Radio Astronomy Advanced Instrumentation Research and SETI

Y. Zhang, Michael Garrett

Radio Astronomy Advanced Instrumentation Research (RAAIR) Lab was established between the School of Physics and Astronomy, The University of Manchester and the 38th Institute of China Electronics Technology Group Cooperation (CETC38). This is based on the shared experience on technology development for the Square Kilometre Array (SKA) and the joint research laboratory – RAAIR raise the collaboration to a new level. The RAAIR aims to deliver advanced technologies for radio astronomy.

In the SKA era now, complementary to the conventional dish radio telescopes, aperture arrays provide a revolutionary approach to achieve an exceptionally large Field of View (FoV), at the same time sampling the sky with high angular resolution. The broadband aperture array with multibeam techniques significantly increases the effective FoV (approximately two orders of magnitude than other existing telescopes) and this allows observing a large fractions of the sky in a short period of time with a very wide bandwidth. These unparalleled properties of aperture array are critically beneficiary also extremely important for transient sciences and SETI.

Traditionally, the cost of such aperture arrays at microwave frequencies has limited their application. Recent large scale integrated circuit development now allows cheap duplication of low noise receivers attached to many individual receptors. However, it remains a large engineering and science challenge to implement it in a square kilometre scale. Particularly digitization at the element level will be the key to realise its full wide FoV potential to make more sophisticated radio astronomy observations.

Less challenging in term of scale, integration of Phase Array Feed (PAF) on existing reflector antennas opens the possibility of a multi-beam receiver that can adapt to the geometric optics of any radio telescope by synthesizing multiple, simultaneous beams on the sky for complete coverage of the available FoV, without loss of sensitivity in each beam. As a result, the survey speed figure of merit (SVS) is expected to increase by more than an order of magnitude. However, comprehensive beamforming, RFI cancelling algorithms and cryogenic array technology have to be developed for robust and stable observations by reflector antennas embedded with PAFs.

RAAIR aims to be an international research centre focusing on research and development on technologies related to radio astronomy. Projects involving in PhD students and International research exchange pursuing frontier researches will be encouraged. Instrumental development in the following aspects will be the main scope: (1) Increase the range of observations; (2) Increase frequency bandwidth and sensitivity; (3) Increase angular resolution; (4) Develop new intelligent data processing method.