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# eLoran Provider, Monitoring and User equipment Performance

- Timing and Harbour Entrance & Approach -

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NAV08 – ILA37

October 28-30, Church House, London

# Receiver characteristics

- eLoran requires the receivers to be:
  - All-in-view eLoran
  - Small size
  - Integrated with GPS
  - eLoran data channel capable
  - Firmware upgradeable
- RTCM SC-127 working group on Minimum Performance Standards for eLoran receivers

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eLoran equipment for Maritime Harbour Entrance & Approach

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→3D N

eLoran equipment for Maritime Harbour Entrance & Approach

C-MAP Link

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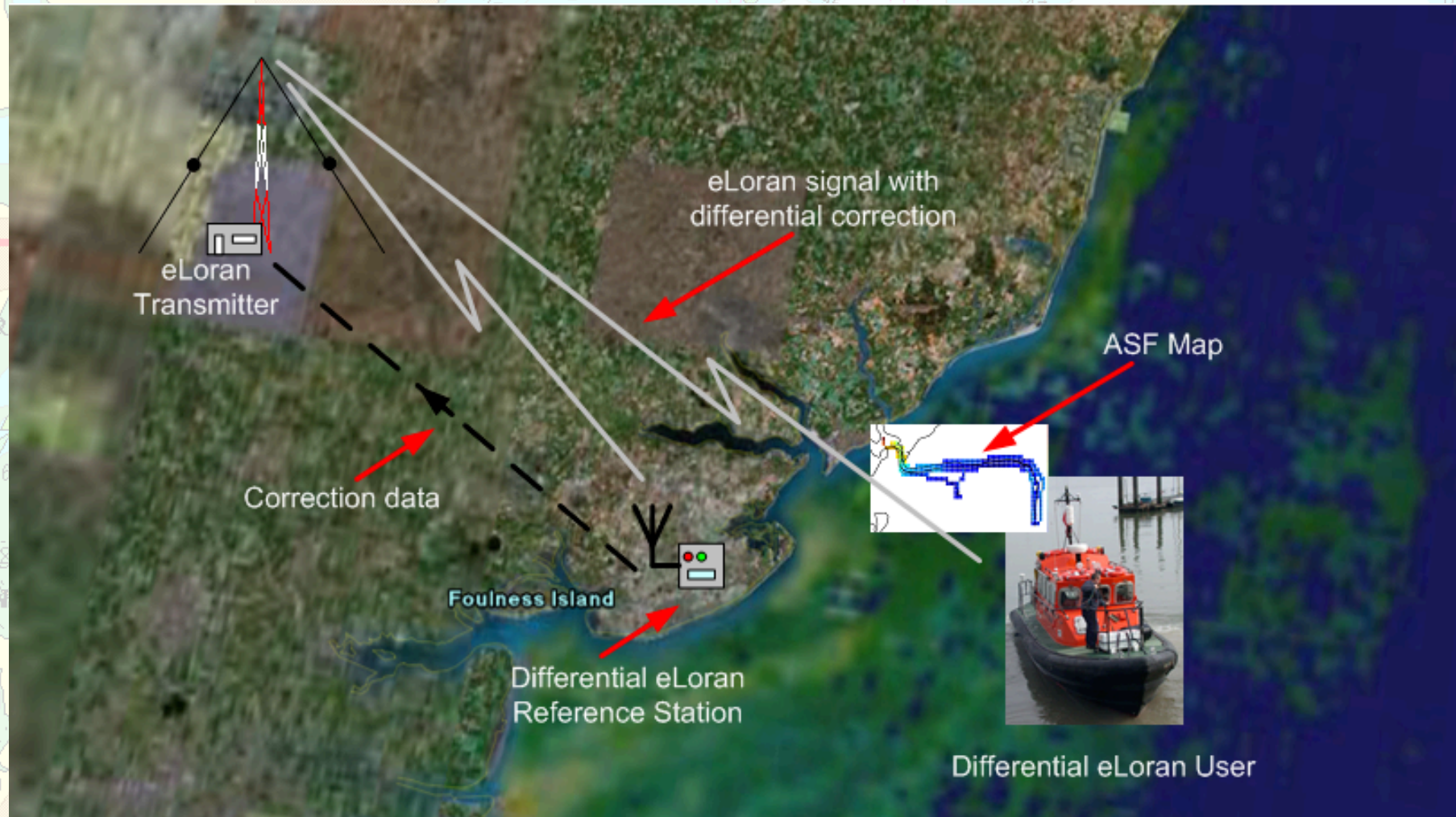
3D N

eLoran equipment for Maritime Harbour Entrance & Approach

C-MAP Link

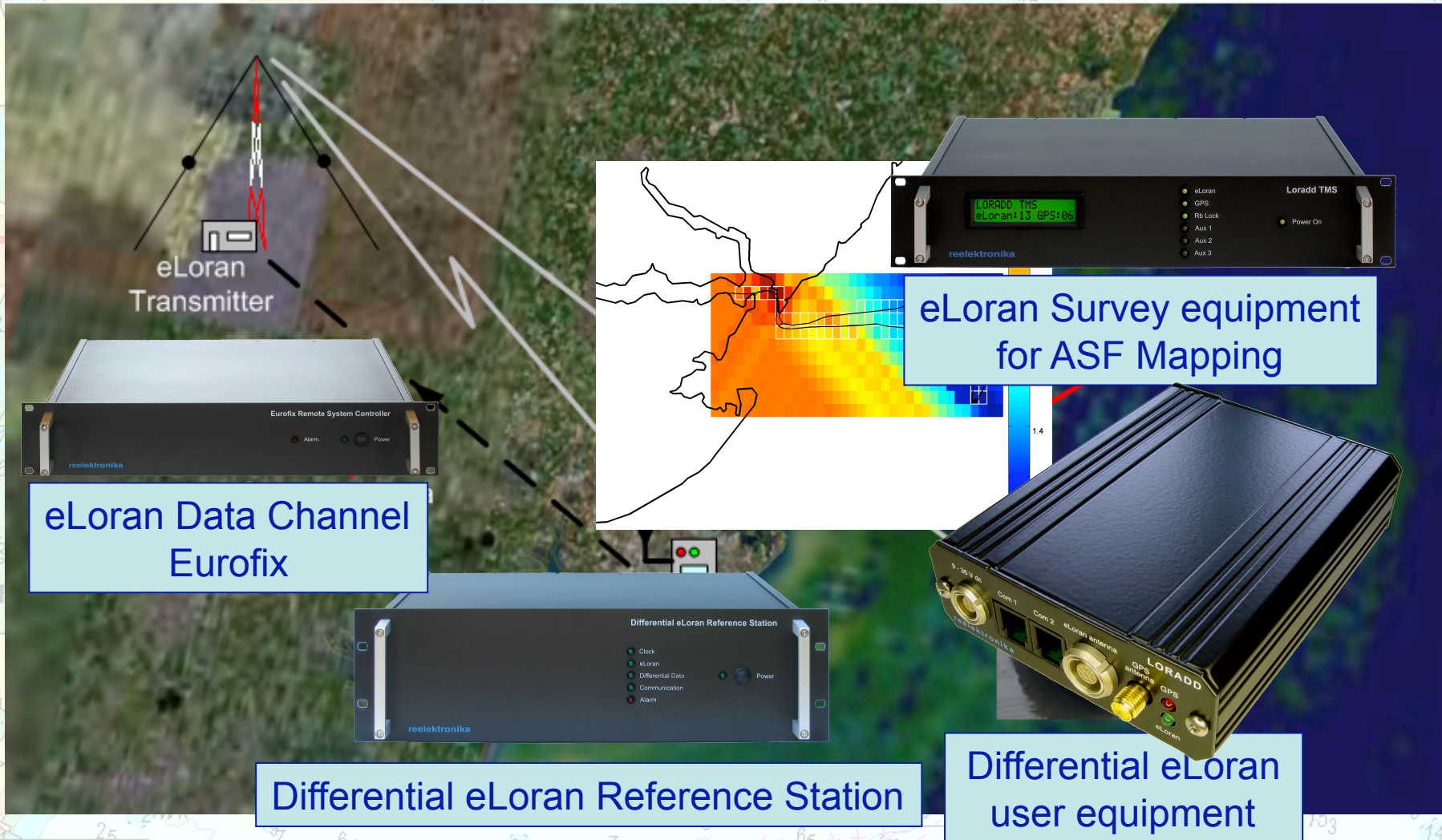


# Maritime Harbour Entrance & Approach





# Maritime HEA requires...



eLoran Data Channel  
Eurofix

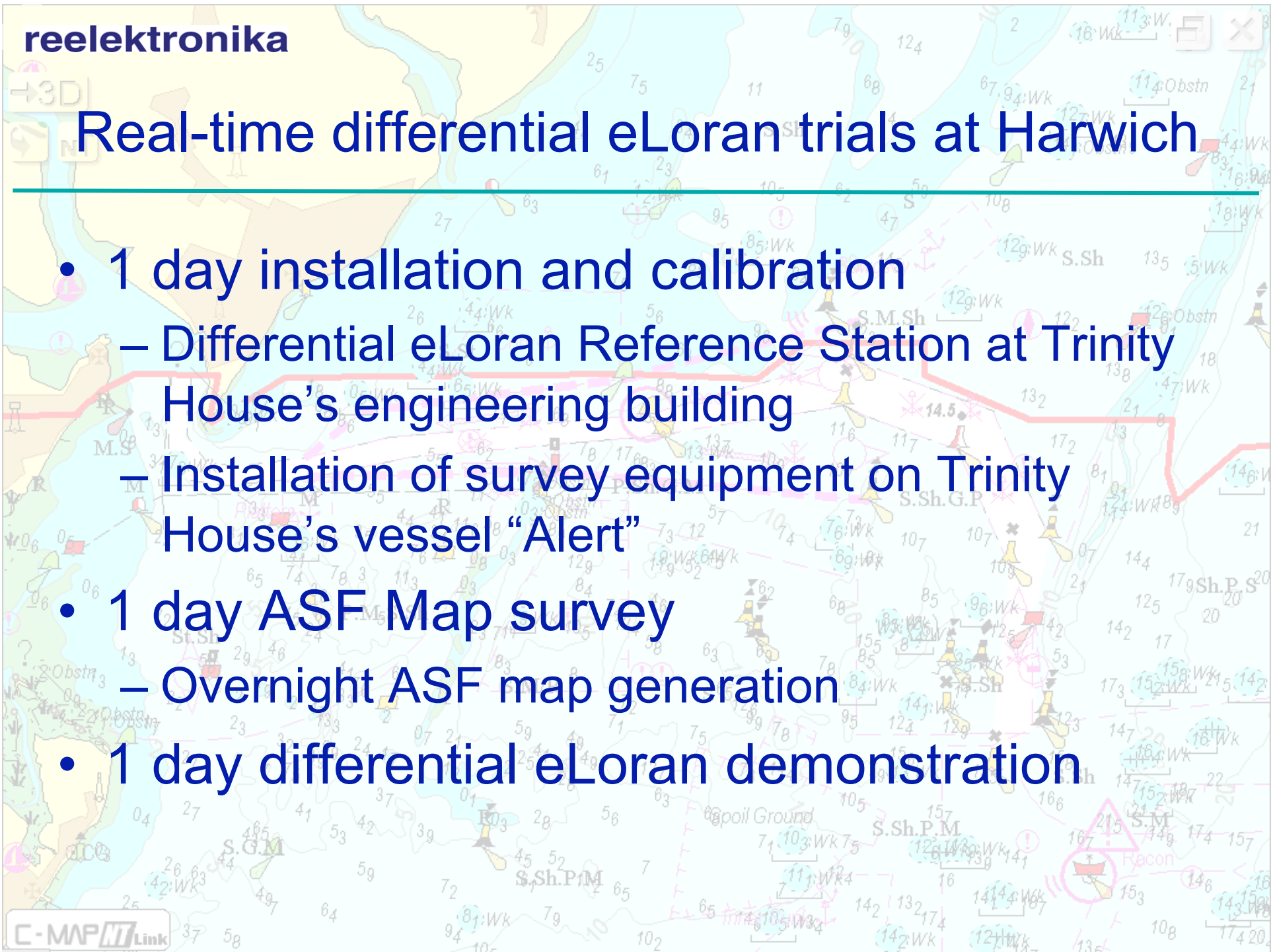
eLoran Survey equipment  
for ASF Mapping

Differential eLoran Reference Station

Differential eLoran  
user equipment

# Real-time differential eLoran trials at Harwich

- 1 day installation and calibration
  - Differential eLoran Reference Station at Trinity House's engineering building
  - Installation of survey equipment on Trinity House's vessel "Alert"
- 1 day ASF Map survey
  - Overnight ASF map generation
- 1 day differential eLoran demonstration





# Antenna installation on the “Alert”

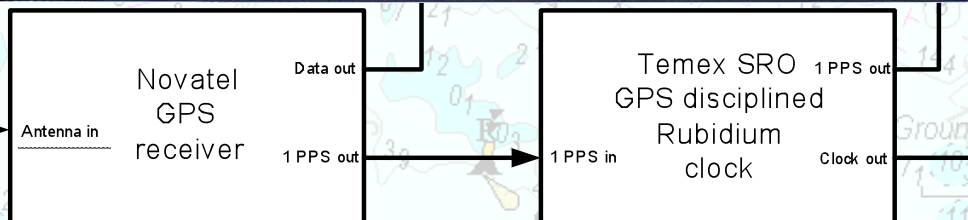
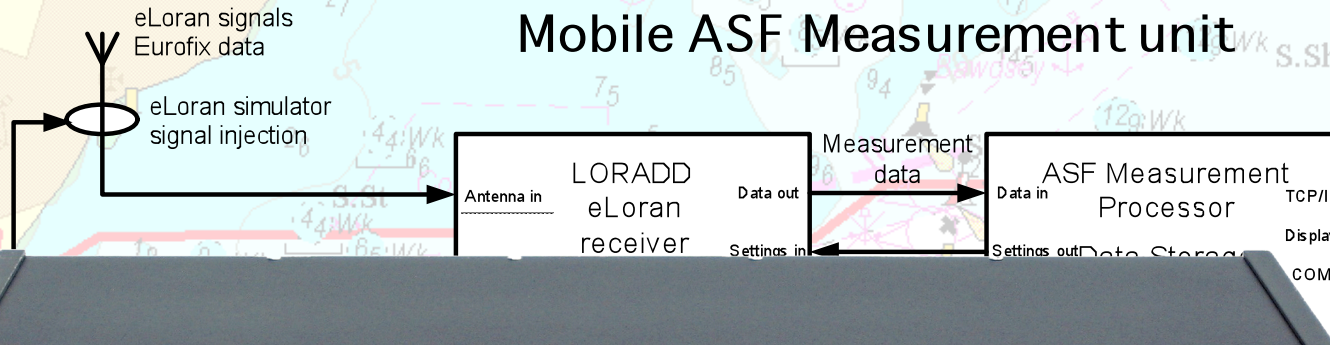


- Location 1 proved to be difficult to calibrate due to non-symmetrical installation on the vessel
- Location 2 is used for the survey and trials

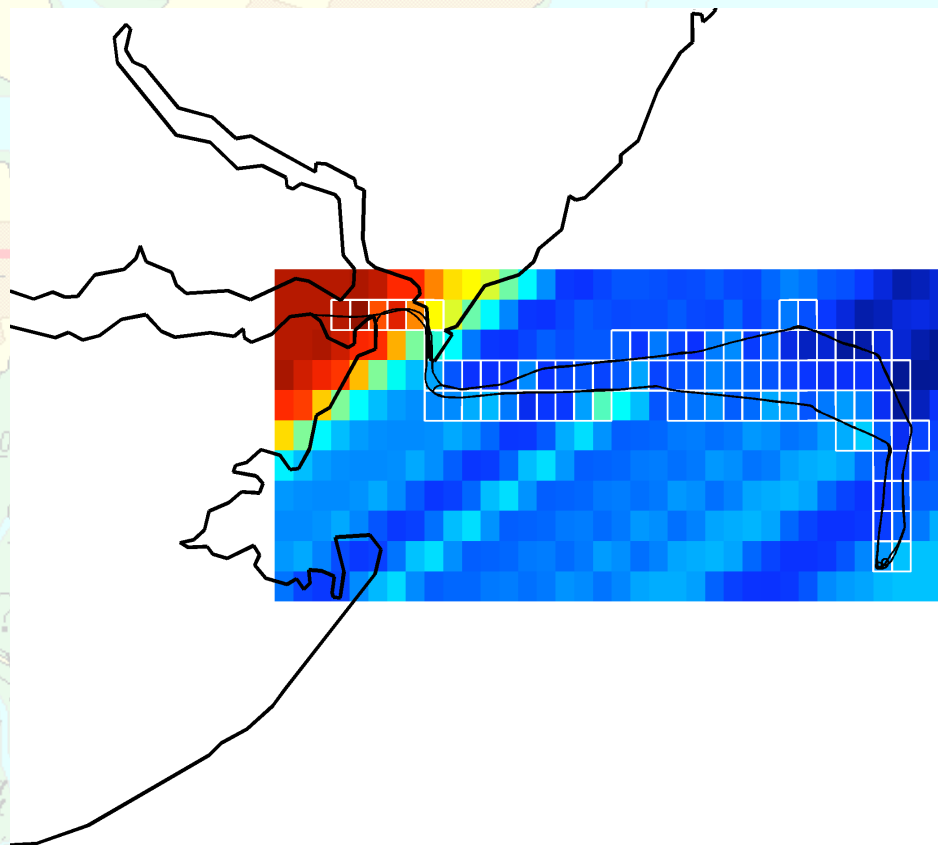


# ASF Survey equipment

## Mobile ASF Measurement unit



# ASF Map generation



## ASF Maps for:

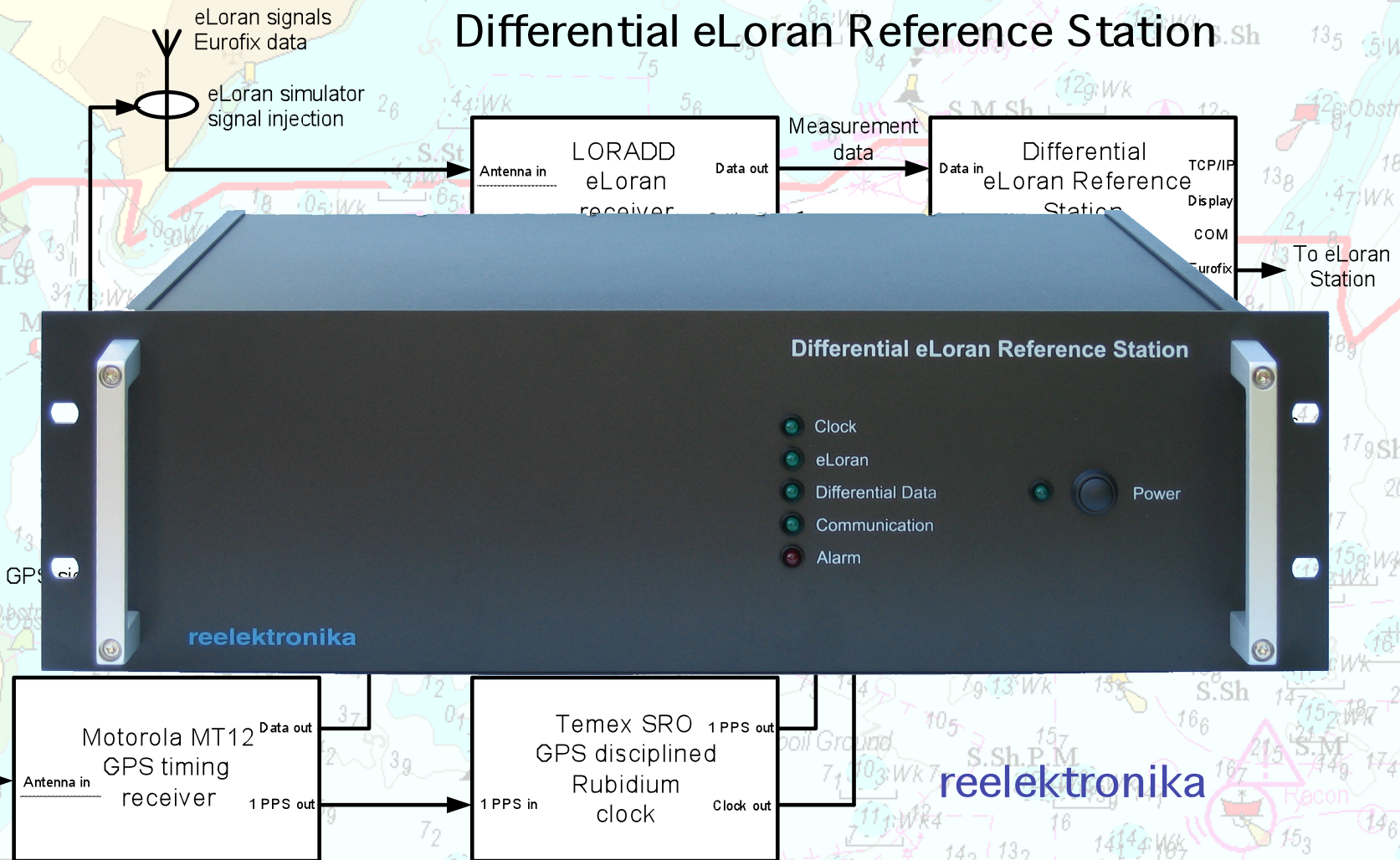
- Lessay (6731M & 7499X)
- Anthorn (6731Y)
- Sylt (6731Z & 7499M)

Grid size: 0.01 degrees



# Differential eLoran Reference Station

## Differential eLoran Reference Station





# Differential eLoran Reference Station interface

**Reelektronika Differential eLoran Reference Station**

File View Window About

**Status**

- ☒ Clock
- ☒ eLoran
- ☒ Differential Data
- ☒ Communication
- ☐ Alarm
- ☒ Horizontal Position Error

**Differential eLoran Configuration**

Reference Station

Name: Harwich

ID (0-1023): 100

Latitude: 51.945767660

Longitude: 1.285599610

Correction Update: 10

Correction Priority: 1

Differential eLoran Integrity Monitoring

Horizontal Protection Limit: 10.0

HPL Observation Interval: 10

Max ASF Correction: 2.000

Restore from Registry

Configure Reference Station

**Differential eLoran Almanac**

Correction Set	eLoran ID 1	Nominal ASF	eLoran ID 2	Nominal ASF
Correction Set 0:	<input checked="" type="checkbox"/> 6731M	0.590	<input checked="" type="checkbox"/> 6731X	3.100
Correction Set 1:	<input checked="" type="checkbox"/> 6731Y	0.907	<input checked="" type="checkbox"/> 6731Z	0.280
Correction Set 2:	<input checked="" type="checkbox"/> 7499M	0.260	<input checked="" type="checkbox"/> 7499X	0.590
Correction Set 3:	<input checked="" type="checkbox"/> 7499Y	0.050	<input checked="" type="checkbox"/> 9007Y	0.050
Correction Set 4:	<input type="checkbox"/>		<input type="checkbox"/>	
Correction Set 5:	<input type="checkbox"/>		<input type="checkbox"/>	

**Differential eLoran Corrections**

Time: 12:44:16.50

Date: 08/07/08

Reference Station: Harwich

Latitude: 51.945755040

Longitude: 1.285615720

UTC Quality: 0

Age of Correction: 300

Number of Stations: 6

Loran ID	Nominal	Diff Cor	Flag
-> 6731M	0.590	-0.008	0x01
-> 6731X	2.530	0.029	0x01
6731Y	1.500	-0.130	0x01
6731Z	0.080	-0.109	0x01
7499M	0.080	-0.149	0x01
7499X	0.590	-0.018	0x01

**LCPOSA - ASF Corr...**

Time: 6050.00

Lat: 51.9457910

Lon: 1.2856014

HDOP: 1.00

Version: 1.0

Velocity: 0.10

Heading: 14.80

Compass: 0.00

Number of Loran: 5

Loran	Residual	Weight
6731M	-4.00	1.00
6731Y	0.00	0.60
6731Z	-4.00	0.49
7499M	4.00	0.49
7499X	4.00	0.99

**Differential eLoran Position Error Monitor**

File Edit Plot

Statistics

Current Data:

Lat : 51.94573340

Lon : 1.28560020

Mode : Differential

Statistics:

Avg Lon : 51.94577305

Avg Lon : 1.28558661

Offset : 1.1 m

Avg Err : 2.3 m (50%)

5.3 m (95%)

6.8 m (99%)

Real Err: 2.4 m (50%)

5.7 m (95%)

7.2 m (99%)

#Obs : 1603

Reference Position

Latitude: 51.945767660

Longitude: 1.285599610

Set

Restore from Registry

Protection limit

10.0 m

Set

10 seconds observation

Restore from Registry

Options

Max number of points: 20000

Set

Log Data:

6.46,0.093,-3.510,0.129,0000,50752.5814,-8.5053e-09,6010.91,9007Y,39.19.5.98,0.236,-

1.412,0.227,0000,60716.5147,1.0046e-08,6010.91\*06

\$LCGLC,6731,40752.7170,A,,,,,14888.9473,A,27567.4720,A,4275

3.0160,A\*69

\$LCGLC,7499,925.6869,A,,,,,13447.0160,A,31160.7925,A,\*36

File control

500 Lines/s

Set

Disconnect

Select

\$

9.347 MB logged to DeLoran-20080708.log

**Differential eLoran Position Error Monitor**

Latitude (m)

Longitude (m)

Scale: 25 m

Centre

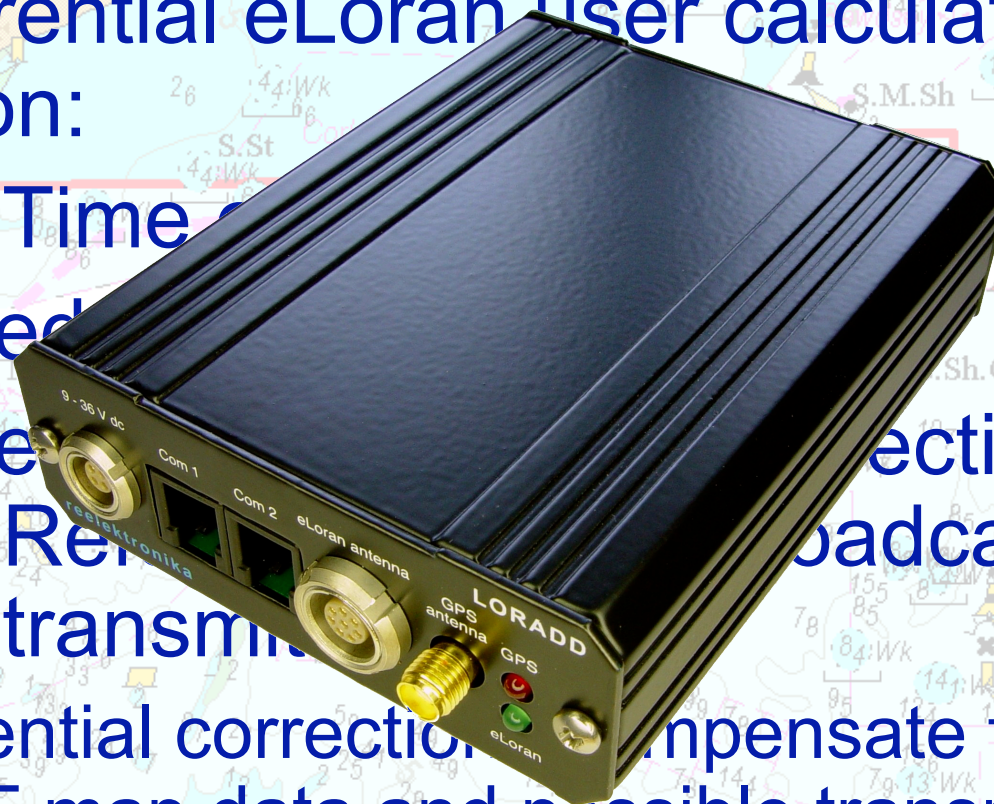
Freeze

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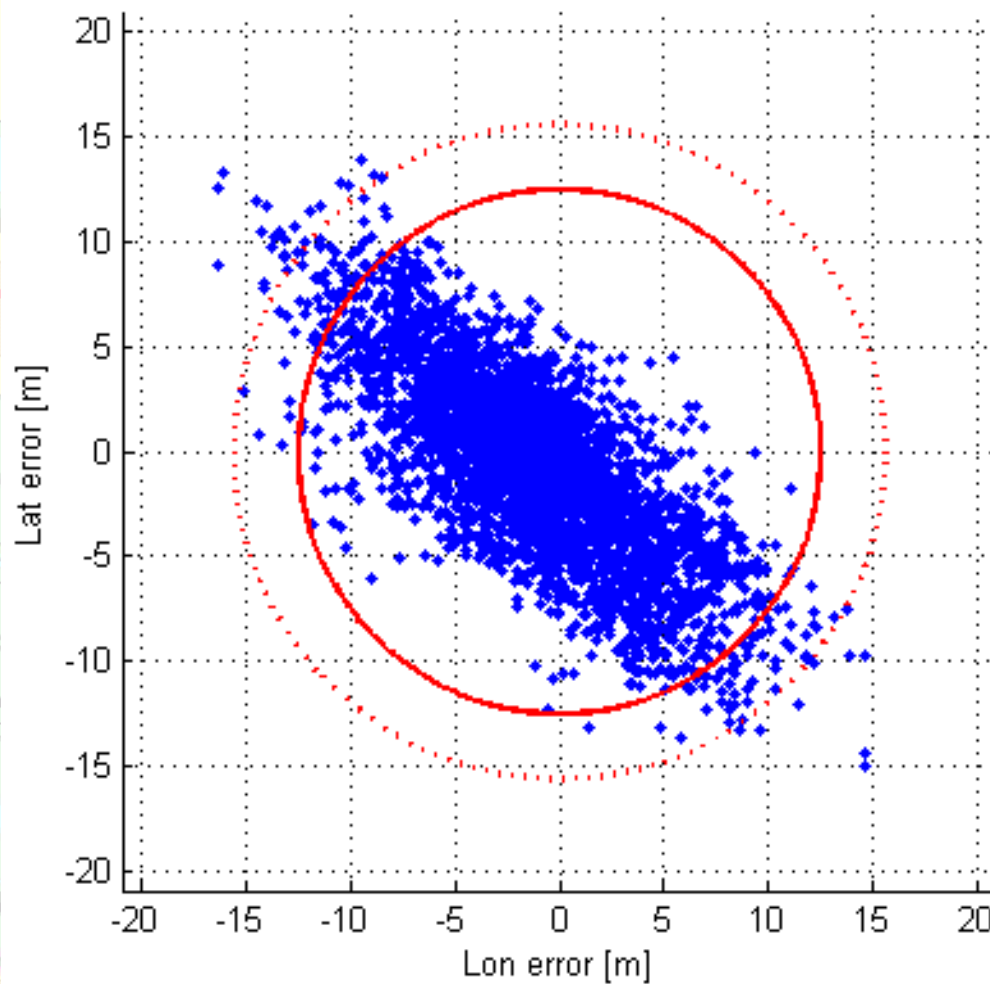
# HEA User equipment

The Differential eLoran user calculates position based on:

- eLoran Time
- Corrected
- Corrected
- eLoran Receiver
- eLoran transmission
- Differential correction
- in ASF map data and possible transmitter timing errors



# Differential eLoran vs DGPS truth



Accuracy  
12.6 m (95%)

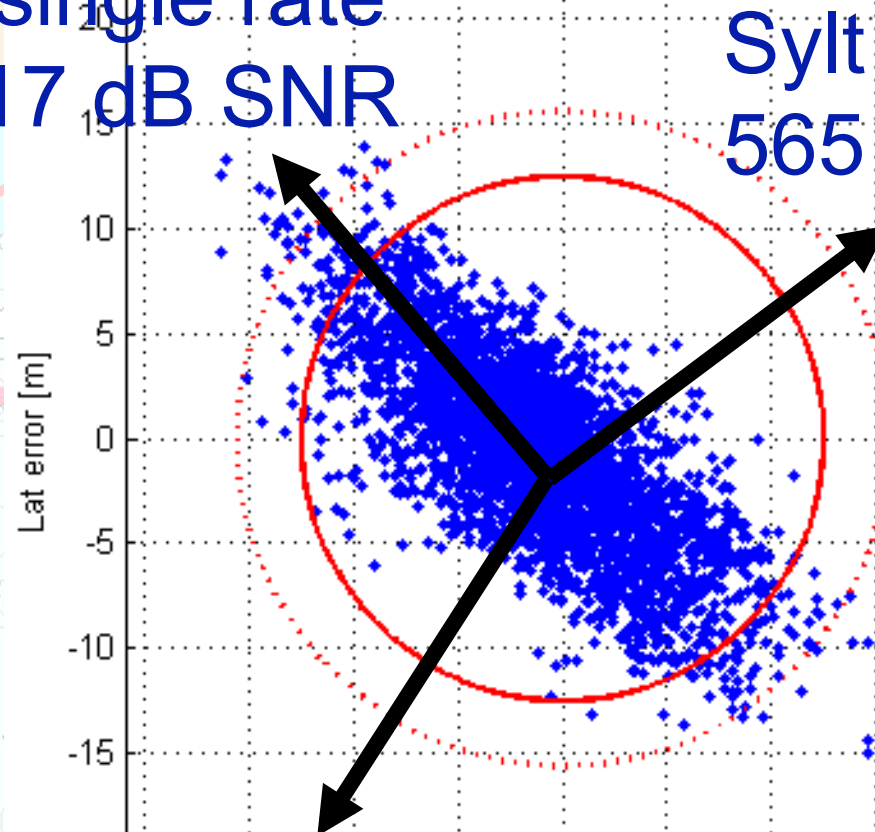


# Geometry, distance and SNR

Anthorn single rate  
448 km 17 dB SNR

Sylt dual rate  
565 km 16 dB SNR

Lessay dual rate  
368 km 22 dB SNR





eLoran Timing equipment

# *Loradd UTC series*



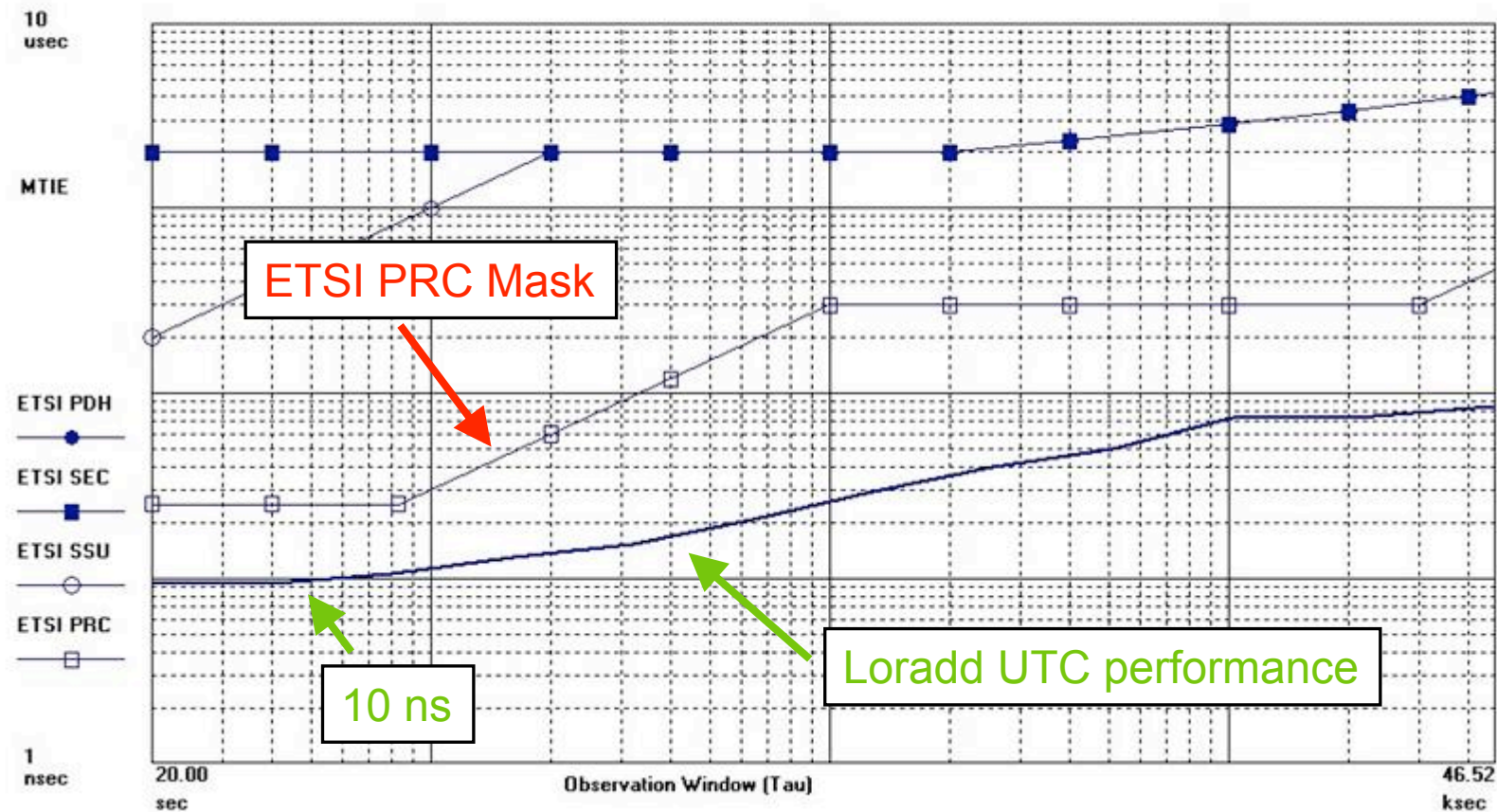
- All functionalities of a normal LORADD receiver
- Ovenized crystal for improved stability and hold-over (SRS SC10)
- 10 MHz, 2.048 MHz and 1.544 MHz outputs
- 1 PPS (Loran derived) output
- 1 PPS (GPS derived) output
- Loran Timing Source Station selectable
- Eurofix & 9<sup>th</sup> pulse capable



# Test results - MTIE

Symmetricom TimeMonitor Analyzer

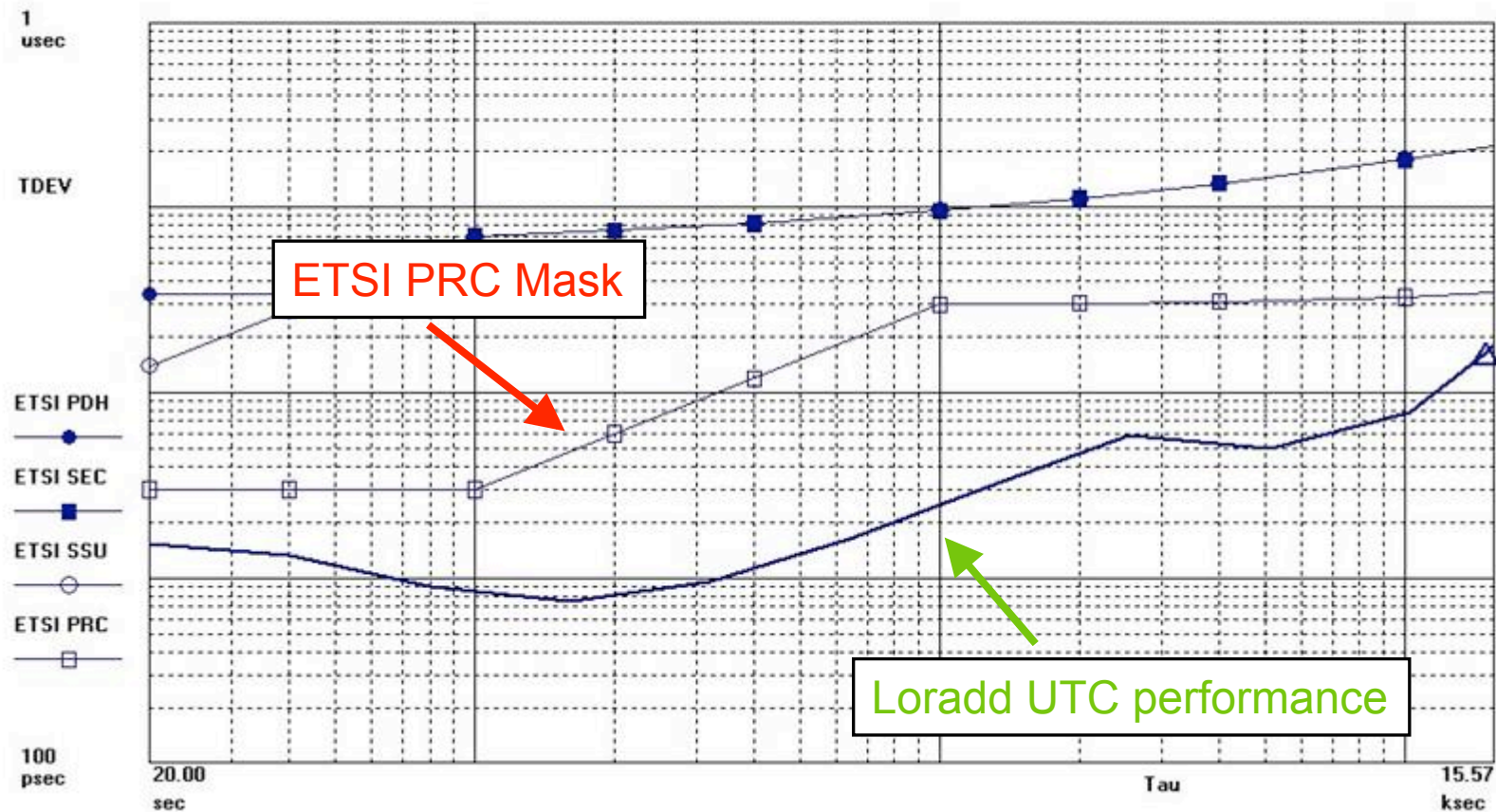
MTIE on zoomed area; 2.329 hours to 15.24 hours; Fo=1.000 Hz; Fs=50.00 mHz; \*28/06/06 06:03:23 PM\*; \*29/06/06 09:19:42 AM\*;  
Fluke PM6680B; Test: 612; LORADD; 1PPS; TS3100; Samples: 2748; Gate: 1 s; Glitch: 40.00 nsec; Ref ch1; TI/Time Data Only; TI 1->2;



# Test results - TDEV

Symmetricon TimeMonitor Analyzer

TDEV on zoomed area; 2.273 hours to 15.24 hours; Fo=1.000 Hz; Fs=50.00 mHz; \*28/06/06 06:03:23 PM\*; \*29/06/06 09:19:42 AM\*;  
Fluke PM6680B; Test: 612; LORADD; 1PPS; TS3100; Samples: 2748; Gate: 1 s; Glitch: 40.00 nsec; Ref ch1; TI/Time Data Only; TI 1->2;





# *Working on... Loradd-F*

- Loradd-F
- Low-cost XO



- No GPS
- 10 MHz output via SMA





For more information

Visit our booth in the Assembly Hall



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