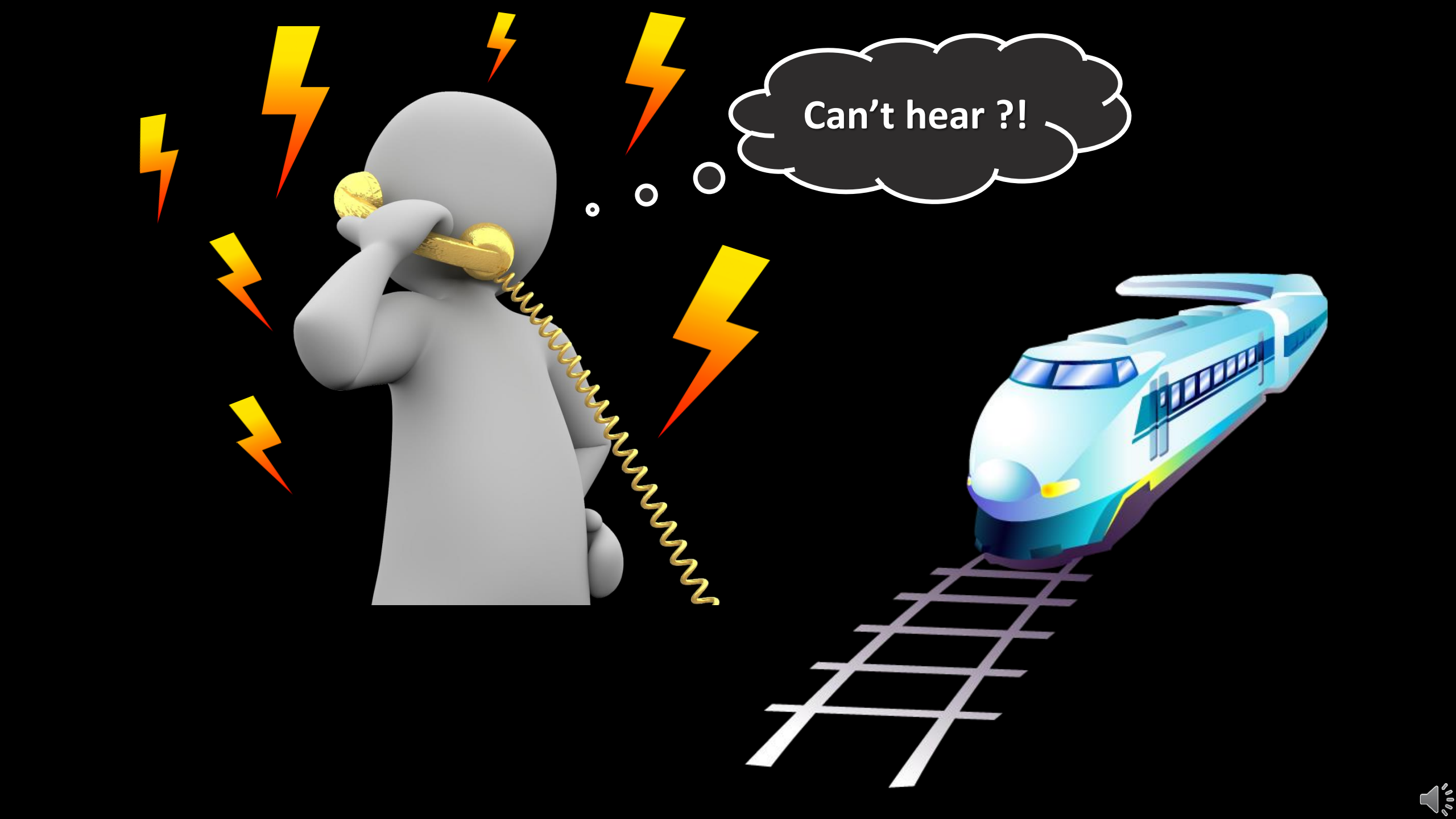
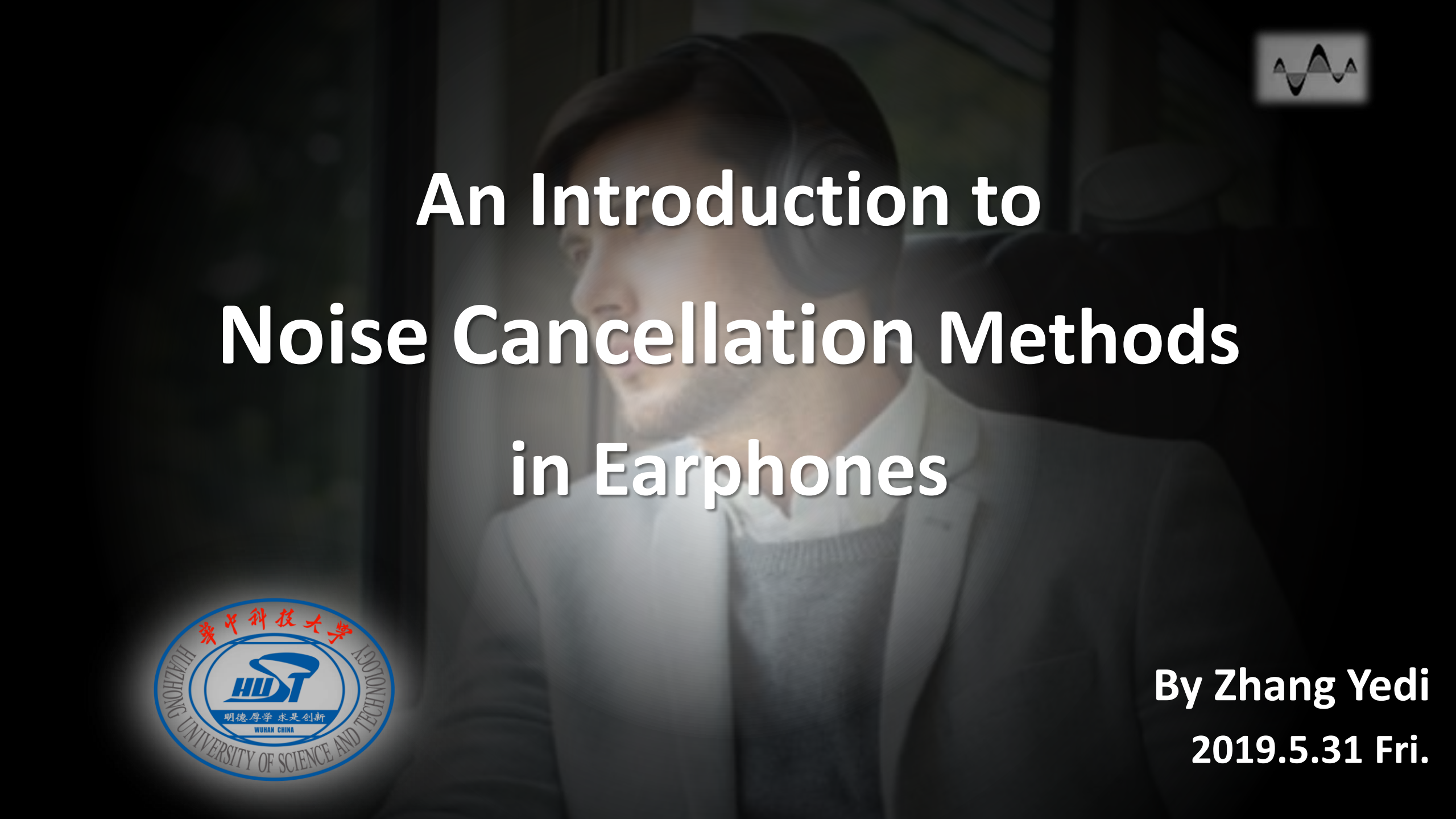

Can’t hear ?!



An Introduction to Noise Cancellation Methods in Earphones

By Zhang Yedi

2019.5.31 Fri.

OUTLINE

Introduction	1st	What is noise cancellation?
	2nd	Why do we need it?
Main Body	3rd	How do earphones do it?
Conclusion	4th	What is the future trend?

1st question:

What is noise cancellation?

To eliminate or decrease noise.

2nd question:

Why do we need NC function?

NC: Noise Cancellation

2nd question:

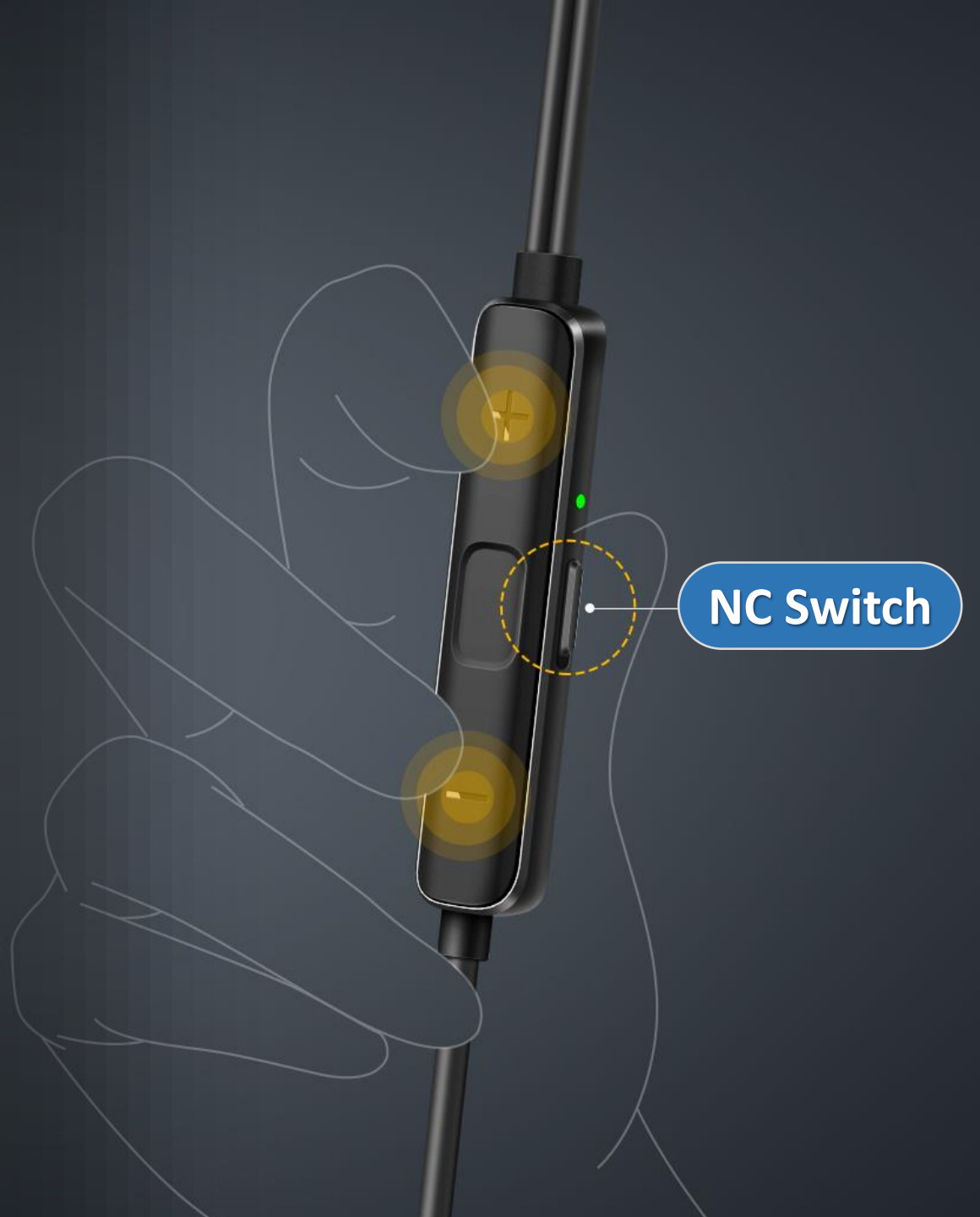
Why do we need NC function?

Professional Usage

Personal Usage

3rd question:

How does an earphone manage to cancel noise?



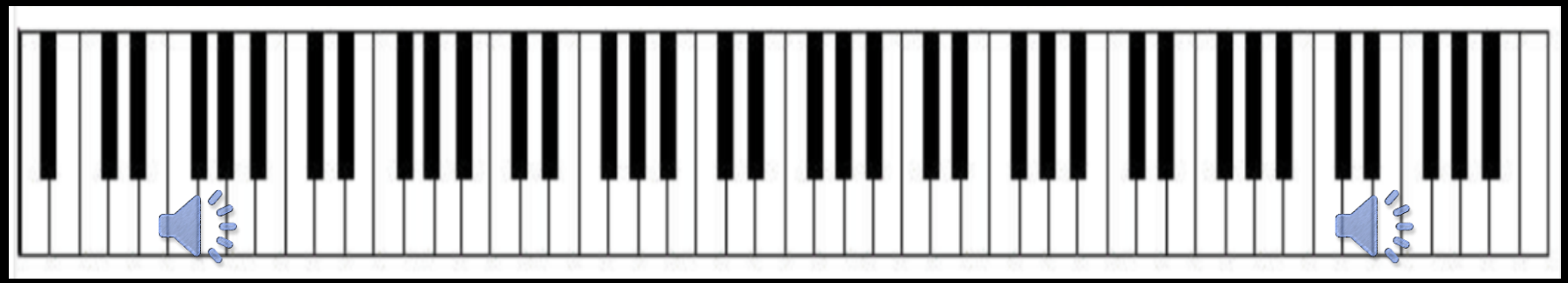
3rd question:

How does an earphone manage to cancel noise theoretically?

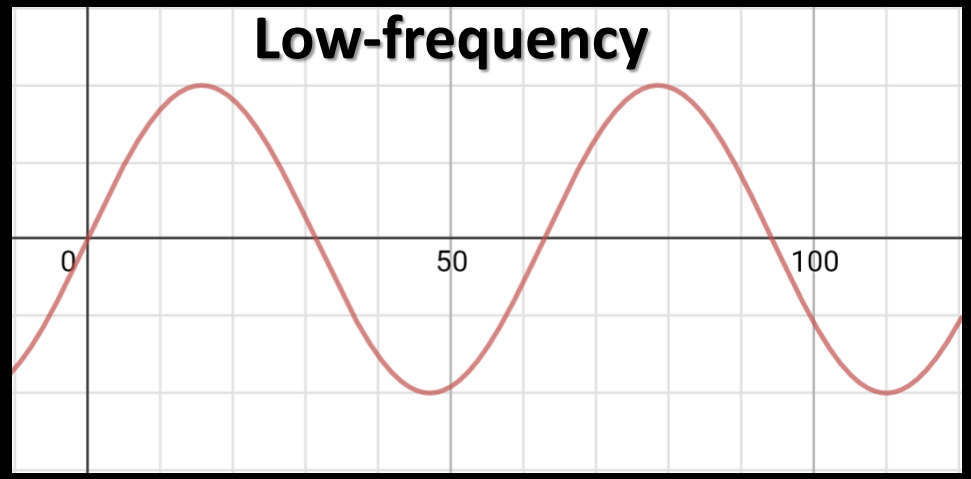
PNC Passive Noise Cancellation

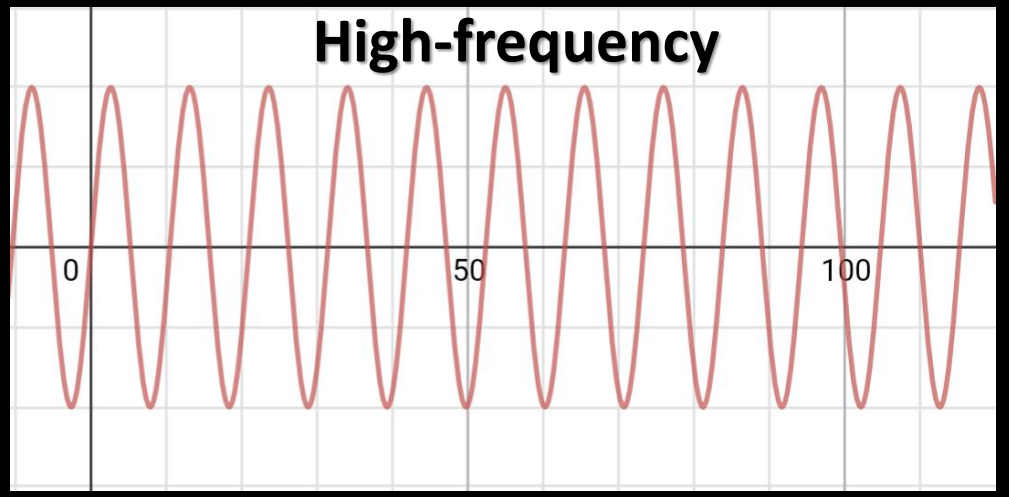
Soundwaves are physically reflected and absorbed.

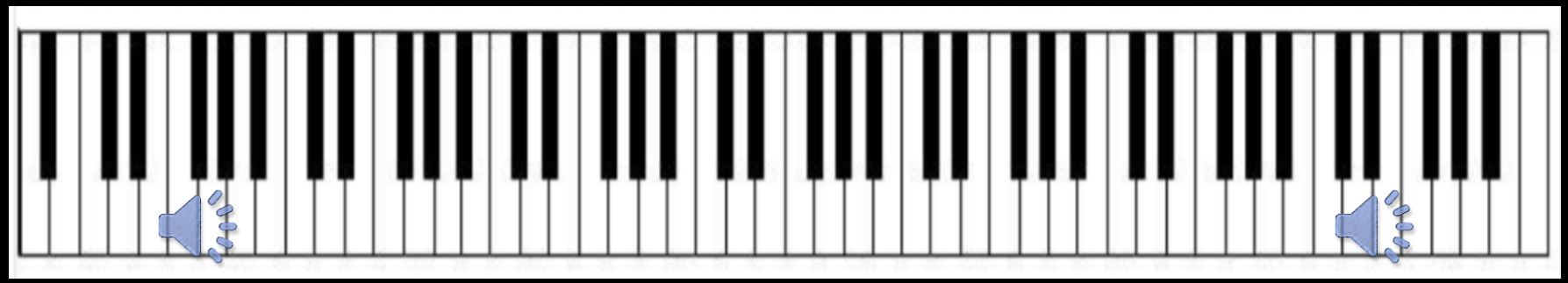
	PNC	ANC
Advantage	Cancelling high-frequency noise	
Disadvantage	Cancelling low-frequency noise	



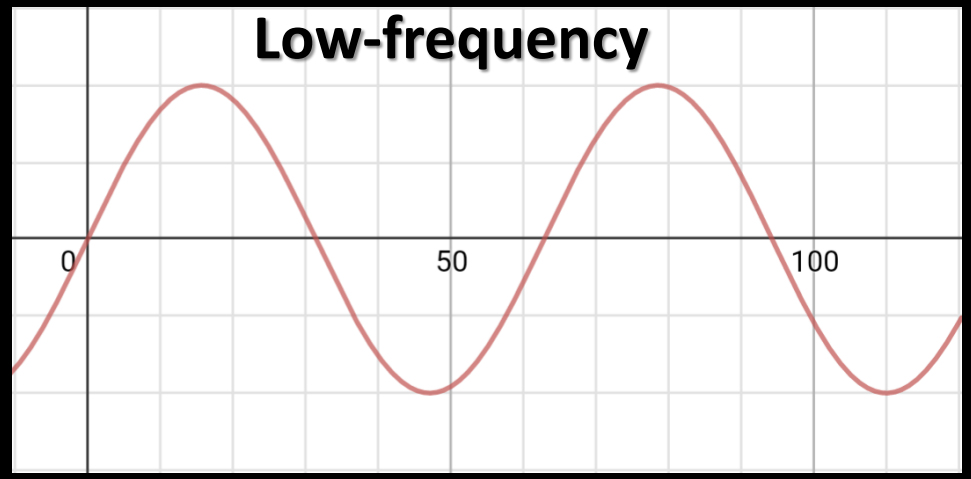
Frequency

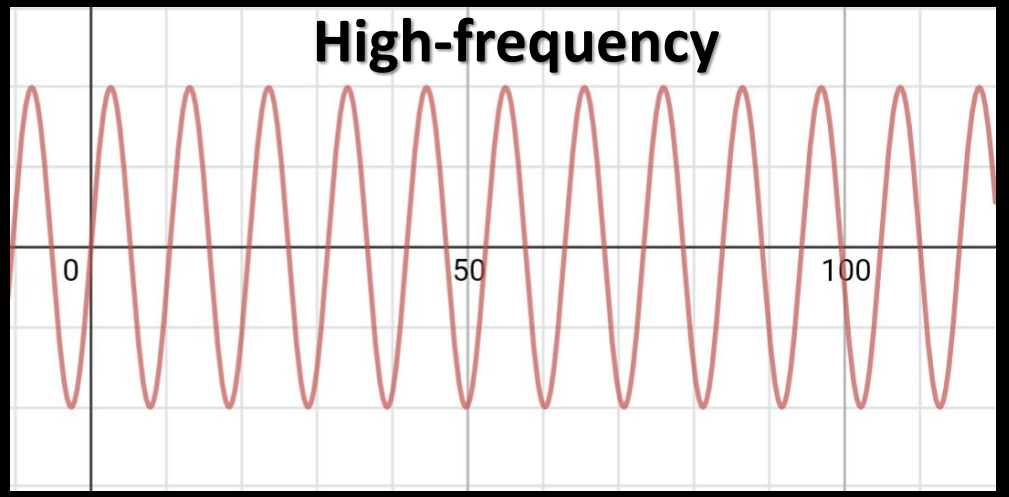


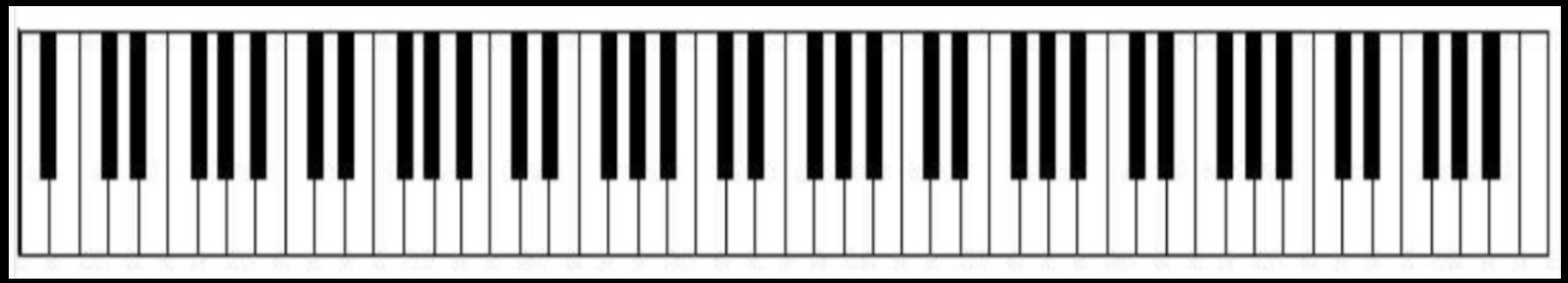




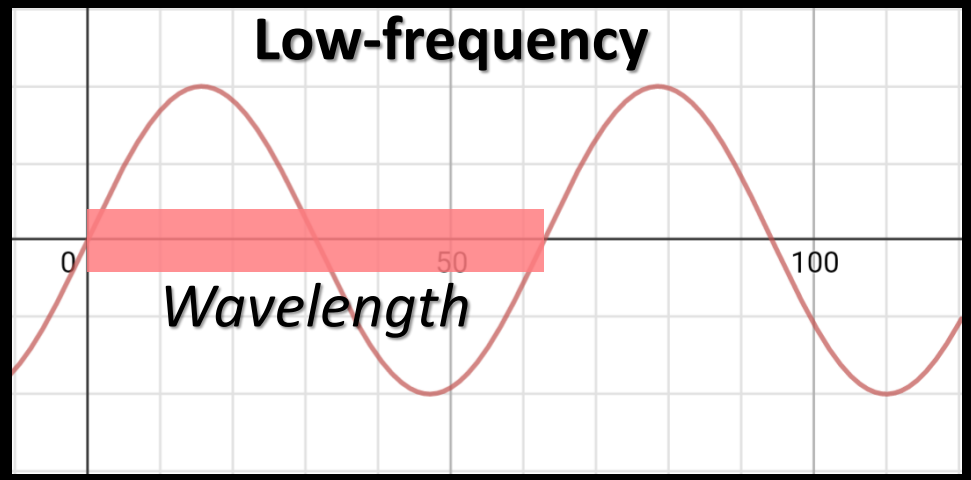
Frequency

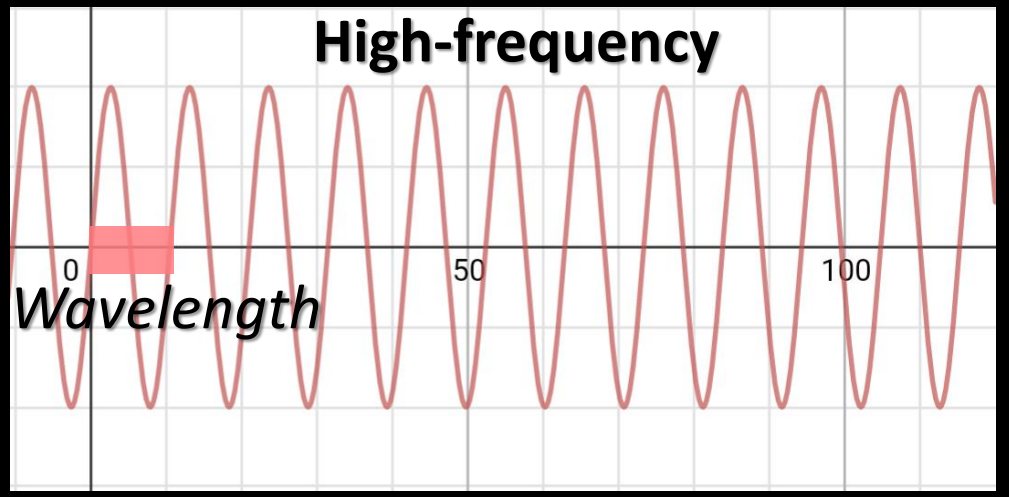




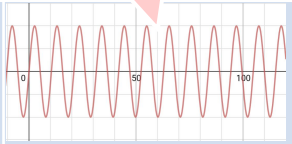
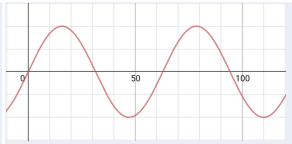


Frequency


Low-frequency
0
50
100
Wavelength

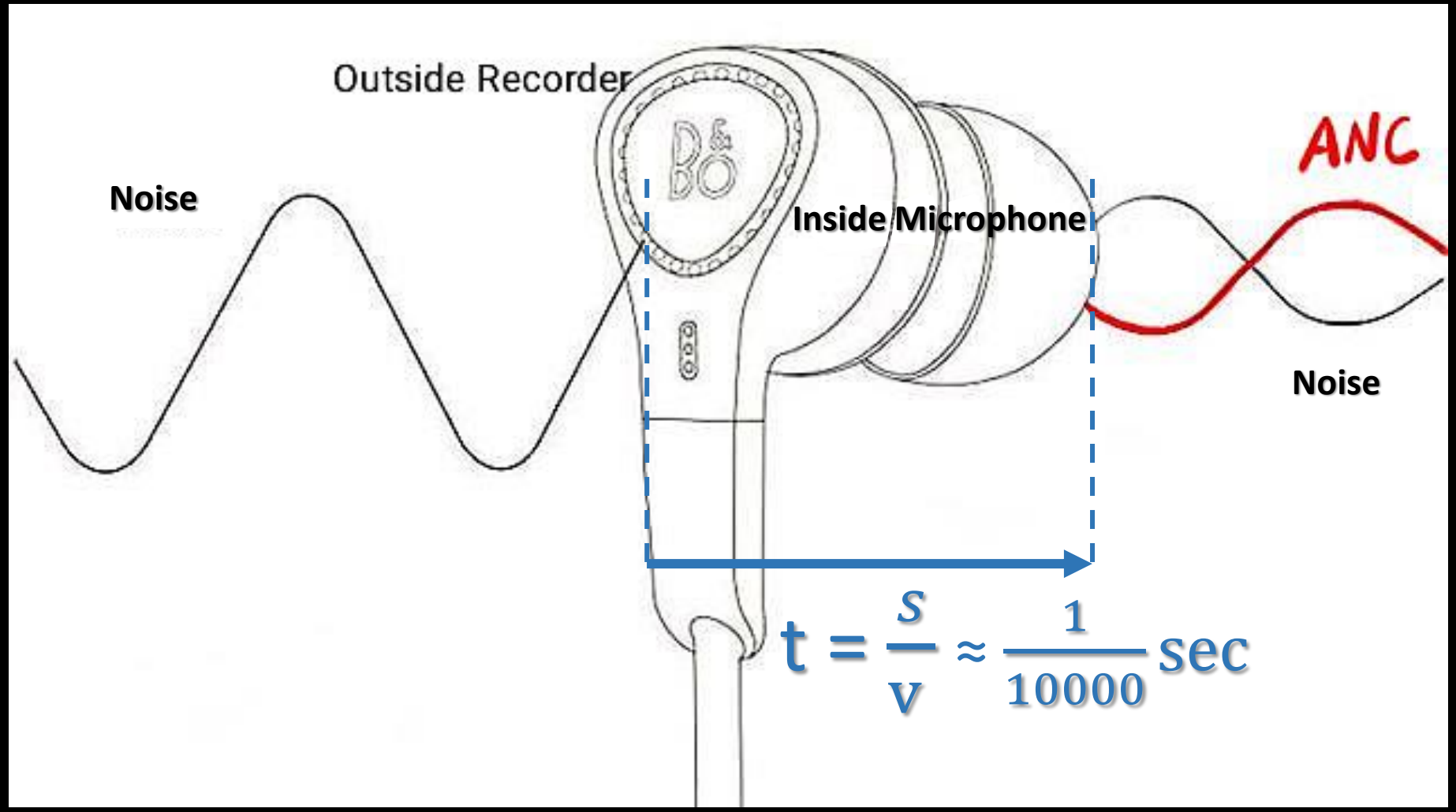

High-frequency
0
50
100
Wavelength

Less penetrating ability

	PNC	ANC
Advantage	 Cancelling high-frequency noise	
Disadvantage	 Cancelling low-frequency noise	

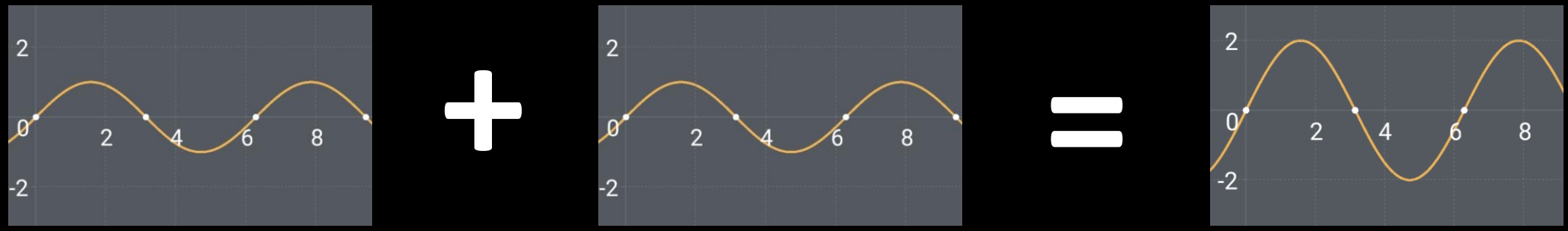

Passive Noise Cancellation
NEW*
Active Noise Cancellation

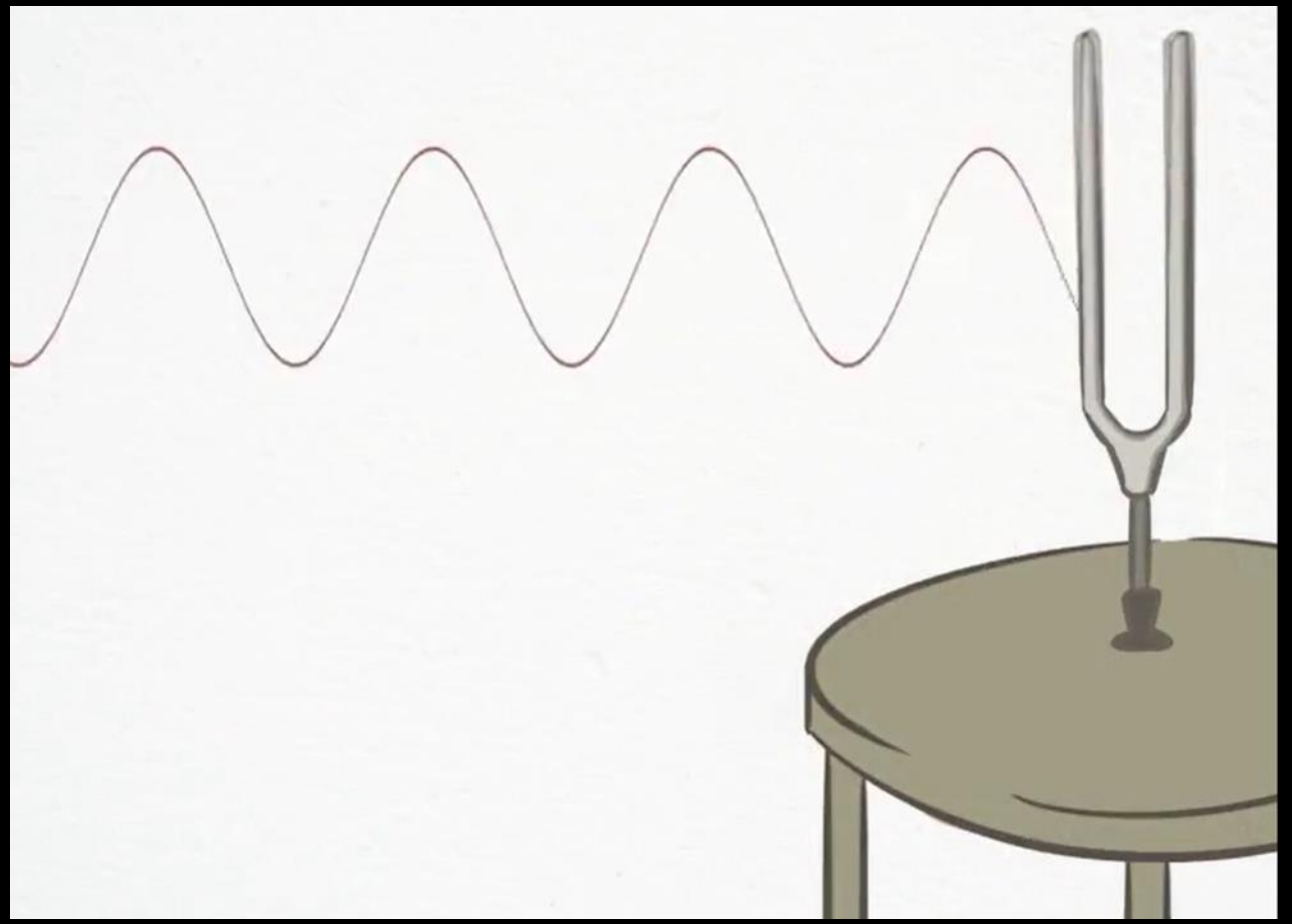
ANC Active Noise Cancellation



ANC Active Noise Cancellation

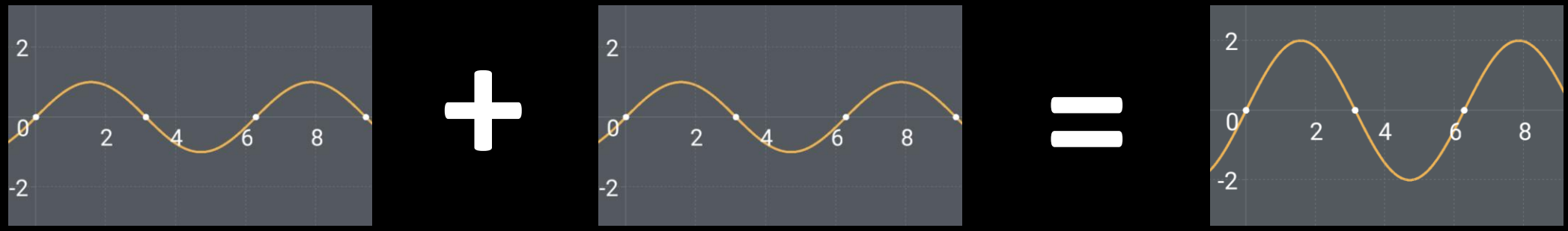
Constructive Interference

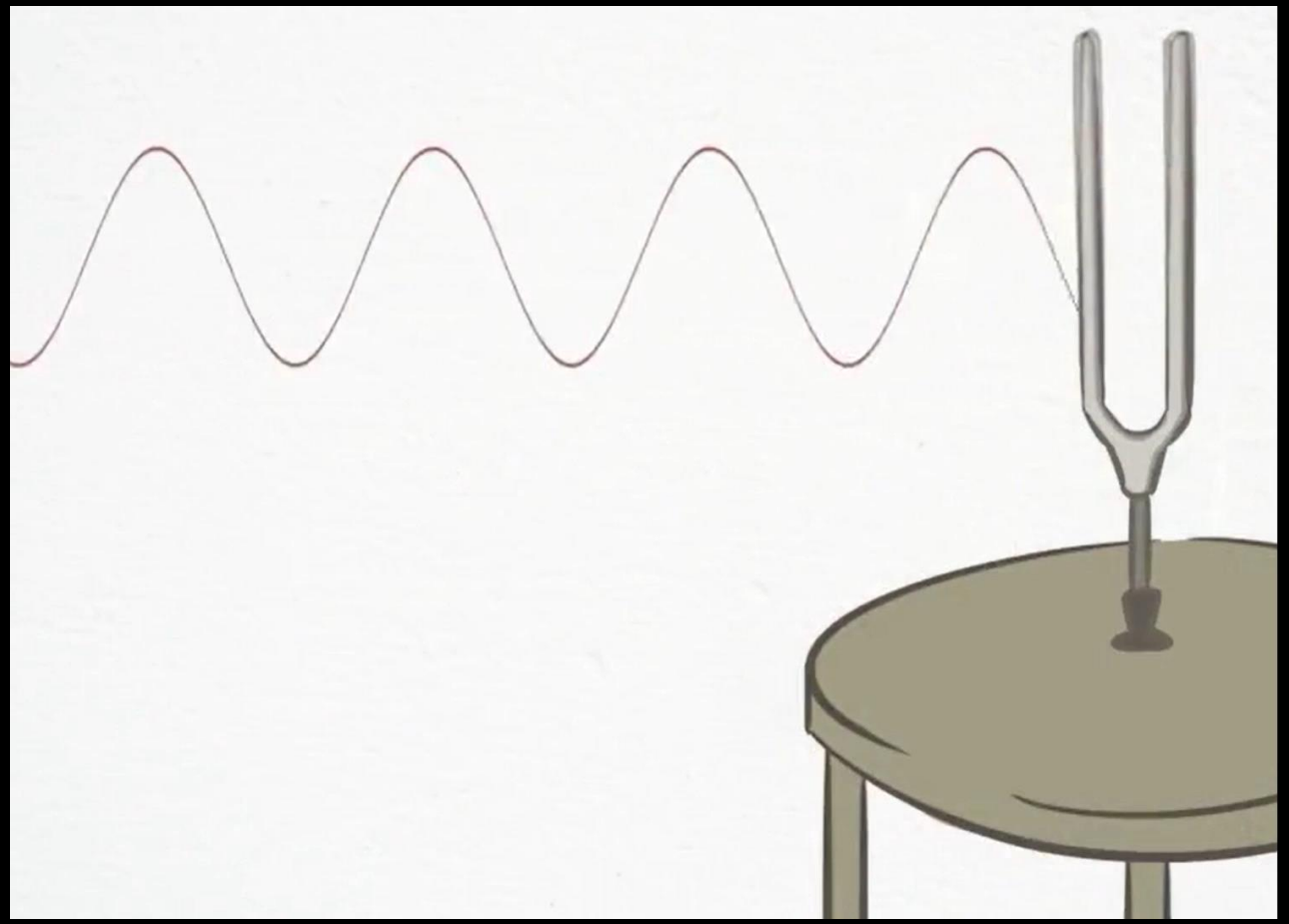




ANC Active Noise Cancellation

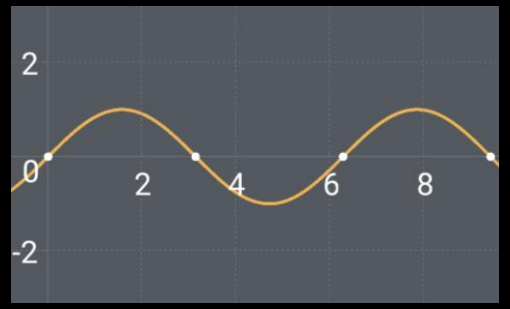
Constructive Interference





ANC Active Noise Cancellation

Destructive Interference



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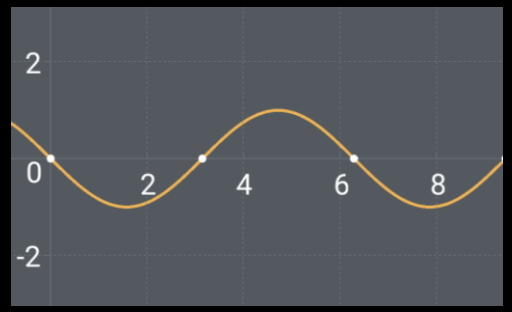

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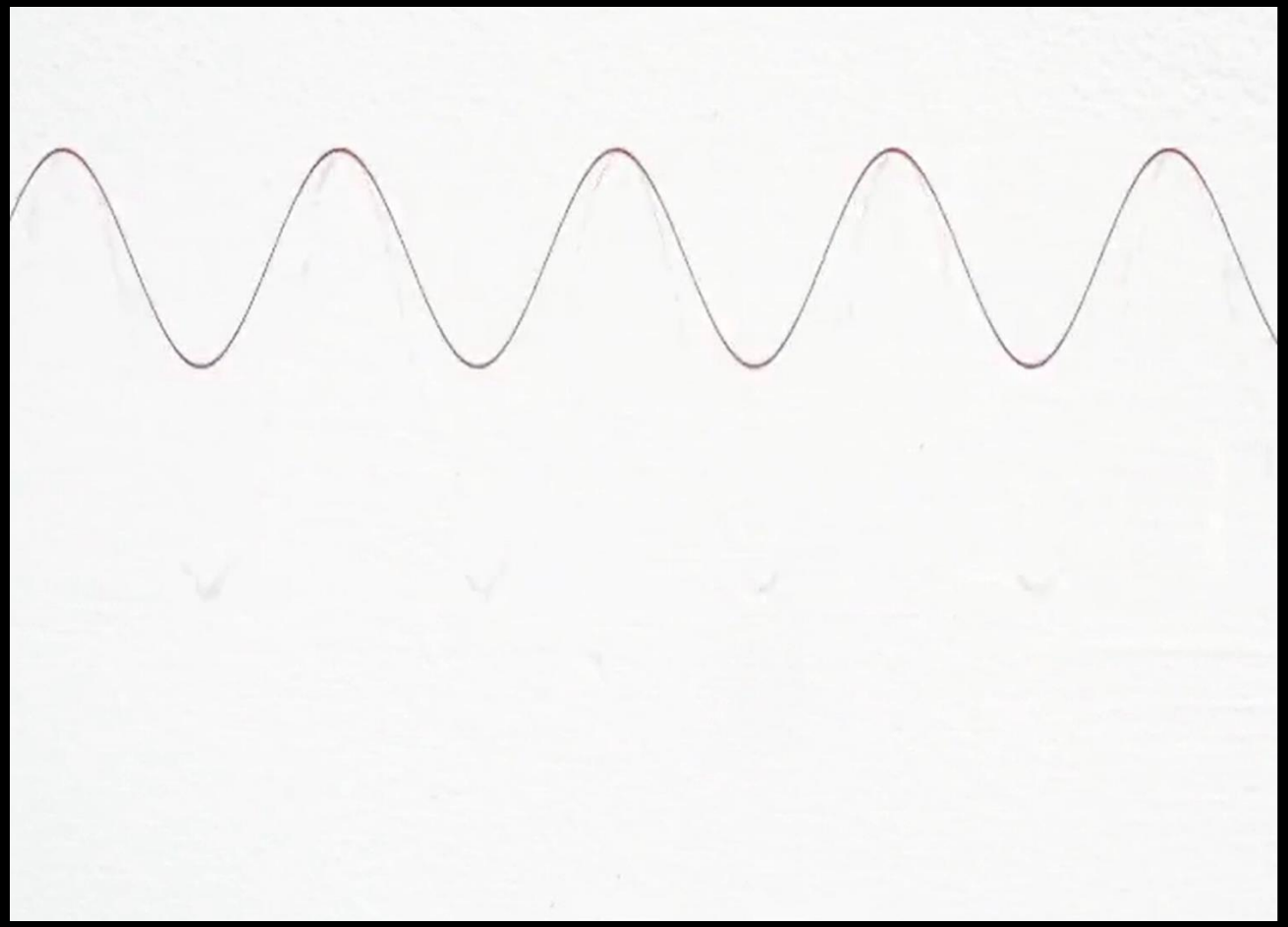


$$\frac{1}{10000}\ \text{sec}$$

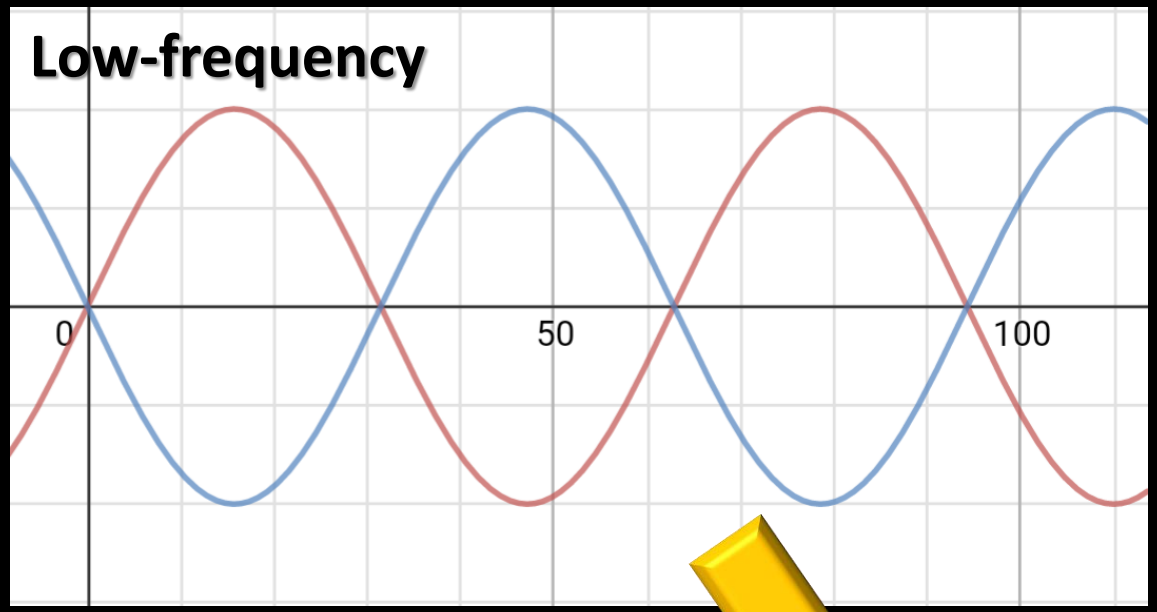
$$\frac{1 \pm 0.1}{10000}\,\text{sec}$$

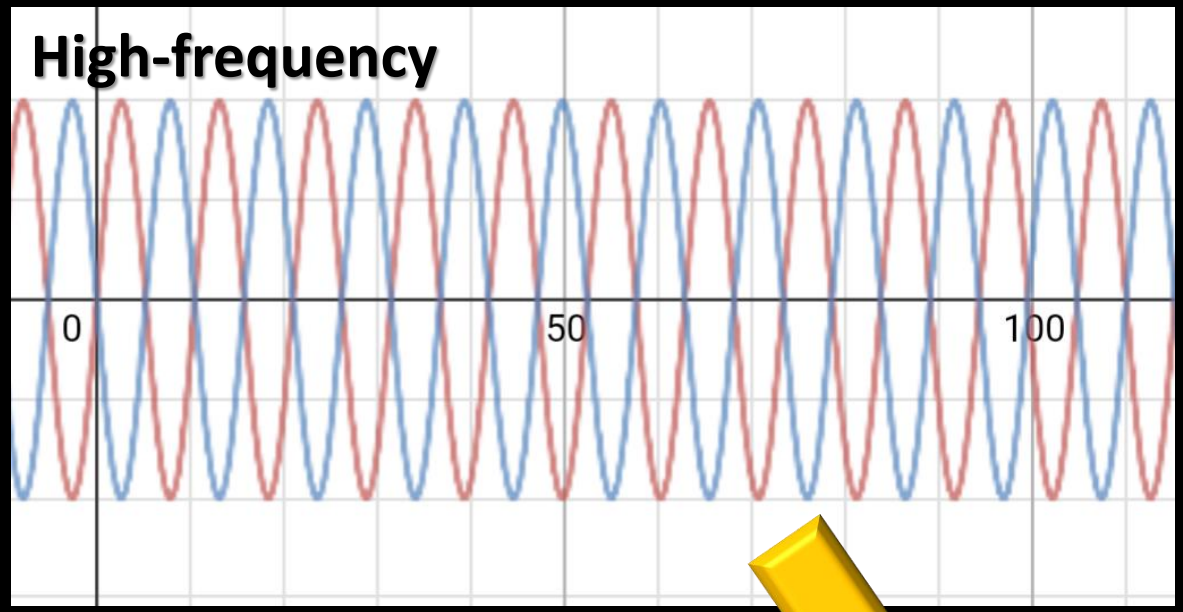
→ How do errors influence ANC's effectiveness of cancelling different frequency sounds?

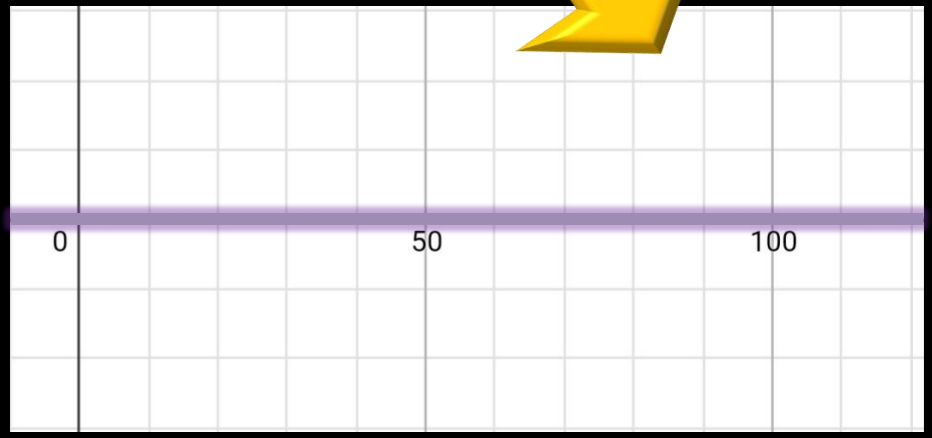
ANC Active Noise Cancellation

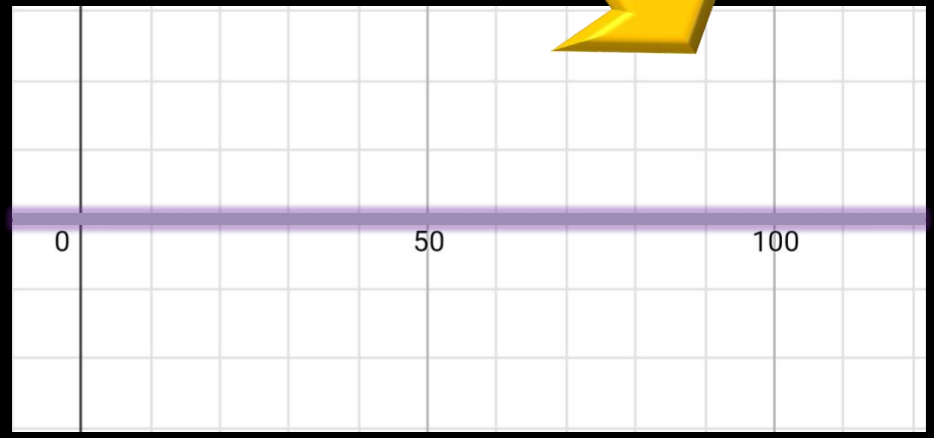
Accurate ANC

RED: Noise
BLUE: ANC



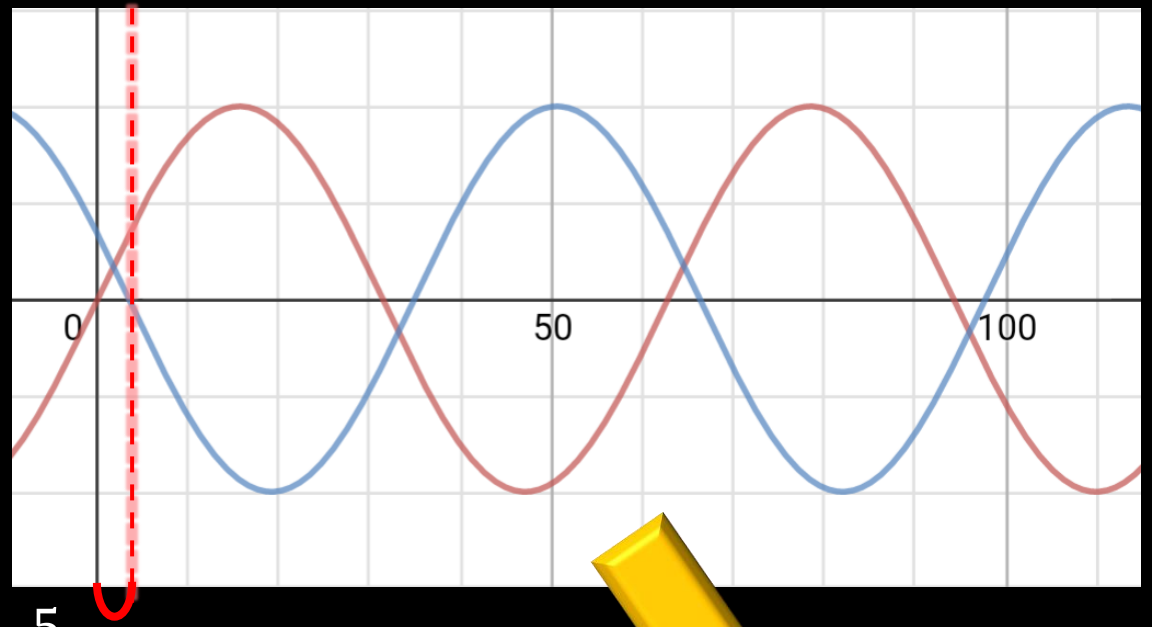




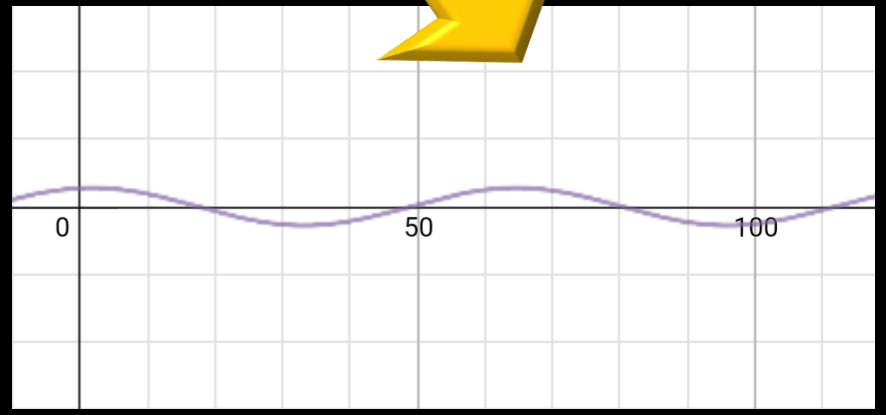


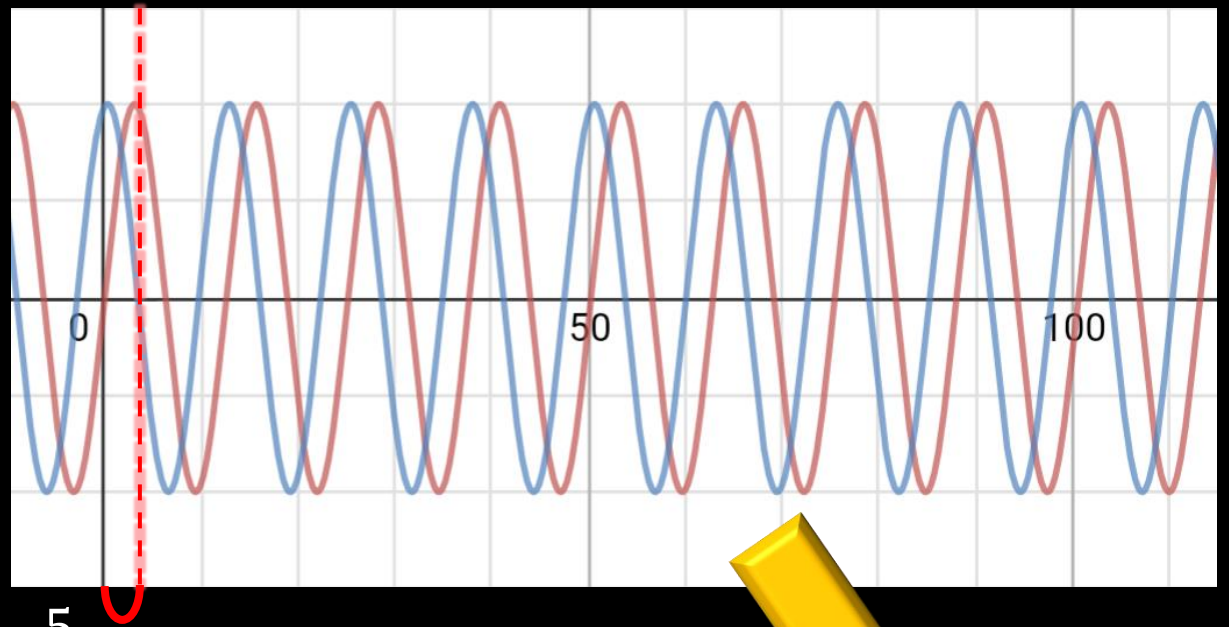
ANC with an error: “$\frac{0.05}{10000}$sec late”

RED: Noise
BLUE: ANC

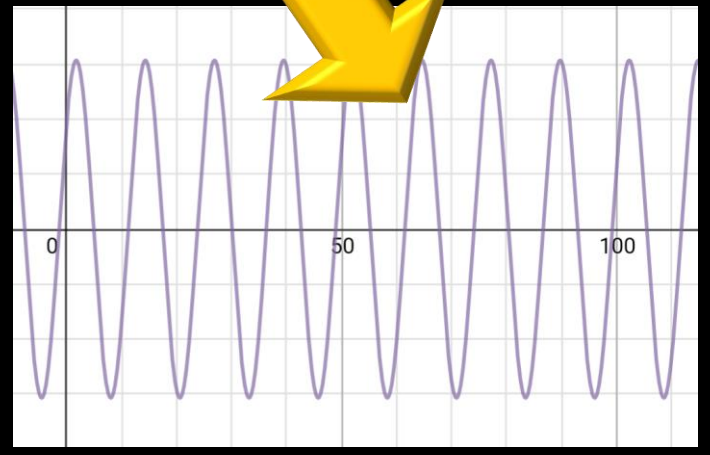


$\frac{5}{100000}$sec late



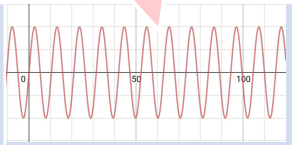
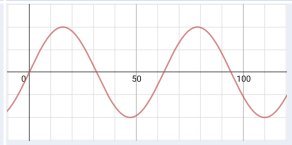
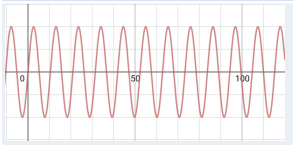


$\frac{5}{100000}$sec late



Less penetrating ability

More tolerance for errors

	PNC	ANC
Advantage	 Cancelling high-frequency noise	 Cancelling low-frequency noise
Disadvantage	 Cancelling low-frequency noise	 Cancelling high-frequency noise

4th question:

What is the future trend?

Earphones

Acoustic Pollution

1.Cheaper

- Sony WH1000XM3
- ¥2899　$420

2.Smarter

Music

Noise

Voice

3.Applied to larger scope

Past

Now

Future?

References

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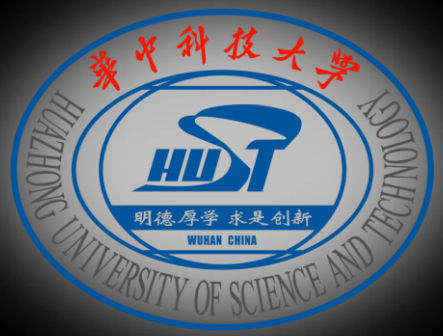
- Jiguang Jiang, Yun Li. Review of active noise control techniques with emphasis on sound quality enhancement. *Applied Acoustics* (2018)
- Xu Yongcheng, Wen Xisen, Chen Xun. An overview on active noise control technology and application. *Journal of National University of Defense Technology* (2001)
- Mika Oinonen, Harri Raittinen, Markku Kivikoski. Active noise cancellation hearing protector with improved usability. *Mechatronics for Safety, Security and Dependability in a New Era* (2007)



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