Summary of the context and overall objectives of the project

EISCAT_3D will be a multi-static phased array radar system dedicated to observations of the coupling of Earth's atmosphere to space in the European sector of the Arctic regions. This project (EISCAT3D_PfP) functions as a critical step toward reaching production readiness for a design of the EISCAT_3D system that, in a cost- and energy-efficient way, achieves the goals that were described by the scientific community in the Preparatory Phase project's EISCAT_3D Science Case. For the purpose of this text we need to make the important distinction between EISCAT_3D and EISCAT3D_PfP: EISCAT_3D is the overall research infrastructure that is planned for implementation at locations in Finland, Norway, and Sweden, while EISCAT3D_PfP is the Horizon2020 project aimed at preparing for this larger implementation.

The overall objective of this project, “EISCAT_3D: Preparation for Production” (EISCAT3D_PfP), is to facilitate a smooth and swift transition of the EISCAT_3D project from the FP7 Preparatory Phase to its implementation. The eventual system will be owned by EISCAT Scientific Association, the Coordinator of the previous EISCAT_3D Preparatory Phase project which was completed in September 2014 and achieved the major requirements for implementing EISCAT_3D.

EISCAT3D_PfP involves collaboration with engineering companies, electronic manufacturers and other industrial partners and SMEs to bridge from the FP7 Preparatory Phase toward the efficient implementation of this new research infrastructure. An important first step in the technical integration and system testing is setting up a test-bed made up of an array consisting of 91 antenna elements. This Test Subarray will be used to test manufacture-ready sub-assemblies, low-level software, and the integration/interoperability of the system components prior to launching full scale production of the 9,919 antenna elements in the transmitter/receiver array as well as the 19,838 antenna elements for two receiver arrays in the first stage of the EISCAT_3D implementation. This project will speed the transition from engineering prototypes to production readiness so EISCAT_3D can quickly reach a mass producible instrument configuration that is cost-effective, energy efficient and easy to maintain. The Test Subarray will also be used for systems integration tests and for implementation of the sub-array beam forming in order to verify the performance of the entire array.

The main tasks to reach this objective are:

- Carrying out engineering work in collaboration with industry to finalise the design of critical subsystems of the EISCAT_3D instrument.
- Developing and procuring a Test Subarray for EISCAT_3D and assembling it in the Arctic environment.
- Developing dedicated engineering-level software.
- Verifying and validating the performance of the Test Subarray and developing protocols for the construction and commissioning of EISCAT_3D.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

The EISCAT3D_PfP project started with a kick-off meeting and a technical workshop held at EISCAT headquarters in Kiruna. The meeting presentations and discussions were focused on the overall project, its connections to other EISCAT activities, and the present status of the technical design of the EISCAT_3D system.

Consoden AB was signed as the manufacturing consultant contractor for this project. This consultant firm supported the project's procurement by effective interactions with industry and vendors, definition of the procurement strategy and preparation of the tendering documents.

Different approaches in designs for the sub-array beamformer were analysed by considering cost, complexity and power consumption. The design and technical specifications of the critical sub-systems of the EISCAT_3D Test Subrray: the Antenna Unit (AU), the First Stage Receiver Unit (FSRU) and the Pulse and Steering Control Unit (PSCU) were finalised and an open tendering process started. Contracts were signed with Huber+Suhner for the AU and with National Instruments for the FSRU. For the PSCU, on the other hand, no bidder were within the project budget and hence EISCAT Scientific Assoociation built two limited-capability prototypes in-house to be used in the Test Subarray. In parallel to these activities, the low-level software needed to control the Test Subarray was developed, which also gave insights into the definition of the software architecture of the future full EISCAT_3D system.

In the summer of 2017, the different items of hardware for the Test Subarray were delivered to the EISCAT Ramfjordmoen site, where the Test Subarray was erected and the subsystems were installed. The sub-systems were tested for functionality and to ensure interoperability, and the conclusions from these tests were incorporated in the plans for the construction of the full EISCAT_3D system.

Materials related to the project, including reports and deliverables were published on the dedicated EISCAT_3D website. A quarterly newsletter was also published, presenting the progression of the project progression and containing up-to-date information. The project was made visible through participation at various relevant conferences and workshops, and through interaction with media when the opportunity arose. The general public was also reached through coverage in Swedish national radio and regional TV, and in contacts with students at local schools.

Progress beyond the state of the art and expected potential impact

The ambition of the EISCAT3D_PfP project is to connect existing knowledge in radar-, electronic- and systems engineering to produce beyond state of the art radar solutions by utilising the competence from several actors in industry, academia and the civil society.

The basic technologies behind EISCAT_3D have been used in scientific, civilian and military radar systems since the 1970s. However, EISCAT_3D is the first attempt to combine high-power phased

array radar technology with large off-set between the transmitters and receiver arrays and with simultaneous multi-beam capabilities at wide receive bandwidths. To achieve this, EISCAT has developed new ways to integrate radar technologies, electrical and systems engineering advances, high-performance computing and data integration. The combined knowledge to take the system design to blueprints ready for production exists today in industry, academia and civil society in Europe and EISCAT's Asian partner countries, but not necessarily at one single provider. During the preparations for EISCAT_3D, EISCAT Scientific Association established collaborations with SMEs and international engineering companies as well as with civil agencies with a responsibility for innovation procurement. Within the EISCAT3D_PfP project EISCAT took these collaborations further. By collaborating with national agencies, EISCAT uses innovation procurement to establish cooperation with SMEs and international engineering companies to develop and test components ready for industrial scale production to be used at the EISCAT_3D radar sites.

The collaboration on EISCAT_3D will certainly bring benefits to the future users of the system as they will gain access to a world leading and cost-efficient system for studies of the Arctic/sub-Arctic atmosphere and near-Earth space environment. Simultaneously, it will raise the competence in civil society for the use of innovation procurement and the competitiveness of the industry partners within fields such as radar-, electronic- and systems engineering.