

# RASFX Correlator Accuracy Characteristics

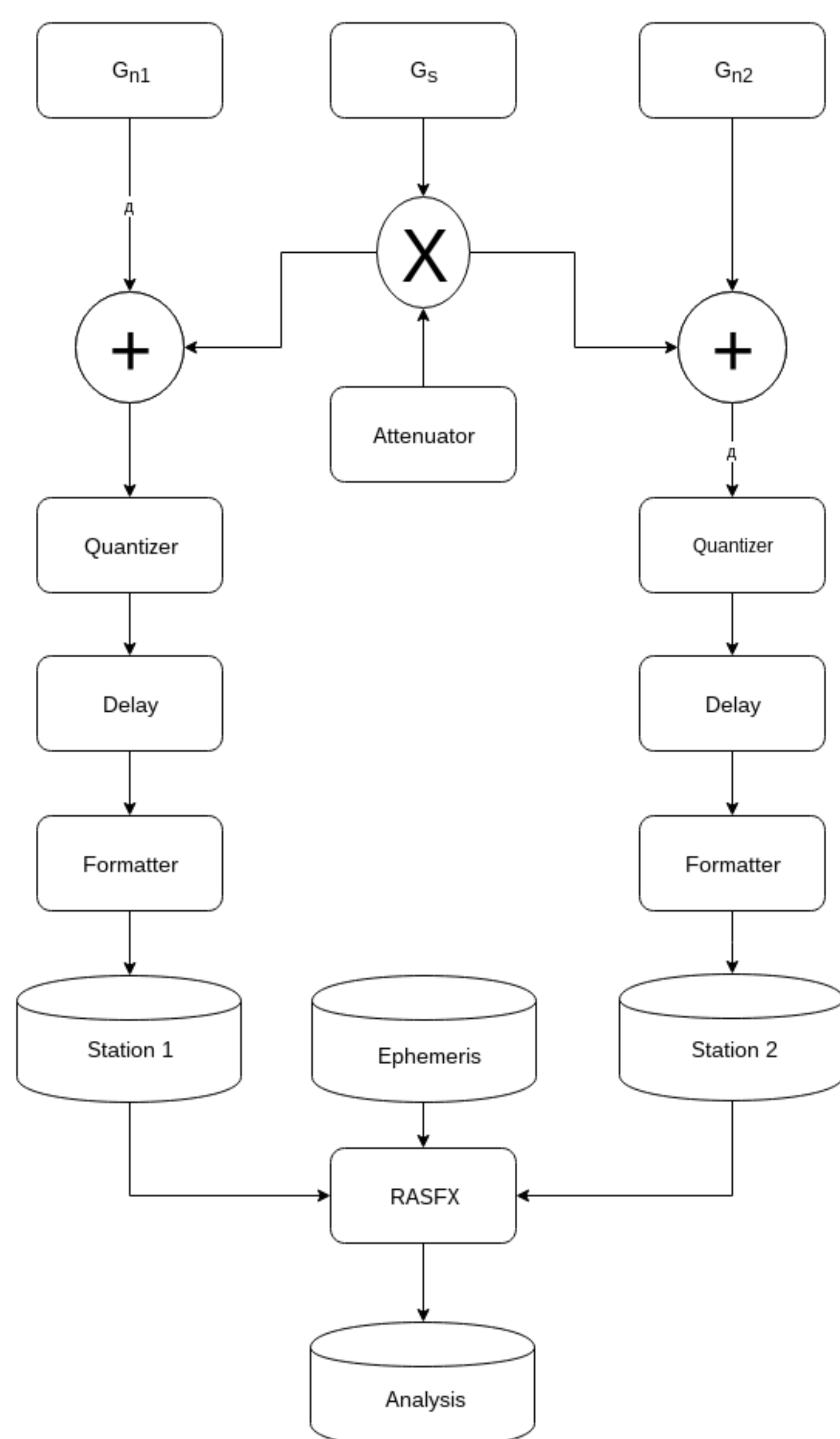
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## Experiment description

RASFX correlator based on hybrid-blade (Nvidia GPU + Intel CPU) HPC cluster was designed in IAA RAS in 2014 and now is mainly used for the UT1 determination. To estimate the correlator's true error the model of 2-station VLBI system was created using 3 normally distributed pseudorandom numbers noise generators ( $G_{n1}$ ,  $G_{n2}$ ,  $G_s$ ) included in MATLAB numerical computing environment. The  $G_s$  generator imitates quasar signal,  $G_{n1}$  and  $G_{n2}$  -- the receiving system noise. Two scans with 1ms baseline were generated and processed with prior ephemeris delay models.

### Simplest VLBI software model



$$S1 = G_{n1} + A \cdot G_s$$

$$S2 = G_{n2} + A \cdot G_s$$

$$A = 1 / \sqrt{1000}$$

$$\frac{G_{n1}}{G_s} = \frac{G_{n2}}{G_s} = 1000$$

### Initial conditions:

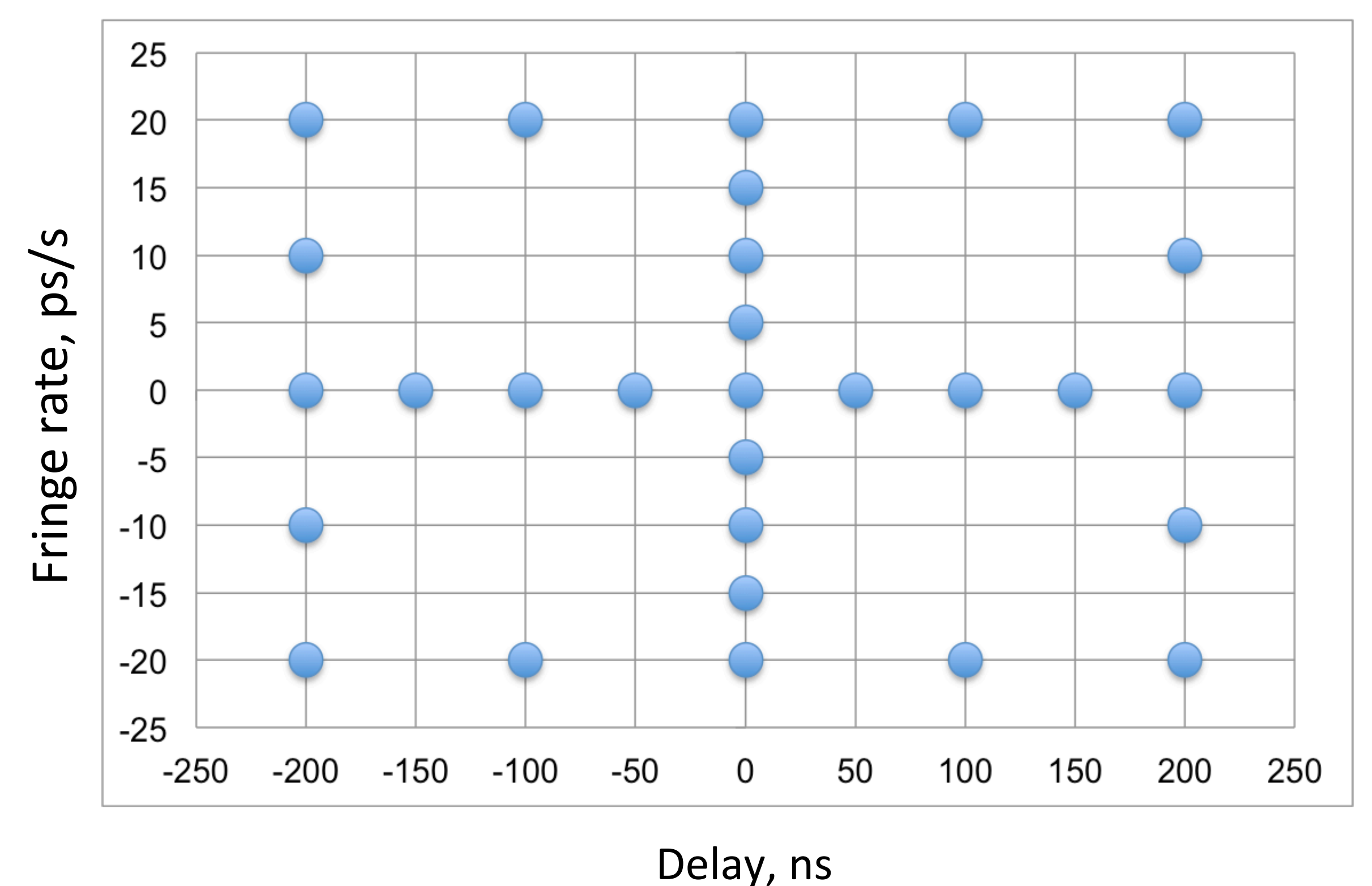
- Delay between stations – 1ms
- Ephemeris delay for 1<sup>st</sup> station – 1ms
- Ephemeris delay for 2<sup>nd</sup> station – 2ms
- Ephemeris fringe rate – 100 ns/s

### Correlator input data:

- 2 VDIF-scans
- 2-bit sampling
- 16 sec duration
- $F_{tact} = 1024$  MHz
- 28 delay models

### Processing & Analysis

Two 16 sec 2-bit 1 channel wideband scans were created, the 1 ms baseline delay was included. The clock offset and fringe rate were produced using ephemeris delays. The 28 delays combination were used for the scans processing with the 8248 MHz carrier frequency, 2048 spectra channels resolution and 0.0625 sec accumulation period.



# Exp.	Ephemeris set			Calculated fringe parameters		Residuals	
	Ephemeris delay, ns	Delay at scan center, ns	Fringe rate, ps/s	Delay, ns	Fringe rate, ps/s	Delay, ps	Fringe rate, ps/s
1	-200	200	0	200,013	-0,03	13,7	-0,03
2	-150	150	0	150,013	-0,025	13,7	-0,025
3	-100	100	0	100,0153	-0,025	15,3	-0,025
4	-50	50	0	50,0145	-0,023	14,5	-0,023
5	0	0	0	0,0145	-0,023	14,5	-0,023
6	50	-50	0	-49,987	-0,0185	13,0	-0,0185
7	100	-100	0	-99,9878	-0,0165	12,2	-0,0165
8	150	-150	0	-149,989	-0,016	10,9	-0,016
9	200	-200	0	-199,99	-0,018	9,7	-0,018
10	0	-0,36	-20	-0,346	-20,04	13,7	-0,04
11	0	-0,18	-10	-0,160	-10,01	20,2	-0,01
12	0	-0,09	-5	-0,073	-5,03	16,8	-0,03
13	0	0,09	5	0,105	4,98	14,7	-0,02
14	0	0,18	10	0,193	9,94	13,7	-0,06
15	0	0,27	15	0,284	14,94	14,1	-0,06
16	0	0,36	20	0,373	19,94	12,8	-0,06
17	-200	199,64	-20	199,65	-19,97	13,2	0,03
18	-200	199,82	-10	199,83	-9,97	14,9	0,03
19	-200	200,18	10	200,183	9,95	3,1	-0,05
20	-200	200,36	20	200,37	19,97	5,5	-0,03
21	-100	99,64	-20	99,656	-19,96	15,1	0,04
22	-100	100,36	20	100,366	19,98	6,1	-0,02
23	100	-100,36	-20	-100,345	-19,96	14,9	0,04
24	100	-99,64	20	-99,63	19,99	6,5	-0,01
25	200	-200,36	-20	-200,35	-19,96	13,6	0,04
26	200	-200,18	-10	-200,17	-9,97	13,3	0,03
27	200	-199,82	10	-199,84	9,96	2,4	-0,04
28	200	-199,64	20	-199,64	19,98	4,4	-0,02

### Results:

The 28 result fringes were analyzed and compared with the prior estimate.

The delay residuals vector was calculated as the difference of RASFX correlator calculated delays and prior delays at the scan center.

The mean of delay residuals is 12 ps, it is a RASFX correlator systematic error.

**The delay' standard deviation – 4.4 ps.**

We found the RASFX correlator accuracy is less than the formal error.

The act of metrological certification was acquired from VNIIFTRI.

### References:

1. V. Ken et al. IAA VGOS GPU-based Software Correlator: current status and broadband. *Proceedings of the 22 nd European VLBI Group for Geodesy and Astrometry Working Meeting processing*
2. Igor Surkis. The RASFX VGOS GPU Based Software Correlator. *This session*