Electromagnetic Range Consortium Overview

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Electromagnetic Range Consortium - Background

- Established 1984
- Memberships to companies
- Government people invited as company member guests
- 2004-05 Membership, $22,000 per year
- Research efforts at OSU-ESL on EM measurement issues
- Annual technical meeting
    - Present results of research and related new technology
    - Members decide on important topics for next year
- Consultation and measurement in ESL range offered to each member annually

EM Range Consortium Mission Statement

- Perform research on new advances in electromagnetic measurements
- Educate graduate students in EM measurements
- Update our members on recent advances in EM measurements
- Support the membership with consulting and measurements in the ESL range

EM Range Consortium Membership

- Raytheon
- General Electric Aircraft Engines
- Northrop Grumman
- Boeing Tulsa
- Boeing St. Louis
- MI Technologies

EM Range Consortium
Range Certification Issues

- Top-Down (Cost Effective) Certification Approach
- Range Error vs Range Uncertainty
- Inter-range comparisons
- Participation in Range Certification Group Meetings
- ESL Range as Guinea Pig for Certification Approaches

EM Range Consortium
Range Operators Workshop

- The best measurement range depends on a talented range operator for good data
- One-layer-deeper information gives operators added insight
- Empower range operators for full participation in the measurement process
- Best practices in calibration, set-up, range process parameters, range data documentation
- Offered to the public, but consortium members get a $500 discount

Range Operators Workshop
Agenda I

- Day 1
- Introduction – Basic Measurement Concepts
- In Class
  - Data Processing 1 – Frequency and Time Domain
  - Data Documentation Best Practices
- Hands-On
  - Initial Measurement System Checkout Procedure
  - Initial Target-Related Checkout Procedure
- Summary/Discussion

Range Operators Workshop
Agenda 2

- Day 2
- Introduction – Calibration and Background Subtraction
- In Class
  - Data Processing 2 – Patterns and Images
  - Normalized Antenna Transient Pattern Images
- Hands-On
  - Target Setup Procedures
  - Overall Measurement Plan Evaluation
- Summary/Discussion

Range Operators Workshop Agenda 3

- Day 3
- Introduction – Range Evaluation
- In Class
    - Field Probe Processing
- Hands-On
    - Range Field Probing
- Summary/Discussion

Range Evaluation and Data Processing

- Range Evaluation
  - Quiet zone field probing
  - Diagonal flat plate test
  - Stray Signal localization
- Data Processing
  - Advanced radar imaging techniques
  - Image editing and data reconstruction

Uncertainty Workshop Paper Results from 1998

- Most Significant Error Sources
  - Quality of target zone fields
  - Target support interactions
  - Cross Polarization
  - Calibration target uncertainties
  - Mechanical Drift
- Any given RCS range has error sources
- These error sources impact RCS measurements
- The impact can be characterized as random or deterministic

Stray Signal Analysis

- Near field focusing
- DOA estimation techniques
  - MUSIC algorithm
  - Beam forming
  - Parameter estimation techniques
- Time of Arrival (TOA) Estimation Techniques
  - Conventional Fourier transform
  - Superresolution techniques
  - Sinograms
  - Probe data calibration
- Time and Direction of Arrival (TADOA) Estimation
- Time domain near field focusing

Advanced Radar Imaging Techniques

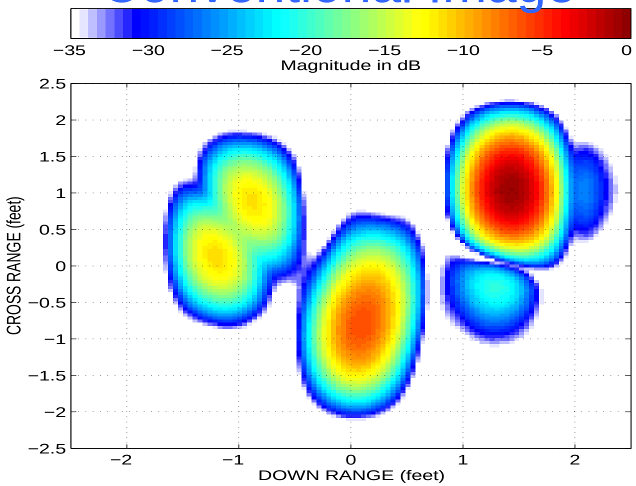
- Imaging using data extrapolation
- Modified Prony's method
- MUSIC Algorithm
- ML Algorithm for parameter estimation
- Time-Frequency distribution

Quiet Zone Field Probing

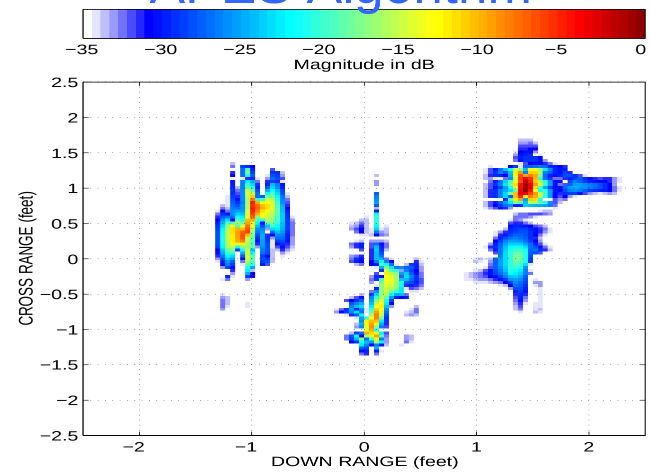
- Direct measurement of quiet zone field quality
  - Taper
  - Ripple
  - Phase uniformity
  - Cross-polarization
- Probe data can be processed to localize stray signal sources

Images of an Experimental Target (six corner reflectors)

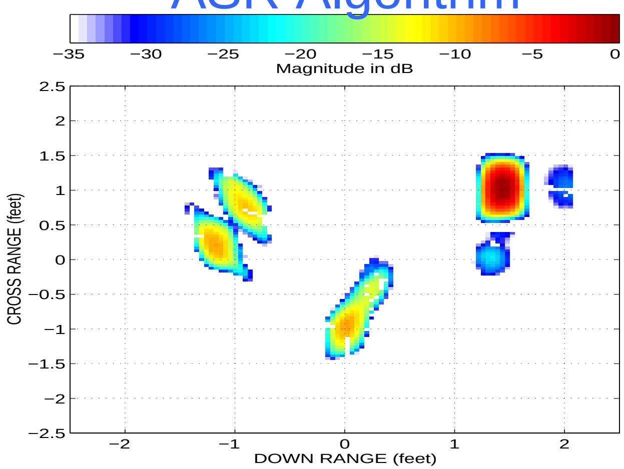
Conventional Image



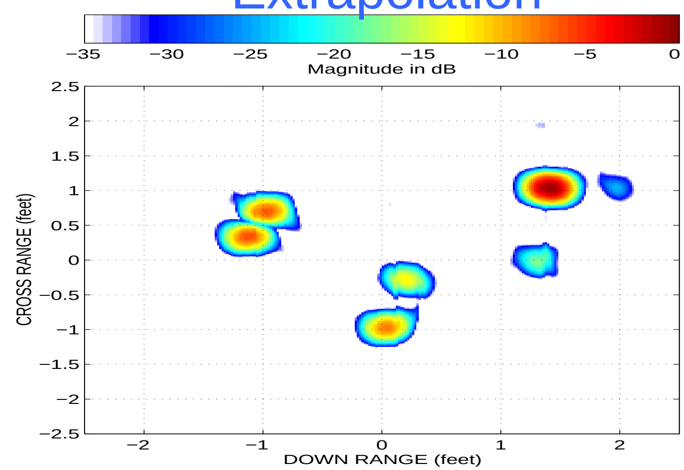
APES Algorithm



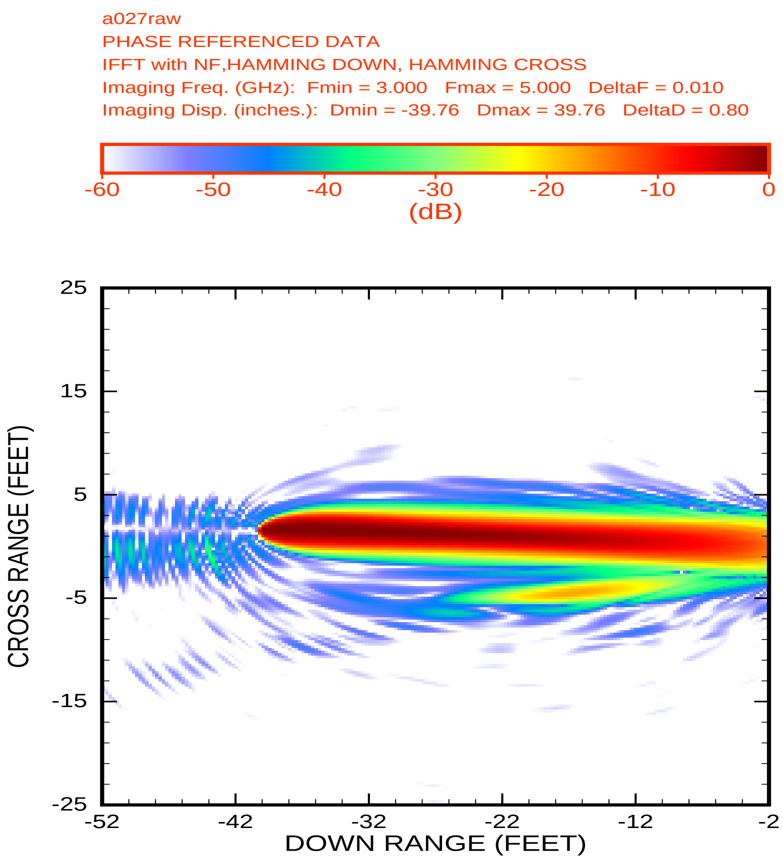
ASR Algorithm

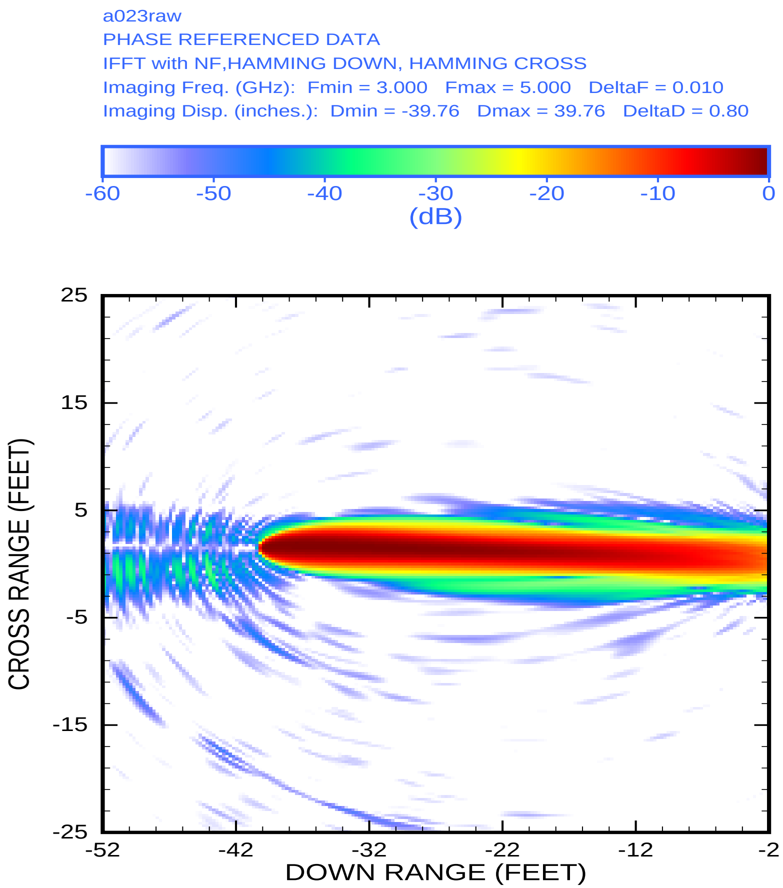


Extrapolation



Stray Signal Analysis using Time Domain Near Field Focusing



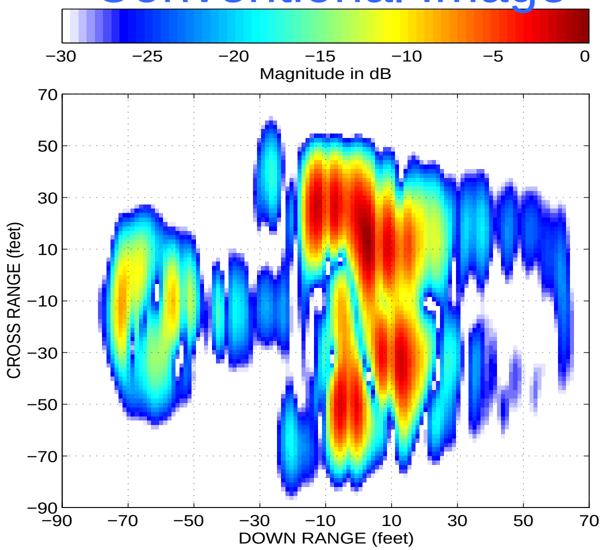


No-fence probe data

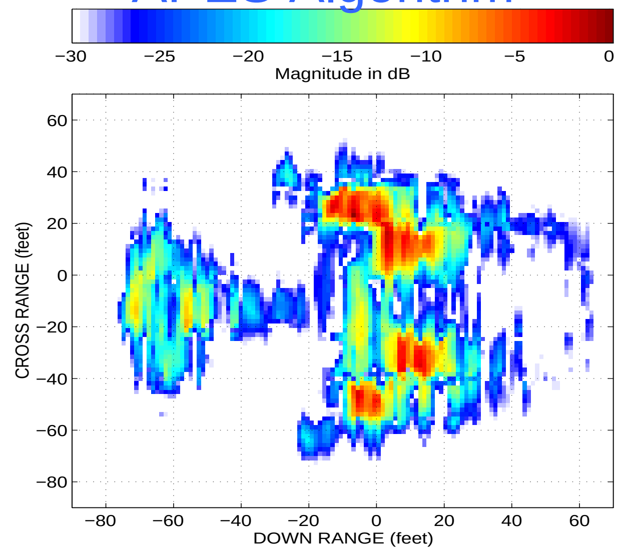
Probe Data with R-card fence

Images of KC-135 in flight

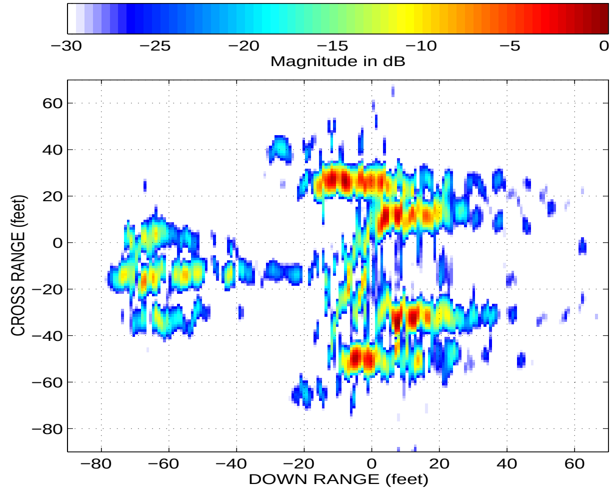
Conventional Image



APES Algorithm

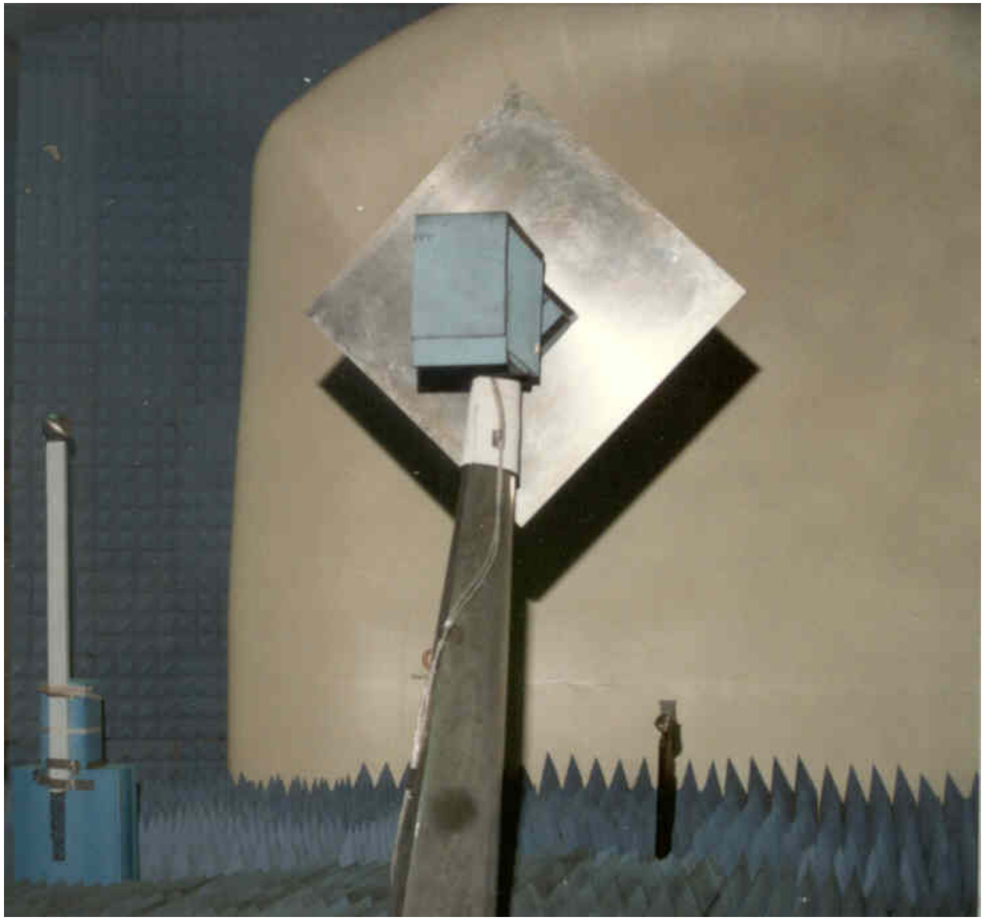


Extrapolation



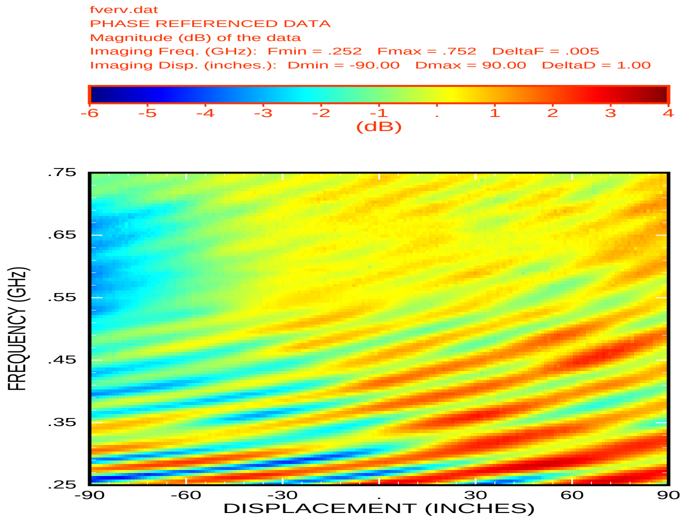
Diagonal Flat Plate Test

- Can identify very weak stray signals
- ISAR imaging techniques can be used to localize stray signals
- Can't measure field quality directly

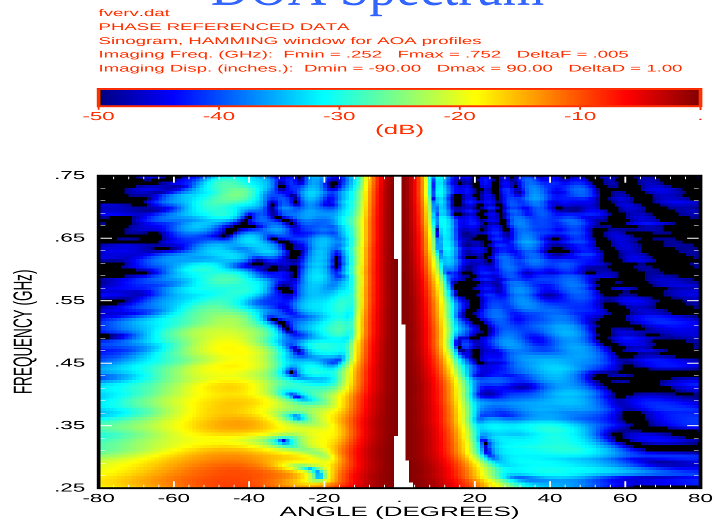


Examples of Stray Signal Analysis

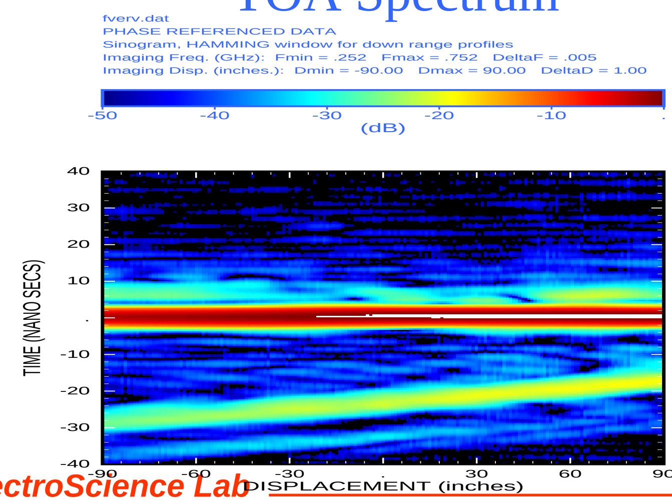
Probe Data



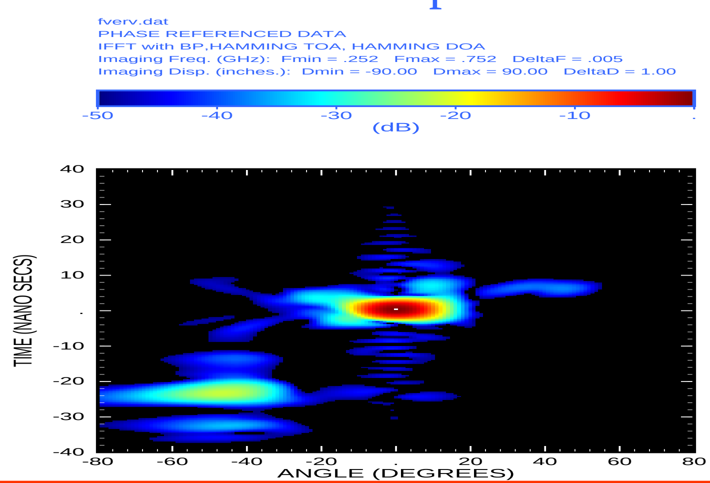
DOA Spectrum



TOA Spectrum



TADOA Spectrum



Issues Identified for FY 2002

- Range Standards for Antenna Measurements
  - *Standard Inter-Range Comparison Antenna*
  - *Antenna Range Standards*
  - *Advanced Antenna Measurement Practices*
- New Feed Antennas
  - *Polarization performance off principal axis*
  - *Use for Field Probing, Near Zone, etc*
- Continuation of Workbench (Analysis) Devt.
- Photonics

2002 Range Consortium Issues

- Consulting on site
- Sponsor pays travel, but gets one day of consulting free
- Presentations/planning in September?
- Range Operators Short Course On Site?
- Membership cost
  - *One year notice: increase to match inflation?*