

RFI2004

Workshop on Mitigation of
Radio Frequency Interference
in Radio Astronomy

Dominion Radio Astrophysical Observatory
Penticton BC Canada
July 16-18, 2004

Report on RFI2004

Steve Ellingson, Virginia Tech
Wim van Driel, Obs. de Paris / IUCAF



**Workshop on Mitigation of
Radio Frequency Interference
in Radio Astronomy**

Objectives of the Workshop

- **Present and discuss the “latest and greatest” in the field of RFI mitigation technology**
 - **Update to similar workshop sponsored by IUCAF in Bonn 2001**
 - **Alternative to RFI working group sessions held at annual international SKA meetings of previous years**
- **Improve understanding and inspire collaboration between the communities of observing astronomers and research engineers**
- **Consider what this means for SKA design**
- **Consider what this means for SKA-related regulatory efforts**

Participation

- 79 registered attendees
- 31 oral presentations (2 invited)
- 4 poster presentations
- **Excellent representation**
 - Across international boundaries
 - Across organizational boundaries
 - Scientists ↔ Engineers
 - “Mitigators” ↔ “Regulators”

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**Thanks to DRAO
(Dewdney, Tapping,
Morgan, Veidt,...)**

**and the WOC
(Briggs, van Driel,
Boonstra, Jeffs,...)**

and the participants

**for making this
a success!**

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Program

- **Friday, July 16**
 - Introductory Session (Ekers, Briggs, Fisher)
 - Regulatory Session (van Driel, Gergely, Tzioumis)
 - Radar and Iridium
 - Applications
- **Saturday, July 17**
 - Precorrelation Array Techniques
 - Postcorrelation Array Techniques
 - Characterization & Algorithms
 - Mitigating RFI at RF
- **Sunday, July 18**
 - Directed discussion (van Driel)

Sessions

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**Technical
Program**

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**Regulatory
Issues**



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Workshop Product

- **Web-based proceedings**
 - <http://www.vt.edu/~swe/rfi2004> (will change soon)
 - **Program / Abstracts** available now
 - **Presentations** available shortly
 - **Papers** available shortly
- ***Radio Science* special section, est. Fall 2005**
- **Summary in *Experimental Astronomy* special section on SKA2004**

Some Impressions

- **RFI Mitigation technology continues to show great promise** – many exciting demonstrations presented: L-band radar, DME, Digital TV, Iridium, ILS, Strong HF, ...
- **There is much useful stuff to be learned** from the signal processing community: Kalman Filtering, Eigendecomposition methods, Subspace/projection methods, Cyclostationarity...
- **The “tried and true” methods still apply** and can be greatly improved: Blanking, Exploiting RFI phase closure, Automation of data editing
- **A full-court press is underway**: LOFAR, ATA, Nancay, WSRT are all implementing *serious* RFI mitigation HW

Some More Impressions

- **Much of the success achieved is not surprising in retrospect:**
 - “We tend to forget how much hand-tuning goes into our algorithms”
 - We tend to choose problems we think we can solve
- **We are peeling only the first layers of the “RFI onion”...**
 - We are becoming very good at mitigating moderate RFI, but that may not be the toughest part of the problem
 - What forms of RFI lies at the extreme limits of sensitivity...?
- **Successes remain anecdotal.**
 - Much more field experience with real astronomy required
 - “Comfort level” is currently low (toxicity? Operational issues?)

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Even More Impressions

- Propagation of mitigation processing artifacts into the product?
- Need an analytical framework to understand results of brute force simulations... RFI processing (and other effects!)

What this means for SKA...

- **RFI mitigation will be more important for SKA than for other telescopes not necessarily because it will be more sensitive, but because it will produce more data**
 - **Exceptions, too: High redshift HI, High fractional-BW observing below 1 GHz**
- **Need to work on automating the simple, effective things that are done manually now...**
- **Correlator dump times $<$ or \ll 10 ms will be very important**
- **Mitigation should not be improvised later, it should be designed in.**
 - **At least, incorporate appropriate “hooks” into the system**



RFI 2004
regulatory
recap

SKA spectrum management

The task of accommodating all competing services and systems within the finite usable range of the radio spectrum

Global:

Radio Regulations of the International Telecommunication Union (ITU) provide the global framework for spectrum management

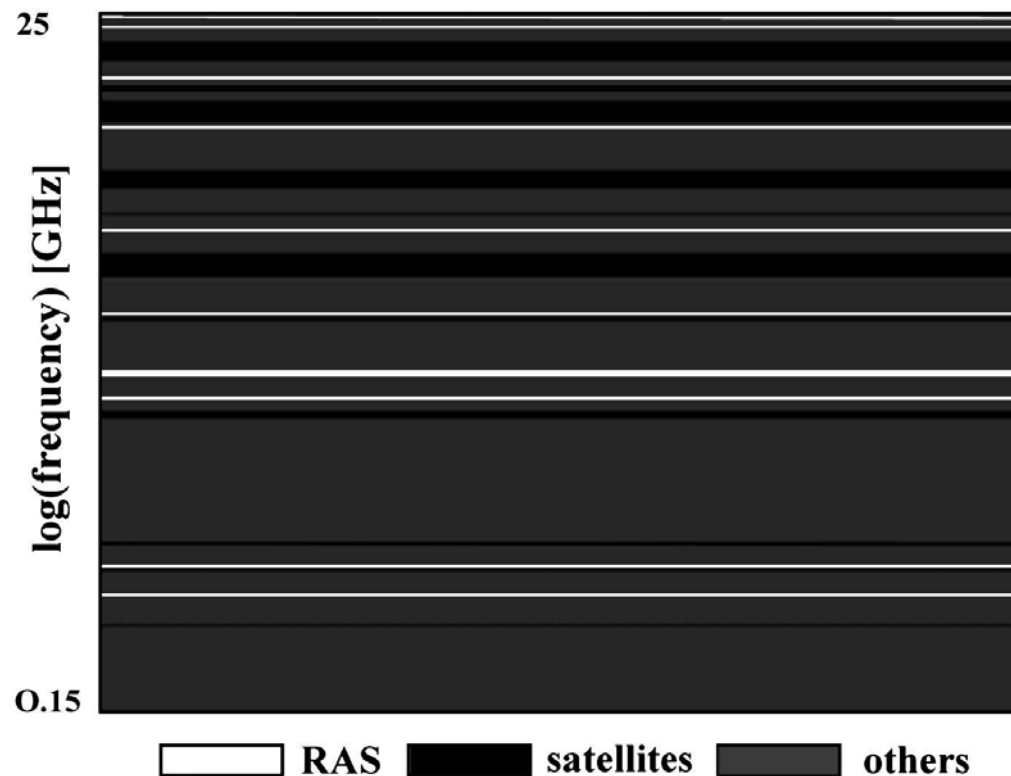
National:

National frequency Administrations regulate spectrum use, in accordance with the ITU Radio Regulations

- including the implementation of an **SKA Radio Quiet Zone**

Enabling the “new radio astronomy”

Can mitigation techniques, *including regulatory measures*, deal with the RFI environment, with the SKA in 2020 in the 0.1-25 GHz frequency range?



Allocated frequency bands in 0.15-25 GHz range

RFI 2004: Regulation

The time has come define the regulatory protection criteria *we* want for the SKA – regulators want *levels* on emissions by other spectrum users at potential SKA sites (*and soon*)

National: Discussions with Australian and South African Administrations:

- they define and regulate national Radio Quiet Zones
(can limit terrestrial transmitters only, not satellites)

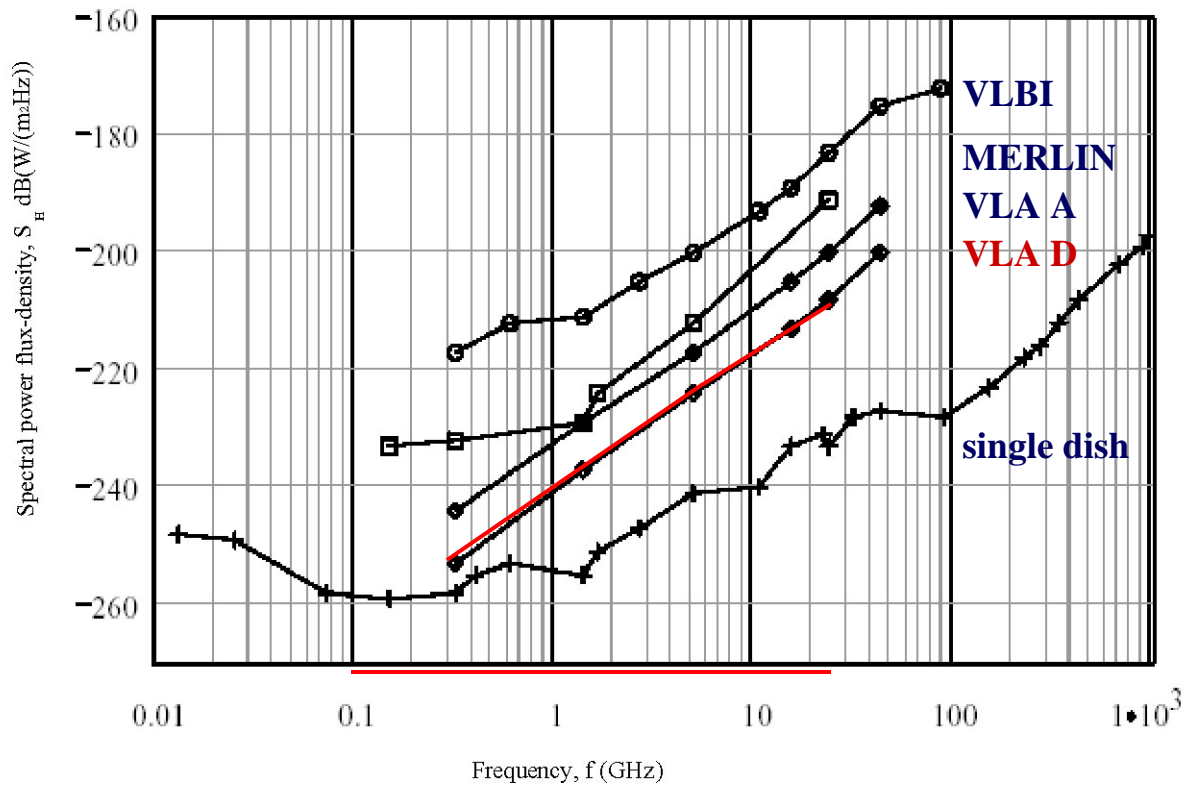
Global: Question on Radio Quiet Zones accepted at the ITU:

- get ITU Recommendation on Radio Quiet Zones,
for guidance to national frequency Administrations

RFI2004: Basic protection criteria for the SKA
are based on those for linked interferometers in *Rec 769*
(Recommendation RA.769 in ITU Radio Regulations)

Propose SKA Regulatory Subcommittee

SKA regulatory protection criteria



**Rec 769 power flux density threshold levels
for interference detrimental to radio astronomy:**

**as for the VLA-D, ~15 dB above the Rec 769 single-dish levels,
for protection in a Radio Quiet Zone in the entire 0.1-25 GHz range.**

RFI 2006

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