The Asteroid Thermal Mapping Spectrometer: An Imaging Mid-IR Spectrometer for the Marco Polo NEO Sample Return Cosmic Vision Candidate Mission. N. E. Bowles[1], S. Calcutt[1], F. Reininger[1] , S. F. Green[2] and H. Mortimer[3], [1]bowles@atm.ox.ac.uk Atmospheric Oceanic and Planetary Physics, Department of Physics, University of Oxford, Parks Road, Oxford, UK, [2]Planetary and Space Sciences Research Institute, The Open University, Walton Hall, Milton Keynes, UK., [3] Science and Technology Facilities Council, Rutherford Appleton Laboratory, Harwell Science and Innovation Campus, Didcot UK.

Introduction: The Marco Polo Near Earth Object (NEO) sample return mission [1] has been selected for further study as part of ESA's on-going Cosmic Vision mission planning exercise [2]. The mission's primary aim is "*To return a sample from a Near-Earth Object belonging to a primitive class to the Earth"* [3].

A multi-spectral, mid-infrared imaging instrument is essential to the Marco Polo remote sensing payload [3]. It will provide key information on the nature of the surface by measuring its diurnal thermal response (thermal inertia) and mineralogy, essential to selecting sampling sites compatible with the Marco Polo sample acquisition system.

We describe the Asteroid Thermal Mapping Spectrometer (ATMS) currently under development at the University of Oxford. The ATMS is a compact Fourier transform spectrometer that fully meets the requirements of the Marco Polo mid-IR instrument [3]. The ATMS uses a fixed set of beam splitters and Fourier optics rather than a traditional moving mirror design to generate an interferogram on a two dimensional detector array. The resulting instrument is compact (<3kg), robust (no moving parts except a scan/calibration mirror assembly) and has adequate spectral resolution (3-20cm^{-1}) and spectral range (5-25μm depending on detector array used).

Instrument Description: The ATMS is based on designs for Spatially Modulated Interferometers (SMI) developed at Oxford to breadboard level over the last ten years [4], [5]. Previous versions of the SMI were designed for atmospheric remote sensing applications, so required higher spectral resolution (<1cm^{-1}) and needed low noise cooled (e.g. MCT) detector arrays to meet their science objectives. The lower spectral resolution required (10-20 cm^{-1}) coupled with an order of magnitude improvement in throughput for the ATMS design over previous versions of the SMI allows the use of an un-cooled micro-bolometer array (ULIS 640x480). This simplifies the mechanical design of the instrument significantly. The SMI approach gives flexible operating modes, with a programmable resolution and extremely efficient light utilization (figure 1).

Why a spectrometer? A spectrometer is necessary to meet the science goals described in [3]. Although individual mineral absorption features are relatively broad, higher resolution allows better interpretation of overlapping bands and the opportunity to use the instrument to survey for unknown constituents (since the bulk of our current knowledge is *almost* entirely based on disc averaged spectra). The spectral information may allow improved constraints on particle size distributions to be determined and provide additional science opportunities during any interplanetary cruise phase (e.g. Venus gravity assists).

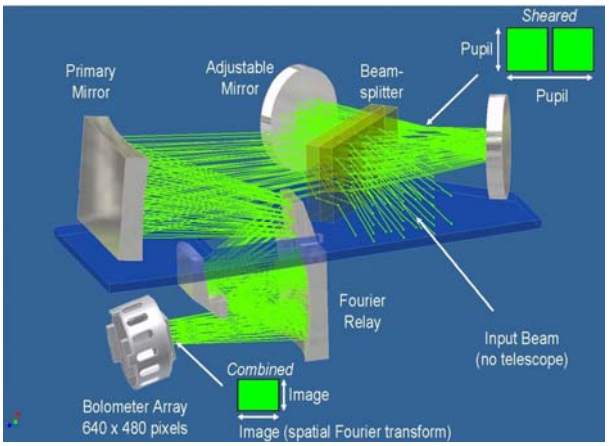

Figure 1. *The ATMS Warm Detector Array Breadboard optical layout. The instrument dimensions are approximately 160 x 220 x 370 mm^3.*

References: [1] Barucci M. A. et al. Exp Astron, in press 2009. [2] Cosmic Vision Brochure BR-247, 2005. [3] Marco Polo Science Requirements (MP-RSSD-RS-001), 2008. [4] Reininger F. M. Infrared Physics and Technology 42 (2001) 345-362. [5] Mortimer D. Phil Thesis University of Oxford 2008.

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