ONR Seabed Characterization Workshop

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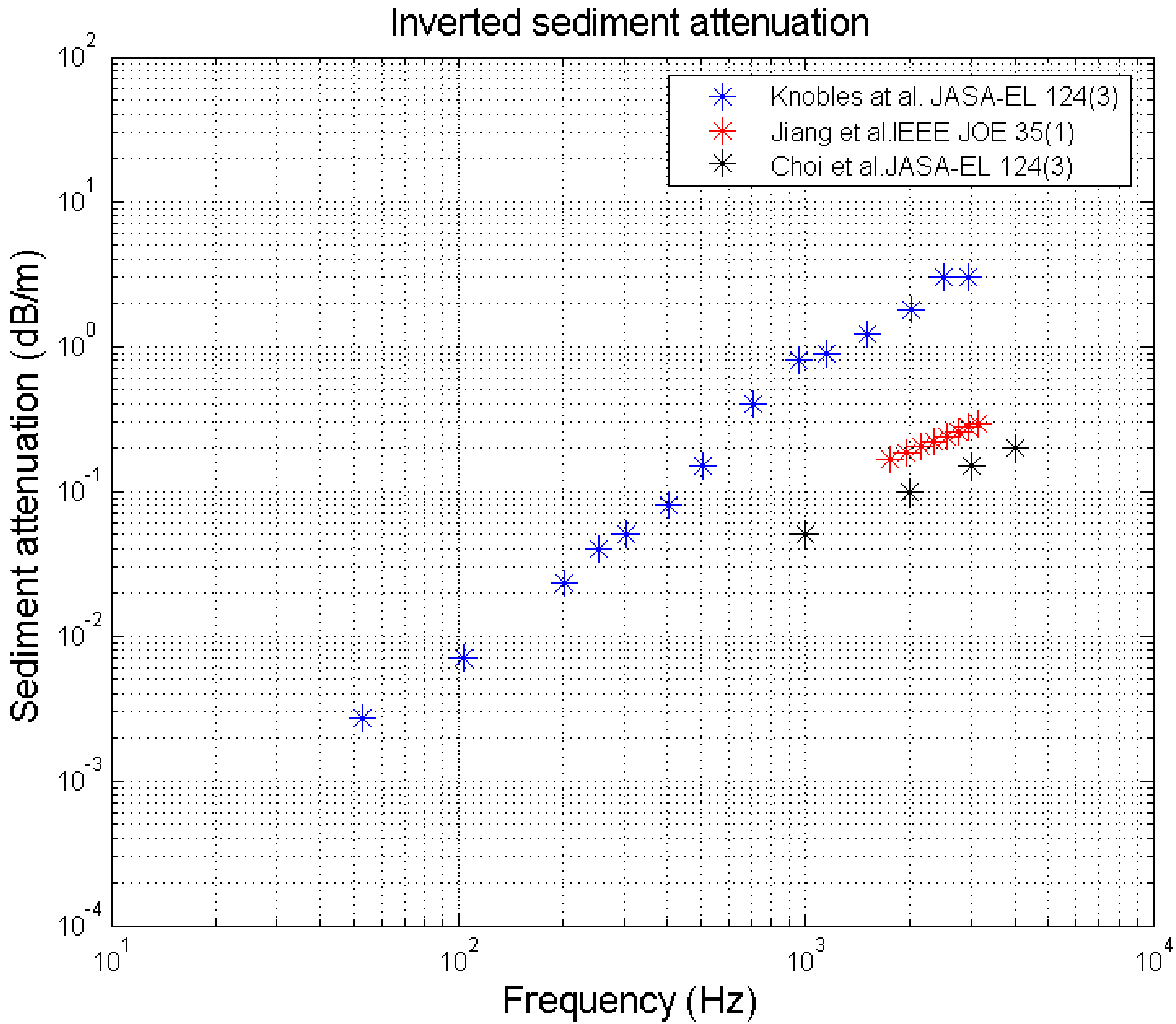
Geo-acoustic inversion results in SW06

Paper/Author	**Location**	**Water Depth**	**Range**	***f***	**Inverted results**
Knobles *et. al.* JASA-EL 124(3)	(39º 12'N, 72º 57.97'W) (39º 3.6'N, 73º 7.90'W)	~ 75m	4.7km 15-20km	50Hz-3000Hz	Sediment speed/attenuation Layer thickness
Balard *et. al.* JASA-EL 124(3)	39.0209N, 73.0497W	~ 85m	1.5-6.5km	125, 175Hz	Sediment speed
Balard *et. al.* IEEE JOE 35(1)	39.0209N, 73.0497W	~85m	Up to 6.5km	125Hz	Sediment speed, Layer thickness
Stotts et al. IEEE JOE 35(1)	(39º 12'N, 72º 57.97'W)	~ 70m	~7km	Up to 150Hz	Sediment speed Layer thickness
Potty et. al. JASA-EL 124(3)	39.09195N, 73.09303W	65-110m	~21km	20-200Hz	Sediment speed Layer thickness

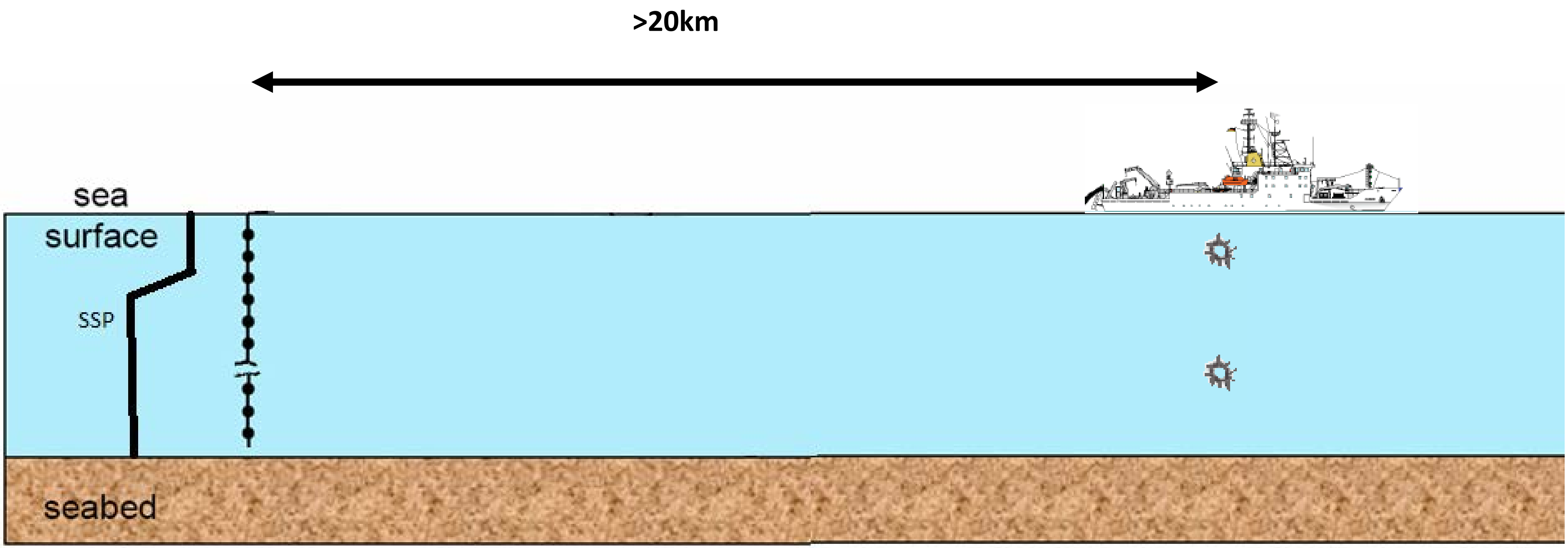
Geo-acoustic inversion results in SW06

Paper/Author	Location	Water Depth	Range	*f*	Inverted results
Jiang & Chapman JASA-EL 123(6) JASA 125(5)	39.02462N, 73.03765W	~ 80m	1,3,5km	53-703Hz	SSP, Sediment speed/attenuation Layer thickness
Jiang *et al.* JASA-EL 124(3) JASA-EL 125(4) IEEE JOE 35(1)	39.02462N, 73.03765W	~ 80m	230m	1.75kHz-3.15kHz	Sediment speed/attenuation Layer thickness
Bonnel & Chapman JASA-EL 130(2)	39.02462N, 73.03765W	~80m	~7km	Up to 200Hz	Sediment speed /density
Park et al. IEEE JOE 35(4)	39.02462N, 73.03765W	~ 80m	Circle:230m, Straight: <600m	100Hz-900Hz	Sediment speed/density Layer thickness
Yardim et al. JASA 131(2)	39.02462N, 73.03765W	I. ~ 80m II. 82~130m	I. 1.5-3.5km II. 5-18km	I. 303-953Hz II. 53-253Hz	SSP, Sediment speed/ Layer thickness
Huang et. al. JASA-EL 123(6)	39.02462N, 73.03765W	~ 80m	1 km	53-703Hz	SSP, Sediment speed Layer thickness
Choi et. al. JASA-EL 124(3)	39.02462N, 73.03765W	~80m	200m and 300m	1kHz-20kHz	Sediment speed/attenuation Layer thickness



Inverted sediment attenuation
Knobles at al. JASA-EL 124(3)
Jiang et al.IEEE JOE 35(1)
Choi et al.JASA-EL 124(3)
Sediment attenuation (dB/m)
Frequency (Hz)
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^1
10^2
10^3
10^4

Geo-acoustic inversion using long range broadband acoustic measurements



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Geo-acoustic Inversion method

a. Seabed sound speed inversion

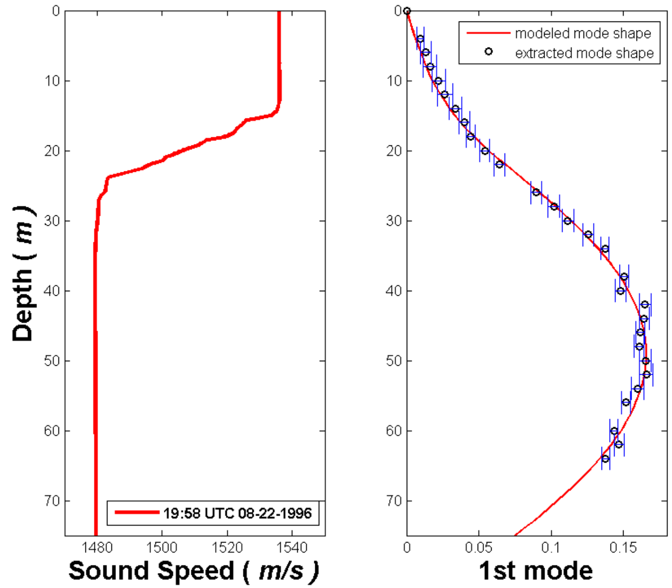
(1) normal mode depth functions
(2) modal arriving times

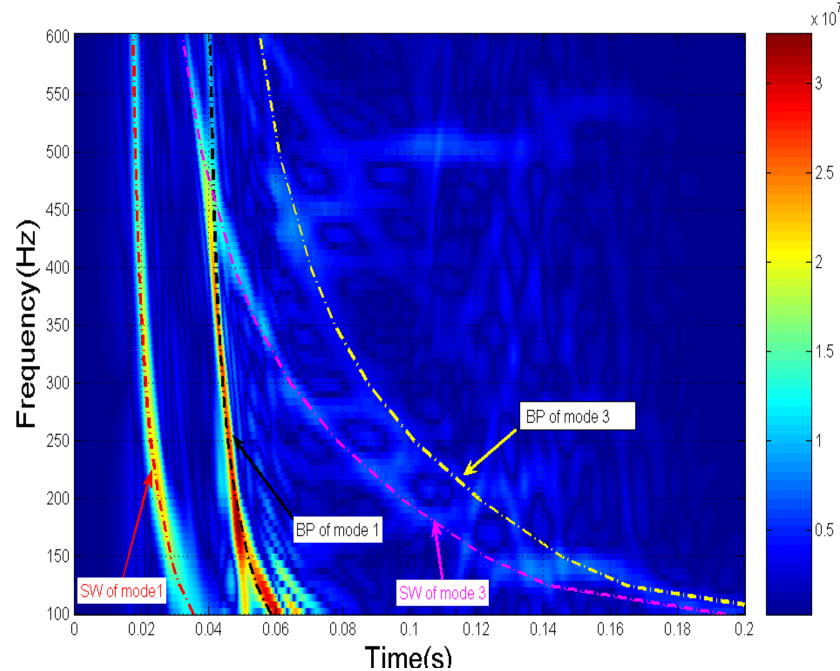
b. Seabed sound attenuation inversion

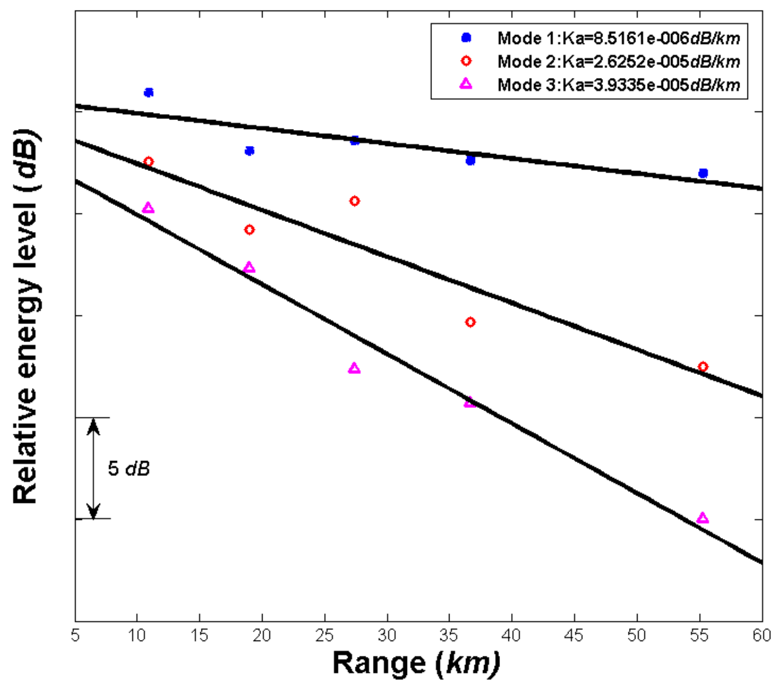
(1) modal attenuation coefficient
(2) modal amplitude ratio of higher mode to the first mode
(3) sound transmission loss
(4) vertical/horizontal longitudinal coherence of sound propagation

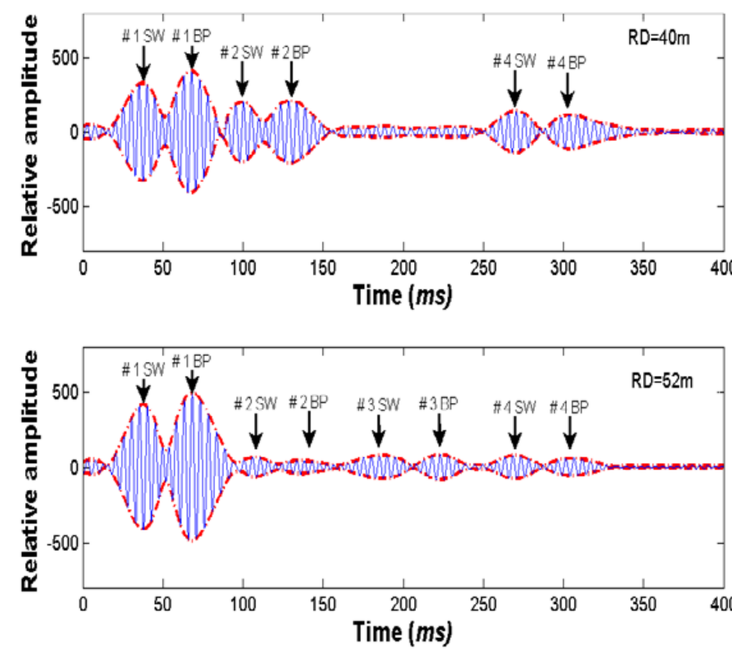
a(1), a(2), b(1), b(2) and b(3) have been successfully utilized.
(Wan, Zhou, and Rogers, 2010, JASA)

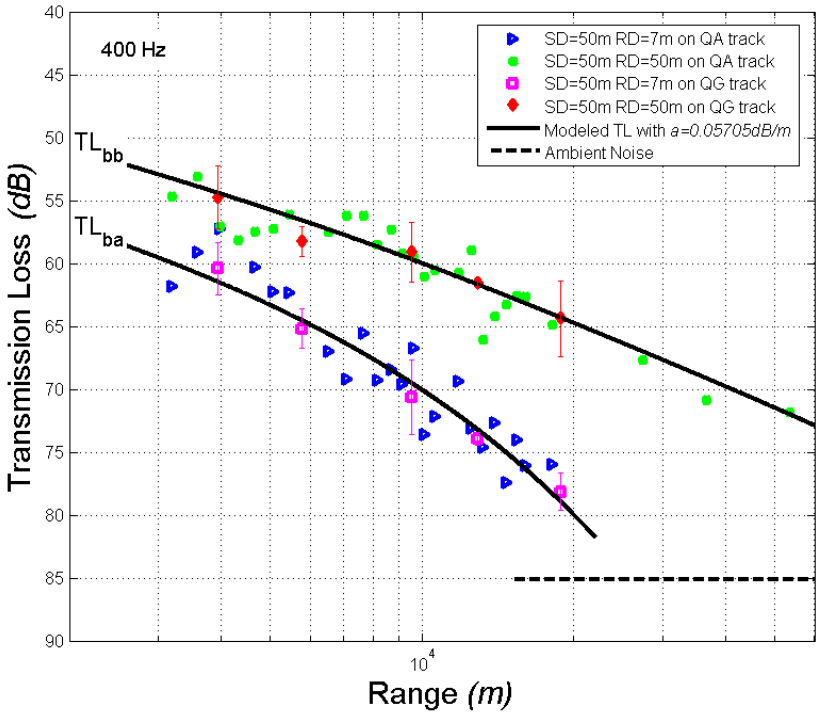
b(4) has been used to analyze the Yellow Sea data.
(Wan, Zhou, and Rogers, 2010, SWAC09)

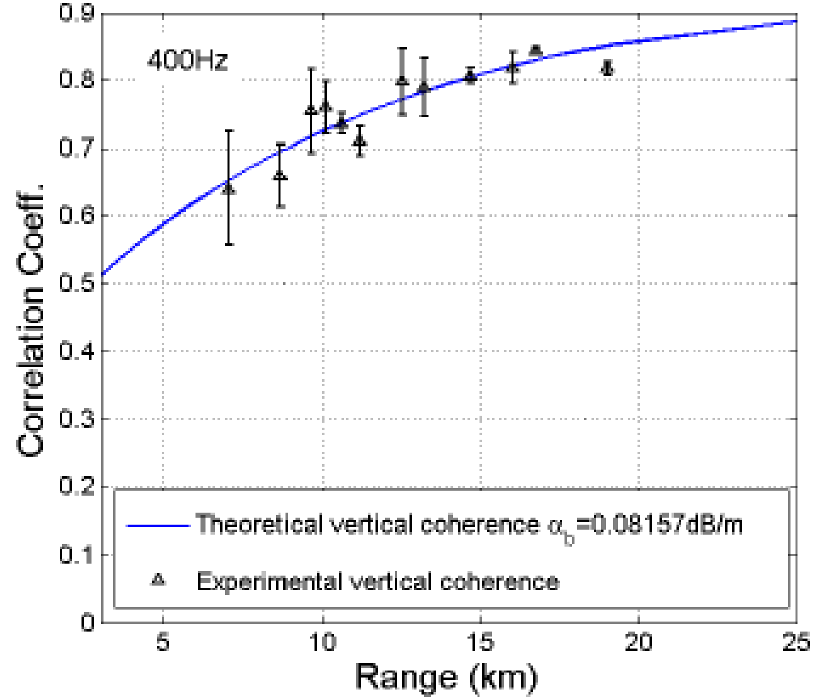

Depth (m)
Sound Speed (m/s)
19:58 UTC 08-22-1996
1st mode
modeled mode shape
extracted mode shape

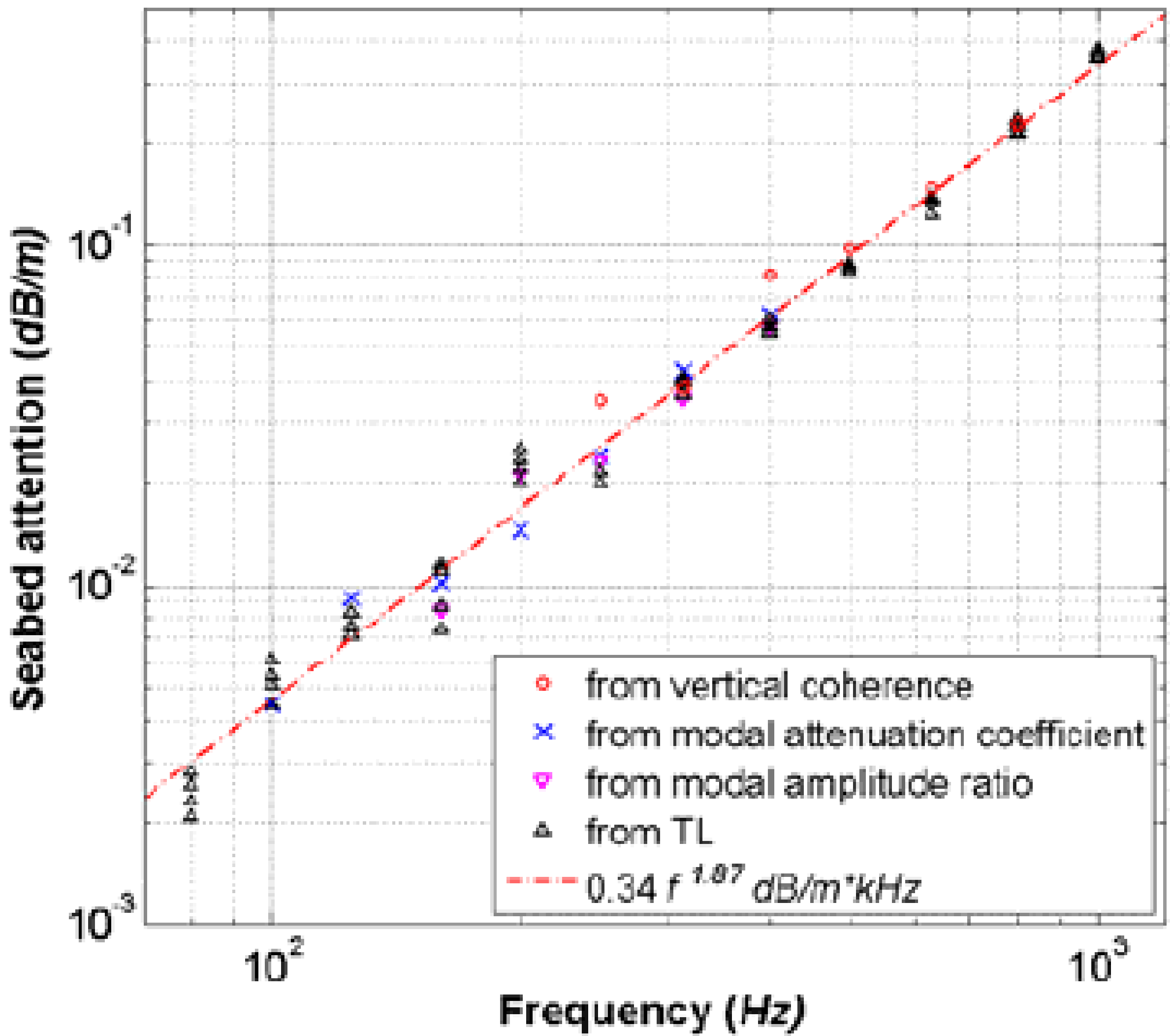

Frequency(Hz)
Time(s)
x 10^7
BP of mode 3
BP of mode 1
SW of mode1
SW of mode 3


Mode 1:Ka=8.5161e-006dB/km
Mode 2:Ka=2.6252e-005dB/km
Mode 3:Ka=3.9335e-005dB/km
Relative energy level (dB)
5 dB
Range (km)


#1 SW
#1 BP
#2 SW
#2 BP
#4 SW
#4 BP
RD=40m
Relative amplitude
Time (ms)
#1 SW
#1 BP
#2 SW
#2 BP
#3 SW
#3 BP
#4 SW
#4 BP
RD=52m
Relative amplitude
Time (ms)


400 Hz
SD=50m RD=7m on QA track
SD=50m RD=50m on QA track
SD=50m RD=7m on QG track
SD=50m RD=50m on QG track
Modeled TL with a=0.05705dB/m
Ambient Noise
TLbb
TLba
Transmission Loss (dB)
Range (m)


400Hz
Theoretical vertical coherence αb=0.08157dB/m
Experimental vertical coherence
Correlation Coeff.
Range (km)



Seabed attention (dB/m)
Frequency (Hz)
10^-1
10^-2
10^-3
10^2
10^3
from vertical coherence
from modal attenuation coefficient
from modal amplitude ratio
from TL
0.34 f 1.87 dB/m*kHz

Acoustic Source at UDel

- Air gun (5 in^3 [also available 20 in^3]:

Source Level 165 to 175 dB/micro Pa

Calibration Hydrophone @ 1m

Frequency band 30 Hz to 300 Hz

<u>Advantages:</u>

a) Very sharp pulse, provide a very good source for modal analysis

b) Compact to use, mobile, easy to use

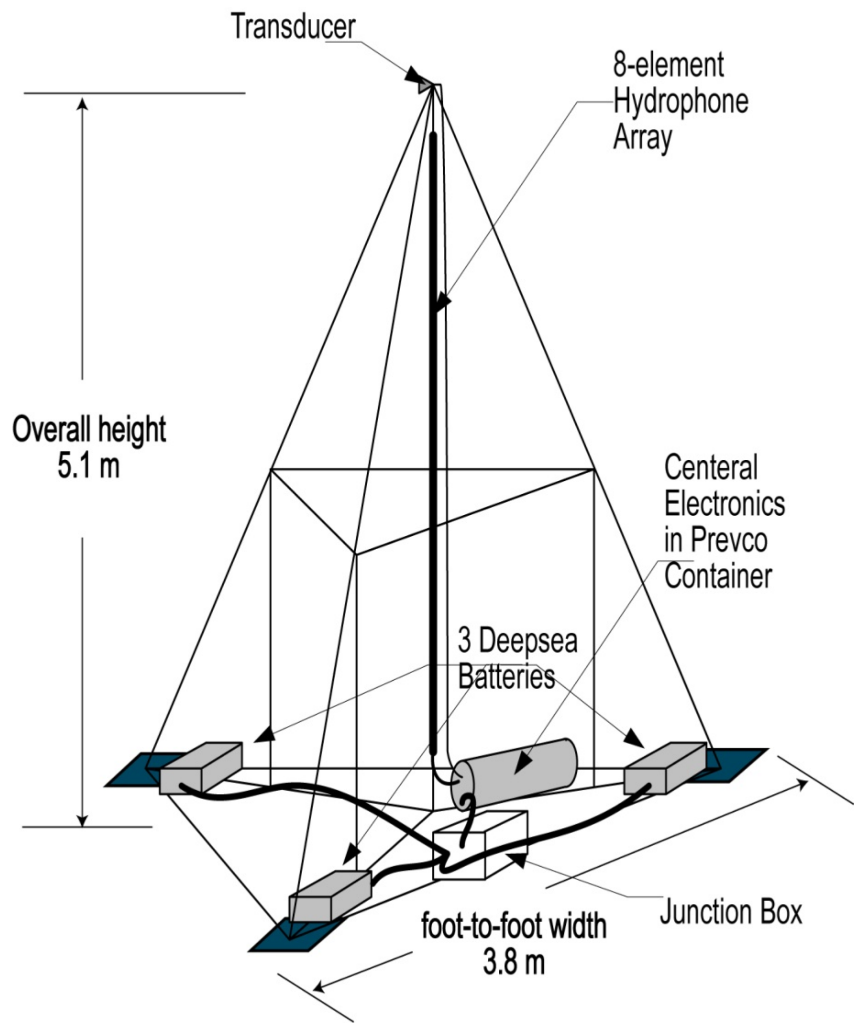
c) Available and calibrated already

<u>Disadvantage:</u>

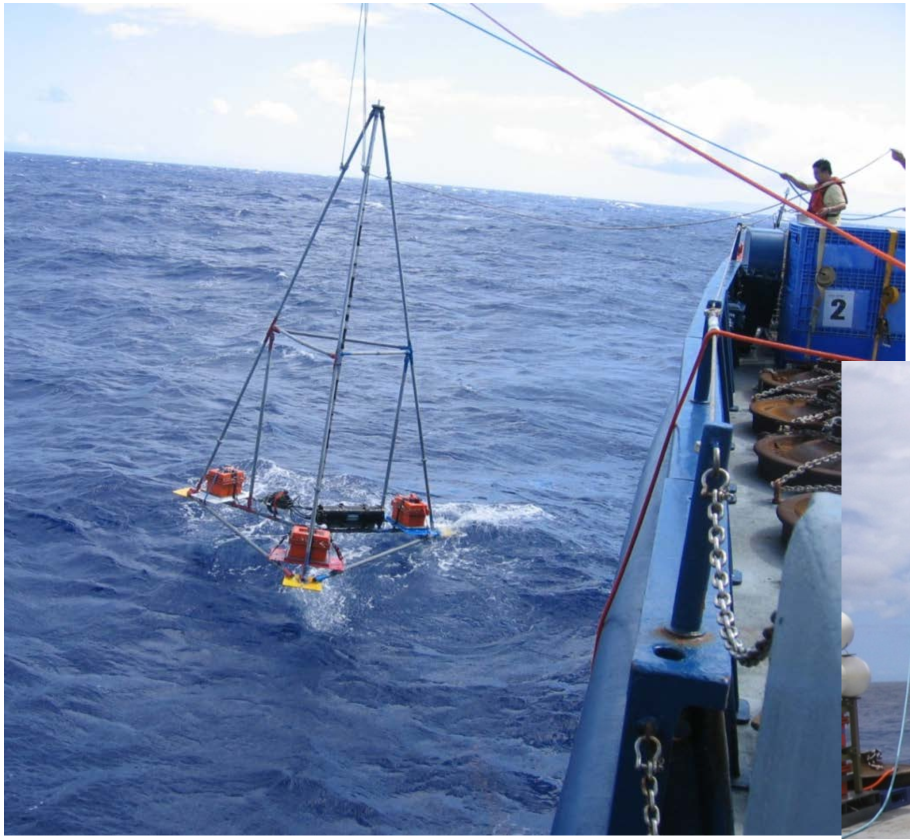
a) Need to apply for permit “soon” in advance to the experiment.

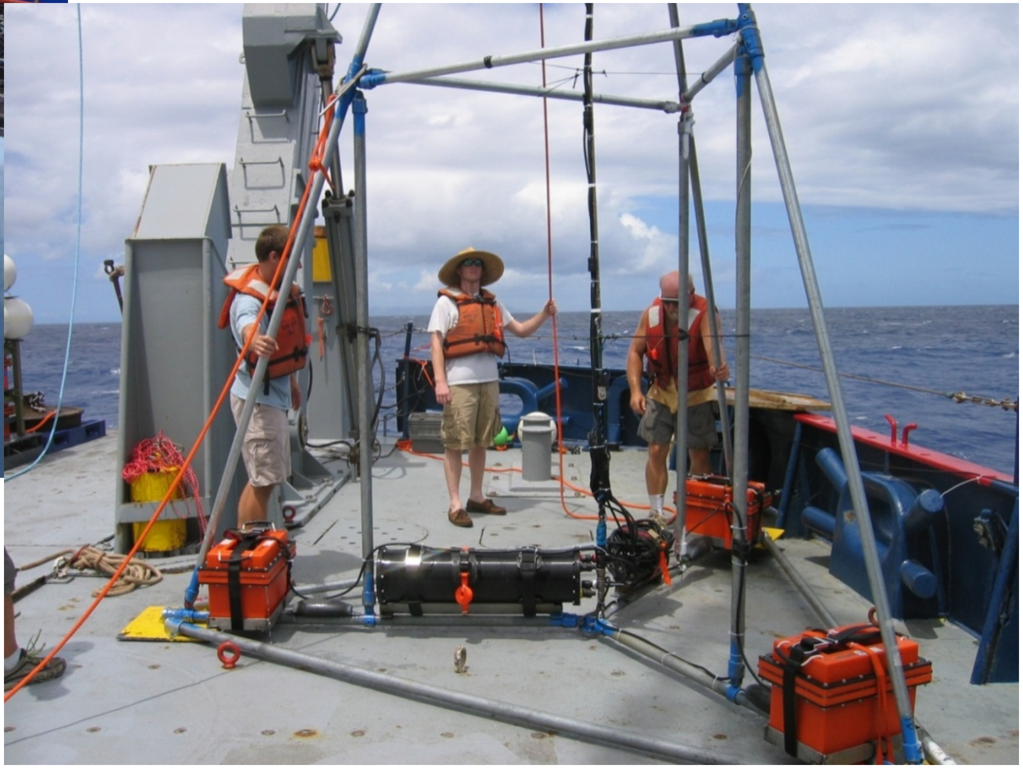
Tripod Acoustic Systems

- Tripod VLA:
  - Eight receiving elements
  - 80 kHz sampling frequency
  - ~50 hours of underwater lifetime
- Single Source
  - ITC3013 source near the top (~4 m from the sea floor)

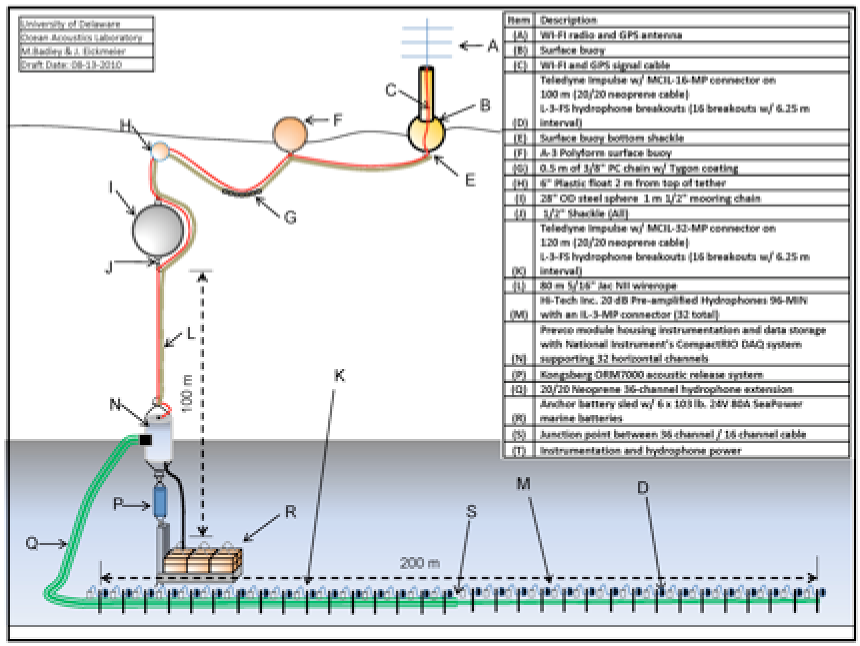


Tripod operations during KAM08

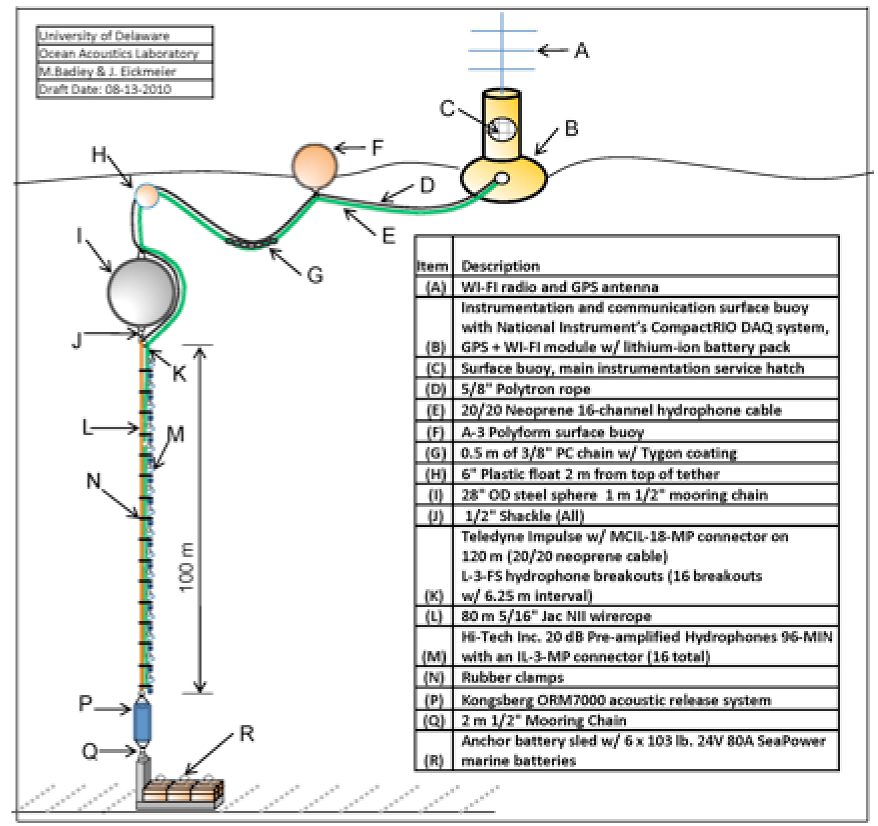




VLA and HLA



University of Delaware
Ocean Acoustics Laboratory
M.Badiey & J. Eickmeier
Draft Date: 08-13-2010
Item Description
(A) WI-FI radio and GPS antenna
(B) Surface buoy
(C) WI-FI and GPS signal cable
(D) Teledyne Impulse w/ MCIL-16-MP connector on 100 m (20/20 neoprene cable) L-3-FS hydrophone breakouts (16 breakouts w/ 6.25 m interval)
(E) Surface buoy bottom shackle
(F) A-3 Polyform surface buoy
(G) 0.5 m of 3/8" PC chain w/ Tygon coating
(H) 6" Plastic float 2 m from top of tether
(I) 28" OD steel sphere 1 m 1/2" mooring chain
(J) 1/2" Shackle (All)
(K) Teledyne Impulse w/ MCIL-32-MP connector on 120 m (20/20 neoprene cable) L-3-FS hydrophone breakouts (16 breakouts w/ 6.25 m interval)
(L) 80 m 5/16" Jac NII wirerope
(M) Hi-Tech Inc. 20 dB Pre-amplified Hydrophones 96-MIN with an IL-3-MP connector (32 total)
(N) Prevco module housing instrumentation and data storage with National Instrument's CompactRIO DAQ system supporting 32 horizontal channels
(P) Kongsberg ORM7000 acoustic release system
(Q) 20/20 Neoprene 36-channel hydrophone extension
(R) Anchor battery sled w/ 6 x 103 lb. 24V 80A SeaPower marine batteries
(S) Junction point between 36 channel / 16 channel cable
(T) Instrumentation and hydrophone power
100 m
200 m



University of Delaware
Ocean Acoustics Laboratory
M.Badiey & J. Eickmeier
Draft Date: 08-13-2010
Item Description
(A) WI-FI radio and GPS antenna
(B) Instrumentation and communication surface buoy with National Instrument's CompactRIO DAQ system, GPS + WI-FI module w/ lithium-ion battery pack
(C) Surface buoy, main instrumentation service hatch
(D) 5/8" Polytron rope
(E) 20/20 Neoprene 16-channel hydrophone cable
(F) A-3 Polyform surface buoy
(G) 0.5 m of 3/8" PC chain w/ Tygon coating
(H) 6" Plastic float 2 m from top of tether
(I) 28" OD steel sphere 1 m 1/2" mooring chain
(J) 1/2" Shackle (All)
(K) Teledyne Impulse w/ MCIL-18-MP connector on 120 m (20/20 neoprene cable) L-3-FS hydrophone breakouts (16 breakouts w/ 6.25 m interval)
(L) 80 m 5/16" Jac NII wirerope
(M) Hi-Tech Inc. 20 dB Pre-amplified Hydrophones 96-MIN with an IL-3-MP connector (16 total)
(N) Rubber clamps
(P) Kongsberg ORM7000 acoustic release system
(Q) 2 m 1/2" Mooring Chain
(R) Anchor battery sled w/ 6 x 103 lb. 24V 80A SeaPower marine batteries
100 m