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Title : Coordinate Systems for GMRT Antennas

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ABSTRACT

The azimuth-elevation coordinate system used by astronomers and its relation to the actual coordinates used to describe the antenna position is discussed.

Coordinate Systems for GMRT Antennas

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keywords - control and monitor, servo, coordinate system

The GMRT antennas are Alt-Az mounted dishes that point to different directions and track sources under computer control. The elevation, azimuth coordinate system is the most convenient and practical system for specifying the position of a source. However, since, to minmise 360° swings in azimuth, the cable wrap of the antenna is designed so that the antenna can rotate through 540° in azimuth and also, in elevation, from 15° through 90° (zenith) to 75° on the other side, the antenna can point to some directions in the sky in more than one way. Thus, the astronomical elevation and azimuth of a source do not uniquely specify the state of the antenna (though the reverse is true), and we need a more elaborate coordinate system to describe the state of the antenna as far as pointing is concerned. The aim of this note is to explain the antenna coordinate system that is being used the the C3 antenna, describe its relation to the astronomical coordinate system and describe how the present software handles the two.

The astrononmical elevation starts at 0°, which is pointing to the horizon, and increases to the maximum value of 90°, which is the local zenith. The astronomical azimuth starts at 0° which is north, and increases towards the east as shown in Fig. 1.

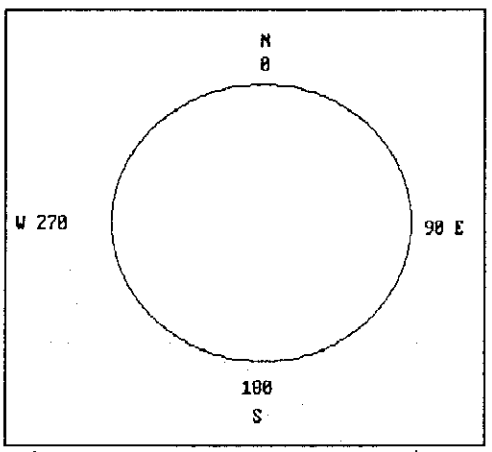

Figure 1 Astronomical Azimuth System

The antenna elevation is identical to the astronomical elevation in the range 0 to 90°. But to take into account the fact that the elevation gear system allows the antenna to go beyond 90° and tip some 15° in the other direction, the antenna elevation extends beyond 90°, upto 105°. Antenna coordinates 90+theta and 90-theta both refer to the same astronomical elevation of 90-theta degrees.

While the astronomical azimuth ranges from 0° to 360°, the antenna azimuth goes from -270° to +270°, with the zero of the antenna azimuth towards the south (Fig 1.). The antenna azimuth is 180° offset with respect to the astronomical azimuth. The antenna azimuth is single valued in the south, but is double valued in the north. For the antenna azimuth, one can talk of an inner track where the antenna azimuth goes from -270° to +90° and an outer track where the it goes from -90° to +270°. Both the inner and outer tracks are complete in the sense that either can

be mapped to the astronomical azimuth system and so be used for pointing at a source. However, it is often advantageous to go from the inner track to the outer and vice versa when observing sources both to the north and south of the local zenith since this can reduce the azimuth slew times. To use the hardware features optimally, one should have an overview of the hardware and software layers involved in positioning of the antennas.

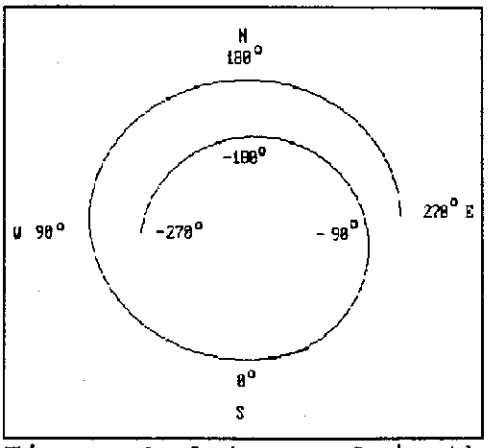

Figure 2 Antenna Azimuth System

The movement of the antenna is controlled by the Servo Control Computer (SCC) which understands only the antenna coordinate system. The user interacts with the Control and Monitor system through the task "USERINPUT" which runs on a Sun workstation. The task USERINPUT recognises both astronomical and antenna coordinate systems and has features that enable one to get tha antenna to whatever direction required.

The procedures in USERINPUT, MVAZ(ang), MVEL(ang), MV(az,el), TRKAZ(time,ang), TRKEL(time,ang) and TRK(time,az,el) can be used if one wants to work in astronomical coordinate systems. The MV (move) commands move the antenna to the specified azimuth or/and elevation, while the TRK (track) commands move the antenna so as to reach the specified position at the specified time. The default conversion from astronomical to antenna coordinates is such that the antenna elevation is in the range 0 to 90° while the antenna azimuth is on the inner track. The procedure GOOUTER (cancelled by GOINNER) changes the default mapping from the inner to the outer track while the procedure GOOVER (cancelled by GOUNDER) does the same thing for elevation.

The procedures AMVAZ, AMVEL, AMV, ATRKAZ, ATRKEL and ATRK perform similar functions as above but work directly in the antenna coordinate system.

In the first version of the software, there is no automatic azimuth move optimisation facility. The user has to explicitly control the passage from the inner to the outer tracks and vice versa (as also the tipping of the antenna over the top).