Robust multi-frequency sparse Bayesian learning: data results

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Presentation objectives

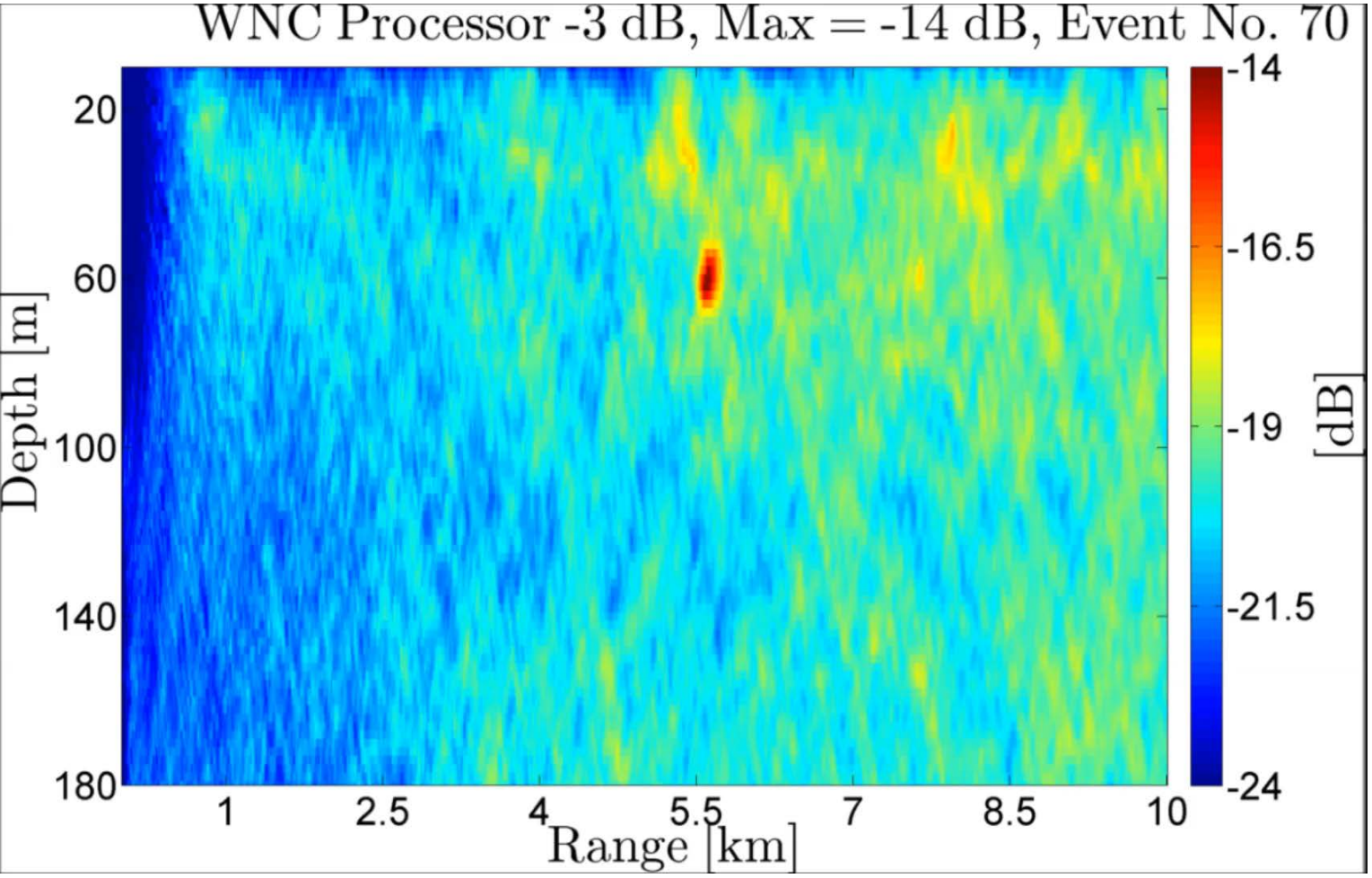
We investigate SBL performance for MFP and CBF and demonstrate using data:

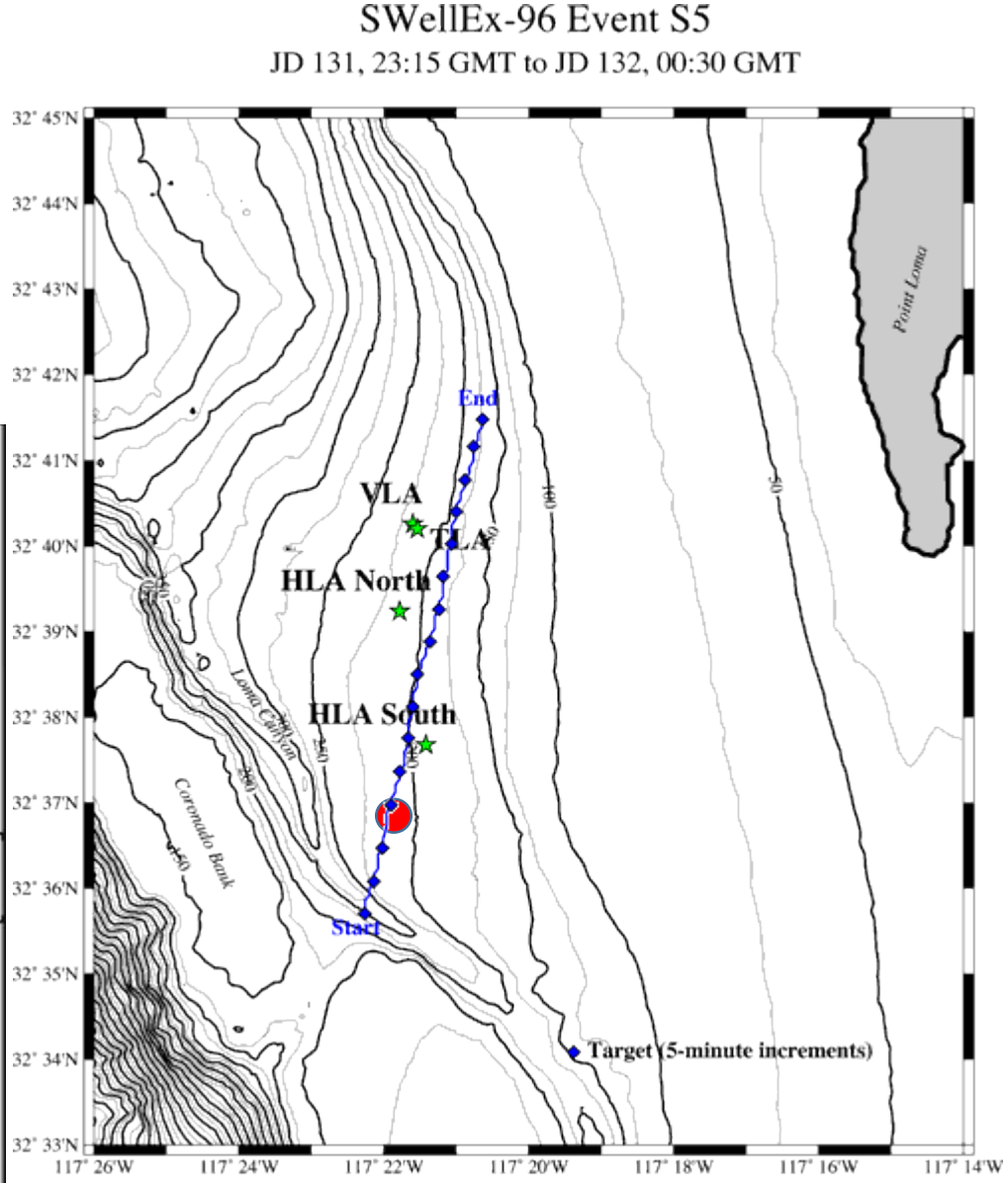
1. SBL behaves similarly to an adaptive processor. The output of SBL is compared to the white noise constraint (WNC), MVDR, and MUSIC processor in a two-source MFP scenario. SBL performs similar to MUSIC and is robust to a “degree” of array-tilt mismatch.

2. SBL can be used to help identify ray-arrivals for CBF.

- Results are demonstrated with simulated and the SwellEx-96 & Noise-09 data.

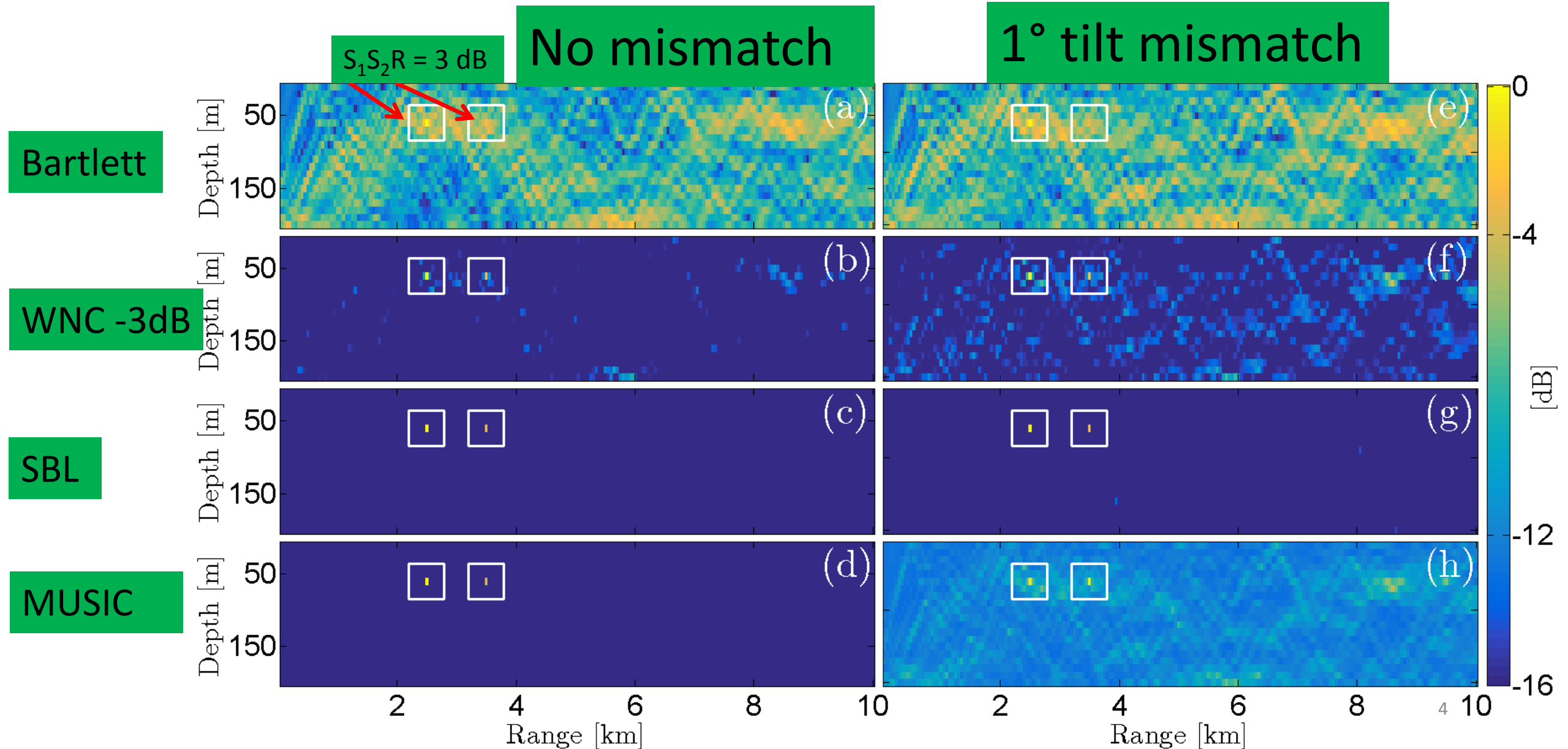
SWellEx-96 – Event S5 – Deep Source





Experiment site (near San Diego) with source track

SNR Localization Curves – Simulation Intro



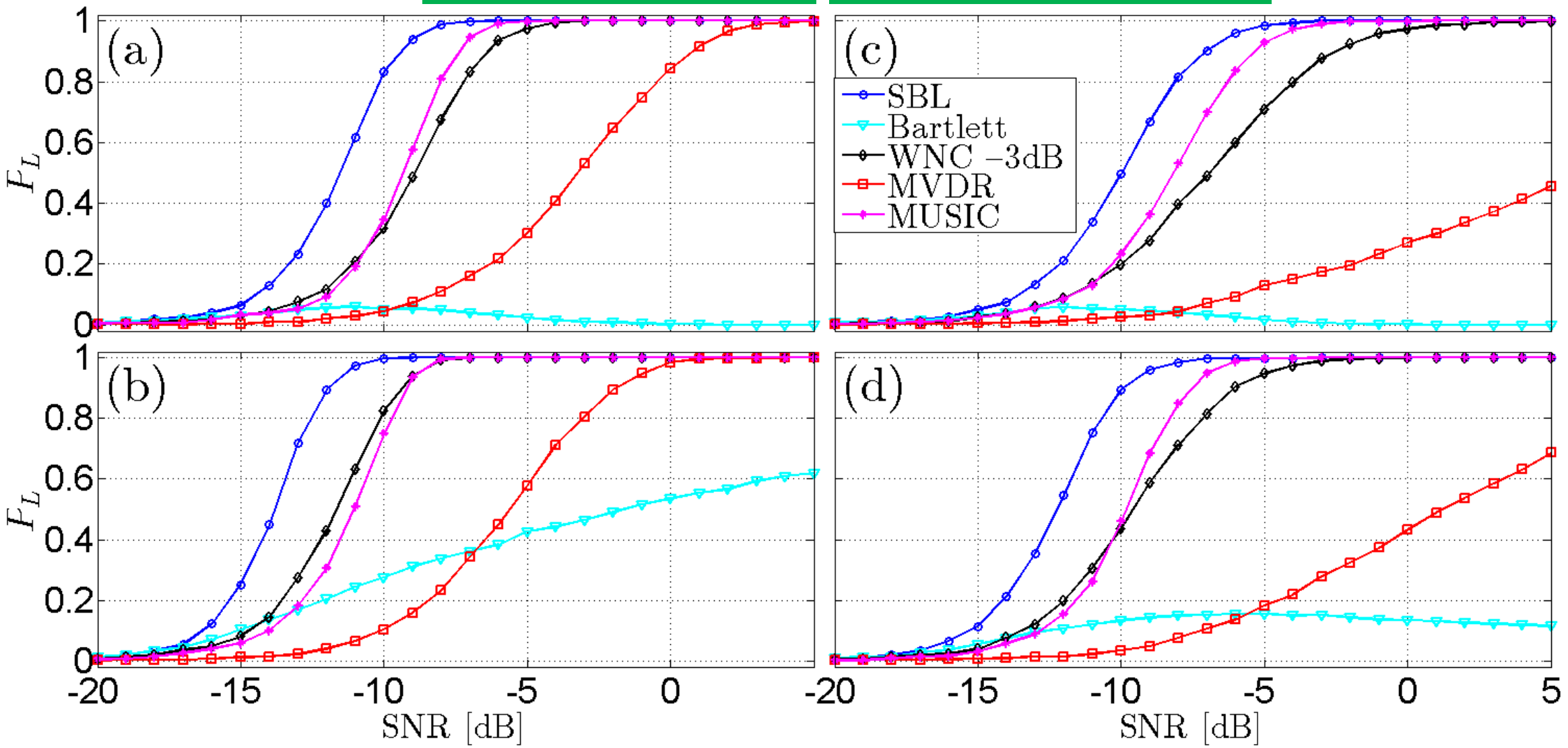
Simulations
166 & 201 Hz

No mismatch

1° tilt mismatch

1F

2F



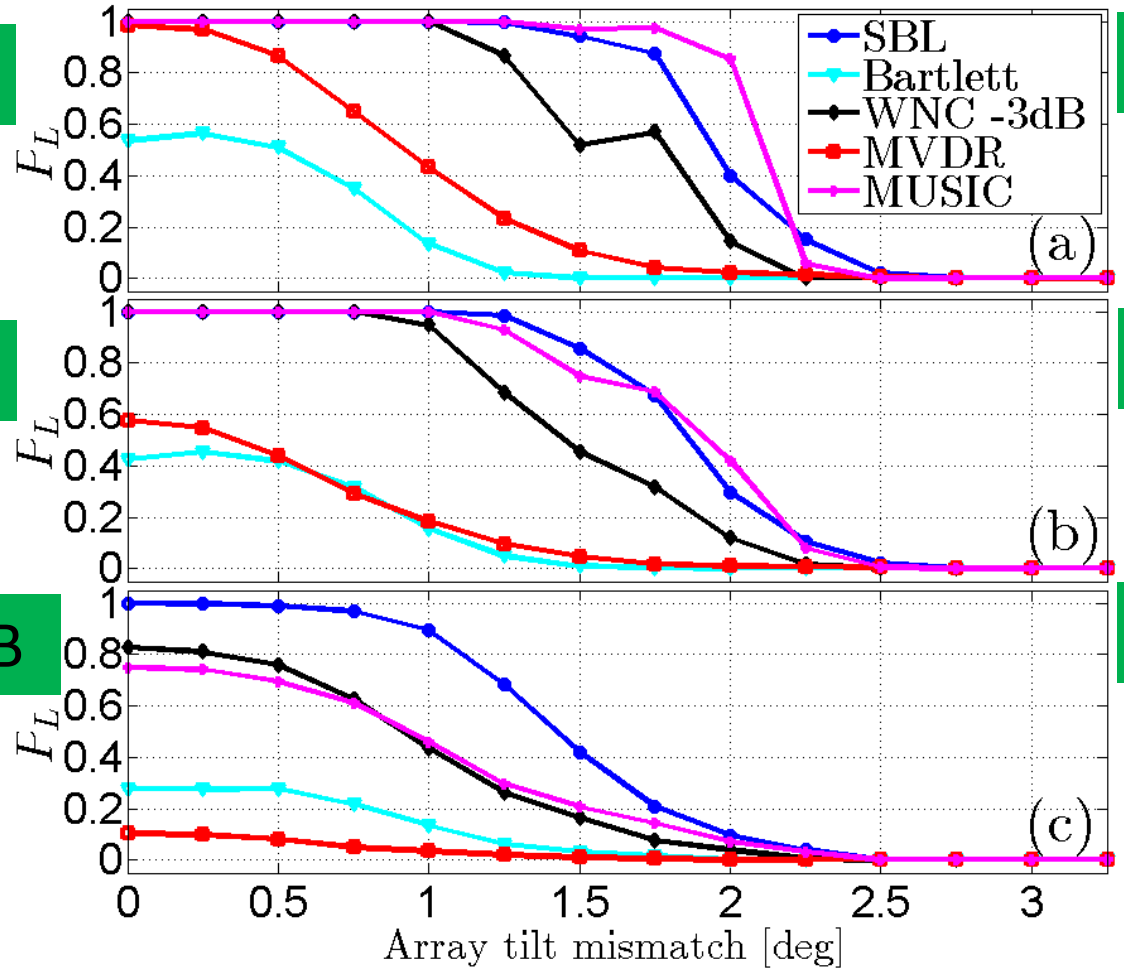
Simulations 166 Hz and 201 Hz

SNR vs mismatch

0 dB

-5 dB

-10 dB

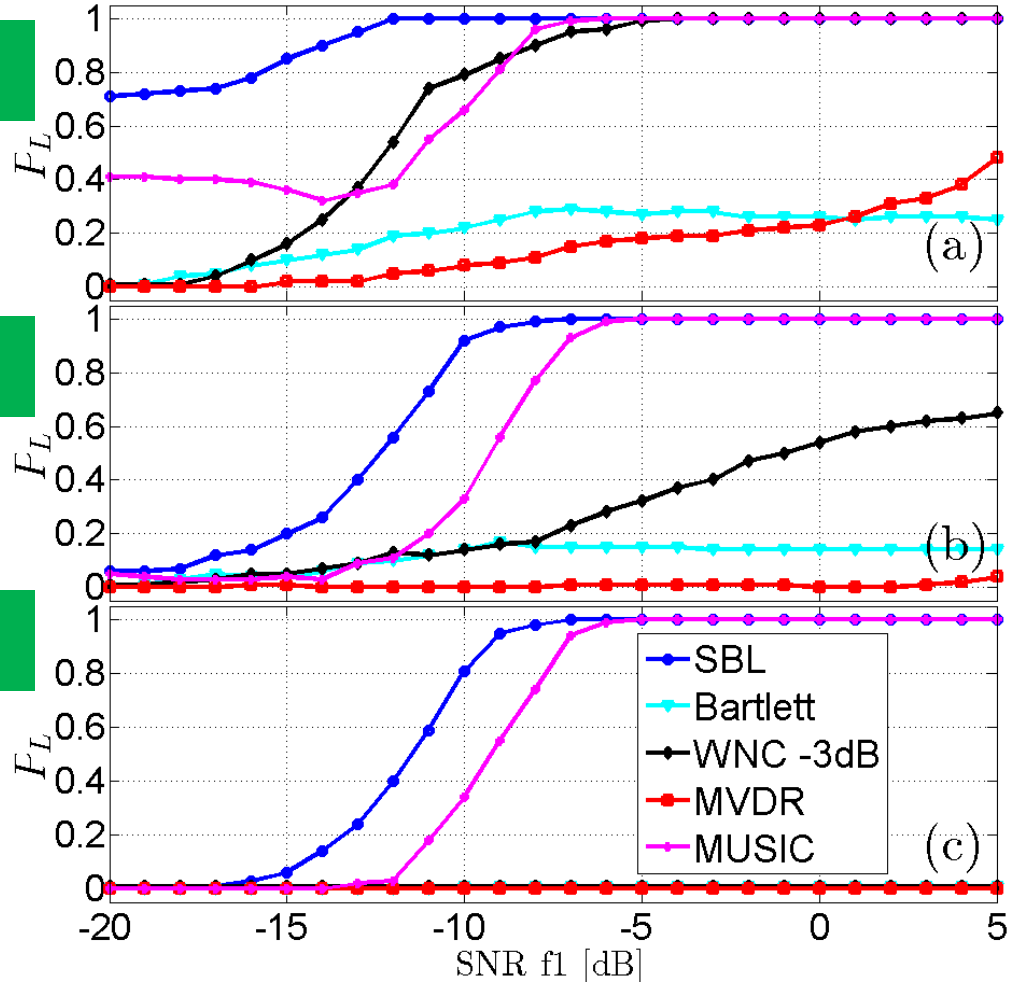


SNR f2 vs SNR f1

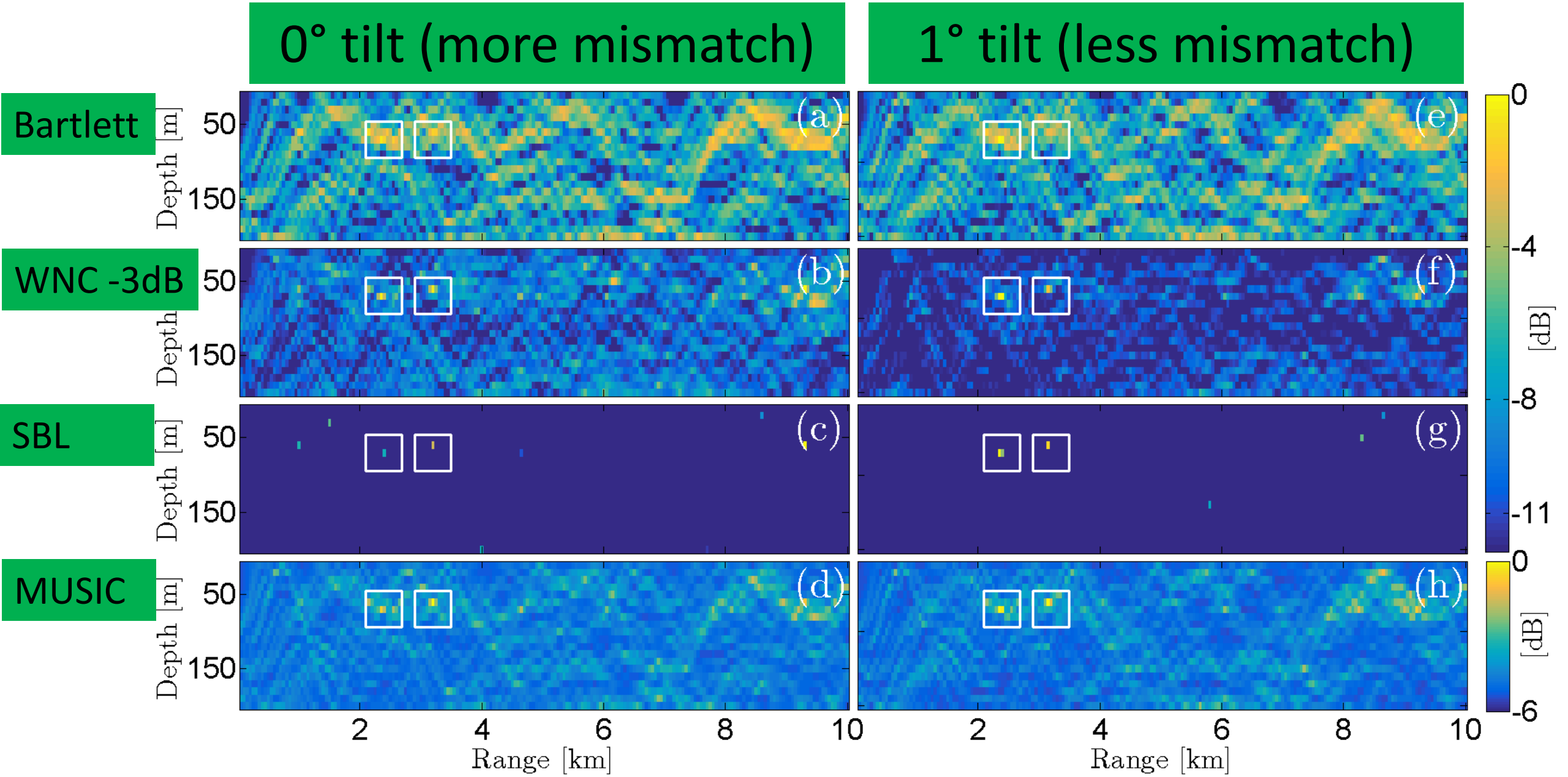
-10 dB

-15 dB

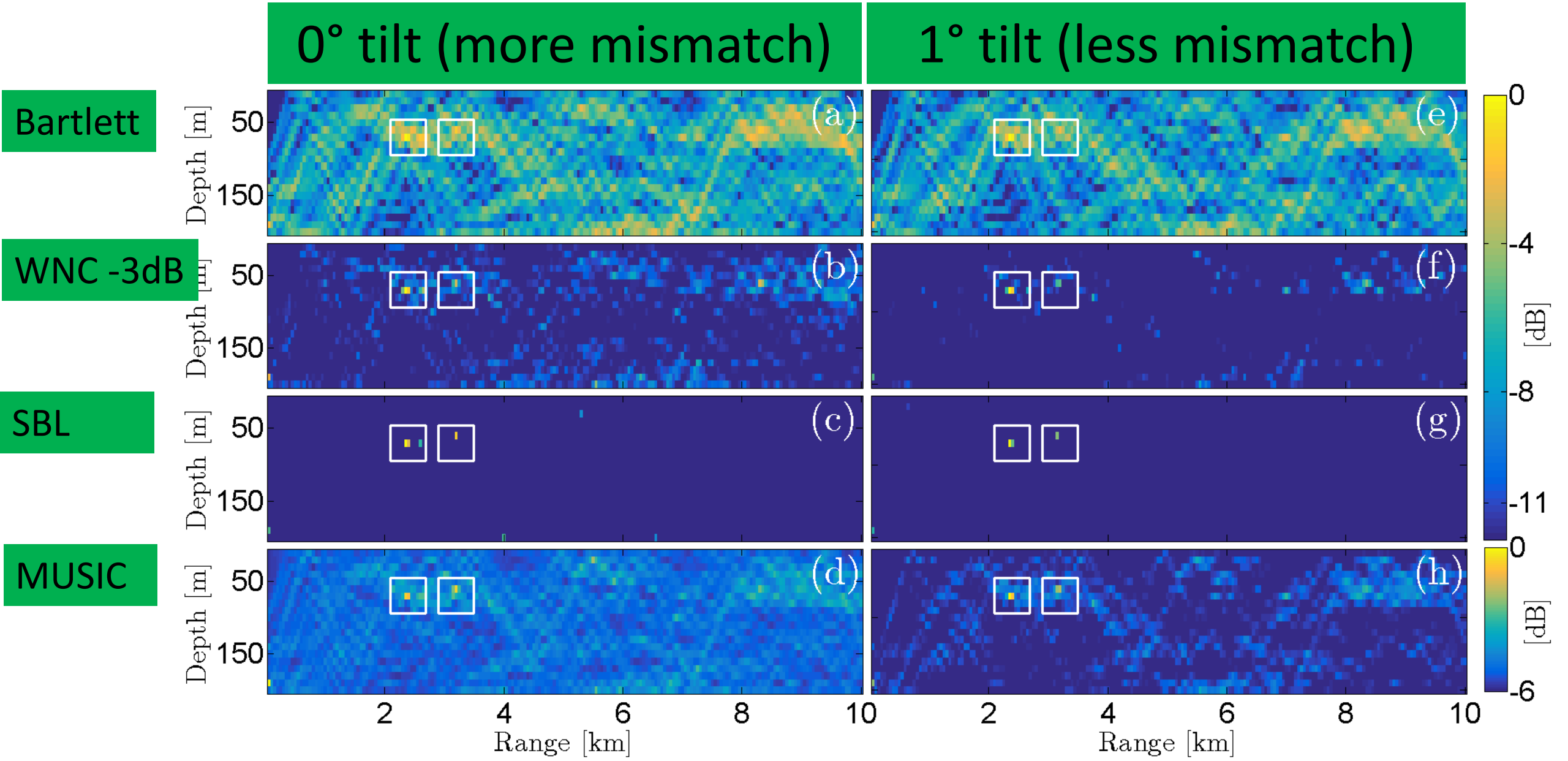
-20 dB



SWellEx-96 2-Source Localization: 166 Hz



SWellEx-96 2-Source Localization: 166 & 201 Hz



SWellEx-96 Event S5 2-Source Localization

0° tilt (more mismatch)

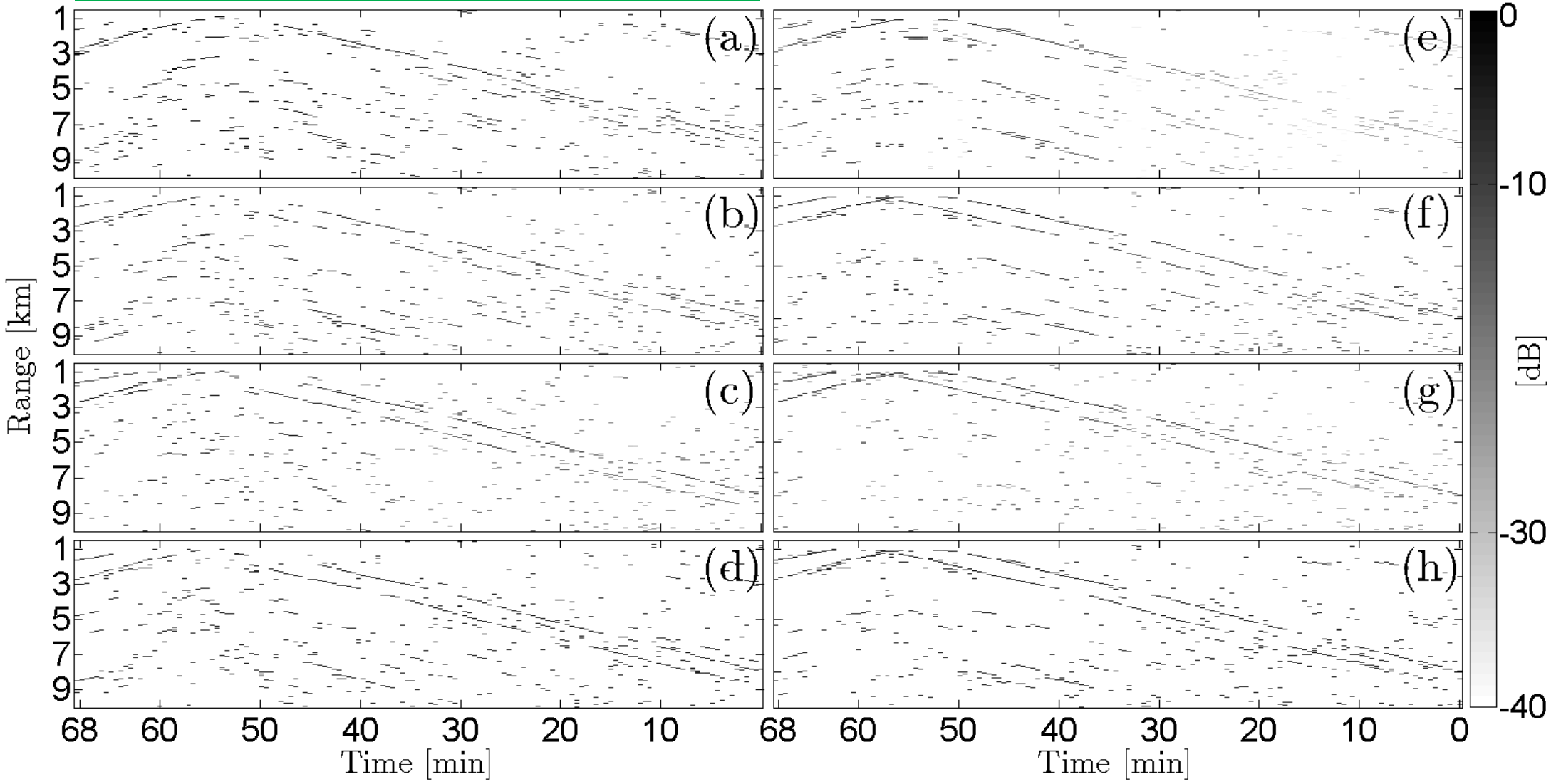
1° tilt (less mismatch)

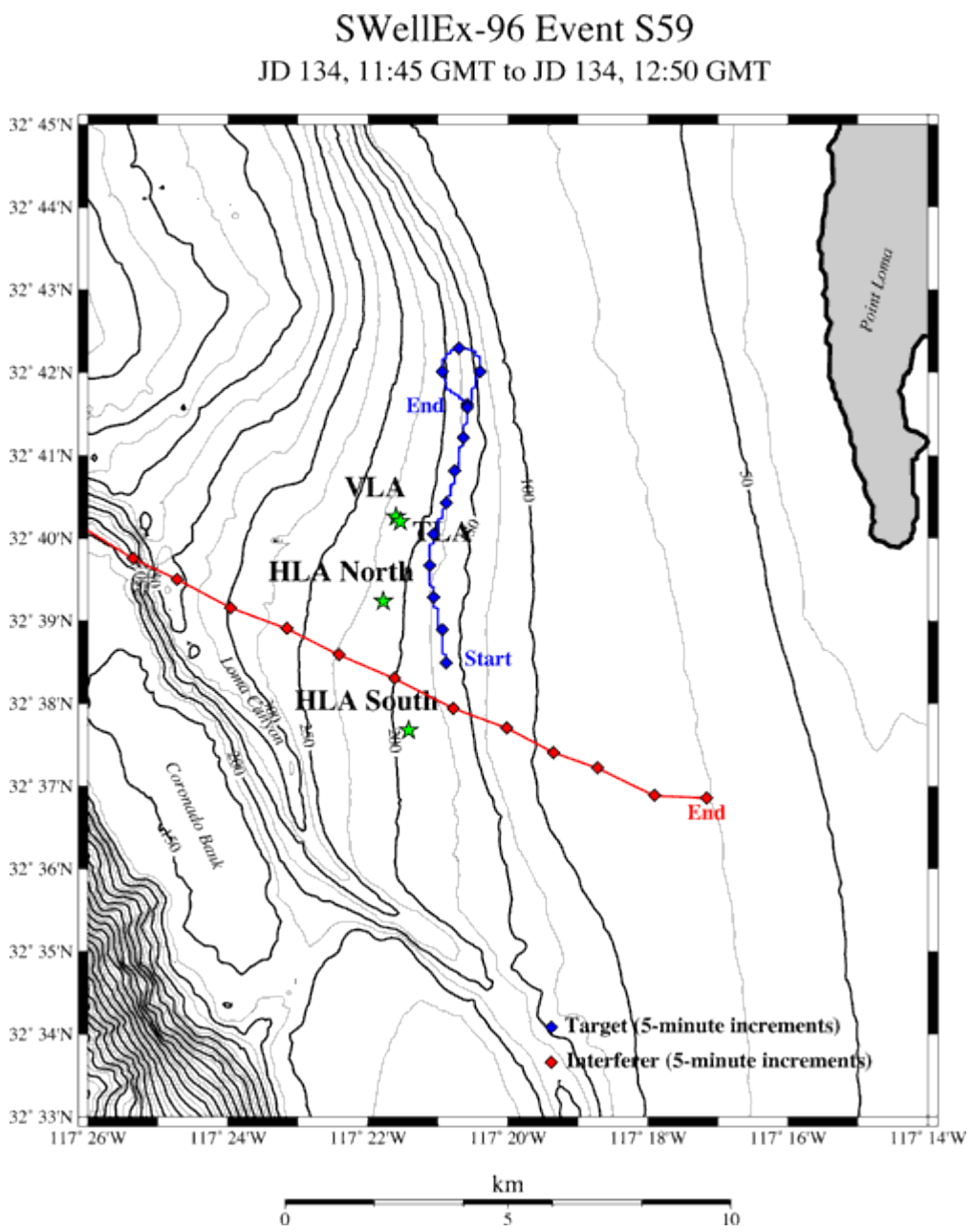
Bartlett

WNC -3dB

SBL

MUSIC

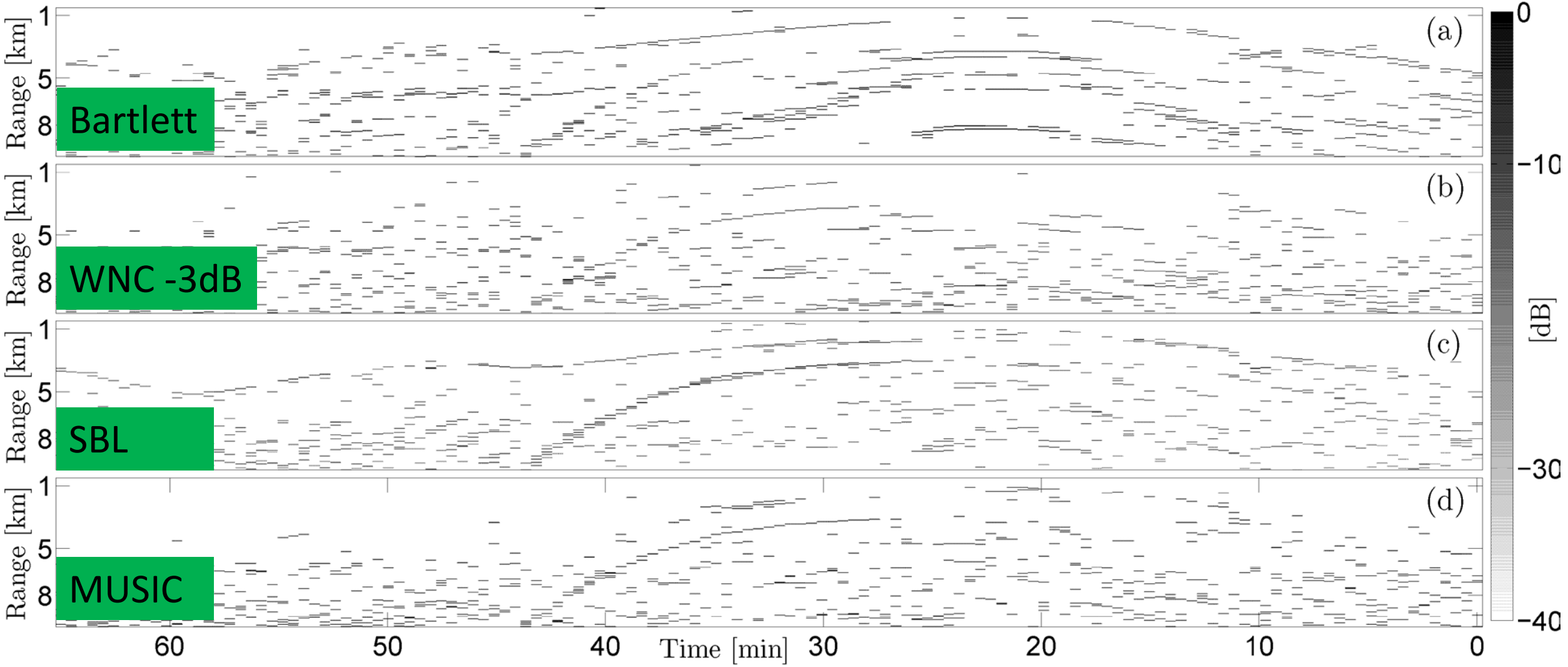


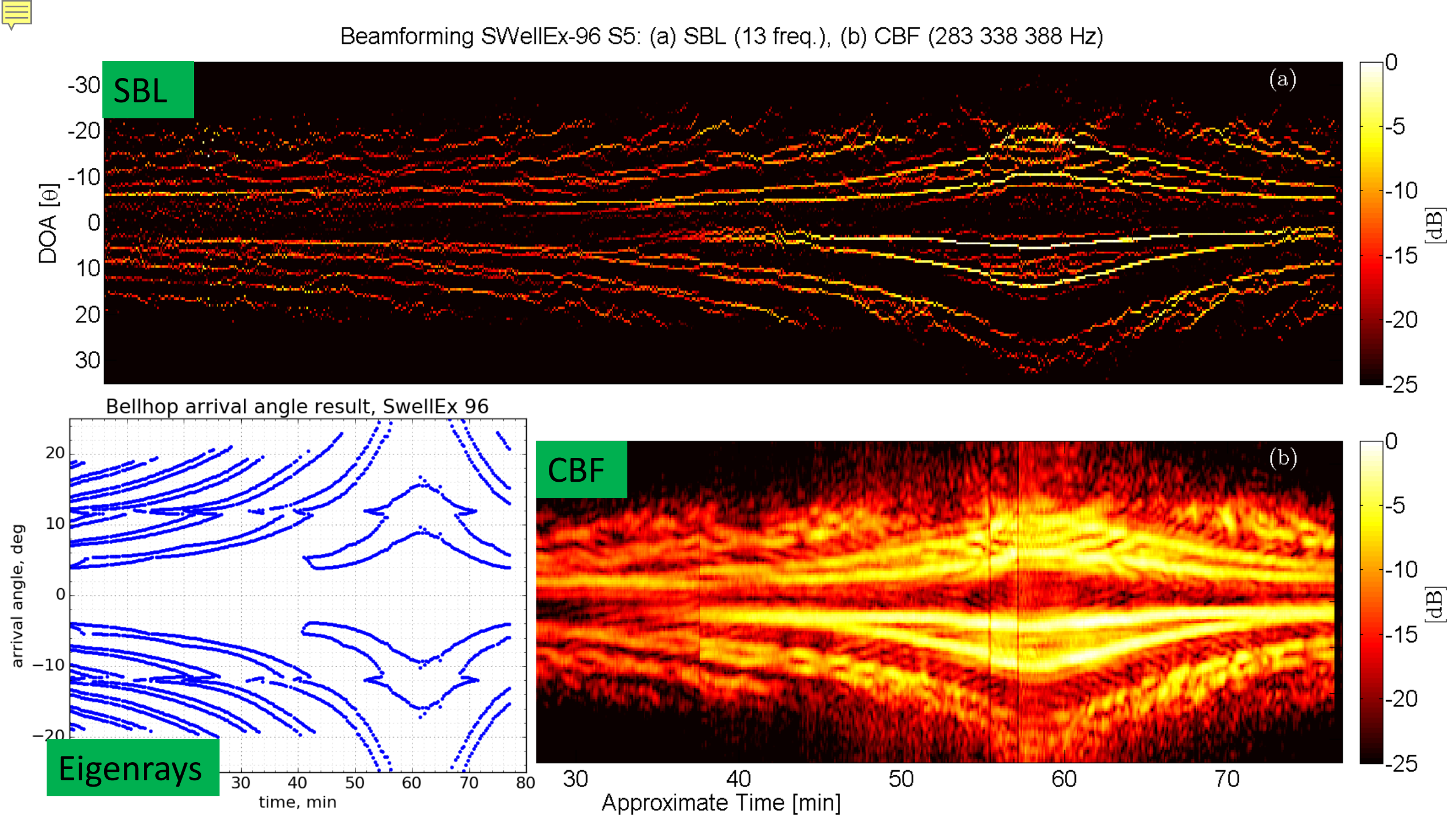


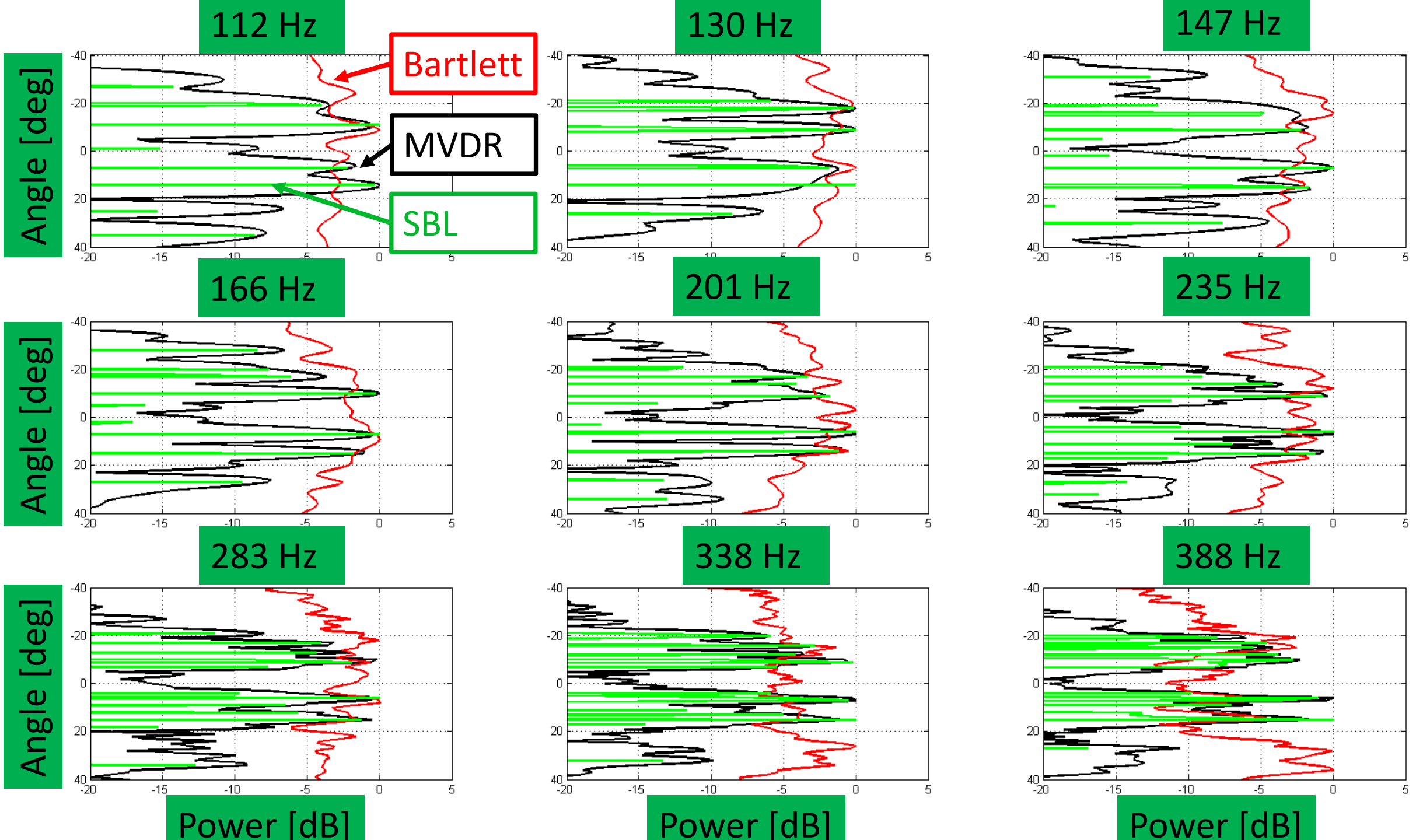
SWellEx-96 Event S59:

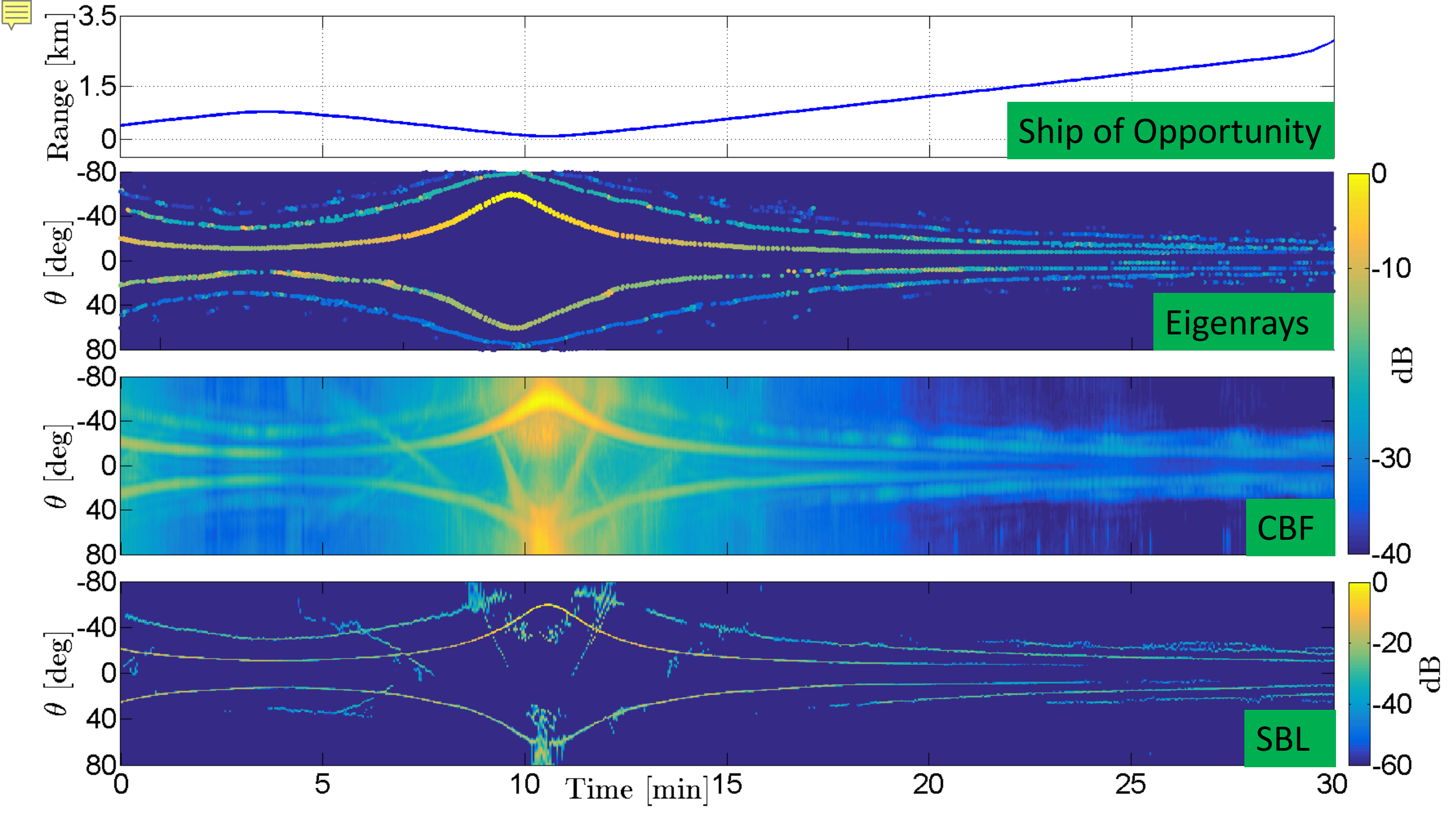
- 1 source (60 m) & 1 interferer (surface)
- 45 Processed Frequencies:
  - 166 201 Hz (top set at 158 dB)
  - Entire 2nd set (13 F at 132 dB)
  - +/- 1 bin
- FFT Length: 4096 samples
- Fs: 1500 Hz
- 21 Snapshots @ 50% overlap / segment

Event S59: Deep Source with Surface Interferer




Beamforming SWellEx-96 S5: (a) SBL (13 freq.), (b) CBF (283 338 388 Hz)
SBL
(a)
DOA [θ]
-30
-20
-10
0
10
20
30
0
-5
-10
-15
-20
-25
[dB]
Bellhop arrival angle result, SwellEx 96
arrival angle, deg
20
10
0
−10
−20
30
40
50
60
70
80
time, min
Eigenrays
CBF
(b)
30
40
50
60
70
Approximate Time [min]
0
-5
-10
-15
-20
-25
[dB]


112 Hz
130 Hz
147 Hz
166 Hz
201 Hz
235 Hz
283 Hz
338 Hz
388 Hz
Bartlett
MVDR
SBL
Angle [deg]
Angle [deg]
Angle [deg]
Power [dB]
Power [dB]
Power [dB]

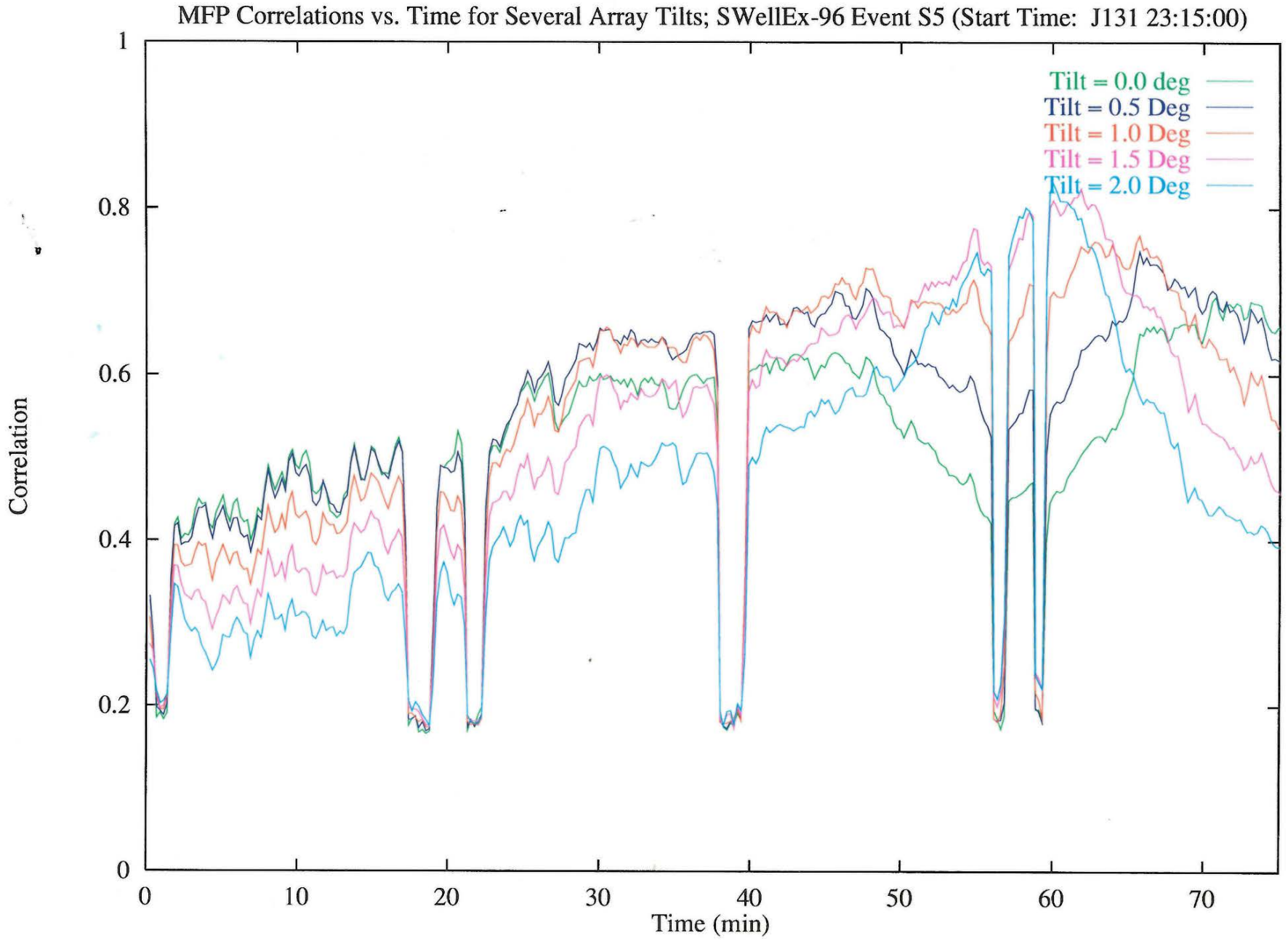

Range [km]
3.5
1.5
0
Ship of Opportunity
θ [deg]
-80
-40
0
40
80
Eigenrays
CBF
SBL
dB
0
-10
-30
-40
-20
-60
0
5
10
15
20
25
30
Time [min]

Conclusions

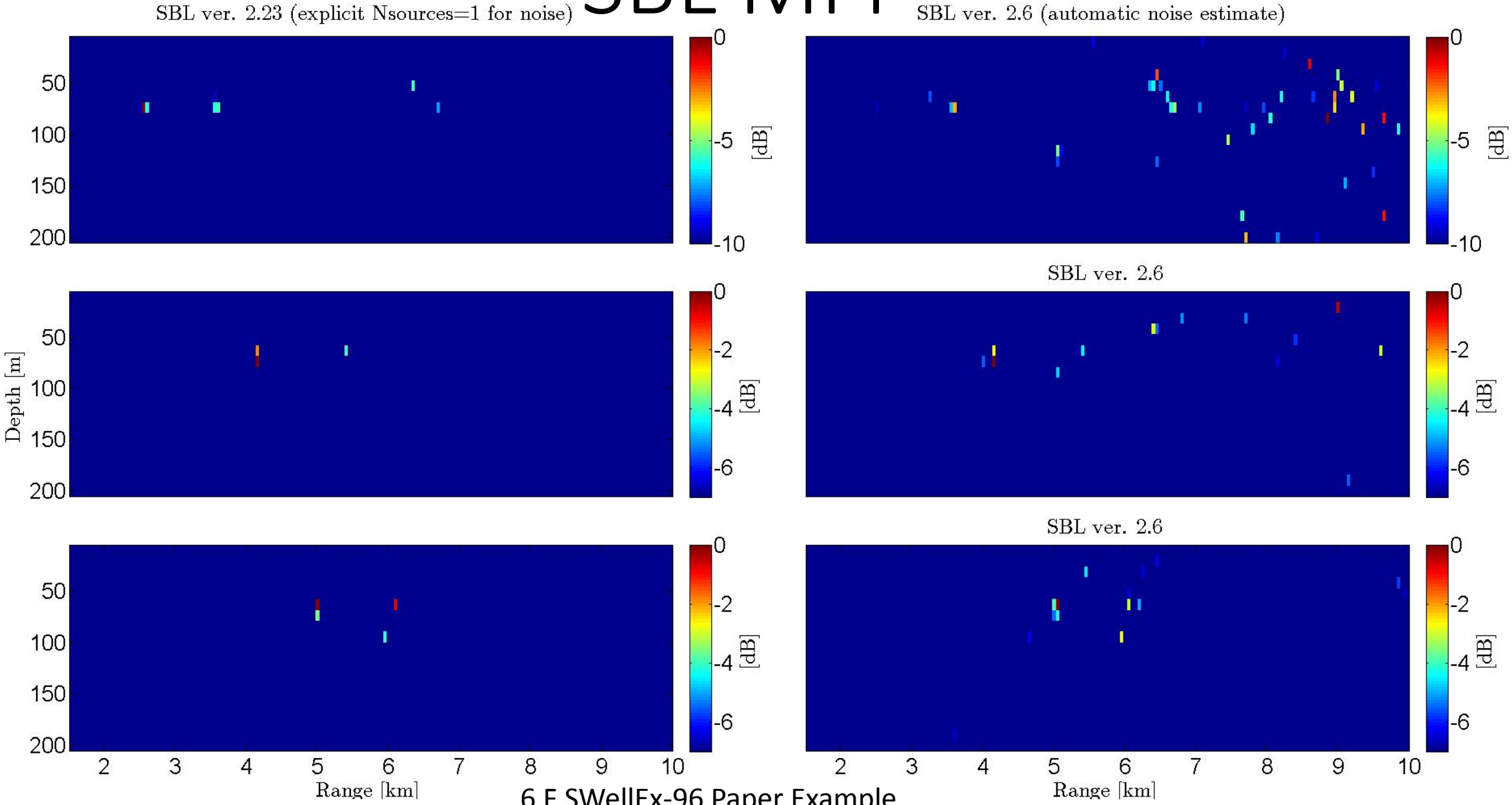
- SBL behaves similarly to an adaptive processor and can discriminate against sidelobes. For MFP, SBL performance is comparable to MUSIC.
- SBL appears robust to modest data-replica mismatch demonstrated using array-tilt. It also appears robust in situations when multiple snapshots or frequencies correspond to adjacent range-depth cells at the expense of possible additional solutions (SBL yields an ambiguity surface).
- SBL requires less tuning than Basis Pursuit and is computationally faster.
- SBL appears as a convenient tool in identifying ray arrivals.

Gemba K L, Nannuru S, Gerstoft P, and Hodgkiss W S. Multi-frequency sparse Bayesian learning for matched field processing in the presence of mismatch, J Acoust. Soc. Am., to be submitted

- End of presentation -


MFP Correlations vs. Time for Several Array Tilts; SWellEx-96 Event S5 (Start Time: J131 23:15:00)
Tilt = 0.0 deg
Tilt = 0.5 Deg
Tilt = 1.0 Deg
Tilt = 1.5 Deg
Tilt = 2.0 Deg
Correlation
Time (min)
0
0.2
0.4
0.6
0.8
1
0
10
20
30
40
50
60
70

SBL MFP



6 F SWellEx-96 Paper Example