From VIP's to Building Facades
Three Levels of Thermal Bridges

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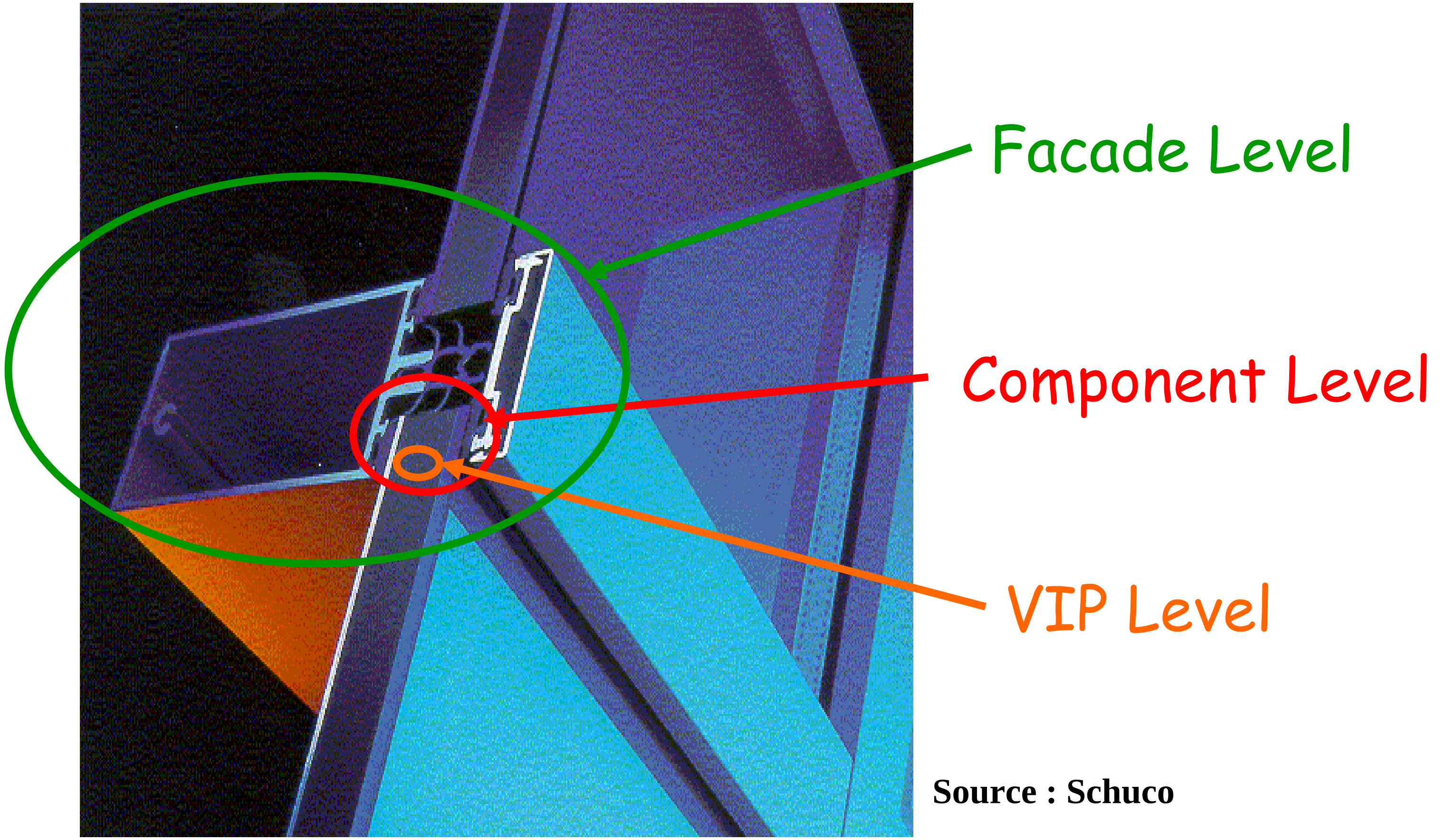
European Project : VIP Products & Services

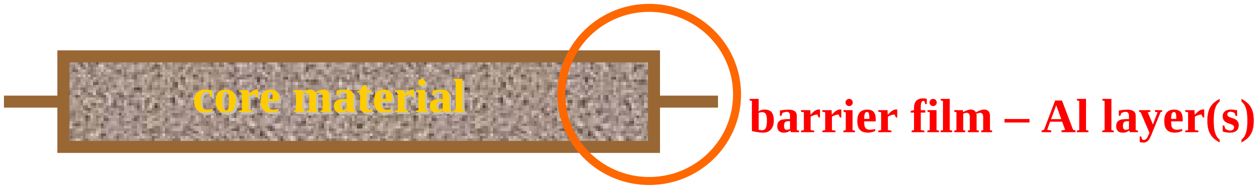
VIP in Façade Cladding Systems



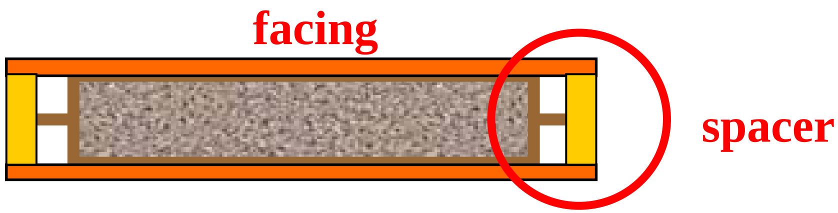
Source : Schuco

Three Level Approach

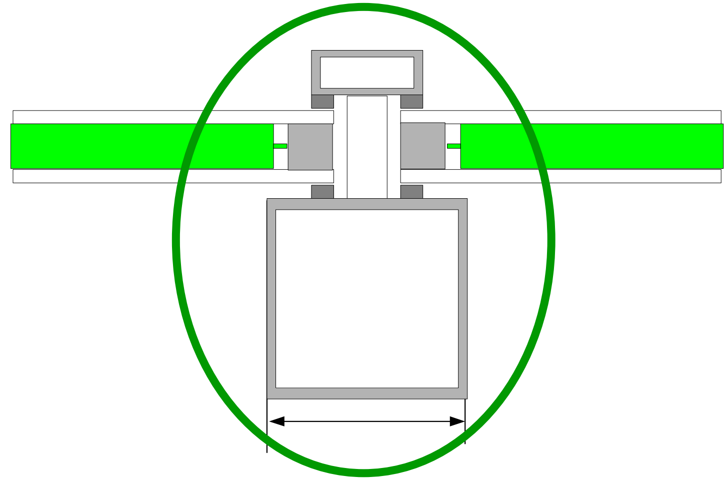
1 : VIP level



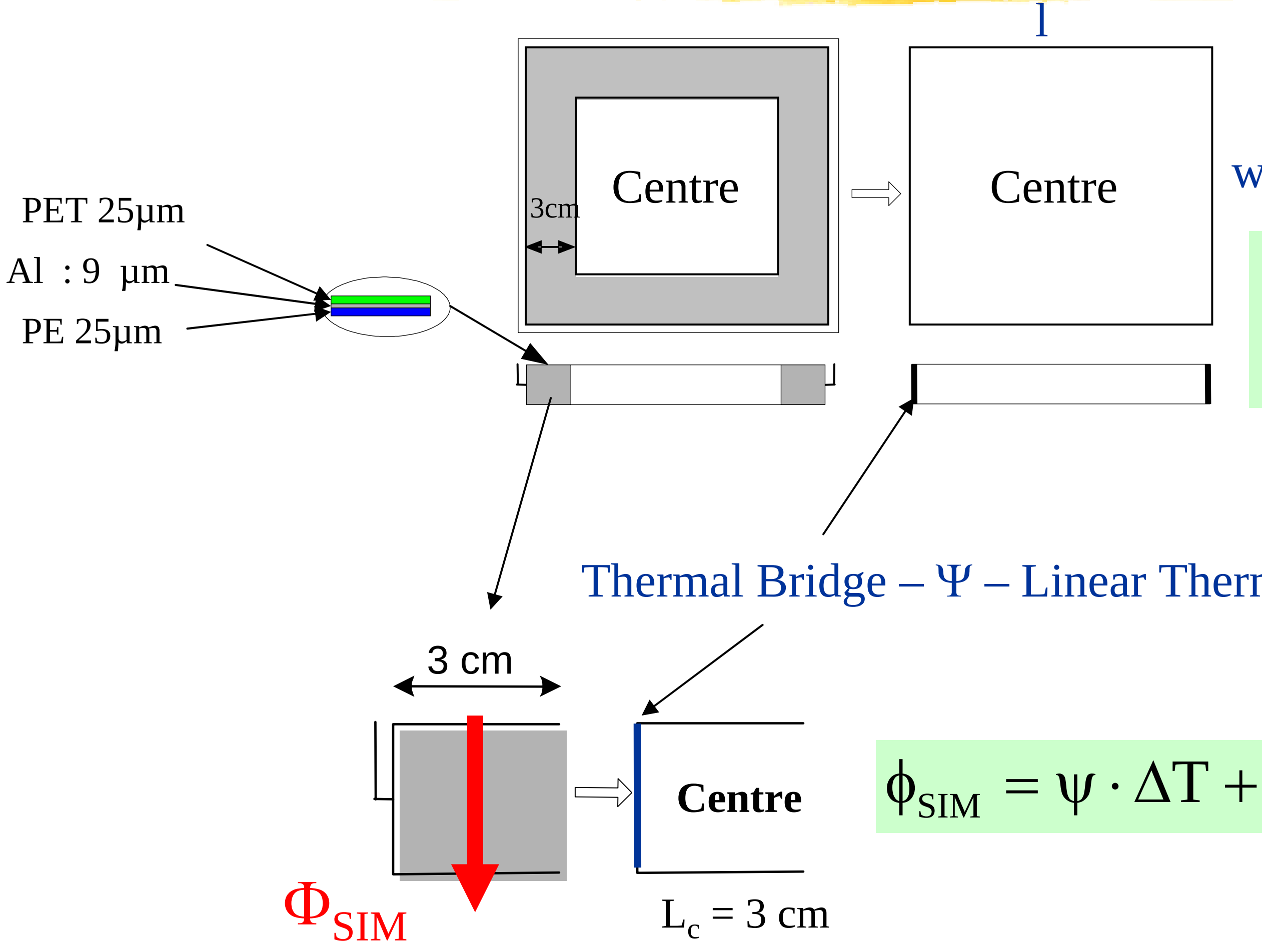
2 : Component



3 : Façade



VIP Level
Thermal Bridge due to the barrier film

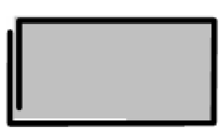


$$U_{VIP} = U_C + \psi \cdot \frac{P}{A}$$

W/m².K

$$\phi_{SIM} = \psi \cdot \Delta T + U_C \cdot L_C \cdot \Delta T$$

VIP Level - Simulation

Type	Set Up	
A	**Film :PE/Al/PET** **Core: Silica**	
B	**Film :PE/Al/PET** **Core : Silica**	
C	**Film :PE/Al/PET** **Core : Silica**	
D	**Film :PE/Al/PET** **Core : Silica**	

Materials	**Thickness**	**Thermal conductivity** *W/m.K*
Core	20 mm	0.005
Film **PE**/Al/PET	25 µm	0.4
Film PE/**Al**/PET	9 µm	225
Film PE/Al/**PET**	25 µm	0.4

$\Delta T = 20°C$ ($T_{out} = 0°C$ $T_{in} = 20°C$)

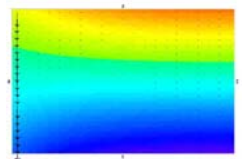
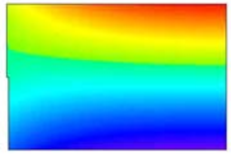
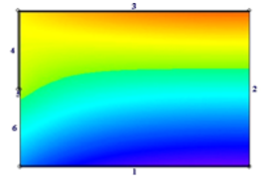
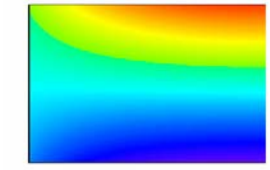
$R_{si} = 0.13$ and $R_{se} = 0.04$ m²K/W

Thickness e = 20 mm

Length $L_c = 30$ mm

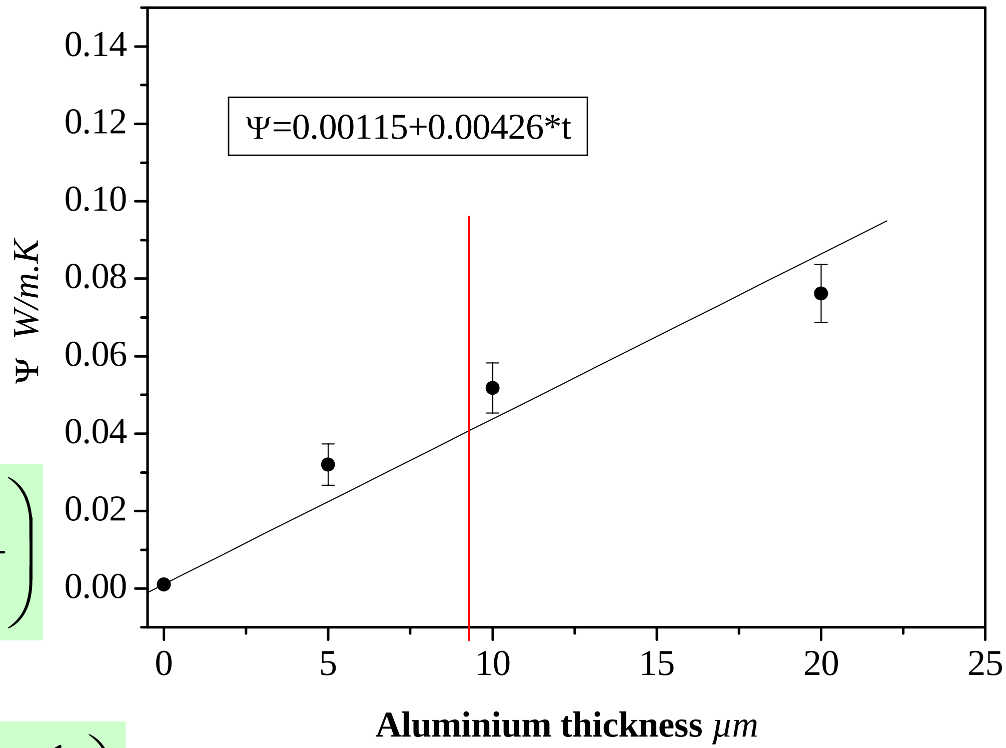
$\lambda_c = 5$ mW/m.K

VIP Level – Linear Thermal Transmittance

	Temperature Profiles	Ψ *W/m.K*
		**0.041**
		**0.046**
		**0.055**
		**0.052**

VIP Level – Effective Thermal Conductivity

Ψ is a function of the Aluminium thickness

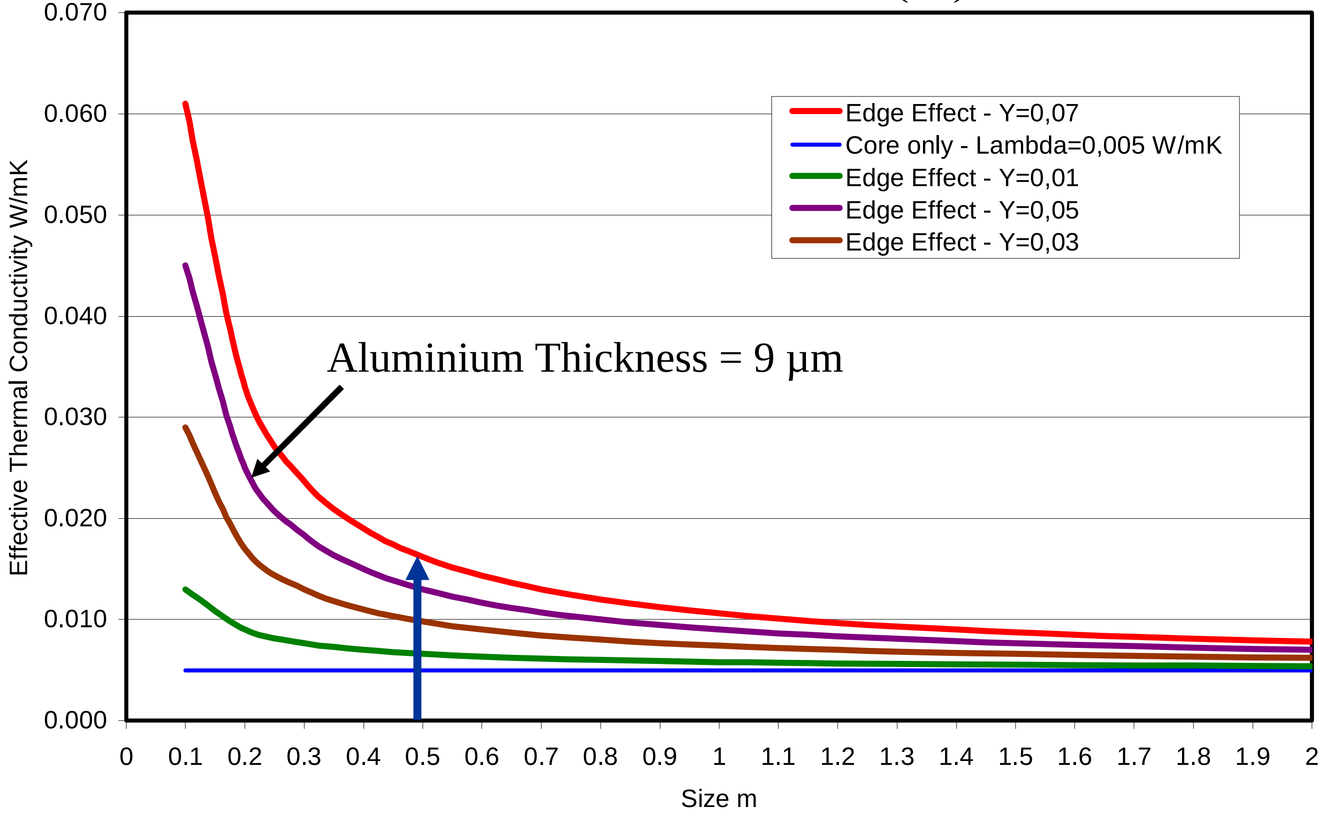


$$\lambda_{eff} = \lambda_c + \psi(t_{Al}) \cdot e \cdot 2 \cdot \left(\frac{1}{l} + \frac{1}{w}\right)$$

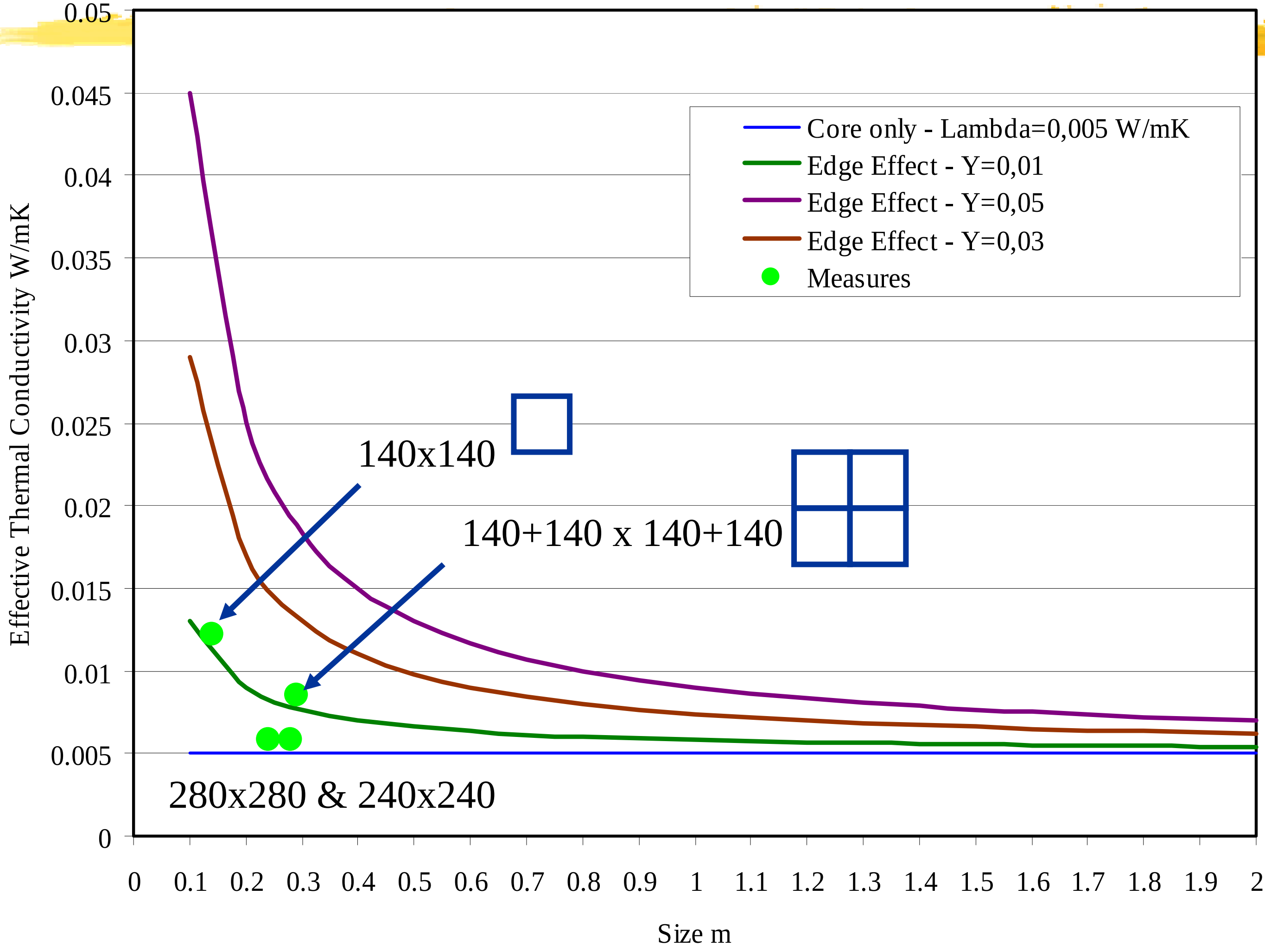
$$\lambda_{eff} = \lambda_c + (a + b \cdot t_{Al}) \cdot e \cdot 2 \cdot \left(\frac{1}{l} + \frac{1}{w}\right)$$

VIP Level - Effective Thermal Conductivity

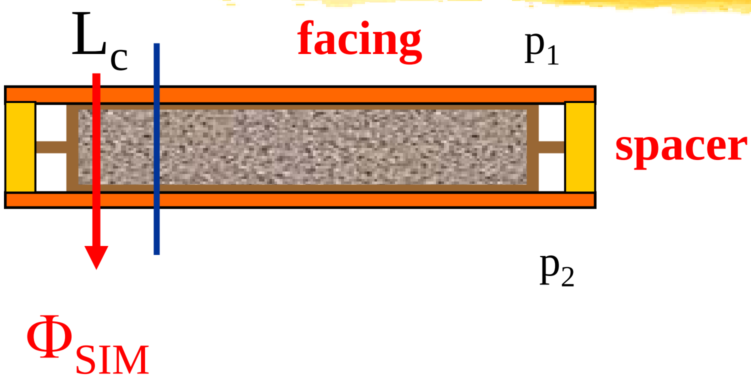
$$\lambda_{eff} = \lambda_c + \psi \cdot e \cdot \left(\frac{4}{l}\right)$$



VIP Level - Effective Thermal Conductivity

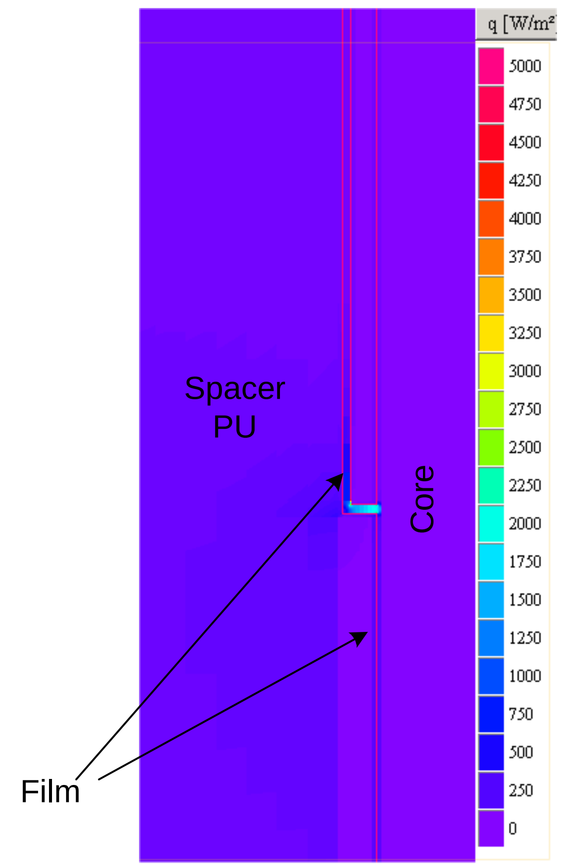


Component Level

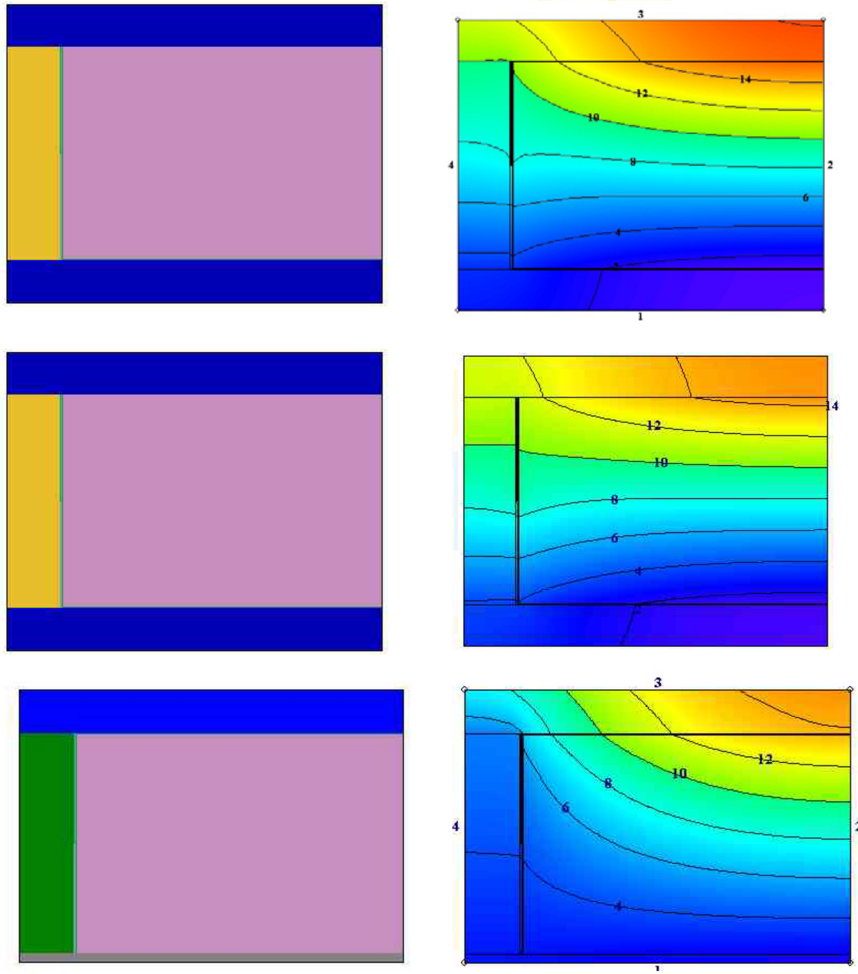


$$\psi = \frac{\phi_{SIM}}{\Delta T} - U_C L_C$$

$$U_C = \frac{1}{\frac{e_{p1}}{\lambda_{p1}} + \frac{e_C}{\lambda_C} + \frac{e_{p2}}{\lambda_{p2}}}$$



Component Level



Component Level

Type	Components	ψ *W/m.K*
1	Glass/VIP/Glass -- Spacer=PU	0.082
2	Wood/VIP/Glass - Spacer=PU	0.070
3	Wood/VIP/Steel - Spacer=PU	0.075
4	Wood/VIP/Al - Spacer=PU	0.076
5	Wood/VIP/Steel – Spacer = Alu+EPDM	0.102

Linear transmittance between panel and VIP

CSTB
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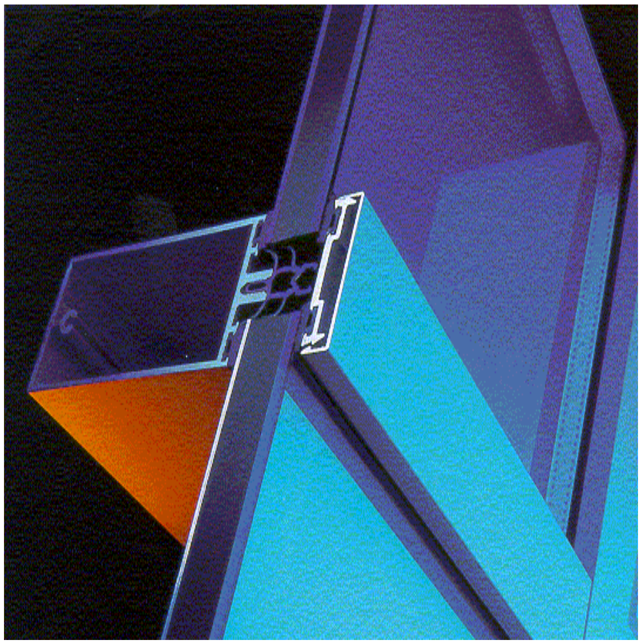
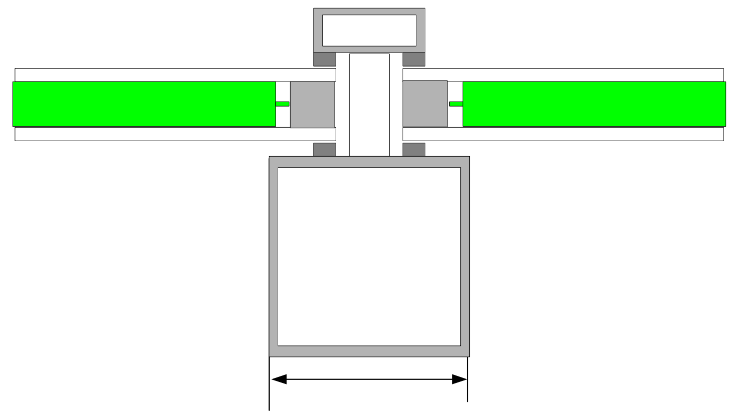
Façade Level

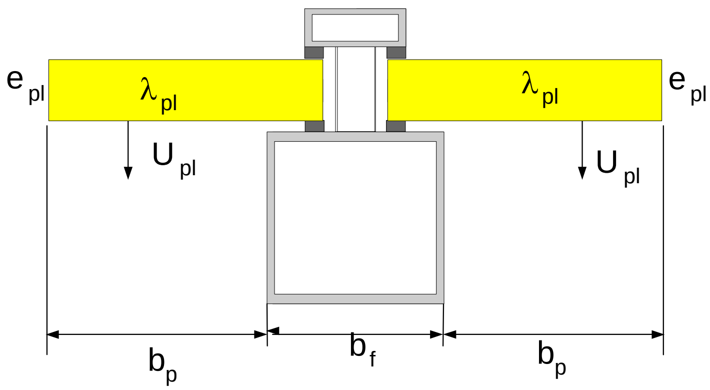


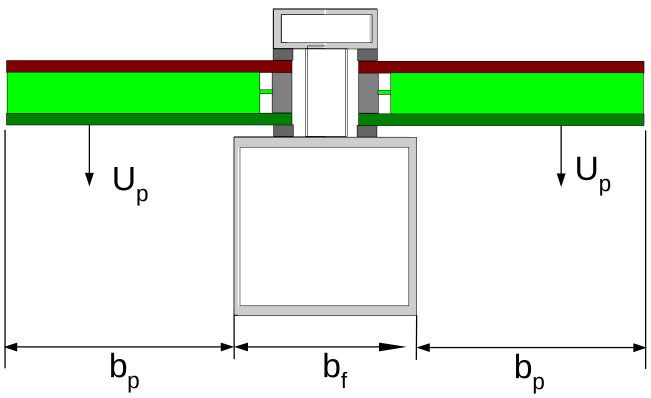
Source : Schuco



Standards : EN ISO 10077-1 & 2

Two step method



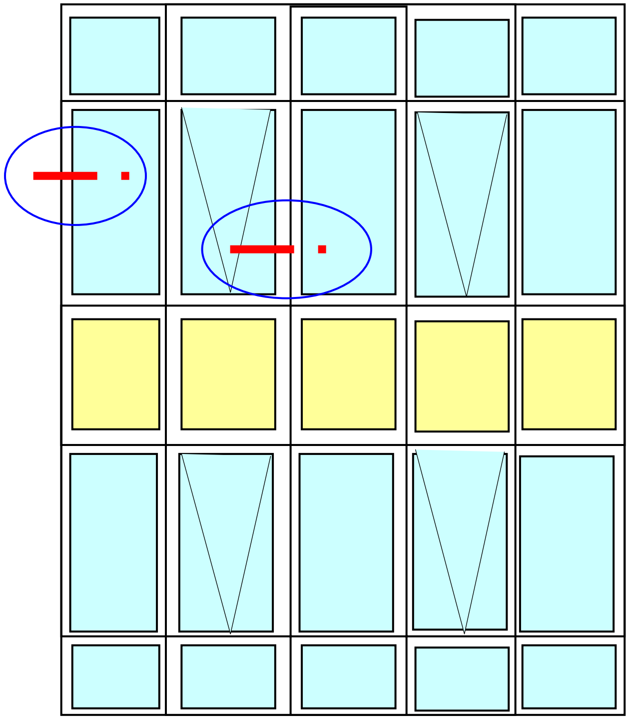


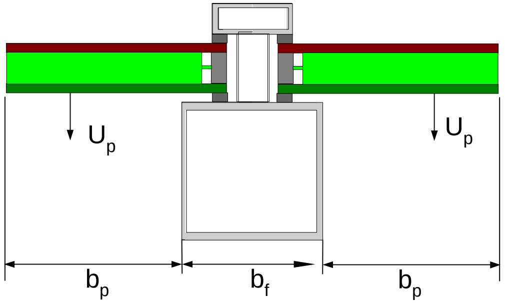
$$U_f = \frac{\dfrac{\phi_{SIM1}}{\Delta T} - U_{pl}\, b_p}{b_f}$$

$$\psi_p = \frac{\Phi_{SIM2}}{\Delta T} - U_f\, b_f - U_p\, b_p$$

$$U_p = \frac{1}{R_{se} + \dfrac{e_{p1}}{\lambda_{p1}} + \dfrac{e_{eff}}{\lambda_{eff}} + \dfrac{e_{p2}}{\lambda_{p2}} + R_{si}}$$

Façade Level : Curtain Wall





$$U_{cw} = \frac{\sum U_p A_p + \sum U_f A_f + \sum \psi_p l_p}{\sum \left(A_p + A_f \right)}$$

cw : curtain wall, p : component, f : frame

Thermal transmittance U_{cw}

Frame	Set_Up	Ψ_p *W/m.K*	U_p *W/m².K*	U_f *W/m².K*	U_{cw} *W/m².K* L × l (m): 1 x 1
Alu	Glass/VIP/Glass Spacer: PU	0.127	0.459	14.11	2.93
Alu + PU breaker	Glass/VIP/Glass Spacer: PU	0.057	0.459	7.268	1.67
Wood	Glass/VIP/Glass Spacer: PU	0.066	0.459	2.003	0.91
COMPOSITE	Glass/VIP/Glass Space:r PU	0.066	0.459	1.718	0.87
Alu	Steel/VIP/Wood Spacer: PU	0.171	0.457	14.11	3.08
COMPOSITE	Steel/VIP/Wood Spacer: PU	0.070	0.457	1.718	0.88
COMPOSITE	Glass/VIP/Al Spacer: PU	0.079	0.460	1.718	0.92
COMPOSITE	Composite/VIP/Composite Spacer: PU	0.043	0.459	1.718	0.79
COMPOSITE	Glass/VIP/Al Spacer: Al+EPDM	0.259	0.460	1.718	1.42

Composites in Building Envelope

Source : Fiberline

Windows

Facade

CSTB
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Conclusion

At the VIP level, the thermal bridge due to the aluminium layer does exist but is not the main problem for facade claddings.

Facings, Spacers and Frames made with low thermal conductivity materials (wood, PU, composites …) should lead to more efficient components for building envelope : facade claddings, doors, roofs …

Thank You for your attention