SHIL Light Array User Guide

SHIL LightArray Advanced User Guide 378P

Section Half Imaging Logger Light Array Installation and Calibration: Advanced User Guide

Manual Information

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Introduction

This manual presents techncial staff with information about installing and calibrating the light array.

Theory

Multiple Lighting

In order to achieve the required depth of field at the target gantry speed design goals, a very intense light source is needed (F/16 = 120 s for 150 cm of travel). To achieve that light intensity, the light source must be very close to the area to be illuminated.Light dissipates to the square of the distance; therefore, at the distance between the light source and the core sample, even minor deviations in distance result in a density change that is noticeable to the human eye and possibly beyond the dynamic range of the camera sensor's sensitivity.Core samples do not necessarily present flat surfaces; indeed, some of the recovered cores have surface variations as large as 30 mm.As shown on the diagram, light source to core surface distance AB results in proper exposure, whereas light source to core depth distance AC results in underexposure. Therefore, to light the sample uniformly through the entire depth, an uneven light source must be used.Diagram missingA method of illuminating every different level presented by a sample is necessary because of sample depth and irregular core surface. Providing this illumination requires a highly controllable light path by including baffles or focusing lenses that produce directional beams of light. Fine control is needed to paint the sample with light evenly throughout its elevation range.The light source selected is an Advanced Illumination light-emitting diode (LED) array focused through a lens, which generates a 6 mm wide beam of light at 100 mm distance from the face of the lens. The solution to providing the illumination required is an arrangement of 6 lights in 2 banks in a fan-like configuration. The lower 2 lights illuminate the surface, the middle 2 lights illuminate the middle depth of the core, and the top 2 lights illuminate the lowest depth of the core. LED lights offer the following advantages:

- Cooler temperature
- Color temperature does not vary with power setting
- Long lasting
- Lens focused beam
- Very intense (90 klx at 75 mm)

The LED lights chosen for this system consist of 12 separate emitters in a row focused to a beam by an acrylic lens. The beam narrows to a path 5 mm wide at 75 mm from the face of the lens. At distances <75 mm from the face of the lens, each LED emitter is projected as a separate beam, resulting in unusable light banding and hot spots. The light from the emitters is not blended to a homogeneous beam until it is >75 mm from the face of the lens. The beam yields its best light at 100 mm from the face of the lens.The light is rated for maximum intensity at 75 mm from the lens, but this distance is not recommended because of the poor quality of the light beam. The ideal usable distance is between 75 and 100 mm from the face of the lens; 100 mm is the target distance.Therefore, each pair of lights in the array fan is placed 4 inches (~100 mm) from the illumination target area of the core.

Light Array Arrangement and Naming

The light array is configured with 2 banks of 3 lights each. Facing the light control panel side of the core logger, the left bank of 3 lights is labeled "P1" and the right bank of 3 lights is labeled "P2." (The bank names correspond to labels on the controller units.)Pairs of lights, one from each bank, are responsible for illuminating different levels of the core sample to be imaged. However the lights are named, it is important to pair the levels of lights to the same power controller. Naming suggestions follow:

- Each bank has lights A, B, and C, giving the following pairs :
    - P1-A and P2-A
    - P1-B and P2-B
    - P1-C and P2-C

- Each bank has lights to illuminate surface (S), middle (M), and bottom (B), giving the following pairs:
    - P1-S and P2-S
    - P1-M and P2-M
    - P1-B and P2-B
- Change bank numbers to B1 and B2 with levels A, B, and C, giving the following pairs (Note, this naming convention is used throughout the rest of this manual):
    - B1-A and B2-A
    - B1-B and B2-B
    - B1-C and B2-C

Light Installation

This process should be followed upon initial installation and any time a light source is moved or replaced. Light installation includes the following:

- Installing the lights
- Adjusting the lights: coarse and fine adjustments
- Adjusting power intensity

Light Installation

The LED light array mounting hardware consists of 4 plates, each with 4 sets of countersunk holes 0.25 inches apart. These countersunk holes allow each light to be set 100 mm from the target area it must illuminate. The bottom-most set of countersunk holes is not used.

Initial Lighting Installation

	Level all mounting plates by measuring using the gantry base plates as a datum marker.
	Mount light pair B1-A and B2-A 100 mm from the core surface ("zero") using the second set of countersunk holes from the bottom of the plate.
	Mount light pair B1-B and B2-B 100 mm from 15 mm below the surface of the core (–15) using the third set of countersunk holes.
	Mount light pair B1-C and B2-C 100 mm from 25 mm below the surface of the core (–25) using the fourth set of countersunk holes.

Lighting Adjustment

Lighting adjustment occurs in 2 major steps, initial adjustment and fine adjustment.

Making Initial Adjustments to Lighting

	Place the calibration target sample in the core sample rail support.
	Using the grab function and free gantry travel, center target on screen (ensure camera is set to grab mode).
	Align the target precisely to the single line of pixels.
	Turn on the lowest bank of lights (pair A) and slightly loosen the countersunk adjustment screws.
	Point each light on either side of the target and split each beam at the surface (level zero) of the target.
	Slightly snug the countersunk screws.
	Slightly loosen the countersunk screws on light pair B and turn on the lights.
	Adjust the lights to span the level 15 mm below the target surface (–15) to touch the beam of light pair A.
	Slightly snug the countersunk screws.
	Slightly loosen the countersunk screws of light pair C and turn on the lights.
	Adjust the lights to place the beam between the level 25 mm below the target surface (–25) and touching the beam from light pair B.
	Slightly snug the countersunk screws.

Fine Adjustment

Up to this point, the vertical target line has been used to align the lights. The 45° slope line will be used in the fine adjustment to achieve feathering or overlap of the beam. During fine adjustment, the line represents the line of pixels that camera images. On the line it is apparent that target areas are not covered smoothly, as the beam edges may not touch. Disregard the intensity or apparent brightness of the beams and concentrate on "painting" the line from top to bottom with light. Density adjustments will be made during a later step.Note that 3 pairs of lights at 5 mm beam width each will not quite cover the full 35 mm of core depth. If needed, bias the light coverage starting at the top of the core, as this is the most frequently imaged. Sacrificing the deepest 5 mm (level 30-35 mm below the core surface [-30 to -35]) in light coverage and focus is acceptable.

Making Fine Adjustments to Lighting

	Carefully overlap the beams until they barely touch, maintaining even light coverage along the target line.
	Tighten all countersunk screws to set the beam adjustments.
	Proceed to final adjustment and calibration of the camera color and exposure (see "Camera Calibration"), after which the density adjustment for the sample at different levels will be achieved by adjusting the power settings.

Power Intensity Adjustment

In theory, the installation procedures above should provide the same light intensity to each of the levels targeted in the core (however, they do not). The reason the intensity differs is the angle at which the light strikes the core surface. Therefore, the weakest light is that with the shallowest angle to the core surface (lights B1-A and B2-A).Despite efforts to provide even illumination, it is still not equal at each target area of the core. This illumination level discrepancy is normalized by using individual power settings for each light pair. Recommended initial power levels are as follows:

- Pair B1-1 and B2-A: 100%
- Pair B1-B and B2-B: 50%
- Pair B1-C and B2-C: 25%

These settings illustrate that light angle has more effect on intensity than distance does. However, the target distance of 100 mm must be maintained because it is the ideal distance for light quality without hot spots or banding.Because power settings <100% may prolong bulb life, recommended initial power settings based on testing at F/16 are as follows:
[Author: Do you have recommendations for F/22?]

- Light pair A: 70%
- Light pair B: 40%
- Light pair C: 25%

Adjusting Light Power Intensity

	After the camera is calibrated and adjusted, image the multilevel core calibration standard.
	Read density targets in PhotoShop. Disregard normal density gray card settings (e.g., 128) because the dynamic range of the camera is not linear. Expect gray card densities in the range 70–128.
	Look at trends and ratios to the topmost density target on the core standard and then match the lower targets using power settings for light pairs B and C.

Author: I have callouts and captions but no photos for the following figures:

1. **Light source with distances A, B, and C in relation to the split core sample.**
2. **Light source with baffles or multiple beams.**
3. **Arrangement of six lights.**
4. **LED bulbs and LED lens focus lengths.**
5. **Naming of light banks and levels.**
6. **Overlapping light beams.**Provide screenshots, drawings, photos, or applicable.