Microphone array beamforming

MATLAB tutorial series (Part 1)

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Introduction to audio and video techniques (ELEN0002-2)
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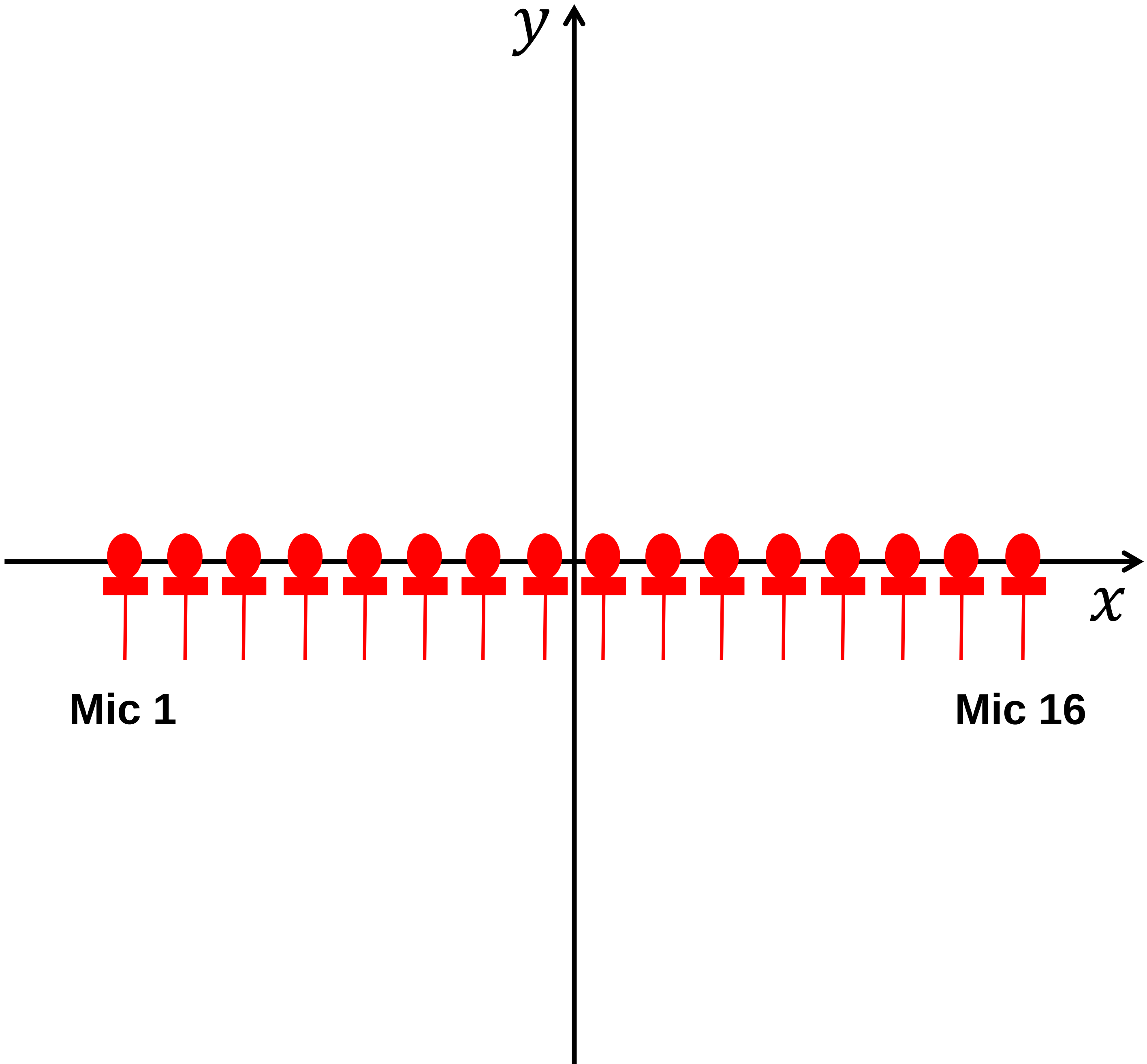
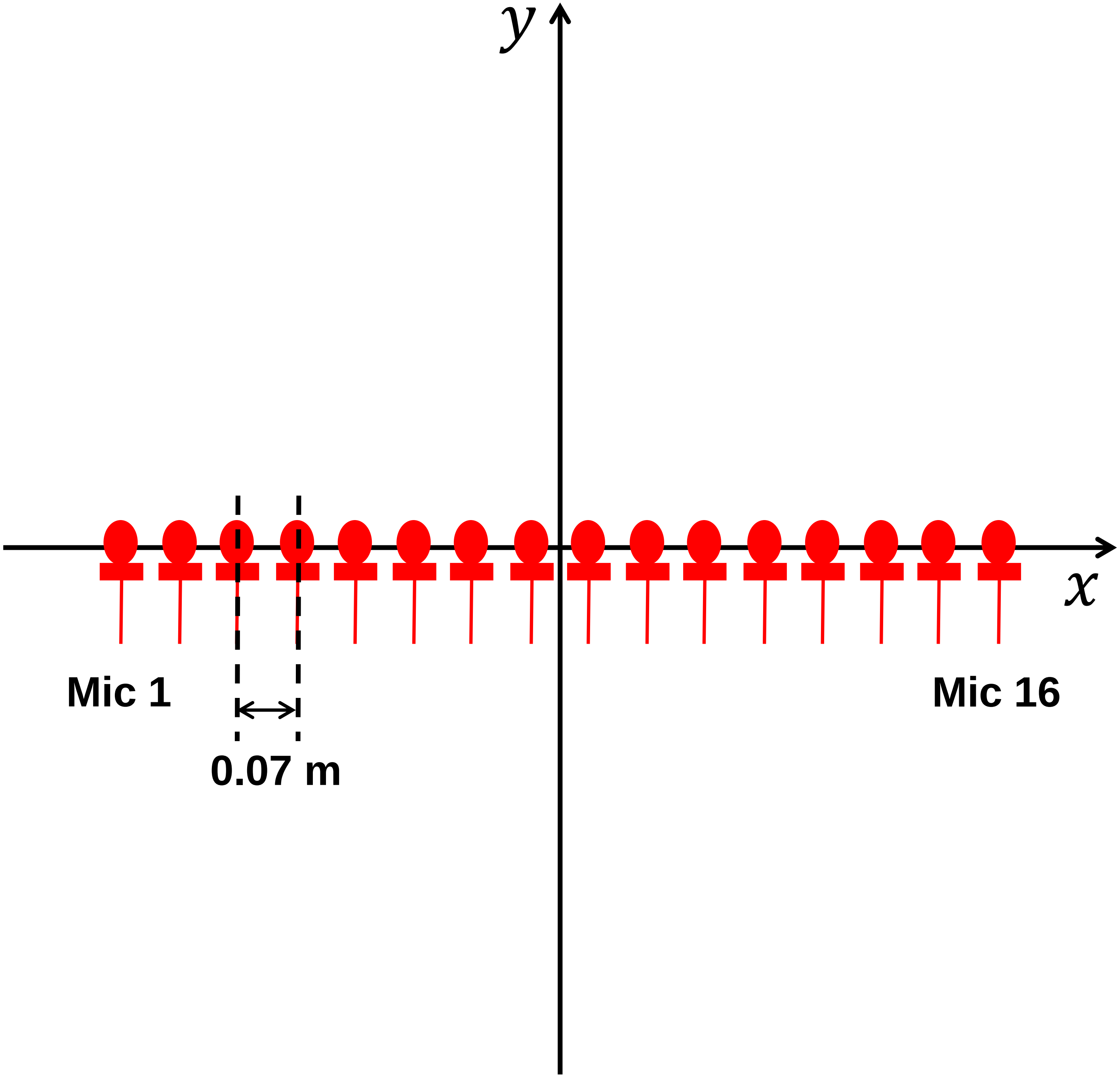
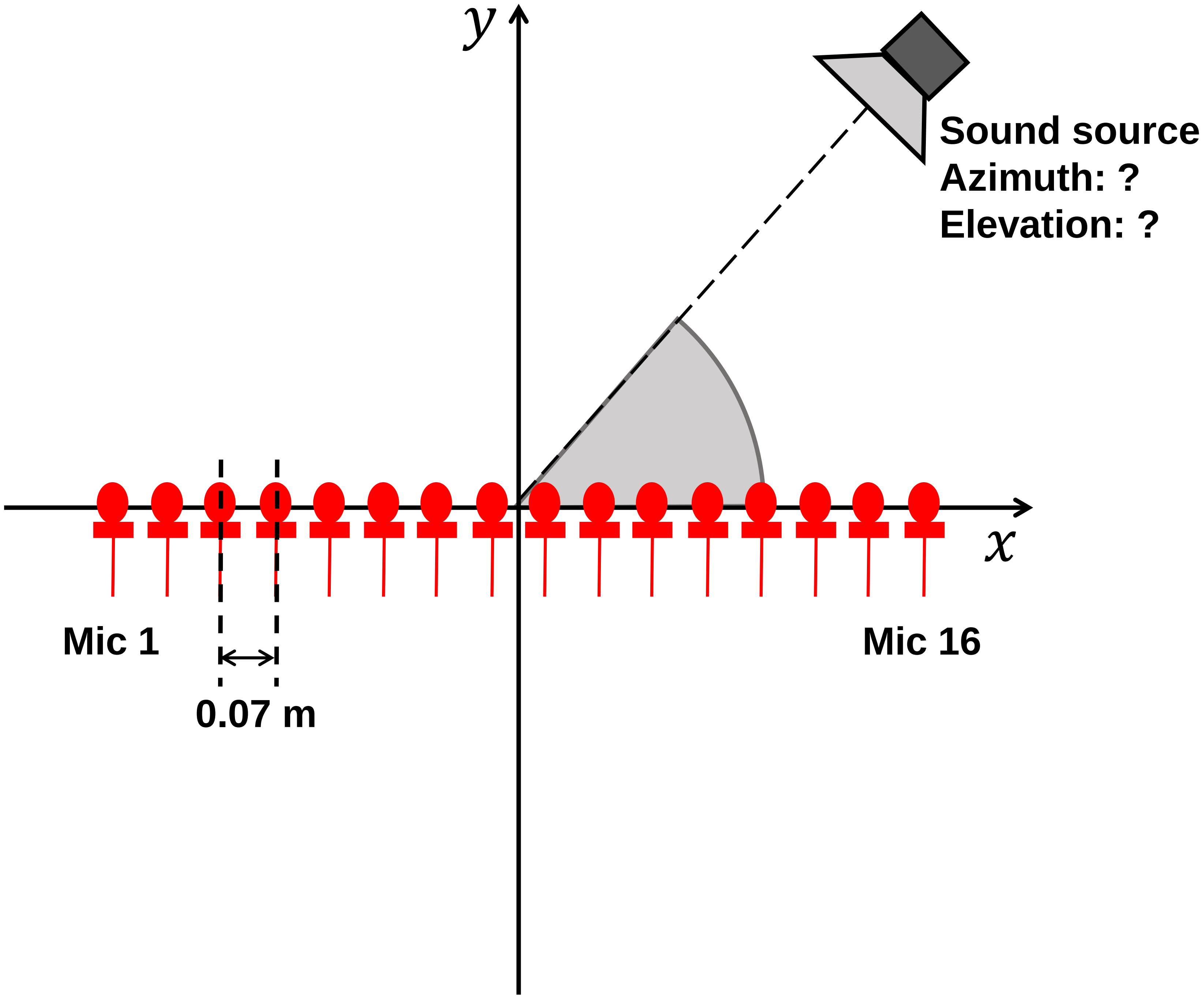
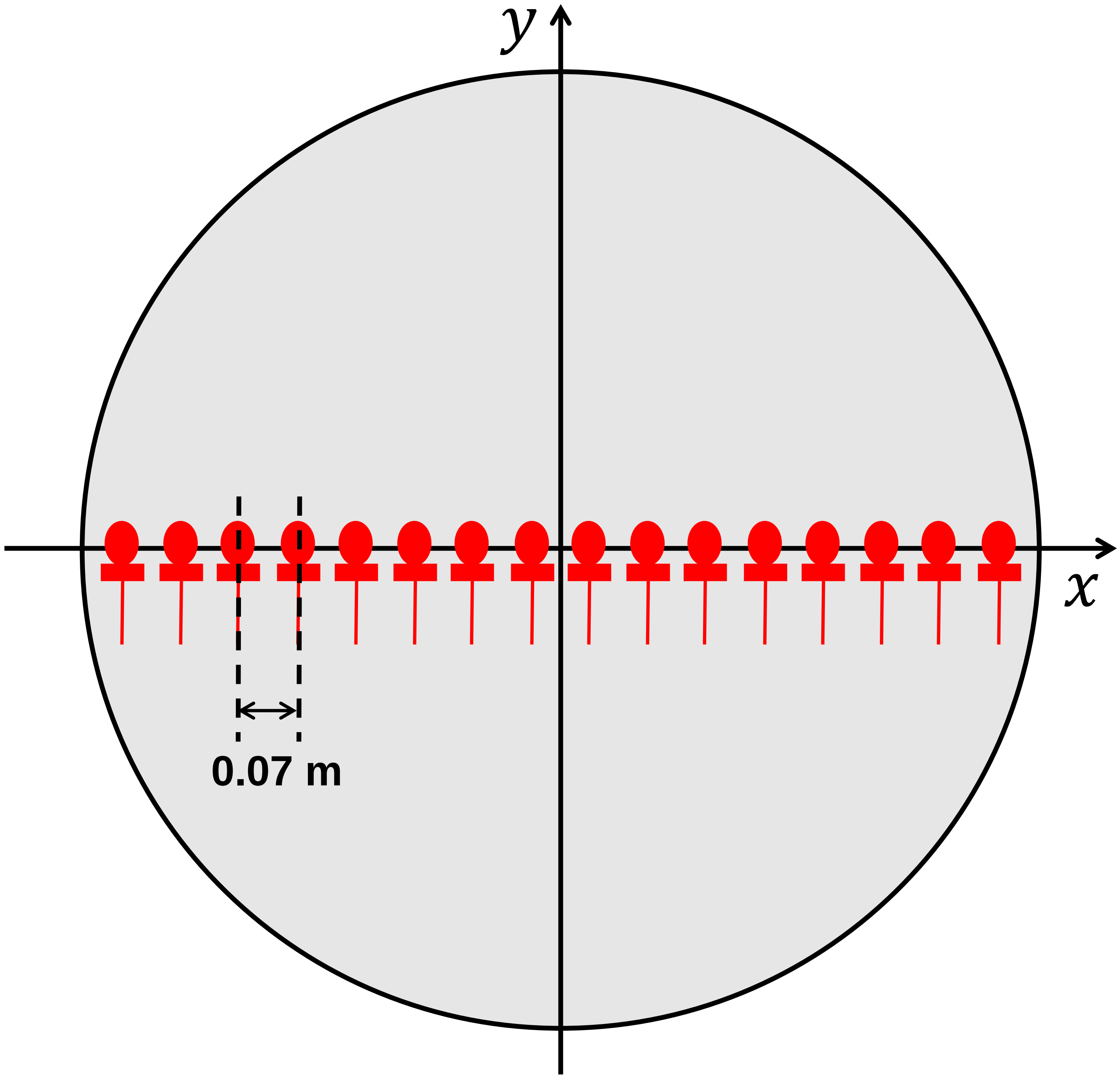
Acoustic array geometry


y
x
Mic 1
Mic 16

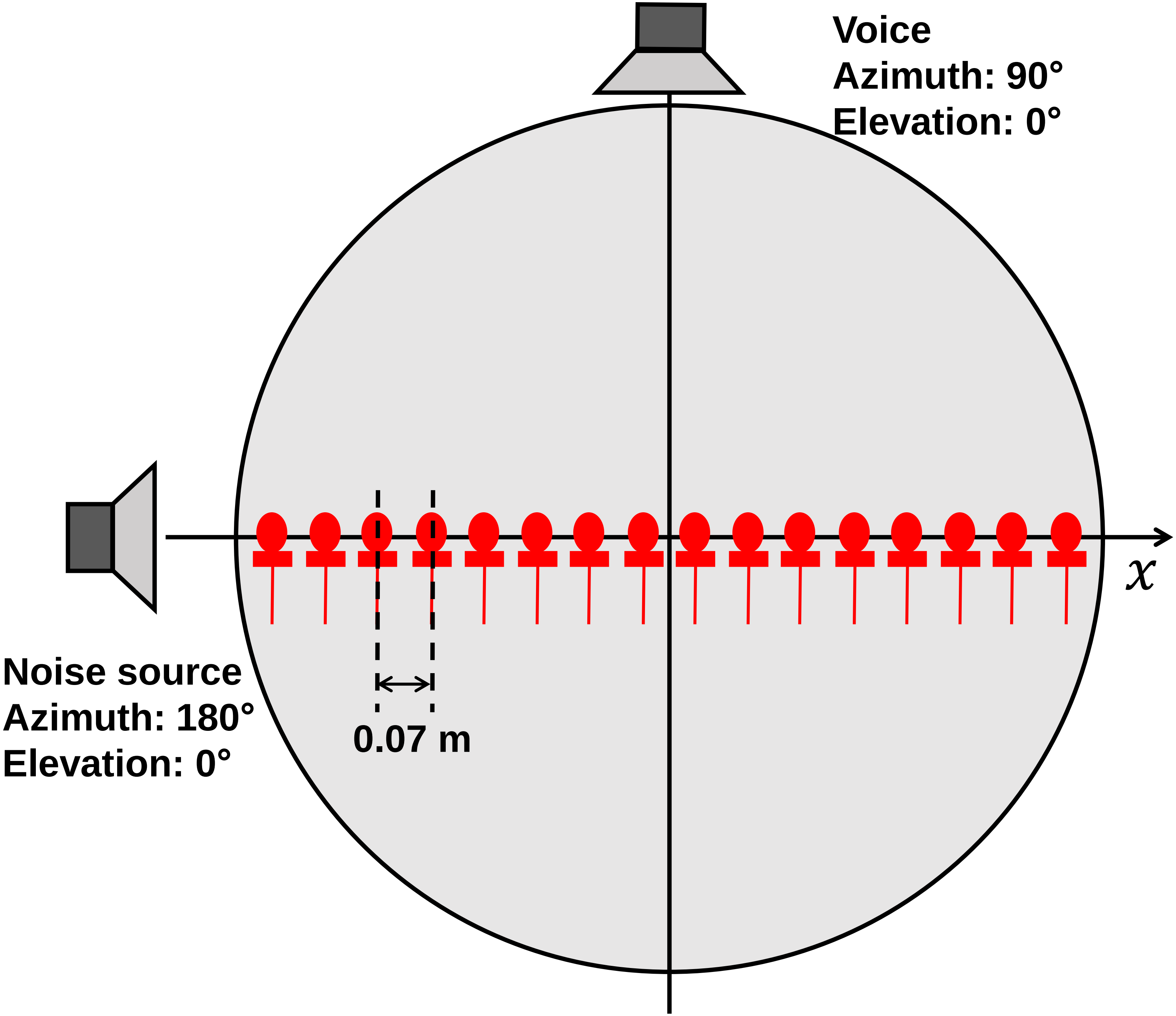


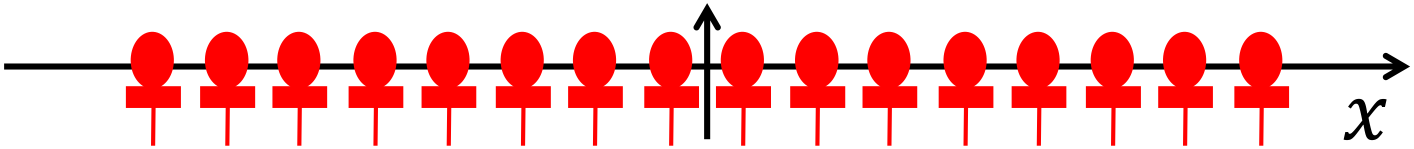
y
x
Mic 1
Mic 16
0.07 m


y
Sound source
Azimuth: ?
Elevation: ?
x
Mic 1
Mic 16
0.07 m

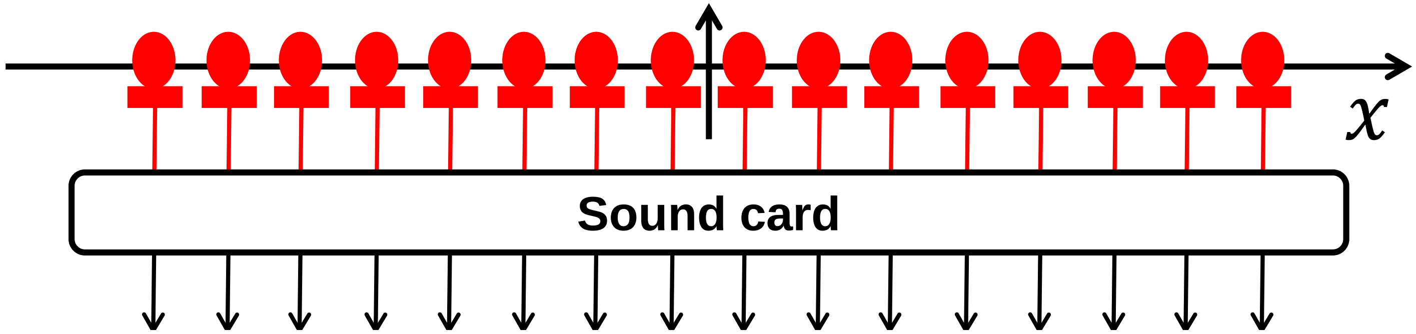

y
x
0.07 m

Part 1: beamforming


Voice
Azimuth: 90°
Elevation: 0°
Noise source
Azimuth: 180°
Elevation: 0°
0.07 m
x



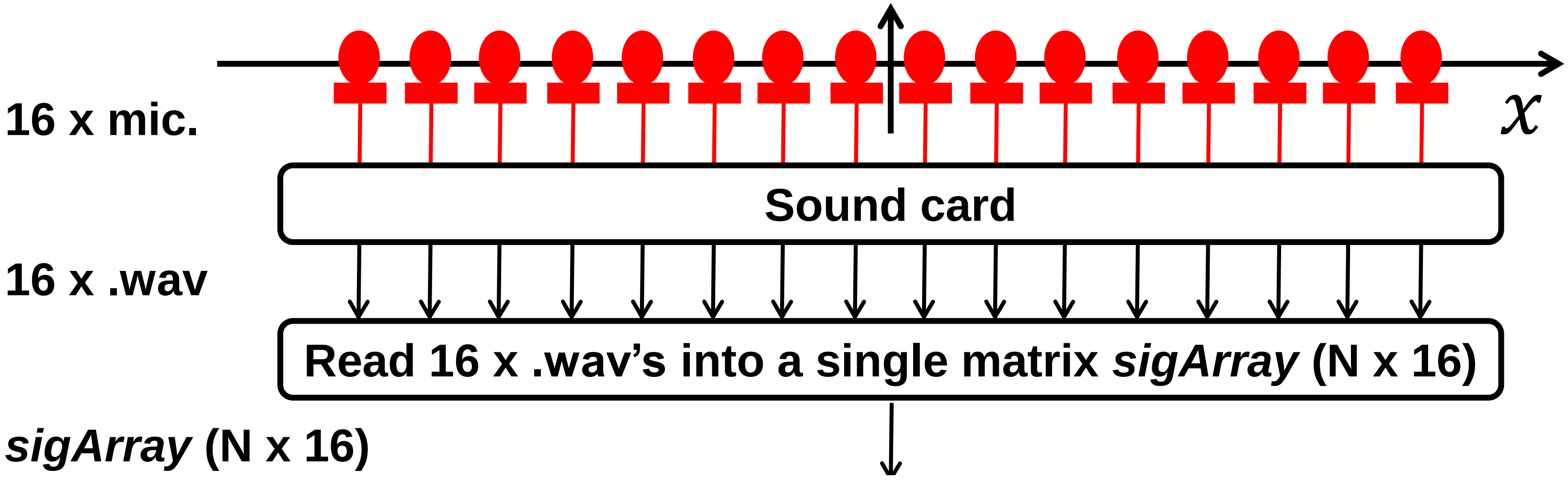
16 x mic.



16 x mic.

Sound card

16 x .wav



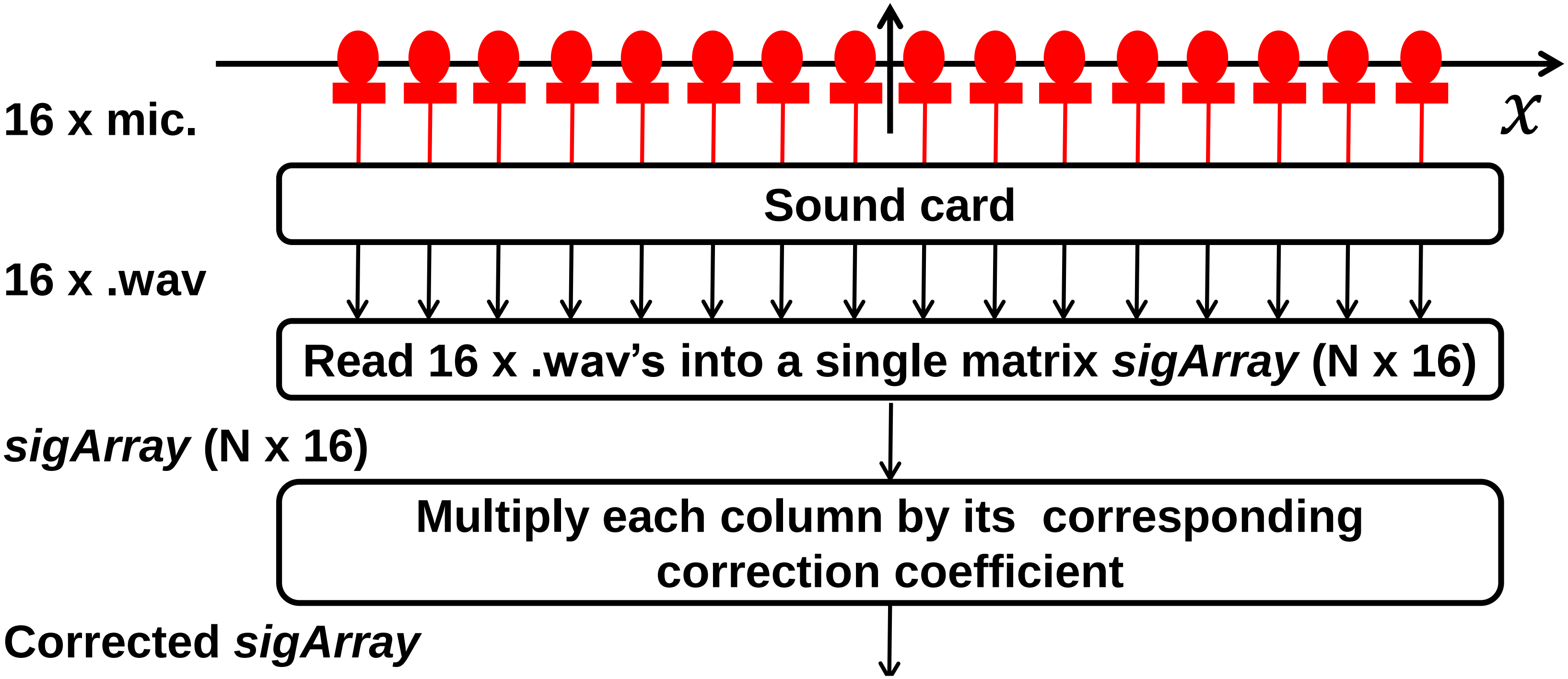
16 x mic.

Sound card

16 x .wav

Read 16 x .wav’s into a single matrix *sigArray* (N x 16)

***sigArray* (N x 16)**



16 x mic.

Sound card

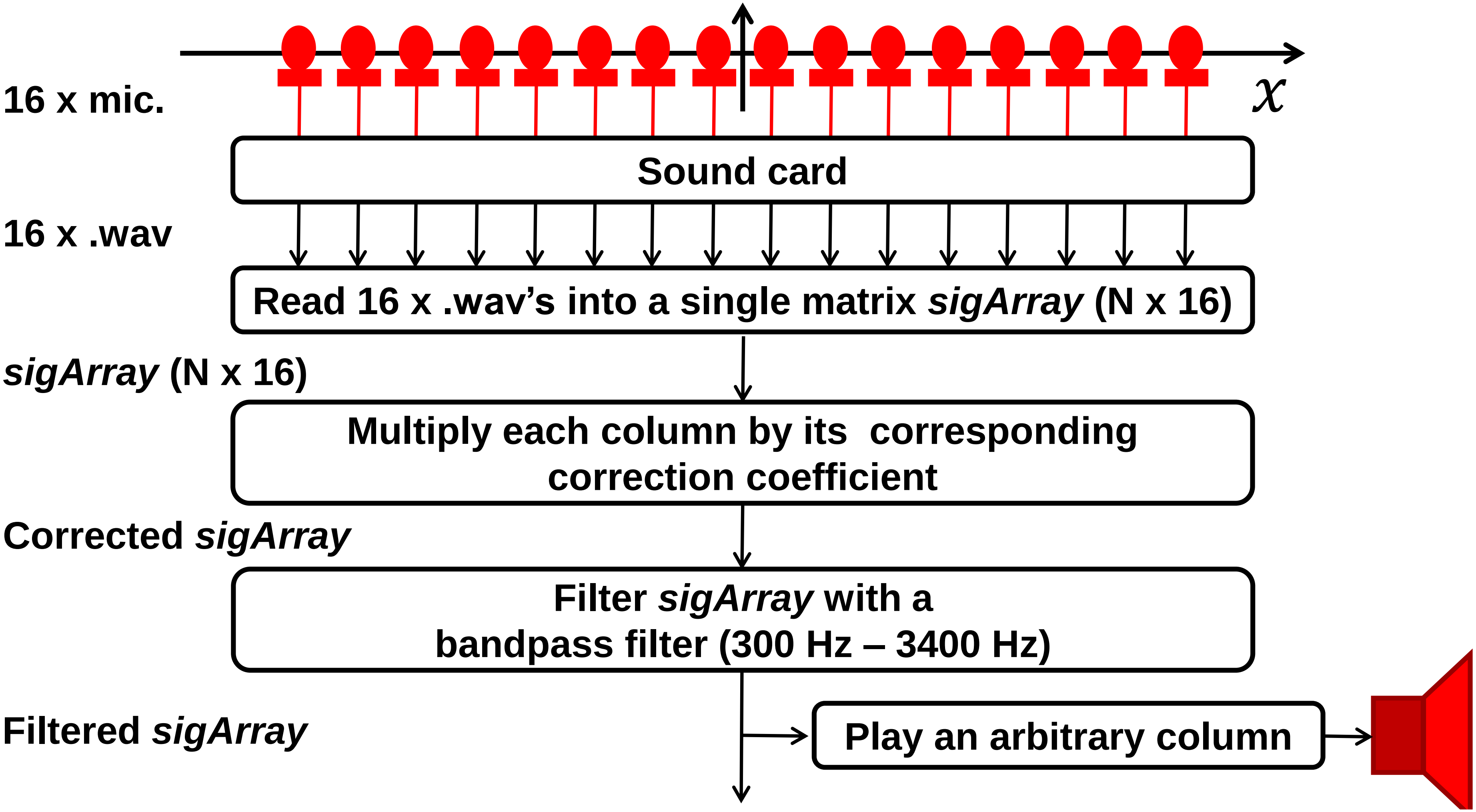
16 x .wav

Read 16 x .wav's into a single matrix *sigArray* (N x 16)

***sigArray* (N x 16)**

Multiply each column by its corresponding correction coefficient

Corrected *sigArray*



16 x mic.

Sound card

16 x .wav

Read 16 x .wav’s into a single matrix *sigArray* (N x 16)

sigArray (N x 16)

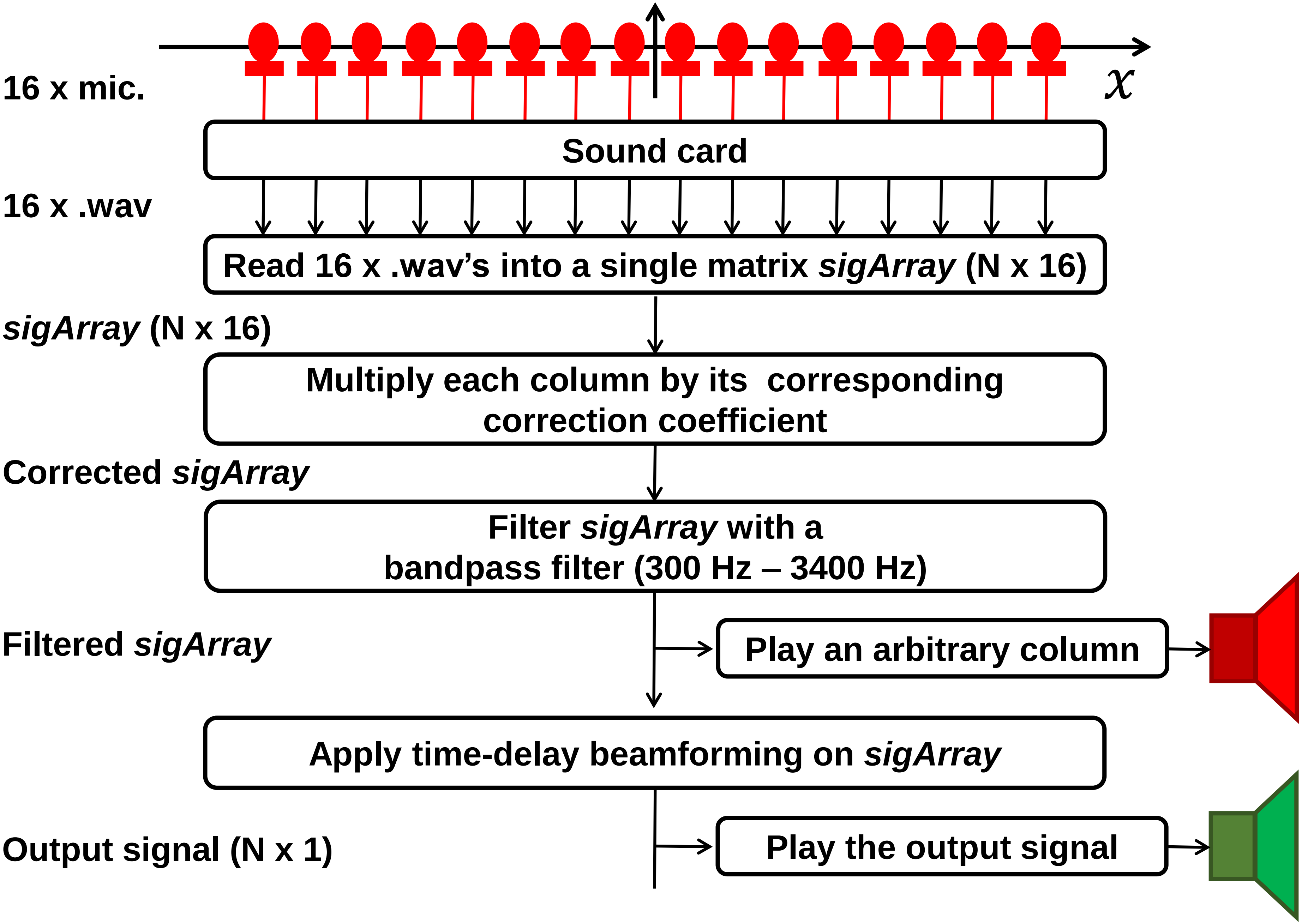
Multiply each column by its corresponding correction coefficient

Corrected *sigArray*

Filter *sigArray* with a bandpass filter (300 Hz – 3400 Hz)

Filtered *sigArray*

Play an arbitrary column



16 x mic.

Sound card

16 x .wav

Read 16 x .wav’s into a single matrix *sigArray* (N x 16)

***sigArray* (N x 16)**

Multiply each column by its corresponding correction coefficient

Corrected *sigArray*

Filter *sigArray* with a bandpass filter (300 Hz – 3400 Hz)

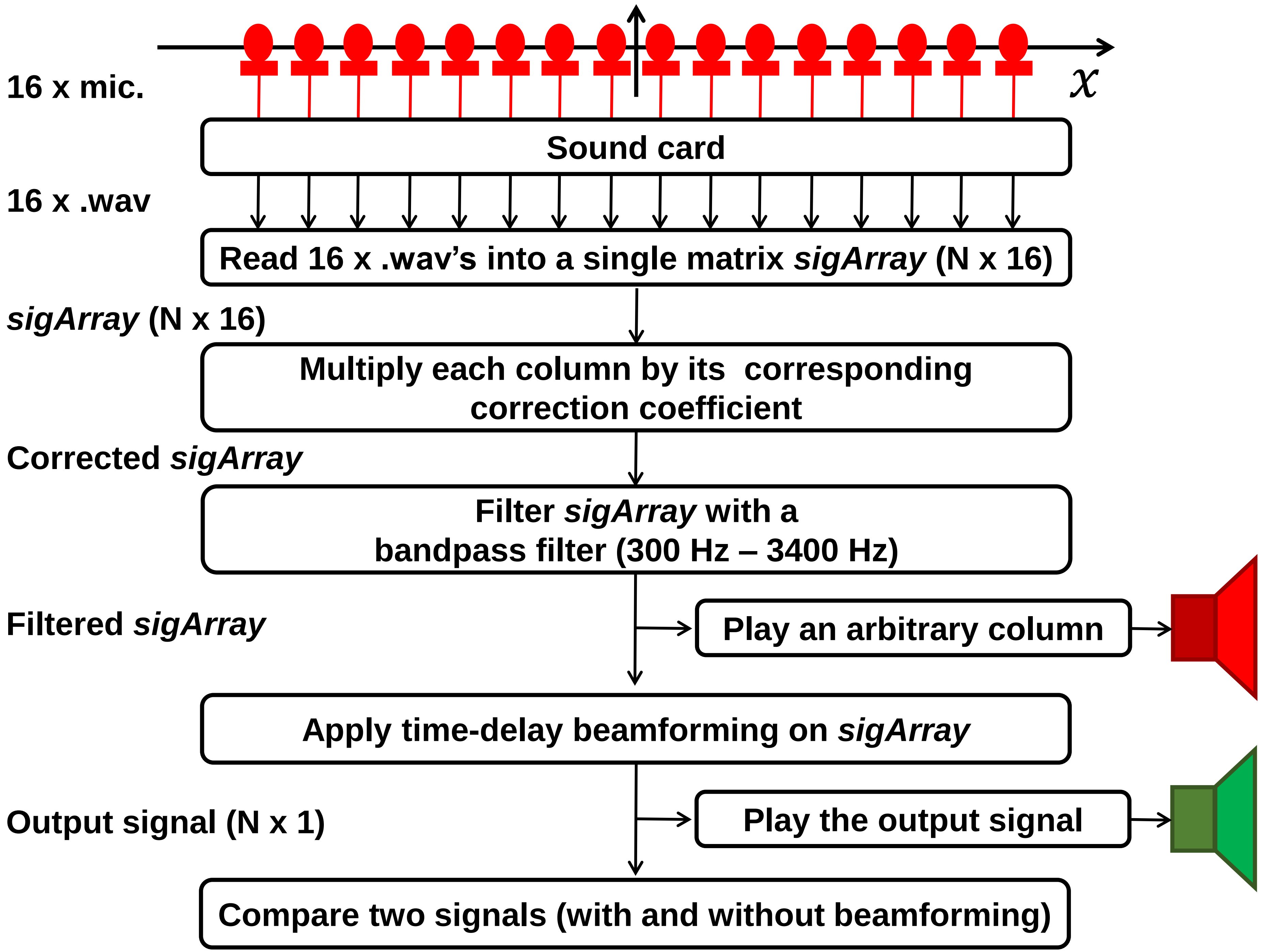
Filtered *sigArray*

Play an arbitrary column

Apply time-delay beamforming on *sigArray*

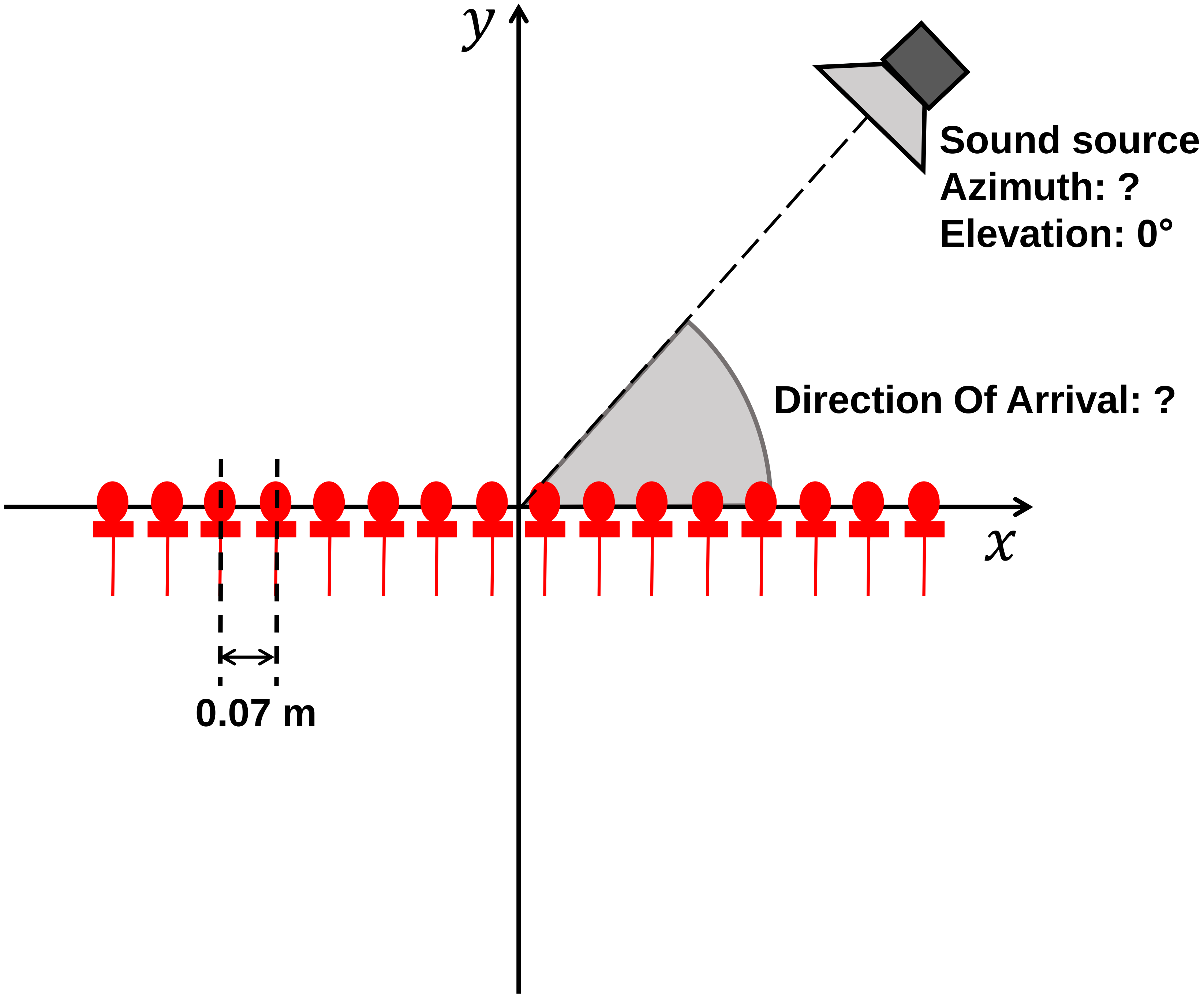
Output signal (N x 1)

Play the output signal

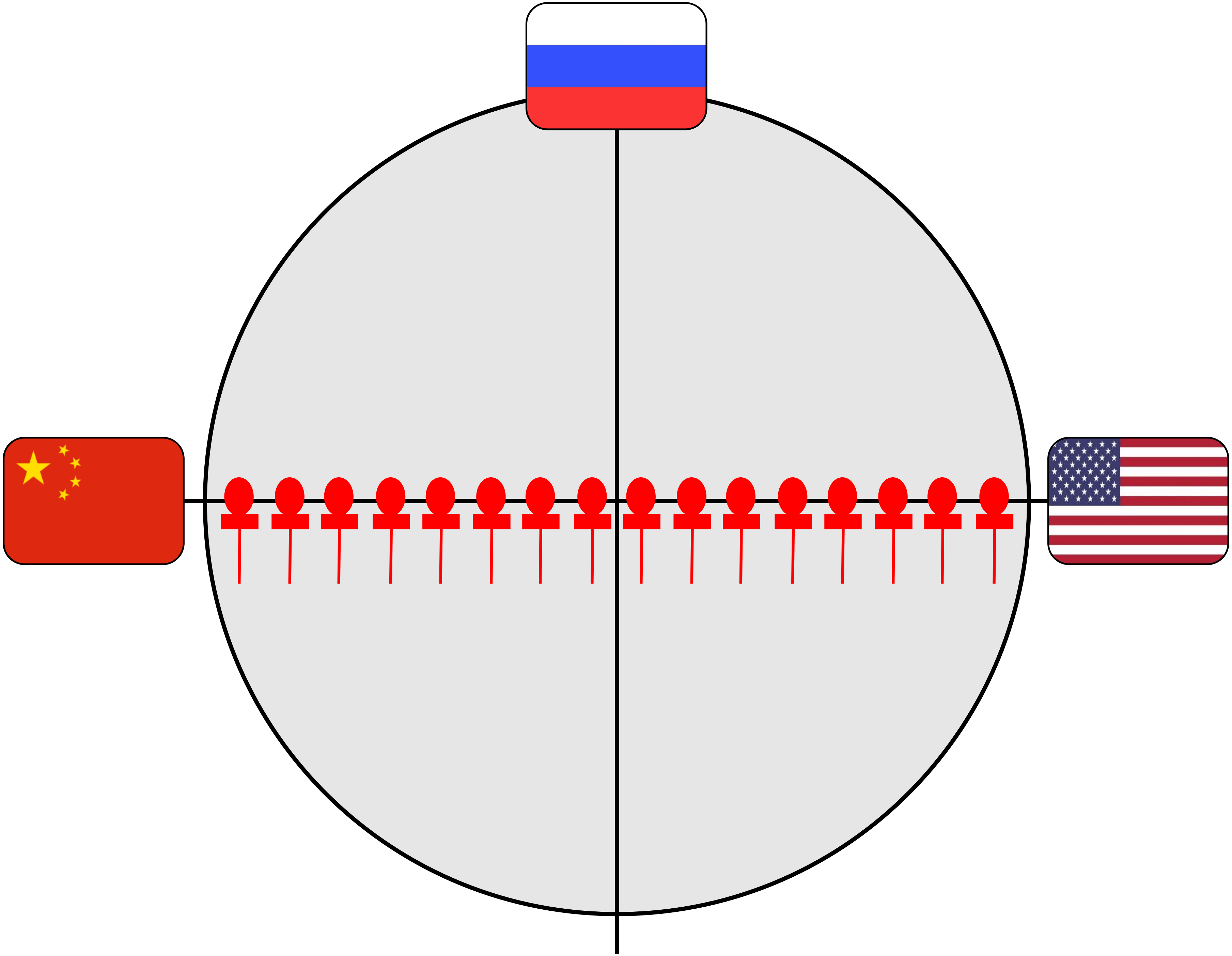

16 x mic.
x
Sound card
16 x .wav
Read 16 x .wav's into a single matrix *sigArray* (N x 16)
sigArray (N x 16)
Multiply each column by its corresponding correction coefficient
Corrected *sigArray*
Filter *sigArray* with a bandpass filter (300 Hz – 3400 Hz)
Filtered *sigArray*
Play an arbitrary column
Apply time-delay beamforming on *sigArray*
Output signal (N x 1)
Play the output signal
Compare two signals (with and without beamforming)

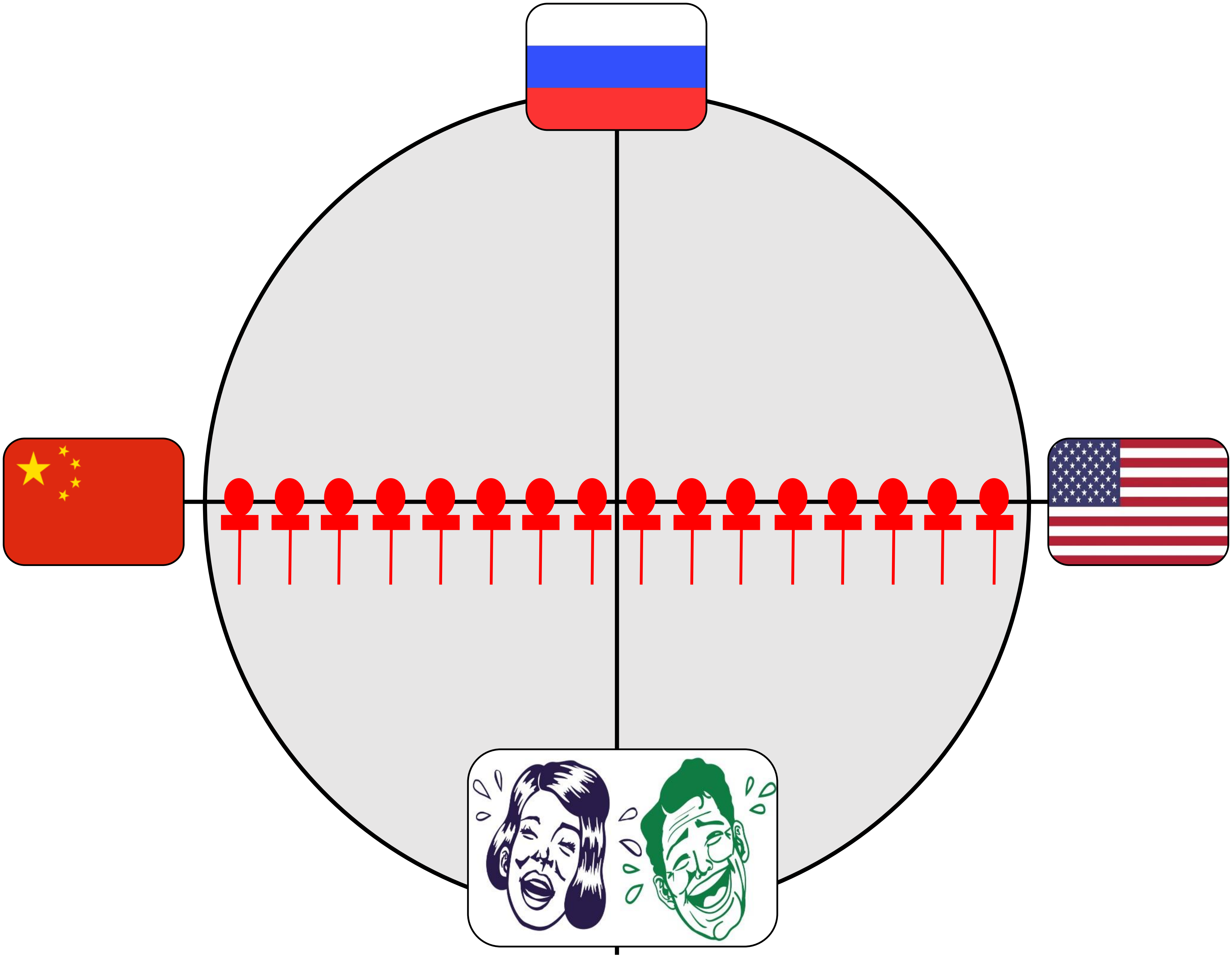
Part 2: finding the DOA

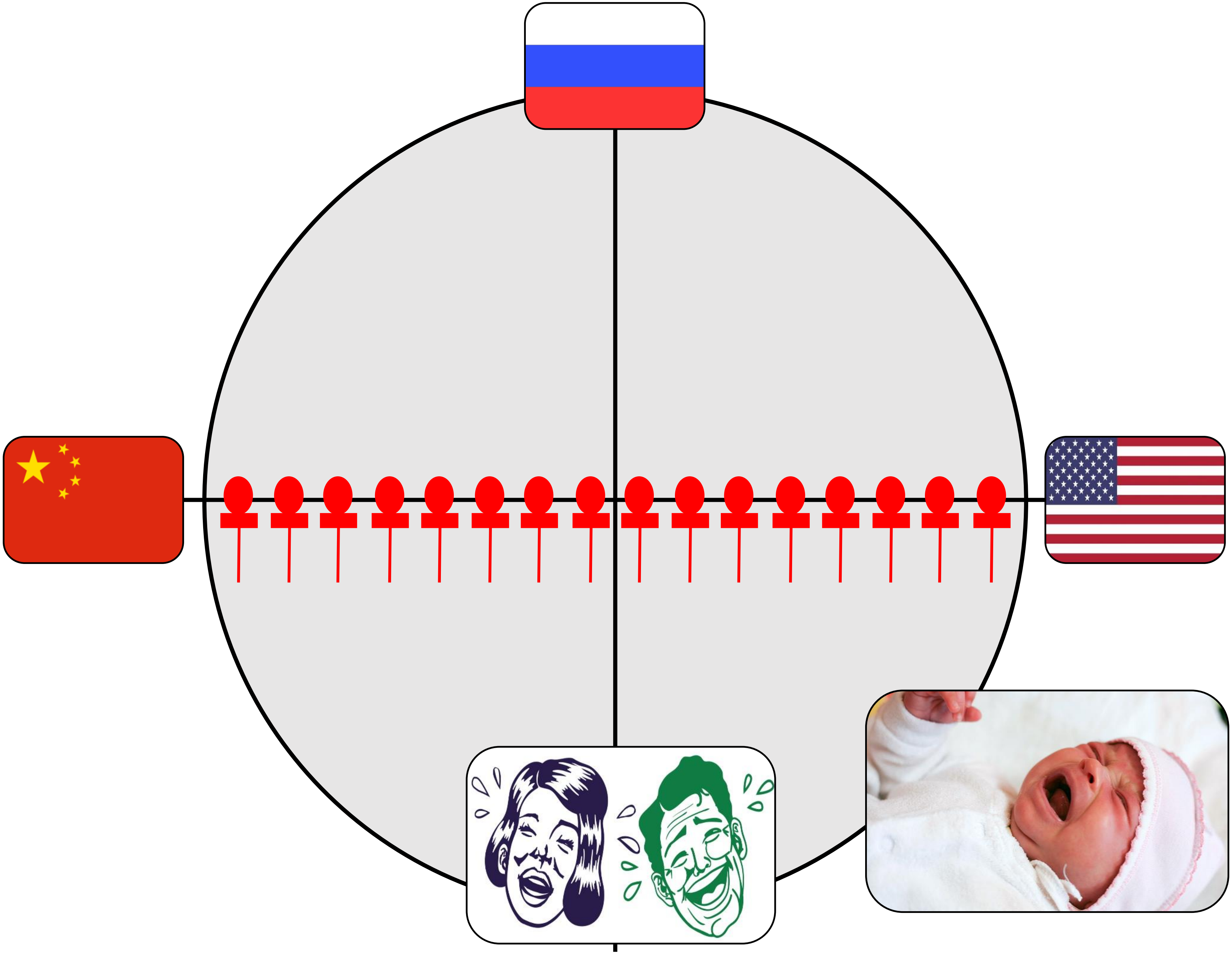
Not included for 2020!

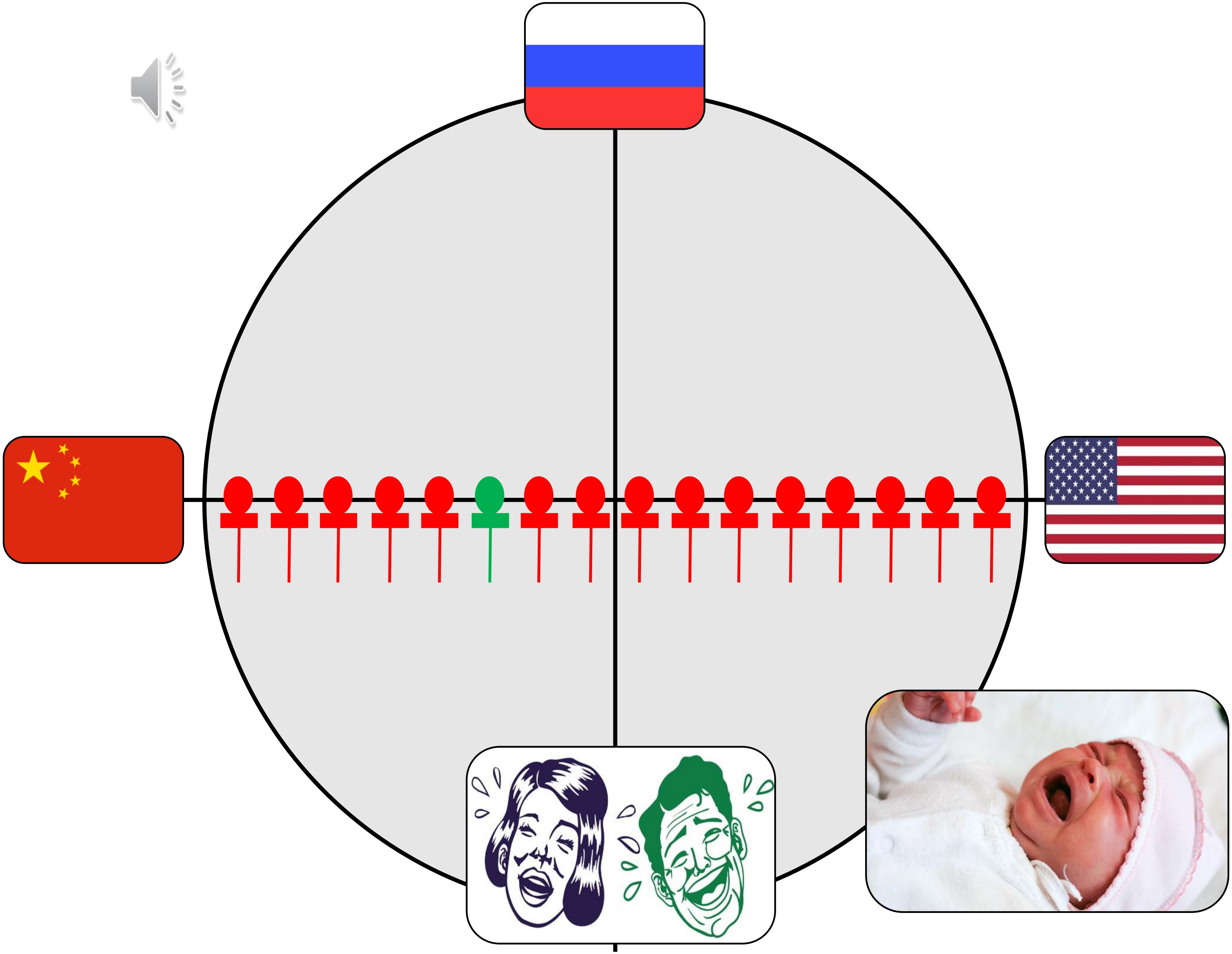

y
Sound source
Azimuth: ?
Elevation: 0°
Direction Of Arrival: ?
x
0.07 m

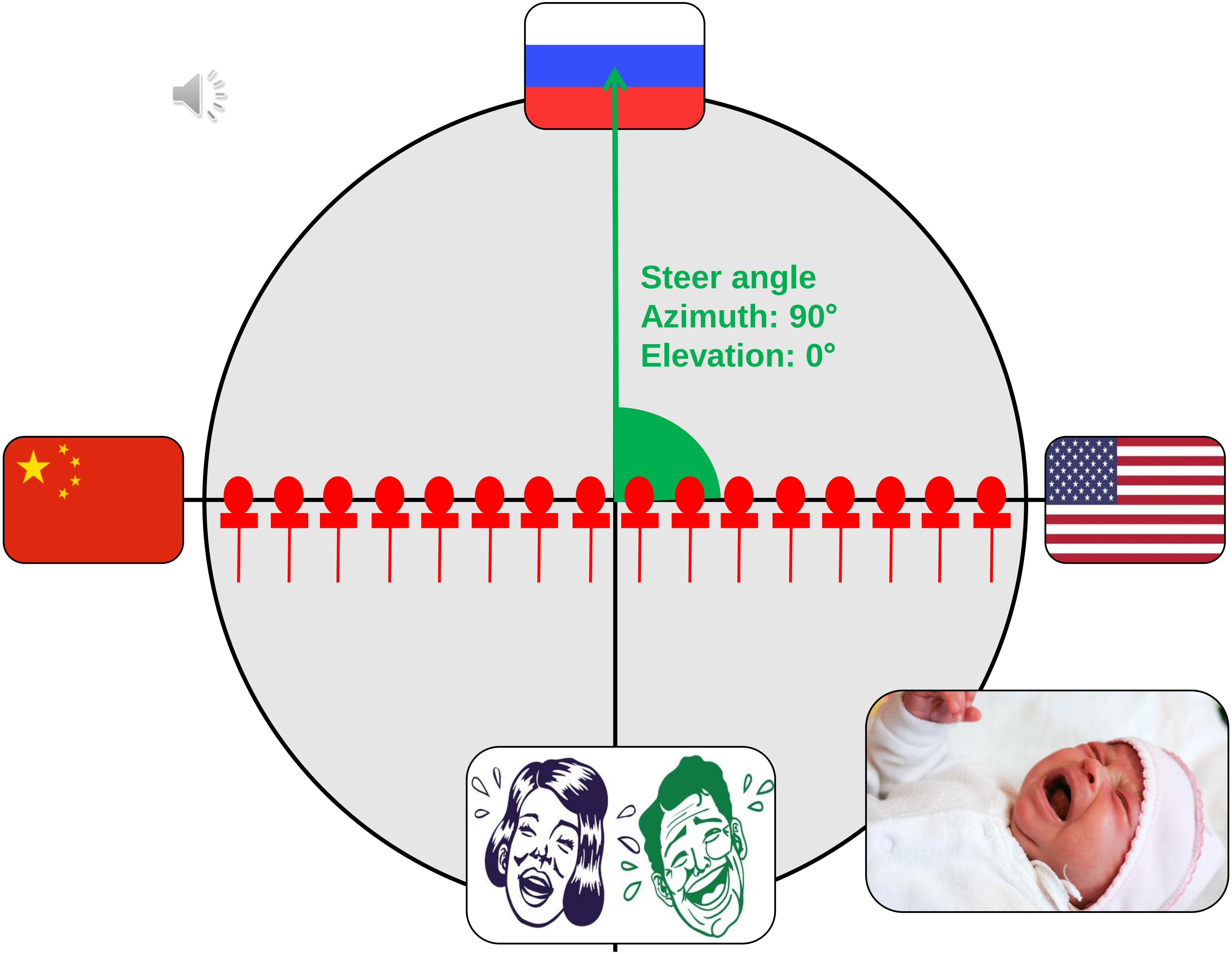
Example: beamforming



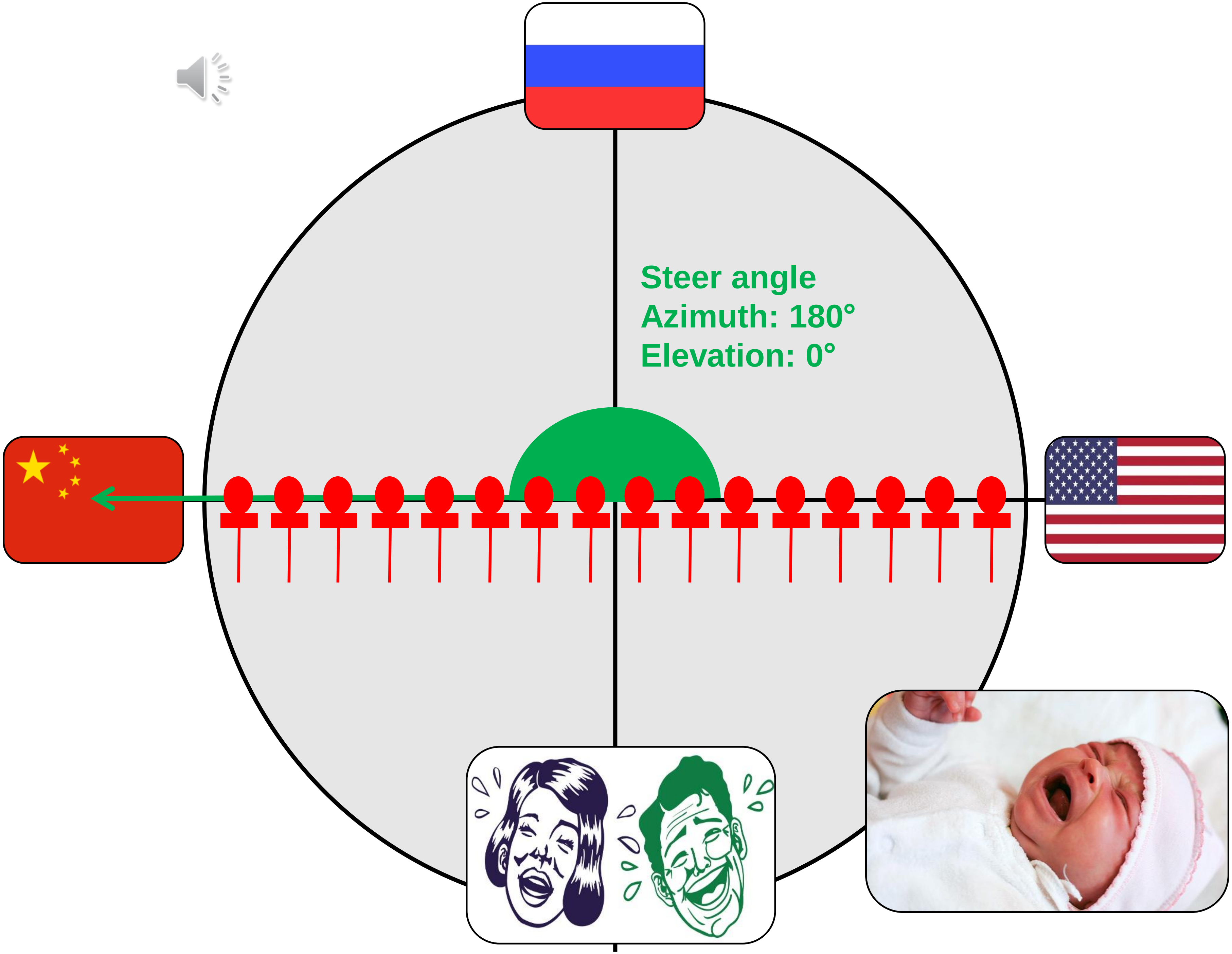




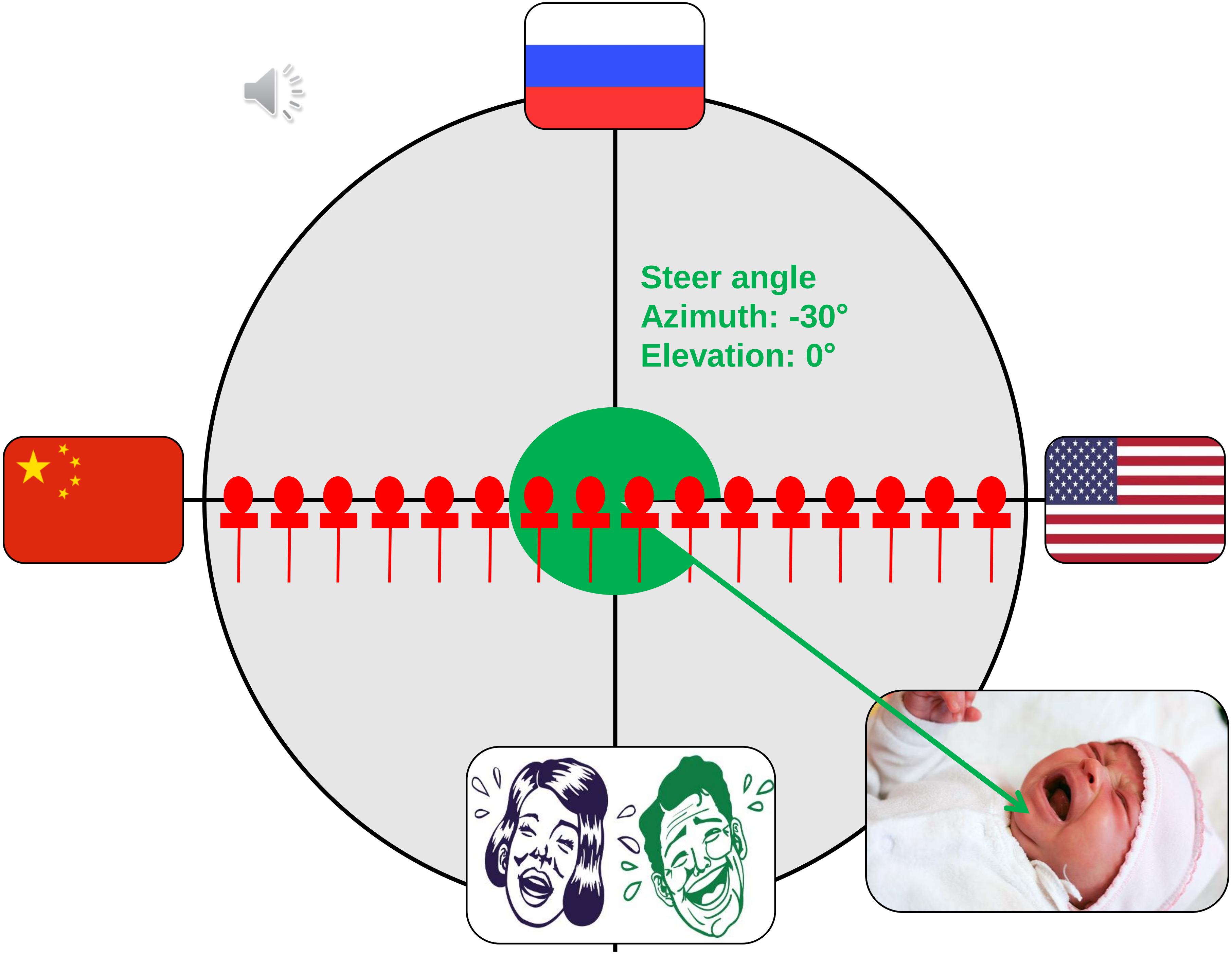




Steer angle
Azimuth: 90°
Elevation: 0°



Steer angle
Azimuth: 180°
Elevation: 0°



Steer angle
Azimuth: -30°
Elevation: 0°

Useful links

- https://nl.mathworks.com/help/phased/ug/acoustic-beamforming-using-a-microphone-array.html
- https://nl.mathworks.com/help/phased/direction-of-arrival-doa-estimation-1.html
- https://people.montefiore.uliege.be/ebrahimbabaie/applieddigtial_fichiers/TPS/TP2/Final/Slides/Powerline%20noise%20elimination.pdf