**New Folder Name** Beam Imaging Diagnostic Systems

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CONCERNING: Beam imaging diagnostic systems
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Beam imaging cameras may be useful diagnostic tools for development of interferometers and other optical projects. They fall into two classes, intensity imaging cameras and phase imaging cameras. This memo discusses intensity imaging cameras, particularly the Spiricon system, which was demonstrated for us earlier this month.

The system which was demonstrated consisted of a CID camera, a frame grabber board, real-time monitor, IBM PC-AT computer, and Spiricon software. The camera, manufactured by CID Technologies, was the Spiricon Model CID2509. Also available is a model CID2250. Table 1 shows the relevant properties of each.

| Model | CID2509 | CID2250 |
|---|---|---|
| No. pixels | 250 × 255 | 500 × 512 |
| Pixel size | 28 $\mu$ × 28 $\mu$ | 15 $\mu$ × 15 $\mu$ |
| Overall size | 7.0 mm × 7.14 mm | 7.5 mm × 7.68 mm |
| Spectral response | 190 to 1100 nm | 190 to 1100 nm |
| Pixel scan rate | 5 MHz | 10 MHz |
| Max. frame rate | 67 Hz | 30 Hz |
| Dynamic range | 320 | 200 |
| Sensitivity | 20 nW/cm$^2$ | 18 nW/cm$^2$ |
| Saturation power | 6.5 $\mu$W/cm$^2$ | 4.5 $\mu$W/cm$^2$ |
| Weight | 13.5 oz. | 36 oz. |
| Dimensions | 3.37" × 3.0" × 2.89" | 3.37" × 3.0" × 6.82" |
| Cost | $2700 | $3775 |

Table 1. Silicon cameras

The frame grabber plugs into a PC-AT or compatible computer. It uses the space of 2 slots, one for the digitizer and one for the camera interface. It consists of an 8 bit digitizer and 1 Mbyte of memory to store up to 12 consecutive frames of 256 × 256 data or 4 consecutive frames of 512 × 512 data. The frame grabber provides a real-time false color video output. It can be externally triggered. The prices are $5400 and $6400 for the boards compatible with the CID2509 and CID2250 cameras, respectively. The real-time monitor costs $700.

The Spiricon software package calculates and displays laser beam spatial data. It includes isometric 3-d displays, 11 color contour plots, rotation, tilt, and zoom. It can do Gaussian and top hat least squares fits and calculate peak to average energy ratios, peak to total energy ratios, and integrated energy. The software costs $4000.

We used the Spiricon camera with the stationary interferometer and with the prototype Miser accelerometer. The camera was positioned to look at the dark fringe output of the interferometer, at light picked off from the input beam to one cavity, and at the transmitted light signal from one cavity. The camera saturates easily, and it was often necessary to decrease the incident laser intensity or to otherwise attenuate the beam incident on the camera. The false color, real-time monitor was extremely useful for component alignment and the visualization of aberrations in the intensity distribution. Manipulation of the data with the PC-AT and the Spiricon software was less useful. It took the computer about thirty seconds to process and display an image (a 386 machine would be faster). The processed images were no better for on-line analysis than the real-time images, and the fitting and contour plotting capability are of limited utility. The processed image can be stored on floppy disk, allowing for off-line manipulation of the data. This could be extremely useful. The figures show data which was transferred to the SUN. Figure 1 is a 3-d contour plot of the transmitted light from one cavity resonating in the $TEM_{01}$ mode. Figure 2 shows a ten level 2-d contour plot of the intensity output at the dark fringe of the interferometer. The figures do not show the full resolution of the data, as groups of four pixels have been averaged together for plotting.

With the prototype Miser accelerometer, which uses 1.06 micron light, the system was very useful for visualization and alignment of the beam.

There are several ways in which an intensity camera system could be configured. One option is to operate the system as it is sold, with the Spiricon frame grabber and a portable computer. The whole system can be mounted on one wheeled rack and used wherever needed in real-time mode. For further processing, data stored on floppy disk can be transferred to the SUN.

A second option is to buy the intensity camera from Spiricon or one of its competitors, and to buy a frame grabber card (from Data Translation, for instance) which would allow us to operate the camera directly from either a SUN or the Concurrent lab computer. This system would have the same real-time capability and would interface directly with our laboratory computer. This option costs less; we would not have to purchase a PC and the Data Translation frame grabber card costs less, \$2500 as compared with \$5400. Data Translation software costs \$2000, half the cost of the Spiricon software. It doesn't do as much, but with either software package we will have to write our own code for off-line analysis. If we buy a frame grabber for the laboratory computer, then we sacrifice mobility. If we connect it to a SUN (the SUN/3 Iseult is what we have in mind), then we can put the system on wheels and move it from room to room.

We have also reviewed literature describing a similar system marketed by Big Sky Software Corporation. On the whole, it appears similar to the Spiricon system, and more expensive.

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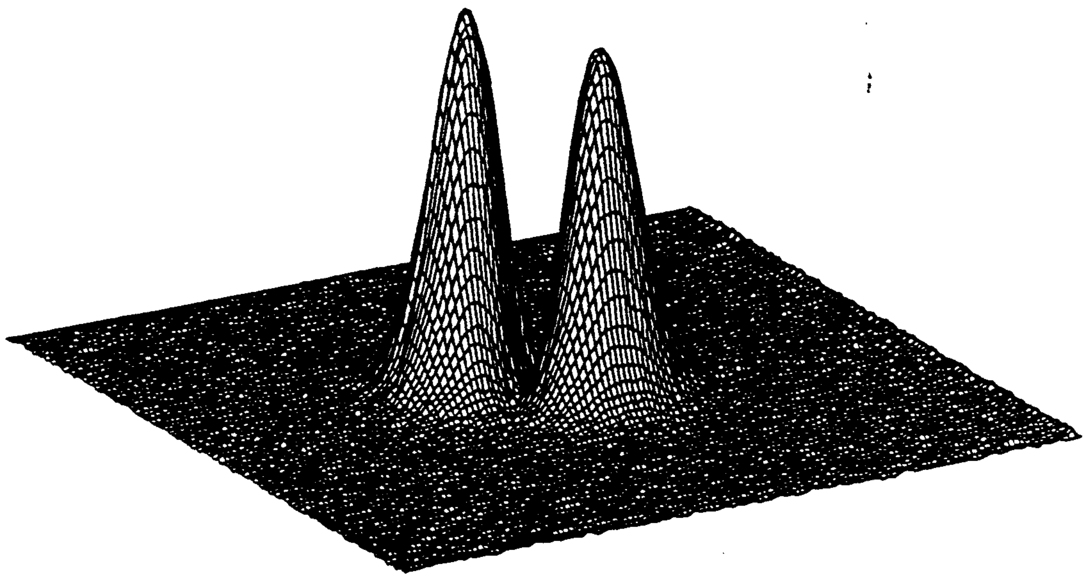

Figure 1. Transmitted light intensity from stationary interferometer cavity resonating in $TEM_{01}$ mode.

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Figure 2. Intensity at dark fringe output of stationary interferometer.