Experiment 949
Technical Note # NNN

# Fiber optic bundles for E949 Range Stack monitoring system

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**Abstract**

This note describes layout, production and testing of fiber optic bundles for E949 Range Stack monitoring system, based on a fiber network with a blue LED as light source. Each bundle of 175 fibers is divided into 7 mini-bundles of 25 fibers and covers six sectors of Range Stack or 12 sectors of Barrel Veto and Barrel Veto Liner photomultipliers. One of these (25 fibers) mini-bundles serves as a control for each big bundle to monitor LED light source stability. In total 14 bundles have been produced (6 will be used on each side of the detector + 2 spare ones).

## 1 Introduction. General system layout.

The E949 RS Gain Monitoring system is based on a fiber optic network with a blue LED as light source for each bundle of fibers. The system outline is presented on Fig. 1. Main elements are: LED and Control photomultipliers

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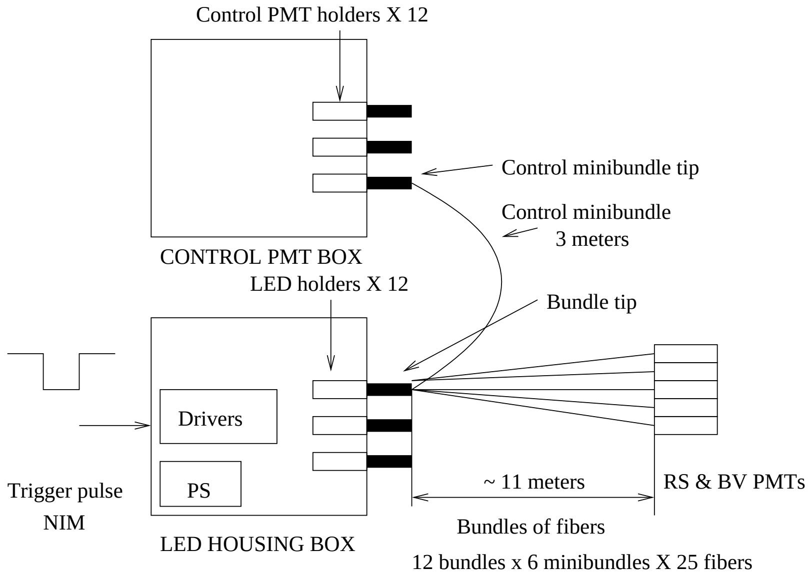


Figure 1: General layout of monitoring system.

temperature controlled boxes, fiber bundles, LED holders, LED drivers and power supplies, control PMT holders, and RS (or BV,BVL) PMT region fiber mounting structures.

For temperature stability reasons light sources, e.g. LED holders with driving circuitry, are housed inside one temperature controlled box, the control PMTs for monitoring of the LED's light output on flash by flash basis are housed inside of a second temperature controlled box.

Each bundle of 175 fibers is divided into 7 mini-bundles of 25 fibers, has its own light source (NSPB320BS) with individual driver, and covers six sectors of Range Stack or 12 sectors of Barrel Veto and Barrel Veto Liner photomultipliers. One of these 25 fibers mini-bundles is used as a control for each big bundle and serves to monitor LED light source stability. In total 14 bundles have been produced (6 will be used on each side of the detector + 2 spare ones).

This note covers only fiber optic part of the system.

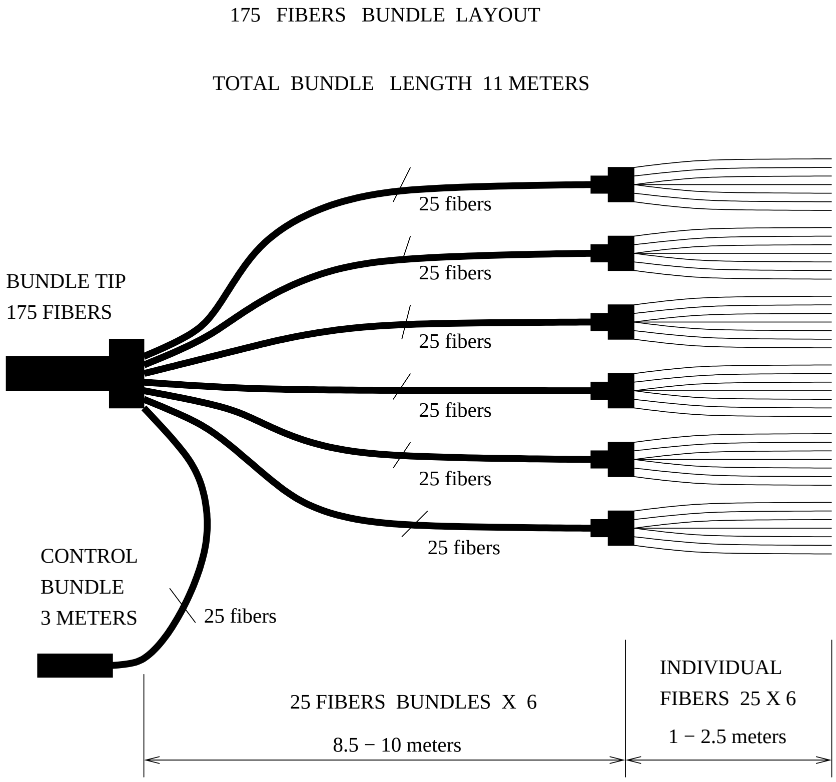


Figure 2: Bundle layout.

## 2 Bundle outline

The bundle outline is presented on Fig. 2. Each bundle consists of 7 mini-bundles and common bundle tip. Each mini-bundle has 25 fibers. Total length for each fiber is 11 meters except for the control fibers which are 3 meters long. The control mini-bundle has its own tip common for 25 fibers. Working mini-bundles have 8.5 (for BV type bundles) to 10 (for RS type bundles) meters of fibers together in common PVC tube, and 1 to 2.5 meters of fibers separated individually in individual PVC tubing. Joint between common PVC tube and individual fibers is protected with black noryl transition cap filled with RTV. Separation of fibers with individual protection tubing is started inside this cap.

The picture of one fiber bundle is shown on Fig. 3. The picture of Bundle

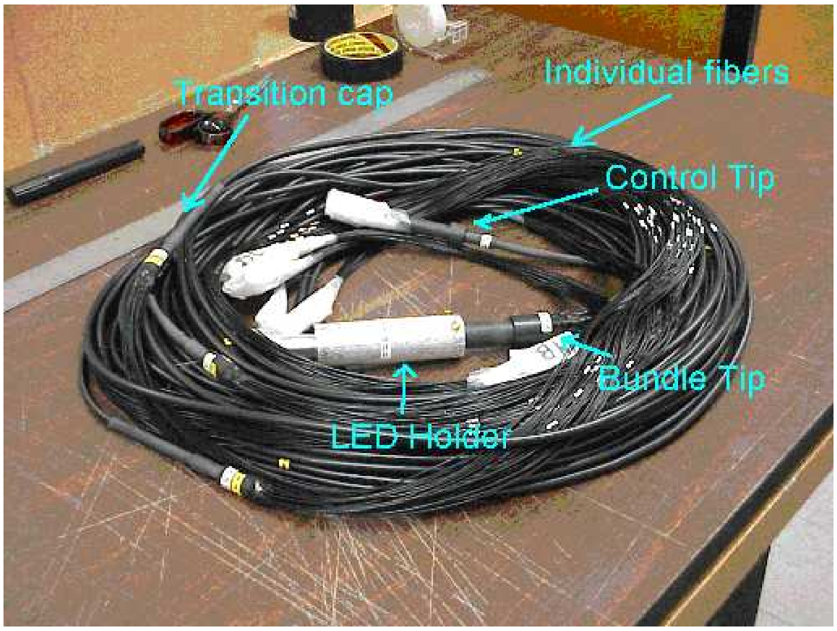


Figure 3: Bundle of 175 fibers.

tips is shown on Fig. 4.

We used communication grade Mitsubishi Rayon Co. Ltd. Eska Premier GK-20 plastic fiber with following specs:

• Core diameter - 500 microns (0,5 mm),

• Refractive Index: Core - 1.492, Clad - 1.402

• Numerical Aperture - NA = 0.51,

• Temperature range - -55°C $\div$ +85°C,

• Attenuation - 0.18 dB/meter (0.14 dB/meter typical).

For fibers protection black PVC tubing was used:

• Alpha Wire PVC-105-4 with ID = 5.28 mm for common mini-bundle part,

• Alpha Wire PVC-105-22 with ID = 0.68 mm for individual fibers.

The ends of fibers on the common bundle end were fitted in a black noryl tip, then all free space was filled with epoxy (TraCon FC-113SC), and after this the face of the tip with the fibers inside was polished using a felt polishing wheel to produce a good surface on fiber ends. The same procedure was done for control mini-bundle tip.

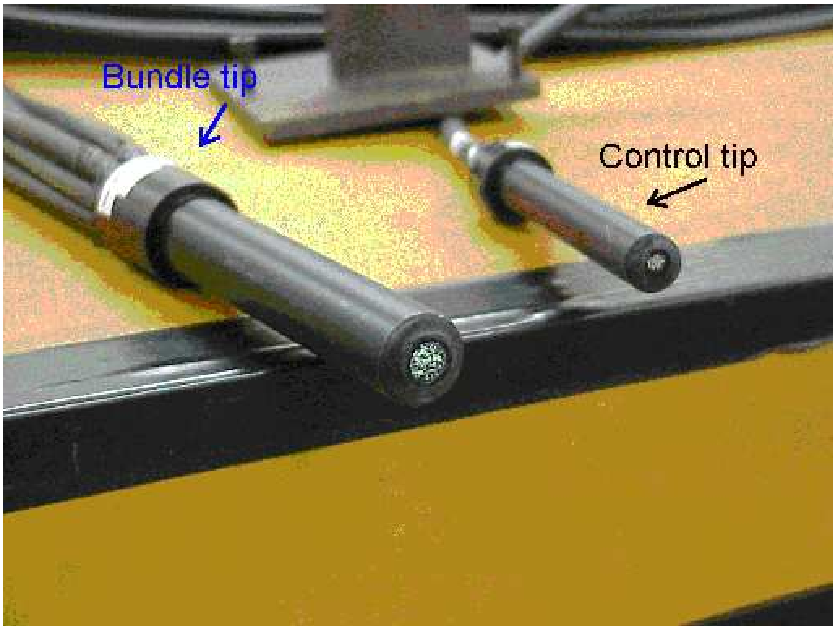


Figure 4: Bundle tips.

For other ends of fibers treatment procedure was the following. First a drop of epoxy was applied on the end of individual PVC tubing. Because of surface tension this epoxy was sucked inside that tubing fixing fiber and its protective tubing together on the end. Then fiber was cut by a hot knife shortly near (0.5 - 1 mm) the end of PVC tubing. The final step was to polish that fiber end on felt polishing wheel.

Tips and transition caps were fixed to the protective PVC sleeve by short pieces of shrink tubing, so all mechanical stability of the whole bundle is based on PVC tubing. Fibers inside are fixed only on the ends, have ability for some movement, and have no mechanical tension applied to them. Finally for light insulation all gaps in tips and transition caps were filled with black RTV.

Schematic layout of the LED holder is shown on Fig. 5. The holder is a cylindrical aluminum piece with a LED press mounted on one side and bundle tip inserted from the other side. The distance from the LED to the bundle tip edge can be adjusted by moving the tip and fixing it with screws. The LED is protected from outer light by black RTV applied over it. Mounting

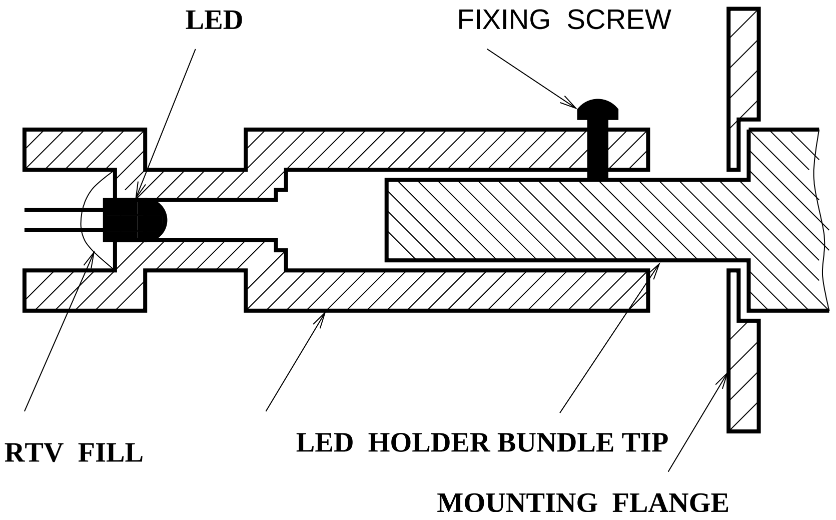


Figure 5: LED holder schematic layout.

of the holder and bundle tip together to the temperature controlled box wall is done with a mounting flange glued to the bundle tip, so no mechanical strength is applied to the holder – bundle tip contact in the event of any bundle movement.

Schematic layout of control PMT holder is shown on Fig. 6. The control PMT holder is a rather complicated structure. Not all elements of it are shown on the picture. The PMT is spring loaded into a holder made from black noryl. The amount of light from control bundle is decreased by ND filter to be on scale with the light output from $YAlO_3$ light pulser which provides a absolute stable reference. Mounting of the holder and bundle tip together to the temperature controlled box wall is also done with a mounting flange glued to the control bundle tip for the same reason of mechanical stability of the holder to bundle contact.

# 3 Test procedure and results

All 14 bundles were tested on setup which is shown on Fig. 7. Relative light output of each individual fiber was determined for each bundle. After all 25 fibers of one mini-bundle were loaded into slits in moving stage, the light output of each one was scanned when moving against a photomultiplier

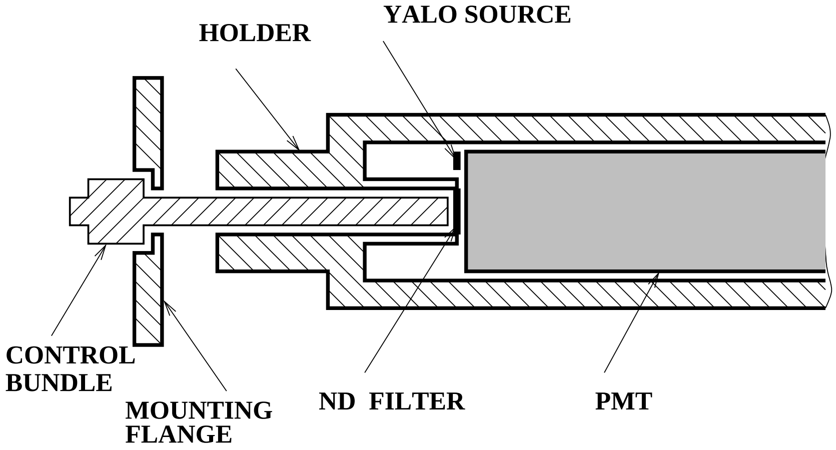


Figure 6: Control PMT holder schematic layout.

window covered by screen with a vertical slit in it. Each bundle was tested with its own LED/LED Holder and the same LED driver card, but different LED driving pulse amplitude to make the light amount about equal in output.

## 3.1 Test results.

# 4 Conclusions

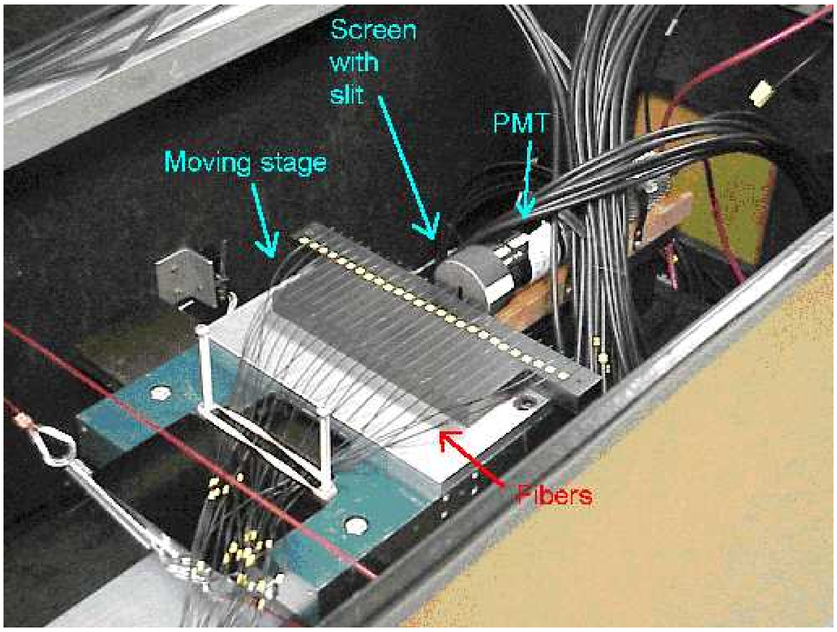


Figure 7: Test setup.