

# UNDERWATER DETECTION A ONE DAY EXERCISE WITH US NAVY EOD GruOne

## Presentation at SPAWAR Systems Center San Diego

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# INTRODUCTION

- ◆ 1-DAY EXERCISE WITH EOD GruOne
- ◆ BRIEFING PROVIDED TO THE US NAVY
- ◆ SYSTEM
  - HARDWARE & SOFTWARE
  - TEST CONFIGURATION
- ◆ ANALYSIS
- ◆ RESULTS
- ◆ REMARKS
  - APPLICATION FOR SPAWAR GROUP
  - DEMONSTRATION

# Air Force Explosive Hazard Reduction (EHR) Program



May 2001

**US AIR FORCE *EarthRadar*  
Feasibility Demo  
for  
COMEODGRU ONE**

# **US AIR FORCE EarthRadar FOR UNDERWATER DETECTION AND DISCRIMINATION**

Presentation to:  
RADM Mike Sharp  
UNITED STATES NAVY  
Program Executive Officer  
Mine and Undersea Warfare  
Coronado Island

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May 8, 2001

# Feasibility Demo

**Objective:** Determine the potential of *BakhtarAquaRadar* for detecting underwater mines.

**Background:** Air Force *EarthRadar* in basic R&D. System being developed under AF Small Business Innovation Research (SBIR) Program with Bakhtar Associates, Newport Beach CA (inventor/developer). System appears to be a technology breakthrough. R&D unit used successfully to:

- Detect and trace underground tunnels (>130' depth)
- Underwater plastic mines, Camp Pendleton
- Water Tables (>150 feet)
- Burial Dumps
- UXO

**Sponsor:** Demonstration sponsor US Air Force, AAC/WMGB

# SUMMARY

- ◆ TRANSMITTED LOW POWER (0.01-watt) RF ENERGY
- ◆ DIPOLE ANTENNAE FREQUENCY BAND 125 – 277 MHz
- ◆ PENETRATED TO 11.5-ft WATER AND 65-ft OF OCEAN FLOOR
- ◆ THREE MINES
  - ROCKAN (RADAR CROSS-SECTION, GPS MISMATCHED)
  - PDM MINE (3-DIMENSIONAL IMAGE)
  - MKB MINE (3-DIMENSIONAL IMAGE)
- ◆ ALL DEPTH REPORTED
- ◆ OPERATION SUCCESSFUL
- ◆ MORE TESTS NEEDED TO FINE TUNE *BakhtarAquaRadar*

# RF TRANSMISSION THROUGH VARIOUS INTERFACES

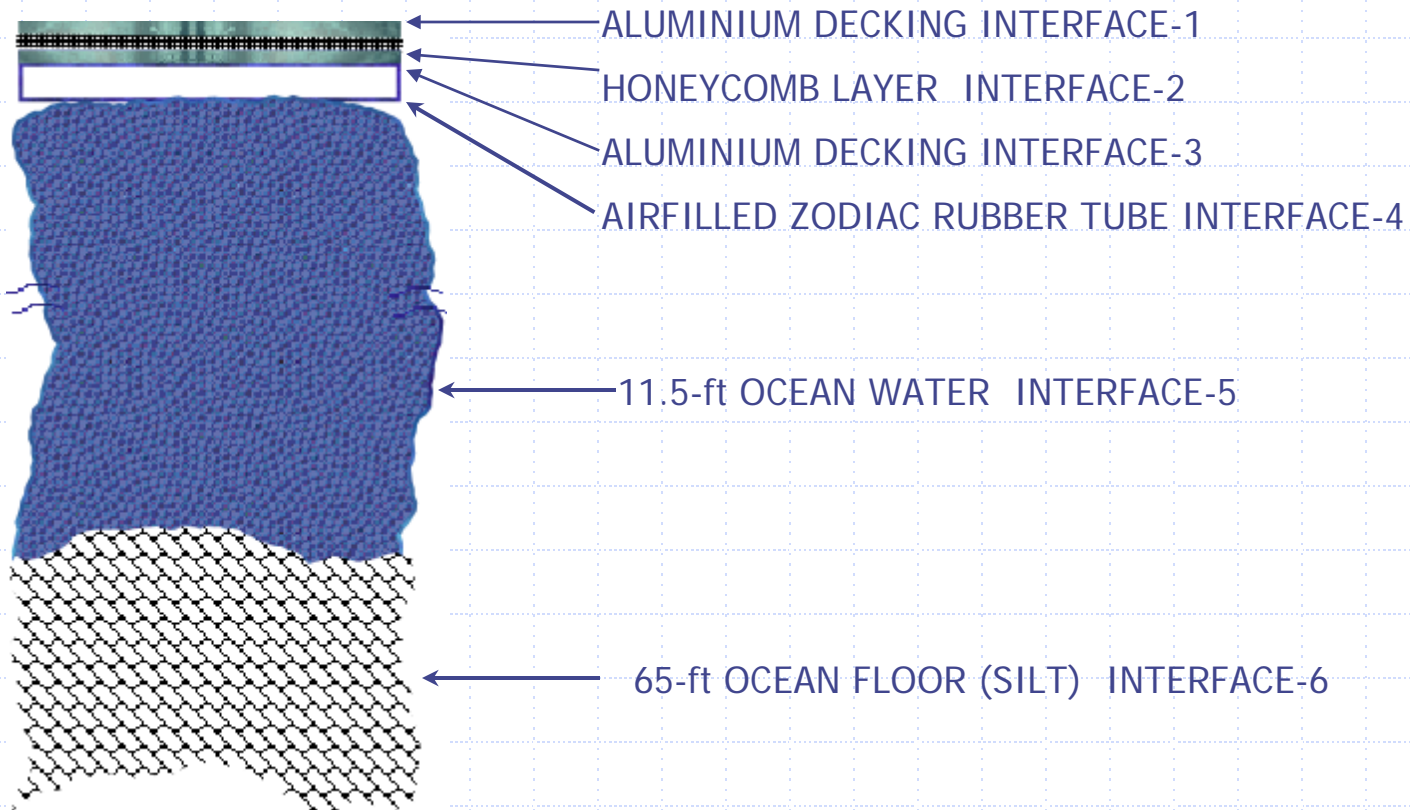


FIGURE 1 – SCHEMATIC REPRESENTATION SHOWING VARIOUS LAYERS THROUGH WHICH RF ENERGY TRANSMITTED FOR UNDERWATER MINE DETECTION AND DISCRIMINATION

**NOT TO SCALE**

# SCHEMATIC OF TEST CONFIGURATION

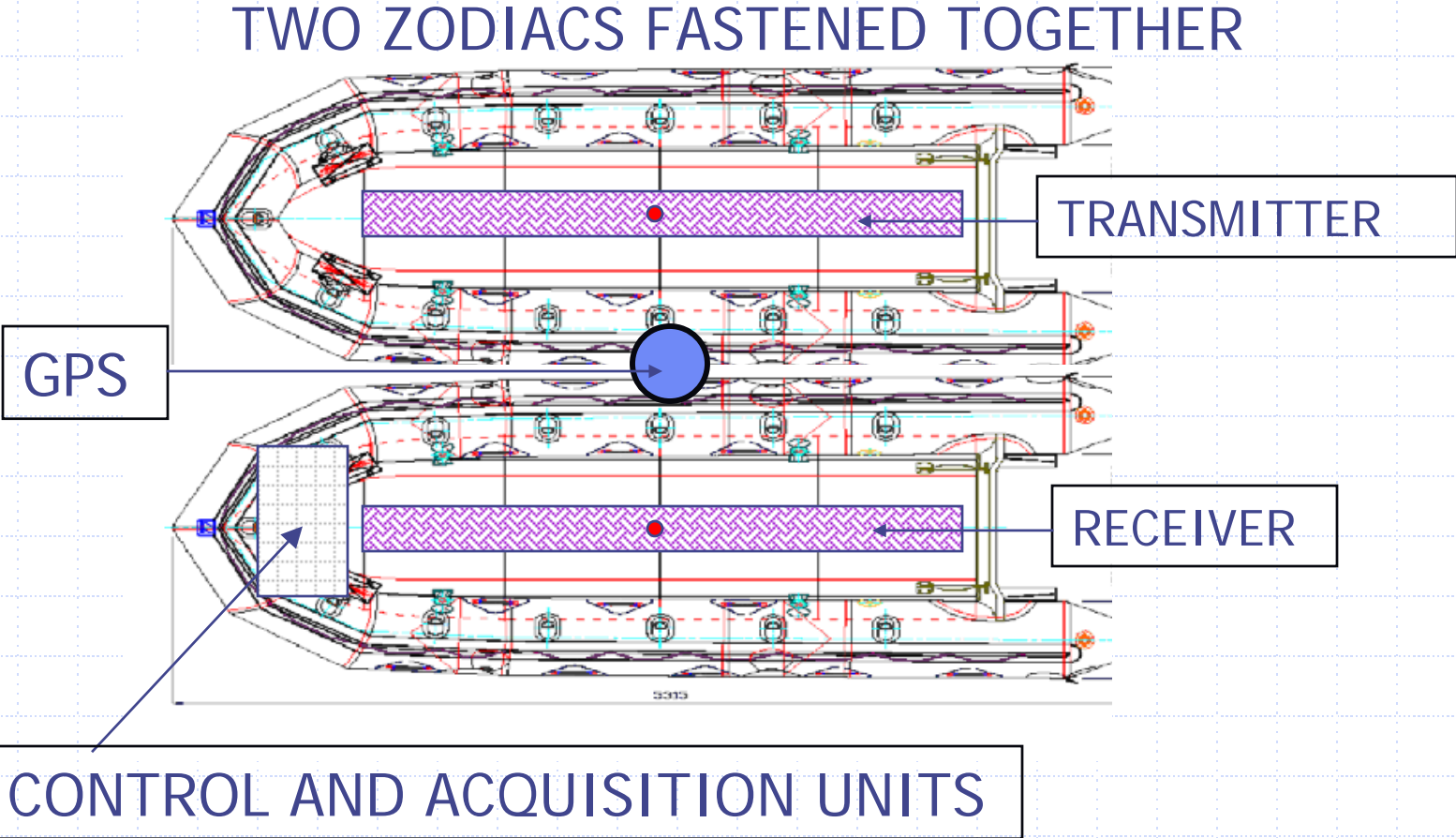


FIGURE 2 – SCHEMATIC REPRESENTATION OF TEST CONFIGURATION



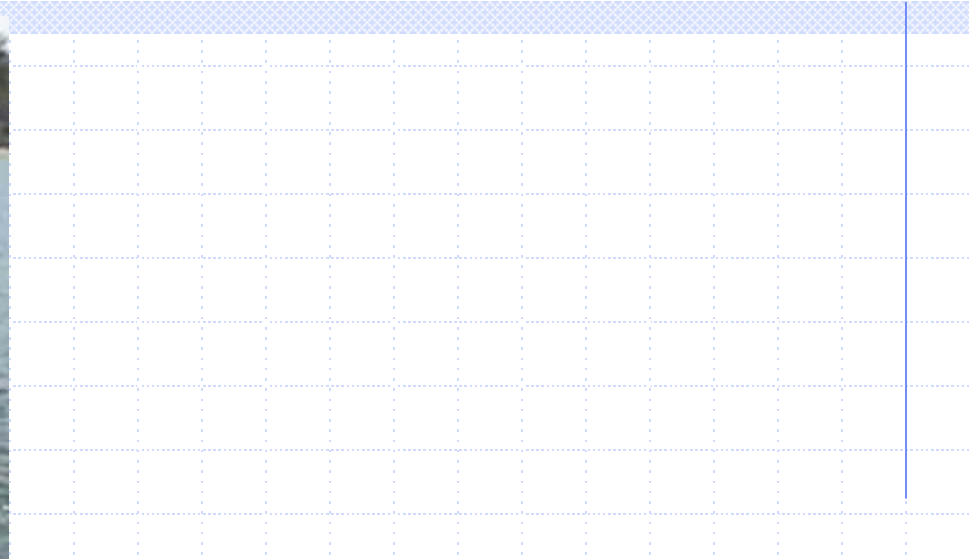


FIGURE 3 – PHOTOGRAPHS SHOWING THE EXERCISE CONDUCTED WITH NAVY EOD GruOne

# RADIATORS

- ◆ OPERATION COMPLEX
- ◆ RECEIVER RESPONDS TO BOTH ELECTRIC AND MAGNETIC FIELDS
- ◆ ELECTROMAGNETIC FIELD SURROUNDING TRANSMITTING RADIATOR CONSIST OF TWO PARTS
  - NEAR FIELD – submerged target detection, Mine, UXO
  - FAR FIELD – depth & horizontal detection, submarine, vessels. etc.
- ◆ LOW OPERATING  $\Delta f$  LONG  $\lambda$
- ◆ POLARIZATION (DEFINES DIRECTIONS OF ELECTRIC **E** AND MAGNETIC **H** FIELDS)
  - DIRECTION OF ELECTRIC FIELD **E** DETERMINES RADIATOR POLARIZATION (VERTICAL POLARIZATION FOR AZIEL)
- ◆ FORCED RESONANCE CONCEPT
  - ◆  $\{[L] + [C] + [R]\} - \{[L] + [C]\} = \{[R]\}$
  - ◆ AVOID REACTIVE COMPONENTS
  - ◆ BALANCED FOR 50-ohm IMPEDANCE
- ◆ INSURE GOOD IMPEDANCE MATCH

# RADIATORS

## ◆ RECEIVER AND TRANSMITTER

### ■ IDENTICAL CHARACTERISTICS

- ◆ GAIN
  - ◆ DIRECTIVITY
  - ◆ IMPEDANCE
  - ◆ POLARIZATION
  - ◆ etc.
- 
- ◆ NO SIGNAL AMPLIFICATION !

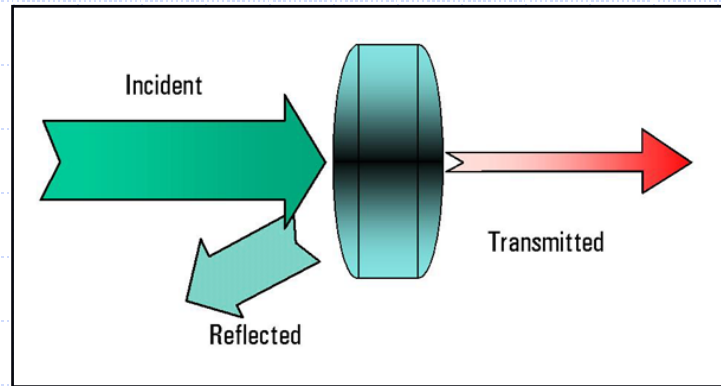
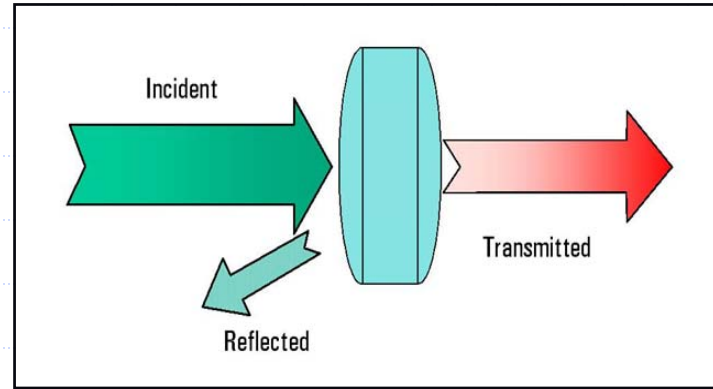
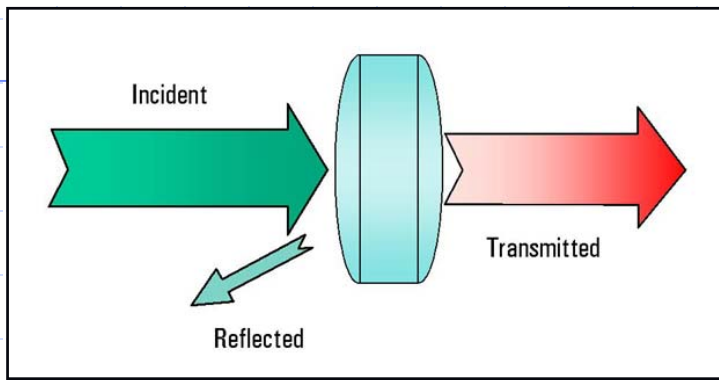


FIGURE 4 - SAME ANALOGY AS REFLECTION THROUGH LENSES  
POWER INCREASES  $\Rightarrow$  REFLECTIVITY INCREASES

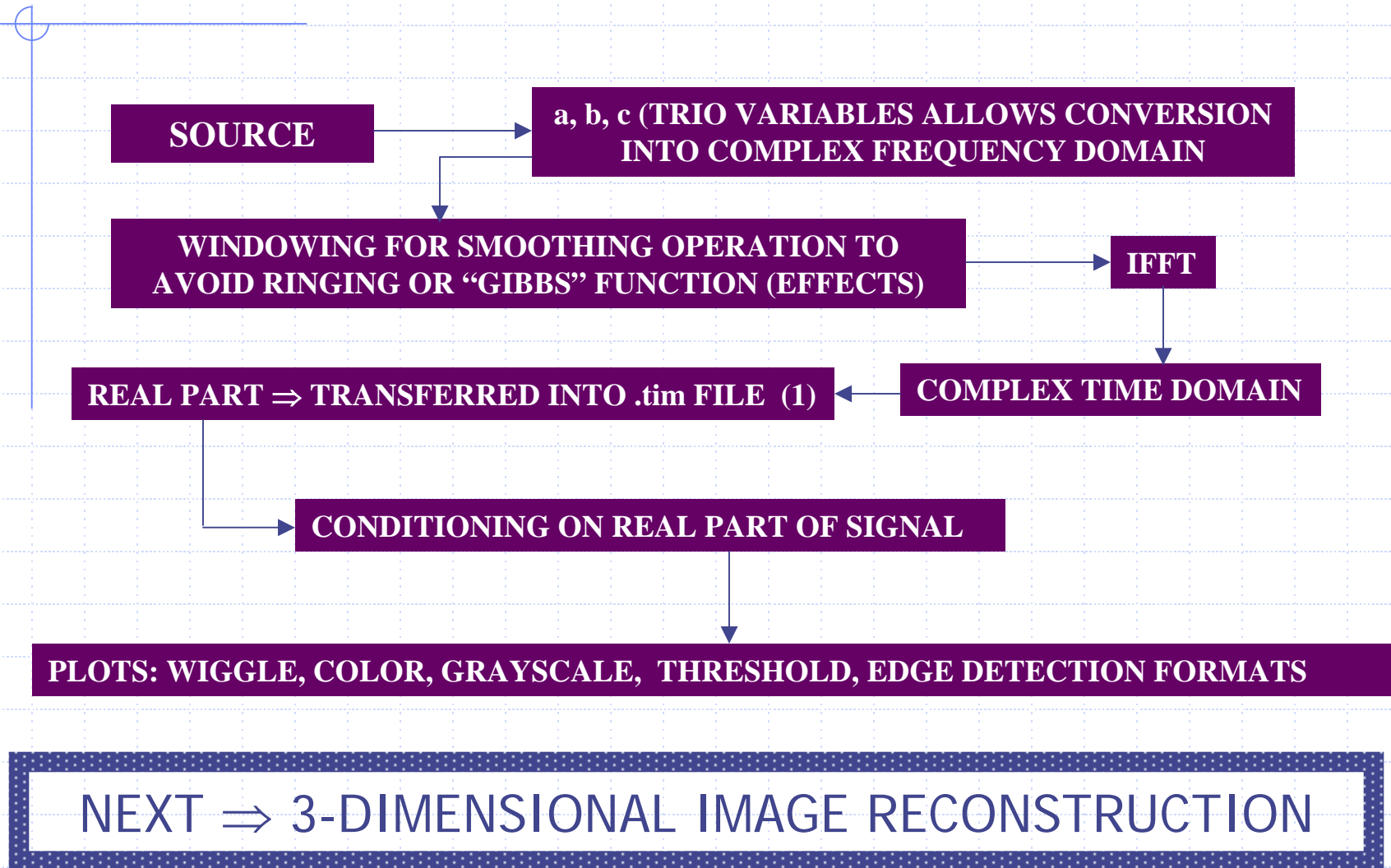
# RADIATOR DESIGN CONCEPT

- ◆ IN SITU CHARACTERIZATION
- ◆ EMWS
- ◆ OPERATING FREQUENCY RANGE
- ◆ ANTENNAE CHARACTERISTICS
- ◆ NOTE:

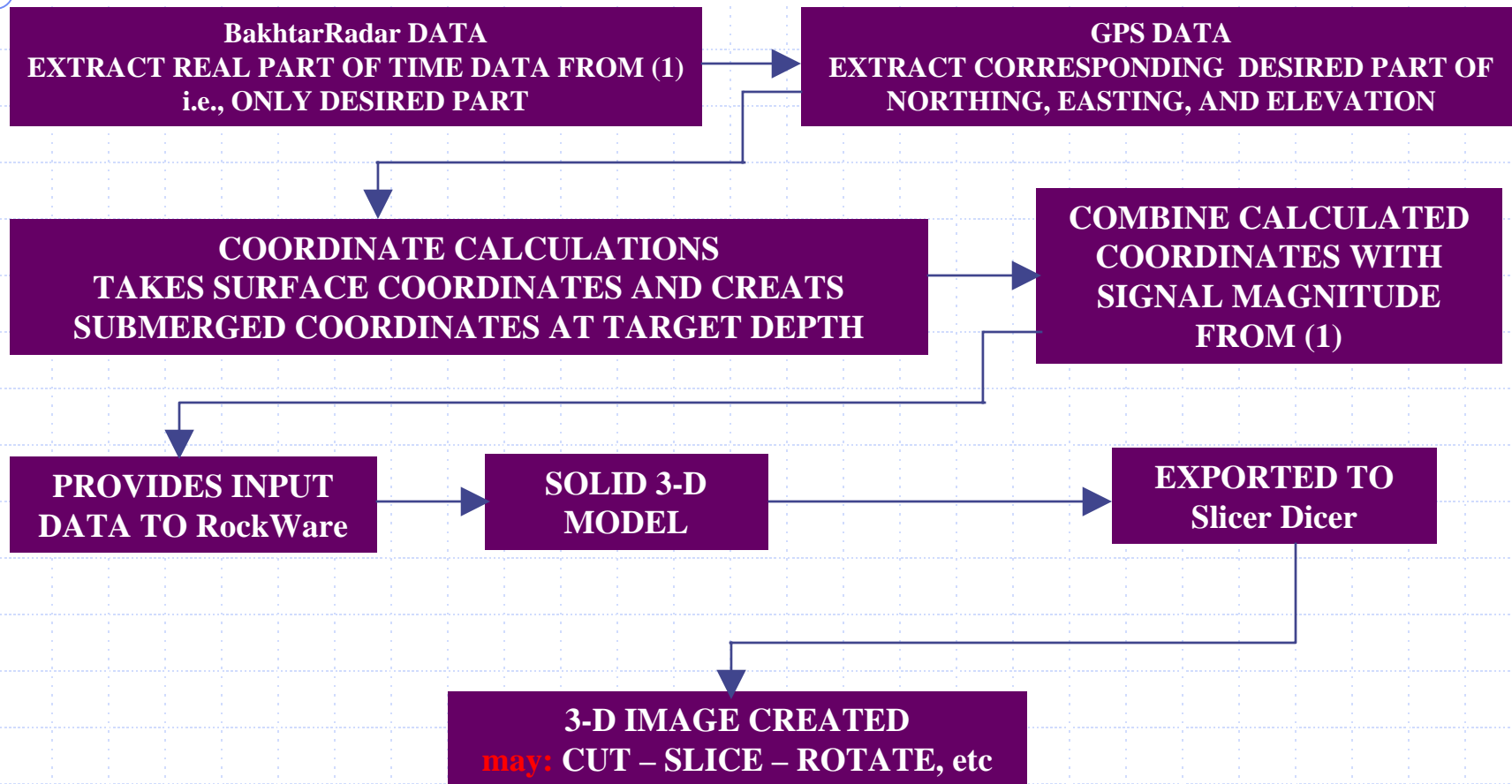
$$f_{CENTER} = \frac{c}{\lambda}$$

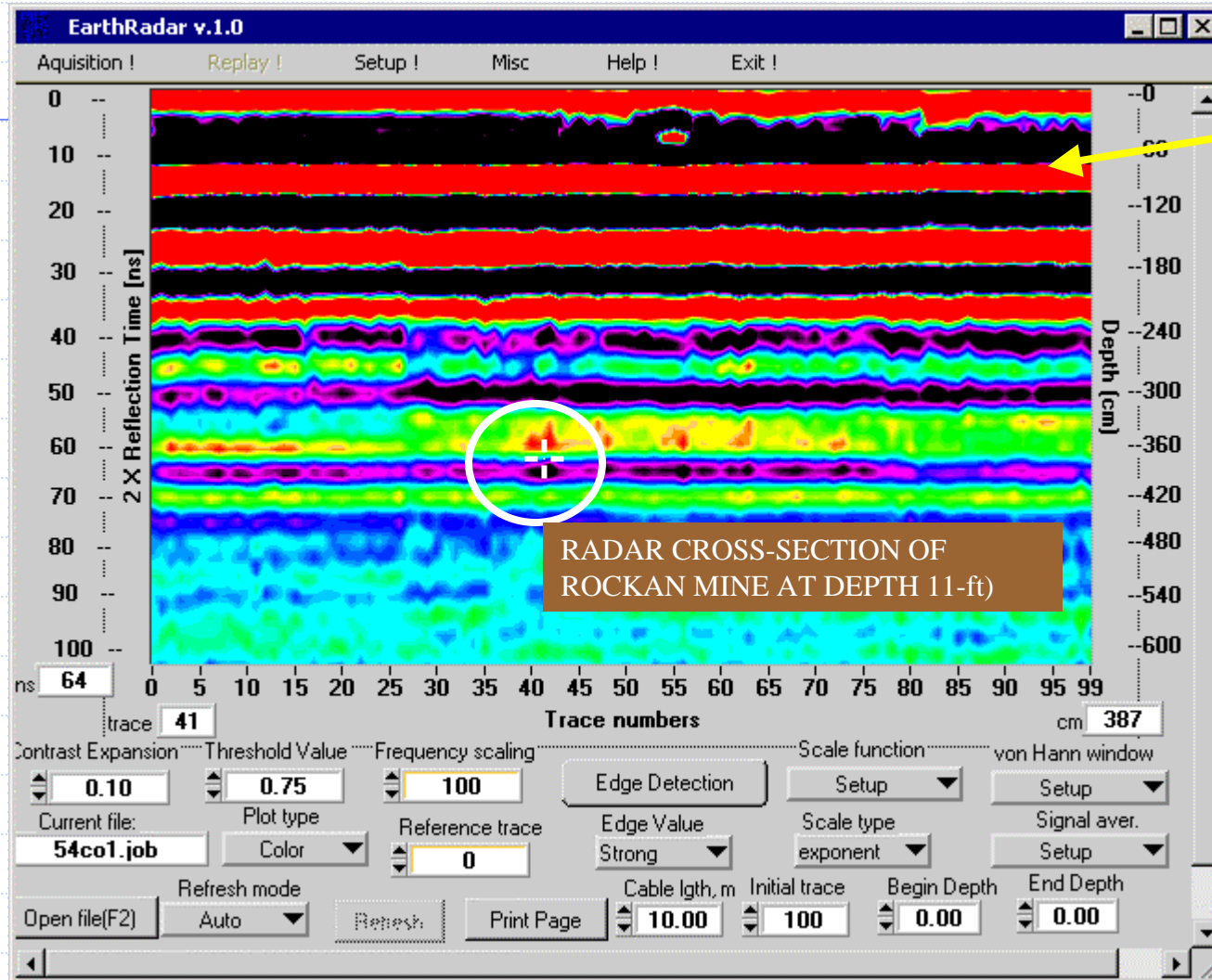
$$APERTURE\ SIZE = 2\lambda$$

# SIMPLIFIED LINE-DIAGRAM OF PROCESSING ALGORITHM



# 3-DIMENSIONAL IMAGE RECONSTRUCTION SIMPLIFIED ALGORITHM





BOAT-WATER SURFACE INTERFACE  
76-cm

RADAR CROSS-SECTION OF ROCKAN MINE AT DEPTH 11-ft)

FIGURE 5 - RADAR CROSS-SECTION OF ROCKON MINE AT DEPTH 11-ft BELOW WATER SURFACE



# Target #2 (PDM, MOORED)

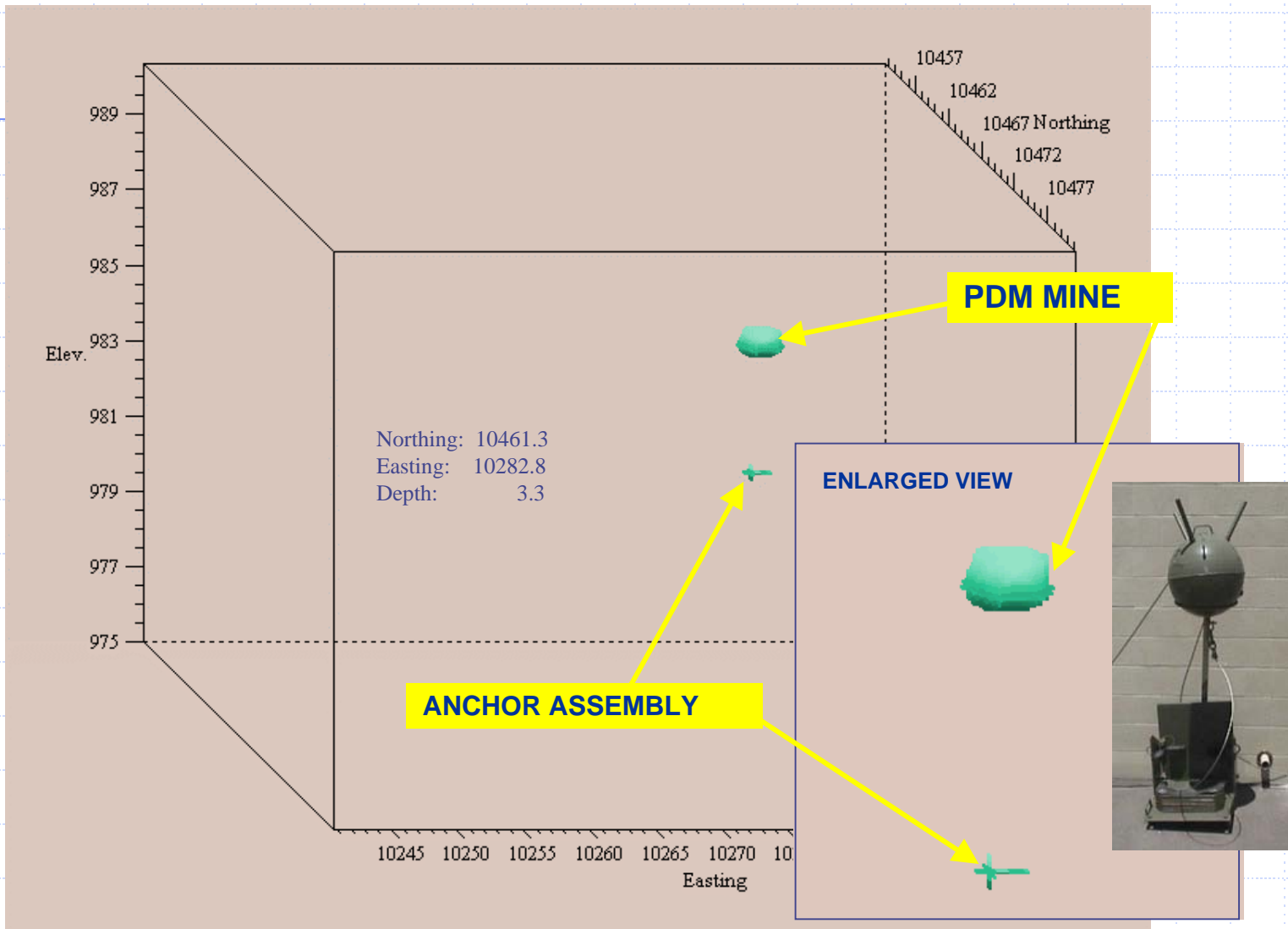


FIGURE 6 - COORDINATES WITH RESPECT TO ORIGIN N 10,000; E 10,000; ELEV. 1000 SET ON SHORE IN RECREATION AREA

# MKB

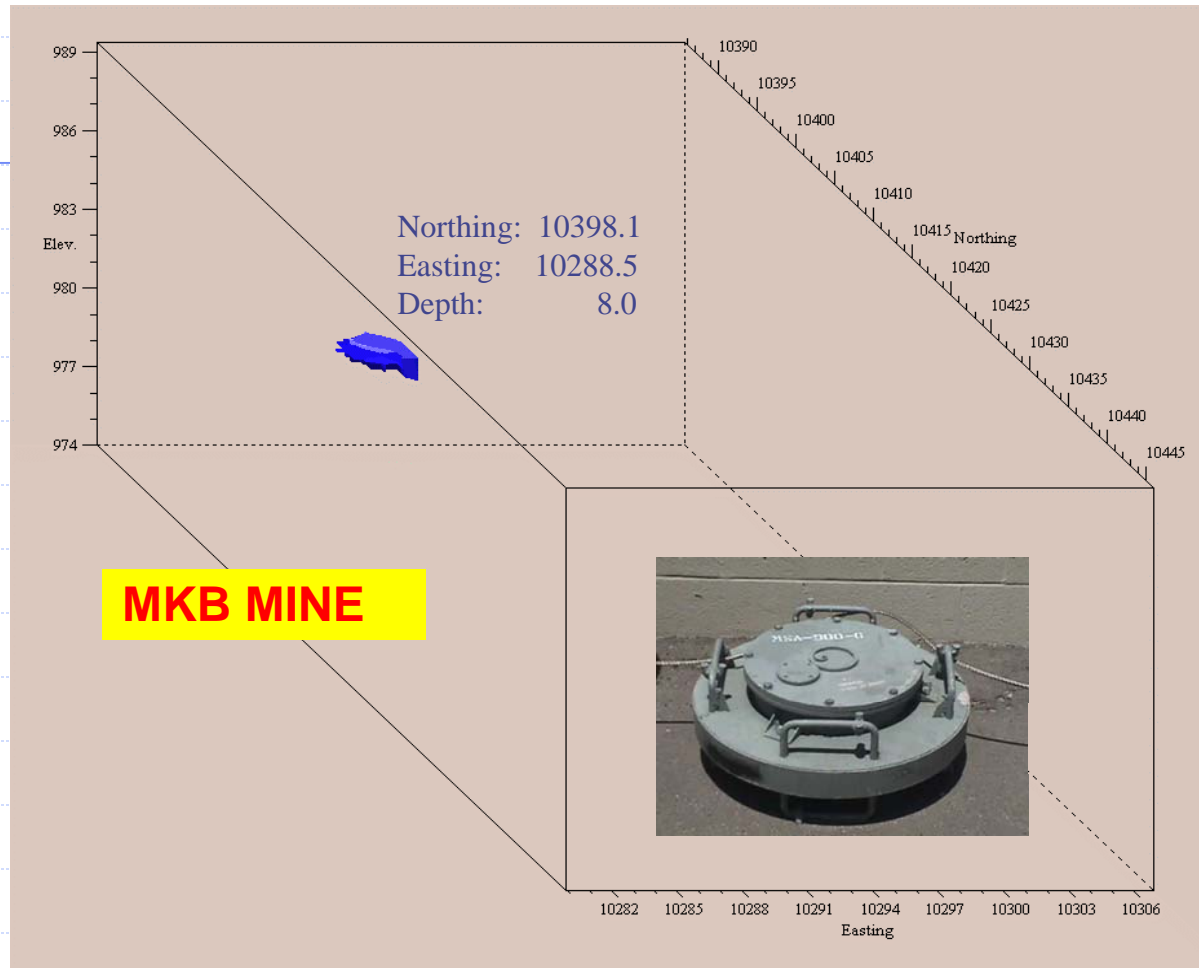


FIGURE 7 - COORDINATES WITH RESPECT TO ORIGIN N 10,000; E 10,000; ELEV. 1000 SET ON SHORE IN RECREATION AREA

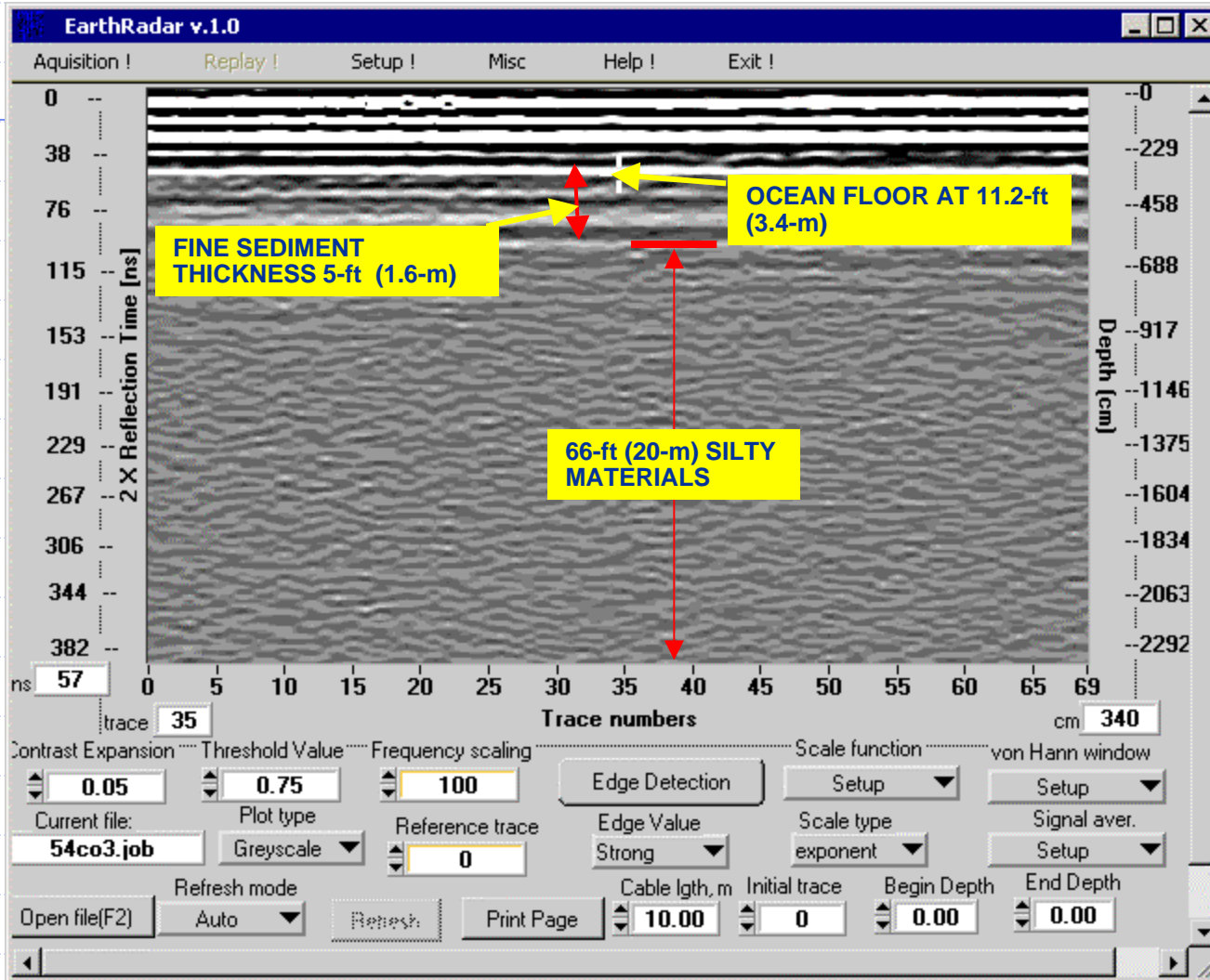


FIGURE 8 - RADAR CROSS-SECTION THROUGH 65-ft (20-m) OF OCEAN FLOOR

# REMARKS

## ◆ APPLICATIONS FOR SPAWAR

### ■ UNDERWATER TARGET DETECTION

- ◆ VERTICAL
  - ◆ HORIZONTAL
  - ◆ OBLIQUE ANGLES
- } VECTOR ORIENTATION

### ■ FORCED PROTECTION

- ◆ SHIPS
- ◆ SUBMARINES

## ◆ DEMONSTRATION (TO BE DISCUSSED)



# BakhtarRadar

LAND BASED EarthRadar

