Ideas and Guidelines for Rapid-Response Observations with the EVLA

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The purpose of this short document is to delineate a set of ideas and guidelines that are designed to place the EVLA at the forefront of time-domain astronomy. These guidelines are based on over a decade of experience with rapid response science at the VLA by the authors, and focus on three critical issues:

1. Automated generation of observe files.
2. Rapid triggering of requested observations with minimal human intervention, using a robust queue system.
3. Rapid access to the resulting data products.

Over the past several years NRAO has made great progress on each of these points. However, we anticipate that with the increased demand on both the observatory staff and the users when EVLA turns on, it will be advantageous to automate and streamline some aspects of the rapid-response process. With the recent introduction of the OPT and planned developments for a new dynamic queue as well as a data-calibration pipeline, we believe now is the time to outline the needs for time-domain science.

1. Automated Generation of Observe Files

Some rapid-response projects can benefit greatly from reaction to triggers on a timescale of minutes. These include, for example, follow-up observations of flaring objects, searches for coherent emission from gamma-ray bursts and supernovae, and searches for counterparts to gravitational wave sources. However, the increased complexity of the Observation Preparation Tool (OPT) and the multiple observing modes of the EVLA, may lead to delays in rapid triggering of pre-approved target-of-opportunity programs. At the same time, the XML formating of the OPT output files is highly conducive to automation.

Since most rapid-response observations are likely to require simple continuum capabilities, we recommend that NRAO create standard XML templates for each frequency range that can then be fed with target coordinates either manually or through an automated system such as VOEvents. The template should also be capable of automatically choosing an appropriate phase calibrator. Once a file is generated, it should be submitted automatically into the EVLA queue, bypassing manual entry through the OPT.

2. An Automated Queue

The current VLA queue system has already enabled some key discoveries to be made in time-domain science including dwarf novae, short gamma-ray bursts, type Ib/c supernove and others. However, there are some deficiencies that could be fixed. For example, observe

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files for rapid-response observations are submitted to `dynsoc nrao.edu` and are then placed **manually** into the queue. In addition, the current queue does not automatically distinguish between a rapid-reponse file and a normal file once they are in the queue. As a result, the queue scheduling software may choose to execute a normal file before a rapid-response file based on secondary considerations such as weather, elevation, etc. Both of these issues serve as key choke points.

To overcome these problems we recommend a fully automated queue submission mode for certain rapid response projects that involve no human intervention. This approach merges naturally with the automated generation of observe files.

While we do not presume to tell NRAO how to design such a system, one approach that would facilitate a smooth merging of rapid-response files with the active queue is the adoption of a figure-of-merit parameter as a determining factor. This parameter can be defined as follows:

$$\mathrm{FOM} = \mathrm{FOM}_{\mathrm{prop}} \times \mathrm{FOM}_{\mathrm{trigger}} \times \mathrm{FOM}_{\mathrm{user}} \times \mathrm{FOM}_{\mathrm{conditions}}, \quad (1)$$

where $\mathrm{FOM}_{\mathrm{prop}}$ is the intrinsic grade assigned to each proposal by the NRAO Time Allocation Committee, $\mathrm{FOM}_{\mathrm{trigger}}$ is the trigger grade, $\mathrm{FOM}_{\mathrm{user}}$ is a user-supplied value that can downgrade the importance of the specific observation based on the user's individual criteria, and $\mathrm{FOM}_{\mathrm{conditions}}$ designate the effect of the current observing conditions. Since each FOM value is ≤ 1, the maximum value of $\mathrm{FOM}_{\mathrm{prop}}$ issued by the TAC will also designate the override status of the observation. This status should include "execute as soon as queued", "execute as soon as current observation is finished", and "execute within N hours or discard". In addition, $\mathrm{FOM}_{\mathrm{prop}}$ can be used to designate "non-interruptible" files in the queue.

This system will also allow the user to submit multiple files for various contingencies (e.g., X+C, C+K, L+C), with the understanding that once one of the files is executed based on its combined value of FOM, the other files will be removed from the queue.

To help assess the probability of execution, users should also be able view the current and projected status of the queue over a period of several hours. Within the current system, this may require direct contact with the telescope operator.

3. **Rapid Access to Processed Data Products**

The final aspect of enabling rapid-response science with EVLA is rapid access to processed data products. As mentioned in §1 most rapid-response observations require only continuum information, and this can considerably simplify the reduction process. We recommend that NRAO develop a quick-look data reduction pipeline in CASA capable of making continuum images in near real-time.

Finally, we wish to emphasize that all of us are willing to do what is needed to help make these improvements for rapid-response observations. This could include helping with software specifications, testing prototypes, and the like.