KELVIN HUGHES

Using Solid State Radar in Piracy Detection

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Vice President

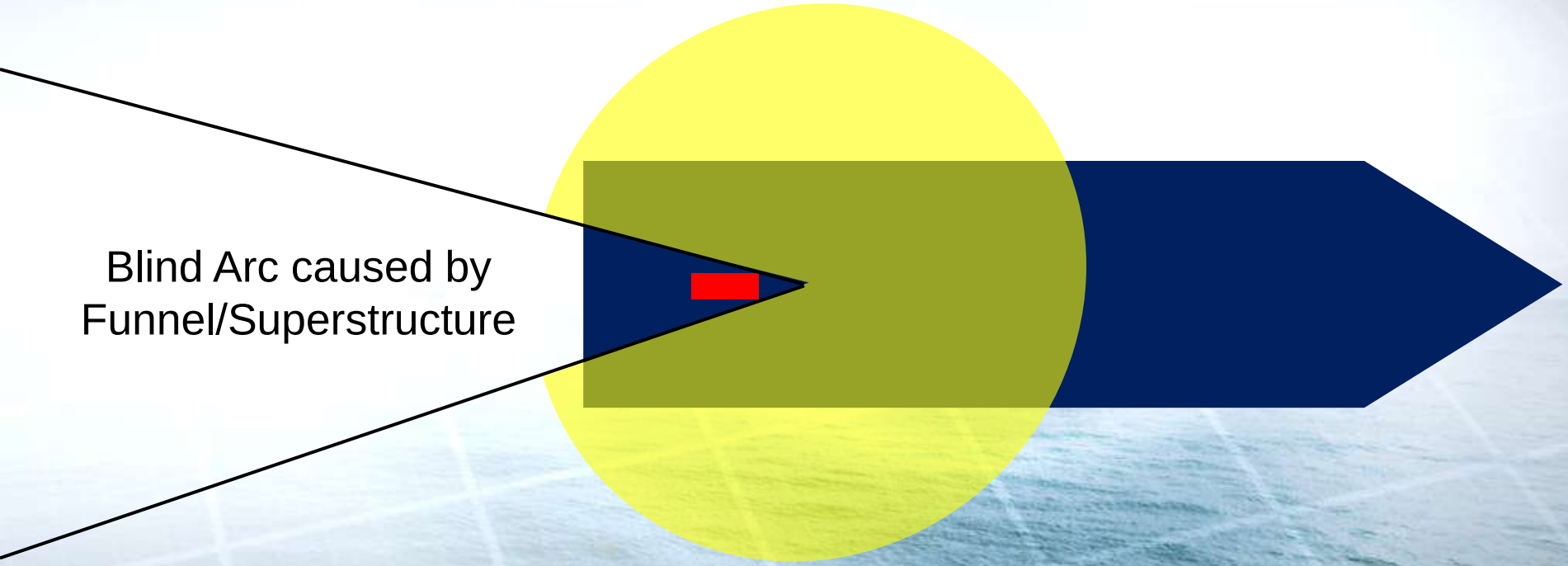
The Challenges

- Targets to be detected
- Sea state/weather “hides” targets
- Radar installations on board
- Current radar technology and how Solid State gives you an advantage
- What can we do with the data

Small RCS

Pirate craft are usually around 3 m^2 RCS or less
Low lying in the water
Easily hidden by bad weather

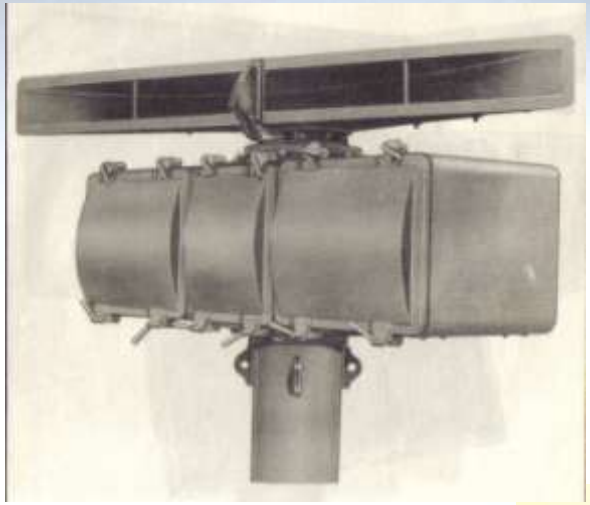
Ship’s Blind Spot



Current Technology

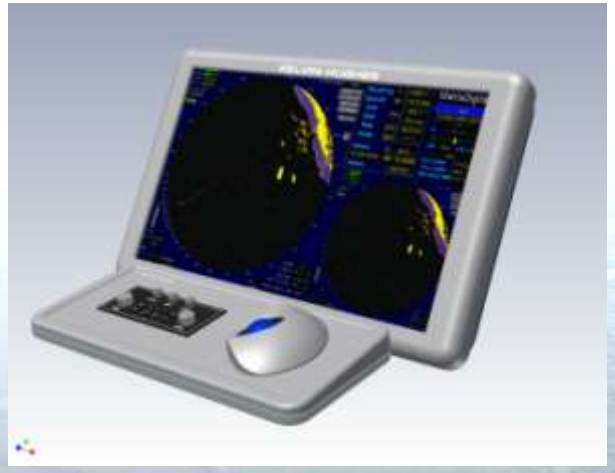
- 99.9% of ships radars are based on 1940's technology
- All magnetron radars suffer from heavy clutter especially in rain
- Unless regularly maintained, performance degrades over time

Origin of Commercial Radar



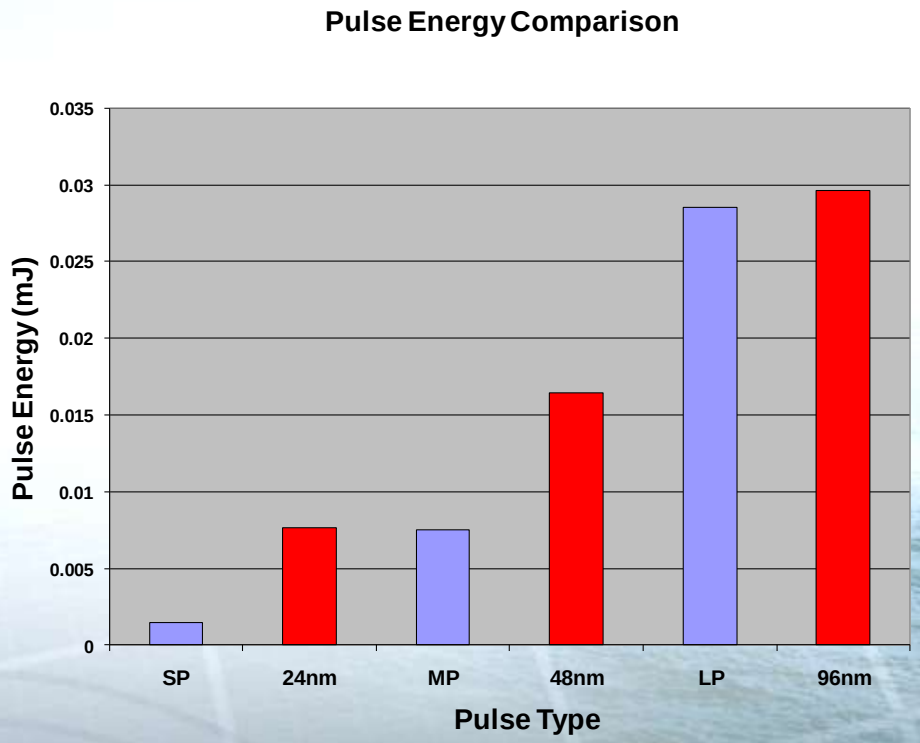
- **1st UK Type Approved Marine Radar**
  - **11th August 1948**
- **Specification**
  - **Upmast Transmitter/Receiver**
  - **Antenna Rotation: 30RPM**
  - **Peak Power:- 30kW**
  - **RF Frequency:- 9.434GHz - 9.524GHz**
  - **PRF:- 1kHz**
  - **Pulse Width: 0.2µs**
  - **Azimuth Beamwidth:- 1.5°**
  - **Elevation Beamwidth:- 27°**

System Improvements



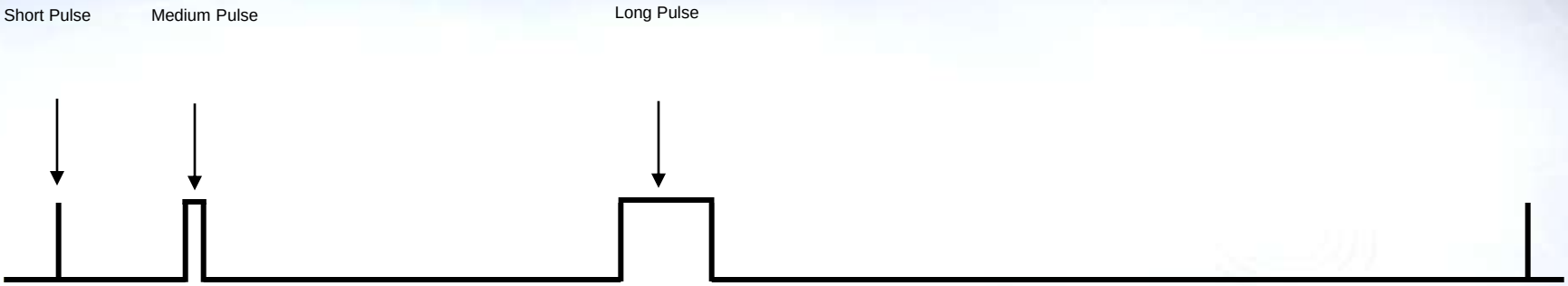
- Some Notable Improvements
  - Flat Panel Displays
  - Daylight Viewing
  - Colour Displays
  - Image Orientation
  - Chart Overlay
  - Automated Radar Plotting Aid
  - Motion Stabilisation
  - Scan to Scan Correlation
  - Interference Rejection
  - Human Machine Interface
  - Low Profile Slotted Waveguide Antenna

Solid State Transmitter



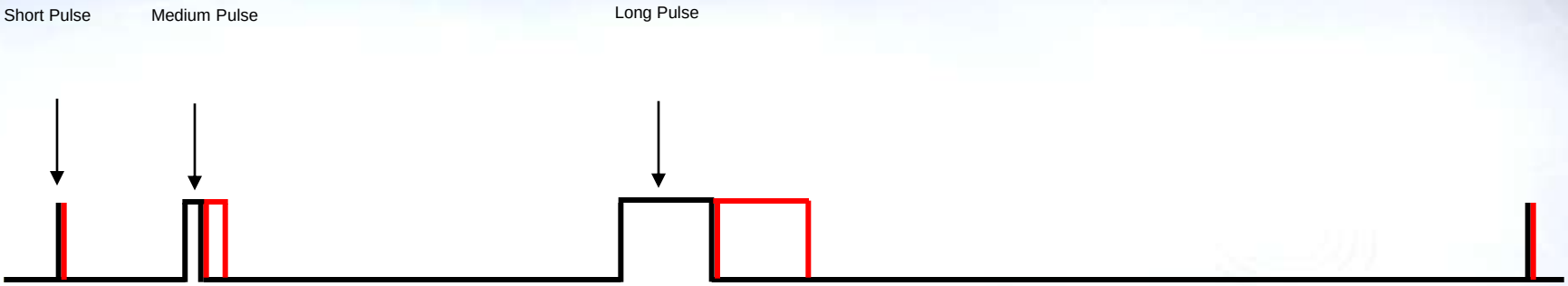
- Transmissions
  - **Pulse Energy**
    - **Energy in pulse limits detection range, NOT peak power**
  - **Minimum range**
    - **For monostatic radar pulse duration defines minimum range**
      - **IEC 60936 states 50m (333ns)**
  - **Complex pattern of 3 pulses/frame**
    - **Provides energy for detection and meets minimum range constraint**
    - **Allows detection of targets close to clutter**

Solid State Transmitter - Transmission Frame



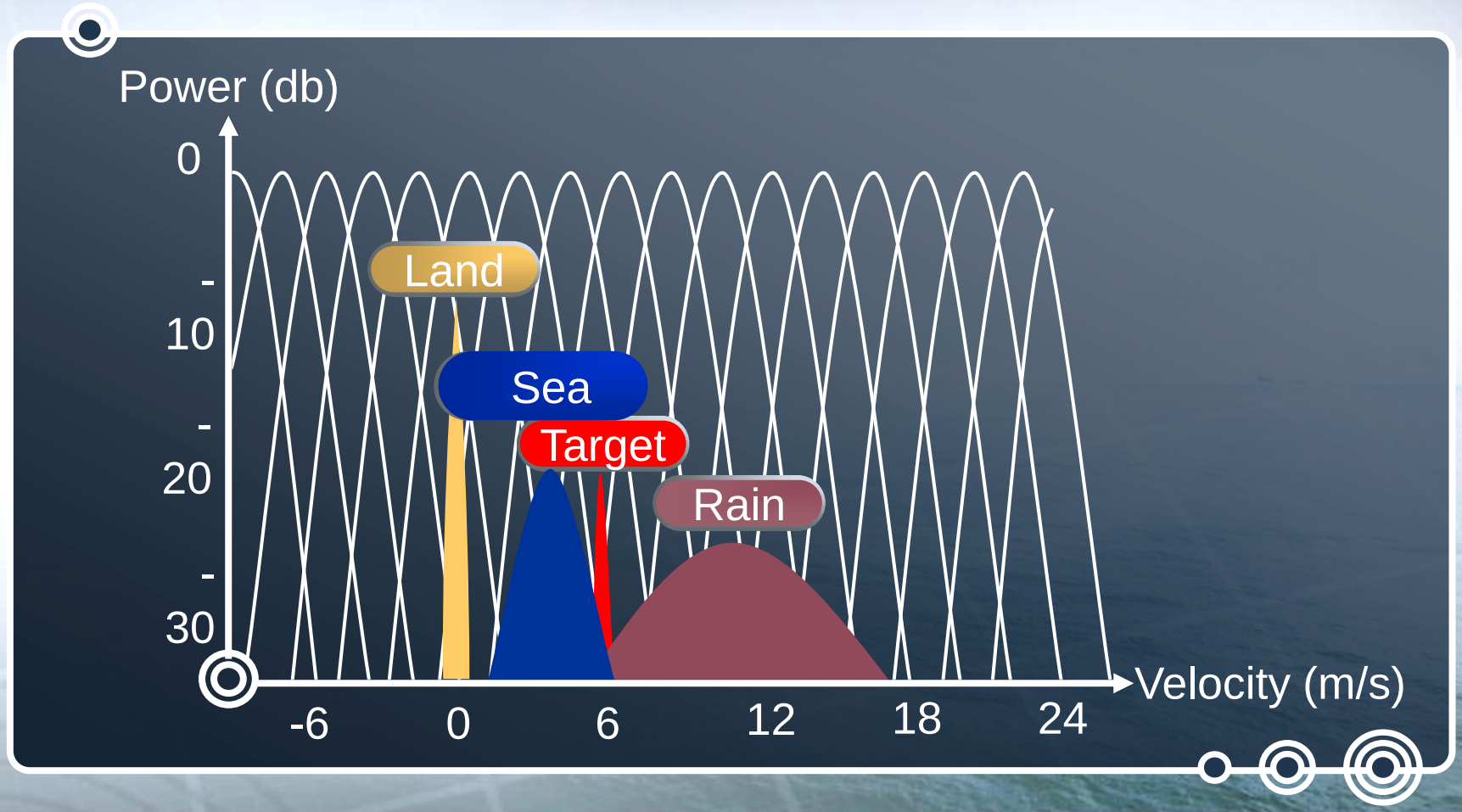
- 3 Pulse Transmission Frame
  - Short Pulse enables 30m Minimum Range
  - Medium and Long Pulses provide Detection Performance
  - Range Cell Size recovered via Pulse Compression
  - Provides protection from multiple time around echoes
  - Composite Video Formed from Received Data from frame
  - Multiple Frames on Target per Beamwidth
  - Block of Frames Doppler Processed to extract Velocity Information

Frequency Diversity - Transmission Frame

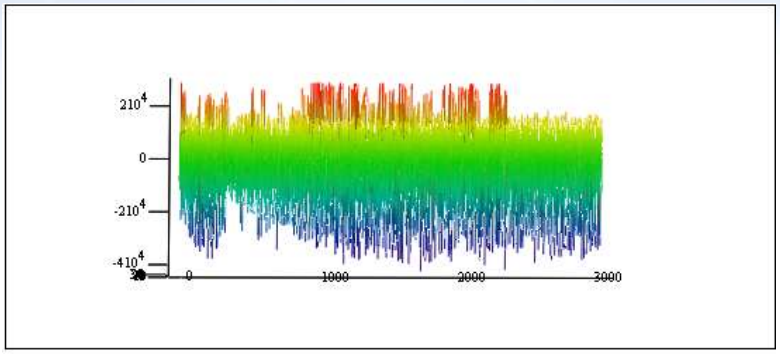


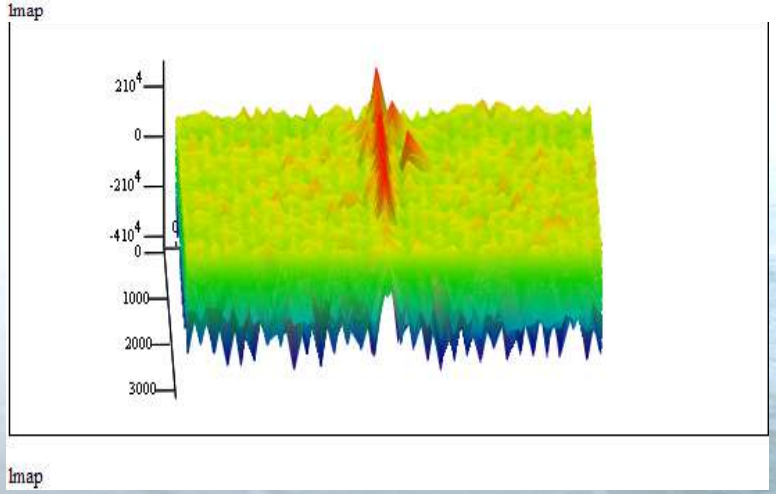
- Diversity Transmission Frame
  - Additional Pulses inserted into frame
  - Second receiver channel and signal processor added
  - 30m Minimum Range maintained
  - Channels processed independently & combined
  - Improved detection & clutter performance
  - Small improvement in multipath

Doppler Processing



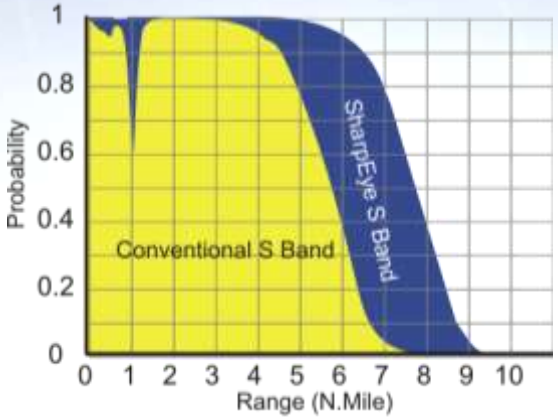
SharpEye™ Pulse Doppler



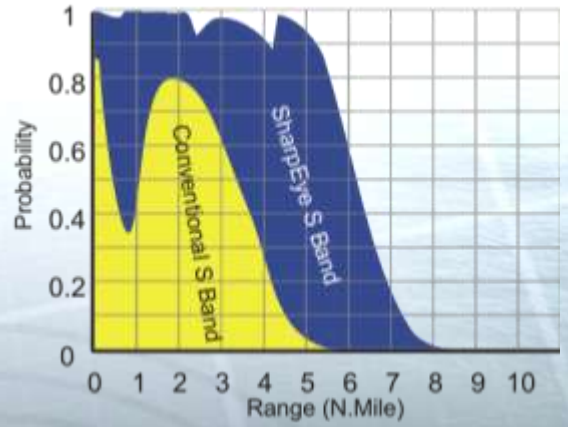


- Range - Doppler Map
  - Echoes from 1 burst (32 pulses)
    - Data obtained from Hainault
      - X axis (Horizontal)
        - » Radial Velocity
      - Y axis (Out of Page)
        - » Range
      - Z axis (Vertical)
        - » Signal Amplitude
  - Central Ridge
    - Ground Clutter (zero velocity)
  - Right Half Plane (+ve velocity)
    - Two Targets

SharpEye™ S Band Radar



10m² target sea state 5 and heavy clutter conditions



0.5m² target sea state 5 and heavy clutter conditions

- Cost vs Performance Comparison
- Performance
  - Exceeds magnetron radars in almost all conditions
- Cost
  - Acquisition
    - Comparable with a magnetron system
  - Through-life
    - Less than a magnetron system

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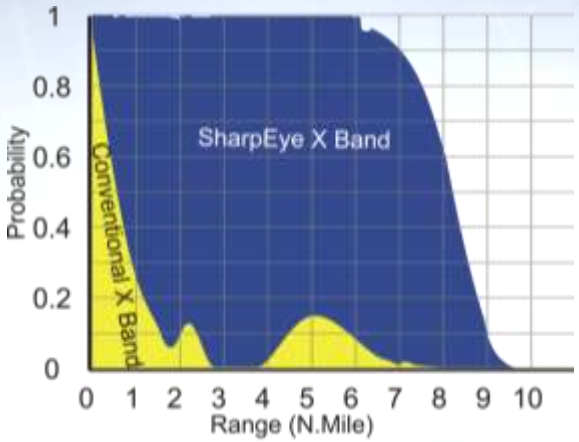
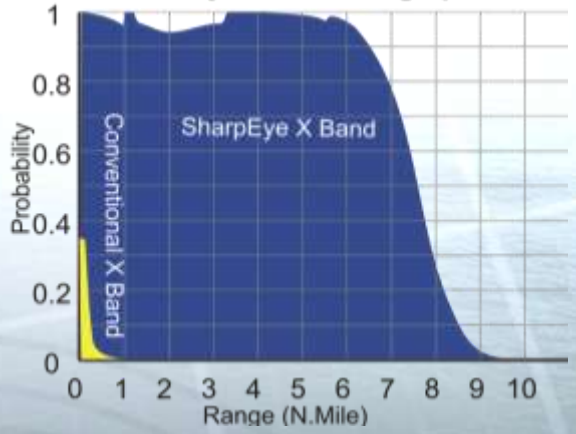
SharpEye™ X Band Radar



10m² target sea state 5 and heavy clutter conditions



0.5m² target sea state 5 and heavy clutter conditions

- Cost vs Performance Comparison
- Performance
  - Exceptional in its class
  - Exceeds magnetron radars in almost all conditions
- Cost
  - Through-life
    - Less than a magnetron system

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S Band SharpEye™ in Gothenburg

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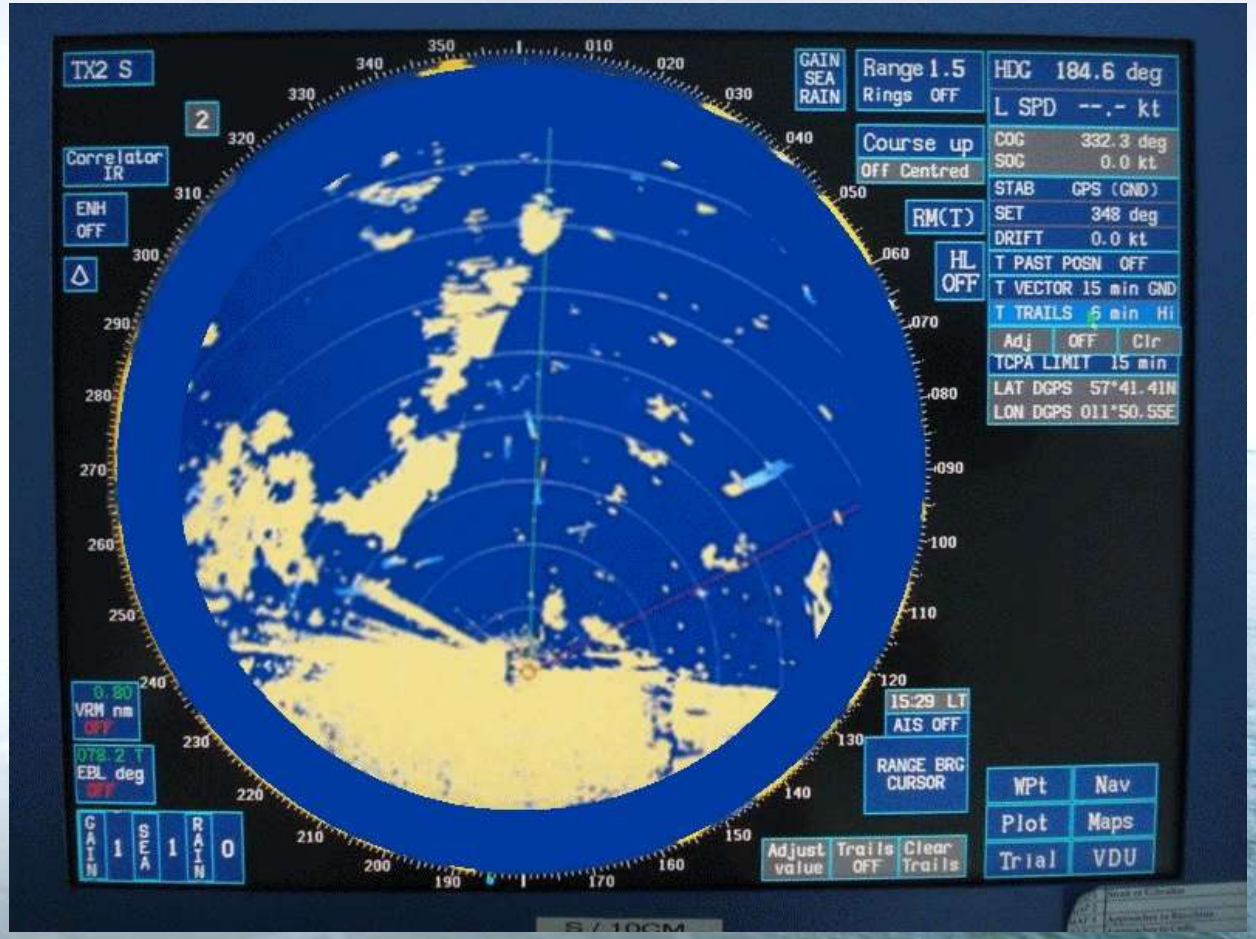
Radar Reinvented

Comparison: S Band SharpEye™ with 25kW X Band Magnetron Radar



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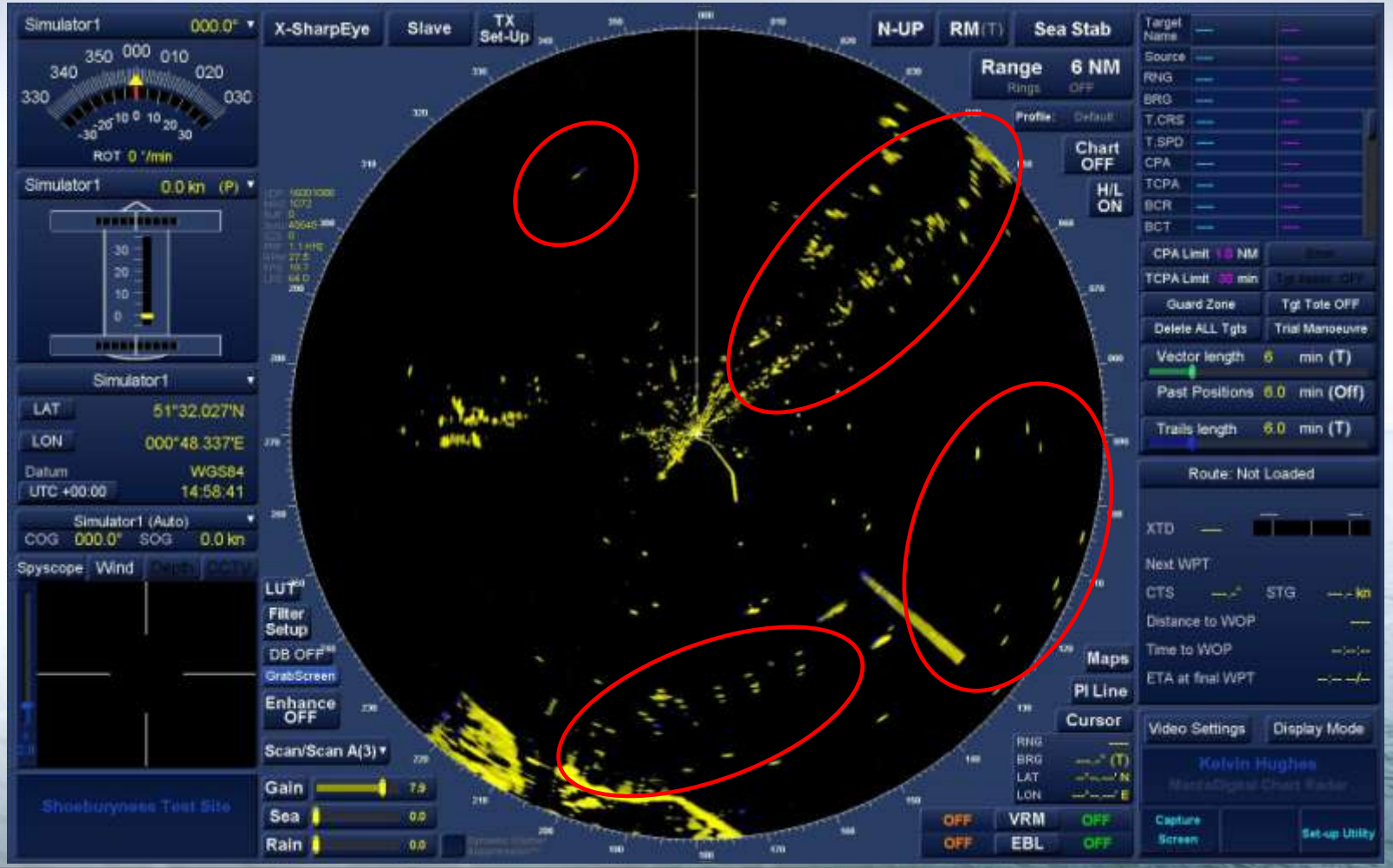
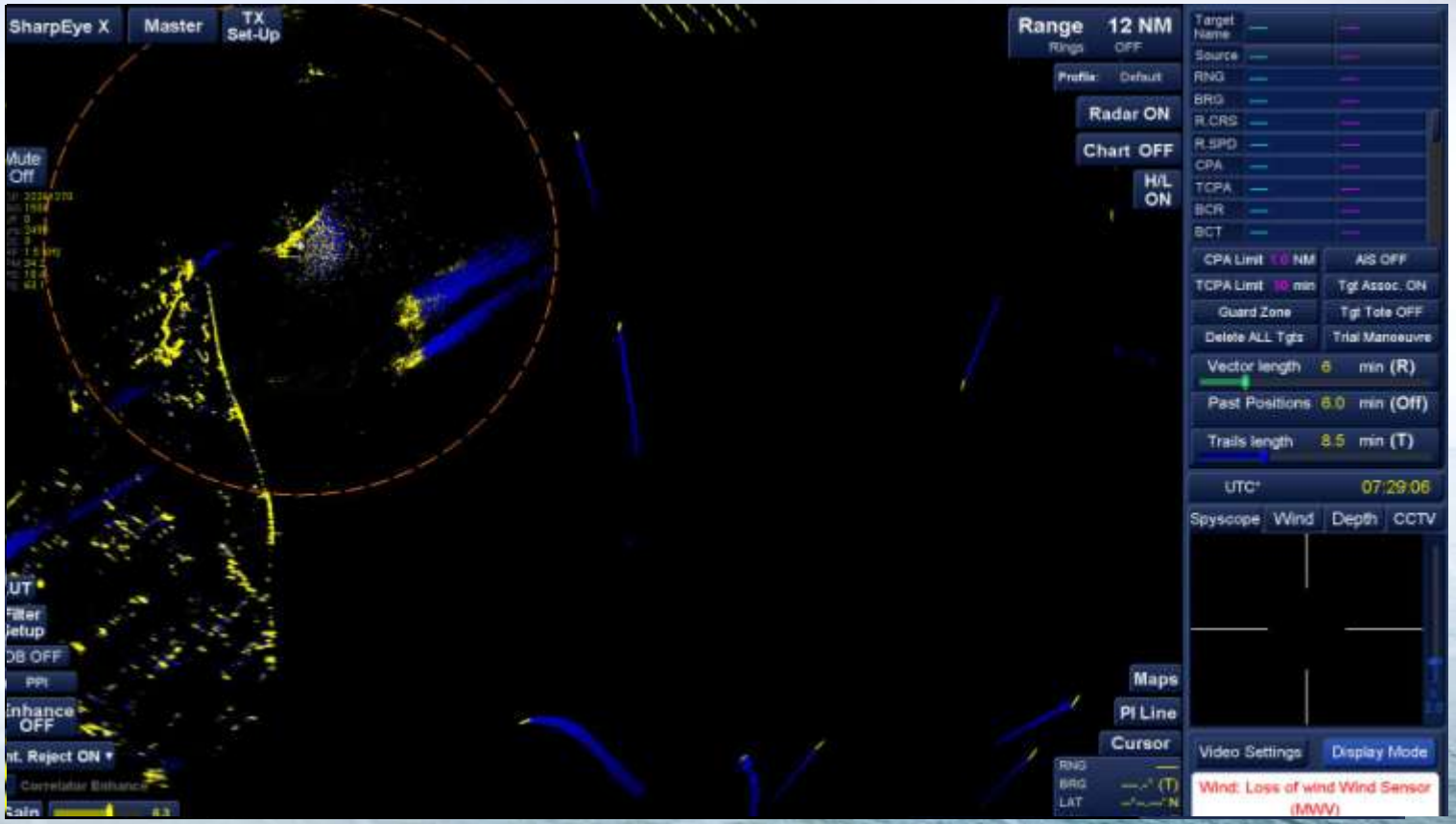
Radar Reinvented

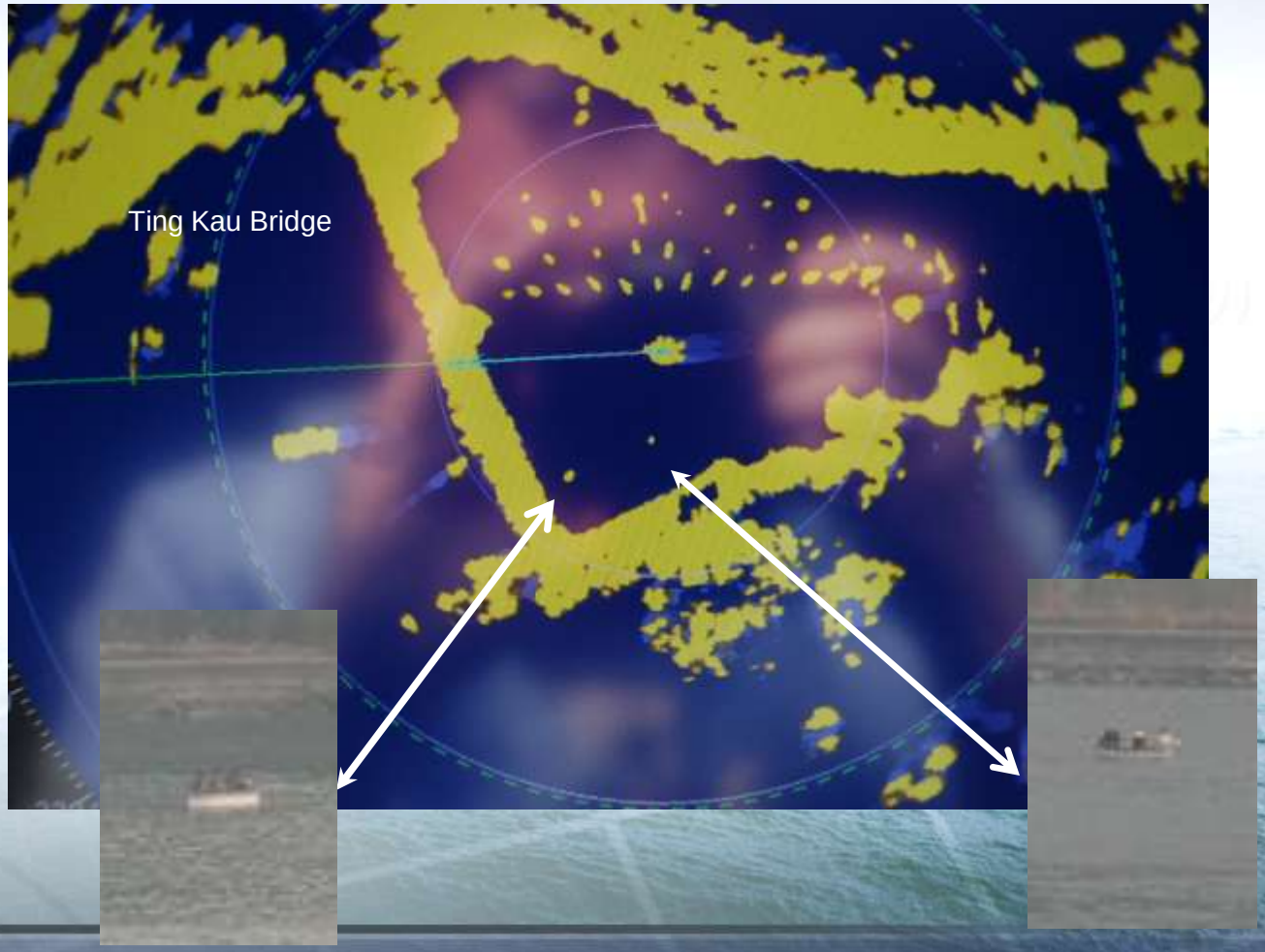
Solid State X Band Comparison



Weather Clutter elimination



Small vessel detection



What can we do with the information

- Get a much earlier chance to take prevention measures
- Radar system can give input/drive/control:
  - Daylight PTZ cameras
  - Infra Red Cameras
  - LRAD
  - Advanced radar processors
- Can be transferred to remote monitoring station/Shore office

Containerized Version

Summary

- SharpEye provides a Radar sensor with:
  - Significant increase in small target detection in clutter
  - Significant increase in Navigation radar capability
  - Flexibility to include future enhancements for incremental capability
  - High Reliability
    - Reduced Spares Holding
    - Lower Through Life Cost
  - Low Risk
    - Similar technology in service with military/ATC for many years
  - Affordable price

Thank You