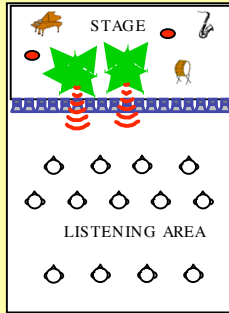


Using WFS in Concert situations



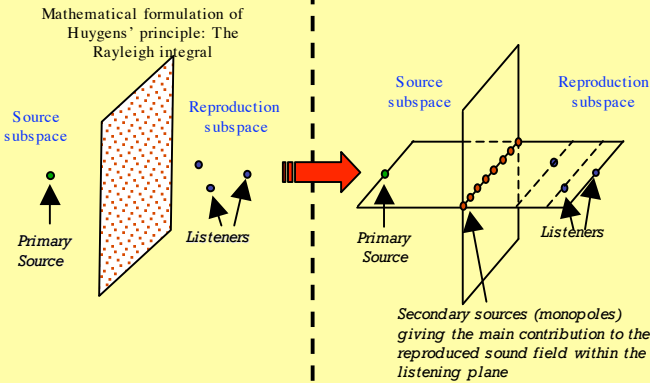
Objective: Rendering virtual sources alongside real instruments

Possible setup: Loudspeaker array in front of the stage

Listeners compare virtual sources with real ones using two cues:

- ➔ Direct sound field
- ➔ Associated reverberated sound field

Formulation of the WFS equations

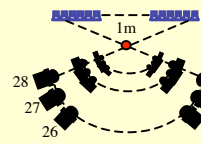


Necessary simplifications for practical implementation of WFS :

1. Infinite plane -> Infinite line source (Reduction of the reproduction subspace to a plane)
2. Infinite Line source -> Segment (further reduction of the listening area, diffraction)
3. Continuous Segment -> Discrete Segment (Spatial aliasing)

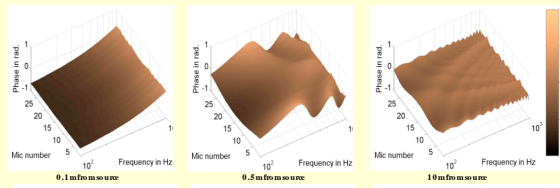
Infinite plane -> Infinite line source Spatial dependency of the wave front

- Simulation**
- Linear array of 32 ideal monopole sources with regular 16.5cm spacing
 - WFS virtual source synthesized 1m in front of the monopole array
 - Recording microphone arrays composed of 28 microphones each centered on the source (radii respectively 0.1m, 0.5m and 10m)

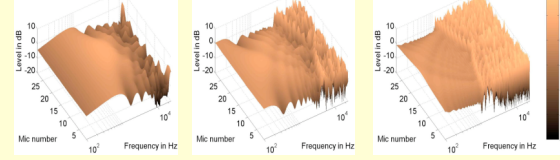


Results

Phase evolution: (after subtraction of theoretical propagation delays and normalization)

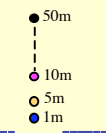


Frequency evolution: (after normalization by mean value over all microphone positions)

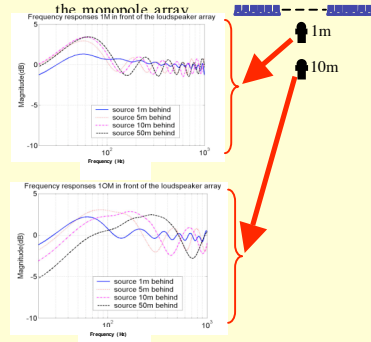


Infinite line source -> Segment Diffraction Effects

- Simulation**
- Linear array of 32 ideal monopole sources with regular 16.5cm spacing
 - WFS virtual sources synthesized 1m, 5m, 10m and 50m behind the monopole array
 - Microphones record sound field 1m and 10m in front of the monopole array



Results



Consequences on Practical implementation

Real loudspeakers present deficiencies

Necessity to use an array of microphones to control the emitted sound field along a given line;

Variation of the sound field characteristics during propagation

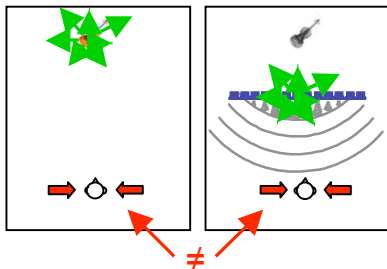
Obligation to adapt the control line to fit audience positioning (small auditorium vs. large concert hall)

Reverberation of WFS sources

Main issues :

- Linear shape of the WFS array (implies axisymetry of the reproduced sound field)

- Windowing of the virtual source by the array



➔ One can expect differences between WFS sources and real 3D sources in terms of criteria such as clarity, IACC, late reverberance, etc...

Choice of « late reverberance » criterion to characterize the reverberated field associated to WFS sources

This criterion is linked to emitted power

It can also be affected by source directivity and orientation

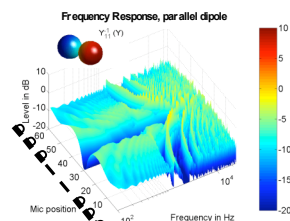
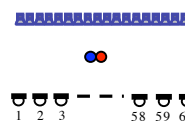
➔ Characterization of the power emitted by the WFS array when reproducing a simple directive source, i.e. a dipole

Source Directivity Synthesis

Synthesis of elementary source directivity
+
Combination (pattern and orientation control)



Dipole Synthesis



Emitted Power

