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# SPATIAL IMAGING USING CONFOCAL FABRY-PEROT INTERFEROMETERS

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## ABSTRACT

A diagnostic imaging package containing confocal Fabry-Perot interferometers is used to provide spatial intensity information for each of several closely spaced wavelength components of a single laser beam.

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SUMMARY

In support of laser isotope separation activities at the Lawrence Livermore National Laboratory, the Beam Control and Diagnostic Group is responsible for diagnosing dye laser beams containing multiple wavelength components. We have developed a diagnostic package based upon the use of confocal Fabry-Perot interferometers in order to measure the spatial intensity profile and location of each of these components, whose frequencies may differ by less than 10 GHz.

The requirement for a very narrow bandpass precluded our use of a conventional interference filter, but we were aware that a Fabry-Perot interferometer could have more than adequate frequency resolution for our purposes. It was not so obvious until we analyzed the device that the confocal, or spherical, Fabry-Perot (SFP) configuration[1,2] could faithfully transmit images while maintaining this frequency resolution.

We also exploited other advantages of the SFP: its relative insensitivity to alignment, both internal and with respect to other components; its electrical tunability, allowing a single device to be used for various wavelengths; and the possibility of constructing it to have zero optical power, simplifying its integration into an optical system. Characteristics of the SFP that are undesirable from our point of view include its multiple transmission peaks as well as the fixed frequency spacing between these peaks, which is set by the curvature of the mirrors.

The imaging properties of an SFP are coupled to its frequency resolution. In our design effort we considered both spatial resolution and uniformity of transmission over the field. By choosing the free spectral range of the device to be about 5 GHz, the mirror reflectivity to be 0.9, and limiting the aperture and input angle into the SFP as shown in Fig. 1, we were able to achieve our

goals of a 400 MHz bandpass and the ability to transmit with zero optical power an image containing 100 line pairs, while maintaining a transmission uniformity of better than ± 5%.

Figure 2 is an optical schematic of the diagnostic package, which receives a sample of the composite dye laser beam, reduces it to manageable size and relays an appropriate object plane to a reticle. This reticle is then imaged onto several video cameras through parallel optical paths. Each of these paths consists of an image quality bandpass filter for coarse wavelength separation, a SFP filter to distinguish between closely spaced wavelengths and an optical system to image the common reticle onto the video camera.

We have developed a diagnostic package that allows us to measure the individual spatial intensity profiles of closely spaced wavelengths in a common laser beam. The key to meeting the simultaneous requirements of very narrow bandpass and good image quality is the use of confocal Fabry-Perot interferometers.

1. M. Hercher, " The Spherical Mirror Fabry-Perot Interferometer," Appl. Opt. 7, 951 (1968).

2. G. Hernandez, Fabry-Perot Interferometers. (Cambridge University Press, Cambridge, 1986), pp. 122-149.

D.W. Myers
"Spatial Imaging Using Confocal Fabry-Perot Interferometers"

## CAPTIONS

Figure 1. Confocal Fabry-Perot interferometer used to separate individual wavelength components in a laser beam. We predicted and found experimentally that the beam size on the SFP had to be surprisingly small to obtain uniform transmission over the image ( Drawn to scale ).

Figure 2. Optical block diagram of diagnostic package. Major optical components are shown.

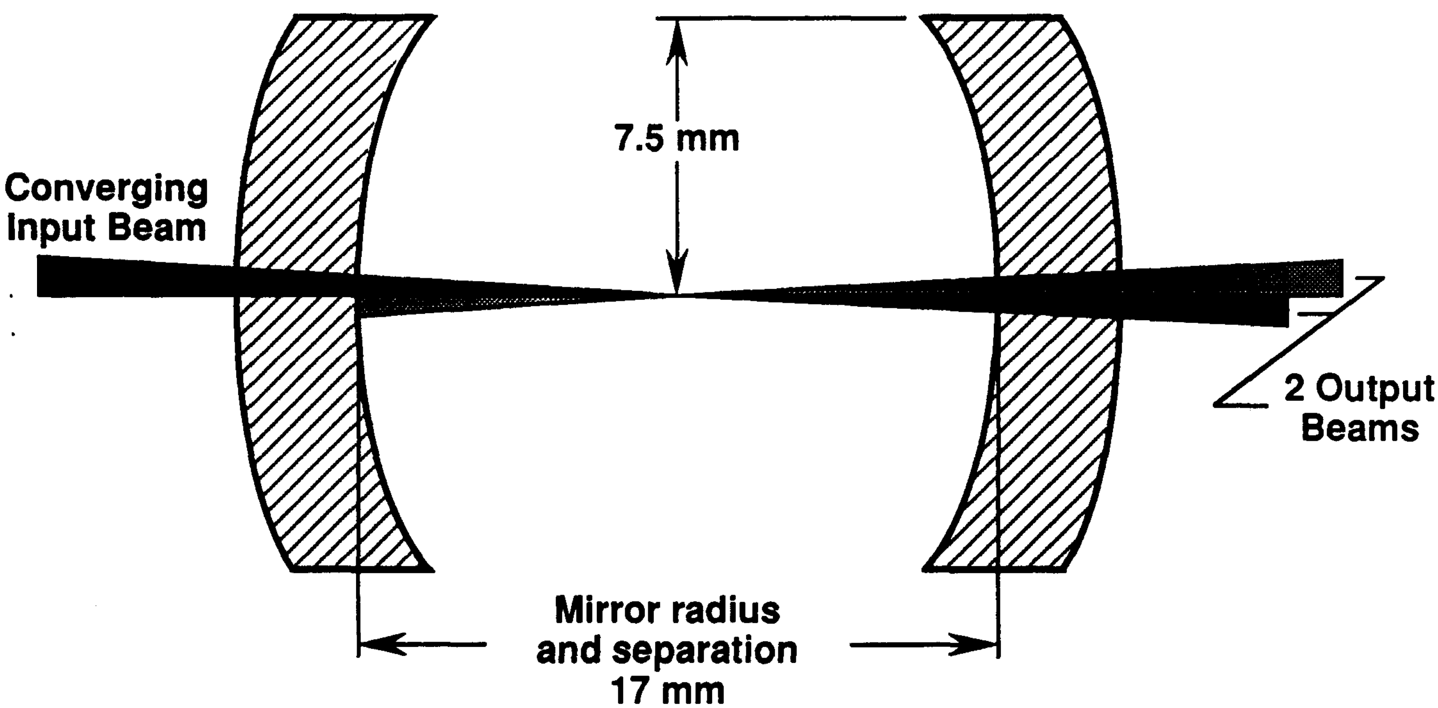
7.5 mm
Converging
Input Beam
2 Output
Beams
Mirror radius
and separation
17 mm

Figure 1.

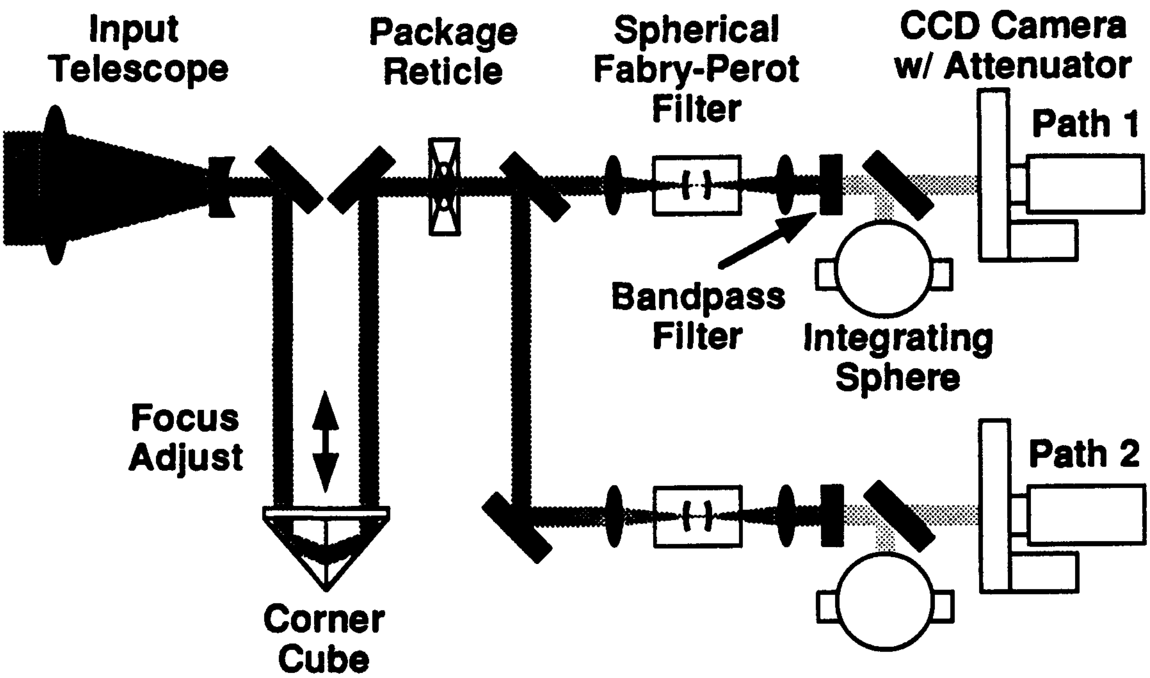
Input
Telescope
Package
Reticle
Spherical
Fabry-Perot
Filter
CCD Camera
w/ Attenuator
Path 1
Bandpass
Filter
Integrating
Sphere
Focus
Adjust
Path 2
Corner
Cube

Figure 2.