URSI AT-AP-RASC, Gran Canaria, Spain, May 29- June 3, 2022

From Arecibo to FAST Array - the Voyage of Perseverance

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Arecibo was a technical and scientific wonder of the 20th century. Originally proposed as an atmospheric radar experiment, Arecibo got funded by the then-newly-established Advanced Research Projects Agency (ARPA). An insightful and informative recount of Arecibo's history can be found in Prof. Campbell's (the former director of the observatory) presentation for its 50th anniversary celebration, held on the telescope site in 2013.

Inspired by the accomplishment and vision of Arecibo, the Five-hundred-meter Aperture Spherical radio Telescope (FAST) was originally proposed as a unit concept for the square kilometer array (SKA). An array of ~20 Arecibo-like giant antennae, with modern electronics and innovative servomechanism, would have realized the most cost-effective square-kilometer-scale collective area. The FAST concept was among the final four SKA concepts. Toward the end of 2007, FAST was approved by the National Reform and Development Council (NRDC) as a standalone project, which was finally finished on Sep. 25, 2016. The ensuing commissioning had been full of venture and excitement, probably too much so. After a final successful project review, normal operation started in early 2020. Since then, more than 100 peer-reviewed papers, including four on the Nature magazine and one on Nature Astronomy, have been published based on FAST data. The productivity evinces the unprecedented and unparalleled sensitivity of FAST, a gain 16 K/Jy in L-band.

From 2015, we developed a novel observing mode to enable an unprecedented large-scale commensal survey, which has not been realized in other major single-dish facilities. The core innovation is a high-cadence electronic CAL signal injected at the highest sampling rate, e.g., every 49.3 μs, thus allowing necessary calibration for spectral-line observations as well as preserving sufficiently clean power spectrum for pulsar search. The resulting Commensal Radio Astronomy FasT Survey (CRAFTS [1]) simultaneously records four data streams, namely, pulsar, Galactic HI, extra-galactic HI, and transient-triggered events, the first such survey of its kind. CRAFTS has so far discovered more than 150 pulsars, 44 of which are milli-second pulsars, including one double-neutron-star system (DNS), and 6 new high DM (>1000 pc cm^{-3}) fast radio bursts (FRBs), including one new repeater.

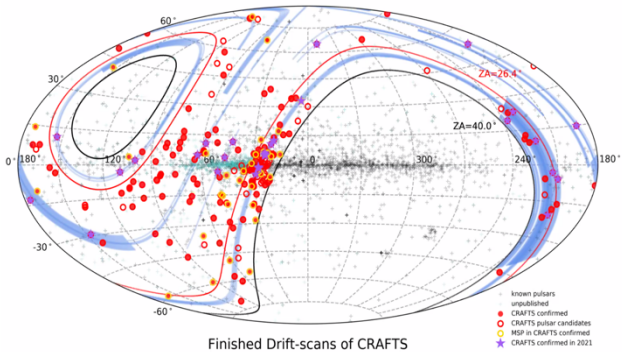

Fig. 1 New pulsars (>150) from the CRAFTS.

Other dedicated programs have also been fruitful. The FAST-Fermi/LAT collaboration has discovered 5 new MSPs, including one compact binary and the most radio-faint pulsar[2]. The search for extra-terrestrial-intelligence (SETI) programs[3] have been producing candidate signals. The first successful HI narrow self-absorption (HINSA) Zeeman detection was featured on the cover of Nature. Just to name a few.

We are reviving the FAST array (FASTA) concept. With five more FAST-like antennae, FASTA aims for a 0.5μJy/beam sensitivity (1 σ in 1 h). The aspiration and legacy of Arecibo and FAST will continue.

References

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