MAMBO: THE MARS ATMOSPHERE MICROWAVE BRIGHTNESS OBSERVER.

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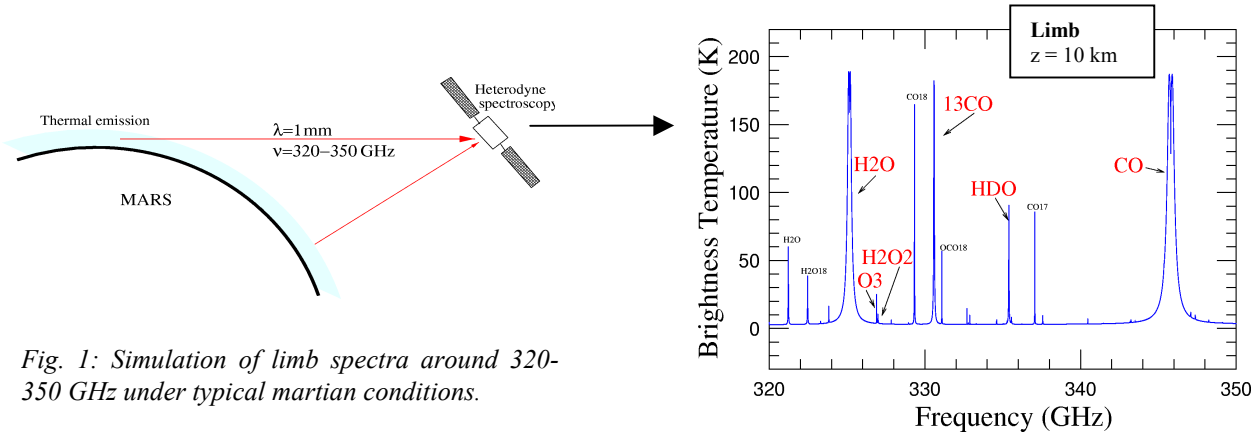


Fig. 1: Simulation of limb spectra around 320-350 GHz under typical martian conditions.

The microwave sounder MAMBO aims to characterize the dynamic and the composition of the Martian atmosphere, with an unprecedented sensitivity. For this purpose, we propose to analyze the thermal emission of the atmosphere at microwave frequencies using heterodyne spectroscopy, for the first time from orbit around another planet. In practice, MAMBO will perform measurements at the atmospheric limb and at nadir using a receiver dedicated to the monitoring of selected lines of key molecule around 320-350 GHz: H_2O, CO, ^{13}CO, HDO, O_3, H_2O_2.

In such conditions, the instrument performance will allow the 3D mapping, with an excellent spatial coverage, of the following characteristics :

- ***Winds :*** The high spatial resolution allows to make use of the line profiles and their Doppler shift. Limb viewing thus allows the fist direct measurements of the winds on Mars from orbit from 20 to 110 km with a vertical resolution better than 10 km and an accuracy of about 15 $m.s^{-1}$ Such a measurement will provide key information on the atmospheric dynamic..
- ***Temperature*** **:** The temperature profile will be retrieved with high vertical resolution (5 km) without regard to dust opacity and season. A unique characteristic of Microwave sounding is the ability to profile temperature up to 120 km, compared to 70 km for previous sounders.
- ***Water Vapour*** **:** near the surface up to 60 km, with a sensitivity and vertical resolution (5 km) much better than previous experiments, without regard to dust opacity and season.
- ***D/H Ratio*** : This isotopic ratio will be mapped accurately from 0 to 40 km by simultaneous spectroscopy of H2O and HDO. Mapping the variation D/H ratio is a key investigation to understand the evolution of water on Mars, escape processes, and Mars cloud microphysics..
- ***Hydrogen Peroxyde (H_2O_2)*** : This species has never been observed on Mars, yet. However, several models have shown its key importance for the photochemistry of the martian atmosphere (control of H2, O2 and CO) and for its role (thought to be major) in oxydizing the martian soil, a problem of key interest for exobiology
- ***Ozone :*** Ozone profile will be measured accurately up to 70 km, simultaneously with water vapor. This will allow us to better understand the relationship between the two species

- ***Carbon Monoxyde*** : the variations of this species will be monitored up to 120 km, providing important clues on the meridional transport in the Martian atmosphere.
- ***Surface Science:*** MAMBO will perform a dedicated mapping of the surface microwave emission. By observing both the Horizontal and Vertical polarization and using varying viewing angles and local time, we will map the variations due to 1) subsurface ice contents 2) surface roughness 3) CO2 ice cap characteristic variations, and 4) variation of the temperature sensing depth.

Overall, the combination of these measurements provides us with a complete view of Mars Atmospheric dynamics, Water cycle, and atmospheric photochemistry. In such a context, strong synergy with the Netlander mission and the other Premier Orbiter instruments are identified.

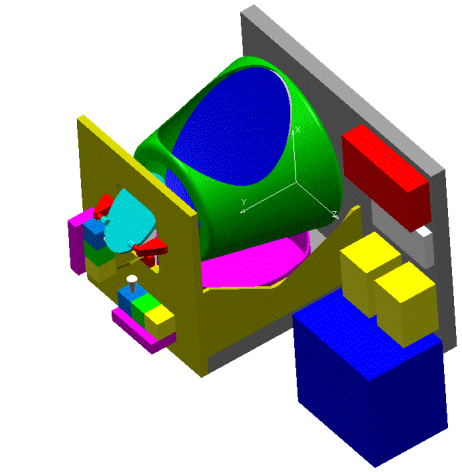
Programming

MAMBO has been proposed and pre-selected on the model payload of the orbiter of the PREMIER mission (CNES) initially planned to be launched in 2007. Following various problems related to the decision processes and the funding of the entire Mars PREMIER program, the near future of MAMBO remains uncertain.

MAMBO key characteristics :

Receiver frequency	323 – 347 Ghz
System Temperature DSB	1500 K
Maximal spectral resolution	100 kHz
Antenna aperture	23 cm
Antenna beam width at limb	~8 km
Mass	27.8 kg
Power	62.5 W
Data rate to Earth	350 to 50 Mbits/day
Size (sensor unit)	420 x 500 x 360 mm
Size (electronic unit)	270 x 200 x 200 mm

MAMBO design is such that it fulfills scientific objectives totally independently of Orbiter configuration: MAMBO is thermally isolated from the Orbiter and mechanical and power inrterfaces are reduced to the minimum. MAMBO nominal position on Orbiter is towards nadir or on +Y/-Y sides along velocity vector.



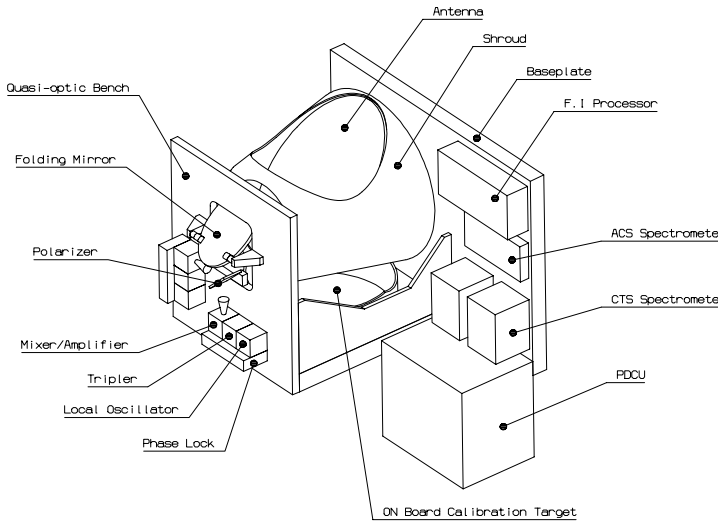


Fig. 2: MAMBO design and key components (drawing from ASTRIUM)

The MAMBO instrument is made of two heterodyne receivers at sub-millimeter wavelength, designed for continuum and spectroscopic detections in both polarizations . A 23-cm Gregorian antenna performs cross-track field-of view observations. A polarizing grid separates the signal into two orthogonal polarizations and directs them towards each receiver. The low-noise heterodyne receivers are based on uncooled 330-GHz subharmonically pumped mixers using planar Schottky diodes technology. A phase-locked ultra-stable oscillator is used to provide very high frequency stability for the spectroscopic measurements.

A set of spectrometers allows to observe both:

- pressure-broadened spectral lines at 1–8 MHz resolution, and
- atmospheric spectral lines at 100-kHz resolution.

The onboard computer will control housekeeping and scan mechanism and will monitor the 350-Mbits daily data rate.