RPW Consortium Meeting #19

Effect on the thermal bending on Direction finding capabilities

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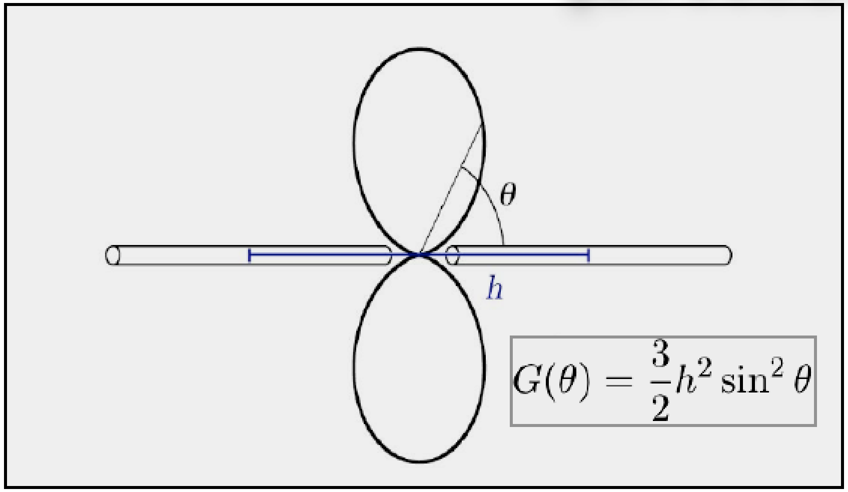
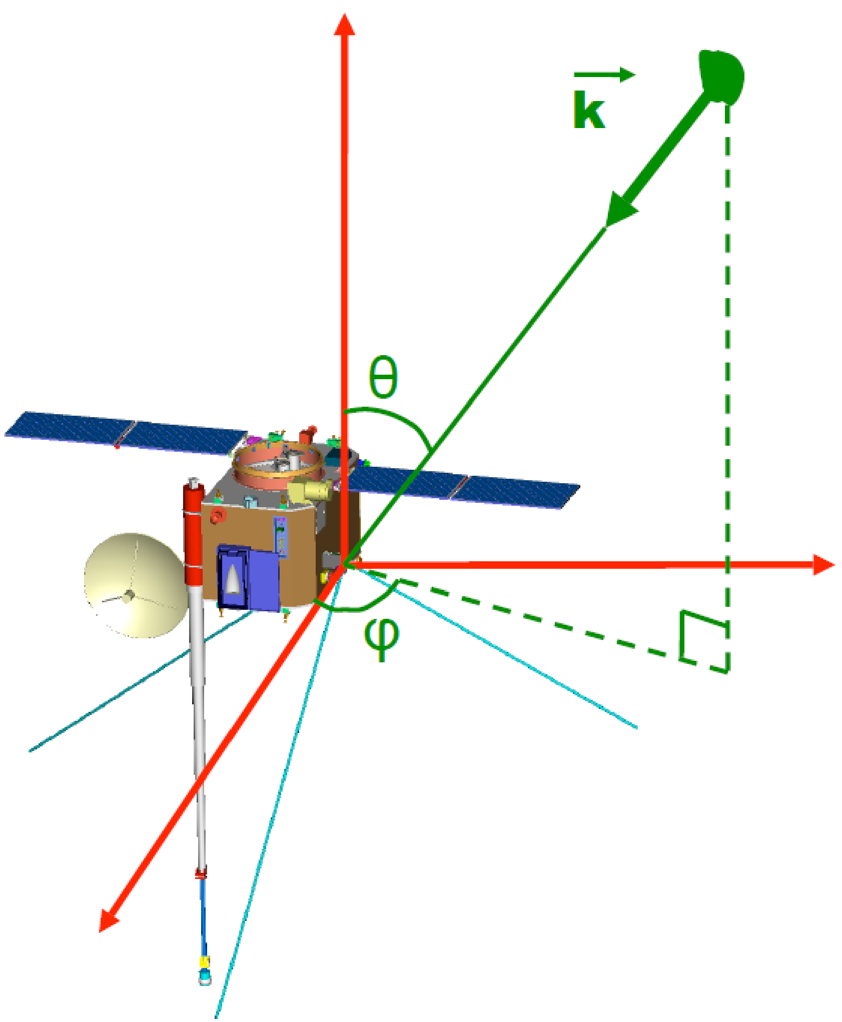
19-21 June 2017,
KTH, Stockholm

Basics of the Goniopolarimetry
(direction-finding)





$$V_h = \int_{\mathbf{h}} \mathbf{E}.\mathrm{d}\mathbf{h}$$

- Short antenna hypothesis ($h << \lambda$)

$$\boxed{V_h = \mathbf{h}.\mathbf{E}}$$

(i.e. : $E.h.\cos\theta$)

First Goniopolarimetry with STEREO/waves

Auto(Ch1)
Auto(Ch2)
Re(Cross)
Im(Cross)

$\rightarrow S, V, \theta, \varphi$

colatitude &
azimuth
in S/C frame

circular polar. degree

(cross phase is calibrated)

$[V^2/Hz]$ (*not* $[W/m^2/Hz]$)

Background level picked by hand
(will be automatic in routine data analysis)

Antenna parameters (effective length/directions)
from austrian team, computed through simulations
(Oswald et al.,submitted to ASR)

Methods Recall from consortium meeting #7

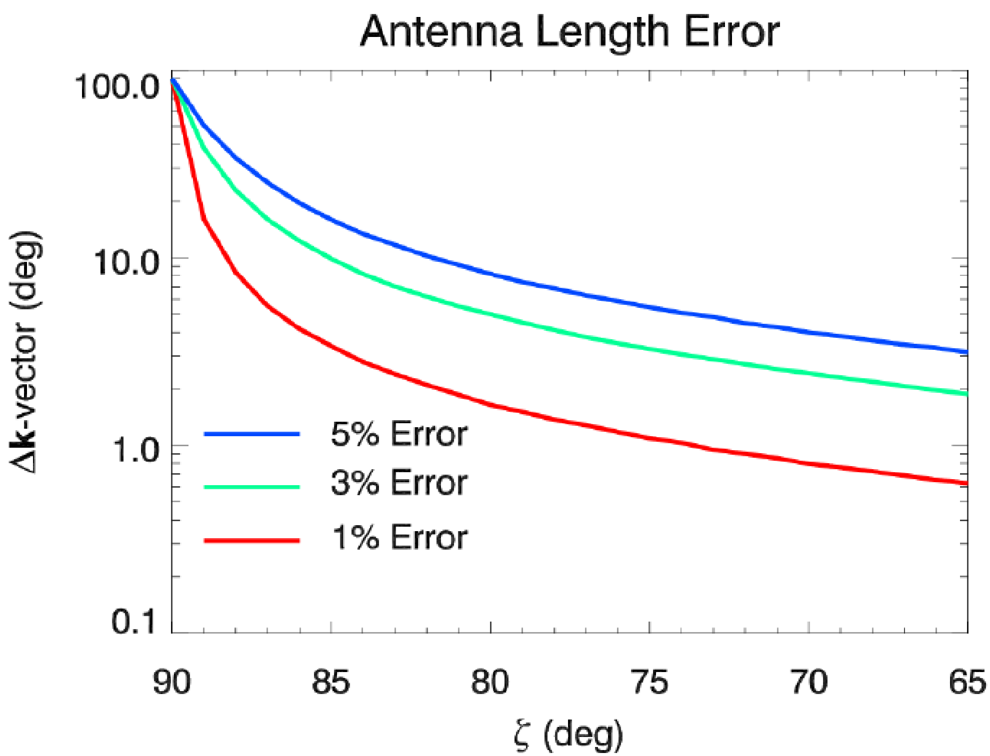
- **Modeled spectral matrix:**

$$
\begin{aligned}
P_{ij} \;=\; & \frac{Z_0\, G\, S h_i h_j}{2}\left[(1+Q)\left(A_i A_j \frac{\Gamma_2}{2} + C_i C_j\left(\Gamma_1 - \frac{\Gamma_2}{2}\right)\right)\right. \\
& +(U-iV)\left(A_i B_j \frac{\Gamma_2}{2}\right) + (U+iV)\left(A_j B_i \frac{\Gamma_2}{2}\right) \\
& +(1-Q)\left(A_i A_j \frac{1}{2}\left(\Gamma_1 - \Gamma_2 + \frac{\Gamma_3+\Gamma_1}{4}\right) + B_i B_j \frac{1}{2}\left(\Gamma_1 + \frac{\Gamma_3+\Gamma_1}{4}\right)\right. \\
& \left.\left. +C_i C_j\left(\frac{\Gamma_2}{2} - \frac{\Gamma_3+\Gamma_1}{4}\right)\right)\right]
\end{aligned}
$$

$$
\begin{aligned}
A_k &= -\sin\theta_k \cos\theta \cos(\phi-\phi_k) + \cos\theta_k \sin\theta \\
B_k &= -\sin\theta_k \sin(\phi-\phi_k) \\
C_k &= \sin\theta_k \sin\theta \cos(\phi-\phi_k) + \cos\theta_k \cos\theta
\end{aligned}
$$

- **10,000 simulations for different sources of errors**

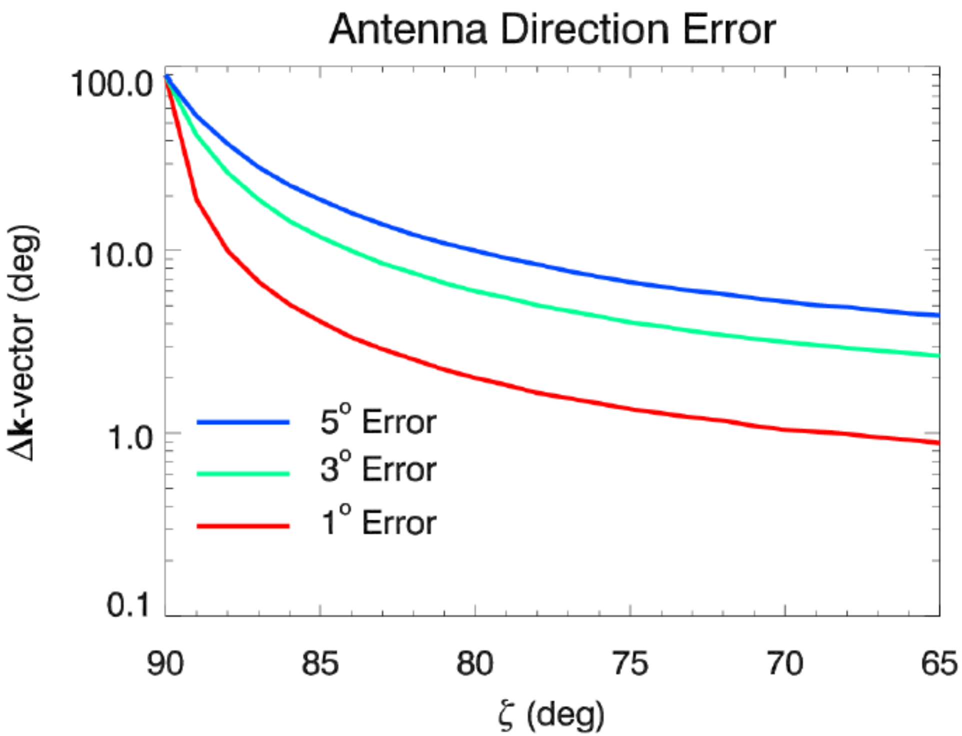
Results



1%	$\zeta = 85^{\circ}$:	$\Delta\mathbf{k} = 3.39^{\circ} \pm 1.76^{\circ}$
1%	$\zeta = 80^{\circ}$:	$\Delta\mathbf{k} = 1.64^{\circ} \pm 0.88^{\circ}$
1%	$\zeta = 75^{\circ}$:	$\Delta\mathbf{k} = 1.09^{\circ} \pm 0.57^{\circ}$
3%	$\zeta = 85^{\circ}$:	$\Delta\mathbf{k} = 9.87^{\circ} \pm 5.11^{\circ}$
3%	$\zeta = 80^{\circ}$:	$\Delta\mathbf{k} = 4.99^{\circ} \pm 2.63^{\circ}$
3%	$\zeta = 75^{\circ}$:	$\Delta\mathbf{k} = 3.27^{\circ} \pm 1.74^{\circ}$
5%	$\zeta = 85^{\circ}$:	$\Delta\mathbf{k} = 15.94^{\circ} \pm 7.91^{\circ}$
5%	$\zeta = 80^{\circ}$:	$\Delta\mathbf{k} = 8.20^{\circ} \pm 4.30^{\circ}$
5%	$\zeta = 75^{\circ}$:	$\Delta\mathbf{k} = 5.44^{\circ} \pm 2.88^{\circ}$

Simulated antenna lengths: Normal distributions of lengths centered on the nominal lengths h_j, with sigma(h_j)/ h_j =0.01,0.03,0.05

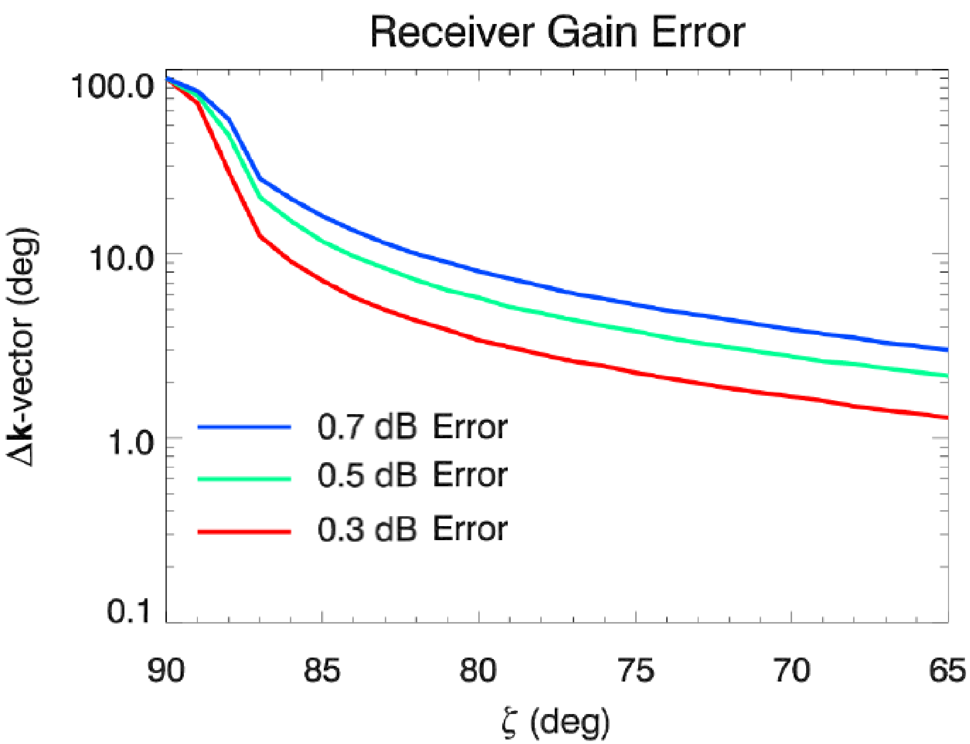
Results



1°	$\zeta = 85^\circ$:	$\Delta\mathbf{k} = 4.09^\circ \pm 2.36^\circ$
1°	$\zeta = 80^\circ$:	$\Delta\mathbf{k} = 2.01^\circ \pm 1.18^\circ$
1°	$\zeta = 75^\circ$:	$\Delta\mathbf{k} = 1.36^\circ \pm 0.79^\circ$
3°	$\zeta = 85^\circ$:	$\Delta\mathbf{k} = 11.87^\circ \pm 6.61^\circ$
3°	$\zeta = 80^\circ$:	$\Delta\mathbf{k} = 6.00^\circ \pm 3.46^\circ$
3°	$\zeta = 75^\circ$:	$\Delta\mathbf{k} = 4.05^\circ \pm 2.35^\circ$
5°	$\zeta = 85^\circ$:	$\Delta\mathbf{k} = 19.02^\circ \pm 9.91^\circ$
5°	$\zeta = 80^\circ$:	$\Delta\mathbf{k} = 9.99^\circ \pm 5.62^\circ$
5°	$\zeta = 75^\circ$:	$\Delta\mathbf{k} = 6.72^\circ \pm 3.87^\circ$

Simulated antenna directions: Normal distributions of absolute deviations centered on the nominal directions, with sigma=1°,3°,5°; Uniform distributions of azimuth

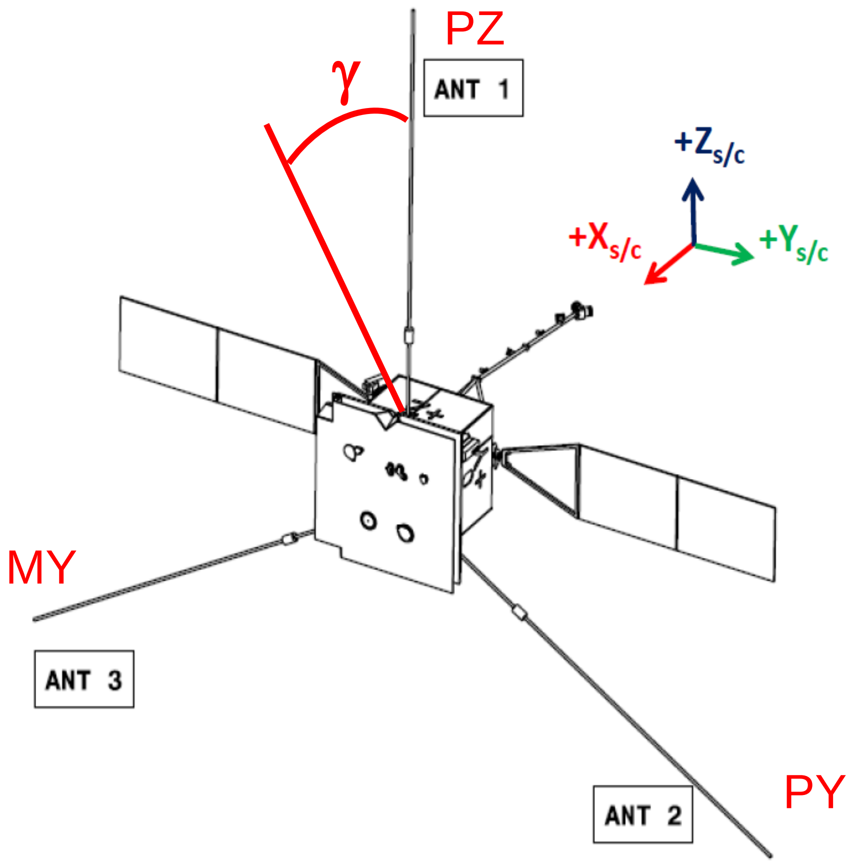
Results



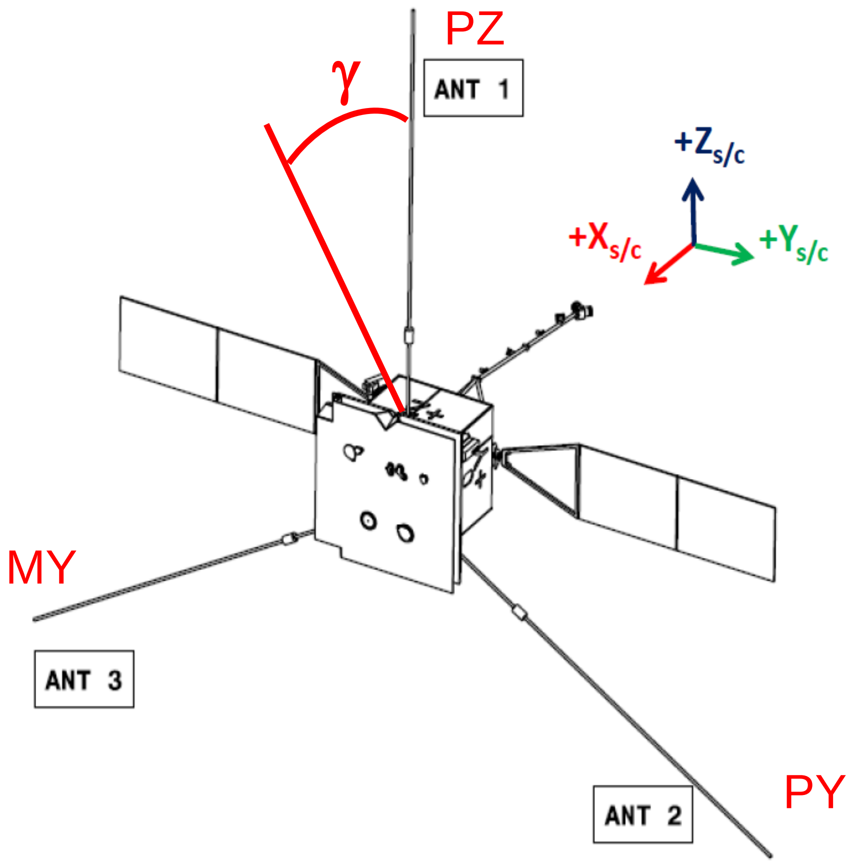
0.3 dB	$\zeta = 85^\circ$:	$\Delta\mathbf{k} = 7.18^\circ \pm 5.79^\circ$
0.3 dB	$\zeta = 80^\circ$:	$\Delta\mathbf{k} = 3.40^\circ \pm 2.61^\circ$
0.3 dB	$\zeta = 75^\circ$:	$\Delta\mathbf{k} = 2.27^\circ \pm 1.73^\circ$
0.5 dB	$\zeta = 85^\circ$:	$\Delta\mathbf{k} = 11.70^\circ \pm 9.64^\circ$
0.5 dB	$\zeta = 80^\circ$:	$\Delta\mathbf{k} = 5.80^\circ \pm 4.39^\circ$
0.5 dB	$\zeta = 75^\circ$:	$\Delta\mathbf{k} = 3.80^\circ \pm 2.87^\circ$
0.7 dB	$\zeta = 85^\circ$:	$\Delta\mathbf{k} = 16.04^\circ \pm 12.75^\circ$
0.7 dB	$\zeta = 80^\circ$:	$\Delta\mathbf{k} = 8.06^\circ \pm 6.11^\circ$
0.7 dB	$\zeta = 75^\circ$:	$\Delta\mathbf{k} = 5.30^\circ \pm 3.99^\circ$

Simulated uncertainty of receiver gain: Normal distributions of the uncertainties in dB centered at o dB

Monopole



	ANT1 Heff (m)	ANT1 γ (deg)	ANT2 Heff (m)	ANT2 γ (deg)	ANT3 Heff (m)	ANT3 γ (deg)
Plettemeier	3.797	90-81.34 = 8.66	3.385	90-79.81 = 10.19	3.277	90-79.87=10.13
Panchenko	~~4.38~~ 4.41	9.1	3.91	13.6	~~3.92~~ 3.91	13.6
ratio	1.16		1.15		1.19	

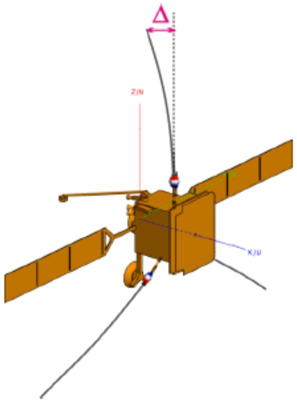


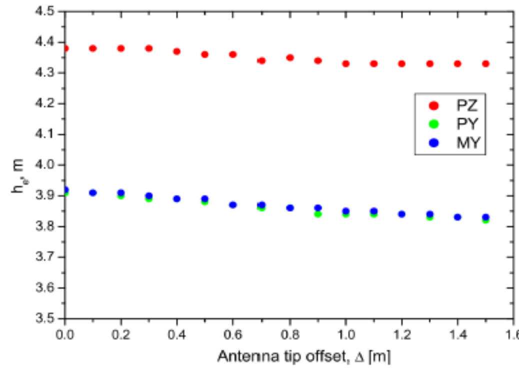
DIPOLE

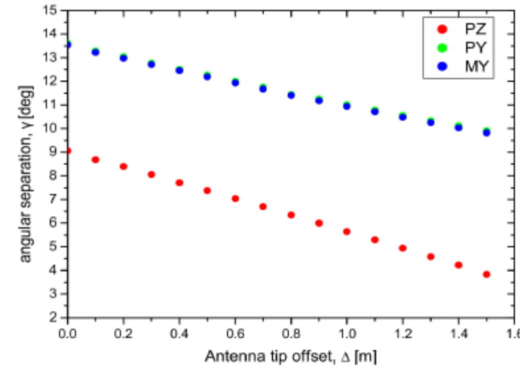
	ANT1-2 Heff (m)	ANT1-2 γ (deg)	ANT2-3 Heff (m)	ANT2-3 γ (deg)	ANT3-1 Heff (m)	ANT3-1 γ (deg)
Plettemeier	6.49		4.79		6.20	
Panchenko	7.53	9.1	5.60	0.0	7.53	5.6

Graz simulations (M. Panchenko).

<u>Question</u> : Why are the effective lengths different to those with the Dresden group ?

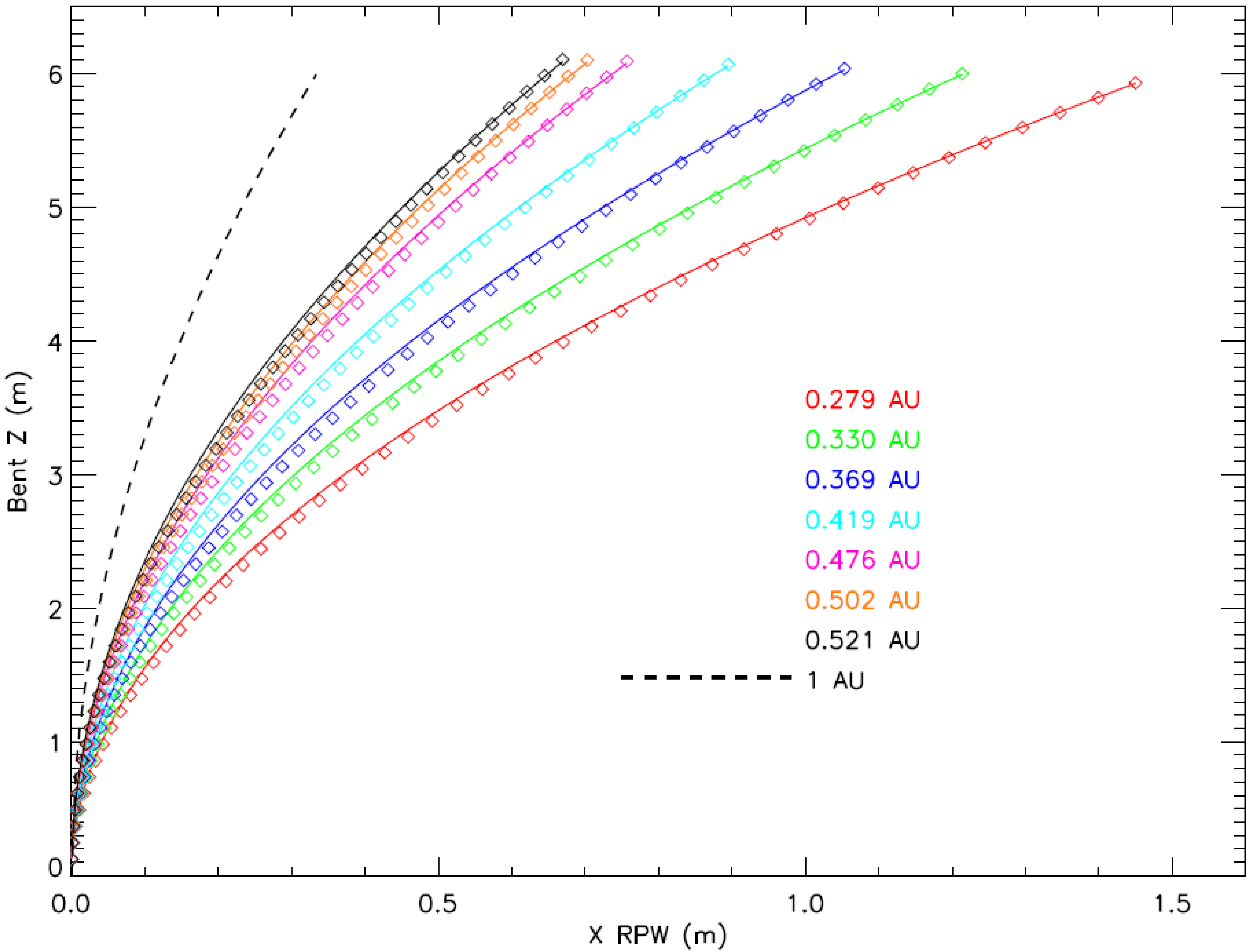


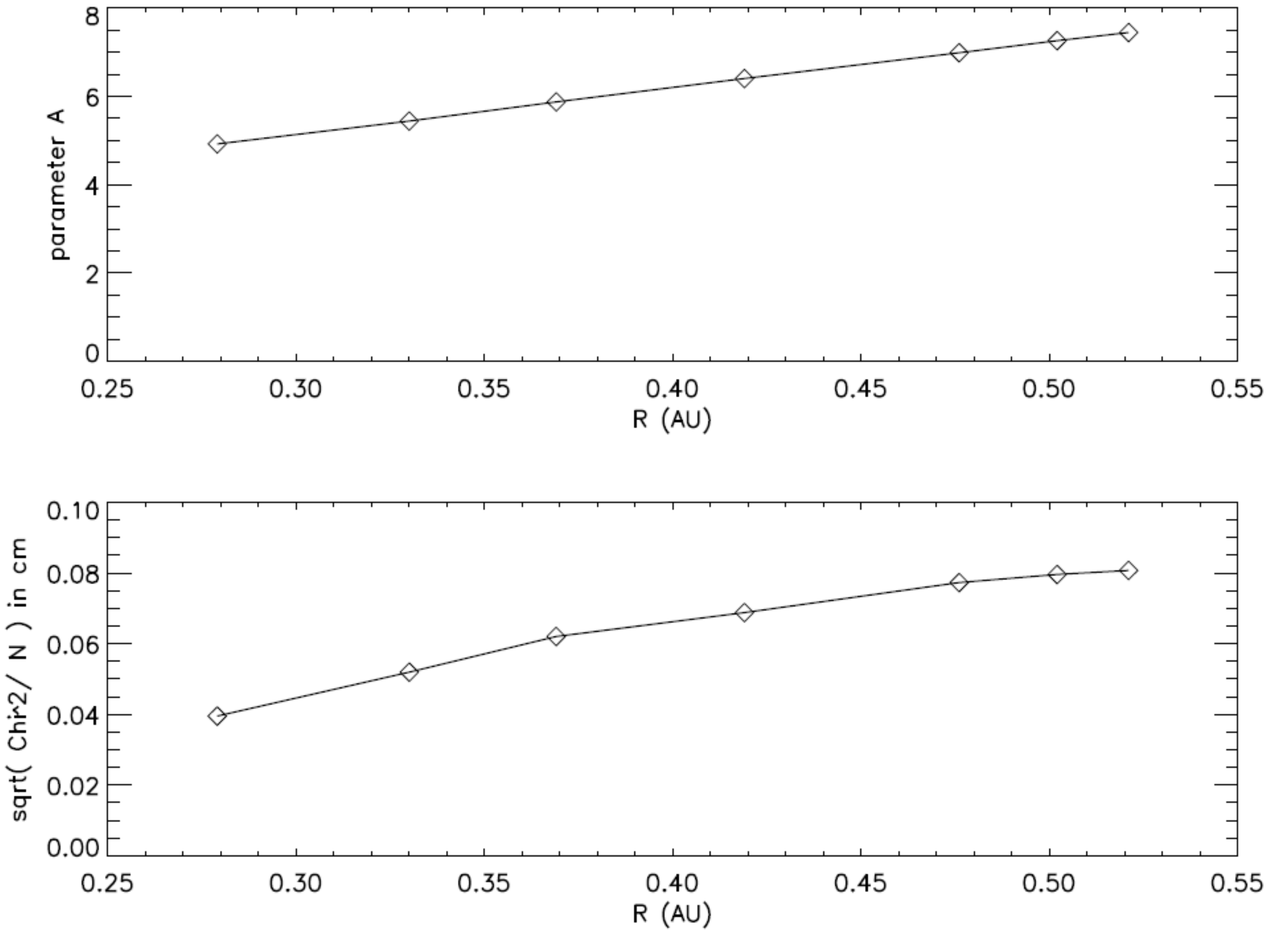




The effective antenna vectors for different thermal bends (Δ) of the antennas.

Tip offset	Effective antenna vectors											
	PZ				PY				MY			
Δ, m	h_e, m	θ, deg	φ, deg	γ, deg	h_e, m	θ, deg	φ, deg	γ, deg	h_e, m	θ, deg	φ, deg	γ, deg
0	4.38	9.1	-0.6	9.1	3.91	132.4	75.3	13.6	3.92	132.3	-75.3	13.6
0.2	4.38	8.4	-0.6	8.4	3.9	132.5	76.3	13.1	3.91	132.4	-76.3	13.0
0.4	4.38	7.7	-0.7	7.7	3.89	132.7	77.3	12.5	3.89	132.6	-77.3	12.5
0.6	4.37	7.0	-0.8	7.0	3.87	132.8	78.3	12.0	3.87	132.7	-78.3	11.9
0.8	4.36	6.3	-0.5	6.3	3.86	132.9	79.3	11.5	3.86	132.9	-79.4	11.4
1.0	4.35	5.7	-0.9	5.7	3.84	133.1	80.4	11.0	3.85	133.0	-80.4	10.9
1.2	4.33	4.9	-1.1	4.9	3.84	133.2	81.5	10.6	3.84	133.1	-81.5	10.5
1.4	4.33	4.2	-1.3	4.2	3.83	133.3	82.6	10.1	3.83	133.2	-82.6	10.0


Bent Z (m)
X RPW (m)
0.279 AU
0.330 AU
0.369 AU
0.419 AU
0.476 AU
0.502 AU
0.521 AU
1 AU
0
1
2
3
4
5
6
0.0
0.5
1.0
1.5



parameter A
R (AU)
sqrt(Chi^2/ N) in cm
R (AU)

Direction Finding simulations by V. Krupar

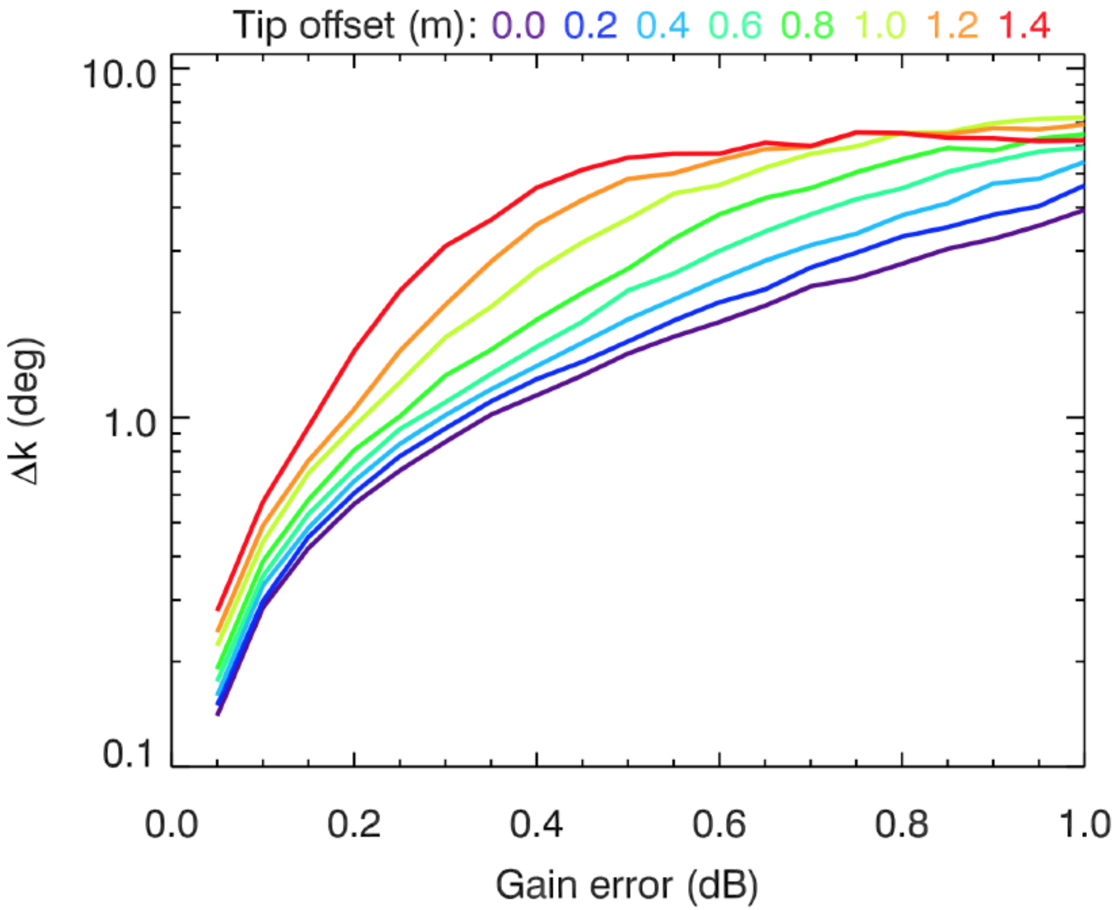


Figure 3. The simulated difference between input and output wave vector direction as a function of an uncertainty on the receiver gain for 8 values of the tip offset (in color).

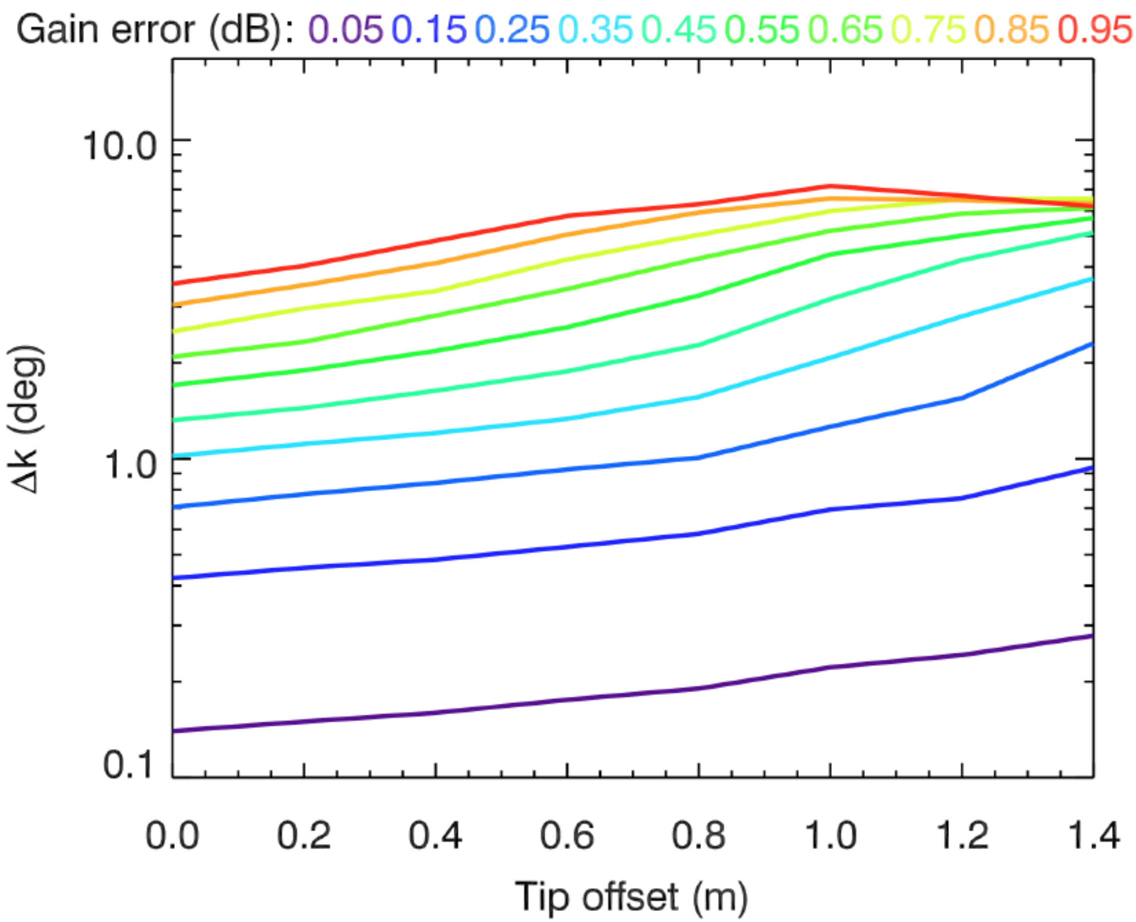


Figure 4. The simulated difference between input and output wave vector direction as a function of the tip offset gain for 10 values of an uncertainty on the receiver (in color).