DRAFT

August 31, 1999
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Characteristics Specifications:
Photomultiplier Tube R7761
for the CDF Upgrade / TOF Detector

1. Characteristics

(A) In the absence of magnetic fields, PMTs have to meet the following requirements.

1.1 Intrinsic output pulse width:	5 ns typical (FWHM)
1.2 Current amplification:	A current amplification of 1.0×10^7 (MYU) or larger at a high voltage of 2000 V.
1.3 Applicable high voltage limit:	250 V above the voltage that gives a gain of 7.0×10^7 (MYU).
1.4 Cathode blue sensitivity:	Minimum of 8.0 μA/lm-blue. More than 85% of the tubes have to have at least 9.0 μA/lm-blue.
1.5 Anode dark current:	Maximum of 300 nA at the high voltage that gives a current amplification of 7.0×10^7 (MYU).
1.6 Pulse linearity:	Within $\pm 2\%$ up to 50 mA.
1.7 Temperature dependence of gain:	The variation of anode output for a wavelength of 420 nm should be $-0.6\%/^\circ$C at the maximum.
1.8 TTS:	The transit time spread (TTS) for single photoelectrons should be less than 500 ps (FWHM) at a high voltage of 2000 V.
1.9 Stability of anode dark current:	No sparks or unstable behavior should be observed when anode dark current is measured in the dark for at least three hours with a high voltage (positive polarity) applied.

(B) In the presence of a 1.41-T axial, uniform magnetic field, PMTs have to meet the following requirements.

1.10 Gain:	At a high voltage of less than 2.5 kV, PMTs should have a gain of 3×10^5.

2. Tests and Inspections
The test methods and data are specified as follows for the items listed in Section 1.

(A) Outside a magnetic field:

2.1 Intrinsic output pulse width:	Guaranteed, but measurements will be done for more than 5% of the tubes.
2.2 High voltage limit:	HPK will test all tubes before shipping.
2.3 Current amplification/Gain:	HPK will test all tubes before shipping.
2.4 Cathode blue sensitivity:	HPK will test all tubes before shipping.
2.5 Anode dark current:	HPK will test all tubes before shipping.
2.6 Pulse linearity:	Guaranteed, but measurements will be done for more than 2% of the tubes.
2.7 Temperature dependence of gain:	Measurements will be done for more than 3 tubes that are randomly selected.
2.8 TTS:	Guaranteed, but measurements will be done for more than 10% of the tubes.

(B) Inside the 1.41-T magnetic field:

2.9 Gain:	The purchaser measures the gain as specified in (1.10) for all tubes.

3. Data to be Supplied

[1] Measurement data from the tests performed outside a magnetic field for all tubes:
Each PMT shipment lot should be accompanied by measurement data in a floppy disket for the following measurement items.
Also a list of the serial numbers for the shipped tubes should be provided.
The data disket and the serial number list must be contained in the same shipment box as the tubes.

1) Serial number
2) Cathode lumen sensitivity (Sk) : (μA/lm)
3) Cathode blue sensitivity (Sk-blue) : (μA/lm-blue)
4) Anode sensitivity (Sp at 2000 V) : (A/lm)
5) Current amplification (MYU) at 2000 V : (E7)
6) Anode dark current at 2000 V : (nA)
7) Equivalent voltage at MYU $= 7.0 \times 10^7$: (V)
8) Anode dark current at MYU $= 7.0 \times 10^7$: (nA)

[2] Measurement data from the tests done outside a magnetic field for selected tubes:
Data should accompany PMT shipments at an appropriate frequency.
The data must be contained in the same shipment box as the tubes.
The following data should be provided.

1) Intrinsic pulse width : waveform
2) Pulse linearity : figures
3) Temperature dependence : figures
4) TTS : waveform
5) Long term stability : figures (operation at anode current of 100 μA for more than 3000 hours. Data for at least 5 tubes)