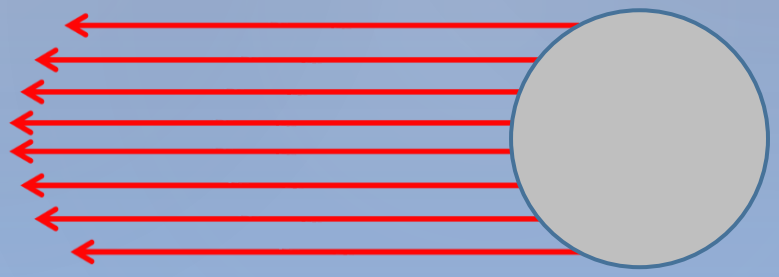
How high is the Moon?

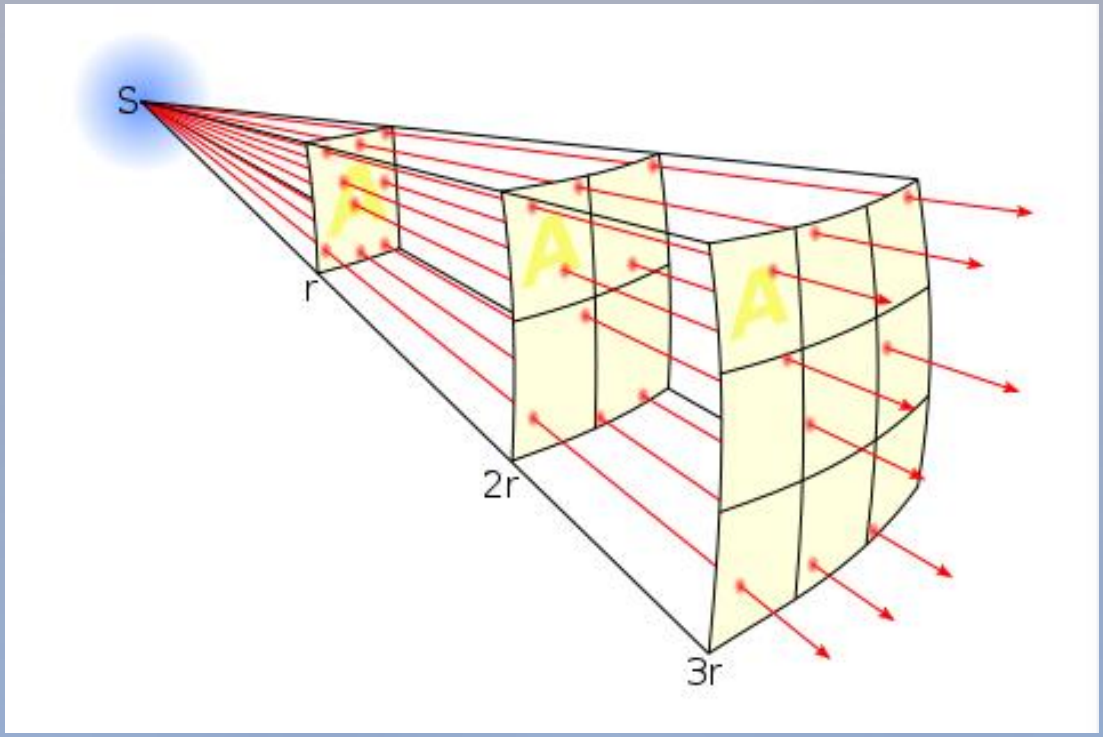
Entfernung von der Erde:	363.300 km im Perigäum
	405.500 km im Apogäum
Geschwindigkeit:	1.842 km/h
Mittlerer Durchmesser:	3.476 km
Reflexionsvermögen (Radio):	ca. 7%

Der Mond in Zahlen

Entfernung von der Erde:	363.300 km im Perigäum
	405.500 km im Apogäum
Geschwindigkeit:	1.842 km/h
Mittlerer Durchmesser:	3.476 km
Reflexionsvermögen (Radio):	ca. 7%
Signallaufzeit:	2,5 bis 2,7 Sekunden
Laufzeitdifferenz:	11 ms



Der Mond in Zahlen



$$P_r = P_t \frac{G_t\, G_r\, \lambda^2\, \sigma}{(4\pi)^3 R_t^2 R_r^2}$$

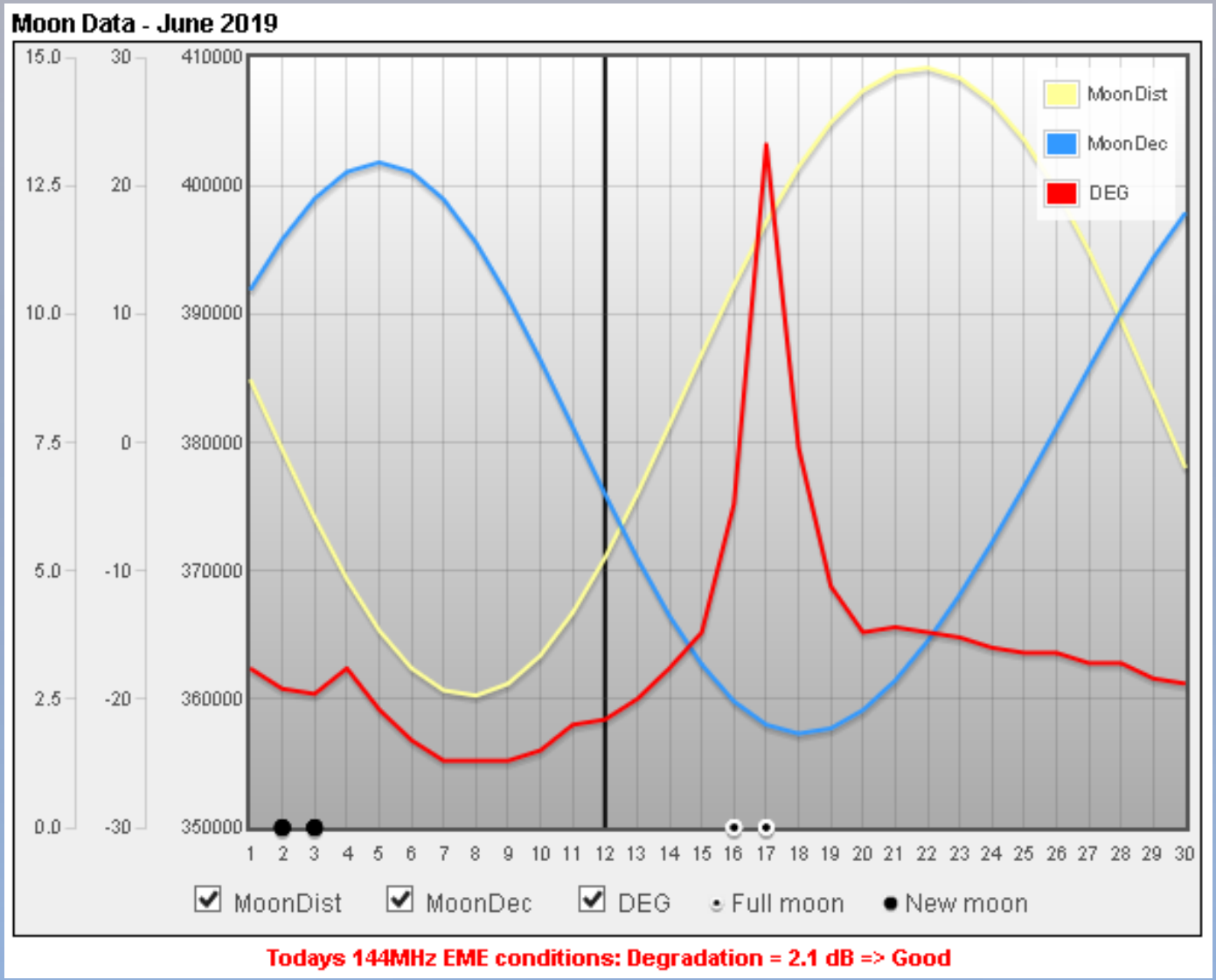
Streckendämpfung

Band [MHz]	Perigäum [dB]	Apogäum [dB]
144	-251,5	-253,5
432	-261,0	-263,0
1296	-270,5	-272,5
2320	-276,0	-278,0

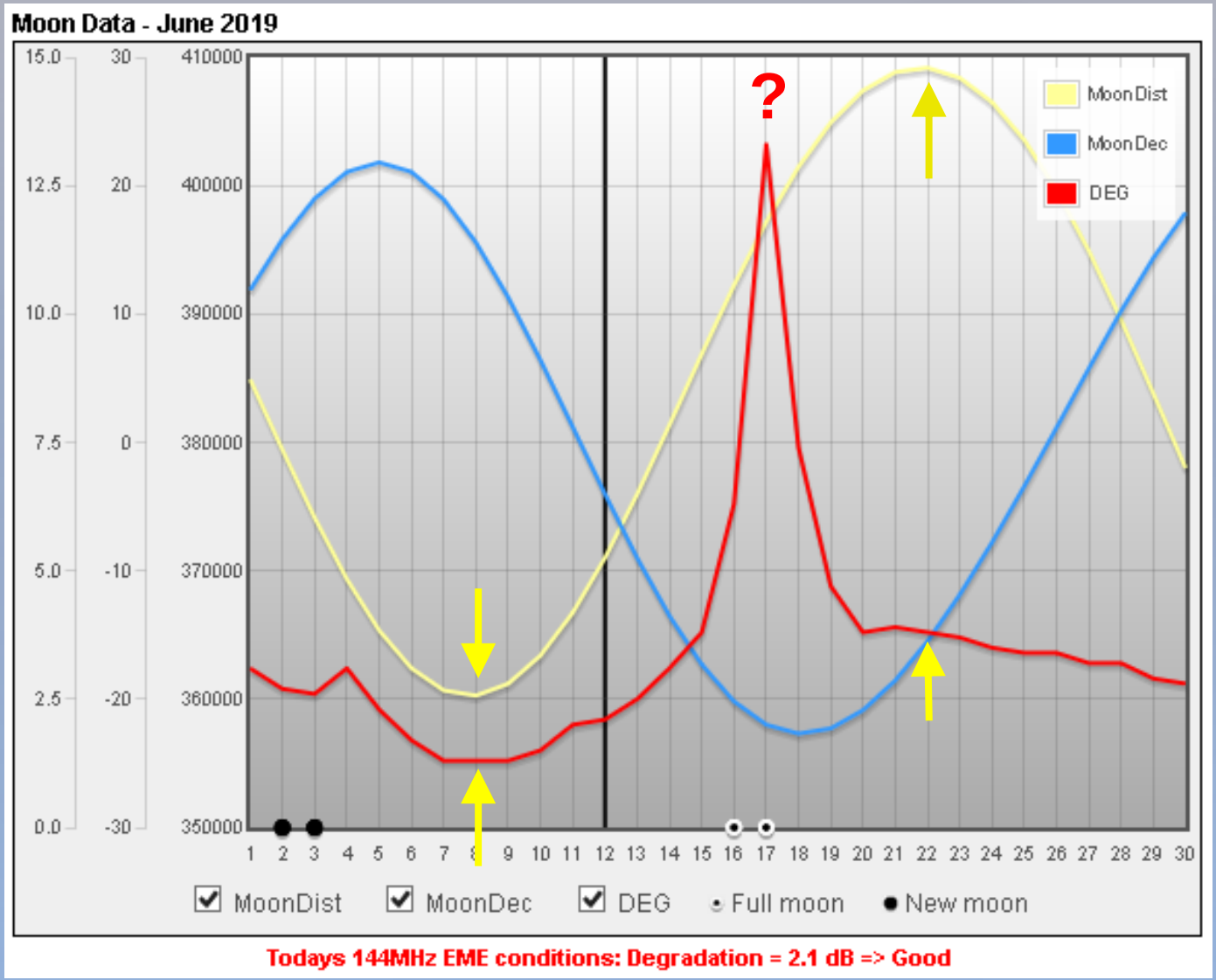
Band [MHz]	TX Power [dBm]	Antenne [dBi]
144	60	20
432	60	24
1296	60	30
2320	50	33

Beispiel 23 cm: -270,5 dB +60 dBm (=1000 W) + 30 dBi +30 dBi = -150,5 dBm

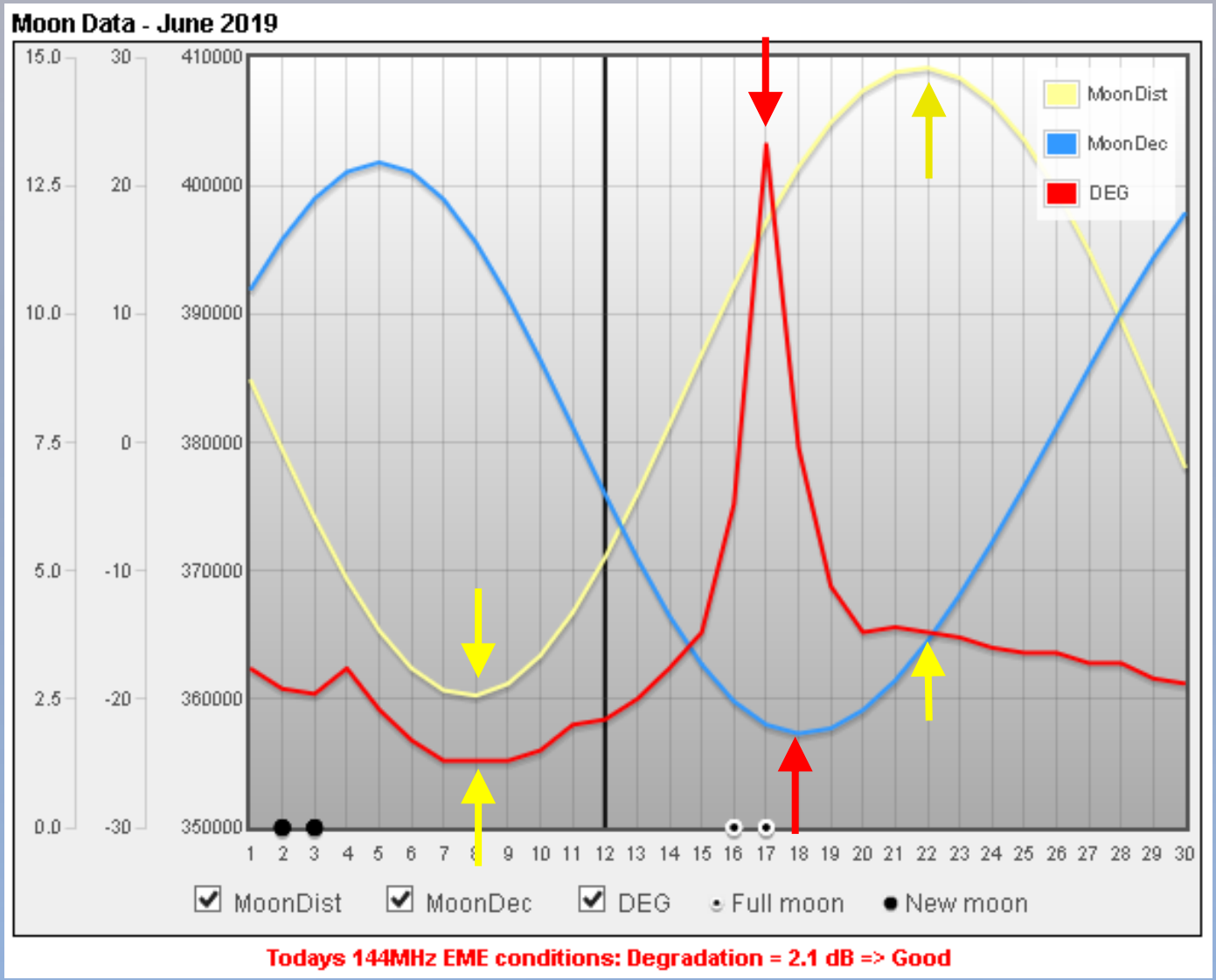
Streckendämpfung



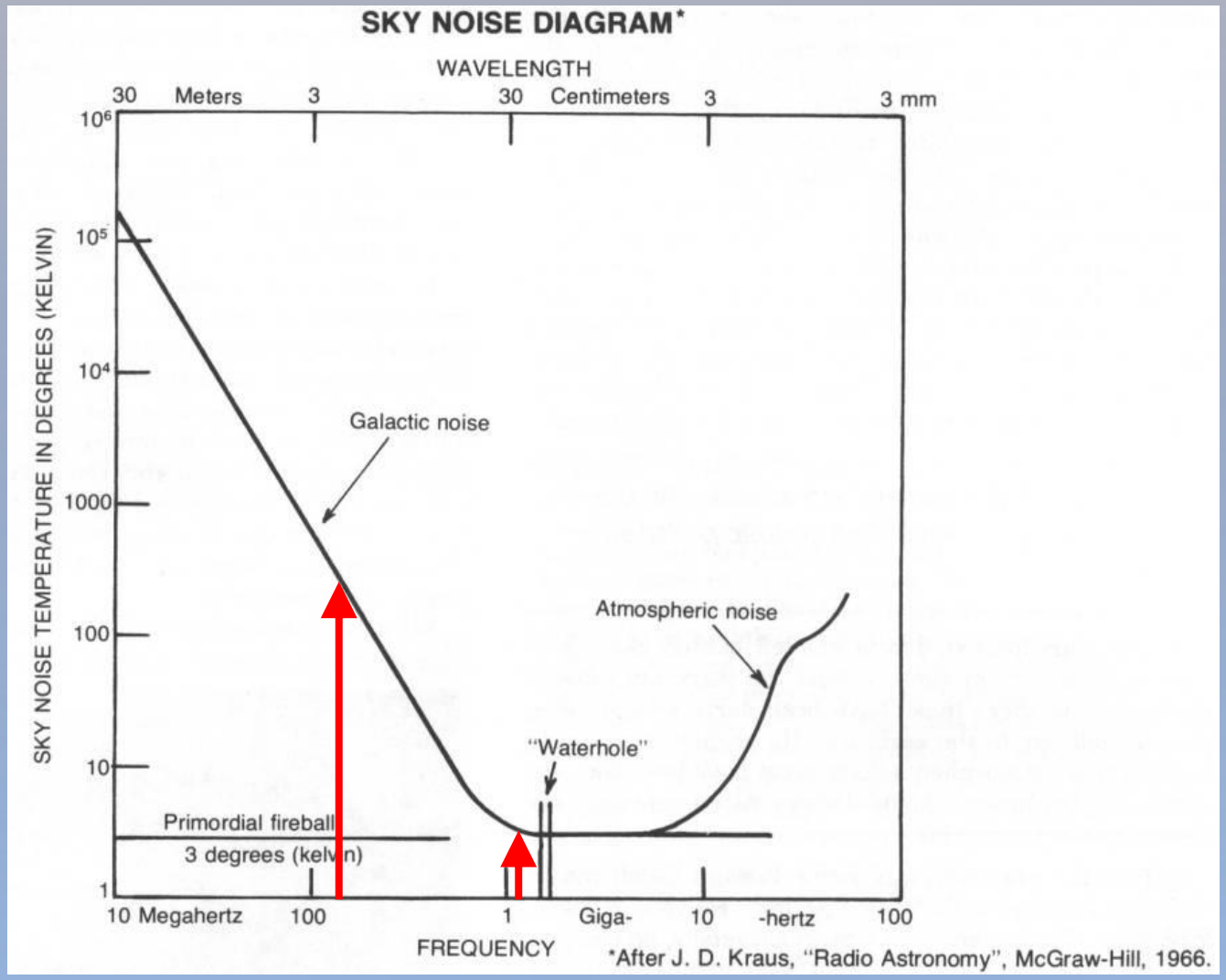
VHFDX.EU: EME-Bedingungen für 144 MHz, Juni 2019



VHFDX.EU: EME-Bedingungen für 144 MHz, Juni 2019



VHFDX.EU: EME-Bedingungen für 144 MHz, Juni 2019



Radioquellen

WSJT-X - Astrono...

2019 Jun 12	
UTC:	14:15:17
Az:	100.3
El:	2.8
SelfDop:	242
Width:	0
Delay:	2.50
DxAz:	97.9
DxEl:	0.5
DxDop:	239
DxWid:	0
Dec:	-4.5
SunAz:	246.4
SunEl:	47.8
Freq:	144
Tsky:	311
Dpol:	-1.3
MNR:	0.0
Dgrd:	-2.4

☐ Doppler tracking

WSJT-X - Astrono...

2019 Jun 12	
UTC:	14:16:28
Az:	100.5
El:	2.9
SelfDop:	726
Width:	1
Delay:	2.50
DxAz:	98.2
DxEl:	0.7
DxDop:	715
DxWid:	1
Dec:	-4.5
SunAz:	246.7
SunEl:	47.6
Freq:	432
Tsky:	20
Dpol:	-1.3
MNR:	0.0
Dgrd:	-1.2

☐ Doppler tracking

WSJT-X - Astrono...

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UTC:	14:16:54
Az:	100.6
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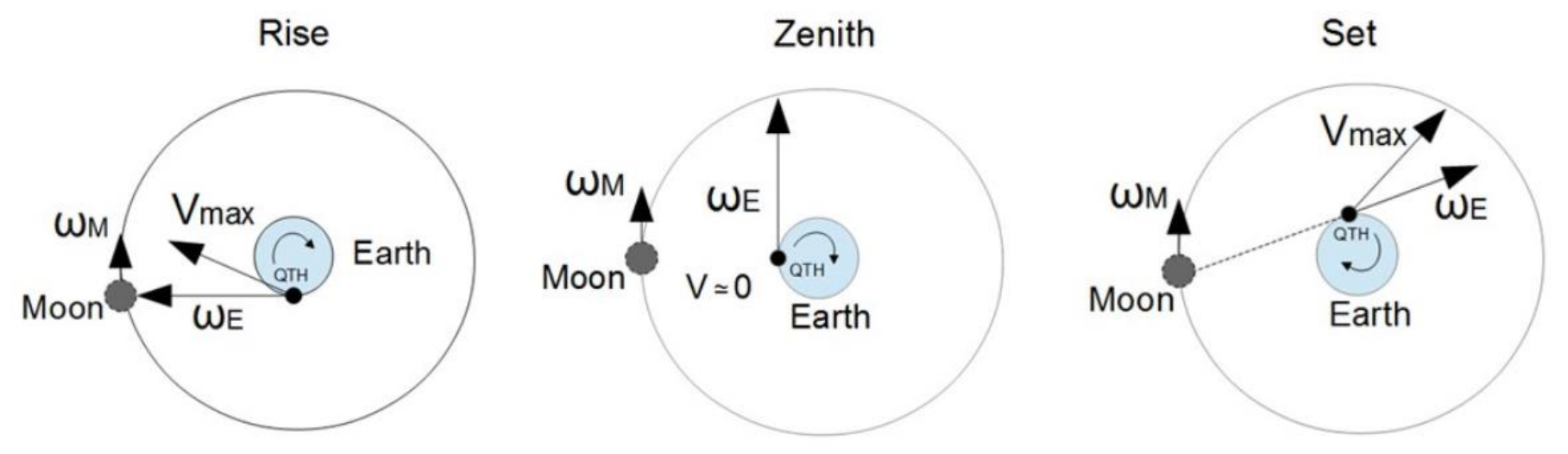
SelfDop:	2178
Width:	4
Delay:	2.50
DxAz:	98.2
DxEl:	0.8
DxDop:	2145
DxWid:	4
Dec:	-4.5
SunAz:	246.9
SunEl:	47.5
Freq:	1296
Tsky:	4
Dpol:	-1.3
MNR:	0.0
Dgrd:	-1.0

☐ Doppler tracking

WSJT – Astronomical Data: Sky Noise per Band

Der Doppler-Effekt



144 MHz:	**440 Hz**
1296 MHz:	**4 kHz**
10 GHz:	**30 kHz**

Der Doppler-Effekt

WSJT-X - Astrono...

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UTC:	14:15:17
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El:	2.8
SelfDop:	242
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Delay:	2.50
DxAz:	97.9
DxEl:	0.5
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DxWid:	0
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☐ Doppler tracking

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☐ Doppler tracking

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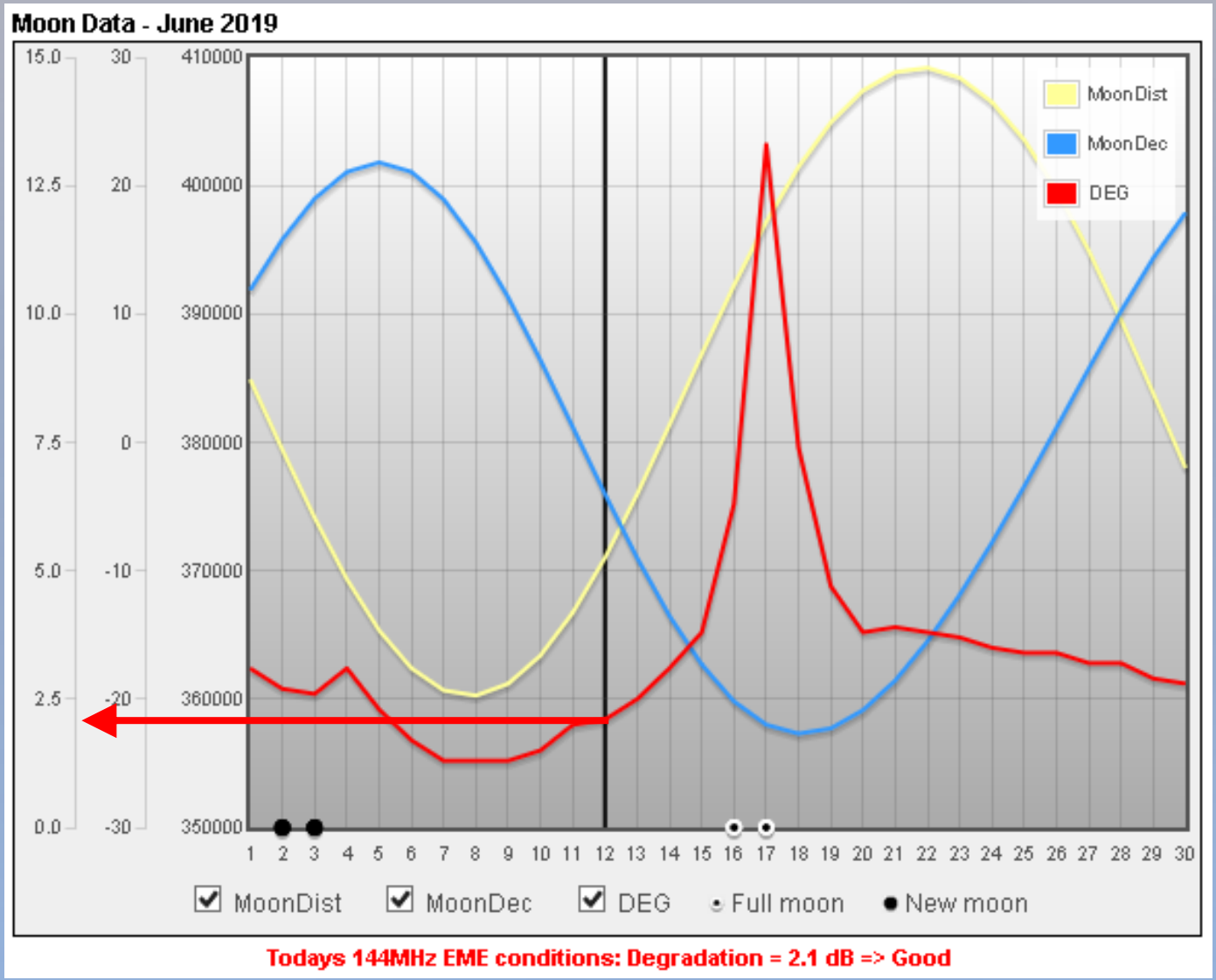
SunAz:	246.9
SunEl:	47.5
Freq:	1296
Tsky:	4
Dpol:	-1.3
MNR:	0.0
Dgrd:	-1.0

☐ Doppler tracking

WSJT – Astronomical Data: Doppler per Band



EME-Bedingungen für 144 MHz, Juni 2019

WSJT-X - Astrono...

2019 Jun 12	
UTC:	14:15:17
Az:	100.3
El:	2.8
SelfDop:	242
Width:	0
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DxAz:	97.9
DxEl:	0.5
DxDop:	239
DxWid:	0
Dec:	-4.5
SunAz:	246.4
SunEl:	47.8
Freq:	144
Tsky:	311
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Doppler tracking

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Doppler tracking

WSJT-X - Astrono...

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DxDop:	2145
DxWid:	4
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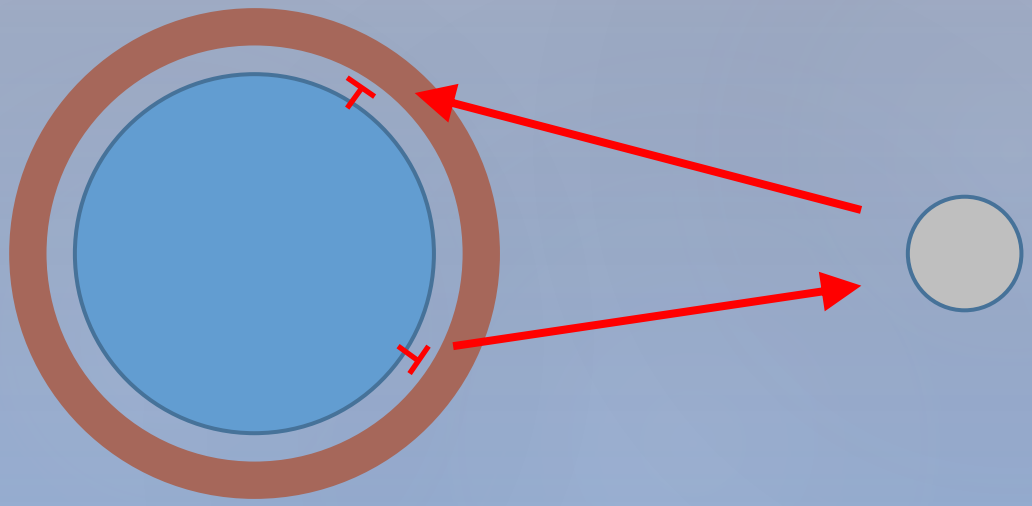
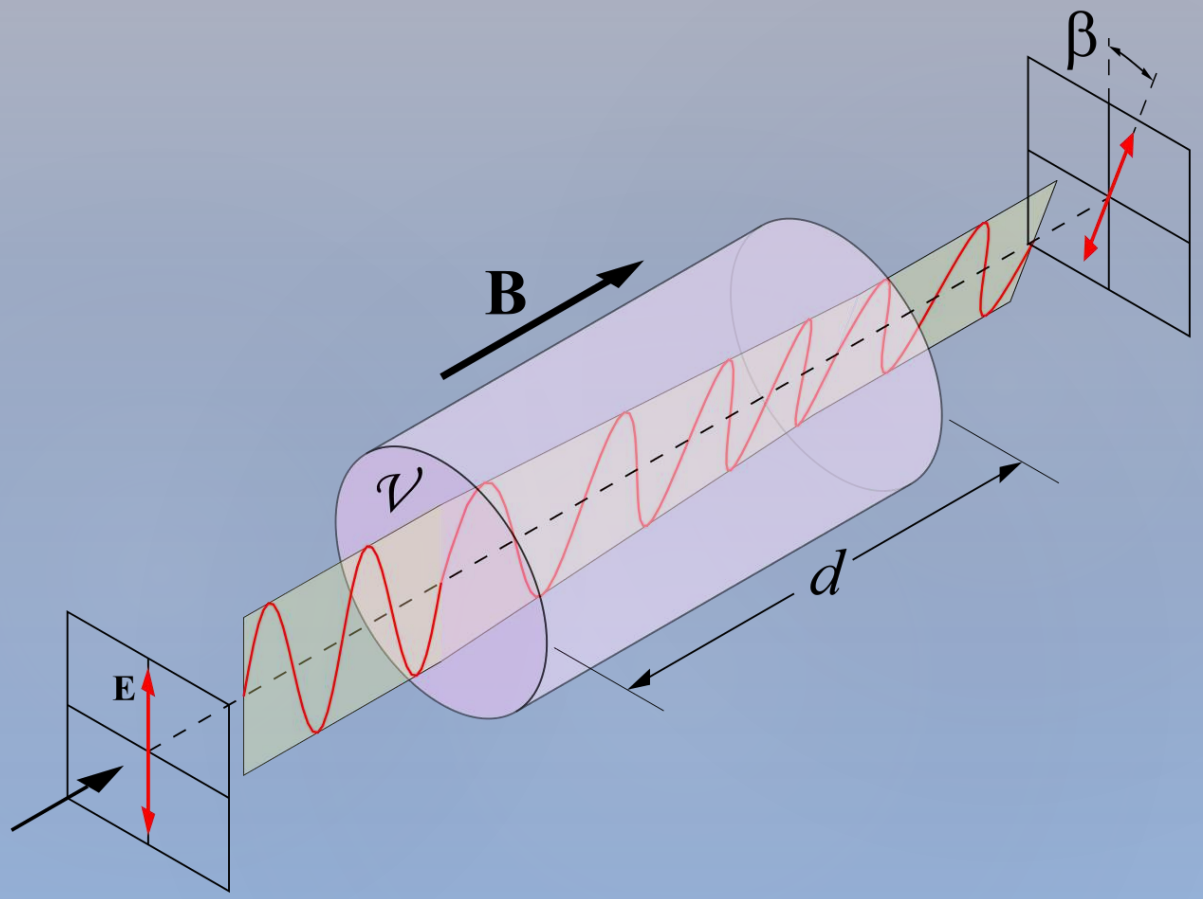
SunAz:	246.9
SunEl:	47.5
Freq:	1296
Tsky:	4
Dpol:	-1.3
MNR:	0.0
Dgrd:	-1.0

Doppler tracking

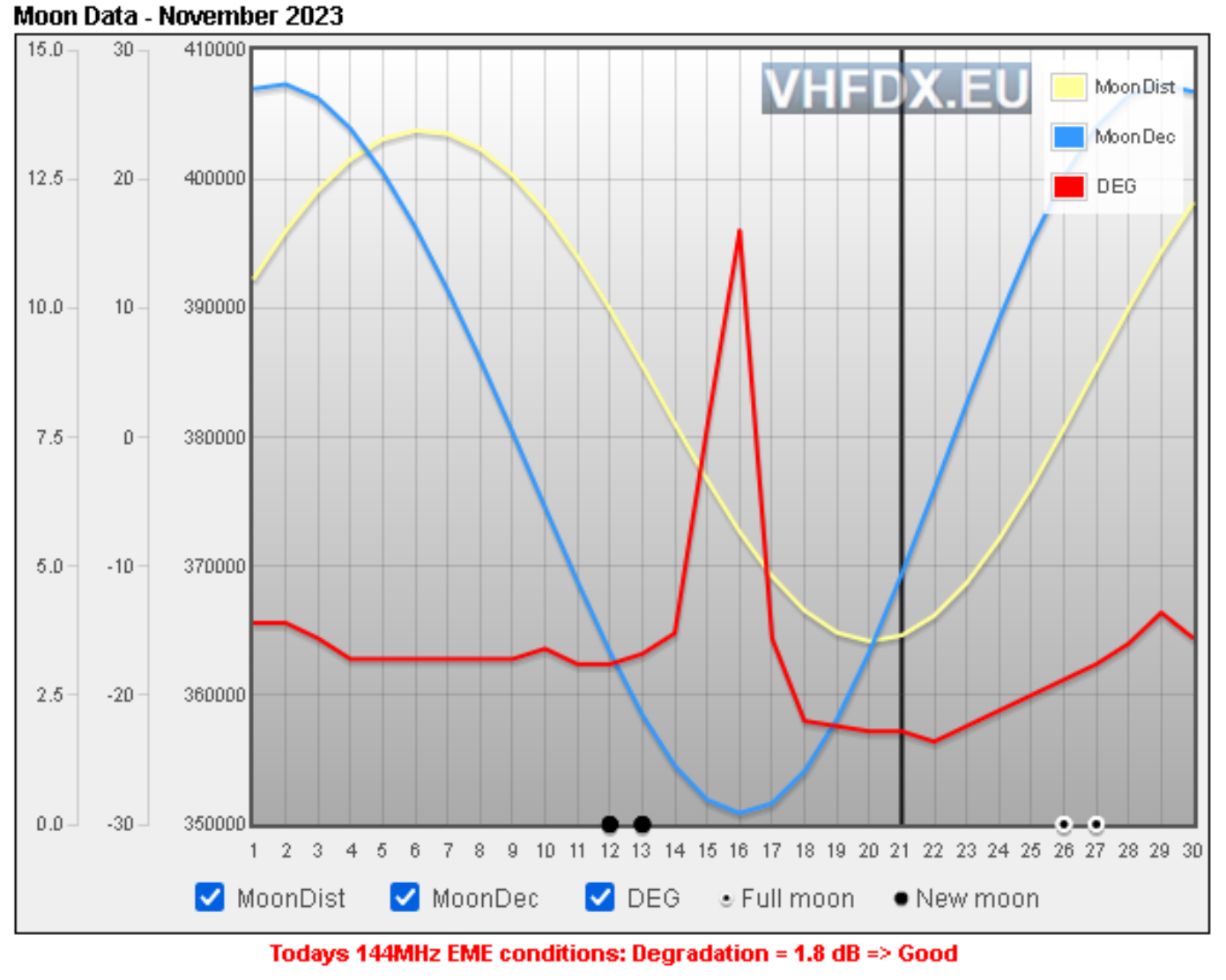
WSJT – Astronomical Data: Degradation per Band



Geometrische Drehung der Polarisation



Drehung der Polarisation durch den Faraday-Effekt



VHFDX.EU: EME-Bedingungen für 144 MHz, November 2023

PI9CAM: 25 m Radio Teleskop für 432 und 1296 MHz

Band	Gewinn	Sonnenrauschen
2m:	27 dBd	schwierig wegen QRM
70 cm:	37 dBd	ca. 27 dB
23 cm:	47 dBd	ca. 32 dB
13 cm:	52 dBd	noch nicht gemessen
9 cm:	55 dBd	noch nicht gemessen
6 cm:	nicht bestimmt	ca. 22 dB (improvisierte Ausrüstung)

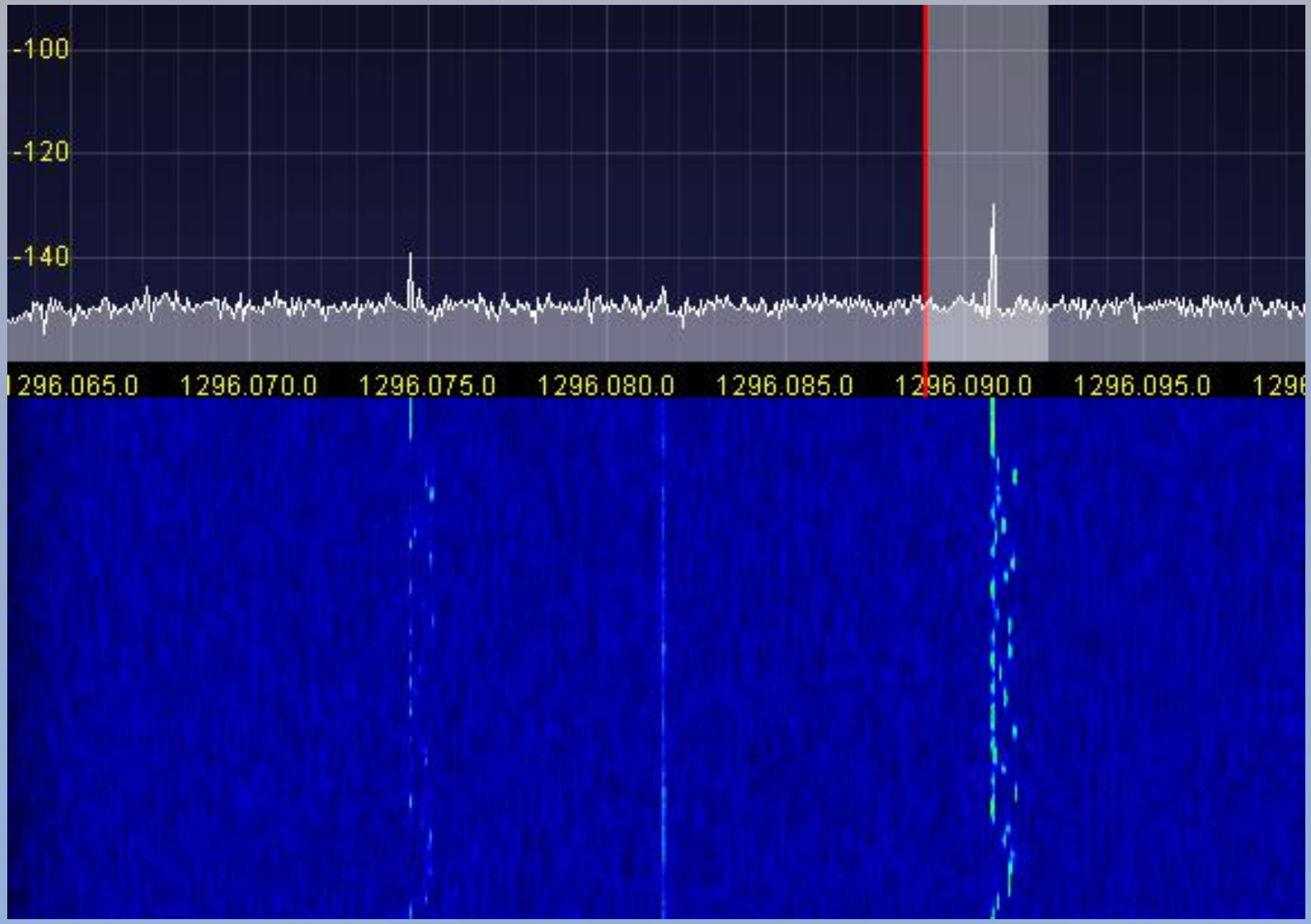
Über 9 cm sinkt wegen der Netzweite von 7 x 7 mm der Wirkungsgrad

Die Sendeleistung ist im Normalbetrieb auf 120 W limitiert

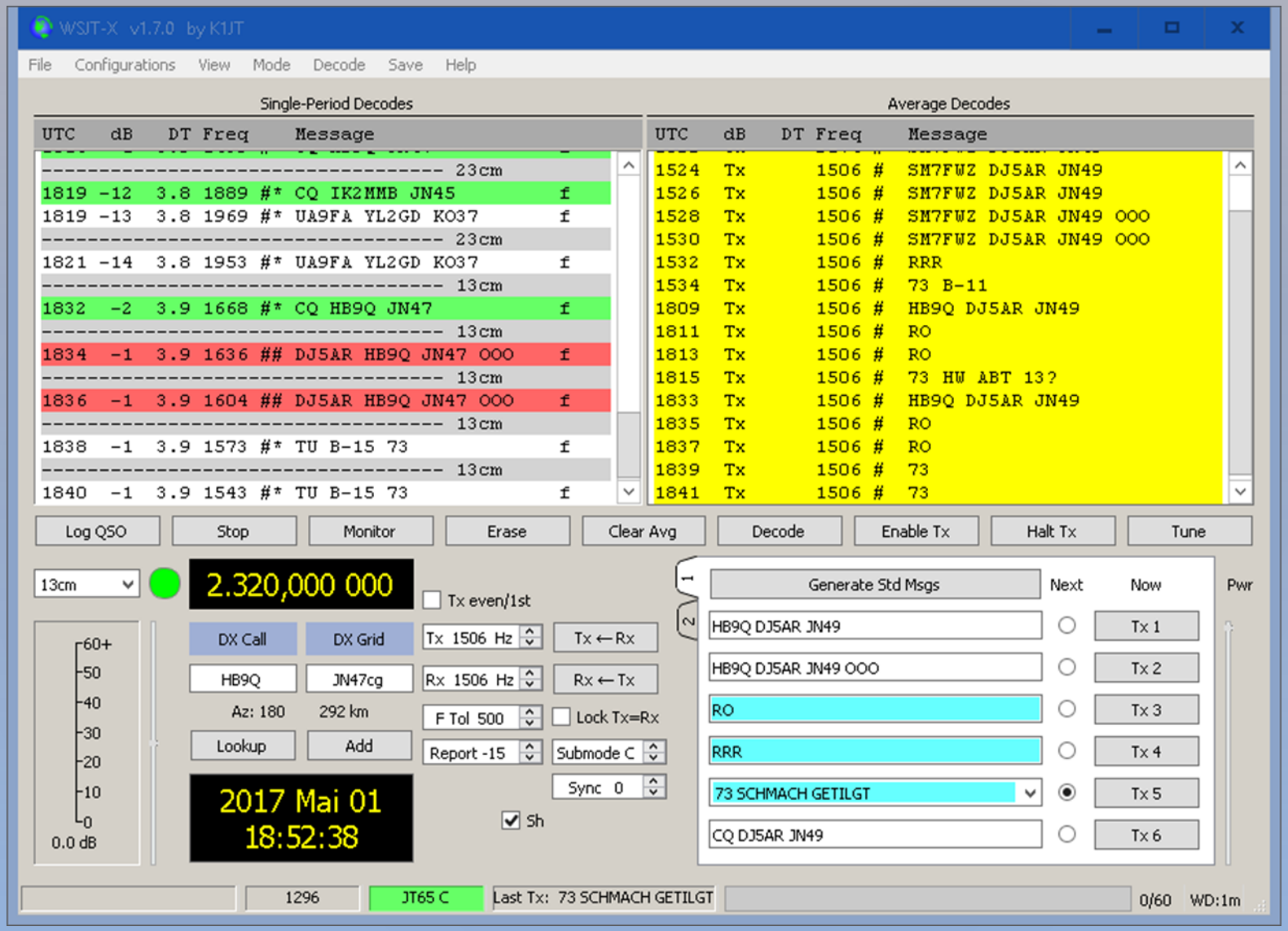
PI9CAM: Technische Daten des Antennensystems

DL7APV: 128 x 11 Element Yagi für 432 MHz

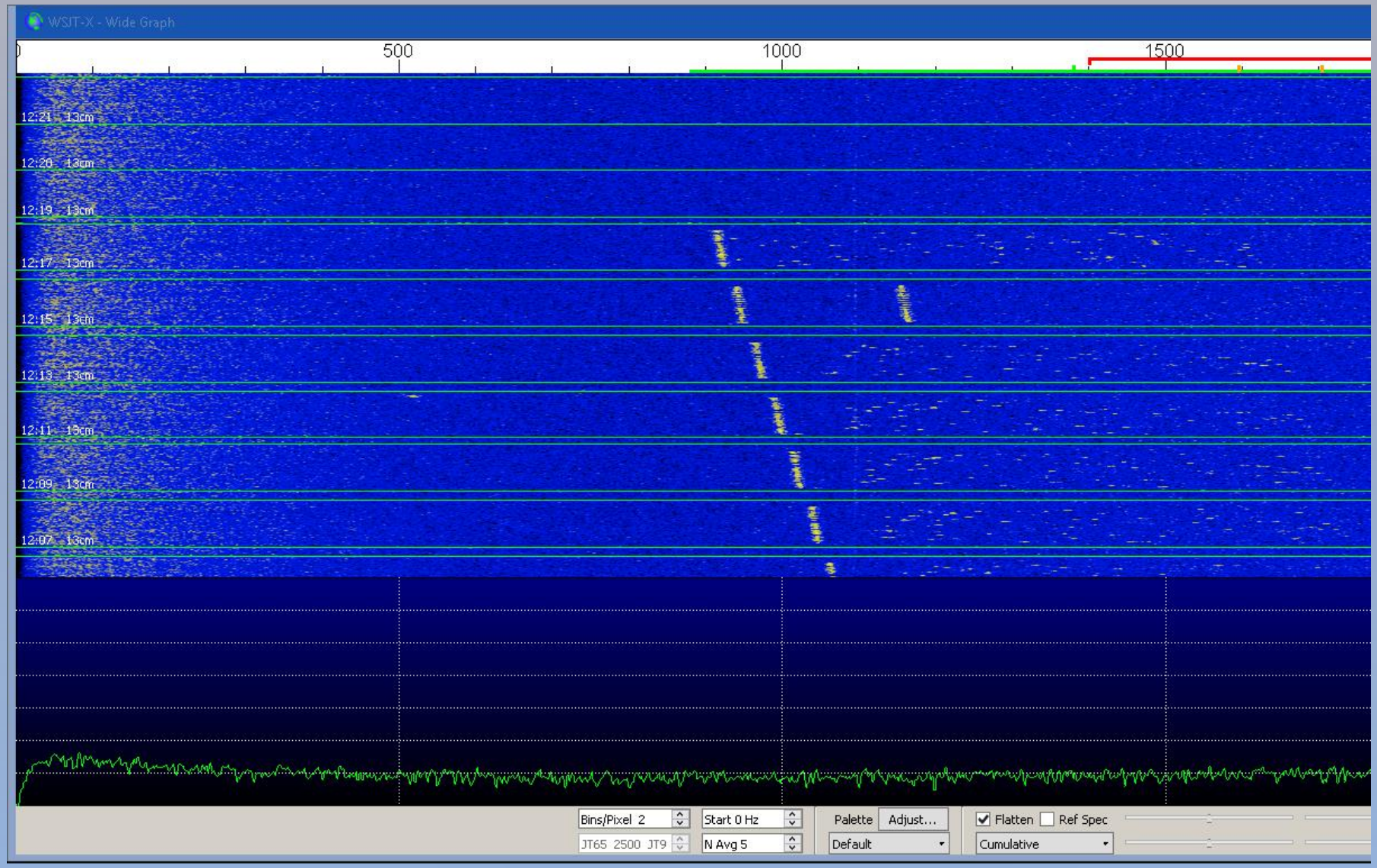
DJ5AR: 3 m Spiegel, Dualbad-Feed (linear) für 23 und 13 cm



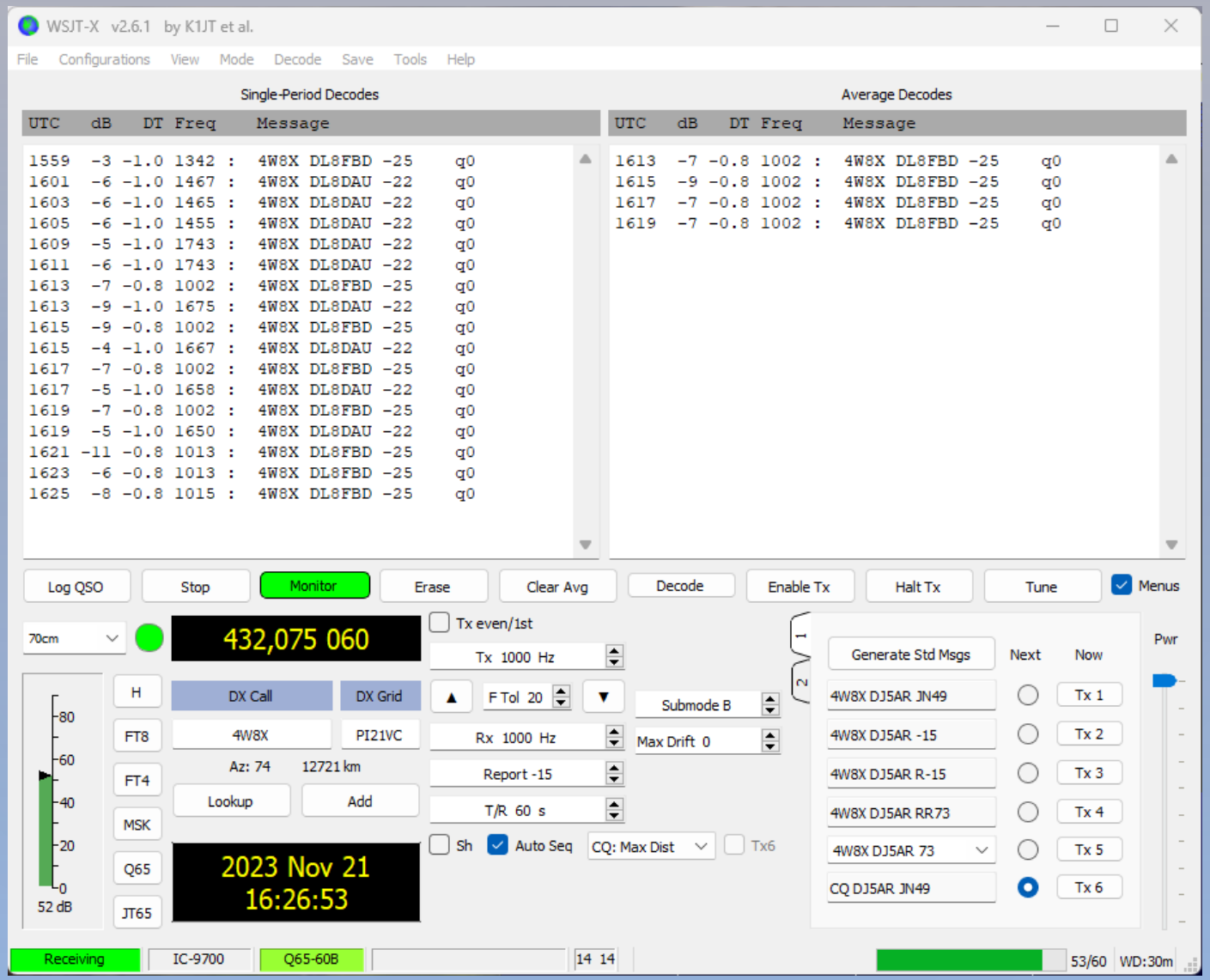
HB9Q in JT65c auf 23 cm im Wasserfall-Diagramm



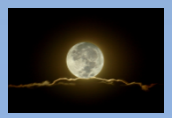
WSJT ermöglicht EME auch für „kleine“ Stationen

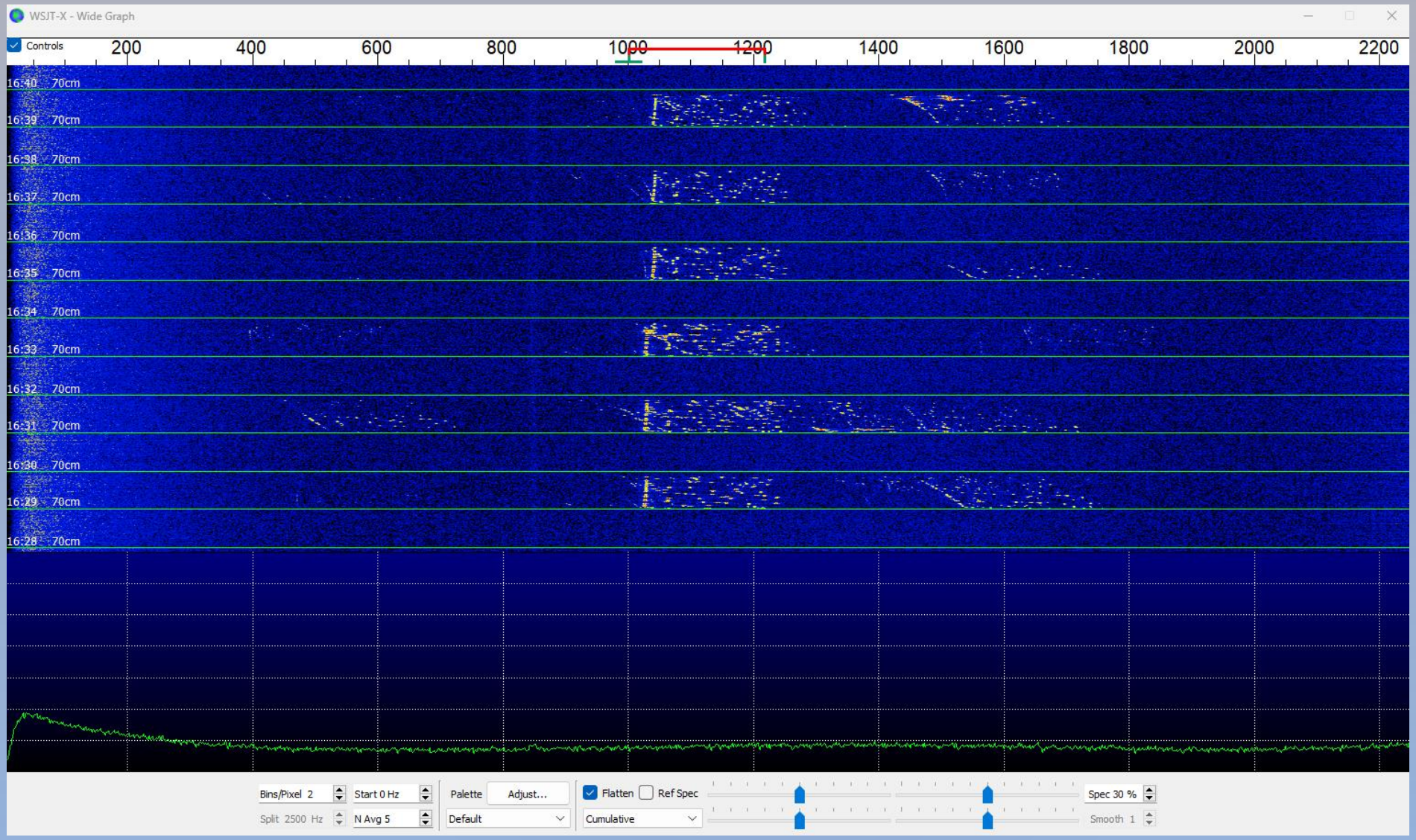


JT65 im WSJT Wide Graph

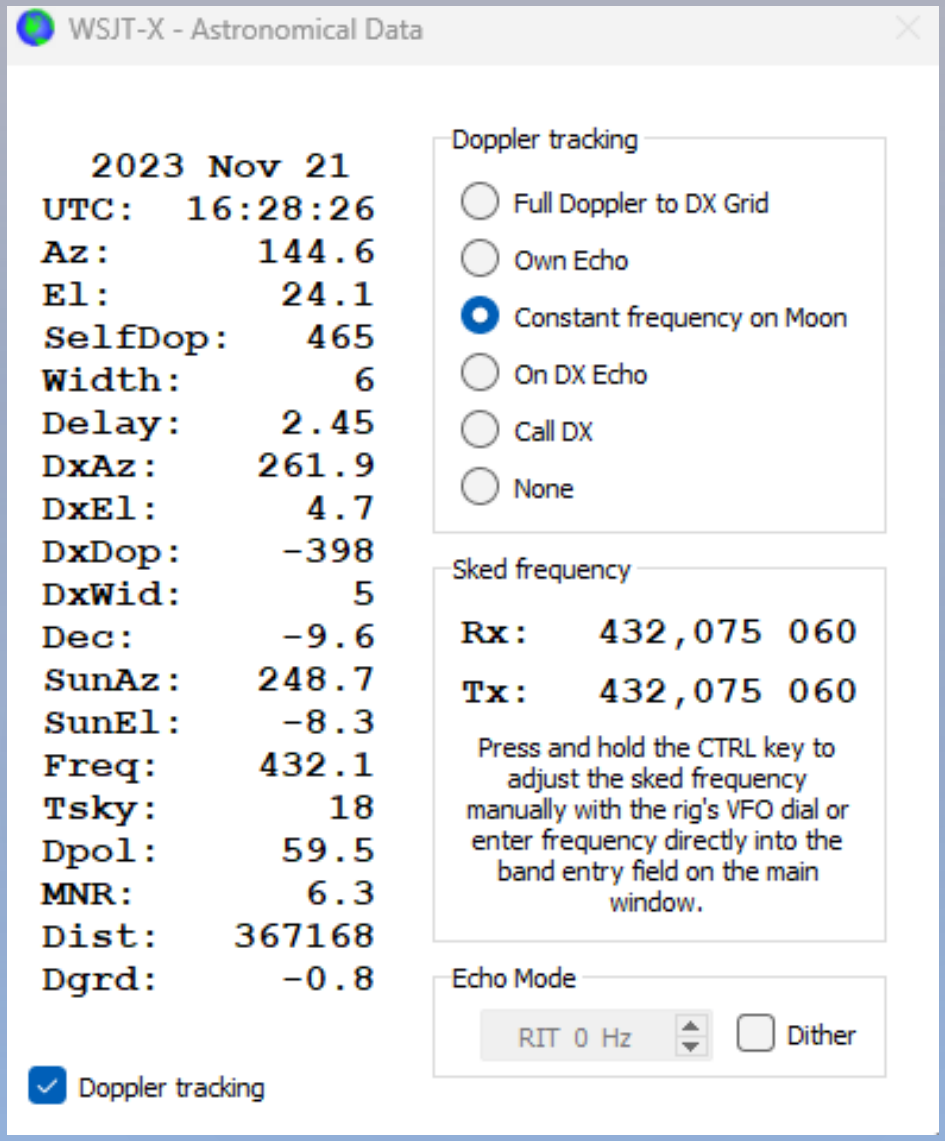


Heute wird meist Q65 verwendet





Q65 im WSJT Wide Graph



WSJT-X ermöglicht automatische Doppler-Nachführung

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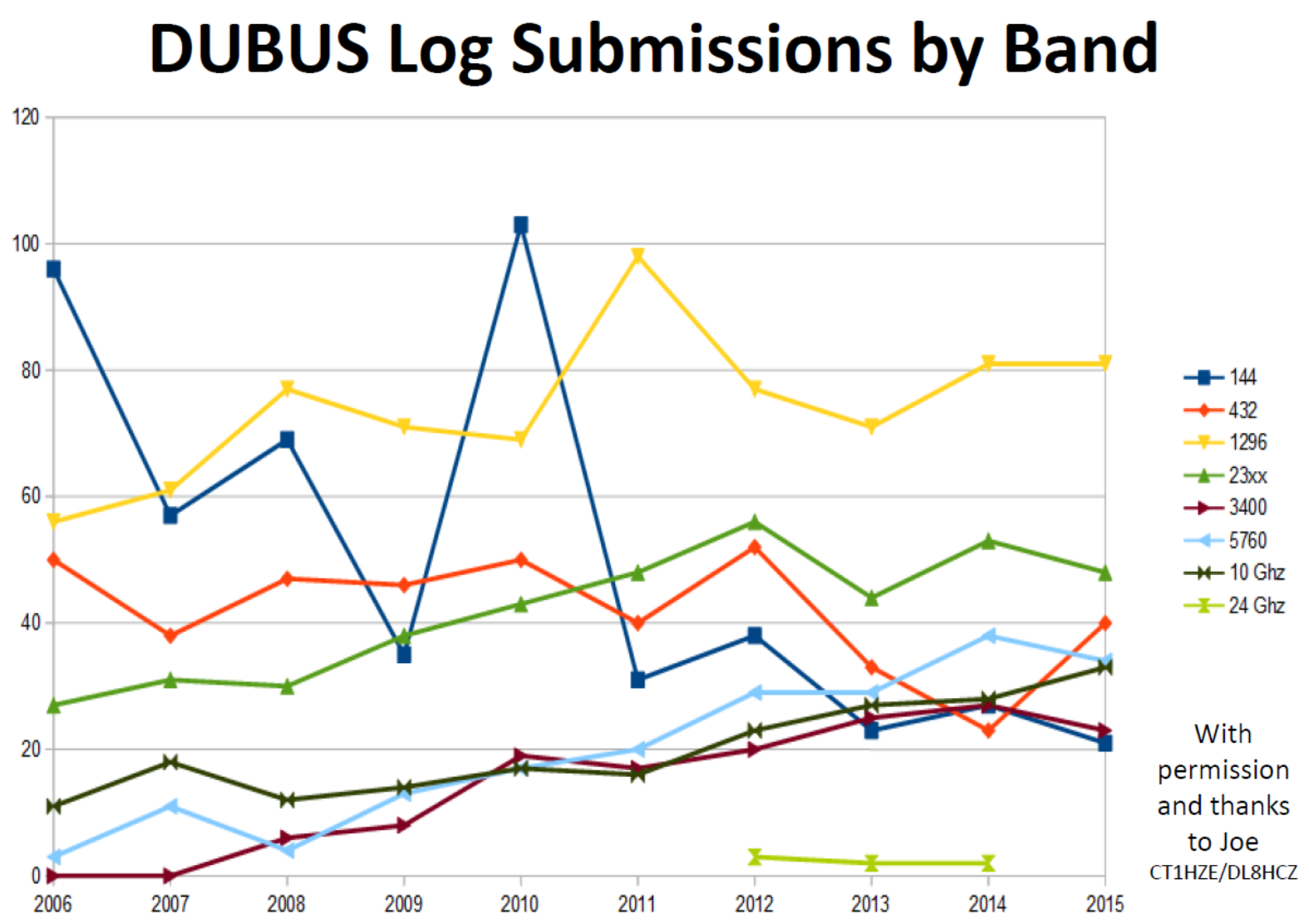
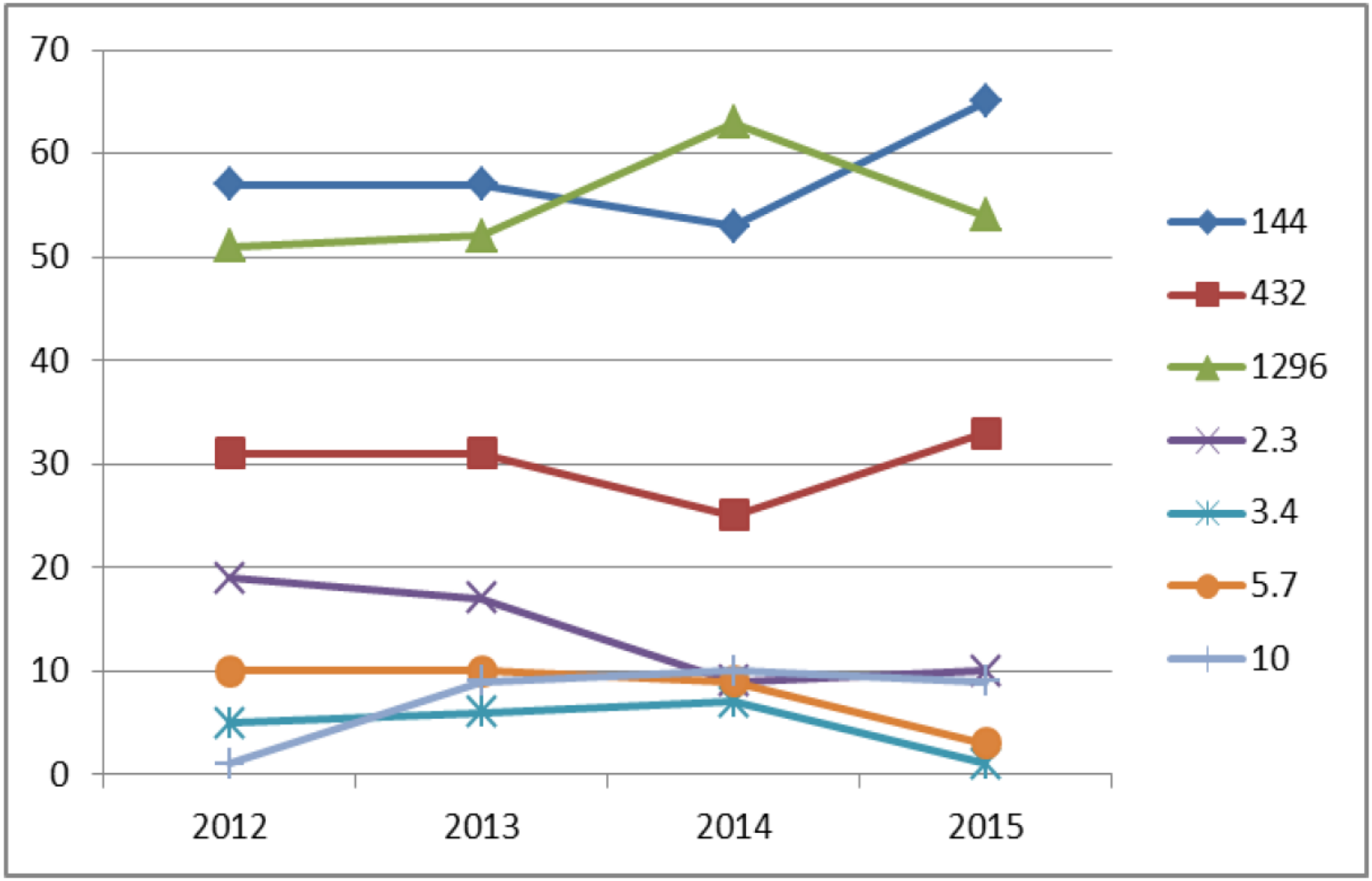
Wie geht es los?



Qual der Wahl: Auf welchem Band QRV werden? Graph by K1DS

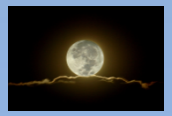
ARRL EME Log Submissions by Band



Qual der Wahl: Auf welchem Band QRV werden? Graph by K1DS

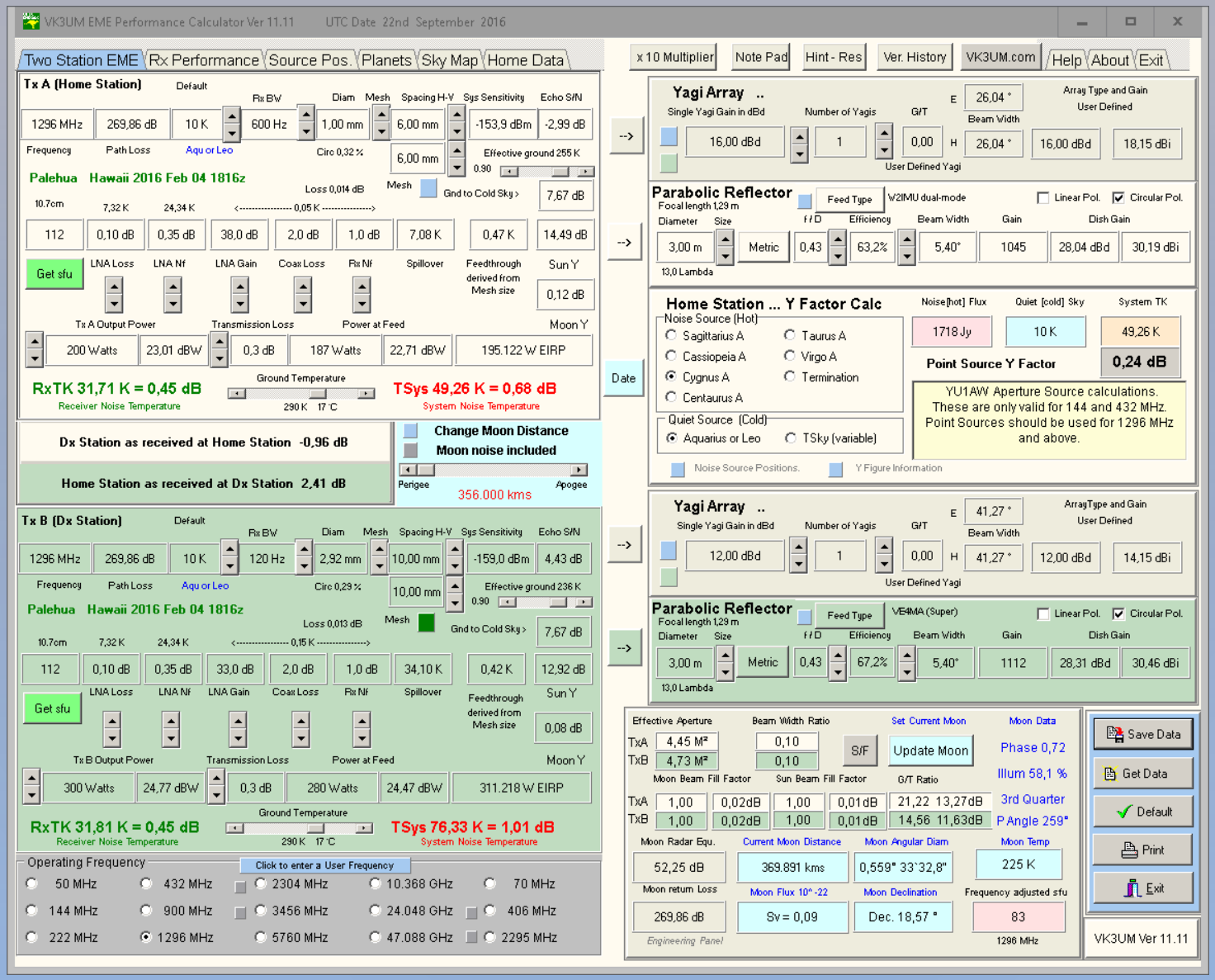
Parabolspiegel oder Yagi (-Gruppe)

Qual der Wahl: Welche Antenne?



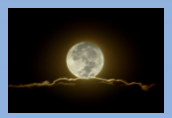
Empfindlichkeit und Sendeleistung

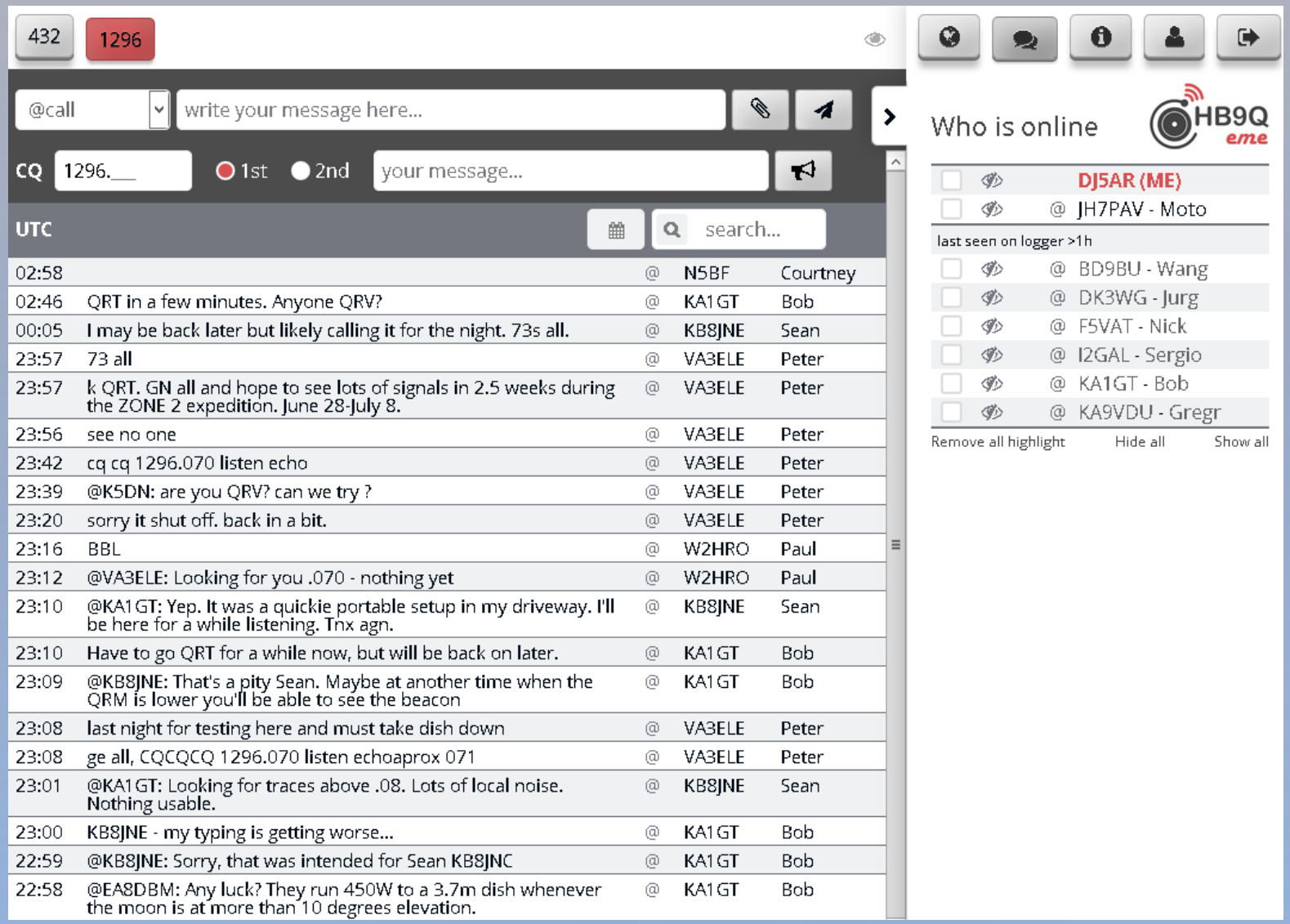
Qual der Wahl: Welche HF-Ausrüstung?



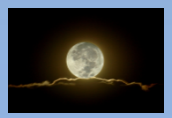
Doug McArthur (sk): VK3UM EME Performance Calculator

Andreas Imse, DJ5AR: Moon Bounce





Partner finden: HB9Q Logger



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Amateurfunk und Kunst?

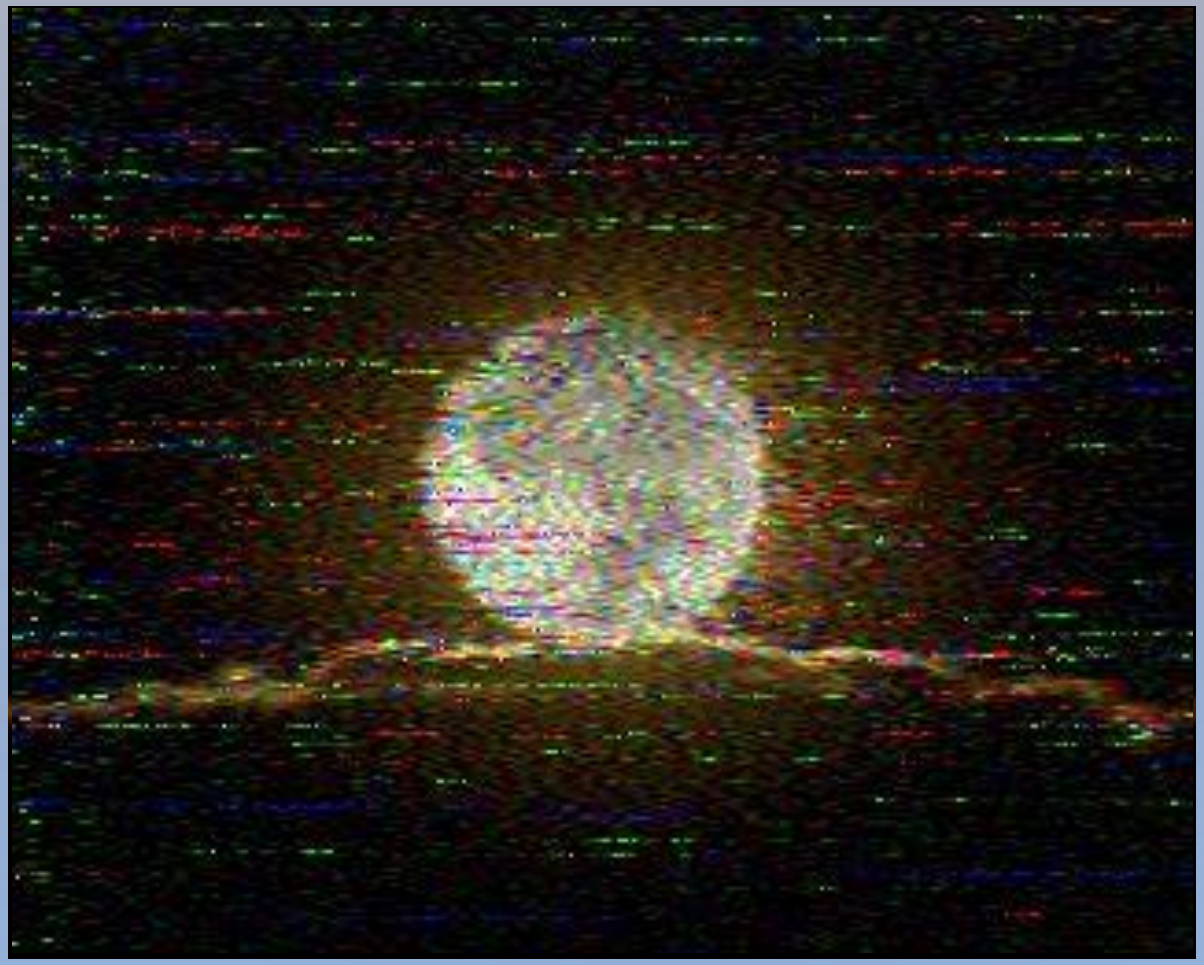
Amateurfunk und Kunst

Amateur Radio and Arts

Amateurfunk und Kunst

Jan van Muijlwijk, PA3FXB: Vader Jakob

Amateurfunk und Kunst

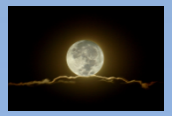


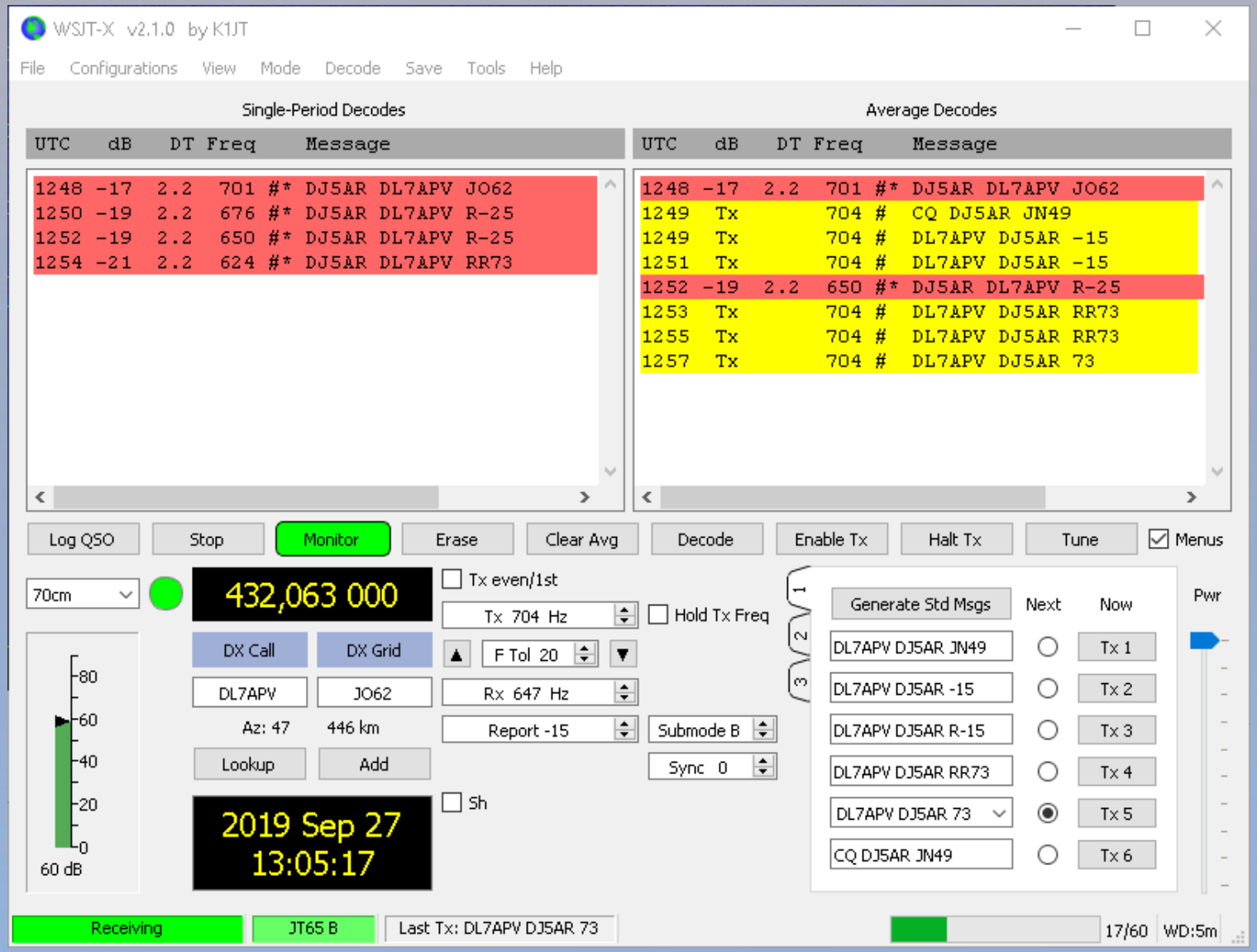
Daniela de Paulis: Visual Moonbounce

DJ5AR/p:

Transceiver Yaesu FT-897
15-Element Yagi nach YU7EF
PA Gemini 70, ca. 200 W
Vorverstärker SHF-Elektronik, 0,8 dB NF
Software WSJT-X, V 2.1.0
Sendeart JT65B

Praktischer Versuch





Praktischer Versuch

DL7APV: 128 x 11 Element Yagi, 750 W