

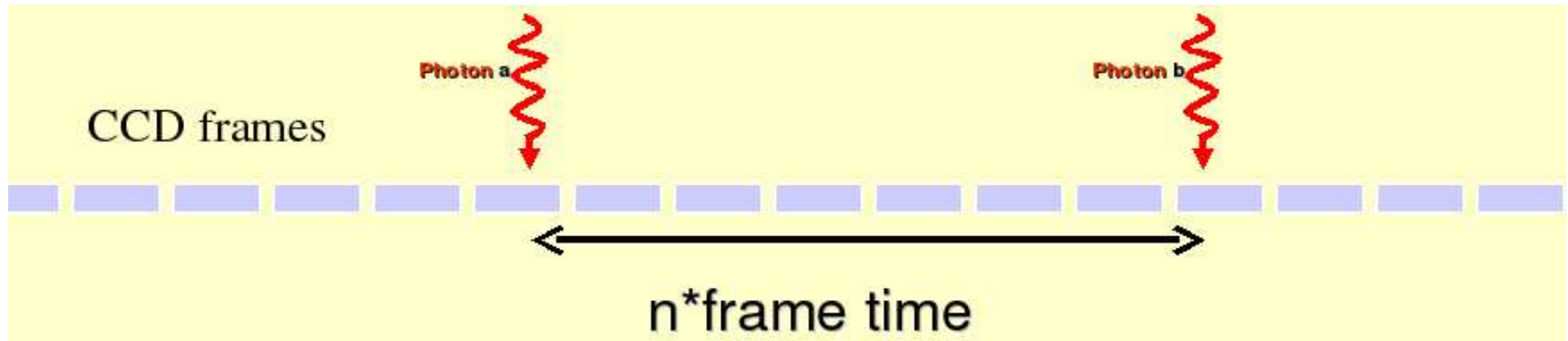
SAS-7.1: status report on EPIC-pn time jumps

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ESAC + MPE Garching

- History + theory
- SAS-7.1: implementation and testing

EPIC-pn frames

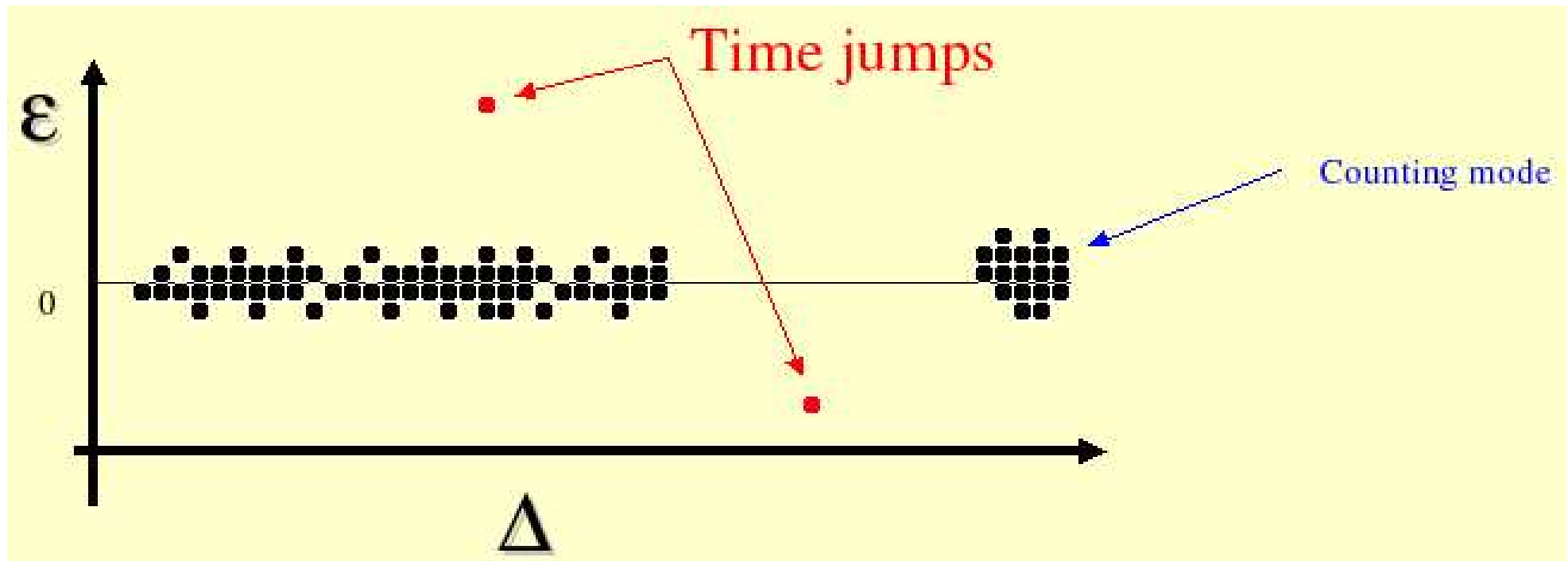


- Intrinsic EPIC-pn time resolution: 40 ns (25 MHz oscillator)
- PNAUX1 time resolution: $20.48 \mu\text{s}$ ($512 \times$ intrinsic)
- Event time computation by OAL: $T = T_0 + \text{FTCOARSE} + \text{FTFINE} \times 20.48 \mu\text{s} + T_{\text{cal}}$
- Does not need frame time values of `EPN_TIMECORR_####.CCF [FRAMETIME]`
- Accessed CCF values: `EPN_TIMECORR_####.CCF [TIMECORR]`
- Event time: center of integration time of that CCD

- Frames without events (after EPEA) are not transmitted (\rightarrow gaps)
- Frame times are not multiples of 512 oscillator clocks: jitter by 1 FTFINE unit

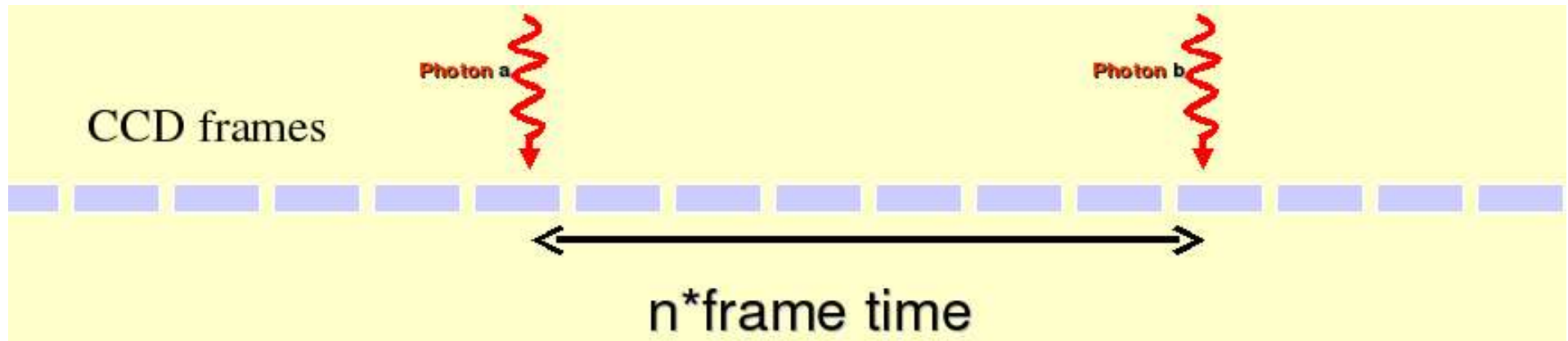
EPIC-pn time jumps

- normal reset after 32400s (but: telemetry outage ...)
- Difference of 2 event times has to be integer multiple of frame time
- Deviations indicate possible time jumps



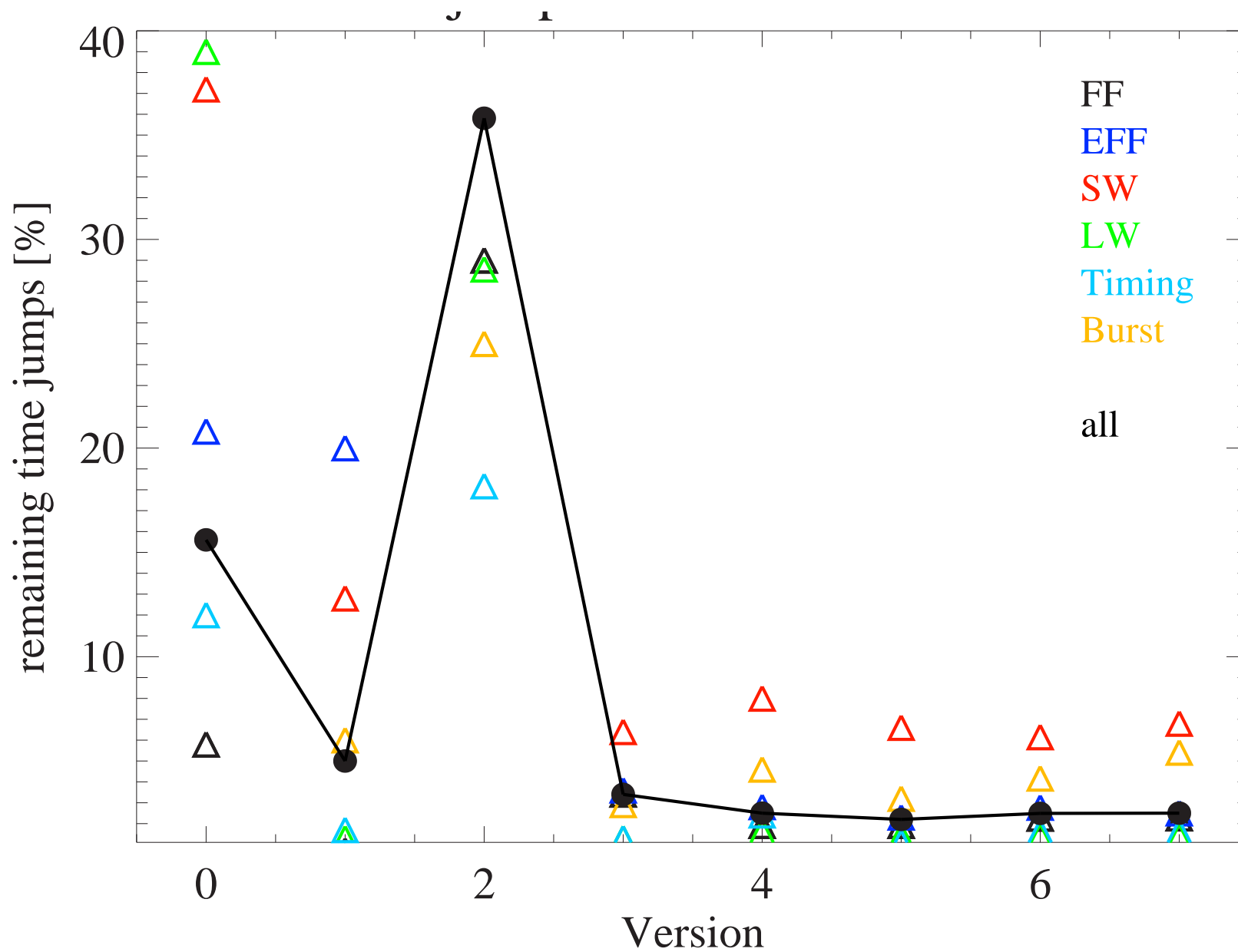
- Δ = time difference in units of frame time
- ε = deviation from integer number

EPIC-pn frames

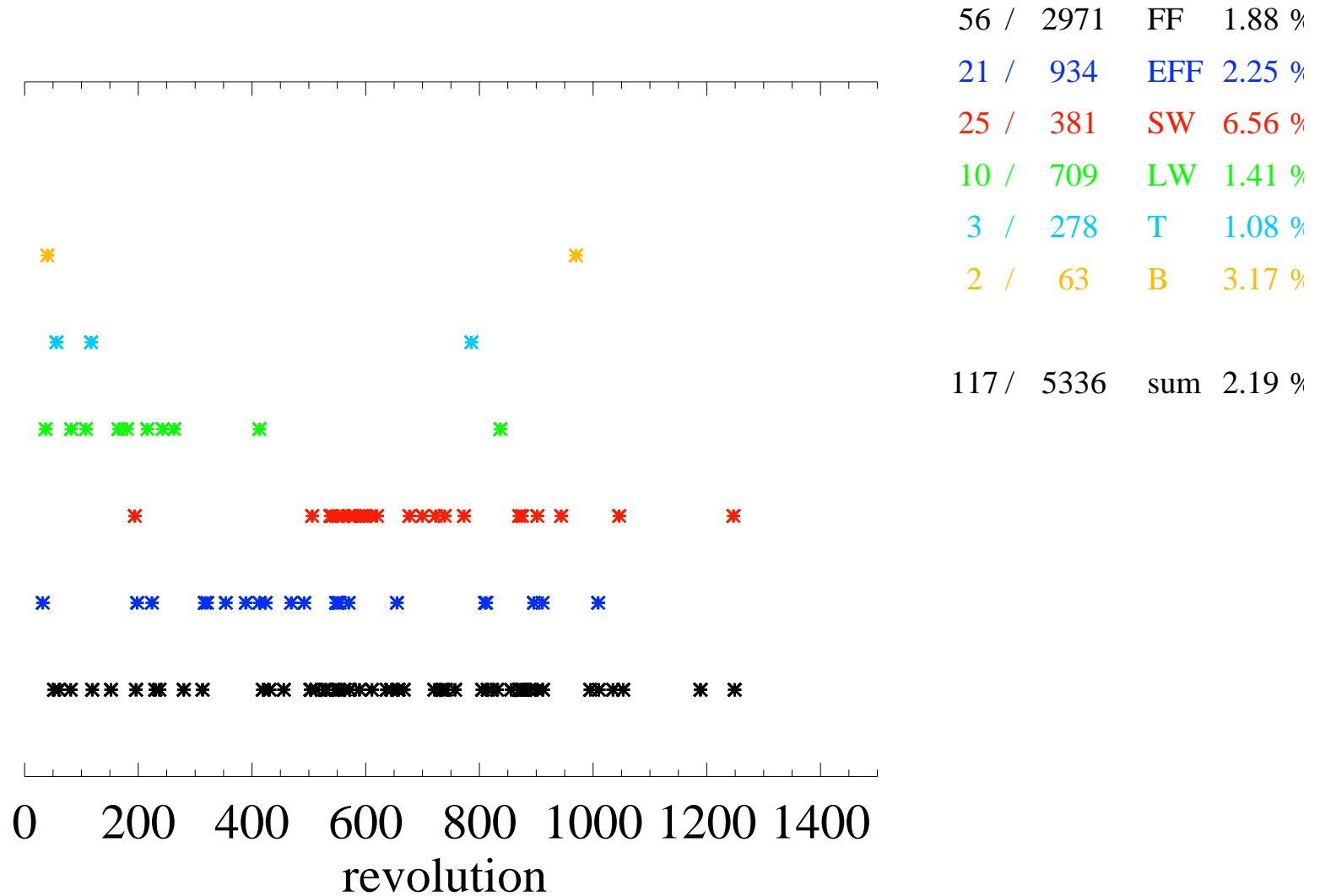


- Large intervals require high precision knowledge (and stability) of frame times
- Only (but very !) relevant for time anomaly detection:
- Event time difference divided by frame time should be (close to) an integer
- Most typical time anomaly: wrong increments of FTCOARSE: full seconds shift
- Once event times are randomized: no way to detect residual time anomalies

EPIC-pn time jumps: SAS-7.1 testing: versions



EPIC-pn time jumps: SAS-7.1 testing: status

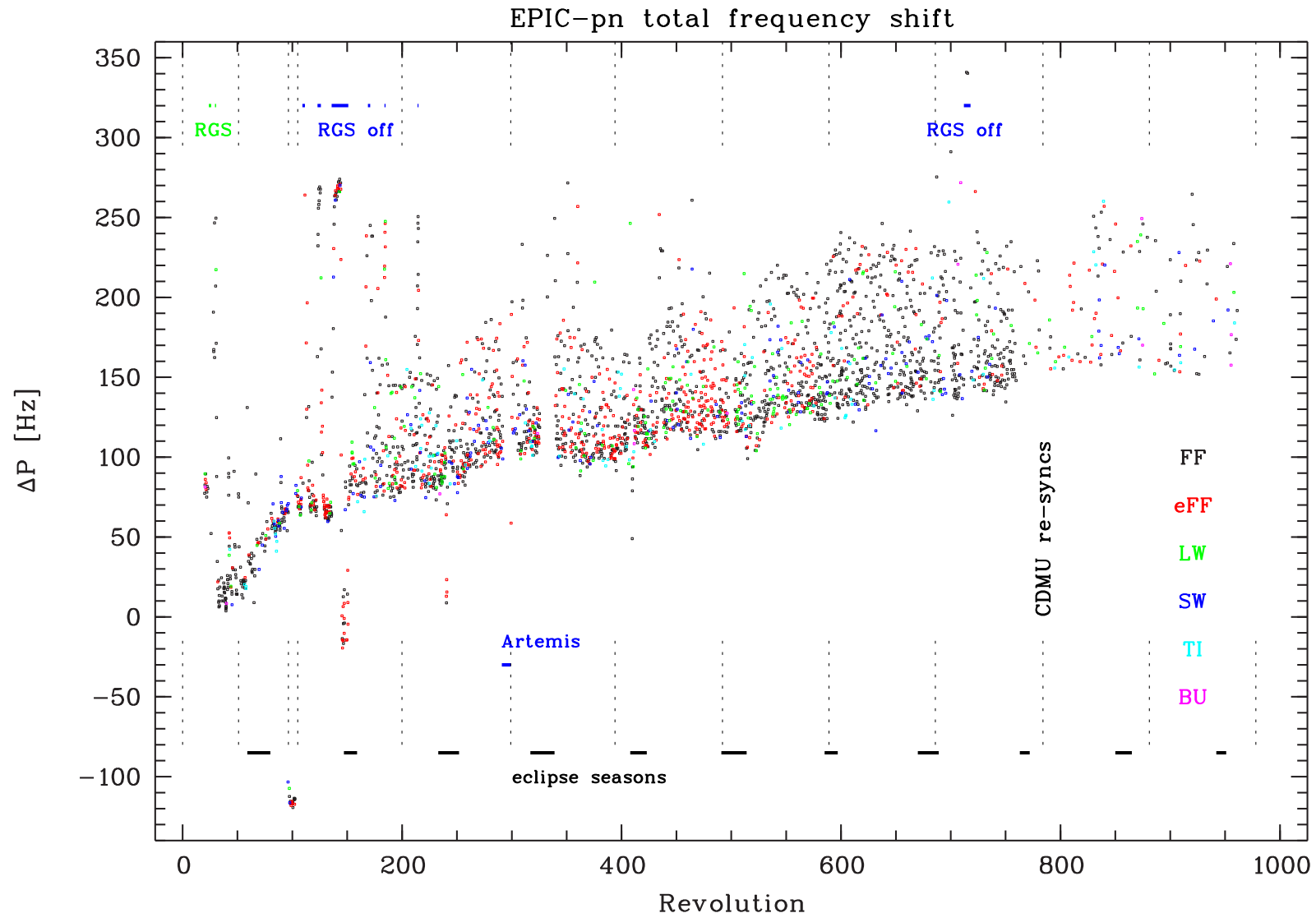


EPIC-pn time jumps: SAS-7.1 testing: summary

Mode	oldCCF+oldalgo	newCCF+oldalgo	newCCF+19	newCCF+20
FF	5.8	0.7	29.0	3.4
EFF	20.8	20.0	58.33	3.6
SW	37.2	12.8	59.09	6.4
LW	39.0	1.3	28.57	1.3
Ti	12.0	1.7	18.18	1.3
Bu	52.9	6.0	25.00	2.9
SUM	15.6	5.0	35.81	3.3

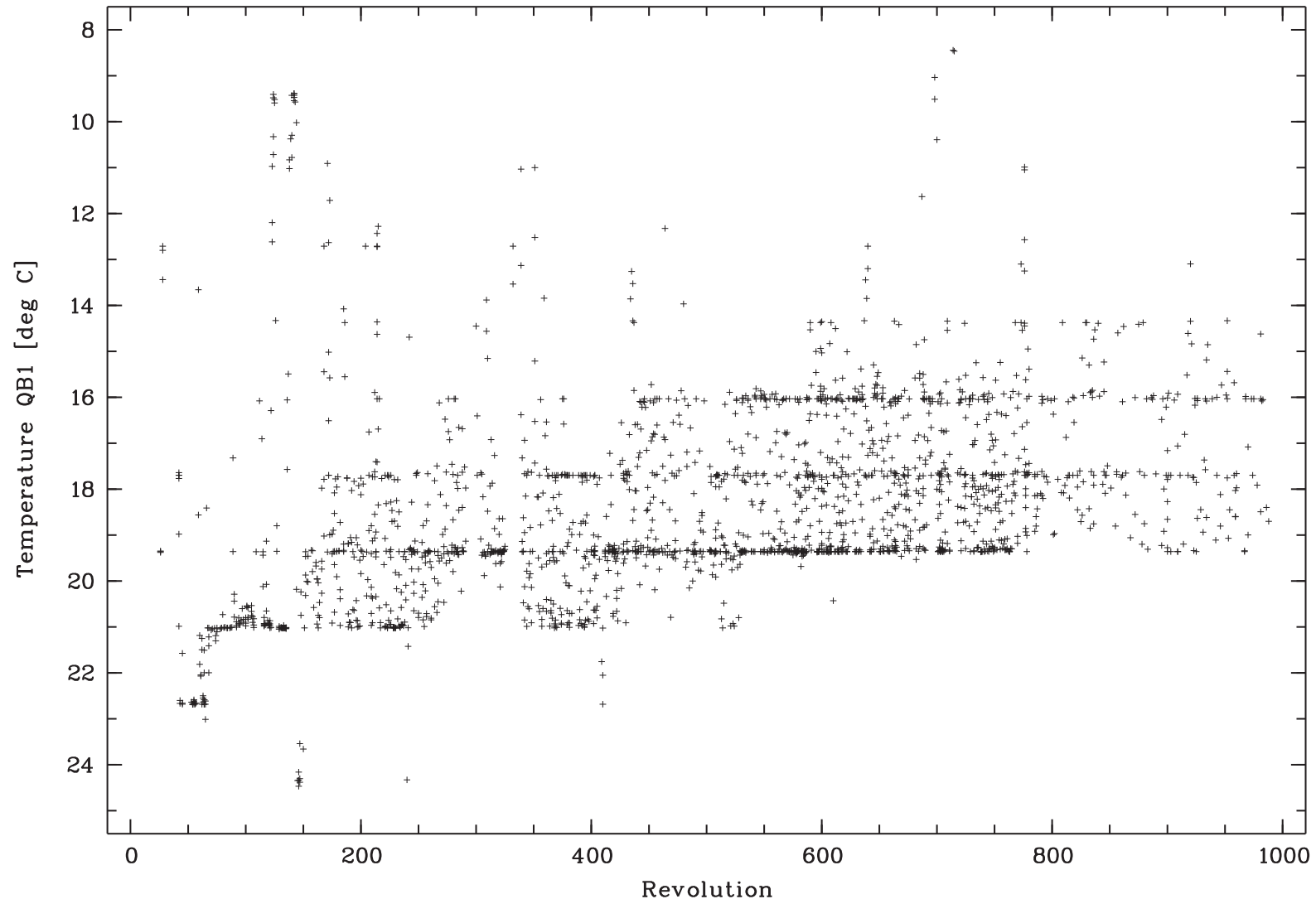
Mode	newCCF+21	newCCF+22	newCCF+23	newCCF+24
FF	1.9	1.9	2.25	2.26
EFF	2.8	2.3	2.77	2.5
SW	8.0	6.6	6.15	6.8
LW	1.6	1.4	1.42	1.4
Ti	2.4	1.1	1.60	1.6
Bu	4.6	3.2	4.17	5.41
SUM	2.5	2.2	2.49	2.5

EPIC-pn frame times: 25 MHz oscillator



Total difference of the effective frequency of internal EPIC-pn oscillator (combined with external OBT oscillator effects) from the nominal value of $f_{pn} = 25$ MHz as function of time and instrument mode. External events like eclipse seasons or RGS switch offs are indicated; dotted vertical lines show CDMU re-syncs. The long-term increase of the frequency is probably due to external temperature effects or to ageing the EPIC-pn oscillator. There is no apparent mode dependency. ftp://ftp.xray.mpe.mpg.de/people/mjf/public/mpe_report_288_159.pdf

EPIC-pn frame times: 25 MHz oscillator



Evolution of EPIC-pn quadrant box temperature for quadrant Q1 (which includes the target CCD) for FF mode, averaged over an exposure. The temperature sensor has only a coarse sampling (1 step = 0.88°C), for shorter exposures only one value during an exposure is realized. The ordinate has been intentionally inverted, higher temperatures are toward the bottom. When comparing with oscillator frequency plot a similarity in terms of general trend is suggestive: a decreasing quadrant box temperature increases the frequency of the oscillator (which is not temperature stabilised). ftp://ftp.xray.mpe.mpg.de/people/mjf/public/mpe_report_288.159.pdf

Current situation: SAS-7.1

- acceptance threshold (margin) of time jump vs. jitter:
environment variable `SAS_JUMP_TOLERANCE`, in `FTFINE` units
- iterating + testing + fine tuning: to make sure that all existent time jumps are detected and properly corrected and that no new time jumps are introduced by the software
- Strictly speaking: frame times are not constant in [ms] but in [clocks]
- However, SAS assumes [ms], but absolute effect small (other effects ?)