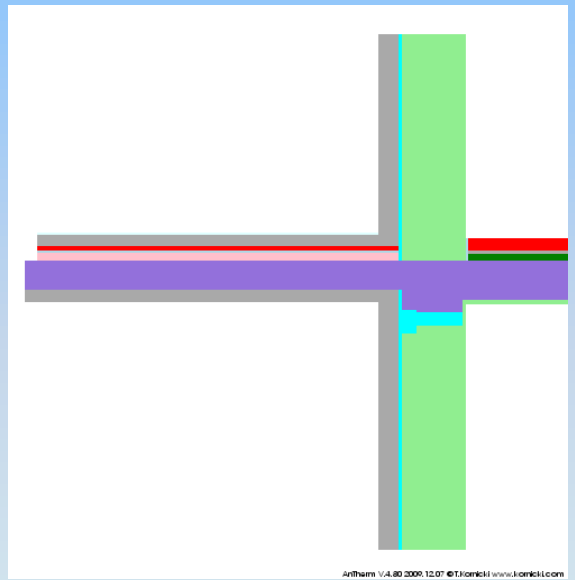


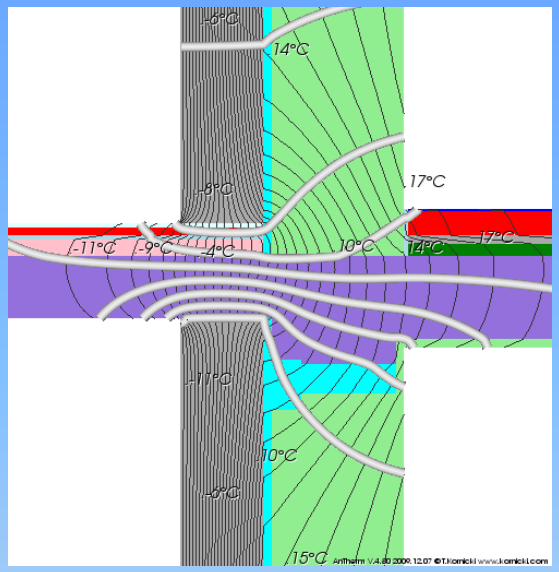
Renovating the balcony

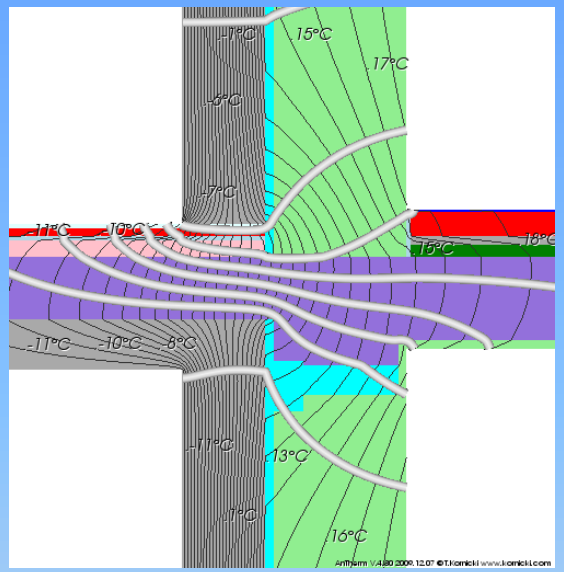
Simulation in 2D
with
AnTherm

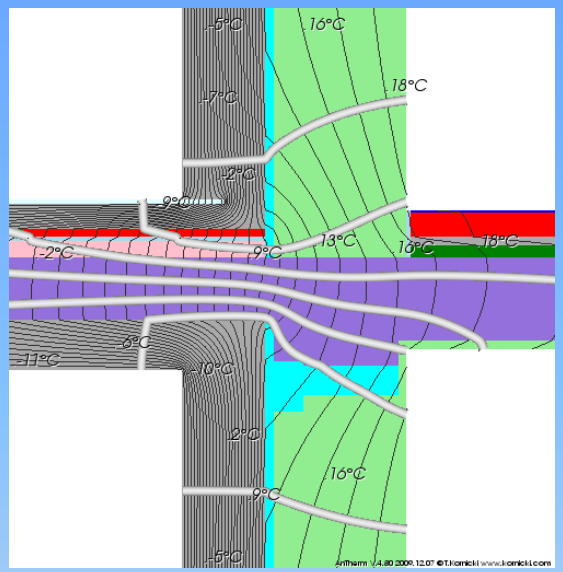












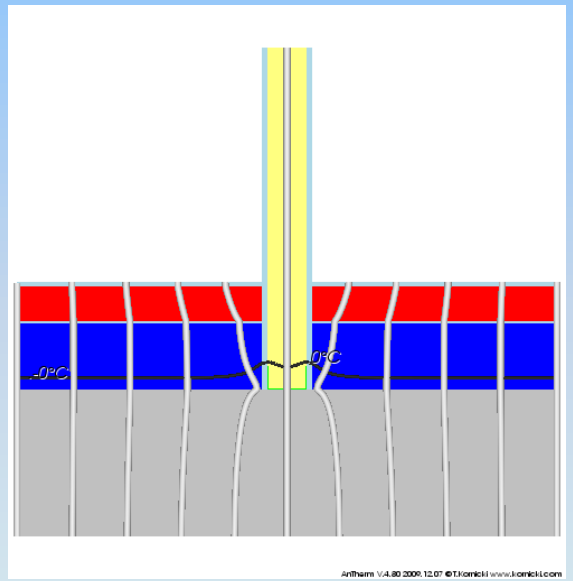
		U [W/m²K]	L2D [W/mK]	Vergl. zu V1	ψ [W/mK]		T* [°C]	fRsi
V1	Without insulaiton	1,2466	3,6822		0,4409		8,91	0,65
V2	Wall insulation 10cm	0,3028	1,4400	39%	0,6526		13,53	0,80
V3	+ Balcony bottom insul. 6cm	0,3028	1,3293	36%	0,5419		14,31	0,82
V4	+ Balcony total insulation	0,3028	1,0998	30%	0,3124		15,87	0,87
V2'	Wall insulation 20cm	0,1724	1,0611	29%	0,6130		14,71	0,83
V3'	+ Balcony bottom insul. 12cm	0,1724	0,9697	26%	0,5215		15,33	0,85
V4'	+ Balcony total insul. (12cm/6cm)	0,1724	0,7640	21%	0,3159		16,73	0,90

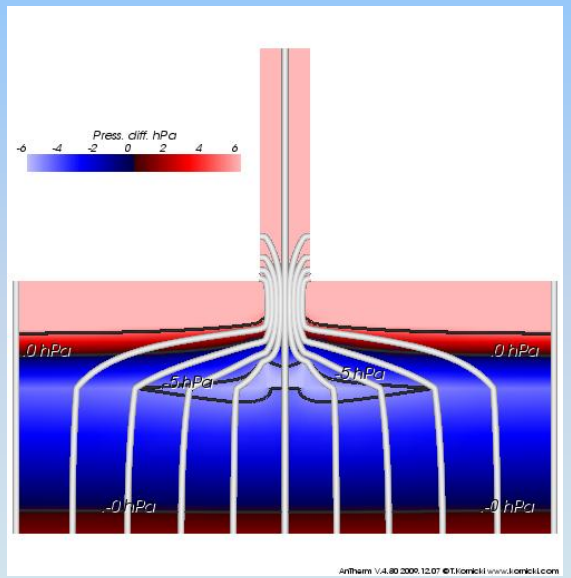
Garage slab without insulation
Condensation and freezing

Simulation in 2D

with

AnTherm





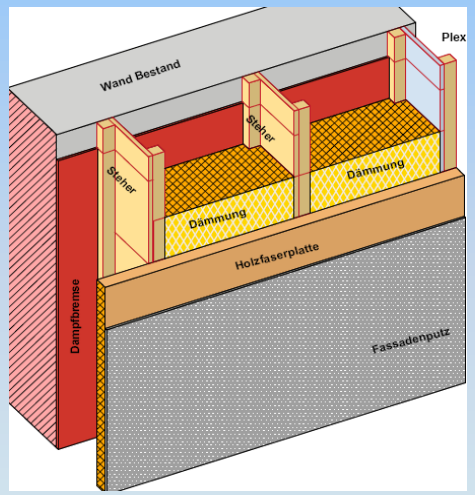
- Forgoing the insulation of the slab over garage which was initially declared as “closed, not conditioned”
- Change of the concept to partly open garage **(error 1)**

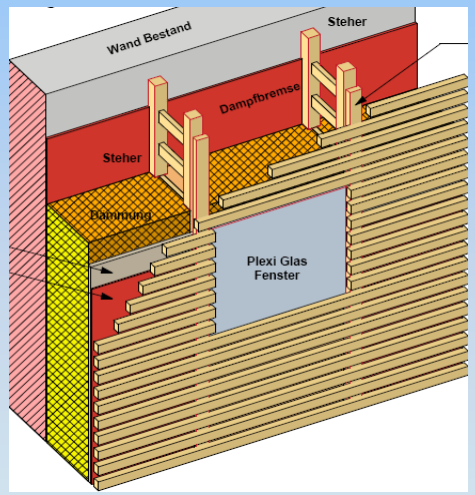
- Partition walls installed prior to floor construction - including the miss of vapour barrier **(error 2)**

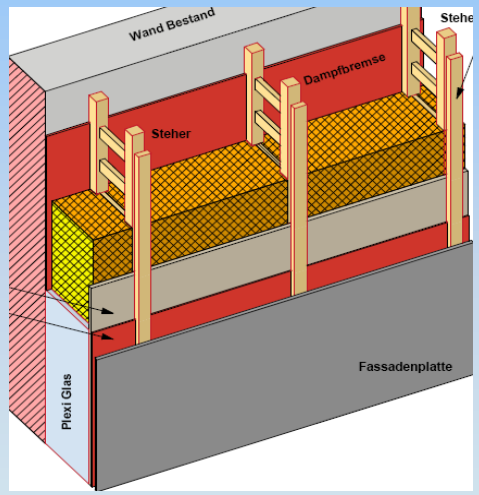
- Temperature at the bottom of the partition wall (at the aluminium profile) below 0°C (by -5°C in the garage)
- All the vapour diffusion goes through the brake within the vapour barrier towards the profile
- The partial vapour pressure significantly above the saturation pressure – **core condensation**, ascending humidity within the partition wall, freezing at the bottom

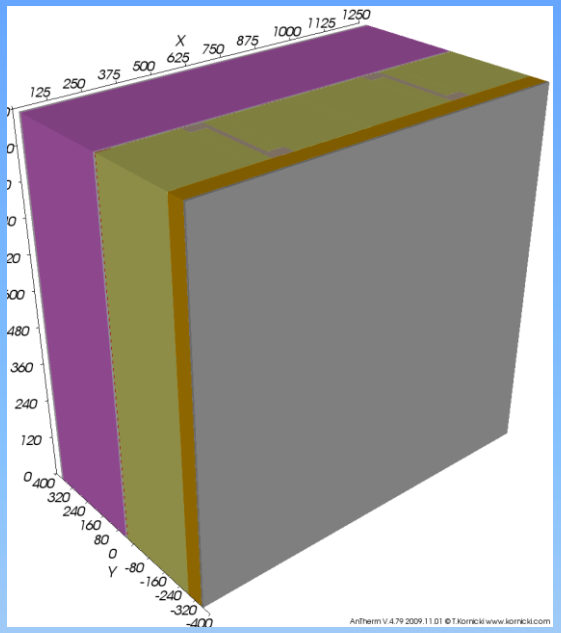
- Proper insulation of the slab is the only correct solution

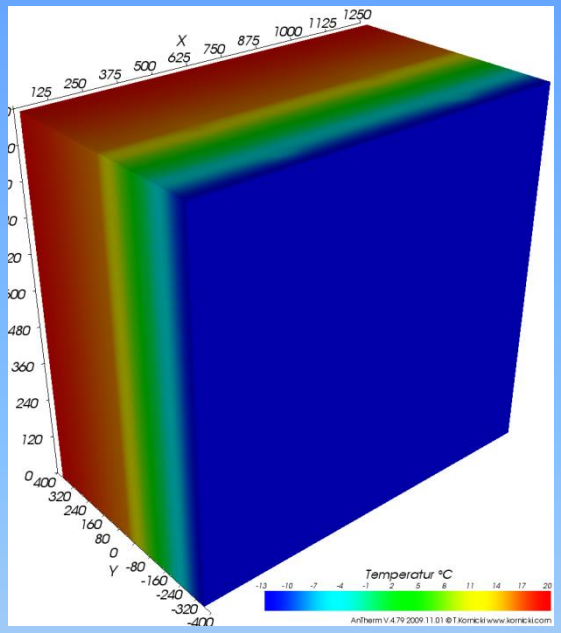
Results
For
Renovation-Simulation
with
AnTherm

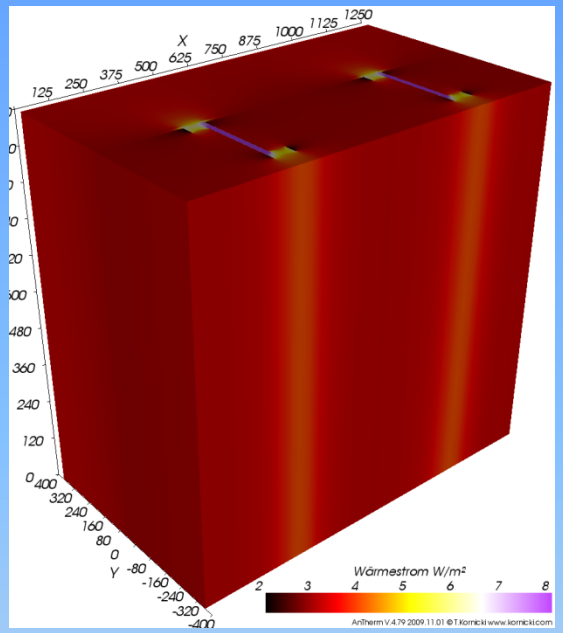




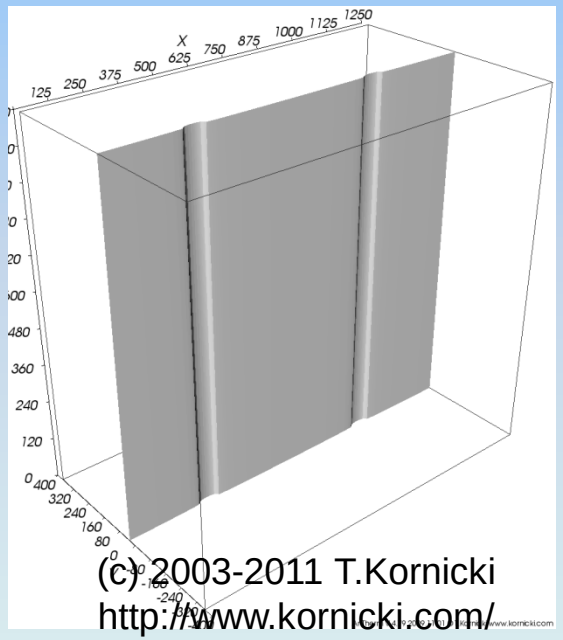


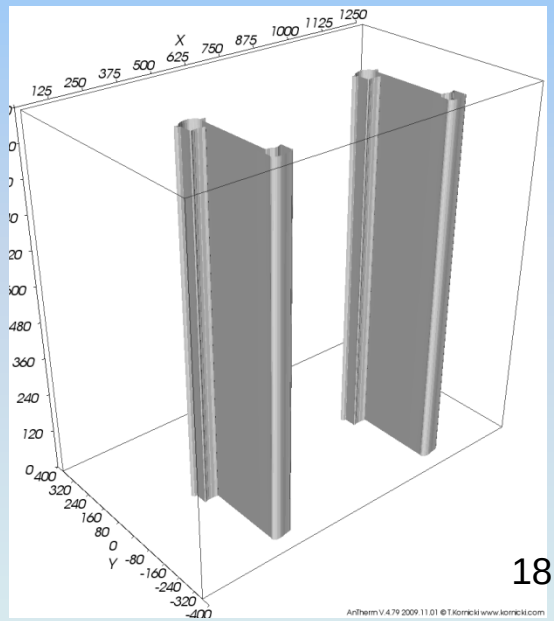






Wall 1 insulated





Wand 1 basis
350mm masonry wall

U_{base} = 0,7236 W/m²K

U_{mean} = **0,7236 W/m²K**

$T^*_{20°C/-13°C}$ = 14,21 °C

f_{Rsi} = 0,82

Wall 1 inszúlated (section 1m high with one jointer in the middle)
Model 625x1000mm

$U_{insulated}$ = 0,0969 W/m²K

$L^{2D}_{625x1000}$ = 0,064280 W/K

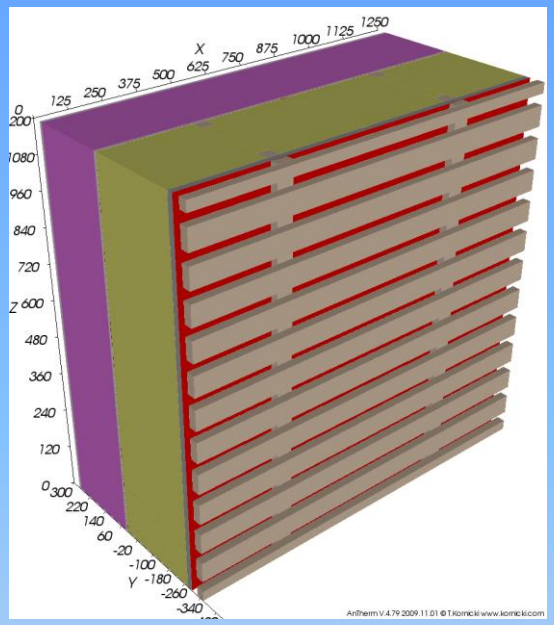
U_{mean} = 0,1028 W/m²K

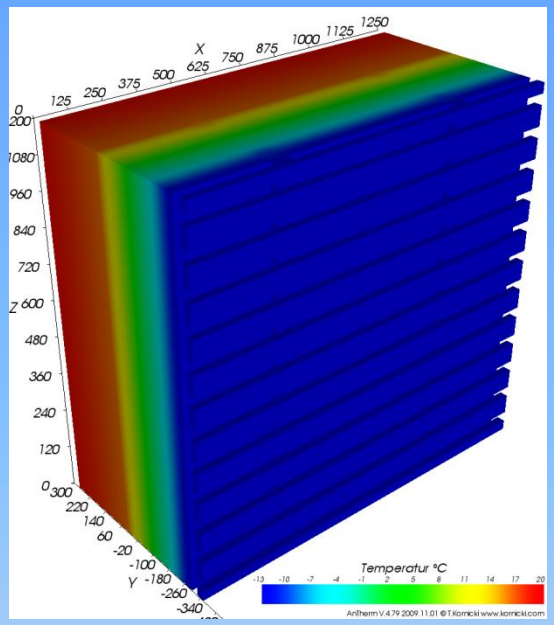
Ψ = 0,0037 W/mK

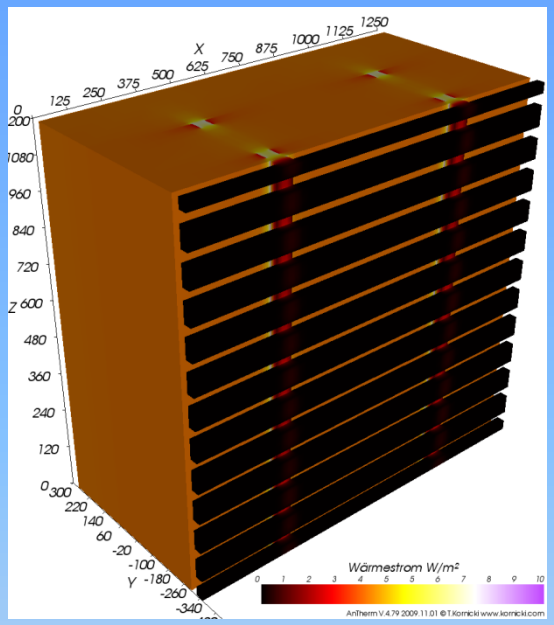
$T^*_{20°C/-13°C}$ = 19,15 °C

f_{Rsi} = 0,97

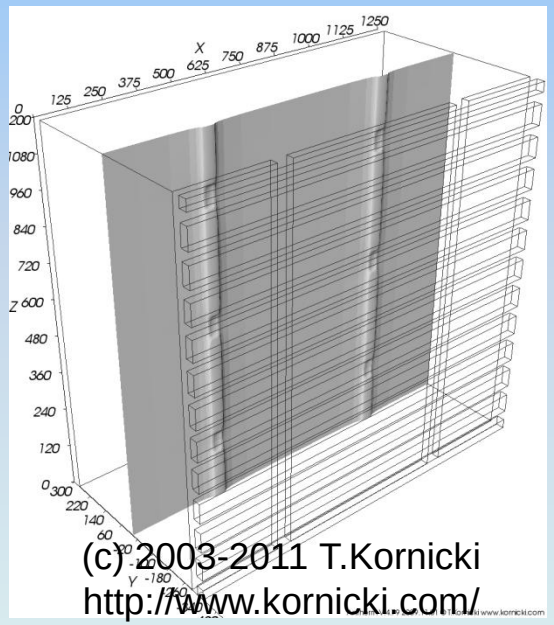
Diffusion: dry (p>psat)

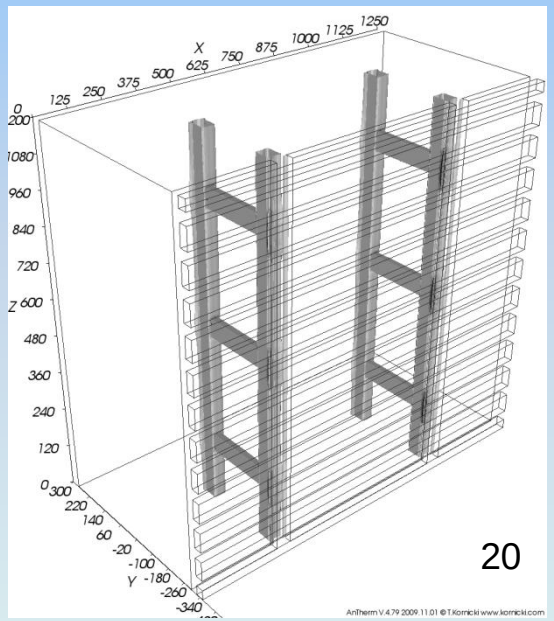






Wall 2 insulated





Walls 2 and 3 base
250mm masonry

U_{base} = 0,9283 W/m²K

U_{mean} = **0,9283 W/m²K**

$T^*_{20°C/-13°C}$ = 12,34 °C

f_{Rsi} = 0,77

Walls 2/3 insulated (section 0.4m high with one jointer in the middle)
Model 625x400mm

$U_{insulated}$ =0,1136 W/m²K

$L^{3D}_{625x400}$ = 0,029110 W/K

U_{mean} = 0,1164 W/m²K

χ = 0,00071 W/K

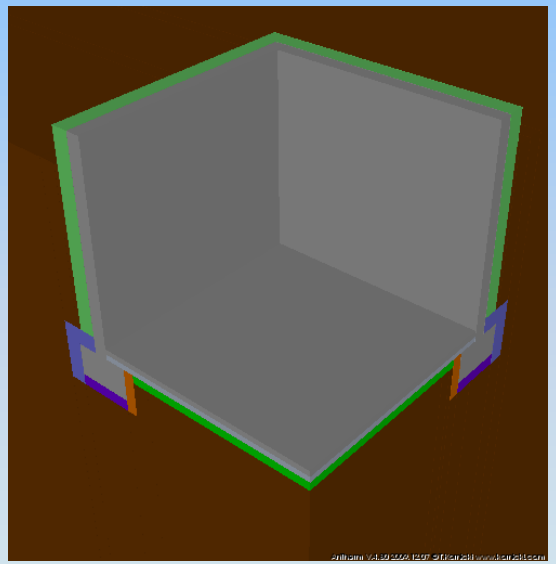
$T^*_{20°C/-13°C}$ = 19,03 °C

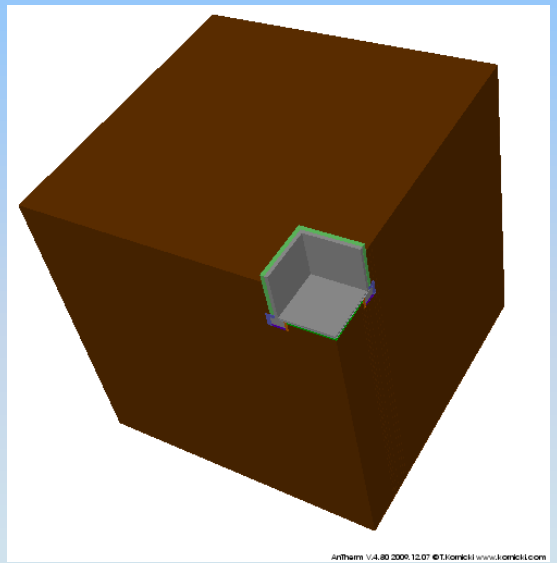
f_{Rsi} = 0,97

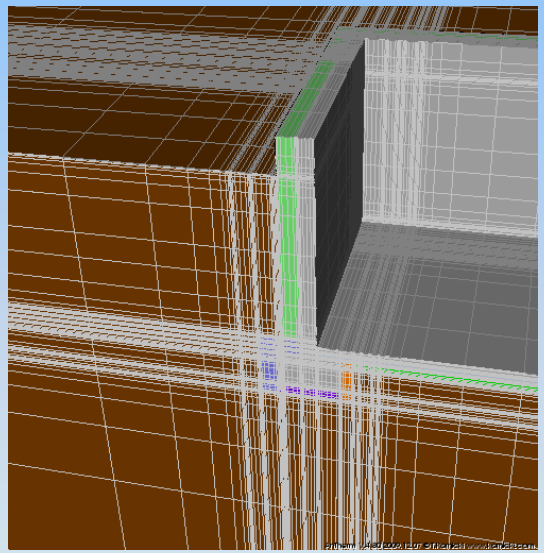
Diffusion: dry (p>psat)

Groundwork

Simulation in 3D
mit
AnTherm







T.Kornicki, Dienstleistungen in EDV und IT
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Tel./Fax. +43-1-6157099
email: tkornicki@chello.at

AnTherm (WALTER/UDO)
Version 4.80 2009.12.07

File: D:\Entw\01 Forum Passivhaus Poznan\Pyszczek\STOPA FUNDAMENTOWA-01_tko.antherm

Number of evaluated cells: 538272 (Nodes > 4306176)

Boundary conditions and resulting Surface Temperatures / Condensing Humidity

	Air temperature [°C]	min.temperature [°C]	max.temperature [°C]	Condensing.H. [%]	f^*_{Rsi}
INDOOR	16,00	11,35	15,56	73,90 %	0,87
OUTDOOR	-20,00	-20,00	-19,51	100,00 %	

Weigting factors for coldest surface point of each room

	INDOOR	OUTDOOR
g(INDOOR)	0,870846	0,000098
g(OUTDOOR)	0,129154	0,999902

Coordinates (x,y,z) for coldest surface point of each room

	x	y	z	Temp.[°C]	f^*_{Rsi}
INDOOR	-125,0000	-125,0000	800,0000	11,35	0,87
OUTDOOR	20000,0000	20000,0000	3700,0000	-20,00	

Thermal Coupling Coefficients [W / K]

Room\Room	INDOOR	OUTDOOR
INDOOR		6,741698
OUTDOOR	6,741750	

Precision information

	Close-up error [W / K]	Coeff. sum [W / K]	Relative close-up error
INDOOR	5,29186e-005	6,741750	7,84938e-006
OUTDOOR	-5,29186e-005	6,741698	-7,84944e-006

Boundary conditions

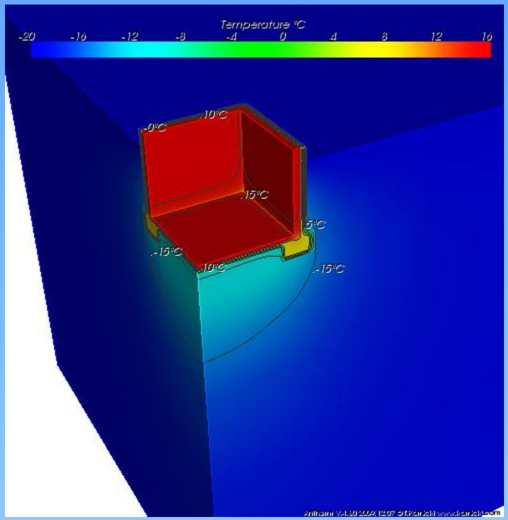
Extremes and surface condensation

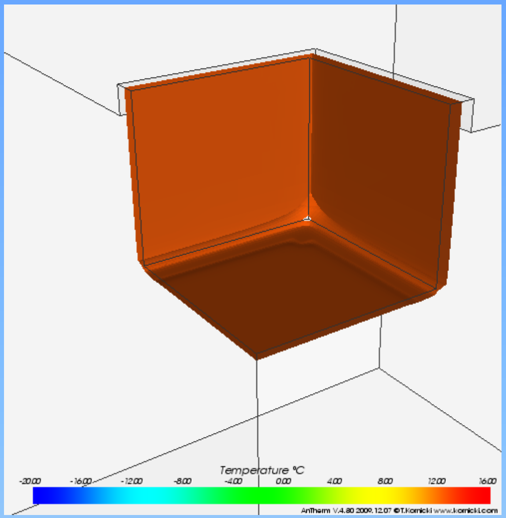
Weighting factors (g-values)

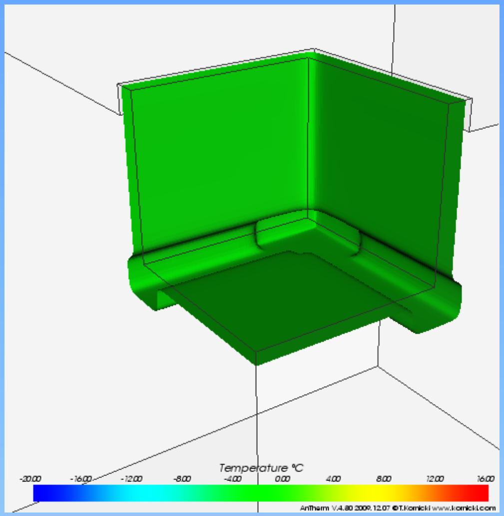
Critical locations

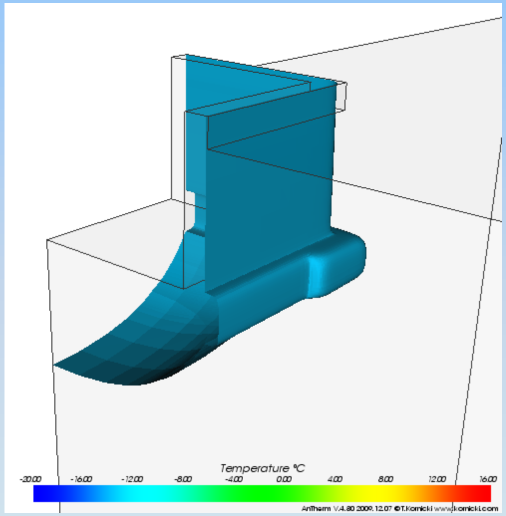
Coupling Coefficients (Thermal Heat Loss Factors)

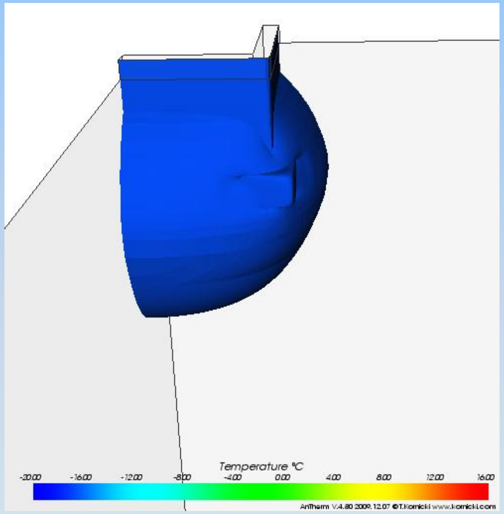
Precision information (error estimates)

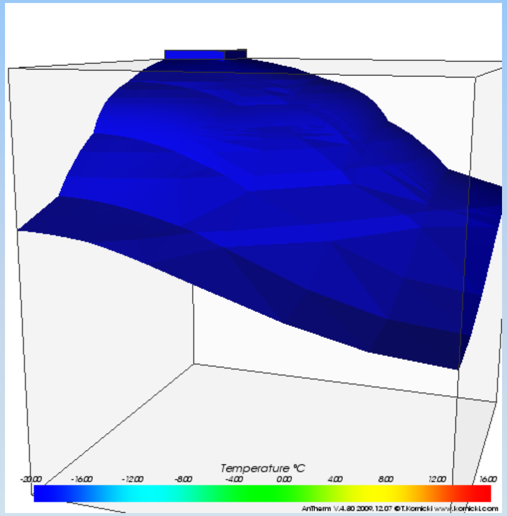

Temperature °C
-20
-16
-12
-8
-4
0
4
8
12
16

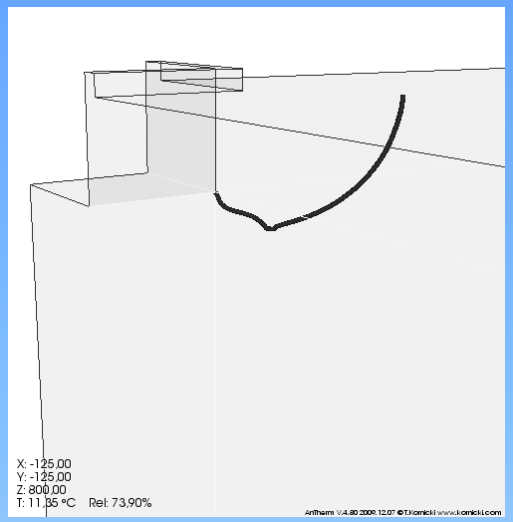

Temperature °C

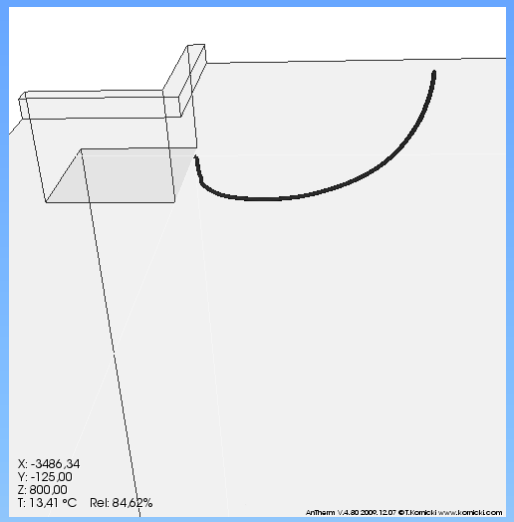

Temperature °C

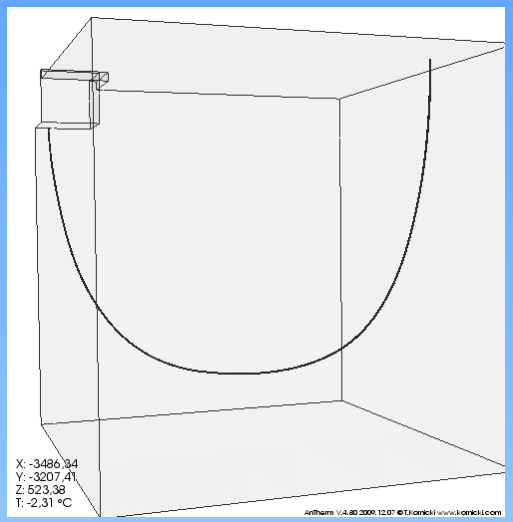

Temperature °C

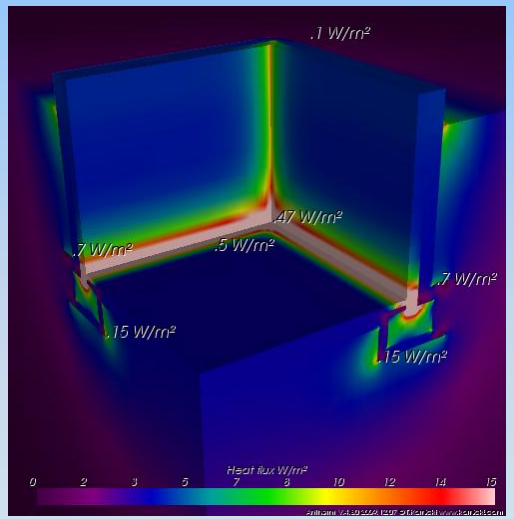

Temperature °C

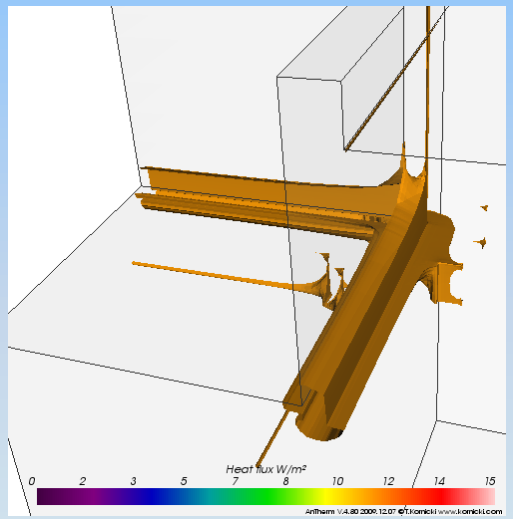

Temperature °C

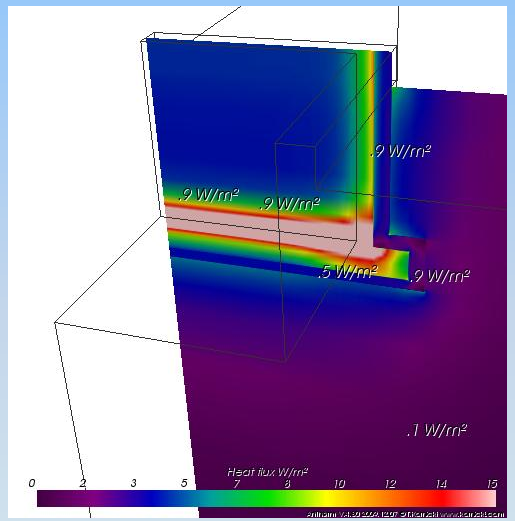






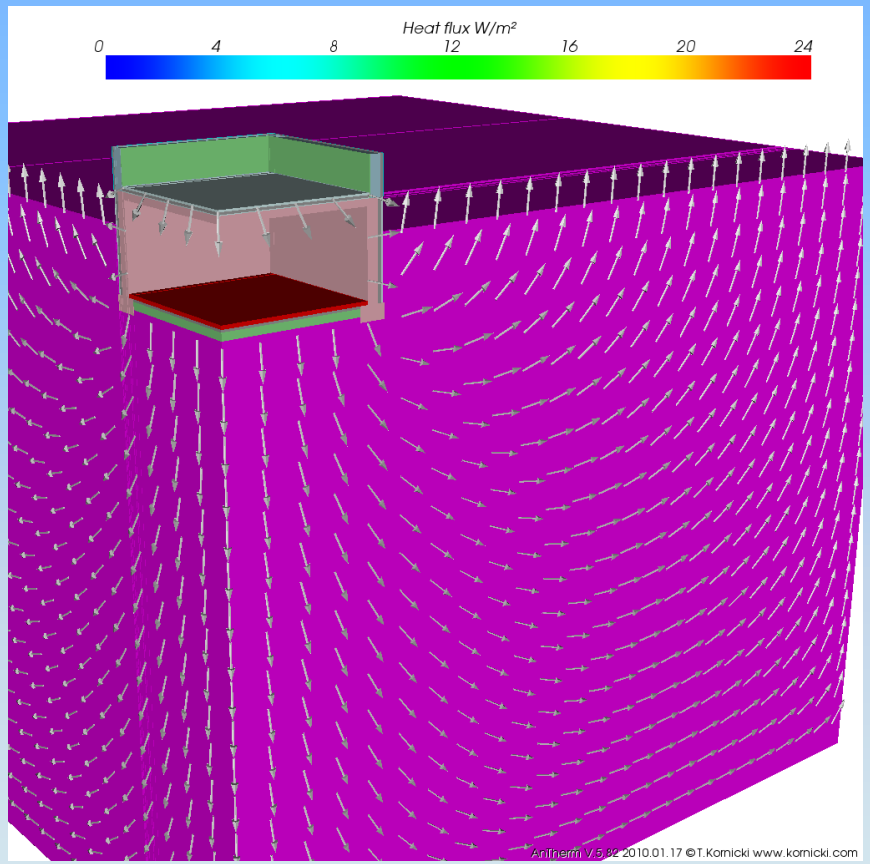


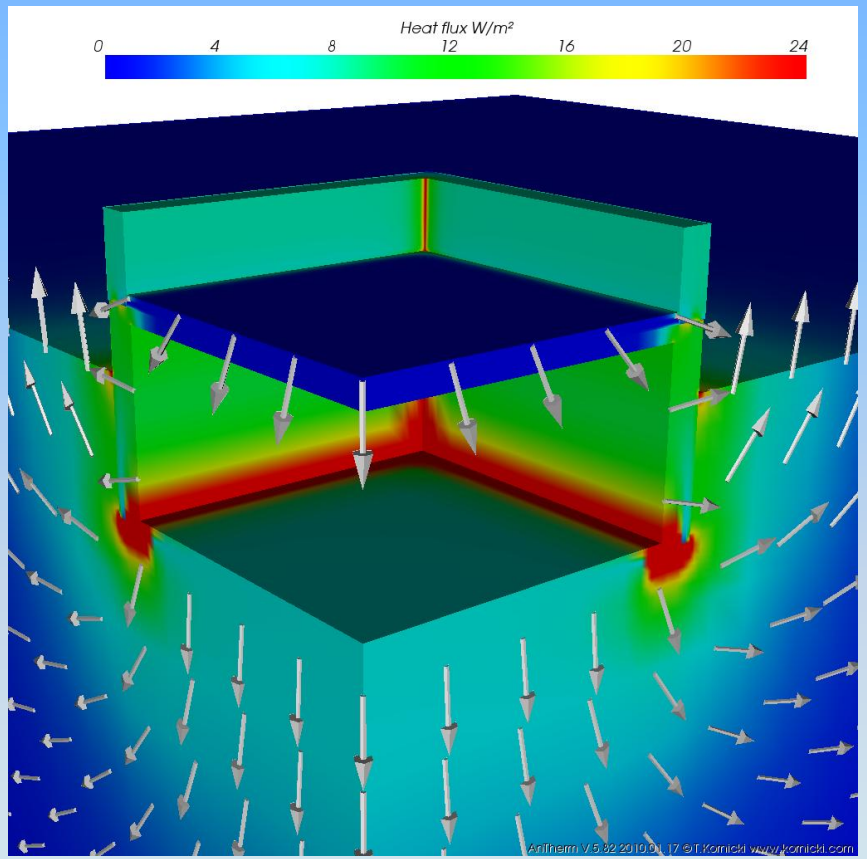




Foundation deep in ground dynamic transient problem

Harmonic simulation in 3D





Harmonic thermal coefficients and the dependant **Phase Lag** of heat losses following the temperature changes

- calculated **directly**
- independent of boundary conditions (no need to know them)
- shown as complex number and as the amplitude and phase lag

Thermal Coupling Coefficients [W / K]

Space\Space	Room 0	Room 1	Room 2
Room 0		2,116365	15,705269
Room 1	2,116364		10,089766
Room 2	15,705270	10,089766	

Harmonic Thermal Condactance for the period of **31536000 s** **Year**

Space\Space	Room 0		Room 1		Room 2	
	Re	Im	Re	Im	Re	Im
Room 0	-372,1741	-343,2399	2,1133	-0,0619	7,2899	-2,9619
Room 1	2,1130	-0,0616	-12,2096	-0,4732	10,0850	-0,2123
Room 2	7,2866	-2,9647	10,0853	-0,2123	-28,3451	-6,3106

Space\Space	Room 0		Room 1		Room 2	
	Amplitude [W/K]	Phase [months]	Amplitude [W/K]	Phase [months]	Amplitude [W/K]	Phase [months]
Room 0	506,2876	-4,5772	2,1143	-0,0559	7,8686	-0,7371
Room 1	2,1139	-0,0557	12,2187	-5,9260	10,0872	-0,0402
Room 2	7,8666	-0,7380	10,0876	-0,0402	29,0391	-5,5816

Steady state coefficient heat loss factor

harmonic coefficient heat loss factor

Amplitude

Phase-Lag

...

- ...

Stable on Target

- **Experience of more then 20 years** din development of software for building physics already
- Basic understanding of building physics alone is absolutely sufficient to use and control the application
- Deep **automation** of the numerical models in use, **no „scientific sophistication“**
- Results are **immediately evaluated**
- Highest **quality of results** can be transferred directly into reports

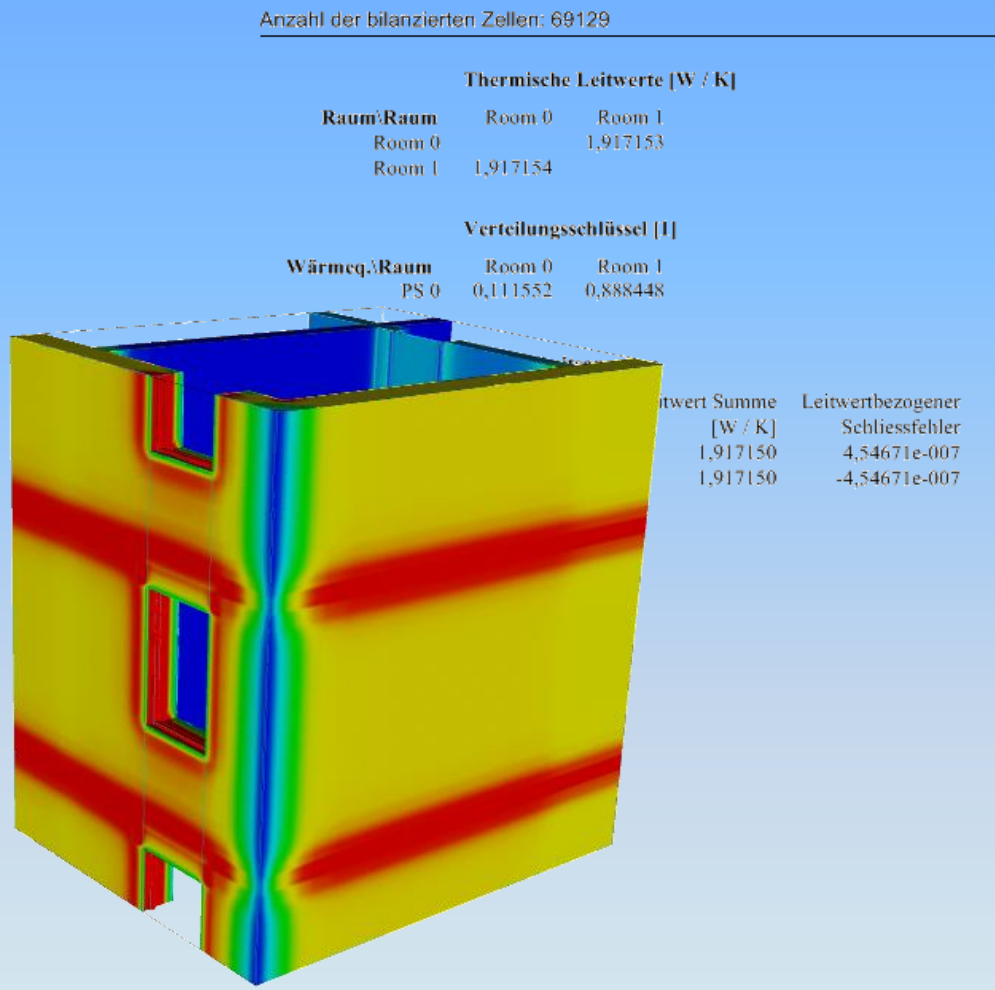
Phenomenally simple

- AnTherm stands for **very innovative** application for the **building physics**
- It provides an **integration** new visualisation capabilities **into the everyday life** of a engineer, while that technology is rooted in supercomputing and scientific visualization of large amounts of physical data
- What was far beyond the access of building physics professionals, due to its complexity and inacceptable learning effort, is made in AnTherm **phenomenally simple**
- The front end of the program is intentionally kept as simple as possible – casual user must be able **to control the application immediately without special learning efforts**

Higher Value, More Use

Results obtained easily from AnTherm, specially visualizations (pictures describing highly complex physical phenomena obtained in a straight forward manner and self describing, even for non professionals) significantly improve the value of building physics analysis processes and by that the commerciall success of users of such massive and supportive tool

Simply more value!
Simply more use!



… even more value

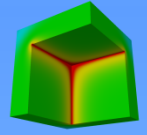
- Easy to learn and to control
- Saves time
- Exact and precise calculation
- Standard conformant (EN ISO 10211, 10077, 13786, …)
- **In one tool**:
  - 2D and 3D
  - Heat transport
  - Ψ (psi) – value calculaiton
  - Mould- and condensation controls
  - Vapour diffusion
  - Transient harmonic
- Mobility with dongle license
- Free demo version

…it's only you...

- Only you can decide if thermal heat bridge calculation will be comfortable and pleasant to you.
- It is only your responsibility on how much time must be spent on calculating thermal bridges.
- Only you can convince yourself that the tool can simplify and improve your job.
- Only you make the decision that somebody else earns money from you for thermal bridge calculations.

…assured…

- I promise you comfortable work
- I promise you enjoyment on completed job
- I promise you that your thermal bridge calculations will be precise each 24 hours and 365 days through
- I promise you that with the ability to perform correct thermal bridge calculations you will avoid any conflicts and hassles
- I promise you that by your work with **AnTherm** you can provide better, more precise, highly qualitative and reliable results to your customers



AnTherm

- Innovative user application
- Rooted on many years of experience
- and proven technologies you admire so

- Observing the continuing competition we are steadily aimed to make the application be the best, fastest, most exquisite and unflawed, ideal tool

Variability of Functions

- 2D and 3D
- Equation Size breakdown (number of cells)
- Functional options:
  - Steady State Heat Transmission (Base)
  - Steady State Vapor Diffusion (VAPOR-option)
  - Harmonic Heat Transmission & Storage (HARMONIC)
- Additional options:
  - Multi Processor (MULICORE)
  - Binocular 3D Visualization (STEREO3DVIEW)
- License Mobility (DONGLE)
- Free Demo-Version (3D with Vapour diffusion)

Variability of Functions

AnTherm Functionality Classification	3D	2D	+ VAPOR Option	+ HARMONIC Option	+ DONGLE Option	+ MULTICORE Option	+ STEREO3D Option
No Cell Limit	✓	✓	✓	✓	✓	✓	✓
Max. 1.000.000 Cells	✓	✓	✓	✓	✓	✓	✓
Max. 300.000 Cells	✓	✓	✓	✓	✓	✓	✓
Max. 50.000 Cells	✓	✓	✓	✓	✓	-✓-	✓
Max. 10.000 Cells	---	✓	✓	✓	✓	---	✓

Got spoiled for choice?

- Typical 2D projects result in 50.000 cells (equations)
- Typical 3D projects result in 1.000.000 cells

- Extension possible later on demand
  - Not a new license
  - Delta price between „now“ and „more“ (eventually an update is required)
- Harmonic- or Vapor-options adjustable at will

- Extensions are used to raise the power (e.g. shorten the calculation time)

- Cost effective Mobile Dongle License (instead of multiple licenses)

Trial instead of elaboration

- Fee demo version:

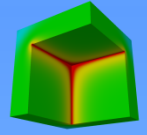
  http://www.antherm.eu/
- Registration required (contact data)

- Example videos on YouTube:

  http://www.youtube.com/user/tkornicki
- Imagery created with AnTherm on PicasaWeb:

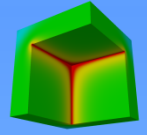
  http://www.picasaweb.com/antherm
- User Guide, Theory, Learning materials, Tutorials:

  http://help.antherm.eu/



Conclusio

Good replaced with Better



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http://www.kornicki.at/

AnTherm

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in building constructions with thermal bridges

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