



Development of NEUNET system for neutron experiments

High energy accelerator research
organization (KEK)

Neutron science laboratory (KENS)

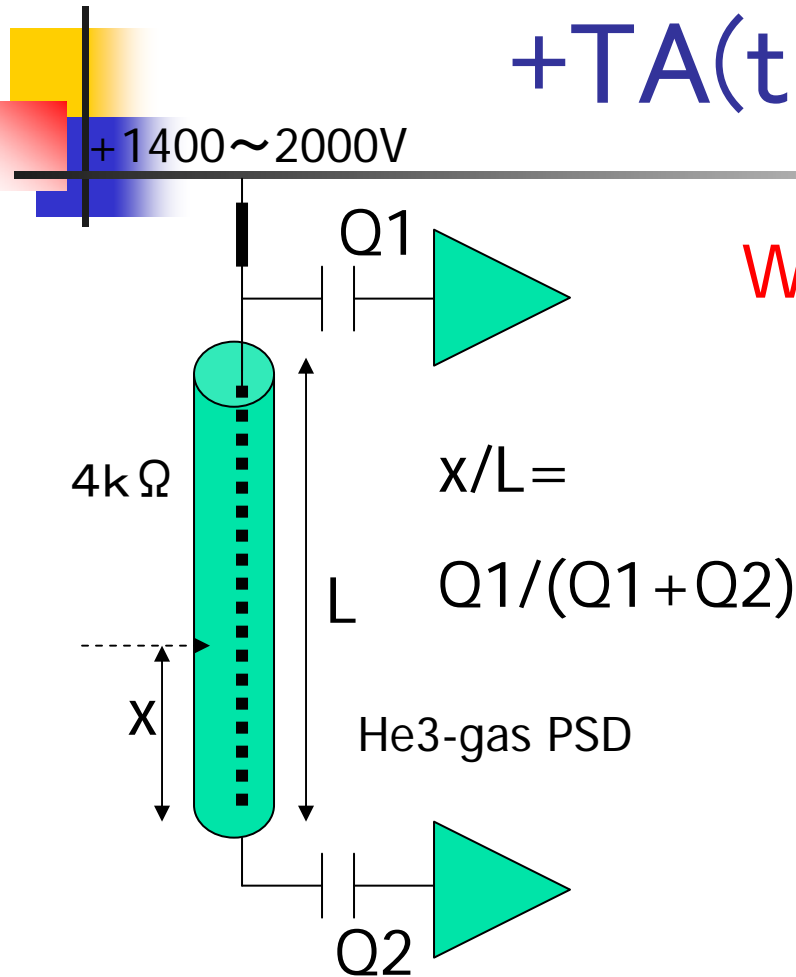
Setsuo Satoh



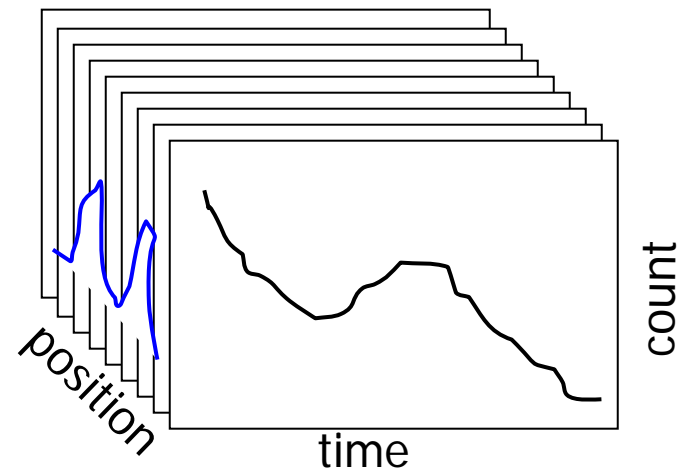
Outline

- About He3-PSD.
- NEUNET system.
- He3-PSD performance.
- Conclusions.

PSD (position sensitive detector) +TA (time analyzer)



We need position and time.



A time of flight method.

A charge division method.

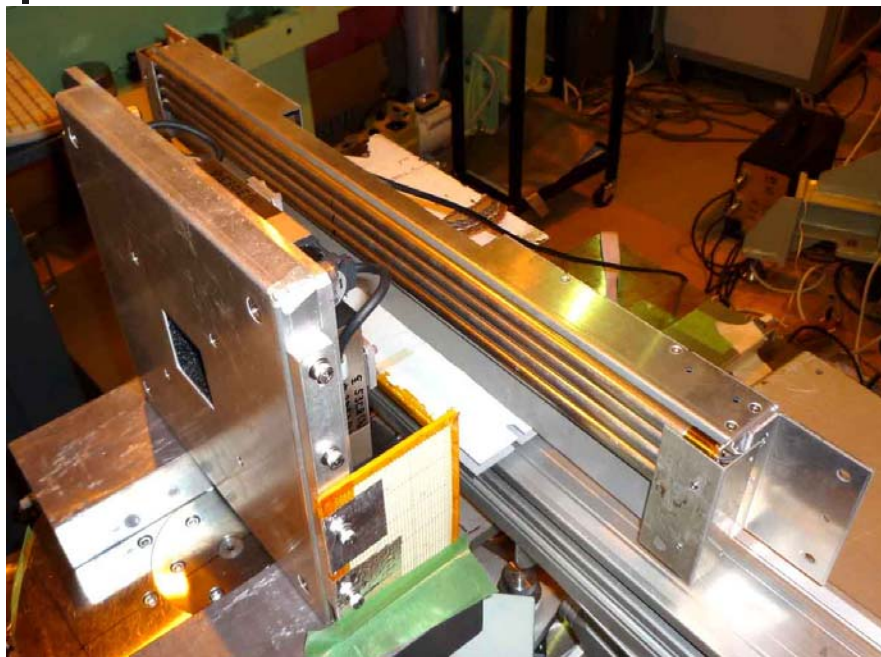


He3 detector

Signal

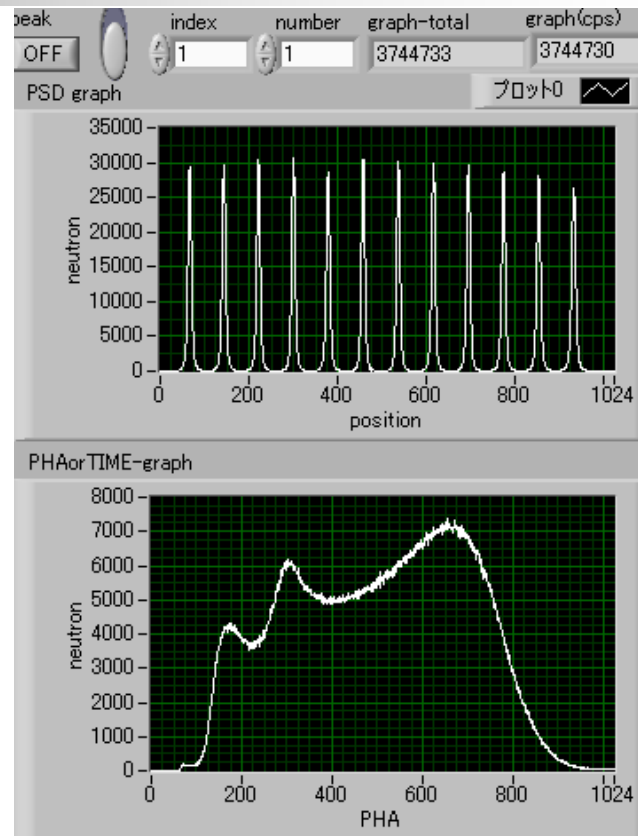
- $\text{He3} + n = \text{H3} + p + 765\text{keV}$.
- Energy ionizing a molecule is 24eV
 - We need
- If g High-gas gain,
- The High resistance wire, and 23,
T= High restriction stopping gas.
(1us) $\approx 2TC$.
- The wall effect and the range of the molecule flight (more than 3mm, that depends on a stopping gas) are other noise sources.

Position, Pulse-height data



Experiment of He3-PSD, collimator and moving-table.

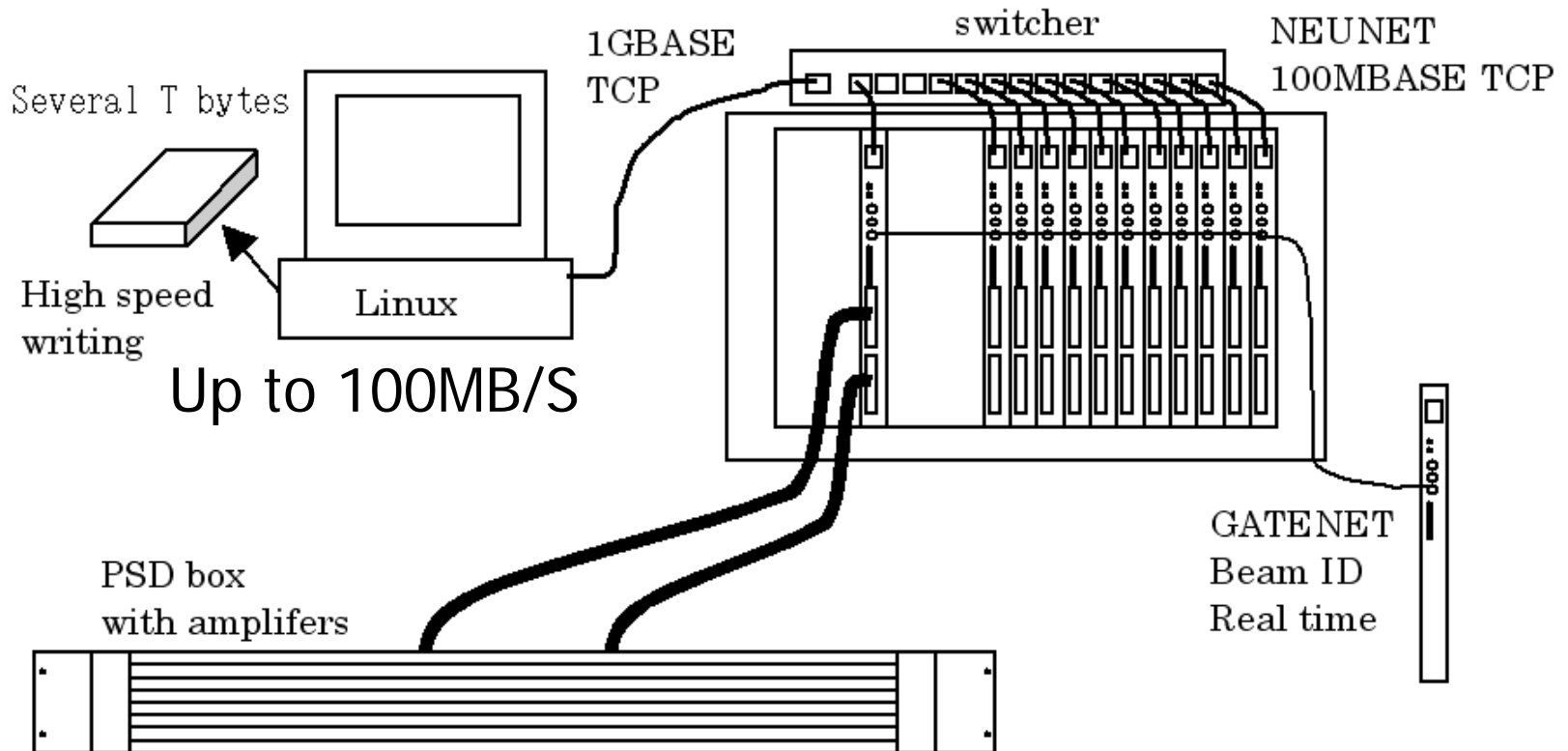
Position data (12 points every 5cm, FWHM=5mm)



The position data (upper) has the thermal noise and the range of the molecule flight.
The pulse-height data (lower) has the wall effect of the gas-tube.

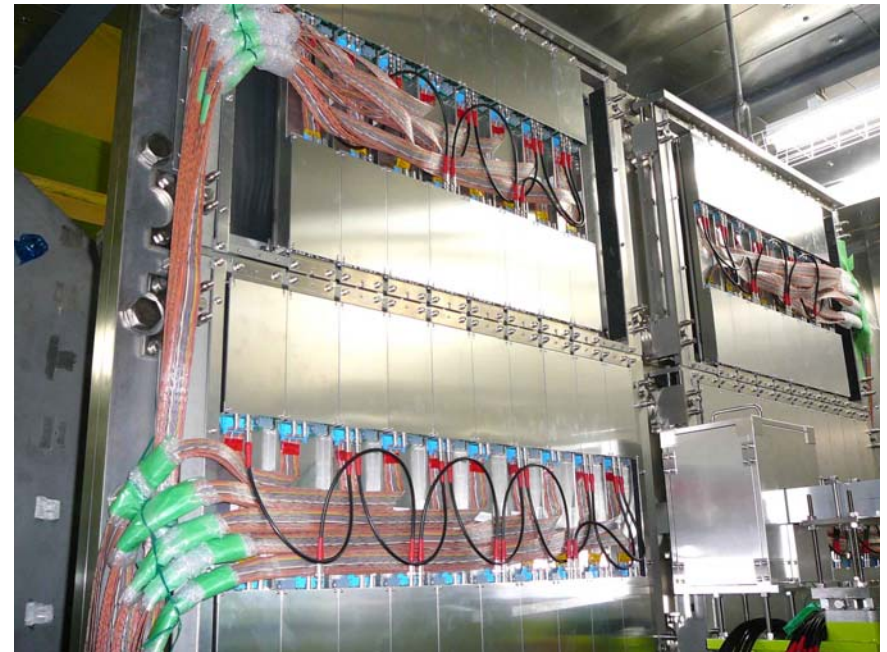
NEUNET system

8PSDs/NEUNET > 100MBASE > 1GBASE > HDD



NEUNET system

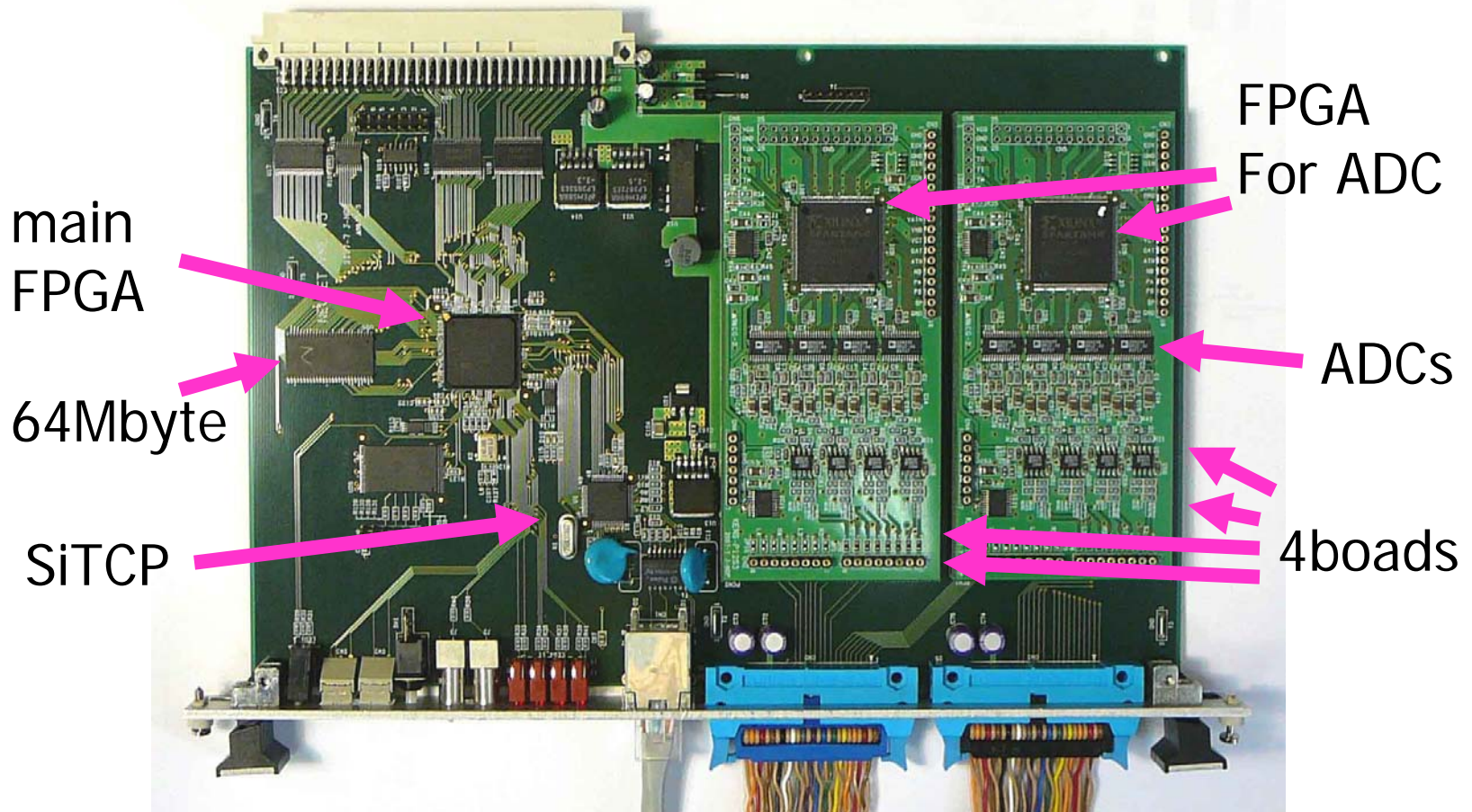
- Network is used as a high speed data bus.
- All neutron data are stored as event data.
- All event data are synchronized by the time data.



For example, BL20 at MLF uses 100 NEUNET modules, and controls 800 PSDs.

NEUNET module

FPGAs, memory, network chip, 4 ADC boards



Storing data with event mode

PC requests data.

NEUNET answers
a length of data +
array of events.
Each size is 8 bytes.

Event types

1. neutron
2. Pulse ID
3. Time

TCP/IP, IP address = 192.168.0.16+<module address>, port = 23

----- DAQ system >> NEUNET module -----

<Command : requesting event data>

header		LN(23:0)
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LN(23:0)= maximum size of transfer data; unit = 16 bits.

----- NEUNET module >> DAQ system -----

<The number of event data : continuing event data size>

L(31:0)	< event data>
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L(31:0)= real size of transfer data; unit = 16 bits.

<event data : neutron data>

header	T(23:0)	P(7:0)	PL(11:0)	PR(11:0)
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T(23:0)= the time in the pulsed neutron frame; unit=25ns.

P(7:0)= detector number, PL(11:0)= left-pulse height, PR(11:0)= right-pulse height

<event data : KP-ID>

header	C(7:0)	M(7:0)	K(39:0)
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C(7:0)= crate number, M(7:0)= module number, K(39:0)= KP-ID; 25Hz at J-PARC

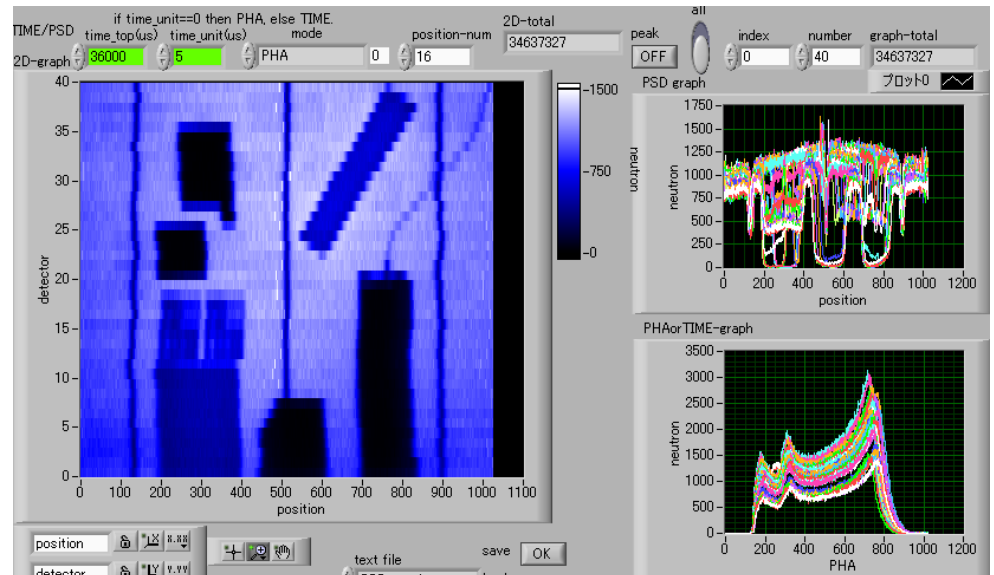
<event data : instrument time>

header	S(29:0)	SS(14:0)	US(10:0)
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S(29:0)= seconds, SS(14:0)= subseconds; 32.768kHz, US(10:0)= module clock; 40MHz

Various things data.

- 2 dimensions data with 40 PSDs.
- 5cm lead shadow and 5mm acrylic shadow are almost the same intensity.





Conclusions.

- Many instruments of J-PARC are using He3-PSD with Charge-division and TOF methods.
- NEUNET system processes data digitally, stores it with event mode, and sends it through the high-speed network.
- NEUNET system obtains FWHM=5mm at 60cm-PSD, and the count rate is up to 30kcps with 10% loss.