

3rd Activity Report

EISCAT_3D

European Next Generation Incoherent Scatter Radar

Design Study

implemented as

Specific Support Action

Contract number: 011920
Project Co-ordinator: EISCAT Scientific Association
Project website: <http://www.eiscat.se>
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A. ACTIVITY REPORT

1. Progress report

1.1 Summary of the activities and major achievements

Executive Summary

The third year of the EISCAT_3D project has seen continued progress towards the project's planned goals. Following a successful mid-term review at the beginning of the reporting period, the remaining goals and requirements have been reconsidered in the light of the work and investigations already completed and a comprehensive re-evaluation of work flow has been conducted. Both the mid-term review and the subsequent re-evaluations confirmed the appropriateness of the overall vision and plan of the new radar design while the detailed results from the first two years enabled various elements to be revised. Some components of the project had turned out to be more straightforward than originally expected while others had uncovered the need for additional studies and developments. Taking everything into account, the remaining project goals and resource allocations have been fine tuned to reflect the evolving requirements and to ensure that the project is completed as planned leading to the delivery of a detailed design at the end of the fourth year.

Work on the proof-of-concept receiver array at Kiruna has proceeded somewhat ahead of schedule and the first signals have been successfully received using one of the existing EISCAT radars as a source. This is a very important milestone in the overall project and its early completion is witness to the dedication and enthusiasm of the entire EISCAT_3D design team.

The emerging EISCAT_3D radar design more than addresses the original scientific and technical requirements, has illuminated and extended our understanding of the problems, solutions, and above all the potential of the system, not only for studies of atmospheric physics but also in a wide range of other related scientific, technical and service areas. The increasing visibility and importance of the project is reflected by a formal proposal to include the facility in the revised ESFRI road map, though the outcome of that proposal is unknown at the time of writing.

Based on the work completed to date, the final year of the project will be characterised by the completion of the revised studies, preparation and assembly of the various reports into a complete design document, and directly related preparations for the provision of appropriate sites, frequency allocations, and funding options.

The project at the end of the third year:

WP1: 'Management of the Design Study' is proceeding well and as planned. In order to streamline the work within package, the frequency sub-package will be moved to the new WP13.

WP2: 'Evaluation of design performance goals' has been completed as originally planned.

WP3: 'Evaluation of options for the active element': Further effort on elementary antenna element design can reduce the overall build cost dramatically but considerably more resources are required for the work. We have therefore decided to allocate more resources. The package will also be rescheduled and lead by another Partner.

WP4: 'Phased array receivers' was re-scoped at LTU to include appropriate antenna simulations. The Demonstrator cost will not be as much as first assumed. More personnel resources are though needed. The overall size of the Work Package will remain roughly as initially planned.

WP5: 'Interferometry' is on schedule with most tasks completed and effort running slightly ahead of plan.

WP6: 'Active Element': The Work Package is delayed. The problem is tied to the delays in WP3. We will therefore reschedule the package and move it to another Partner.

WP7: 'Distributed Control and Monitoring': was originally over-allocated since the existing EISCAT Real-time Operating System (EROS) can largely be reused. The package will be down-sized.

WP8: 'Data archive and distribution': continues roughly as planned. The foreseen shortage of staff resources at the Partner will be handled by bringing in another Partner taking over parts of the work.

WP9: 'Signal Processing' continues basically as foreseen. The work will though be reprioritised and rescheduled. All Partners are involved in this package.

WP10: 'New techniques': continues. A new area of study will be pursued and some additional effort will be allocated to the Work Package.

WP11: 'Implementation Blueprint' will undergo a larger rearrangement. The initial plan to make a complete design with blueprints was dropped. The overall size of the package will be reduced.

WP12: 'Networking and reference time and frequency' has turned out to be a much bigger task than allowed for in the original plan and more resources will be allocated the package.

WP13: 'Enabling Procedures' is a new Work Package that will be introduced. It will harbour the frequency sub-package from WP1 but will mainly focus on tasks relating to land and infrastructure issues.

We are confident that the Design Study will provide the expected results at the end of the project. Some rearrangements are though imperative and a request for Contract Amendment

will soon be submitted to the Commission. The amendment involves rescheduling, redistribution of resources within the existing Partners and the introduction of a fifth Partner: Institutet för Rymdfysik (IRF) / Swedish Institute of Space Physics.

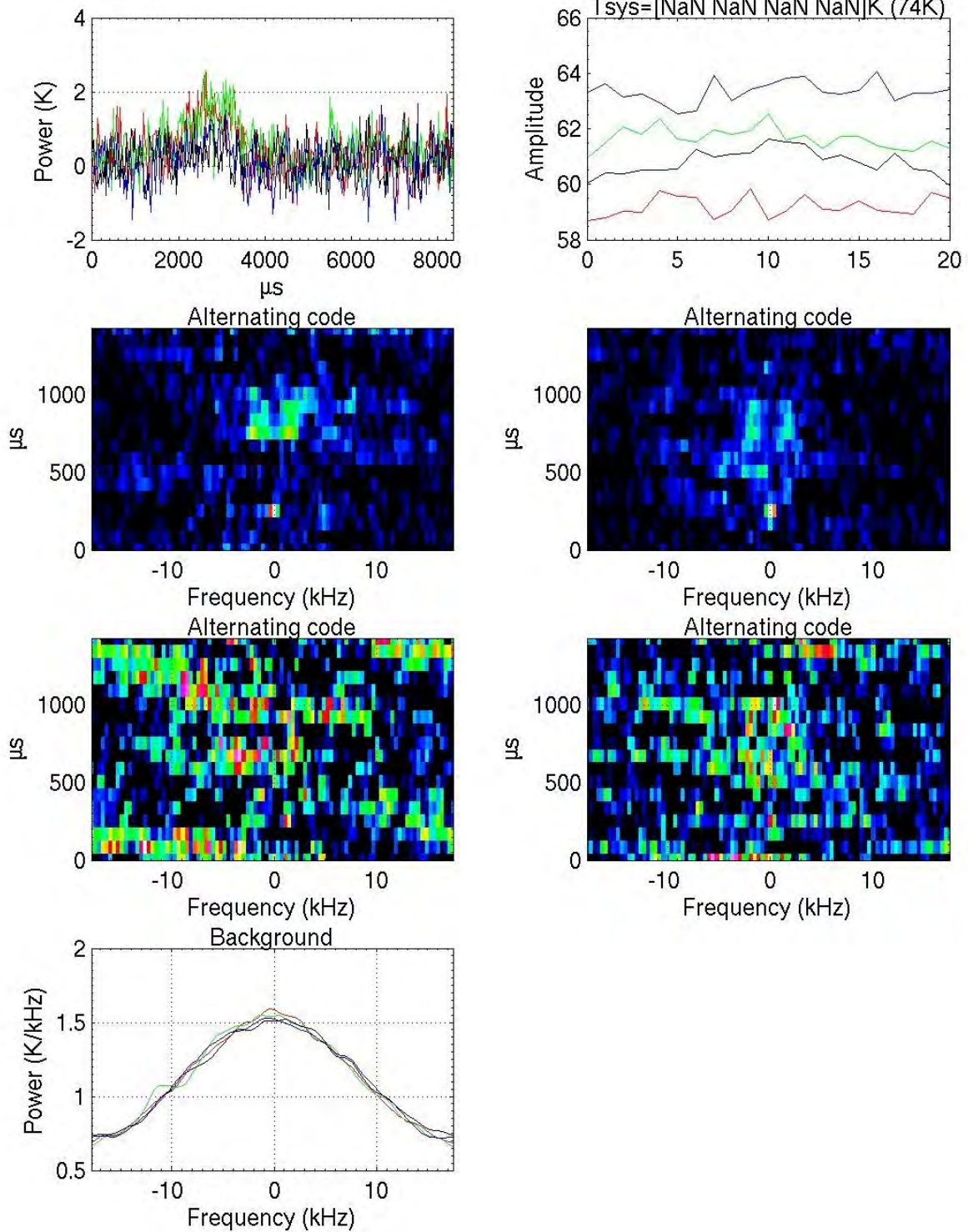
Most tasks will be completed around 2-3 months before the end of the project thus giving ample time for primarily WP11 (the technical design documents) and WP1 (the overall project results) to finalise before the end at 30 April 2009.

First light

The Test Array, or the “Demonstrator”, is the test device for trying design features. The Demonstrator hardware is accounted in the Design Study but is paid by EISCAT.

The first successful data from the Demonstrator was received in an experiment performed 16 and 17 October, 2007. Using the EISCAT VHF transmitter to illuminate the ionospheric F region overhead the Tromsø EISCAT site, incoherently scattered signals from about 290 km altitude were received by the Demonstrator at approximately 4% signal-to-noise ratio, thus proving both the correct mechanical alignment of the array and the correct behaviour of the phasing system. The signal quality was of so good quality that the signal could be successfully analysed for physical quantities (e.g. electron density, temperatures and Doppler shift) by the normal EISCAT analysis procedure [figure next page].

Data from the first tests
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The Demonstrator has subsequently been operated in the same single-beam mode on several occasions.

1.2 Consortium management activities

Consortium management effort of all contractors

Work Package 1: Management of the Design Study includes the consortium management of the project. The deployed human effort is presented in the Management Work Package.

Consortium management summary

The Consortium Agreement, activated 21 March 2005, regulates the consortium management handling. The day-to-day management of the project is done by the Co-ordinator, EISCAT. The co-ordinating tasks are handled in a separate Work Package, WP1: Management of the Design Study. The main overall vehicle for the project is the General Assembly, where each Partner has representation. The consortium agreement also includes a Steering Group that supports the Co-ordinator and the General Assembly. The Steering Group also functions as the internal Project Review Panel.

The Council for the Central Laboratory of the Research Councils (CCLRC) was merged with the Particle and Physics and Astronomy Research Council (PPARC) as of 1 April 2007. The merged organisation is called the Science and Technology Facilities Council (STFC). The contract was amended in autumn 2007 with a retroactive amendment date as of 1 April 2007.

Following the move of EISCAT Headquarters, an address change was submitted to the Commission.

General Assembly

The General Assembly held three meetings during the reporting period.

The fifth General Assembly meeting of the project was held 16 January 2008

The meeting was held at the Arlanda Conference and Business Center, Stockholm, Sweden. Present were Prof. Richard Harrison and Dr. Ian McCrea, both RAL/STFC (via telephone), Prof. Jerker Delsing, LTU, Prof. Asgeir Brekke, UiT, Prof. Tony van Eyken and Dr Gudmund Wannberg, both EISCAT/Co-ordinator. Invited was Dr. Lars Eliasson representing the Swedish Institute of Space Physics (IRF) was invited.

The meeting considered the reported outcome from the August Mid-Term Review and other regular items, including the release of funding to settle the first two years of the project. The main topic was though the proposed inclusion of IRF as a fifth partner in the Design Study and the consequent revision of the project plan to make room for the new partner.

The General Assembly approved the proposed inclusion of IRF and agreed that the joining the project date could be set to the meeting day though completing formalities would take some time. It is envisaged that the Commission will accept 16 January 2007 as retroactive start date for IRF.

The sixth General Assembly meeting of the project was held 12 March 2008

The meeting was held using teleconferencing. Present were Dr. Ian McCrea formally representing Prof. Richard Harrison, Prof. Tony van Eyken, Prof. Jerker Delsing, Prof. Asgeir Brekke, assisted by Prof. Cesar La Hoz (UiT) and Dr. Gudmund Wannberg, from 1 March, 2008, IRF (invited).

The General Assembly considered the paperwork needed for IRF joining the project and the planned revision of the project plan, where decisions regarding priorities were needed.

The seventh General Assembly meeting of the project was held 10 April 2008

The meeting was held using teleconferencing. Present were Dr. Ian McCrea formally representing Prof. Richard Harrison, Prof. Tony van Eyken, Prof. Jerker Delsing, Prof. Asgeir Brekke, assisted by Prof. Cesar La Hoz and Dr. Lars Eliasson (invited).

The General Assembly considered the updated paperwork needed for IRF joining the project and the final considerations regarding the planned revision of the project plan.

Next meeting of the General Assembly

The eighth meeting of the General Assembly is scheduled for end-May 2008.

Steering Group

The Steering Group had two meetings during the reporting period.

12 February 2008, Conference centre at Stockholm/Arlanda Airport

Present at the sixth meeting were Dr. Ian McCrea, Mr. Henrik Andersson, Prof. Tony van Eyken, Dr. Gudmund Wannberg, Dr. Jonny Johansson, Prof. Cesar La Hoz, Mr. Markku Postila (EISCAT) and Mr Ingemar Wolf (invited, representing IRF).

The Steering Group handled regular project related matters and the proposed inclusion of IRF into the project, including re-distribution of tasks and resources.

4 April 2008, teleconference

Present at the seventh meeting were Dr. Ian McCrea, Dr. Gudmund Wannberg, Dr. Jonny Johansson, Prof. Cesar La Hoz, Mr. Markku Postila and Mr. Ingemar Wolf (invited).

The Steering Group considered the prioritisation of the revised project plan, as requested by the General Assembly.

Next meeting of the Steering Group

The eighth meeting of the Steering Group is scheduled for 16 September 2008.

Mid-Term Review Meeting

The Mid-Term Review meeting was held 28 August 2008, at the Swedish Institute of Space Physics. Present were Mr. Henrik Andersson, Prof. Tony van Eyken and Dr. Gudmund Wannberg from EISCAT/Co-ordinator. UiT was represented by Prof. Asgeir Brekke and Prof. Cesar La Hoz. LTU was represented by Prof. Jerker Delsing. RAL/STFC was represented by Dr. Ian McCrea. From the European Commission, Mrs. Anna-Maria Johansson and Prof. Tauno Turunen (external reviewer).

Project WEB site

Work Package 1: Management of the Design Study included the setup of a project web site. This site contains a restricted area where all internal project related documents are included. There is also a public area, accessible by everyone, for published material.

Management and general meetings (where all participants were invited)

See 1.3.1 Work Package 1: Management of the Design Study

Milestones and deliverable achievements

See 1.3.1 Work Package 1: Management of the Design Study

1.3 Other specific activities (Design Study/Construction activities)

1.3.1 Work Package 1: Management of the Design Study

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months	2.91				2.91

Short description and planned results

The overall Project Management is conducted by the Headquarters Staff of the EISCAT Scientific Association located in Kiruna, Sweden. The Project Manager is Prof. Anthony Paul van Eyken, Director of the Association. Technical Project Leader is Dr Gudmund Wannberg, ~~Deputy Director of EISCAT~~ (IRF from 1 March 2008). Mr Henrik Andersson, Head of Administration of the Association, oversees the financial management and overall budgetary control.

Objectives: The Management work package runs throughout the Design Study and ensures a co-ordinated and concerted approach towards the project objectives. The Package also covers administrative and reporting tasks as well as provision for timely and appropriate distribution of funds between the partners and procurement of audit certificates by each of the Partners at regular intervals. A detailed project plan will be developed during the first three months of the Design Study, and subsequently used for Project Management.

Description of work: This work package includes the overall technical and financial management of the Design Study. Monitoring of all Work Packages, milestones, and deliverables and formulation of corrective measures when necessary. Control and monitoring of the financial operation of the Project, distribution of funds to partners and collation of Partner financial reports. Provision of progress and accounting reports for the European Union. Operation and maintenance of the Project Web site, including secure archiving of project materials. Preparation and distribution of project reports, including public access literature. Investigation of actual and potential funding for the build phase of the new facility. Control and monitoring of EISCAT Work Packages.

Deliverables: D1.1 P1 Design Study Progress + Financial accounting Report, due 15 June 2006 ✓
D1.2 P2 Design Study Progress + Financial accounting Report, due 15 June 2007 ✓
D1.3 P3 Design Study Progress + Financial accounting Report, due 15 June 2008 ✓
D1.4 Final Design Document for the Next Generation EISCAT Incoherent Scatter Radar, due 15 June 2009

Milestones and expected result:

Month 12 Annual Progress Report (D1.1) ✓
Month 24 Annual Progress Report (D1.2) ✓
Month 36: Annual Progress Report (D1.3) ✓
Month 48: Final Design Document (D1.4)
Month 48: Finance plan for build phase of the new facility

WPI – Sub-Package

Objectives: The planned radar is an active remote-sensing device whose operation depends critically on access to 10 MHz or more of the radio frequency spectrum at or about 225 MHz. This work package therefore includes an element addressing the technical, spectrum-engineering, and regulatory aspects involved with a view towards obtaining long-term protected spectrum allocations at all potential radar sites.

Description of work: The frequency management authorities in Sweden, Norway, and Finland will be notified of the EISCAT_3D project and information meetings arranged. European-level frequency management bodies (ERO, CEPT), international bodies (URSI, IUCAF) will be informed and advice sought from the ESF Committee for protection of Radio Astronomy Frequencies (CRAF). Applicable parts of the Radar Performance Specification Document will be translated into RF spectrum requirements. Discussions with the Nordic frequency management authorities will be opened. These will be continued into a formal negotiation phase, ending by frequency allocations being made and agreements between EISCAT and the authorities drafted and signed.

Deliverables: D1.5: Agreements between EISCAT and the regulatory bodies in Sweden, Norway and Finland, due 2 January 2006
D1.6: Protected frequency allocations in all three countries, valid from 2009 until at least 2020 with options for extension, due 6 February 2006

Milestones and expected result:

Month 6: Preliminary indication of spectrum availability and frequency allocation available for inclusion in the Performance Specification Document ✓
Month 6: Handover meeting with WP2, WP3, WP4 ✓
Month 8: Planned: Negotiations completed; draft agreements and frequency allocations available (D1.5)
Month 9: Planned: Agreements signed; firm frequency allocations made (D1.6)

Management summary

The Work Package is devoted to management of the Design Study. Internal EISCAT issues meant that Dr. Gudmund Wannberg left EISCAT and joined IRF 1 March 2008. Dr. Wannberg continues to be the Technical Project Leader for the project. The management work continues therefore uninterrupted though the EISCAT management effort will be reduced because of the technical project leadership is moved outside the management Work Package.

The sub-package relating to the frequency spectrum allocation has continued as planned.

Work progress

The management of the Design Study runs for the duration of the project. Three General Assembly meetings, two Steering Group meetings, a number of individual meetings and supporting documents have been managed during the reporting period. The Mid-Term Review was also performed during this reporting period. The management works satisfactory.

The planned revision of the project took longer than first envisaged but all inputs have now been processed and the revised project plan is basically ready for dispatch to the Commission for Contract Amendment.

The Frequency sub-package

Contacts with telecommunications authorities in all three countries have continued, and also on pan-European and international levels. The spectrum allocation issue is finally starting to move ahead. Following a recommendation from the Finnish and Swedish telecommunication administrations, applications for a coordinated allocation of 10 MHz of active spectrum in the 230-MHz range in the three EISCAT host countries, including a request for protection of the allocated spectrum for 25 years, have been submitted to the three Nordic administrations. The administrations are regarding the matter favourably and a proposal for a spectrum slot for active use is currently being prepared by the Norwegian administration.

Resources deployed

The administration and financial management of the project have been handled by Mr. Andersson, Head of Administration, EISCAT. Dr. Wannberg was part of this Work Package up to the end of February. Mr. Postila, EISCAT, has joined the management team.

Milestones and deliverable achievements

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Subtask No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
D1.3	P3 Design Study Progress + Financial accounting Report (this document)		EIS	Month 36	Month 38
D1.5	Agreements between EISCAT and the regulatory bodies in Sweden, Norway and Finland, due 2 January 2006	Sub- package 1	EIS	2 Jan	Expected autumn 2008
D1.6	Protected frequency allocations in all three countries, valid from 2009 until at least 2020 with options for extension	Sub- package 1	EIS	6 Feb	Expected April 2009

Major meetings and workshops organised under this activity

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
28 Aug 2007	Mid-Term Review Meeting	Kiruna, Sweden	9	project web site
16 Jan 2008	Fifth General Assembly Meeting	Arlanda, Sweden	7	project web site
12 Feb 2008	Sixth Steering Group Meeting	Arlanda, Sweden	8	project web site
12 Mar 2008	Sixth General Assembly Meeting	Tele-conference	6	project web site
4 April 2008	Seventh Steering Group Meeting	Tele-conference	6	project web site
10 April 2008	Seventh General Assembly Meeting	Tele-conference	6	project web site

Major deviations from the project plan and corrective measures

No Work Package issues have been identified. For reasons outside the control of the parties, deliverables D1.5 and D1.6 outstanding from the first reporting period will not materialise until later.

1.3.2 Work Package 2: Evaluation of design performance goals

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months					

Short description and planned results

Objectives: This work package includes a comprehensive review of current and future requirements, leading to a Specification Document describing the specific and detailed performance goals to be achieved.

Description of work: The operating parameters, strengths, weaknesses and actual performance of all existing incoherent scatter radars (including the present EISCAT systems), as well as radar systems under construction, will be reviewed. Scientific performance requirements for the next generation European incoherent scatter system put forth by the scientific community will be identified. Operational performance requirements will be identified in consultation with EISCAT staff and expert users. All findings and requirements will be collated into a draft Radar Performance Specification Document to be released for public consultation, presented to the EISCAT Scientific Advisory Committee for comments, and reviewed at a Radar Performance Review meeting. Based on the input received, the specifications will then be updated and after a final round of consultations the final Performance Specification Document, forming the baseline for the actual design study, will be issued.

Deliverables: D2.1 EISCAT_3D Radar Performance Specification Document ✓

Milestones and expected result:

Month 4: EISCAT_3D Radar Performance Review meeting ✓

Month 5: Draft Performance Specification Document issued for public consultation ✓

Month 6: Performance Specification Document finalized (D2.1) ✓

Management summary

The Work Package was completed during the first reporting period.

1.3.3 Work Package 3: Evaluation of options for the active element

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months	0.08				0.08

Short description and planned results

Objectives: A major part of the cost of the new facility will be invested in the production of the high power transmission capability. The relative benefits, and consequences for the design of other subsystems, of adopting either a phased array (with the transmitter integral with, and distributed across, the antenna) or a multi-component transmitter (providing multiple feeds to support electronic beam steering with a conventional antenna) will be evaluated as part of this work package and used to identify the optimum solution in terms of scientific return, performance, ease of manufacture and commissioning, reliability, maintainability and cost.

Description of work: Information and literature research will be conducted to establish the current state of the art in high power RF generation at VHF. This will cover active device technology, radar systems, particle accelerator RF systems, fusion RF sources, broadcasting systems and the industry R&D outlook for the future. High-power components, devices and subsystems and antenna designs will be identified and rated for performance, suitability, availability, reliability, lifetime, and cost. Contacts to industry, owners, and operators of other large VHF radar installations and the RF groups at accelerator laboratories (CERN, DESY and others) will be established and, if found advantageous, study visits will be made to some of these establishments. For each of three or more possible transmitter / transmission antenna configurations meeting the baseline performance requirements, tentative architectures for the active element will be established, performance requirements for the component parts will be laid down and suitable system components identified. Integral to this exercise, interferometry-specific boundary conditions, and/or performance requirements will be identified and used to constrain and/or raise the performance requirements. For each of the configurations, scientific and operational advantages and disadvantages of including or not including a receiving capability as part of the active element will be investigated and constructional and cost consequences assessed. Budgetary cost estimates for the different active element architectures will be requested from industry. Logistical, environmental, maintenance and cost-of-ownership aspects of the different architectures will be assessed separately. Facts, results, costings, and conclusions will be collated into a draft report to be circulated for public comment and discussed at a "Next Generation European Incoherent Scatter Radar Active Element" workshop. Following the Workshop, the final selection of the active element architecture and technology will be made and the final Active Element Subsystem Report published.

Deliverables: ~~D3.1 Next Generation European Incoherent Scatter Radar Active Element Workshop, due 4 September 2006~~
D3.2 EISCAT_3D Radar Active Element Subsystem Report, due 1 January 2007

Milestones and expected result:

~~Month 13: Draft Active Element Subsystem Report issued for public consultation~~
~~Month 16: Next Generation European Incoherent Scatter Radar Active Element Workshop;~~
handover meeting w/WP6
Month 17: Active element technology selected, EISCAT_3D Radar Active Element Subsystem Report published (D3.2).

Management summary

The Work Package is running very much behind schedule. The work has focused on only continuing with the modular phased-array transmitting antenna design. The Work Package is fully with EISCAT but staff resources are lacking.

1.3.3.1 EISCAT

Work progress

The numerical analysis of a number of short Yagi antenna designs with respect to their suitability as 3D active array elements, as well as of the whole array, jointly defined by EISCAT and Universität Rostock as the M. Sc. project for Mr. Renkwitz, has made excellent progress. Using the industry-standard NEC software package, three different Yagis, including a very original design with sloping elements, have been thoroughly evaluated. A fairly conventional design, using a folded dipole driven element, is shown to offer the best compromise between the initial design requirements of a wide main lobe, low gain at 80° and large VSWR bandwidth. Additionally, the grating lobe performance of two different array geometries, viz. orthogonal and isosceles, has been analysed. The isosceles geometry is shown to be clearly superior to the orthogonal one, in good agreement with previous studies.

The Technical Project Leader has served as external thesis advisor to Mr. Renkwitz, who is now putting the finishing touches on his thesis. The defence is scheduled for June 19, 2008.

Resources deployed

One person has been working in the Work Package. Totally about 1.5 days were deployed during the period. The work done by Mr Renkwitz is not accounted in the Work Package.

Milestones and deliverable achievements

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Subtask No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
D3.2	EISCAT_3D Radar Active Element Subsystem Report		EIS	1 Jan 2007	Draft available. Excepted finalisation is now earliest Nov 2008

Major meetings and workshops organised under this activity

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
	No major meeting during the reporting period			

Major deviations from the project plan and corrective measures

The work is behind schedule. The Work Package is part of the revision of the project plan.

1.3.4 Work Package 4: Phased array receivers

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months	12.47		32.06		44.53

Short description and planned results

Objectives: A key element of the next generation radar is the ability to receive scattered radar power over a wide range of altitudes by employing an essentially unlimited number of simultaneous receiving beams, generated by sophisticated signal processing of the signals received at the individual antenna elements of two or more large phased arrays located at distances of the order of 100-300 km from the transmitter site. This work package includes all the design and development work to prepare construction blueprints for such arrays.

Description of work: The phased-array antenna subsystem can be separated into three substantially separate component parts: element antenna, receiver front end, and time synchronization of antenna elements.

This leads to the following sub-tasks to be addressed within the Work Package:

- Antenna array design: Computer simulations of array design for several different choices of element antenna. As part of this task, the performance requirements imposed on the antenna electronics subsystem by different array topologies and architectures will be investigated and a specific array architecture selected.
- Antenna subsystem architecture: An antenna subsystem laid out in accordance with the selected array architecture will be simulated and tested to ensure feasibility of future implementation. Iteration may prove necessary.
- VHF receiver VLSI electronics: Design, simulation and layout of VLSI front-end: (224 +/- 10) MHz RF => (40-50) Msamples/s). Design and layout of VLSI electronics necessary for time synchronization and communication of data from arbitrary antenna element. Time synchronization requirement is expected to be better than 50 ps. Manufacturing of design in one or two VLSI circuits.
- Verification of VLSI circuits: Design and construction of a test circuit, and its use to verify performance of manufactured VLSI units. Test of manufactured VLSI circuits.
- Design of antenna subsystem: Design of complete antenna subsystem meeting global antenna requirements. Including multi-beaming capabilities, adaptive real time pointing calibration, real time command, and control and data communication.
- Validation of array subsystem concept: Including verification of multi-beaming capabilities, adaptive real time pointing calibration and real time command, control and data communication on a demonstrator sub-array [5 - 10 array elements].
- Report: Writing of WP report.

Deliverables: ~~D4.1 Complete specifications for antenna array subsystem, due 6 October 2006~~
D4.2 EISCAT_3D Radar Receiver/Receiving Antenna Subsystem Report, due 30 April 2009

Milestones and expected result:

- ~~Month 12: Antenna array design completed; most promising architecture selected~~
- ~~Month 13: Complete specifications for antenna array subsystem laid down~~
- ~~Month 18: Antenna subsystem architecture simulations completed successfully~~
- Month 30: Receiver VLSI electronics design completed; design committed to silicon ✓ [note]
- Month 32: VLSI components successfully tested and validated ✓ [note]
- Month 40: Antenna array subsystem design finished
- Month 46: Successful validation of antenna subsystem using demonstrator sub-array
- Month 48: Receiver/Receiving Antenna Subsystem Report issued (D4.2)

Management summary

The Work Package is running well on schedule.

1.3.4.1 EISCAT

Work progress

Commissioning of the Demonstrator array is progressing extremely well, albeit slightly slower than hoped. Following a failure by a sub-contractor to produce the parts for the power combiners to the required precision, these were eventually manufactured, assembled and tested in-house. Cabling of the feed system for single beam operation was completed in early summer 2007.

Following the installation of a set of low-noise preamplifiers for the 224 MHz operating frequency, followed by two (224 => 114) MHz down-converter units which transpose the Demonstrator signal to the first intermediate frequency of the regular EISCAT UHF receiver, correct operation of the array was demonstrated in an experiment performed on October 16 and 17, 2007. Using the EISCAT VHF transmitter to illuminate the ionospheric F region overhead the Tromsø EISCAT site, incoherently scattered signals from about 290 km altitude were received by the Demonstrator at approximately 4% signal-to-noise ratio, thus proving both the correct mechanical alignment of the array and the correct behaviour of the phasing system. The signal quality was of so good quality that the signal could be successfully analysed for physical quantities (e.g. electron density, temperatures and Doppler shift) by the normal EISCAT analysis procedure. The array has subsequently been operated in the same single-beam mode on several occasions.

Resources deployed

The work done in the Work Package has continued to be very active. 12.47 person-months were deployed during the period. The required staff effort in this Work Package has been, and will continue to be, much higher than first envisaged. However, non personnel costs are lower than budgeted. The spend-rate after the third reporting period is about 136% (100% = on budget). The Work Package will be allocated more resources in the coming revision of the project plan.

1.3.4.3 LTU

Work progress

The work has been focused in a number of sub-areas, which are each commented below.

Front end design.

The two most critical parts of the front end system required for the verification of the digital time-delay beam steering concept are the LNA board with integrated time synchronization coupler, and the A/D board with integrated filters, amplifiers, and high precision oscillator. These have been successfully designed, produced, and tested. The boards have subsequently been integrated in subsystem units with integrated power supply and control system. On system level, the LNA boards have been housed in temperature controlled housings in order to stabilize performance. The subsystems have been bench tested and shown to meet and exceed required system level performance.

Time synchronization.

Two options are under investigation to reach the stringent requirements for time synchronization. For the *cable based solution*, hardware design is completed and integrated in the front end electronics. Calibration signals are injected in the LNA through PCB strip line

couplers. Simulations have been performed that verify the performance targets of the system. The system will be deployed and tested in the demonstrator array.

The other option is to use **GPS based** time synchronization. Here, measurements and simulations have been performed that verify the possibility of the approach. A first publication has been written on the system, “*A Picosecond Accuracy Timing System Based on LI-only GNSS Receivers for a Large Aperture Array Radar*”.

System level array simulation.

The system level Matlab model has been further refined. It has been used to verify the usage of shorter filter lengths than initially envisaged, thus opening up the possibility of hardware cost reduction for the digital filters. The software will be used to verify the results stemming from the work on the robust beamforming. One publication has been revised as a result of the work, “*Simulation of Post-ADC Digital Beamforming for Large Aperture Array Radars*”, Radio Science 2008.

Antenna Simulations.

The work on antenna simulations has been combined with measurements during the winter period. Antenna elements were placed on the roof of Luleå University of Technology, and the performance was measured during heavy snowfall. It was shown that the performance of the antennas depends heavily on the covering snow layer, which causes a centre frequency shift. One publication has been written based on the results, “*Performance of a Yagi Antenna During Snowfall*”. Based on these results the simulation models will be developed to allow modelling of the behaviour. The results also allow precautions to be taken at this early stage of the design process to hinder performance degradation during winter.

Low complex adaptive beamforming.

The theories and algorithms required for ultra-low complex adaptive beamforming have been developed. The work has resulted in a first scientific publication, “*A Hierarchical approach to adaptive estimation*“. The low complexity of the algorithms can be exploited to allow adaptive beam forming in large array, such as the EISCAT_3D system. Feasibility tests are planned in the demonstrator array during autumn 2008.

Adaptive polarization

Following decisions in the General Assembly, an addition of work has been made in the field of adaptive polarization estimation. The target is to develop procedures enabling the receiving system to dynamically and rapidly adapt its polarization response to match the polarization of the incoming wave. The work has been initiated during the spring 2008. Publications are expected during the summer of 2008. The work is planned to continue as a part in WP9, Signal processing.

Resources deployed

PhD students and regular staff have been working with the Work Package. Total man effort amounts to 32.06 person-months. The personnel have attended internal project meetings and conferences. Computers, software, hardware, and laboratory accessories have been purchased for use in the Work Package. Scholarships have been granted students working in the project.

Milestones and deliverable achievements

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Subtask No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
Month 30	Receiver VLSI electronics design completed; design committed to silicon		LTU	Month 30	Month 32 [note]
Month 32	VLSI components successfully tested and validated		LTU	Month 32	Month 35 [note]

Major meetings and workshops organised under this activity

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
	No major meeting during the reporting period			

Major deviations from the project plan and corrective measures

The Work Package is task wise on target though overspending. This will be accounted for in the revision of the project plan.

[Note] The decision was at an early stage in the project taken to abandon the VLSI solution for the use of discrete components. The front end design based on discrete components has now been completed and front end components based on a discrete solution have been integrated and validated on system level.

1.3.5 Work Package 5: Interferometry

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months		11.58			11.58

Short description and planned results

Objectives: Studies of very fine scale plasma phenomena require the routine employment of interferometric techniques in order to resolve features whose spatial scales are less than the scales of the scattering volumes defined by range gating and the transmitter beam geometry, or the intersection geometry of transmit and receive beams. This work package includes studying interferometry-specific requirements for the receive systems and developing designs for the hardware and software required to make interferometric observations a routine component of the radar operation.

Description of work: - Comprehensive evaluation and characterization of different design options for an interferometric receiver antenna array for imaging of radar scattering targets. A progress report will be delivered at the 2005 EISCAT Workshop. - Definition of data acquisition and phase calibration performance requirements for interferometric array. This task includes identifying and defining interferometry-specific requirements for absolute synchronization to UTC, through the use of GPS or otherwise. - Implementation, characterization, and evaluation of imaging inversion algorithms. In interferometric imaging, the instrument detects only part of the true brightness distribution. The resulting raw image is therefore an incomplete and noisy estimate which must be cleaned and smoothed through the application of appropriate inversion algorithms. In this task, different algorithms will be investigated, implemented and their performance evaluated against imaging criteria derived from simulations. - Design of visualization techniques for multi-dimensional imaging radar results. Presenting the data from the imaging radar in a way that conveys its physical significance is a great challenge. This task addresses the development of techniques for presenting multi-dimensional data and includes the development and validation of a minimum set of visualisation primitives, sufficient to validate the design concept when run on data generated by the demonstrator array operated in an imaging mode.

Deliverables: D5.1 EISCAT_3D Radar Imaging Array Configurations Report, due 7 August 2006 ✓
D5.2 EISCAT_3D Radar Imaging Algorithms Report, due 21 May 2007
D5.3 EISCAT_3D Radar Multidimensional Imaging Radar Data Visualisation Report, due 5 November 2007

Milestones and expected result:

Month 12: Interferometry-specific requirements for time synchronization and phase stability identified and laid down; handover meeting with WP12 ✓
Month 15: Imaging Array Configurations Report completed (D5.1) ✓
Month 25: Imaging Algorithms Report completed (D5.2) ✓
Month 30: Multidimensional Imaging Radar Data Visualisation Report completed (D5.3)
Month 46/47: Validation of imaging algorithms on demonstrator array

Management summary

The Work Package functions well and is on track. It has been agreed to delay the two remaining deliverables.

1.3.5.2 UIT

Work progress

The Work Package Work Package functions well and is on track in terms of deliverables.

The deliverable D5.2, EISCAT_3D Radar Imaging Algorithms Report, was submitted according to the agreed re-schedule. A supplement to the report will be published in June 2008.

Resources deployed

Project employed staff have been working with the Work Package. Total man effort amounts to 11.58 person-months.

Milestones and deliverable achievements

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Subtask No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
D5.2	EISCAT_3D Radar Imaging Algorithms Report		UIT	21 May 2007	Re-scheduled and delivered, as planned, 30 Jan 2008
D5.3	EISCAT_3D Radar Multidimensional Imaging Radar Data Visualisation Report		UIT	5 Nov 2007	Re-scheduled to 15 Jan 2009

Major meetings and workshops organised under this activity

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
	No major meeting during the reporting period			

Major deviations from the project plan and corrective measures

The Work Package is on track.

1.3.6 Work Package 6: Active Element

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months	0.14				0.14

Short description and planned results

Objectives: This package covers the detailed design of the active component of the radar including generation, modulation and distribution of the RF signal, RF power generation, the transmitting antenna system, the control and monitoring systems and, if required, the necessary transmit receive switching and receiver protection.

Description of work: At the beginning of this WP, a handover meeting will be held jointly with WP3 and WP7. Starting from the specifications laid down in D3.2 (EISCAT_3D Radar Active Element Subsystem Report) and D7.1 (Distributed Control and Monitoring Interim Report), a detailed design for the active element topology will be worked out. Based on this, the work will be split into several sub-packages, interfaces between these will be defined, and an Active Element Interim Report will be issued. The number and scope of the sub-packages will depend on technology selections made in WP3 and WP7 and so cannot be completely specified initially; the organisation of this work package therefore needs to be revisited once the Interim Report is available.

Some sub-packages will however be required in all scenarios: - Design of the RF exciter / modulator system - Design of RF power amplifier modules - Validation of power amplifier design - Design of element antennas - Design of antenna array and simulation of antenna performance - Design of built-in test equipment (BITE) - Global simulation of active element performance

At least three work meetings will be called during the course of this WP: - WM 6.1 (month 19, active element topology design finalised): Active Element Interim Report drafted, sub-WPs defined and assigned), - WM 6.2 (month 30): WP-internal meeting - WM 6.3 (month 42): Drafting of Active Element Design Document. The draft Design Document will be made available for public comment before or by month 43.

Deliverables: D6.1 Active Element Interim Report, due 5 November 2007
D6.2 EISCAT_3D Radar Active Element Subsystem Design Document, due 1 December 2008

Milestones and expected result:

Month 19: Active element topology design finished; number and scope of sub-packages defined and staff assigned
Month 30: WP6 meeting
Month 43: EISCAT_3D Radar Active Element Subsystem Design Document available in draft form for public comment

Management summary

The Work Package has started but is delayed. The Active Element work is depending on the completion of Work Package 3: Evaluation of options for the active element. Work Package 3 is not ready to hand over yet.

1.3.6.1 EISCAT

Work progress

The first test bed for evaluating the performance of the NXP high-power RF FETs has been completed. Initial tests have verified the manufacturer's specification for operation at the 300-watt level. The relatively high thermal resistance of the device-heat sink thermal interface has been found to be a limiting factor during extended full-power operation. An improved test bed, incorporating a copper heat spreader, has been designed and is now being manufactured.

In November, 2007, all high power RF equipment was transferred from Tromsø to the Kiruna EISCAT site. The test bed has now been re-established and preparations for pulsed high-power tests are currently in progress.

Resources deployed

One person has been working in the Work Package. Totally about 2.5 days were deployed during the period.

Milestones and deliverable achievements

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Subtask No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
Month 19	Active element topology design finished; number and scope of sub-packages defined and staff assigned		EIS	Month 19	Not expected before Month 43
D6.1	Active Element Interim Report		EIS	5 Nov 2007	Not expected before Dec 2008

Major meetings and workshops organised under this activity

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
	No major meeting during the reporting period			

Major deviations from the project plan and corrective measures

The work is behind schedule. The Work Package will be rescheduled and resources will be redistributed in the revision of the project plan.

1.3.7 Work Package 7: Distributed Control and Monitoring

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months	0.00				0.00

Short description and planned results

Objectives: Both the global control and monitoring of the whole facility and the low-level control and monitoring of the thousands of distributed antenna elements within the individual arrays place large demands on the support systems and software. This work package includes an evaluation of existing concepts and strategies for managing real-time, geographically widespread systems and the design and validation of a flexible, expandable and (insofar as possible) future-proof control and monitoring system.

Description of work: Information and literature research will be conducted to establish the current state of the art in real-time control systems architecture and software. Standards (both internationally agreed and established de facto) will be investigated for suitability. Communications protocols, in particular the Internet Protocol, will be reviewed. Contacts to industry, owners, and operators of other large-scale scientific installations, in particular the latest generation radio astronomy arrays (including LOFAR) and accelerator laboratories (CERN, DESY and others) will be established and study visits will be made to some of these establishments. Specific control/monitoring performance requirements resulting from the design choices made in WP3, WP4 and WP9 (e.g. latency, response times, throughput) will be identified at handover meetings and project meetings. The most promising already existing control system software packages identified in the initial part of the work package (commercial as well as public-domain) will be evaluated against the project-specific requirements. Budgetary costing estimates for commercial packages will be requested from industry and licensing and IPR-related aspects of public-domain packages will be clarified. User-friendliness, robustness, fault recovery, maintenance, vendor support and cost-of-ownership aspects of the different alternatives will be assessed. If no existing control system is found that meets the specific requirements of the EISCAT_3D project, the next-best alternatives will be revisited with particular attention to ease of modification, expandability, and cost. Facts, results, costings and conclusions and recommendations will be collated into a draft report and considered at a "Control and Monitoring" project meeting. For the purpose of validating the chosen design strategy, a time-limited license for the chosen package will be procured and a strictly reduced set of control and monitoring software primitives, sufficient to handle the basic functionality of the WP4 demonstrator, will be coded and mated with the demonstrator. A final Control and Monitoring Subsystem Report will be produced.

Deliverables: D7.1 Basic set of control and monitoring software primitives for the WP4 Demonstrator, due 5 November 2007
D7.2 EISCAT_3D Radar Control and Monitoring Subsystem Report, due 5 May 2008

Milestones and expected result:

Month 6: Handover meeting with WP12; important array-internal network hardware parameters frozen ✓
Month 6: Project meeting jointly with WP4 and WP9; receiving-array control, monitoring and communication requirements defined ✓
Month 16: Handover meeting jointly with WP3, WP6 and WP9; active element control, monitoring and communications requirements defined ✓
Month 30: Software primitives for demonstrator ready (D7.1)
Month 36: Control and Monitoring Subsystem Report issued (D7.2)

Management summary

The Work Package is going but will need much less effort than first planned. The package will be resized in the revision of the project plan. No effort has been spent during this reporting period. That is according to the revised target.

Milestones and deliverable achievements

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Subtask No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
Month 16	Handover meeting jointly with WP3, WP6 and WP9; active element control, monitoring and communications requirements defined		EIS	Month 16	Ad-hoc spring 2008
D7.1	Basic set of control and monitoring software primitives for the WP4 Demonstrator		EIS	5 Nov 2007	Expected Dec 2008

Major meetings and workshops organised under this activity

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
	No major meeting during the reporting period			

Major deviations from the project plan and corrective measures

The Work Package is progressing in accordance with the revised schedule. The size of the Work Package will be reduced in the revision of the project plan.

The deliverable: D7.1 Basic set of control and monitoring software primitives for the WP4 Demonstrator is mostly ready since existing know-how is reused. The final EISCAT_3D Test Array specific software will be made when all hardware is in place. This is expected to happen autumn 2008. D7.1 will be published soon thereafter.

1.3.8 Work Package 8: Data archive and distribution

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months				12.58	12.58

Short description and planned results

Objectives: This work package covers several areas related to the efficient collection and distribution of large volumes of data across the geographically extended radar installations and between the instruments themselves and the user and consumer communities. The work package includes the design of the Data Distribution System and the Secure Data Archive, as well as the design of Data Visualisation and Data Assimilation tools to allow users and consumers to access and utilise the output of the new facility efficiently and effectively.

Description of work: (1.) An initial high-level design study into possible system structure, functionality and hardware solutions available for various levels of resource will be undertaken. Results will be presented in a report to be made available for public consultation before or by the EISCAT International Workshop 2005. (2.) Based on the input received, the initial design will be iterated on to produce a high-level baseline specification of the overall system and the system specification document will be updated to reflect the required changes. (3.) An initial low-level design relating to computing hardware, data storage, and network solutions for a secure archive will be undertaken, including evaluation of the relative merits of on-line and near on-line storage. (4.) Two parallel, initial low-level design studies into structure, functionality, and interfaces of viz. the raw data archive and the analysed data archive will be undertaken, incorporating database functionality and metadata handling. (5.) Draft design documents for the above low-level studies will be produced for discussion by EISCAT staff, the user community, and other consortium partners. Based on consultation and inputs received, the low-level design studies will be refined and completed and a final design study documents for these components produced. (6.) A low-level design study will be undertaken for the “access layer” software, which would form the link between the database and the applications software, and allow inter-operability between different data sets. (7.) Low-level design studies for new visualisation systems for both raw and analysed data will be carried out. (8.) A low-level design study for software to combine multi-instrument data into “value-added” data products, to allow assimilation of data into models and visualisation of multi-instrument data sets will be performed.

Deliverables: D8.1 High-level system structure document, specifying possible system configurations available for various levels of resource, due 3 February 2006 ✓
D8.2 Low-level design document: Networking and data storage requirements and favoured hardware solutions, due 26 January 2007 ✓
D8.3 Low-level design document: Access layer software, due 20 July 2007
D8.4 Low-level design document: Raw data visualisation system, due 18 February 2008
D8.5 Low-level design document: Analysed data visualisation system, due 18 February 2008
D8.6 Design document for multi-instrument data combination, data display and data assimilation functionality, due 15 August 2008

Milestones and expected result:

Month 4: Initial design document (completion of task 1) ✓
Month 10: Revision of initial document (completion of task 2) ✓
Month 16: Initial designs of raw and analysed data archives and hardware system (completion of tasks 3, 4 and 5) ✓
Month 26: Design documents for raw and analysed data archives and hardware system finalized (completion of tasks 6)
Month 29: Access layer software design finalized (completion task 7)
Month 34: Completed designs for raw and analysed data visualisation systems (completion of tasks 8 and 9)
Month 43: Completed design for multi-data visualisation and assimilation software (completion of task 10, and end of Work Package).

Management summary

The Work Package functions well but will undergo some changes when the project plan is revised. The RAL personnel have focused on design study critical areas whereas the tasks that will be part in the revision have attained less priority by the RAL group.

1.3.8.4 RAL/STFC

Work progress

Work has continued on confirming the detailed requirements for the data distribution and archive system, focusing on identifying and refining specific hardware solutions for the remote sites and the central archive, along with the requirements for data access and communications between the sites. Because of the agreed changes to the resources assigned to this package, some of the milestones planned for this year have been deferred, but there has been substantial progress in identifying suitable vendors capable of supplying systems which perform at the required level – this is important given that some of the requirements of data flow and storage capacity are very challenging. The emphasis has been on showing that the assumed specifications of the EISCAT_3D data system are achievable with today's technology and this has been successfully demonstrated. We are now working closely with a number of interested companies and hope to involve some of them in the forthcoming “all-hands” meeting in Kiruna scheduled for September 2008.

Resources deployed

In summary, a total of 12.58 person-months have been expended in the third reporting period of the design study.

Milestones and deliverable achievements

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Subtask No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
Month 26	Design documents for raw and analysed data archives and hardware system finalized (completion of task 6)	Task 6	RAL/STFC	Month 26	Deferred
Month 29	Access layer software design finalized (completion task 7)	Task 7	RAL/STFC	Month 29	Deferred
Month 34	Completed designs for raw and analysed data visualisation systems (completion of tasks 8 and 9)	Tasks 8 and 9	RAL/STFC	Month 34	Deferred
D8.3	Low-level design document: Access layer software		RAL/STFC	20 July 2007	Draft available Final expected June 2008
D8.4	Low-level design document: Raw data visualisation system		RAL/STFC	18 Feb 2008	Deferred
D8.5	Low-level design document: Analysed data visualisation system		RAL/STFC	18 Feb 2008	Deferred

Major meetings and workshops organised under this activity

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
	No major meeting during the reporting period			

Major deviations from the project plan and corrective measures

The Work Package is part of the revision of the project plan.

1.3.9 Work Package 9: Signal Processing

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months	2.20				2.20

Short description and planned results

Objectives: The effective operation of the distributed components of the receiver, the post-set forming of multiple antenna beams with arbitrary polarisations, the automatic beam pointing checking and correction, the adaptive interference excision and the effective decoding of the transmitted radar modulations place heavy demands the hardware and software signal processing components. This work package includes a critical assessment of different signal processing strategies and topologies and the design and validation of a comprehensive, expandable set of hard- and software processing primitives.

Description of work: The structuring of the work and the number and scope of sub-packages will be largely governed by technology selections made in WP4 and WP12 and so cannot be completely specified initially; the organisation of this work package therefore needs to be revisited at the Month 6 Project meeting and frozen by Month 10.

Deliverables: D 9.1 Basic set of processing primitives required for the operation of the WP4 demonstrator, due 3 November 2008
D 9.2 EISCAT_3D Radar Signal Processing Subsystem Report, due 2 March 2009

Milestones and expected result:

Month 6: Project meeting jointly with WP4 and WP7; different design alternatives for the receiver hardware evaluated in terms of receiving-array internal data communications protocols, formats, data rates etc. ✓
Month 9: Project meeting jointly with WP4 and WP7; receiver design concept defined, work divided up into sub-packages ✓
Month 42: Processing primitives validated in simulator mode and delivered to WP4 for in-system test phase (D9.1)
Month 46: Radar Signal Processing Subsystem Report completed (D9.2)

Management summary

This Work Package is running behind schedule. Certain tasks have been identified as less critical whereas new tasks within the Work Package will require resources. The Work Package will be reprioritised and rescheduled. Currently not assigned Partners will join the Work Package.

1.3.9.1 EISCAT

Work progress

Work has focused on digital down-converter units (DDCs). The DDCs will be used to band-limit and re-sample the array data to reduce the demands on the fibre-optic links and the beam-former system. DDC programming, testing and verification has mainly taken place at the EISCAT Sodankylä site.

Resources deployed

Totally 2.20 person-months were deployed during the reporting period.

Milestones and deliverable achievements

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Subtask No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
	No milestones nor deliverables during this period				

Major meetings and workshops organised under this activity

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
	No major meeting during the reporting period			

Major deviations from the project plan and corrective measures

The Work Package is included in the revision of the project plan.

1.3.10 Work Package 10: New techniques

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months		12.38			12.38

Short description and planned results

Objectives: The unique capabilities of the proposed new incoherent scatter radar will make it possible to undertake continuous observations of different physical parameters in the polar upper atmosphere. Long and continuous time series of such parameters are of vital importance for understanding the climatic conditions in the upper parts of the atmosphere. This work package will exploit the use of such data for climatic studies. The application of such long time series for continuous correction for ionospheric disturbances in remote sensing polar orbiting satellite data and especially in Galileo, as well as GPS data, will be addressed. The application of such data in space weather studies and for the correction of SAR remote sensing data will also be investigated.

Description of work: (1.) Investigation of the feasibility of using long time series of incoherent scatter radar data for climatic studies, using the existing EISCAT data base and other data sources. (2.) Investigation of the feasibility and utility of using long incoherent scatter radar data time series for improving the ionospheric corrections models used by the Galileo and GPS systems and remote sensing polar orbiting satellites. Applications in space weather studies and for the correction of SAR imagery will also be investigated.

Deliverables: D10.1 Progress Report, due 1 May 2006 ✓
 D10.2 Progress Report, due 30 April 2007 ✓
 D10.3 Progress Report, due 5 May 2008
 D10.4 EISCAT_3D Radar Climatic Studies Feasibility Study report, due 1 April 2009
 D10.5 Feasibility Study report: Use of Long Time Series ISR Data for Improving Ionospheric Correction Models, due 1 April 2009

Milestones and expected result:

Month 12: Project meeting; progress report (D10.1) ✓
 Month 24: Project meeting; progress report (D10.2) ✓
 Month 36: Project meeting; progress report (D10.3)
 Month 46: Project meeting; deliverables issued (D10.4 + D10.5)

Management summary

The Work Package work is progressing well. A new study area will be explored and the Work Package will be moderately extended to accommodate this.

1.3.10.2 UIT

Work progress

The Work Package progresses as planned. The third progress report (D10.3) is slightly delayed but will be published soon.

Resources deployed

Two persons have deployed totally 12.38 person-months during the reporting period.

Milestones and deliverable achievements

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Subtask No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
D10.3	Third Progress Report		UIT	5 May 2008	Expected June 2008

Major meetings and workshops organised under this activity

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
	No major meeting during the reporting period			

Major deviations from the project plan and corrective measures

The Work Package progresses well. It will be extended to accommodate a new study area. This will be implemented in the coming revision of the project plan.

1.3.11 Work Package 11: Implementation Blueprint

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months					

Short description and planned results

Objectives: The goal of the Design Study is to produce a complete specification and set of appropriately tested and costed design blueprints suitable to support a detailed procurement exercise as the initial task of a successor project which should construct and commission the new radar. This work package will start towards the end of the overall study and co-ordinate the preparation of the final deliverable design documents across the other work package areas.

Description of work: Assimilation of results, review, and construction of complete system specification. Preparation of detailed blueprints. Identification of suppliers. Implementation time line. Definition of future research and development projects. Final deliverable preparation

Deliverables: D11.1 EISCAT_3D Radar Final Design Study document, due 3 March 2009

Milestones and expected result:

End of Project: Final Design Study document (D11.1)

Management summary

The Work Package was started a few months early to handle a specific task. The Work Package has been deliberately kept dormant during this reporting period.

Milestones and deliverable achievements

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Subtask No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
	None during the reporting period				

Major meetings and workshops organised under this activity

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
	No major meeting during the reporting period			

Major deviations from the project plan and corrective measures

The Work Package started early in order to prepare needed material. The final design document to be delivered at the end of the project will look different from first thought. The plan to create detailed blueprints has been dropped. The Work Package is included in the coming revision of the project plan.

1.3.12 Work Package 12: Networking and reference time and frequency

Contractors and deployed human effort

Participant number	1	2	3	4	
Participant short name	EISCAT	UIT	LTU	RAL/STFC	Total
Person-months	2.02				2.02

Short description and planned results

Objectives: At each antenna array, high quality timing and frequency reference signals must be generated and distributed to all elements to achieve the stringent synchronisation (to better than 50 ps) required for the overall system to function as intended. Also, command data must be passed to each array element and the data streams from the receiving elements must be collected, concentrated, and routed onto a high-capacity backbone network. This work package covers the design of the time and frequency reference systems and the array-internal fibre-optic network topology and communication protocols.

Description of work: Information and literature research will be conducted to establish the current state of the art in precision time and frequency keeping and distribution. Contacts to operators of large radio astronomy arrays (e.g. Owens Valley, Merlin, Westerbork, and LOFAR) will be established and study visits will be made to some of these. Specific timing, frequency, and synchronisation requirements resulting from design choices made in WP3 and WP4 will be identified. Existing techniques for multiplexing time and frequency reference signals onto data communications networks will be investigated and resulting network performance requirements identified. A time and frequency reference system and an array-internal network architecture meeting the performance requirements laid down in the Radar Performance Specification Document and WP3 / WP4 design documents will be designed. For the purpose of validating the chosen design, a minimum time/frequency system, sufficient to handle the basic functionality of the WP4 demonstrator, will be assembled from leased and/or borrowed equipment and mated with the demonstrator. A final Time, Frequency, and Synchronisation Subsystem Report will be produced.

Deliverables: D12.1 EISCAT_3D Radar Time, Frequency and Synchronisation Subsystem Report, due 1 May 2007
D12.2 EISCAT_3D Radar Array Networking / Communication Report, due 1 June 2007

Milestones and expected result:

Month 6: Specific requirements of WP3/WP4 and internal network performance specifications dictated by time/frequency keeping defined; handover meetings with WP3/4 ✓
Month 12: Specific requirements of WP5 defined; handover meeting with WP5 ✓
Month 42: Minimum time/frequency system assembled
Month 45: Minimum time/frequency system validated in Demonstrator run.

Management summary

The work has progressed on schedule.

1.3.12.1 EISCAT

Work progress

Media converters, serial-to-parallel converters and other data communications hardware for the Test Array have been selected and a fast serial optical link has been configured and run in bench test mode.

Resources deployed

One engineer has been involved in the Work Package. Totally 2.02 person-months were deployed during the reporting period.

Milestones and deliverable achievements

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Subtask No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
D12.1	EISCAT_3D Radar Time, Frequency and Synchronisation Subsystem Report		EIS	1 May 2007	Expected Nov 2008
D12.2	EISCAT_3D Radar Array Networking / Communication Report		EIS	1 June 2007	Expected Dec 2008

Major meetings and workshops organised under this activity

Date	Title/subject of meeting /workshop	Location	Number of attendees	Website address
	No major meeting during the reporting period			

Major deviations from the project plan and corrective measures

The Work Package has grown somewhat compared with the initial assessment. The Work Package will be included in the coming revision of the project plan.

The two deliverables due during the reporting period have been postponed into the fourth period.

2. List of deliverables

Consolidated list of all deliverables planned and/or achieved during the reporting period

Task number	Deliverable No [sort order]	Deliverable Name	Workpackage /SubTask No	Delivered by Contractor(s)	Planned (in months)	Achieved (in months)
WP1	D1.3	Design Study Progress + Financial accounting Report*		EIS	15 June 2008	10 June 2008
WP3	D3.2	EISCAT_3D Radar Active Element Subsystem Report		EIS	1 Jan 2007	Draft available. Excepted finalisation Oct 2007 delayed until Nov 2008
WP5	D5.2	EISCAT_3D Radar Imaging Algorithms Report		UIT	21 May 2007	Re-scheduled and delivered, as planned, 30 Jan 2008
WP5	D5.3	EISCAT_3D Radar Multidimensional Imaging Radar Data Visualisation Report		UIT	5 Nov 2007	Re-scheduled to 15 Jan 2009
WP6	D6.1	Active Element Interim Report		EIS	5 Nov 2007	Not expected before Dec 2008
WP7	D7.1	Basic set of control and monitoring software primitives for the WP4 Demonstrator		EIS	5 Nov 2007	Expected Dec 2008
WP(D8.3	Low-level design document: Access layer software		RAL/STFC	20 July 2007	Draft available Final expected June 2008
WP8	D8.4	Low-level design document: Raw data visualisation system		RAL/STFC	18 Feb 2008	Deferred
WP8	D8.5	Low-level design document: Analysed data visualisation system		RAL/STFC	18 Feb 2008	Deferred
WP10	D10.3	Third Progress Report		UIT	5 May 2008	Expected June 2008
WP12	D12.1	EISCAT_3D Radar Time, Frequency and Synchronisation Subsystem Report		EIS	1 May 2007	Expected Nov 2008
WP12	D12.2	EISCAT_3D Radar Array Networking / Communication Report		EIS	1 June 2007	Expected Dec 2008

* This document

Bold: Achieved Deliverables (available on the web).

3. Use and dissemination of knowledge

Conference presentations resulting from the project

Date	Title/subject of meeting /workshop	Location	Website address
6 – 10 Aug 2007	13th International EISCAT Workshop	Mariehamn, Åland	http://www.sgo.fi/Events/EISCAT2007
	Rico Behlke, V. Belyey and C. La Hoz: The use of long-time EISCAT data series for improving ionospheric corrections models: First results		
	V. Belyey and Cesar La Hoz: First results of an open-source based program for acquiring long time series of ionospheric parameters from the EISCAT Madrigal database		
	V. Belyey, T. Grydeland and Cesar La Hoz: Interferometric imaging (WP5) for EISCAT_3D		
	T. Grydeland, Cesar La Hoz and V. Belyey: Phase calibration of an aperture synthesis imaging array by means of incoherent scattering		
	Derek McKay, I. Finch, S. Crothers and I. McCrea: Data archive and distribution systems for the EISCAT_3D radar		
	John Kelly: The next generation of incoherent scatter radars: AMISR, EISCAT_3D, and beyond (invited)		
	Tore Lindgren, G. Stenberg, M. Larsmark, J. Borg and J. Johansson: Time synchronization in the EISCAT_3D Incoherent Scatter Radar		
	Mike Lockwood: EISCAT: Scientific strategy for the next five, ten and thirty years (invited)		
	Gustav Stenberg: Presentation of the Large Aperture Array Radar Simulation Environment (LAARSE), a Matlab simulation tool developed for the EISCAT 3D radar		
	Gudmund Wannberg: EISCAT_3D: Background, progress, current status and next steps (invited)		

Patentable discoveries resulting from the project

None

Publications resulting from the project

1. G. Stenberg, T. Lindgren, J. Johansson, "Picosecond Accuracy Timing System Based on L1-only GNSS Receivers for a Large Aperture Array Radar". Accepted for publication at ION GNSS 2008, Savannah, Georgia, USA.
2. G. Stenberg, J. Borg, J. Johansson, M. Lundberg Nordenvaad, G. Wannberg "Simulation of Post-ADC Digital Beamforming for Large Aperture Array Radars". Under revision for Radio Science 2008.
3. T. Lindgren, J. Ekman, "Performance of a Yagi Antenna During Snowfall". Submitted to ISAP2008, Taiwan.
4. M. Lundberg Nordenvaad, J. Ståbis, "A Hierarchical approach to adaptive estimation". To be submitted to IEEE Transactions on Signal Processing.

Public Relations in connection with the project

In addition to presentations at formal conferences and workshops as already detailed, the EISCAT_3D project is included in all presentations made to visitors to the existing EISCAT facilities, and in all general presentations on the EISCAT Scientific Association at meetings throughout the World. The presentations include the goals, rationale and progress updates on the project as well as summaries of the roles of the project partners and the European Union's Sixth Framework project as both a funding source and supporter of the work.

Web-based activities in connection with the project

All-year: The project web-site is constantly updated.

Other actions in connection with the project

Date	Title/subject of meeting /workshop	Location	Website address
31 May – 1 June 2007	EISCAT Council meeting, review of EISCAT_3D project	Nagoya, Japan	Internal meeting
6 – 10 Aug 2007	13th International EISCAT Workshop	Mariehamn, Åland	http://www.sgo.fi/Events/EISCAT2007/
5 Nov 2007	EISCAT Management Committee Meeting, review of EISCAT_3D project	Oslo, Norway	Internal meeting
15 – 16 Nov 2007	EISCAT Council meeting, review of EISCAT_3D project	Helsinki, Finland	Internal meeting
15 Feb 2008	EISCAT Management Committee Meeting, review of EISCAT_3D project	Tele-conference	Internal meeting

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