

Jonas Christensson

Komfortutvecklare



Innemiljön - påverkar människor

jonas.christensson@saint-gobain.com

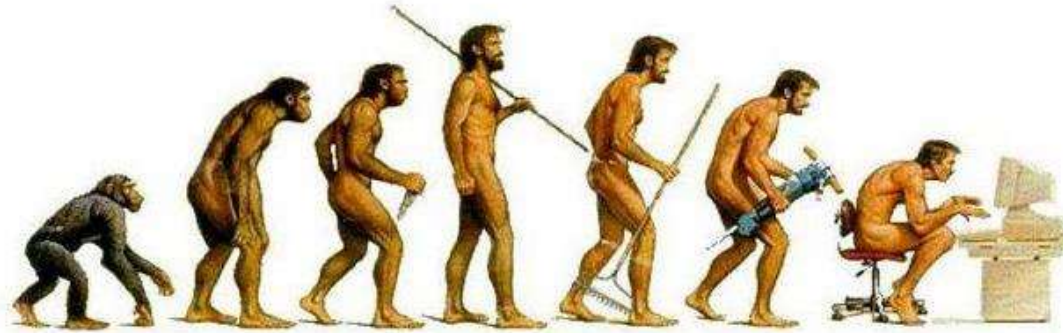
+46 701 45 83 39



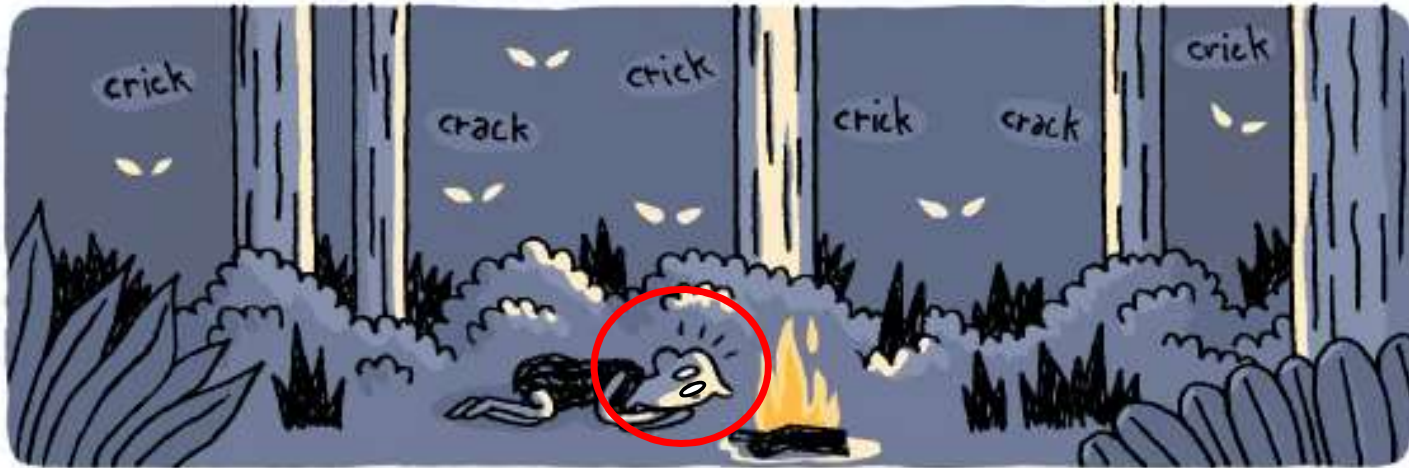


Våra sinnen är "gamla"





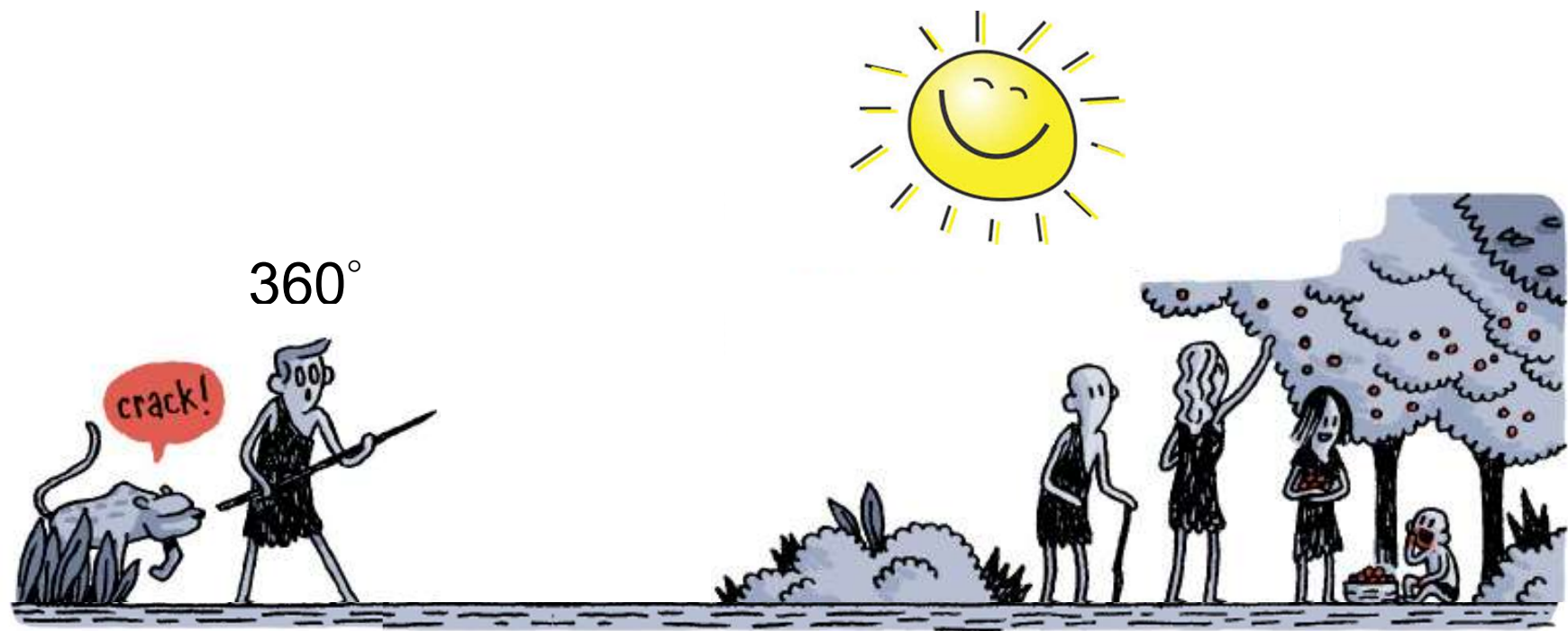
Sinnena har inte förändrats - Miljön

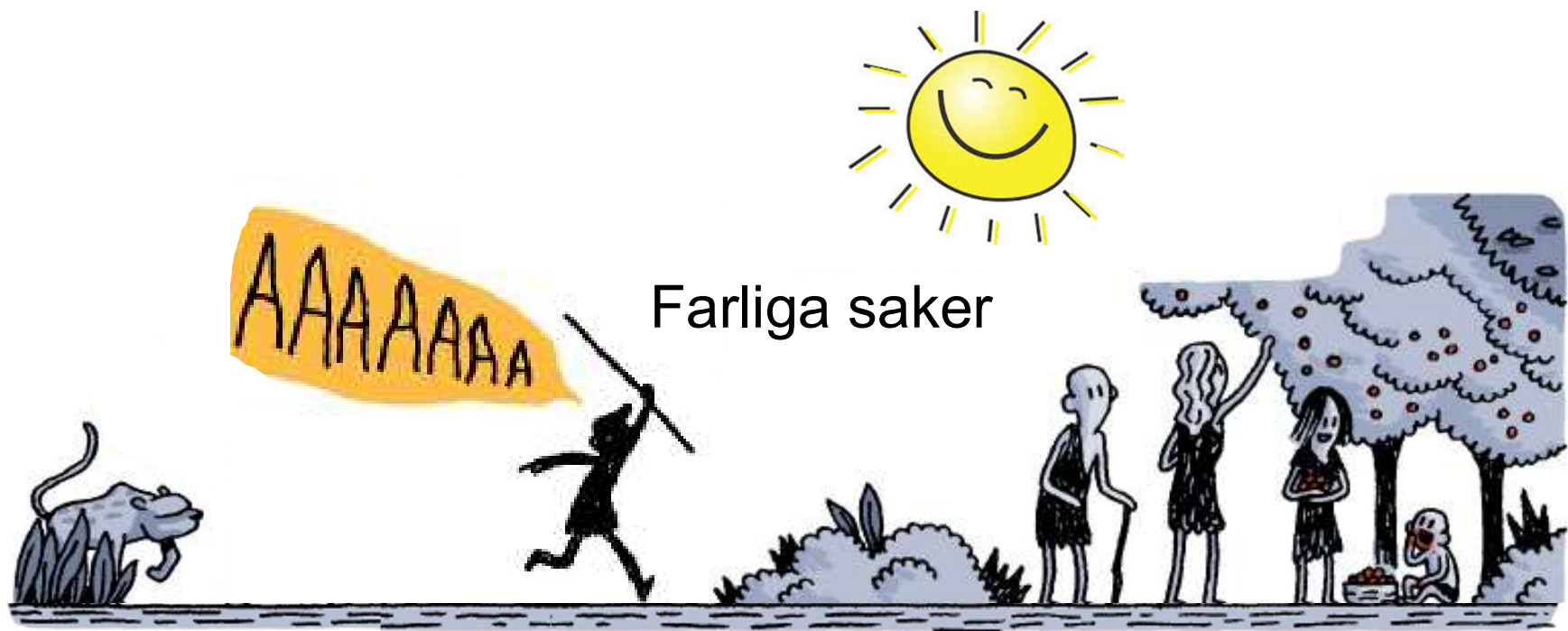


Hörseln "vaktar" när vi sover





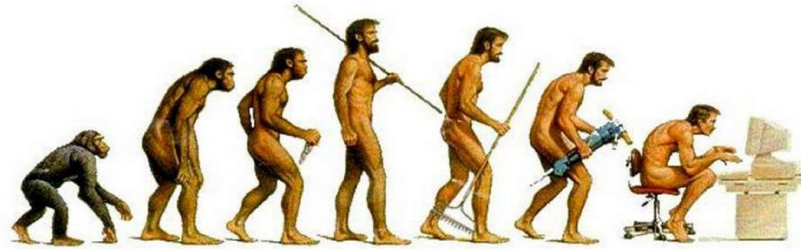




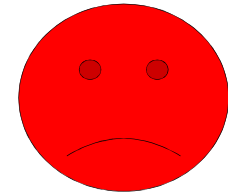




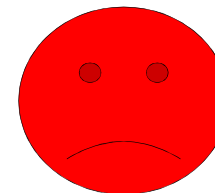
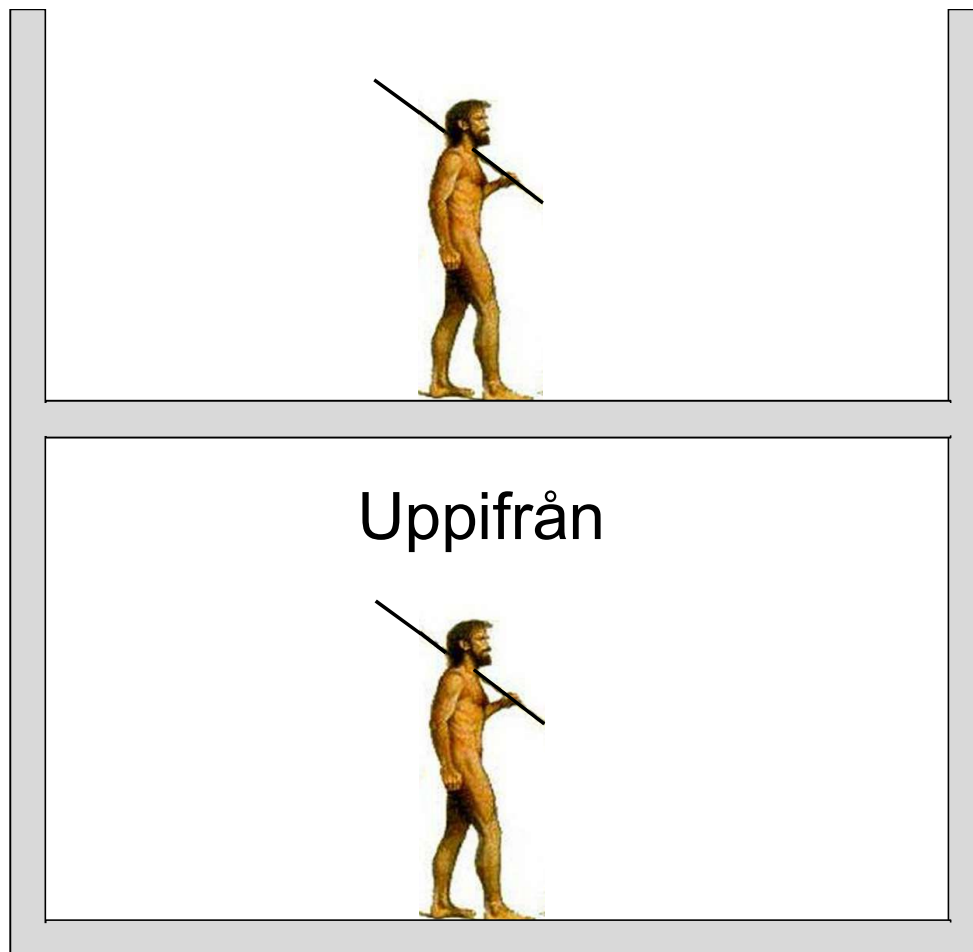




Rovdjur - Oväder



Lågfrekvent ljud



Lågfrekvent ljud

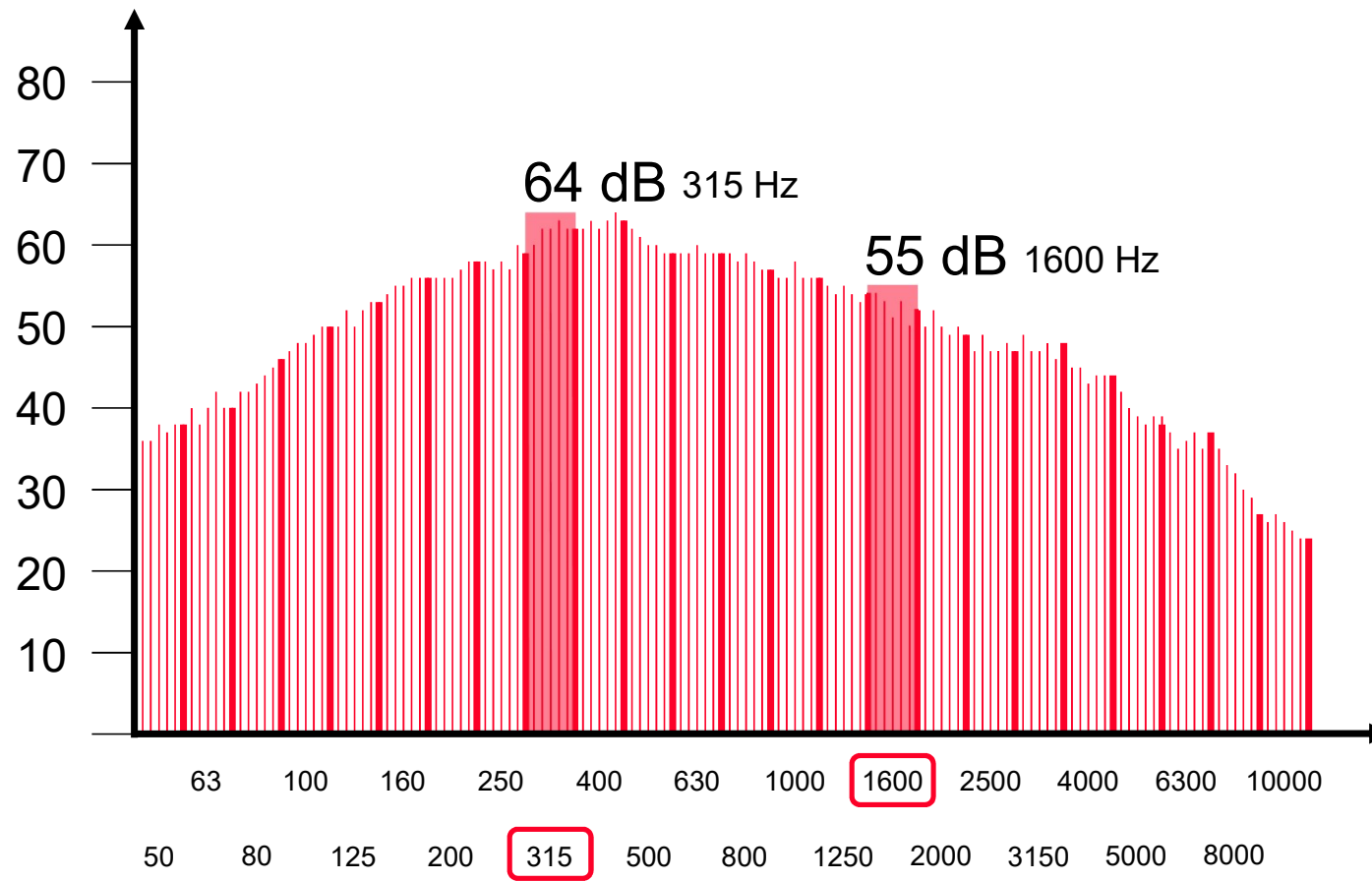
Ljudtrycksnivå

Tersband

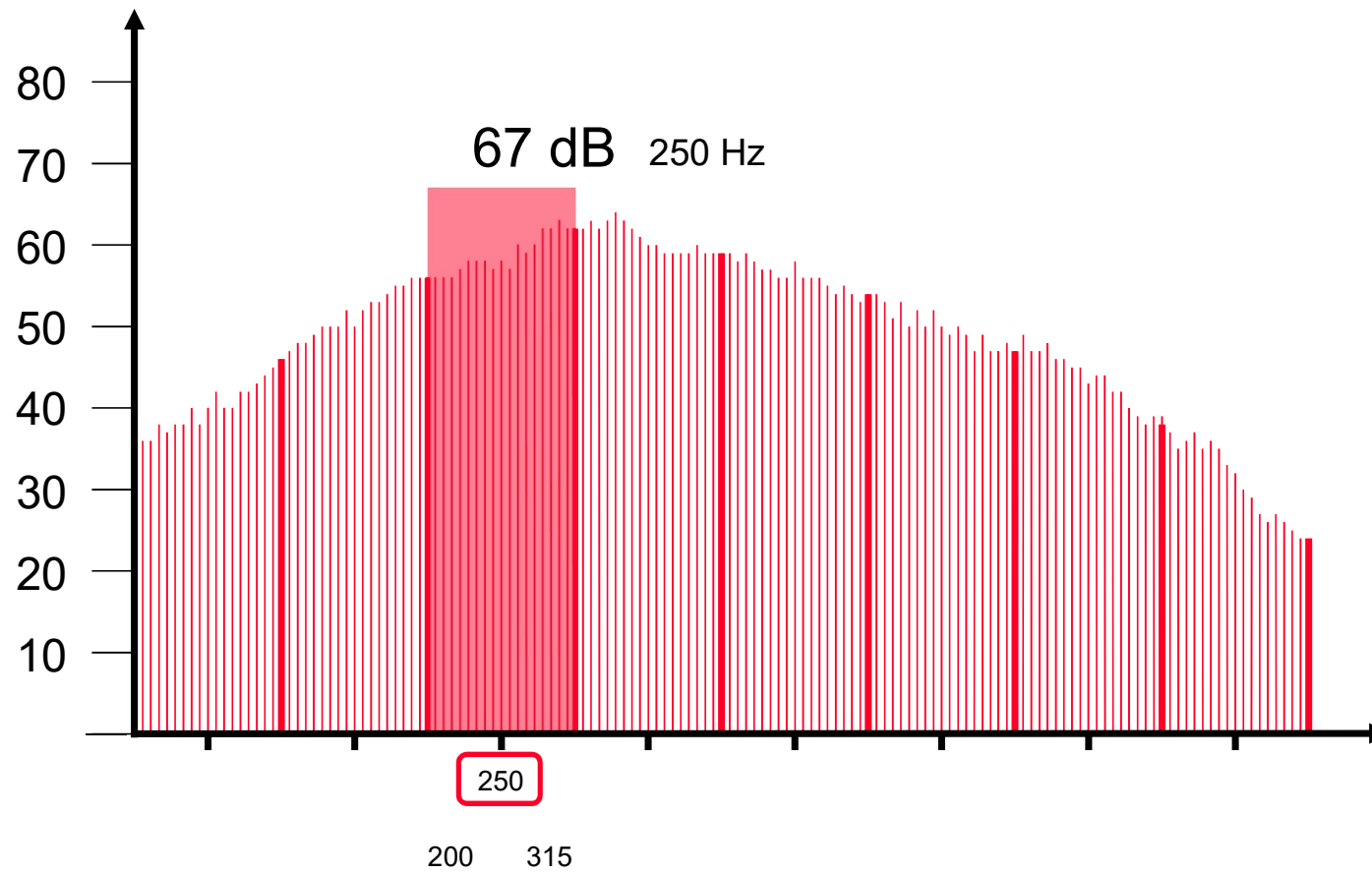
Oktavband

dBA dBC

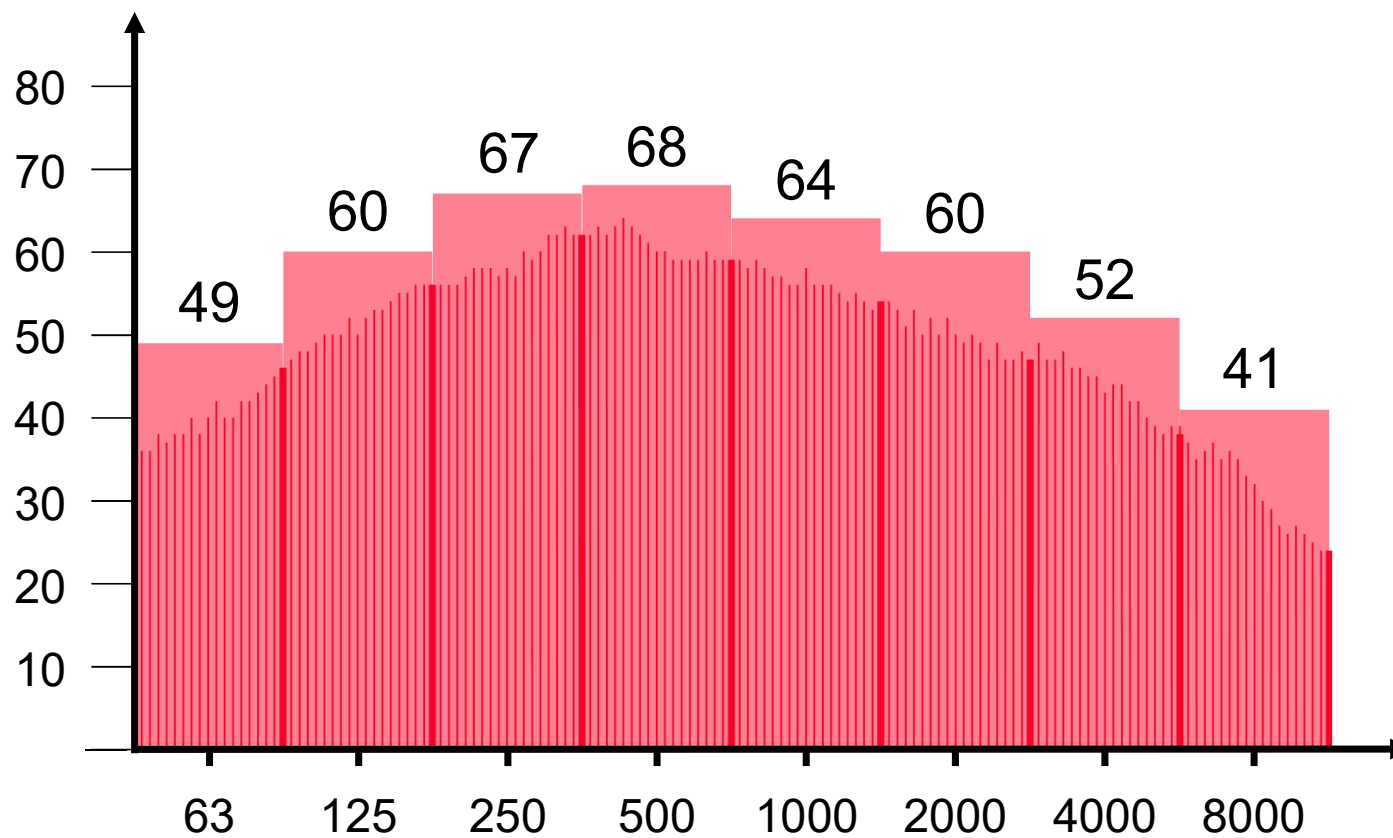
Tersband



Oktavband



Entalsvärde



Entalsvärde

49 60 67 68 64 60 52

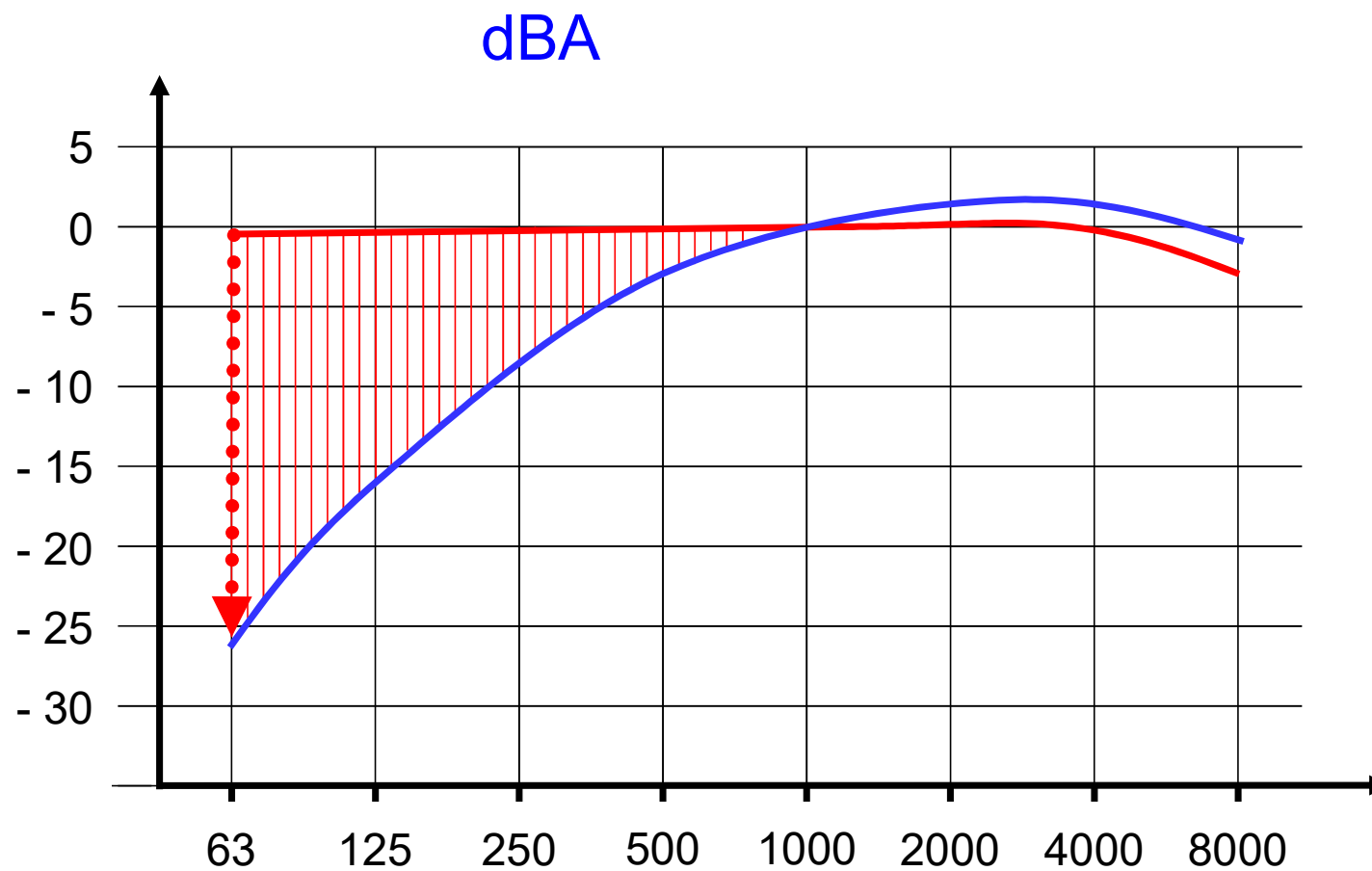
$$L_p = 10 \log \left(10^{(49/10)} + 10^{(60/10)} + 10^{(67/10)} + 10^{(68/10)} + 10^{(64/10)} + 10^{(60/10)} + 10^{(52/10)} \right)$$

$$L_p = 10 \log \left(10^{4,9} + 10^{6,0} + 10^{6,7} + 10^{6,8} + 10^{6,4} + 10^{6,0} + 10^{5,2} \right) = 72 \text{ dBZ}$$

Inget vägningsfilter

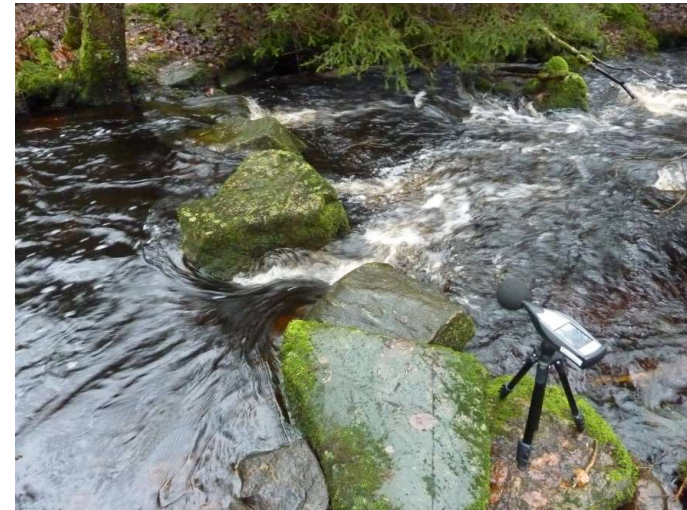
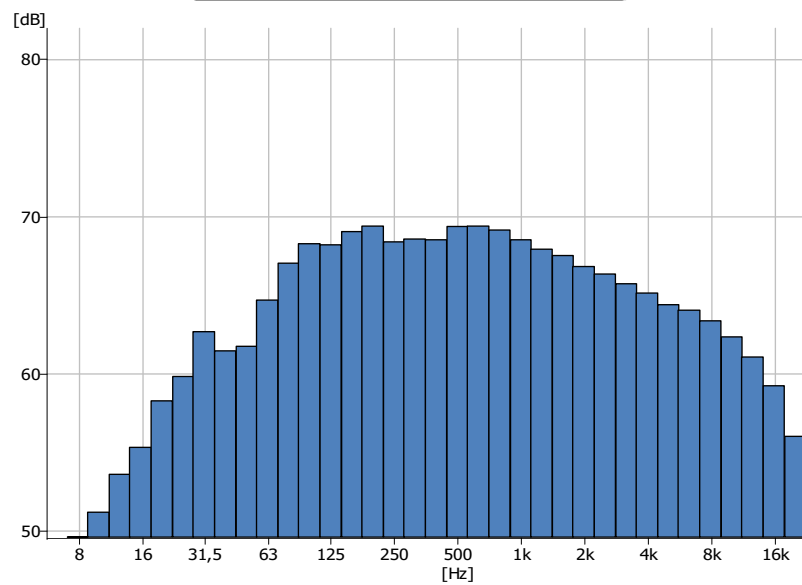
Zero

Vägningsfilter

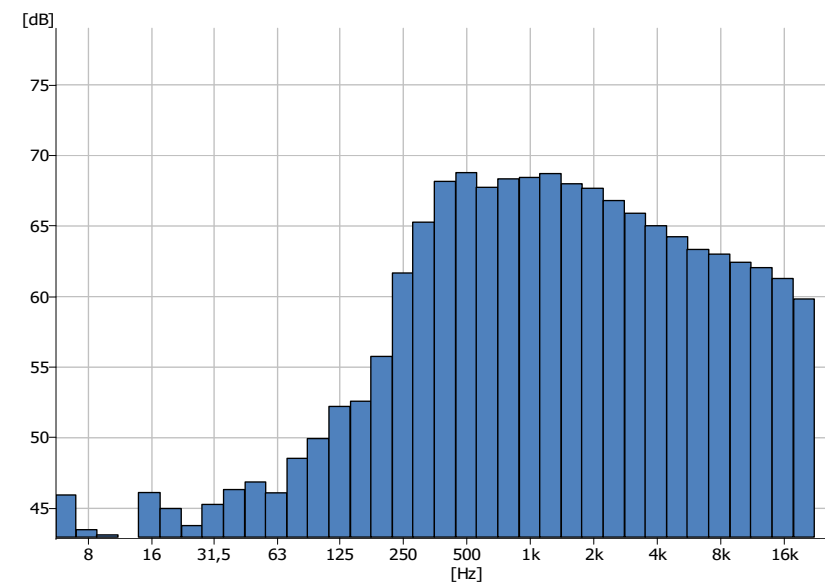




Vattenfall



Bäck

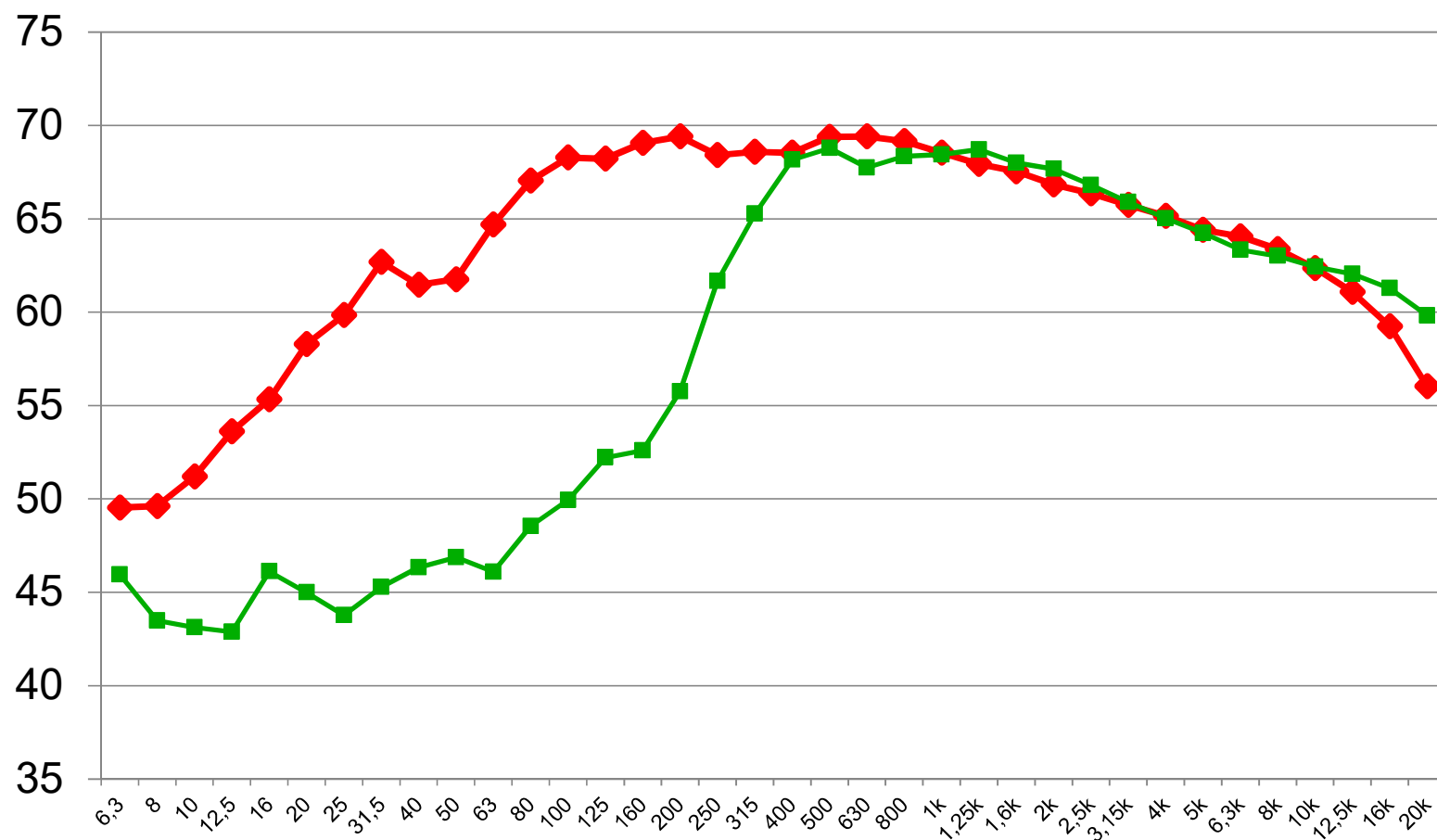


Vattenfall

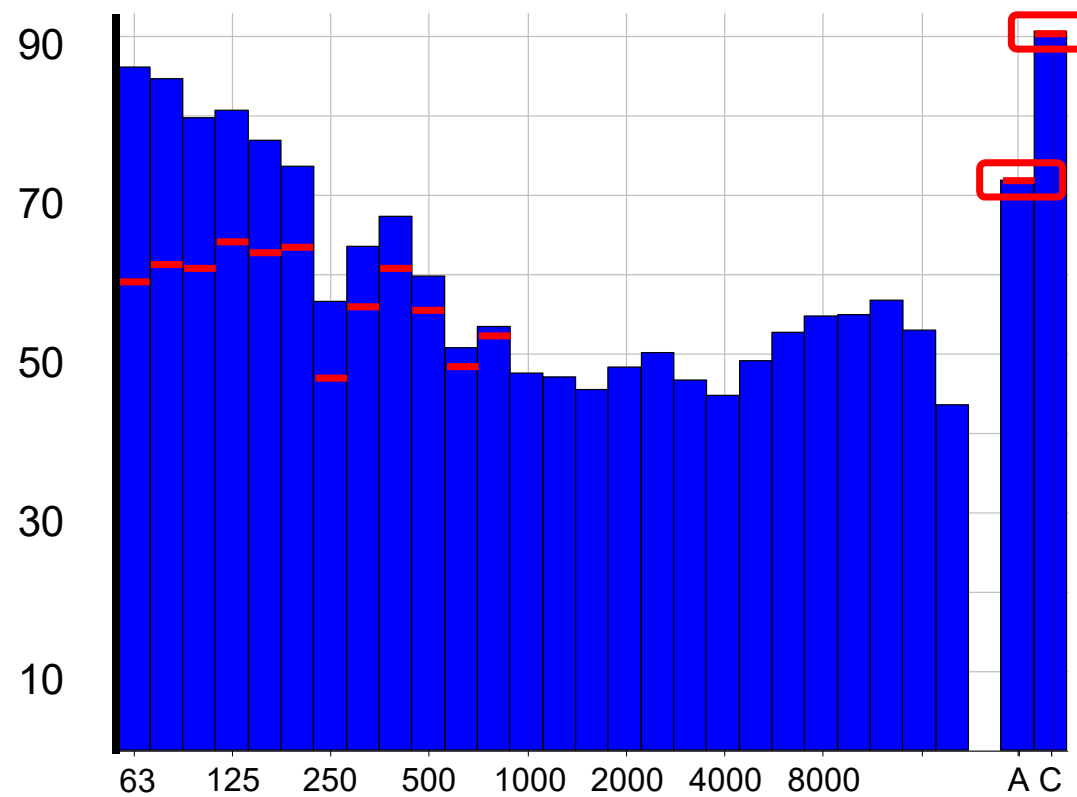
79 dBA

Bäck

79 dBA

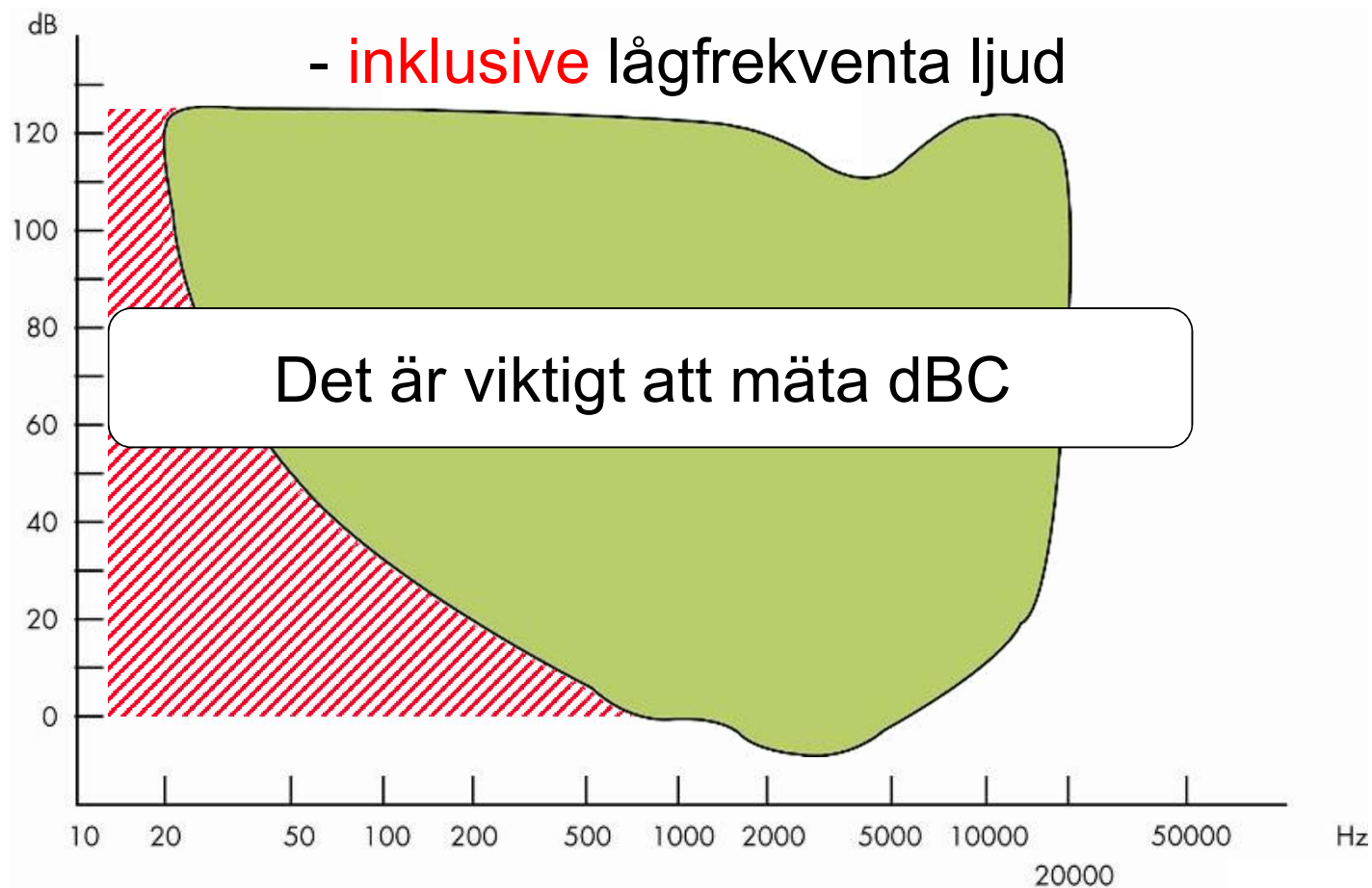


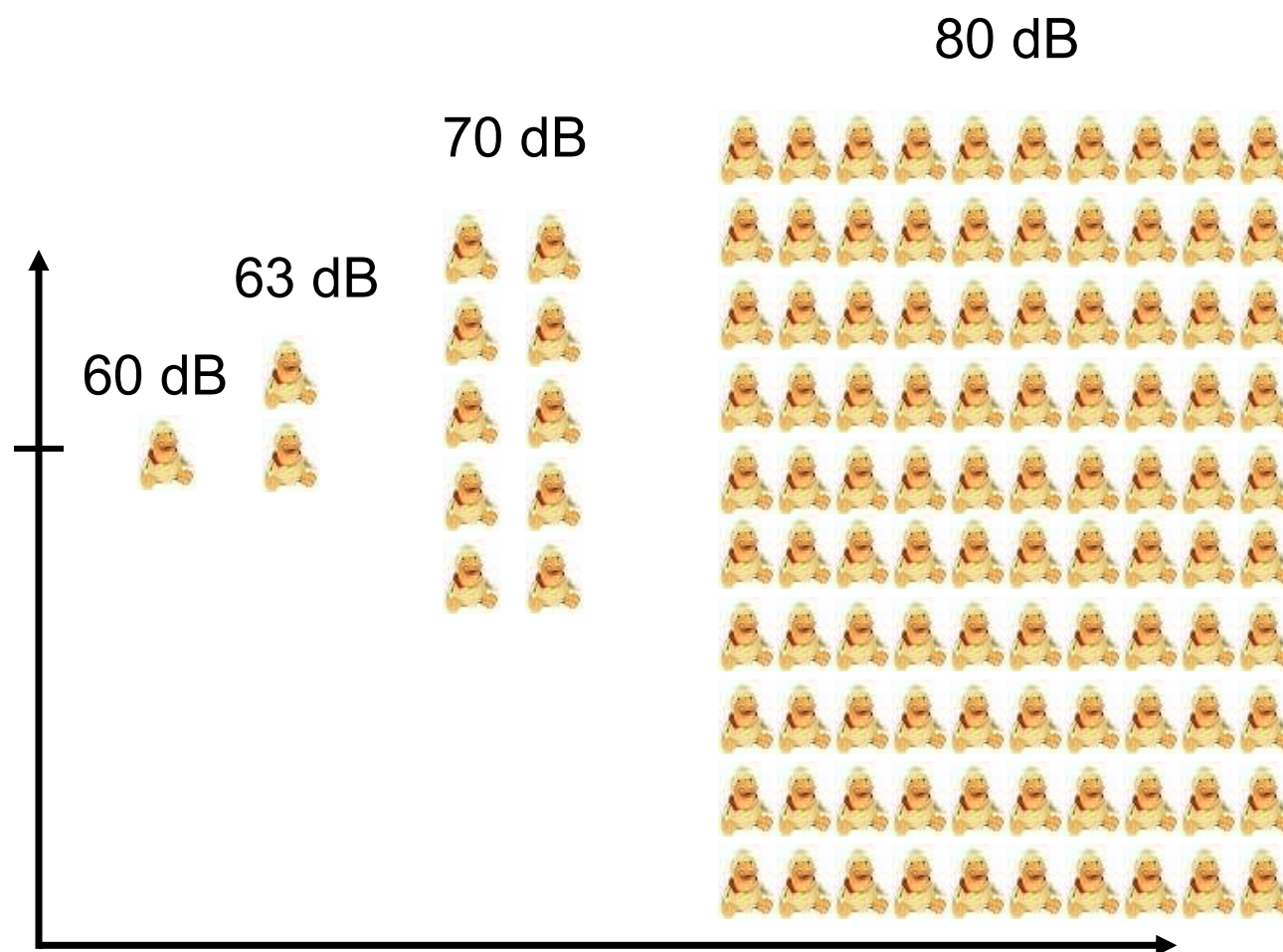
72 dBA 91 dBC

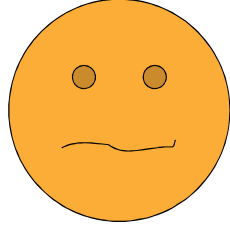


dBC

- inklusive lågfrekventa ljud



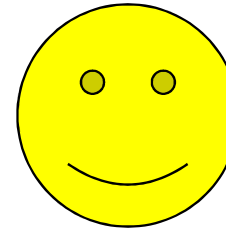


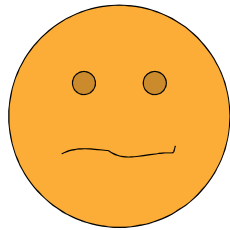


80 dB



- 99%





- 99%

80 dB

60 dB



"Tyst" 30 dB - 99,999% 80 dB



Ljudnivåskillnad på 10 dB

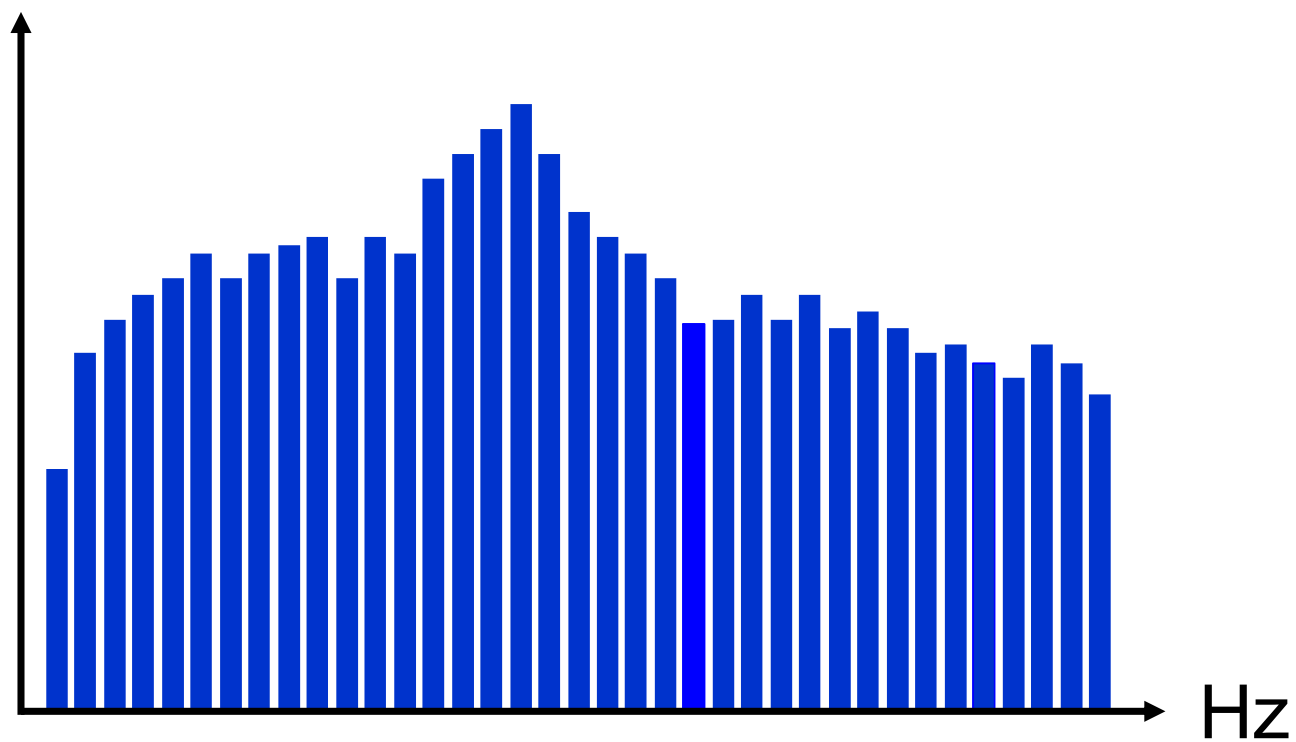
Upplevs som en Halvering - Fördubbling

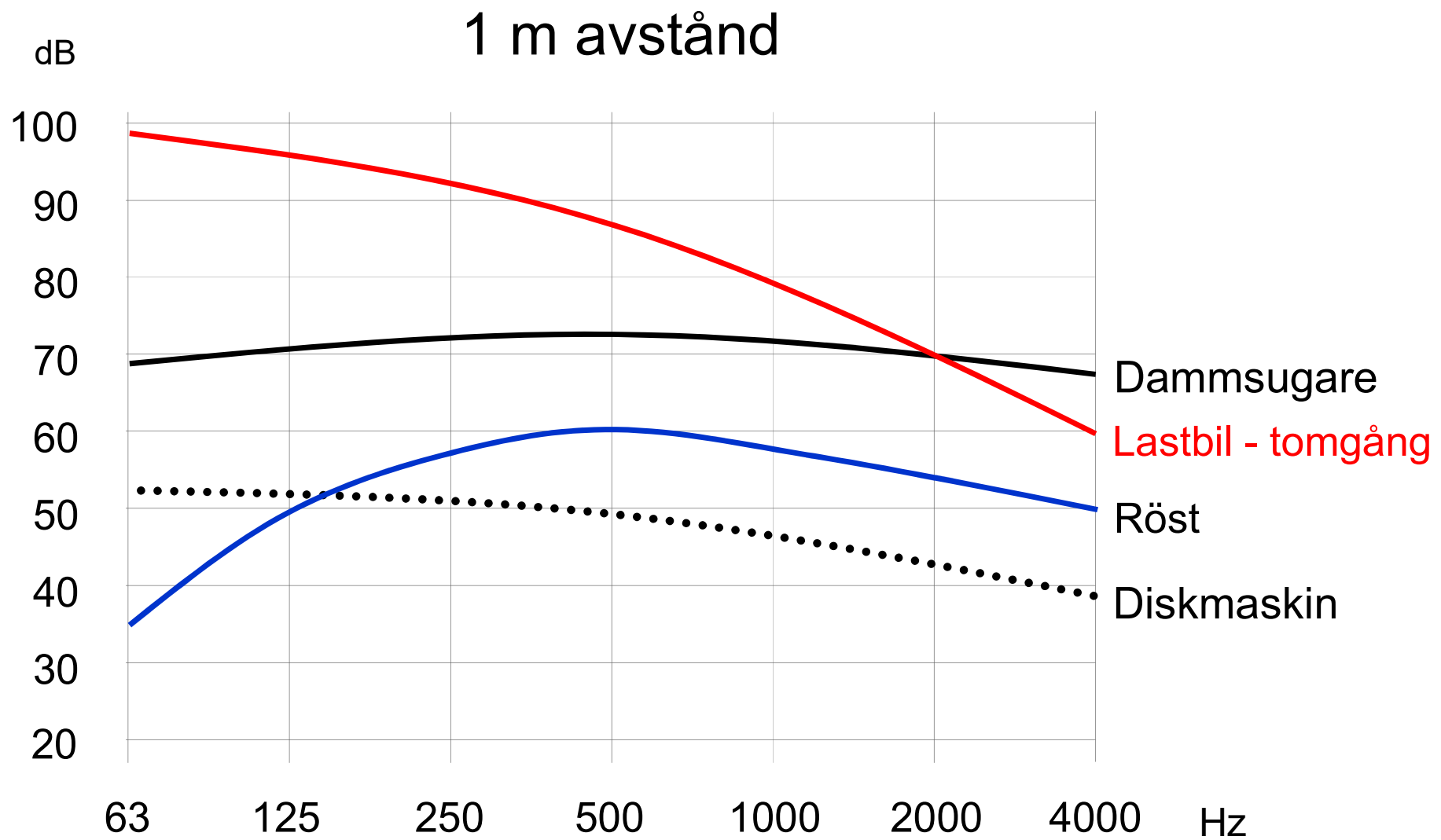
$$63 \text{ dB} + 63 \text{ dB} = 66 \text{ dB}$$

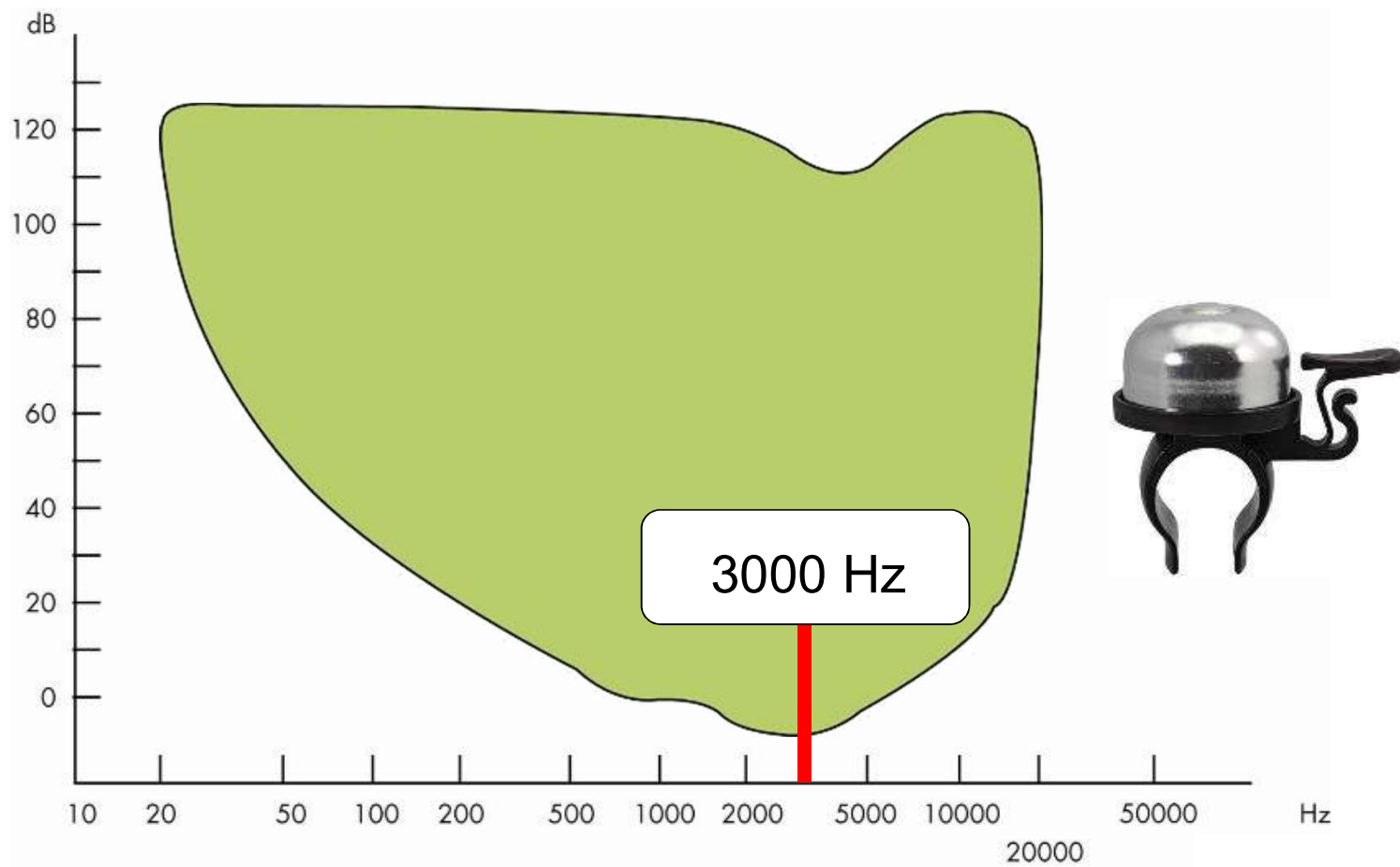
$$60 \text{ dB} + 60 \text{ dB} = 63 \text{ dB}$$

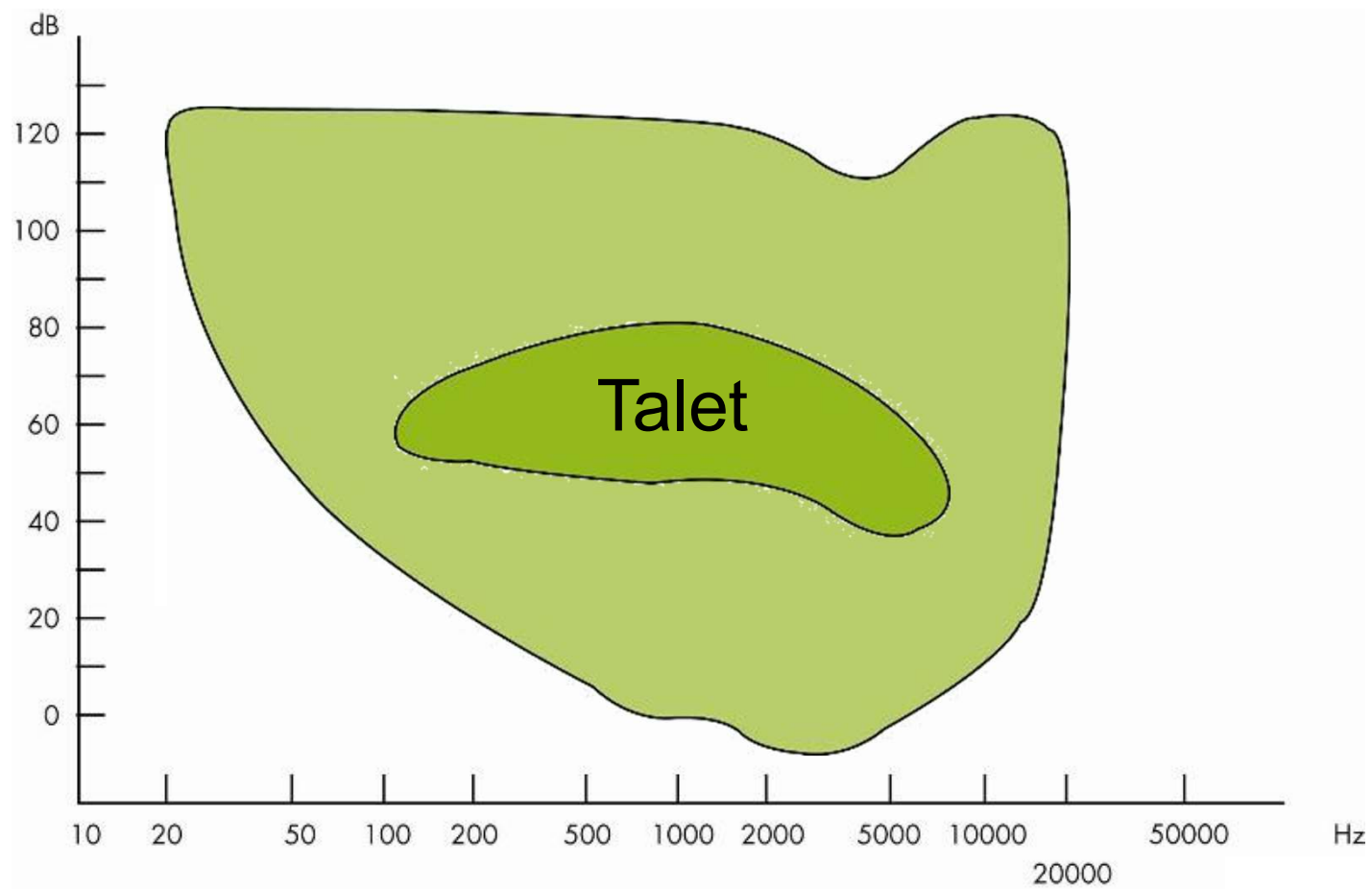
 +  =  + 3 dB

Halvering av ljudenergi - 3 dB











5 ljudkrav - BBR

SS 25267

SS 25268



- Luftljudsisolering
- Stegljudsnivå
- Rumsakustik
- Ljud från installationer
- Ljud från trafik

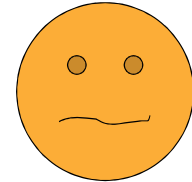
Olika ljudklasser - "kvalitetsklasser"

Beställaren ska bestämma ljudklass

Ljudklass A bättre ljudmiljö än klass B

Ljudklass B bättre ljudmiljö än klass C

Ljudklass C uppfyller Boverkets minimikrav



ca 20%

Ljudklass B



Olika akustiska utmaningar

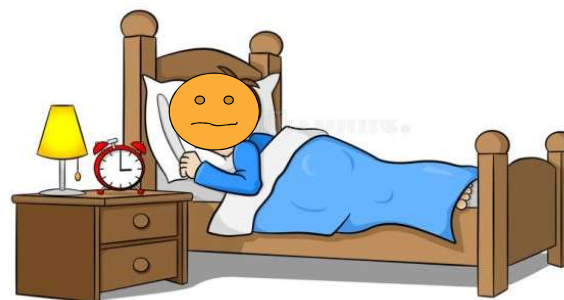
Stegljud - Låga frekvenserna

Ljudisolering - Låga frekvenserna

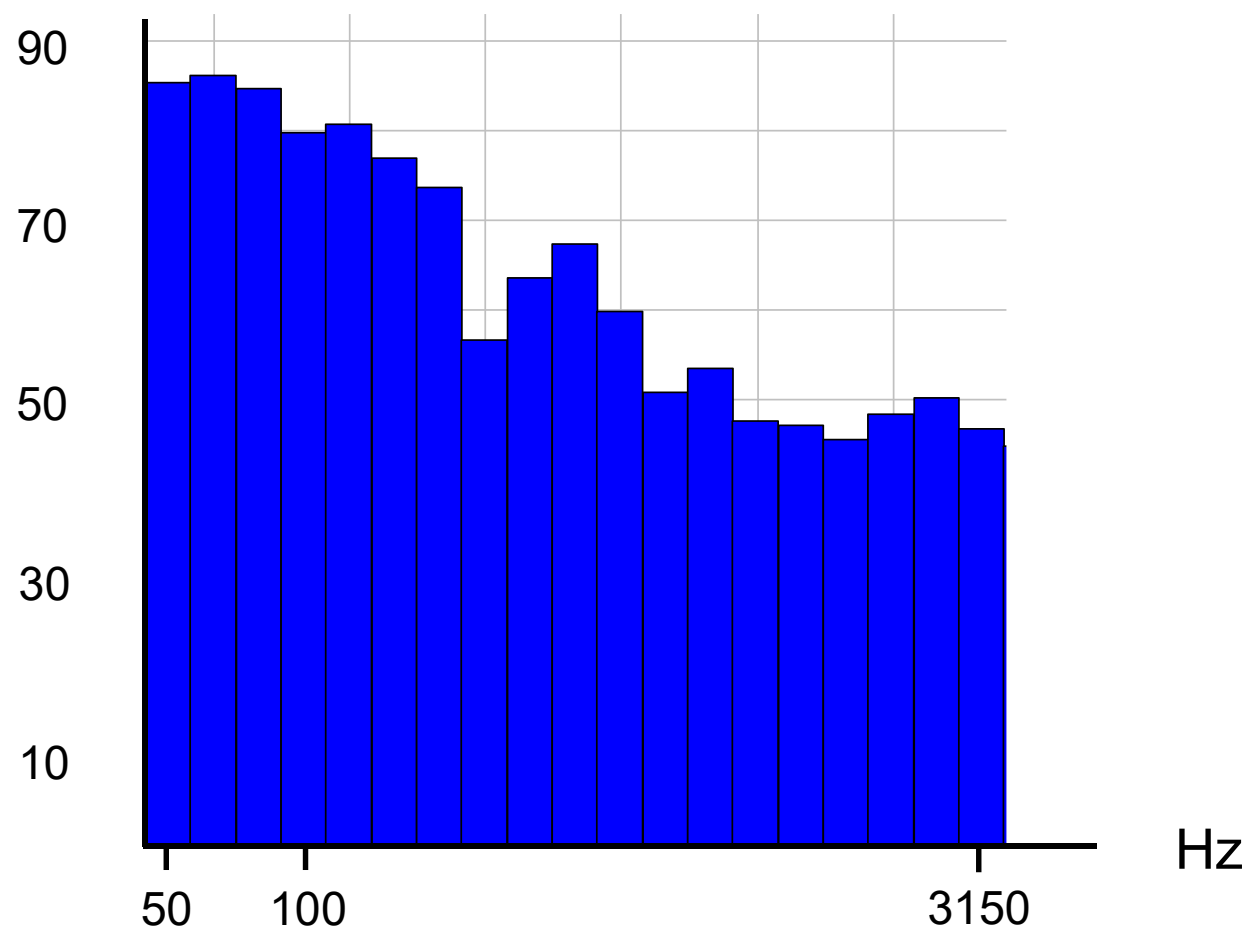
Trafikbuller - Låga frekvenserna

Ventilation - Låga frekvenserna

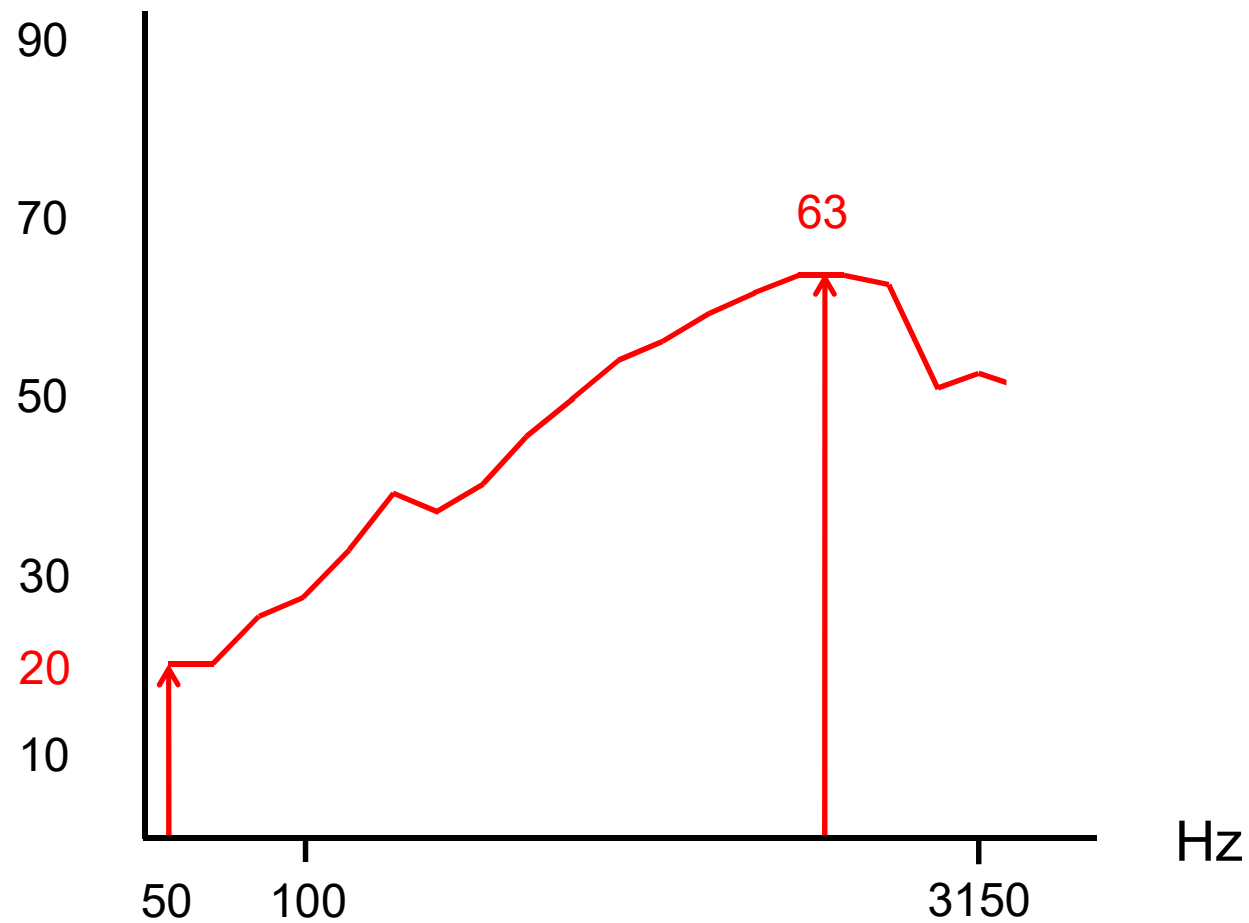
Efterklangstid - Låga frekvenserna



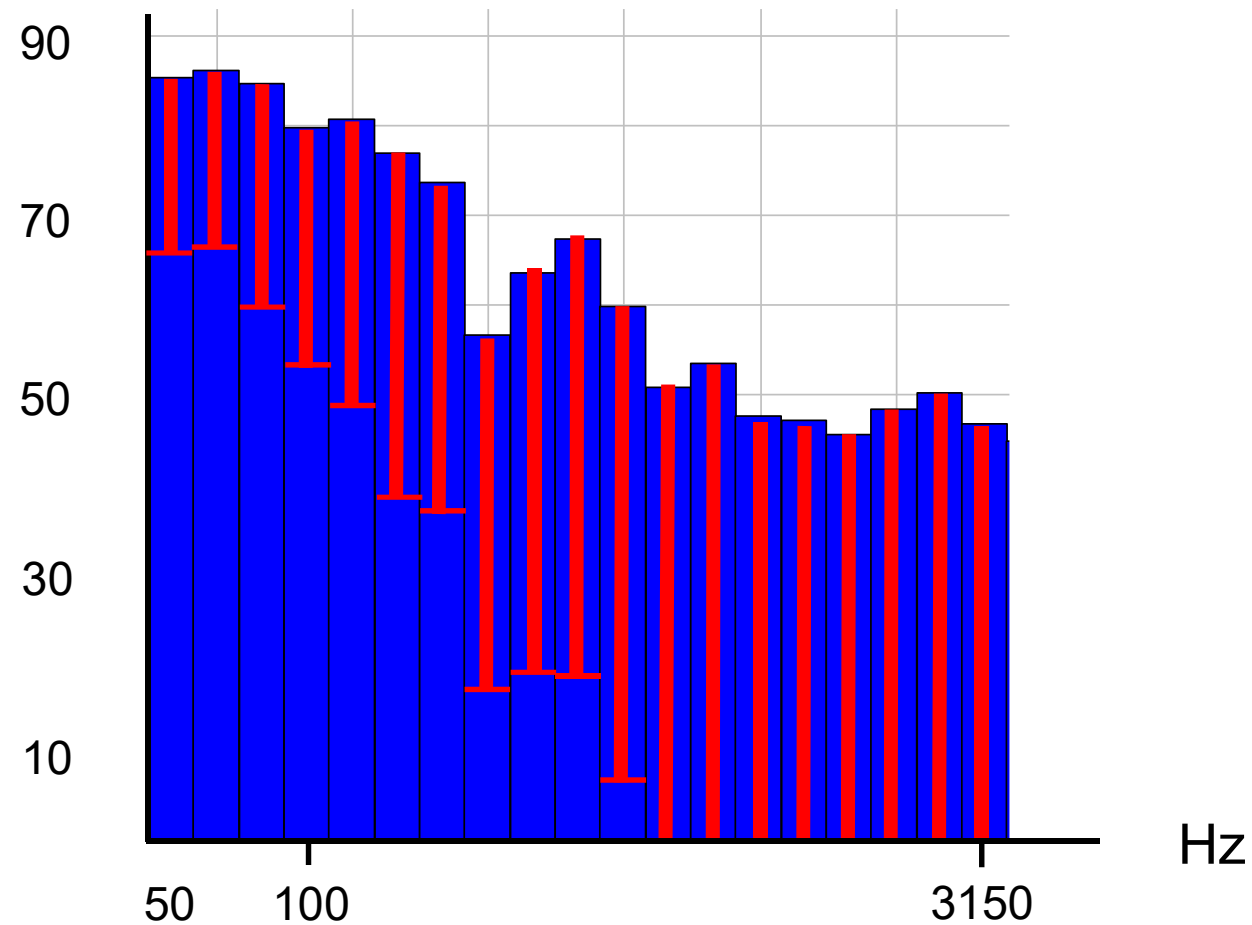
Ljudnivån i sändarrummet



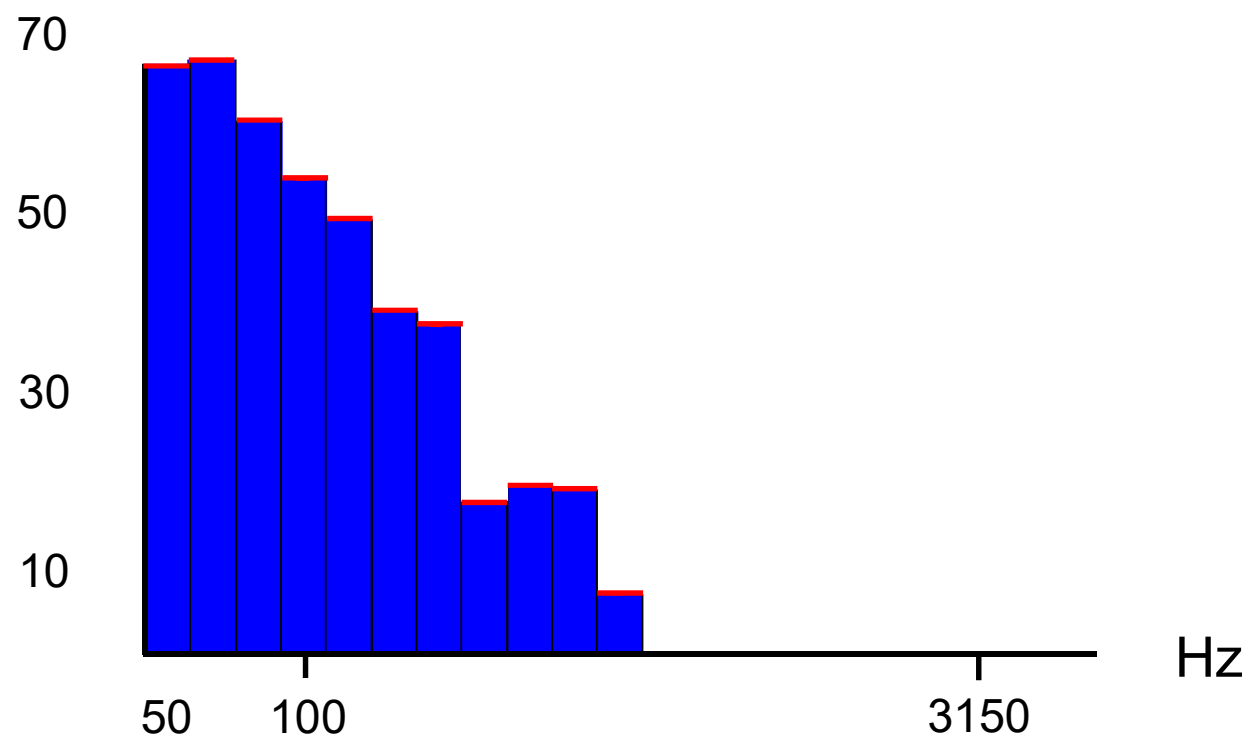
Ljudisolering - Väggen



Ljudnivån i sändarrummet - Väggen

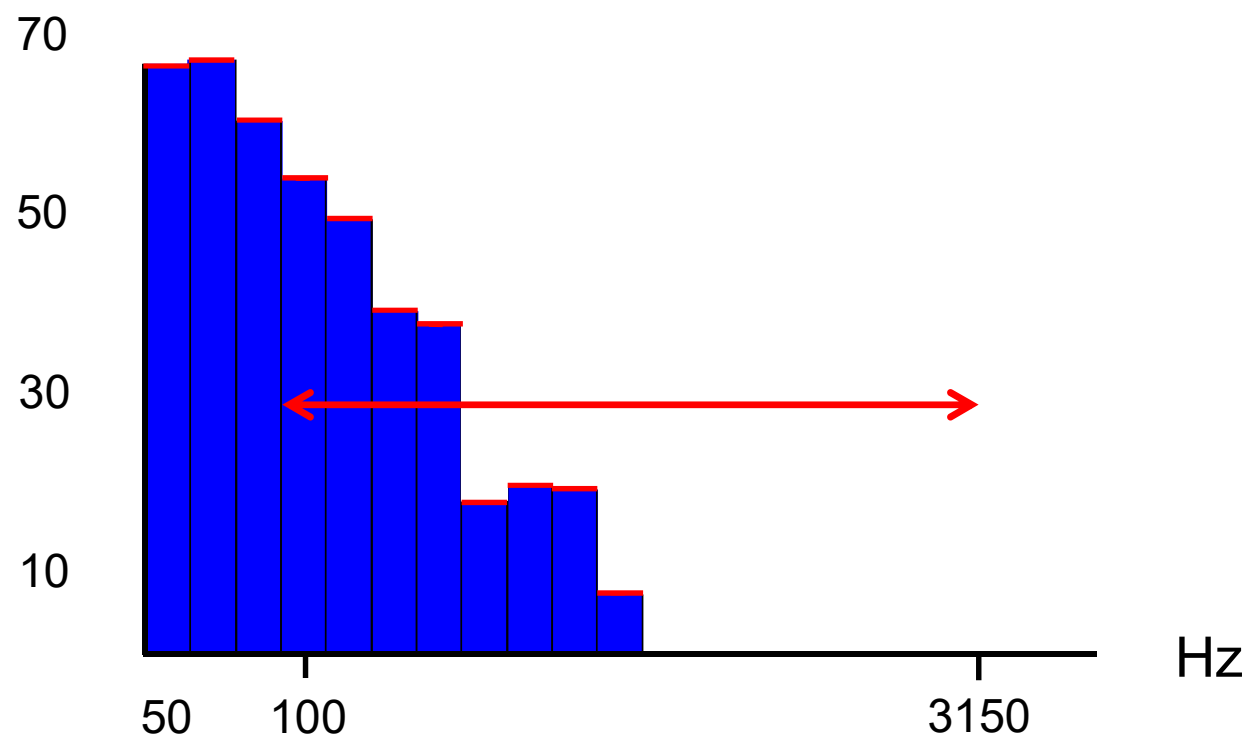


Ljudnivån i mottagarrummet

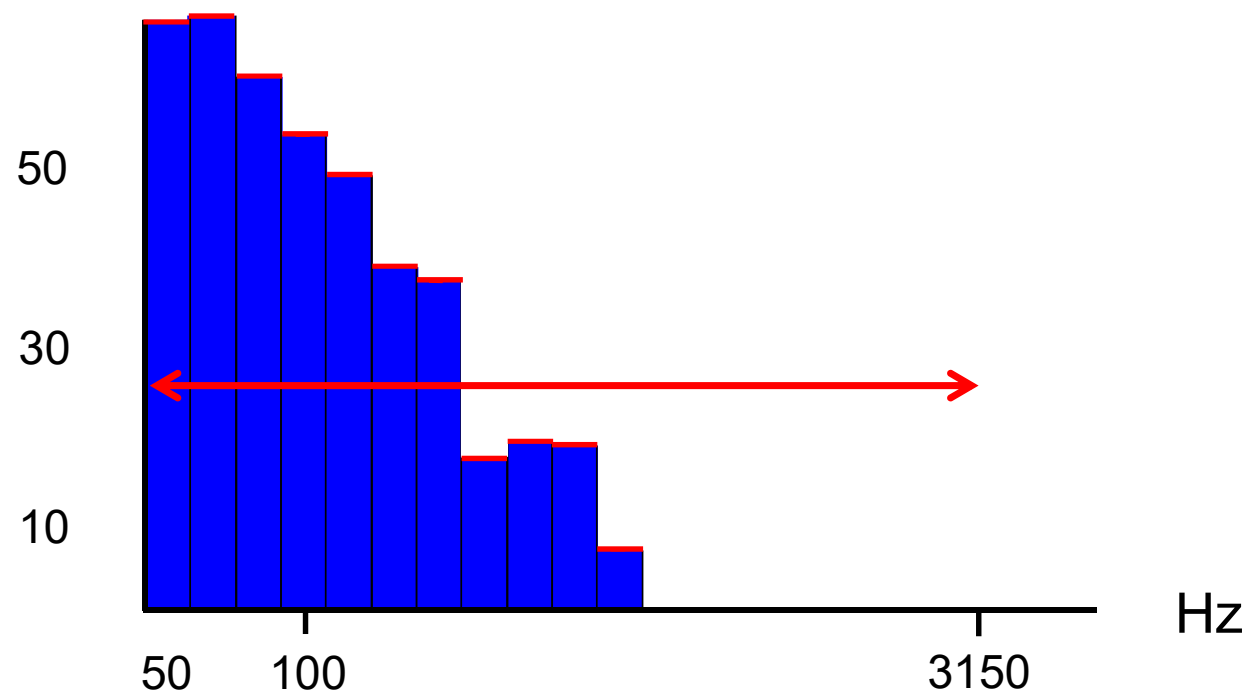


Vissa mätningar

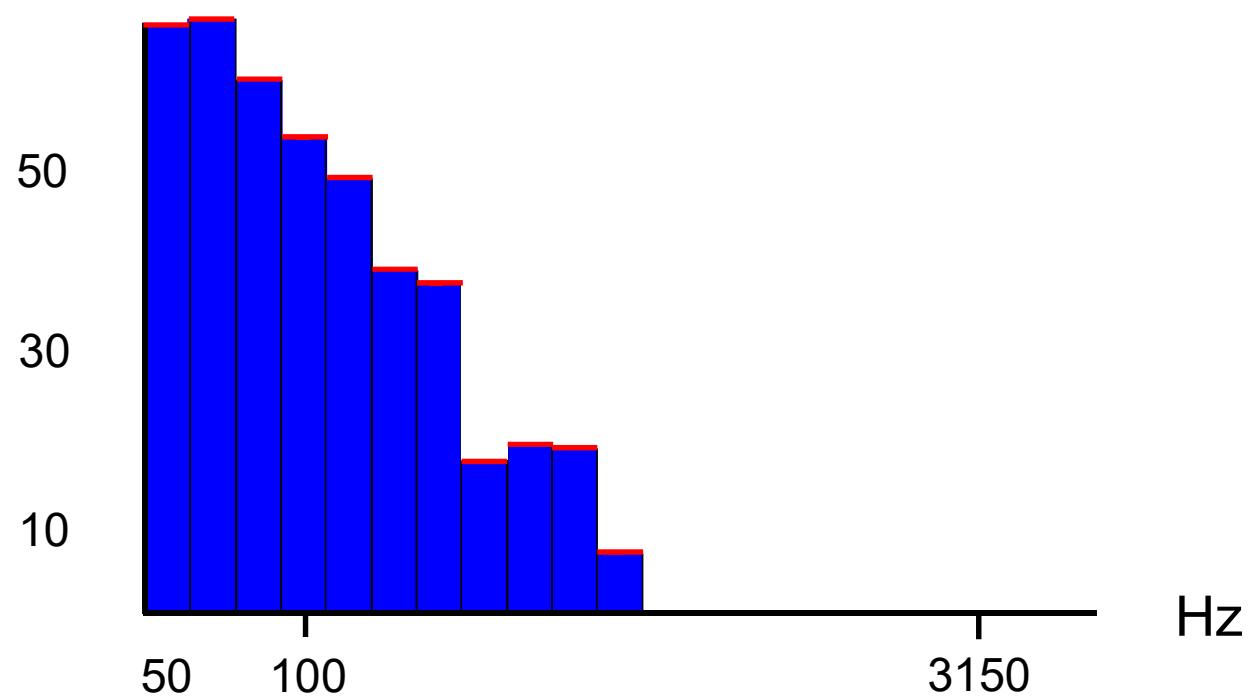
100 - 3150 Hz



Viktigt att mäta ner till 50 Hz



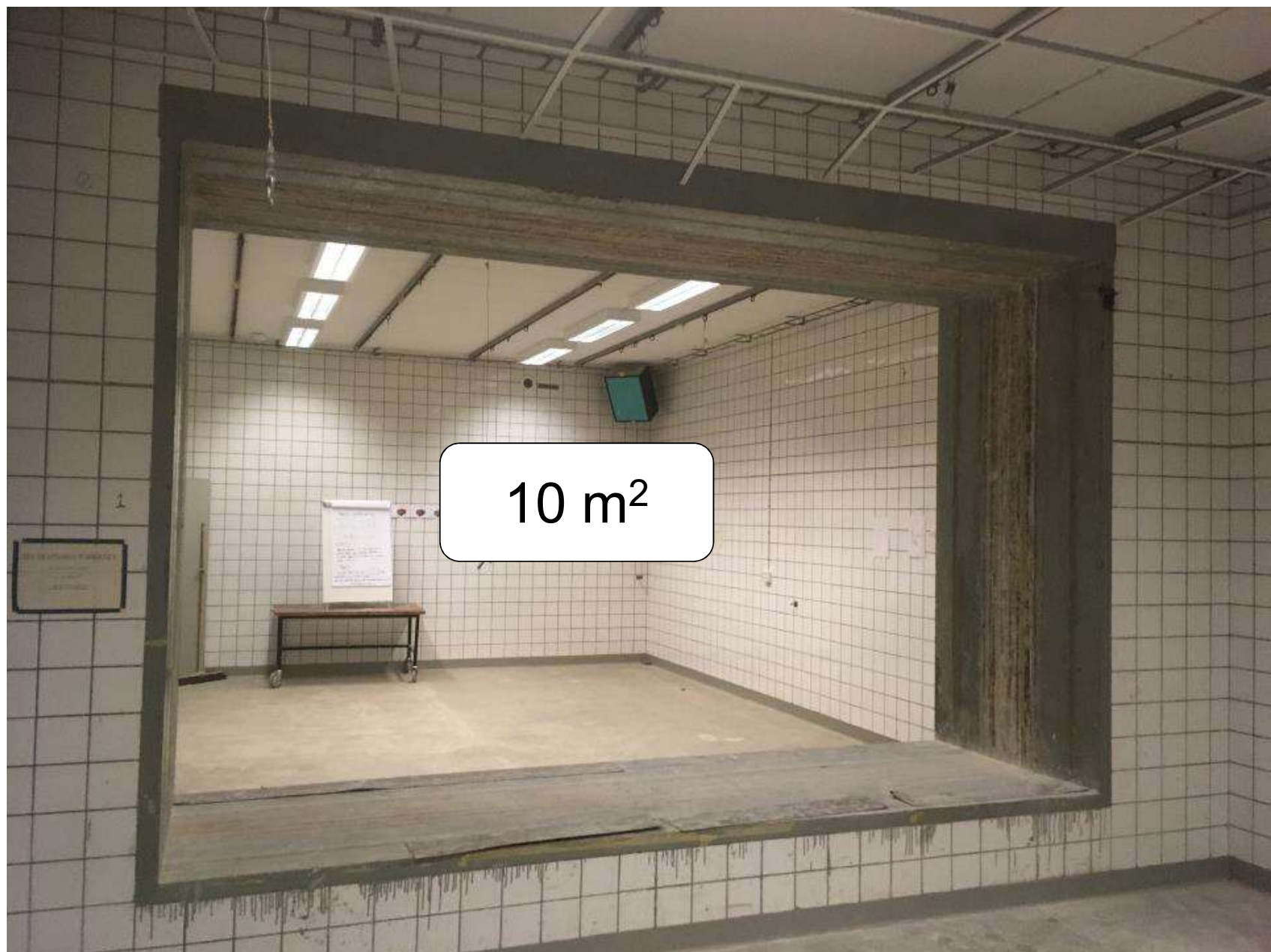
Lågfrekventa ljud stör människor



$D_{nT,w}$ Mäts i färdig byggnad

R'_w Mäts i färdig byggnad

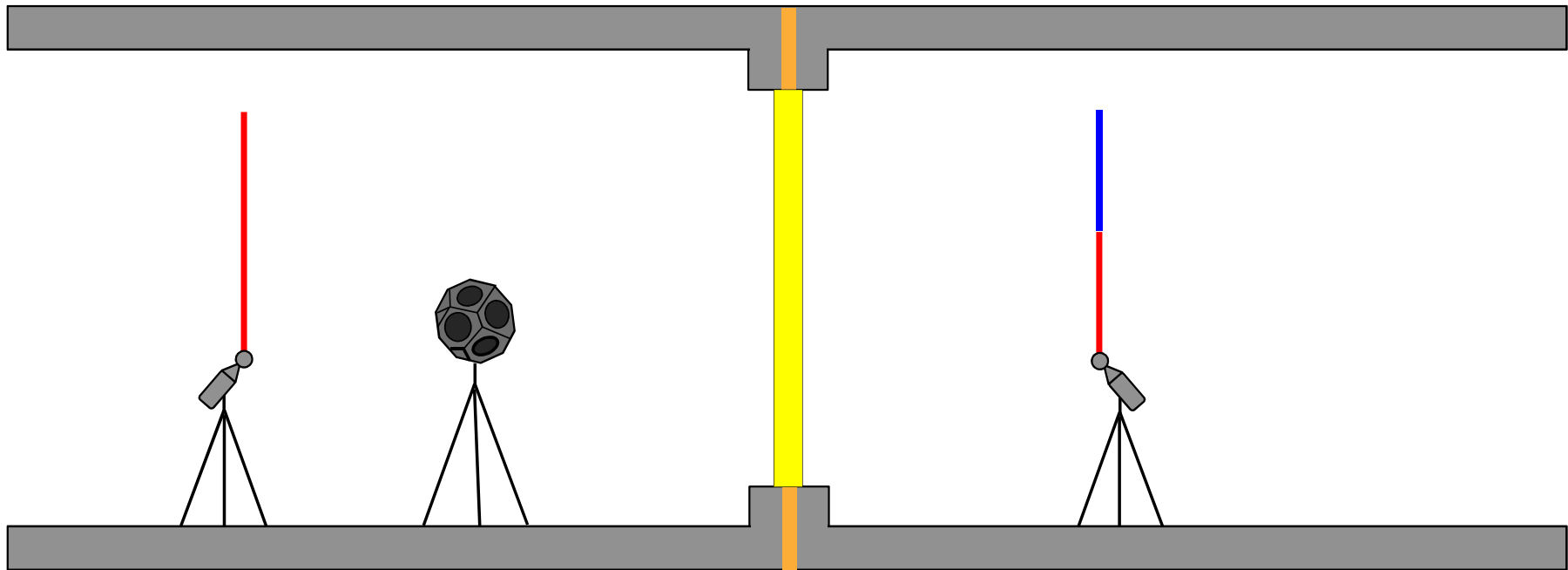
R_w Mäts i laboratorium

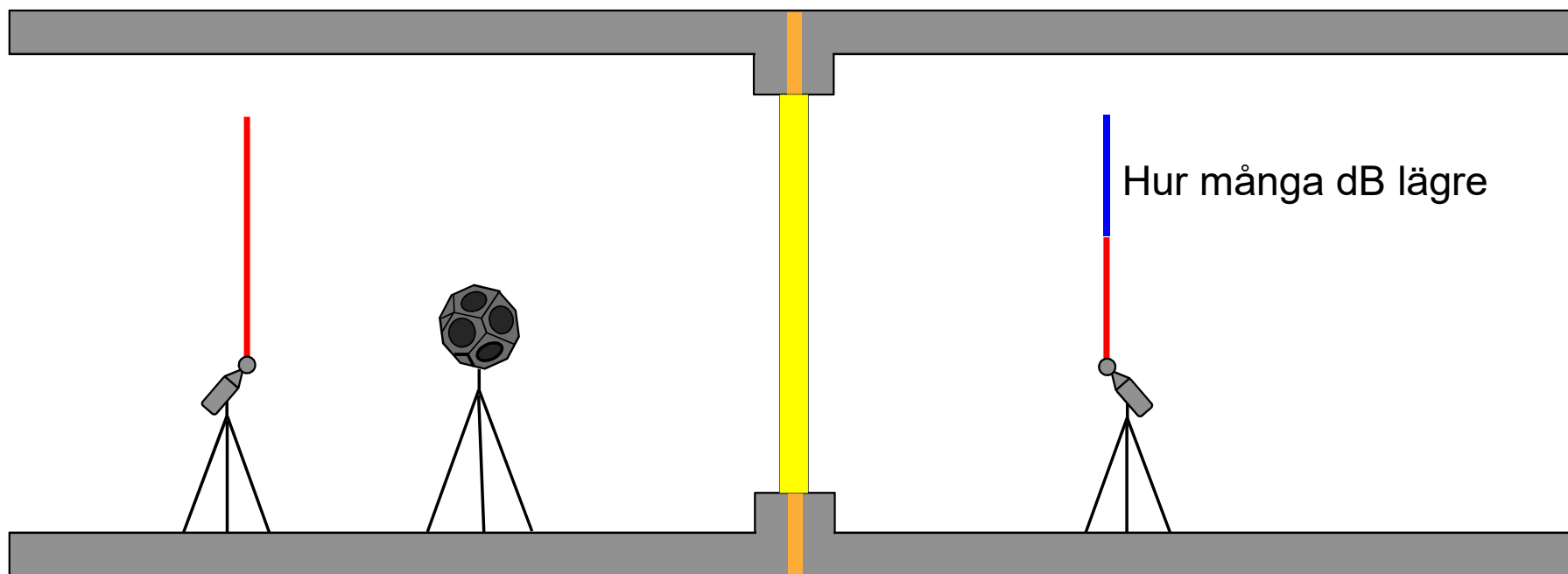


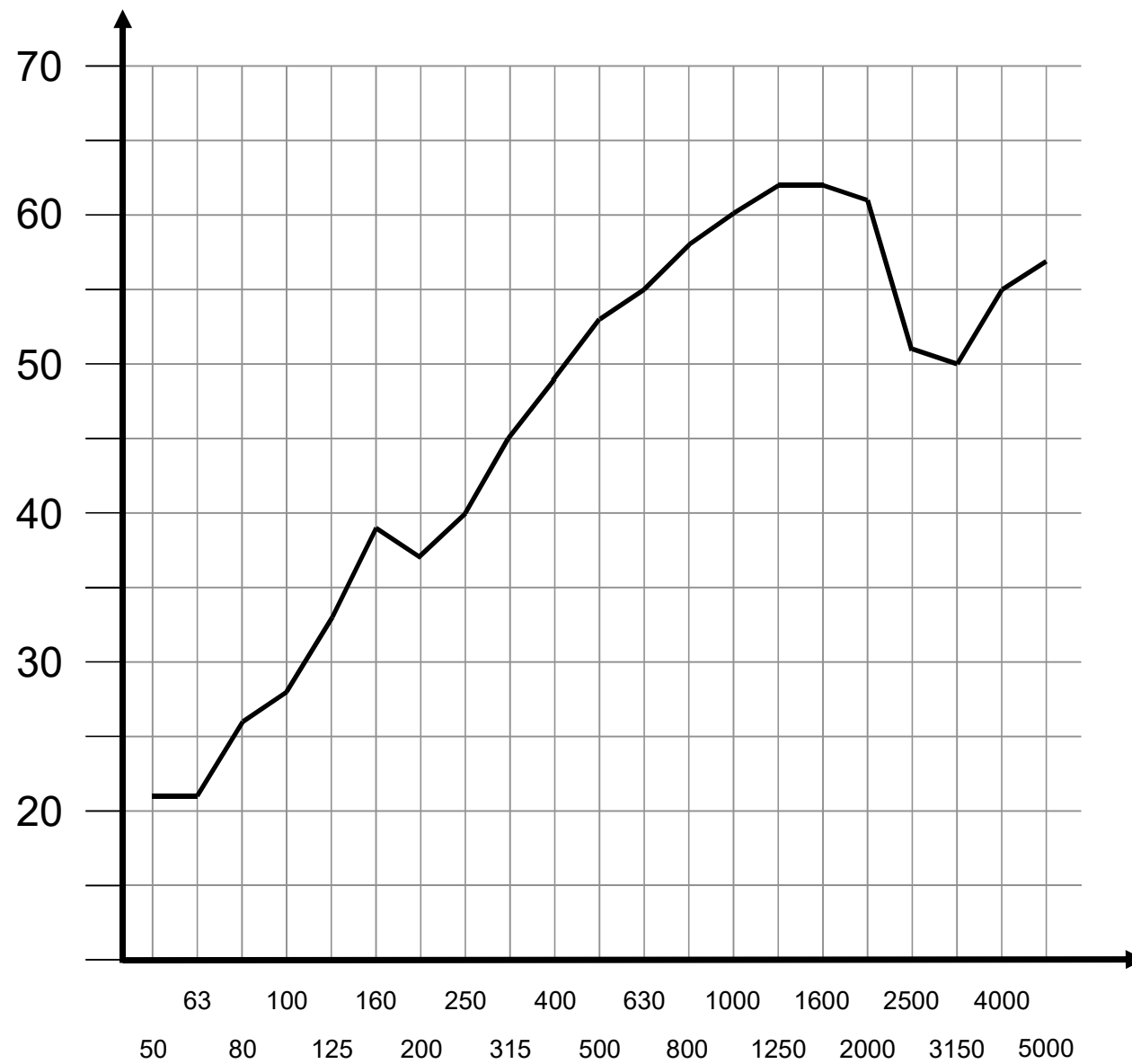
10 m²

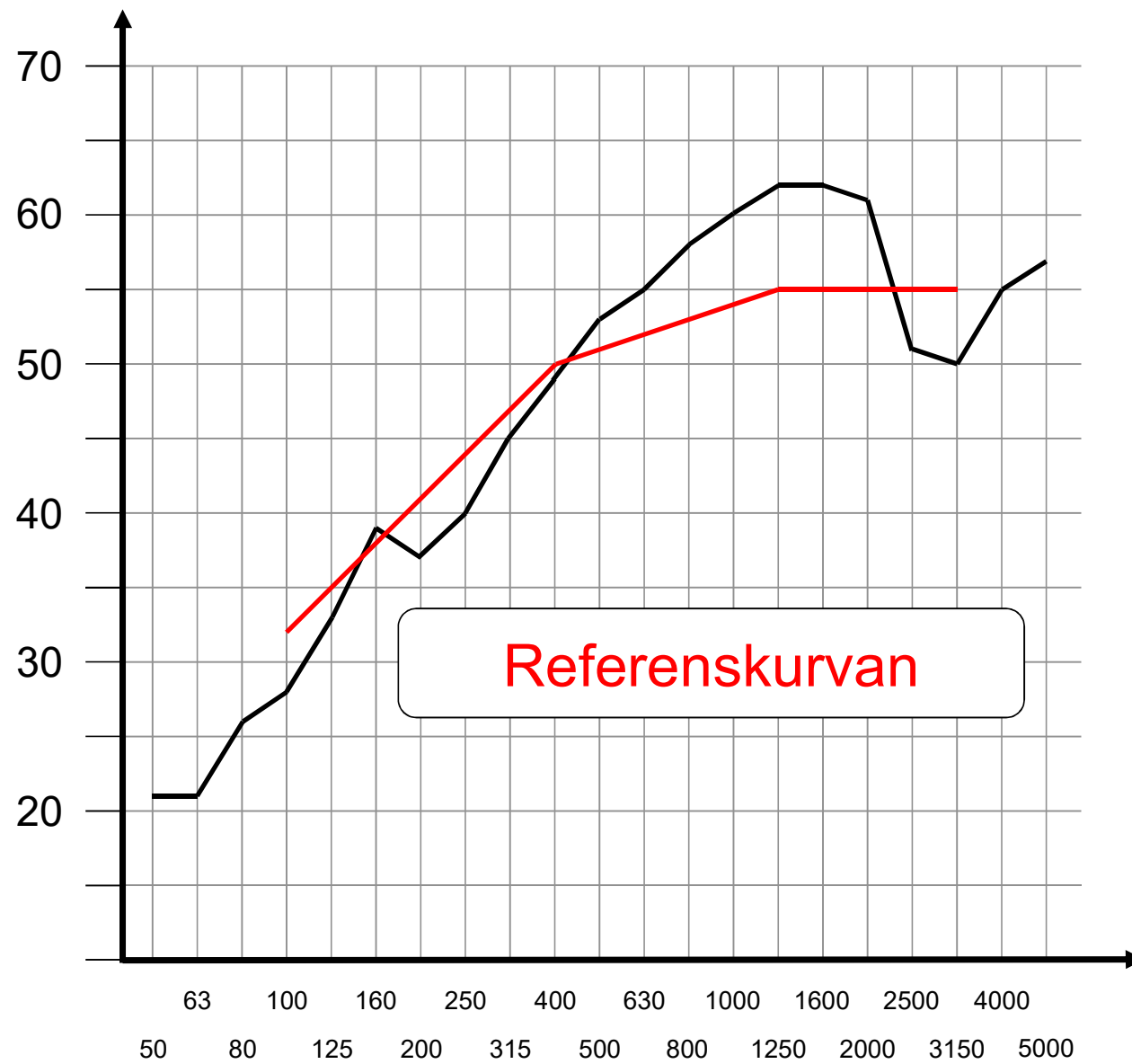
R_w

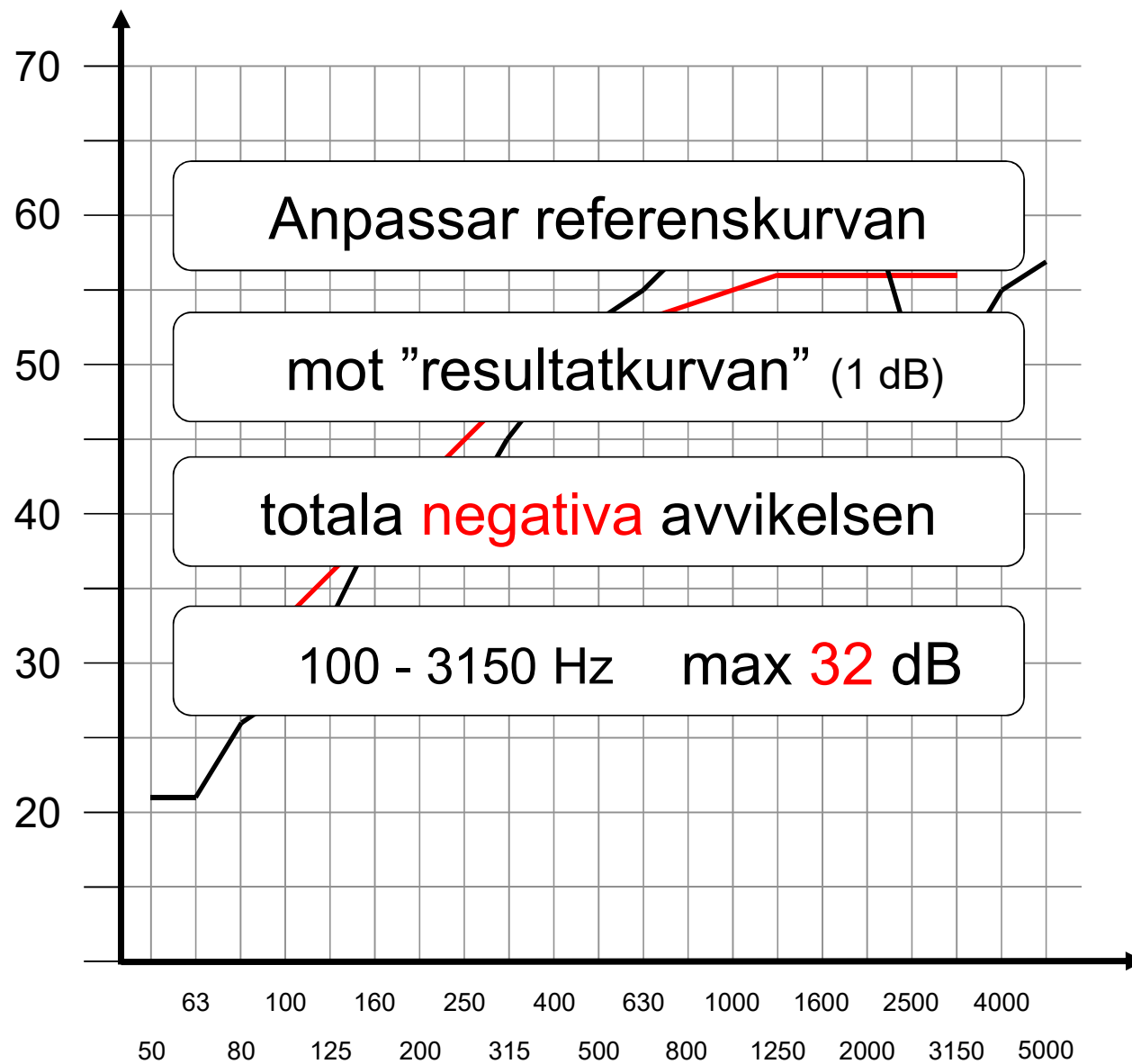
Mäts i laboratorium

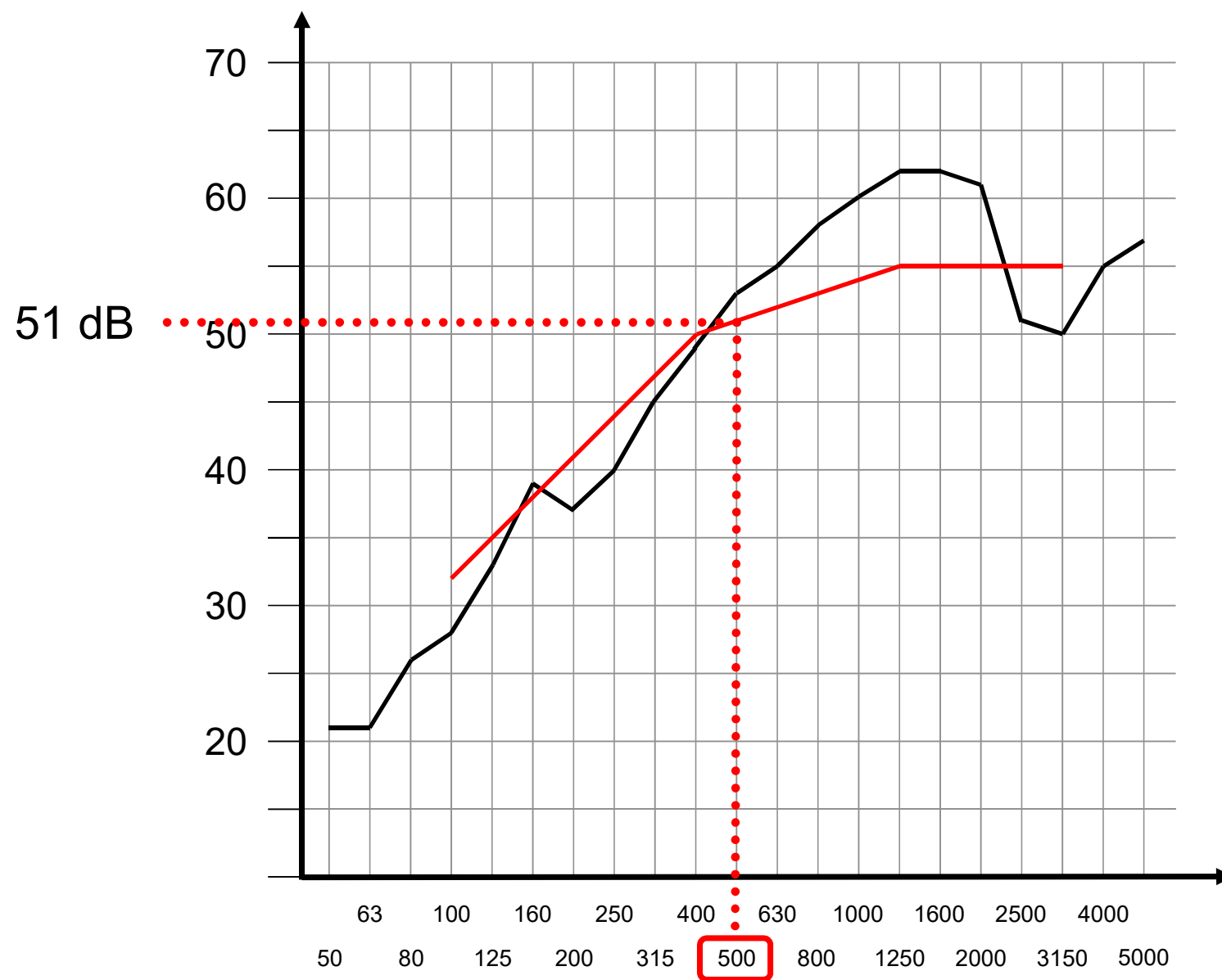


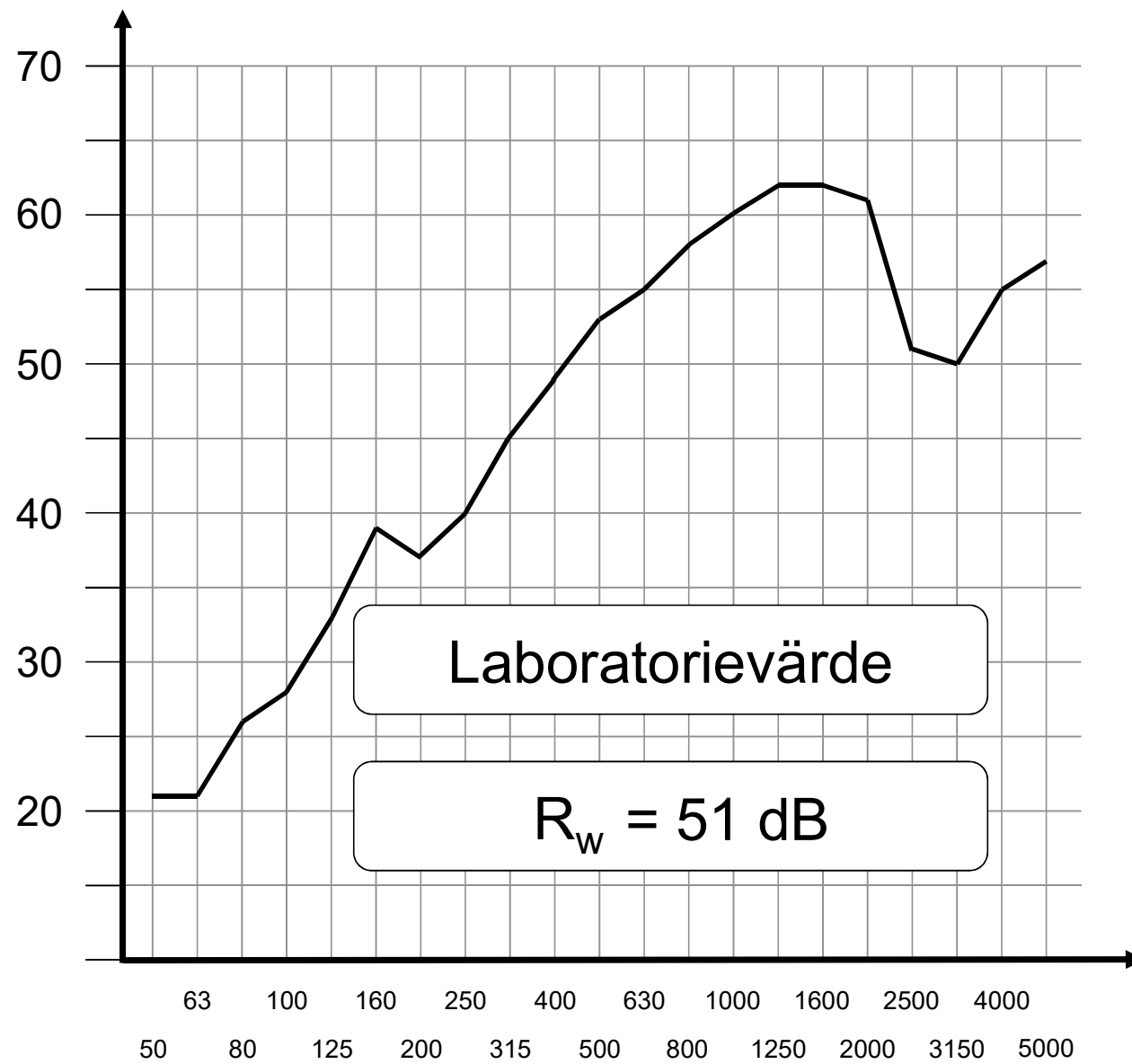












R_w

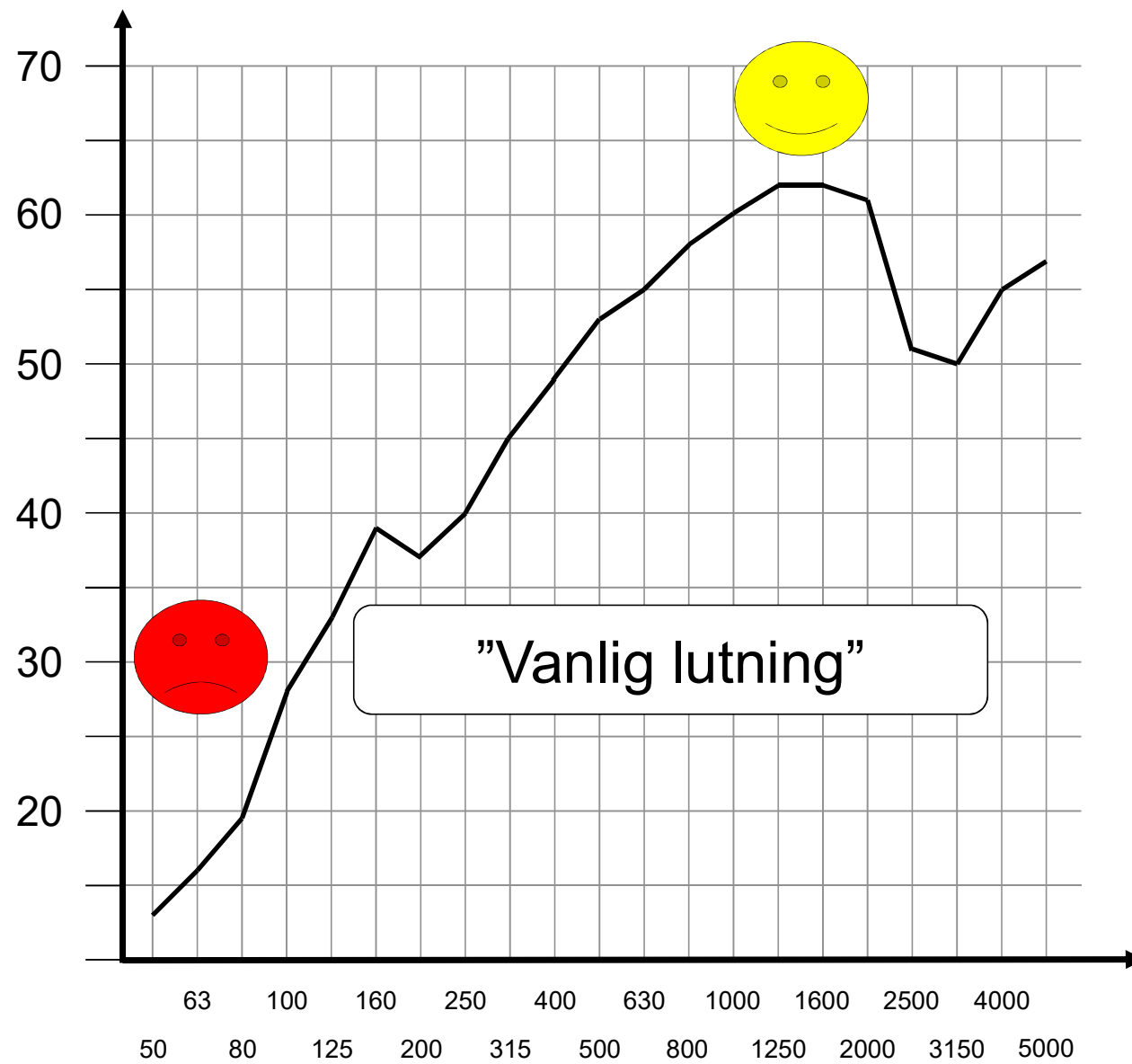
51 dB

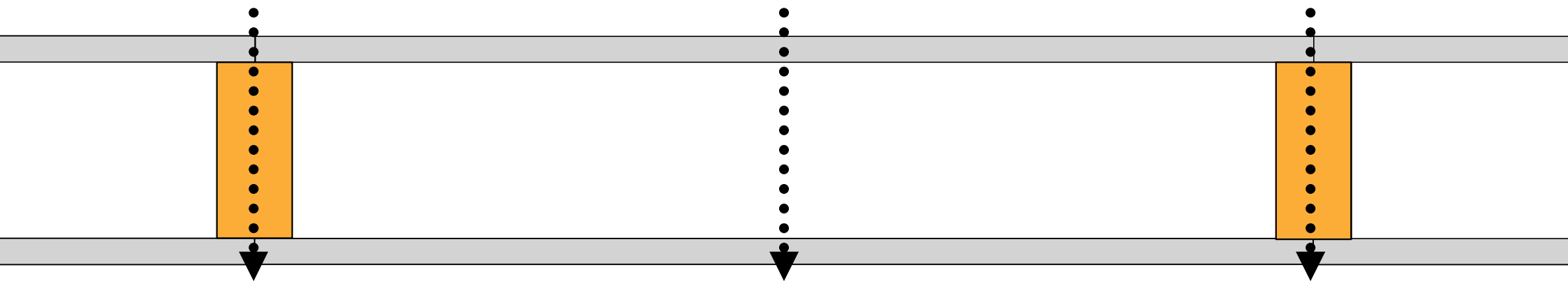
Olika resultat

Olika vägningskurvor

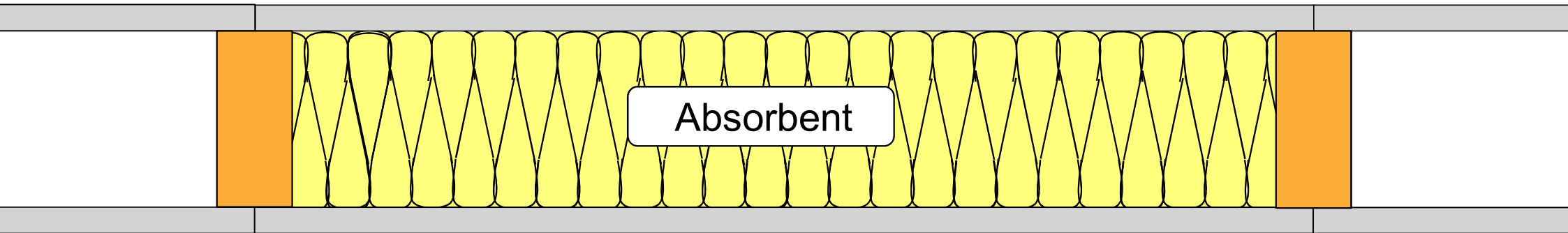
$R_w + C_{50-3150} \quad (-2)$

49 dB

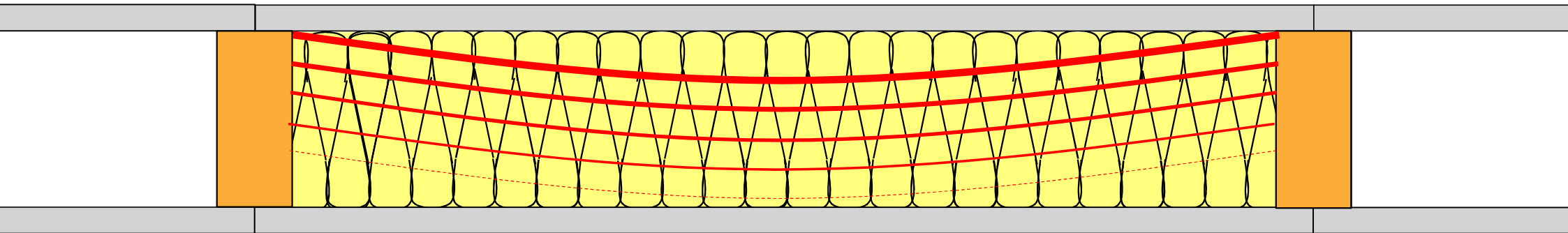


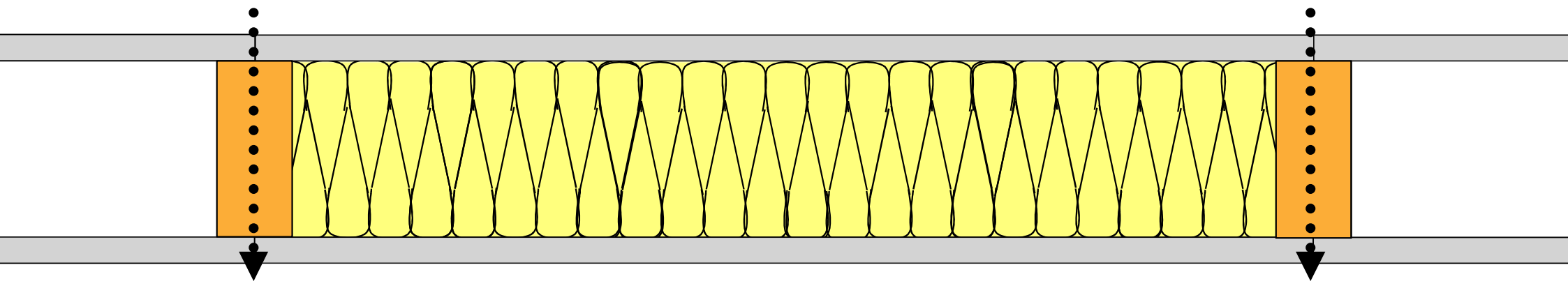


Minimera ljudtransmissionen genom väggen

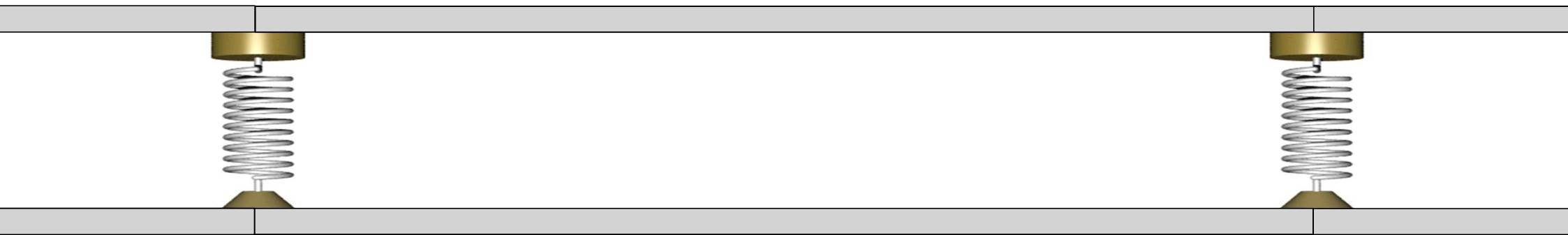


"Strömingsmotstånd"

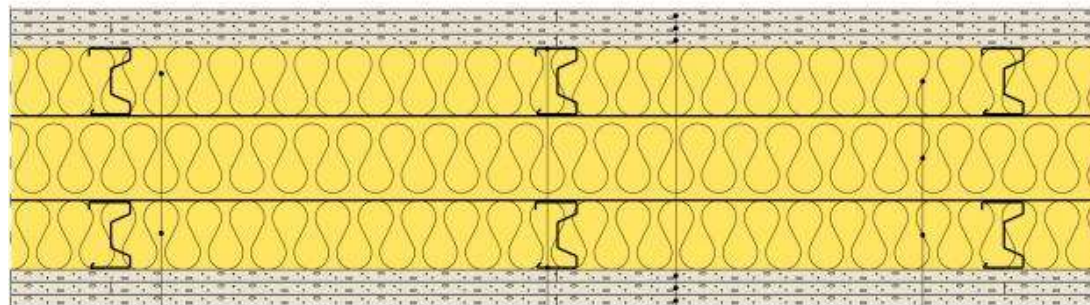








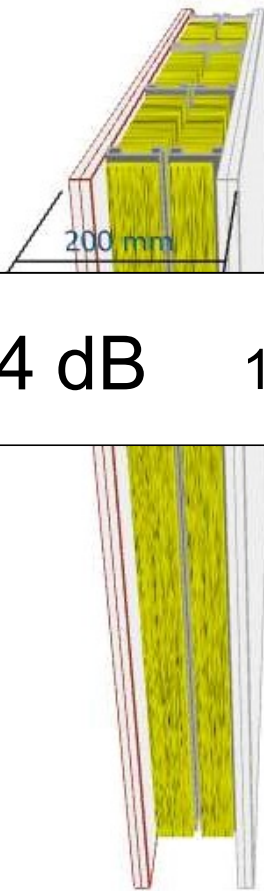
Tjock Tung Tät



R_w 74 dB

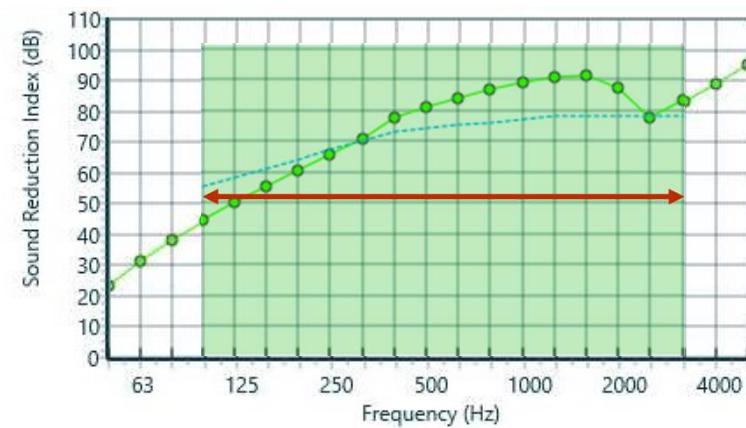
Lab-värde

74 dB 100 - 3150 Hz

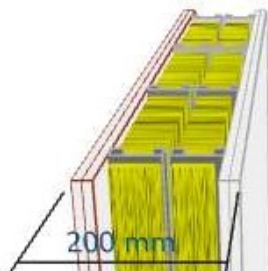


Panel 1: fc: 2533Hz Surface Mass 28,0 kg/m²

Version 9.0.17



R_w 74 dB



74 dB 100 - 3150 Hz

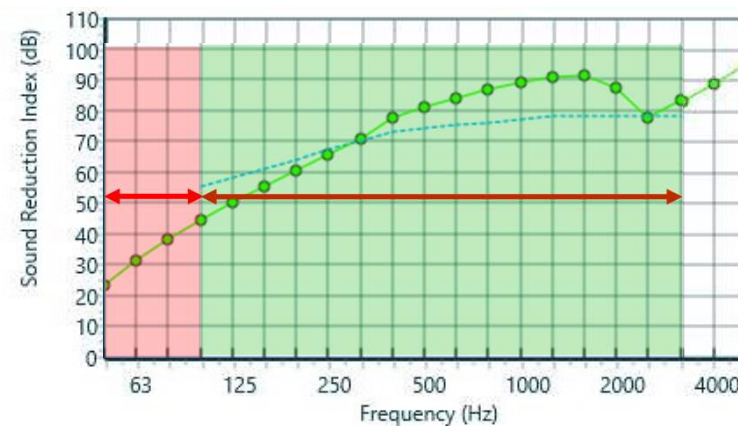
$C_{50-3150}$ - 12 dB

$R_w + C_{50-3150} = 62$ dB

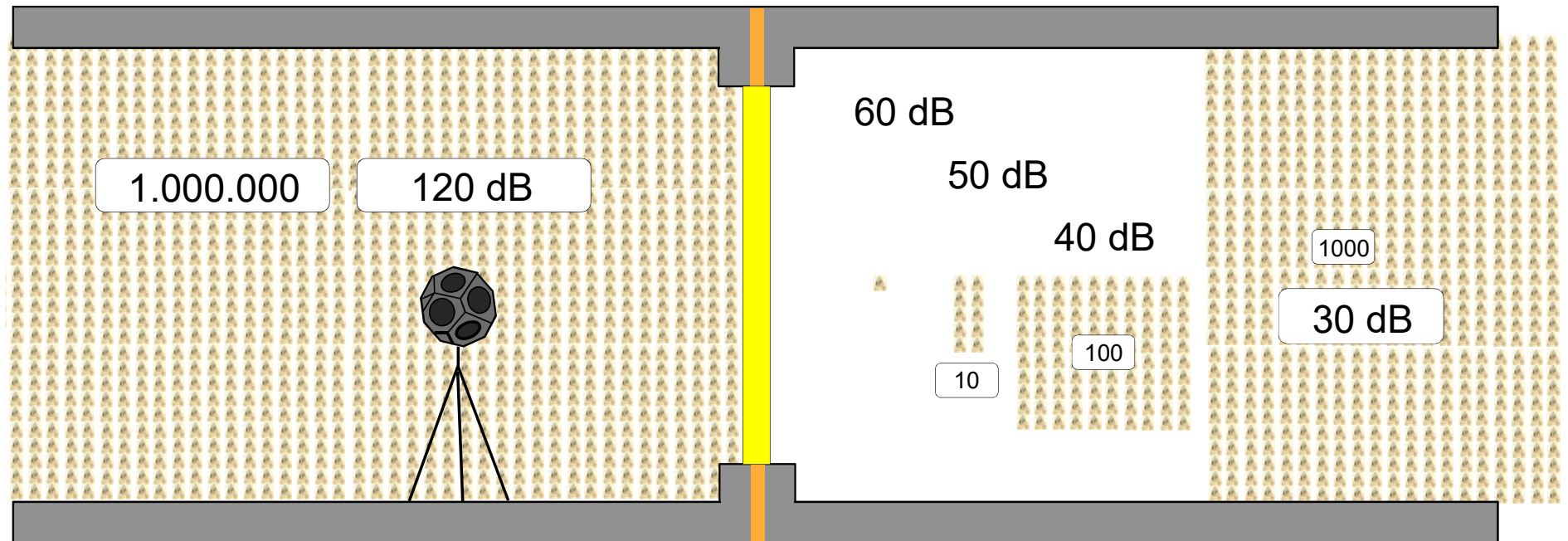
Panel 1: fc: 2533Hz Surface Mass 28,0 kg/m²

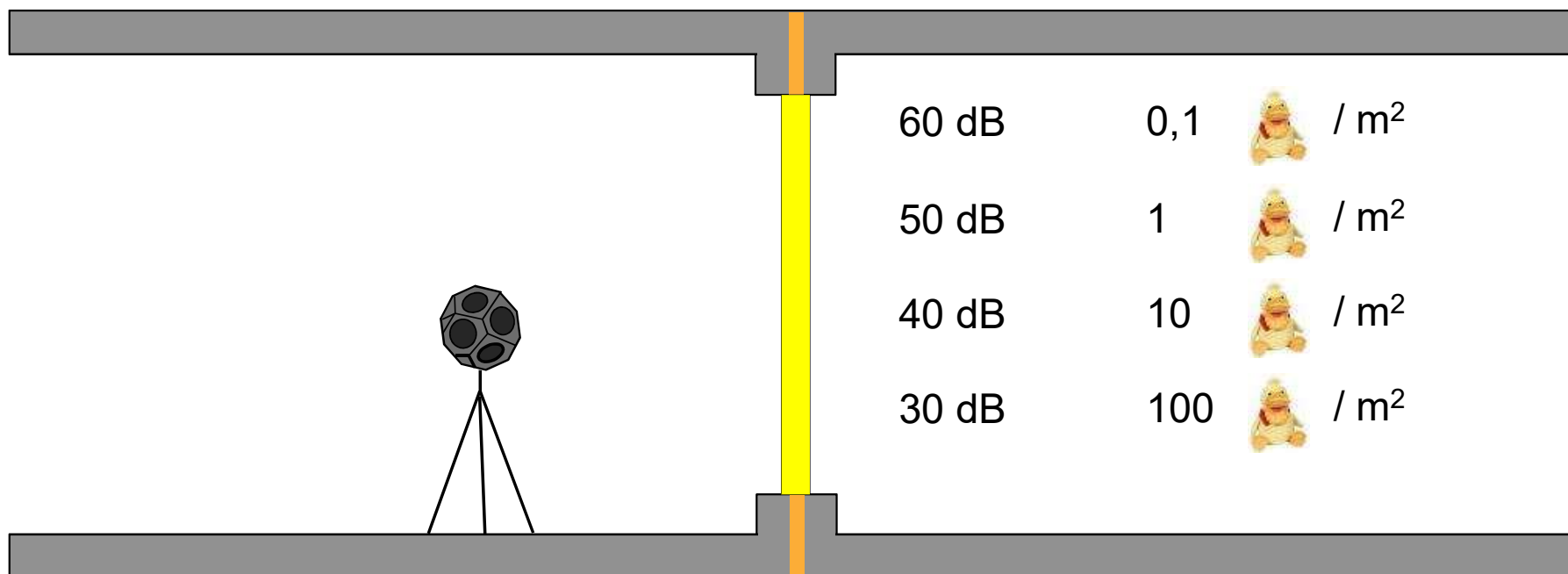
Version 9.0.17

Lab-värde

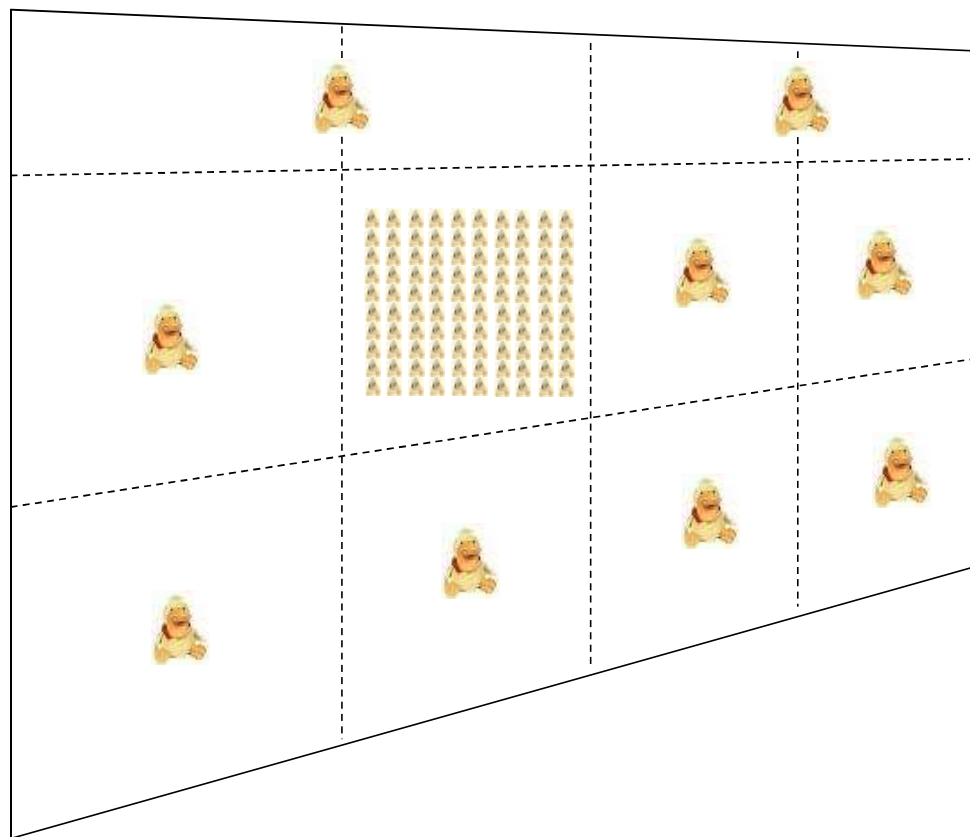


Ljudisoleringen - Väggen

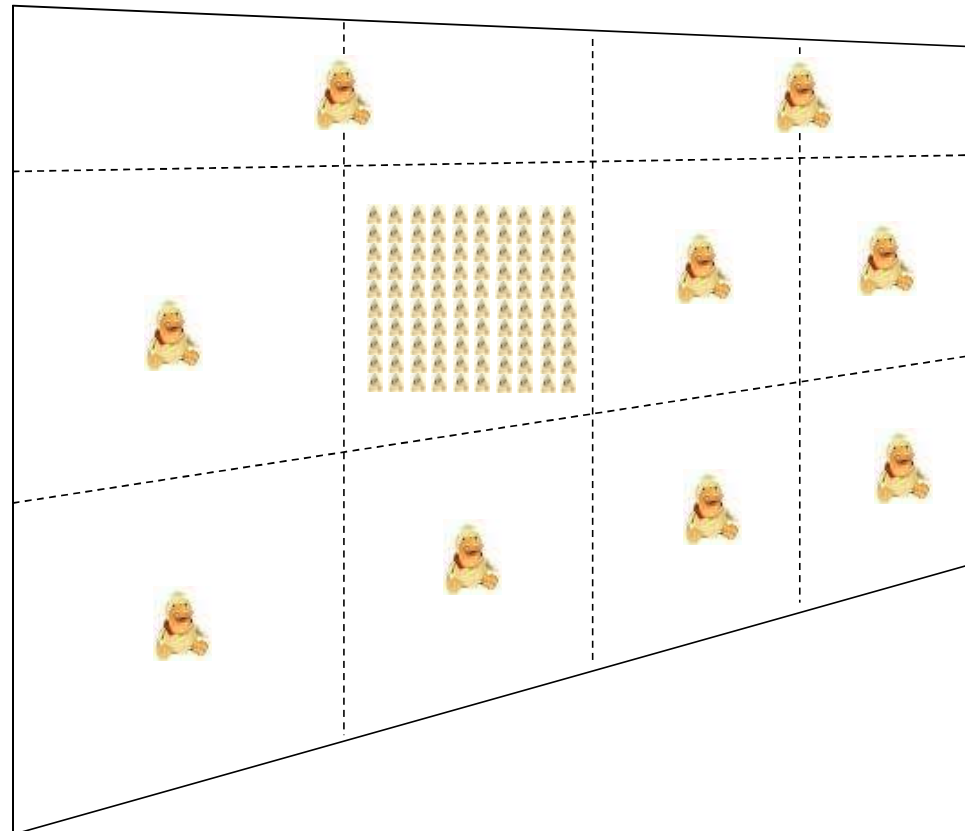




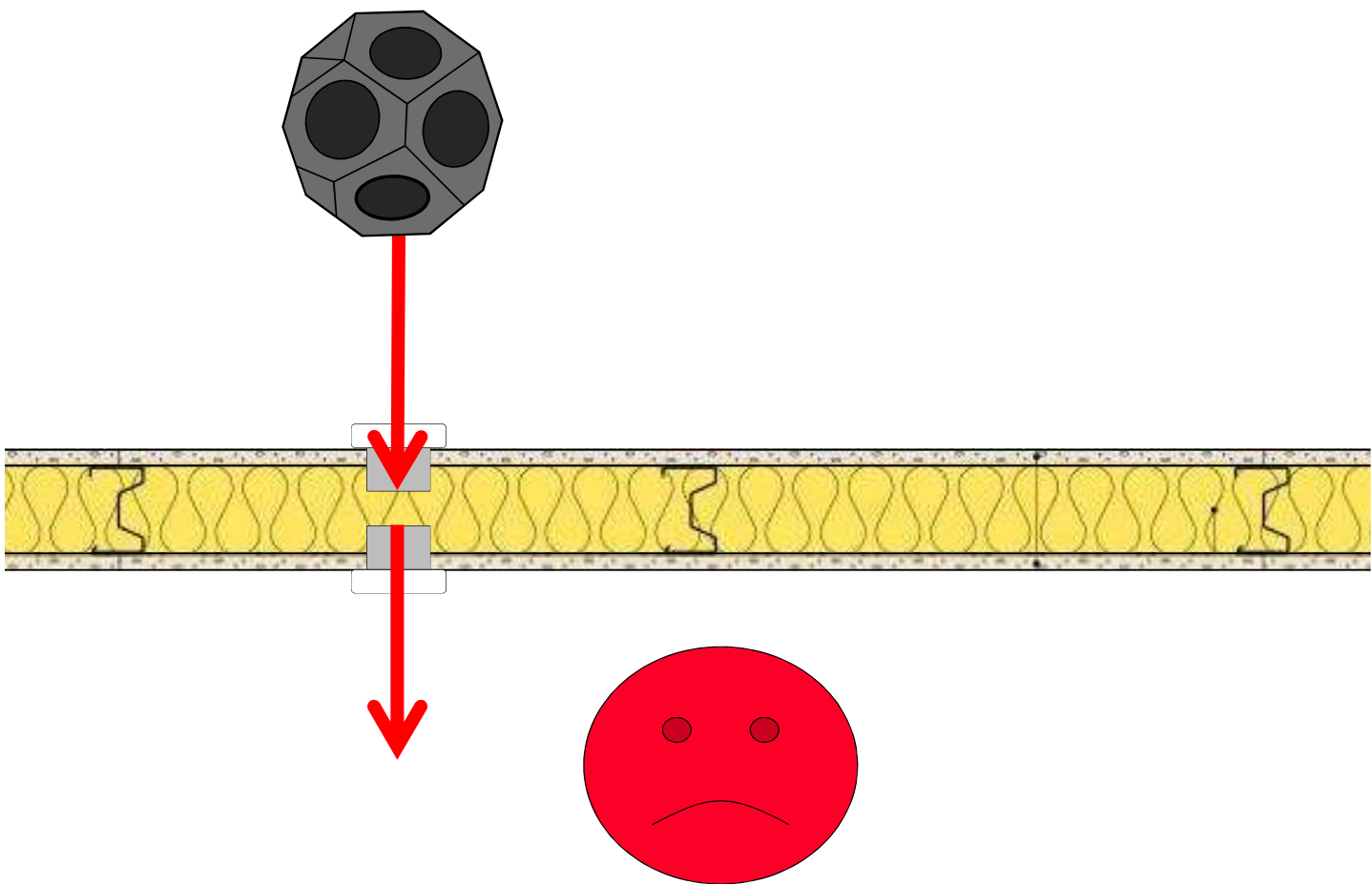
Vägg 50 dB 9 m² Fönster 30 dB 1 m²

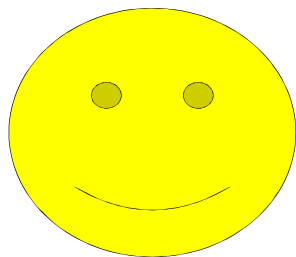
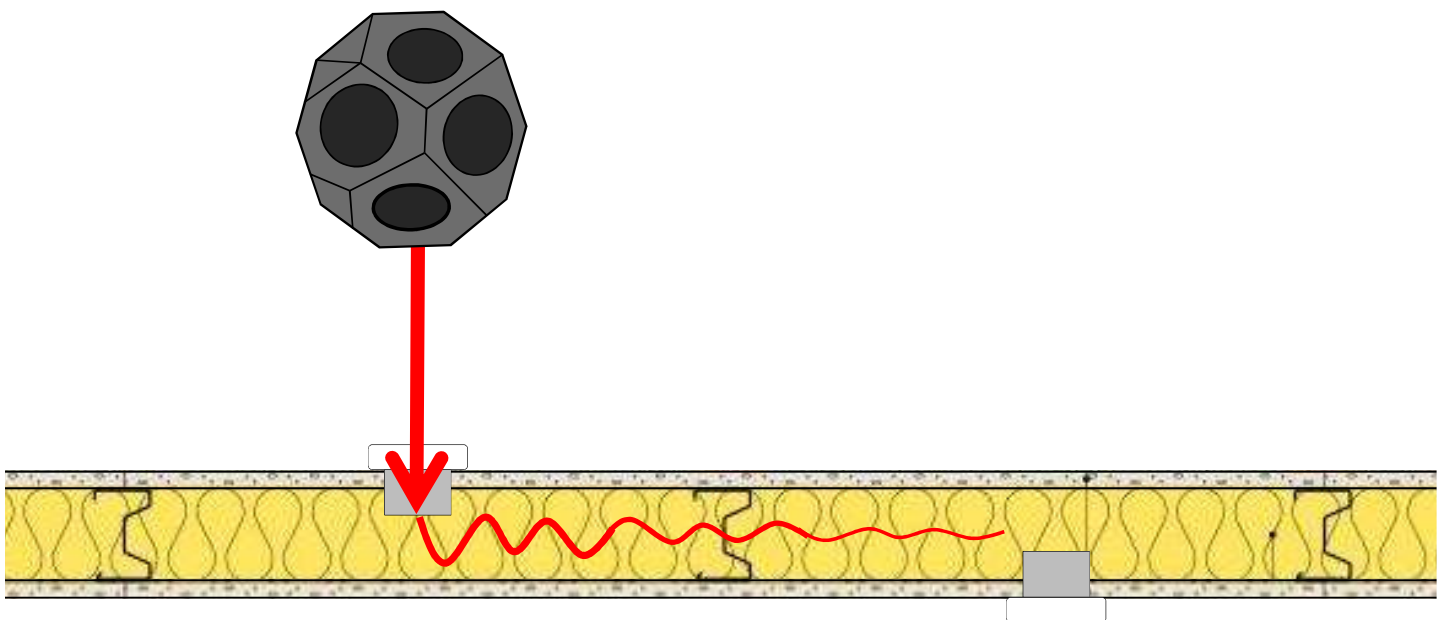


Åtgärda den "svagaste" delen









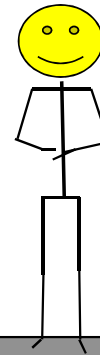
Ljudisolering - Ljud är som vatten - Bygg "vattentätt"



Stegljudsnivå



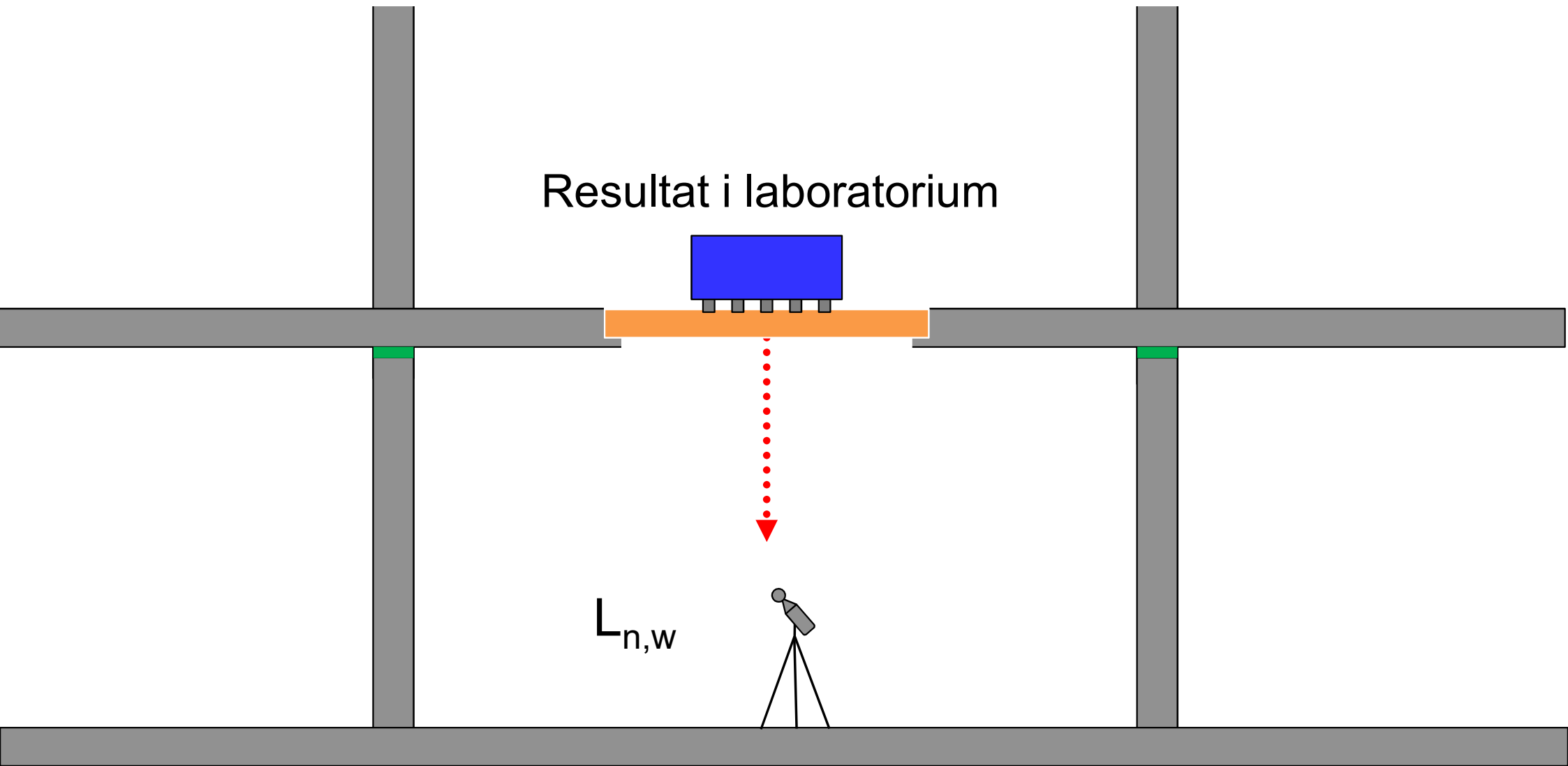
Bra stegljudsisolering
Låg nivå



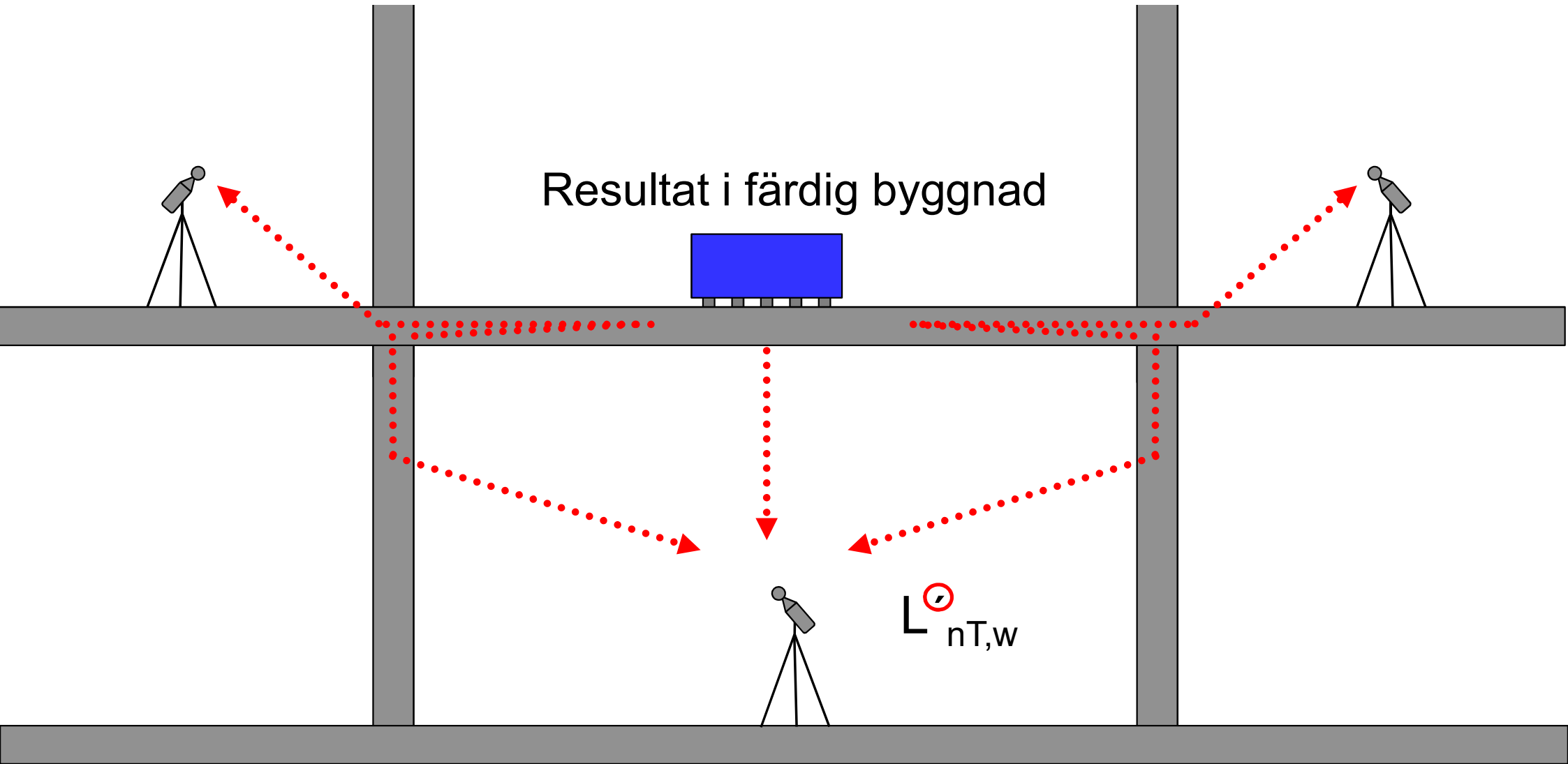
A black rectangular device with a handle on top and five legs at the bottom, resting on a wooden floor. The device has a white label in the center that reads "5 kolvar".

5 kolvar

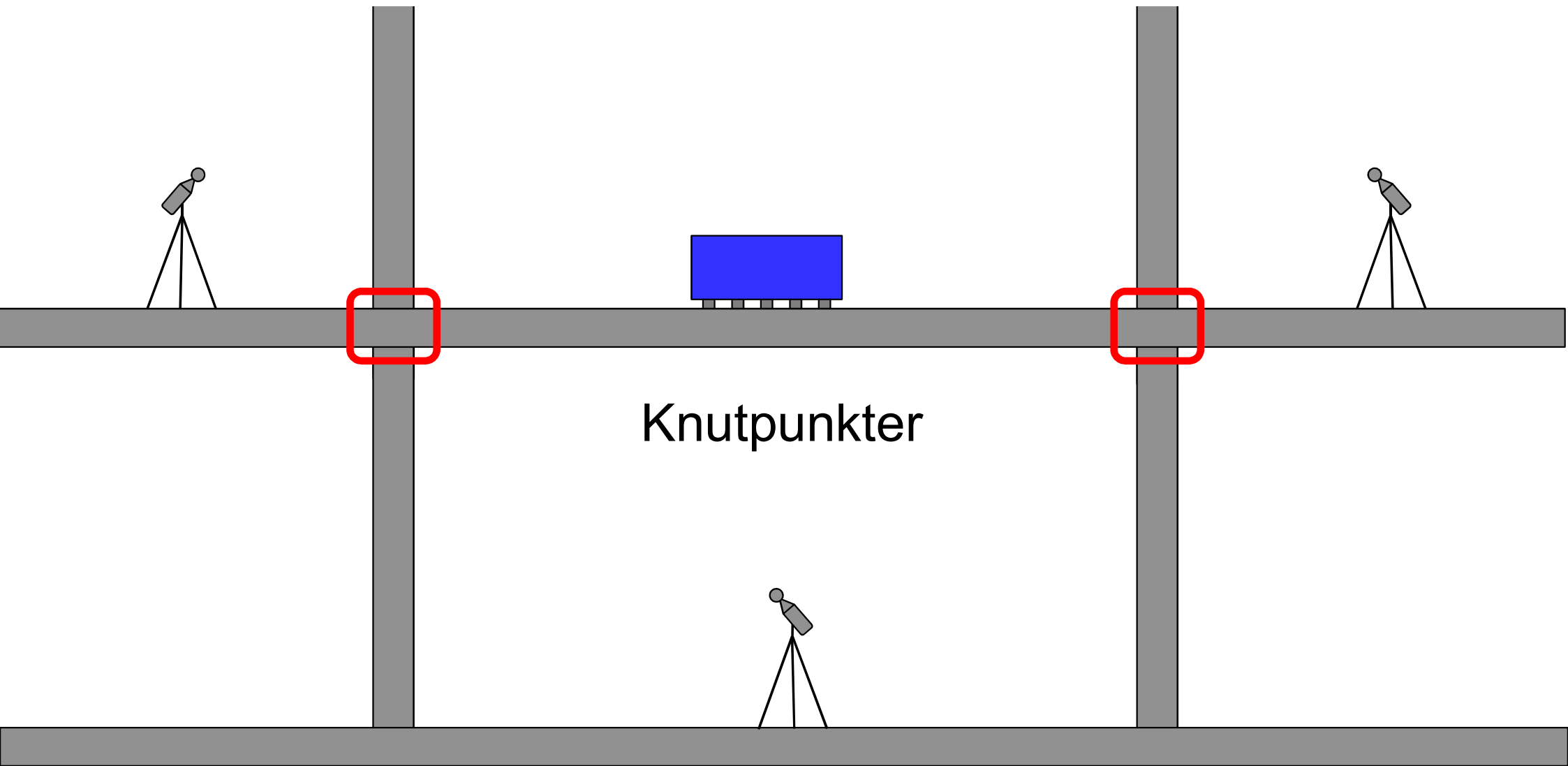
Resultat i laboratorium

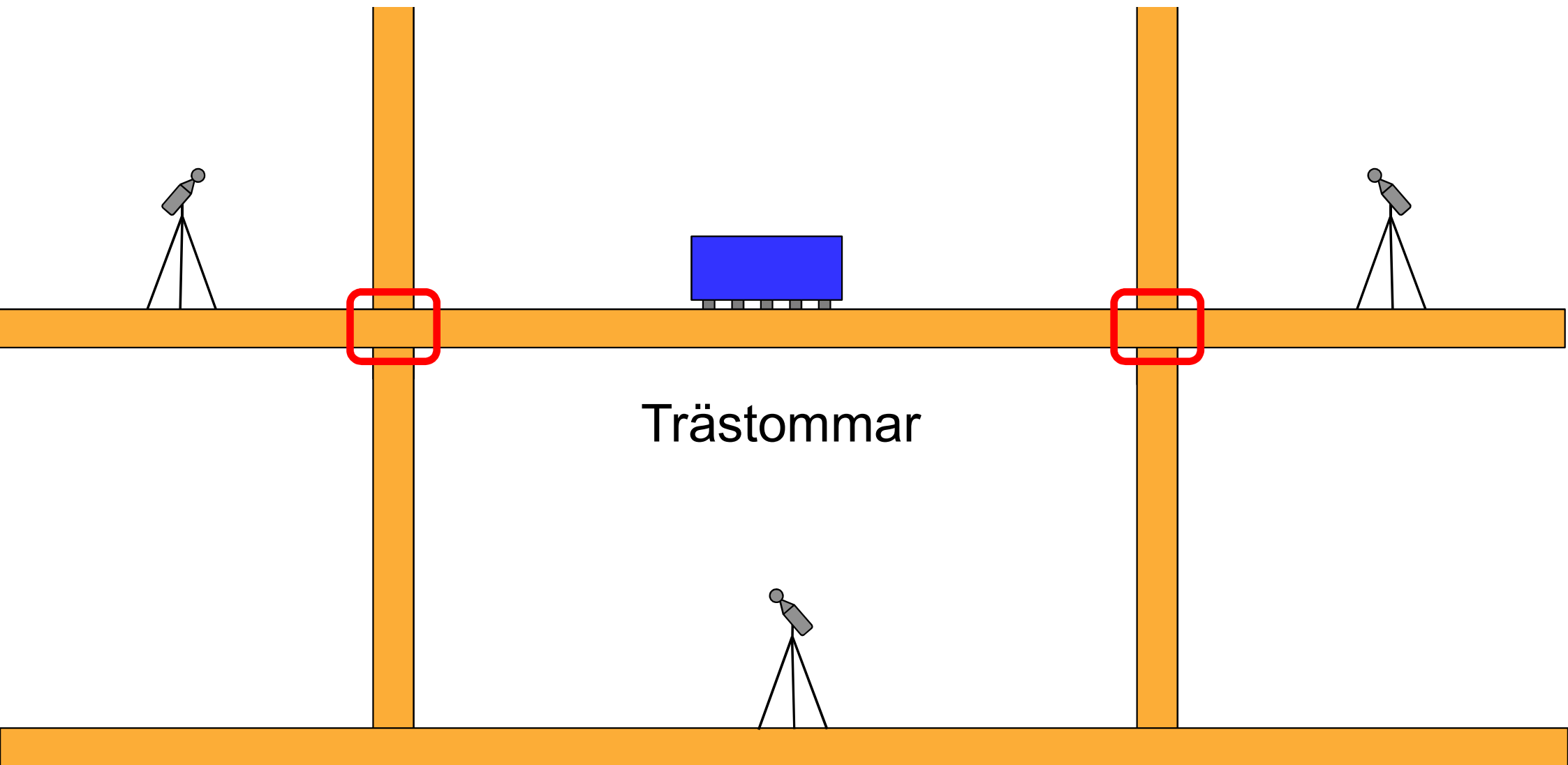


Resultat i färdig byggnad

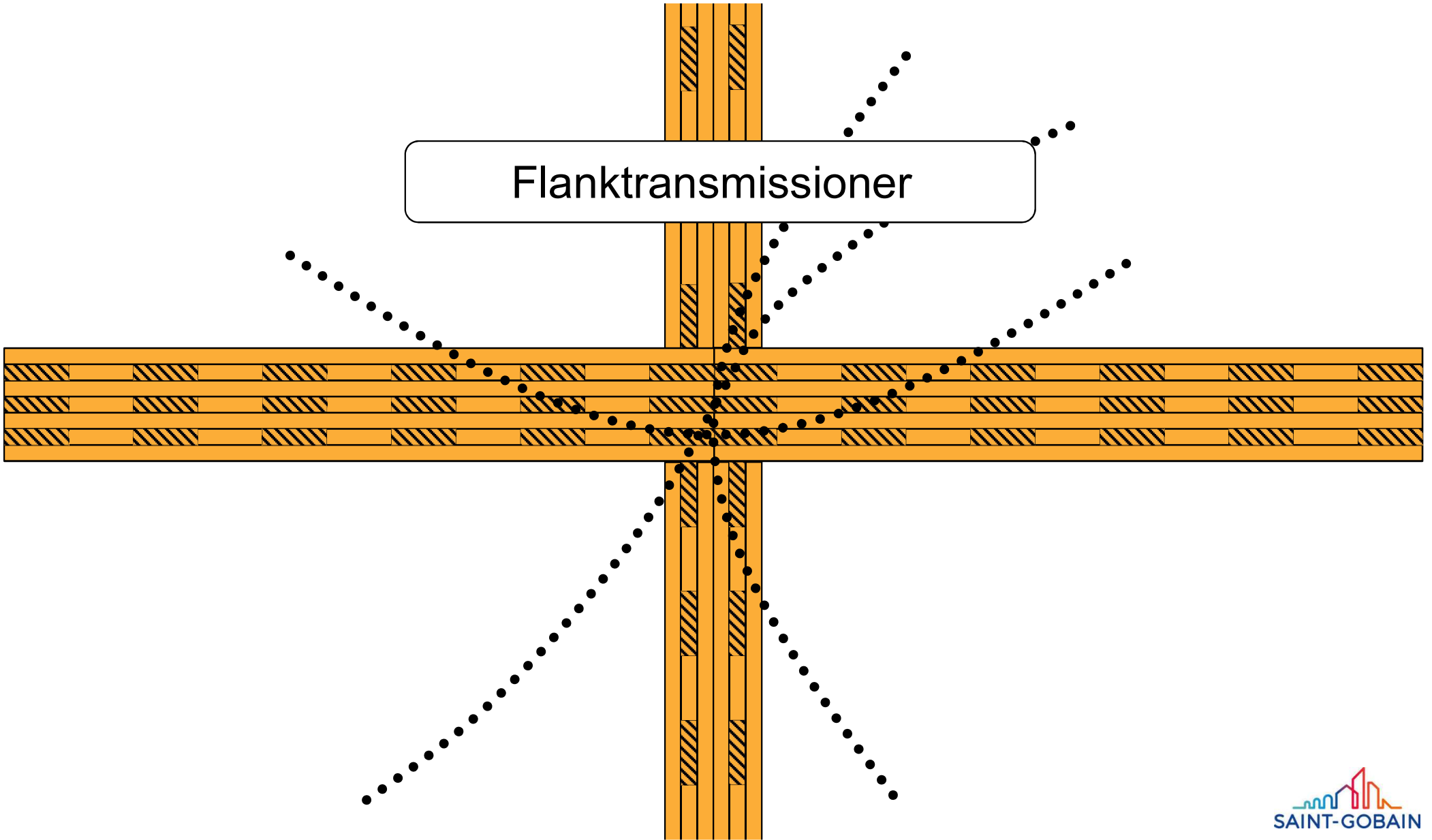


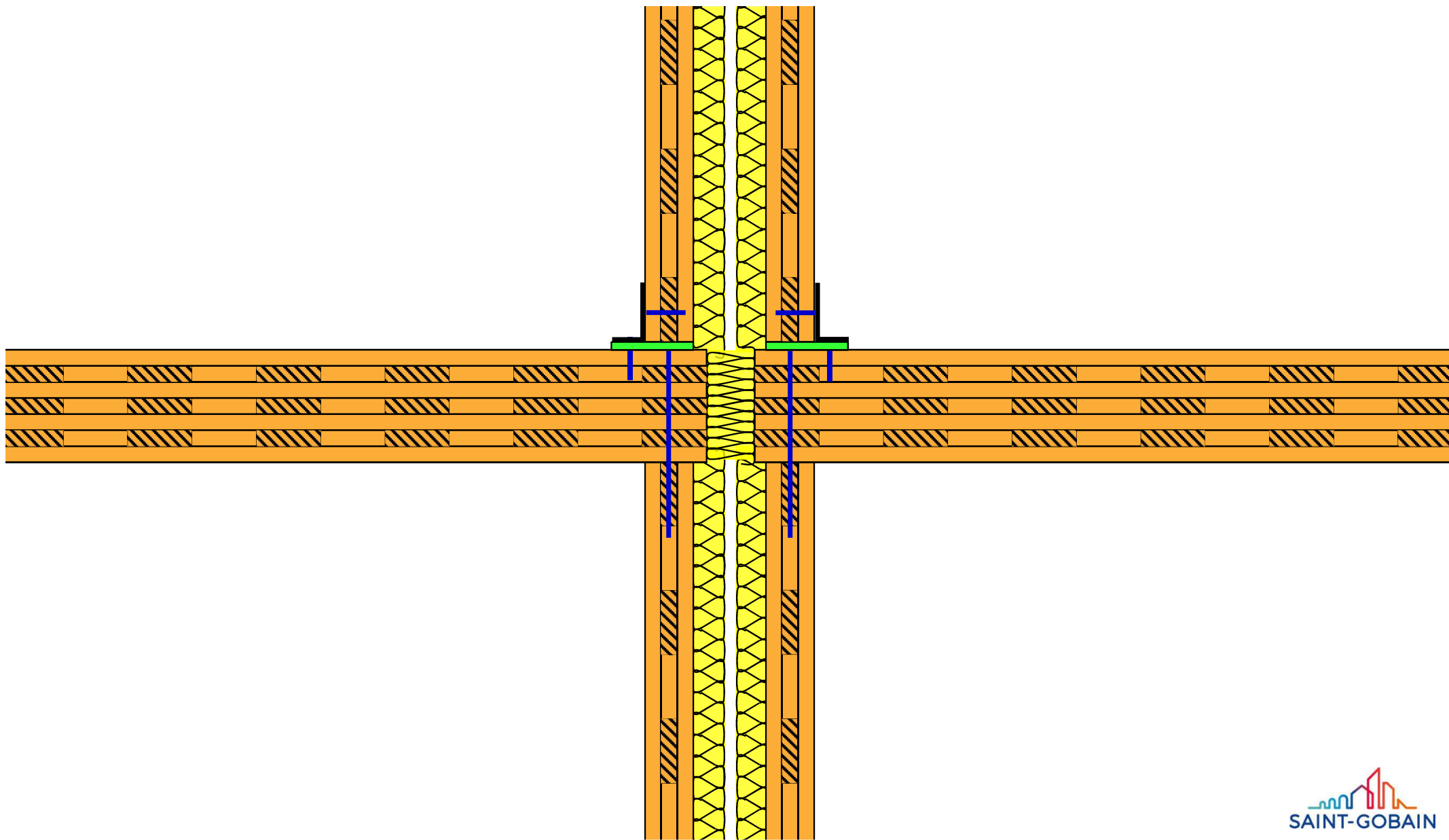
$L_{nT,w}$



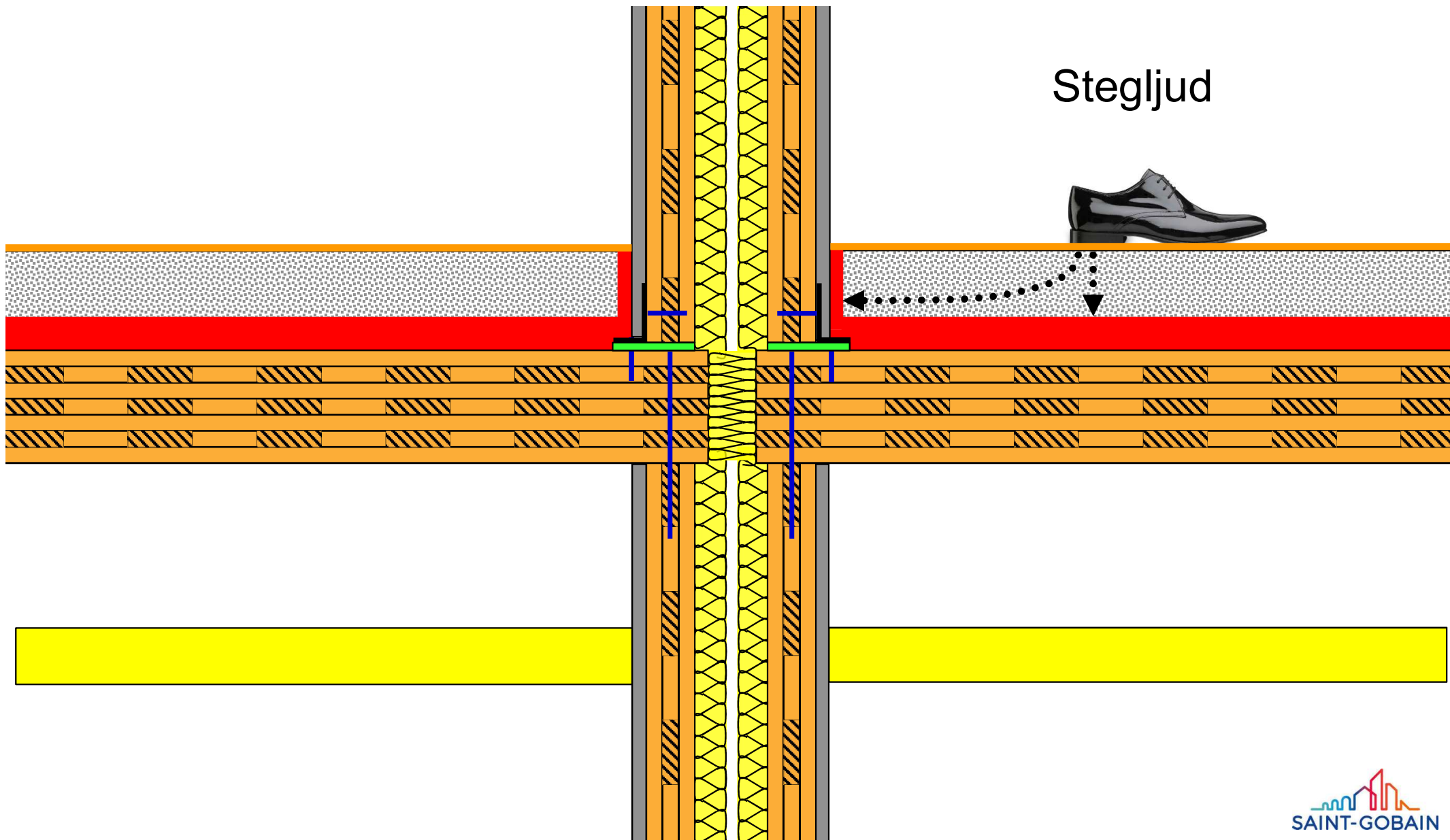


Flanktransmissioner

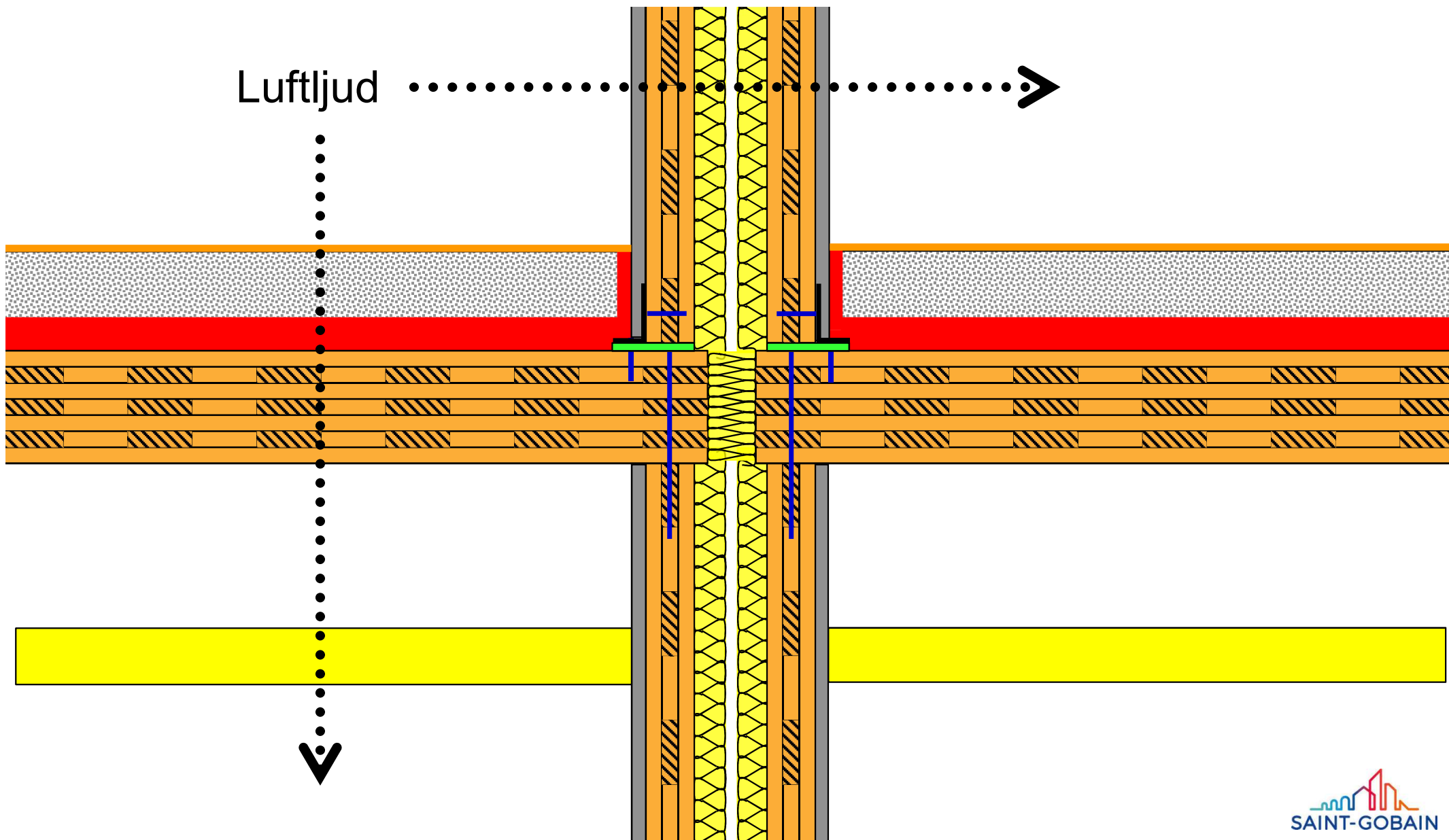




Stegljud



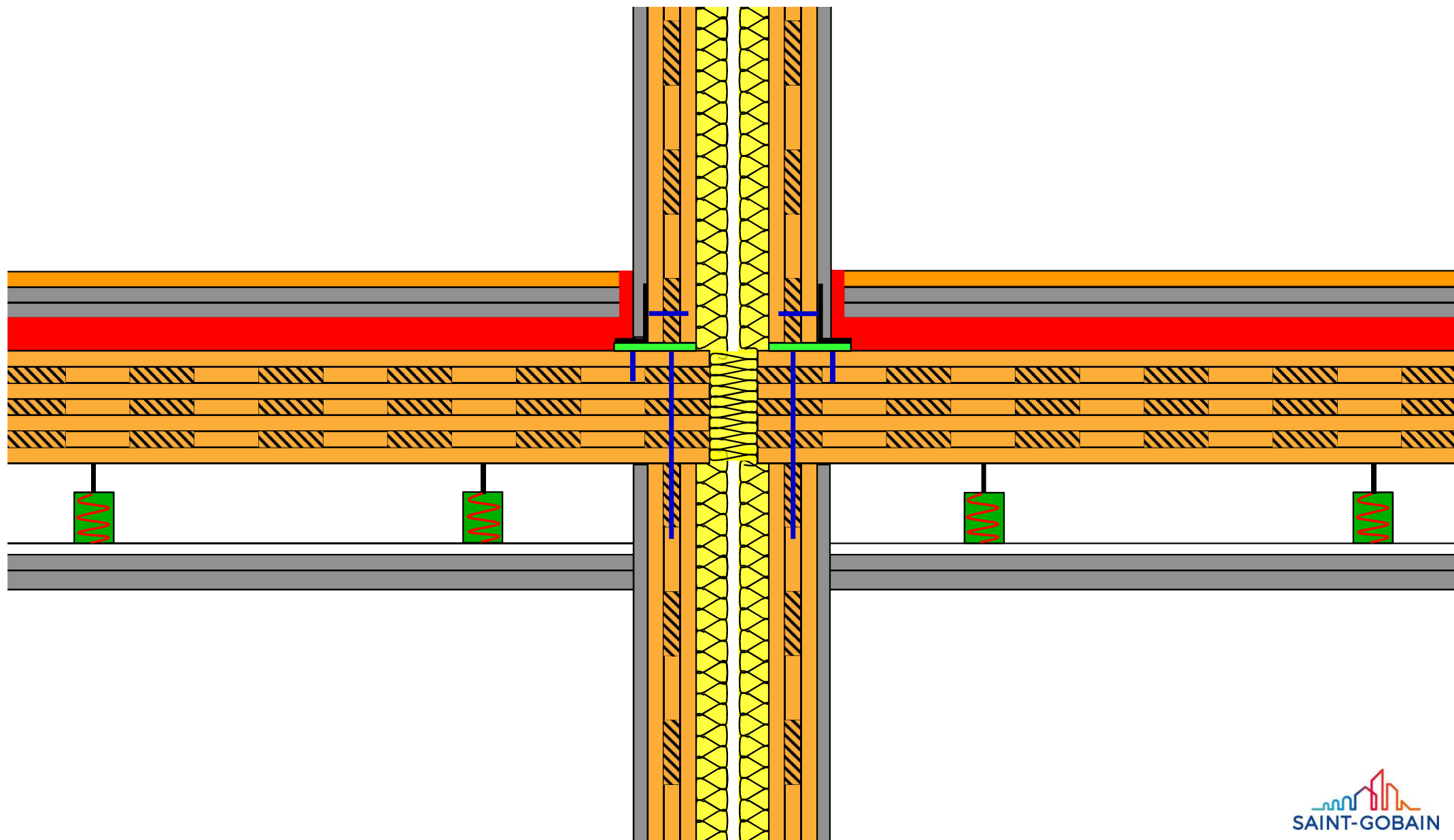
Luftljud



Tabell 2 – Högsta vägda standardiserad stegljudsnivå, $L_{nT,w,50}$, i dB

Typ av utrymme	Ljudklass ^a		
	A ^b	B ^b	D
Från utrymme utanför bostad till utrymme i bostad	48	52	60 ^c
I följande fall gäller dock:			
-	44	48	56
-	48	52	62 ^c
-	58	62	66 ^c
- från loftgång, trapphus eller korridor till bostad i entréplan ^e	48	52	62 ^c
Inom bostad med fler än 2 bostadsrum till minst ett bostadsrum	68	-	-

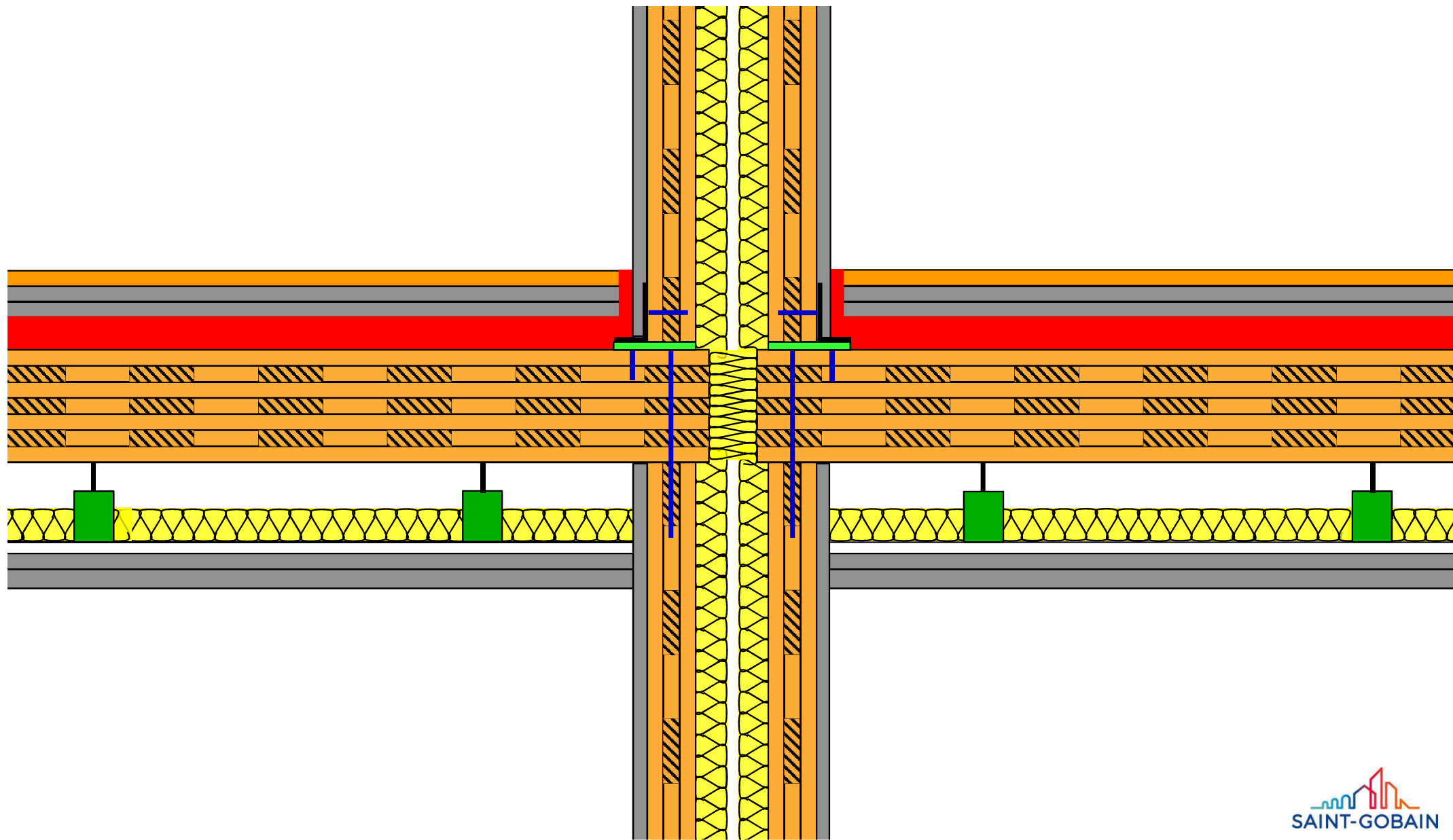
BBR Ljudklass C 56 dB



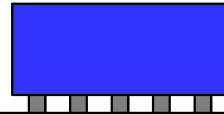




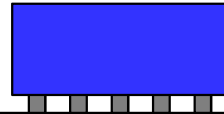




"Lätta" bjälklag



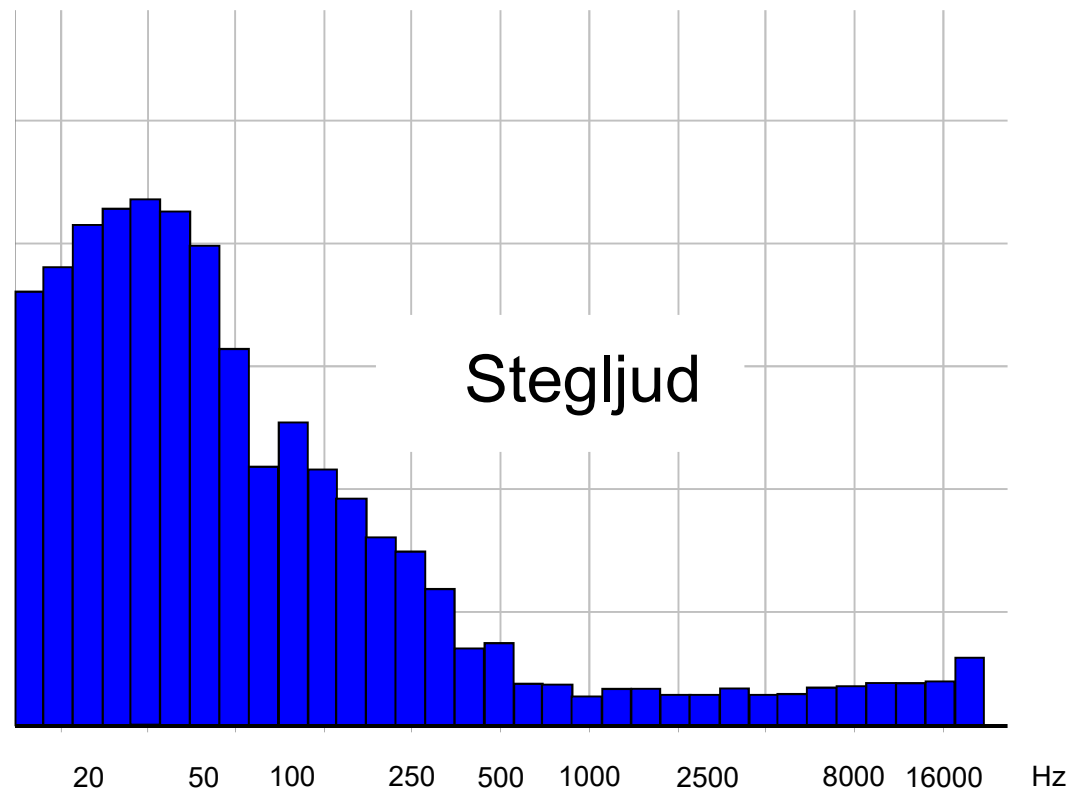
"Tunga" bjälklag



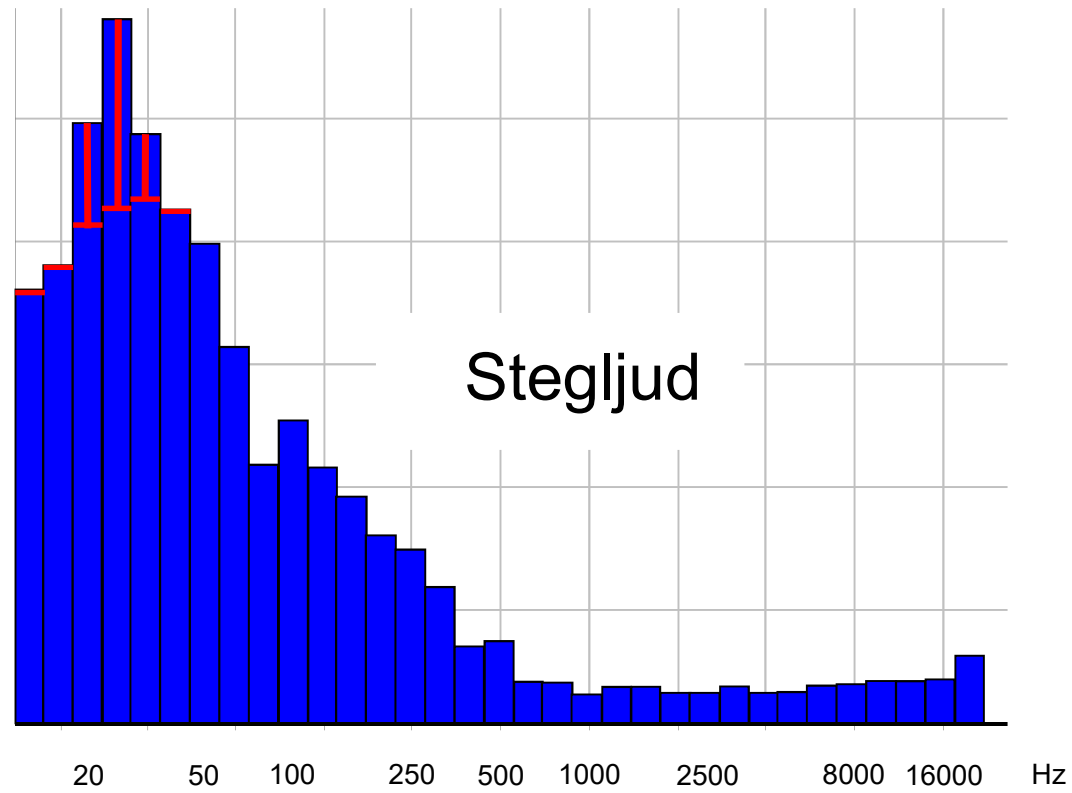
Ljudnivån



"Tunga" bjälklag



"Lätta" bjälklag





Akustiska utmaningar

Utmaningen - Låga frekvenserna

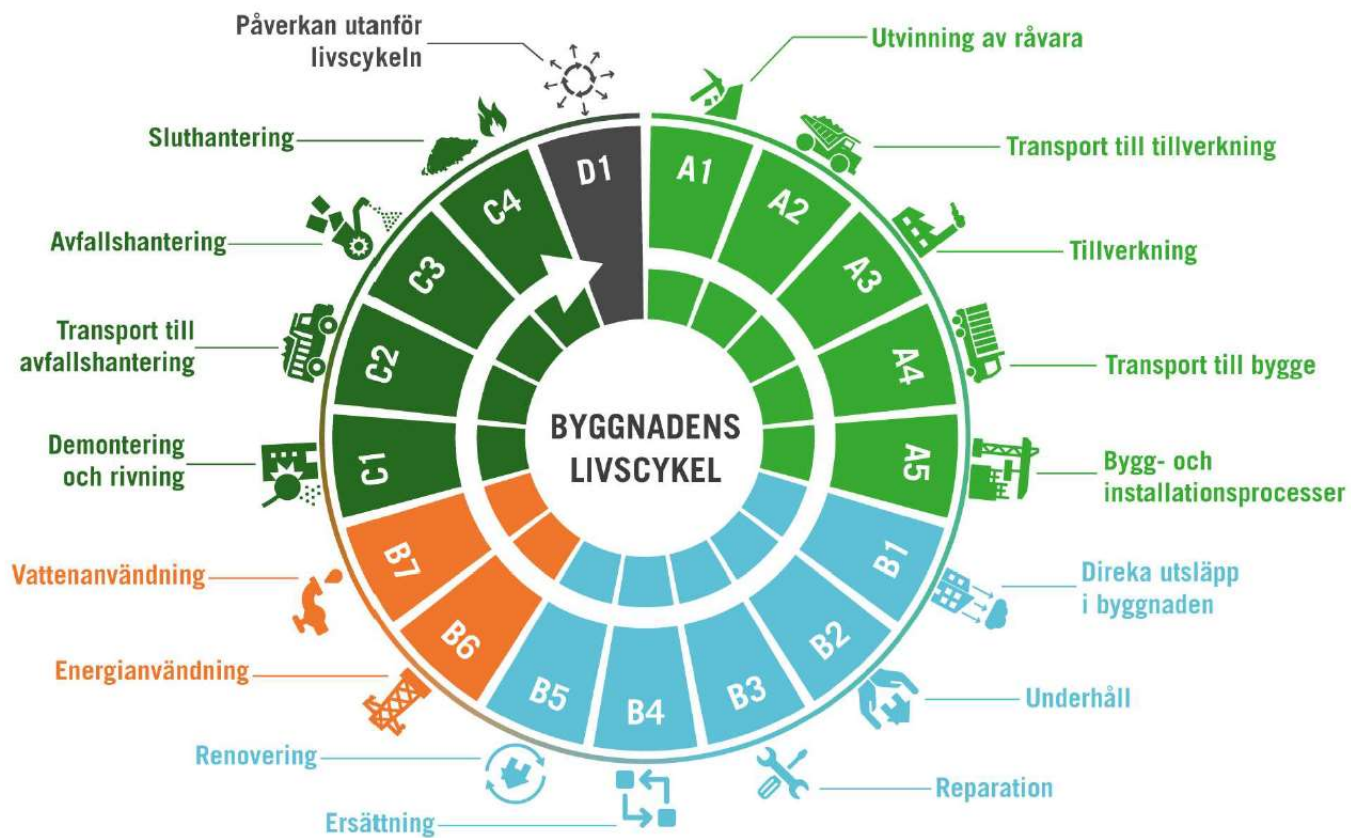
Miljövänliga hus - bra ljudmiljö

Anlita en akustiker

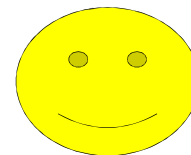


Byggnadens klimatpåverkan







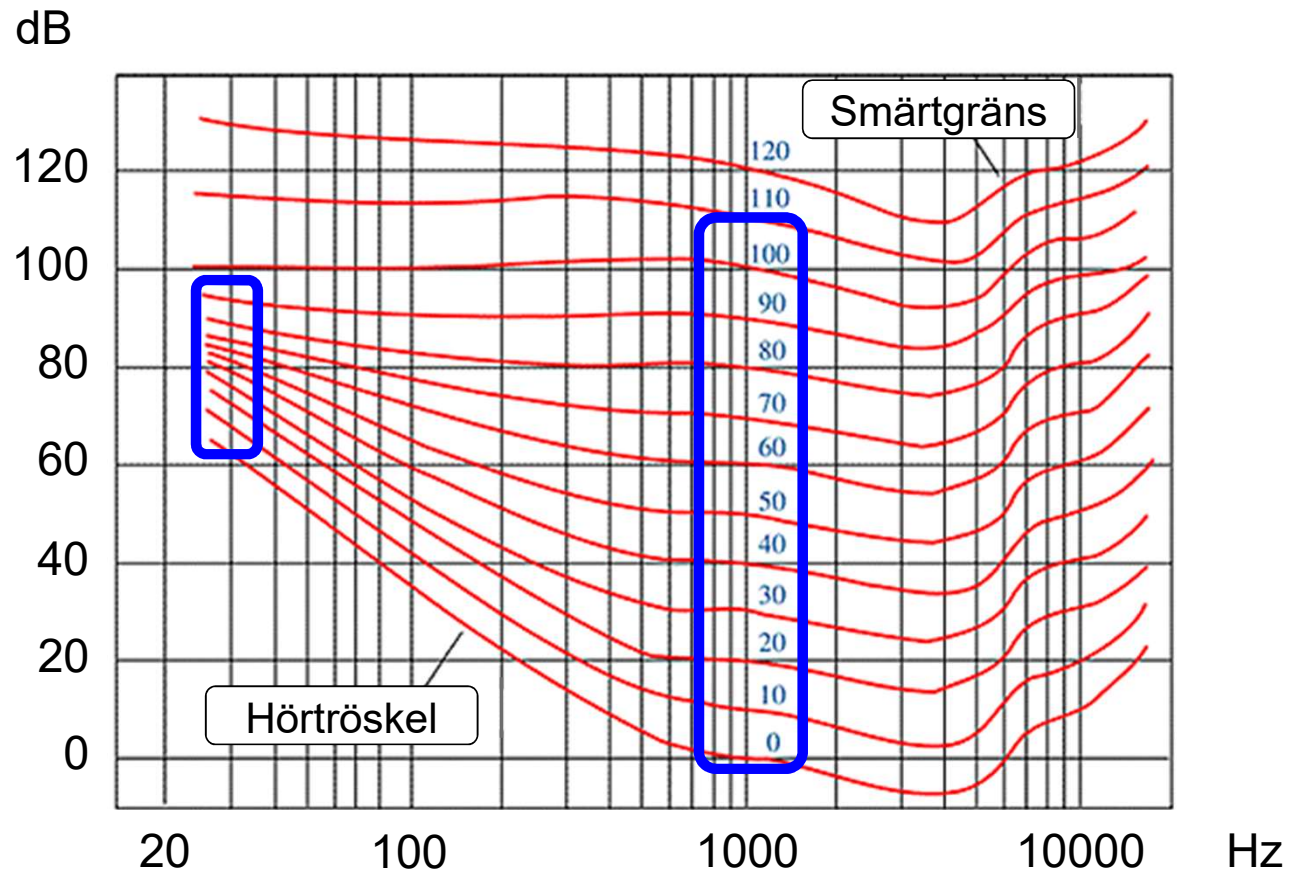


Byggnadens klimatpåverkan

Noll CO₂



"Phonkurvor"



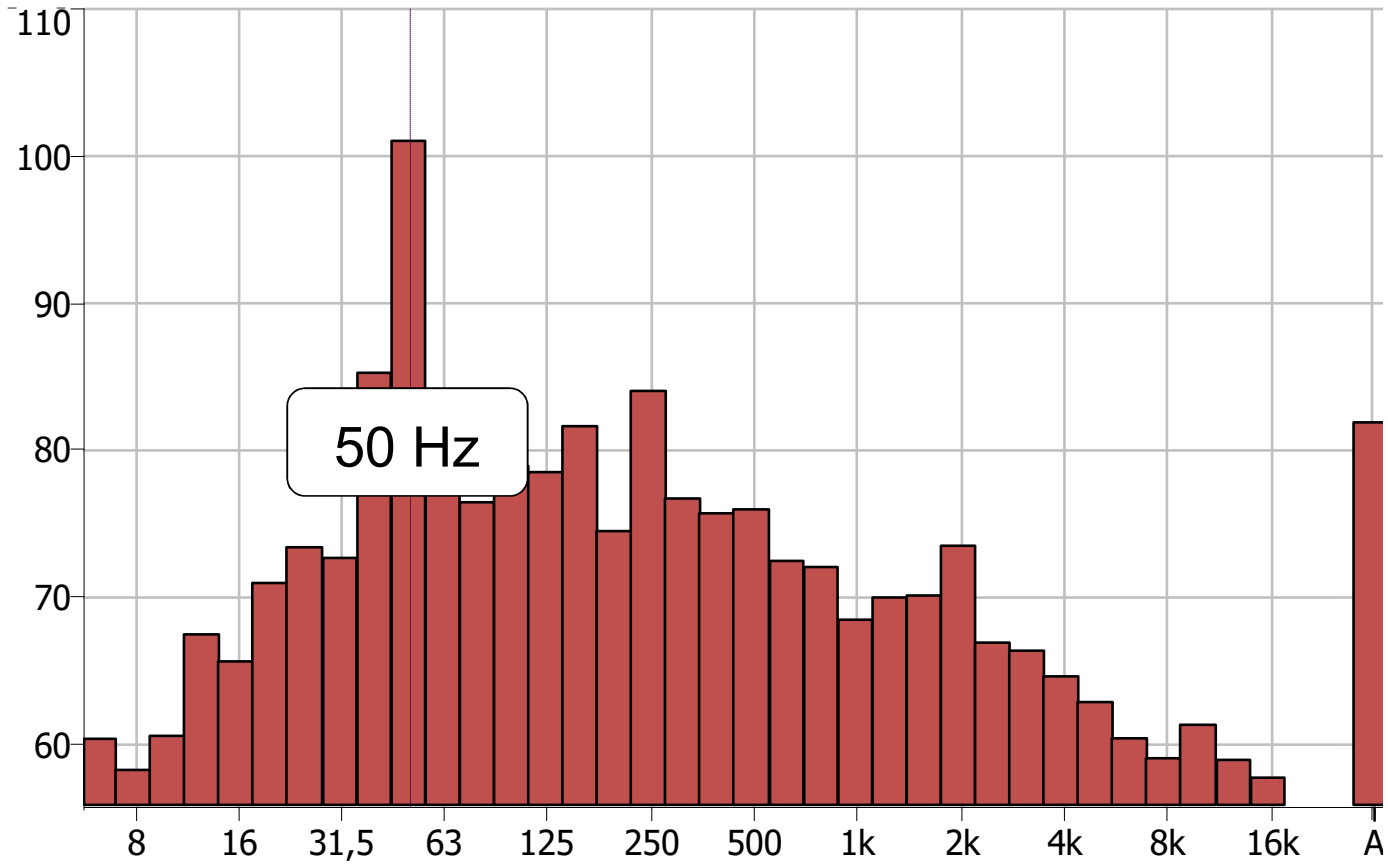
"Tätare"

10 dB





101 dB



82 dBA

Sammanfattning

Våra sinnen fungerar bäst utomhus

90% - inomhus

Vi mår bra av naturliga ljud

Vi störs av **lågfrekventa** ljud



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” We shape our buildings,
and afterwards our buildings shape us.”