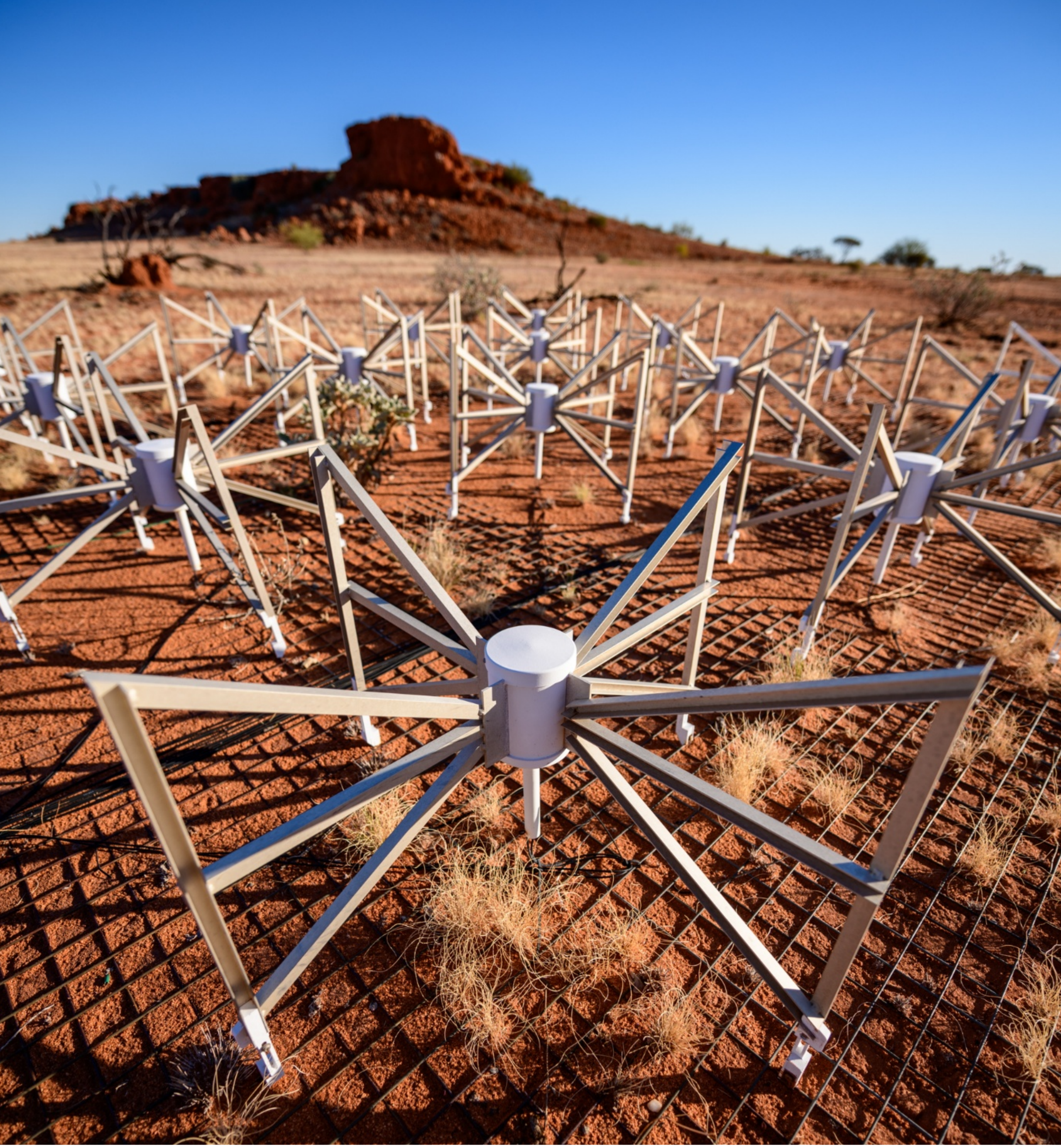

MWA Project Meeting 2025 book of abstracts

We acknowledge the Wajarri Yamaji as Traditional Owners and Native Title Holders of Inyarrimanha Ilgari Bundara, the CSIRO Murchison Radio-astronomy Observatory.

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MWA Project Meeting

Wednesday, 27 August

Welcome

Steven Tingay / MWA Director report

Invited Speakers

Andrew McPhail / Completion of the MWA Phase III upgrade. I. (online presentation)

Greg Sleap and Operations Team / Completion of the MWA Phase III upgrade. II.

Dev Null / A farewell to the Coarse Channel Harmonic

Until recently, one out of every eight channels in an MWA observation were considered unreliable due to a quirk of the critically sampled polyphase filter bank. The regular spacing of these channels has obscured large regions of the 21cm power spectrum, limiting the EoR experiment. Recent upgrades to receiver and correlator hardware have enabled oversampling, which offers a much smoother coarse channel bandpass. In this talk, we'll provide an update on recent developments in MWA data reduction and compare 2025 EoR results against previous seasons.

Galactic and Extragalactic (GEG) Science

Silvia Mantovani / GaLactic and Extragalactic All-sky Murchison Widefield Array survey eXtended (GLEAM-X) III: Galactic Plane

Radio surveys of the Galactic Plane are essential for understanding how the Milky Way evolves, what it is composed of, and what emission processes take place. Low radio frequencies are particularly useful for constraining the distribution of cosmic rays and magnetic fields, as well as studying the spectral properties of pulsars and the diffuse emission of supernova remnants.

The GLEAM-X survey is incrementally made available to the community as portions are completed. The first two data releases covered 14892 deg2 of the extragalactic sky. We present here the third data release for the GLEAM-X survey, covering ≈3800 deg2 of the southern Galactic Plane (GP) with 233∘<l<44∘ and |b|<11∘ over a frequency range of 72--300 MHz. However, GLEAM-X alone is not sensitive to the large-scale diffuse emission, abundant along the GP.

To address this, we jointly deconvolved GLEAM-X data with the original GLEAM survey to recover spatial scales 45"−15∘ - a capability unmatched by other low-frequency surveys - using a GPU-based Image Domain Gridding (IDG) extension of WSClean. This release represents the most detailed low-frequency survey of the GP to date, with only the SKA expected to produce deeper and broader coverage. The GP release has an RMS noise level of 10-2 mJy beam−1 across the observing band, and almost 90000 sources with spectral fitting. In this talk, we will present the new images and catalogues and showcase some early science results including spectral studies of SNRs, HII regions classification and pulsar detections at low frequencies.

Susmita Sett / Imaging pulsar census of the Galactic Plane using MWA VCS data

Traditional pulsar surveys have primarily employed time-domain periodicity searches. However, these methods are susceptible to effects like scattering, eclipses and orbital motion. At lower radio frequencies (≲ 300\,MHz), factors such as dispersion measure and pulse broadening become more prominent, reducing the detection sensitivity. On the other hand, image domain searches for pulsars are not limited by these effects and can extend the parameter space to regions inaccessible to traditional search techniques. Therefore, we have developed a pipeline to form 1-second full Stokes images from offline correlated high time-resolution data from the Murchison Widefield Array (MWA). This led to the development of image-based methodologies to identify new pulsar candidates.

This talk focuses on the detection of the known pulsar population which were present in the Galactic Plane region of the sky observed using both image-based and beamformed methods. This resulted in the detection of 83 known pulsars, with 16 pulsars found only in Stokes I images but not in periodicity searches applied in beamformed data. Notably, for 14 pulsars these are the first reported low-frequency detections. This underscores the importance of image-based searches for pulsars that may be undetectable in time-series data, due to scattering and/or dispersive smearing at low frequencies. This highlights the importance of low-frequency flux density measurements in refining pulsar spectral models and investigating the spectral turnover of pulsars at low frequencies.

Sarah White / The M(agnificent) W(idely-)A(waited) G4Jy Sample (online presentation)

Thanks to MWA observations of the entire southern sky, through the GLEAM Survey, it has been possible to create a legacy compilation of the brightest radio-sources (S151 MHz > 4 Jy) in preparation for the SKA: the GLEAM 4-Jy (G4Jy) Sample (White et al. 2020a, 2020b). In this talk I will present the results of widely awaited multiwavelength analysis, which includes the calculation of intrinsic properties that reveal the true power of these powerful radio-galaxies (White et al., in prep.). This is thanks (in large part) to collating spectroscopic redshifts for 34% of the sample, with 169 of these being new redshifts courtesy of dedicated follow-up on the Southern African Large Telescope (White et al. 2025; Sejake et al., in prep.). I will conclude with a list of 'next steps' to encourage continued participation from the MWA Collaboration.

Stefan Duchesne / Making use of the archival GLEAM observations: 300 MHz and joint-deconvolution strategies

The Galactic and Extragalactic All-sky MWA (GLEAM) survey covers the sky up to declination ~+30 across most of the frequencies MWA observes at, covering multiple telescope configurations. This talk will cover some uses of these archival datasets, namely the previously unreleased GLEAM 300 MHz survey (GLEAM-300) and strategies to combine phase I and phase II GLEAM data for imaging projects looking at galaxy clusters and nearby star-forming galaxies.

Transient Science

Alexander Hedge / Radio selections of high-redshift radio galaxies: The MHz-peaked spectrum population

In a rapidly approaching SKA era, the need to characterise radio sources and their host galaxies accurately has emerged as a non-trivial problem, especially for undetected host galaxies. For this population without clear hosts, overlapping with infrared-faint radio sources (IFRSs), the bottleneck in obtaining redshifts lies in dedicated follow-up at sub-mm or infrared wavelengths using over-subscribed instruments.

Given the wealth of sensitive, all-sky observations in the radio, there has to be a better way of determining the redshifts for this IFRS-like population which include the elusive powerful radio galaxies at z>5. Previously using the GLEAM survey, efforts were made to select low-frequency turnover high-redshift radio galaxies by their spectral index and curvature within GLEAM and then filter out by other characteristics and verify with follow-up at optical to sub-mm wavelengths. Two z>=3 radio galaxies that were verified from that pilot study now have LOFAR Low Band Antenna data spanning ~35-65 MHz, complementing GLEAM and opening a window into the MHz-peaked turnovers previously hinted at.

We compare the rest-frame turnovers and linear source sizes for these sources at very high redshift with known relations and investigate the MHz-peaked spectrum population of sources that are within the large LOFAR field of view. We explore these as potential candidate high-redshift radio galaxies that can be selected or inferred from broadband radio SEDs that extend to <50 MHz.

Natasha Hurley-Walker / Widefield radio transient monitoring: challenges and opportunities

Recent radio surveys have demonstrated that the radio sky is far more dynamic and variable than previously thought, with a host of new transient discoveries rapidly following wide-area surveys conducted with SKA precursors such as LOFAR, ASKAP, and the MWA. In particular, the long-period radio transients (LPTs) have motivated searches of the time domain between seconds to hours, a timescale historically understudied.

In this talk I describe a high-cadence monitoring survey covering the entire Galactic Plane south of Declination +30 degrees, using the MWA at 200MHz. Covering timescales from four seconds to three years, this survey has enabled the discovery of three LPTs, five pulsars, 20 new supernova remnants, and has contributed measurements to a host of other projects, including ASKAP-selected LPTs, studies of eclipsing binary millisecond pulsars, and new Galactic Centre Radio Transients.

Low-frequency surveys offer a multitude of benefits, but also challenges, and I will describe our solutions, along with future upgrades that will enable an even larger discovery space. I will conclude with an outlook on the future of low-frequency monitoring of the Galactic plane, both in the medium-term, and once the SKA-Low arrives.

High Performance Computing (HPC)

Richard Dodson / Compression over deletion: Keeping the MWA archive

The MWA archive is creaking; data is being deleted. All of that data represents valuable observing time, yet some of that data has never been examined. Both of these problems relate to the size of the file; when the processing takes too long the data never gets imaged, particularly if one starts to consider division by frequency or time. However, if we could reduce the sizes of the files we could both avoid discarding the data and fully exploit the MWA archive to extract the full potential of the instrument, as the I/O limit is one of the bottlenecks to investigating all of the dimensions of the data held. Compressing the data is an obvious solution; for visibilities only lossy compression can deliver a significant saving and we have been investigating the impacts on the final data products, and find these can be minimal.

We are using the lossy compression tool MGARD, which is a richly featured multi-grid compression application. This outperforms existing solutions, i.e. DYSCO, by allowing us to apply physical error limits (i.e. a fraction of the system temperature) and to alter our compression conditions as a function of observing parameters. That is, for example, we can implement compression that is time dependent, or baseline length dependent.

We will present our results, demonstrating that no significant losses are introduced. We are building all our tools into a simple user interface, which will allow a user to pull their data from the archive, compress it by an order of magnitude and replace the original version, rather than delete it.

Cristian Di Pietrantonio / High time resolution imaging for fast radio bursts searches within archival MWA VCS observations

In this presentation I will introduce the BLINK pipeline, now publicly available, a novel high time resolution imaging software for low-frequency Fast Radio Bursts (FRBs) searches within MWA VCS observations. Detection of FRBs at low frequencies is computationally challenging due to the high time and frequency resolution requirements imposed by the nature of FRBs, coupled with the large dispersive delay, in the tens of seconds, affecting the signal. BLINK tackles these challenges by implementing imaging-based FRB searches that take full advantage of the computational power of the Setonix GPU partition, Pawsey's latest supercomputer. Intermediate I/O operations between stages are eliminated, and all computation executes on GPU, supporting both AMD and NVIDIA hardware vendors. In a test case, representative of what is required for FRB searches, the BLINK imaging pipeline achieves a 3687x speedup compared to a traditional MWA imaging pipeline employing WSClean. Finally, I will present the strategy to extend the pipeline to perform de-dispersion on the large quantity of images produced, and to run time series analysis for FRB detection.

MWA Project Meeting

Thursday, 28 August

Epoch of Reionisation (EoR) Science

Ridhima Nunhokee / Deepest upper limits on the 21 cm power spectrum with MWA

The 21 cm hydrogen line is a unique tool that allows scientists to study the vast space between galaxies, known as the intergalactic medium (IGM) and to track how it changed over time as the universe evolved. By measuring tiny fluctuations in this signal, researchers can learn about the temperature and ionisation state of the early universe. In this talk, we present the deepest limits ever achieved on the 21 cm power spectrum at redshifts z = 6.5, 6.8, and 7, which correspond to a time when the universe was just a few hundred million years old. These results are based on ten years of observations with the Murchison Widefield Array (MWA), collected between 2013 and 2023. Of the total 657 hours of data, a carefully selected 268-hour subset was used for the final analysis, following advanced techniques to remove interference from brighter foreground sources. These results offer the first evidence that the IGM was already heating up during this crucial stage in cosmic history.

Cath Trott / Deepest 21cm limits at 800 million years after the Big Bang, using Gaussian information

In Nunhokee et al (2025), the MWA EoR Collaboration published the deepest limits on the brightness temperature of the 21cm signal from 800 million years after the Big Bang. This work used all of the observed data from the EoR0 field, and our high-band at 167-197 MHz, culminating in 267 hours of clean data. That work reached a limit of 30.2 mK in brightness temperature fluctuation on scales of 20 arcmin, yielding constraints that helps us understand conditions in the early Universe. In this talk, I will describe work (Trott et al 2025, in review) that post-processes these same observations, and uses the Gaussianity of the 21cm signal, relative to contaminants, to improve these results to 21.7 mK on the same scale. This limit is comparable to the deepest limits obtained at higher redshift by the HERA Collaboration.

Aishwarya Selvaraj / Introducing the Central Redundant Array Mega-tile: Advancing 21 cm Signal Detection

Exploration of the 21cm signal from the Cosmic Dawn and the Epoch of Reionisation (EoR) can unravel the mysteries of the early Universe when the first stars and galaxies were born and reionised the intergalactic medium. However, the 21cm signal is exceptionally weak; thus, detecting amidst the bright foregrounds is extremely challenging.

The Murchison Widefield Array (MWA) aims to measure the brightness temperature fluctuations of neutral hydrogen from the early Universe. The MWA telescope observes the radio sky with a large Field of View (FoV) that causes the bright galaxies in the side lobes near the horizon to contaminate the measurements. In response to the challenges faced, a new zenith-pointing instrument, the Central Redundant Array Mega-tile (CRAM), is installed and integrated into the Phase II configuration of MWA. The CRAM (consists of 8 x 8 dipoles) is twice the size of a regular MWA tile in each dimension (which consists of 4 x 4 dipoles), and therefore, it has half the FoV at each frequency under consideration. The primary objective of this new instrument is to mitigate the impact of bright radio sources near the field centre in accordance with the reduced primary beam shape and reduce the contamination of foreground sources near the horizon with the reduced sidelobe response of the larger array configuration.

In this talk, I will briefly present the details of the instrument, the data acquisition process, and the gain and receiver temperature estimation analysis, leading to the work for my first paper. Further, I will present how the new instrument will benefit EoR science, using the results obtained through power spectrum simulations. I will demonstrate how the new instrument, with a reduced FoV, can reduce the impact of the foregrounds. Finally, I will conclude with the ongoing work, where I analyse real interferometry data from the hybrid array.

Shintaro Yoshiura / Progress of the MWA drift-scan at ultra-low frequency

The redshifted 21 cm line is a powerful tool for studying the state of the intergalactic medium (IGM) before the epoch of reionization. The MWA's ultra-low-frequency band, spanning 75 MHz to 100 MHz, covers the 21 cm line from redshift of 15. This redshift corresponds to the epoch when the first stars formed and the IGM was heated by X-ray radiation. However, observations at these frequencies are significantly contaminated by foregrounds such as Galactic synchrotron radiation. Additionally, measurements in this band suffer from systematics, including ionospheric effects. Therefore, detecting 21 cm fluctuations at these redshifts requires a deep understanding of the low-frequency sky, instrumental systematics, and calibration strategies.

In this talk, we report progress in our data analysis of MWA drift-scan observations at ultra-low frequencies. The observation covers right ascensions from −45° to +75° with zenith pointing. Calibration was performed using MWA Hyperdrive with the latest calibration source catalogue. Our key findings include: (1) short baselines are dominated by Fornax A and Pictor A around LST ≈ 50; (2) Fornax A is effectively subtracted, though residuals from other sources remain; (3) the power spectrum's dynamic range varies with LST; (4) the level of systematics dominating the power spectrum depends on nights; and (5) current upper limits are constrained primarily by gain calibration errors. We also report ongoing analysis related to ionospheric conditions, RFI from the Moon, gain smoothing, and statistical analysis of visibilities.

Jaiden Cook / Southern Hemisphere maps from m-mode Spherical Harmonic Transit Interferometry with the MWA and the EDA2

Spherical harmonic functions are a natural set of basis functions for describing the brightness distribution of the celestial sphere. As the Earth rotates, the fringes projected on the sky by a zenith phased interferometer sample the celestial sphere. The resulting visibilities measured by a single baseline are therefore periodic over a sidereal day, and are Fourier conjugate with the spherical harmonic phase term m.

By Fourier transforming the measured visibilities over a 24-hour transit observation, and with knowledge of the instrument (baseline fringes, beam pattern), we can solve for the real spherical harmonic coefficients of the sky. As a result, the m-mode transit interferometry technique precludes the need to mosiac images and naturally includes the widefield effects present for instruments such as MWA and LOFAR, without the need to perform w-projection or w-stacking. Therefore, this technique is well suited for making high quality all-sky maps, of the large-scale diffuse Galactic emission.

Accurate maps of large-scale structures are paramount for Epoch of Reionisation science (a key SKA science goal), and are necessary for mitigation, calibration and removal of foreground contaminants. Therefore, all-sky maps are important not just for precursor instruments such as the MWA, but for the SKA-LOW. Current foreground models use the scaled and desourced version of the 408MHz Haslam map, which is suboptimal for the low frequency ranges of the cosmic dawn and EoR.

In this work, we present an all-sky map at 160 MHz with a resolution of ~40 arcminutes (comparable to the 408 MHz Haslam map), covering the entire Southern Hemisphere to bridge this gap. This map was constructed by combining data from both the MWA and the EDA2 (an SKA-low prototype station), where the EDA2 samples large-scale diffuse structures, and the MWA samples finer small-scale angular structures. Future maps made with the SKA-LOW will greatly improve upon this work, by utilising the high sensitivity and baseline distribution of the SKA-LOW core. This will result in highly sensitive maps across a range of frequencies, and angular scales (arc minute scale), for the scientific community.

Nick Seymour / Searching for the First Black Holes with the MWA

Radio surveys are unique tracers of black holes in the distant Universe. Only the most massive black holes (108−109M⊙) can produce the synchrotron jets which are luminous enough to appear in relatively shallow all sky radio surveys.

After stagnating for a decade or so, we have seen a renaissance in this field over recent years with the discovery of numerous radio-loud AGN in the first billion years. Surveys with the MWA have led to the discovery of the most luminous radio galaxy at z>5.5 and has characterised the radio spectra of many radio-loud active galactic nuclei (AGN) at higher redshifts including the most luminous, super-Eddington AGN at this epoch.

I will briefly summarise the results to date as well present the motivation for continuing this search including discovering the early black holes which are too rare and massive to be found in the narrow JWST fields as well as the potential for studying the early interplay of the galaxies with the interstellar medium via the 21-cm forest with the SKA.

Pulsars and Fast Transient (PFT) Science

Ramesh Bhat / Pulsars and Fast Transients: Science Updates and Forward Look

Over the past decade, pulsar and fast transient science with the MWA has critically relied on the voltage capture system (VCS) and associated software sub-systems and processing pipelines. Notwithstanding numerous data management/processing challenges and inevitable software development/support needed for science extraction, this unique capability has been exploited for a range of science in the areas of pulsars, FRBs, cosmic-ray detections and passive radar applications. It has also presented excellent opportunities for student/ECR training in software, sub-system development and HPC, and these efforts have culminated in undertaking large projects such as the SMART survey, the datasets from which are now utilised to conduct the most sensitive southern-sky pulsar survey at low frequencies.

With the VCS no longer offered for routine science during the transition to Phase 3, the focus is shifting to science extraction from Petabytes of data collected for the SMART. I will present an overview of recent developments and science updates, and pitch a forward look when real-time processing and beamforming will be supported for MWAX VCS, which will offer a range of new science avenues with the MWA's potential to emerge as a major low-frequency monitoring facility for high-time resolution science in the southern hemisphere.

Chris Lee / A census of millisecond pulsars with the MWA

Millisecond pulsars (MSPs) are the most precise natural clocks in the known Universe and have proven to be powerful tools for advancing fundamental physics. Observations of MSPs at low radio frequencies (below 300 MHz) play an important role in characterising both their emission properties and the effects of the ionised interstellar medium on the received signals; both of which are critically important for high-precision pulsar timing.

To date, only a small fraction of the known MSP population has been detected below 300 MHz, and nearly all previous MSP studies at these frequencies have been conducted with northern telescopes. We present the results of a census of MSPs in the Southern-sky MWA Rapid Two-metre (SMART) survey, covering declinations south of +25 deg at a centre frequency of 154 MHz. We have detected 40 MSPs, with 11 being the first published detections at low frequencies. For each MSP, we generated coherently-dedispersed full-polarimetric pulse profiles and measured flux densities and dispersion measures (DMs). We also measured Faraday rotation measures (RMs) for 25 MSPs with precisions comparable or better than MeerKAT and Murriyang/Parkes.

Three MSPs exhibit apparent rotation-phase-dependent RM, two of which we show are likely due to interstellar scattering. The pulse profiles show minimal evolution in component spacing when compared with higher-frequency profiles, consistent with the emission originating from compact magnetospheres. The results of this census will be a valuable resource for planning future MSP monitoring projects at low frequencies, and will also help to improve survey simulations to forecast the detectable MSP population with the SKA-Low.

Chia Min Tan / The second pass of SMART pulsar survey

The Southern-Sky MWA Rapid Two-Metre (SMART) pulsar survey is an ongoing project to search the whole southern sky for pulsars and fast transients with the Murchison Widefield Array (MWA) telescope.

The observing campaign for SMART has been completed, with 71 80-minute observations taken with the Voltage Capture System (VCS) covering the whole southern sky below 30deg declination. The second pass processing of the SMART observations begun in 2024, where the full 80-minute observations are being processed compared to 10-minute in the first pass, with thousands of tied-array beams being beamformed and searched for each observation. As of May 2025, we have processed 8% of the observation data, which has yielded the discovery of 11 new pulsars, including a 24ms binary pulsar in a long orbit of 833 days.

In this talk, I will give an update on the progress of the second pass processing of SMART, including an updated pipeline that incorporates the Fast Folding Algorithm and the properties of the new pulsars discovered by SMART.

Quiyang Fu / Improving pulsar search efficiency for long dwell time survey with artificial intelligence

Our work proposes an optimized pulsar search pipeline that utilizes deep learning to sift "snapshot" candidates generated by folding de-dispersed time series data. This approach significantly accelerates the search process. We also developed a script to generate simulated pulsar signals, optimizing the training set and improving model performance.

The benchmark uses the globular cluster NGC 5904 data and simulated pulsar data. This approach shows that reducing candidate folding time by a factor of ~10 still maintains full detection capability for all identifiable pulsars. We tested the artificial intelligence (AI) model's pulsar classification on real data collected from the Five-hundred-meter Aperture Spherical radio Telescope (FAST), Green Bank Telescope (GBT), Murchison Widefield Array (MWA), Arecibo, and Parkes (Murriyang), demonstrating that the method can be generalized to different telescopes.

Due to the wide-field of view of radio telescope arrays, such as the SKA-Low, even with the long observation times for the pulsar survey, it is possible to complete the observational pulsar survey plan in a short amount of time compared to single-dish telescopes. As the observation time for a single point is extended, the resulting raw data size increases correspondingly. This directly increases the time required for folding the growing raw data. Note that our developed method effectively accelerates pulsar searches if folding dominates computational time.

Piyush Panchal / Speeding up the Pulsar Search Pipeline

The SMART Pulsar survey has generated petabytes of raw data, of which only a small fraction has undergone coarse processing for pulsar searches using PRESTO, a toolkit that supports basic thread- and node-level parallelism. To search a larger portion of the dataset and enable more refined searches within reasonable timeframes, software improvements are necessary. The bulk of computation in pulsar searches is dominated by de-dispersion and jerk search algorithms, which follow a hit-and-trial approach and are naturally parallelizable. In this work, we present our contributions to GPU-based implementations of these two algorithms and compare their performance with the standard PRESTO library.

Dilpreet Kaur / Unlocking the Potential of Pulsars for Space Weather Monitoring at Low Radio Frequencies

Pulsars, nature's most precise cosmic clocks, have proven to be invaluable tools for a wide range of applications, including space weather studies. Extending these studies to low radio frequencies presents exciting opportunities to deepen our understanding of space weather dynamics.

Low-frequency pulsar observations are especially sensitive to dispersive and scattering effects induced by the interstellar medium, solar wind, and coronal mass ejections (CMEs). These frequencies provide enhanced capabilities for detecting variations in electron density and plasma turbulence, making them particularly effective for monitoring the evolving conditions of the heliosphere. Utilizing low-frequency observatories such as the Murchison Widefield Array (MWA), pulsar observations offer a cost-effective and high-resolution approach to space weather monitoring. These observations complement existing high-frequency studies by providing unique insights into the early stages of CME evolution and the dynamics of the solar wind, contributing significantly to the development of improved predictive models.

In this talk, I will delve into the potential of low-frequency pulsar observations for space weather applications, emphasizing their advantages, discussing their integration into existing methodologies, and outlining steps to expand their role in heliophysics research.

MWA Project Meeting

Friday, 29 August

Solar, Heliospheric and Ionospheric Science (SHI)

Divya Oberoi / Overview of solar physics activities with the MWA

Over the past decade the MWA has established itself as the leading instrument for high fidelity and dynamic range spectroscopic high time resolution images at low radio frequencies. These unprecedented images have enabled a wide variety of solar science, especially for detailed studies of the brightest and faintest active emissions.

More recently the MWA solar group has been developing polarimetric imaging pipelines tailored for solar observations. Our first principles approach to polarimetric calibration, in conjunction with the high signal-to-noise solar observations are yielding solar radio images with unprecedented polarization purity. These images are in turn not only enabling more sophisticated analyses and better constrained model parameters for some of the anticipated applications, but also to unexpected discoveries, most notably of the presence of linear polarization during a variety of active solar emissions.

We are in the process of initiating a coordinated observing campaign with PROBA-3, a technology demonstration space mission which will offer high quality coronagraph images in the range from 1.1 to 3.0 solar radii. The lower part of this range has only rarely been observed due to instrumental limitations, but is exactly the region where solar radio emissions in the MWA range arise. This talk will present an overview of solar, and some aspects of heliospheric science being pursued with the MWA along with plans for the near future.

Deepan Patra / Enabling Real-Time Triggered Solar Observations for SKAO-low: A demonstration using MWA and YAMAGAWA (online presentation)

Spectroscopic snapshot solar imaging at radio wavelengths can yield detailed understanding of the emission processes responsible for solar radio bursts associated with massive eruptive events like flares and coronal mass ejections (CMEs). Cutting-edge radio interferometers, e.g. Murchison Widefield Array (MWA), are exceptionally well-suited for this purpose. However, spatially resolved observations of solar radio bursts from these instruments remain rather limited.

Despite the availability of exquisite imaging instruments, most studies of solar radio bursts are still based on non-imaging observations using solar dedicated instruments. This is because the observing time of these versatile cutting-edge radio interferometers tends to be oversubscribed. This, coupled with the fact that solar activity is inherently unpredictable, leads to few events of interest being captured in the limited solar observing time available. Enabling observations of a large number of solar radio bursts with these new-generation instruments requires a robust and reliable automated near-real time observing trigger. Using precious observing time only when some solar activity is known to have just taken place, can vastly increase the efficiency of limited available observing time to capture solar activity. With observatories like the Square Kilometre Array Observatory (SKAO) on the horizon, the need for such a system is even more imperative.

We present such a system for the SKAO-low precursor, the MWA, based on near-real time data from the YAMAGAWA spectrograph which observes the Sun daily from rise to set in the band from 70 MHz to 9 GHz and is located at similar longitude as the MWA. We have devised, implemented and tested algorithms for this automated triggering system using archival YAMAGAWA data. End-to-end tests of triggered observations have successfully been carried out at the MWA. This real time triggering has now been operationalized at the MWA, a very timely development in view of the ongoing solar maxima.

Angelica Waszewski / Tipping Solar Science on its Side

Modern low-frequency instruments, such as the Murchison Widefield Array (MWA), coupled with the technique of interplanetary scintillation (IPS), have made key advances in the field of solar and space science. IPS is a fantastic space weather tool as it is able to measure the solar wind density along any line of sight an arbitrary distance from the Sun, and with the MWA's huge field of view, allows us to probe the entire inner heliosphere. Coming out of a solar maximum, large scale efforts are being undertaken globally to improve forecasting of the solar wind and the events therein. The unique capabilities of MWA IPS have seen unrecorded solar events being caught that satellites aren't able to detect due to their restricted orbits.

In this talk, I will focus on the work that is being done to lay the groundwork in incorporating MWA IPS measurements into models and simulations. We also show how modern-day radio telescopes can be integrated into the goliaths that are solar observatories.

Puja Majee / A Detailed Polarimetric Study of a Type-II Solar Radio Burst with MWA – (online presentation)

Type-II solar radio bursts are plasma emissions generated by collision less shocks in the corona and interplanetary space, typically driven by energetic solar eruptions such as flares and coronal mass ejections (CMEs). Their close association with such large-scale eruptions makes them relevant for space weather studies as well. The geoeffectiveness of a CME largely depends on the properties of the magnetic field it carries and how it interacts with the ambient solar magnetic field. Therefore, probing the magnetic field entrained in CMEs is crucial.

The polarimetric properties of type-II bursts offer one of the few remote-sensing tools available for directly studying the strength and topology of magnetic fields at CME-driven shocks. However, reported polarization levels in the literature span a broad range, from negligible or weak polarization to strong circular polarization of several tens of percent. Most of these earlier studies are based on Sun-as-a-star observations, which provide spatially averaged measurements. Given the presence of multiple active regions and spatially varying polarized emission on the Sun, such integrated measurements are susceptible to beam depolarization, potentially leading to inaccurate results. To overcome these limitations, spatially resolved imaging is essential. The advent of new-generation instruments like the Murchison Widefield Array (MWA) has made it possible to obtain high-dynamic-range, high-fidelity full-polar solar radio images with good temporal, spectral, and angular resolution.

Leveraging these capabilities, we have conducted a detailed polarimetric imaging study of a type-II solar radio burst. Our analysis includes characterization of sources in both total intensity and polarized emission, along with an in-depth examination of their temporal and spectral evolution. This study represents an important step toward using polarimetric imaging to advance our understanding of type-II bursts and coronal propagation.

Devojyoti Kansabanik / Calibrating the Instrumental Polarization at Meter Wavelengths using Unpolarized Sky: A Demonstration using the MWA – (online presentation)

Accurate calibration of instrumental polarization is essential for extracting magnetic field information from polarized radio emissions in astrophysical, heliospheric, and geospace environments. At meter wavelengths, this task becomes complicated due to the lack of bright polarized calibrators, a consequence of strong Faraday depolarization.

We present a new calibration framework tailored for wide-field, low-frequency instruments such as the MWA, LOFAR, NenuFAR, OVRO-LWA, and SKAO-Low. This approach utilizes the apparent polarization of the intrinsically unpolarized sky, induced by the instrument's polarized primary beam response, as a calibration reference. Crucially, it eliminates the need for bright polarized sources and remains unaffected by ionospheric Faraday rotation. Validation with MWA data demonstrates the reliability and precision of this method. By overcoming longstanding challenges in low-frequency polarization calibration, this formalism enables robust polarimetric studies with the MWA and similar instruments, expanding our ability to probe cosmic magnetic fields.

Soham Dey / First robust detection of linear polarization from metric solar radio bursts (online presentation)

For nearly five decades, it has been widely assumed that linear polarization from the Sun at low radio frequencies would be entirely depolarized by strong Faraday rotation in the solar corona. As a result, most solar radio studies at these wavelengths either ignored linear polarization measurements or treated them as zero during calibration.

Here, we will present the first robust evidence of intrinsic linear polarization in solar emissions at meter wavelengths, based on simultaneous observations with two widely separated and fundamentally different instruments: the Murchison Widefield Array (MWA) and the upgraded Giant Metrewave Radio Telescope (uGMRT). Both datasets independently show consistent linear polarization fractions. The rapid temporal and spectral variability of the observed polarization further rules out instrumental effects.

We will also explore and discuss the possible physical mechanisms that could give rise to such polarized emission. Assuming absence of linear polarization in solar radio emissions can result in incorrect interpretation of solar observations and as well as those of other flare stars, which are often guided by learnings from solar studies. This discovery highlights the need for relaxing this assumption, and is essential for precise estimation of polarization signatures, ultimately leading to a better understanding of the plasma conditions in the Sun and other stars.

Discussion

Steven Tingay / Open discussion: The MWA on a 5-year timescale – leading into SKA-Low

Other sessions

Tasso Tzioumis / Spectrum issues in radio astronomy

George Heald / How MWA is helping to get SKA-Low up and running

Construction of SKA-Low is well underway, with four full stations already operational in the current Array Assembly (AA0.5), and at least another twelve stations expected to be integrated into the array by the end of this year. SKA-Low AA0.5 is already being used to progress a comprehensive suite of Science Commissioning activities. Through our first tests of SKA-Low's interferometric and tied-array capability, we have been able to generate first images of calibrator fields and detect several tens of known pulsars.

This presentation will share an overview and update of SKA-Low Science Commissioning activities, and throughout the talk I will focus in particular on the key role that MWA experience and outputs are playing in enabling that progress. From the gold-standard sky models derived from the GLEAM family of surveys to the catalogue of low-frequency pulsars developed by the SMART survey, I'll share one viewpoint into the ways that MWA is enabling SKA-Low to jumpstart progress in unlocking the full potential of the telescope. I'll conclude with a look ahead to where the commissioning process will take us in the years to come and as MWA enters its Phase 3 era.