USN - Unité scientifique de la station de Nançay

Rapport Hcéres

agence d'évaluation de la recherche
et de l'enseignement supérieur

Section des Unités de recherche

Evaluation report

Research unit :

Station de Radioastronomie de Nançay

(USN) - USR 704

de l'Observatoire de Paris

April 2009

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Le Président de l'AERES	Section des unités de recherche
	Le Directeur
Jean-François Dhainaut	**Pierre Glorieux**

april 2009

Evaluation report

The research unit :

Name of the research unit : **Station de Radioastronomie de Nançay**

Requested label : **USR**

N° in case of renewal : **704**

Head of the research unit : **Mme Nicole CORNILLEAU-WEHRLIN**

University or school :

Observatoire de Paris

Other institutions and research organization:

CNRS

Date(s) of the visit :

April 8th and 9th of 2009

Members of the visiting committee

Chairman of the committee :

Mr Michael GREWING, Institut de radioastronomie millimétrique, Grenoble, and Institute for Astronomy and Astrophysics, University of Tuebingen, Germany

Other committee members :

Mr Nicolo D'AMICO, Observatoire de Cagliari, Italie

Mr Tim BASTIAN, National Radio Astronomy Observatory, Charlottesville, USA

Mr Philippe CAIS, Observatoire de Bordeaux

Mr Bernard LAZAREFF, Institut de radioastronomie millimétrique, Grenoble

Mr Jan-Erik WAHLUND, Swedish Institute of Space Physics, Uppsala, Suède

CNU, CoNRS, CSS INSERM, (représentant INRA, INRIA, IRD…) representatives :

Mr Jonathan BRAINE, Laboratoire d'Astrophysique de Bordeaux, for CoNRS

Mr Laurent CAMBRESY, Observatoire astronomique de Strasbourg for Conseil National des Astronomes et Physiciens(CNAP)

Mr Stéphane CORBEL, CEA/IRFU/AIM for CNU

Observers

AERES scientific representative :

Mme Rosine LALLEMENT

Research organization representatives :

Mr Daniel EGRET, President of the 'Observatoire de Paris'

Mr Jean-Marie HAMEURY, CNRS/INSU Deputy Director (partly)

Mr Alain CASTETS, 'Chargé de Mission' CNRS/INSU

1 • Short presentation of the research unit

The Radioastronomical Station at Nançay has a total staff of 49 persons. A number of scientists should, however, be counted in addition because they are the scientific leaders of activities and projects at the station, despite the fact that these scientists are based in other locations (Paris, Meudon and Orléans).

- Permanent Researcher Staff : 1 CNRS Directeur de recherche
- Permanent technical and Administrative Staff : 41
  - Administration : 5
  - Technicians : 18
  - Engineers : 18
- Non permanent technical and Administrative Staff : 3 (CDD)
- PHD students : 3
- Post-docs : 1
- Rank A Publications by Nancay members or associate scientists between 15/10/2004 and 15/10/2008 : 149 (Journals: 78 , published Conference Proceedings: 71)
- PHD's defended during the 4 years : 3 (Orleans University)

As shown in this table, there is only one scientist permanently based at the Radioastronomical Station in Nançay who is at the same time the Director.

2 • Preparation and execution of the visit

The Director of the Radioastronomical Station at Nançay had prepared a detailed Agenda for the 2-day visit and supplied a 99 pages long report that described the activities during the last 4 years as well as the activities planned for the next 4 years. This report was distributed well before the visit.

In addition, the Committee members received copies of the White Paper on the future of the Nançay Radio Telescope (NRT) and the report of the Visiting Committee which met in 2007 to discuss the White Paper.

Furthermore, the Committee had asked for a copy of the Report prepared by the previous Visiting Committee in 2005 in order to know what the recommendations had been for the current 4 year period.

The visit itself was organised at the Observatory and included a number of oral presentations: a general presentation by the Director, focused presentations by scientists from the GEPI, LESIA, LPCE and PRISME laboratories and by Staff members of Nançay. Visits to the major facilities and to the laboratories have been conducted, and the Committee had several discussion periods with the Laboratory Council, the Technical and Administrative Staff, the Direction of the Laboratory and with the 'Tutelles'.

Many of the oral presentations contained substantial amounts of new material, mostly due to recent developments during the 6 months which have passed since the original report was written. These presentations were made available to the Visiting Committee as handouts and in electronic form during the visit.

During most of the meeting high level representatives from the CNRS/INSU, the Paris Observatory and the University of Orléans were present. This allowed us to obtain valuable additional information and to discuss e.g. interface questions between these institutions and the Radioastronomical Station at Nançay.

3 • Overall appreciation of the activity of the research unit, of its links with local, national and international partners

Before entering into any details, the Visiting Committee wishes to underline the special role that the Radioastronomical Station at Nançay plays as a service institution that benefits the scientists at the Paris Observatory, at the OSUC (Observatoire des Sciences de l'Univers en Région Centre) in Orléans, which is presently in a build-up phase, at other French institutes, and also scientists from other European and non-European countries. As a consequence, the composition of the Nançay staff is very special as compared to many other Observatories in that there is only one scientist, the Director, who is a permanent staff member at the Station, and all other scientists are based elsewhere. They are nevertheless directly involved in defining observational requirements and guiding the R&D activities, and, of course, in the scientific exploitation of the existing facilities.

As a location for forefront R&D activities with applications at radio wavelengths, the Radioastronomical Station at Nançay is in a unique position because its engineering and technical staff has built-up an enormous amount of experience from the long-term maintenance and operation of the existing facilities, performs state-of-the-art developments e.g. in the field of micro-electronics and software tools, and utilises the existing facilities as a test-bed for new devices in realistic field experiments. The fact that the site is under special protection against radio interference is very important in this respect. This status must be preserved also in the future.

The two large facilities at the Radioastronomical Station at Nançay, the Nançay Radio Telescope (NRT) and the Radio Heliograph (RH) have been opened in 1965 and in 1976, respectively. The fact that they are still in demand by a community of well over 100 scientists is owed to the fact that the instruments and the attached equipment have repeatedly been upgraded and modernised and their operation to a large extent automated. This has allowed the Station to reduce the size of the operators' group to a minimum without too much loss of useful observing time and data quality. It is interesting to note that both facilities are most appreciated for their important contributions to multi-wavelength studies, in the case of the NRT e.g. for the precision timing of pulsars, and in the case of the RH because of the long-term monitoring of active regions on the Sun and in the solar corona.

Scientists at the institutes in Paris, Meudon and Orléans, but also in other French institutes are the primary users of the Nançay facilities, but a very significant fraction of the observing time goes into international collaborations, in many cases with groups who have access to facilities that operate in other wavelength bands, on the ground or in space. Details will be discussed below.

In the local context, the Radioastronomical Station at Nançay plays quite a visible role through its outreach program and the fact that interested groups can come and watch the ongoing activities on the site. This clearly stimulates interest in science, in astronomy in particular, and in the enabling technologies.

4 • Specific appreciation team by team and/or project by project

4.1 The existing facilities

The committee congratulates the Radioastronomical Station at Nançay for the continued and effective operation of its key assets, the Radio Telescope (NRT), the Radioheliograph (RH), and the Decameter Array (DAM). These instruments have performed reliably and have supported productive science programs, despite the recent reduction of manpower assigned to the operation and maintenance of the instruments.

The NRT is a Kraus-type telescope. It operates between 1.1-3.4 GHz and, due to its design, can access 83% of the northern sky. It is currently designated a National Instrument. Following a major upgrade (FORT) it has focused on four key science programs: cometary studies, stellar physics, pulsar studies, and extragalactic studies. Observing proposals are invited two times per year. 12-18 proposals are typically received per semester, of which 30-50% involve a PI from outside of France. A Time Allocation Committee awards the time on the NRT with input from 10 domestic and 10 foreign referees. The collected NRT data serve as the basis for about 10 publications annually. Data have also been collected for a fair number of PhD theses over the past decade. NRT HI and pulsar archival data are readily available through a web-based interface. With the decline of manpower available for operations and maintenance of the NRT, progress has been made in automating monitor and control functions for the purpose of automated or semi-automated observing.

A very large fraction of the observing time is dedicated to pulsar research. In the last few years, pulsar astronomy at Nançay has reached a top class international level. Indeed, the NRT is particularly suited for long term timing programs, and the advanced instrumentation developed, such as the coherent de-dispersor and the associated supercomputing resources, make it prone to yield major achievements. Pulsar observations at Nançay are carried out regularly with a dense sampling in time and allow researchers to investigate the long term timing properties of neutron stars, to determine pulsar proper motions, to detect pulsar glitches, and to provide in turn a reference time base for high energy gamma ray observations such as those carried out with the Fermi GLAST satellite mission. 42 years after their discovery, pulsars are an important tool to study a wide range of physics questions from tests of relativistic theories of gravity to cosmology, from solid-state physics of super-dense matter to the study of super-fluid and super-conducting material, from plasma physics under extreme conditions to the core collapse physics of massive stars. Rarely does the study of a single class of objects allow to perform high-precision experiments for such a diverse range of modern and fundamental physics. In the last ten years or so, pulsar research in Europe has obtained by far the most outstanding results. This collaboration, in which Nançay plays a crucially important role, is currently striving to use all discovered millisecond pulsars to detect gravitational radiation directly or to put meaningful limits on its existence. This is in contrast to the indirect measurements from orbital decay in binary pulsars, for which already a Nobel Prize has been awarded to Hulse & Taylor in 1993. What is predicted is a stochastic background spectrum of waves from energetic processes in the early Universe such as possible phase transitions, cosmic strings and the merger of super-massive black holes. Millisecond pulsars, discovered and timed to high precision, act effectively as the end-points of arms of a huge, cosmic gravitational wave detector sensitive to waves at nano-Hz frequencies that are below the band accessible even to the future LISA. Pulsar timing is therefore complementary to current ground-based and future space-born gravitational wave detectors. The detection of a signal from a gravitational wave background would be a major achievement in the history of physics.

Along with the pulsars, one of the main projects with the Nançay radiotelescope is to obtain velocities in the 21cm HI line for almost all of the galaxies of the local universe (with velocities less than 10,000 km per second). So far over 8,000 galaxies have been observed with the telescope and these velocities and line profiles have been used to map the peculiar velocity field and calculate masses to provide the Tully Fisher relationship using K-band magnitudes. The project is called "Kinematics of the Local Universe" and has generated a series of articles, some of them quite well cited, starting in the 1990s, with the most recent one published in 2007. One of the most interesting figures of these articles is a peculiar velocity field showing how the large-scale structures, in particular something that they call the Great Wall, attract galaxies, resulting in peculiar redshifts or blue shifts depending on which side of the large-scale structures the galaxies are on. The Nançay telescope is the second producer of HI observations after Arecibo, with the emphasis now on HI observations of galaxies from the Sloan Digital Sky Survey. However, while the project has produced interesting results, it is expected to end soon. In agreement with the May 21, 2007 Committee Report on the Nançay radiotelescope, the committee believes that the pulsar research will then be the most important contribution of the NRT, especially in multi-wavelength studies, like e.g. the collaboration with the Fermi group. This should yield particularly interesting and unique results over the next few years.

The RH is a solar dedicated radio telescope comprising 47 antennas deployed in a T-array. Since 1996 it has performed 2D Fourier synthesis imaging at discrete frequencies between 150-450 MHz. It is the only instrument of its kind in the world. Its particular strength is its ability to image a variety of physical processes in the solar corona at multiple frequencies. Among the recent results presented to the committee are Earth-rotation synthesis maps of the quiet solar corona; high resolution imaging obtained by combining data from the RH with data from the GMRT (Giant Meterwave Radio Telescope); the use of type III radio bursts as tracers of particle propagation in the coronal and interplanetary magnetic field; and the radio detection of a CME-driven shock.

Unlike the NRT, the RH observations are not related to individual observing proposals, instead the data are available to the wider community as images, and more recently, calibrated visibility data through the BASS2000 web-based interface. RH data are particularly powerful when used with a variety of ground-based (e.g., VLA, NDA) and space-based (SOHO, TRACE, ACE, WIND, RHESSI, Hinode, STEREO, Coronas, and in future years, SDO, Solar C, Solar Orbiter, and Solar Probe) instrumentation. The RH data can also be used to predict "space weather" in a systematic manner, a subject with rising commercial interest (see also our comments in Section 6). Furthermore, the RH has played a role in developing RFI mitigation techniques in anticipation of FASR, a U.S. initiative. The RH has served as the basis for roughly 8 publications annually.

The Nançay Decameter Array, constructed between 1975 and 1978, is a large filled-aperture phase array originally built in support for the Voyager spacecraft projects. It observes the Sun, Jupiter, and certain other cosmic sources over a frequency band of 10-120 MHz. It performs standalone science but excels when used in collaboration with complementary ground- and space-based instrumentation. In the case of solar observations, the DAM has been used successfully with the RH and numerous spectrographs on the ground, as well as the Ulysses, WIND, and STEREO, missions in space. Similarly, the Decameter Array has been used with the Galileo and Cassini missions for comprehensive radio observations from Jupiter. The committee was impressed by recent work presented on Jovian S-bursts which give information on how electrons are accelerated there. The detailed high temporal resolution observations from the Decameter Array, along with a substantial theory and modelling effort, could be understood in terms of the cyclotron maser instability, modulated by the Jupiter-Io interaction, and possibly by double-layer potential drops along the Jupiter-Io flux tube. The continued collaboration with other radio facilities (e.g., the Ukranian T-shape Radio Telescope UTR-2 and the Low Frequency Array - LOFAR) has potential for the future. Another noteworthy study is the determination of reconnection physics and resulting electron acceleration using solar corona radio emissions observed with several different instruments. Both planetary and solar physics research at Nançay have a broad international basis with many foreign users, reasonable publication rates and attract a fair amount of students that gain valuable experimental knowledge through the use of the Nançay facility. Publications using the Decameter Array data average about 4 annually, along with similar numbers of contributions to conferences. Two PhD theses have been based on DAM data in the last five years. In the future, the Decametric Array should continue its support role in upcoming solar and planetary missions : JUNO, EJSM/JGO, Solar Orbiter, and SDO, and it is expected to serve as a test facility in testing LSS antennas for the proposed LOFAR Super Station at Nançay. A study of such a station is funded by ANR.

4.2 R&D activities connected to future large facilities

The Radioastronomical Station at Nançay has started a number of R&D projects, comprising micro-electronic developments, work on focal plane arrays, conceptual design work on a LOFAR Super Station (LSS), the development of general purpose spectral backends, and last but not least work on the suppression of interference effects at radio wavelengths. In the longer term, these R&D activities can lead to important contributions to the SKA (Square Kilometer Array) and its precursor projects, in the shorter term at least some of these developments could also benefit the existing telescopes, first of all the NRT.

This wide range of development activities is possible, because of the rather unique combination of skills that the Nançay staff has, and which are today much appreciated also at international level.

It is indeed impressive to see how the electronics groups, and the informatics group have shifted over the past 4 years their focus from the operation and maintenance of the existing facilities towards this R&D work. The Nançay team is now an important partner in European projects such as the SKA, and an important contributor to the development of Phased Array systems. As a consequence, the Station receives special funds, e.g. from the ANR, in support of this work.

The Visiting Committee very much welcomes this change in emphasis, and encourages the management to continue along this route without, however, reducing too much the necessary maintenance work on the existing facilities. The discussions showed a general awareness of this balance problem.

Given that the resources are limited, not all of the developments which have been started can be carried on (and expanded) into the future. A clear set of priorities should therefore be established which the entire Nançay staff has to support. Especially for those projects whose future development is strongly affected by decisions that will be taken elsewhere, the activity plan for the next 4 years should be regularly updated. This applies e.g. to a project like FASR (Frequency Agile Soar Radiotelescope), but also to AAVP (Aperture Array Verification Programme) and LOFAR (Low Frequency Array) LSS (LOFAR Super Station).

A clear and reliable long-term perspective is particularly important in areas where the Station engages in multi-year developments, like e.g. with the micro-electronics lab. The big efforts which have been made to build up this lab and to bring it to a level where it can now produce high added-value micro-circuits for dedicated applications, can only be amortized in a stable multi-year planning scenario. This will also be required to justify the increase in the number of staff (at least by one) that is needed to reach the "critical mass" that is necessary to remain successful against strong international competition. The Visiting Committee understands that the University of Orléans has a genuine interest to support such a development in the field of micro-electronics.

4.3 Other technical developments

The Visiting Committee noted with interest the results obtained so far with the CODALEMA project. The Nançay Station has been an ideal platform for the development phase of this experiment that measures the electrical signals from cosmic ray induced particle showers in the Earth's atmosphere. The decision whether or not to expand this experiment into a major new high-energy physics facility, requires in our view a detailed comparison of this with other experimental approaches in terms of scientific potential and cost efficiency. The Committee was not in a position to make such a comparison. In any case, an astroparticle physics experiment was not considered a top priority for Nancay. Indeed, the concern was expressed that the use of active radio transmitters in such an experiment, either on the Station site or scattered about the countryside runs counter to the need for a clean site and other solutions have to be found in agreement between the different actors.

5 • Appreciation of resources and of the life of the research unit

The major resource of the Station is the human capital, the knowledge, experience and competence that the staff has acquired through many years of maintaining, operating, and upgrading the existing facilities, and by embarking on the preparation of major new projects.

The Visiting Committee debated the question whether the engineers and technicians involved in these R&D activities would in future times better be located in an academic environment (e.g. in Paris or Orléans) where the contact and exchange with other teams with complementary knowledge could be more frequent and synergies easier to achieve. In the longer term, when the priorities in French radioastronomy are newly defined, e.g. when the ALMA and SKA projects become operational, thereby changing the role of the Radioastronomical Station in Nancay, this may be an option to keep in mind. In the short-term the presence of the engineers and technicians in Nancay is essential to fully exploit the second major resource of the Station: the existing facilities. This will become an even more demanding task with the arrival of the LOFAR station by the end of 2009, and if the LOFAR Super Station, currently under study, would be built in a few years from now (2012/13?).

The existing radio astronomical facilities at Nancay, located in a protected environment, represent a second major resource. They produce on the one hand scientific results that could not easily be obtained elsewhere, and they serve, on the other hand, as an excellent test-bed to try out new ambitious technical developments that could become highly visible French contributions to the next generation of large, international radioastronomical facilities.

Co-locating the scientists and engineers involved in these preparatory tasks is, however, highly desirable in the eyes of the Visiting Committee, and this question should be considered further (see also Section 6).

As repeatedly stated above, the scientific output from the Nançay facilities is at present mostly produced elsewhere, primarily at the Paris/Meudon Observatory. It requires therefore a special effort to have a feedback to the operators and the engineers and technicians in Nançay to show them what the scientific impact of the Station is. We understand that occasional seminars are one mechanism to provide this kind of feedback, but more could certainly be done.

Another factor which bears on the working atmosphere at the Station relates to the fact that the management has decided to apply a "matrix organisation". This seems necessary in order to cope with both the maintenance and operational needs of the existing facilities on the one hand, and the manpower required for quite a number of R&D projects on the other hand. This means, however, that the staff members work in dynamically changing teams where they report on the one side to the Head of their respective group, and on the other side to the project leaders. It is well known that such a management scheme requires special skills to assure the staff that there is a career perspective and that their skills are used in the best possible ways to achieve the project goals and schedules without putting an overload on anybody. What we have seen of the detailed manpower planning at the Station has shown us how difficult a task this is.

This brings us to a final observation that we want to mention: in view of the fact that the staff is increasingly engaged in long-term projects of global dimension, like the SKA project, there is good reason for a positive outlook and enthusiasm. We saw the serious effort that the Direction and the staff are making but we also noted a certain amount of anxiety. It is difficult for us to judge if there are specific reasons for this or if this relates to the recent widespread concern about the future level of support for basic research in France.

6 • Recommendations and advice

- Strong points :
  - highly skilled staff,
  - reliable operation of existing telescopes,
  - necessary steps taken to automate operational elements,
  - sensible strategic investments in SKA and LOFAR and related R&D,
  - appropriate partnership established with Orléans and OSUC,
  - unique opportunity for students to get hands-on experience with radio-astronomical equipment and observing procedures. A number of PhD theses and lower level certificates have come out of this.

- Weak points:
  - a significant organizational/structural weakness lies in the fact that scientists who are scientifically responsible for projects carried out in Nançay are not permanently based at the station,
  - the decision making process is not always clear or transparent,
  - the station is lacking financial means to adequately maintain the major facilities,
  - with its participation in major international initiatives and associated R&D, the station has not kept pace with necessary test equipment maintenance, replacements, and upgrades.

– Recommendations:

(1) On existing facilities :

For the coming four years the Visiting Committee considers the following four scientific activities as necessary and at the same time as sufficient to give a clearly defined "raison d'être" to the Radioastronomical Station in Nançay :

- for **the NRT** a continuing focus on pulsar observations and the full integration of these observations into the broad range of scientific activities for which they play a key role, both at national and at international level; in principle, another significant fraction of the observing time could go in the future into VLBI observations, and there is a proposal for related investments (see below). This topic needs further discussion, and first of all a clear expression of significant scientific interest from the French community if the project is to be pursued. Unfortunately, the Visiting Committee did not have the time and the opportunity to discuss this matter (see also the comments in Annex 1),
- for the RH a continuation of the systematic monitoring of the activity on the Sun and in the solar corona, and a further strengthening of the coordination between these observations and studies in other regions of the electro-magnetic spectrum, in particular the ongoing and planned space experiments; the same data allow to predict the "space weather". This application, which has a rising commercial interest (for the safe operation of satellites in orbit, but also e.g. for power lines on the ground) could be pursued more aggressively with the aim to provide this service under contract with the respective agencies (government agencies as well as NGOs). The minor upgrades which have been proposed for the RH (online computing) should definitely be made (see also Annex 2). The more substantial upgrades which are under consideration, like a new broadband digital spectrometer; moving a suite of 5 radiometers,
- from Finland to France, and adding the 610 MHz band to the RH, should only be approved after detailed cost estimates and after a study of the impact on the site (including operation, repair, maintenance aspects),
- In the future, scientific collaborations should be continued and/or newly established where the Decametric Array continues during the coming 4 years its support role in upcoming solar and planetary missions: JUNO, EJSM/JGO, Solar Orbiter, and SDO. This seems to be the scientifically most promising approach; the DAM can also serve as a test facility in testing LSS antennas for the proposed LOFAR Super Station at Nançay,
- Prepare and coordinate the scientific participation of the French scientists involved in the LOFAR project. Effective coordination will be needed because the technical know how and the data handling expertise will build up in Nançay whereas the scientific members of the "French LOFAR Consortium" (FLOW) are scattered over 16 different locations, widely distributed across France (and even in Austria). There are indeed many challenges to meet, like the calibration of long baselines on any but the brightest sources in the sky. For the transfer of know how between LOFAR and SKA, the Nançay staff will also have to play a key role.

(2) On new projects :

We understand that at present the top priority for French radioastronomy is an active role in the preparation of the ALMA project at (sub-)mm-wavelengths, and its scientific exploitation as soon as this will start. In the longer term, there is, however, also interest in playing a major role in the next generation long-wavelength radioastronomy project. This will be the Square Kilometer Array (SKA), an international project with a predicted cost of >1.5 billion Euros. It is currently prepared in many countries through laboratory developments and the construction of precursor and pathfinder projects (in Europe, South Africa and Australia).

The Radioastronomy Station at Nançay is actively engaged in European efforts to prepare the SKA, like the SKADS project (square kilometre array design study), and the PrepSKA project (preparatory phase project for the SKA) in which Nançay staff is heavily involved.

How much the Station has changed its orientation towards these new projects is visible from the following Table which shows the manpower distribution (in man-weeks) for the 12 most demanding tasks during the period February to May 2009 :

Etudes SKA : SKADS/PrepSKA/AAVP	129.0
RT – Fonctionnement	84.5
RH + Surveillance solaire - Développements (détails dans feuille RH)	45.0
Informatique	37.0
FAN	27.8
R&D ASIC	26.5
RadioNet	20.0
Station LOFAR	19.0
RT – Développements	17.0
DAM – Développements	17.0
CODALEMA	16.0
RH + Surveillance solaire - Fonctionnement	15.1

Taking 15 weeks as the net working time during this period, the SKA-related activities represent 18% of the total staff effort. We have not been able to study how much this and other numbers vary from trimester to trimester.

The Visiting Committee fully endorses the emphasis put on SKA related activities. The results that have already been produced are impressive and much appreciated by the other European partners and the project management. The SKADS activities receive EC-FP6 funding until the end of 2009. The PrepSKA activities will run until 2012 with EC-FP7 support. As follow-on to the SKADS activities, preparations are under way for the AAVP (aperture array verification program) for which national funding is sought. This program, if funded, would run from 2009 until 2012, i.e. parallel to the PrepSKA activities. When PreSKA and AAVP will end in 2012, *it will be much clearer on which timescale the international SKA project can be implemented, and whether or not further investments into preparatory and/or precursor projects like LOFAR make sense*. Investments into an LSS in Nancay, a French contribution to more LOFAR standard stations in order to significantly improve the u-v-plane coverage of this facility, and a French contribution to the SKA project funding that should ramp up some time after 2012, need to be planned in a careful and balanced manner ahead of time as part in order to decide on the long-term strategy, even if the respective funds differ widely, ranging from about 1 million EUROS for the LSS, to several million EUROS for the LOFAR extension, to tens of millions for the SKA contribution if this project is to be financed by national funding agencies (the current baseline).

For the Visiting Committee all other plans for the preparation and participation in future projects, like e.g. the full-scale CODALEMA project, were clearly of lower priority and should in its view not be continued if this would weaken the activities in the above prioritized areas. The FASR project could become a special case. If it will be funded on the U.S. side, the French groups may want to be involved, and the current development work could become the basis for that.

(3) On the investment plan :

The active participation in ambitious R&D projects in connection with the SKA and the preparatory projects, make the replacement of aging lab equipment and an investment into new, sometimes expensive new diagnostic test equipment mandatory. The Visiting Committee has analysed the current investment plan and offers more detailed comments and suggestions in Annex 1. While in many cases the proposed investment and the related cost appear justified, there are some which the Visiting Committee considers of lesser importance and/or where alternative solutions should be considered that would lead to cost reductions.

What we want to emphasize here is the urgency to create as soon as possible a budget line that allows to maintain the integrity of the NRT and the RH during the coming 4 years. Otherwise corrosion will continue and at some point start to affect the reliability of these facilities.

(4) On Management/Administration :

Discussions with the Conseil d'Unité and ITA have left the Visiting Committee with the impression that the transparency of the decision making processes that lead to the choice and prioritisation of tasks and the corresponding staff assignments, and the communication of the decisions taken needs to be improved. The internally available webpage is useful but apparently not sufficient.

It is recommended that the Direction of the Nancay Station, together with the Directions of the associated observatories, initiate and pursue actively (including periodic reviews) an effort to :
- make sure that the scientific and technical requirements for technical activities (whether initiated from the national community or at international level) are clearly spelt out;
- promote contacts of technical staff, and not only project managers, with the outside world, including the allocating of adequate travel funds.

Another general concern which the Visiting Committee noticed relates to individual long-term career perspectives and to the retention and training of young staff, and the replacement of experienced senior staff lost to retirement. If not already underway, the relevant authorities (from the Paris Observatory, CNRS, University of Orléans), together with the Station management, should develop a staffing roadmap in tandem with the strategic roadmap for R&D and project activities to understand and anticipate future staffing needs.

Finally, it is recommended to complete as soon as possible the work on the "Règlement intérieur" for the Station. With a total staff of 49, distributed over 6 teams, there is a need to define clearly the role of a Technical Director/Coordinator and the Group Leaders "vis-à-vis" the Project Responsibles, and how each of them gets appointed. This is all the more important under "matrix management" which is applied at the Station.

(5) Embedding the Nançay Station in a strong cooperation between the Paris Observatory and the OSUC at Orléans :

The Visiting Committee noted with interest the statements by the President of the Paris Observatory, by the Vice-President of the University of Orléans, and by the Director of the "Observatoire des sciences de l'Univers en Région Centre", that discussions are under way to strengthen the already existing collaboration and possibly increase the engagement of the University of Orléans in the support for the Nançay Station. There are a number of topics of mutual interest, ranging from shared scientific interests, common interests in R&D activities, student training, public outreach etc.. By combining efforts it should be possible to increase the manpower and the financial resources available to the Station, in order to reach "critical mass", e.g. in such important areas as micro-electronics.

(6) On the longer-term future of the Radioastronomy Station at Nançay :

An analysis of the publications that we received shows a significant change in two areas between those published in 1998-2003, and those published from 2004-2008. In particular, only 7% of the papers in the first five years were pulsar papers, whereas 53% were on extragalactic topics. In the second five years, the pulsar papers have increased four-fold to 28%, whereas the extragalactic papers have declined to 33%. Papers on comets and Jupiter account for 12-17% of the total; those on galactic and stellar subjects account for 24-28%. This trend illustrates the changing role of the Nançay facilities, and this change will continue, first of all when LOFAR becomes operational and even more so when the SKA starts operating (beyond 2015). This will definitely shift the centre of gravity of French radioastronomy from operating and exploitation the facilities at Nançay and using these as a test-bed for new technical developments in support of big international projects, towards the full participation in the scientific exploitation of these new projects.

Especially in view of the growing interest of the University of Orléans to participate in the utilisation of the Nançay Station as discussed in the previous point, it seems timely to prepare again a White Paper, this time not only for one facility, the NRT, but for the future role of the entire Station.

(7) Communication in an international environment :

Astronomy has a long tradition for international collaboration and most if not all of the future projects will be realised in large scale European or even global collaborations. For the sake of efficiency, English is usually the language in which documents are prepared and discussions are held. The large majority of scientific publications is also written in English. The European Journal "Astronomy and Astrophysics" is but one example.

The Visiting Committee recommends to make a conscious effort to prepare reports and presentations systematically in English whenever this increases their usefulness. The same applies to the information on the website of the Station. The work of the Visiting Committee would have been eased if this had been systematically applied for this meeting.

To maximize the French role in current and future collaborative projects, this is a mandatory requirement.

Note de l'unité	Qualité scientifique et production	Rayonnement et attractivité, intégration dans l'environnement	Stratégie, gouvernance et vie du laboratoire	Appréciation du projet
Non renseigné	Non renseigné	Non renseigné	Non renseigné	Non renseigné

ANNEX 1

Comments on the Investment Plan proposed for the Nancay Observatory for the Period 2010-2013 :

The following documents had been made available to the Visiting Committee :

(RD #1) - STATION DE RADIOASTRONOMIE DE NANÇAY : Prospective pour les années 2010-2013 which contains the Investment Table on p.85. It is reproduced at the end of this document. The numbers used in the comments below correspond to the entries in this table.

(RD#2) - Proposition d'équipements dans le cadre du CPER 2007-2013 présentée pour la Station de Nançay (submitted by NCW upon a request from the Vis.Comm.)

Gray room for ASICS (#1) 30k€

The need for a "gray" room to manipulate "naked" ASICS is well founded. It is suggested to consider as an alternative a tbd number of laminar flow hoods, harboring work-stations for definite operations. For reference, IRAM purchased laminar flow hoods for about 8k€ each.

Computer for RH (#2) 15k€

This seems well justified as a means of further enhancing the reliability of the RH operations.

VLBI equipment (#3-4) 92k€

As stated already in the recommendations, investment into VLBI is justified only if there is a clear expression of a strong scientific interest from the French astronomical community. Only then would the financial investment and the manpower needed to install and maintain the new equipment be justified. Before taking a final decision, an overall plan should be agreed at EVN level, that specifies how many experiments per year are typically executed at the different VLBI frequencies, and how many of these the NRT is expected to support, given its limitations as a meridian instrument and the limited frequency range that is covered.

To guarantee full functionality of a VLBI station at Nancay, and an active and visible role in the data analysis and interpretation, a small team of scientists and engineers/technicians would have to be formed to learn how to operate the terminal, to monitor and periodically maintain the maser, and last but not least to calibrate and reduce the data. The related manpower costs will quickly outweigh the investment costs.

Computer and networking equipment (#5-13) 189k€

The high speed link for LOFAR is mandatory. Whether it is necessary to have a site-wide gigabit network (need to upgrade all routers, etc.) depends on the installation of new equipment, e.g. the LSS, which is still not decided. The cost of a site-wide network is more than half of the computer equipment budget, and a substantial fraction (12%) of the investment plan. Apparently a much cheaper solution for a site-wide network has been studied that meets the requirements that are firmly known today. The final decision on this budget line should take that into account.

Given the importance that the Visiting Committee has assigned to the collaborative nature of many of the projects executed at Nancay, often with international partners, the purchase of an efficient conferences system seems a good investment. The Observatory should try to buy a system that is fully compatible with the systems used in the partner institutions.

Equipment for numerical developments around RFI mitigation (#14-18) 236k€

RFI mitigation is, of course, a high priority topic. The presentation which we received was mostly on algorithm development. Unfortunately, there was no time to discuss a roadmap with specific developments and strong ties to large projects.

The proposed investments are the largest budgetary item in the list. The investment items aiming at developing numerical receivers (#17) and feeding them with simulated input (#16, 18) seems relatively better justified than those aimed at capturing elusive "natural" RFI signals and analyzing them according to certain data protocols. The cost of the latter (#14, 15) is 119k€.

Equipment for analogue RF electronics (#19-21) 164k€

Since the development of analogue ASICS appears to favor balanced input/output, a differential network analyzer (#19) seems well justified.

The same holds for a noise figure analyzer (#20), although the need may not be that acute, since in RD#2 is is listed as " Mesureur de bruit ou autre" (noise meter or other).

Concerning the tuner (#21) it is commented in RD#2 " Non prioritaire" (not first priority). Based on that comment, we suggest, if such an equipment is finally purchased (presumably for infrequent use) to consider a manual tuner (~5k€ new).

Furthermore, RD#2 lists software tools for ASIC developments, for a non-negligible total of 240k€. These items do not appear in RD#1, and therefore the Committee had no chance to discuss and evaluate them. Possibly, since RD#2 was prepared in 2007, these software tools were already purchased.

Paint for RT and RH (#22) 120k€

If the NRT is to continue operation at least for another 4 years, its mechanical structure needs painting, and the Visiting Committee supports the creation of a budget line for this purpose. This statement was made on the assumption that the total cost would be in the order of 200 k€, including contributions from the Observatoire de Paris and the Département du Cher.

In the Email (of which RD#2 was an attachment) the Director of Nancay stated that a new cost evaluation is under way, and that the cost could be considerable higher. If that turns out to be the case, the question of amortizing such an investment would, of course, have to be addressed The four year period that the Visiting Committee was asked to look at seems rather short for that.

I.2.3 – Proposed investment items for the period 2010-2013 :

Descriptif et nombre	Coût unitaire	Source de financement CNRS /MEN, autres	Coût total
1 Salle grise pour ASIC	30.000	CNRS/MEN	30.000
1 Calculateur RH	15.000	CNRS/MEN	15.000
1 Horloge Maser H pour VLBI	77.000	CNRS/MEN	77.000
1 Convertisseur numérique VLBI	15.000	CNRS	15.000
4 Imprimantes laser	1.500	MEN	6.000
20 PC bureautique	1.000	CNRS/MEN	20.000
5 PC portables	1.500	MEN	7.500
Serveurs	20.000	MEN	20.000
Stockage de données sécurisé	15.000	CNRS	15.000
Serveur NTP	4.000	MEN	4.000
Visioconférence	10.000	MEN	10.000
Robot de gravage CD/DVD	7.000	MEN	7.000
Réseau de site (1 Gbit)	100.000	CNRS/MEN	100.000
1 Oscilloscope 20Gs/s	49.000	CPER	49.000
1 Analyseur de spectres 8 GHz	70.000	CPER	70.000
1 Générateur de données 2,7Gb/s	62.000	CPER	62.000
Plateforme de développement R&D RFI	45.000	CPER	45.000
1 Logiciel de développements numériques	10.000	CNRS/MEN	10.000
1 Analyseur de réseau différentiel	64.000	CPER	64.000
1 Mesureur de bruit	20.000	CNRS/MEN	20.000
1 Tuner pour mesure	80.000	CPER	80.000
Peinture RT et RH	120.000	MEN	120.000
Total			**846.500**

l'Observatoire de Paris USN

Unité Scientifique de Nançay

CNRS CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

Nançay, le 7 Mai 2009

Référence : USN.n° 2009-Dir-09

Objet : Commentaires concernant le rapport du comité de visite de L'AERES à la Station de Radioastronomie de Nançay, USR 704

Tout d'abord, le comité de visite doit être remercié pour l'analyse détaillée qu'il a faite des activités de la Station de Radioastronomie de Nançay. Néanmoins quelques compléments ou remarques ont besoin d'être donnés.

Les commentaires qui suivent sont donnés tels qu'ils sont suggérés au fur et à mesure de la lecture du document.

4 Project by project analysis:

"4.1 The existing activities".

En ce qui concerne le grand radiotélescope décimétrique, **NRT**, il faut mentionner qu'à côté des programmes dédiés à l'observation des pulsars, en particulier multi-longueur d'ondes, contrairement à ce que semble regretter le comité, les programmes dédiés à l'observation des galaxies ne sont pas stoppés ; à la suite du programme KLUN terminé il y a deux ans, un nouveau programme est engagé, le programme NIBLES dédié à l'étude en H1 des galaxies (Pi W. van Driel). Si bien sûr les programmes considérés comme « Key programmes » par le Comité des Programmes sont prioritaires, il semble opportun de ne pas négliger des petits programmes ciblés qui ont l'avantage de donner des résultats rapidement et donc une meilleure visibilité du NRT et de la Station.

En ce qui concerne le Réseau Décamétrique **(DAM)**, Il convient de mentionner que quatre antennes du réseau ont servi de point de départ pour le projet CODALEMA d'étude de la contrepartie radio des gerbes cosmiques, projet qui a été financé par une ANR et qui donne des résultats très prometteurs, avec deux thèses déjà soutenues sur les résultats obtenus par CODALEMA à Nançay. A long terme, des antennes radio pourraient être utilisées seules pour ces études, alors que dans la phase actuelle du

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projet scintillateurs et antennes radio sont utilisés simultanément, ce qui a permis de caractériser les émissions radio dues aux gerbes.
Pour le radiohéliographe **(RH),** il est prévu fin juin un atelier comprenant des experts internationaux en radioastronomie solaire pour faire le point des mises à jour de l'instrument à proposer, compte tenu du retard de FASR.

4.2 R&D (et 6.2)

Le comité de visite remarque qu'il faudra le cas échéant faire des priorités entre les possibles études de R&D envisagées. Ce sera fait si le potentiel humain ne permet pas de mener à bien ces études, qui ne sont pas forcément faites en parallèle mais peuvent être successives ; en particulier, c'est le cas avec le projet FASR de radiohéliographe US qui est en « stand by » actuellement. La station a deux outils pour ces arbitrages, d'une part le comité de direction scientifique (présidé par le Président de l'Observatoire de Paris, comprenant des représentants des tutelles, CNRS/ INSU et j'espère bientôt l'Université d'Orléans, les directeurs des laboratoires associés, des personnalités scientifiques « extérieures »), et entre temps, les réunions de planning trimestrielles, auxquels tous les responsables de projets, d'instruments et d'équipe participent (et de fait ces participants comprennent des membres élus et des membres nommés du Conseil de Laboratoire).
Le comité rappelle que la priorité donnée à Nançay a été la préparation du futur radiotélescope international **SKA** (Square Kilometer Array) qui sera construit – au mieux - entre 2015 et 2020 dans l'hémisphère sud. Il convient de noter, que contrairement à la suggestion faite par le comité, on ne peut pas attendre la fin de PrepSKA pour s'engager dans **AAVP** ; en effet la coordination européenne AAVP a pour but de mener à bien des études complémentaires à celles faites dans le cadre de PrepSKA (FP7) afin de valider le concept européen développé dans le cadre de SKADS (FP6)de réseaux phasés pour les basse fréquences. D'ailleurs AAVP est maintenant partie intégrante de PrepSKA à travers le « WorkPackage 2 » de PrepSKA. De fait l'implication technique dans PrepSKA était très légère par rapport à celle de Nançay dans SKADS, permettant de mettre des forces supplémentaires dans le cadre de AAVP, les répartitions de tâches étant encore en cours de définition. La logique veut que la participation à AAVP soit dans la continuité des études entreprises pour SKADS à Nançay (microélectronique, traitement numérique, élimination des interférences en

coopération avec le LESI). Les résultats des études doivent être fournis à la fin de PrepSKA, et il semble que participer à AAVP fait partie de la priorité de préparer SKA. Dans le cas de LSS (LOFAR Super Station), une demande de R&D soumise à l'ANR a récemment été acceptée.

4.3 Autres développements

En ce qui concerne le projet **CODALEMA,** il faut noter que c'est une coopération fructueuse entre des laboratoires de l'INSU et de l'IN2P3. L'étude de la contrepartie radio des rayons cosmiques entre pleinement dans la thématique pluridisciplinaire mise en avant au CNRS, à savoir les « astroparticules ». Les résultats obtenus jusqu'à présent sont très encourageants et ont donné lieu entre 2004 et 2008 à 9 articles dans des revues à comité de lecture, 26 communications et 6 thèses, dont 2 spécifiquement sur les mesures faites à Nançay. Des améliorations ont besoin d'être faites, compte tenu de l'expérience acquise, avant de passer « à une très grande échelle ». Les porteurs de ce projet souhaitent améliorer l'utilisation des antennes existantes, en utilisant le réseau décamétrique et aussi implanter d'autres antennes, en augmentant la distance entre les points de mesures. S'il est exclu que l'utilisation de la radio soit faite pour rapatrier les données depuis ces antennes éventuellement réparties sur la station, un projet peut être proposé, en accord entre l'INSU et l'IN2P3, qui ne présente pas de perturbations radio pour les autres instruments du site. Il serait dommage de ne pas considérer des améliorations potentielles de cette expérience pluridisciplinaire et prometteuse.

5 Ressources, vie de l'Unité

Il faut dans les années à venir considérer LOFAR comme un instrument du site, une station arrivant à la fin 2009, accompagnée d'une liaison à très haut débit vers RENATER et GEANT pour le traitement des données provenant de l'ensemble des stations aux Pays Bas.

La communication entre les équipes techniques et scientifiques qui ne sont pas en permanence sur le même site est un point délicat. Internet induit une baisse de fréquentation des chercheurs sur place, même si certains viennent très régulièrement et même chaque semaine. Tout le monde en est conscient, c'est en particulier le but

des séminaires mensuels, un séminaire scientifique et un séminaire technique chaque mois. Faire participer les membres des équipes techniques à des réunions à l'extérieur qu'elles soient dans le cadre des projets, de conférences ou autre, sont bien sûr des priorités pour la direction de la Station, dans la limite du budget disponible.
Une autre action consiste à organiser des réunions, colloques, etc à Nançay.

6 Recommandations

La direction de la Station prendra en compte, dans la mesure du possible, les recommandations qui la concerne, elle ou les membres de la Station.

Un effort de coordination pour l'analyse des données LOFAR va être entrepris, en se basant sur le consortium FLOW. Des propositions ont déjà été faites à l'INSU dans ce sens, pour avoir un comité scientifique de FLOW, en relation avec SKA, dont LOFAR est considéré comme un « pathfinder ». L'arrivée prochaine d'une station fait que c'est un point prioritaire pour les semaines et mois à venir, pour la direction et pour les collègues porteur du projet.

Concernant AAVP, la remarque sur la date de démarrage a été faite plus haut.

Sur le long terme ou plutôt moyen terme, c'est d'ici 3 ans que pourra être réalisée LSS, si la R&D soutenue par l'ANR est positive ; par ailleurs, même dans le cas de la construction de FASR avec des antennes à basse fréquence, des besoins dans le cadre de la météorologie spatiale devraient conduire à continuer de faire fonctionner le RH. Enfin, les grands instruments internationaux sont soumis à une très forte pression, et la disponibilité de moyens moins performants, mais plus accessibles est aussi à considérer.

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