ECC PT1

ECC PT1 #68

Web meeting, 12-13 and 26-29 April 2021

Date issued: [enter date]

Source: CRAF, SKAO

Subject: Compatibility studies for RAS protection under WRC-23 AI1.2;

Group membership required to read? (Y/N)

N

Summary:

RR No. **5.149** urges administrations to take all practicable steps to protect the radio astronomy service in the frequencies listed under this footnote when making assignments to other services. CRAF notes that the large number of countries within a comparatively small geographical area within Region 1 (Europe) means that the necessary protection areas for the band 6650 - 6675.2 MHz may extend outside national boundaries and therefore may require coordination at the international ITU-R level. Hence, studies will be required to assess the potential, harmful interference that may require cross-border coordination.

Preliminary studies (Section 2) have shown that minimum separation distances for the in-band sharing scenario are up to 400 km and therefore cannot be addressed on a national level only.

Furthermore, radio observatories outside of CEPT but (co-)funded by CEPT countries (such as the SKAO), could also be affected by IMT transmissions in this frequency band.

Proposal:

Support the inclusion of compatibility studies for the protection of the methanol maser band at 6.65 GHz under AI 1.2 and also support the addition of it to the WP7D reply LS to WP5D.

Background:

RAS stations in several CEPT countries make heavy use of the band 6650 - 6675.2 MHz (see Table 1 in Section 1).

As astronomy is a very international science, with many global collaborations, scientists in other countries inside and outside CEPT also profit significantly from open access to European RAS facilities or from the provided scientific data. Furthermore, observatories outside CEPT but co-funded by CEPT countries (such the SKAO) will also make use of this frequency band.

1 INTRODUCTION

Observations of the methanol spectral line in the RR 5.149 band, 6650.0–6675.2 MHz, are of utmost importance to radio astronomers around the world. In Europe, there are a large number of radio telescopes, which are equipped with state-of-the-art receivers to perform measurements of this spectral line and a substantial percentage of the total observing time is invested, see Table 1. According to footnote RR 5.149 of the Radio Regulations, administrations are urged to take all practicable steps to protect the RAS from harmful interference in the band 6 650.0−6 675.2 MHz.

With RR 5.149 the ITU-R recognised the importance of methanol observations in the 6.6 GHz band. Since then, the methanol line has become extremely important for the study of star formation in its earliest stages. In fact, its detection and study in the inner parts of star forming regions is the only way for astronomers to observe star formation in its earliest stages. Since its comparatively recent discovery in star-forming regions, in conjunction with observations of the spectral line arising from the water molecule at ~22 GHz, its detection and study in the inner parts of star forming regions is the primary means for astronomers to know about and then follow the process of star formation in its earliest stages, as the regions are opaque to other (e.g., optical) spectral lines. Methanol is also one of the few species that produce strong masers, which allows us to detect it over cosmic distances, e.g., in the core of active galaxies orbiting super-massive black holes, and thus providing insights into black hole physics and the high-energy processes in their vicinity. For this, the European VLBI Network is essential, consisting of a large number of CEPT RAS stations. VLBI observations of methanol masers are also vital in high-precision astrometry studies, which e.g. allow the determination of the spiral structure of the Milky Way with unprecedented accuracy, or provide an independent probe of the value of the famous Hubble constant. The possible allocation of frequencies within the band 6650 – 6675.2 to IMT is therefore of great concern to the RAS. It was for this reason that protection of the RAS in this band was addressed in earlier study cycles, e.g., AI 1.20 (WRC-12). The importance of the spectral line for the RAS has not changed, other than possibly to grow, since that time.

Table 1: List of CEPT countries with RAS stations operating in the frequency band 6650−6675 MHz.

RAS station	*Country*	*Geographic longitude*	*Geographic latitude*
Effelsberg	Germany	06° 53′ 01.0″	50° 31′ 29.4″
Wettzell		12° 52′ 38″	49° 08′ 42″
Medicina	Italy	11° 38′ 49″	44° 31′ 15″
Noto		14° 59′ 20″	36° 52′ 33″
Sardinia		09° 14′ 42″	39° 29′ 34″
Irbene	Latvia	21° 51′ 18″	57° 33′ 13″
Westerbork	Netherlands	06° 36′ 15″	52° 55′ 01″
Badary	Russia	102° 14′ 00″	51° 46′ 10″
Svetloe		29° 46′ 54″	60° 31′ 56″
Sao Zelenchukskaya		43° 47′ 15″	41° 34′ 00″
Yebes	Spain	–03° 05′ 13″	40° 31′ 28.8″
Onsala	Sweden	11° 55′ 04″	57° 23′ 35″
Bleien	Switzerland	08° 06′ 43.3″	47° 20′ 23.7″

RAS station	Country	Geographic longitude	Geographic latitude
Jodrell Bank	UK	–02° 18′ 26″	53° 14′ 10″
Pickmere		–02° 26′ 42″	53° 17′ 20″
Darnhall		–02° 32′ 09″	53° 09′ 24″
Knockin		–02° 59′ 49″	52° 47′ 26″
Defford		–02° 08′ 39″	52° 06′ 03″
Cambridge		00° 02′ 14″	52° 10′ 01″
Goonhilly*		–05° 11′ 00″	50° 03′ 02″
Chilbolton*		–01° 26′ 19″	51° 08′ 42″
SKA-MID	South Africa**	21° 26′ 38″	-30° 42′ 47″

* Planned operations

** While the SKA-MID is located outside of CEPT, it is co-funded by several CEPT countries. The separation distance needed to protect its observations could be even larger than the size of the SKA-MID radio quiet zone .

2 PRELIMINARY COMPATIBILITY STUDY: IMT AT 6.65 GHZ VS. THE RAS

Unfortunately, final technical parameters for IMT at 6.6 GHz are not yet available. However, based on existing IMT equipment at other frequencies and some of the provided input documents, an estimate of the potential coordination zone sizes can be made and is presented here. The calculation is based on a single-entry worst-case scenario for an IMT BS, assuming a conducted power of 52 dBm/40 MHz, a feeder loss of 3 dB and an antenna gain of 18 dBi, i.e., an EIRP of 51 dBm/MHz. These numbers stem from a typical LTE base station, but as other studies have shown (e.g., ECC Reports 281 and 308), 5G installations tend to have comparable transmitted powers (EIRP). An advantage of 5G systems would be the possibility to employ additional mitigation measures, such as avoiding beamforming towards RAS stations. Therefore, in the following analysis, results are also presented for 10 and 20 dB additional mitigation.

Based on the path propagation loss model of Rec. ITU-R P.452-16 and the RAS thresholds according to Rec. ITU-R RA.769-2 (spectroscopy threshold: –175 dBm/MHz), the separation distances necessary to not exceed the RAS threshold can be calculated. The results for a generic calculation (assuming flat terrain) are displayed in Figure 1, while an example site-specific calculation for the German 100-m telescope at Effelsberg is provided in Figure 2.

Figure 1 provides evidence, that even with (potential) additional mitigation measures, which would lower the EIRP by as much as 20 dB, the resulting separation distances are very large, up to few hundreds of kilometres. Even when terrain is included (compare Figure 2), the required coordination zones are too large to be a national-only issue (white circle mark distances in steps of 100 km).

It is noted that for a final assessment of the IMT-RAS compatibility also aggregate scenarios need to be studied, which take into account deployment, i.e., number densities and distribution properties, of the IMT devices. From other compatibility studies involving 5G/AAS technology (e.g., WRC-19 AI 1.13, TG5/1 Chairman’s Report) it is known, however, that aggregate scenarios lead to somewhat larger separation distances (by about 50%), even when terrain heights, statistical effects owing to the beam forming (e.g., BS only form beams toward ground), and relatively additional high clutter losses are all taken into account for the aggregation, while the single entry studies are laid out as worst-case scenarios (i.e., no clutter, maximum antenna gain).

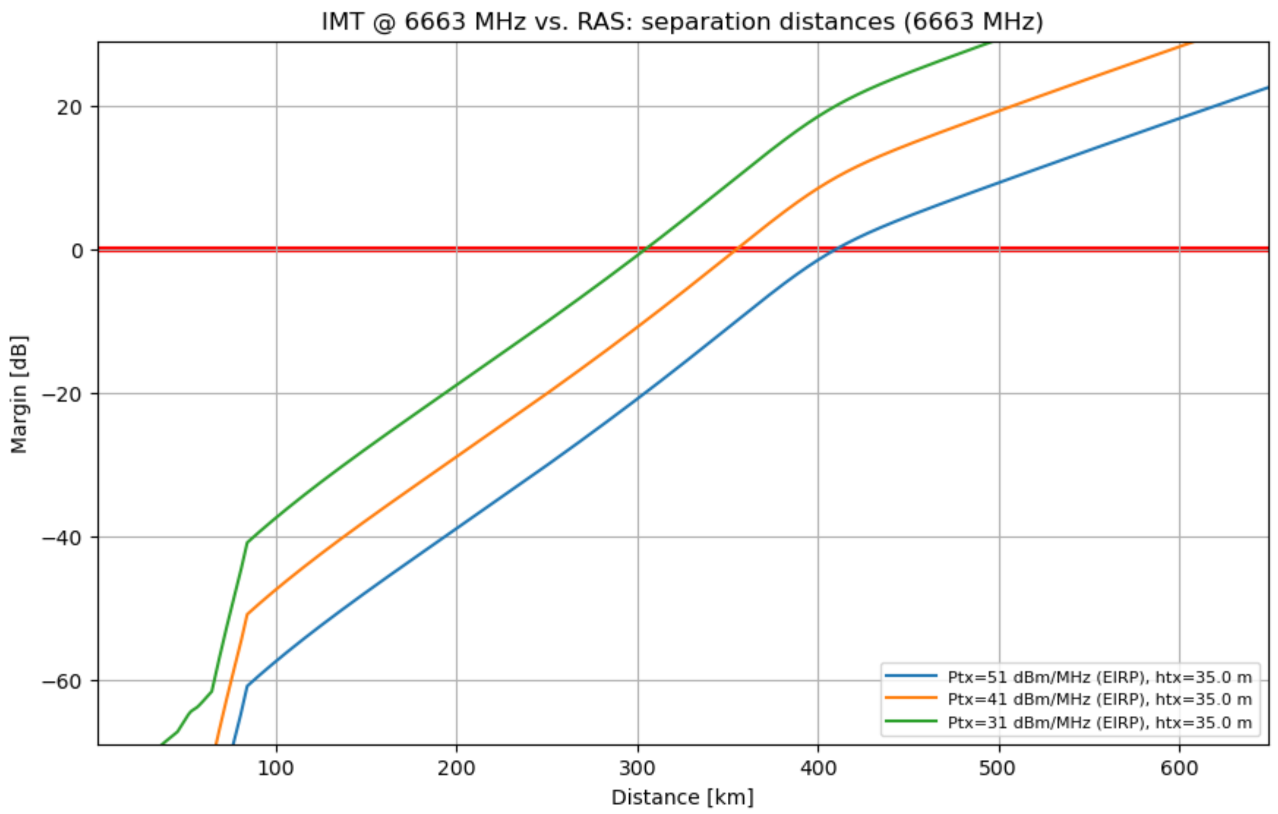

Figure 1: Single entry generic study.

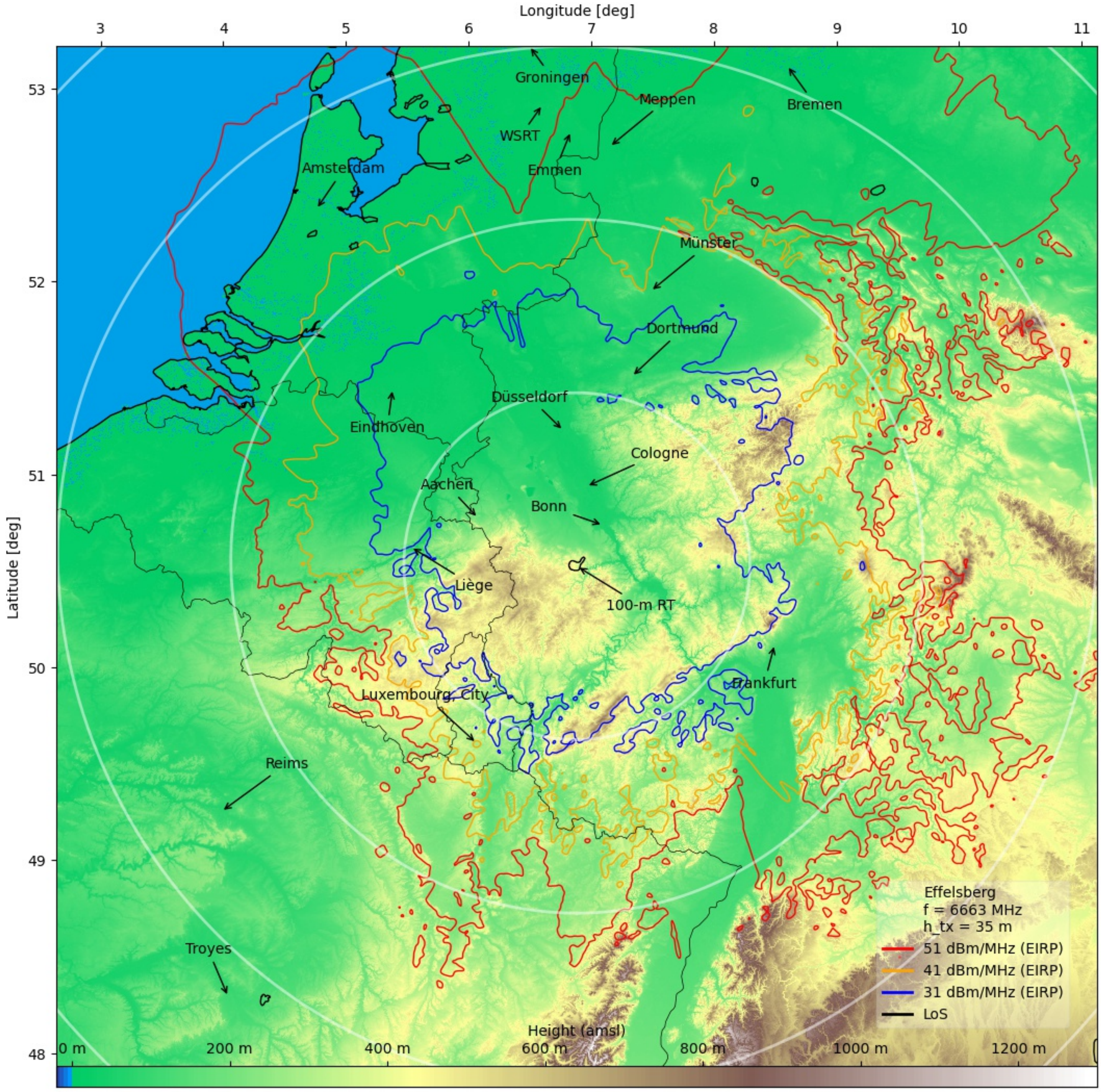

Figure 2: Single-entry site-specific study for the RAS station Effelsberg, Germany.

3 CONCLUSION FOR PROTECTION OF THE RAS

Once final technical parameters for potential IMT at 6.6 GHz and deployment scenarios are available, the RAS community will conduct further compatibility studies to address the issue.

CRAF is of the view that administrations are urged by the RR No. **5.149** to take all practicable steps to protect the RAS in the frequencies listed under this footnote when making assignments to other services. The large number of countries within a comparatively small geographical area within Region 1 (Europe) means that the necessary protection areas for the RAS band 6650 - 6675.2 MHz may extend outside national boundaries and therefore may require coordination at the international ITU-R level. Hence, studies will be necessary to assess the potential, harmful interference that may require cross-border coordination.

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