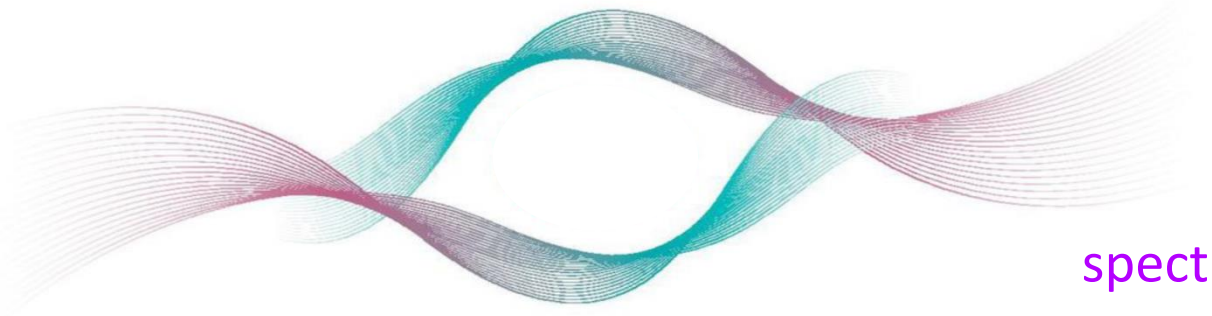
Allocation or identification of relevant bands above 100 GHz and below 1000 GHz for active services and applications

Simon Pike

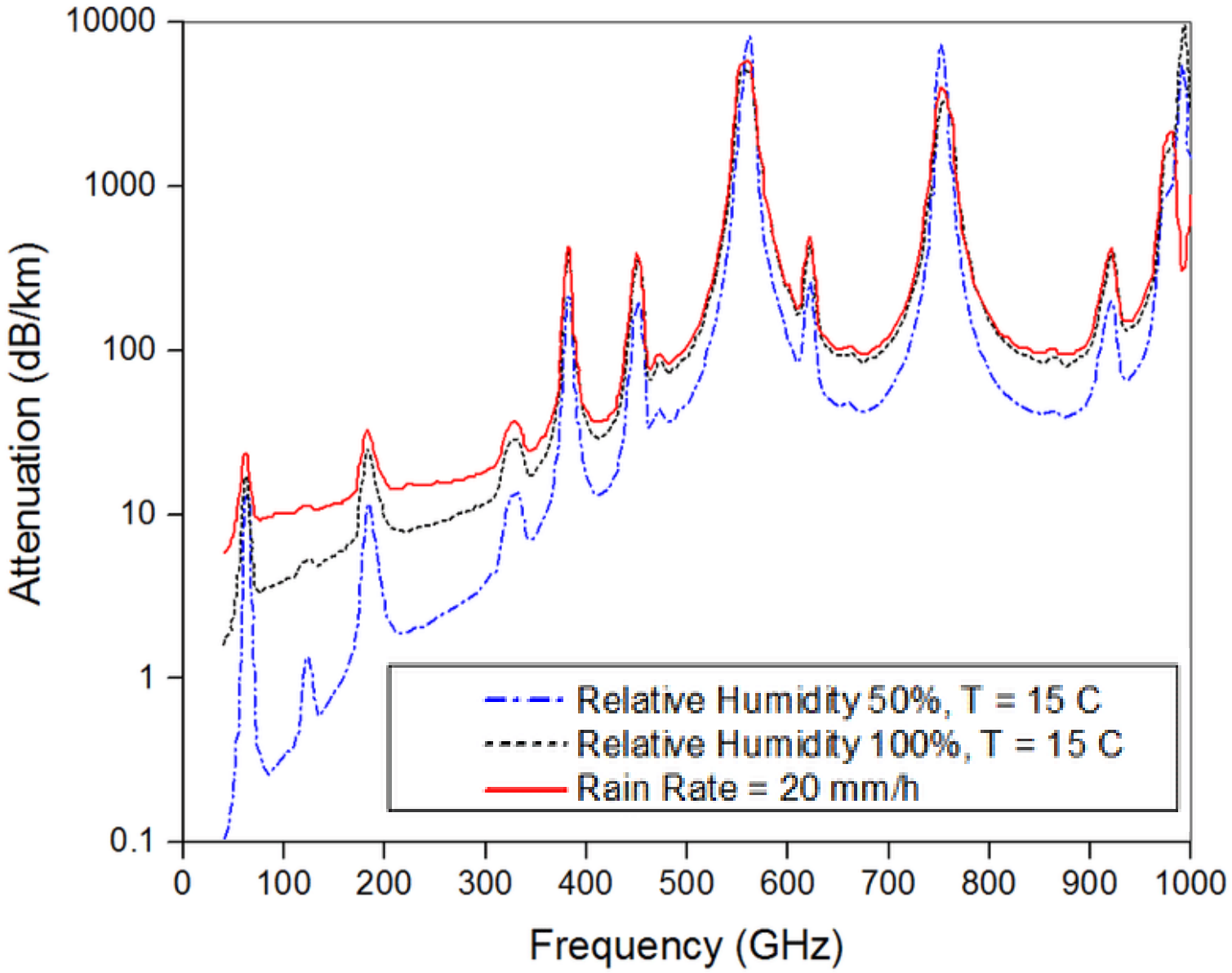


spectrum@simonpike.eu

Introduction

- There is increasing interest for active services in spectrum above 100GHz
  - including 6G, backhaul and fronthaul, sensing and inter-satellite links
- It is often assumed that wide bandwidths are available
- but the spectrum is restricted and fragmented by passive services
  - Below 275GHz, by allocations to passive services, many with No. 5.340
  - Above 275GHz, by bands identified by No. 5.565 to EESS, SRS and RA
- However, co-channel sharing between active and passive services may be feasible in some cases, due to:
  - the high atmospheric attenuation in some bands
  - transmissions at these frequencies will be highly directional
    - Or have extremely short range

Atmospheric attenuation above 100GHz



The attenuation peaks above 120GHz are due to water

Above ~100GHz, the attenuation is too high for ground-based radio astronomy* or for EESS to make measurements on the earth's surface.

* Except in very arid regions or at high altitudes where the population density will be low

Simon Pike

Allocations between 100GHz and 275GHz

- 19% of spectrum has footnote No. 5.340
  - Compared with ~2% below 100GHz
- The largest ‘active’ band is 32.5GHz
  - Only five bands have >10GHz bandwidth
  - Shared between active services
  - Possibly minus guardbands
- Other bands have co-primary allocations to passive services without No. 5.340
- Do all emissions in all of these passive bands need to be prohibited in order to protect the passive services that could feasibly use them?

Bands available for active services between 100 and 275 GHz			
S5.340 Passive bands			‘Active’ band
Lower edge (GHz)	Upper Edge (GHz)	Band width	Available bandwidth
100	102	2	
109.5	111.8	2.3	7.5
114.25	116	1.75	2.45
148.5	151.5	3	32.5
164	167	3	12.5
182	185	3	15
190	191.8	1.8	5
200	209	9	8.2
226	231.5	5.5	17
250	252	2	18.5
Total bandwidth		33.35	
		19%	

Simon Pike

Spectrum identified for active and passive services above 275GHz

- Identification of spectrum within 275 – 450 GHz for land mobile and fixed services is addressed by No. 5.564A
  - For 139 GHz of this spectrum, “no specific conditions are necessary to protect EESS (passive) applications”
  - There is no mention of other active services
- Identification of spectrum within 275 – 1000 GHz for Radio Astronomy, EESS (passive) and SRS (passive) is addressed by No. 5.565
  - There are eight bands for Radio astronomy and 27 bands for EESS/SRS
  - Only 160 GHz bandwidth is not identified for RA or EESS/SRS
  - All of 275 GHz - 510 GHz is identified for RA and/or EESS/SRS
  - The widest band above 510 GHz not identified is 30 GHz

Questions for stakeholders (and potential future stakeholders)

100 – 275 GHz

- Could active services operate co-channel with passive services?
  - Due to either atmospheric attenuation or angular discrimination

275 – 1000 GHz

- Do Nos. 5.464A and 565 provide enough certainty for commercial development?
  - Especially for active services other than land mobile and fixed
- Is there a need for any restriction on active terrestrial services above 450 GHz?
  - Can EESS penetrate to the earth's surface, and radio astronomy from it?

Should UK propose an agenda item to WRC-27 to address some of these issues?
If not, it should be prepared to respond to proposals from other Administrations

- This could be addressed in part by WRC-27 preliminary AI 2.1 and Res. 663
  - Which is currently limited to Radiolocation
  - Should UK consider proposing refinements to these to WRC-23?
  - There are already studies in ITU WP1A, CEPT SE24 and ETSI TGUWB
  - Including under ITU-R Res. 731

Simon Pike

ITU-R Resolution 663

resolves to invite the ITU Radiocommunication Sector

1 to study the future requirements for globally harmonized spectrum for the RLS, in particular for millimetre and sub-millimetre wave imaging applications above 231.5 GHz, as referred to in *considering a)* and *b)* ;

2 to define technical and operational characteristics, including required protection criteria, for millimetre and sub-millimetre wave imaging systems;

3 to study sharing and compatibility of active millimetre and sub-millimetre wave imaging applications with other systems in the frequency range between 231.5 GHz and 275 GHz, while ensuring that the EESS (passive), SRS (passive) and RAS allocated in this frequency range are protected;

4 to conduct sharing and compatibility studies between RLS applications and EESS (passive), SRS (passive) and RAS applications operating in the frequency range 275-700 GHz, while maintaining protection of the passive service applications identified in No. 5.565;

5 to study sharing and compatibility of receive-only millimetre and sub-millimetre wave imaging applications with other systems in the frequency range between 275 GHz and 700 GHz;

6 to study possible new allocations to the RLS on a co-primary basis in the frequency range between 231.5 GHz and 275 GHz, while ensuring the protection of existing services in the frequency bands considered and, as appropriate, adjacent frequency bands;

7 to study a possible identification of frequency bands in the frequency range 275-700 GHz for use by RLS applications;

8 to review studies under 1 to 7, and elaborate regulatory measures for the possible introduction of millimetre and sub-millimetre wave imaging systems;

Simon Pike

ITU-R Resolution 731

resolves

to invite a future competent world radiocommunication conference to consider the results of ITU-R studies referred to in invites the ITU Radiocommunication Sector below with a view to taking the necessary action, as appropriate, in order to accommodate the emerging requirements of active services, taking into account the requirements of the passive services, in frequency bands above 71 GHz,

invites the ITU Radiocommunication Sector

1 to continue its studies to determine if and under what conditions sharing is possible between active and passive services in the frequency bands above 71 GHz, such as, but not limited to, 100-102 GHz, 116-122.25 GHz, 148.5-151.5 GHz, 174.8-191.8 GHz, 226-231.5 GHz and 235-238 GHz;

2 to conduct studies to determine the specific conditions to be applied to the land-mobile and fixed-service applications to ensure the protection of EESS (passive) applications in the frequency bands 296-306 GHz, 313-318 GHz and 333-356 GHz;

3 to study means of avoiding adjacent-band interference from space services (downlinks) into radio astronomy frequency bands above 71 GHz;

4 to take into account the principles of burden-sharing to the extent practicable in their studies;

5 to complete the necessary studies when the technical characteristics of the active services in these frequency bands are known;

6 to develop Recommendations specifying sharing criteria for those frequency bands where sharing is feasible,

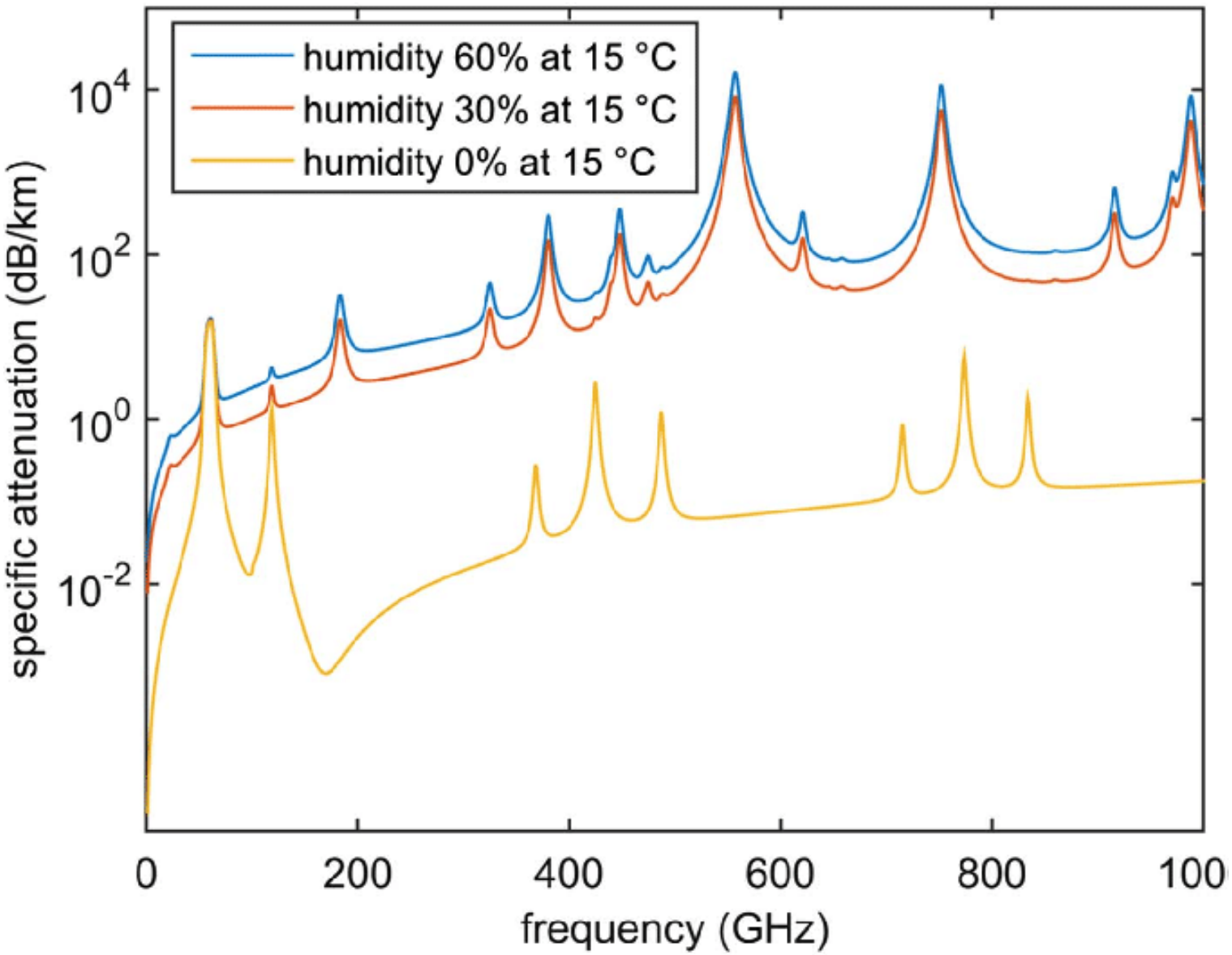
Post meeting information

On 2nd December, Ofcom published a short discussion document and request for views on Unlocking the potential of Terahertz radio spectrum: The role of spectrum management

See: https://www.ofcom.org.uk/__data/assets/pdf_file/0032/228929/terahertz-spectrum-paper.pdf

Simon Pike

Backup – attenuation peaks in dry and moist air



The attenuation peaks for 0% humidity – from atmospheric gases apart from water vapour – make no significant contribution to the total attenuation of moist air

The peaks at 60GHz and 120GHz are due to oxygen

These graphs are for relative humidity. The relationship to specific humidity is a function of temperature

Simon Pike