Report from
the Short Term Mission – STM

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HOST INSTITUTE	*Observatorio de Yebes, Castilla La-Mancha, Spain*
DATE OF THE STM:	*4TH – 17TH OF JUNE, 2017*

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.*

The main topic of the visit was collaboration in feed development inside the BRAND project for RadioNet. Onsala Space Observatory, Onsala, Sweden and the Technological Development Center at National Geographical Institute, Yebes, Spain have similar involvement in a number of common projects as for example IVS and EVN. Both institutions are also involved in the BRAND project, part of the EC funded Radio Net H2020. Within the project both institutions are supposed to develop broad-band feeds for illumination of reflector optics antennas with different geometries. In addition there are number of areas where face to face discussion of common technical challenges and exchange of ideas will be crucial for finding novel solutions. The personal visit of Jonas Flygare to Yebes was of great use in order to refine the project related issues and also to facilitate direct exchange of technical experience. This short term mission was also good opportunity for Jonas to create contact with some world leading companies in the area of radio astronomy located near Madrid in Spain.

2. PROPOSED AND PERFORMED WORK

- *Describe the goals of your visits and achieved work. Specify the highlights and occurred problems, providing the solution.*

The goals of the visit was setup as follows when formulated in the STM application:

- **1) Work on common format of far-field patterns for data exchange between CST and GRASP.**
- **2) Investigate different noise models and computational approaches for calculating the noise pick-up via side-lobes.**
- **3) Suggest and investigate alternative solutions for controlling the modes in broad band feeds.**
- **4) Suggest and investigate alternative designs for the feeding and back-short of QRFH.**

Between the STM approval and the visit of Jonas to Yebes, a visitor named Samuel Lopez Ruiz, from Yebes who also received STM grant stayed at Onsala for two weeks. During his stay at Onsala a lot of work progressed into how different feed solutions could be used to cover the 10:1 band and maintain a very broad beam. This would fall under point 1), 2) and 4) of the initial goals. A lot of work was put into the coaxial-feeding structure and QRFH to show its potentials in the project. Due to successful efforts, there were additional goals set for Jonas visiting Yebes to continue this feed design, since the same two people were involved and could continue their work together face-to-face. This totaled the time to a 1 month of joint work which resulted in very good progress. The issue of the broad band and broad beam combination is very challenging. The broad band can most likely be achieved through a coaxial structure, however the beam width is most likely not possible. Therefore the approach to insert a QRFH feed into the inner waveguide of the coaxial structure was investigated...This to make sure a broader beam was guaranteed for the upper band and from there optimize the coaxial structure. See example of the structure in the figure below.

As the problem of a too narrow beam was seen, the coaxial QRFH concept, also furthered the development of a pure wideband QRFH solution. There, we have now reached a promising concept for a 1.5 – 15.5 GHz feed that can show a broad enough beam (half-angle 79 degrees) to be mounted on the Effelsberg prime-focus telescope which is one of the deliverables in the BRAND project. The combination of analytically defined horn profiles together with the splined profile concept appears to give a converging solution. One key solution was to use a dielectrically loaded feed which has been introduced previously, but now optimized to fit the design goals.

Also, the opportunity to participate in the RFI workshop sponsored by RadioNet occurred as it was within the time frame (8-9 June). This was an excellent opportunity to attack the potential RFI

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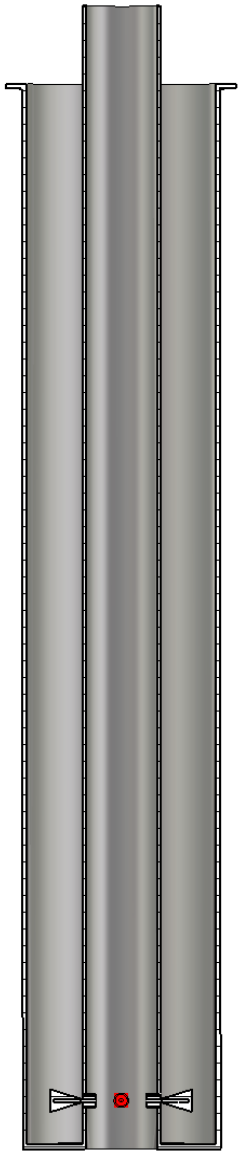
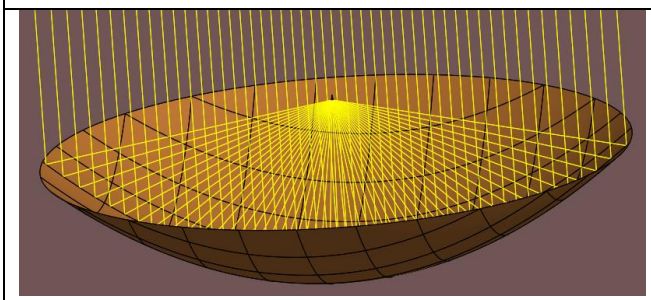
problems that can be an issue for such broadband feeds, and assess point 2) in the initial goals as well. Therefore participation in this workshop was also added to the list of goals.

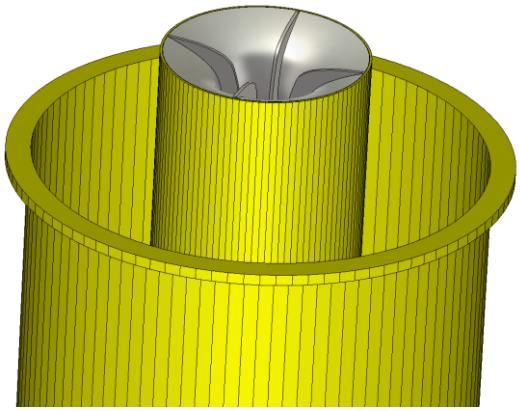


Coaxial Feed

Flared Coaxial Feed



Effelsberg illustrated fully illuminated



Coaxial QRFH Feed

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3. CROSS-DISCIPLINARITY

– *Please specify the cross-disciplinary fertilization; especially transfer of scientific knowledge to the next generation of scientists and engineers.*

Yebes and Onsala are working on similar topics as for example feeds for reflector antennas and low-noise amplifiers. Those components are also of interest for the geodetical VLBI (IVS) and also for the SKA. Outcomes from the development could be used for ground-based and satellite communication. The development of the broadband feed will be documented as publication and the new techniques used to develop it is for further use in both radio astronomy, geo-VLBI, communications, wireless and so on. The development of optimization code for the BRAND feed design is already used within optimization for the SKA project. When the feed design for BRAND is finalized, it is scalable and can be re-optimized to fit projects within the suggestions given above.

The international co-operation needed between engineers and astronomers in terms of the RFI area is very obvious. This visit inspired directly a more open communication between the Spanish and Swedish engineers to clearly state what is demanded and what is possible in terms of equipment for RFI monitoring. What are the problems astronomers see? What is most important for their observations? What is possible from the engineering side? How do we affect governments and companies to reduce their unnecessary RFI in an appropriate way? How do we get enough material to convince them about this? These were all areas raised during the visit which is very important for the future as more and more frequency bands are opening up for next generation Over the Air systems for data transfer and communication. Cross-disciplinary work is extremely important here for us to stay impactful in the observation community.

As additional result of this trip, ideas on how to further develop the optimization code for the BRAND (and in future other projects at Onsala, such as currently exemplified in SKA), are now being implemented.

4. IMPACT

– *Please explain the impact on collaboration of European radio astronomy engineers with industry and a wider community (scientific, technical, industry).*

As the main goal of this exchange is to further develop the feed design to be applicable for all interested EVN stations, the final product will be of great interest for the technical industry as hardware needs to be built. The collaboration means that possibilities to construct the prototypes and finished product will be opening up and can spread the knowledge of the design work to many different industries within Europe. The joint collaboration proves that taking advantage of expertise from different disciplines is both challenging and developing as the strive is to find the best solution.

Through the visit knowledge within the scientific and technical community is shared between the institutions. New knowledge and approaches to the problem is thought of jointly and gives the visit a double impact compared to solo research. Not only knowledge, but network is spread through this visit. The connection between several countries, particularly Sweden and Spain, is strengthened and will lead to even better collaboration and opportunities in the future.

5. PUBLICATIONS

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

First publication will most likely be a conference paper for the EuCap 2018, (European Conference on Antennas and Propagation) in London, 2018, April. This is the largest European conference on AoP and very impactful, a perfect place to further spread the BRAND and RadioNet goals. The development of such a wideband feed with this particularly broad beam is very interesting for the community and especially the optimization procedure.

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Future aim for the manufactured prototype is a journal publication when measurements are done and the prototype is thoroughly tested.

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]