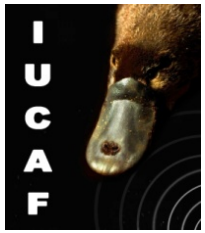

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Masatoshi Ohishi (NAOJ)

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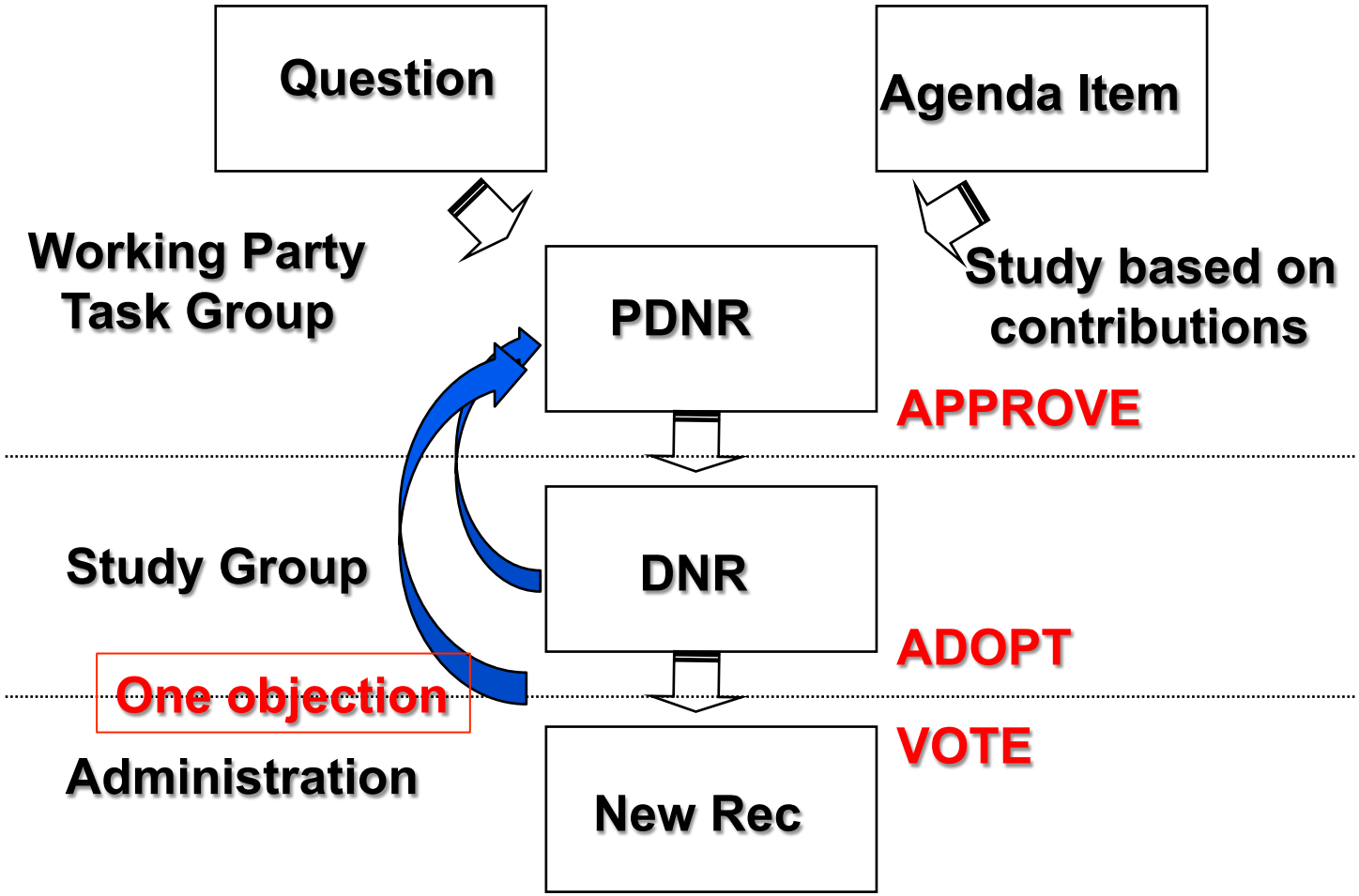
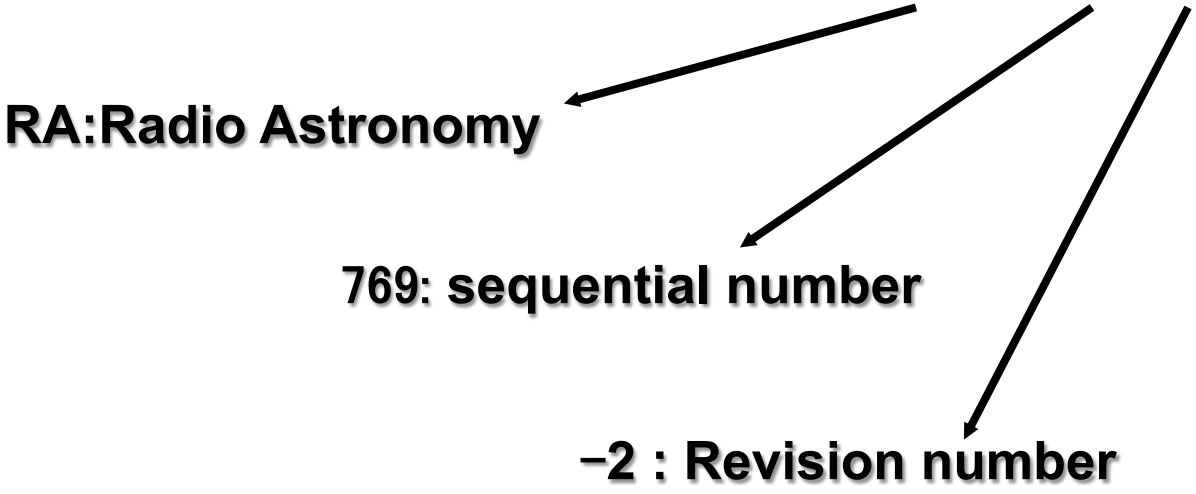


ITU-R Recommendation Series

BO Satellite Delivery
BR Recording for production, archival and play-out; film for television
BS Broadcasting service (sound)
BT Broadcasting service (television)
F Fixed service
M Mobile, radiodetermination, amateur and related satellite services
P Radiowave propagation
RA Radio astronomy
RS Remote Sensing systems
S Fixed satellite service
SA Space applications and meteorology
SF Frequency sharing and coordination between fixed satellite and fixed service systems
SM Spectrum management
SNG Satellite news gathering
TF Time signals and frequency standards emissions
V Vocabulary and related subjects

How to Name Recs

Recommendation ITU-R RA.769-2



ITU-R Recommendations in the Radio Astronomy Series (1)

Basic Protection Criteria

RA.314 Preferred frequency bands for radio astronomical measurements

RA.769 Protection criteria used for radio astronomical measurements

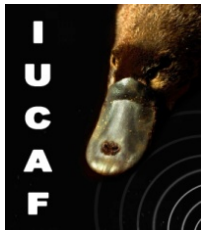
RA.1513 Levels of data loss to radio astronomy observations and percentage-of-time criteria resulting from degradation by interference for frequency bands allocated to radio astronomy on a primary basis

RA.1860 Preferred frequency bands for radio astronomical measurements in the range 1-3 THz

Coordination Zones

RA.1031 Protection of the radio astronomy service in frequency bands shared with other services

RA.1272 Protection of radio astronomy measurements above 60 GHz from ground based interference



ITU-R Recommendations in the Radio Astronomy Series (2)

Out-of-Band and Spurious transmissions

RA.517 Protection of the radio astronomy services from transmitters operating in adjacent bands

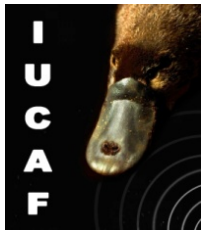
RA.611 Protection of the radio astronomy service from spurious emissions

RA.1237 Protection of the radio astronomy service from unwanted emissions resulting from applications of wideband digital modulation

Protection of regions in Space

RA.479 Protection of frequencies for radioastronomical measurements in the shielded zone of the Moon

RA.1417 A radio-quiet zone in the vicinity of the L2 Sun-Earth Lagrange point



ITU-R Recommendations in the Radio Astronomy Series (3)

Miscellaneous

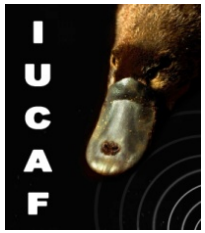
RA.1630 Technical and operational characteristics of ground-based astronomy systems for use in sharing studies with active services between 10 THz and 1000 THz

RA.1631 Reference radio astronomy antenna pattern to be used for compatibility analyses between non-GSO systems and radio astronomy service stations based on the epfd concept

RA.1750 Mutual planning between the Earth exploration-satellite service (active) and the radio astronomy service in the 94 GHz and 130 GHz bands

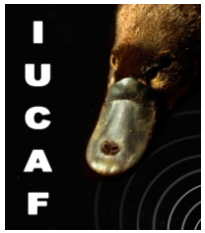
Other Recs relevant to RAS

- P-series
- SM-series: SM.329 (Unwanted emissions in the spurious domain)
- M.1316: OH band vs MSS
- M.1583 & S.1586: RAS vs non-GSO
- „



Preferred Bands for RAS Rec. 314

(<1000 GHz)

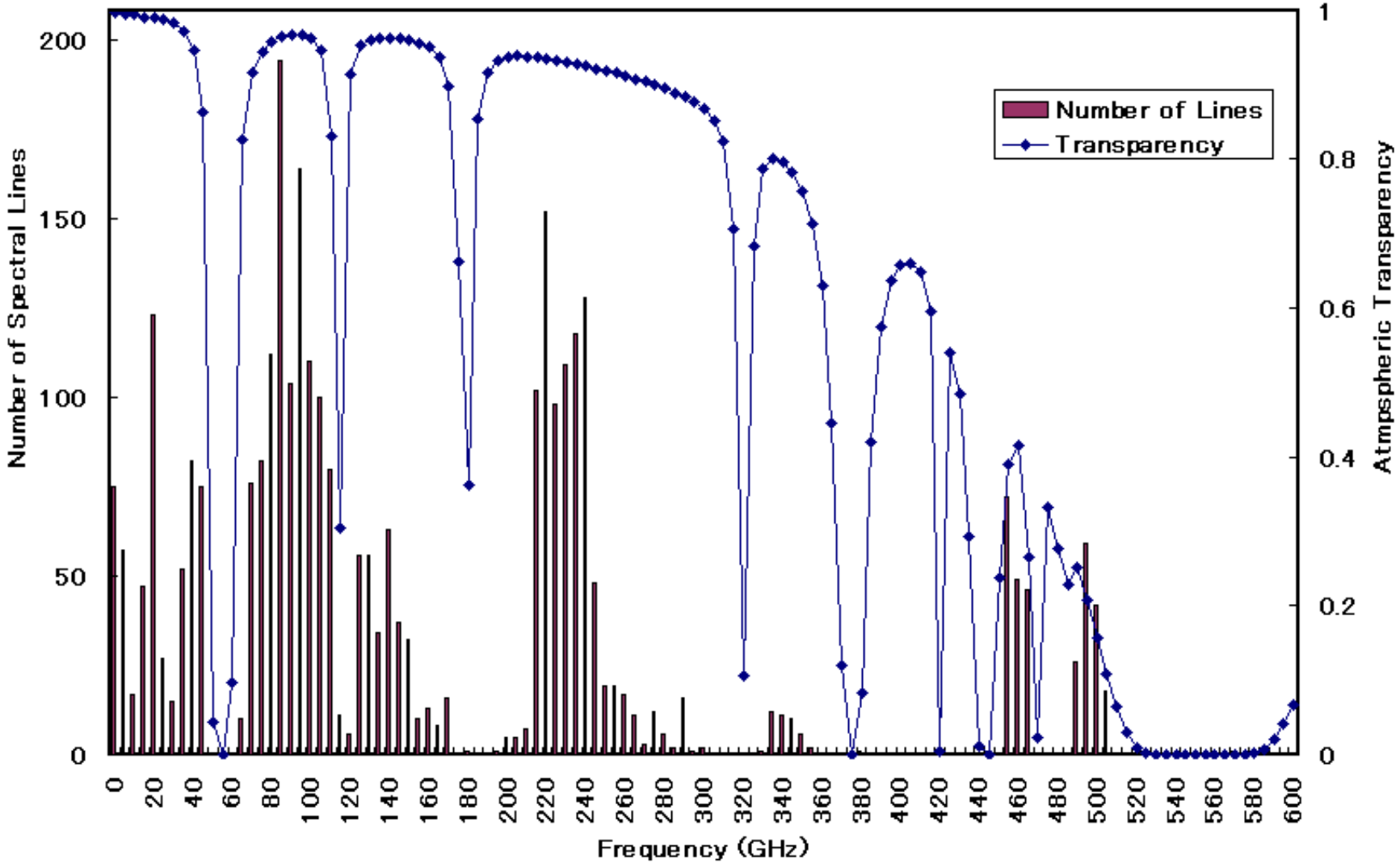


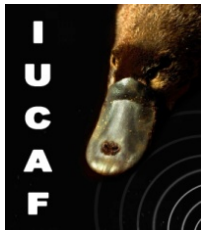
IAU Resolution B16

- List of Important Spectral Lines
  - > Two tables (0-275 GHz, 275-1000 GHz)
  - > doesn't mean that other lines are not important
  - > A minimum set to demonstrate to NON-Astronomers
- Updated in 2000 @ Manchester to include many lines up to 1000 GHz
- Referred to by Recommendation ITU-R RA.314

Rec. ITU-R RA. 314

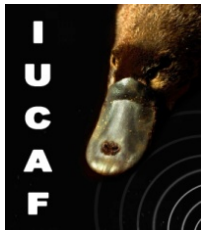
- List of most important lines among observed 3,000/ possible 10,000 ones
- Frequency < 1000 GHz
- Frequency bands for Continuum observations
- Recommends to protect these bands
- Bands not listed in the Rec are also important for RAS


Number of Lines
Transparency
Number of Spectral Lines
Atmpspheric Transparency
Frequency (GHz)
0
50
100
150
200
0
0.2
0.4
0.6
0.8
1
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600



Preferred Bands for RAS Rec. 1860

(1000-3000 GHz)

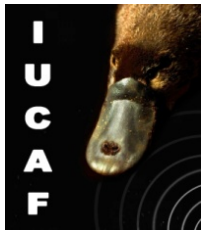


Line Selection

- **Very abundant species**
  → commonly used by many observers
  e.g., CO, H_2O, CS, NH_3
- **Their isotopologues**
  → avoid opacity problems
  e.g., ^{13}CO, $C^{18}O$, HDO
- **Unique in 1-3 THz**
  → atomic lines, metal hydrides, etc.
  e.g., NII, CH, NH

Substance	Rest frequency	Suggested minimum band
Carbon monoxide (CO)	1 036.912	1 035.88 – 1 037.95
Carbon monoxide (CO)	1 267.014	1 265.75 – 1 268.28
Trihydrogen ion (H2D+)	1 370.085	1 368.71 – 1 371.46
Carbon monoxide (CO)	1 381.995	1 380.61 – 1 383.38
Nitrogen Ion (N +)	1 461.132	1 459.814 – 1 462.731
Carbon monoxide (CO)	1 611.793	1 610.18 – 1 613.40
Water (H218O)	1 646.398	1 644.75 – 1 648.04
Oxonium hydride (H3O+)	1 655.834	1 654.18 – 1 657.49
Hydroxyl (OH)	1 834.747	1 832.91 – 1 836.58
Hydroxyl (OH)	1 837.816	1 835.98 – 1 839.65
Carbon monoxide (CO)	1 841.346	1 839.50 – 1 843.19

Substance	Rest frequency	Suggested minimum band
Carbon monoxide (CO)	1 956.018	1 954.06 – 1 957.97
Tricarbon (C3)	1 968.595	1 966.63 – 1 970.56
Carbon monoxide (13CO)	1 979.726	1 977.75 – 1 981.71
Carbon monoxide (CO)	2 413.917	2 411.50 – 2 416.33
Hydrofluoric acid (HF)	2 463.428	2 460.96 – 2 465.89
Hydroxyl (OH)	2 509.948	2 507.44 – 2 512.46
Hydroxyl (OH)	2 514.316	2 511.80 – 2 516.83
Carbon monoxide (CO)	2 528.172	2 525.64 – 2 530.70
Oxonium hydride (H3O+)	2 972.100	2 969.13 – 2 975.07
Oxonium hydride (H3O+)	2 980.725	2 977.74 – 2 983.71

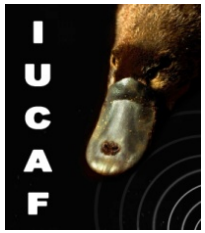


Results

- **~360 lines tabulated in 2000 GHz range, with suggested "coverage"s**
  → ~ 1 line/ 6GHz
- **Continuum bands observable from the ground**

→Proposed to the ITU

→ Approved as Recommendation ITU-R RA.1860 "Preferred frequency bands for radio astronomical measurements in the range 1-3 THz"

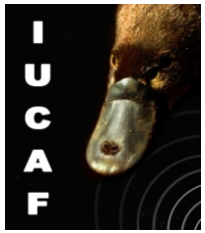


The most important Recommendation

Rec. 769

RA.769

- Defines threshold levels of interference detrimental to RA observations, and recommends to meet these levels
- Calculation method
- Two modes
  - > Continuum mode (Table 1): total power into an entire RA band
  - > Spectral line mode (Table 2): power into a reference band width
- Threshold values for both modes should be simultaneously met



Calculation of thresholds

$$\frac{\Delta P}{P} = \frac{1}{\sqrt{\Delta f_0 t}}$$

$$\Delta T = \frac{T}{\sqrt{\Delta f_0 t}}$$

$$T = T_A + T_R$$

$$\Delta P_H = 0.1\,\Delta P\,\Delta f$$

$$S_H \Delta f = \Delta P_H + 20\log f - 158.5$$

P: power spectral density
at the radio meter input

Integration time:

t=2000 sec
typical value

$\Delta P_{\downarrow H}$: interference threshold level in power

$S_{\downarrow H}$: spectral power flux density for a 0dBi gain antenna

TABLE 1

Threshold levels of interference detrimental to radio astronomy continuum observations

Centre frequency [1] f_c (MHz)	Assumed bandwidth Δf (MHz)	Minimum antenna noise temperature T_A (K)	Receiver noise temperature T_R (K)	System sensitivity [2] (noise fluctuations)		Threshold interference levels [2] [3]		
				Temperature ΔT (mK)	Power spectral density ΔP (dB(W/Hz))	Input power ΔP_H (dBW)	pfd $S_H \Delta f$ (dB(W/m^2))	Spectral pfd S_H (dB(W/(m^2 · Hz)))
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
13.385	0.05	50 000	60	5 000	–222	–185	–201	–248
25.610	0.12	15 000	60	972	–229	–188	–199	–249
73.8	1.6	750	60	14.3	–247	–195	–196	–258
151.525	2.95	150	60	2.73	–254	–199	–194	–259
325.3	6.6	40	60	0.87	–259	–201	–189	–258
408.05	3.9	25	60	0.96	–259	–203	–189	–255
611	6.0	20	60	0.73	–260	–202	–185	–253
1 413.5	27	12	10	0.095	–269	–205	–180	–255
1 665	10	12	10	0.16	–267	–207	–181	–251
2 695	10	12	10	0.16	–267	–207	–177	–247
4 995	10	12	10	0.16	–267	–207	–171	–241
10 650	100	12	10	0.049	–272	–202	–160	–240
15 375	50	15	15	0.095	–269	–202	–156	–233
22 355	290	35	30	0.085	–269	–195	–146	–231
23 800	400	15	30	0.050	–271	–195	–147	–233
31 550	500	18	65	0.083	–269	–192	–141	–228
43 000	1 000	25	65	0.064	–271	–191	–137	–227
89 000	8 000	12	30	0.011	–278	–189	–129	–228
150 000	8 000	14	30	0.011	–278	–189	–124	–223
224 000	8 000	20	43	0.016	–277	–188	–119	–218
270 000	8 000	25	50	0.019	–276	–187	–117	–216

(1) Calculation of interference levels is based on the centre frequency shown in this column although not all regions have the same allocations.

(2) An integration time of 2 000 s has been assumed; if integration times of 15 min, 1 h, 2 h, 5 h or 10 h are used, the relevant values in the Table should be adjusted by +1.7, –1.3, –2.8, –4.8 or –6.3 dB respectively.

(3) The interference levels given are those which apply for measurements of the total power received by a single antenna. Less stringent levels may be appropriate for other types of measurements, as discussed in § 2.2. For transmitters in the GSO, it is desirable that the levels be adjusted by –15 dB, as explained in § 2.1.

TABLE 2*

Threshold levels of interference detrimental to radio astronomy spectral-line observations

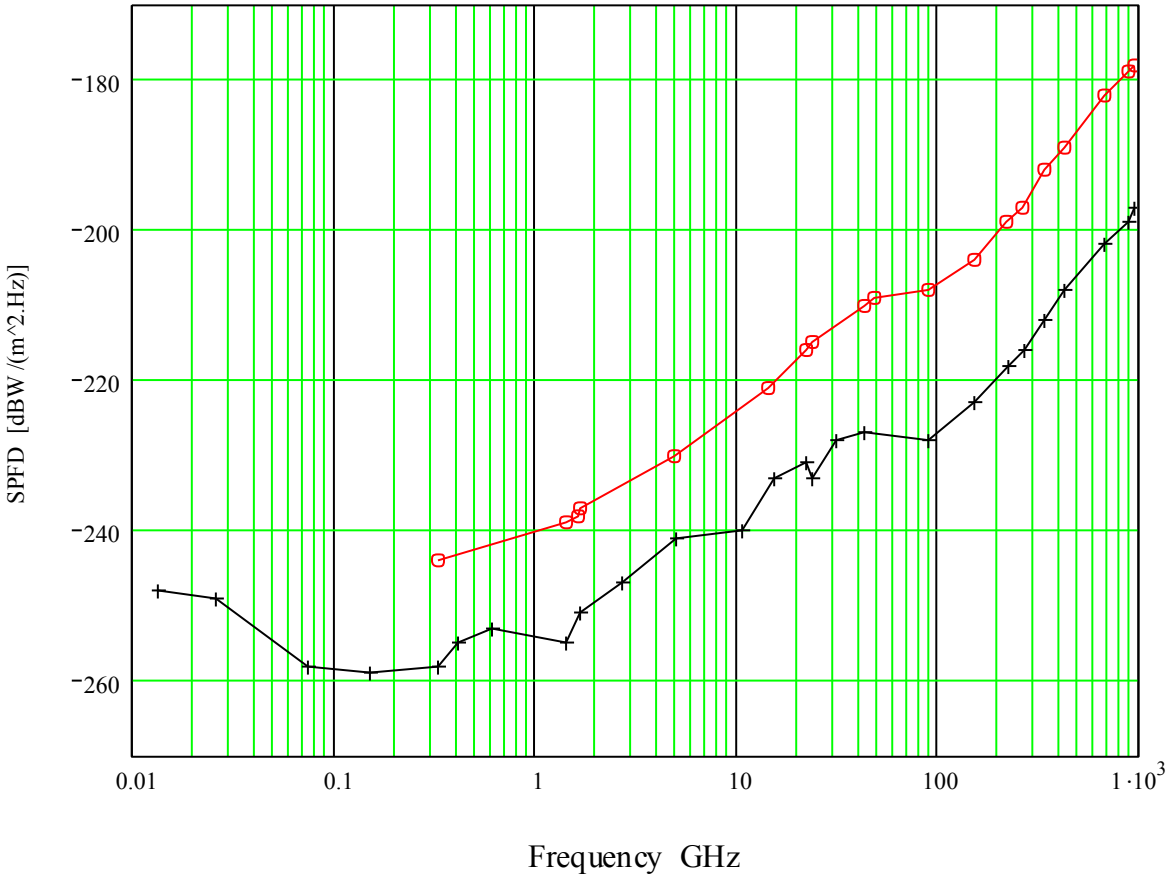
Frequency f (MHz)	Assumed spectral line channel bandwidth Δf (kHz)	Minimum antenna noise temperature T_A (K)	Receiver noise temperature T_R (K)	System sensitivity(2) (noise fluctuations)		Threshold interference levels(1) (2)		
				Temperature ΔT (mK)	Power spectral density ΔP_S (dB(W/Hz))	Input power ΔP_H (dBW)	pfd $S_H \Delta f$ (dB(W/m^2))	Spectral pfd S_H (dB(W/(m^2 · Hz)))
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
327	10	40	60	22.3	–245	–215	–204	–244
1 420	20	12	10	3.48	–253	–220	–196	–239
1 612	20	12	10	3.48	–253	–220	–194	–238
1 665	20	12	10	3.48	–253	–220	–194	–237
4 830	50	12	10	2.20	–255	–218	–183	–230
14 488	150	15	15	1.73	–256	–214	–169	–221
22 200	250	35	30	2.91	–254	–210	–162	–216
23 700	250	35	30	2.91	–254	–210	–161	–215
43 000	500	25	65	2.84	–254	–207	–153	–210
48 000	500	30	65	3.00	–254	–207	–152	–209
88 600	1 000	12	30	0.94	–259	–209	–148	–208
150 000	1 000	14	30	0.98	–259	–209	–144	–204
220 000	1 000	20	43	1.41	–257	–207	–139	–199
265 000	1 000	25	50	1.68	–256	–206	–137	–197

* This Table is not intended to give a complete list of spectral-line bands, but only representative examples throughout the spectrum.

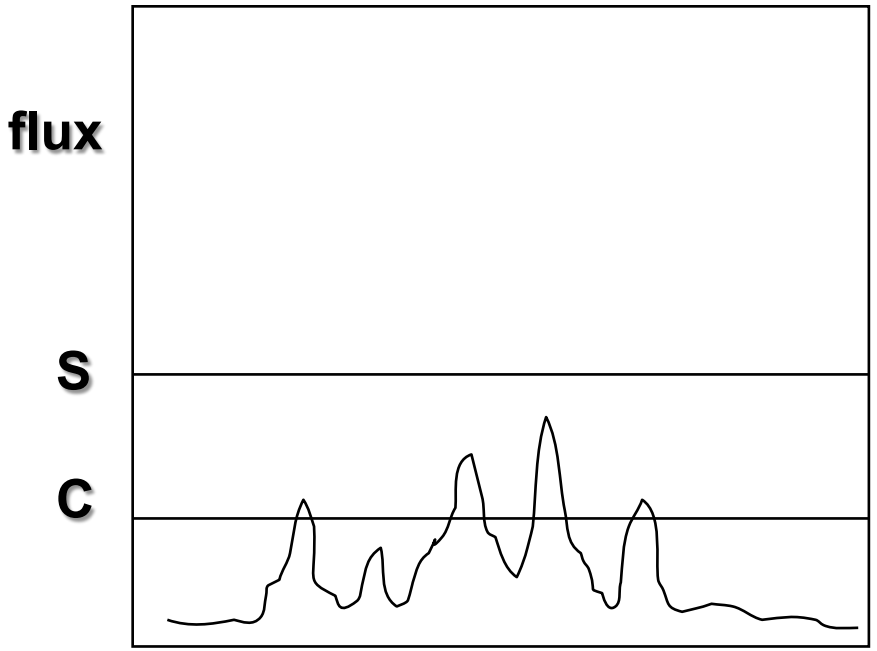
(1) An integration time of 2 000 s has been assumed; if integration times of 15 min, 1 h, 2 h, 5 h or 10 h are used, the relevant values in the Table should be adjusted by +1.7, –1.3, –2.8, –4.8 or –6.3 dB respectively.

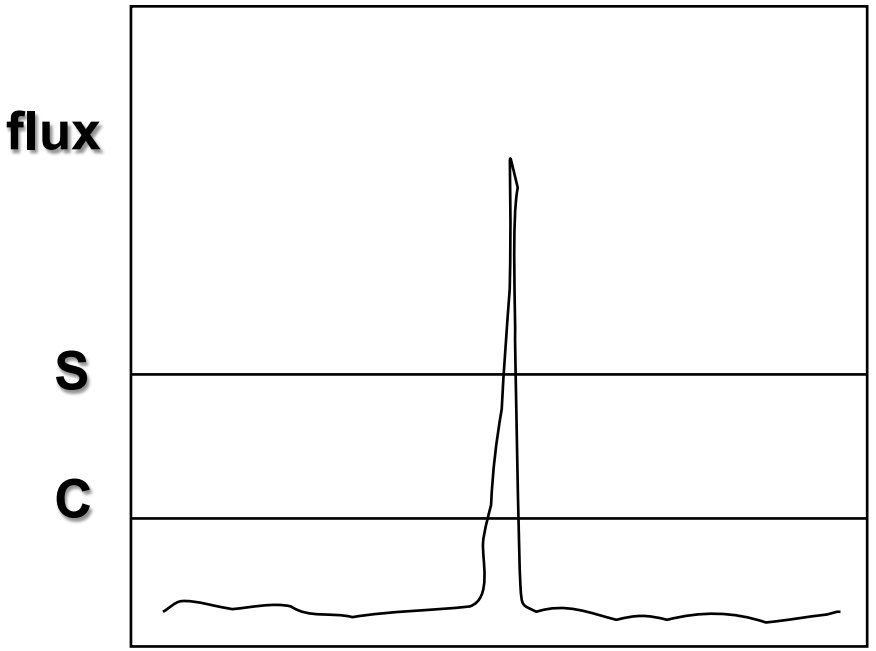
(2) The interference levels given are those which apply for measurements of the total power received by a single antenna. Less stringent levels may be appropriate for other types of measurements, as discussed in § 2.2. For transmitters in the GSO, it is desirable that the levels need to be adjusted by –15 dB, as explained in § 2.1.

Detrimental thresholds for total power observations



black, continuum; red, spectral line





Total power of interference does not exceed the continuum mode threshold value, AND interference power in ANY reference band does not exceed the spectral line mode threshold level

→ meets the Rec

Total power of interference does not exceed the continuum mode threshold value, BUT interference power in at least one reference band exceeds the spectral line mode threshold level

→ does not meet the Rec

Threshold-level Formula

Voltage ratio at receiver output:

$$\frac{Interference}{rms\ noise} = \left[\frac{S_H(c^2/4\pi f^2)\Delta f}{k(T_A + T_R)\Delta f}\right]\sqrt{\Delta f\,\tau}$$

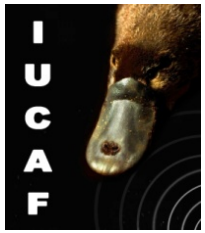
For Interference/rms noise = 0.1,

$$S_H = \frac{0.4\pi k f^2 (T_A + T_R)}{c^2\sqrt{\Delta f \tau}}$$

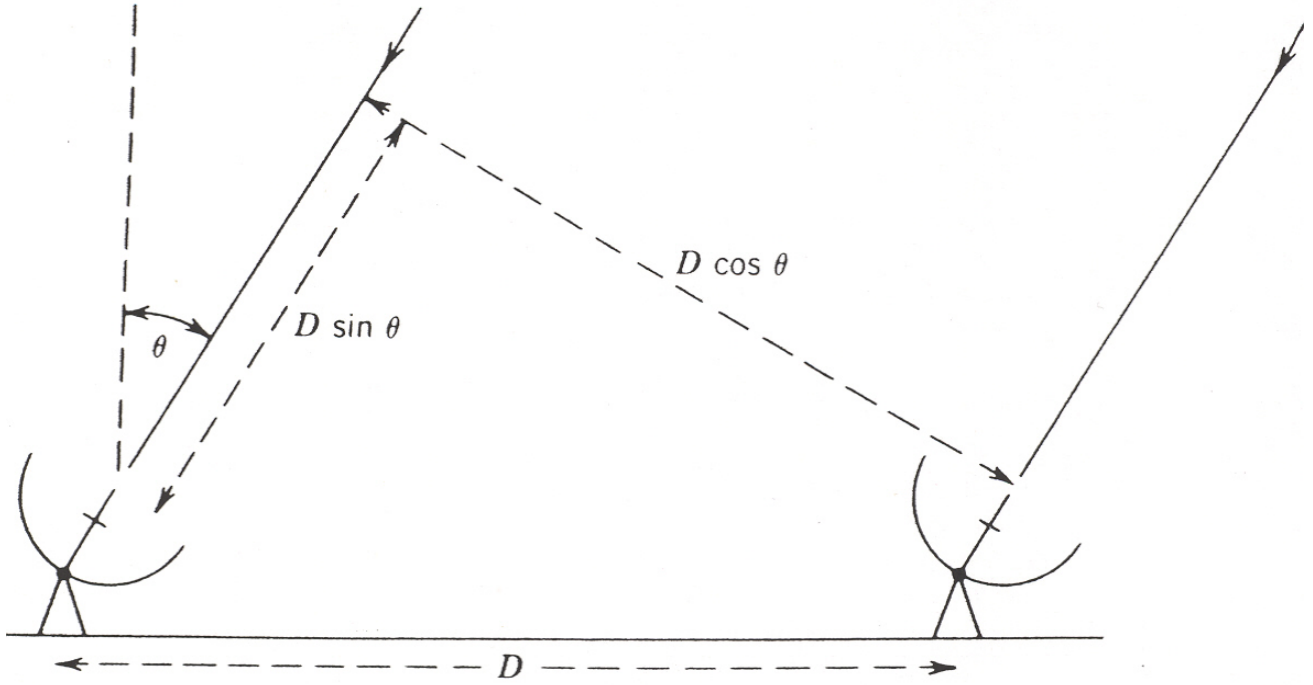
(see ITU-R RA Handbook Eq. 4.10)
Units of S_H are W m^{-2}Hz^{-1} (spectral power flux density)

$$F_H = S_H \Delta f = \frac{0.4\pi k f^2 (T_A + T_R)}{c^2}\sqrt{\frac{\Delta f}{\tau}}$$

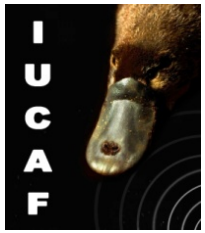
Units of F_H are W m^{-2} (power flux density)



Basic Radio Interferometer



Fringe-frequency oscillations occur in the output of an interferometer as a result of the variation of the path difference *D* sin *θ* as the source moves across the sky. Removal of the fringe oscillations from the response to a source introduces similar oscillations into an RFI signal from a stationary transmitter. Time-averaging reduces the response to the RFI oscillations.



Interference threshold for VLBI

In VLBI, the natural fringe frequency is so high that the RFI fringe amplitude can be considered to be reduced to zero at the correlator output. However, the presence of RFI in the receiver can introduce errors into the system calibration. Thus the Interference threshold criterion for VLBI is the level at which the interference power within the receiver (before detection) is 1/100 of the noise power.

The power ratio *interference/noise* within the receiver is:

$$\left[\frac{S_H(c^2/4\pi f^2)}{k(T_A+T_R)}\right]$$

The RFI threshold for *interference/noise* = 1/100 is:

$$S_H = \frac{0.04k(T_A+T_R)f^2}{c^2}$$

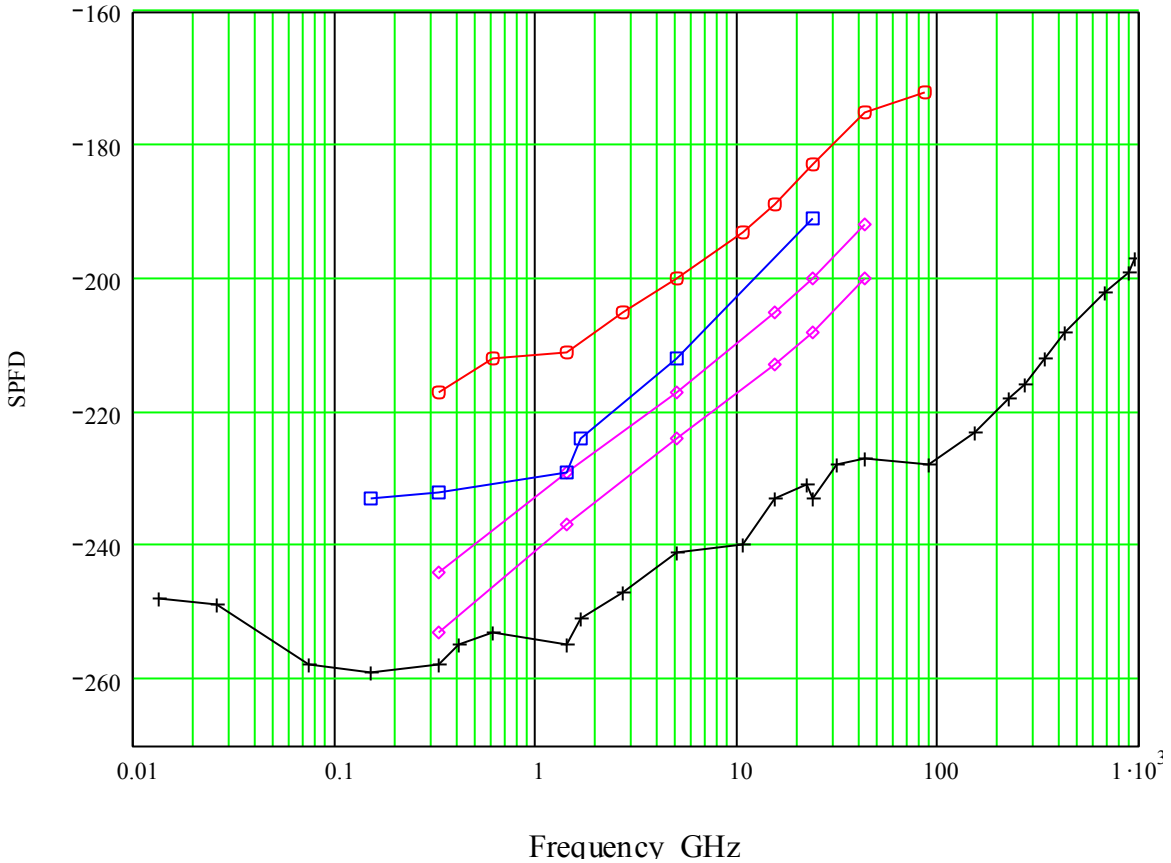
For VLBI Observations

TABLE 3

Threshold interference levels for VLBI observations

Centre frequency (MHz)	Threshold level ($dB(W/m^2 \cdot Hz)$)
325.3	–217
611	–212
1 413.5	–211
2 695	–205
4 995	–200
10 650	–193
15 375	–189
23 800	–183
43 000	–175
86 000	–172

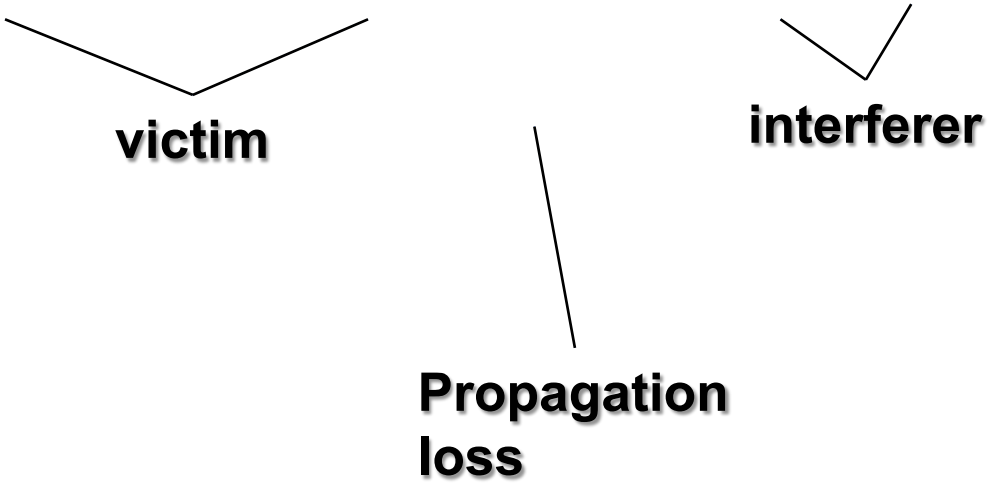
Detrimental thresholds for continuum observations

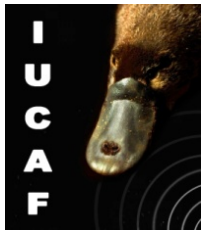


black, total power ; magenta, VLA (D and A); blue, Merlin; red, VLBI

Evaluation of RFI

$$P_r = G_r \, 1/L_p \; G_t \, P_t$$





Example of sidelobes

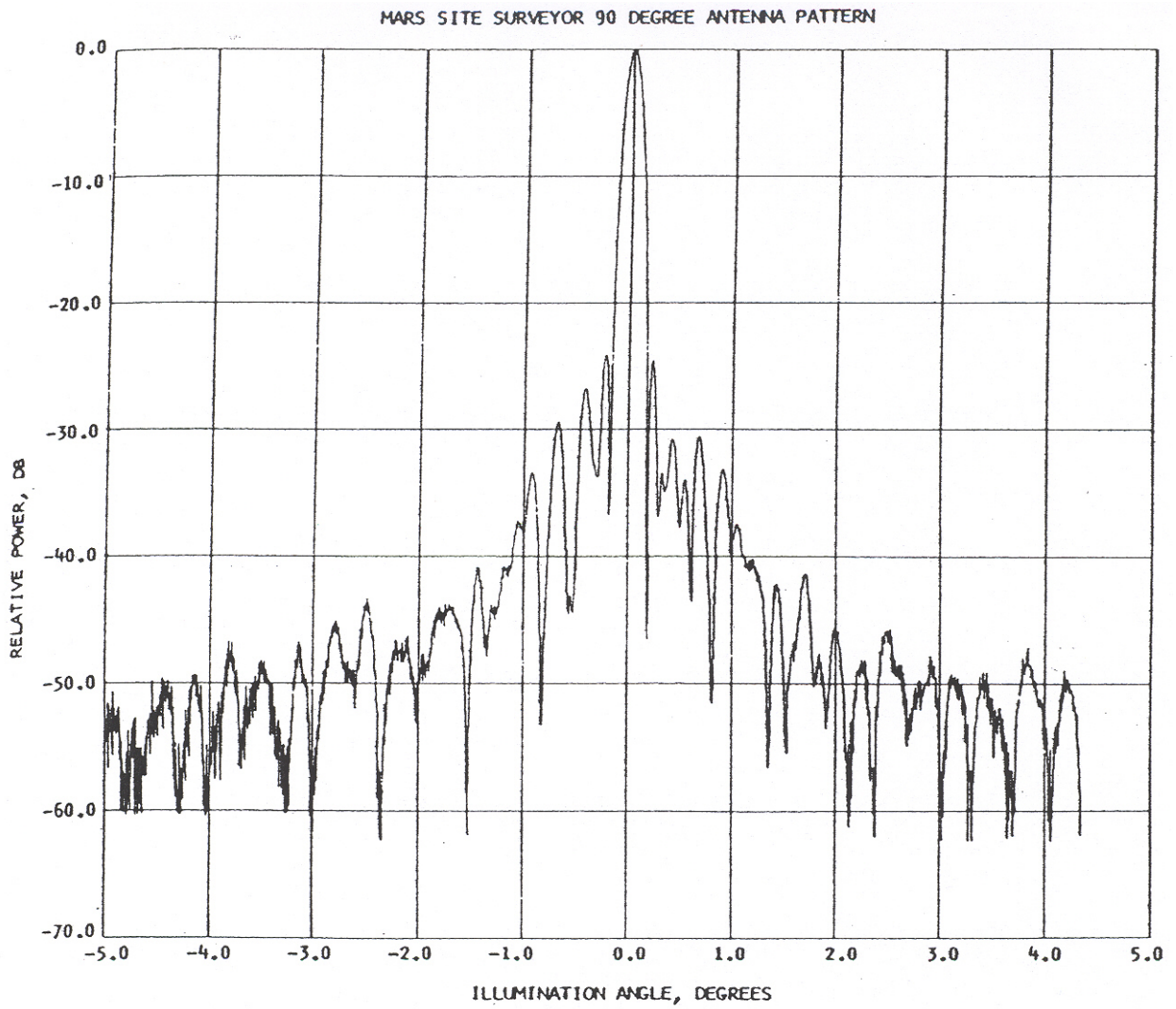
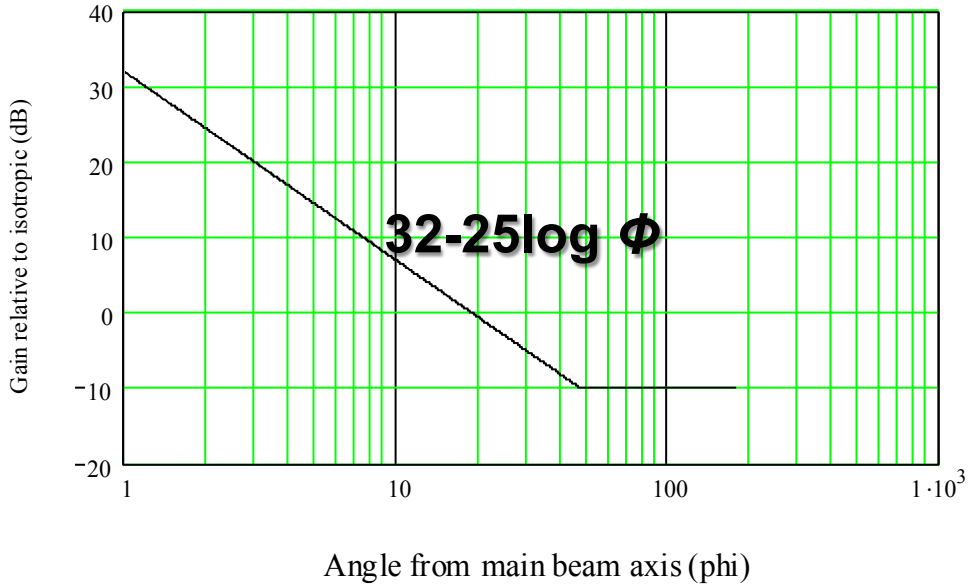


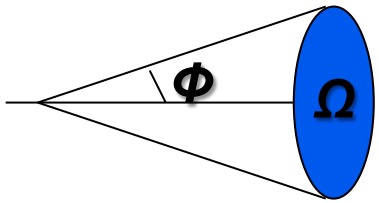
Fig. 5. AAS elevation radiation pattern.

210-ft antenna at S-band, from Levy, G. S., et al., IEEE Trans. AP-15, 311, 1967.

SA.509 Sidelobe Model



Empirical sidelobe model for reflector antennas of diameter ≥ 100 wavelengths. 90% of sidelobe peaks lie below the curve. Representative of symmetric parabolic-reflector antennas.



Solid angle $\Omega = 2\pi\ (1-\cos\Phi)$

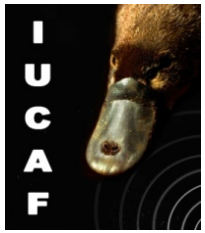
In RA threshold calculations, sidelobe gain of 0 dBi is used in assessing RFIs.

Gain (*G*) and aperture (*A*) for detrimental threshold calculation

$$\Omega = 2\pi (1 - \cos\phi)$$

	ϕ G = 1 (0 dBi)	$\Omega/2\pi$
32-25 log ϕ (SA.509)	19.05°	5.5%
29-25 log ϕ (S.580)	14.45°	3.2%
34-30 log ϕ (RA.1631 and S. 1248)	13.59°	2.85%

$$A = \frac{G\lambda^2}{4\pi} = \frac{Gc^2}{4\pi f^2}$$



RFIs may exceed threshold levels

RA.1513

- Defines tolerable fraction of interference that exceeds the threshold level
- Not fraction of time, but fraction of “Data Loss”
- RA bands on a primary basis only

- Data loss due to any single network
  - > <2%
- Aggregated data loss due to all networks
  - > <5%; methodology of apportionment between different networks is to be studied

Statistical Evaluation of “Data Loss”

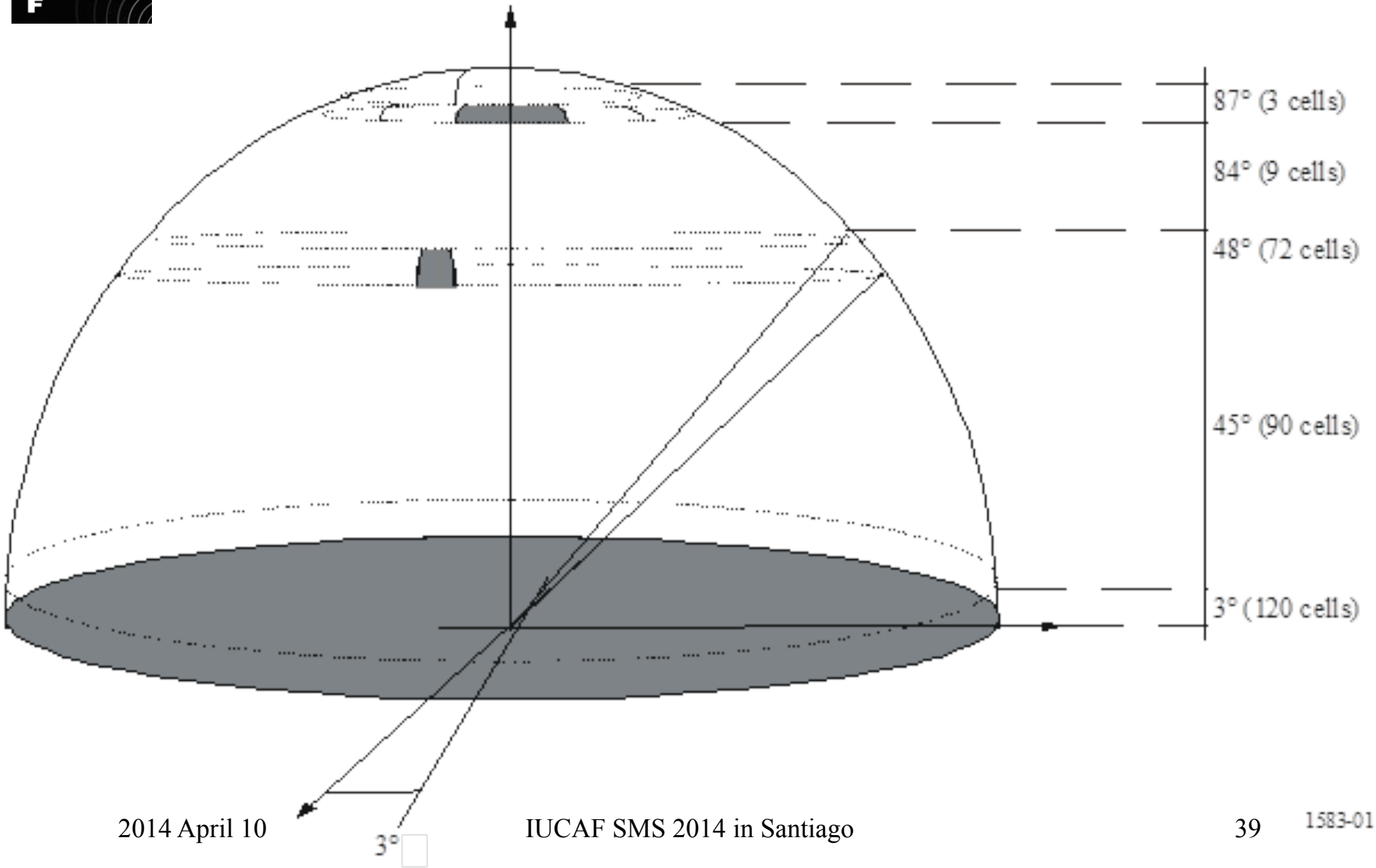
- **Recommends 3**
  - > **that the percentage of data loss, in frequency bands allocated to the RAS on a primary basis, be determined as the percentage of integration periods of 2 000 s in which the average spectral pfd at the radio telescope exceeds the levels defined (assuming 0 dBi antenna gain) in Recommendation ITU-R RA.769. The effect of interference that is periodic on time scales of the order of seconds or less, such as radar pulses, requires further study;**

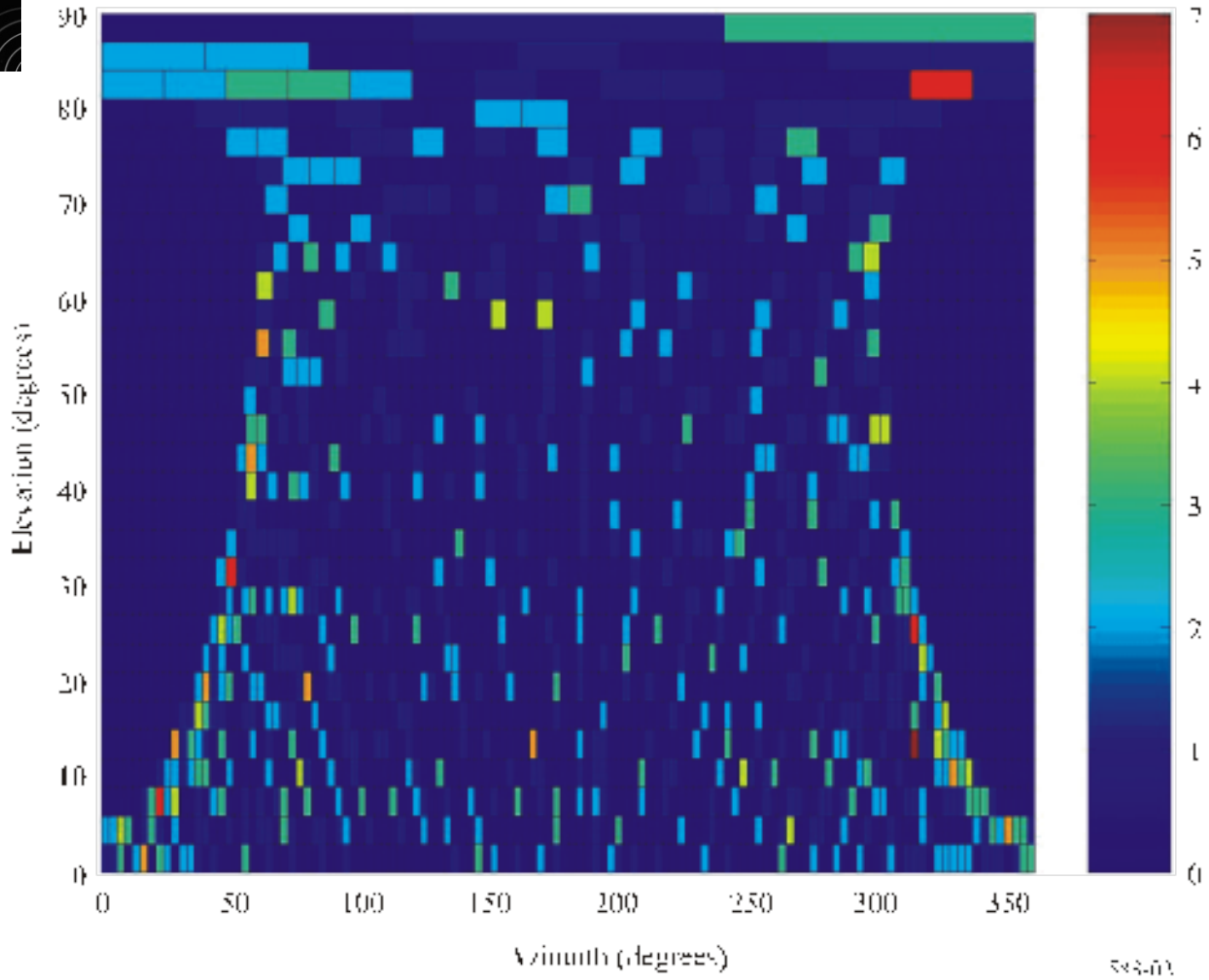
Cases of non-GSO satellites

- Recommends 4
  - > Use methodology described in Recs S.1586 and M.1583
  - > Divide the sky into 2334 cells of approximately 9 square degrees of solid angle each
  - > Calculate aggregate interference from visible satellites; randomly point a RAS telescope and statistically evaluate the data loss in each cell
  - > In each cell compare the interference level with Rec. 769
  - > Evaluate if the fraction of total number of cells that exceed Rec.769 relative to the 2334 cells exceeds 2%

FIGURE 1

Example of division of the sky in cells of approximately 9 square degrees of solid angle




90
80
70
60
50
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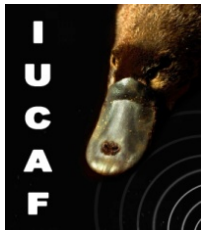
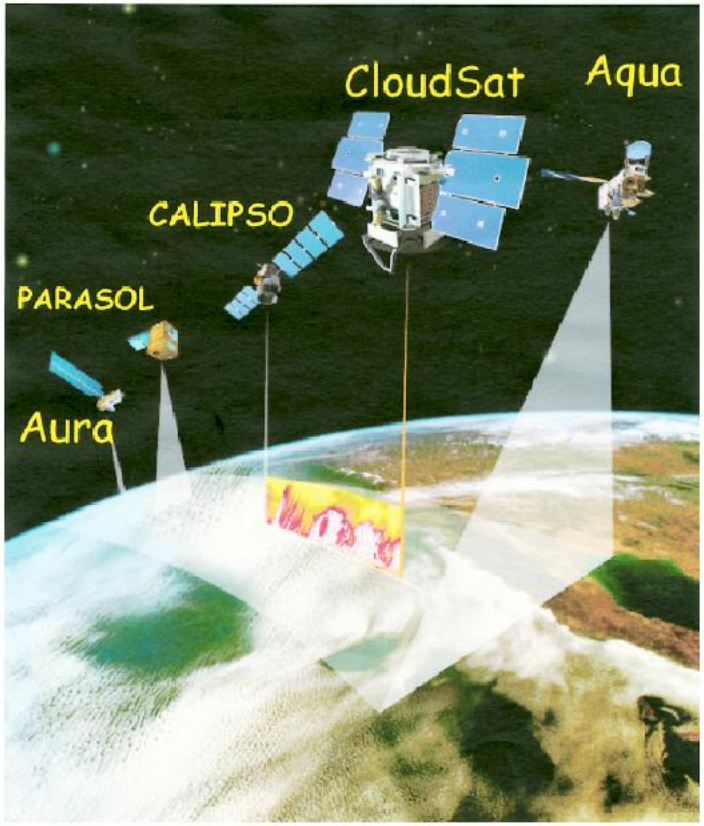


Cloud Sat

Rec. RA. 1750
also visit at http://www.iucaf.org/CloudSat/



- @94.05 GHz, 100 MHz wide, 1.8 kW
  → may burn out RA Rx → close "shutter"
- RA.1750 defines the coordination procedure; IUCAF is the gateway
- Liszt's lecture in this afternoon

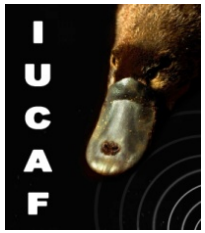
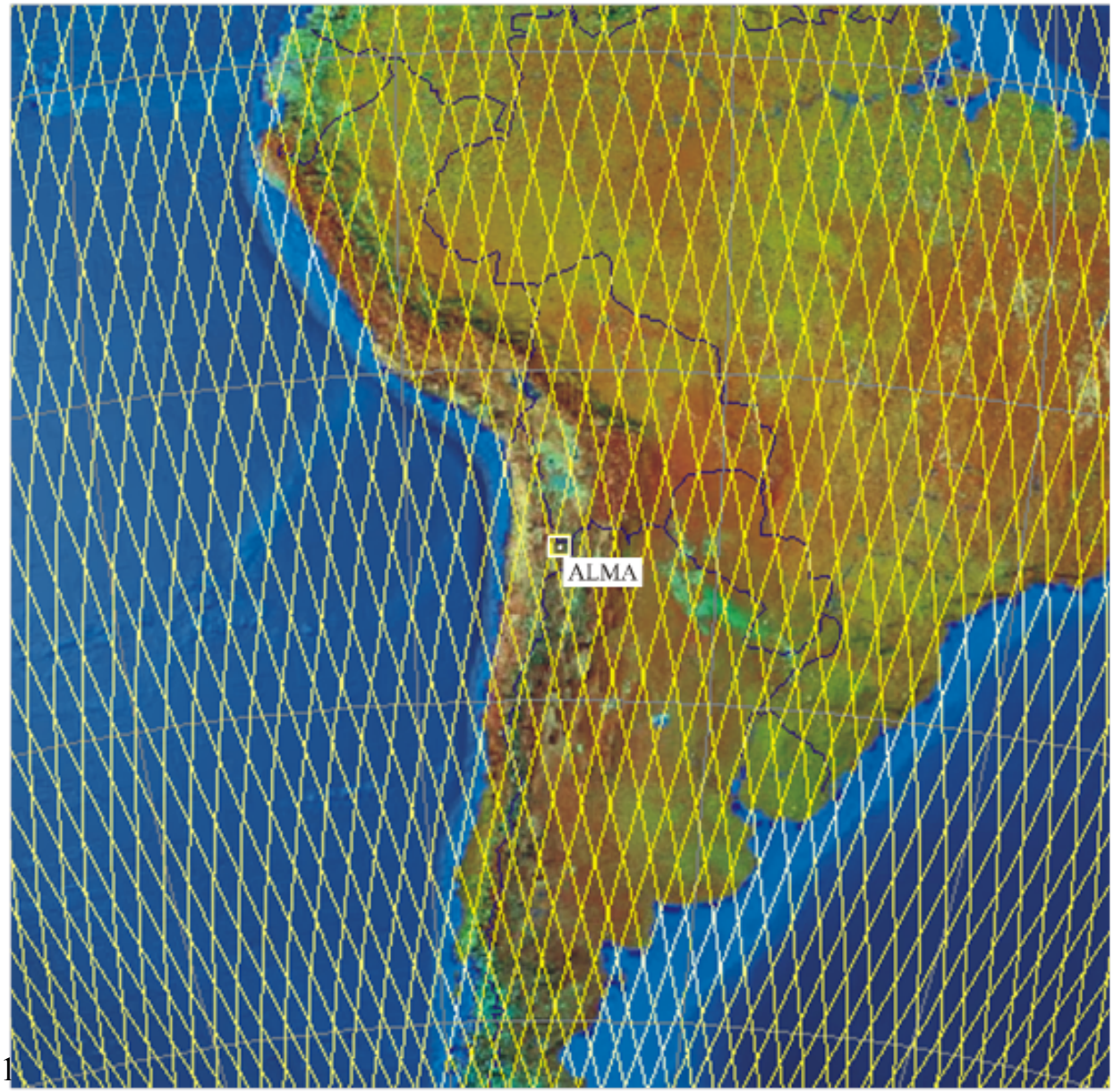
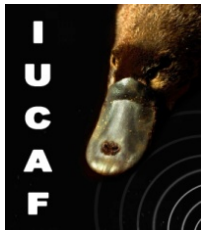


FIGURE 2

Ground tracks of AQUA over a full 16-day period, with the position of ALMA marked on a map of South America



1750-02

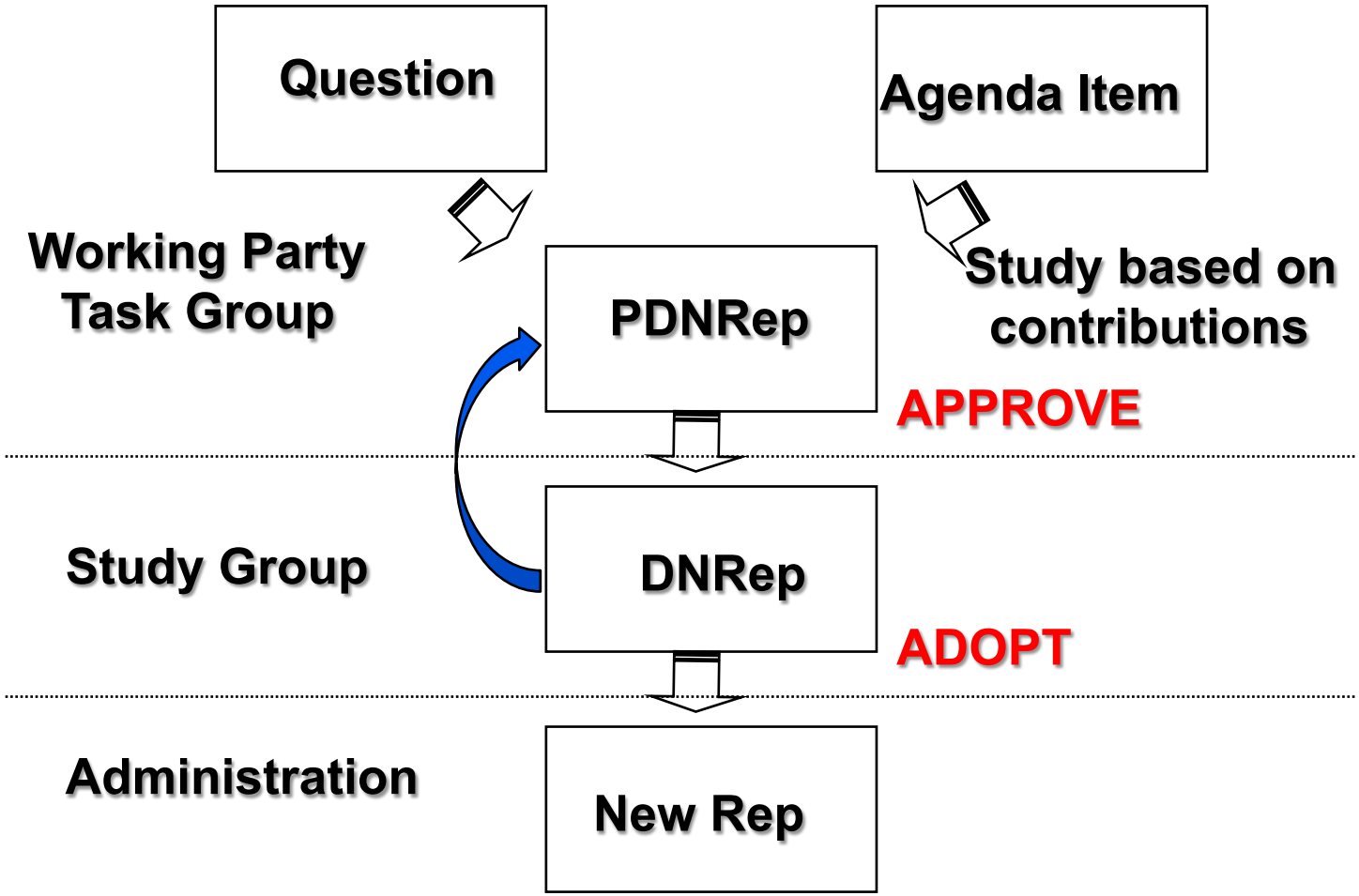


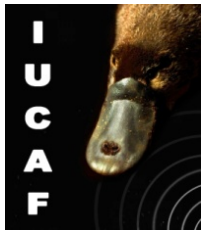
<break>

Reports

A technical, operational or procedural statement, prepared by a Study Group on a given subject related to a current Question or the results of studies referred to in § 3.3 (Resolution ITU-R 1-5)

Production of Reps.





RA series Reports

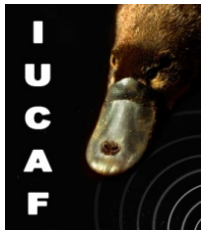
RA.2099	Radio observations of pulsars for precision timekeeping
RA.2126	Techniques for mitigation of radio frequency interference in radio astronomy
RA.2131	Supplementary information on the detrimental threshold levels of interference to radio astronomy observations in Recommendation ITU-R RA.769
RA.2163	Astronomical use of frequency band 50-350 THz and coexistence with other applications
RA.2188	Power flux-density and e.i.r.p. levels potentially damaging to radio astronomy receivers
RA.2189	Sharing between the radio astronomy service and active services in the frequency range 275-3 000 GHz
RA.2195	The transition to digital television and its impact on the unprotected use by the radio astronomy service of bands used for terrestrial television broadcasting
RA.2259	Characteristics of radio quiet zones

Rep. ITU-R RA.2131
Supplementary info for Rec.769

- Conversion from spfd/pfd to field strength

  $E(dB(\mu V/m)) = 145.7633 + TV(769)$

- Comparison between Rec RA.769-1 and 769-2
  - > One administration claims that it denies "769-2", but prefers to "769-1"
  - > "769-1" and "769-2" levels are identical for f < 50 GHz
  - > "769-2" contains threshold levels for the 22GHz band



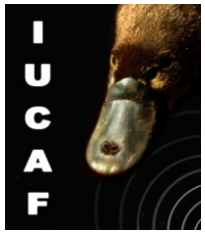
Common Values in Rec 769 (continuum)

Centre frequency (MHz)	Bandwidth (MHz)	pfd (dB(W/m^2))	Spectral pfd (dB(W/(m^2 · Hz)))	Electric field (dB(μV/m))
13.385	0.05	−201	−248	−55.2
25.610	0.12	−199	−249	−53.2
73.8	1.6	−196	−258	−50.2
151.525	2.95	−194	−259	−48.2
325.3	6.6	−189	−258	−43.2
408.05	3.9	−189	−255	−43.2
611	6.0	−185	−253	−39.2
1 413.5	27	−180	−255	−34.2
1 665	10	−181	−251	−35.2
2 695	10	−177	−247	−31.2
4 995	10	−171	−241	−25.2
10 650	100	−160	−240	−14.2
15 375	50	−156	−233	−10.2
23 800	400	−147	−233	−1.2
31 550	500	−141	−228	+4.8
43 000	1 000	−137	−227	+8.8

Different Values in Rec 769 (continuum)

Centre frequency (MHz)	Bandwidth (MHz)	pfd (dB(W/m^2))	Spectral pfd (dB(W/(m^2 · Hz)))	Electric field (dB(μV/m))
22 355 (769-2 only)	290	−146	−231	−0.2
89 000	6 000 → 8 000	−125 → −129	−222 → −228	+20.8 → +16.8
110 500 (769-1 only)	11 000	−121	−222	+24.8
150 000 (769-2 only)	8 000	−124	−223	+21.8
166 000 (769-1 only)	4 000	−120	−216	+25.8
224 000	14 000 → 8 000	−114 → −119	−215 → −218	+31.8 → +26.8
270 000	10 000 → 8 000	−113 → −117	−213 → −216	+33.8 → +28.8

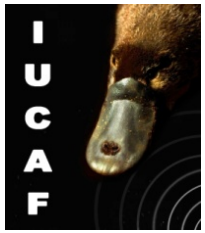
* Arrows have been used to indicate changes in the sense Recommendations ITU-R RA.769-1 → ITU-R RA.769-2.



Common Values in Rec 769 (spectral line)

Centre frequency (MHz)	Bandwidth (kHz)	pfd (dB(W/m^2))	Spectral pfd (dB(W/m^2 · Hz))	Electric field (dB(μV/m))
327	10	−204	−244	−58.2
1 420	20	−196	−239	−50.2
1 612	20	−194	−238	−48.2
1 665	20	−194	−237	−48.2
4 830	50	−183	−230	−37.2
14 488	150	−169	−221	−23.2
22 200	250	−162	−216	−16.2
23 700	250	−161	−215	−15.2
43 000	500	−153	−210	−07.2
48 000	500	−152	−209	−06.2

* Arrows have been used to indicate changes in the sense Recommendations ITU-R RA.769-1 → ITU-R RA.769-2



Different Values in Rec 769 (spectral line)

Centre frequency (MHz)	Bandwidth (kHz)	pfd (dB(W/m^2))	Spectral pfd (dB(W/(m^2 · Hz)))	Electric field (dB(μV/m))
88 600	1 000	−144 → −148	−204 → −208	−58.2 → −62,2
98 000 (769-1 only)	1 000	−143	−203	−57.2
115 000 (769-1 only)	1 000	−141	−201	−55.2
140 000 (769-1 only)	1 500	−139	−200	−54.2
150 000 (769-2 only)	1 000	−144	−204	−58.2
178 000 (769-1 only)	1 500	−136	−198	−52.2
220 000	2 500 → 1 000	−133 → −139	−197 → −199	−51.2 → −53.2
265 000	2 500 → 1 000	−131 → −137	−195 → −197	−49.2 → −51.2

* Arrows have been used to indicate changes in the sense Recommendations ITU-R RA.769-1 → ITU-R RA.769-2.

Rep. ITU-R RA.2189
Sharing between 275 and 3000 GHz

- **WRC-12 agenda item 1.6**

1.6 to review No. 5.565 of the Radio Regulations in order to update the spectrum use by the passive services between 275 GHz and 3 000 GHz, in accordance with Resolution 950 (Rev.WRC-07), and to consider possible procedures for free-space optical-links, taking into account the results of ITU-R studies, in accordance with Resolution 955 (WRC-07);

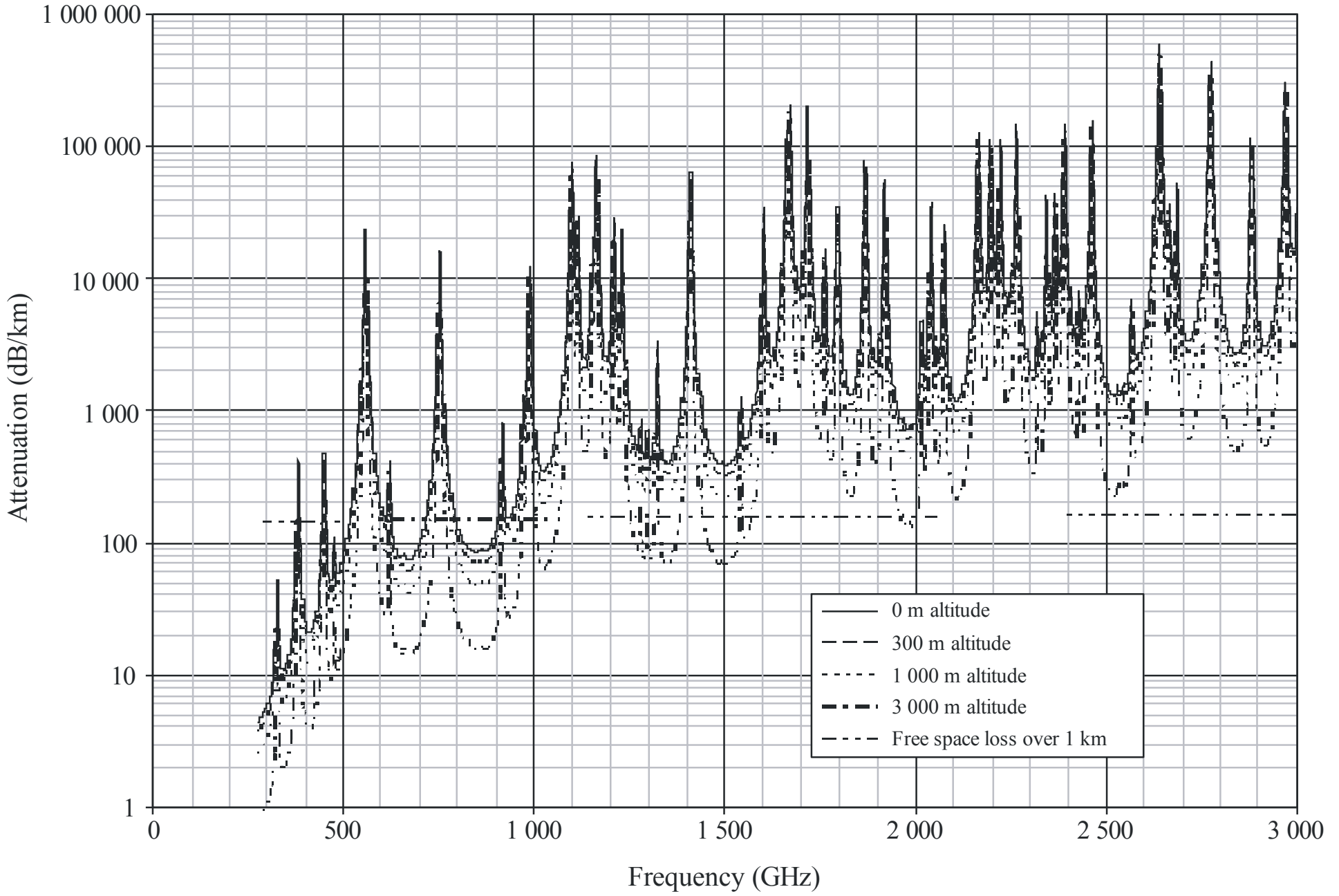
Concerns by active services

- **“First-in first-served”; new-comers need to demonstrate that they do not interfere with existing services**

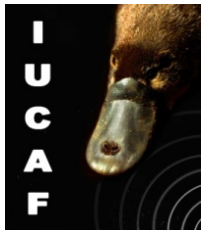
- **high frequency region might be exclusively used by passive services**
  → no future developments can be made for active services

Rep. ITU-R RA.2189

- **Was a fundamental material in demonstrating that the RAS can generally coexist with active services in the frequency region above 275 GHz**
- **Very large atmospheric attenuation/km:**
  > between hundreds to hundreds of thousands of dB per km at sea level
- **Terrestrial radio astronomy can only be conducted at the very highest and driest sites, where THz-frequency emitters are unlikely to be located**



Report RA.2189-01



Upgraded FN 5.565

5.565 The following frequency bands in the range 275-1 000 GHz are identified for use by administrations for passive service applications:

– radio astronomy service: 275-323 GHz, 327-371 GHz, 388-424 GHz, 426-442 GHz, 453-510 GHz, 623-711 GHz, 795-909 GHz and 926-945 GHz;

– Earth exploration-satellite service (passive) and space research service (passive): 275-286 GHz, 296-306 GHz, 313-356 GHz, 361-365 GHz, 369-392 GHz, 397-399 GHz, 409-411 GHz, 416-434 GHz, 439-467 GHz, 477-502 GHz, 523-527 GHz, 538-581 GHz, 611-630 GHz, 634-654 GHz, 657-692 GHz, 713-718 GHz, 729-733 GHz, 750-754 GHz, 771-776 GHz, 823-846 GHz, 850-854 GHz, 857-862 GHz, 866-882 GHz, 905-928 GHz, 951-956 GHz, 968-973 GHz and 985-990 GHz.

The use of the range 275-1 000 GHz by the passive services does not preclude use of this range by active services. Administrations wishing to make frequencies in the 275-1 000 GHz range available for active service applications are urged to take all practicable steps to protect these passive services from harmful interference until the date when the Table of Frequency Allocations is established in the above-mentioned 275-1 000 GHz frequency range.

All frequencies in the range 1 000-3 000 GHz may be used by both active and passive services. (WRC 12)

RA.2259
Characteristics of Radio Quiet Zones

- A summary of existing RQZs
- NRQZ (US), ALMA (CL), MRO (AU), AGAA (ZA), FAST (CN),,,,
- Details will be given by Millenaar

Some administrations were reluctant to study RQZs, especially international ones.

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