

Stiff textiles or felts glued on light impervious layers: a new "green" light septum fiber technology

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New "green" light septum fiber technology

Introduction

- Sustainable lightweight and green technologies, meaning recycled and recyclable, are key for the automotive industry in order to reach the new CO2 emissions regulations in 2020.
- Absorbing systems based on cotton waste felts bonded by polyester bi-component fibers or resins (called shoddy sometimes) like the bi-permeable concept: felt / compressed felt, have succeeded to remove heavy layers (EPDM-EVA-mineral charge), but at the cost of good insulation properties.
- Even with significant improvements like the quadri-permeable concept: felt / compressed felt / felt / AFR NW, these absorbing technologies remain dedicated to bad pass-through situations, where the insulation properties are destroyed anyway.

New "green" light septum fiber technology

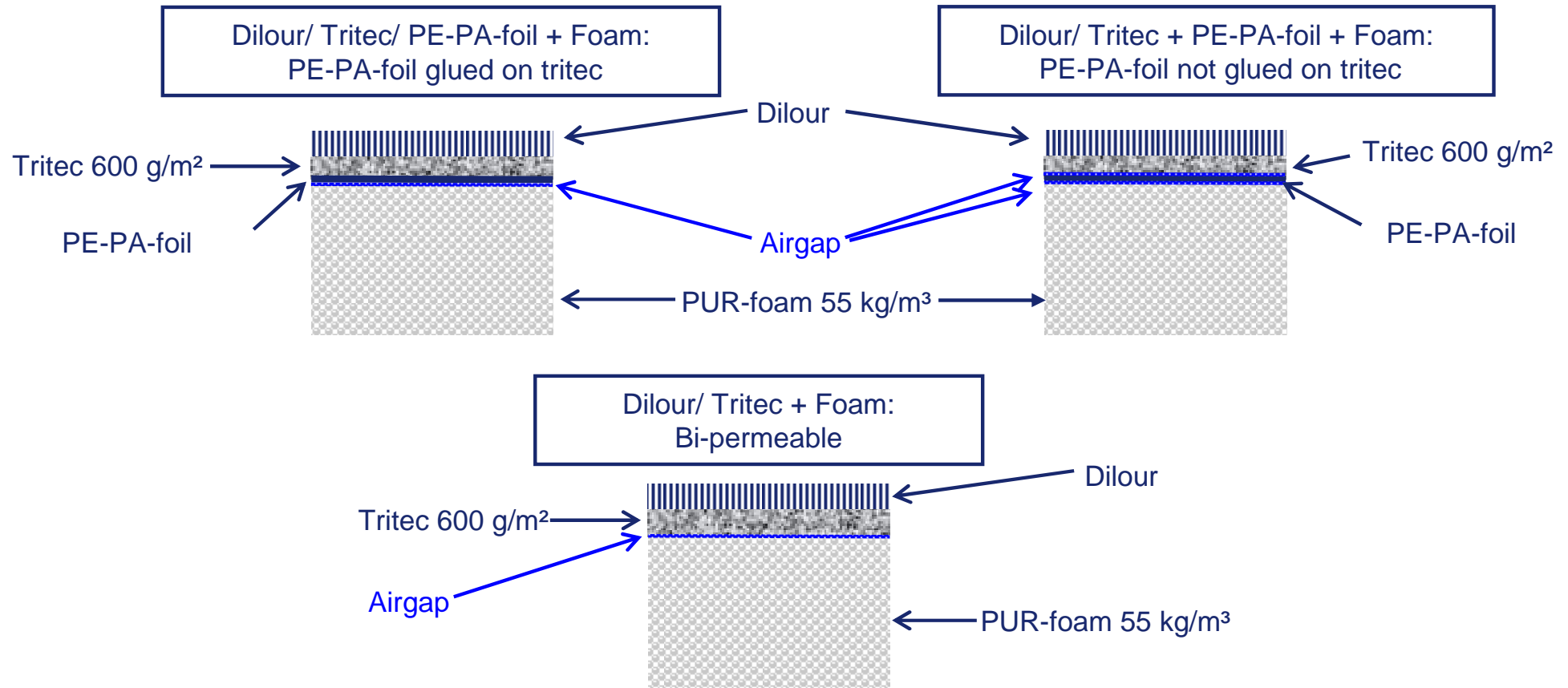
Introduction

- This paper presents a new way to overcome these difficulties, meaning maintaining the good insulation slopes (18 dB/oct in Transmission Loss for flat samples) with light solutions, while removing heavy layers, allowing up to 100% recycled and recyclable contents.
- This new "green" light septum is simply a stiff compressed textile or felt glued on a light impervious layer, generally backed by an open porous foam or felt.
- The light impervious layer captures the mass in Transmission Loss of the stiff compressed textile or felt as long as the bending stiffness is higher than $B = E \cdot h^3 / 12 = 0.01 \text{ N.m}$.

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Influence of the presence and gluing of the foil

Lightweight carpet tritec insulation: < 1500 g/m²:

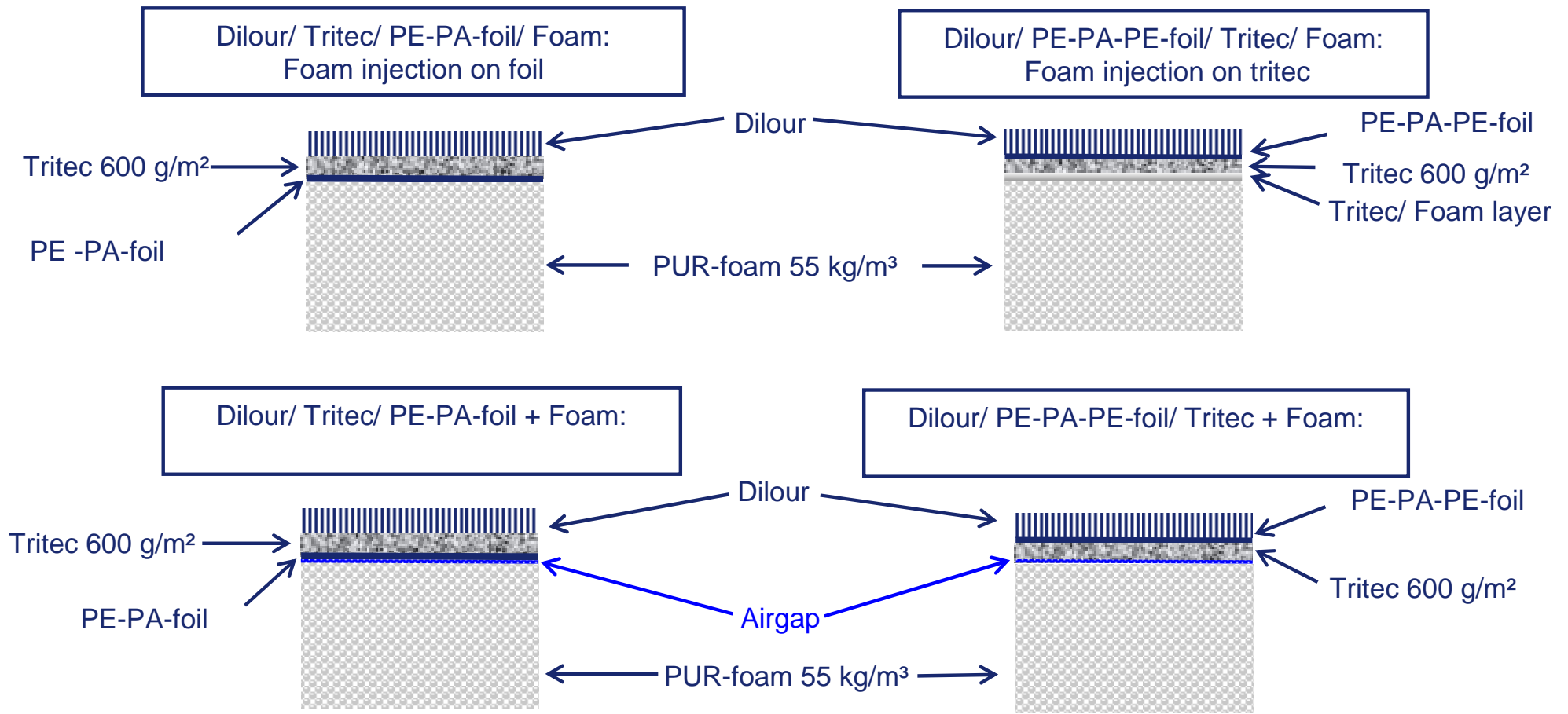


Remark:
- „/“ means bonded
- „+“ means not bonded

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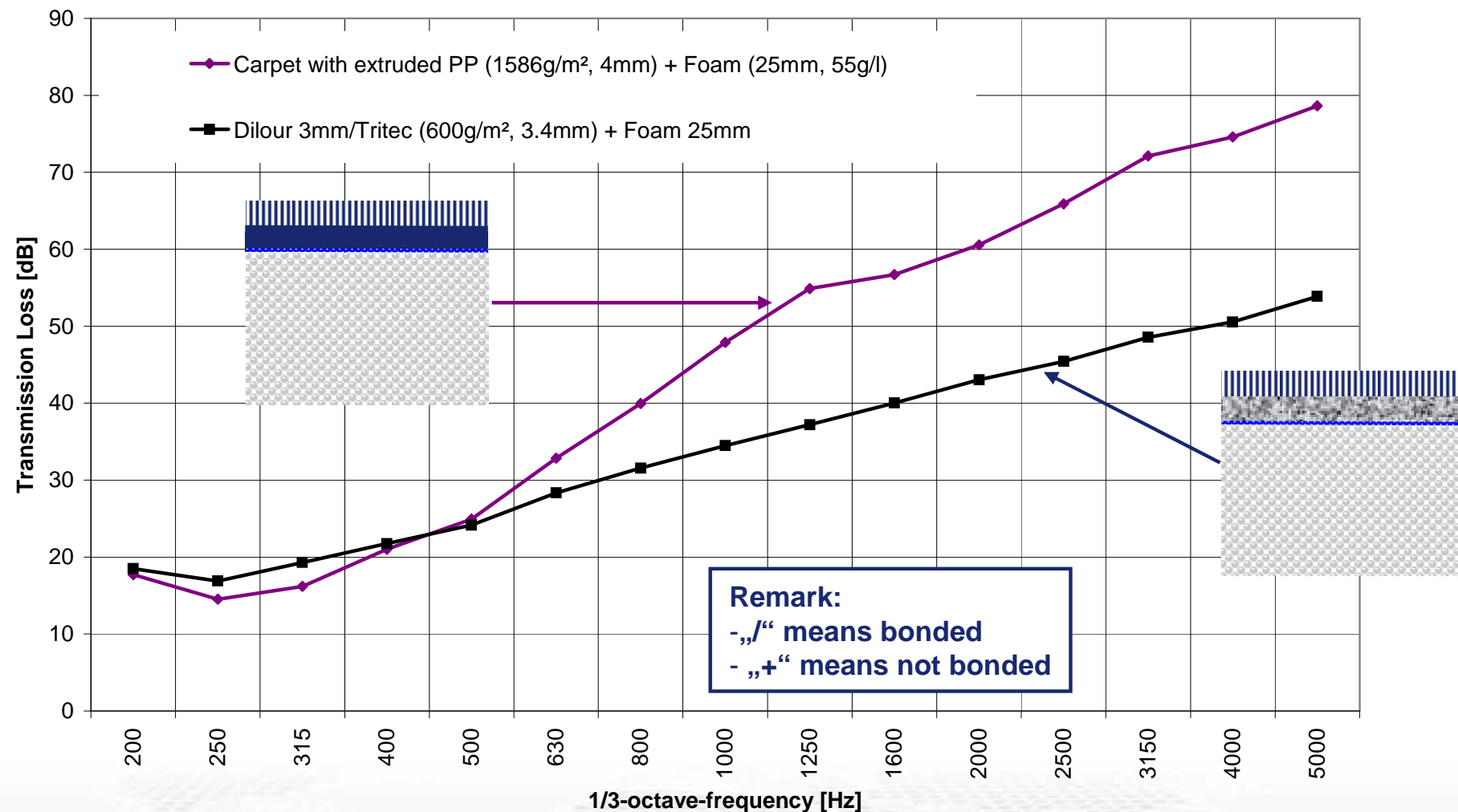


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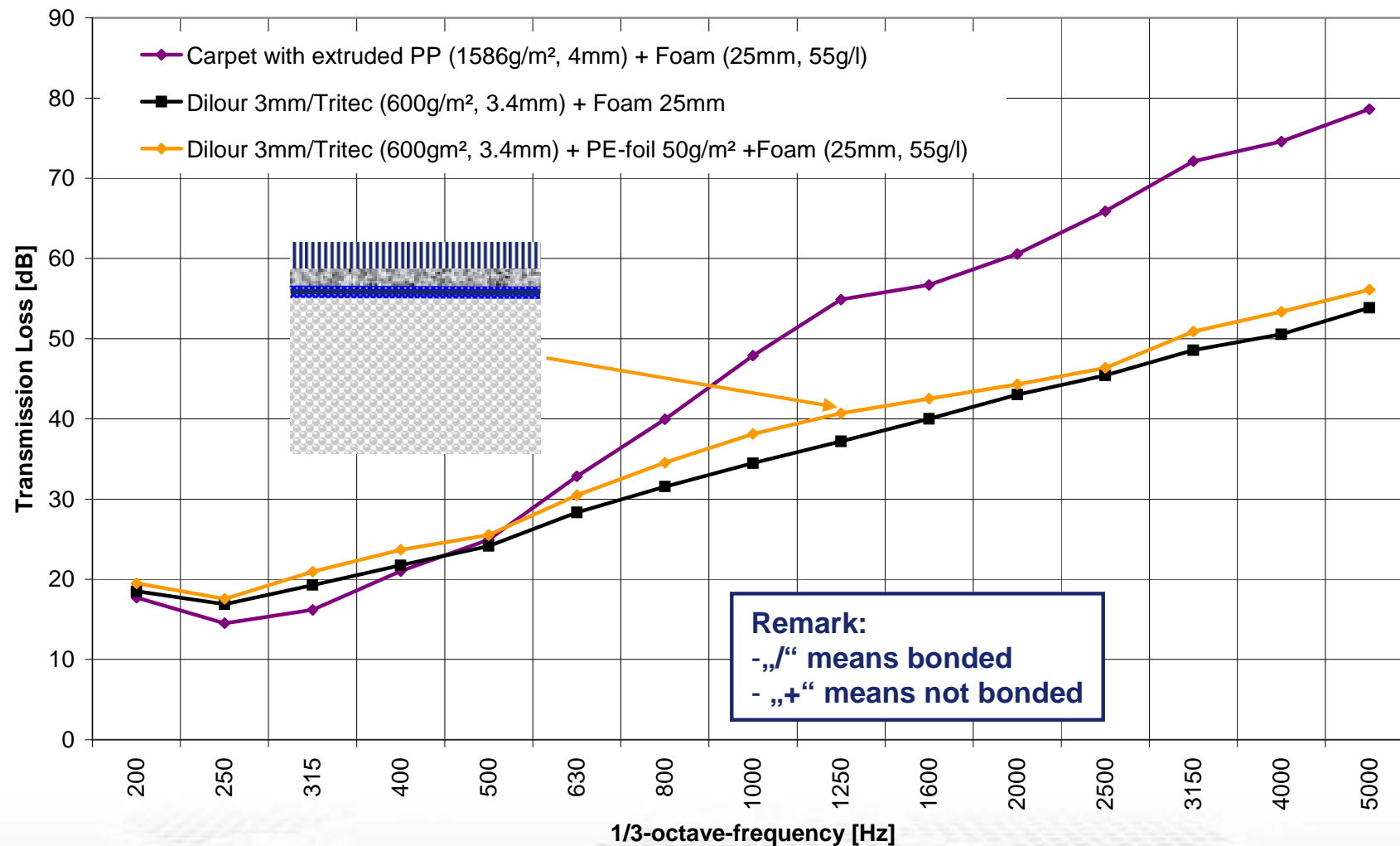
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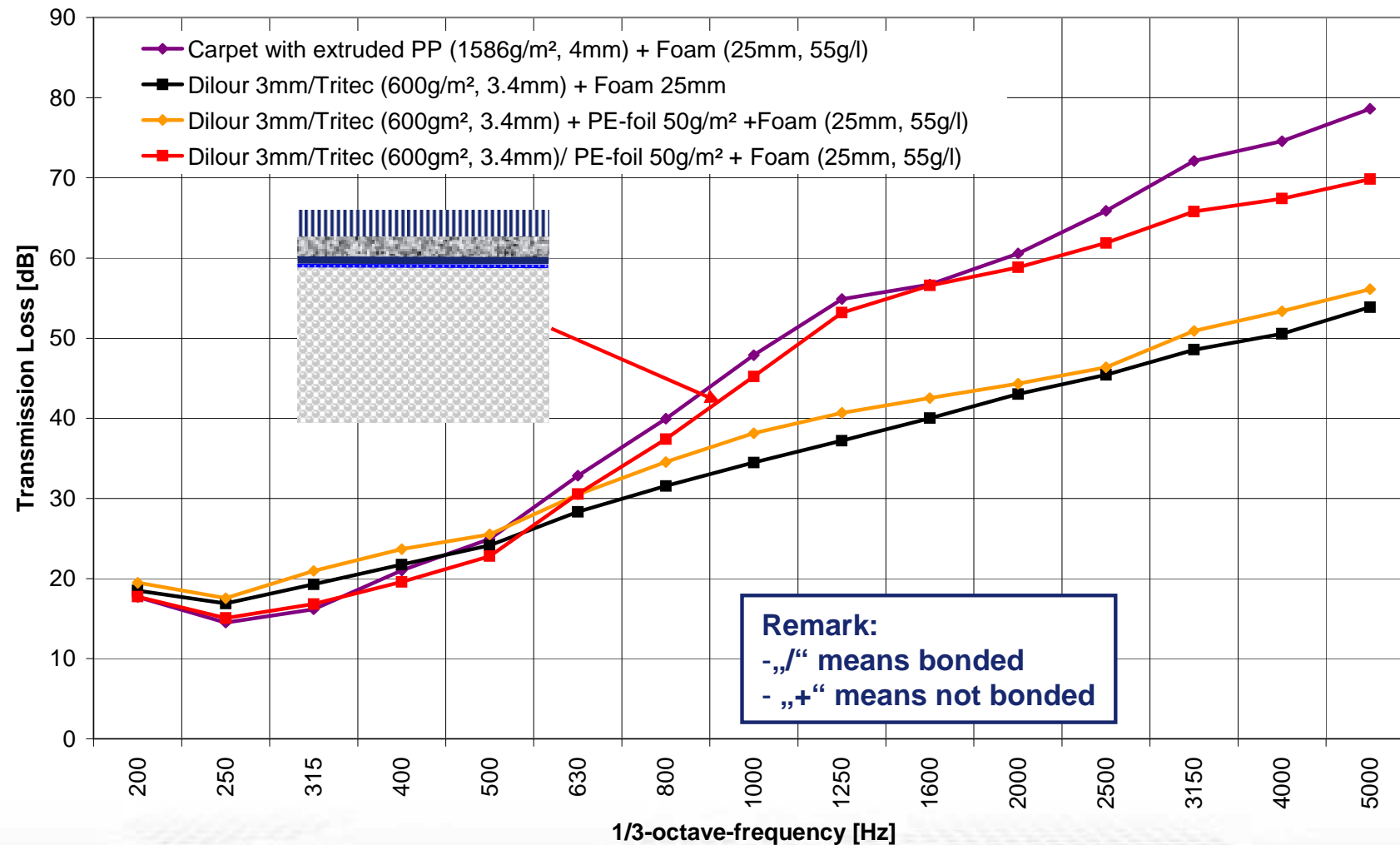
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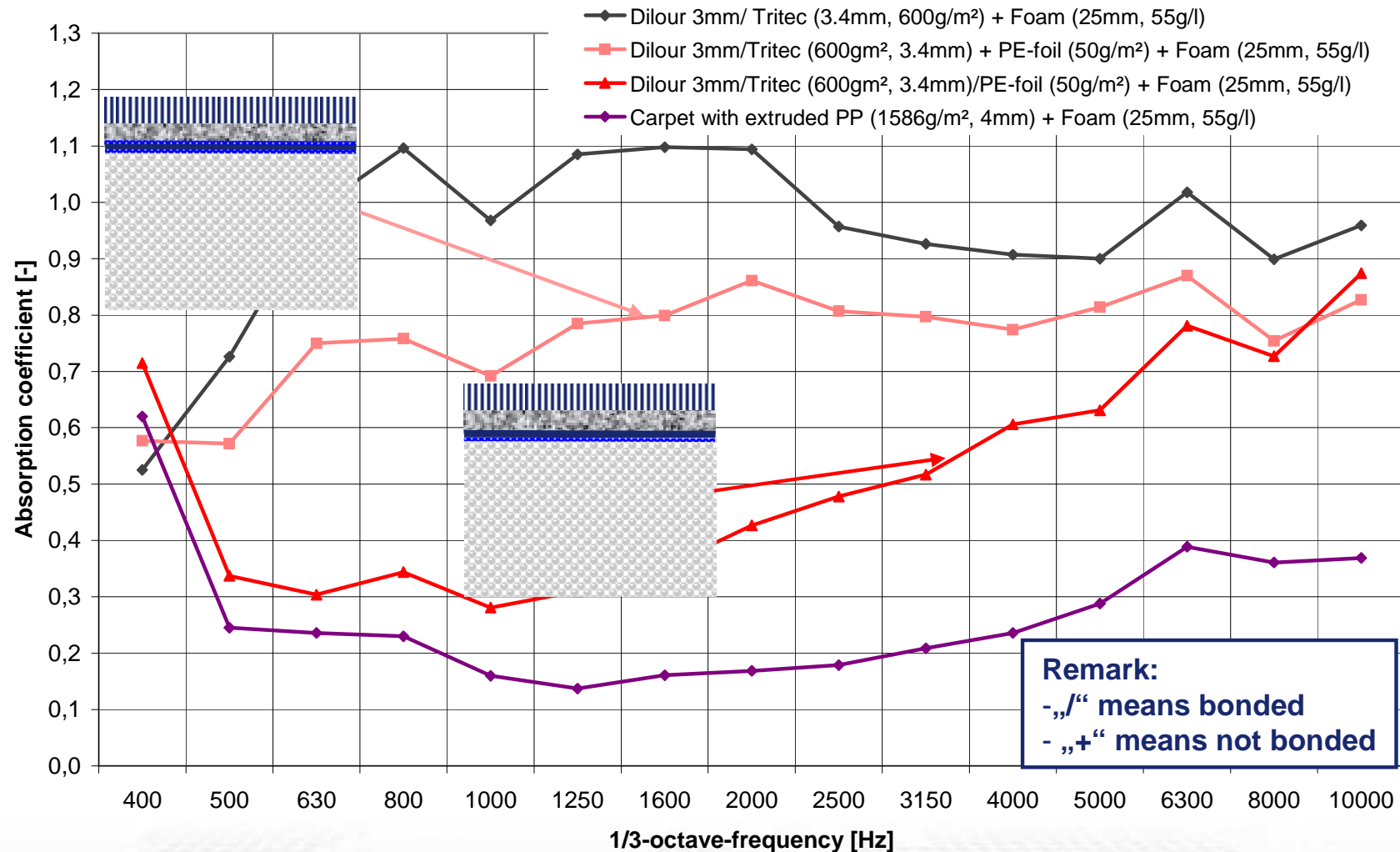
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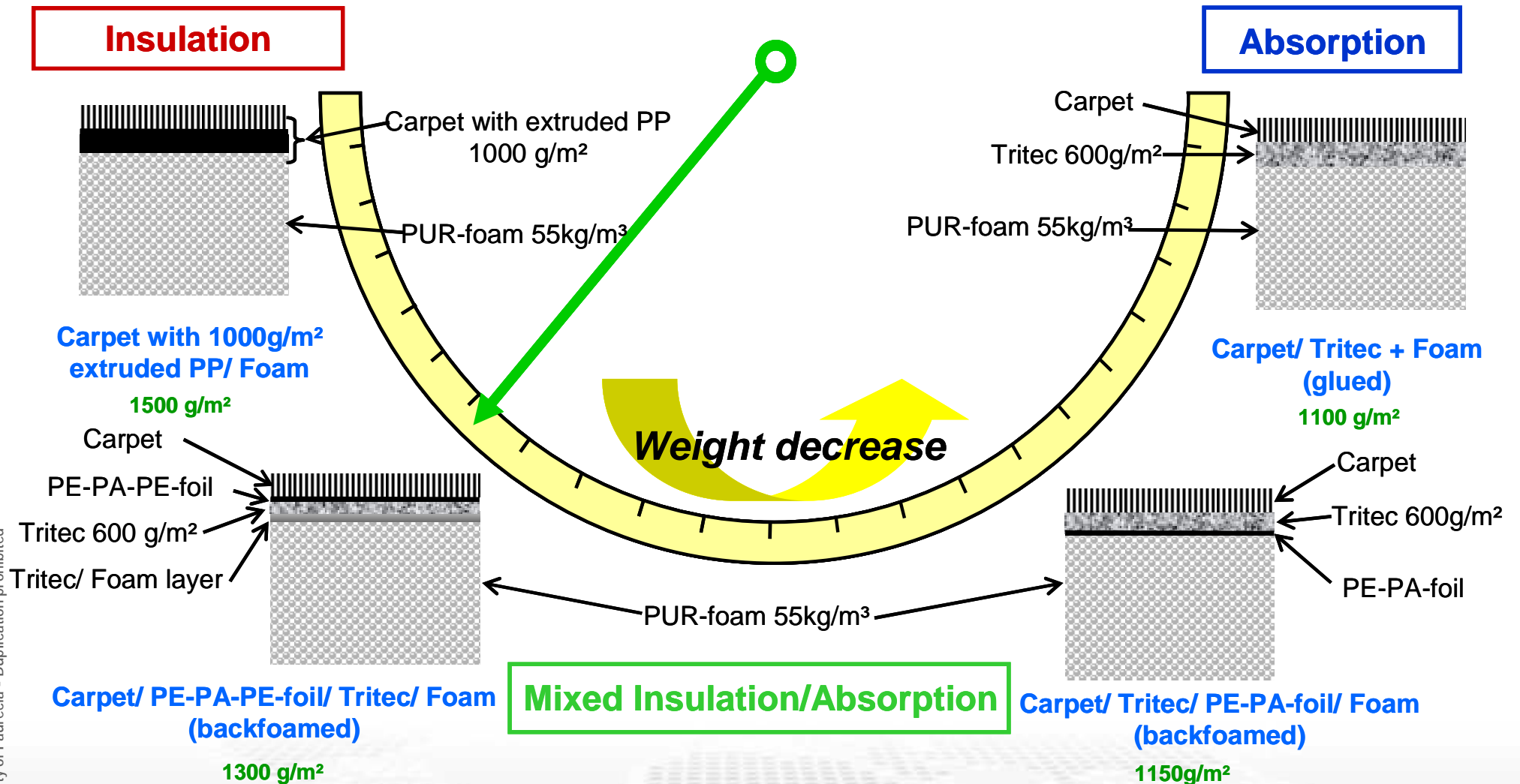
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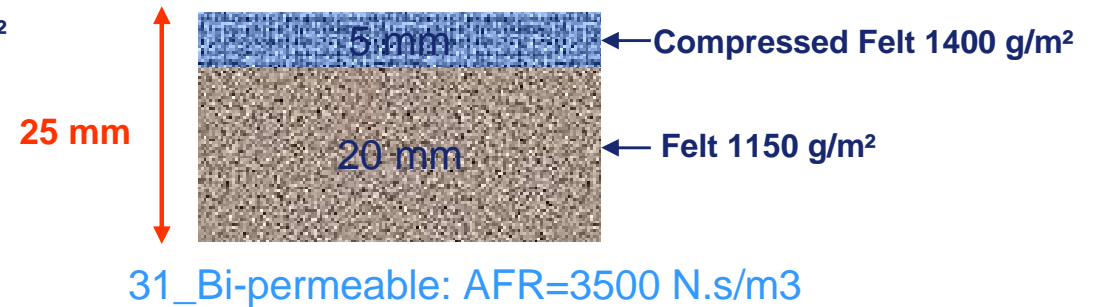
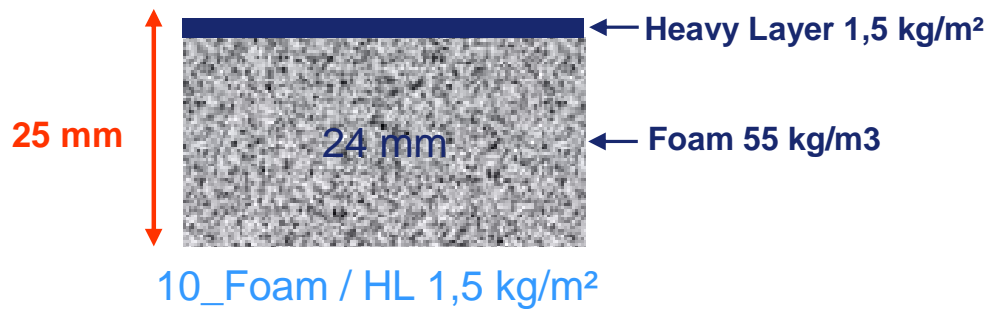
New "green" light septum fiber technology

Influence of the presence and gluing of the foil

Lightweight carpet acoustic galvanometer: $< 1500 \text{ g/m}^2$

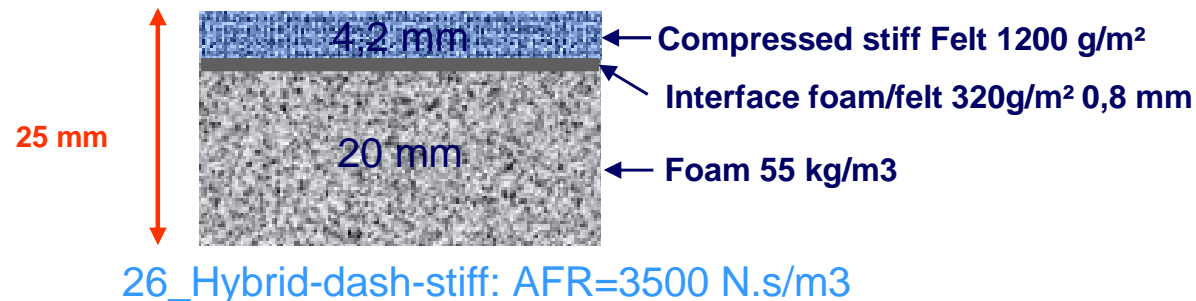


New Hybrid-Stiff Concept: simulated configurations

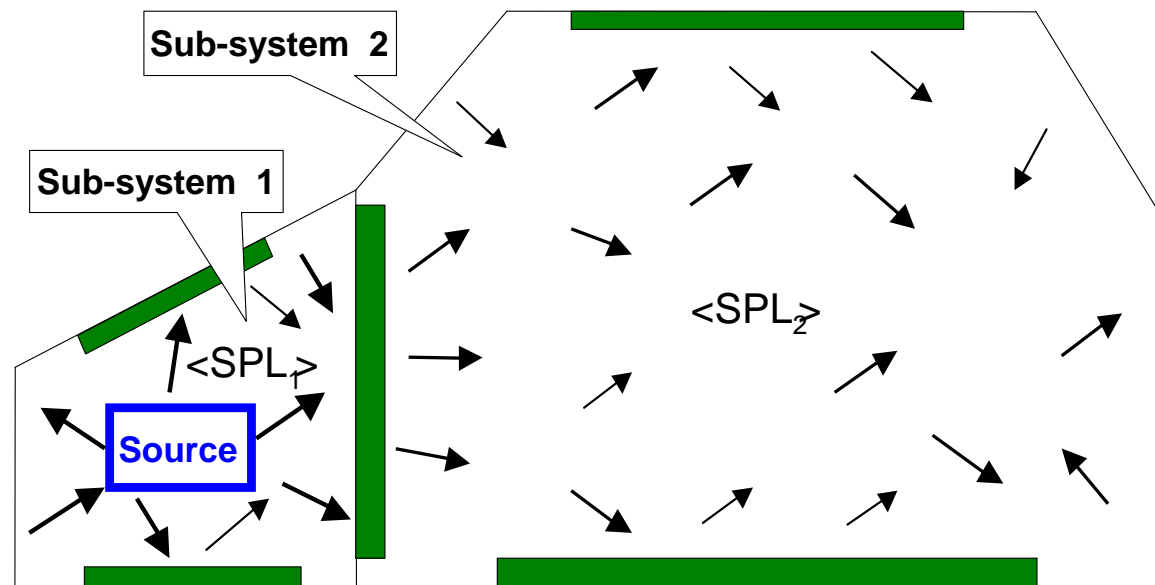


No influence of the stiffness of the compressed felt

Patent 2007 / 2011



Strong influence of the stiffness of the compressed felt



$$NR_{dB} = SPL_1 - SPL_2$$

$$A = \sum_i \alpha_i \cdot S_i$$

NR: Noise reduction

TL: Transmission Loss

A: Absorption area

α : Absorption coefficient

S: Area

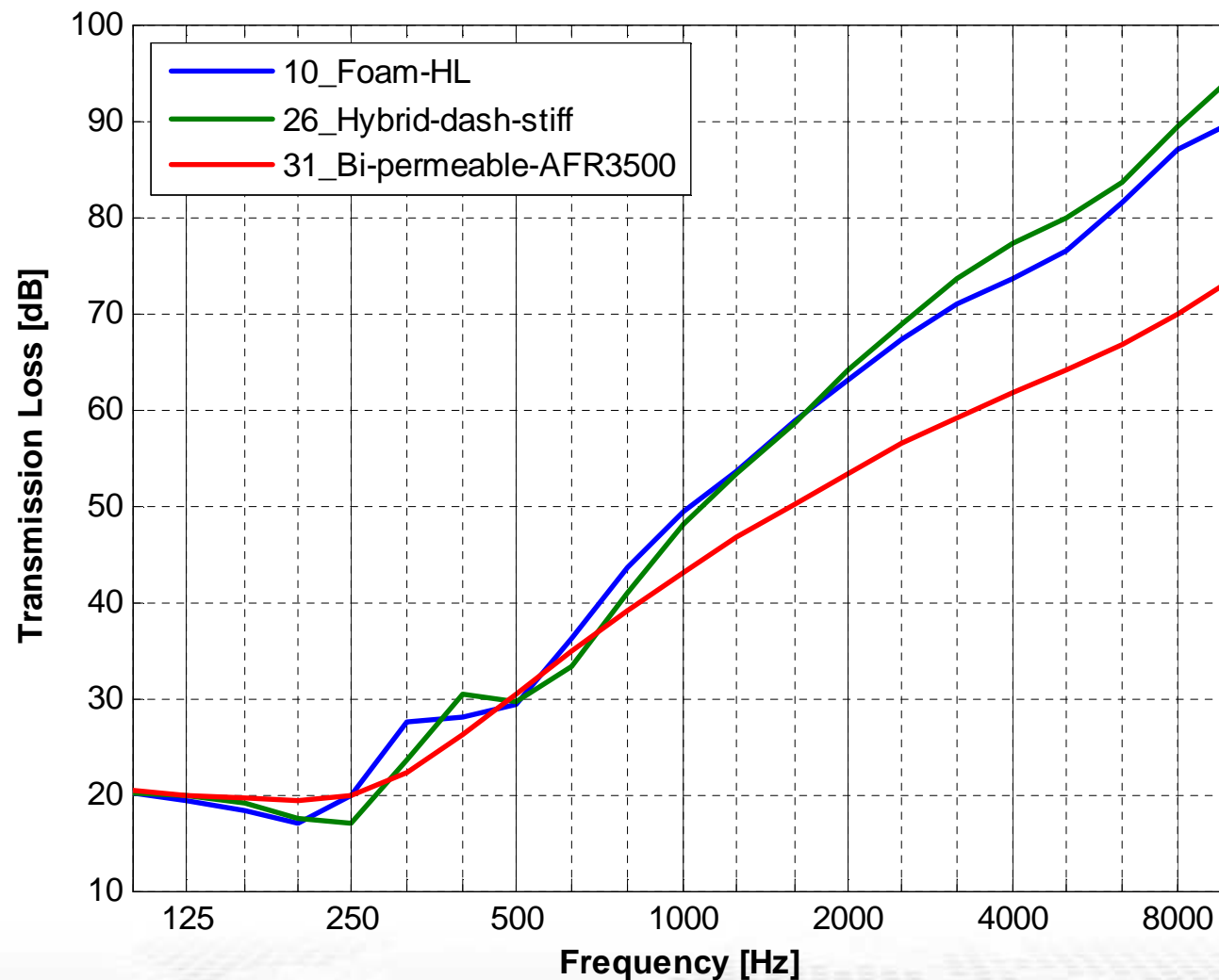
SPL: Sound Pressure Level

The aim is to minimize the Sound Pressure Level SPL_2 in the passenger compartment; consequently the Noise Reduction NR must be maximized.

$$NR_{(dB)} = TL - 10 \log \left(\frac{S}{A} \right)$$

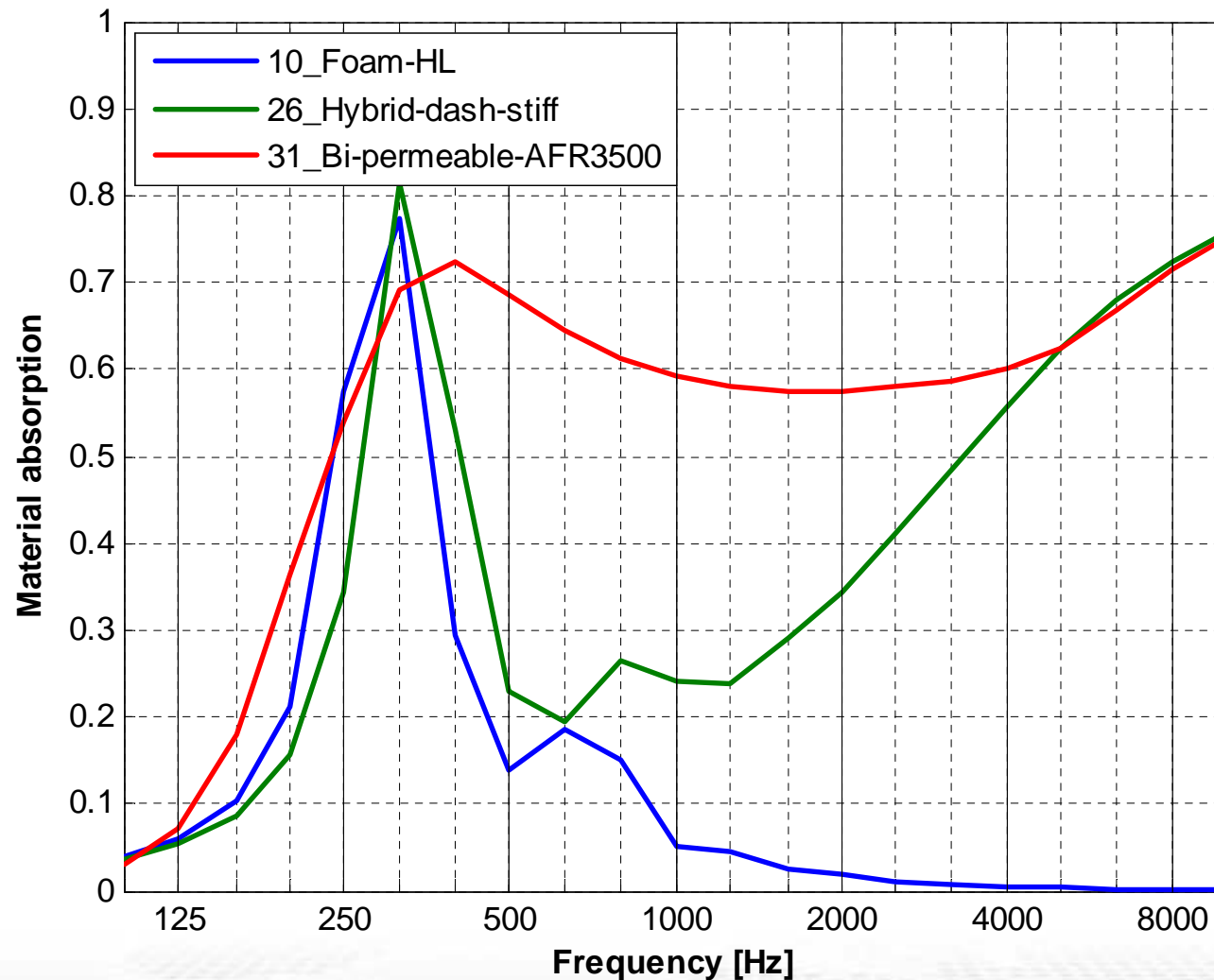
→ We need both, *insulation* and *absorption*.

Transmission Loss (diffuse field): New Hybrid-Stiff Concept



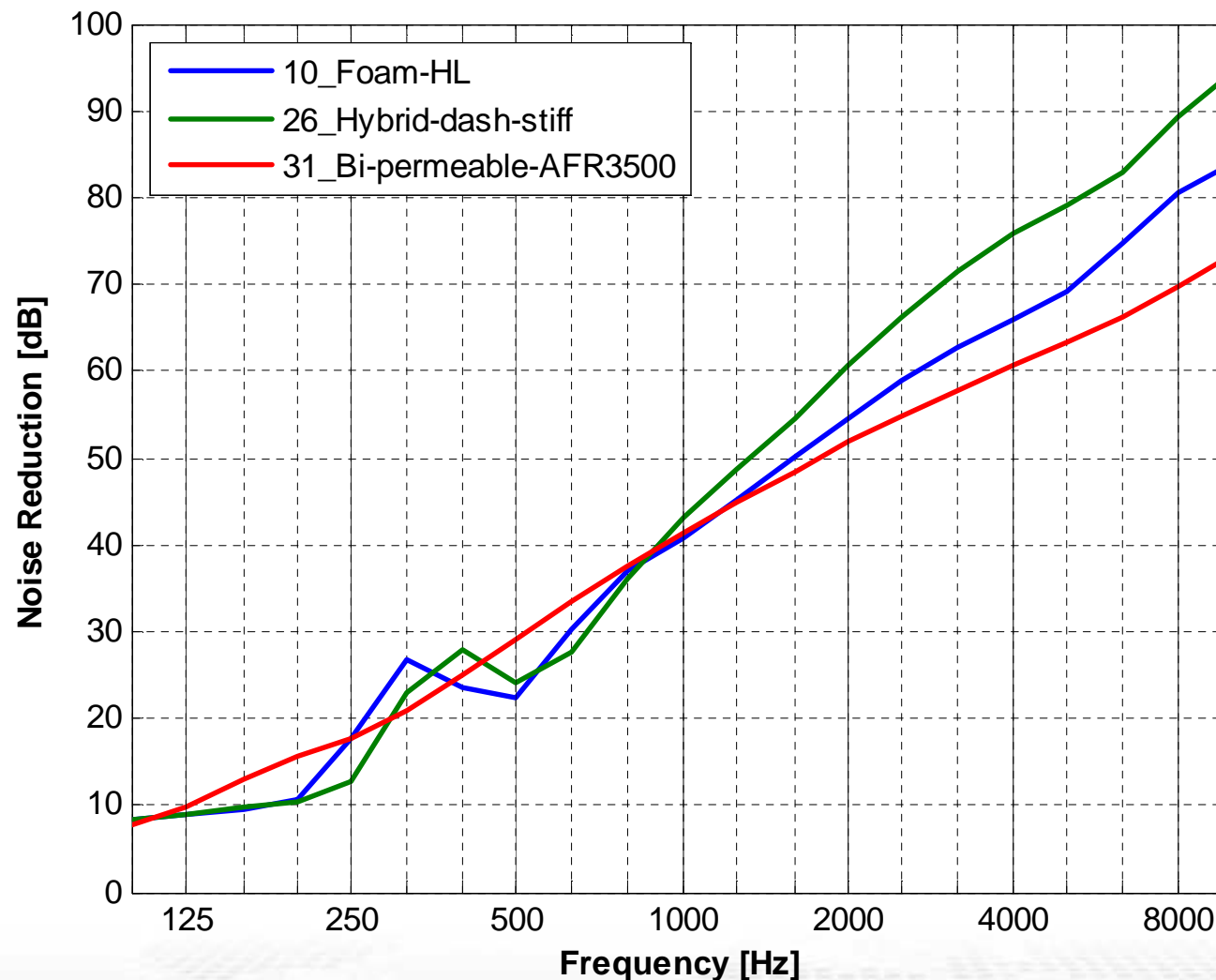
The airtight intermediate layer foam/felt of the Hybrid Stiff Concept captures the mass insulation performance of the stiff compressed felt (not the case for the classical bi-permeable concept even with high AFR)

Absorption Coefficient (diffuse field): New Hybrid-Stiff Concept



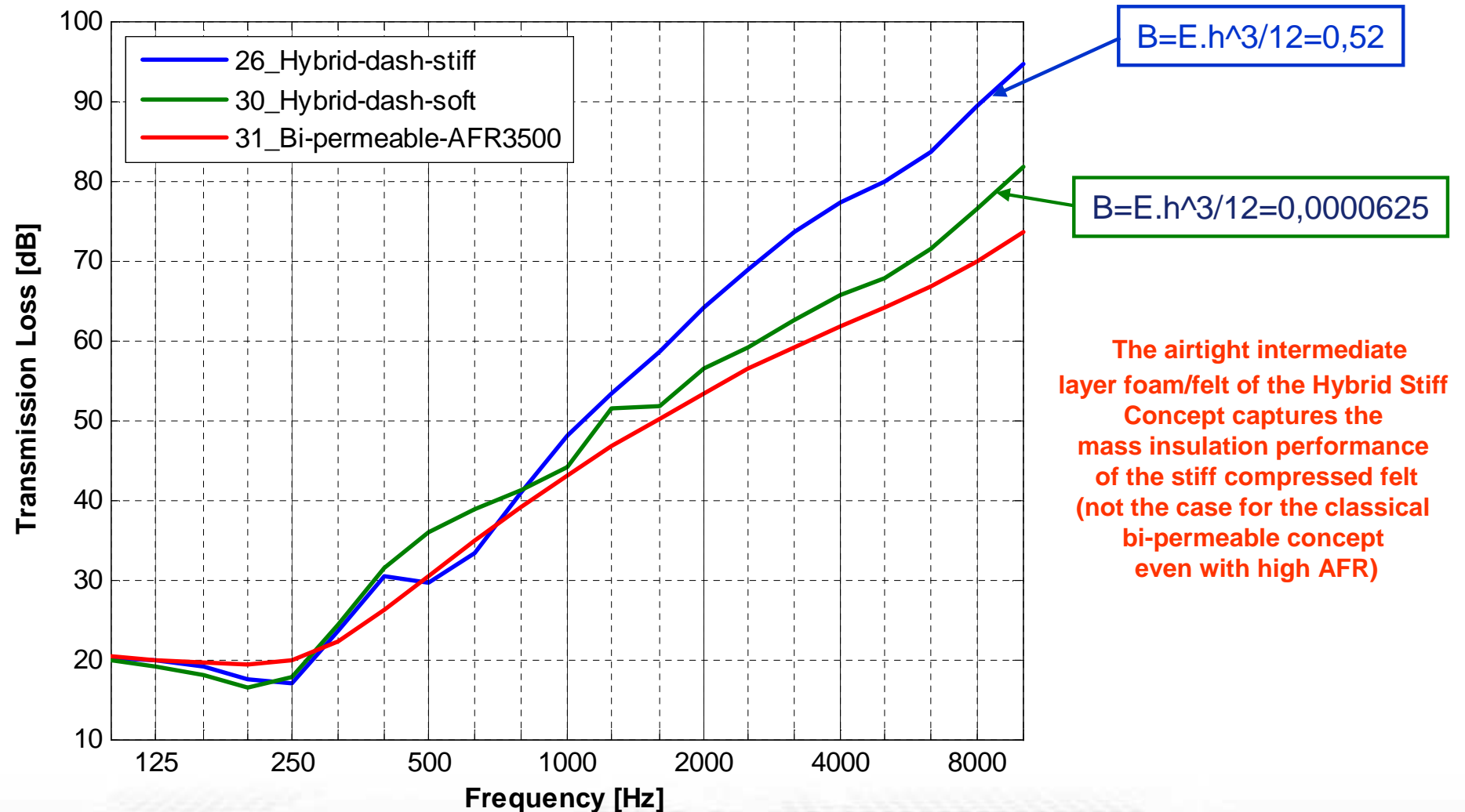
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Noise Reduction (dB): New Hybrid-Stiff Concept

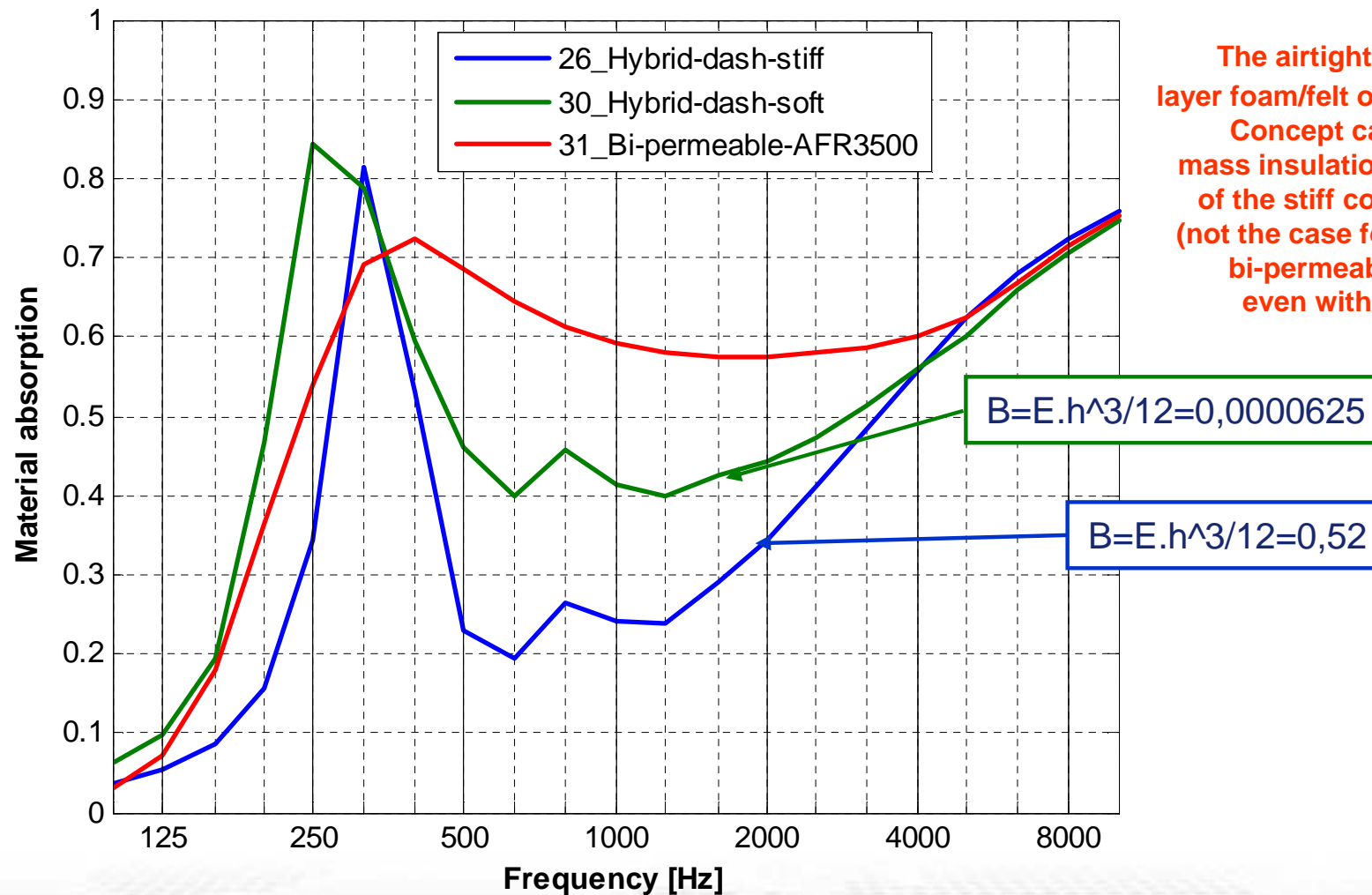


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Transmission Loss (diffuse field): New Hybrid-Stiff Concept



Absorption Coefficient (diffuse field): New Hybrid-Stiff Concept

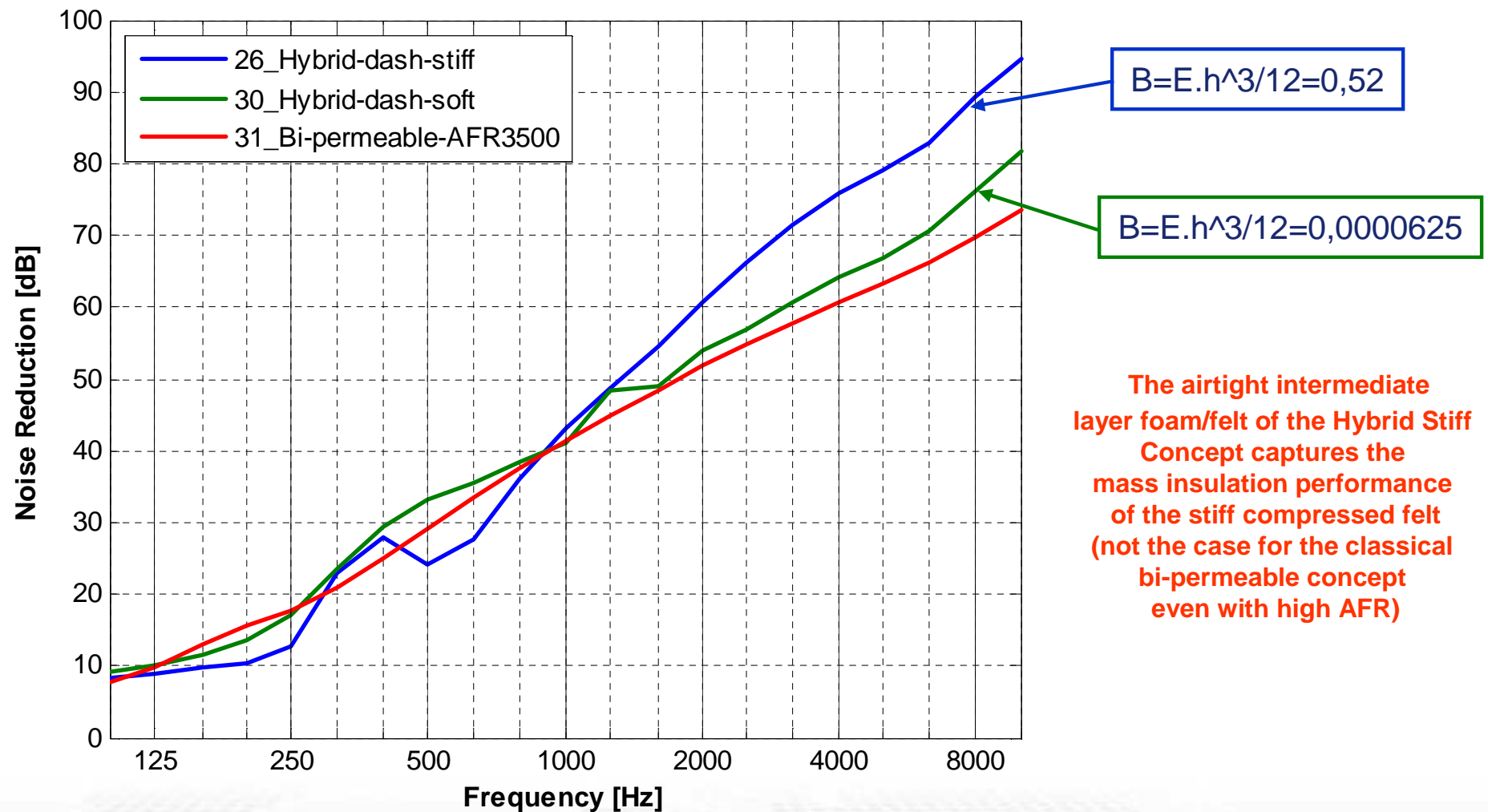


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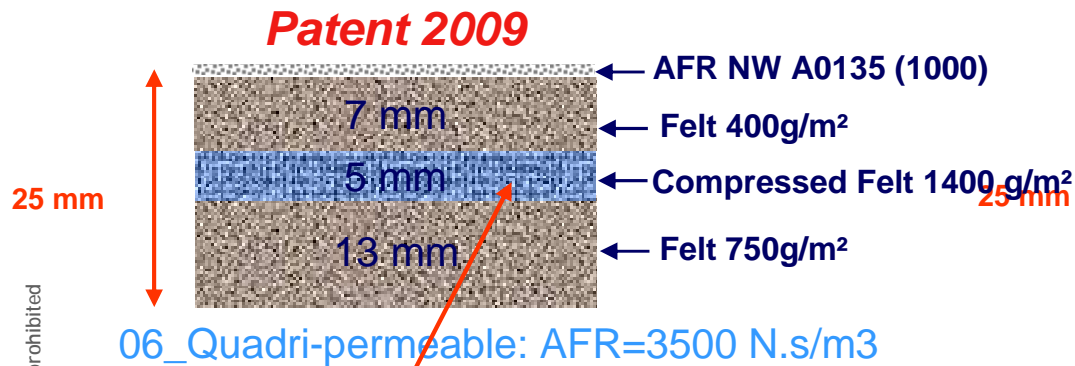
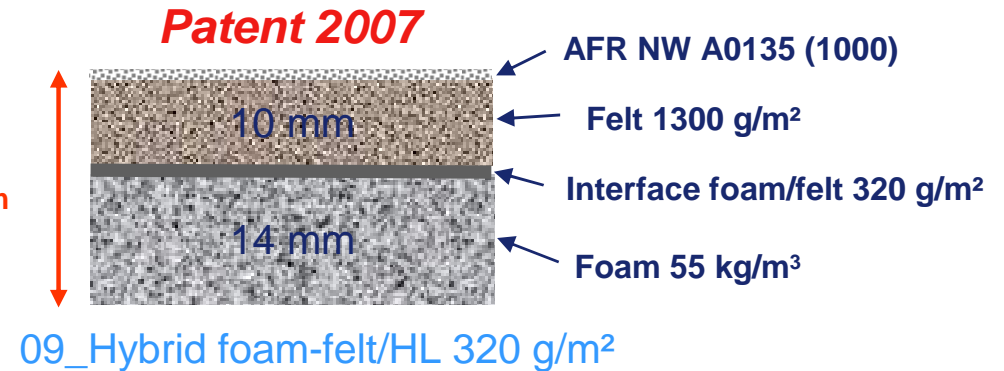
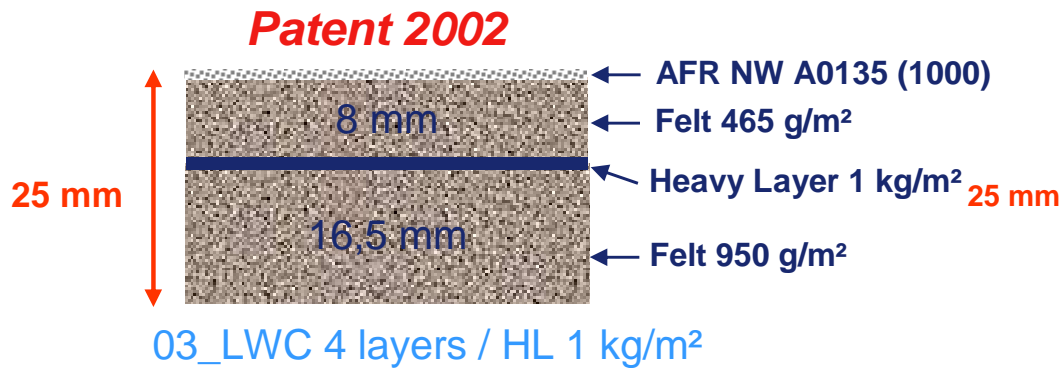
$B = E \cdot h^3 / 12 = 0,0000625$

$B = E \cdot h^3 / 12 = 0,52$

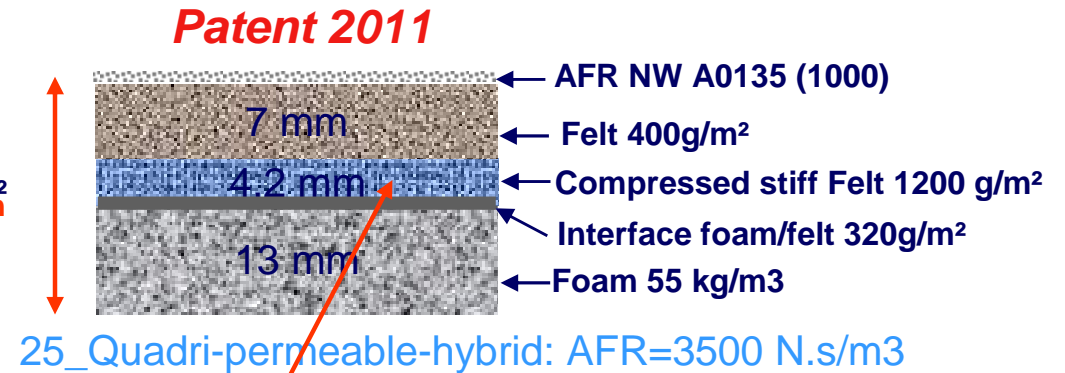
Noise Reduction (dB): New Hybrid-Stiff Concept



New Quadri-permeable-hybrid Concept: simulated configs.



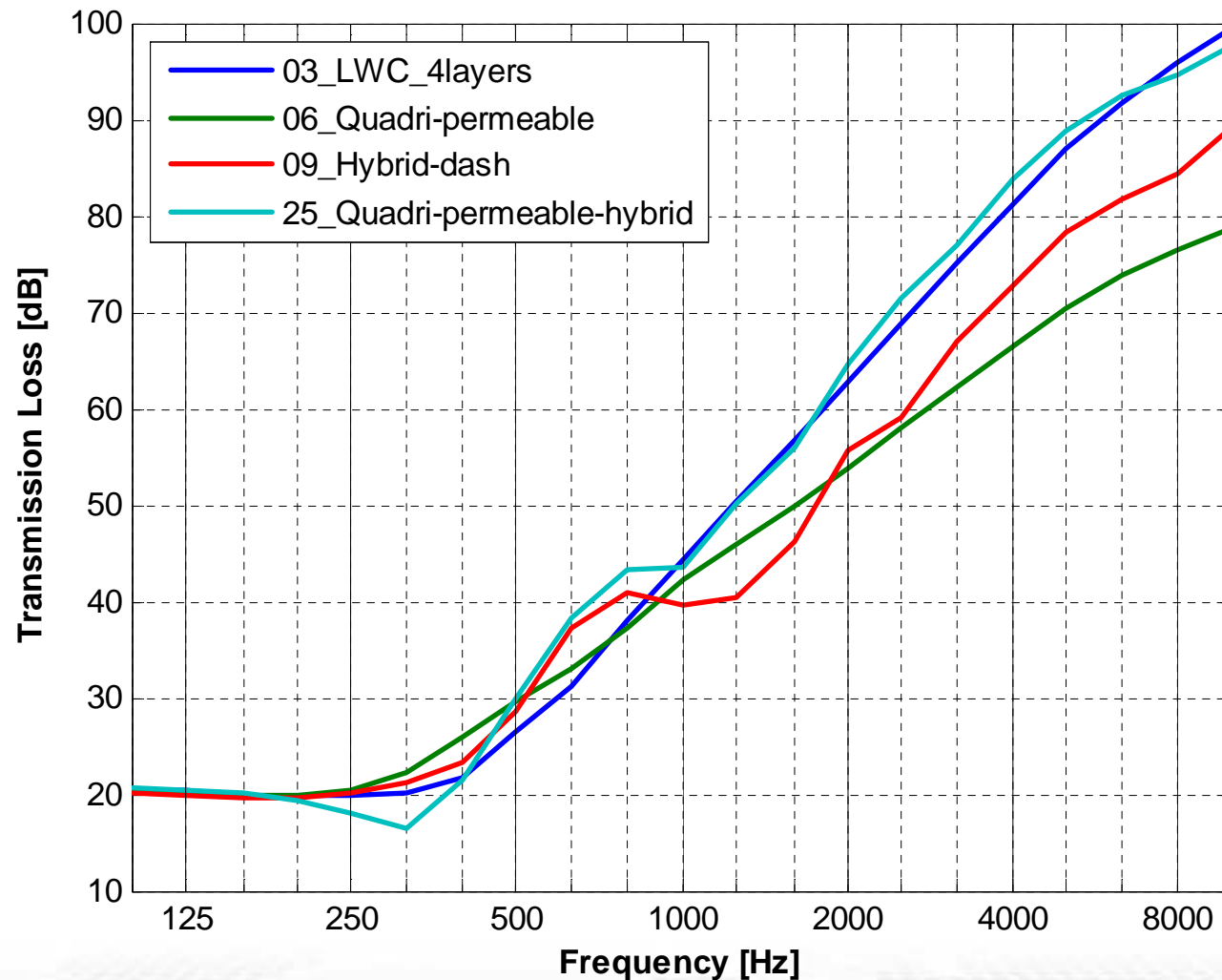
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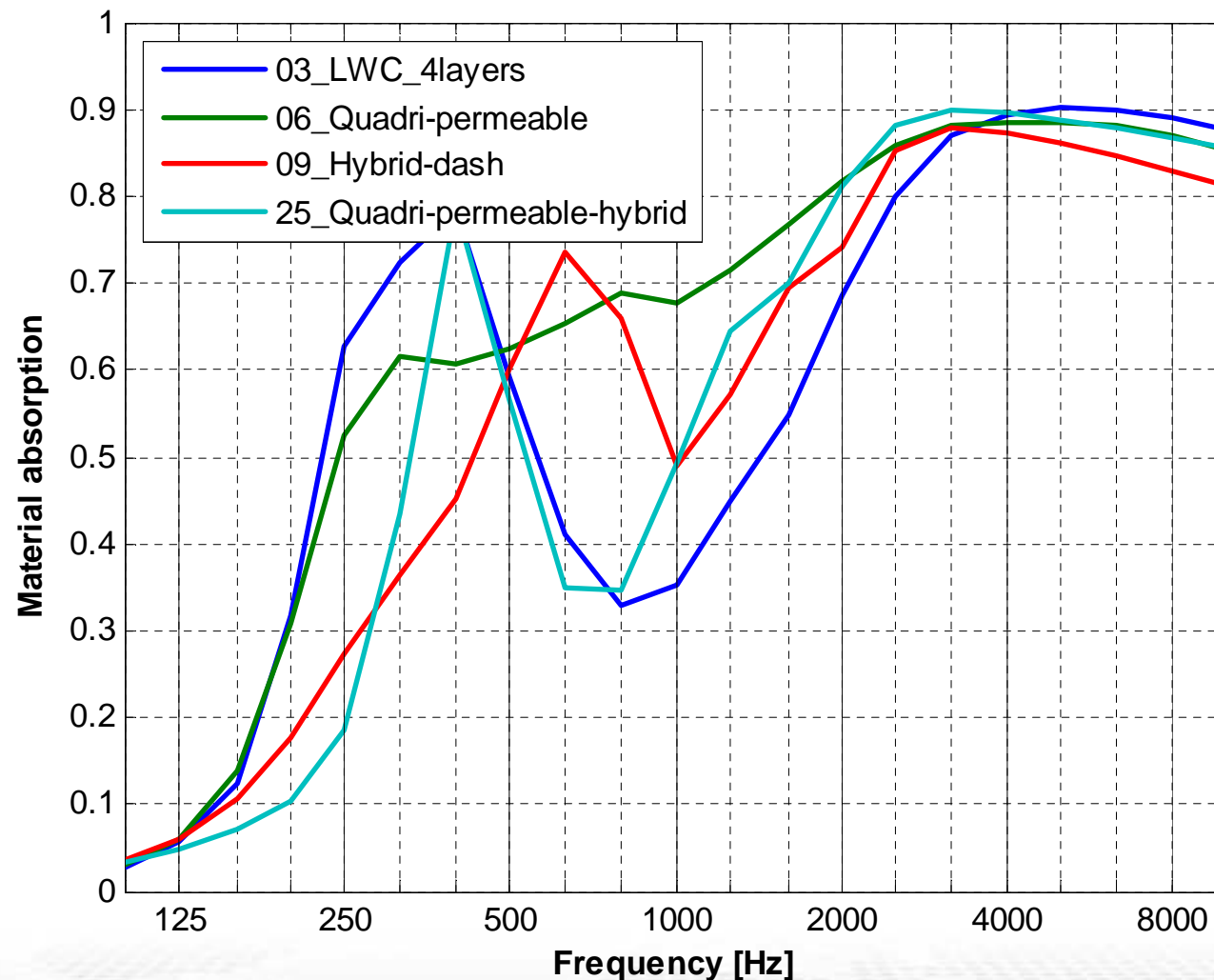
$$B = E \cdot h^3 / 12 = 0,52$$

All lightweight solutions: 2500 g/m²

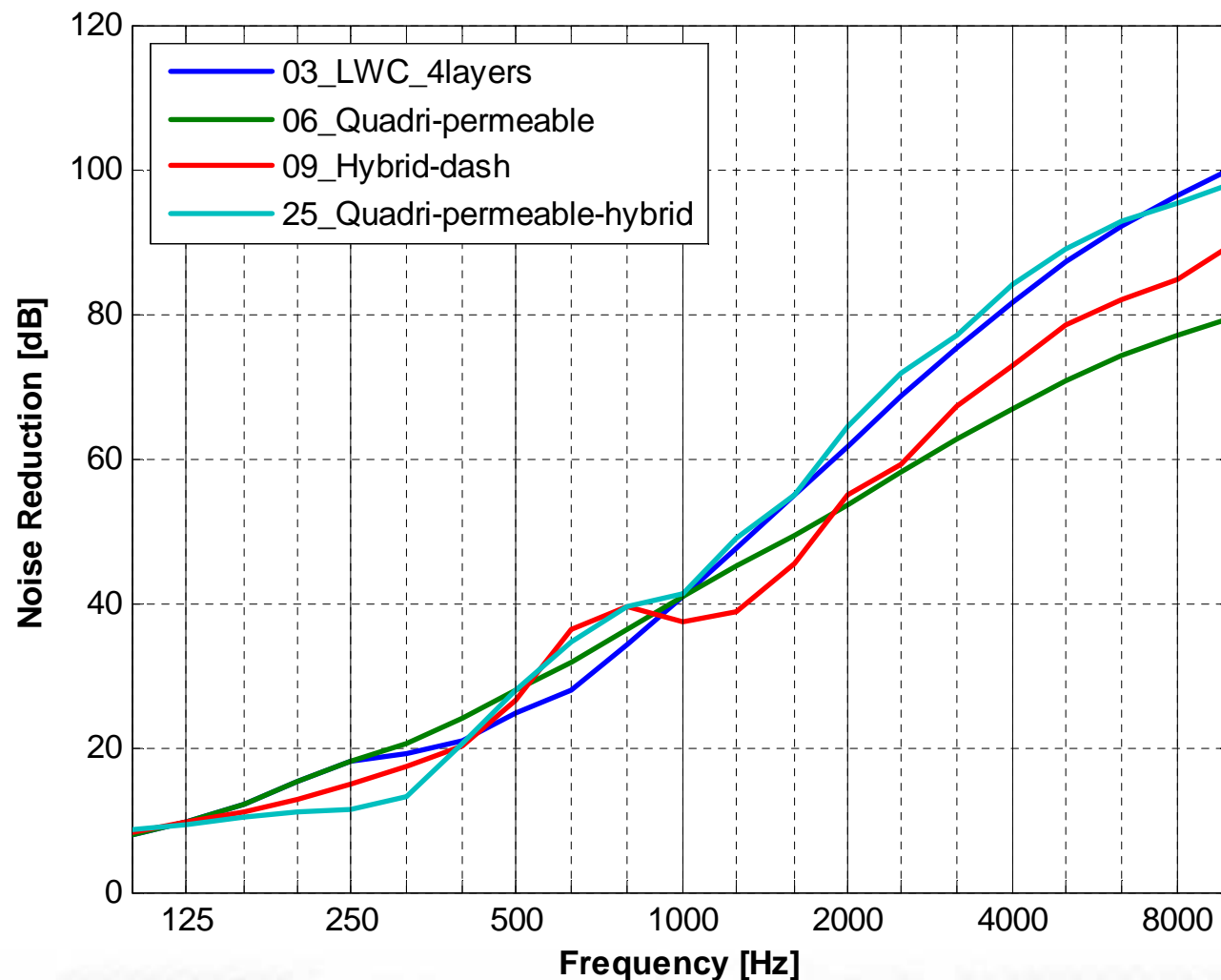
Transmission Loss (diffuse field): New Quadri-permeable-hybrid



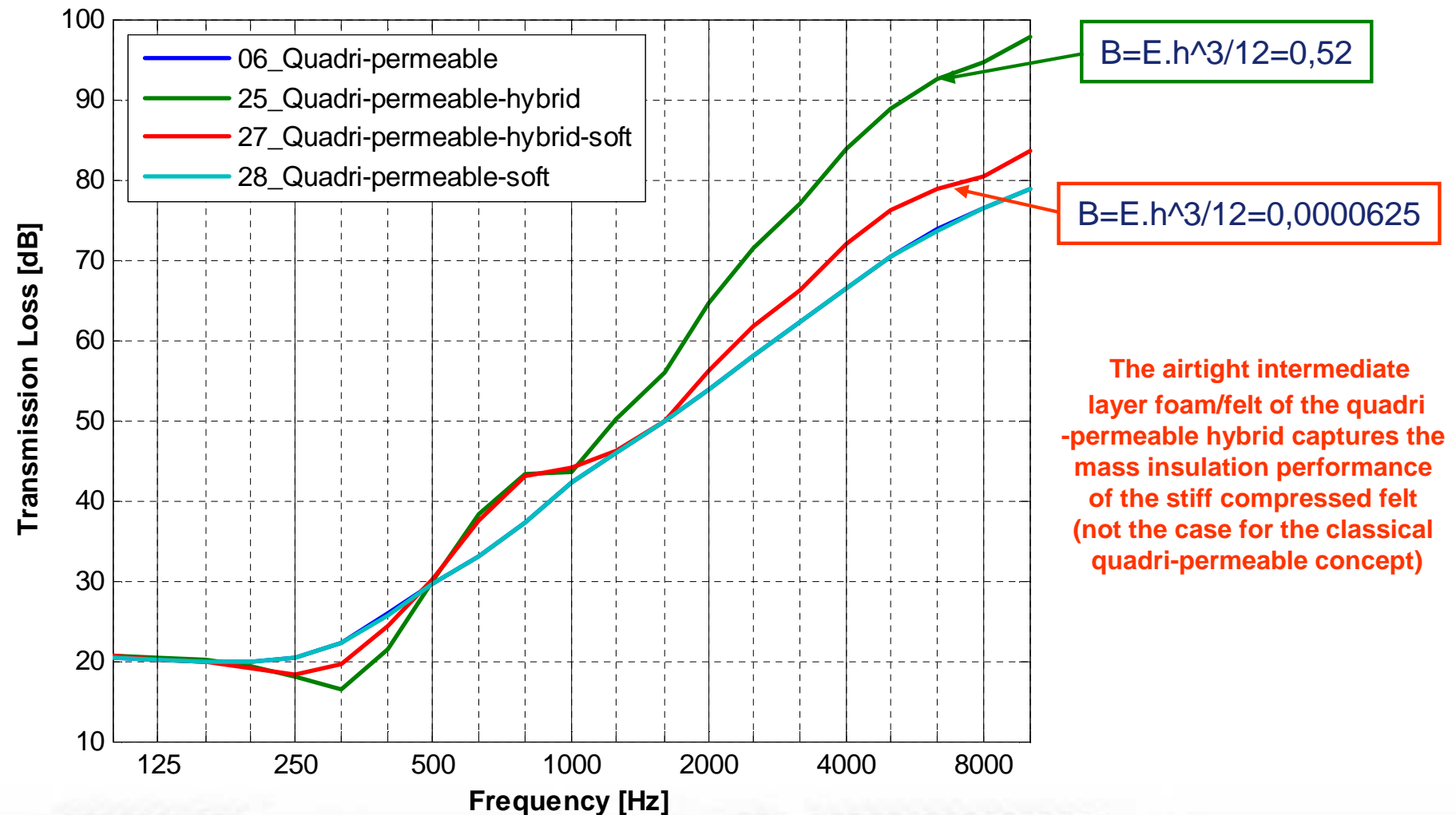
Absorption Coefficient (diffuse field): New Quadri-permeable-hybrid



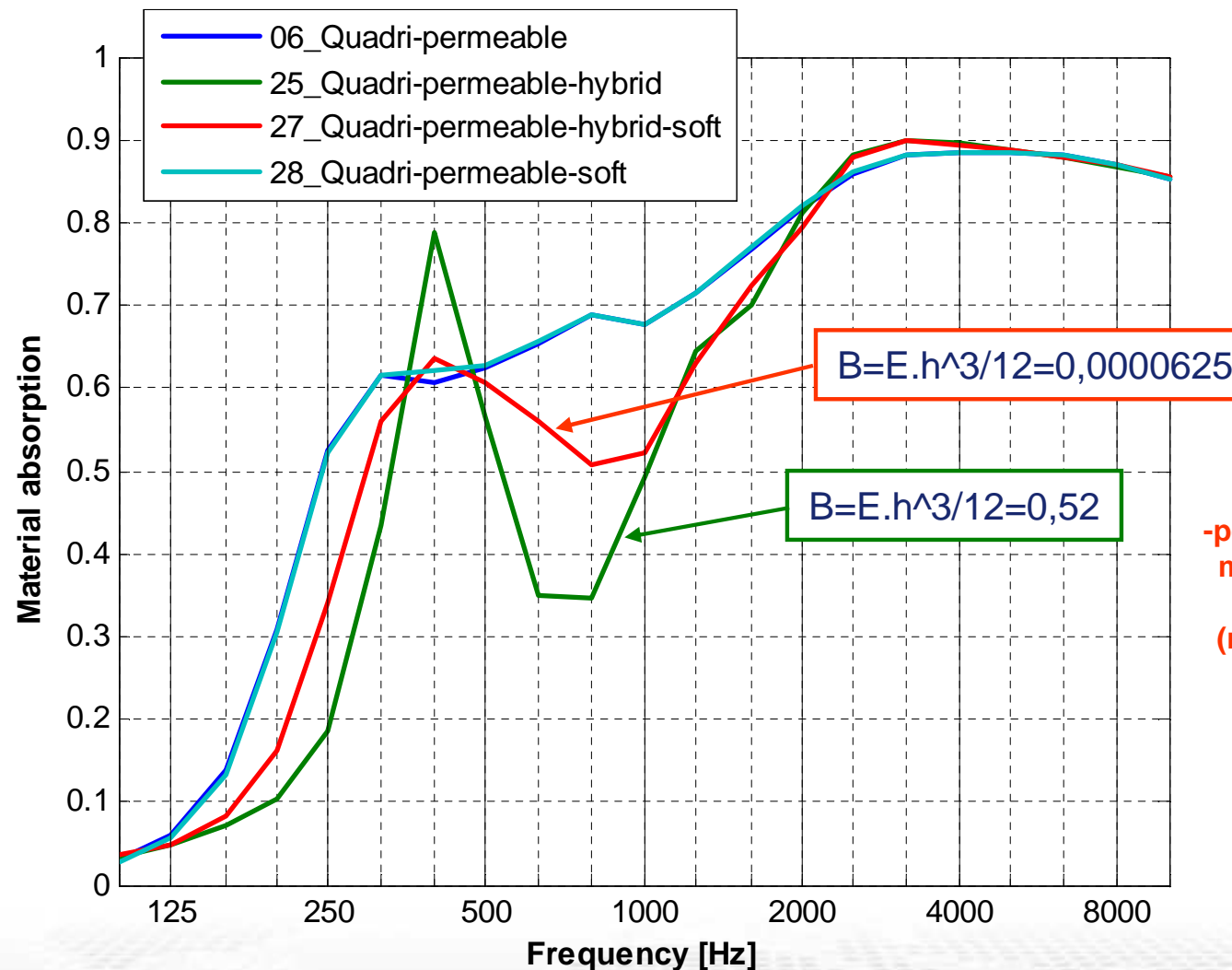
Noise Reduction (dB): New Quadri-permeable-hybrid



Transmission Loss (diffuse field): New Quadri-permeable-hybrid

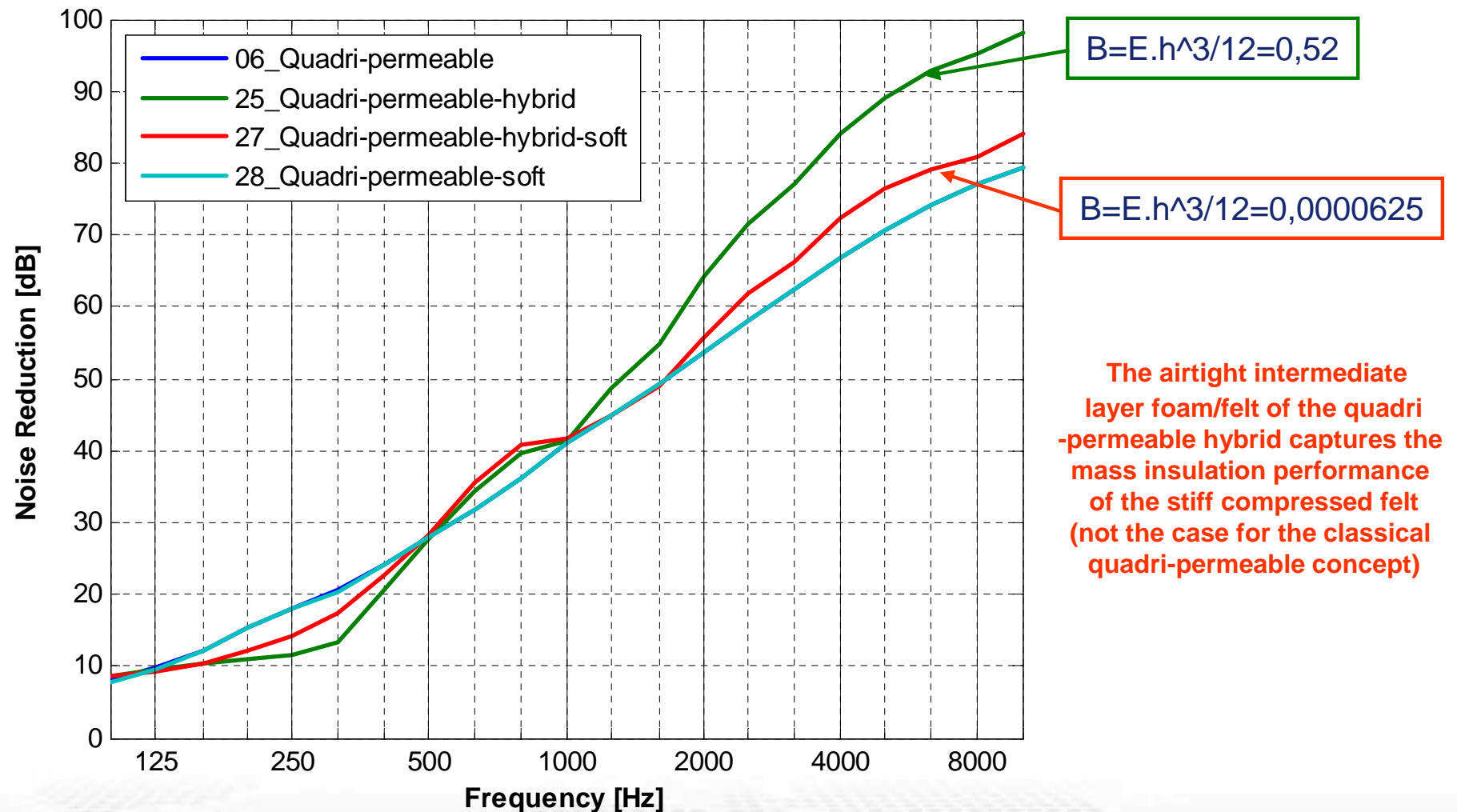


Absorption Coefficient (diffuse field): New Quadri-permeable-hybrid

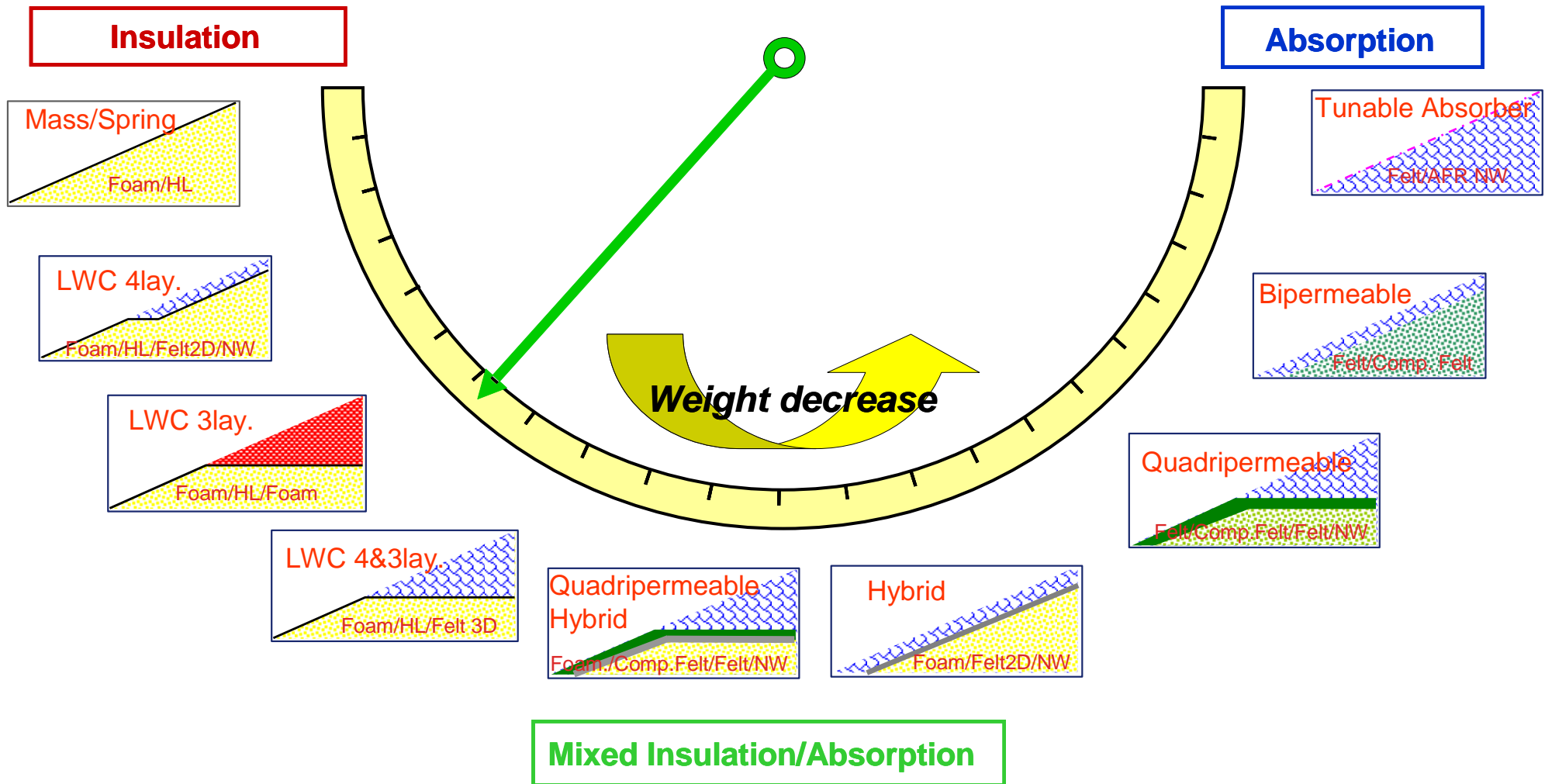


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Noise Reduction (dB): New Quadri-permeable-hybrid



New "green" light septum fiber technology Acoustic Galvanometer 3D




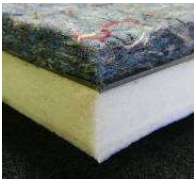


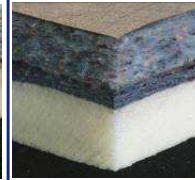


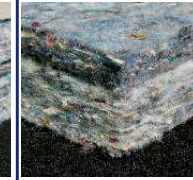
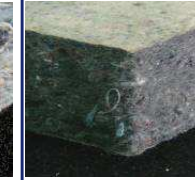
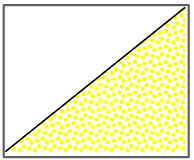
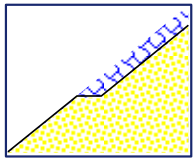
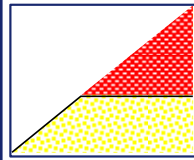
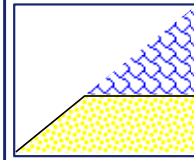
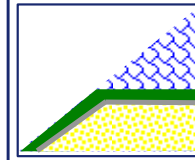
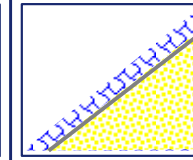
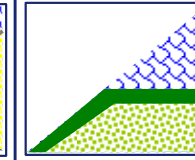
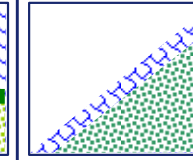
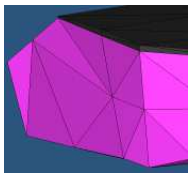
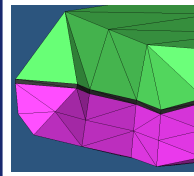
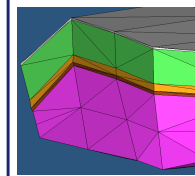
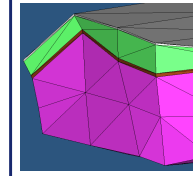
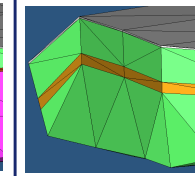
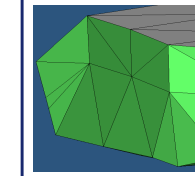
New "green" light septum fiber technology

Acoustic Galvanometer 3D

Insulation

Mixed Insulation/Absorption

Absorption

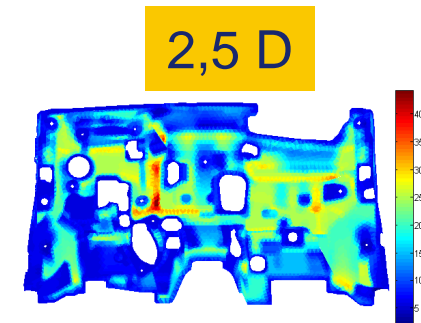
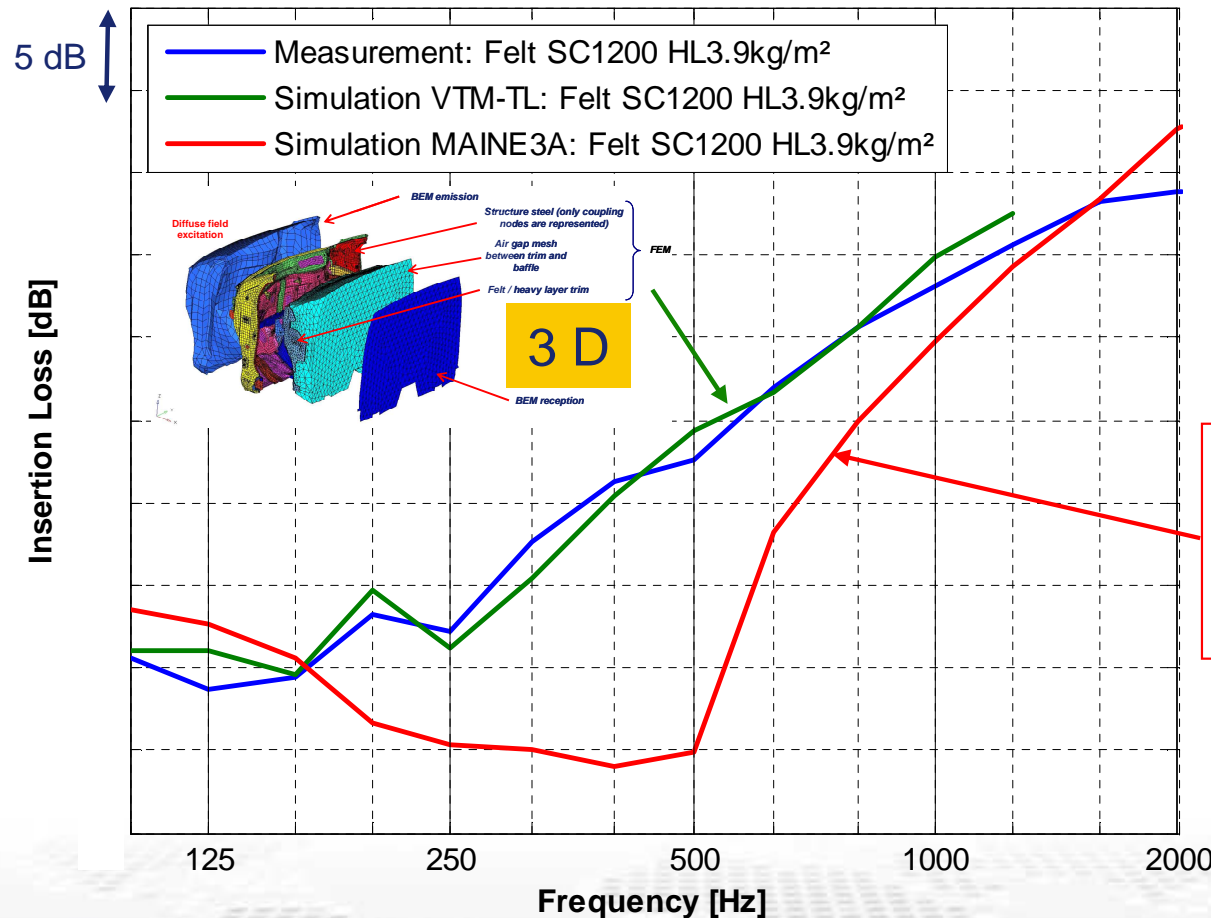
		Foam Heavy Layer	LWC Foam HL Felt 2D	LWC Foam HL Foam	LWC Foam HL Felt 3D	Quadri-permeable Hybrid	Hybrid	Quadri-permeable Felt	Bi-permeable	Tunable Absorber
Lab	2D Flat Samples									
	Simulations	FTMM 2.5D								
FEM 3D BEM 3D										
Measurements	Coupled Rooms	On-going activity								
	Roller Bench	On-going activity								

Trim FEM Transmission Loss Simulation

Dash insulator cut out module: TL

Low and middle frequency dash trim FEM Transmission Loss model: airborne noise

- Correlation Measurement / Simulation: Insertion Loss (dB)



Simulation with FTMM (Finite Transfert Matrix Method), according to the thickness 3D map of the dash insulator (based on CAD): 2,5 D

$$\tau S = \sum_i \tau_i S_i \quad TL = 10 \log \left(\frac{1}{\tau} \right)$$

- The advantage of this is new "green" light septum fiber technology is that one maintain the absorption properties of the compressed textile or felt, as if it were positioned on an heavy layer.
- If the impervious layer is not glued or missing, you lose the effect and goes back to a classical compressed textile or felt acoustic property (bi-permeable effect).
- This means that the bending stiffness, the mass per unit area are much more important here, than the airflow resistance (AFR) of the compressed felt or textile.

- On the contrary, both measurements and simulations show that the presence of a glued light impervious layer without the right bending stiffness for the compressed textile or felt leads to bad insulation properties like the bi-permeable concept.
- All these physical phenomena have been measured and easily reproduced using the classical Transfer Matrix Method for 2D or 2,5D simulations or using Poroelastic Finite Elements for 3D simulations.
- Other implementations and applications of this new "green" light septum fiber technology should be easily transposed to other transportation industries or to building industry.

Thank you for your attention...



Technical perfection, automotive passion

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