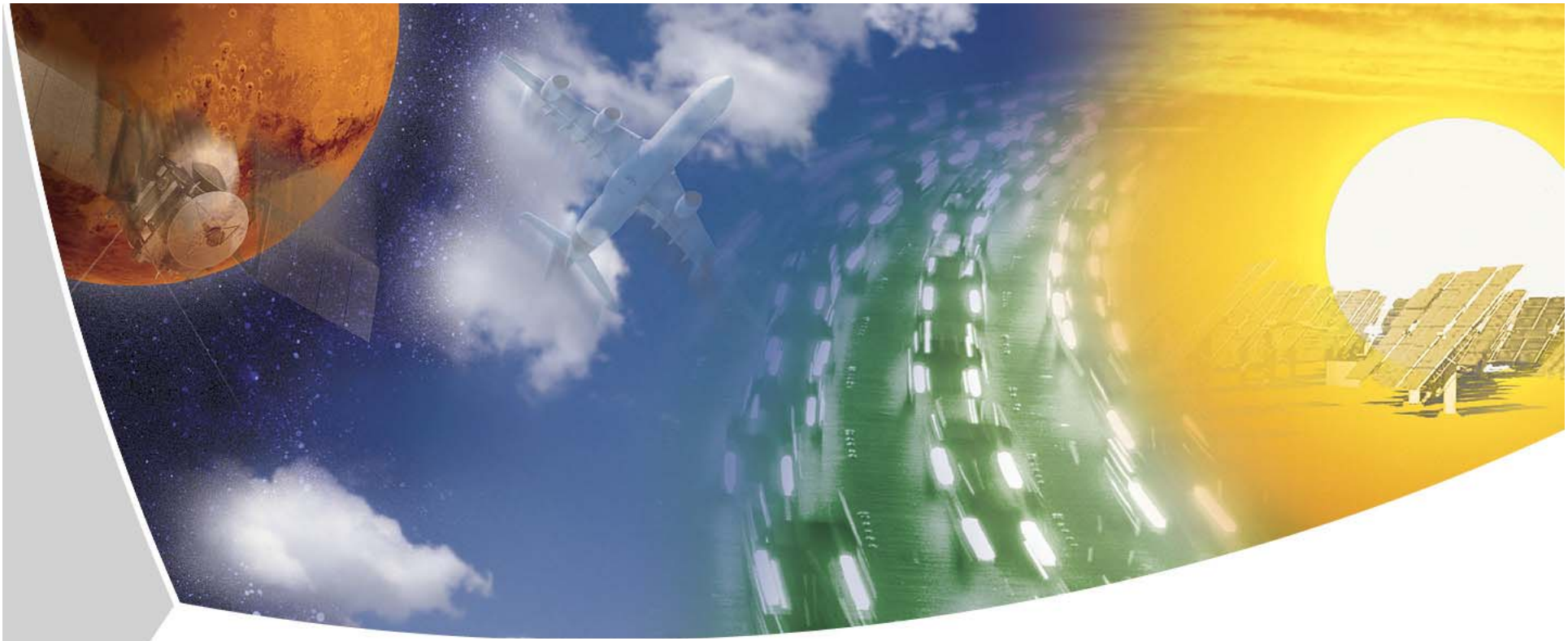


Virtual Tower

Norbert Fürstenau

Michael Rudolph, Markus Schmidt, Bernd Werther

Airport – Bottleneck or Booster for Future ATM

11.–13. Oct. 2005

DLR-Institute of Flight Guidance, Braunschweig, Germany

Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

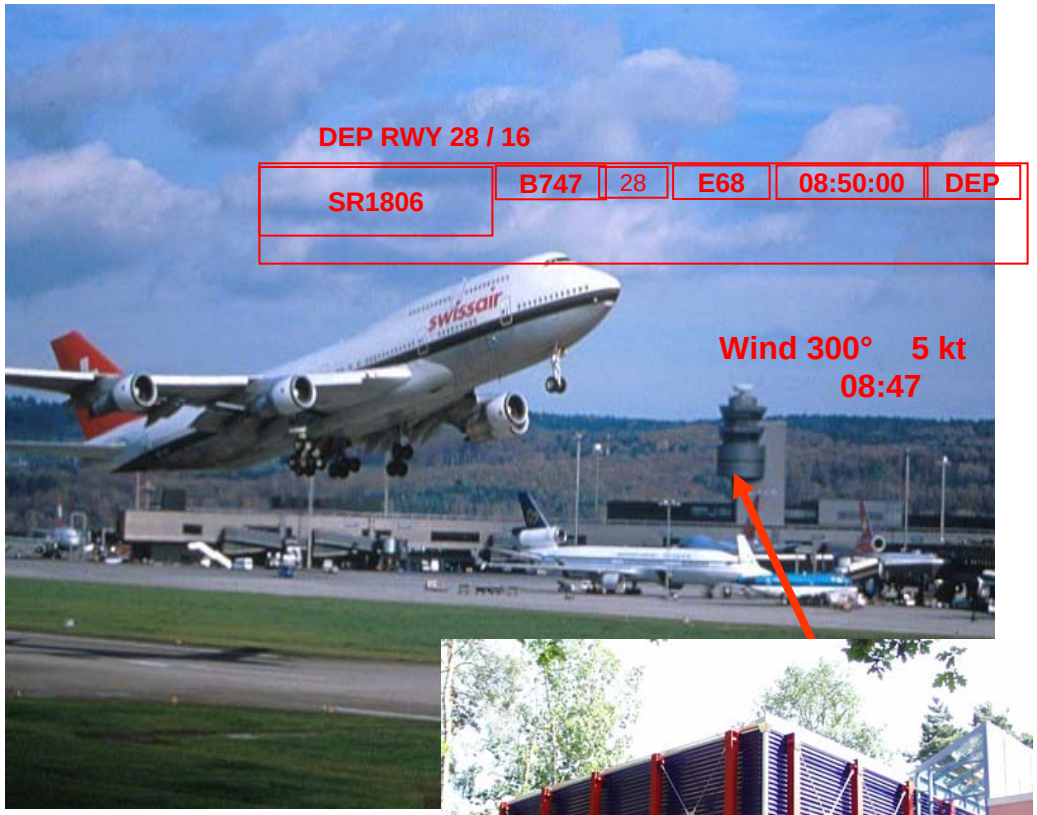
Tower Control Problems:

Human Computer Interaction:
situation awareness
/ head down times under
increasing traffic

Cost… of Tower Building; … of
Operator staff for small airports

Safety: Airport - Safety
Management System with Replay

Capacity: Weather Dependence



Advanced Control Center
Simulator (ACCES)

Solution:
Sensor Based (Windowless) Control Center with Augmented Vision Video Panorama

- Virtual Tower Study (ViTo: 2002 – 2004)

  Requirements & Initial Concept

  Augmented Tower Vision

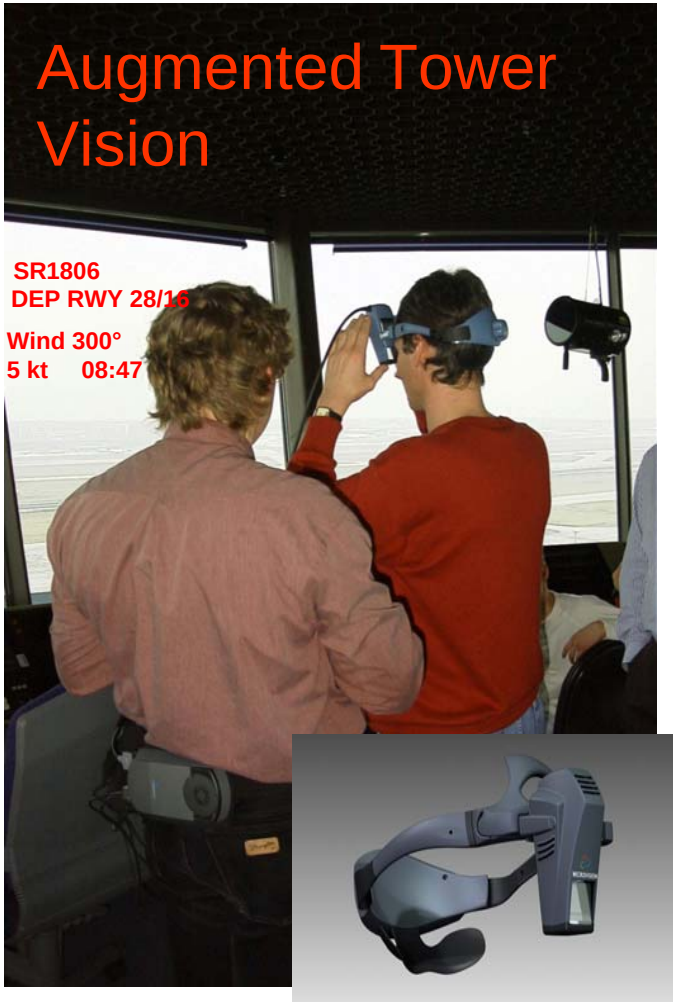
  Cognitive Modeling for HMI Design

- Remote Tower Operation (RapTOr: 2005-2007)

  Work Analysis & Modeling

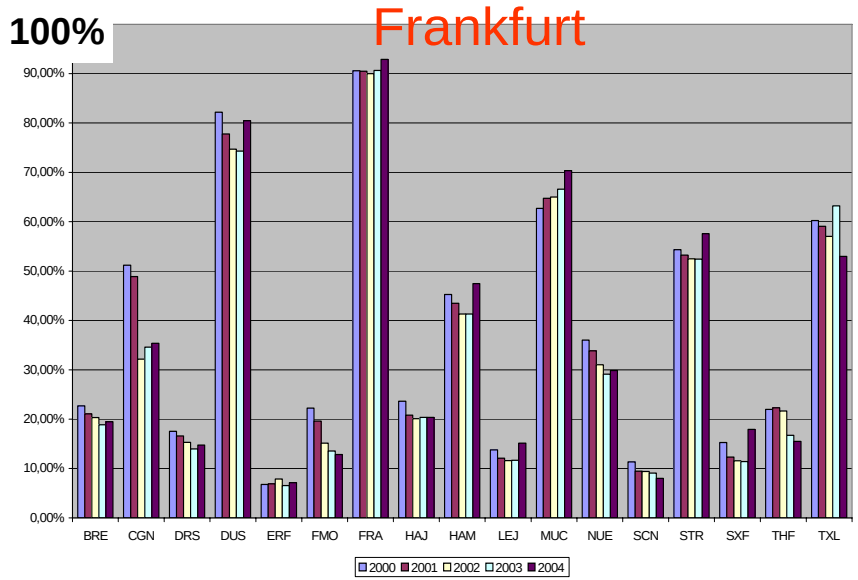
  RTO Experimental Testbed

HCI: Problem of head down times under increasing traffic



Augmented Vision:
Integrating Far View and Data for improving Situation Awareness

✓ - direkter Kontakt innerhalb der letzten 3 Monate

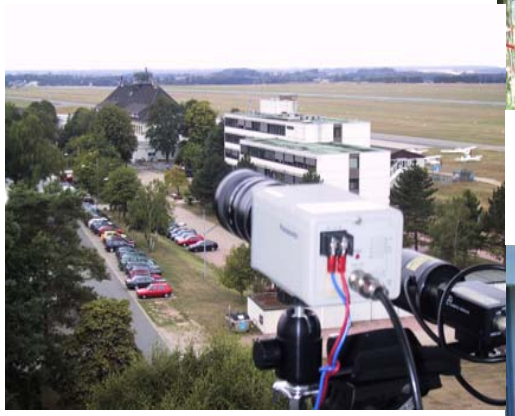


Average Capacity Usage at large German Airports

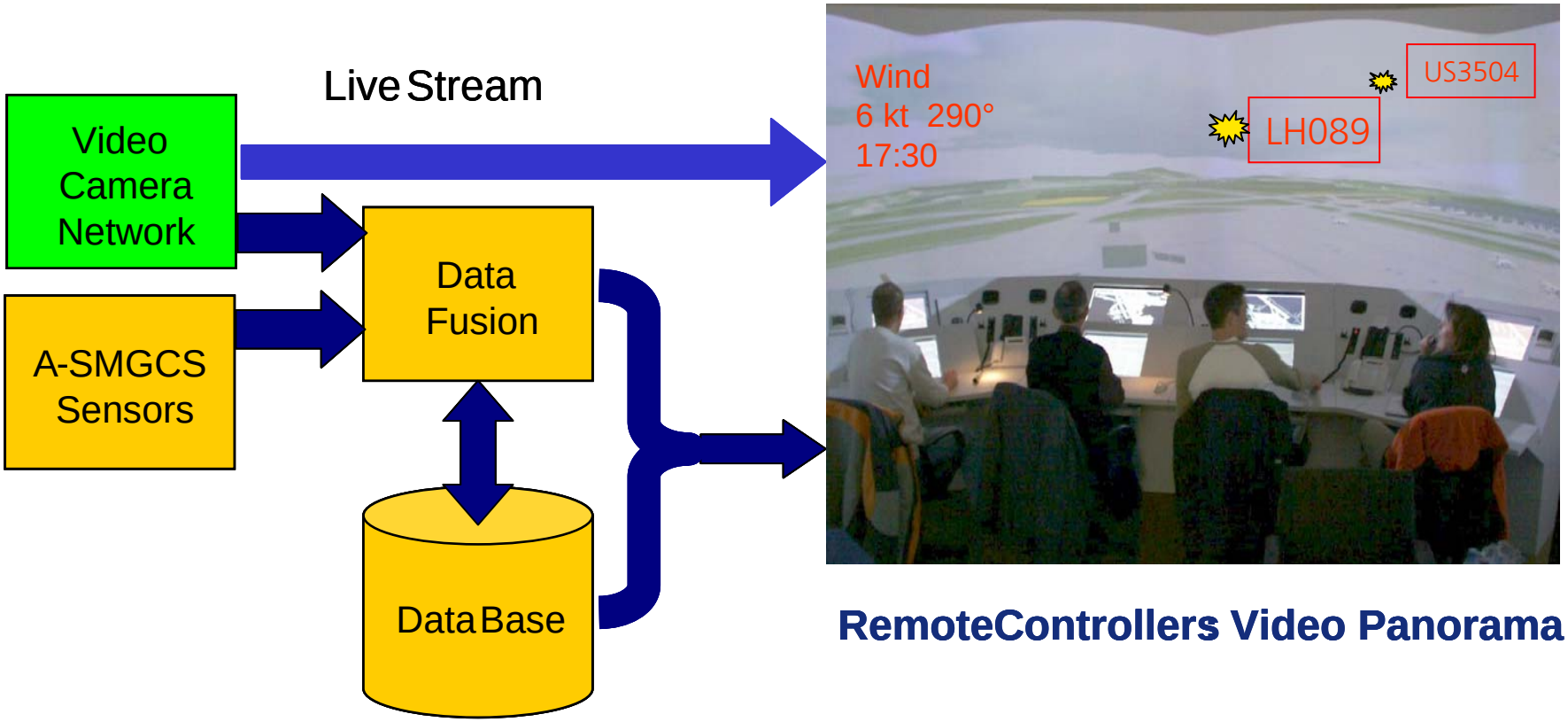
To meet capacity problems and request of low cost carriers:

Provide cost effective controlled airspace to Regional Airports via Remote Tower Operation (RTO).
Example:
Leipzig – Erfurt, L. - Altenburg

Virtual Tower / Remote Tower Operation RTO



ACCES
as experimental RTO - HMI



RemoteControllers Video Panorama

ViTo / RTO – Concept.

Augmented Vision – Video Panorama with integrated Flight Data

- Virtual Tower Study (ViTo: 2002 – 2004)

  Requirements & Initial Concept

  Augmented Tower Vision

  Cognitive Modeling for HMI Design

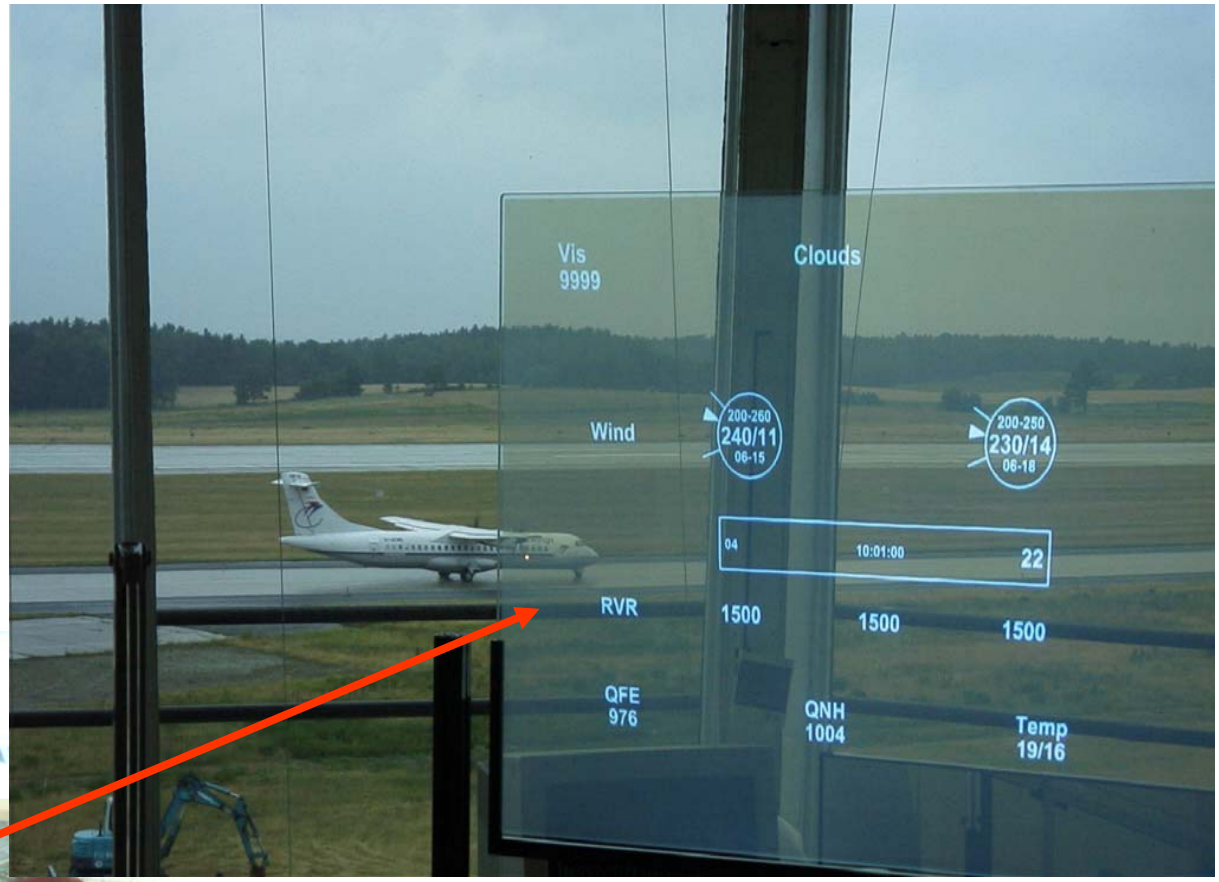
- Remote Tower Operation (RapTOr: 2005-2007)

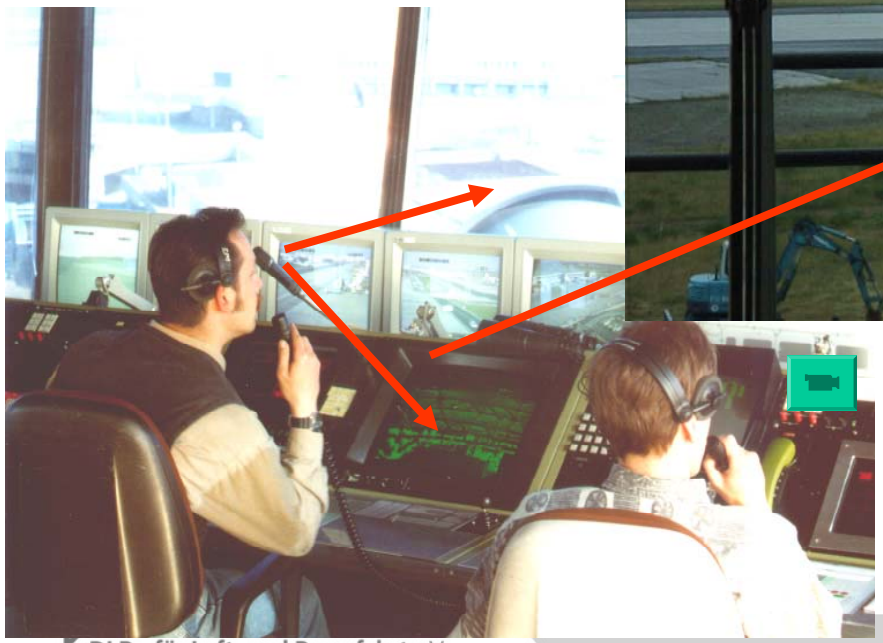
  Work Analysis & Modeling

  RTO Experimental Testbed

Augmented Tower Vision ATV

reducing
head down times
and
weather dependence





Holographic Transparent Projection:
Weather Display TWR Dresden
[2003]

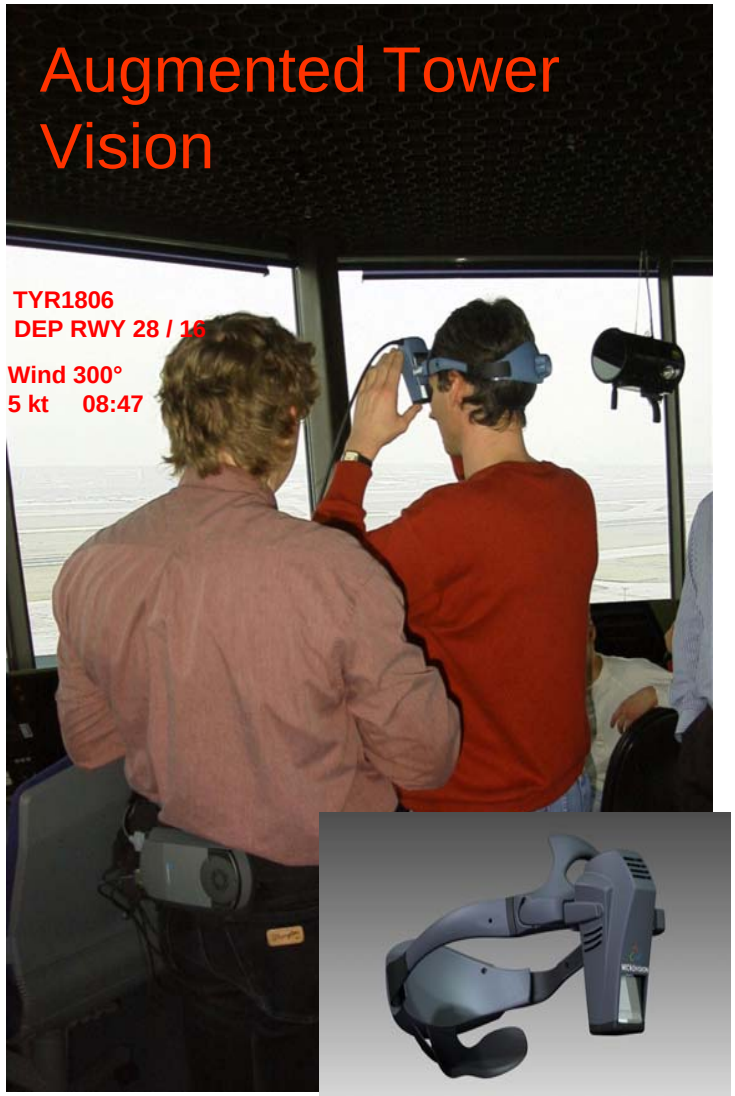
Head Down Time Reduction ! ⇐

Decrease of Reaction Times !?⇐

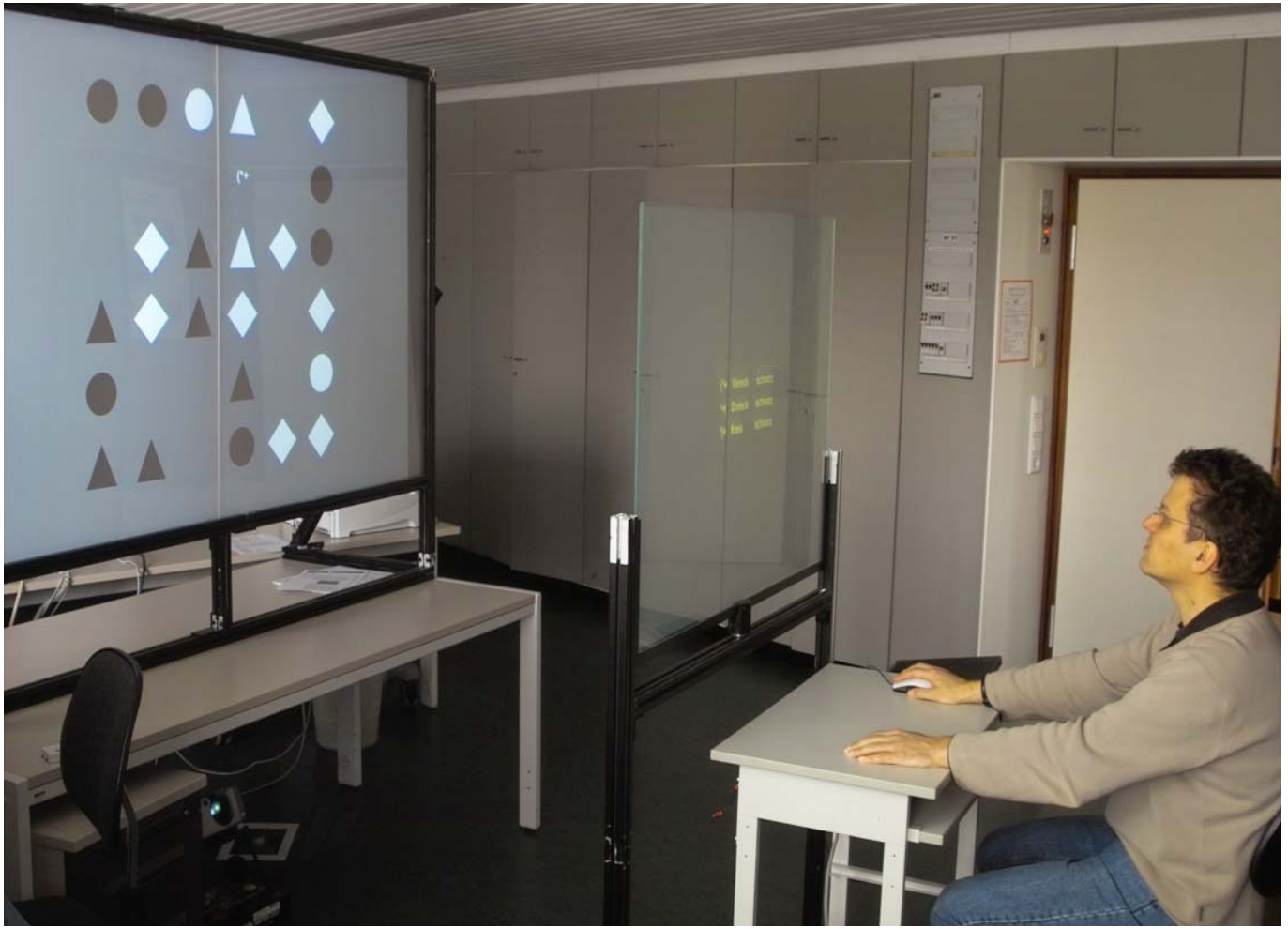
Problems:
Spontaneous Perception Switching

Binocular Rivalry / Cognitive Multistability
[Peli1990][Laramé 2000][USAARL Rep.#2002-2]

⇒ **Experiments and Cognitive Models**



Test of Laser Retinal Scanning Display (RSD) at Frankfurt Airport Tower (2/03).



Augmented Vision Response Times with holographic Projektion Display

[Fürstenau, Rudolph, Schmidt, Lorenz, Albrecht: HPSAAII Conf., Daytona Beach, 3/2004]

- Virtual Tower Study (ViTo: 2002 – 2004):

  Requirements & Initial Concept

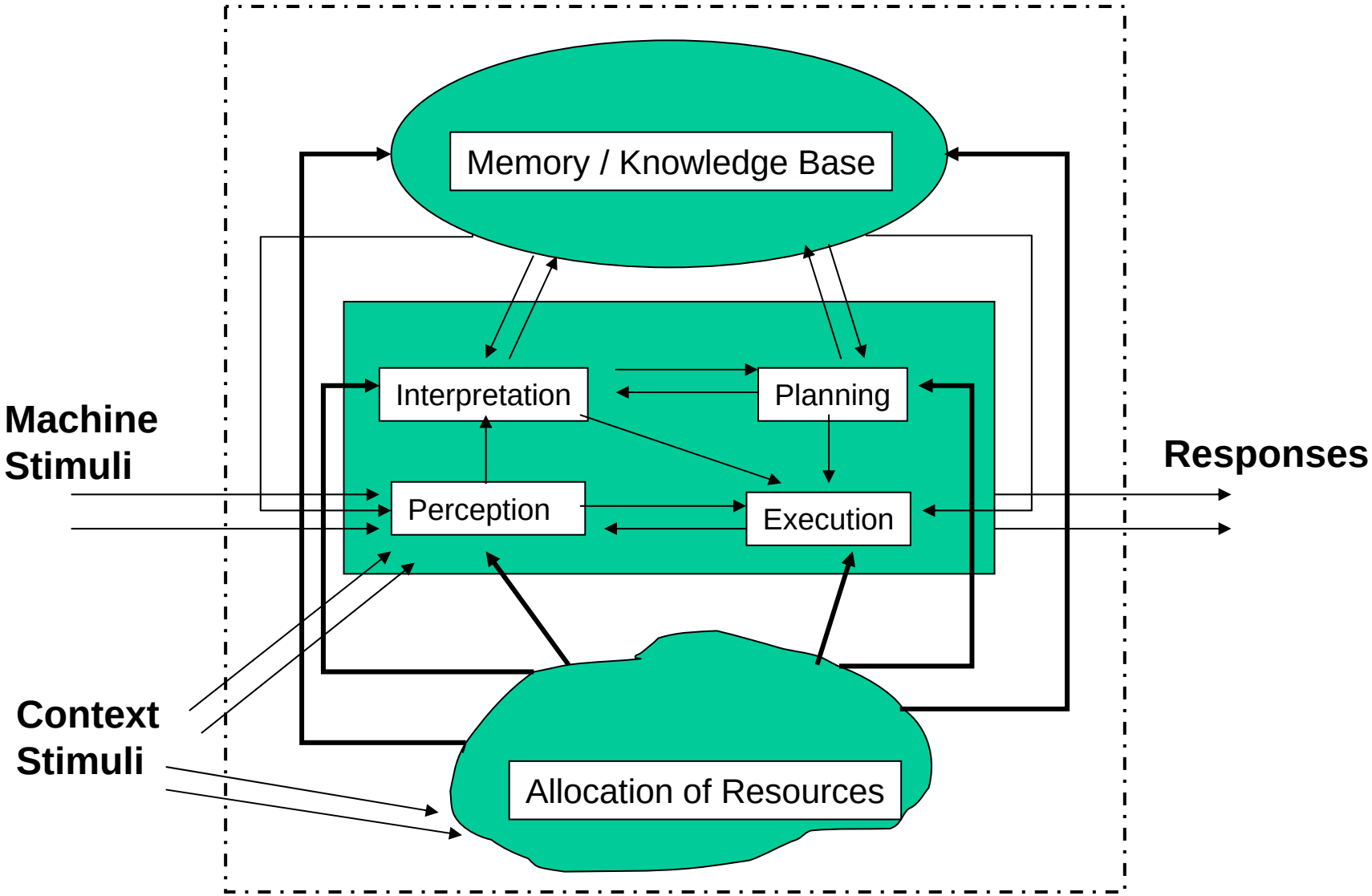
  Augmented Tower Vision

  Cognitive Modeling for HMI Design

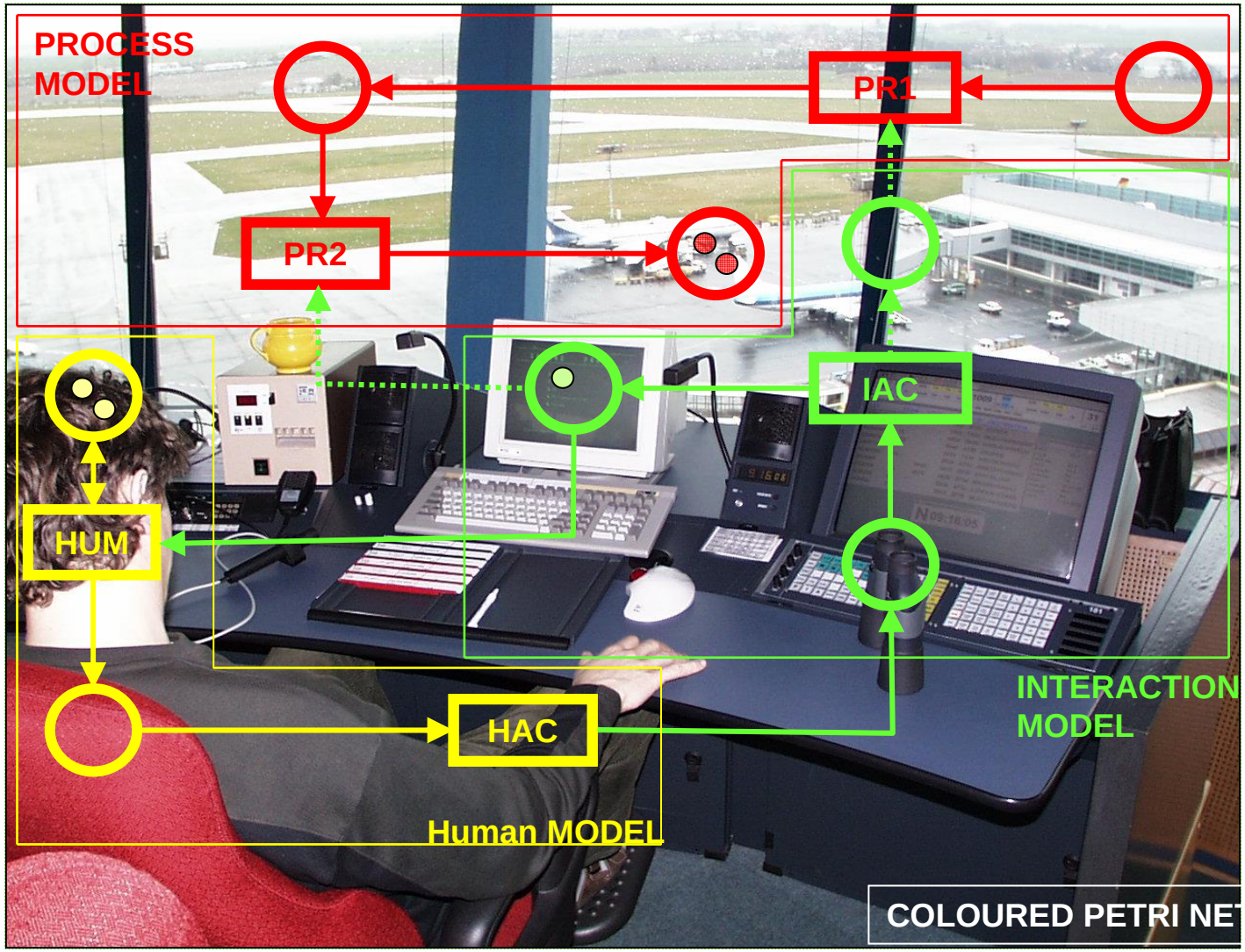
- Remote Tower Operation (RapTOr: 2005-2007):

  Work Analysis & Modeling

  RTO Experimental Testbed



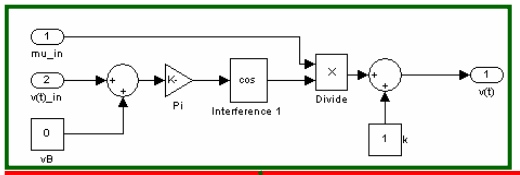
Supporting HMI Design by Cognitive Modeling & Simulation of Work Process using Ressource based Cognitive Architecture [Cacciabue 99] [B. Werther 2002-05]

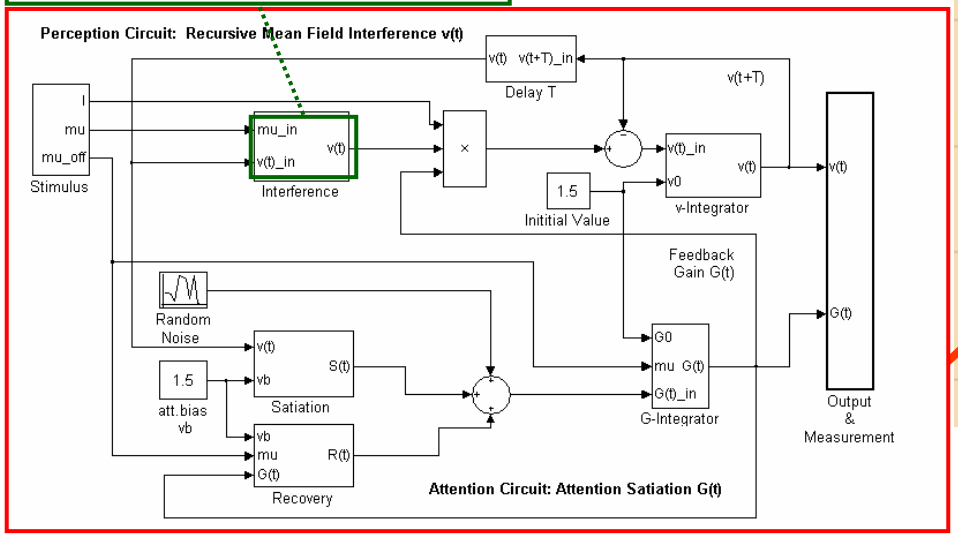


Process, Interaction & Operator Cognitive Work Model with Design – CPN

[B. Werther, PhD Dissertation 2005]

Ambiguous Visual Stimuli

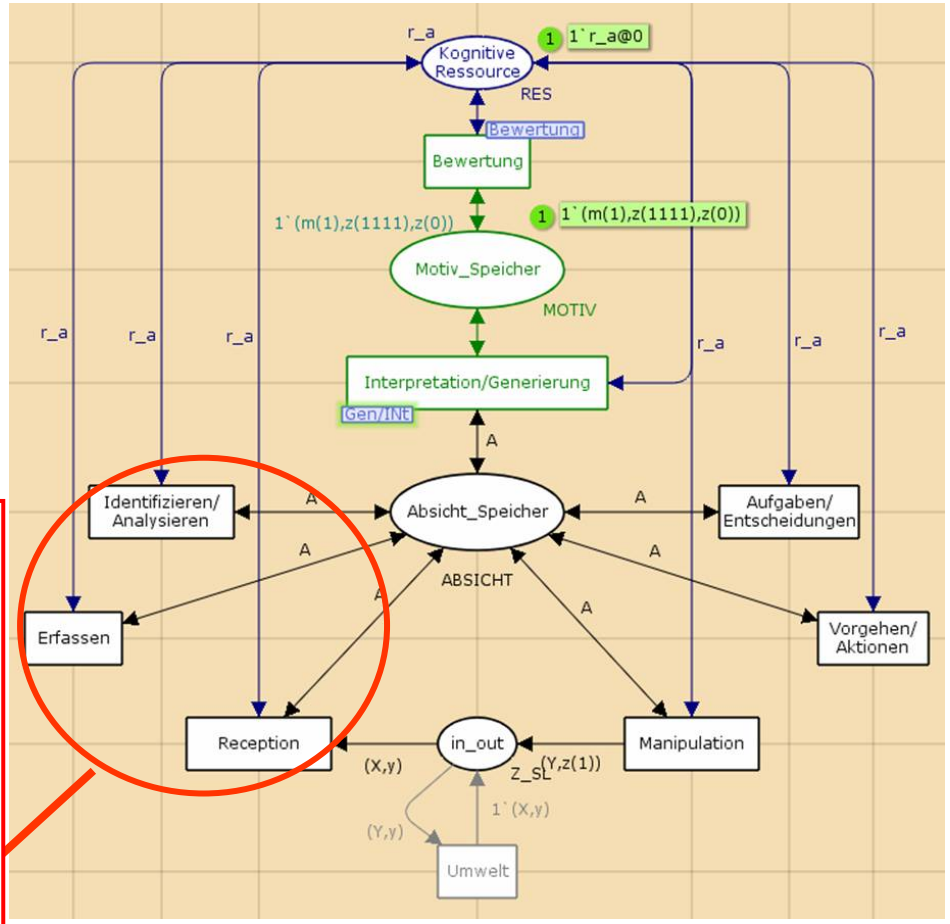




Nonlinear Dynamics Attention - Perception Model

(tool: Matlab – Simulink) [Fürstenau 2002 – 05]

Cognition based Decision Making



Petrinet Cognitive Ressource Model

(tool: Design-CPN) Werther 2002-05]

- Virtual Tower Study (2002 – 2004):

  Requirements & Initial Concept

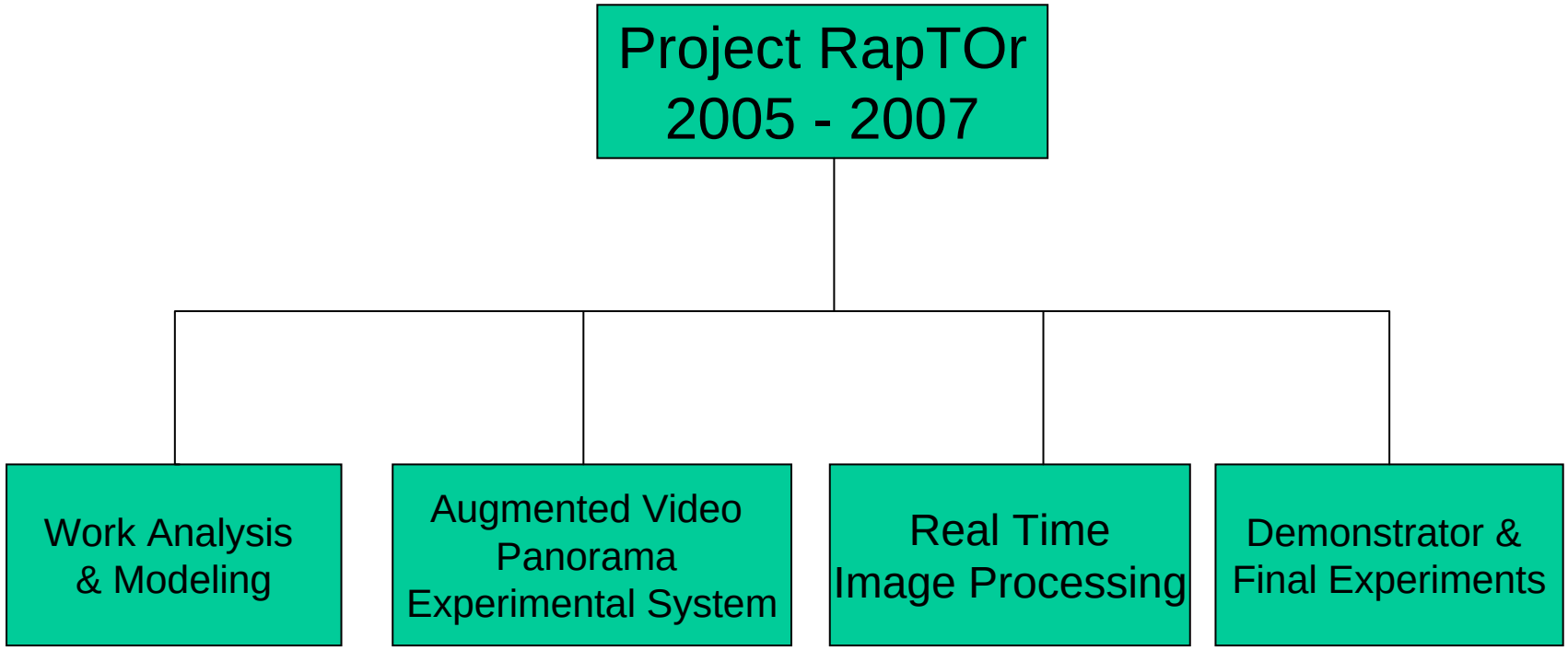
  Augmented Tower Vision

  Cognitive Modeling for HMI Design

- Remote Tower Operation (2005-2007):

  Work Analysis & Modeling

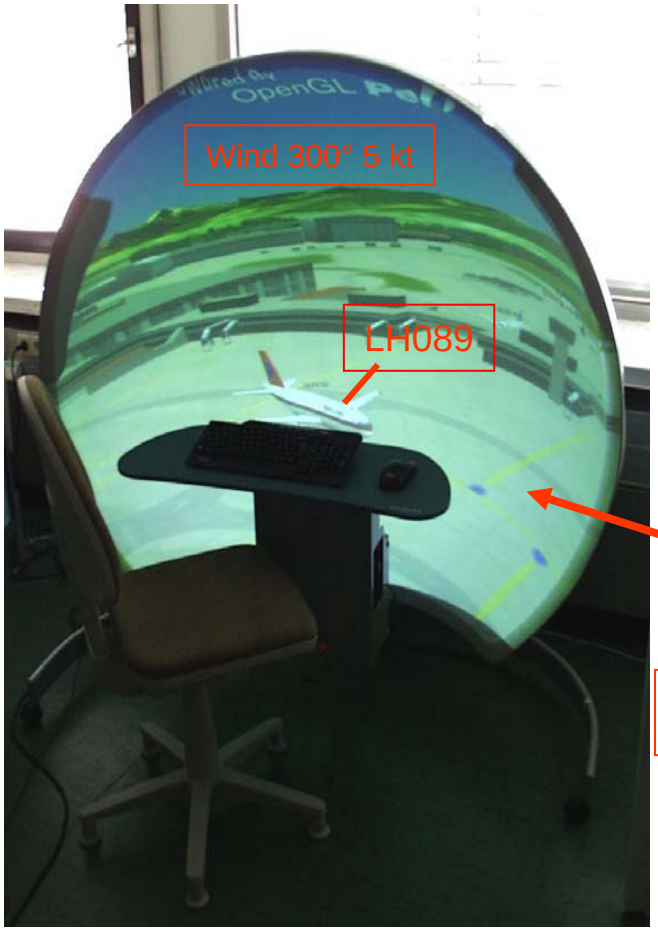
  RTO Experimental Testbed



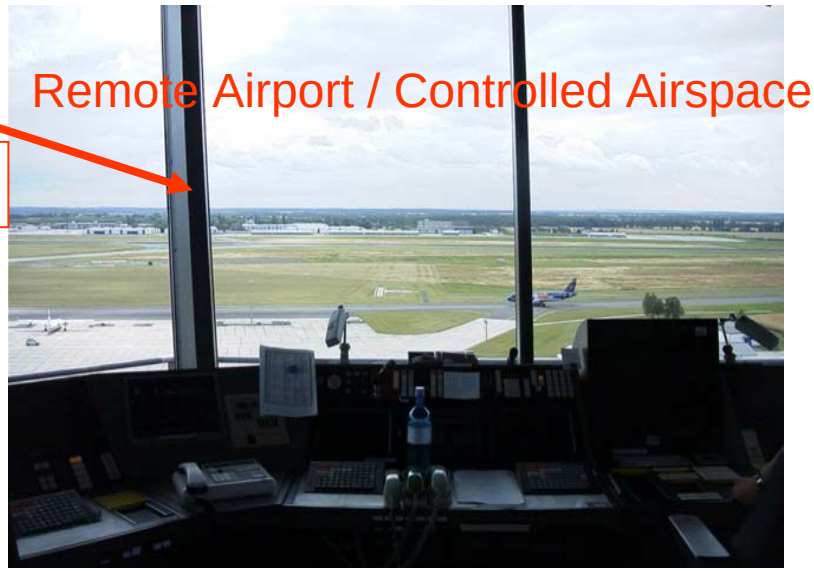
Budget: 2.5 M€
Effort: 20 PY
Participation: DLR Inst. of Flight Guidance
Inst. of Traffic Systems
Unit Optical Information Systems
Cooperation: German Air Traffic Control (DFS) / Tower GmbH

(Cognitive) Task & Work Analysis [Vicente 1999]

- Work Domain Analysis
- Control Task Analysis
- Strategy Analysis
- Analysis of Social Organisation und Cooperation
- Operator – Competency Analysis



GBit/s Datalink

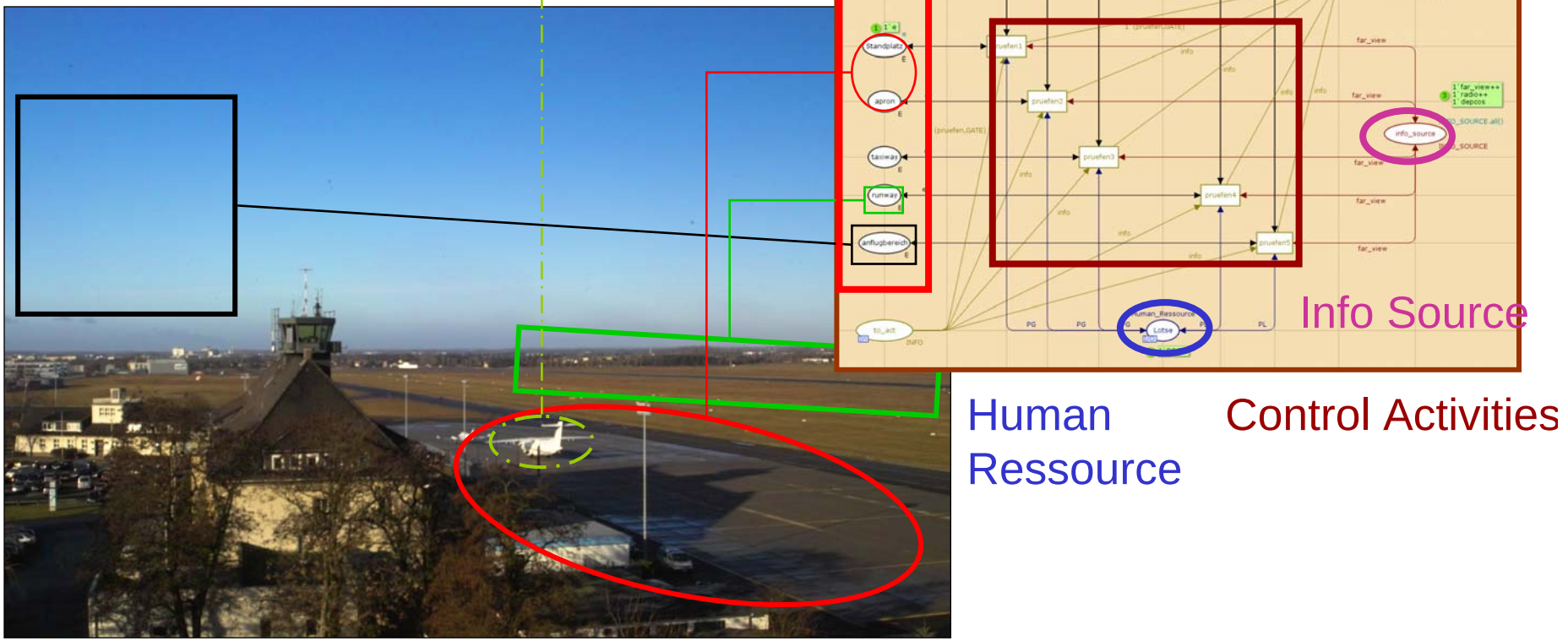


RTO Controller Workplace within Remote TWR: Augmented Vision Video Panorama

Analysis & Design of Information Sources (HMI) using Petri Net Model

(Replacement of Far View by Videopanorama & Augmented Vision)

[B.Werther 2005]



- Virtual Tower Study (ViTo: 2002 – 2004):

  Requirements & Initial Concept

  Augmented Tower Vision

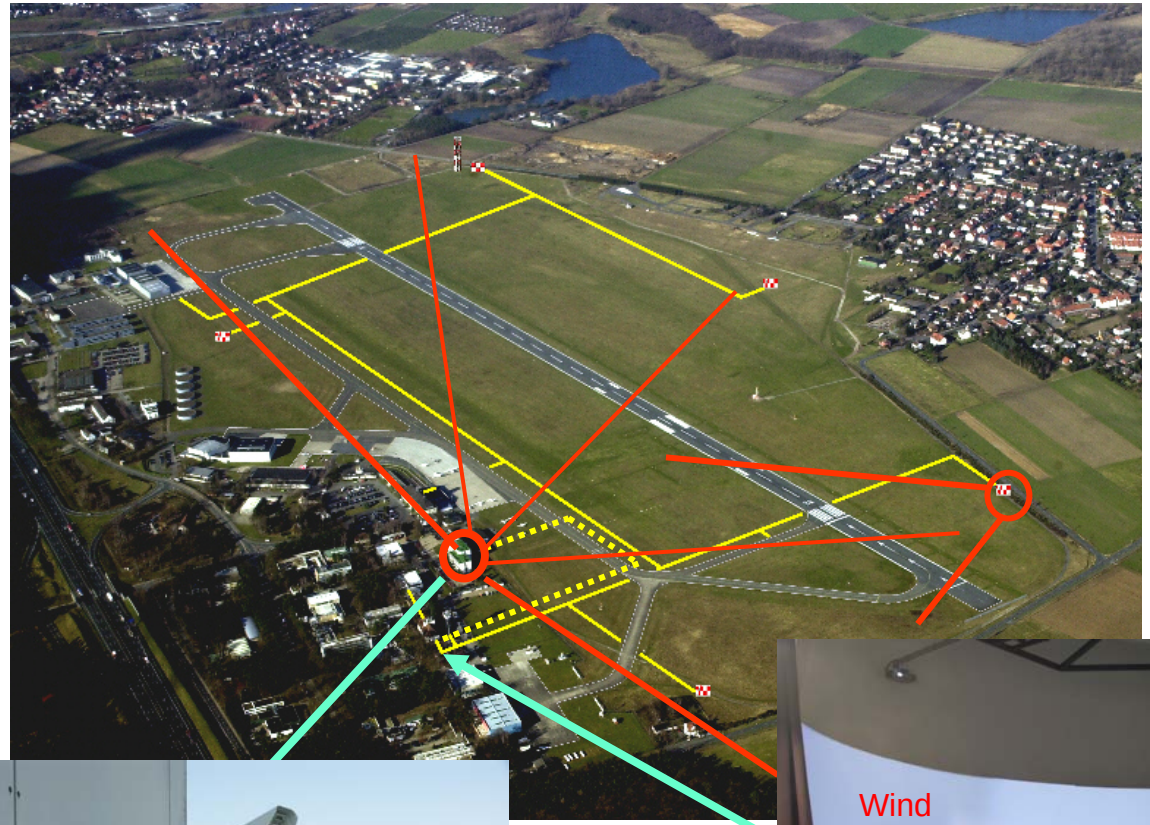
  Cognitive Modeling for HMI Design

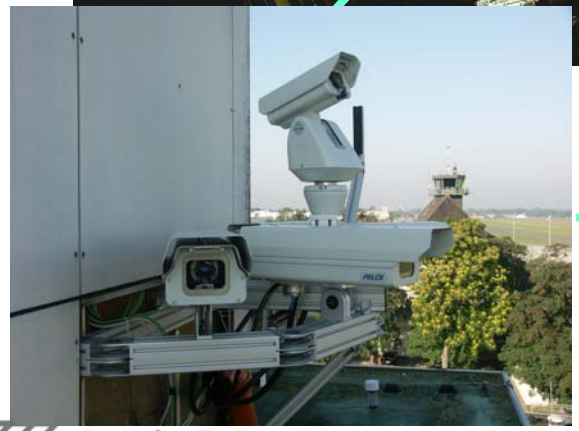
- Remote Tower Operation (RapTOr: 2005-2007):

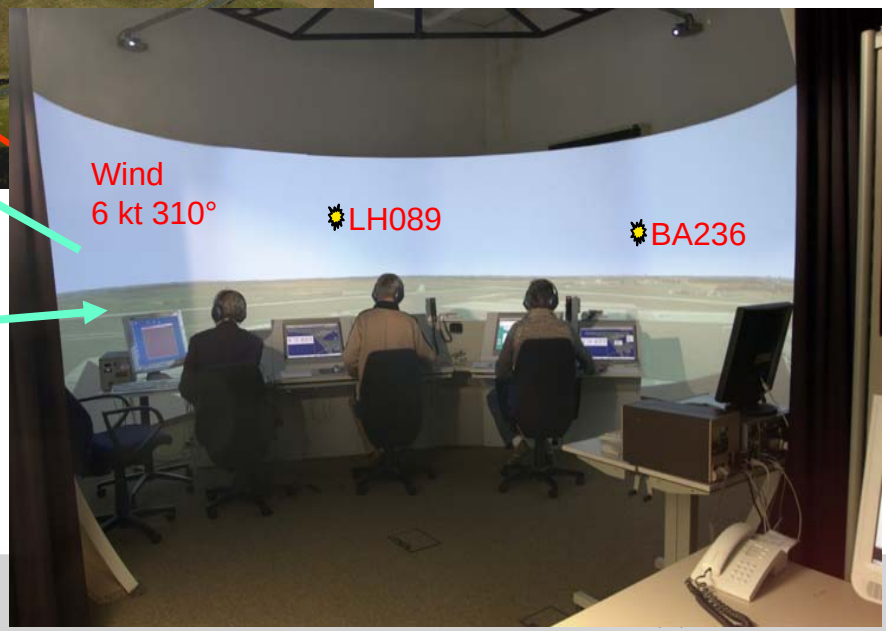
  Work Analysis & Modeling

  RTO Experimental Testbed

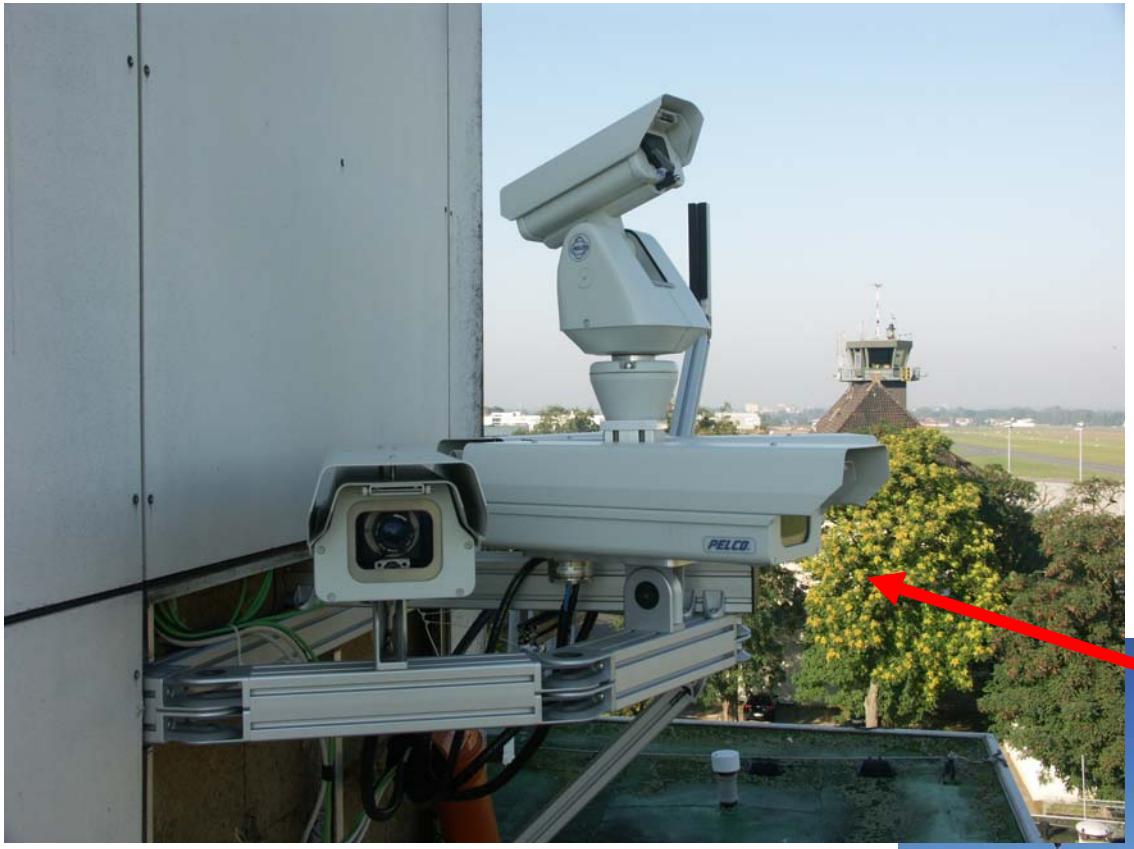
Augmented Video Panorama System at Braunschweig Airport





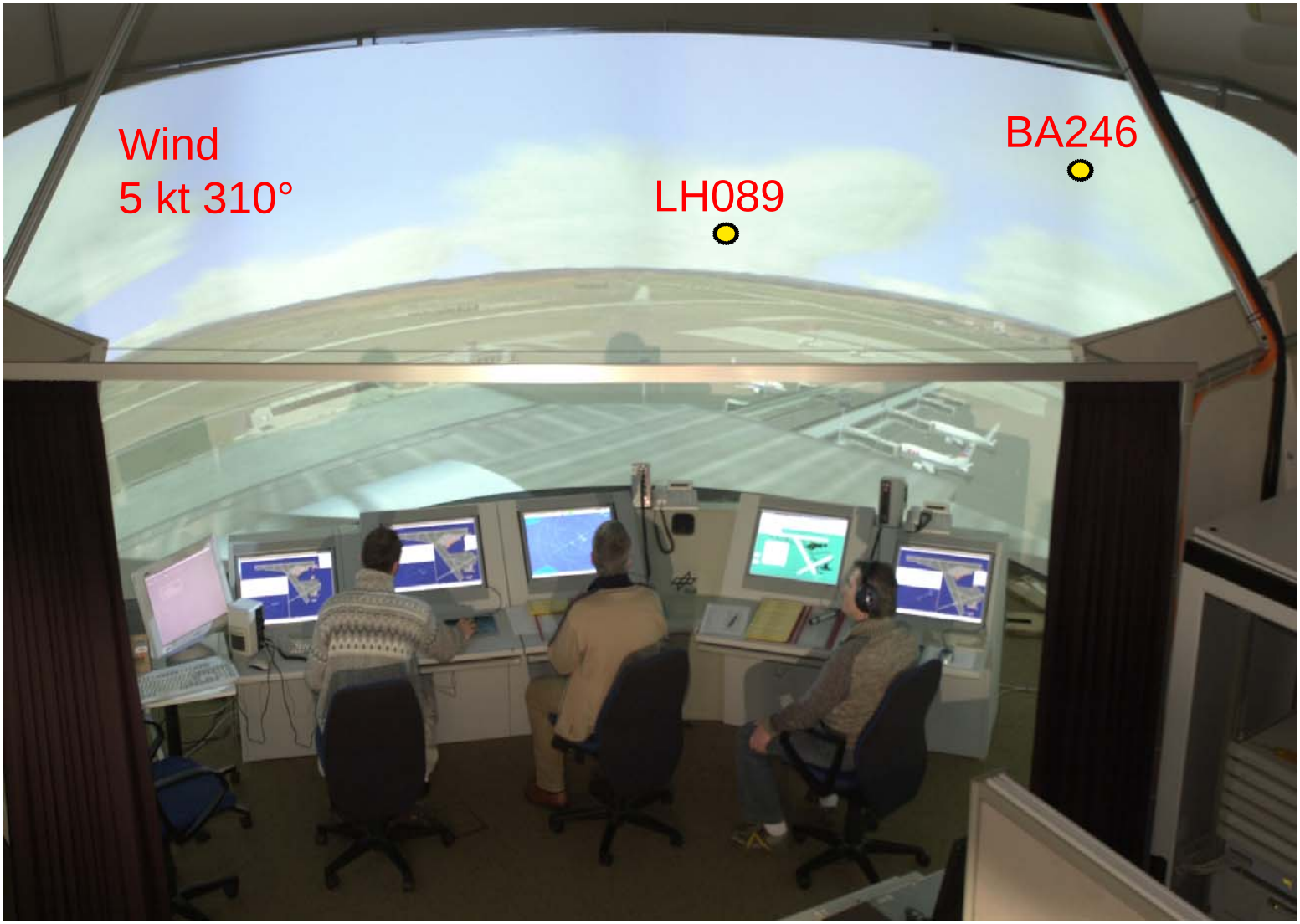


- **Video system for panorama and image processing**
- **Gbit/s - Fibre optic LAN**
- **Experimental Augmented Vision HMI**



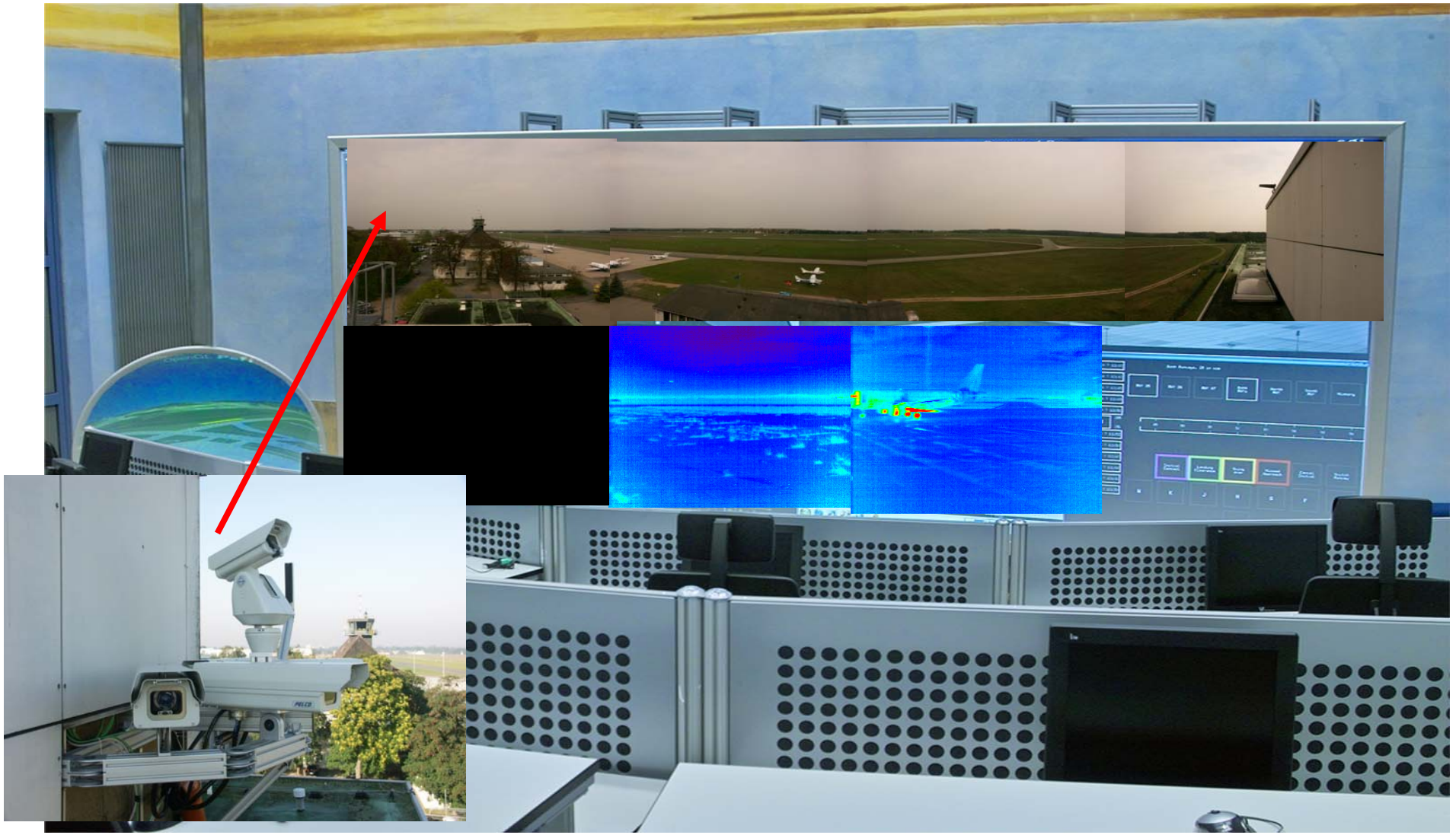
High resolution panorama camera system showing section with Braunschweig Tower and west part of airport

RTO visualization: Lab system for hard-/software development & ATV design

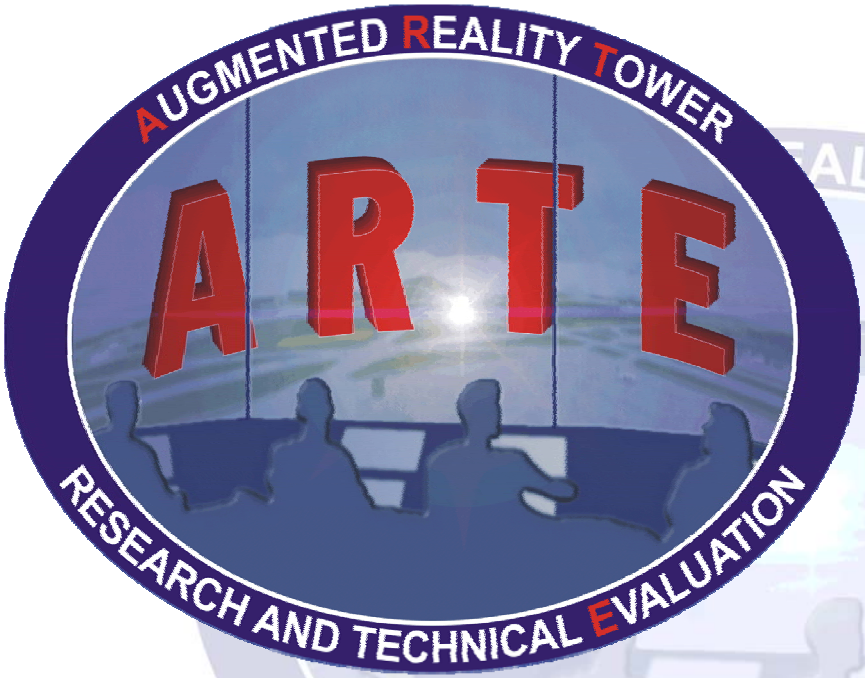


RTO Visualisation System with DLR TWR Simulator (6x SXGA(1280x1024))

Control Center Simulator: RTO Panorama Projection (5120 x 2048 Pixel)



*Proposed **EC Project 2006 – 2008:***



Partners

- Industries
  - SELEX-SISTEMI (AMS, Coordinator) (I)
  - Oerlikon Contraves (I)
- Universities
  - Tor Vergata University (I)
  - Genova University (I)
- Research LABs
  - DLR (D)
  - FhG-HHI (D)
  - PIT Telecom Res. (PL)
  - SICTA LAB (I)
- ANSP
  - ENAV (I)
  - HCAA (GR)
- SME
  - ASIS (D)
  - Deep Blue (I)
  - Sector (GR)
  - TAW (I)

STREP-FP-6 Proposal # 030761

Effort: 588 PM

Budget: 7.7 MEuro

Augmented Reality Tower Research & Technical Evaluation at Malpensa/I