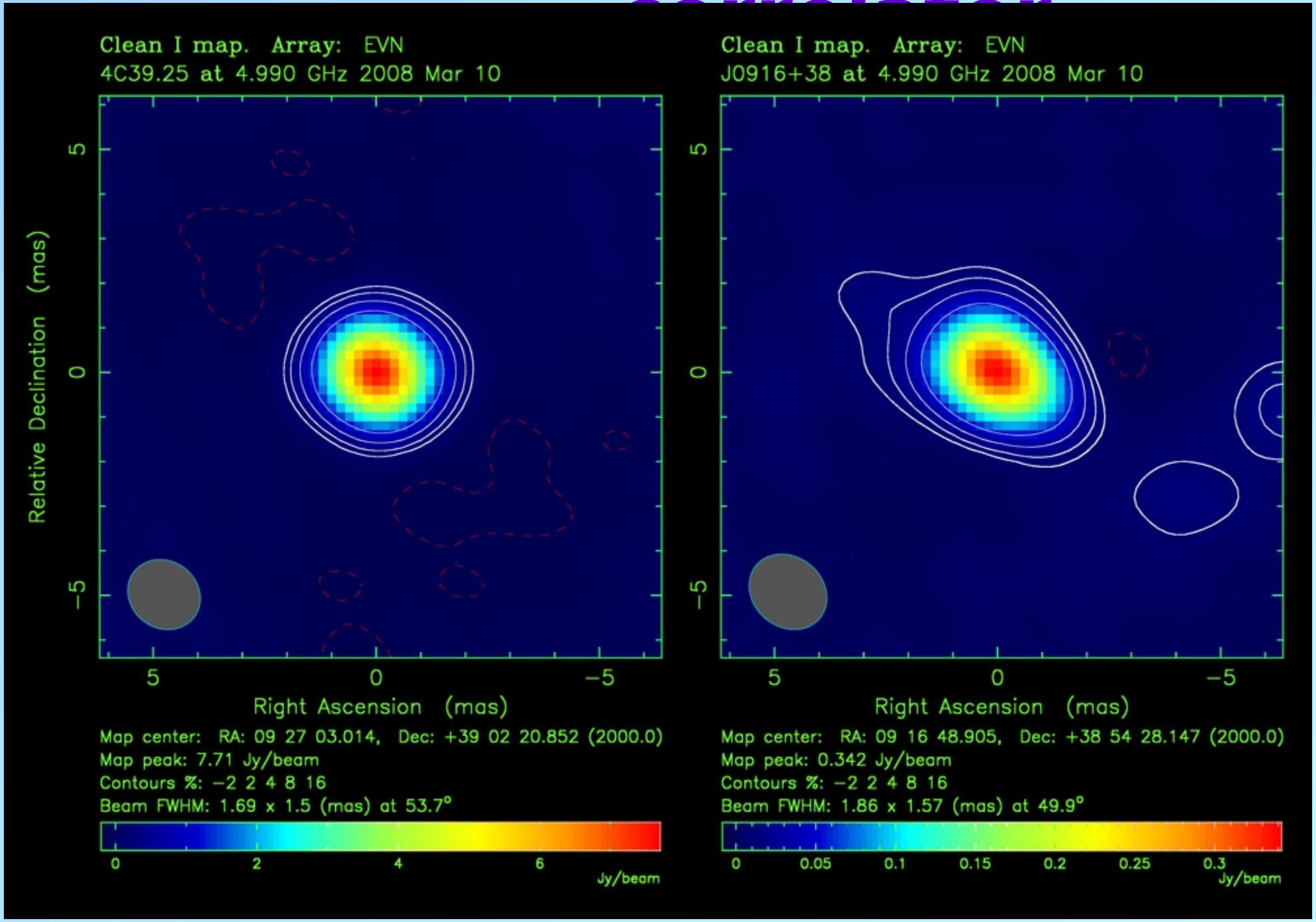
Yurii Pidopryhora, Aard Keimpema & Mark Kettenis

The latest tests of the SFXC software correlator



8th International e-VLBI Workshop

Observatorio Astronomico de Madrid

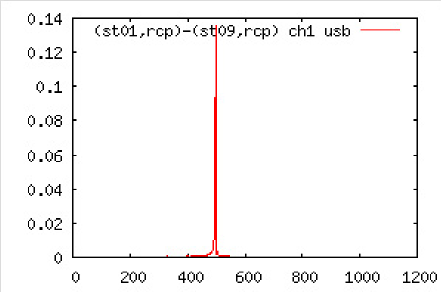
Madrid, Spain

June 22-26 2009

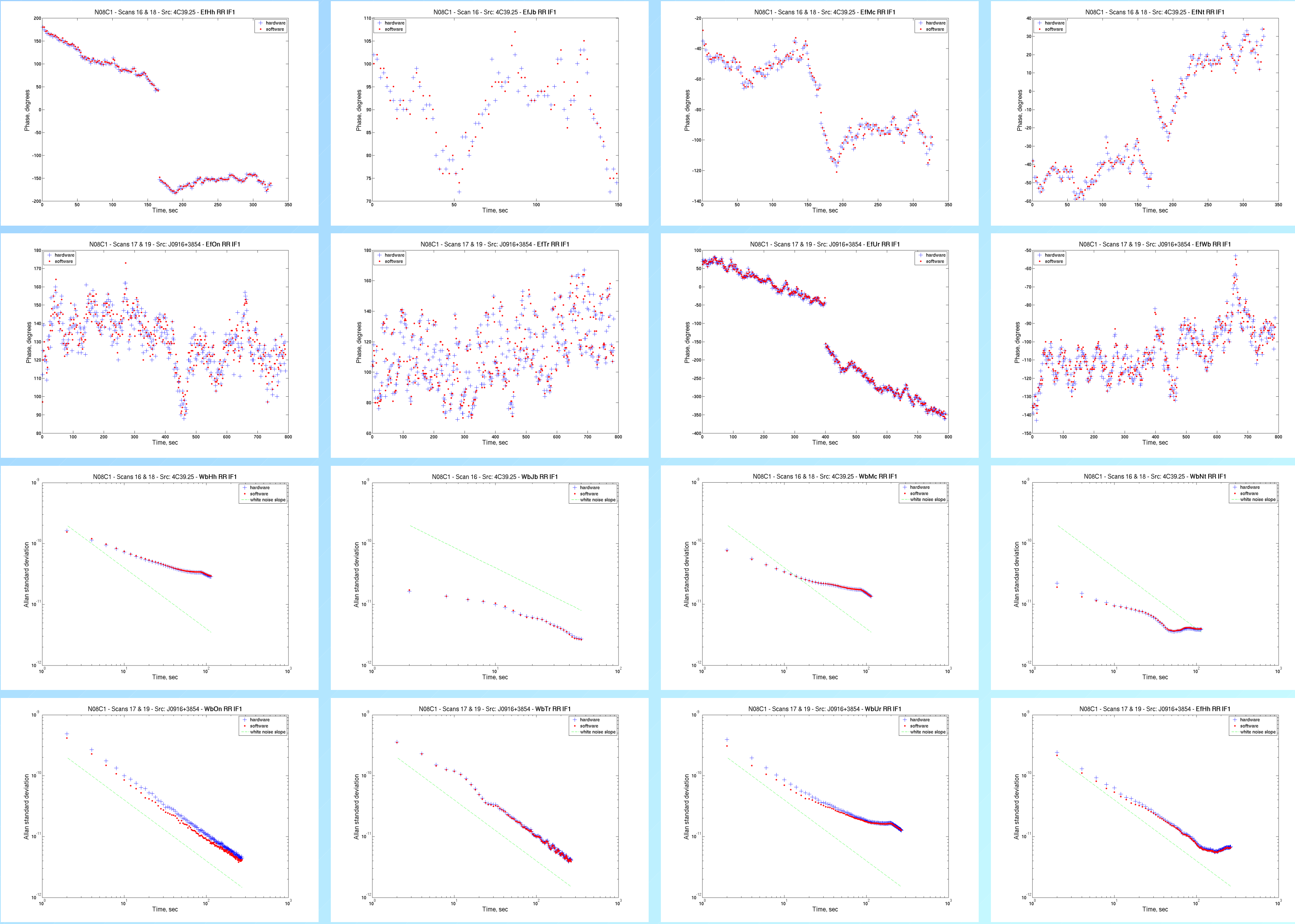
FTP-tests of EVN runs

Vex file -- Integration time: 4s -- Start of the integration: 2009y162d13h57m56s0ms

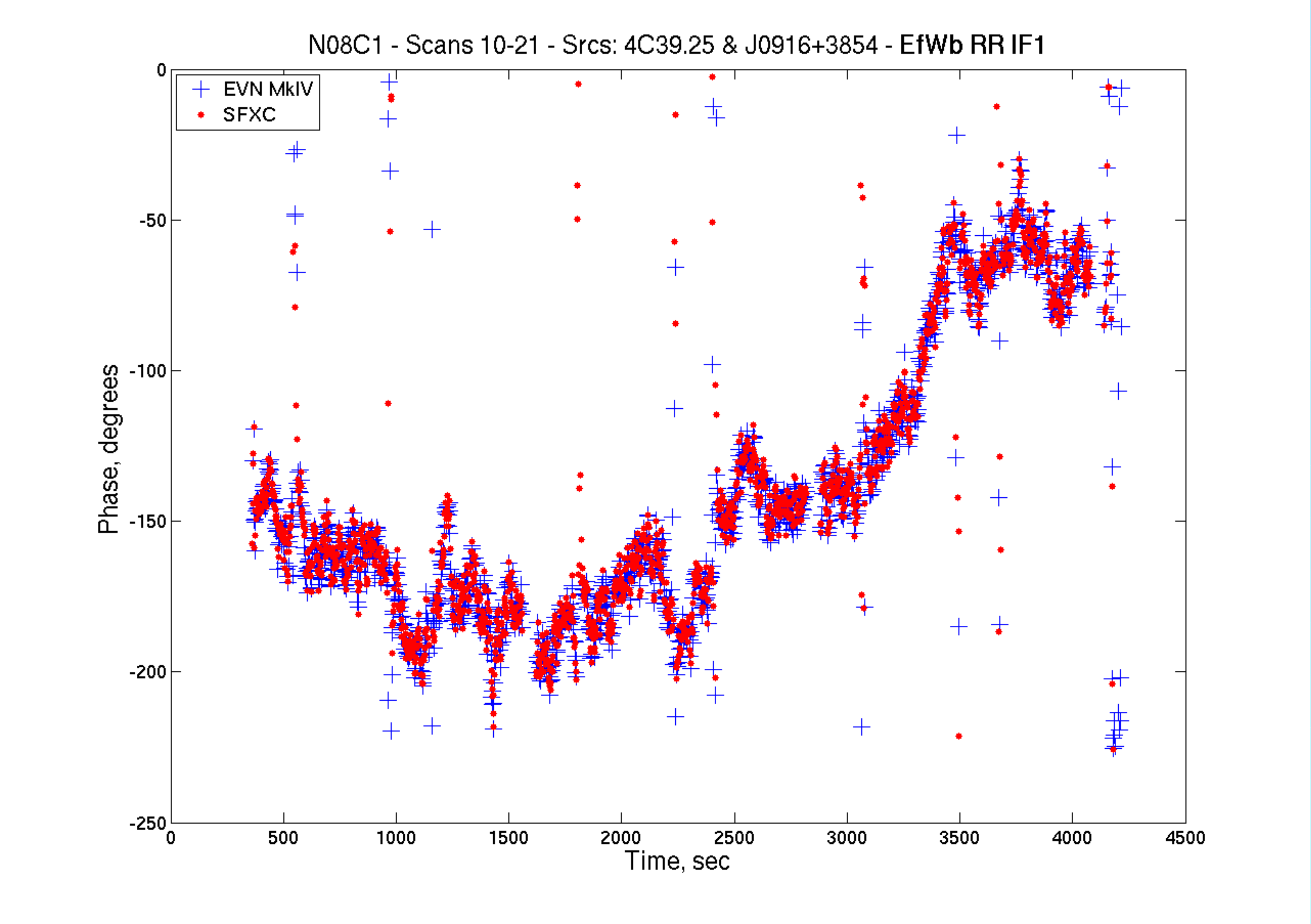
N09C2	Auto correlations											Cross correlations									
	Cm	Ef	Jb	Mc	Nt	On	Sh	Tr	Ur	Wb	Ys	Cm-Ef	Ef-Jb	Ef-Mc	Ef-Nt	Ef-On	Ef-Sh	Ef-Tr	Ef-Ur	Ef-Wb	Ef-Ys
4974.49MHz, USB, Rcp-Rcp	1	2	2	2	1	2	1	1	2	2	1	4.108 A P offset: 119	593.4 A P offset: 0	1163 A P offset: 1	983.2 A P offset: -3	560.3 A P offset: 3	362.7 A P offset: 6	284.8 A P offset: 2	635.8 A P offset: -2	1268 A P offset: -16	640.5 A P offset: 1
4974.49MHz, USB, Rcp-Lcp	Cross hands											4.719 A P offset: -27	29.41 A P offset: 0	20.39 A P offset: 1	145.7 A P offset: -3	48.78 A P offset: 3	26.02 A P offset: 6	65.98 A P offset: 2	9.096 A P offset: -2	79.7 A P offset: -16	63.58 A P offset: 0
4974.49MHz, USB, Lcp-Lcp	2	1	1	1	2	1	2	2	1	1	2	4.526 A P offset: 133	561 A P offset: 0	1128 A P offset: 1	961.2 A P offset: -3	558.3 A P offset: 3	373.1 A P offset: 6	255.9 A P offset: 2	613.2 A P offset: -2	1195 A P offset: -16	634.3 A P offset: 1
4974.49MHz, USB, Lcp-Rcp	Cross hands											5.615 A P offset: 23	14.71 A P offset: 0	75.58 A P offset: 1	113.7 A P offset: -3	22.31 A P offset: 3	21.17 A P offset: 6	120.4 A P offset: 2	14.11 A P offset: -1	94.2 A P offset: -16	37.37 A P offset: 1
4982.49MHz, USB, Rcp-Rcp	3	4	4	4	3	4	3	3	4	4	3	890.4 A P offset: -2	527.6 A P offset: 0	1114 A P offset: 1	741.8 A P offset: -3	516.7 A P offset: 3	376.2 A P offset: 6	254.5 A P offset: 2	594.7 A P offset: -2	1217 A P offset: -16	629.4 A P offset: 0
4982.49MHz, USB, Rcp-Lcp	Cross hands											22.23 A P offset: -3	20.78 A P offset: 0	31.2 A P offset: 1	86.31 A P offset: -3	50.13 A P offset: 3	26.37 A P offset: 6	53.39 A P offset: 2	12.34 A P offset: -1	35.45 A P offset: -16	56.76 A P offset: 0
4982.49MHz, USB, Lcp-Lcp	4	3	3	3	4	3	4	4	3	3	4	870.4 A P offset: -2	435.6 A P offset: 0	1212 A P offset: 1	955.3 A P offset: -3	535.9 A P offset: 3	396.3 A P offset: 6	243.3 A P offset: 2	647.7 A P offset: -2	1326 A P offset: -16	648.7 A P offset: 1
4982.49MHz, USB, Lcp-Rcp	Cross hands											121.7 A P offset: -3	24.01 A P offset: 0	71.71 A P offset: 1	81.15 A P offset: -3	19.72 A P offset: 3	17.66 A P offset: 6	106.9 A P offset: 2	6.554 A P offset: -1	12.44 A P offset: -17	40.85 A P offset: 0
4990.49MHz, USB, Rcp-Rcp	5	6	6	6	5	6	5	5	6	6	5	695 A P offset: -2	565 A P offset: 0	1046 A P offset: 1	846.3 A P offset: -3	517.3 A P offset: 3	364.1 A P offset: 6	233.2 A P offset: 2	499.6 A P offset: -2	1159 A P offset: -16	563.6 A P offset: 0
4990.49MHz, USB, Rcp-Lcp	Cross hands											48.74 A P offset: -2	25.77 A P offset: 0	45.84 A P offset: 1	91.76 A P offset: -3	52.15 A P offset: 2	25.01 A P offset: 6	44.67 A P offset: 2	15.66 A P offset: -2	31.33 A P offset: -16	73.35 A P offset: 0
4990.49MHz, USB, Lcp-Lcp	6	5	5	5	6	5	6	6	5	5	6	866.5 A P offset: -2	587.1 A P offset: 0	1047 A P offset: 1	778.2 A P offset: -3	534.6 A P offset: 3	373.5 A P offset: 6	211.1 A P offset: 2	606.8 A P offset: -2	1194 A P offset: -16	581.7 A P offset: 0
4990.49MHz, USB, Lcp-Rcp	Cross hands											136.5 A P offset: -2	5.348 A P offset: 0	35.39 A P offset: 1	128.4 A P offset: -3	24.57 A P offset: 3	24.37 A P offset: 6	94.13 A P offset: 2	6.02 A P offset: -2	46.55 A P offset: -16	34.17 A P offset: 0
4998.49MHz, USB, Rcp-Rcp	7	8	8	8	7	8	7	7	8	8	7	3.706 A P offset: -207	605.5 A P offset: 0	990.7 A P offset: 1	837.4 A P offset: -3	525.9 A P offset: 3	355 A P offset: 6	216.4 A P offset: 2	606.6 A P offset: -2	32.86 A P offset: -16	619.4 A P offset: 0
4998.49MHz, USB, Rcp-Lcp	Cross hands											3.725 A P offset: 165	28.45 A P offset: 0	40.41 A P offset: 1	68.75 A P offset: -3	57.15 A P offset: 2	28.34 A P offset: 6	44.57 A P offset: 2	8.538 A P offset: -2	1196 A P offset: -16	65.1 A P offset: 0
4998.49MHz, USB, Lcp-Lcp	8	7	7	7	8	7	8	8	7	7	8	5.344 A P offset: 27	625.9 A P offset: 0	1086 A P offset: 1	944.6 A P offset: -3	528.9 A P offset: 2	364.2 A P offset: 6	196.1 A P offset: 2	424.7 A P offset: -2	32.45 A P offset: -16	667.5 A P offset: 0
4998.49MHz, USB, Lcp-Rcp	Cross hands											6.273 A P offset: -22	11.46 A P offset: 0	28.28 A P offset: 1	67.53 A P offset: -3	26.08 A P offset: 2	27.45 A P offset: 6	86.3 A P offset: 2	4.455 A P offset: -1	1172 A P offset: -16	46.65 A P offset: 0



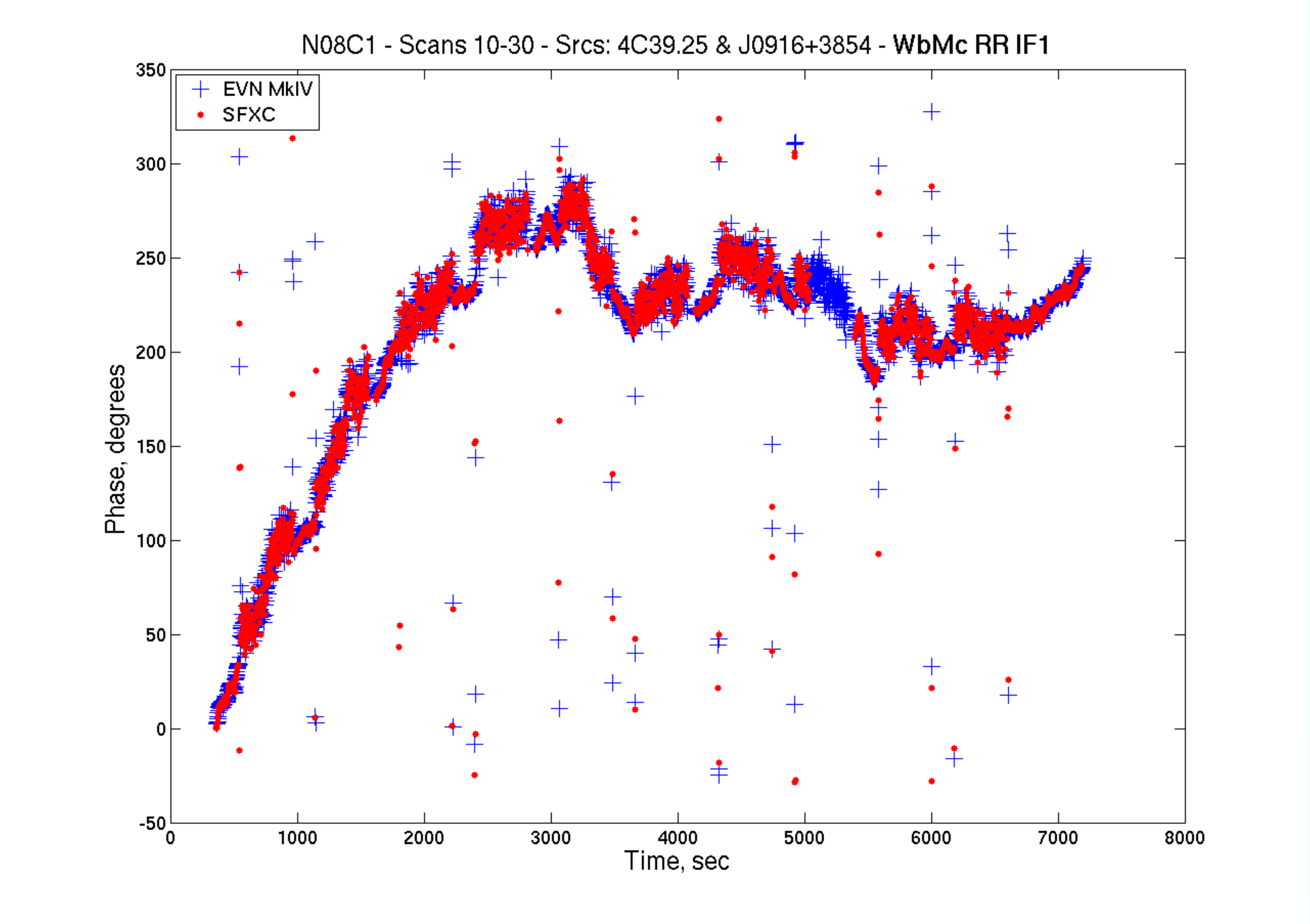
Extensive testing



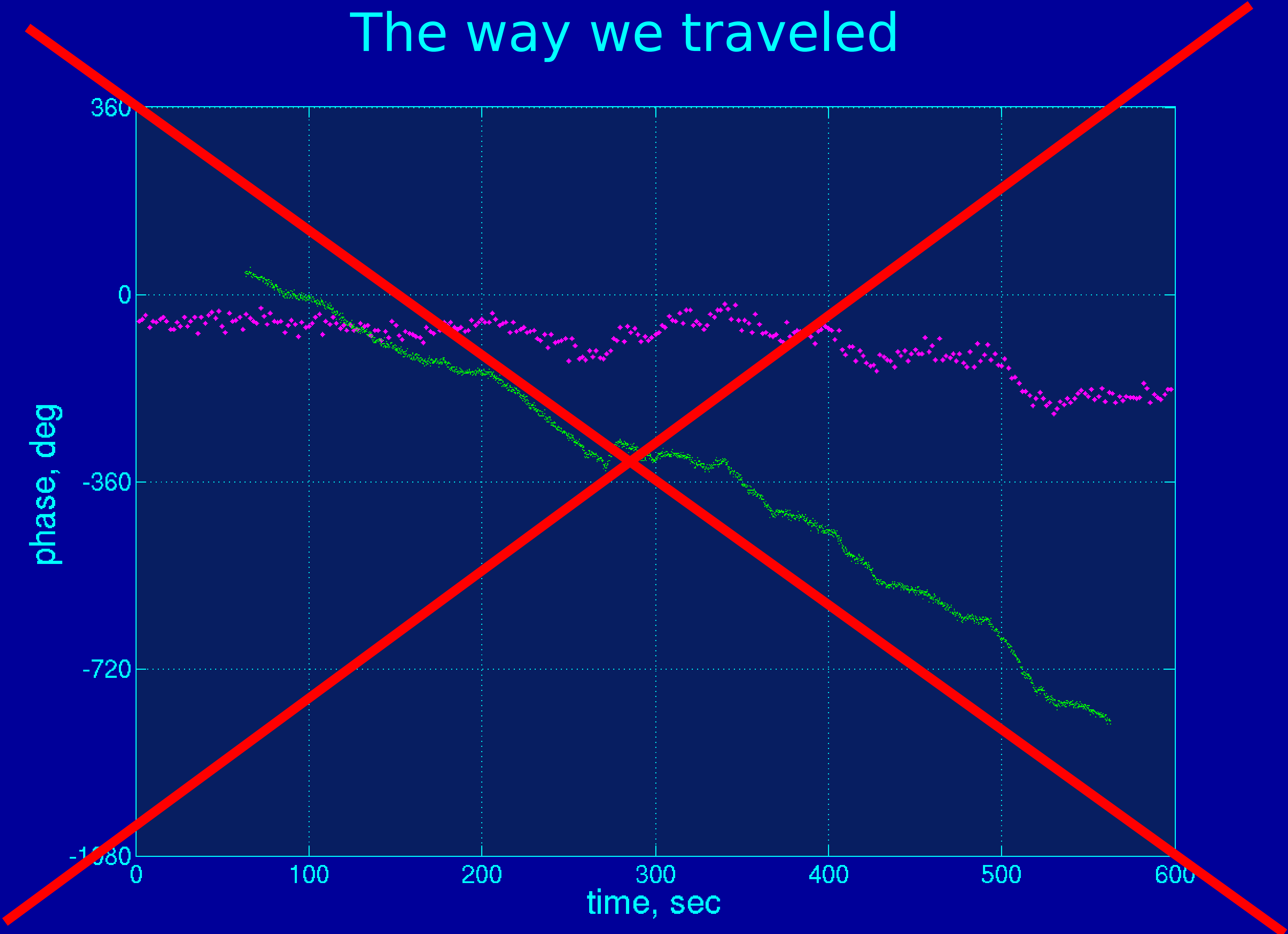
Comparison with EVN Mark IV hardware correlator



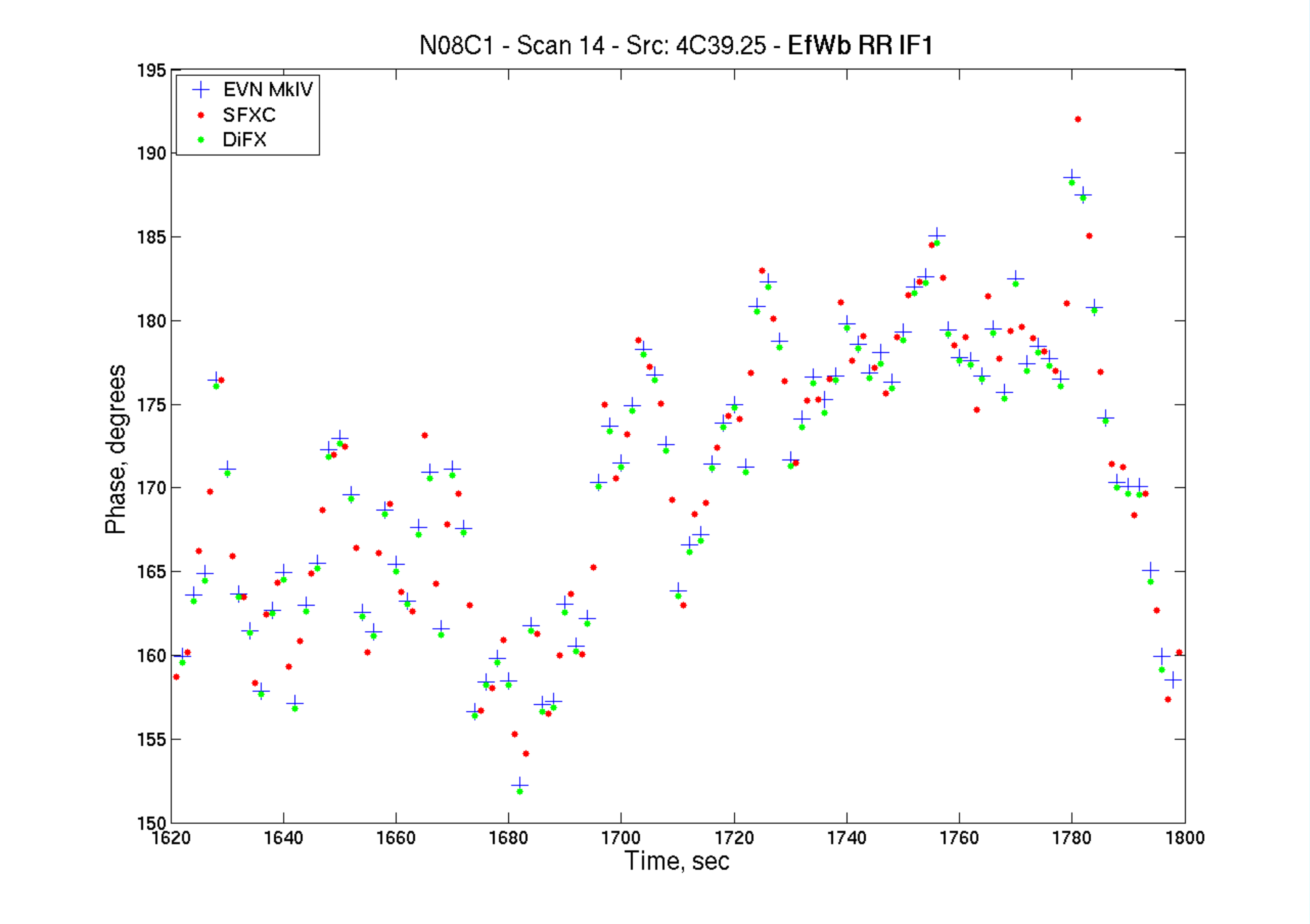
Comparison with EVN Mark IV hardware correlator



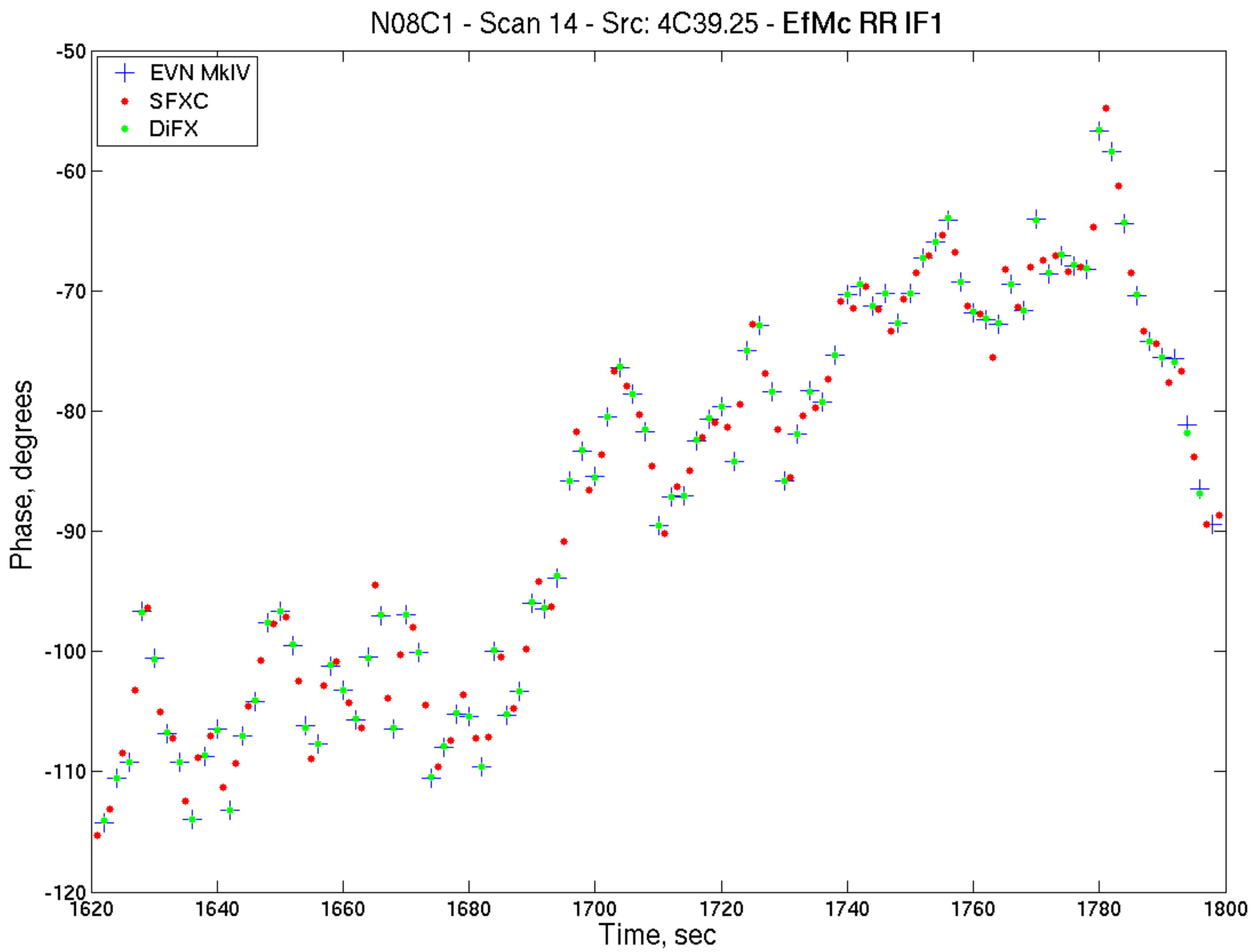
The way we traveled



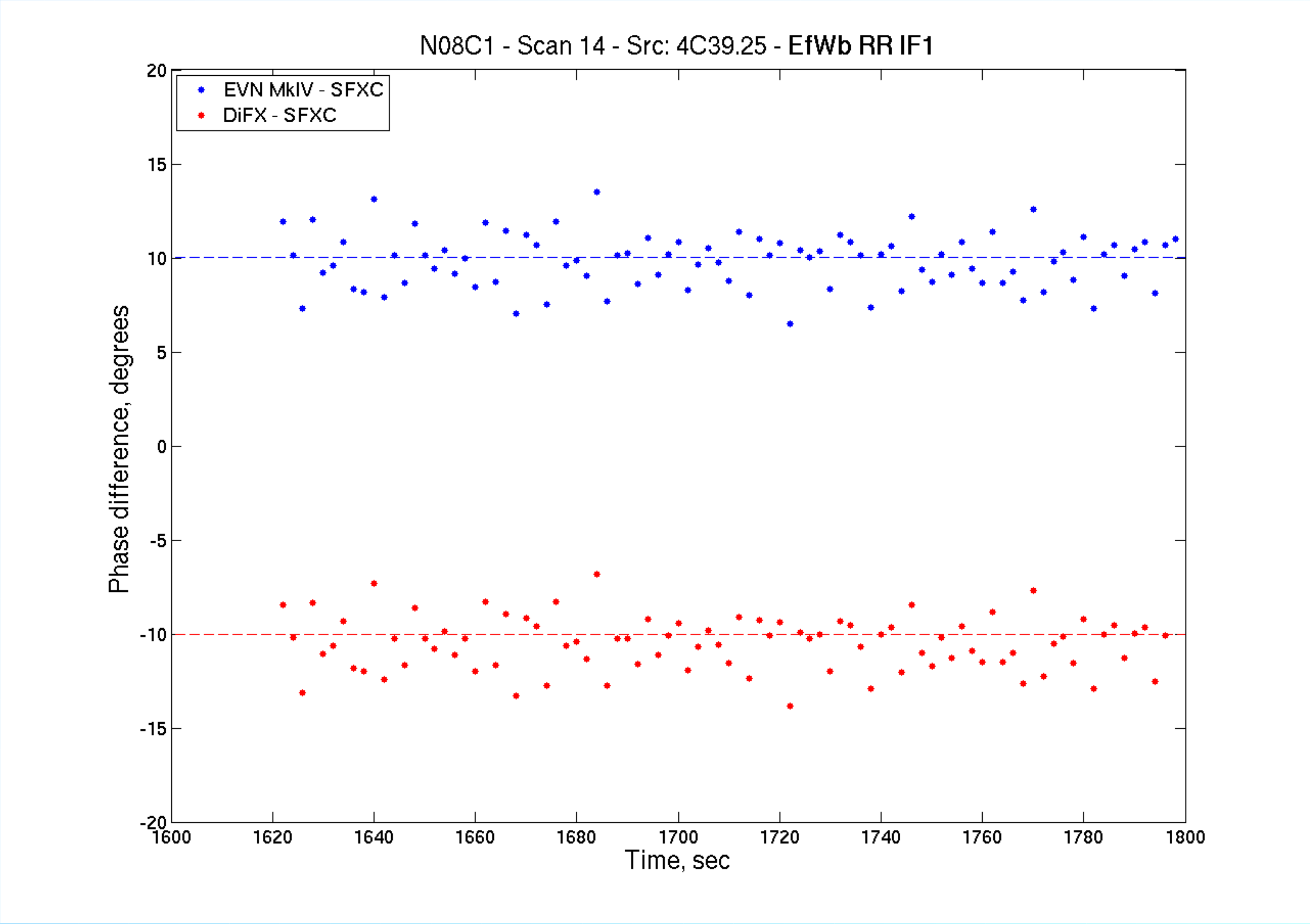
Comparison with DiFX software correlator



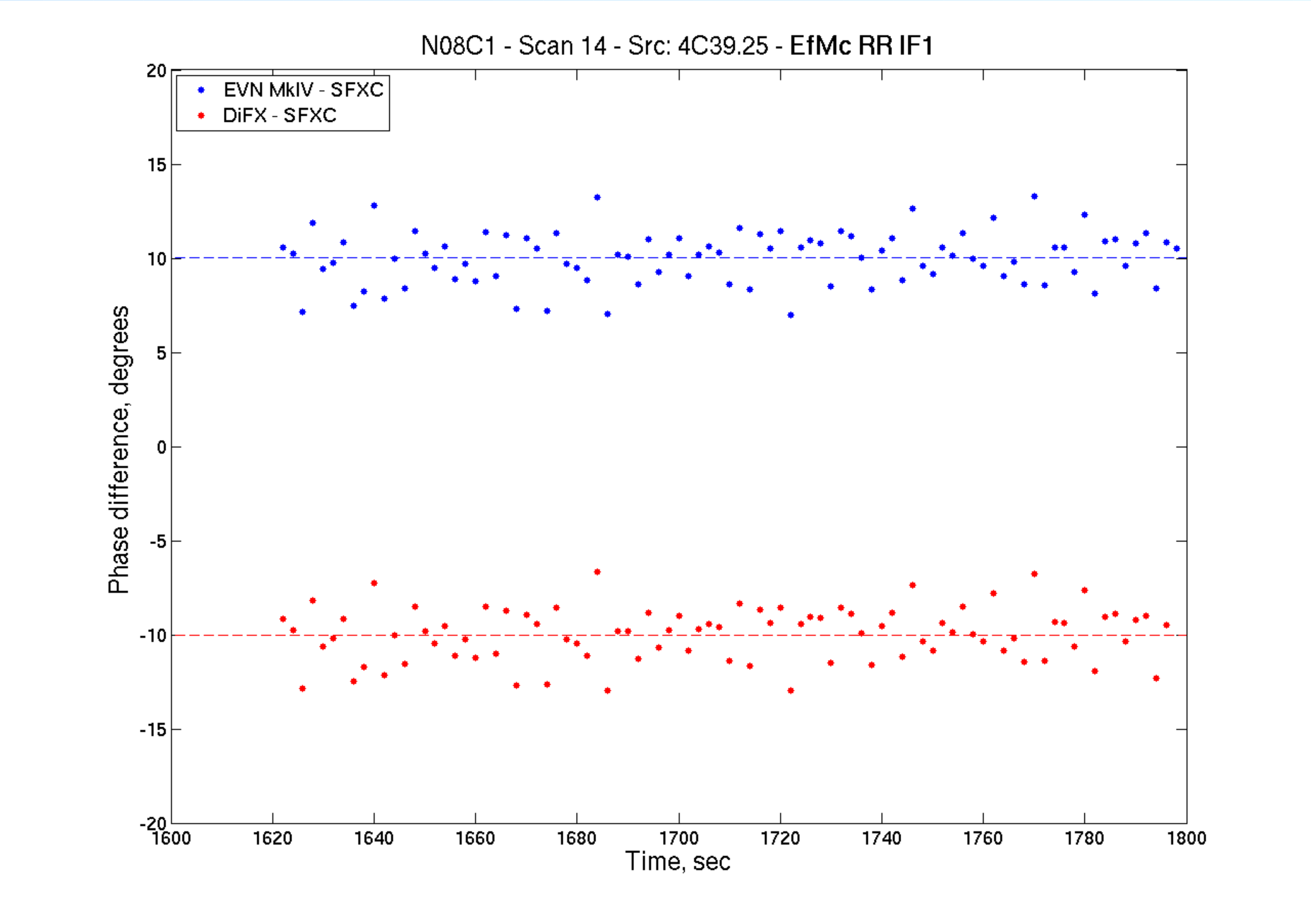
Comparison with DiFX software correlator



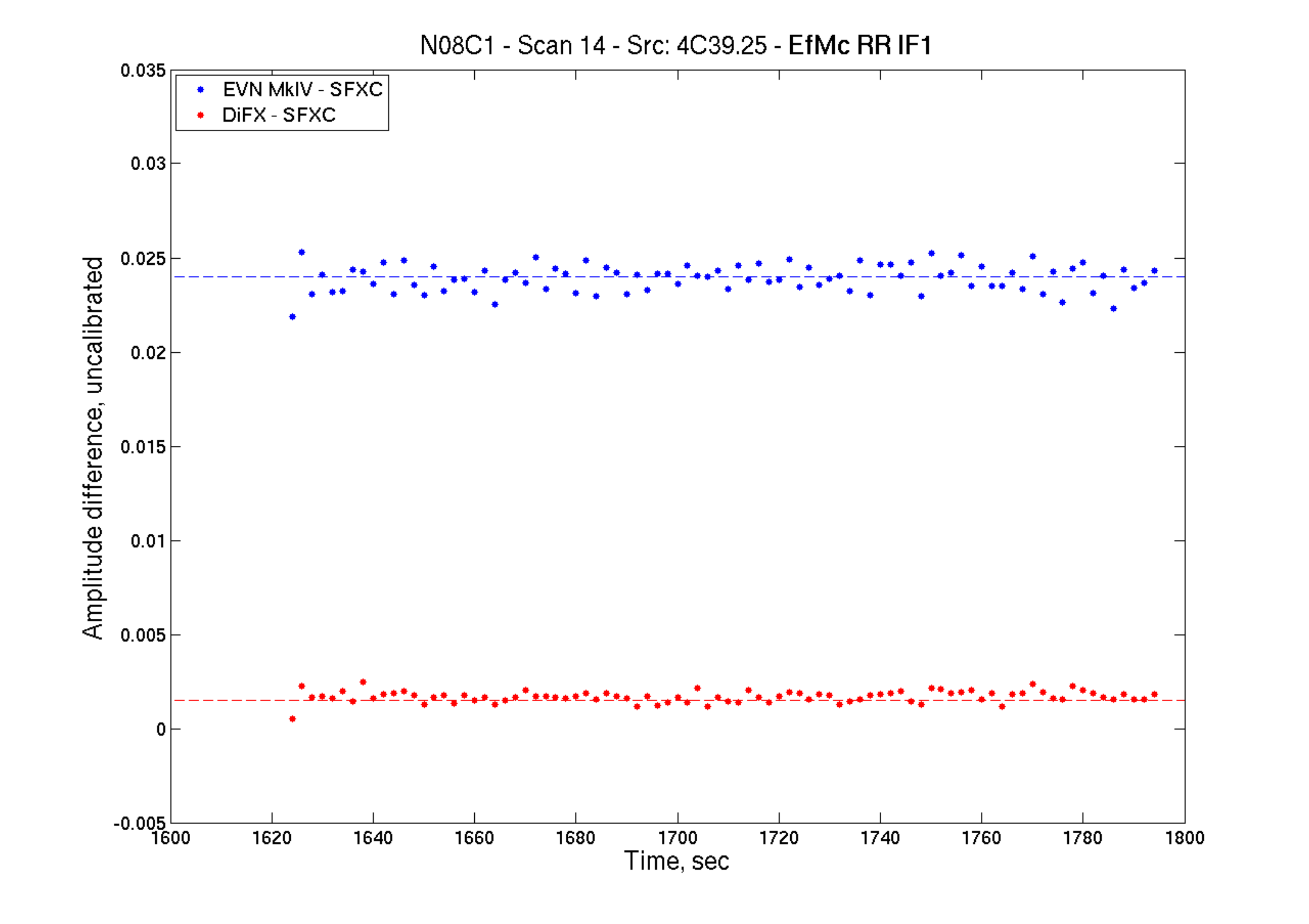
Phase difference



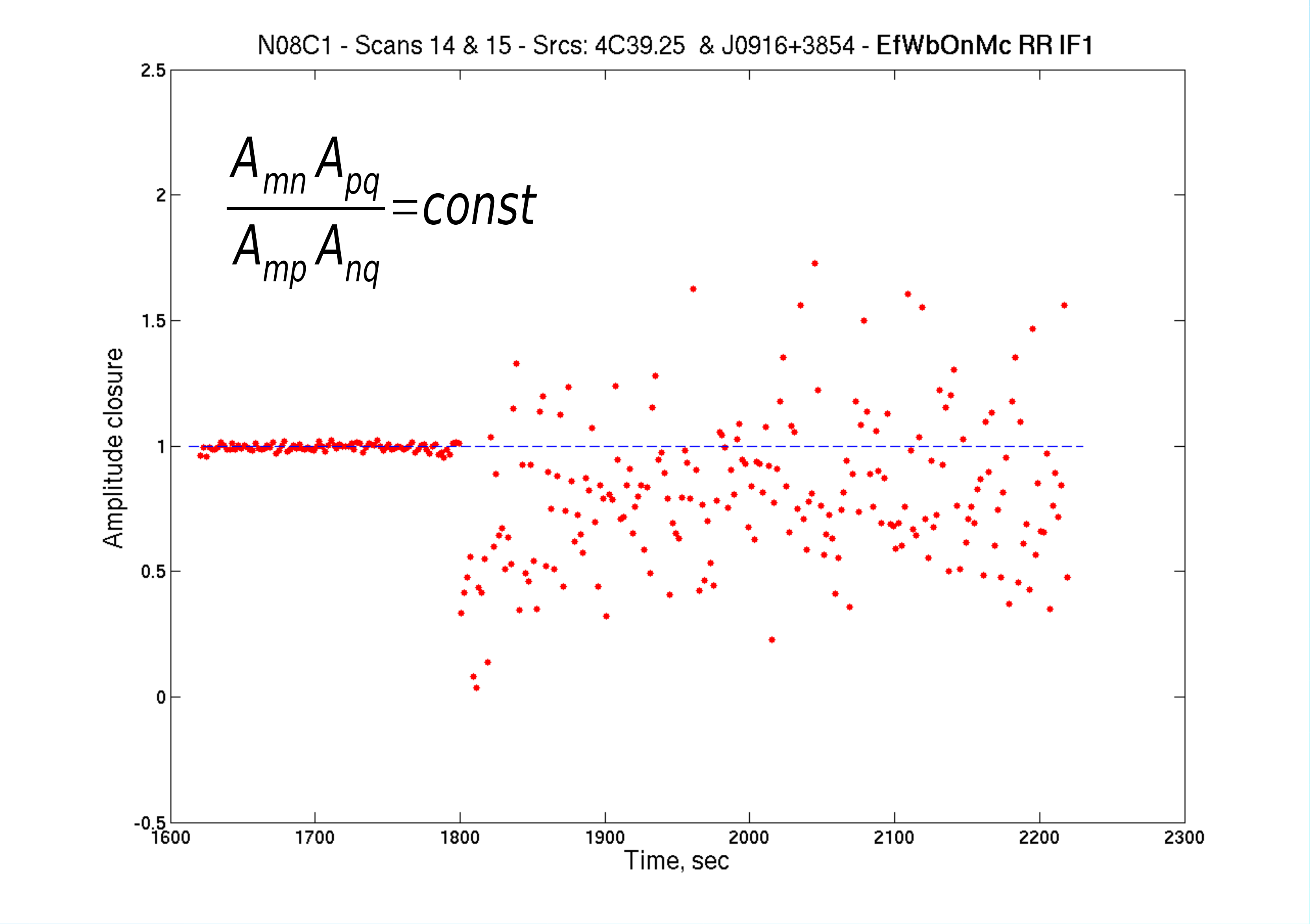
Phase difference



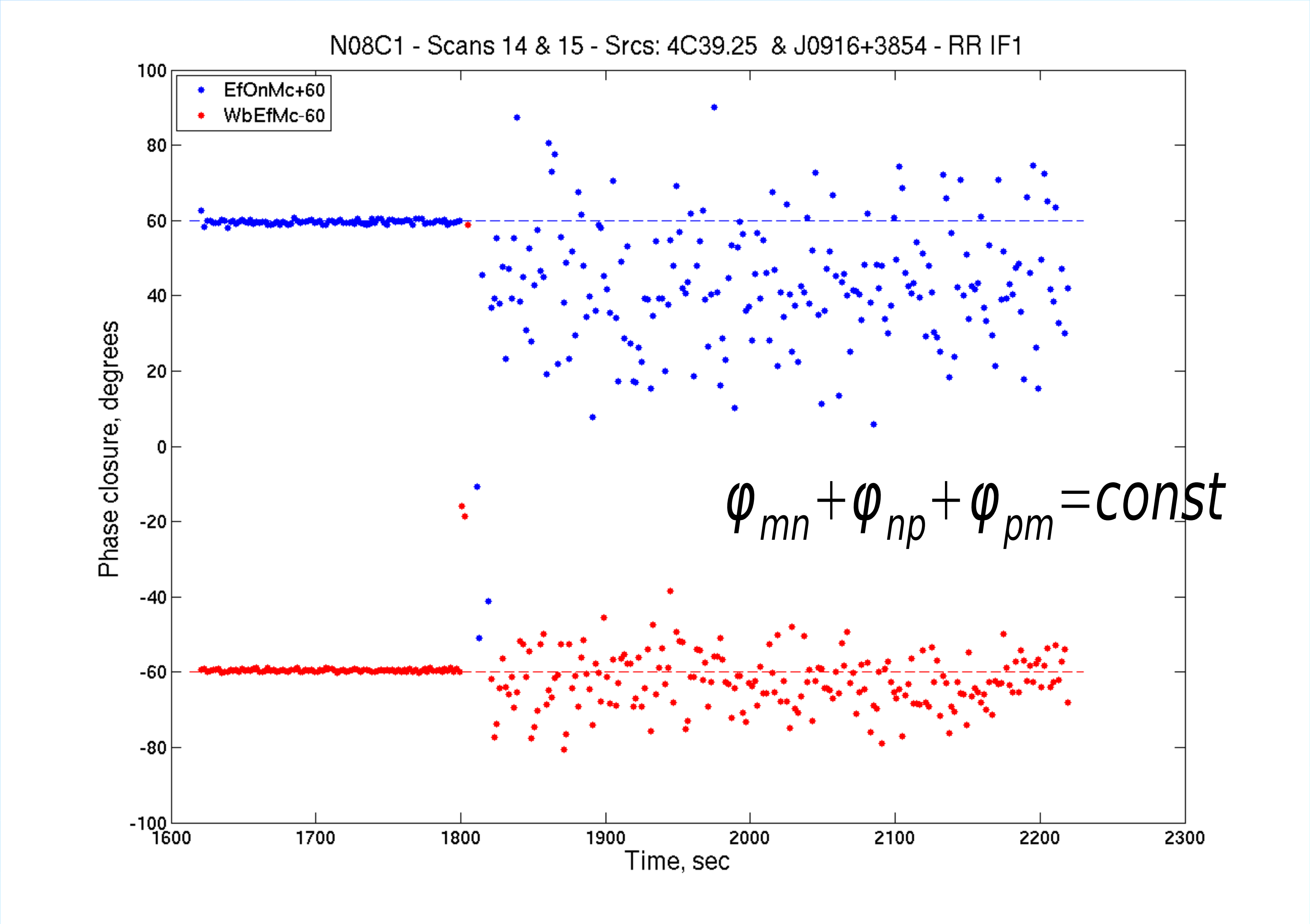
Amplitude difference



Amplitude closure



Phase closure



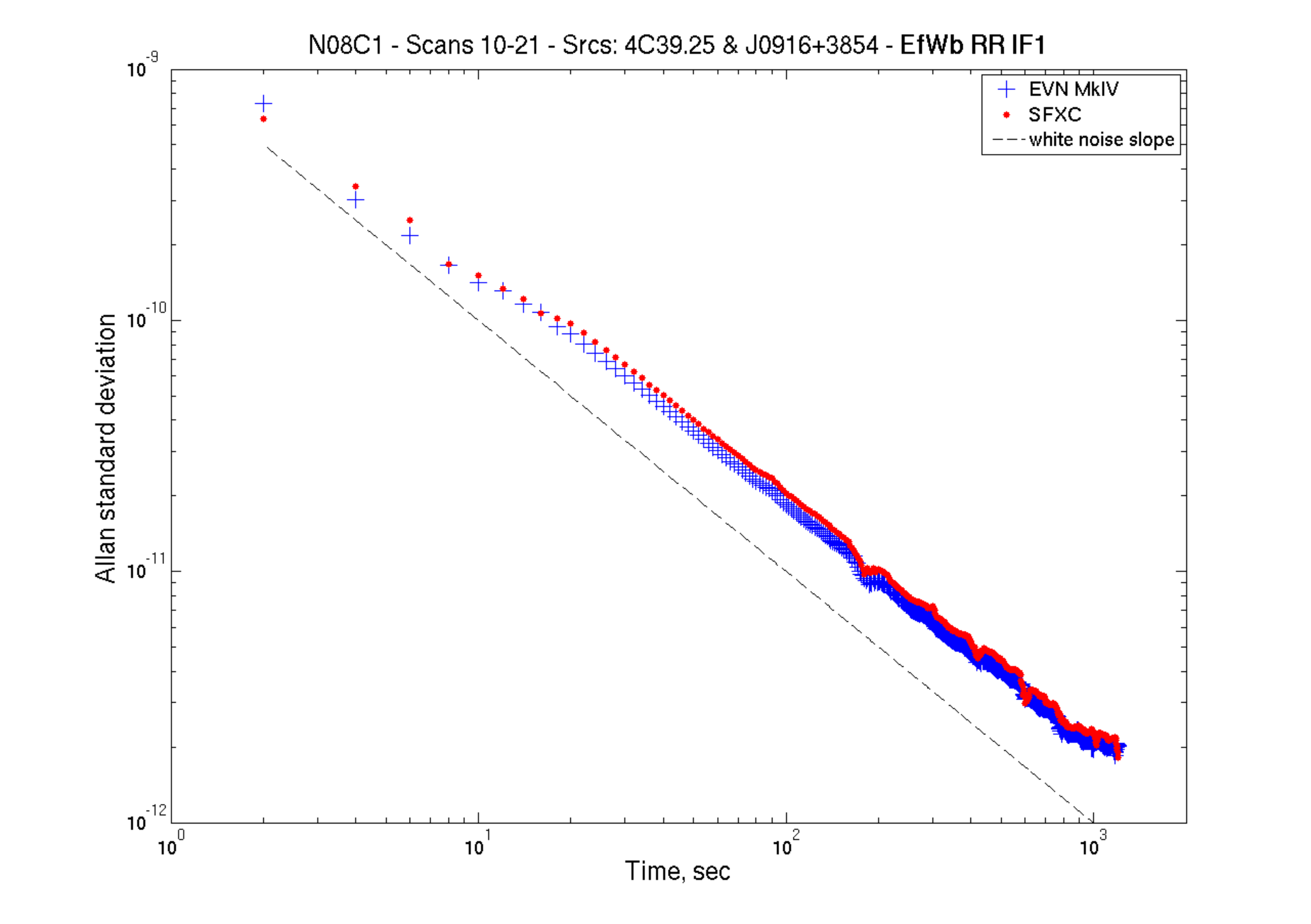
$$\varphi_{mn}+\varphi_{np}+\varphi_{pm}=const$$

Noise analysis

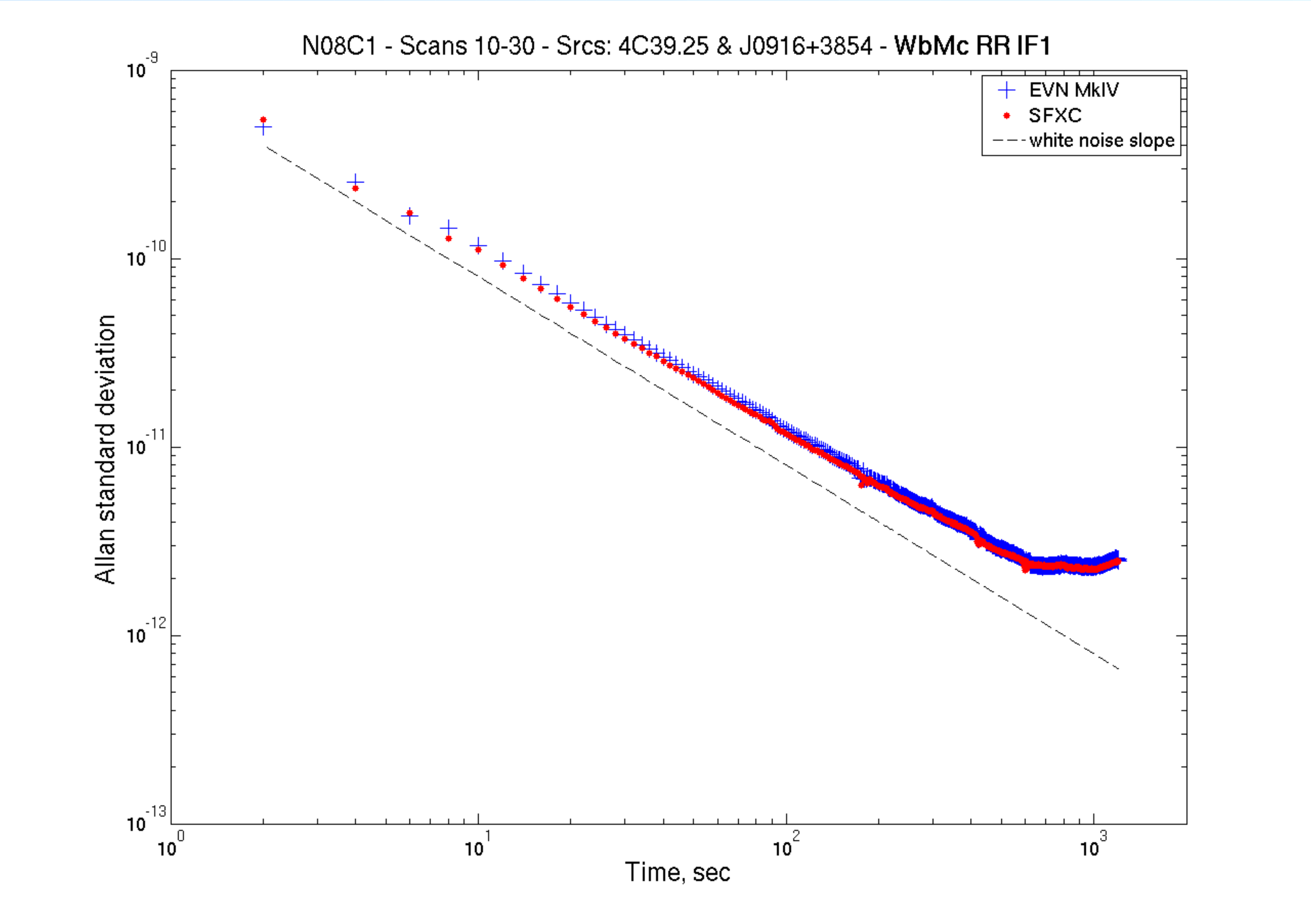
Allan standard deviation

$$\sigma^2(\Delta t) = \frac{\left\langle \left[\varphi(t + 2\Delta t) - 2\varphi(t + \Delta t) + \varphi(t) \right]^2 \right\rangle}{8\pi^2 \nu_0{}^2 \Delta t^2}$$

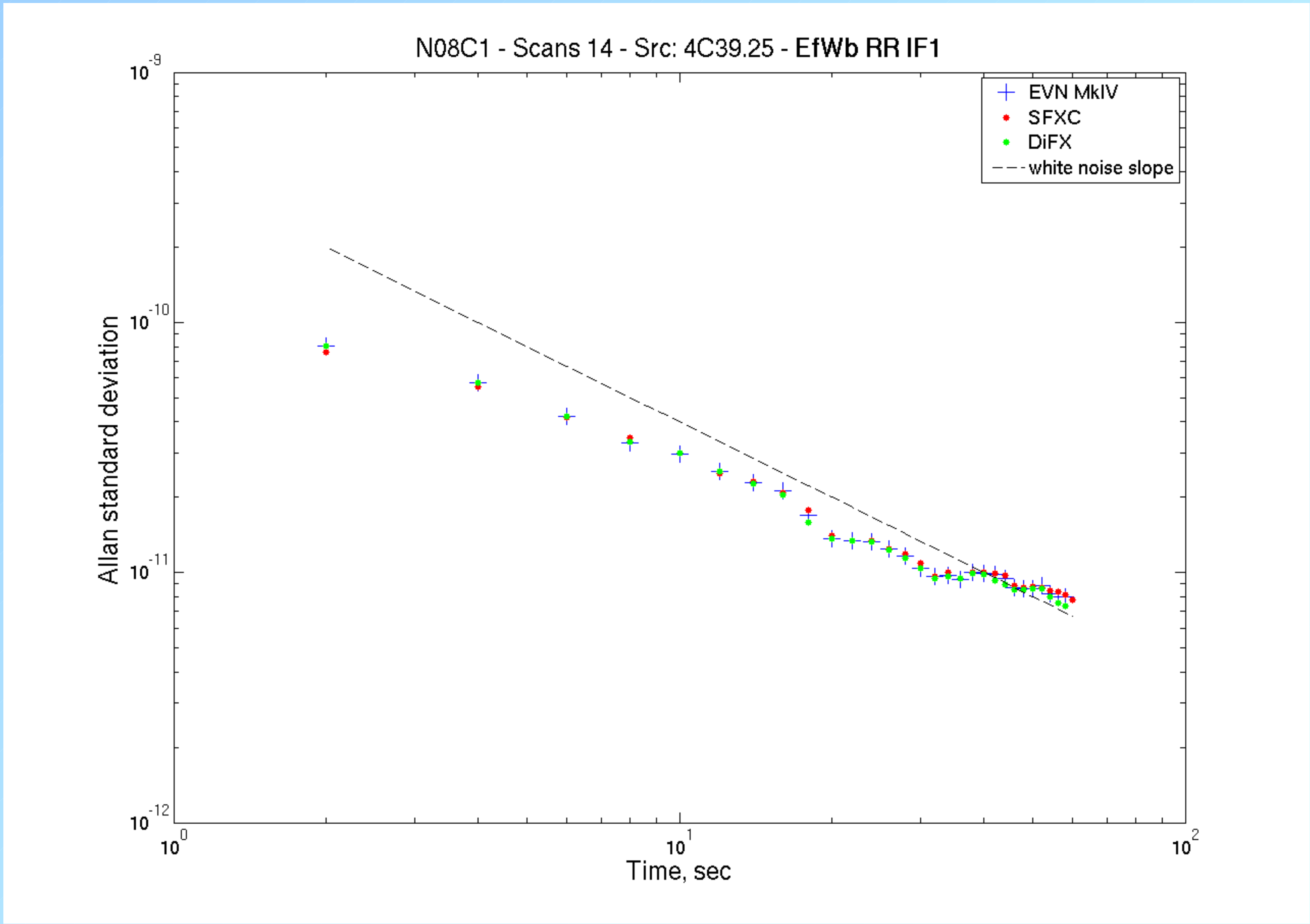
Noise analysis



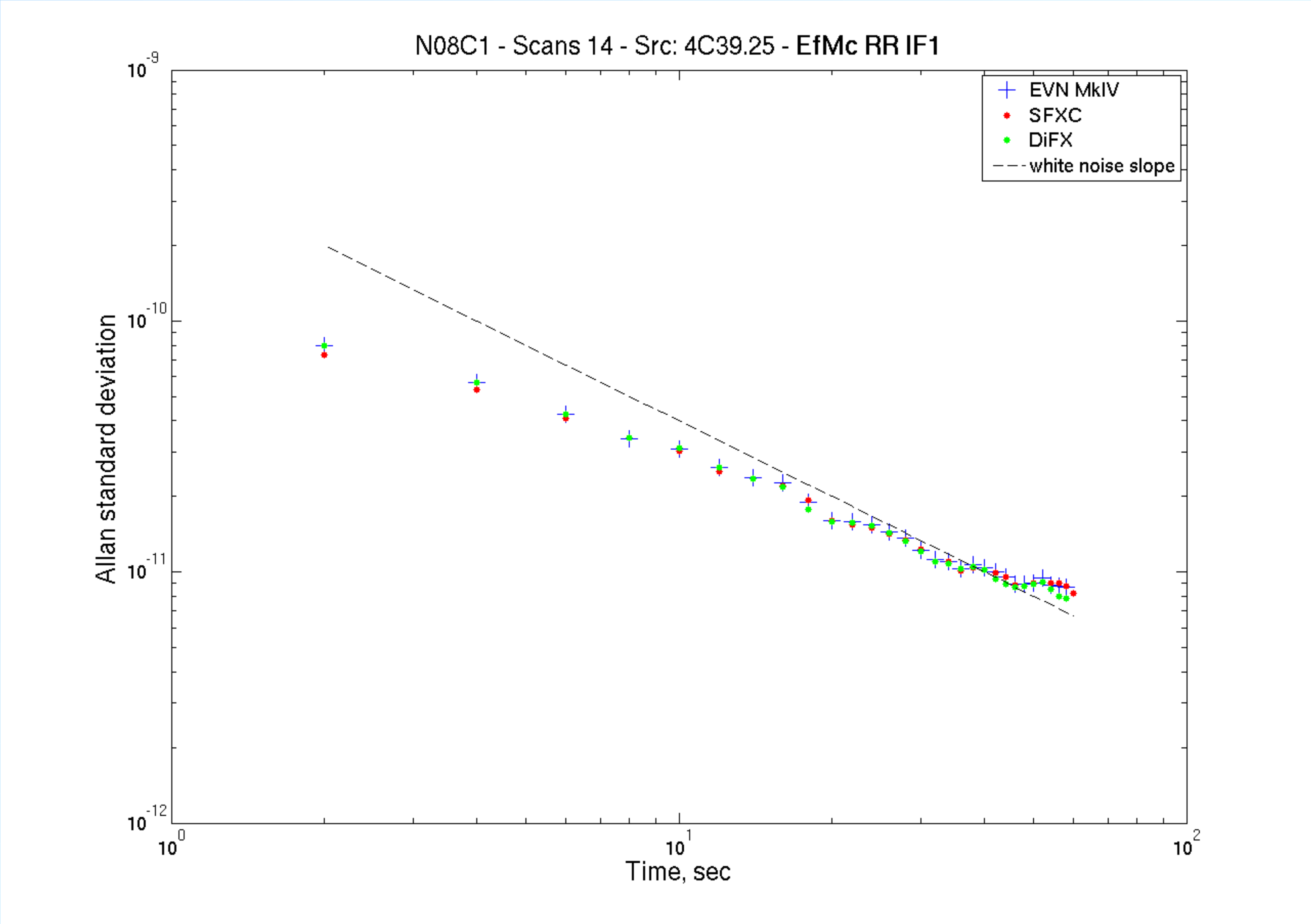
Noise analysis



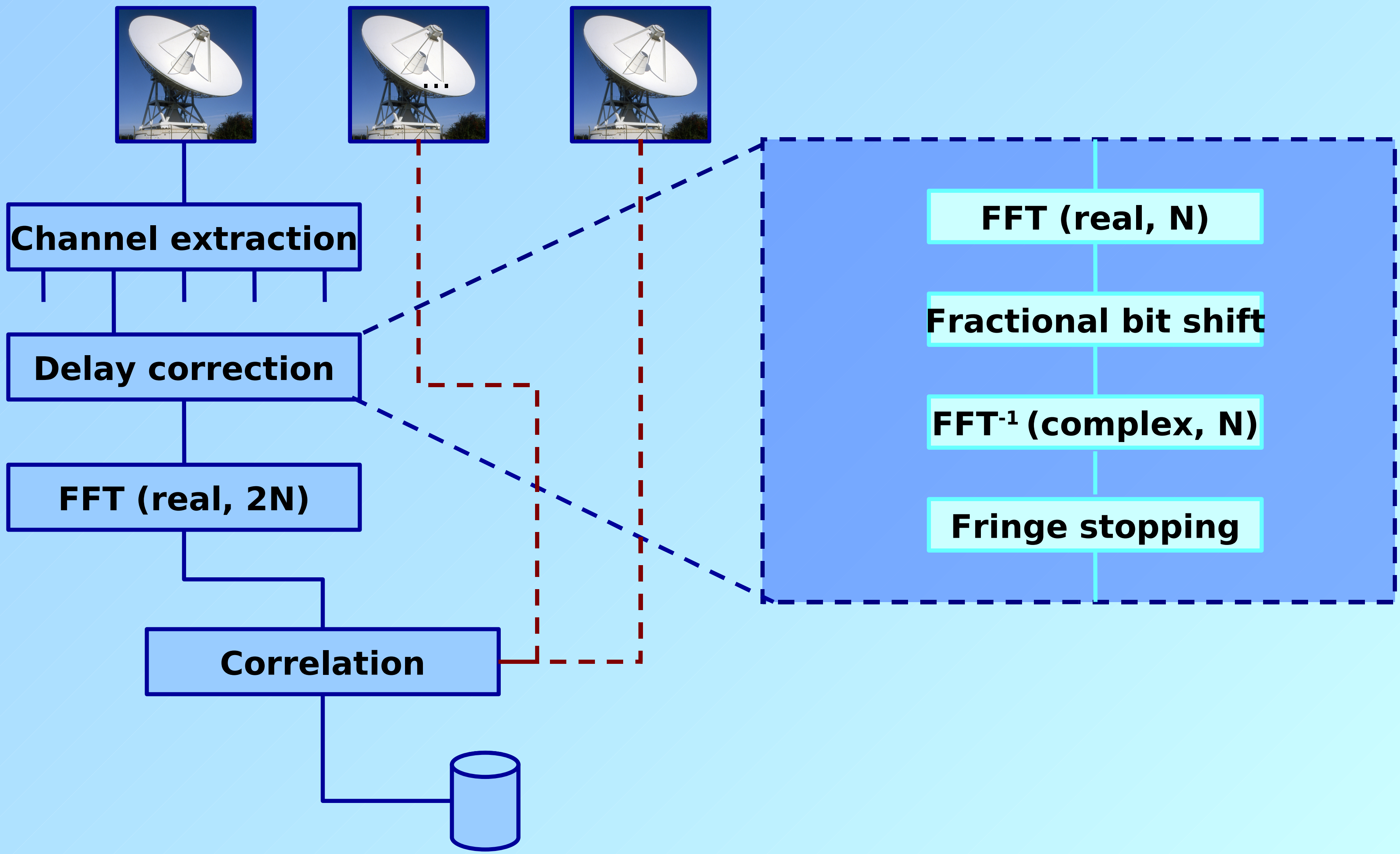
Noise analysis



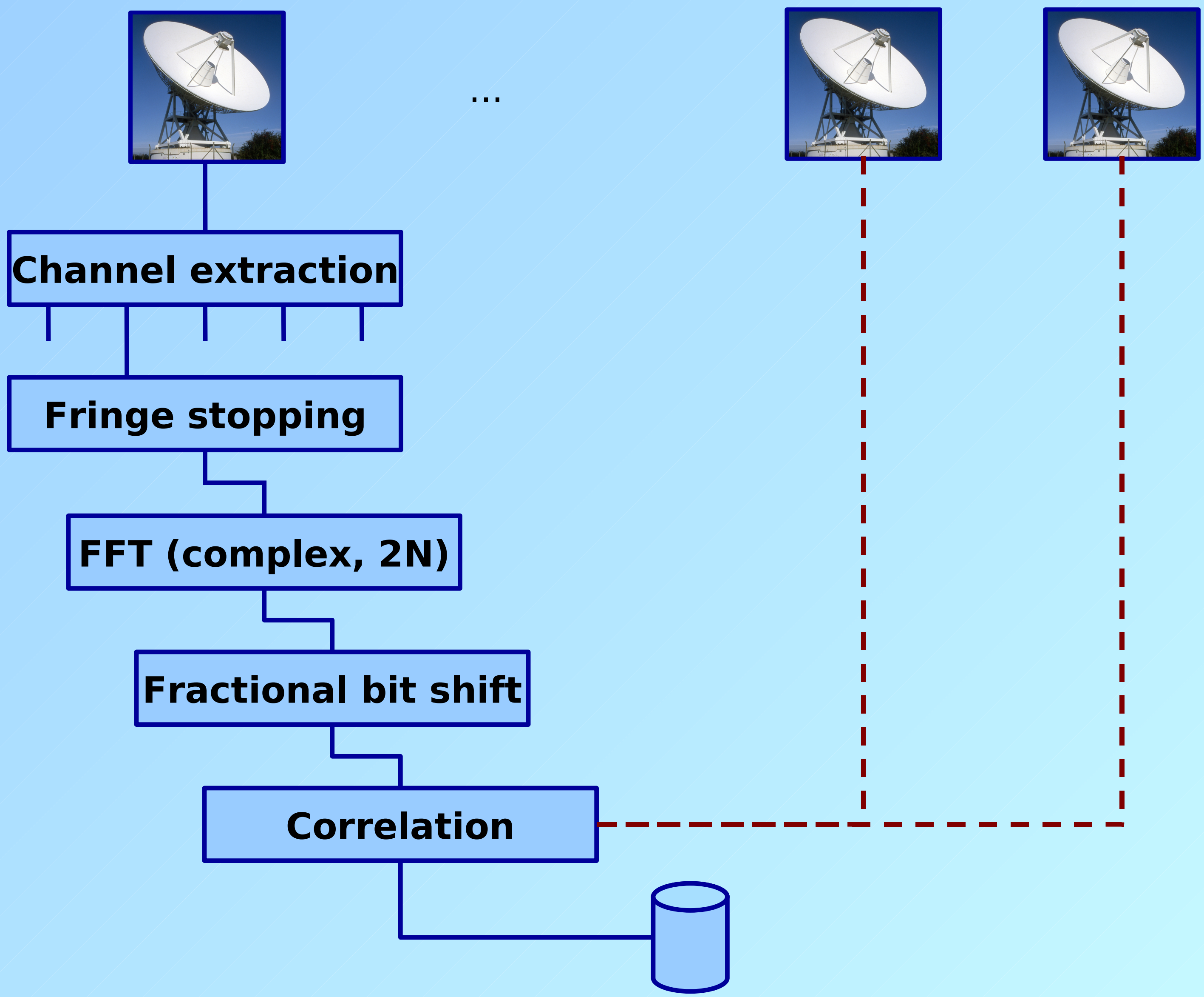
Noise analysis



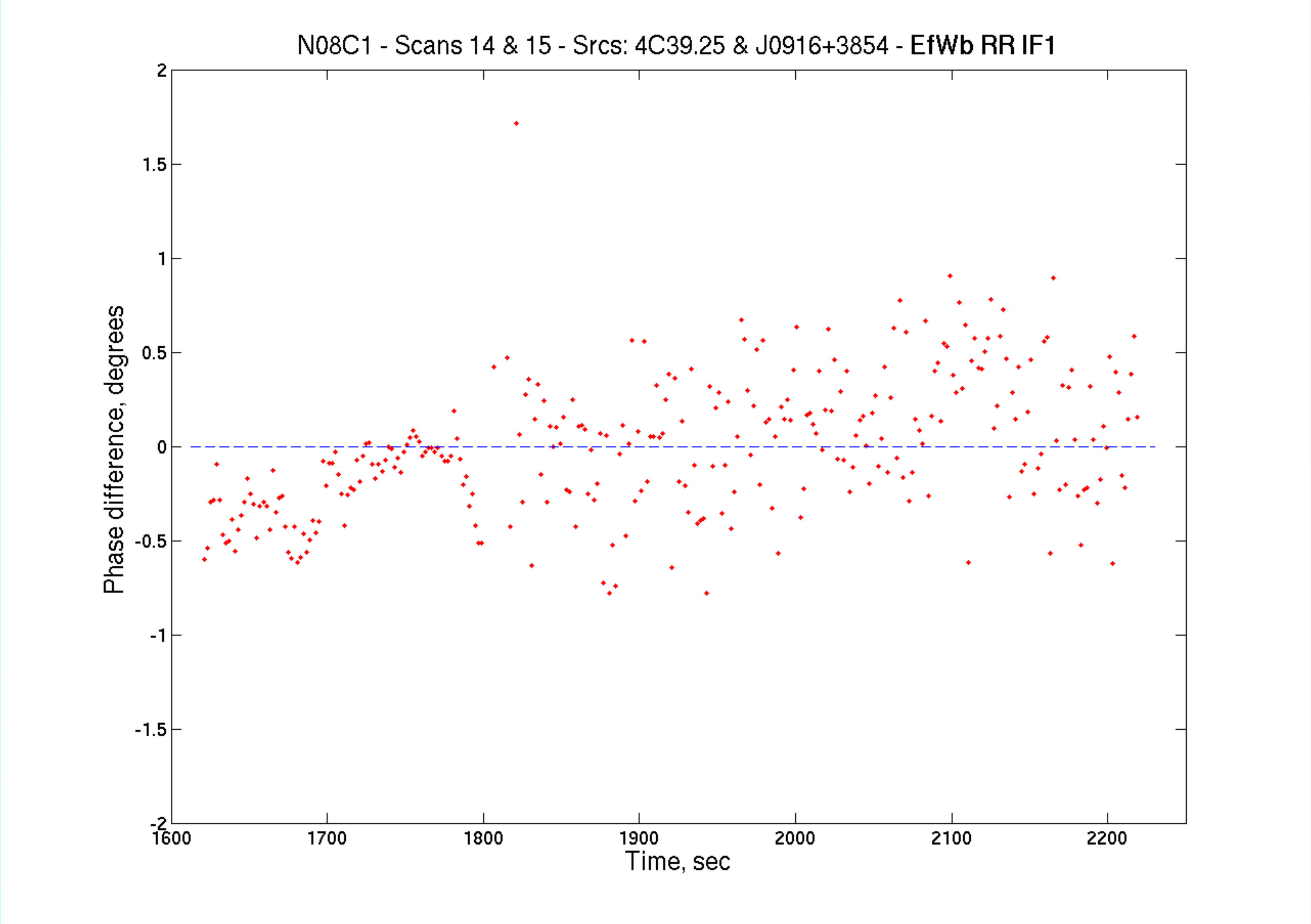
The Original Algorithm



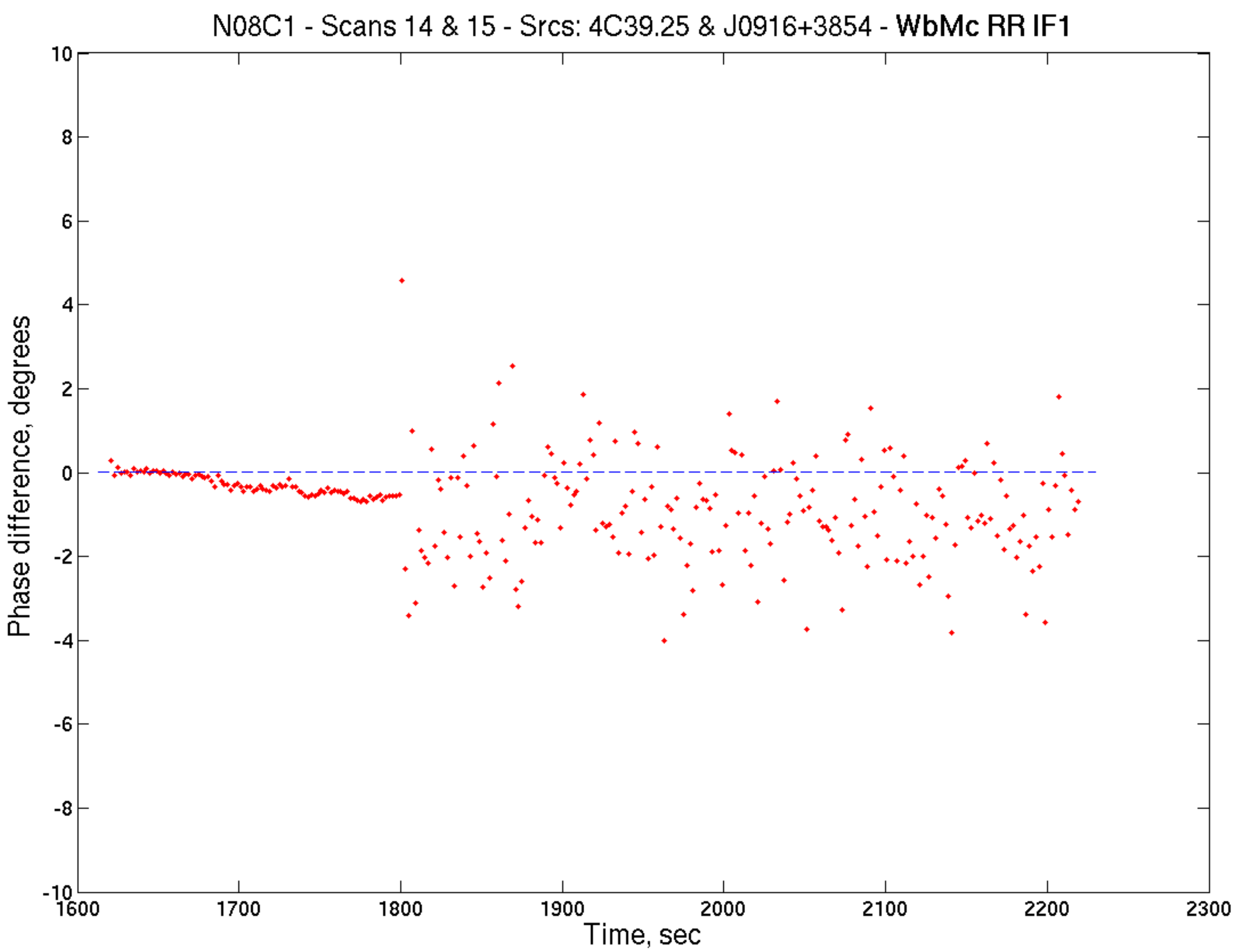
The New Algorithm (~25% less FFT)



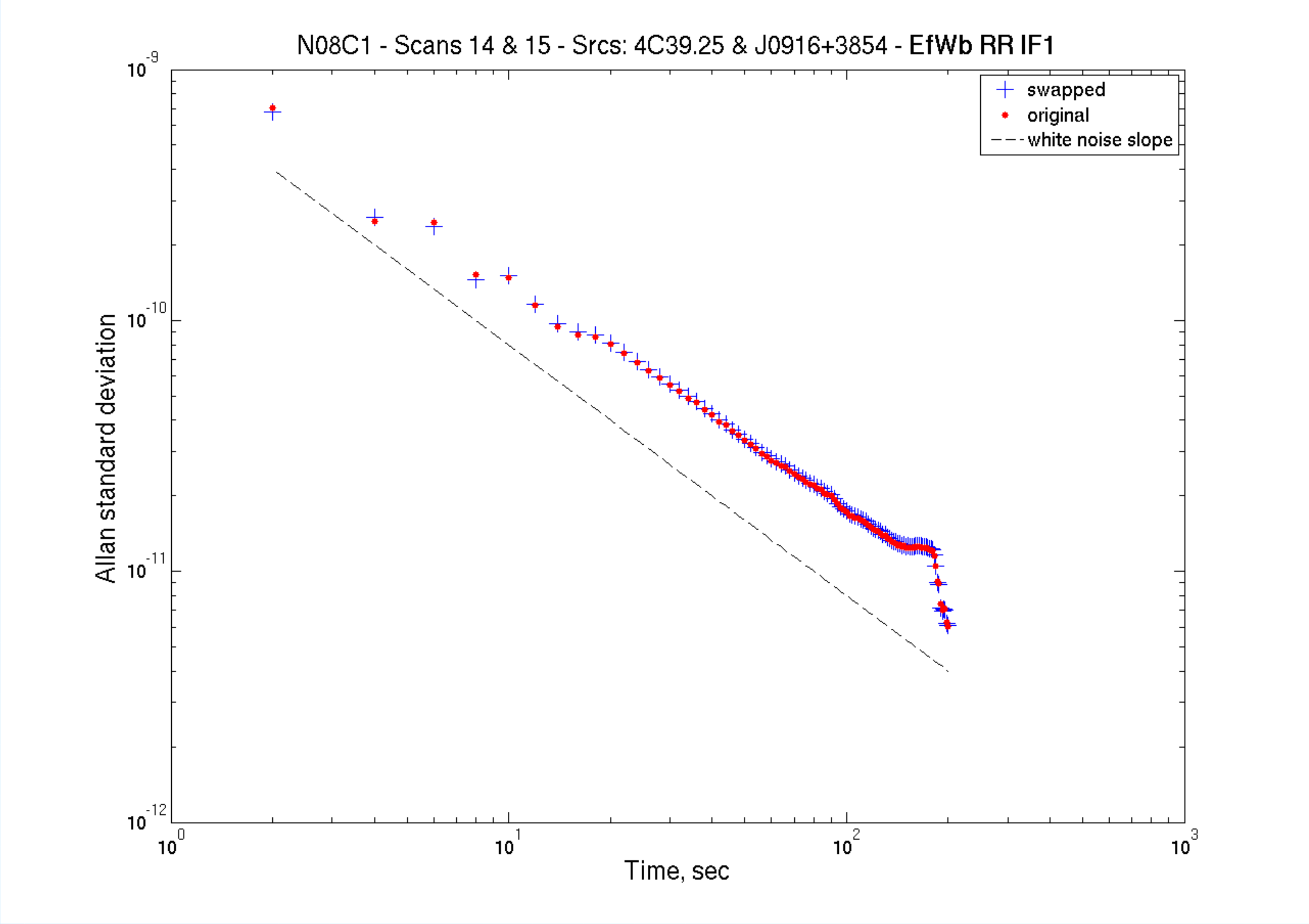
Algorithm comparison - phase



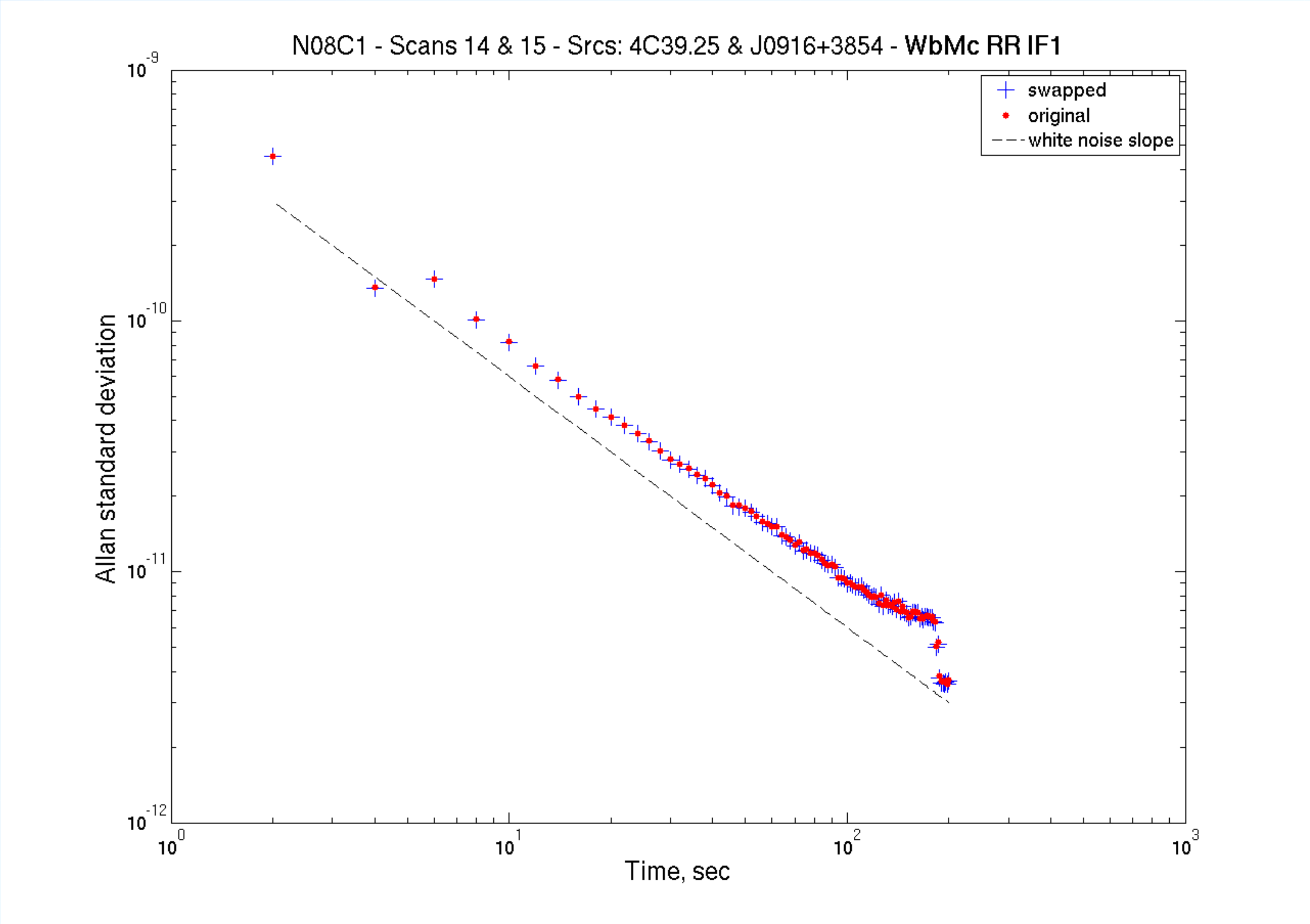
Algorithm comparison - phase



Algorithm comparison - noise



Algorithm comparison - noise



Conclusions

- The SFXC correlator is a fully operational tool, suitable for processing astronomical data on productive scale
- It checks well against both EVN Mark IV hardware and DiFX software correlators
- The new algorithm of introducing delay corrections was developed, which also checks well against its predecessor and may be used for boosting the SFXC correlator productivity