Rutgers University
Coastal Ocean Observation Lab

>20 Researchers, >100 Undergrads, >$100 M Funding
The Center for Secure and Resilient Maritime Commerce (CSR)

HF Radar Team
Rutgers University -
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CODAR Ocean Sensors -
Don Barrick, Pete Lilleboe, Chad Whelan, Belinda Lipa, Bill Rector, Jimmy Isaacson

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Applied Mathematics, Inc -
Bill Browning

University of Alaska –
Tom Weingarter, Hank Statscewich

Ocean Power Technologies –
Debbie Montagna, Bruce Downie

Naval Research Laboratory
Michael Lovellette, Dan Newton

Norwegian Defence Research Establishment (FFI)
Terje Johnsen, Walther Asen

CODARNor
Anton Kjelaas

Rutgers University – CODAR Ocean Sensors
Academic – Industry Partnership since 1998
INTRODUCTION TO HF RADAR
CODAR Compact HF Radar Antennas

25 MHz
Combined Transmitter & Receiver

13 MHz

5 MHz
Separate Transmitter & Receiver

The Center for Secure and Resilient Maritime Commerce (CSR)
Standard CODAR Shore Site:

Shed, Enclosure, Tx/Rx, Comms, Power, GPS, AIS

- Shed
- Enclosure
- A.C. unit
- Transmitter
- Lightning Protection
- Monitor
- Receiver
- UPS system
- Computer & external hard drive
- Two lines of Communication
- Computer
- External hard drive
- Lightning Protection
- Shed
- Enclosure
HF Radar Bistatic Transmitters – Extending Range & Number of Look Angles

On Buoys

On Ships

On Shore
Surface Current Mapping Capability

25 MHz
Radar $\lambda$: 12 m   Ocean $\lambda$: 6 m
Range: 30 km   Resolution: 1 km

13 MHz
Radar $\lambda$: 23 m   Ocean $\lambda$: 12 m
Range: 80 km   Resolution: 3 km

05 MHz
Radar $\lambda$: 60m   Ocean $\lambda$: 30 m
Range: 180 km   Resolution: 6 km
Mid-Atlantic Bight HF Radar Network

1000 km Alongshore Length Scale

Mid-Atlantic HF Radar Network
16 Long-Range CODARs
8 Medium-Range CODARs
17 Short-Range CODARs
41 Total

Triple Nested & Multistatic

The Center for Secure and Resilient Maritime Commerce (CSR)
Vessel Detection Capability

25 MHz
Range: 11 nmi
Height >10 ft

13 MHz
Range: 43 nmi
Size: >19 ft

05 MHz
Range: 65 nmi
Size: >49 ft
The Center for Secure and Resilient Maritime Commerce (CSR)

Vessel Tracking Research Areas

Current Testbeds
- New York Harbor
- Delaware Bay
- Chesapeake Bay
- Port of Miami
- Western Puerto Rico
- Barrow Alaska

Proposed Testbeds
- Great Inagua
- Norway
- San Diego

The Center for Secure and Resilient Maritime Commerce (CSR)
NEW YORK HARBOR TESTBED RESULTS
Track of Hurricane Sandy
The Center for Secure and Resilient Maritime Commerce (CSR)
PORT MONMOUTH
The Center for Secure and Resilient Maritime Commerce (CSR)
The Center for Secure and Resilient Maritime Commerce (CSR)

Irene 2011

Sandy 2012
SEA BRIGHT
The Center for Secure and Resilient Maritime Commerce (CSR)
The Center for Secure and Resilient Maritime Commerce (CSR)
The Center for Secure and Resilient Maritime Commerce (CSR)

850 m

Shed Starting Location
The Center for Secure and Resilient Maritime Commerce (CSR)
The Center for Secure and Resilient Maritime Commerce (CSR)
SEASIDE PARK
The Center for Secure and Resilient Maritime Commerce (CSR)
Location of Enclosure

The Center for Secure and Resilient Maritime Commerce (CSR)
The Center for Secure and Resilient Maritime Commerce (CSR)
Resources

- [http://google.org/crisismap/2012-sandy](http://google.org/crisismap/2012-sandy)
NY HARBOR RECENT RESULTS
GPS Track YM Los Angeles

CSR Experiment
AIS Data November 09 2009
0600 - 1200 GMT
Pepper Plot

\[ R_x = \text{SEAB}, N_{\text{FFT}} = 128, \text{threshold} = 8\,\text{dB} \]

Median bck. gnd. (3x7)


Detections on a Map

Rx: SEAB, 1 trg dir's (09-Nov-2009 06:02:25 - 09-Nov-2009 08:41:14)


update interval = 32 sec (Today : 27-Jan-2010)
Association of GPS with Detections

Detection Rate = 50.7%, RMSerr = 10.2° (0.5° excluding outliers), Mean Error = -6.8°
## Processing Matrix - YM Los Angeles 11/9/09

**Threshold (dB)**

<table>
<thead>
<tr>
<th>FFT Points</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
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<tbody>
<tr>
<td>16</td>
<td>NSD</td>
<td>NSD</td>
<td>NSD</td>
<td>NSD</td>
<td>NSD</td>
<td>NSD</td>
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<td></td>
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<tr>
<td>32</td>
<td>6.6</td>
<td>6.1</td>
<td>4.1</td>
<td>1.7</td>
<td>0.8</td>
<td>NSD</td>
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<td>1.4</td>
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<td>17.8</td>
<td>16.2</td>
<td>13.7</td>
<td>10.6</td>
<td>9.3</td>
<td>6.1</td>
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<tr>
<td>128</td>
<td>41.8</td>
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<td>39.7</td>
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<td>36.0</td>
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<td>28.6</td>
<td>26.1</td>
<td>25.0</td>
<td>22.1</td>
<td>19.6</td>
</tr>
</tbody>
</table>

**IIR – Red**  **Median – Blue**  **NSD = No Ship Detected**
NY HARBOR 2012 RESULTS
2012 Summer Research Institute

The Center for Secure and Resilient Maritime Commerce (CSR)

2012 Summer Research Institute

High Frequency Radar Final Report

Submitted to
CSR Summer Research Institute

By
Fernando Valverde Valle
Raúl A. Huertas Avila
Isaac Jourdan Forty

July 25, 2012

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Coast Guard searching N.Y., N.J. for fake boat explosion caller

Published: Wednesday, June 13, 2012, 3:15 PM   Updated: Wednesday, June 13, 2012, 3:15 PM

By James Queally/The Star-Ledger

SANDY HOOK — The person behind the fake distress call that sent hundreds of rescue personnel racing to Sandy Hook Monday may have sent the message from some point between New York City and Monmouth County, U.S. Coast Guard officials said today.

The preliminary investigation into Monday's probable hoax — which sent nearly 200 people to Sandy Hook looking for the scene of a reported yacht explosion that killed three people — is ongoing.

The Star-Ledger's James Queally reported from Sandy Hook Monday night that, after the Coast Guard arrived, they were unable to find any explosion and were surprised by the crowd that assembled at the site.

Queally quoted a U.S. Coast Guard official who said he believes the caller may have been somewhere above or below Sandy Hook, perhaps in a small boat or on one of the many yachts that dot the New York harbor.

Another U.S. Coast Guard official told Queally that the investigator is looking for any clues about the location, even if it's unknown.

Sandy Hook is a Long Island Sound peninsula between New York City and New Jersey that is home to an array of marine vessels, including a Coast Guard station.

The Star-Ledger's report said that while the Coast Guard was searching for a possible explosion, the Website of the city of Sandy Hook posted a message that the situation was under control and that there were no problems.

The Sandy Hook Peninsula is known for its scenic natural beauty and its role as a coastal defense rampart for New York City.

Sandy Hook is also home to the Sandy Hook Visitor Center, which offers a variety of information about the area.

The Sandy Hook Peninsula is also home to the Sandy Hook National Wildlife Refuge, which is managed by the U.S. Fish and Wildlife Service.

The Star-Ledger's report noted that the Sandy Hook Peninsula is also home to a number of marinas and boatyards, as well as a number of other businesses and services.

The Sandy Hook Peninsula is also home to a number of other natural areas, including the Sandy Hook Project, which is a conservation effort that seeks to protect the area.

The Sandy Hook Peninsula is also home to a number of events and activities, including the Sandy Hook Music Festival, which is held in July.

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Detections Overlaid on AIS

June 11, 2012
06:00-07:00

Median Background
512 pt. FFT
14 dB SNR
Detections Overlaid on AIS

June 11, 2012
07:00-08:00

Median Background
512 pt. FFT
14 dB SNR

The Center for Secure and Resilient Maritime Commerce (CSR)
AIS Density July 2011 to June 2012
31% of HF Radar Detections NOT on AIS

Approaches to New York Harbor
16 Vessels per Hour in HFR
5 Vessels NOT on AIS
Calusa Coast Comparison
11-Jun-2012 10:59:00 - 11:00:00

Calusa Coast Test Case
CSR Ship Detection Visualizer
Selected Recent Publications

HF Radar for Surface Current Mapping:


Selected Recent Publications

**HF Radar for Surface Current Mapping:**


Selected Recent Publications

**HF Radar for Surface Current Mapping:**


Selected Recent Publications

HF Radar for Vessel Tracking:


Selected Recent Publications

**Education:**


**International Talks**
Spain, Norway, Sweden, Poland, Brazil, United Kingdom, South Korea