Controlling the ESS Testbeamline at HZB
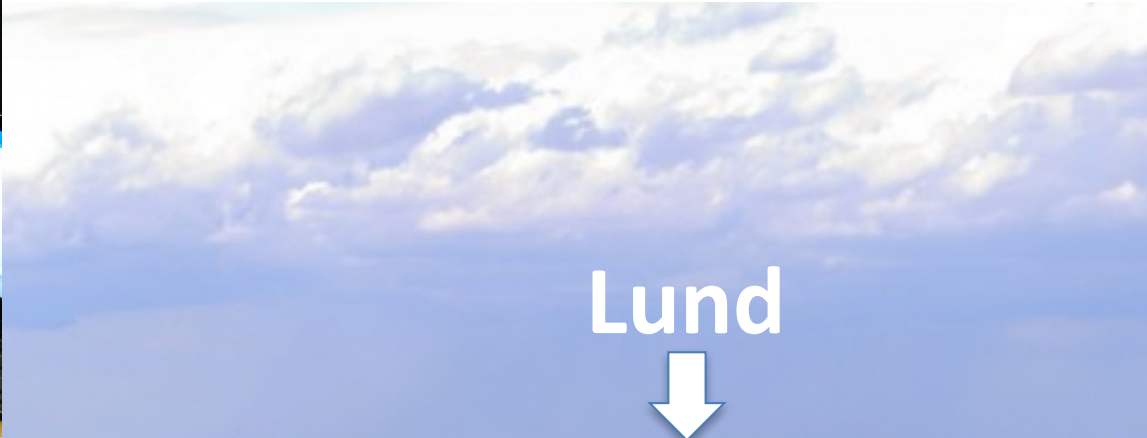
Michael Wedel

DMSC, Instrument Data Group

www.europeanspallationsource.se

7 April, 2017

Outline

- Introduction

- Equipment and controls

- DMSC Instrument Data Group Activities
  - Installations
  - Supported experiments

- Conclusion & outlook

V20
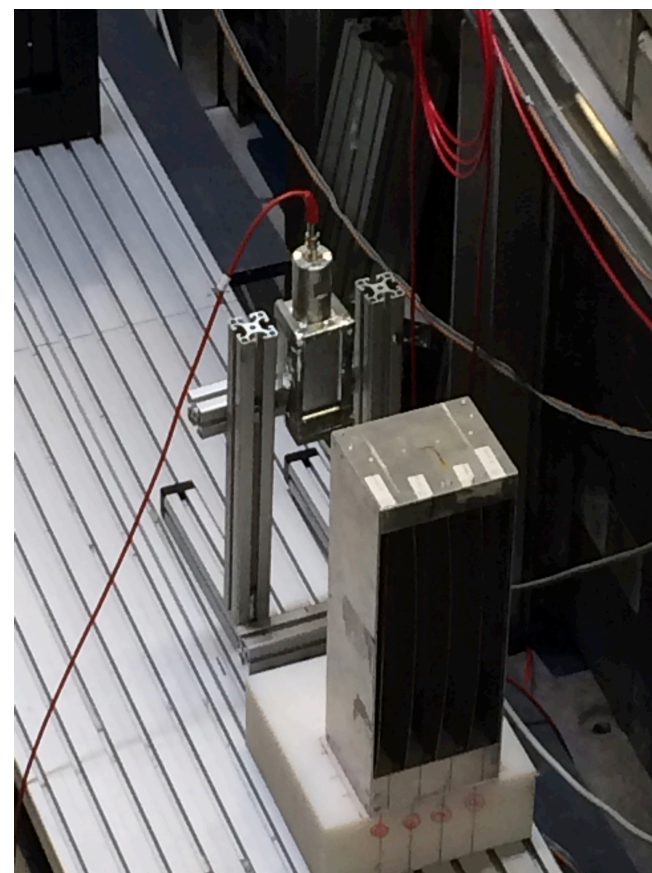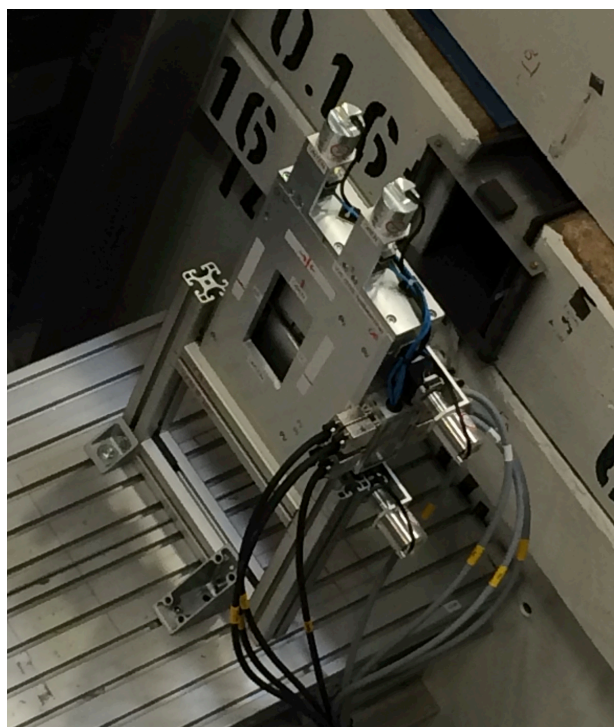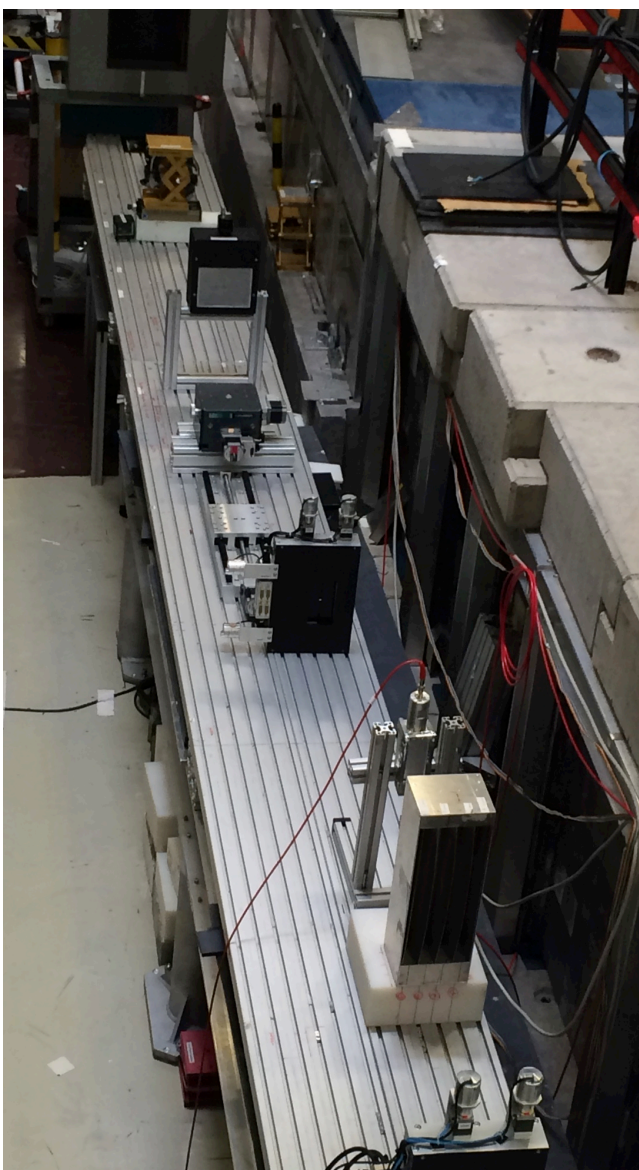
Lund

BERII (10MW)

Introduction

- Testbeamline V20 at HZB

- Chopper cascade models ESS pulse structure

- Main purpose: Method development, Integration

- Responsible on site: Robin Woracek
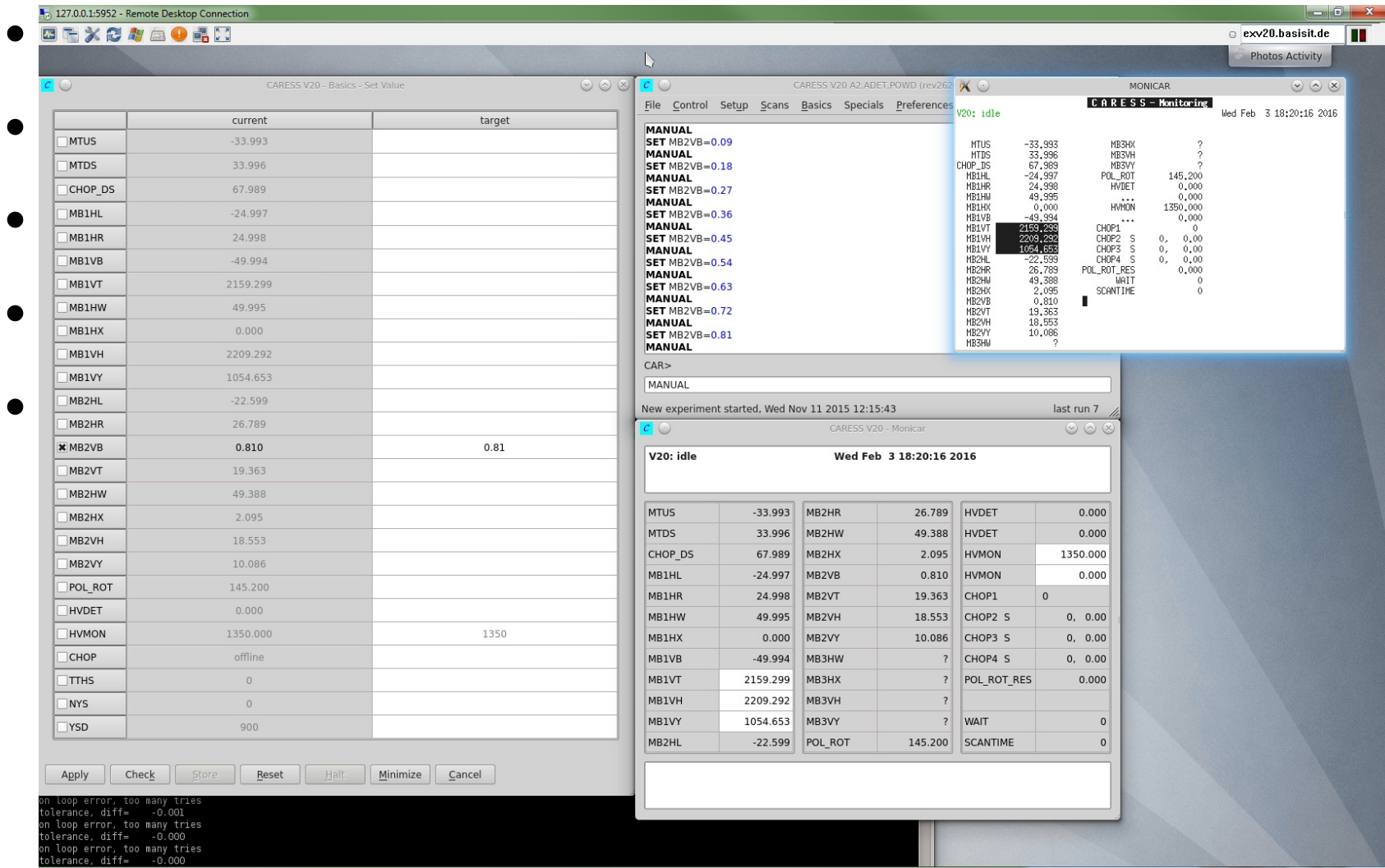
DMSC Instrument Data Group

- Development of high level control interface
- V20 provides full beamline with user operations
- Very good opportunity to gain experience

Equipment I

- Base configuration:
  - 2 Airbus choppers (generating "ESS-Pulse")
  - 4 JCNS choppers mounted on motion stages (WFM)
  - 2 four-blade slit systems
  - 2 linear motion stages
  - Beckhoff BK9000 with many DAC modules
- Optional components:
  - 3 axes goniometer
  - Detectors, monitors, high voltage power supplies
  - Very large quantities of user equipment

Equipment II

Control system

Networks

- Beamline-local network
- Hall network, accessible via HZB login node

NICOS
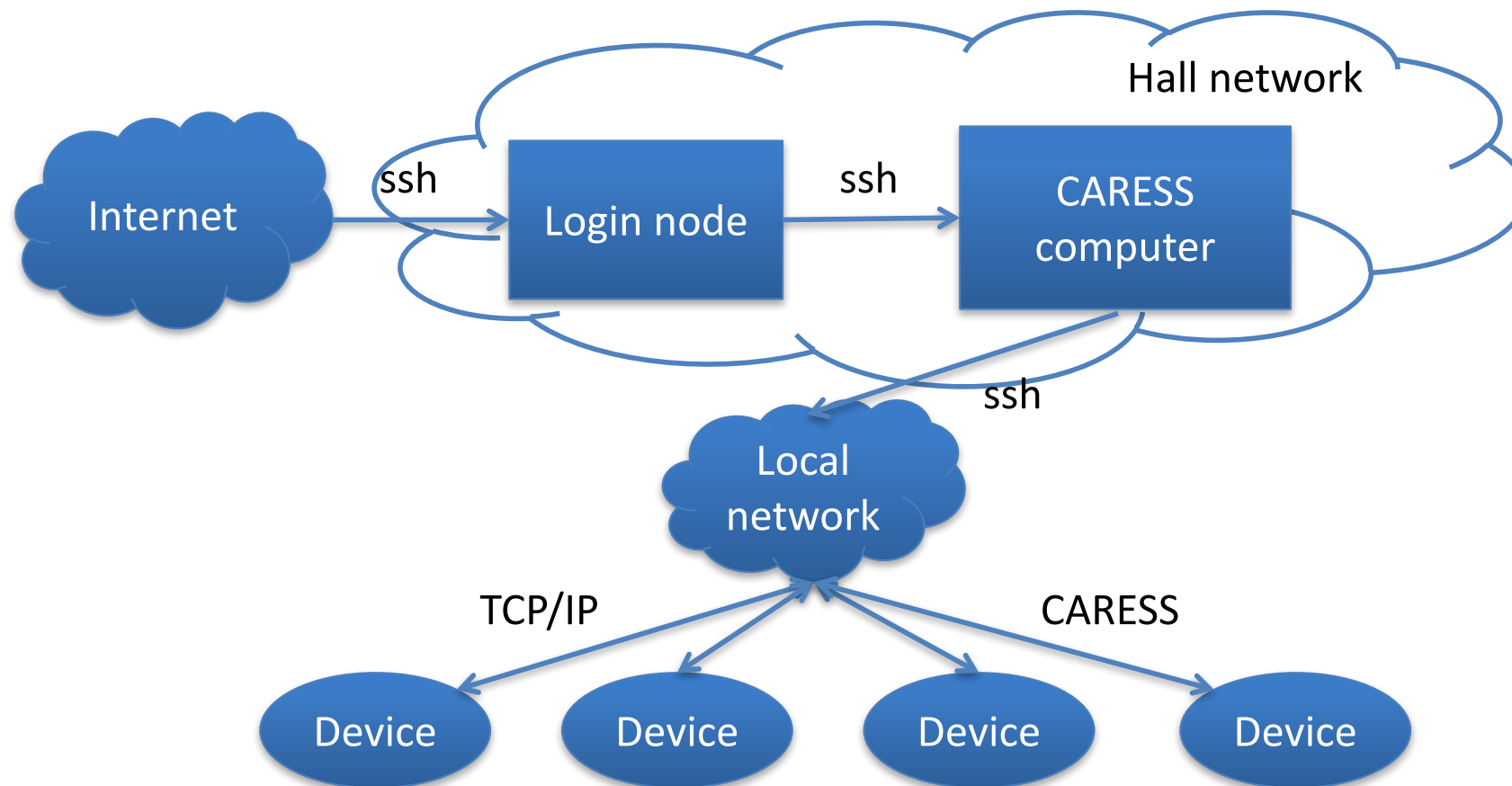
- High level control software at MLZ/FRM-II/…

- Open source (GPL), written in Python

- Supports different protocol (EPICS, Tango, CARESS)

- Device abstractions (Readable, moveable, motor, …)

- Pre-defined commands for scans (1D, 2D, …)

- Fully scriptable (Python), GUI (Qt)

Networked Instrument COntrol System

NICOS GUI

Developing a plan

- First visit in June 2016, with in-kind partners, ICS
- Initial activities
  - Use NICOS with existing CARESS infrastructure
  - Integrate other devices using their protocols
  - Support user operations
- Future activities
  - Slowly replace CARESS layer by EPICS layer
  - Follow CARESS to EPICS change in NICOS
  - Continue iteratively until ESS control architecture is implemented
- Iterative approach

Iterations timeline

Iteration 1   Iteration 2

Installations 1   Experiment 1   Installations 2   Experiment 2

June 2016   September 2016   October 2016   November 2016
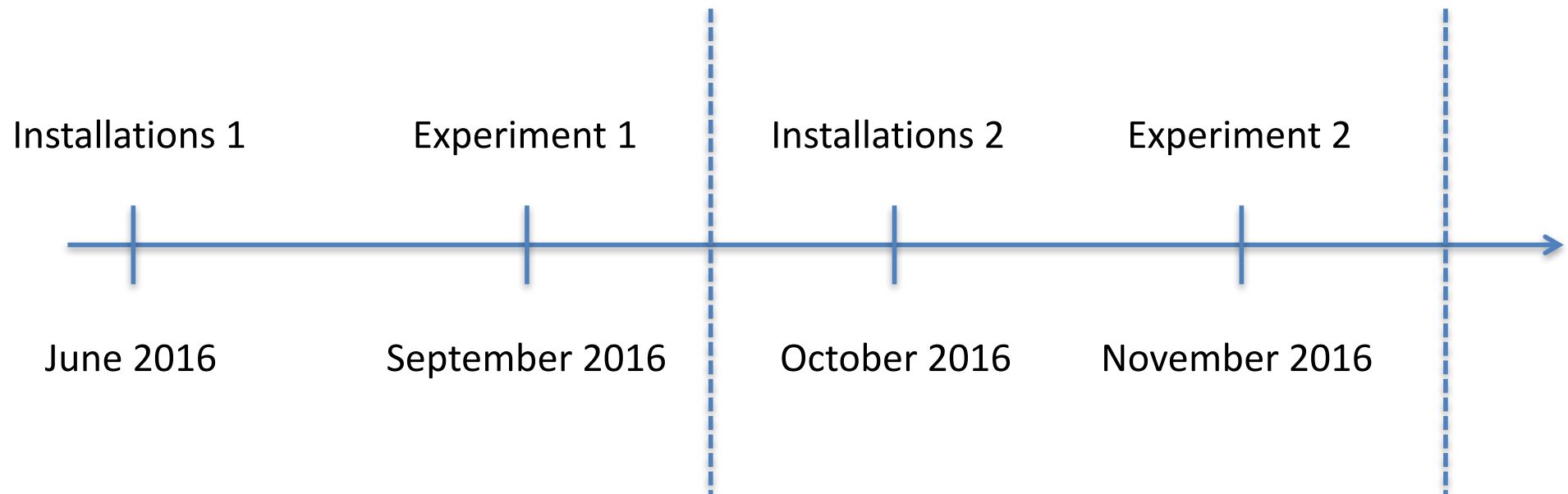
Installations 1

- Installed NICOS on Raspberry Pi

- Integrated some devices via CARESS:
  - Slit systems, linear stages, HV supplies, chopper stages

- Installed GUI on Windows PC

CARESS PC

Raspberry PI

| CARESS | ←→ | NICOS server |

Device ← → Device

NICOS GUI

Windows PC
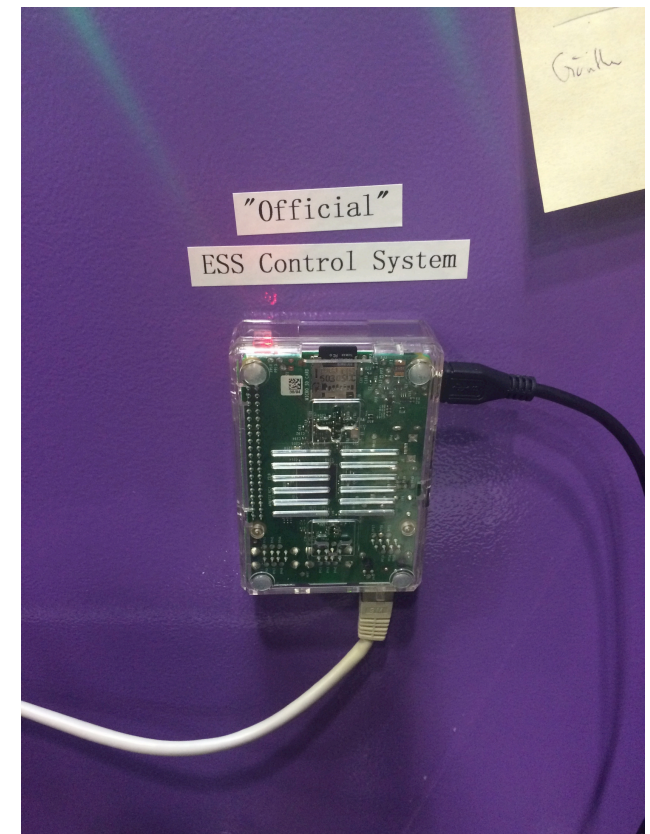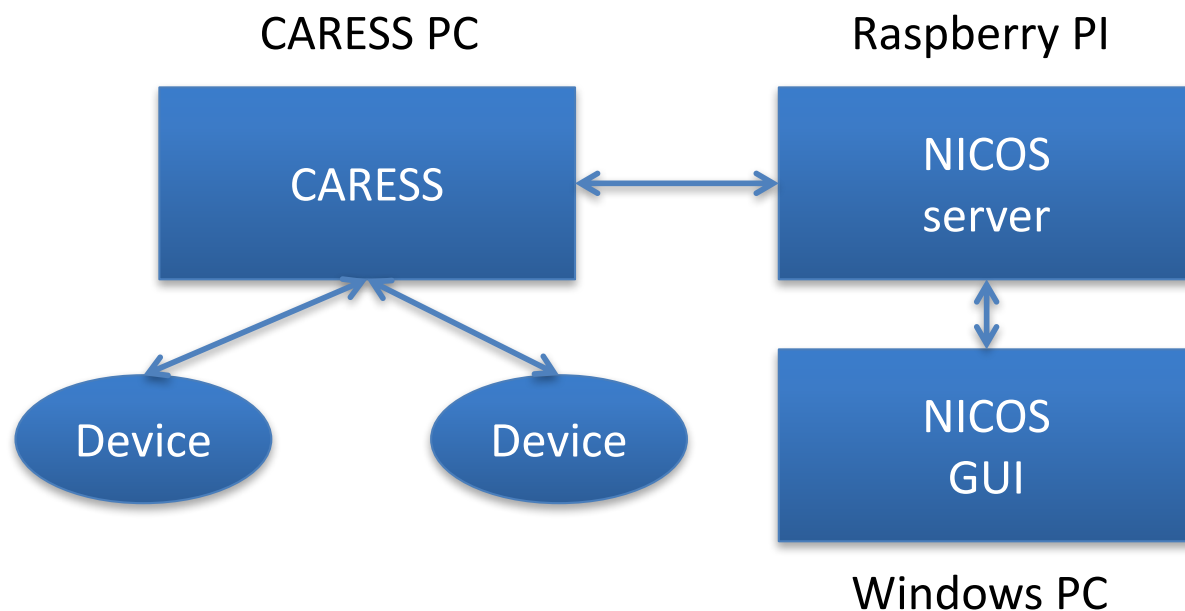
User experiment 1: NGI

- Grating interferometry experiment (PSI)
- Detector
  - Triggering via UDP service
- Motion stage from PSI
  - ASCII via RS232, network via MOXA box
- Integrated both devices

User experiment 1: NGI

- **Scans were running fully automated**
  - No full nightshifts necessary
  - Time spent analyzing data instead
  - Scan example:

```
# Collect data at each motor position
scan(motor, [672,784,896,1008,1120])
maw(lin1, 400) # Move linear stage
scan(motor, 0, 112, 11)
maw(lin1, 290)
```

- **GUI PC had hardware failure**
  - Server continued running, scan finished properly
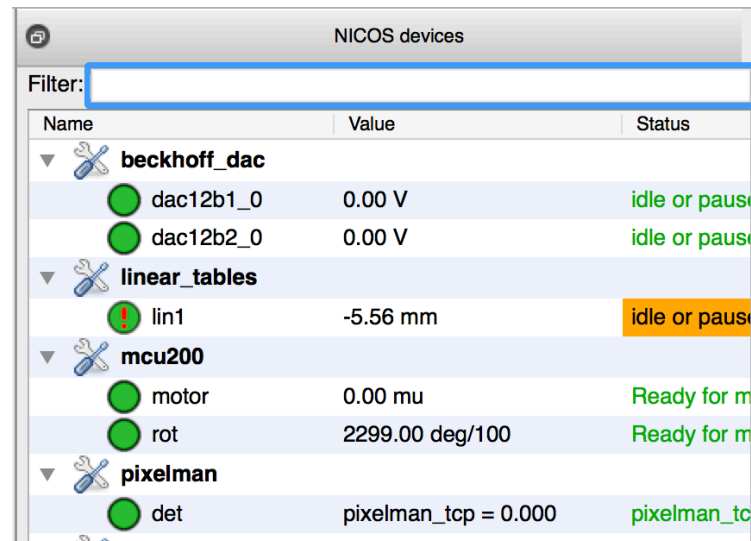 - Command line client on NICOS computer instead of GUI
- **Communication with non-CARESS devices must improve**

Installations 2

- Replaced Raspberry Pi (ARM) with a fitlet mini PC (x86_64)

- Installed GUI on CARESS PC

- Worked on CARESS support in NICOS with J. Krüger, L. Rossa

- Integration of more equipment (DAC modules)

- Raspberry Pi still connected and running

User experiment 2

- SEMSANS experiment (TU Delft)
- Lots and lots of equipment
- Integrated two most important devices:
  - Agilent 33521A function generator
  - TU Delft magnet controller for 4 magnetic fields

Lewis
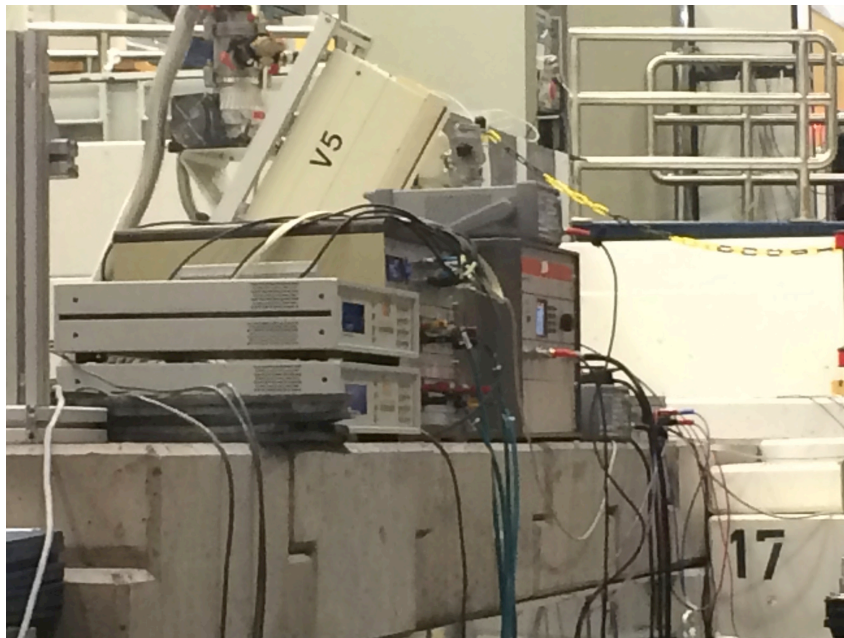
- Python based hardware simulation framework
- Cycle-based, non-threaded, completely deterministic
- Modeling complex devices using state machine
- Communication interfaces separate from simulation, multiple protocols supported (EPICS CA, TCP/IP stream, modbus*)
- Additional, unrestricted access to simulation and simulated device via control server (optional)
- Started to be used at RAL (ISIS, CLF)
- Resources:
  - http://github.com/DMSC-Instrument-Data/lewis
  - http://lewis.readthedocs.io/
  - https://pypi.python.org/pypi/lewis

```
pip install lewis[epics]
```

Ad-hoc EPICS devices

- Communication via MOXA-box difficult to manage
- Function generator kept losing connection
- Intermediate EPICS based solution using Lewis (communicate with hardware instead of simulation)
- Quick way to write and deploy simple "IOCs"

More devices…

Lessons from user experiments 2

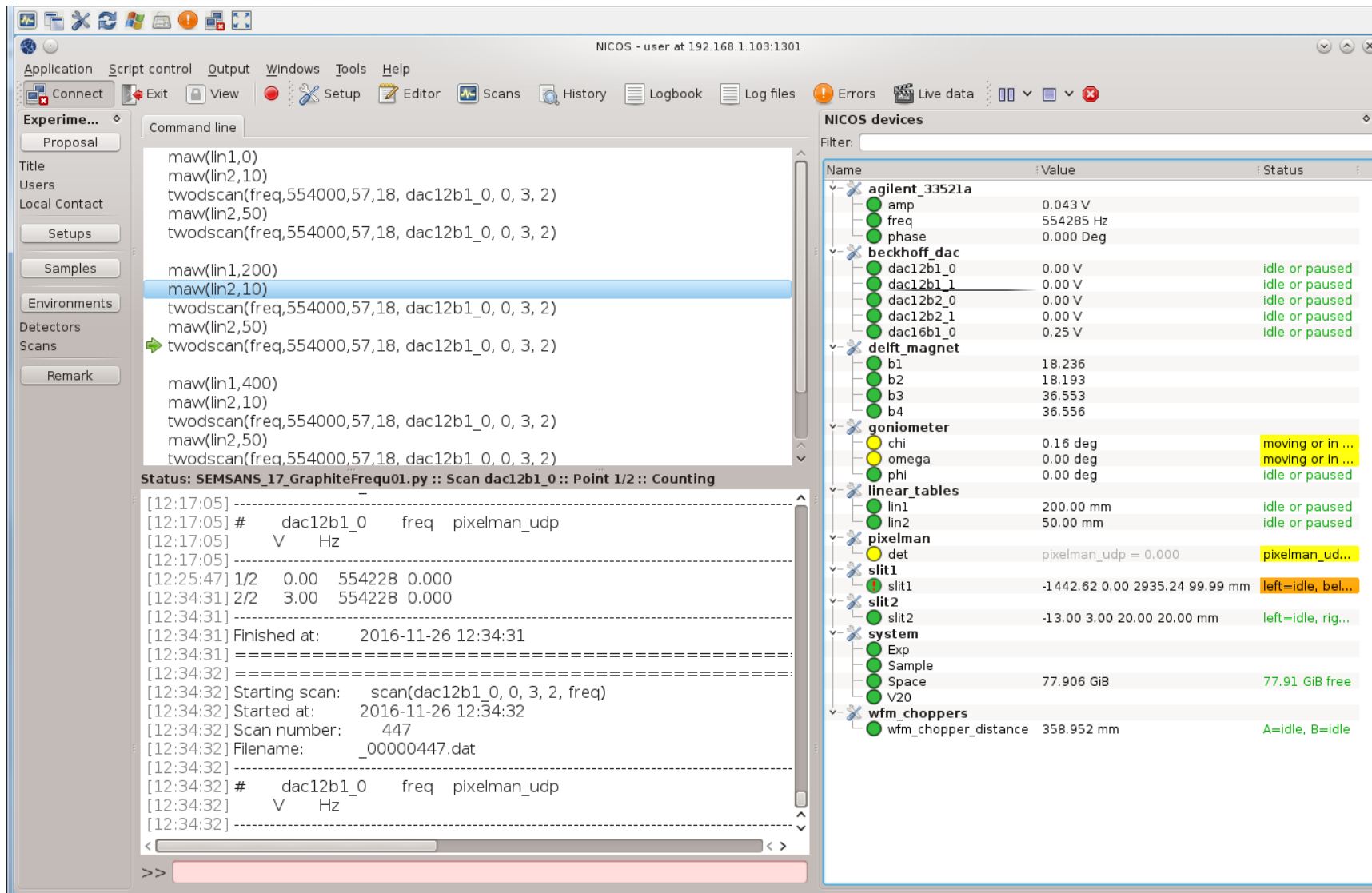- Users ran several hundred scans in 10 days

- Extensive use of 2D-scan feature (Frequency, motor)

- Automation helped produce much more data than in earlier experiment at V20, no full night shifts

- Users generally happy with Python scripting interface, more examples requested

- "Ad-hoc EPICS devices" stable for two weeks of experiments (still running after over 2 months)

Summary

- Successful control of V20

- CARESS based equipment can be controlled

- Other devices can be controlled via Channel Access

- User experiments have been successfully supported

- Demonstrated V20 to be valuable tool for gaining integration experience for DMSC ID

Lessons learned

- Lessons learned:
  - Users bring equipment with little notice, little or no docs
  - Remote support is possible if access is sufficient
  - Remote/phone support makes integrating real hardware more complicated
  - People will unplug things if they think they need the cable/port
  - Computers break, have backup-solutions ready
  - Deployment on computers without access to internet, without physical access can be challenging
- Listen to user feedback

Outlook

- Integrate JCNS Choppers using ad-hoc EPICS approach via "Lewis"

- Improve detector integration so that useful information can be obtained

- Try to follow standard procedures for NICOS experiments more closely so that meta data is stored properly

- Switch to Docker-based deployment

- Eventually replace CARESS infrastructure with EPICS infrastructure (together with ICS)

Acknowledgements

- Robin Woracek (V20 beamline responsible)
- Jens Krüger (FRM-II NICOS team)
- Lutz Rossa (HZB controls group)
- Owen Arnold, Michael Hart, Freddie Akeroyd (STFC ISIS in-kind & controls)
- R. Harti, M.Morgano, J. Plomp (users at V20)
- Erik Dahlbäck (fitlet support)
- HZB IT group for providing access and support

Thank you for your attention

Questions?