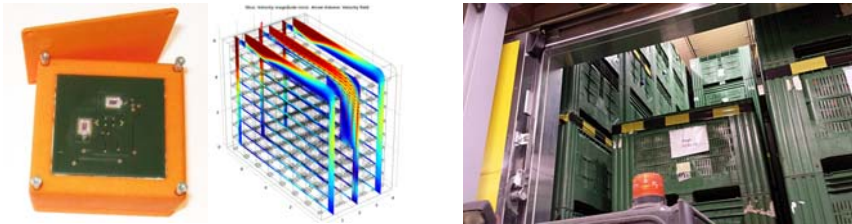




Reiner Jedermann, Nico Hartgenbusch, Mykhailo Borysov, Chanaka Lloyd, Ulrike Praeger, Marc Spuler, Walter Lang

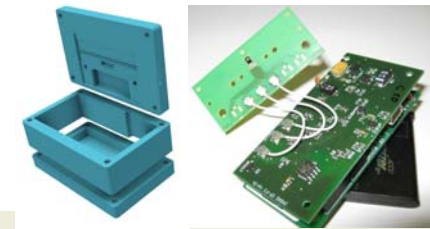
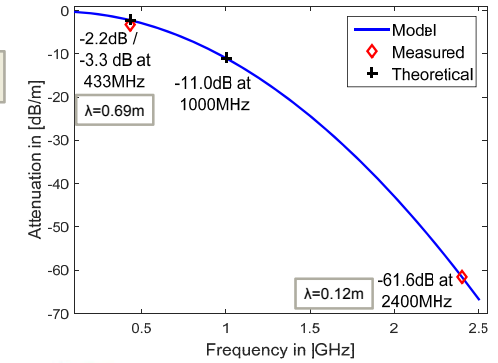
Spatial profiling of airflow conditions in cold storage warehouses by wireless anemometers



WAM Type #0

Used in field tests

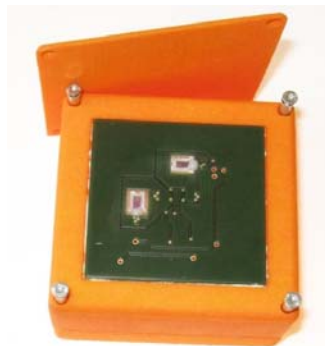
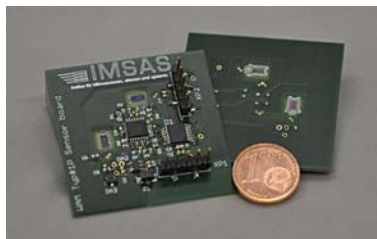
- Wireless, battery powered
- Radio communication 2.4 GHz
- 1-Dimensional measurement
- Poor accuracy at 0.2 m/s



WAM Type #1

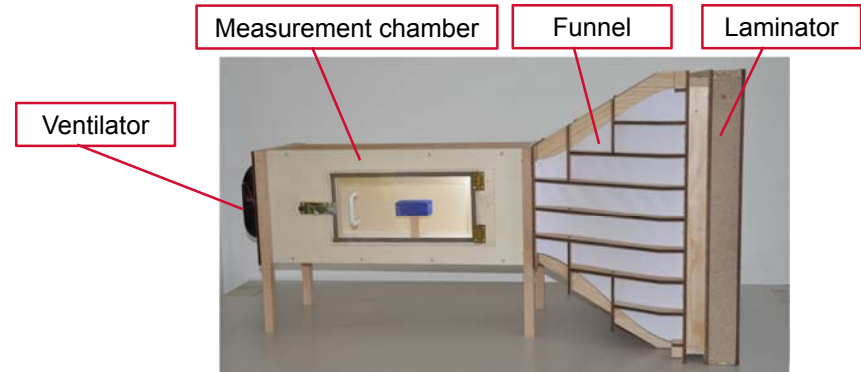
New design with higher sensitivity, 2-D measurement

- Wireless, battery powered
- Radio communication 433 MHz
- New heater control (Constant Energy)



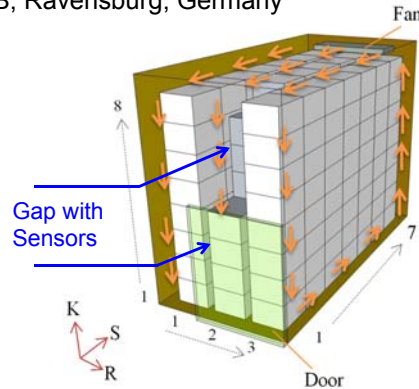
Wind-Tunnel

- For Calibration, cross section 20 cm by 20 cm
- Control of fan for low flow speed difficult → dedicated motor controller
- Range from 0.1 m/s to 2 m/s



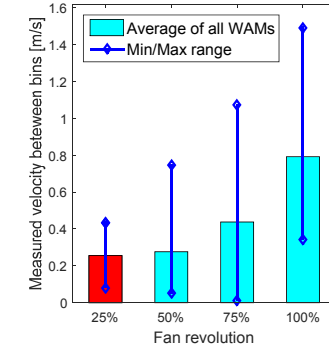
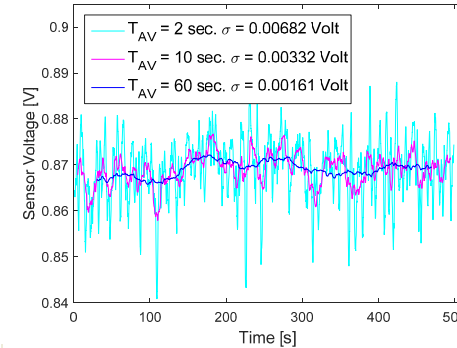
Installation in Warehouse

- 163 bins with 300 kg Apples each
- 23 WAMs #0 installed in one vertical gap
- KOB, Ravensburg, Germany



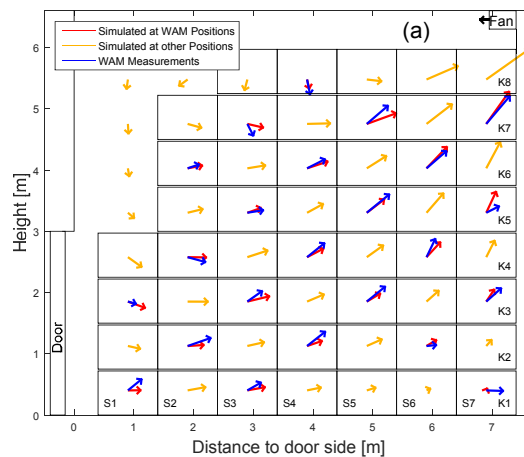
Test Results: Turbulences and Resolution

- Stable measurements require smoothing over at least 30 seconds
- For measurement at low Fan Revolution rates, sensitivity at flow rates < 0.2 m/s has to be improved



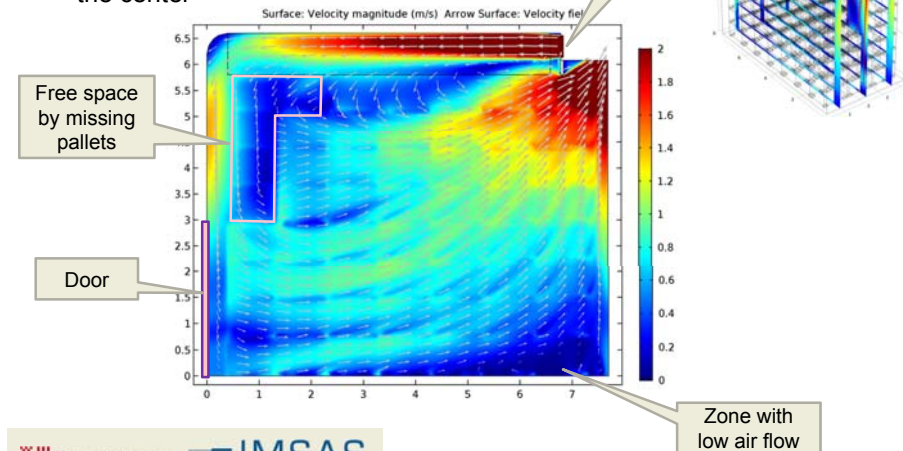
Spatial airflow pattern

- Measured airflow between 0.34 m/s and 1.5 m/s
- Simplifications:
 - no air flow through boxes
 - ...
- COMSOL took 14 days
- General pattern and magnitude of air flow confirmed



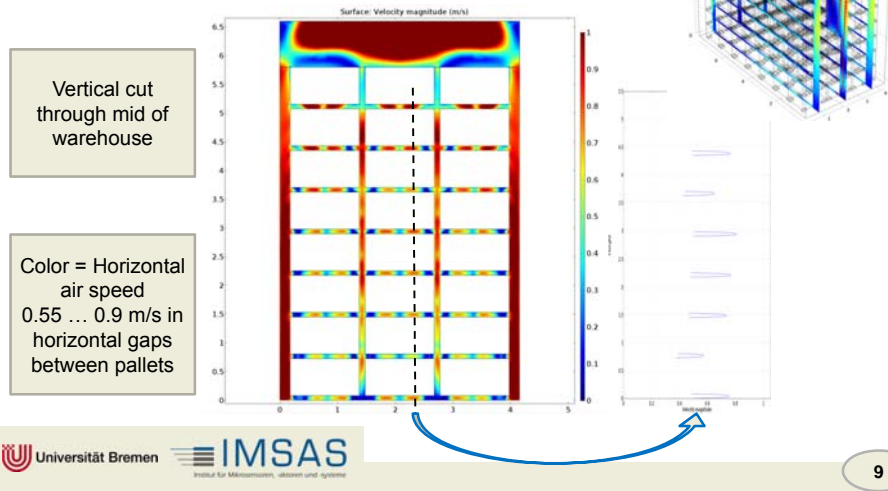
CFD air flow simulation

- Test for possible eddies with low flow in the center



CFD air flow simulation

- Test for even airflow in horizontal gaps



Conclusions

- Angular variation of air flow → 2-dimensional measurement necessary
- WAM Type #1 with better resolution → next test in Autumn 2016
- Goal Single-Chip 2-Dimensional Sensor
- Define sensor positions for automated fan revolution control
 - 3 corners, critical for low air flow
 - 1 corner below fan, critical for high air flow
 - Center of stack, for average air flow
- Due to turbulences, measurands have to be averaged > 30 sec

Thanks for your attention

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