

#### Use Case 4: Transient Detection in Radio Astronomy Search Data

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**Motivation:** In astronomy, there has been significant evolving interest in variable astrophysical objects; in particular, the Astro 2010 Decadal Survey: New Worlds, New Horizons in Astronomy and Astrophysics (The National Academies Press, 2010) emphasizes the importance of both time domain and cyber-discovery to astronomy research over the next decade and beyond. The next generation of telescopes – including the Large Synoptic Survey Telescope (LSST) and the Square Kilometer Array (SKA) – will have major investments in the study of transient phenomena, with consequently important cyberinfrastructure demands. Required in the investigation of the time domain is data of sufficiently high time resolution to capture transient events and other datasets to search for similar classes of object for confirmation and to enhance the calculation of occurrence rates. Examples included the recent discovery of Fast Radio Bursts (FRBs) in data taken at the Parkes Observatory [1,2], which received subsequent confirmation in pulsar search data of the PALFA project at the Arecibo Observatory [3], and the discovery of Rapidly Rotating Radio Transients (RRATS) in historical pulsar search data [4].

**Activity:** The PALFA project [5] searches for radio pulsars using the Arecibo Observatory, the world's largest telescope. Pulsars are rapidly spinning neutron stars, the massive and exotic remnants left behind after massive stars die in supernova explosions; the data set, consisting of samples taken at 64 microsecond intervals taken across about 1000 0.4 MHz channels, comprises a valuable and durable record of the Arecibo radio sky around a frequency of 1400 MHz. The proposed research is the provision of a data set and pipeline that can be searched, by members of PALFA and the astronomical community, for transient phenomena according to whatever templates they chose. The raw dataset is currently 240TB, accumulated from 210,000 on-sky "beams"; a reduction by a factor of 2 in frequency resolution and 4 in time resolution is sufficient for discovering or confirming novel transient events with existing pipelines and will allow the dataset to be reduced to 30TB, with a corresponding eightfold reduction in processing time. Additional data will accumulate at 3-5TB per year. We will provide a pipeline to search the data, which takes as input templates for the events to be searched in the time-frequency plane, as an extension of the existing "single-pulse" search pipeline of Spitler and Cordes [6]; processing a typical single 268s beam of the PALFA dataset will take 1-2 core-hours. Processing can be parallelized, so it is suitable for use on cloud nodes; pipeline RAM and storage media access demands are met by the proposed resources.

This project is well suited to the proposed resource as there is currently no simple mechanism to support the provision of the dataset for on-demand processing by astronomers or the public, and because the processing of a given beam is typically executed on a single CPU, requiring no high-performance node interconnections. A complete re-processing of the entire data set would require approximately 500,000 core-hours, depending on search parameters, and processing a representative sample or a subset parametrized by observation date or sky position would consume

proportionally less core-hours. Searches done during the course of this proposal would be subject to a proprietary period after which the results would be made public, as described in the Data Management Plan. This release policy will allow researchers sufficient time to use the results in their research endeavors; results will then be released to enhance community research efforts and avoid duplication of effort. Lastly, this project is extensible to operation on data from other current telescopes, such as the Green Bank Telescope, the Jansky Very Large Array, the Parkes Observatory and others, in addition to the next generation of radio telescopes such as Meerkat and the Square Kilometer Array, providing a prototype for community involvement in exploration of the key frontier of transient-phenomenon astronomy, both broadening the scope of the search for new objects and reducing the time to discovery.

## References

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