Environmentally Adaptive Sonar Technology (EAST) Program

Presented to

Uncertainty DRI Review and Planning Meeting

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Environmentally Adaptive Sonar Technology (EAST) Goals

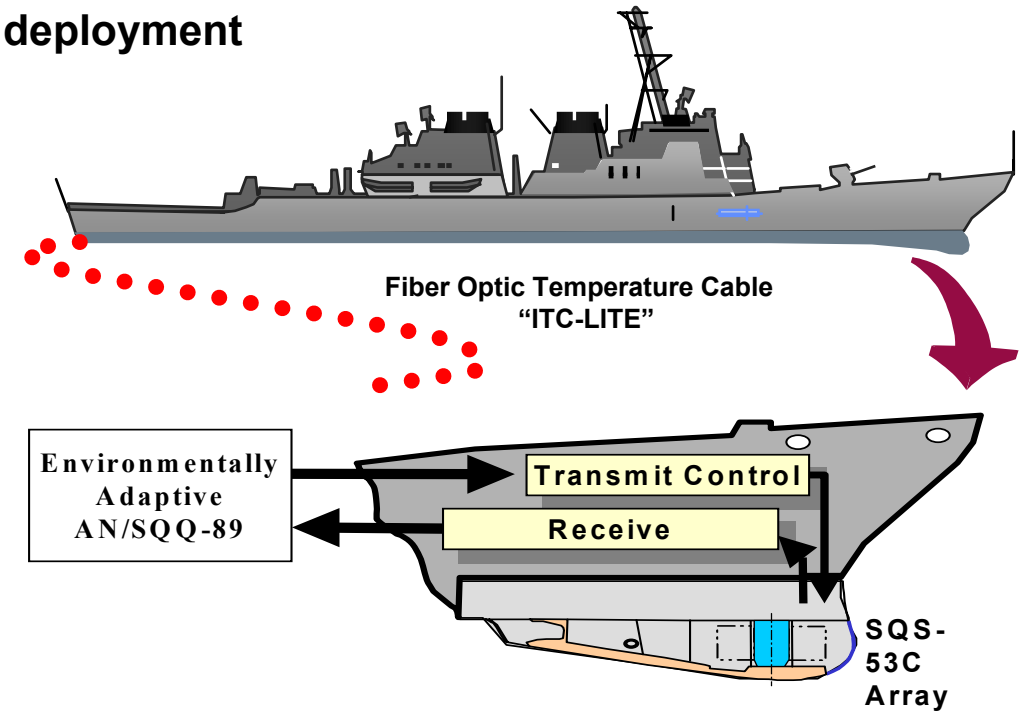
- **Improved SONAR Detection Performance**
  - Clutter/False Alarm Reduction
  - Assisted Detection and Classification
  - In-Situ Transmit Setup
  - Extensive Automation
- **Improved Sonar Search Confidence**
- **Transition, Transition, Transition**
  - Utilize Acquisition's Existing System Baselines
- **Full-Scale FY03 Demonstration**
  - AN/SQS-53C Based Fully Automated Sensing, Adaptive Control and Processing System

Environmentally Adaptive Sonar Technology (EAST)

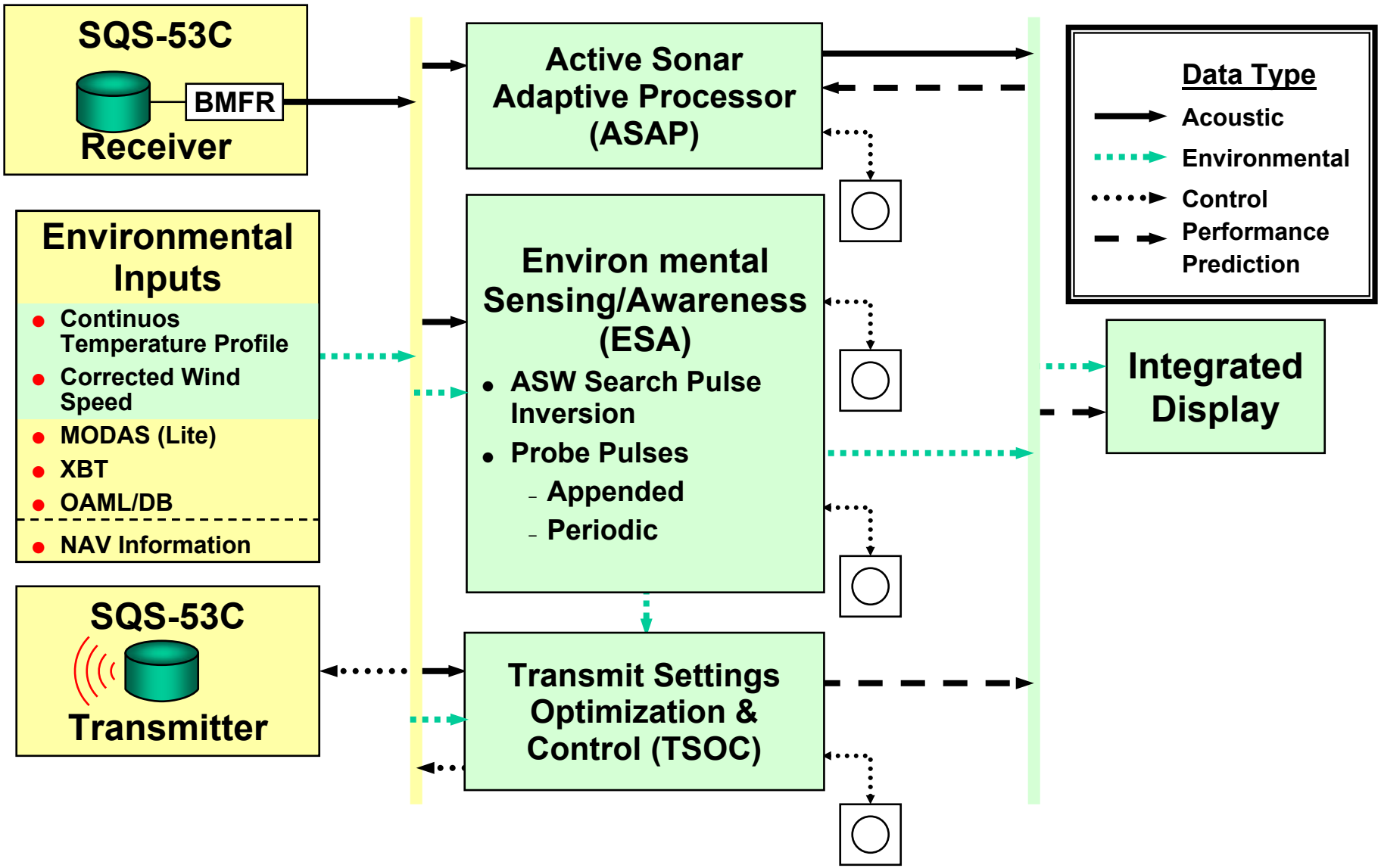
- **Underlying Perspective**
  - Sonar performance highly dependent on the environment
  - The environment is often highly variable and difficult to predict
  - Optimum sonar performance can only be achieved by in-situ environmental characterization and automated real time system adaptation
  - The (Active) sonar system itself is inherently a principal source of critical environmental information

AN/SQQ-89(V)6 Hull Mounted Sonar

- **Surface Warfare's Principle Mobile ASW Search Sonar System**
  - System Parameters "Set at the Factory"
  - Sonar System Typically Setup to Default
  - Historical Databases (except XBT) Used to Characterize Environment
- **Constraints**
  - Hull mounted sonar physics
  - Legacy transmit and receiver sub-system and software
  - Tactical deployment

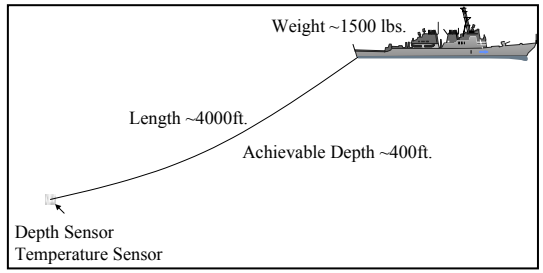


EAST Demonstration System (Simplified Functional Diagram)

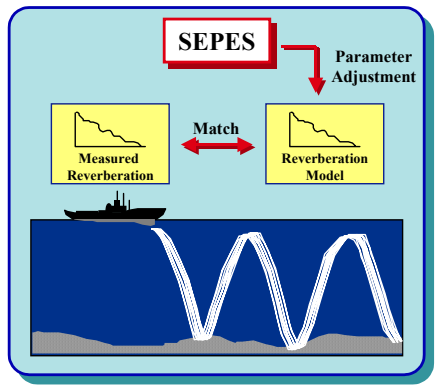


Environmental Sensing and Estimation

- **Towed Optical Temperature Sensor (ITC-"lite")**
  - 3/8 inch Diameter "Sensor Only" Version of The LBVDS Tow Cable
  - 2 minute Temperature Sampling @ 0.5 Meter Depth Resolution to 400 ft.

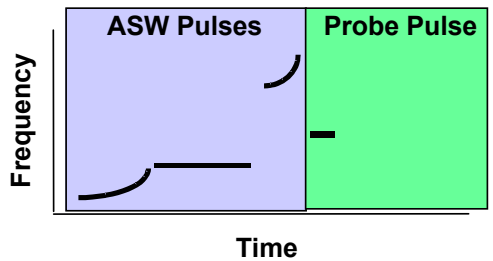


- **Environmental Parameter Estimation**
  - Bottom Loss, Bottom and Volume Scattering Inversion
  - Derive from ASW and probe pulses



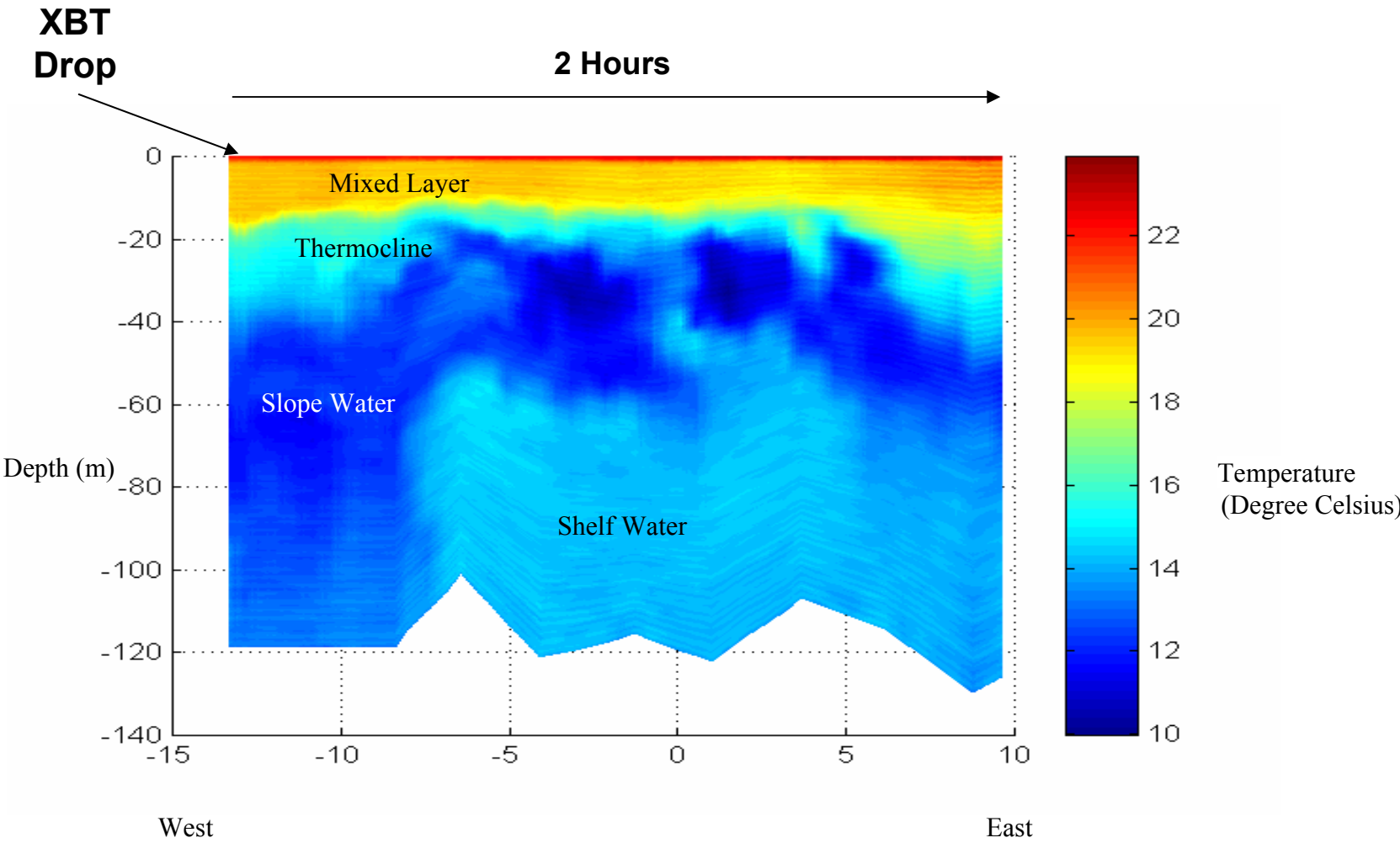
- **Probe Pulses**
  - Sample Depression Angles and Center Frequencies
  - Appended: 10ms CW at 5 Discrete Frequencies
  - Periodic: 1 second Broadband FM and 10ms CW

Augmented ASW Transmissions



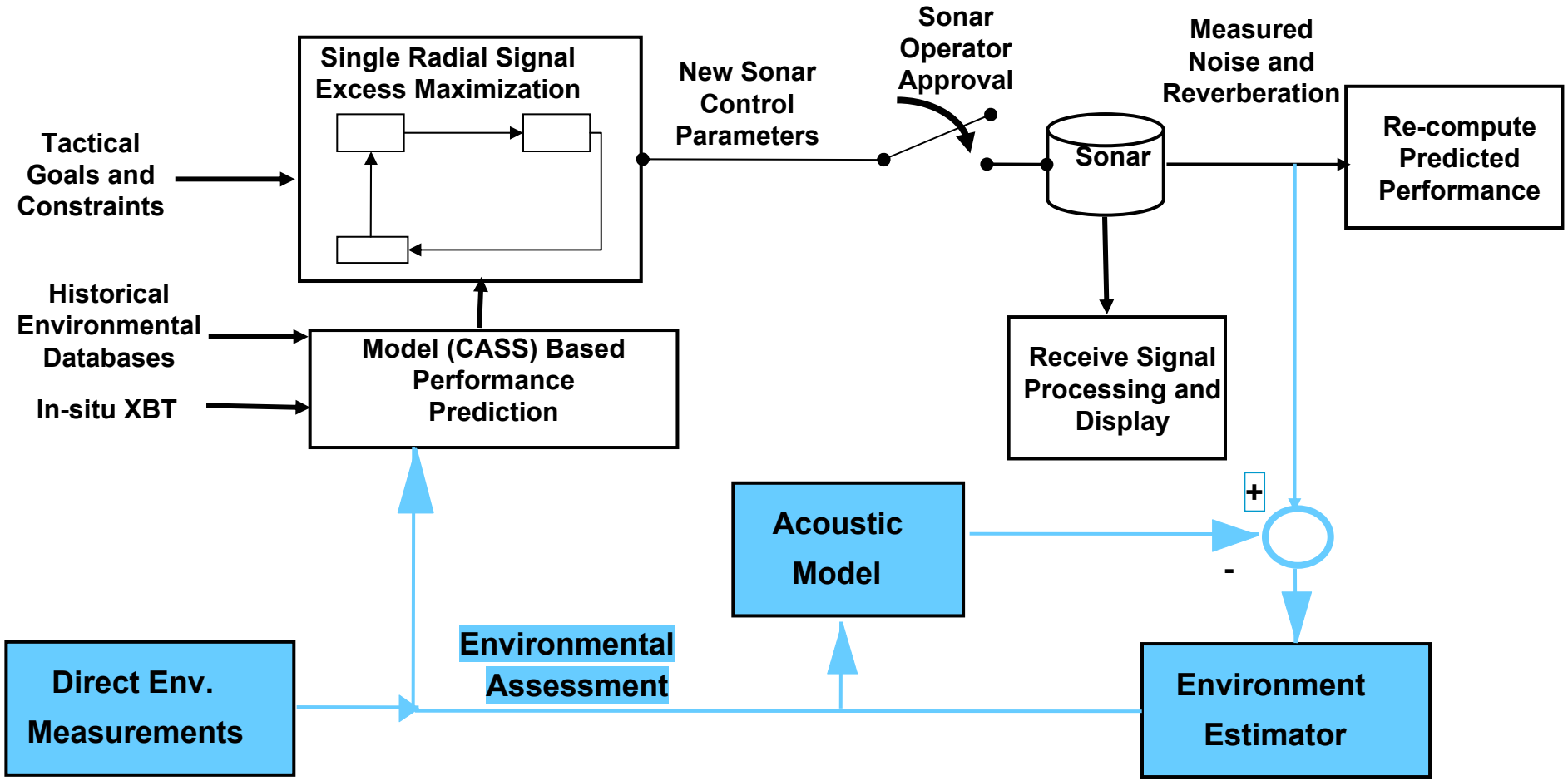
- **Assimilate In-Situ Information with Historical Database**

Example:
Fiber Optic Temperature Sensor



Sampled temperature data collected from South of New England using the Instrumented Tow Cable in June 2000. The horizontal axis is distance in kilometers measured relative to 71 degrees West.

EAST Transmit Analysis and Control Concept



Automated Sonar Transmit Setup

- **Predict Active Propagation and System Performance**
  - Current Sonar Setup and Alternatives Over Range, Bearings, and Depths
  - Neural Network Acoustic Model Emulator Speed Up Increase Resolution
- **Compare Estimated Parameters to Measurements**
  - TL from Consorts and AN/SSQ-57SPC Sonobuoy
  - Received reverberation of new transmit setup
  - Bottom depth from the Fathometer
- **Determine "Acoustic Best" Sonar Active Transmit Setup Within Given Tactical Constraints**
  - Bandwidth, Pulse Length, Depression Angle, and Center Frequency
  - Notify Sonar Operator of Recommended Change and Reason Why
- **Acoustic Environment Change Detection**
  - Continuos Model Runs

East Adaptive Processing

- **Environmentally Adaptive Normalization**
  - Optimize Normalizer Gap to the Environment using Predicted Target Echo Extent
- **Echo Integration**
  - Recover Echo Energy Spreading Loss Induced by the Environment
  - Match to Expected Time Spreading of Environment
- **Tracking and Classification**
  - Use Observed Environmental Characteristics to Rank and Select the Best Classification Features
- **Multi-Hypothesis Processing**
  - Parallel Replicated Sets of Linked Algorithms and Decision Processing Each Designed to Exploit a Specific Condition

Coordination With Uncertainty DRI

- **Common terminology for expression of certainty on sonar performance**
- **Share EAST data, analysis results, and interpretations**
- **EAST Data Products**
  - **AN/SQQ-89 Hull Sonar Acoustic, Environmental, and Platform Position Data in Tactically Significant Environments**
    - **Element Level and Beamformed output**
    - **Fathometer, Raw XBT, Lat-Lon position**
  - **Raw ITC temperature measurements**
  - **Estimates of Bottom Loss, Bottom Backscattering, and Volume Scattering, and Transmission Loss**
  - **Independent Measurements for data quality comparisons**
    - **AN/SSQ-57SPC, APL/UW Vertical Line Array, and NAVO TL runs**
  - **Active Processing Detection/Track Data and Reconstruction**

EAST Data Collection

- **Existing AN/SQS-53C Data**
  - Long Bay (Charleston, S.C. OPAREA)
    - SCV97, LWAD 99-3, LWAD 00-1, LWAD98-4
  - SHAREM 138: NAVO Characterization
- **FY02**
  - New Jersey OPAREA (GEOCLUTTER Site)
    - DDG71 with ITC and Probe Pulses in May
  - SHAREM 141: Transit through SWAC 1 Area
  - SHAREM 142: NAVO Characterization
- **Plans for FY03**
  - Long Bay data collection test
  - SHAREM-NAVO data collection test
  - System data collection and demonstration test, ex. SHAREM, JTFX,...

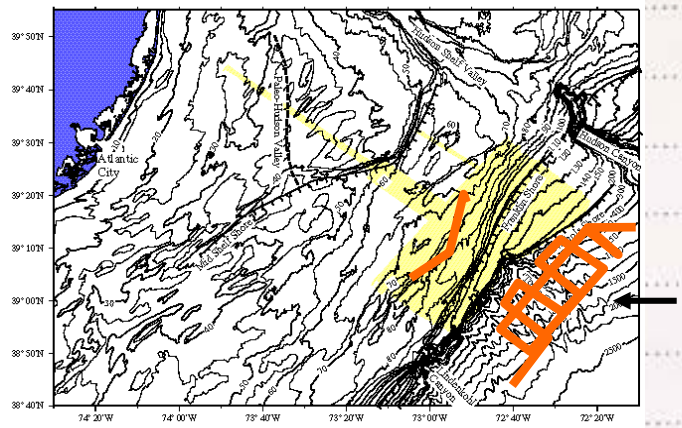
East Team Members

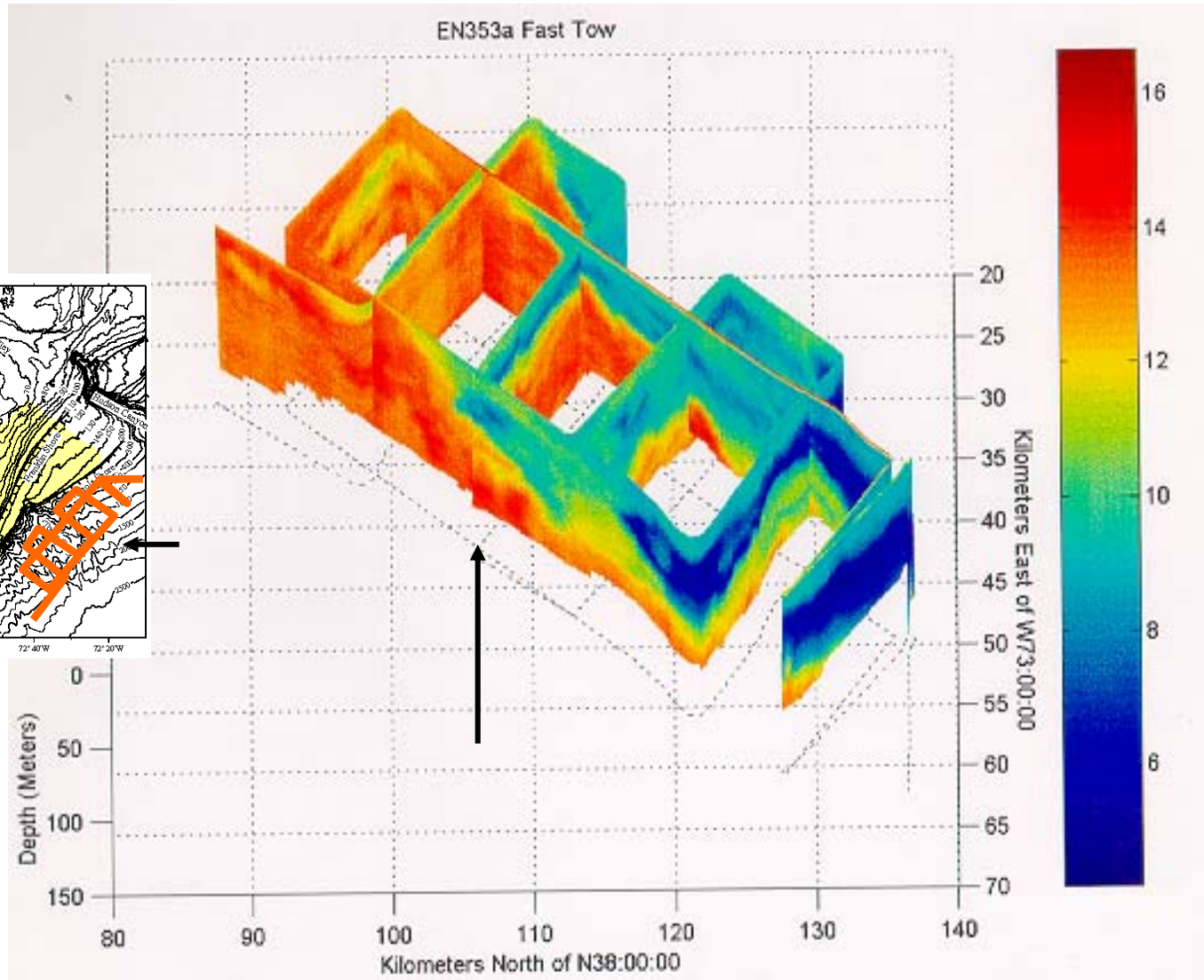
- **EAST Team Members**
  - Ken Dial, Jim McEachern, and Mike Traweek, ONR
    - Sponsors
  - Wayne Beers, PMS411
    - AN/SQQ-89A(V)15 Acquisition Sponsor
  - STGCS Steve Elkins, Afloat Training Group, Mayport, FL
    - Fleet representative
  - Bernie Cole, Planning System Incorporated (New London, CT)
    - Bottom and Volume Inversion
  - Warren Fox, Applied Physics Lab / University of Washington
    - Bottom Inversion, Neural Net Controller, Assimilation
  - Mike Sundvik, NAVSEA Newport
    - Temperature Cable (ITC)
  - Don Lerro, Anteon (Mystic)
    - Adaptive Processing, TSOC Transmit Control
  - Karl Fisher, Applied Research Lab / University of Texas
    - AN/SQQ-89 ATAWG Chair and Displays
  - Bob Overkott, Vreedenburg
    - Fleet Liaison Team Coordinator

Summary

- **Navy Need**
  - Operators Overloaded and Missing Potential Contacts
- **Coordination with Uncertainty DRI Teams**
  - Data Products, Processing Results, and Interpretations
- **EAST Seeks to reduce Uncertainty**
  - Temperature Measurements, TL Measurements.
  - Estimate bottom properties, and TL using sensor reverberation
  - Improve Detection performance and situational awareness
- **Transition, Transition, Transition**
  - Adaptive Tracker and Temperature Fibers in AN/SQQ-89A(V)15 Procurement

"Fast Tow" (7 kt) measurements for 19 hours on May 5-6, 2001





Bottom Scattering Strength for Stump '88 locations

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