Two Way Time Transfer for TAI

- Situation TAI-0708 based on the latest BIPM data set

Z. Jiang and W. Lewandowski

BIPM

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Summary

- Raw data situation of TAI 0708
- TAI links
- Some H. maser links
- Comparison of TW-GPS of TAI 0708
- Conclusion

Numbers of measures per day

CH 0708: Mjd 54311-54341

Mjd

TAI link

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
1	CH	IPQ	358	12	12	12	11	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
2	CH	USNO	300	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
3	CH	NIST	359	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
4	CH	ROA	359	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
5	CH	PTB	359	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12
6	CH	IT	360	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
7	CH	SP	355	12	12	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12	11	12	12	11	12	12	10	12	12	12	12	12
8	CH	OP	52	7	3	2	9	7	6	2	6	6								1	1									2		
9	CH	VSL	343	12	12	12	12	12	12	12	12	12	12	12	12	1	7	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12
10	CH	TUG	49	6	4	5	2	4	6	6	6	5	1	3	1																	
11	CH	AOS	53	6	5	7	2	4	6	6	6	5	3	3																		
12	CH	OCA	148		3	12	12	12	12	12	12	11	12	9			8	12	12	9												

Total measurements of a TAI month

Number of measurements per day at CH side

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Numbers of measures per day

IT 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
13	IT	ROA	353	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	12	12	11	8
14	**IT**	**PTB**	**355**	**12**	**12**	**11**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**8**
15	IT	VSL	325	12	12	12	12	12	12	11	12	12	12	12	11	1	6	11	11	11	10	12	12	12	10	11	12	10	11	12	12	12	7
16	IT	SP	331	10	12	12	12	12	11	12	11	11	11	12	11	12	12	12	12	10	11	8	10	10	11	11	11	11	12	11	12	12	6
17	IT	OP	339	12	12	12	12	12	12	12	12	11	12	12	10	10	12	12	12	12	12	12	11	9	9	8	11	12	12	12	12	12	8
18	IT	IPQ	350	12	12	12	10	12	12	12	12	12	12	12	12	12	12	12	12	11	12	12	11	12	12	12	12	11	12	11	12	12	8
19	IT	CH	354	12	12	12	11	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	8
20	IT	NIST	354	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	7
21	IT	USNO	296	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	6
22	IT	AOS	52	7	5	8	2	3	6	6	5	5	1	2	2																		
23	IT	OCA	148		2	12	12	12	12	12	12	12	12	10			7	12	12	9													
24	IT	NPL	5						1					1					1				1				1						

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Numbers of measures per day

KRIS 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
25	KRIS	NICT	676	24	23	22	22	15	24	23	24	23	23	23	24	23	24	23	24	20	22	21	22	23	23	24	23	23	24	21	23	21	22
26	KRIS	NMIJ	559	24	22	22	22	15	24	23	24	23	23	23	24	23	24	23	24	20	22	21	22	22	23	21	22	23					
27	KRIS	TL	652	23	23	21	21	14	24	21	22	23	23	23	24	22	23	22	22	20	20	20	22	22	22	24	22	23	24	19	22	20	21
28	KRIS	SG	656	24	23	20	22	13	23	23	23	23	23	23	24	22	24	23	24	20	19	19	20	23	23	22	22	23	24	20	23	20	21
29	KRIS	NTSC	666	24	23	20	20	13	24	23	23	21	23	22	24	23	24	23	24	20	22	21	22	22	23	24	23	24	24	21	22	22	22

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Numbers of measures per day

NICT 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
30	NICT	KRIS	676	24	23	22	22	15	24	23	24	23	23	23	24	23	24	23	24	20	22	21	22	23	23	24	23	23	24	21	23	21	22
31	NICT	NMIJ	572	24	22	23	24	21	24	23	24	24	23	24	24	23	24	23	24	22	22	21	22	22	24	21	22	22					
32	NICT	TL	674	23	23	22	23	21	24	21	23	24	23	24	24	22	23	22	22	22	20	20	22	22	24	24	22	23	24	21	23	20	23
33	NICT	SG	669	24	23	21	23	19	23	23	23	22	23	24	24	22	24	23	24	22	19	19	20	23	24	22	22	22	24	22	24	19	22
34	NICT	NTSC	683	24	23	21	22	19	24	23	23	21	22	23	24	23	24	23	24	22	22	21	22	23	24	24	23	23	24	23	24	22	23
35	**NICT**	**PTB**	**484**	**20**	**22**	**21**	**23**	**23**	**23**	**21**	**21**	**21**	**20**	**22**	**21**	**23**	**23**	**21**	**15**	**19**	**17**	**17**			**11**	**22**	**22**	**20**			**3**	**13**	

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Numbers of measures per day

NIST 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
36	NIST	IPQ	352	12	12	12	10	12	10	12	12	12	12	11	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	11	12	11	12
37	NIST	CH	360	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
38	NIST	SP	349	12	12	12	12	12	12	12	12	12	11	11	11	12	11	12	12	12	11	12	12	12	12	10	9	12	12	12	12	11	12
39	NIST	OP	359	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
40	NIST	VSL	343	12	12	12	12	12	12	12	12	12	12	12	12	1	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
41	NIST	OCA	191	11	6	12	12	12	12	12	12	12	12	12	10	12	11	12	12	9													
42	**NIST**	**PTB**	**359**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**11**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
43	NIST	IT	356	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	8
44	NIST	ROA	357	12	12	12	12	11	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11
45	NIST	AOS	55	7	5	8	2	4	6	6	6	5	1	3	1					1													

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Numbers of measures per day

OCA 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
46	OCA	VSL	147	___	3	12	12	12	11	12	12	12	12	10	______		6	12	12	9	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
47	OCA	AOS	37	___	1	7	2	3	6	6	4	5	1	2	______		_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
48	OCA	CH	148	___	3	12	12	12	12	12	12	11	12	9	______		8	12	12	9	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
49	OCA	IPQ	146	___	3	12	12	12	11	12	12	10	12	9	______		8	12	12	9	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
50	OCA	NIST	149	___	3	12	12	12	12	12	12	12	12	9	______		8	12	12	9	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
51	OCA	USNO	140	___	1	10	10	10	10	10	10	10	10	10	10	___	10	10	10	9	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
52	OCA	ROA	147	___	2	11	12	12	12	12	12	12	12	10	______		7	12	12	9	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
53	OCA	IT	148	___	2	12	12	12	12	12	12	12	12	10	______		7	12	12	9	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
54	OCA	OP	147	___	2	12	12	12	12	12	12	11	12	10	______		7	12	12	9	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
55	OCA	SP	144	___	2	12	12	12	12	12	12	11	11	10	______		6	12	12	8	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
56	OCA	PTB	142	___	1	11	12	12	12	12	12	12	12	10	______		6	10	12	8	___	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Numbers of measures per day

OP 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
57	OP	VSL	338	12	12	12	12	12	12	12	12	12	12	12	12	1	3	11	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12
58	OP	SP	348	12	12	11	12	12	12	12	12	11	11	12	12	12	9	12	12	11	12	10	11	11	12	12	11	12	12	12	12	12	12
59	**OP**	**PTB**	**354**	**12**	**12**	**11**	**12**	**12**	**12**	**12**	**12**	**11**	**12**	**12**	**12**	**11**	**9**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
60	OP	IT	355	11	12	12	12	12	12	12	12	11	12	12	12	12	9	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
61	OP	ROA	354	12	12	12	12	12	12	12	12	11	12	12	12	12	9	12	12	12	12	12	12	12	12	12	12	12	11	12	12	11	12
62	OP	USNO	297	10	10	9	10	10	10	10	10	10	10	10	10	10	9	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	10
63	OP	NIST	356	12	12	11	12	12	12	12	12	12	12	12	12	12	9	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
64	OP	CH	355	12	12	11	12	12	12	12	11	12	12	12	12	12	9	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
65	OP	IPQ	343	12	12	11	12	11	12	11	12	11	11	12	11	12	7	12	11	12	12	11	12	11	12	11	11	12	12	12	12	12	11
66	OP	L11	9	9																													
67	OP	OCA	149	1	2	12	12	12	12	12	12	11	12	10	1	1	6	12	12	9													
68	OP	AOS	45		5	7	1	3	6	6	6	5	2	2	2																		
69	OP	NPL	13		1		1	1	1	1	1			1		1					1	1		1						1	1		

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Numbers of measures per day

PTB 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
70	PTB	OCA	185	12	4	11	12	12	12	12	12	12	12	12	11	11	10	10	12	8													
71	PTB	IT	360	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
72	PTB	ROA	358	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	12	12	11	12
73	PTB	OP	231	12	10	7	11	12	10	12	9	11	10	8	5	9	8	5	5	6	6	5	3	5	8	4	8	6	7	6	12	5	6
74	PTB	VSL	341	12	12	12	12	12	12	12	12	12	12	12	12	1	6	12	12	12	11	11	12	12	12	12	12	12	12	12	12	12	12
75	PTB	SP	345	12	12	12	10	11	11	11	12	11	9	11	12	12	12	12	12	12	12	10	11	11	12	12	11	12	12	12	12	12	12
76	PTB	CH	719	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	23	24	24	24	24	24	24	24	24	24	24	24
77	PTB	IPQ	355	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	11	12	12	10	11	12	12	12	12	12	12	12
78	PTB	USNO	300	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
79	PTB	NIST	359	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12
80	PTB	NPL	231	5	9	4	11	9	9	8	7	10	11	6	6	8	5	7	6	4	11	9	10	10	6	8	8	8	7	5	8	7	9
81	PTB	AOS	53	7	5	8	2	3	6	6	5	5	2	2	2																		
82	PTB	NICT	484	20	22	21	23	23	23	21	21	21	20	22	21	23	23	21	15	19	17	17					11	22	22	20	3	13	

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Numbers of measures per day

ROA 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
84	ROA	IT0	360	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
85	ROA	OCA	189	11	5	12	12	12	12	12	12	12	12	12	12	9	11	12	12	9													
86	**ROA**	**PTB**	**358**	**12**	**12**	**11**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**11**	**12**	**12**	**12**	**12**
87	ROA	SP	335	11	11	12	11	11	12	9	12	12	10	10	11	12	11	12	11	11	12	9	11	9	12	11	12	12	12	12	12	11	11
88	ROA	VSL	341	12	12	12	12	12	12	12	12	12	12	12	12	1	6	11	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12
89	ROA	OP	358	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	12	12	12	12
90	ROA	CH	360	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
91	ROA	IPQ	352	12	12	12	11	12	12	12	12	12	11	12	12	12	12	12	12	10	12	12	12	12	12	11	11	12	12	11	12	11	12
92	ROA	USNO	300	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
93	ROA	NIST	360	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
94	ROA	L11	52	7	5	8	2	3	6	6	5	5	1	2	2																		
95	ROA	NPL	132	5	3	6	4	3	2	5	3	4	6	6	4	4	5	3	4	4	7	6	5	6	5	3	4	8	3	2	2	5	5

Tsoft

Numbers of measures per day

SP 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
96	SP	VSL	329	4	12	12	12	12	12	12	12	12	12	12	11	1	6	11	12	10	11	12	12	12	12	12	11	12	12	12	12	12	12
97	SP	OP	206	5	11	10	12	12	12	12	10	11	12	8	1	6	8	5	1	7	12	4	1	1	2	2	4	4	6	11	8	8
98	SP	ROA	346	4	12	12	12	12	12	12	12	12	12	12	11	12	12	12	12	10	12	12	12	12	12	12	11	12	11	12	12	11	12
99	SP	IT	349	4	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	9	12	12	12	12	12	12	12	12	12	12	12	12	12
**	SP	PTB	347	5	12	12	12	12	12	12	12	12	12	12	11	12	12	12	12	11	12	10	12	12	12	12	11	12	12	12	12	12	11
**	SP	NIST	346	6	12	12	12	12	12	12	12	12	12	11	11	12	12	12	12	10	11	11	12	12	12	12	10	12	12	12	12	12	12
**	SP	USNO	294	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	10	10	10	10	10
**	SP	CH	351	4	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12
**	SP	IPQ	330	3	11	11	12	11	11	11	12	11	12	9	12	12	12	12	10	12	10	10	11	12	11	12	12	10	12	12	12	10	12
**	SP	OCA	175	3	4	12	12	12	12	12	12	12	12	12	9	10	10	12	12	7													
**	SP	AOS	47	2	5	8	1	3	6	6	5	5	2	2	2																		
**	SP	NPL	29	1	3	1	1		2			1		1	2	1	1					3	3	1	3		2	3					

Tsoft

Numbers of measures per day

TL 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
**	TL	NICT	674	23	23	22	23	21	24	21	23	24	23	24	24	22	23	22	22	22	20	20	22	22	24	24	22	23	24	21	23	20	23
**	TL	KRIS	652	23	23	21	21	14	24	21	22	23	23	23	24	22	23	22	22	20	20	20	22	22	22	24	22	23	24	19	22	20	21
**	TL	NMIJ	554	23	22	22	23	21	24	21	23	24	23	24	24	22	23	22	21	22	20	20	22	21	23	21	21	22					
**	TL	SG	647	23	23	21	21	19	23	21	22	23	23	24	24	21	23	21	22	22	17	19	19	21	24	22	21	21	24	20	23	17	23
**	TL	NTSC	645	23	23	21	21	19	24	21	22	15	10	23	24	22	23	22	22	22	20	20	22	22	24	23	22	23	24	21	23	21	23

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Numbers of measures per day

USNO KU 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
**	USNO	CH	285	10	10	10	10	10	10	7	1	8	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
**	USNO	OP	283	10	10	9	9	10	10	7	1	8	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
**	USNO	VSL	270	10	10	10	10	10	10	7	1	8	9	10	10	1	4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
****	**USNO**	**PTB**	**284**	**10**	**10**	**10**	**9**	**10**	**10**	**7**	**1**	**8**	**9**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
**	USNO	ROA	281	10	10	10	9	9	10	6	1	8	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	9
**	USNO	IT	281	10	10	10	9	10	10	7	1	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	6
**	USNO	AOS	41	6	5	7	2	4	5	3	1	3	1	3	1																		
**	USNO	OCA	135	1	1	10	9	10	10	7	1	8	9	10	10	10	10	10	10	9													
**	USNO	SP	209								1	8	9	10	10	10	9	9	10	9	10	10	9	9	10	9	10	9	8	10	10	10	10

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Numbers of measures per day

VSL 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
**	VSL	SP	337	12	12	12	12	12	12	12	12	12	11	12	12	1	6	12	12	11	12	10	11	11	12	12	12	12	12	12	12	12
**	VSL	OP	342	12	12	12	12	12	12	12	12	11	12	12	12	1	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
**	VSL	IT	343	12	12	12	12	12	12	12	12	12	12	12	12	1	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
**	VSL	ROA	342	12	12	12	12	12	12	12	12	12	12	12	12	1	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	12
****	**VSL**	**PTB**	**341**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**1**	**6**	**12**	**12**	**12**	**11**	**11**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
**	VSL	OCA	177	11	6	12	12	12	12	12	12	12	12	12	12	1	6	12	12	9													
**	VSL	USNO	285	10	10	10	10	10	10	10	10	10	10	10	10	1	4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
**	VSL	NIST	343	12	12	12	12	12	12	12	12	12	12	12	12	1	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
**	VSL	IPQ	340	11	12	12	12	12	12	12	12	12	12	12	12	1	6	12	12	11	12	12	12	12	12	12	12	12	12	12	11	12	12
**	VSL	CH	344	12	12	12	12	12	12	12	12	12	12	12	12	1	7	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
**	VSL	NTSC	982	36	36	36	36	36	36	36	36	35	33	35	36		21	6	24	36	36	36	36	36	36	36	36	36	36	36	36	36	36
**	VSL	AOS	53	8	5	8	1	3	6	6	5	5	2	2	2																		
**	VSL	NPL	5																		2		1		1		1						

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Numbers of measures per day

X Band USNO-PTB 0708: Mjd 54311-54341

No	Lab1	Lab2	54311	12	13	14/	15	16	17	18	19/	20	21	22	23	24/	25	26	27	28	29/	30	31	32	33	34/	35	36	37	38	39/	40	41
**	USNX	PTBX	280	11	8	8	11	11	11	10	8	6	11	11	11	11	12	11	11	11	11	11	6	7	12	11	11	11	7___	8	12___		
**	PTBX	USNX	280	11	8	8	11	11	11	10	8	6	11	11	11	11	12	11	11	11	11	11	6	7	12	11	11	11	7___	8	12___		

Remark: there were 24 points per day before !

Tsoft

Summary Raw data situation

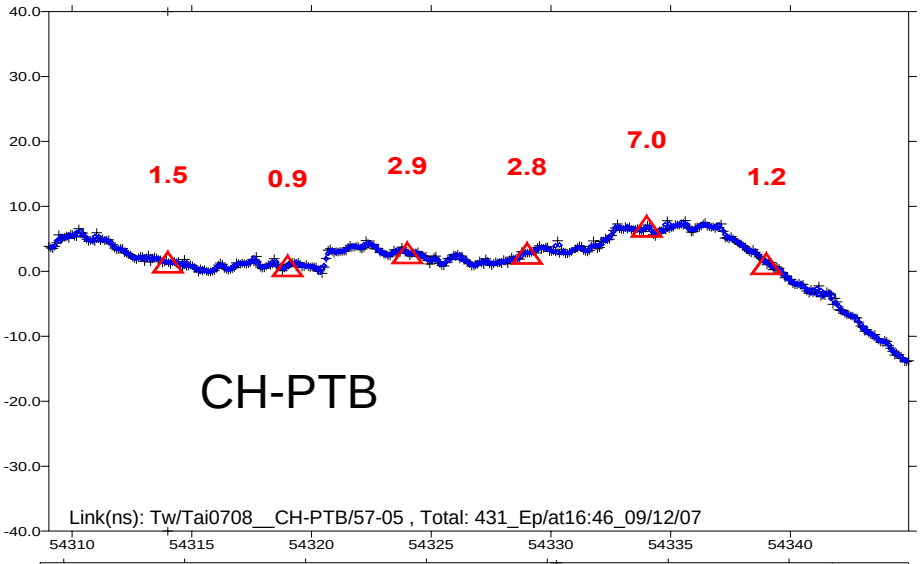
- Total « one way » links: 135
- Europe-American: 12 points per days
- Double TW link USNO-PTB Ku and X bans
- Asia-Pacific: 24 points per days
- Asia-Europe NICT-PTB: 24 per days
- Other Asia-Europe links are under taking

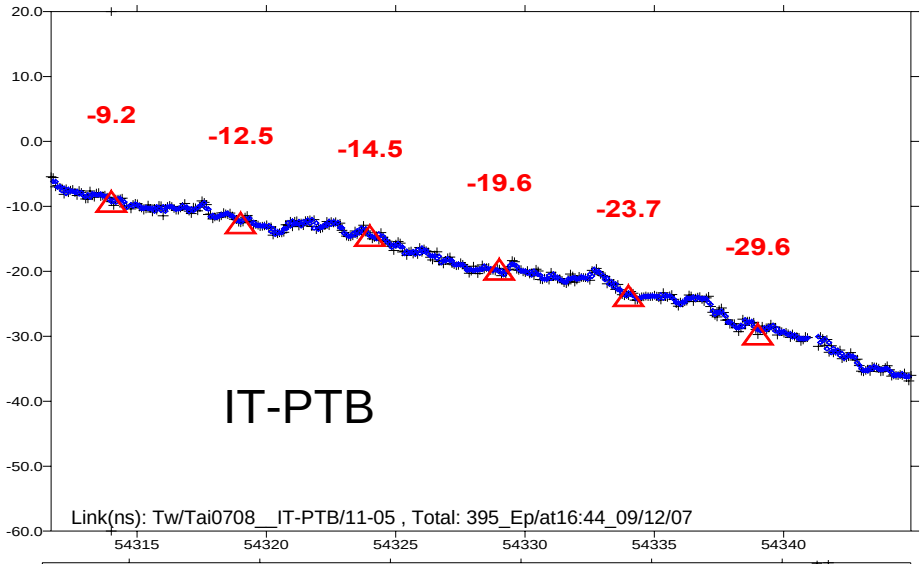
- Some holes including TAI links
- Calibrations

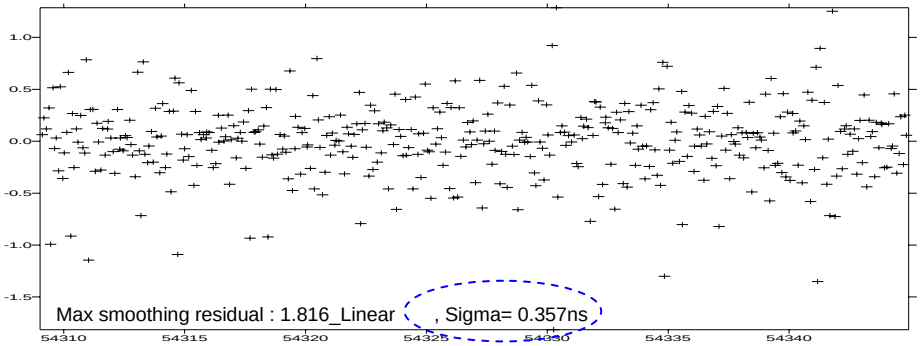
TAI 0708 links

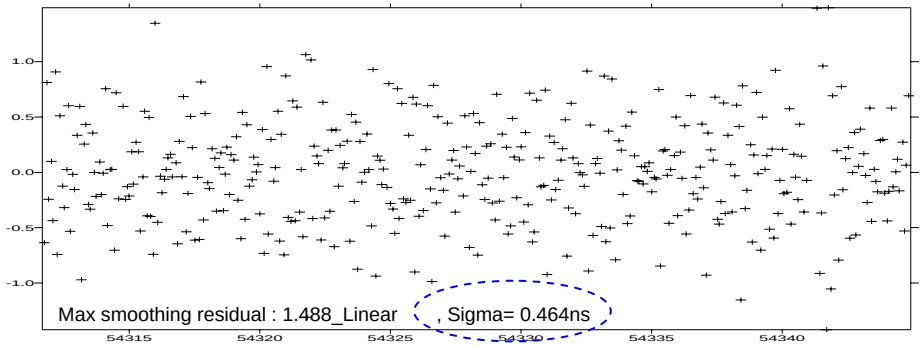
PTB with

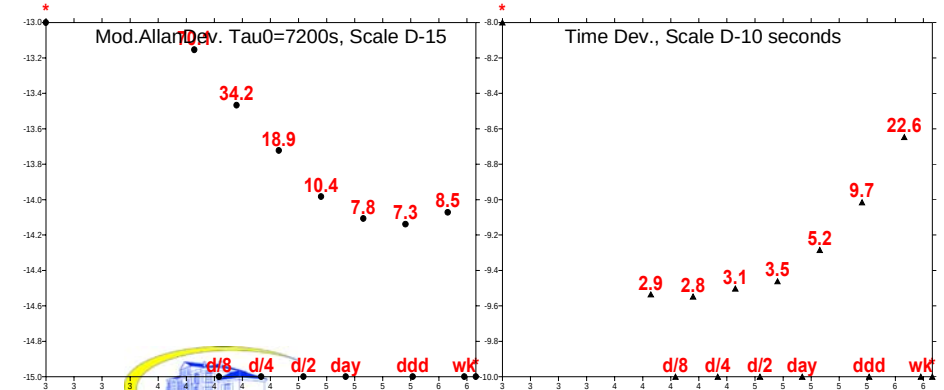
- CH
- IT
- NICT
- OP
- ROA
- SP
- USNO
- VSL
- NPL not available since months

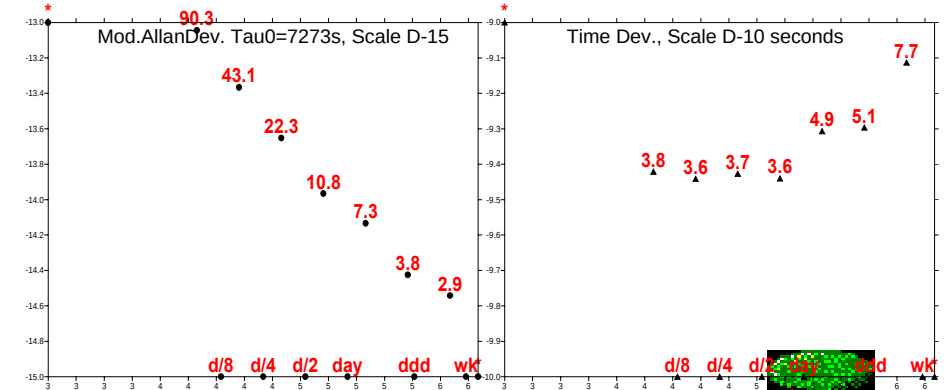

1.5
0.9
2.9
2.8
7.0
1.2
CH-PTB
Link(ns): Tw/Tai0708__CH-PTB/57-05 , Total: 431_Ep/at16:46_09/12/07

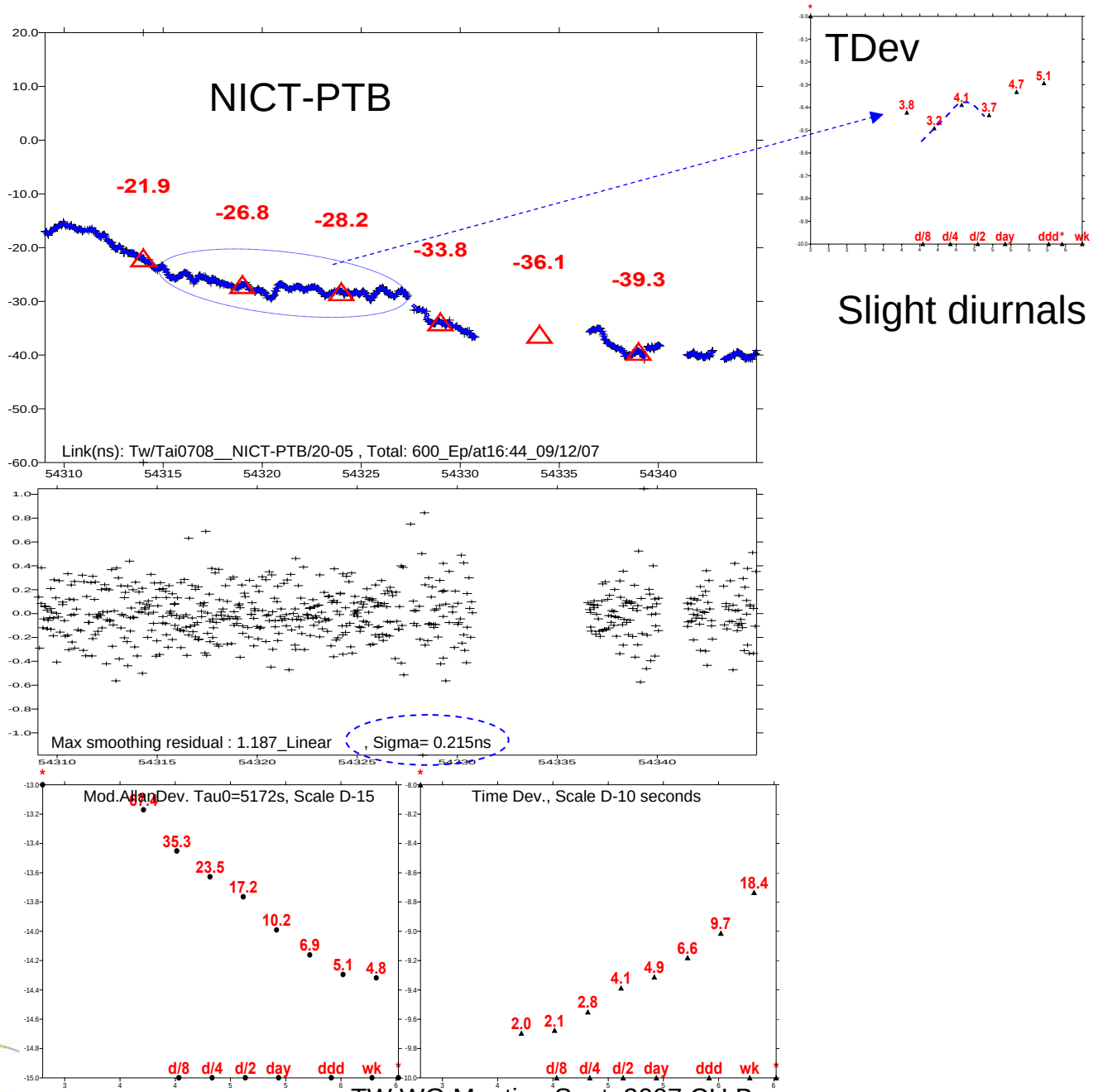

-9.2
-12.5
-14.5
-19.6
-23.7
-29.6
IT-PTB
Link(ns): Tw/Tai0708__IT-PTB/11-05 , Total: 395_Ep/at16:44_09/12/07


Max smoothing residual : 1.816_Linear , Sigma= 0.357ns

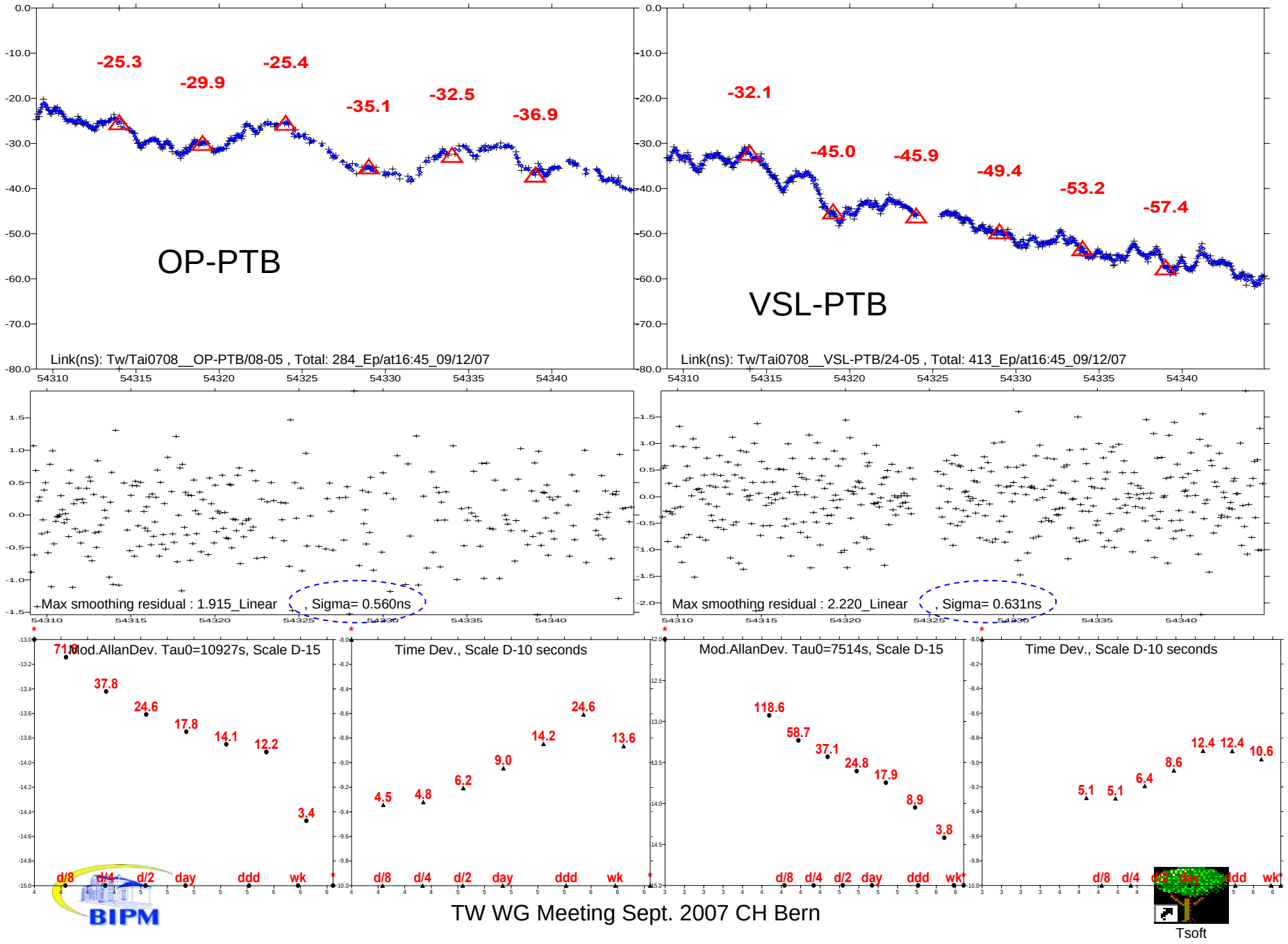

Max smoothing residual : 1.488_Linear , Sigma= 0.464ns


Mod.AllanDev. Tau0=7200s, Scale D-15
34.2
18.9
10.4
7.8
7.3
8.5
Time Dev., Scale D-10 seconds
22.6
9.7
5.2
2.9
2.8
3.1
3.5
d/8 d/4 d/2 day ddd wk

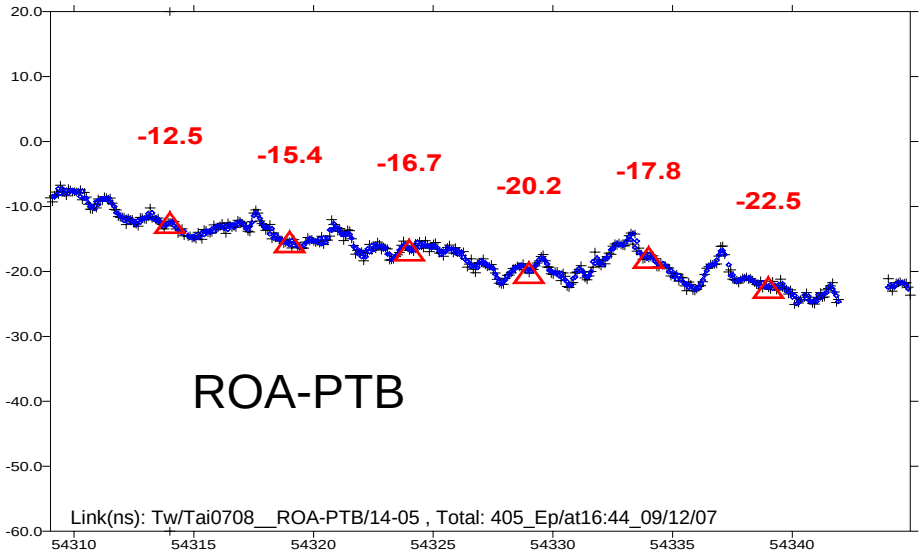

Mod.AllanDev. Tau0=7273s, Scale D-15
90.3
43.1
22.3
10.8
7.3
3.8
2.9
Time Dev., Scale D-10 seconds
7.7
4.9
5.1
3.8
3.6
3.7
3.6
d/8 d/4 d/2 day ddd wk

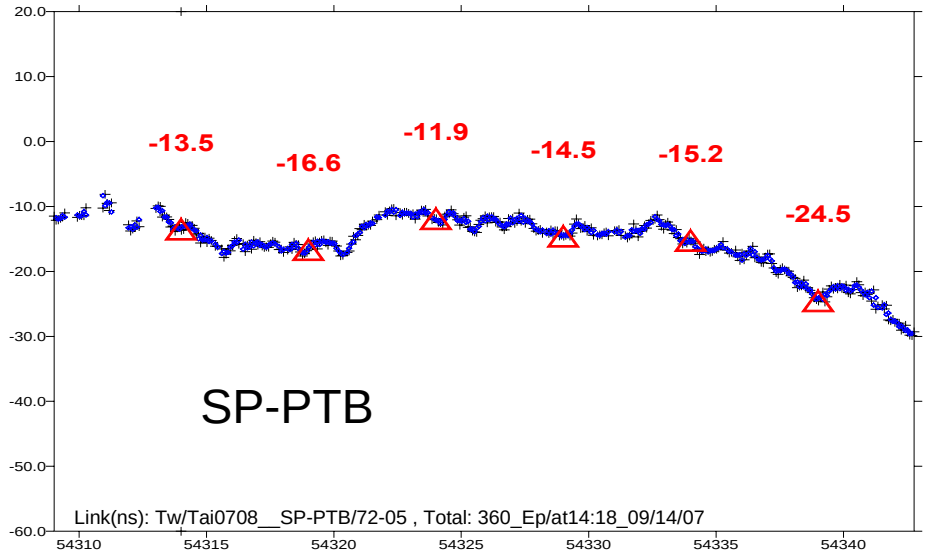

NICT-PTB
-21.9
-26.8
-28.2
-33.8
-36.1
-39.3
Link(ns): Tw/Tai0708__NICT-PTB/20-05 , Total: 600_Ep/at16:44_09/12/07
Max smoothing residual : 1.187_Linear
, Sigma= 0.215ns
Mod.AllanDev. Tau0=5172s, Scale D-15
Time Dev., Scale D-10 seconds
d/8 d/4 d/2 day ddd wk
TDev
3.8
3.2
4.1
3.7
4.7
5.1
Slight diurnals

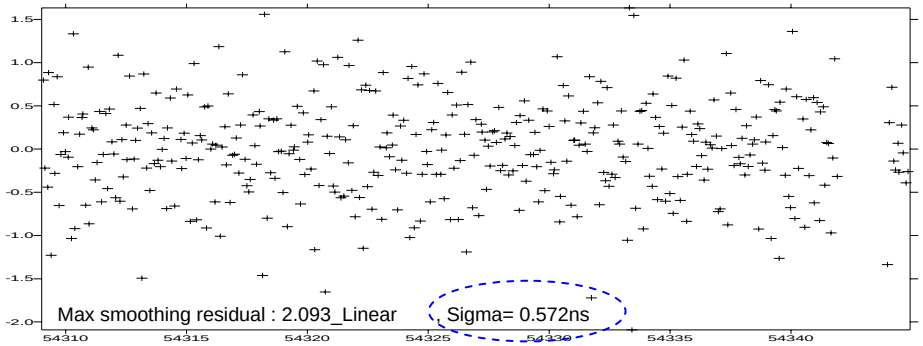
Tsoft

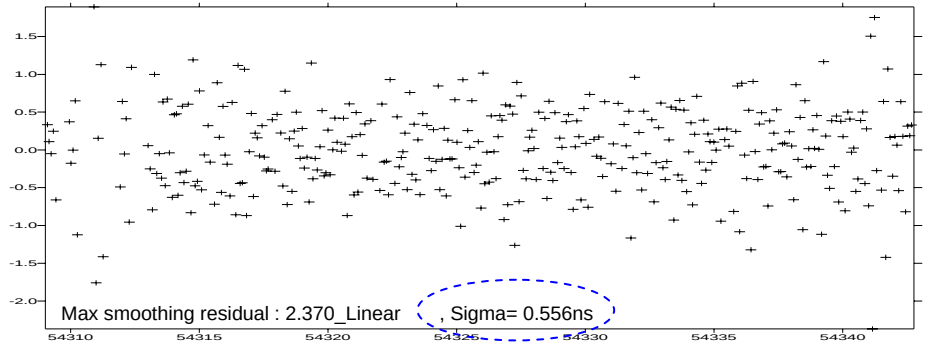

OP-PTB
-25.3
-29.9
-25.4
-35.1
-32.5
-36.9
Link(ns): Tw/Tai0708__OP-PTB/08-05 , Total: 284_Ep/at16:45_09/12/07
VSL-PTB
-32.1
-45.0
-45.9
-49.4
-53.2
-57.4
Link(ns): Tw/Tai0708__VSL-PTB/24-05 , Total: 413_Ep/at16:45_09/12/07
Max smoothing residual : 1.915_Linear , Sigma= 0.560ns
Max smoothing residual : 2.220_Linear , Sigma= 0.631ns
Mod.AllanDev. Tau0=10927s, Scale D-15
71.8
37.8
24.6
17.8
14.1
12.2
3.4
Time Dev., Scale D-10 seconds
4.5
4.8
6.2
9.0
14.2
24.6
13.6
Mod.AllanDev. Tau0=7514s, Scale D-15
118.6
58.7
37.1
24.8
17.9
8.9
3.8
Time Dev., Scale D-10 seconds
5.1
5.1
6.4
8.6
12.4
12.4
10.6
d/8 d/4 d/2 day ddd wk

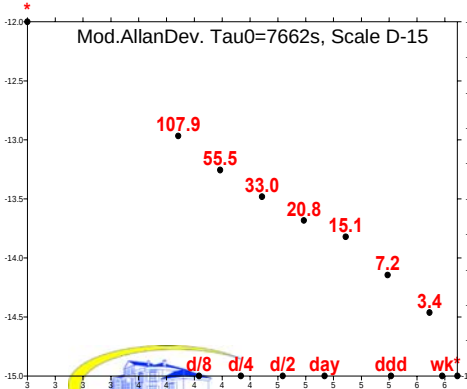
Tsoft

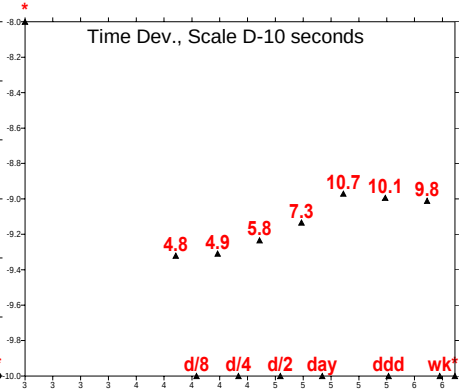

-12.5
-15.4
-16.7
-20.2
-17.8
-22.5
ROA-PTB
Link(ns): Tw/Tai0708__ROA-PTB/14-05 , Total: 405_Ep/at16:44_09/12/07

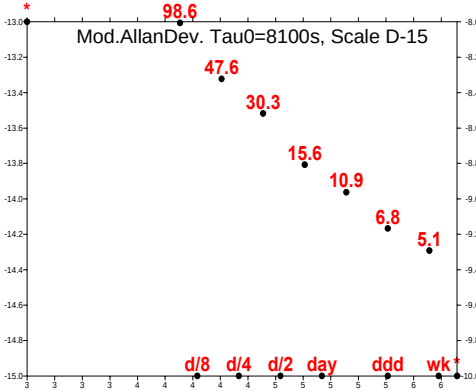

-13.5
-16.6
-11.9
-14.5
-15.2
-24.5
SP-PTB
Link(ns): Tw/Tai0708__SP-PTB/72-05 , Total: 360_Ep/at14:18_09/14/07

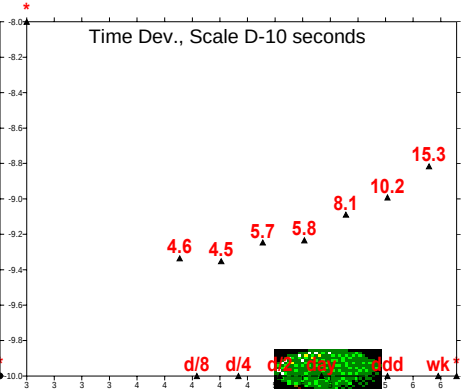

Max smoothing residual : 2.093_Linear
Sigma= 0.572ns


Max smoothing residual : 2.370_Linear
, Sigma= 0.556ns

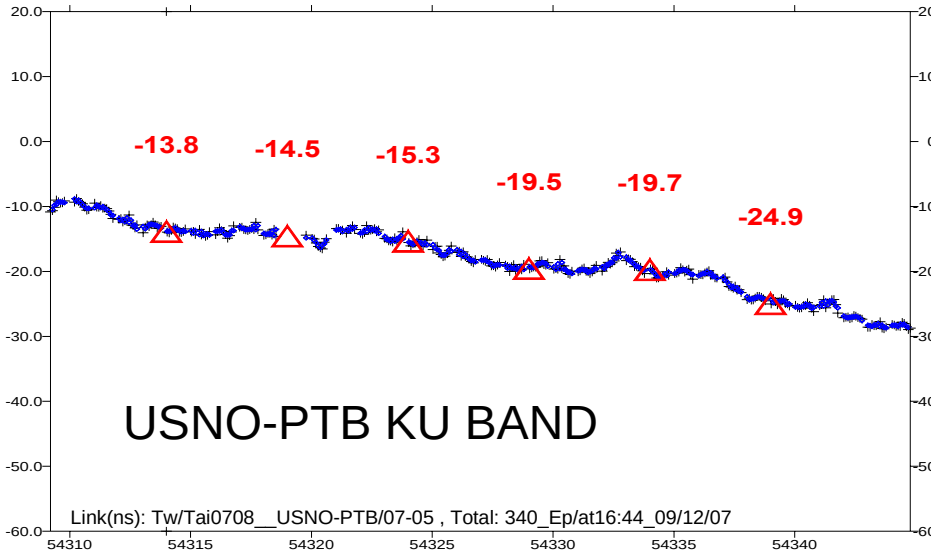

Mod.AllanDev. Tau0=7662s, Scale D-15
107.9
55.5
33.0
20.8
15.1
7.2
3.4
d/8 d/4 d/2 day ddd wk*

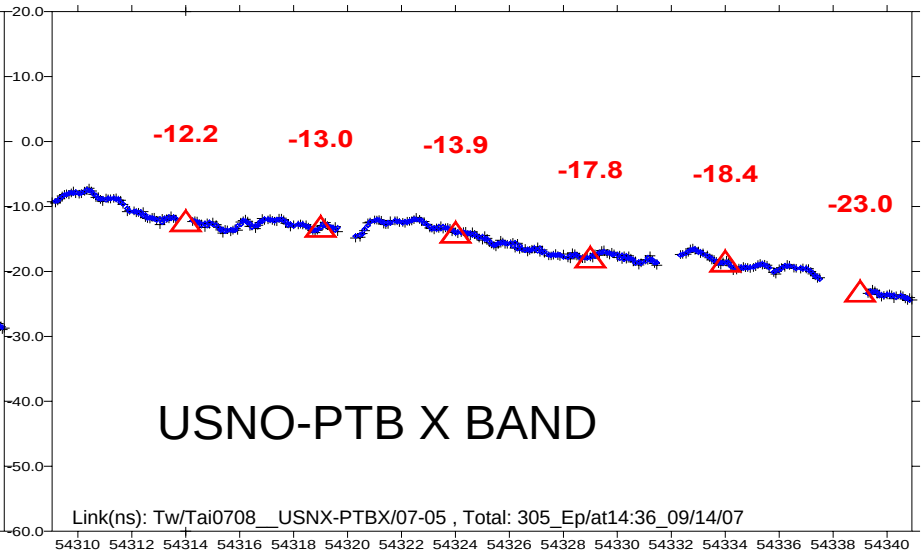

Time Dev., Scale D-10 seconds
4.8
4.9
5.8
7.3
10.7
10.1
9.8
d/8 d/4 d/2 day ddd wk*

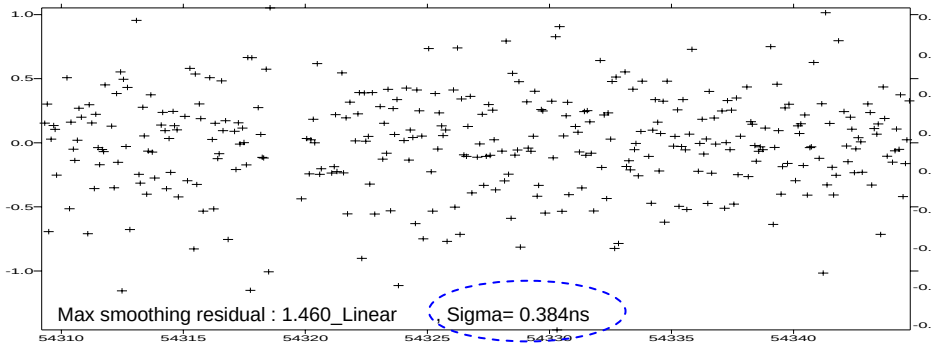

Mod.AllanDev. Tau0=8100s, Scale D-15
98.6
47.6
30.3
15.6
10.9
6.8
5.1
d/8 d/4 d/2 day ddd wk*

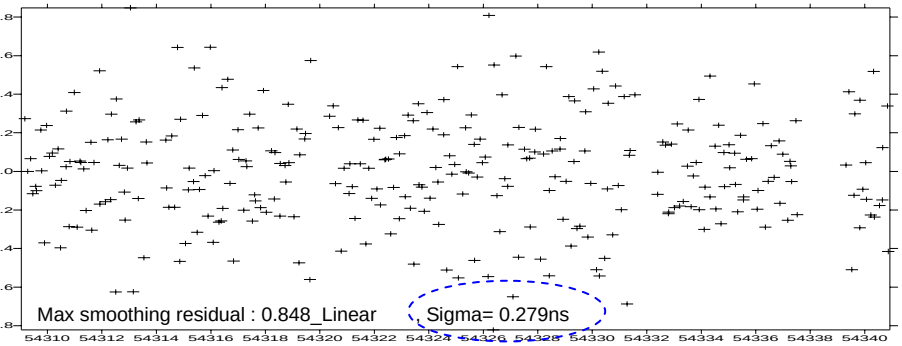

Time Dev., Scale D-10 seconds
4.6
4.5
5.7
5.8
8.1
10.2
15.3
d/8 d/4 d/2 day ddd wk*

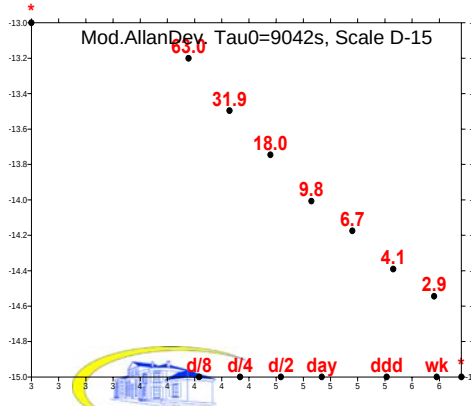
Tsoft

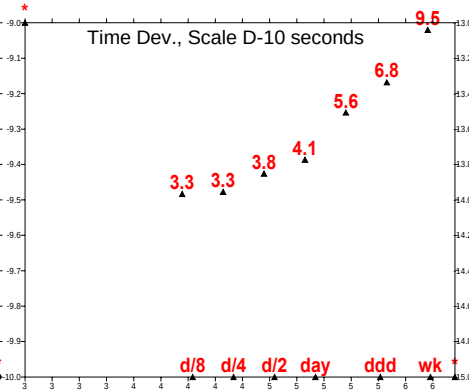

-13.8
-14.5
-15.3
-19.5
-19.7
-24.9
USNO-PTB KU BAND
Link(ns): Tw/Tai0708__USNO-PTB/07-05 , Total: 340_Ep/at16:44_09/12/07

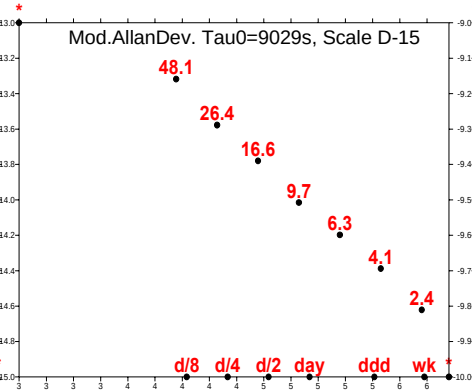

-12.2
-13.0
-13.9
-17.8
-18.4
-23.0
USNO-PTB X BAND
Link(ns): Tw/Tai0708__USNX-PTBX/07-05 , Total: 305_Ep/at14:36_09/14/07

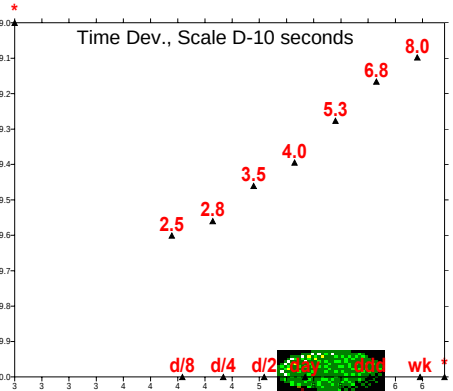

Max smoothing residual : 1.460_Linear
Sigma= 0.384ns


Max smoothing residual : 0.848_Linear
Sigma= 0.279ns


Mod.AllanDev. Tau0=9042s, Scale D-15
63.0
31.9
18.0
9.8
6.7
4.1
2.9
d/8 d/4 d/2 day ddd wk


Time Dev., Scale D-10 seconds
9.5
6.8
5.6
4.1
3.8
3.3
3.3
d/8 d/4 d/2 day ddd wk


Mod.AllanDev. Tau0=9029s, Scale D-15
48.1
26.4
16.6
9.7
6.3
4.1
2.4
d/8 d/4 d/2 day ddd wk

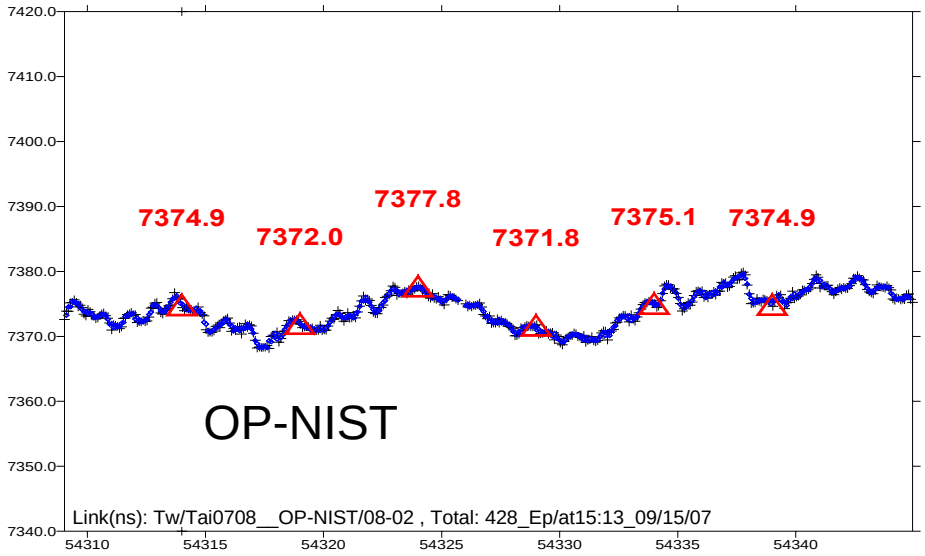

Time Dev., Scale D-10 seconds
8.0
6.8
5.3
4.0
3.5
2.8
2.5
d/8 d/4 d/2 day ddd wk

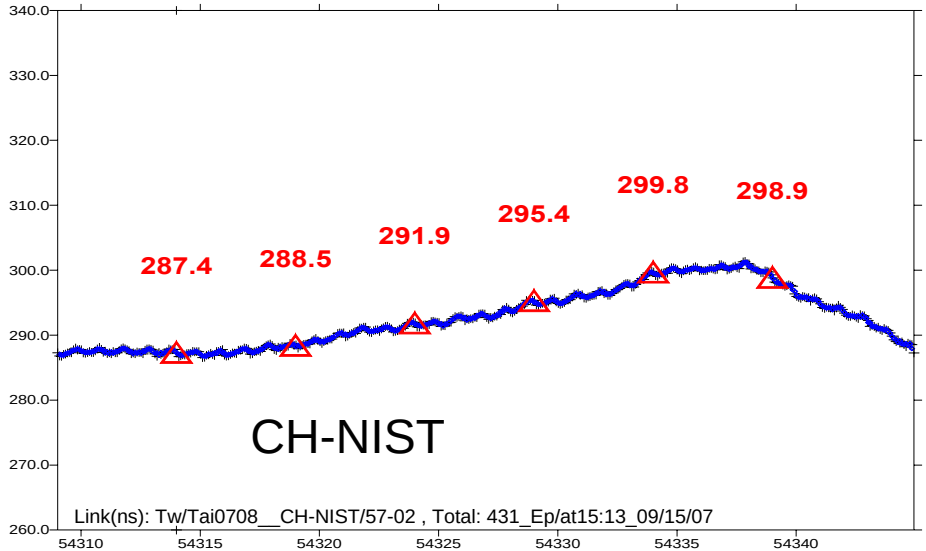
Summary TAI TW links

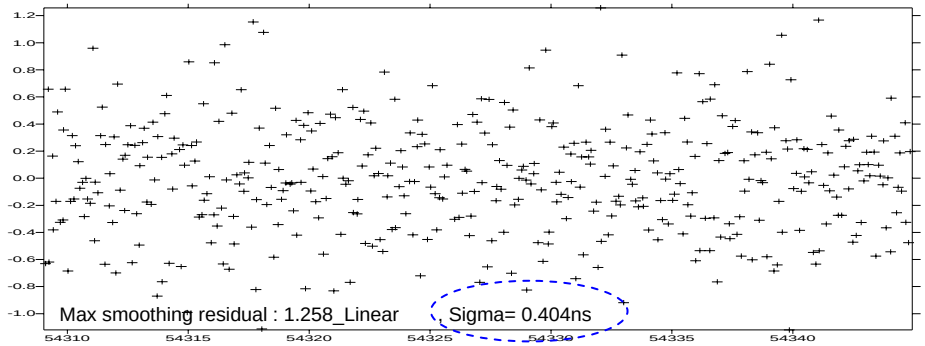
- Sigma 0.2 ~ 0.6 ns: less noisy than last year
- Slight diurnals from time to time
- High redundancy in TW networks
- All backed up by GPS geodesic receivers

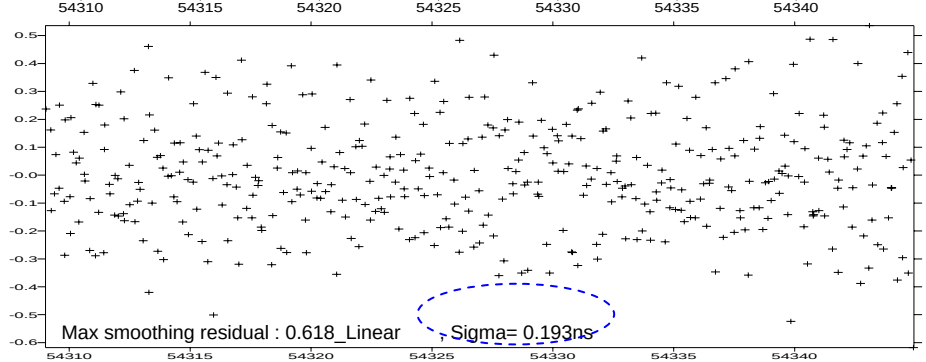
Some H-Maser links

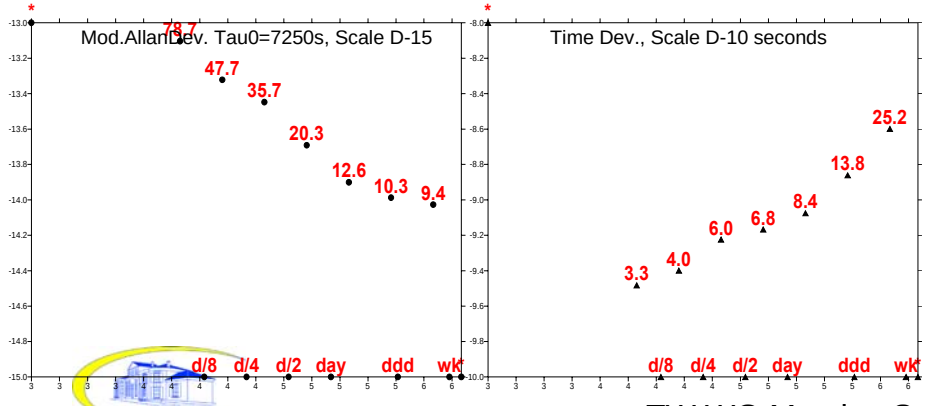
- Europe-American: CH NIST OP SP USNO
- Asia: NICT TL KRIS


7374.9
7372.0
7377.8
7371.8
7375.1
7374.9
OP-NIST
Link(ns): Tw/Tai0708__OP-NIST/08-02 , Total: 428_Ep/at15:13_09/15/07

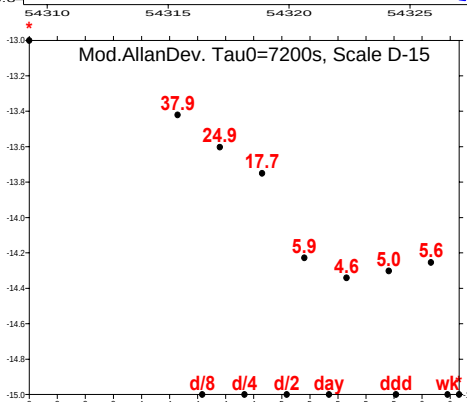

287.4
288.5
291.9
295.4
299.8
298.9
CH-NIST
Link(ns): Tw/Tai0708__CH-NIST/57-02 , Total: 431_Ep/at15:13_09/15/07

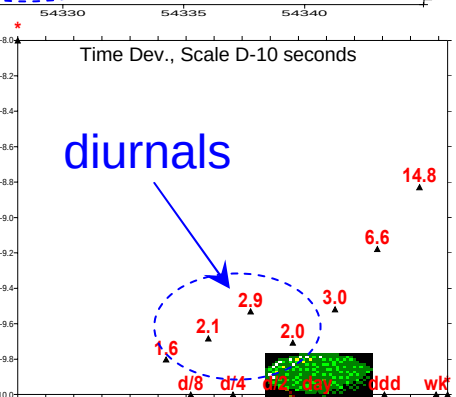

Max smoothing residual : 1.258_Linear
Sigma= 0.404ns


Max smoothing residual : 0.618_Linear
Sigma= 0.193ns

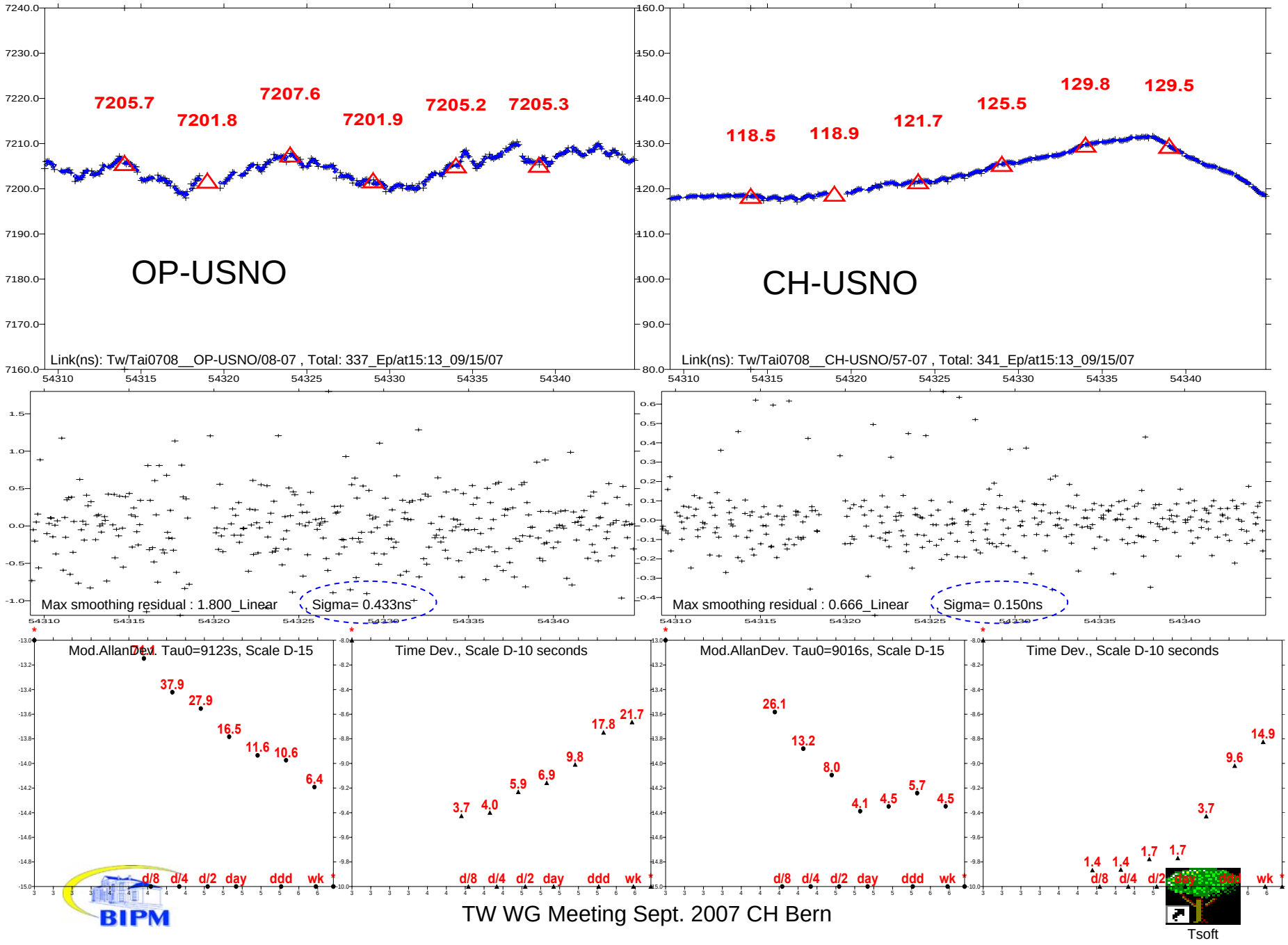

Mod.AllanDev. Tau0=7250s, Scale D-15
47.7
35.7
20.3
12.6
10.3
9.4
d/8 d/4 d/2 day ddd wk

Time Dev., Scale D-10 seconds
3.3
4.0
6.0
6.8
8.4
13.8
25.2
d/8 d/4 d/2 day ddd wk

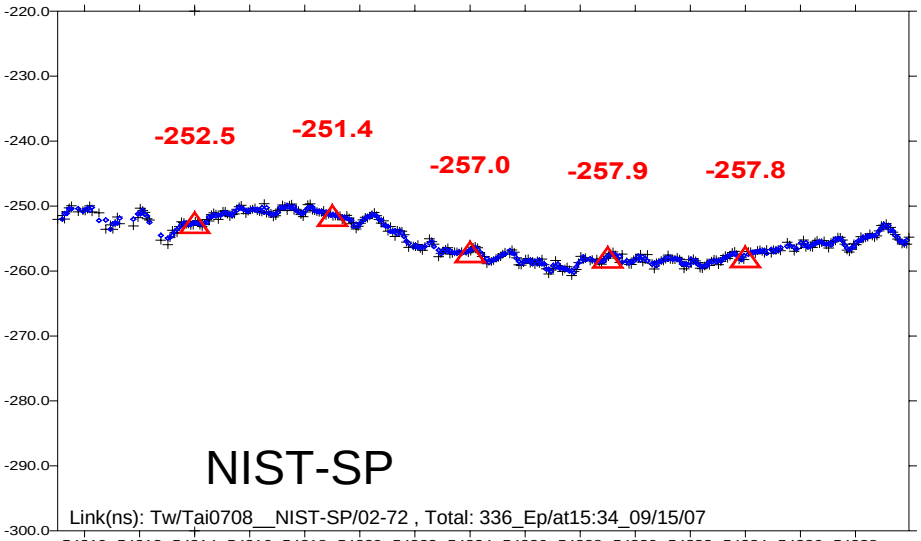

Mod.AllanDev. Tau0=7200s, Scale D-15
37.9
24.9
17.7
5.9
4.6
5.0
5.6
d/8 d/4 d/2 day ddd wk

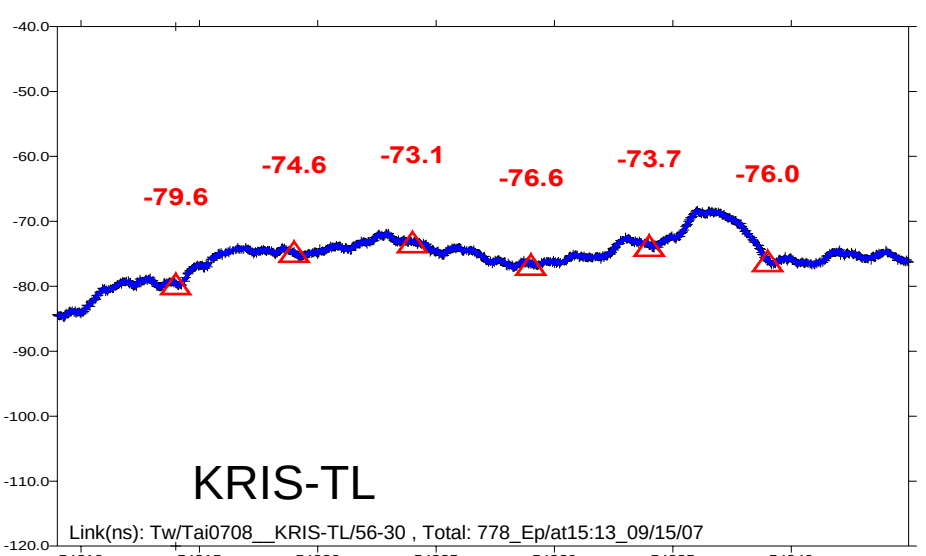

Time Dev., Scale D-10 seconds
diurnals
1.6
2.1
2.9
2.0
3.0
6.6
14.8
d/8 d/4 d/2 day ddd wk

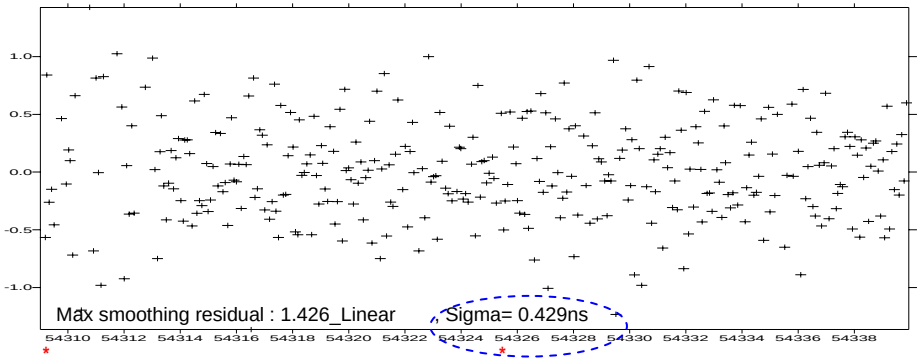
Tsoft

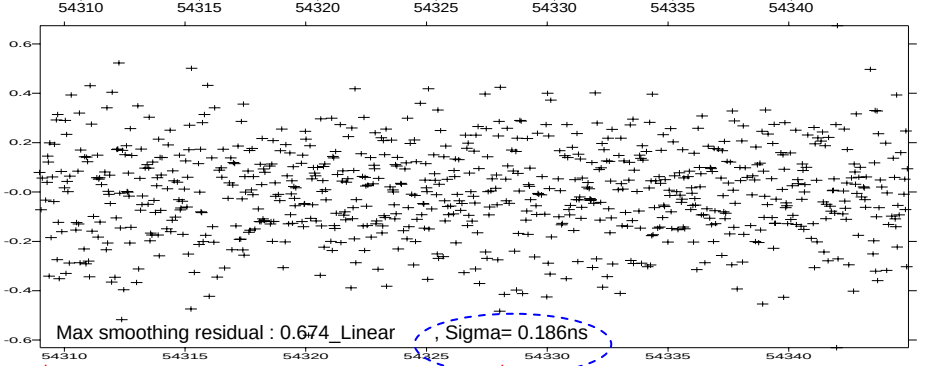

7205.7
7201.8
7207.6
7201.9
7205.2
7205.3
OP-USNO
Link(ns): Tw/Tai0708__OP-USNO/08-07 , Total: 337_Ep/at15:13_09/15/07
118.5
118.9
121.7
125.5
129.8
129.5
CH-USNO
Link(ns): Tw/Tai0708__CH-USNO/57-07 , Total: 341_Ep/at15:13_09/15/07
Max smoothing residual : 1.800_Linear
Sigma= 0.433ns
Max smoothing residual : 0.666_Linear
Sigma= 0.150ns
Mod.AllanDev. Tau0=9123s, Scale D-15
Time Dev., Scale D-10 seconds
Mod.AllanDev. Tau0=9016s, Scale D-15
Time Dev., Scale D-10 seconds
d/8 d/4 d/2 day ddd wk

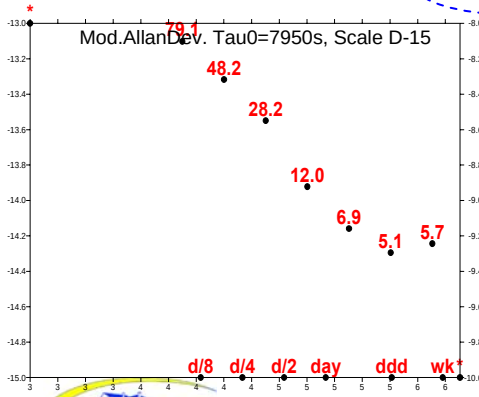
Tsoft

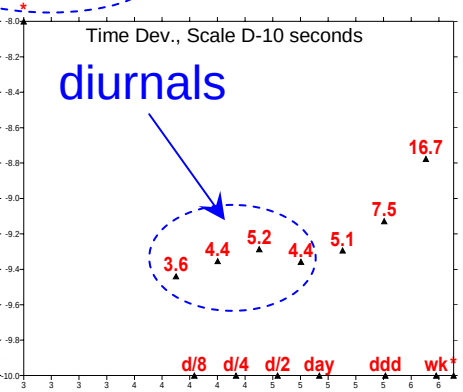

-252.5
-251.4
-257.0
-257.9
-257.8
NIST-SP
Link(ns): Tw/Tai0708__NIST-SP/02-72 , Total: 336_Ep/at15:34_09/15/07

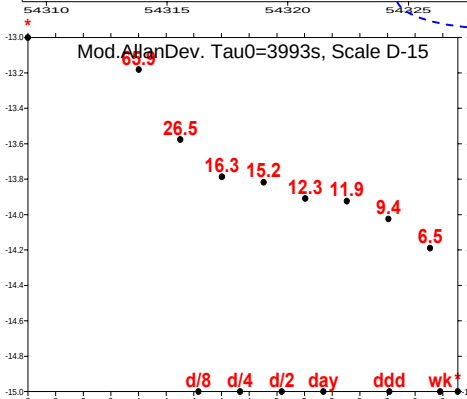

-79.6
-74.6
-73.1
-76.6
-73.7
-76.0
KRIS-TL
Link(ns): Tw/Tai0708__KRIS-TL/56-30 , Total: 778_Ep/at15:13_09/15/07

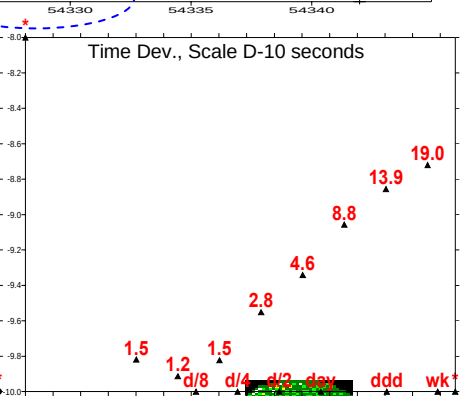

Max smoothing residual : 1.426_Linear , Sigma= 0.429ns

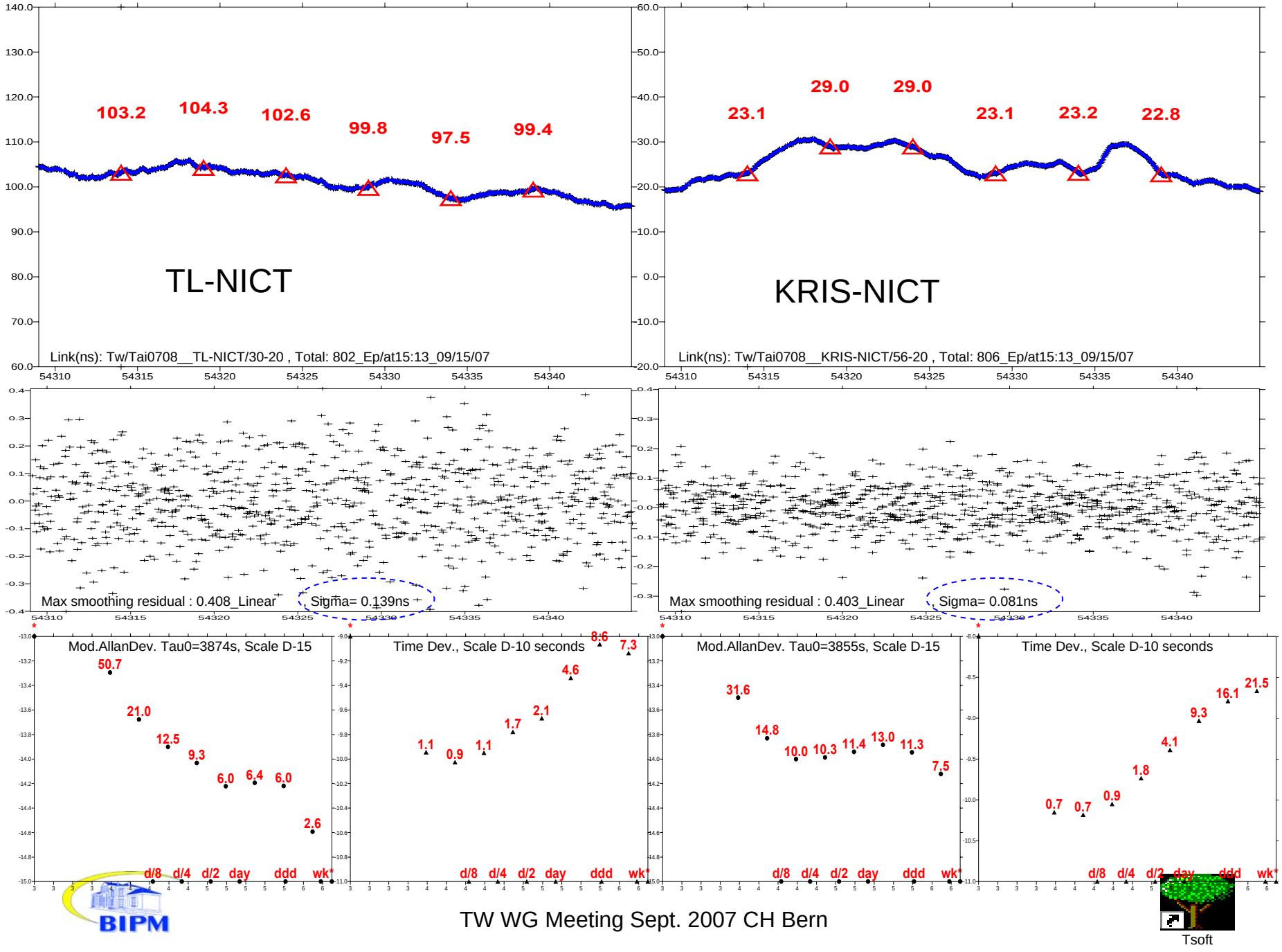

Max smoothing residual : 0.674_Linear , Sigma= 0.186ns


Mod.AllanDev. Tau0=7950s, Scale D-15
79.1
48.2
28.2
12.0
6.9
5.1
5.7
d/8 d/4 d/2 day ddd wk*


Time Dev., Scale D-10 seconds
diurnals
3.6
4.4
5.2
4.4
5.1
7.5
16.7
d/8 d/4 d/2 day ddd wk*


Mod.AllanDev. Tau0=3993s, Scale D-15
69.9
26.5
16.3
15.2
12.3
11.9
9.4
6.5
d/8 d/4 d/2 day ddd wk*


Time Dev., Scale D-10 seconds
1.5
1.2
1.5
2.8
4.6
8.8
13.9
19.0
d/8 d/4 d/2 day ddd wk*


103.2
104.3
102.6
99.8
97.5
99.4
TL-NICT
Link(ns): Tw/Tai0708__TL-NICT/30-20 , Total: 802_Ep/at15:13_09/15/07
23.1
29.0
29.0
23.1
23.2
22.8
KRIS-NICT
Link(ns): Tw/Tai0708__KRIS-NICT/56-20 , Total: 806_Ep/at15:13_09/15/07
Max smoothing residual : 0.408_Linear
Sigma= 0.139ns
Max smoothing residual : 0.403_Linear
Sigma= 0.081ns
Mod.AllanDev. Tau0=3874s, Scale D-15
50.7
21.0
12.5
9.3
6.0
6.4
6.0
2.6
Time Dev., Scale D-10 seconds
1.1
0.9
1.1
1.7
2.1
4.6
8.6
7.3
Mod.AllanDev. Tau0=3855s, Scale D-15
31.6
14.8
10.0
10.3
11.4
13.0
11.3
7.5
Time Dev., Scale D-10 seconds
0.7
0.7
0.9
1.8
4.1
9.3
16.1
21.5
d/8 d/4 d/2 day ddd wk*

Tsoft

Summary of the MH links

- The precision uA in the best case: < 100 ps

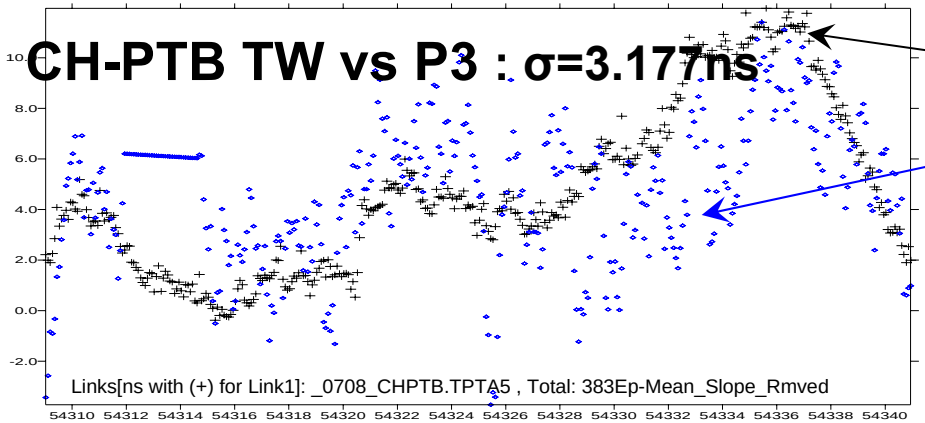
Comparison TW-GPS MC/P3

- P3: CH KRIS NICT PTB TL USNO VSL
- MC: PTB NIST NICT
- X band: PTB-USNO

- P3 not complete (may be problem of BIPM data collection this month) : IT NIST OP ROA SP …

- Link comparisons are available and updated monthly: ftp://tai.bipm.org\TimeLink\LkC\YYMM\

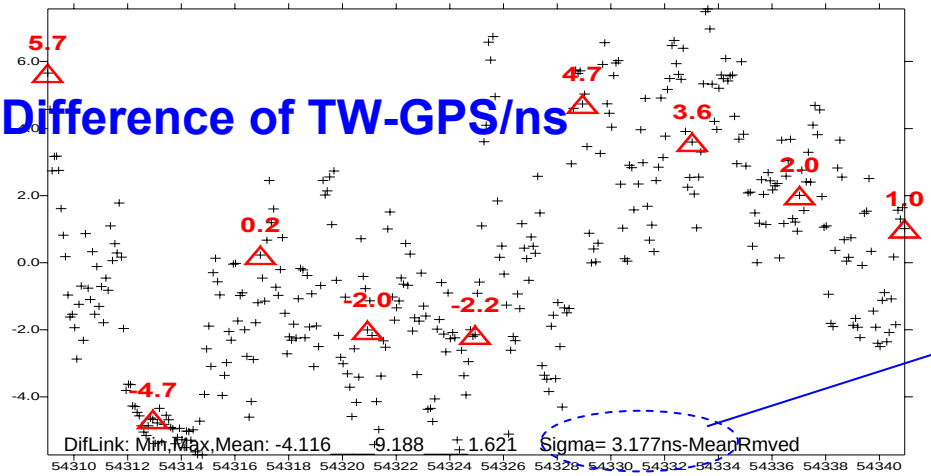
CH-PTB TW vs P3 : σ=3.177ns

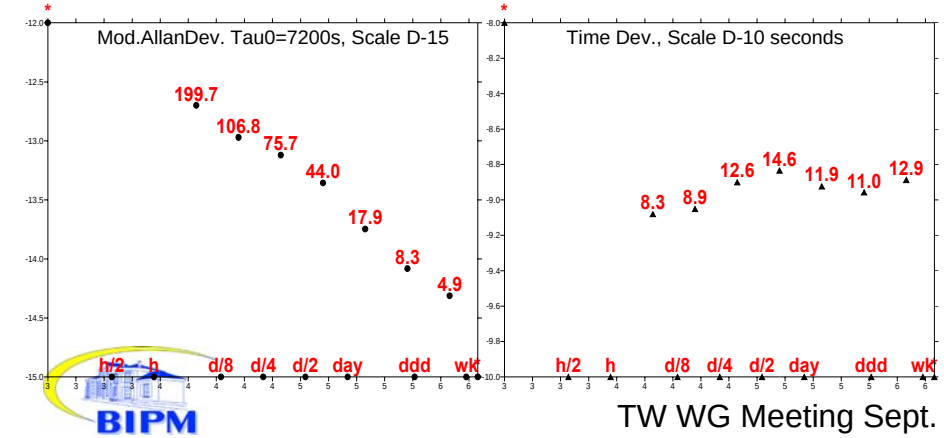


TW LINK : black crosses

GPS LINK: blue circles

Difference of TW-GPS/ns



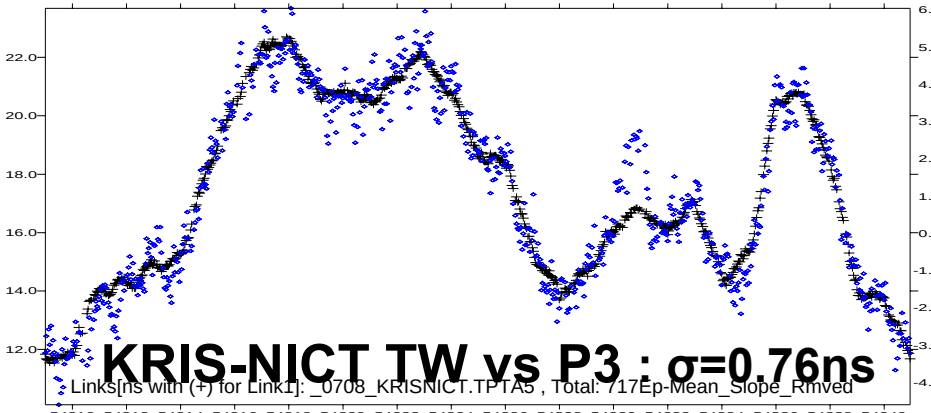


Remark: The is sigma is **3.177ns** due to the GPS is not linked to the master clock and there are only **5** measures between the GPS driving clock and the master clock driving TW:

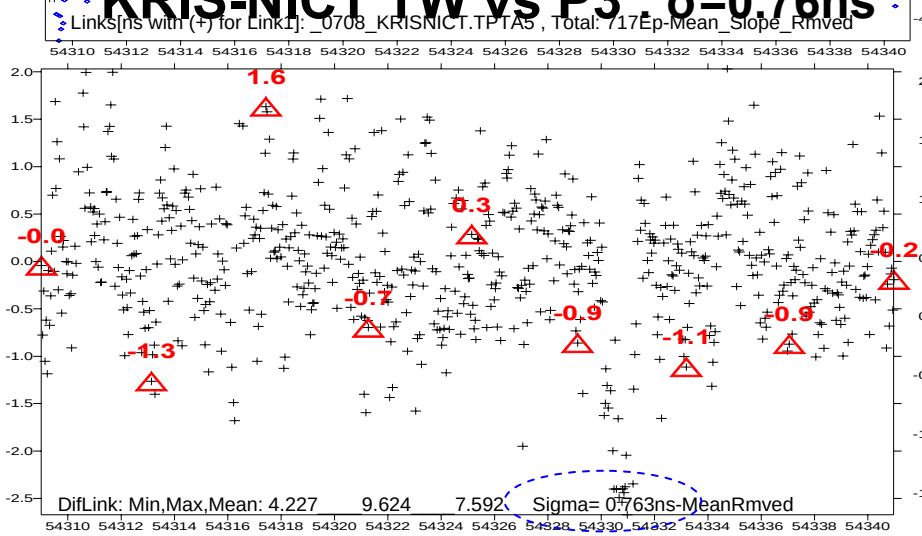
LZCH0054.310

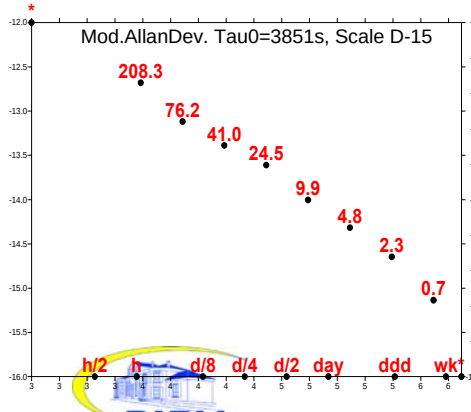
54310.000	-9012.744
54311.000	-9011.434
54312.000	-9018.850
54313.000	-9027.432
54314.000	-9026.854

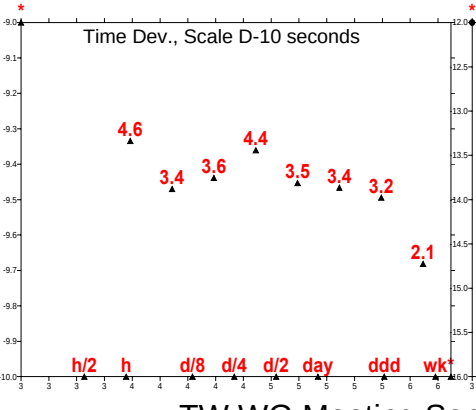
Tsoft



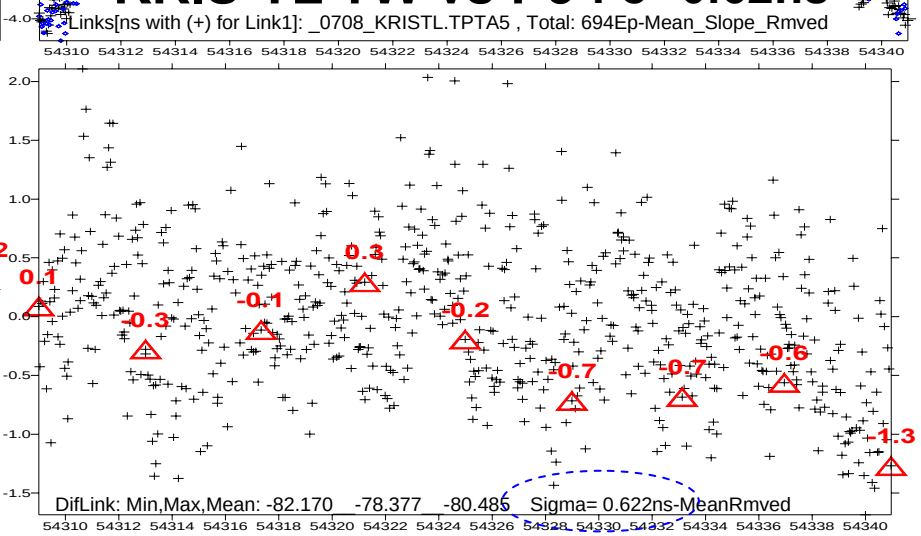
KRIS-NICT TW vs P3 : σ=0.76ns

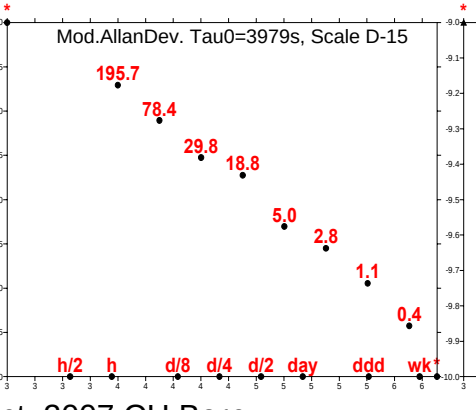


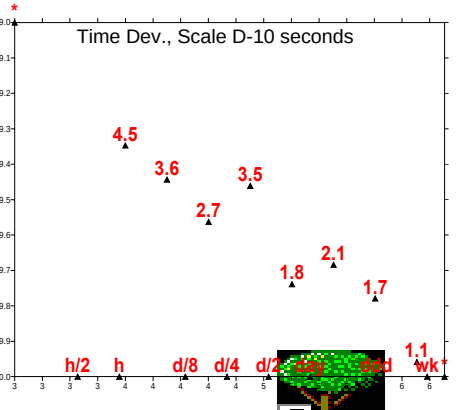




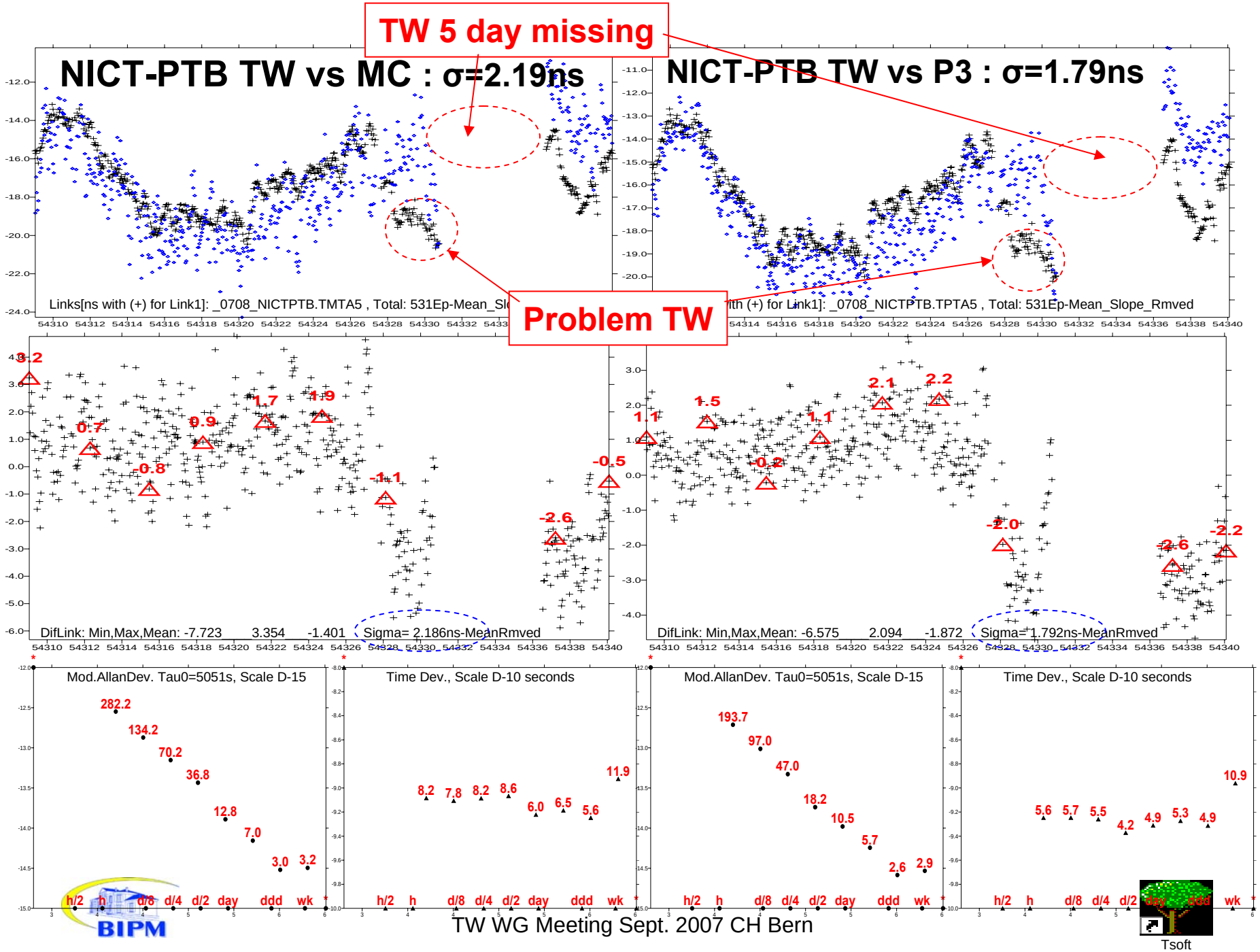
KRIS-TL TW vs P3 : σ=0.62ns

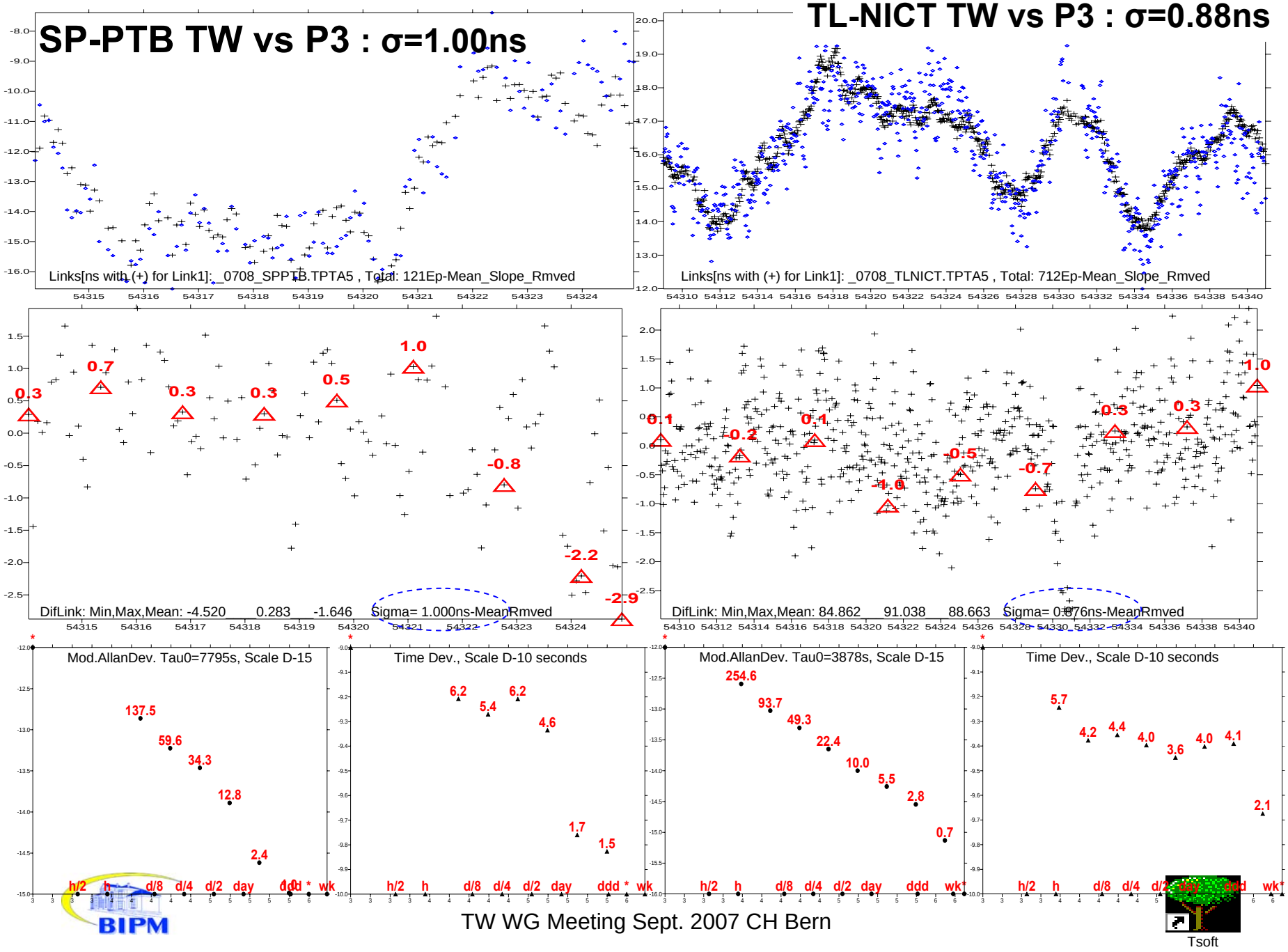




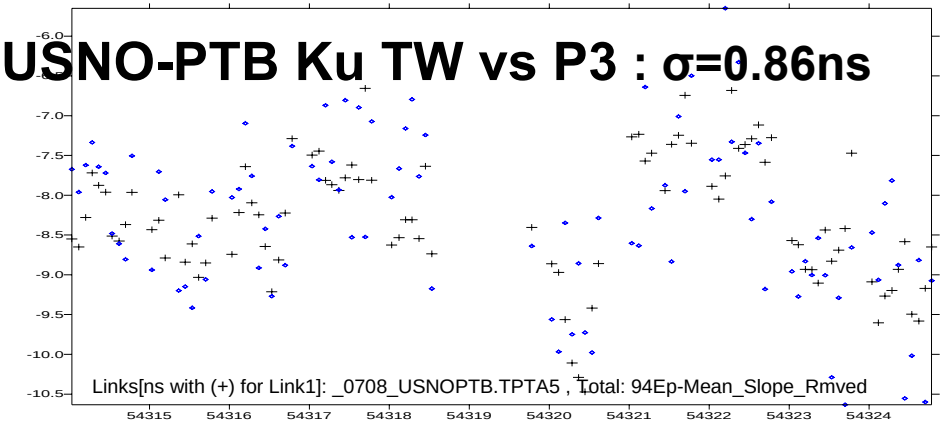


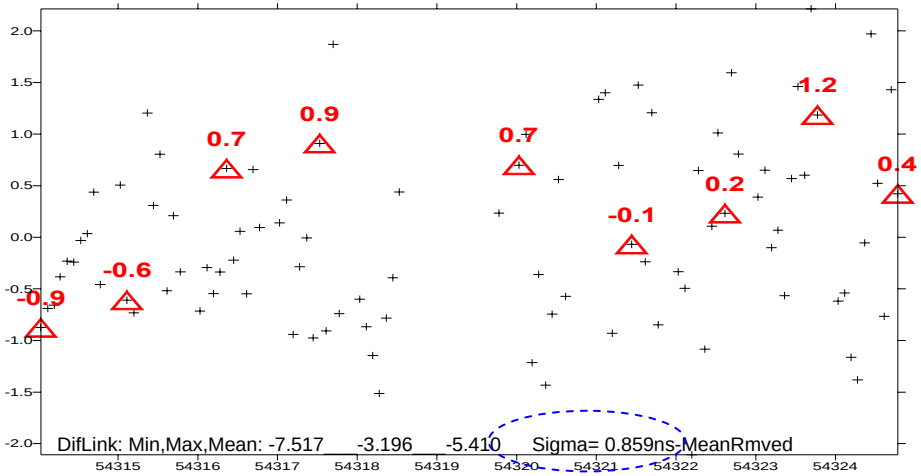
Tsoft

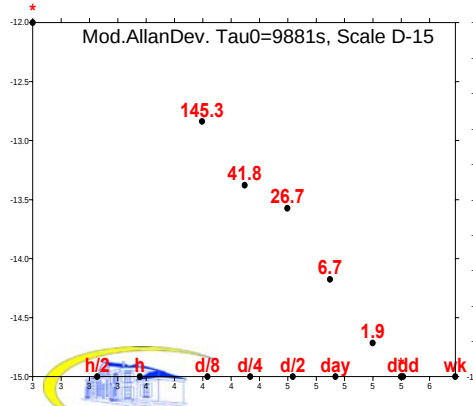

TW 5 day missing
NICT-PTB TW vs MC : σ=2.19ns
NICT-PTB TW vs P3 : σ=1.79ns
Problem TW
Links[ns with (+) for Link1]: _0708_NICTPTB.TMTA5 , Total: 531Ep-Mean_Sl
ith (+) for Link1]: _0708_NICTPTB.TPTA5 , Total: 531Ep-Mean_Slope_Rmved
DifLink: Min,Max,Mean: -7.723 3.354 -1.401 Sigma= 2.186ns-MeanRmved
DifLink: Min,Max,Mean: -6.575 2.094 -1.872 Sigma=1.792ns-MeanRmved
Mod.AllanDev. Tau0=5051s, Scale D-15
Time Dev., Scale D-10 seconds
Mod.AllanDev. Tau0=5051s, Scale D-15
Time Dev., Scale D-10 seconds
h/2 h d/8 d/4 d/2 day ddd wk
BIPM
TW WG Meeting Sept. 2007 CH Bern
Tsoft

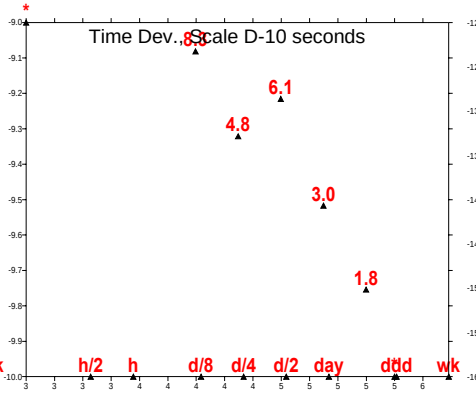

SP-PTB TW vs P3 : σ=1.00ns
TL-NICT TW vs P3 : σ=0.88ns
Links[ns with (+) for Link1]: _0708_SPPTB.TPTA5 , Total: 121Ep-Mean_Slope_Rmved
Links[ns with (+) for Link1]: _0708_TLNICT.TPTA5 , Total: 712Ep-Mean_Slope_Rmved
DifLink: Min,Max,Mean: -4.520 0.283 -1.646 Sigma= 1.000ns-MeanRmved
DifLink: Min,Max,Mean: 84.862 91.038 88.663 Sigma= 0.876ns-MeanRmved
Mod.AllanDev. Tau0=7795s, Scale D-15
Time Dev., Scale D-10 seconds
Mod.AllanDev. Tau0=3878s, Scale D-15
Time Dev., Scale D-10 seconds
h/2 h d/8 d/4 d/2 day ddd * wk
BIPM
TW WG Meeting Sept. 2007 CH Bern
Tsoft

USNO-PTB Ku TW vs P3 : σ=0.86ns

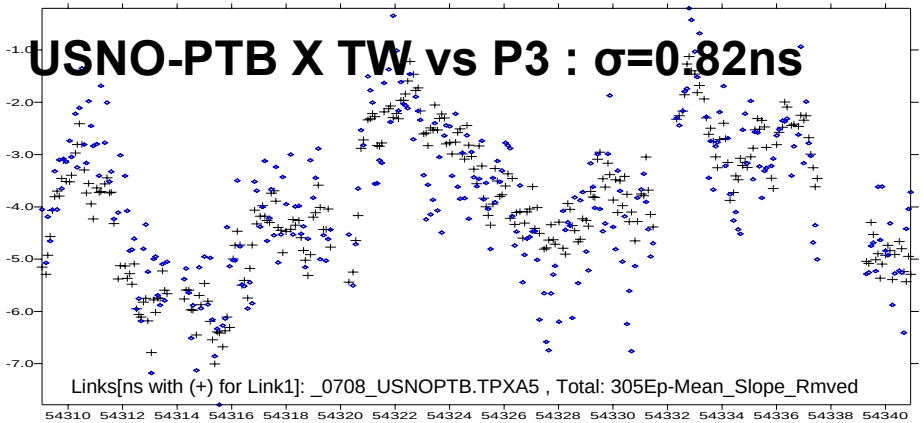


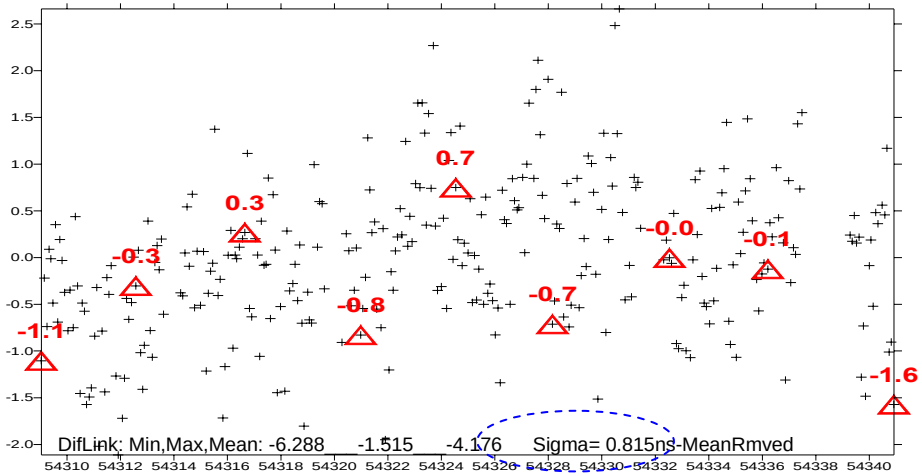


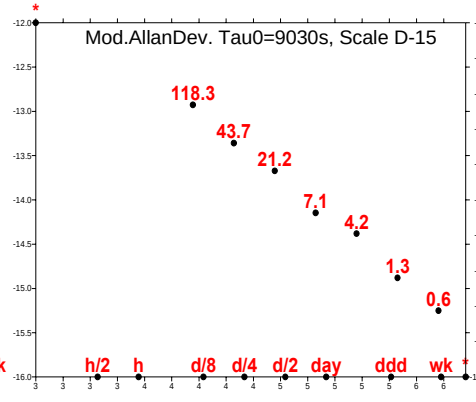


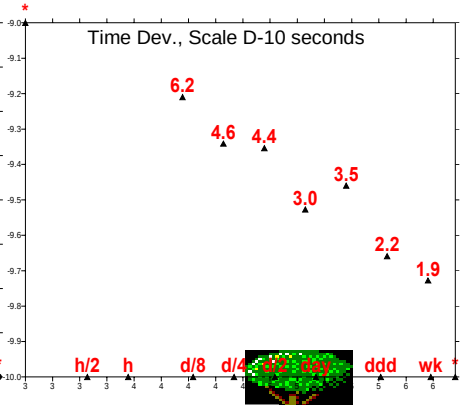


USNO-PTB X TW vs P3 : σ=0.82ns

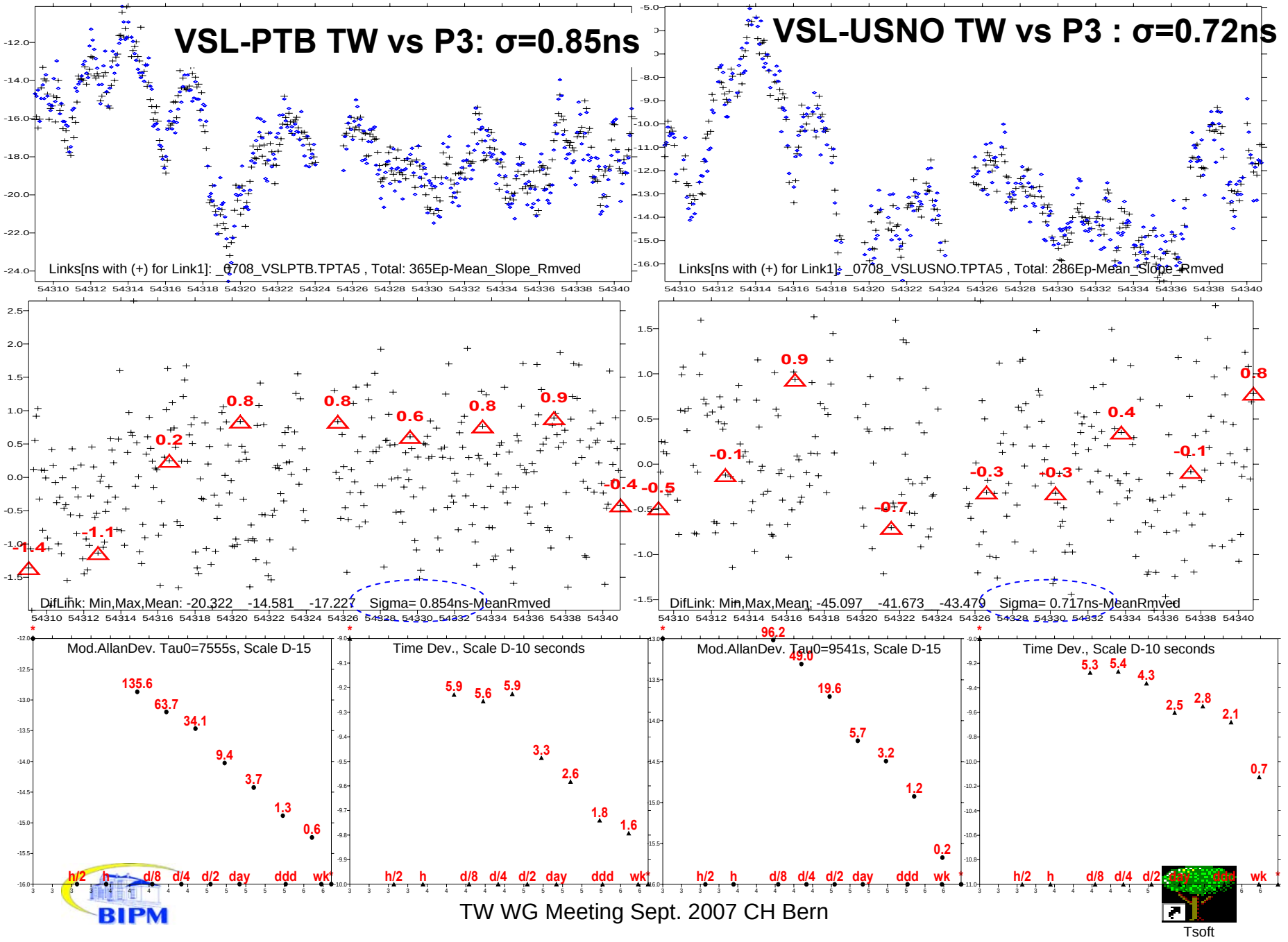




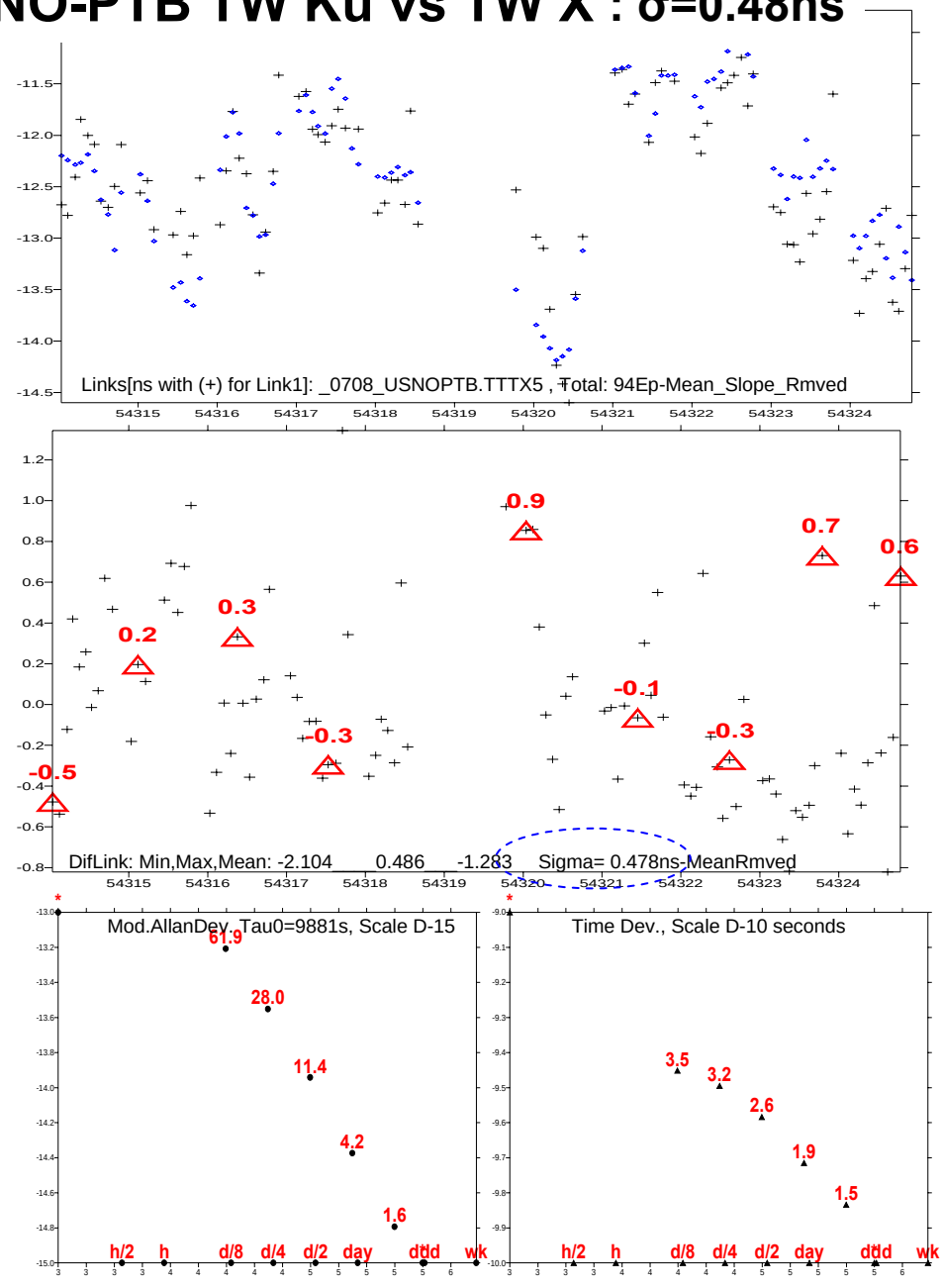




Tsoft


VSL-PTB TW vs P3: σ=0.85ns
VSL-USNO TW vs P3 : σ=0.72ns
Links[ns with (+) for Link1]: _0708_VSLPTB.TPTA5 , Total: 365Ep-Mean_Slope_Rmved
Links[ns with (+) for Link1]: _0708_VSLUSNO.TPTA5 , Total: 286Ep-Mean_Slope_Rmved
DifLink: Min,Max,Mean: -20.322 -14.581 -17.227 Sigma= 0.854ns-MeanRmved
DifLink: Min,Max,Mean: -45.097 -41.673 -43.479 Sigma= 0.717ns-MeanRmved
Mod.AllanDev. Tau0=7555s, Scale D-15
Time Dev., Scale D-10 seconds
Mod.AllanDev. Tau0=9541s, Scale D-15
Time Dev., Scale D-10 seconds
h/2 h d/8 d/4 d/2 day ddd wk
BIPM
TW WG Meeting Sept. 2007 CH Bern
Tsoft

USNO-PTB TW Ku vs TW X : σ=0.48ns



Conclusion

- TW links takes 15% of total TAI links but transfer about 70% clocks and all the PFSs

- The uA : 0.1 ~ 0.5 ns
- The uB : 1.0 ns the best case

- Diurnals in some trans-continental links

- TW monthly agrees with GPS P3 AV 0.6~1 ns due to GPS biases and TW diurnals ?

- One side: The actual TAI time link is of one pivot PTB; on the other side: the TW network is highly redundant and all backed up by GPS.

  -- How to fully use the potential of the redundant TW/GPS data:

  1. *TW network time transfer ?*
  2. *Combination of GPS+TW ?*

Thanks all the TW laboratories