SPECIFICATION OF THE TAGGER MICROSCOPE DETECTOR AND THE READOUT ELECTRONICS

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0. Introduction

This document provides the specifications for the Tagger Microscope and corresponding electronics.

1. Optical Fiber Dimensions

- Transverse tolerances on optical fiber dimensions are set based upon the minimum variation we can hope to achieve in the thickness of the glue layers between the fibers. Random sampling of the fibers from the manufacturer give variations between +0 and -40 microns from nominal. Gaps are easier to deal with than bulges, so the tolerances are asymmetric.
    - Coming from the spool:
        - 2.00 + 0.02 - 0.08 mm
    - Fused joint bulge:
        - 2.00 + 0.04 - 0.08 mm
    - After painting:
        - 2.00 + 0.05 - 0.08 mm
- Scintillating fiber length tolerances are set at 5% of the total length, partly because this is easy to achieve with our construction methods, and partly because the final gain match fiber-to-fiber is not expected to be better than this. Light guide fiber length tolerances are set to keep the time dispersion between fibers in a summed column much less than the 200ps time resolution of a single column.
    - 2.00 + 0.10 - 0.10 cm for scintillator segments
    - 168 + 0.5 - 0.5 cm for light guide segments

2. Fiber Bundle Dimensions

- Glued bundle outer dimension tolerances are set to what can be readily achieved with our construction method.
    - Height (5 fibers high):
        - 1.00 + 0.20 - 0.40 mm
    - Width (6 fibers wide):
        - 1.20 + 0.24 - 0.44 mm

3. Light Guide to SiPM Alignment

- Separate tolerances are specified for the air gap between the SiPM and the polished

end of the light guide, and the transverse misalignment of the light guide and the active area of the SiPM.

- Air gap: 0.5 + 0.3 - 0.2 mm
- Centering: 0 +/- 0.5 mm

4. Angular Alignment of Bundles with Focal Plane

- Tolerance on angular placement of the individual fibers on the mounting rail inside the microscope is set to be small compared to the characteristic alignment angle between the electron trajectories and the fiber axis of 2 degrees. The following tolerance is a local divergence between the nominal electron ray at that point on the focal plane and the fiber bundle that it intersects.
  - angular alignment: +/- 0.5 degrees

5. Fiber Bundle Alignment with Horizontal Midplane

- The external alignment motors are capable of centering the middle fiber row on the spectrometer midplane, but this requires that the central fiber row be aligned internally to itself. This tolerance is just half the tolerance on the total height of the bundles given above.
  - Center of central fiber row: 0 +/- 0.10 mm

6. Total Material in Nominal Electron Pathway

- This specifies the geometry of the light guide, which will bend downward out of the electron pathway so as to minimize showering in the light guides. This figure includes both the scintillating fiber and the light guide material.
  - total track length in polyethylene: 7.0 +/- 2.0 cm

7. Light Transmission

- Light transmission will be measured for each bundle relative to a reference bundle. The reference bundle will be chosen for uniformity of transmission seen in visual inspection. Light transmission through all other bundles will be compared to the reference bundle by exposing both to the same light pulses viewed through a diffuser.
  - light transmission variation: less than +/- 15%

8. Preamplifier Component Placement

- The SiPM location tolerance is 0.2mm from the silkscreen outline

9. Preamplifier Board

- The following tolerances are stated for preamplifier boards with the external VCC power pins set at 5.75V, as measured at the voltage reference sub-circuit.
    - The dc operating points must agree with the supplied 'dc operating points' spreadsheet
    - Rise time of pulses from laser diode pulser: 2.0 +/- 1.0 ns
    - Fall time of pulses from laser diode pulser: 12 +/- 3 ns
    - Single pixel pulse height in high gain mode: 12 +/- 2mV
    - Ratio high/low gains seen with a pulser: 10 +/- 1

10. Control Board

- The control board should give the expected responses to all programmed commands issued over ethernet. A test suite will be written to guarantee this. The DAC must be capable of the following:
    - all channels should give the same voltage out in response to a given DAC value to within +/- 0.1 V at zero current.
    - all channels should be able to supply up to 200 microAmps of current without sagging by more than 0.2 V from the level at zero current.
    - all channels should be able to supply up to 700 microAmps of current without sagging by more than 1.0 V from the level at zero current.
    - clock frequency should be 20 +/- 2 MHz.