Projects in Electrical & Computer Engineering 2007-2008

Alternate Navigation Plan: Terrestrial Beacons

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Sponsor: USCGA ECE Section

Outline

- Vulnerabilities GPS
- eLORAN and DGPS ranging alternative
- Project Results: testing and MATLAB

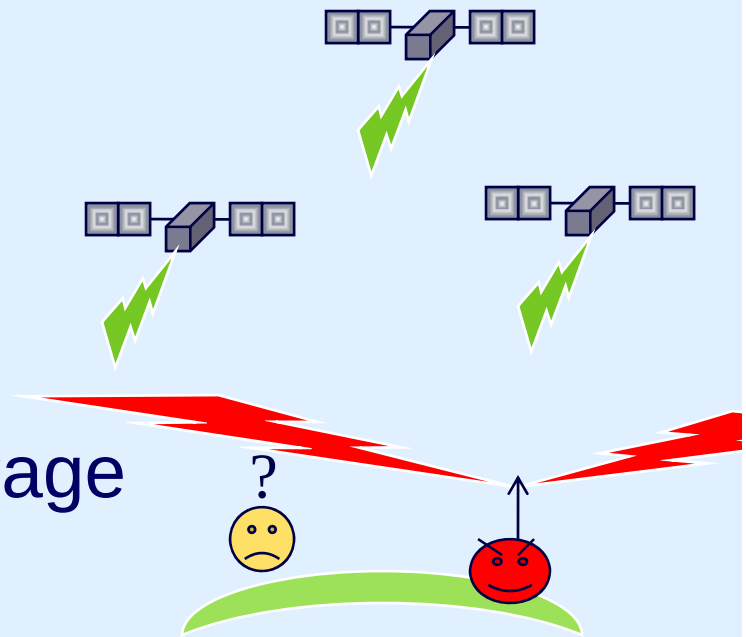
Vulnerabilities of GPS

- 2001 Study by Department of Transportation
- Current research by 1/c Ellsworth

Boat from James Bond: Tomorrow Never Dies.

DGPS as Supplement

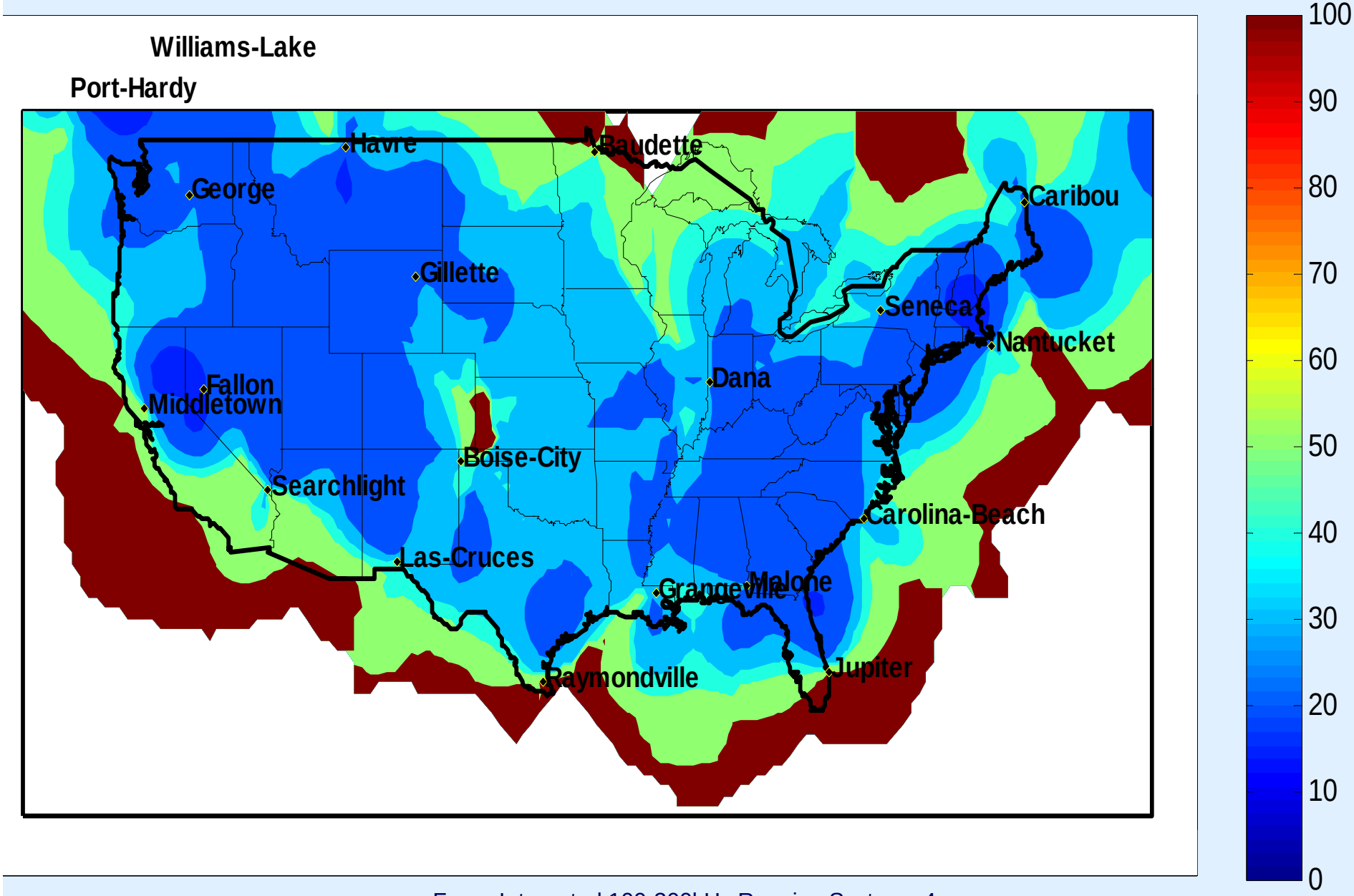
- Selection Criteria
  - Standardized message format
  - National Coverage
- DGPS Signal
  - USCG regulated sites
  - Coastal and Inland Coverage
  - Long term life-cycle



Horizontal Dilution of Precision Problem (HDOP)

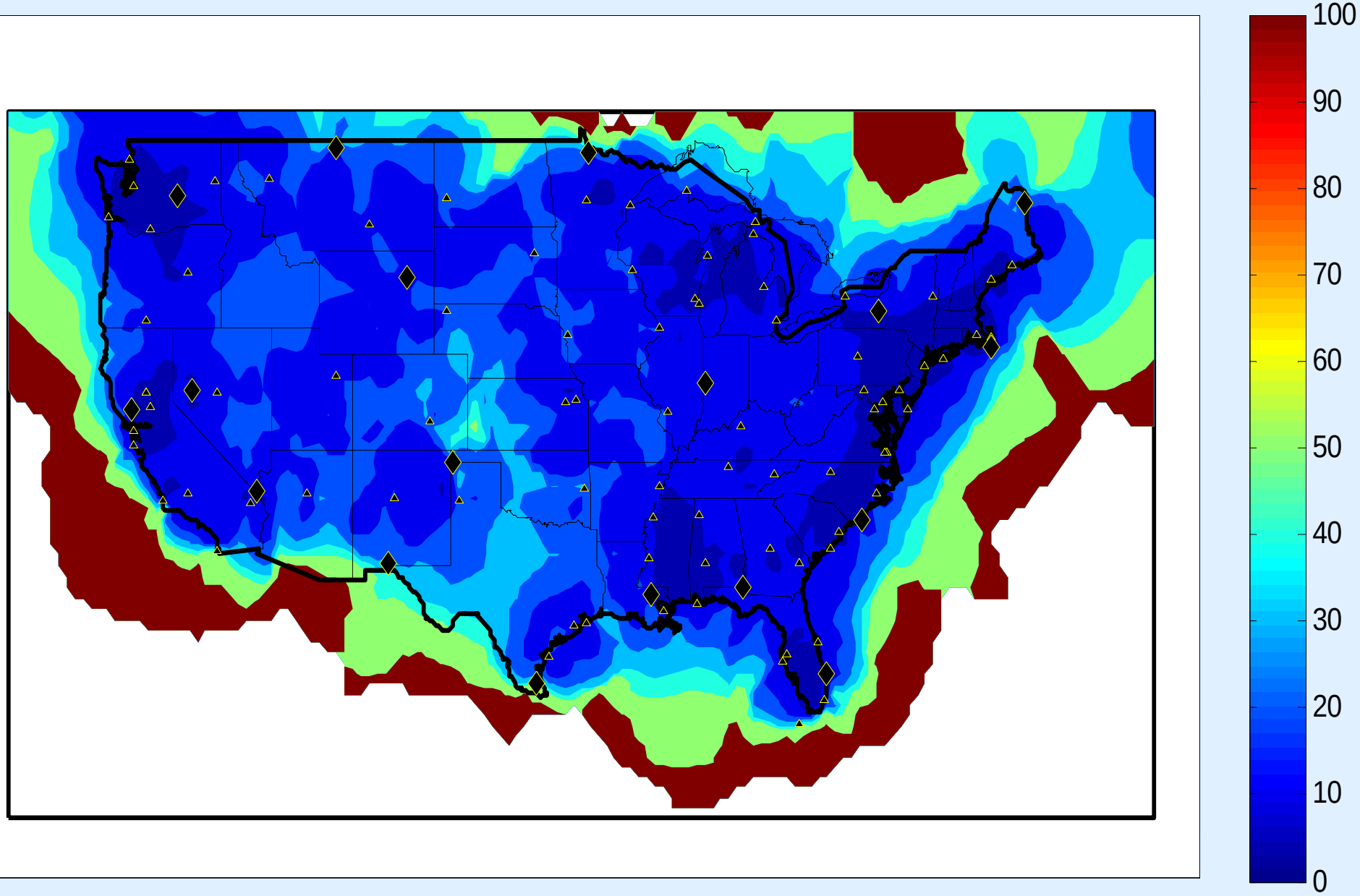
- eLORAN (20/10-m accuracy)

HDOP for Loran only



From: Integrated 100-300kHz Ranging System v4

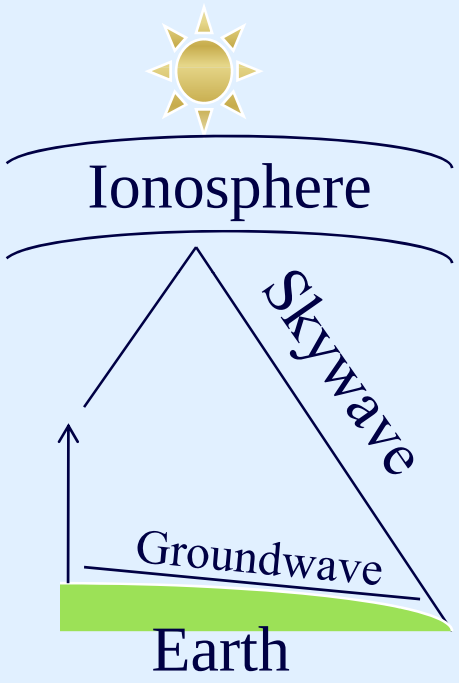
HDOP for Combined Loran and Beacons



From: Integrated 100-300kHz Ranging System v4

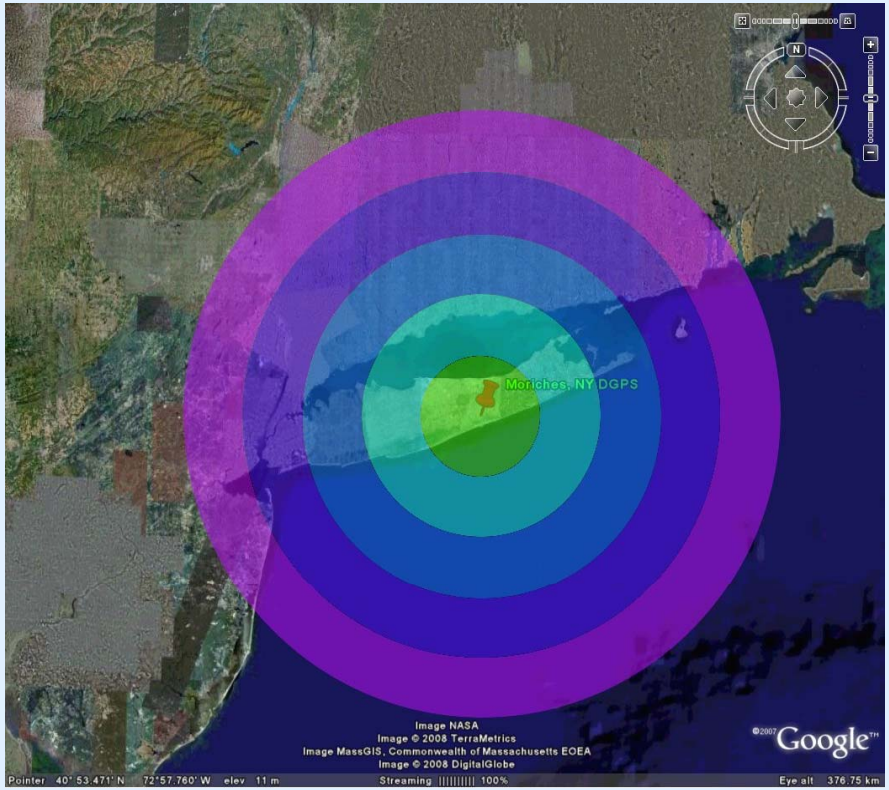
Complications of DGPS

- Long Range Signal degradation and corruption
- System Timing Standard
  - Independent of GPS
  - Accurate
- Cesium based clocks – C2CEN



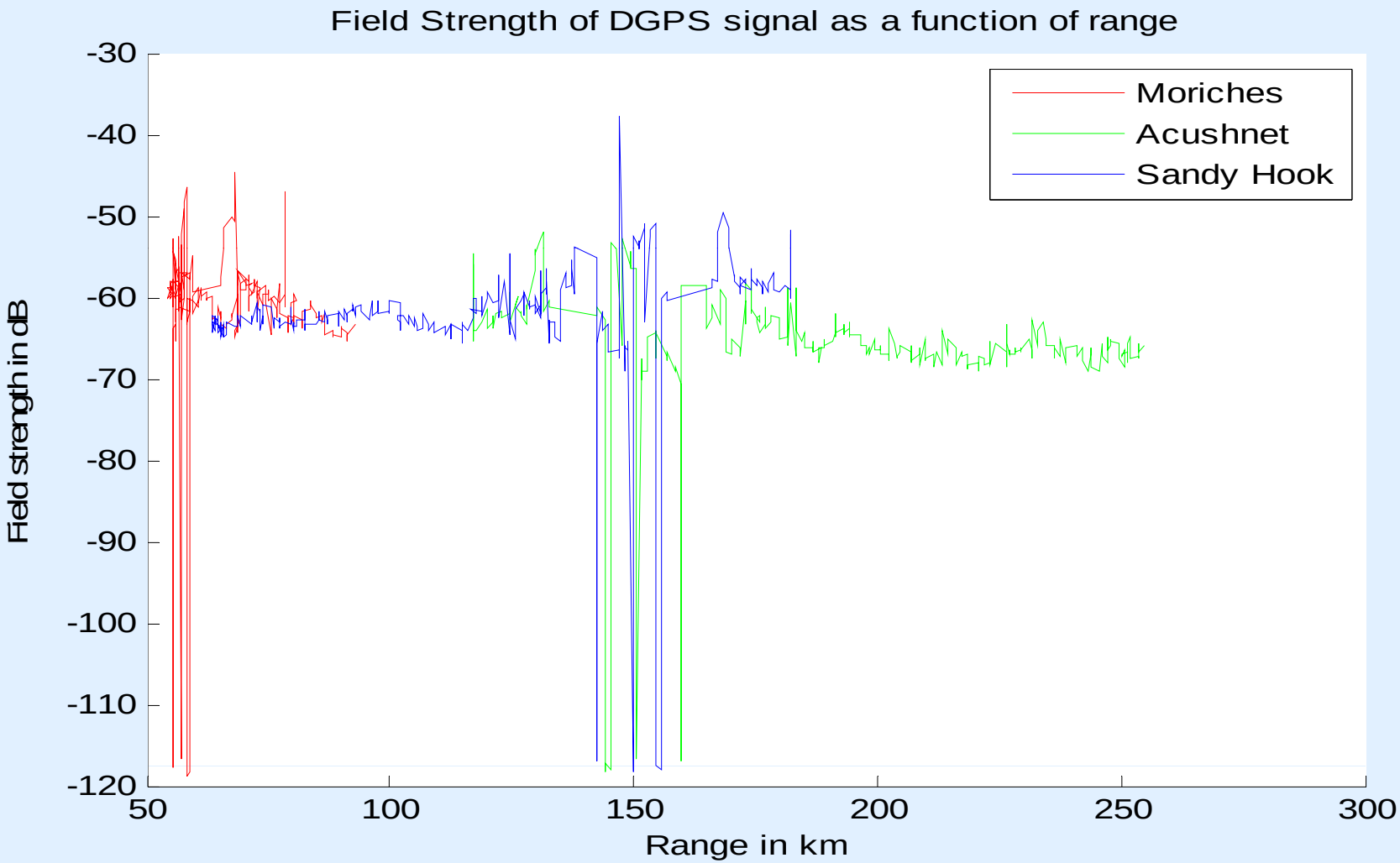
Results

Field Strength Test



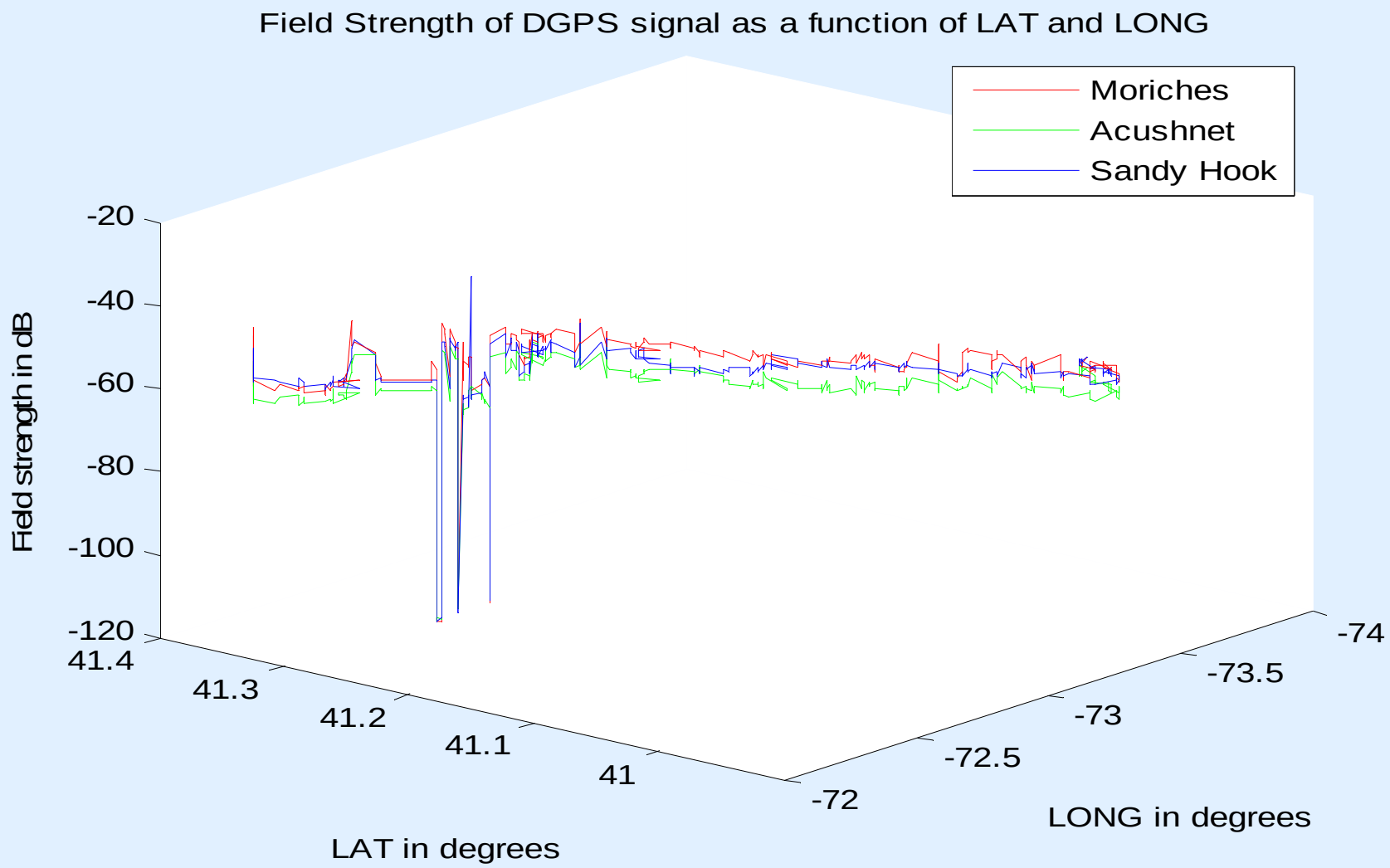
Results

Field Strength Results



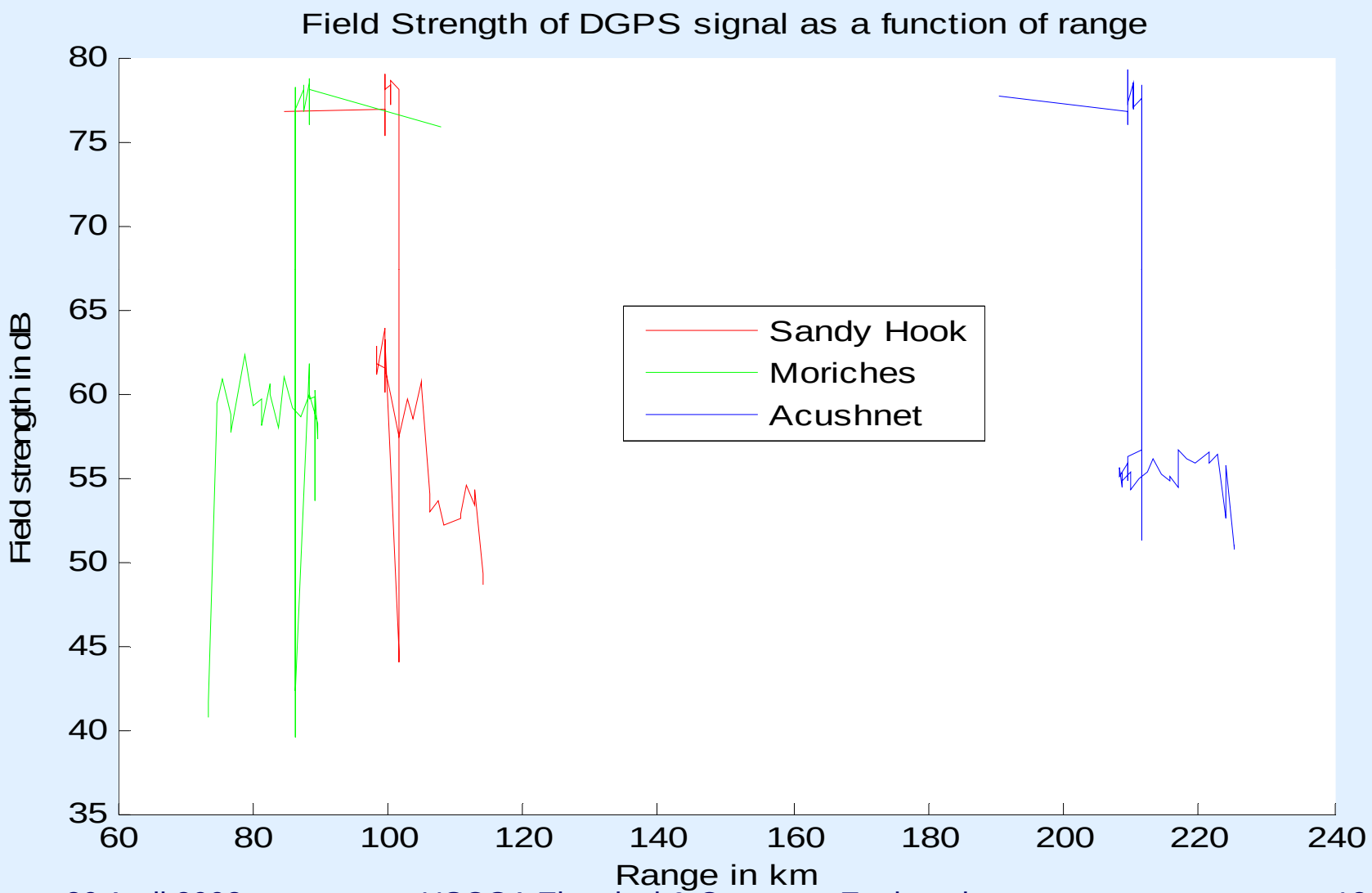
Results

Field Strength Results



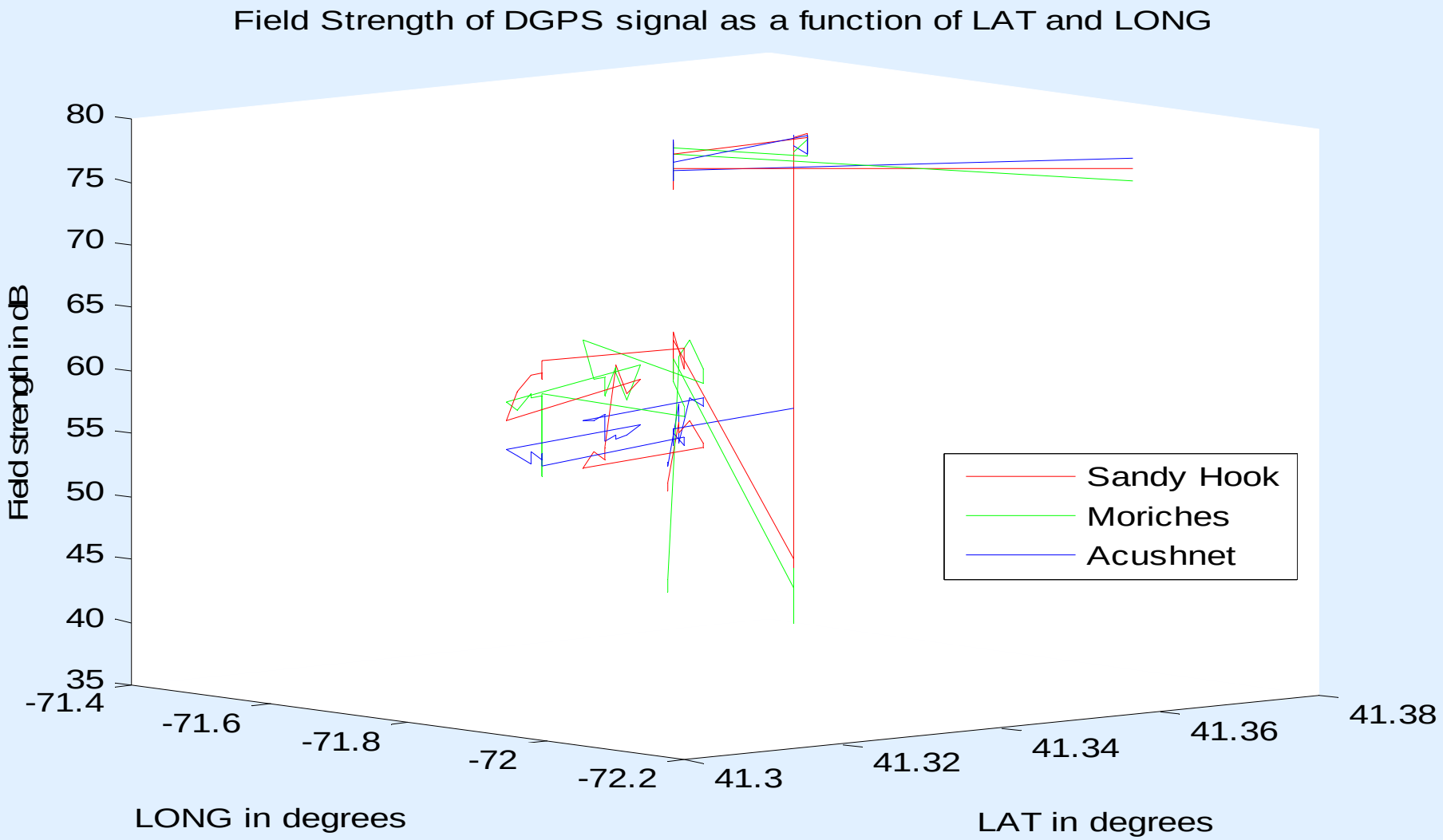
Results

Field Strength Results



Results

Field Strength Results

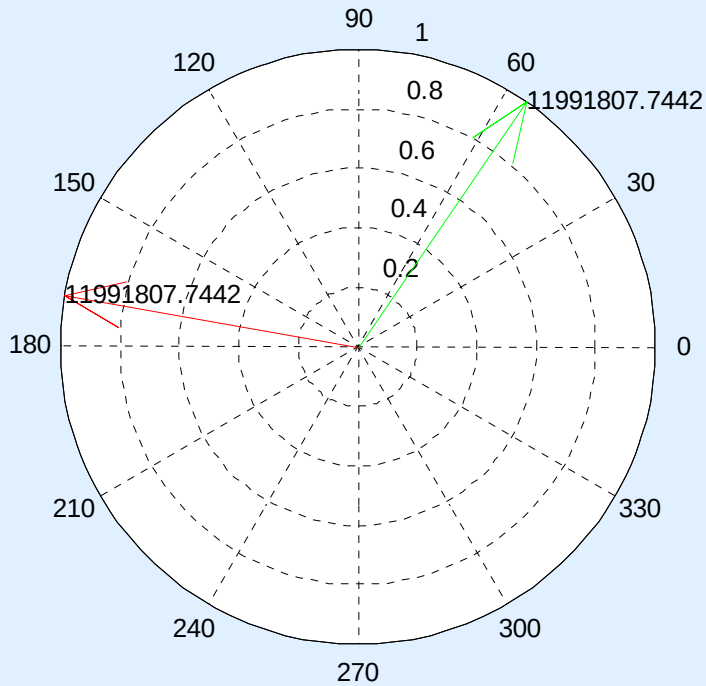


Converting Phase to Range

- Phase Difference
- Phase Ordered Pairs

Converting Phase to Range

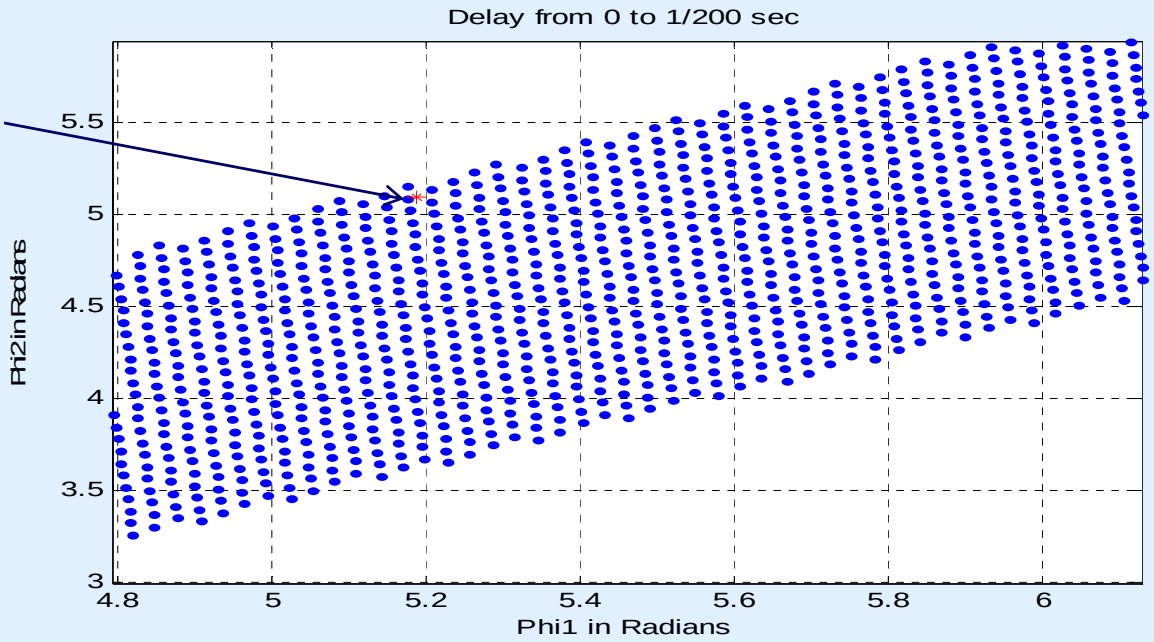
- Phase Difference
  - Accuracy (in meters) is: 3
    Discrimination required (in radians) is: 1e-008



Converting Phase to Range

- Phase Ordered Pairs

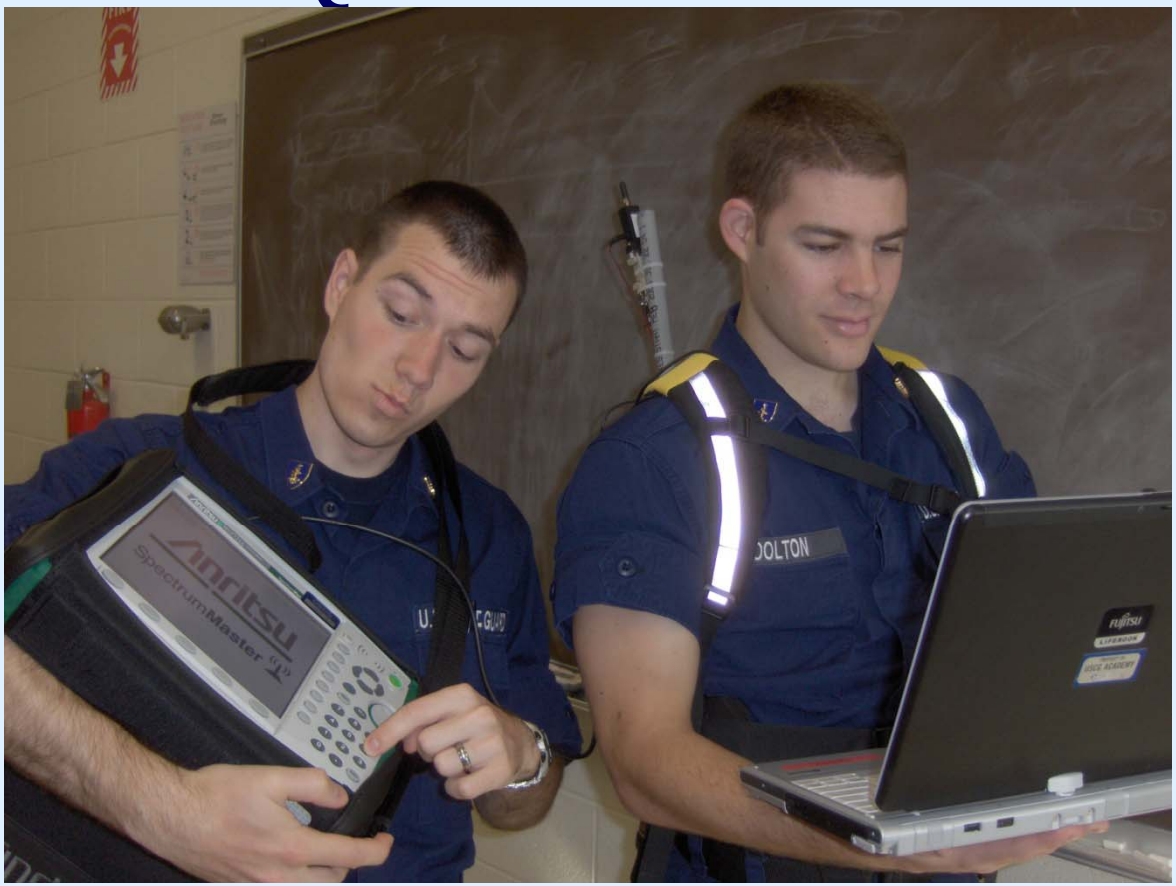
CGA range to Moriches



Conclusions

- GPS is vulnerable to jamming
- eLORAN and DGPS integrated system
- Field Strength Results and MATLAB phase-to-range algorithm

Future Work

- Continuation of Field Strength Study
- Develop prototype with accurate timing at DGPS site.

Questions?