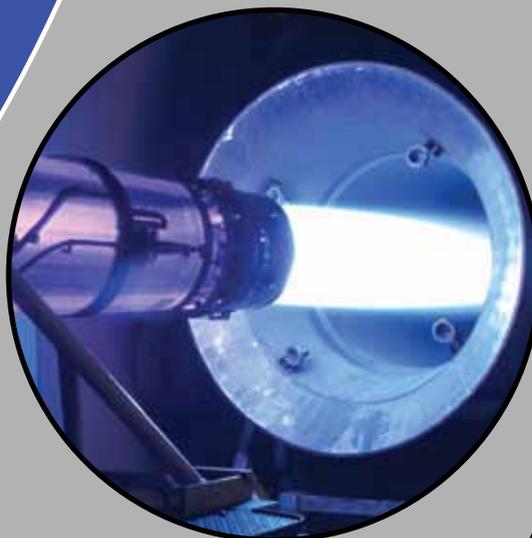
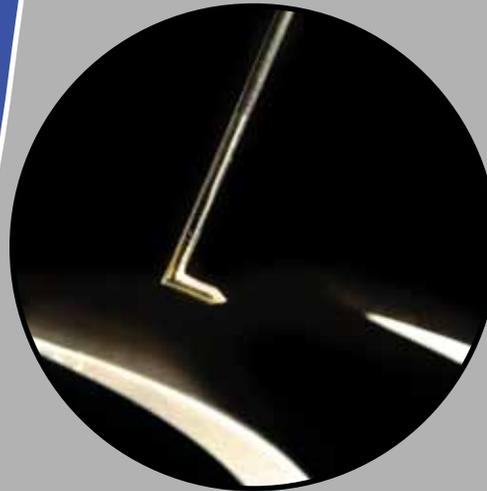
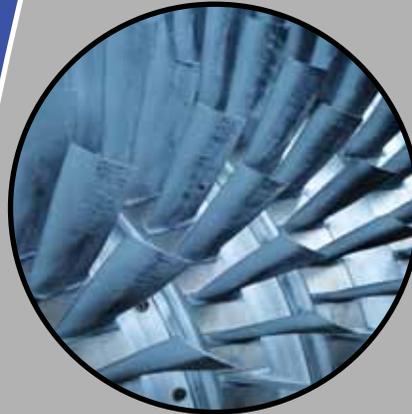




# Turbomachinery Applications

Engineering  
Flow-Measurement  
Solutions



A  
E  
R  
O  
P  
R  
O  
B  
E

# Aeroprobe Mission:

Design, develop, manufacture, and deliver 21st -century technology **air/liquid flow measurement probes** characterized by miniaturization, high accuracy & fast response.

# Aeroprobe Technology:

## Probes and Systems

We have over 10 years' experience providing multi-hole probe solutions for difficult measurement applications. "Customization is our standard" - tells us about your application requirements, and we will work with you to identify the best Aeroprobe for you! We don't just supply the probes but also the complete system support required for measurement, including:

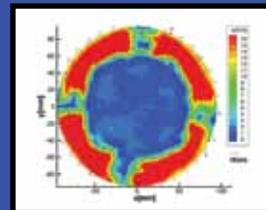
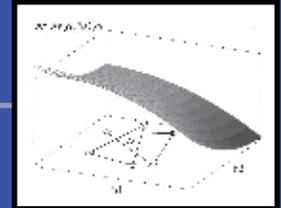
- Calibrated Aeroprobe
- Calibrated Pressure Sensors
- Data Acquisition Hardware and Software
- Pressure-to-Velocity Reduction Software
- Traversing Systems and Motor Controllers
- Data Visualization Software
- On-Site Installation and Technical Support



Aeroprobe System, with Probe, Data Acquisition and Traversing

## Calibration Services

The purpose of the multi-hole probe is to interact minimally with the flow in a consistent, repeatable manner so that a robust probe calibration can be performed. Aeroprobes are calibrated at > 2000 points, over pitch and yaw angles ranges up to 70° (for seven-hole probes) with respect to the probe tip axis. Pressure sensor calibrations are NIST-traceable and are provided with each sensor we sell.



Clockwise from upper-left:  
Probe Calibration Mount, Example of  
Calibration Map, Screenshot from Multiprobe  
Reduction Software, Reduced 3D Velocity  
Data from Axial Fan Test

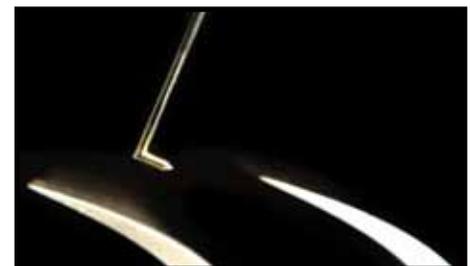
## Multiprobe Software (Pressure-Velocity Reduction)

In order to reduce measured pressures to meaningful velocity data, Aeroprobe offers the Multiprobe software. Using a high-accuracy local search-and-fit technique, Multiprobe reduces the acquired port pressures to the local total pressure, static pressure, and tow equations with additional user-supplied thermodynamic information, the Mach number and velocity magnitude are determined (Ref. 1). Standard accuracies are  $\pm 0.4^\circ$  in flow angles and  $\pm 0.8$  in total velocity.<sup>o</sup>

## Probe Geometry

Aeroprobe has developed and perfected the "drilled elbow" probe, which enables an L-shaped probe with a conical or hemispherical tip to have a very short tip length. This design allows the probe to access tight spaces in turbomachinery, without sacrificing the accuracy for which Aeroprobes are known. Probe tips as small as 1.6 mm OD reduce flow interference.

Right Image: Drilled Elbow Aeroprobe and Blade Cascade



## Fast-Response Probes

Aeroprobe's patented fast-response probes with embedded sensors provide frequency response to 3 kHz. This capability can be used to:

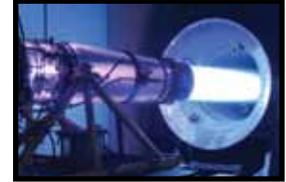
- Acquire accurate time-series data in unsteady flows
- Decreased run times and facility costs when the probes are continuously traversed



**Fast-Response Drilled Elbow Probe for Turbine Application. Embedded Sensors Are Located at Cross-Section beneath Screws**

## High Temperature Probes

Aeroprobe has developed Inconel probes that can be used at temperatures up to 950°C, and ceramic-metallic probes for temperatures up to 1250°C. Standard geometries are suitable for vane mounting, but ask us about other geometries for your application.



**Aeroprobe's high-temp probes are employed to return flow and pressure data from the turbines of aircraft and helicopter engines. Conventional Aeroprobes are used to provide flow data from the engine inlet.**

## Select Turbomachinery Applications:

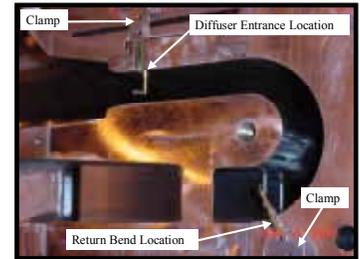
### Centrifugal Compressors

The Dresser-Rand company employed drilled-elbow 5-hole Aeroprobes to investigate the performance of multi-stage centrifugal compressors. The data gathered with the Aeroprobes supplied insight into the impeller exit flowfield. The pictures to the right show the placement of probes within compressor (Ref. 2).

**“The use of 5-hole [Aero]probes in production machines has allowed us the measurement of flow angle information that was not previously available from production-type testing of multi-stage axial compressors. For one particular application this data...allowed us to enhance the performance of the production of the machine.”**

--James Sorokes, Manager Development Engineering Group, Dresser-Rand

**Right Images: Aeroprobes Mounted n Centrifugal Compressor at the Dresser-Rand Company. Photos Courtesy of Dresser-Rand.**



### Aircraft Engines

**“We have purchased six customized cobra probes with 1.6mm tips from Aeroprobe. These miniature multi-hole probes from Aeroprobe performed beyond our expectations. The use of the Aeroprobes has allowed us to better understand the flowfield characteristics, an understanding that is expected to lead to better engine designs with enhanced performance.”**

--Hyoun-Woo Shin, Ph.D. Senior Engineer, GE Aircraft Engines

### References

1. Johansen, E.J., Rediniotis, O.K., Jones, G., “The Compressible Calibration of Miniature Multi-Hole Probes,” Journal of Fluids Engineering, Vol. 123, pp. 128 – 138, March 2001.
2. Gilarranz, J. L., Ranz, A. J., Kopko, J. A., and Sorokes, J. M., "On the Use of 5-Hole Probes in the Testing of Industrial Centrifugal Compressors", ASME Journal of Turbomachinery, Vol. 127, pp. 91-106, 2005.

## Aeroprobe Mission:

Design, develop, manufacture, and deliver 21<sup>st</sup>-century technology air/liquid flow measurement probes characterized by miniaturization, high accuracy & fast response.

## More About Aeroprobe:

A Virginia Tech spin-off, Aeroprobe Corporation is located in the VT Corporate Research Center. Maintaining close ties with VT enables Aeroprobe to perform basic and applied research aimed at advancing probe technology.



Aeroprobe works closely with manufacturing partner Schultz-Creehan to design, test, and produce high-quality, custom-built measurement devices and equipment employing modular lean-manufacturing methods. Schultz-Creehan has unique mechanical and electronic design, test, and simulation capabilities, which are applied to meet specific customer needs.

## Aeroprobe Customers:

- Rolls Royce, Bristol (UK)
- ITP (Spain)
- CTA (Spain)
- GE Aircraft Engines
- GE Nuovo Pignone (Italy)
- GE Power Systems
- Turbomeca (France)

## International Business:

With distributors in 20 countries and approximately 50% of sales outside the USA, Aeroprobe is an internationally recognized name.

We have distributors in the following countries:

Argentina	Germany	Portugal
Australia	India	Singapore
Austria	Italy	Slovakia
Belgium	Japan	Spain
Brazil	Korea	Sweden
Czech Republic	Mexico	Switzerland
Finland	Netherlands	Turkey
France	Norway	U.K.

**Aeroprobe Corporation**  
1700 Kraft Dr.  
Suite 2350  
Blacksburg, VA 24060



**Ph: (540) 951-3858**  
**Fax: (540) 951-8618**  
**info@aeroprobe.com**  
**www.aeroprobe.com**