Report from the event supported by RadioNet

TITLE	*5TH LOFAR DATA PROCESSING SCHOOL*
DATE:	*17-21 SEPTEMBER 2018*
LOCATION:	*(DWINGELOO NL)*
MEETING WEBPAGE:	*http://www.astron.nl/lofarschool2018/*
HOST INSTITUTE:	*ASTRON*
RADIONET BENEFICIARY / NO:	*NOW-I / ASTRON - 02*

RadioNet has received funding from the EU's Horizon 2020 research and innovation programme under the grant agreement No 730562

Report:

1. SCIENTIFIC SUMMARY

The Fifth LOFAR Data Processing School took place on September 17-21, 2018 at ASTRON in Dwingeloo, the Netherlands. The school was hosted by the ASTRON Radio Observatory and the LOFAR project.

LOFAR is delivering unique scientific data in the relatively unexplored spectral window below 200 MHz. At the present time, 51 operational stations are part of the LOFAR array, of which 38 are located in the Netherlands, and 13 are in Germany, Ireland, France, Poland, Sweden, and the United Kingdom. Two new stations will soon be built in Latvia and Italy. In parallel, several data processing pipelines have been developed and are able to generate science ready data products. These go to the benefit of users who have obtained observing and processing time through the observing Cycles or want to make use of public LOFAR data. The aim of this School is to introduce the LOFAR system to new members of the community who will analyze both interferometric and high time resolution beam formed LOFAR data. Hands-on sessions have played a crucial role during the School giving attendees an opportunity to gain experience with real LOFAR data.

The School covered the many aspects of the LOFAR system:

- the capabilities of the station hardware;
- the interaction with the Radio Observatory including proposal preparation and submission, data quality assessment, data retrieval and software installation;
- the calibration and imaging software and pipelines;
- final science data products.

Lectures and tutorials were presented by experienced members of the LOFAR project team as well as staff from the many institutions involved in the collaboration. Dedicated 'Question&Answer' sessions were included at the end of every session, to facilitate interaction between participants and lecturers.

The first three days of the event were plenary sessions focused on general topics and radio interferometric tutorials. These were aimed to understand basic calibration and imaging of a simple LOFAR dataset and to expose the participants to the specifications of the LOFAR software. The image included below was chosen by the organizing committee as the best image produced by a team of two participants during the wide-field imaging tutorial.

For the final two days of the school, each participant made a choice out of a set of three predefined advanced tutorial sessions and lectures that ran in parallel:

- **Long baseline interferometric data processing (15 participants).** During the tutorial, the participants learned to set up and run the newly developed long baseline pipeline, which is needed to exploit the highest possible angular resolution attainable to LOFAR. Participants were exposed to understand the structure of the data products and to debug in case of problems. As a result of this tutorial, an image of a LOFAR dataset including all international stations was made.
- **Direction-dependent interferometric data processing (25 participants).** During this tutorial, the participants learned to set up and run the direction independent and direction dependent pipelines, prefactor and FACTOR respectively. They were exposed to understand the structure of the data products and to debug in case of problems. As a result of this tutorial, a thermal noise limited image of a LOFAR dataset including all Dutch stations.
- **Beamformed observing and transient buffer board data (7 participants).** So far, the non-interferometric observing modes of LOFAR – beamformed and transient buffer board (TBB) – are mainly used by a select group of scientist, mainly expert users. These modes provide much higher time and frequency resolution than the interferometric mode and are thus applicable to particular science cases. In this parallel session, the first of its kind in any LOFAR data processing school, a group of inexperienced users were introduced to the usage of LOFAR as a tied array instrument. Hands-on sessions were

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spent on visualizing and inspecting example data sets, selected from real scientific observations of pulsars, the Sun, and lightning events. Participants were also introduced to the pulsar pipeline in use at the LOFAR observatory, and used it in a tutorial. This is an important breakthrough in making the non-interferometric modes of LOFAR accessible to a broader user base.

During the 5th LOFAR data processing school 47 participants gained experience with the LOFAR system and the LOFAR calibration. This event has reduced the gap between the instrument, considered so far a niche instrument, and the more general astronomical community. This will allow more people to scientifically exploit LOFAR data.

Please find here the webpage of the event: http://www.astron.nl/lofarschool2018/

2. AGENDA OF THE EVENT

Monday 17/9		
L: Scientific introduction (R. Pizzo)		
L: Low frequency introduction (J. McKean)		
L: Overview of LOFAR (M. Brentjens)		

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L: RO interaction (M.H.D. van der Wiel)		
L:Quality assessment (V. Moss)		
L:LTA Retrieval (T. Franzen)		
T:Software installation (S. Sridhar)		
Tuesday 18/9		
L: Removal of instrumental and external effects (T. Shimwell, R. Van Weeren, M. Mevius)		
L: Radio Observatory processing (E. Orru')		
T: Data editing (T. J. Dijkema)		
T: Calibration part 1 Calibration part 2 (S. Sridhar)		
Wednesday 19/9		
L:Wide field imaging (B. van der Tol)		
T:Wide field imaging part 1 Wide field imaging part 2 (A. Offringa)		
T: wide field imaging (A. Offringa)		
visit to LOFAR site		
Parallel session		
Thursday 20/9		
Interferometry Direction Dependent	Beamformed	Interferometry Long Baseline
T: Error analysis: direction independent calibration (W. Williams)	L: Beamformed observing modes (C.G. Bassa)	
L: Long baseline calibration (L. Morabito)	T: Beamformed data inspection (C.G. Bassa)	
T: Error analysis: direction independent calibration (W. Williams)	T: Pulsar Pipeline (V. Kondratiev)	
T: Error analysis: direction dependent calibration (D. Rafferty)	T: Pulsar Pipeline (V. Kondratiev)	T: Long baseline calibration (M. Iacobelli, A. Drabent)
	L/T Transient buffer boards (S. ter Veen/B. Hare)	
Friday 21/9		
T: Error analysis: direction dependent calibration (D. Rafferty)	L: Beamformed Observations of the Sun (P. Zucca)	
L/T: Polarization (M. Iacobelli)	T: Beamformed Observations of the Sun (P. Zucca/M.H.D. van der Wiel)	T: Long baseline calibration (M. Iacobelli, A. Drabent)
Concluding remarks		

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3. PARTICIPANTS

A total of 47 participants took part in the school. The majority in the PhD student stage of their career, but the group also included more senior researchers. Of the 24 invited lecturers and tutorial leaders, five were women. The participants, 38%/62% female/male ratio, hailed from institutes clustered in Europe (including Bulgaria, a country not affiliated with the LOFAR collaboration), four from Asia, and one from the United States. Twenty percent of participants were from either Italy or Latvia, a noticeably increased fraction compared to earlier LOFAR data processing schools, undoubtedly related to the upcoming construction of the 52nd and 53rd LOFAR stations in these two countries.

By bringing this diverse group of (young) scientists with varying scientific interests together for a week, we believe that this school has fostered opportunities for new collaborations to be formed.

Please find attached the signed list of of the participants.

4. RADIONET FINANCIAL CONTRIBUTION

We decided to use the RadioNet grant of 4500 euro to cover local organisational costs such as meals, coffee breaks, bus transport to the LOFAR site, rental of bicycles for the participants and shuttle buses from/to the Hogeveen. Detailed divisions of the expenses will be sent by the ASTRON finance department.

5. PUBLICATIONS

The dissemination of material and instruction gathered during the 2018 edition of the LOFAR data processing school will go through the webpage, which features the RadioNet logo and the acknowledgement phrase. No additional forms of publication are anticipated.

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