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Identification of acoustic moving sources in the context of a road vehicle at pass-by: a numerical and experimental comparison

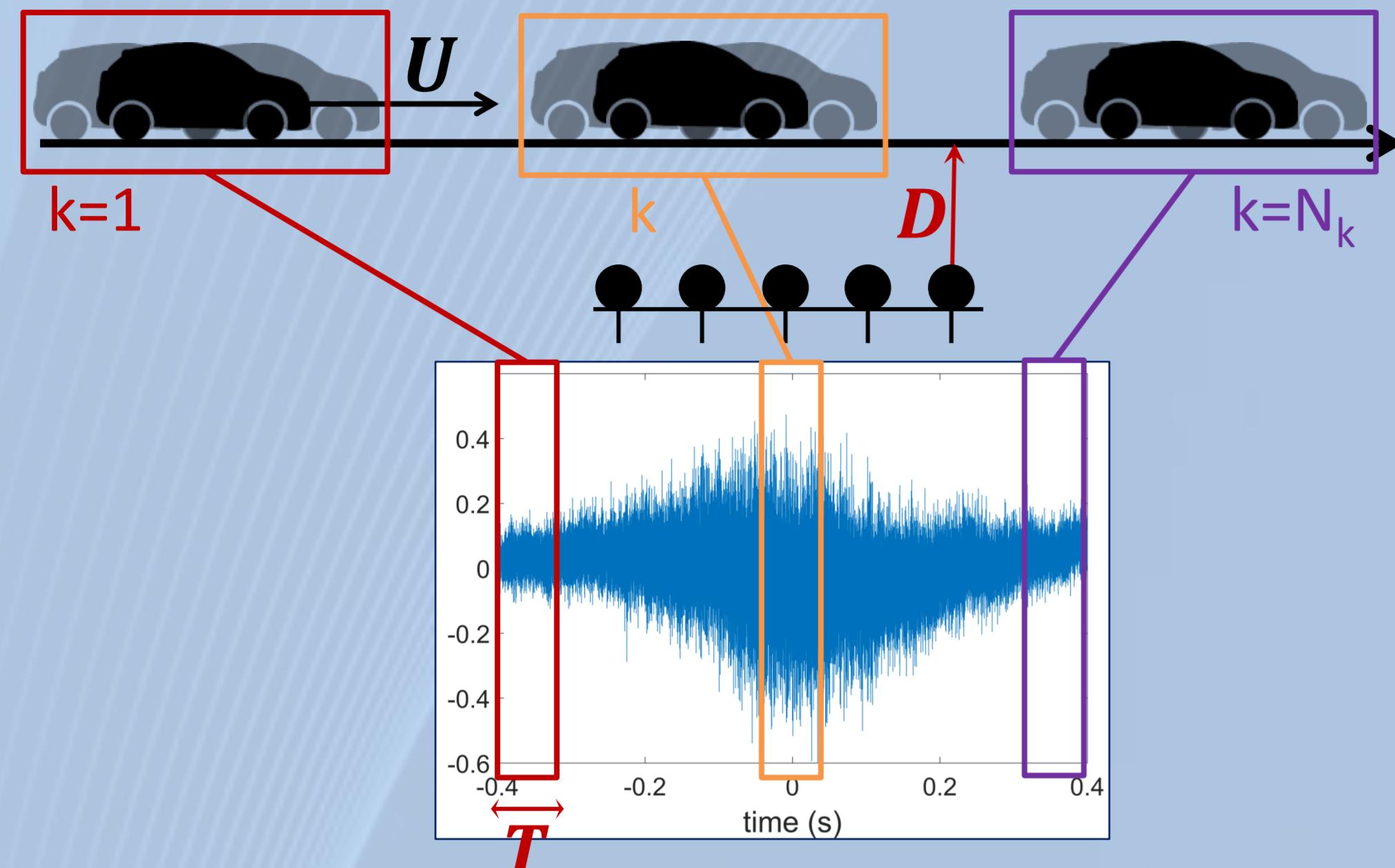


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Abstract n°2713429

METHOD DESCRIPTION: MOVING SOURCE ADAPTED - PSF



Assumptions:

- Uncorrelated sources
- Monopoles linearly moving at constant speed U
- $UT \ll D$
- Ergodic random sources
- Differences in dopplerized frequencies $< \Delta f (= \frac{1}{T})$

$$\tilde{\mathbf{H}}(\omega_p)\mathbf{s}(\omega_p) = \mathbf{b}(\omega_p)$$

$$\tilde{H}_{i,j}(\omega_p) = \left| \sum_{m=1}^{N_M} \tilde{G}_{i,m}^{(k)*} \left(\frac{\omega_p}{1 - M_{i,m,0}^{(k)}} \right) \tilde{G}_{j,m}^{(k)} \left(\frac{\omega_p}{1 - M_{i,m,0}^{(k)}} \right) \right|^2$$

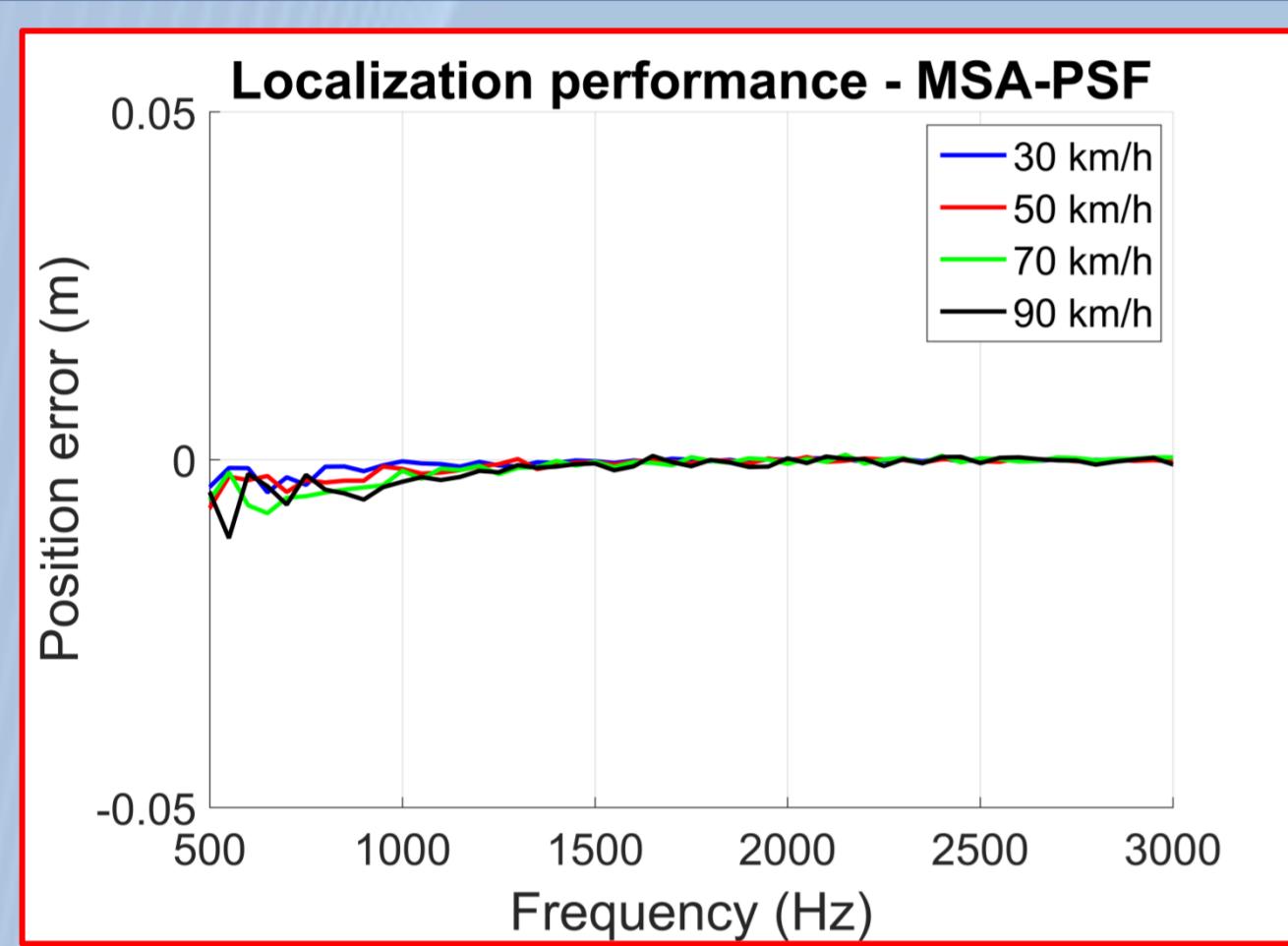
- Snapshot $k (k=1..N_k)$: Beamforming at frequency $f_{dopp}^{(k)} = \frac{f}{1-M \cos \theta_k}$
PSF calculated at $f_{dopp}^{(k)}$
- Averaged BF output over N_k
- Averaged PSF over N_k
- Deconvolution

$$b_i(\omega_p) \approx \sum_{m,n=1}^{N_M} \overline{\tilde{G}_{i,m}^{(k)*} \left(\frac{\omega_p}{1 - M_{i,m,0}^{(k)}} \right)} \Gamma_{i,m,n}^{(k)}(\omega_p) \tilde{G}_{i,n}^{(k)} \left(\frac{\omega_p}{1 - M_{i,n,0}^{(k)}} \right)$$

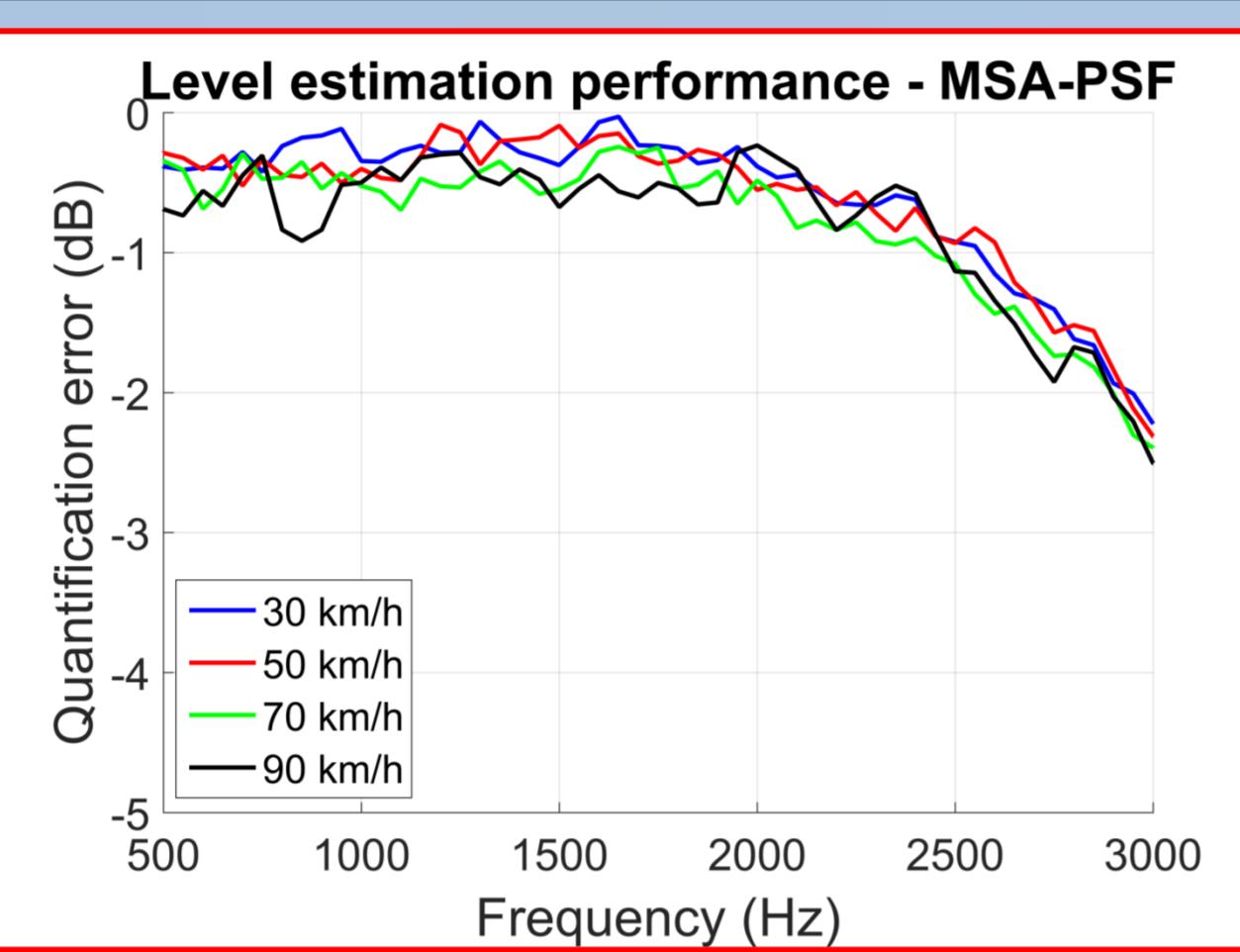
$$\Gamma_{i,m,n}^{(k)}(\omega_p) = \hat{p}_m^{(k)} \left(\frac{\omega_p}{1 - M_{i,m,0}^{(k)}} \right) \hat{p}_n^{(k)*} \left(\frac{\omega_p}{1 - M_{i,n,0}^{(k)}} \right)$$

NUMERICAL SIMULATIONS: PERFORMANCE ASSESSMENT

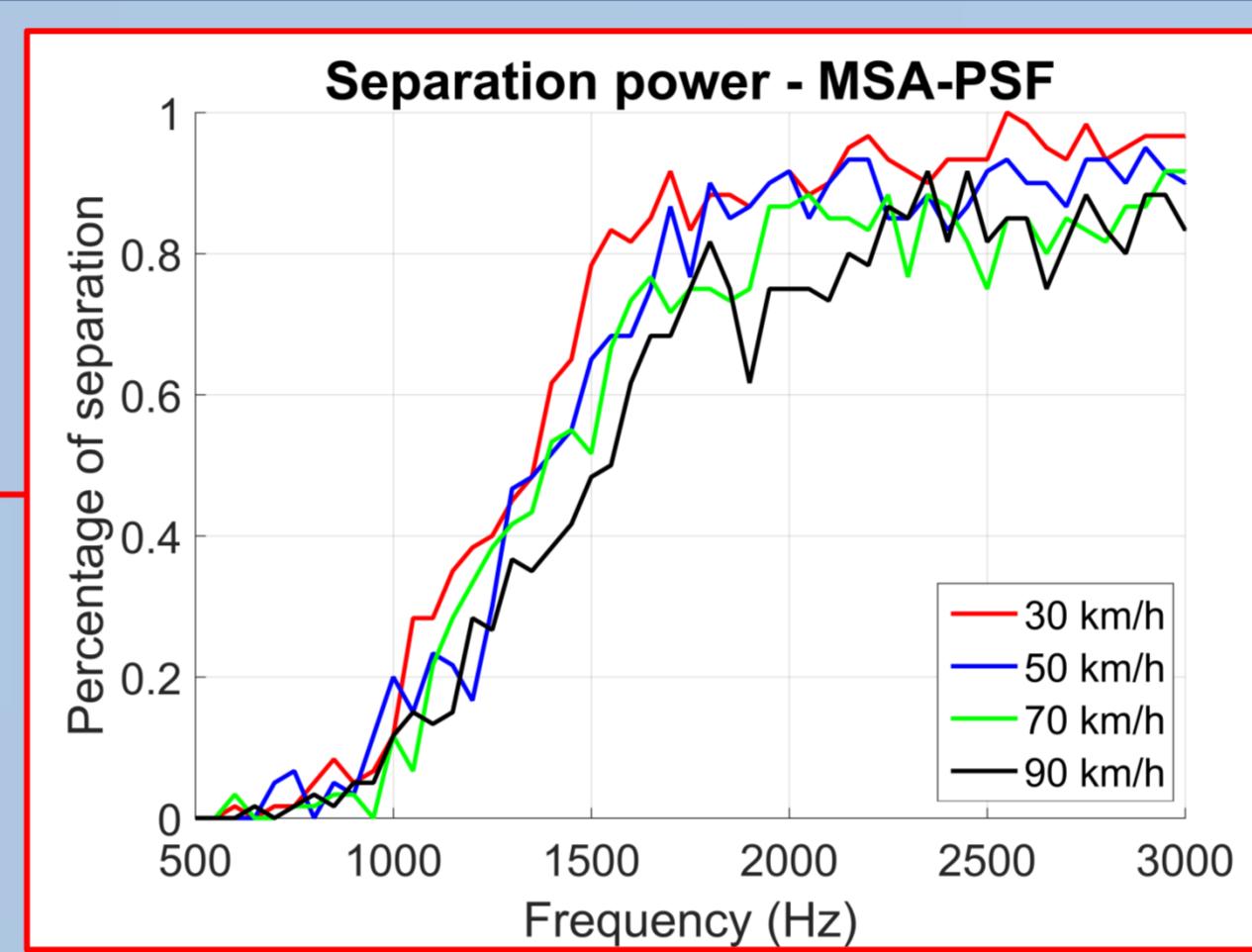
1. LOCALIZATION



2. QUANTIFICATION



3. SEPARATION POWER



SIMULATION PARAMETERS

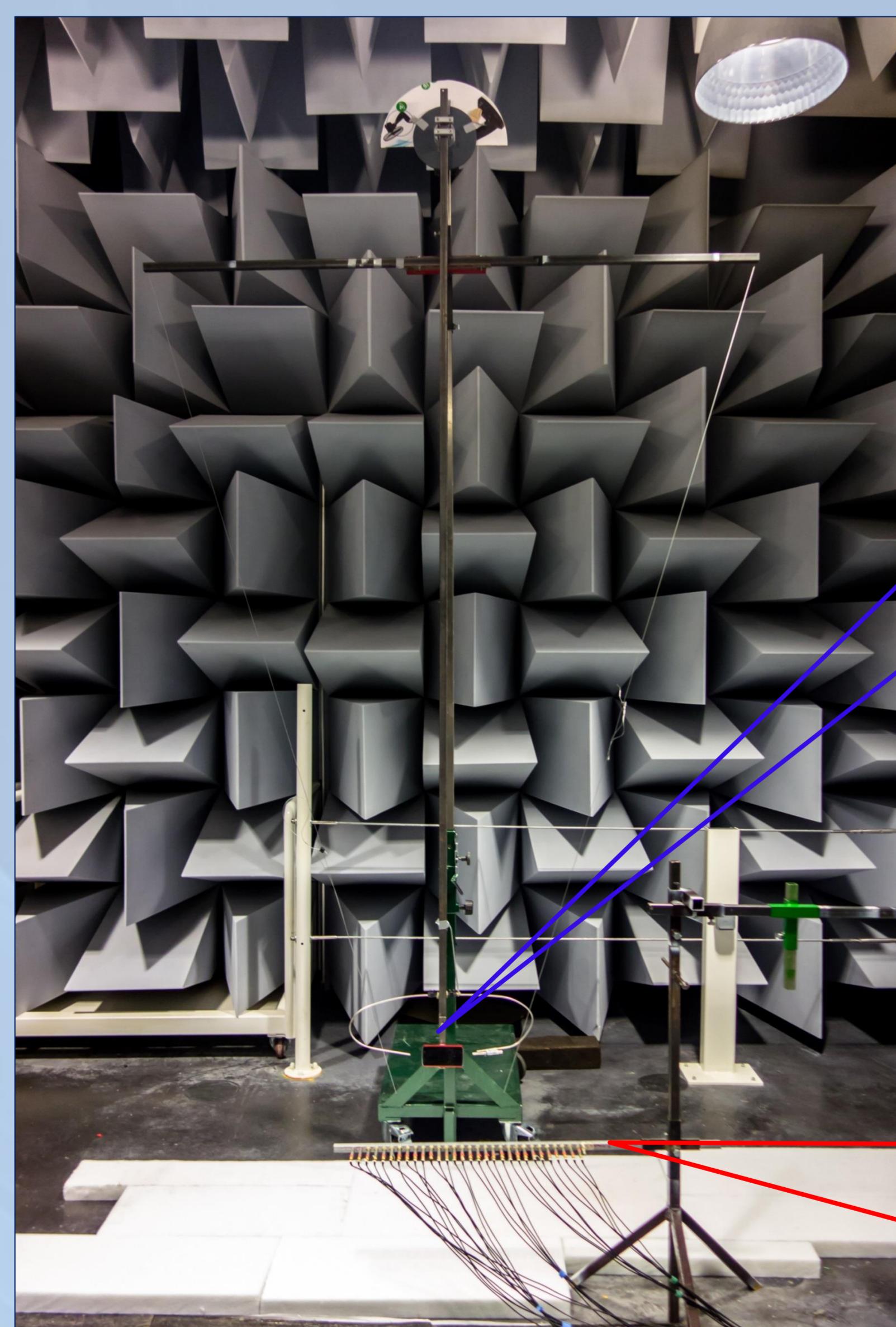
$F_s = 8000$ Hz	$X_{source} = 0$ m
$N_M = 32$ sensors	$X_{sep} = [-0.05 ; +0.05]$ m
$d = [0.05 - 0.29]$ m	$f_{range} = [500 - 3000]$ Hz
$L_{array} = 4$ m	$T = 0.02$ s
$D = 4$ m	$N_k = 29$
$T_{signal} = 2$ s	Overlap = 60%
$U = [30 - 90]$ km/h	$N_{simus} = 60$

MSA-PSF: Moving Source Adapted - Point Spread Function

CBF: Conventional Beamforming
(Sweeping focus time domain BF + Deconvolution with static PSF)

- Better localization of sources: more robust and less dispersive
- Better quantification: error < 1 dB until 2.5 kHz vs error > 1 dB in whole frequency range for CBF
- Better separation of close sources

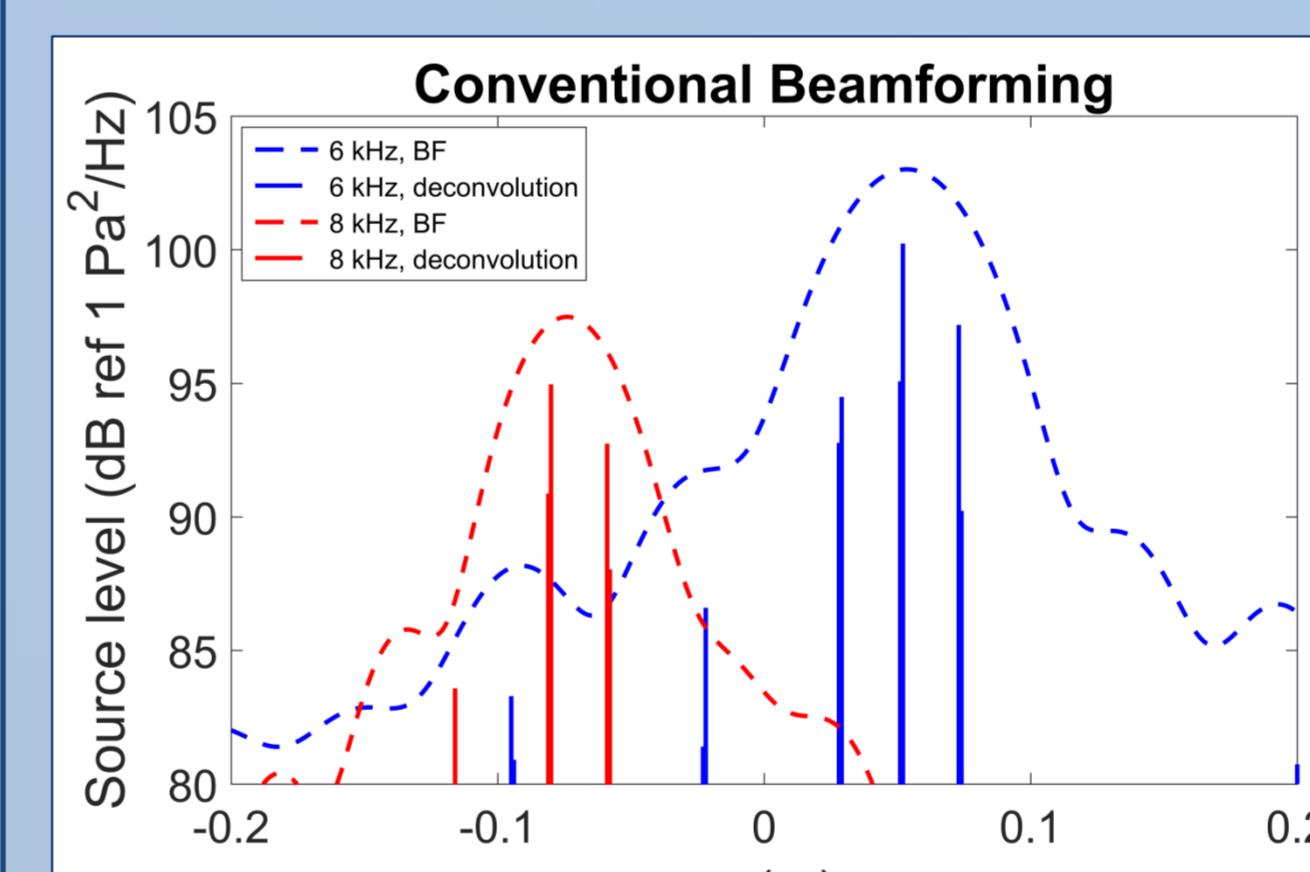
ACADEMIC EXPERIMENT



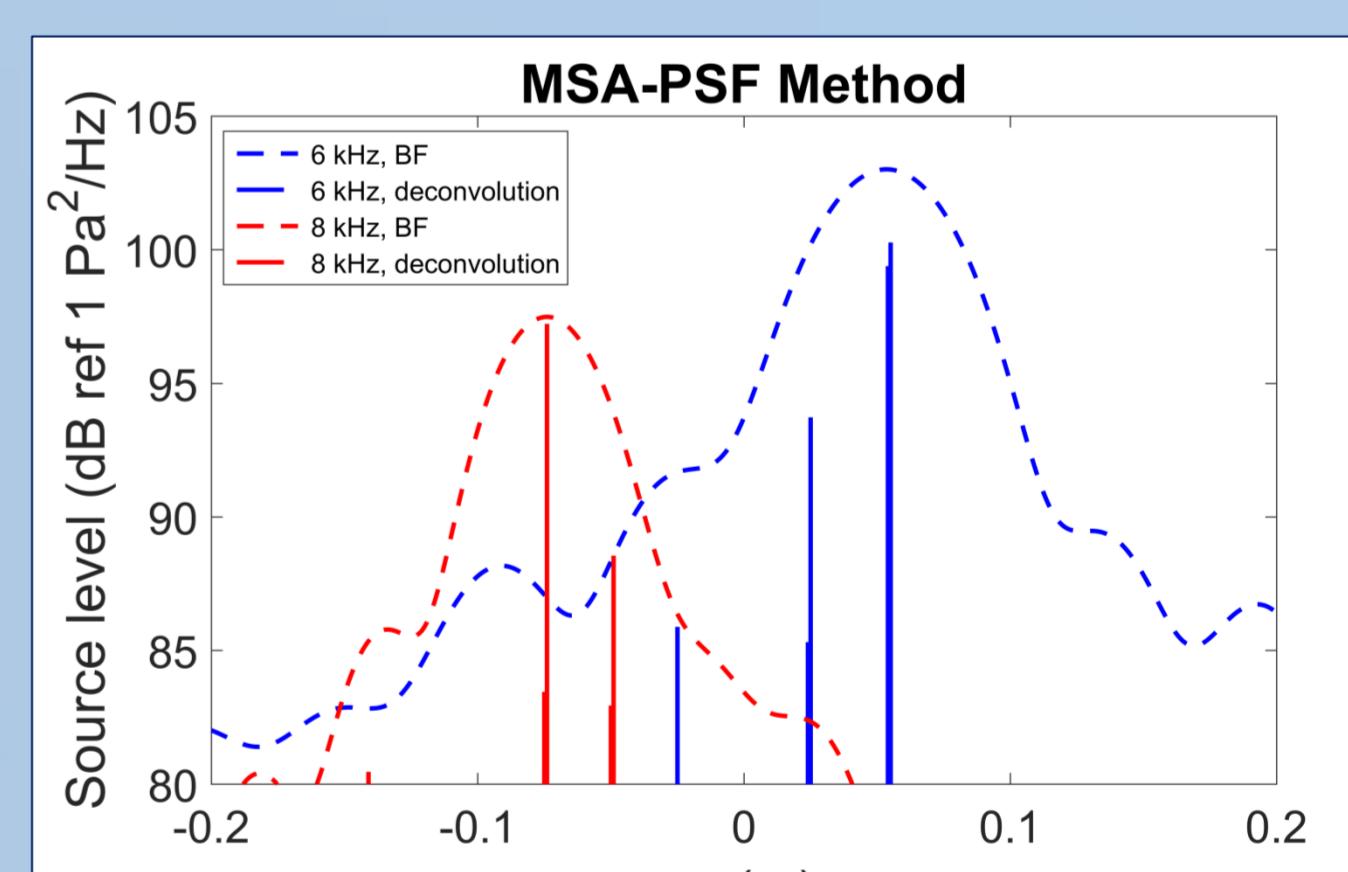
Moving sources:
Smartphone with two independent
loudspeakers

30 Microphones linear array
microphones

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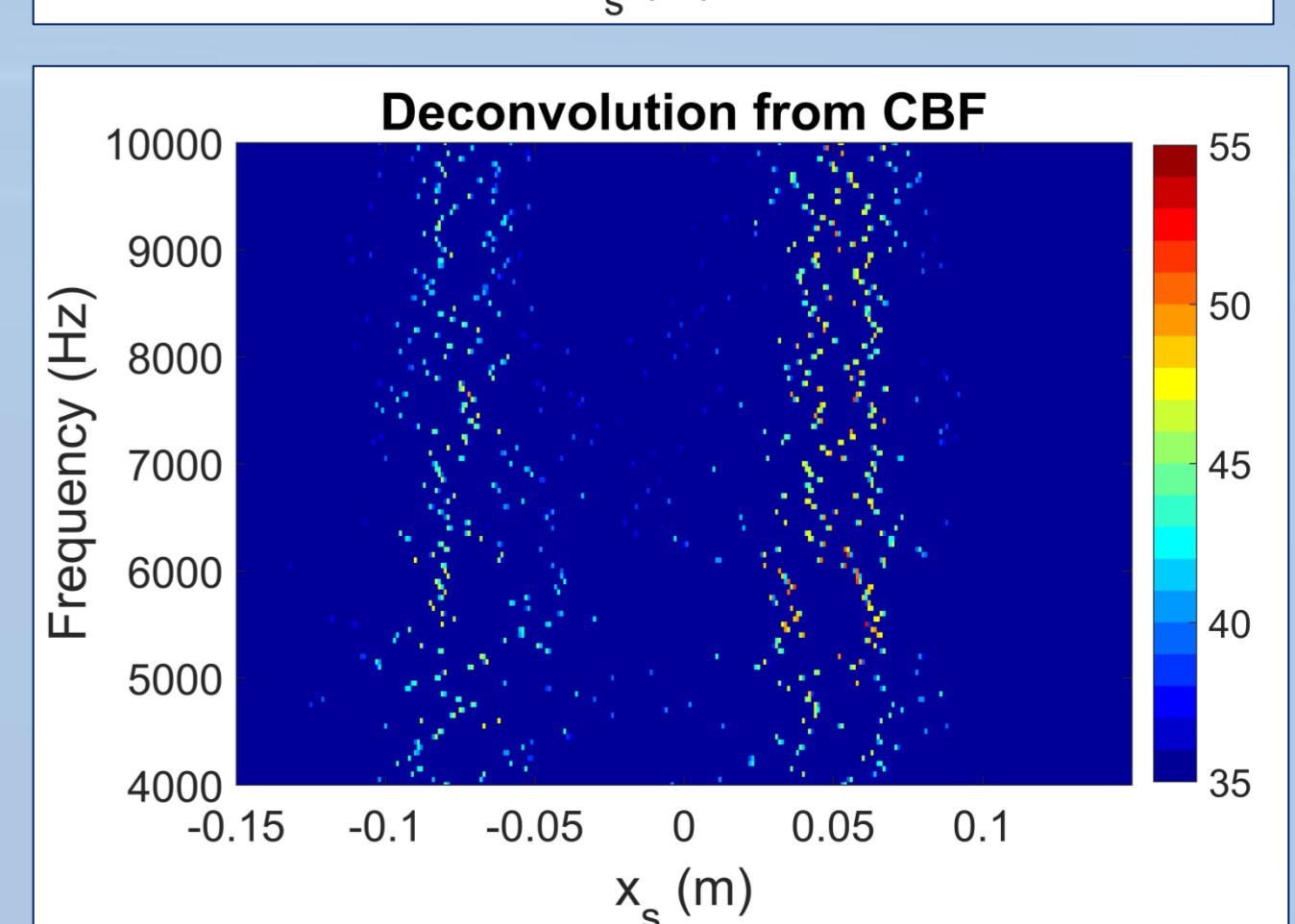
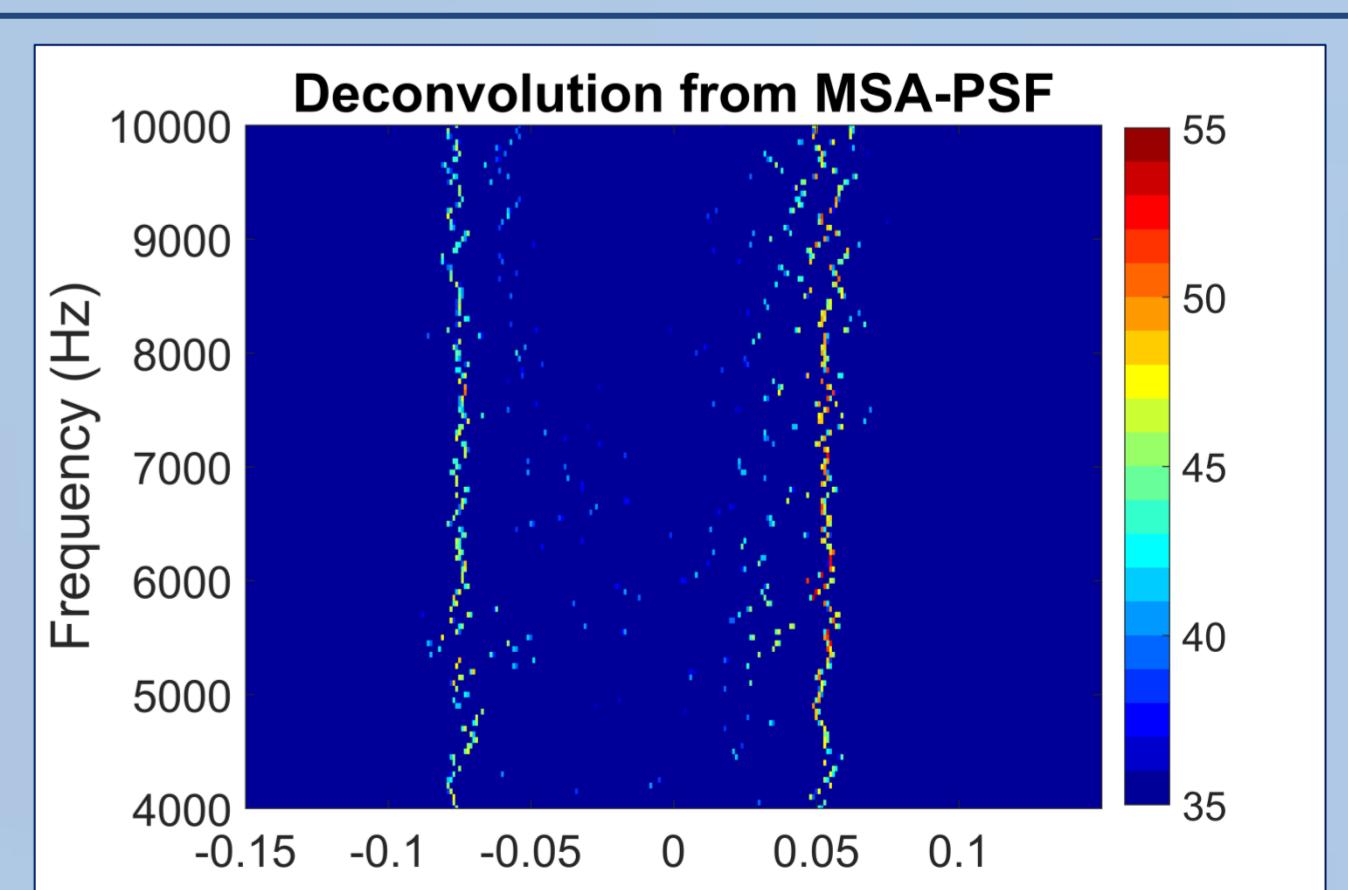
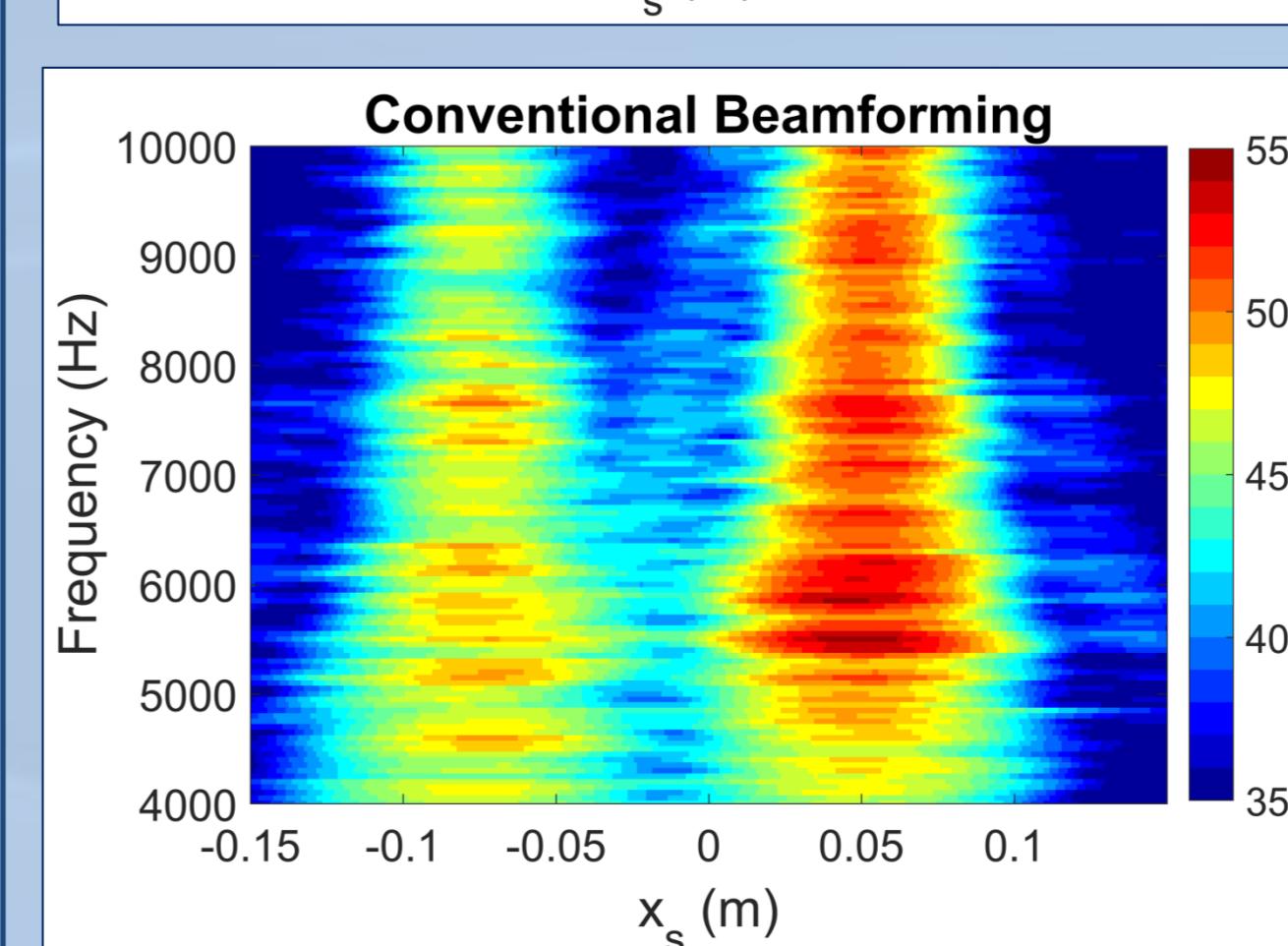
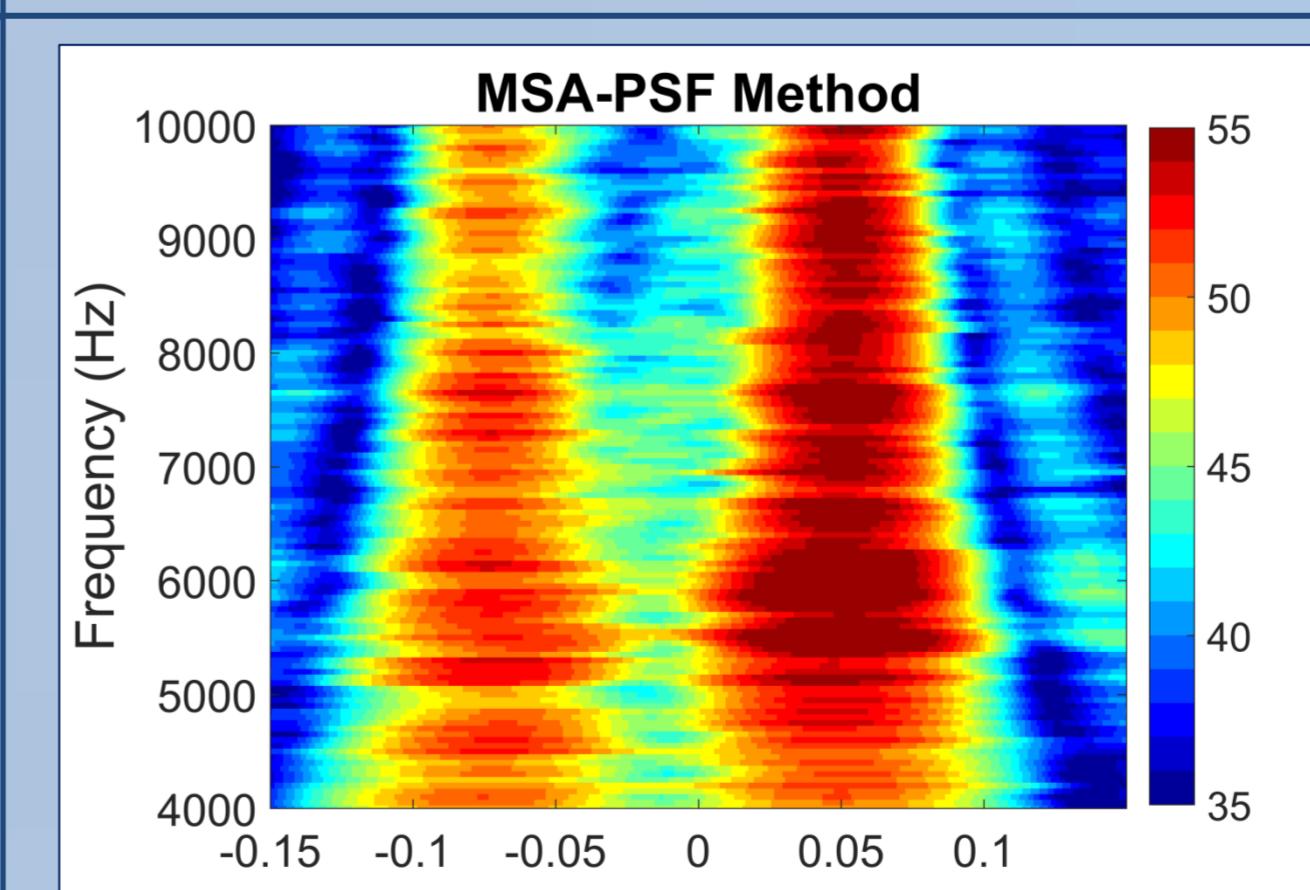


$F_s = 51200$ Hz
 $P = 30$ sensors
 $d = 0.02$ m
 $D = 0.5$ m
 $T_{signal} = 2$ s
 $U = 3.5$ m/s



$X_{sources} = [-0.06 ; +0.06]$ m
 $f_{S1} = 8$ kHz
 $f_{S2} = 6$ kHz
 $T = 0.02$ s
 $N_k = 21$
Overlap = 60%

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REFERENCES

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- B. Oudompheng, Array processing for the localization and the contribution of acoustic sources of passing-by ship using a short antenna, Univ. Grenoble Alpes (2015)
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PERSPECTIVES

Real pass-by condition measurements

