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Determination of the MIR–REM observations times

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Contents

1 Introduction

In the original MIR–REM data files, the start times of the accumulations are only specified by the internal time of the on–board computer (AREM time). Synchronization with real time is done later, after the data has been send to ground. This is achieved by exploiting the fact, that after all scientific data has been send, AREM sends its actual time to ground. Comparing these time stamps with the time of reception on ground allows to make the linkup between AREM time and Moscow (Universal) time. The method has been described in report "MIR DATA PREPROCESSING" from June, 1995 [1]. However, during data transmission to ground AREM is somehow delayed, which has to be taken into account when calculating the REM observation times.

In paragraph 2.3 of the above cited report it was assumed that the AREM clock is switched off during data transmission. Later it has then been realized that this is not the case and a new approach has been used which is described in report "Determination of the MIR–REM observation times" from October 1995 [2]. A new analysis of the problem in Moscow together with L. Masslenikov from RSC ENERGIA in May 1996 has resulted in the algorithm described in this document. This algorithm has been applied to all observations and shows, with few exceptions, good results.

2 MIR-REM observation times

2.1 AREM time during data transmission

The MIR-REM data is transmitted to ground in packages of 64 bytes (called frames) at a frequency of 47 Hz [3]. At reception of each frame on ground, the actual Moscow time is attached to the frame. After all data frames have been read by AREM from the REM data buffer and have been send to ground, AREM continuous to send status frames containing the actual AREM time. Comparing AREM time of the status frames with the Moscow time of reception allows to link AREM time with real time.

However, during transmission AREM time is retarded with respect to Moscow time. This is shown in Figure 1 where Moscow and AREM times of a series of status frames from data file t9508231.rem are compared.
Moscow time increases after every 47th frame by one second. As the frame transmission rate is 47 Hz, this is what is expected. However, AREM time only increases after 50 frames. Thus per one second transmission time, AREM time is retarded by $3/47 = 0.0638$ seconds with respect to real world time. This is observed in all the data files.

This delay can only be measured with the status frames because they allow to compare actual AREM time with actual Moscow time, which is not the case for the data frames. However, **we assume that the time delay is the same during data frame transmission and status frame transmission**, although the mechanism causing this delay is not understood.

2.2 Determination of the observation times

Figure 2 illustrates the involved parameters. t_{Msc_1} is the Moscow time of the reception of the first data frame, t_{AREM_i} is the AREM time of data frame i, t_{Msc_n} is the Moscow time of the

Moscow	AREM	Nr
11 1f 28	db 13 0c	001
11 1f 28	**dc 13 0c**	002
11 1f 28	dc 13 0c	003
11 1f 28	dc 13 0c	004
11 1f 28	dc 13 0c	005
11 1f 28	dc 13 0c	006
11 1f 28	dc 13 0c	007
11 1f 28	dc 13 0c	008
11 1f 28	dc 13 0c	009
11 1f 28	dc 13 0c	010
11 1f 28	dc 13 0c	011
11 1f 28	dc 13 0c	012
11 1f 28	dc 13 0c	013
11 1f 28	dc 13 0c	014
11 1f 28	dc 13 0c	015
11 1f 28	dc 13 0c	016
11 1f 28	dc 13 0c	017
11 1f 28	dc 13 0c	018
11 1f 29	dc 13 0c	**019**
11 1f 29	dc 13 0c	020
11 1f 29	dc 13 0c	021
11 1f 29	dc 13 0c	022
11 1f 29	dc 13 0c	023
11 1f 29	dc 13 0c	024
11 1f 29	dc 13 0c	025
11 1f 29	dc 13 0c	026
11 1f 29	dc 13 0c	027
11 1f 29	dc 13 0c	028
11 1f 29	dc 13 0c	029
11 1f 29	dc 13 0c	030
11 1f 29	dc 13 0c	031
11 1f 29	dc 13 0c	032
11 1f 29	dc 13 0c	033
11 1f 29	dc 13 0c	034
11 1f 29	dc 13 0c	035
11 1f 29	dc 13 0c	036
11 1f 29	dc 13 0c	037
11 1f 29	dc 13 0c	038
11 1f 29	dc 13 0c	039
11 1f 29	dc 13 0c	040
11 1f 29	dc 13 0c	041
11 1f 29	dc 13 0c	042
11 1f 29	dc 13 0c	043
11 1f 29	dc 13 0c	044
11 1f 29	dc 13 0c	045
11 1f 29	dc 13 0c	046
11 1f 29	dc 13 0c	047
11 1f 29	dc 13 0c	048
11 1f 29	dc 13 0c	049
11 1f 29	dc 13 0c	050
11 1f 29	dc 13 0c	051
11 1f 29	**dd 13 0c**	052
11 1f 29	dd 13 0c	053
11 1f 29	dd 13 0c	054
11 1f 29	dd 13 0c	055
11 1f 29	dd 13 0c	056
11 1f 29	dd 13 0c	057
11 1f 29	dd 13 0c	058
11 1f 29	dd 13 0c	059
11 1f 29	dd 13 0c	060
11 1f 29	dd 13 0c	061
11 1f 29	dd 13 0c	062
11 1f 29	dd 13 0c	063
11 1f 29	dd 13 0c	064
11 1f 29	dd 13 0c	065
11 1f 2a	dd 13 0c	**066**
11 1f 2a	dd 13 0c	067
11 1f 2a	dd 13 0c	068
.		
.		

Δ Nr = 50

Δ Nr = 47

Figure 1: Moscow and AREM times of a series of status frames from data file t9508231.rem. Moscow time increases every 47th frame by one second. This is expected because the nominal frame transmission rate is 47 Hz. AREM time only changes every 50th frame. Per one second of transmission time, AREM time is retarded by $3/47 = 0.0638$ seconds with respect to real time.

reception of the first status frame following the data frames, and t_{AREM_n} is the AREM time of the first status frame following the data frames. The transmission time t_{trans} is given by the difference between t_{Msc_n} and t_{Msc_1}

$$t_{trans} = t_{Msc_n} - t_{Msc_1} \tag{1}$$

The time lost in the AREM clock due to data transmission t_{loss} is

$$t_{loss} = t_{trans} * 3/47 \tag{2}$$

The Moscow time of the observations t_{obs_i} is finally given by

$$t_{obs_i} = t_{Msc_n} + (t_{AREM_i} - (t_{AREM_n} + t_{loss})) \tag{3}$$

In order to calculate the observation times, the various involved times have to be transformed to common units.

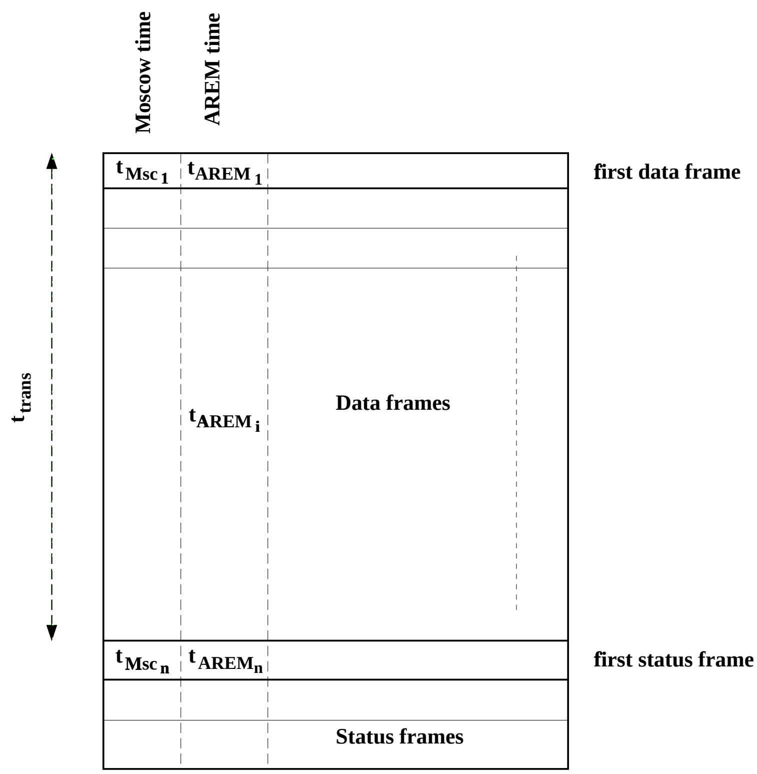

Figure 2: Illustration of the various times involved in the observation time calculation.

3 Results

The algorithm is accurate enough to measure the anisotropy of the proton flux in the SAA [4] !

References

[1] Bühler, P., Mchedlishvili, A., Zehnder, A. The radiation environment monitor, MIR data preprocessing. Technical report, Paul Scherrer Institut, June 1995.

[2] Bühler, P. Determination of the MIR–REM observation times, Revised Version. Technical report, Paul Scherrer Institut, October 1995.

[3] Lebedev, O., Antonov, V. Shvetz, N., Adams, L., Zehnder, A. Final report on results of REM experiment preparation and realisation on MIR station. Technical report, Rocket and Space Corporation ENERGIA, 1995.

[4] Bühler, P., Desorgher, L., Zehnder, A., Adams, L., Daly. REM measurements aboard Mir during 1995. In *COSPAR Scientific meeting*, Birmingham, United Kingdom, July 1996, in press.