The Fly's Eye: Instrumentation for the Detection of Millisecond Radio Pulses

***Andrew Siemion*[1,2], *Peter McMahon*[1,4,5], *Geoff Bower*[2], *Griffin Foster*[1,2], *Joeri van Leeuwen*[1,2], *Mark Wagner*[1,3], *Dan Werthimer*[1,3]**

[1]Center for Astronomy Signal Processing and Electronics Research, University of California, Berkeley, 2108 Allston Way, Suite 200, Berkeley, CA 94704, United States of America. siemion@berkeley.edu, peter@dotnet.za.net, joeri@astro.berkeley.edu, m_wagner@berkeley.edu, danw@ssl.berkeley.edu

[2]Department of Astronomy, University of California, Berkeley, 601 Campbell Hall, Berkeley, CA 94720, United States of America. gbower@astro.berkeley.edu

[3]Space Sciences Laboratory, University of California, Berkeley, 7 Gauss Way, Berkeley, CA 94720, United States of America.

[4]Department of Electrical Engineering, University of Cape Town, University Private Bag, Rondebosch 7701, South Africa.

[5]Karoo Array Telescope, Lonsdale Building, Lonsdale Road, Pinelands 7405, South Africa.

Abstract

The discovery by Lorimer et al. of a powerful and highly dispersed radio pulse in Parkes survey data has demonstrated how little we currently know about the transient radio sky. We will present the design, construction, deployment and testing of the Fly's Eye, an FPGA-based fast readout spectrometer designed to detect and elucidate powerful dispersed radio transients using the Allen Telescope Array. The Fly's Eye processes 44 independent signal paths, each with a bandwidth of 209 MHz, and produces 128-channel (8 bit/channel) spectra, accumulated for 0.6ms, to give a total data rate of 32 GB/hour.

1. Summary

The recent discovery by Lorimer et al. of a powerful (~30 Jy) and highly dispersed (DM ~ 375 pc cm^{-3}) radio pulse in Parkes multi-beam survey data has dramatically demonstrated how little we currently know about the transient radio sky. The large dispersion measure of the Lorimer pulse, and the apparent absence of any interstellar matter or Small Magellanic Cloud contribution that could have generated this dispersion, led Lorimer to conclude that the pulse may have originated well outside our galaxy (500Mpc). As analyzed by Kulkarni et al., other potential electron-rich sources, such as a suitably arranged ionized nebula, cannot account for the large dispersion measure seen in the pulse.

The strongest known sources of radio bursts, rotating radio transients and pulsar giant pulses, are incapable of producing a pulse of a comparable power to the Lorimer Pulse at such a great distance. Thus if we accept that the Lorimer Pulse is indeed extra-galactic, it hints at the existence of a previously unobserved, highly energetic, transient radio phenomena that could provide an invaluable means of probing the intergalactic medium.

We will present the design, construction, deployment and testing of the "Fly's Eye," an FPGA-based fast readout spectrometer designed to detect and elucidate powerful dispersed radio transients using the Allen Telescope Array (ATA). The Fly's Eye instrument processes 44 independent signal paths, each with a bandwidth of 209 MHz, and produces 128-channel (8 bit/channel) spectra, accumulated for 0.6ms, to give a total data rate of 32 GB/hour. A hexagonal close-packed antenna-pointing configuration yields a maximum total field-of-view of approximately 198 square degrees.

The Fly's Eye has been successfully installed at the ATA, and to-date approximately 24 hours of observations has been performed. We have detected three pulsars (B0329+54, B0355+54, B0950+08) and six giant pulses from the Crab pulsar in our diagnostic pointing data, and analysis of our initial close-packed hexagon pointings is currently underway.

2. Acknowledgements

PM, JvL, and DW are partially supported by National Science Foundation Grant No. 0619596. We would like to acknowledge the students, faculty and sponsors of the Berkeley Wireless Research Center, and the National Science Foundation Infrastructure Grant No. 0403427. PM gratefully acknowledges the financial support of the MeerKAT project, and South Africa's National Research Foundation. AS gratefully acknowledges the financial support of the Josephine De Kármán Fellowship Trust.

3. References

Lorimer, D. R., Bailes, M., McLaughlin, M. A., Narkevic, D. J., and Crawford, F. 2007, *ArXiv e-prints*, 709

S. R. Kulkarni, E. O. Ofek, J. D. Neill, M. Juric & Z. Zheng, ”Giant Sparks at Cosmological Distances?” *pre-print*, http://www.astro.caltech.edu/ srk/sparker.pdf