EUROPEAN SCIENCE FOUNDATION
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NEWSLETTER No. 17 – May 2008

CRAF NEWS

Expert Committee on Radio Astronomy Frequencies (CRAF)

Editorial

Nowadays many radio astronomical instruments are being planned to operate across very large bandwidths, which have not been allocated to the radio astronomy service. A result of this is that there is a view that the preservation of the limits of RFI in the radio astronomy bands, as well as a continuous monitoring of the bands, do not really matter and that the development of ever-improving mitigation techniques will be the answer to all of our problems. Nothing could be further from the truth. All our past experience points in the opposite direction: any relaxation of the surveillance monitoring of our bands and/or the lack of appropriate protection by the national Administrations has always resulted in more interference and the loss of good scientific data. Simply accepting for the future the present levels of interfering signals, which are the result of many years of continuous effort by CRAF and all of our technical collaborators, will also not guarantee the preservation of the present level of observational sensitivity when one considers the new developments of the telecommunications market.

First, we really do need some bands protected to the levels defined in the previous RA 769. We really do need bands allocated as 'exclusive' to radio astronomy (S.5340), even if they are very narrow, not only because they are often centred on the special natural emission lines, but also as the place where we can guarantee the credibility of our measurements and calibrations. Credibility comes from better measurement accuracy (i.e. no unpredictable noise added by interference). The bands specifically allocated to radio astronomy can also be used not only for the study of particular astronomical objects, but also as 'references' when assessing the efficiency of any new mitigation techniques. One can compare how much one can recover from a band allocated to the radio astronomy service with one that is not. One should also not forget that, even after a summation of all the spectrum in our bands, it is a very small fraction of the total spectrum now considered valuable for commercial applications.

Second, we ask for 'radio protection zones' around our telescopes. The surface area we look for is again a very small fraction of the total territory and invariably well separated from the civilian 'hot spot'".

Third, and this is really a key issue for us these days, we try our best to make all other users of the radio spectrum aware of the danger associated with the unlicensed spread of poor quality Ultra Wide Band emitters, that sooner or later will affect not only the high sensitivity receivers used at radio astronomy observatories, but all other radio services. Something built on the cheap today cannot be the best strategy for spectrum management in the future.

All that has been said up to now is aimed at searching for a *compatibility* among all radio services.

Interference caused by poor quality transmitters are going to affect not only the high sensitivity receivers used for radio astronomy: we are simply at the forefront of a reality that all others will have to handle sooner or later. This compatibility works for us today and it can continue to do so in the future, but only if appropriate rules are updated now and strenuously enforced.

Everybody should appreciate that the radio spectrum belongs to society as a whole and, in this context the passive services form the most vulnerable class of users. Thus, the passive users can be considered to be those most credible when verifying that the value of the radio spectrum to society is not misused by the more powerful users (the active services).

Finally it should be stressed that our untimely death, as a radio service that suffocated through a lack of better control of unwanted radio emissions, would not provide a panacea for all the other users, but simply mark the first victim at the start of a deregulation regime where the reliability of ***any*** radio service would ultimately be affected.

Roberto Ambrosini

Report from the 45th CRAF meeting

The 45th CRAF meeting was held on 26-27 November 2007 at the European Space Research and Technology Centre (ESTEC), Noordwijk, the Netherlands following the kind invitation of Edoardo Marelli. On the second day of the meeting, CRAF members had an opportunity to visit the laboratories of ESTEC, the largest site and the technical heart of the European Space Agency (ESA).

H. Smith, from the Mullard Radio Astronomy Observatory (UK), T. Lery, from the European Science Foundation and A. Tiplady, from SKA South Africa/Hart RAO participated in CRAF meetings for the first time. During the CRAF meeting, the following key items were discussed:

- The International Telecommunication's World Radiocommunication Conference 2007 (WRC-07) was a major event, in which 2800 participants from 164 countries and more than 100 recognised organisations worked for a month towards updating and revising the international treaty defining the ITU Radio Regulations. These provide the global framework for the use of the radio frequency spectrum and allocation of satellite orbits in which radio services are involved. WRC-07 addressed some 30 agenda items relating to almost all terrestrial and space radio services and applications. CRAF was represented at the conference by Ambrosini, Alexe and Deschamps. Twelve other radio astronomers and spectrum managers with an astronomy background participated as members of various national delegations or IUCAF. In addition to the agenda items relating to radio astronomy which were successfully discussed, the Conference provided a good opportunity for an active exchange of views between radio astronomers and CEPT Administrations, thus enabling the radio astronomers to draw attention to items currently under discussion in various CEPT meetings. CRAF was indeed present and very visible during WRC-07. As a general conclusion, the WRC-07 work produced favourable results for all the scientific services and for radio astronomy in particular.
- Many initiatives, which were encouraged by the ESF could be of interest to CRAF: for example joint activities, international initiatives, conferences, workshops, public outreach activities, public awareness, ESA-ESF-EC projects. In order to exploit the 2009 International Year of Astronomy, a CRAF task force was created to collect ideas.
- The new FP7 RadioNet Spectrum Management proposal has been submitted to the internal subcommittee for their approval. The proposal received the following comment: 'This activity was deemed essential for the community and worthy of continued RadioNet support. Suggested total cost: 130K Euro. The committee would like to give the proposers an opportunity to further update and improve upon the proposal'.
- A major limitation in the assessment of Iridium interference into the RA band was the limited scope of ITU-R Recommendation RA 1513. This recommendation gives definitions of data loss and introduces the Equivalent Power Flux Density (epfd) concept. CEPT SE40 asked for a revision of this Recommendation, but the WG SE decided that this revision should be made by the CEPT SE21 project team. CRAF is expected to provide a more detailed contribution to the meaning of data loss for the cases of spectral line and continuum observations, explaining the differences between these types of observations.
- CRAF and ESA (both concerned with the passive radio science services) agreed to a closer collaboration and coordination of their activities, especially bearing in mind the 2011 ITU World Radiocommunication Conference WRC-11; many aspects are relevant for both communities, for example short range devices (SRDs) and frequency allocations above 275 GHz.
- Concerning IUCAF, the following activities were highlighted as of potential interest to CRAF: COSPAR 37th Scientific Assembly (13-20 July 2008, Montreal), URSI 29th General Assembly (9-16 August 2008, Chicago), 3rd Summer School on Spectrum Management for Passive Radio Science (planned for 2009, in Korea).

The next CRAF meeting is scheduled for April 17-18, 2008 in Thessaloniki (Greece).

Pietro Bolli

Protection of Radio Astronomy: a Success in South Africa

Southern Africa is one of the two sites (the other being Australia) that have been pre-selected as suitable for the emblematic future global radio telescope, the Square Kilometre Array (SKA) (www.skatelescope.org).

By the time this newsletter goes into print, the South African Astronomy Geographic Advantage (AGA) Bill will have been signed into law by the President of South Africa, having recently passed its final round of approval by the National Assembly.

The purpose of the bill is to protect astronomy, in particular radio and optical astronomy, in South Africa through the declaration of Astronomy Advantage Areas (AAA). Three types of frequency-protected areas may be declared:

- Core Area – this encompasses the physical extent of the astronomy facility. The most stringent International Telecommunication Union recommendations for radio astronomy interference threshold levels are enforced in this area.
- Central Area – this area immediately surrounds the Core Area. Any activity that operates within the area that is deemed to have a detrimental impact on the astronomy facility operating within the Core Area is prohibited.
- Coordinated Area – this area surrounds the Central and Core Areas. Operators of high-powered transmitters require coordination with the astronomical facility in order to operate.

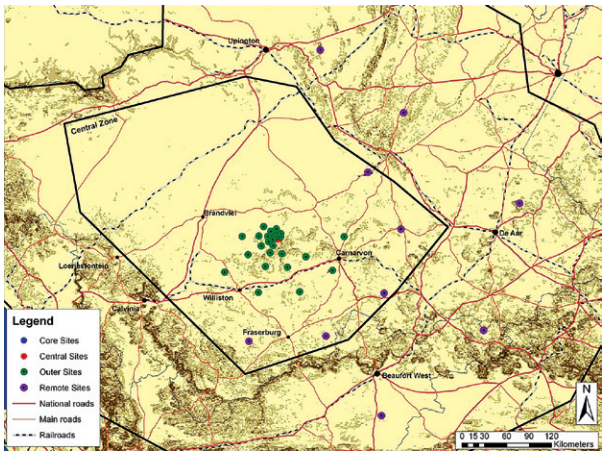

Figure 1: Central Area appropriate for frequencies below 1 GHz. The proposed South African SKA configuration has been superimposed.

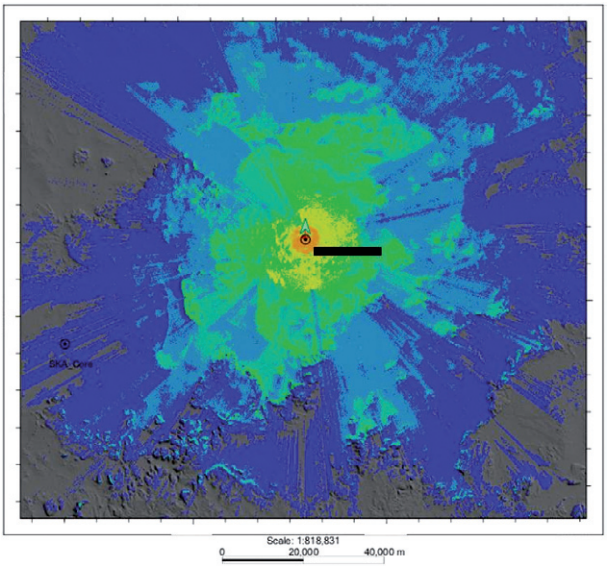

Figure 2: Coverage of GSM base station.

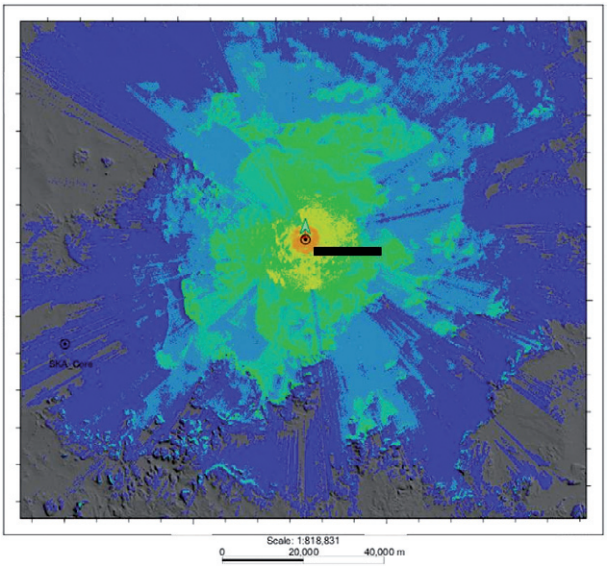

Figure 3: Coverage of GSM base station following implementation of mitigation techniques by GSM operator.

Figure 1 indicates a Central Area that would be appropriate for frequencies below 1 GHz. The proposed South African SKA configuration is superimposed. This Central Area is over 400 km^2 in extent.

The progress of the AGA bill has been supported by a majority of wireless telecommunication operators in South Africa. During the promulgation process, a number of case studies were undertaken to analyse the impact of an Astronomy Advantage Area on the existing radio frequency infrastructure in the affected areas. Feasible solutions were then investigated to re-engineer existing radio frequency infrastructure to ensure compatibility with the operation of a radio astronomy facility in the Core Area, as well as to prevent the future establishment of radio frequency infrastructure in the area without the consent of the astronomy facility. Solutions include: migration of mobile communications to frequencies beyond those used by the SKA, the use of phased array antennas for fixed transmitters and the replacement of high-powered transmitters by local satellite downlinks and low-powered repeaters. Figure 2 indicates the signal coverage of a typical GSM base station. Following the implementation of mitigation techniques using phase array antennas, the signal is reduced in the direction of the core site, illustrated in Figure 3.

Adrian Tiplady

For more information, please contact Adrian Tiplady (atiplady@ska.ac.za) at the South African SKA Project Office.

New prospects for solar radio astronomy in Belgium

In the course of 2008 work will begin on the revival of the Humain station in order that it will once again become the only operational radio astronomy facility in Belgium. The station, located 120 km South-East of Brussels in a fairly isolated area in the Famennes region, was founded by the Solar Physics Department of the Royal Observatory of Belgium (ROB) in 1952. Two main instruments were originally installed at the station. The oldest one, a 610 MHz radiometer based on a refurbished Second World War German 'Wurzburg' radar dish (7m diameter), provided a continuous series of absolute solar flux measurements from 1952, producing the longest series of solar radio fluxes to be compared with the standard 10.7cm flux measurements from Ottawa-Penticton (DRAO, Canada). The largest instrument on the site was built during the 1960s and is a 408 MHz radioheliograph. This interferometric array is formed from 48 parabolas (4m and 6m diameter) aligned along two lines in an asymmetrical 'T' configuration with a maximum baseline of 620m. Dedicated to the imaging of solar radio bursts, the instrument was in fact never fully completed and did not deliver the ultimate products that were envisaged: high time resolution images of solar flares (time resolution < 0.1s, angular resolution: 4 arcmin).

Figure 4: Parabaolas of the 408 MHz radioheliograph at the Humain station

A lack of funding and the necessary staff required for maintaining such a large array meant that the radioheliograph was operated only in a slow drift mode (high S/N integrations of 1-dimensional E-W and N-S profiles). After 30 years, a decision was finally taken in 2002 to stop operations entirely, its comparability with the Nancay radioheliograph (France) being one amongst many reasons.

When the 610 MHz radiometer was taken out of service in 2005 because of ageing issues, a redeployment project was prepared and submitted to the ROB scientific council. This project completely reconsidered the concept and goals of the Humain facility, taking into account the limited material resources that were available and more importantly the new orientations of the scientific activities of the Solar Physics team at the ROB. Indeed, over the last 25 years, the team grew and developed several new research and operational service activities. Currently, under the Solar Influences Data analysis Centre (SIDC), the solar physics group is involved in several solar space missions focusing on extreme-UV solar imaging of the corona with, for example SOHO, STEREO, PROBA2. It runs several international services dedicated to the monitoring of solar activity and its impact on Earth and human technologies (space weather). These include the World Data Centre for the International Sunspot Index R_i (since 1981) and the Regional Warning Centre for Europe in the International Space Environment services (ISES) (since 2000). The above services continuously collect and redistribute solar and geomagnetic data and provide activity forecasts as well as real-time alerts of solar flares, coronal mass ejections (CME), solar wind disturbances and their consequences, geomagnetic storms, radio blackouts, etc.

In order to provide information for these new services it was decided to take advantage of the existing hardware at the Humain station, and to refurbish a subset of the 50 parabolic antennas with new state-of-the art receivers. Each antenna is now used as an independent single radio telescope but the frequency coverage is widely expanded. The new instruments will include:

- Radio spectrographs covering the 30 MHz to 2 GHz frequency range, for monitoring and diagnostics of solar type II and type III bursts associated with solar CMEs and flares.
- Radiometers in several narrow bands protected for radio astronomy. This will include the 610 MHz band to continue the historical Humain series, and also the 2.8 GHz band (10.7cm index). Other frequencies in the decimetric range will probably be implemented later.

The above instruments will be developed and operated in the context of international collaborations. Thus, spectrographic instrument work will be undertaken with the ETH-Zürich solar team (A. Benz), who has developed the CALLISTO decimetric spectrograph. For the radiometric measurements, joint work has just been initiated with the DRAO-Penticton team (K. Tapping). A key element of the new instruments will be the real-time transmission of data and their continuous redistribution via the existing SIDC data services. Thus by combining expertise the new radiotelescopes can be immediately included in world-wide virtual observatories based on multiple solar radiotelescopes distributed in longitude and allowing an unprecedented 24h/24 7d/7 monitoring of solar activity. The scientific information provided by radio observations are also fully complementary to extreme-UV and X-ray data from space-borne instruments and will thus enrich the 'alert' and forecasting capabilities of the SIDC and other space weather services in the world.

In view of this new wider coverage of the radio spectrum, an initial survey of the spectrum in the 40 to 800 MHz range was carried out at the Humain station in May 2006 with the help of the ETH-Zürich team (C. Monstein). Despite the high population density in Belgium, the measurements showed that the level of radio frequency interference was below average when compared with a large number of other locations elsewhere in Europe. In particular, the natural emission background is still accessible at many frequencies in the long wavelength range (40-87 MHz, 200-400 MHz), which is particularly important for following the expansion of CMEs (type II bursts). A more thorough RFI spectrum survey extending to higher frequencies is planned in the near future.

Over the past few years, constant attention has been paid to the preservation of the site quality (protection zone, potential adverse impact of neighbouring activities such as a quarry or a wind turbine project). We have also maintained a constant dialogue with the Belgian Administration in charge of spectrum management (Belgian Institute for Post and Telecommunication, BIPT) and on a number of occasions, we have obtained good support from the BIPT monitoring services and from the Belgian delegation responsible for international negotiations.

Since the beginning of this year, the Humain redeployment project has been funded in the framework of a newly created Belgian Solar-Terrestrial Centre of Excellence. This new structure, supported by the Belgian Federal Science Policy (BELSPO), combines three federal research institutes: the ROB, the Institute of Space Aeronomy (BISA) and the Royal Meteorological Institute (RMI). It is in this context of combining multiple expertise that the actual construction of the new Humain radio facility will progress during 2008. Two or three new job positions will become available and, by the end of this year, at least one or two of the planned receivers will be completed and will start to deliver a continuous stream of solar activity data.

Frederic Clette

Bad news from the UK relating to frequency management

As indirectly referred to in the Editorial, governments have realised during the past few years that they can acquire vast sums of money (tens of billions of Euros/pounds) without doing very much at all or even upsetting a majority of the electorate, by simply stating that they own the radio frequency spectrum and auctioning it off to the highest bidder. The UK government has been 'leading the charge' within Europe in this 'spectrum trading' and the first 3G auction realised ~22.5 billion pounds for the Treasury. The latest proposal is to auction ~192 MHz of spectrum at frequencies of ~2.6 GHz with a view to it being used for WiMax. Once again the auction winners will pay 'up-front' for a fixed-term licence (20 years?) and a significant annual sum for spectrum rights. It does not take much thought to realise that there is a passive band allocated for the use of radio astronomy in this region and that it represents a problem for a government wishing to make a few tens of billions of pounds from the sale of a block of spectrum. In fact, since radio astronomers realised a very long time ago that there was a need for and had bands allocated to them for observations throughout the radio frequency spectrum in order to be able to understand the physical processes in the universe, it is clear that the sale of blocks of spectrum for broadcasting at ~ 600 MHz , WiMax at ~2.6 GHz, etc. may not be as straight-forward for governments as they might have thought. The result in the UK is constant pressure from the government (licensing authority) for radio astronomers to give up their use of the most commercially valuable bands. This was particularly the case for the passive band from 2690 MHz to 2700 MHz because it has hardly been used for observations in recent years. Although the band has still been retained as a passive band, the protection that will in future be afforded to it from 'spill-over' from adjacent channels will not be to the level defined in ITU-R 769. This means, of course, that should an 'important' molecule (e.g. an amino acid) be found to have a spectral line within this band, that a future search for it (i.e. for life) elsewhere in the universe will be severely limited.

In addition to the above described 'sell-offs', the UK government has decided that all users of any spectrum must pay a commercial rate for the spectrum that they use. For passive bands, this is obviously not the huge sums of money referred to above, but is nevertheless significant. However, there are many bands which radio astronomers share with the commercial world with protection for radio astronomy being provided by 'terrain coordinations'. Funding has been provided by the government to pay for the use of spectrum shared with commercial users for our *current* telescope configurations. However, this means that one of our MERLIN telescopes which currently does not operate at K-Band frequencies and is therefore no longer protected can probably never be sensibly upgraded. Commercial organisations can now start to transmit in its vicinity and once such links are installed, it will probably be impossible to have them removed.

Radio astronomers in the UK also share a number of bands with the Ministry of Defence (MoD), who manage a significant fraction of the entire radio spectrum. Three of these bands, at 408 MHz and ~5 GHz, are of particular importance for UK radio astronomy. However, the MoD is being forced to pay commercial rates (and by implication so are we) for the spectrum that they use and manage, and to give up as much spectrum as possible so that the government can make even more money from its sale. Until now, the radio astronomers and the MoD have helped each other and shared spectrum access to the mutual benefit of both parties without any financial accounting. Sadly, that is about to end as the government is clearly set on pursuing spectrum pricing, and at the present time it is not understood as to how radio astronomy will pay for spectrum that we hope to use.

Peter Thomasson

WRC-07 has gone! WRC-11 is coming!

Report from WRC-07

The 2007 World Radiocommunication Conference (WRC-07) was held in Geneva between 22 October and 16 November 2007. Its main purpose was to address the worldwide use of radio frequencies and to meet the global demand for spectrum. As a finite resource, the use of and access to the radio-frequency spectrum is nowadays one of the driving forces behind the world's economic and social systems. The WRC brought together nearly 3000 participants from all over the world.

The Radio Astronomy Service (RAS) is a passive (receive only) service which has less than 2% of the allocated spectrum. For radio astronomy the 'operating' frequencies are mostly imposed by natural physical phenomena, and the distance between a 'transmitter' and receiver cannot be changed. The 'transmitter' power levels, being extremely low and without any means of control, require on the other 'side' of the link the most sensitive state-of-the-art receivers.

By its nature, being a passive service, the RAS never causes interference to other users of the radio spectrum, but unfortunately it is becoming increasingly more difficult to protect radio astronomy observatories from radio interference produced by both terrestrial and space-borne communications operating in adjacent or sometimes the same bands. That is why radio astronomers pay special attention to the spectrum allocation process and to the global decisions relating to the usage of the spectrum taken in international fora, such as the ITU.

At WRC-07, the main agenda items of interest to the radio astronomy community were:

- establishing out-of-band emission limits for satellites operating in the bands adjacent to RAS allocations, above which administrations operating the satellites networks are required to consult with Administrations operating radio astronomy observatories;
- suppression of the allocation for satellite up- and downlinks straddling the 1.4 GHz RAS allocation;
- establishing limits to the emissions from ground stations and handsets of Mobile Satellite Systems operating in the band 1668-1668.4 MHz above which Administrations operating a satellite system would have to consult with Administrations operating space-based radio astronomy systems.

Overall, the WRC-07 output is fairly satisfactory for the European Radio Astronomy community.

Figure 5: CRAF participated in WRC-07 with a three-person delegation led by Roberto Ambrosini, the CRAF Chairman.

Future WRC-11

The ending of a WRC initiates the start of the next one and a new cycle of ITU activity. The next WRC is scheduled for 2011.

The WRC-11 agenda items will be studied during the coming years and some of the work on items relevant to the RAS will be carried out within CEPT (for the preparation of European Common Proposals), as well as at ITU level within Study Group 7 (Science Services) – specifically within Working Party 7D (WP7D, Radio astronomy) – and in other study groups.

Of specific interest to radio astronomers are the following agenda items (AI):

- use of the radio spectrum between 275 and 3000 GHz, under AI 1.6. No allocations for the use of this frequency band will be made at WRC-11, but the radio astronomy community has to identify a list of specific bands of interest;
- additional spectrum for the Aeronautical Mobile Service (5GHz), under AI 1.4;
- additional spectrum for the Aeronautical Mobile Satellite Service (1.6 GHz band), under AI 1.7;
- Fixed Services in the range 71-238 GHz, under AI 1.8;
- review of the Radiolocation Service in the range 30-300 MHz, under AI 1.14;
- allocation in the range 3-50MHz to the Radiolocation Service for oceanographic radar, under AI 1.15;
- Software Defined Radio and Cognitive Radio Systems, under AI 1.19;
- Gateway links for High Altitude Platform Stations in the range 5850-7500 MHz, under AI 1.20;
- primary Radiolocation Service Allocation in the band 15.5-15.7 GHz, under AI 1.21;
- Short Range Devices, under AI 1.22;
- additional Spectrum for Mobile Satellite Service, particularly in the range 4-16GHz, under AI 1.25.

All these agenda items with potential impact on radio astronomy will be studied and discussed in four Project Teams (A, B, C, D) of the CEPT Conference Preparatory Group (CPG).

Laurentiu Alexe

Summer 2008 meetings on spectrum management

This summer, there will be two major scientific Assemblies with meetings and sessions on topics dealing with spectrum management for passive radio science services, including radio astronomy. One of the underlying goals is the strengthening of the links between radio astronomy and other scientific communities in these matters, both technical (RFI mitigation) and regulatory (spectrum management). CRAF members have been actively involved in their organisation, mostly through their IUCAF affiliation.

COSPAR 37th Scientific Assembly, 13-20 July 2008, Montreal (http://www.cospar-assembly.org/):
at Scientific Event E110 'Spectrum management and COSPAR – keeping the passive services free from interference', presentations will be given on spectrum management for radio astronomy and space science, outlining the different cultures, common goals and ways to work towards achieving the latter.

URSI 29th General Assembly, 9-16 August 2008, Chicago (http://www.ece.uic.edu/2008ursiga/):
session J07 'Splinter Meetings' includes an open IUCAF meeting and a 'RFI Mitigation' session at which the efforts in this area performed by the astronomy and remote sensing communities will be reviewed. Session E05 'Spectrum Management' is devoted to effective utilisation of the radio spectrum from both a scientific and commercial perspective, and at session HBDGJK 'Solar Power Satellites', the protection of passive radio science services from unwanted interference from these satellites will be reviewed.

Wim van Driel

Committee on Radio Astronomy Frequencies (CRAF)

CRAF is an Expert Committee of the European Science Foundation. Established in 1988, it represents all the major radio astronomical observatories in Europe. Its mission is to coordinate activities to keep the frequency bands used by radio astronomers in Europe free from interference.

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Print run: 350 – June 2008