R & D of
Tohoku reactor monitor Ⅱ

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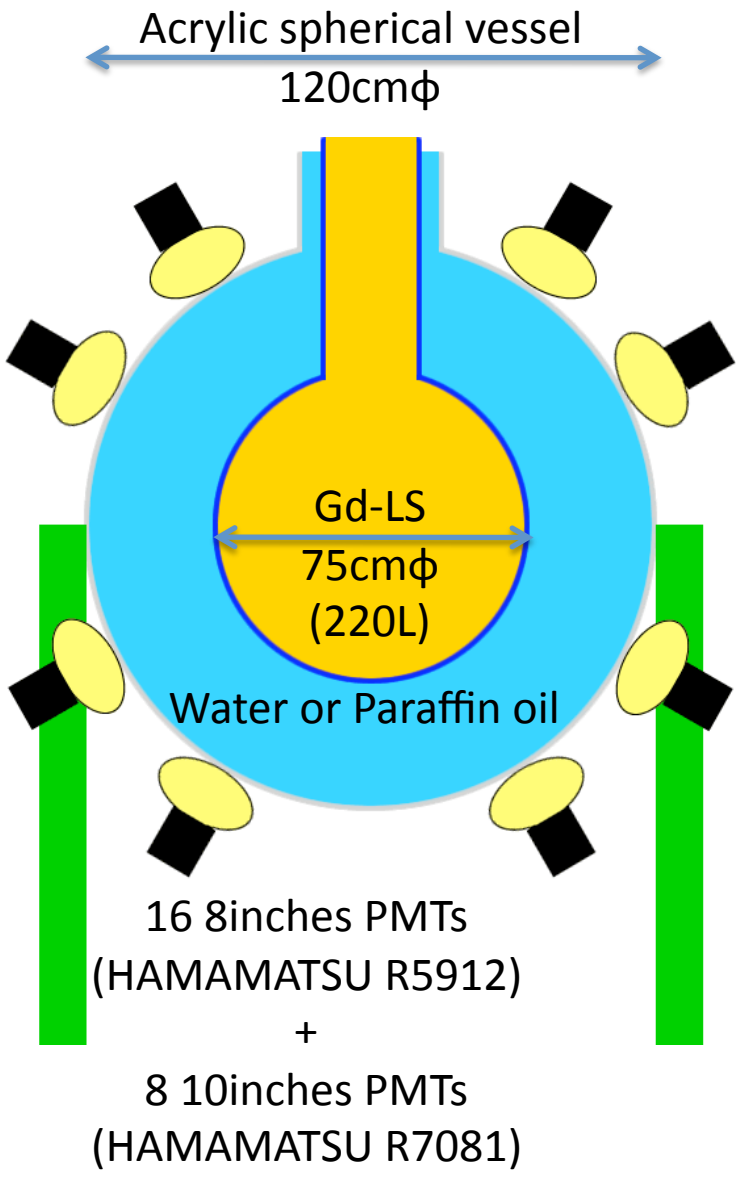
Contents

The upgraded detector design (plan)



Joyo detector

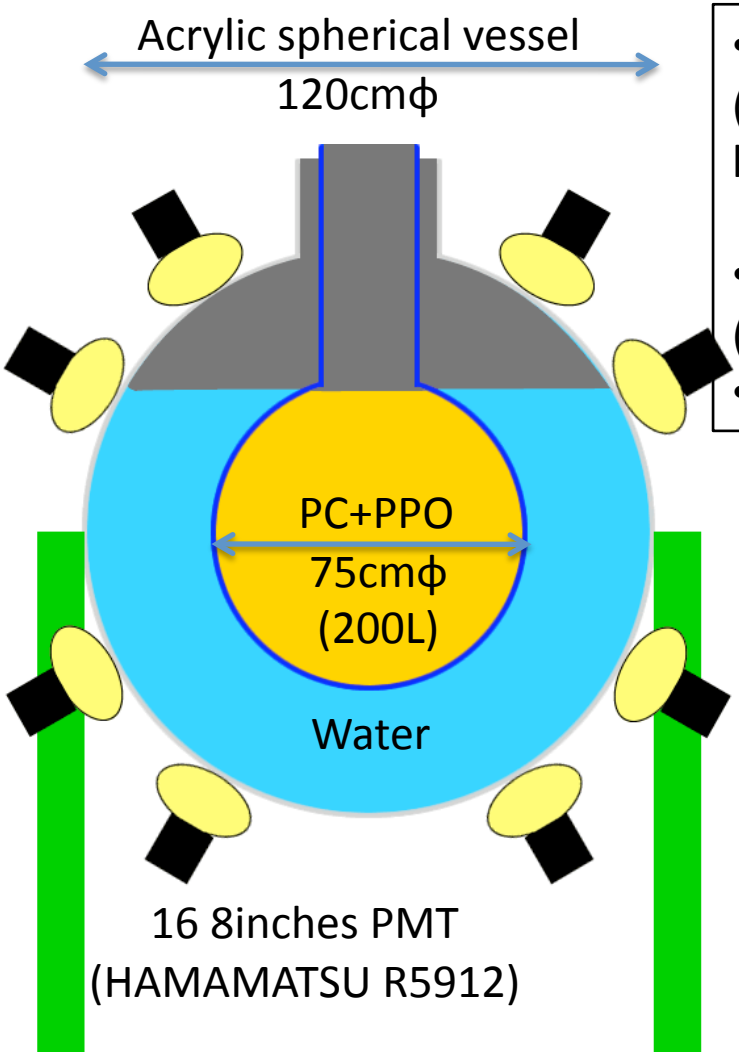
- The whole volume was filled with the Gd-LS(900L)
- **16 8inches PMT** (isotropic)
- Gd-LS (0.05w%)(only target layer)
  (BC521(10w%) + **PC(15w%)** + Paraffin oil(75w%))
- Cosmic veto counters(Top and sides)
- Paraffin blocks(10cm thickness)

The upgraded detector

- Target and buffer layer
  (Add a glass flask (75cmϕ))
- Gd-LS (~0.05w%) with PSD ability
  (BC521(~10w%) + **PC(~90w%)**)
- Buffer layer(22cm thickness)
  (Paraffin oil)
- Add 8 10inches PMTs
- Data taking with Flash ADC(for PSD)
- No cosmic veto counter
- No shields

Current status of the construction

Installation of the glass flask is complete.
16 8inches PMTs were mounted on the acrylic vessel.



The current detector condition

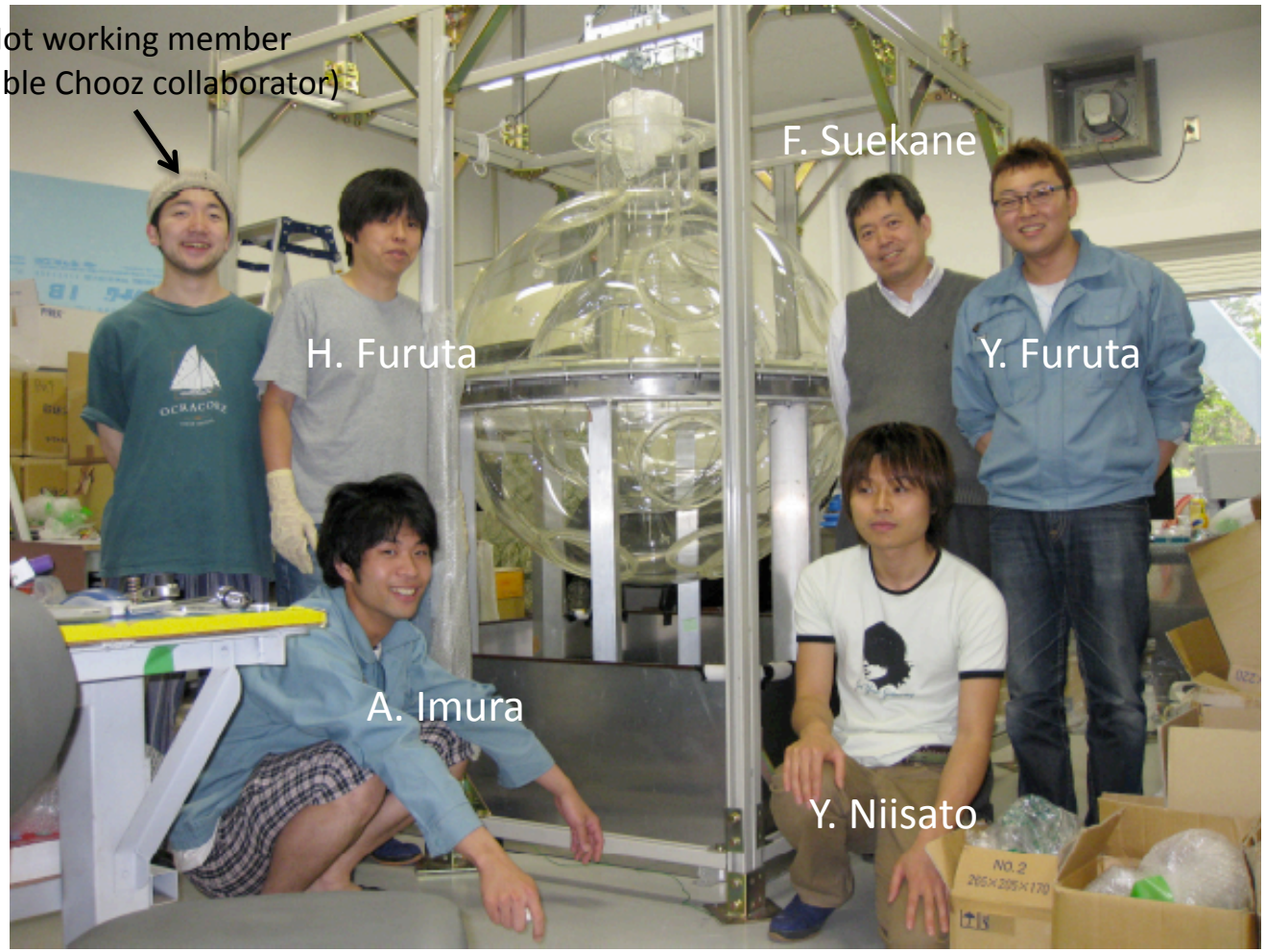
- Target layer: PC(100w%)+PPO(3g/L)
(Target volume has been filled with PC (200L) because of a limitation of the storage volume by fire lows,
-> under application for increase of the storable volume)
- Buffer layer: Water
(The liquid level is same as the target layer)
- Measurable with Flash ADC modules.

-> Checking response of the detector and the PSD ability with radioactive sources (^{60}Co, ^{241}Am^{9}Be, ^{252}Cf) are ongoing.

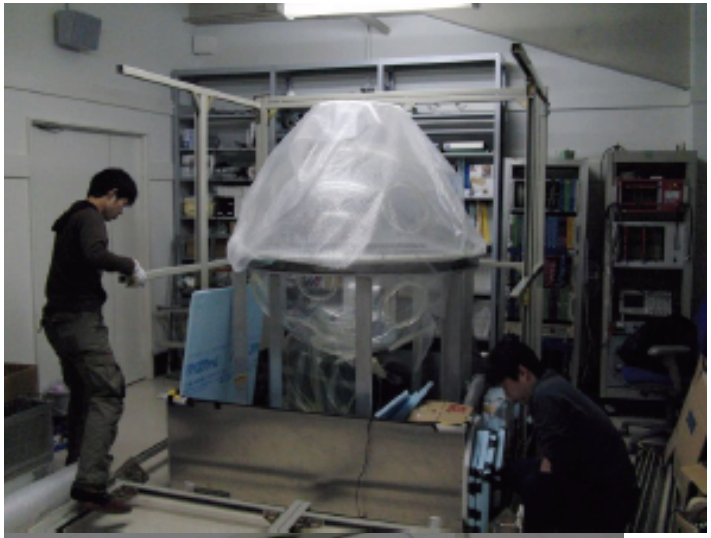
Other activities

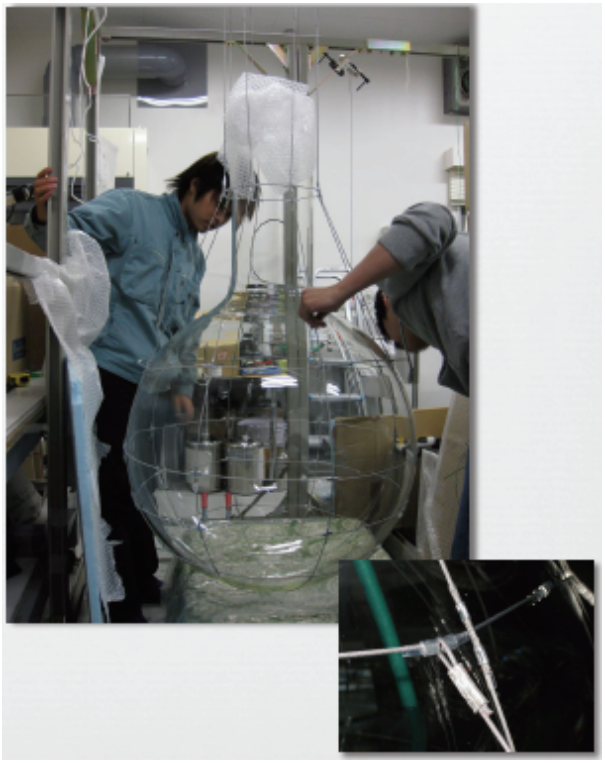
- Aging test of Gd-LS
- Development of an online monitoring system
- Development of MC simulator

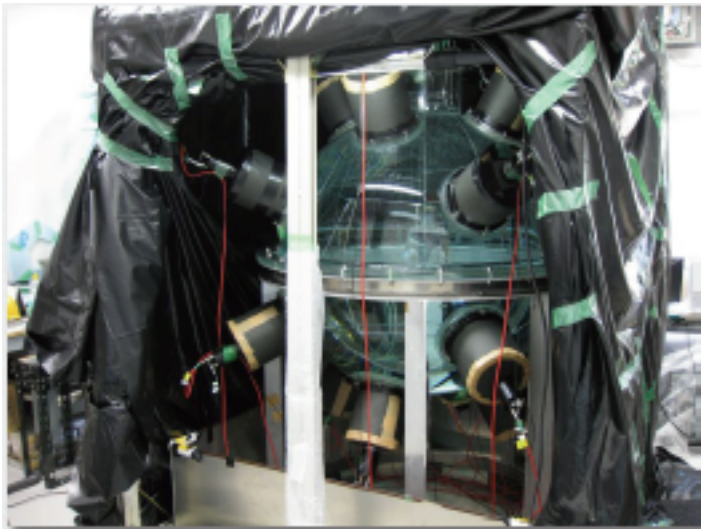
Working members for Tohoku reactor monitor



View of the detector construction



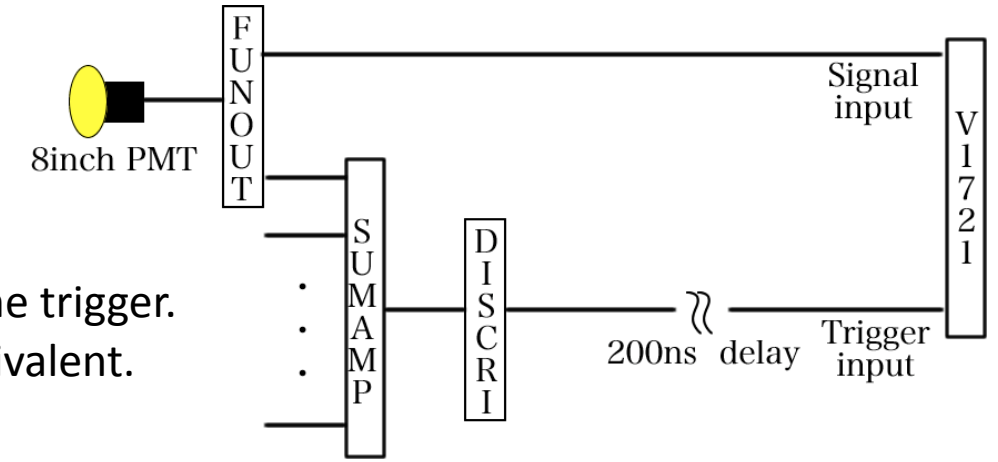




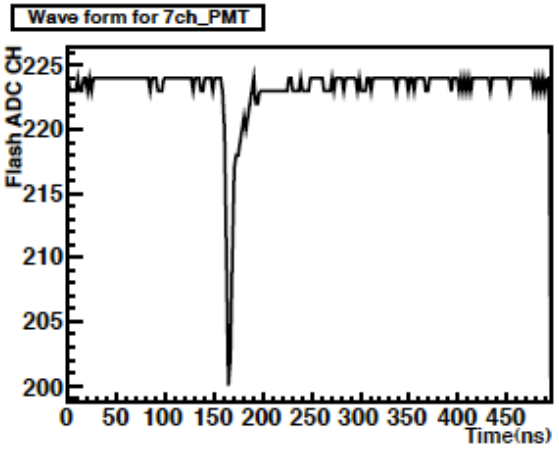
Data taking with Flash ADC

CAEN V1721×2 (PMT 16ch)

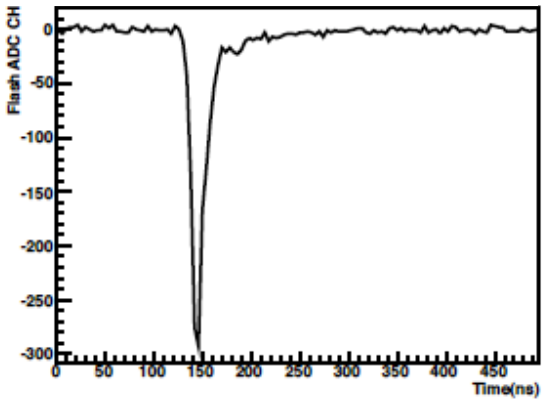
500MS/s
8bit (4mV/FlashADC_ch)



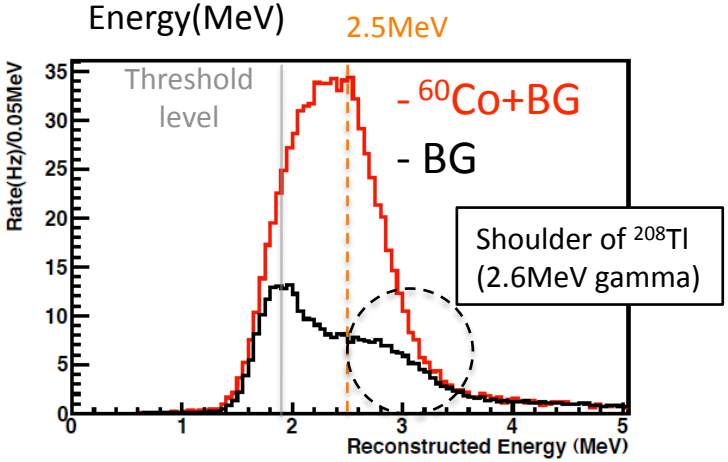
Sum pulse shape for all PMTs is used for the trigger.
Current threshold level is about 2MeV equivalent.
(The BG rate is 450Hz)



Sum of pulse shapes for all PMTs



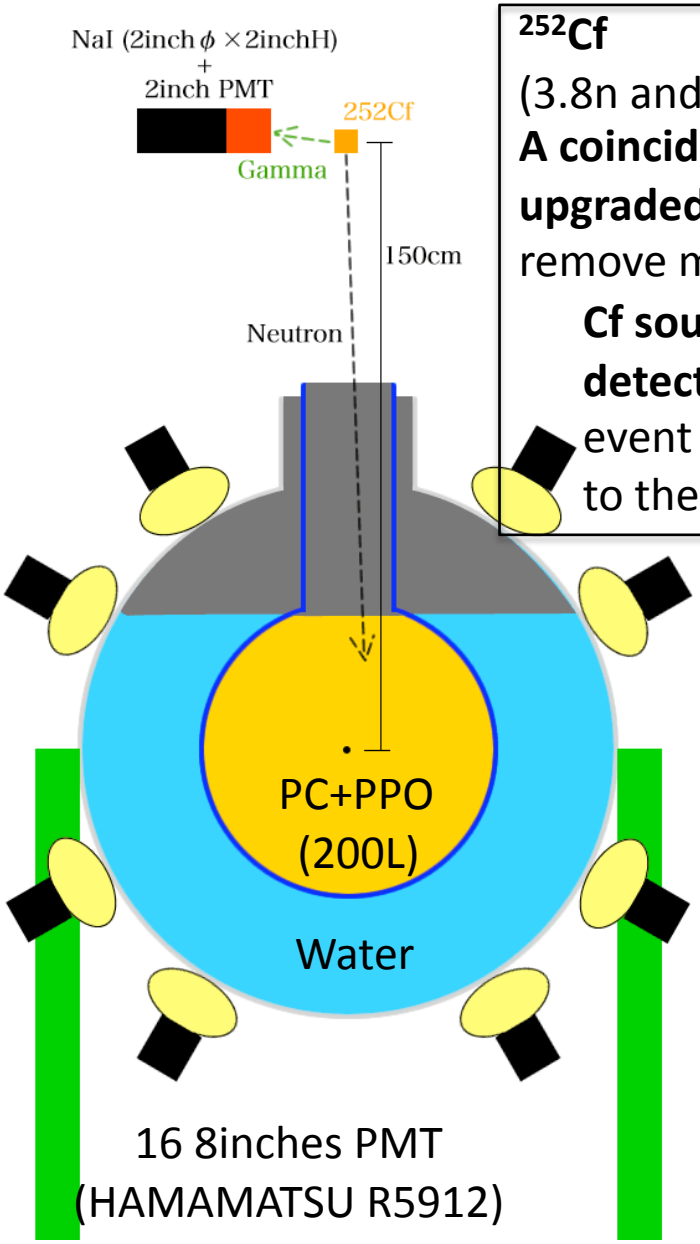
Reconstructed Energy(MeV)



Now the energy scale has been calibrated roughly with 2.5MeV peak of the total charge distribution for the ^{60}Co source data.

Test of the PSD ability (ongoing)

Setup



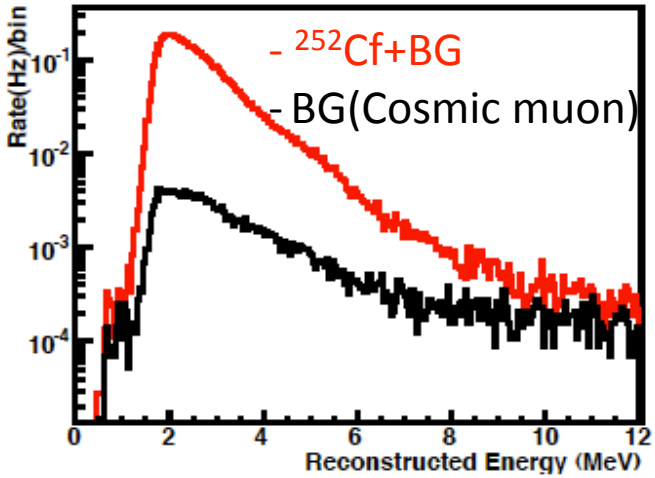
^{252}Cf

(3.8n and 9.7gamma per fission)

A coincidence trigger with the upgraded detector and NaI (To remove much BG)

Cf source is set away from the detector because of decreasing event such as gamma and n hit to the LS at the same time.

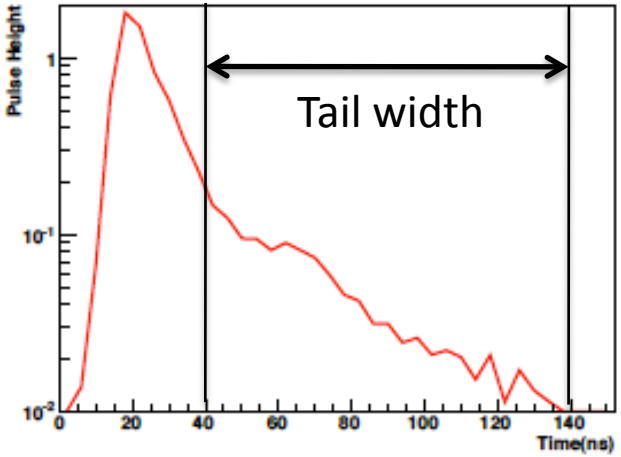
Energy spectra with the coincidence trigger



Check Tail_Q /Total_Q

1. Compare with ^{60}Co data
(emit only gamma, 1.17 and 1.33MeV)
2. Compare with Cf data with Paraffin block for neutron rejection.

Sum pulse shape inverted to the positive

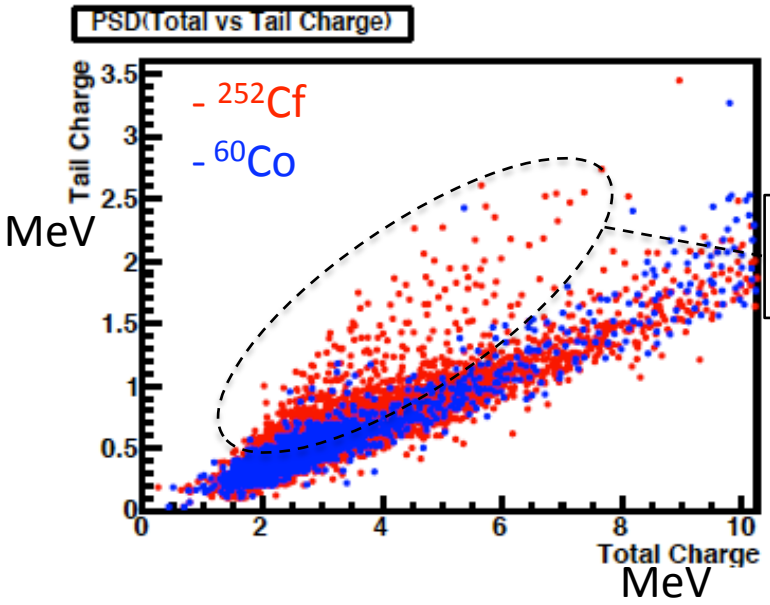


Evaluation of the PSD ability

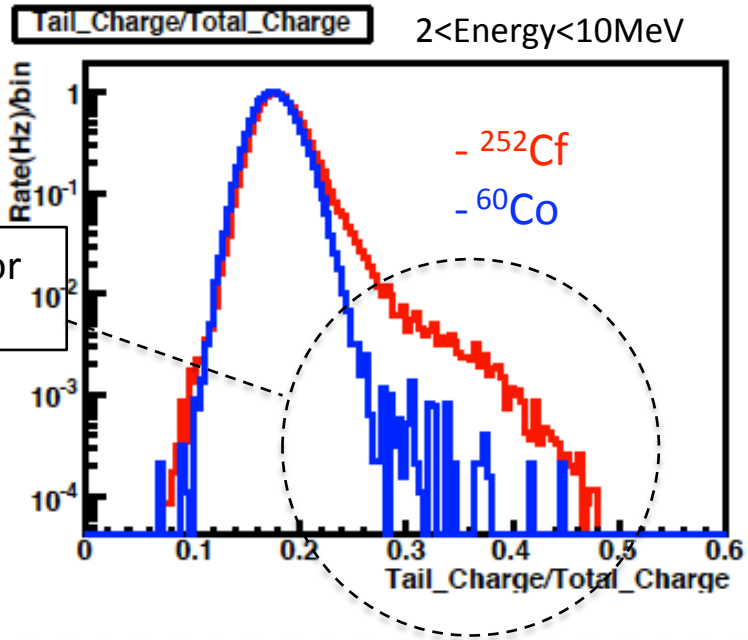
Calculate n/γ cut efficiency with the distribution of Tail_Q /Total_Q

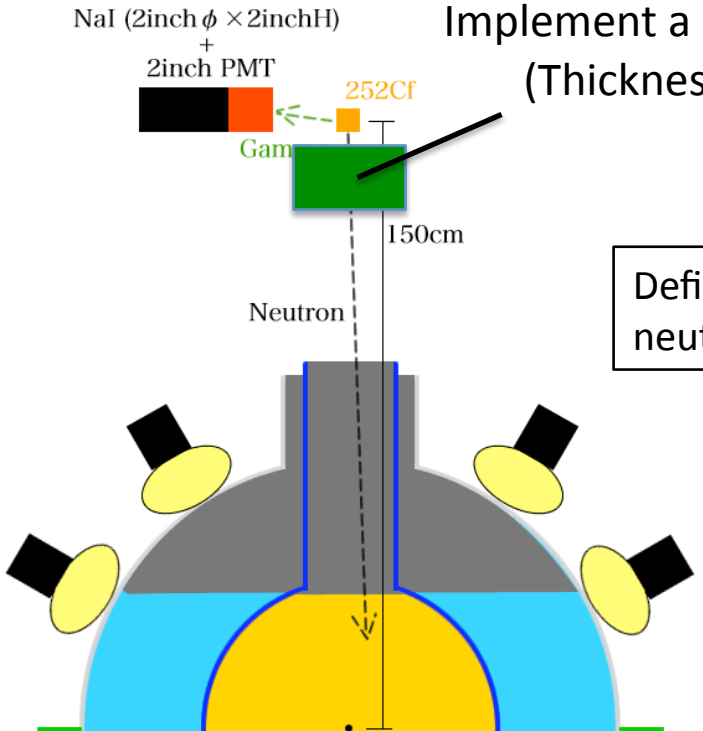
Test of PSD ability

Comparison of the ratios of tail and total charges with ^{60}Co (gamma) and ^{252}Cf(n+gamma)



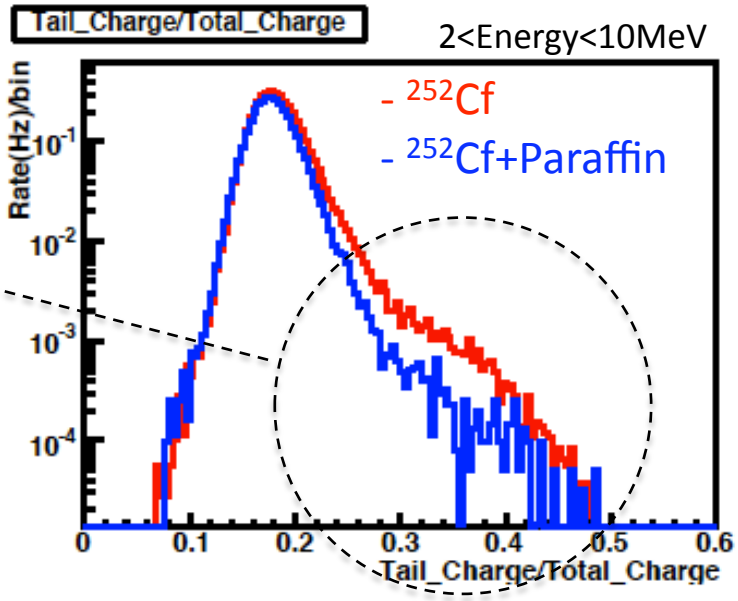
One more peak for neutron emerges





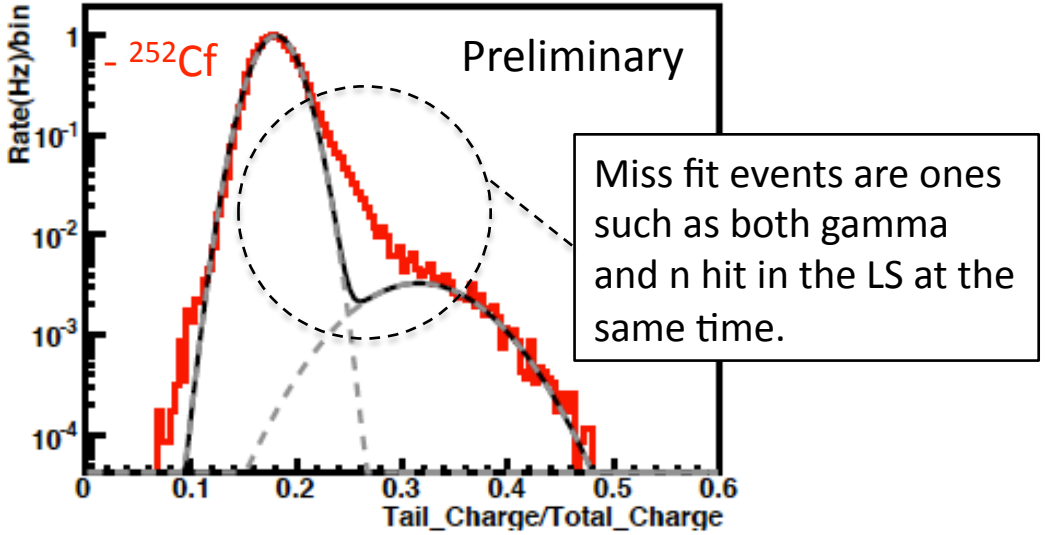
Implement a paraffin block (Thickness of 8cm)

Deficit of the neutron peak.

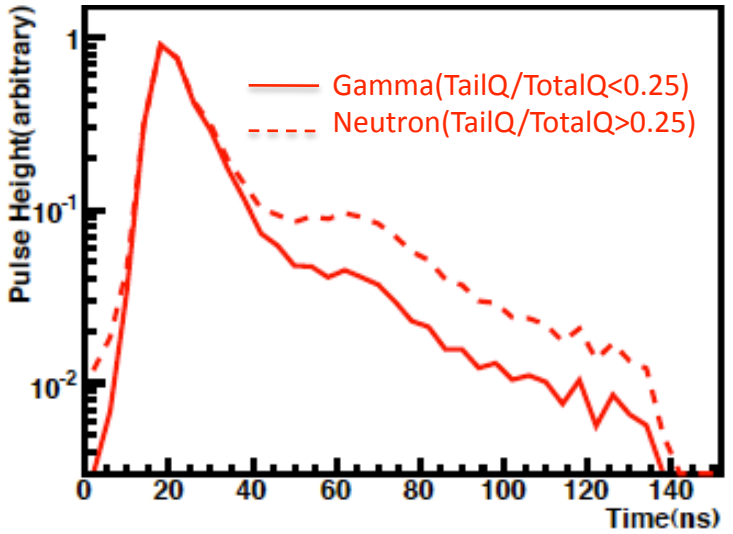


Cut efficiency for Gamma and Neutron events

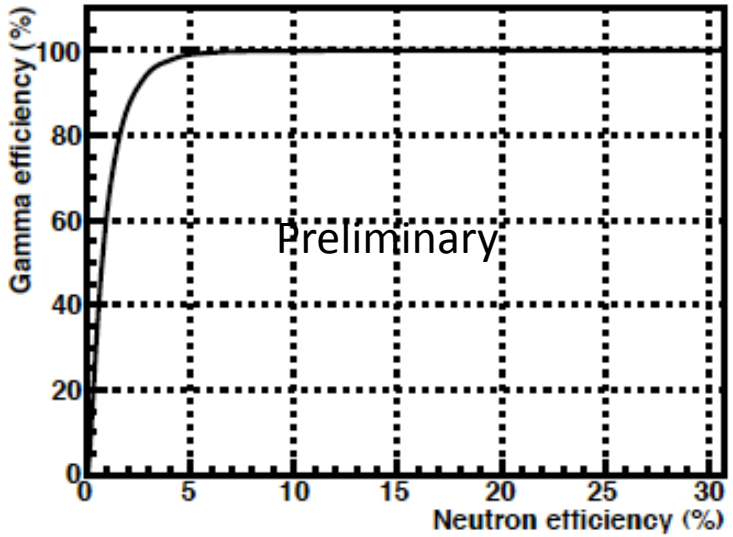
Fit roughly to TotalQ/TailQ distribution with 2 Gaussian curves



Mean sum pulses for gamma and n candidates



The cut efficiency curve with the upgraded detector



In case that target LS is PC100%, the S/N improvement is estimated to be 20 times with keeping the signal efficiency.

Even if considering that implement of Gd cause to decrease of the PSD ability, we can expect that the new Gd-LS is used enough for neutron BG rejection.

Future plan

1. Define Gd concentration for the new Gd-LS (~0.05w%) considering with …
   Neutron capture efficiency, Neutron capture time, PSD ability and Cost.

2. Fill the Gd-LS and buffer oil in the target and buffer layers, respectively.

3. Measure BG at RCNS with the upgraded detector and tune the MC simulator.
-> Evaluate the neutrino detection ability of the detector by combining the BG data and the MC simulation.

We hope to measure neutrinos with the upgraded detector in MONJU site.
(Thermal power of MONJU is 714MW)

Summary

- Now we are constructing the new Gd-LS detector and the preliminary data taking.
- Evaluation of the PSD ability with the new Gd-LS detector is ongoing.
- The new Gd-LS can be expected to have high neutron BG rejection.
- We need more preparation for neutrino detection.

(complete of the construction, the MC tuning and BG measurement at RCNS)

We hope to measure neutrinos from MONJU with the new Gd-LS detector!