

APPLICATION FOR GATEWAY EARTH STATION

I. OVERVIEW

The Commission has authorized Space Exploration Holdings, LLC (“SpaceX”) to launch and operate a constellation of 4,409 non-geostationary orbit (“NGSO”) satellites (call sign S2983/S3018) using Ku- and Ka-band spectrum.¹ In doing so, the Commission recognized that granting the SpaceX Authorization would “allow SpaceX to make efficient use of valuable spectrum resources more safely, quickly, and cost-effectively as it initiates a new generation of broadband services available to customers worldwide, including those in areas previously underserved or even totally unserved by other broadband solutions.”² In May, SpaceX began launching satellites to populate its constellation.

This application, filed by a sister company, SpaceX Services, Inc. (“SpaceX Services”), is one of five applications for authority to operate Ka-band gateway earth stations that SpaceX will use to deliver broadband data between the satellites of its NGSO system and terrestrial Internet exchange points. This particular application seeks authority for eight technically identical 1.5-meter antennas in Conrad, Montana (the “Conrad Gateway”). Consistent with SpaceX’s space station authorization, these earth stations will transmit in the 27.5-29.1 GHz and 29.5-30.0 GHz bands and receive in the 17.8-18.6 GHz, 18.8-19.3 GHz, and 19.7-20.2 GHz bands.

Below, we discuss certain spectrum sharing issues relevant to the operation of these earth stations. We then demonstrate that grant of this application would serve the public interest. Lastly, we provide technical information to supplement the information provided on Form 312. To

¹ See *Space Exploration Holdings, LLC*, 33 FCC Rcd. 3391 (2018) (“SpaceX Authorization”); *Space Exploration Holdings, LLC*, 34 FCC Rcd. 2526 (IB 2019) (“SpaceX Modification”). These authorizations anticipate that Ka-band spectrum would be used for gateway communications.

² SpaceX Modification, ¶ 1.

support its ambitious timetable for launching satellites and deploying broadband services, SpaceX Services requests that the Commission grant the requested license as expeditiously as possible.

II. SPECTRUM SHARING ISSUES

Under the Commission's spectrum allocations and the plan adopted for the Ka-band in particular,³ SpaceX Services will need to share with a variety of other systems operating in its bands. Below we demonstrate that the proposed Conrad Gateway will comply with all relevant sharing requirements.

A. Uplink Bands

The Commission has designated the 27.5-28.35 GHz band for use by the Upper Microwave Flexible Use Service ("UMFUS") on a primary basis, with a secondary designation for FSS. As between NGSO and GSO systems in this band, the Commission has clarified that NGSO systems must operate on an unprotected, non-interference basis with respect to GSO networks.⁴ FSS is primary throughout the 28.35-29.1 GHz band, with NGSO once again designated as secondary to GSO in the 28.35-28.6 GHz portion and NGSO designated as primary in the 28.6-29.1 GHz portion. FSS is co-primary with Mobile Satellite Service ("MSS") in the 29.5-30.0 GHz band, with NGSO designated as secondary to GSO.⁵

At this time, SpaceX Services intends to operate on a non-interference basis with respect to UMFUS systems in the 27.5-28.35 GHz band.⁶ The Commission has not yet issued a UMFUS

³ See *Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, 32 FCC Rcd. 7809, App. B (2017) ("NGSO Update Order").

⁴ See *id.* ¶ 23.

⁵ See *id.* App. B.

⁶ At a later date, SpaceX Services intends to demonstrate that its operation of the Conrad Gateway will comply with the provisions in Section 25.136(a)(4) of the Commission's rules, which allows earth station licensees in the band to operate without providing additional interference protection to UMFUS stations when certain conditions are satisfied. See 47 C.F.R. § 25.136(a)(4).

license for Pondera County where the Conrad Gateway is located. The Comsearch Report submitted with this application confirms that SpaceX Services has coordinated with existing terrestrial licensees in this band in compliance with the Commission’s rules and can operate without causing harmful interference to any such deployments. Moreover, in the unlikely event that harmful interference does arise, SpaceX Services will be able to operate this gateway using the remaining Ka-band spectrum identified in this application until the issue has been resolved.

SpaceX Services makes no claim of interference protection from U.S.-licensed GSO FSS systems in the 27.5-28.6 GHz and 29.5-30.0 GHz bands. In addition, SpaceX Services will comply with the applicable equivalent power flux-density (“EPFD”) limits set forth in Article 22 and Resolution 76 of the ITU Radio Regulations, which the Commission has found to be sufficient to protect GSO systems against harmful interference.⁷ SpaceX has demonstrated that its NGSO system will comply with these EPFD limits, and doing so is a condition of its Authorization.⁸

B. Downlink Bands

The Commission has allocated the 17.8-18.3 GHz band on a primary basis to the terrestrial fixed service (“FS”) and on a secondary basis for FSS. The 18.3-18.6 GHz band is allocated on a primary basis to FSS, with NGSO secondary to GSO and subject to international EPFD limits. The 18.8-19.3 GHz band is allocated to FSS on a primary basis, with NGSO designated as primary.

⁷ See, e.g., *Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range*, 16 FCC Rcd. 4096, ¶ 77 (2000) (concluding that implementation of EPFD limits “will adequately protect GSO FSS networks”); 47 C.F.R. § 25.289 (NGSO satellite systems that comply with EPFD limits will be deemed not to cause unacceptable interference to any GSO network). SpaceX believes that the EPFD limits designed to protect GSO FSS systems will also protect GSO MSS systems in the band.

⁸ See SpaceX Authorization, ¶¶ 40(b), (d), and (e); 47 C.F.R. § 25.115(f)(1) (incorporating certification requirement in 47 C.F.R. § 25.146(a)(2)).

FSS is co-primary with MSS in the 19.7-20.2 GHz band, with NGSO designated as secondary to GSO.⁹

SpaceX has previously demonstrated that its NGSO system will protect terrestrial fixed stations in the 17.8-18.6 GHz and 18.8-19.3 GHz bands, in compliance with a condition placed on its license.¹⁰ Moreover, the Comsearch report submitted with this application confirms that there should be no additional limitations placed on operations of the Conrad Gateway. Similarly, SpaceX has demonstrated that its NGSO system will comply with the relevant EPFD limits in the 18.3-18.6 GHz band, which the Commission considers sufficient to protect GSO networks from unacceptable interference.¹¹ SpaceX believes that the EPFD limits designed to protect GSO FSS systems will also protect GSO MSS systems in the 19.7-20.2 GHz band.

III. GRANT OF THIS APPLICATION WOULD SERVE THE PUBLIC INTEREST

Granting this application would serve the public interest by helping to speed broadband deployment throughout the United States by authorizing the ground-based component of SpaceX's satellite system. U.S. and worldwide demand for broadband services and Internet connectivity continues to increase with escalating requirements for speed, capacity, and reliability and ongoing adaptations for usage. The volume of traffic flowing over the world's networks has exploded, with one report estimating that annual global Internet protocol traffic reached 1.5 zettabytes in 2017 –

⁹ See *NGSO Update Order*, App. B. Footnote 334 to the U.S. Table of Frequency Allocations requires coordination with federal earth stations prior to commencement of operations in the 17.8-20.2 GHz band in Denver, CO; Washington, DC; San Miguel, CA; and Guam. See 47 C.F.R. § 2.106 n.334(b). The Conrad Gateway is located well outside of the relevant areas, and thus the requirement is inapplicable to this application.

¹⁰ See SpaceX Modification, ¶ 29.

¹¹ See SpaceX Authorization, ¶ 9.

meaning that approximately 1,500 billion gigabytes of data were exchanged worldwide that year.¹²

Yet, as the Commission has recognized, many communities across the United States and the world still lack access to reliable broadband connectivity, preventing them from fully participating in economic, social, and civic activities.¹³ To help close this digital divide, SpaceX is designing, constructing, and deploying an innovative, cost-effective and spectrum-efficient satellite system capable of delivering robust broadband service to customers around the world. SpaceX has already secured U.S. authority for the space station components of its NGSO system. This application takes the next step by seeking authority for one of the gateway earth stations that will connect the satellite system to the terrestrial Internet. Accordingly, an expeditious grant of this application would serve the public interest.

¹² See Cisco Visual Networking Index: Forecast and Methodology, 2017-2022, at 1, CISCO (Nov. 26, 2018), <https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white-paper-c11-741490.html>.

¹³ See, e.g., *Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion*, 33 FCC Rcd. 1660, ¶ 50 (2018) (noting that “over 24 million Americans still lack fixed terrestrial broadband at speeds of 25 Mbps/3 Mbps,” and that “the gap in rural and Tribal America remains notable: 30.7 percent of Americans in rural areas and 35.4 percent of Americans in Tribal lands lack access to fixed terrestrial 25 Mbps/3 Mbps broadband”). Internationally, the disparities between broadband access and absence are even greater, with 4.2 billion people (or 57% of the world’s population) offline. See BROADBAND COMMISSION FOR SUSTAINABLE DEVELOPMENT, “Open Statement from the Broadband Commission for Sustainable Development to the UN High-Level Political Forum (HLPF)” (July 11, 2016), <http://broadbandcommission.org/Documents/publications/HLPF-July2016.pdf>. See also BROADBAND COMMISSION FOR SUSTAINABLE DEVELOPMENT, “The State of Broadband 2015,” at 8 (Sep. 2015), <http://www.broadbandcommission.org/Documents/reports/bb-annualreport2015.pdf> (“A large body of evidence has now been amassed that affordable and effective broadband connectivity is a vital enabler of economic growth, social inclusion and environmental protection.” (footnotes omitted)).

Respectfully submitted,

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TECHNICAL APPENDIX

In this Technical Appendix, SpaceX Services provides additional information on the proposed operations of its gateway earth station to supplement the data provided in Schedule B to Form 312 filed with this narrative application.¹

A. Minimum Elevation Angle

SpaceX Service's gateway earth stations will communicate only with those SpaceX satellites that are visible on the horizon above a minimum elevation angle. In the very early phases of constellation deployment and as SpaceX first initiates service, this angle may be as low as 25 degrees, but this will return to 40 degrees as the constellation is deployed more fully and more satellites are in view of a given gateway site. For purposes of this application, SpaceX Services has supplied the lower angle in order to capture the full potential range of service.

B. Antenna Patterns

Section 25.209 of the Commission's rules imposes reference antenna pattern requirements for certain satellite earth stations. Most of these relate to earth stations communicating with GSO systems, as the rule was developed to facilitate GSO-to-GSO sharing where a constant level of interference is present.² While Section 25.209(h) specifies performance standards for transmitting antennas in a gateway earth station communicating with NGSO FSS satellites in the 10.7-11.7 GHz and 14.4-14.5 GHz bands,³ there is no similar specification with respect to Ka-band gateway earth stations. The Commission recently confirmed that it "has not yet determined what off-axis

¹ To the extent relevant, SpaceX Services hereby incorporates the technical information submitted with SpaceX's space station applications. See IBFS File Nos. SAT-LOA-20161115-00118, SAT-LOA-20170726-00110, and SAT-MOD-20181108-00083.

² See *Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range*, 16 FCC Rcd. 4096, ¶ 81 (2000) ("*Ku-Band NGSO Order*").

³ See 47 C.F.R. § 25.209(h).

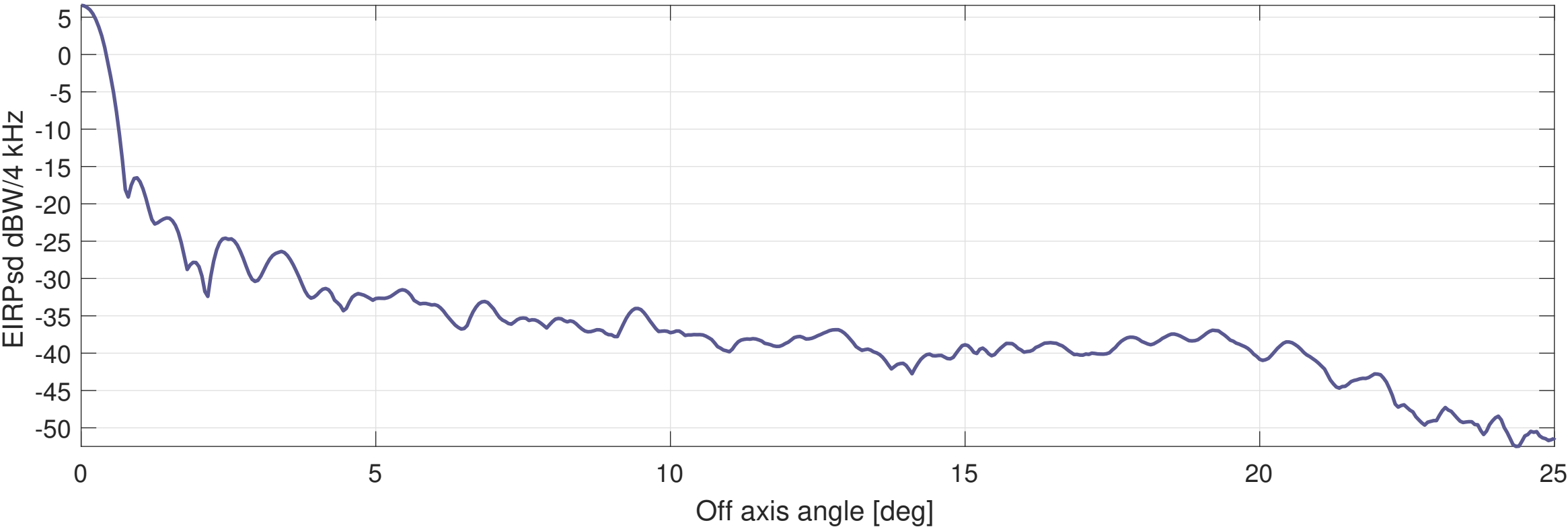
gain envelopes might be appropriate for earth stations operating with NGSO FSS space stations, either to facilitate NGSO-to-NGSO or NGSO-to-GSO interference protection.”⁴ Accordingly, there are no antenna performance standards applicable to this application.

In support of its application, SpaceX Services (1) states that the half power beamwidth for its proposed gateway earth station is 0.5 degrees at 30 GHz, and (2) provides below information on the EIRP mask for its proposed gateway earth station, for both co-polarized and cross-polarized signals.

⁴ *Comprehensive Review of Licensing and Operating Rules for Satellite Services*, 30 FCC Rcd. 14713, ¶ 213 (2015). See also *Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, 32 FCC Rcd. 7809, ¶¶ 54-55 and n.121 (2017) (declining to adopt NGSO earth station antenna performance standards).

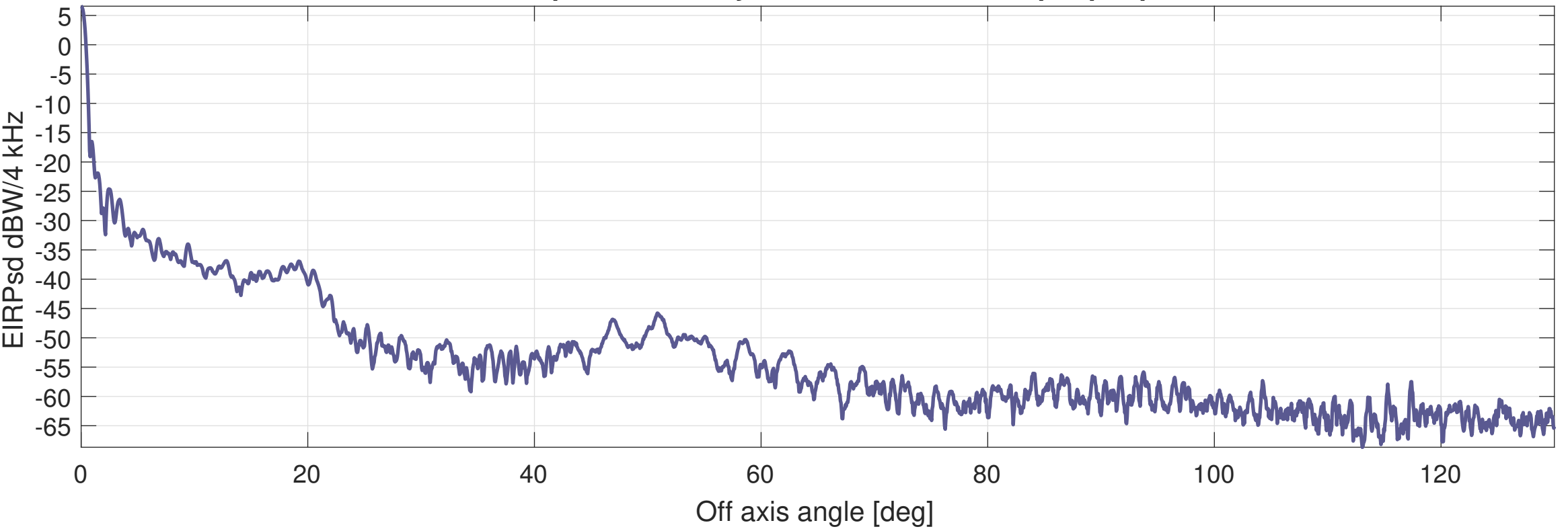
SpaceX (Co-pol)

1.47 Meter EIRP Spectral Density @ -42.8 dBW/4 kHz input per polarization



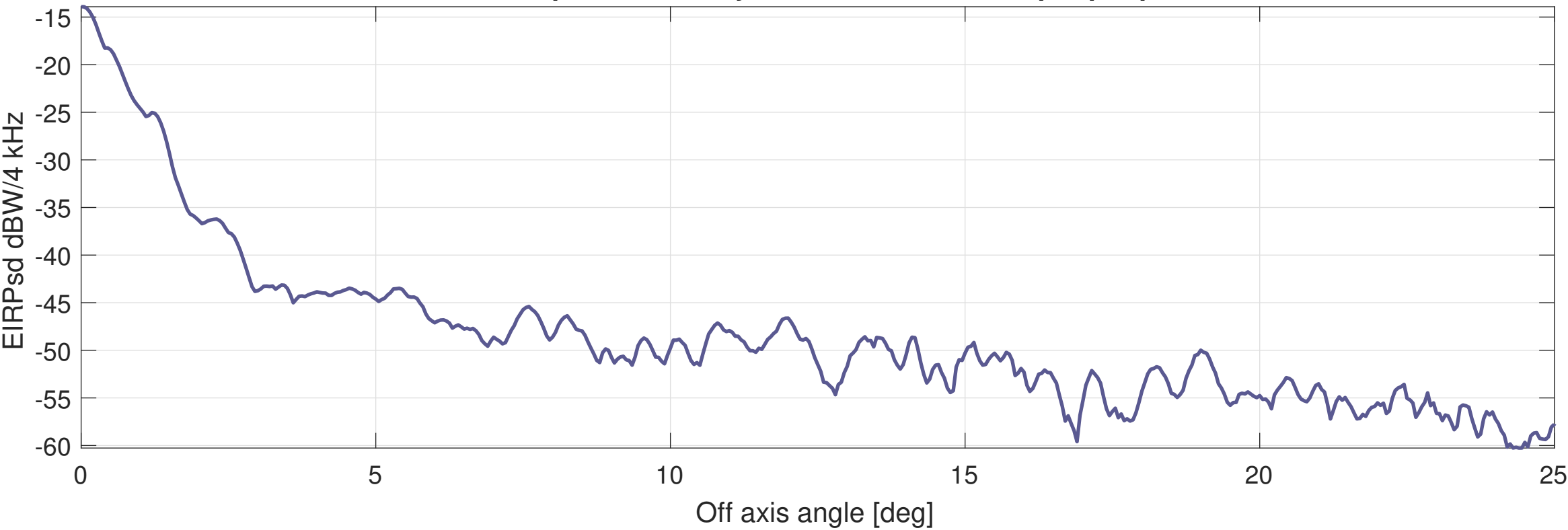
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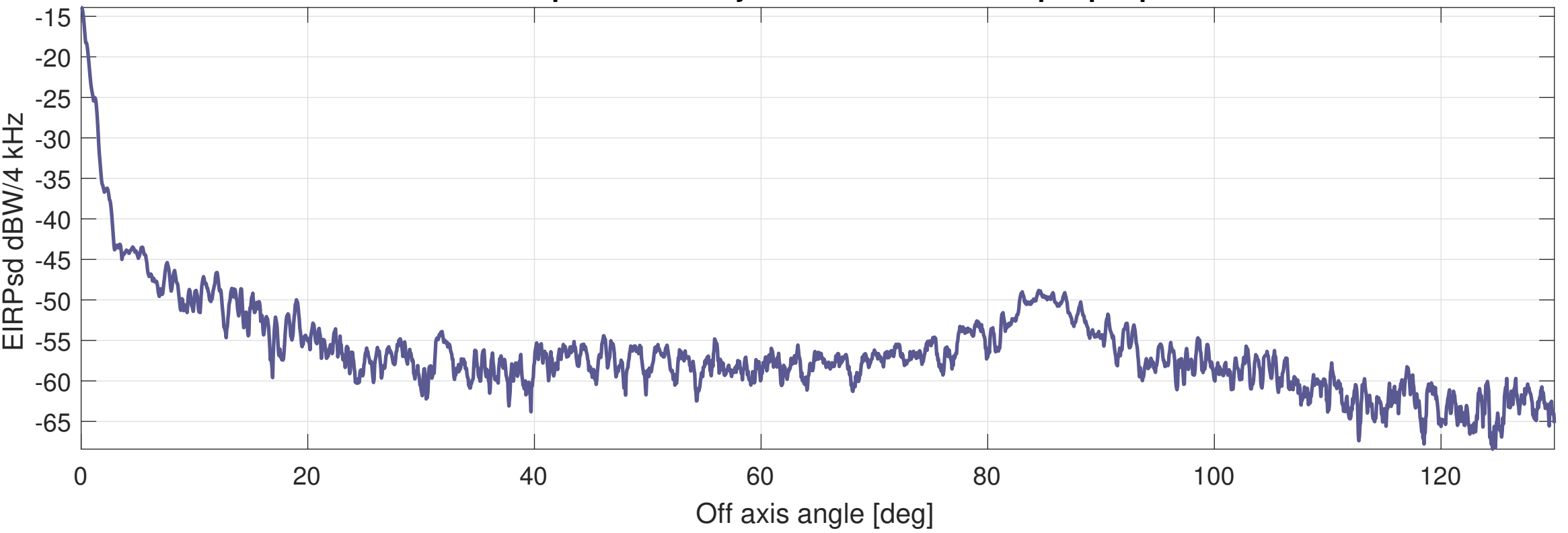
SpaceX (Cross-pol)

1.47 Meter EIRP Spectral Density @ -42.8 dBW/4 kHz input per polarization

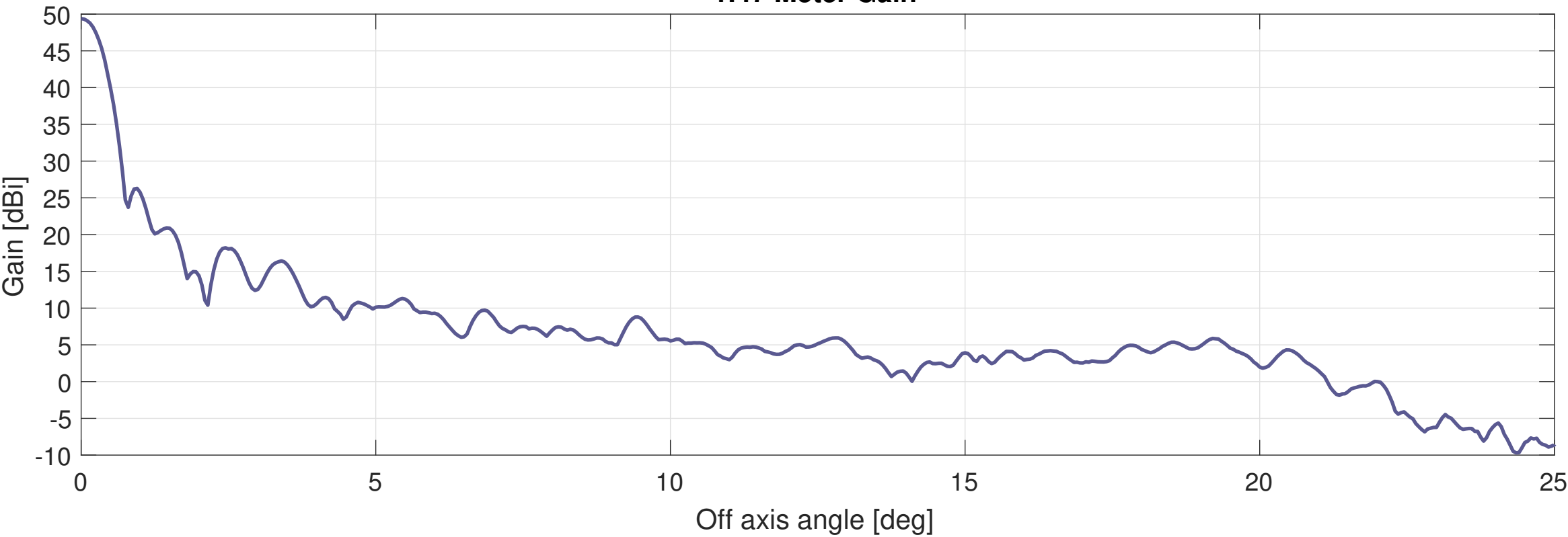


SpaceX (Cross-pol)

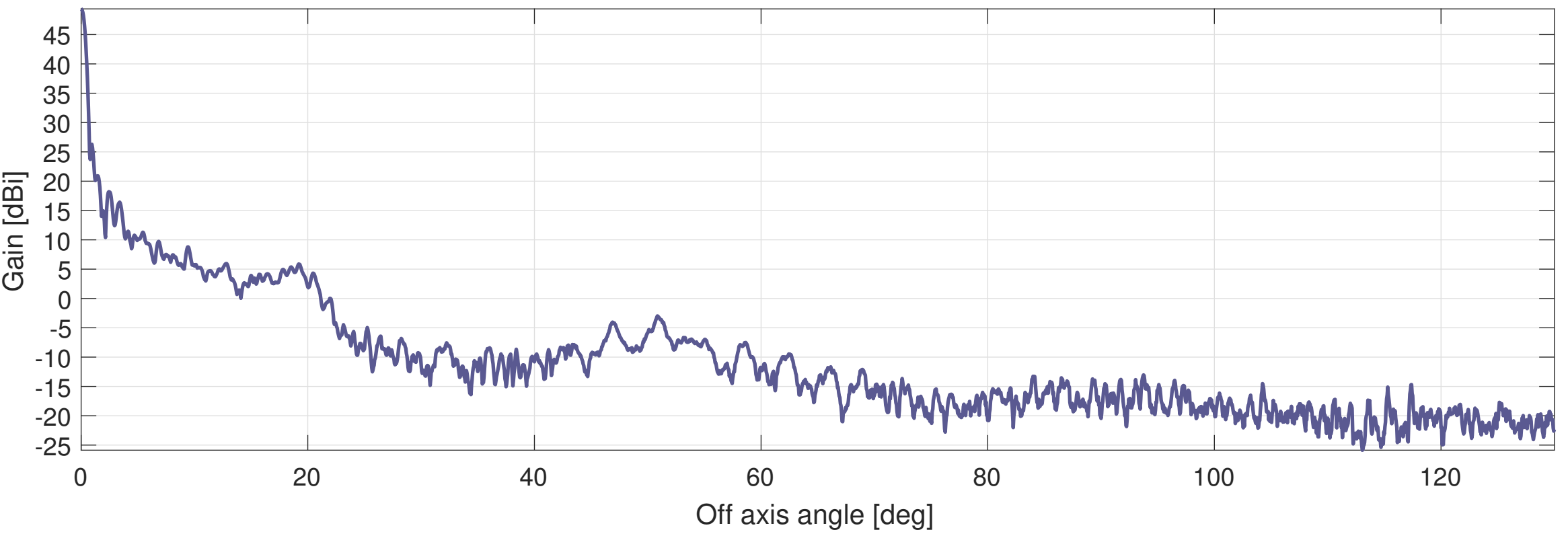
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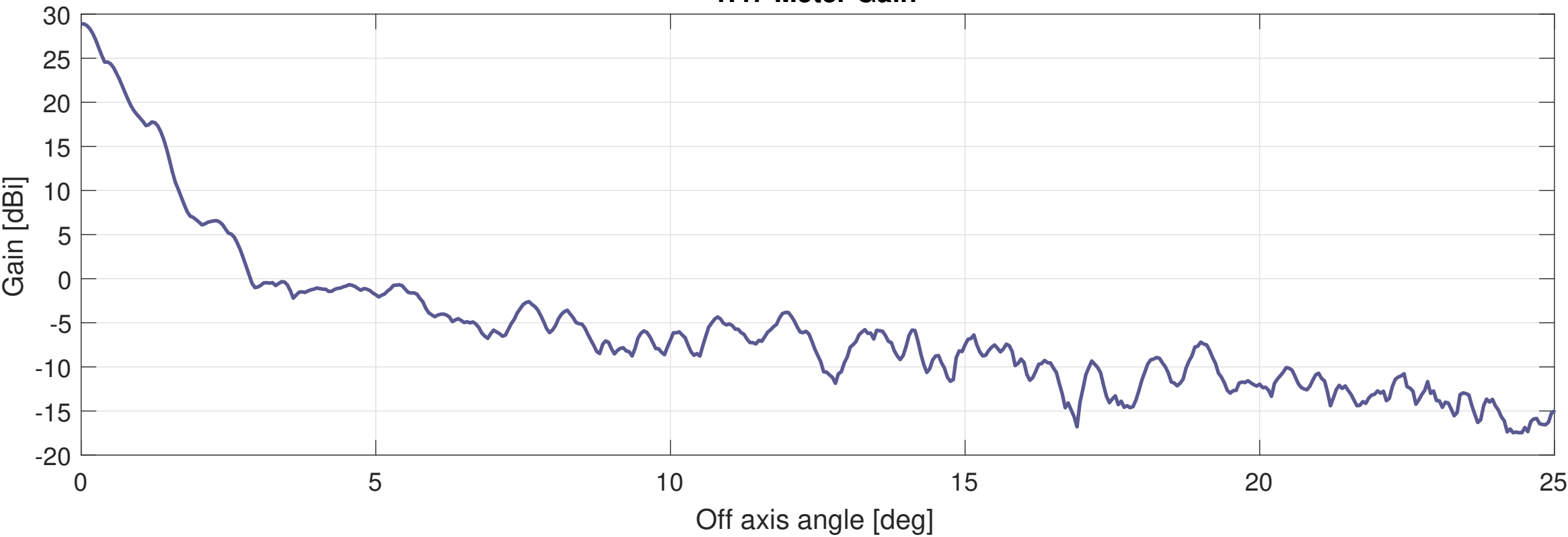
SpaceX (Co-pol)
1.47 Meter Gain



SpaceX (Co-pol)
1.47 Meter Gain



**SpaceX (Cross-pol)
1.47 Meter Gain**



**SpaceX (Cross-pol)
1.47 Meter Gain**

