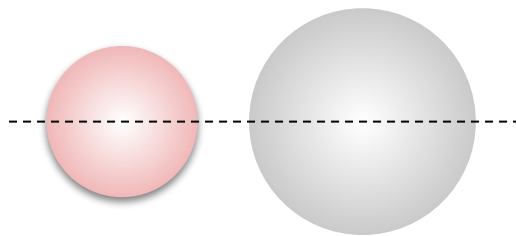




LED angular distribution measure

01/12/2021

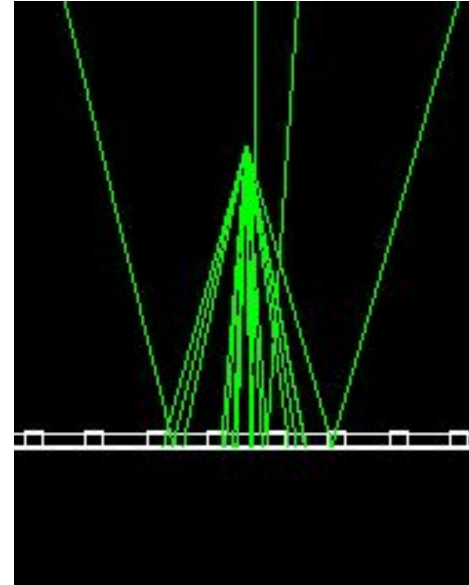
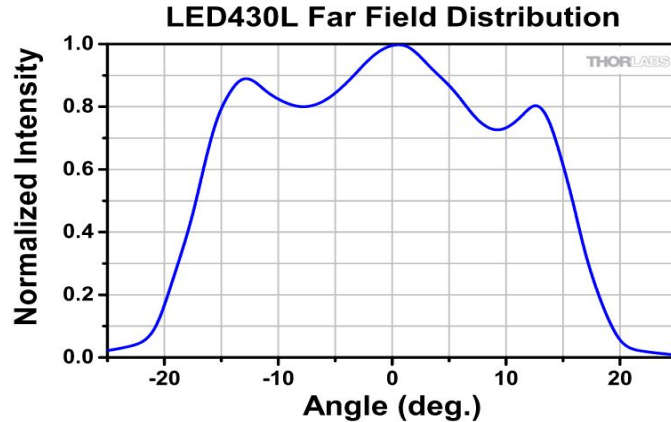
Julio Ureña



Procedure

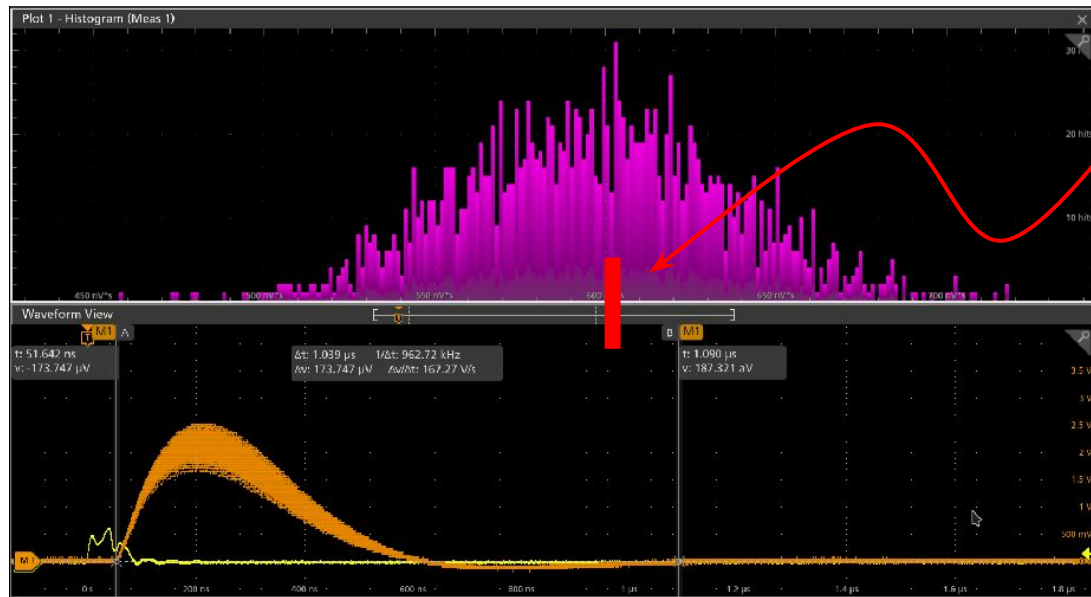
1. Take the manufacturer's info regarding the angular relative intensity distribution via digitization

$$I_r^0(\theta)$$



Procedure

2. Take (relative) intensity vs. angle measurements

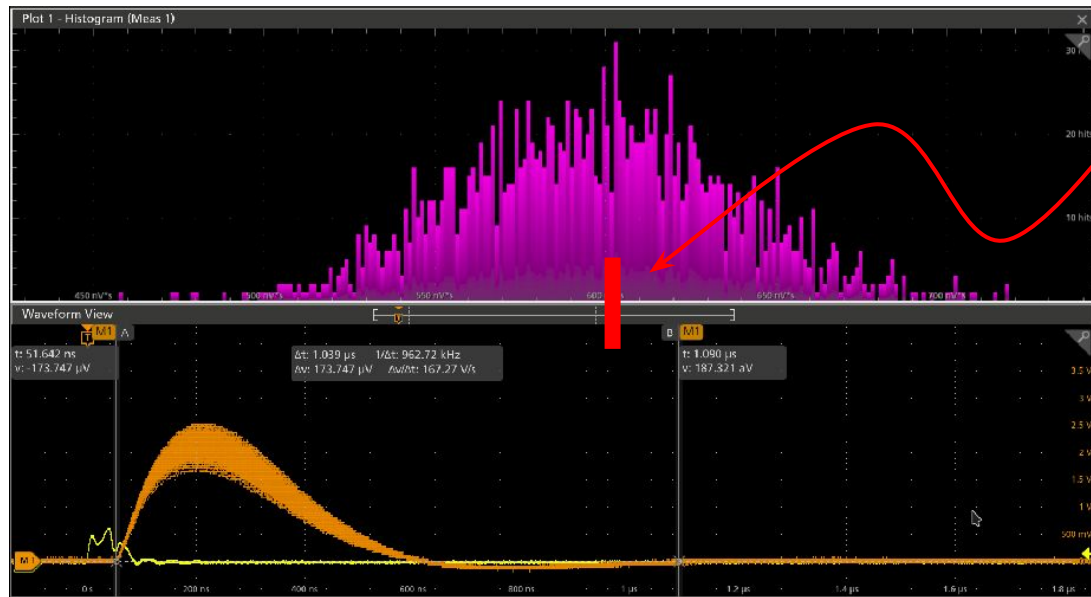


The averaged released charge in the SiPM is proportional to the averaged received intensity

Thus, in order to compute relative intensities at different SiPM positions by computing released charge ratios, the signal baseline needs to be adjusted to zero

Procedure

2. Take (relative) intensity vs. angle measurements

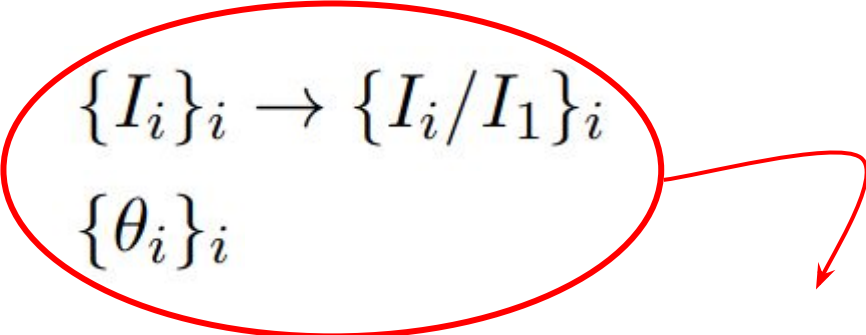


The averaged released charge in the SiPM is proportional to the averaged received intensity

$$\{I_i\}_i \rightarrow \{I_i/I_1\}_i$$

$$\{\theta_i\}_i$$

3. Assume LED symmetry under rotation and fit the manufacturer's distribution to the taken data

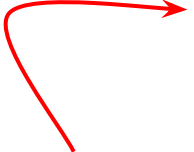

$$\{I_i\}_i \rightarrow \{I_i/I_1\}_i$$
$$\{\theta_i\}_i$$

Compute the minimum of the f function, which depends on the global angle shifting $\Delta\theta$ and the reference scaling parameter θ_1^*

$$f(\theta_1^*, \Delta\theta) = \sum_i \left| \frac{I_i(\theta_i)}{I_1} - \frac{I_r^0(\theta_i - \Delta\theta)}{I_r^0(\theta_1^*)} \right|$$

3. Fit the manufacturer's distribution to the taken data

The fitted relative intensity distribution is referred to the first taken measure, whose angle with respect to the LED axis is a priori unknown and is determined as part of the optimization process

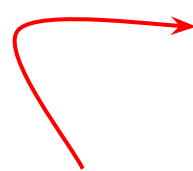

$$I_r^1(\theta) = \frac{I_r^0(\theta - \Delta\theta)}{I_r^0(\theta_1^*)}$$

$$f(\theta_1^*, \Delta\theta) = \sum_i \left| \frac{I_i(\theta_i)}{I_1} - \frac{I_r^0(\theta_i - \Delta\theta)}{I_r^0(\theta_1^*)} \right|$$

3. Fit the manufacturer's distribution to the taken data

The new relative intensity distribution is also optimally shifted to compensate the fact that the LED might not be perfectly aligned towards the SiPM card

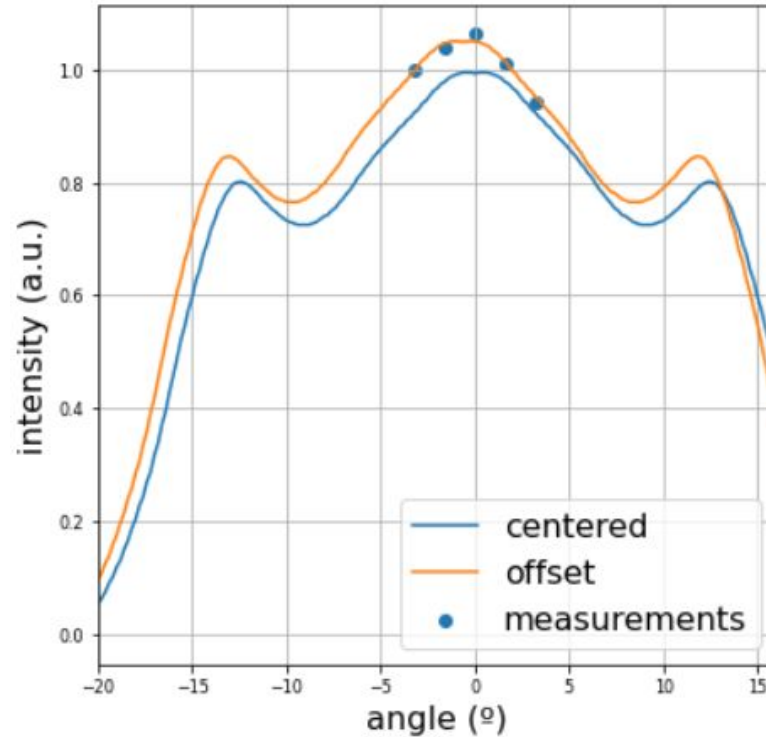
Actually $\Delta\theta = \Delta\theta(\theta_1, \theta_1^*)$ it was set as a free parameter for a better fit.


$$I_r^1(\theta) = \frac{I_r^0(\theta - \Delta\theta)}{I_r^0(\theta_1^*)}$$

$$f(\theta_1^*, \Delta\theta) = \sum_i \left| \frac{I_i(\theta_i)}{I_1} - \frac{I_r^0(\theta_i - \Delta\theta)}{I_r^0(\theta_1^*)} \right|$$

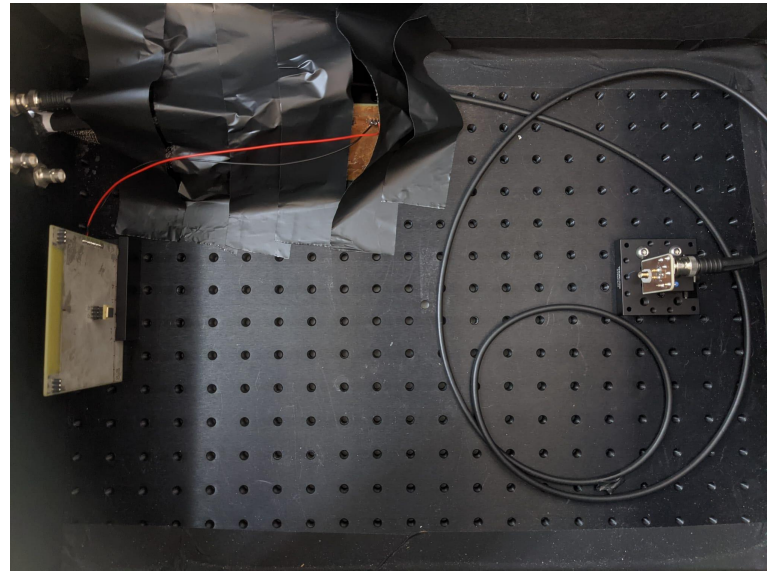
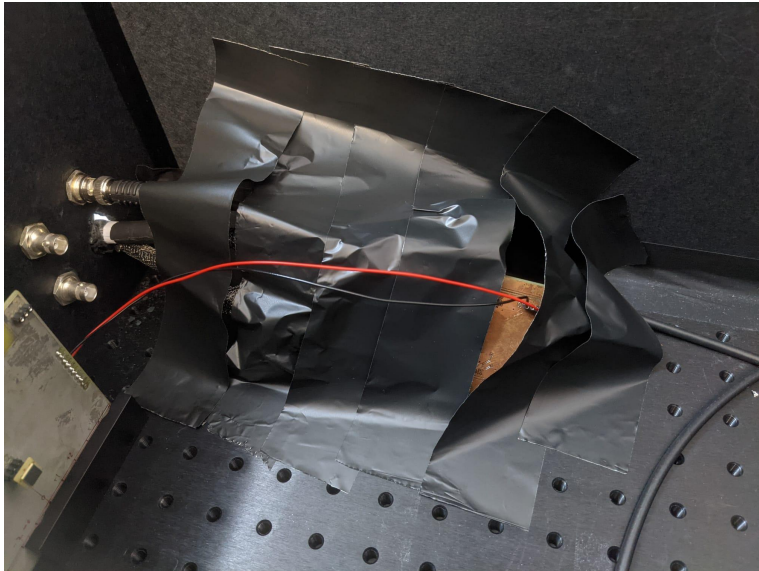
Results

Measurements that were taken closer to the (reflective) auxiliary card reveal a higher intensity



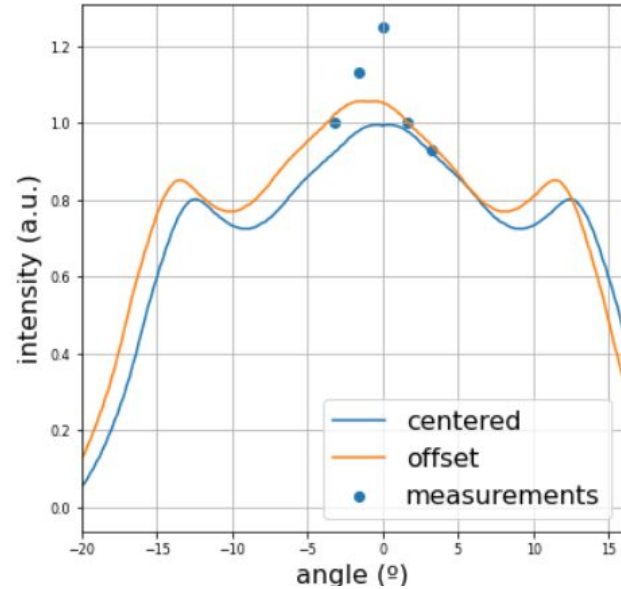
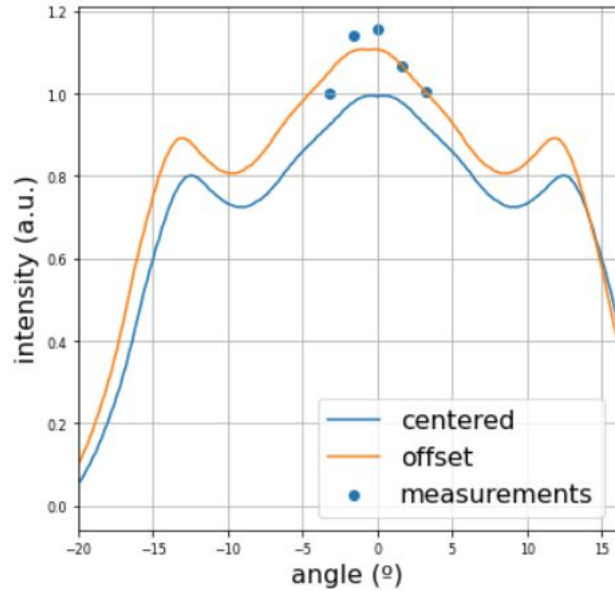
Results

To try to compensate this effect, the secondary card was shielded with black tape



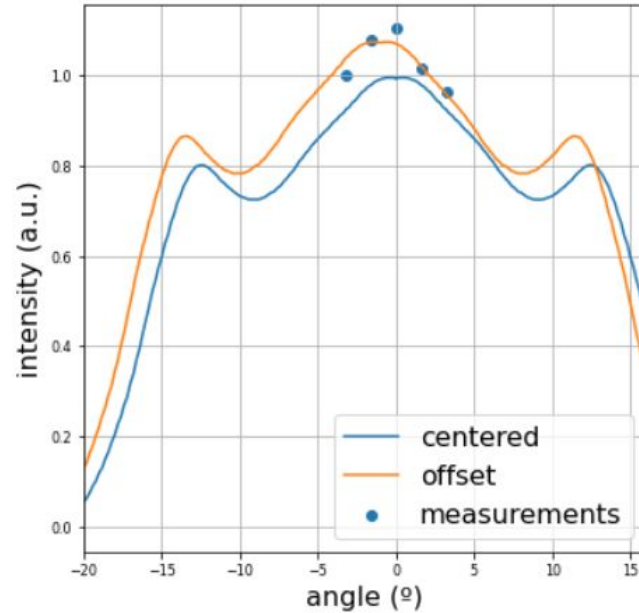
Results

The results were actually worse



Results

Removing the black shield and retaking the measurements was not satisfactory either



However, although the current precision seems to be not enough, the fact that all measurements showed higher intensities for negative angles may actually indicate that the LED is not symmetrical in the sampled plane

Conclusion

This measurements are, to some extent, irreproducible. The need for opening and closing the big box to modify the SiPM position could indirectly affect the LED direction with the current setup. The setup should be upgraded to be more robust, maybe adding proper optical tools.