"Forecasting of the Radiation and Geomagnetic Storms
by networks of particle detectors
(FORGES-2008)"

Filtering Algorithms For ASEC Data

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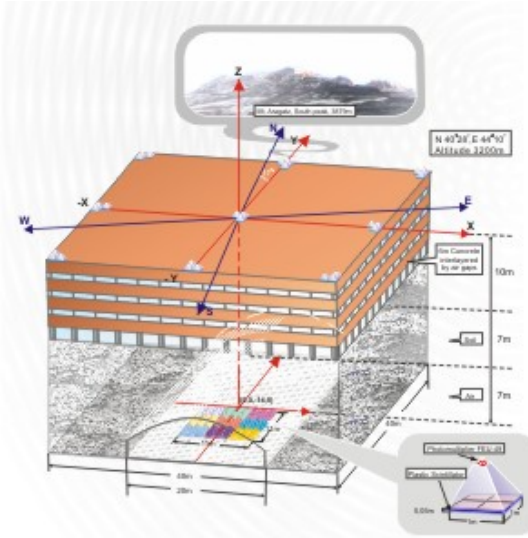
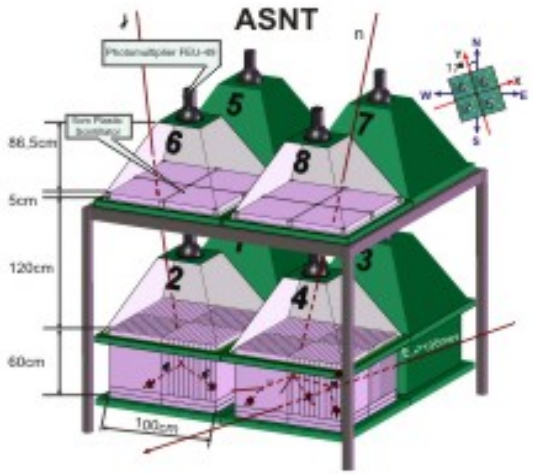
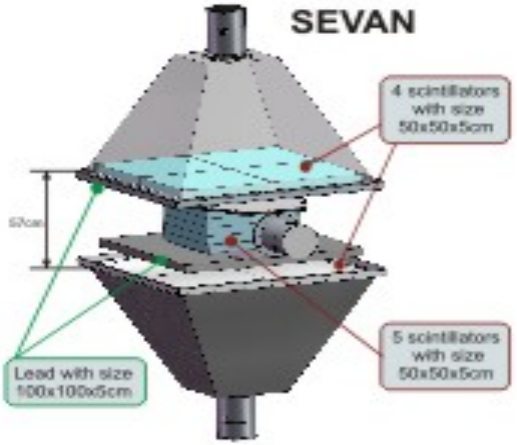
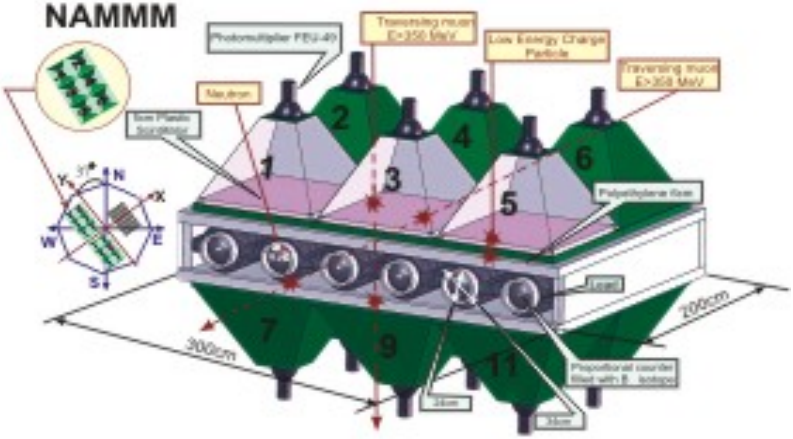
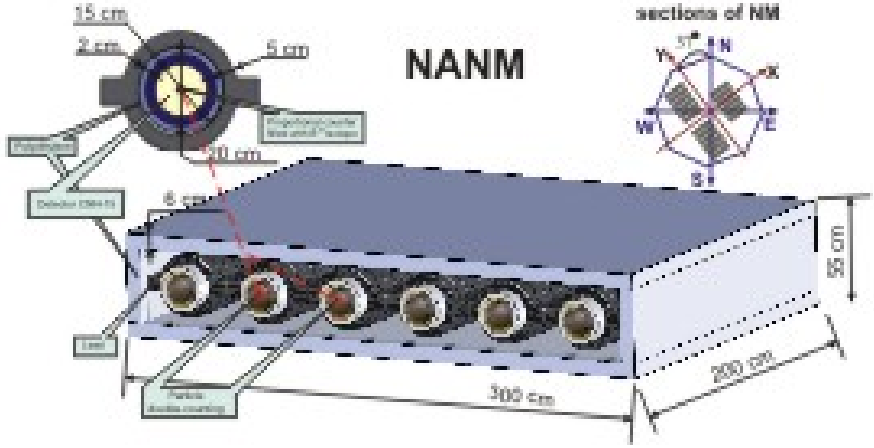
ASEC Monitors



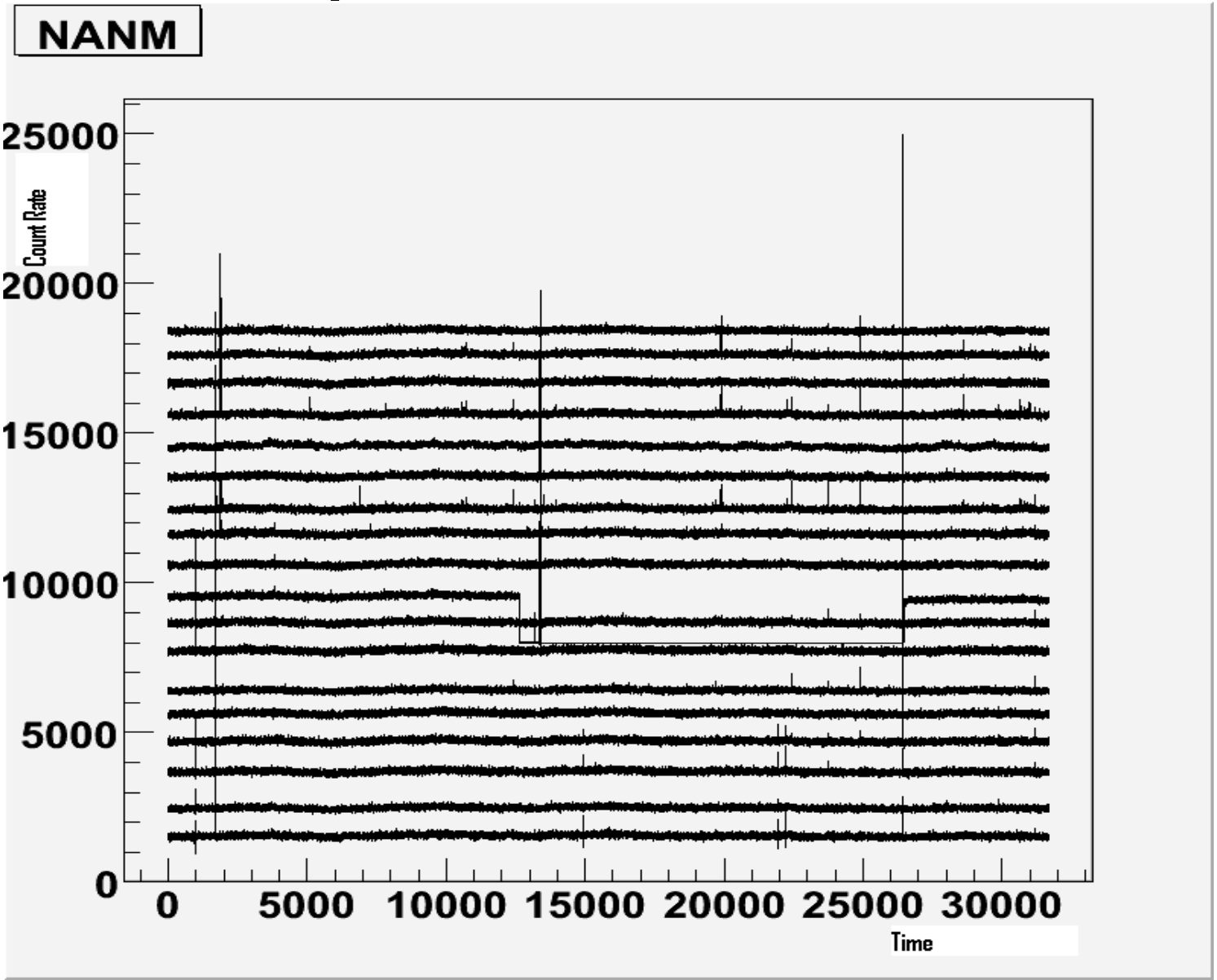






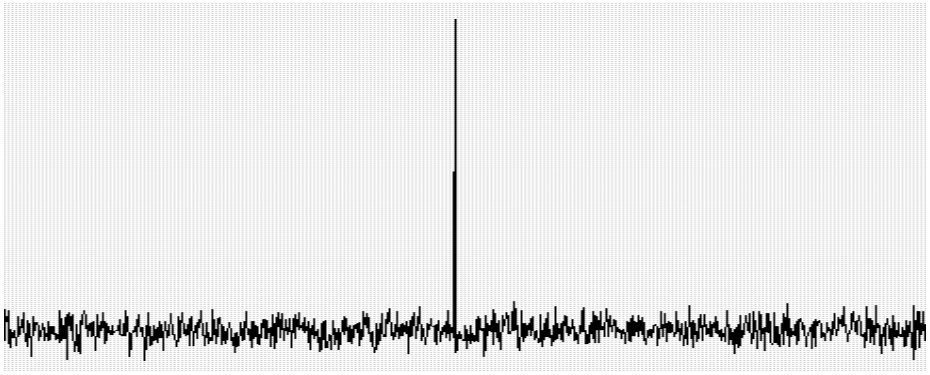


Example of Data Errors

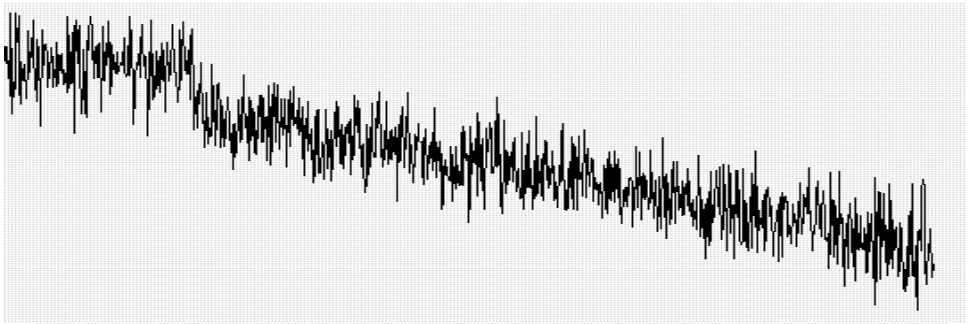


Different Kinds of Errors

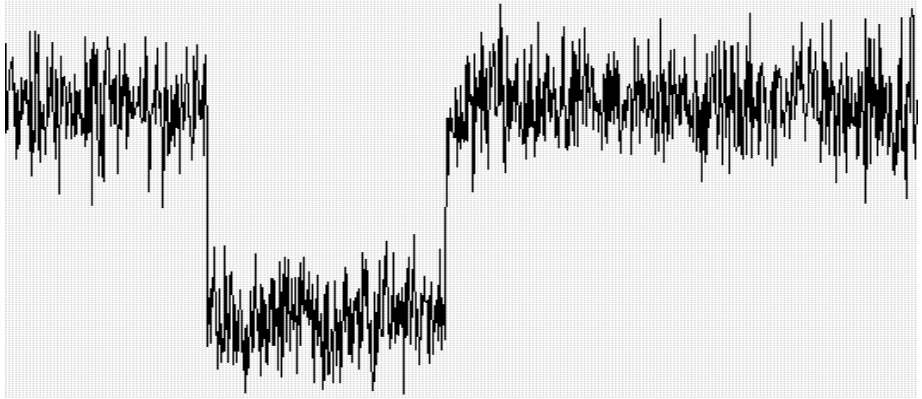
1 Spike



2 Slow Drift

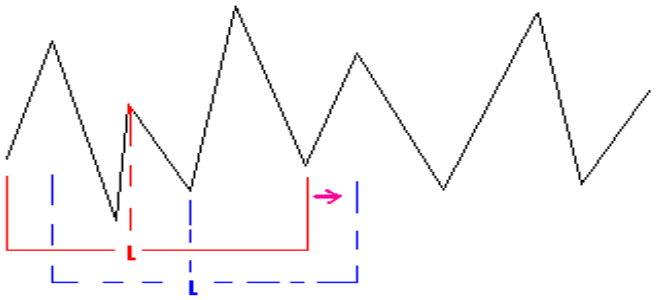


3 Abrupt change of mean



Algorithm 1 – Moving Median Filter(MMF)

- Moving window width – L; L=2l+1, where l is number of detections to the left and to the right of the filtering (smoothing) measurement;
- Maximal possible value – Pmax
- Minimal possible value – Pmin
- Maximal value of window width – Lmax



Algorithm Description

1 Select time series from database with N elements;
2 Start smoothing from the (l+1)th measurement of time time series – Vi , i=l+1;
3 Calculate the median value Mi,L;
4 Validate the median value: Mi,L ε (Pmin;Pmax) if not, enlarge L by 2, and after checking L<=Lmax go to 2;
5 ELSE go to STOP and report operator about data failure;
6 Substitute selected measurment by median value Mi,L →Vi;
7 Move to next i+1 element of time series;
9 If i+1<=N THEN GO TO 2
10 ELSE STOP, ask operator where to write smoothed time series.

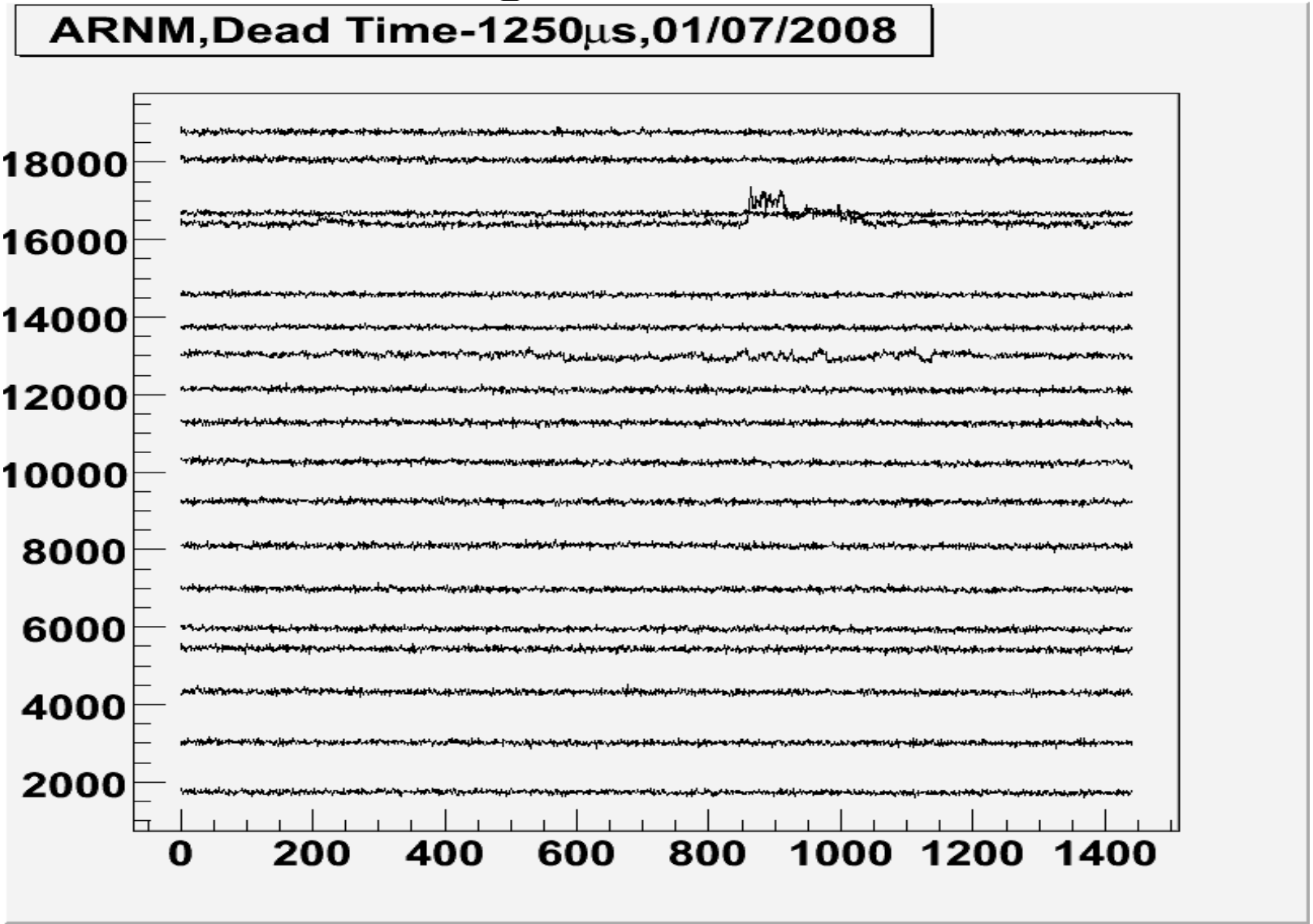
Algorithm 2 – Median filter for multichannel measurements

- Let's suppose that we have M channels of one monitor, and several of them have been down for some period.
- $F_i = \frac{n_i * M}{Sum}$, where ni are mean values of each channel, Sum is the sum of means of all channels (1)
- $V_i = F_i * Med$,where Med is median of all working channels at same minute, (2)
- Fi are coefficients of each channel. These coefficients are the relation of total median value of all channels for same minute and the i-th channel mean.
- For each minute of corrupted period of corrupted channel we calculate Med value(which is median of working channels), and then calculate value for that minute using equation (2).

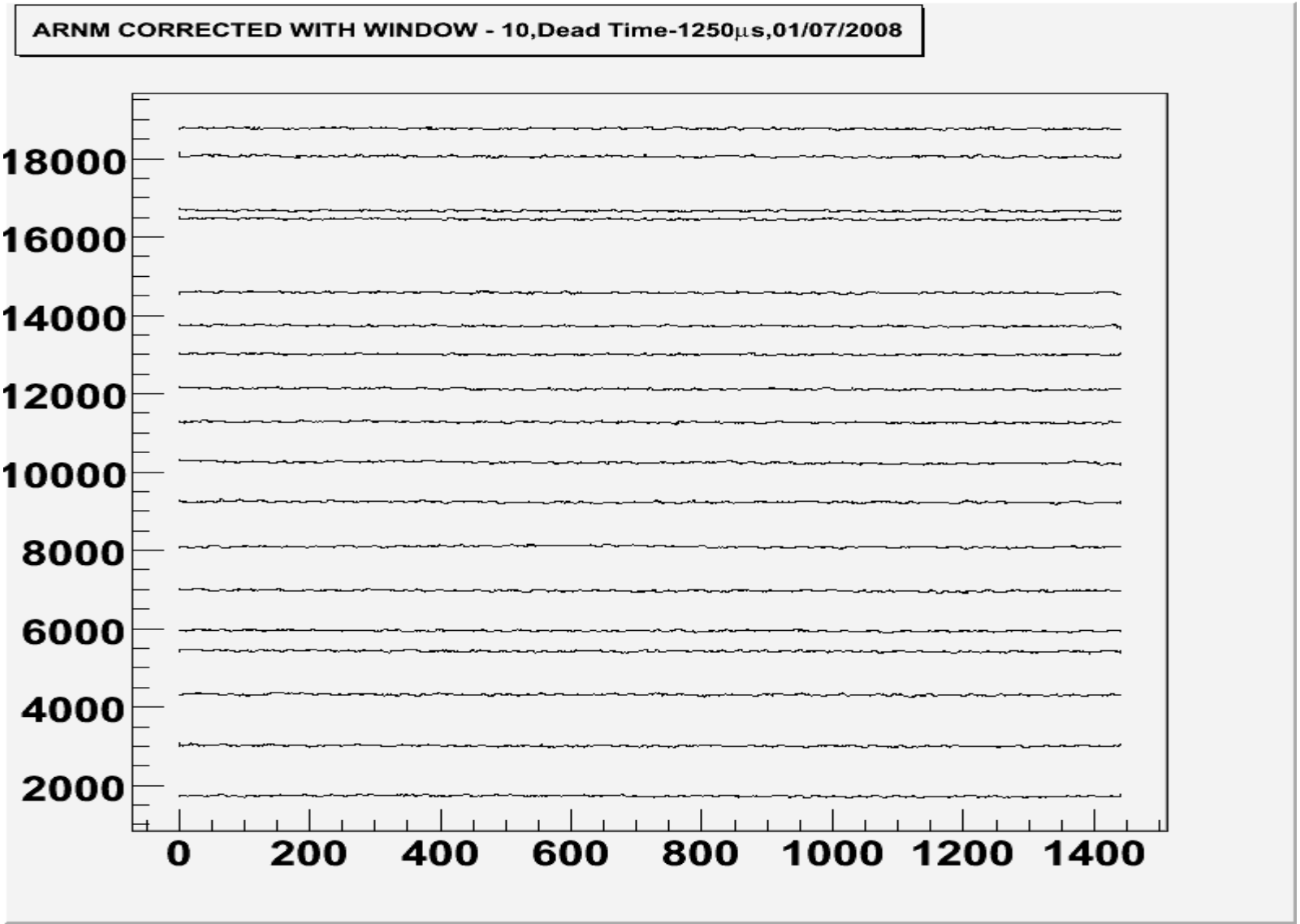
Combination of 2 Algorithms

1. We have some date to start the smoothing, for that beginning we calculate n_i and F_i coefficients and write them to a file
2. Then we take 1 day data and start smoothing all channels with constant and not big I.e. (10 minute) window.
3. If some channels have been not corrected by 1 algorithm, second one turns on, it reads the means and coefficinets from files we have created
4. After correcting with 2 algorithm , if everithing is ok, we calculate again means and coefficients for corrected data and write them to a the same file.
5. If second algorithm didn't corrected the data (which means that all or nearly all channels have been corrupted) send an e-mail to operator.
6. Take next Period and do 2-5 again.

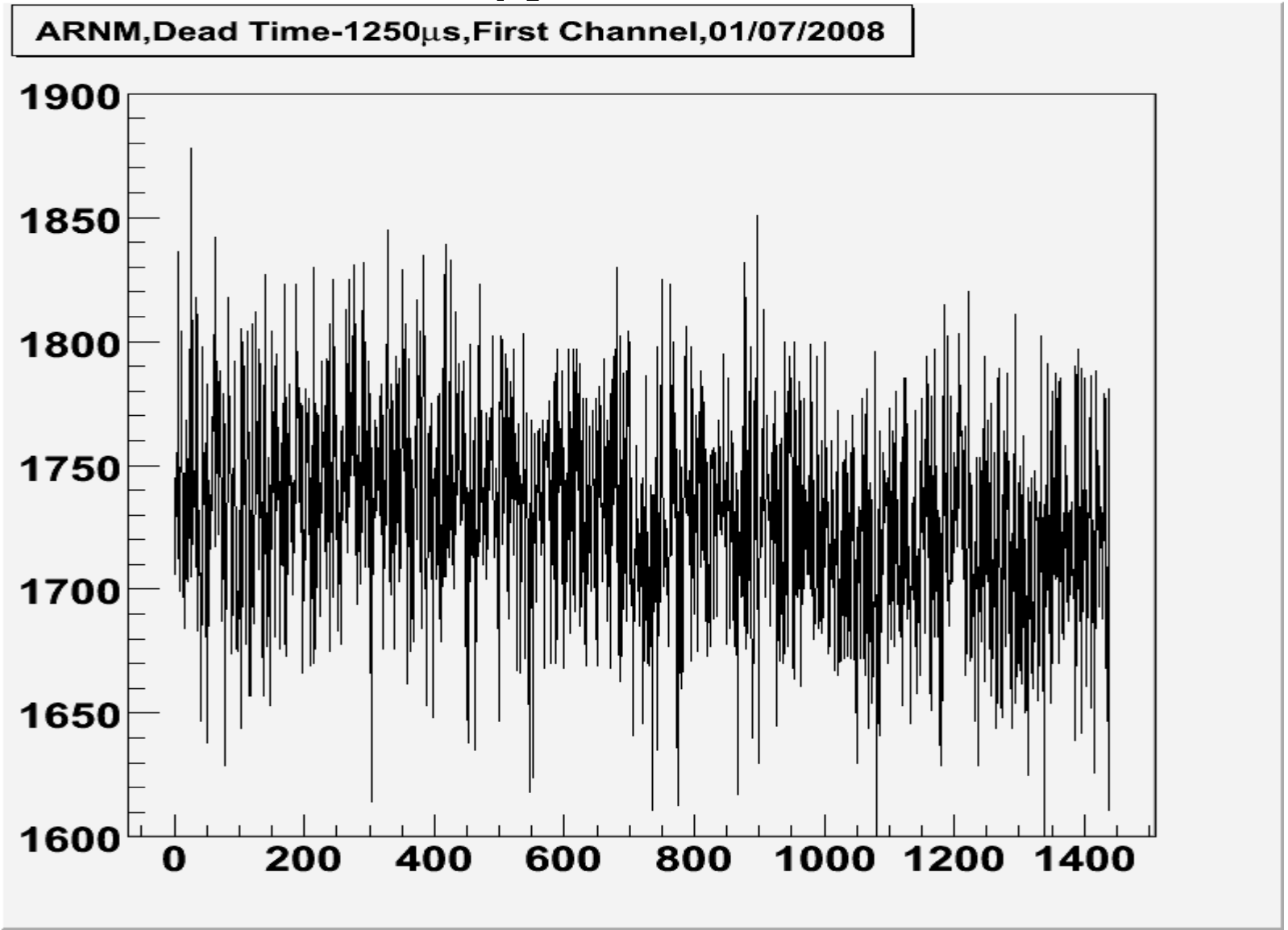
Some Results of Filtering Algorithms



The Same Period After Filtering with 10 minute window



The Same Period For 1 channel,yet not filtered



First Channel filtered with 10 minute window

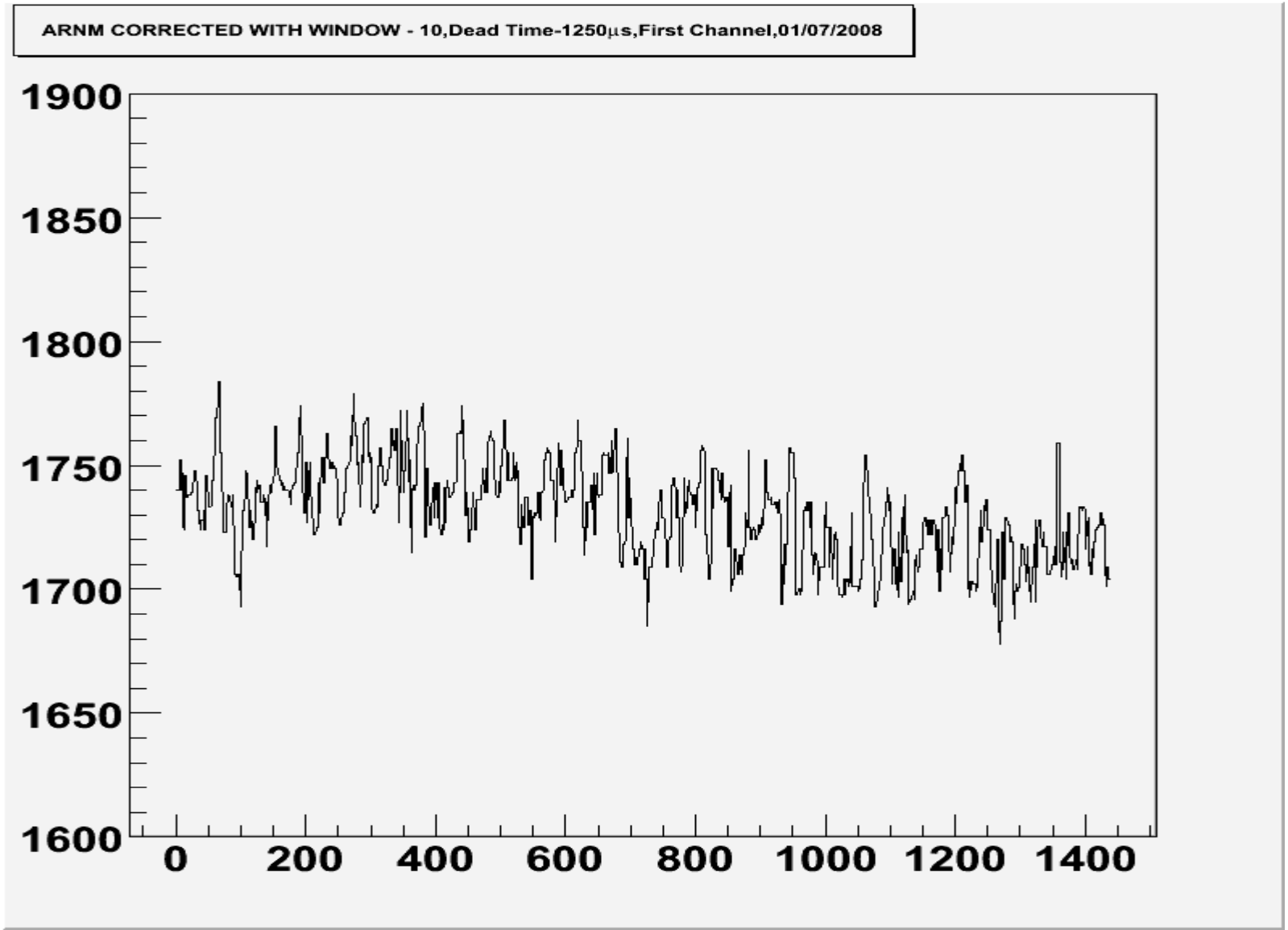
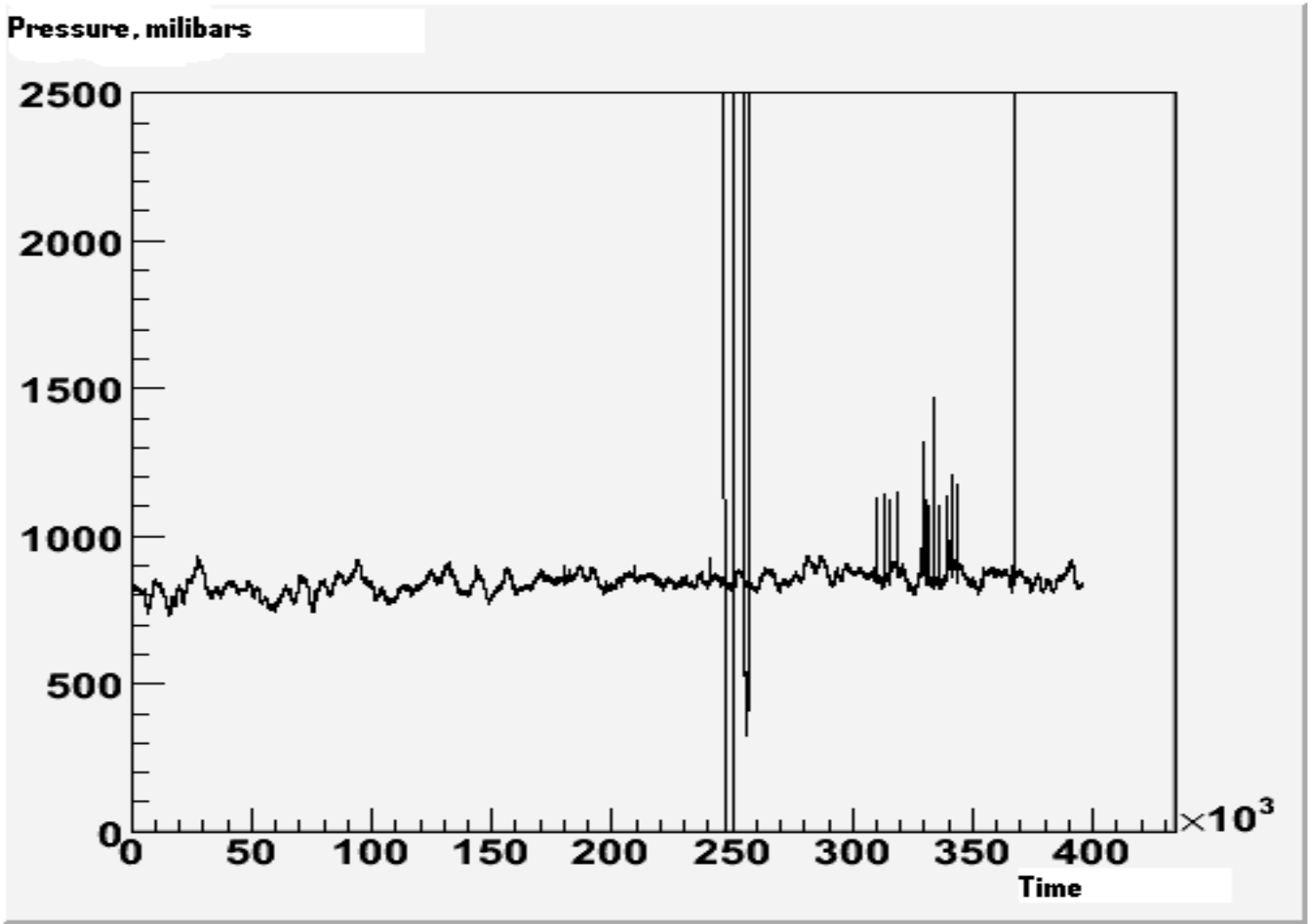


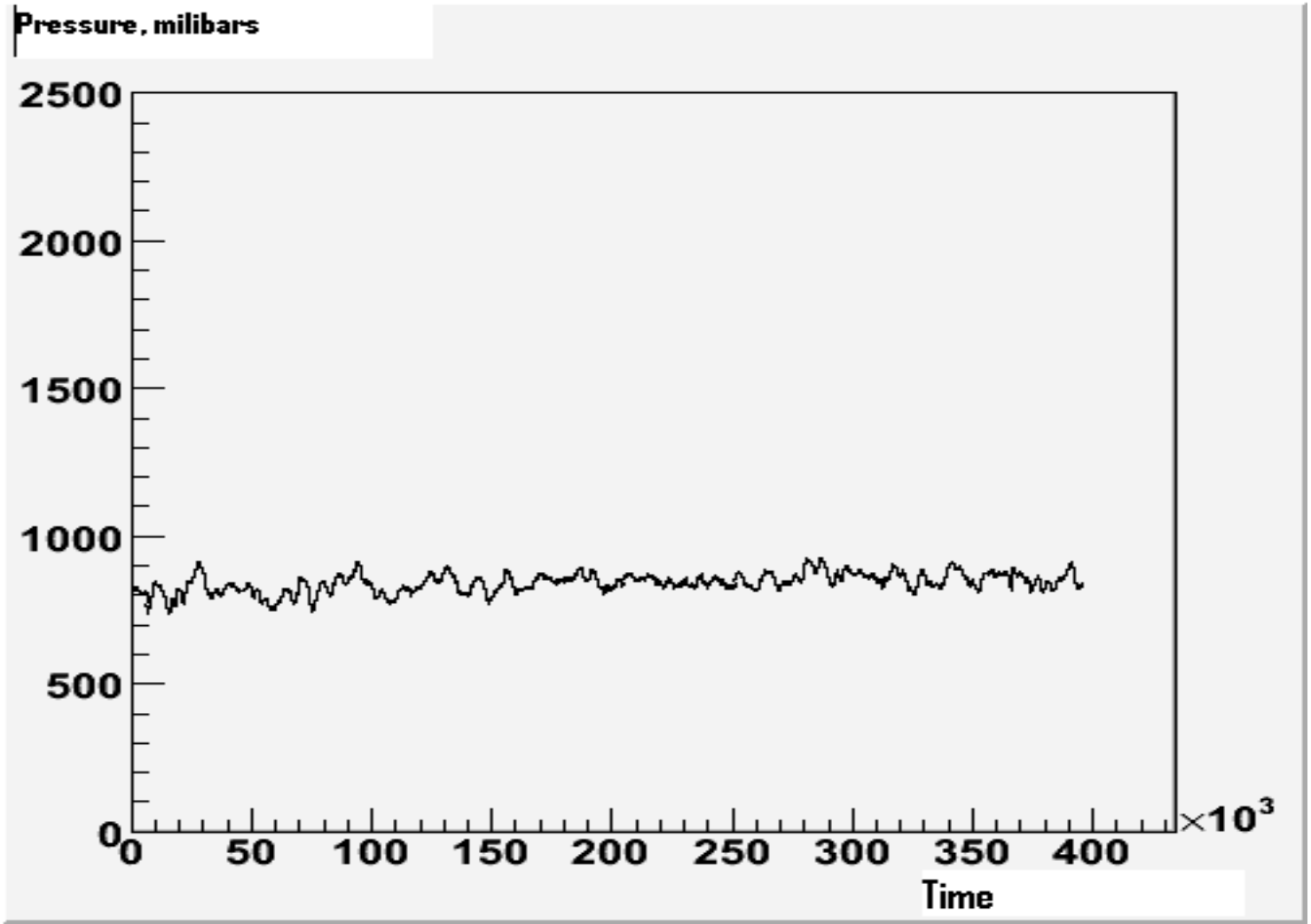
Table 1 - Mean, Sigma, Relative Error for first channel before and after filtering

	MEAN	SIGMA	RE
BEFORE FILTERING	1730	42	0.024
AFTER FILTERING(10)	1731	19	0.010

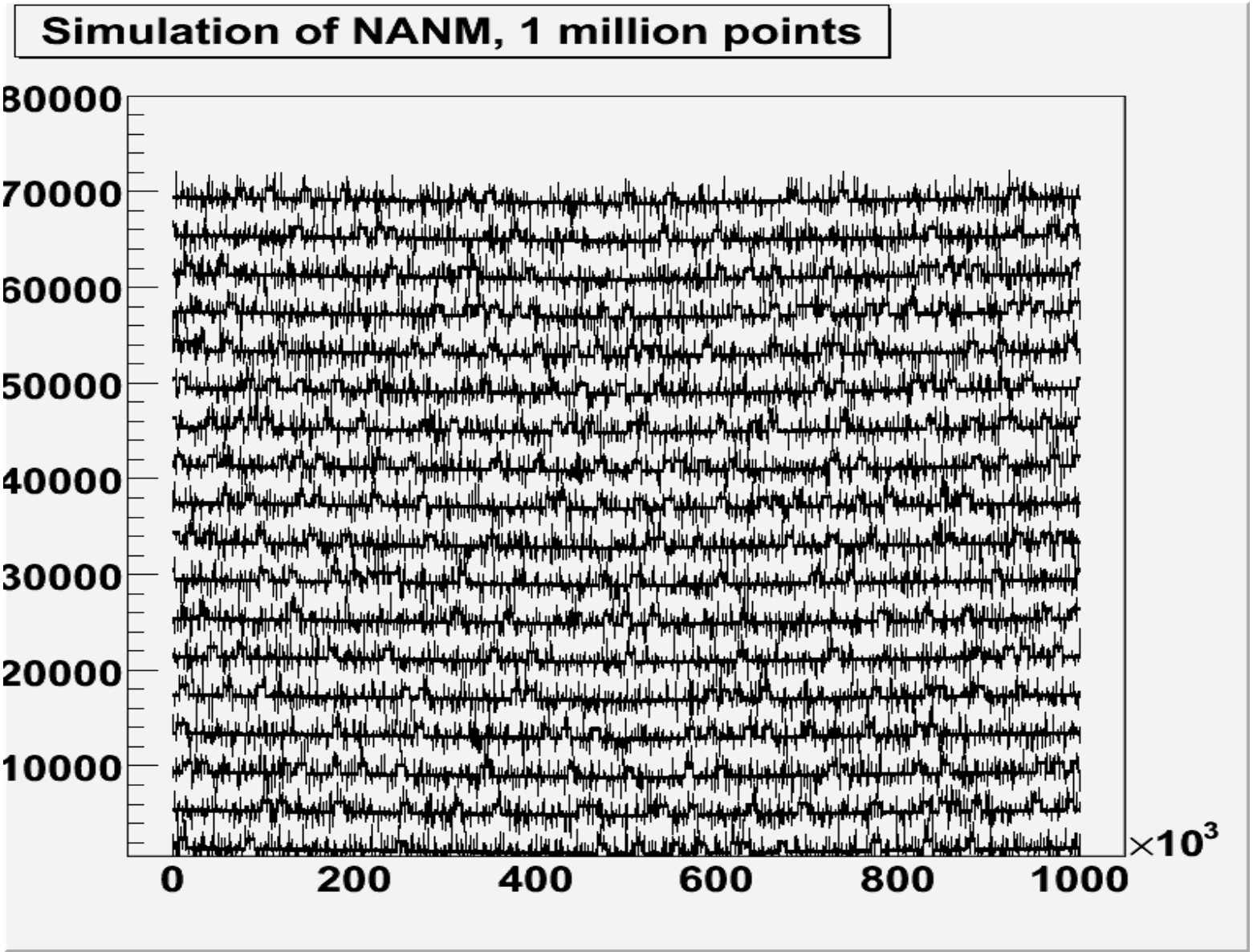
Atmospheric Pressure, Nor-Amberd Station, Period – 6 Months



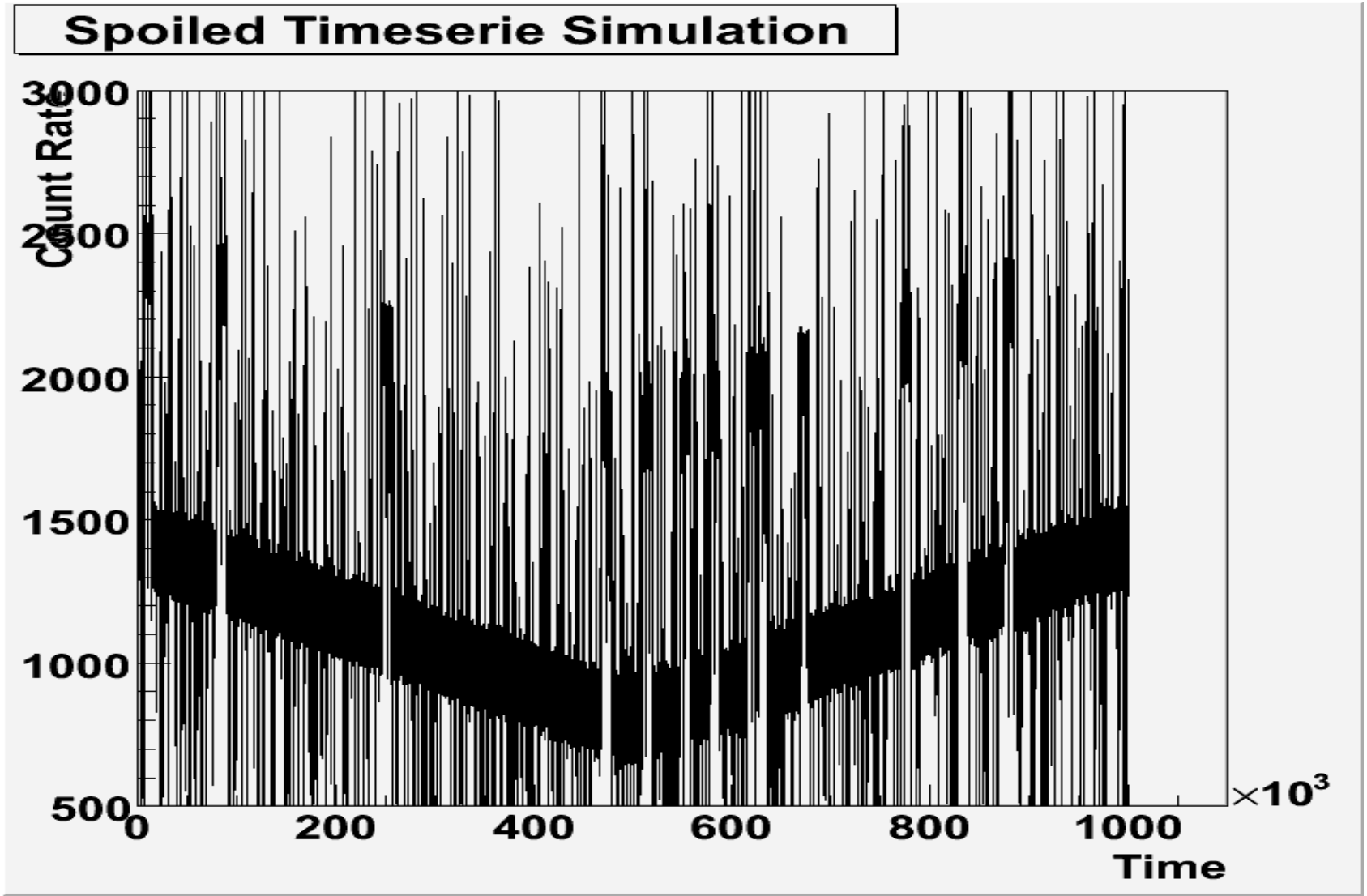
Atmospheric Pressure - Corrected



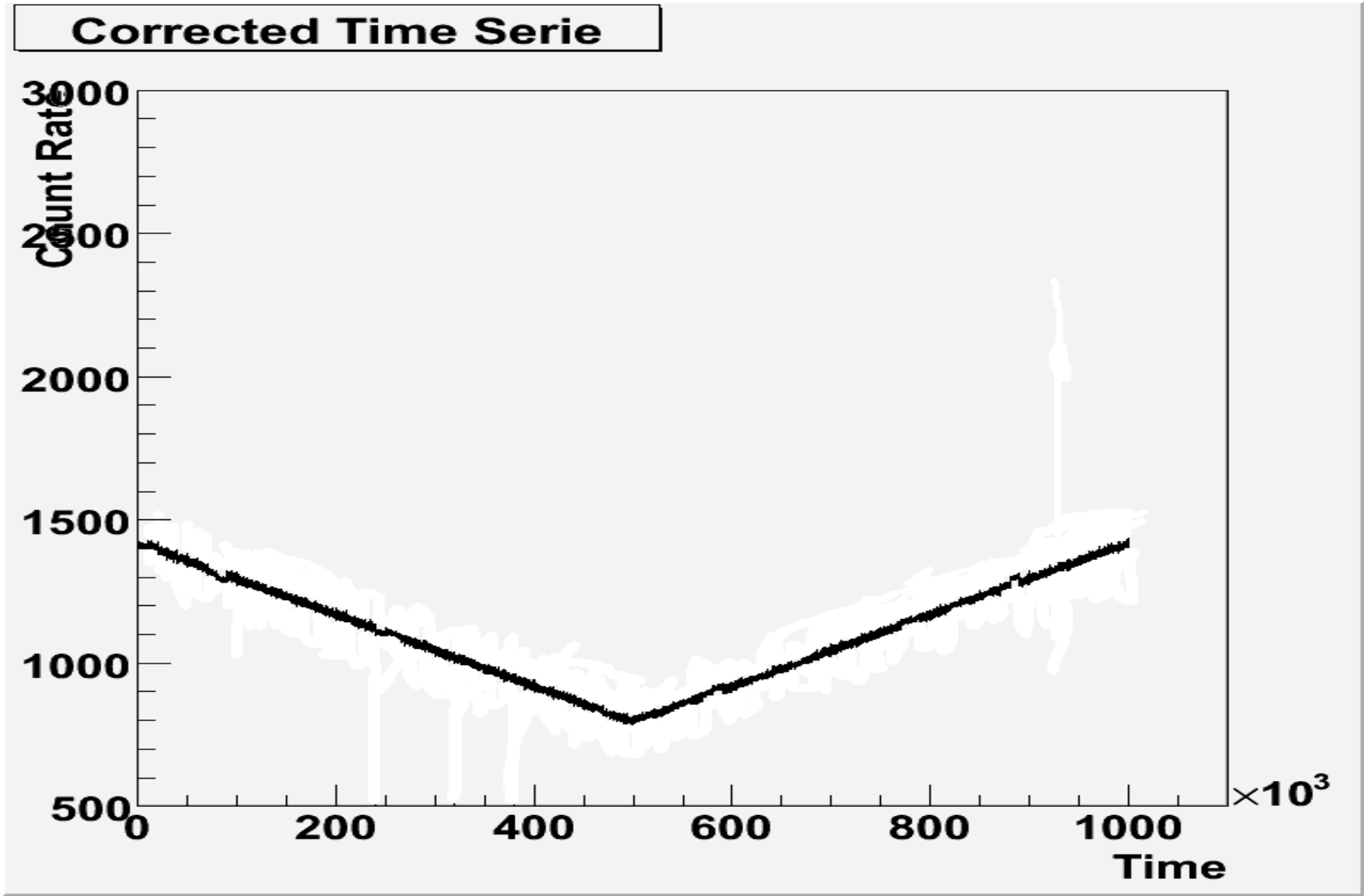
Simulation of Data For NANM



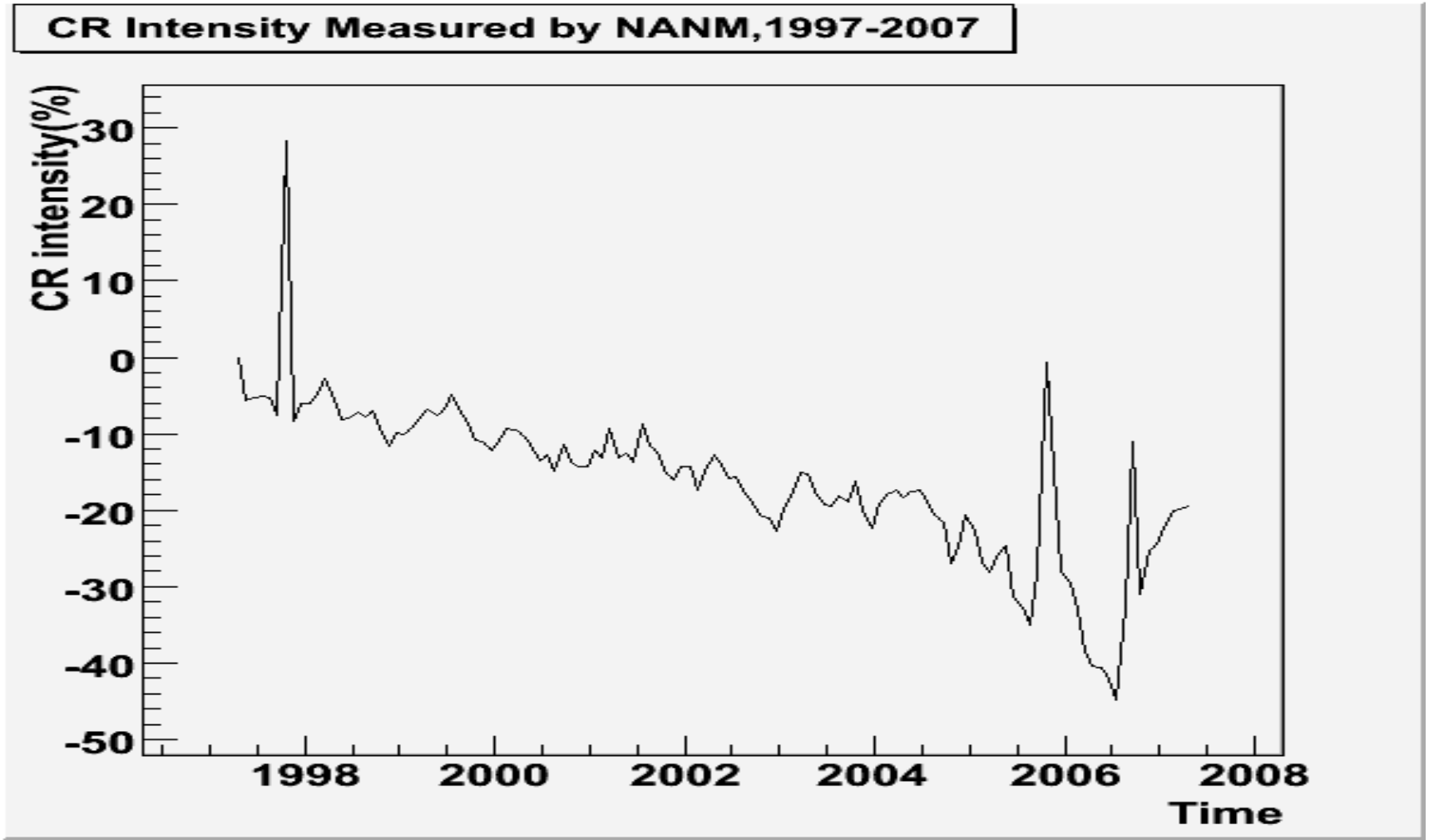
Simulation of Spoiled Timeserie



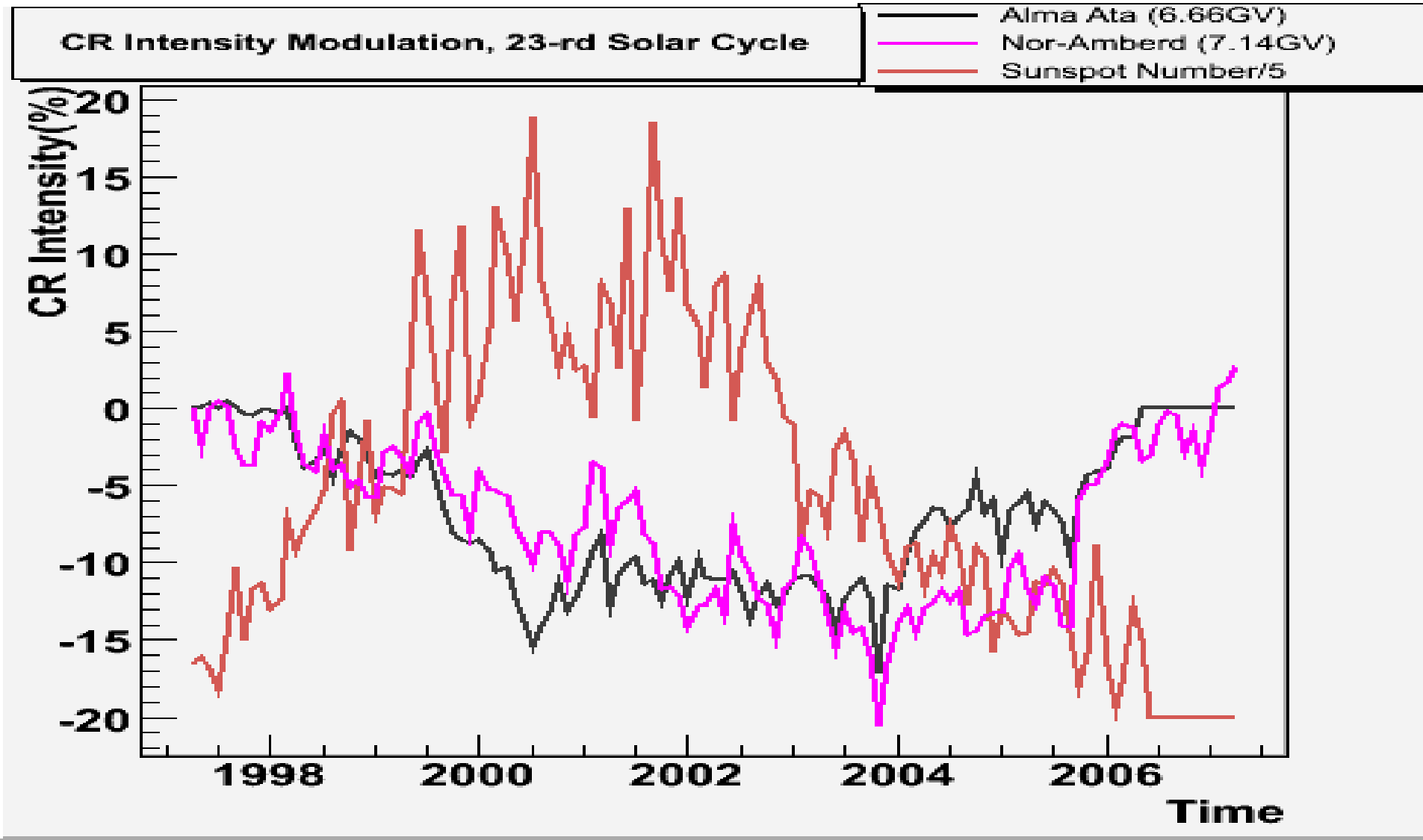
The Same Timeserie After Correction



CR Intensity Modulation during 23th solar cycle, Measured by NANM



Comparison of Corrected Data of NANM with Alma-Ata Data



Conclusions

- We use this method for online and offline filtering of ASEC data. The program is online filtering the data of Nor-Amberd Neutron Monitor, and soon it'll be implemented to other monitors. In one month the corrected data will be available in Data Visualization Interactive Network (DVIN).

- Besides the filtering, this programme will provide also an automatic alerting system in case of malfunctioning of some of 250 detecting channels.