Canadian Radio Astronomy Issues

(*Report to CORF, 2008*)

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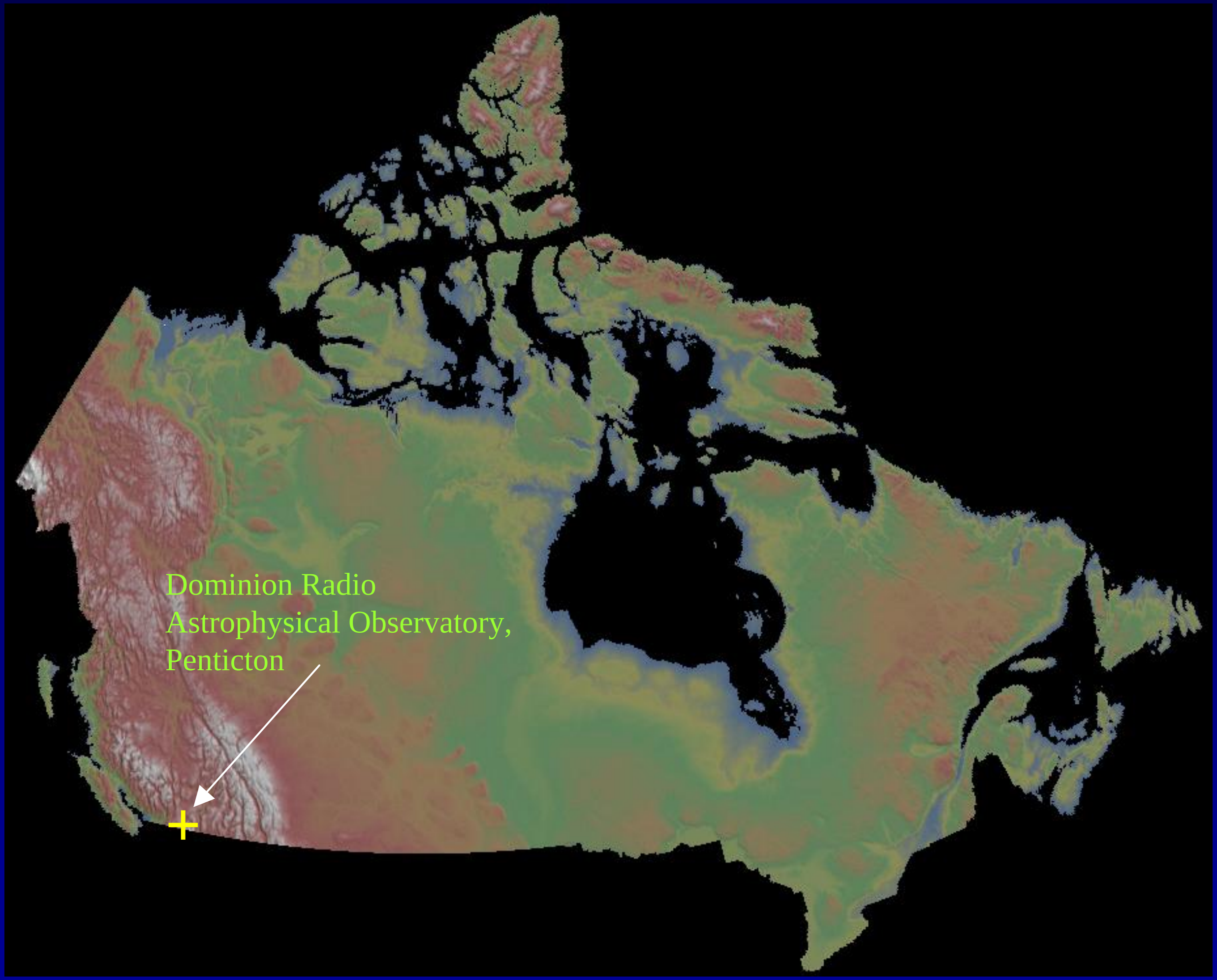
Main Issues - Activities

- New Technology Radio Telescope Antenna
- DRAO Protection Zone Redefinition Project
- Noise Background Project
- Other Canadian issues of interest.

Dominion Radio Astrophysical Observatory



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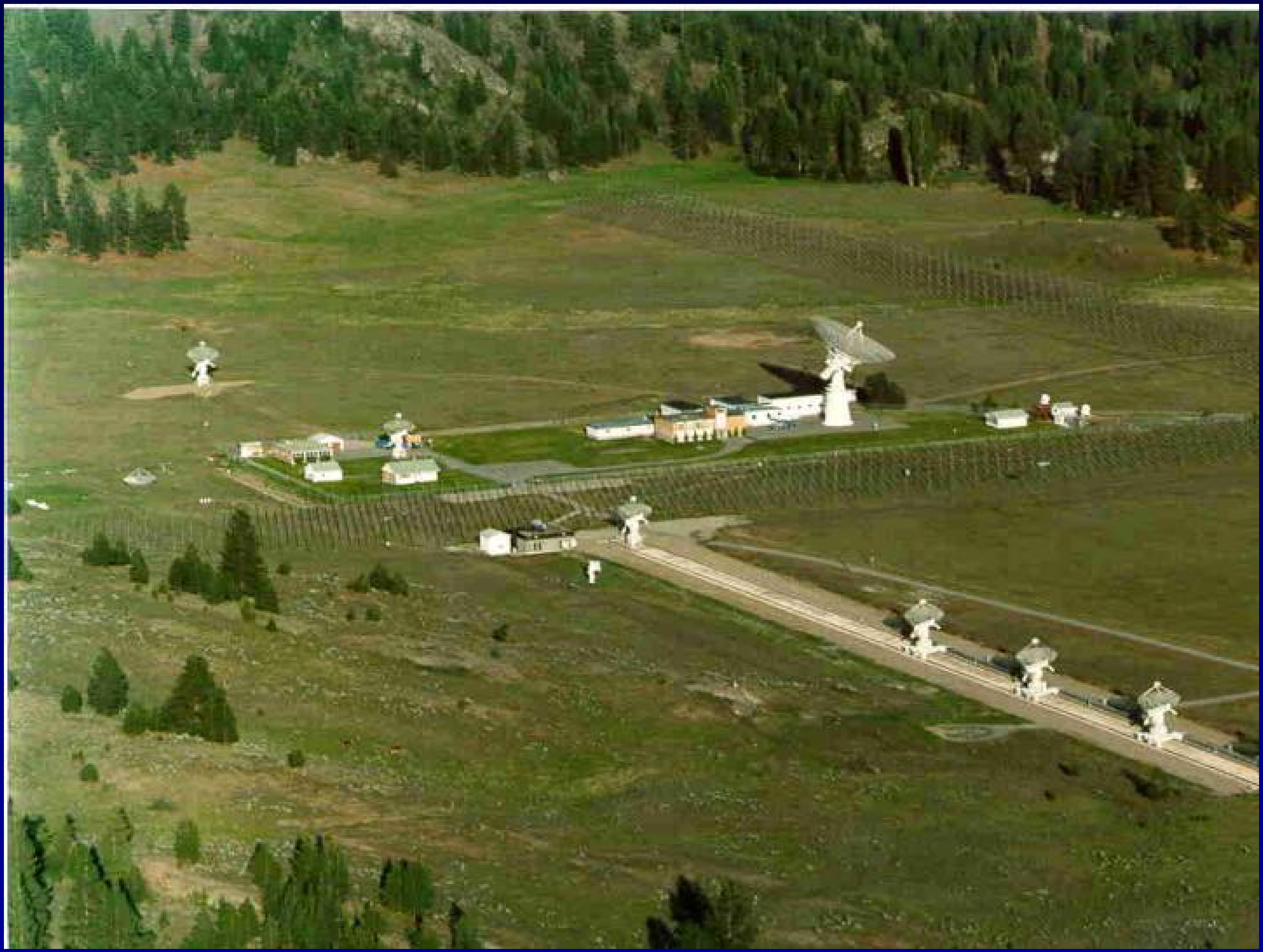
Dominion Radio Astrophysical Observatory



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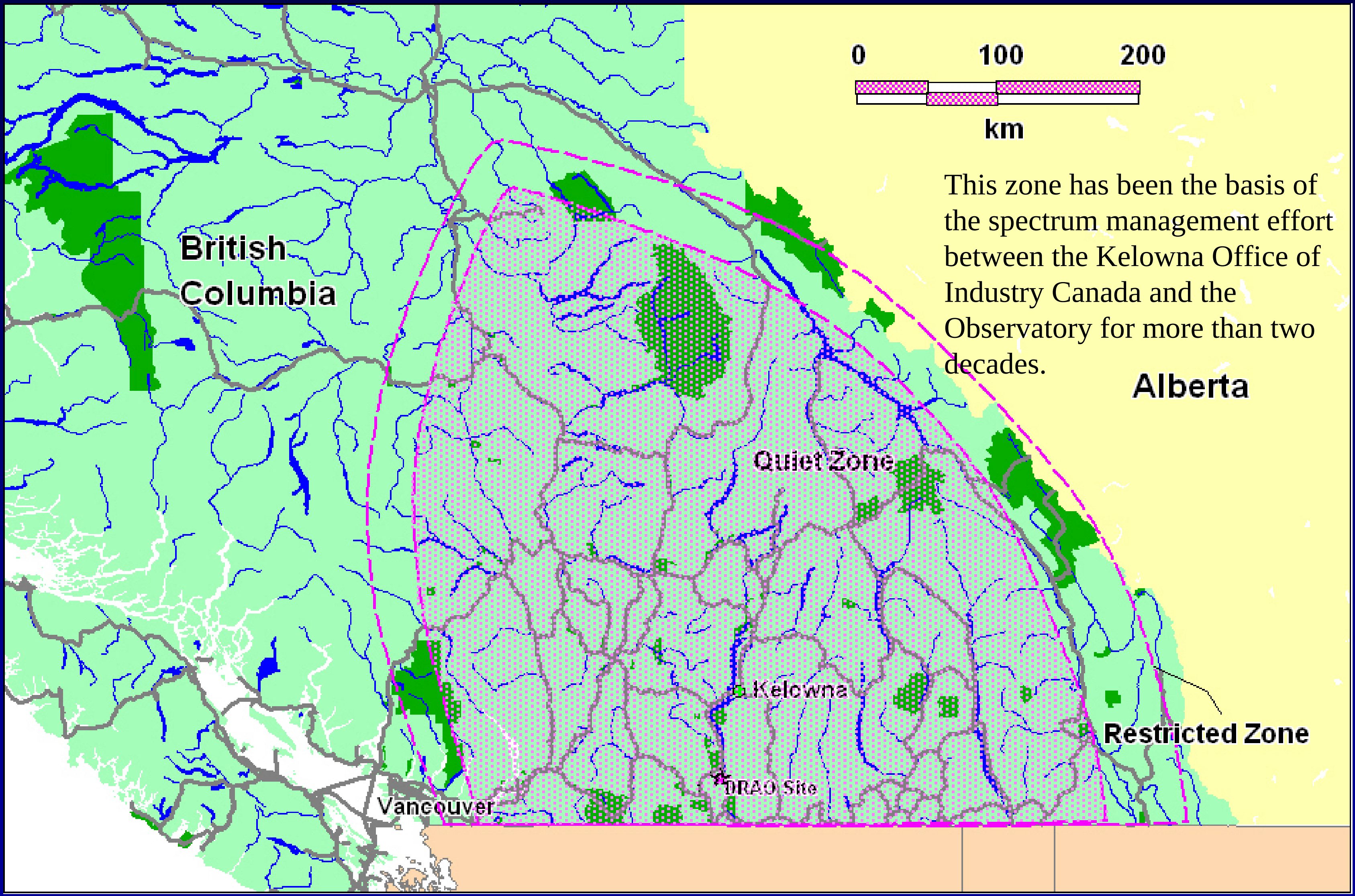
DRAO Radio Protection Zone



This zone has been the basis of the spectrum management effort between the Kelowna Office of Industry Canada and the Observatory for more than two decades.

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Evaluation and Re-Definition of the DRAO Controlled Emission Zone Why?

- The population of southern British Columbia, especially the Okanagan region is growing rapidly.
- Communities in the zone want to allow development and concomitant expansion of infrastructure.
- “Normal Domestic Life” now involves more use of radio devices than ever before, and this is expanding. What was once regarded as a luxury (*e.g.* microwave ovens) are now essentials.
- Wireless, unlicensed devices, cell phones, UWB gadgets etc. etc.

The zone definition and current spectrum management techniques do not provide effective tools for planning and regulation.

Evaluation and Re-Definition of the DRAO Controlled Emission Zone

- On a band-by-band basis, measure and model propagation loss as a function of location in the zone, so we can find out what levels of unwanted or wanted (in the case of shared bands) correspond to interference thresholds at DRAO.
- To repeat measurements, add additional measurements and use various models and computation approaches in order to achieve some convergence between measurements and models.
- Establish both the threshold levels and the protection margins required to maintain aggregate data loss at DRAO to be below 5% (as per ITU-R Rec 1513).
- To define "problem flags" which are agreed criteria for the need for action.

Other Objective: To pull the local, regional and national components of the Canadian Administration into the process of protecting DRAO as partners rather than those we complain to.

Standing Amid Savage Scenery




Observatory Equipment Configuration

406.1-410 MHz system for single-frequency propagation measurements

Calibration Signal from Precision Signal Generator (ifr 2023B)

↓

Directional Coupler

↓

Amplifier

↓

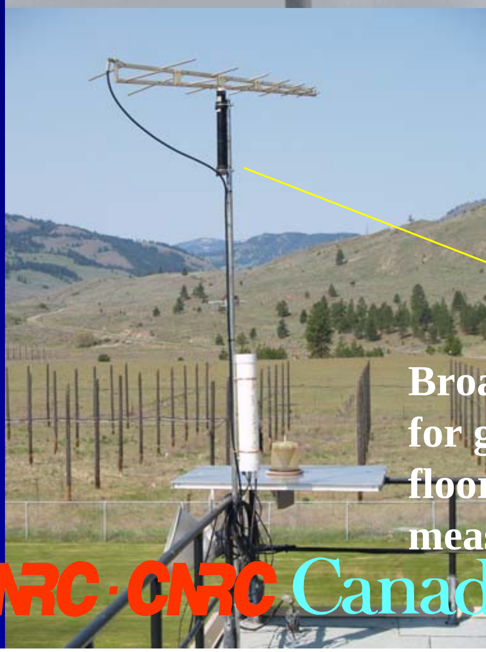
Splitter

↓

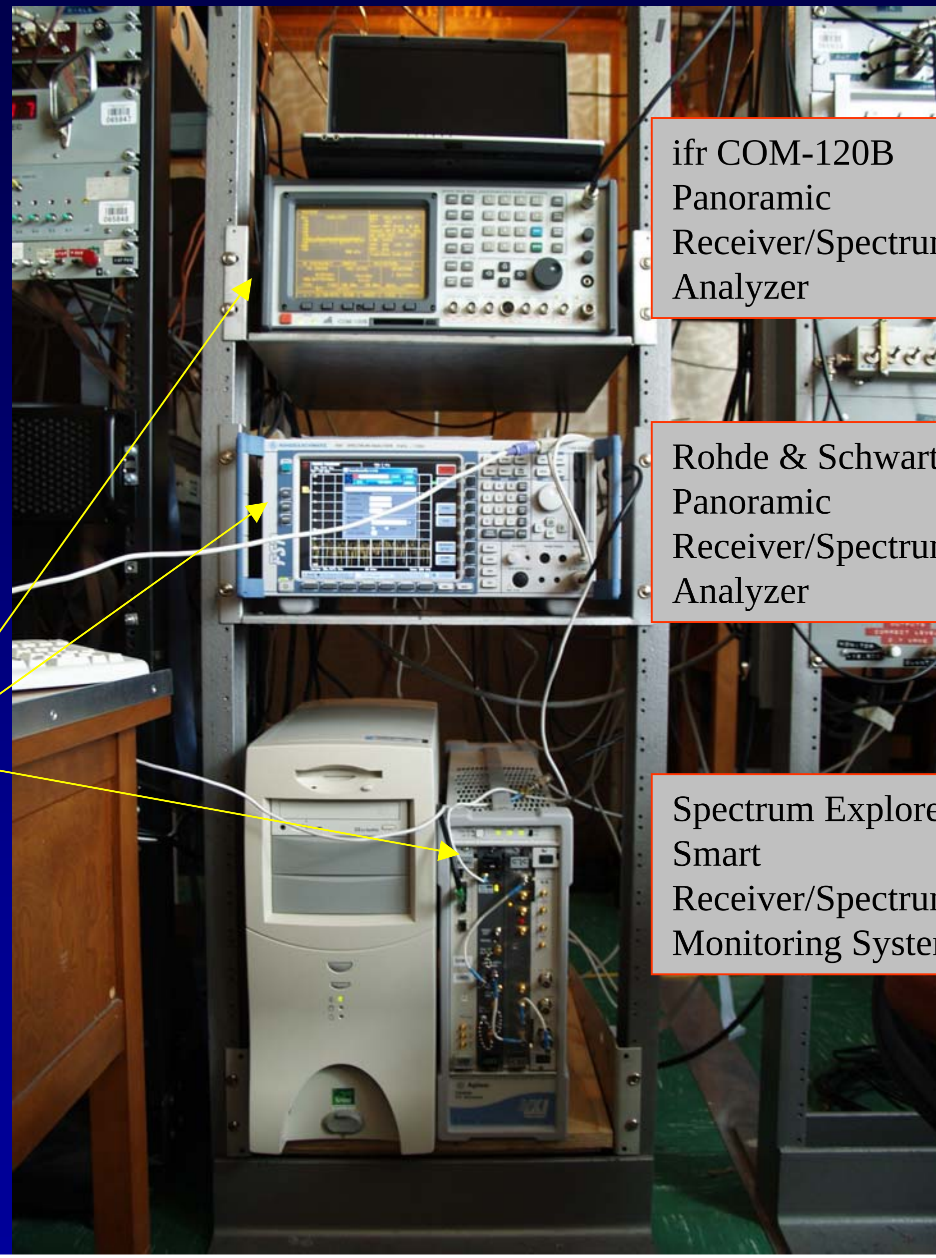
Switches

↑

Amplifier



Broadband system for general noise floor measurements



ifr COM-120B Panoramic Receiver/Spectrum Analyzer

Rohde & Schwartz FSP Panoramic Receiver/Spectrum Analyzer

Spectrum Explorer Smart Receiver/Spectrum Monitoring System

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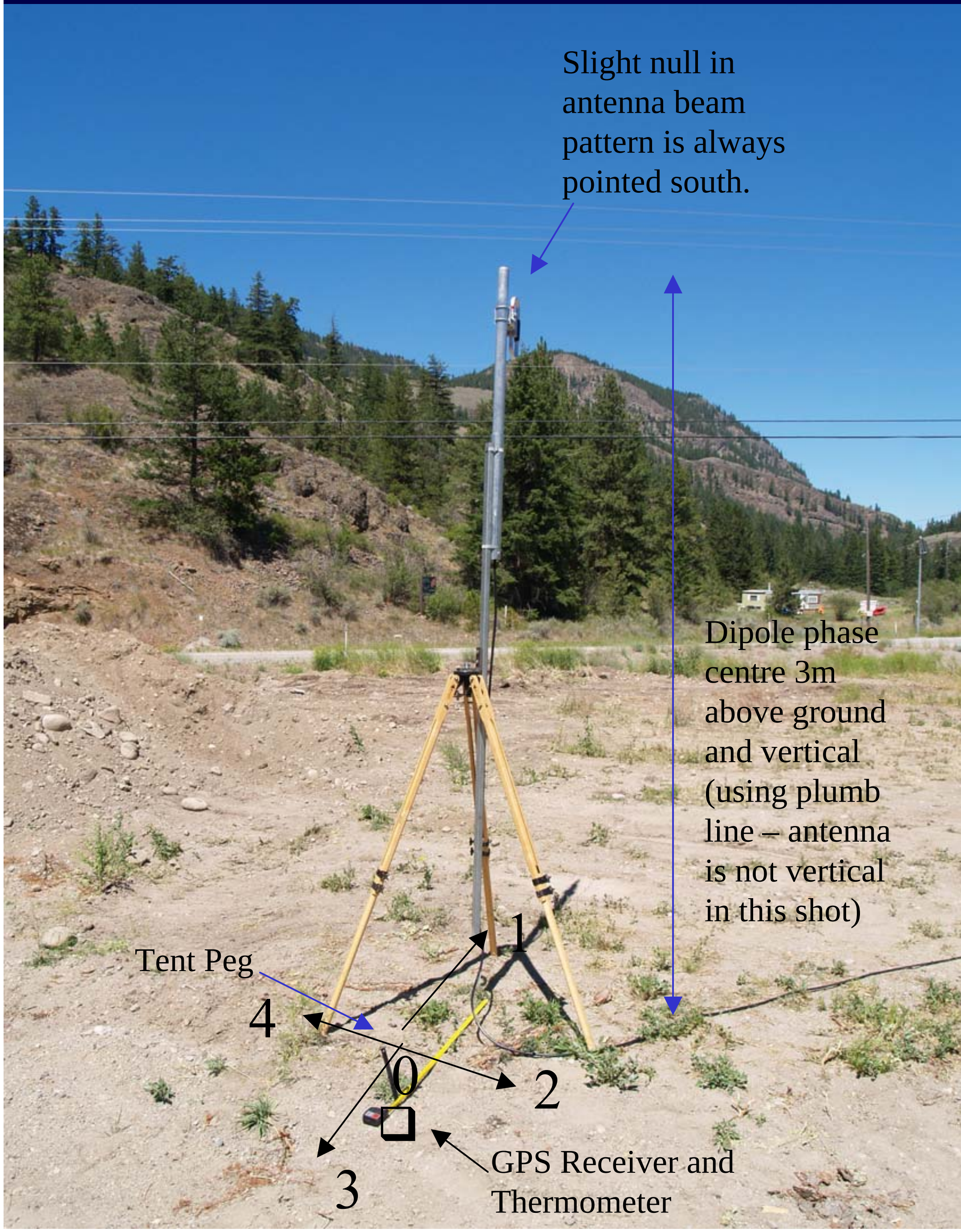
Basic Measurement Procedures

Two Modes

Transportable Base Mode using the mounted folded dipole as shown (more precise but takes longer),
Mobile Mode, using the whip antenna on the van roof (less precise but easy to get lots of data)

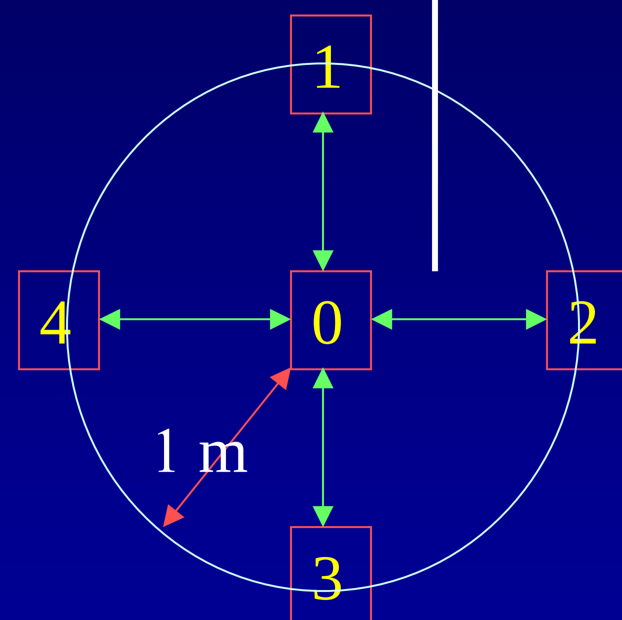
Signals received by both calibrated dipole and log periodic antennas

Relocatable Station Measurement Procedure



This 5-point measuring procedure is recommended by the ITU-R for fixed-point measurements.

North



Process repeated for low (4.5 W), medium (24 W) and high (42 W) transmitter power at 406.9875 MHz. Transmission BW = 15 kHz.

Results So Far…

- By matching the bandwidth (15kHz) of the receiver to the bandwidth of the test transmitter, we can reach the Rec RA769 continuum level in the 406.1-410 MHz band much more quickly than the DRAO radio telescopes can (~2 min).
- As more or less expected, the terrain and propagation models are not really good enough, and the required sampling density of real measurements is much higher than used.
- We have made measurements with snow on the mountains, as opposed to bare summer conditions, but still need to process them.
- The provisional procedure, which we might well end up with adopting finally, is to take the worse case (lowest path loss or measurement, whichever is worse, and add a margin of 20dB).

We are still working on it.

Most Important Consequences

- This project has brought together the local, regional and national offices of the Canadian Administration in a project aimed at protecting a radio observatory.
- This has resulted in an excellent atmosphere of collaboration with a better appreciation of the protection needs of radio astronomy in general and the observatory in particular.
- It has brought onto the site some very nice test equipment that Industry Canada might find quite difficult to get back.

Changes in the Noise Background at DRAO

Although interference from distinct sources is an increasing issue, dealing with it can be fairly straight forward. However the general increase in noise level in radio astronomy bands due to large numbers of radio devices all operating legally and meeting emission limits is a much more difficult issue. The sources are harder to identify and even if identified it is not clear how one deals with them.

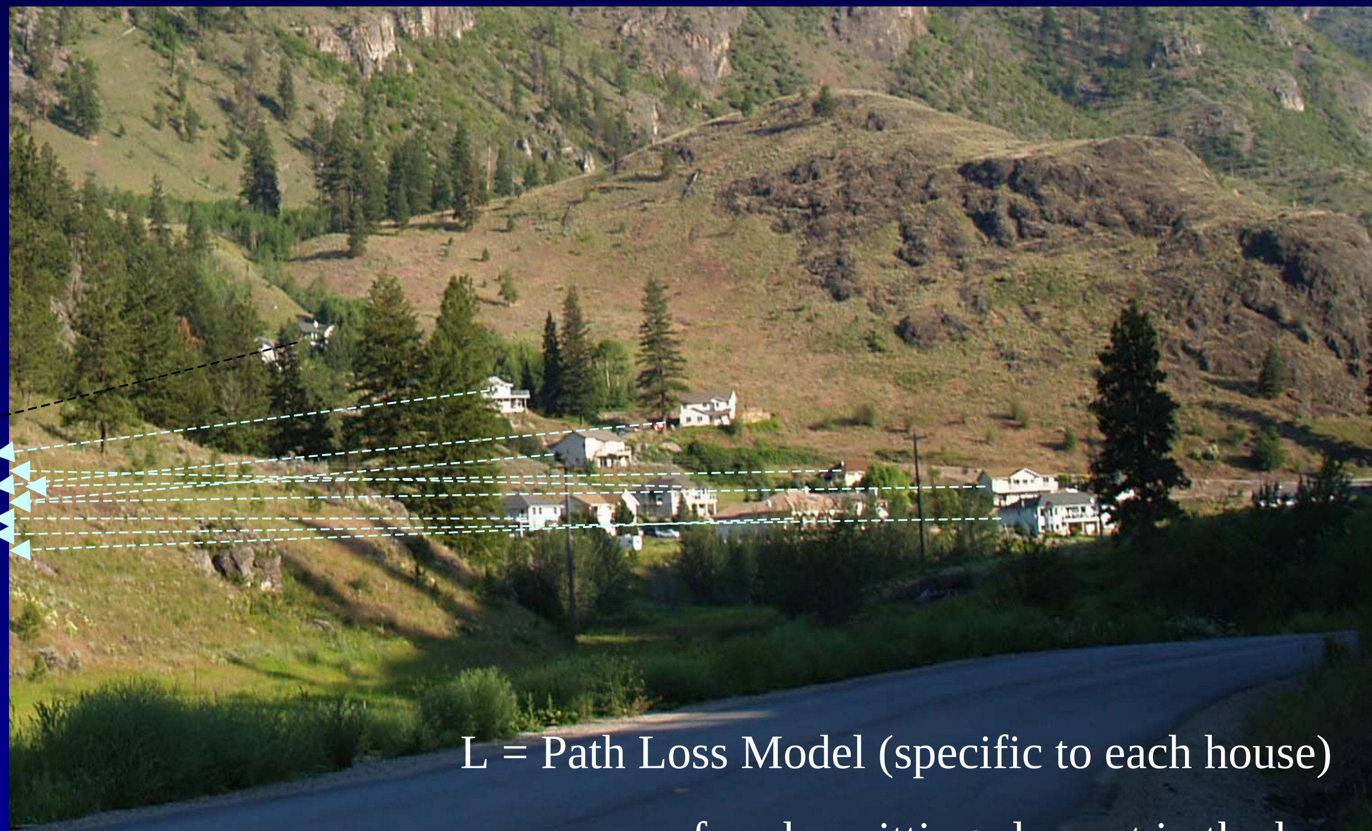
Sadly, as the number of (usually unlicensed) systems proliferates, this could be the main problem for ground-based radio astronomy. How can we deal with it?

Local, Regional and National offices of Industry Canada are working with us on this problem.

Case Study

- There has been for many years a development (St. Andrew’s by the Lake, where a golf course lies right outside the front door) about 4km from the observatory.
- DRAO has been protected by building codes and covenants that restrict the choice of radio-emitting devices that can be used in that community.
- However, radio devices (*e.g.* microwave ovens and domestic wireless networks and devices) were either luxuries or not available when the covenant was signed, but are regarded as domestic necessities today.
- A developer is asking how much additional housing could be accommodated on the site without causing undue(?) operational problems for DRAO.
- Since this issue is likely to grow up elsewhere too, Industry Canada sees this as an opportunity to learn more about it and how to approach it before it becomes more general.

Case Study: Important to DRAO



L = Path Loss Model (specific to each house)

p = power of each emitting element in the house

P = power received at the observatory

i = the house

j = the RF emitting device in the house.

$$P(f,t) = \sum_i \sum_j L_i(r_i, f) p_j(f)$$

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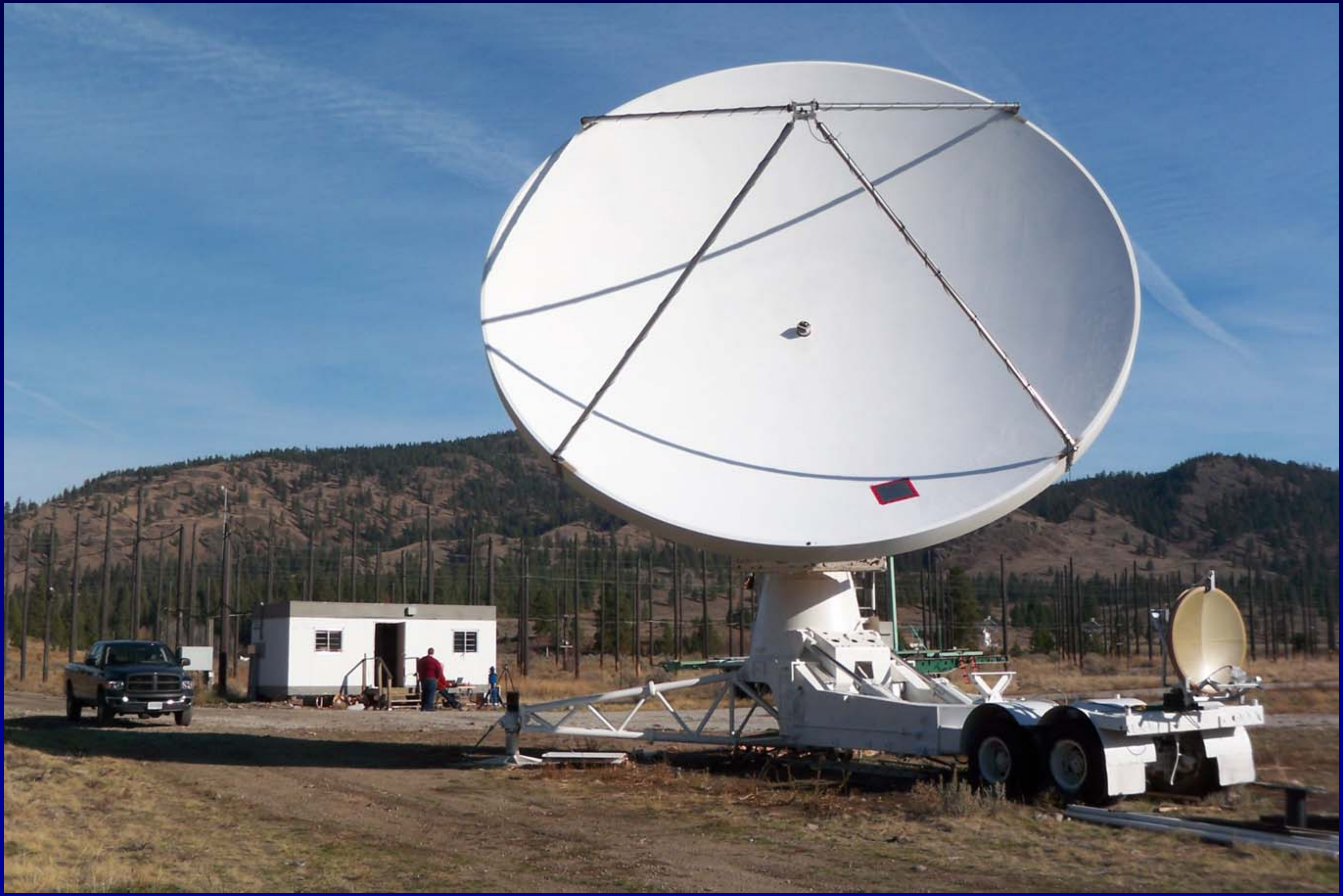
Initial Assumptions

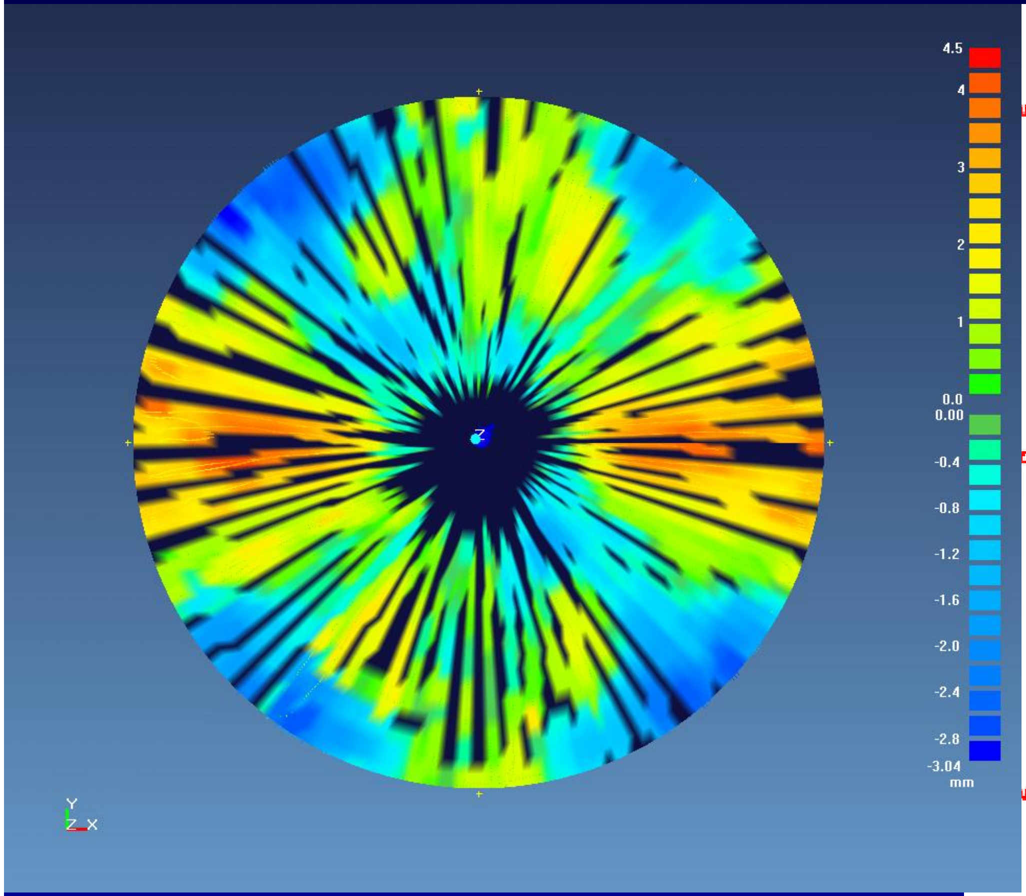
- On the average we can concentrate on radio devices that are switched on for large amounts of time, so that at any time the aggregate could be significant (*e.g.* computers and televisions).
- That the walls of the houses are lossless, so that we can directly apply lab bench measurements of PC's etc. to the modelling.
- That the emission is isotropic.
- Assume simple line-of-sight propagation. This certainly applies to part of the St. Andrew's community and the part of the DRAO site where the New Technology Radio Telescope is under development.

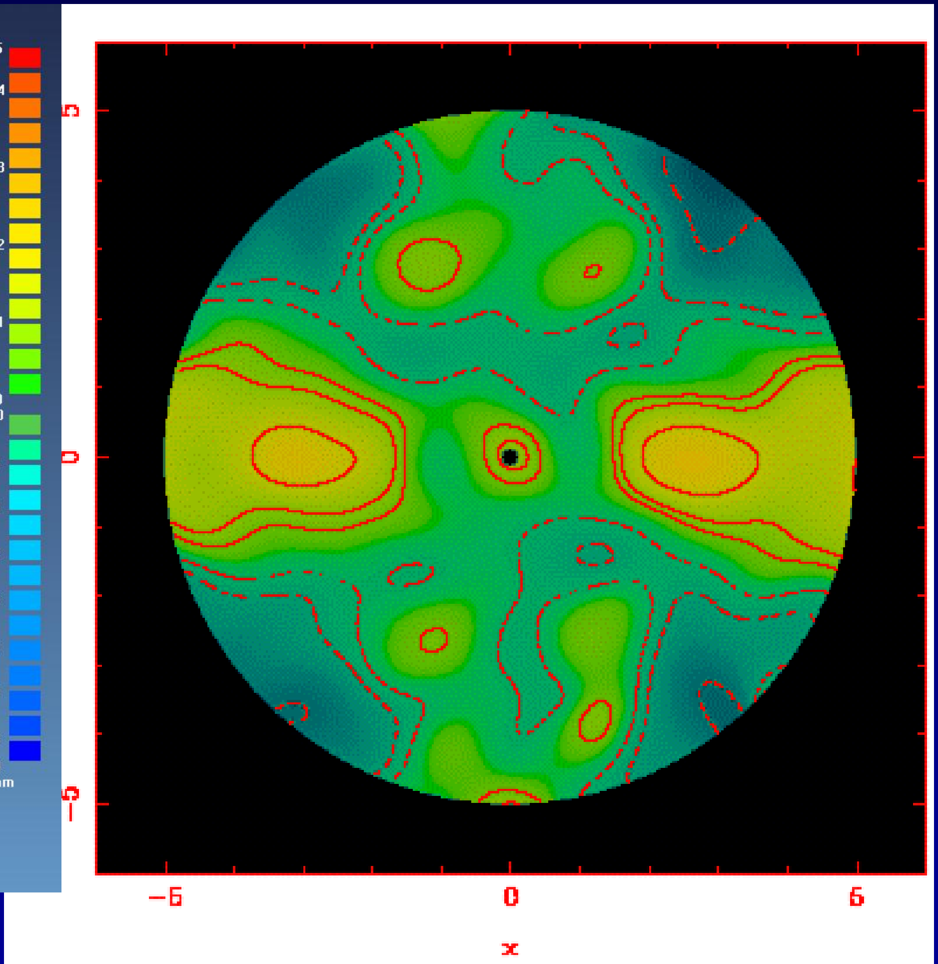
10-m Mark 1 composite reflector

10-m Mark 1 composite reflector



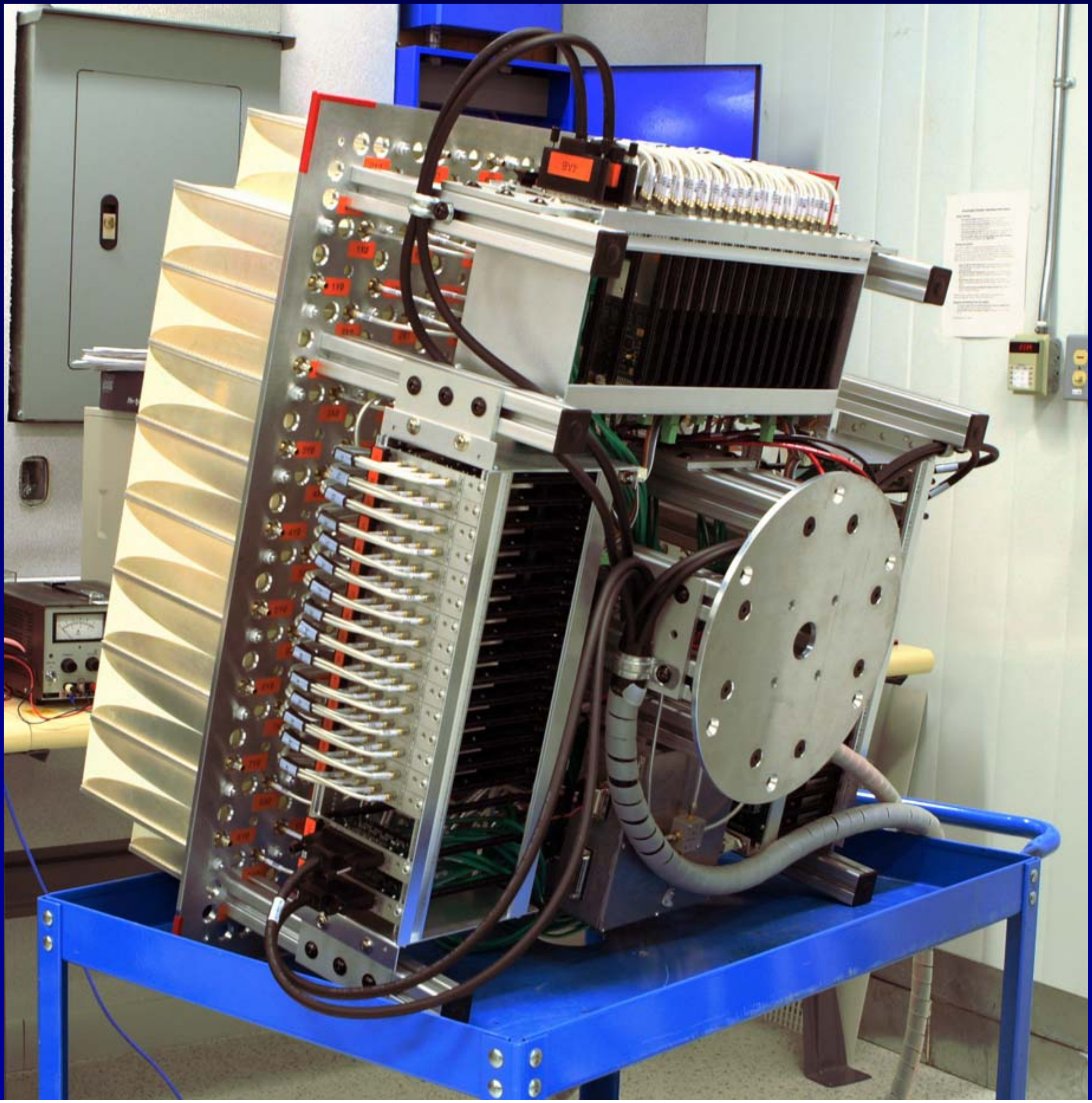
Holography vs surface measurement





- Surface measurement rms ~1 mm (15 GHz) – SKA spec rms 1.5mm
- Holography => conductive surface = physical surface

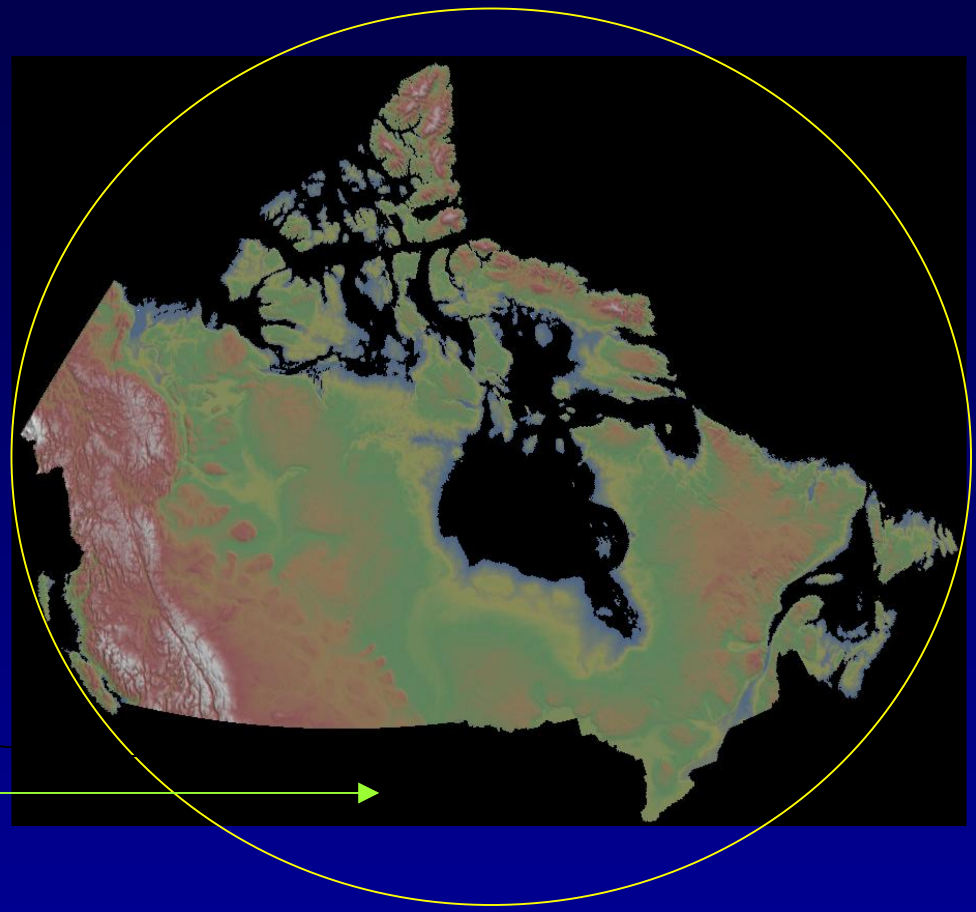
Phased Array Feed



Other Issues

- Building the information base necessary for addressing protection issues for infra-red and near-infra-red telescopes now that those bands are seeing increasing use for communications, radiolocation etc.
- How do we address interference issues due to unlicensed devices?
- We might have a programme investigating the increase in the noise background due to the aggregate unwanted emissions from a huge number of devices all operating legally. However we still need to come up with a way to address it (maybe only distance and terrain blocking).
- Band allocations to 3,000 GHz.

The Protection Zone



Minor negotiations are expected to be necessary regarding this area:

No radio transmissions whatever are permitted in the frequency range $0<f<\infty$ in the above-defined protection zone.

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