

# LAMPS Neutron Detector Array Status & DAQ software plan

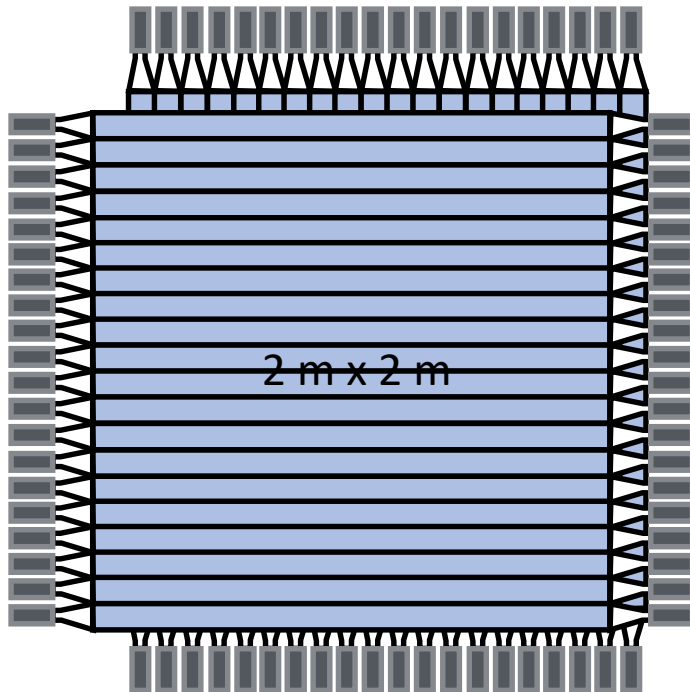
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**KOREA**  
UNIVERSITY



# LAMPS Neutron Detector Array

- 4 layer
- 160 x BC408 ( 100 mm x 100 mm x 2000 mm )  
+ 2 H7195 Scintillation detector
- Measure neutron TOF with < 200 ps timing resolution with 2 m x 2 m detection area



Setup for cosmic ray measurement

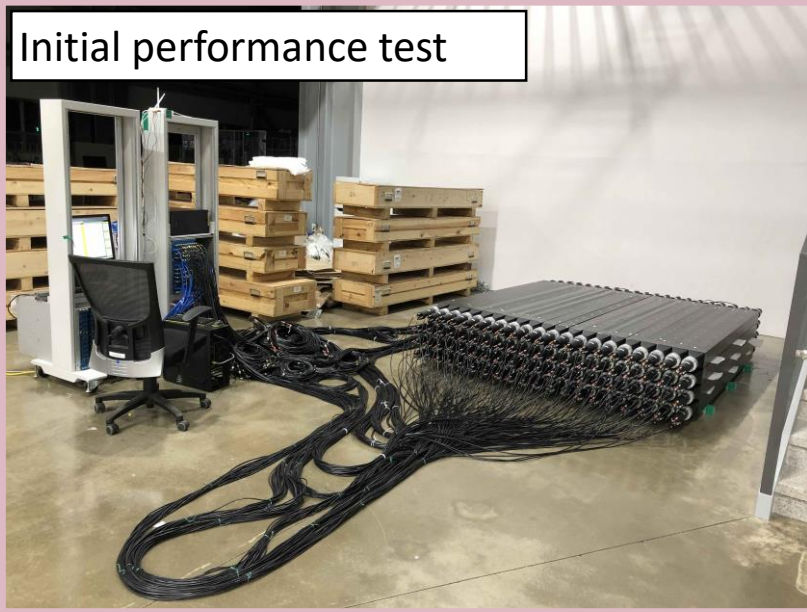
Detector sorting



Detector Installation(1)



Initial performance test



Detector Installation(2)



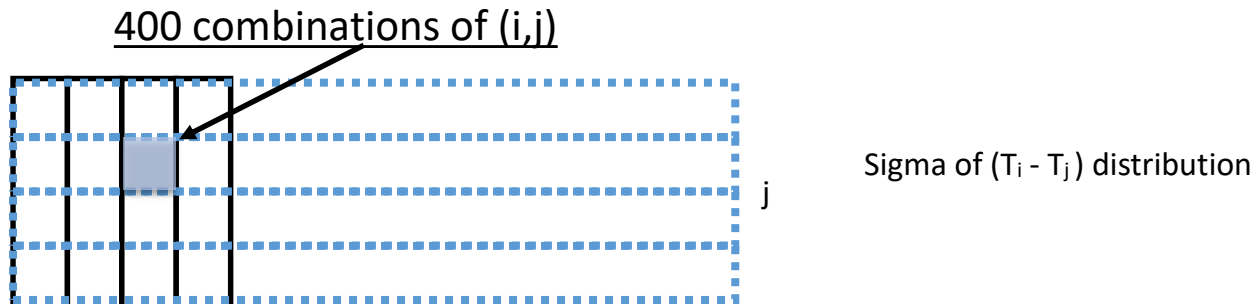
Construction complete



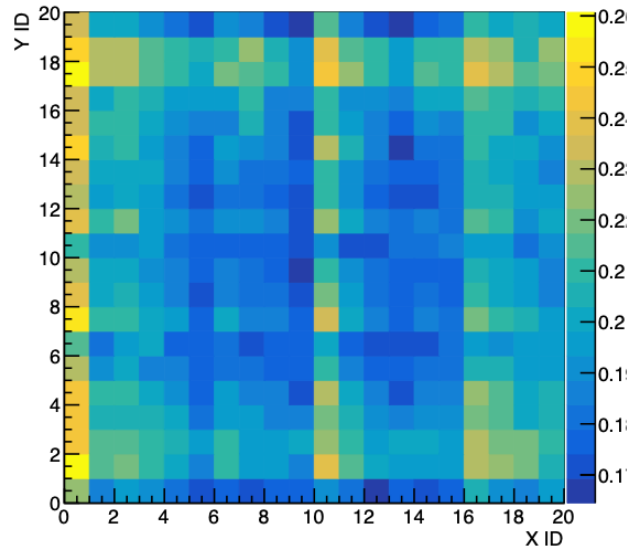
December 27, 2018

# Timing resolution

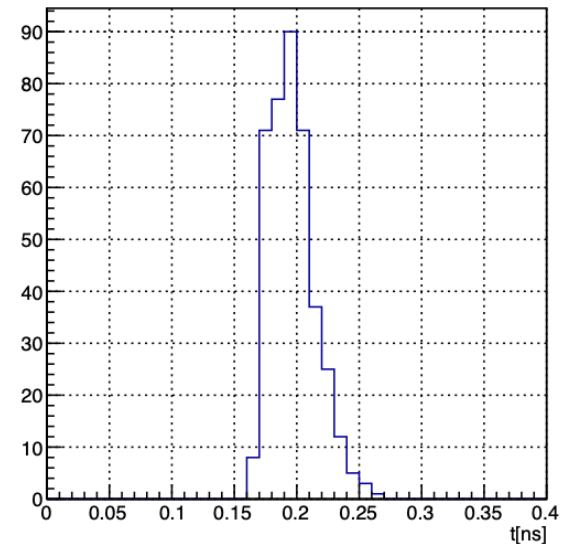
Only two plane -> Difficult to derive timing resolution



Timing Resolution Distribution



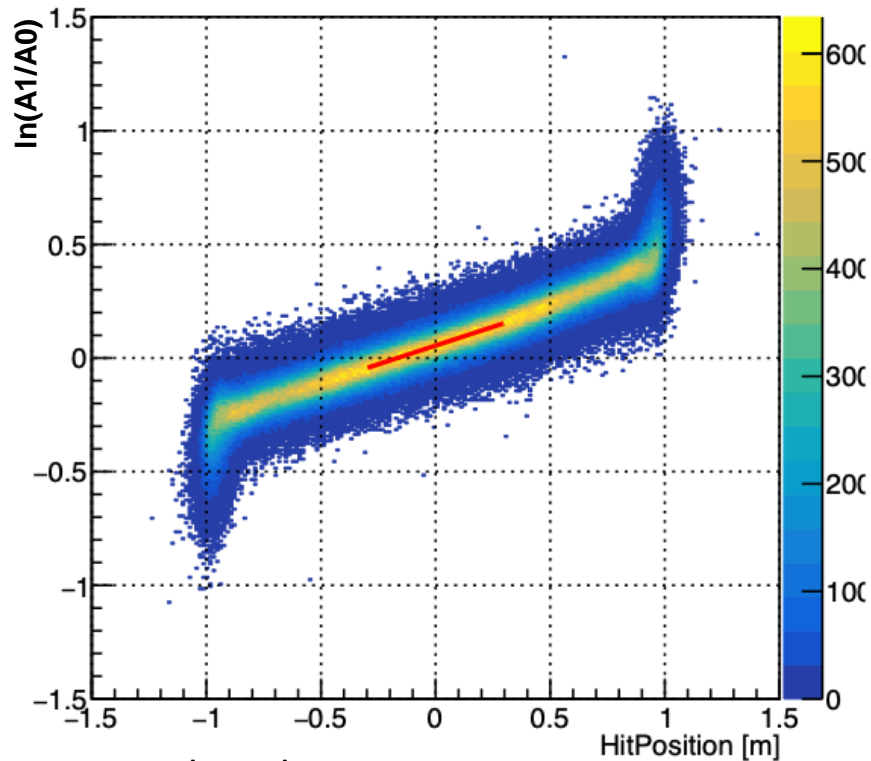
Timing Resolution



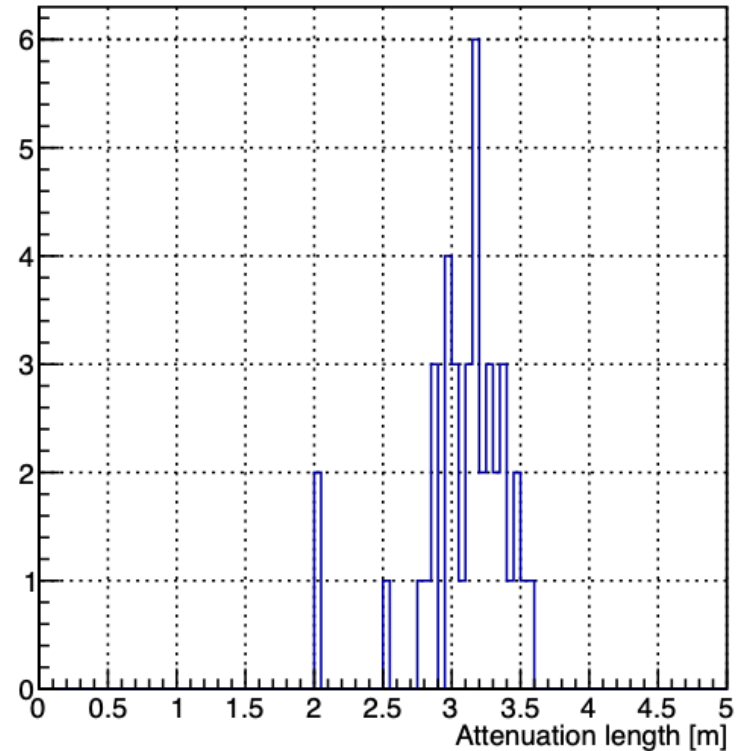
Mean value : 197ps -> ~140 ps

# Detector Performance - Attenuation length

Signal attenuation



Attenuation



Attenuation length

Average :  $\sim 3.1$  m

Minimum : 2 m

Threshold=200 cnt, Cosmic Peak=1000

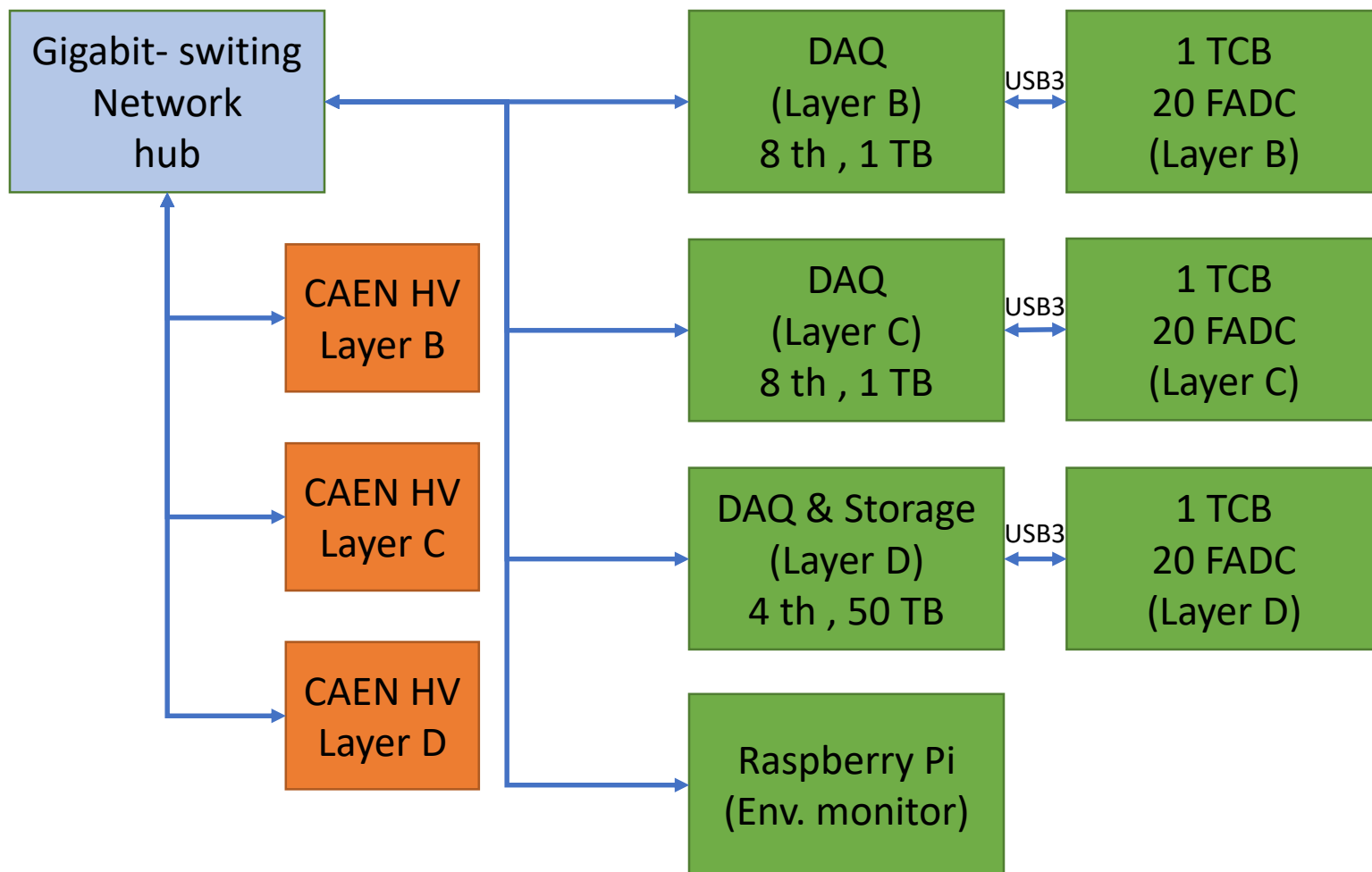
=> Dynamic Range : 5.6  $\sim$  50 MeV

	Prev ( 1 module )	Current ( 40 module )
t res.	139 ps	140 ps ( 197 ps )
pos res.	23 mm	-
Attenuation length	3.3 m	3.1 m

# Requirements for Neutron detector array DAQ system & Software

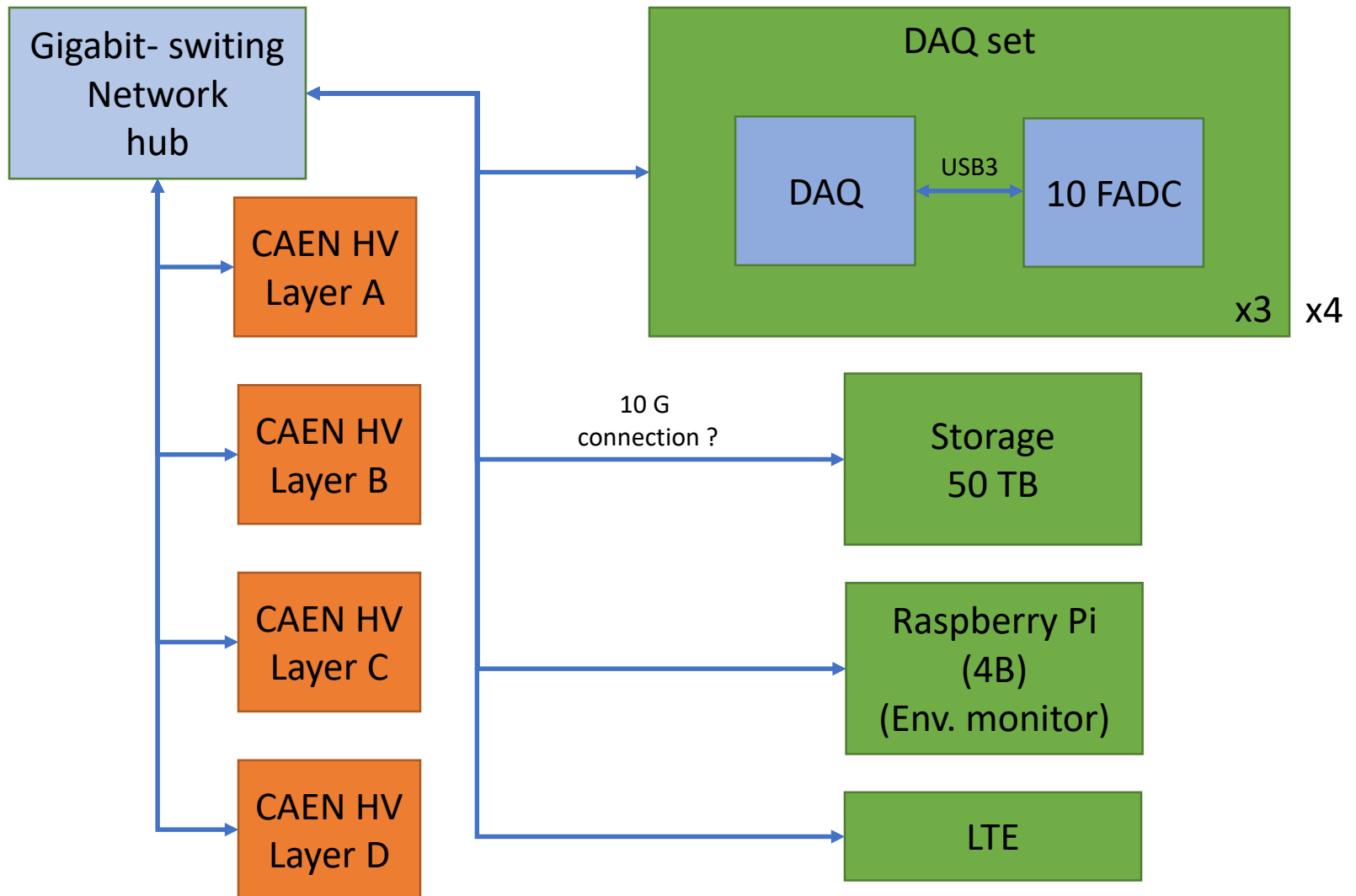
- DAQ
  - DAQ should run under network ( multiple machines for DAQ ) : Socket programming
  - Only one USB3 device handled by single process : Multi-process
  - Run many process simultaneously & Control them via network
  - TCB & FADC upgrade
  - LTE
- Calibration & gain ( HV ) adjustment
  - Make automated calibration & HV adjustment program ( 180 module – 360 PMTs )
  - Make criteria for gain adjustment
- Environment monitoring
  - Searching good tools for displaying chronological data
- Data base for RUN data

# Current setup – Network connection

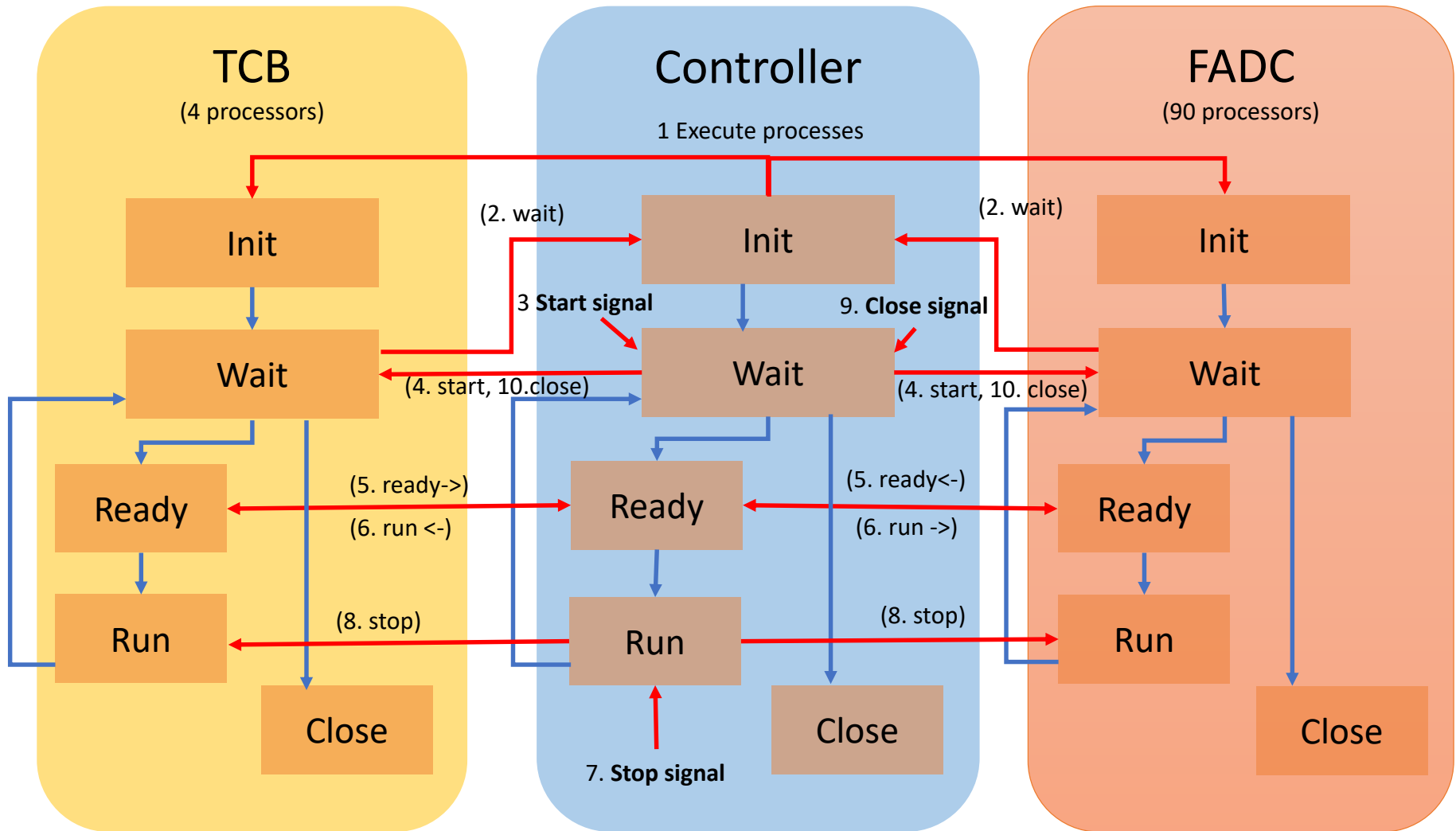




# Future setup ( Full setup )



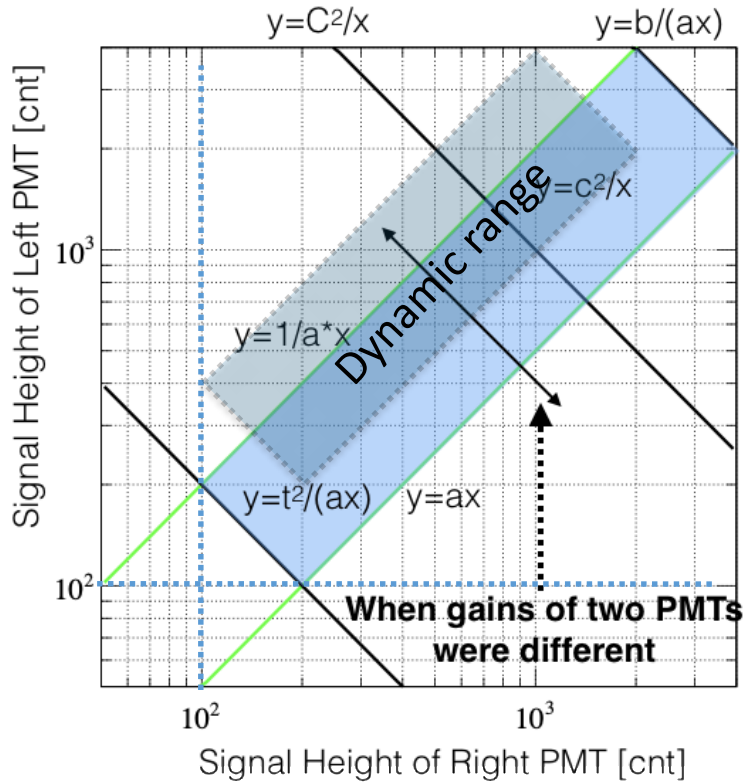
# DAQ diagram



(TCB & FADC sends their own status to the controller by 5 secs)

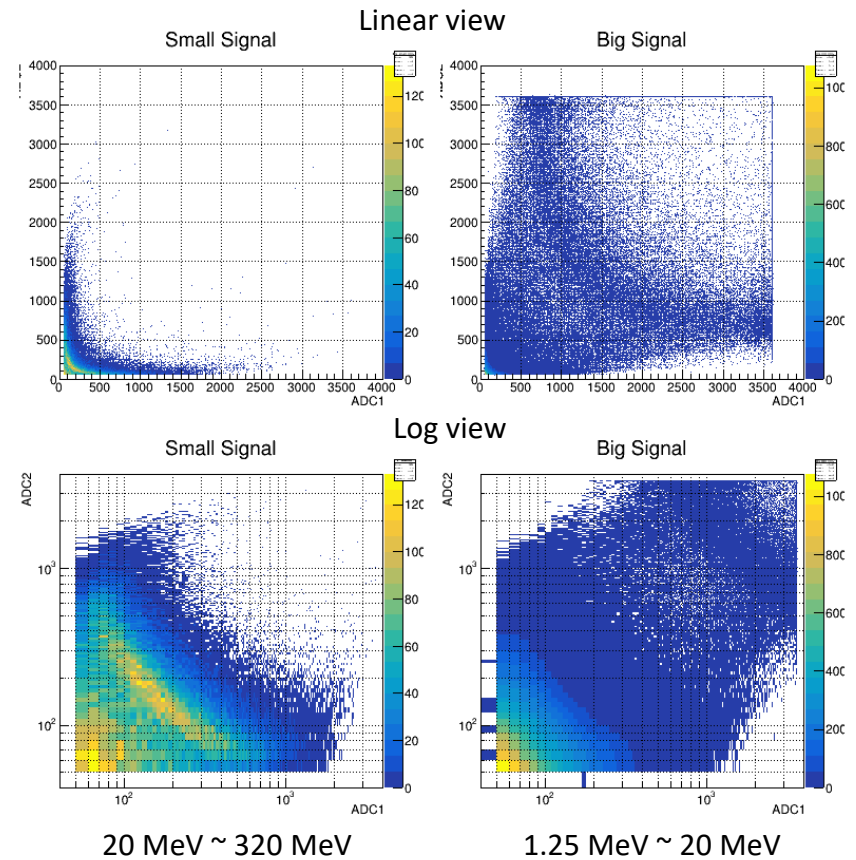
# Gain alignment

## Dynamic range of scintillator



C : Cosmic ray MIP  
 t : threshold ( count )  
 a : attenuation for 2 m

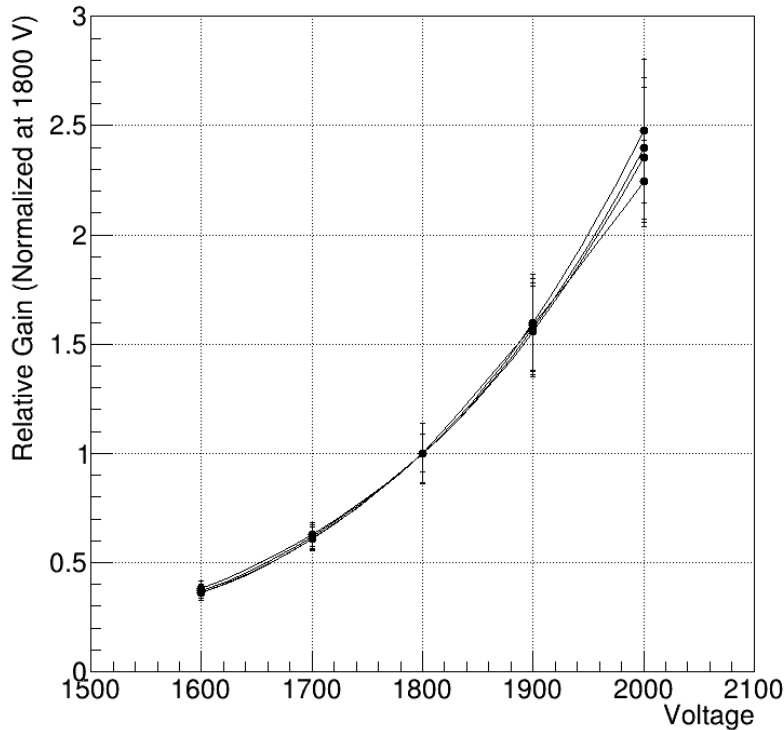
## Sample Distributions



# HV & Gain adjustment

$$V = e^{\frac{1}{8.56}} \times \ln(\text{Gain}/a)$$

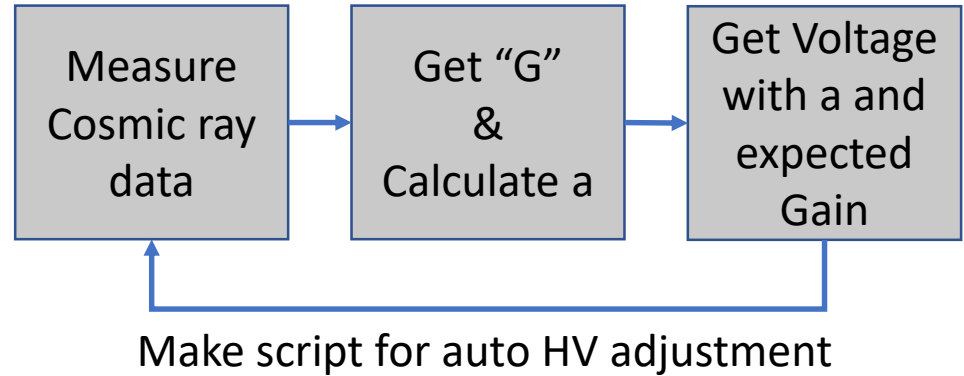
PMT HV Gain curve (H7195)



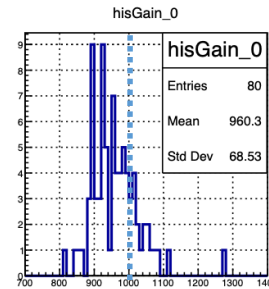
$$G(V) = a (V/1000)^{8.56}$$

Dynode stages : 12

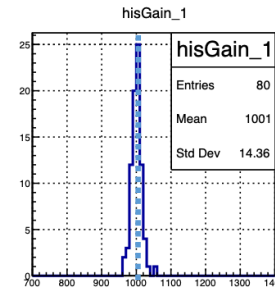
Collection Efficient : 0.71



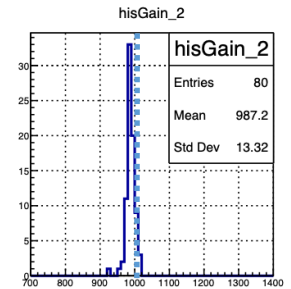
Initial Gain Dist.



Adjust 1 times



Adjust 2 times



All gains were aligned with ~2% by two times of HV adjustment

Each measurement took 1~2 hr ( 3~6 hr total )

# HV control

- CAEN HV control library
  - Can control All types of CAEN HV supplies.
  - Connected via LAN to SY5257 ( Current HV supply system )
  - Run HV control command in command line ->Automation!
- CAEN GECCO2020
  - GUI program for HV control
- WEB : CAEN HV supply embedded

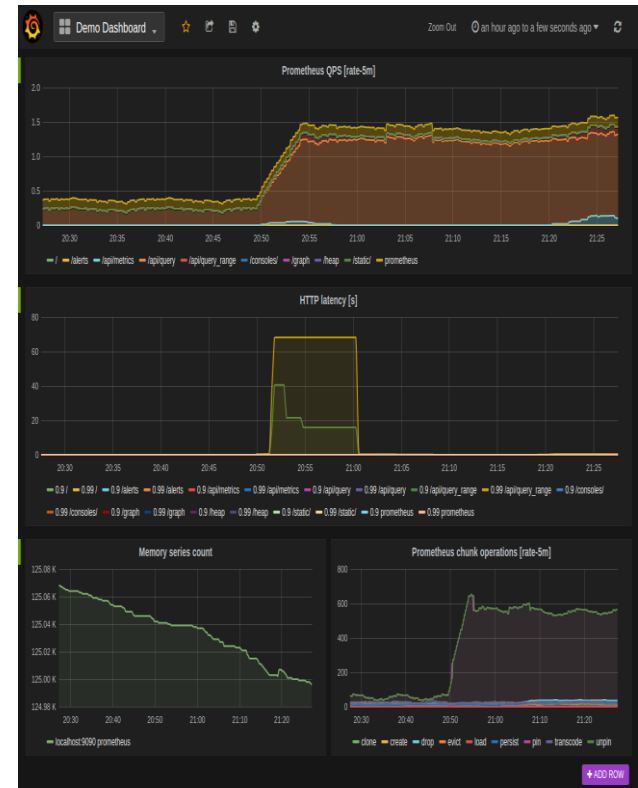


The screenshot displays the GECCO2020 software interface, which is used for controlling CAEN HV supplies. The main window shows a table of channels with columns for Channel, Name, ISet, VSet, IMax, VMax, P, and Stat. The channels are listed from 09.000 to 09.023. A red circular logo with a gecko and the text 'CAEN GECCO 2020' is overlaid on the bottom left of the screenshot.

Channel	Name	ISet	VSet	IMax	VMax	P	Stat
09.000	CHANNEL00	900.00 uA	100.0 V	0.10 uA	0.0 V		Off
09.001	CHANNEL01	900.00 uA	100.0 V	0.15 uA	0.0 V		Off
09.002	CHANNEL02	900.00 uA	100.0 V	0.00 uA	0.0 V		Off
09.003	CHANNEL03	900.00 uA	100.0 V	0.20 uA	0.0 V		Off
09.004	CHANNEL04	900.00 uA	100.0 V	0.10 uA	0.0 V		Off
09.005	CHANNEL05	900.00 uA	100.0 V	0.10 uA	0.0 V		Off
09.006	CHANNEL06	900.00 uA	100.0 V	0.05 uA	0.0 V		Off
09.007	CHANNEL07	900.00 uA	100.0 V	0.00 uA	0.0 V		Off
09.008	CHANNEL08	900.00 uA	100.0 V	0.10 uA	0.0 V		Off
09.009	CHANNEL09	900.00 uA	100.0 V	0.15 uA	0.0 V		Off
09.010	CHANNEL10	900.00 uA	100.0 V	0.00 uA	0.0 V		Off
09.011	CHANNEL11	900.00 uA	100.0 V	0.15 uA	0.0 V		Off
09.012	CHANNEL12	900.00 uA	100.0 V	0.10 uA	0.0 V		Off
09.013	CHANNEL13	900.00 uA	100.0 V	0.00 uA	0.0 V		Off
09.014	CHANNEL14	900.00 uA	100.0 V	0.10 uA	0.0 V		Off
09.015	CHANNEL15	900.00 uA	100.0 V	0.10 uA	0.0 V		Off
09.016	CHANNEL16	900.00 uA	100.0 V	0.15 uA	0.0 V		Off
09.017	CHANNEL17	900.00 uA	100.0 V	0.15 uA	0.0 V		Off
09.018	CHANNEL18	900.00 uA	100.0 V	0.05 uA	0.0 V		Off
09.019	CHANNEL19	900.00 uA	100.0 V	0.10 uA	0.0 V		Off
09.020	CHANNEL20	900.00 uA	100.0 V	0.10 uA	0.0 V		Off
09.021	CHANNEL21	900.00 uA	100.0 V	0.05 uA	0.0 V		Off
09.022	CHANNEL22	900.00 uA	100.0 V	0.15 uA	0.0 V		Off
09.023	CHANNEL23	900.00 uA	100.0 V	0.10 uA	0.0 V		Off

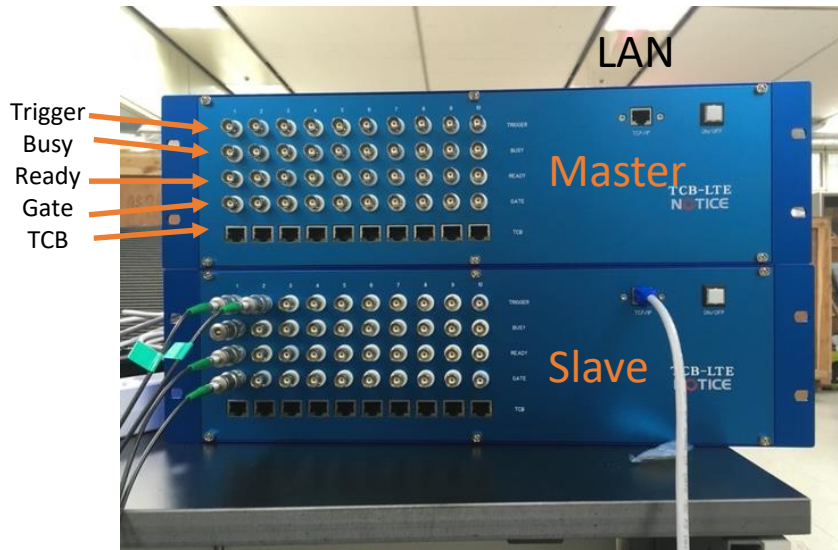
# Chronological data monitoring and Run info data base

- Many chronological data to monitor
  - Trigger rate
  - Data size & free storage size
  - HV & current
  - Environment data
    - temperature
    - humidity
    - vacuum
    - Gas flow
    - Beam intensity?
- Prometheus + Grafana : Under test.
- EPICS?
- RUN info data base with Run number, Trigger type, Start time, End time, etc..



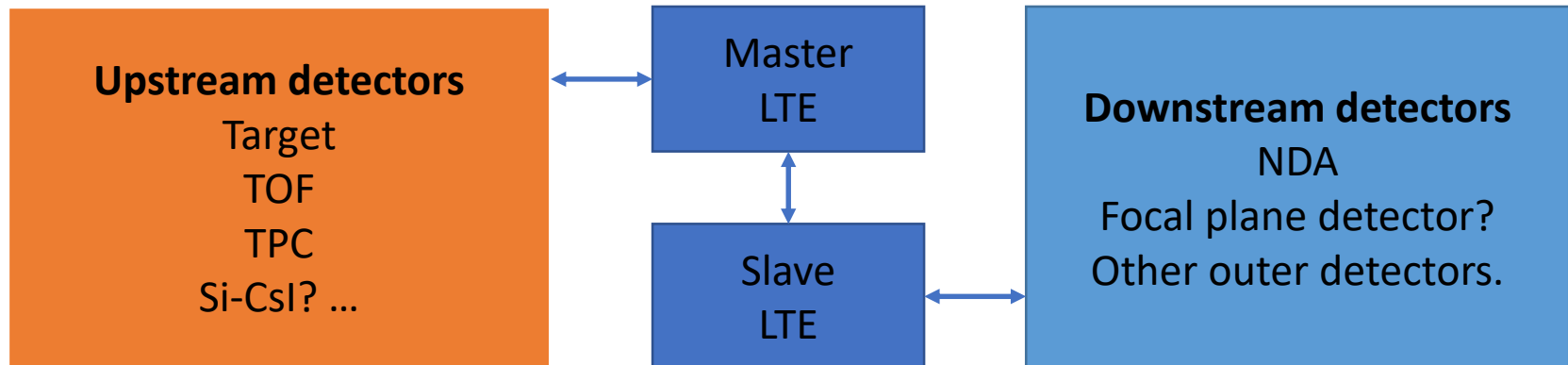
# Trigger System

LTE module



## Concept

- LTE has its own processor ( PC ).
- All trigger information from connected detectors will be recorded.
- All time stamp of detector DAQs synchronize with Master's clock.
- Handle VETO signal.
- Trigger decision
- ...



# TCB & FADC Firmware upgrade plan for LTE

- FADC
  - Buffer full readout ( buffer size  $\geq 16k$  ) -> Ontime readout / buffer full readout selectable
- TCB
  - Trigger logic upgrade
  - Time sync : No time sync ( own clock ) -> Sync time with LTE
  - Handle VETO signal
- RUN mode
  - Self Trigger mode : Check hit pattern ( 4 ch set ) -> Record data ( Ordinary one )
  - External Trigger mode : Send trigger signal via UTP port ( RJ45 ) or LEMO input -> Record data (Upgraded one)
  - Mixed mode : Check hit pattern in TCB (Self trigger mode) -> Send Trig info to LTE -> Trigger decision in LTE -> Send back & distributes trigger signal to all TCB - > Record data ( New one)



# Summary

- Neutron detector array was build.
- DAQ system & Programs are preparing now.
  - New version of DAQ program was developed.
  - TCB & FADC firmware will be upgraded for final version.
  - New Trigger controller (LTE) is under development.
  - Monitoring system is testing.