

Marine Radar Imaging of the Surface Expression of Nearshore Bar Structure

**Dennis Trizna, Ph.D.
Imaging Science Research, Inc.
9310A Old Keene Mill Road
Burke, VA 22015
703-801-1417 Voice
703 455-4851 FAX
triznad@erols.com**

**Jesse McNinch, Ph. D.
Virginia Institute of Marine Sciences
Chesapeake, VA**



Outline:

- **A. Motivation for the Experiment**
- **B. Video Imaging of Bar Structure**
- **C. Bar Surface Radar Expression**
- **D. Experiment Design, Results**
- **E. Summary**



Motivation:

Beach Migration & Sediment transport

- **New VIMS results suggest coastal geological base important**
 - Hard rock coastal outcropping foundation may accelerate beach loss locally
 - Loss & Replenishment measurements of bar morphology needed at specific locations
 - 'Field Lab' site, such as USACE FRF Pier not representative of these conditions
- **Importance of timely and spatially extensive measurements**
 - Measurements needed along extensive coastal range (~10 km)
 - Fixed sites expensive, tower sites unavailable
 - Mobile solution sought - dune buggy platform solution
- **Video Methods not appropriate**
 - Requires extensive height- ill suited for mobile platform
 - Stability of camera an issue for pixel registration
- **ISR Marine Radar chosen for field testing**



Video Wave Imaging Studies

Rob Hollman (U. Oregon) developed video bar mapping techniques

- Wave breaking over the offshore bar produces whitewater over the area
 - Soliton creation in shallow water, small scale breaking & whitewater results
- Video Images averaged over a few minutes
 - Indicates bar height ~ image whitewater brightness
- Bar mapping methods developed based on this principle
 - Need daylight to support observations
 - High towers required for proper perspective (150 meters at FRF Duck, NC)
 - Rain, fog cause deterioration of data quality
- *Can a mobile marine radar image processing produce equivalent results?*



Wave Breaking in shoaling conditions

- Waves steepen over the offshore bar
- Moderate in again deeper water
- Break at the shoreline



Radar imaging questions to resolve

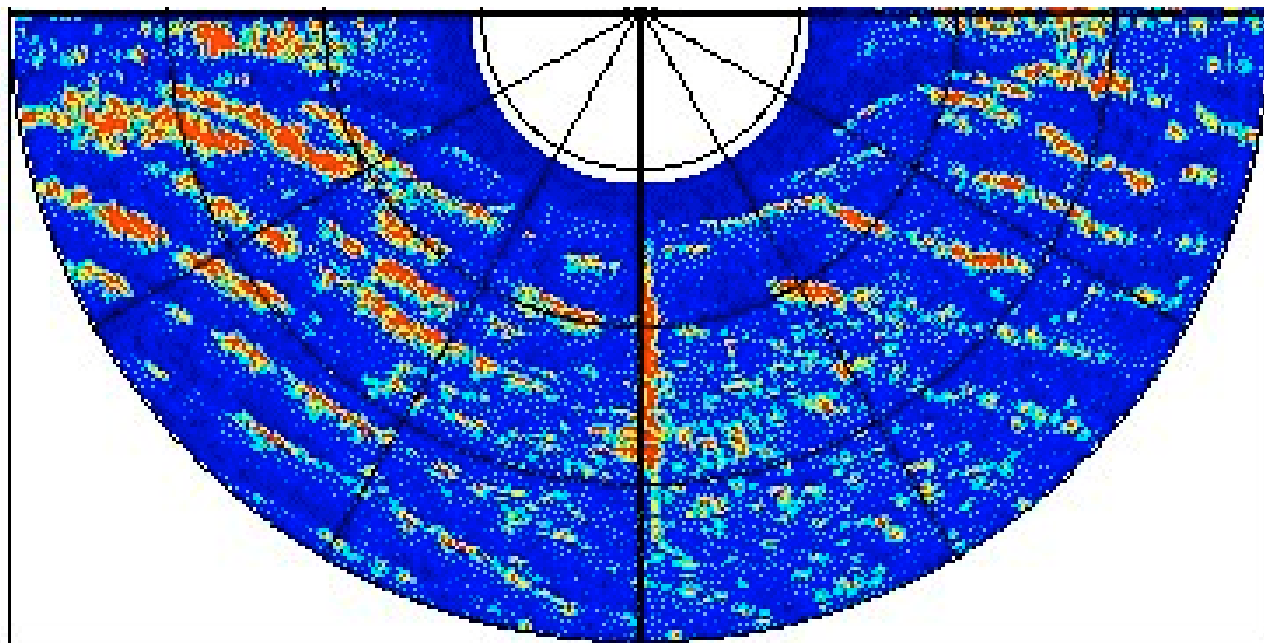


- Experience with radar on FRF lab roof
- Mobile radar on beach challenges
 - lower grazing angle effects on RCS
 - possible wave shadowing
 - registration of images along beach
 - field implementation of hardware
- Experiment designed using 36-in Raytheon R70 radar



Marine Radar Wave Imaging Studies

**Marine Radar image
sequence Duck
USACE FRF pier lab
roof site**



- 32 HH images, 1.85-s apart
- Collection repeated each 15 minutes
 - 1.5 km max range typical
 - ~6-m range resolution
 - 5 to 20-m in azimuth (~Range)
- Transformed to calibrated RCS



Marine Radar Wave Imaging Studies

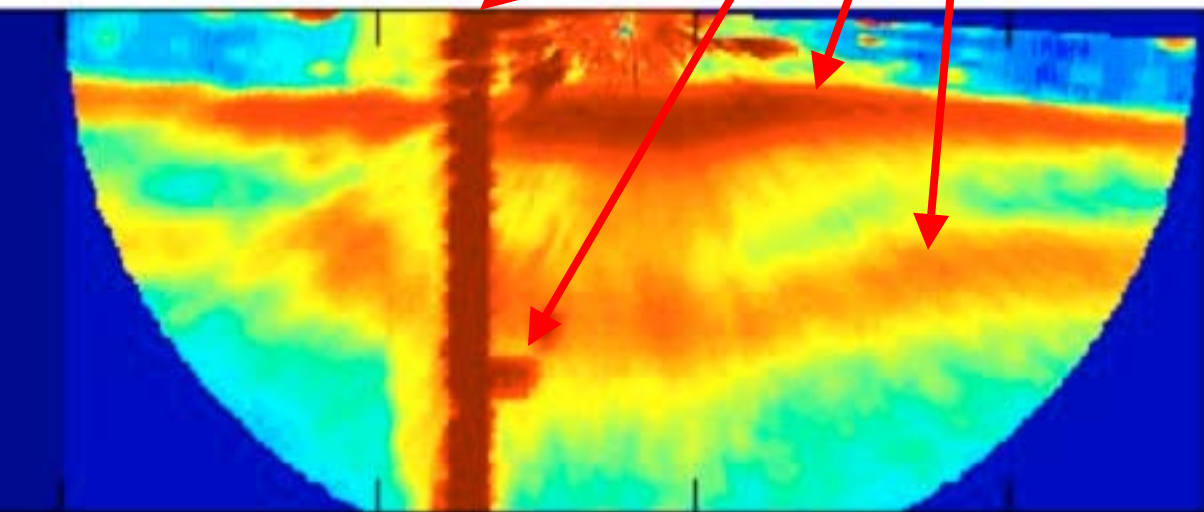
Marine Radar image sequence

- shore based radar.

Averaged over ~600 seconds,

256 antenna rotations

- Pier echo, with instruments over the side
- Waves breaking at the shore
- Waves breaking over the off-shore bar



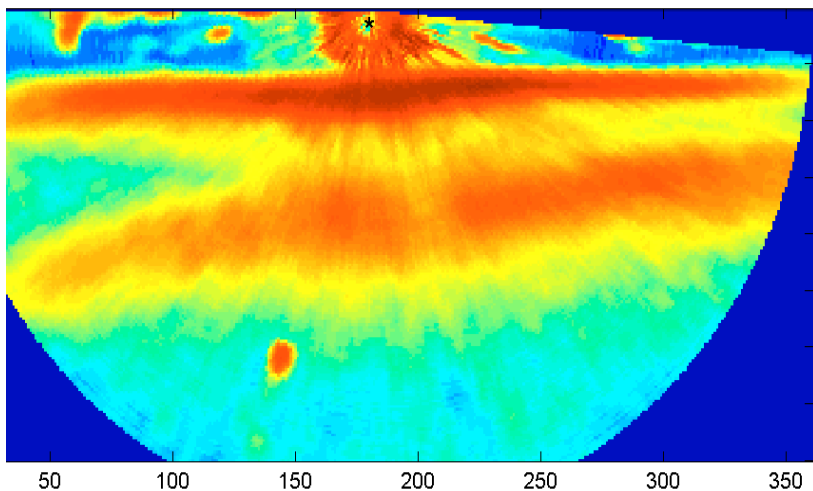
Data Acquisition Plan

- **Radar Mounted on Dune Buggy Equipment Platform**
 - Small antenna allows mobility
- **Measurements made at a sequence of Positions along the Beach**
 - Spacing of ~500 m, to allow overlap of imagery
- **Data averaged over full 10 minute acquisition period**
- **Images merged using COTS software**

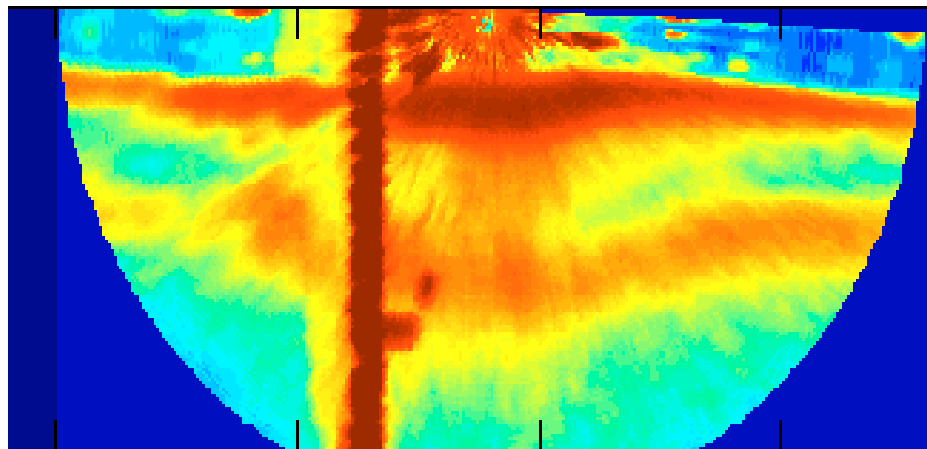


Data Acquisition Plan

A-Loc. Result



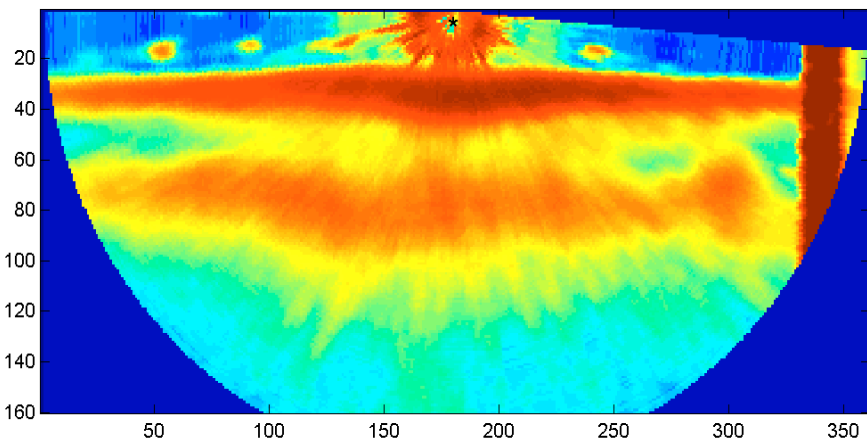
B-Loc. Result



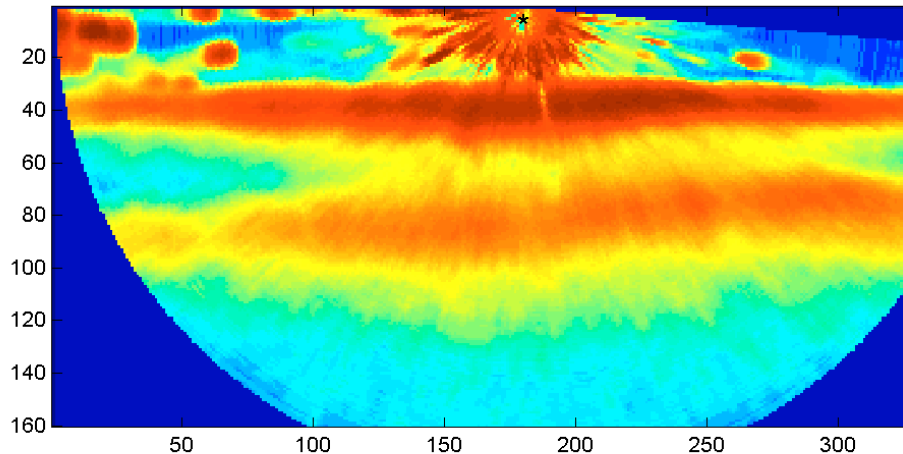
10-minute time averages of received radar intensities *at four locations* along the FRF beach

10

C-Loc. Result

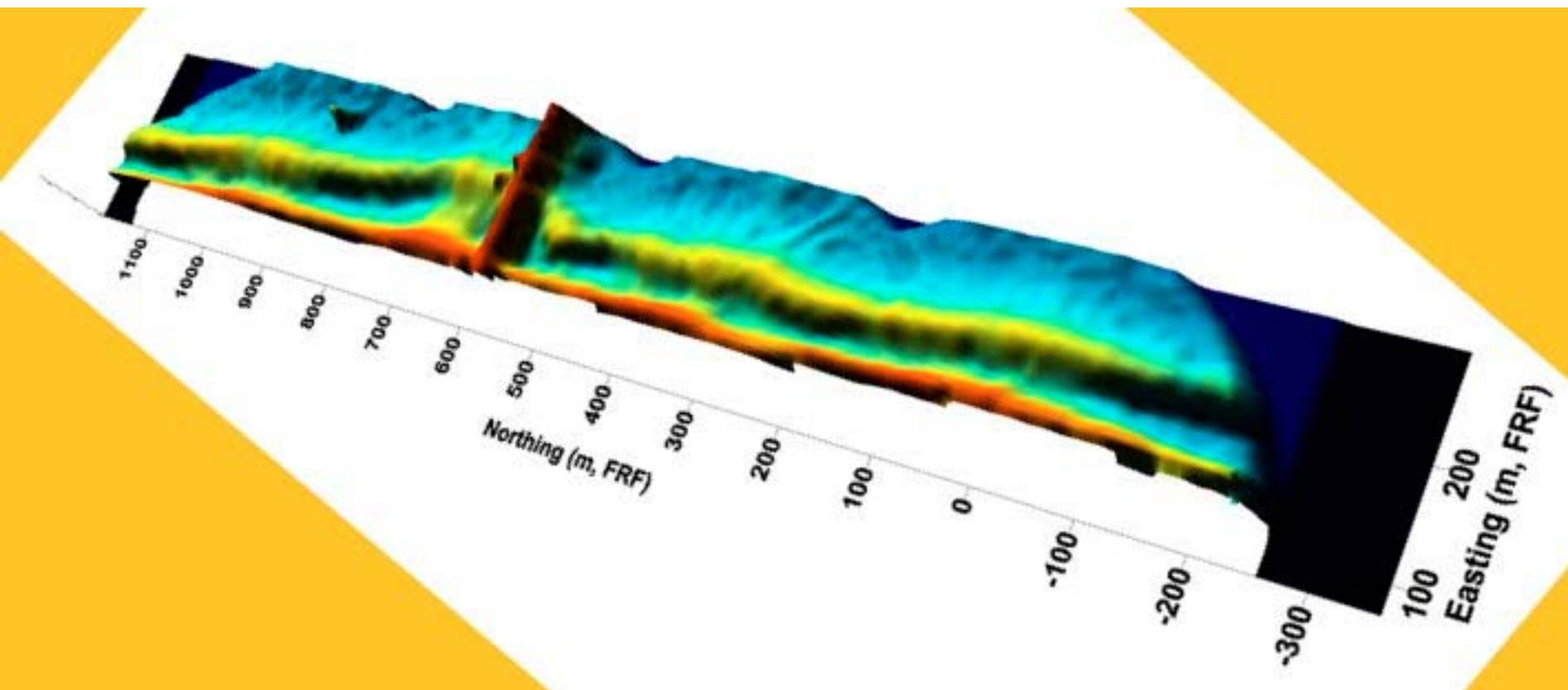


D-Loc. Result



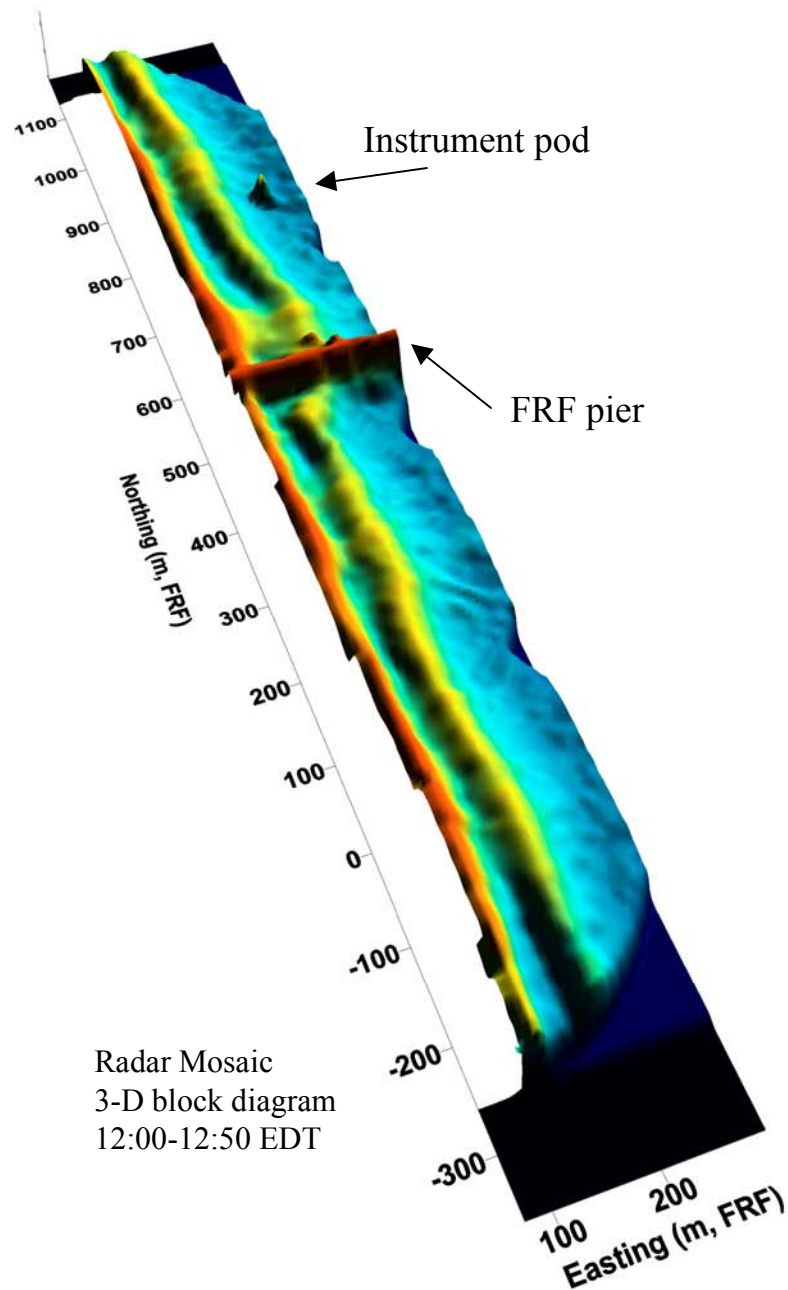
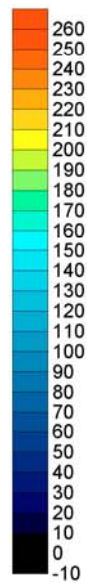
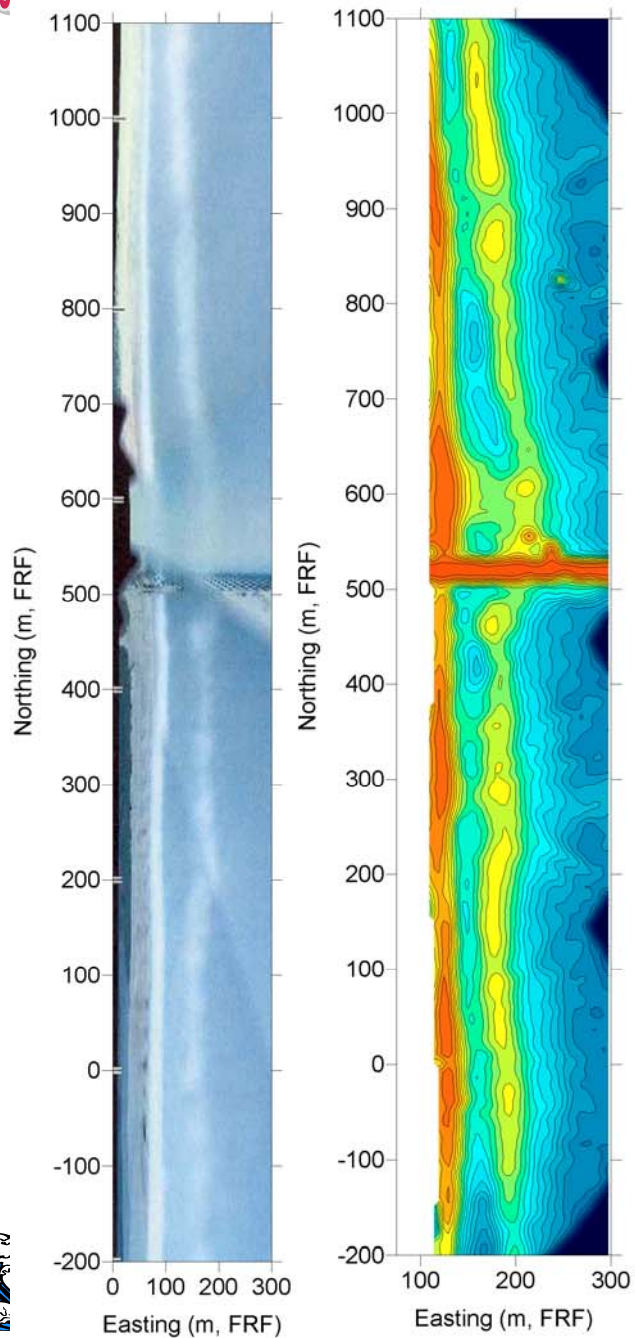
Merged Result

- 4 Images merged, R^4 losses corrected
- Color scheme overlay on 3D mapped based on intensity of radar echo



Imaging **ARGUS Mosaic**
Timex 12:20 EDT

Radar Mosaic
12:00-12:50 EDT



Radar Mosaic
3-D block diagram
12:00-12:50 EDT

Summary

- **Marine radar ability to map offshore bar from radar at ~10m height previously shown**
- **Our new results show mapping from radar just a few meters above MSL is feasible**
 - Light weight radar mounted on dune-buggy equipment platform
 - Integration of a sequence of image means at different locations allows extended map
- **Radar promising as a mobile tool for bar morphology studies:**
 - Does not require daylight, as do video imaging systems - 24 hour coverage.
 - Mobile beach platform possible - no requirement for altitude platform, as for video imaging
 - Capable under heavy surf, rain conditions, where video imaging is marginal

