

PARTICLE-I IMAGING SYSTEM Flight Probe



Wind Tunnel and Aircraft-Based Droplet and Ice Crystal Measurements

**Size and shape
Number density**

**Liquid and Ice Water
Content**

Drop Velocity

Cloud studies

*Icing wind-tunnel
applications*

Turnkey operation

The Particle-I Imaging Flight Probe (PI-FP) has been developed specifically for aircraft-based cloud studies that require precise measurement of liquid droplet and ice crystal size distributions, number density, liquid water content (LWC), and ice water content (IWC).

The PI-FP is a high-speed imaging system that takes advantage of the latest advances in CMOS sensing technology and combines it with an innovative particle illumination method to deliver precise measurements of particulate size and shape. The flight probe incorporates high intensity pulsed LEDs that are used to simultaneously illuminate the particulate field. The LED illumination is collected by a receiver lens which creates a shadow (or bright-field image) of the particles on the CMOS sensor.

The use of LED significantly reduces measurement errors due to intensity variations and diffraction noise that are a problem for bright-field imaging instruments using lasers. Furthermore, LED illumination does not pose any danger of eye damage to the user. The optics and electronics are packaged in a rugged design that is proven to be air-worthy. The probe heads are well heated to prevent ice accretion while flying in extreme icing environments. The pulsed LEDs used in the probe provide stability, compactness, ruggedness, highly uniform illumination, very long lifetime, and high reliability.

The PI-FP offers turnkey operation with a fully automated setup feature. The complete instrument includes the flight probe, data acquisition computer, image acquisition card, and the AIMS system software. The software analysis package includes sophisticated algorithms for identifying particles that are in focus, calculating various shape parameters, and classifying ice crystals into its various habits. Methods for differentiating between liquid drops and ice crystals are also included. The LEDs can be double-pulsed to measure drop velocity using the Particle Tracking Velocimetry method (PTV).

Technical Specifications

Aerodynamic Wing-shaped enclosure	
Anti-shatter particle probe tips available	
Heaters for cold operation	< -50° C
Altitude operation requirement	< 15 km
Size dynamic range	200:1
Estimated size accuracy	+/- 2.5 μm
Estimated size resolution	+/- 2.5 μm
Velocity measurement range	< 300 m/s
Liquid Water Content (LWC) accuracy	+/- 15%
Distance between receiver and transmitter windows	100 mm
Illumination type	Pulsed LEDs, 470 nm wavelength
Droplet Velocity Measurements (PTV)	-100 to 200 m/s
Optional particle trigger detection	532nm DPSS laser and PMT
Camera (CMOS Digital)	
Camera frame rate	to 400 fps
Camera resolution	2600 x 2160 pixels 5.6 Mpix
Sampling area at 3 μm/pix	6 mm x 2.7 mm
Continuous sampling	< 1 terabyte



†**U.S. Patents**
 10,705,001 B2
 10,578,538 B2



Ice particles



*Droplet image for a flow speed of 200knts
 Quasi-real time display of results
 (Real time display of all data is not possible)*

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