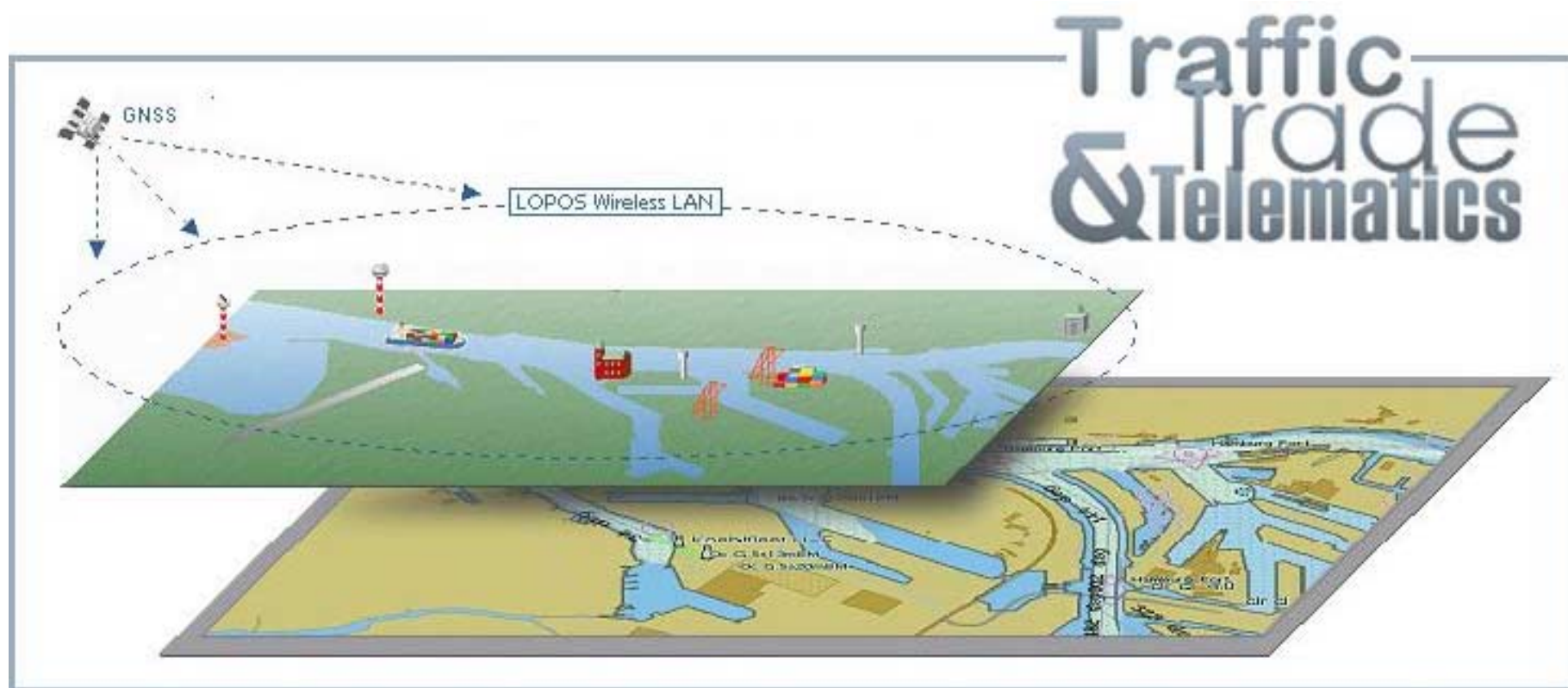


MARLET: Maritime **lopos** EGNOS Testbed:



MARLET - The Aim:

Test and Investigation of

- EGNOS in the maritime environment
- EGNOS as „AIS-improvement“
- EGNOS-based maritime applications
- EGNOS-based Vessel Traffic Management and Information System

Test Results

lopos Test- and Demonstration Site

Wireless Communication
via IP-supporting wireless networks

Precision Navigation
by GNSS and Electronic Navigation Charts

Failsafe Monitoring
of vessel traffic and internal system operation



- High Performance Data Network (802.11 / 1 Mbit)
- Own Local GNSS Augmentation Site - integrated in Network
- Electronic Navigation Chart (ECDIS-standard)
- **linked** to
- Tidal Predictions
- Gage System
- Weather Data
- Internet

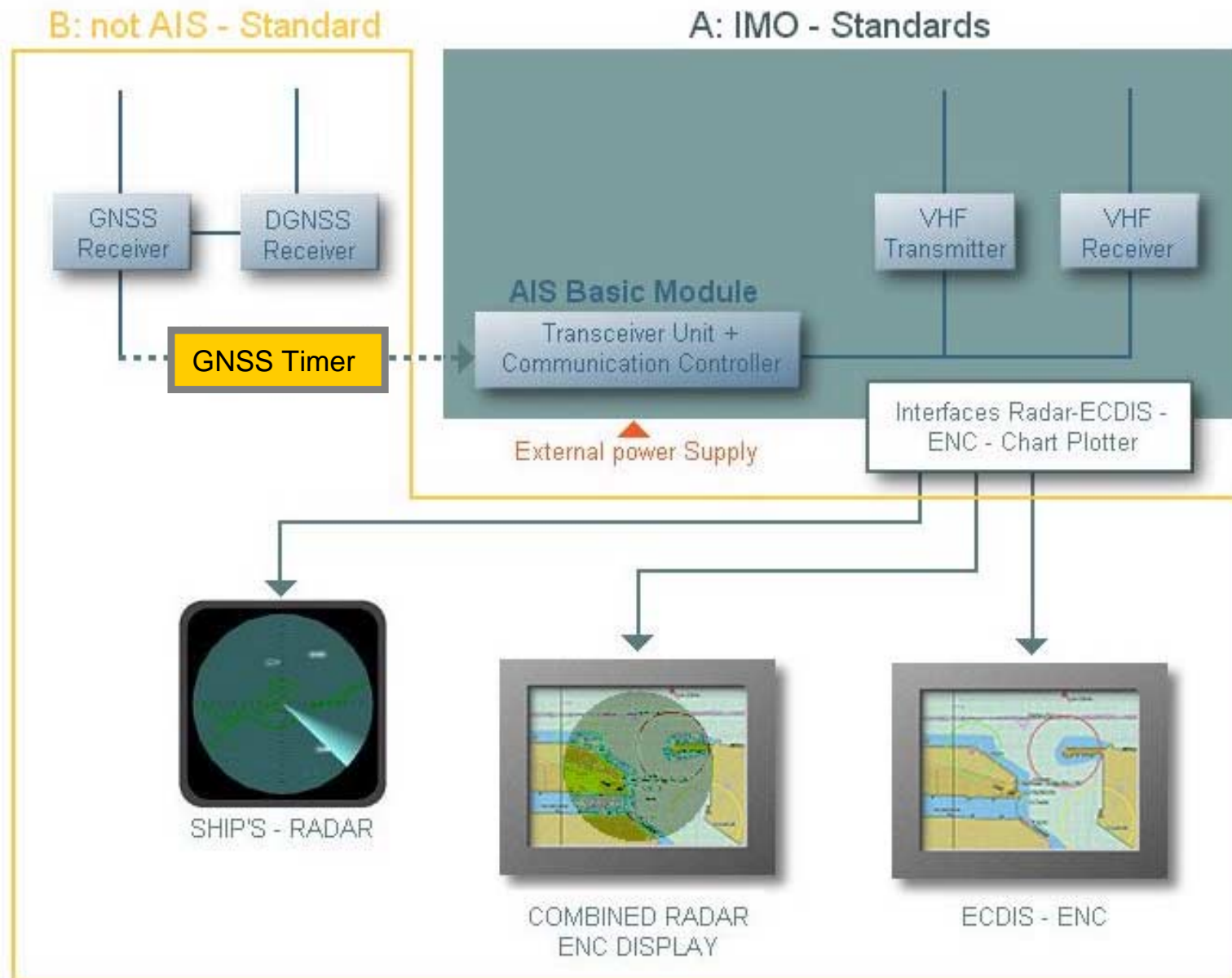
The LOPOS Test-Ships:



EGNOS
GNSS-
Antenna

LOPOS
DGNSS-
Antenna

AIS Standard:

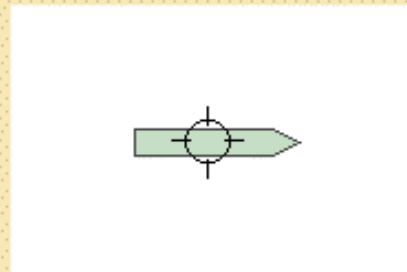


AIS Performance

AIS Position Accuracy

Position Display Variable
Up-Date Rate by:

- ▶ Speed
- ▶ Traffic density
- ▶ Priority



Position Variable by Sensor

- ▶ GPS type+make
- ▶ DGPS (IALA signal)
- ▶ DGPS (local signal)
- ▶ EGNOS / WAAS

Radar Position Accuracy

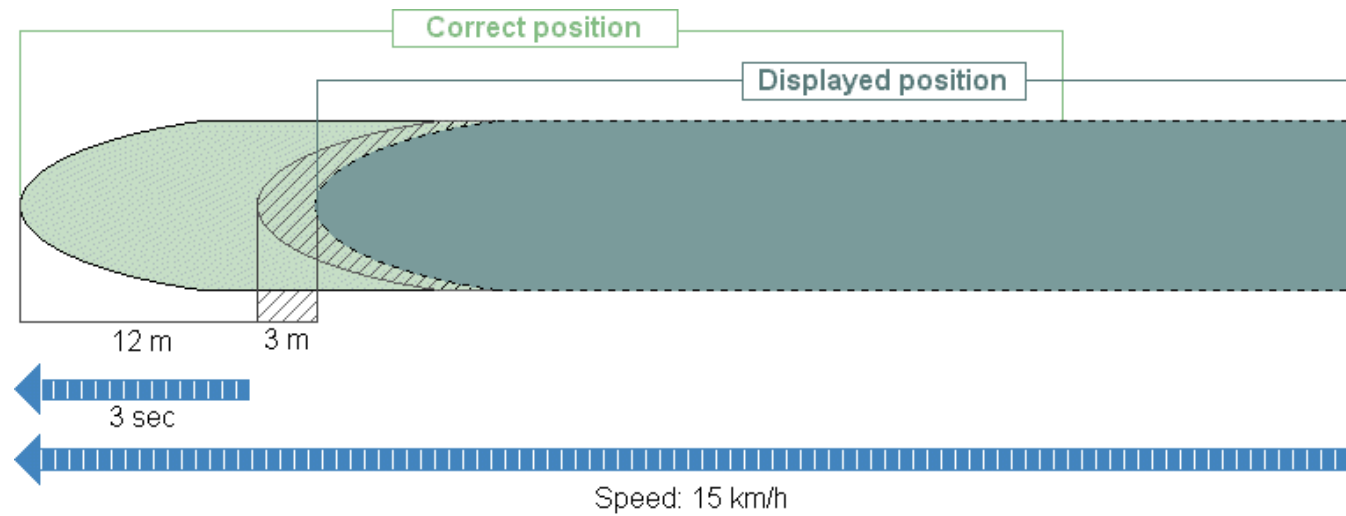
Up-Date = AIS ?



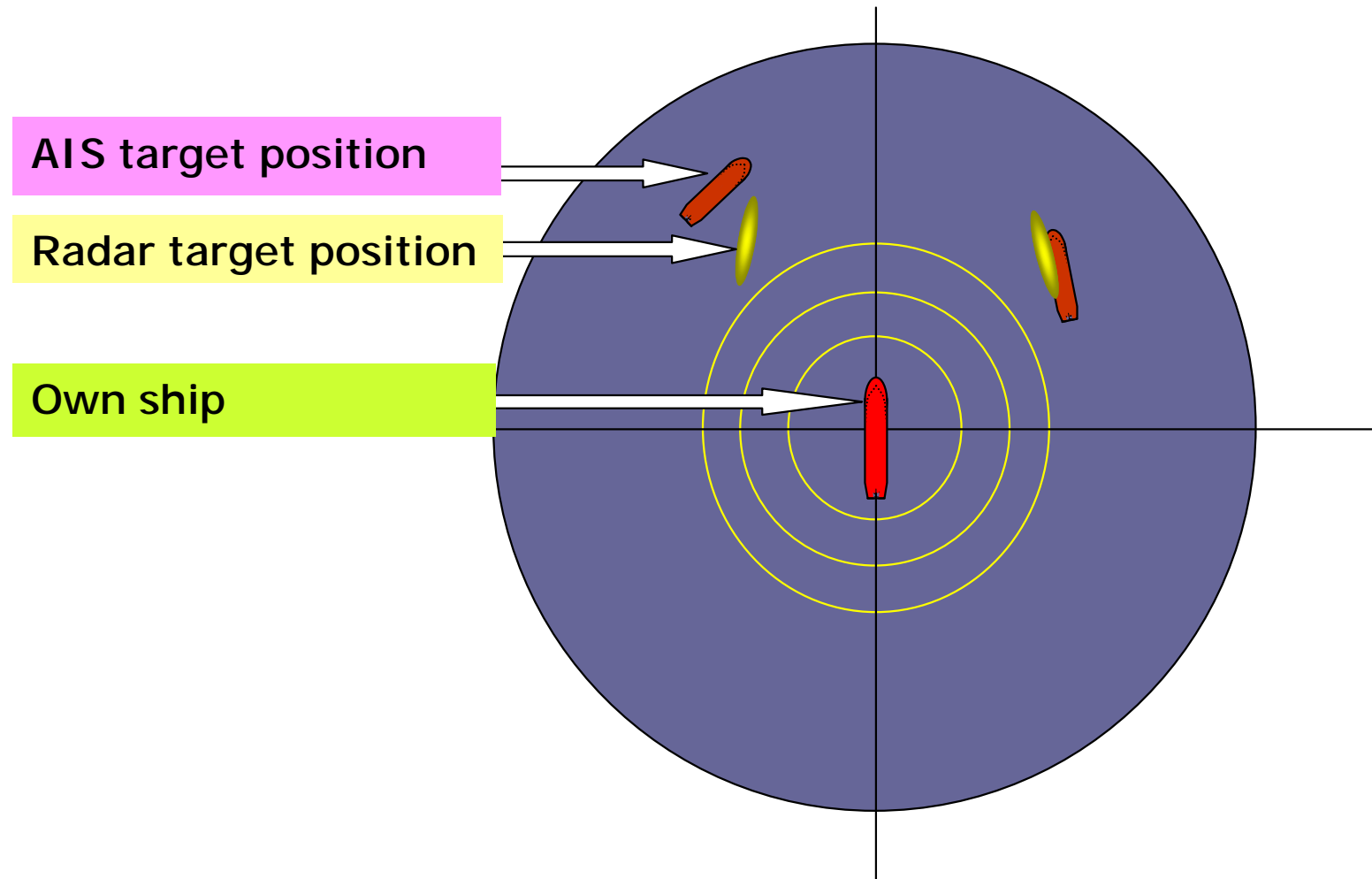
Variable by

- ▶ Speed
- ▶ Distance
- ▶ Weather (rain, waves...)

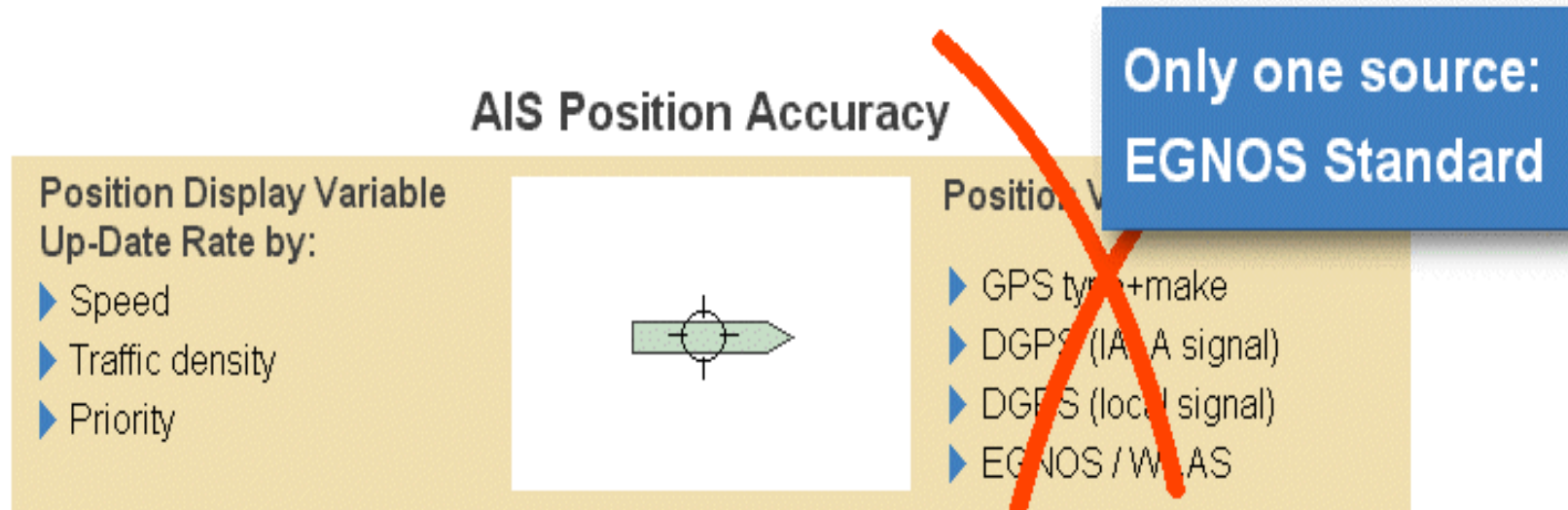
Up-date Rate = Possible Risk



Display Difference Radar - AIS



Proposal for AIS-Improvement Step 1:

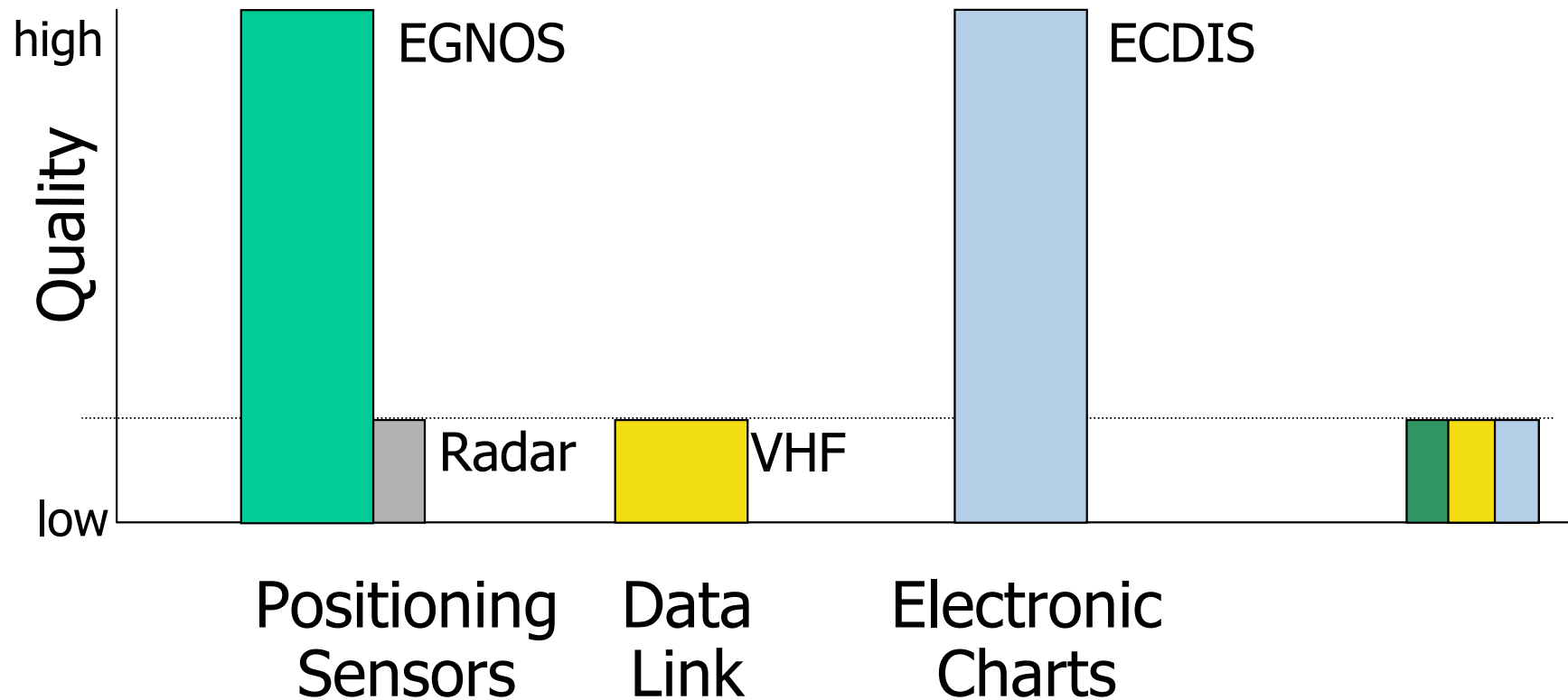


Elimination of Variables "Position Sensor"
by setting of EGNOS (WAAS / MSAS)
quality standards for AIS - Position sensor

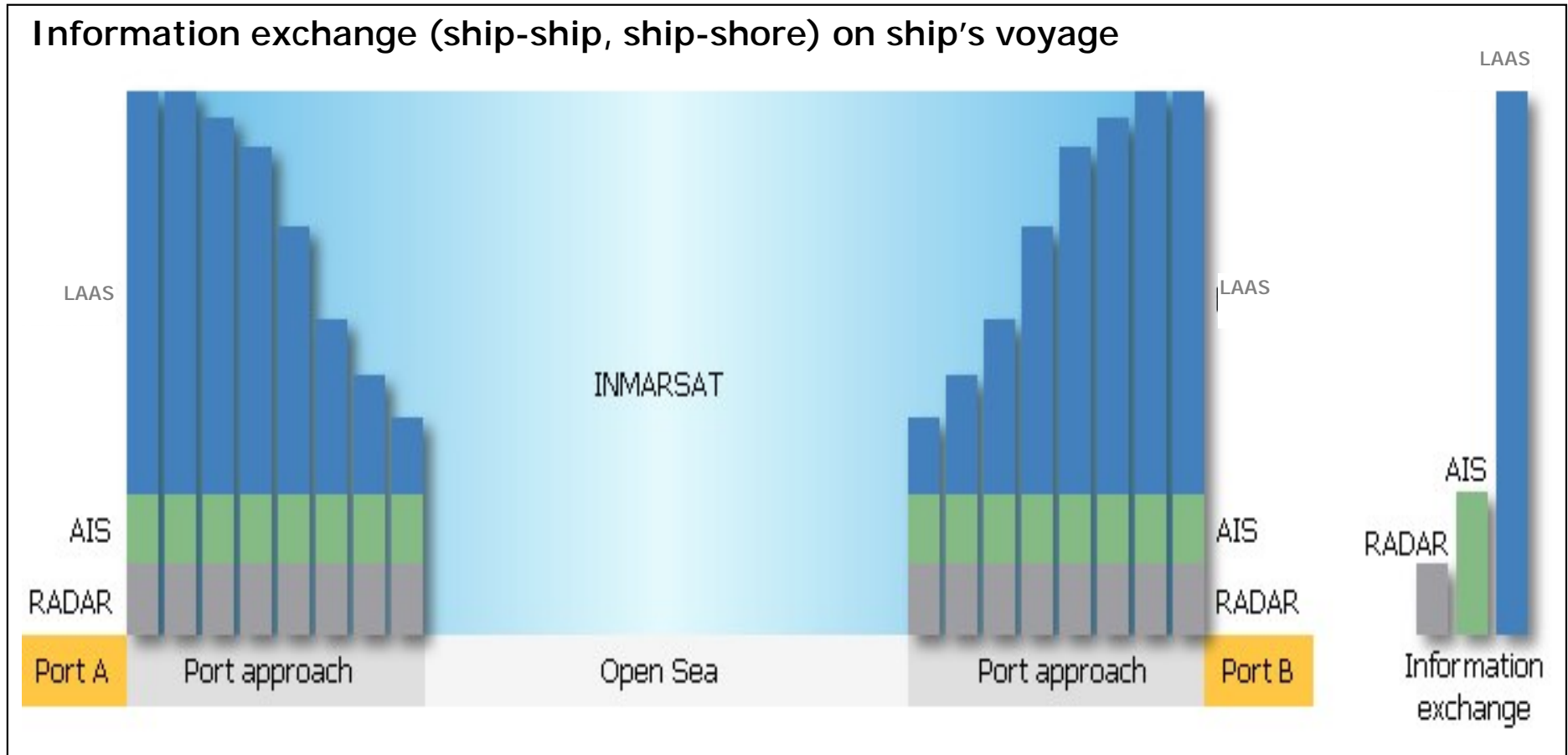
Step 2 - EGNOS - improved AIS:

Systems Quality

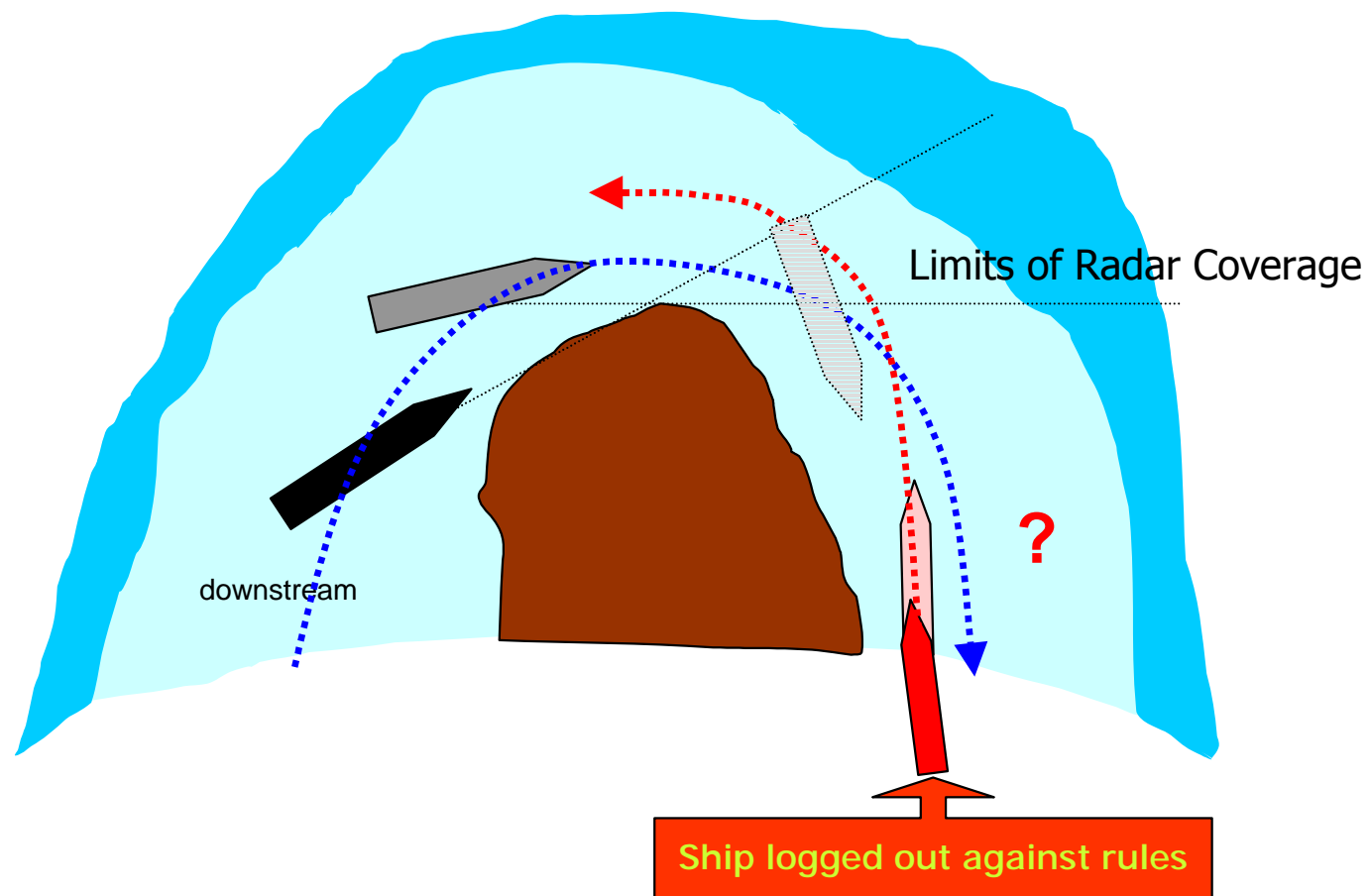
A system is as strong as its weakest link:



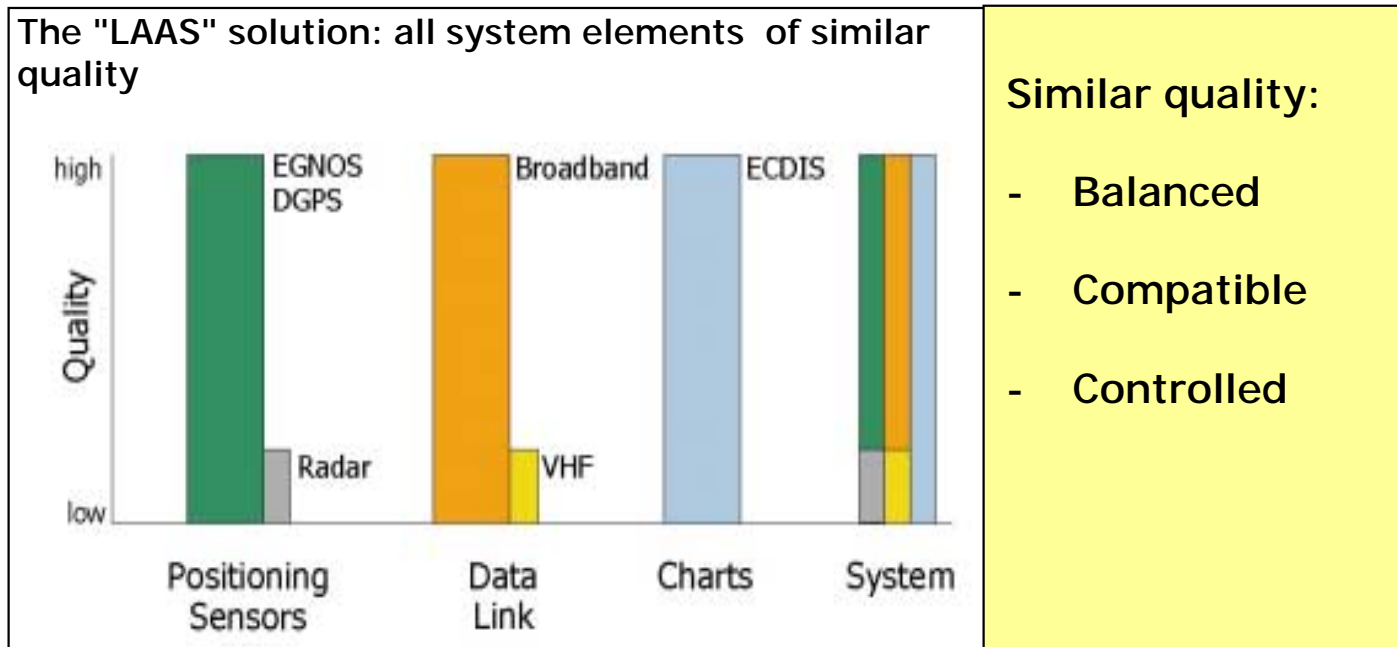
The Need for Detailed - Local Information



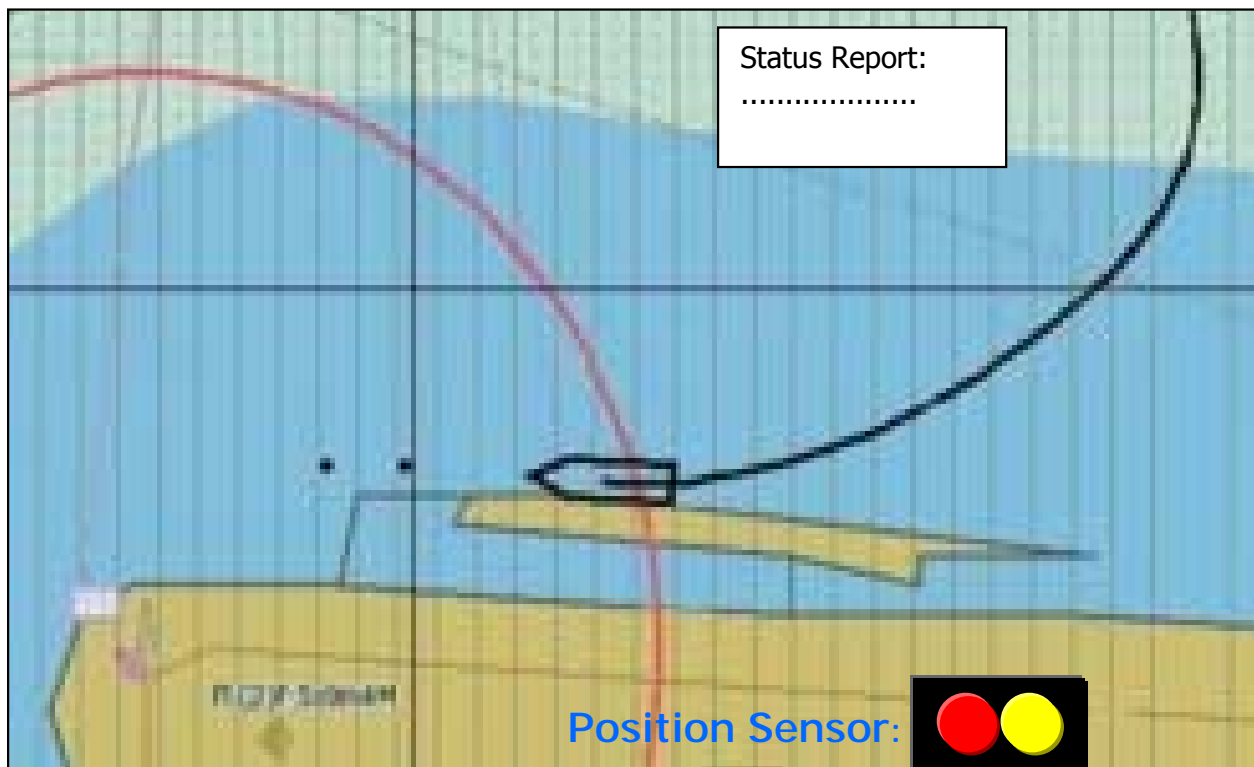
Why is Quality Needed?



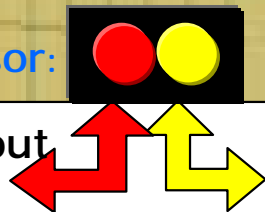
Prerequisite for a complete VTMISS of commercial value:



Display of System Status



GNSS-Deviation out of defined limits



No Augmentation Signal/
No Heading Information

Safety Procedures Prerequisite

1. Positioning Device

- accurate
- liable
- continuous

2. Network

Management
Monitoring
Capacity
Reserves

» 9.600 bit/sec

3. Chart

Survey Data

Complete

Actual

correct

available

.....

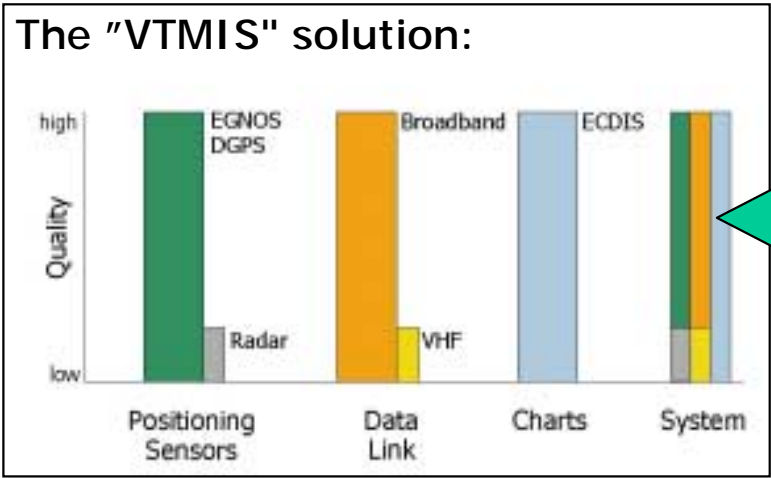
"20% of ww-
coast-line"

(Prof. Baan)



Summary:

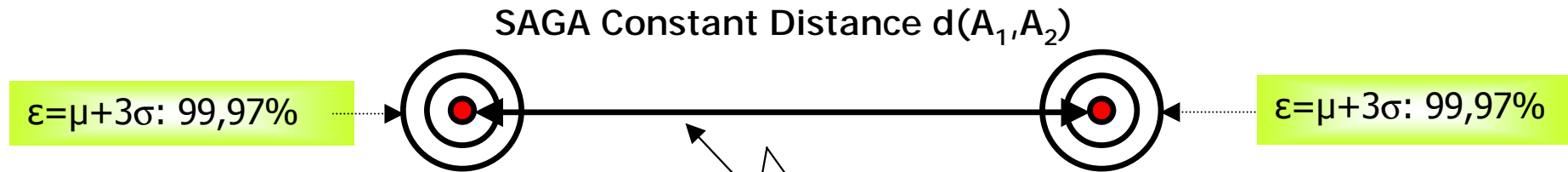
VTMIS-Quality needs
High Performance
Data Communication
= local / terrestrial
Chart Quality
= local (port approach) data
Environmental Information
= locally available



All Elements of
Balanced
Compatible
Controlled
Quality

A LOCAL AREA VESSEL TRAFFIC MANAGEMENT AND INFORMATION SERVICE - VTMIS - IS INDISPENSIBLE IN ADDITION TO WORLDWIDE IMPROVED AIS!

Synthetic Aperture Antenna SAGA:

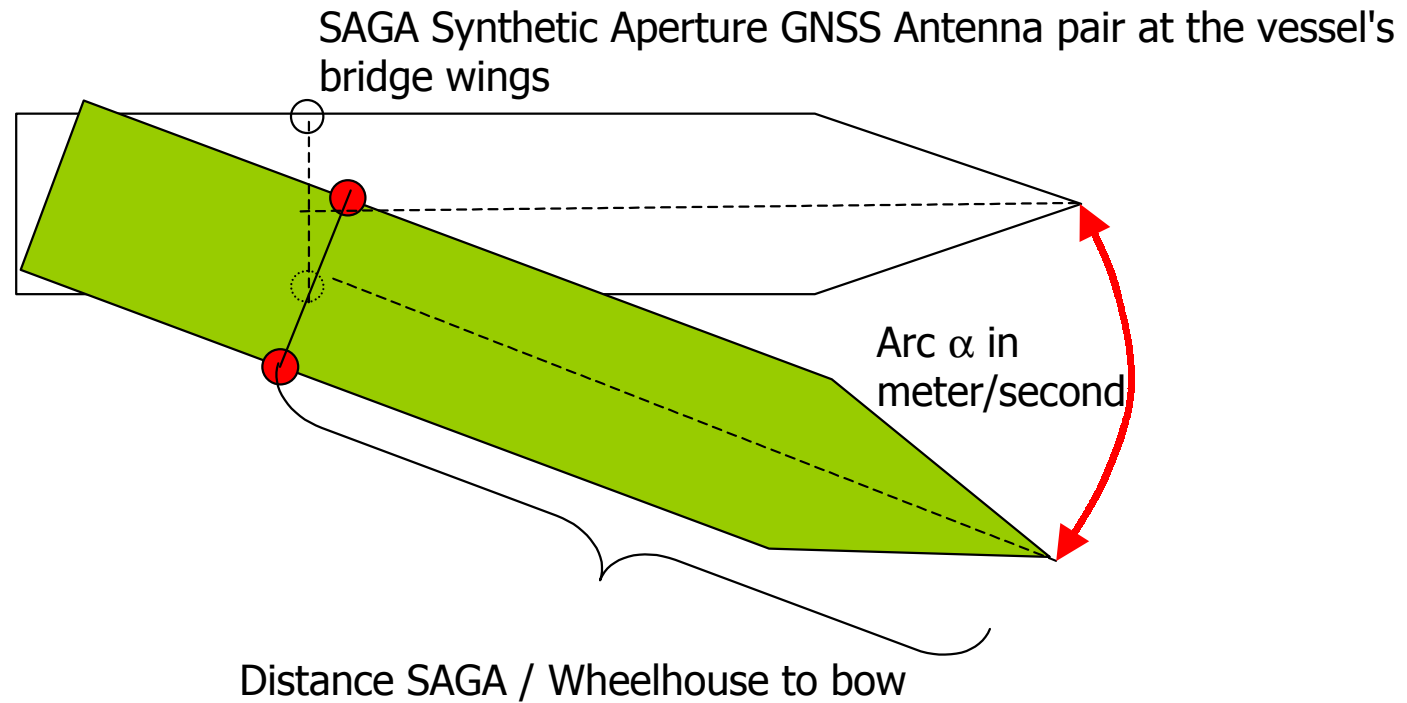


SAGA Synthetic Aperture GNSS Antenna with Distance Error $\epsilon = \mu + 2 * 3\sigma$:
for 99,97% and $\epsilon = \mu + 2 * 2\sigma$ for 95,45% of all parallel records



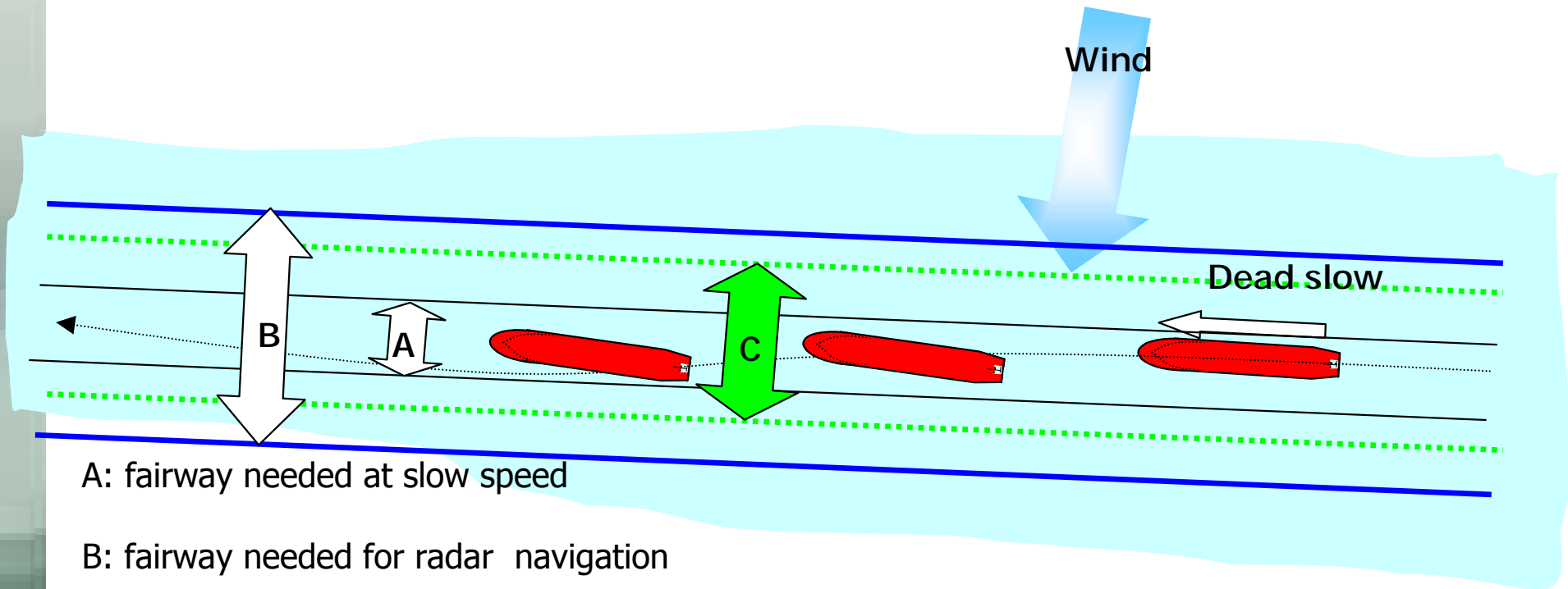
= Ship's own Reference System to improve GNSS Accuracy
= independent + exact GNSS-based Rate of Turn definition:

Rate of Turn Definition



Calculation of the **angular arc velocity** of a vessel for a turning or berthing manoeuvre

The Legal Aspect



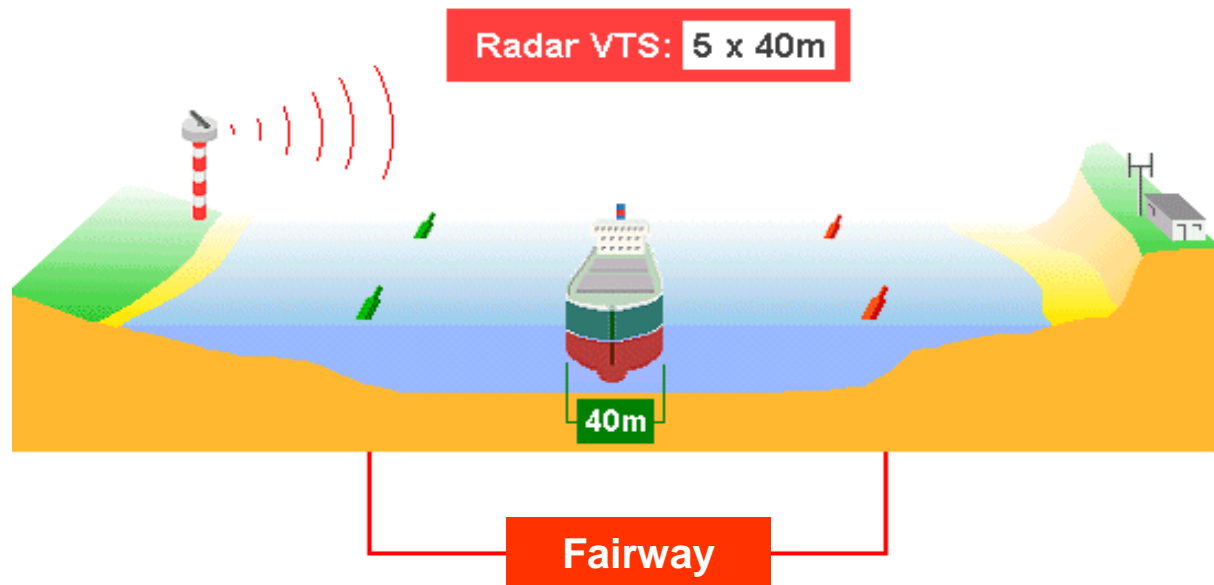
A: fairway needed at slow speed

B: fairway needed for radar navigation

C: fairway needed for "precision navigation"
(better than +/- 5m)

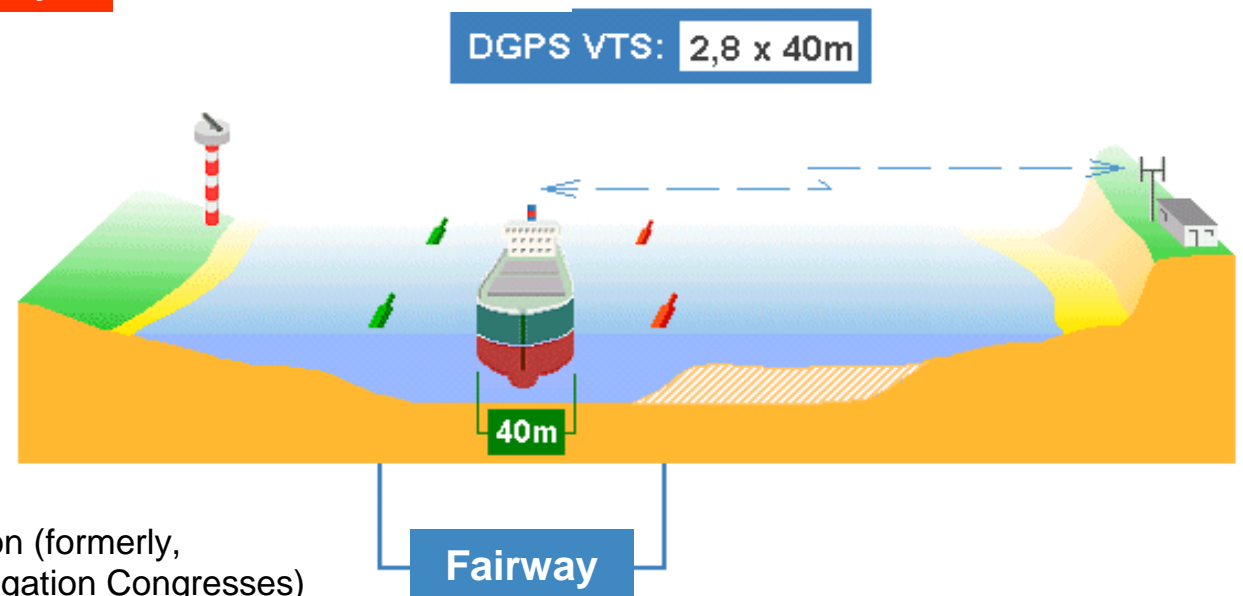
Fairway Definition

PIANC: International Fairway Tolerances



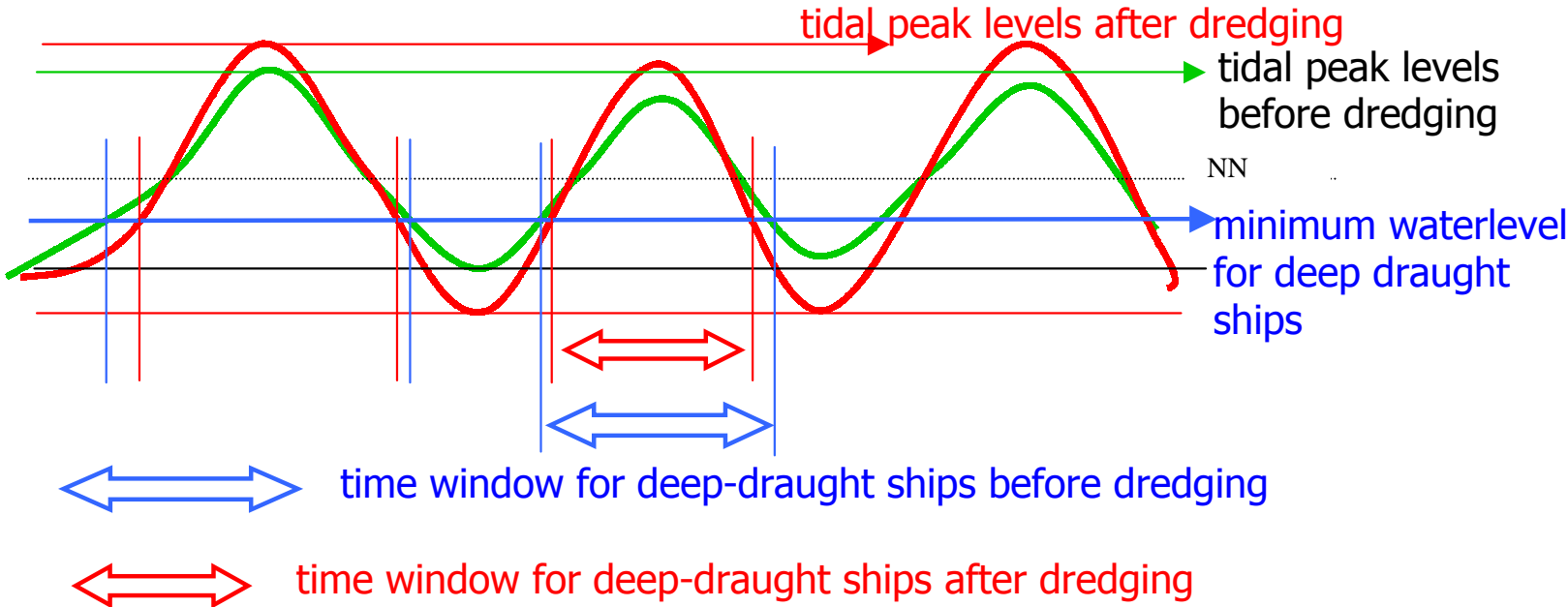
PIANC recommends a fairway **5x** the width of the largest ship **when guided by radar.**

PIANC recommends a fairway **2.8x** the width of the largest ship when **guided by more precise GNSS** navigation.



PIANC = International Navigation Association (formerly, Permanent International Association of Navigation Congresses)

Environmental Argument



Impact of Dredging on Current and Tide

MARLET Result

233 hrs Survey
4 Antenna: 892 hrs Survey
~ 3,2 mio Position Data

Position Accuracy of EGNOS
+ LOPOS Real Time Deviation Detection Routine
+ Synthetic Aperture GNSS Antenna

0.7 m at 88.8%

1.4 m at 99.7%

- without Ground-Based Augmentation System.

NOTE:
Difference
radar signature
to chart
~ 15m

1815

2150

Tug

Shore-
based
Radar

Ship's
length:
~ 310 m

Turning Basin Radius 450
m

Tug



TSING MA BRIDGE

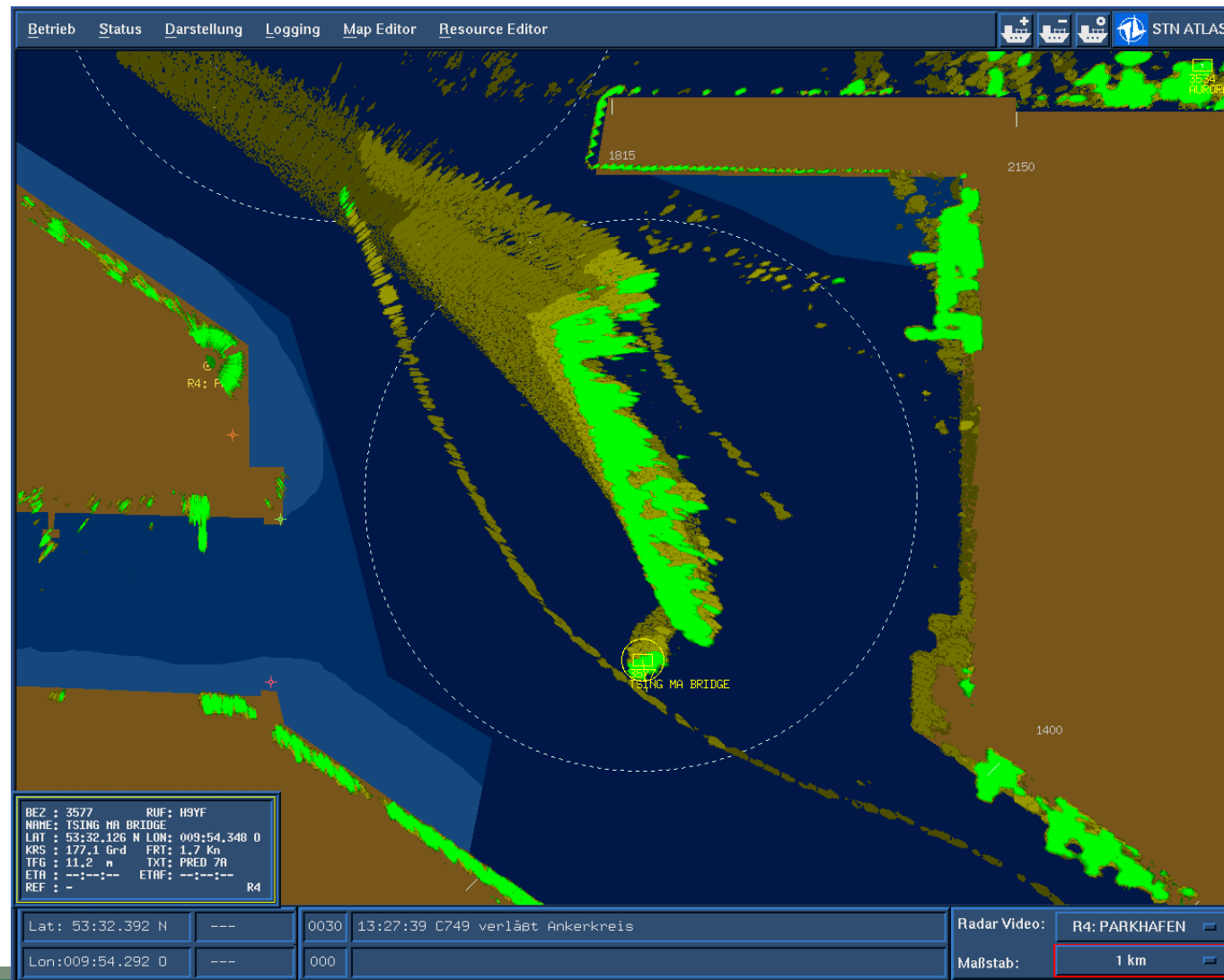
1400

Notes to the Radar Image

YF

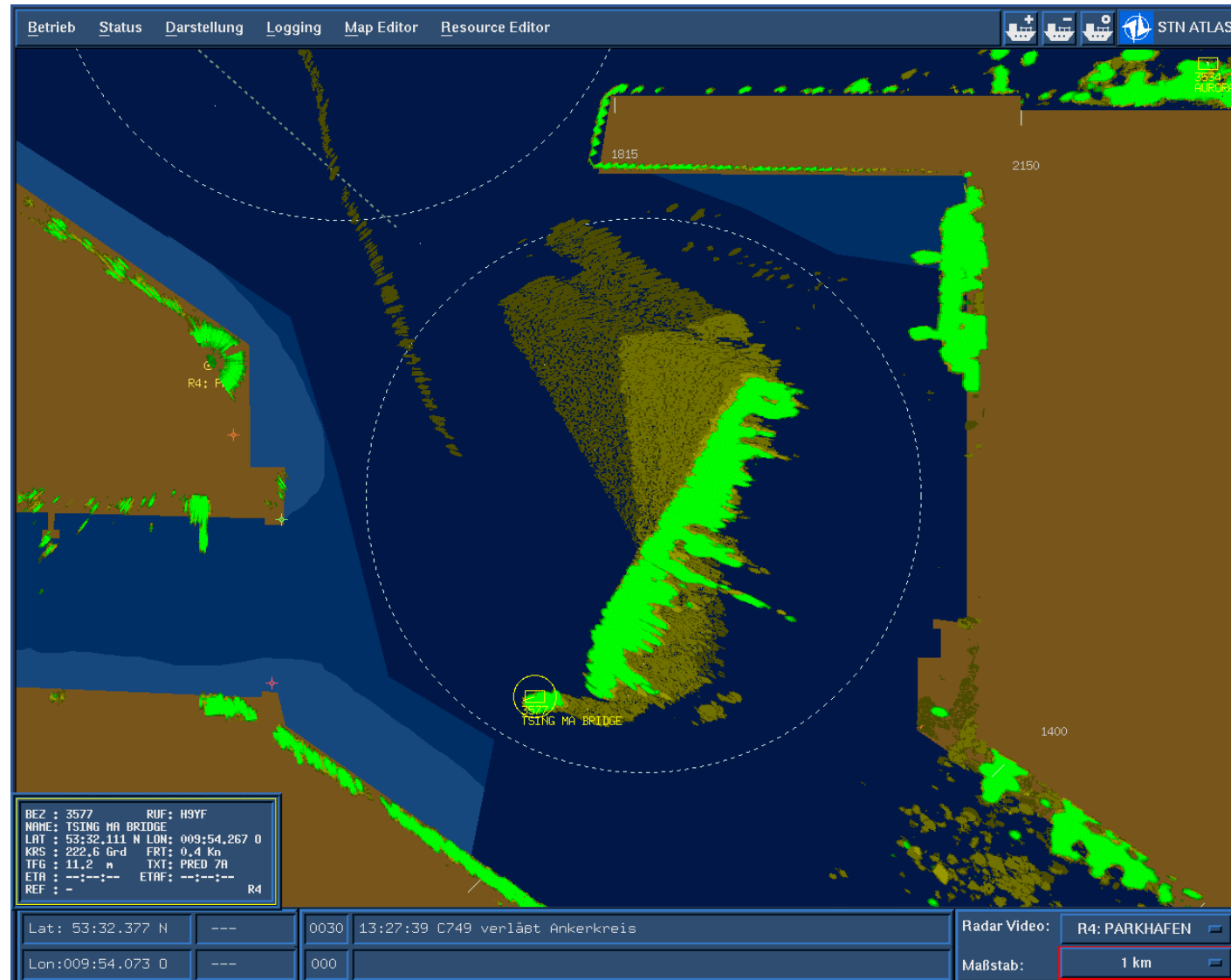
Radar Sequence - Turning a Ship

1



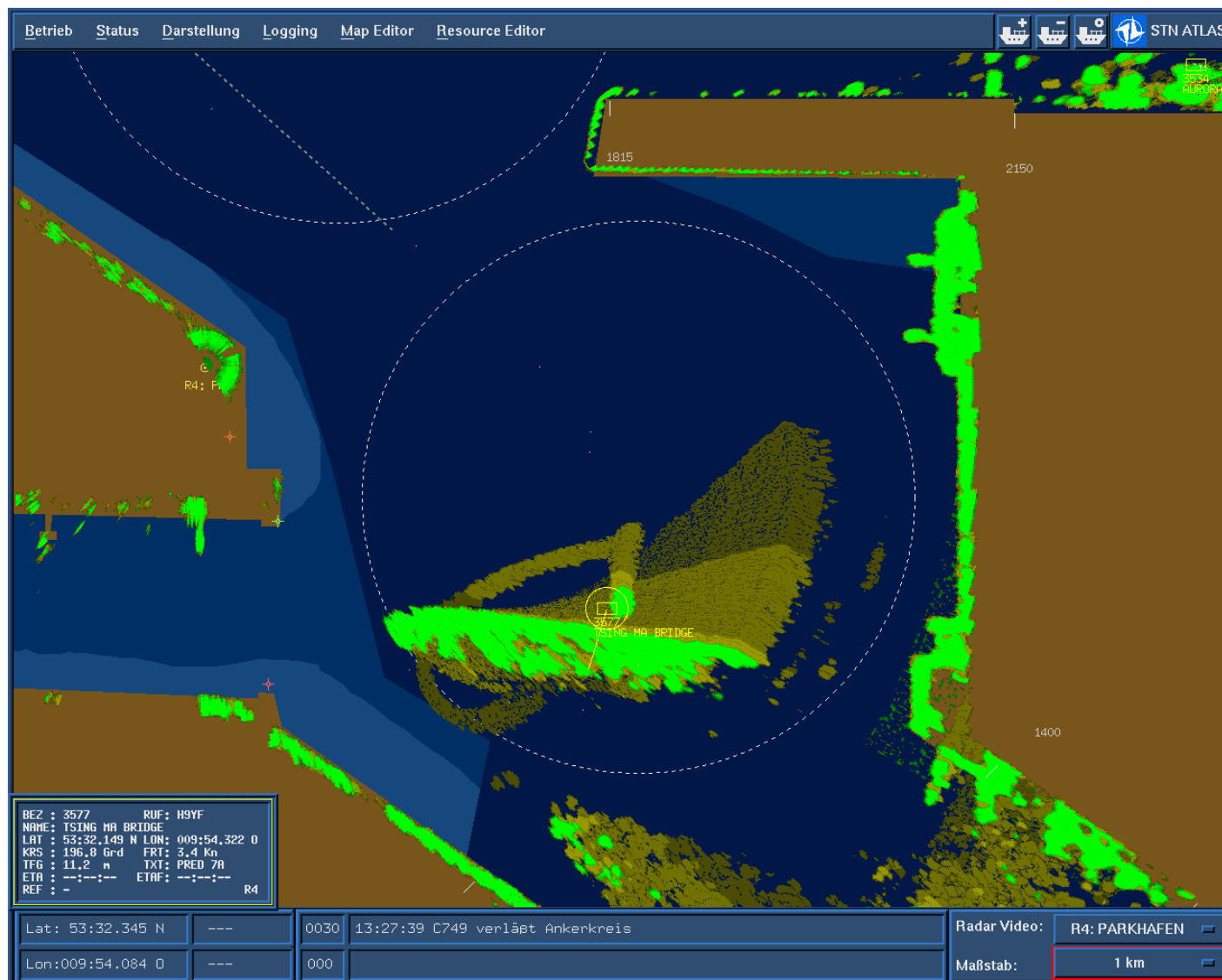
Radar Sequence - Turning a Ship

2



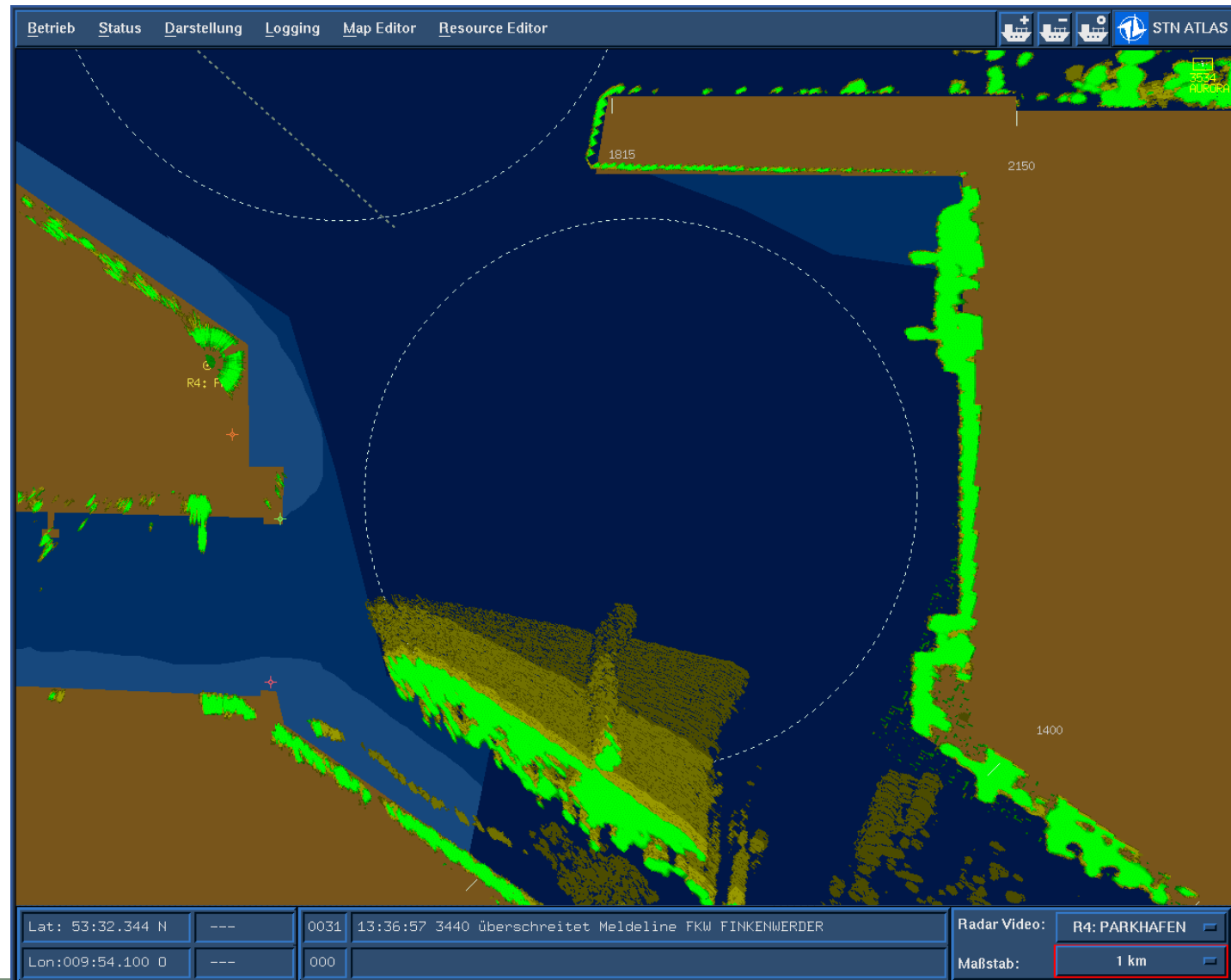
Radar Sequence - Turning a Ship

3



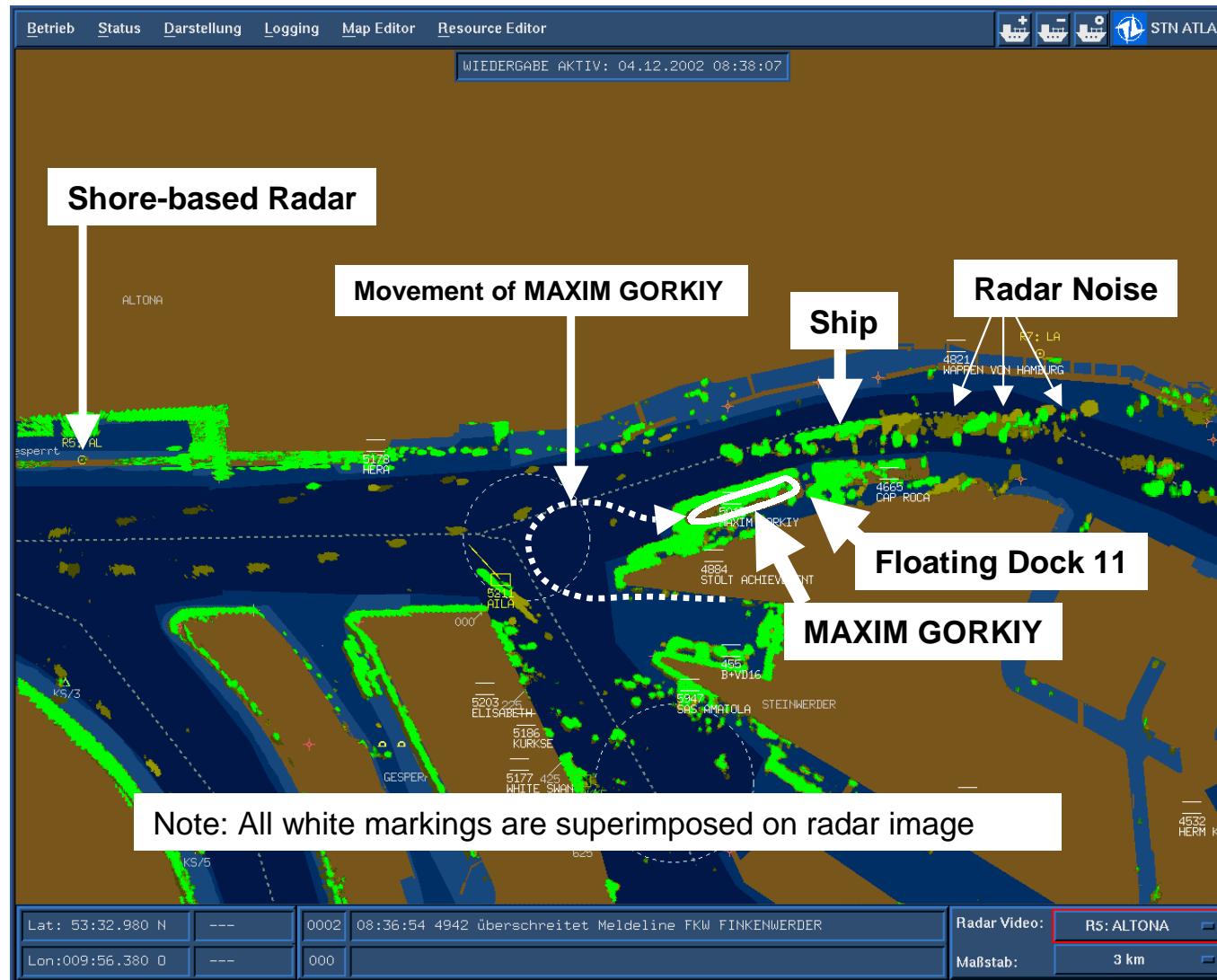
Radar Sequence - Turning a Ship

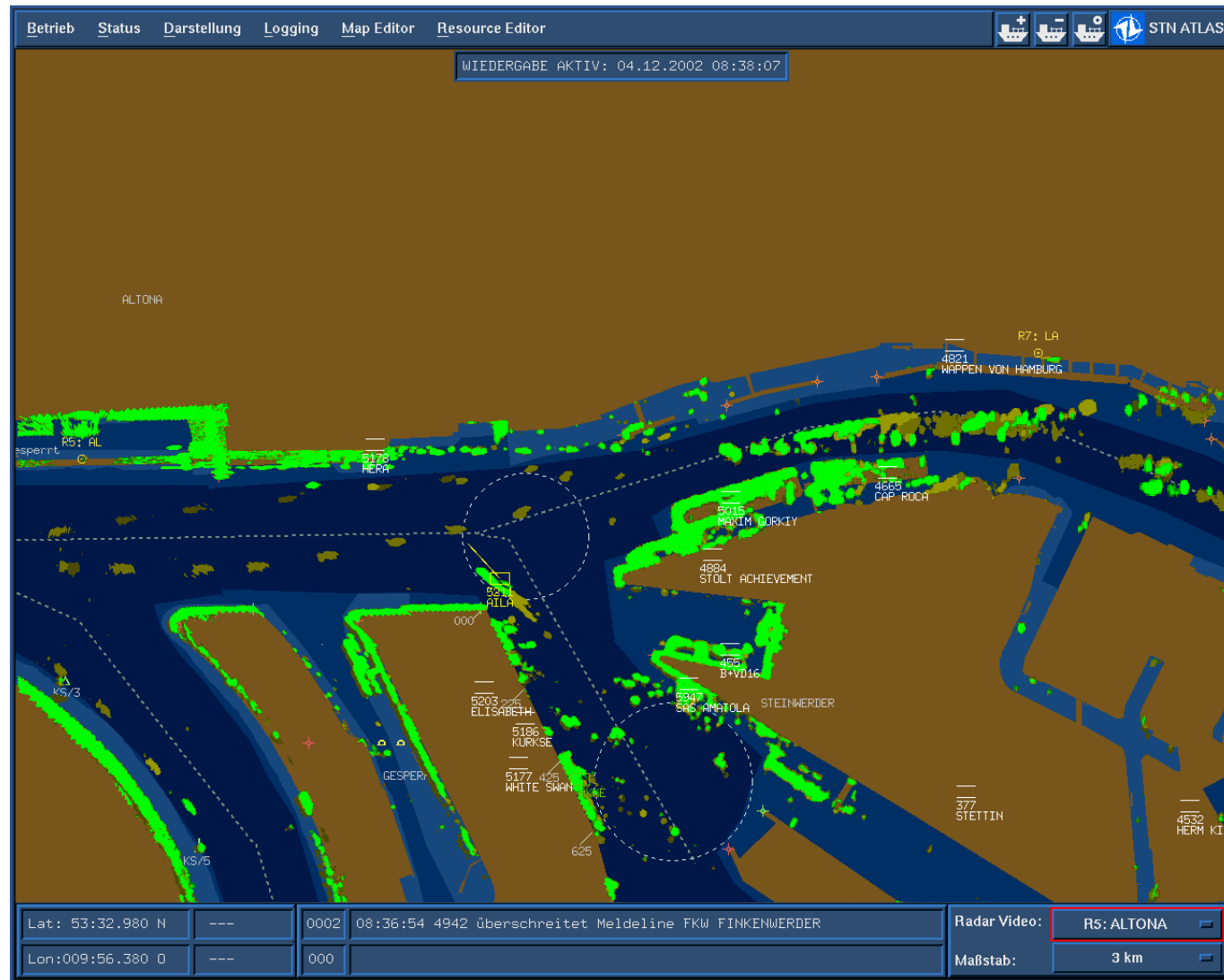
4



Radar Sequence Passing the MAXIM GORSKI

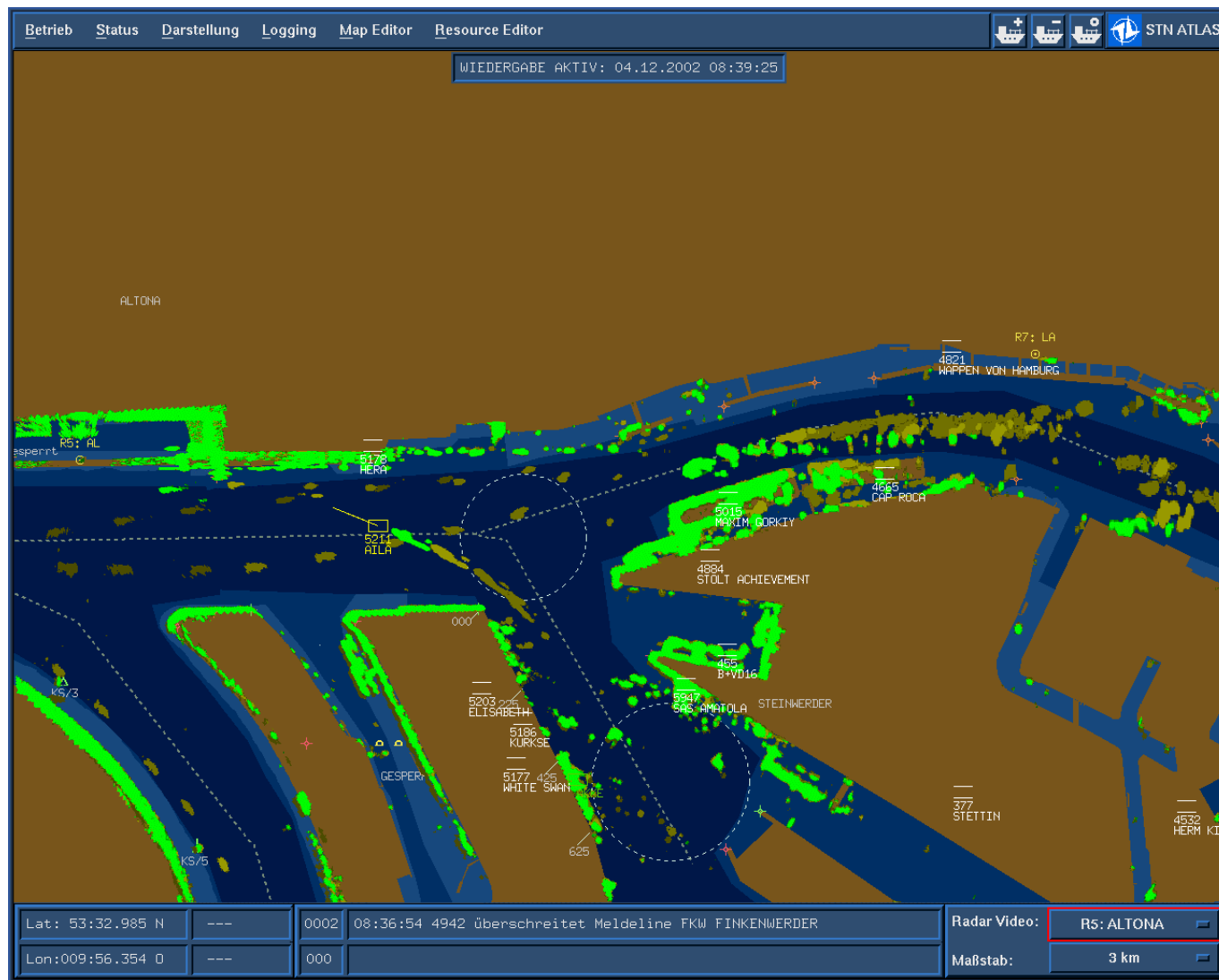
1





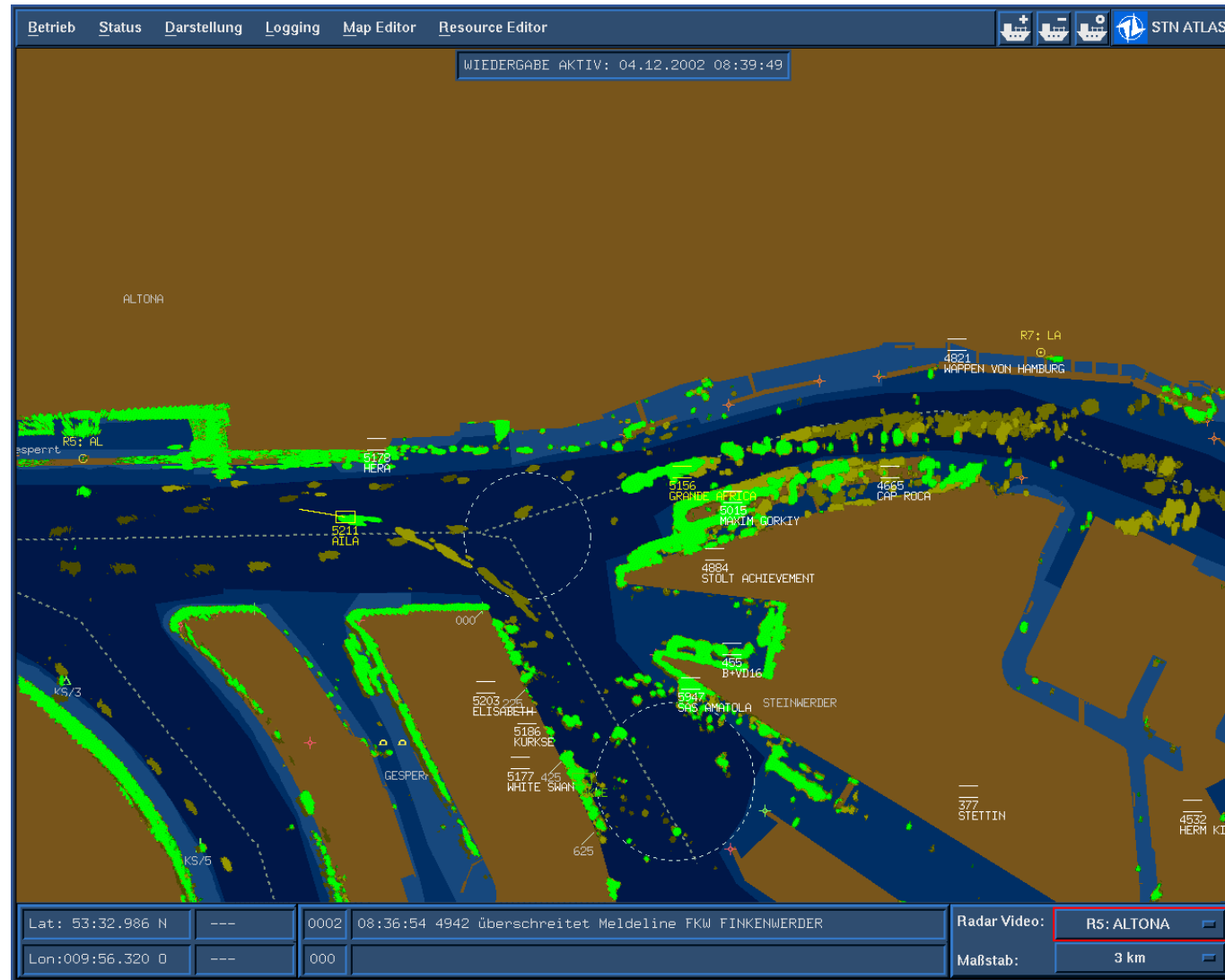
Radar Sequence Passing the MAXIM GORKI

2



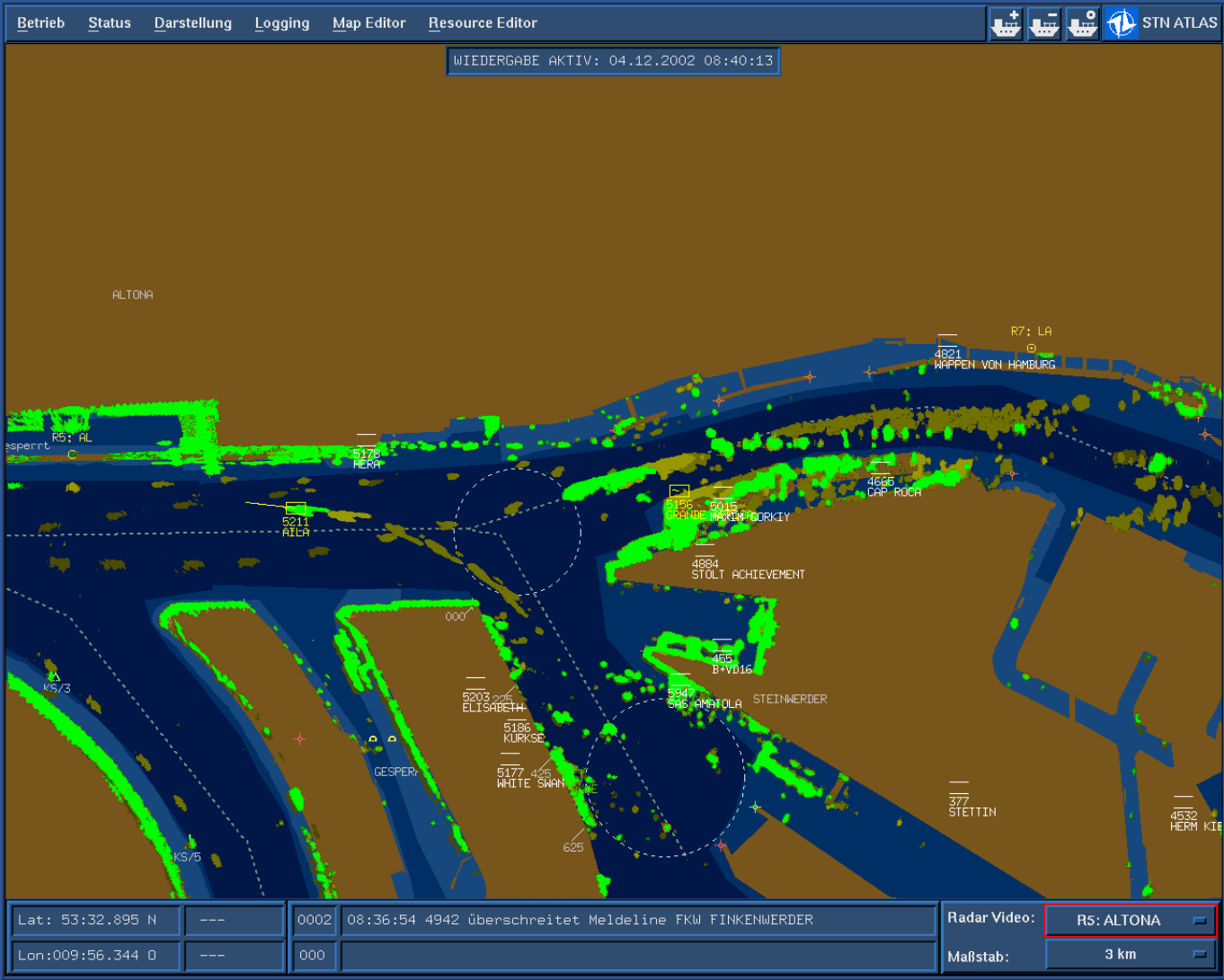
Radar Sequence Passing the MAXIM GORSKI

3



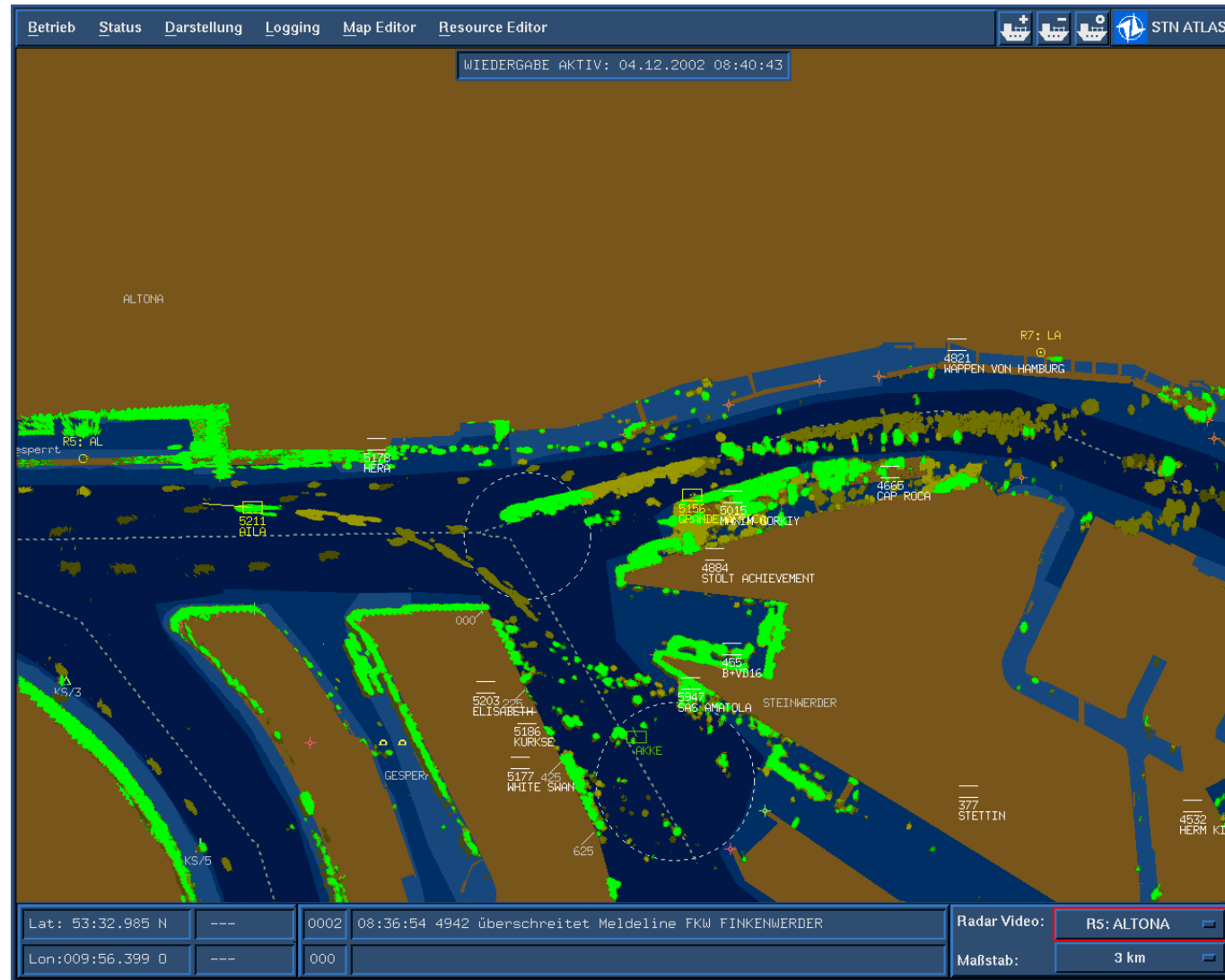
Radar Sequence Passing the MAXIM GORKI

4



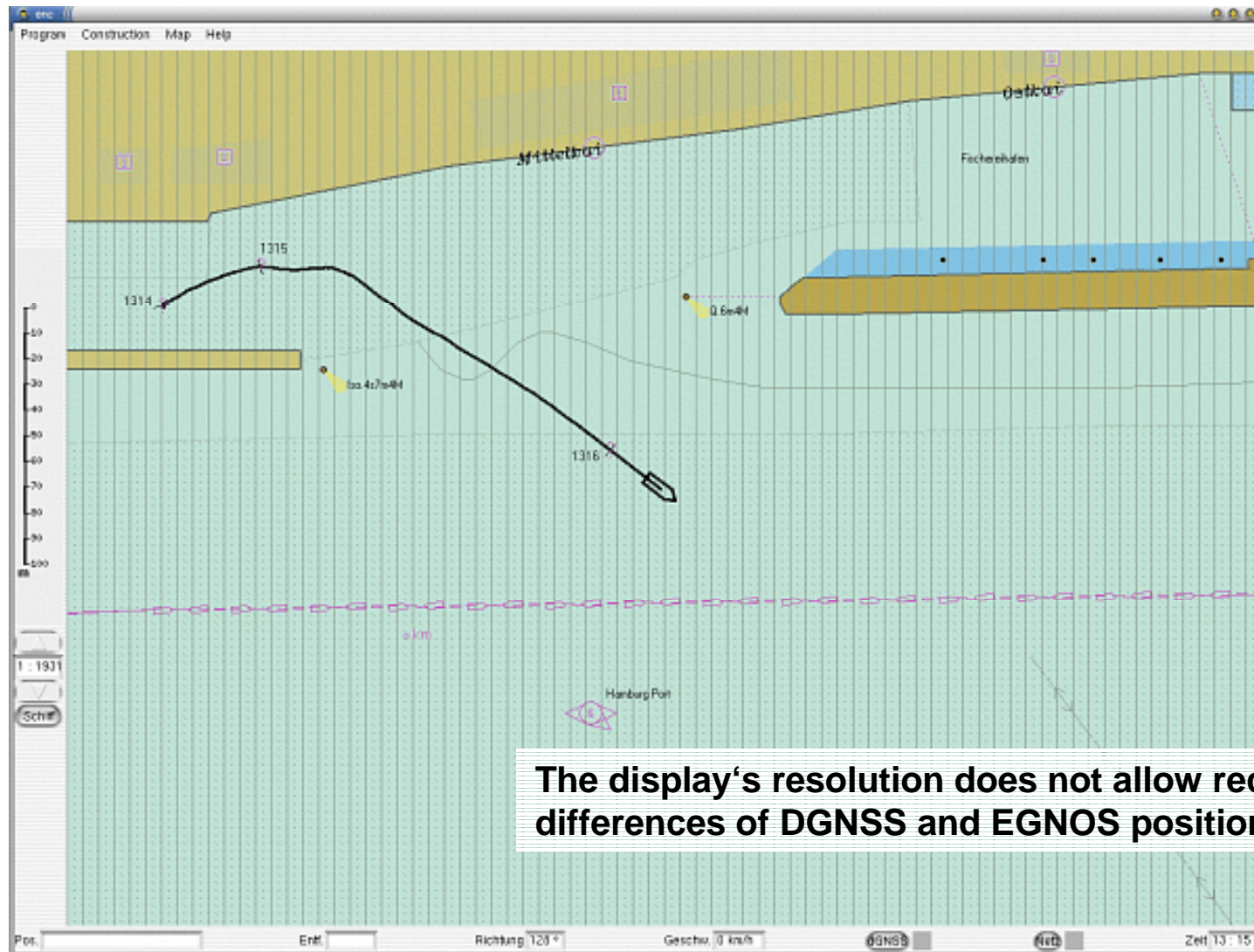
Radar Sequence Passing the MAXIM GORKI

5



DGNSS vs. EGNOS

Parallel Display of Past-tracks



Towing MAXIM GORKIY to the Dock

Screenshot of MARLET Test (Video on demand)

