Report from the Short Term Mission – STM

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HOST INSTITUTE	IRAM, Institute de Radioastronomie Millimetrique
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RadioNet has received funding from the EU's Horizon 2020 research and innovation programme under the grant agreement No 730562

Report:

1. Topic

- *Please describe briefly the topic of the performed visit addressing its relevance to the RadioNet goals.*
- *Development of a new 22 GHz vapour radiometer prototype for radio astronomy observations and calibrations. The effect of Earth's atmosphere results in important degradations when it comes to analyze signals in interferometry at millimeter wavelengths. In these interferometric observations, atmospheric water vapor causes fluctuations in the signal received by radio telescopes. These fluctuations cause two important effects in the observations: they introduce a limit in the angular resolution and attenuate the astronomical signal by reducing the sensitivity of the observation. Therefore, the correction of the delay of the signal due to the fluctuations of the water vapor is essential if one wants to observe with long baselines, large integration times and high frequencies.The measurements obtained with a water vapour radiometer will provide precise detection of delays between signals, resulting in an improvement of interferometry accuracy of every interferometric observation.*

2. Proposed and Performed Work

- *Describe the goals of your visits and achieved work. Specify the highlights and occurred problems, providing the solution.*
- *The objective of this research proposal is to develop a new generation receiver, sensitive to water vapour emission (called water vapour radiometers) to counter the effects of the atmosphere on astronomical imaging. It will help the Atlantic Network of Geodetic and Space Studies, based at the Astronomic Center of Yebes, where this technology is still not used.*

  In addition, they portability of the instrument will be studied so that it can be adapted to the analysis of weather conditions in other locations. This characteristic makes it a very useful tool for location studies of the fundamental geodesic stations to be installed in Azores and the Canary Islands, thus allowing measuring which places with low water vapor contents are the best for the location of the stations.

  In the first place, a deep study has been made using bibliography and technical documentation provided by the IRAM in order to start a design for a first prototype of WVR. After this, some simulations and tests of different components have been performed in order to know if they are suitable for the radiometer.

  Also, some measurements of the new water vapor radiometer developed at IRAM have been made in order to understand its performance and evaluate its performance.

3. Cross-Disciplinarity

- *Please specify the cross-disciplinary fertilization; especially transfer of scientific knowledge to the next generation of scientists and engineers.*
- *The new generation water vapour radiometer development will include two main topics: RF design and test and development of calibration schemes. The prototype could be implemented in any radio telescope working in VLBI.*

4. Impact

- *Please explain the impact on collaboration of European radio astronomy engineers with industry and a wider community (scientific, technical, industry).*
- *In interferometry at millimeter wavelengths, additional delays are introduced by refraction of the incoming radiation inside the Earth's atmosphere. The effect results in radio signals not travelling*

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along straight paths, and the excess and variations of path, introduce an artificial delay which results in a degradation of the image quality. In particular, drops of water vapour in the atmosphere are responsible for this effect. A direct measurement of the intensity of the water vapour radiation through the shape of the 22 GHz water line, will provide the amount and variations of the path in the propagation of the astronomical signal towards the telescope. Precise detection of time delays will improve interferometric accuracies. Therefore, the development of a water vapour radiometer instrument will be of big impact in interferometry accuracy with long baselines, large integration times and high frequencies, by an increase of angular resolution in the observation, a decrease in the attenuation of the astronomical signal and an increase of the sensitivity of the observation, enabling long integrations of very weak objects.

5. PUBLICATIONS

- *In case of future publication - please provide additional information: place & date. Remember to insert the acknowledgment of the RadioNet support:*

The project leading to this publication has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730562 [RadioNet]