



中國科學院為能物況研究所 Institute of High Energy Physics Chinese Academy of Sciences

# The R&D of the Ultra Fast MCP-PMTs for High Energy Physics

Lishuang MA(马丽双), Qi

Tutor: Sen Qian (钱森

Institute of High energy Physics, Chinese Academy of Science qians@ihep.ac.cn 11th. August. 2022

中国物理学会高能物理分会第十一届全国会员代表大会暨学术年会



# The Motivation of the FPMTs

# ♦ 2. The Key Technologies of the FPMTs

# ♦ 3. The Performance of the FPMTs

#### 1.1 Motivation



IHEP Design: After the successfully 20 inch MCP-PMT R&D, the PMT group in IHEP try to design and produce the 2 inch FPMT(Fast PMT), with high QE photocathode, and low cost!

# 1.3 The Ability of the R&D for the MCP-PMTs





### 1. The Motivation of the FPMTs

# ♦ 2. The Key Technologies of the FPMTs

#### ♦ 3. The Performance of the FPMTs

#### 2.1 The FPMT Simulation Models



Ref: Qi Wu, Oral report. The performance simulation and Structure Optimization of Small Fast MCP-PMT, IEEE NSS&MIC, 2020

6

#### 2.2 FPMT Anti-magnetic Performance



#### construction of different types of FPMTs.

Ref: Yao Zhu et al., Sensors and Actuators A 318 (2021) 112487.

#### 2.3 The Limit Time Resolution of the FPMTs



Resolution, the best TTS of the FPMT.

----Some FPMT can not test the SPE spectrum and the TTS<sub>SPE</sub>, but can get this TTS<sub>limit</sub>. Ref: Yao Zhu et al., Y. Zhu et al., "Study of Time Characteristic Test Method of the Fast Timing MCP-PMT, 2019 IEEE NSS&MIC. 8

### 2.4 Summary of Key Technologies





# 1. The Motivation of the FPMTs

# ♦ 2. The Key Technologies of the FPMTs

# ♦ 3. The Performance of the FPMTs

#### 3.1 Sigle Anode FPMT



Ref: Lishuang MA et al., R & D of a novel single anode fast timing MCP-PMT, 2022, Pre-proof, NIMA.

#### 3.2 2\*2 Anodes FPMT



Ref: Sen Qian, Oral report, The R&D of the Ultra Fast 8X8 Readout MCP-PMTs, ICHEP 2020

#### 3.3 4\*4 Anodes FPMT



Ref: Lishuang Ma, The status of the R&D of Ultra-Fast 8 times 8 readout MCP-PMTs in IHEP, Pos (ICHEP2020) 867

#### 3.4 8\*8 Anodes FPMT



Ref: Qi Wu et al., R&D of ultra-fast 8 × 8 anodes MCP-PMT, 2022 JINST 17 T04002.

#### Summary

- FPMT sample tubes of single anode, 2\*2 anodes, 4\*4 anodes and 8\*8 anodes have been successfully developed.
- Successfully developed dedicated ultra-fast front-end electronics, high-frequency signal processing circuits, and ps waveform analysis algorithms.
- The TTS @ SPE of single anode FPMT can reach 27.2 ps, the TTS @MPE is less than 5 ps, which is an exciting result for the development of fast time detection technique.
- The TTS@SPE of 8\*8 anode FPMT has achieved 38.5 ps, TTS@MPE is less than 10ps.
- Further optimization like rise time and uniformity are in processing.