

First trials of the LORADD integrated eLoran/GPS/WAAS receiver

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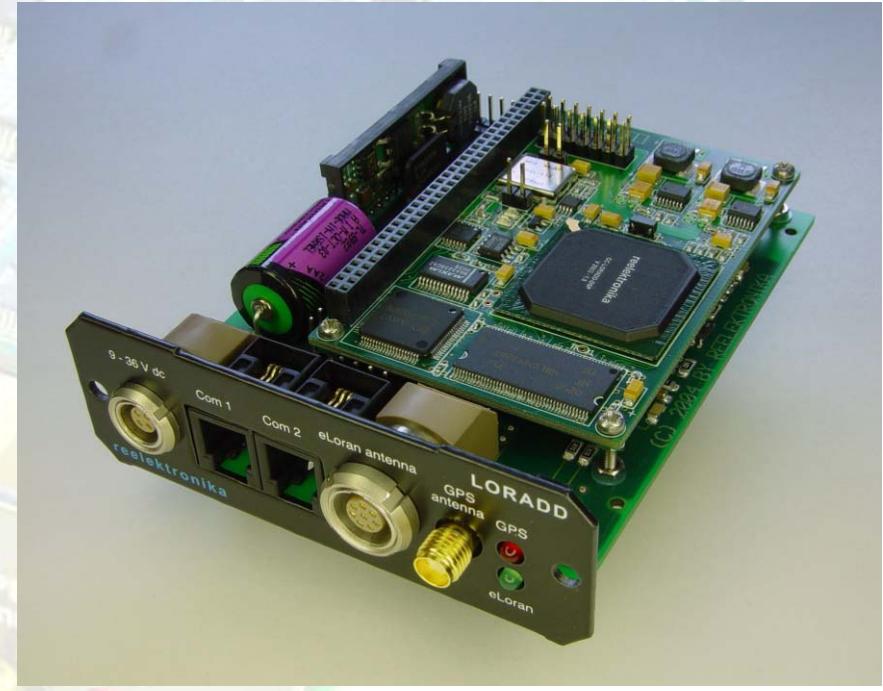
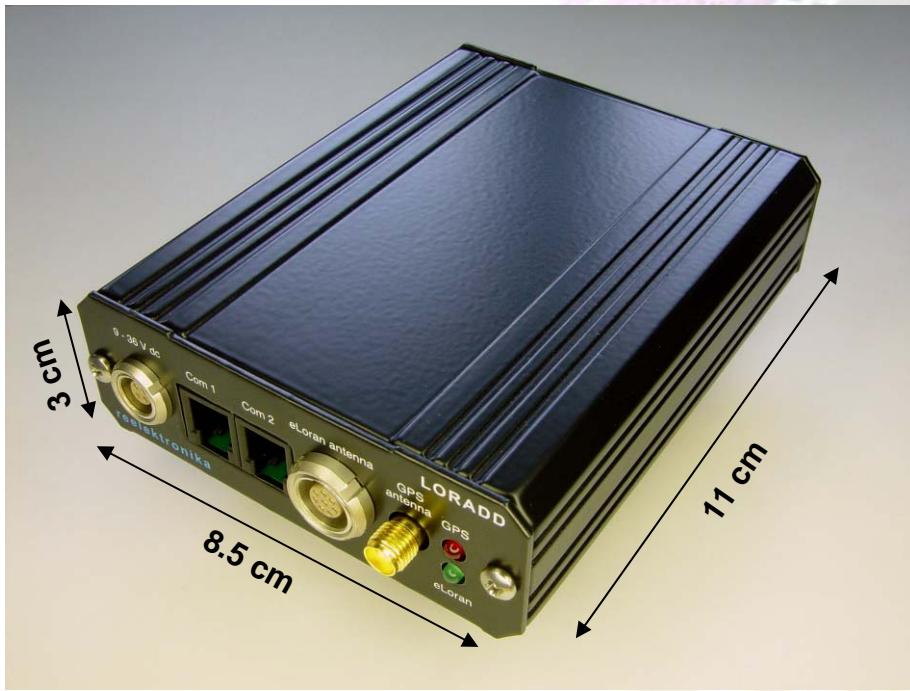
Reelektronika B.V.

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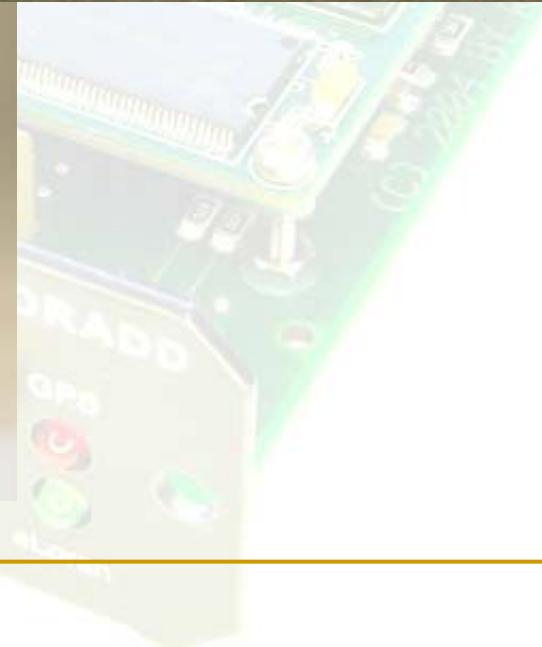
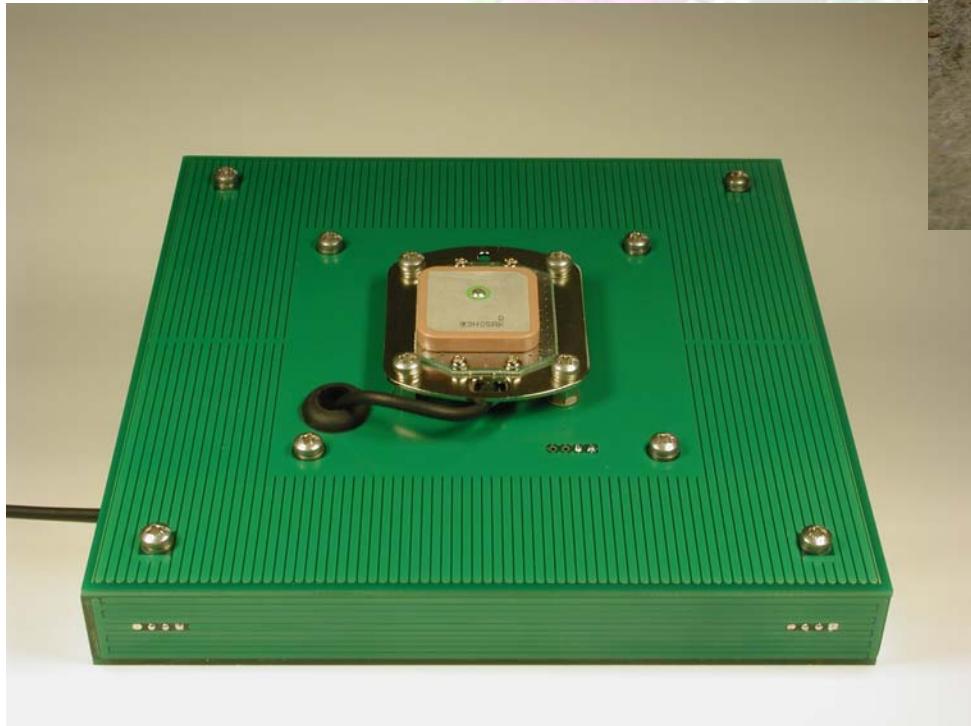
The Hardware

Reelektronika DSP platform



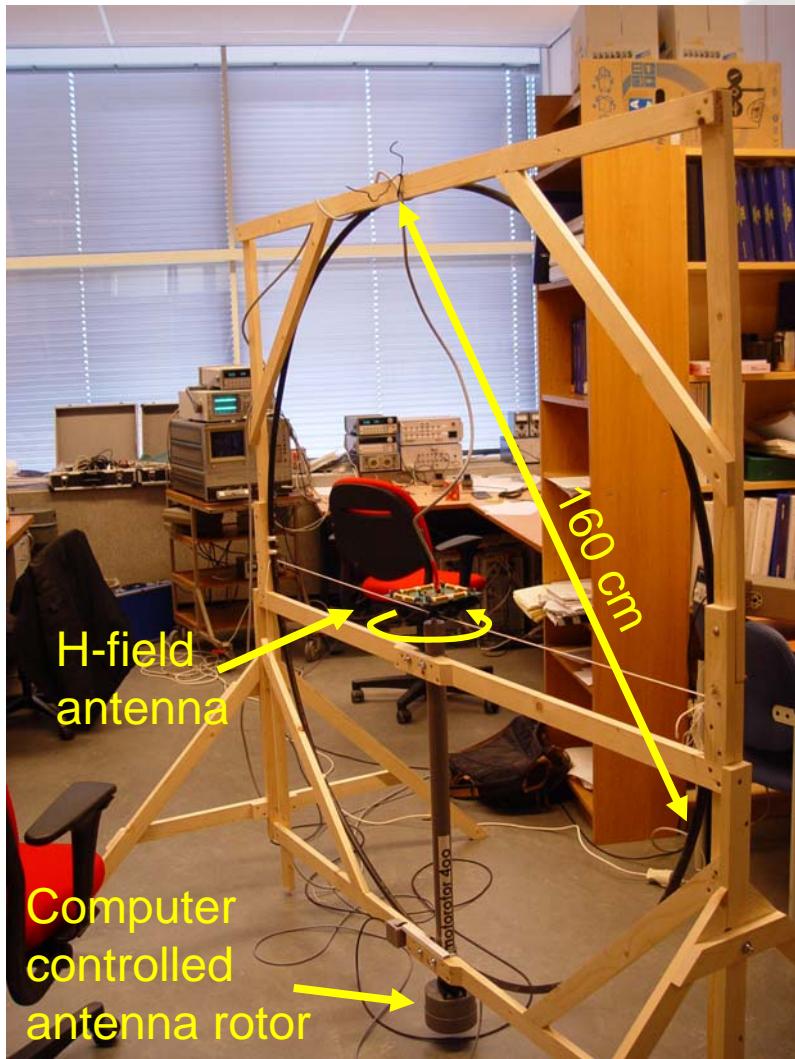
The Sensor

Dual-loop H-field antenna

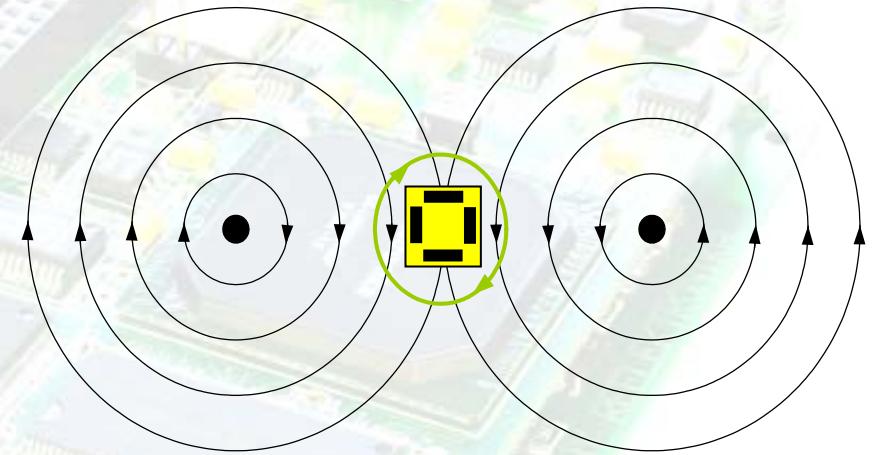


The Sensor

Dual-loop H-field antenna - measurements



Measurement Setup



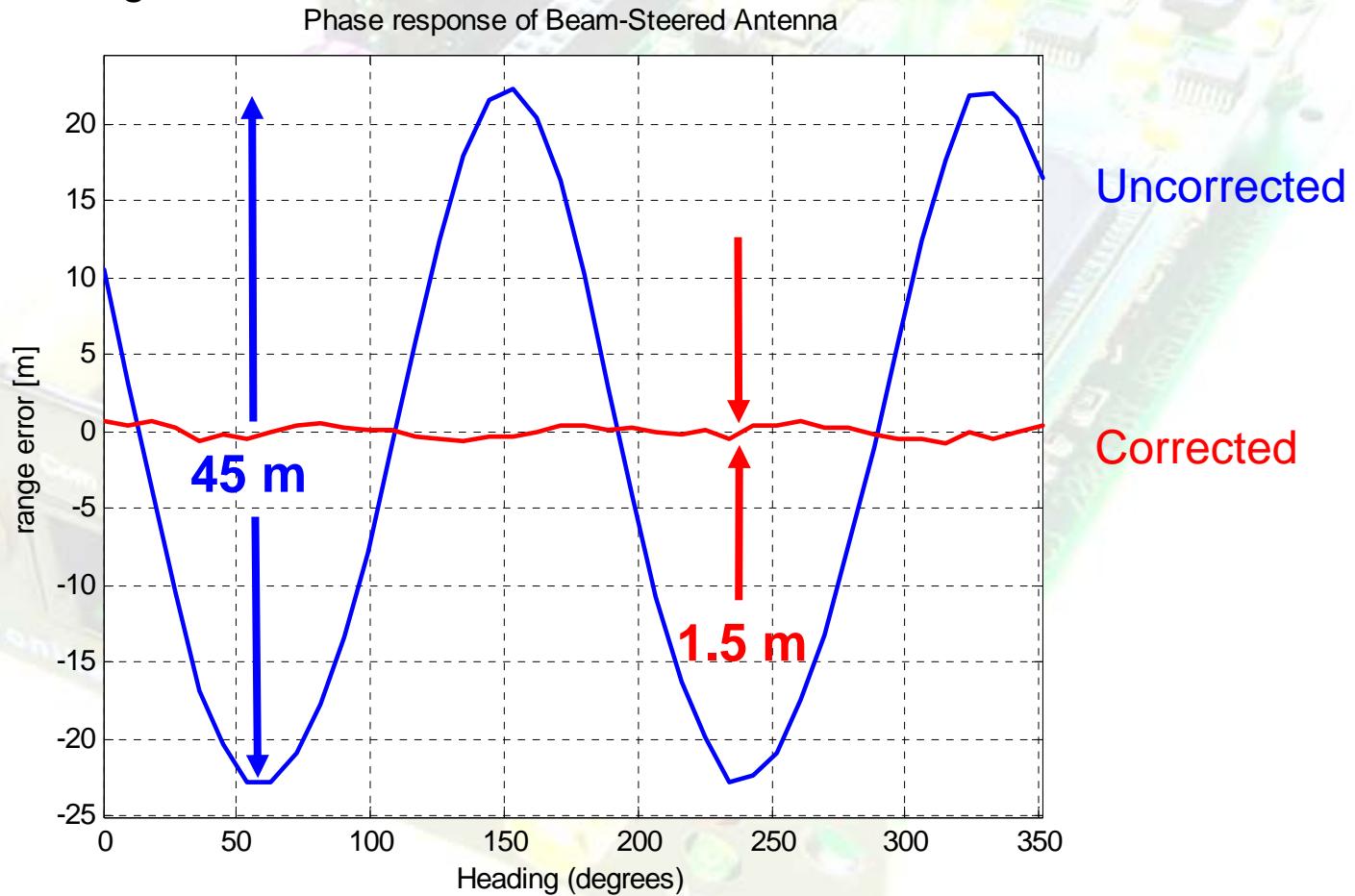
Cross-section of measurement setup

The H-field antenna is rotated inside a measurement loop. The field at the centre of the loop is quite homogeneous due to the large diameter of the loop (1.60m)

The Sensor

Dual-loop H-field antenna - compensation

- Comparison of Uncorrected and Feed-Forward Corrected Response after Beam-Steering

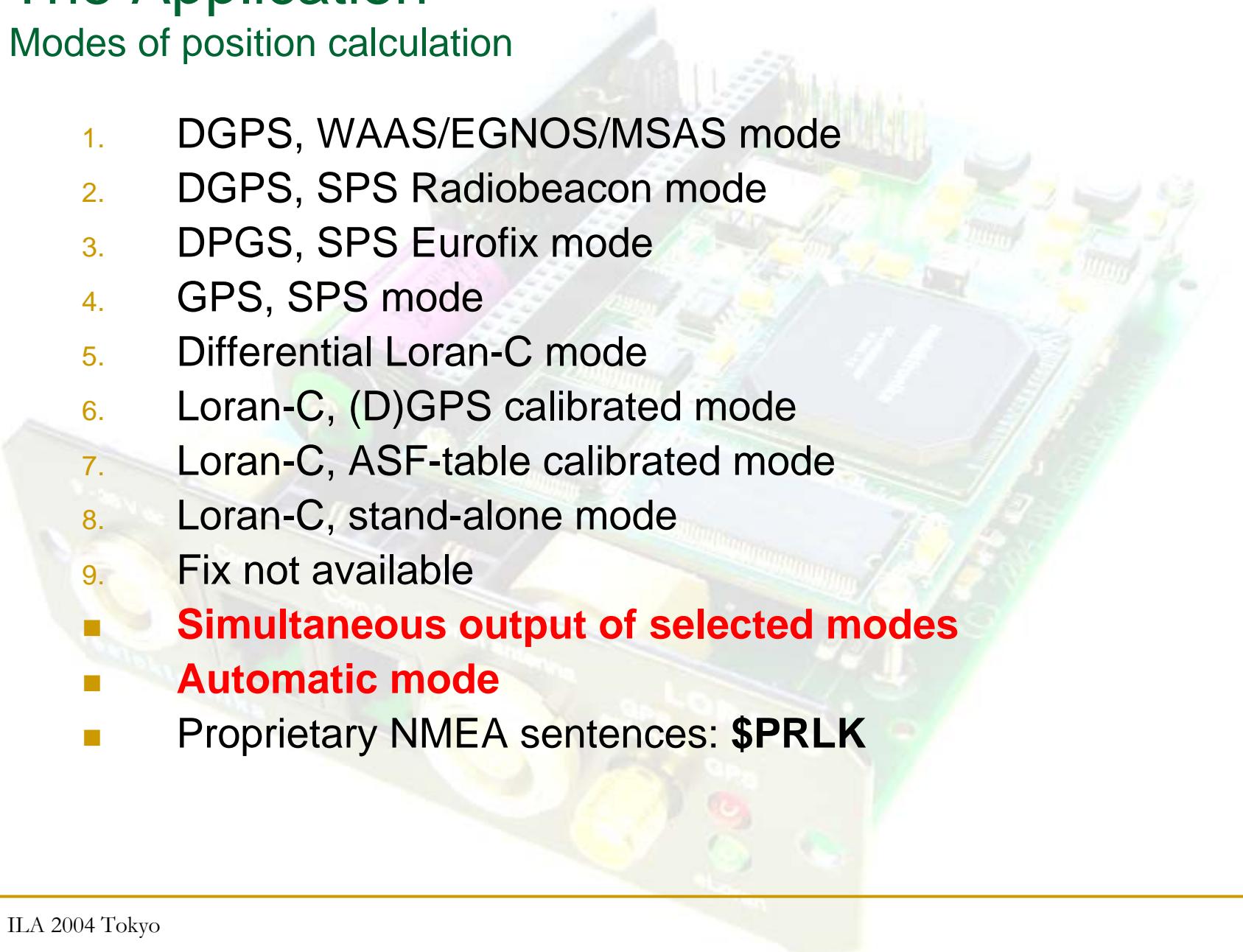


The Algorithms

- Algorithms are a result of many man-years of research – started in 1999
- Features of the Reelektronika eLoran receiver:
 - Multichain all-in-view Loran signal tracking
 - Fast acquisition (<30 seconds)
 - Interference mitigation
 - Integration with GPS
 - ASF and Differential Loran capabilities
 - Data demodulation
 - Regular position updates (e.g. every 5 seconds)
- Outputs:
 - TOA / TD
 - Position
 - Compass heading

The Application

Modes of position calculation

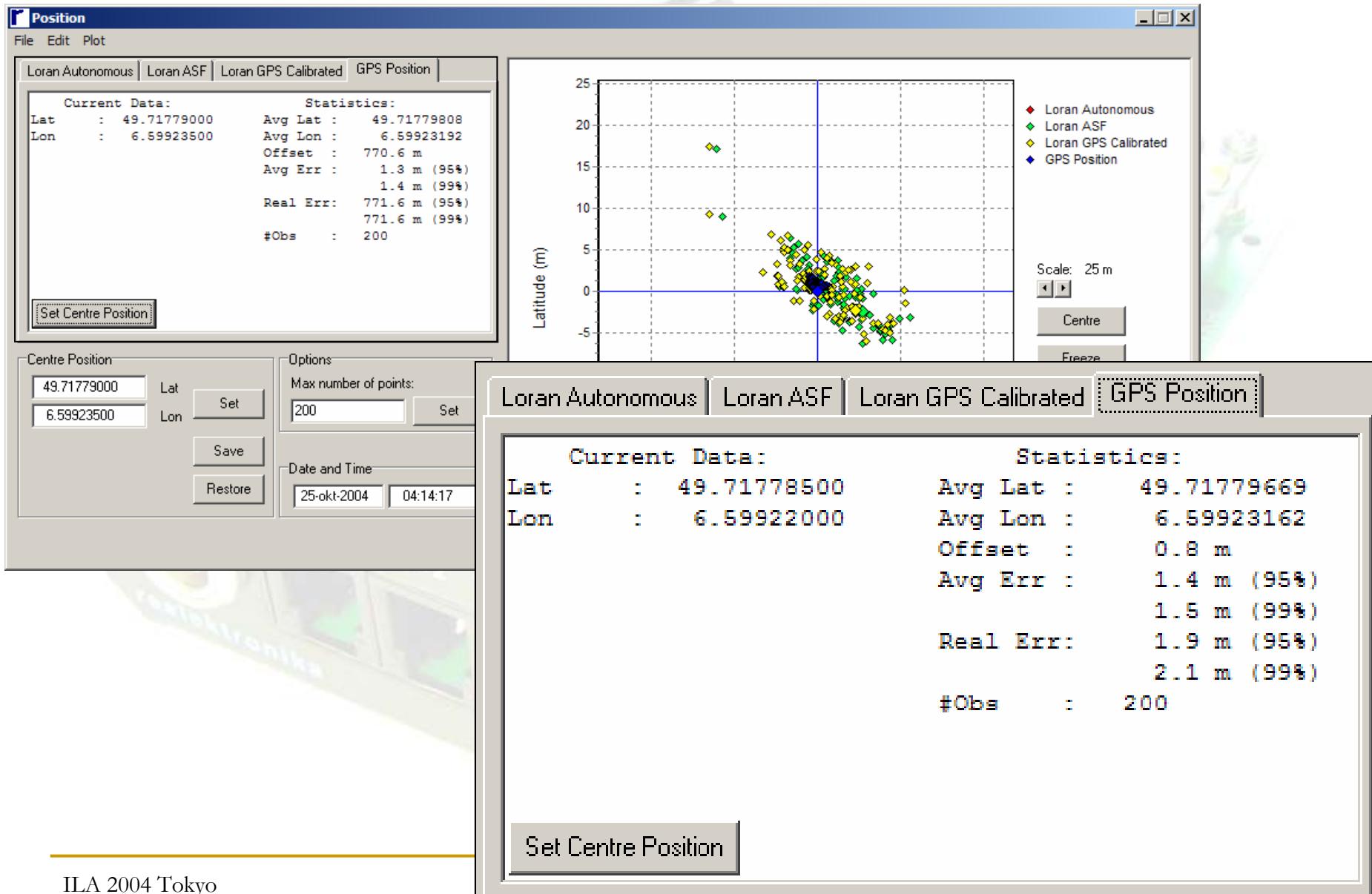
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1. DGPS, WAAS/EGNOS/MSAS mode
 2. DGPS, SPS Radiobeacon mode
 3. DPGS, SPS Eurofix mode
 4. GPS, SPS mode
 5. Differential Loran-C mode
 6. Loran-C, (D)GPS calibrated mode
 7. Loran-C, ASF-table calibrated mode
 8. Loran-C, stand-alone mode
 9. Fix not available
- **Simultaneous output of selected modes**
 - **Automatic mode**
 - Proprietary NMEA sentences: **\$PRLK**

Tools: LeroxAnalyser

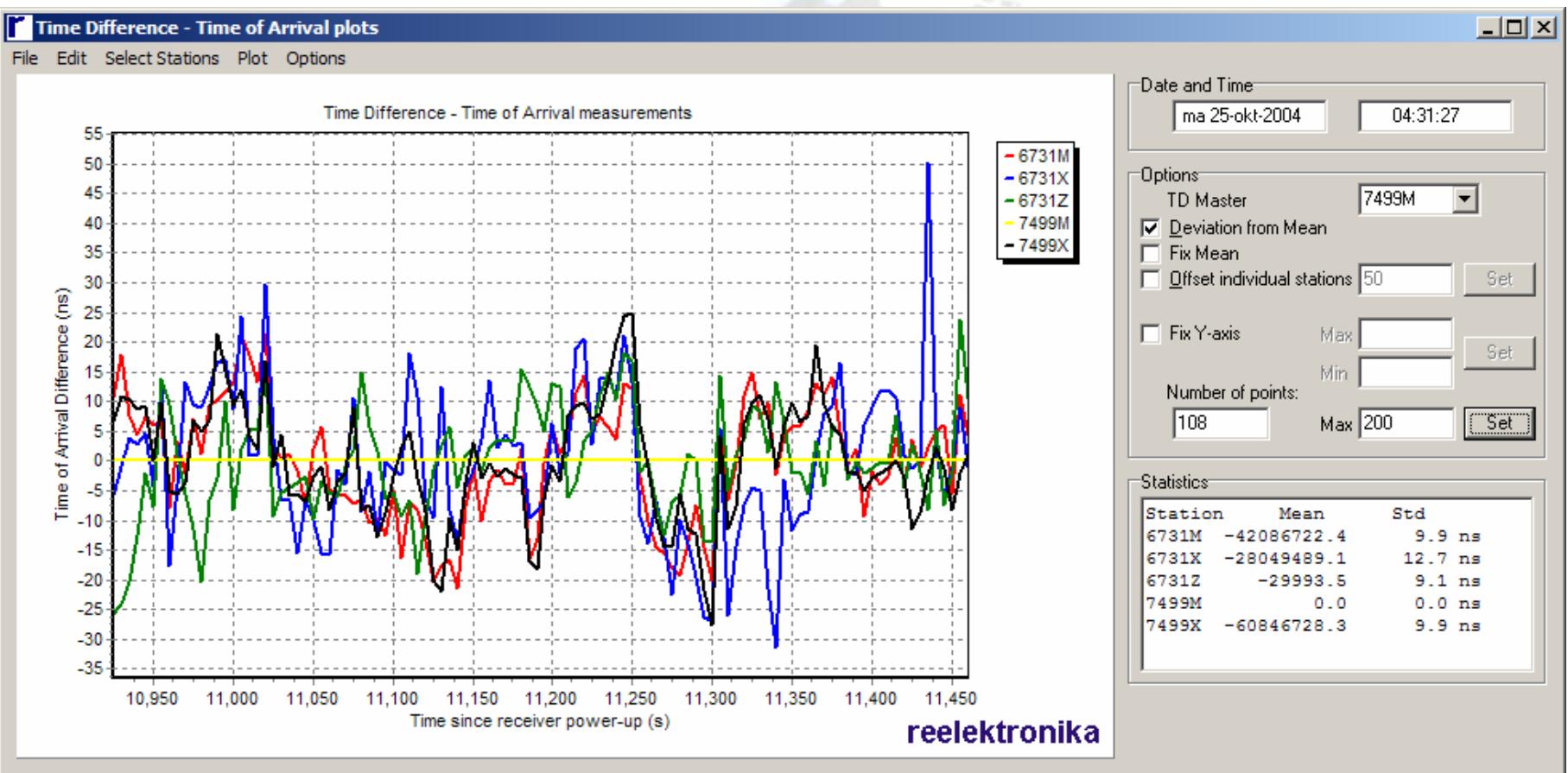
LeroxAnalyser Tools Overview:

- Position:** Shows current Loran data (Lat: 49.72343160, Lon: 6.59297680), statistics (Avg Lat: 49.72344430, Avg Lon: 6.59296878, Offset: 774.4 m, Avg Err: 9.2 m (95%), Real Err: 781.5 m (95%), 789.6 m (99%), #Obs: 113), and a scatter plot of Loran stations.
- TOAA Logs:** Displays TOAA logs for timestamp 10620.00, showing 8 stations with various parameters like SS, SNR, B-Q, ECD, CI-Q, State, TOA (us), Doppler, and LockTime.
- GPGGA Logs:** Displays GPGGA logs for timestamp 10620.01, showing station details, mode (GPS SPS), latitude (4943.3352 N), longitude (635.3776 E), number of observations (8), HDOP (1.00), height (47.70), undulation (-91.70), age (0.00), and RTCM ID.
- LCPOSA - Autonomous:** Shows LCPOSA logs for timestamp 10620.00, version Matlab, with data for stations 6731M, 6731X, 6731Z, 7499M, 7499X, 9007M, and 9007Y.
- LCPOSA - ASF corrected:** Shows LCPOSA logs for timestamp 10620.00, version Matlab, with data for stations 6731M, 6731X, 6731Z, 7499M, 7499X, 9007M, and 9007Y.
- LCPOSA - GPS Calibrated:** Shows LCPOSA logs for timestamp 10620.00, version Matlab, with data for stations 6731M, 6731X, 6731Z, 7499M, 7499X, 9007M, and 9007Y.
- Monitor:** Displays serial data from file 20041008_BertemTrier_2.Matlab.txt, showing a series of binary values.
- DECA logs:** Shows DECA logs for timestamp 0, listing stations and their failure counts.
- FFT Plot:** Displays two measured frequency spectra (H-field Loop 1 and H-field Loop 2) from FFT_1.0, showing amplitude (dB) vs. frequency (kHz).
- Time Series Plot:** Shows a time series plot of measurements over time since receiver power-up (s), with multiple colored lines representing different stations (673, 6731, 6731X, 6731Z, 7499, 7499X).

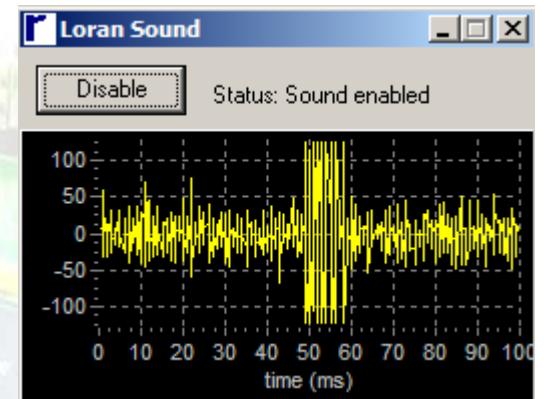
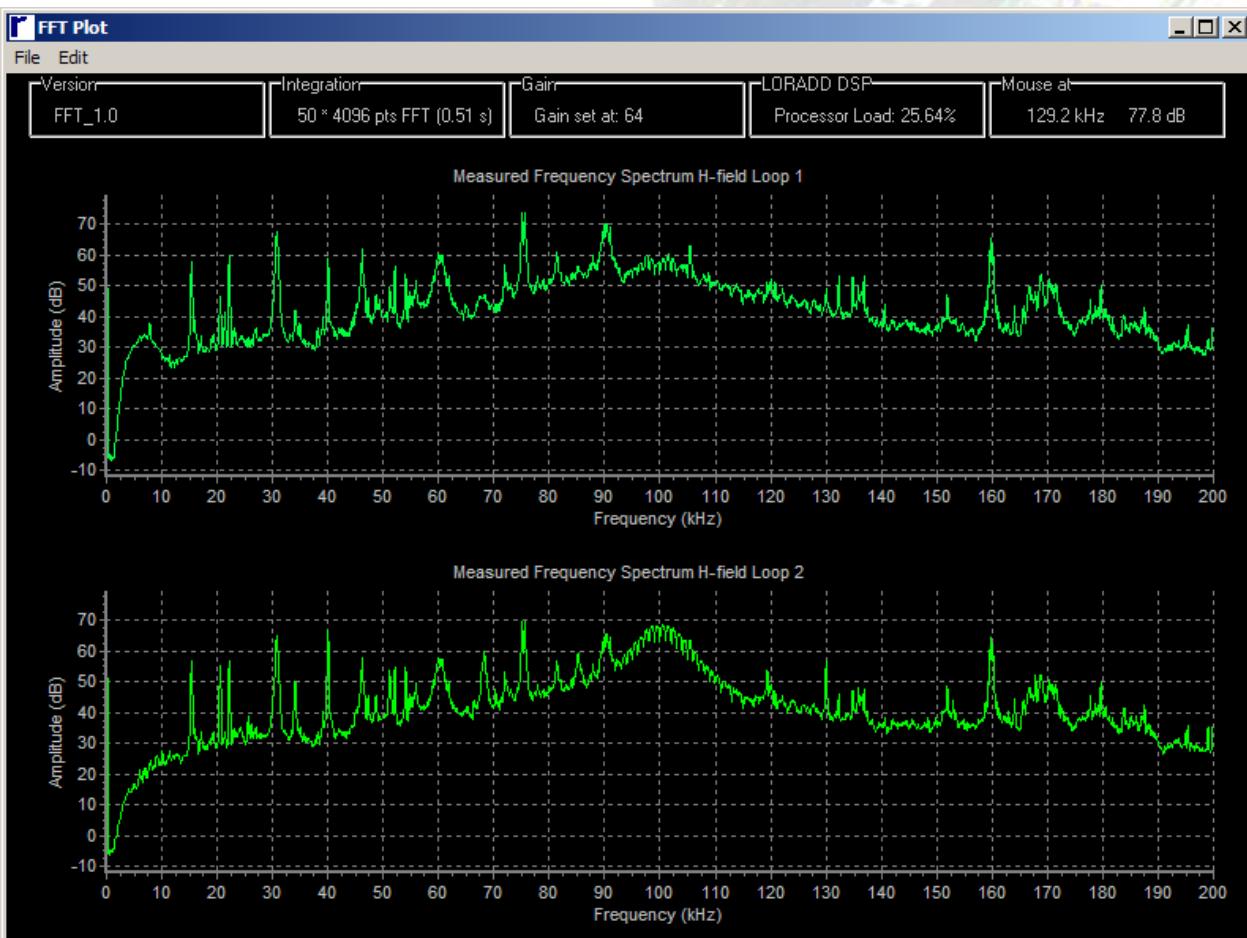
LerxAnalyser: Position



LerxAnalyser: TOA/TD & Heading



LerxAnalyser: Installation tools



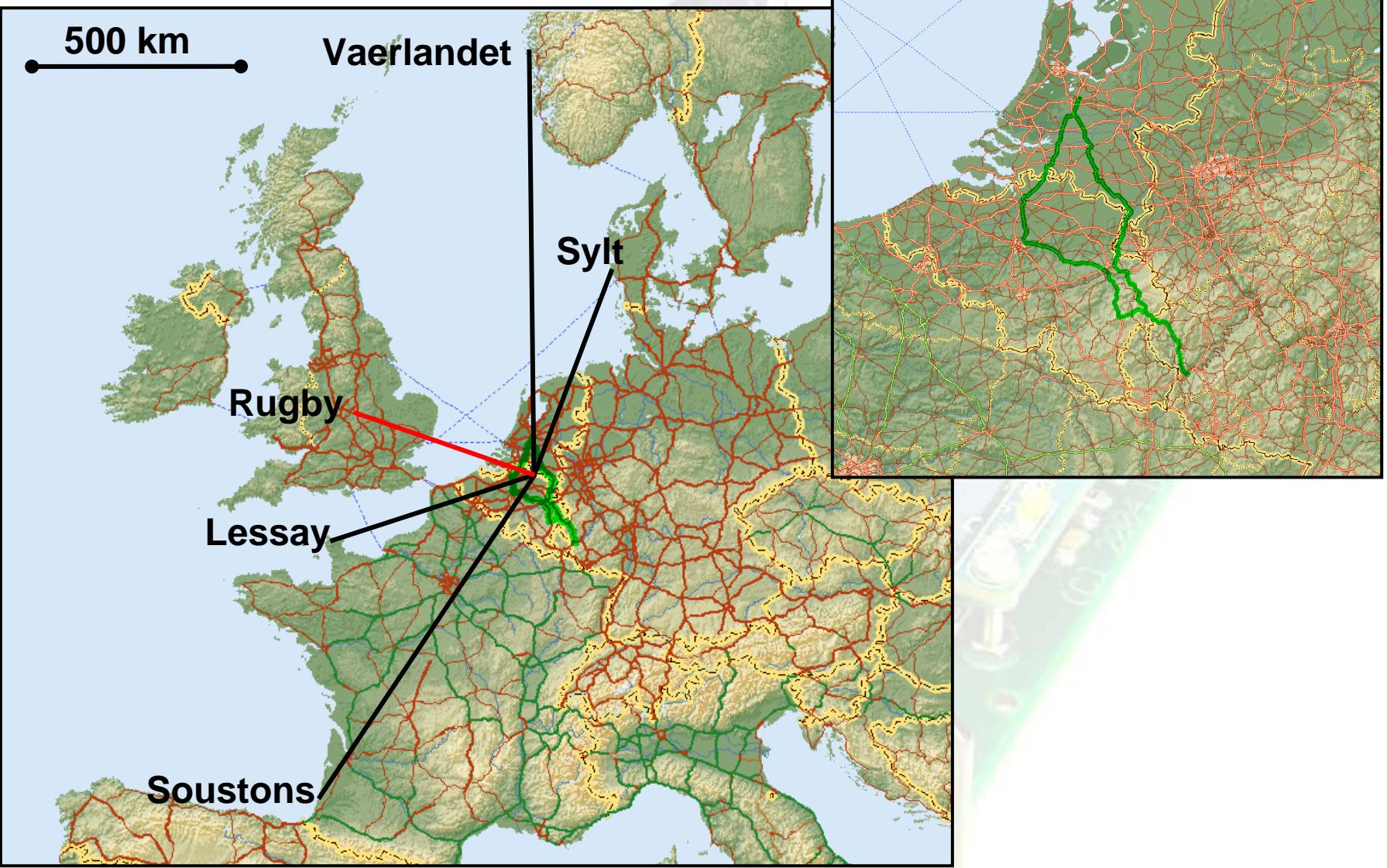
- No interference
- Local interference
- Powerline

Measurements

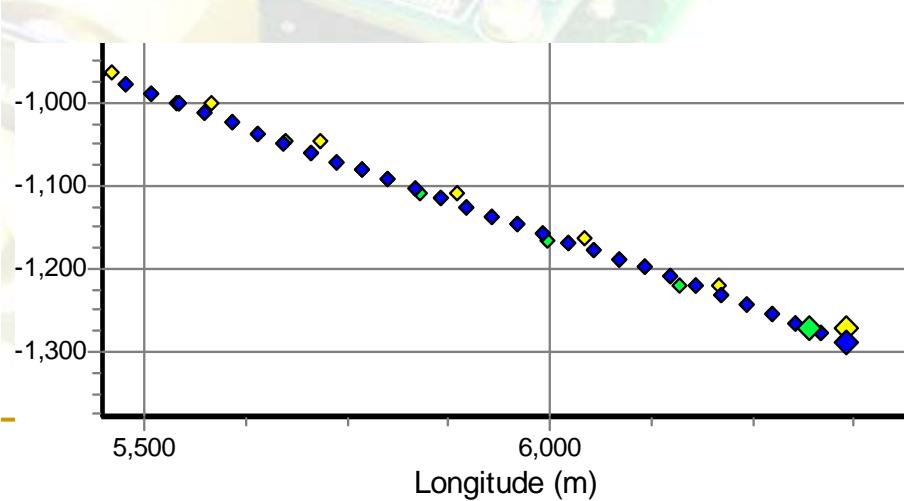
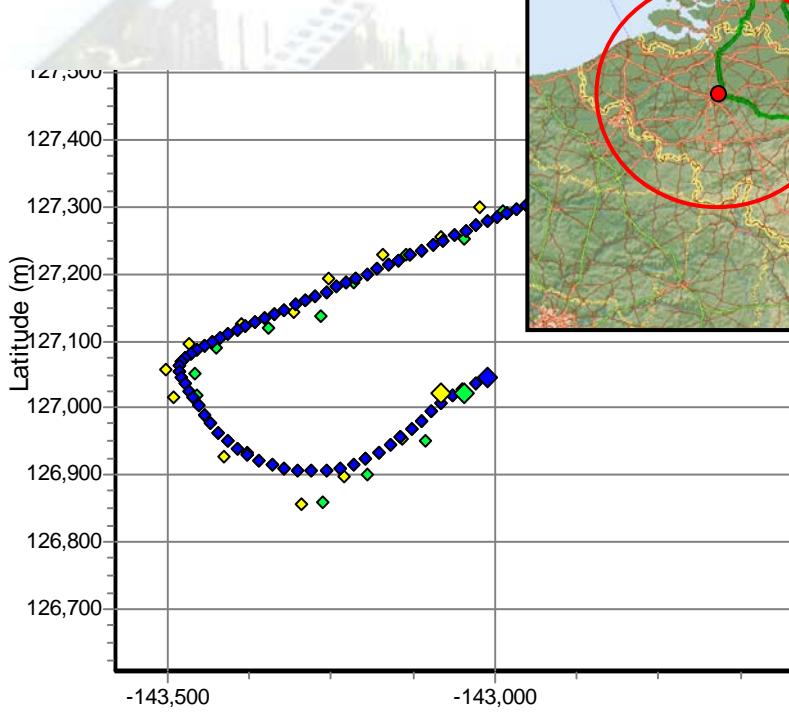
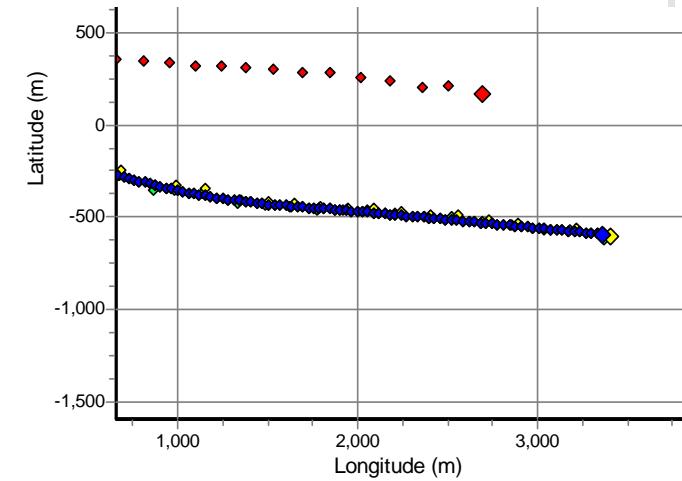
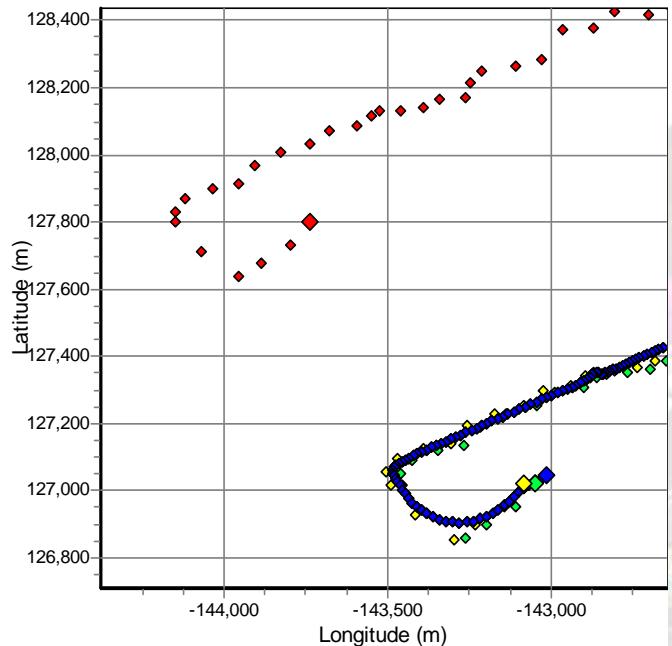


- Static measurements Reeuwijk (NL)
- Static measurements Boston (US)
- Static measurements Trier (D)
- Dynamic measurements Delft (NL)-Utrecht (NL) – Bertem (B) – Trier (D)

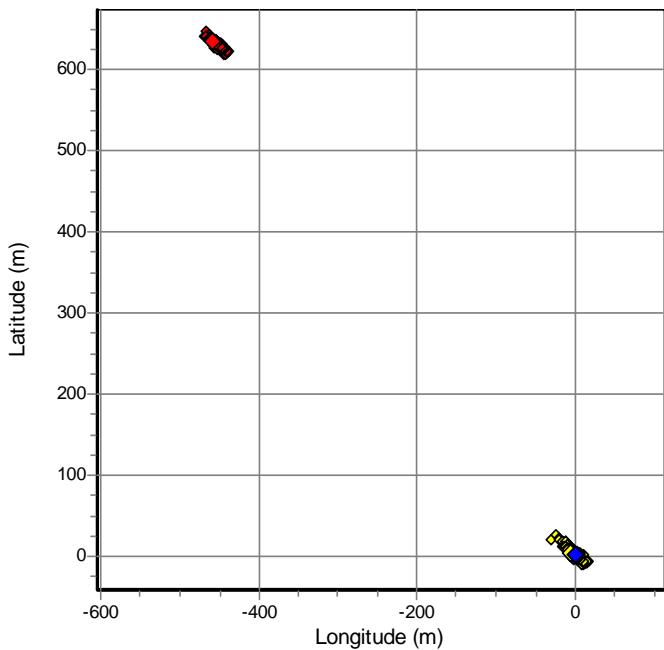
Utrecht (NL) – Bertem (B) – Trier (D)



Bertem (dynamic)

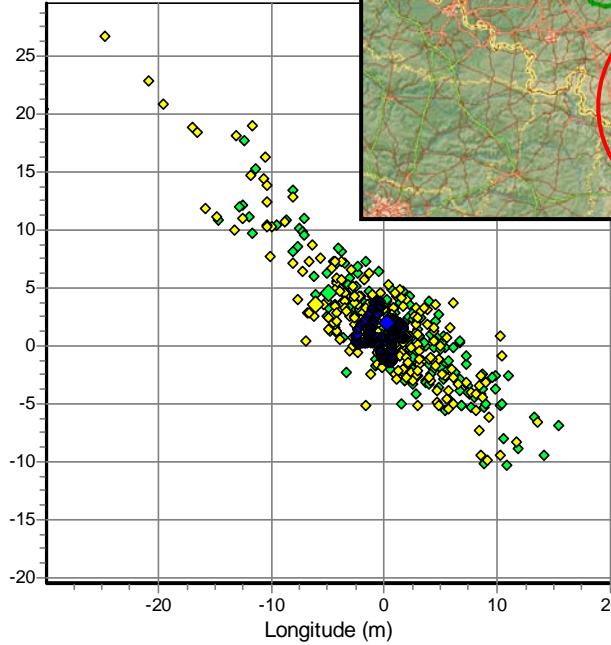


Trier, static



- ◆ Loran Autonomous
- ◆ Loran ASF
- ◆ Loran GPS Calibrated
- ◆ GPS Position

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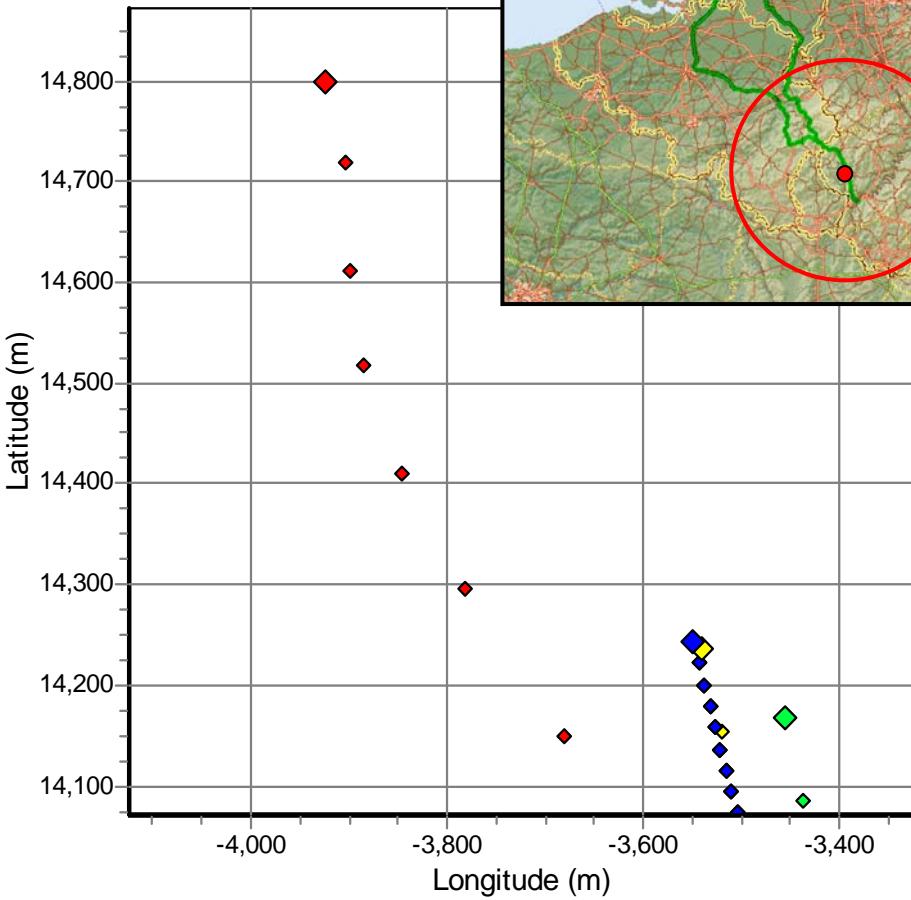
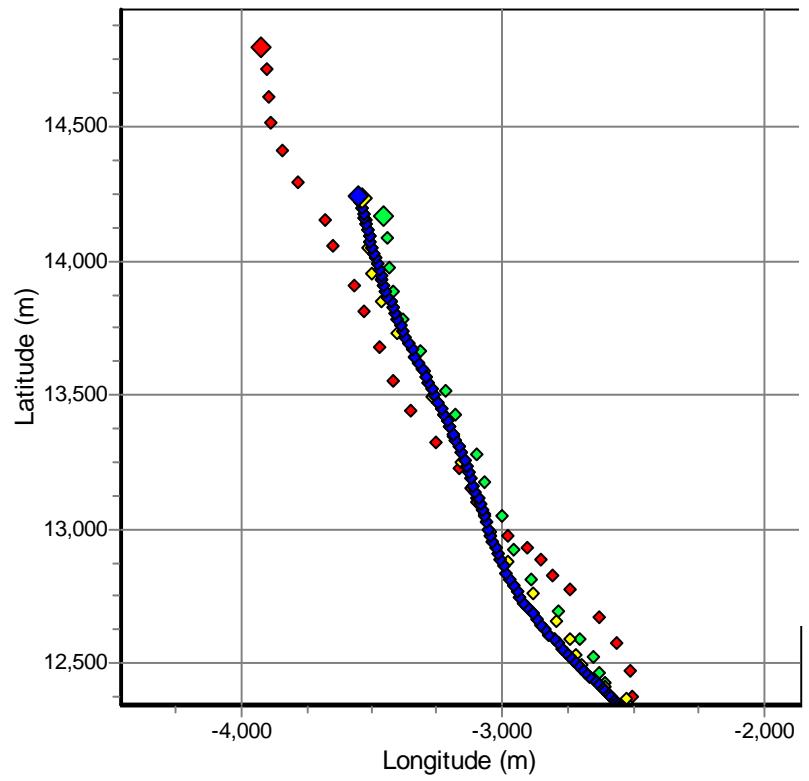
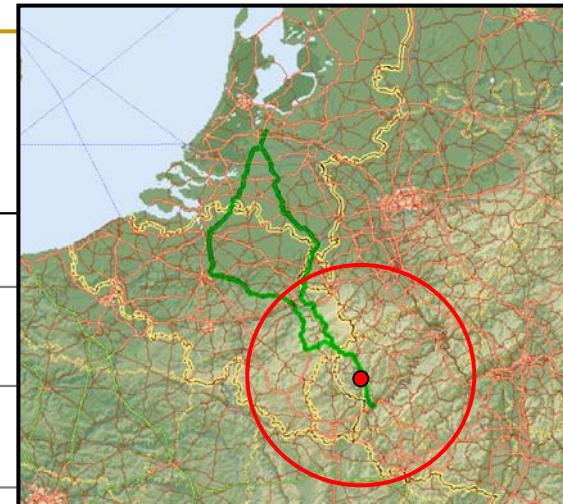
Loran Autonomous: 14.7m 95%, offset 776m

Loran ASF: 14.7m 95%, offset 1.7m

Loran GPS Calibrated: 16.5m 95%, offset 2.6m

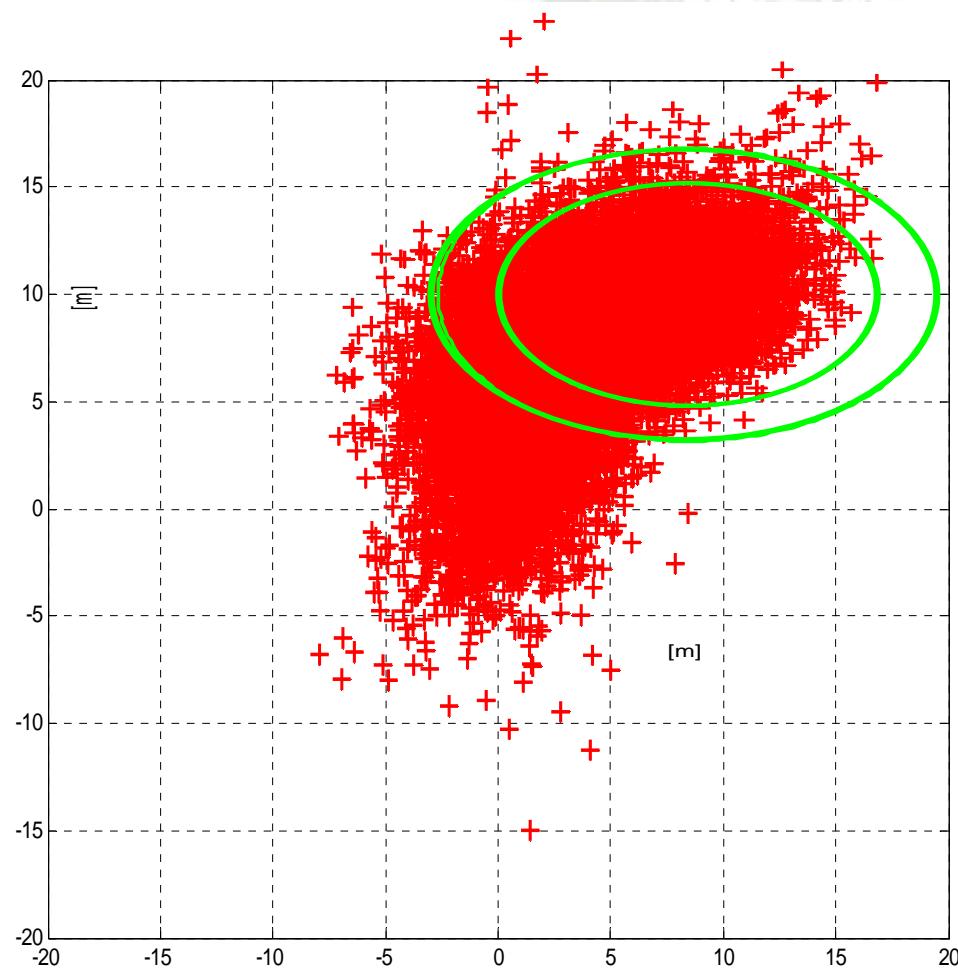
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Trier, dynamic (highway)



- ◆ Loran Autonomous
- ◆ Loran ASF
- ◆ Loran GPS Calibrated
- ◆ GPS Position

Boston (static, 72 hours)



Receiver status

- “1st time right” hardware design
- Algorithms finalized
- Pilot testing is ongoing
- First 50 units produced and sold

