Der intelligente Container
The Intelligent Container

Workshop at Floriade 2012: **Agro & food needs technical inspiration**

Prof.-Dr. Walter Lang
Dr.-Ing. Reiner Jedermann

Sensor supervision of perishable products by the intelligent container

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Universität Bremen IMSAS

The intelligent container project

- Supervision of chilled food transports
  –
- Topics
  – Bananas and meat products
  – Wireless sensor networks
  – Telemetric supervision
  – Effects of temperature deviation on product quality

The alliance

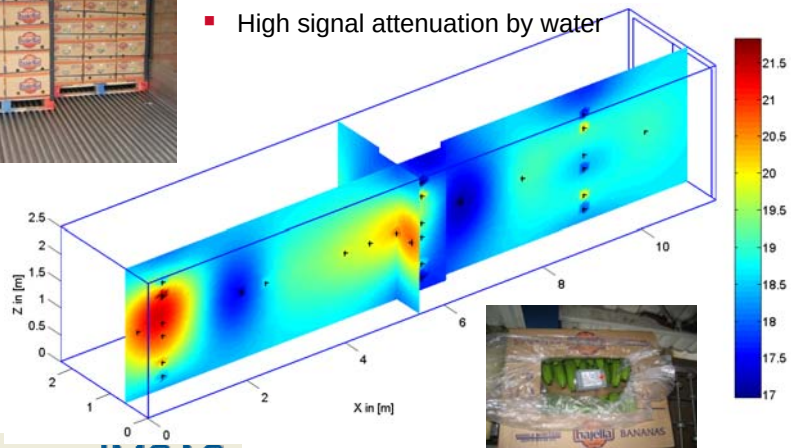
- Project from Mid 2010 to Mid 2013
- 14 industrial and 6 research partners

Project goals / Outline

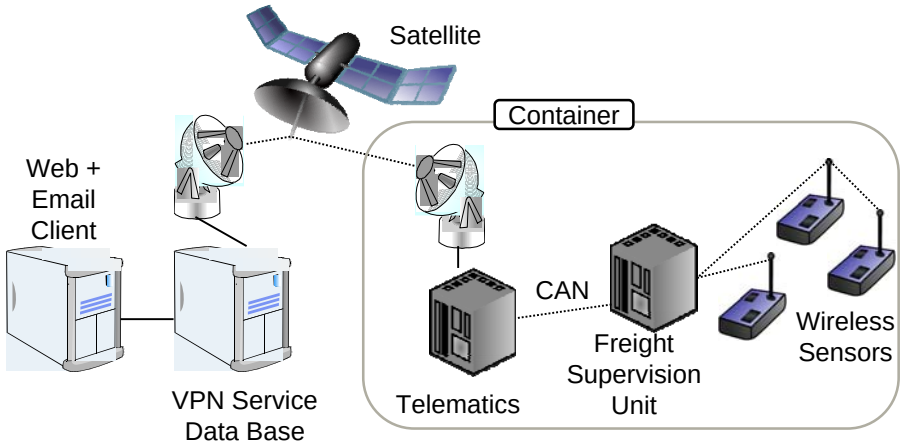
- Provide remote access / telemetric supervision of temperature per pallet
- Evaluate resulting shelf life losses
- Detect critical cooling states
- Detect unwanted ripening by ethylene gas sensors
- Integration into warehouse management

Measured temperature distribution

- Test of 4 different types of wireless sensors
- High signal attenuation by water

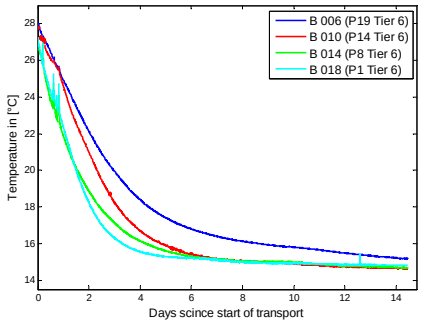


Telemetric supervision



What can we learn form temperature curves?

- Calculate Shelf/Green Life
- Detect critical cooling states



Green life modeling

- Remaining Green Life = How many days are left until the bananas start ripening without additional triggers
- The duration of the Green Life decreases for higher temperatures
- Model calculates how much of the Remaining Green Life is **lost per day** as function of temperature
- Additional influence factors such as atmosphere (CO_2, O_2, Humidity) have to be considered

ATB
Leibniz-Institut für Agrartechnik
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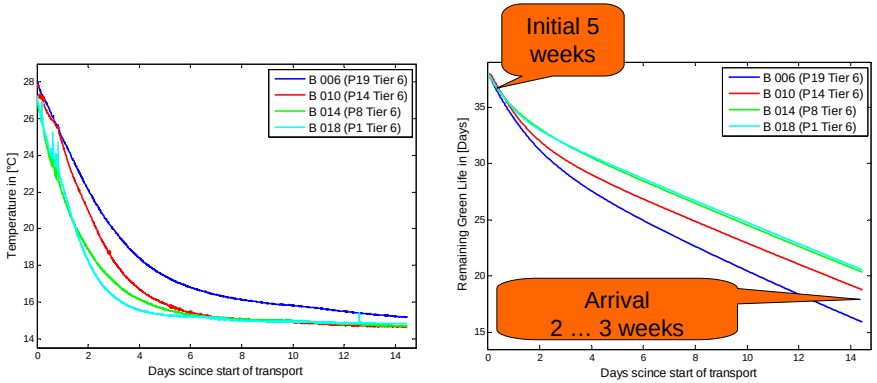
Green life modeling

Temperature diagram → Green Life diagram

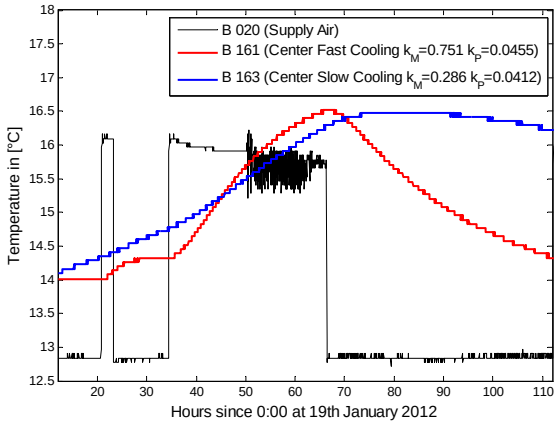


Detection of critical cooling states

- Detect insufficient cooling
  - box is cut off from the air stream provided by the unit
- Experiments ashore with controlled conditions
- Simulate ‘careless’ packing of container
  - gaps
  - It’s easy to create temperature differences

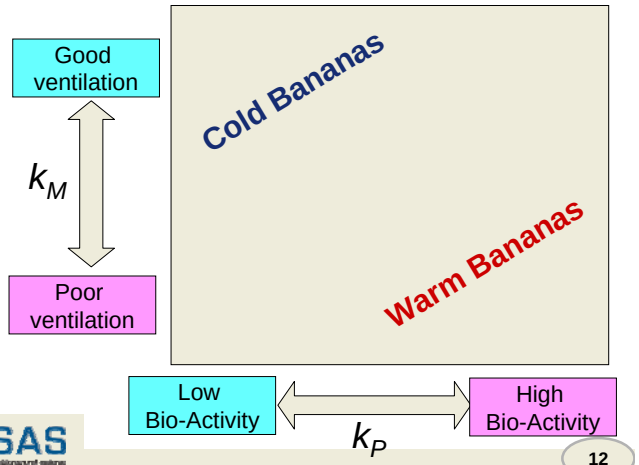
Identify parameters of cooling

- Mathematical model to describe the speed of cooling
- Two parameters
  - Coupling of one box to the air stream k_M
  - Generated heat by self-warming k_P
- Run parameter estimation



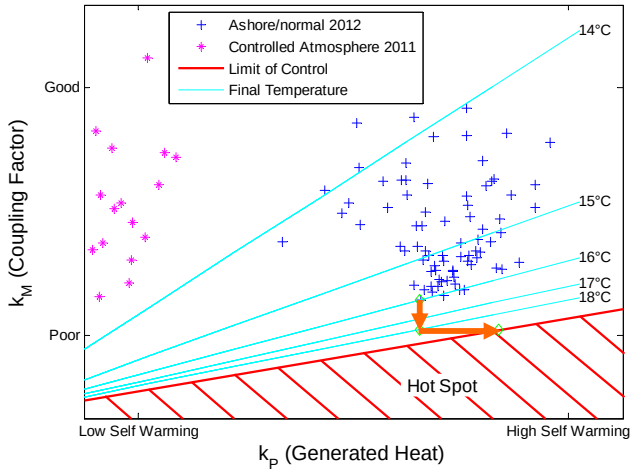
Prediction of critical states by model

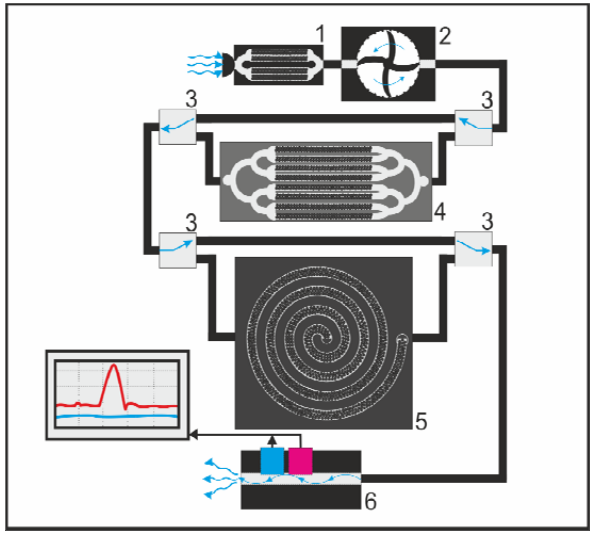
- 2-Dimensional field of the parameters k_P and k_M



Prediction of critical states by model

- If generated heat is larger than the heat that can be removed by the air stream, the process becomes incontrollable!
- Little change of parameters (-25%) can generate a hot spot





Gas sensors for ethylene

1 Filter

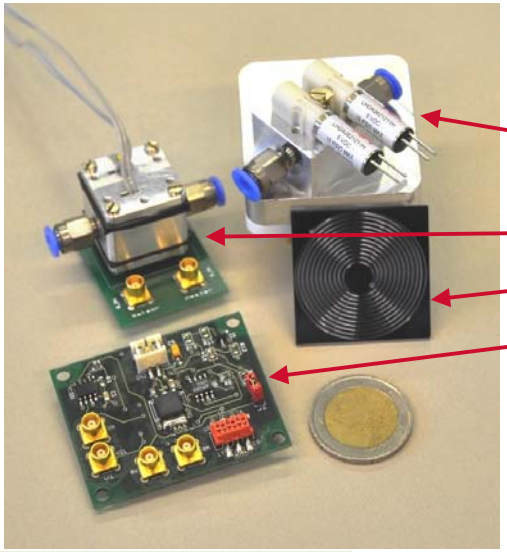
2 Pump

3 Vales

4 Pre-Concentrator for Ethylene

5 Chromatography Column

6 Metal-Oxide Sensor Humidity Sensor

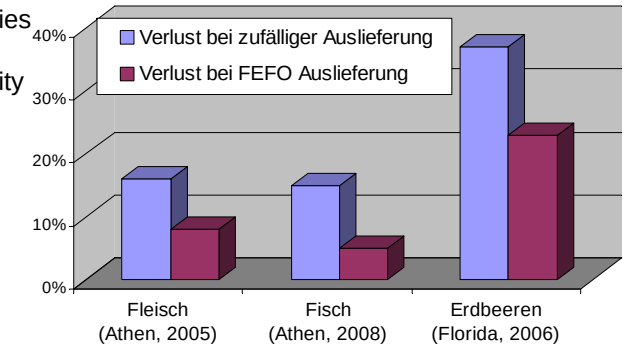


Gas sensors for ethylene

- GC-Housing with vales
- MOX Sensor
- GC Column
- Electronics for MOX

First expires first out

- Organize warehouse management by remaining Shelf/Green Life
- Keep high shelf life products for storage or long distance deliveries
- Assign low shelf life products for immediate sale in nearby shops
- Encouraging studies from literature
- Reduction of quality related losses by 8% to 15 %



Intelligent warehouse management

- Containers with low Green life
  - Priority unloading in harbor
  - Schedule first for ripening room
- Handling of critical containers / losses
  - Early warning
  - Inform farm
  - Replacement (critical for branded boxes)
  - No unloading from the vessel (tax saving)
- Advantages not quantified yet
  - Report will be presented at end of project

Summary and Conclusions

- A warning system for fresh fruits has to include the following components:
  - Green Life / Shelf Life modelling
  - Detection of critical cooling states
  - Gas sensors
- The self-supervising container
  - Detect cooling and quality problems automatically
  - Calculate a percentage indicator
  - Inform the customer / warehouse management
  - Assign the right product in the right quality to the right customer
- More information: www.intelligentcontainer.com

Thanks for your attention

www.intelligentcontainer.com

Dr. Ing. Reiner Jedermann
University Bremen, FB1
Institute for Microsensors, -actors and –systems
(IMSAS)
Otto-Hahn-Allee, NW1
D-28359 Bremen, GERMANY
Phone +49 421 218 62603, Fax +49 421 218 98 62603
Email rjedermann@imsas.uni-bremen.de