Research and Development of LAMPS starting counter

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CENuM workshop

6th July 2020

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Motivation

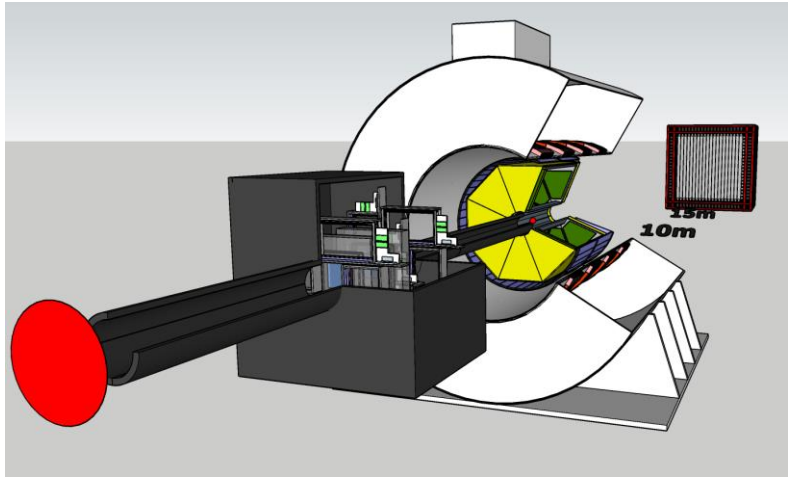
- LAMPS (Large Acceptance Multi-Purpose Spectrometer) is a detector system for studying the nuclear symmetry energy at RAON (Rare Isotope Accelerator Complex for On-line experiments)

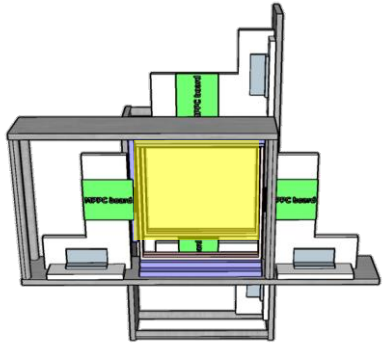
- Starting counter is used as a beam trigger detector for LAMPS.

- Starting counter is made of a thin scintillator and MPPC sensor. The scintillator should cause as little loss of beam energy and produce as many photons as possible.
  - ▸ we made a starting counter using thin scintillator ($0.2\mathrm{mm}$) and veto counter using thick scintillator ($5\mathrm{mm}$)

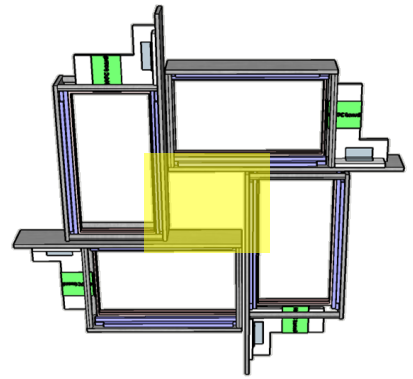
- For avoiding magnetic field effect, we use MPPC(Multi-Pixel Photon Counter) sensor instead of PMT.

- To perform the role of the trigger of LAMPS well, the starting counter must have good timing resolution (~ $100\mathrm{ps}$)





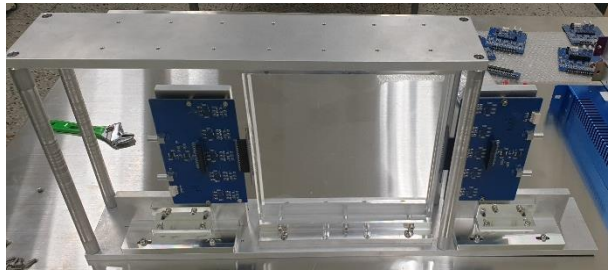
▲ starting counter

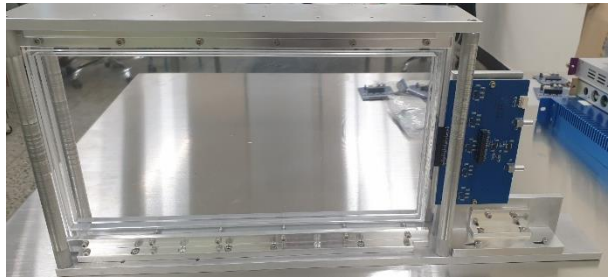


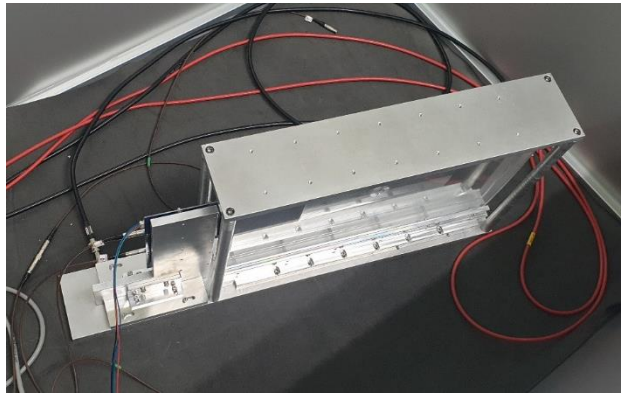
▲ veto counter

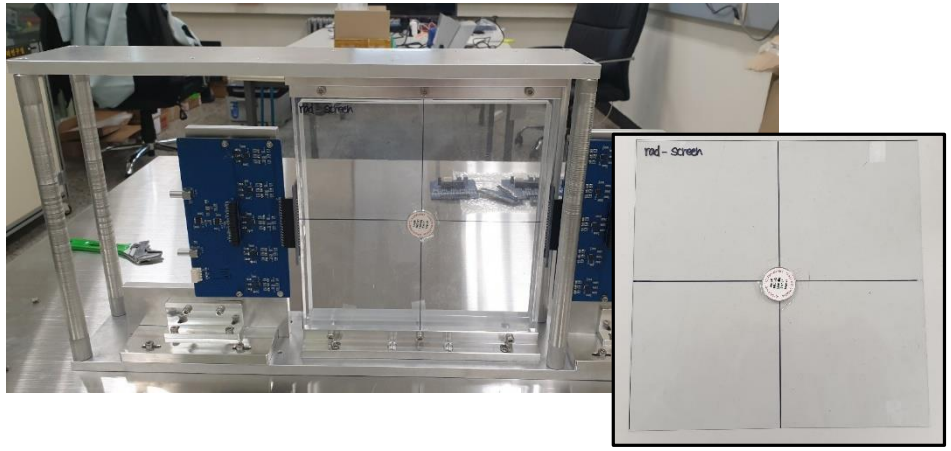
Set up

- The scintillator of a starting counter is $200\text{mm} \times 200\text{mm} \times 0.2\text{mm}$ in size
- The scintillator of a veto counter is $400\text{mm} \times 200\text{mm} \times 5\text{mm}$ in size
- For blocking light, an experiment was conducted in a dark box.
- We used Am-241 source instead of Cosmic muon since the signal size of the cosmic muon is too low.

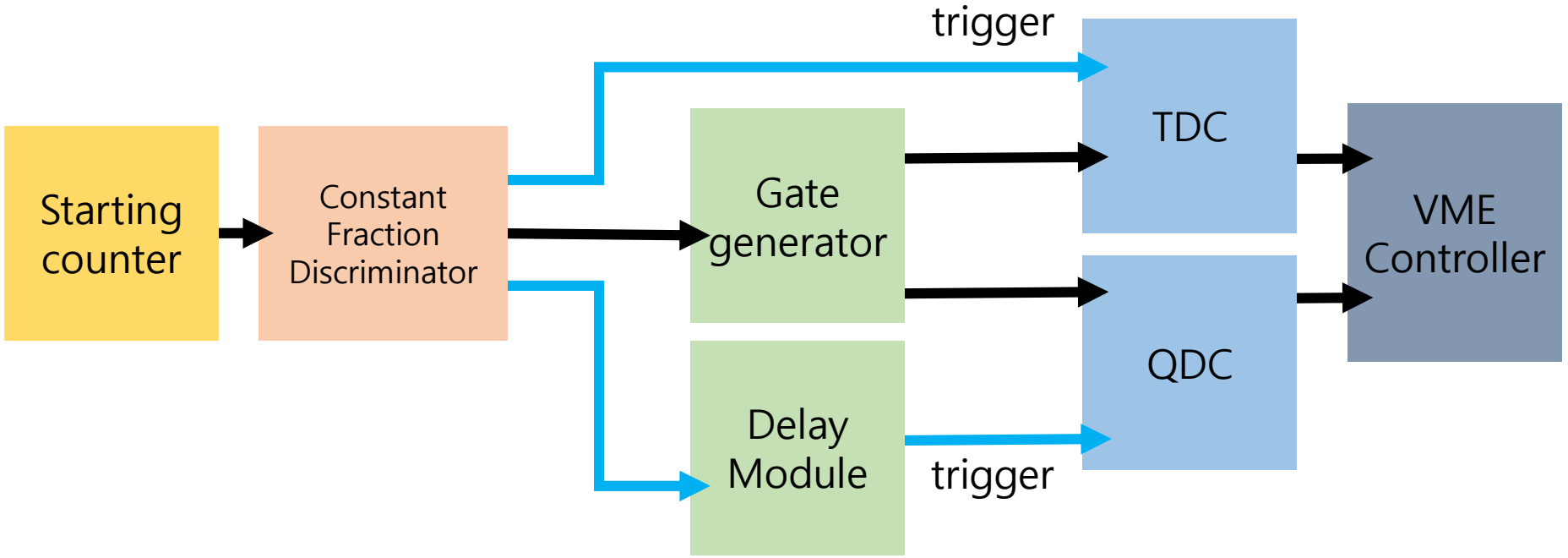








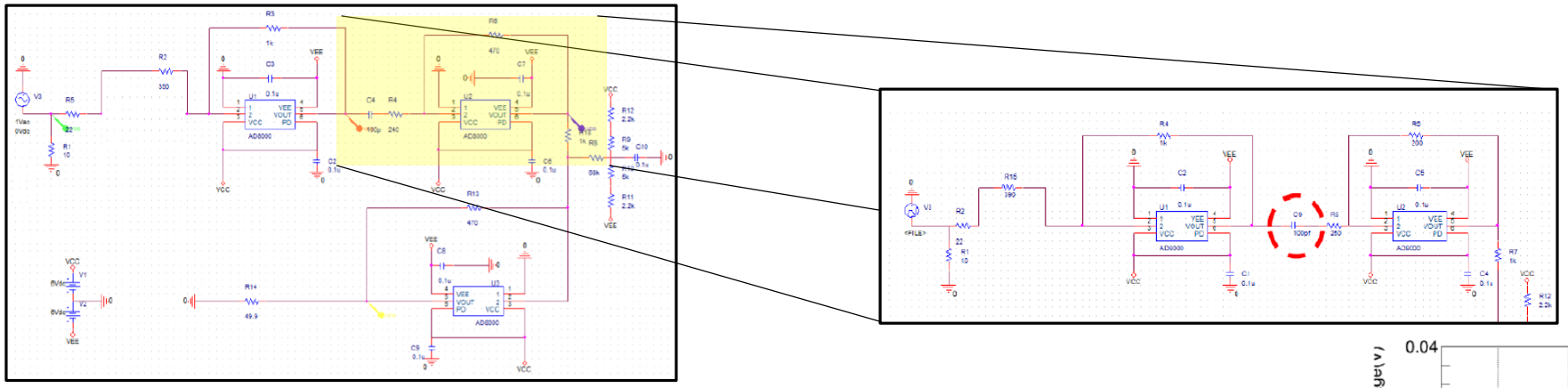
DAQ



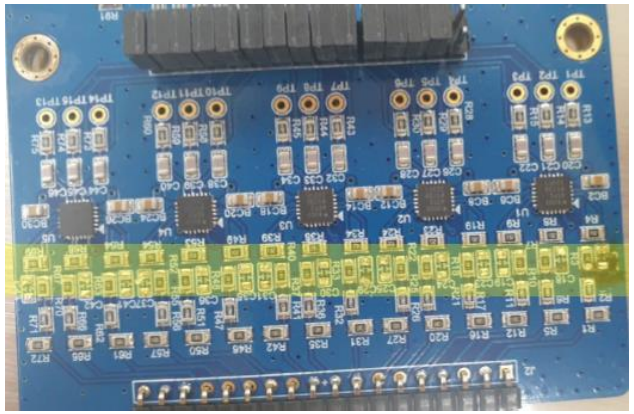
- We are connecting a starting counter with TDC.
- There is an problem that TDC cannot read the time value from starting counter.
- We will solve the problems within this month and start taking data using DAQ.

Simulation & Test

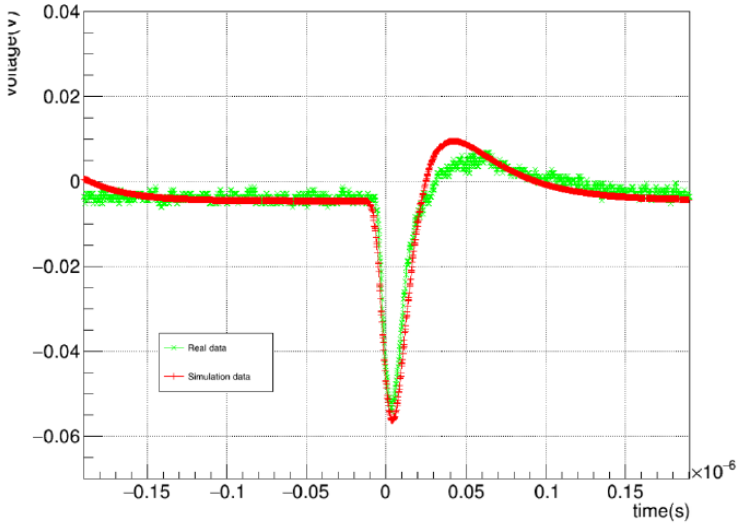
- Using Pspice program, we simulated the MPPC circuit
- To solve overshoot problem, we modified a circuit in red dashed circle.



- The modified circuit make similar output pulse to the simulation.
- The input signal in simulation is Landau distribution.

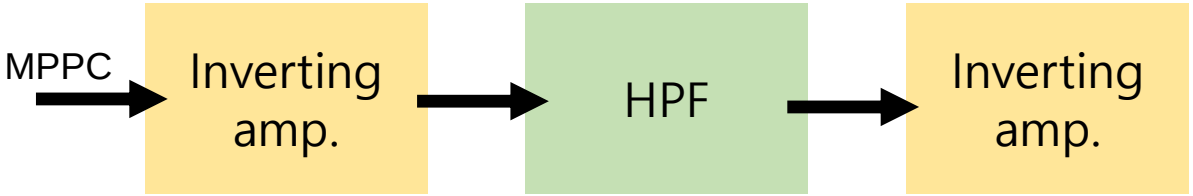


MPPC signal



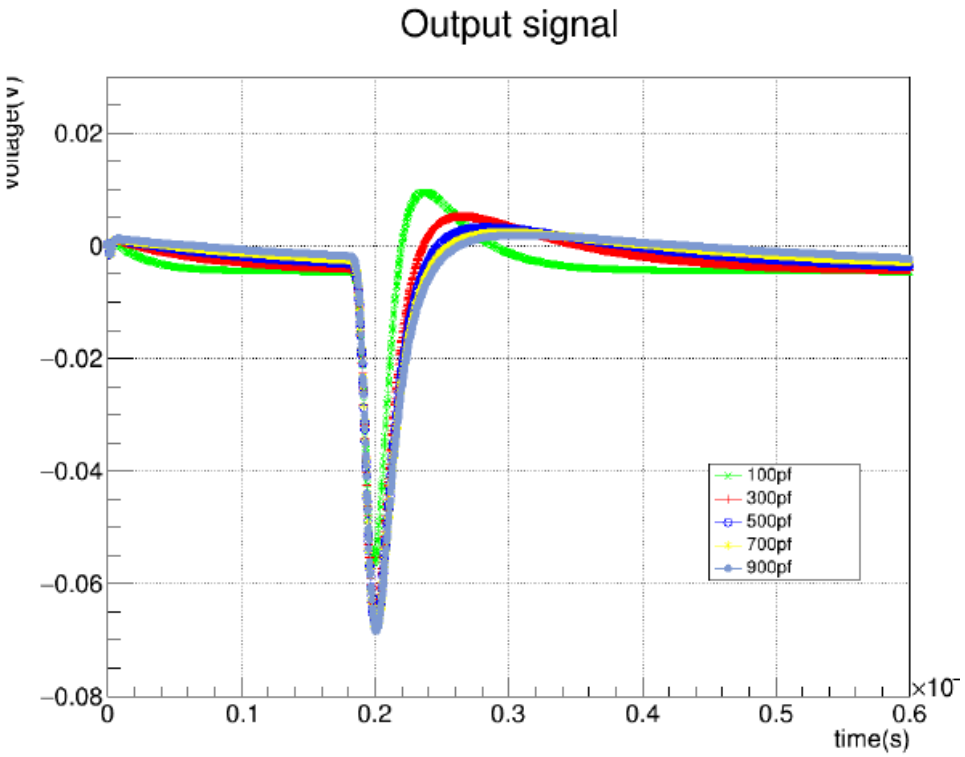
Simulation & Test

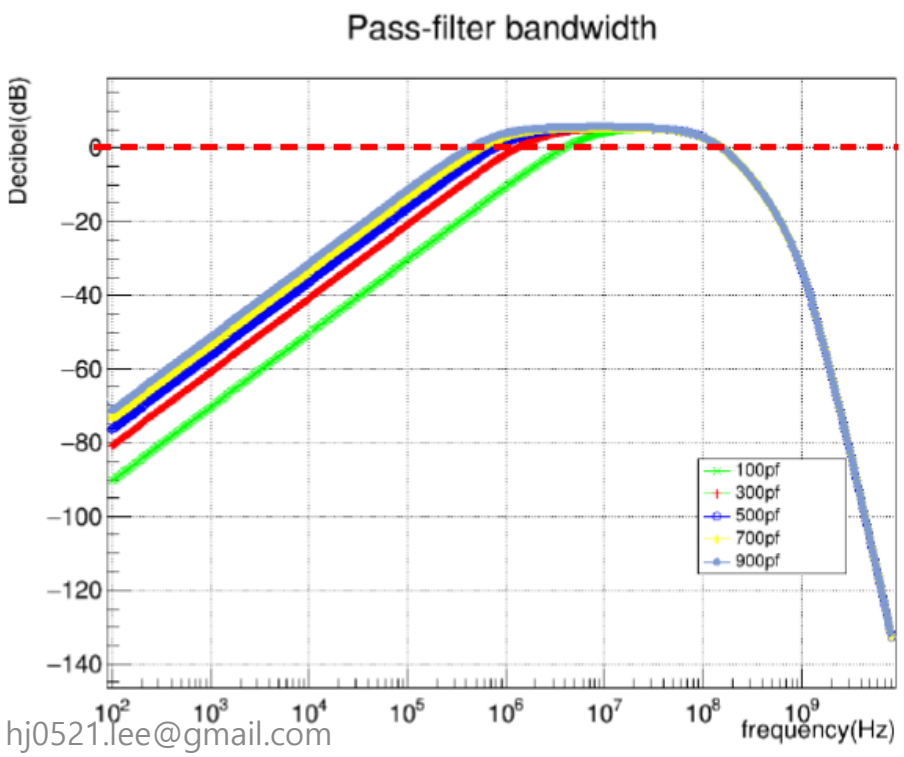
- Modified circuit :



- As changing the capacitor value in red dashed circle, the overshoot of output pulse is more smooth.

- In addition the Bandwidth becomes broader.

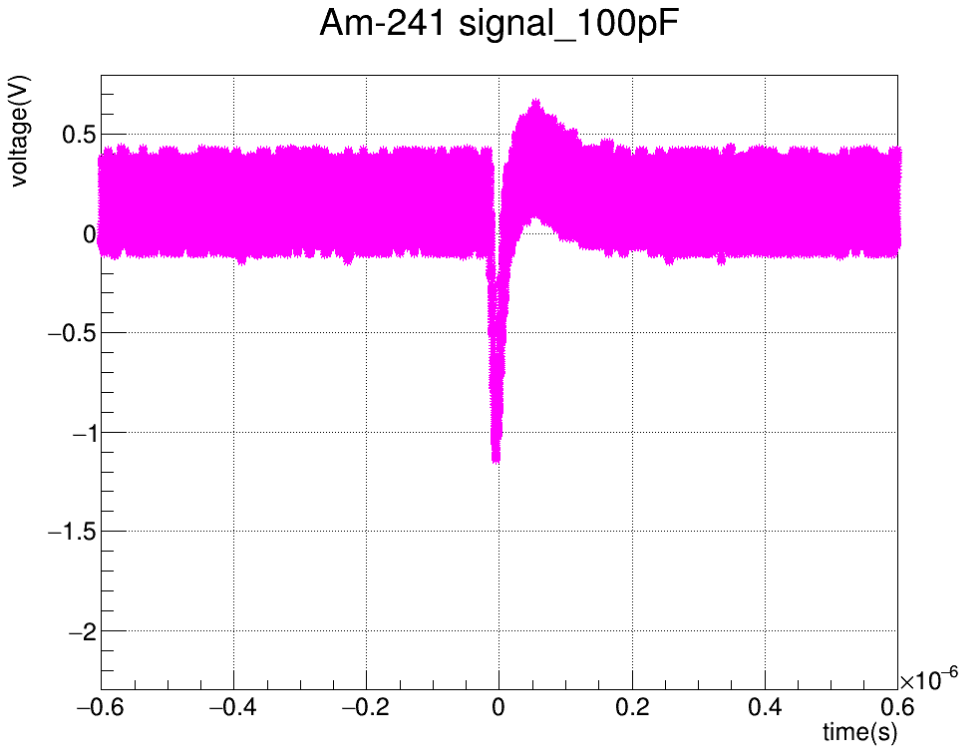


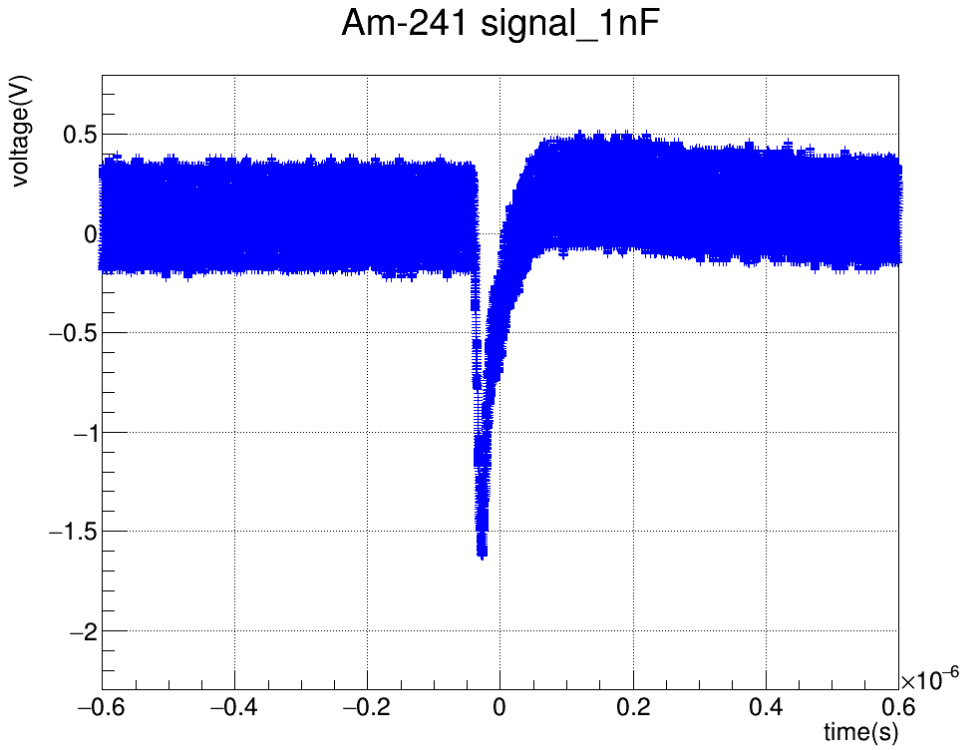


$$\mathrm{dB} = 20\log\left(\frac{v_{out}}{v_{in}}\right)$$

Result

- We tested using veto counter because the veto counter signal is larger than starting counter.
- We checked the difference as changing the capacitance from $100\mathrm{pF}$ to $1\mathrm{nF}$
- The overshoot is smoother like simulation result, but the very big noise is occurred.



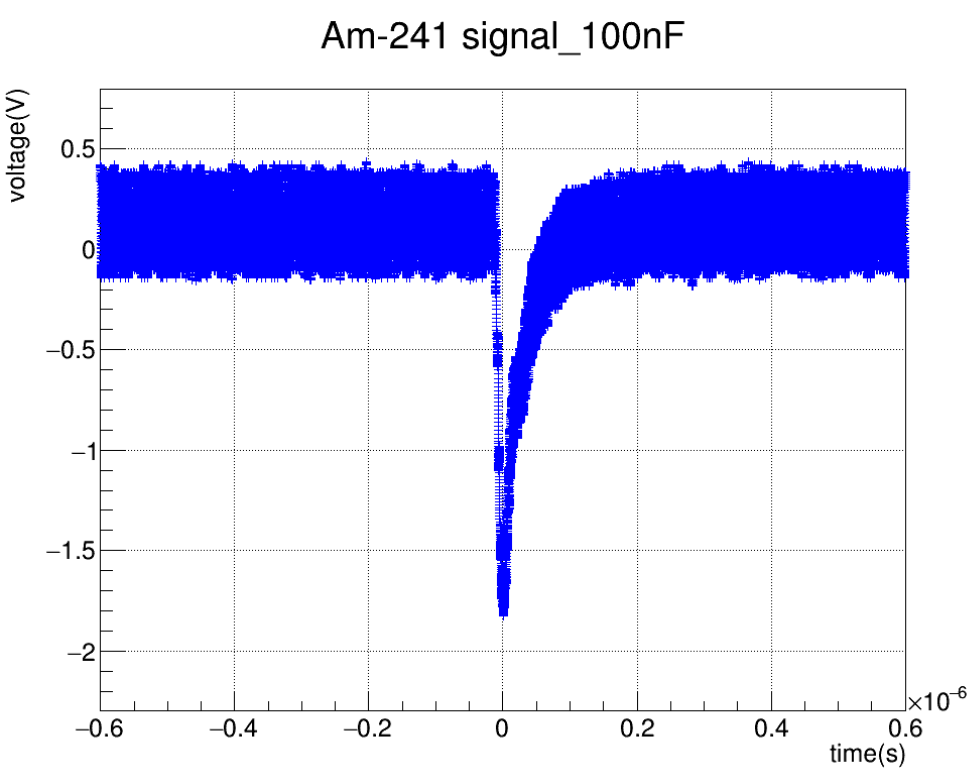


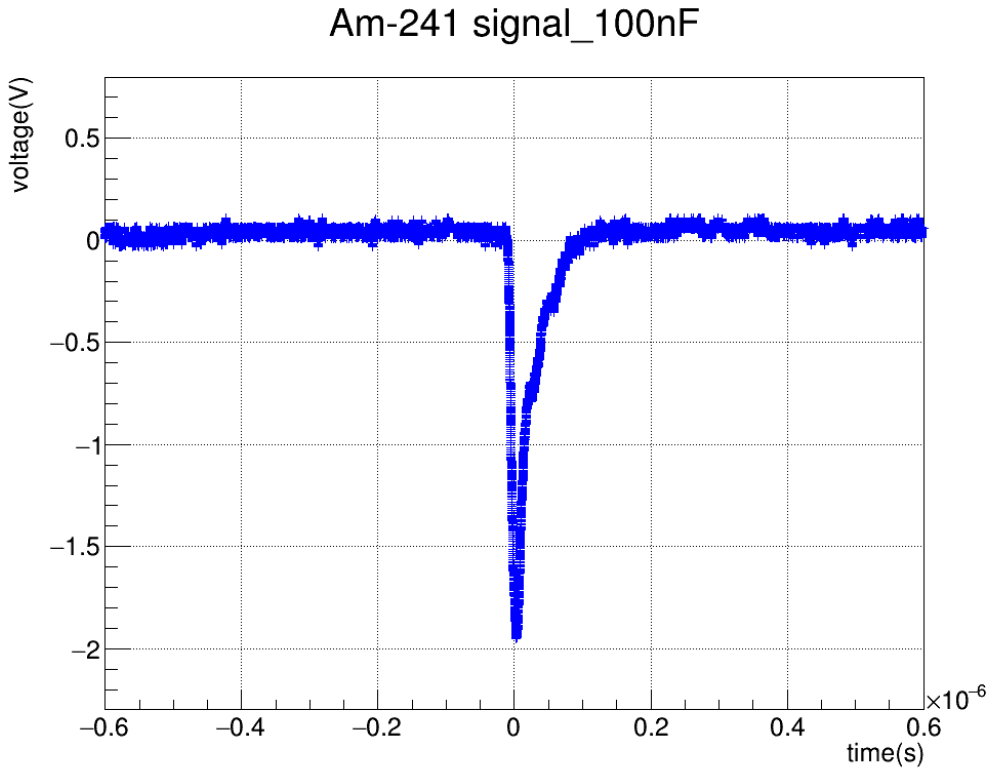
Result

- Modified the circuit. : MPPC → Differentiator. → HPF → Inverting amp.

- For Making the overshoot small, we increased the capacitance value.

- We checked that the noise and overshoot became smaller.





Summary & Plan

- In order to perform the trigger well in LAMPS, a starting counter with a good timing resolution is required.
- We make a starting counter using MPPC sensor which can avoid a magnetic field effects.
- We simulated a circuit using Pspice and checked whether the simulation was reliable or not.
- We checked an overshoot became smooth by increasing a capacitance value.
- We modified the circuit and succeeded to make a output pulse with relatively small overshoot and noise.
- We will debug DAQ code and will analyze a timing resolution of the starting counter as soon as possible.
- We will have proton beam test on Oct. at the KOMAC in Gyeongju.