

Development of the gamma-ray tracking detector system at RCNP

Yasutaka Yamamoto

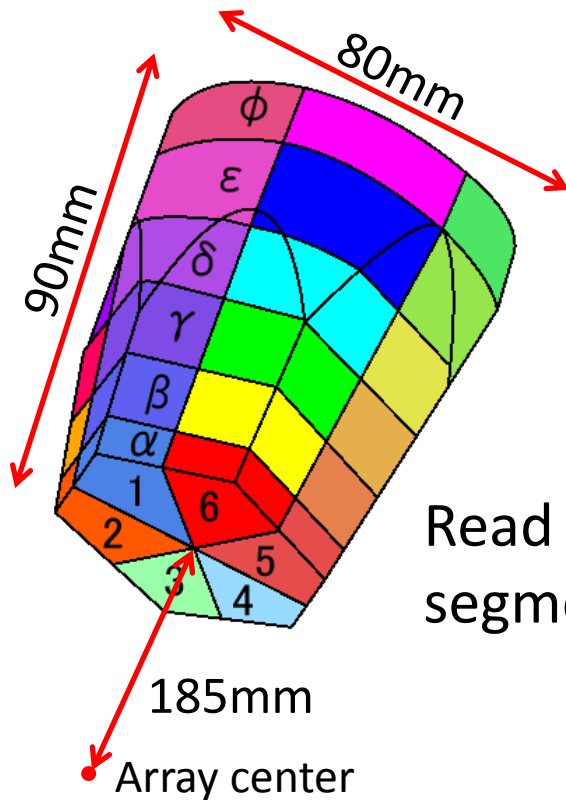
RCNP, Osaka Univ.

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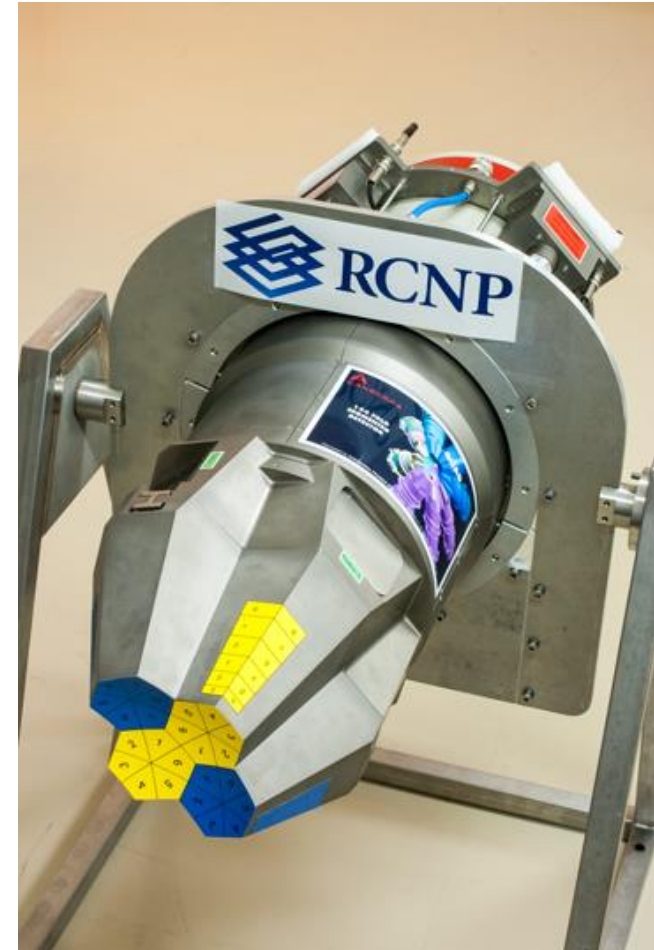
- Gamma-ray tracking detector
 - Quad Ge detector
 - Electronics
 - DAQ system
- Physics Experiment
 - Search of “non-inverted” deformed states in ^{36}S
 - Experimental setup

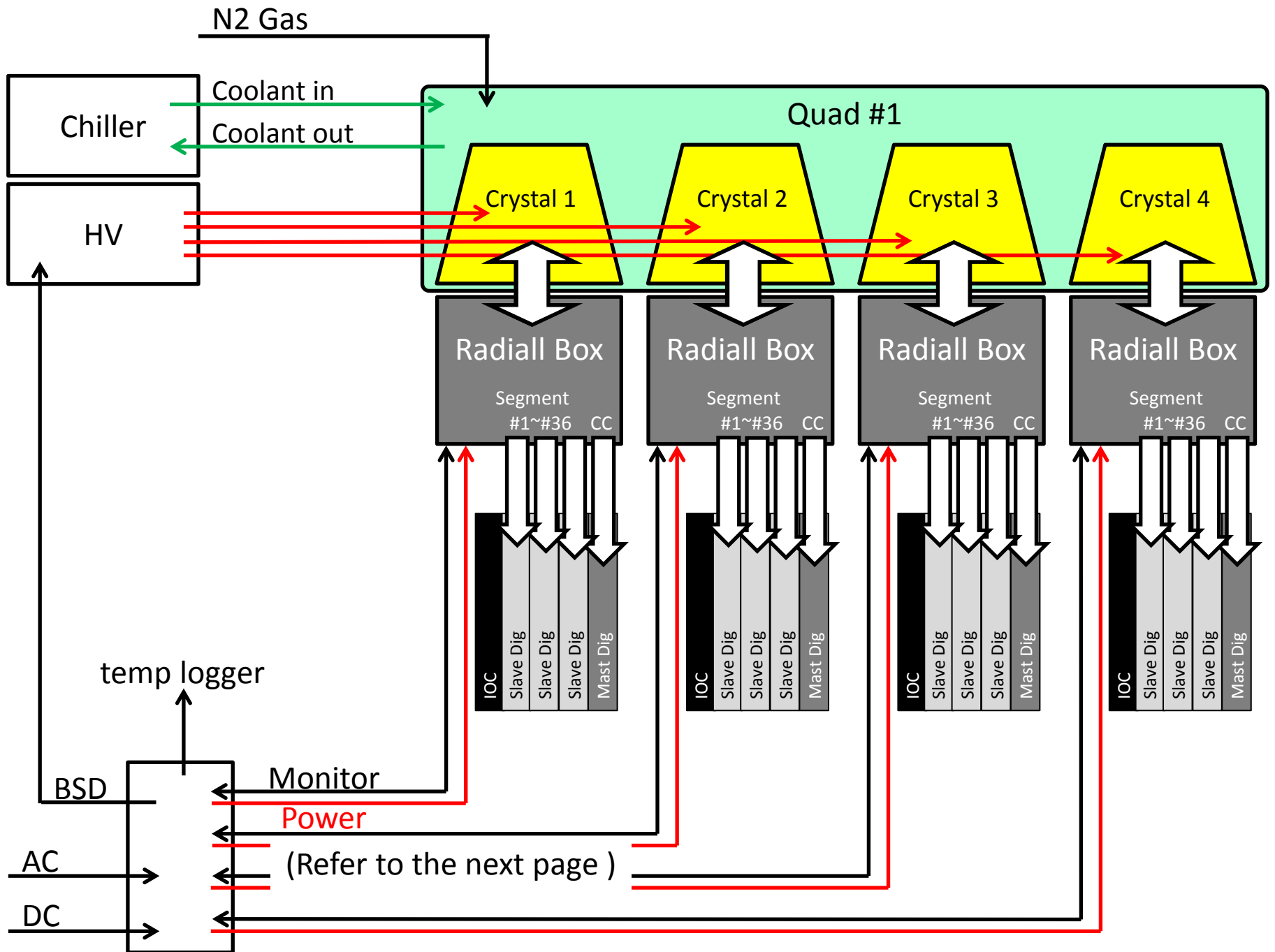
Quad Ge detector

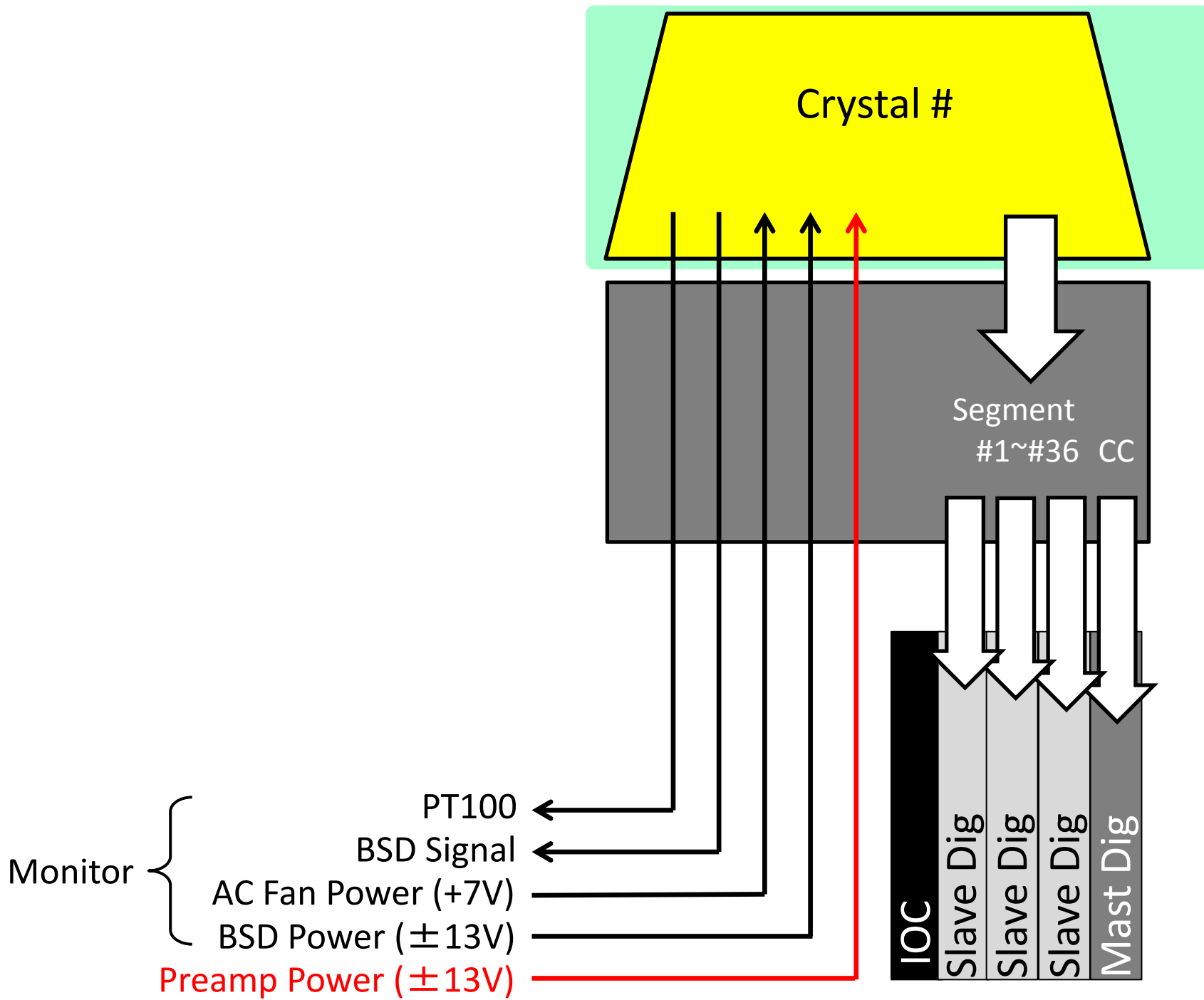
- Same as GRETINA (US Tracking) detector
- N-type HPGe crystal $\times 4$
 - ϕ 80mm \times 90mm
 - 36 segments + central contact(CC) / crystal



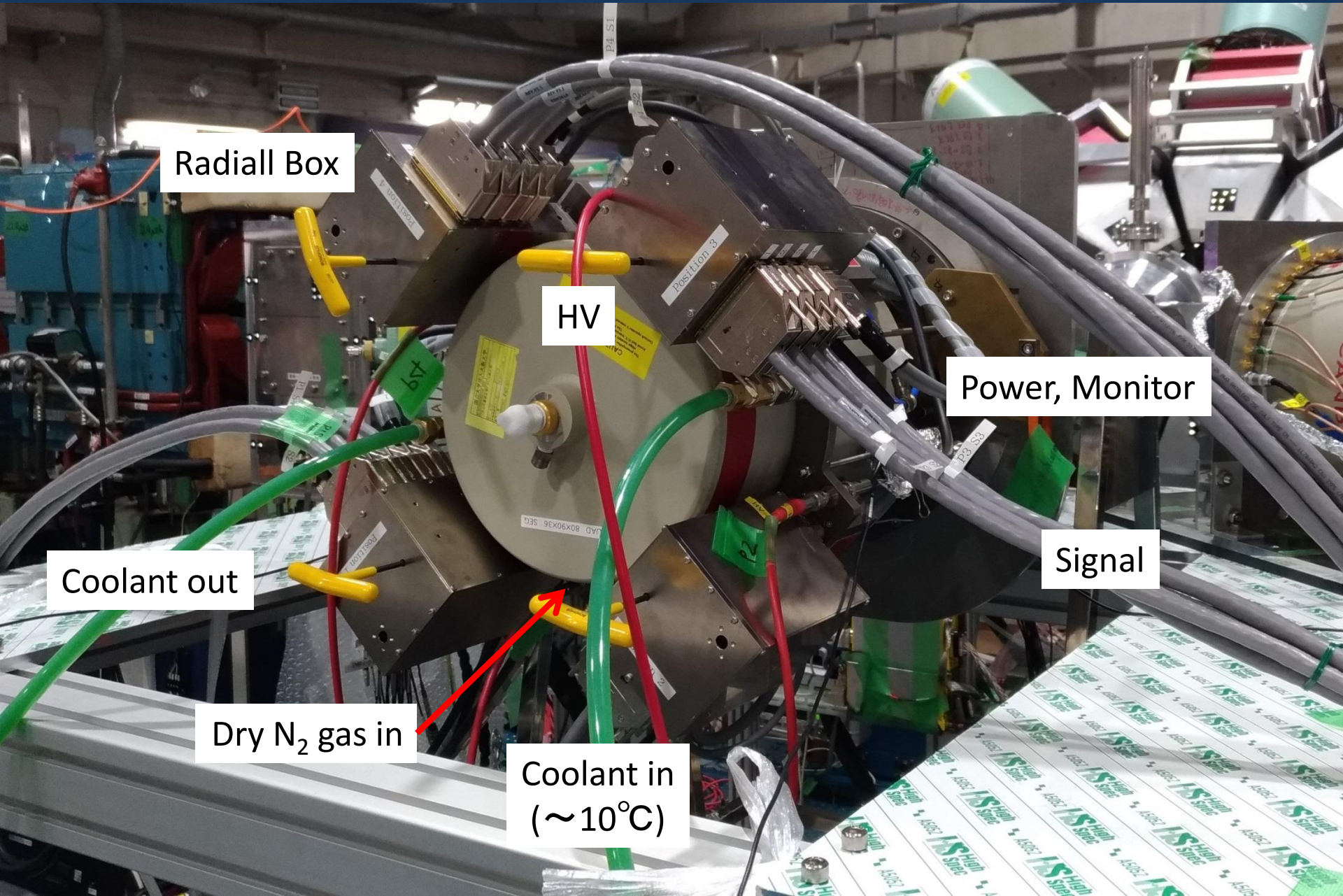
Read out signals from each segment (Cathode)







Quad Ge detector



Radial Box

HV

Power, Monitor

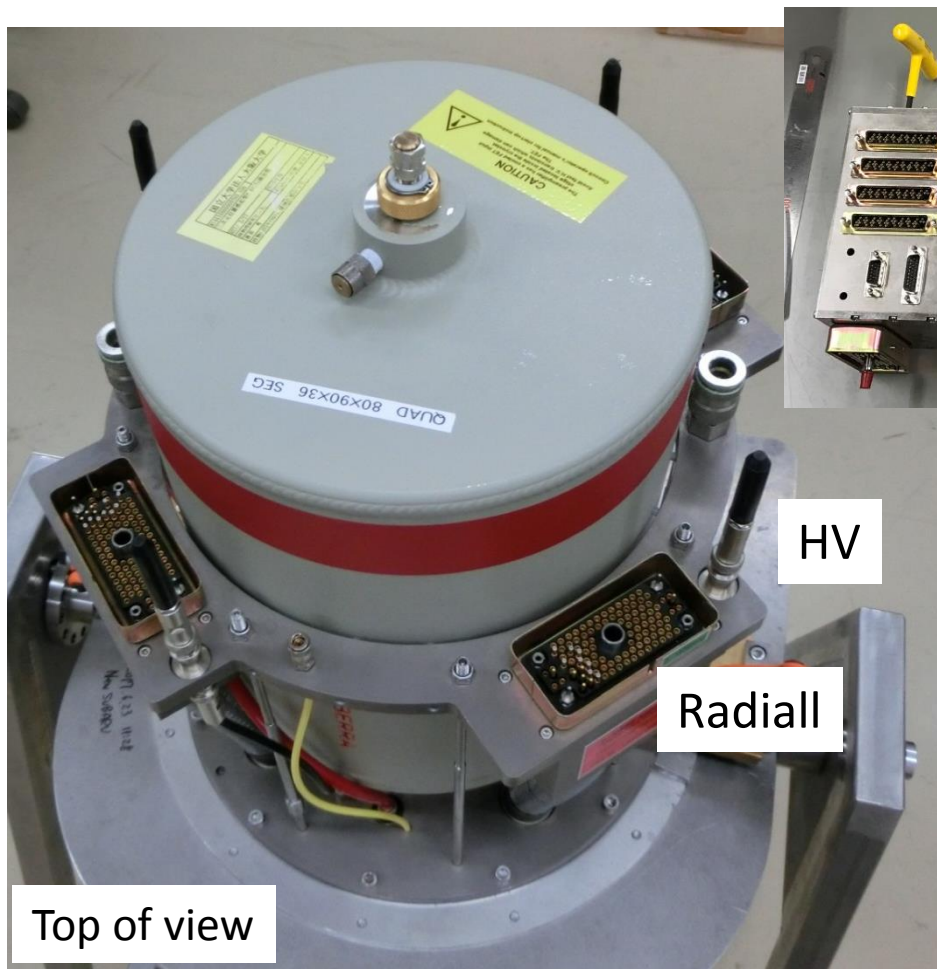
Signal

Coolant out

Dry N₂ gas in

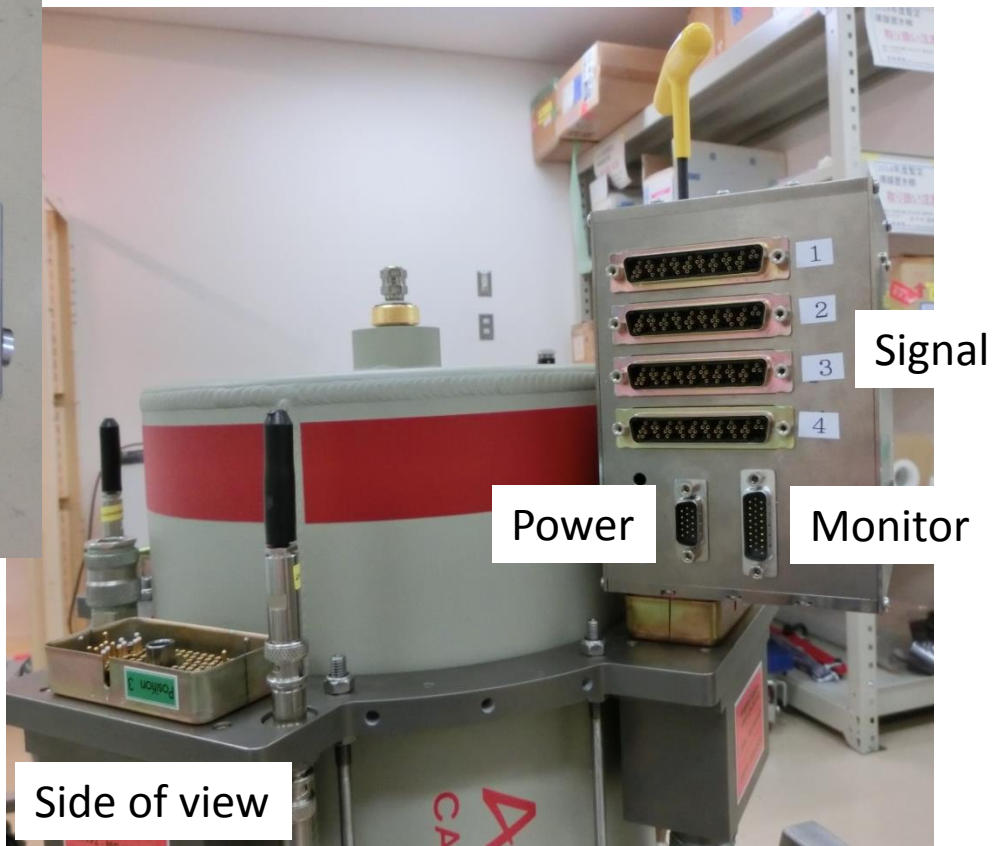
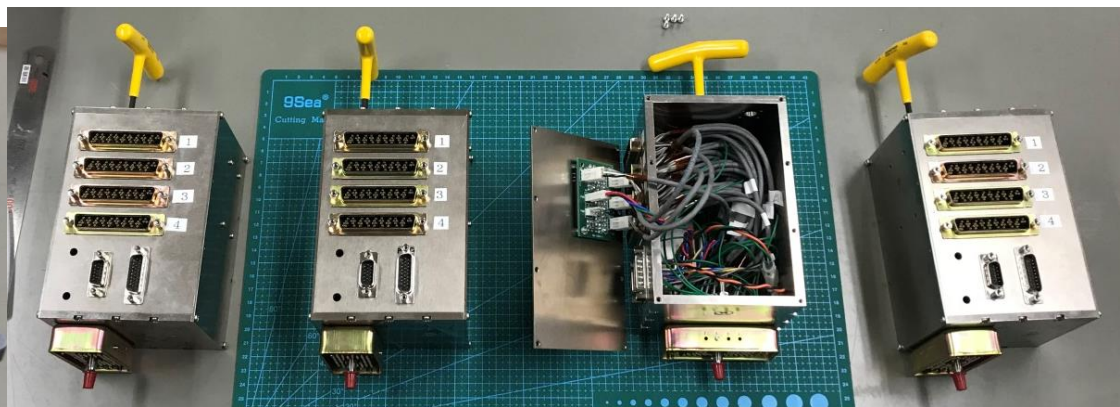
Coolant in
(~10°C)

Radial Box

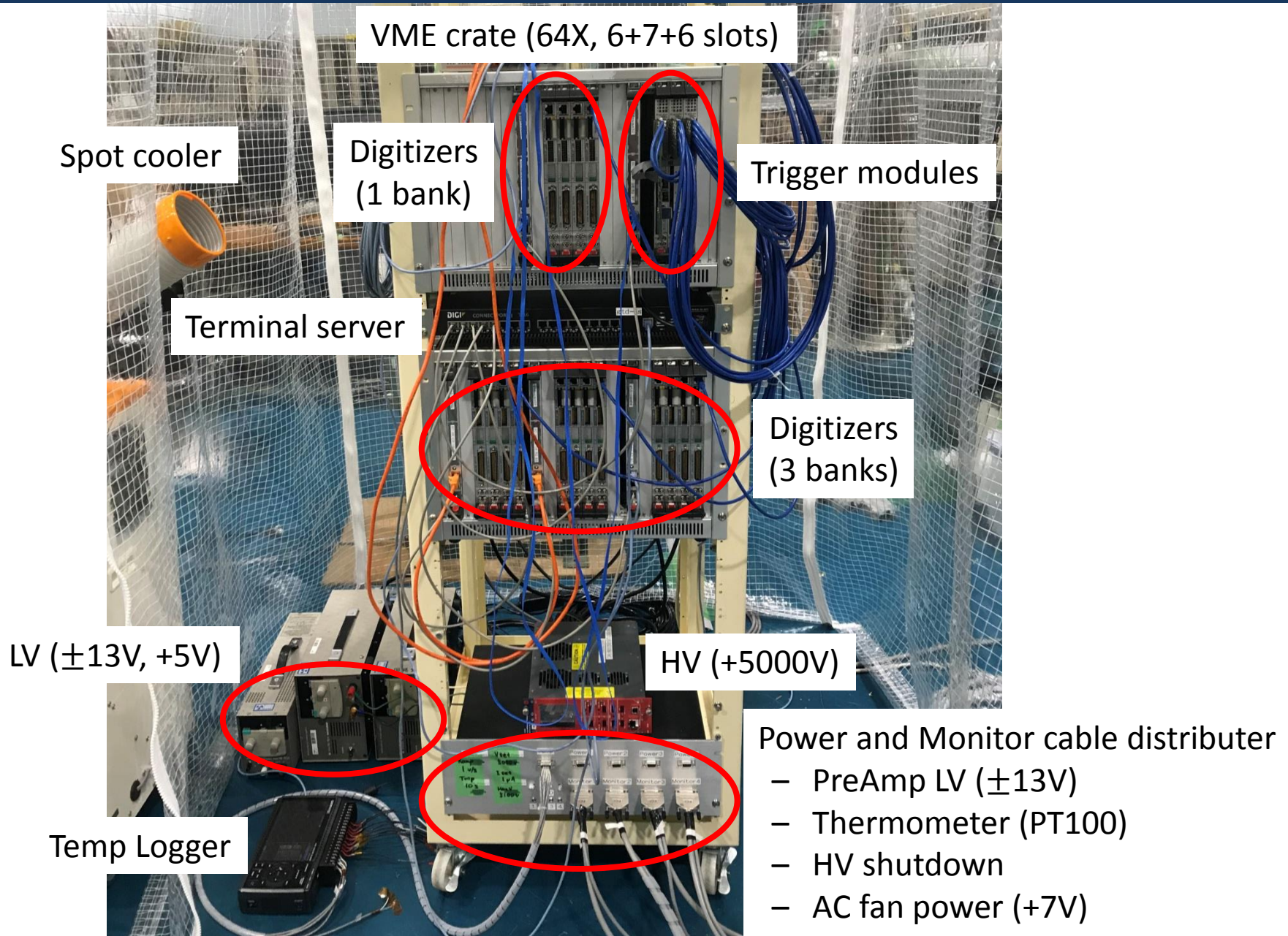


HV

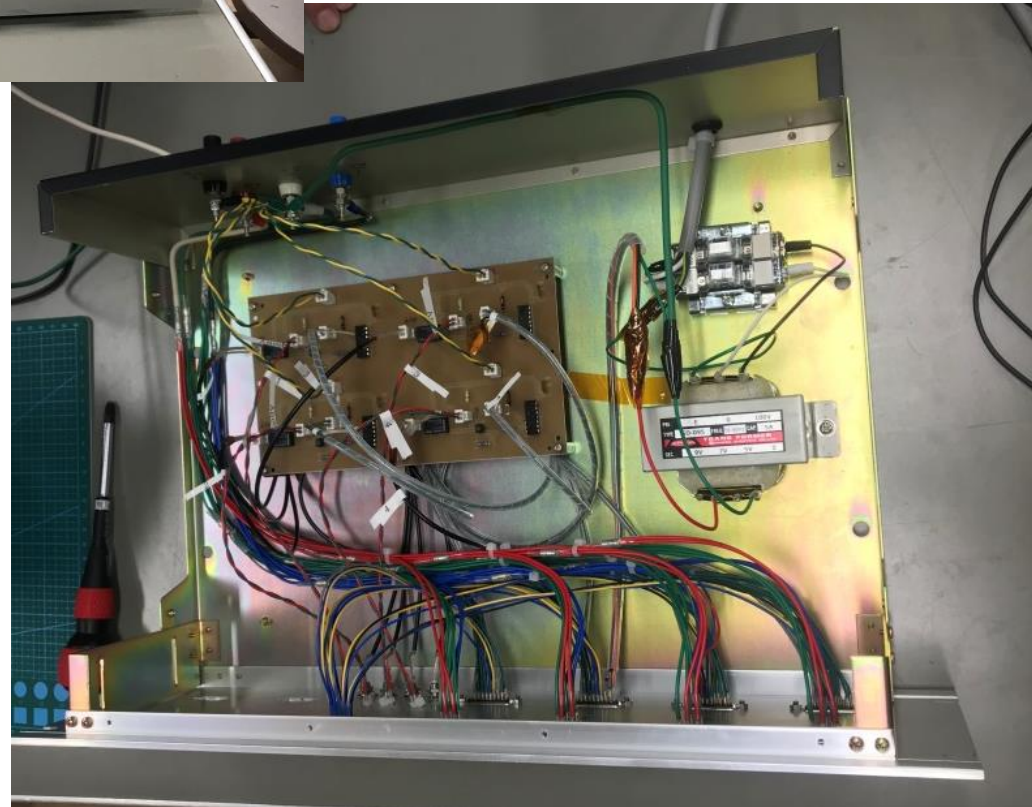
Radial



Electronics for quad Ge detector



Power and Monitor cable distributor



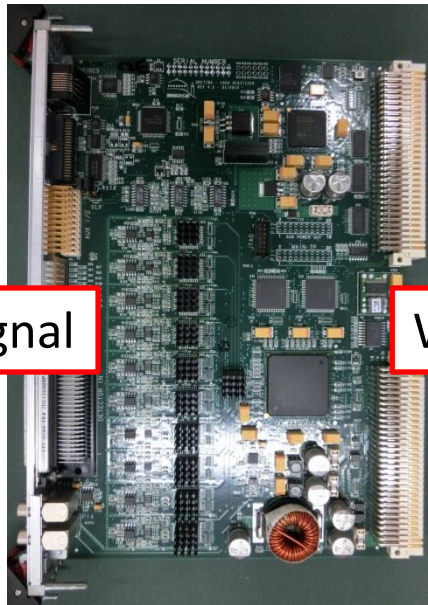
Quad DAQ data flow

Mode3(waveform) data: 16 kB/event
(1 kHz/crystal -> 160 MB/10 crystals·sec)
Mode2(decomposition) data: 480 Byte/event
(1 kHz/crystal -> 5 MB/10 crystals·sec, **150 core**)

Digitize waveform



Analog signal



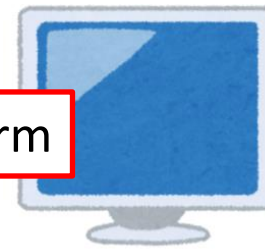
GRETINA Digitizer

(development at LBNL)

- 10 channel (4 modules/crystal)
- Flash ADC ($\pm 1V$, 14bit, 100MHz)
- Energy (trapezoidal filter)
- Leading Edge Timing

Signal Decomposition

Waveform



Computer Cluster

Processing: 2 crystals/4 nodes

(2 processors/node
4 core/processor)

< 15 ms/event (cputime)

Interactions



Computer Room

Experimental Area

VME on-board CPU

IOC 1

VME on-board CPU

IOC 2

VME on-board CPU

IOC 3

VME on-board CPU

IOC 4

node 1

node 2

node 3

node 4

node 5

node 6

node 7

node 8

Event Receiver
(Decomposition nodes)

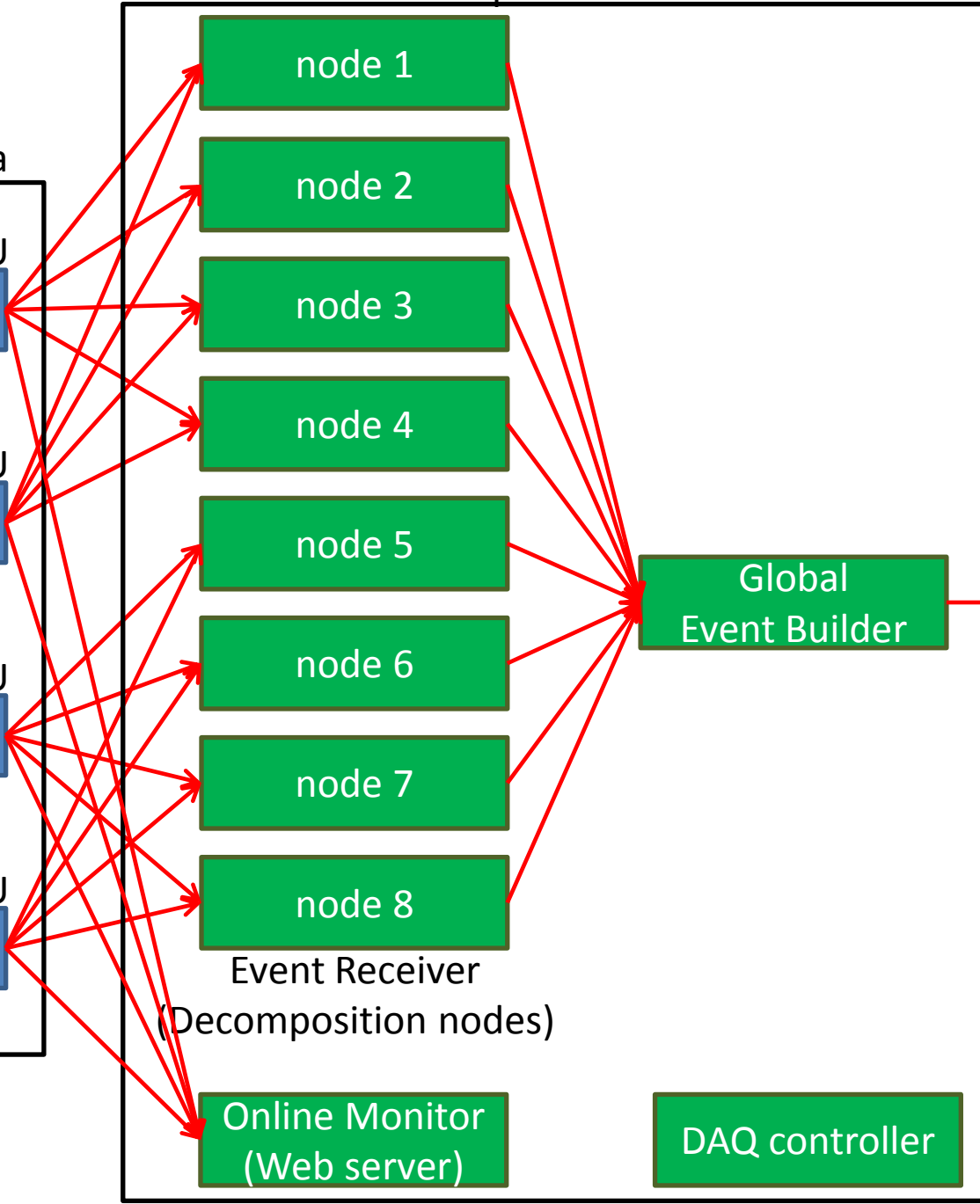
Online Monitor
(Web server)

Global
Event Builder

DAQ controller



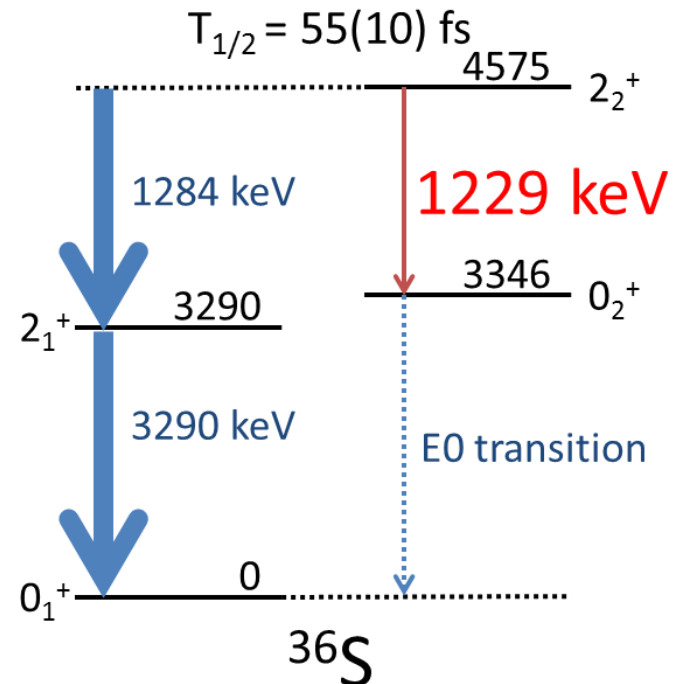
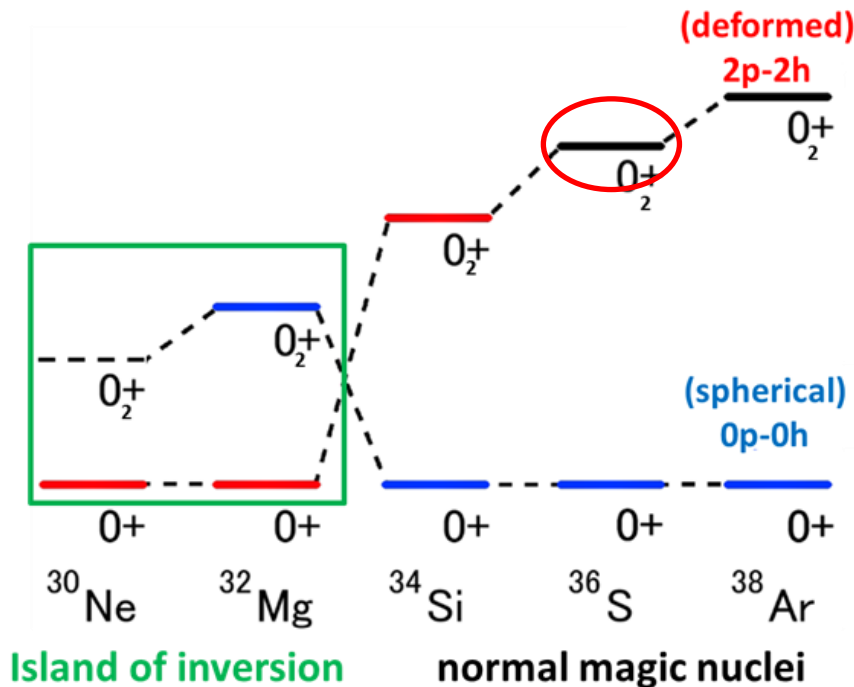
RCNP
general purpose
storage



Physics Experiment

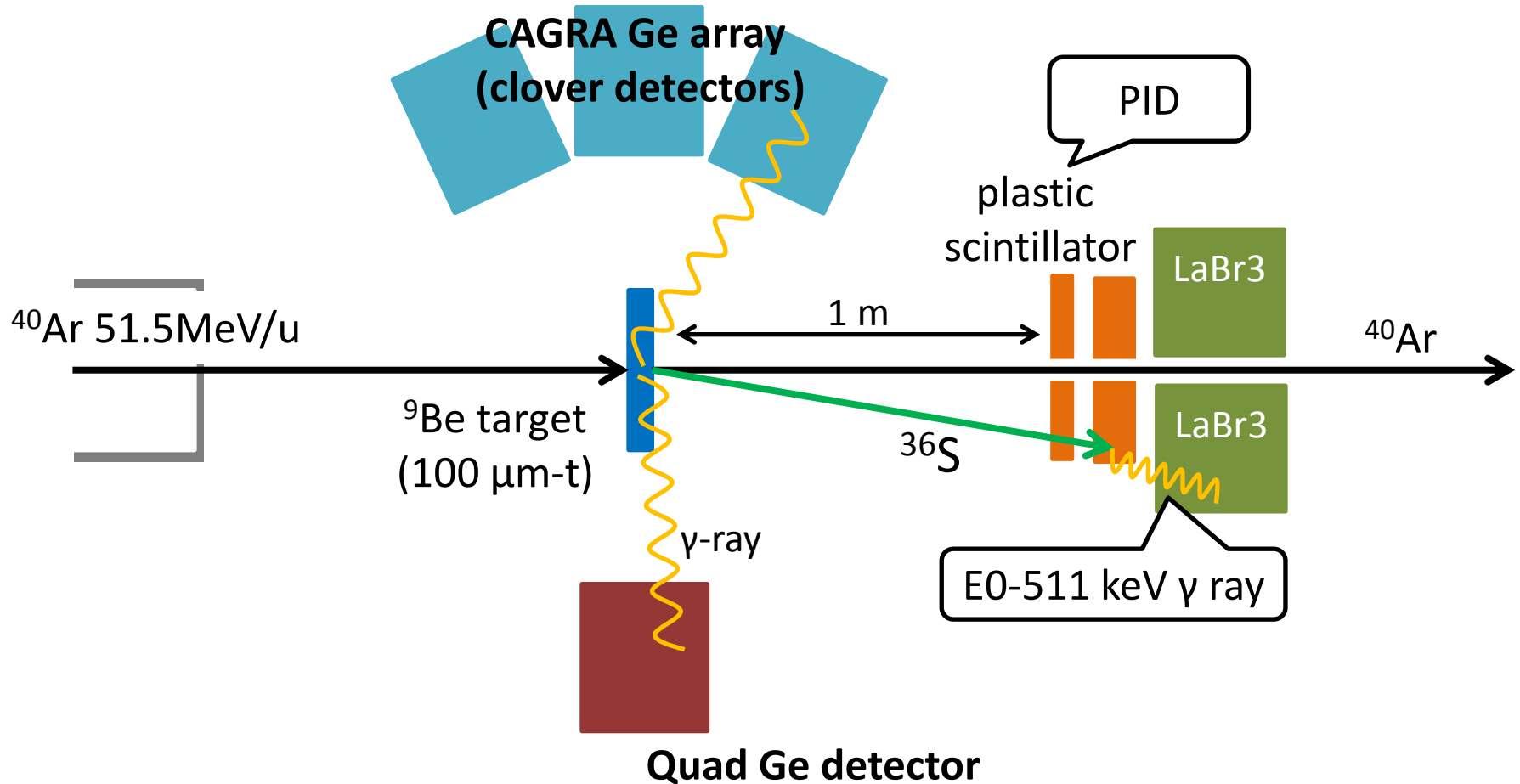
- Physics experiment (E486) using a quad Ge detector at RCNP in December 2018
- Search for the “**non-inverted**” **deformed** state in ^{36}S
 - Explore the mechanism of transition of the ground state into the 2p-2h state from the 0p-0h state
- Measure the branching ratio:

$$R \left(\frac{2^+_{2 \rightarrow 0^+_{2}}}{2^+_{2 \rightarrow 2^+_{1}} \right) \text{ to obtain } B(E2: 2^+_2 \rightarrow 0^+_2)$$

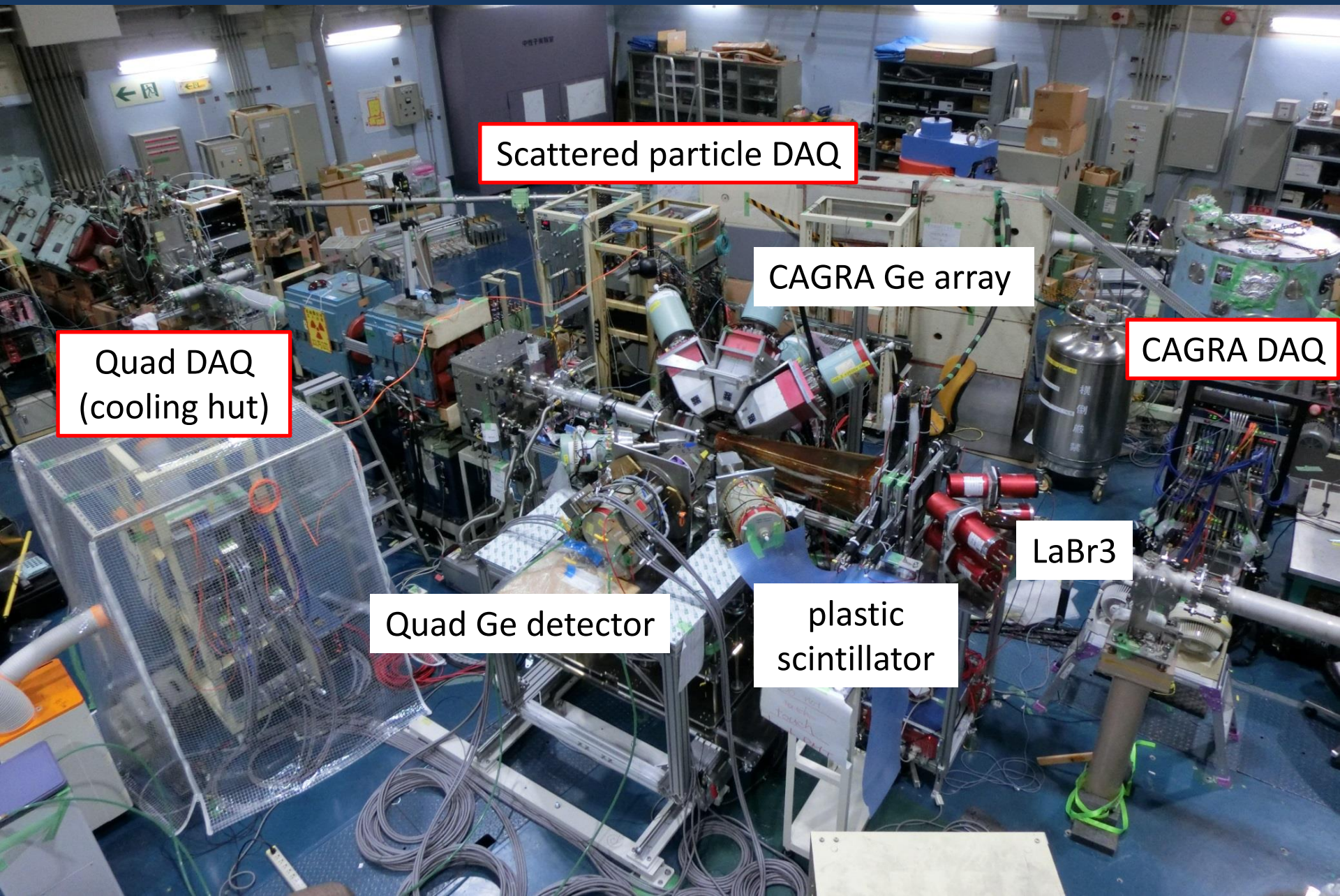


Experimental setup

^{36}S production: projectile fragmentation of ^{40}Ar



Experimental setup



Scattered particle DAQ

CAGRA Ge array

Quad DAQ
(cooling hut)

CAGRA DAQ

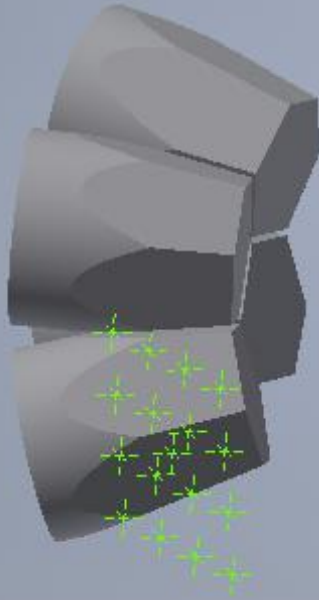
Quad Ge detector

plastic
scintillator

LaBr3

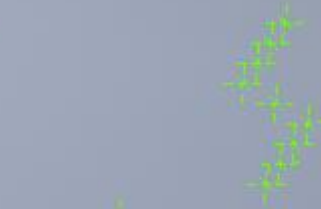
Geometry identification with V-STARS

Quad crystals



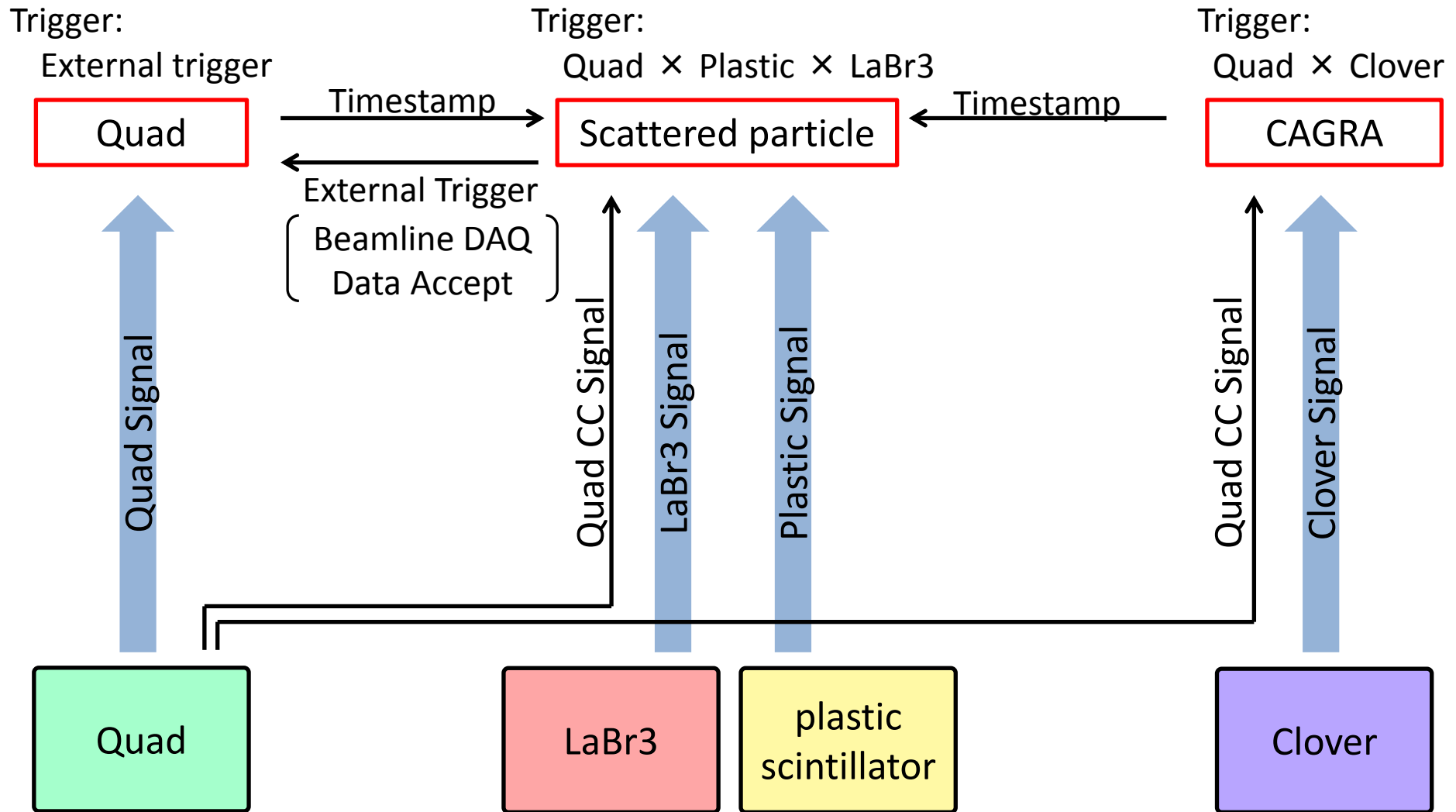
Target

Beam

A red arrow originates from the top right and points towards the blue square target. Another red arrow originates from the bottom left and points towards the blue square target.

center point of
each segment region
(CAGRA)

Experimental DAQ system block diagram



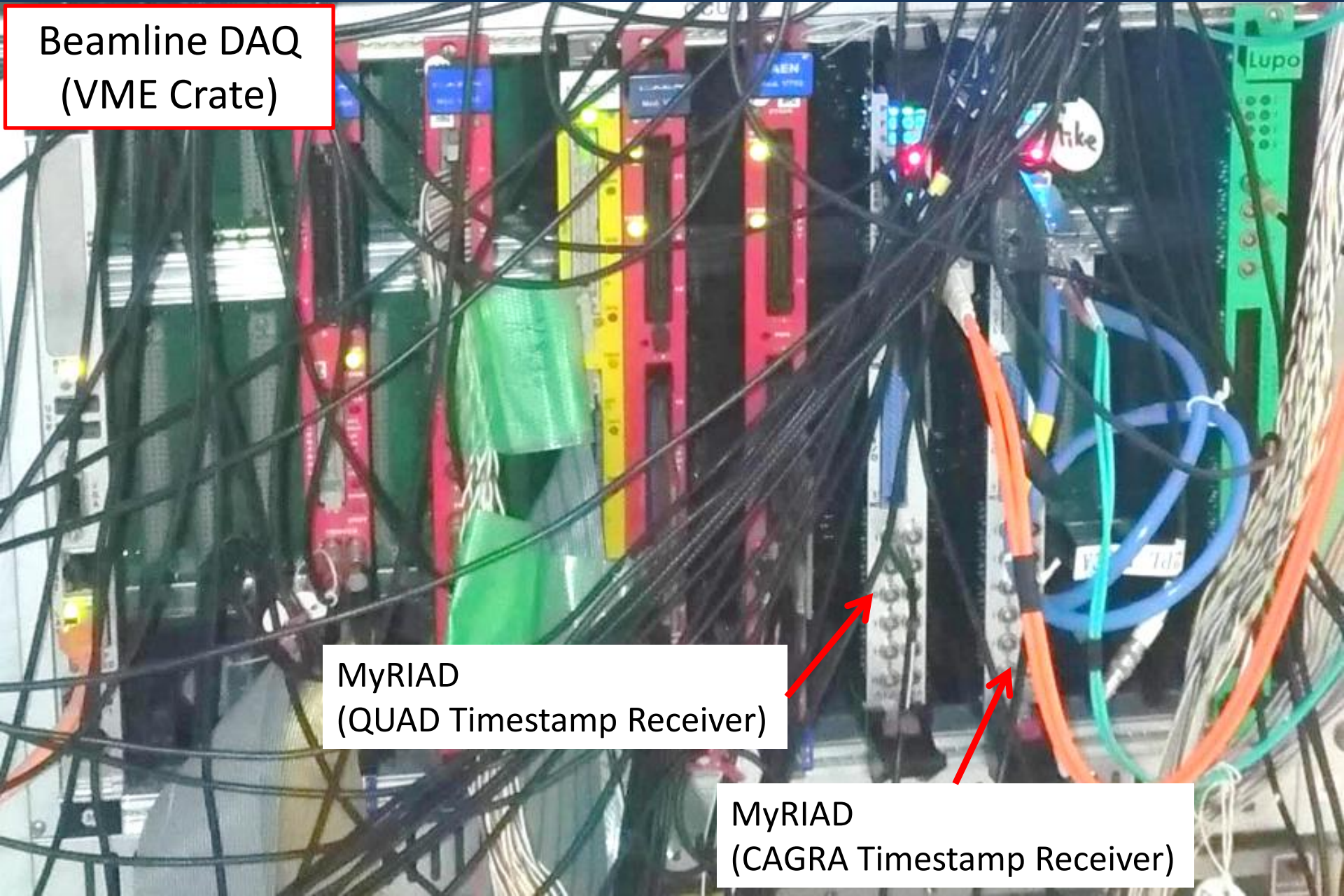
Quad DAQ gamma-OR < 1 μ s (CPLD)
CAGRA DAQ gamma-OR < 10 μ s (TTCS)

Experimental DAQ system block diagram

Beamline DAQ
(VME Crate)

MyRIAD
(QUAD Timestamp Receiver)

MyRIAD
(CAGRA Timestamp Receiver)



Summary

- Have finished construction of Gamma-ray tracking (GRETINA) detector system at RCNP
- Search for the “non-inverted” deformed state in the magic nuclei ^{36}S
 - Measure the branching ratio in order to obtain the $B(E2: 2^+_2 \rightarrow 0^+_2)$

Acknowledgement

GRETINA/GRETA collaboration

In particular

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CAGRA collaboration