T2-mode

A special measurement mode of the PicoHarp 300, HydraHarp 400 and TimeHarp 260

In T2 Mode both signal inputs of the PicoHarp 300 are functionally identical. There is no dedication of input channel 0 to a SYNC signal. Usually both inputs are used to connect photon detectors. The events from both channels are recorded independently and treated equally. In each case an event record is generated that contains information about the channel it came from and the arrival time of the event with respect to the overall measurement start. The timing is recorded with 4 ps resolution. Each T2 Mode event record consists of 32 bits. There are 4 bits for the channel number and 28 bits for the time-tag. Routing is not supported. If the time tag overflows, a special overflow marker record is inserted in the data stream, so that upon processing of the data stream a theoretically infinite time span can be recovered at full resolution. Dead times exist only within each channel (95 ns typ.) but not across the channels. Therefore, cross correlations can be calculated down to zero lag time. This allows powerful new application such as FCS with lag times from picoseconds to hours. Autocorrelations can also be calculated at the full resolution but of course only starting from lag times larger than the dead time.

The 32 bit event records are queued in a FIFO (First In First Out) buffer capable of holding up to 256 k event records. The FIFO input is fast enough to accept records at the full speed of the time-to-digital converters (up to 10 Mcps each). This means, even during a fast burst no events will be dropped except those lost in the dead time anyhow. The FIFO output is continuously read by the host PC, thereby making room for fresh incoming events. Even if the average read rate of the host PC is limited, bursts with much higher rate can be recorded for some time. Only if the average count rate over a long period of time exceeds the readout speed of the PC, a FIFO overrun could occur. In case of a FIFO overrun the measurement must be aborted because data integrity cannot be maintained. However, on a modern and well configured PC a sustained average count rate over 4 Mcps is possible. This total transfer rate must be shared by the two input channels. For all practically relevant fluorescence detection applications the effective rate per channel is more than sufficient.

For maximum throughput, T2 Mode data streams are normally written directly to disk. The current *Harp software does not provide any immediate data visualization during a T2 Mode measurement, except count rate and progress display. However, using custom software it is also possible to analyze incoming data “on the fly”. Even on-line correlation can be implemented. Obviously this requires efficient processing and possible restrictions in average count rate. The PicoHarp software installation CD contains demo programs to show how T2 Mode files can be read by custom software. The implementation of custom measurement programs requires the *Harp programming library, which is available as a separate option.

Note: From a mathematical point of view, the T2 mode should be able to store 28 bit = 228 = 268435456 time bin data before need to “wrap around”. However, the real wrap around time as shown in the demo code is only 210698240. This discrepancy is due to the design of the TDCs. Briefly, the TDCs include a coarse scaler and an interpolator for the the short times. This interpolator is not working in a binary fashion, which finally leads to the fact that not the full available memory is used. This does not lead to any data loss. To reconstruct the full temporal time trace one only needs to follow the procedures shown in the demo code

see also t3-mode

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