Why are Acoustics Important for Natural Ventilation?

A CIBSE Natural Ventilation Group Webinar
Tues 8th May 2018

Ze Nunes & Owen Connick

MACH GROUP

Breathing Buildings

Agenda

- Why are acoustics important for natural ventilation?
- What are the different factors that pull on ventilation design?
- What tools are available to aid designers in balancing these competing tensions?

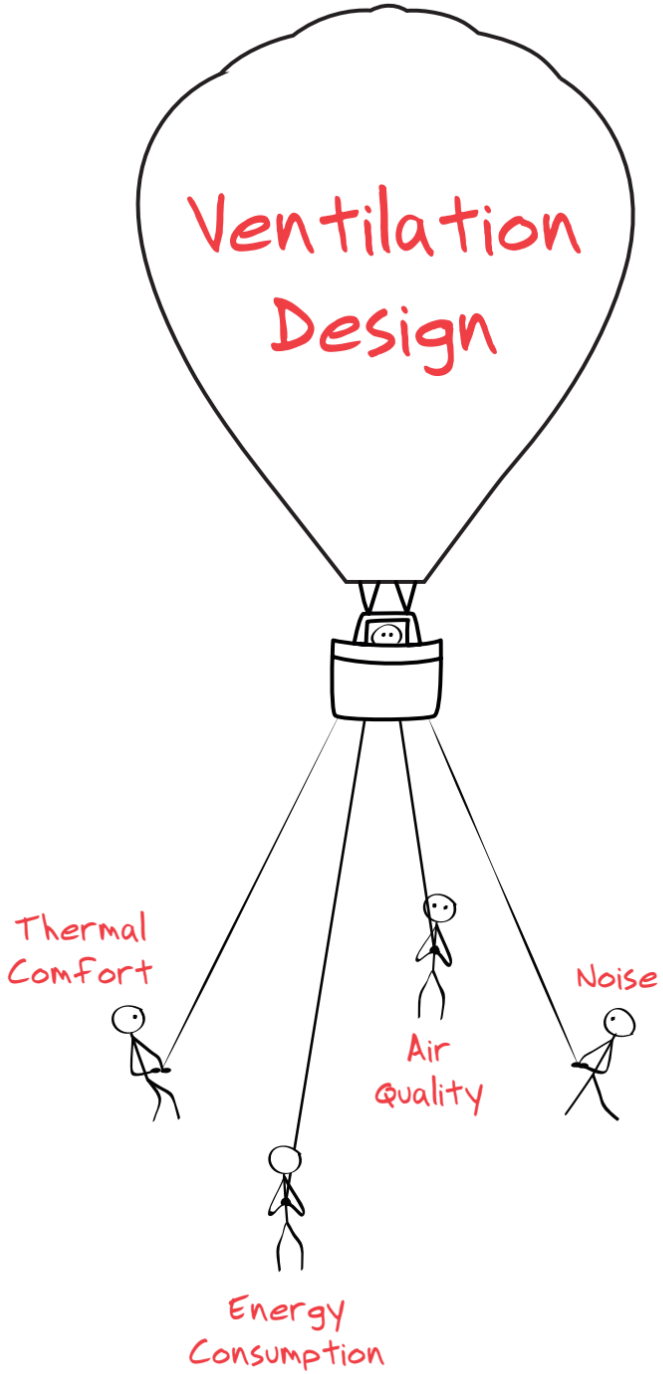
Why it matters…

Health implications of long-term exposure to elevated noise levels include:

- Annoyance
- Speech Intelligibility / Hearing Impairment
- Hypertension
- Sleep Disruption
- …

Regulations governing noise levels in the UK:

- Offices / Non-domestic new builds = **British Standard BS8233**
- Schools / Education = **Building Bulletin BB93**


Ventilation Design
Thermal Comfort
Air Quality
Noise
Energy Consumption

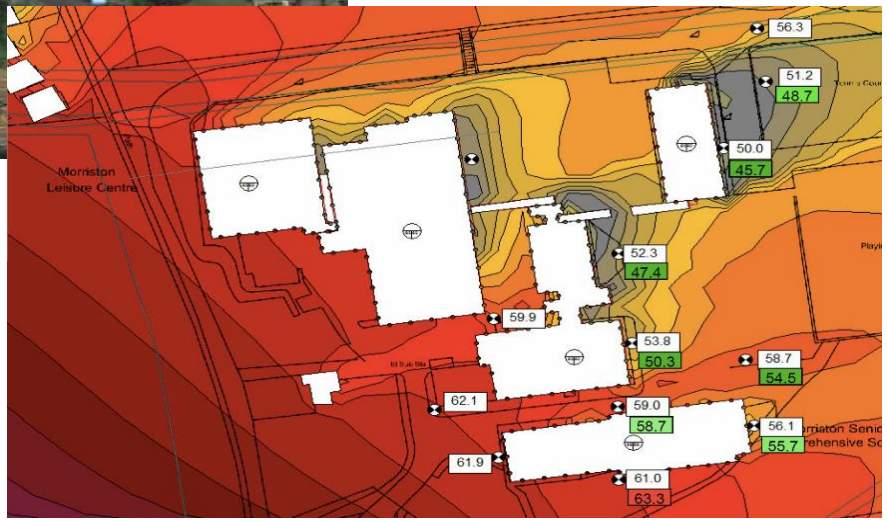
Tools for Managing Noise

1. **Site Mapping** – Understanding the Site/Location

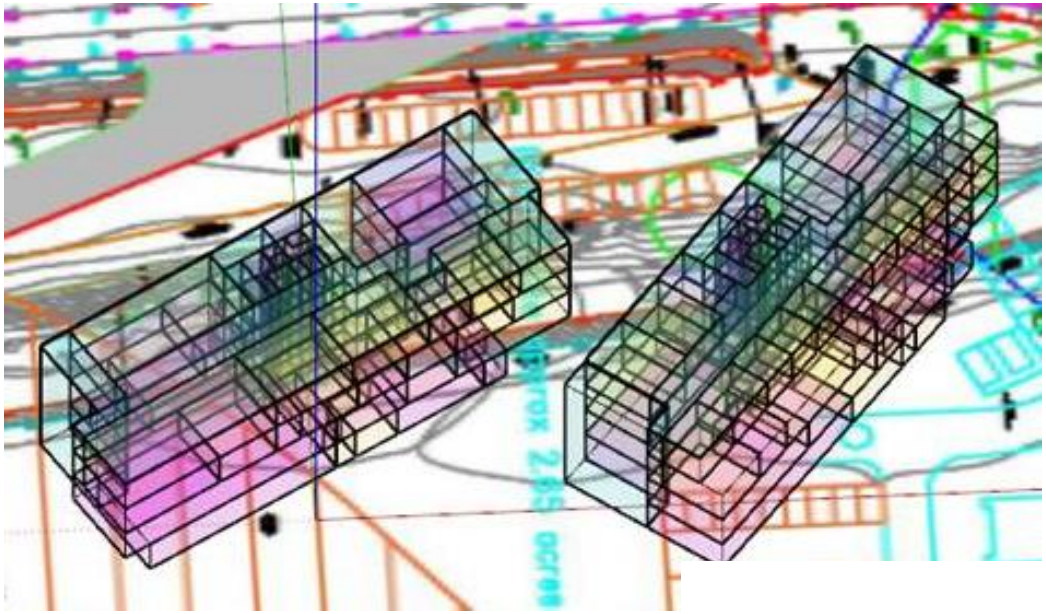
2. **Ventilation Design** – Building Layout & Ventilation Type

3. **Ventilation Design** – Façade and Vent Shaping for acoustics benefits

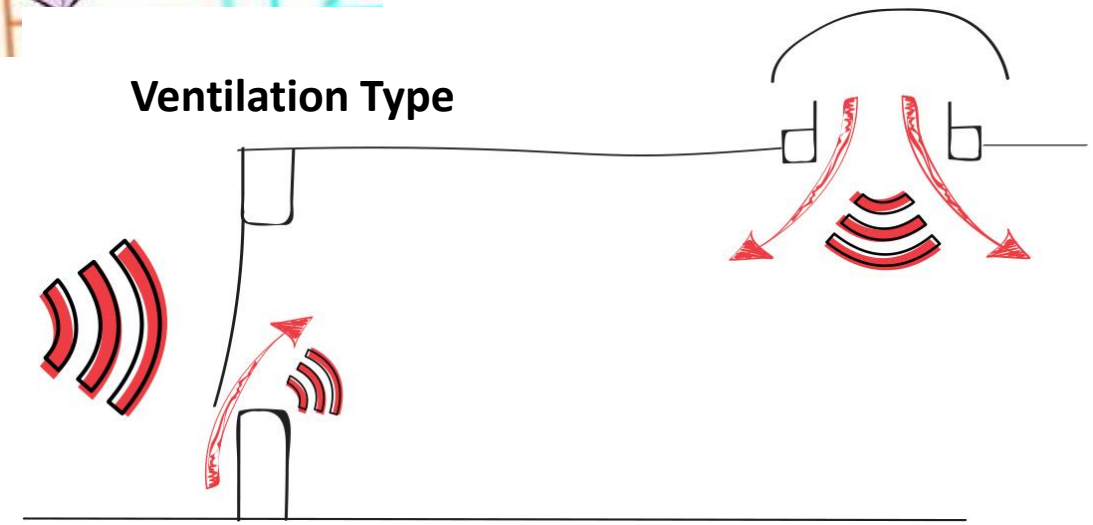
Tools for Managing Noise – **Site Mapping**



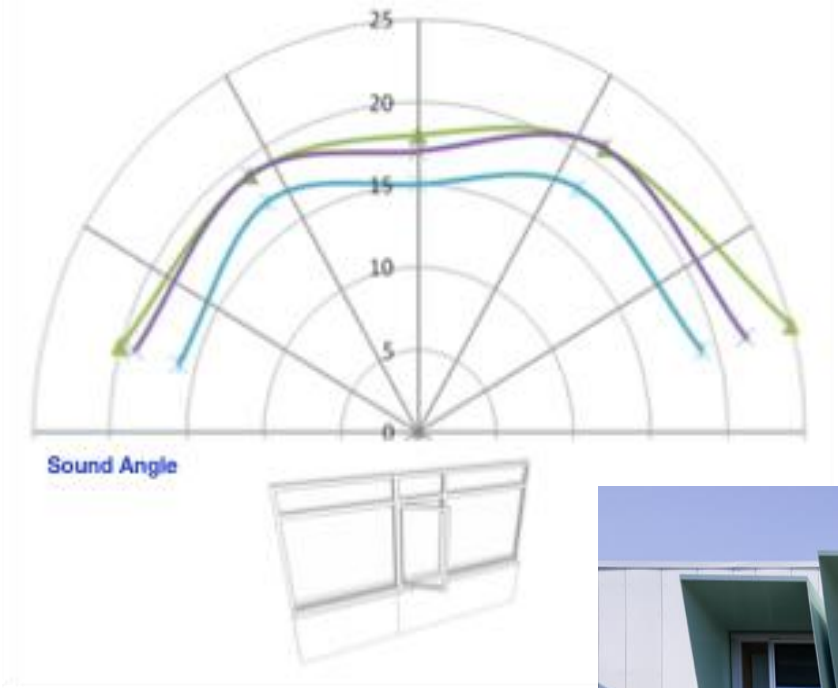
Building Massing



Ventilation Type



Tools for Managing Noise – **Façade and Vent Shaping**



Tools for Managing Noise

1. **Site Mapping** – Understanding the Site/Location

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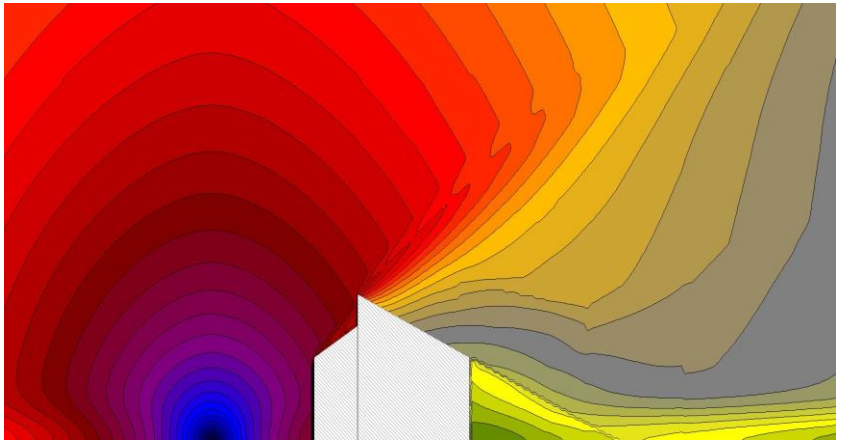
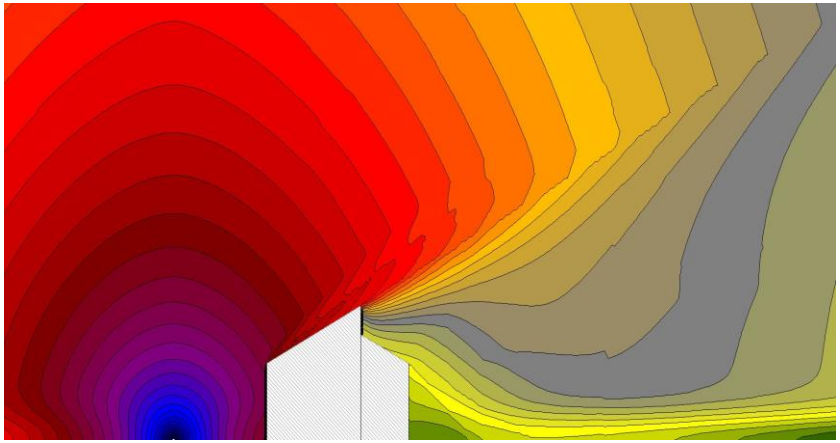
Case study 1 - Early Noise Mapping

Case study 2 – The Detailed Noise Mapping

Case study 3 – Intelligent Noise Mapping & Ray Tracying



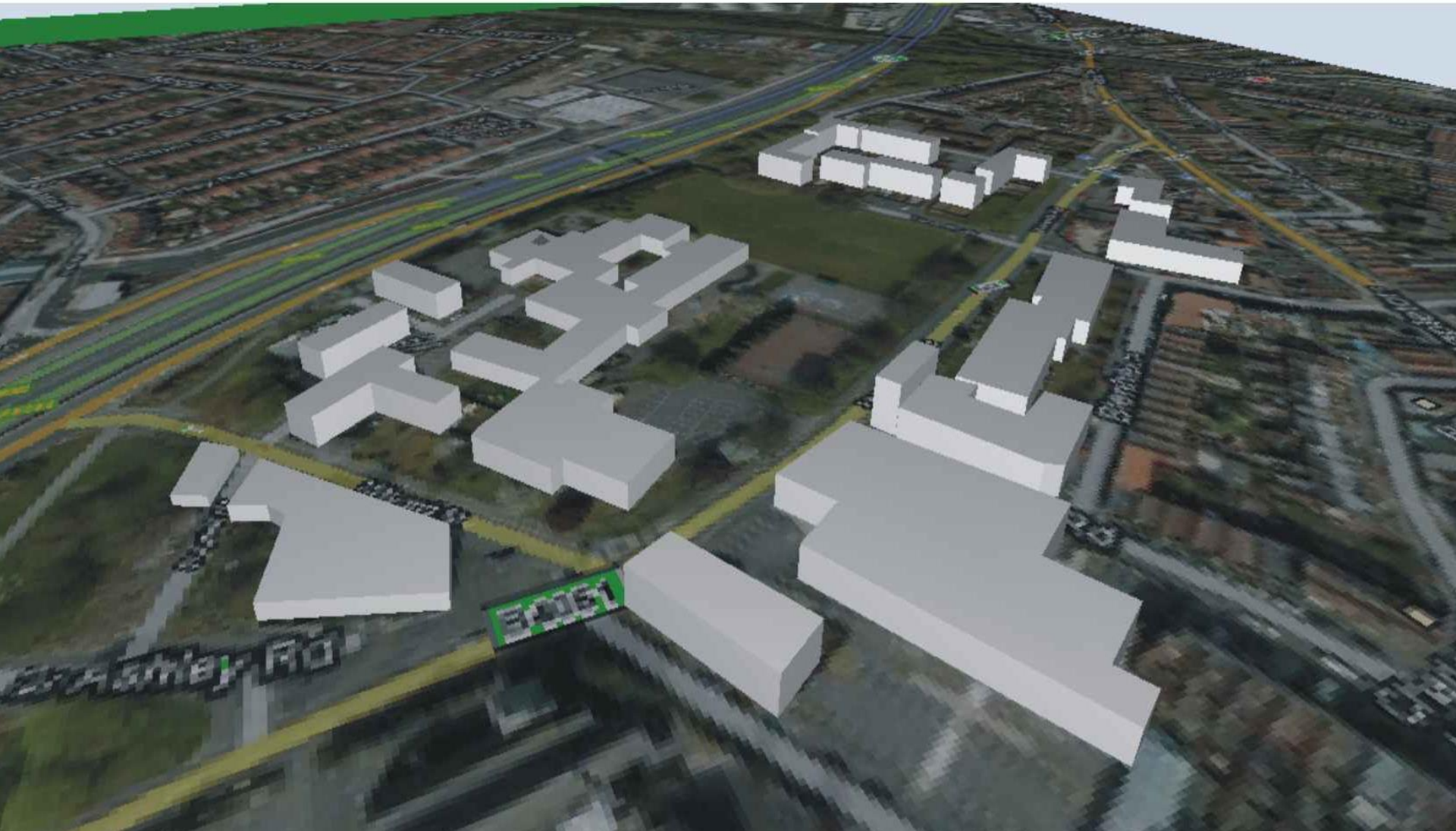


Case study 1 - Early Noise Mapping

School site adjacent to the M32, Bristol – Making the most of this site

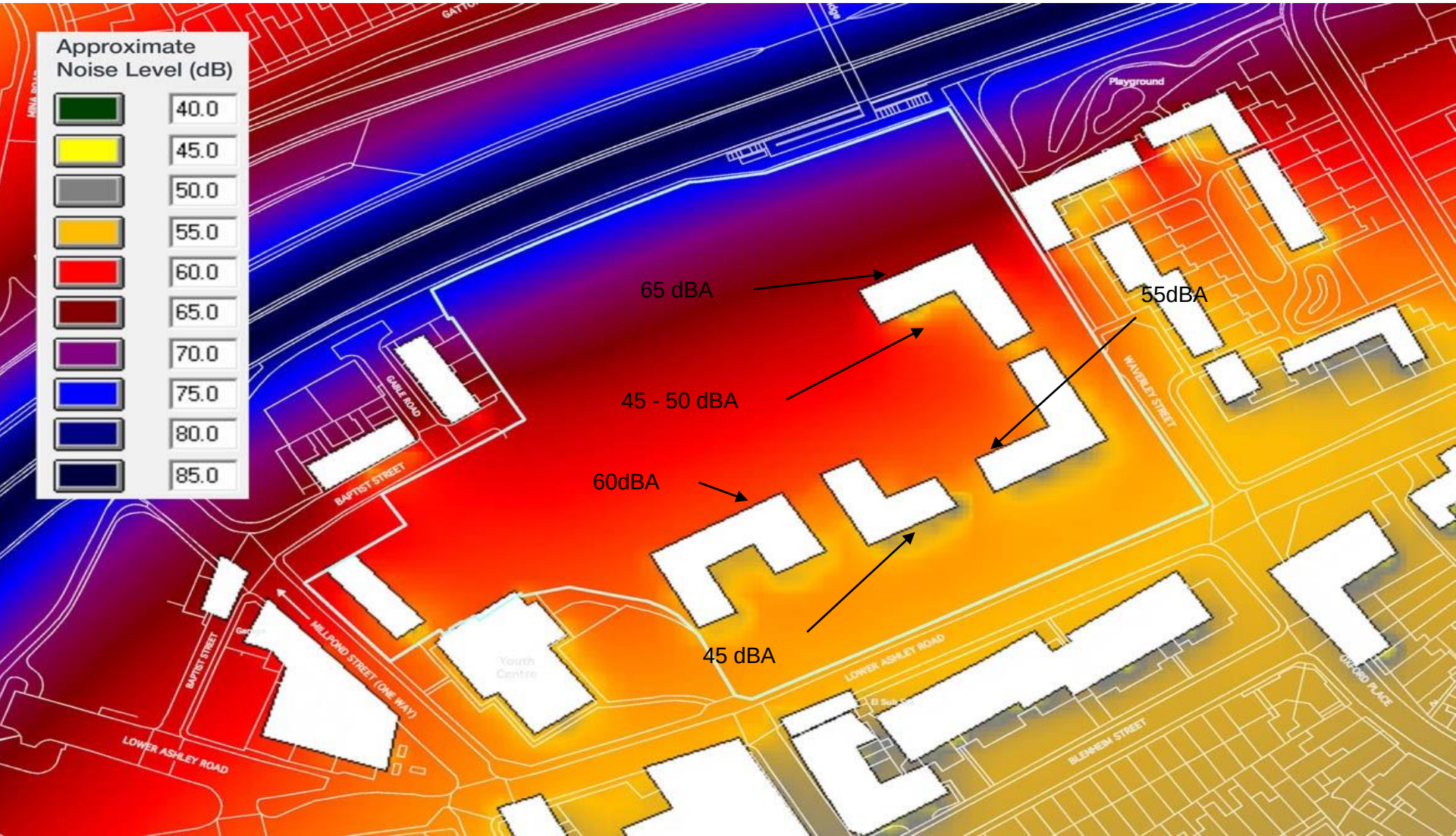
Case study 1 - Early Noise Mapping

Firstly with import the site detail and add the adjacent buildings



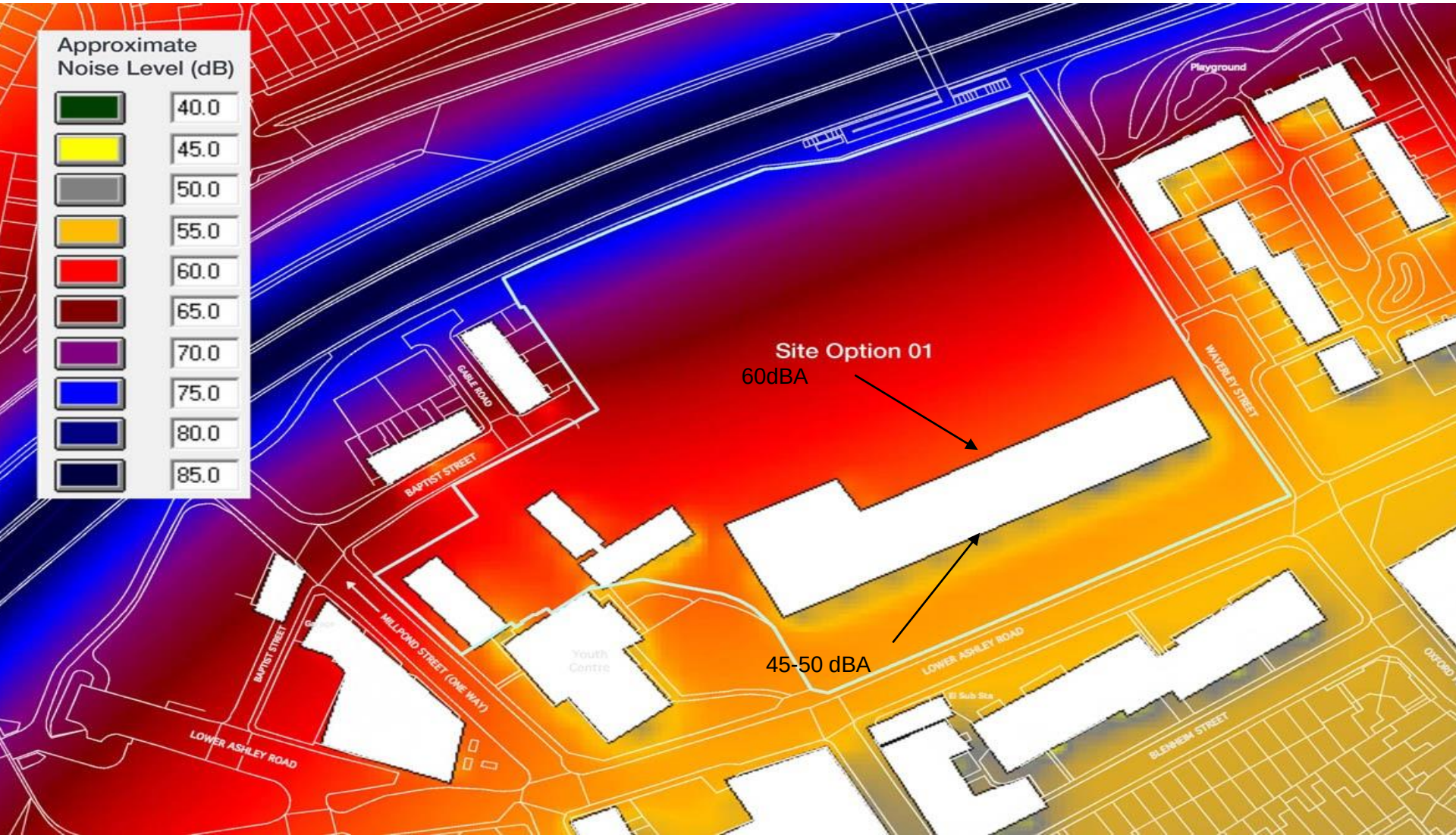
Case study 1 - Early Noise Mapping

Option 1 – External Calculation



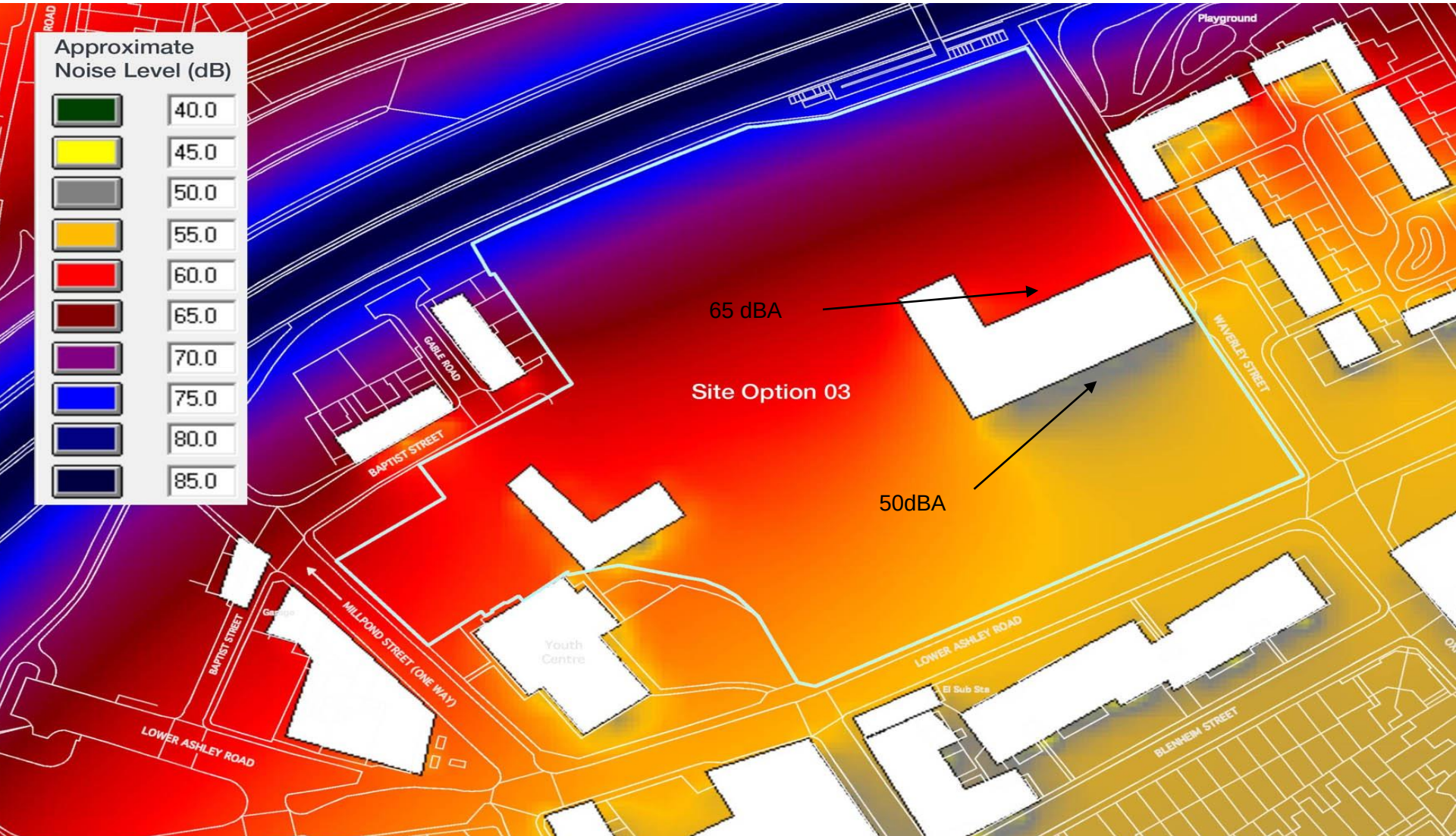
Case study 1 - Early Noise Mapping

Option 2 – Traditional dual aspect design



Case study 1 - Early Noise Mapping

Option 3 – Two story option reducing the building footprint



Case study 2 – The Detailed Noise Mapping

Morriston Comprehensive adjacent to the M4 – **Noise?**

Case study 2 – The Detailed Noise Mapping

Embankment to the **West** of the site

Case study 2 – The Detailed Noise Mapping

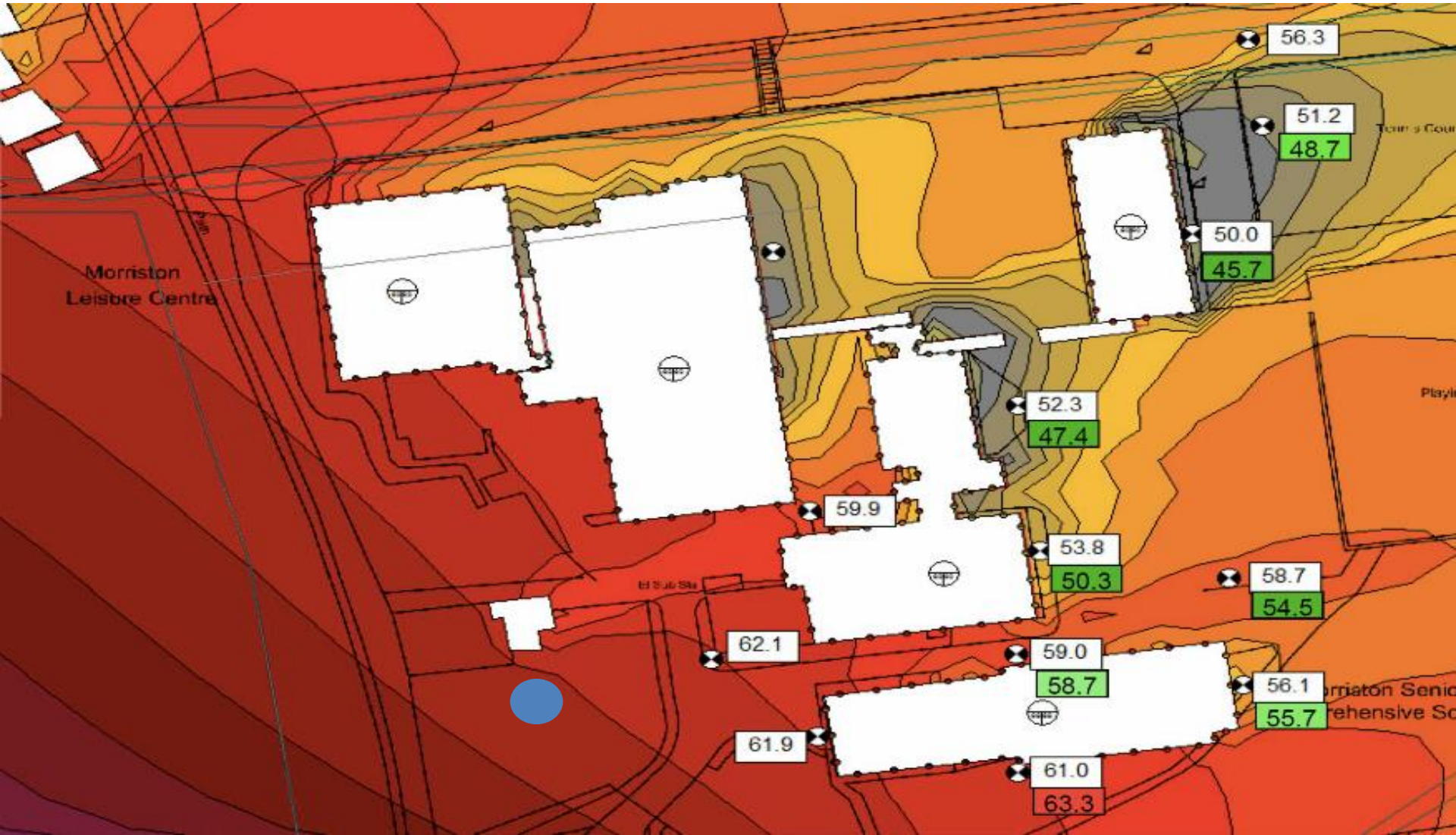
Large embankment to the **East** of the site

Case study 2 – The Detailed Noise Mapping

Morriston Comprehensive adjacent to the M4 – **Noise?**

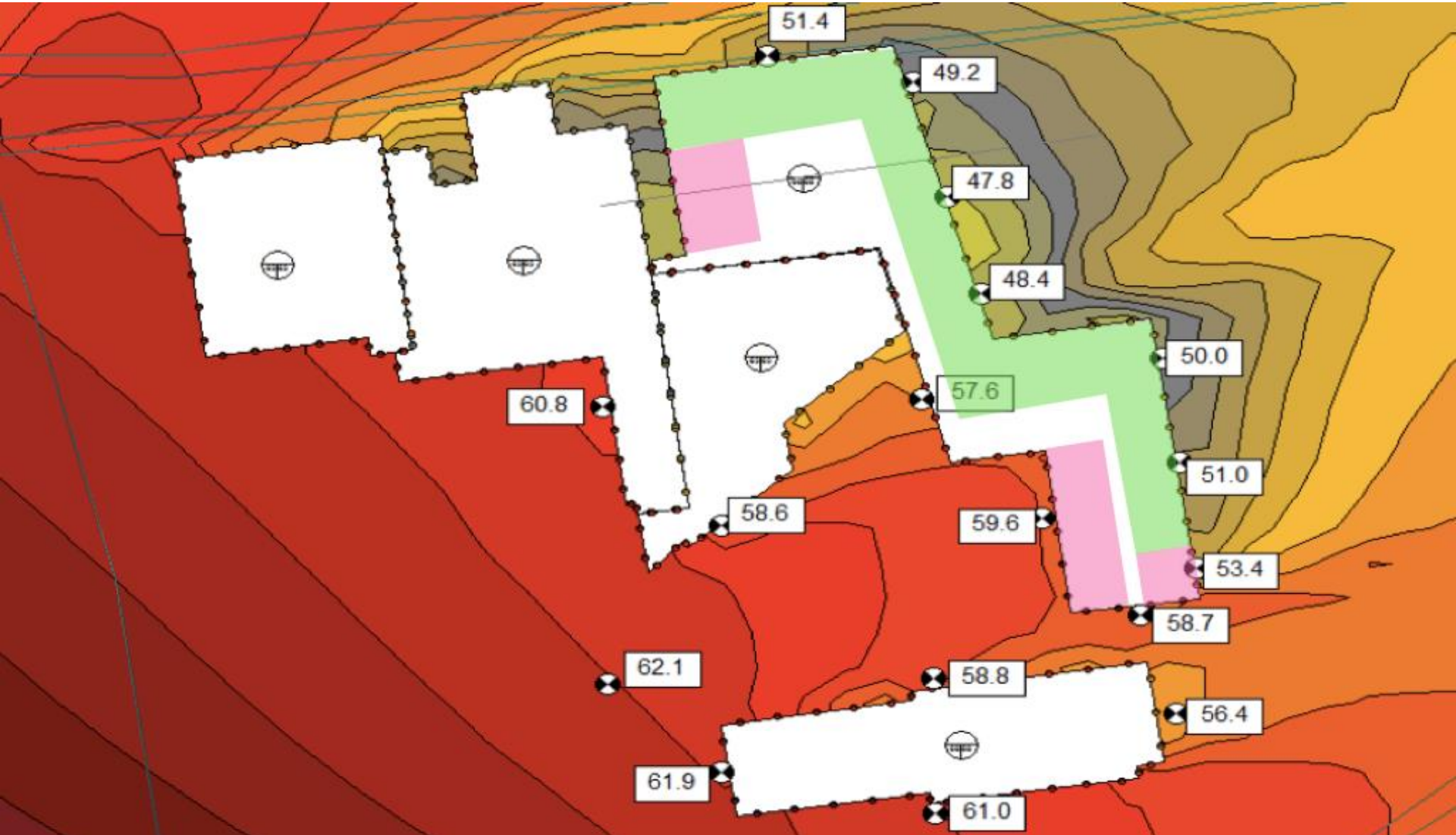
Case study 2 – The Detailed Noise Mapping

Calibrating the noise map



Case study 2 – The Detailed Noise Mapping

Noise levels at the proposed facades – Classroom vented through open windows



Case study 2 – The Detailed Noise Mapping

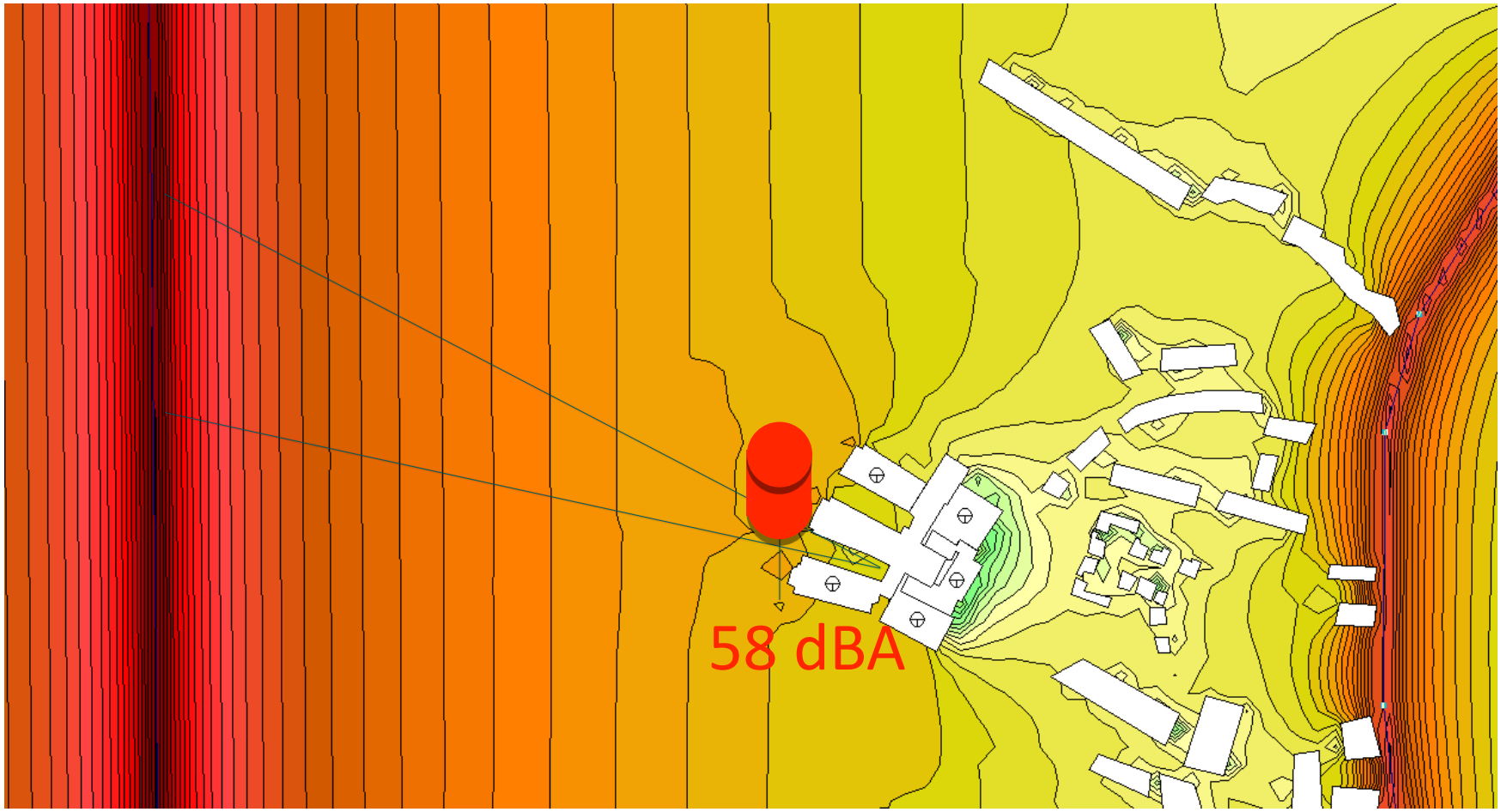
Mechanical ventilation system removed through detailed noise mapping

Case study 3 – Noise Mapping & Ray Tracing

Case Study - Broxbourne School – The effects of sound angle

Case study 3 – Noise Mapping & Ray Tracing

Calibrated noise map of Broxbourne School

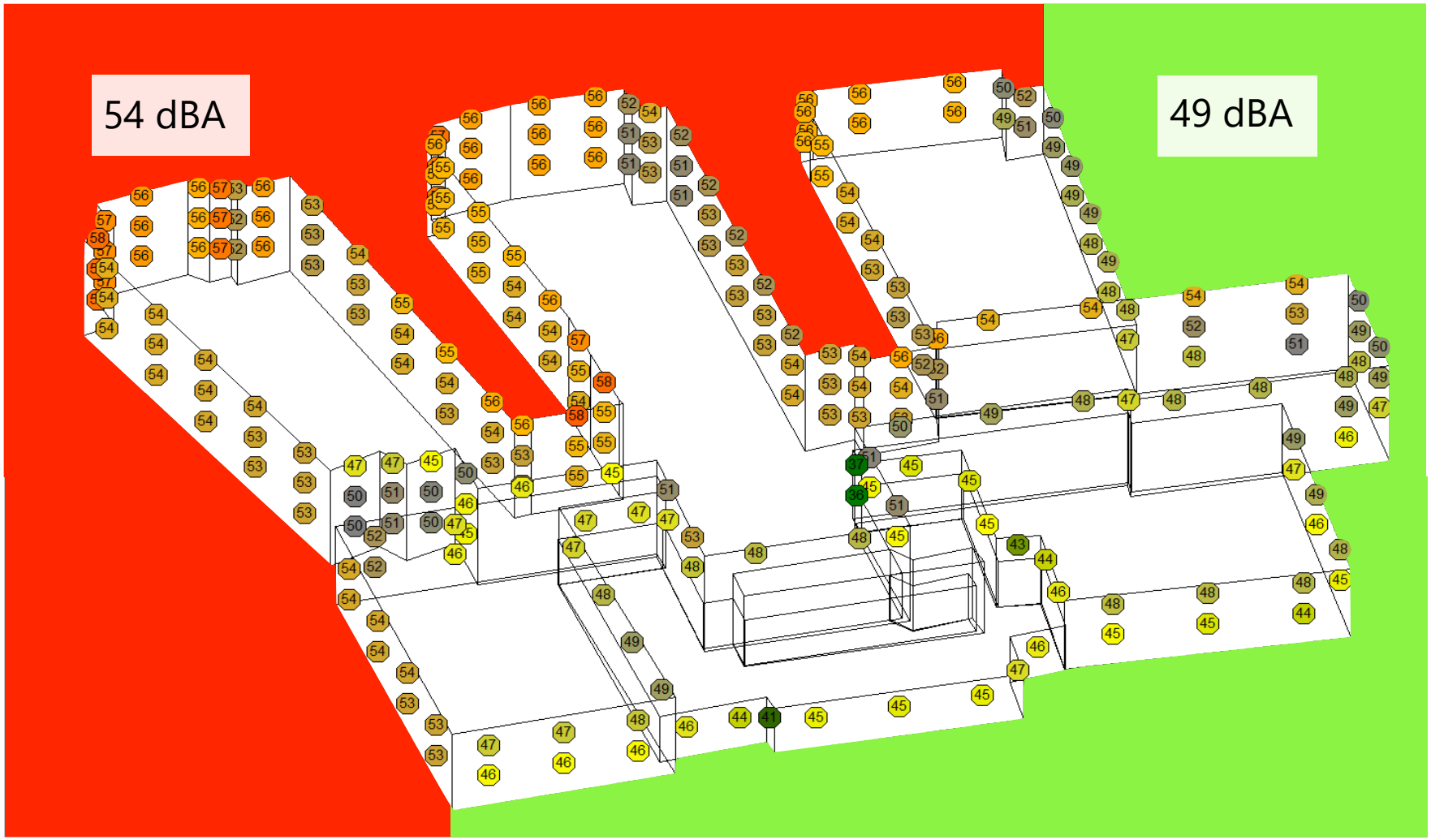


The sound reduction of open windows

Document name	Quoted value for open window sound insulation performance
BB93 - Acoustics for Schools	10-15dB Rw
BS8233:1999	10dB or 15dB
WHO (1999)	10dB - 15dBA
Nelson – Transportation noise (1987)	5-15dB

Case study 3 – Noise Mapping & Ray Tracing

The sound reduction of open windows



Intelligent acoustics - Napier University Work

Napier University carrying out the biggest study into the acoustics performance of open windows over 425 separate test.

Napier University – Work The sound Reduction of An Open Window

Document name	Quoted value for open window sound insulation performance
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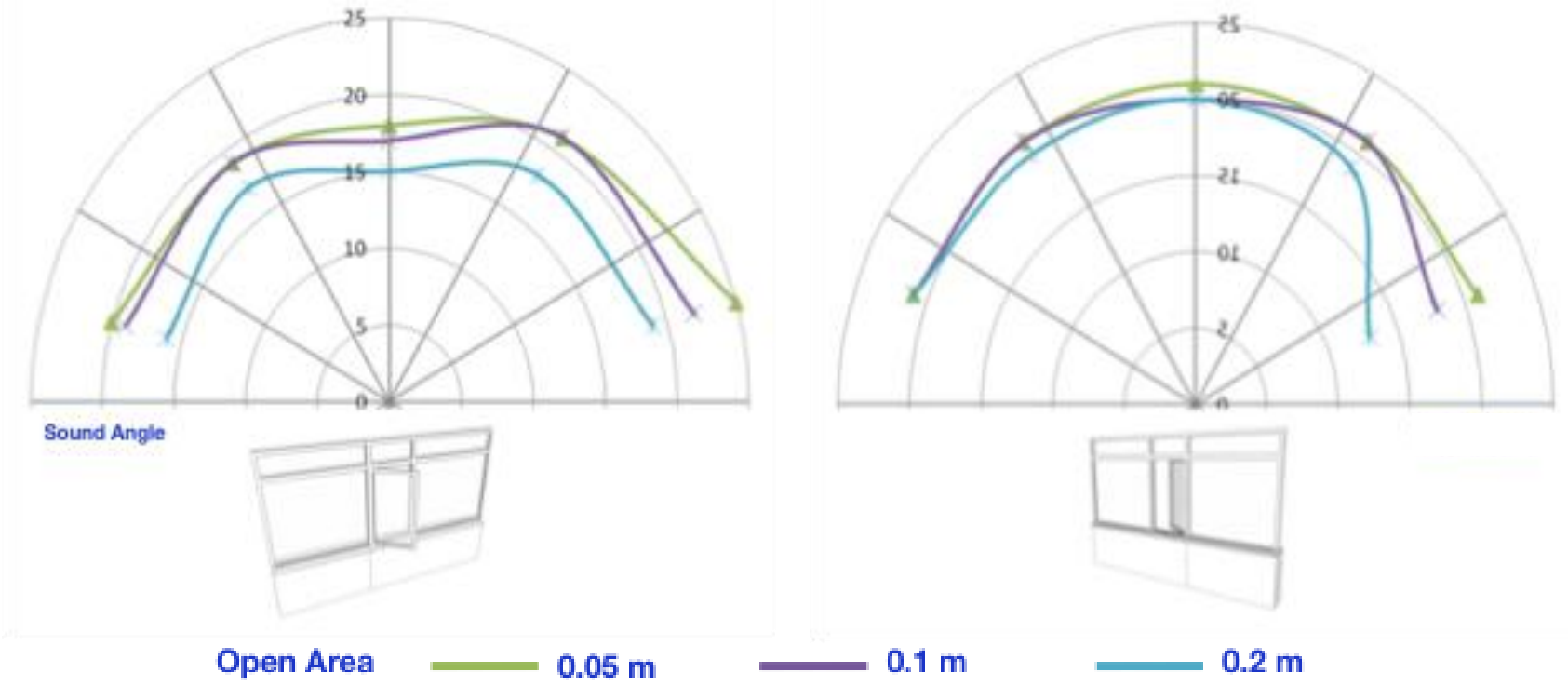
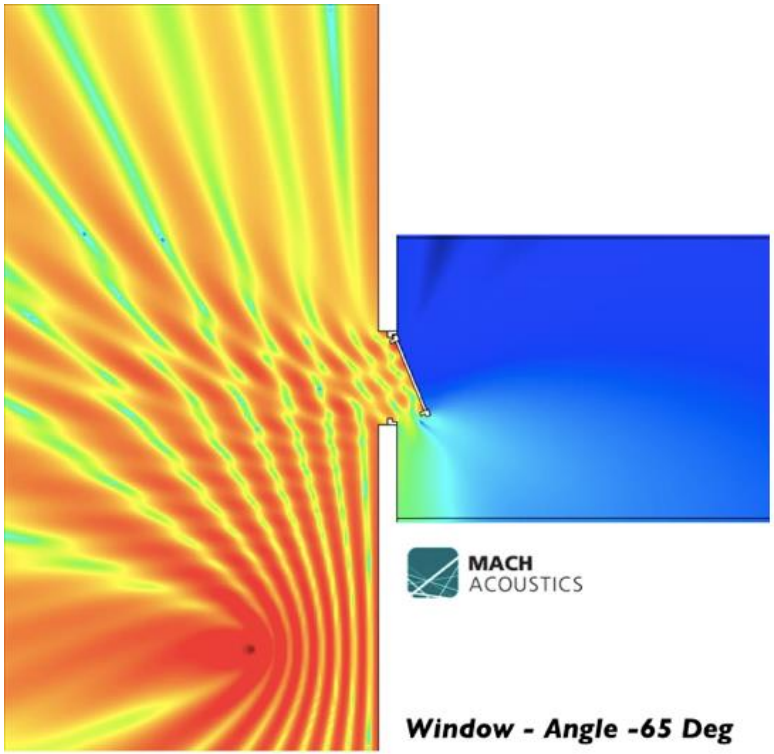
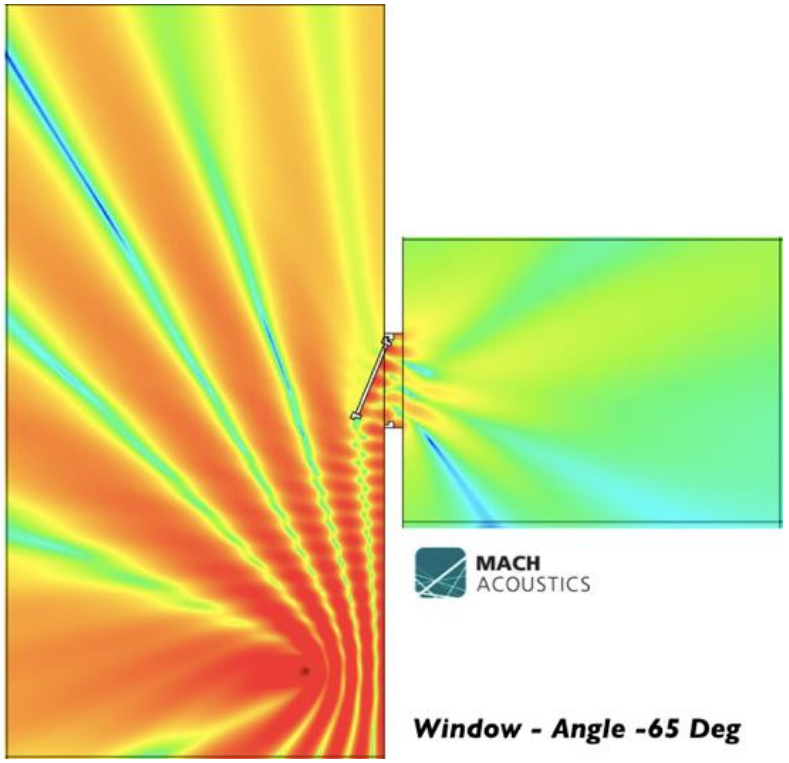
Napier University – The effects of sound angle



Case study 3 – Noise Mapping & Ray Tracing

The effects of sound angle – FEA modeling





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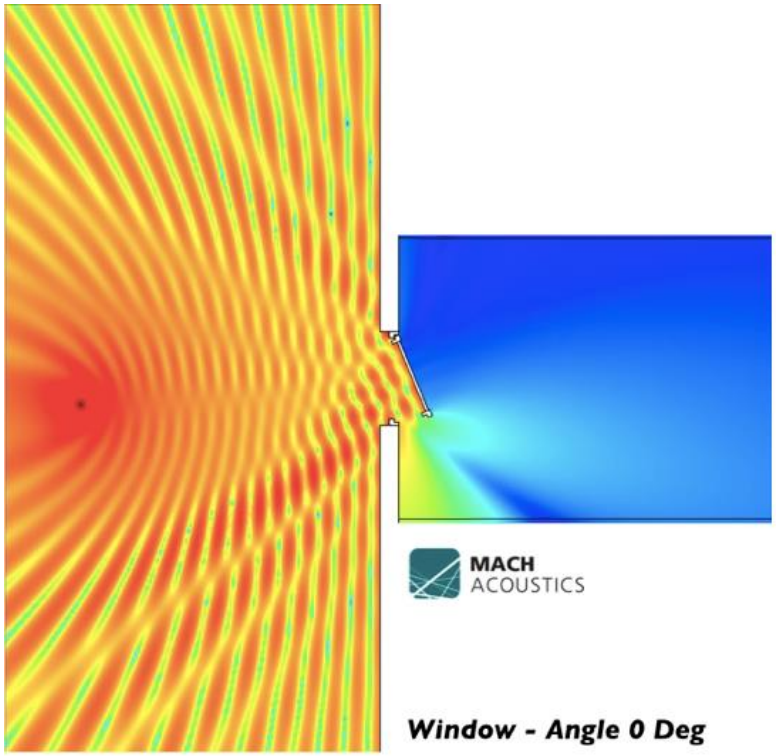

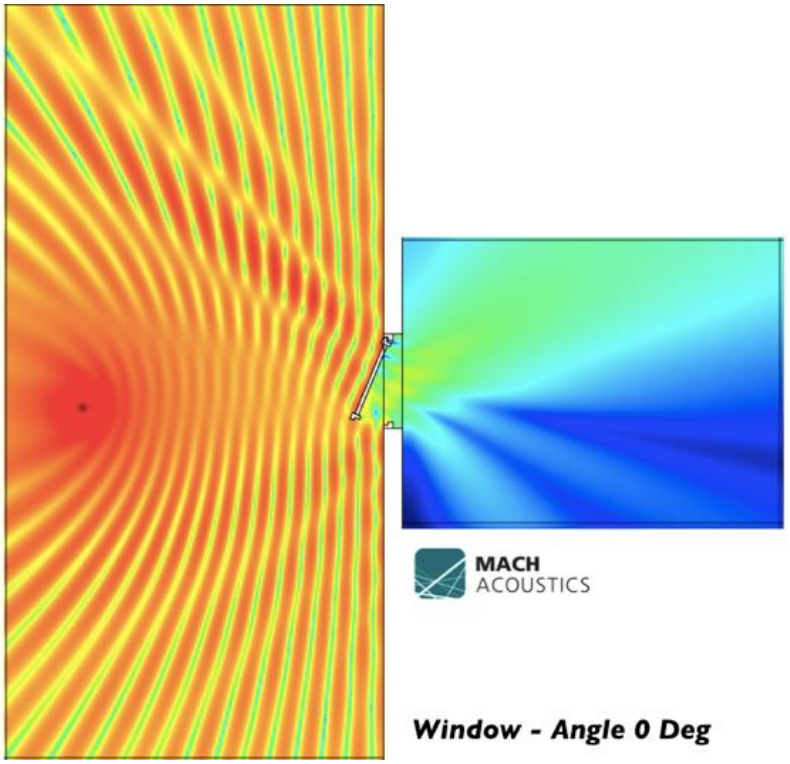

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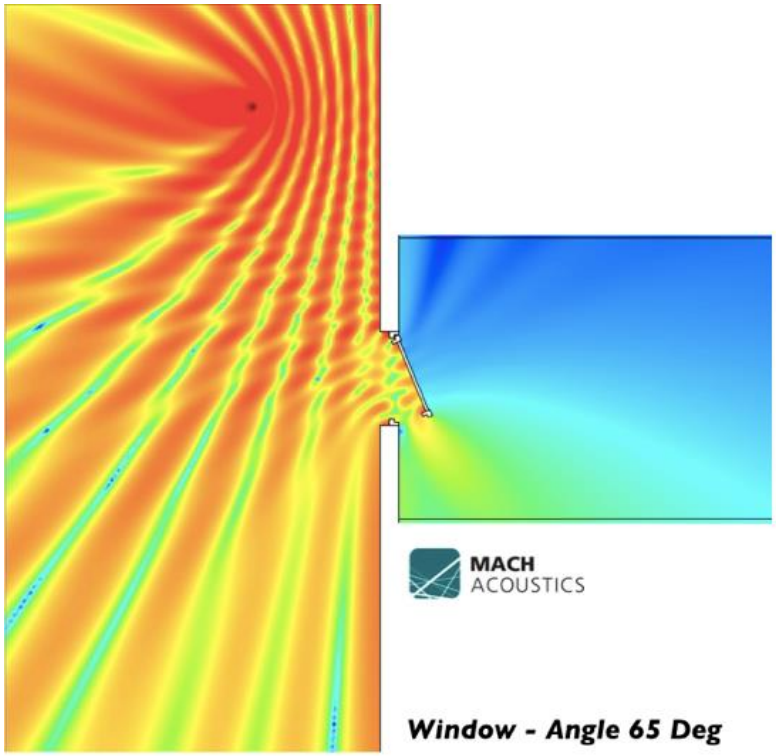
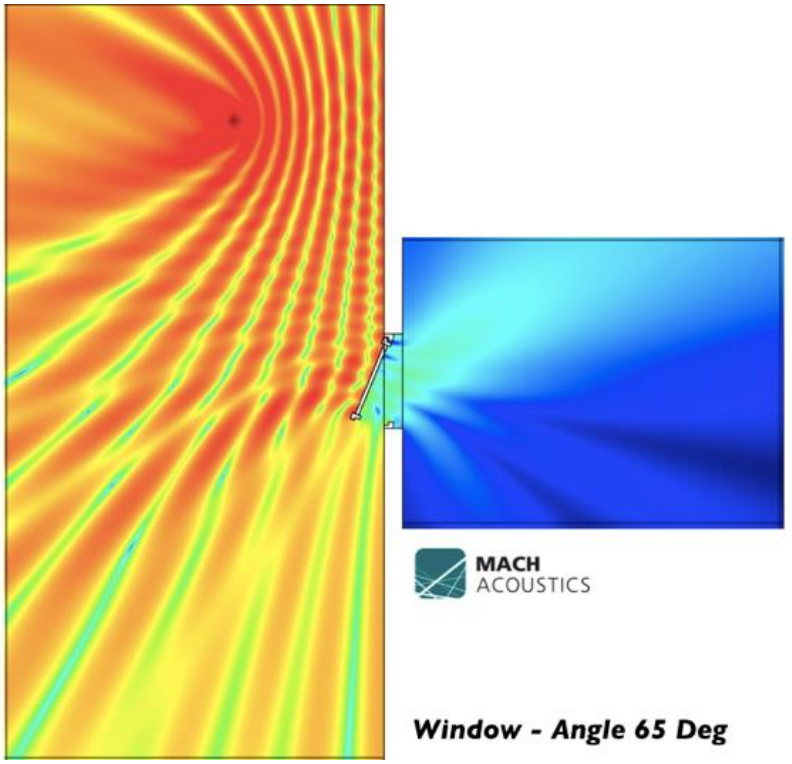
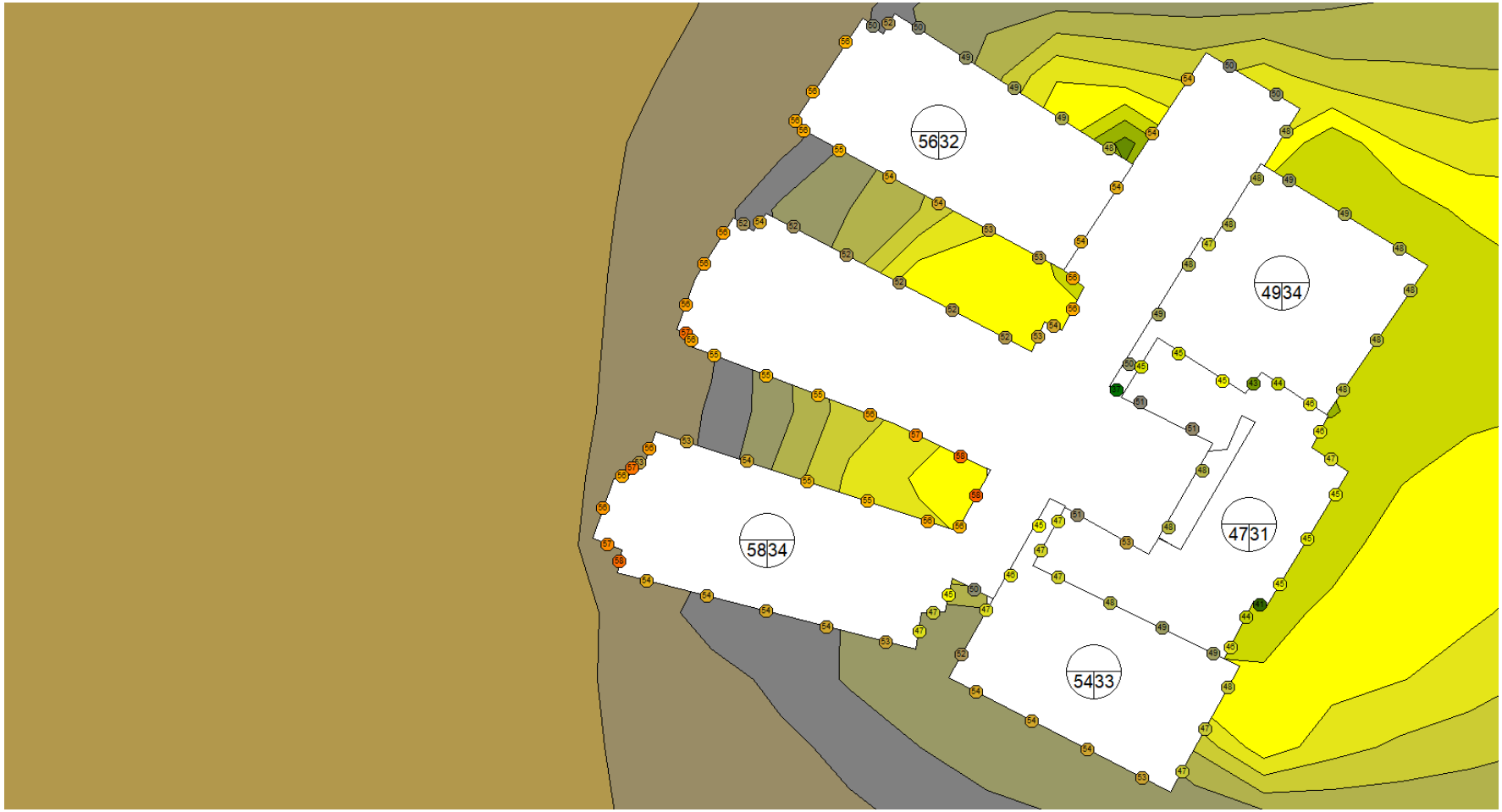




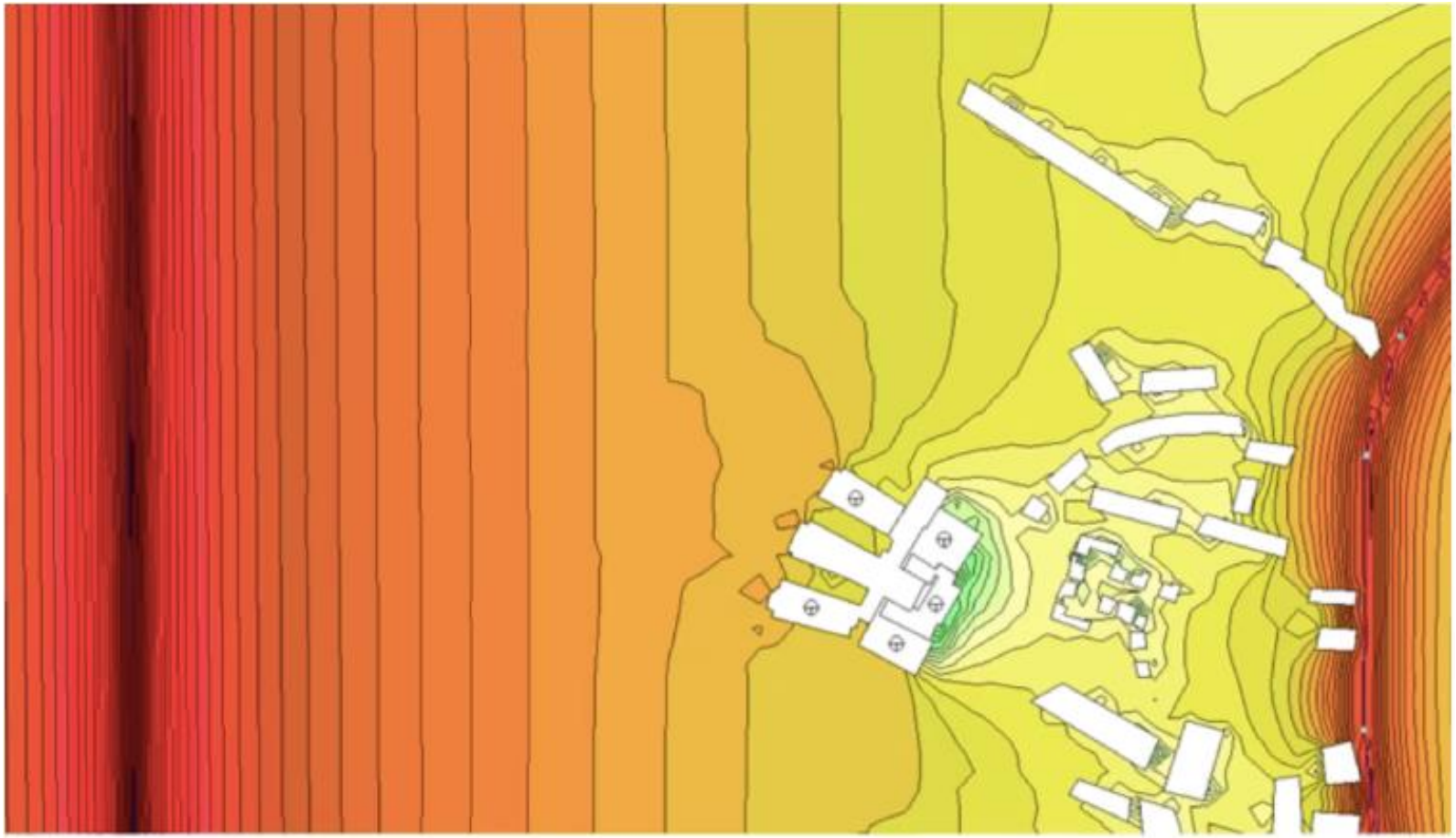
Case study 3 – Noise Mapping & Ray Tracing

Using the effects of sound angle at Broxbourne School



Case study 3 – Noise Mapping & Ray Tracing

Establishing the sound angle of a noise source through noise mapping



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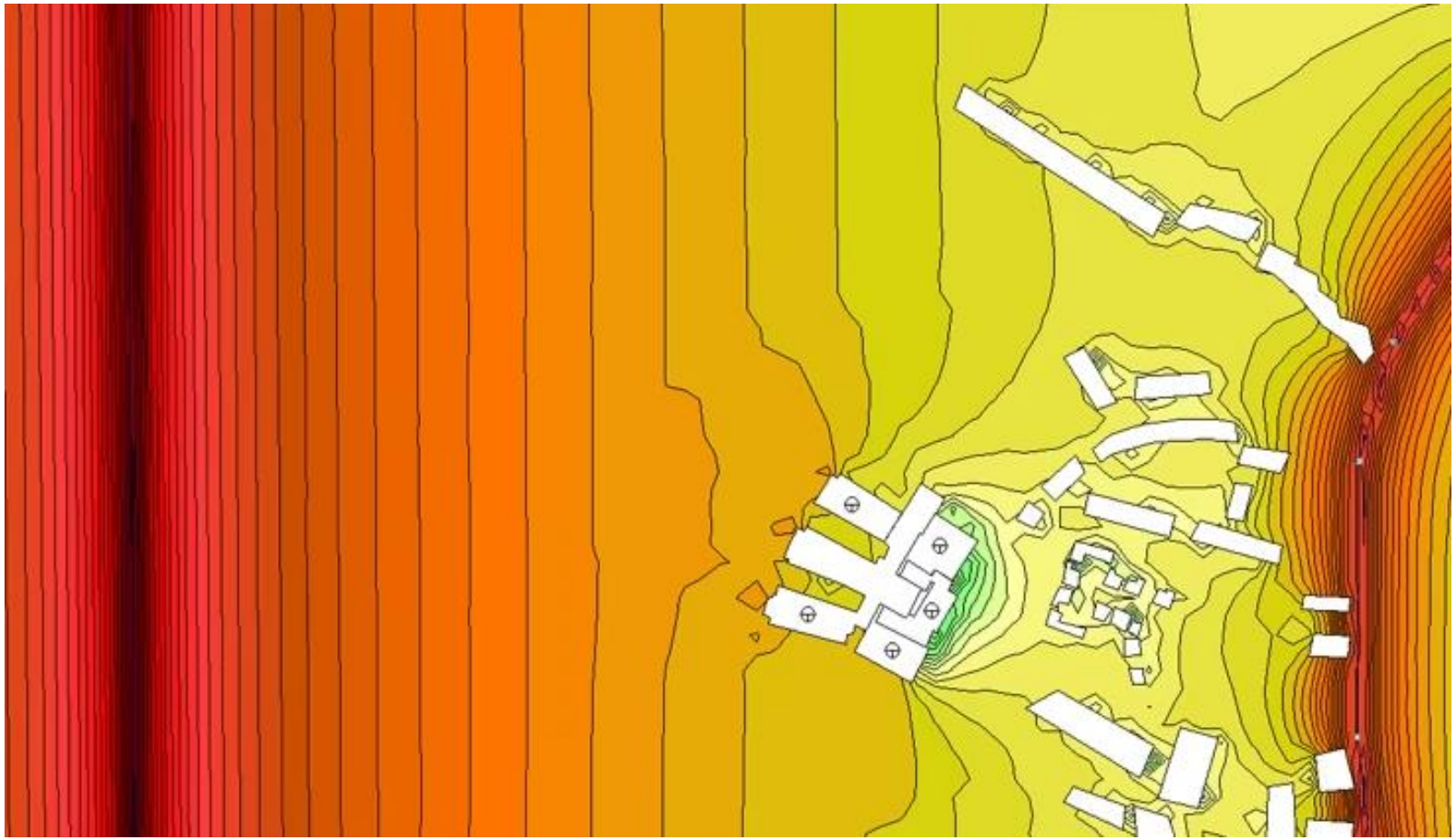

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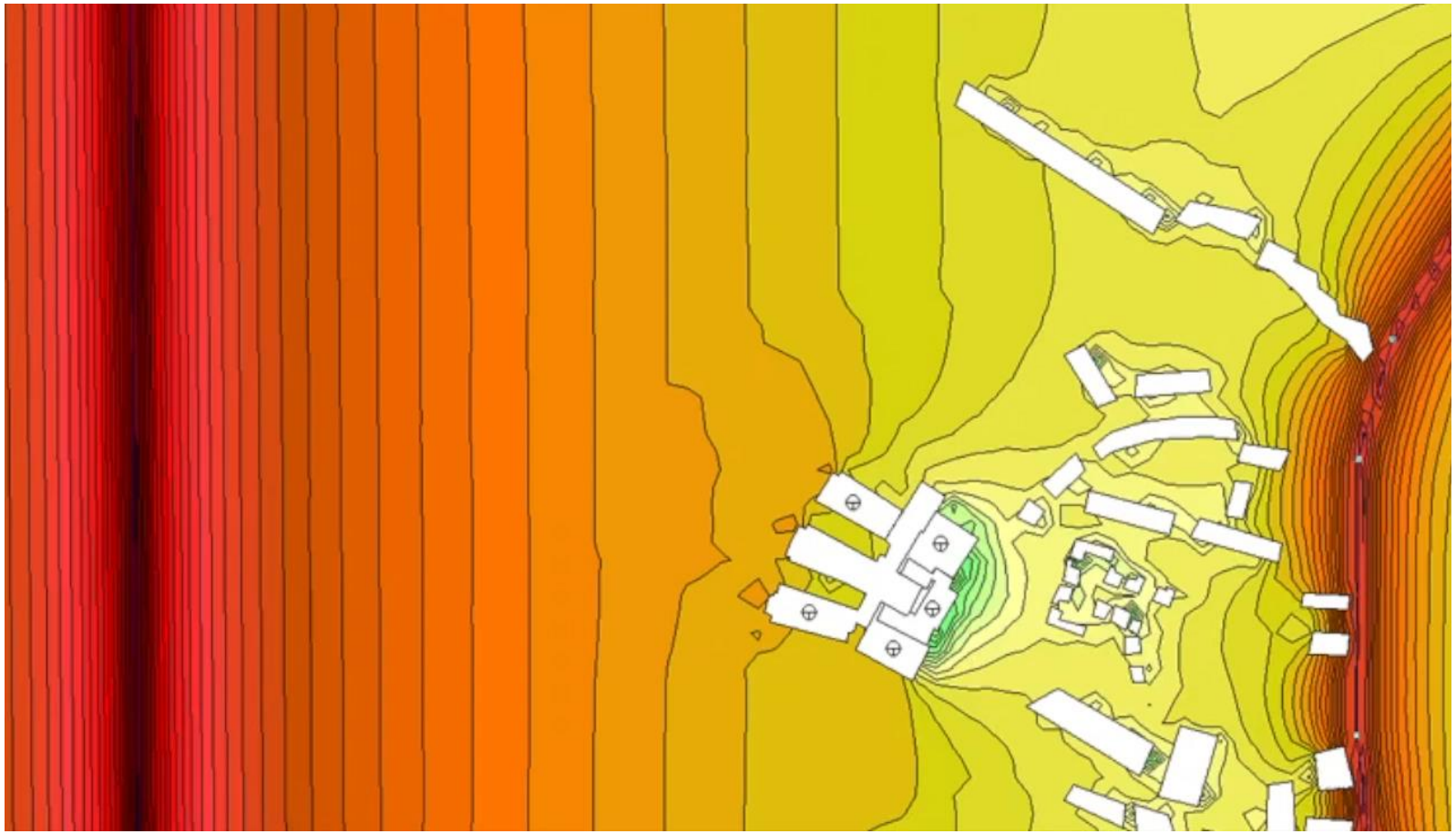

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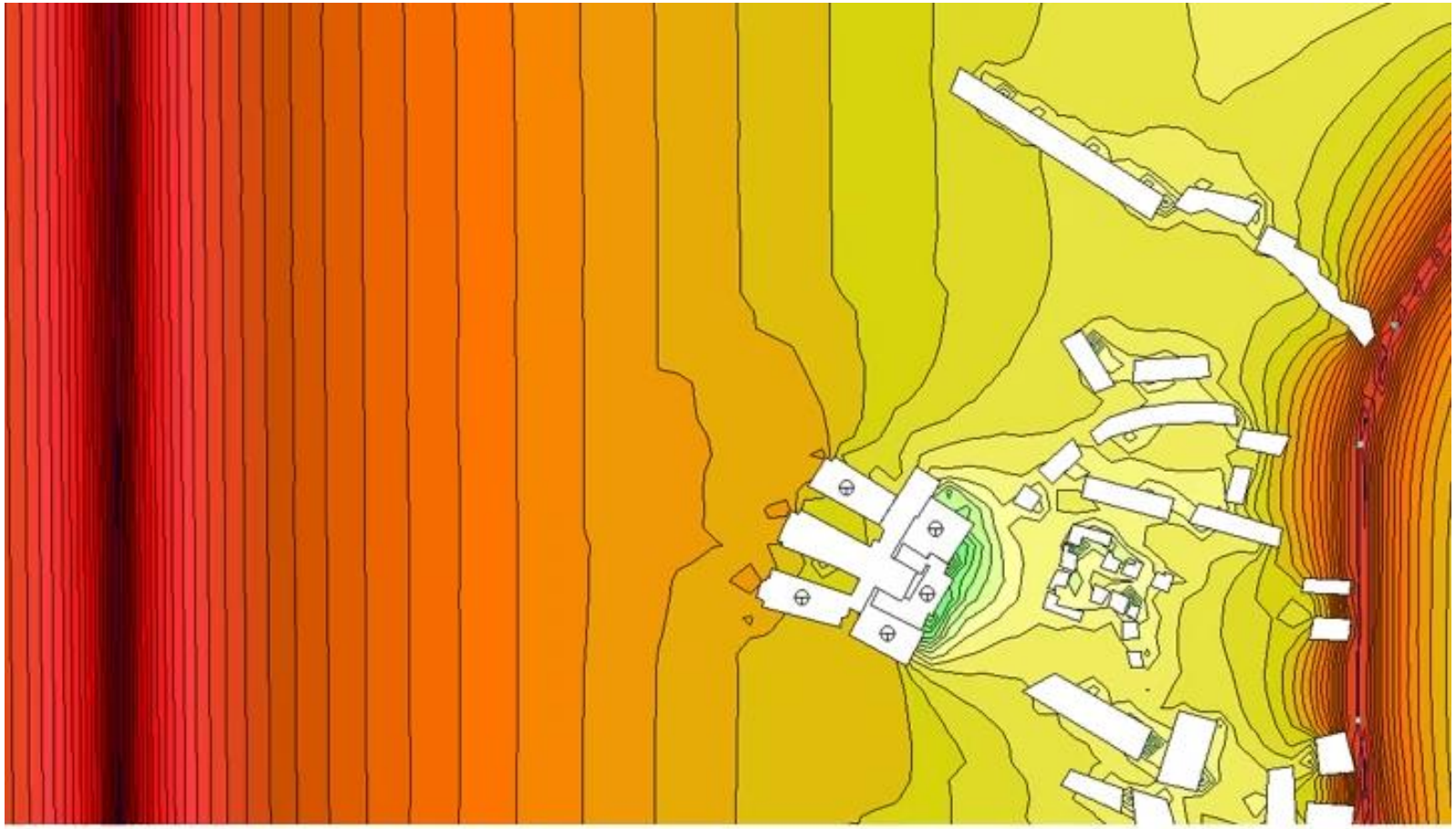
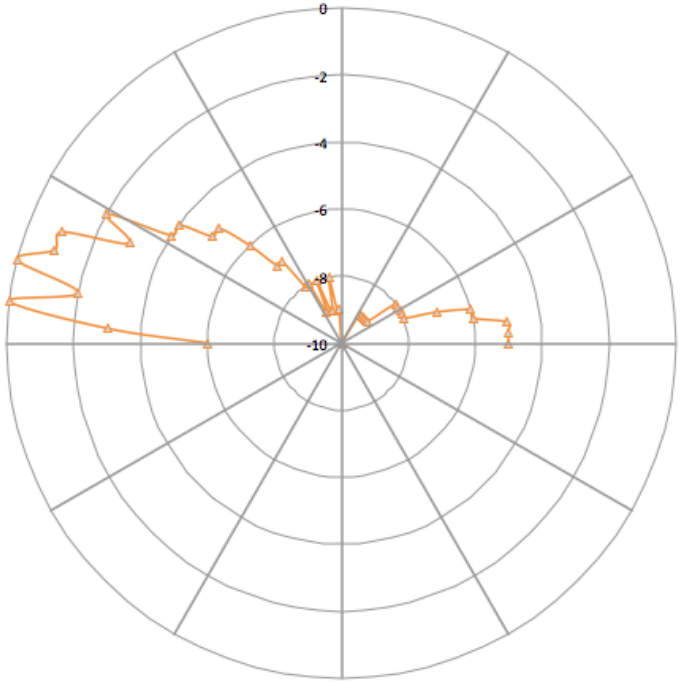


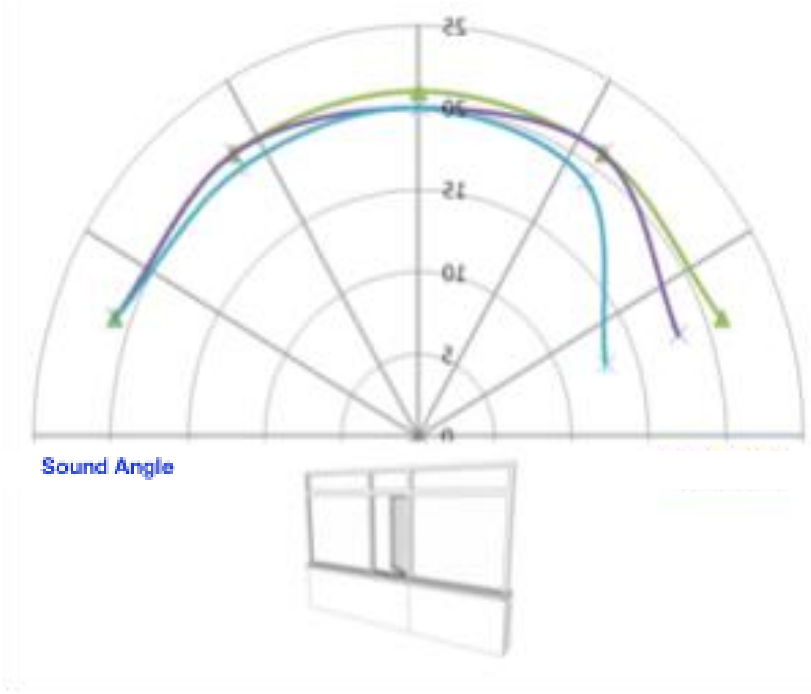
Case study 3 – Noise Mapping & Ray Tracing

Modeling the effect of the building on sound angle

Case study 3 – Noise Mapping & Ray Tracing

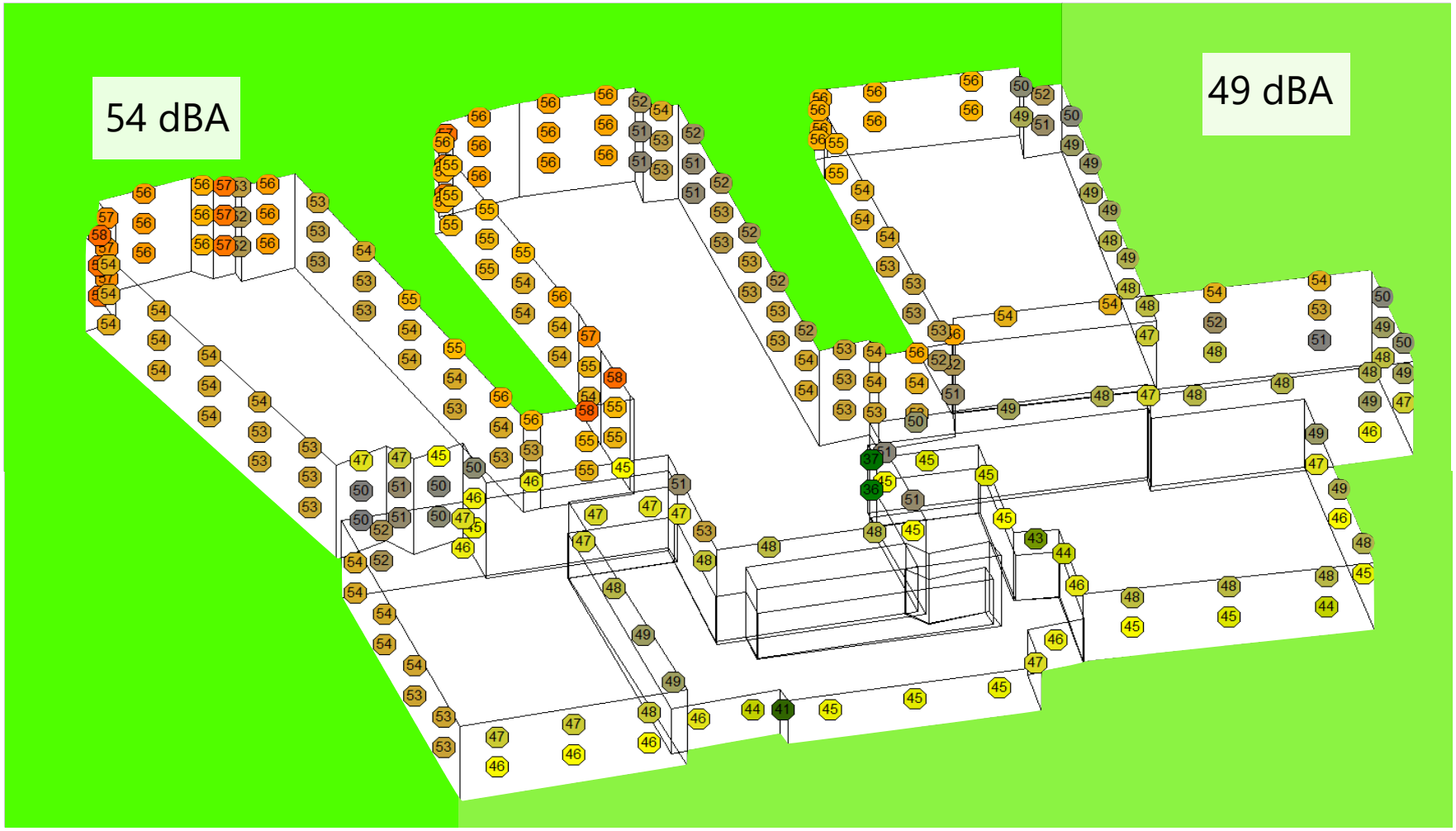
Combining the environment directivity of the sound with the directivity of the open window.





Case study 3 – Noise Mapping & Ray Tracing

Results the school being ventilated by means of angled windows



Tools for Managing Noise

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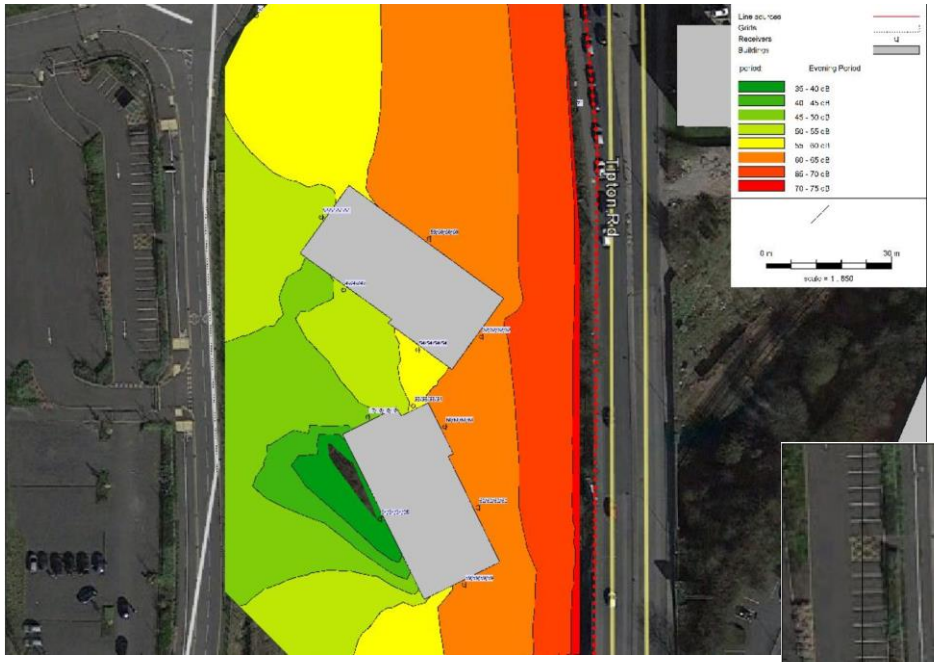
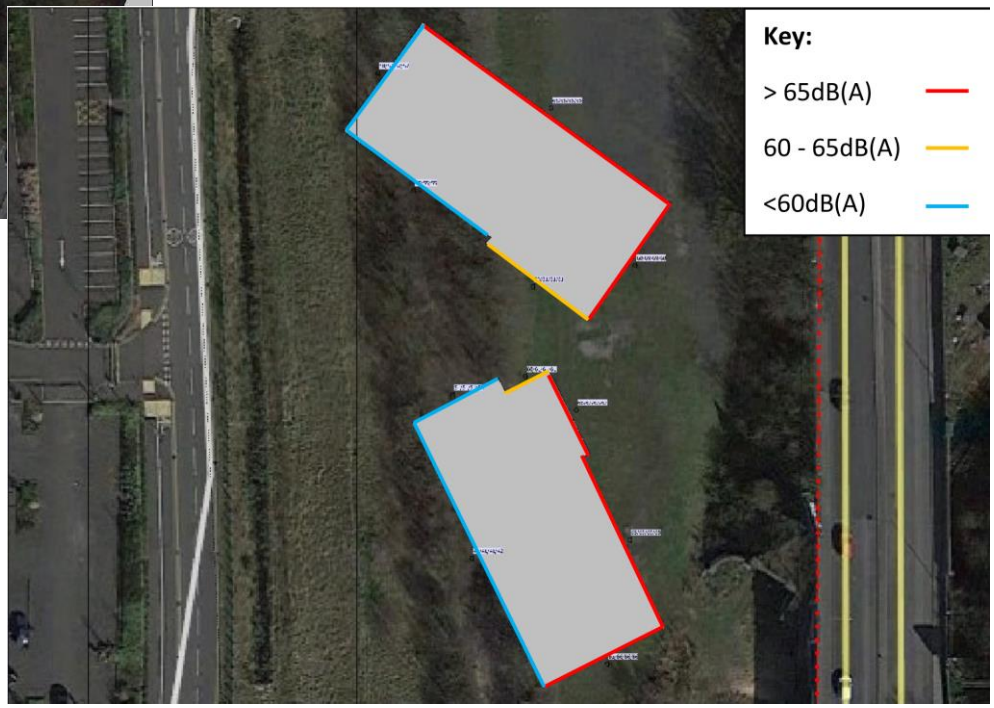
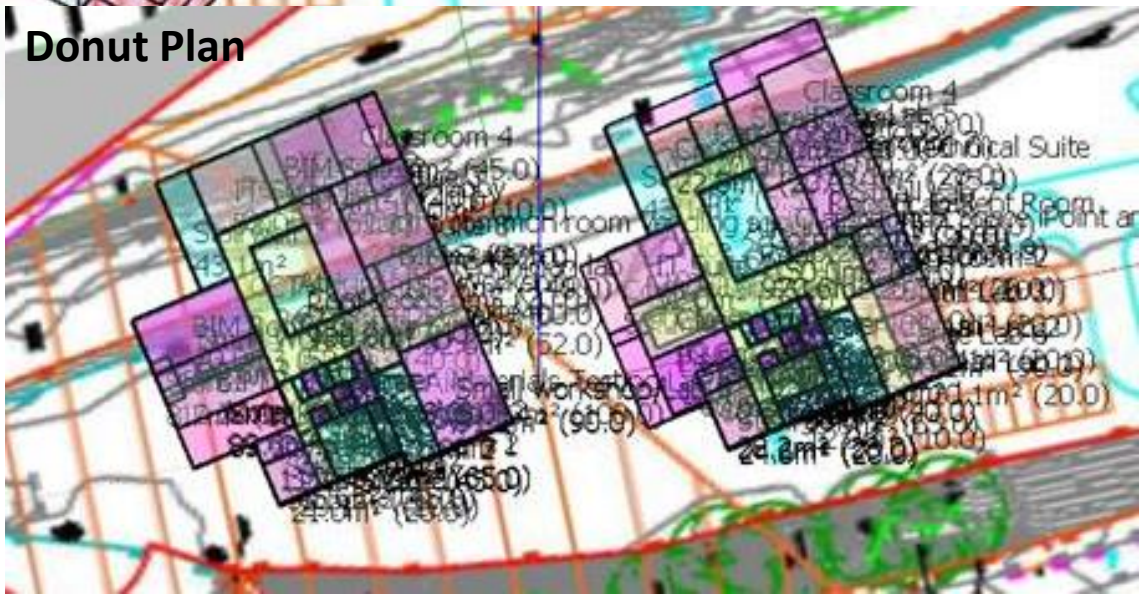
Tools for Managing Noise – **Building Massing**





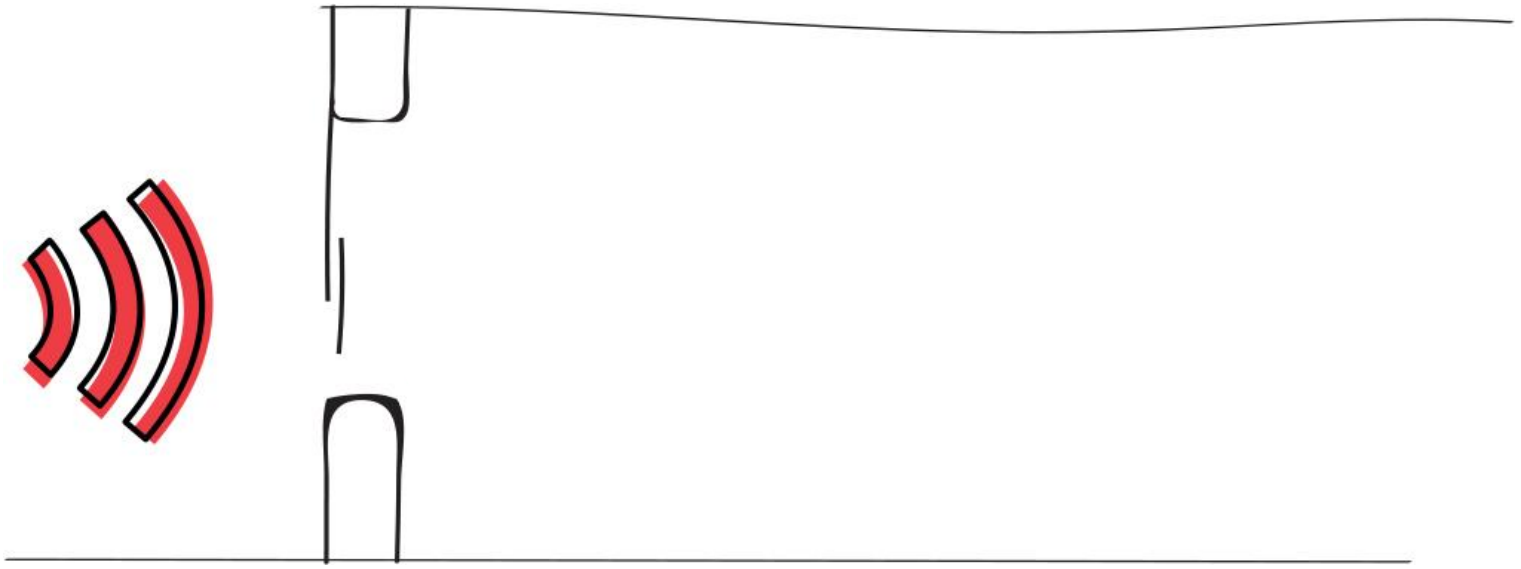
LAUNCHPADD



LAUNCHPADD

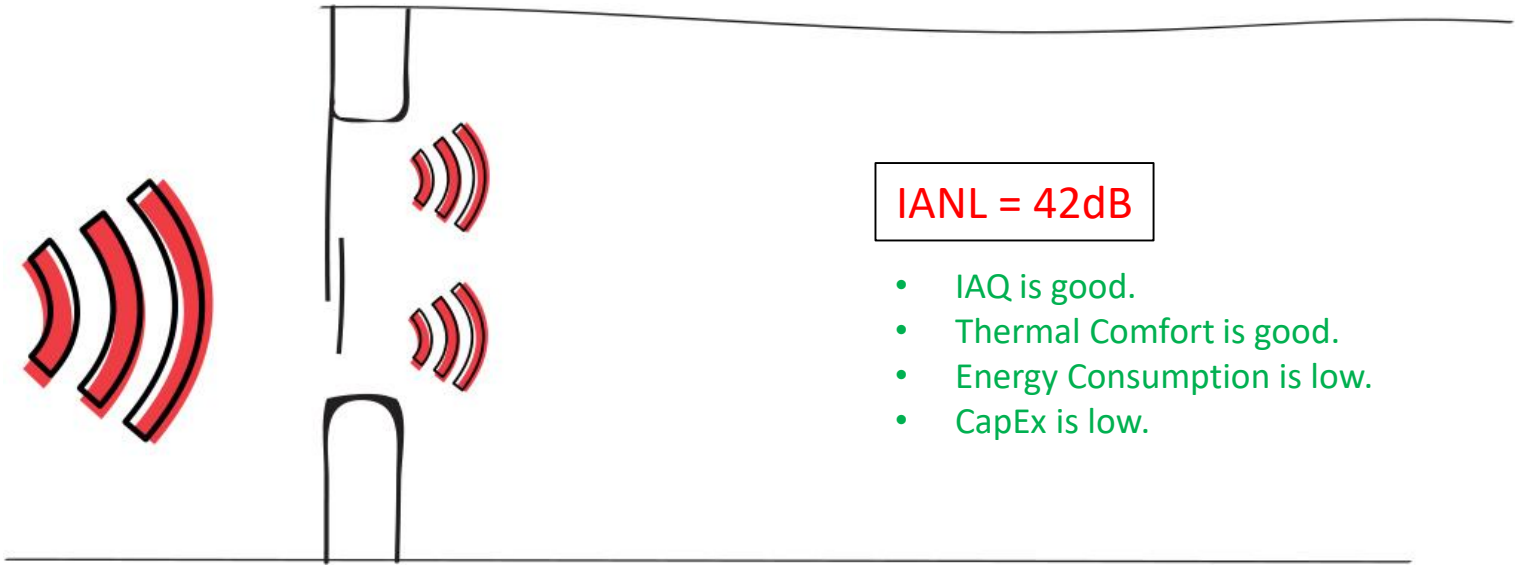
External Noise Source

External Noise Source
55dB



Nat Vent with Opening Windows

External Noise Source
55dB



IANL = 42dB

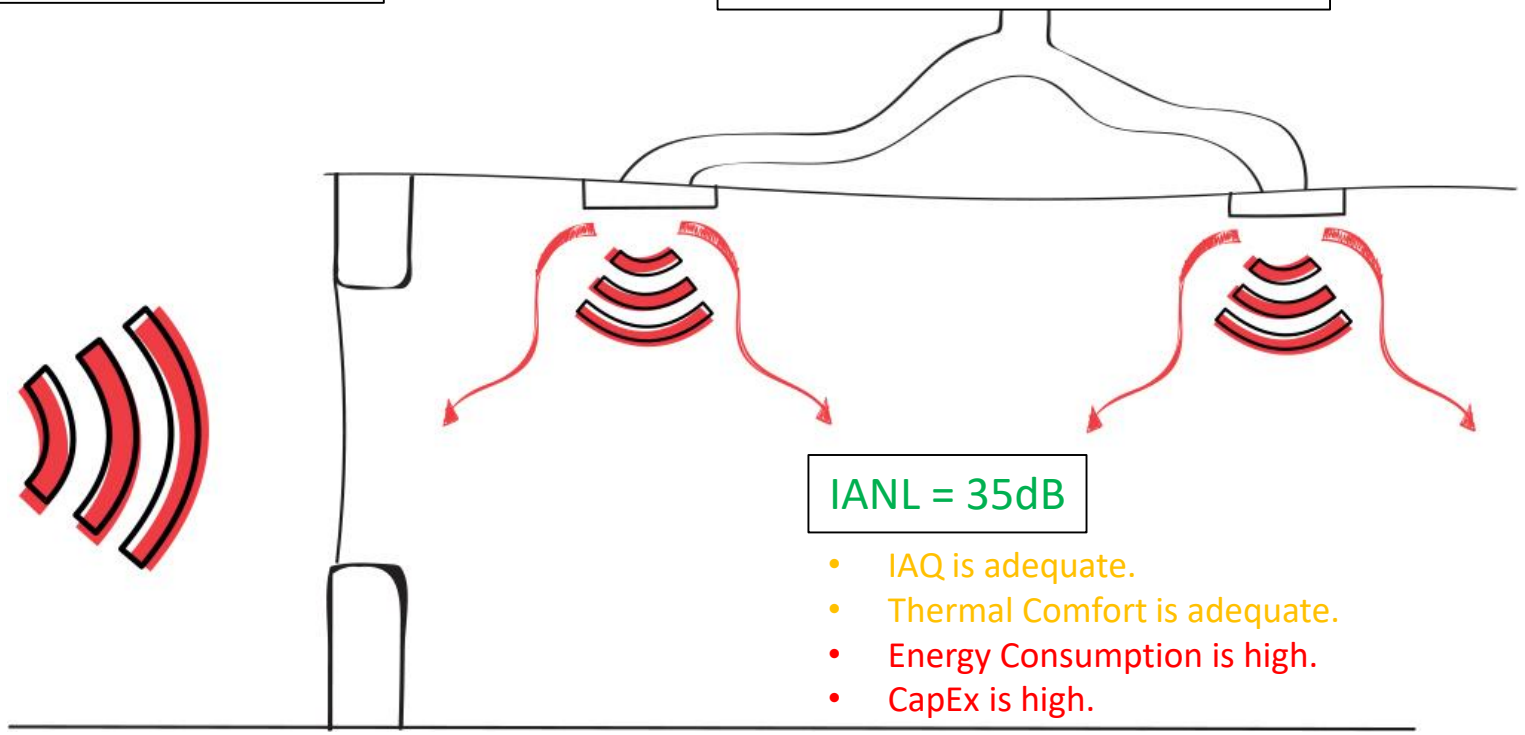
- IAQ is good.
- Thermal Comfort is good.
- Energy Consumption is low.
- CapEx is low.

Sound reduction through
an open window
~ 13dB

Fully Sealed Mech Vent

External Noise Source
55dB

Mechanical Ventilation Noise



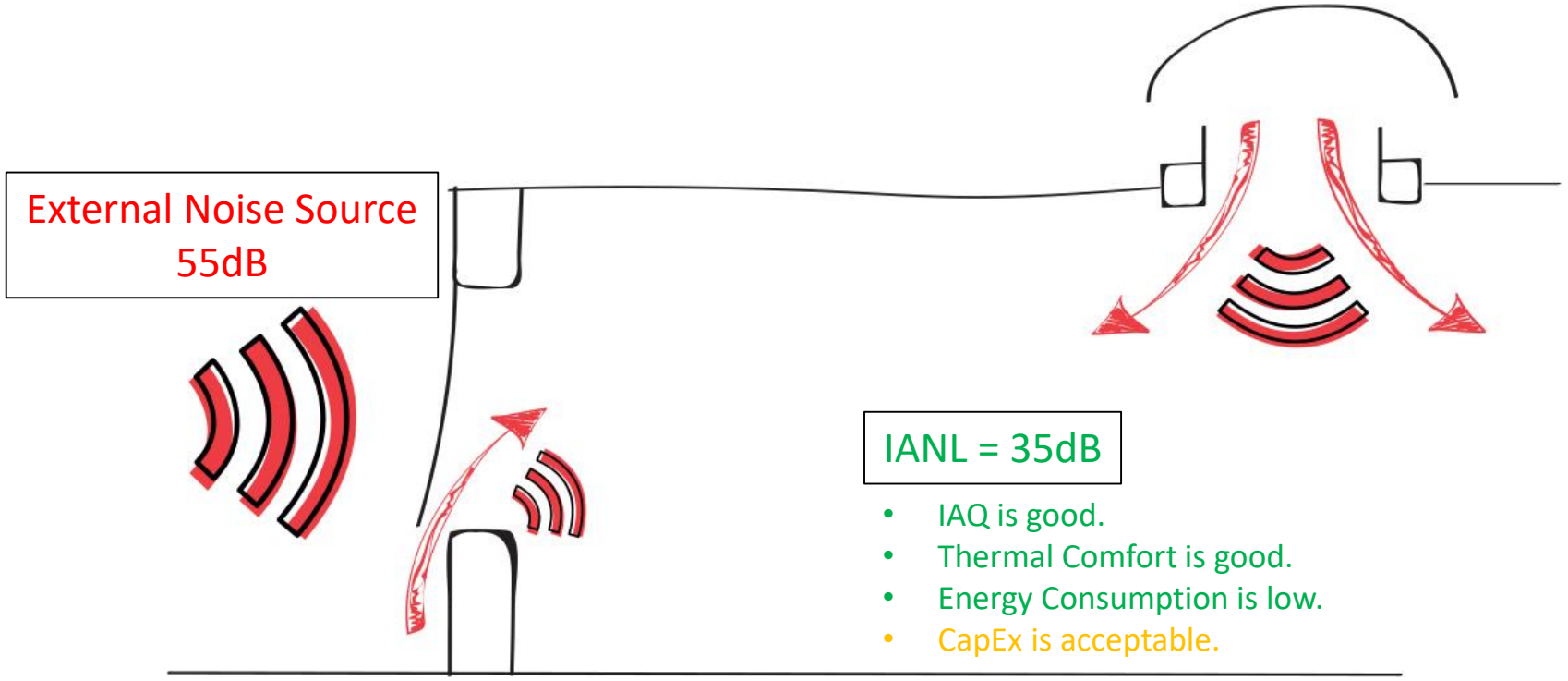
IANL = 35dB

- IAQ is adequate.
- Thermal Comfort is adequate.
- Energy Consumption is high.
- CapEx is high.

Nat Vent with Roof Terminal

Noise Pressure at Roof
40dB

External Noise Source
55dB



IANL = 35dB

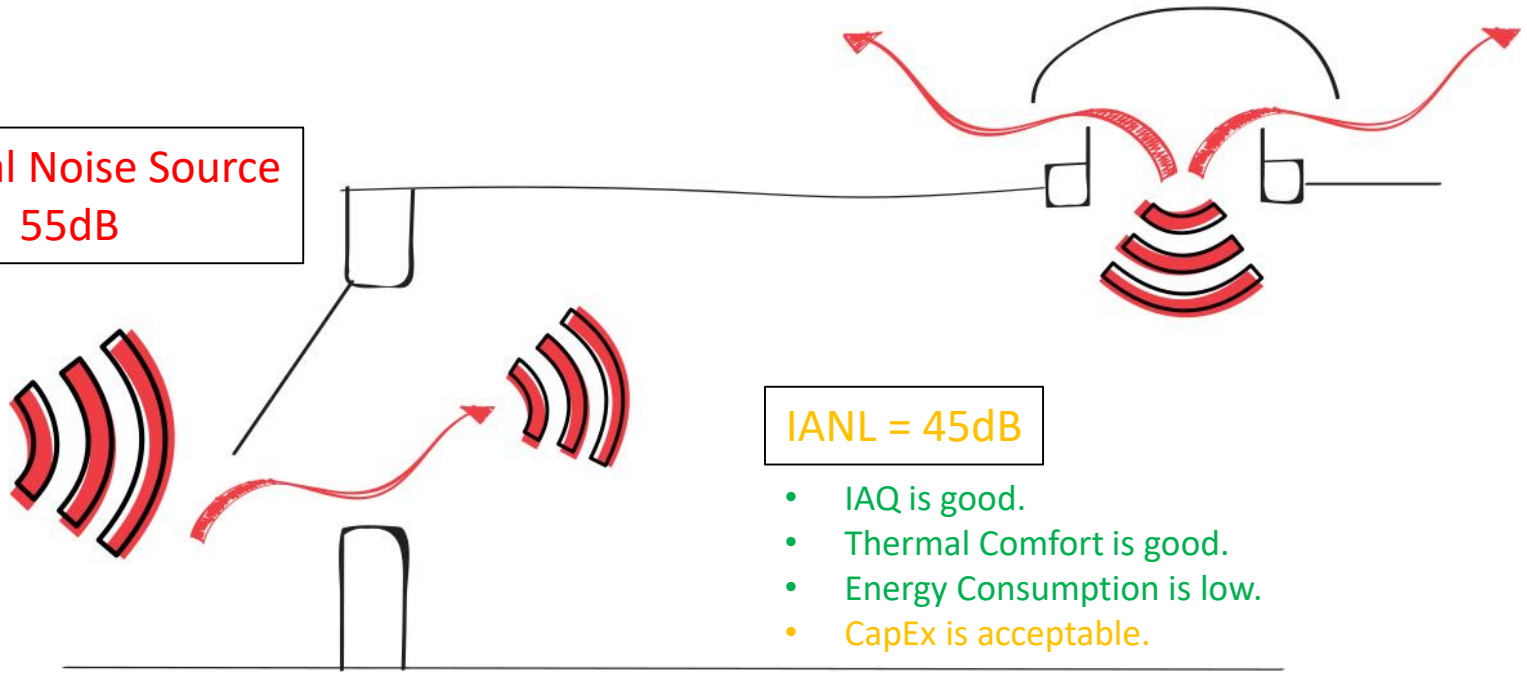
- IAQ is good.
- Thermal Comfort is good.
- Energy Consumption is low.
- CapEx is acceptable.

Sound reduction through an attenuated opening
> 25dB

Nat Vent with Roof Terminal – Peak Summer

Noise Pressure at Roof
40dB

External Noise Source
55dB



IANL = 45dB

- IAQ is good.
- Thermal Comfort is good.
- Energy Consumption is low.
- CapEx is acceptable.

Sound reduction through a open window
~ 13dB

Tools for Managing Noise

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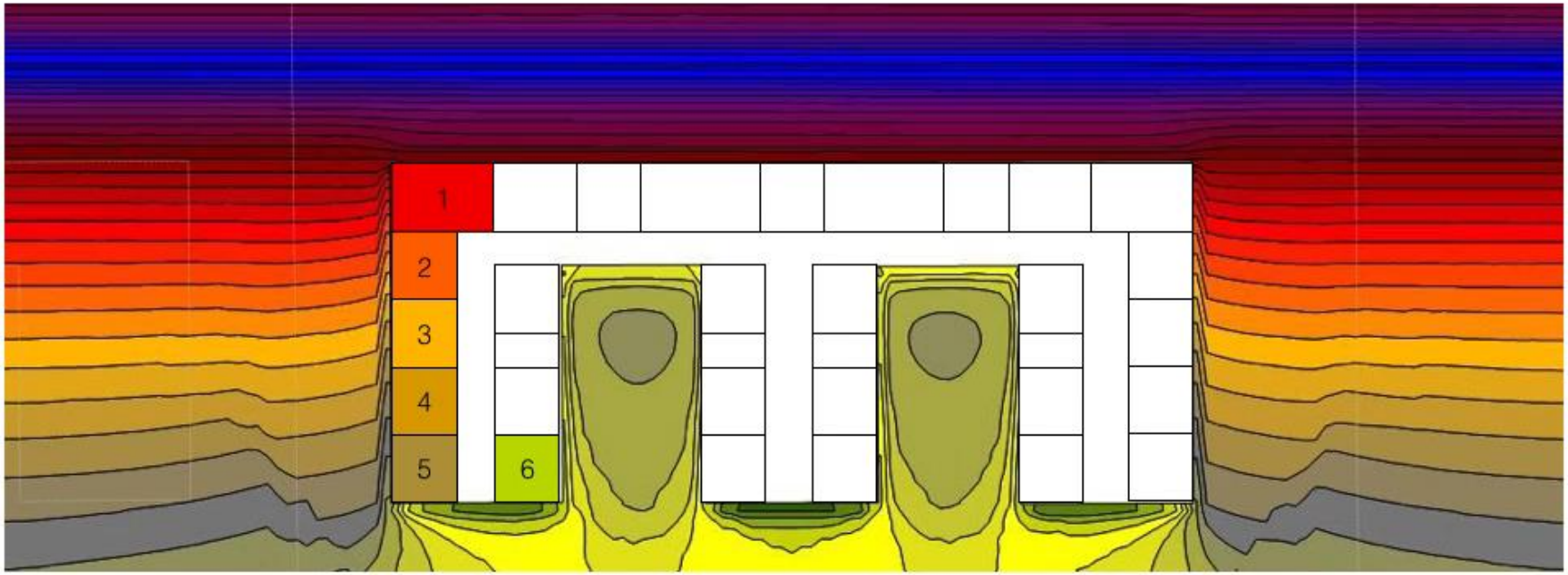
Calculating the sound reduction of a facades / air vent

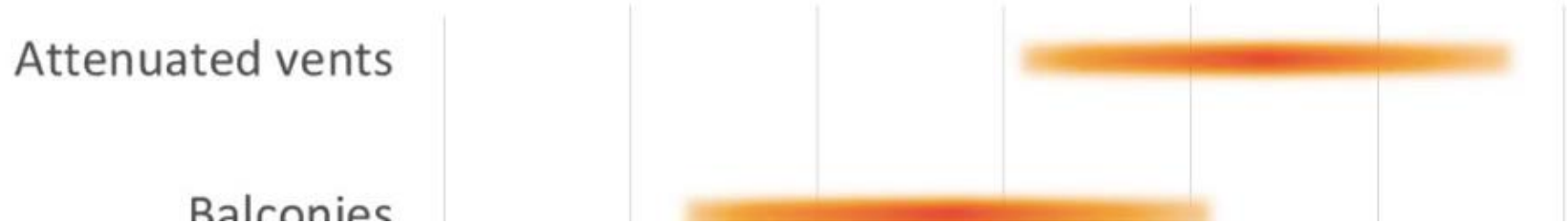
Façade / Vent Sound Reduction =

External Noise - Internal Noise + Correction

We will keep this constant

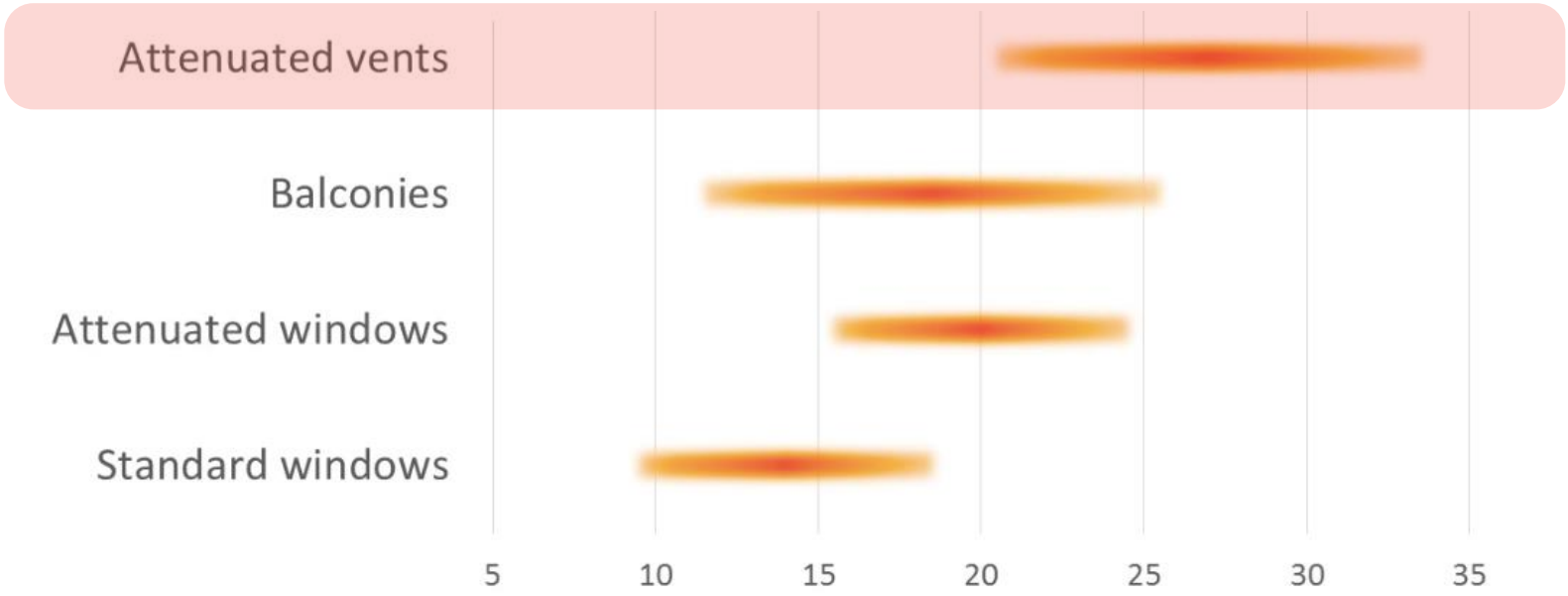
Calculating the sound reduction of a facades / air vent



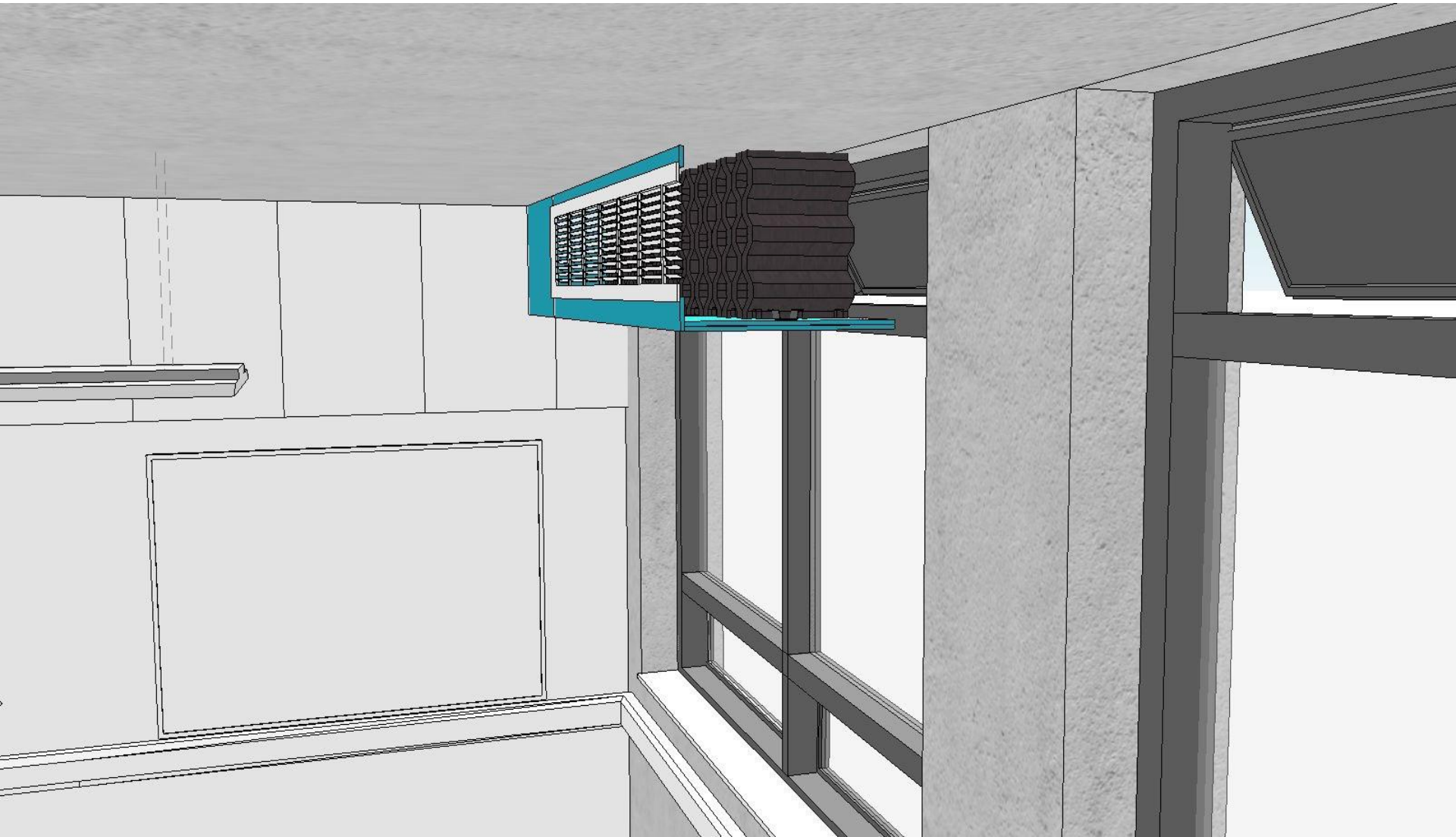


Attenuated Vents

Sound reduction of different façade types



Selecting the attenuator length



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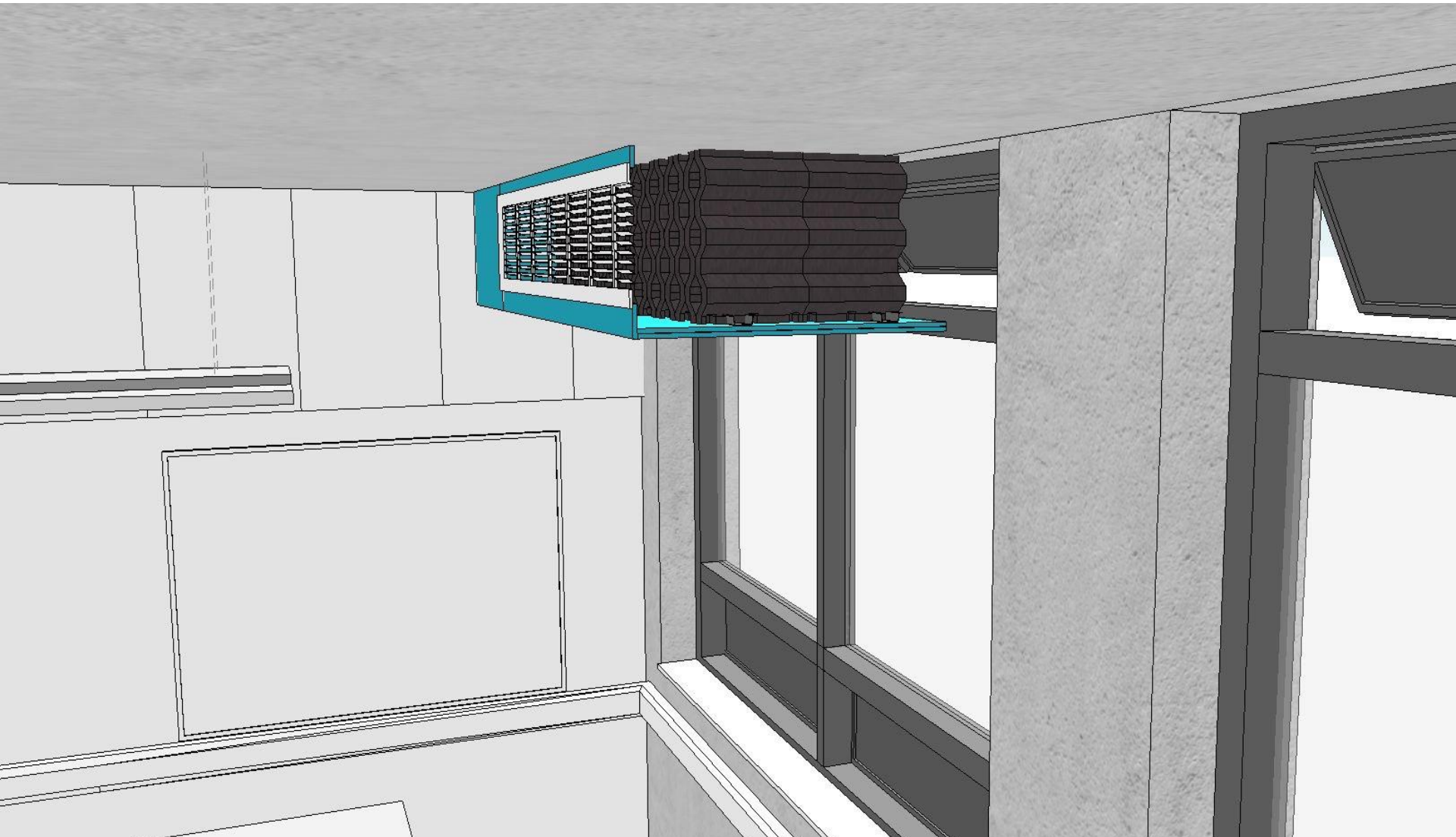
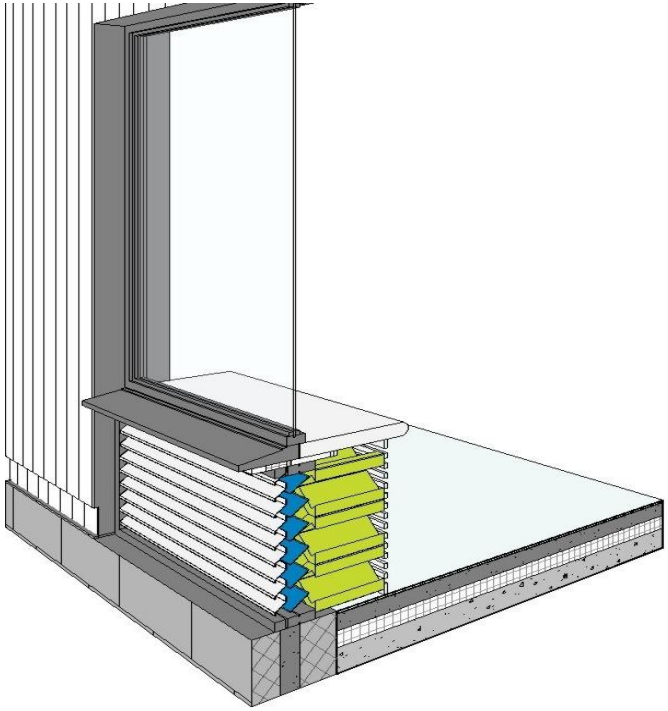
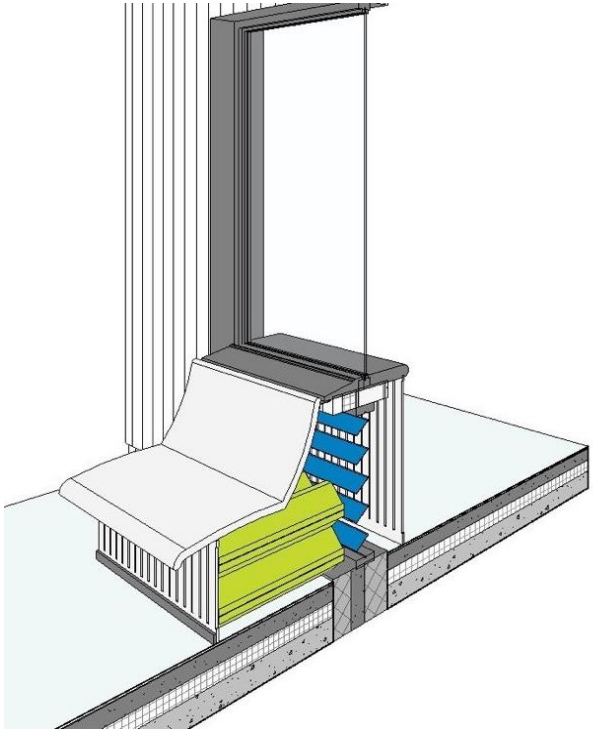


Attenuated Vents

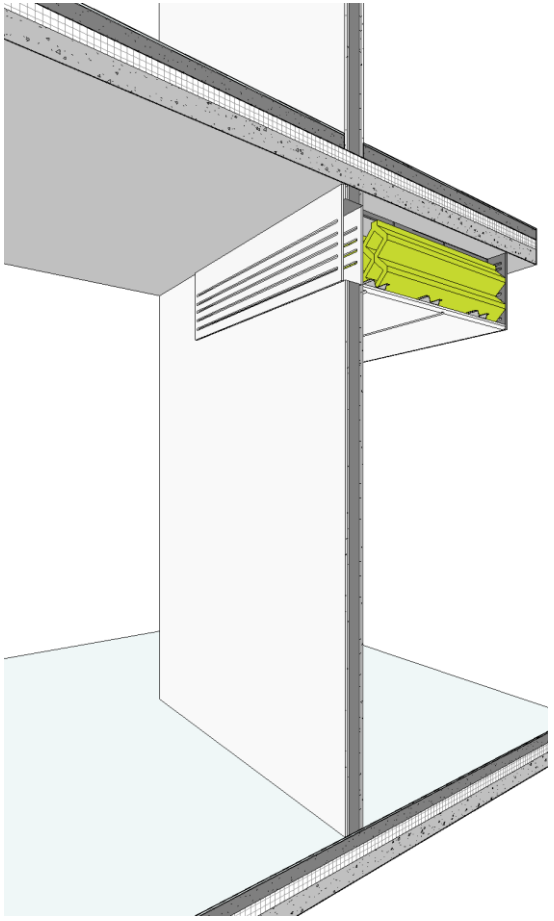
Attenuated façade options





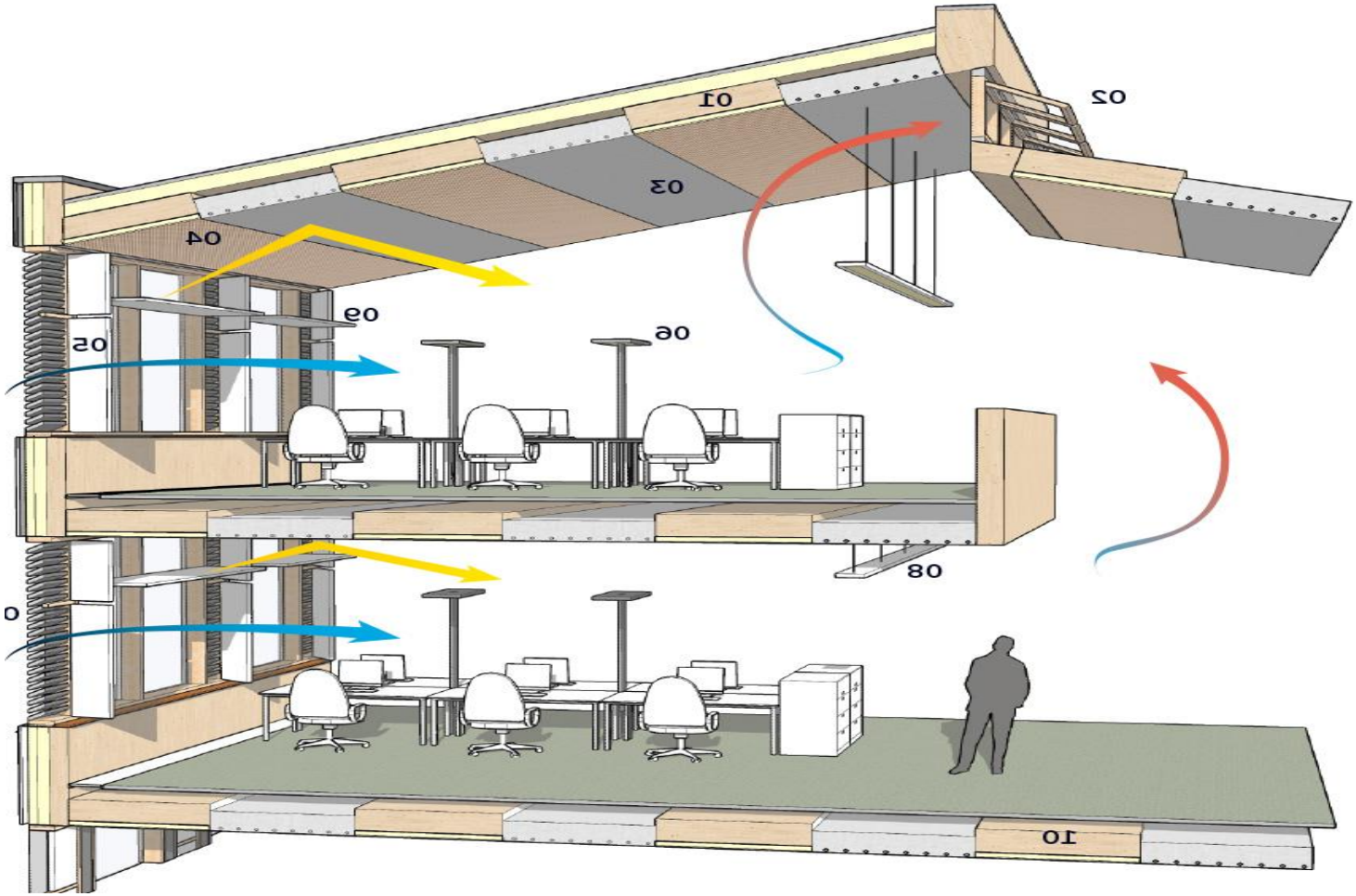
Attenuated Vents

Cross ventilation as a form of noise control



Attenuated Vents

Attenuated façade – Acoustic louvers



Attenuated façade – Acoustic louvers

Attenuated façade – Acoustic louvers

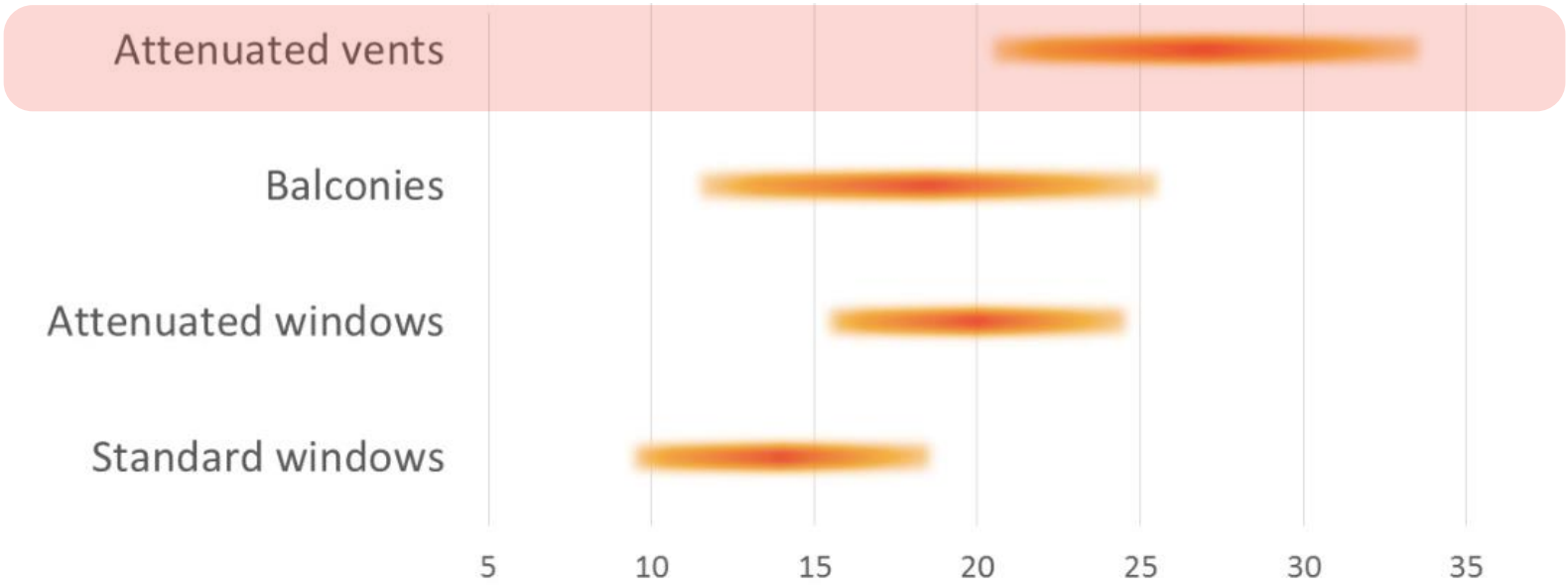
Attenuated Vents

Attenuated façade – Acoustic louvers

Attenuated façade – Acoustic louvers

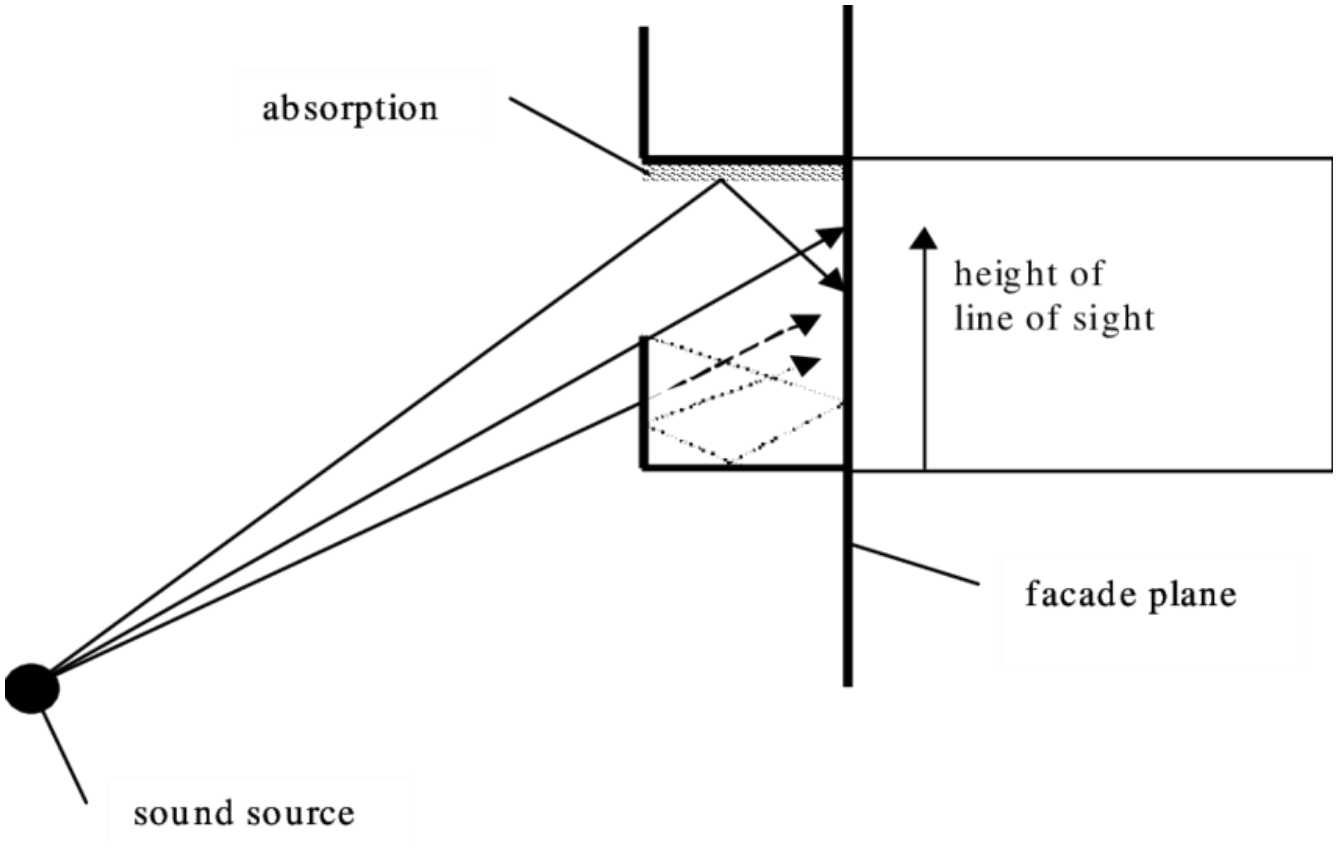
Balconies as a form of noise control

Sound reduction of different façade types

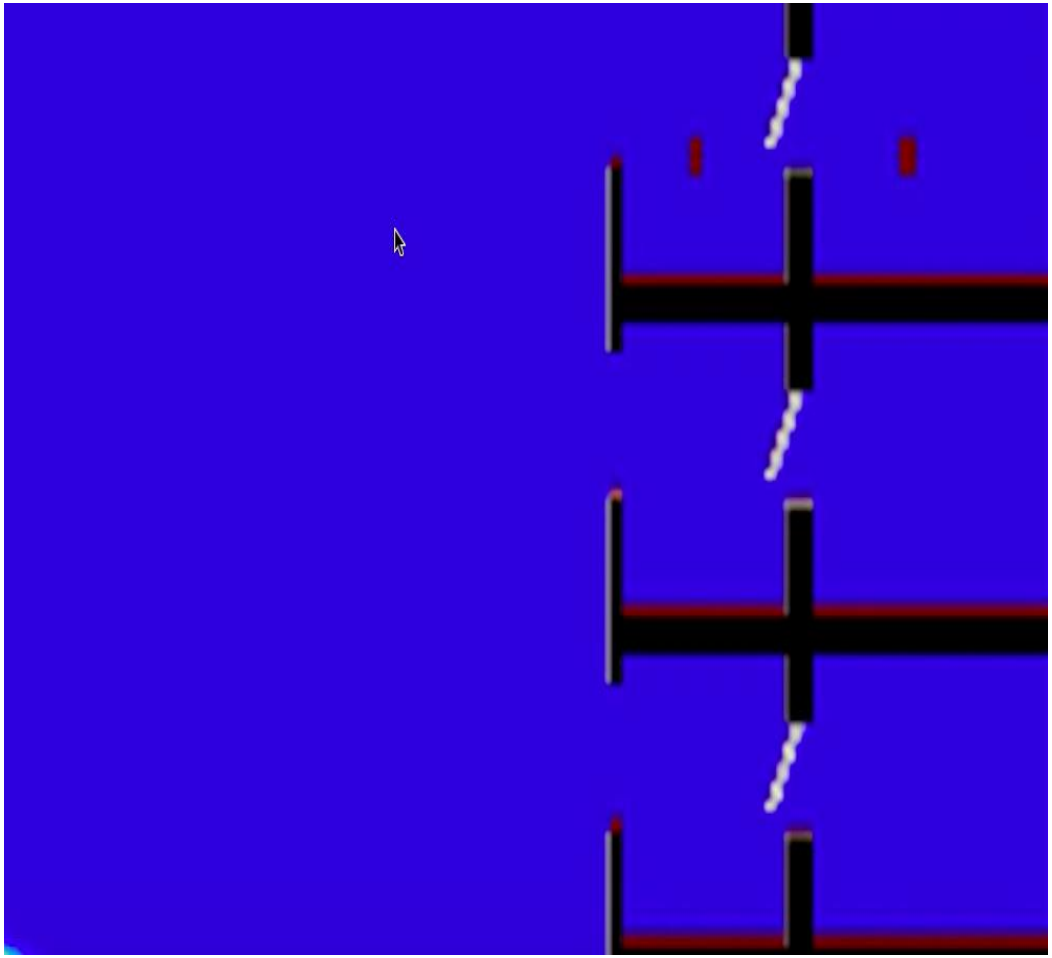


Balconies as a form of noise control

BS EN 12354 : Building Acoustics Sound Insulation



Modeling the acoustics effect of balconies



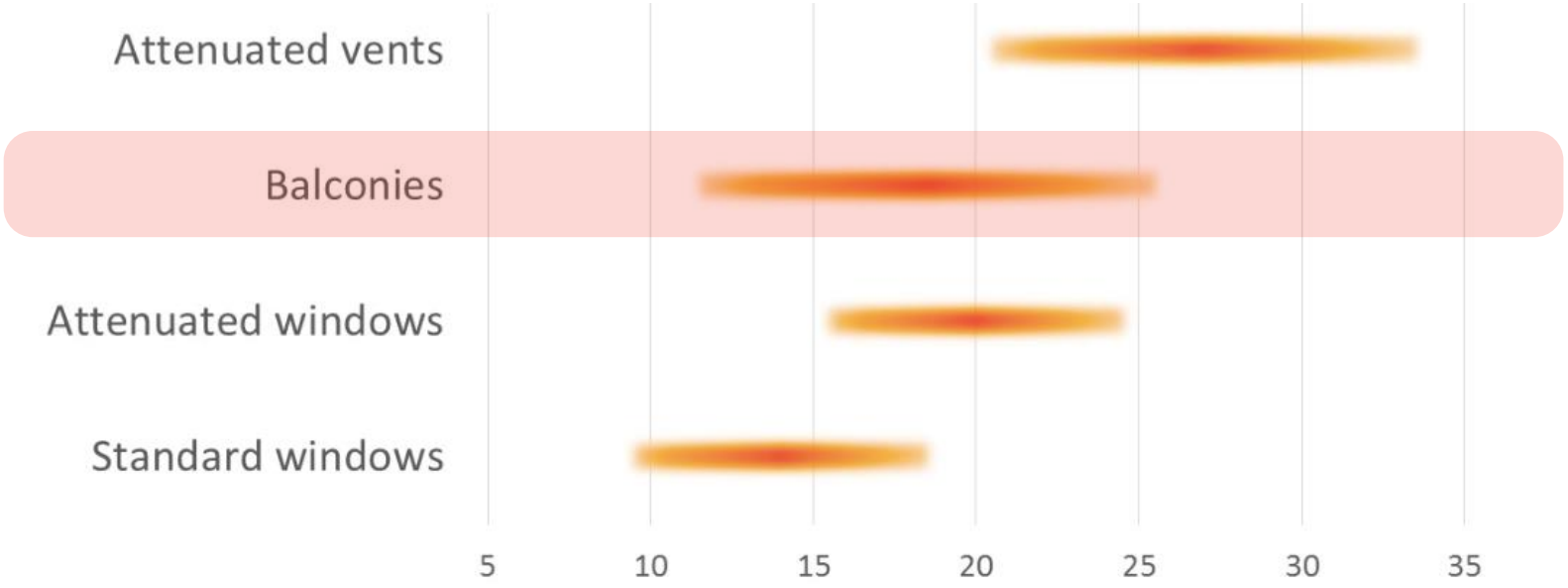
Balconies as a form of noise control

Case Study – Windford Primary School

Case Study – Windford Primary School

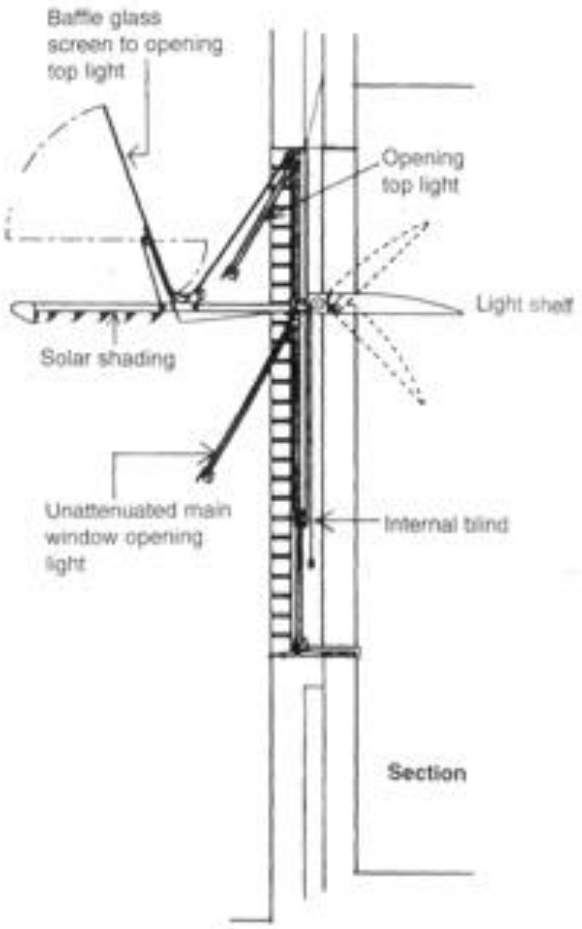
Attenuated Windows

Sound reduction of different façade types



Attenuated Windows

CIBSE guidance on baffle windows



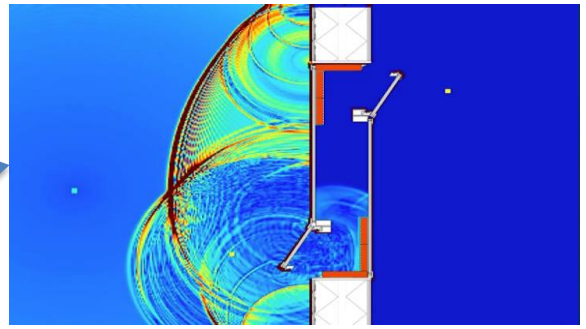
Normal openable window 10-15 dB of sound reduction

Screened window as shown 15- 25 dB of sound reduction.

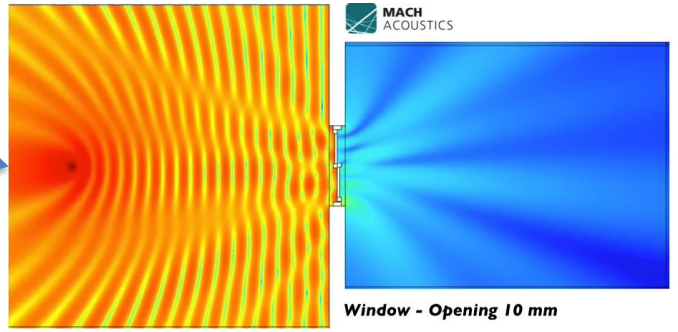
Design proses for an acoustic vent

Establish the vents Sound Reduction

Visually model the passage of sound through the vent



Undertake 2D and 3D modeling to



Model the air flow through the vent

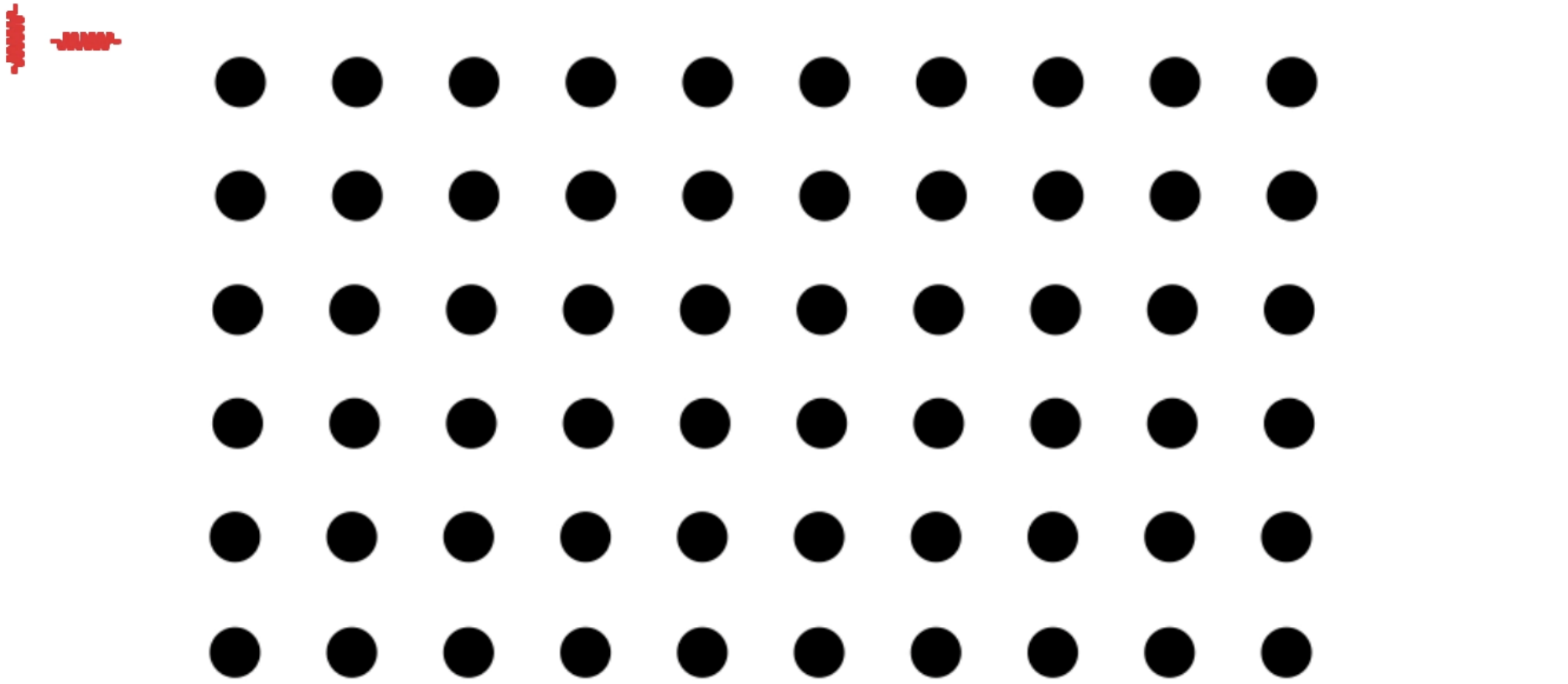
Measure the acoustics and airflow performance of the vent

Attenuated Windows

Acoustic vent & loudspeaker shaping

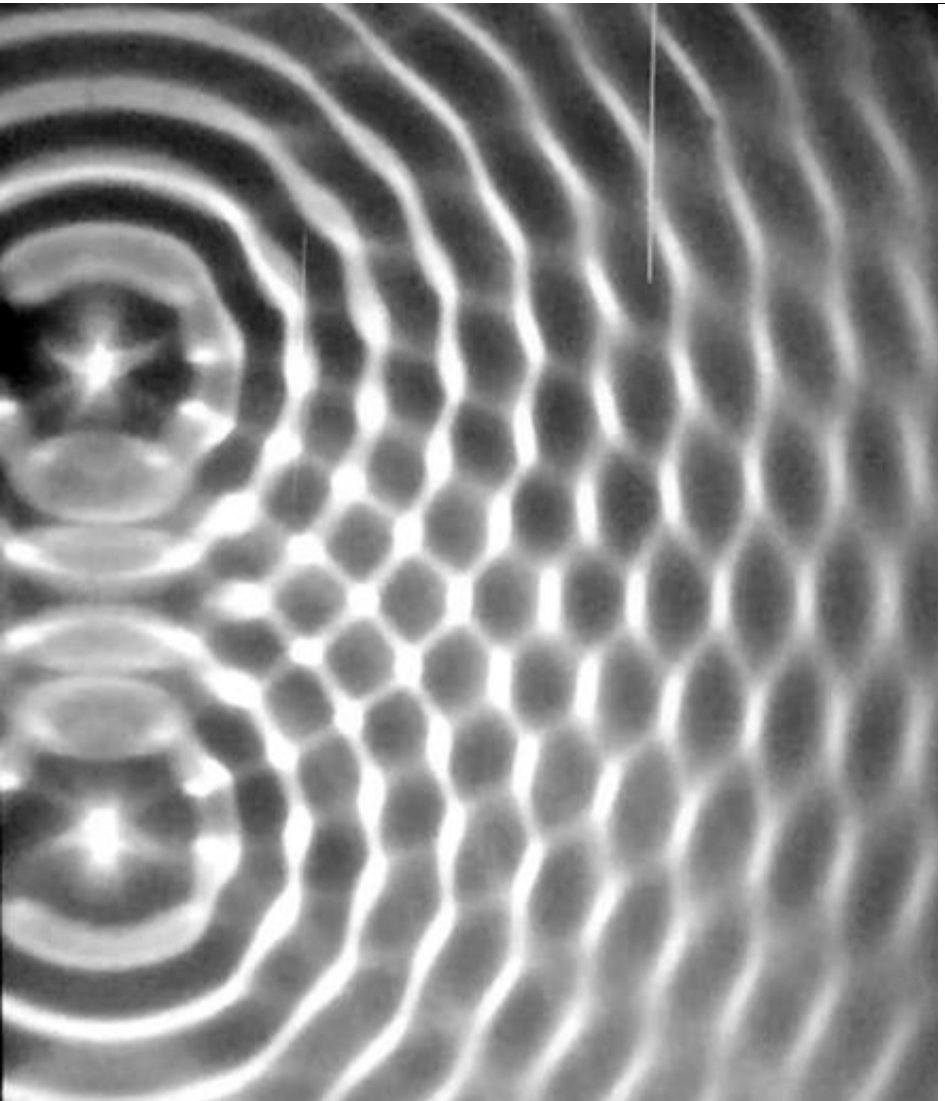
Attenuated Windows

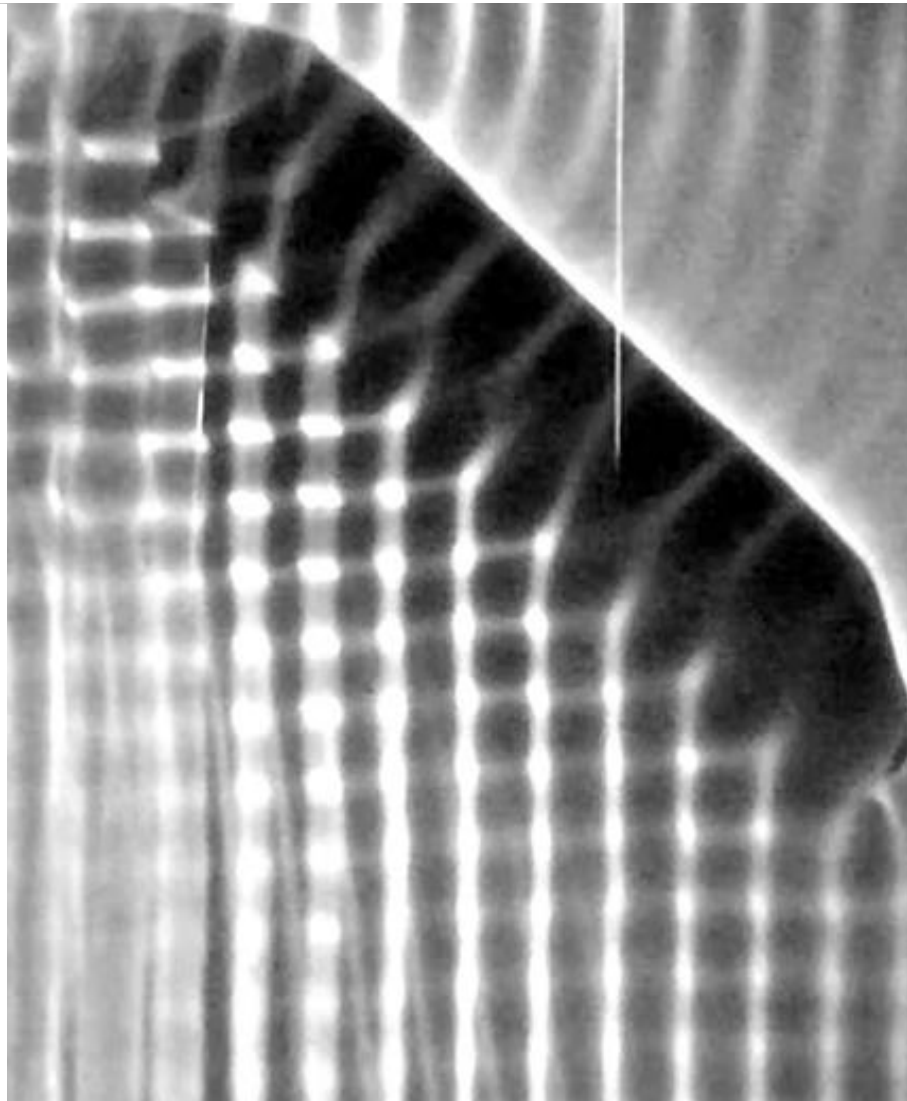
An introduction into Finite Time Difference Modeling



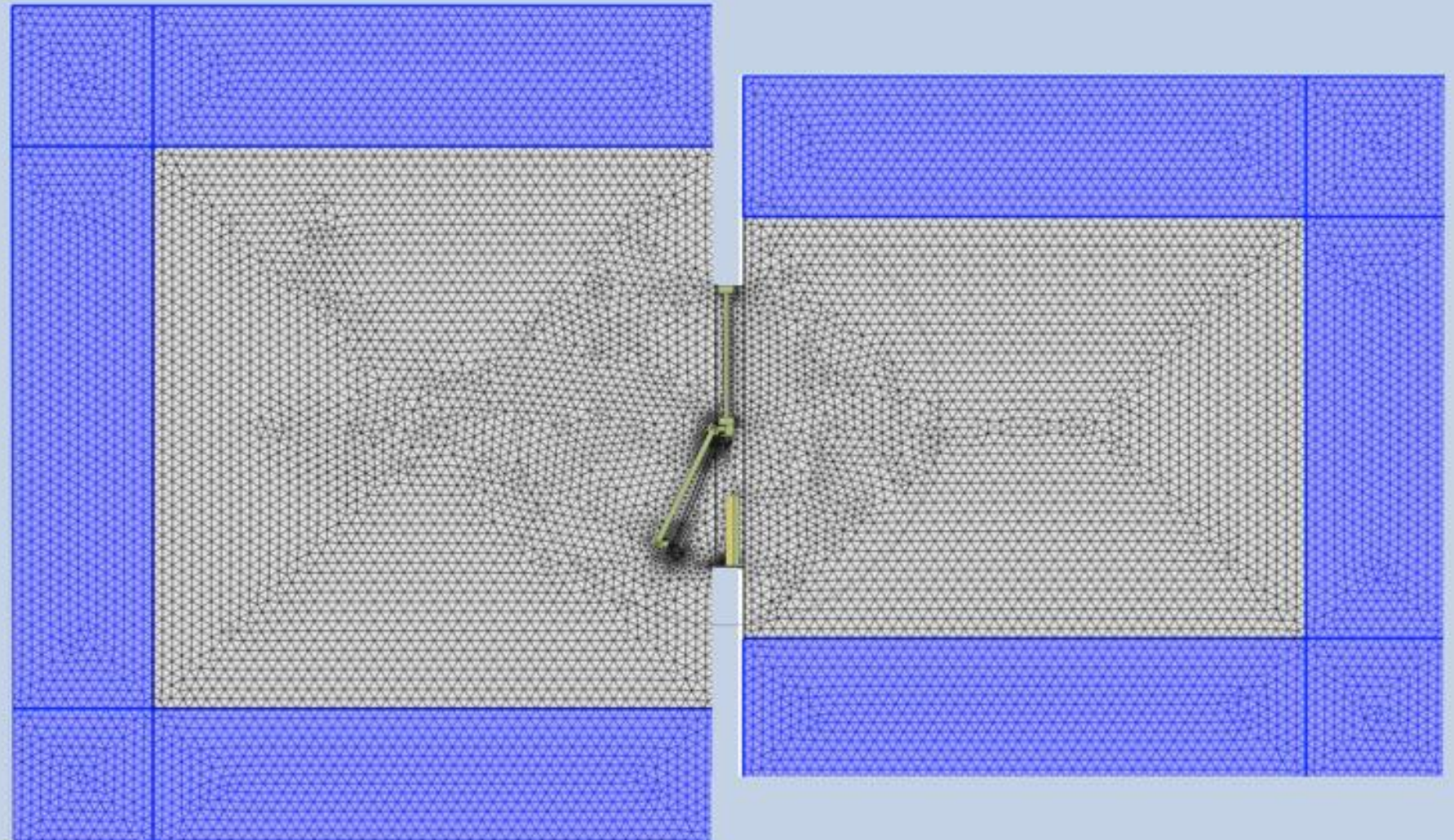
Attenuated Windows

Finite Elements Analysis

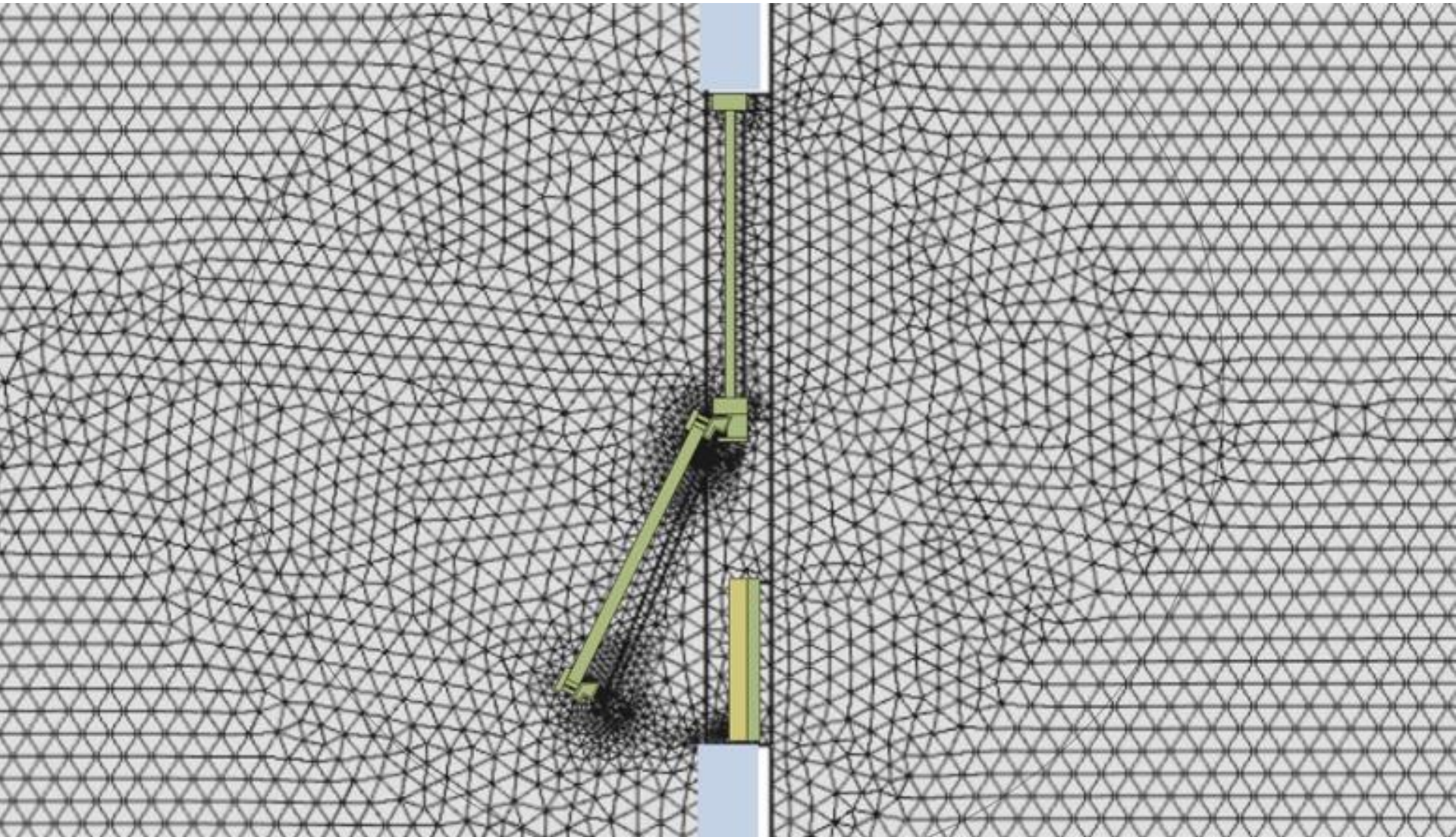




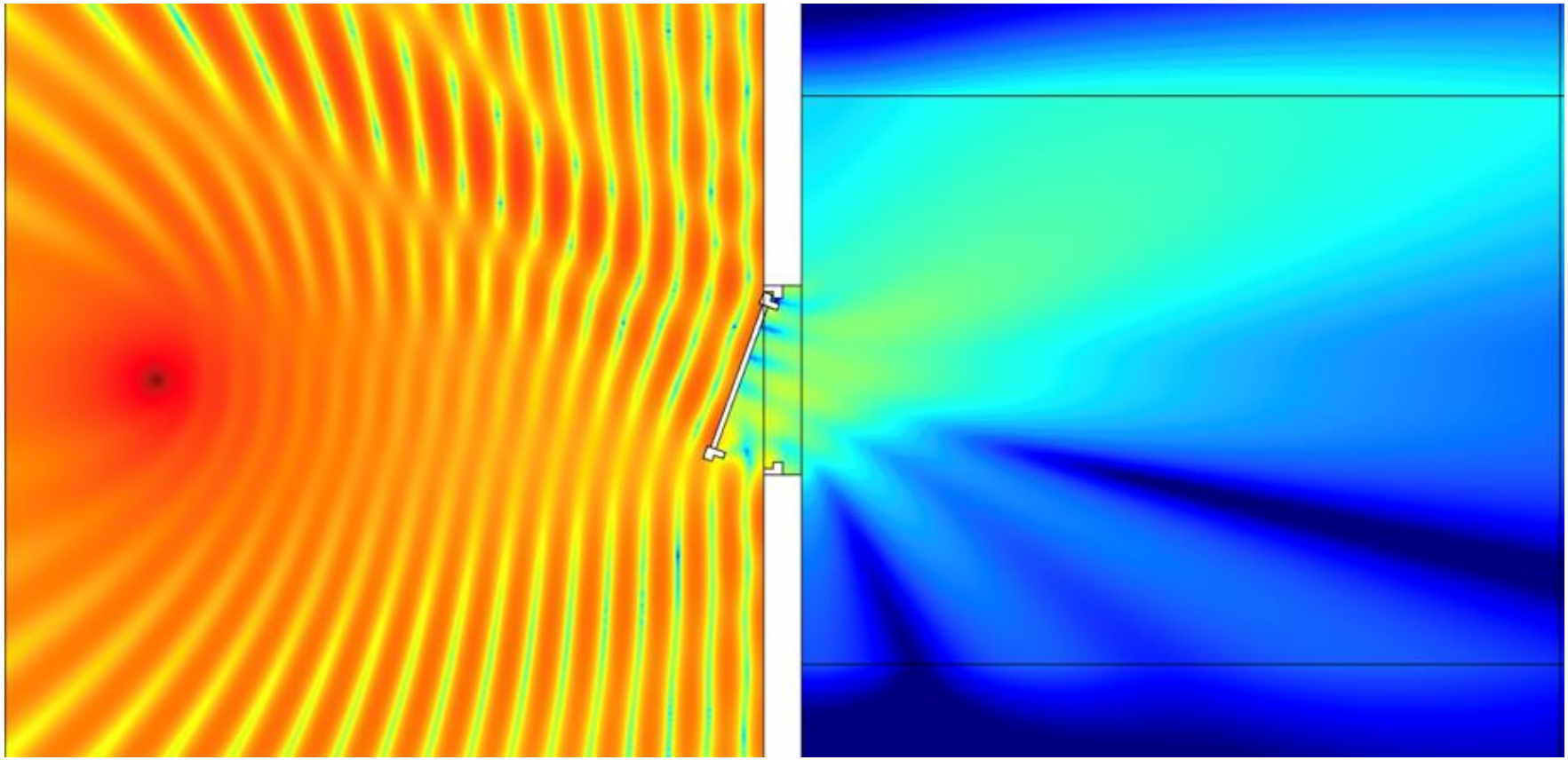
Finite Elements Analysis – The mesh



Finite Elements Analysis – The mesh



Finite Elements Analysis – Results – Baffled Open Window



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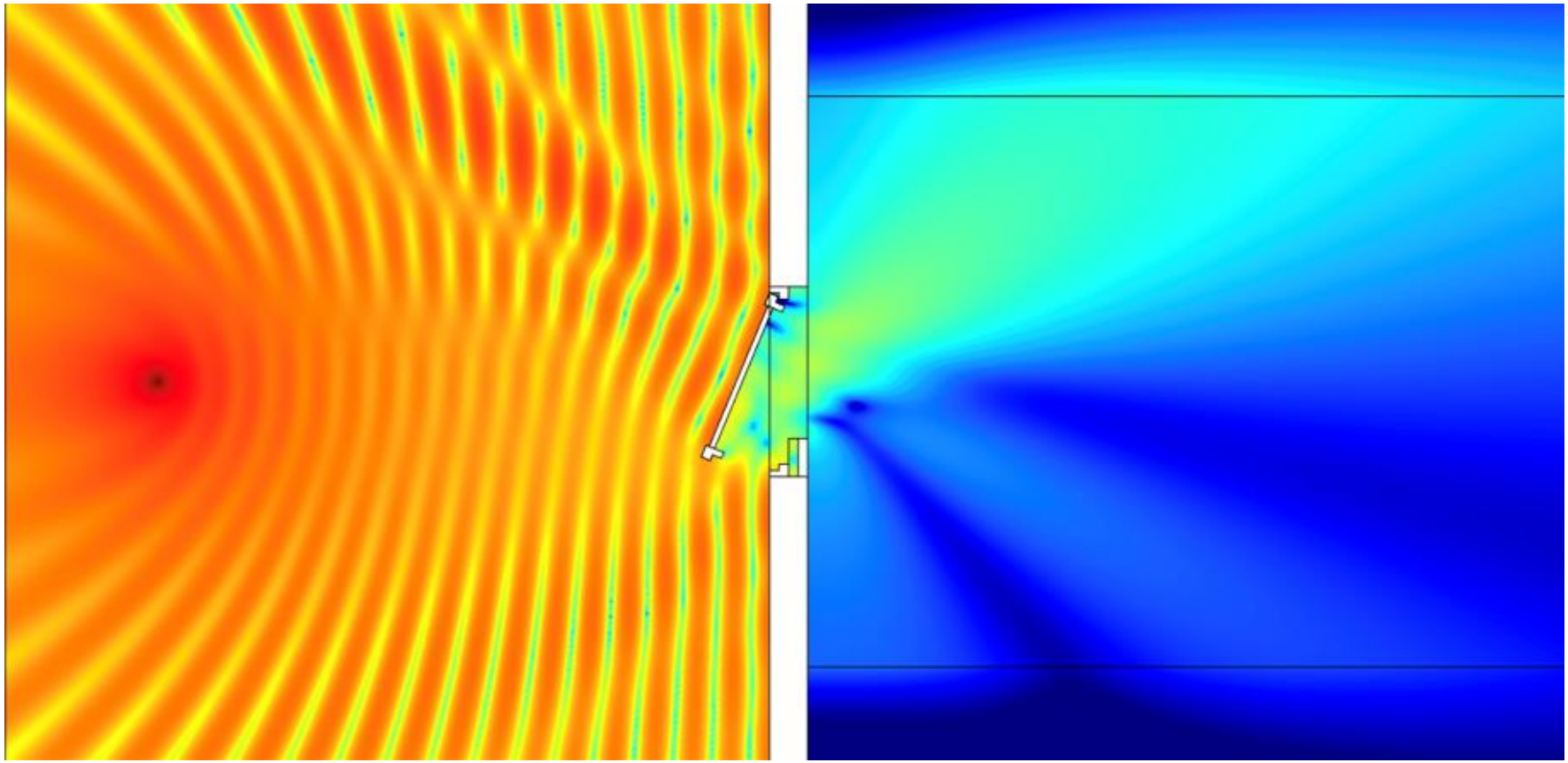

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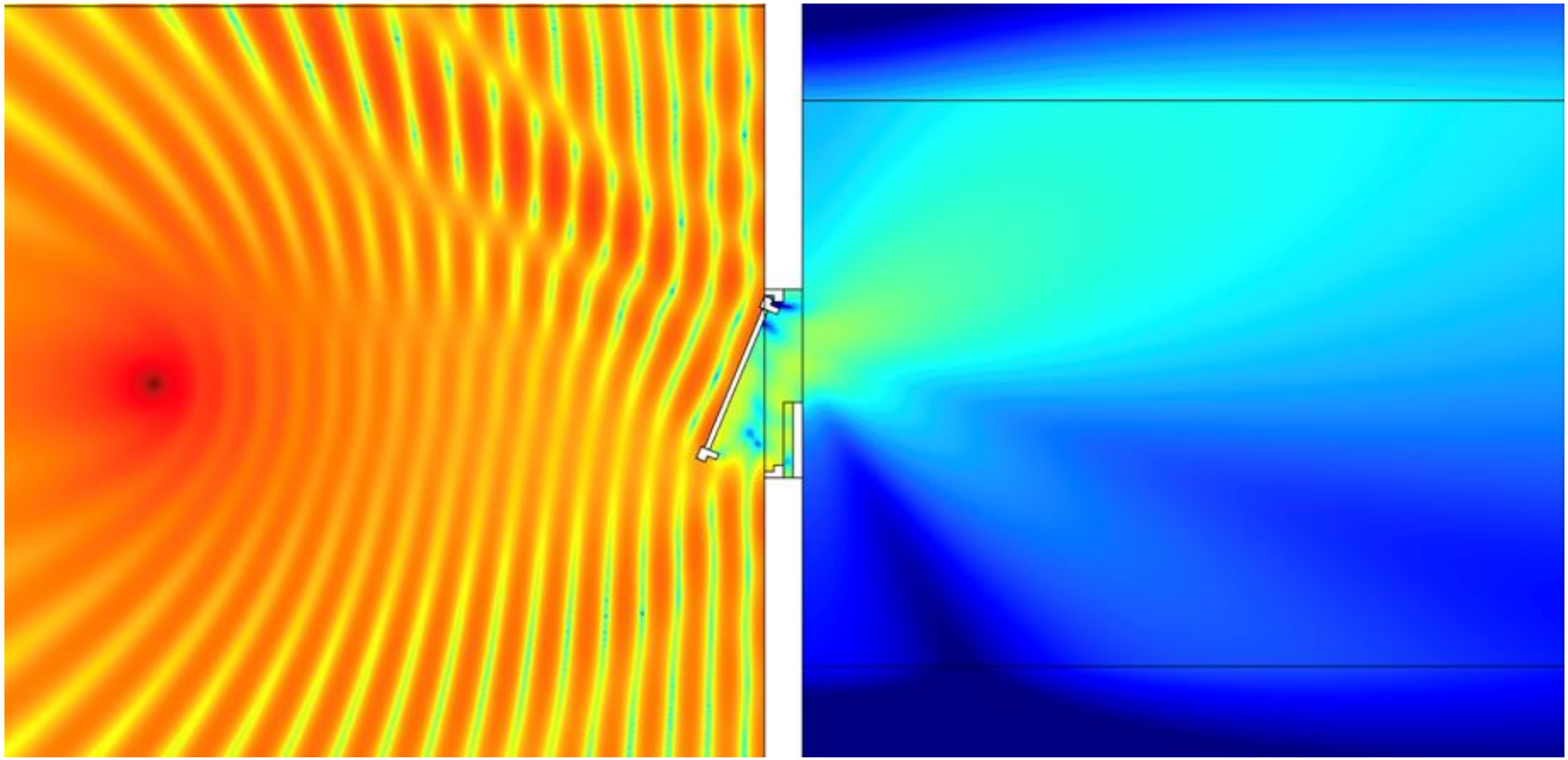

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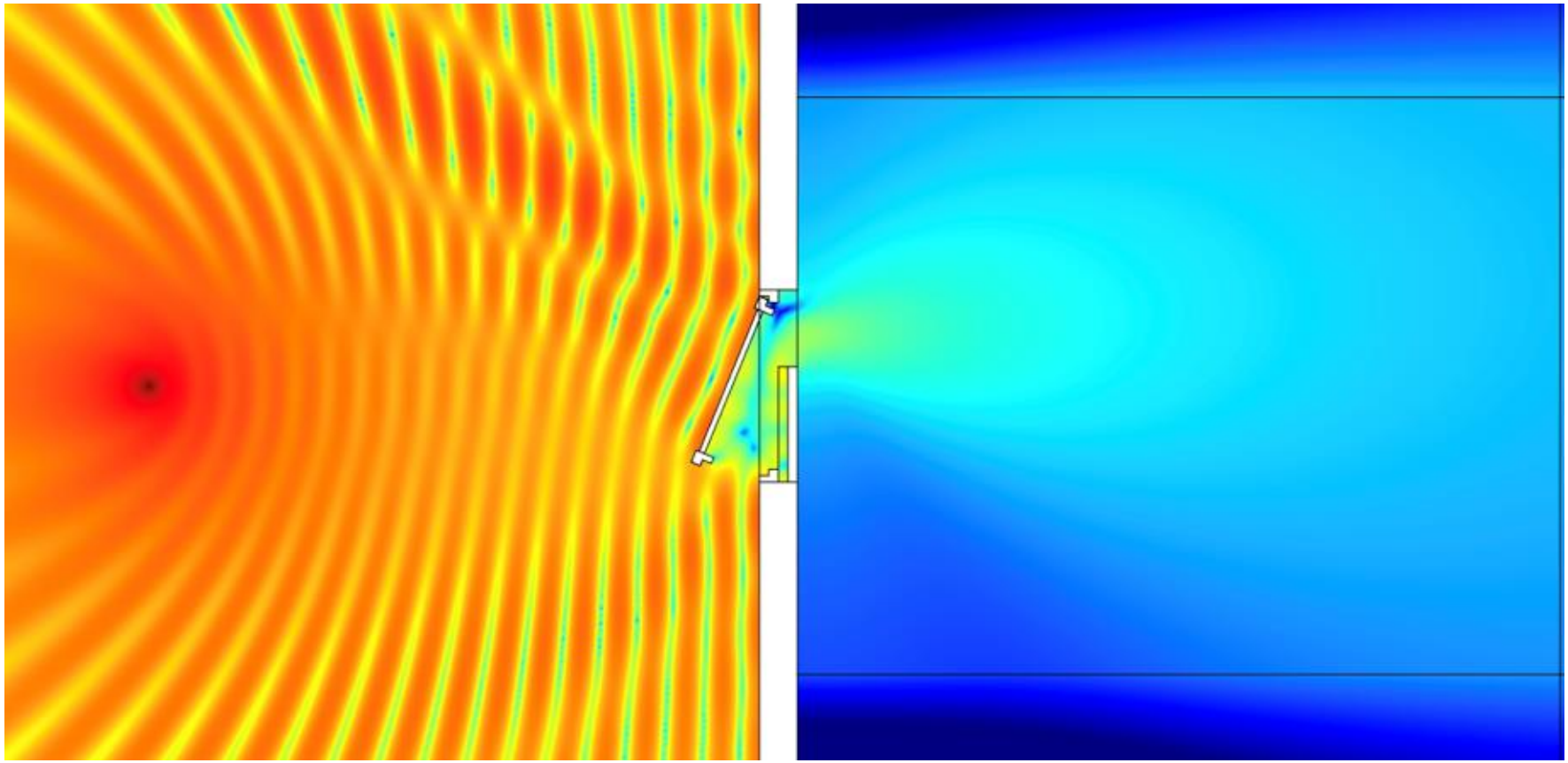
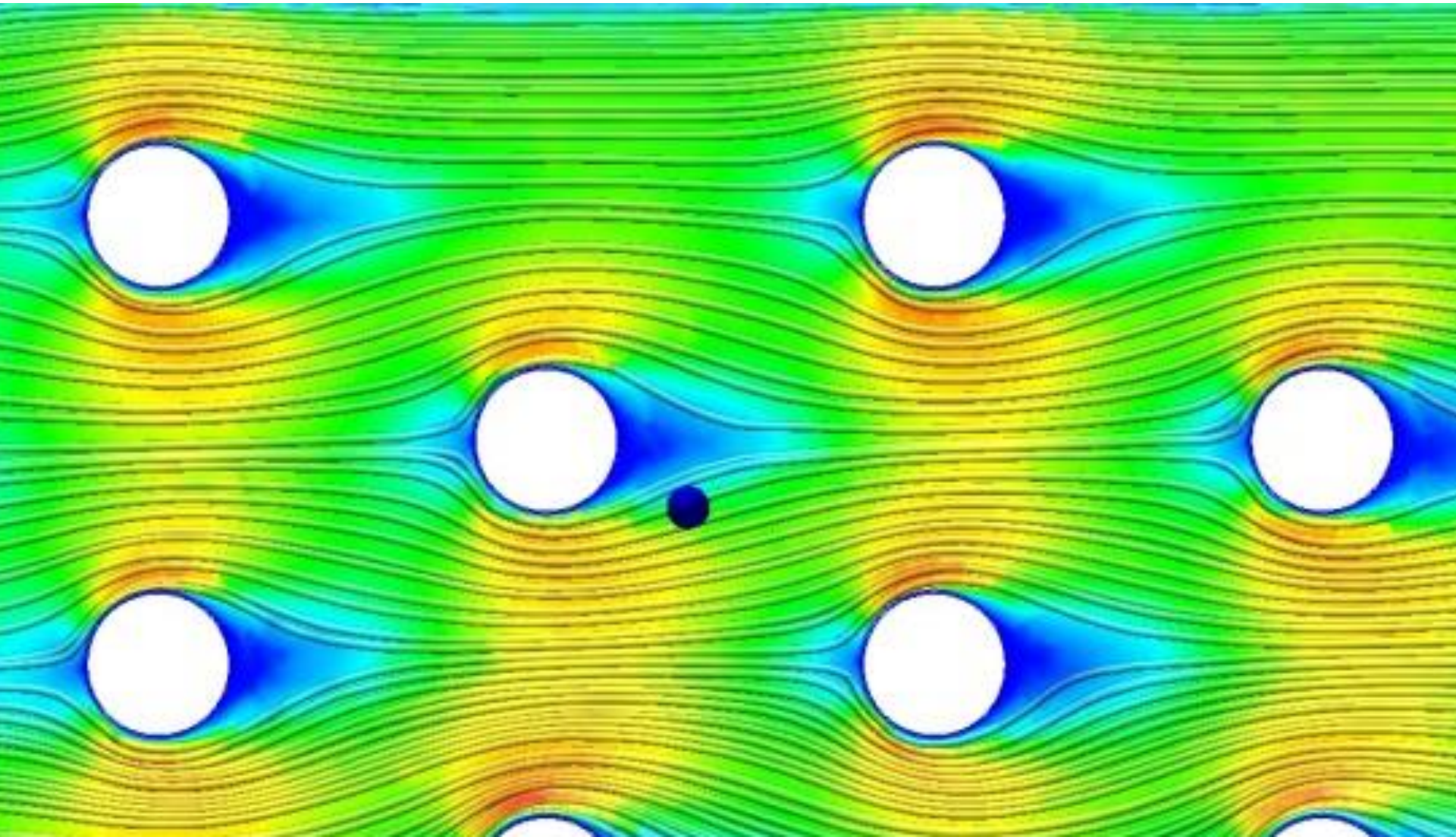
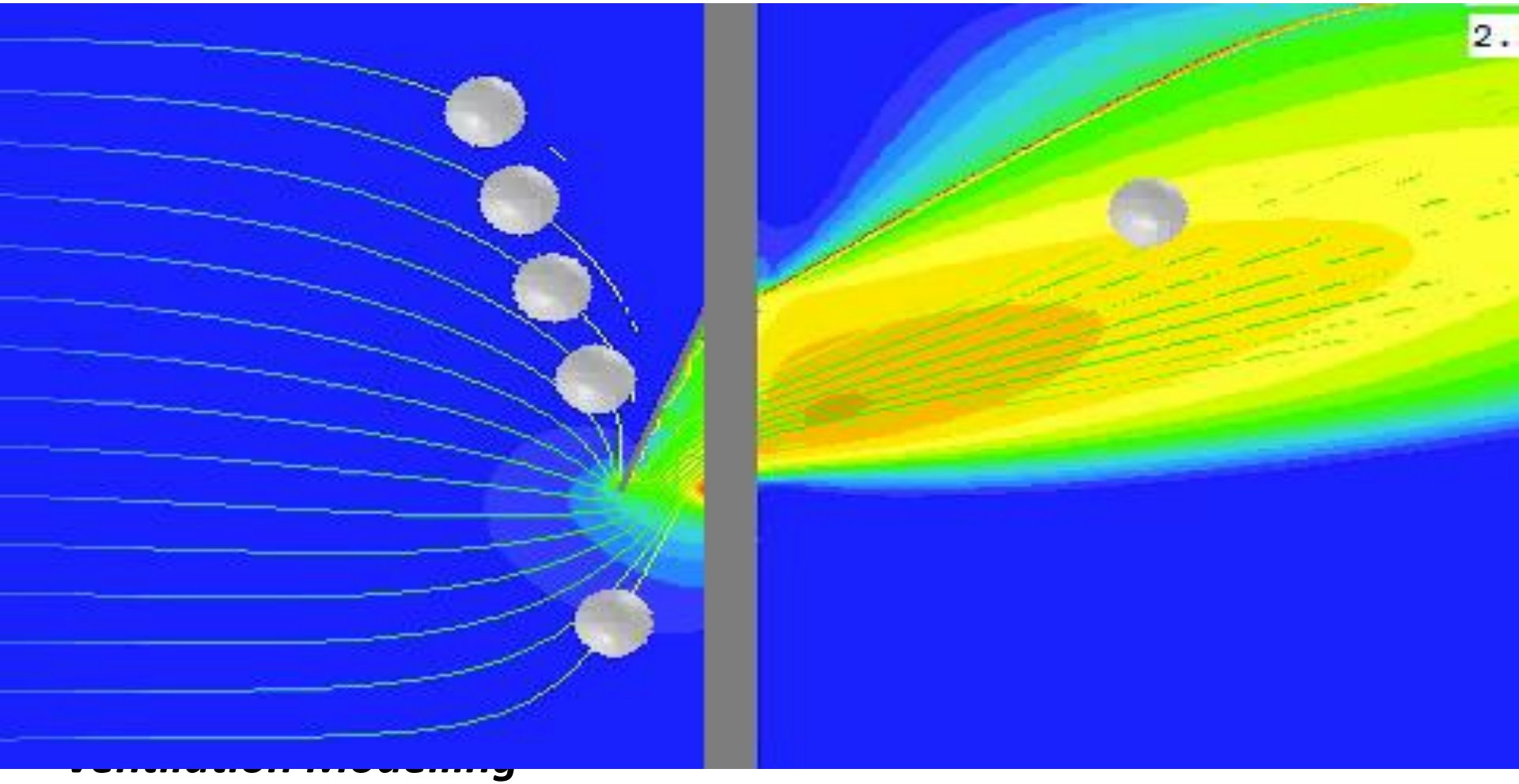


Modeling air flow – Computational fluid dynamics



Attenuated Windows

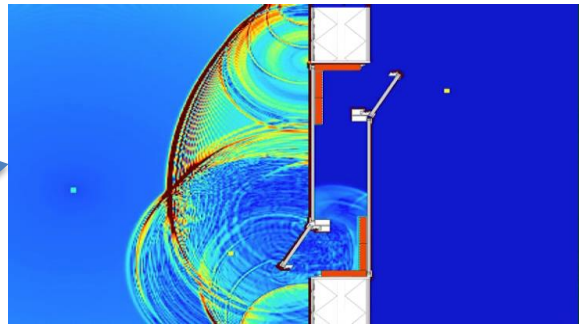
CFD – Top hung window



Design proses for an Acoustic Vent

Establish the vents Sound Reduction

Visually model the passage of sound through the vent



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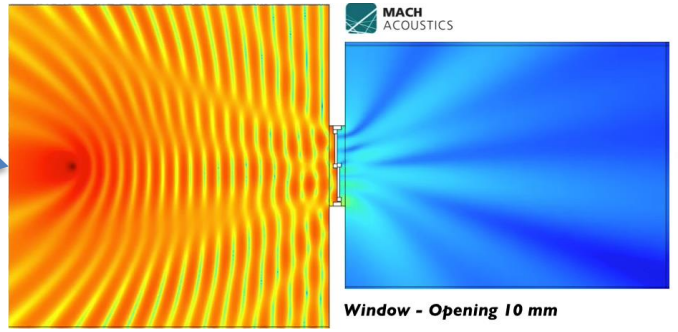


Model the air flow through the vent

Measure the acoustics and airflow performance of the vent

Conclusions

- Why are acoustics important to natural ventilation?
- What are the different factors that pull on ventilation design?
- What tools are available to aid designers in balancing these competing tensions?

Why are Acoustics Important for Natural Ventilation?

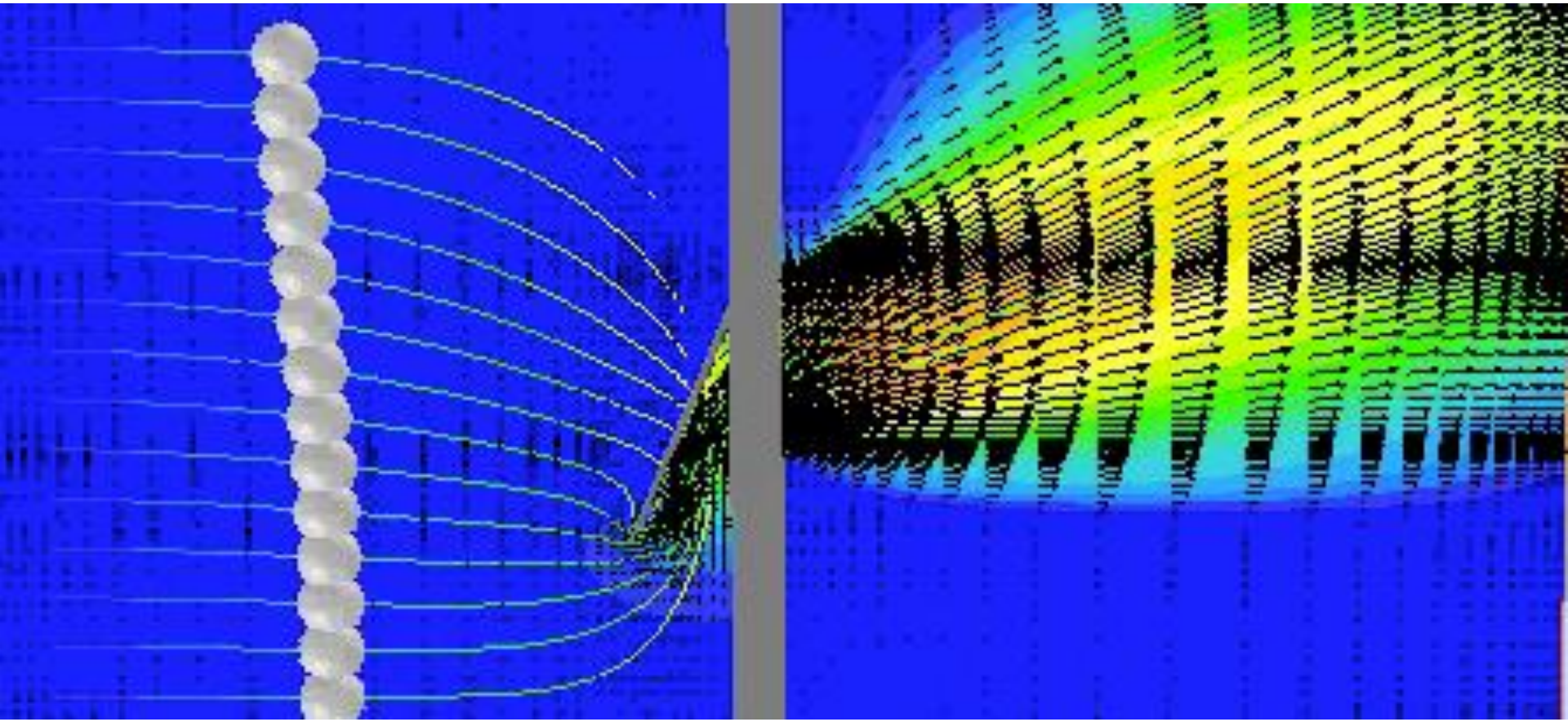
A CIBSE Natural Ventilation Group Webinar
Tues 8th May 2018

Ze Nunes & Owen Connick

MACH GROUP

Breathing Buildings

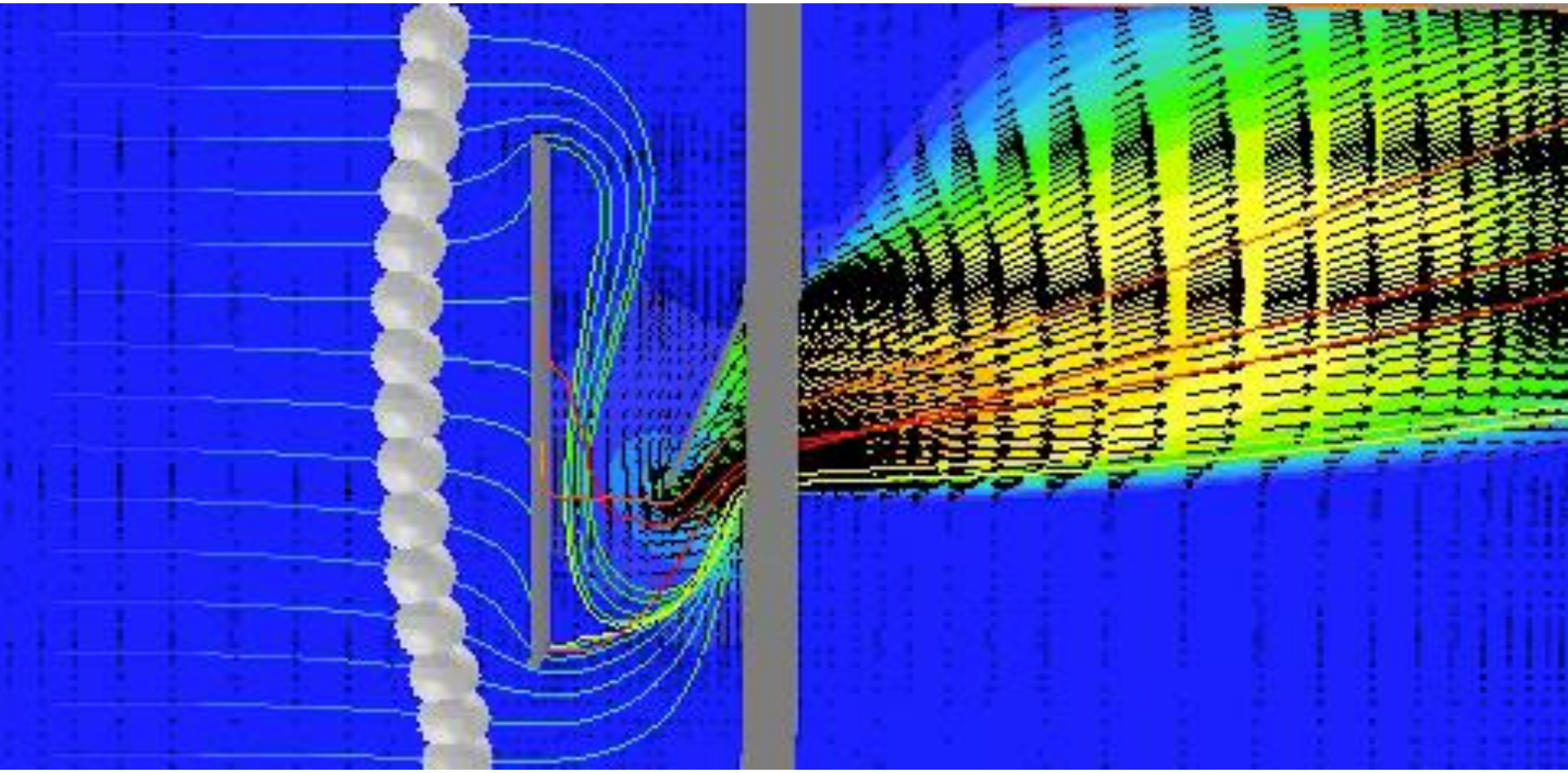
CFD – Top hung window with an extended frame



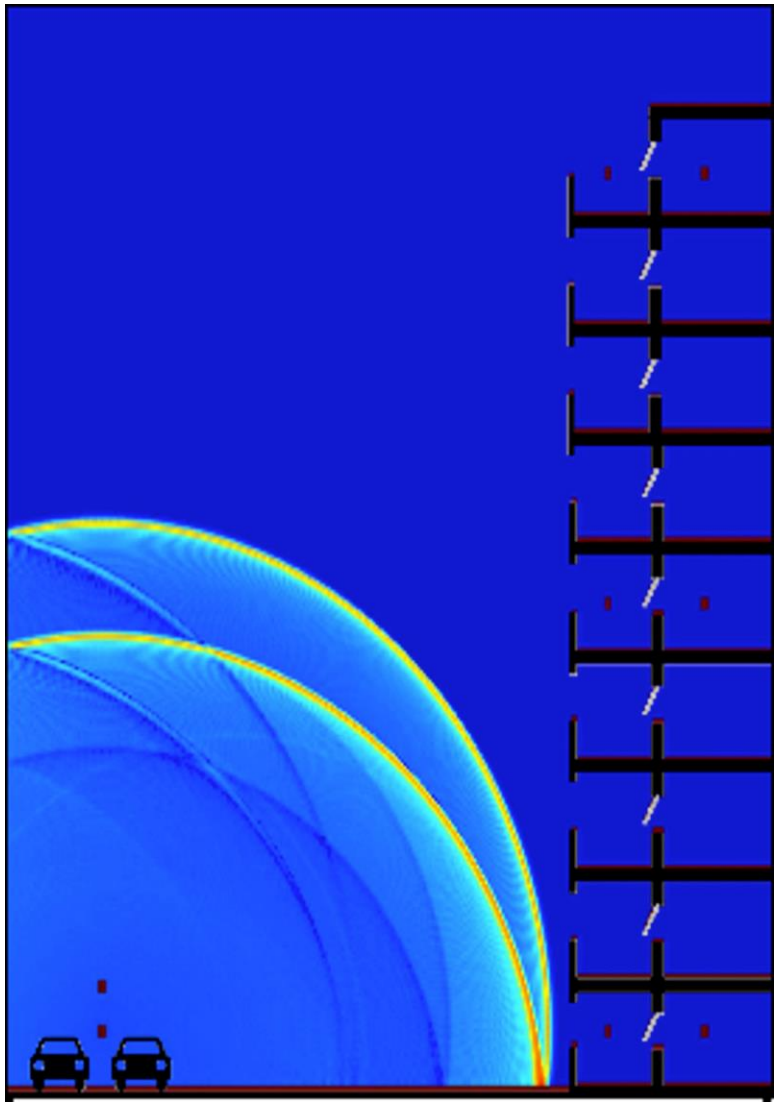
Ventilation Modelling

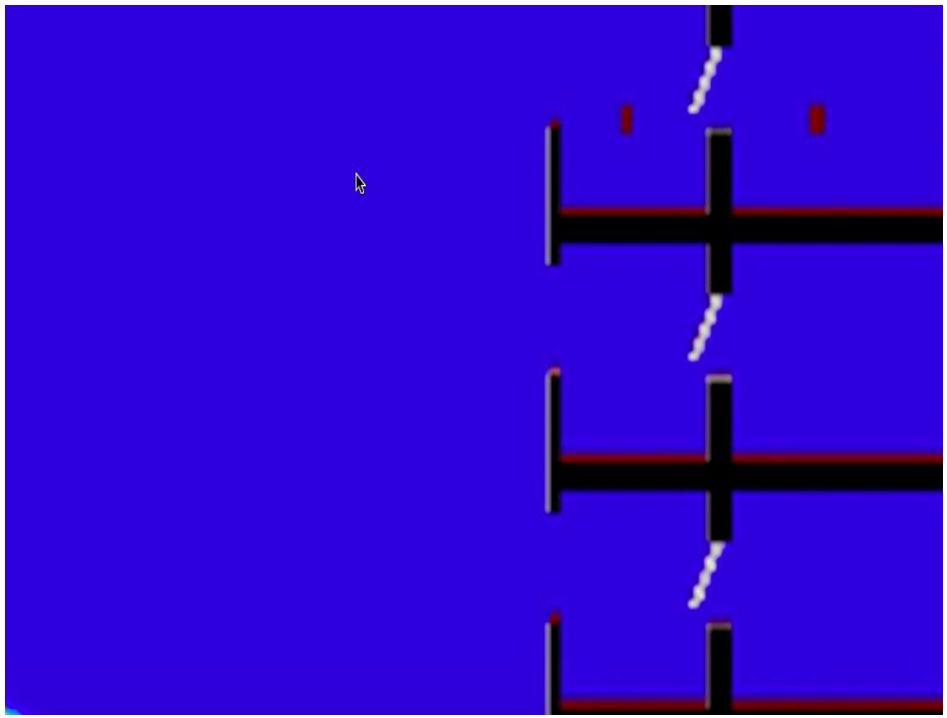
Attenuated Windows

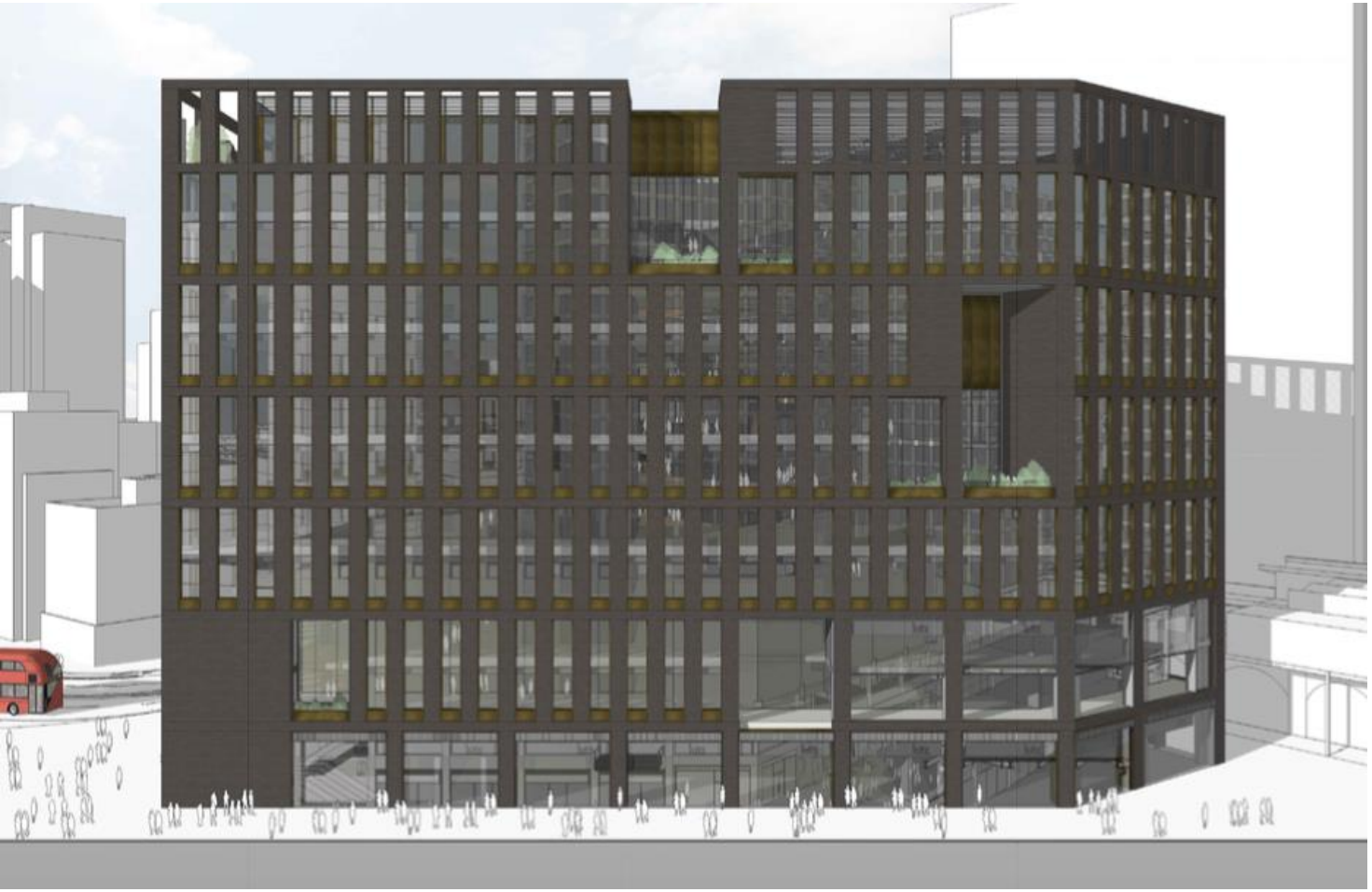
CFD – Top hung window plus baffel

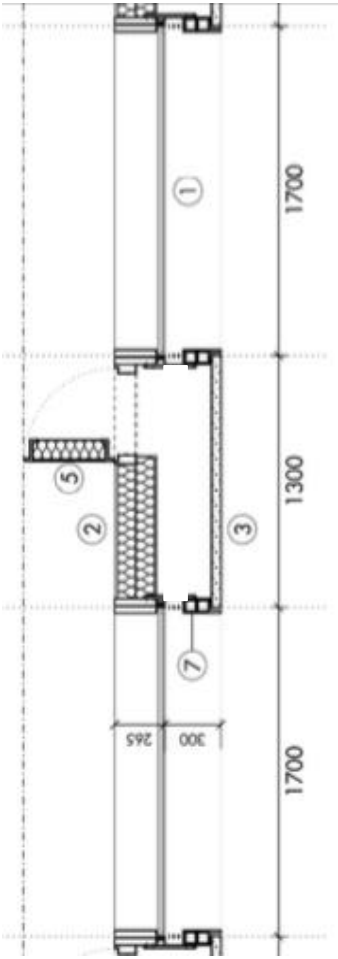


Modeling the acoustics effect of balconies





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1300
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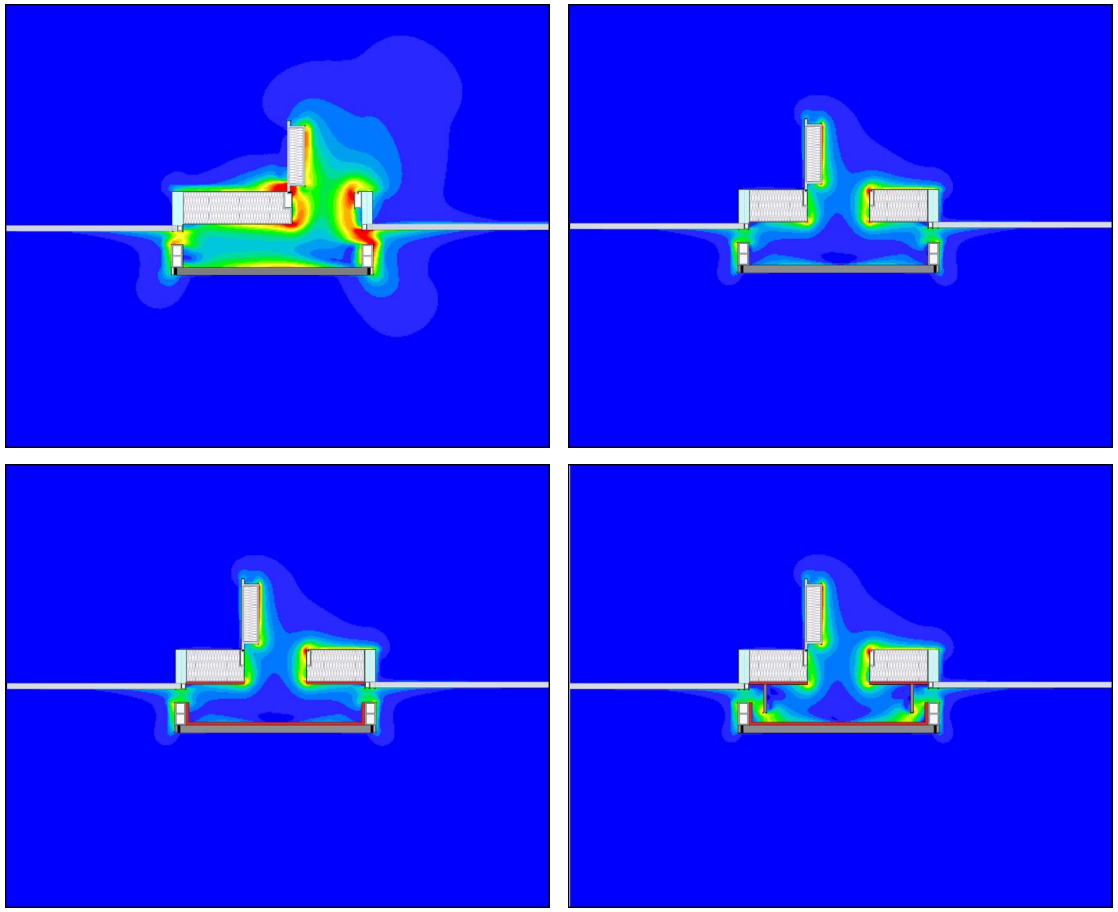
Velocity, m/s
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5.250000
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4.500000
4.125000
3.750000
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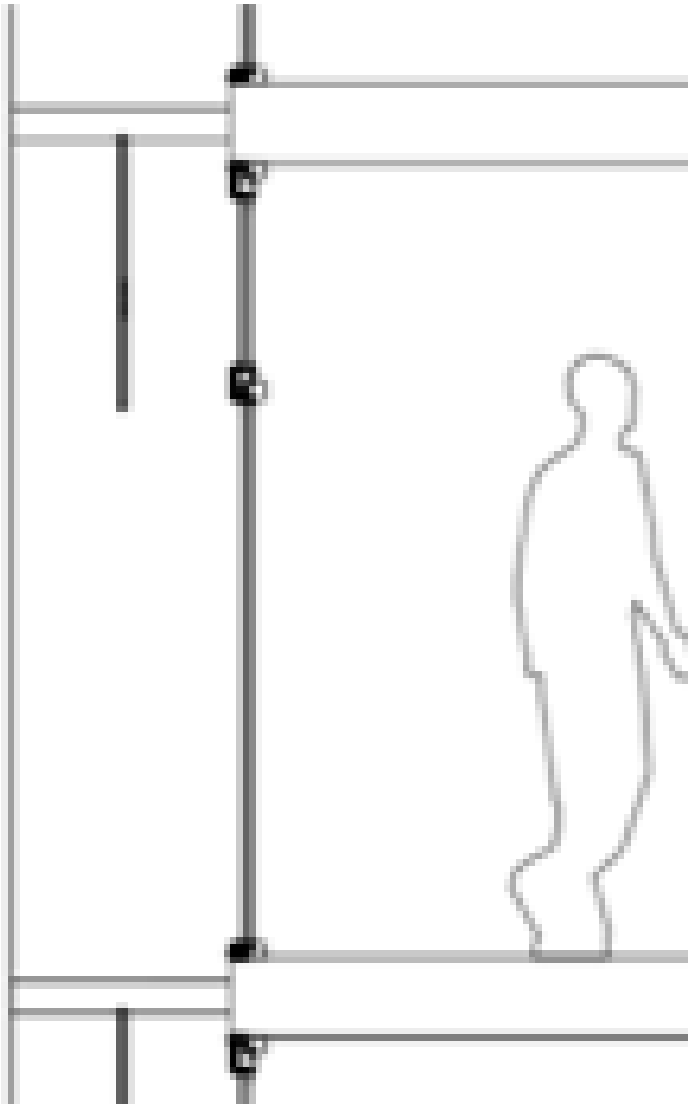
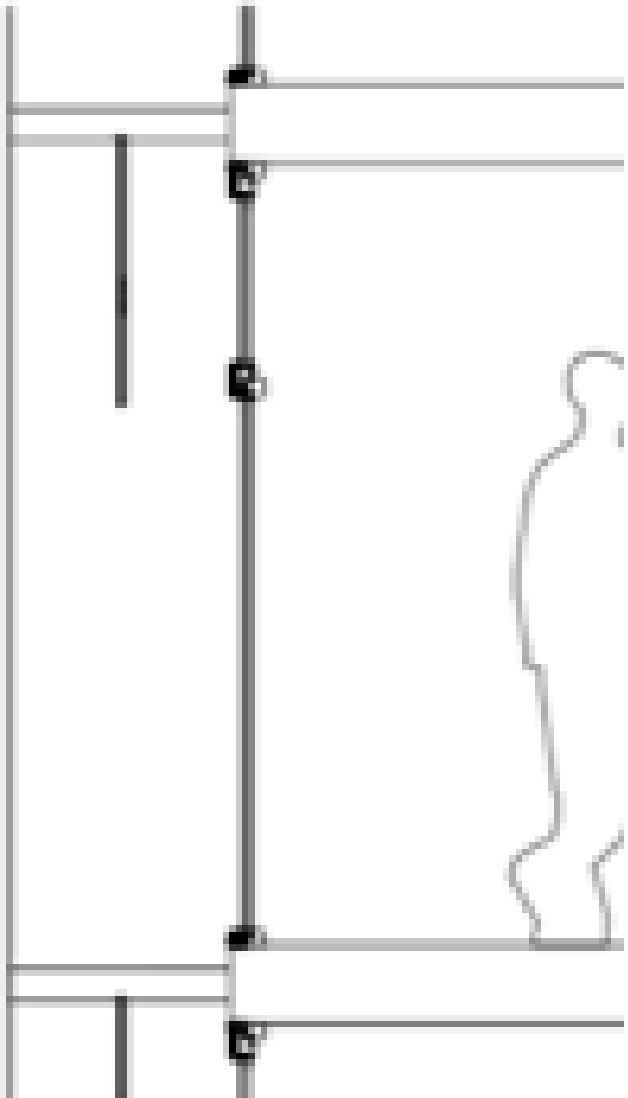
0.000000



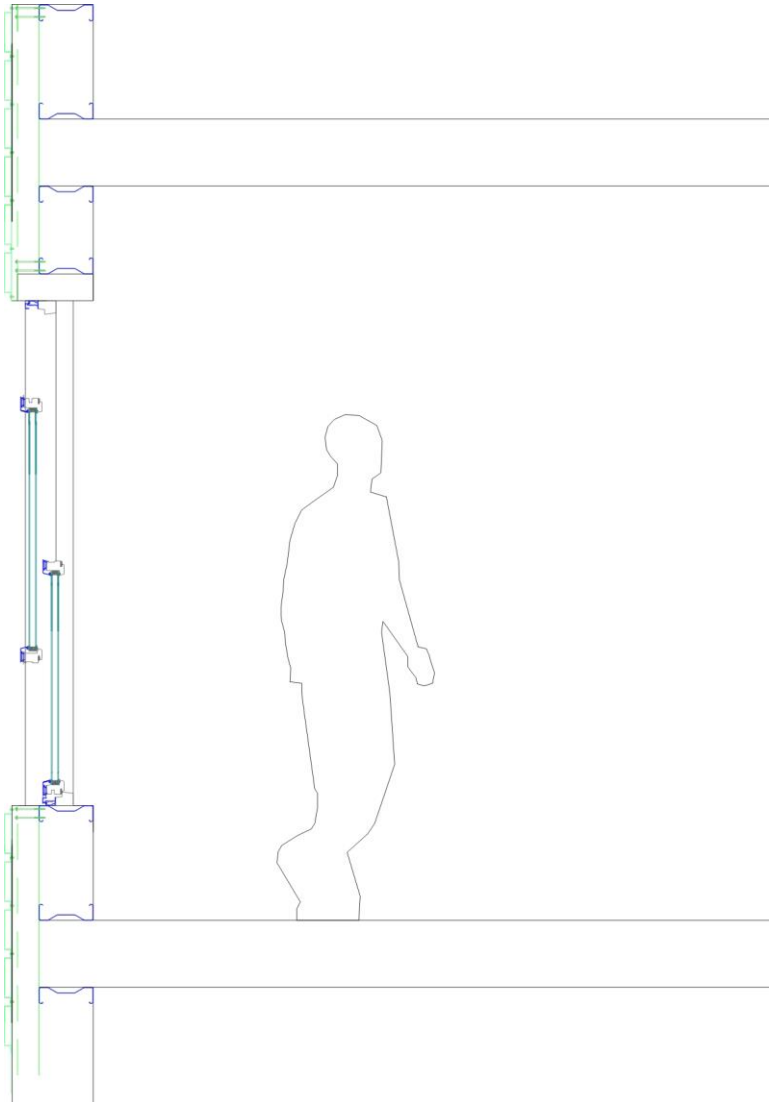
Sash Window



- Very low level of air resistance
- Thus small opening
- Hence easy to achieve day lighting requirements

- Low levels of acoustics sound resistance.
- What is this resistance?

Sash Window



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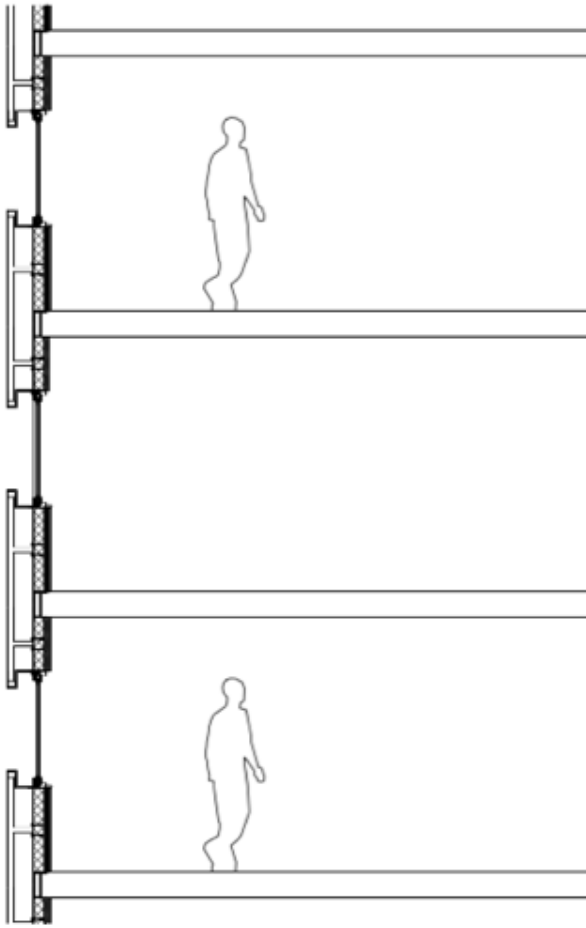
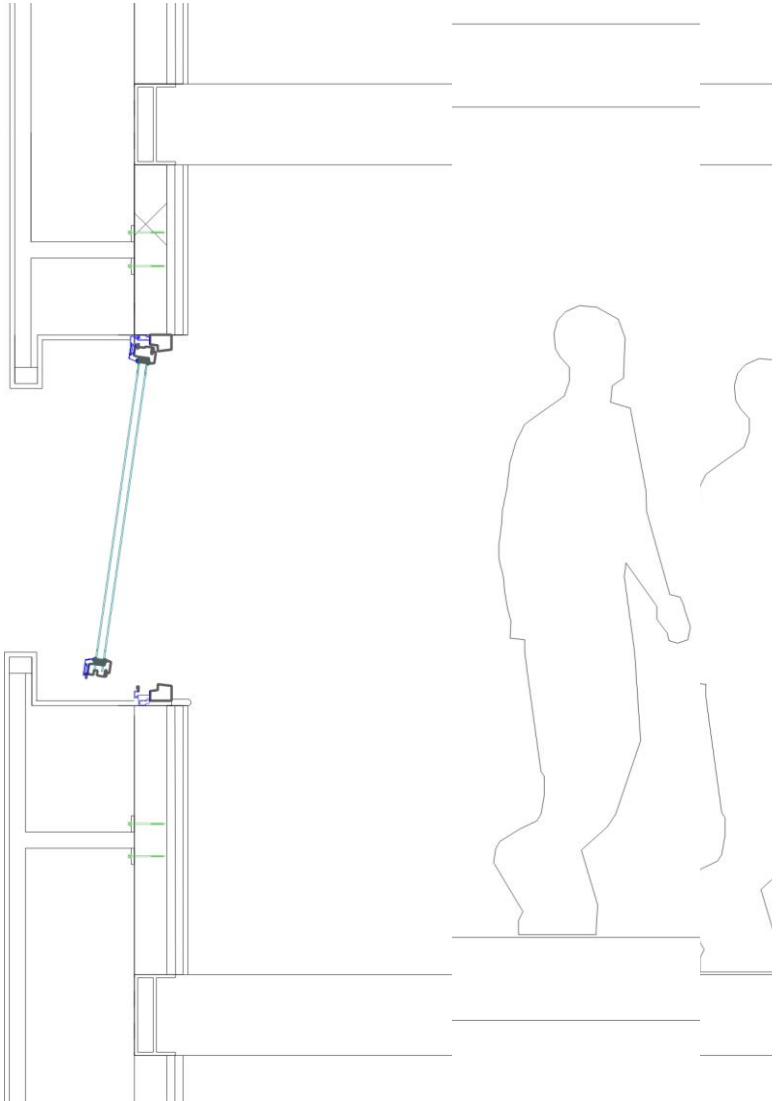
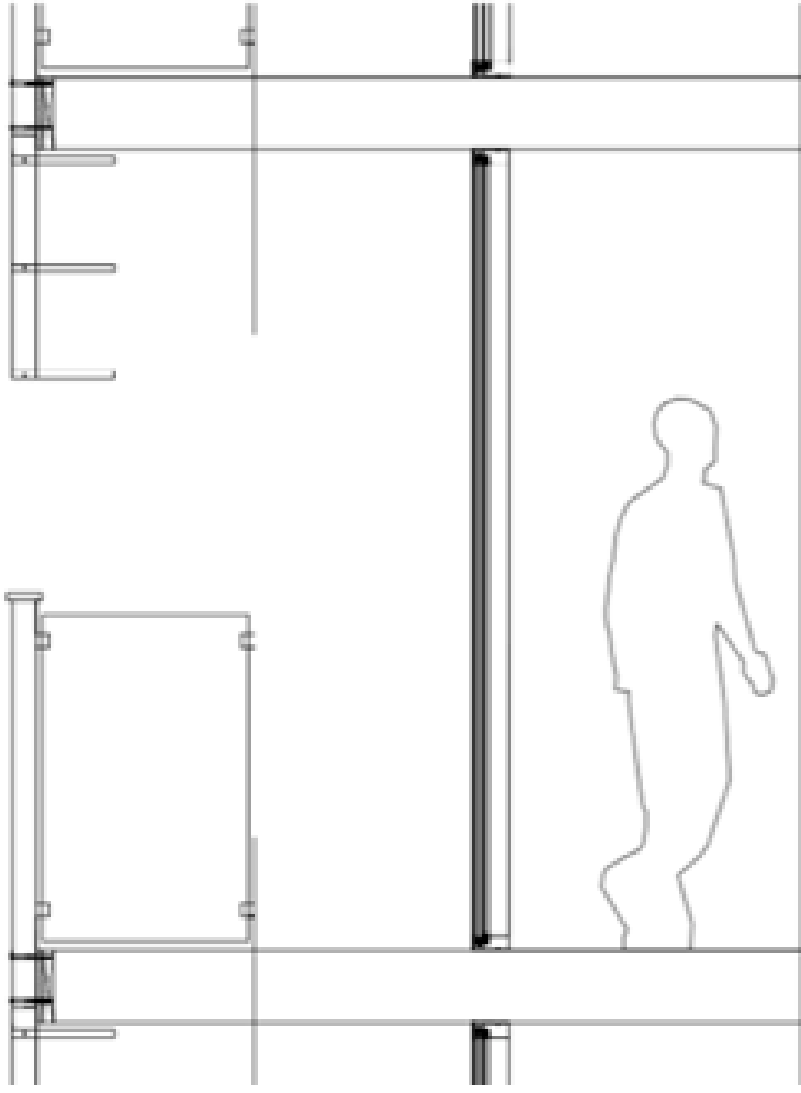


Baffled - Top Hung Window

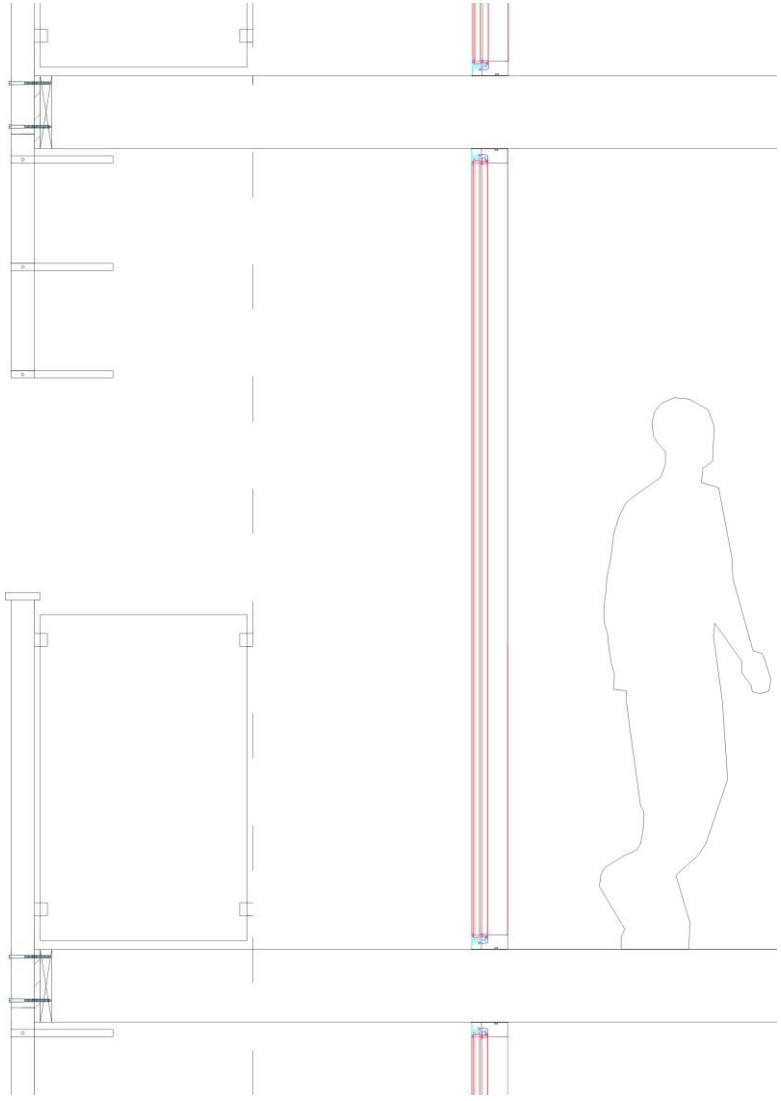


- Very low level of air resistance?
- Thus small opening
- Hence easy to achieve day lighting requirements

- Low levels of acoustics sound resistance.
- Is the sound resistance increased?

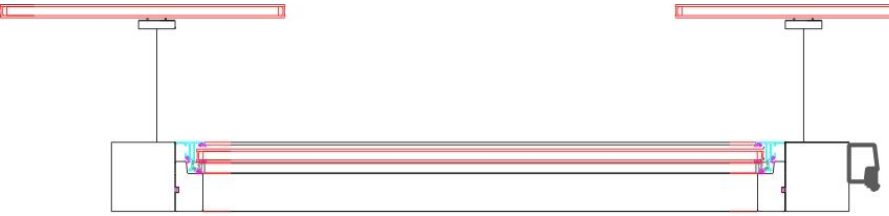


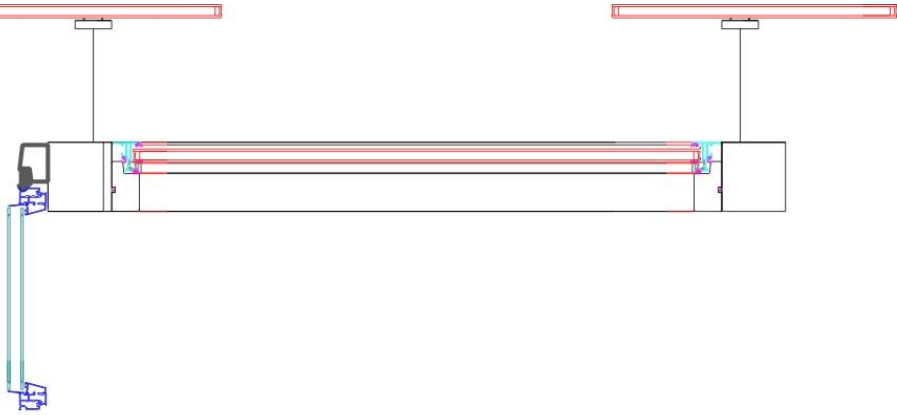
The Effect of Balconies

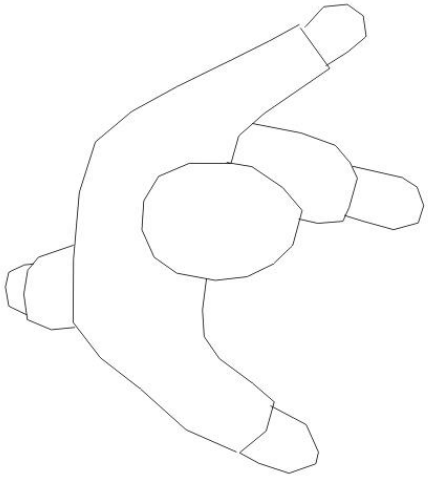


- Does the balcony have an effect on the sound reduction of the opening in the facade?

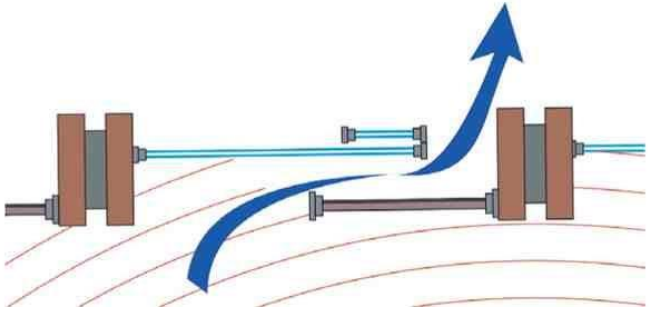
Baffled Air Vents



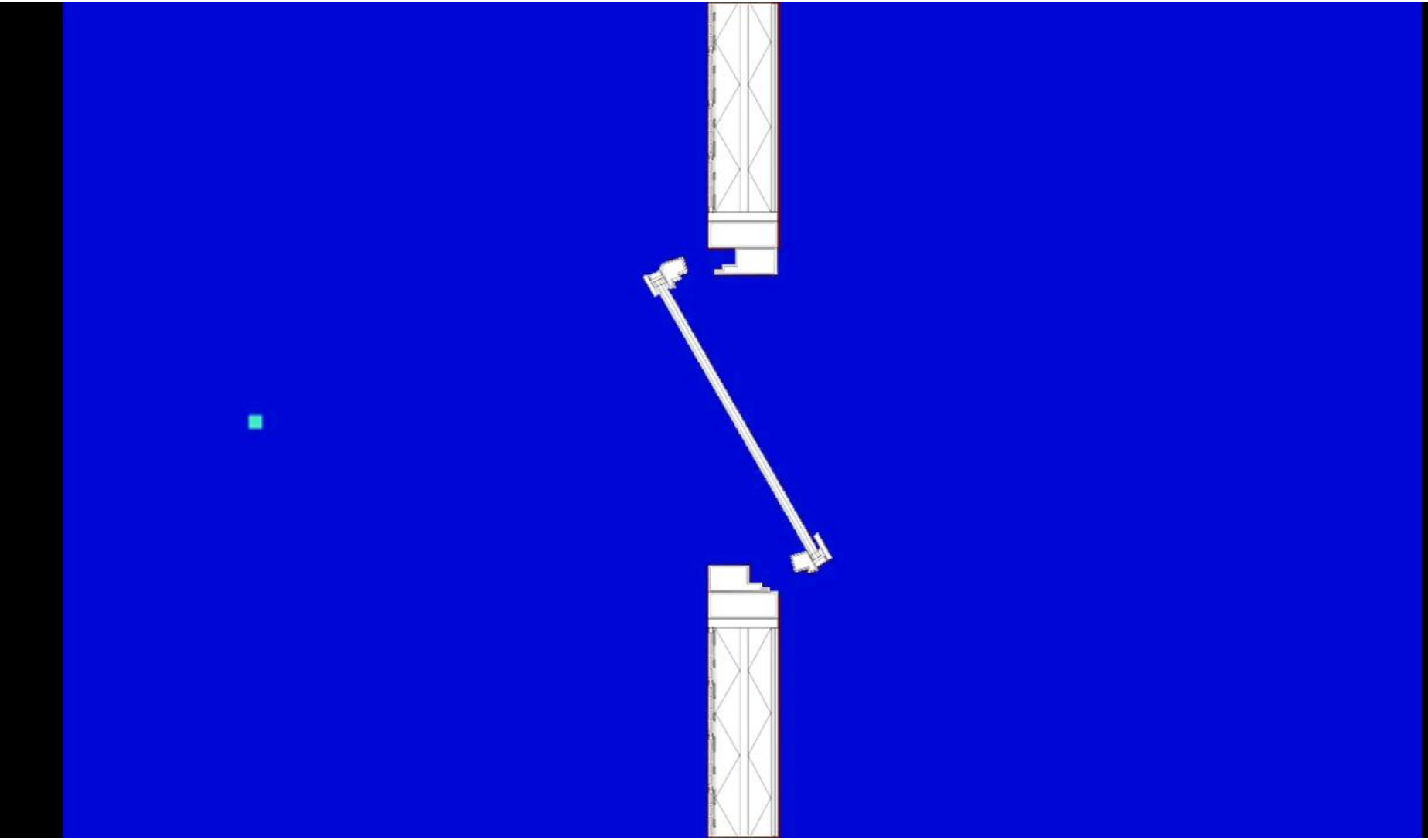


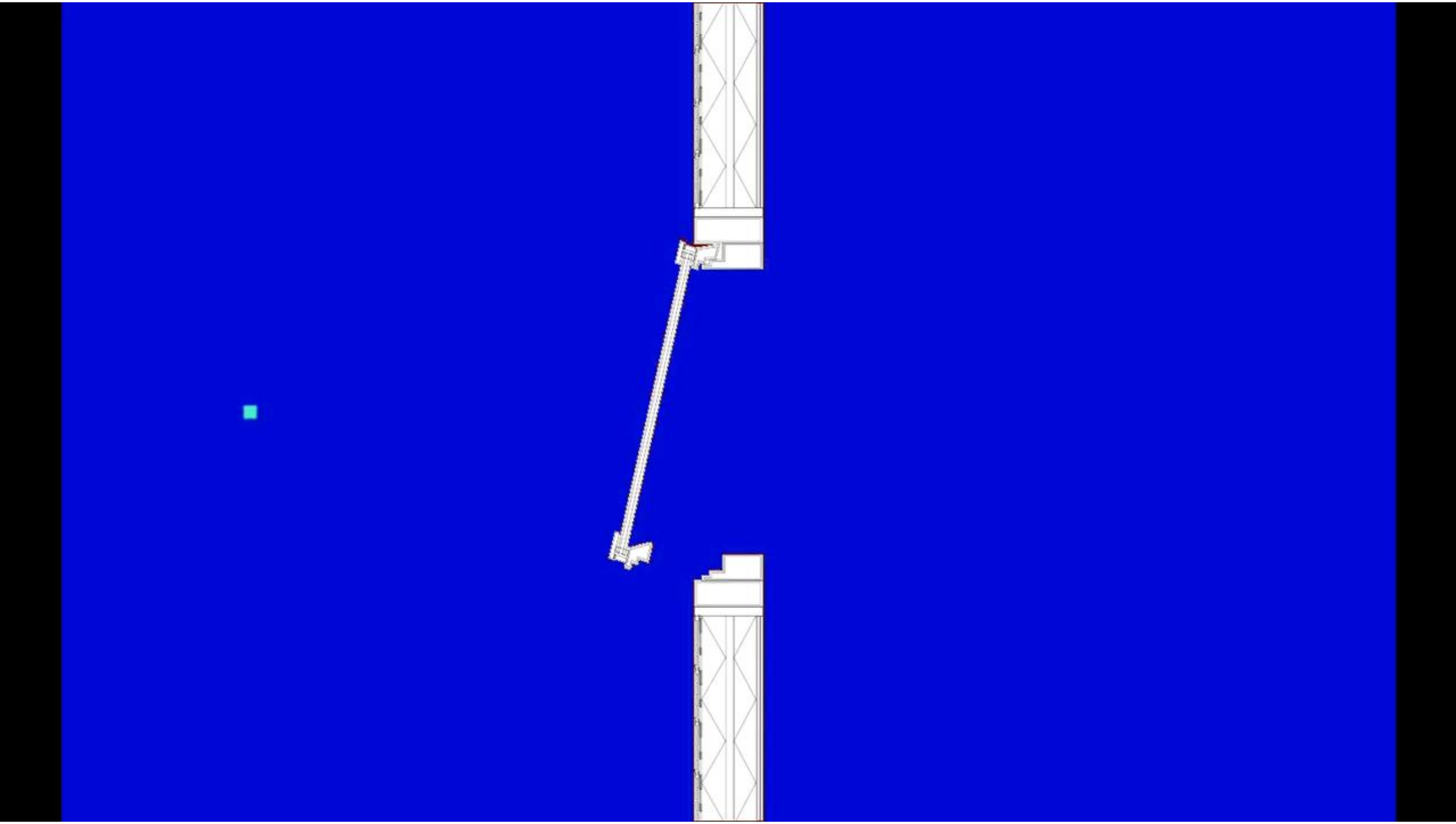


- Can baffles be used to increase the sound reduction of the facade?
- What is the effect of this baffles on the air flow?




Rosmarinstraße



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