Data transfer performance of SRS (J-PARC E16 Experiment)

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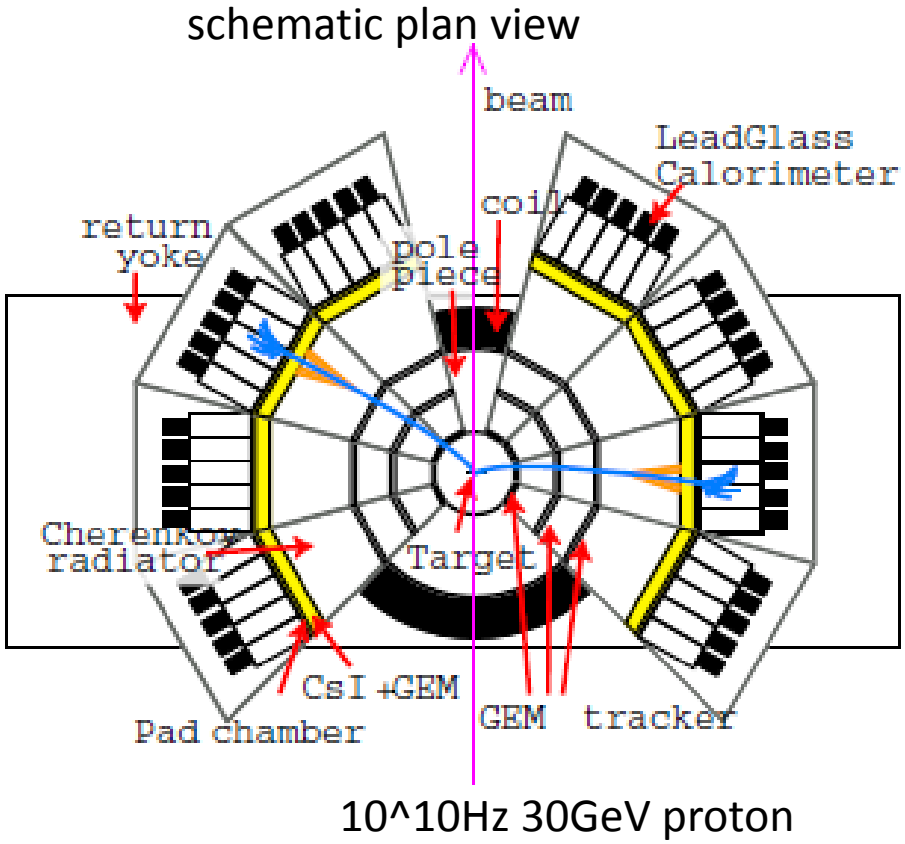
E16 Experiment

E16 experiment

→ study mass modification of vector mesons in dense nuclear matter

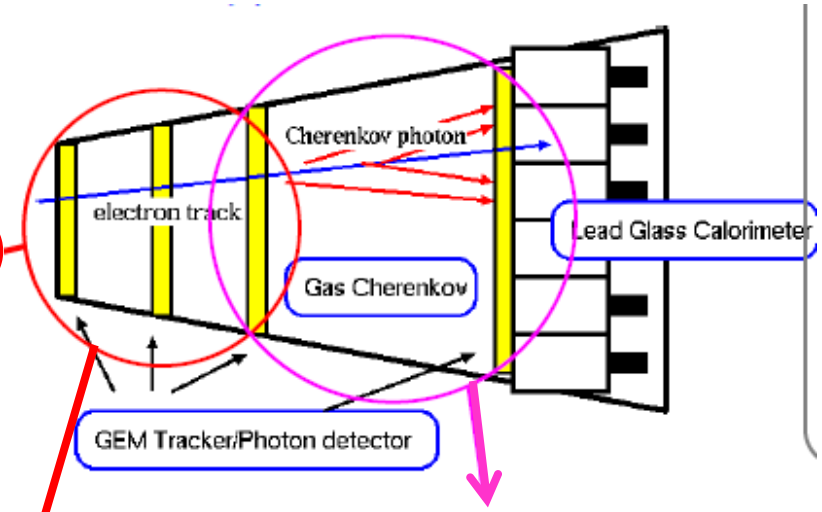
Method

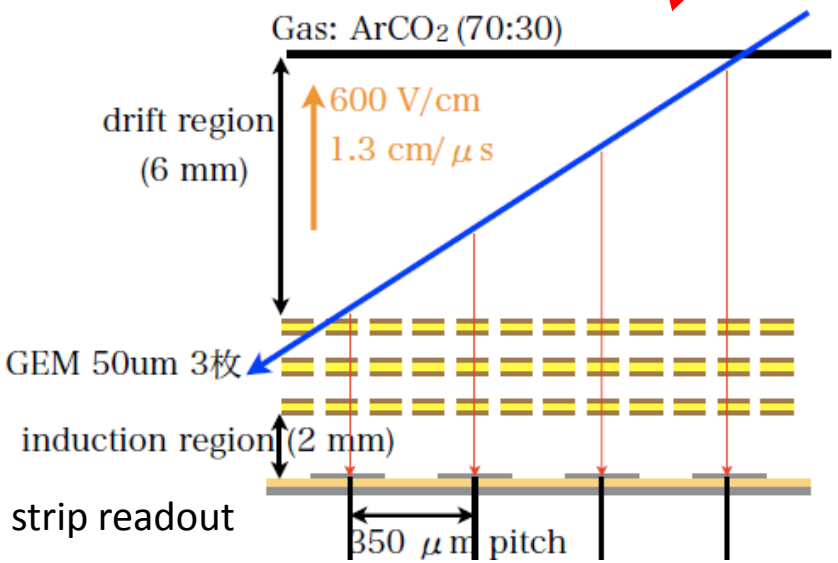
measurement of di-electron from vector mesons(ρ,ω,ϕ) decay in the nuclei.



E16 Detectors

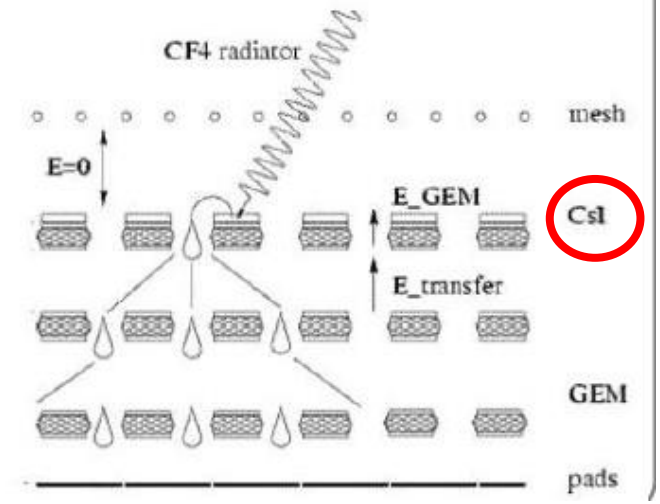
GEM tracker
(momentum measurement)
+ HBD
(electron identification)
+ Lead Glass
(electron identification)





Resolution 100μm
Two-dimensional readout

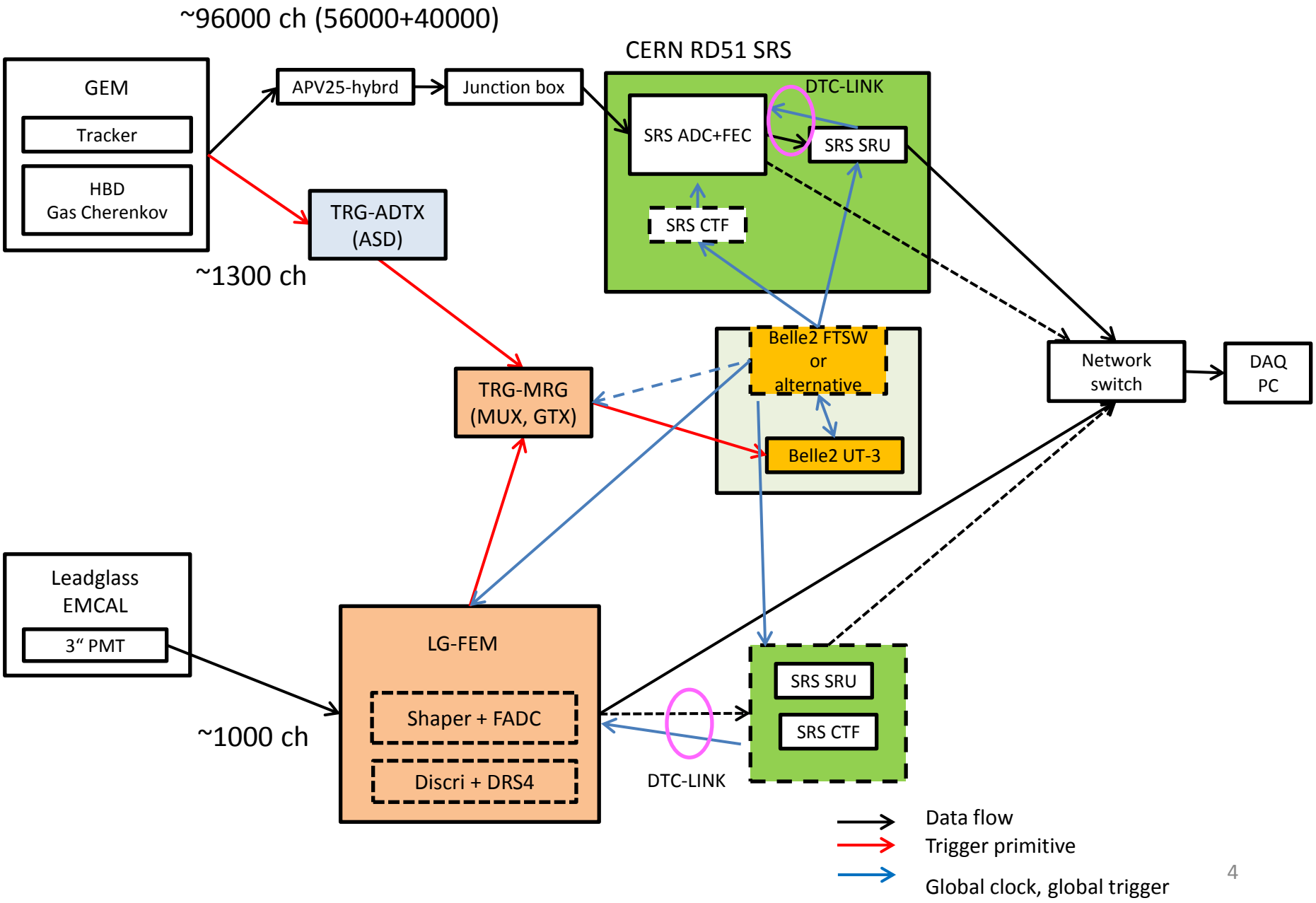
HBD(Hadron Blind Gas Cherenkov Detector)schematics



Cherenkov detector

GEM is a key detector for E16

E16 Readout System(Plan)



E16 Data size (rough estimation)

- With zero suppress
- GEM tracker(GTR) 26module(56000ch), HBD 40000ch

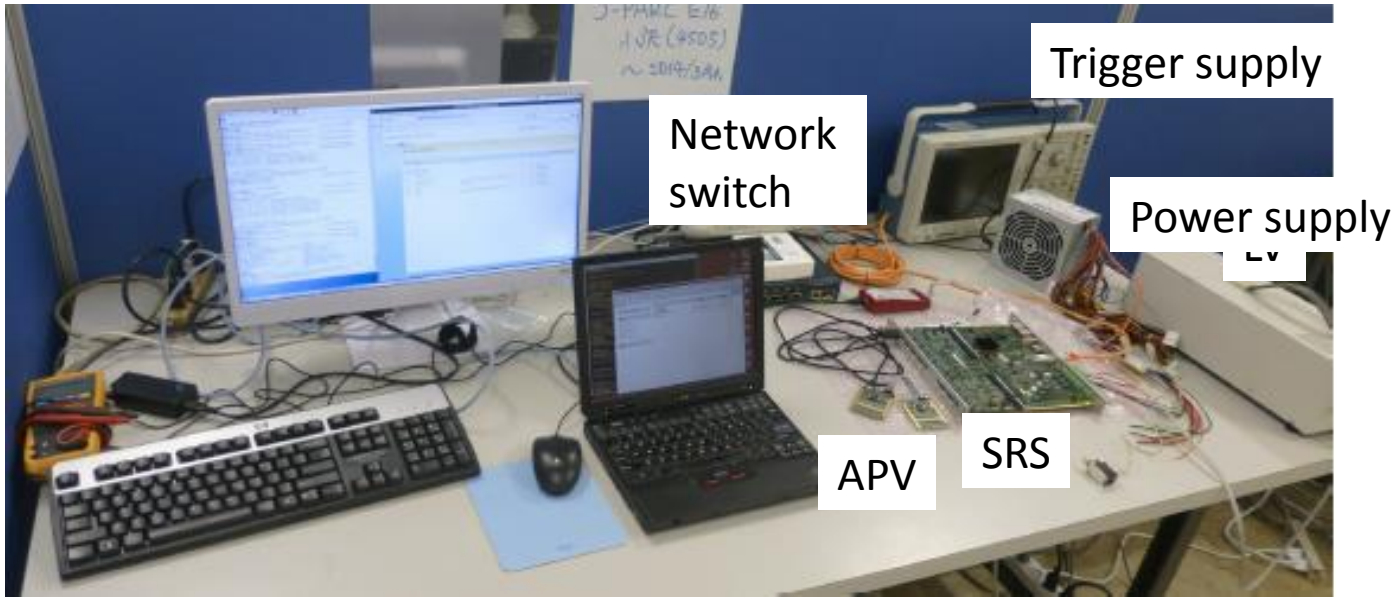
APV25
- GTR 16 bit x 21 sample/ch ~ 45 B/ch
- HBD 16 bit x 6 sample/ch ~ 15 B/ch

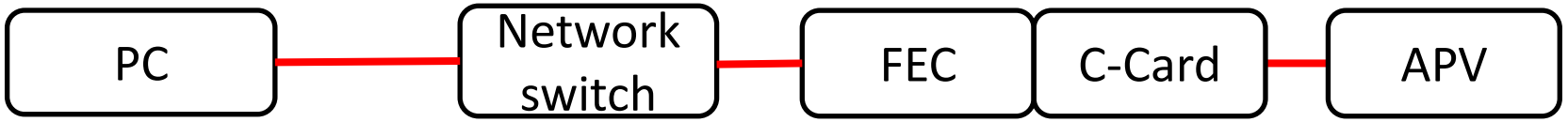
	fire/hit	fire/layer	Occup. [%]	Size [kB/event]
GTR 100□ X	5	1.5k	20.0	68
GTR 100□ Y	2	0.6k	32.1	27
GTR 200□ X	5	1.6k	10.0	72
GTR 200□ Y	2	0.6k	16.0	27
GTR 300□ X	5	1.5k	5.0	68
GTR 300□ Y	2	0.6k	8.0	27
HBD	3	0.3k	1.0	5
LG	2	23	2.5	5

~300kB/event
→300MB/s @1kHz trigger

Most severe condition at E16→ occupancy 30%, # of sample 21
Expected trigger rate::1~2 kHz
SRS system must transfer data with 2kHz @ occupancy 30%

Test Environment





PC

・CPU・・・Intel Xeon® CPU E5-2680

・OS・・・Scientific Linux 6.3

Network switch

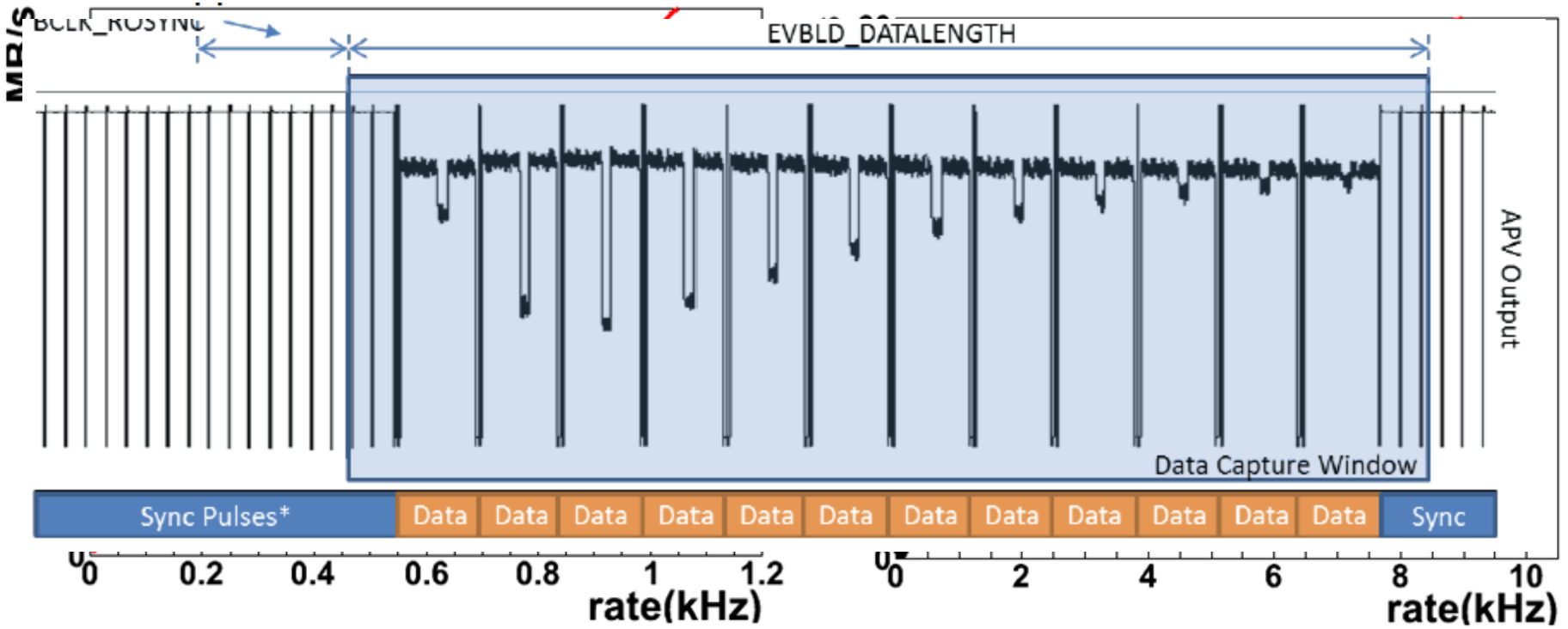
・Cisco Catalyst 2960G

・Gigabit ethernet

Send data was checked with header information and test pulse →OK
Transfer speed was measured at PC.
no input for APV(pedestal data),　no writing to harddisk

Measurement result(1)

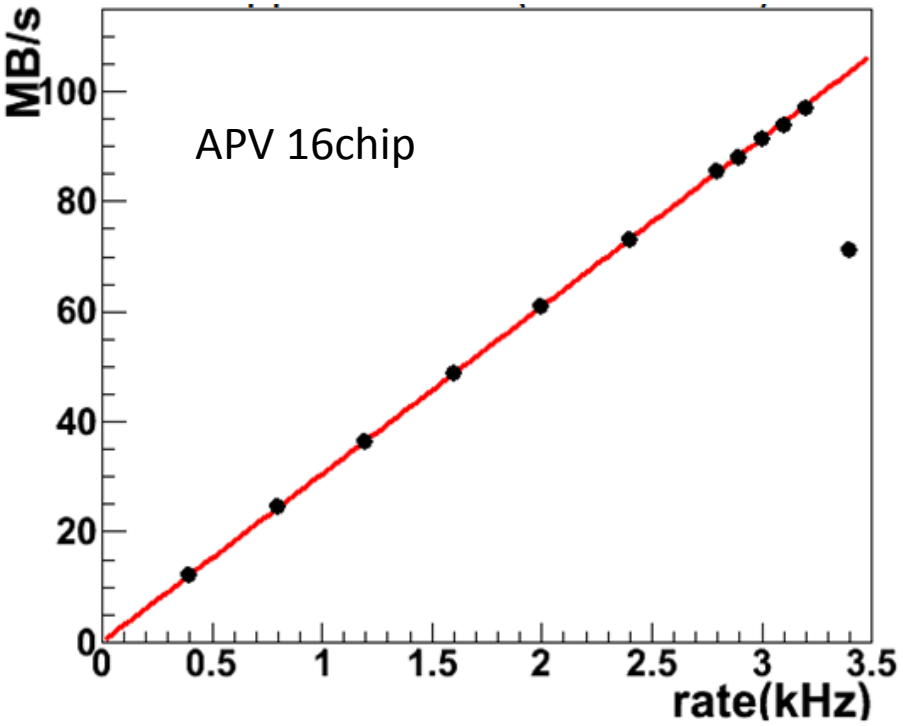
ADC mode readout (without zero suppression)
Event length = 3840
Trigger rate was controlled by function generator.

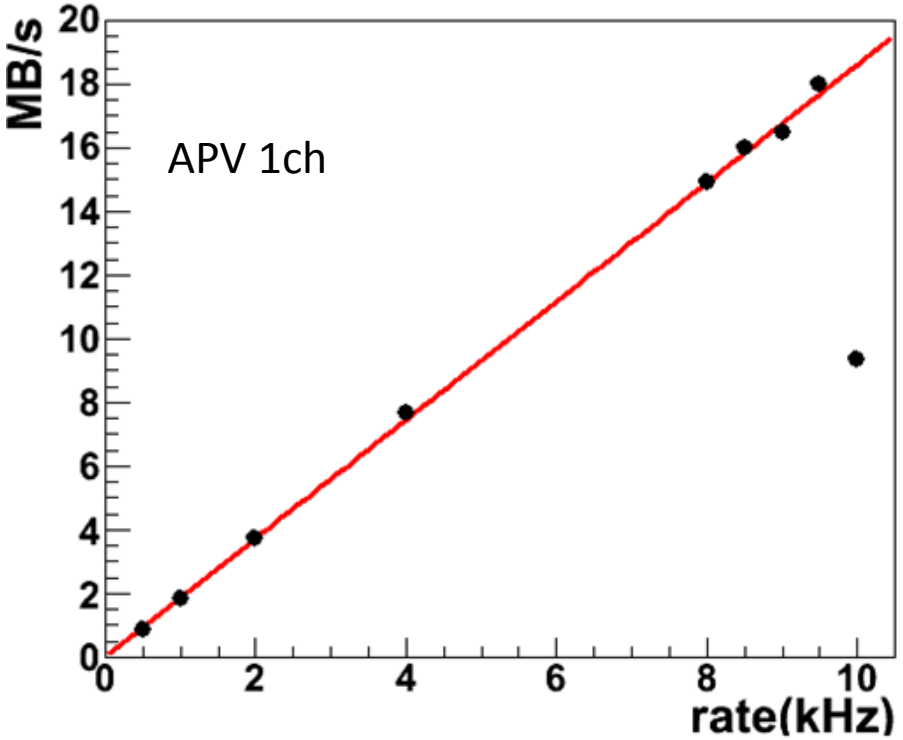


APV 16chip→ transfer speed reached ~110MB/s (close to ethernet limit)
APV 1chip → transfer speed reached ~60MB/s, trigger rate reached 9kHz
(close to the limit by time window length of readout(~10μs))

Measurement result(2)

Event length = 3840
APZ mode readout (with zero suppression)
data was suppressed to ~28% (controlled by pedestal value)



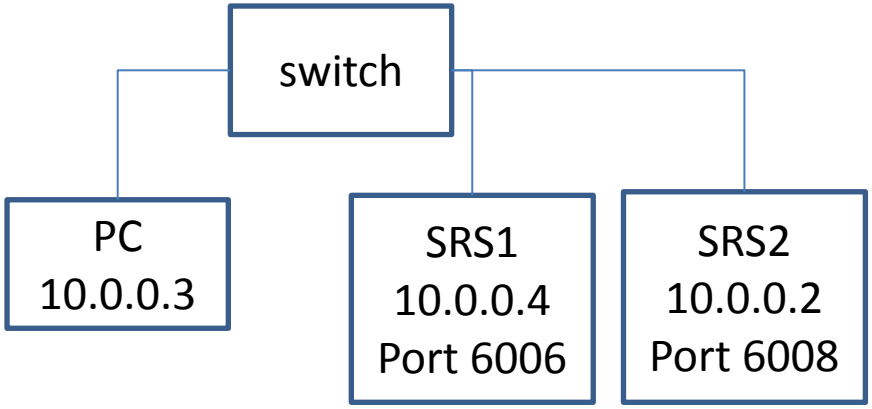


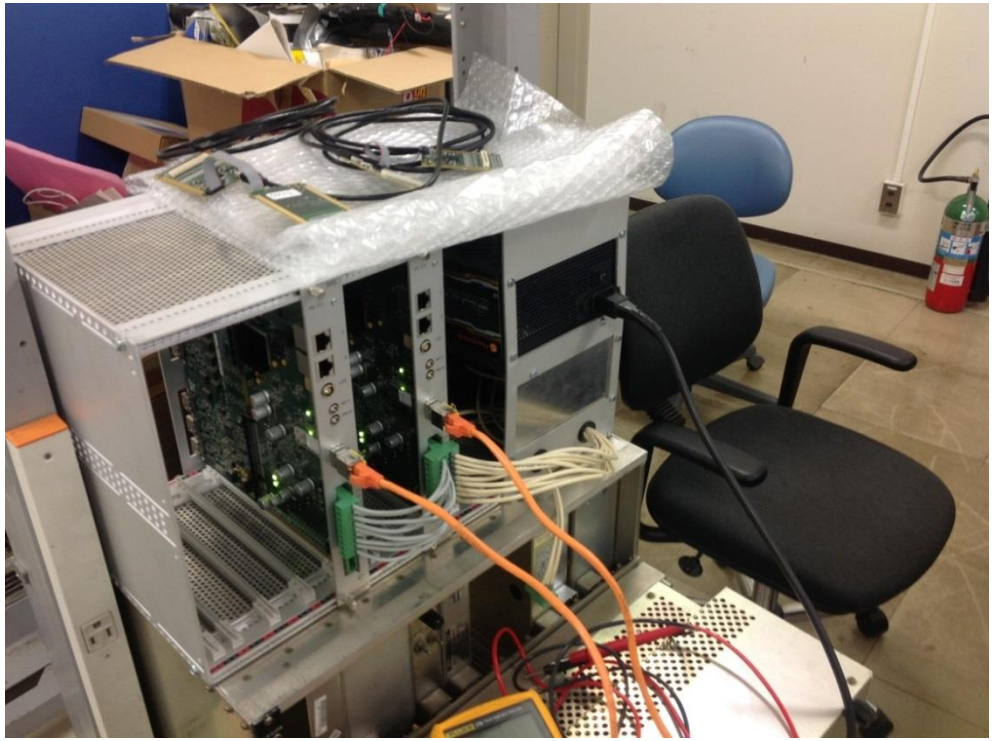
APV 16chip→ transfer speed reached ~110MB/s (close to ethernet limit)
trigger rate reached 3kHz.

APV 1chip → transfer speed reached ~20MB/s, trigger rate reached ~9kHz
(close to the limit by time window length of read data)

Test with two SRS modules

The effect on transfer speed of using two SRS modules was studied.
(unbalanced data transfer makes some bad effect?)

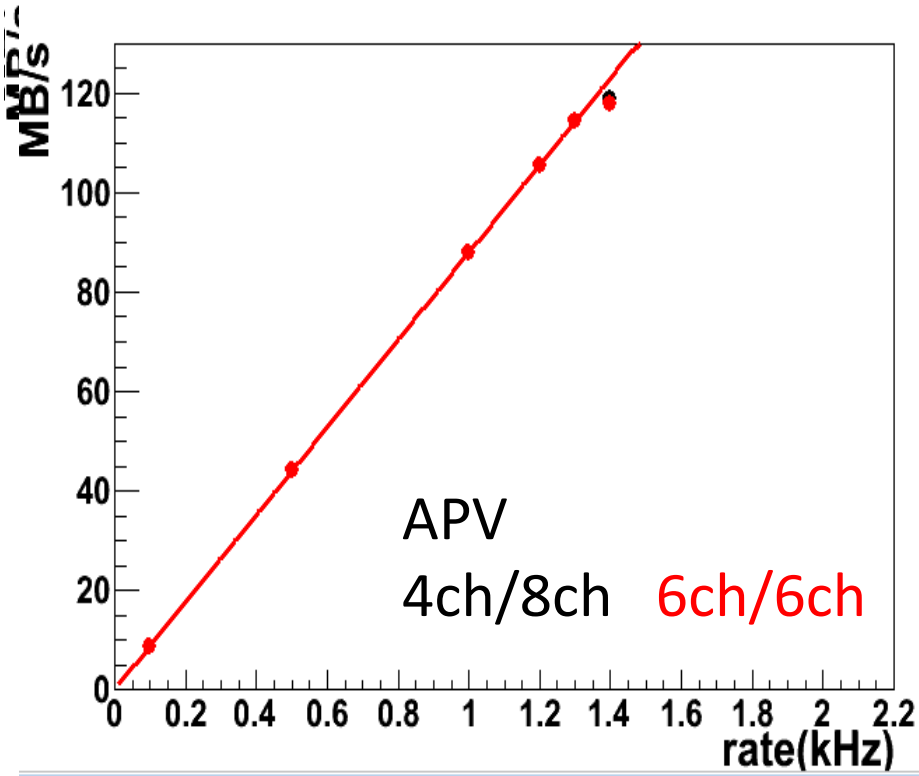


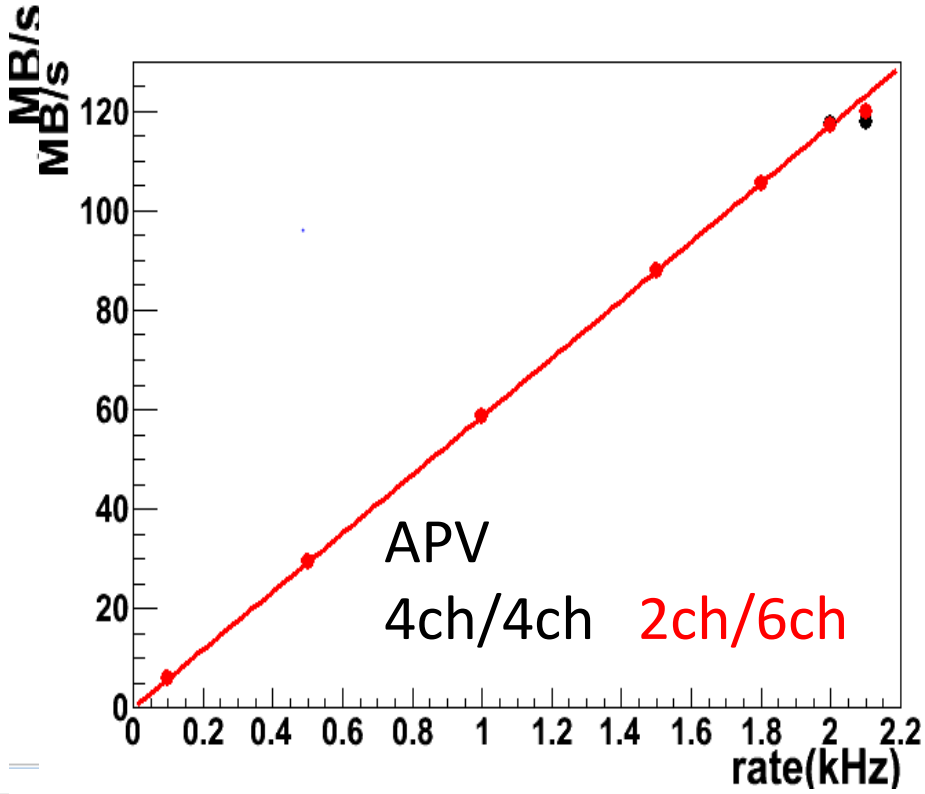


We confirmed data from each SRS modules is valid from header information and test pulse input.
Module identification of send data can be performed by PORD ID

Measurement result(3)

ADC mode readout (without zero suppression), # of readout APV is changed
Event length = 3840
Common trigger rate was controlled by function generator.

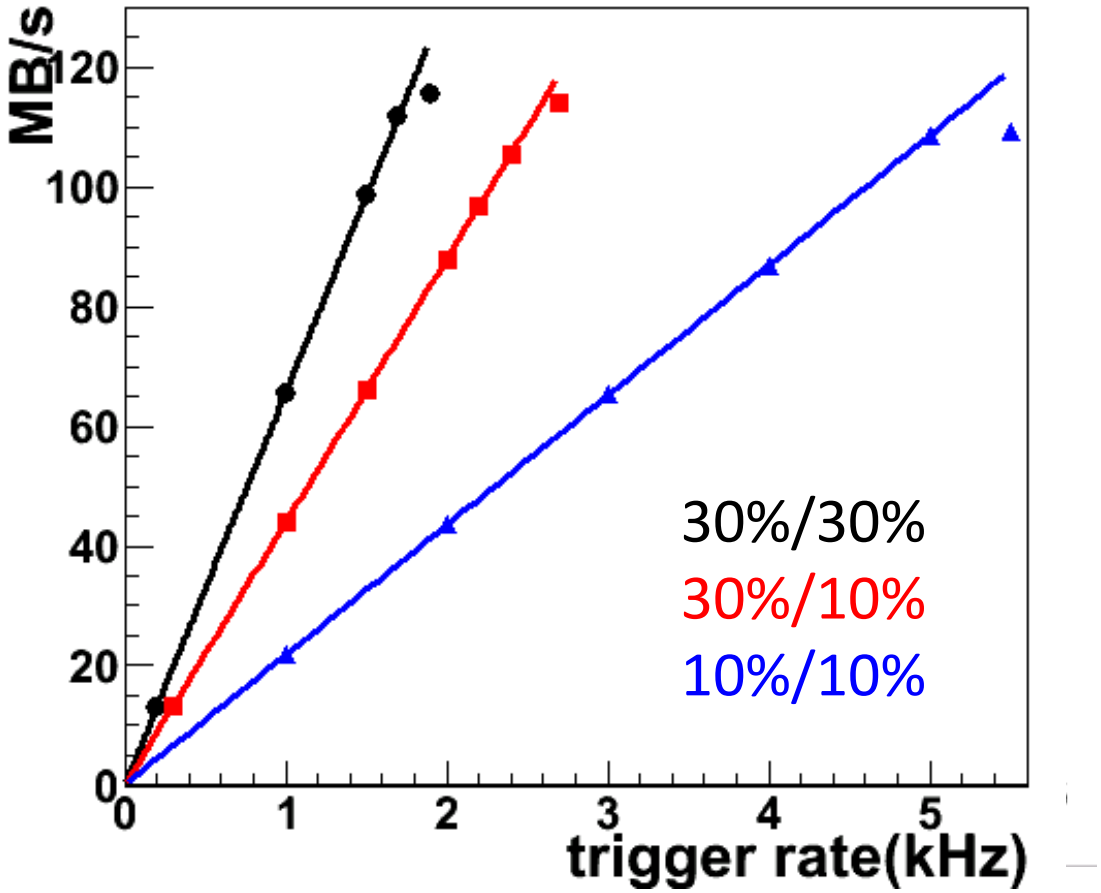




Sum of transfer speed is determined by # of readout APV.
Transfer speed reached ~120MB/s (close to the limit of ethernet) regardless of # of readout APV

Measurement result(4)

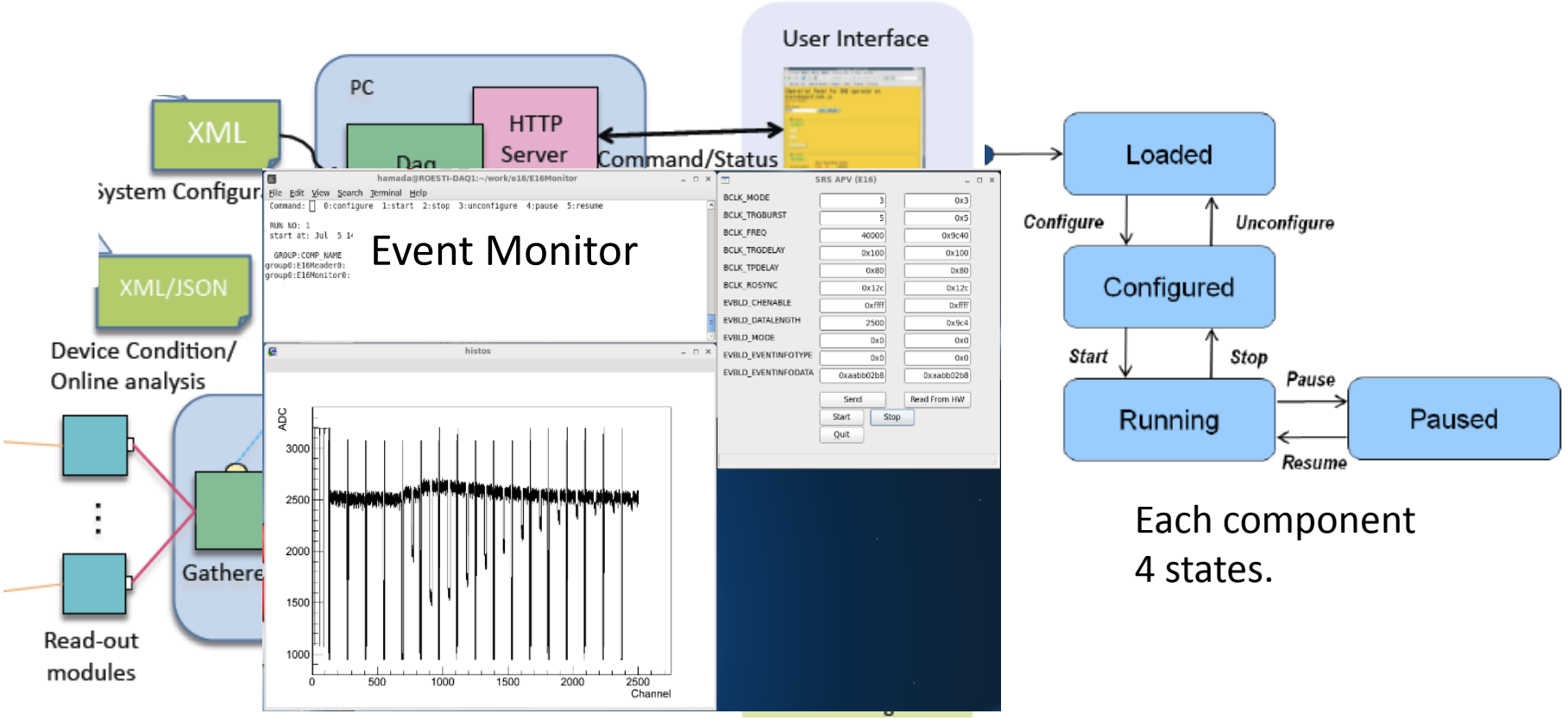
Event length = 3840, APV 16ch
APZ mode readout (with zero suppression)



Transfer speed reached ~120MB/s (close to the limit of ethernet) regardless of suppression degrees.
Unbalanced data transfer does not have bad effect on the transfer speed.

DAQ-middleware(developed by KEK)

http://daqmw.kek.jp

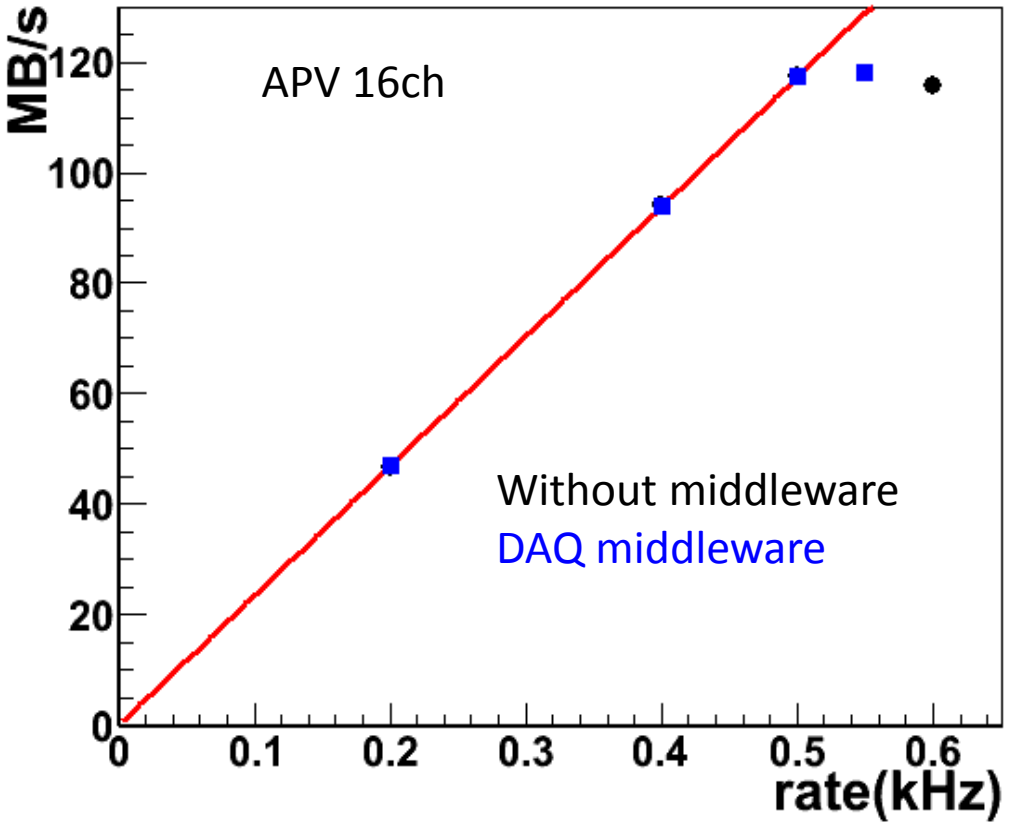


Each component
4 states.

We have a plan to use DAQ-middleware for E16 DAQ system.
DAQ-middleware is DAQ framework based on Robot-technology middleware.
Transfer speed was measured with DAQ-middleware system.
-- harddisk writing.
-- brief event monitor worked.
Two SRS modules were used for this measurement.

Measurement with DAQ middleware(1)

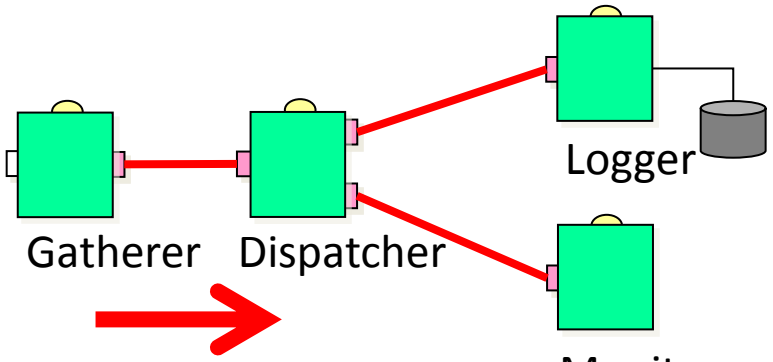
ADC mode readout (without zero suppression)
Event length = 3840
Common trigger rate was controlled by function generator.

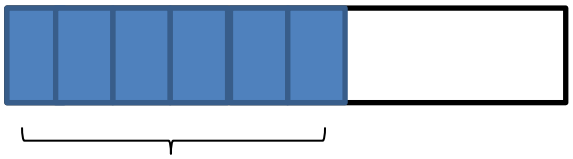


Processing speed does not change when DAQ-middleware is used.

Measurement with DAQ middleware(2)

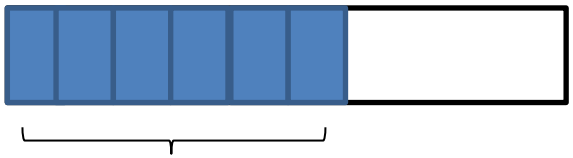
Too much frequent data transfer in DAQ-middleware slow processing speed in DAQ.





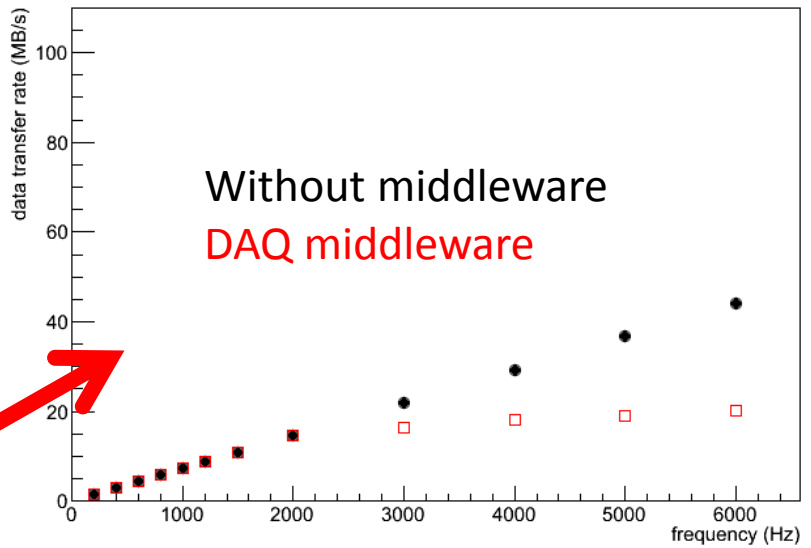
1event

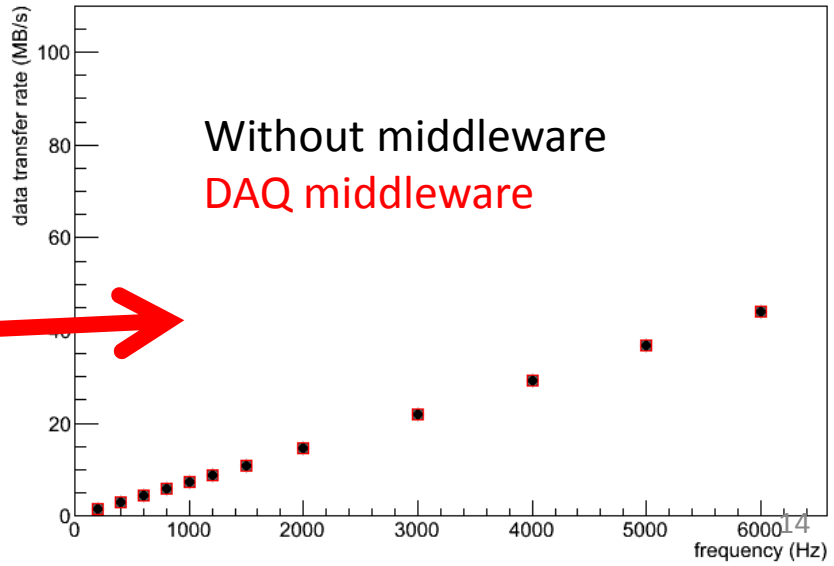
Data transfer next component event by event



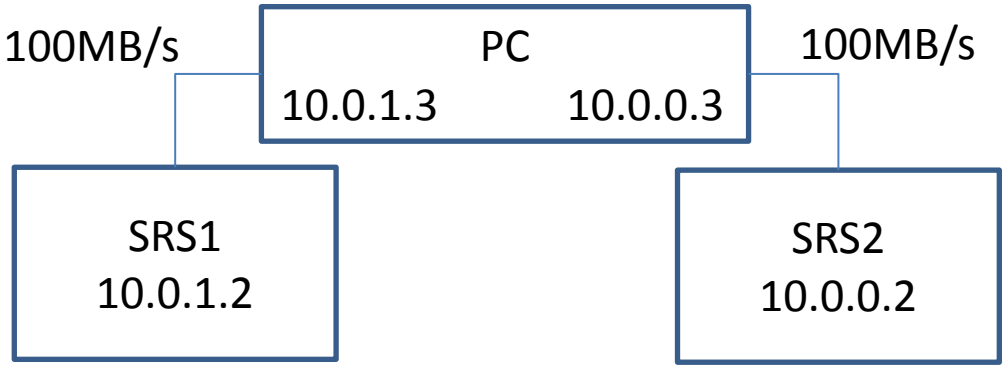
200kB

Data transfer next component 200kB by 200kB

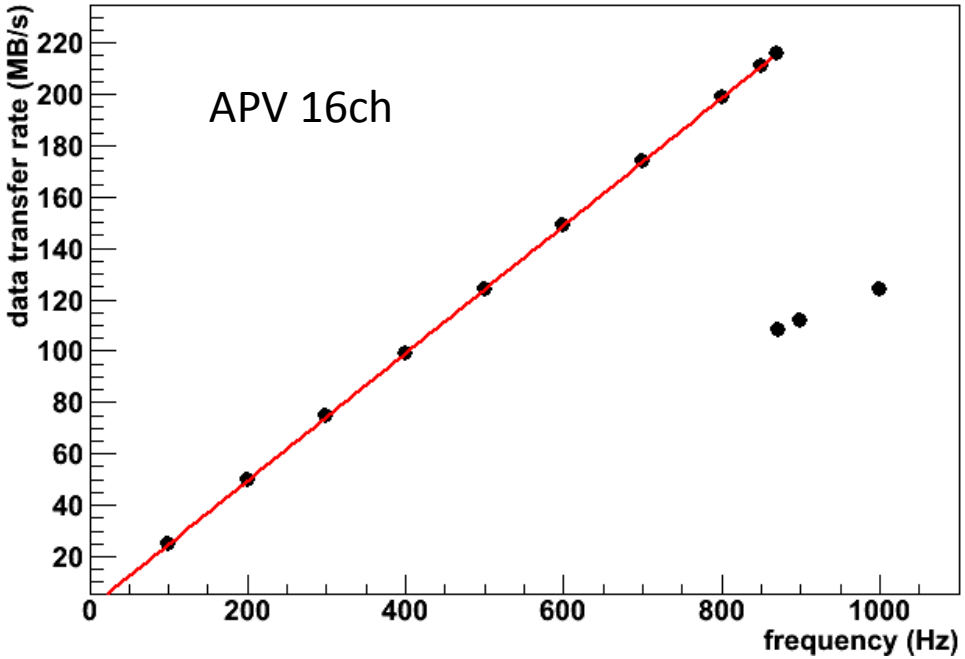




Measurement with DAQ middleware(3)



Transfer speed was measured without network switch.



Transfer speed reached ~220MB/s without network switch.
The limit of transfer speed seems to be determined by the limit of ethernet until the trigger rate reaches close to the time window of read data.

Summary

- J-PARC E16 experiment uses APV and SRS modules for readout of GEM detectors.
- 30% occupancy data must be readout. Trigger rate is 1~2kHz.
- The speed of data transfer reaches ~120MB/s when the trigger rate is not close to the limit of the time window.
  The limit does not depend on # of APV channels and suppression degrees.
  The performance of SRS data transfer satisfy E16 requirement.
- The transfer speed also reaches ~120MB/s with DAQ-middleware.

Outlook

- The transfer speed should be measured with random trigger.
- DAQ development for E16 experiment. (Eventbuild)