

LOFAR Long Baseline Working Group (LLBWG)

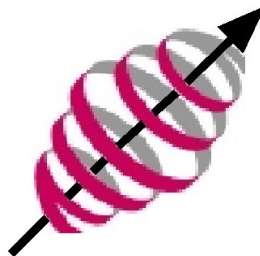
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On behalf of LOFAR
and the LLBWG

John Conway co-(also-trying-to-get-out-of-the-job)-chair

Max-Planck-Institut
für Radioastronomie



LOFAR



MAX-PLANCK-GESELLSCHAFT



LOFAR

2nd Major LLBWG Meeting 2009 May 20

- Followed LOFAR Technical Status Meeting in Dwingeloo
- Minutes sent out by John to LLBWG list in early June
 - ~15 people attended parts of meeting
 - If you wish to **contribute** to LLBWG work, and are not on the mailing list, please let John or myself know
- Areas of concern identified
- Action items, tasks for next ~4 months
- Manpower estimates
- Next meeting planned
 - Probably late September, day after Bonn-Dwingeloo meeting in Bonn

Concern Area 1: Correlation

- Wide field imaging requires short correlator integration times, small channel bandwidths
- Correlator needs to handle integration times < 1 s
- Full LOFAR HBA use requires 2nd rack of Blue Gene
- Output data rate currently limited to 50 Gb/s
 - See next slide for more details
 - **Problem also for Dutch-only observations**
 - **This is a problem which affects nearly all of us**
 - Can probably get factors of a few reduction in data rate
 - **Solutions involve money and/or time**
 - More hardware to accommodate data rate
 - Significant software development effort to get around problem

Data Rates

- Correlator polyphase filterbank generates 256 channels per subband by default
 - 763 Hz channel width for 200 MHz clock
 - 610 Hz channel width for 160 MHz clock
 - Total of 63488 channels for standard 16 bit mode
 - 253952 channels for 4 bit mode
- Visibility **output** rate limited to 50 Gb/s (6.25 GB/s) by current storage cluster input rate
 - For LOFAR operation (18 Core, 18 Remote, 8 International stations):
 - LOFAR Core (18 C stations), 1 s integrations
 - 16, 8, and 4 bit data modes all fit under storage rate limit
 - LOFAR Remote (18 C + 18 R stations), 1 s integrations
 - 16, 8 bit data modes all fit under storage rate limit (but see ionosphere comments)
 - 4 bit fits for LBA, does not fit for HBA
 - LOFAR International (18 C + 18 R + 8 I stations), 0.25 s integrations
 - All bit depths have storage rates too high
 - 127 Gb/s for 16 bit mode, 508 Gb/s for 4 bit mode (15.9, 63.5 GB/s)

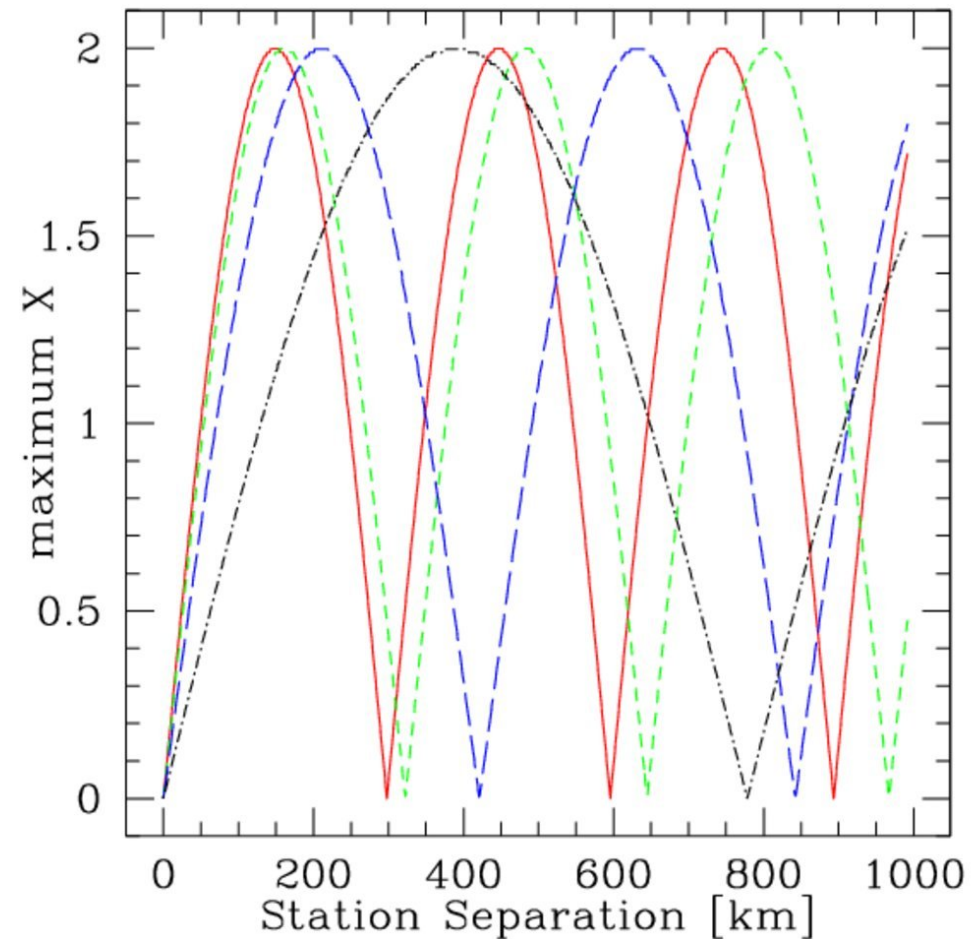
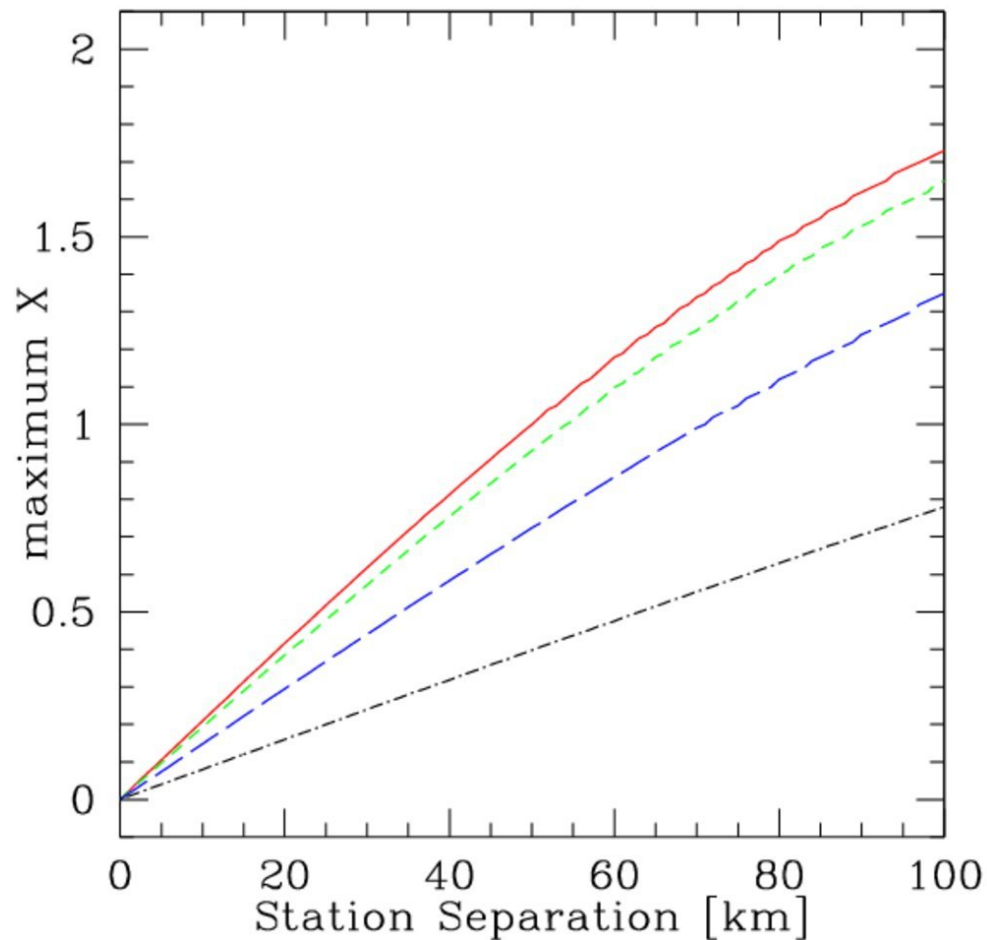
Concern Area 2: Ionosphere

- Ionospheric limits on channel bandwidths and integration times
 - LLBWG memo by JM Anderson
- For example, allowing for up to 10% coherence loss, maximum integration times are

	30 MHz	60 MHz	120 MHz
• $XA=0.5$	0.8	1.6	3.2
• See next page for $XA=1.0$	0.4	0.8	1.6
• more info on $XA=2.0$	0.2	0.4	0.8
• $XA=4.0$	0.1	0.2	0.4

- To allow only 1% coherence loss, divide times by ~ 3
- Ionospheric calibration on long baselines
 - Structure in ionosphere
 - Software development

Ionospheric Wave Scale Factor



- X factor for vertical direction (for 30 deg elevation, multiply by 2)
- X reaches 0.5 by baseline length of 30 km
 - 10 000 km VLBI phase not significantly worse than VLA A-array
- Wave amplitude A typically 1 for daytime, ≤ 0.1 for night

Concern Area 3: Calibrator Flux Density

- Scaling from 320 MHz suggests that there is enough flux density to calibrate LOFAR long baselines
 - Lenc et al. 2008
 - Stokes I only, polarization calibration far more difficult as polarized flux on sky order(s) of magnitude weaker
- May have significant interstellar scattering problems
 - LBA region could have significant calibration problems
- Initial calibrator survey needed to find out what is going on at frequencies of interest for LOFAR

Concern Area 4: Computing

- Wide field imaging for long baselines
 - Lots of pixels, lots of CPU time
 - Does the software work for long baselines
 - Side note: Interferometer “station” power beam is the multiplication of the individual baseline element station voltage patterns (with a complex conjugate). Thus, the interferometer beam is not simply the smaller of the two element beams. For LOFAR, the long baseline stations have mostly baselines to Dutch stations, half of which are the small Core ears for HBA observations, and the resulting interferometer beam is not too different in size from a Dutch remote station.
- Are the CEP resources enough to process long baseline data to images?
 - For that matter, is it enough to process just the Dutch baselines?
- Just need to start observing and find out

Concern Area 5: Manpower

- **“It is clear that more manpower was needed”**

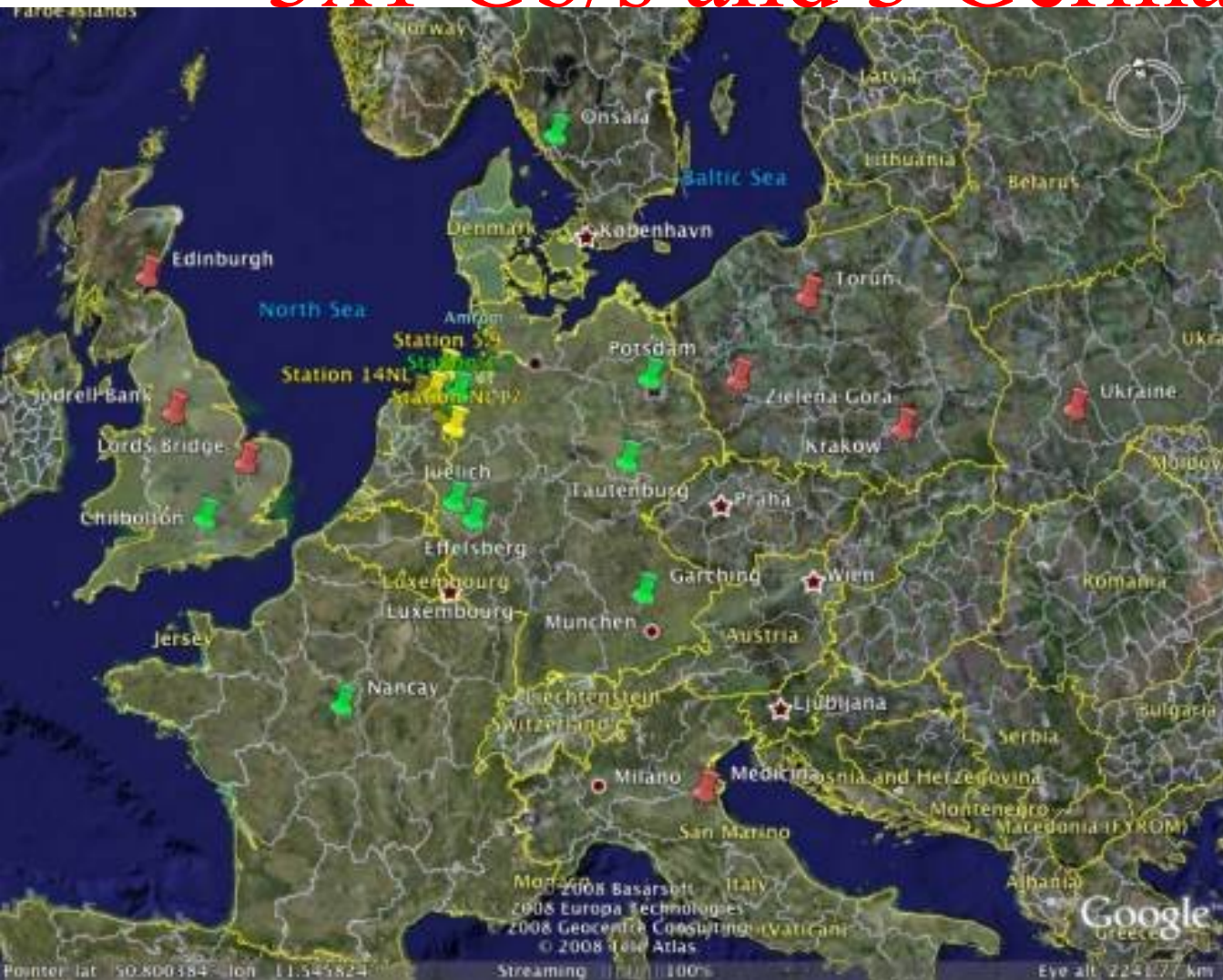
International Station Rollout



- Ef ready to install HBAs early July
 - Contract signed?
- Ef network connection soon...
- Tb, Uw have LBAs and electronics
 - No network connections yet
 - When will HBAs be installed?
- Pb can start building
- Ju and Cb must wait for crop harvest this fall

- On must also wait for crops, likely not available until 2010?
- Nc not available until 2010

3x1 Gb/s and 3 German Stations



- Pb, Tb, Uw all have issues going to 10 Gb/s and may end up at only 3x1 Gb/s

- Major pain in the ***

- Will result in < 30 MHz aggregate bandwidth

- 10 Gb/s stations have 48 MHz bandwidth

- Difficulty for scheduling observations

- Which subbands are on which RSP boards

- Continuum experiments probably ok

- Long baseline LOFAR effectively smaller

- Line experiments, including Faraday rotation may be severely compromised



Long Baseline Commissioning

- JMA entered a number of proposals into the LOFAR Observation Tracker system on June 15
- Some basic correlator tests, 0.25 s integrations, full LOFAR data rate simulation test
- Initial fringe tests with Effelsberg
- Long baseline calibrator surveys
 - HBA, then LBA
 - **Also useful for initial Global Sky Model comparison using the short-baselines included in the measurements**
- Ionospheric monitoring campaign
- Repeat Lenc et al. Observation to test wide-field imaging on a known test field
- **Data flood will start soon --- we really have to organize commissioning manpower at this stage**



The End