

K2 comparison

1. Idea

The extended source size correction factor can be calculated using the vendor-provided polynomial factor formula, using the approximation formula for uniform illumination, or using the direct integration of the radiation pattern.

1.1 Polynomial factors

Polynomial factors are taken from Viasat K2 polynomial approximation formula for X-band antennas.

The polynomial formula is following:

$$K_2 = a_0 \theta_d f_{GHz}^2 + a_1 f_{GHz} + a_2 f_{GHz}^2 + a_3 f_{GHz} + a_4 \theta_d f_{GHz} + a_5 \theta_d^2 f_{GHz} + a_6 + a_7 \theta_d + a_8 \theta_d^2 + a_9 \theta_d^3$$

Coefficients	5.4m	7.3m	9.1m	10.26m	11.28m
a ₀	0.22124	-3.22454	0.4137	0.5541	0.7434
a ₁	-0.00975	0.13412	-1.2490	-2.9581	-0.3145
a ₂	0.16554	-2.12968	31.6666	75.1404	7.6079
a ₃	-0.57331	8.21186	-269.3682	-637.2681	-60.4003
a ₄	-4.52011	50.88899	1.0325	-0.6066	-12.6905
a ₅	1.64387	4.04585	-5.8184	-7.3650	0.9865
a ₆	-0.21724	3.08215	776.2878	1808.7976	153.4486
a ₇	23.47034	-201.17202	-80.5964	-65.4370	66.2610
a ₈	-15.20528	-30.70381	142.7291	156.7675	12.4544
a ₉	4.70339	4.38388	-50.1728	-60.9194	-17.1503

Table 1: Typical parabolic antenna K2 coefficients

1.2 Uniform-illumination approximation

The estimate of extended source size correction factor can be obtained also using the uniform-illumination formulas. In following, two different approximation formulas will be taken into the consideration (i.e. Gaussian far-field antenna pattern).

$$K = \frac{(s\sqrt{\ln 2})^2}{1 - \exp[-(s\sqrt{\ln 2})^2]} \quad (1)$$

$$K = \frac{(1.616s)^2}{4[1 - J_1^2(1.616s) - J_0^2(1.616s)]} \quad (2)$$

1.3 Radiation pattern integration

To integrate radiation pattern, firstly it is important to normalize the pattern in a way that the maximum radiation value is unity (1).

The radiation pattern is presented in the UV grid for easier integration and not neglecting the maximum radiation peak.

Integration has been performed in MATLAB.

For each pattern, the UV grid boundaries were set to $[-\sin(1^\circ) \sin(1^\circ)]$ inside the 401x401 matrix. Also, in all antennas, the blockage was included and the edge taper was set to -10dB.

1 Results

Test 1:

- Frequency: 8.25 GHz
- Edge taper: -10 dB
- Blockage: ON
- Antenna design: Cassegrain (reflector $f/D = 0.3$)

	K2: Polynomial				
	0.45°	0.49°	0.5°	0.53°	0.56°
D=5.4m	1.498 0	1.610 5	1.6411	1.739 8	1.848 9
D=7.3m	1.766 5	1.9511	2.001 7	2.167 4	2.345 2
D=9.1m	2.821 0	3.295 1	3.424 9	3.836 4	4.274 8
D=10.26 m	3.722 3	4.407 1	4.582 5	5.1127	5.641 3
D=11.28m	4.442 3	5.248 2	5.447 6	6.039 3	6.619 0

	K2: Approximation 1 (k = 70)				
	0.45°	0.49°	0.5°	0.53°	0.56°
D=5.4m	1.34941 0	1.42145 7	1.44079 0	1.50209 3	1.56853 3
D=7.3m	1.68697 3	1.83720 5	1.87783 7	2.00743 1	2.14896 2
D=9.1m	2.15368 8	2.41722 6	2.48867 4	2.71671 4	2.96560 1
D=10.26 m	2.54272 9	2.90108 4	2.99807 1	3.306911	3.64250 1

D=11.28m	2.94665 4	3.40163 6	3.52436 7	3.91389 6	4.33488 2
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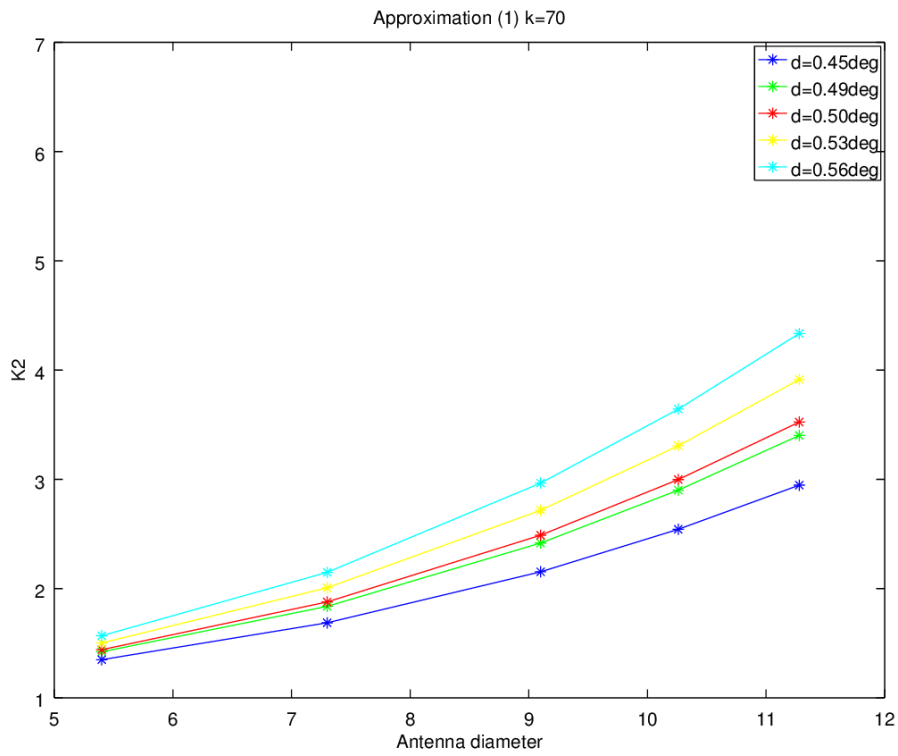
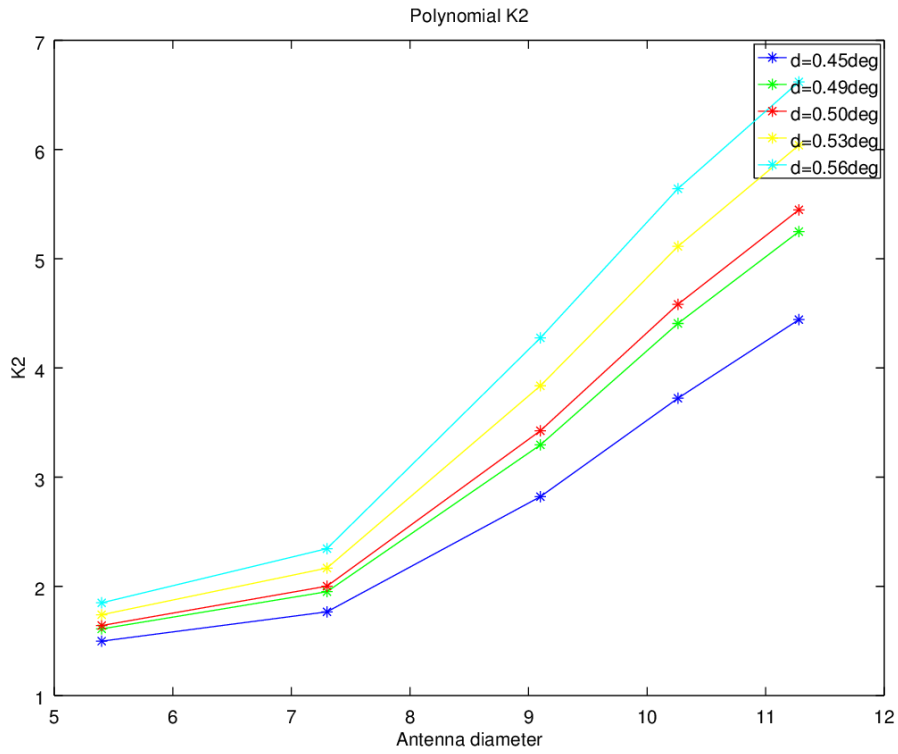
	K2: Approximation 1 (k = 66.33)				
	0.45°	0.49°	0.5°	0.53°	0.56°
D=5.4m	1.39327 5	1.47514 0	1.49714 0	1.56697 9	1.64279 5
D=7.3m	1.77820 7	1.95032 1	1.99692 1	2.14564 1	2.30815 6
D=9.1m	2.31358 3	2.61621 0	2.69821 9	2.95976 7	3.24476 8
D=10.26 m	2.76024 7	3.17094 1	3.28190 8	3.63465 3	4.01683 7
D=11.28m	3.22309 0	3.74264 8	3.88243 5	4.32506 4	4.80175 3

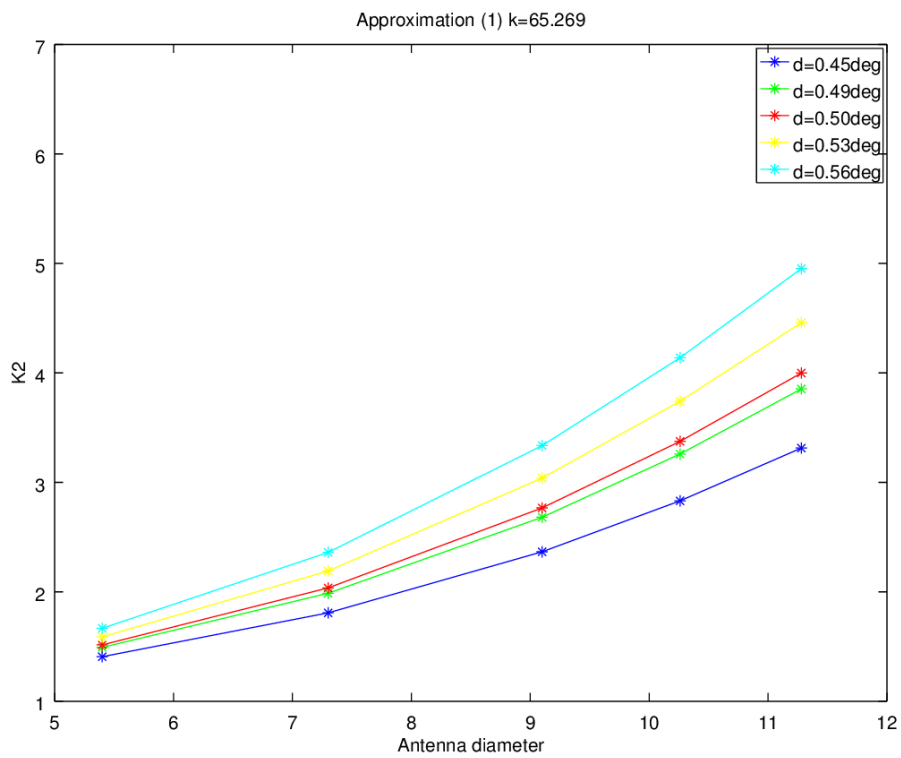
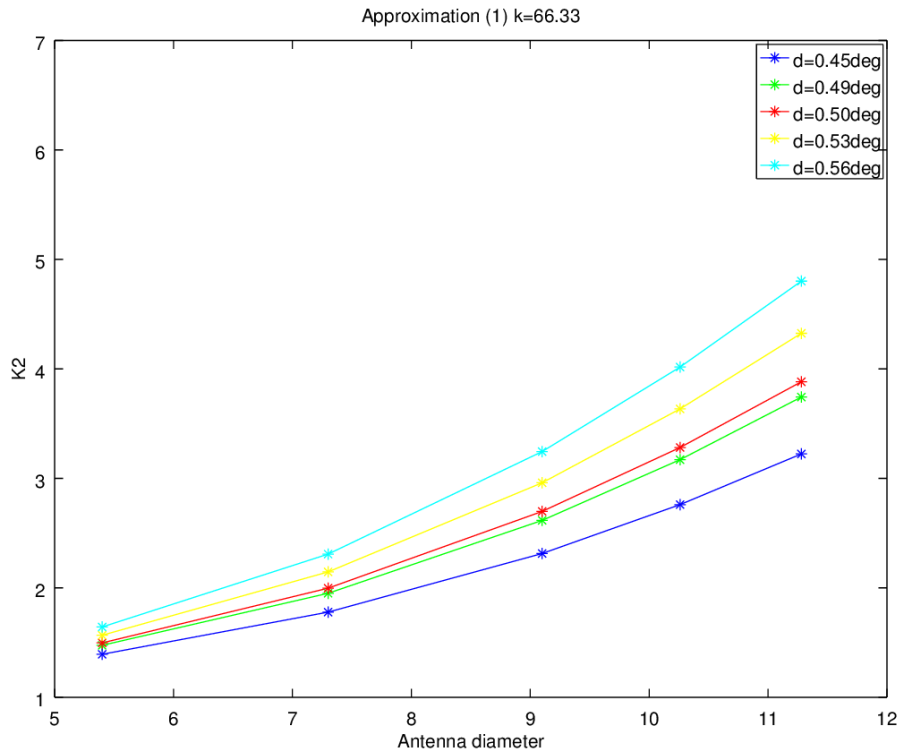
	K2: Approximation 1 (k = 65.269)				
	0.45°	0.49°	0.5°	0.53°	0.56°
D=5.4m	1.40753 4	1.49261 7	1.51549 2	1.58813 4	1.66703 0
D=7.3m	1.80802 2	1.98733 1	2.03589 1	2.19089 1	2.36028 5
D=9.1m	2.36594 2	2.68134 2	2.76679 3	3.03923 1	3.33592 0
D=10.26 m	2.83141 6	3.25908 5	3.37456 8	3.74145 0	4.13857 0
D=11.28m	3.31336 1	3.85370 6	3.99896 1	4.45856 3	4.95299 7

	K2: Approximation 2				
	0.45°	0.49°	0.5°	0.53°	0.56°
D=5.4m	1.33939 0	1.41201 2	1.43165 4	1.49437 3	1.56308 8
D=7.3m	1.68746 9	1.84862 0	1.89283 4	2.03556 7	2.19428 2
D=9.1m	2.19963 0	2.50238 1	2.58585 3	2.85556 3	3.15441 2
D=10.26 m	2.64935 5	3.07659 0	3.19365 4	3.56860 9	3.97671 9
D=11.28m	3.13153 4	3.68390 4	3.83322 7	4.30458 3	4.80478 6

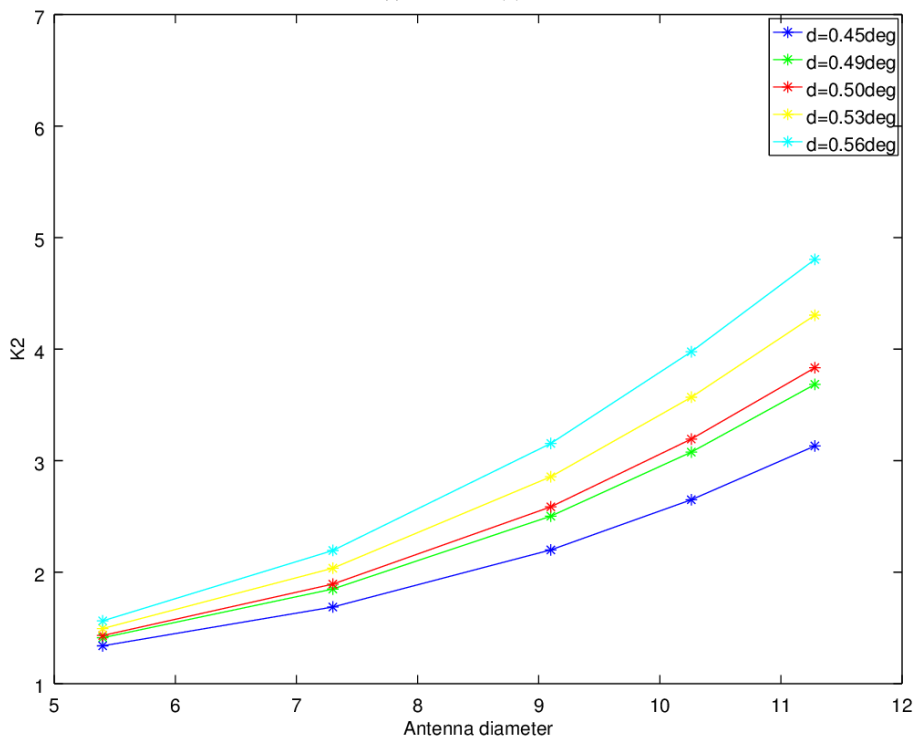
	K2: Integration				
	0.45°	0.49°	0.5°	0.53°	0.56°
D=5.4m	1.37366 3	1.45266 9	1.47498 2	1.54374 9	1.62025 4
D=7.3m	1.76373 0	1.94013 6	1.99059 3	2.14756 4	2.32432 6
D=9.1m	2.33970 1	2.67014 1	2.76484 4	3.05900 9	3.38793 5
D=10.26 m	2.828110	3.28591 3	3.41608 5	3.81669 0	4.257118
D=11.28m	3.35182 0	3.93727 7	4.10172 7	4.60190 1	5.14181 7

	HPBW			
	simulation	k = 70	$k = 58.96 \cdot (1 + 0.0125 \cdot Te)$	$k = 58.96 \cdot (1 + 0.0107 \cdot Te)$
D = 5.4m	0.451°	0.471 °	0.446°	0.439°
D = 7.3m	0.332°	0.348 °	0.331°	0.325°
D = 9.1m	0.266°	0.279 °	0.265°	0.261°
D = 10.26m	0.235°	0.248 °	0.235°	0.231°
D = 11.28m	0.215°	0.226 °	0.214°	0.210°

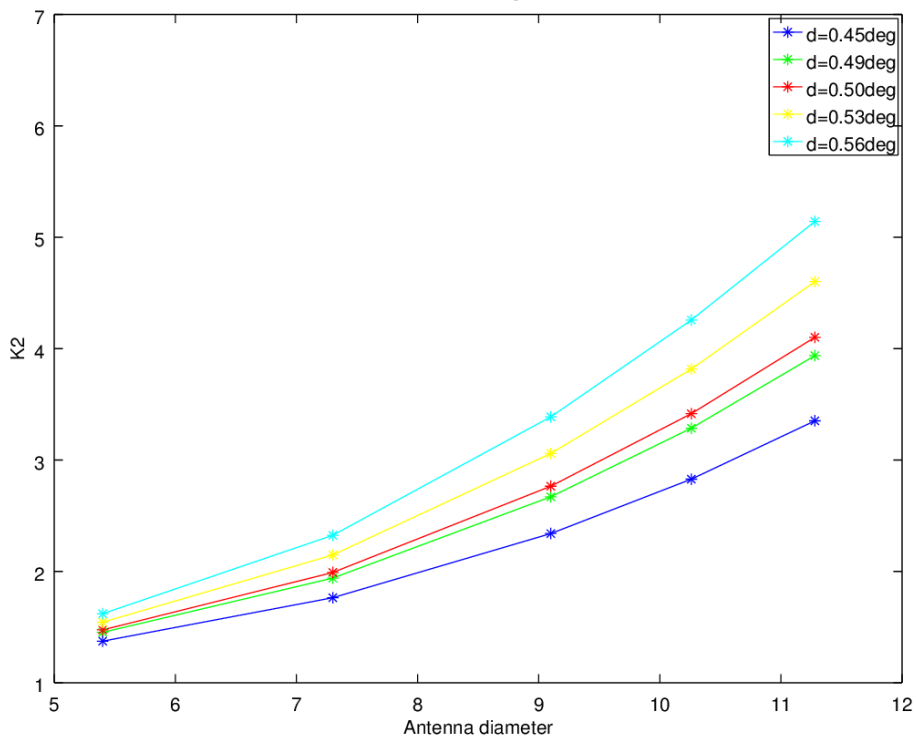




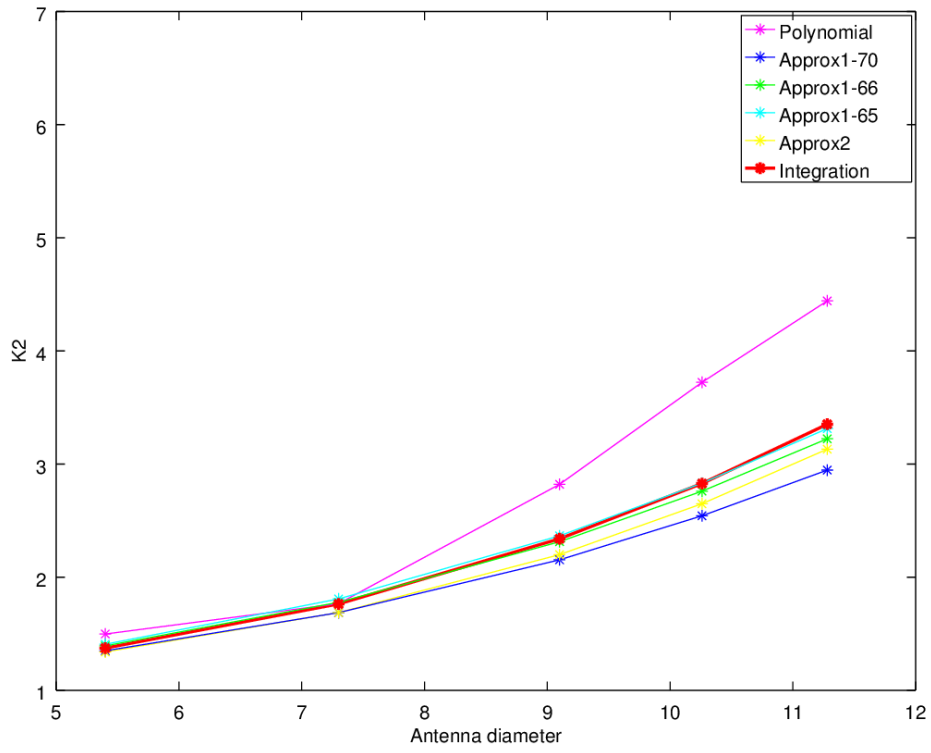
Approximation (2) Bessel



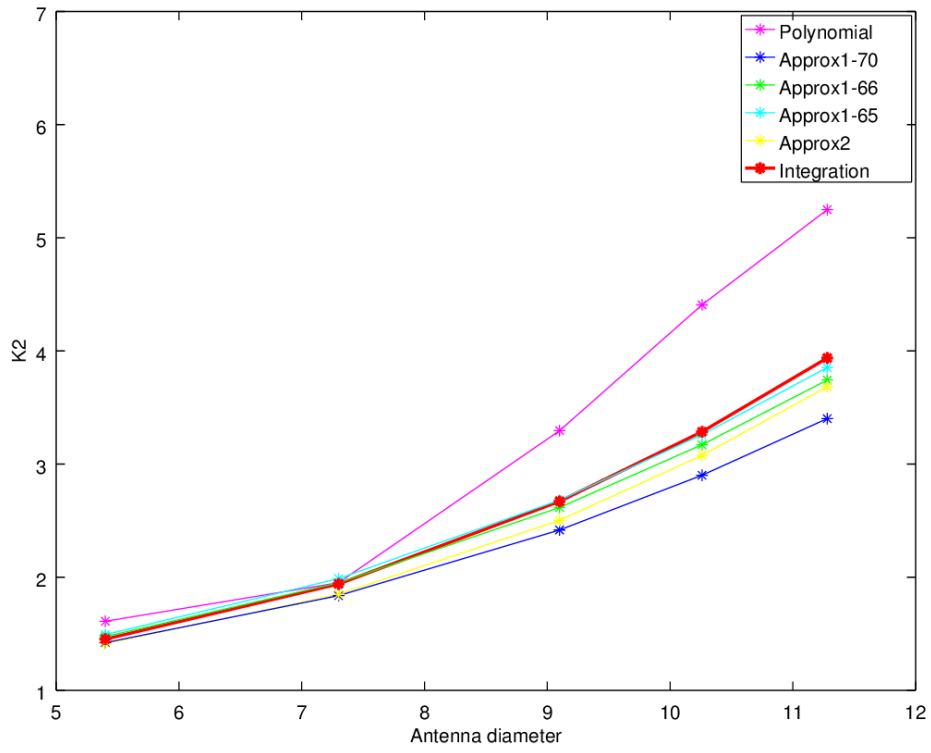
Product of Integration



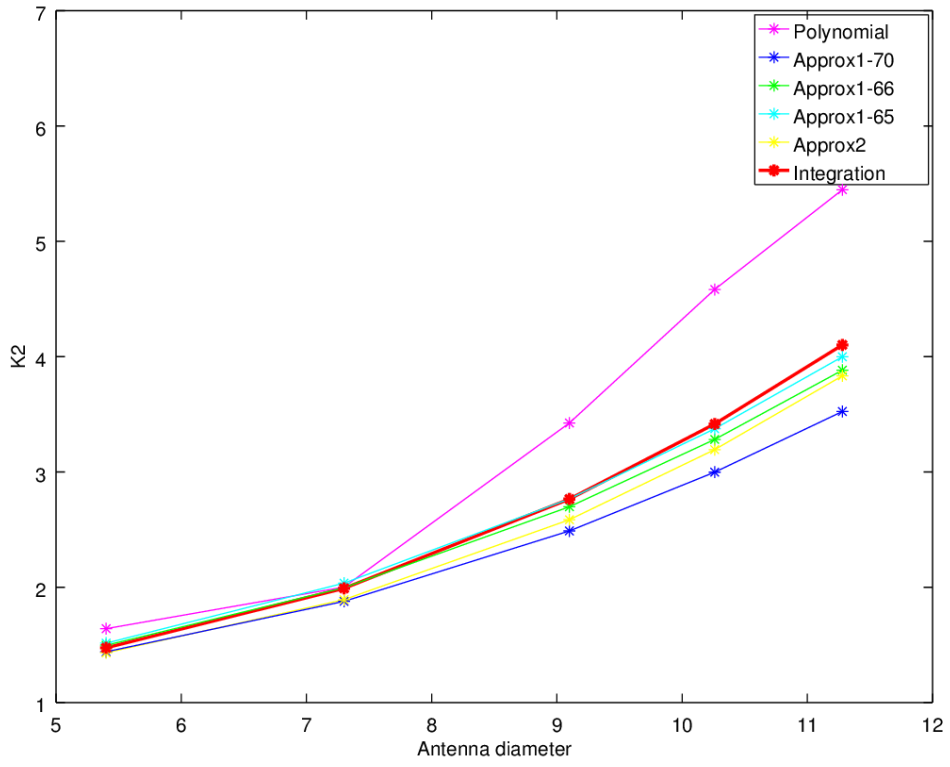
Moons angular diameter 0.45deg



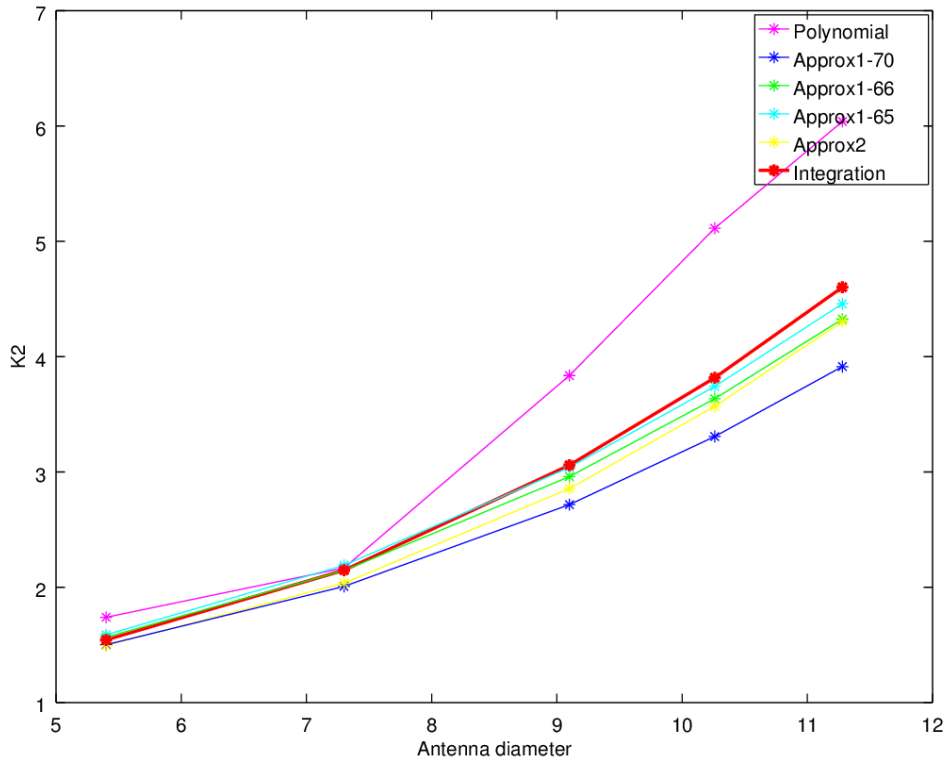
Moons angular diameter 0.49deg

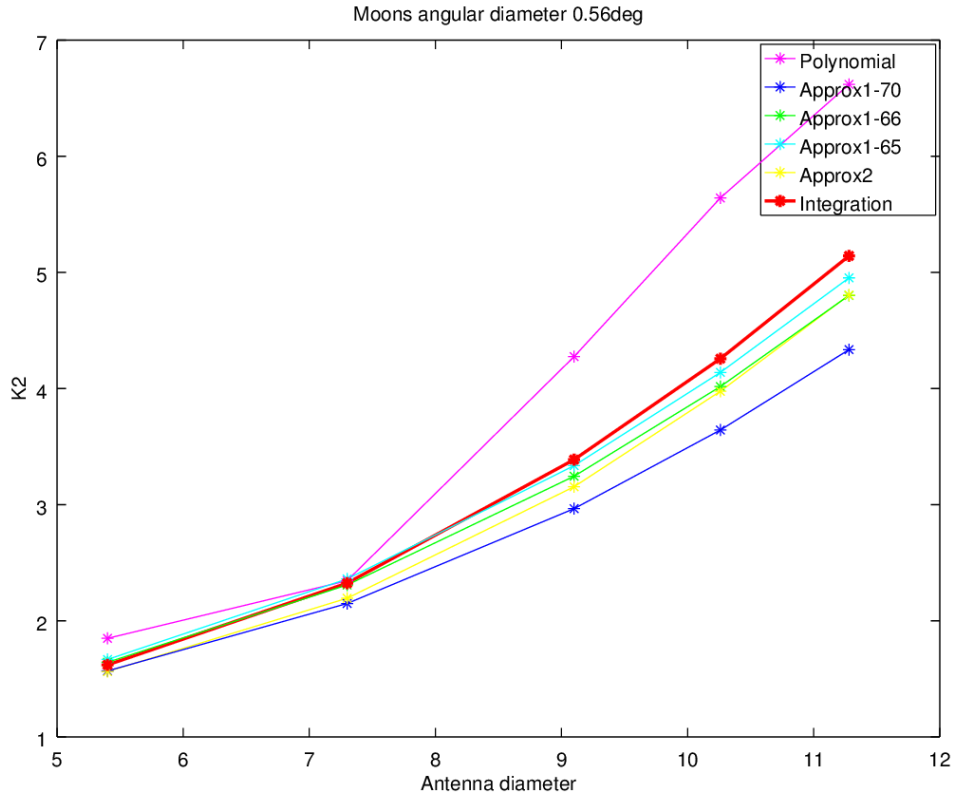


Moons angular diameter 0.50deg



Moons angular diameter 0.53deg

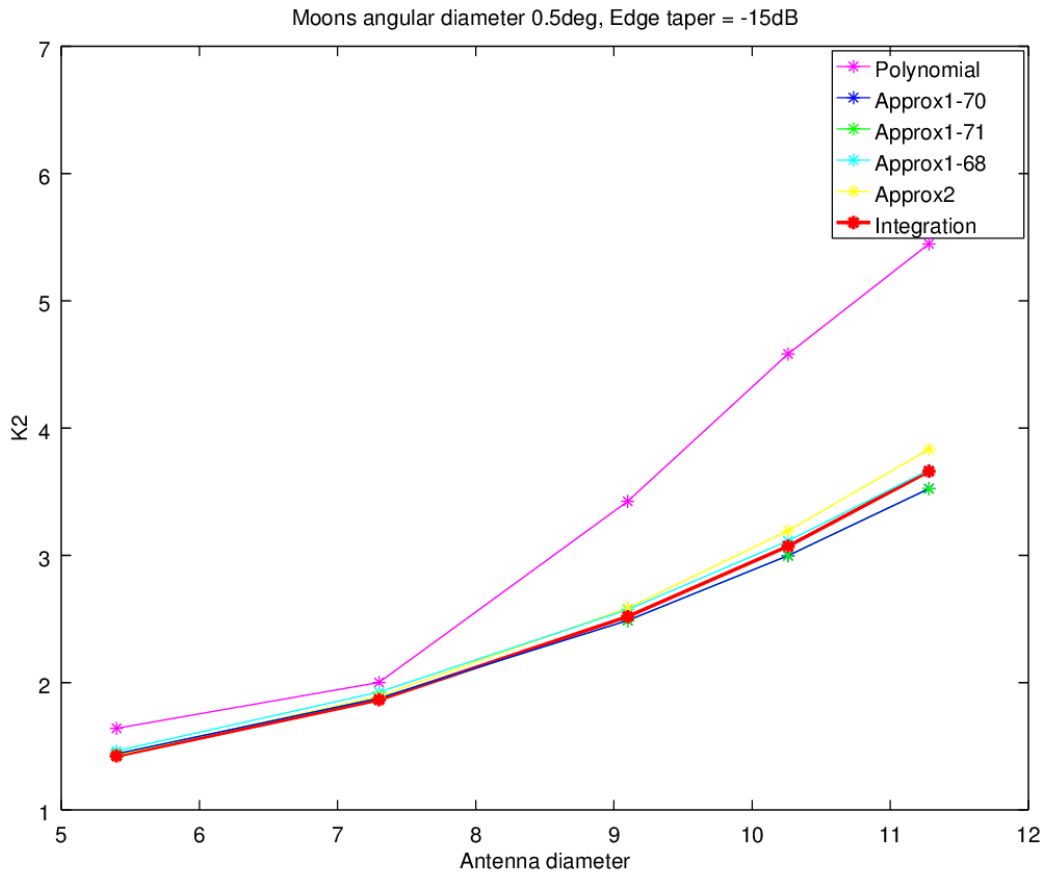




Test 2:

- Frequency: 8.25 GHz
- Edge taper: -15 dB
- Blockage: ON
- Antenna design: Cassegrain (reflector f/D = 0.3)

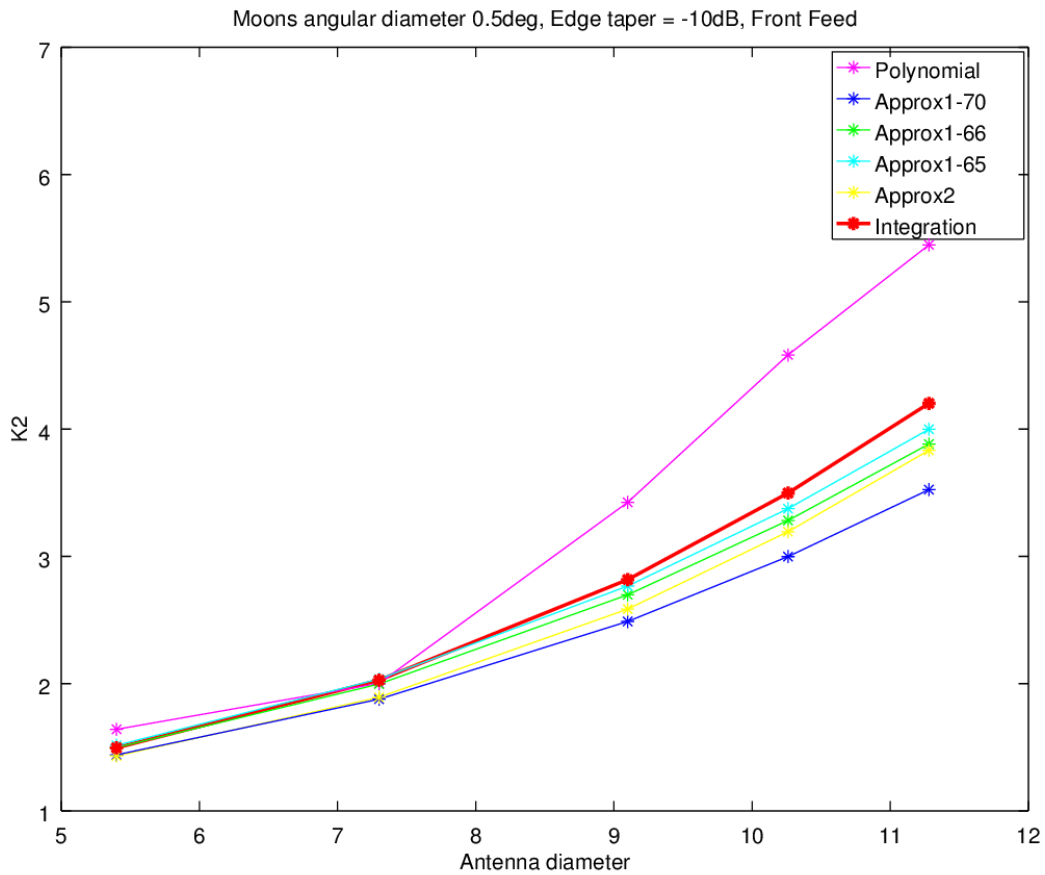
	K2: d=0.5°					
	Polynom.	Approx.1 k=70	Approx.1 k=58.96·(1+0.0125·Te)	Approx.1 k=58.96·(1+0.0107·Te)	Approx.2	Integration
D=5.4m	1.6411	1.440790	1.440580	1.463744	1.431654	1.423525
D=7.3m	2.0017	1.877837	1.877396	1.926235	1.892834	1.865033
D=9.1m	3.4249	2.488674	2.487897	2.573823	2.585853	2.519243
D=10.26m	4.5825	2.998071	2.997016	3.113526	3.193654	3.071917
D=11.28m	5.4476	3.524367	3.523033	3.670220	3.833227	3.660750



Test 3:

- Frequency: 8.25 GHz
- Edge taper: -10 dB
- Blockage: OFF
- Antenna design: Front Feed (reflector $f/D = 1.5$)

K2: $d=0.5^\circ$						
	Polynom.	Approx.1 $k=70$	Approx.1 $k=58.96 \cdot (1+0.0125 \cdot Te)$	Approx.1 $k=58.96 \cdot (1+0.0107 \cdot Te)$	Approx.2	Integration
D=5.4m	1.6411	1.440790	1.497140	1.515492	1.431654	1.495669
D=7.3m	2.0017	1.877837	1.996921	2.035891	1.892834	2.027442
D=9.1m	3.4249	2.488674	2.698219	2.766793	2.585853	2.817384
D=10.26m	4.5825	2.998071	3.281908	3.374568	3.193654	3.497375
D=11.28m	5.4476	3.524367	3.882435	3.998961	3.833227	4.202437



Test 4:

- Frequency: 8.25 GHz
- Edge taper: -15 dB
- Blockage: OFF
- Antenna design: Front Feed (reflector $f/D = 1.5$)

K2: $d=0.5^\circ$						
	Polynom.	Approx.1 $k=70$	Approx.1 $k=58.96 \cdot (1+0.0125 \cdot Te)$	Approx.1 $k=58.96 \cdot (1+0.0107 \cdot Te)$	Approx.2	Integration
D=5.4m	1.6411	1.440790	1.440580	1.463744	1.431654	1.432414
D=7.3m	2.0017	1.877837	1.877396	1.926235	1.892834	1.881754
D=9.1m	3.4249	2.488674	2.487897	2.573823	2.585853	2.537953
D=10.26m	4.5825	2.998071	2.997016	3.113526	3.193654	3.102206
D=11.28m	5.4476	3.524367	3.523033	3.670220	3.833227	3.693291

