Radio Astronomy's Accommodations to Active Earth Exploration Satellites

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Frequency Allocation Footnotes

- 5:562 → The use of the band 94-94.1 GHz by the Earth exploration satellite (active) and space research (active) services is limited to spaceborne cloud radars
- 5.562A → In the bands 94-94.1 GHz and 130-134 GHz, transmission from space stations of the Earth exploration-satellite service (active) that are directed into the main beam of a radio astronomy antenna have the potential to damage some radio astronomy receivers. Space agencies operating the transmitters and the radio astronomy stations concerned should mutually plan their operations so as to avoid such occurences to the maximum extent possible.
- 5.563B → The band 237.9-238 GHz is also allocated to the Earth exploration satellite service (active) and the space research service (active) for spaceborne cloud radars only.

Why inter-service coordination?

John Ponsonby's impact analysis

1. Main beam to main beam
2. Side-lobe to main beam
3. Side-lobe to side-lobe

Consequences of an encounter

1. Possible front-end performance degradation if not permanent damage
2. Interference Levels

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- US342 → In making assignments to stations of other services to which bands:

partial list	111.8-114.25 GHz	151.5-158.5 GHz	195.75-196.15 GHz
76-86 GHz	128.33-128.59 GHz	168.59-168.93 GHz	209-226 GHz
92-94 GHz	129.12-129.49 GHz	171.11-171.45 GHz	241-250 GHz
94.1-100 GHz	130-134 GHz	172.31-172.65 GHz	252-275 GHz
102-109.5 GHZ	136-148.5 GHz	173.52-173.85 GHz	

  are allocated (* indicates radio astronomy use for spectral line observations), all practicable steps shall be taken to protect the radio astronomy service from harmful interference. Emissions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service (see Nos. 4.5 and 4.6 and Article 29 of the ITU Radio Regulations).

Coordination Remedies

1. Modification of existing radio astronomy instrumentation
2. Changes to existing radio astronomy operating procedures
3. Community Education
4. Design of accommodating operating procedures by satellite operators

Changes to the pre-existing radio astronomy operating procedures

1. Add a protection device to shield the receiver from an incoming signal
2. Prohibit the antenna from moving into a dangerous orientation

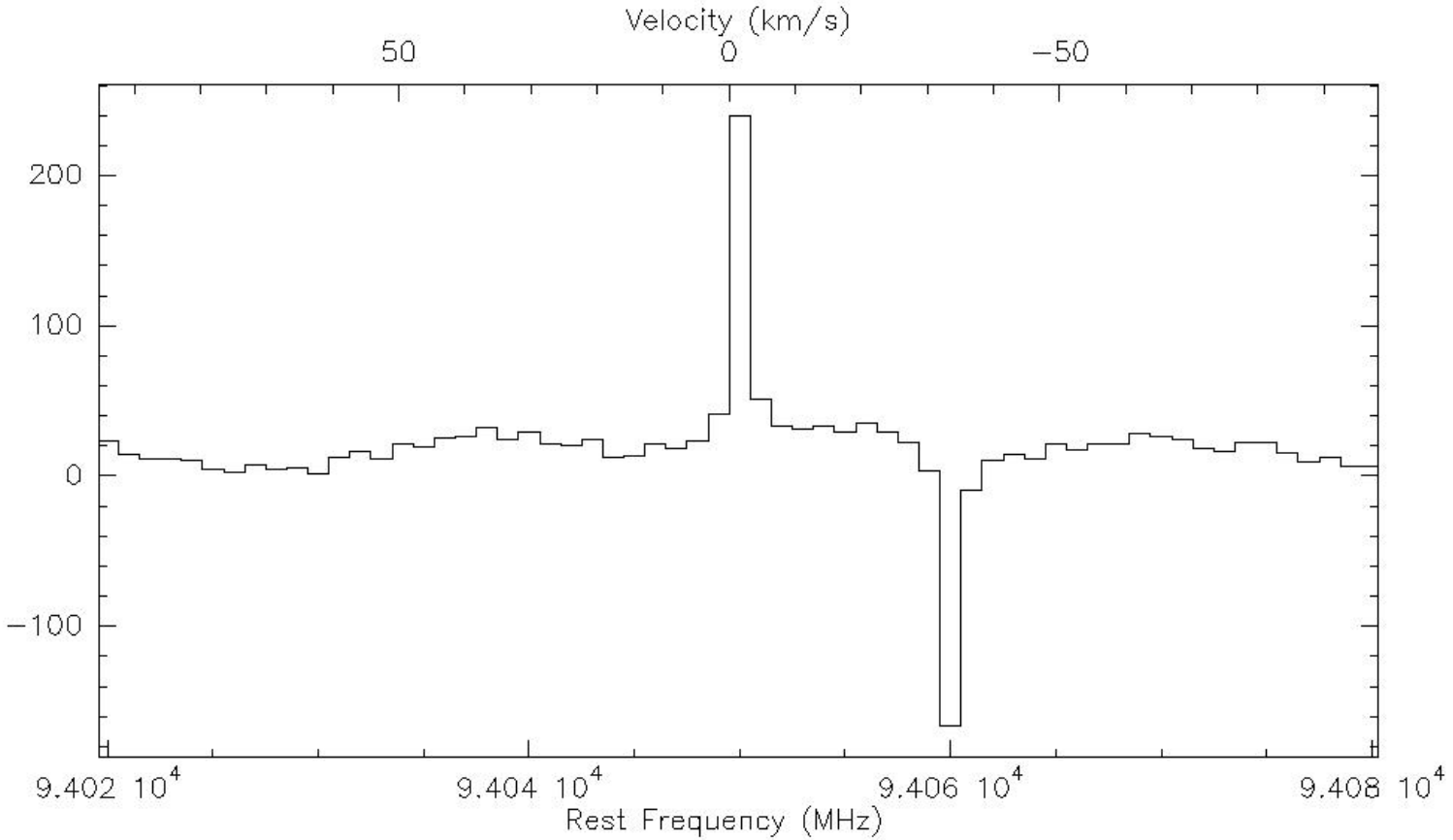
Summary of Various Observatory Precautions

Organization	Facility	Procedures	Comments	Contact
CARMA	CARMA	Limit zenith to < 87.5º	Stow pins inoperative on 6 m	J Lamb
NRAO - ALMA	ALMA	Opaque shutter Limit zenith to < 89º	Included in obs procedures Stow pins inoperative	D Emerson
NRAO	RCByrd GBT	Not yet in place	No operational receiver	J Lockman
NRAO	VLBA	3 mm not selected by subreflector Limit zenith to < 88/89º	Added to obs procedures Original specification Front-end uses HEMT amplifiers	P Perley
UofA - ARO	12-meter	Calibration vane Limit zenith to < 89º	Included in obs procedures	R Freund
UofA - ARO	SMT	Absorbing vane	2 mm lowest freq obs	R Freund

Summary

1. Coordination is recommended by the ITU and FCC and is especially beneficial to the radio astronomy community
2. Instrument safety , both electronic and mechanical
3. Varying levels of harmful interference

2215; 1 service CLOUDSAT 12M−FB11 O: 11−DEC−2007 R: 11−DEC−2007
RA: 20:40:45.695 DEC: 50:12:35.46 (1950.0) Offs: 0.0 0.0 Eq
Unknown Tau: 1.679 Tsys: 2865. Time: 3.3333E−02 El: 84.40
N: 128 I0: 64.50 V0: 0.000 Dv: −3.188 Ear.
F0: 94049.5000 Df: 1.000 Fi: 91049.5000



2217; 1 service CLOUDSAT 12M-FB21 O: 11-DEC-2007 R: 11-DEC-2007
RA: 20:40:45.695 DEC: 50:12:35.46 (1950.0) Offs: 0.0 0.0 Eq
Unknown Tau: 1.679 Tsys: 9427. Time: 3.3333E-02 El: 84.40
N: 128 I0: 65.00 V0: 0.000 Dv: -9.5628E-02 Ear.
F0: 94049.5000 Df: 3.0000E-02 Fi: 91049.5000