Summary of XPOL observations done on 04/06/2018

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The technical time on June 4th was used to investigate the instrumental circular polarization found on the E090 band of the EMIR receiver. Contrary to most of the previous occasions, this time the weather did collaborate so the data is much more reliable.

The source used during the entire test was Uranus except for a short scan on Mercury at the end of the session. Observing modes were position and wobbler switching with a -100 +100 arc seconds throw and 2 second phase time.

On sky observations

The Stokes parameters observed on Uranus on a standard position switching, with a -600 0 arc seconds reference in projection, is about -2.2% (see fig 1). This value stays more or less the same in wobbler switch mode.

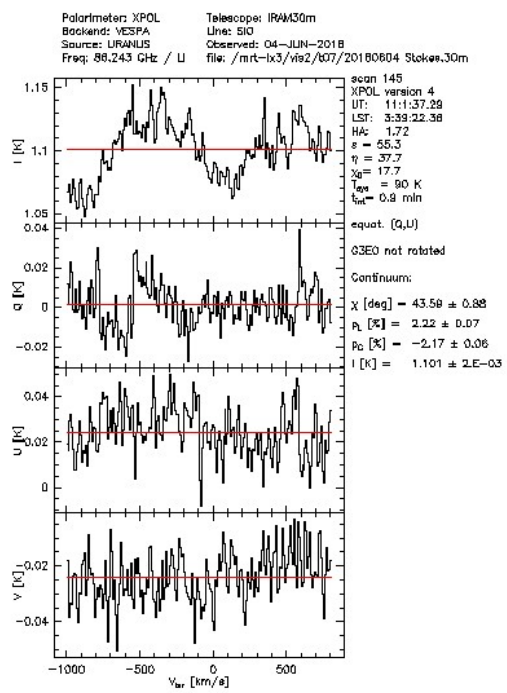

Figure 1. Standard position switching observation on Uranus

Repeating the position switching scan with a 600" offset on the source (blank sky) gives no circular polarization (see fig. 2). The problem with measurement without source is that there is no signal (Stokes I ~ 0) so the normalization of the V parameter is not well defined. To introduce a power difference between the on and the off phases we used two different methods: The first method is a change of the total power by adding a 1dB attenuation to the off phase of all the IF signals. The

second is to take a far away reference position in elevation, which is effective at low antenna elevations.

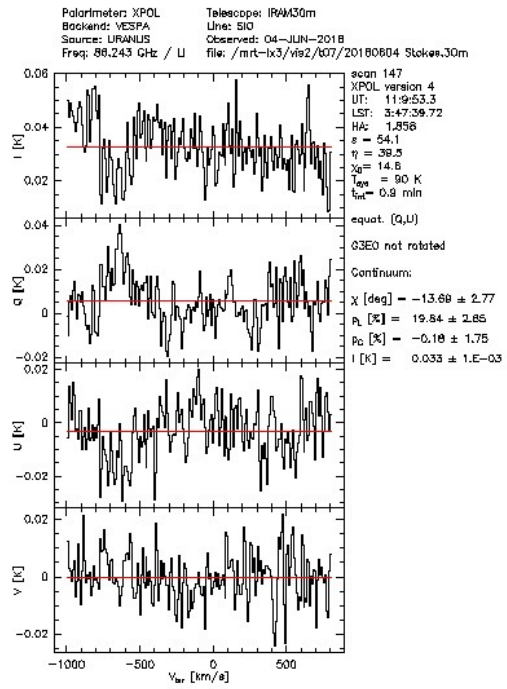

Figure 2. Observation at 600 arc seconds from Uranus.

Changing the reference position to -3600 arc seconds in elevation (True horizontal mode) gives a completely different result for the circular polarization (see fig 3). Pc is now lower and positive.

At the end of the test the source was rapidly going down in elevation. This fact was used to make regular short integrations following the source in order to investigate any possible effect on the instrumental polarization. The observing mode was position switching with a 1 degree reference in elevation. The result of the test is summarized in figure 4.

As expected, and due to the large offset in the reference position, Stokes “I” increases as the elevation is lowered. On the other hand, the residual circular polarization hardly changes or tends to decrease at a much modest rate.

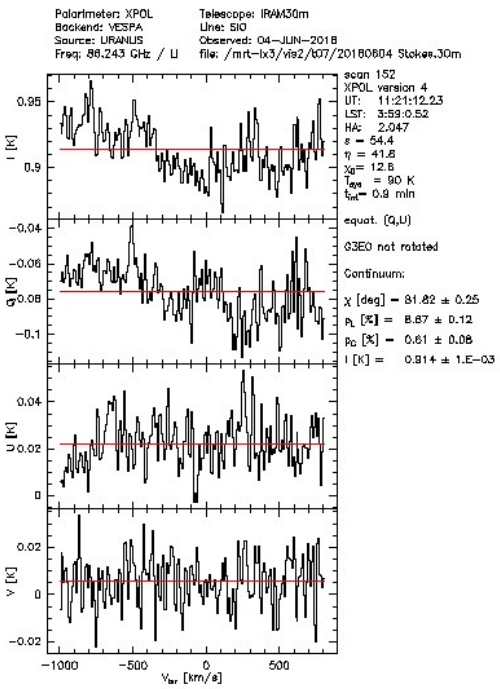

Figure 3. Reference at -3600 arc seconds.

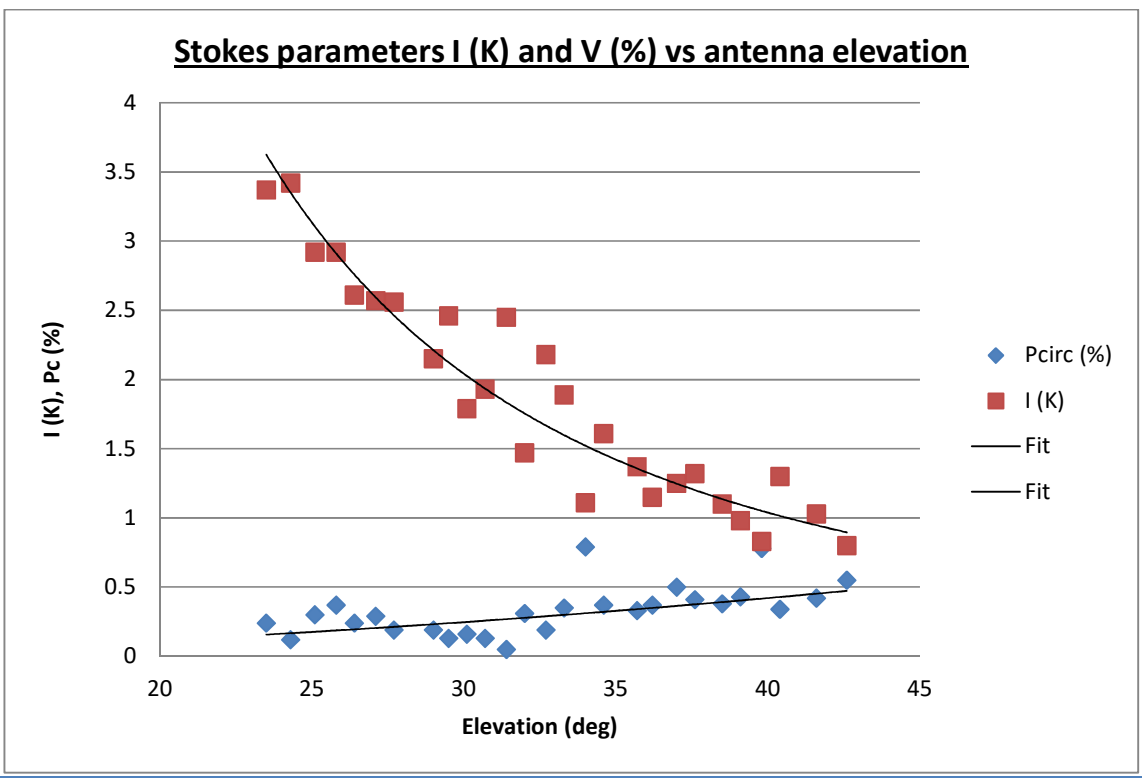

Figure 4

Observations on absorber

To isolate the receiver from the influence of the sky and part of the optics, an absorber was introduces at several positions in the optical path:

- At the level of the VLBI quarter wave plates, between M6 and M7
- CoveringM4
- Covering M3

In order to have a non zero Stokes "I" parameter a 1dB attenuation was introduced on the off phase of all the EMIR IF cables. In all cases (see example on fig. 5) the residual circular polarization was very close to zero.

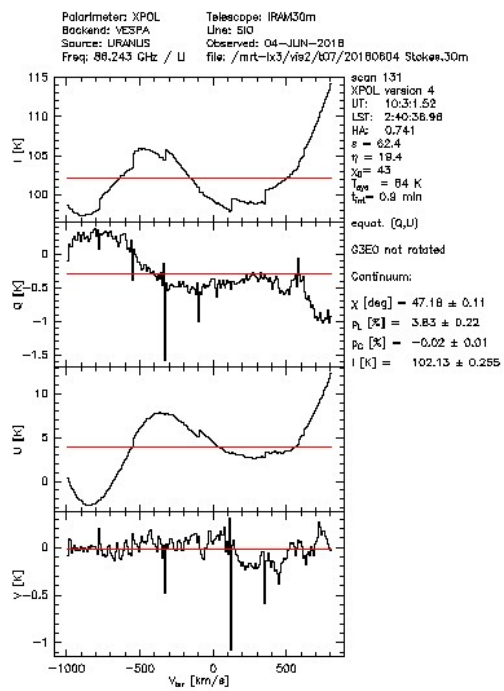

Figure 5. Absorver between EMIR M6 and M7 mirrors. 1 dB step attenuation on the off phase.

Technical Time on 04-06-2018. Scan information

Source	Scan	Type	Comment	P. circular (%)	I (K)	V abs	Elevation
Uranus	119	CAL	BBC				
Uranus	120	POINT					
Uranus	121	POINT	SET POINT 7 5				
Uranus	122	FOCUS					
Uranus	123	FOCUS	SET FOCUS -2.2				
Uranus	124	CAL	VESPA				
Uranus	125	ONOFF	NORMAL. REF AT 600 ". NSUB 4. Con Pos. Switching	-2.54	1.14		
Uranus	126	ONOFF	NORMAL. REF AT 600 ". NSUB 4	-2.67	1.1		
Uranus	127	ONOFF	NORMAL. REF AT 600 ". NSUB 4				
Uranus	128	ONOFF	NORMAL. REF AT 600 ". NSUB 2				
Uranus	129	ONOFF	NORMAL. REF AT 600 ". NSUB 2	-3.04	0.95		
Uranus	130	CAL					
Uranus	131	ONOFF	WITH ABSORVER ON QWP. Removing 1dB on second subscan with console attenuators	-0.02	102		
Uranus	132						
Uranus	133	ONOFF	WITH ABSORVER ON M4. Removing 1dB on second subscan with console attenuators	-0.08	104		
Uranus	134	ONOFF	WITH ABSORVER ON M4. Removing 1dB on second subscan with console attenuators	-0.08	104		
Uranus	135						
Uranus	136						
Uranus	137	ONOFF	WITH ABSORVER ON M3. Removing 1dB on second subscan with console attenuators	-0.06	103		
Uranus	138	ONOFF	WITH ABSORVER ON M3. Removing 1dB on second subscan with console attenuators	-0.306	103		

Uranus	139	CAL					
Uranus	140	ONOFF	WITH VERTEX CLOSED. Removing 1dB on second subscan with console attenuators	0.02	106		
Uranus	141	ONOFF	WITH VERTEX CLOSED. Removing 1dB on second subscan with console attenuators	0.01	107		
Uranus	142	ONOFF	Normal on Uranus	-1.21	1.19		
Uranus	143	ONOFF	On Uranus but removing 1dB with console attenuators	-0.05	24.5		
Uranus	144	CAL					
Uranus	145	ONOFF	Normal on Uranus	-2.17	1.1		
Uranus	146	ONOFF	Normal on Uranus	-1.2	1.19		
Uranus	147	ONOFF	At 600" out of Uranus	-0.18	0.033		
Uranus	148						
Uranus	149						
Uranus	150	ONOFF	Uranus. Reference at -3600" in elevation	0.61	-0.57		
Uranus	151	ONOFF	Uranus. Reference at -3600" in elevation	0.51	0.62		
Uranus	152	ONOFF	Uranus. Reference at -3600" in elevation	0.61	0.91		
Uranus	153	POINT	BBC. Set point 2 4				
Uranus	154	CAL					
Uranus	155	POINT	set point 2 2				
Uranus	156	FOCUS					
Uranus	157	FOCUS	Set focus -2.1				
Uranus	158	CAL	VESPA				
Uranus	159	ONOFF	Normal with reference at -600 0 projection	-2.42	1.15		
Uranus	160	ONOFF	Normal with reference at -600 0 projection	-2.44	1.15		
Uranus	161	ONOFF	Normal with reference at -600 0 projection				
Uranus	162	CAL					
Uranus	163	ONOFF	With wobbler swwob -100 100 /t 2	-2.4	1.1		
Uranus	164	ONOFF	With wobbler swwob -100 100 /t 2	-2.4	1.1		
Uranus	165	ONOFF	With wobbler swwob -100 100 /t 2	-1.8	1.1		

Uranus	166	ONOFF	With wobbler swwob -100 100 /t 2 . NSUB 8	-2	1.1		
Uranus	167	ONOFF	With wobbler swwob -100 100 /t 2 . NSUB 8	-2	1.1		
Uranus	168	CAL					
Uranus	169	ONOFF	Pos. Switching. NSUB 8. Truehorizontal	-1.7	1.2		
Uranus	170	ONOFF	Pos. Switching. NSUB 8. Truehorizontal	-1.7	1.3		
Uranus	171	CAL					
Uranus	172	ONOFF	Uranus. Reference at -3600" in elevation	0.55	0.8	0.44	42.6
Uranus	173	ONOFF	Uranus. Reference at -3600" in elevation	0.42	1.03	0.4326	41.6
Uranus	174	CAL					
Uranus	175	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.34	1.3	0.442	40.4
Uranus	176	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.78	0.83	0.6474	39.8
Uranus	177	CAL					
Uranus	178	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.43	0.98	0.4214	39.1
Uranus	179	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.38	1.1	0.418	38.5
Uranus	180	CAL					
Uranus	181	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.41	1.32	0.5412	37.6
Uranus	182	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.5	1.25	0.625	37
Uranus	183	CAL					
Uranus	184	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.37	1.15	0.4255	36.2
Uranus	185	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.33	1.37	0.4521	35.7
Uranus	186	CAL					
Uranus	187	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.37	1.61	0.5957	34.6
Uranus	188	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.79	1.11	0.8769	34
Uranus	189	CAL					
Uranus	190	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.35	1.89	0.6615	33.3
Uranus	191	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.19	2.18	0.4142	32.7
Uranus	192	CAL					
Uranus	193	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.31	1.47	0.4557	32
Uranus	194	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.05	2.45	0.1225	31.4

Uranus	195	CAL					
Uranus	196	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.13	1.93	0.2509	30.7
Uranus	197	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.16	1.79	0.2864	30.1
Uranus	198	CAL					
Uranus	199	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.19	2.15	0.4085	29
Uranus	200	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.13	2.46	0.3198	29.5
Uranus	201	CAL					
Uranus	202	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.19	2.56	0.4864	27.7
Uranus	203	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.29	2.57	0.7453	27.1
Uranus	204	CAL					
Uranus	205	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.24	2.61	0.6264	26.4
Uranus	206	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.37	2.92	1.0804	25.8
Uranus	207	CAL					
Uranus	208	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.3	2.92	0.876	25.1
Uranus	209	CAL					
Uranus	210	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.12	3.42	0.4104	24.3
Uranus	211	CAL					
Uranus	212	ONOFF	Uranus. Reference at -3600" in elevation . NSUB 4	0.24	3.37	0.8088	23.5
Mercury	213	CAL					
Mercury	214	ONOFF	Normal: onoff 0 0 /sys projec /ref -600 0 project	-2.37	10.32		