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RRI Efficient Linear-array Imager: salient aspects

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Recently, a new optics entitled Efficient Linear-array Imager [1] has been proposed to use radio receivers efficiently for imaging the skies. The new optics demonstrates that it is possible to trade instantaneous sensitivity to instantaneous field-of-view while conserving the $A\Omega$ product. For a dish of size D fitted with N receivers, this product is $\sim D^2\,N$. This can be rewritten as $2\,(D \times \frac{D}{N/2}) \times (N/2)^2$. The first part, $2\,(D \times \frac{D}{N/2})$, implies two orthogonal areas of elliptical cross section with an $N/2$ aspect ratio. The second part, $(N/2)^2$, indicates the number of simultaneous beams formed with N receivers. Thus, the resultant configuration is two telescopes of elliptical cross sections laid in a cross-configuration, each fitted with $N/2$ receivers. Then, by cross correlating each set of receivers with the orthogonal set of receivers, one obtains the $(N/2)^2$ beams.

This approach has several benefits: (a) reduces the primary area; (b) the primaries become parabolic cylinders that are easy and economical to manufacture; (c) the increased instantaneous field-of-view makes the system suitable for studies of transients; (d) the cross correlation based imaging system immunizes against receiver gain variations; (e) the telescope responds to very short-spacing sky signals. It has promises for the low-cost element needed for SKA, especially at high frequencies. To demonstrate these benefits a prototype cm-wavelength transit survey telescope is being built at the field station of the Raman Research Institute at Gauribidanur, India.

As a first step, a new stiff and light-weight backup structure has been designed. By keeping the center of mass of the moving system close to the elevation shaft axis, the need for counter-weights has been mitigated. A skip mechanism allows the dish to be rotated nearly 180^o to support transit survey. To tune and smoothen the manufacturing process, a 1:3 scale model has been built (Fig. 1a). Now, the full-scale prototype construction has begun. The joint parts are made of laser-cut and CNC-folded stainless steel boxes with welded-shoes to support off-plane members. We have evolved a procedure to make light-weight sturdy cylindrical panels for the primary (Fig. 1b). Currently, the surface accuracy is being measured and the panel making procedure is being fine tuned to obtain panels with surface deviations less than 1 mm rms. A new elevation drive train is being built. Two cm-wave receivers operating in the 7-11 GHz range are also being built along with a continuum back-end to serve as the first light receivers to demonstrate the concept. In this paper, we will present the overall telescope system including interesting construction aspects, the motion-system, first-light receivers and performance measurements.

Figure 1. (a) Left picture is the 1/3 scaled-model of the RRI Efficient Linear-array Imager, being constructed at the Gauribidanur field-station. (b) Right picture shows the first prototype light-weight cylindrical panel made.

References

[1] R. Balasubramanyam, “An Efficient Linear-array Imager for Radio Astronomy”, *MNRAS*, **444**, November 2014, pp. 2212-2217, 10.1093/mnras/stu1470.