Good essay on photo multiplier tubes (pmt)

Environment, Disaster

Instrumentation

Advantages and disadvantages of different types of photomultiplier tubes (PMT) in the context of the gamma camera

Tubes with GaP(Cs)

The Tubes with GaP(Cs) is an example of a PMT. Fliyckt and Marmonier (2009) state that one of its advantages as the high secondary emission coefficient of the GaP(Cs) which enables it to reduce the unexpected fluctuations of gain in most PMTs and therefore, improving the energy resolution. This is especially beneficial for light pulses that can allow the cathode produce only a few electrons. Since the GaP(Cs) also has a dynode, it allow the viewer to discriminate light pulses that produce either 1, 2, 3, 4, or 5 photoelectrons (Fliyckt and Marmonier 2009). In addition, the time factor is also improved as it reduces the number of dynodes required for a favorable multiplication statistic. The disadvantages of the GaP(Cs) are that they have very high operational bias. They are also very bulky and sensitive to magnetic fields.

Microchannel-plate photomultipliers

The second is the microchannel-plate photomultipliers. These were developed through the study of secondary emission properties of selected glasses. The microchannel-plate photomultipliers have numerous advantages as well as some limitations. The first advantage is that they are very fast in responding due to the short distance that the electrons travel and the high electric field that they have, therefore, reducing the transit time (Evdokimov and Denisov 2008). Secondly, they are insensitive to magnetic fields. This is enabled by the ability of the particles to travel fast, their high electric field, and the restriction created by the microchannels rendering the electron paths impervious to magnetic fields. Finally, Fliyckt and Marmonier (2009) claim that they have spatial resolution. The honeycomb structure of the microchannel plate enables the optical image at the cathode of an electron be replicated on the anode simply by proximity focusing. This makes the spatial image recoverable using mosaic anode (Evdokimov and Denisov 2008).

Unfortunately, the microchannel-plate photomultipliers also have limitations. The first is the disadvantage of the charge capacity per channel. It confines the gain to about 106 while also limiting the current that can be delivered per pulse. This results to changing the shape and the length of the pulse. The second disadvantage of the microchannel-plate photomultipliers is created by the inefficient count rate and linearity in the pulse mode. This problem is created by in-built problem at the output and a long recovery time per second. The third and final is the short useful life that the microchannel-plate photomultipliers have. The large surface area of a microchannel plate creates a problem when trying to outgas the channel completely even if the temperatures are high. Evdokimov and Denisov (2008) argue that it then results to the accumulation of electrons, which subsequentially creates ions that attack the cathode, which then quickly loses its sensibility. Even though there are wars to counteract these effects, they prevent the microchannel-plate photomultiplier from working at an optimum (Fliyckt and Marmonier 2009).

Multi-channel photomultipliers

This PMT was created to correct the limitations of the microchannel-plate photomultipliers. This model of the PMT has 10 foil dynodes of CuBe creating parallel channels. These tubes also have 94 and 96 channels with a variety between channels below 5% (Fliyckt and Marmonier 2009). It improves the packing ratio in the useful and dead areas. However, this version of a channel still suffers from low quantum efficiency and a below average gain between pixels and linearity.

Smart photomultipliers

These are a combination of large electro-optical preamplifier tubes and a small photomultiplier tube. They outshine the rest of the PMTs because their tubes have a high immunity to magnetic fields as the earth (Ling et al. 2013). They also have the ability to detect a low-level multi electron signal in an environment with high single photoelectron background. A good example is the deep-water muon and neutrino detectors. The problem with the Smart photomultipliers is that they require large detection volumes as water, ice, or scintillator, which, as a result require large numbers of photomultipliers (Ling et al. 2013).

An alternative to the classical photomultiplier tubes (PMT) and its advantages and disadvantages

Technological advancements today enable the scientist develop alternatives to traditional equipment something that would have proved very difficult in the past. The silicon photomultiplier (SPM) technology is a distinct and impressive alternative to the classical photomultiplier. Li et al. (2012) provides research indicating that the silicon photomultiplier works very efficiently and even sometimes better than the classical photomultiplier tubes.

Winning features in the SMP include high-energy physics, fast radiation detection, its use for PET AND MRIs, confocal microscopy, cytometry, and spectroscopy. Many scientists argue that these winning characteristics enable the SMP to perform exquisitly in areas that require the use of PMT. However, the one disadvantage that the SMP has is that it produces too much noise (Li et al. 2012).

Ideal characteristics of an ideal photomultiplier tubes (PMT) in nuclear medicine

Today, the photomultiplier tube technology is used to benefit the medical areas through scanning and other operations. The sophisticated equipment SPECT is utilizing the gamma camera to help detect diseases through high spectrum imaging. A patient is injected with a radiophermacuitical which targets the required organ that it results to produce gamma rays. The medical technichians then use the gamma cameras that utilize different technology to detect the emitted gamma rays. Scintigraphy (scint) uses two dimension images to cupture emitted radiation from the isotopes in the body. The second technology is the SPECT imaging that is used in nuclear cardiac stress testing that also uses the gamma cameras. The SPECT technology uses one or more detectors that rotates around the patient's torso. Nucleur medicine also usesposition emission tomography that uses multi head PMTs on the gamma cameras.

For cameras to be used, they must pocess certain characteristics for it to be fully functional in the medical sector. The most important feature of gamma cameras utilizing the photomultiplier tube is high sensitivity. High sensitivity is made possible today by scientist constantly striving to improve the ability of the cameras to achieve that spectacular sensitivity that provides proper detection of activity in the human body (Yamamoto et al. 2012). Recently, scientists added two to three camera heads in the SPECT to aid sensitivity even more. With more than one camera, the equipment is now able to count gamma ray pairs from a positron-emitting nuclide (Yamamoto et al. 2012). Another feature that is very necessary for photomultiplier tubes used in nuclear science is high spatial resolution. Its advantage is that the RI rapidly changes in the distribution and can be easily measured. In addition, the length of time used to diagnose diseases is dramatically shortened (Yamamoto et al. 2012).

A good scanner must also have very high spatial resolution. Such a feature is very important since animals being used to improve medicine mostly require scanning. Since the animal organs are, too small they require equipment with very high resolution. The gamma cameras use large numbers of scintillation detectors that comprise of position sensitive photomultiplier tubes. In addition, they combine these tubes with 32 BGO scintillation (Yamamoto et al. 2012). They utilize 240 photomultiplier tubes, therefore, 7, 680 BGO scintillators are needed to make a well-functioning gamma camera.

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