Harvard Flatscreen Calibration Project

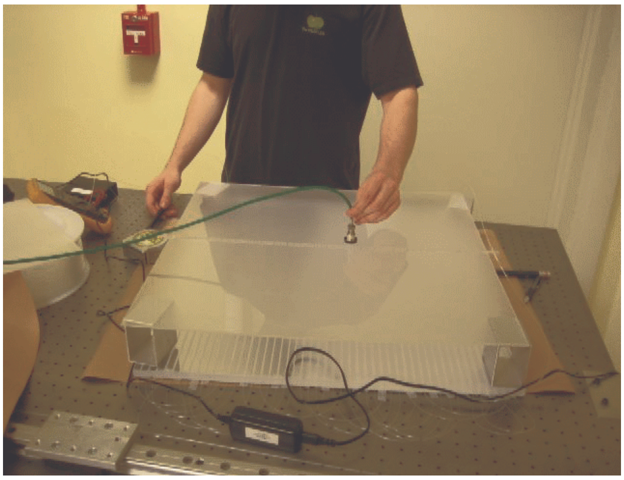
Progress Report

2 March 2006

Design Concept

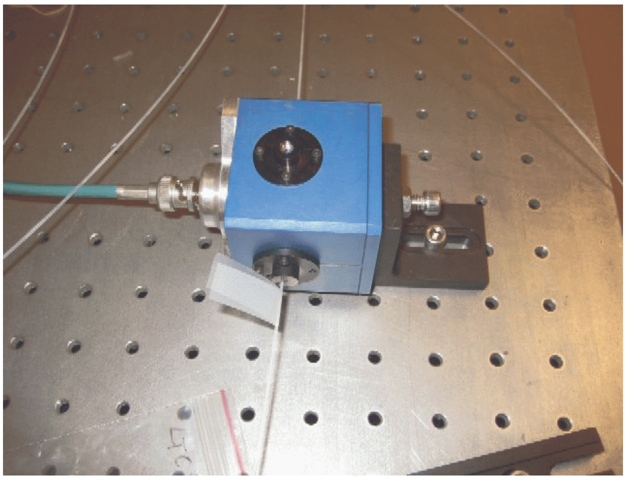
- Design details are firming up with laboratory experience.
- The radiating panel consists of three layers: a sheet of acrylic with a “side-emitting” optical fiber embedded in it, a mirror backing, and a diffusing sheet of acrylic in front.
- The radiating panel is supported by being captured between two aluminum honeycomb structural panels. The front panel has a circular hole the size of the telescope aperture.
- The radiating optical fiber is fed by a tunable pulsed laser.
- The fiber is laid out in a series of straight, parallel channels spaced 1/2 inch apart. The filling order of the channels is chosen to even out the falloff of intensity of the emission along the length of the fiber.
- A design elaboration under consideration is to use several fibers fed in parallel, thus mitigating the intensity falloff problem. This approach also obviates the need to procure a single very long fiber. The challenge is to design a suitable multiplexer.

Test Progress


Surface brightness testing.

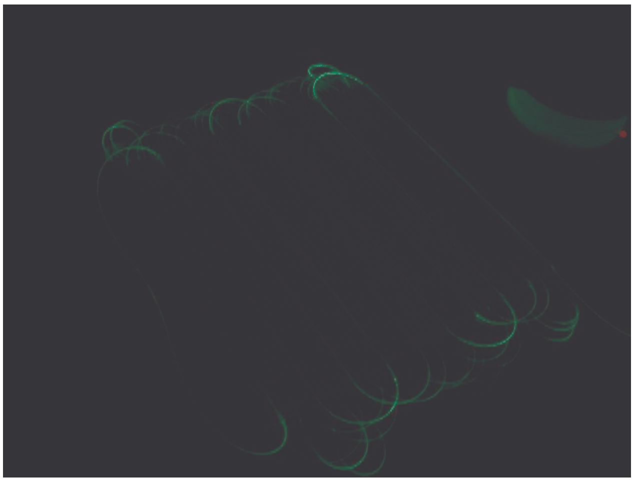
- We are in the process of constructing a 24-inch square (16-inch diameter radiator) prototype to evaluate our assembly ideas and to evaluate our ability to produce even illumination.
- Following construction of the 24-inch prototype, we have planned a 48 inch prototype to evaluate planned techniques of joining larger acrylic panels. This exercise will also give us the opportunity to evaluate the optical performance of a longer fiber, or multiple fibers.
- We have bench-assembled a 24-inch radiator using inexpensive plastic fiber (Eska). Currently the fiber is excited with a green laser diode (a green laser pointer with a fiber coupler fitted) or an incandescent fiber illuminator.
- After considerable searching, we have found a supplier of 800μ silica-core, side-emitting fiber with the appropriate optical bandwidth. The fiber is supplied with a retroreflector fitted to the distal end. This fiber is drawn with its attenuation constant specifically matched to the fiber length so that the illuminance at the distal end is (approximately) equal to the illuminance at the

feed end. There is some falloff towards the center of the length of fiber, but this arrangement makes for relatively even illumination. The supplier is Somta, Ltd, Riga, Latvia. The principal of this company is Dr. Janis Spigulis of the University of Latvia. He has been very cooperative and helpful in advising us on the use of this product.



Optical pickoff for fiber characterization.

- We have developed a method of characterizing fibers using a modified 1-inch integrating sphere and Hamamatsu photodiode as a probe. Experiments with sample fibers indicate some surprises in the emission profile with length, but encourage us that the design approach is practical.
- We are working on improving the fiber analysis apparatus to include a spectrographic capability. We need to be able to characterize the wavelength dependence of the side emission property.



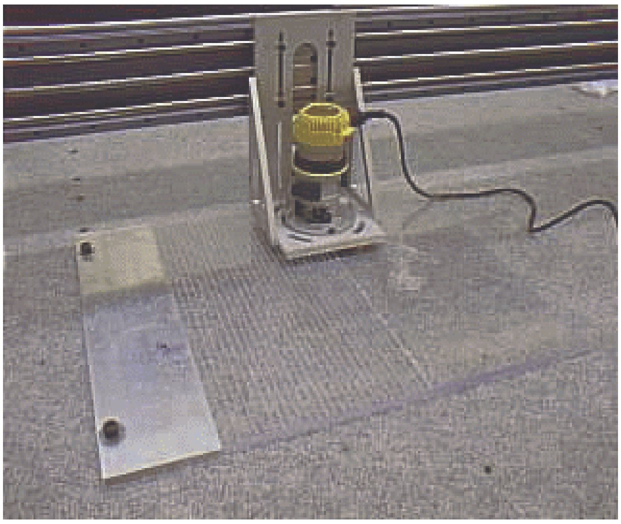
Test setup showing 24-inch panel illuminated with green laser pointer. No diffuser.

- We have experimented with different diffuser configurations and have found that using a single layer "P-95" diffusing surface at 3 inches spacing from the fiber plane provides good blurring of the fiber pattern.
- We have performed some preliminary emission profiles across the diffuser. Current results indicate very good smoothness, but pronounced falloff at the edges. We are currently installing a "reflector box" around the borders of the space between the fiber plane and the diffuser. This mirror should mitigate the edge effects.

Fabrication Progress

- We plan to embed the optical fibers in a large sheet of 1/2-inch thick acrylic by milling channels across the sheet. Each channel is just large enough to hold a fiber in a light press fit. The channels lie at 1/2-inch spacing, and will be 8 feet long in the version to be delivered to PANStarrs. The LSST version will be more than 26 feet square.
- The channel milling operation takes place on a 10-foot square granite surface plate equipped with a computer-controlled motorized x-y stage.

- The surface plate and x-y stage have been refurbished for our use. We have fabricated and installed adjustable bracketry to mount a router head on the stage.
- The router has successfully milled channels on acrylic sheets up to 24 inches square. We anticipate no difficulty in extending this operation to larger sheets.
- The largest available sheets of acrylic and honeycomb panel are smaller than the ultimate sizes we will need. We have devised methods of splicing these sheets together. These methods are untested.
- We have identified suppliers of the honeycomb and acrylic materials and have samples in house.



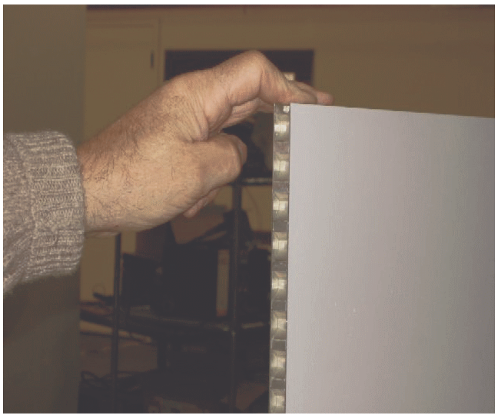
The router milling grooves in a sample sheet.

Organizational Issues

- We have assembled a team including two experienced machinists, a computer specialist (for x-y stage programming), and an undergraduate student.
- We have use of the facilities of the LPPC, including machine shop, optical lab, and electronics shop.

Plans

- The current immediate objective is to fabricate a 24-inch prototype that will demonstrate all the fabrication methods, and provide an easily transported demonstration unit.
- We still have the ongoing effort to characterize fibers. The outstanding issue with regard to this effort is to devise a method to couple the spectrometer to the optical pickoff.
- With a working prototype, we need a more accurate method of measuring the emission profile of the surface.
- Coupling of sources to fibers remains a challenge. We will acquire a selection of fiber-coupled diode laser sources at different wavelengths and study the effects of different coupling methods, and then choose the best method.
- With all these pieces in place, we will then construct a 48-inch prototype which will include panel splicing techniques and multiple fibers. Evaluation of this device will determine the approach to the 1.8-meter device for PanSTARRS.



Honeycomb structural panel.