# SUCCESS STORY


## UAV Flight Analysis for Wind Measurement

MASC is a small UAV developed for atmospheric boundary layer research. The Ellipse-N has been chosen to record the UAV position, ground speed, and attitude angles. By taking into account the airflow, wind speed and direction can be accurately calculated.


CLIENT

Environmental Physics Group at the Eberhard Karls Universität Tübingen, Germany

APPLICATION

Wind energy plant site evaluation using a UAV

PRODUCT

Ellipse-N, Miniature Attitude & Heading Reference System (AHRS) with integrated GNSS receiver

PROJECT

UAV position, ground speed, and attitude angles recording

The Multi-Purpose Airborne Sensor Carrier (MASC) is a small unmanned aerial vehicle (UAV) developed for atmospheric boundary layer research. It is designed and operated by the Environmental Physics group at the Eberhard Karls Universität Tübingen, Germany.

The typical payload for this UAV is a meteorological measurement system, designed to calculate turbulent fluxes. Compared to terrestrial systems or aircrafts, the MASC UAV is a cost-effective and valuable tool for researches such as wind energy plant site evaluation in complex terrain.

### "IN-FLIGHT" WIND SPEED COMPUTATION

In-flight wind computation might be tricky because airspeed and incident angles, measured by the embedded airflow probe, need to be compensated by the actual UAV behavior. By subtracting the UAV ground speed and attitude from the airflow vector, wind speed and direction can be calculated. Thus, a precise inertial measurement unit is crucial to perform the UAV flight analysis.

### ELLIPSE-N, CHOSEN FOR UAV FLIGHT ANALYSIS

Turbulence plays an important role in the transport and exchange of energy in the lower atmosphere. A high data rate is required to record these very fast fluctuations in the wind speed. "We were looking for a precise inertial measurement unit. Required specifications were an accuracy in attitude angles of <1°, and a high data output rate" declares Uwe Putze, Dr.-Ing. at the

> *"The Ellipse-N was selected because it fulfills all the requirements and provides a unique balance of accuracy, size and weight"*
>
> Dr.-Ing. Uwe Putze

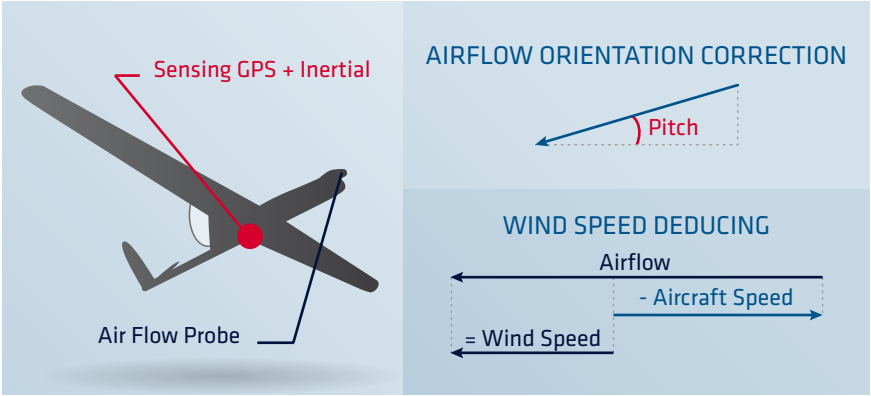
SBG SYSTEMS

# SUCCESS STORY - MASC

Eberhard Karls Universität Tübingen. As the unit had to be mounted in a small unmanned aerial vehicle, small size and low weight were also important for the project. “The Ellipse-N was selected because it fulfills all the requirements and provides a unique balance of accuracy, size and weight”, adds the Project Engineer. Small-size and lightweight, the Ellipse-N offers more than attitude and heading measurement. It fuses inertial data with GPS and pressure sensor information to provide a robust position and an enhanced altitude accuracy. The report showing the sensor dynamic calibration over the full temperature range made the team even more confident that the system would meet the announced specifications.

## HIGH QUALITY DATA

The Ellipse-N has been easily integrated into the on-board measurement computer through a serial interface. While the airflow probe measures airspeed and incident angles, the Ellipse-N records the UAV position, ground speed, and attitude angles. Raw data is stored in the computer, and can also be displayed in real-time on the ground station, thanks to a telemetry link.




By using this sensor, the system can measure wind speed with an accuracy of +/- 0.5 meters per second in all threes axes, and record speed variation at up to 20Hz. The output rate of 200Hz made any data interpolation unnecessary.

## WHAT’S NEXT?

The measurement system has been tested in several field campaigns. Based on various results and experience, the Environmental Physics Group works on improving the system and data analysis tools to further increase accuracy.

As the Ellipse-N performed so well during tests, the group is already integrating the sensor in many other research aircrafts.


- Dr.-Ing. Uwe Putze, Eberhard Karls Universität Tübingen
  & Hélène Leplomb, SBG Systems


## ELLIPSE-N KEY FEATURES

- 0.2° Attitude, 0.5° Heading
- 2 m Position accuracy
- Accurate attitude even in high G maneuvers
- Precise UTC referenced output and SyncOut signal
- Automatic magnetic declination and local gravity
- Integrated Kalman Filter

## ABOUT THE PROJECT

The Environmental Physics group is part of the Eberhard Karls Universität Tübingen. The fundamental aim of this group is to promote physics within the context of the environmental sciences. At the Eberhard Karls Universität Tübingen, turbulent atmospheric flows are mainly studied using automatically operating unmanned airborne vehicles (UAV). Different classes of automatically operating UAVs are under development, mostly light and small electrically powered aeroplanes.

More information:
http://www.geo.uni-tuebingen.de/umphy