BROWN

Supplemental Statement of Brown University

FCC Experimental License File 1756-EX-ST-2019

This application is for facilities intended to be used by Prof. Daniel Mittleman[1] of the School of Engineering, for propagation measurement experiments on the Brown University campus in Providence RI. Prof. Mittleman is a qualified researcher in this field who has written extensively on the subject of terahertz propagation.[2] The purpose of the experiment is to gather measurement data in a complex environment at frequencies of approximately 100 and 200 GHz.

The tests will involve both measuring path loss over time and measuring achievable data rates over time, and will therefore need multiple hours of observations. Measurements will also be made of scattering by objects on the campus. **All radiated emissions will use antennas with a negative or zero elevation angle so there will be no direct illumination of the sky.**

We believe that the technology being tested here is "new technology in the context of 47 U.S.C. 157 and that the results from this experiment will help to further other use by others of spectrum above 95 GHz that now lacks any FCC rules[3]. Therefore, we ask that this be treated under the provisions of Section 7, particularly with respect to the burden test of § 157(a):

> Any person or party (other than the Commission) who opposes a new technology or service proposed to be permitted under this chapter shall have the burden to demonstrate that such proposal is inconsistent with the public interest. (Emphasis added)

Some of the spectrum covered in the application overlaps with passive allocations. Thus, we readily acknowledge that following provisions of §5.85(a)(2) apply to this application:

> (2) Applications to use any frequency or frequency band exclusively allocated to the passive services (including the radio astronomy service) must include an explicit justification of why nearby bands that have non-passive allocations are not adequate for the experiment. Such applications must also state that the applicant acknowledges that long term or multiple location

[1] https://www.brown.edu/research/labs/mittleman/http%3A/www.brown.edu/research/labs/mittleman/people/daniel-m-mittleman

[2] https://scholar.google.com/citations?hl=en&user=O3T1F7cAAAAJ&view_op=list_works

[3] There are two minor exceptions: ISM and Amateur Radio Service use on small slivers

use of passive bands is not possible and that the applicant intends to transition any long-term use to a band with appropriate allocations.

The spectrum with primary passive allocations involved is 100-102 GHz, 200-205 GHz. Note that these passive bands are included within the requested bands 97.5-103 GHz and 195-205 GHz, but the requested bands are not identical to the passive allocations.

Brown would be willing to participate in any reasonable coordination activities with passive interests that the Commission find necessarily in order to comply with the letter and spirit of §5.85(a)(2).

Statements required by § 5.85(a)(2)

Justification of why nearby bands that have non-passive allocations are not adequate for the experiment. The basic purpose of this experiment is propagation measurement in a complex outdoor environment. At these frequencies atmospheric absorption is a key issue and varies with frequency.[4] In many cases multipath is also important and varies with frequency. A wide variety of frequencies are needed to fully characterize the nature of propagation at the regions being studied. Transmitters at these frequencies are not in general production and are usually quite expensive. Brown has identified a readily available signal source that has the tuning range specified in the application and that is available at a realistic price for this research. Avoiding the passive bands that overlap with the tuning range would either require a much more expensive custom made signal source or would result in less data collected on this area of the spectrum there little measurement data is available for complex paths.

While the technical data gathered in this experiment is expected to lead to "innovative devices and/or services on frequencies above 95 GHz", the use of the specific bands requested is based the capabilities of Brown's off-the-shelf Virginia Diodes AMC 626 transmitter which has been used under previous FCC licenses and is planned for this license also. Use of nearby bands without US246 restrictions would require a much more expensive custom-made transmitter and additional delay in its procurement.

There is no intention to focus on the specific requested bands for any long-term application. Indeed, Brown University is a research university, not an equipment developer. This program involves basic radio propagation and data modulation research which is necessary to establish an important foundation for the future development of terahertz spectrum.

Applicant acknowledgements: The applicant has no intention of long term use of these frequencies and understands that their use in multiple locations may not be possible. The sole purpose of this experiment is to generate propagation data and propagation models that characterize terrestrial propagation in the region above the present 95 GHz upper

[4] FCC, "Millimeter Wave Propagation: Spectrum Management Implications", OET Bulletin No. 70, July 1997, https://www.fcc.gov/bureaus/oet/info/documents/bulletins/oet70/oet70a.pdf

limit of the Commission's Rules and to test wideband modulations techniques at these frequencies.

Statements required by § 5.702

The new Spectrum Horizons Experimental Radio License provisions of § 5.702, given below, *may* apply to this license application. In any case, we are providing this information since it will be useful in resolving any concerns about possible interference to other radio services from this experiment:

> **§ 5.702** Each application must include a narrative statement describing in detail how its experiment could lead to the development of innovative devices and/or services on frequencies above 95 GHz and describe, as applicable, its plans for marketing such devices. This statement must sufficiently explain the proposed new technology/potential new service and incorporate an interference analysis that explains how the proposed experiment would not cause harmful interference to other services. The statement should include technical details, including the requested frequency band(s), maximum power, emission designators, area(s) of operation, and type(s) of device(s) to be used.

§ 5.702 requests an explanation of "how the proposed experiment would not cause harmful interference to other services". Parts of the requested bands, specifically 100-102 GHz, 200-205 GHz are allocated to the EARTH EXPLORATION-SATELLITE (passive), RADIO ASTRONOMY SPACE RESEARCH (passive) services in the US and internationally.

The closest radio astronomy facility with known capability at these frequencies is the MIT Haystack Observatory in Westford MA[5] which is 88 km away but without a line of sight path. The azimuth from Brown to Haystack is 355°. Out of an abundance of caution, Brown will avoid all transmissions in azimuths from 340° to 370°. Brown will accept a coordination requirement with Haystack should FCC wish to impose it as a condition.

It is unknown if there is any actual present use of these bands for RADIO ASTRONOMY SPACE RESEARCH (passive) which involves satellites with antennas focused away from the Earth and thus unlikely to be impacted by any sidelobe emissions from this experiment. However, if such use exists Brown proposes to address it by coordination with the satellite operators on experiment times and azimuths/elevation angles of any emissions.

With respect to EARTH EXPLORATION-SATELLITE (passive) use of these two bands, Appendix B of the Docket 18-21 *Notice of Proposed Rulemaking* contains a "list of current and proposed passive satellite operations above 95 GHz … provided by the National Aeronautics and Space Administration." (Emphasis added)

The list covers both US and foreign satellites. There are no entries for either of these bands. A check of the World Meteorological Organization's Observing Systems Capability Analysis and Review Tool (OSCAR) database[6] also shows no present or planned use of these bands. Based on

[5] http://www.haystack.mit.edu/

[6] https://www.wmo-sat.info/oscar/satellitefrequencies

presently available public information there is no interference threat to "other services" because there are no other services in the requested spectrum at this time.

Should "other services" arise during the term of this license, Brown proposes two alternative conditions for the license for protecting other services:

1) The first alternative is the approach taken by FCC in Special Condition 6 of license WM9XXI, File Number 0753-EX-ST-2018 issued to University at Buffalo, The State University of New York on July 11, 2018. This provides:

   > "The University of Buffalo shall not transmit in the 226-231.5 GHz or 250-252 GHz frequency bands when the NASA Aura spacecraft (NORAD designation 28376 or international spacecraft ID 2004-07-15) is within horizon-to-horizon view of the testing location."

   Thus, if the Commission identifies specific satellites that require protection, Brown will accept a condition that no transmissions will occur while such satellites are "within horizon-to-horizon view of the testing location".

2) Alternatively, Brown would be willing to submit to NTIA or any interested federal agency at least a month in advance the total time requested for a future month-long period of experiments and approximate times desired and request a listing of allowable times and possible azimuth restrictions. This alternative approach does not require disclosure to Brown of satellite orbit parameters.

Technical Issues in Application

The application asks for mobile use as the transmitter will be moved around the university campus in making the tests. Unlike most mobile use, the experiments will use a high gain antenna which will be directed in different azimuth during the tests. The antenna system can not be readily indicated in the format of FCC Form 442 so we are taking this opportunity to clarify our intentions.

The antennas to be used in this project are listed below with key parameters:

Virginia Diodes Model Number	Frequency Range in Experiment (GHz)	Beam Width (Degrees)	Gain (dBi)
WR 8.0 CH	97.5-103	12	21
WR 5.1 CH	195-205	13	21
WR 3.4 DH	292-308	10	26
WR 2.2 DH	390-410	10	26

The application form submitted uses the 13 degree maximum beam width in all bands for simplification.

The STOP BUZZER contact for this experiment is Dr. Mittleman who can be reached at (713) 992-4137, daniel_mittleman@brown.edu

Any questions about this application should be directed to Dr. Michael Marcus, consultant to Brown University, 301-229-7714, mjmarcus@marcus-spectrum.com

/s/

Daniel M. Mittleman, Ph. D.
Professor of Engineering
401-863-9056
daniel_mittleman@brown.edu