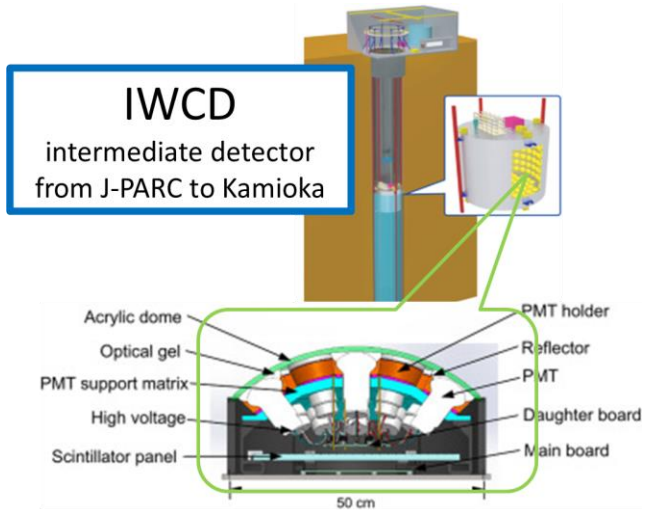
Electric-field dependence of dark noise in a photomultiplier tube

Yuto Maekawa Keio university

講演番号 32



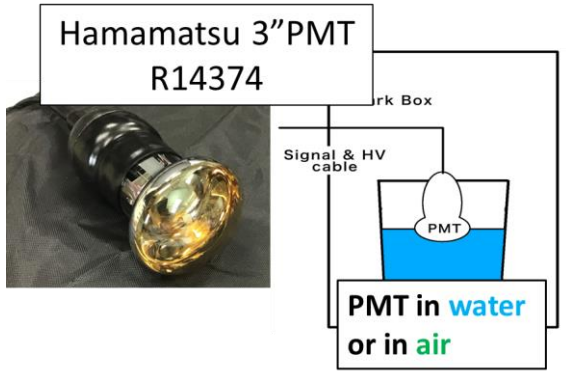
On going plan, IWCD
use m-PMT that consists of 19 3”PMTs.

In neutrino experiments, photomultiplier tubes (PMTs) in water or liquid scintillators are generally used.

Dark hit can be serious background for neutrino measurements. → It is important to suppress the amount and instability of dark hit rate

Dark hit rate is affected by the surrounding environment and PMT bias voltage.

How much impact of the detector condition for Dark rate?



Measure the dark rate of 3”PMT surrounded by water or air.
The bias voltage of this PMT can change +HV or –HV.

mode	+HV		-HV	
condition	in air	in water	in air	in water
dark rate/Hz	291 ± 1	255 ± 1	274 ± 2	21326 ± 952

Water Temp :25℃
(temp variation ~0.2℃)

At –HV mode in water, the dark rate was high and depended significantly on a small temperature change.

Electric-field dependence of dark noise in a photomultiplier tube

Yuto Maekawa Keio university

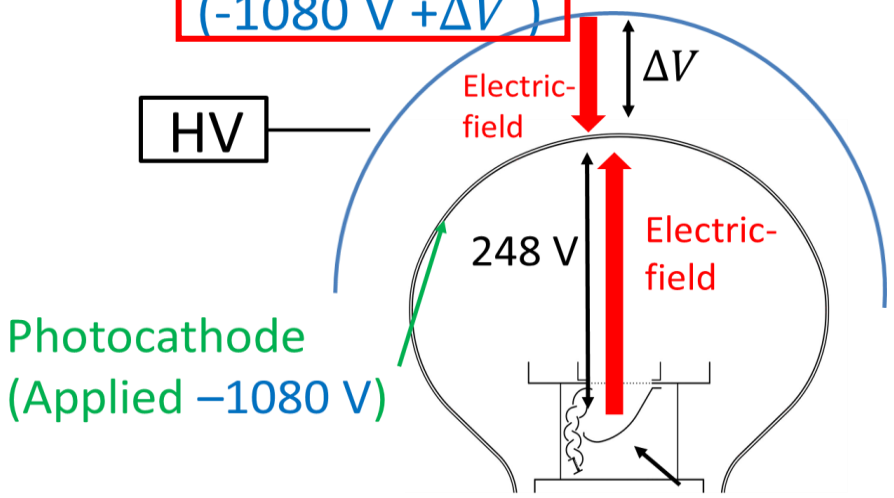
講演番号 32

Is it possible to model the dark rate as a function of temperature of external electric-field together?

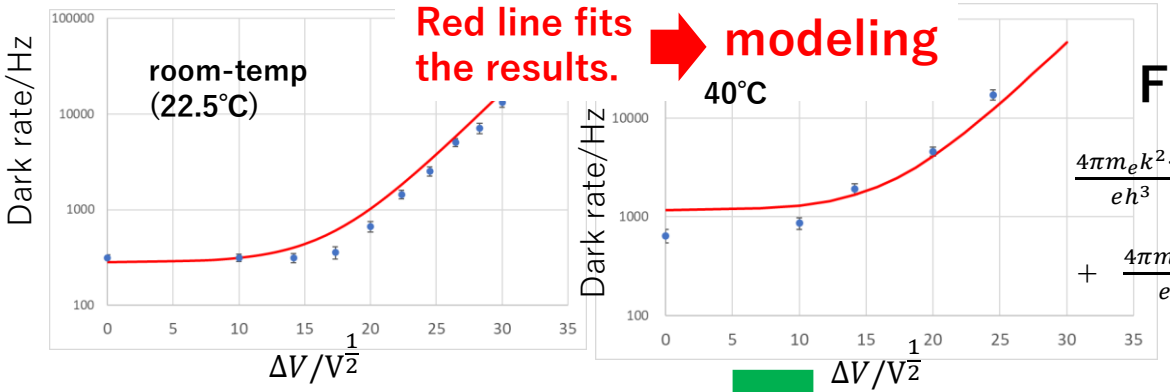
Measure the dark rate at room-temperature and 40℃.

Change

Aluminum-foil (-1080 V +ΔV)

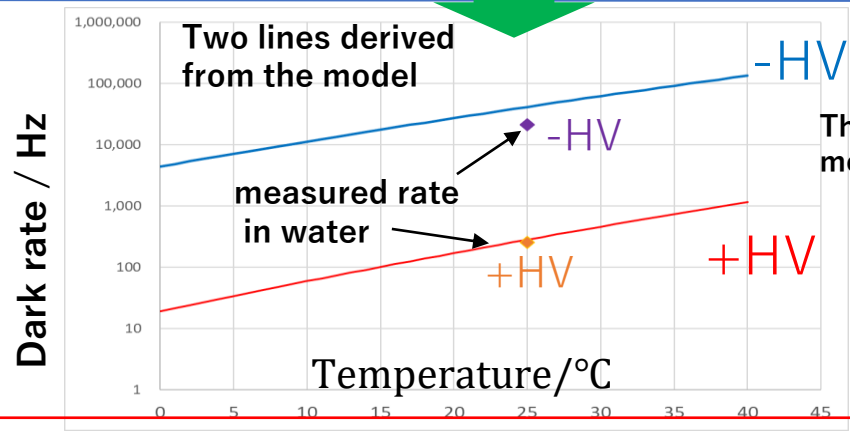


Change the temperature and voltage ⇒ Measure the dependence of dark rate.



Fit function

$$\frac{4\pi m_e k^2 \cdot S}{eh^3} T^2 \exp\left(\frac{\sqrt{\frac{e^3}{4\pi\varepsilon_0}}\sqrt{\beta_1 \Delta V} - \phi}{kT}\right) + \frac{4\pi m_e k^2 \cdot S}{eh^3} T^2 \exp\left(\frac{\sqrt{\frac{e^3}{4\pi\varepsilon_0}}\sqrt{\beta_2 \cdot 248\ \mathrm{V}} - \phi}{kT}\right)$$



This model is roughly consistent to the measured rate in the water.

The model indicates that the dark rate highly depends on the temperature for the PMT with –HV bias in the water and it is sensitive to the grounding around the PMT.