Results on gamma irradiation of Select Cut-Off SM Fiber S630 (bare fiber) from Nufern

1. Goals

Quantify the radiation-induced attenuation on Nufer fiber Select Cut-Off SM Fiber S630

Establish the feasibility of using these fibers in the CMS radiation environment.

2. Experimental setup

2.1 Samples preparation and irradiation facility

The bare fiber from Nufern was cut in several samples of different length: five samples of 4m and two of 3m. Each sample was irradiated with gamma rays up to a different dose: 20KGy, 50KGy, 75KGy, 100KGy, 120KGy, 150KGy and 300KGy. For the irradiation a ^{60}Co source was used. The gamma ray energy is about 1.2 GeV. The irradiation rate was 139.86Gy/min. The dosimetry error in the delivered dose was 9.81%. The irradiation was done at a mean temperature of about 16.5 ºC.

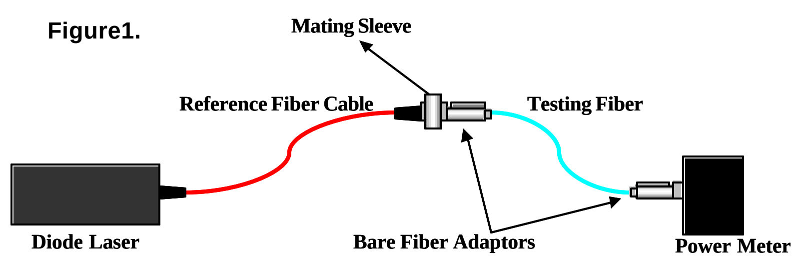
2.2. Experimental layout for attenuation measurement

We measured the transmission losses of the fiber, before and after irradiation, with respect to a reference fiber. The experimental layout is shown in figure 1.

We have used a semiconductor 670nm laser module from MONOCROM. The laser module is coupled to a single mode fiber cable (reference fiber) 15 meters long (3M single mode fiber, FS-SN-3224-630nm). The testing bare fiber (Nufern Select Cut-Off SM Fiber S630) is connected at the end of the reference fiber. The optical power is measured using a PD300-UV smart head from Ophir Optronics, Inc.

The optical power out of the reference fiber is about 0.2 mWatt. The reference cable has FC connectors at its ends. To connect the bare testing fiber to the reference fiber and the power meter head, a Newport single mode FC bare fiber adapter is used at each end of the testing fiber.

Figure1.



3. Attenuation measurement

3.1 Measurement sequence

For each fiber sample we measured the attenuation three times, before and after irradiation, as follows:

1. We connected bare fiber adaptors to each end of the testing fiber.
2. We measured the optical power out of the reference fiber.
3. We connected the testing fiber to the reference fiber and we measured the optical power out of the testing fiber.
4. We disconnected the two bare fiber adaptors from the test fiber.
5. Connecting the bare fiber adaptors requires cleaving a small tip of the testing fiber, therefore the testing fiber length slightly decreases for each measurement. To take this in to account we measured the length of the testing fiber between measurements.

3.2. Measurement errors.

The dominant source of uncertainty in the measurement procedure described above comes from connecting the bare fiber adaptor to the testing fiber. To determine the losses induced in these connections, we have measured nine times the transmission losses for three equal length fibers. To avoid further systematic effects introduced by the laser power drift we wait for the laser power stabilization. Figure 2 shows the optical power stability out of the reference fiber during this sequence of measurements. Reference stability for these series of measurements is excellent, less than 1%.

The loss introduced by connecting the bare fiber to the power meter and reference fiber in each of the measurement is shown in Figure 3. The average loss is equal to 2.32dB with a dispersion of RMS = 0.37dB. These values have been used to correct the raw attenuation measurement values of the irradiated fibers, and also for the error estimates.

Figure 2.

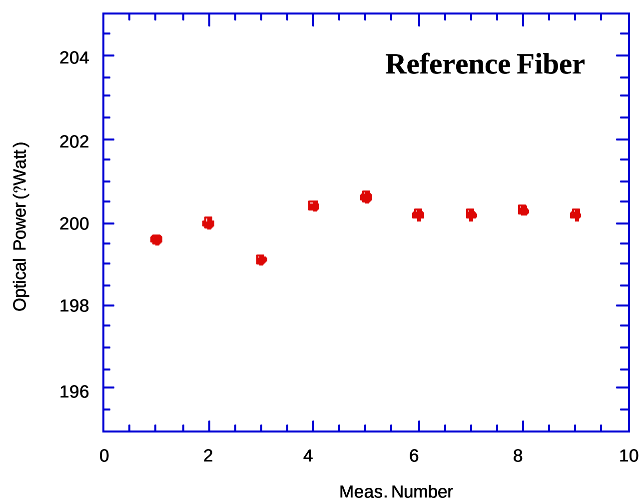
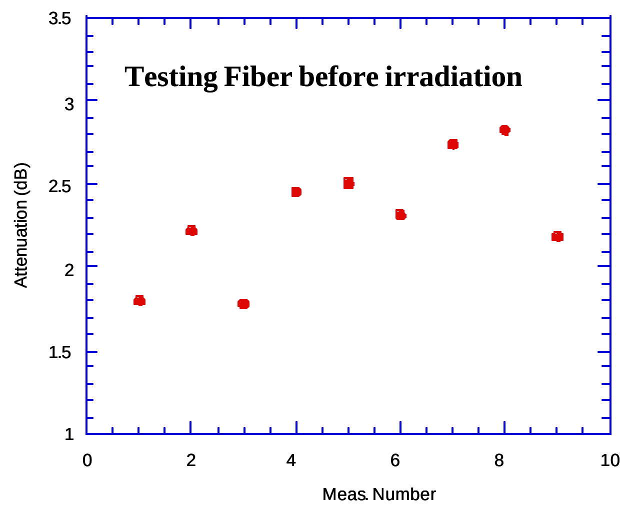


Figure 3.



4. Results

We show in Figure. 4 the radiation-induced attenuation on the testing fiber for the different integrated doses at 670nm.

Figure 4.