Reception of Al Yah 1 (52.5° E) Carriers in the Out Of Footprint Zone

A case study from Lučenec (Slovak Republic) with a Prodelin prime-focus reflector, D = 450 cm: six carriers from the EAST beam and one from the MENA beam in the Ku band

Author of the measurements and methodology: Roman Dávid, www.dxsatcs.com
Reception site: Lučenec, Slovak Republic (48.3331° N, 19.6664° E)
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Data sources: the author's signal monitoring records (7 carriers, 510 h in total); AZ/EL from dishpointer.com; SES/Yahsat radiation patterns
Processing: text, calculations and graphs prepared by the Claude language model (Anthropic) from the author's data and statements; all measured values originate from the author.

Abstract. The study analyses the continuous reception of seven carriers of the Al Yah 1 satellite (Yahsat 1A, 52.5° E) in Lučenec, i.e. in an area far outside the footprint (Out Of Footprint) of the EAST and MENA beams. Reception was monitored with a Prodelin reflector 450 cm in diameter; each carrier was observed for at least 72 hours, 510 hours in total, which at a sampling rate of 1 Hz corresponds to 1 836 000 measurement points. The quality parameter Q never dropped to zero, which means that not a single loss of lock occurred, even during occasional showers of moderate intensity. The derivation of the pointing (AZ 139.2° / EL 26.2°), the signal path (38 962 km, free-space loss 205.8 dB), the modulation thresholds and the rain attenuation shows that the observed state is physically consistent with an indicative link budget. A comparison with the 2022 records, after conversion to the common quantity Es/N_0, suggests a decrease in signal level of the order of 3 to 6 dB (typically around 4 dB), while the cause can be determined only by further control measurements. The study also states the limits of interpretation that must be observed in publication.

Keywords: Al Yah 1, Yahsat 1A, 52.5° E, Ku band, Out Of Footprint, EAST, MENA, DVB-S, DVB-S2, Es/N_0, signal margin, rain attenuation, Lučenec, Central Europe.

1. Introduction and Aim of the Study

Satellite reception outside the footprint (Out Of Footprint) is reception in an area for which the satellite's radiation pattern is no longer designed to provide coverage, and the received signal therefore comes from the outer parts of the main lobe or from its steep roll-off away from the core of the coverage area. The EIRP there is lower than at the peak of the pattern by tens of dB, and reception is possible only thanks to a large effective antenna area, a low noise temperature of the receiving chain and the stability of the entire path. The Al Yah 1 satellite (Yahsat 1A) transmits at the 52.5° E position in the Ku band in several beams. Two are important for this study: the EAST beam, intended for the area from the Persian Gulf to Central Asia, and the MENA beam, which covers North Africa and the Middle East.

The aim of the study is to analyse in detail the results of the long-term signal monitoring carried out by the author in Lučenec and to place them in a physical and mathematical framework. The study addresses three questions:

(a) What is the reception geometry (azimuth, elevation, distance, free-space loss, antenna beamwidth) and what does it imply for the required pointing accuracy?
(b) What results were achieved (duration, number of measurement points, absence of loss of lock) and what statistical and physical significance do they have?

(c) How does the present state differ from the 2022 records, and what explanations does the decrease in signal permit?

The author's key statement is as follows: with a 450 cm reflector, seven carriers from Al Yah 1, including one carrier from the MENA beam, can be received in Central Europe over the long term and without loss of lock. The study develops this statement in detail and shows the extent to which it is supported by the measured data. Where data will be added later (for example, rainfall tables), this is stated explicitly.

2. Reception Geometry: AZ/EL, Distance and Antenna Beamwidth

2.1 Antenna Pointing for Lučenec

The antenna pointing data are taken from dishpointer.com (screenshot below the text). For the location 48.3331° N and 19.6664° E and a satellite at 52.5° E, the correct values are as follows:

Quantity	Value (dishpointer.com)	Independent calculation
Azimuth (true, relative to true north)	139.2°	139.18°
Azimuth (magnetic)	133.1°	difference 6.1° = magnetic declination
Elevation	26.2°	26.16°
LNB skew	−25.8°	–
Length of the slant path satellite – antenna	–	38 962 km
Signal propagation time (one way)	–	≈ 130 ms

I verified the values from dishpointer.com by an independent calculation based on the geometry of the geostationary orbit (Appendix A). The results of 139.18° and 26.16° agree with the values of 139.2° and 26.2° within rounding, so these data are used in the study as authoritative.

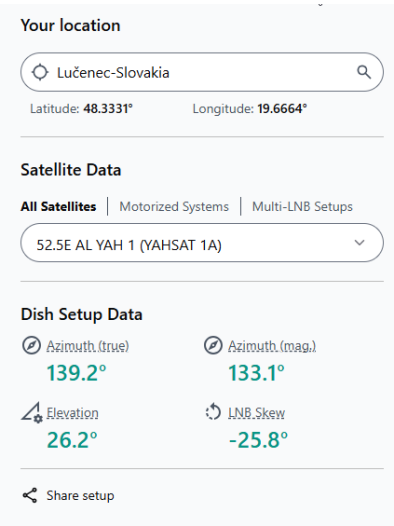


Fig. 1 – Antenna pointing for Lučenec and Al Yah 1 (Yahsat 1A) at 52.5° E according to dishpointer.com: AZ 139.2° (true), 133.1° (magnetic), EL 26.2°, LNB skew −25.8°.

2.2 Significance of the Low Elevation

An elevation of 26.2° is moderately low. The signal passes through the troposphere along a slant path that is approximately 1 / sin(26.2°) ≈ 2.3 times longer than in the zenith direction. For Ku-band reception, three consequences follow: greater gaseous attenuation (oxygen and water vapour), a longer path through the rain layer and a greater amplitude of tropospheric scintillation. Conversely, a low elevation raises the requirement for a direct line of sight in the 139° direction (obstacles, trees, buildings). The long-term stability of lock on all seven carriers at the same time indirectly confirms that the path is clear.

2.3 Free-Space Loss and Delay

At a distance d = 38 962 km and a frequency f = 11.9 GHz, the free-space loss is

$$L_{fs} = 92.45 + 20 \cdot \log_{10}(d\ [km]) + 20 \cdot \log_{10}(f\ [GHz]) \approx 205.8\ dB.$$

This is the dominant loss of the path. Each doubling of the distance would add 6 dB, but for a geostationary satellite the distance is fixed; in practice, therefore, only the antenna gain, the noise temperature and, of course, the EIRP can be varied, the latter being influenced only by the operator.

2.4 Gain and Beamwidth of the 450 cm Reflector

The wavelength at 11.9 GHz is λ ≈ 2.52 cm. The gain of a parabolic reflector with diameter D and efficiency η is

$$G = \eta \cdot (\pi \cdot D / \lambda)^2$$

For D = 4.5 m and η = 0.60 to 0.70, G ≈ 52.8 to 53.4 dBi (mean value 53.1 dBi for η = 0.65). The beamwidth at a drop of 3 dB is approximately

$$\theta_{3\ dB} \approx 70 \cdot \lambda / D \approx 0.39°.$$

A narrow beam has two sides. The good side is excellent suppression of signals from neighbouring satellites and of terrestrial interference. The drawback is the strict requirement on pointing accuracy: a deviation from the maximum by Δθ causes a gain drop of approximately

$$\Delta G \approx 12 \cdot (\Delta\theta / \theta_{3\ dB})^2\ [dB].$$

For Δθ = 0.05° this is ≈ 0.2 dB, for Δθ = 0.10° ≈ 0.8 dB, and for Δθ = 0.20° ≈ 3.2 dB. If the signal margin is at the level of 1 to 2 dB, every tenth of a degree is therefore critical; wind, thermal expansion of the structure and small shifts of the mount can thus consume the margin completely. The observed stability therefore also testifies to a mechanically very rigid mount.

For comparison: a reflector 300 cm in diameter has a gain lower by $20 \cdot \log_{10}(450/300) = 3.52$ dB and a beam about 0.59° wide. This difference is used in Chapter 8.

3. EAST and MENA Radiation Patterns and the Position of Lučenec

Figures 2 and 3 show the official Ku-band EIRP patterns for the EAST and MENA beams of the Yahsat 1A satellite. Fully coloured areas indicate areas with a higher EIRP; the contours are in dBW. The EAST beam has the contours 51, 50 and 48 dBW marked, the MENA beam 50, 48, 46 and 44 dBW.

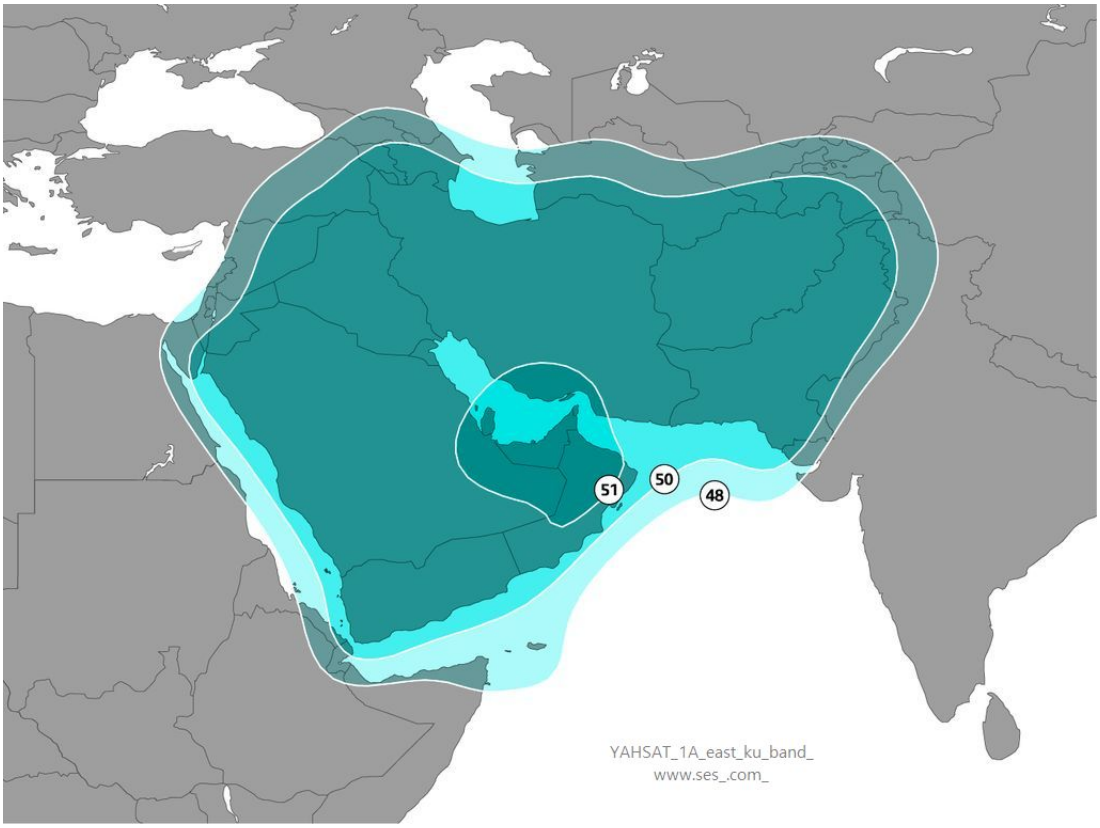


Fig. 2 – EAST radiation pattern (Ku band) of the Yahsat 1A satellite; EIRP contours 51/50/48 dBW. Source: SES (www.ses.com). Lučenec lies north-west of the section shown, outside all the contours shown.

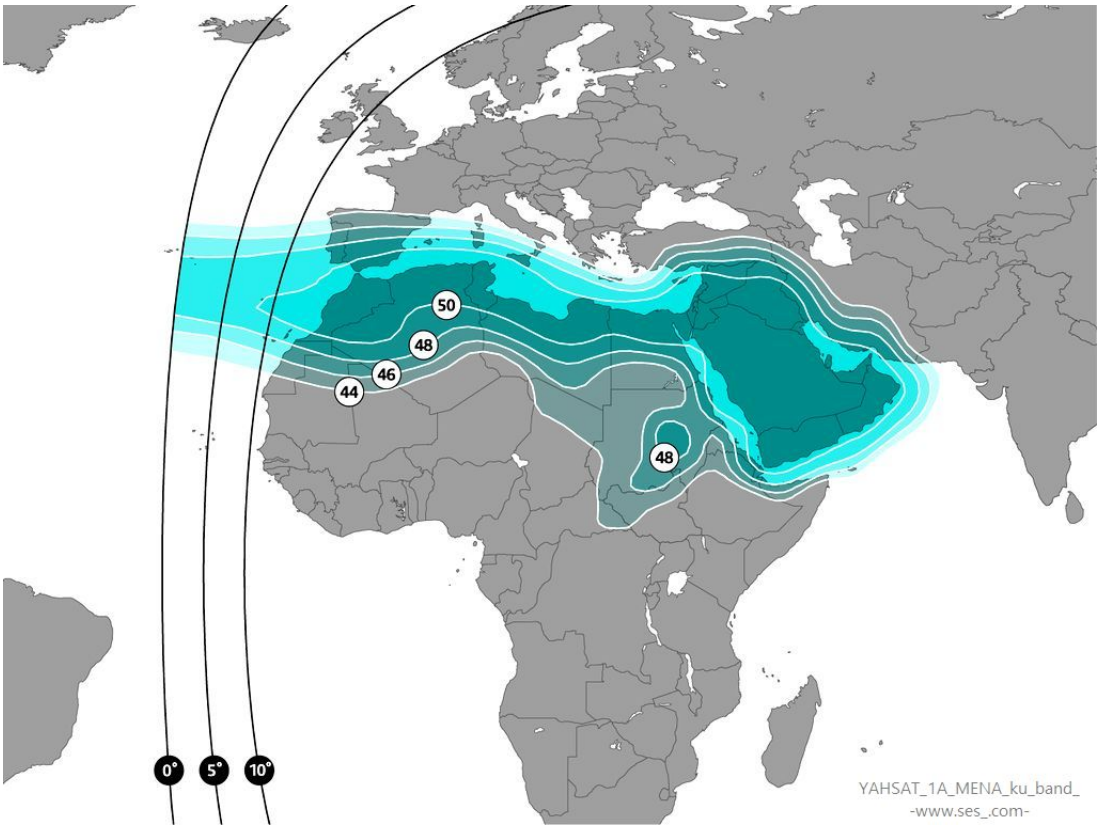


Fig. 3 – MENA radiation pattern (Ku band); EIRP contours 50/48/46/44 dBW. Source: SES (www.ses.com). Central Europe lies north of the outermost contour shown.

Both patterns show that Lučenec lies **outside all the contours shown**, and thus outside the nominal coverage area. In the EAST beam, the distance from the coverage boundary is considerable: the coverage is directed towards the Arabian Peninsula, Iran, Afghanistan and western Asia, whereas Central Europe lies on the north-western edge, which is reached only by the steep roll-off of the pattern. In the MENA beam, the coverage lies around the Mediterranean basin and the Middle East; Central Europe is north of the outer contour.

Neither the manufacturer nor the operator states a guaranteed EIRP for this area, so the actual values at the reception site are not known from the documentation. For this reason, this study does not use the EIRP figure from the pattern but the values implied by the measurement (Chapter 9). It is important that reception of seven carriers at such a distant location requires the gain of the entire receiving chain to be close to the threshold, and this is exactly what corresponds to the small margins observed.

4. Methodology of the Signal Monitoring

The methodology follows the author's rules (dxsatcs.com): for Out Of Footprint zones, the minimum unit duration of monitoring of one carrier is t = 72 hours. The reason is that the record should cover several daily cycles (daily variation of temperature, humidity and wind, and possible daily variation of EIRP) and thus be truly representative. For each carrier, the receiver lock and the quality Q (blue trace) were monitored. The failure criterion was unambiguous: a loss of lock corresponds to the value Q = 0.

4.1 List of Monitored Carriers

#	Frequency / pol.	Beam	Content	Modulation, SR, FEC	Duration	Samples (1 Hz)
1	11 766 V	EAST	Yahlive	DVB-S, QPSK, 27 500, 7/8	72 h	259 200
2	11 842 V	EAST	Yahlive	DVB-S2, 8PSK, 27 500, 2/3	72 h	259 200
3	11 881 V	EAST	GEM Turkey	DVB-S, QPSK, 27 500, 5/6	72 h	259 200
4	11 977 H	EAST	Yahlive	DVB-S, QPSK, 27 500, 5/6	77 h	277 200
5	11 996 V	EAST	Yahlive	DVB-S, QPSK, 27 500, 7/8	72 h	259 200
6	12 072 V	EAST	Yahlive	DVB-S, QPSK, 27 500, 5/6	72 h	259 200
7	12 168 H	MENA	Du UAE	DVB-S2, 8PSK, 27 500, 5/6	73 h	262 800
	Total				**510 h**	**1 836 000**

Tab. 1 – The seven monitored carriers. The number of samples is derived from the duration and the 1 Hz sampling rate (hours × 3 600); the total of 1 836 000 corresponds to the figure given by the author.

Check of the total: 5 × 72 h + 77 h + 73 h = 510 h; 510 h × 3 600 s/h = 1 836 000 samples. The number of measurement points given by the author thus corresponds exactly to the 1 Hz sampling rate.

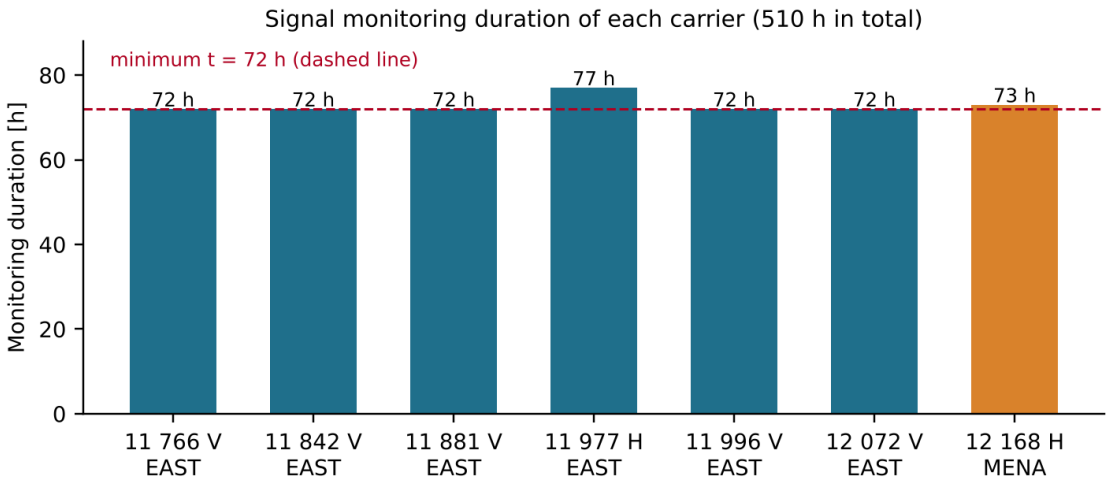


Fig. 4 – Monitoring duration for each carrier. All records meet the minimum of 72 h for Out Of Footprint zones.

4.2 What the Quantity of 510 Hours Means

The author speaks of “one continuous and uninterrupted course of stable lock function”. More precisely, it is a **sum of seven continuous records** (each of at least 72 hours), which together make up 510 hours without a loss of lock. This formulation is safer for a scientific publication, because it does not suggest that all carriers were monitored simultaneously; judging by the sum of the durations, they appear to have been monitored one after another. Regardless of this, each of the seven records is a separate piece of evidence for its carrier, and their consistent result strengthens the overall conclusion.

5. Parameters of the Received Carriers and Their Thresholds

In order to compare margins between different modulations and years, they must be expressed in a common physical quantity, namely the ratio of symbol energy to noise spectral density, Es/N_0. For DVB-S2, the ETSI EN 302 307-1 standard gives ideal Es/N_0 thresholds for quasi-error-free reception (PER = 10^{-7}); for DVB-S, the values are derived from the required E_b/N_0 according to ETSI EN 300 421, taking into account the code rate and the Reed-Solomon code (188/204).

Carrier	System	Modulation, FEC	Ideal threshold Es/N_0 [dB]	Spectral efficiency [bit/symbol]
11 766 V, 11 996 V	DVB-S	QPSK 7/8	≈ 8.5	1.61
11 842 V	DVB-S2	8PSK 2/3	6.62	2.00
11 881 V, 11 977 H*, 12 072 V	DVB-S	QPSK 5/6	≈ 7.9	1.54
12 168 H (MENA)	DVB-S2	8PSK 5/6	9.35	2.50

*Tab. 2 – Ideal thresholds (AWGN, without receiver implementation losses). A real receiver typically requires 0.5 to 1.5 dB more. The spectral efficiency of DVB-S includes RS(204,188); for DVB-S2 it is without pilots and the frame header. * For 11 977 H, the author's list gives FEC 5/6, whereas the author's comparison section speaks of 7/8 (see Chapter 8).*

An interesting conclusion follows from the table. The carrier at 12 168 H from the MENA beam uses 8PSK modulation with FEC 5/6, which has the highest threshold (9.35 dB) of all seven carriers. Since a 73-hour record without a loss of lock was obtained on it, Es/N_0 in Lučenec must have been **permanently above 9.35 dB plus the receiver implementation loss** throughout the record. This is at the same time a lower bound for the signal level of this carrier that can be read from the result without further assumptions. In the same way, lower bounds follow for the other carriers: ≈ 8.5 dB for QPSK 7/8, ≈ 7.9 dB for QPSK 5/6 and 6.6 dB for 8PSK 2/3.

6. Results: Lock Stability and Statistical Significance

6.1 Primary Result

On all seven carriers, lock was maintained throughout the entire monitoring period and the quality value Q never reached zero. The achieved availability is thus an observed 100 % for 1 836 000 measurement points (510 h). This is an unusual result in an Out Of Footprint zone, because operation is close to the threshold: even a small drop in signal of 1 to 2 dB would, with a low margin, cause lock to collapse. Such stability suggests that the signal does not fluctuate (the EIRP, the antenna pointing and the path do not change over 72 hours) and that the margin above the threshold, even if small, is constantly present.

6.2 Statistical Evaluation

A zero count of outages does not mean zero probability of an outage. Statistics gives upper bounds of the risk. According to the “rule of three”: if no event occurs in n independent units, the upper bound of the 95 % confidence interval for the probability of the event is approximately 3/n. If we choose one hour as the unit (and not one second, because second-by-second samples are not independent of each other), then for the entire set of 510 h we obtain:

Set	Hours n	Observed outages	95 % upper bound for the proportion of hours with an outage	Lower bound of availability (hourly)
Each carrier separately (72 h)	72	0	≈ 4.2 %	≈ 95.8 %
All 7 carriers together	510	0	≈ 0.59 %	≈ 99.41 %

Tab. 3 – Statistical bounds for a zero count of outages (rule of three, 95 %).

The figure of 1 836 000 points therefore cannot be interpreted as 1 836 000 independent pieces of evidence. Neighbouring one-second samples are strongly correlated (the signal hardly changes within a second). The independent information is carried rather by the number of different weather and daily situations covered by the record; it is of the order of hundreds to thousands of independent intervals, not millions. The value of the data set therefore lies in **the length of the record and the diversity of conditions** (day/night, dry/rain, temperature), and this the author has met with a minimum of 72 hours per carrier. The figure of 1 836 000 is a true statement about the density of the record, but for a scientific argument 510 hours and seven carriers should be given as the main figure.

7. Influence of Weather Conditions

The author documents the occurrence of rain showers with data from shmu.sk. Physically, this is the main mechanism that degrades reception in the Ku band: raindrops absorb and scatter radiation with a wavelength of 2.5 cm, which is comparable to the size of the drops. According to ITU-R P.838, the specific rain attenuation is expressed by the power-law relation

$$\gamma_R = k \cdot R^{\alpha} \; [dB/km],$$

where R is the rain rate in mm/h. For 12 GHz, k ≈ 0.0246 and α ≈ 1.12 for vertical polarization (ITU-R P.838-3, rounded). The total attenuation is obtained by multiplying by the effective path length in rain. At an elevation of 26.2°, a zero-degree isotherm height of about 3.1 km (ITU-R P.839) and a station height of 0.2 km, the slant path through the rain layer is at most approximately 7.4 km; for local showers the rain cell is smaller, so I also give a shorter effective path of 3 km.

Rain rate R [mm/h]	Character of the rain	Attenuation, 3 km path [dB]	Attenuation, 7.4 km path [dB]
1	light drizzle	0.07	0.18
2	light rain	0.16	0.40
5	moderate rain	0.45	1.10
10	heavier rain	0.97	2.40
20	heavy rain	2.12	5.23

Tab. 4 – Indicative rain attenuation at 11.9 GHz (vertical polarization). This is a model, not a measurement; it serves to assess the consistency of the order of magnitude with the observation.

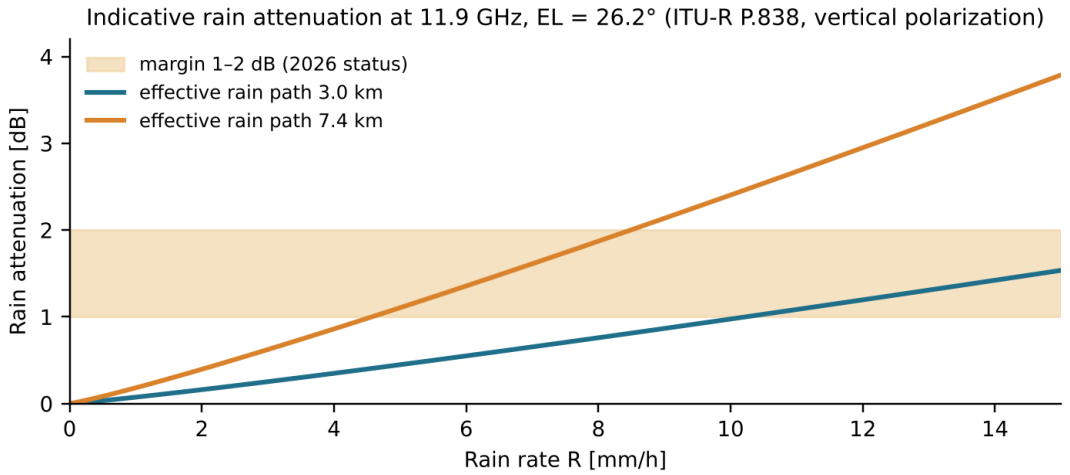


Fig. 5 – Rain attenuation as a function of rain rate. The yellow band represents the 1 to 2 dB margin that was available in 2026 on the 11 977 H carrier.

The model shows that in light to moderate rain (up to approximately 5 mm/h) the attenuation is of the order of tenths of a dB up to one dB. This is compatible with the author's observation: at moderate rainfall intensity, Q did not drop to zero. At a rate of 10 mm/h or more, the attenuation can already reach 1 to 2.5 dB, which with a margin of 1 to 2 dB could lead to an outage. The observed stability therefore does not mean resistance to heavy rain; it means that no heavy rain occurred on the path during the records, or that it was brief.

To this are added further, smaller effects: gaseous attenuation (oxygen, water vapour) of approximately 0.2 dB, cloud attenuation of tenths of a dB and tropospheric scintillation with a typical standard deviation of the order of 0.1 to 0.3 dB, which increases slightly at low elevation. Ionospheric effects are negligible at 12 GHz.

Recommendation for publication: add to Table 1, for each record, the maximum 10-minute rainfall intensity from shmu.sk (mm/h) and the total for the record. This will make the statement “stable reception even during rain showers” measurable and verifiable.

8. Stability of the Trace and Comparison with 2022

8.1 Absence of Step Changes

The author states that no step increase in power or quality occurred in the traces of any of the seven carriers, in contrast to the recording of RT News on 11 475 MHz H from the Express AM-7 satellite (40.0° E), where he captured such steps. A step change is in practice usually explained by operator interventions (a change of uplink power, switching of the transponder or beam, a change of modulation), not by the behaviour of wave propagation. A smooth trace without steps is therefore consistent with the carriers transmitted from Al Yah 1 being in a stable state during the records and with the changes originating only from slow natural processes (temperature, humidity, scintillation).

According to the author, the signal model for these waves did not demonstrate a persistent wave defect in Lučenec, so it was not necessary to use the Synchronous Nanocorrection technology, which is intended to correct defects in Out Of Footprint zones. This study evaluates neither that model nor its technology; all conclusions here are supported only by directly measured traces of Q and lock. It would be beneficial for the expert public to attach a description of the model and the raw records to the study.

8.2 Comparison of 2022 and 2026 on the 11 977 H Carrier

The author's most significant finding is a long-term decrease in signal level. With the same antenna (450 cm), the author reports for 2022 signal margins of around 7 to 9 dB for DVB-S2 QPSK, FEC 8/9, even under markedly degraded conditions. Today, with the changed parameters DVB-S QPSK and FEC 7/8, the margin is only 1 to 2 dB. In 2022, a margin of 3 to 4 dB was present around the clock on the 300 cm reflector, which no longer holds today.

A direct comparison of the margins of 7 to 9 dB and 1 to 2 dB would be misleading, because they have a different reference threshold: a margin is always the distance from the modulation threshold. I therefore convert them to Es/N_0 = threshold + margin:

State	Modulation	Ideal threshold [dB]	Margin [dB]	Estimated Es/N_0 [dB]
2022, PF 450 cm	DVB-S2 QPSK 8/9	6.2	7 to 9	13.2 to 15.2
2022, PF 300 cm (conversion to 450 cm: +3.52 dB)	DVB-S2 QPSK 8/9	6.2	3 to 4	12.7 to 13.7 (for 450 cm)
2026, PF 450 cm	DVB-S QPSK 7/8	≈ 8.5	1 to 2	9.5 to 10.5
2026, PF 450 cm (if FEC is 5/6)	DVB-S QPSK 5/6	≈ 7.9	1 to 2	8.9 to 9.9

Tab. 5 – Conversion of the margins from 2022 and 2026 to the common quantity Es/N_0. The margins are as stated by the author; the thresholds are ideal values from the standards, so the absolute Es/N_0 is subject to an inaccuracy of ±1 dB, but the difference between the years is less sensitive if the receiver displays the margin in the same way.

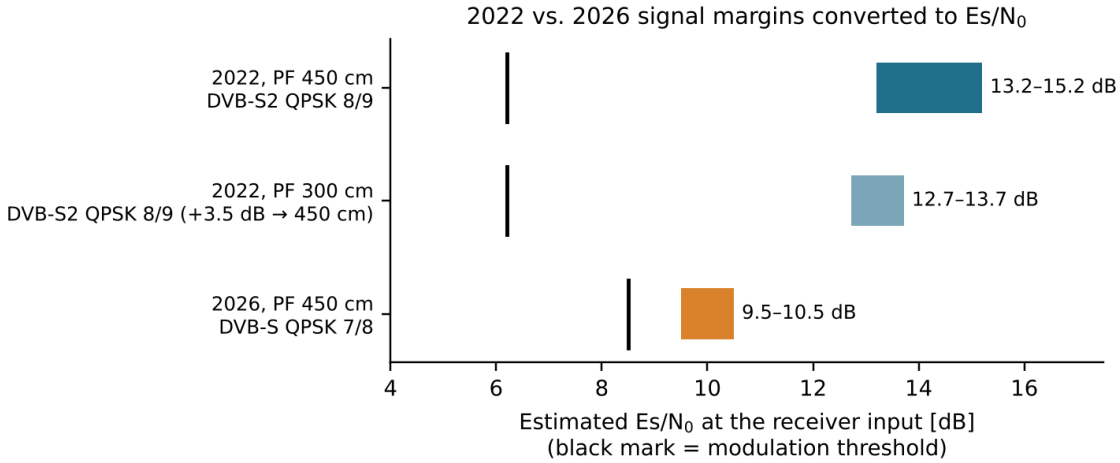


Fig. 6 – Estimated Es/N_0 in 2022 and 2026. The decrease is approximately 3 to 6 dB, typically around 4 dB.

Three conclusions follow from the conversion. **First**, the decrease is not merely an apparent consequence of the change of modulation: even after normalisation to Es/N_0, a reduction of approximately 3 to 6 dB remains (a range of 13.2 to 15.2 dB versus 9.5 to 10.5 dB). **Second**, the 2022 record on the 300 cm reflector, after conversion (+3.52 dB), gives 12.7 to 13.7 dB, which almost corresponds to the lower half of the record on 450 cm (13.2 to 15.2 dB). The author's two independent data sets from 2022 thus do not contradict each other, which increases the credibility of the comparison. **Third**, a decrease of 3 to 6 dB corresponds to a drop in

power to one half up to one quarter of the original value, and is therefore large.

Data check: the list of carriers in Chapter 4 gives FEC 5/6 for 11 977 H, whereas the comparison in Chapter 8 speaks of FEC 7/8. The difference in the result is small (about 0.6 dB in the threshold), but the figure must be harmonised before publication.

8.3 Possible Causes of the Decrease and How to Distinguish Them

The cause of the decrease cannot be determined from the data alone. The following hypotheses come into consideration; for each I give a control measurement that will confirm or rule it out.

Hypothesis	Description	How to verify
H1: change of EIRP on the satellite / operator side	A reduction of transponder power, a change of backoff, an adjustment of the beam or of the satellite's orientation relative to the original state; the satellite has been in service since 2011, so the operating regime may also have changed.	Compare the decrease on carriers from different transponders and polarizations; request data from the operator or compare with another observer in a similar zone.
H2: change of the satellite's orbit (inclination)	A growing orbital inclination would cause a daily fluctuation of Q and a change of gain towards Lučenec.	Look for a 24-hour periodicity in Q; according to the author, neither step nor periodic changes occur.
H3: ageing of the receiving chain	Degradation of the LNB noise figure, moisture in the connectors, a change of the power inserter, loss of cable gain.	Measurement of the LNB noise (Y-factor, Sun or cold sky), replacement of the LNB, inspection of the cable and connectors.
H4: change of the reflector and its alignment	Micro-deformation of the surface, shift of the feed, a slight deviation from the maximum (Section 2.4: 0.1° ≈ 0.8 dB).	Re-peaking on the maximum, checking the focus and polarization, comparison with a reference carrier.
H5: change of the path environment	Growth of vegetation or a new obstacle at an elevation of 26° in the 139° direction.	Photographic inspection of the horizon, comparison of the trace in winter and in summer.

Tab. 6 – Hypotheses on the signal decrease and proposed control measurements.

The author states that the rapid decrease has been repeated on other carriers from the EAST beam over the last four years. This would speak rather in favour of factors common to several carriers (H1, H3, H4) than of phenomena specific to a single frequency. However, if the cause were the receiving chain (H3, H4), this would also affect other satellites received with the same equipment; a comparison with a carrier from another satellite would therefore be the cheapest and most decisive test.

9. Indicative Link Budget and the Implied EIRP in Lučenec

The link budget shows what EIRP must be present in Lučenec to correspond to the observation. For one carrier with a symbol rate of 27.5 Msymb/s,

$$Es/N_0 = EIRP - L_{fs} - L_{other} + G/T - 10\cdot\log_{10}(k) - 10\cdot\log_{10}(R_s),$$

where $-10\cdot\log_{10}(k) = 228.6$ dBW/(K·Hz) and $10\cdot\log_{10}(R_s) = 74.4$ dBHz. Assumptions: antenna gain 53.1 dBi ($\eta = 0.65$), system noise temperature 80 to 120 K (LNB, sky, ground at 26° elevation), other losses 0.5 dB (gases, pointing inaccuracy, polarization).

Situation	Es/N_0 [dB]	Implied EIRP at T = 80 K	at T = 100 K	at T = 120 K
2022 (lower estimate)	13.2	31.2 dBW	32.2 dBW	33.0 dBW
2022 (higher estimate)	15.2	33.2 dBW	34.2 dBW	35.0 dBW
2026 (lower estimate)	9.5	27.5 dBW	28.5 dBW	29.3 dBW
2026 (higher estimate)	10.5	28.5 dBW	29.5 dBW	30.3 dBW

Tab. 7 – Implied EIRP in the direction of Lučenec under the chosen assumptions. This is not a measurement of EIRP; the values serve to assess the order of magnitude and their uncertainty is approximately ±2 dB.

The result shows that the EIRP in the direction of Lučenec is of the order of 28 to 30 dBW, which is about 20 dB less than the peak of the pattern (48 to 51 dBW). This is consistent with the position far beyond the coverage boundary and shows that reception in Central Europe is possible only thanks to the high antenna gain: with a 300 cm reflector (−3.5 dB), the margin in 2026 would fall below zero at the same pointing, which the author also states in his overview (“no longer possible”). This estimate also shows why doubling the reflector diameter (+6 dB) is worthwhile for such an area: it corresponds to the difference between stable reception and its complete loss.

10. Discussion

What the results support. The author's data reliably support the statement that, under the observed conditions, seven carriers from Al Yah 1 could be received in Lučenec with a 450 cm reflector without a loss of lock for 510 hours (seven records of 72 to 77 hours), even during occasional rain showers. The physical model (Chapters 2, 7 and 9) explains this result without contradictions: the margin above the threshold is small but constant, and the attenuation by moderate rain is smaller than the margin.

What the results do not support. They do not support a claim of resistance to heavy rain, nor that reception will be equally stable in other seasons or after a further decrease in EIRP. With a margin of 1 to 2 dB, the system is close to the threshold and a further decrease of a few dB would end reception.

Significance for practice. Three practical conclusions follow for observers in Central Europe. First, **the antenna diameter has a decisive influence**: each doubling of the diameter gives +6 dB, and 450 cm versus 300 cm is +3.5 dB. Second, **the quality of the chain and the pointing accuracy** show up directly in the margin in such a regime (0.1° ≈ 0.8 dB; a degradation of the LNB noise figure by 0.3 dB means roughly a loss of 0.3 dB of margin). Third, **long-term monitoring with documentation of the environment** (rainfall, temperature, wind) is the only way to distinguish changes on the satellite from changes on the ground.

Relation to other satellites. The example of Express AM-7 (40.0° E) with an Indian-region pattern, in which the author captured a step increase in power and quality, shows that steps are common with new or changing transmissions. The smooth traces of Al Yah 1 are therefore a qualitatively different type of behaviour: stable, but at a lower level than in the past.

11. Limitations and Conditions of Reproducibility

For the study to withstand expert assessment, its limits must be stated openly:

- **One site, one antenna, one observer.** The results are valid for Lučenec and the given set-up (reflector, LNB, receiver). Independent confirmation from another site or with a different set-up would substantially strengthen the evidence.
- **Q and margin are parameters of a particular receiver.** Different receivers define them differently, and the scale need not be linear in dB. The conversions in Chapter 8 are therefore indicative; it is advisable to state the receiver model and the way Q is displayed.

- **Sequential records.** The total of 510 hours is the sum of seven records, not one simultaneous trace of all carriers (Section 4.2).
- **Number of samples.** The figure of 1 836 000 measurement points expresses the density of the record; the statistical weight derives from the number of hours and the diversity of conditions (Section 6.2).
- **Rainfall.** The documentation of rain by shmu.sk data should be supplemented with a numerical table of intensity for each record (Chapter 7).
- **The year 2022.** The unpublished records from 2022 must be attached (at least graphs stating the modulation, time and set-up), otherwise the comparison is unverified. For 11 977 H, the FEC figure (5/6 or 7/8) must be harmonised.
- **Cause of the decrease.** The study quantifies the decrease but cannot determine its cause (Table 6).

Recommended package of appendices for publication: raw logs (CSV with a one-second step: time, Q, level, lock), a photograph of the set-up and of the horizon, the LNB and receiver model, a table of rainfall and temperatures for each record, the 2022 records with the set-up information.

12. Conclusion

In Lučenec, which lies far outside the footprint of the EAST and MENA beams of the Al Yah 1 satellite, continuous reception of seven carriers was achieved with a Prodelin 450 cm reflector: six from the EAST beam and one from the MENA beam, in total 510 hours (1 836 000 samples at 1 Hz), without a single loss of lock and without Q dropping to zero. The physical analysis shows that this result is consistent with the reception geometry (AZ 139.2°, EL 26.2°, slant path 38 962 km, free-space loss 205.8 dB), with an antenna gain of approximately 53 dBi, with the thresholds of the modulations used and with the expected attenuation by moderate rain.

The conversion of the 2022 records to the common quantity Es/N_0 shows a decrease in signal level of approximately 3 to 6 dB; today's constant margin is around 1 to 2 dB. The system therefore operates close to the threshold, and the stability of lock is remarkable precisely because the margin is small but constant. A further reduction of a few dB would end reception. The cause of the decrease must be determined by the control measurements given in Table 6.

The study thus demonstrates that reception in the Out Of Footprint zone in Central Europe is possible over the long term with a large reflector and a high-quality chain, and at the same time shows where its limits lie. Once the appendices listed in Chapter 11 have been added, the results can be submitted for independent verification.

References and Sources

[1] ETSI EN 300 421: Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for 11/12 GHz satellite services (DVB-S).

[2] ETSI EN 302 307-1: Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for broadcasting, interactive services, news gathering and other broadband satellite applications (DVB-S2), Part 1.

[3] ITU-R P.618: Propagation data and prediction methods required for the design of Earth-space telecommunication systems.

[4] ITU-R P.838: Specific attenuation model for rain for use in prediction methods.

[5] ITU-R P.839: Rain height model for prediction methods.

[6] ITU-R P.676: Attenuation by atmospheric gases and related effects.

[7] Maral, G., Bousquet, M.: Satellite Communications Systems. Wiley.

[8] Stutzman, W. L., Thiele, G. A.: Antenna Theory and Design. Wiley.

[9] dishpointer.com – AZ/EL calculation for 52.5° E (Al Yah 1 / Yahsat 1A), Lučenec; SES – YAHSAT 1A EAST and MENA radiation patterns, Ku band (www.ses.com); shmu.sk – rainfall data (to be added to the appendices).

Appendix A – Relations Used

For a station with latitude φ and longitude λ_s, a satellite at longitude λ_{sat} and $\Delta = \lambda_{sat} - \lambda_s$, the following holds (R = 6 378 km, r = 42 164 km):

$$\cos\gamma = \cos\varphi \cdot \cos\Delta,\quad EL = \arctan[(\cos\gamma - R/r) / \sin\gamma],\quad AZ = 180° - \arctan[\tan\Delta / \sin\varphi],$$

$$d = \sqrt{(R^2 + r^2 - 2 \cdot R \cdot r \cdot \cos\gamma)}.$$

For Lučenec: φ = 48.3331°, Δ = 32.8336°, γ = 56.04°, which gives AZ = 139.18°, EL = 26.16° and d = 38 962 km. The magnetic azimuth is obtained by subtracting the magnetic declination (≈ 6.1° east), which corresponds to the value of 133.1° from dishpointer.com.

DVB-S thresholds: $Es/N_0 = E_b/N_0 + 10 \cdot \log_{10}(2 \cdot R_c \cdot 188/204)$, with E_b/N_0 = 5.0 / 5.5 / 6.0 / 6.4 dB for R_c = 2/3, 3/4, 5/6, 7/8 (ETSI EN 300 421, rounded). Rule of three: the 95 % upper bound for the probability of an event in n independent trials with no event ≈ 3/n.