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Sensitivity of the Australia SKA Pathfinder Fast Transient Pipeline

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Fast radio bursts are a type of dispersed millisecond duration radio pulses of extragalactic origin. Detecting fast radio bursts (FRBs) requires software pipelines to search for dispersed single pulses of emission in radio telescope data. In order to enable an unbiased estimation of the underlying FRB population, it is important to understand the efficiency of these pipelines and thus the survey completeness.

The Fast Real-time Engine for Dedispersing Amplitudes (FREDDA) [1] search pipeline is a single pulse detection pipeline designed to identify radio pulses over a large range of dispersion measures (DM) with low latency for the Australian Square Kilometre Array Pathfinder (ASKAP). We utilise large-scale simulated single pulses in the low- and high-frequency observation bands of the Commensal Real-time ASKAP Fast Transients (CRAFT) [2] project to analyse the performance of the pipeline and infer the underlying FRB population.

In this talk, we present detailed analysis of the performance of FREDDA, using the realistically simulated dataset of dispersed single pulses. The pipeline's search completeness and reported S/N is tested over variations of DM, pulse width and random propagation effects. The effects on SNR by scattering and intra-channel broadening are also carefully studied using scientific control datasets. Our results show that for Gaussian-like single pulses, a floor > 85 % of the injected SNR is collected using standard matchfilters by FREDDA at DM < 3000 pc cm^{-3} with a 100% detection rate under ideal environments.

Additionally, we identify several sources of random errors and systematic fluctuations in the SNR response curves. We then discuss the effectiveness of S/N algorithms and match filters which may be of importance to future fast transient pipelines. The search sensitivity of FREDDA obtained from these simulation tests is then combined with the real on-sky detection rate of FRBs with ASKAP to calibrate the search completeness of the CRAFT survey.

1. Bannister, K., Zackay, B., Qiu, H., James, C., and Shannon, R., "FREDDA: A fast, real-time engine for de-dispersing amplitudes", Astrophysics Source Code Library, 2019. ascl:1906.003.

2. Macquart, J.-P., "The Commensal Real-Time ASKAP Fast-Transients (CRAFT) Survey", Publications of the Astronomical Society of Australia, vol. 27, no. 3, pp. 272–282, 2010. doi:10.1071/AS09082