Upgrading the GMRT : Plans and Current Status

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Abstract :

We present the plans and current status of our efforts to upgrade the GMRT to a more sensitive and versatile radio telescope. The main thrust areas are : (i) improved frequency range with near seamless coverage from 50 MHz to 1500 MHz, with a maximum instantaneous bandwidth of 400 MHz; (ii) a modern servo system that includes the feed positioning system as an integral part; (iii) a more powerful and sophisticated control and monitor system. These upgrades are expected to keep the GMRT on the forefront as a low frequency radio telescope, for the next decade or so.

1 Summary

The Giant Metrewave Radio Telescope (GMRT), set up near Khodad, approximately 80 Km north of Pune in India has, since its dedication in 2001, established itself as a frontline observing facility for low frequency radio astronomy. It is envisaged to upgrade its capabilities to a more powerful and versatile radio telescope. In this paper, we describe the plans and current status of this upgrade.

At present, the GMRT operates in five radio frequency bands: 130-230 MHz, 215-255 MHz, 305-345 MHz, 580-640 MHz and 1000-1450 MHz, with a maximum instantaneous bandwidth of 32 MHz. The prime target of the upgrade is to improve this frequency range and provide almost seamless coverage from about 50 MHz to 1500 MHz, except for a few spots – like the mobile phone band – where the radio frequency interference is very strong. This requires an overhaul of almost the entire receiver chain : new, broadband feeds, new generation wide-bandwidth and high dynamic range LNAs, modification of the signal transport over the optical fibre to a wideband transmission scheme, new generation back-ends that can process 400 MHz bandwidth for each of 2 polarizations, from 30 antennas. These improvements will greatly increase the frequency agility and sensitivity of the GMRT.

The servo system of the GMRT will be replaced with a modern version. This will include an upgrade to brushless motor drives for the antennas, a precision feed positioning system with position and speed control, a state-of-the-art single board architecture computer for servo control, along with improved servo software. These measures will result in replacement of slowly degrading parts (like motors), guard against obsolesence and increase the reliability of the servo system as a whole.

There are several aspects of the control and monitor system of the GMRT that will also be improved. The microprocessor hardware and software being used at the antennas are more than 15 years old and will be replaced by more powerful and modern versions, with improved interface to the new receiver chain and servo systems. The main control software running in the control room will also be replaced by a new, improved version. The link from the control room to the antennas will be upgraded to a high speed link.

The above upgrades will require to be accompanied by significant improvements in other areas like offline computing facilities, data analysis algorithms and packages, RFI mitigation techniques, antenna mechanical structures, quality of electrical supply, user friendly operations etc.

Work has already been initiated in several of the upgrade activities mentioned above. A few different initiatives for broad-band low frequency feeds are presently underway, as are attempts to design lower noise wideband LNAs for the front-end electronics. A prototype of the scheme for wideband transmission on the optical fibres is being tested. Possibilities for next generation back-ends using different technologies are being explored : FPGA based systems, as well as software back-ends are being considered. For the servo system, designs utilising the PC104 architecture with RT-Linux are under way, as are efforts to procure the prototypes of the brushless motors for initial tests. For the control and monitor system, work is on to replace the existing GMRT Online software with an improved version; new hardware options for the control and

monitor units are being explored, and attempts to identify a new unit for the antenna base computer have also been initiated.

An important feature of the upgrade activities is to engange with partners in industry and experts in relevant fields, to bring to bear the best technologies and methods for improving the GMRT. As a result, different collaborative efforts are being encouraged. A major challenge for the GMRT upgrade is to bring up the new systems with minimal disruption of the operations of the GMRT for regular observations.