Performance study on the 1-inch FPMT

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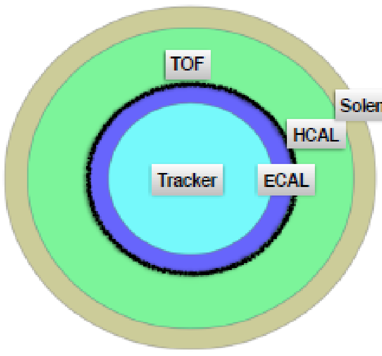
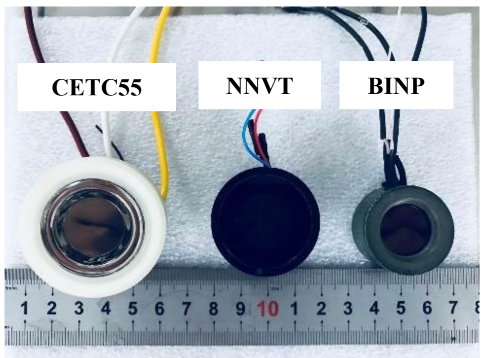
1. Introduction

A micro-channel plate(MCP) is an array of miniature electron multipliers that are each acting as a continuous dynode chain. The compact channel structure results in high spatial and time resolutions and robustness to magnetic fields. Given their very short transit time spread, fast timing MCP-PMTs(FPMTs) will be used in time-of-flight (ToF) and particle identification of CEPC. So far, the R&D of FPMTs is still in progress. Combining the dE/dx and ToF measurements leads to an efficient distinguish between different hadrons. In our laboratory, we have researched and tested several FPMTs, such as CETC55, NNVT and BINP.



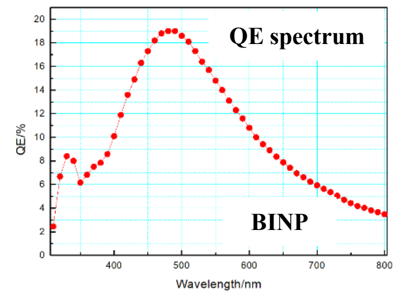
The reduced graph of the CEPC Detector



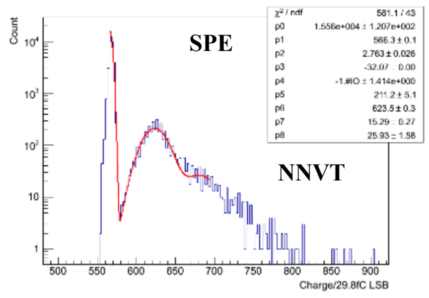
FPMTs in our lab

2. The typical performance of FPMTs

We had build up performance evaluation system and study the properties of FPMTs. All FPMTs have active area diameter of 18 mm.



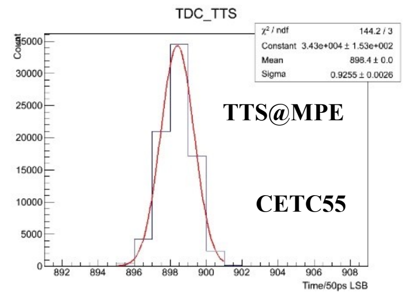
The FPMT of BINP has a good QE, but it can't get SPE spectrum. Therefore, the gain of FPMT is low.



The FPMT of NNVT can get SPE spectrum. The gain of FPMT is more than 10^7.

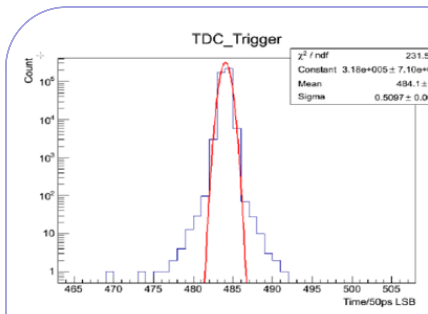
	CETC55	NNVT	BINP
QE	6.3%@540nm	14%@390nm	19%@490nm
SPE	No	Yes	No
Gain	~10^5	>10^7	~10^6

Both FPMTs of CETC55 and BINP are multi-alkali photocathode. However, the NNVT's FPMTs have a bialkali photocathode.

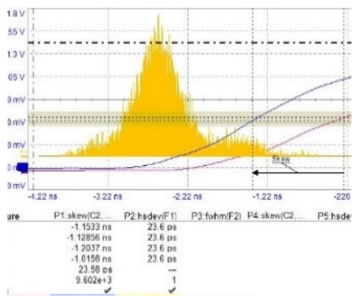


The FPMT of CETC55 has a good TTS.

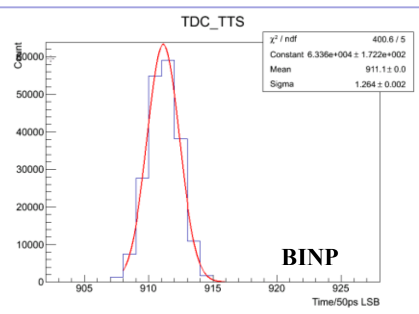
3. The time resolution test of FPMTs



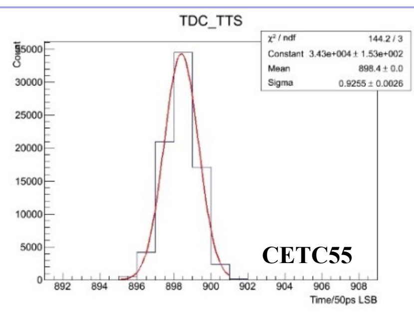
System error@TDC=25.0 ps



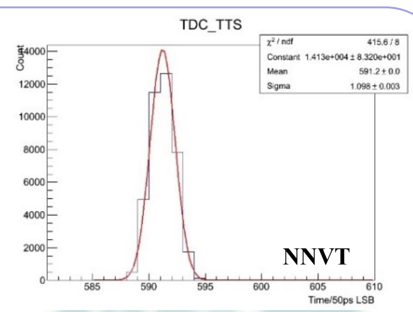
System error@Oscillscope=23.4 ps



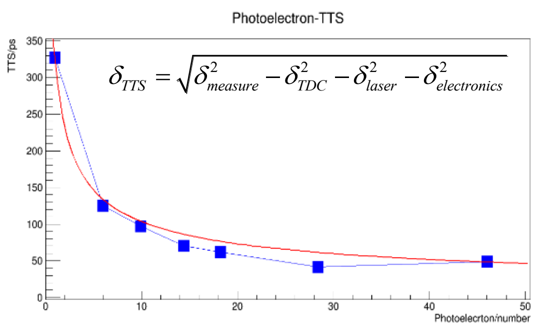
TTS@MPE=63.2ps



TTS@MPE=46.3ps



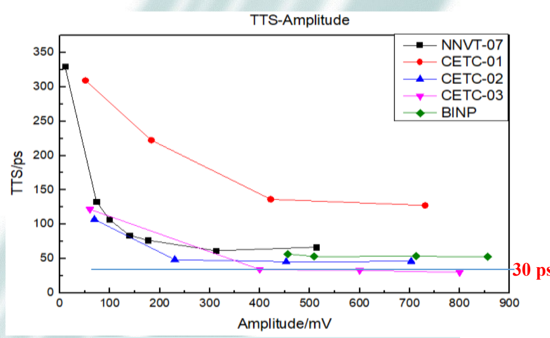
TTS@MPE=54.9ps



TTS VS Photoelectron

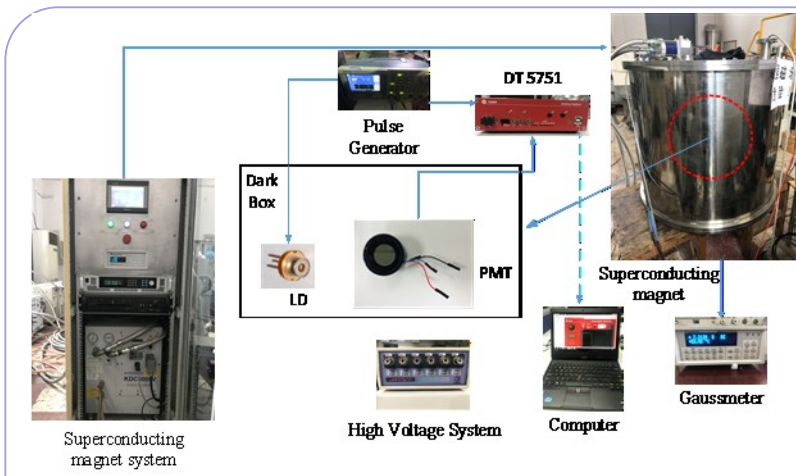
We used two data acquisition systems, TDC and oscilloscope respectively. The system error of these devices must be calibrated before testing TTS. The results show that the system errors of TDC and oscilloscope are almost identical. In addition, the jitter of picosecond laser is 45 ps.

The TTS of FPMT is related to the number of photoelectrons. What's more, we tested different FPMTs' time resolution. The limit time resolution is up to 30 ps. By the test results of the sample tube, we will propose a better solution for FPMT to improve.

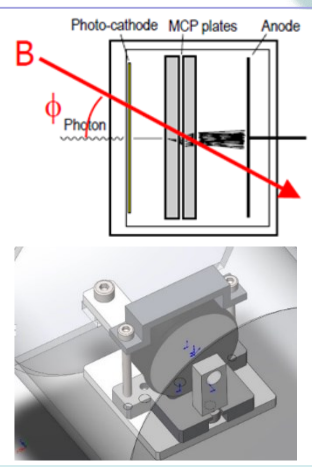


Different FPMTs' time resolution

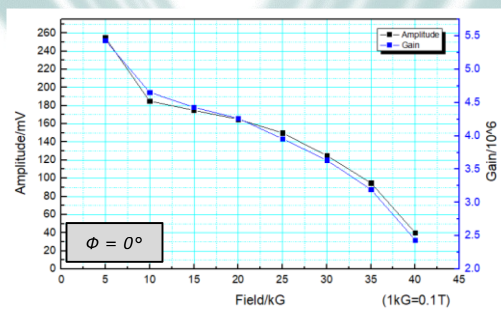
4. The magnetic field test of FPMTs



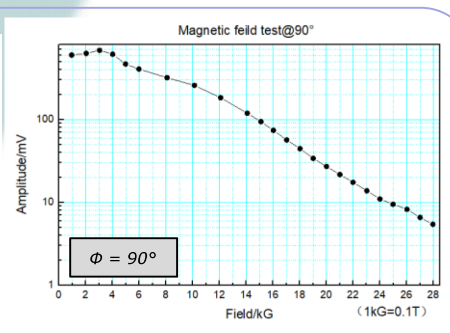
Experiment Setup



The angle between MCP and Field



The change of gain and amplitude @0°



The change of amplitude @90°

*Note: The sample is a **single-anode** FPMT. The magnetic field test will be ended when the SPE can't be tested or the amplitude is decreased by **100 times**.*

Due to their intrinsic properties (narrow amplification channels and proximity focusing electron optics), FPMTs are appropriate detectors for applications involving strong magnetic fields. Test results indicate that robustness to magnetic fields is up to 3T. Both gain and robustness to magnetic fields are best with a 6 μm pore size of MCP module.

Acknowledge

The FPMT development project has been partially supported the Foundation of State Key Laboratory of Particle Detection and Electronics, and the National Natural Science Foundation of China (Grant No.11175198 and No.11475209 and No.11675205 and No.11675196). Thanks to the samples provided by NNVT.