Детекторы альфа-частиц на основе Микро пиксельный лавинных фотодиодов

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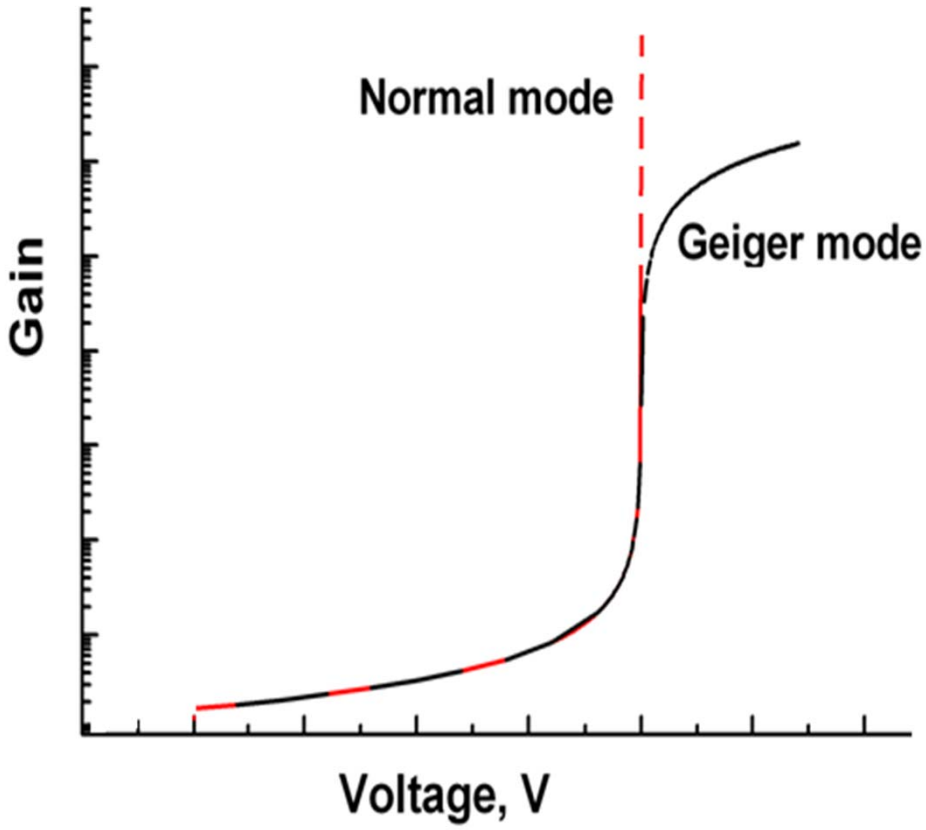
Normal mode and Geiger mode Avalanche Photodiodes



Normal Mode

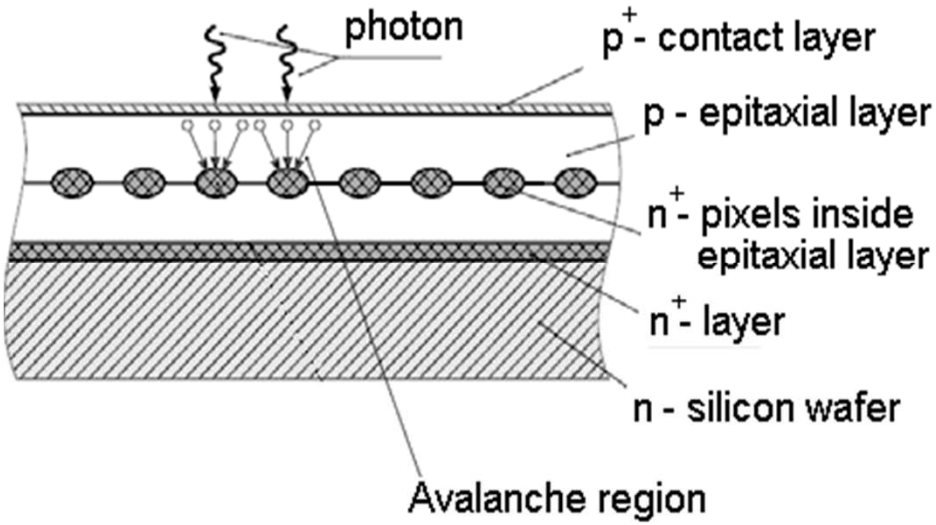
- Bias: slightly below breakdown voltage
- Gain: limited < 300 (1000)
- High linearity
- Excess noise factor >2
- No single photo electron resolution

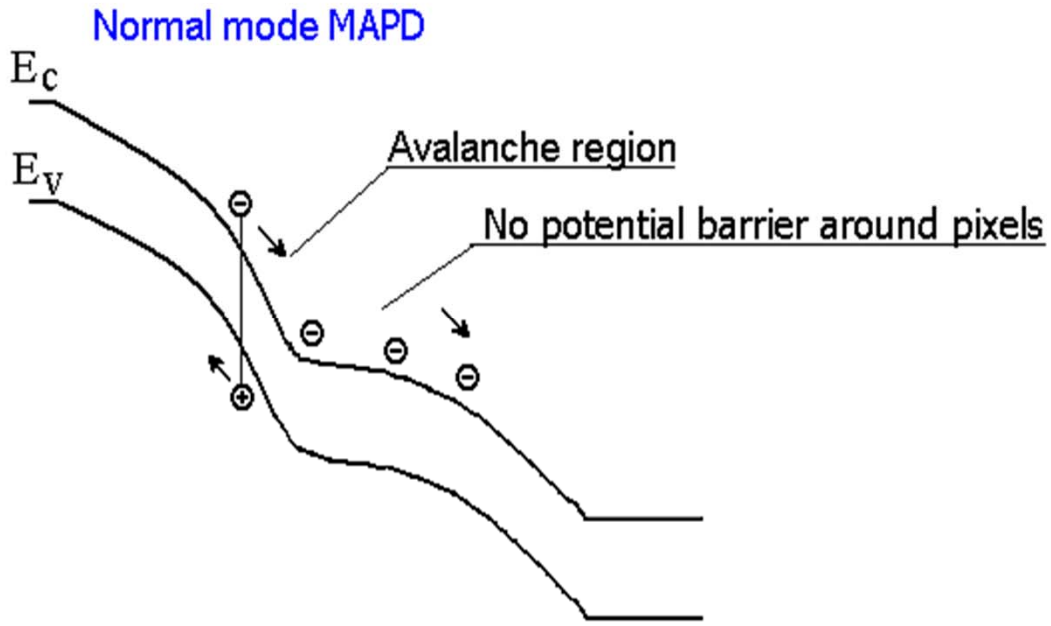
Geiger Mode

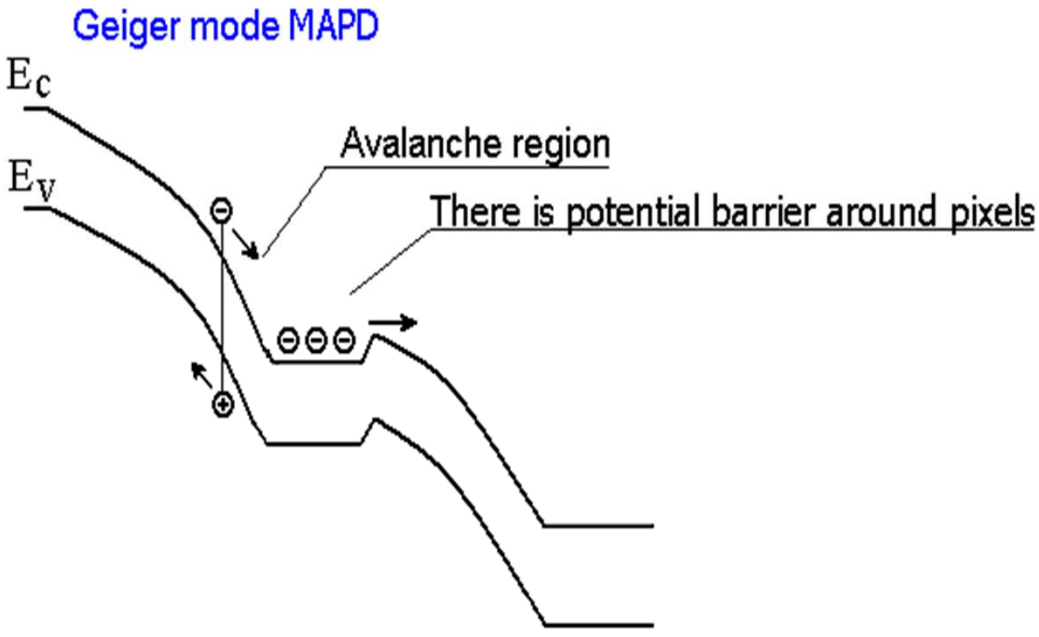
- Bias: about 10% above breakdown voltage
- Gain: 10^4-10^6
- Limited linearity
- Excess noise factor ~1
- High single photo electron resolution

Two types MAPDs

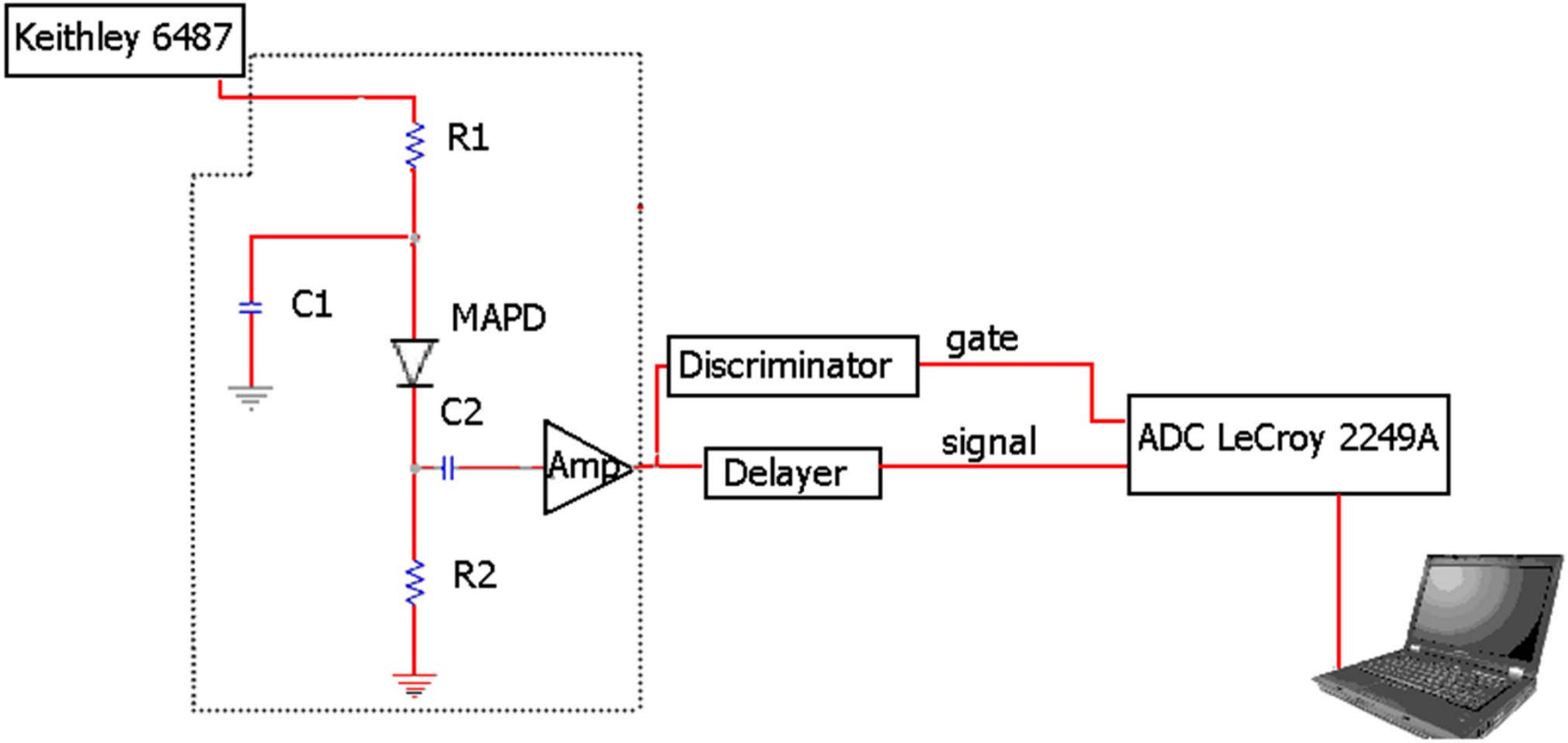
The design of the novel MAPD device with super high linearity

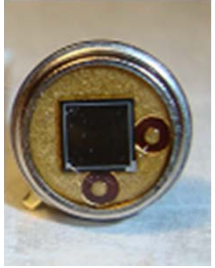






Experimental Setup

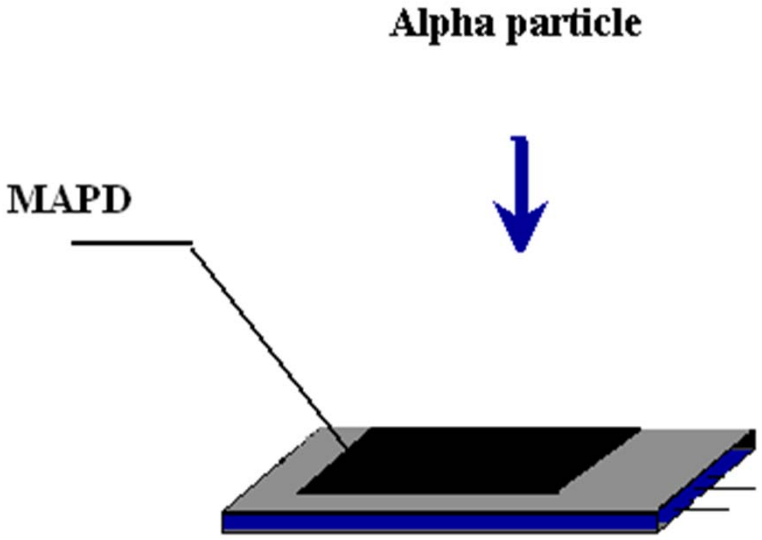


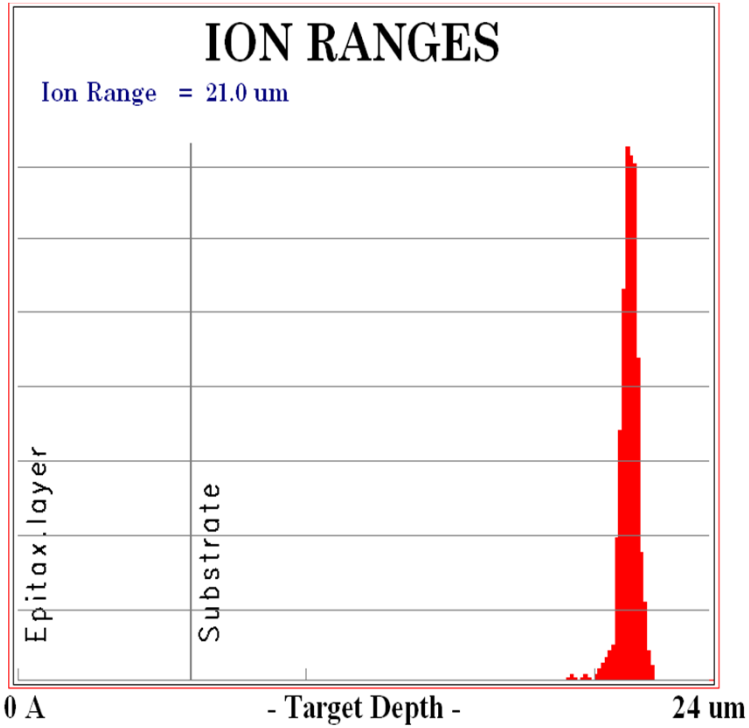


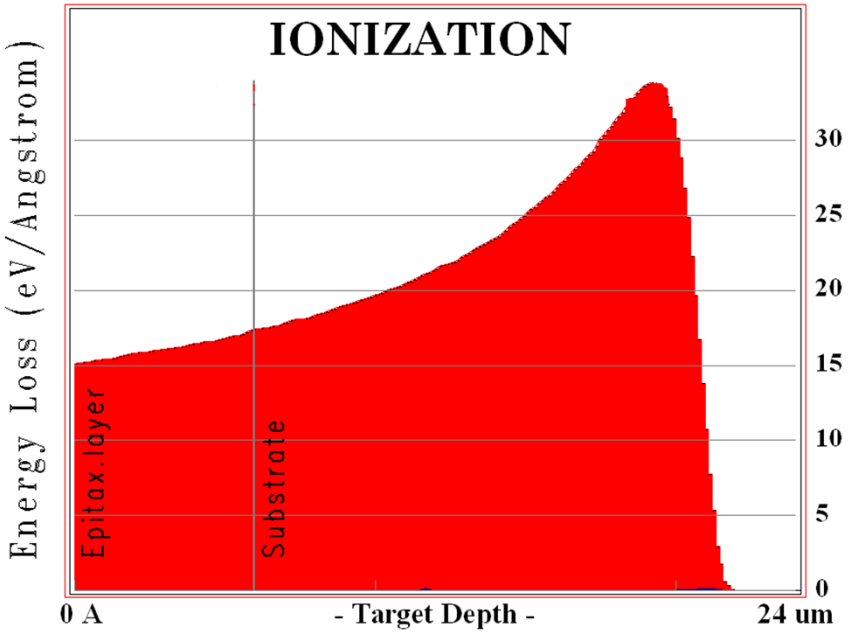
MAPD (Normal mode)

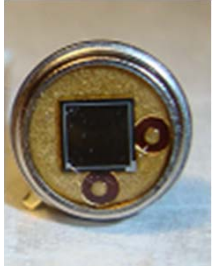
The radionuclide $_{241}$Am (5.486MeV) was used as the source of alpha particle in experiment. Distance between MAPD diode and alpha particle source is 1cm.

Direct detection of alpha particle

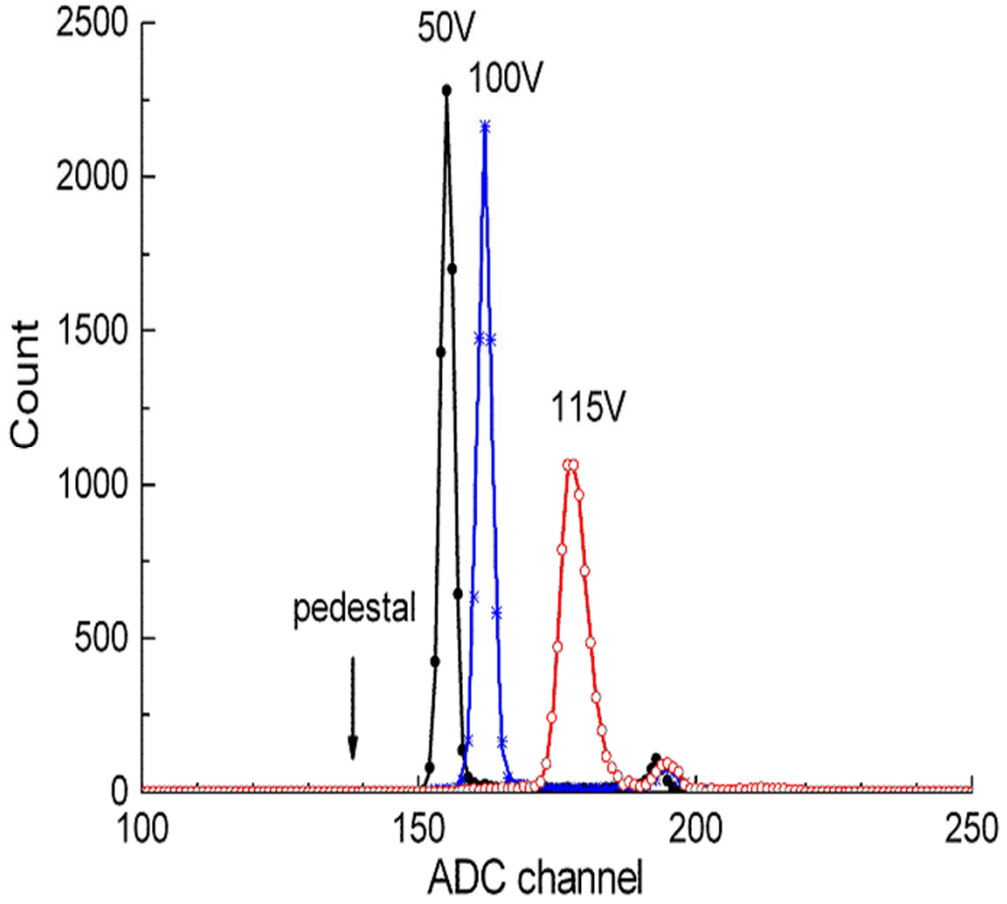




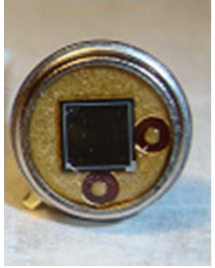




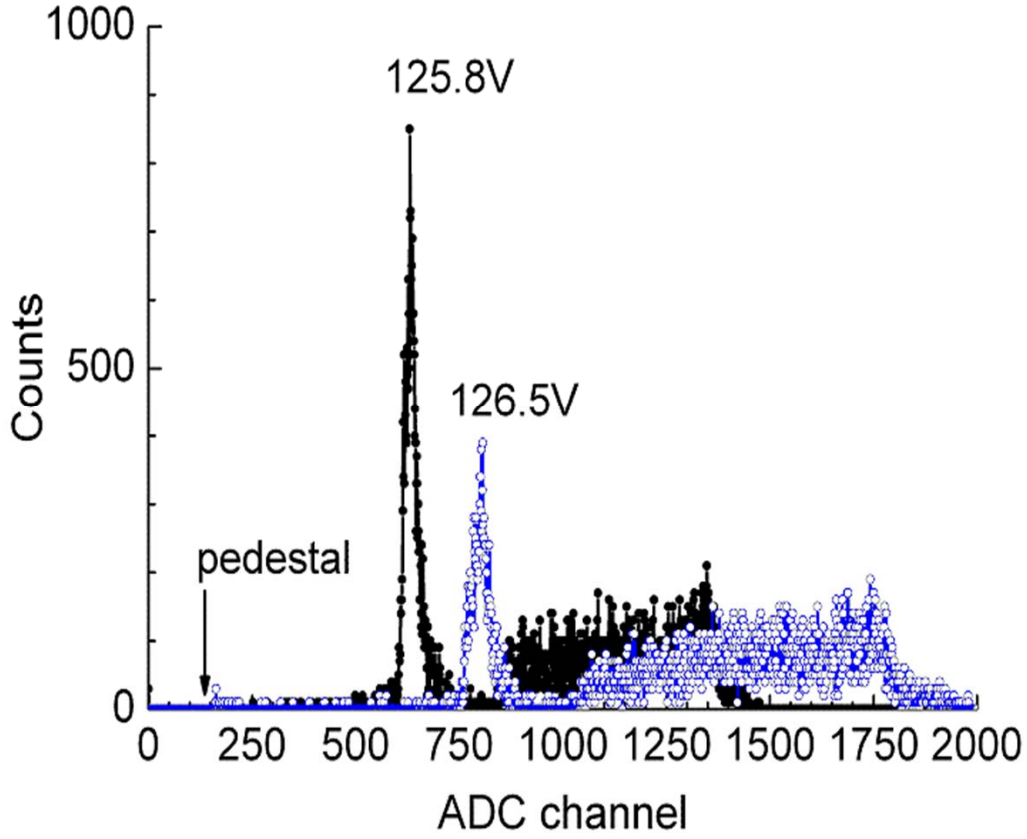
MAPD (Normal mode)



Two peaks was observed in range (50-115V) for 4.5MeV alpha particle energy. Two peaks (50-115 V) corresponding to the same particle energy observed in spectrum. Positions of the primary (left) peak depended strongly on the bias voltage (or gain) while dependence on the voltage of the secondary peak was much weaker .

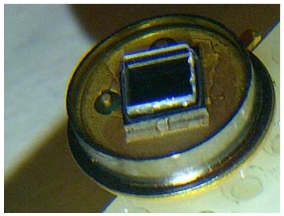


MAPD (Normal mode)

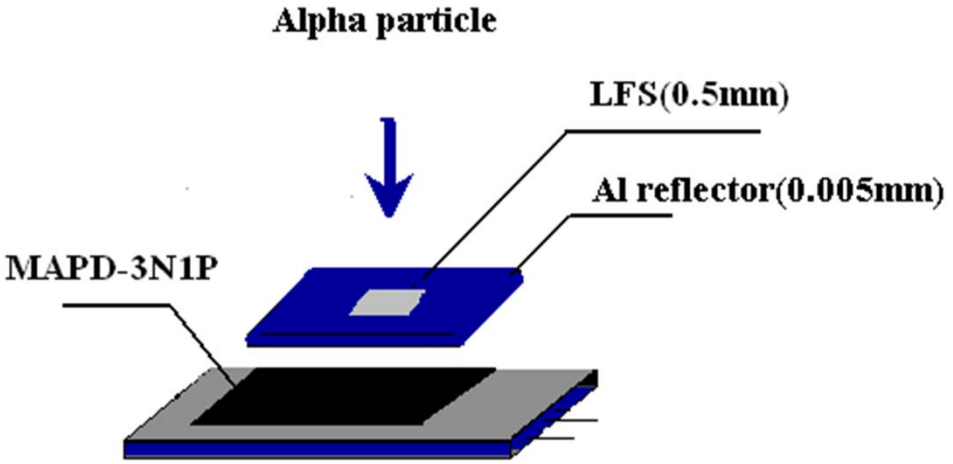


With further increasing voltage and gain the secondary peak became wider and proportion between peak areas had changed. The possible explanation of this is following. In the case of small incident angles, most of the electrons (several hundred thousands) produced by alpha particle hit the same pixel or area between two or four adjacent pixels within very short time (several ns). Due to gain saturation in the first case the pixel does not work in normal mode (or does not multiply electrons in normal mode) while in the second case (hitting area between two or four adjacent pixels) charge is spread between the pixels and that does not cause such saturation.

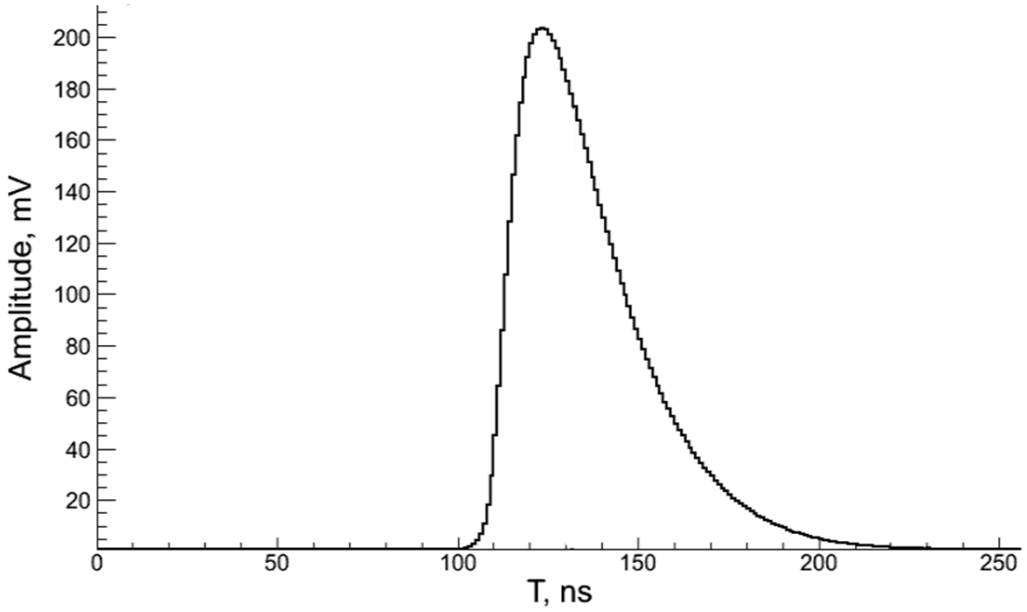
MAPD (Geiger mode) and LFS as alpha detector

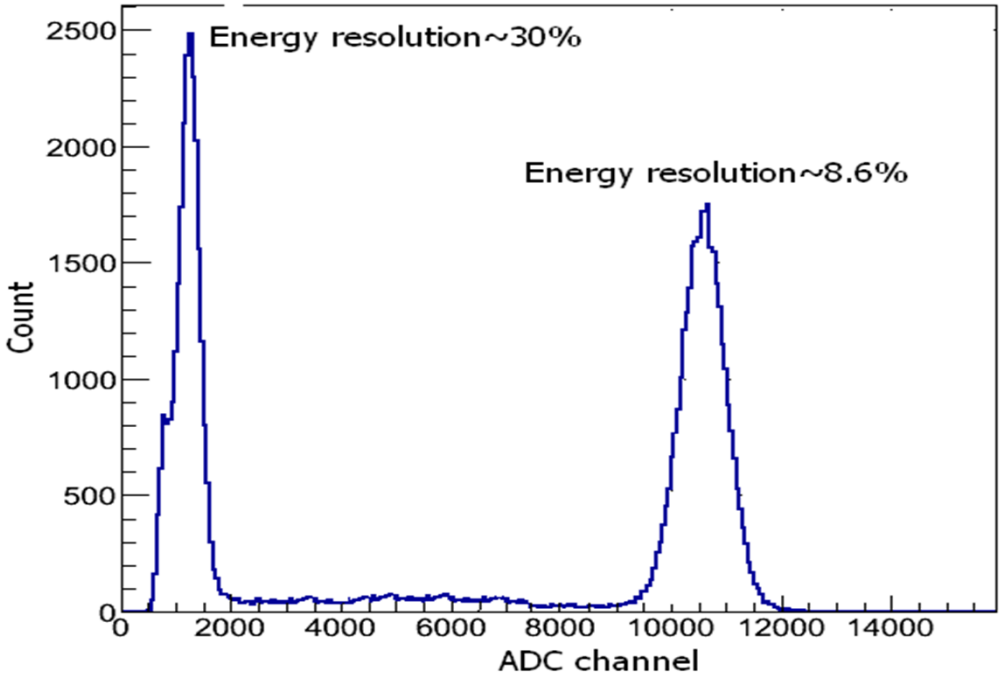


Material	LFS-8
Density (g/cm^3)	7.1
Light output (NaI(Tl) %)	82
Decay time,(ns)	19
Peak emis,(nm)	422



^{241}Am (gamma-59.6keV, alpha-5.486MeV).



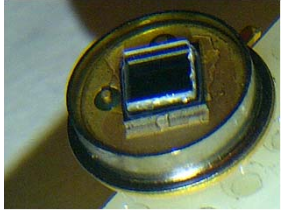


Discussion

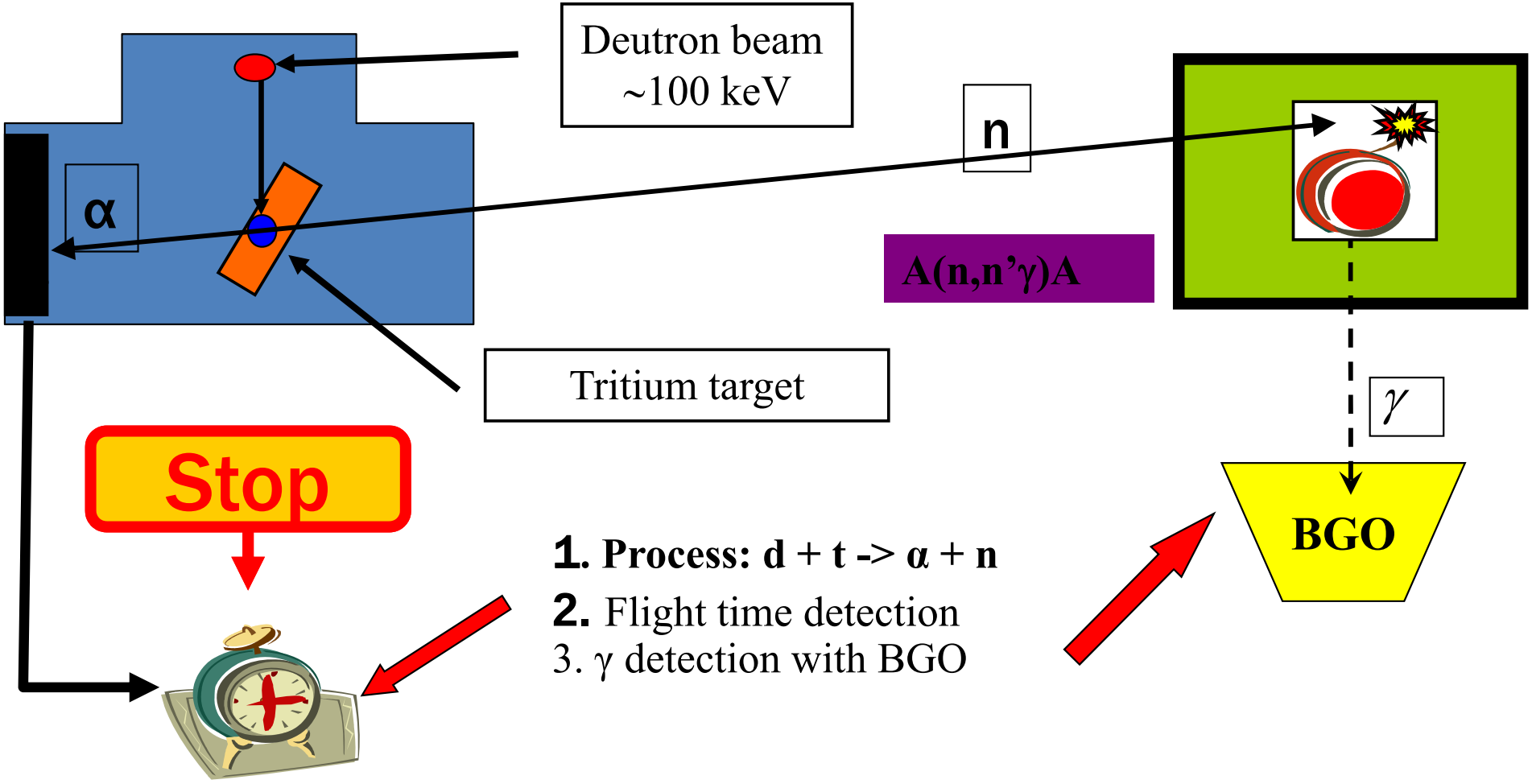
1. **MAPD (normal mode) diode can be used as alpha counter.**

2. **Obtained energy resolution for the 4.5MeV alpha particle with scintillators detector based on MAPD was 8.6%.**

3. **Investigation of alpha particle+gamma ray and neutron detection performance with MAPD+LFS and study Pulse Shape Discrimination of this detector.**



Associated particle imaging



Спасибо за Внимание !