Operation discontinued end of June 2000 !

Report from TUG

- Participation in the regular TW-sessions
- Continous operation of systems TUGØ1 and TUGØ2, both equipped with SatSims (de Jong type)
- Common clock time transfers between TUGØ1 and Ø2 corrected with SatSim data
- Test measurements with IEN
- Test of TUG software package
  (1s data, 1s data files → TW files, comparison of TW files, 'stability' calculations)
  * Recalculations of TW files for all labs (about 3500 data lines)
  * Recalculation of the links reported by BIPM

Evaluation of the Time and Frequency Transfer Performance of a Pair of TWSTFT-Stations Equipped with Satellite Simulators

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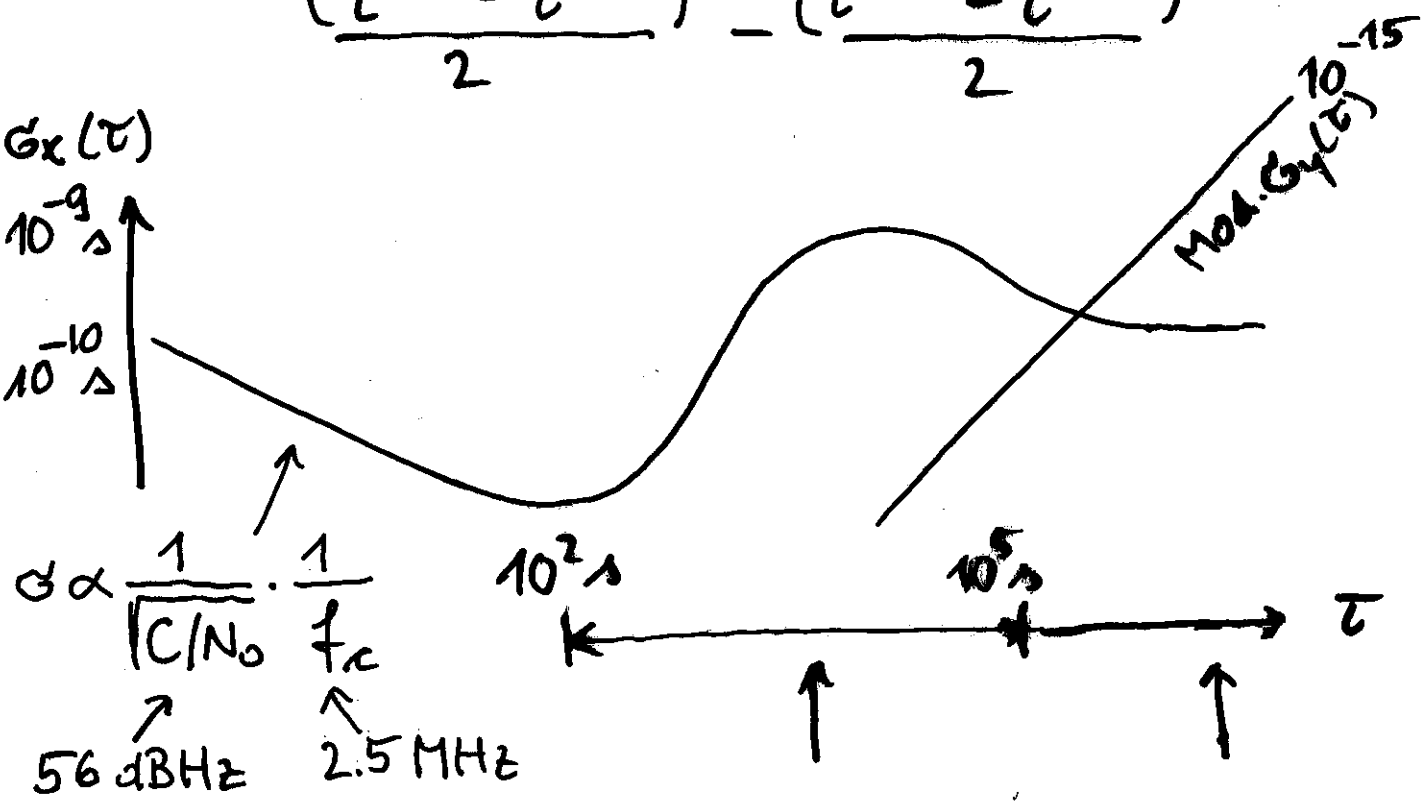
$$\frac{(\tau^{TX}-\tau^{RX})^1}{2} - \frac{(\tau^{TX}-\tau^{RX})^2}{2}$$



- T&F transfer (appropriate remote clocks or other T&F transfer system)

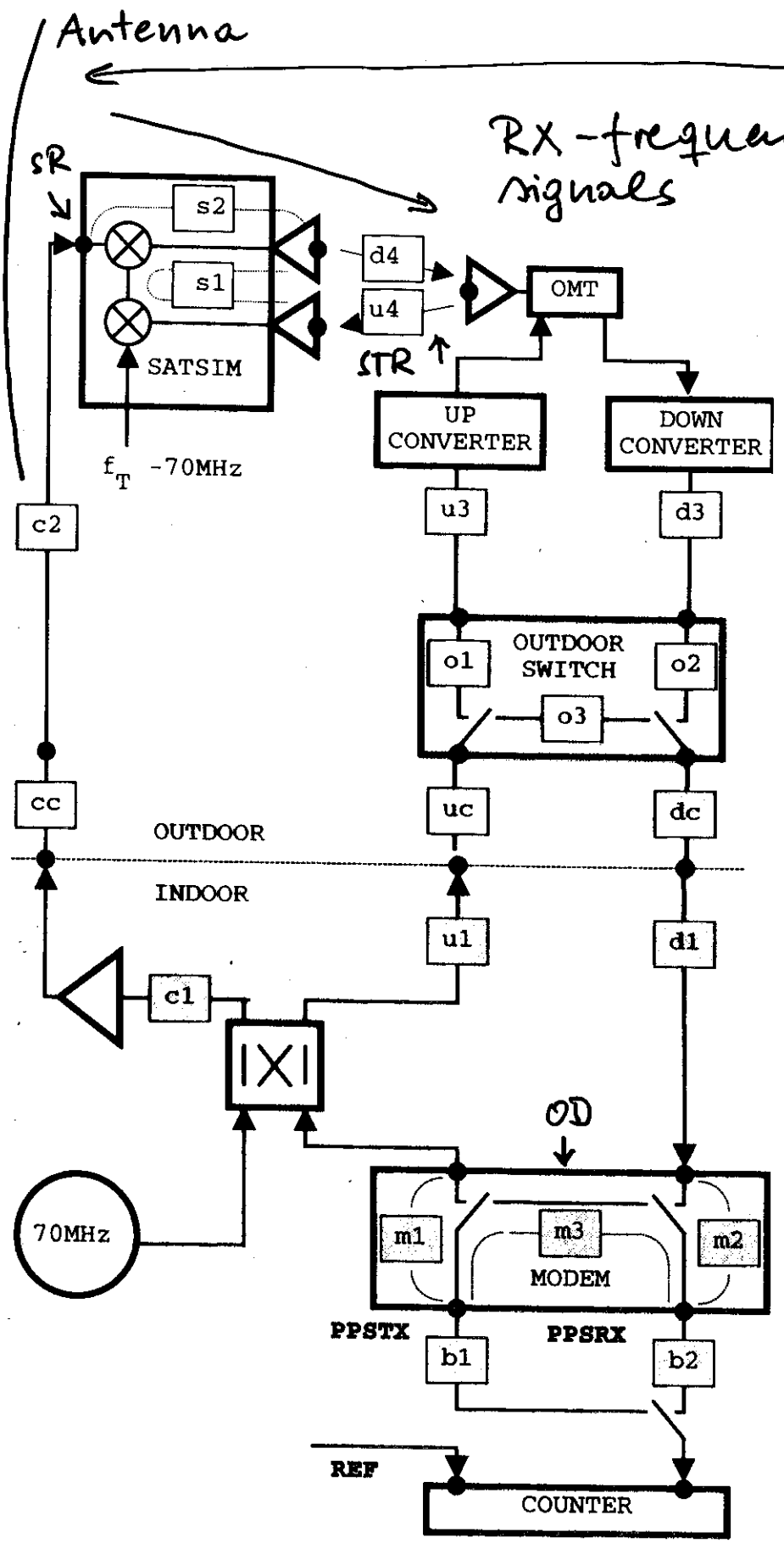
$\Longrightarrow$

- Common-clock T&F transfer
- Measurement of station delay variations (SatSim, others)

Performance of: T&F transfer

SatSim

(T&F transfer corrected with SatSim data)



Satsim
STR loop
SR loop
OD loop
Cal loop
} 100s each

time transfer 120s

repetition period: 720s and regular sessions

Satsim: ~50ps

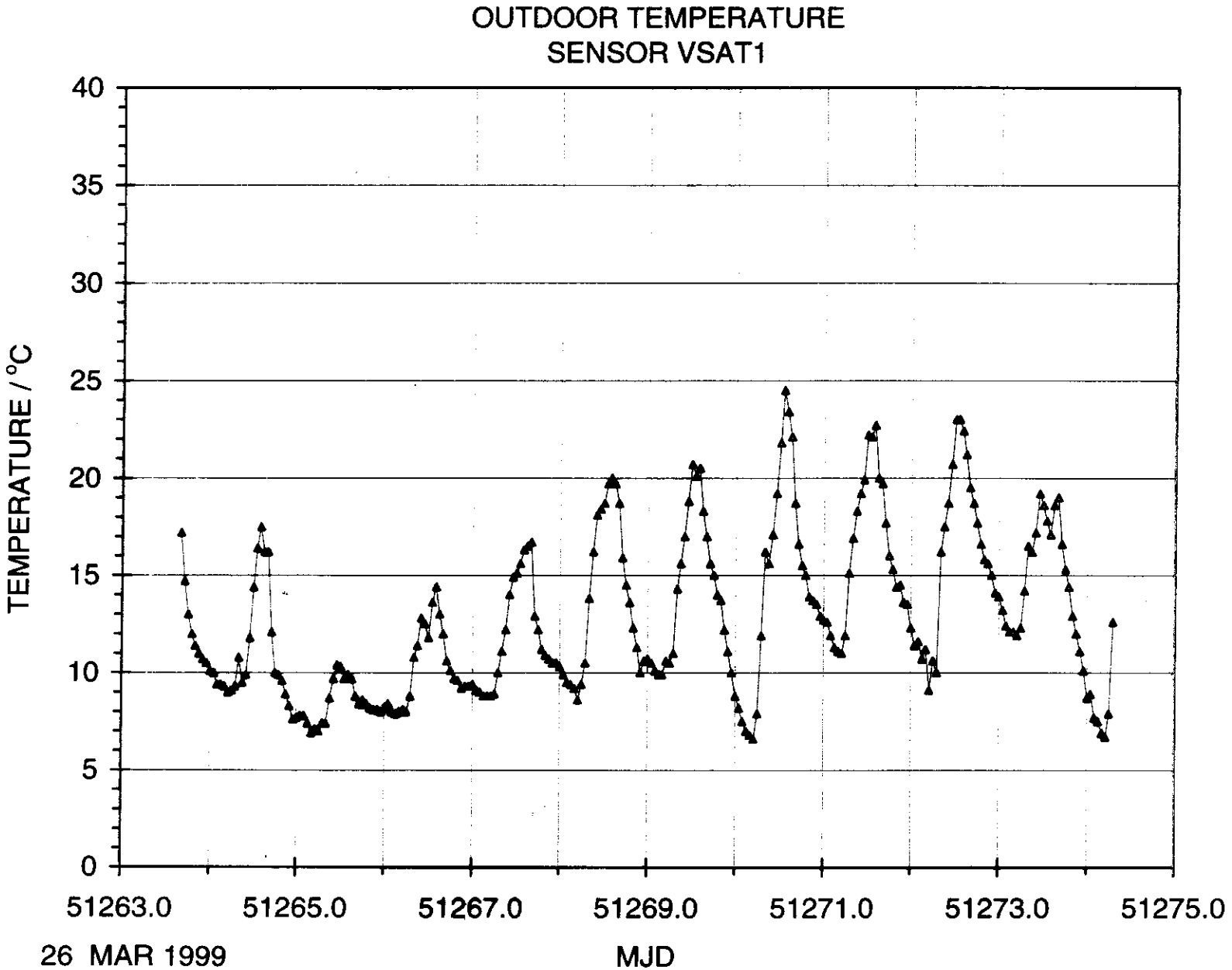
Time transfer: ~30ps

Problems:

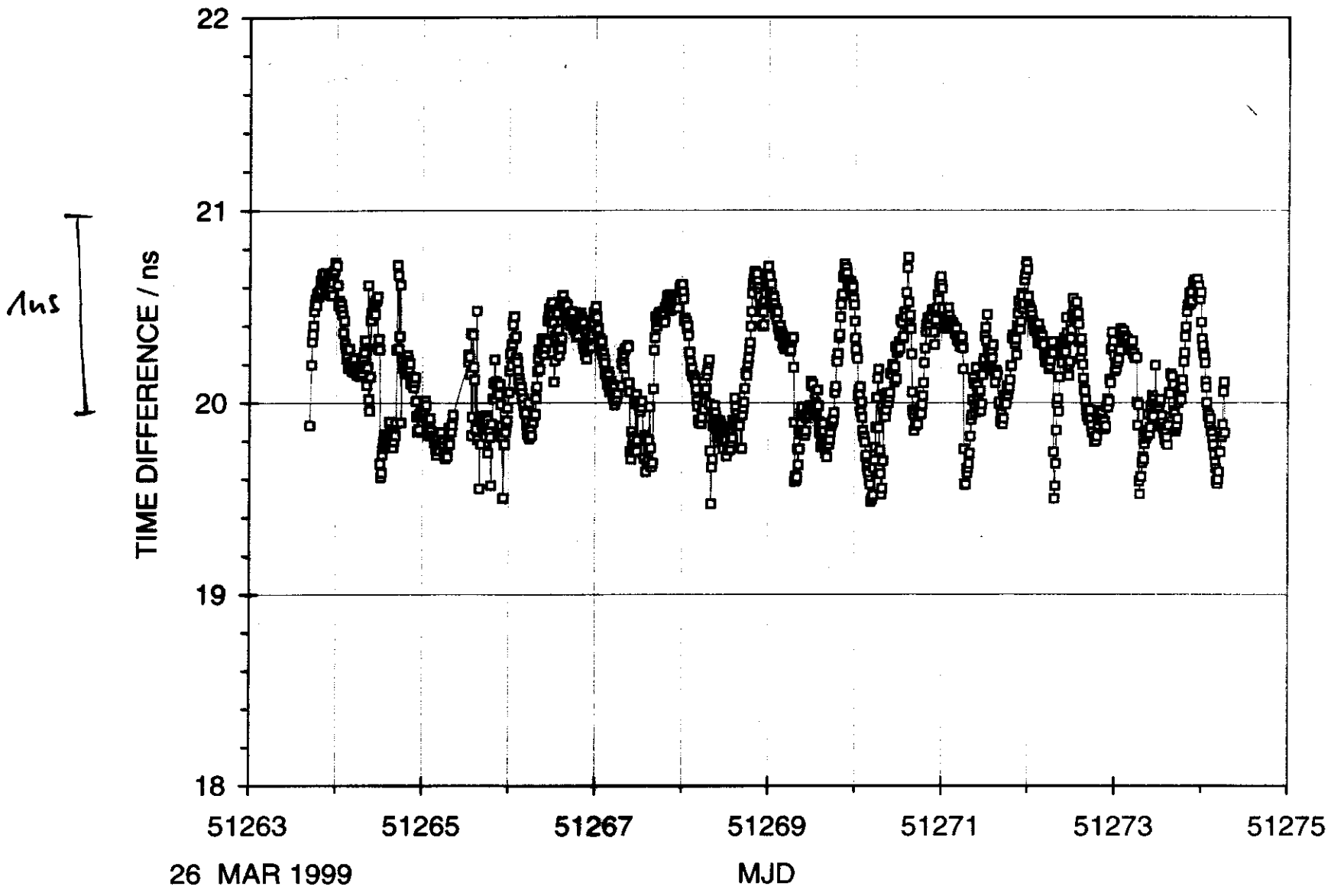
- Reflections cables, multipath (wet surface)
- crosstalk (modem)
- interfering signals from satellite

Interested in: $\frac{(\tau^{TX} - \tau^{RX})}{2}$

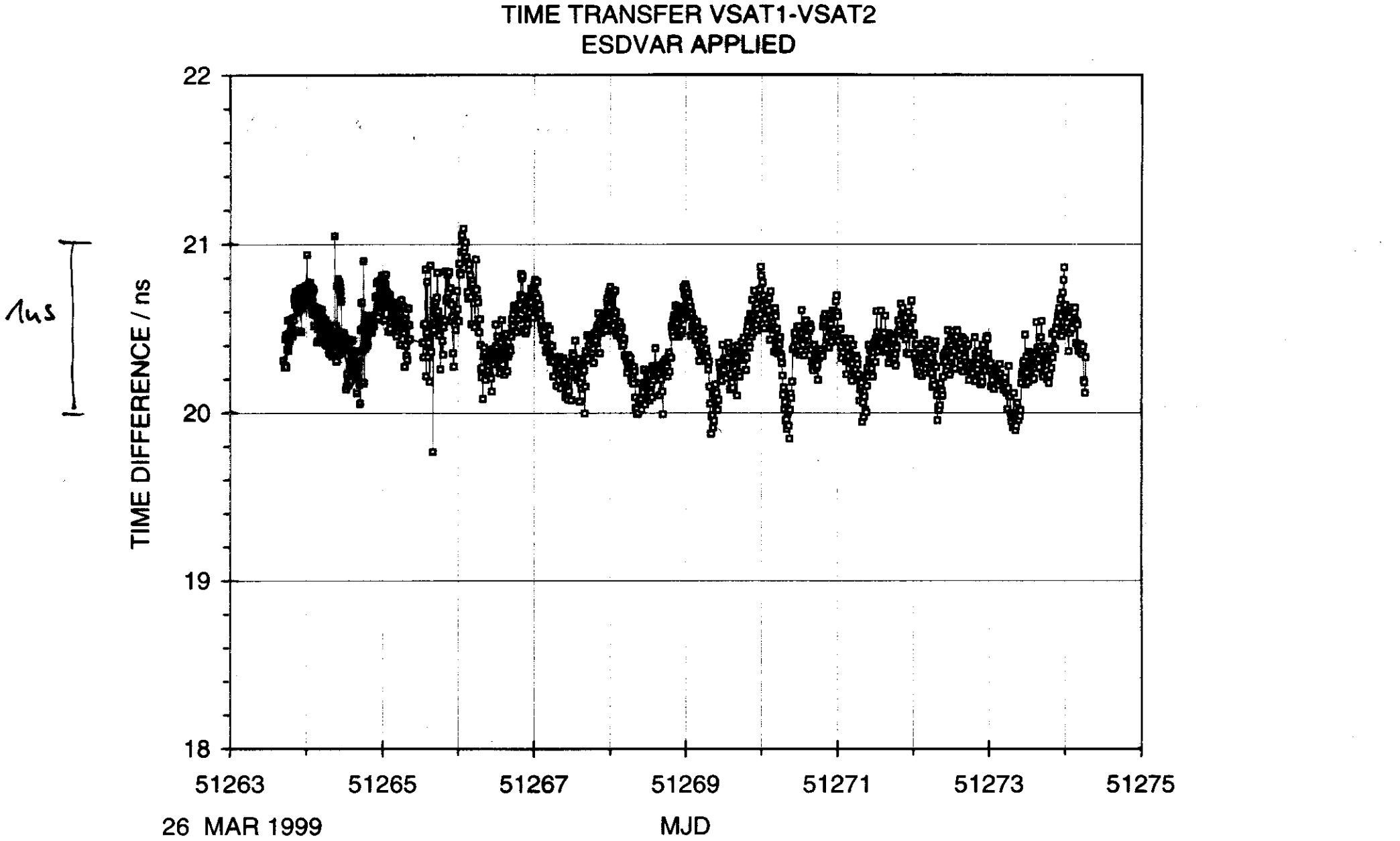
Measured: $\frac{(\tau^{TX} - \tau^{RX})}{2} + \tau^{M}$


OUTDOOR TEMPERATURE
SENSOR VSAT1
TEMPERATURE / °C
40
35
30
25
20
15
10
5
0
51263.0
51265.0
51267.0
51269.0
51271.0
51273.0
51275.0
26 MAR 1999
MJD

06.04.99

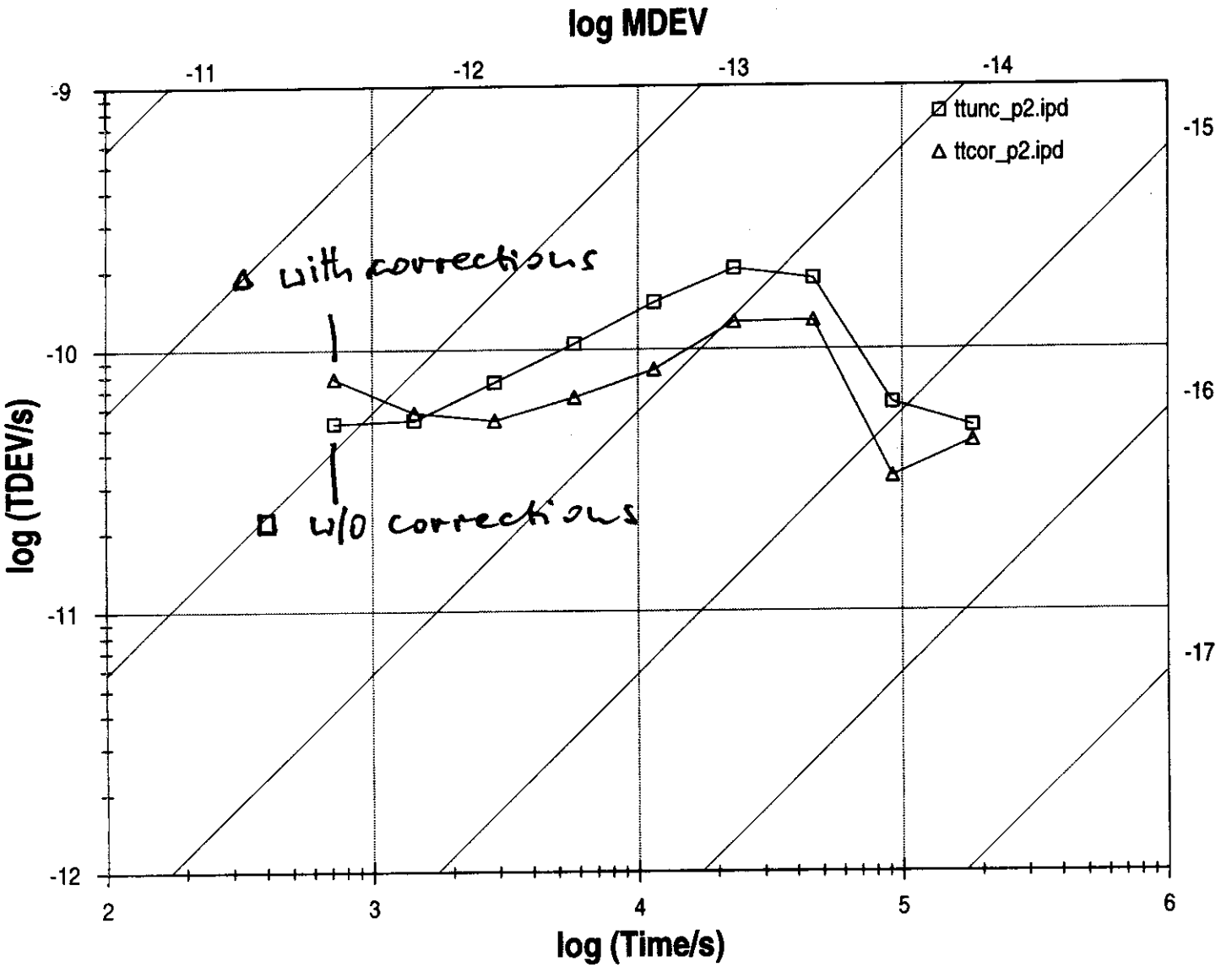

TIME TRANSFER VSAT1-VSAT2
0.5*(TW1-TW2)
22
21
20
19
18
TIME DIFFERENCE / ns
1ns
51263
51265
51267
51269
51271
51273
51275
26 MAR 1999
MJD

06.04.99

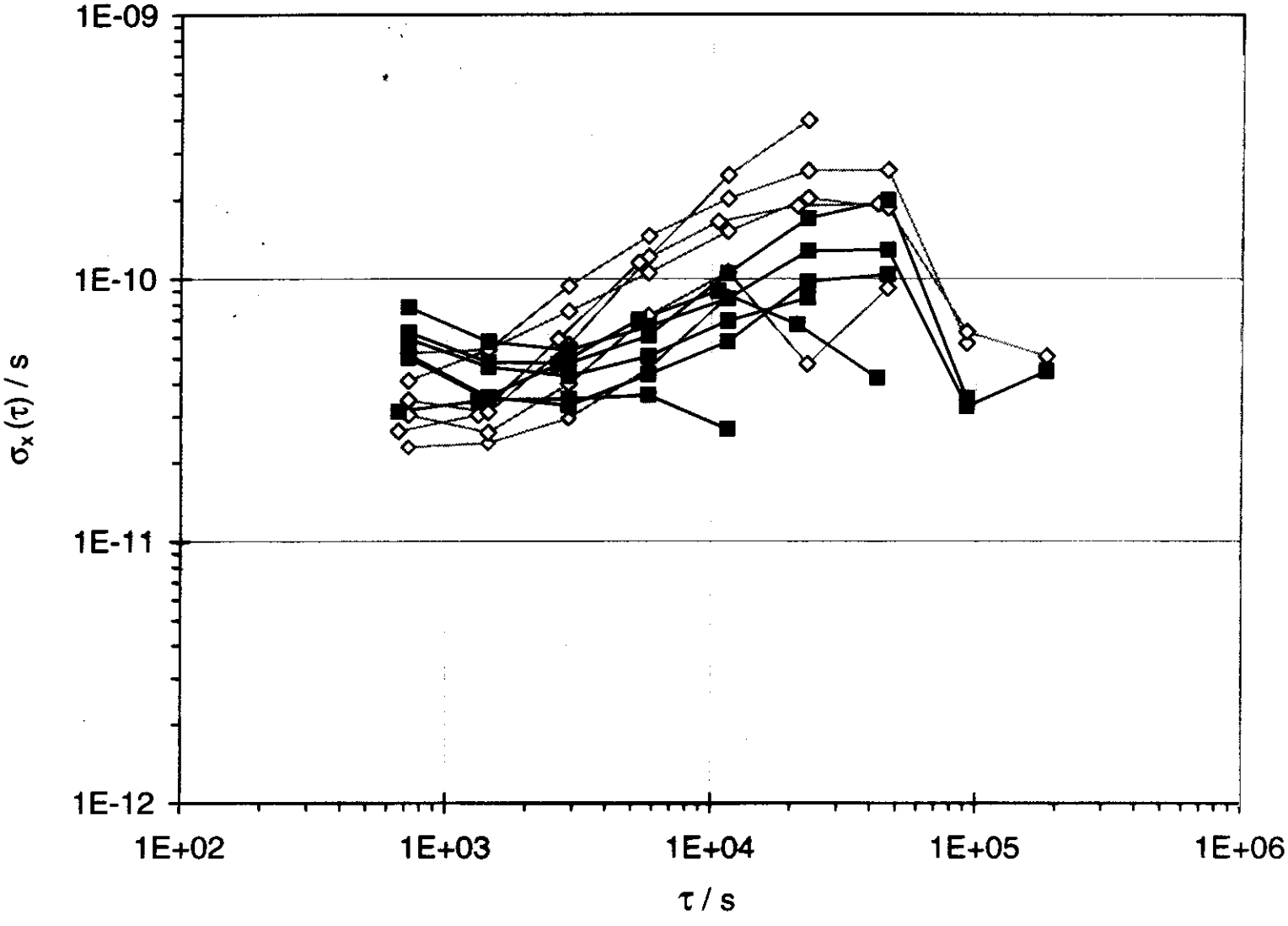

TIME TRANSFER VSAT1-VSAT2
ESDVAR APPLIED
22
21
20
19
18
TIME DIFFERENCE / ns
1ns
51263
51265
51267
51269
51271
51273
51275
26 MAR 1999
MJD

06.04.99

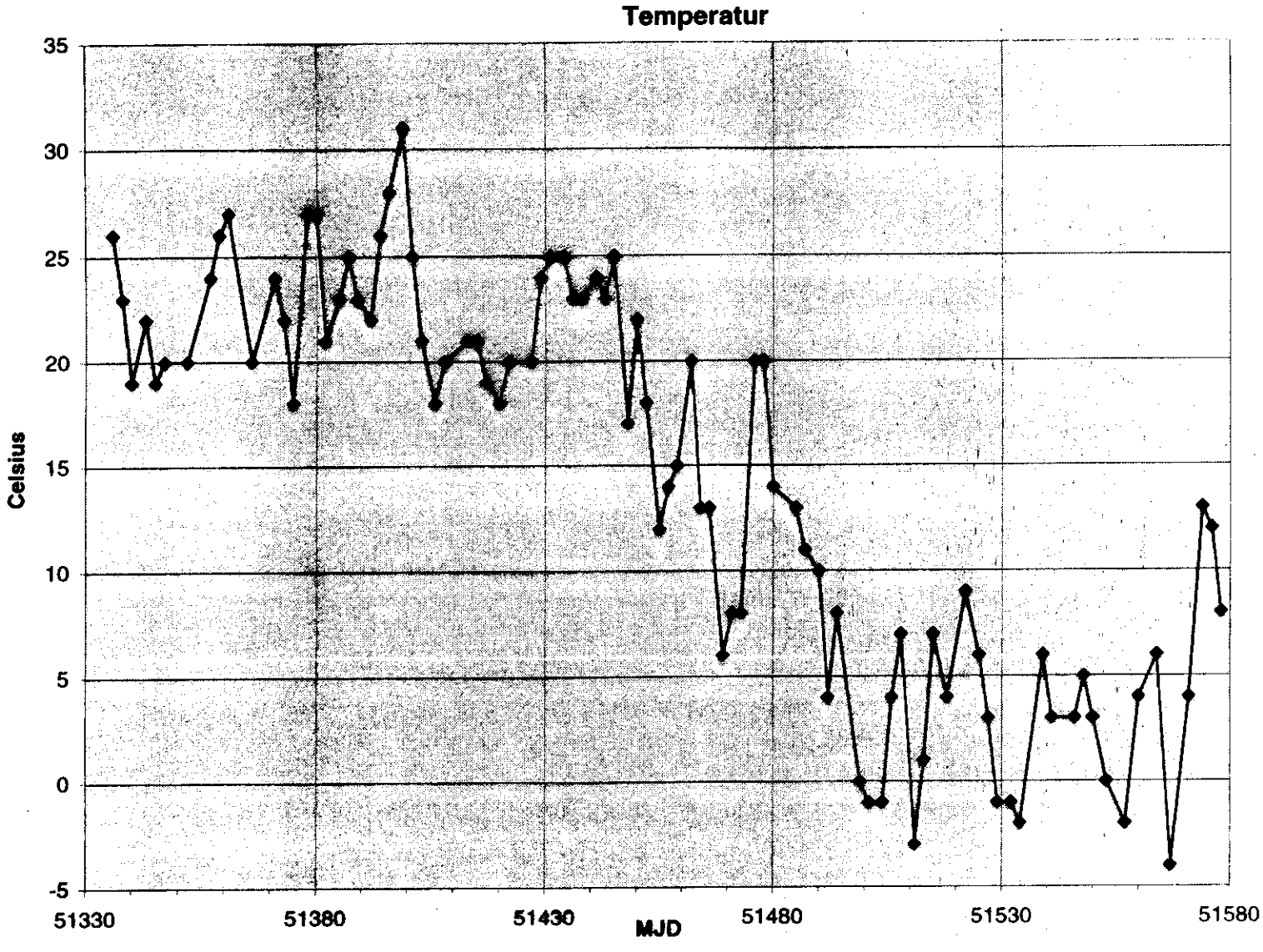
COMMON CLOCK TIME TRANSFER: ECS EXPERIMENT, 28.3 - 6.4.1999



Results of all experiments: □ w/o ■ with corrections



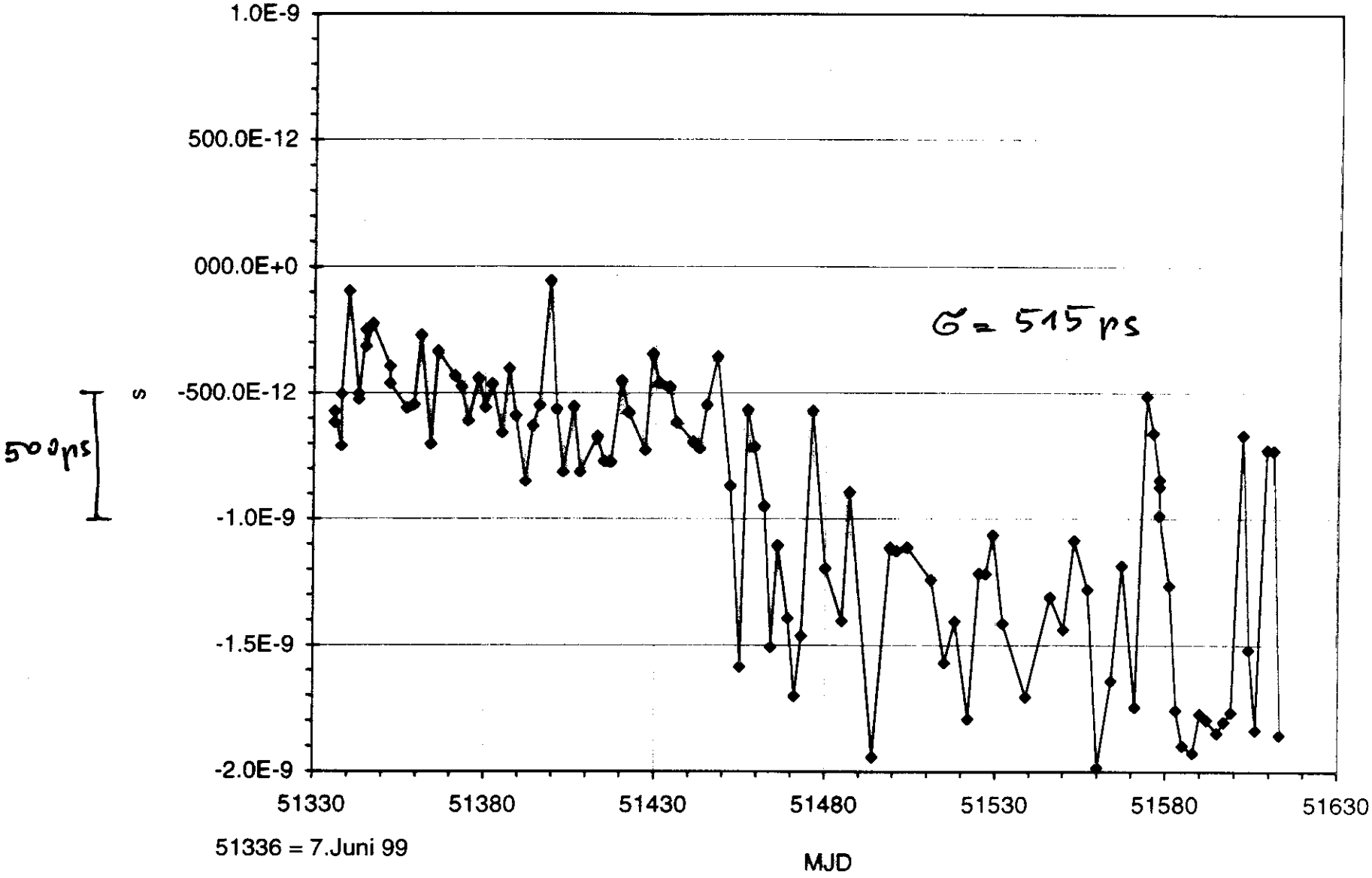
09.04.99


Temperatur
35
30
25
20
15
10
5
0
-5
Celsius
51330
51380
51430
51480
51530
51580
MJD

TEMP1-2.XLS

w/o w/o

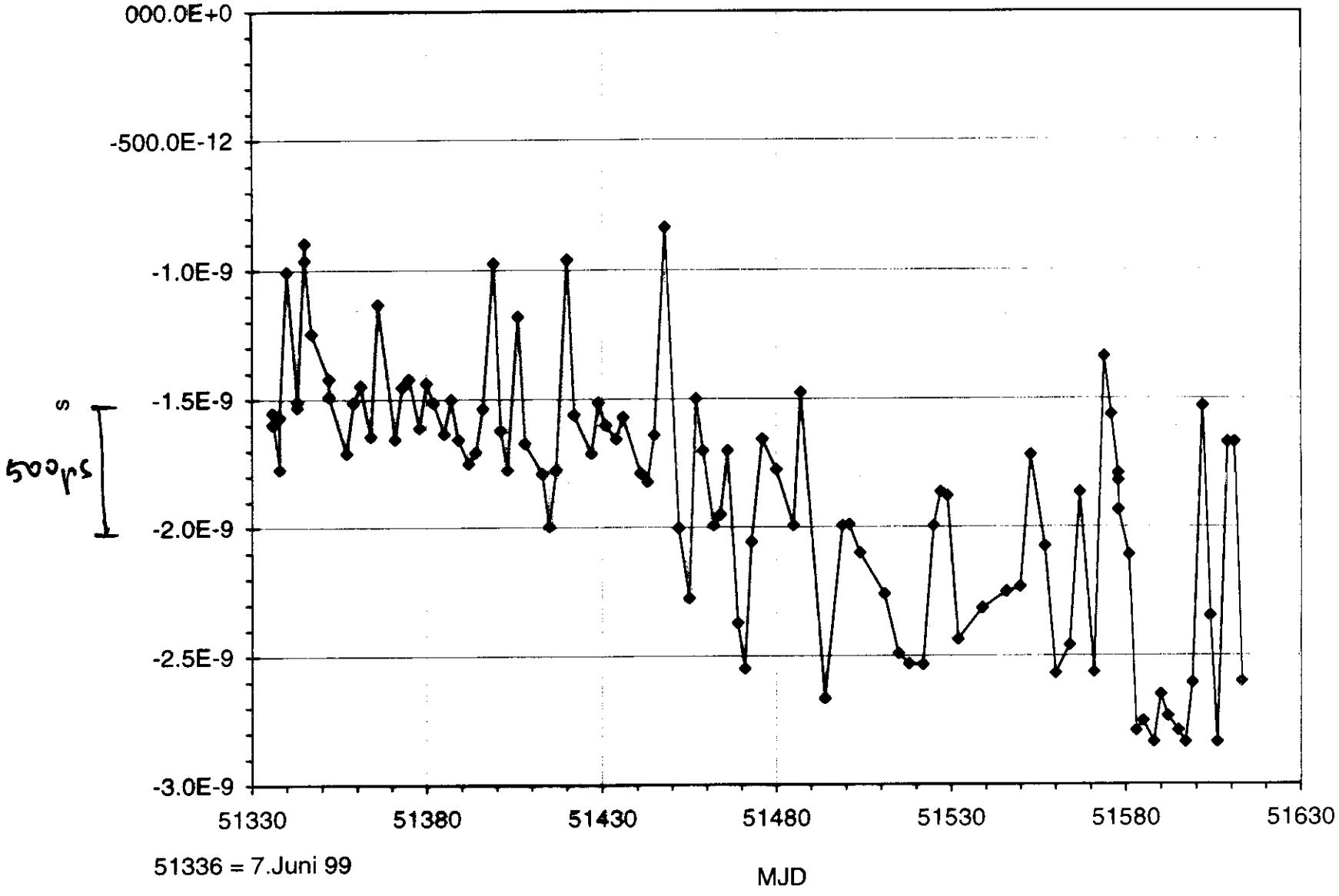
TUG01(ohne SATSIM) - TUG02 (ohne SATSIM)



TUG1-2.XLS

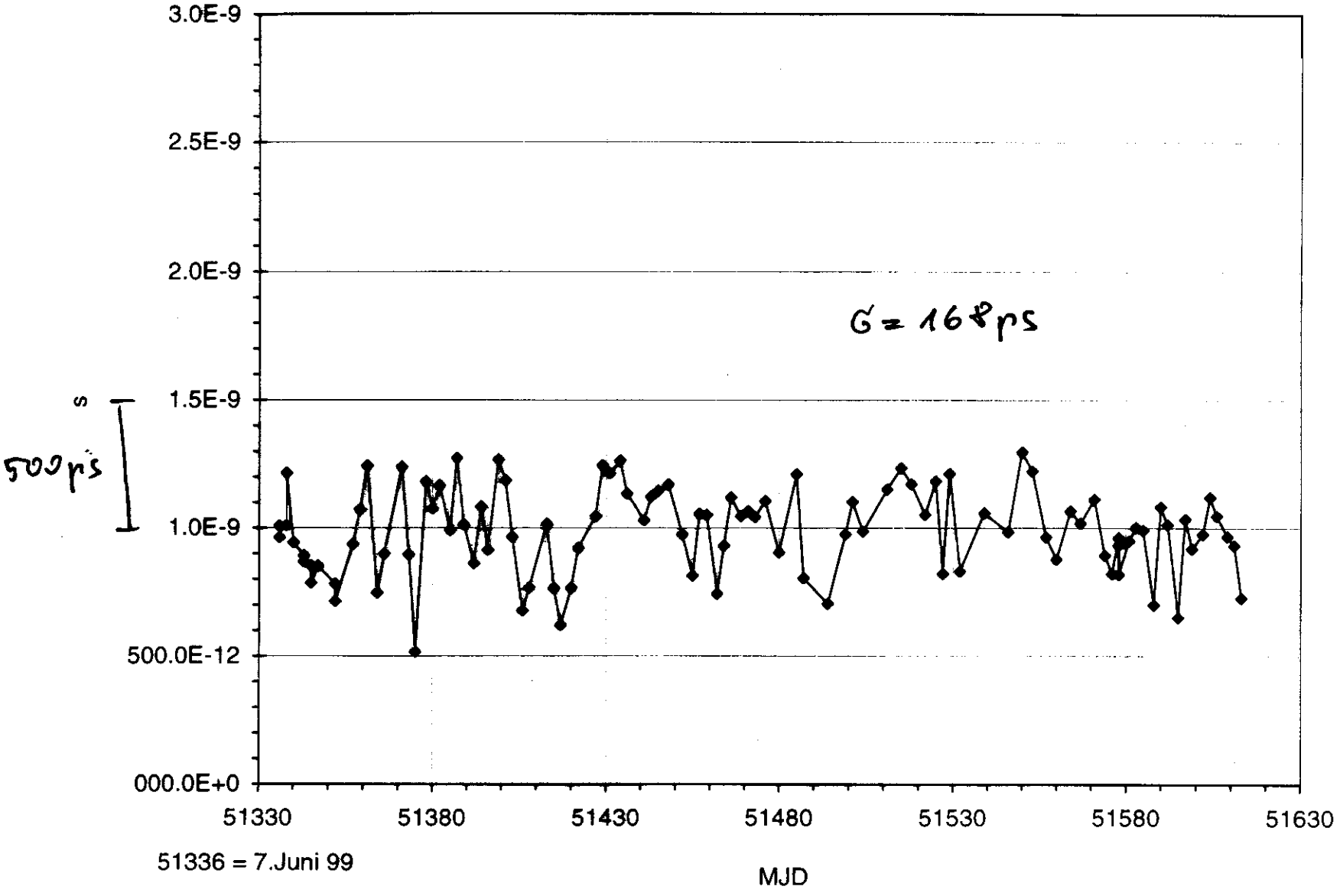
with w/o

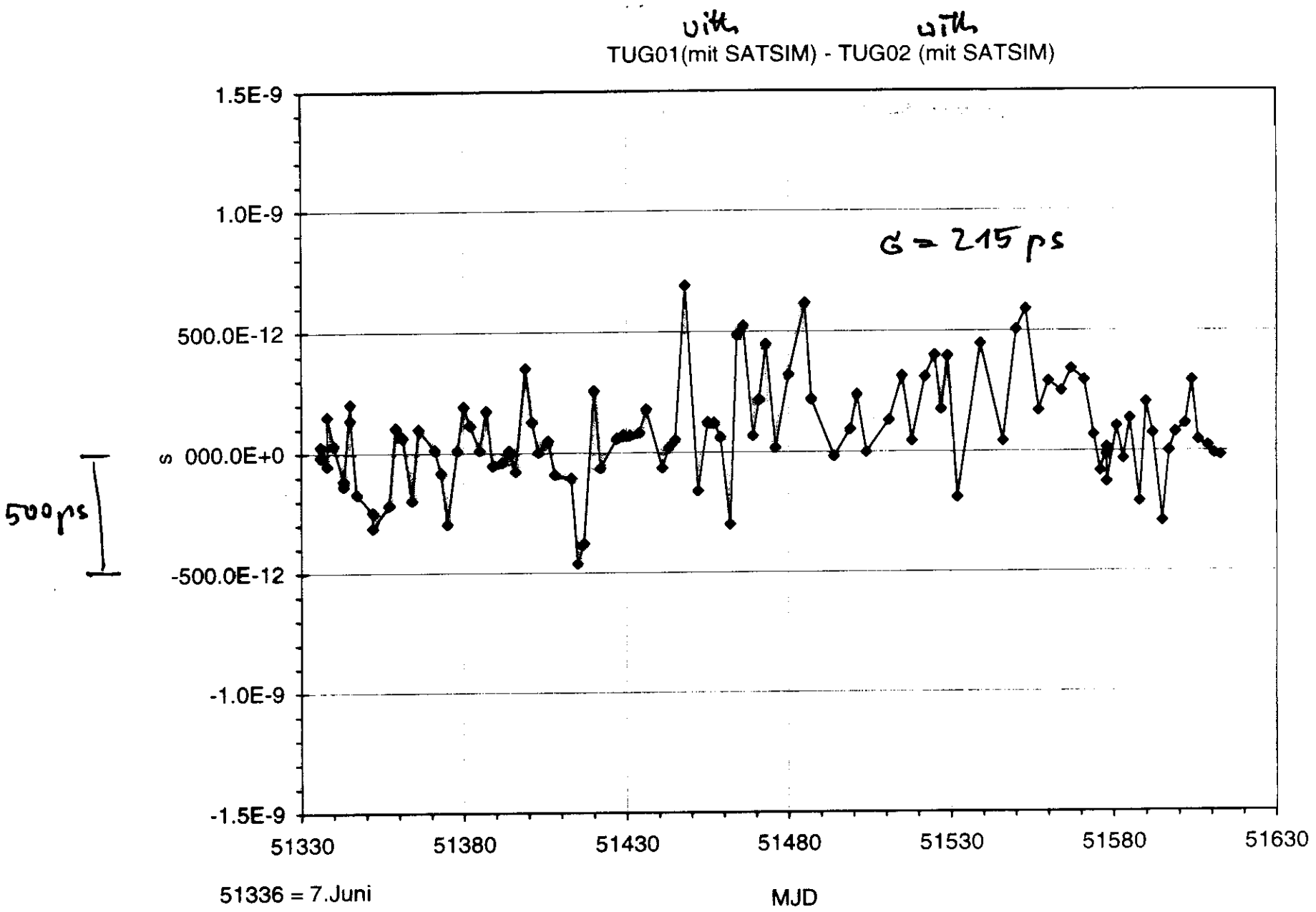
TUG01(mit SATSIM) - TUG02 (ohne SATSIM)



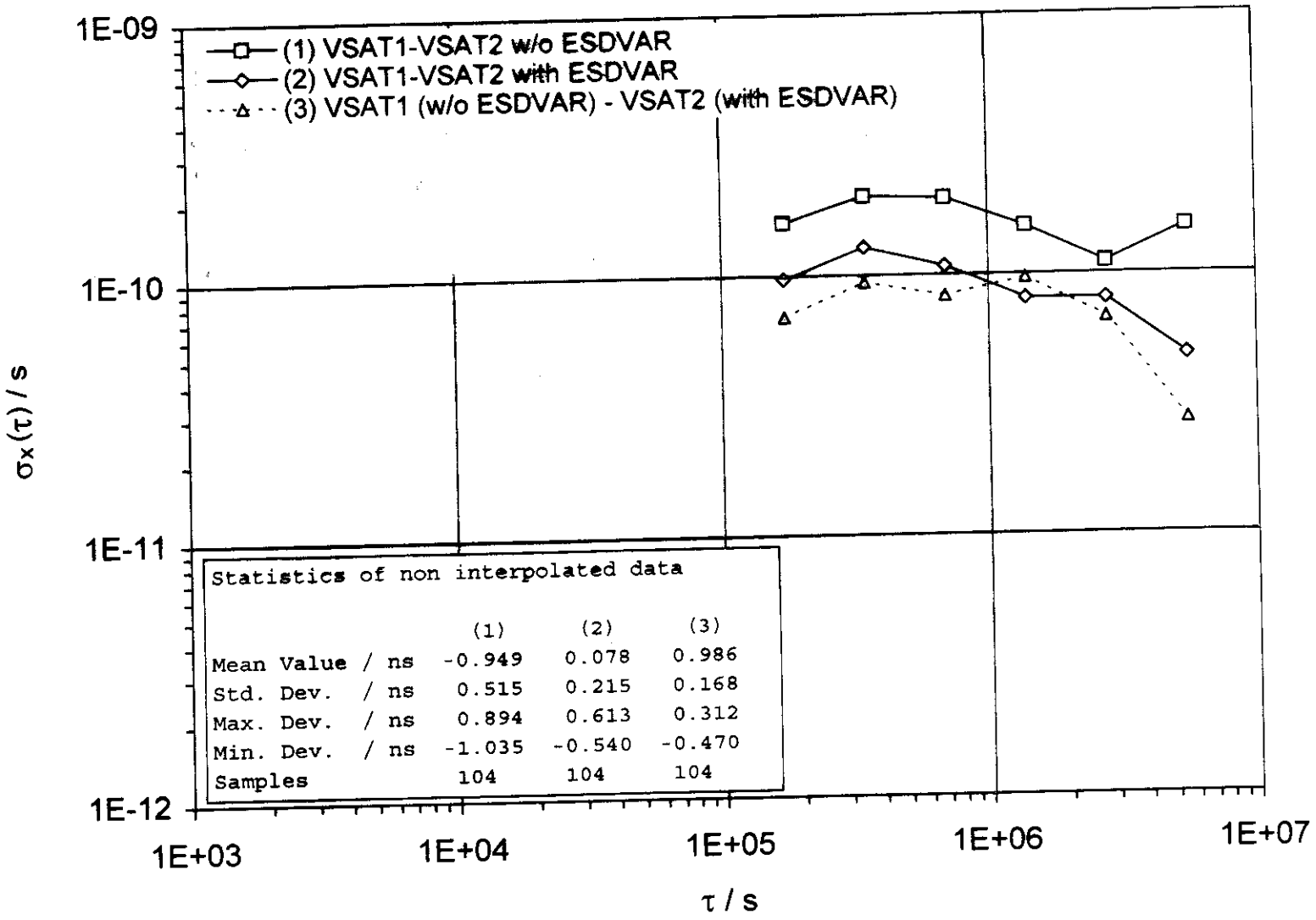
w/o with

TUG01(ohne SATSIM) - TUG02 (mit SATSIM)




with
with
TUG01(mit SATSIM) - TUG02 (mit SATSIM)
1.5E-9
1.0E-9
500.0E-12
s 000.0E+0
-500.0E-12
-1.0E-9
-1.5E-9
σ = 215 ps
500 ps
51330
51380
51430
51480
51530
51580
51630
51336 = 7.Juni
MJD

VSAT1-VSAT2 Time Transfer
51336-51612 (7.6.1999-9.3.2000), 276 DAYS



Statistics of non interpolated data

	(1)	(2)	(3)
Mean Value / ns	-0.949	0.078	0.986
Std. Dev. / ns	0.515	0.215	0.168
Max. Dev. / ns	0.894	0.613	0.312
Min. Dev. / ns	-1.035	-0.540	-0.470
Samples	104	104	104

31.08.00 51612.xls

RESSLER

Uncertainty

Contributions:

Link independent:

- Modem
- Counter
- Satellite Terminal
- T&F distribution
- Measurement scheme

Link dependent:

- Transponder
- Ionosphere
- Sagnac
- C/No

- Calibration

Future Activities

Presently:
2 min, 3/week, 2.5 MHz, 57 dBHz, ITU format via Internet

Possible extensions:

- More frequent fully automated measurements
- Higher chip rate (20 MHz, SATRE is ready)
  - * same equipment, same C/No higher precision and accuracy
  - * smaller terminals, lower C/No same precision, higher accuracy
    - temperature stabilization
    - transportation
    - satellite simulator
- Exchange of IS data via satellite (SATRE is ready and also other modems)
  - change of setup (star system)
  - computation of time differences in central station
    - refinement of modem format
    - format for difference file

Envisaged Activities:

- Extension of TWSTFT network
  - KU-Band
  - X-Band
- Frequent calibrations
- Stability studies
  - Time Transfer (High stable clocks)
  - Common clock experiments
  - Satellite simulators
- Use of CP for TWSTFT (SATRE is ready)
- Comparison with other methods
  - GPS (Code, CP)
  - GLONASS
  - GALILEO
- Development of a small and self contained (hardware, software) station which is simply to operate