LAMPS START COUNTER R&D STATUS

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Introduction

- R&D of the start counter for LAMPS is working on..
  - SπRIT Detector
  - KoBRA Start Detector

- Check the dependence of thickness with an energy deposition and an efficiency using Geant4

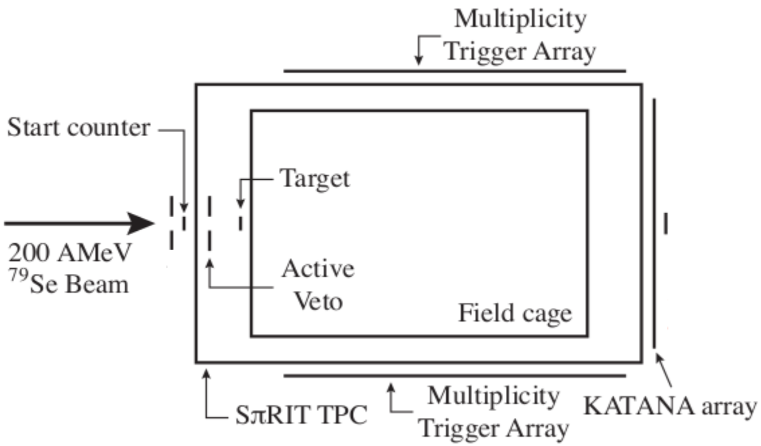
- Test the time resolution of PMTs
  - data analysis is on going..

SπRIT Detector

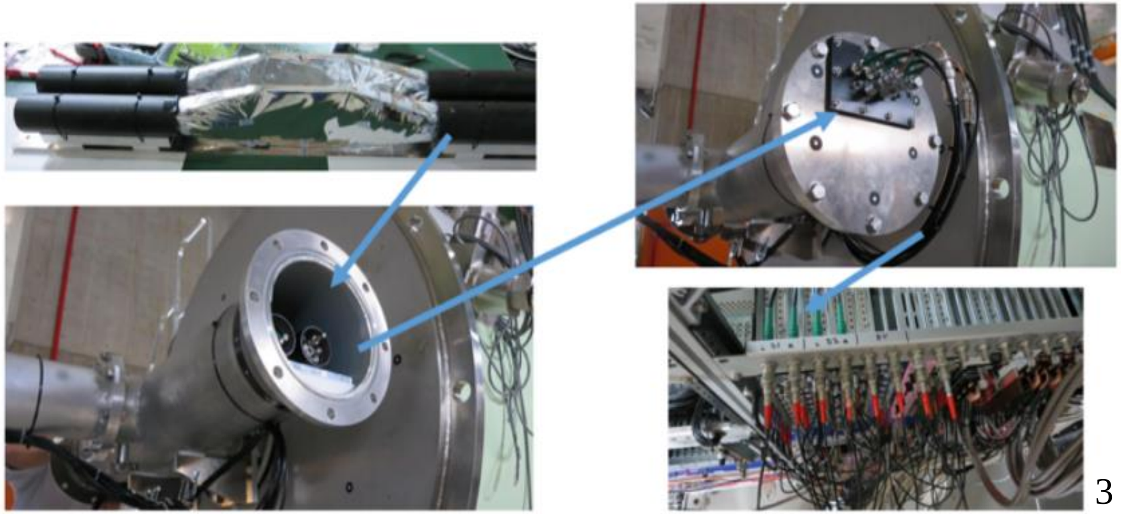
- Use two scintillator in SπRIT Detector :
  Scintillator size : 10cm × 10cm × 200μm
  4 photomultiplier

- Beam profile :
  energy ~ 270AMeV
  ex) Sn-132 with 50% purity
  $x \sim 4.6$ mm , $y \sim 4.4$ mm gaussian.

- The trigger rate at the final stage of Beam line ~ 1k pps



At the moment. A part of KATANA arrays play a role of beam veto

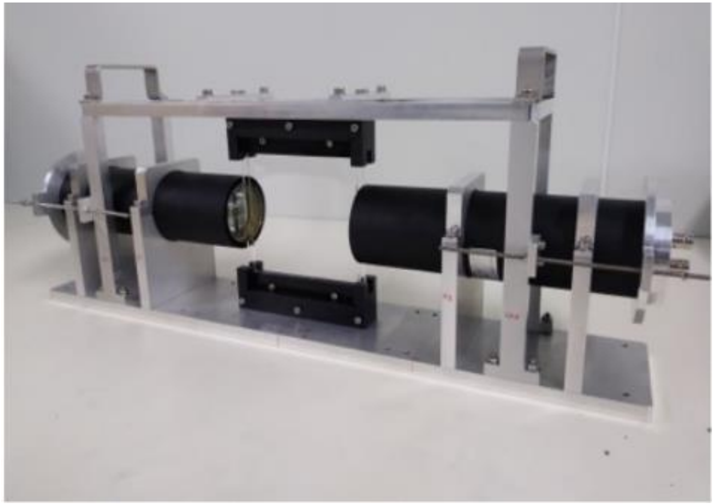


KoBRA Start Detector

- KoBRA Requirement for plastic detector :
  Time resolution $\sim 50\text{ps}(RMS)$ or $\sim 100\text{ps}(FWHM)$
  Scintillator size : $10\text{cm} \times 10\text{cm} \times 100\mu\text{m}$

- Result of test
  Performance test with Am-241
  Time resolution $\sim 44\text{ps}$ without light guide.

- Equipment
  Plastic scintillator : EJ-230
  PMT : H2431-50



KoBRA Start Detector Plastic

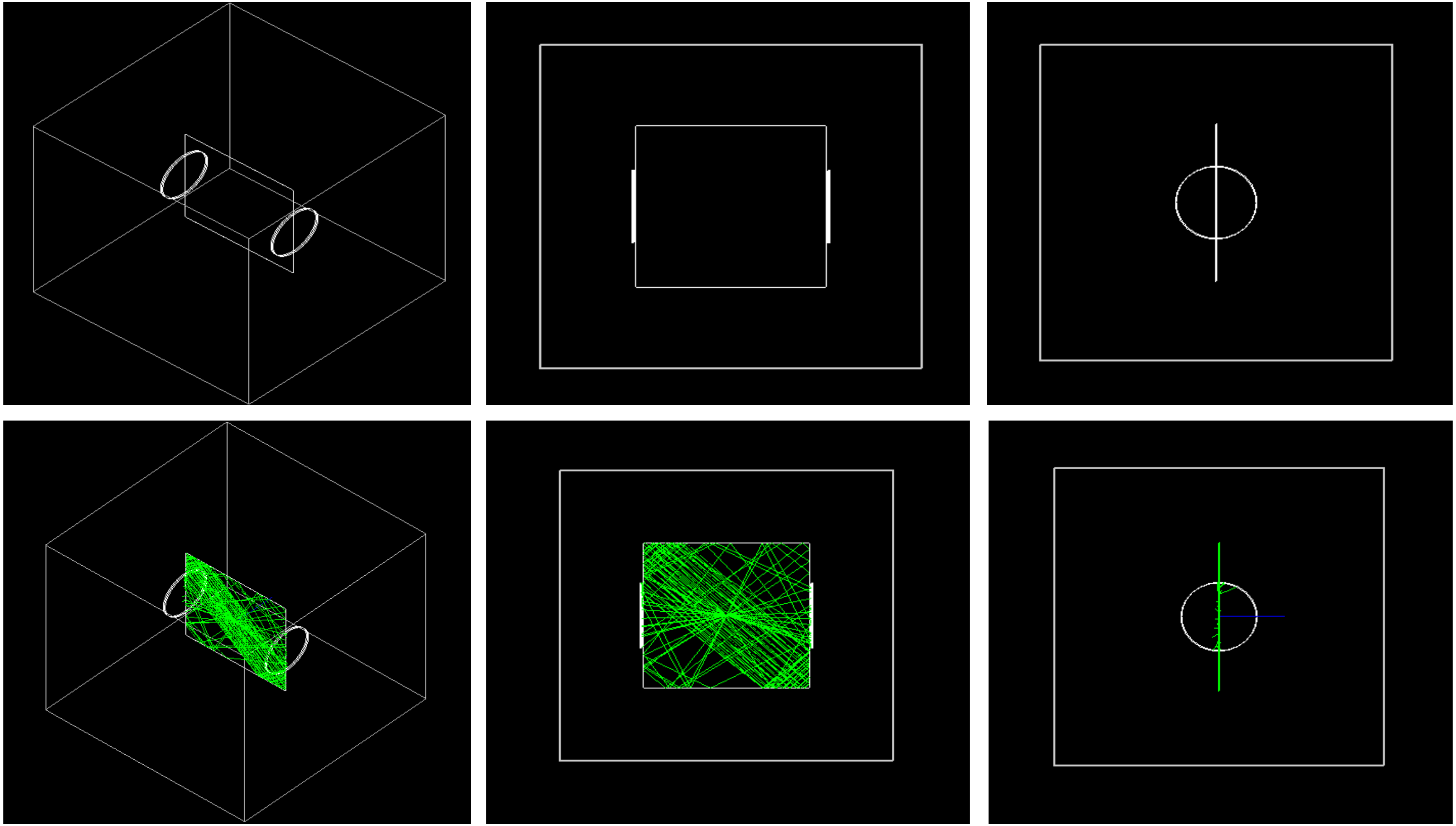
Scintillator	EJ-228	EJ-230	EJ-232	EJ-232Q
Light output (% Anthracene)	67	64	55	19
Rise time (ns)	0.5	0.5	0.35	0.11
Decay time (ns)	1.4	1.5	1.6	0.7
Pulse width, FWMH (ns)	1.2	1.3	1.3	0.36
Bulk light attenuation length (cm)	100	110 (120)	8	8
Scintillation efficiency (photons/1 MeV e-)	10200	9700	8400	2900
Price (10cm x 10cm x 100µm)	\ 875,000	\ 865,000	\ 890,000	-

- EJ−232Q has a lowest Light output
- EJ−232 and EJ−232Q have a fast rise time however the bulk light attenuation length is very short. These are irrelevant on 10cm x 10cm size scintillator.
- EJ−232 and EJ−232Q has a lower efficiency than EJ−228 and EJ−230.
- EJ−228 should be used in small sizes for the best timing results to minimize photon scattering effects. This scintillator is particularly useful where very high count rates are present.
- EJ−230 is a variant on the optimized EJ−228. The Scintillators up to 50 cm can be employed with good timing and light collection results.

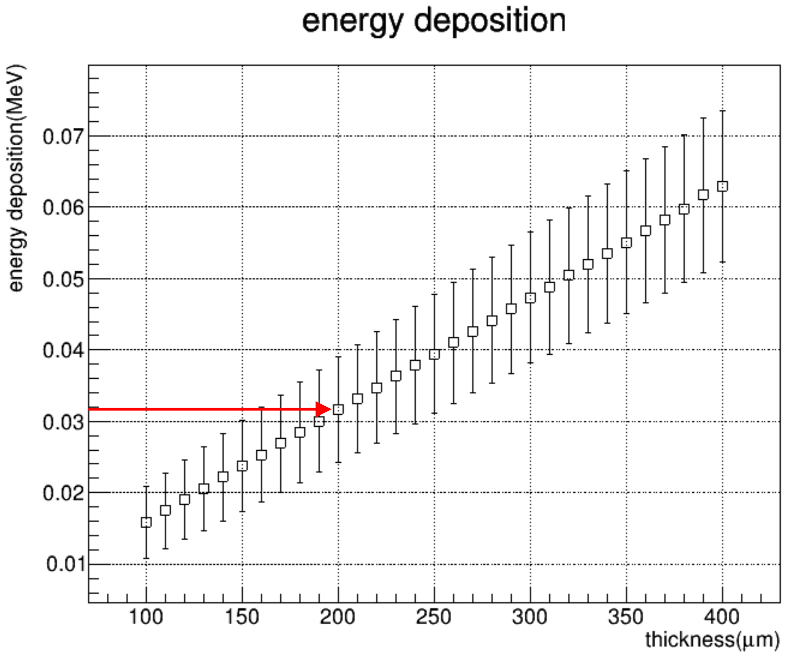
Geant4 simulation

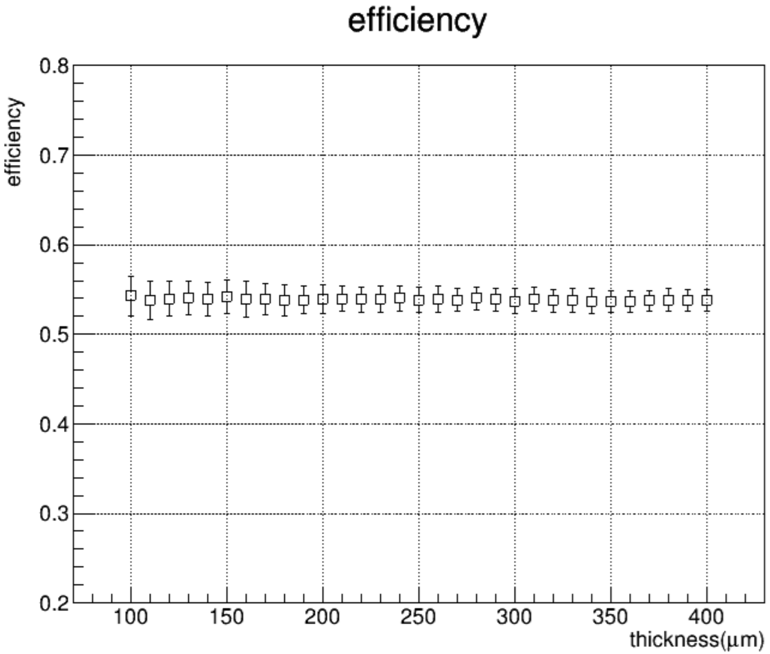
- Simulate a beam response on scintillator using Geant4 to understand the experimental data.
- Beam profile : C-12 beam, total energy 2000MeV(~167AMeV)
- Scintillator : EJ-230 , $10\text{cm} \times 10\text{cm}$
- We have simulated the scintillator without light guide, but we plan to add light guide later.
- We are studying whether the timing resolution of a Scintillator can be obtained using Geant4.

Geant4 simulation



Geant4 simulation





- The Beam is C-12 having 167AMeV
- The energy deposition is increased with thickness as expected.
- The efficiency is not depended on thickness.
- efficiency ≡ the # of photons reached pmt / the # of created photons in the scintillator.
- When the thickness is $200\mu\mathrm{m}$, the energy deposition $\sim 0.032\ \mathrm{MeV}$
- We are studying the thickness dependence of a time resolution.

Energy loss calculation

- Consider C−12 beam with kinetic energy $167\mathrm{AMeV}$ going through polyvinyltoluene (EJ230 $\sim 1.023\mathrm{g/cm^3}$).
  Compute the beam energy loss for the given width.

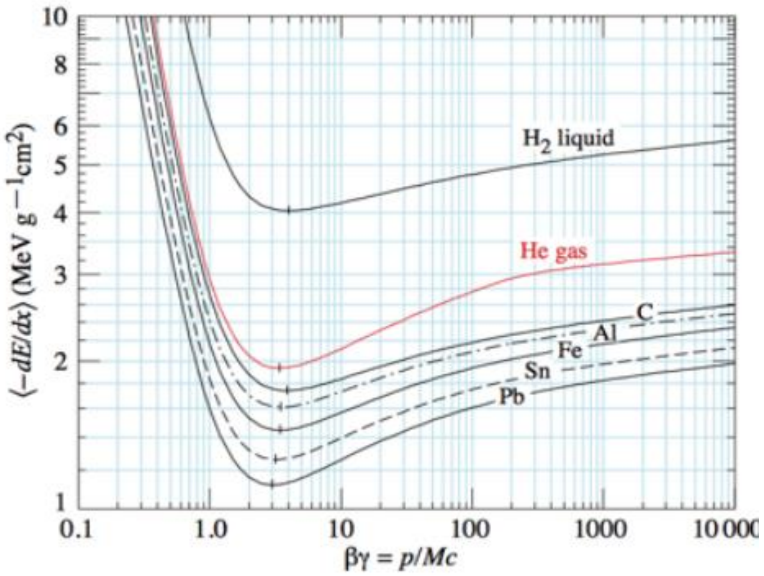
$$KE = E - M : 167\mathrm{AMeV} = E - 78\mathrm{AMeV}$$

$$\therefore E = 245\mathrm{AMeV} \rightarrow p \sim 232\mathrm{AMeV/c}$$

$$\therefore \beta\gamma = p/M \sim 1.39$$

$$dE/dx(\beta\gamma \sim 1.39) \sim 1.9\mathrm{MeV}\cdot\mathrm{cm^2/g}$$

$$\Delta E/\Delta x = 1.023\mathrm{g/cm^3} \times 1.9\mathrm{MeV}\cdot\mathrm{cm^2/g} \sim 1.9\mathrm{MeV/cm}$$



- For $200\mu\mathrm{m}$ thickness, $0.038\mathrm{MeV}$ beam energy loss.

- It is similar with simulation data.

IF RI Beam list

Fragment	Decay Type	Primary beam (400 kW)		Production Reaction	RI beam energy	RI beam Intensity	RI Beam purity
		Type	에너지 (MeV/u)		(MeV/u)	(pps)	(%)
132Sn	Beta- decay	238U	200	in-flight fission	**133.2**	**8.21E+06**	**1.4661**
130Sn	Beta- decay	238U	200	in-flight fission	**133.1**	**3.74E+08**	**13.6**
124Sn	stable	124Sn	230	transmission	**230**	**8.77E+13**	**100**
112Sn	stable	112Sn	263	transmission	**263**	**8.49E+13**	**100**
106Sn	Beta+ decay	124Xe	252	fragmentation	**155.9**	**5.31E+08**	**18.5**
100Sn	Beta+ decay	112Sn	263	fragmentation	**161.1**	**1.41E+01**	**0.0128**
96Zr	stable	96Zr*	248	transmission	**248**	**1.05E+14**	**100**
82Cu	Beta- decay	96Zr	248	fragmentation	**166.8**	**2.72E-03**	**1.2557**
81Cu	Beta- decay	238U	200	in-flight fission	**140**	**5.91E+00**	**0.000012**
80Cu	Beta- decay	238U	200	in-flight fission	**139.9**	**6.17E+01**	**0.0002**
79Ni	Beta- decay	96Zr	248	fragmentation	**167.1**	**2.64E-03**	**1.3223**
78Ni	Beta- decay	238U	200	in-flight fission	**140.3**	**8.99E+00**	**0.000045**
72Ni	Beta- decay	82Se	256	fragmentation	**167.5**	**5.63E+06**	**77.8**
70Ni	Beta- decay	76Ge	260	fragmentation	**169.4**	**2.57E+08**	**15.7**
68Ni	Beta- decay	76Ge	260	fragmentation	**168.4**	**2.65E+09**	**18.6**
77Co	Unknown	86Kr	258	fragmentation	**172.2**	**1.87E-02**	**97.59**

Dr.kim provide this beam list.

- In the same ways for Sn-124(230AMeV)
- For 200μm thickness,
  The beam energy loss ~ 0.12MeV
- For several hundred μm thickness design,
  The beam energy loss is negligible.

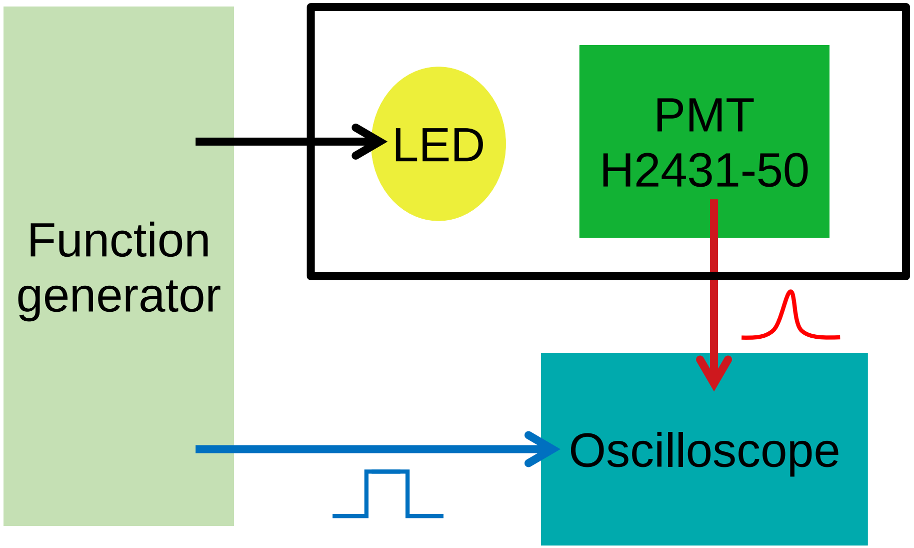
PMT test

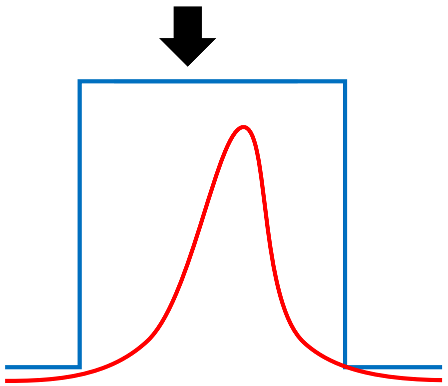
- There are 12 photomultipliers in Korea university which are same model to be used in KoBRA (H2431-50)

- The purpose is finding a time resolution of these PMTs and select the PMTs having good performance.

- The signal data was taken and an analysis is on going.

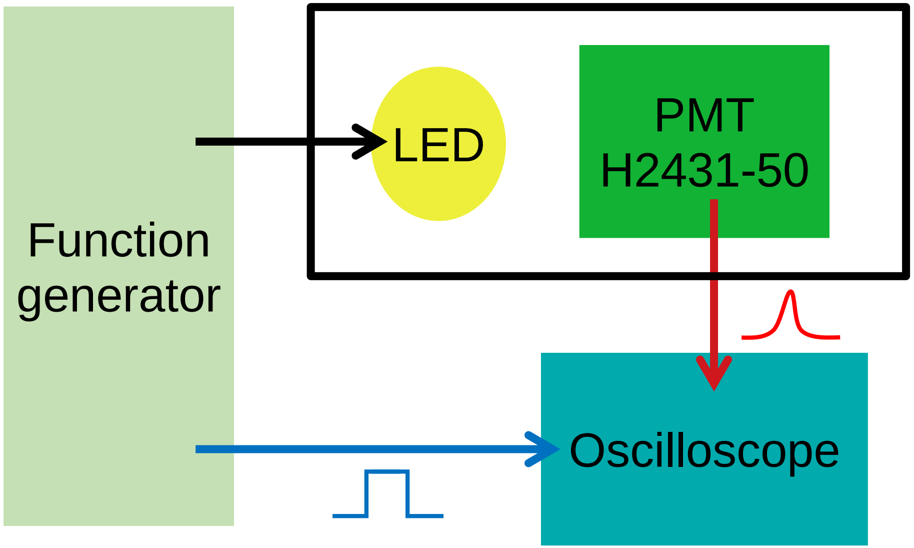
PMT test set up



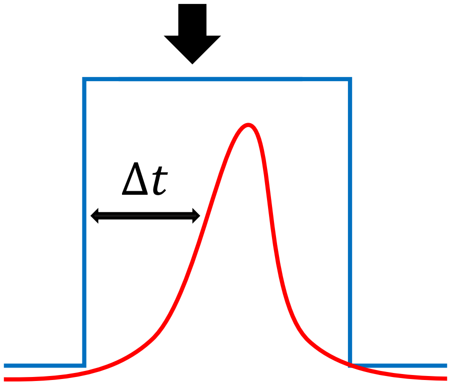


Frequency :2kHz
Width : 20ns
Amplitude : 3.2V

PMT test set up



Frequency :2kHz
Width : 20ns
Amplitude : 3.2V



Summary & Plan

- We finished the simulation using Geant4 and checked the dependence of thickness with respect to the energy deposition and the efficiency.

- We finished the PMTs test and will analyze about given data for finding time resolution of PMTs.

- We will set the light guide on our simulation.

- We will study how to find the time resolution of scintillator in Geant4.

- We will confirm suitable scintillator materials and buy the scintillator in July