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# Measuring and Comparing GPS and Loran-C/Eurofix Performance

*Hardware development and initial trials*

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# Activities at Reelektronika

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- Continue development that started with the Eurofix concept
- Explore the limits of Loran-C using modern hardware and software technologies
- Continue research and development in H-field antennas
- Development of low-cost Loran-C receiver within the GLORIA project



# Receiver development

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Developing a new receiver is done in a 3-step process:

- Hardware, focused on *performance*
  - H-field antenna
  - Front-end
  - DSP platform
- Software
  - First in Matlab
  - Then in real-time code
- Miniaturisation



# How are we progressing?

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- An prototype 2-loop H-field antenna has been developed
- A sample-device taking 400 kS/s on each loop has been developed: the 'Datagrabber'
- Software for real-time and post-processing data analysis is made on a as-needed basis

# H-field antenna



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# Datagrabber

- 2x 12 bit A/D  
@ 400 kS/s
- UTP interface



LDS Host

192.168.42.30 2000 Disconnect

Automatic Reconnect

Received: 314.2 Megabytes  
In TCP Buffers: 100638 / 0  
Sample Number: 157,274,112  
899.8 kilobytes/sec

LDS Control

Current: Gain: 875 | New: Gain: 875 | Send  
Calibrate: Off | Calibrate:  | Send

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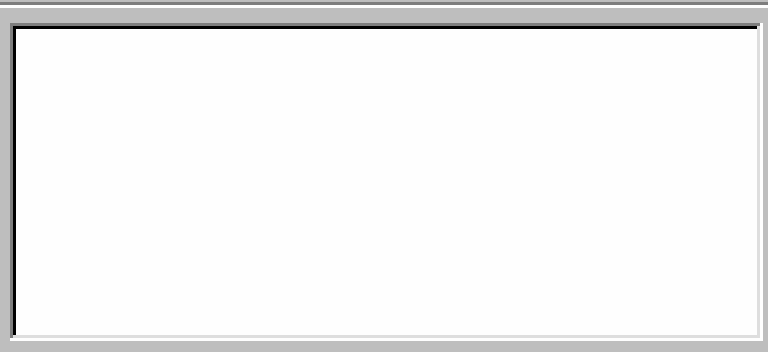
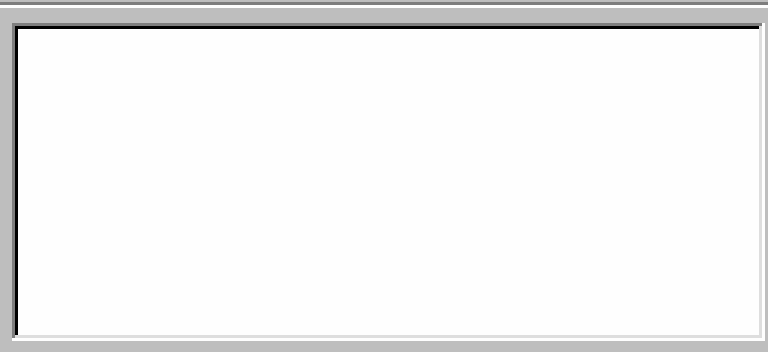
LDS104 Data Grabber V 1.0 © 2001

Clients

127.0.0.1:1035 (0 / 0)  
127.0.0.1:1034 (0 / 0)  
File: Closed

File

No file selected | Choose  
Max File size:  650 MB | Set  
Saved to file: 0 bytes | Save



# Loran-C Movie Player



Host:

Ch 0:

Ch 1:

GRI:  ▼

Integrate:  ▲ ▼

PCI's

Decimate:  ▲ ▼

samples

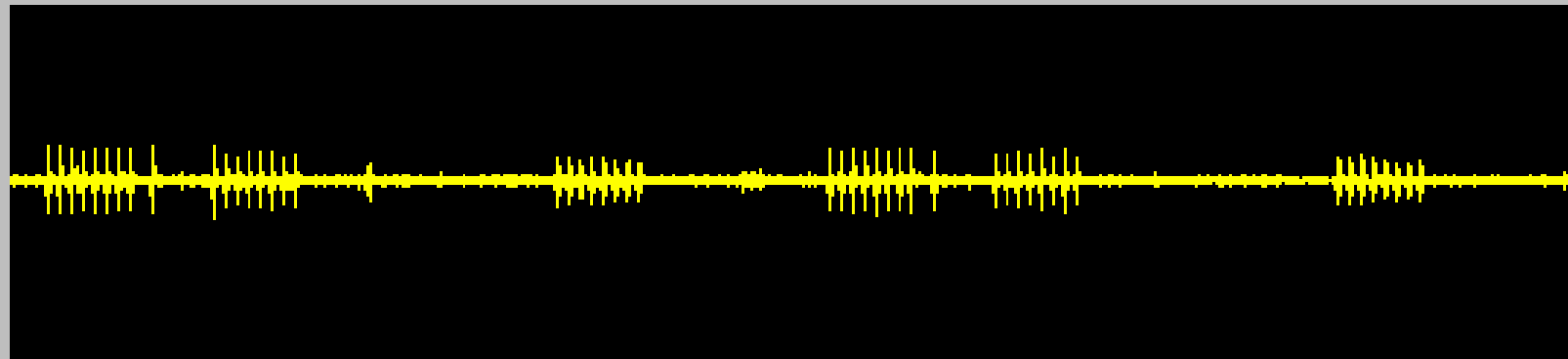
Ch 0 connected to 127.0.0.1:1026  
Ch 1 connected to 127.0.0.1:1027

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Loran-C Movie Player V 1.0 © 2001

625 mV

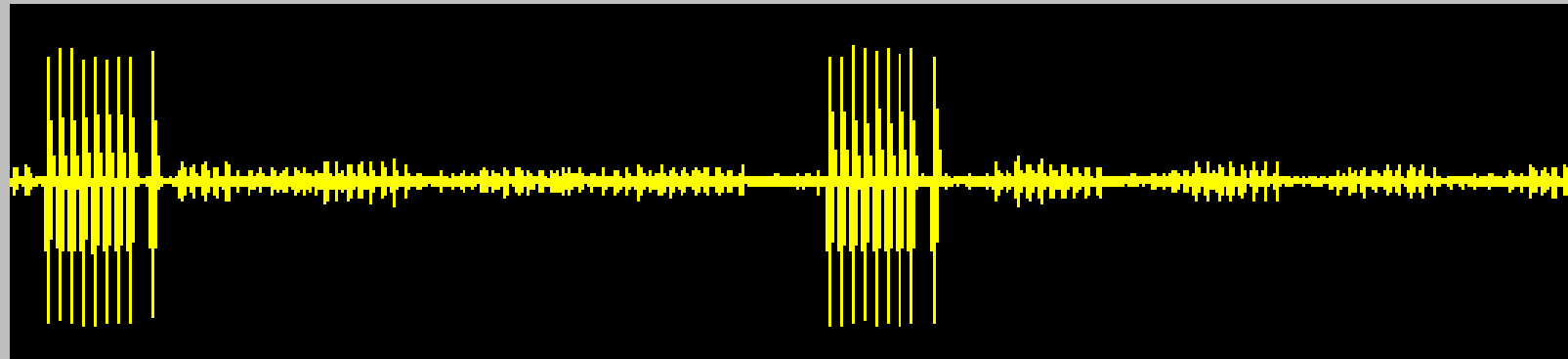
SampleCount: 293,875,712



-625 mV

Viewport: 134.6 ms

625 mV



-625 mV

# Loran-C Movie Player



Host:

Ch 0:

Ch 1:

GRI:  ▼

Integrate:  ▲ ▼

PCI's

Decimate:  ▲ ▼

sample

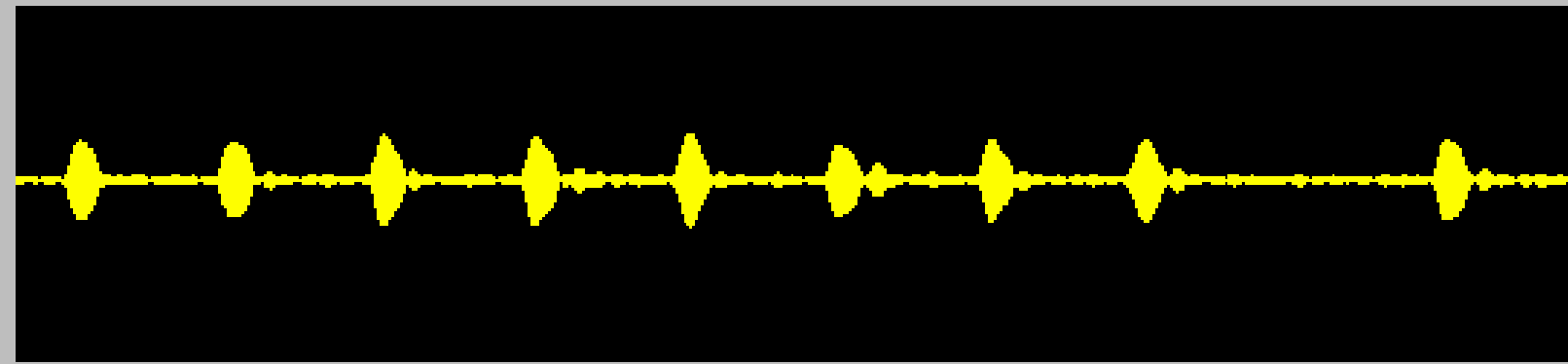
```
Ch 0 connected to 127.0.0.1:1026
Ch 1 connected to 127.0.0.1:1027
```

## reelektronika b.v.

Loran-C Movie Player V 1.0 © 2001

526 mV

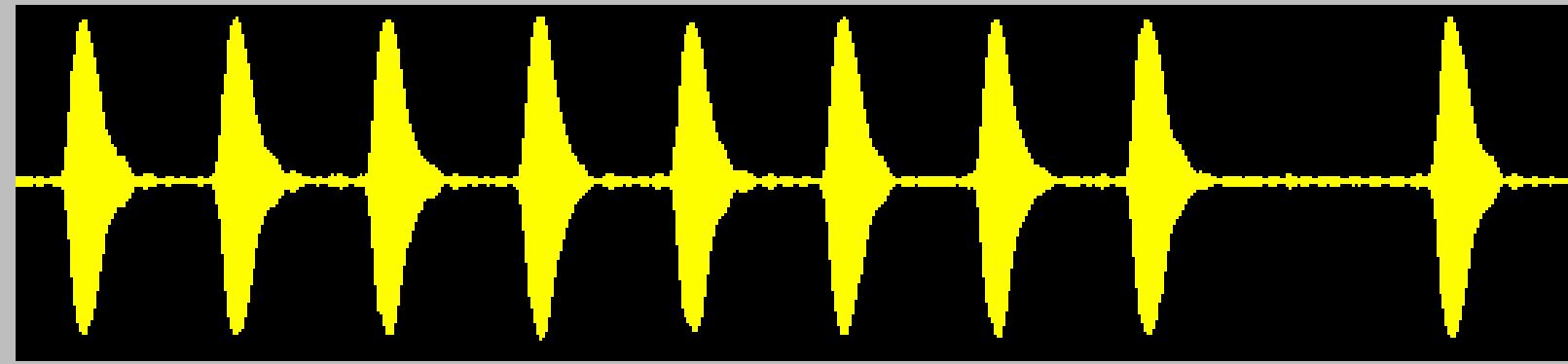
SampleCount: 298,582,016



-526 mV

Viewport: 10.24 ms

526 mV



-526 mV

# Loran-C Movie Player



Host:

Ch 0:

Ch 1:

GRI:  ▾

Integrate:  ▴ ▾

PCI's

Decimate:  ▴ ▾

sample

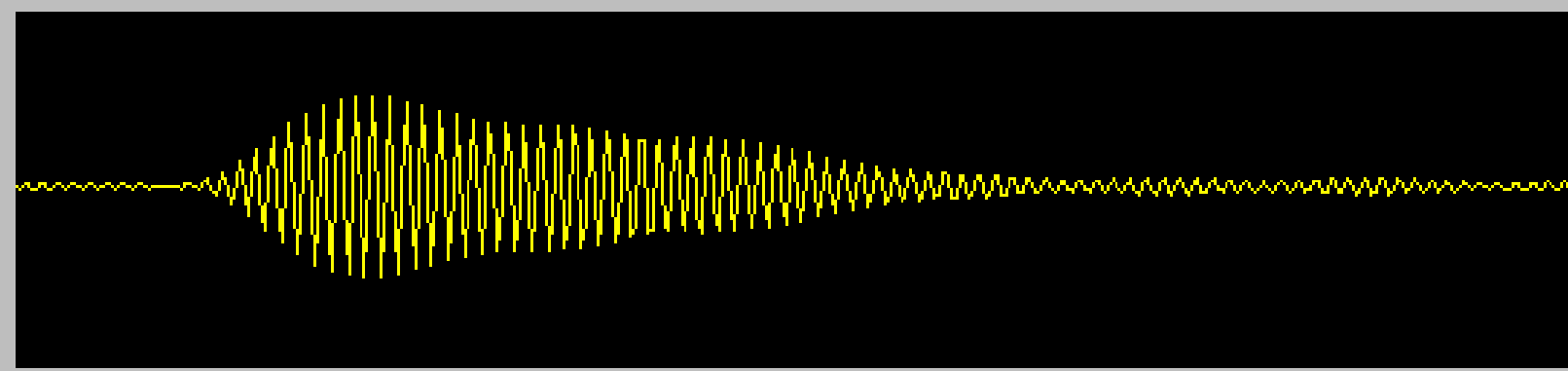
```
Ch 0 connected to 127.0.0.1:1034
Ch 1 connected to 127.0.0.1:1035
```

## reelektronika b.v.

Loran-C Movie Player V 1.0 © 2001

469 mV

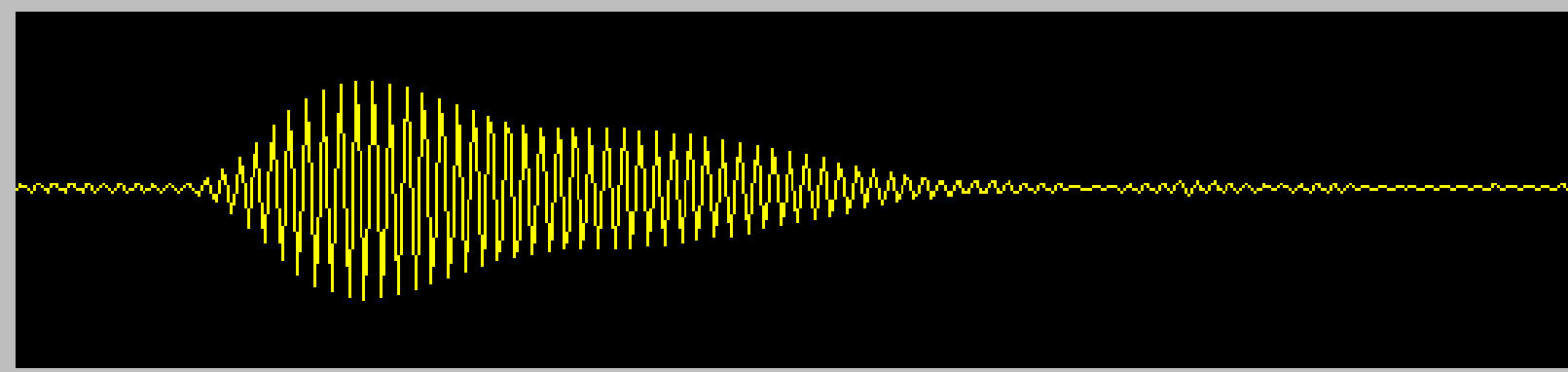
SampleCount: 127,545,344



-469 mV

Viewport: 937.5  $\mu$ s

469 mV



-469 mV



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# Data collection

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The following data is being collected on a series of mobile measurement runs:

- GPS data (L1 code, carrier)
- Locus connected to 1 H-field loop
- Raw Loran samples of 2 H-field loops
  
- Loran & GPS data time-tagged in the same reference frame



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# Anecdotal observations

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- GPS availability limited in various areas of Delft
- Loran-C signals are available. Quality of the signals needs to be investigated.
- Main problem with Loran: man-made noise
  - Power lines
  - Underground cables
  - Car (ignition and generator) noise



# Conclusions

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- Reelektronika developed hardware to assess H-field antenna and quality of Loran-C signals in populated areas
- Focus has to be on interference rejection techniques
  - New antenna + frontend designs
  - Software algorithms
- More transmitters are needed for continental European coverage



# Future work

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- More trials, by ourselves as well as together with our partners in the GLORIA project
- Thorough analysis of collected data
- Development of algorithms to integrate GPS and Loran-C position sensors to provide continued navigation in land-mobile applications