

Atmospheric Structure Investigation: Planetary in situ measurements of atmospheric state including clouds/aerosols. V. Jha, A. Colaprete, D. Banfield, B. White, A. Cook, A. Rademacher, J. Shimada, A. I. Davé, P. Agrawal, N. Rustemeyer. NASA Ames Research Center, Moffett Field, CA. (vandana.jha@nasa.gov)

Introduction: The Atmospheric Structure Investigation (ASI) is a sensor suite designed for descent probes into planetary atmospheres, primarily aimed at Giant planets like Saturn and Uranus, and applicable to Venus, Titan, and Earth-specific missions. ASI aims to provide essential measurements of atmospheric structure, including probe acceleration, rotation, pressure, temperature, vertical winds, aerosol properties, and hydrogen and helium composition, crucial for contextualizing other probe data [1,2].

The ASI instrument: This suite establishes the foundational framework, crucial for contextualizing all other probe measurements, based on methodologies from previous missions like Galileo [3]. It employs similar techniques, such as boom placement on the probe hull for optimal accuracy. ASI uses dual 3-axis accelerometers to measure probe accelerations, an absolute pressure sensor on a Kiel Probe for atmospheric pressure, and differential pressure sensing for vertical velocity determination (Figure 1). Temperature is measured with a triply redundant thermocouples outside the probe's thermal boundary layer. Aerosol properties are monitored with a 2-color backscatter nephelometer, and Helium abundance and Hydrogen ortho/para fraction profiles are derived from novel ultrasonic spectroscopy instruments developed at Ames. These sensors are controlled centrally and interface with the descent probe computer, utilizing mature technology for accelerometry, pressure, and temperature sensing, while advancing nephelometry and ultrasonic spectroscopy technologies.

2-Color Backscatter Laser Nephelometer: In 2018, Ames IRAD supported the development of a 2-color backscatter laser nephelometer featuring NIR diode lasers at 785 nm and 1550 nm, paired with photodiode sensors and control electronics. A dedicated test chamber was constructed to calibrate sensitivity using precise aerosol mixtures. Following successful lab trials, a prototype was flown aboard a Raven Aerostar high-altitude balloon through the Flight Opportunities Program in spring 2021 (Figure 2), identifying areas for engineering enhancement. Subsequent redesigns have improved measurement cadence and timing, added monitoring for laser power and sensor parameters, and transitioned to 980 nm and 1550 nm wavelengths [4]. The nephelometer, integral to the ASI sensor suite, will undergo further testing on a terrestrial stratospheric balloon flight in Fall 2024.

Summary: Our Atmospheric Structure Instrument (ASI) sensor suite is designed for planetary atmospheric descent probes and balloons, providing crucial measurements of accelerations, pressure, temperature, aerosol properties. The components are at TRL5, except for the ultrasonic sensor at TRL3.

References: [1] D. H. Atkins et al. (2005) *Planetary and Space Science.*, v. 53, p. 586-593, 2005. [2] B. K. et al. (2007) *Pl. Sp. Sci.*, Vol 55/13 pp 1845-1876, 2007. [3] A. S. D et al. (1998) *J. Geophys. Res. Planets*, Vol. 103, No. E10, 22,857-22,889. [4] V. Jha et al. (2019, 2022, 2024) IPPW Contribution.

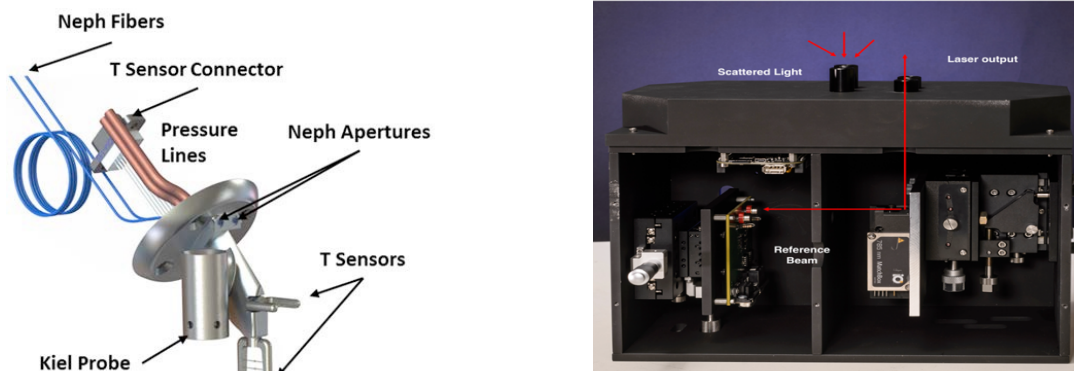


Figure 1 (left): A close view of the ASI's boom and major components (without the ultrasonic spectroscopy sensor). Figure 2 (right): NephEx prototype instrument ready for the balloon flight. The red arrows show the path of laser lights.