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7th 4diac Users Workshop

4diac in Teaching

Lessons from Lab Exercises and Student Projects

Content

- Student background at TU Wiens Electronics Master Programme „Energy and Automation Technology“
- Lab course background
- Lab exercises
- Student project – transportation system
- Conclusion

Student background

- Beginner level C skills (no object-orientation)
- Beginner level Java skills
- Basic Boolean algebra
- Basic understanding of finite-state machines (Mealy and Moore)
- Introduction to IEC 61131 language und execution model
- Introduction to IEC 61499 and its execution model

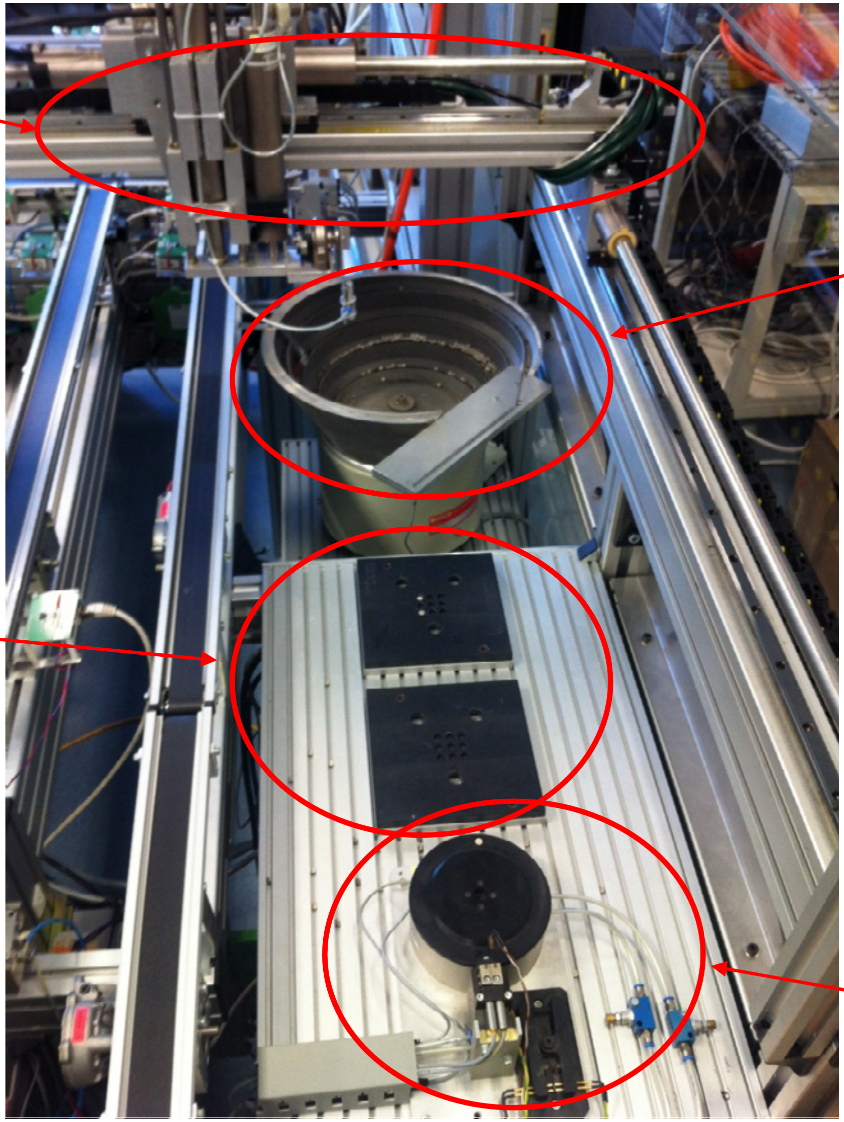
Lab course background

- Master level course
- Focus on automation systems and IEC 61131 / IEC 61499 languages and concepts
- Approximately 120-130 students in one semester
- Four parts / 4h for each part + preparations at home
  - Discrete manufacturing
  - Batch process
  - Industrial robot (6 axis articulated arm)
  - Distributed control with IEC 61499

Lab exercise – Mechanic Press Example

- 4diac sample project
- Tasks
  - Implement control with standard library function blocks only
  - Implement a basic function block to control the mechanic press
  - Add communication function block for control-to-simulation and control-to-GUI communication
- Pros
  - Easy to set up
  - Provided via 4diac systems
  - Distributed scenario (although running on one PC)
  - Easy to debug for students
  - Suitable for large lab classes (30+ students at once)
- Cons
  - Simulation only / no hardware specific problems (e.g. Timings, real signal behavior)
  - As nothing really happens/moves, students percieve the lab as rather boring

Lab exercise – Measure and Sort NTC‘s



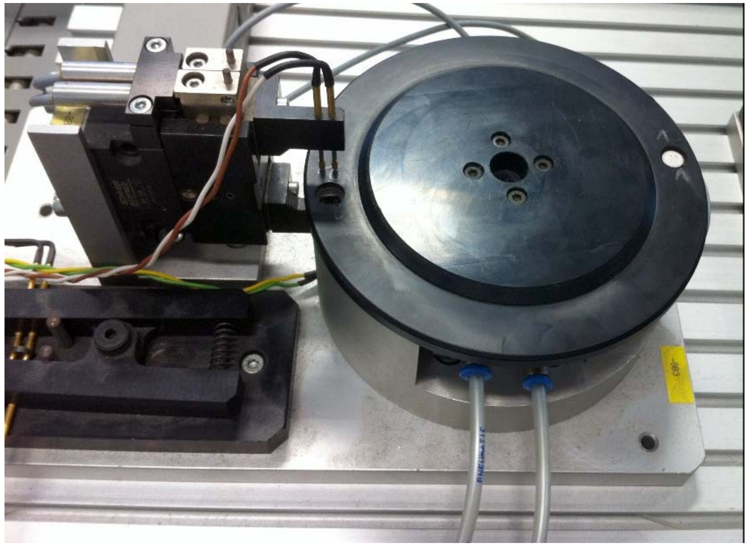
Gantry robot

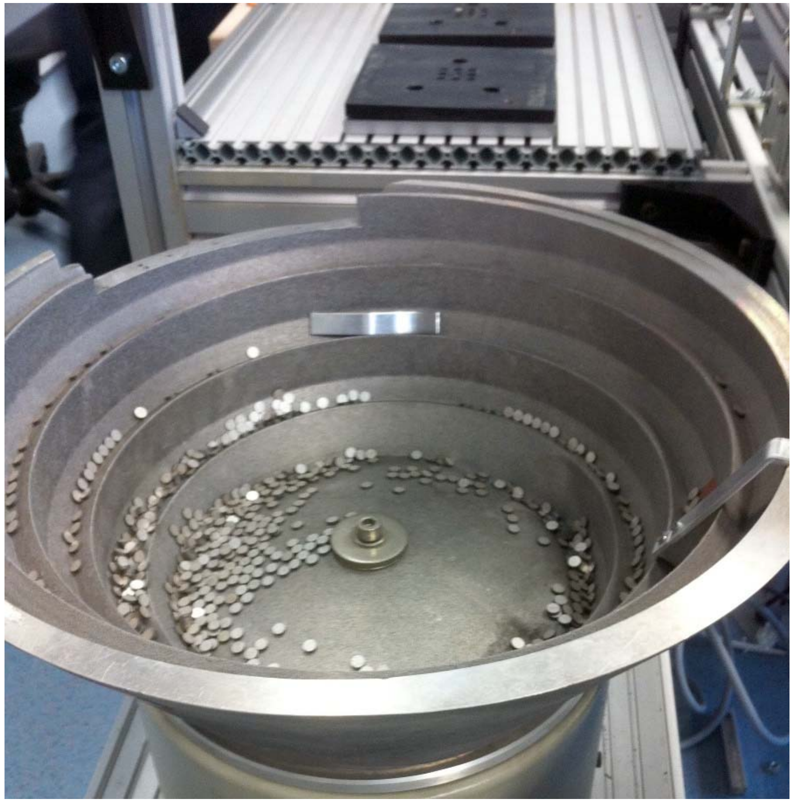
Shaker

Sorting station

Measurement station

Lab exercise – Measure and Sort NTC‘s



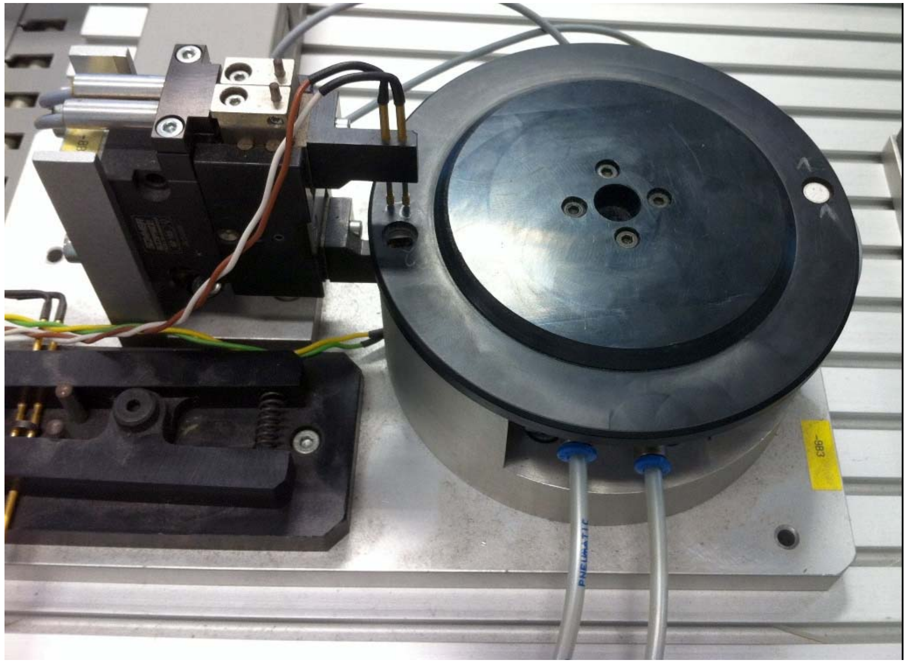


Lab exercise – Measure and Sort NTC‘s

- Lab lecture notes
- Description of the plant
- Explanation of IEC 61499 and 4diac
- 30 minute live demonstration of 4diac (Flip-Flop tutorial)
  - Basic FB creation and export
  - Compile FORTE with new FB
  - Test FB with monitoring
- Consultation with the lab lecture supervisor (me) and the responsible Student Assistant

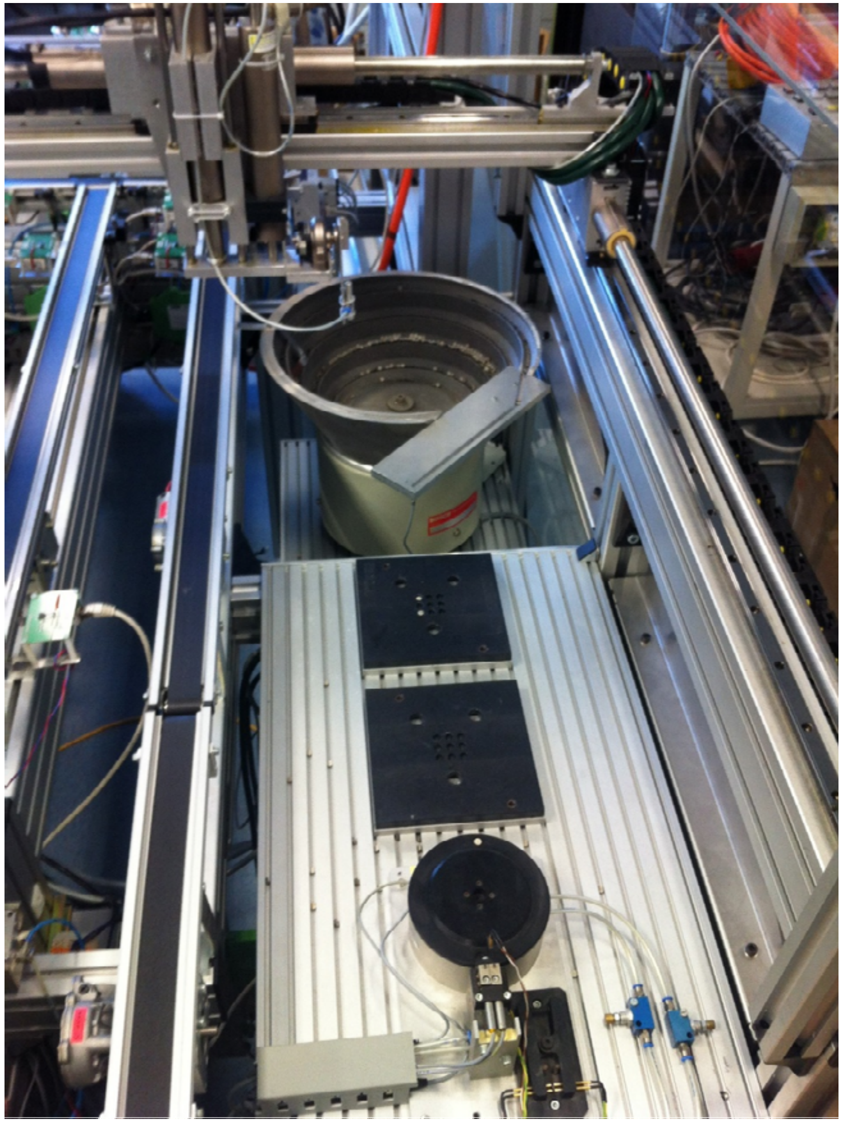
Lab exercise – Measurement Station Control

- Turn table in measurement position
- Close measurement clamps
- Start measurement and readout
- Open measurement clamps
- Turn table back
- Provide measurement to system



Lab exercise – Overall control

- Shake NTC to takeout position
- Grab NTC with gantry robot
- Put NTC into measurement station
- Sort NTC depending on the measurement value



Lessons learned from first year

- Short introduction (30 min) to 4diac IDE/FORTE is not enough for most students to independently create 4diac solutions
- Textual explanations of the desired processes are to inaccurate for preparations, even though we tried to be very accurate
- The event driven approach of IEC 61499 is hard to grasp for students at first
- Basic function block development with ECC and Algorithms is also not always clear to students
- FORTE compilation and FB creation should be all done in the same tool

How to make things better

- Four tutorial videos how to install and use 4diac
  - Available at (German only) https://www.youtube.com/channel/UCt0MlNo6Y7dXCZSDACXFi1g
- Test function blocks, which simulates the plant and gives advice if there are any errors in the desired behavior
- Mandatory preparation of the control program
- No solution for combining FORTE compilation/FB creation steps

How 4diac got better through the use in lectures

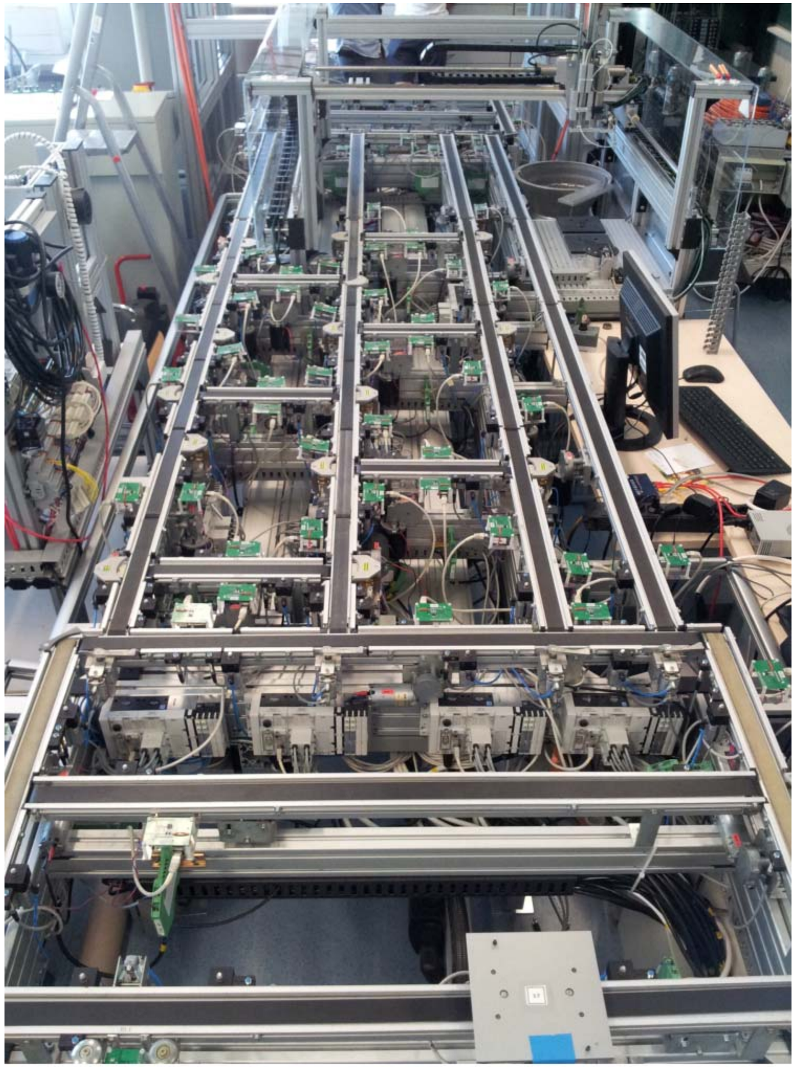
- A lot of bug reports (120 testers per year ☺)
- ADS interface FBs for communication with Beckhoff hardware
- Added serial interface communication for Windows
- Added RawDataLayer for communication
- Tutorial videos
- Input on how to enhance the ECC and Algorithms views in 4diac-IDE

Experiences of the second year

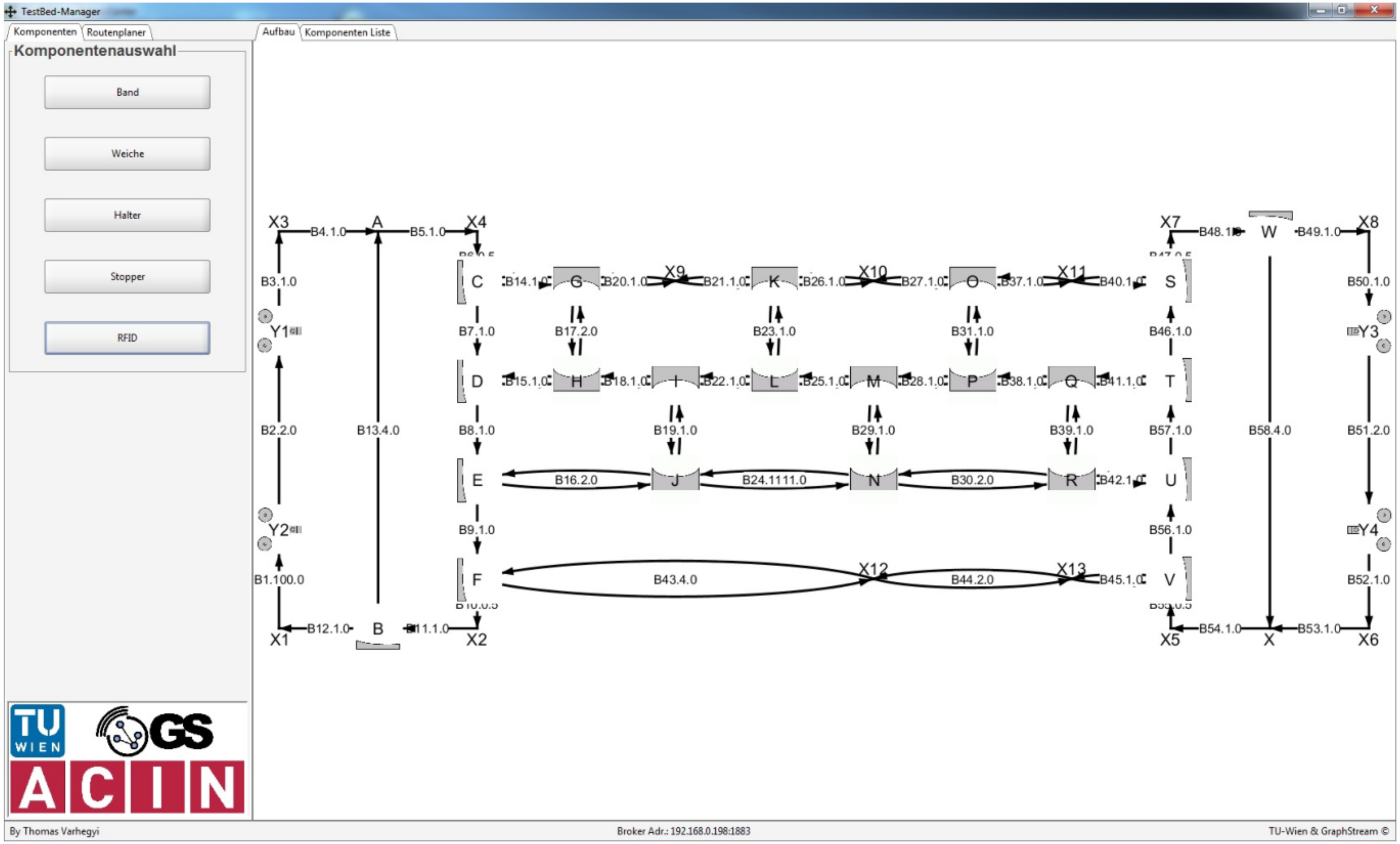
- Tutorial videos helped a lot!
- Setup steps for 4diac IDE and FORTE are a bit to complicated for approximately 30% of students
  - Visual Studio changed
  - Too much tools (CMake, VS or Cygwin, and 4diac IDE)
- Test FBs were very helpful, although they cannot cover all wrong behaviors
- 4diac IDE has become much more stable

Transportation system

- Platform Festo CPX-CEC
- Three different kinds of station types
  - 2-way junction
  - 3-way junction
  - Handling station
- One program for each station
- Find shortest path between two stations
- Activate path in plant
- Communication via MQTT



Testbed manager



By Thomas Varhegyi

Broker Adr.: 192.168.0.198:1883

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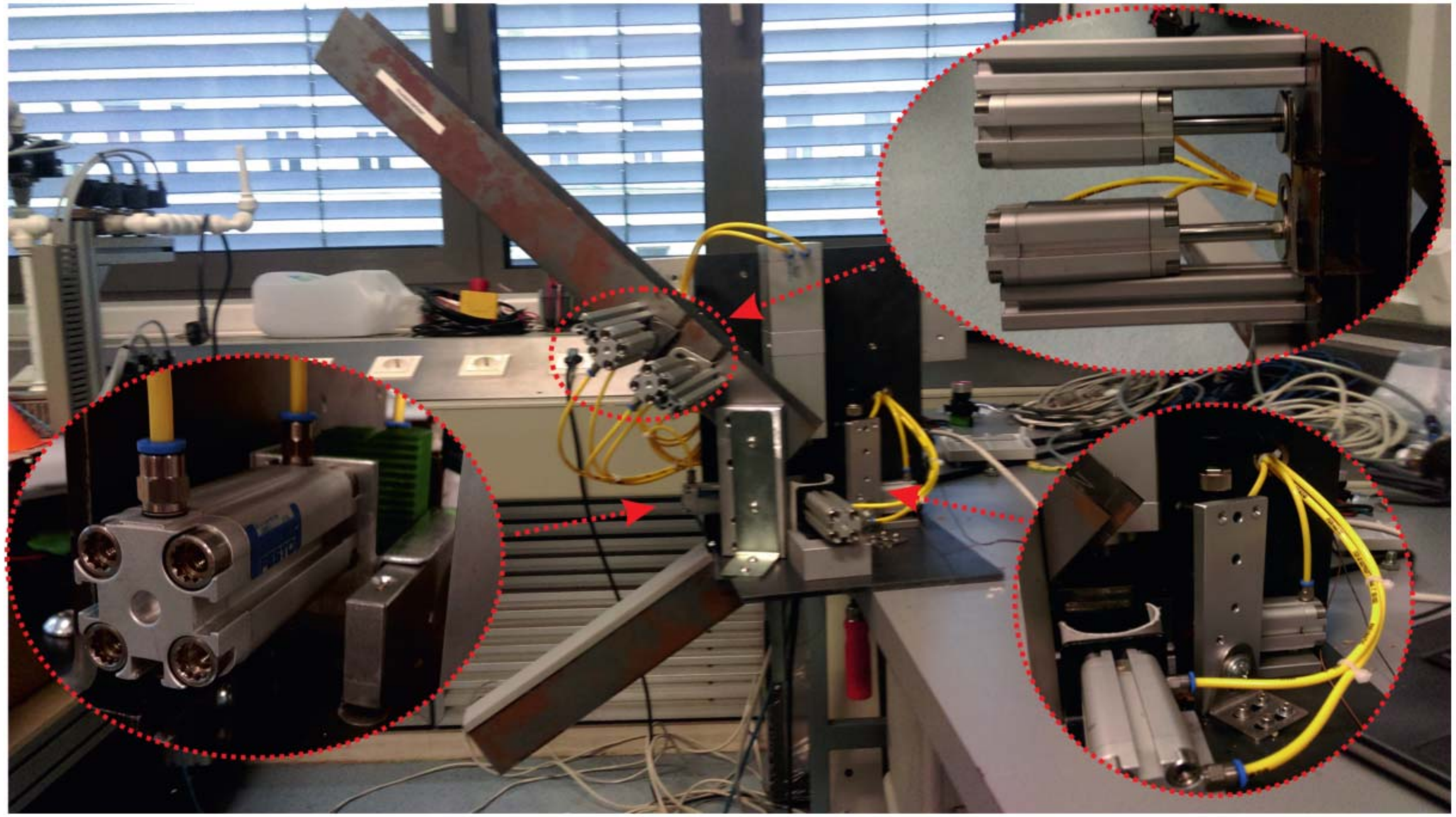
Feedback to 4diac

- Again bug reports
- Most important - MQTT communication layer
- Able to run FORTE on Festo CPX-CEC (again)
  - Can control I/Os and valve ports
  - Unfortunately not open source

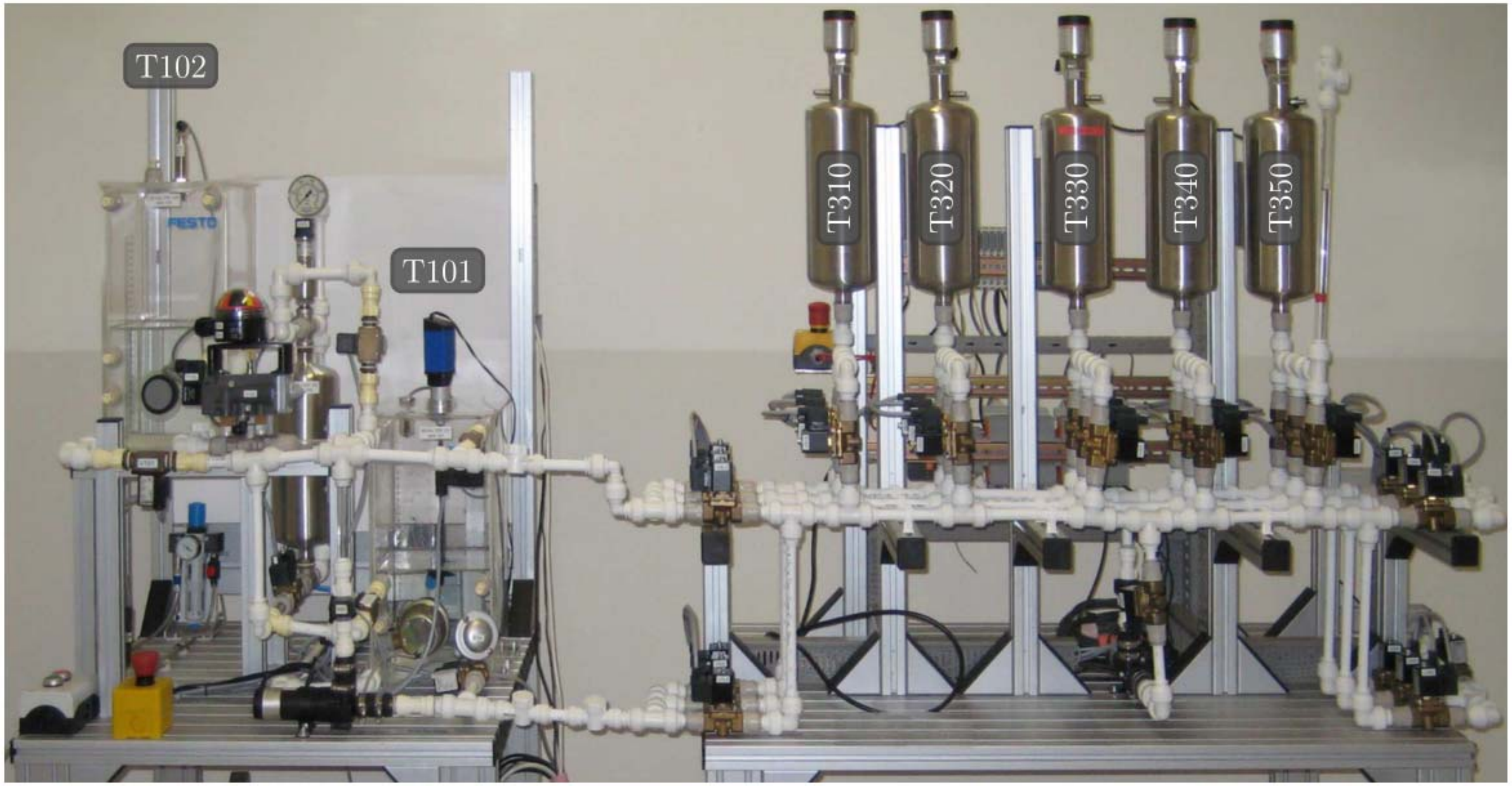
Other systems controlled by 4diac

Nutcracker
Platform: Festo CPX-CEC



Other systems controlled by 4diac

Process plant
Platform: Beckhoff CX5010



Conclusion

- 4diac sample projects make it easy to ramp up a course or lab exercise to introduce IEC 61499, but lack reality
- Demonstration plants for exercises
  - show the complexity and problems of real plants
  - are more valued by students
  - are a LOT more work to prepare and to use in exercises
- Helps to improve 4diac
- Are incubators to create new 4diac features