### BROADBAND SYNTHETIC APERTURE MATCHED FIELD GEOACOUSTIC INVERSION WITH A SINGLE HYDROPHONE

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- Single source and receiver method for low SNR
- Long observation time of P LFM chirps
- Requires waveguide Doppler







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11/6/2012

## MOTIVATION

- Single source/receiver method –operationally attractive.
- To exploit frequency diversity, we use frequency-coherent MFP
- For SNR gain, we coherently exploit multiple LFMs. But method becomes Doppler intolerant.
- To rectify, waveguide Doppler and a different frequency sampling is used.
- Some applications
  - Low SNR scenarios.
  - Source level restrictions (e.g. marine wildlife, expendable sources).
  - Rapid environment assessment with AUVs.



http://www.mbari.org/auv/



#### Motivation Theory Simulation Experimental Data





### WAVEGUIDE DOPPLER

Motivation Theory Simulation Experimental Data

- 1994 Schmidt and Kuperman
  - Spectral/Modal Solution
  - Non-reciprocity



1994 Schmidt 1990 Song 1989 Pierce 1979 Hawker

2005 Weichman

### Example: 400 Hz harmonic source (KRAKEN)

# SW06 SIMULATION

LFM 100–900 Hz  $T=1 \text{ s } T_r = 1 \text{ s}$ 

 Static source/receiver
Coherently exploit P LFMs
Moving source & static receiver
Waveguide Doppler
Enhanced frequency sampling



$$\{\xi, \mathbf{x}\}_{ML} = \operatorname*{arg\,max}_{\xi, \mathbf{x}} \left[ \ln L(\xi, \mathbf{x}) \right]$$
$$= \operatorname*{arg\,min}_{\xi, \mathbf{x}} \left[ 10 \ \log_{10} \Phi(\xi, \mathbf{x}) \right]$$

where the cost function

$$\Phi(\xi, \mathbf{x}) = 1 - \frac{|\mathbf{y}^{\mathrm{H}} \tilde{\mathbf{C}}_{\mathbf{w}}^{-1} \mathbf{b}|^{2}}{\mathbf{y}^{\mathrm{H}} \tilde{\mathbf{C}}_{\mathbf{w}}^{-1} \mathbf{y} \mathbf{b}^{\mathrm{H}} \tilde{\mathbf{C}}_{\mathbf{w}}^{-1} \mathbf{b}}$$

#### Motivation Theory Simulation Experimental Data

## STATIC SOURCE / RECEIVER



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Sensitivity plots



### Monte Carlo inversion versus

- *P*=[1, 2, 4, 8, 16, 32, 64]
  - 200 noise realizations
  - □ SNR = -6 dB
  - **D** Peak frequency sampling  $\Delta f = 5$  Hz



### Motivation Theory Simulation Experimental Data



#### Motivation Theory Simulation Experimental Data

Broadband synthetic aperture matched field geoacoustic inversion with a single hydrophone. Bien Aik Tan btan@ucsd.edu 11/6/2012

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### □ Motivation □ Theory □ Simulation □ Experimental Data

- Single hydrophone broadband matched field inversion in low SNR.
- Coherently exploits multiple LFMs to increase SNR.
- Waveguide Doppler and increased frequency sampling is needed.

### CONCLUSION, QUESTIONS & ANSWERS

Thank you!



Acknowledgements:

ONR Grant No. N00014-11-0320. DSO National Laboratories of Singapore William Kuperman and Hee Chun Song Dave Ensberg



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