

Study on White Rabbit based sub-nanosecond precision timing distribution system for fusion related experiments

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High-speed sampling measurements with more than a giga-sample per second have rapidly become popular in fusion plasma experiments, where the phase delay of the timing signals, such as triggers and clocks, becomes relatively large and thus some delay compensation mechanism would be indispensable for the timing synchronization.

White Rabbit (WR) is the high-precision network time synchronization technology that has been developed and improved in the field of large accelerators physics. It is based on IEEE1588-2008 Precision Time Protocol version 2 (PTP v2) which is now widely used in many fields and industries.

While PTP v2 is capable of synchronizing to International Atomic Time (TAI) with sub-microsecond accuracy, WR can synchronize each Ethernet connected node with sub-nanosecond accuracy.

As the design specifications and the related information of WR are publicly available under the open hardware project, it is easily applicable to other experimental plants comparing with other industrial high-precision synchronization methods.

As a result of some technical surveys and functional verifications, it has been confirmed that the WR technology could be applied to the measurement and control system of fusion related experimental devices if some deficient functionalities such as divided clocks and group operations of multiple nodes would be additionally implemented.

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