Datalist Systems

Datalist TDC Signal Processing Unit

Field of application

The unit is designed to be used in any neutron scattering measurement and using two dimensional position sensitive wire detectors with delay line outputs. The basic mode of operation is event recording. The unit accepts also digital signals from choppers and other signal sources and generates both 2D histograms and event record list data with high resolution timestamps. The unit is optimized also for Time-of-Flight (TOF) and stroboscopic measurements.

Specification

Type: TDC

Housing: 2 unit width NIM module

Power connection: +6 V and GROUND connectors of the NIM crate are used

Signal inputs:

- 5 front end detector signal inputs (LEMO connectors with NIM signal level)
  - Start, X1, X2, Y1, Y2
- 6 dedicated front end event inputs (BNC connectors with TTL signal level)
  - Monitor Counts (Mon)
  - Chopper 1-4 (ChE1-4)
  - + general purpose input, e.g. for stroboscopic events, etc. (Strob)
- 6 general back end event inputs (BNC connectors with TTL signal level)

Time to Digital Conversion:

- Finest internal time bin: 165 ps
- Time resolution used: separately configurable in X and Y direction
- Typical resolution: 1000*1000 pixels with time resolution 330 ps for both X and Y
- Maximal delay between Start and X1, X2, Y1, Y2: 5 microseconds
- Maximal count rate: $5*10^5$ neutron events/sec
- Event recording timestamp: Resolution: 100 ns
  Length: 30 days

Data communication: through Gigabit Ethernet connection

Data outputs:

- Event records as list mode data with timestamp of 100 ns resolution
- 2D X-Y intensity spectrum
- 1D TotalCounts-Time spectrum

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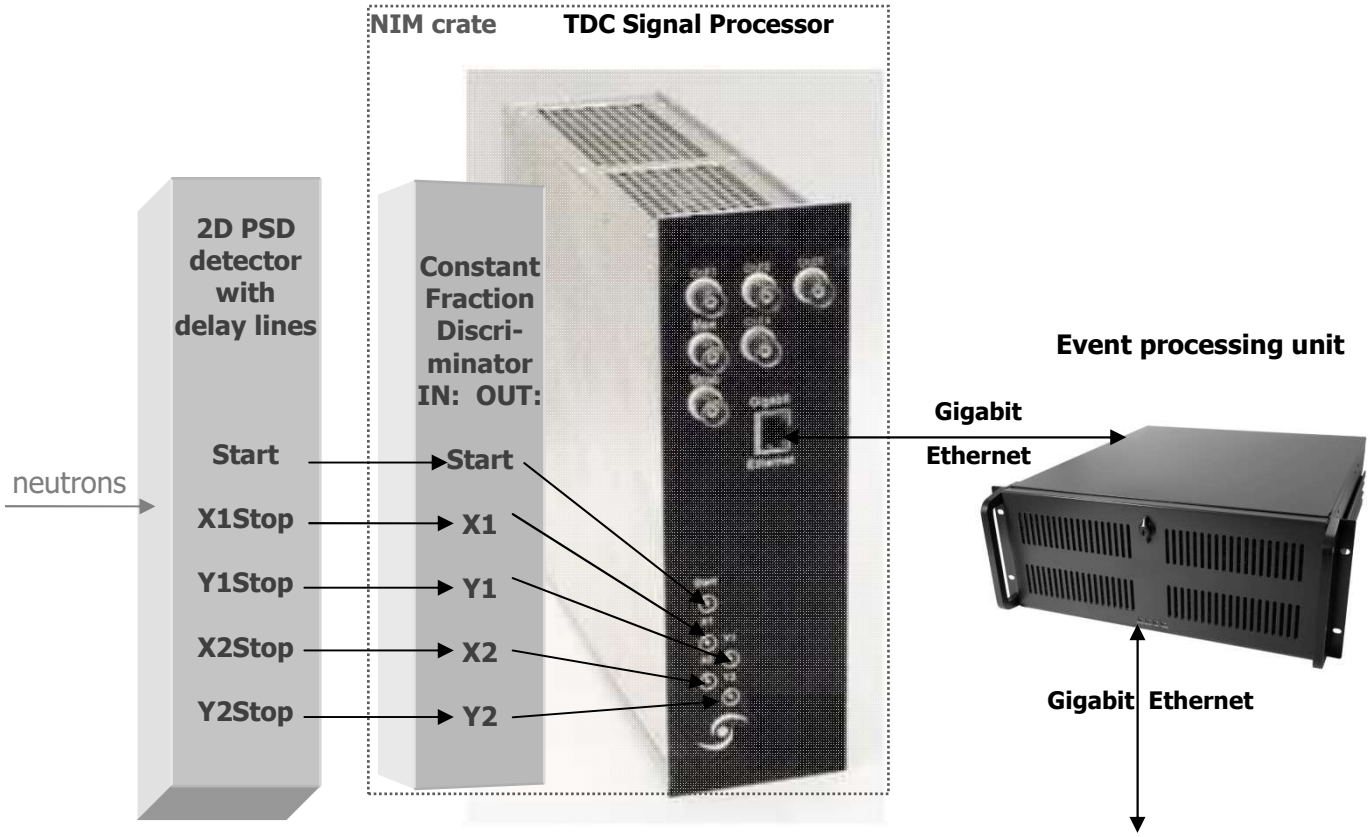
Basic connection arrangement



The TDC Signal Processing Unit gathers the incoming neutron events from the 2D PSD detector through a CFD unit as Start, StopX1, StopX2, StopY1 and StopY2 events. These recorded elementary events together with their high precision (165 ps) timestamp and high resolution (48 bit, 100 ns) timestamp data are sent to the Event processing unit which processes all incoming events. It calculates a single neutron event and the X - Y detector position from the five (Start, X1, X2, Y1, Y2) elementary events. This neutron events are sent to a spectrometer computer. In addition the neutron events are stored in 2D X-Y intensity spectrum which is available from a spectrometer computer upon request.

The event processing unit takes care the elapsed data acquisition time: if the preset time value is exceeded it stops recording the incoming events.

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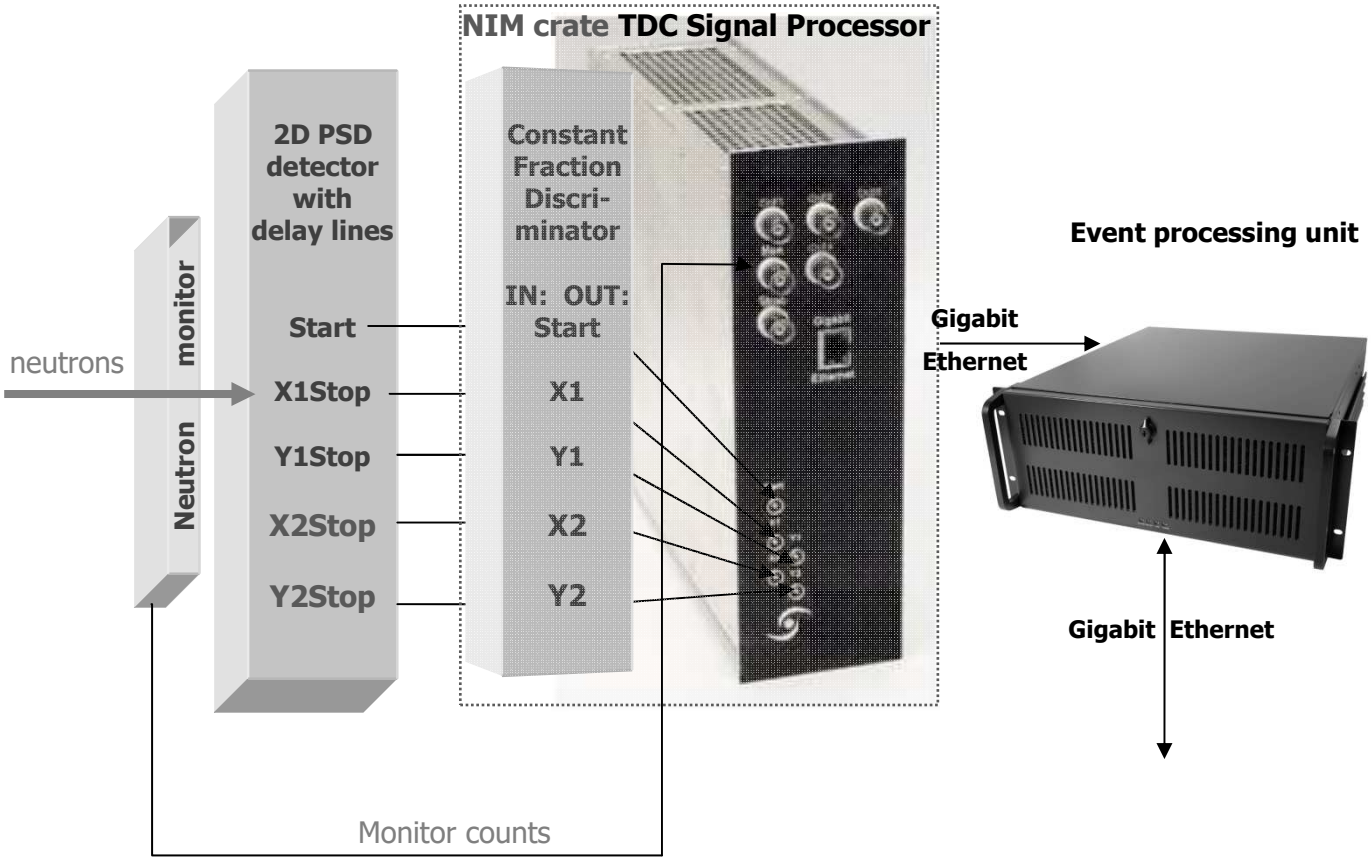
Connection from a Neutron Beam Monitor Unit



In addition to the basic connection arrangement the TDC Signal Processing Unit can gather also each monitor signal counts. In such a case the Event processing unit records

- each elementary neutron events
- each monitor events

and sums up the monitor events as counts coming after the "Start" command. If any of the following state occurs

- the elapsed times exceeds the preset time limit, or
- the number of monitor counts exceeds the preset monitor limit (monitor value)

the Event processing unit stops recording any further incoming events.

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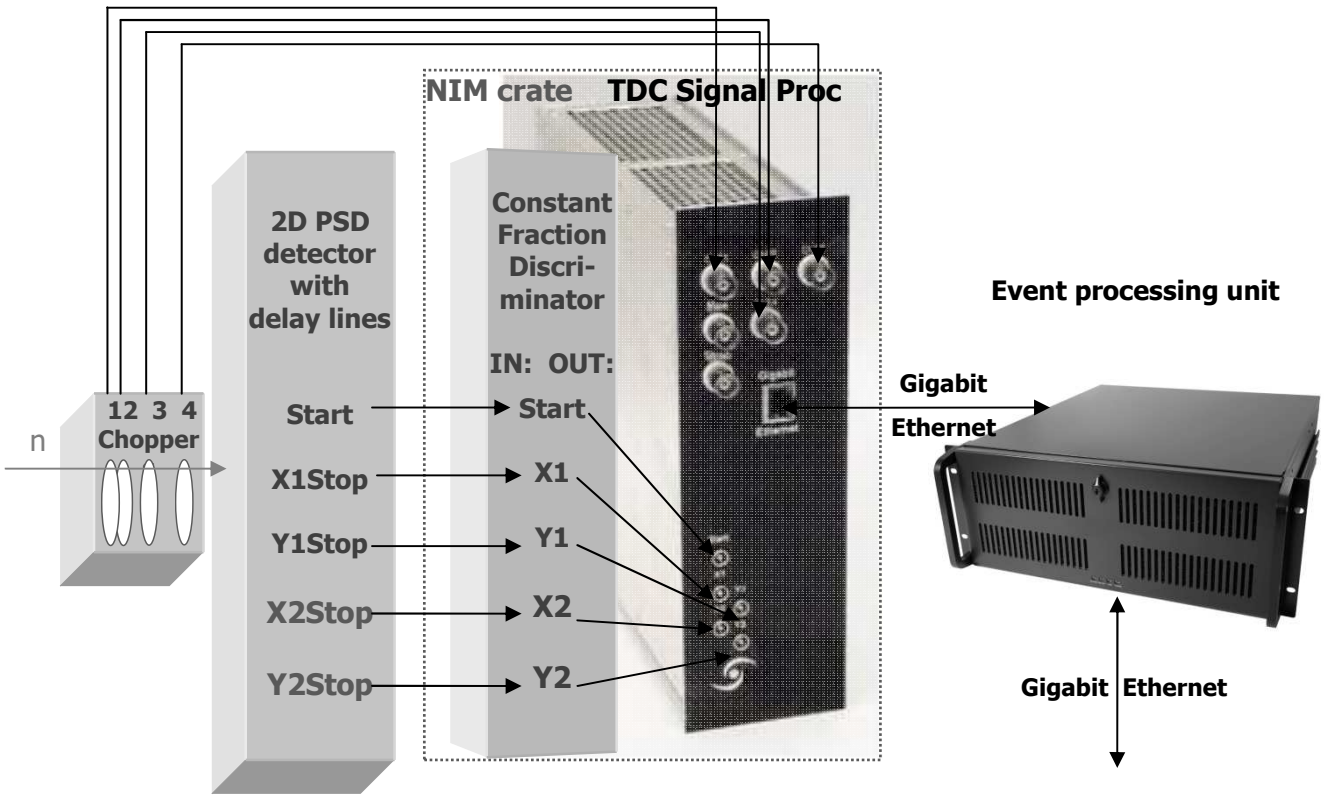
Connection to choppers



In addition to the basic connection arrangement the TDC Signal Processing Unit can gather also the incoming events from the choppers. The Event processing unit records also these chopper events into the event record list and calculates the neutron events with their X - Y detector position together with their elapsed time from the last Chopper1 (or T_0) events. This neutron events and other events like chopper events, etc. with their high resolution timestamp are sent to a spectrometer computer. In addition the neutron events are stored in 2D and 1D histograms which are available from the Spectrometer computer upon request.

Connection both to choppers and monitor unit

A combination of both the monitor counting and chopper event recording is also possible. The TDC Signal Processing Unit can gather

- each chopper events
- each monitor events
- each elementary neutron events.

The Event Acquisition Driver software

- calculates and records the neutron events with their X - Y detector position together with their elapsed time from the last Chopper1 (or T_0) events
- takes care both
  - the elapsed data acquisition time
  - the monitor counts limit (preset monitor value)

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Firmware components

FPGA firmware in TDC Unit

The firmware continuously pays attention to any new occurring events from the 2D PSD detector If a new event occurs it sends it to the Event processing unit through Gigabit Ethernet together with its input source information like Start, X1, X2, Y1, Y2, MonitorCount, Chopper1-4 / T0, etc. and the high precision (165 ps) and high resolution (48 bit 100 ns) timestamps. The data transfer has binary format. The firmware fills the Ethernet packages optimally by taking care of timeouts.

Event Acquisition Driver in Event processing unit

This firmware performs the necessary signal processing. The Event Acquisition Driver firmware processes all incoming events:

- It calculates a single neutron event and the X - Y detector position from the five (Start, X1, X2, Y1, Y2) elementary events.
- It calculates the elapsed time for each neutron event from the last Chopper1 (T_0) signal.
- It records all the events (neutron events, monitor events, chopper events, etc.)

All the recorded events are sent to a spectrometer computer. In addition it stores and continuously updates the following spectra:

- 2D X-Y intensity spectrum
- 1D TotalCounts-Time spectrum

It works as a TCP/IP server program which accepts, performs and responds to commands and requests from a spectrometer computer. The main accepted commands and requests have ASCII format as follows:

`StartDAQ` Start measurement and event acquisition

- Start N (start event acquisition until N millisec time or M monitor count value)
- Example: `StartDAQ, Time=10000, Monitor=15000;`
- Response: `DAQStart;`

`StopDAQ;` Stop measurement (immediate stop)

- Response: `DAQStop;`

`GetStatus;` Status request

- Response: `Status: Running;`

`Get2DHistogram;` 2D spectrum request

- Response example: `Get2DHistogram, seq=20000000, dimx=600, dimy=600, sum=8, shiftx=-10, shifty=50, time=9000, monitor=14567, bytelength=123456789, Histogram=`(binary data)`...;`

`Get1DHistogram;` 1D spectrum request

- Response example: `Get1DHistogram, seq=20000000, dim=1500, sum=4, time=9000, monitor=14567, bytelength=12345, Histogram=`(binary data)`...;`

`GetEvents;` Request for sending all occurring events

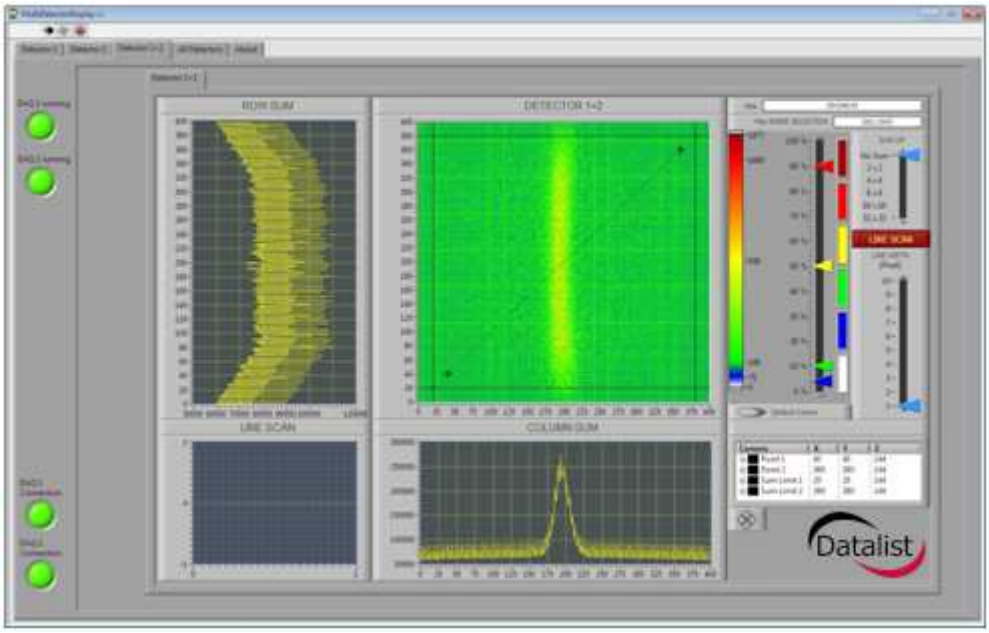
- Response: (Event identities, params, timestamps are sent on separate TCP/IP port)

Software components

The TDC Signal Processing Unit is delivered with the following software components. Both these software components are planned to run on a separate computer called Spectrometer computer.

Detector Display Application

This application software contains a complex program for starting and stopping the data acquisition, displaying the 2D spectrum and storing the actual spectrum. It is useful for demonstration / test purposes also. The Detector Display Application is written as a graphical application in NI LabView under operating system MS Windows. This software component is delivered in binary form.



DAQ Control Application

This program is an example application how to write your own data acquisition control program. This DAQ Control Application sends commands which are described at the Event Acquisition Driver firmware in Event processing unit (see above). It is written in C and delivered in both binary and source code form. For debugging purposes

- you can start your data acquisition by using this DAQ Control Application program, and
- you can display the collected spectrum by using the Detector Display Application program at the same time.

Detailed documentation of the communication protocol, description of commands is delivered together with the software.

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System build up

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Offered system build-ups

1) DAQ system:

Items to deliver: TDC
Event processing unit
software on DVD

This is our standard offered configuration for building up your own spectrometer with event recording capability.

2) Spectrometer system:

Items to deliver: TDC
Event processing unit
Spectrometer computer with configured router
software on DVD

It is a turnkey system for the DAQ part of a spectrometer with event recording capability.

Event recording

We deliver new generation data acquisition equipments for neutron scattering measurements In the standard delivery program the hardware units are equipped with software components also. All these units and modules are constructed to fully support event recording. This kind of the data acquisition means that every single event during the scattering measurement is recorded together with its parameters and with a high resolution timestamp. All these events are collected into a event list file. Typical events are:

- neutron detection event and position from the detector(s)
- monitor count events from a monitor unit
- chopper opening signals from each chopper disk
- Source Pulse (T_0) signal
- in case of dynamic or stroboscopic measurement: start / end of excitation

Event recording obviously provides the following benefits:

- It best suits to Time-of-Flight (TOF) measurements.
- It is not necessary to collect the scattering data into (1D, 2D) spectrum immediately, during the measurement. Instead, user can select or reject parts of the measured data later (offline) to avoid errors.
- User has the option to "replay" (revisit) the whole experiment later and to improve the primary data handling algorithm also.
- Revisiting the data is to replaying a DVD film taken from several camera positions.
- You can reveal dynamic – time dependent – scattering effects also.