IWCD / WCTE 3” PMT Requirements Specification

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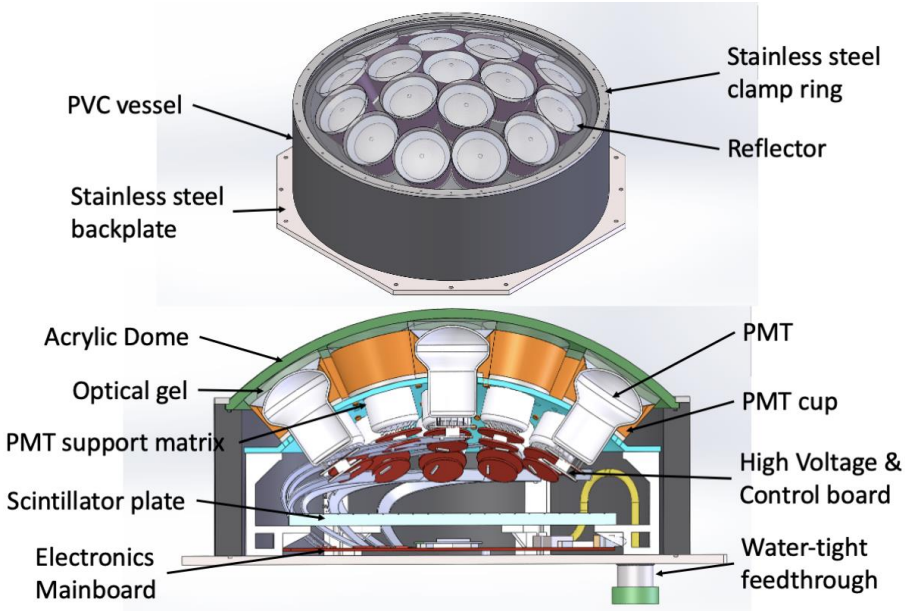
Introduction

This document is meant to list the critical technical requirements for the 3” PMTs for the IWCD and WCTE mPMTs.

The following specifications are for the tendering procedure of 3” photo-multiplier tubes to be placed inside a IWCD mPMT photosensor module. The tubes are designated as 3” but there is a certain amount of flexibility in the diameter. A reflective ring will be installed around the photocathode. A thin layer of silicone gel will make the optical contact with the acrylic done and the photo-cathode. The photomultiplier tubes are suspended in a support structure. A cross-section view of the IWCD mPMT is shown below:



In the following, the min. and max. specifications indicate the values that must be passed by all delivered PMTs. The typ. specifications should be met by 80% of each batch of 1000 photo-multiplier tubes. The photo-multiplier tubes should withstand temperatures of -20° C to +50° C during transport, and 5° C to 30° C with humidity within 20 and 50% during operation. Consideration will be given for photo-multiplier tubes which pass the specifications over a larger photo-cathode area.

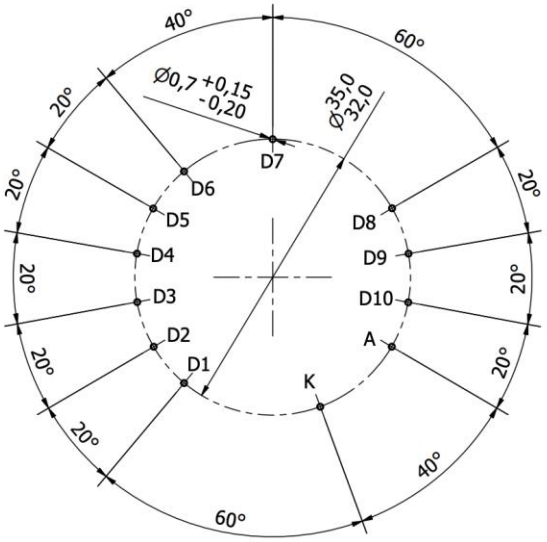
Mechanical Requirement Specifications

1. Minimum diameter of photo-cathode: 72 mm min. This is the diameter over which the total efficiency is at least 50% of the efficiency at the center of the photo-cathode.
2. Length of flying leads: 50 mm min.

3. Length of short flying leads: shorter than 15.9 mm
4. Diameter of wire for flying leads: 0.85 mm max. – 0.50 min.
5. Diameter of circle of flying leads: 32 mm (min) - 35 mm (max)
6. Radius of curvature of front face: 60 mm max.
7. Tolerance on provided Radius of Curvature of front face: ±0.5 mm max.
8. Length from center of front face to center of rear of photo-multiplier tube excluding pins/flying leads and vacuum seal: 105 mm max.
9. Length including vacuum seal: 115 mm max.
10. Largest diameter cannot exceed 81.3 mm.

Pinning and Dynode Voltages:

11. Pinning sequence looking at base of tube: monotonic sequence from Anode to Cathode.
12. The pin ordering, position and size should follow the layout shown in the figure below
13. Number of Dynodes: 10.
14. Number of voltage steps (Nsteps): 13 max.
15. Voltage difference between successive stages (including Anode and Cathode): Integer multiples of (Vcathode-Vanode)/Nsteps
16. Voltage between Cathode and D1: may be subdivided for focusing.



Gain and Linearity:

17. Voltage for gain 0.5×10^7: 950 V min. – 1450 V max.
18. Gain Slope (d log G/ dlog V): 6.5 min. – 8.0 max.
19. For light pulse widths of 5 ns, the PMT should not deviated from a linear response by more than 5% for pulses of 50 p.e. or less.

Efficiency

20. Quantum Efficiency at 470 nm (uniform illumination): 18% min. – 20% typ.
21. Quantum Efficiency at 404 nm (uniform illumination): 25% min.
22. Quantum Efficiency at 325 nm (uniform illumination): 20% min
23. Collection efficiency: 87% min. – 92% typ.
24. Homogeneity of product of collection and quantum efficiency (average value obtained from area within 72 mm diameter): ±20% max. – ±15% typ.

Timing

25. Transit time spread (FWHM) for uniform illumination of cathode for single photoelectron and 0.3 spe threshold: 2.0 ns max. – 1.6 ns typ.
26. Pulse duration for single photo-electron at FWHM: 2 ns min. – 8 ns max.

Noise characteristics

27. Dark count at 20 °C and 0.3 spe threshold within 12 hours: 600 cps typ., 1500 cps max.

Other Detector Parameters:

For the following specifications it is assumed that the photo-cathode is uniformly illuminated with single photons and the detection threshold is set at 0.3 spe, unless otherwise specified. Note that the time is
defined with respect to the main peak.

28. Peak to Valley ratio: 1.8 min., 2.2 typ.
29. Prepulses between -60 ns and -10 ns: 0.1% typ., 0.5% max
30. Delayed pulses between 15 ns and 60 ns (i.e. pulse arriving late with no pulse at correct time): 2.5% typ., 4.5% max
31. Late after-pulses between 100 ns and 10 µs: 10% typ., 15% max
32. For p.e. levels greater than single photo-electron, the afterpulsing rate will not increase with a slope greater than 10% per p.e.

Specifications for soldering

33. The length of the flying leads must be uniform (max. tolerance 2mm)
34. The PMT serial label must always be in the same position to facilitate the assembly operation on the base.
35. Flying leads must be pre-tinplated in accordance with IPC J-STD-003C (JOINT INDUSTRY STANDARD) standard to allow good manual welding with lead-tin wire

Packaging of the PMTs for the transportation

Particular care and attention must be paid to the packaging for the transport of PMTs, with reference to

- strength of the box against mechanical shocks of PMTs during the transportation;
- light tightness;
- handling of the box
- that each PMT is not in contact with the other PMTs inside the box.

It is required, for all deliveries, that each box contains a printed sheet showing the technical characteristics of the delivered PMTs; the presence of an accelerometer or shock indicator is mandatory.

The technical characteristics of each PMT must also be provided in electronics format. The format of the electronic file containing the characteristics of each PMT will be agreed upon after the completion of the tender and provided only to the winning company.

The company has full responsibility for the transport including insurance; the supply will have to be delivered free of customs clearance and all shipping costs including any duties and customs operations will be fully covered by the company.