356990

46

Ultra-Wideband Optical Modulation Spectrometer (OMS) Development

Grant NAG5-10476

Annual Performance Report No. 1

For the period 1 March 2001 through 28 February 2002

Principal Investigator:

Dr. Volker Tolls

December 2001

Prepared for
National Aeronautics and Space Administration Headquarters

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts 02138-1596

The Smithsonian Astrophysical Observatory is a member of the Harvard-Smithsonian Center for Astrophysics

The Technical Officer for this grant is Dr. Guy Stringfellow, Code 076.0, National Aeronautics and Space Administration Headquarters, Washington DC 20546-0001

Study of the Optical Setup of a wide-band Optical Modulation Spectrometer

Grant NAG5-10476

Annual Performance Report No. 1

December 2001

Volker Tolls

The purpose of this study is to advance the design of the optical setup for a wide-band Optical Modulation Spectrometer (OMS) for use with astronomical heterodyne receiver systems. This report describes the progress of this investigation achieved from March until December 2001.

During the last 10 months the following tasks were carried out under this grant:

(1) Selection of an optical design program

In order to be able to model the design of optics of the OMS, a review of available optical CAD programs was performed, which resulted in the purchase of a license of the program Zeemax. This program enables this investigation to calculate the optical beam through most of the components. Only the Fabry-Perot etalon cannot be modeled (the other reviewed program could not perform this task either). However, the purchased program is capable of running scripts and external modules which can perform this task.

(2) Defining the specification for key optical components

Starting with the preliminary design, the specification for the key optical components was reviewed and revised. Figure 1 shows an overview of the preliminary optical setup. The key components include the laser diode, the modulator, the Fabry-Perot etalon, and the linear detector array. All other components are standard optical components which can be purchased off-the-shelf according to their parameters which will be pre-defined and then optimized by the optical CAD program. The main issue with the key components was for which wavelength they need to be specified. Thus, the original specifications were set for two wavelength, 790 nm and 1550 nm. After investigating the availability (see (3) below) and determining that the best operating wavelength would be 790 nm, all specifications were revised accordingly.

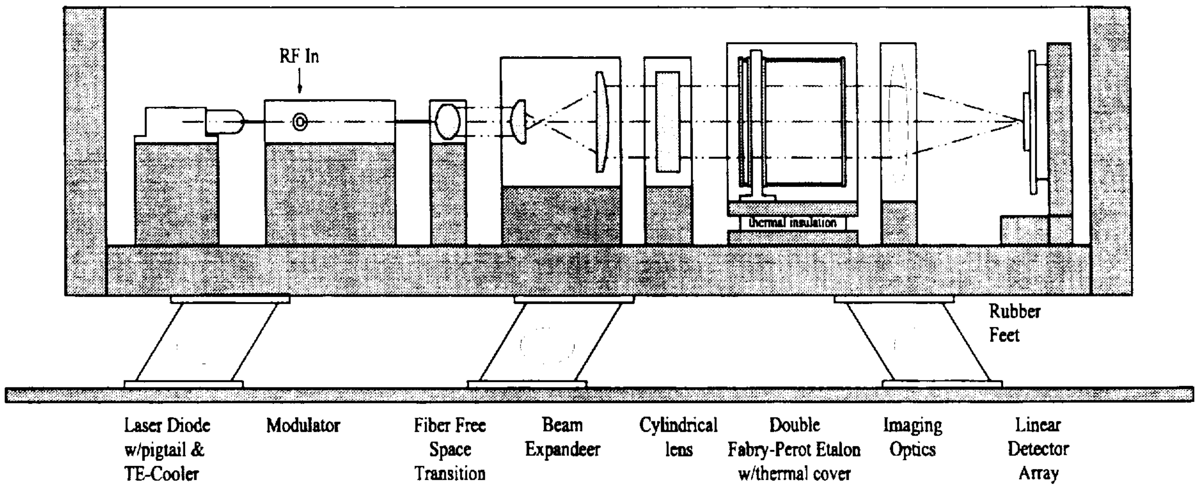

Figure 1: Schematic of the optical design of the Optical Modulation Spectrometer.

(3) Investigation of availability of key optical components

The investigation of the availability of the key optical components focussed mainly on for which wavelength the components were available. All components are available for a wavelength of 790 nm and 1550 nm. For each of the two wavelength, components with superior performance or low-cost components are available. At the end it was decided that for 790 nm the available devices have more favorable performance. E.g., for 790 nm, 2048 pixel CCD line sensors are readily available whereas for 1550 there are linear InGaAs detector arrays available with only 512 sensors. However, for 1550 nm, there are many low-cost modulators available from various vendors whereas for 790 nm a custom-made modulator is required (associated with much higher costs). The decision to use 790 nm components was supported by the fact that there is a lot of experience from the development of acousto-optical spectrometers, a medium bandwidth spectrometer with a similar technology, which would support the development of the OMS since most parts of the electronics can be adapted (e.g., CCD readout electronics). A possible vendor for high finesse Fabry-Perot etalons with rigid mounts was identified as well. This vendor requires only detailed specifications for the etalon.

(4) Detailed modeling of a high finesse Fabry-Perot etalon

Since the program Zeemax (see (1)) can perform the optimization of most components, only the high finesse Fabry-Perot etalon has to be modeled in detail outside of Zeemax. The spectrometer to be developed should have a fairly high resolution, 10 MHz with a bandwidth of 10 GHz. This resolution requires either the use of a high resolution Fabry-Perot etalon or the combination of two lower resolution Fabry-Perot etalons which would give the same resolution. The modeling, which has not been finished yet, will show which of the two methods is favorable and should result in the detailed specification for the etalon(s). The second part of the modeling should result in guidelines for the proper illumination of the etalon. Usually etalons are used for collimated light beams with a narrow wavelength range. For this application, the incident light needs to illuminate a wide area and still fulfills the interference requirements.