Ice detection and measurement systems

Research collaboration between industry and academia

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When does ice form?

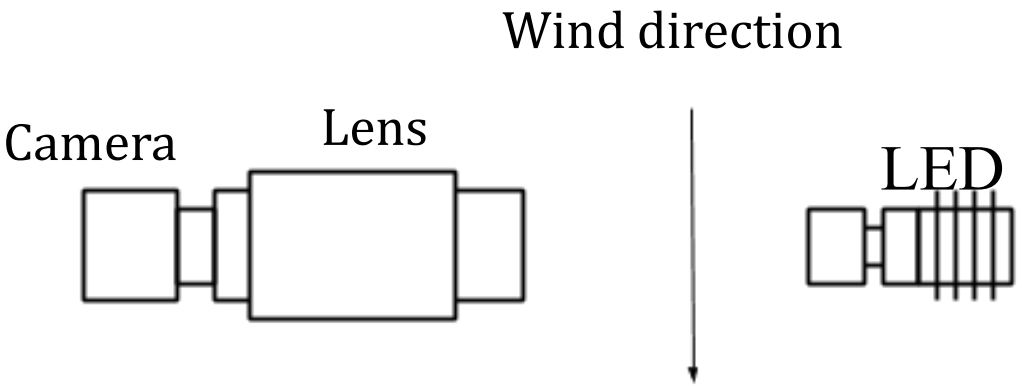
Common calculation methods uses geographical parameters and meteorological parameters.

- Direct methods – Measurement of ice and production losses
- Indirect methods – Measurement of the environment conditions and prognosis of icing

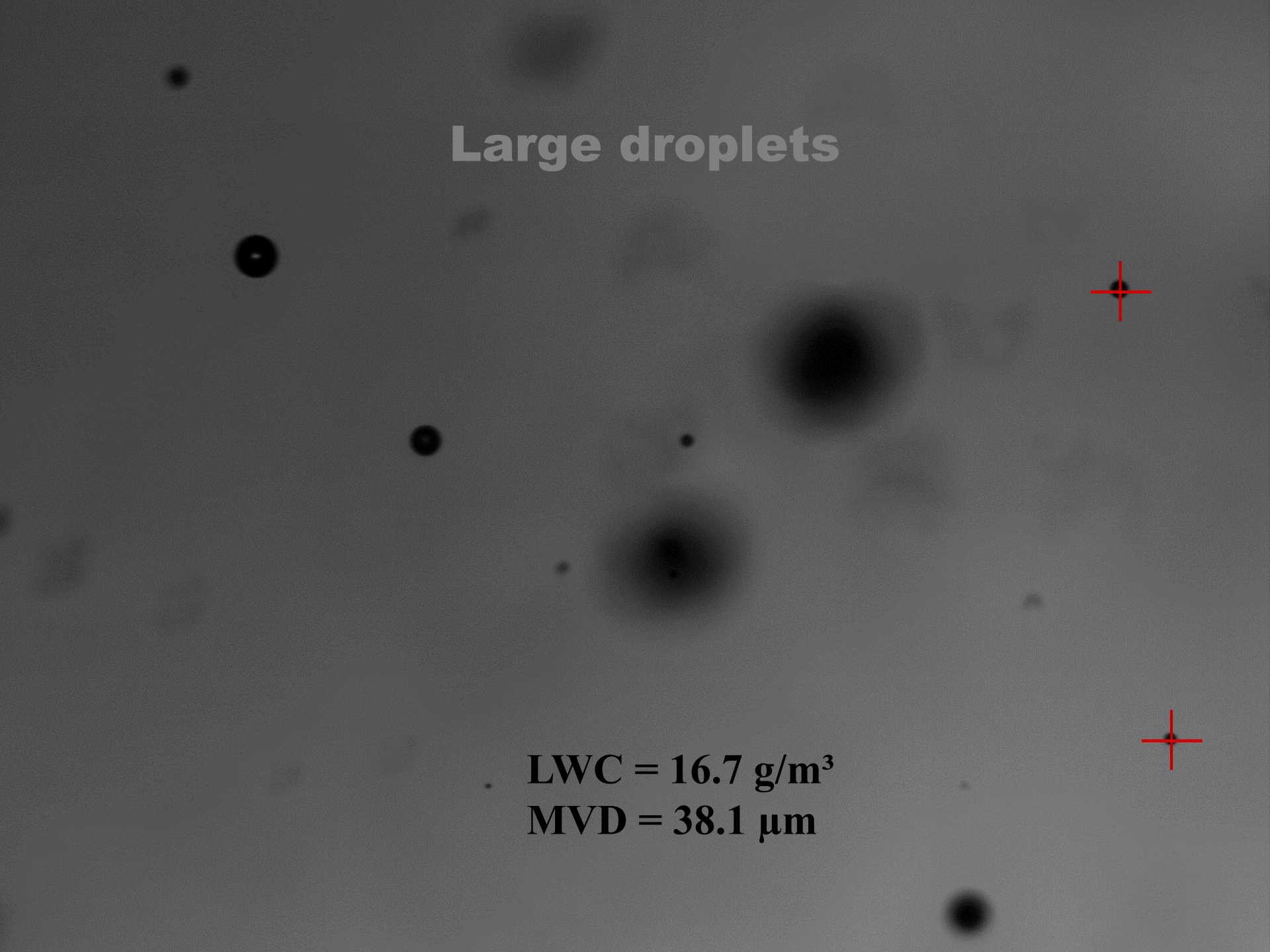
Our Research

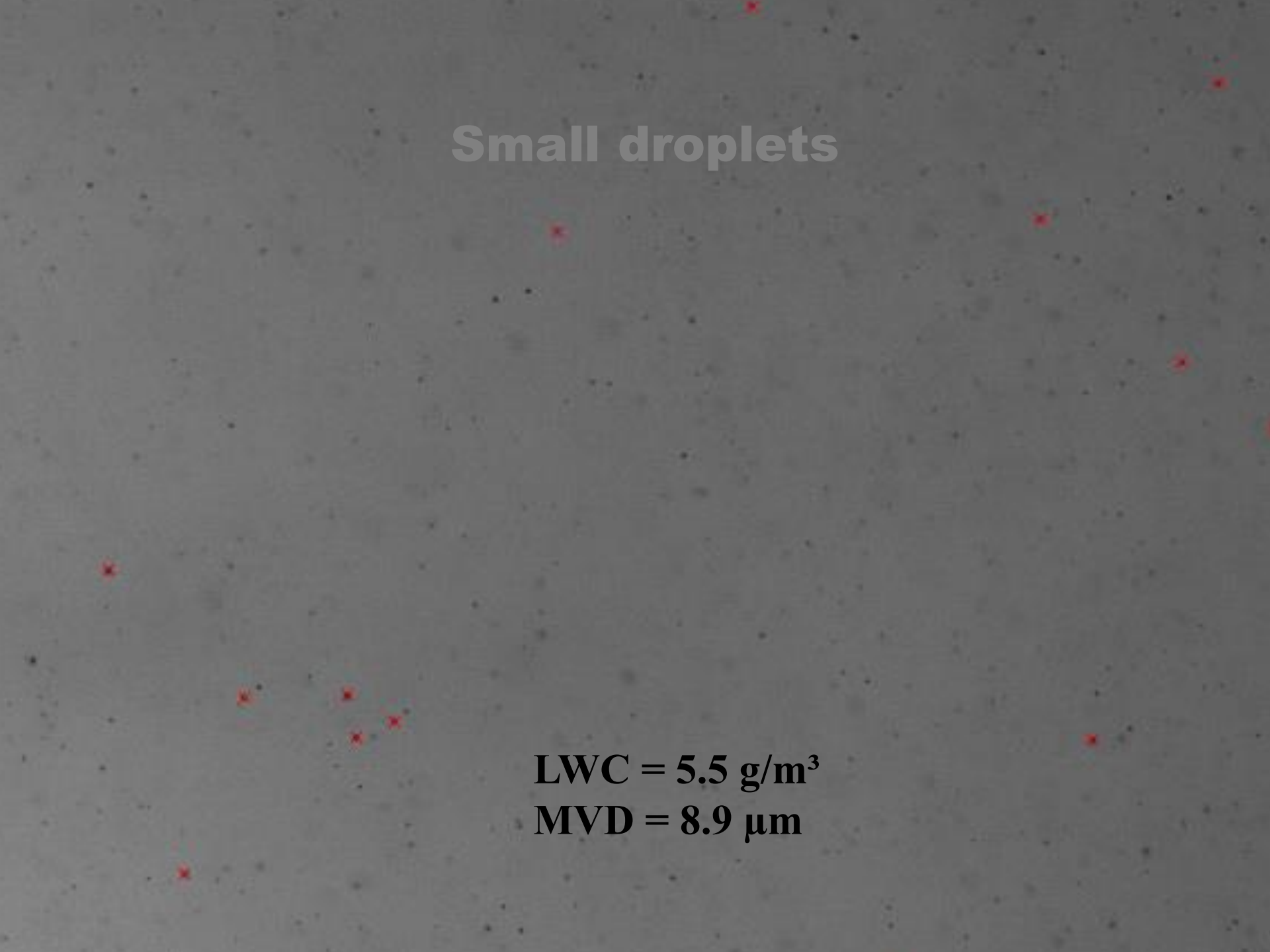
- By using cameras for photographing water droplets in the air it is possible to determine LWC and MVD
- The instrument can be used on different sites and locations
- The instrument must be cost effective enough to allow installation at a larger scale
- The instrument must be possible to integrate with loggers and systems for remote data collection

Droplet measurement principle



- A 4MP CMOS camera with a lense
- LED flasher with collimating optics
- Computer for automatic analysis and storage of data


Large droplets
LWC = 16.7 g/m³
MVD = 38.1 µm


Small droplets
LWC = 5.5 g/m³
MVD = 8.9 μm

Climate chamber and sensor

- **The image shows the monitoring equipment in a climate chamber filled with fog. The sensor can continously report LWC and MVD**

LWC and MVD sensor - Field tests

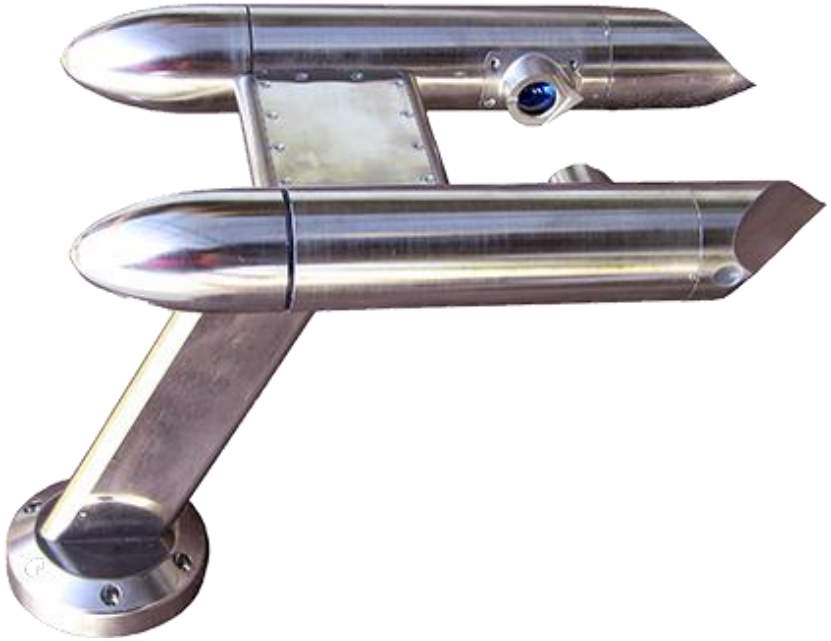
- During 2016 a prototype will be installed for field tests at an SMHI mountain site

- Reference instruments will be
  - IceMonitor™ from Combitech
  - CDP-2 from Droplet Measurement Technologies
- Logger system will be Odin from Combitech

IceMonitor™

- IceMonitor™ designed according to the **ISO 12494** specification (Atmospheric icing of structures)
- The output signal standard 4–20mA
- **Optional logger** and communication unit

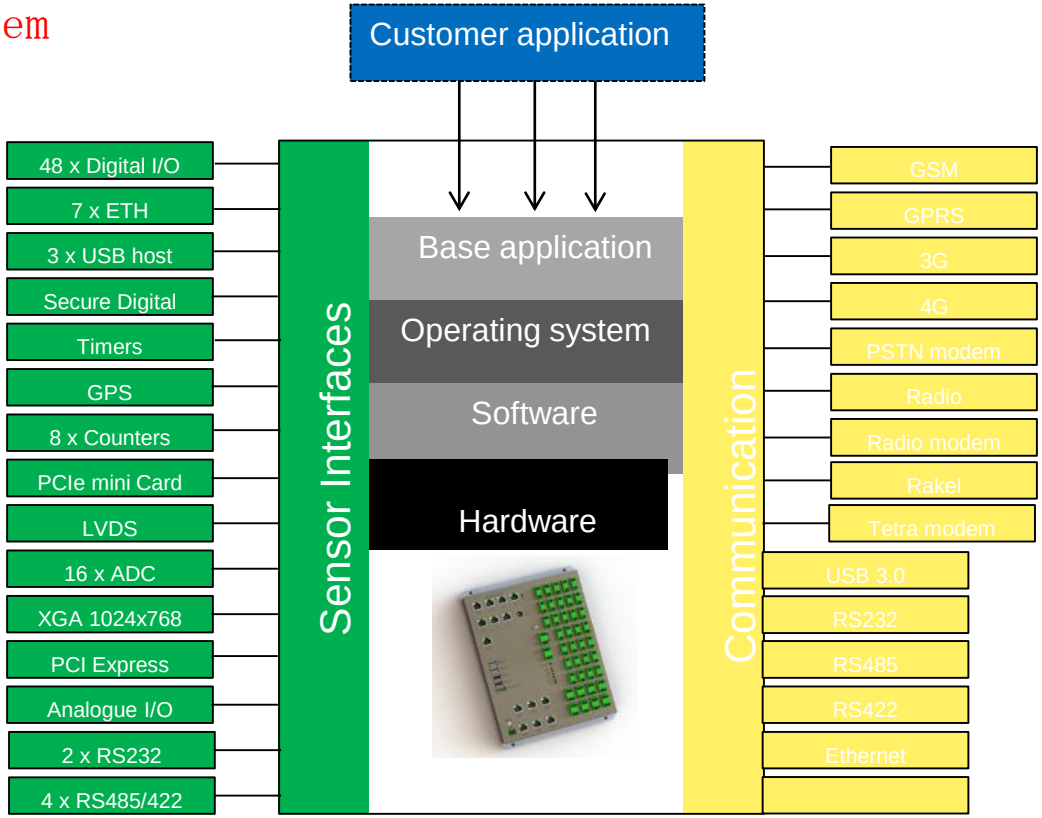
Droplet sensor – CDP2



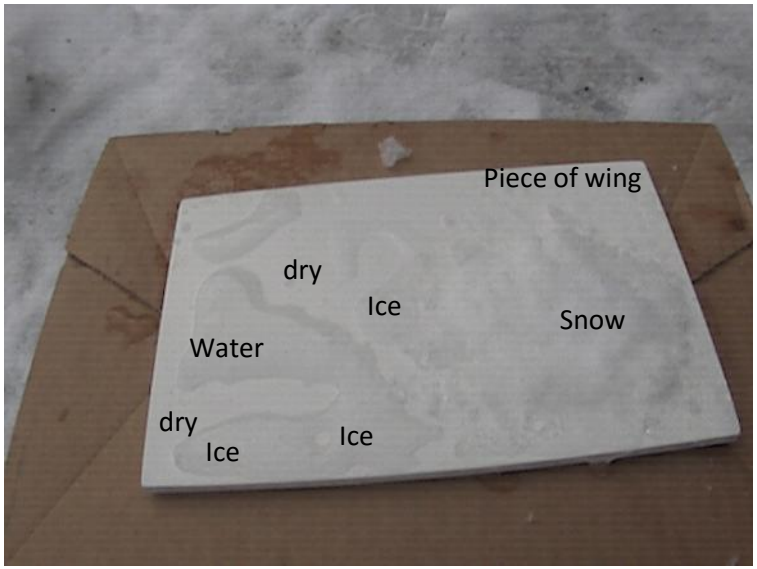
- Forward scattering spectrometer
- A laser beam emitter
- Photodetectors
- Particle size 2-50 µm

Odin – logger unit

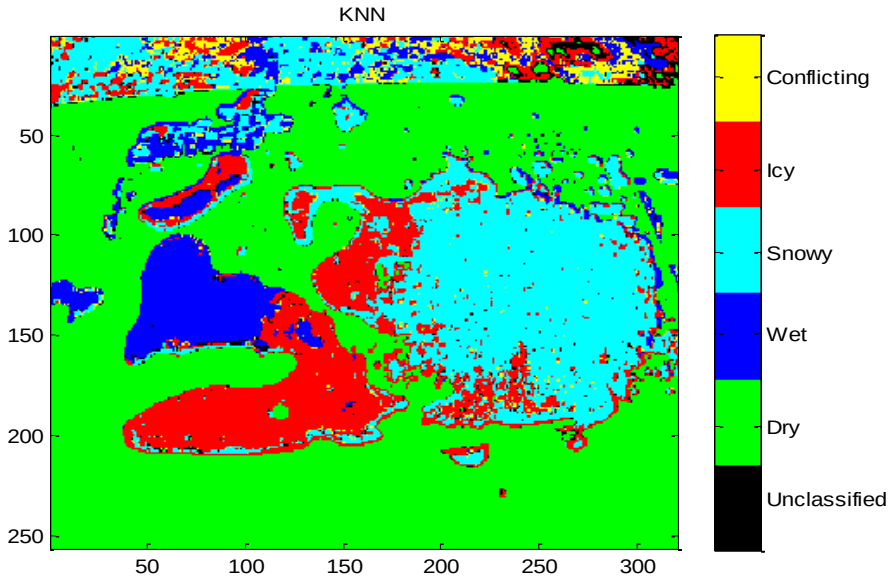
State of the art embedded system



NIR imaging ice detection



Visual image of wing blade piece with water ice and snow

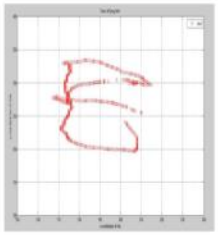


Classified blade surface status

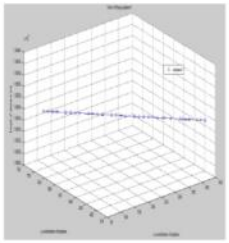
Sky monitoring system

Objects can be classified based on

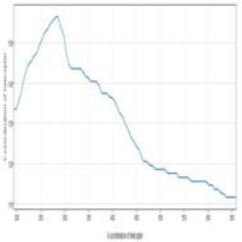
- Physical properties
  - Size
  - Speed
  - Altitude
- Behavioral properties (flight pattern)
  - Numbers of line in the path
  - Number of arcs/ellipses in the path
  - Number of crosses in the path



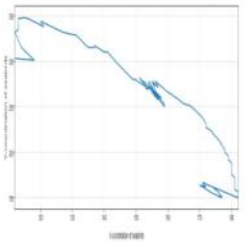
Kites



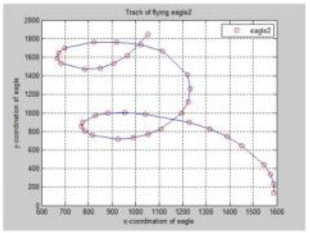
Airplanes



Helicopters



Birds



Eagles

Complete system solution

- **Research** sensor equipment
- **Reference** sensor equipment
- High quality standard **meteorological** sensors
- **Advanced logger unit** (data check, storage, calculations)
- **Communication** solution (3G, 4G, Net1, Radio)
- **Data storage** in SQL database
- Data accessible in **web** interfaces
- **Software development** for logger, communication, analysis, artificial intelligence, classification and presentation of data

Cost effective monitoring system

- Combitech has developed a **low cost monitoring system** with only a small degradation of data quality
- Based on latest small computer units (Beaglebone)
- Very advanced software on an inexpensive hardware
- Sensors supported
  - Meteorological sensors
  - Ice detectors
  - Cameras