

Report from the Short Term Mission – STM

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Report:

1. TOPIC

- *Please describe briefly the topic of the performed visit addressing its relevance to the RadioNet goals.*
- The STM allowed Javier to learn software-correlator operations using DiFX, one of the most popular software correlators among the European radioastronomy community. The traineeship covered the basics from DiFX, from the core architecture and fundamental modules to the auxiliary tools provided with the package to administrate experiment databases. It was also an opportunity to visit one of the biggest correlators currently running in Europe that supports both astronomical and geodetic communities.
- The technical items covered during this mission were the following:
 - DiFX installation.
 - Pre-correlation tasks: database management, input data location, and parameters definition.
 - Correlation results conversion to appropriate output format.
 - Fringe-fitting with fourfit in the HOPS package.
- The long term objective for the Yebes Observatory is to implement a DiFX correlator to provide service to its geodetic VLBI project, the RAEGE interferometric network.

2. PROPOSED AND PERFORMED WORK

- *Describe the goals of your visits and achieved work. Specify the highlights and occurred problems, providing the solution.*
- The goal of this Short Training Stay was to acquire experience in correlation techniques using the DiFX software.
- Firstly Javier was introduced to the architecture and implementation of the MPIfR correlator. It consists on a cluster of commercial servers that offers the needed computing power, a control room where the operator manages correlation operations, a disk-storage area with shelves to keep the disk modules from the stations and a special room to allocate playback units. Both the cluster and the playback units room are temperature and dust controlled room. Some items were identified to be possibly interesting to adopt at IGN, although a small scale system is in mind.
- Dr. Rottman explained the correlation steps theoretically. Prior to the correlation an environment needs to be created. This environment consists on a directory in the cluster file system with several files, some of them automatically generated based on an operation definition file called the V2D file that the operator has to create by hand. On that file many parameters such as frequency resolution, integration time, number of channels, can be specified, but it is also possible to filter the input data by station or time stamps among other parameters. The input datafiles or datastreams are also specified here. Javier went into a practical case with some real observation data. The experiments used in the practical case had been previously correlated, so it was possible to check results. The point of doing this traineeship in MPIfR was to be able to learn with Dr. Rottman who has experience on DiFX development, so one can gain not only a

user perspective but also knowledge of the internal algorithms of the software, which obviously helps to avoid problems and in under certain circumstances speed up the computation.

- During the week the plan was to increase the complexity of the correlation day by day to cover several real-life scenarios. The second day was devoted to correlation from Mark5 / Mark6 system. This is needed to handle observations that include stations where the network speed is not so high and disk modules are shipped. Zoom-band correlation, and interesting functionality of DiFX was approached on another day. The zoom-band technique, the name is self-describing, is needed when one station records a frequency band that is a portion of a broader band recorded in other station. The effect of this method is similar to apply filtering after the data is recorded.
- The last of the items proposed in the STM was to acquire knowledge on post-correlation tools to process the visibility data. AIPS and HOPS were the two software packages selected to complete this goal. The former is software developed by NRAO to calibrate and edit interferometric data, mostly interactively. Its use is not very extended in the geodetic community, therefore the traineeship was focused on the second one. HOPS is used as a fringe finder in geodetic correlators and allows the operator to easily interpret the results of the correlation. An recursive procedure is normally carry out applying new clock offsets and rates after the single band delay is known to precisely determine the observables (singleband delay, multiband delay and fringe rate). The hands-on activities with this post-processing software also included manual pcal corrections. This approach is used when the automatic delays obtained by fourfit do not lead to a channel by channel fringe phase alignment.

3. CROSS-DISCIPLINARITY

- *Please specify the cross-disciplinary fertilization; especially transfer of scientific knowledge to the next generation of scientists and engineers.*
- A small correlation center is planned to be implemented at Yebes Observatory. The long-term goal of this correlator is to correlate the RAEGE network baselines, but in the meanwhile it will serve to validate the VLBI capability of the participating stations. This project will involve the creation of a new group of scientists working on it, but furthermore it will allow station engineers to have a definitive debugging system over the full signal chain, including the optics. The first step towards this objective is to gain experience on DiFX.

4. IMPACT

- *Please explain the impact on collaboration of European radio astronomy engineers with industry and a wider community (scientific, technical, industry).*
- The National Geographic Institute of Spain, through its Observatory of Yebes, manages two radiotelescopes, a 40 m diameter one and another 13.2 m diameter. These telescopes perform routinely VLBI experiments included in the Observing Program of both the EVN and the IVS, among other international smaller projects. The scientific and technological community around those projects is a very active one in terms of knowledge interchange, and the demanding requirements of the technique require high technology products from the industry, both as a final system and also components to be integrated into local developments.
- This STM will allow the Observatory to keep developing its VLBI network running its own correlator, which contribute to increase significantly the number and diversity of experiments that can be performed. Also a working group on correlation is planned to be established at the observatory with the potential of new contributions to software development, not only to DiFX but post processing software.



5. PUBLICATIONS

- *In case of future publication - please provide additional information: place & date. Remember to insert the acknowledgment of the RadioNet support:*
- This traineeship will end up in an internal report to Yebes Observatory that is expected to be finished by end of September 2018. Some of the information in there will be later on used in a “Correlation cookbook”, the manual to operate a correlator in the observatory.

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