



Development of Software for Sensitivity Calculation (G/Tsys) of Single Dish Radio Telescope

Sougata Chatterjee, Anil N Raut, S Suresh Kumar
Front End Group
GMRT-NCRA-TIFR

Email:- sougata@gmrt.ncra.tifr.res.in, anil@gmrt.ncra.tifr.res.in, skumar@gmrt.ncra.tifr.res.in

The GMRT is an aperture synthesis array of 30 fully steerable, 45 metre diameter parabolic dish antennae spread over 30 km region near Pune in western India. It is designed to operate at a range of frequencies from 50 MHz to 1450 MHz, in five distinct frequency bands. A major upgrade of the observatory is nearing completion that will increase its sensitivity significantly and make it a more powerful and versatile facility. The upgrade was planned to provide seamless frequency coverage from 50 to 1500 MHz, with a maximum instantaneous bandwidth of 400 MHz as against the 32 MHz final instantaneous bandwidth of the existing GMRT bands centred at 150 MHz, 233 MHz, 327 MHz, 610 MHz and L-band extending from 1000 to 1450 MHz. The seamless frequency coverage was achieved by designing the wide band feeds and front-end electronics for 120-250 MHz, 250-500 MHz, 550-850 MHz and 1050-1450 MHz band of the upgraded GMRT. As a part of this upgrade, the existing front-end receiver electronics was modified by introducing wideband low noise amplifiers, octave-band polarizers with low insertion loss, and low loss wideband directional couplers for noise injection.

G/Tsys defines the sensitivity of a radio telescope and is an important figure of merit. It is important to know the overall antenna efficiency and system noise temperature of the telescope in order to calculate the G/Tsys. In order to calculate the G/Tsys for uGMRT bands a Software was developed in-house at GMRT-NCRA, named as NGTRA (NCRA Gain by System Noise Temperature for Reflector Antenna).

This paper presents the G/Tsys calculation of any single dish radio telescope (Prime Focus feed/ Cassegrain Feed) using it is a software and can be used for any other reflector antenna. **NGTRA** software has two modules viz Analysis and Synthesis. In Analysis, some basic inputs like primary Dish dimensions (F/D, Dish diameters, angle of quadripod, feed house area etc), Radiation pattern of the feed, LNA noise temperature and receiver losses are required to compute antenna overall efficiency, system noise temperature and finally G/Tsys and secondary Radiation pattern of single dish. In Synthesis, with given G/Tsys, the program computes the primary radiation pattern as well as the receiver temperature of single dish system. The software was validated by calculating the G/Tsys for the upgraded GMRT (uGMRT) bands. The program was also used to calculate the G/Tsys of other radio telescope in order to cross verify the results and the results were found to match closely. This software can run any machine with any platform.

1. Fisher, J.R., "Prime-focus Efficiency, Blockage, Spillover and Scattering Calculations on the HP 9825A Calculator", *EDIN Report.174, NRAO*, Nov.1976.
2. Shafai, L. and Kishk, A.A., "Coaxial Waveguides as Primary Feeds for Reflector Antennas and comparison with Circular Waveguides", *AEÜ*, Band:39, Heft 1, (1985) pp.8-14.
3. Kildal, P-S., "Factorization of the Feed Efficiency of Paraboloids and Cassegrain Antennas", *IEEE Trans. on Ant.&Propg.*, Vol.AP-33, No.8, (1985).