LOFAR Station Processing

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ASTRON
The Instrument
LOFAR System Overview

Central Processor

Remote Station

Core Station

Remote Station

Core Station

Remote Station

Core Station

Specification and Control

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Top level architecture

SHM

Control

Metadata

SAS

Specification

Configuration

Metadata

MAC

Control

Monitoring

Logging

Metadata

Stations

Sky signals

GPS signal

Beam data

Buffered data

WAN

Beam data

Buffered data

CEP

User data
Signal Processing Chain

Antenna | Receiver
---|---
Antenna | Receiver

Beam Former

Delay Compensation

Correlator

Post Processing

Antenna | Receiver
---|---
Antenna | Receiver

Beam Former

Delay Compensation

Antenna | Receiver
---|---
Antenna | Receiver

Beam Former

Delay Compensation

Antenna | Receiver
---|---
Antenna | Receiver

Beam Former

Delay Compensation

Antenna | Receiver
---|---
Remote Station Architecture

Optional
10-… MHz

30-80 MHz

120-240 MHz
## Key Numbers

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unity</th>
</tr>
</thead>
<tbody>
<tr>
<td># subbands</td>
<td>512</td>
<td></td>
</tr>
<tr>
<td>Max. number of beams (B = 4 MHz)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Min. number of beams (B = 32 MHz)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>A/D converter resolution</td>
<td>12 bit</td>
<td></td>
</tr>
<tr>
<td>Sample frequency</td>
<td>200 / 160 MHz</td>
<td></td>
</tr>
<tr>
<td>Number of polarizations</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Output word width (complex)</td>
<td>16+16 bit</td>
<td></td>
</tr>
<tr>
<td>Aggregate output bandwidth</td>
<td>32 MHz</td>
<td></td>
</tr>
<tr>
<td>Output data rate</td>
<td>2048 Mbit/s</td>
<td></td>
</tr>
<tr>
<td>Transient buffer storage period</td>
<td>1 s</td>
<td></td>
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<table>
<thead>
<tr>
<th>Description</th>
<th>Value for fs of</th>
<th>Unity</th>
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<tbody>
<tr>
<td></td>
<td>160 MHz</td>
<td>200 MHz</td>
</tr>
<tr>
<td>Subband width</td>
<td>156 kHz</td>
<td></td>
</tr>
<tr>
<td>Number of beamlets</td>
<td>206</td>
<td>165</td>
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</table>
Low Band Antenna (30-80 MHz)
High Band Antenna (120-240 MHz)
Receiver Bands

0  80  160  240
f (MHz)

0  100  200  300
f (MHz)
Observation modes:

- **Mode I**: 10 - 90 MHz
- **Mode II**: 110 - 190 MHz
- **Mode III**: 170 - 230 MHz
- **Mode IV**: 210 - 250 MHz

Filter frequencies:

- **10 MHz**
- **90 MHz**
- **110 MHz**

Nyquist Zones:

- **200 MHz clock**
- **160 MHz clock**

Frequency range:

- **0 - 300 MHz**

Filters are optional for **Mode I**.
Selecting subbands

- FB00
- FB01
- FB95

- BF00
- BF01
- BF215
Remote Station Processing Board
Transient Buffering

- Compensate cable length differences
- Separate subbands
- Receiver band data
- Subband data
- Detect transients
- Freeze on trigger
- Store/Read-out control
- Detection control
- External trigger
- G. trigger
- (from RCU) antenna data
- (to CEP) Transient buffer data
- Select

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Remote Station Cabinets

Front view
19" profiles 36 HE
Total height 2000 mm
LOFAR-WAN: Characteristics

LOFAR - Core
- ~ 32 stations
- 2 Gb/s per station initially
- 12 Gb/s per station after upgrade
- Intra Core distance < 5 km

LOFAR - arms
- ~ 45 stations
- 2 Gb/s per station
- Distance to LOFAR - Core < 120 km

LOFAR - WAN characteristics
- Unidirectional data transport
- No data routing
- Upgradeable
CEntral Processing Facility

Red arrows indicate the flow from the WAN to the Input Section.

The Input Section contains multiple GbE switches connected to:
- Blue Gene/L processors
- On-Line pipeline processing

The Blue Gene/L processors are connected to the Storage system, which includes:
- Off-line processing
- Off-line user software

The Storage system is connected to the Long term Archiving & Data Export section.

The diagram illustrates the flow of information and processing within the Central Processing Facility.
Blue Gene/L installation April 2005
Processing pipeline works from antenna to dataproduct

The first LOFAR stations are operational in the field

Ready to roll out more stations