Agenda

Tuesday, 16 March

0900-1000 (all times approximate!)
- **Workshop logistics**
- **Workshop goals**
- **Brief background on SAX99 and SAX04**

1000, break, room will be divided
1015, resume as two groups

Agenda for SAX04 component:
1015-1200
- **SAX04 Updates**
- **Environmental Assessment**
- **Begin discussion of SAX04 timeline**

Agenda

Tuesday, 16 March

1200-1300 lunch
1300-1400 bus tour to view portion of APL-UW rail system

Agenda for SAX04 component:
1400-1700
- **SAX04 timeline (cont.)**
- **Logistics at NSWC-PC**

1830 Cash bar at Portage Bay Café
1900 Dinner at Portage Bay Café

Agenda

Wednesday, 17 March

0900-1000
- **Tom Drake, report on Ripples DRI**
- **Kerry Commander, remarks on logistics at NSWC-PC**
- **Jerry Caruthers, side-scan sonar survey**

1000-1015, break
1015-1140, Begin revisiting topics as combined group
- **Environmental assessment (very briefly)**
- **R/V Pelican schedule**
- **SAX04 & Ripples DRI timeline**
- **Logistics at NSWC-PC**

1140-1200, Science break
- **Anatoliy Ivakin, Discrete scattering**

Agenda

Wednesday, 17 March

1200-1300, lunch

1300-1700
Continue topics as combined group

- **R/V Pelican schedule**
- **SAX04 & Ripples DRI timeline**
- **Logistics at NSWC-PC**

Workshop Goals

- R/V Pelican schedule
- SAX04 & Ripples DRI timeline
- Logistics at NSWC-PC

Agenda

Tuesday, 16 March

0900-1000 (all times approximate!)
- **Workshop logistics**
- **Workshop goals**
- **Brief background on SAX99 and SAX04**

1000, break, room will be divided
1015, resume as two groups

Agenda for SAX04 component:
1015-1200
- **SAX04 Updates**
- **Environmental Assessment**
- **Begin discussion of SAX04 timeline**

Sediment Acoustics Experiment (SAX99)

Part of
High Frequency Sediment Acoustics DRI
(FY98-02)

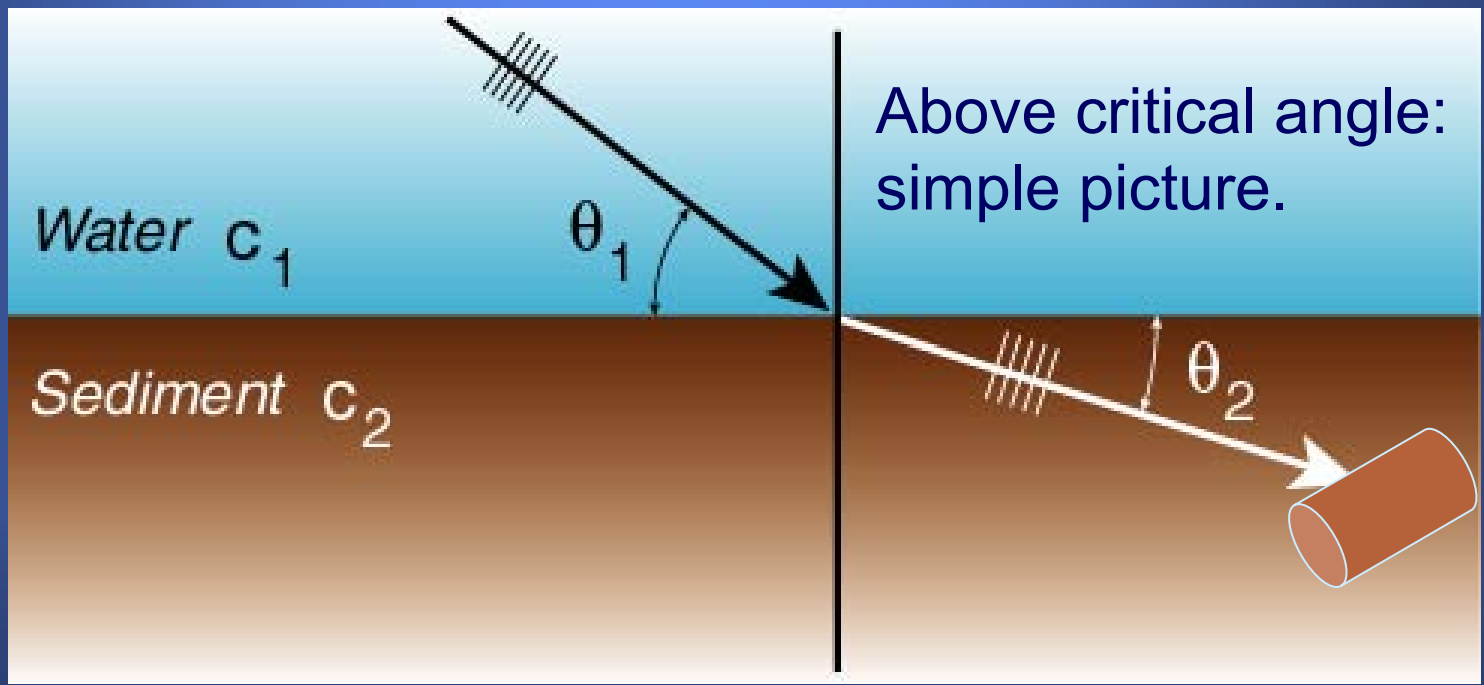
Motivation: Better understand acoustic processes associated with detection of buried mines in sandy sediments

Frequency: 10 – 300 kHz

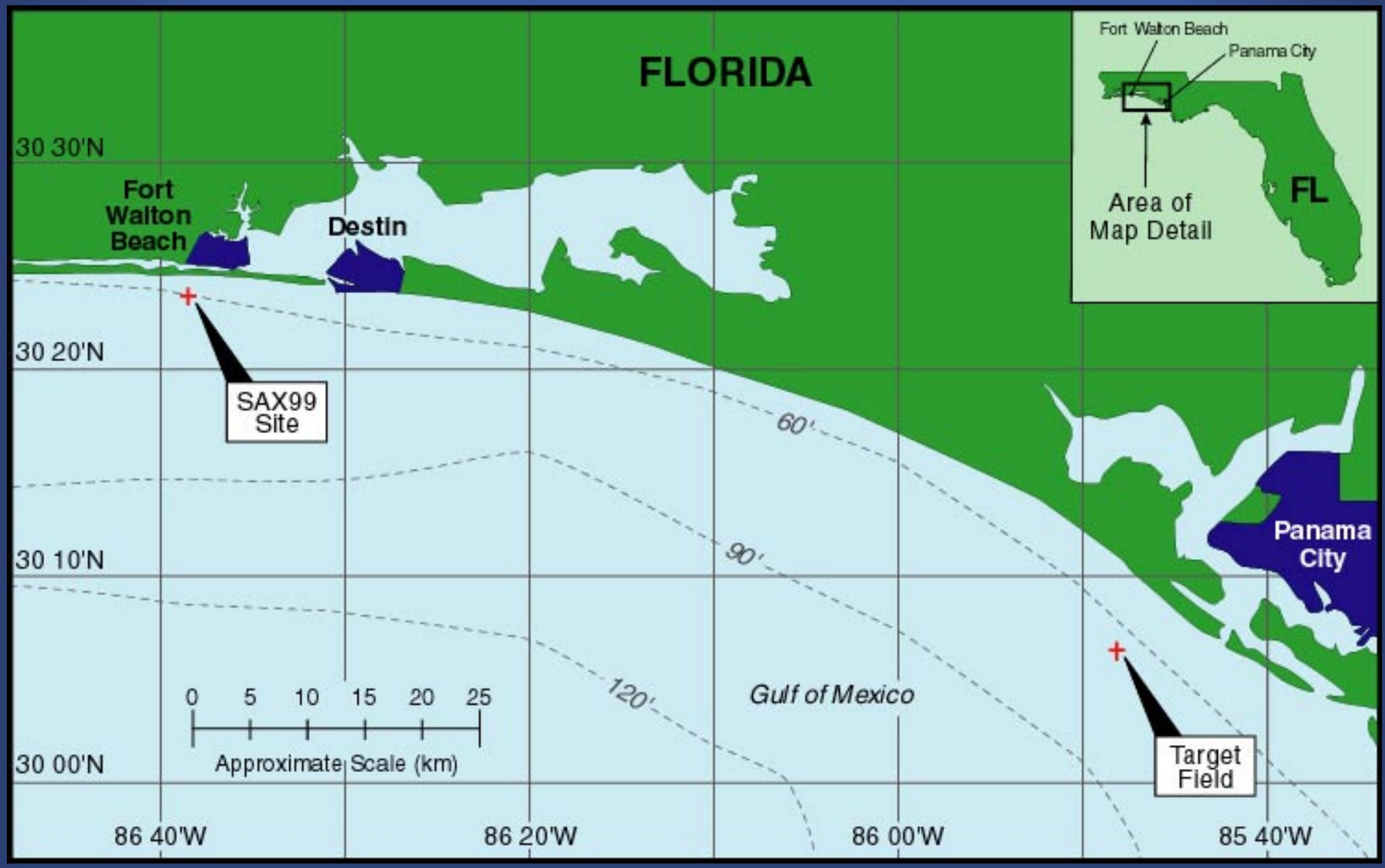
Detection of Mines Buried in Sand

- Understanding shallow grazing angle detection of buried mines requires knowledge of the penetration into, propagation within, and scattering from sand sediments

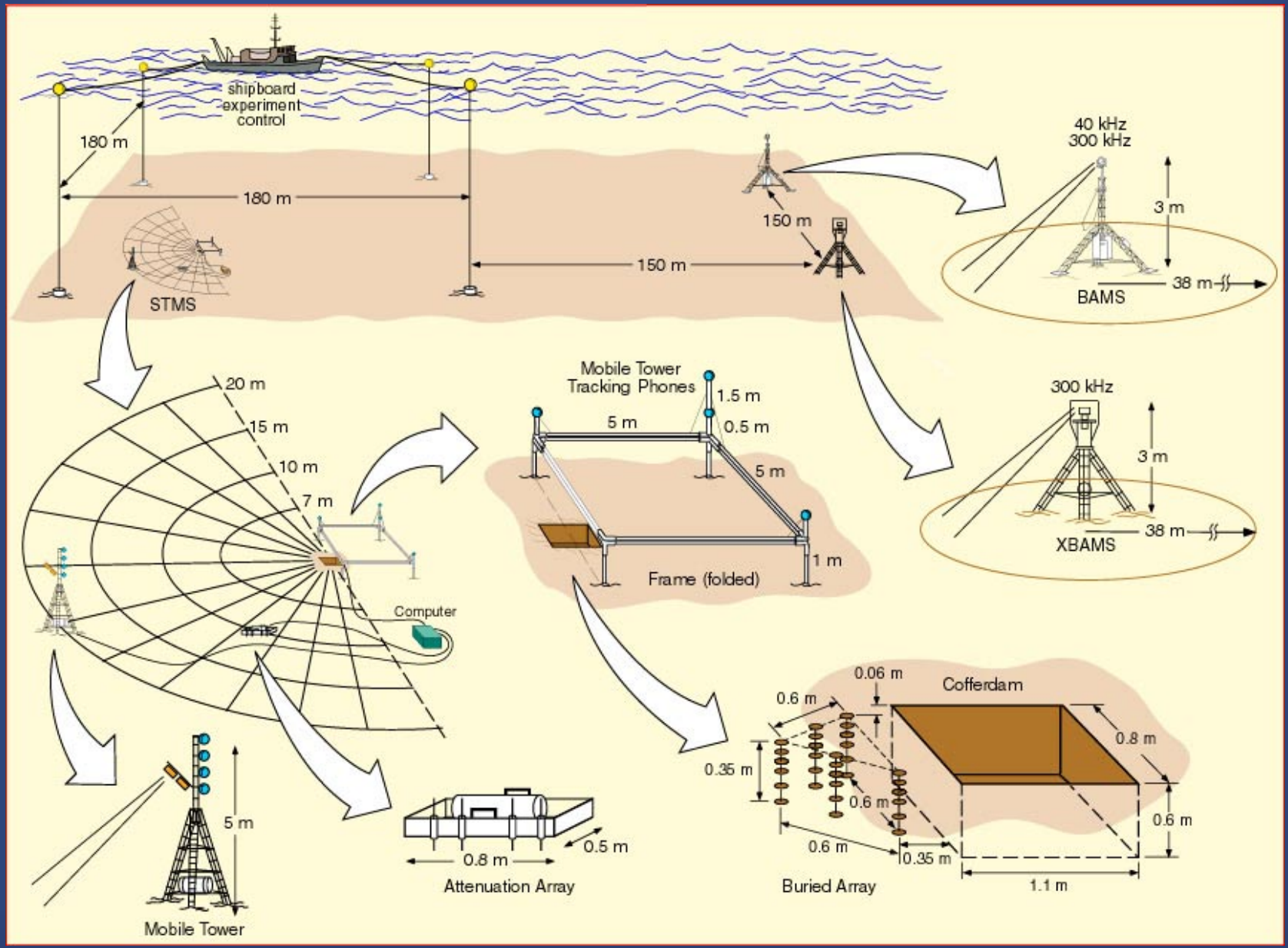
Signal = Penetrate/Propagate/Target/Propagate/Penetrate
Noise = Scatter from Sediment



Site of SAX99



APL-UW Measurements at SAX99

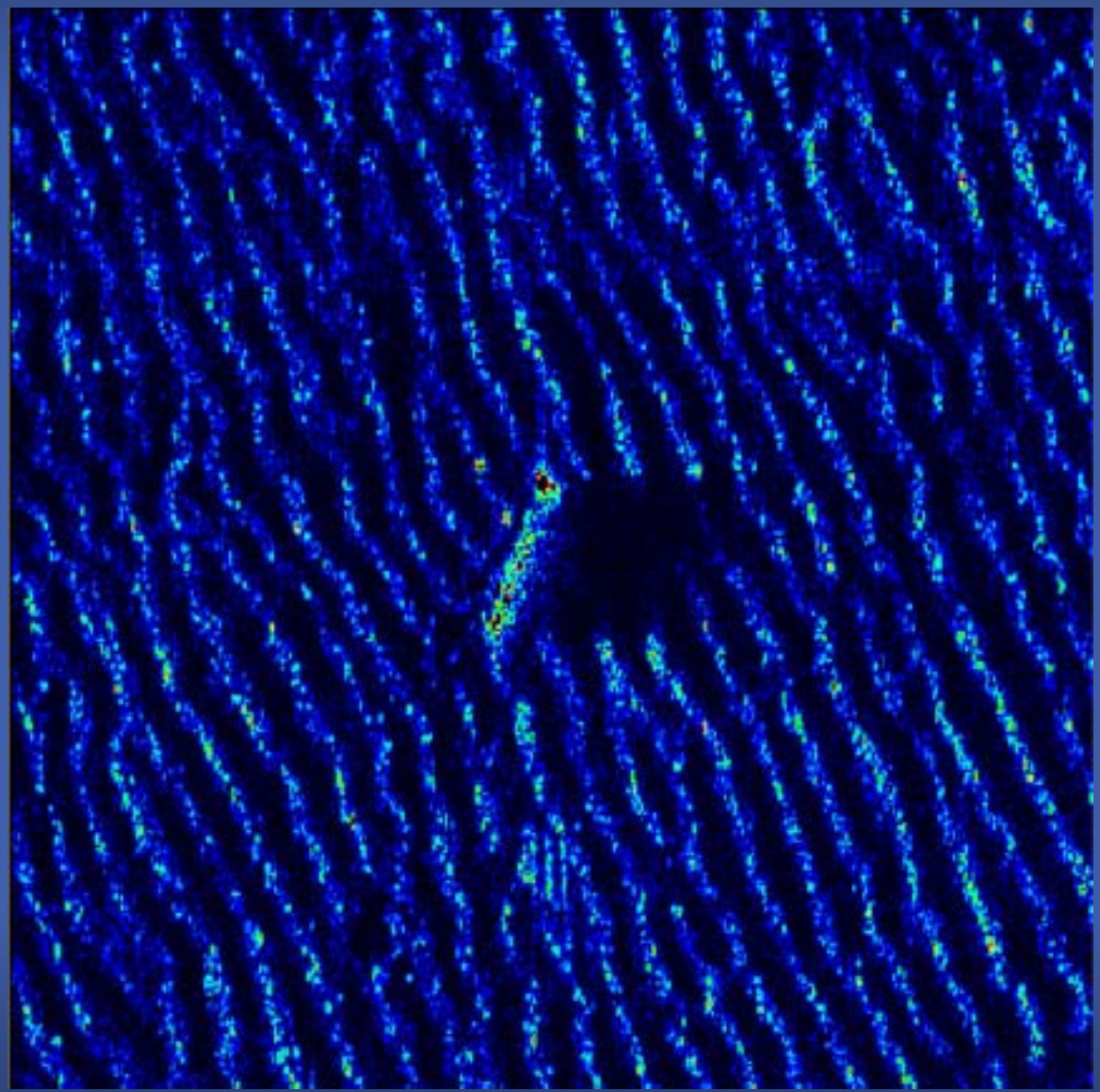


Diver Inserting Hydrophones Through Cofferdam

QuickTime™ and a
Sorenson Video decompressor
are needed to see this picture.

SAS Image of Proud Target

SAX99 Site

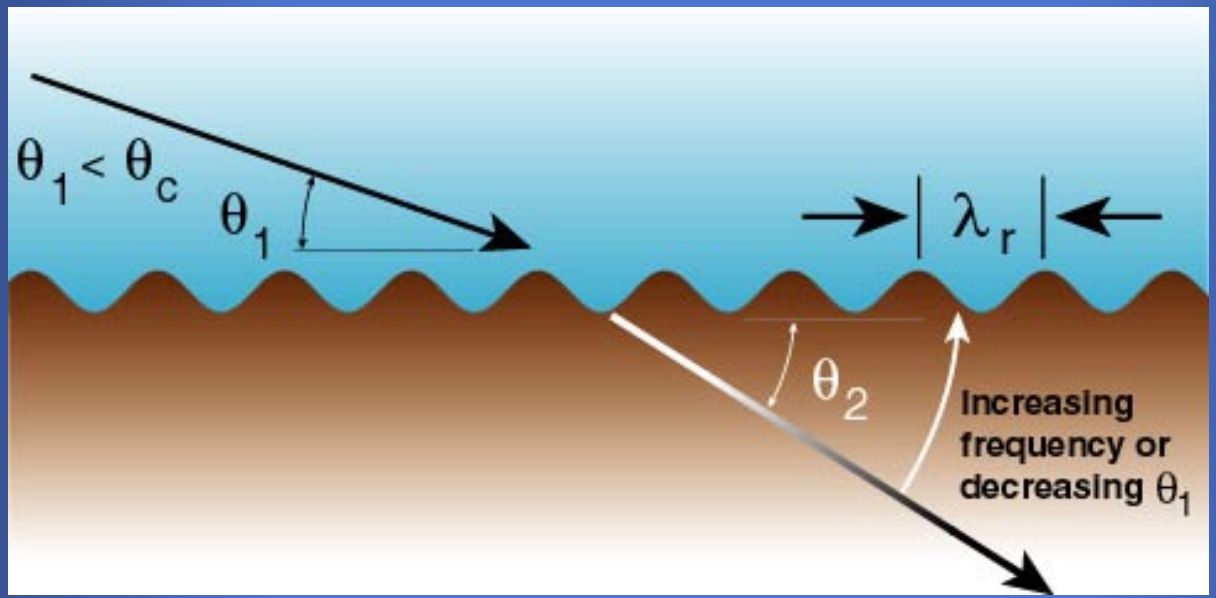


9 m × 9 m

CSS Image, 180 Hz

Dominant Subcritical Penetration Mechanism

Data/model comparisons indicate that the dominant mechanism is scattering due to sand ripples.

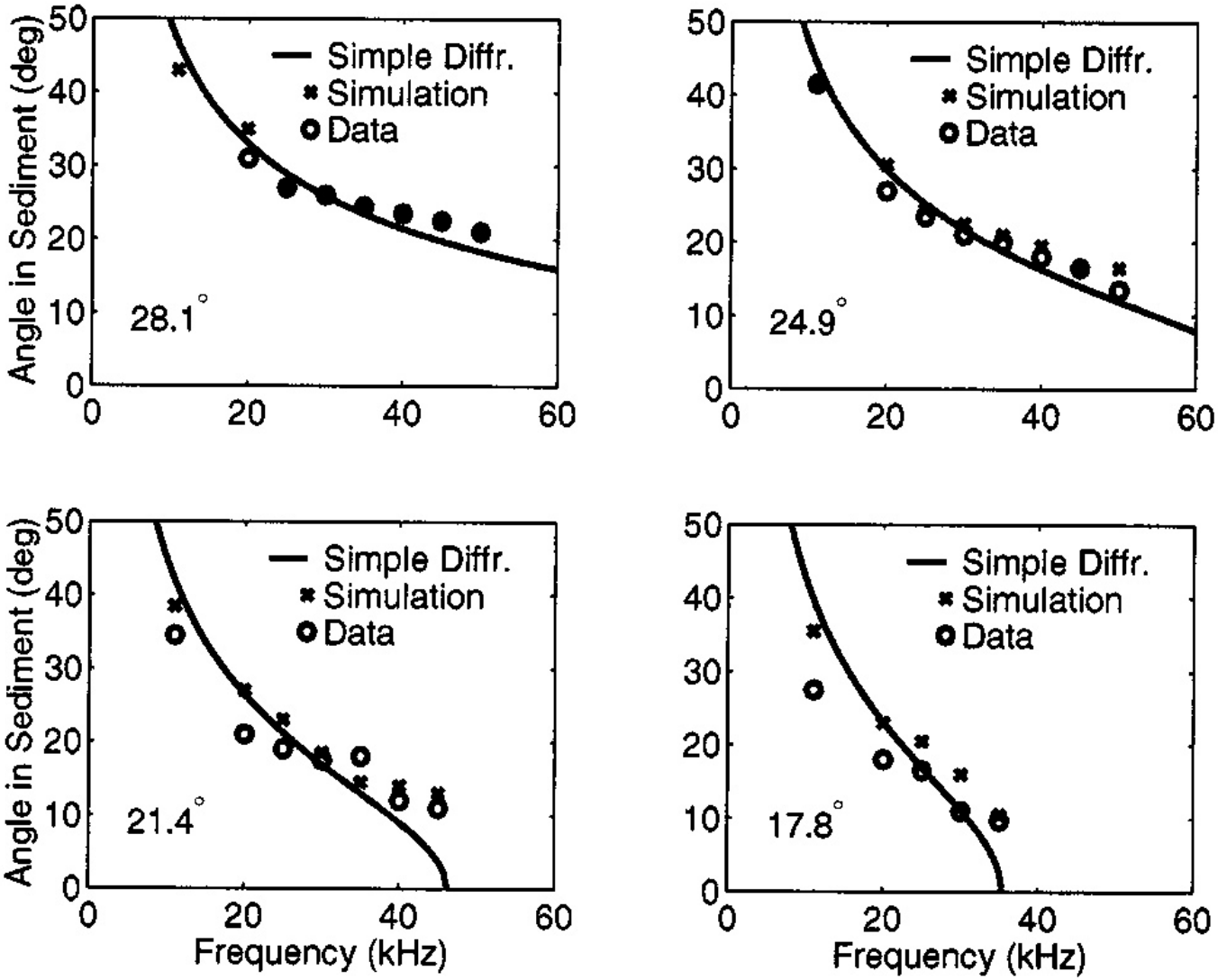


First order perturbation theory gives

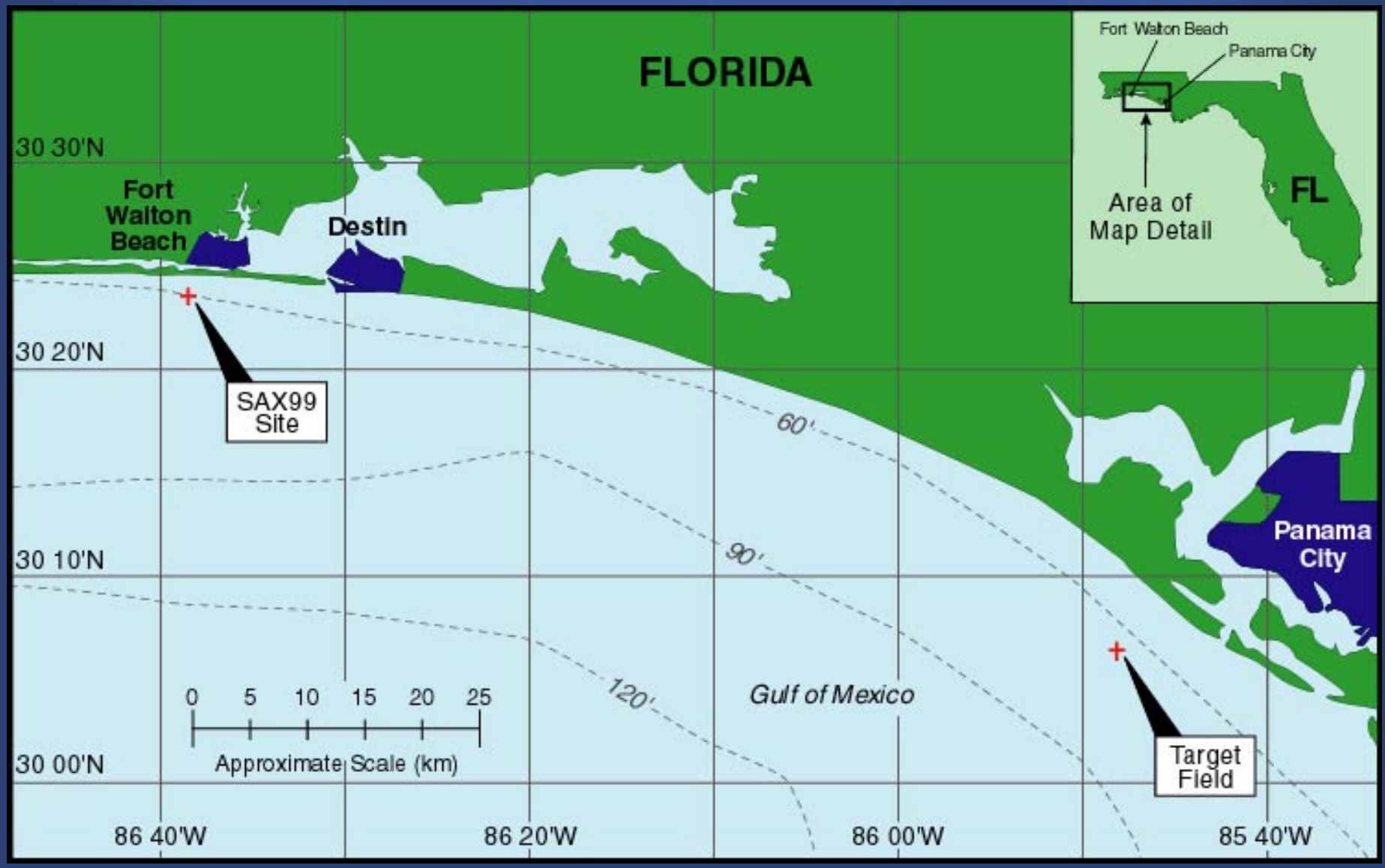
$$\cos \theta_2 = (c_2 / c_1) (\cos \theta_1 - \lambda_1 / \lambda_r).$$

For a given ripple wavelength, there will be a cut-off frequency, above which lowest-order scattering will not occur.

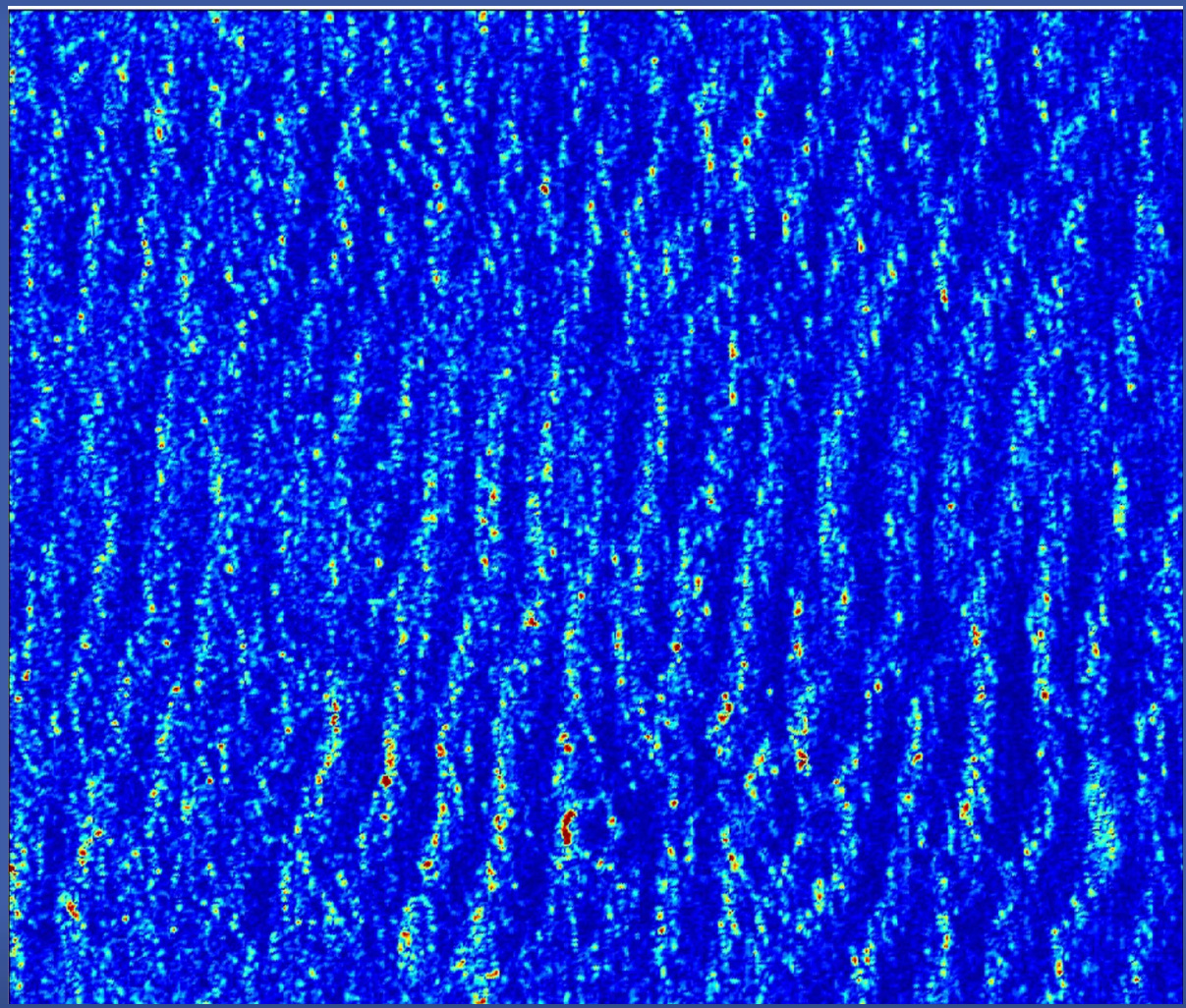
Transmission Across Water/Sand Interface at Shallow Grazing Angles



Site of SAX99



SAS Image of Ripple Field
Target Field Site



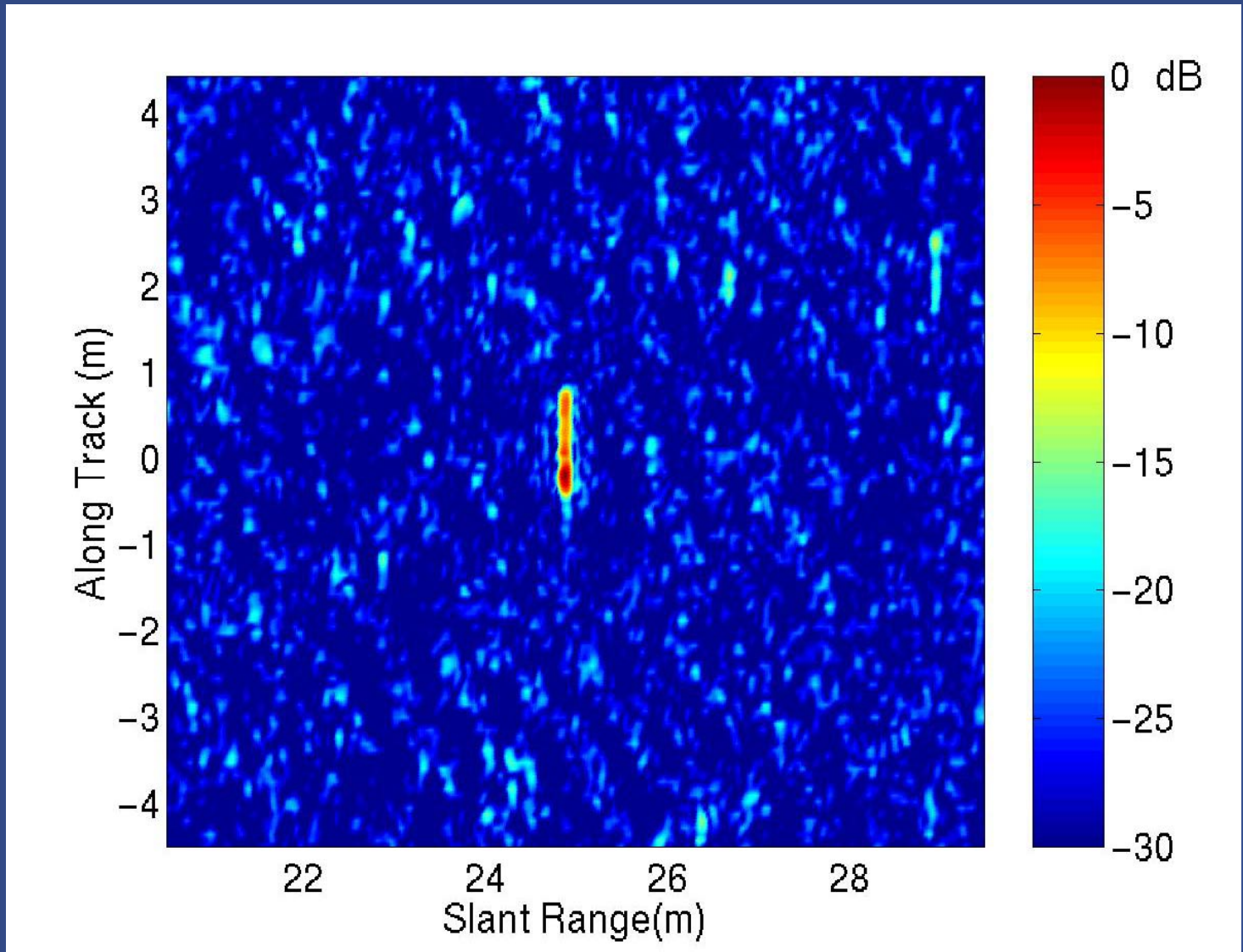
9 m × 9 m

CSS Image, 180 kHz

Target Field Site

- Average ripple wavelength: ~70 cm
- At 20 kHz first-order scattered field evanescent (cutoff) for grazing angles < 13°
- Suggests ripple field not favorable for low grazing angle detections of buried targets using 20 kHz SAS system

CSS SAS Image of Buried Target at 20 kHz



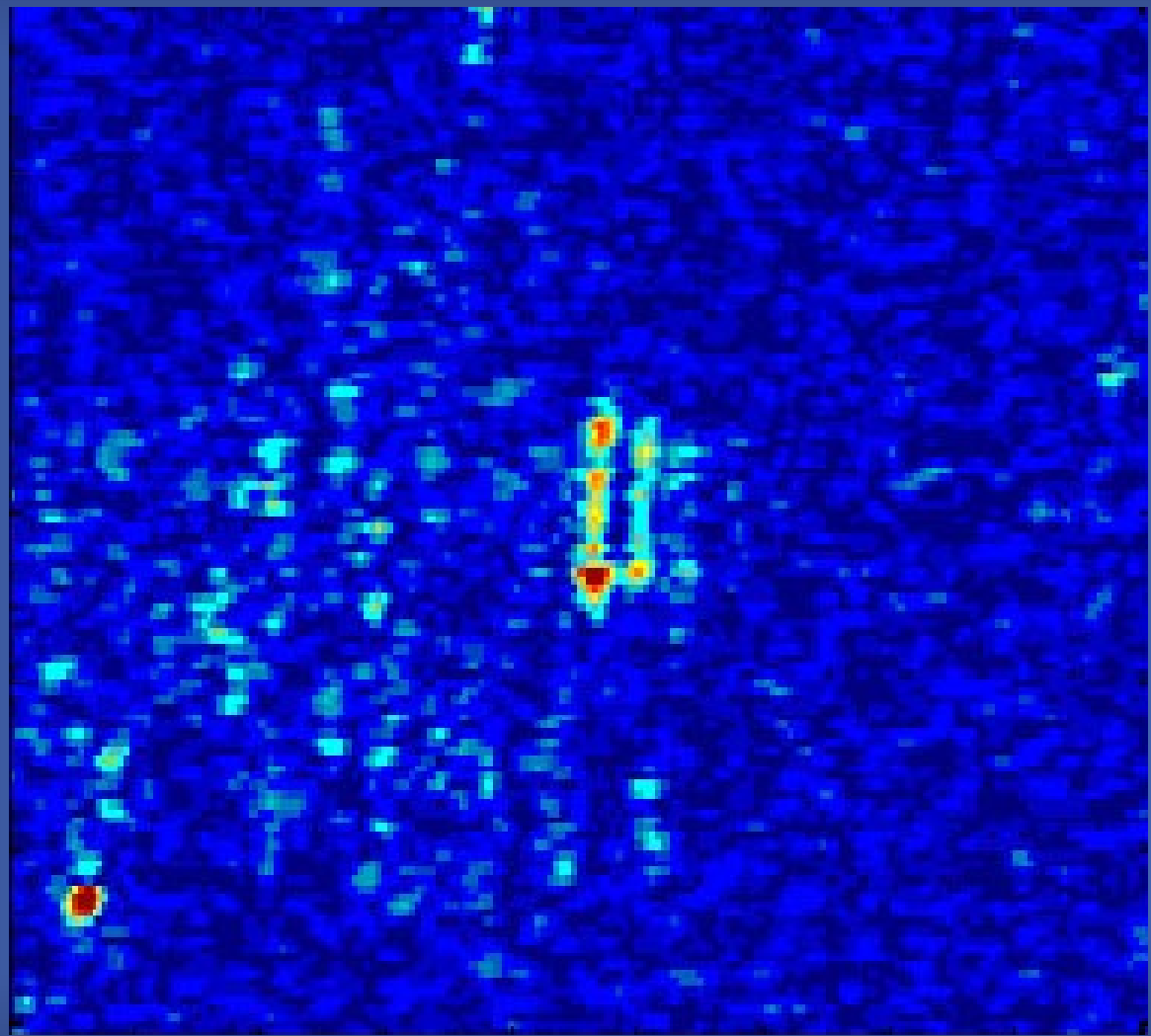
Target depth 15 cm

Grazing angle 10º

Image 9 m × 9 m

Critical angle 30º

CSS SAS Image of Buried Target at 20 kHz



Target depth 50 cm

Grazing angle 4º

Image 9 m × 9 m

Critical angle 30º

Buried Target Detections

- Results better than expected from penetration measurements at SAX99 site

  - Ripple height not measured at Target Field site

- Detection results not completely consistent

  - Target at 15 cm depth detected once in three chances

  - Target at 50 cm depth detected on all five chances

Special Issue Publications

IEEE Journal of Oceanic Engineering

- Special issue on high-frequency acoustics, January 2001

  - Two overview papers on SAX99

- Special issue on high-frequency sediment acoustics, July 2002

  - Thirteen papers on SAX99 results

  - Guest editorial

Continuing Research on Target Detection

- Joint project with APL-UW and CSS
- Measurements at CSS test pond with artificially generated ripple
- Results at 20º grazing angle show enhanced detection over first -order perturbation theory predictions as ripple heights increase

    - Enhancement not yet observed at 10º

Planned SAX04 Research

(Sept. - Nov. 2004)

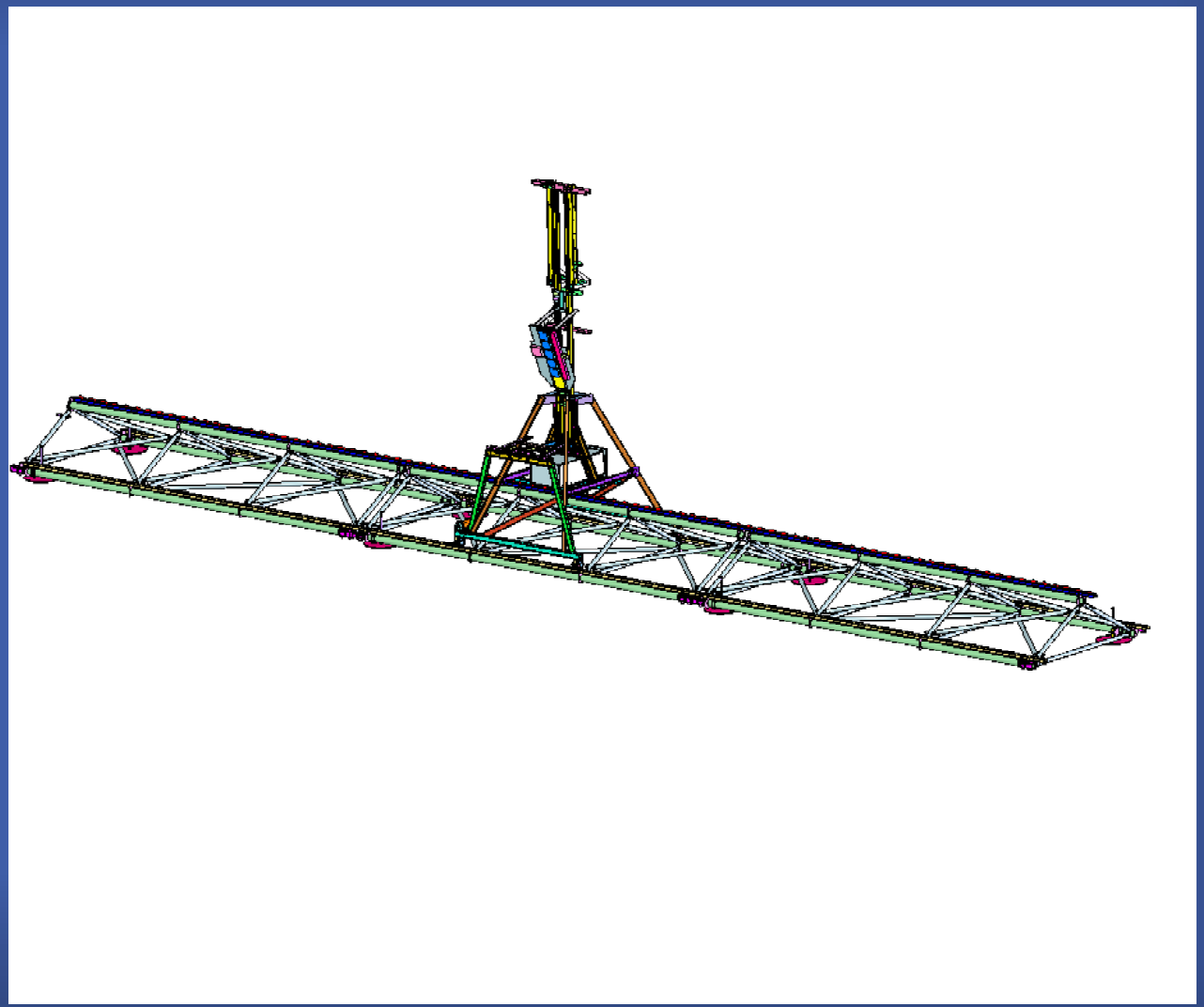
- Fundamental examination of penetration into, propagation within, and scattering from sand sediments

  - Expanded frequency coverage (1- 500 kHz)

  - Detailed environmental characterization (as in SAX99)

- SAS imaging of proud and buried targets using bottom mounted rail system

Portion of SAX04 Bottom Mounted Rail System



Total length 50 m

SAX04 Updates

- Pre-mine burial chirp sonar survey of SAX04 site
  - Schock, 28-29 April

- Mine burial
  - 4-9 May
  - R/V Savannah

- Classified data

- Possible vibracore survey of SAX04 site

SAX04 Updates

- Diving during SAX04

- Site surveys in September
  - Side scan, Caruthers
  - Multi-beam, Mayer
  - Chirp sonar, Schock

Environmental Assessment

- Marine Acoustics, Inc.
  - Bill Metzger
  - Kathleen Vigness Raposa

- Fish: best sensitivity 200 - 800 Hz

- Sea turtles: best sensitivity 200-700 Hz
  high hearing thresholds 160-200 dB

Marine Mammals

- Ridgway et al. 1997, 3-75 kHz, 1 s tones
  - bottlenose dolphins
- Schlundt et al. 2000, extended work down to 400 Hz
  - included beluga whales

Environmental Assessment

- **Result:**

  - Change in behavior: 185 dB re 1 μPa
  - Temporary threshold shift (TTS): 195 dB re 1 μPa

- "Current thought" is that total energy is a more appropriate metric
- Marine Acoustics is now using these levels: (for whales and dolphins)

  - Change in behavior: 186 dB re 1 μPa^2-s
  - Temporary Threshold Shift (TTS): 195 dB re 1 μPa^2-s
  - Permanent Threshold Shift (PTS): 215 dB re 1 μPa^2-s

Environmental Assessment

- **Thresholds:**

  - **Change in behavior: 186 dB re 1 μPa^2-s**
  - **Temporary Threshold Shift (TTS): 195 dB re 1 μPa^2-s**
  - **Permanent Threshold Shift (PTS): 215 dB re 1 μPa^2-s**

- **Highest projected SAX04 levels reported to date:**

- **NSWC-PC 192.5 dB re 1 μPa^2-s at 165-195 kHz**
  189 dB re 1 μPa^2-s at 15-35 kHz
- **APL-UW 188 dB re 1 μPa^2-s at 110-190 kHz**

- **We should be able to operate at night for essentially all measurements**

Email From Ships

Seward Johnson

- **SEAWAVE.com**
  - **Individual PIs can sign up (even on ship)**
  - **Rate: cost to S.J. plus 15% …..$1.79/min (Iridium)**
  - **Baud rate (today): 2400 b/s (Iridium)**
  - **Apparently will be major increase in speed between now and fall**

Pelican

- **Boatracks**
  - **Through ship, for short messages**
  - **Free if not overused**
- **SeaNet**
  - **Suitable for attachments, not free**