RF Fields Group - Antenna Metrology

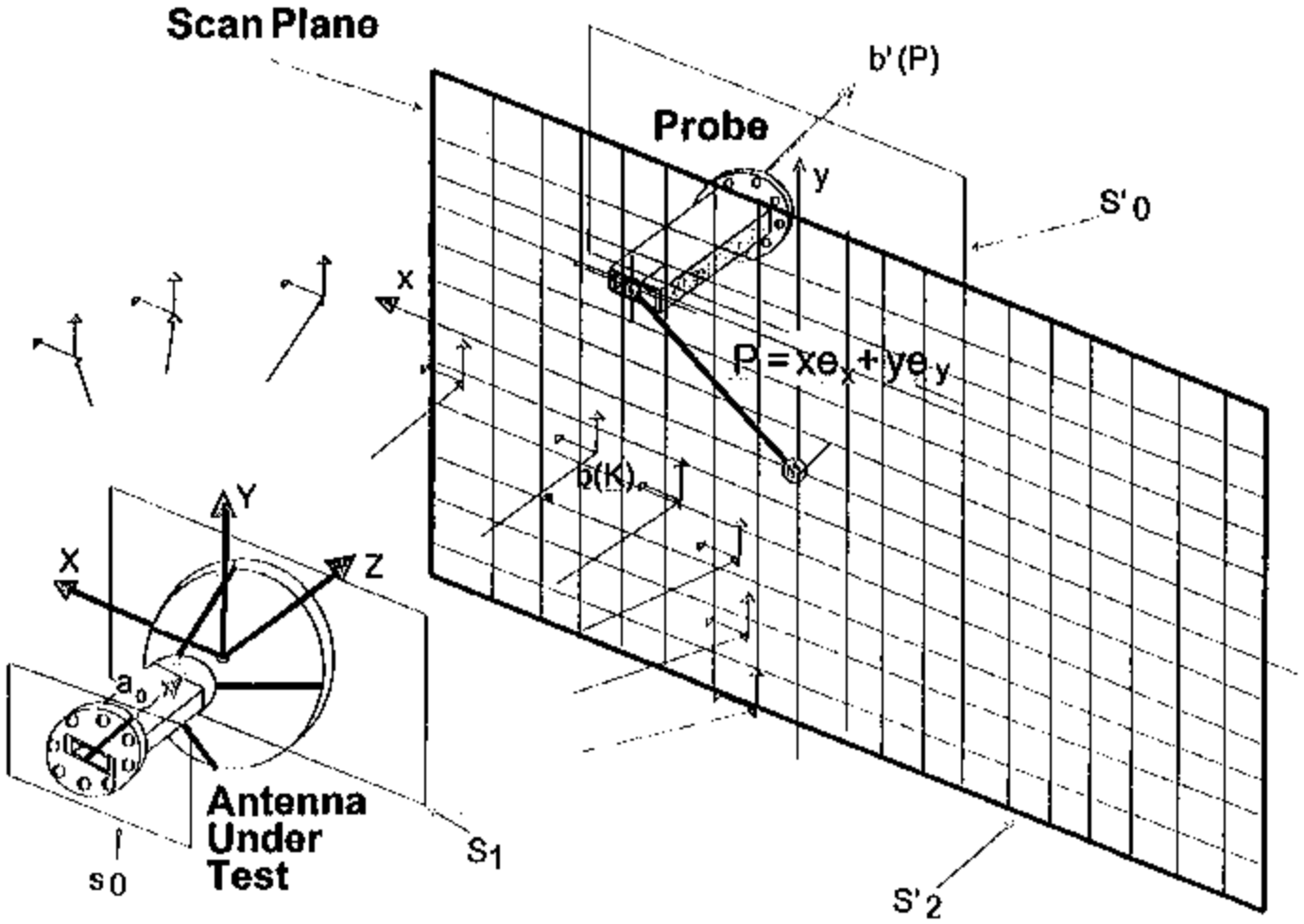
1998 Internal Symposium
on Advanced Radio Technologies
September 9-11, 1998

Andrew G. Repjar
repjar@boulder.nist.gov
Radio Frequency Technology Division
National Institute of Standards and Technology
Boulder, CO 80303 (303) 497-5703

Selected Topics

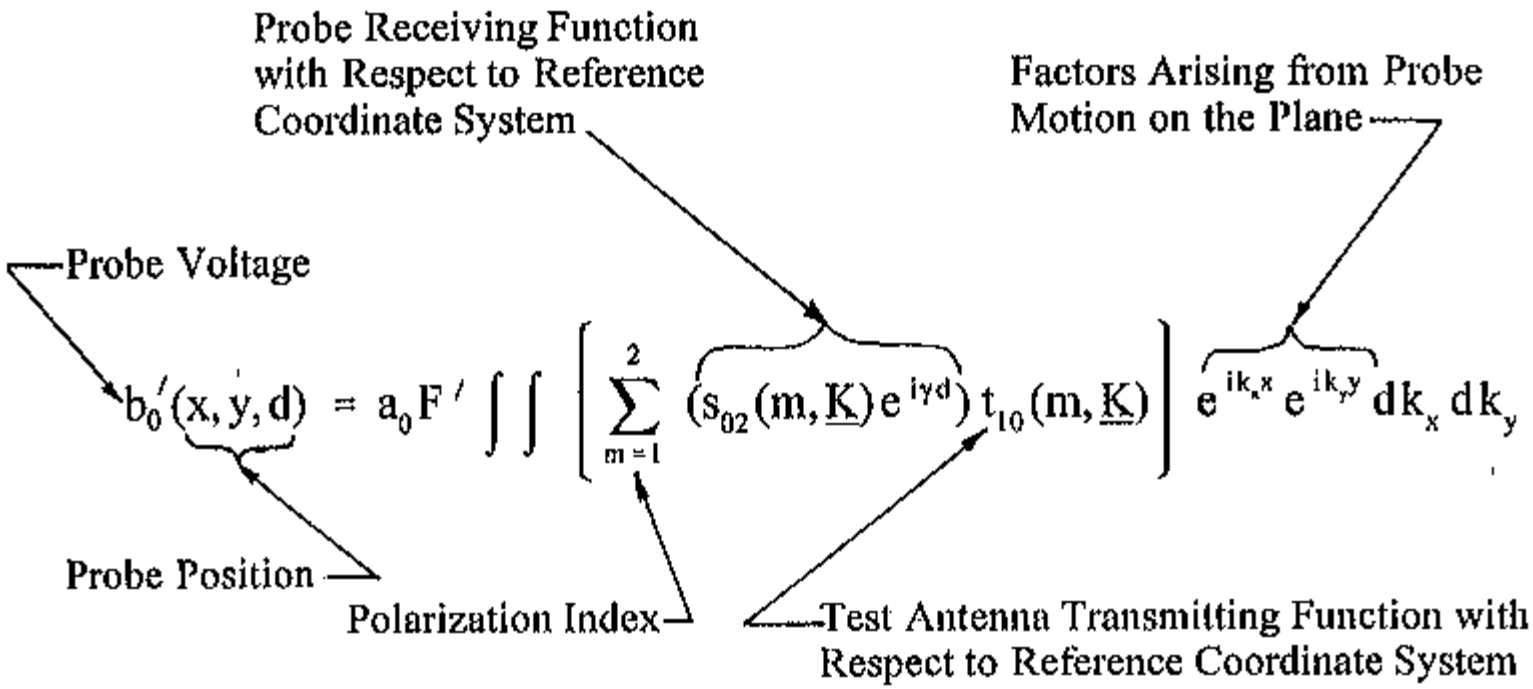
1. Planar near-field theory
2. Array diagnostics
3. Low slidelobe Antennas
4. Quite zone evaluation
5. Thermal holography

Planar Near-field Measurement



PLANR NEAR-FIELD SCANNING

TRANSMISSION EQUATION



COMPARISON OF ANTENNA MEASUREMENT METHODS

NEAR-FIELD METHOD

Advantages

- Relatively small l space
- No weather problems
- No interference (security)
- Complete pattern (3-d), gain, polarization data obtained, vectorial data all at arbitrary distances
- Antenna interactions treatable
- High accuracy
- Useful for arrays
- Much information during design stages

Disadvantages

- Automated system required
- Large amounts of data to acquire and process
- Computer analysis required
- Large apertures and wide beams pose some scanning problems (many problems overcome with non-planar scanning)

COMPARISON OF ANTENNA MEASUREMENT METHODS

FAR-FIELD METHOD

Advantages

- Relatively simple procedure
- No complicated analysis required
- Faster for limited information requirements
- Good for comparison

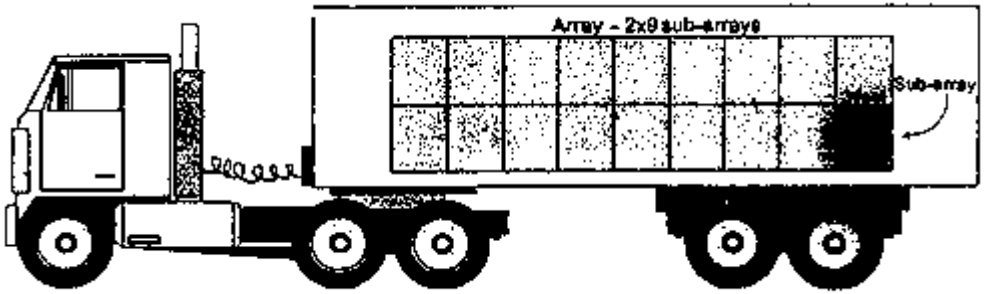
Disadvantages

- Large distances required
- High towers required
- Limited information obtained
- Weather problems
- Interference and security problems

Back Transform Techniques

- Can transform toward the source
- Must eliminate evanescent waves
- Spatial Resolution is about 1 wavelength (as in optics)
- Detect faulty elements
- Adjust excitation
- Merged spectrum

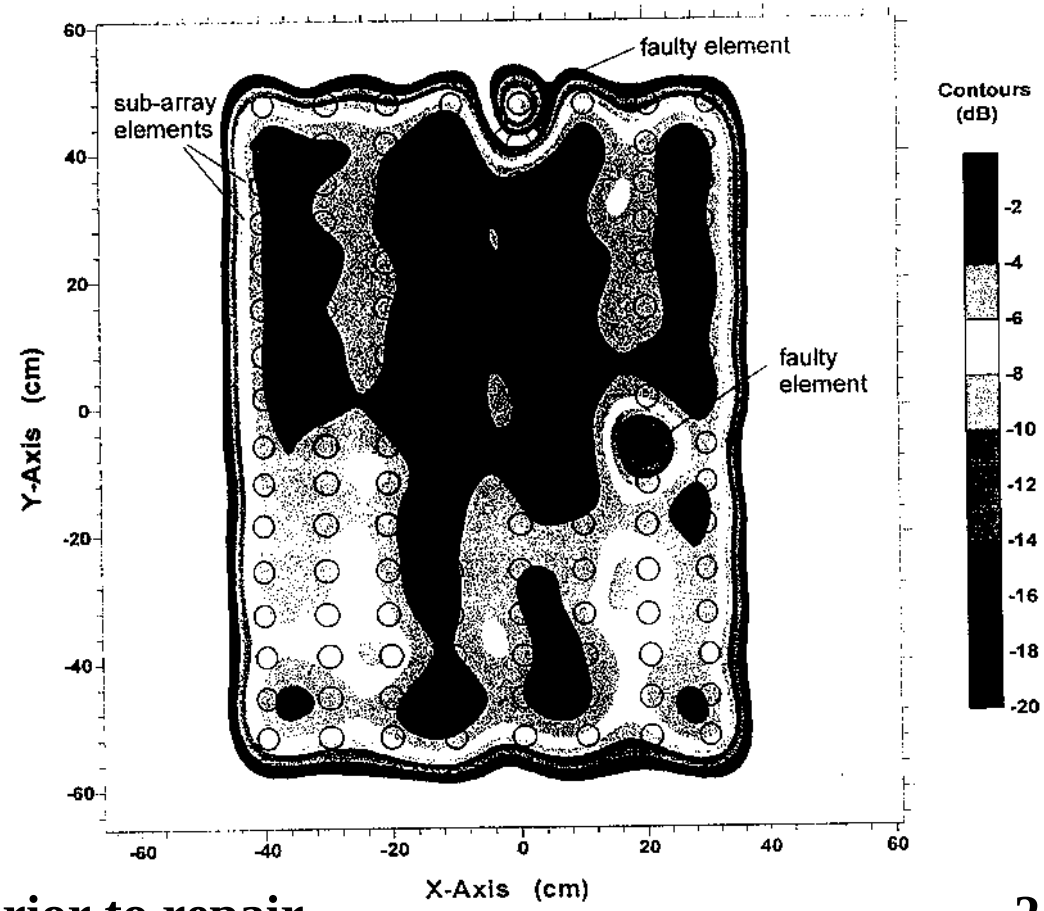
PASS Array Testing



- Array consists of 18 sub-arrays each with 128 elements, 3 bit phase shifters.
- Sub-arrays had high element failure rate due to corrosion problems.
- Gain of the array was not adequate to link up to the satellite.
- Complete repair from contractor would cost $230K and take 2 years
- Sub-arrays were measured to identify faulty elements using the planar near-field measurements at NIST.
- Air Force personnel performed on-site repairs.
- Planar near-field technology was transferred to Air Force.
- Complete repair by McClellan Air Force Base costs $80K and required only 3 months.

Aperture Amplitude

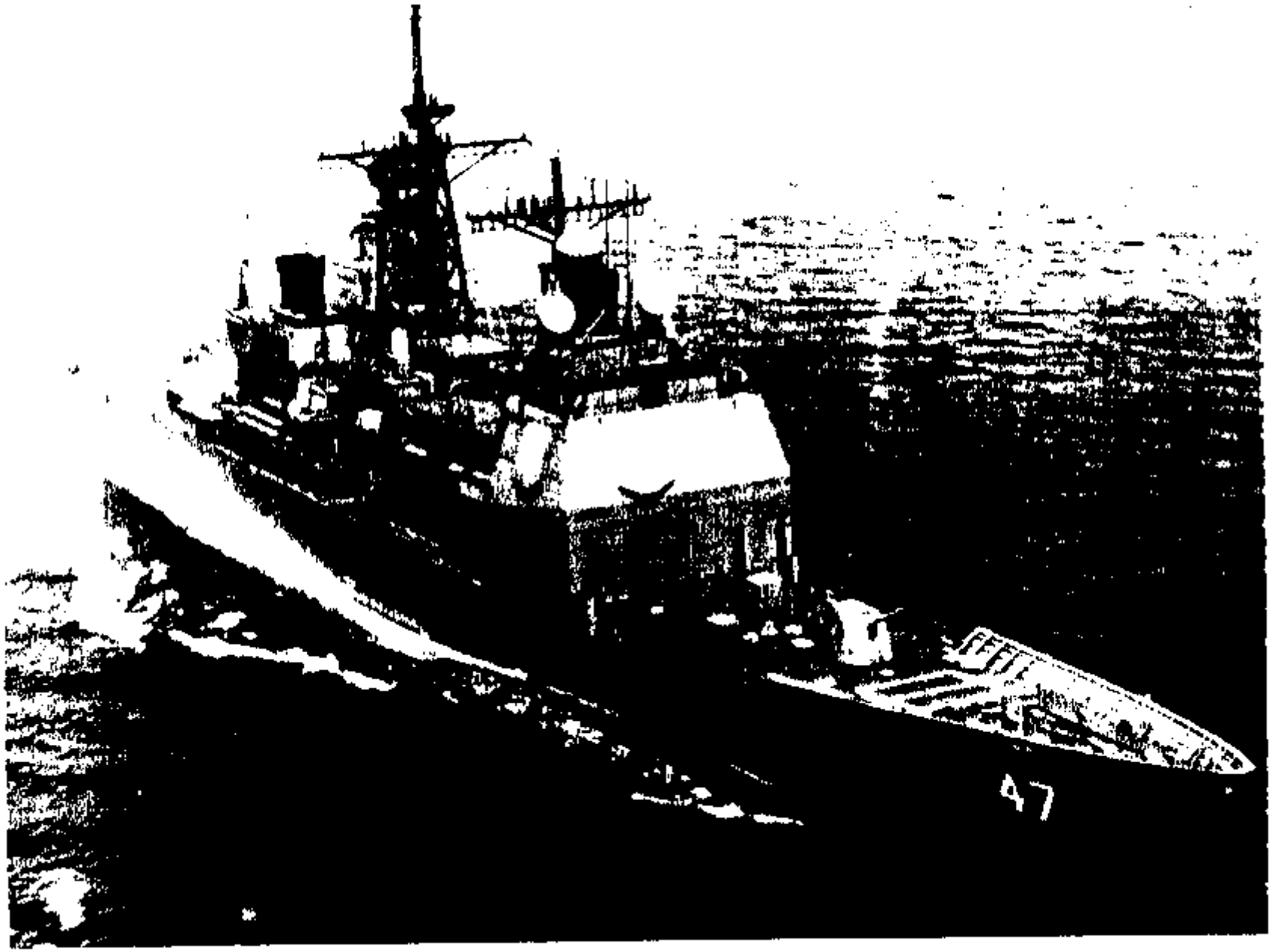
8 X 16 element sub-array



gain prior to repair **24.80 dB**

gain after faulty elements repaired **25.08 dB**

gain after bad sma connecter replaced **26.00 dB**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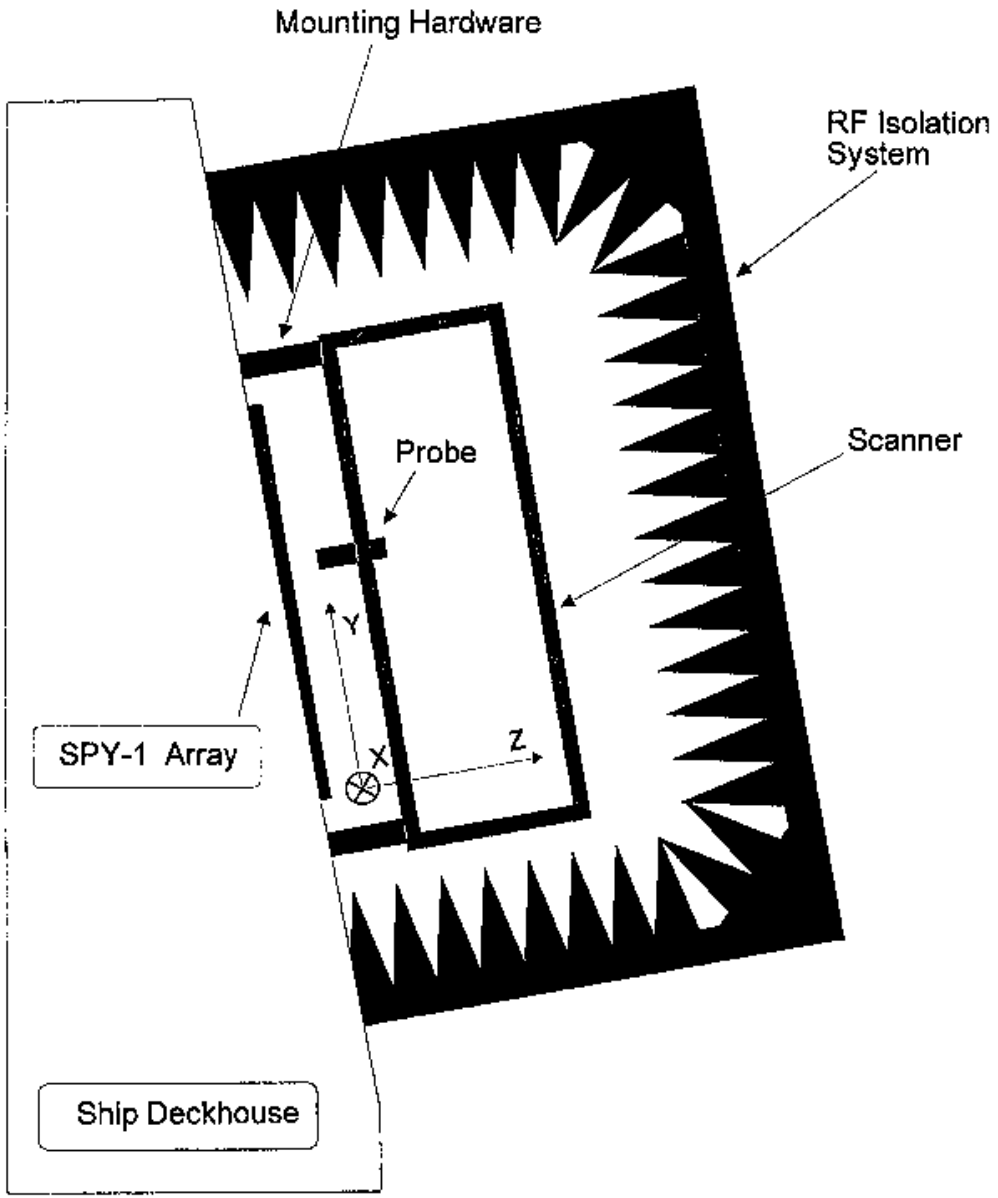
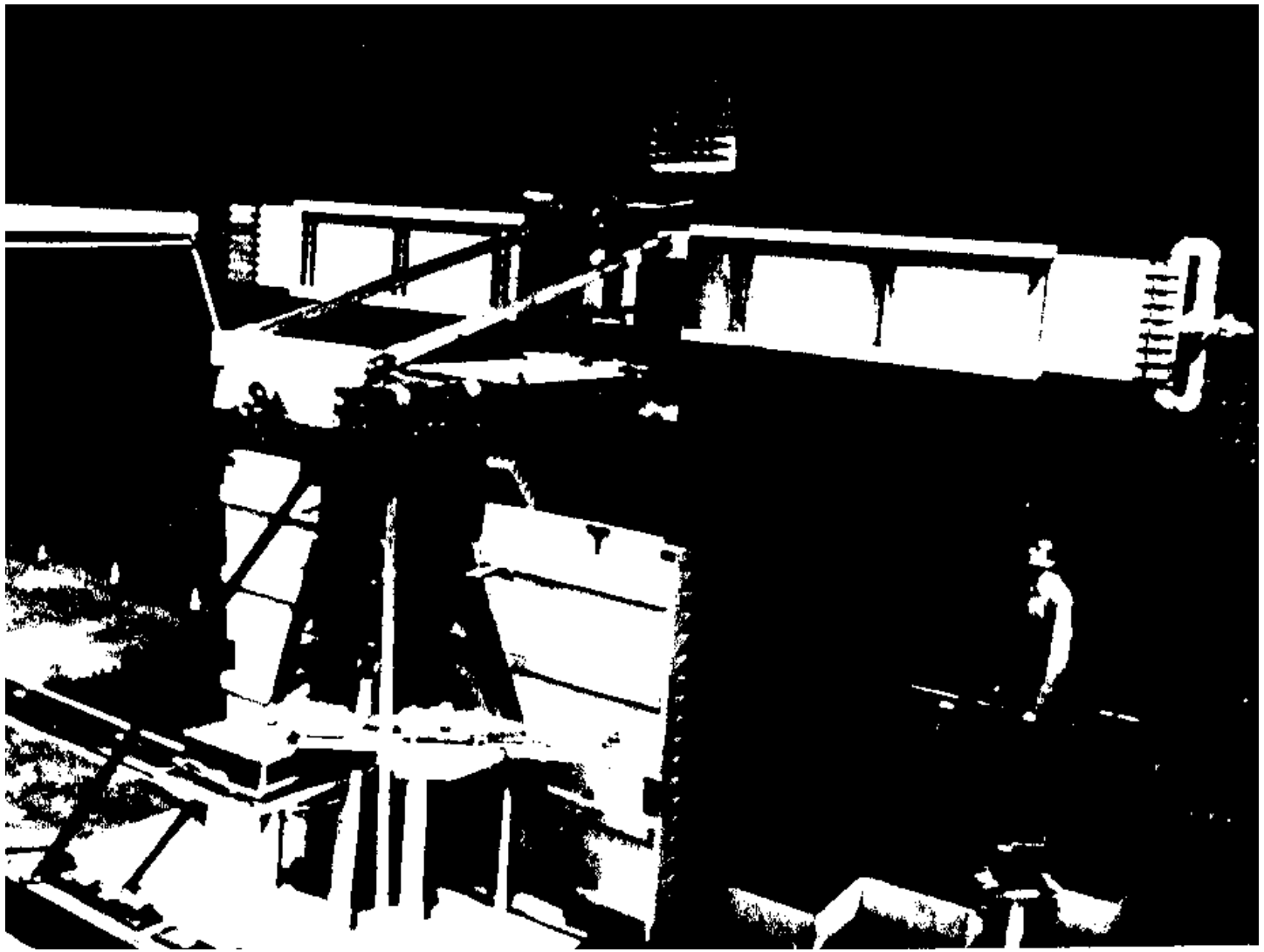

Mounting Hardware
RF Isolation System
Probe
Scanner
Y
X
Z
SPY-1 Array
Ship Deckhouse

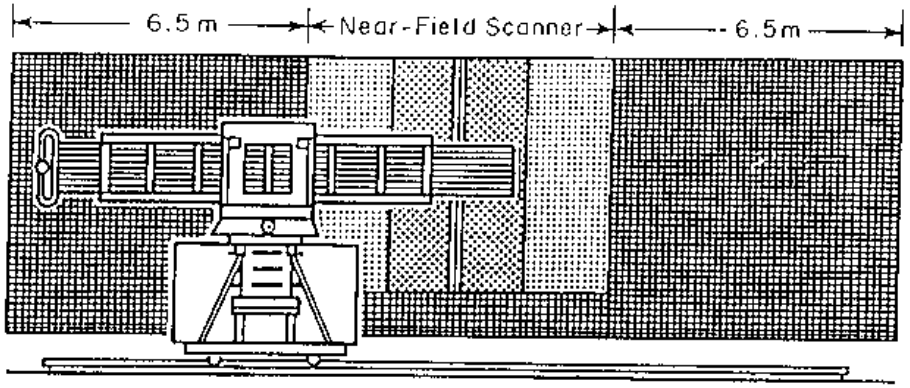
Low Slide-Lobe Antennas

- ULSA
- AWACS
- Fire Finder
- THAAD

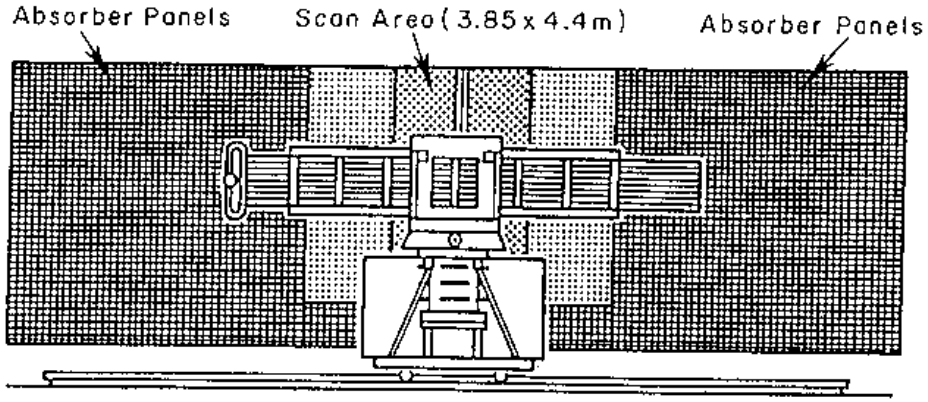
Measurement Goals

- ±5 dB at -55 dB rel peak
- ±20 s beam steering
- ±0.2 dB gain

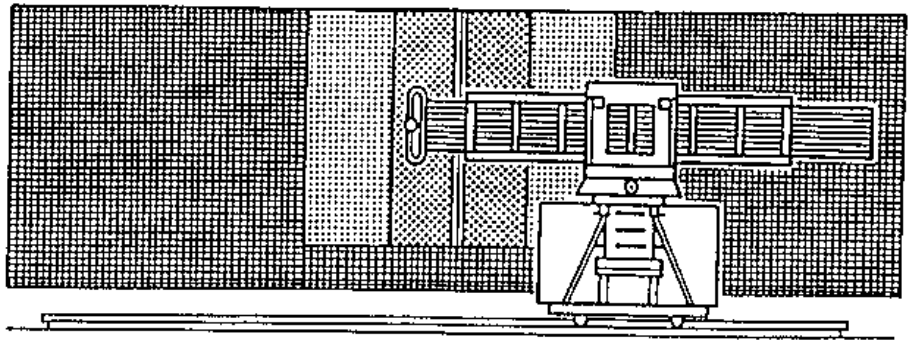




ANTENNA ON NEAR-FIELD SCANNER, POSITION 1



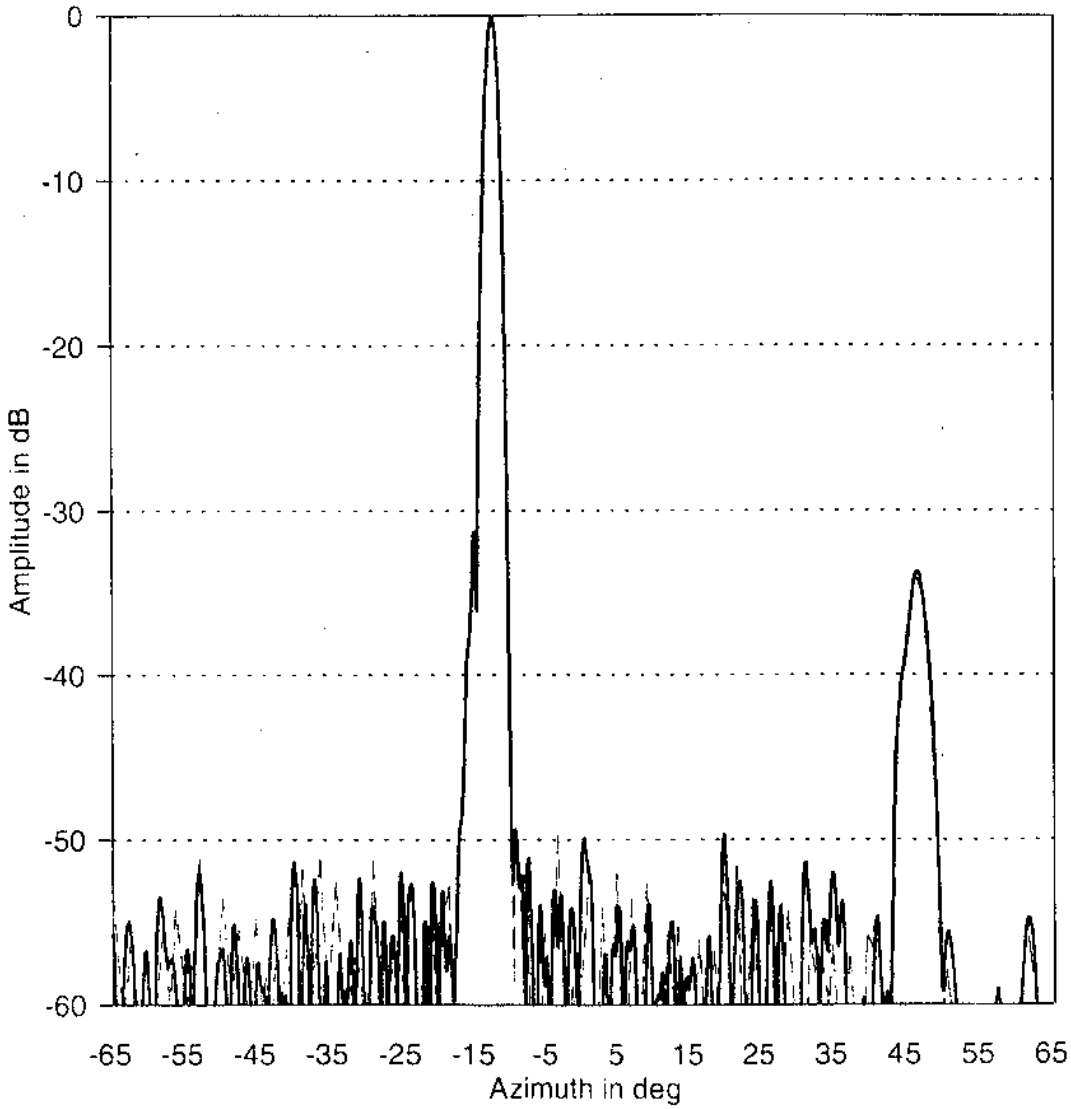
ANTENNA ON NEAR-FIELD SCANNER, POSITION 2



ANTENNA ON NEAR-FIELD SCANNER, POSITION 3

Comparison of NF and FF Results

Frequency=3.0 GHz

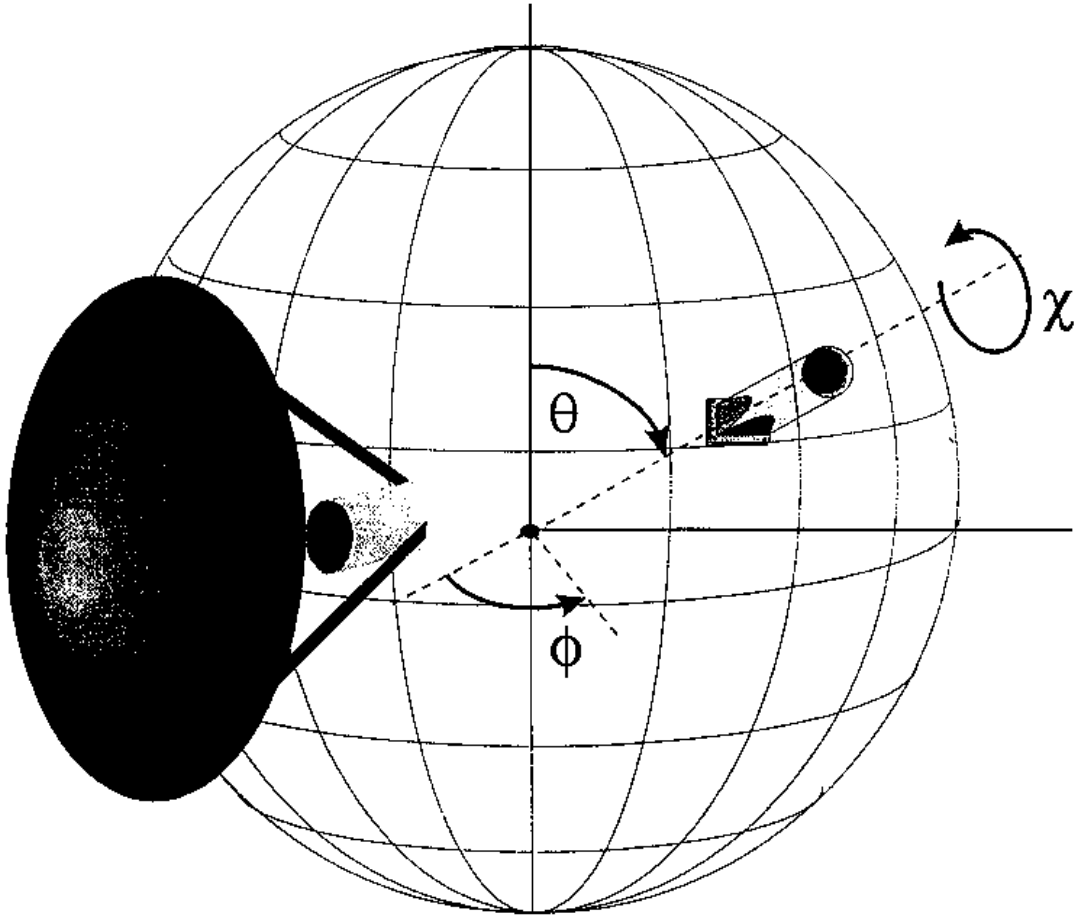


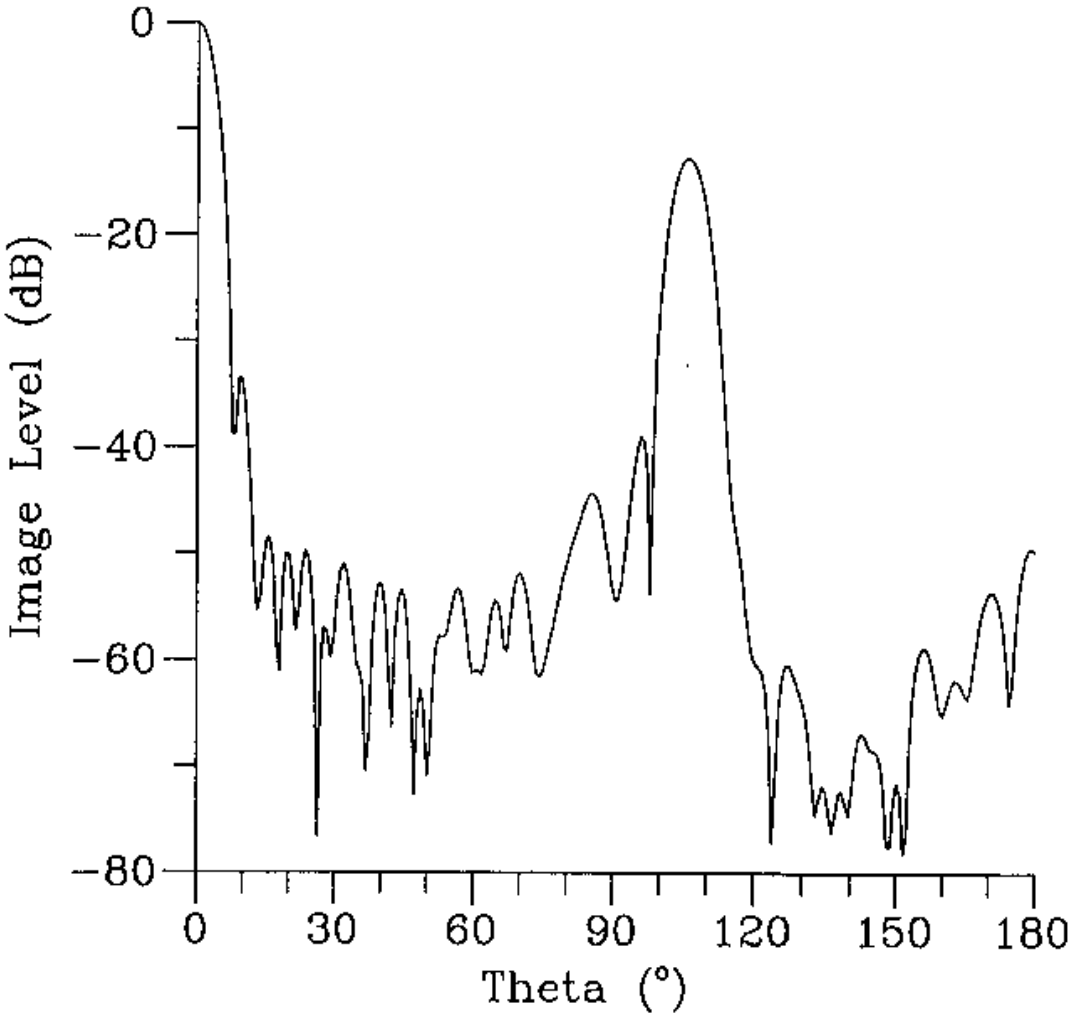
Quiet-Zone

field quality **limits the accuracy** of RCS and antenna measurements on compact and far-field ranges. Incident field information can be used to

- assess measurement **uncertainty**
- **compensate** measurements for nonideal illumination
- **image** sources of unwanted radiation

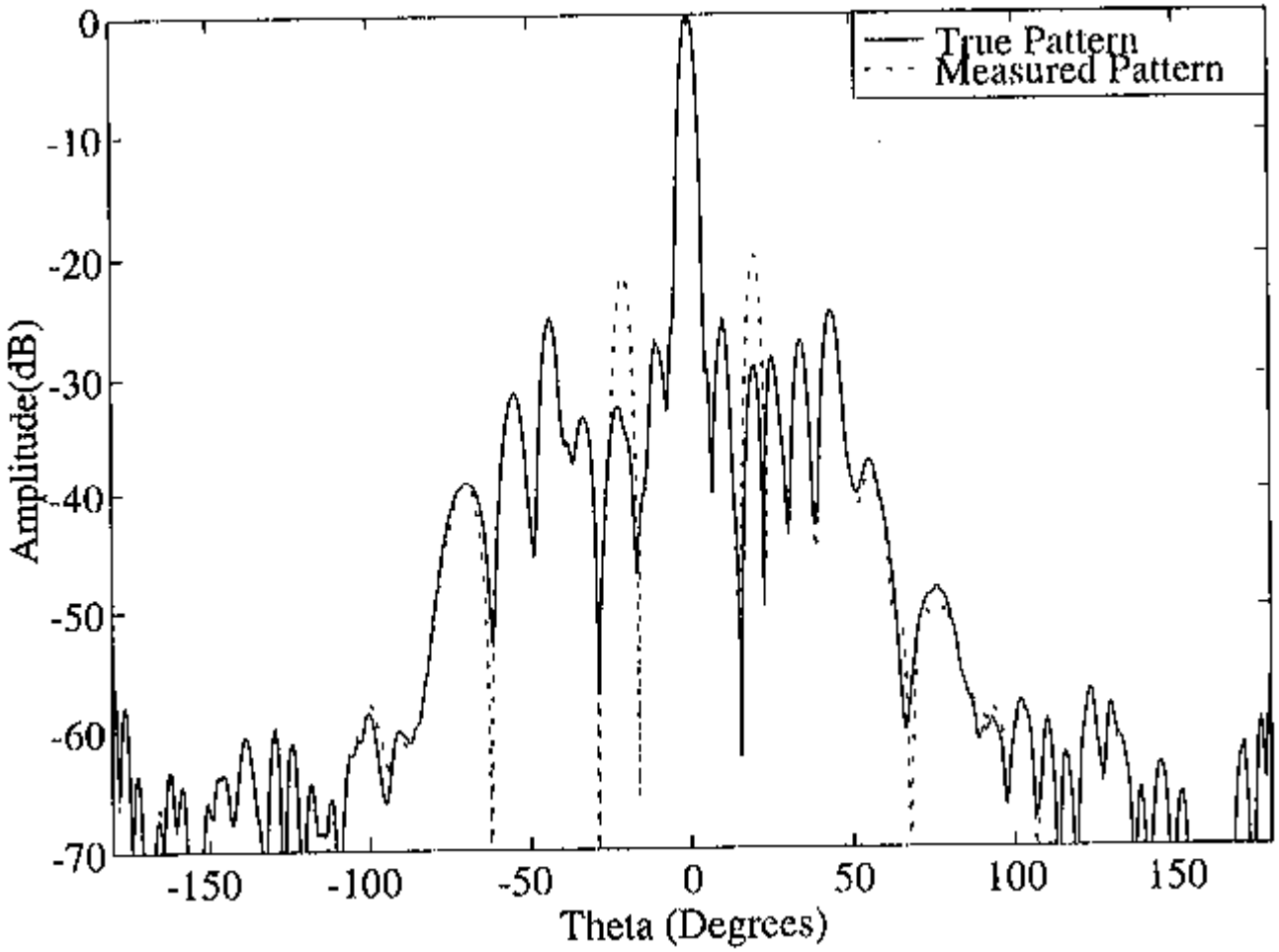
Our SAR/SNF Configuration



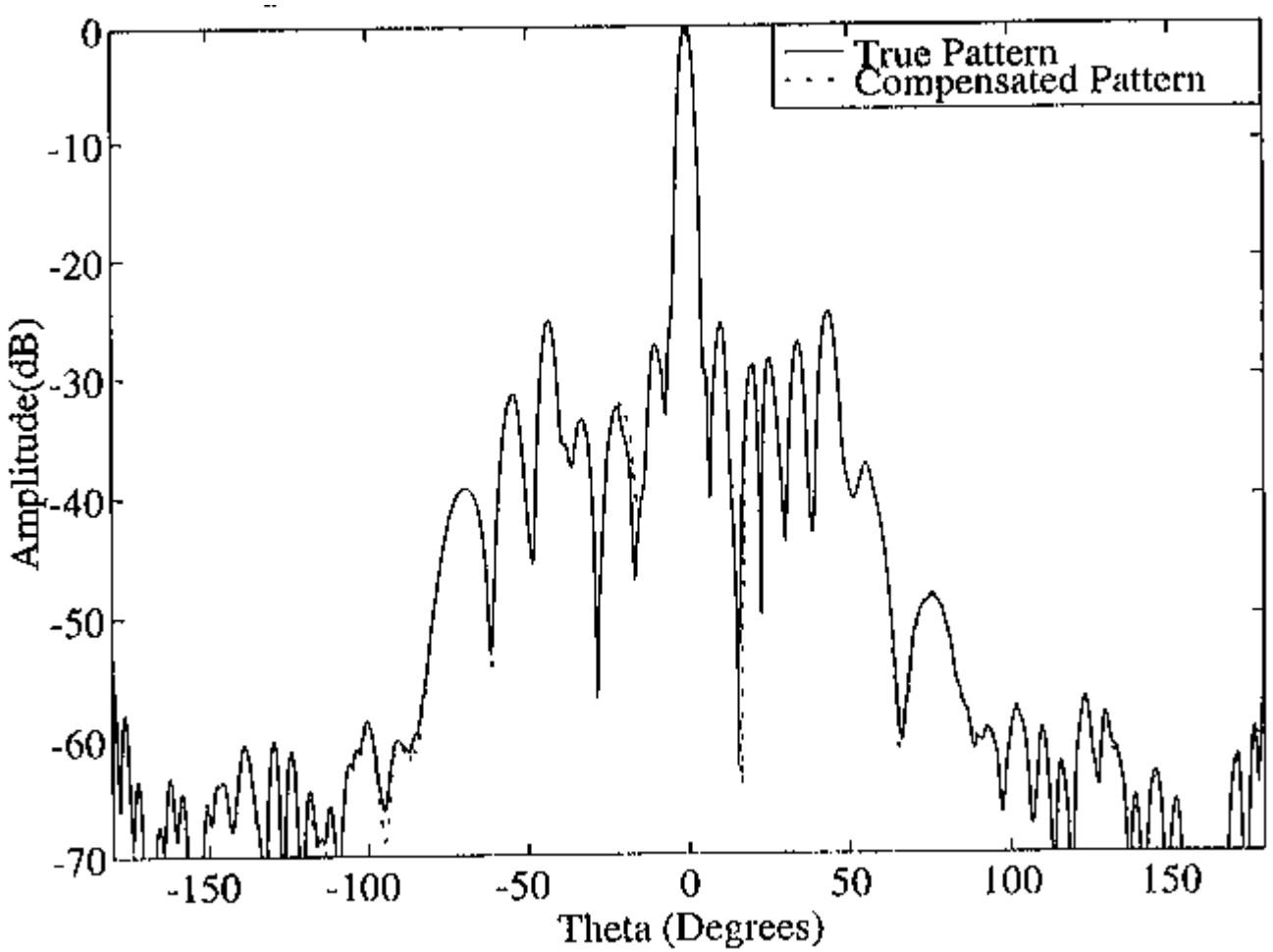


A window function has been applied to increase contrast.

Comparison of True and Measured Patterns



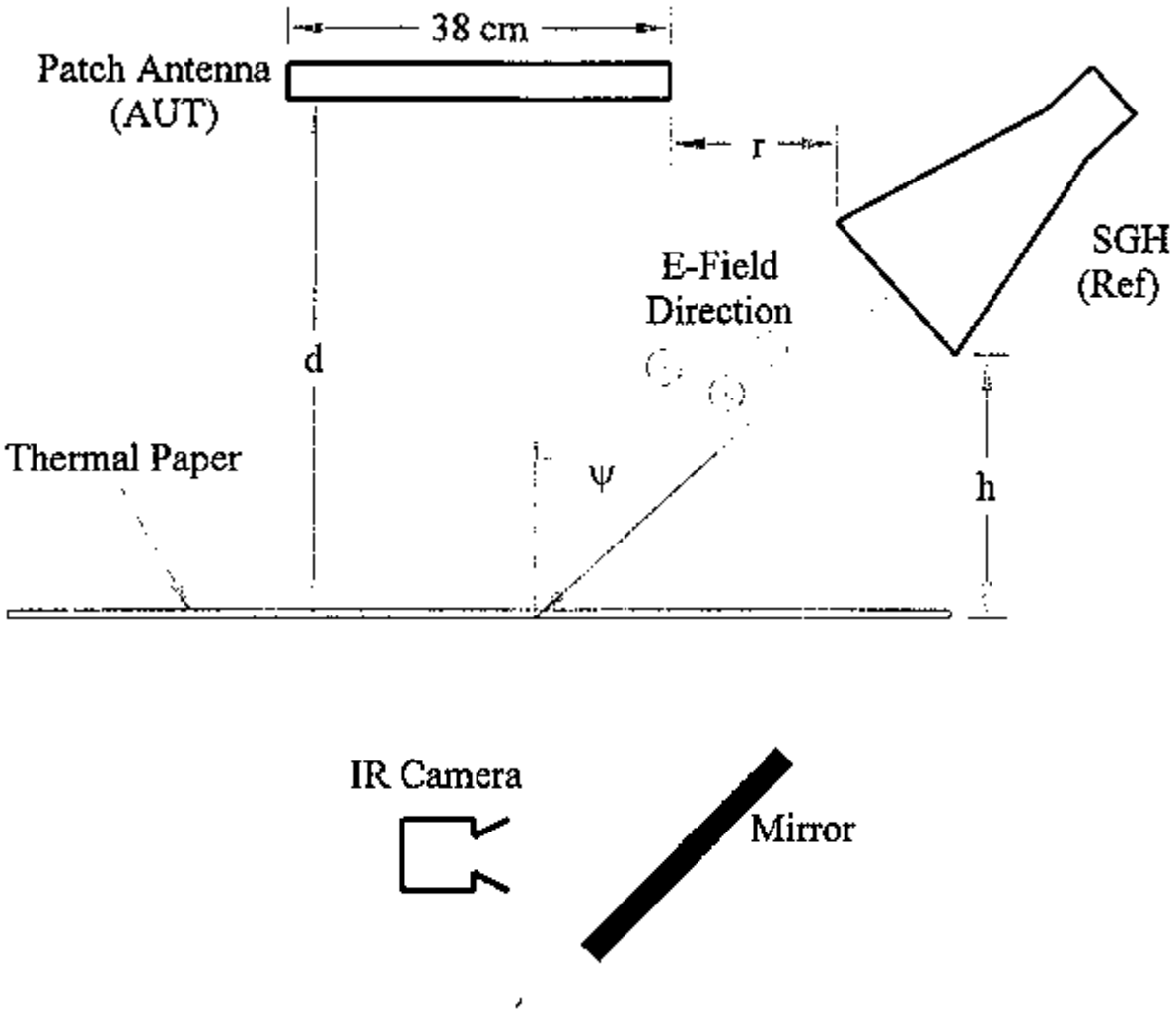
Comparison of True and Compensated Patterns



Thermal Imaging/Holography

- “Phaseless measurements”
- Interference pattern recorded with a thermal camera
- Sensitivity is an issue
- Suitable for production testing?

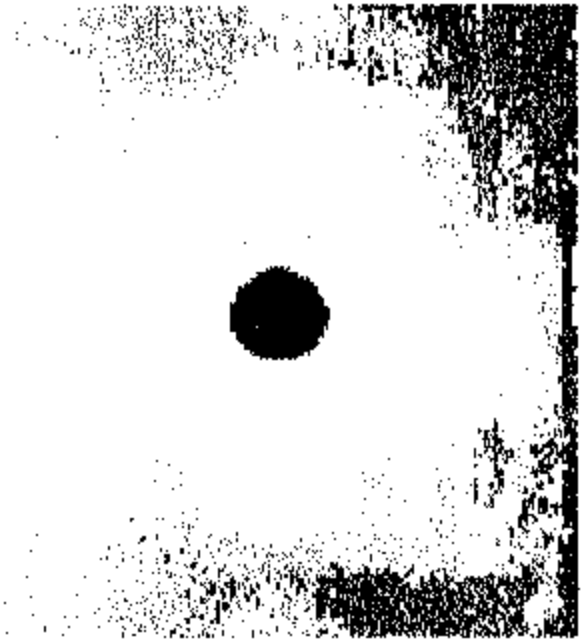
Holographic Recording of Near Field



Antenna, Reference Horn, and Resistive Screen

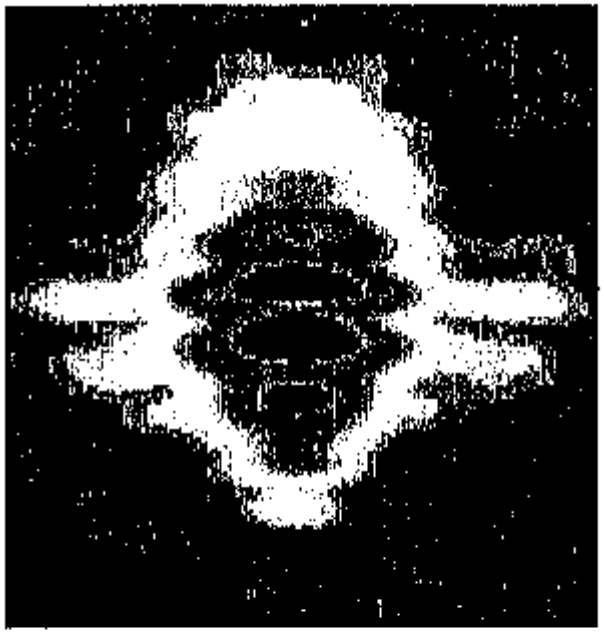
Infrared Images of Antenna Near Fields

Reference Horn

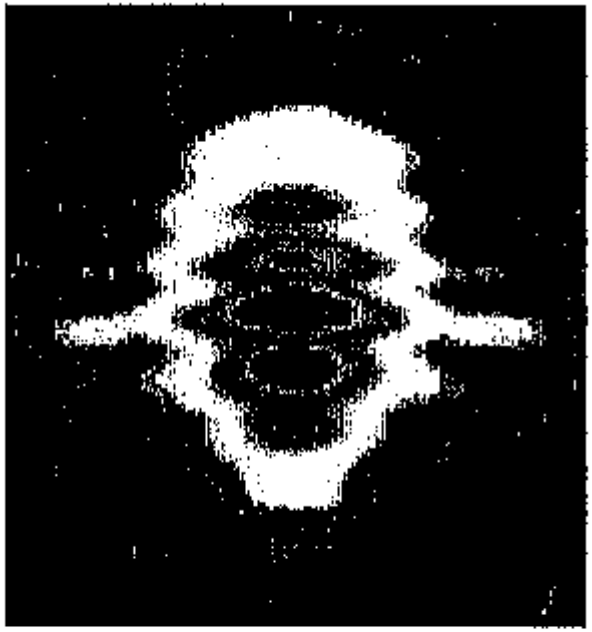


Patch Array

Holograms of Patch Array with Horn Reference



0 Degrees



180 Degrees

Comparison of Far-Field Patterns