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Real-time lossless data compression techniques for long-pulse operation

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Data logging and data distribution will be two main tasks connected with data handling in ITER. Data logging refers to the recovery and ultimate storage of all data, independent on the data source. Control data and physics data distribution is related, on the one hand, to the on-line data broadcasting for immediate data availability for both data analysis and data visualization. On the other hand, delayed analyses require off-line data access. Due to the large data volume expected, data compression will be mandatory in order to save storage and bandwidth. On-line data distribution in a long pulse environment requires the use of a deterministic approach to be able to ensure a proper response time for data availability. However, an essential feature for all the above purposes is to apply compression techniques that ensure the recovery of the initial signals without spectral distortion when compacted data are expanded (lossless techniques).

Delta compression methods are independent on the analogue characteristics of waveforms and there exist a variety of implementations that have been applied to the databases of several fusion devices such as Alcator, JET and TJ-II among others. Delta compression techniques are carried out in a two step algorithm. The first step consists of a delta calculation, i.e. the computation of the differences between the digital codes of adjacent signal samples. The resultant deltas are then encoded according to constant- or variable-length bit allocation. Several encoding forms can be considered for the second step and they have to satisfy a prefix code property. However, and in order to meet the requirement of on-line data distribution, the encoding forms have to be defined prior to data capture.

This article reviews different lossless data compression techniques based on delta compression. In addition, the concept of cyclic delta transformation is introduced. Furthermore, comparative results concerning compression rates on different databases (TJ-II and JET) and computation times for compression/decompression are shown. Finally, the validity and implementation of these techniques for long pulse operation and real-time requirements is also discussed.