

LWA Ionospheric Workshop

Christopher Watts¹ and Kenneth Dymond²

with: Ronald Caton⁵, Clayton Coker², Anthea Coster³, Larry Cox⁴, Pat Crane², Odile De La Beaujardiere⁵, Joe Helmboldt², Chin Lin⁵, Jonathan Makela⁶, Anthony J Mannucci⁷, Xiaoping Pi⁷, Lee J Rickard¹, Paul Rodriguez², Yi-Jiun Su⁵

University of New Mexico¹, Naval Research Lab², MIT Haystack³, Los Alamos National Lab⁴, Air Force Research Lab⁵, University of Illinois⁶, Jet Propulsion Lab⁷

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Overview

The LWA Ionospheric Workshop was held in parallel with the CEDAR workshop at the Eldorado Hotel on Sunday June 28, 2009. The purpose of the workshop was to bring together the ionospheric and astronomy communities and the core working group of the Long Wavelength Array to discuss ionospheric issues related to LWA operation. There were two overarching goals: 1) Discuss options for LWA calibration to mitigate ionospheric effects and 2) Gather input from the ionospheric community for questions of scientific interest that LWA might address, which might possibly adjust the LWA design specifications. The (original) agenda for the workshop is attached at the end of this document.

Workshop summary

The morning session was devoted to brief talks providing an overview of the Long Wavelength Array, its current status and intended science. These were given by L. Rickard, C. Watts, J. Helmbolt (standing in for Aaron Cohen), K. Dymond and J. Makela (standing in for Mike Kelly). There was active discussion during all talks, with clarification on both LWA design issues and science possibilities.

During the afternoon session the group split into two working groups to address the two thematic questions.

Calibration issues

Discussion focused on contrasting the two schemes being put forward by LWA and the Murchison Widefield Array (MWA). There are significant differences, given that the two telescopes have very different frequency bands, physical layout, and science goals. However, there are also significant similarities. Critical issues include refractive and Faraday rotation effects. Ray tracing codes are being used by both groups to better understand these effects. A better understanding of Earth's magnetic field is necessary. The current calibration scheme for LWA calls for using one of four beams to flicker over ~100 sources in a 10 s period, using the Rapid All-Sky Calibration (RASCAL) technique. A network of GPS receivers should be in place to supplement LWA telescope data. Other supplemental data might include passive radar (from FM transmitters) and use of novel radar techniques (e.g. the TIDBIT, 1 mW radar being developed by ASTRA).

Science issues

There were some questions about current LWA specifications, and this hampered discussion to some extent. It was pointed out that in addition to the RASCAL measurements, the stationary beams would also provide valuable ionospheric data too. Science that might be addressed include

a) the occurrence of ionospheric irregularities and their propagation directions, b) traveling ionospheric disturbances (TIDs) and their relationship to acoustic waves, c) scintillation, d) the origin of TIDs (terminator related effects, orographic effects EG mountain waves, jet stream turbulence, generation by tropospheric storms, generation in the polar caps), e) D region absorption (possibly combined with radar), and f) studies of the development and characterization of local ionospheric gradients associated with sunrise and sunset (“dawn and dusk wedge”).

Miscellaneous Issues

The key players, supporting the ionospheric work at the radio interferometers being developed, need to be identified. This would help to avoid duplication of effort and to perhaps more effectively target ionospheric science of interest. It would also tend to foster collaboration between the various groups when the key scientists have been identified.

The primary modes of operation and capabilities of the LWA need to be better refined so that important ionospheric science issues that can be effectively addressed by the LWA can be identified and exploited.

Recommendations

From the discussions, we make several recommendations with regard to the near-term ionospheric program for the LWA.

- 1) Continue to pursue the ionospheric modeling efforts to assess the effectiveness of the proposed RASCAL scheme.
- 2) Assess the implications for ionospheric science that are enabled by high sampling rate measurements of targets of astrophysical interest analogous to current and past observations with the VLA. This also includes synergies between the RASCAL ionospheric measurements and the higher rate measurements that enable other ionospheric studies that have not yet been identified.
- 3) Emphasis should be placed on developing a near-term program of ionospheric science research that can be achieved with a single LWA station. The committee was not clear on whether the immediate plans include two smaller “outlier” stations; these could prove very beneficial in demonstrating LWA’s ultimate ionospheric capabilities.
- 4) Continue (or revive) efforts to use VLA (Very Large Array) data in ionospheric studies and tomographic reconstruction. This would include campaigns similar to the CRICKET campaign.
- 5) Work to foster further collaboration between the ionospheric scientists supporting the various new radio interferometers (LWA, MWA, and LOFAR) under development. One means for doing this is supporting the upcoming URSI Meeting during January 2010, where a joint session between commissions J and G is being organized to foster collaboration in this regard.

Participants and contact info

Ronald Caton	Ronald.Caton@hanscom.af.mil
Clayton Coker	clayton.coker@nrl.navy.mil
Anthea Coster	ajc@haystack.mit.edu
Larry Cox	larrycox@lanl.gov
Pat Crane	Patrick.Crane@nrl.navy.mil
Odile De La Beaujardiere	Odile.delaBeaujardiere@hanscom.af.mil
Kenneth Dymond	kenneth.dymond@nrl.navy.mil
Joe Helmboldt	joe.helmboldt@nrl.navy.mil
Chin S Lin	Chin.Lin@hanscom.af.mil
Jonathan Makela	jmakela@illinois.edu
Anthony J Mannucci	anthony.j.mannucci@jpl.nasa.gov
Xiaoqing Pi	xiaoqing.pi@jpl.nasa.gov
Lee J Rickard	lrickard@unm.edu
Paul Rodriguez	paul.rodriguez@nrl.navy.mil
Yi-Jiun Su	Yi-Jiun.Su@hanscom.af.mil
Christopher Watts	cwatts@ece.unm.edu



LWA Ionospheric Science Workshop

Agenda

Location: Chapparal Room, Eldorado Hotel, Santa Fe

Sunday, 28 June

Breakfast (CEDAR breakfast area): 8:00 - 8:30

Presentations:

8:30 Intro & welcome

8:35 LWA overview as ionospheric instrument: Rickard

9:05 Ionospheric science from radio telescopes: Watts

9:30 LWA calibration scheme and relevance to ionospheric science: Helmboldt

Break 10:00

10:30 Cricket campaign: Dymond

11:00 What can LWA contribute to ionospheric science (near term)?: Kelley

Lunch: 11:30 - 1:00

Open Workshop: 1:00 - 2:00

Break into groups:

1) Ionospheric science with LWA (Dymond)

2) Calibration strategies (Crane)

Integration, Summary & Wrap-up 2:00 - 2:30

Where to next?

Saturday, 27 June

VIP tour of Very Large Array telescope and LWA site. Meet at VLA visitor center 3pm; tour 3:00 - 4:30.

Attendees:

Clayton Coker, Patrick L. Colestock, Anthea Coster, Bill Cotton, Larry Cox, Pat Crane, Geoff Crowley, Odile De La Beaujardiere, Kenneth Dymond, Joe Helmboldt, Mike Kelley, Jonathan Makela, Xiaoqing Pi, Lee J Rickard, Paul Rodriguez, Bob Schunk, Stefan Thonnard, Christopher Watts