MLZ
Heinz Maier-Leibnitz Zentrum

NICOS
Networked Instrument COntrol System

Principle and practice of instrument control in neutron facilities - the NICOS system

Jens Krüger

MLZ is a cooperation between:
JÜLICH Forschungszentrum
Helmholtz-Zentrum hereon
Technical University of Munich

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  Typical answer: **No way**!

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  My answer: Possible

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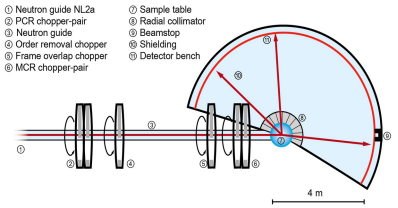

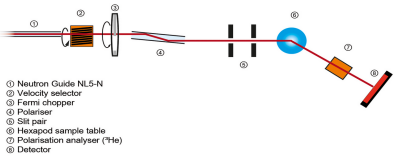

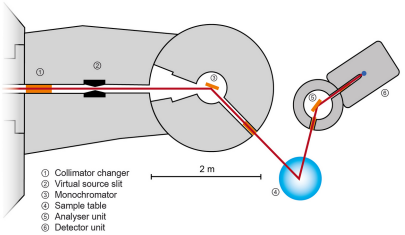

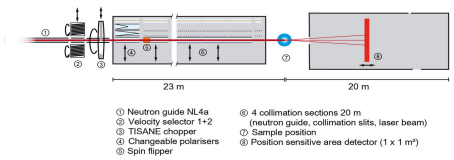

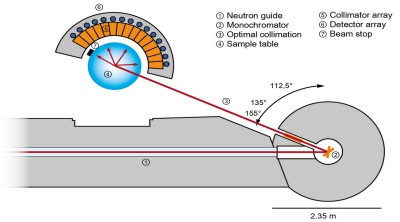

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Higher level actions: Counts, Scans, …

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- Operation with (external) users!

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- Common, but flexible
  - Goal: Users need an interface with ability to program

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- Hardware „independent“ (TANGO, EPICS, SECoP, CARESS, ...)

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- Ran on 5 instruments
- Very simple, not a client/server system
- Diverged lines of development and code states (CVS, not code review)

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- 2025 BNC ?

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- Lightweight:
  - Less code is better
  - Reuse existing code as much as possible
  - Better to configure than to code

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- Open source
  - Everybody is welcome to use and contribute

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- A setup is a simple Python file defining devices and their parameters

```
description = 'MIRA1 monochromator'
group = 'lowlevel'

includes = ['base', 'sample', 'alias_mono']

tango_base = 'tango://miractrl.mira.frm2.tum.de:10000/mira/'

devices = dict(
    co_m1tt = device('nicos.devices.entangle.Sensor',
        visibility = (),
        tangodevice = tango_base + 'mono1/mtt_enc',
        unit = 'deg',
        precision = 0.05,
    ),
    mo_m1tt = device('nicos.devices.entangle.Motor',
        tangodevice = tango_base + 'mono1/mtt_mot',
        visibility = (),
        precision = 0.05,
    ),
    m1tt = device('nicos_mlz.mira.devices.axis.HoveringAxis',
        description = 'monochromator two-theta angle',
        abslimits = (-50.0, 0),
        motor = 'mo_m1tt',
        coder = 'co_m1tt',
        startdelay = 1,
        stopdelay = 4,
        switch = 'air_mono',
        switchvalues = (0, 1),
        fmtstr = '%.3f',
        precision = 0.05,
    ),
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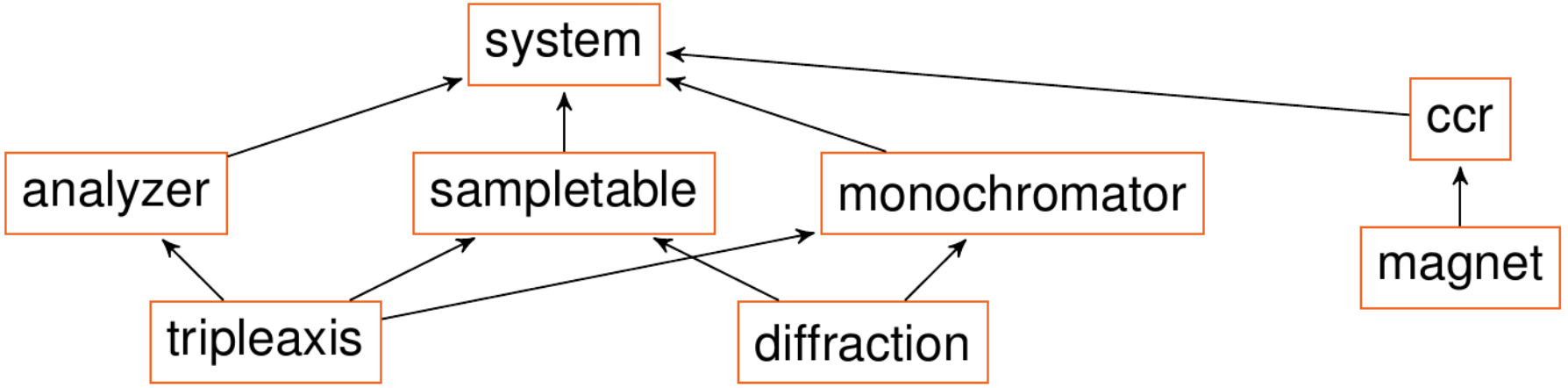

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NewSetup('tripleaxis', 'ccr')
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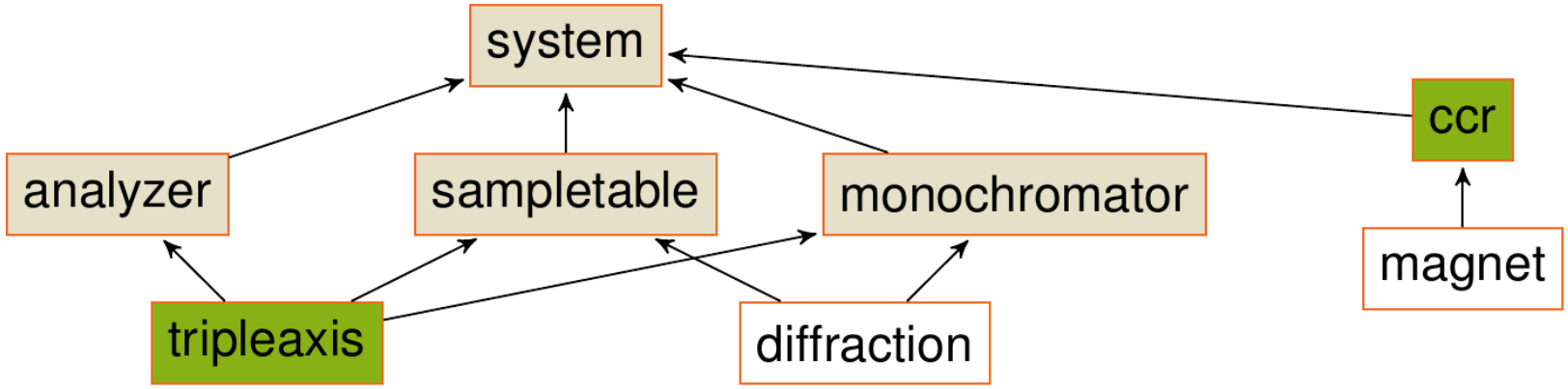

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NewSetup('diffraction', 'magnet')
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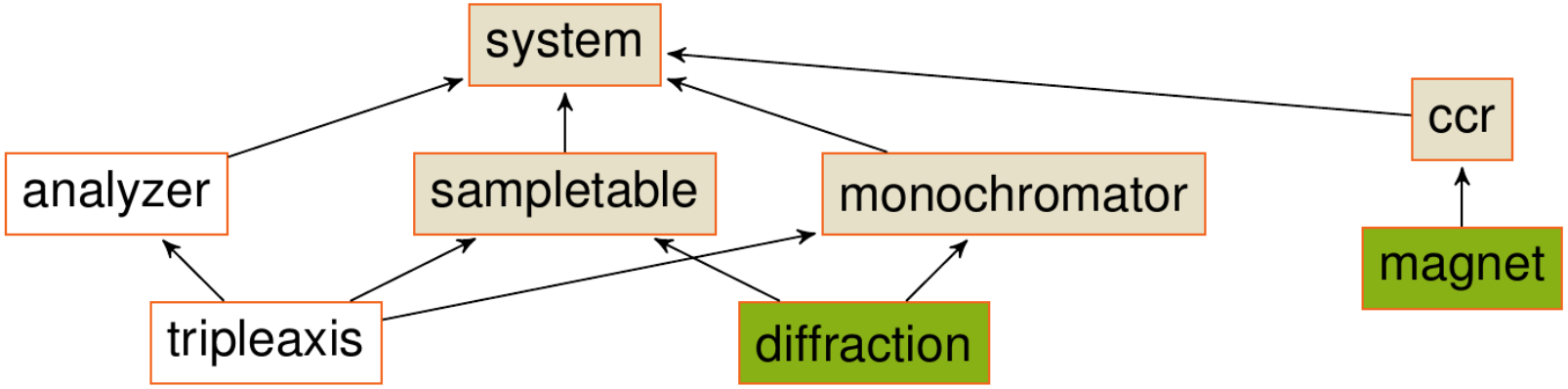

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- Device value and status will be automatically archived

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- Python control structures
  - **loops, conditions, variables, …**

User interface

- Most basic user interface: Python **command** prompt
- Simple commands:
  - `read(device), move(device, target), status(device),…`
- Scanning commands:
  - `scan(device, start, step, num, preset), ...`
- Integrated help system:
  - `help(object), ListDevices(), ListSetups(),...`
- Python control structures
  - **loops, conditions, variables, …**
- Execution environment is safe against user errors
  - **no overriding of devices and commands**

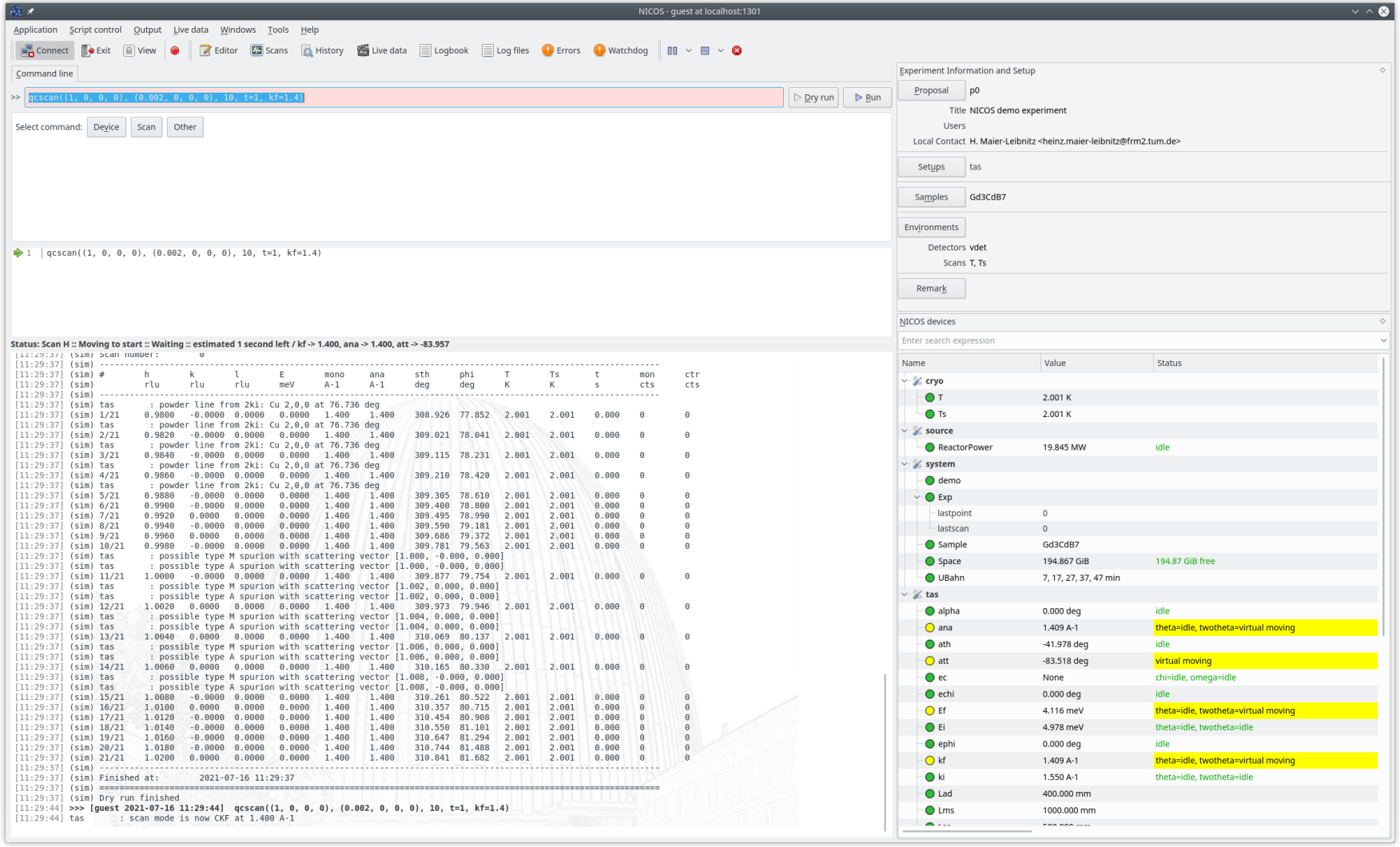
Graphical user interface

- Client-Server architecture: more than one connection possible

Graphical user interface

- Client-Server architecture: more than one connection possible
- Command line window

Graphical user interface



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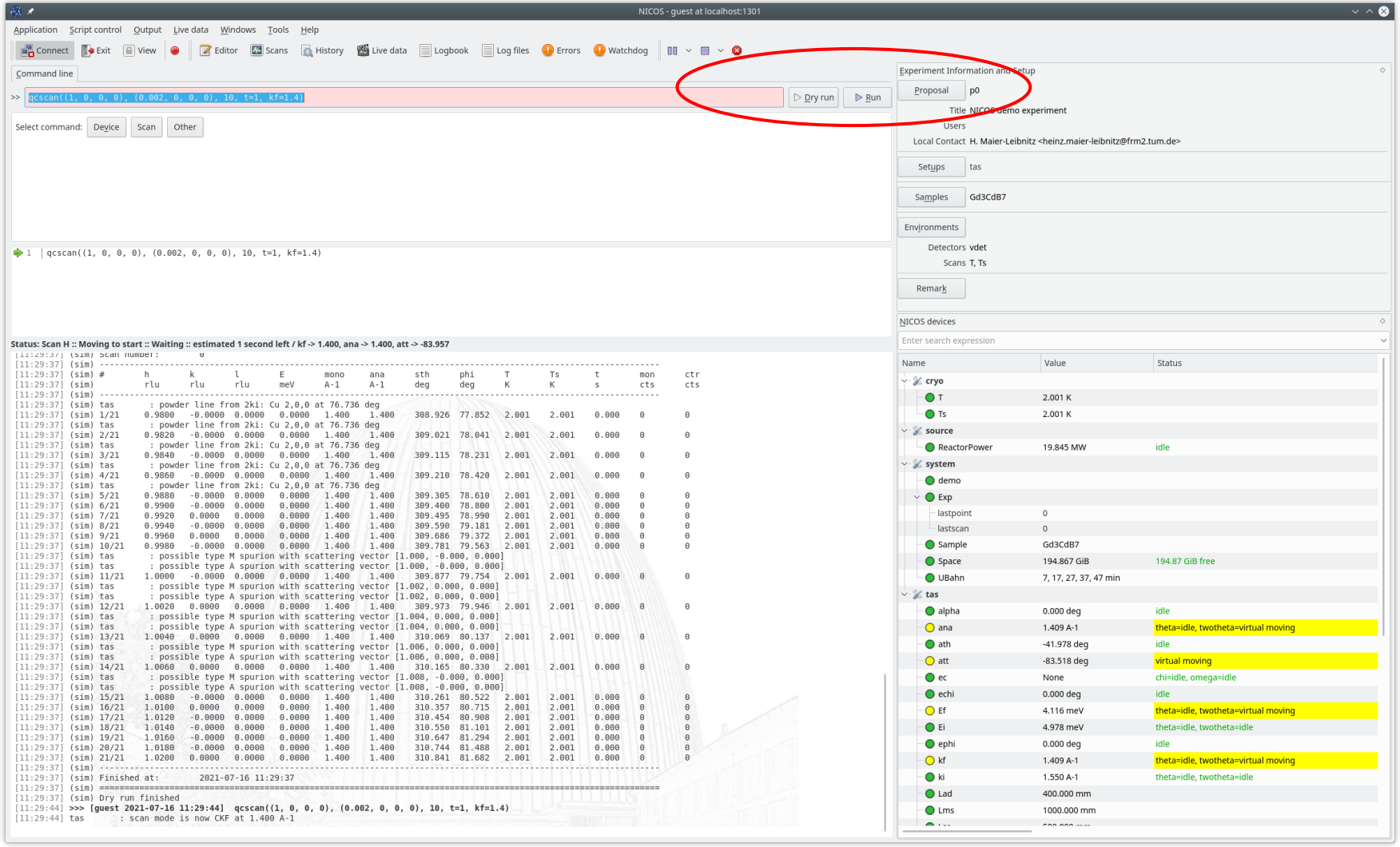

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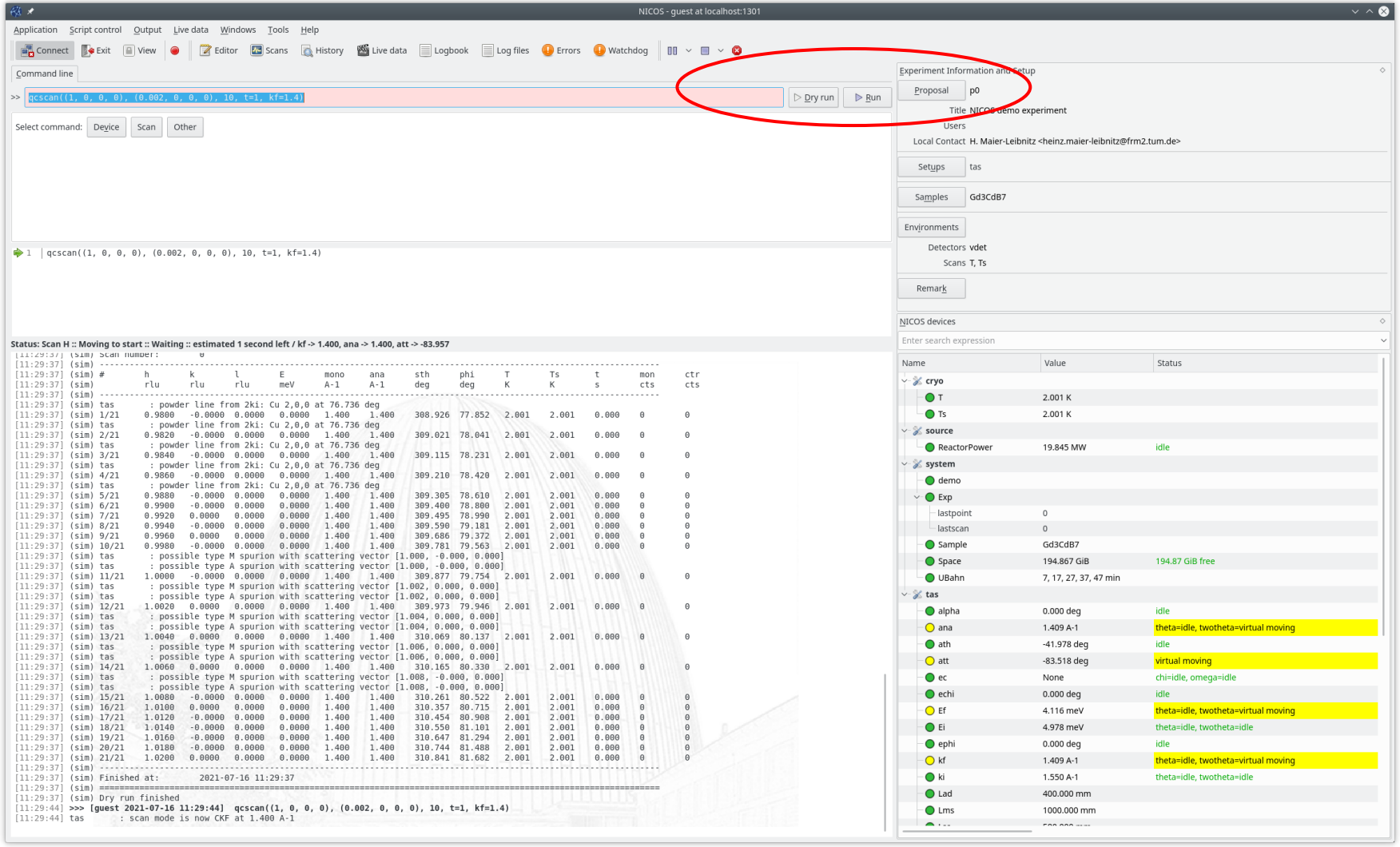

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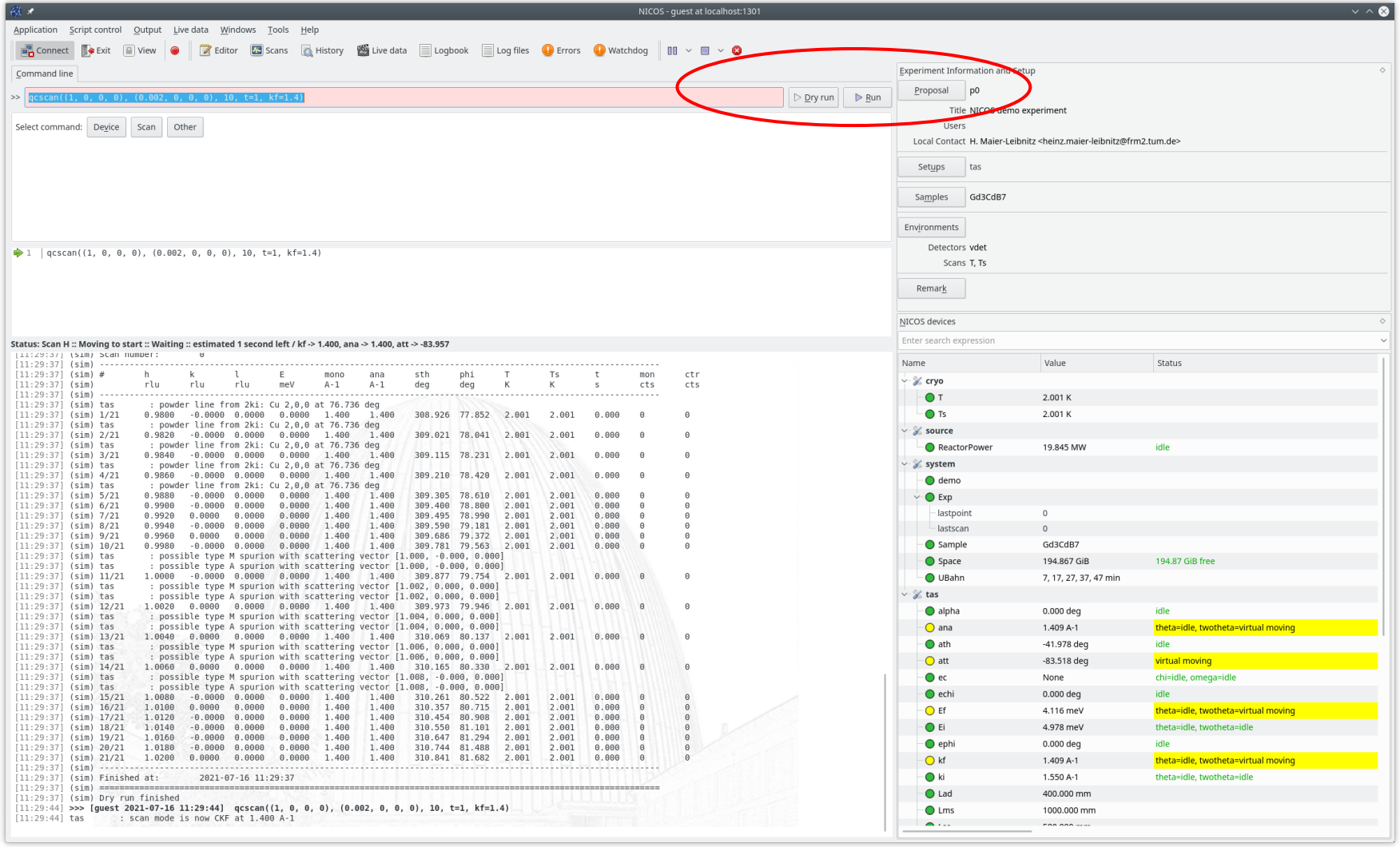

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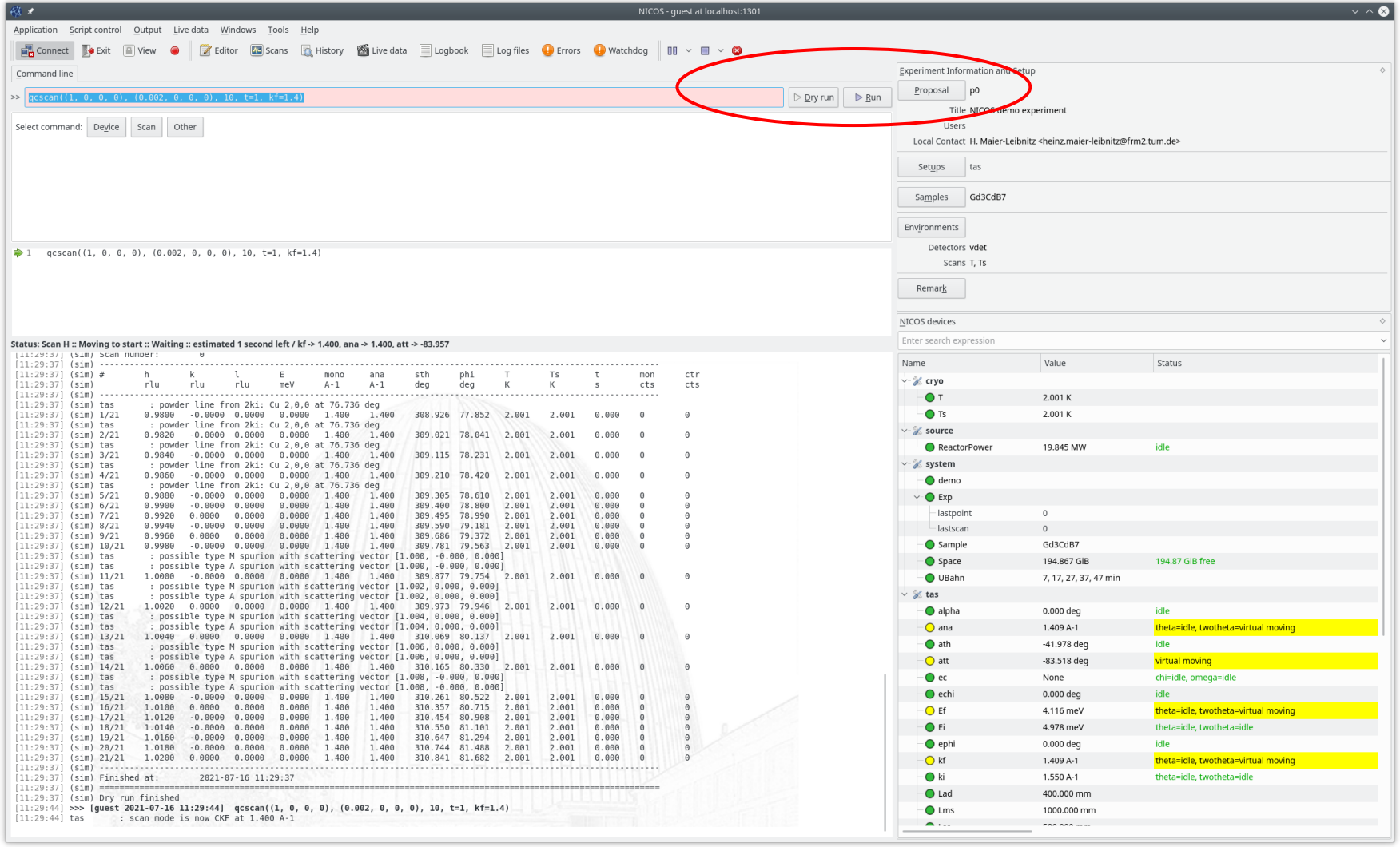

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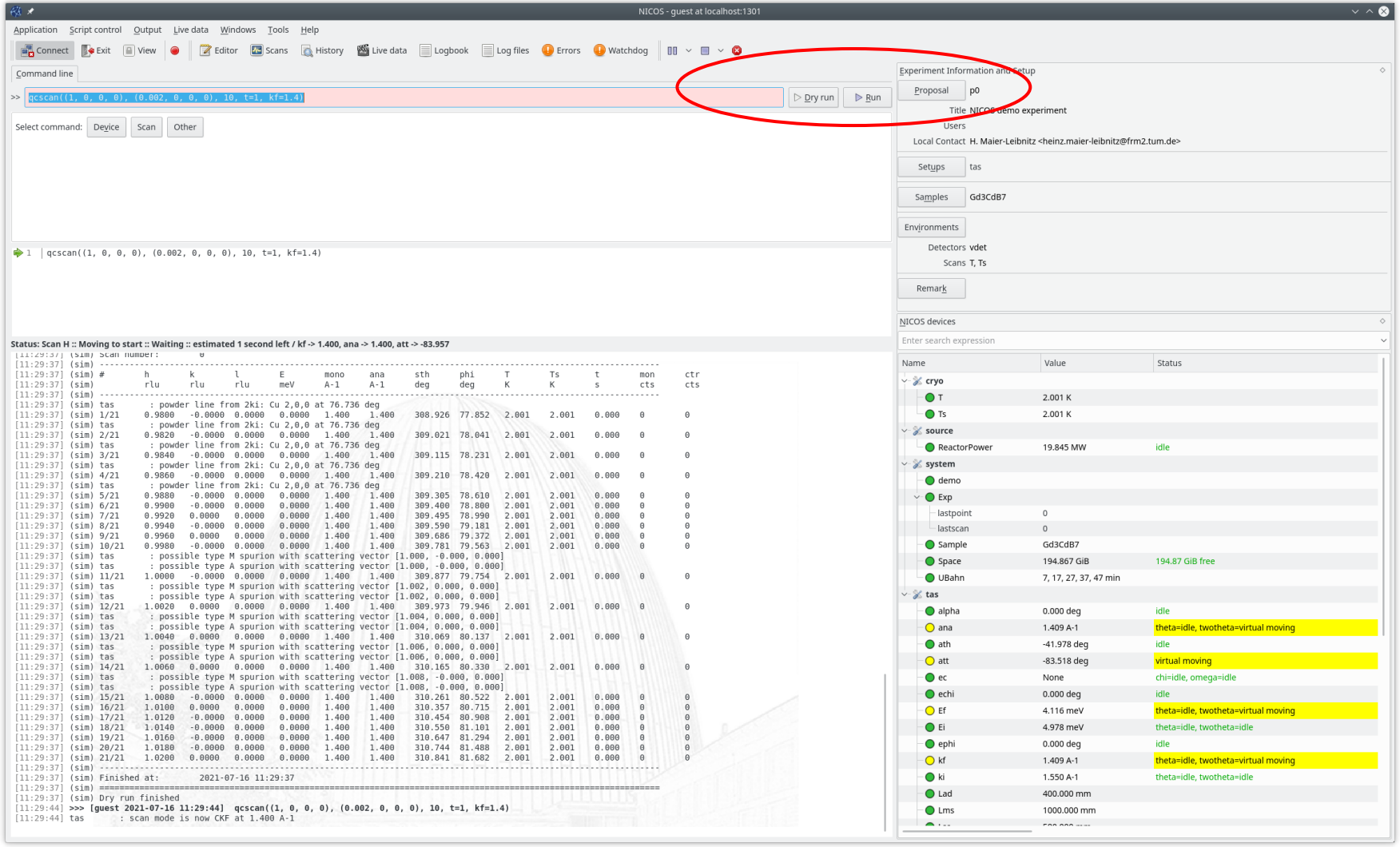

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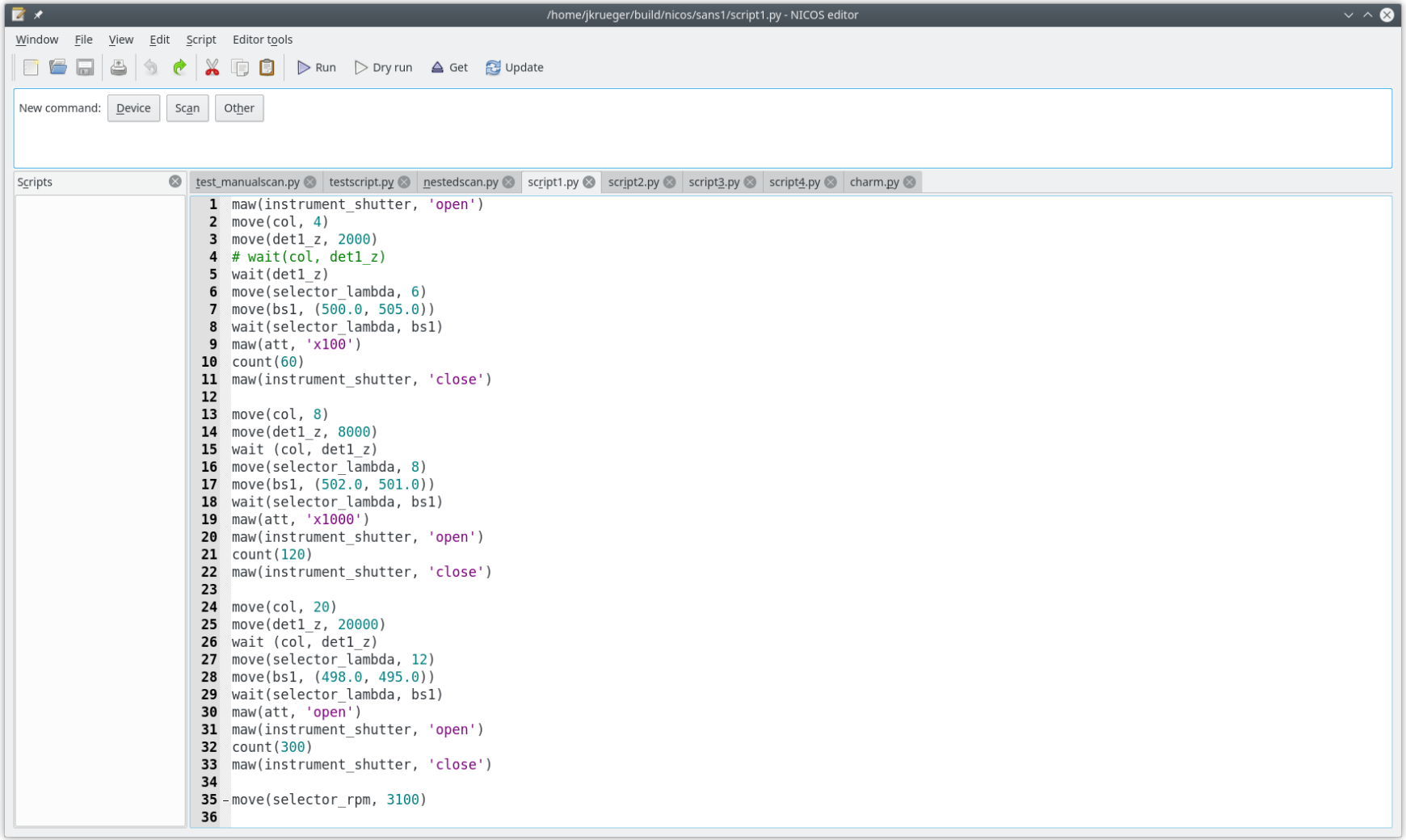

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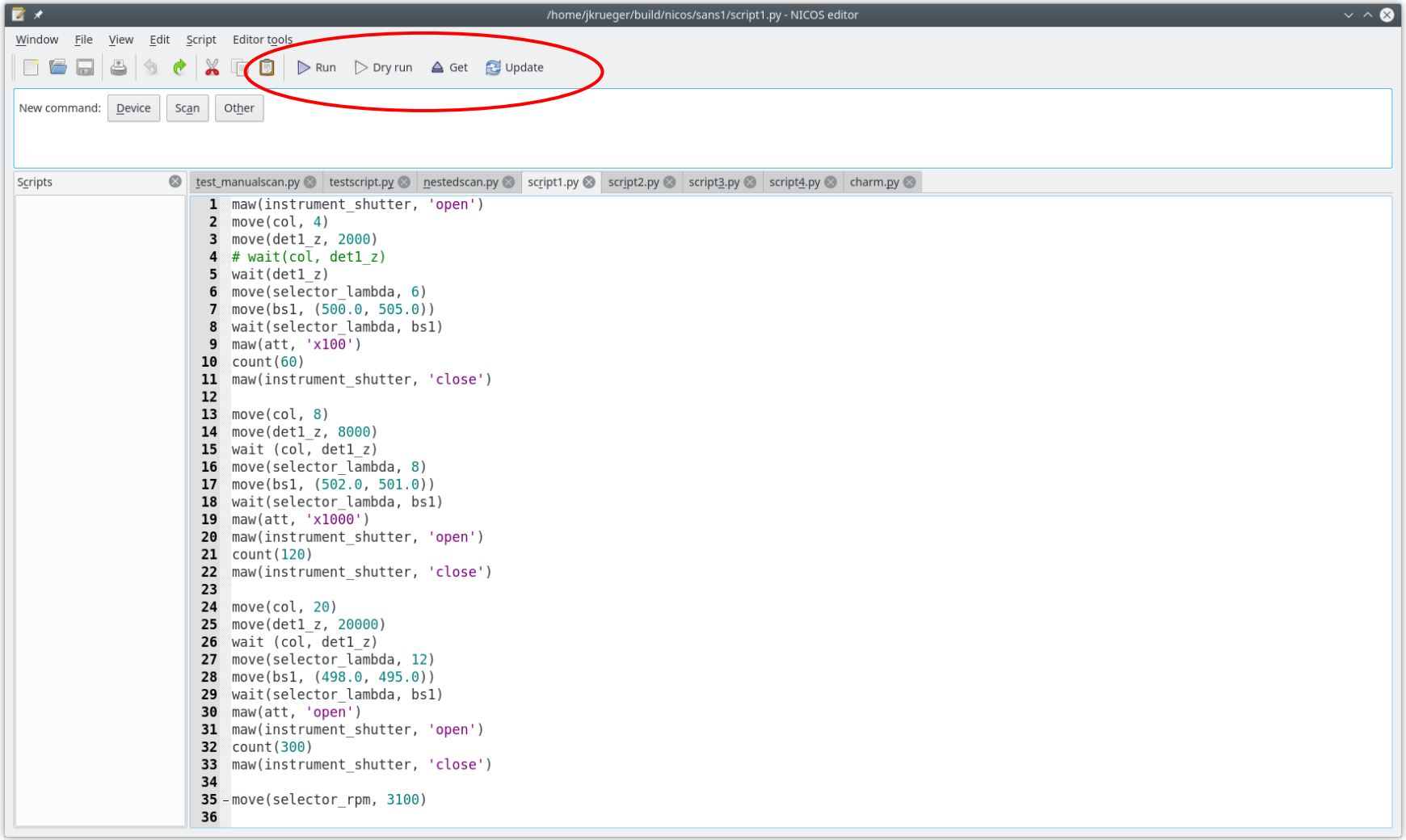

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- History viewer: Display of archived data

Graphical user interface

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- Command lir
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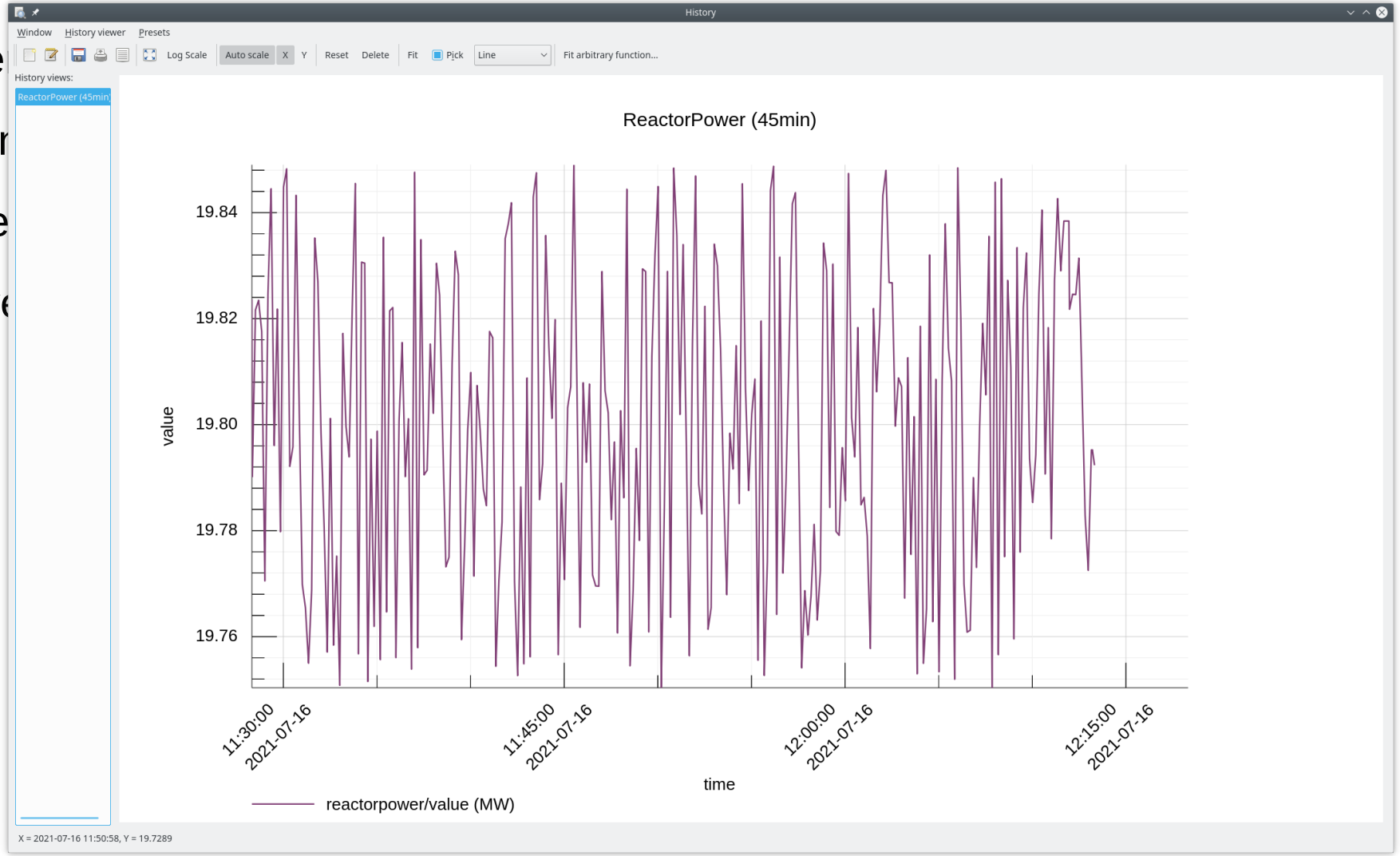

Graphical user interface

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- On-line data display with preliminary fitting

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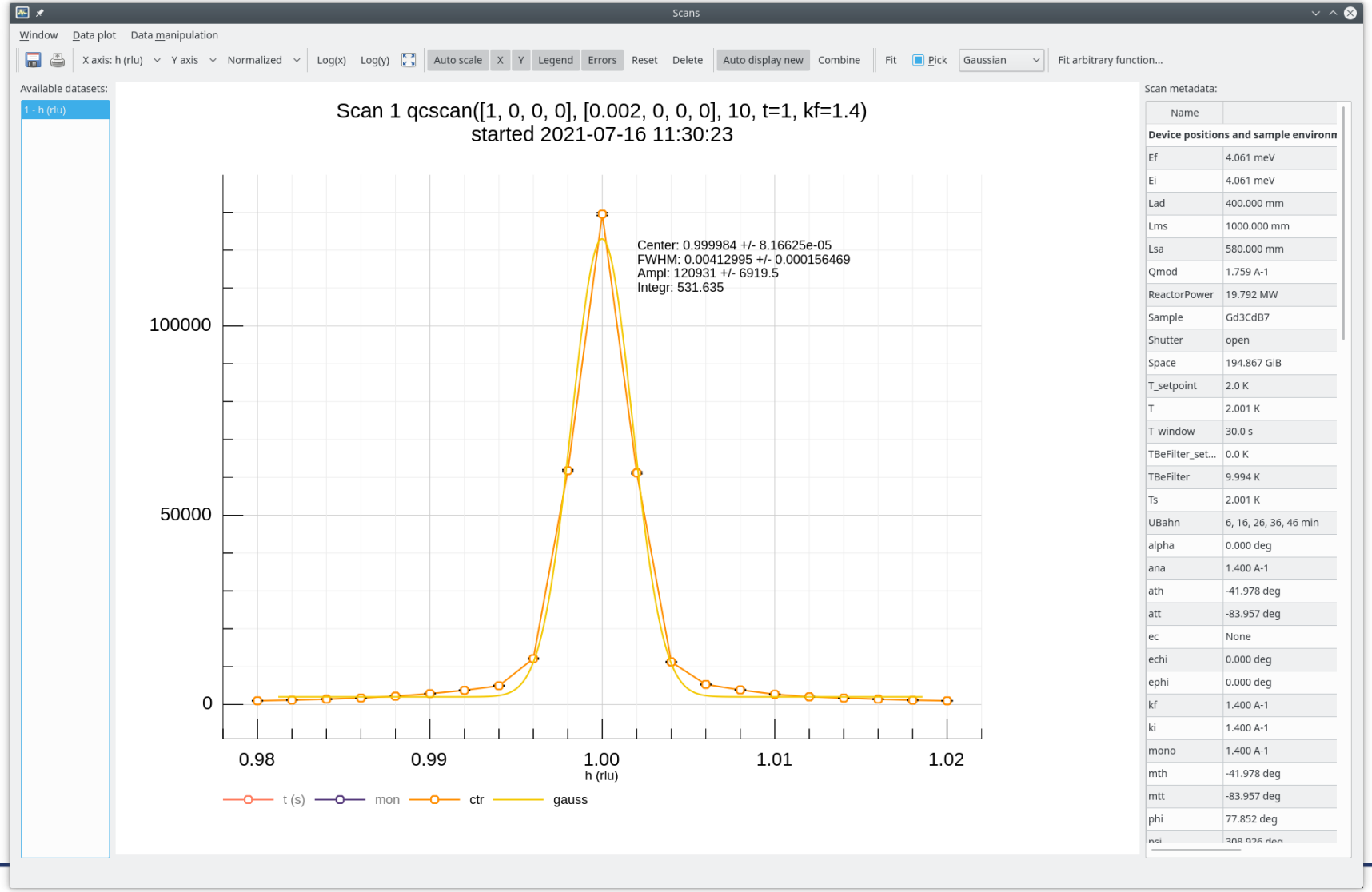

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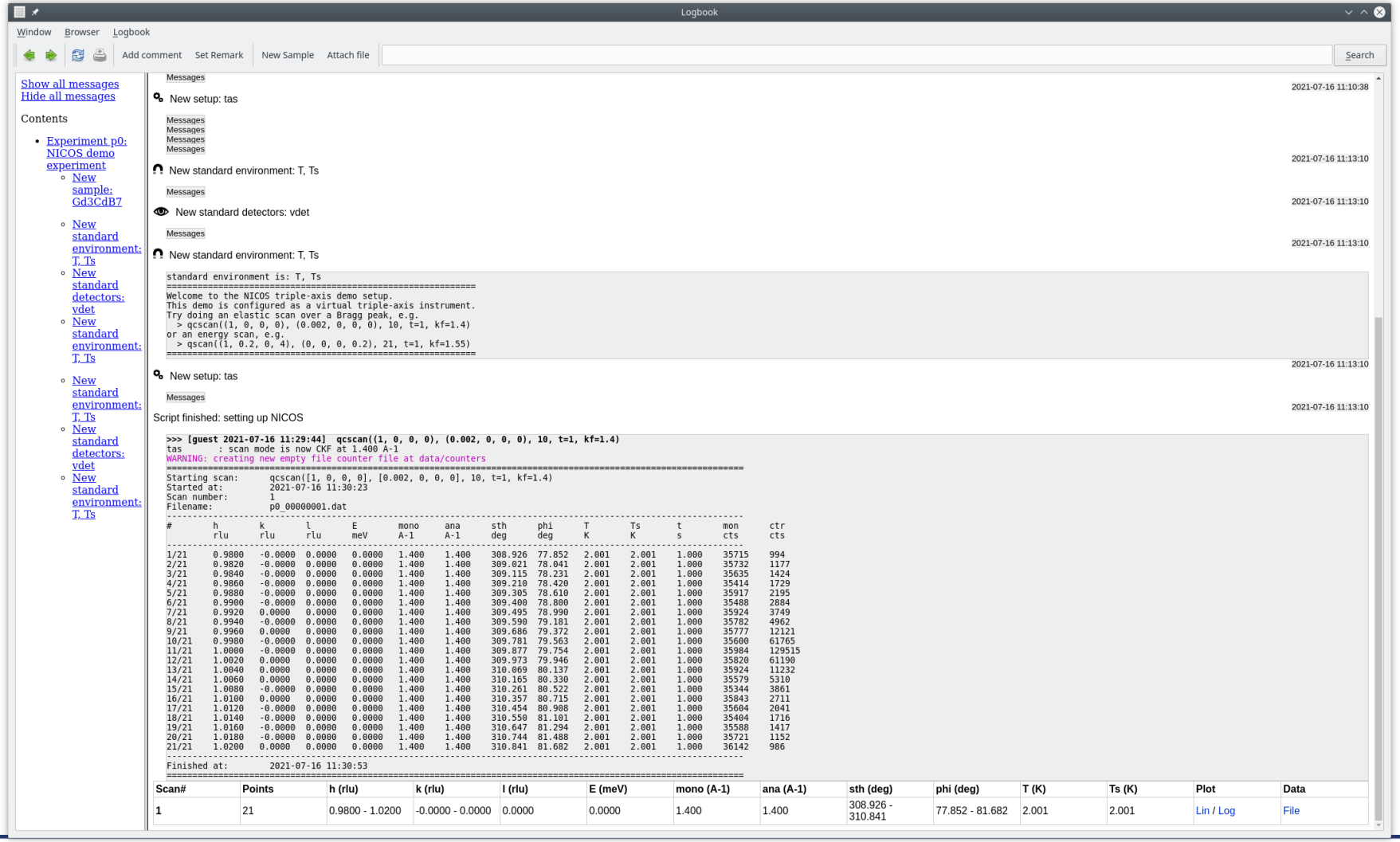

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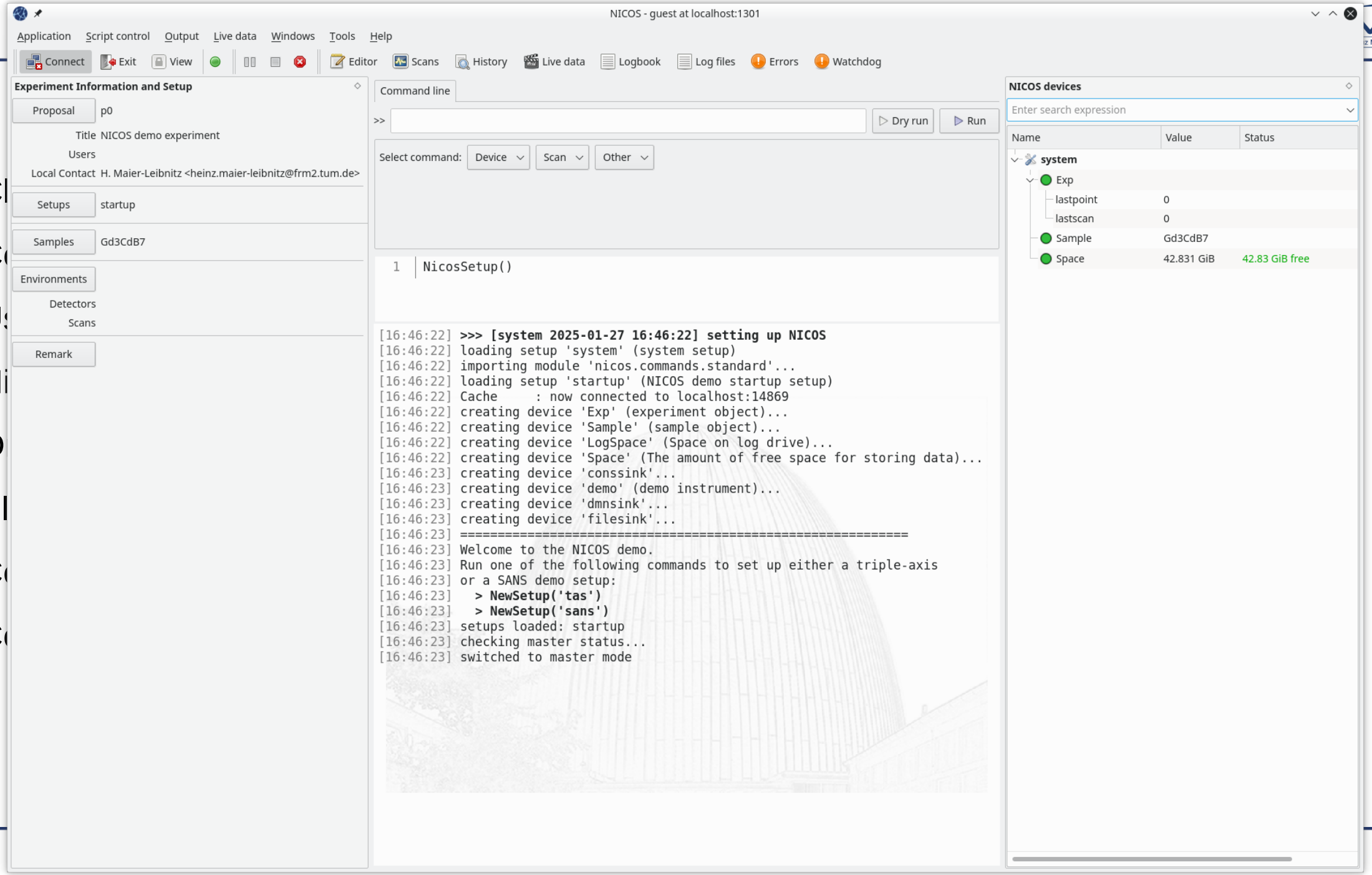

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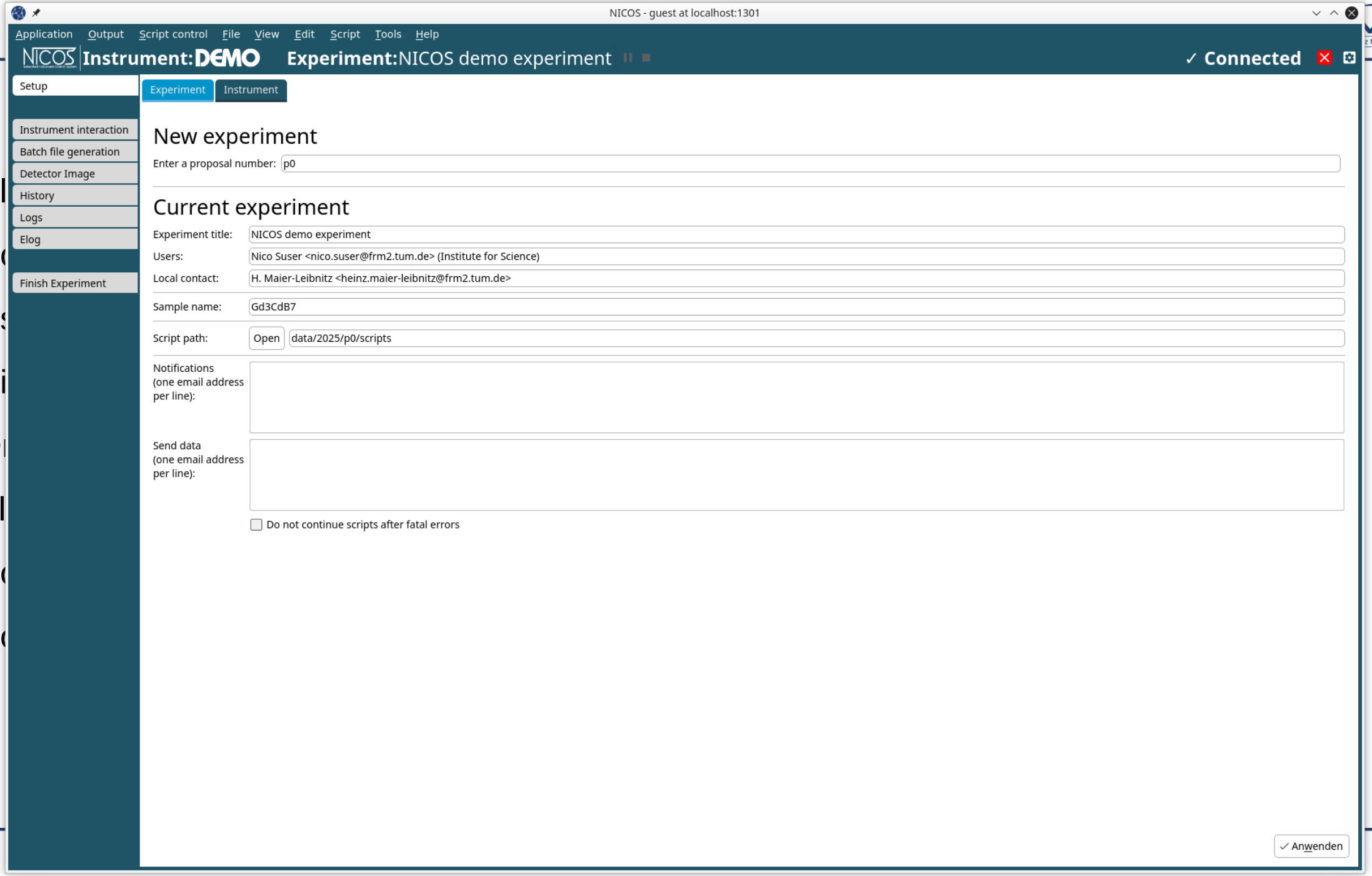

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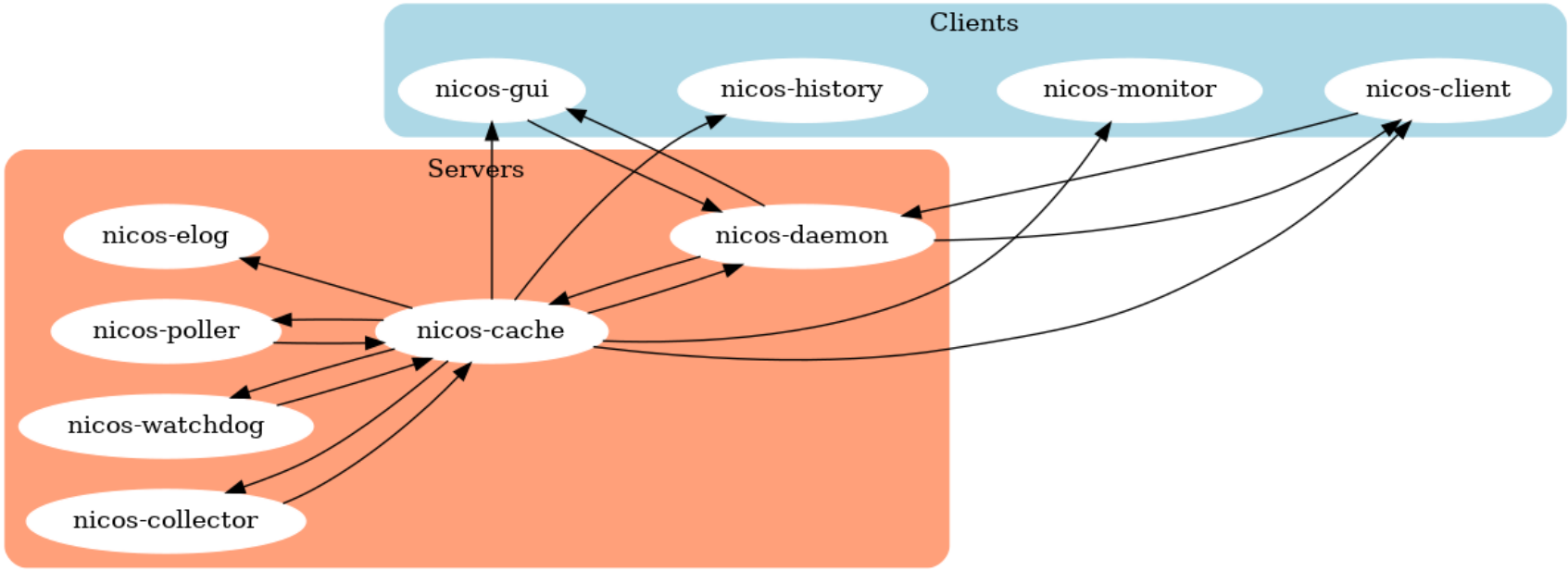
- Configurable and dynamic status monitor
- Configurable and dynamic
- Extendable by custom panels

Components


Clients
nicos-gui
nicos-history
nicos-monitor
nicos-client
Servers
nicos-elog
nicos-daemon
nicos-poller
nicos-cache
nicos-watchdog
nicos-collector

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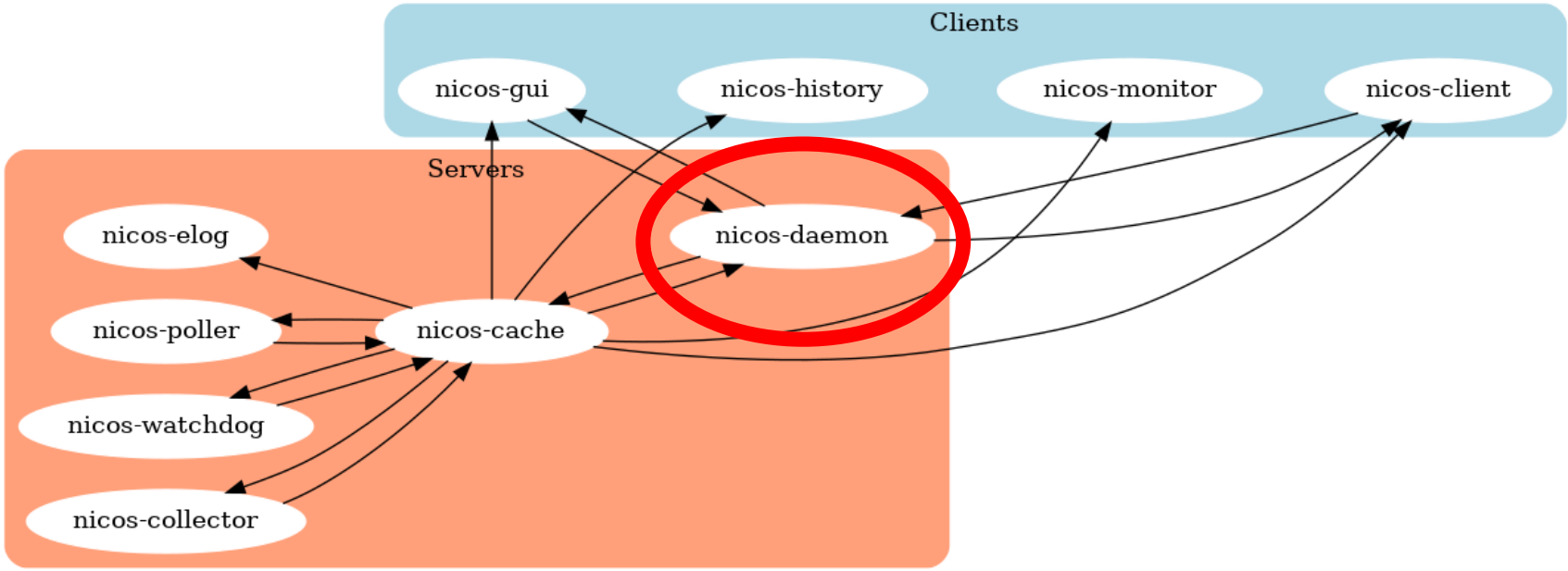
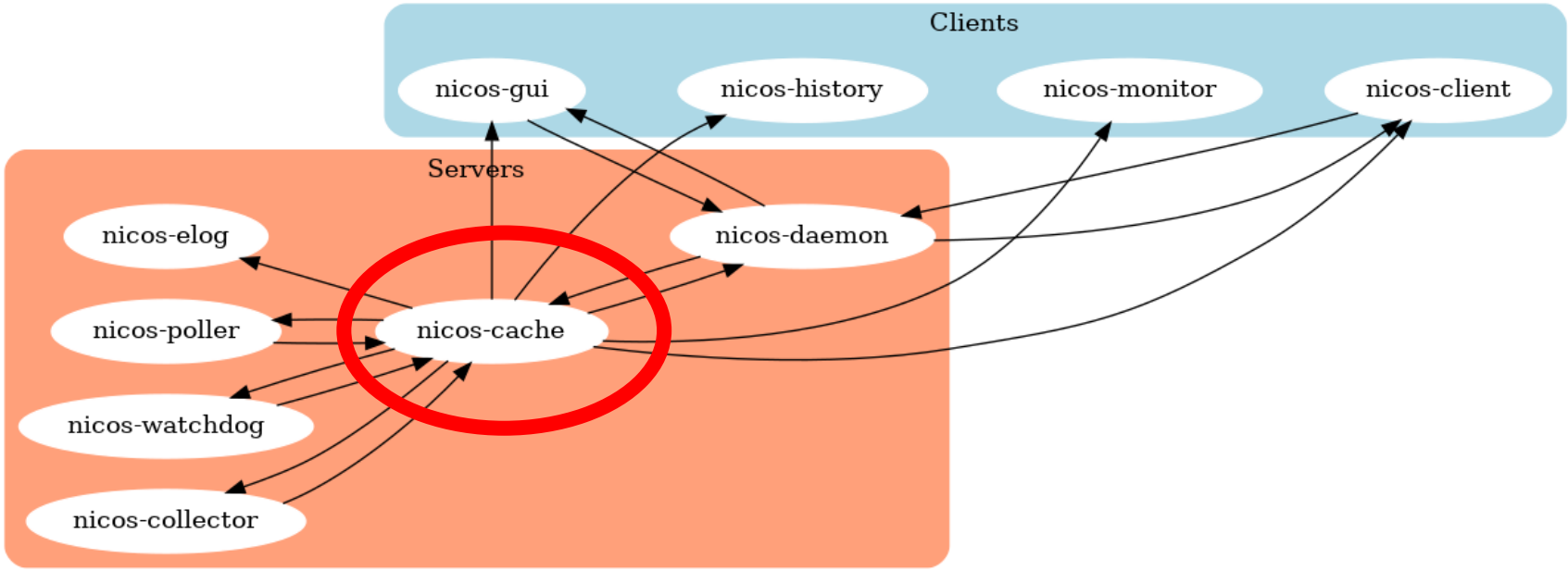


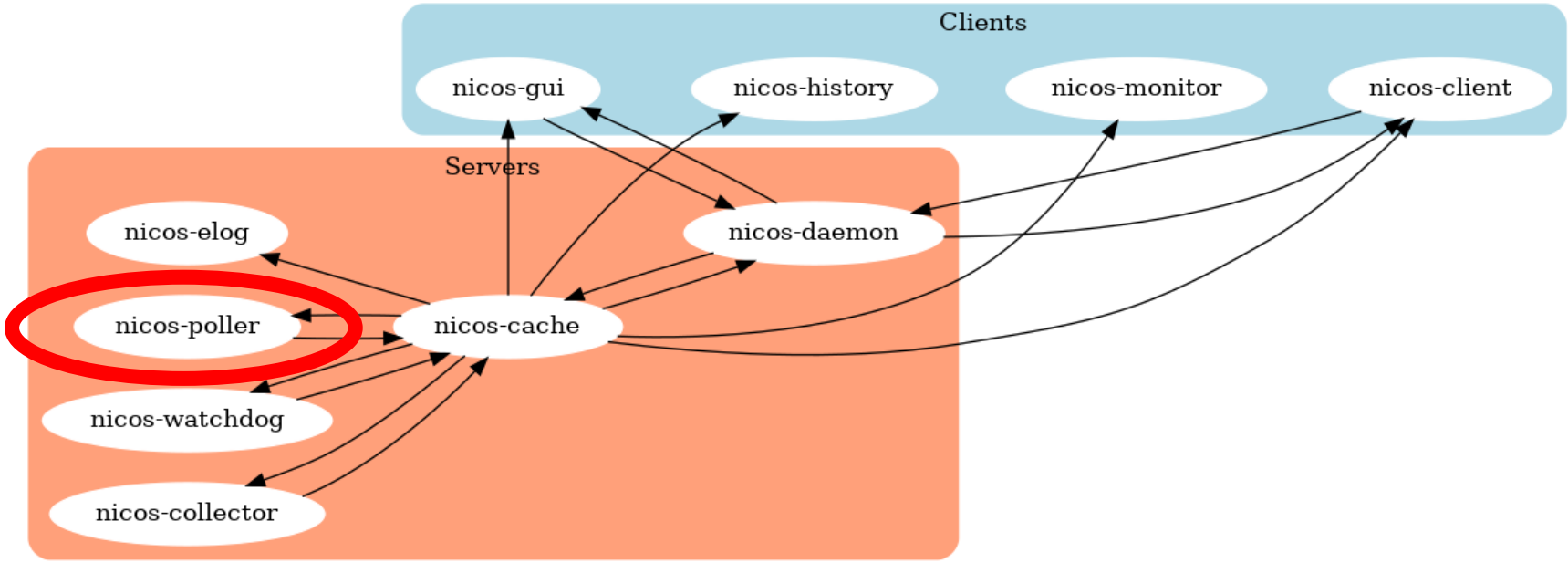
- Execution daemon: executes user input

Components



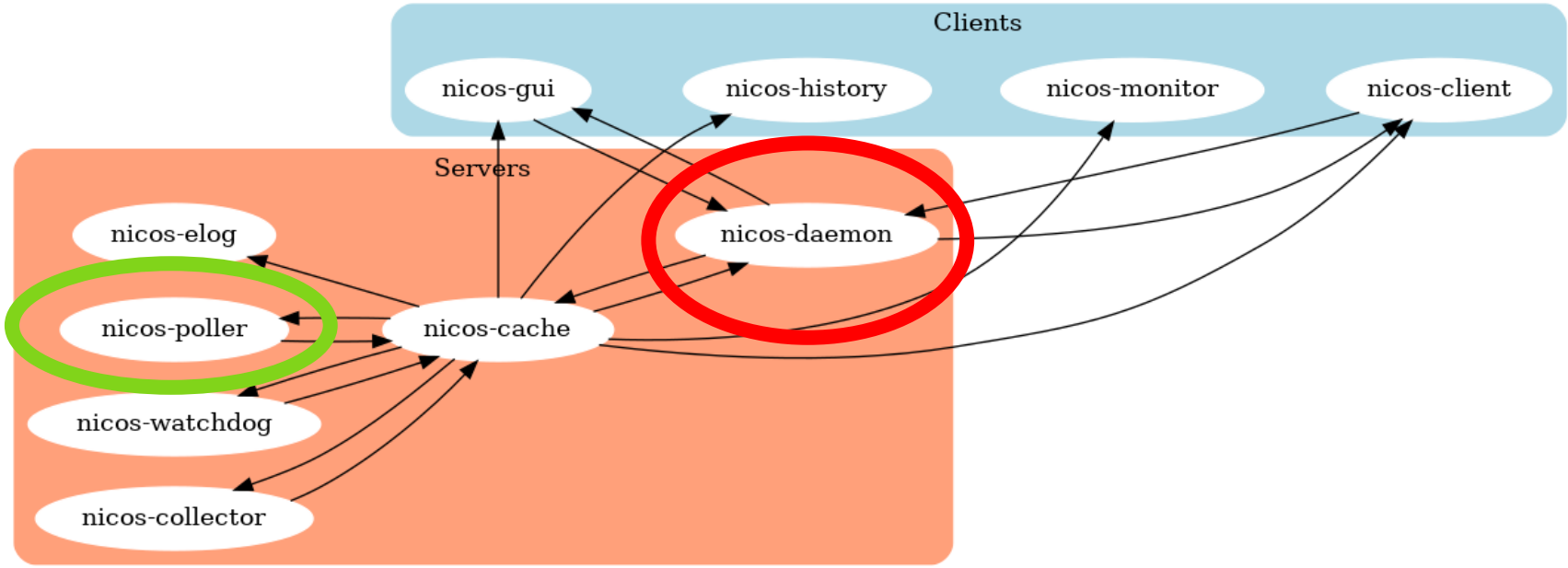
- Cache: save states/values/parameters, pushes value/state changes

Components



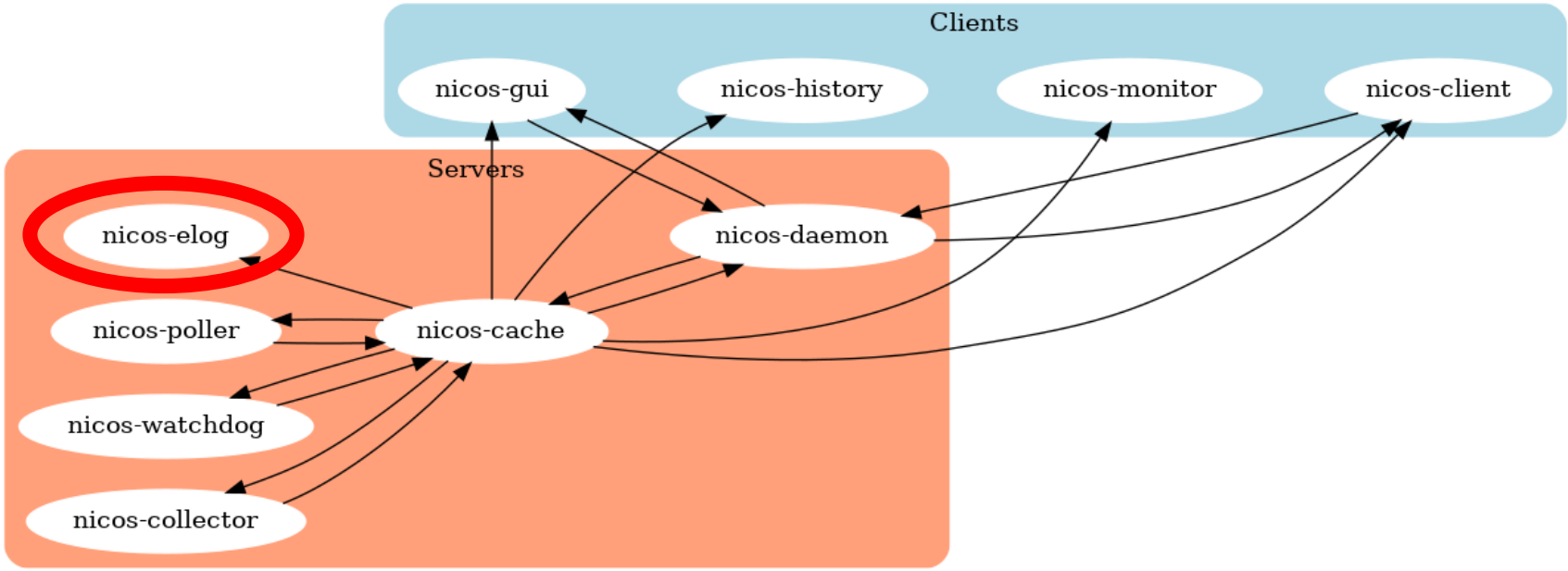
- Poller: fetches periodically values/parameter/states from devices

Components



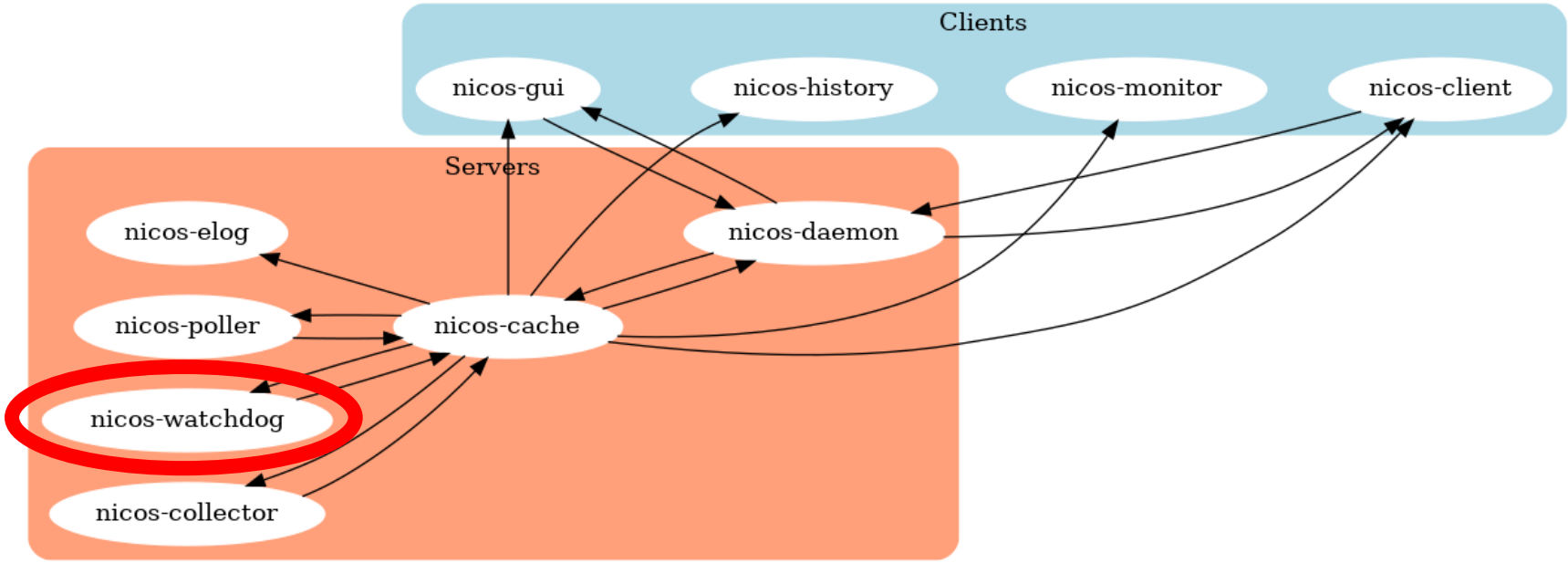
- Daemon and poller (read-only) interact with hardware

Components



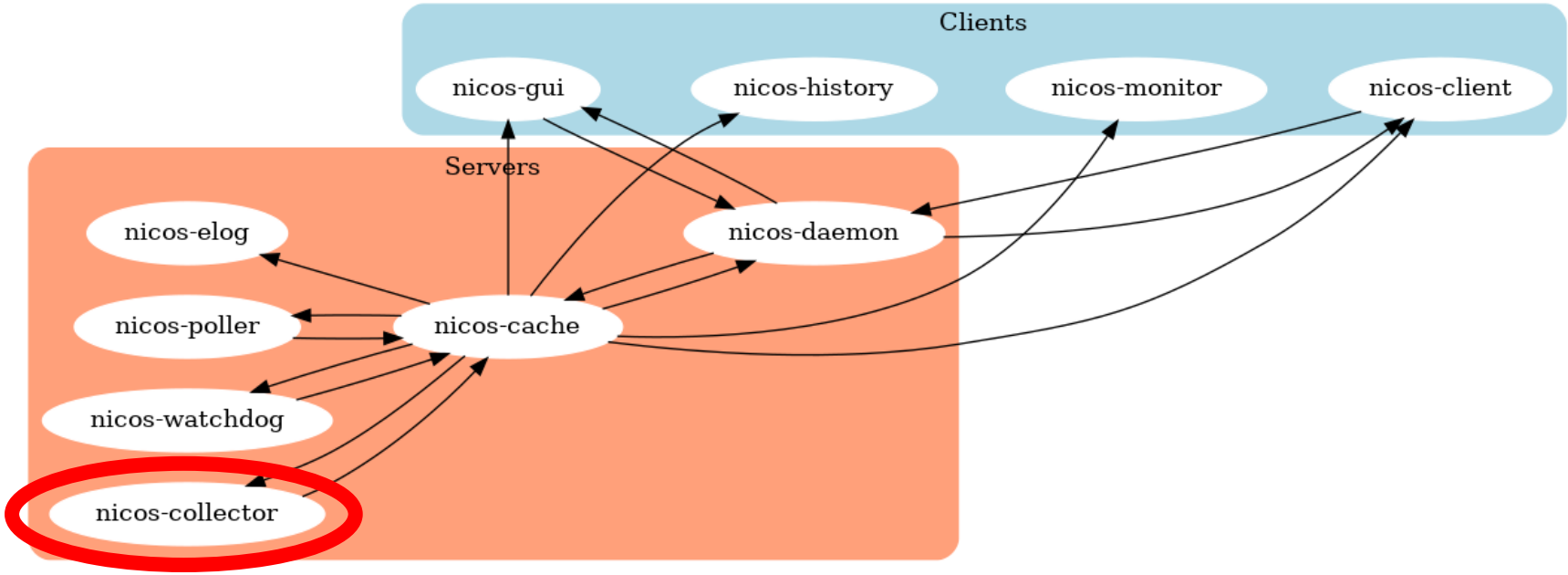
- Electronic logbook: experiment history in user friendly form (ASCII, HTML, external „ELN“, ...)

Components



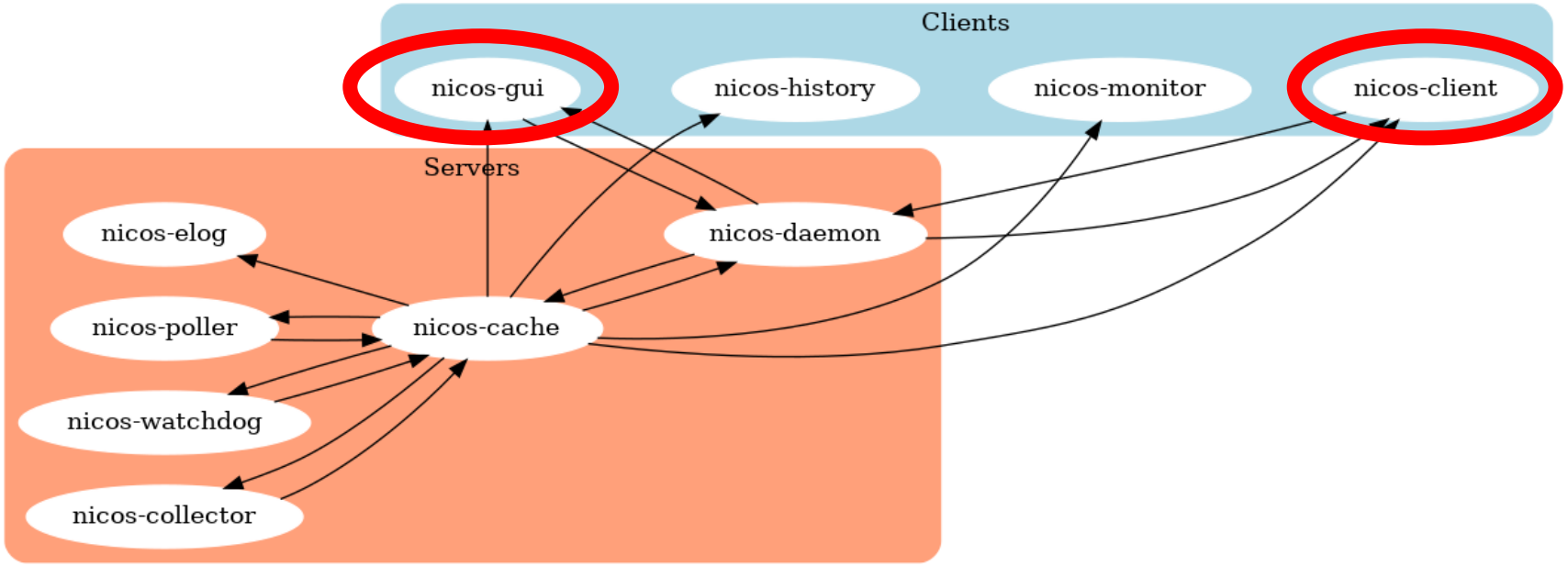
- Watchdog
  - Check for events and send out alerts (Email, SMS, Slack, …)
  - Configurable conditions

Components



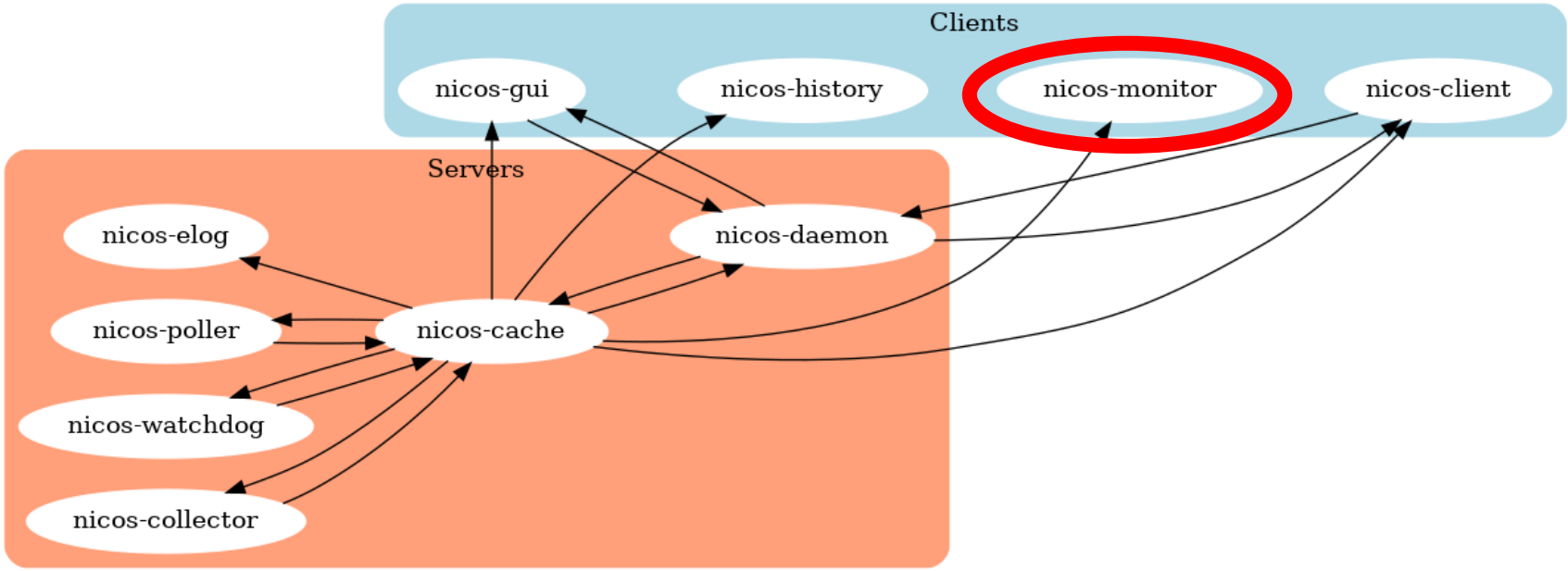
- Collector: transfer data to/from other cache(s)

Components



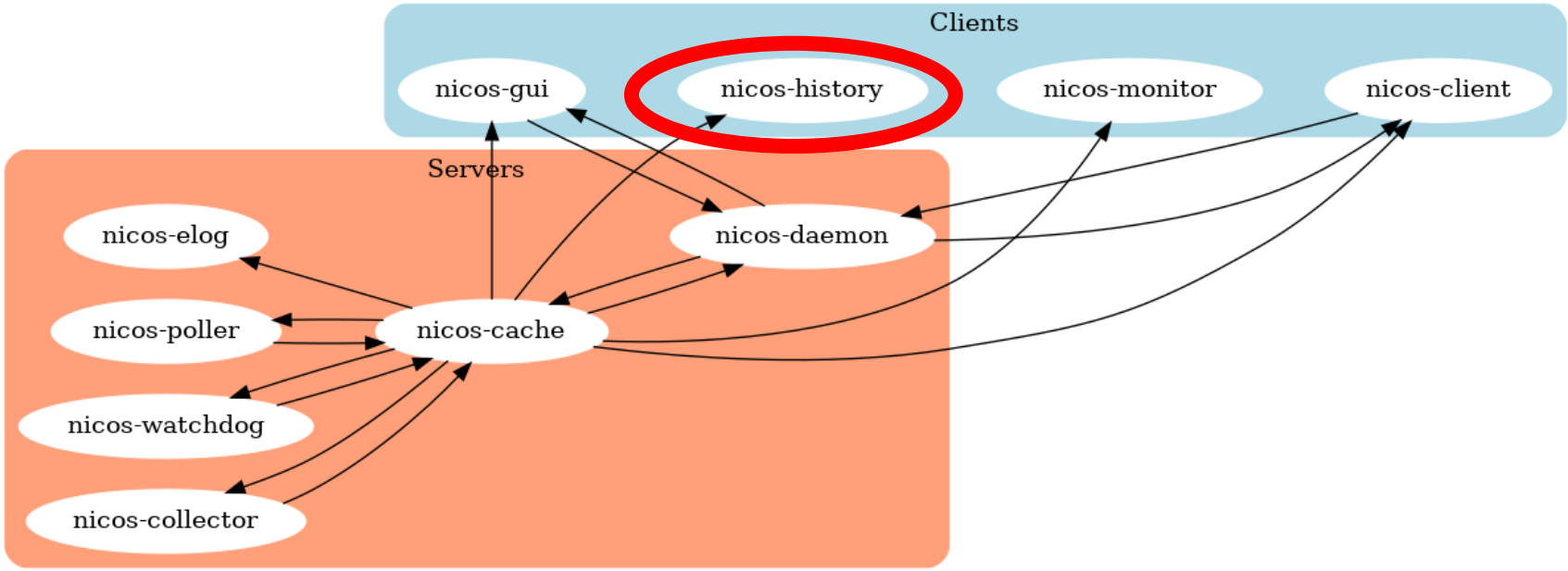
- GUI/client: user interaction

Components



- Monitor: Display status/value/parameter of devices
- Qt and HTML version

Components



- History: Display archived date depending on time

Development

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- Git as version control system

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- Test suite to catch regressions before integrate changes into source

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- Readonly copy on GitHub: https://github.com/mlz-ictrl/nicos

Some reasons to use NICOS at BNC

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  - MLZ 25 instruments + 5 in preparation + several lab installations
  - PSI 16 running instruments
  - ESS ~10 ready to run installations (waiting for hardware and neutrons)

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NICOS in action