MSSS (MS$^{3)}$

or

a quick calibration survey for LOFAR

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(LOFAR calibration PS & PM)

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Why do a MS^3 ?

LOFAR20 needs a ***Global Sky Model (GSM*)** for the northern sky (~ 21,000 $\square^o$) in an early phase and which:

- has a proper flux scale
- has validated (initial) source parameters (spectrum, structure, ..)
- is astrometrically correct to better than 0.5”
- interfaces efficiently to calibration & imaging pipeline (LSM)

It will create a ***joint focus for activities*** related to scheduling, monitoring, processing, calibration & imaging

It will provide realistic requirements for early storage and processing

How to do an MS^3 ?

Proposal:

- 20 stations (13+7) --> three snapshots (5-15m) for uv-coverage
- limit to two frequencies: 60 MHz & 150 MHz
- < 3 months (assuming 50% efficiency) & real-time processing
- 4 beams of ~8 MHz

Providing:

- ~ 1 million sources, of which ~ 100,000 will be high S/N (~ 5 / □^{o})
- 2-3x better resolution than VLSS/WENSS (= initial reference)

MS^3 - project meeting

Why organize meeting now?

- LOFAR calibration + imaging mode = major, fundamental, task
- less than 1 year to go !
- address interfacing & integrating components of end-to-end pipeline
- define detailed tasks & involvement of KSPs (LAD plan)
- start identifying possible (observational) synergy with KSP Project Plans

Also: experiment with format and plan followup meetings on:

- (calibrated) tied-array work
- Solar (system) applications
- European LOFAR issues
- TBB applications, real-time calibration..

Worries/sleepness nights

LOFAR:

- pipeline robustness to hardware/midware failures…
- software readiness
- GSM: parametrization fidelity/updates (extended sources!)
- pipeline integration activities
- availability of personnel

Management:

- effective involvement of KSP DCLA personnel
- communication (especially (inter)national !)

+

- freeing some time to work on EoR KSP issues

LOFAR - beams

LOFAR station diameter and resulting FOV in HBA and LBA bands (after Oct2007 rescope)

HBA			**120 MHz**	**220 MHz**
Array	# tiles/station	station diameter (m)	HPBW (deg)	HPBW(deg)
Core	24 +24	~ 35	~ 5.3	~ 2.9
NL	48	~ 50	~ 3.7	~ 2.0
Europe	96	~ 65	~ 2.9	~ 1.6

Adopted HBPW = 1.3 λ /D (depends on beamformer spatial taper used)
Note that the synthesized FOV has to be typically ~ 2x larger !

On core-NL, core-EU or NL-EU baselines the geometric mean values have to be taken !

LBA			**30 MHz**	**60 MHz**
Array	# dipoles/station	station diameter(m)	HPBW (deg)	HPBW(deg)
Core	48	~ 30 – 82m	9.1 (for 82m)	12.4 (for 30m)
NL	48	~ 30 – 82m	9.1 (for 82m)	12.4 (for 30m)
Europe	96	65	11.5	5.7

Preliminary specifications of LOFAR20 - MS^3

Preliminary specifications for the MSSS

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14-03-2008

	60 MHz	150 MHz
Observing time per FoV	3 times 15 minutes	3 times 5 minutes
FoV	53.8 deg^2	7.0 deg^2
# beams	1	1
Bandwidth	32 MHz	32MHz
PSF resolution (20 km)	67 arcsec	26.8 arcsec
Correlator time resolution	1 s	1 s
Correlator freq resolution	0.76 kHz	0.76 kHz
Uv data size	760 Gbyte	680 Gbyte
Post DP^3 time res.	7.7 s	8.6 s
Post DP^3 freq res	33.75 kHz	93.75 kHz
Post DP^3 uv data size	~ 3.8 Gbyte	~ 0.95 Gbyte
# channels per image cube	5	5
Total image size	0.14 Gbyte	0.12 Gbyte

Table 1: Specifications per pointing / FoV

	60 MHz	150 MHz
Total # fields (2 pi steradian)	1205	9295
Total observing time (100% eff.)	904 hr	2324 hr
Total # sources (10 sigma)	404279	1949202
Total uv data size	916 Tbyte	6.32 Pbyte
Total post DP^3 uv data size	~ 4.6 Tbyte	~ 8.8 Tbyte
Total image data size	169 Gbyte	1.1 Tbyte

Table 2: "All sky" specifications

The above two tables contain the preliminary specifications for the MSSS. These specifications may change after the MSSS meeting and subsequent meetings.

Takes too long !

Comments on MS^3-specifications

Some remarks:

- Each Field / FoV is to be observed 3 times with some hours of time in between, so that a different uv-coverage is obtained for each of the observations. The combination of these three observations then generates a better uv-coverage than a single long observation.
- For comparison, the PSF resolution of the VLSS (74 MHz) is about 80 arcsec, the resolution of WENSS (325 MHz) about 50 arcsec. Hence, from VLSS and WENSS an initial sky model can be constructed.
- The current covering of the sky is based on a square grid (Nyquist sampling). A hexagonal coverage would result is lesser fields to observe (but also yield a slight under sampling).
- Images are made by combining 32 subbands. 5 times 32 equals 160. The remaining 4 subbands might be used for clock calibration.
- The total observing time is 3228 hours or 20 weeks at 100% efficiency. At the more realistic efficiency of 50% this would be 40 weeks, or almost a year. We therefore need to consider ways to reduce the observing time:
  - Shifting to lower frequencies, which increases the FoV
  - Do a different sky coverage with beams (e.g. hexagonal)
  - Trading bandwidth for beams.
  - …
- In order to finish the whole "project" (observing + processing) within half a year or so, the processing must be real time (or faster).