

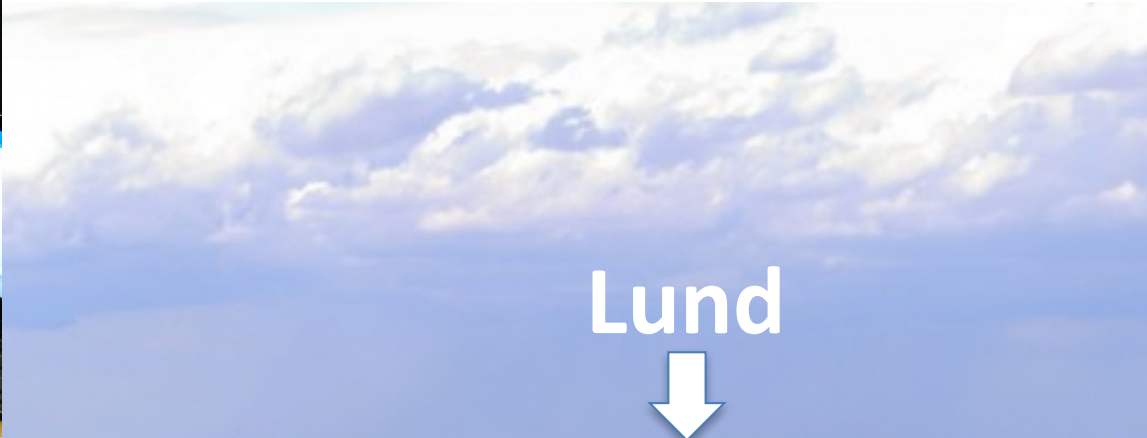
Controlling the ESS Testbeamline at HZB

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DMSC, Instrument Data Group

www.europeanspallationsource.se

7 April, 2017

- Introduction
- Equipment and controls
- DMSC Instrument Data Group Activities
 - Installations
 - Supported experiments
- Conclusion & outlook



BERII (10MW)



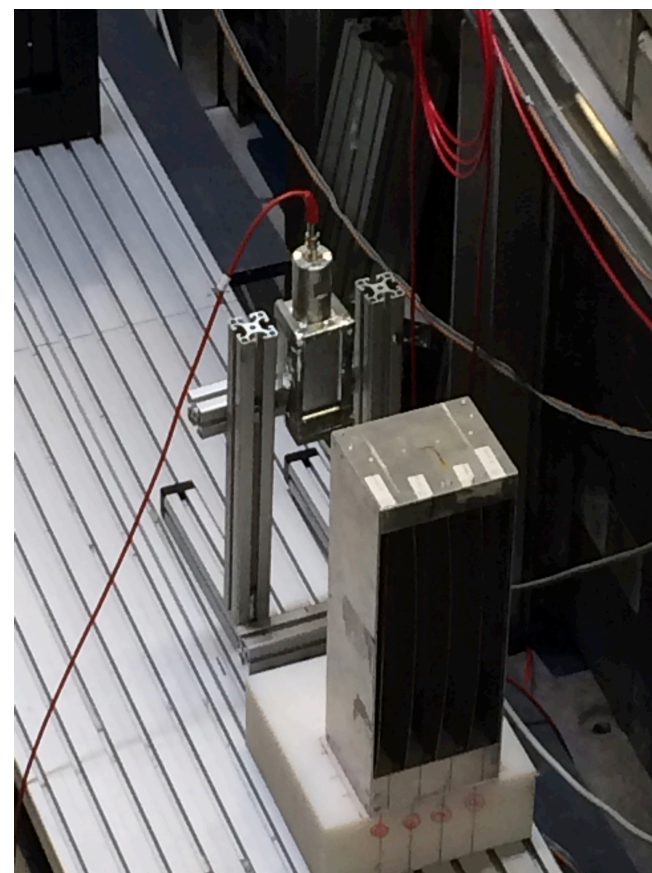
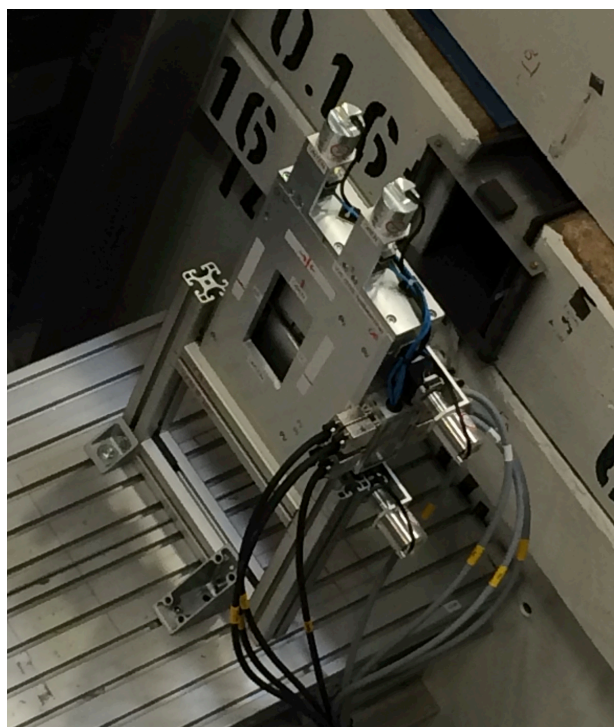
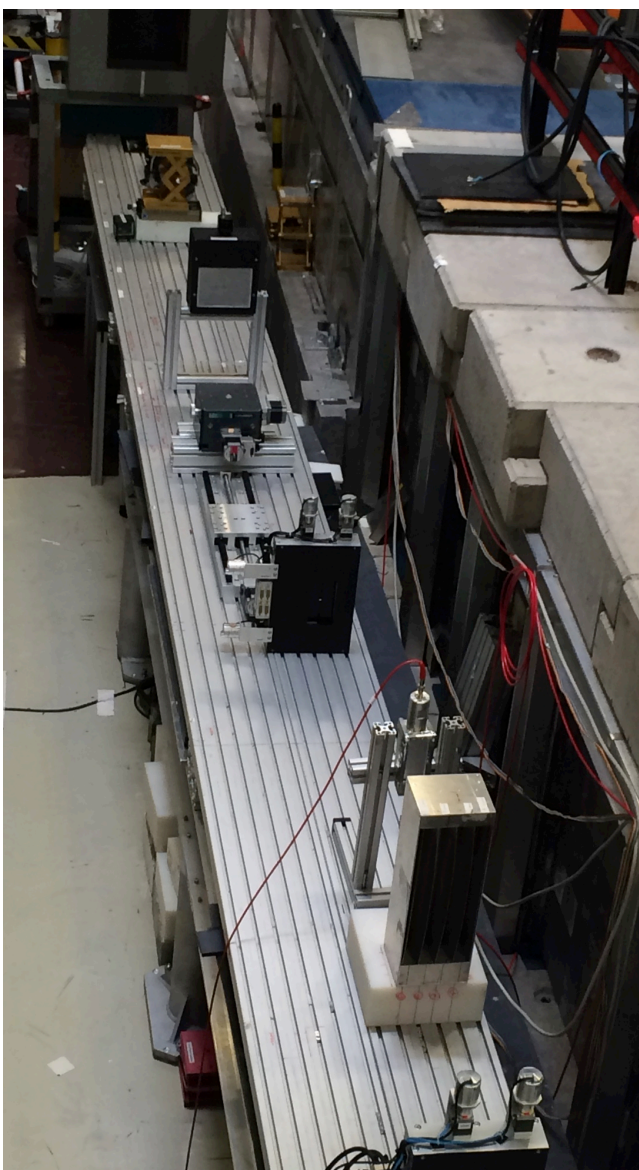
- Testbeamline V20 at HZB
- Chopper cascade models ESS pulse structure
- Main purpose: Method development, Integration
- Responsible on site: Robin Woracek

DMSC Instrument Data Group

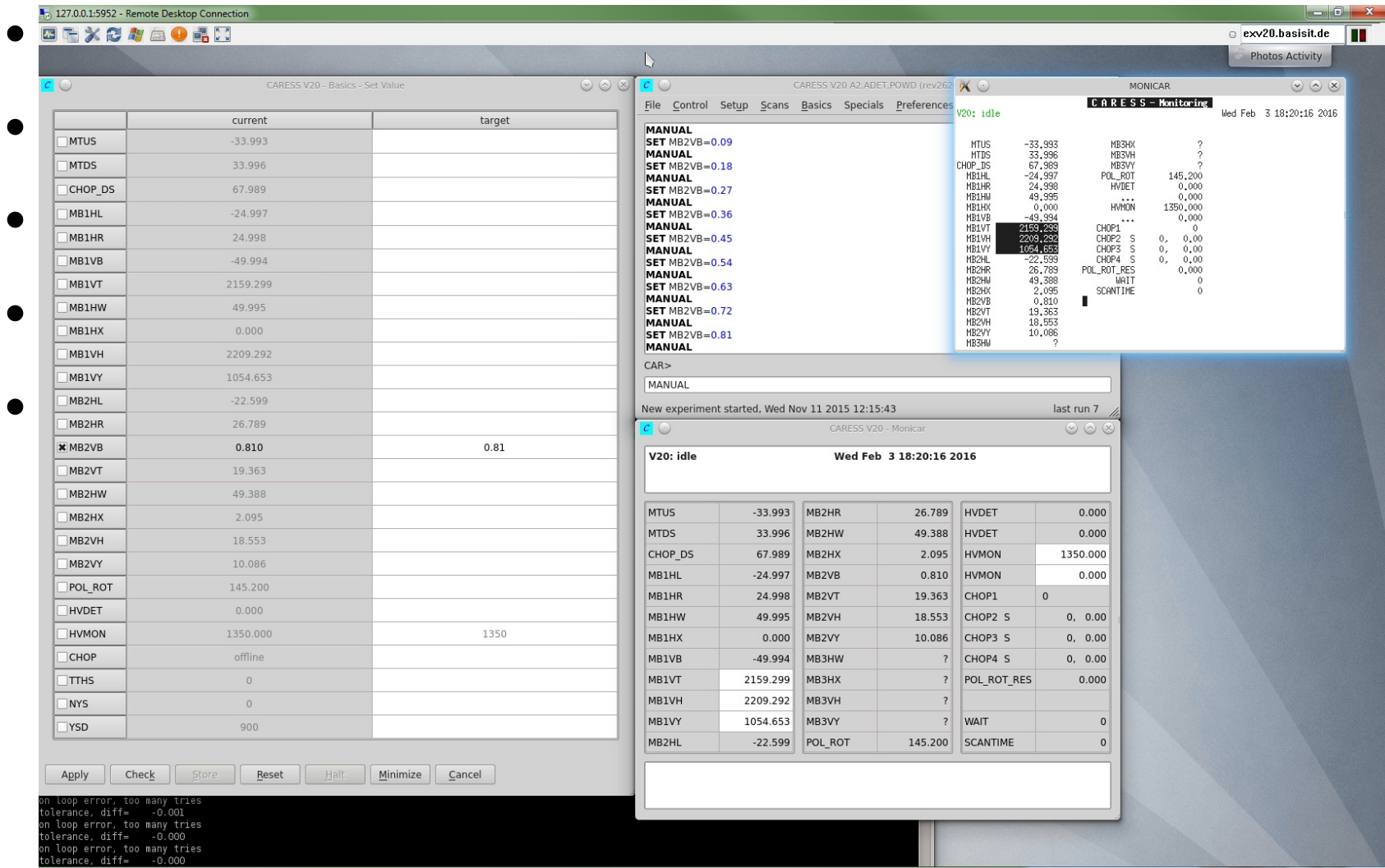
- Development of high level control interface
- V20 provides full beamline with user operations
- Very good opportunity to gain experience

- 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



127.0.0.1:5952 - Remote Desktop Connection

exv20.basit.de

CARESS V20 - Basics - Set Value

	current	target
<input type="checkbox"/> MTUS	-33.993	
<input type="checkbox"/> MTDS	33.996	
<input type="checkbox"/> CHOP_DS	67.989	
<input type="checkbox"/> MB1HL	-24.997	
<input type="checkbox"/> MB1HR	24.998	
<input type="checkbox"/> MB1VB	-49.994	
<input type="checkbox"/> MB1VT	2159.299	
<input type="checkbox"/> MB1HW	49.995	
<input type="checkbox"/> MB1HX	0.000	
<input type="checkbox"/> MB1VH	2209.292	
<input type="checkbox"/> MB1VY	1054.653	
<input type="checkbox"/> MB2HL	-22.599	
<input type="checkbox"/> MB2HR	26.789	
<input checked="" type="checkbox"/> MB2VB	0.810	0.81
<input type="checkbox"/> MB2VT	19.363	
<input type="checkbox"/> MB2HW	49.388	
<input type="checkbox"/> MB2HX	2.095	
<input type="checkbox"/> MB2VH	18.553	
<input type="checkbox"/> MB2VY	10.086	
<input type="checkbox"/> POL_ROT	145.200	
<input type="checkbox"/> HVDET	0.000	
<input type="checkbox"/> HVMON	1350.000	1350
<input type="checkbox"/> CHOP	offline	
<input type="checkbox"/> TTHS	0	
<input type="checkbox"/> NYS	0	
<input type="checkbox"/> YSD	900	

Apply Check Store Reset Halt Minimize Cancel

on loop error, too many tries
tolerance_diff= -0.001
on loop error, too many tries
tolerance_diff= -0.000
on loop error, too many tries
tolerance_diff= -0.000

CARESS V20 A2.ADET.POWD (rev26)

MONICAR

MANUAL SET MB2VB=0.09
MANUAL SET MB2VB=0.18
MANUAL SET MB2VB=0.27
MANUAL SET MB2VB=0.36
MANUAL SET MB2VB=0.45
MANUAL SET MB2VB=0.54
MANUAL SET MB2VB=0.63
MANUAL SET MB2VB=0.72
MANUAL SET MB2VB=0.81
MANUAL

CARESS - Monitoring

Wed Feb 3 18:20:16 2016

MTUS	-33.993	MB2HX	?
MTDS	33.996	MB2VH	?
CHOP_DS	67.989	MB3VY	?
MB1HL	-24.997	POL_ROT	145.200
MB1HR	24.998	HVDET	0.000
MB1HW	49.995	...	0.000
MB1HX	0.000	HVMON	1350.000
MB1VB	-49.994	...	0.000
MB1VT	2159.299	CHOP1	...
MB1VH	2209.292	CHOP2 S	0, 0,00
MB1VY	1054.653	CHOP3 S	0, 0,00
MB2HL	-22.599	CHOP4 S	0, 0,00
MB2HR	26.789	POL_ROT_RES	0.000
MB2HW	49.388	WAIT	0
MB2HX	2.095	SCANTIME	0
MB2VB	0.810		
MB2VT	19.363		
MB2VH	18.553		
MB2VY	10.086		
MB3HW	?		
MB3HX	?		
MB3VH	?		
MB3VY	?		
MB3HW	?		

CARESS V20 - Monicar

Wed Feb 3 18:20:16 2016

V20: idle

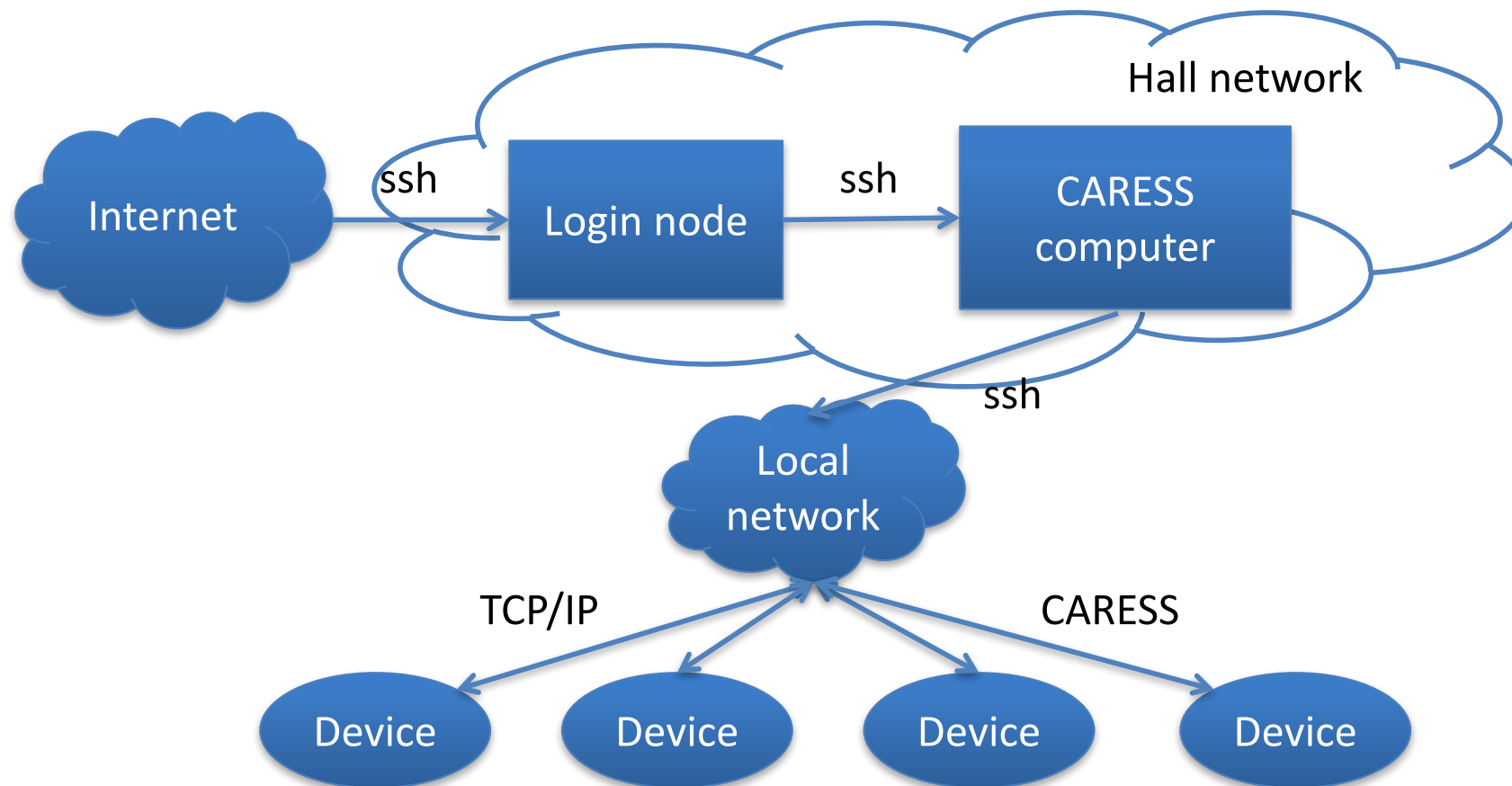
MTUS	-33.993	MB2HR	26.789	HVDET	0.000
MTDS	33.996	MB2HW	49.388	HVDET	0.000
CHOP_DS	67.989	MB2HX	2.095	HVMON	1350.000
MB1HL	-24.997	MB2VB	0.810	HVMON	0.000
MB1HR	24.998	MB2VT	19.363	CHOP1	0
MB1HW	49.995	MB2VH	18.553	CHOP2 S	0, 0.00
MB1HX	0.000	MB2VY	10.086	CHOP3 S	0, 0.00
MB1VB	-49.994	MB3HW	?	CHOP4 S	0, 0.00
MB1VT	2159.299	MB3HX	?	POL_ROT_RES	0.000
MB1VH	2209.292	MB3VH	?	WAIT	0
MB1VY	1054.653	MB3VY	?	SCANTIME	0
MB2HL	-22.599	POL_ROT	145.200		

last run 7

New experiment started, Wed Nov 11 2015 12:15:43

Networks

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



- 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)

NICOS GUI



NICOS - guest at localhost:1301

Application Script control Output Windows Tools Help

Connect Exit View Setup Editor Scans History Logbook Log files Errors Live data

Experiment... Proposal

Title Users Local Contact

Setups

Samples

Environments

Detectors Scans

Remark

Command line

NicosSetup()

Control wfm_chopper_distance

Device: wfm_chopper_distance
Distance between WFM choppers 1 and 2
Current value: 200.007 mm
Status: A=idle or paused, B=idle or paused

Control device

Move to: 200.00728607177734 mm

Parameters

Name	Value
coordinates	equal

Control slit2

Device: slit2
Slit 2
Current value: 0.00 10.00 10.00 20.00 mm
Status: left=idle or paused, right=idle or paused, bottom=idle or paused, top=idle or paused

Control device

Move to: 1,0008545 10 10 20 mm

Control hv_mon

Device: hv_mon
High voltage for beam monitor
Current value: 0.00 V
Status: idle or paused

Control device

Move to: 0.0 V

Parameters

Name	Value
_started	False
caesspath	/opt/caess/parameter
comdelay	0.2
contries	5
config	HVMON 76 2 usemoxa 1 1 0 20 -1 0 0 0
description	High voltage for beam monitor
fmtstr	%2f
loglevel	info
maxage	12.0
nameserver	192.168.1.254
objname	EXV20
pollinterval	5.0
precision	0.01
target	0

History

Window History viewer Presets

Log Scale Auto scale X Y Reset Delete

History views:

slit2 (36h)

slit2 (36h)

value

time

slit2/value[0] (mm) slit2/value[1] (mm) slit2/value[2] (mm) slit2/value[3] (mm)

X = 2016-06-22 12:50:16, Y = 19.7814

NICOS devices

Filter:

Name	Value	Status
high_voltage		
hv_mon	0.00 V	idle or paused
slit1		
slit1	-0.00 0.00 49.9...	left=idle or paused, rig...
slit2	0.00 10.00 10.00...	left=idle or paused, rig...
system		
Exp		
Sample		
Space	3.508 GiB	3.51 GiB free
V20		
wfm_choppers		
wfm_chopper_dist...	200.007 mm	A=idle or paused, B=idl...

Developing a plan

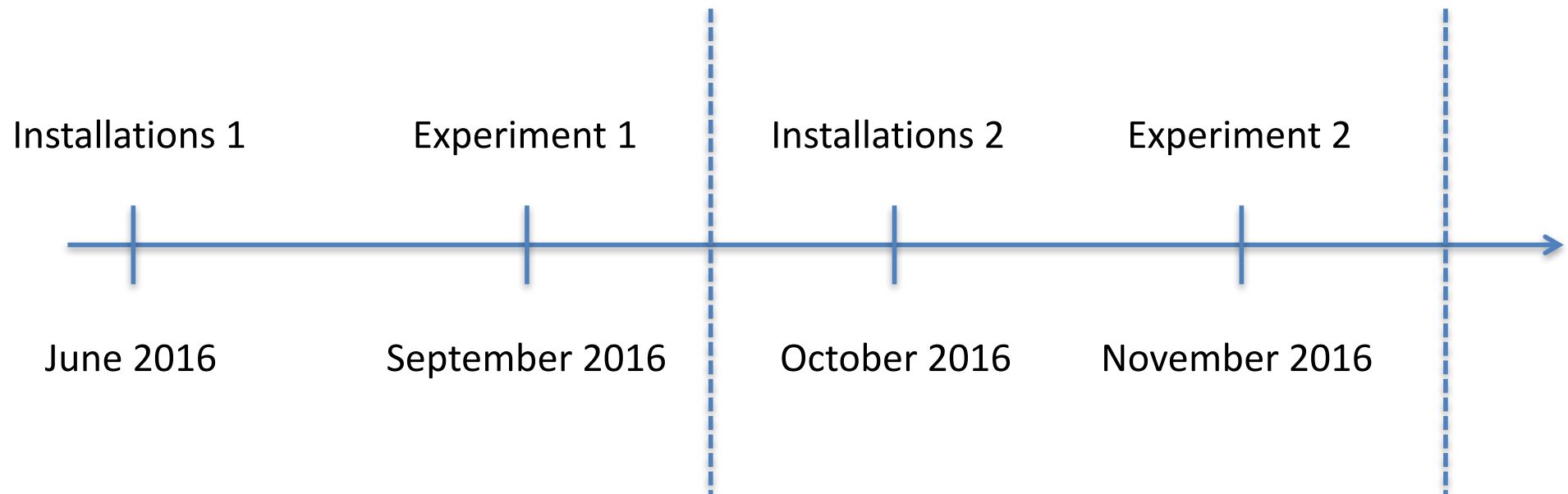


- First visit in June 2016, with in-kind partners, ICS
- Initial activities
 - Use NICOS with existing CARESS infrastructure
 - Integrate other devices using their protocols
 - Support user operations
- Future activities
 - Slowly replace CARESS layer by EPICS layer
 - Follow CARESS to EPICS change in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

Iterations timeline

Iteration 1

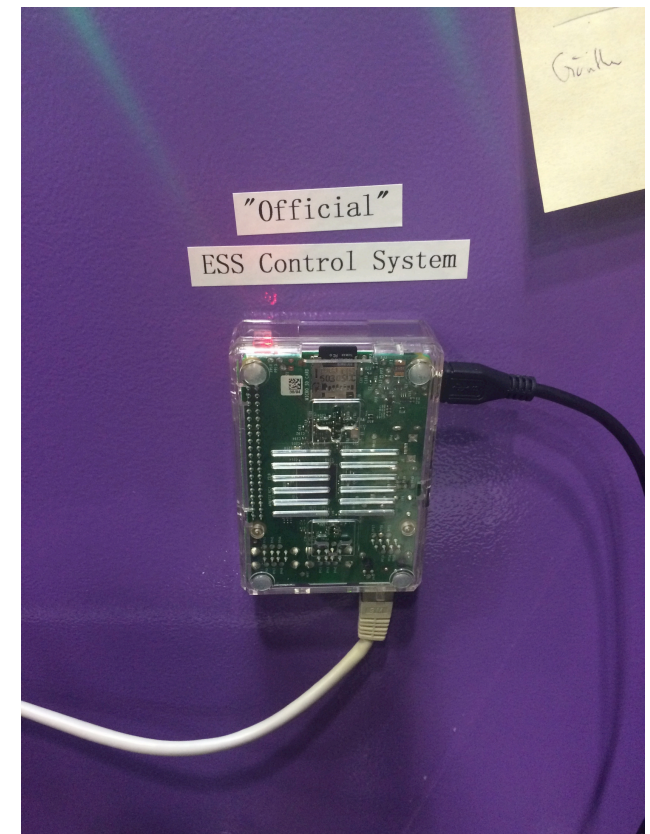
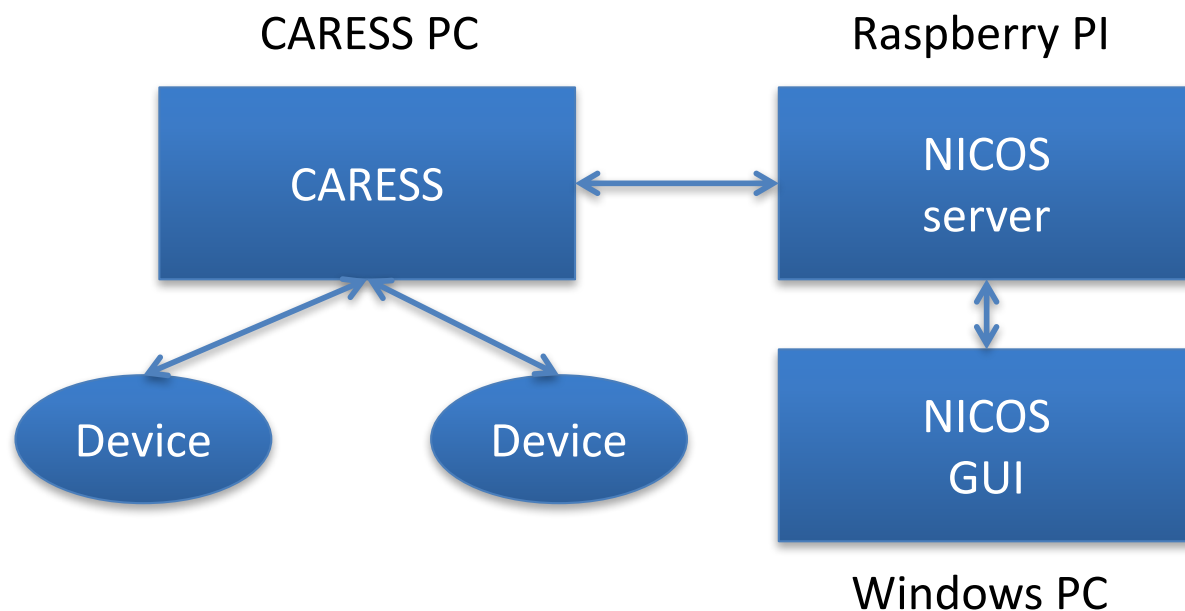
Iteration 2



Installations 1

- Installed NICOS on Raspberry Pi
- Integrated some devices via CARESS:
 - Slit systems, linear stages, HV supplies, chopper stages

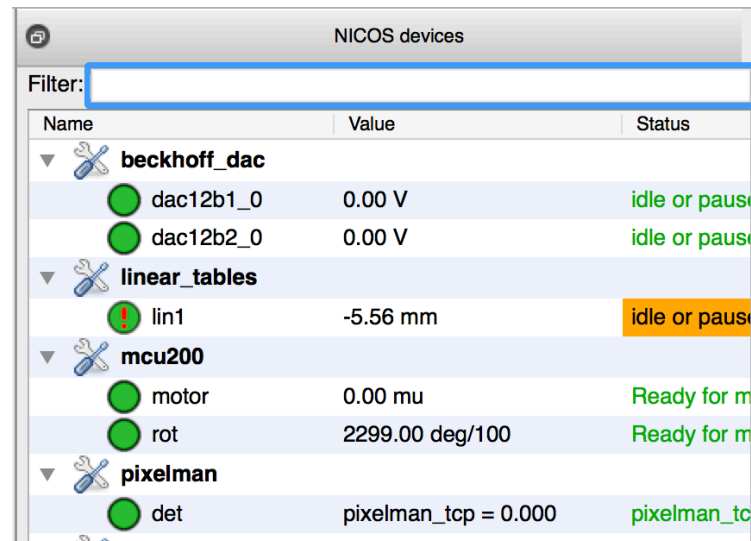
- Installed GUI on Windows PC













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



Name	Value	Status
▼  beckhoff_dac		
 dac12b1_0	0.00 V	idle or pause
 dac12b2_0	0.00 V	idle or pause
▼  linear_tables		
 lin1	-5.56 mm	idle or pause
▼  mcu200		
 motor	0.00 mu	Ready for m
 rot	2299.00 deg/100	Ready for m
▼  pixelman		
 det	pixelman_tcp = 0.000	pixelman_tc

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

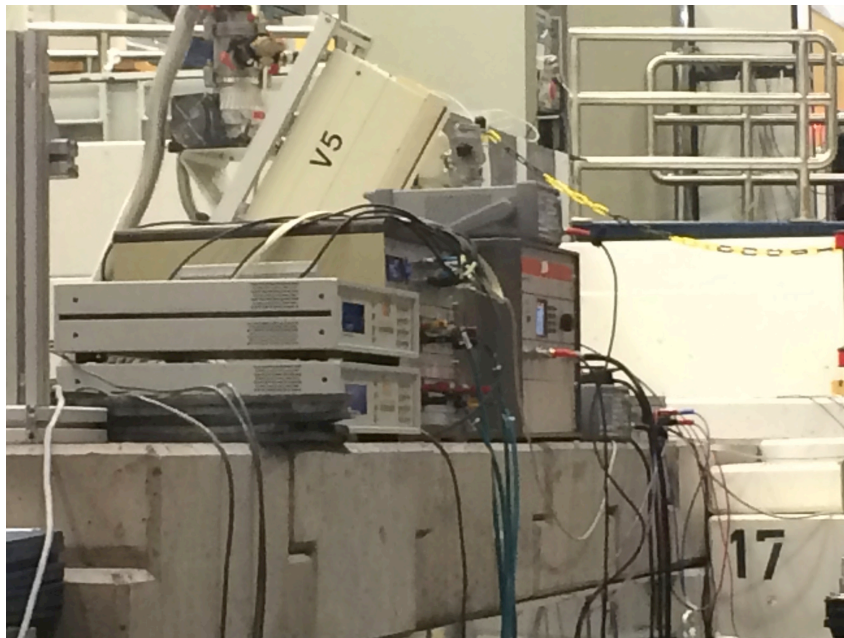
Installations 2

- 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

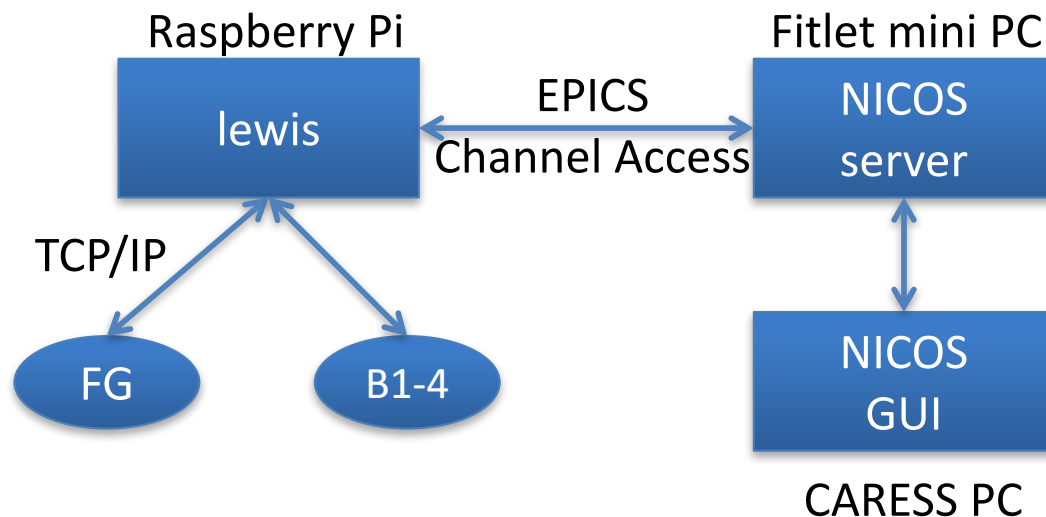


- Python based hardware simulation framework
- Cycle-based, non-threaded, completely deterministic
- Modeling complex devices using state machine
- Communication interfaces separate from simulation, multiple protocols supported (EPICS CA, TCP/IP stream, modbus*)
- Additional, unrestricted access to simulation 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

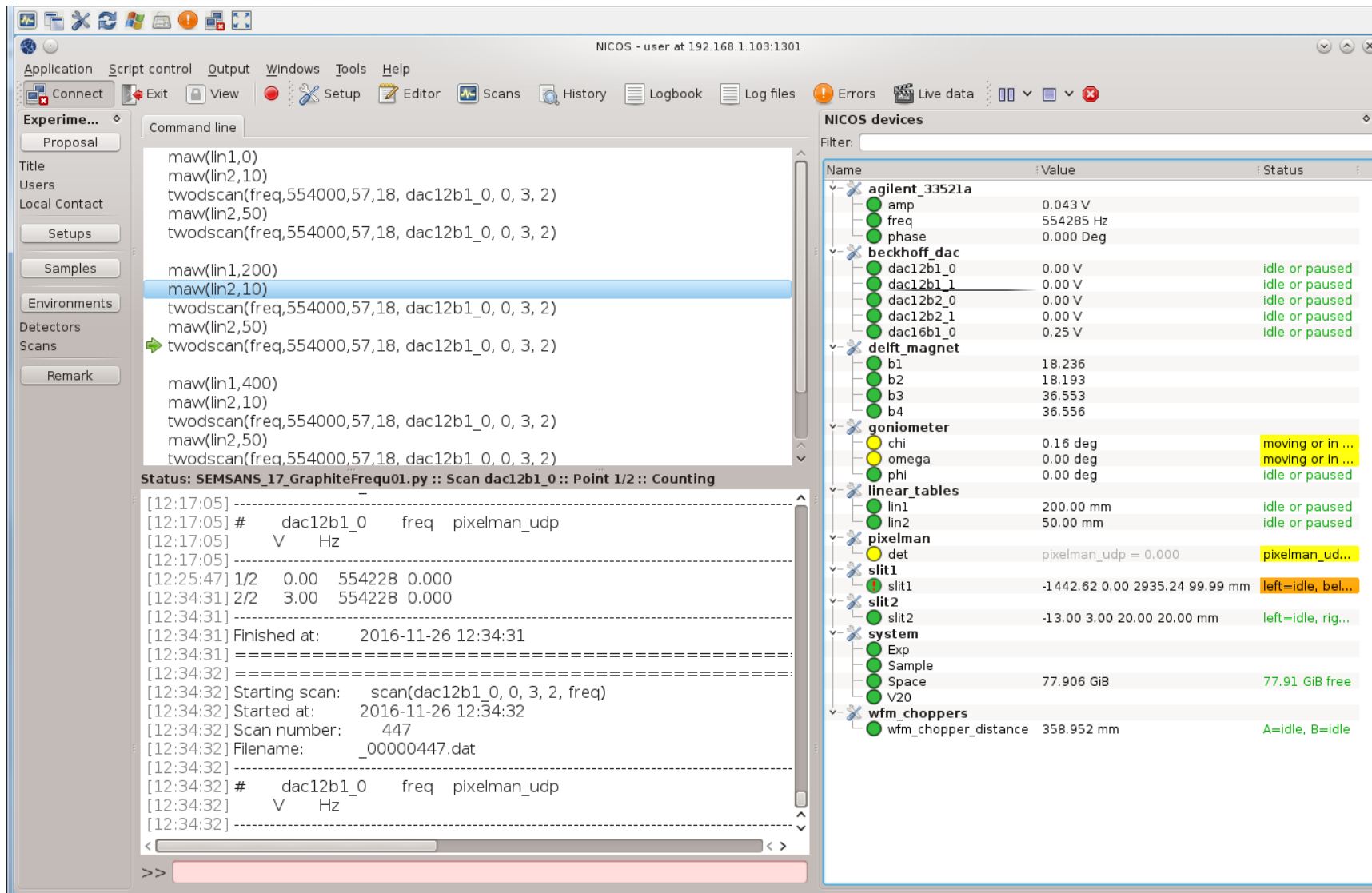
- Communication via MOXA-box difficult to manage
- Function generator kept losing connection
- Intermediate EPICS based solution using Lewis (communicate with hardware instead of simulation)
- Quick way to write and deploy simple “IOCs”



Filter:

Name	Value	Status
✂ agilent_33521a		
● amp	3.000 V	
● freq	500 Hz	
● phase	0.000 ...	
▶ ✂ beckhoff_dac		
✂ delft_magnet		
● b1	10.996	
● b2	5.000	
● b3	8.001	
● b4	10.001	

More devices...



The screenshot displays the NICOS control interface. The main window shows a command line with several scan commands. The status bar indicates the current scan is in progress. The right-hand panel, titled 'NICOS devices', provides a detailed view of the system's hardware and their current states.

Command line:

```
maw(lin1,0)
maw(lin2,10)
twodscan(freq,554000,57,18, dac12b1_0, 0, 3, 2)
maw(lin2,50)
twodscan(freq,554000,57,18, dac12b1_0, 0, 3, 2)

maw(lin1,200)
maw(lin2,10)
twodscan(freq,554000,57,18, dac12b1_0, 0, 3, 2)
maw(lin2,50)
twodscan(freq,554000,57,18, dac12b1_0, 0, 3, 2)

maw(lin1,400)
maw(lin2,10)
twodscan(freq,554000,57,18, dac12b1_0, 0, 3, 2)
maw(lin2,50)
twodscan(freq,554000,57,18, dac12b1_0, 0, 3, 2)
```

Status: SEMSANS_17_GraphiteFrequ01.py :: Scan dac12b1_0 :: Point 1/2 :: Counting

NICOS devices:

Name	Value	Status
agilent_33521a		
amp	0.043 V	
freq	554285 Hz	
phase	0.000 Deg	
beckhoff_dac		
dac12b1_0	0.00 V	idle or paused
dac12b1_1	0.00 V	idle or paused
dac12b2_0	0.00 V	idle or paused
dac12b2_1	0.00 V	idle or paused
dac16b1_0	0.25 V	idle or paused
delft_magnet		
b1	18.236	
b2	18.193	
b3	36.553	
b4	36.556	
goniometer		
chi	0.16 deg	moving or in ...
omega	0.00 deg	moving or in ...
phi	0.00 deg	idle or paused
linear_tables		
lin1	200.00 mm	idle or paused
lin2	50.00 mm	idle or paused
pixelman		
det	pixelman_udp = 0.000	pixelman_ud...
slit1		
slit1	-1442.62 0.00 2935.24 99.99 mm	left=idle, bel...
slit2		
slit2	-13.00 3.00 20.00 20.00 mm	left=idle, rig...
system		
Exp		
Sample		
Space	77.906 GiB	77.91 GiB free
V20		
wfm_choppers		
wfm_chopper_distance	358.952 mm	A=idle, B=idle

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)

- 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

- 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?