

"Passive Measurement of CO₂ Column from an Airborne Platform"

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Abstract

We are in the third and final year of our IIP funding to develop a sensor for very precise determination of the CO₂ Column. Global measurements of this sort from a satellite platform are needed to improve our understanding of the global carbon budget. In previous reports to this meeting we have described the method by which this system operates and presented data taken during ground based tests of the instrument.

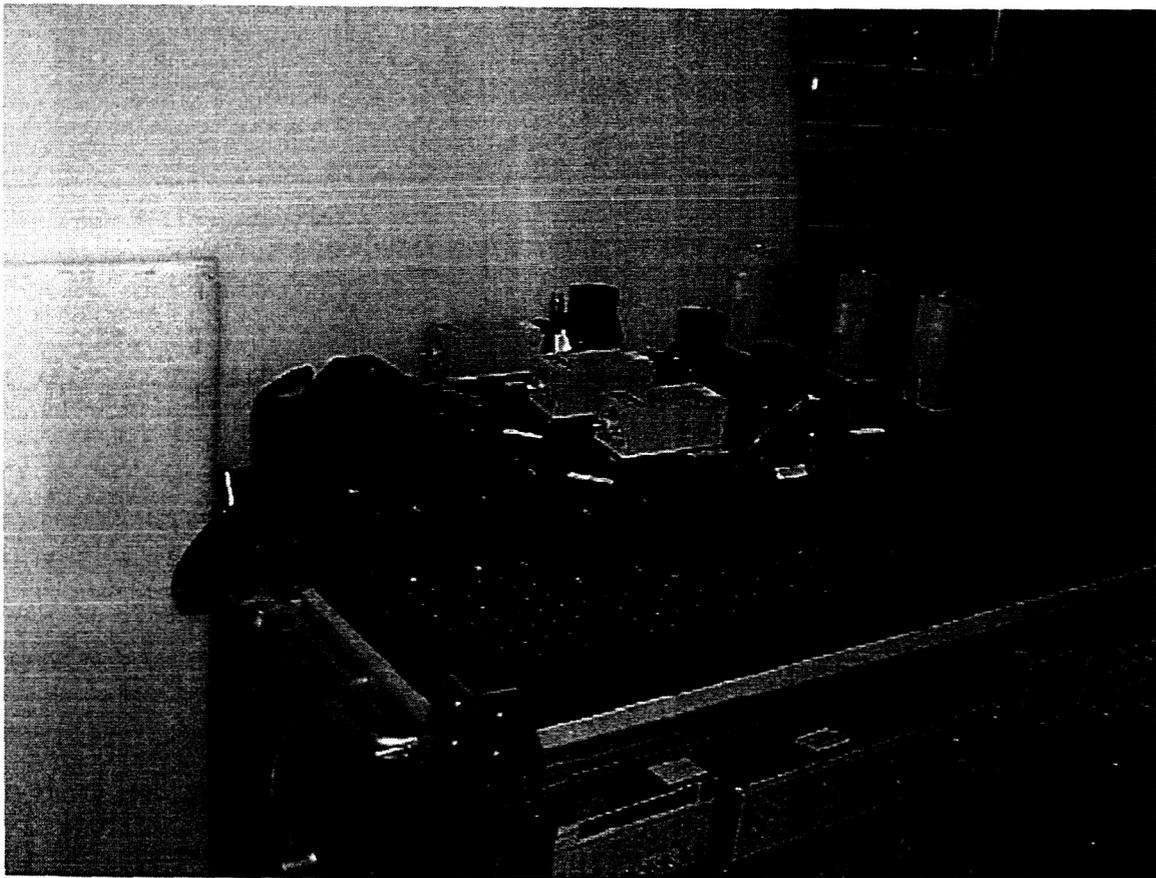


Figure 1

Work in the final year has concentrated on building the flight hardened version of the instrument that will be used in our field trials on the Dryden DC-8. The flight unit represents an integration of three channels into a single instrument. These three channels are the CO₂ channel, the oxygen pressure sensing channel, and the oxygen temperature sensing channel. Integration of the three channels into a single unit significantly decreases the size of the instrument. The flight unit also employs more rugged optical mounts and integrated optical shielding. Figure 1 shows the flight unit during final assembly in the lab. Light enters the instrument from below first striking the right angled

mirror shown extending over the edge of the platform. The light is then focused through a pinhole to define the instrument field of view, chopped and recollimated. Dichroic mirrors are used to separate the CO₂ wavelength from the O₂ wavelength and that light is further divided by a 50-50 beamsplitter between the 2 oxygen channels—the pressure channel and the temperature channel. The six white boxes contain the detectors for each of the three channels. The detectors on the left in the photo serve the reference channels and the detectors on the right are for the Fabry-Perots. CO₂ is measured by the pair of detectors farthest from the viewer. Pressure via O₂ is detected by the central pair of detectors. The closest pair is used to determine temperature via O₂.

In addition to the development of the flight systems we have exerted some effort at securing better optical components in order to improve the performance of the system. As an example we have recently received some etalons manufactured by Coronado Optical of Tuscon, Arizona. Rather than a single solid etalon as we have used in the past these Fabry-Perots are made with the interfering surfaces of the solid plate sandwiched between 2 much thicker pieces of glass. This method of construction permits manufacture of thinner solid etalons and provides a much more rugged package than would be afforded by a single plate of glass 50 cm in diameter but only 120 microns thick. Figure 2 shows a laser scan of 2 of the new type etalons superimposed over a scan of the oxygen

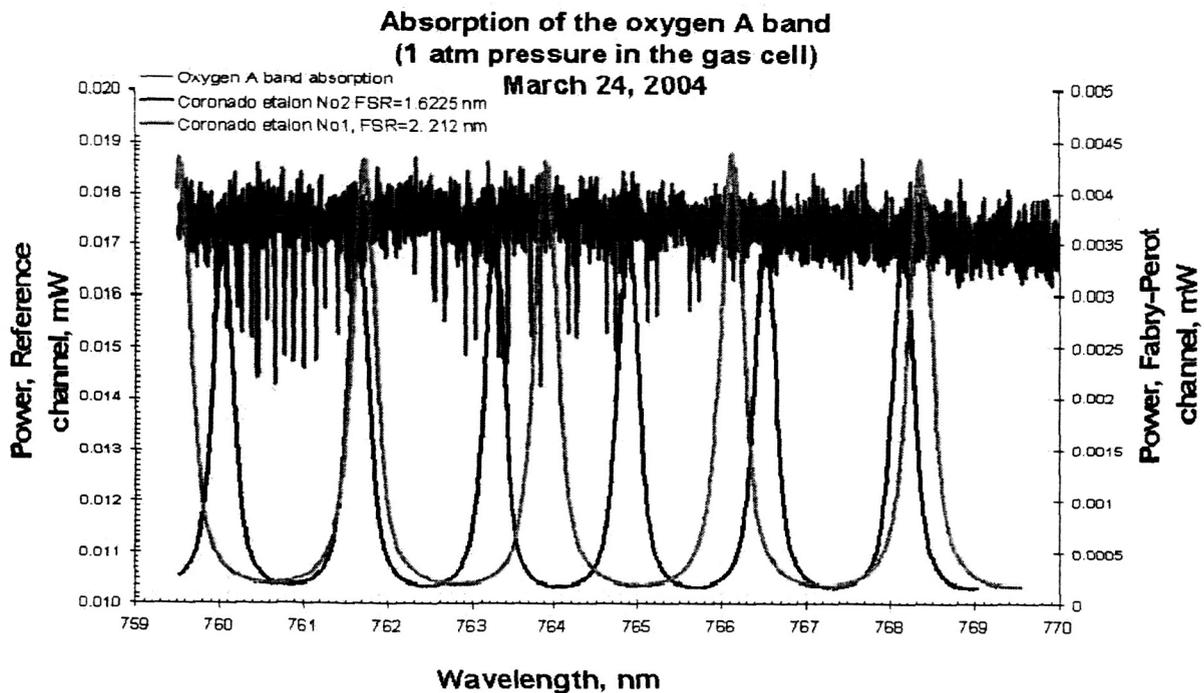


Figure 2

absorption spectrum. Operating in an oxygen channel of our instrument one of these etalons would be temperature tuned so that the absorption peak lies between the 2 branches of the oxygen A-band. A bandpass prefilter is used to restrict the light to a single transmission fringe of the Fabry-Perot. Figure 3 shows the theoretical design layout for this channel.

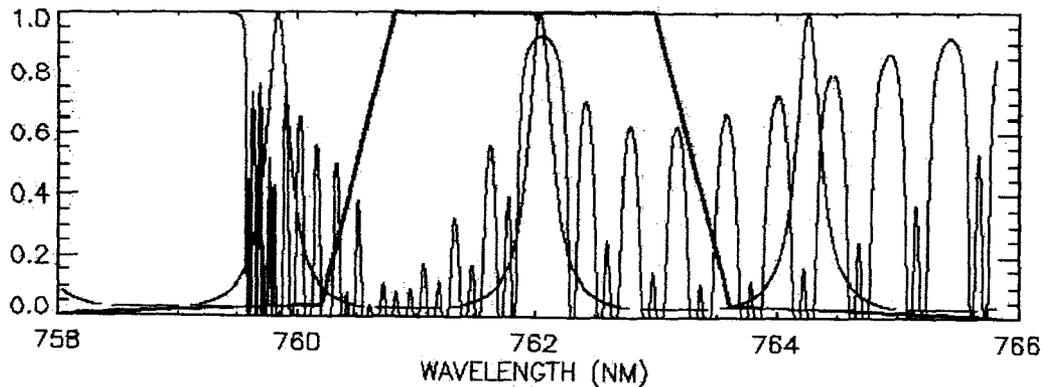


Figure 3

The red curve illustrates how the prefilter confines the observations to a single passband of the Fabry-Perot. Note that the O₂ absorption in Figure 3 represents the effect of the whole column from the ground to the top of the atmosphere while the oxygen absorption shown in Figure 2 represents the absorption observed with the 1.4 meter long cell filled to .5 atmosphere.

We shall present results obtained using the new components as well as results obtained from the upcoming DC-8 flight tests scheduled for this May.