Results of the Irradiation Experiment of Light Emitting Diodes (LED) in Linac II Tunnel of the DESY

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1 Introduction

It's known that neutron flux causes the displacement damage of p-n junction in semiconductors, such as Light Emitting Diodes (LED). It has been observed earlier that, the displacement damage reduces the light emission of the LEDs.

The goal of this experiment is to investigate the nature of displacement damage of the LED irradiated with neutrons at two exposure levels.

2 Test system

Test routine:

1. Measurement of light emission of LEDs.
2. Irradiation at different locations in Linac II tunnel (Figure 1).
3. Measurement of light emission of the irradiated LEDs.

The LEDs were irradiated in neutron/photon mixed field near the positron converter in Linac II tunnel. We used yellow LED (3 mm diameter) manufactured by Panasonic company (model: LN48YPX) placed at two positions (see Figure 1):

1. On the lead shielding of the electron-positron converter (5 diodes) (LED-1 in Figure 1).
2. Near the entrance of the tunnel (4 diodes) (LED-2 in Figure 1).

The LEDs were irradiated for 7 days, from 13:45 hr / 28.10.2003 to 12:15 hr / 4.11.2003. During this time Linac II worked for about 1825 minutes (30,5 hours). The only known value, except beam energy, is beam current in PIA. The PIA is the acronym of Positron Intensity Accumulator. The PIA accummulates positrons produced by the positron converter. The Avarage current in PIA was about 14.96 mA, during the experiment. The current in Linac II / positron converter was calculated to be 8% of the PIA current.

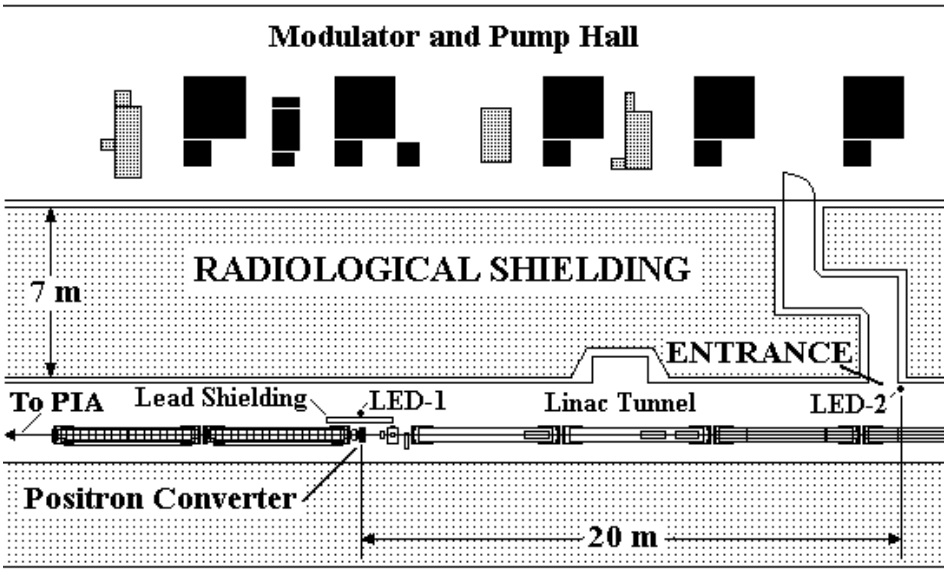

Figure 1: Locations of LEDs in the Linac II tunnel

3 Results

After the experiment, we observed that the light emission of the LEDs changes differently, depending upon their position in Linac II tunnel. The avarage light emission of the LEDs as function of forward current is shown in Table 2. In Figure 3 the ratio of the light emission related to the unirradiated (control) LEDs is graphically displayed as function of forward current. The error bar represents a standard deviation (σ) of +/- 3%.

LED current mA	no irradiation (control) Lux	post irradiation (entrance, LED-2) Lux	post irradiation (converter, LED-1) Lux
20	65.3	60.75	22.2
35	130.9	124.25	48.8
50	190.9	183.25	77.6
70	254.2	245.75	112.6

Figure 2: Avarage LED light output of the control and with neutron irradiated LEDs

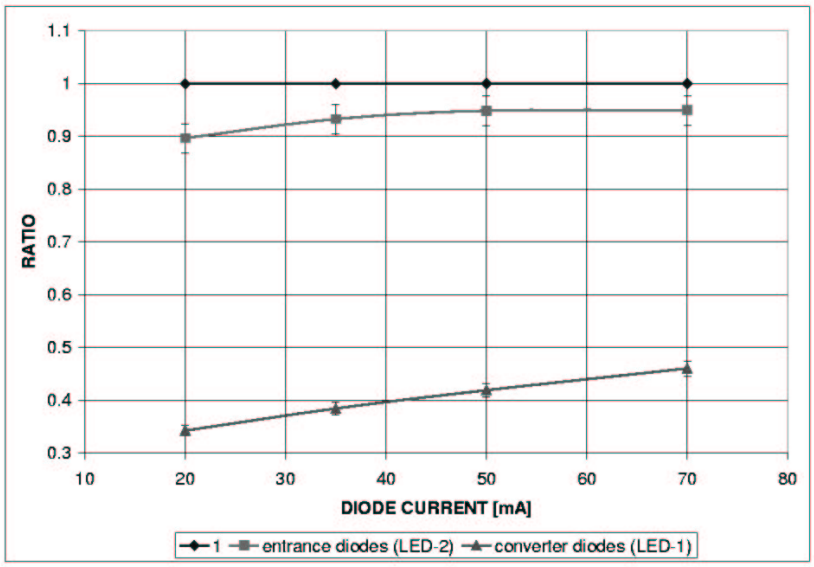

Figure 3: Light emission ratios of the un-irradiated (control) and with neutron irradiated LEDs, shown as a function of diode current

4 Conclusions

This investigation demonstrated the influence of neutron irradiation in the light emission characteristics of the LEDs. The results confirmed that using this technique, a wide dynamic range of neutron flux could be assessed. The optimum operational diode current was found to be 20 mA. Calibration of the LEDs using high energy neutrons will follow soon.