

MWA Low Frequency Demonstrator SHI Science Collaboration

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This document outlines the terms of reference for the Solar-Heliospheric-Ionospheric (SHI) Science Collaboration associated with the US-Australia Mileura Widefield Array – Low Frequency Demonstrator (MWA-LFD), hereafter referred to as the LFD. The document briefly summarizes the planned LFD development and SHI science goals, defines the partners and science collaborators, and sets out the operating plan for the SHI science collaboration.

1. LFD

The radio array is composed of 512 stations (or tiles) operating in the frequency range from 80 to 300 MHz, and will be built in the radio-quiet area of Mileura, Western Australia. The majority of the tiles will be placed in a core area of ~1.5 km diameter, with a subset of 16 tiles deployed at distances of ~3 km from the center to improve angular resolution.

The plan is to deploy 32 tiles within the first 12-18 months of the project (~4Q07) to allow some initial observations of solar bursts and to obtain experience with the instrumentation. The remaining tiles and the full digital signal processors are expected to be completed within 24-30 months (~4Q08), when full science operations are expected to commence. The LFD is initially aimed at operating in a mode of focused experiments with three specific science goals: (1) measurement of redshifted neutral hydrogen to study structure formation in the Epoch of Reionization (EOR), (2) observation of solar-heliospheric phenomena using remote sensing techniques for space weather investigations, and (3) detection of radio transients. Expansion of the LFD for operation as a user facility to support other experiments is expected to follow the initial phase but remains to be defined subject to the availability of sufficient funding.

2. SHI science and techniques

The SHI goals for the LFD include:

- Measurement of interplanetary scintillations using 16 digitally-formed beams to better constrain the density and velocity of coronal mass ejections (CME).
- Observation of the Faraday rotation of polarized radio sources to determine the magnetic field evolution in the heliosphere and in CMEs.
- Imaging of solar radio bursts at high angular resolution with emphasis on emission associated with CME-driven coronal shocks, including Type II bursts.
- Investigation of the small scale ionospheric perturbations that are derived from the array calibration techniques, particularly when caused by solar disturbances.

All the above goals will help improve our understanding of key space weather phenomena, and will contribute to national and international space weather programs.

3. Partners

The LFD array is being developed by founding Partner institutions or consortia in the US and Australia that are contributing substantially to the construction and operation of the array including its primary hardware and software systems, either directly or indirectly. Individuals employed by a Partner institution have the option of becoming SHI science collaborators. Partner institutions will identify a primary representative who will be the point of contact for the SHI research between the project office at the MIT Haystack Observatory and the Partner institution.

4. Collaborators

As part of the development of the SHI project for the LFD, several researchers have already interacted as science collaborators and supported the proposal for the LFD. Other individuals who have an interest in carrying out SHI scientific investigations using LFD observations or providing theoretical/modeling research to support the SHI science may also be named as Collaborators. Membership in the SHI science collaboration requires concrete contributions to the overall LFD development activities, such as the provision of analysis tools and algorithms, software packages of use to the project, theoretical/modeling results, source lists to jumpstart the LFD observations, or complementary data from other instruments that are needed by the LFD in order to accomplish its SHI science goals. Such science collaborators will form the *SHI Working Group*. This group will have early access to the LFD SHI data during its commissioning and testing phase, will assist in the validation and quality control of the observations, and in the early demonstration of the SHI science objectives. A subset of the SHI Working Group will form an *SHI Coordination Committee* as discussed below to organize the collaboration activities.

5. Broader Community

It is the stated goal of the LFD Project Office that all SHI data will be placed in the public domain for use by the broader community which will be encouraged to use it for research. This open data access will occur after a reasonable time for data validation, quality control, and initial demonstrations of science goals by the SHI collaborators. Members of the community will be encouraged to connect with SHI collaborators to ensure proper and efficient use of the SHI data.

6. Terms of Reference

6.1 Science collaborators will be identified to the funding agencies as participants in the LFD project. Science collaborators are encouraged to submit proposals on their own initiative to funding agencies for SHI research using LFD data and will be provided supporting documentation by the LFD project Office and the SHI Coordination Committee, as needed.

6.2 All collaborators and their students/post-docs will have access to the SHI data products and the SHI science packages during the LFD development and operational periods.

6.3 SHI science collaborators may lead the preparation of scientific papers on topics that utilize LFD data and may serve as co-authors on other papers to which they make substantial contributions. Acknowledgements of the LFD technical team and project sponsors are expected.

6.4 Prior to submission of papers associated with the LFD and SHI results, papers would be posted for comment by the LFD-SHI science collaboration members and the LFD Project Office. The purpose of this internal review is to ensure appropriate use of the LFD data, and to give all members of the science collaboration an opportunity to comment on the manuscript and authorship. The comment period may not exceed 3 weeks so that the paper may be submitted in a timely manner.

6.5 All LFD-SHI data will be shared with the community at large and deposited in a data base accessible to the wider community after a suitable period of time (projected to be ~1 year) of initial operations as part of the LFD commissioning phase when data validation and early analysis are completed. The community will be encouraged to seek the involvement of members of the SHI science collaboration in order to ensure proper use of the data.

7. LFD-SHI Working Group and Coordination Committee

All members of the SHI Science Collaboration who are making contributions to the LFD will form the ***SHI Working Group***. A subset of the working group will form the ***SHI Coordination Committee***, initially selected to represent current US and Australian Groups associated with the SHI work, with the intention of further membership. A chair and vice-chair will be elected (one from US and one from Australia), and either they or other members of the SHI Coordination Committee will participate in the LFD Science Council defined in the LFD Management Structure. The chairmanship will be based on a one-year rotating term, with the vice-chair assuming the chair's position to ensure continuity. Suitable adjustment in the first appointments will be made so that both positions are not rotated simultaneously.

The tasks of the SHI Coordination Committee are:

(a) Coordinate the efforts of the science collaboration to ensure that maximum advantage is taken of the LFD data for its SHI applications. Interact with the SHI Working Group and broader community, organize the SHI activities, solicit the SHI working group input on LFD issues, and represent the SHI working group in the LFD project.

(b) Review and discuss requests for membership in the SHI Working Group based on brief descriptions of proposed work and contributions related to the project.

(c) Advise the LFD project management on the design, construction, and operation of the LFD as they pertain to the SHI science.

(d) Review the plans for the LFD development and operations as they become available, and support LFD design reviews.

(e) Promote the LFD in the broader community and help organize regional, national and international workshops on LFD-SHI science.

The SHI Coordination Committee will meet on a regular basis, as called by the Chair or Vice-chair. The meetings will be planned to coincide with LFD project meetings, international conferences, or via video or tele-conferencing to minimize the travel impact on the members. Special meetings may be called to address urgent issues as requested by the Chair or Vice Chair. Requests for such meetings or for agenda items for the meetings may be brought to the attention of the Chair or Vice Chair by any member of the SHI science collaboration Working Group.

8. LFD Partner Institutions

Massachusetts Institute of Technology - Haystack Observatory
Massachusetts Institute of Technology - Kavli Institute for Astrophysics and Space Research
Harvard-Smithsonian Center for Astrophysics
Australia Telescope National Facility/CSIRO
Australian National University
Curtin University of Technology
University of Melbourne

9. SHI Science Collaboration Coordination Committee

The following members are proposed as the initial members of the SHI Coordination Group. Their *primary* areas of science interest are indicated:

Iver Cairns (Univ Sydney) – Theoretical solar and interplanetary modeling
Peter Dyson (Latrobe Univ) – Ionosphere structure
John Foster (MIT/Haystack) – Space Weather, ionospheric structure
Brian Fraser (Univ Newcastle) – Ionosphere structure
Bernie Jackson (UCSD/CASS) – IPS processing, FR inversion
Justin Kasper (MIT/Kavli) – FR system
Merv Lynch (Curtin Univ) – Solar radio bursts system
Divya Oberoi (MIT/Haystack) – IPS system, solar radio burst system
Joseph Salah (MIT/Haystack) – FR analysis, ionosphere structure

At its first meeting, the Coordination Committee will select a chair and a vice chair.

10. SHI Science Collaboration Working Group

The Working Group is formed by the members of the Coordination Committee plus researchers who are performing LFD-SHI scientific work with project-relevant contributions. All members are subject to annual reconfirmation by the Coordination Committee chair, in consultation with the members of the Coordination Committee and the LFD Science Council. It is expected that the membership will be subject to growth and adjustment. The initial membership list, in addition to the Coordination Committee, is as follows:

Mike Bird (Univ Bonn) – FR analysis
Anthea Coster (MIT/ Haystack) – Ionospheric structure/GPS systems
Phil Erickson (MIT/Haystack) – Ionospheric structure and signal processing
Larisa Goncharenko (MIT/Haystack) – Ionospheric structure/GPS analysis
Keith Groves (AFRL) – Ionosphere/GPS calibration
David Herne (Curtin Univ) – GPS measurements/solar burst analysis
Paul Hick (UCSD/CASS) – IPS and FR algorithms
Masayoshi Kojima (Univ Nagoya/STEL) – IPS algorithms/analysis
Frank Lind (MIT/Haystack) – Ionospheric structure and signal processing
John Raymond (Harvard-Smithsonian CfA) – Solar radio burst analysis