Commissioning ESS systems at V20
Lessons learned after 4.5 years

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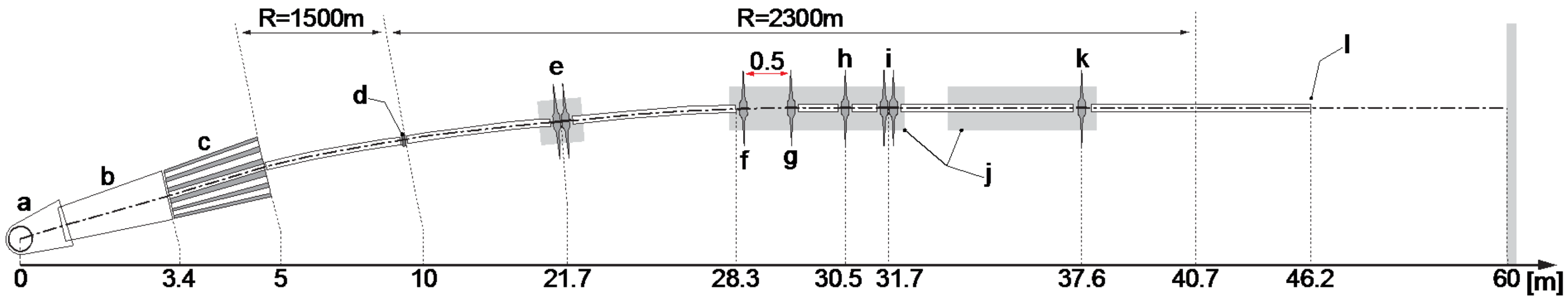
Overview

- ESS testbeamline V20
- Chopper commissioning
- Device control
- Live view
- Position scanning
- WFM stitching
- Data reduction

ESS testbeamline V20

- Dedicated test instrument for ESS
- Choppers provide the ESS pulse structure (14Hz, 2.86ms)
- Additional pulse shaping choppers provide Wavelength Frame Multiplication (WFM) option

- ➢ Experimental test case for “Long pulse”-instrumentation with FLEXIBLE SETUP
- ➢ Develop/establish procedures and data reduction before ESS start
- ➢ Dedicate time to develop new methods



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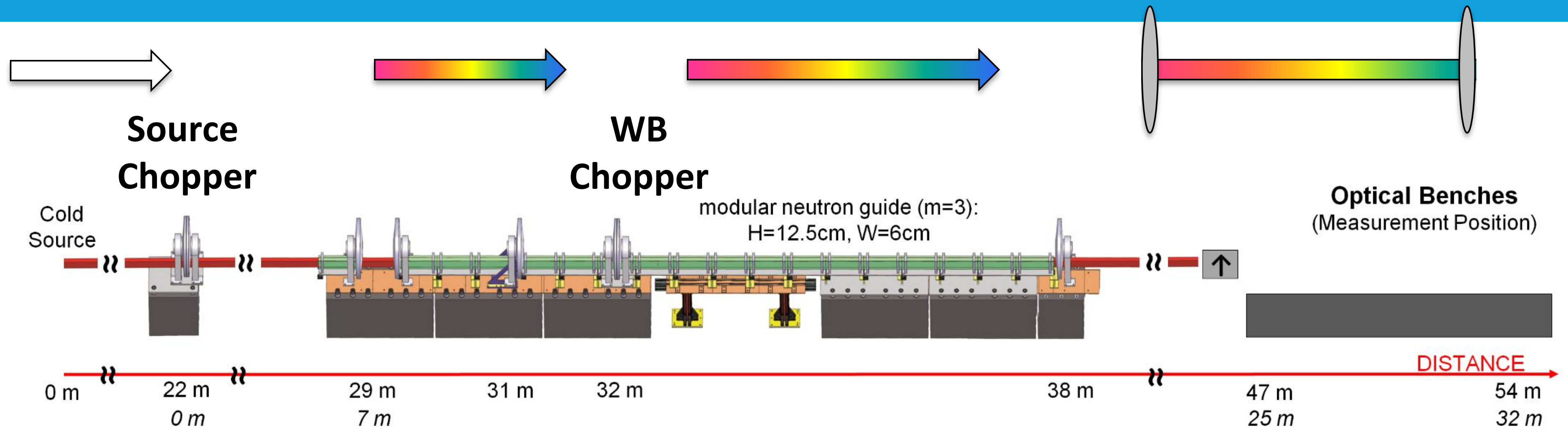
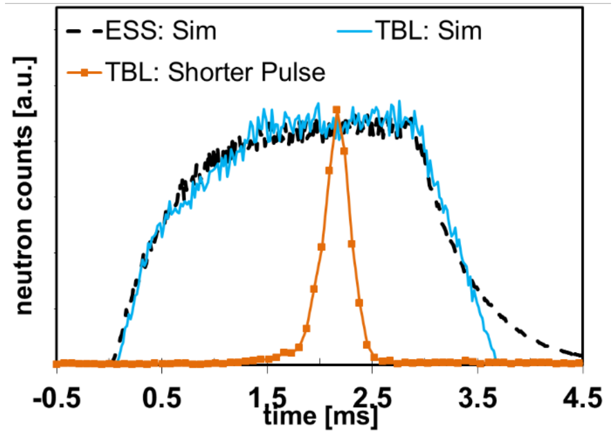
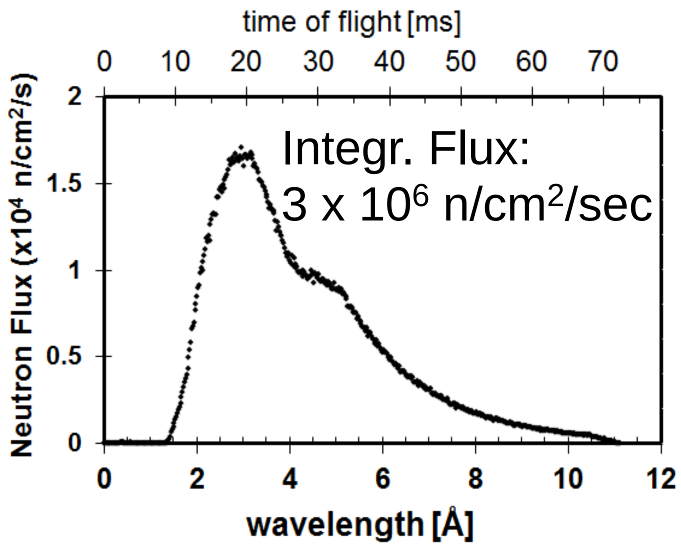
ESS testbeamline V20

The chopper system





Flexibility!
→ *Vitess & McStas model available*



Repetition: variable

Wavelength resolutions: 4%-23%
0.7%-3%

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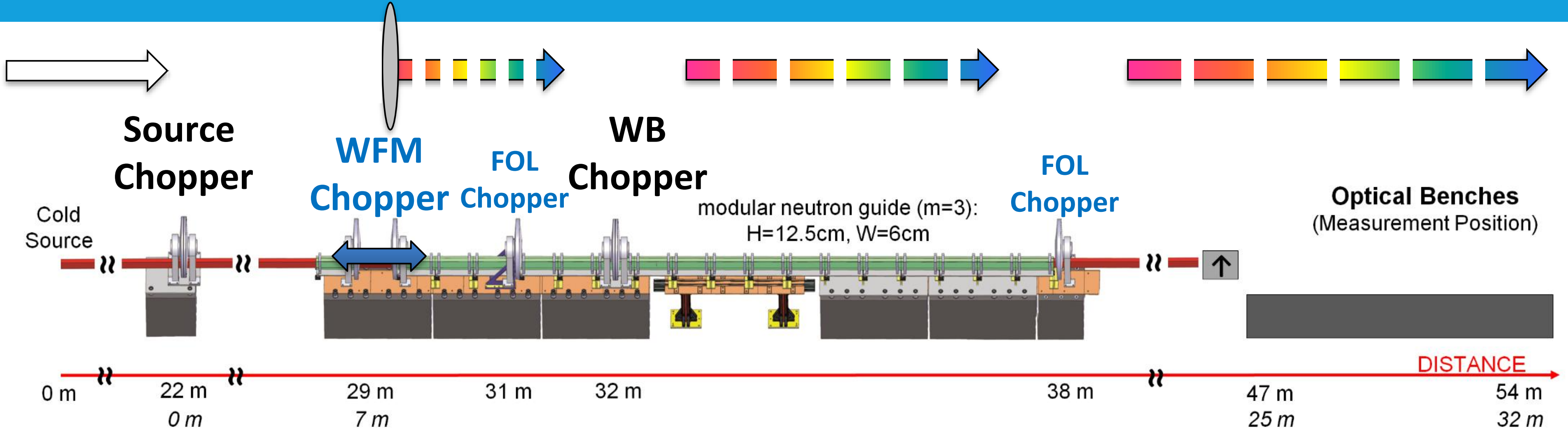
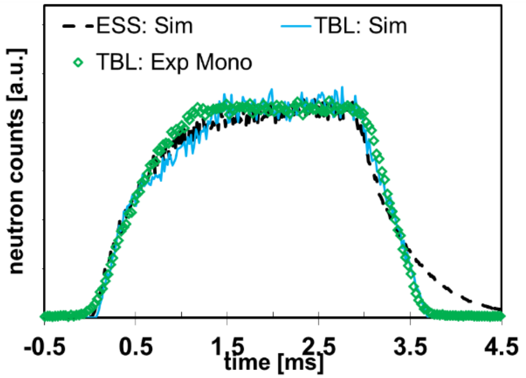
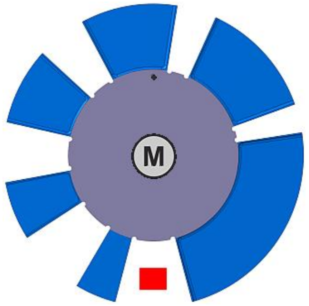
ESS testbeamline V20

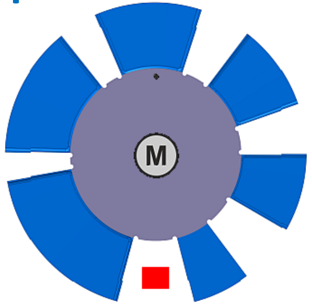
The chopper system

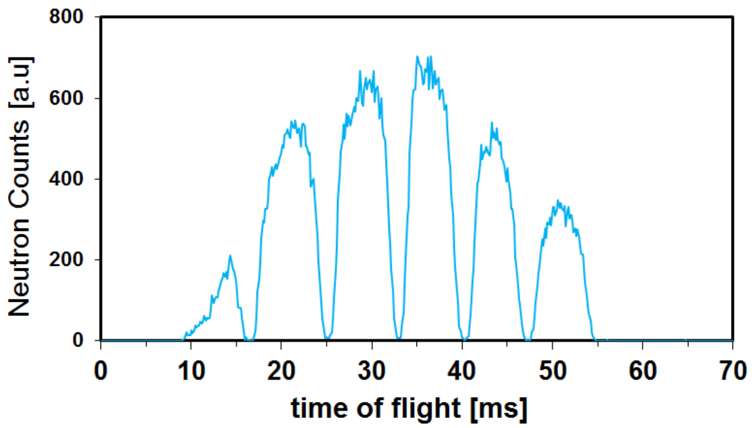






Optical Blind Mode





Tunable (but constant)
Wavelength resolutions: 0.5%-2%

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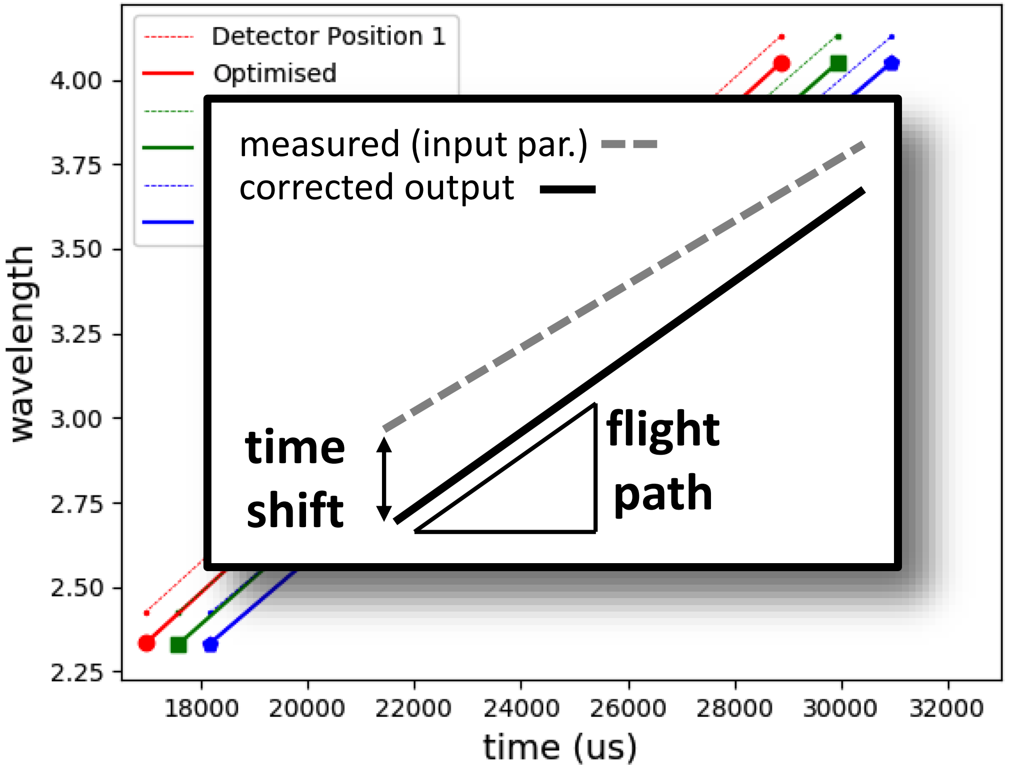
Commissioning of a Multi-Chopper Instrument

Calibration routine in python with data measured at V20

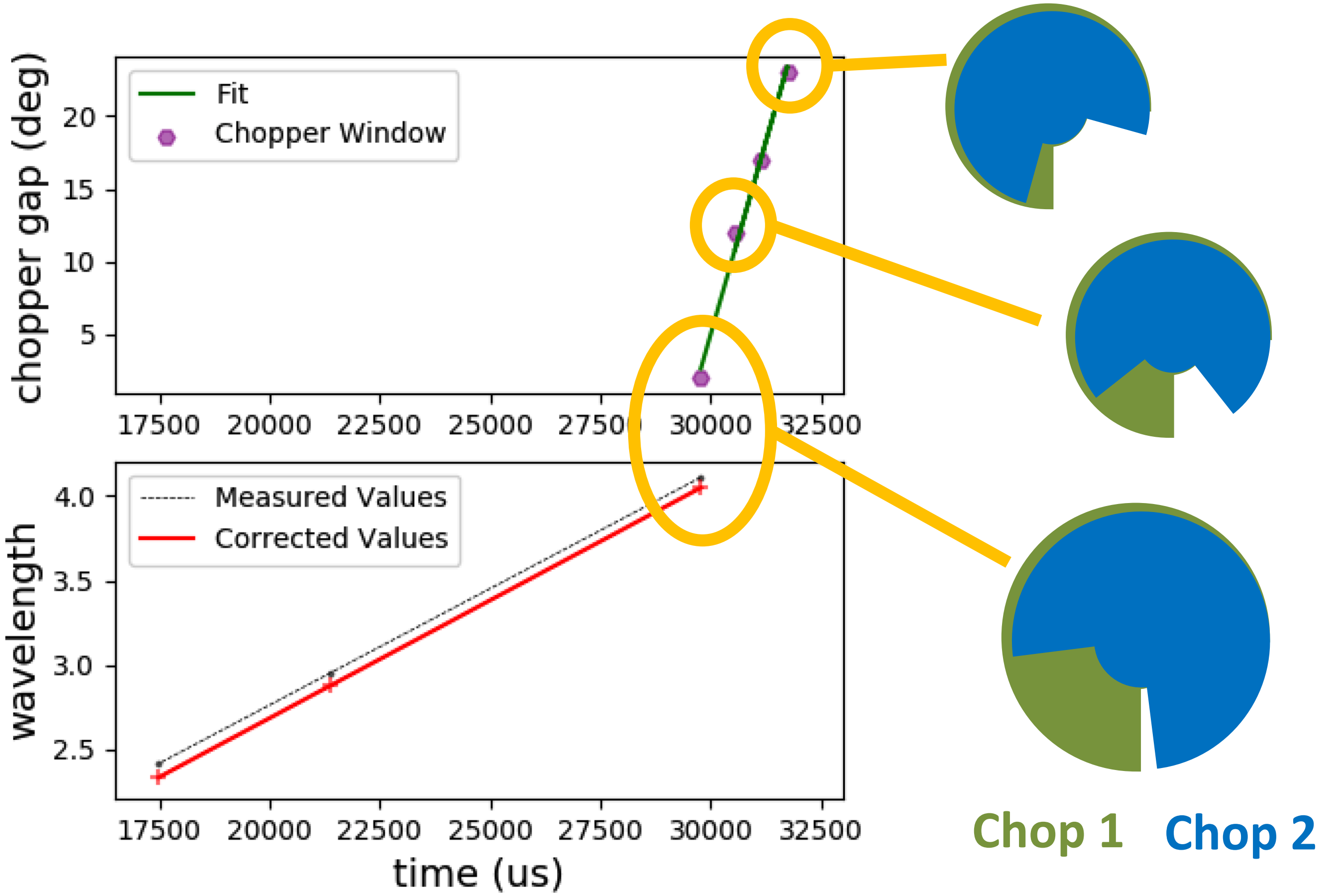
Transmission setup to calibrate

1) Flight Path
2) Time shift:
   - Electronic Delay of DAQ
   - Centre of Signal

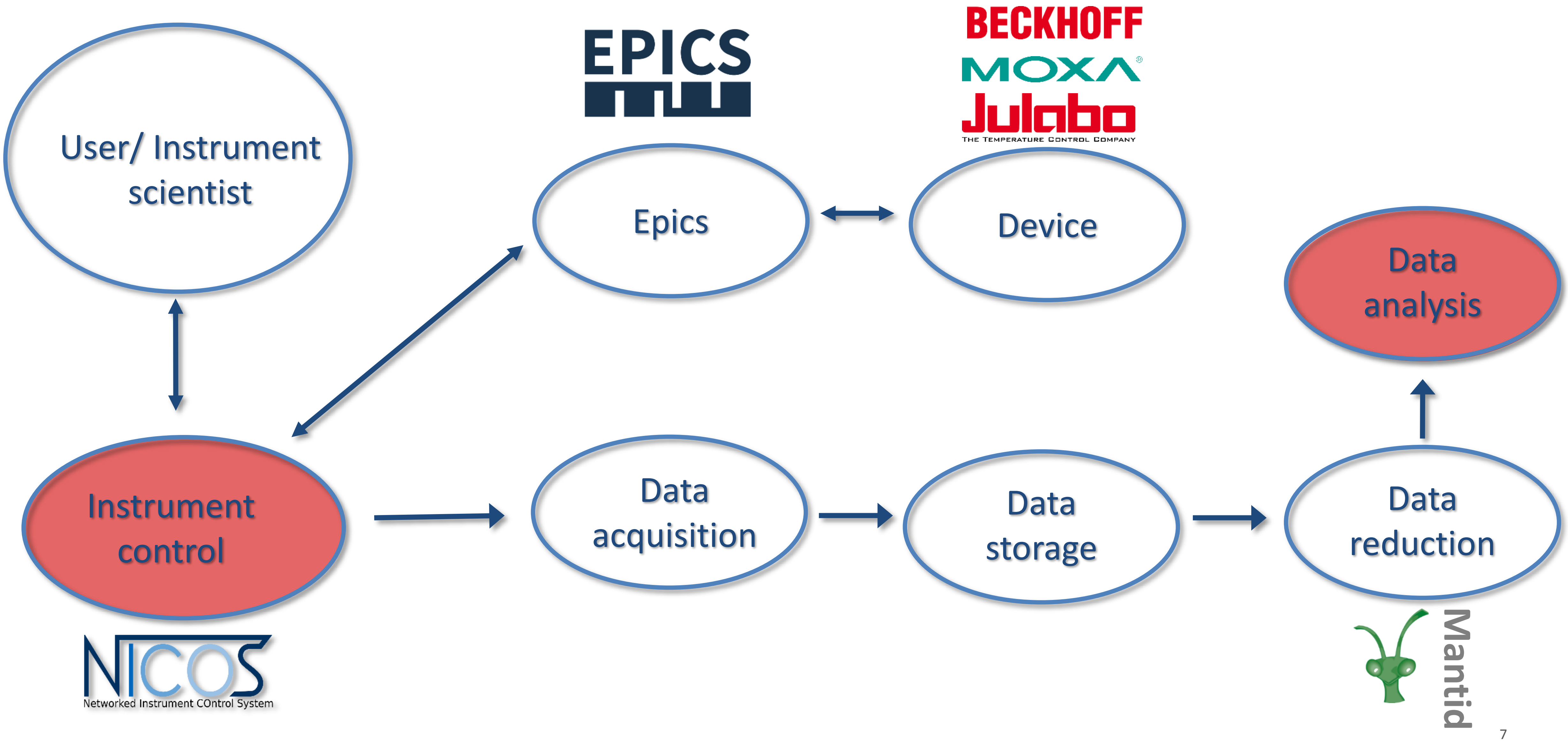


Chopper Mode Calibration

- Shapeable source pulse at V20
- Signal as function of chopper opening



ESS testbeamline V20



ESS testbeamline V20

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Experiences as V20 instrument scientist:

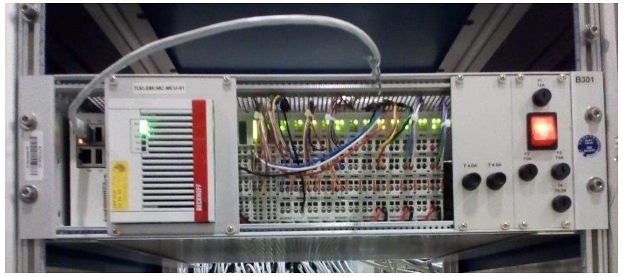
- Sometimes unclear workflow if a problem occurs:
  - ➢ Writing a Jira ticket (too slow during a measurement)
  - ➢ Where is the error?
  - ➢ Who is responsible for solution? DMSC, MCAG, BCG, ICS, …?
- Integration of custom/user equipment sometimes challenging:

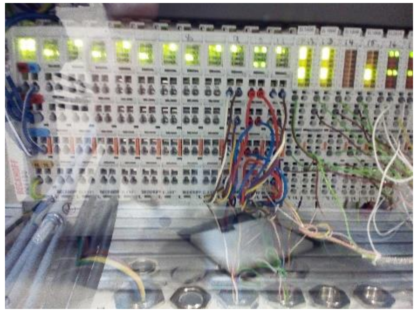
Working with DMSC (BCT/ECDC) over a sustained period has been beneficial for all parties!

Networked Instrument COntrol System

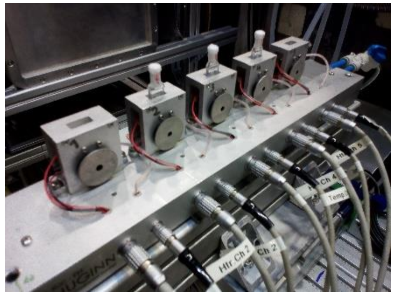
Device control

✓ Motion control
- 2 Beckhoff crates (12 motors)
- Slits, linear and rotation stages



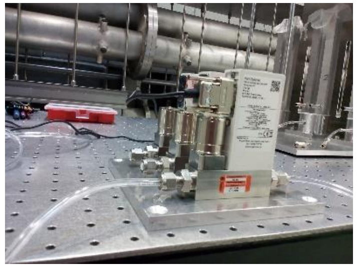


✓ Temperatur control
- Huginn SANS cuvette holder



✓ Moxa boxes + HV supply

❑ Gas flow control
- Bronkhorst flow meter



Implemented devices worked reliable

Live view

DaQuiri and NICOS

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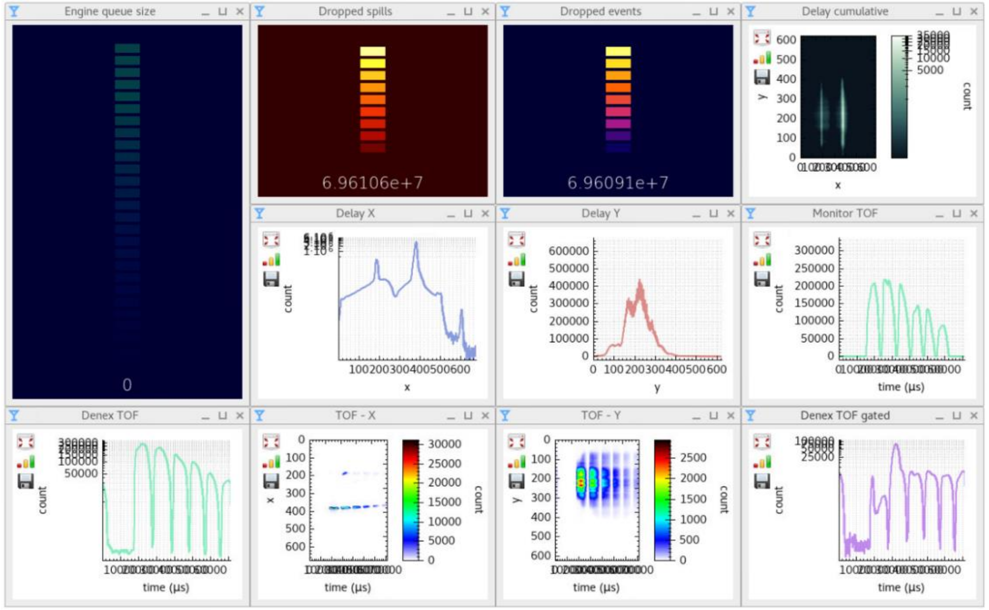
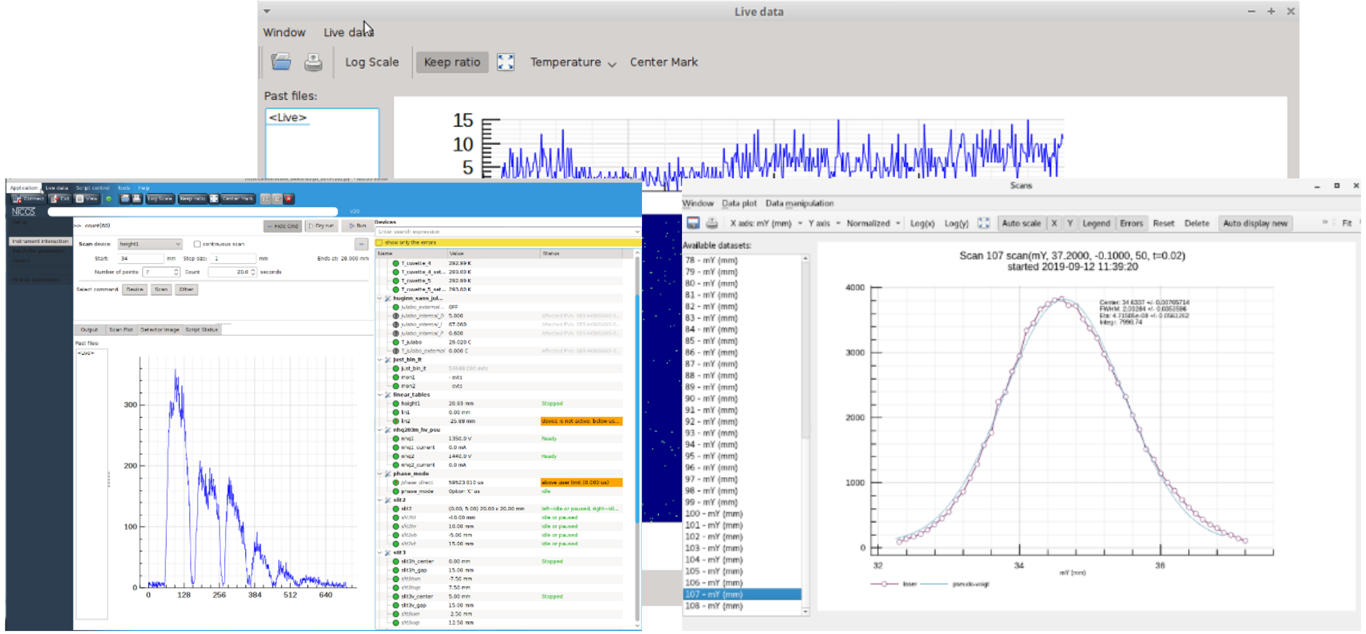




- Provided by DMSC for detector commissioning at V20
- Adjusted to reflectometry

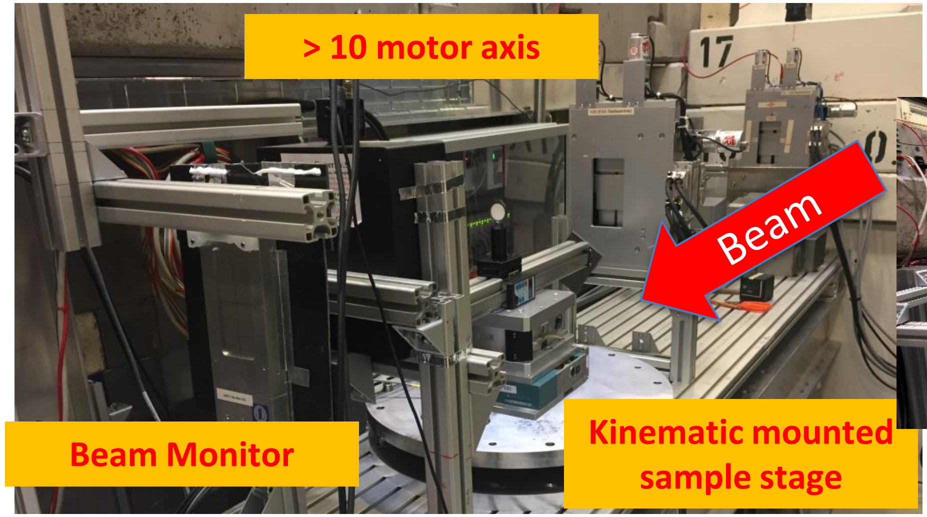
→ Worked well for these experiments

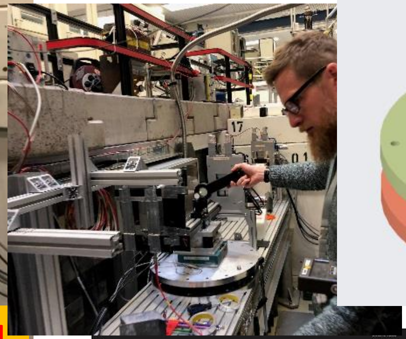
- Instrument data included
- Scriptable (e.g. scan motor position vs counts)
- Fitting without external program

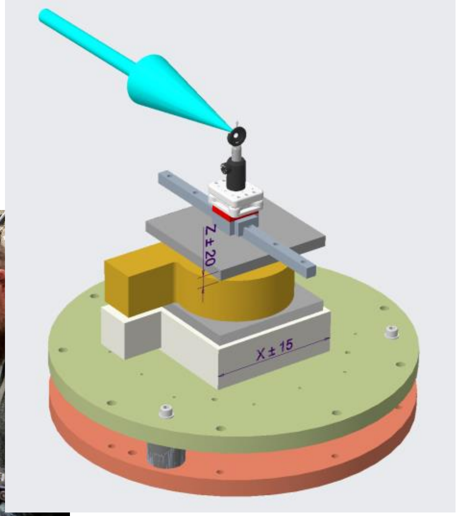
Iterative process between user and developer

Position scanning
Timing requirements

- Beam Scanning and Sample Alignment experiment in April 2019
- Continuous movement of pinhole requires time stamping of motor positions with precision that is sufficient to normalize to the incident beam flux (that varies due to the pulsed beam structure).







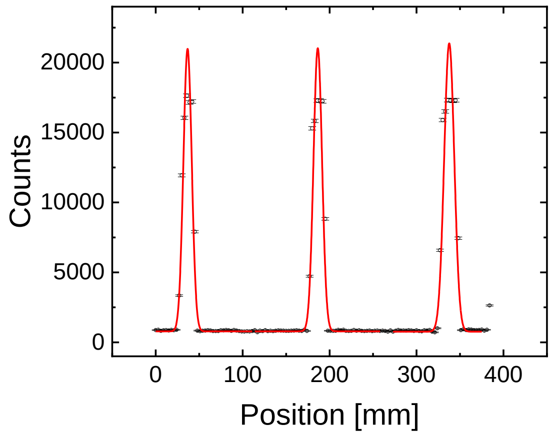
Technical solutions being discussed as outcome from this experiment

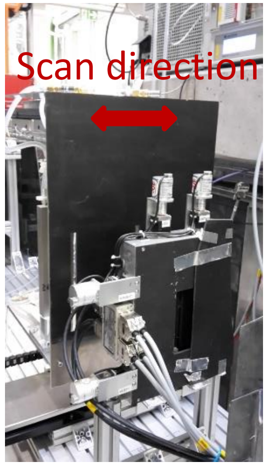
What other use cases?

- Sample alignment scans
- Imaging: tomography
- SE requirements
- …

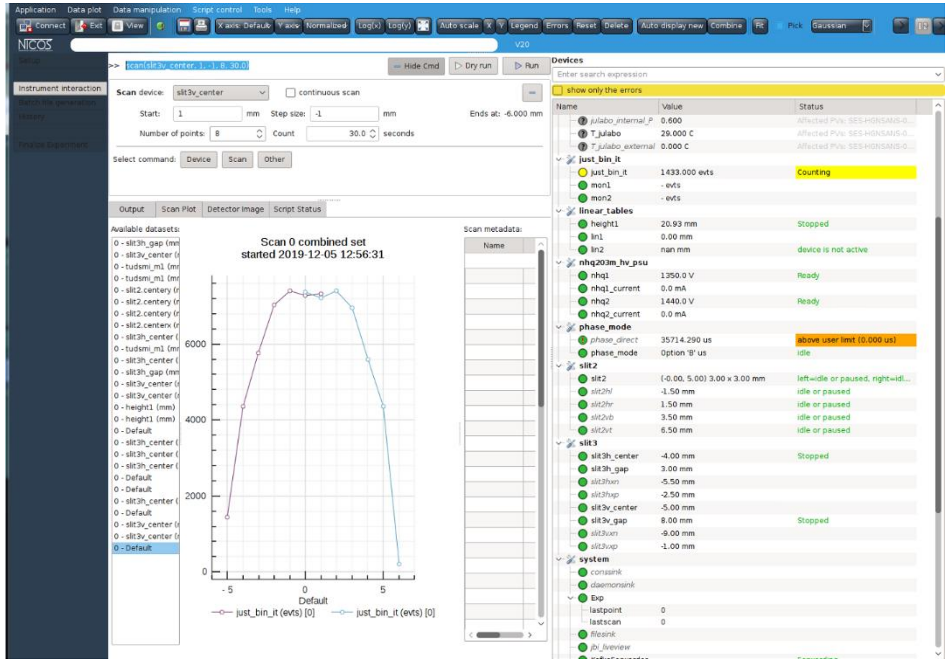
Position scanning
Development

- Beginning 2019
  - Scans were done manually via a script
  - No live view
  - Fitting was done with an external program



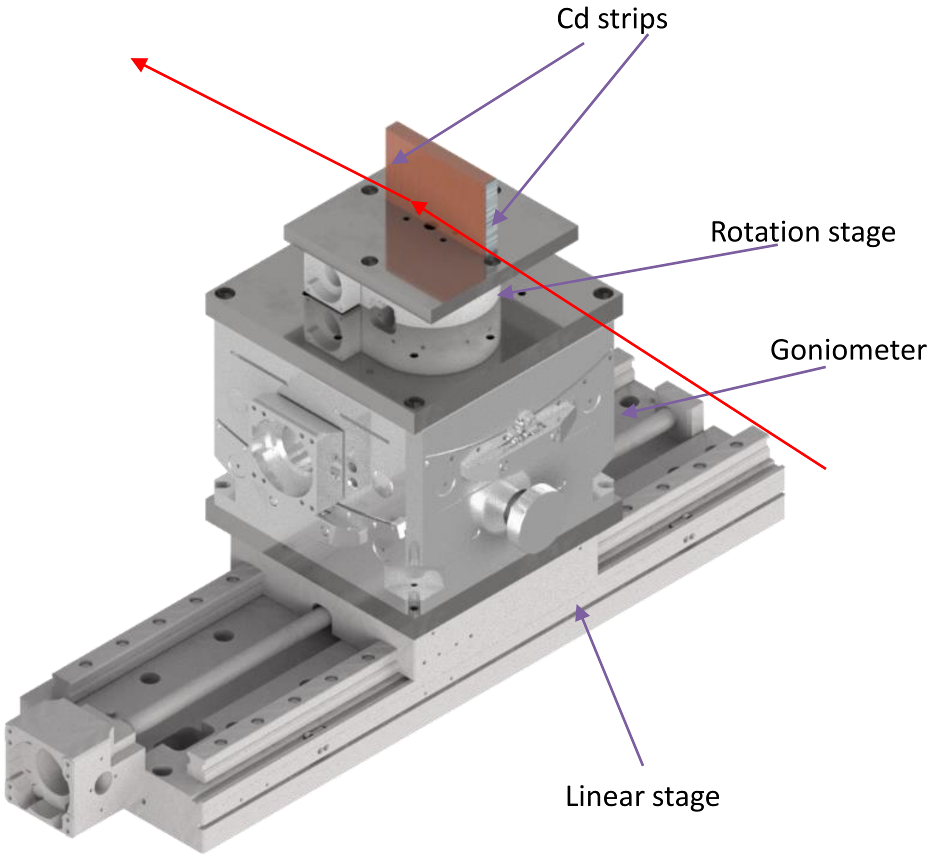


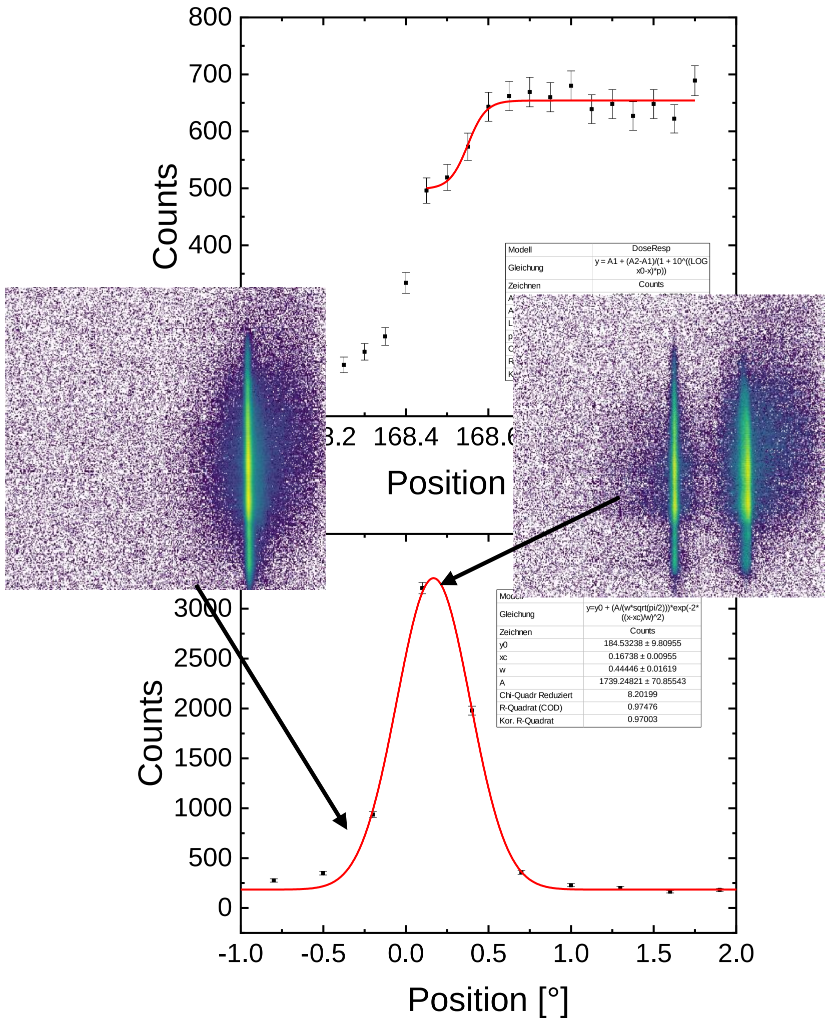
- Mid 2019
  - Implementation in NICOS
  - Live view point by point
  - Simultaneously fitting
  - Live comparison
  - GUI available (no programming necessary)



Position scanning

Alignment of a sample for reflectometry





Total detector counts vs motor position

- Si almost transparent for neutrons

→ Hard to define reversal point

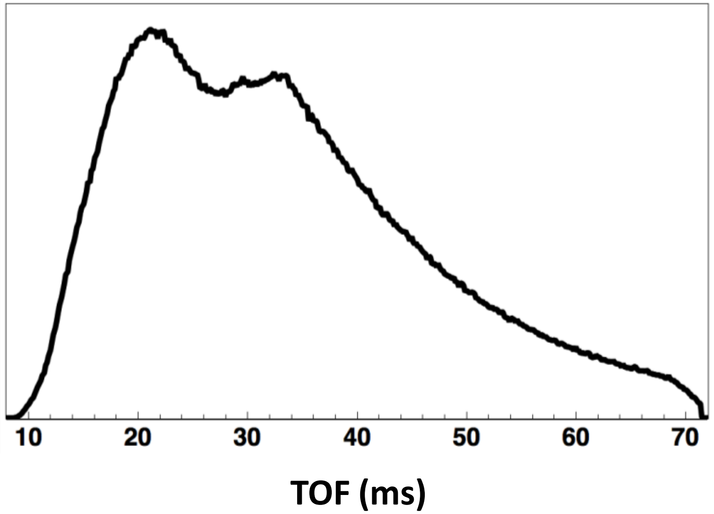
→ Rotation scan leads to wrong peak because the total reflection leads to higher total signal

Live visualization needs masking

WFM stitching
Principle

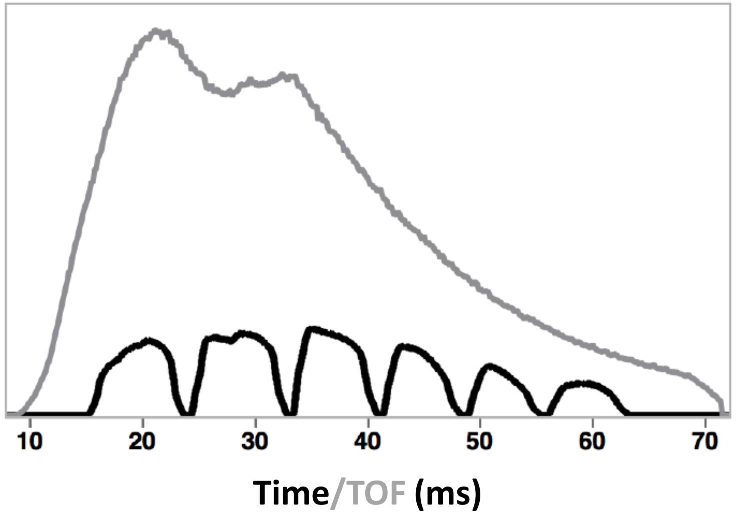
ESS pulse

→ no WFM



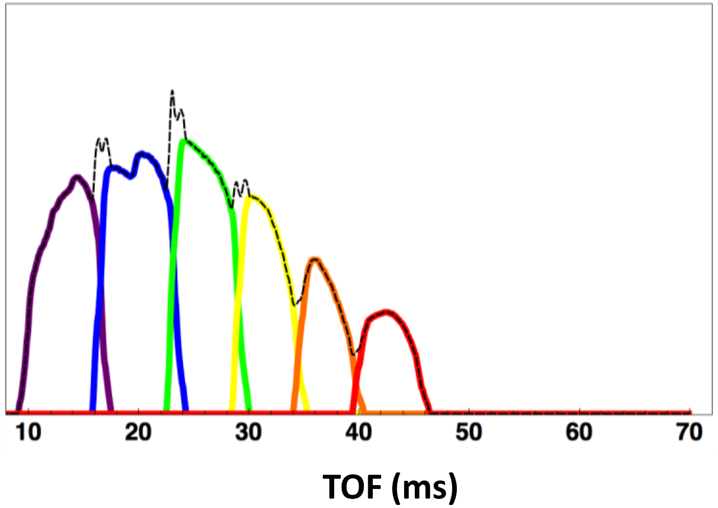
WFM (six-fold)

→ six “source pulses”



WFM stitching

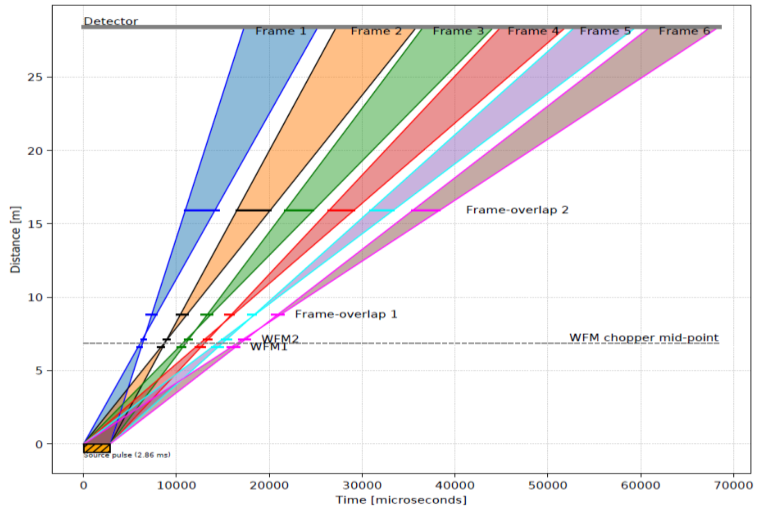
→ setting WFM parameters



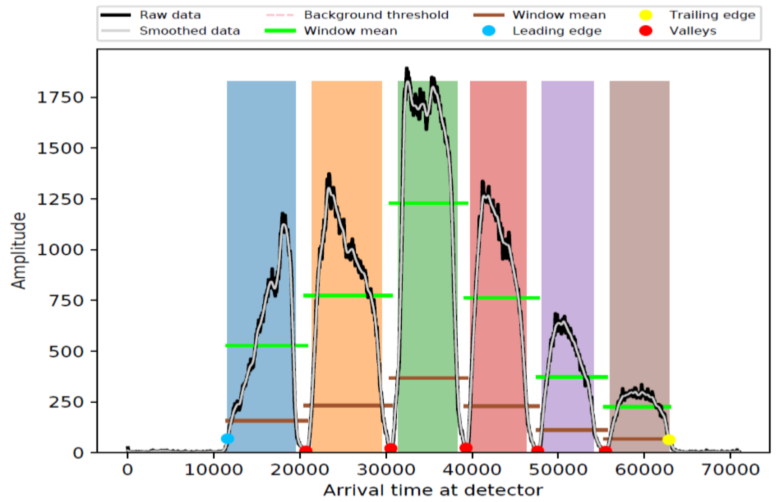
- Division into 6 subframes
- Each subframe has its own t_{zero} (computed from the chopper cut-out angles)
- All 6 frames are separated in time, but they do overlap in wavelength
- Stitching afterwards to correct real TOF

→ Still broad wavelength band but gain in resolution

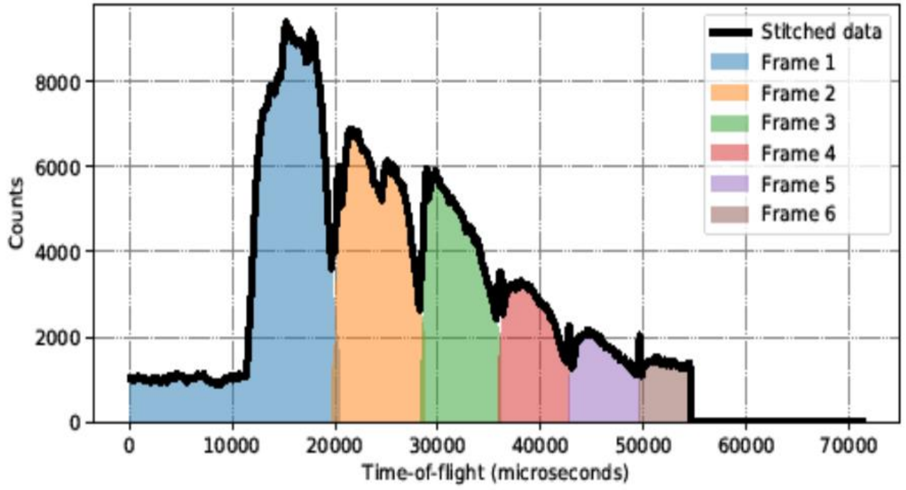
WFM stitching
Realization



TOF diagram for WFM at V20



'As recorded' TOF spectrum



'Stitched' TOF spectrum

V20 presented an ESS prototype for data acquisition in event mode

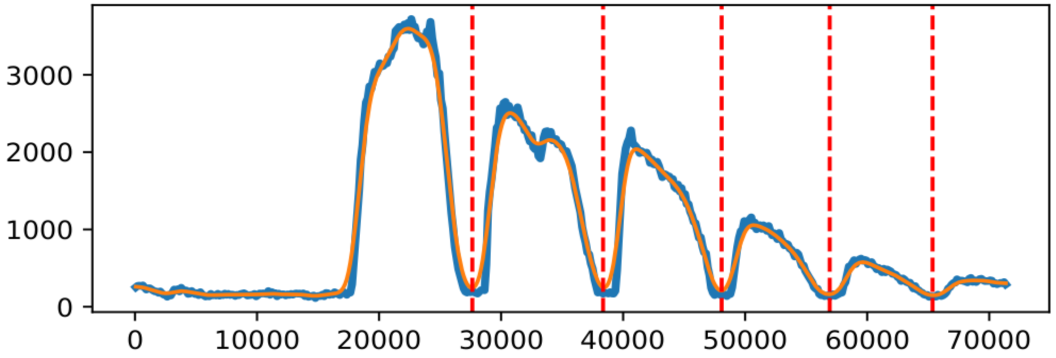
- using a centralized timing system
- timestamping all neutron events and motor movements

→ Focus on reduction of (discontinuous) WFM data into such with continuous wavelength bands

WFM stitching
histogram-based stitching

OLD: histogram-based stitching in Mantid as part of the data reduction

1. Define hard-coded frame boundaries
2. Rebin data in each frame to separate workspace
3. Apply TOF shift to each frame
4. Recombine all the frames into a single workspace



Cons:

- Need to stitch every time reduction is run
- Large memory overhead
- Need new frame edges for monitors or when instrument setup is modified
- Different reduction scripts for with and without

WFM stitching

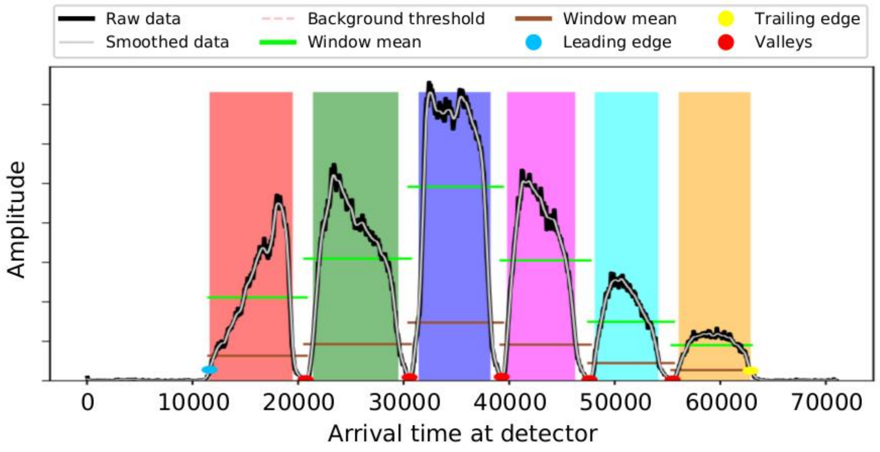
Event-based stitiching

NEW: event-based stitching as a post-processing step

1. Automatically detect frame boundaries
2. Shift the TOF of each individual event (in-place)
3. Save to (new) Nexus file

Pros:

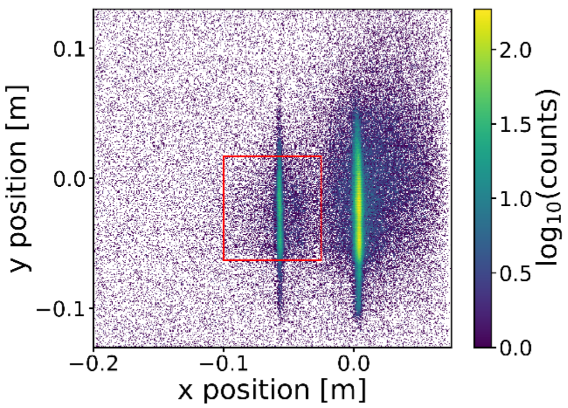
- Only stitch once as post-processing step
- Low-memory usage (reading individual events)
- Only have a single reduction script: once data arrives in Mantid, one does not need to care whether it is WFM or not



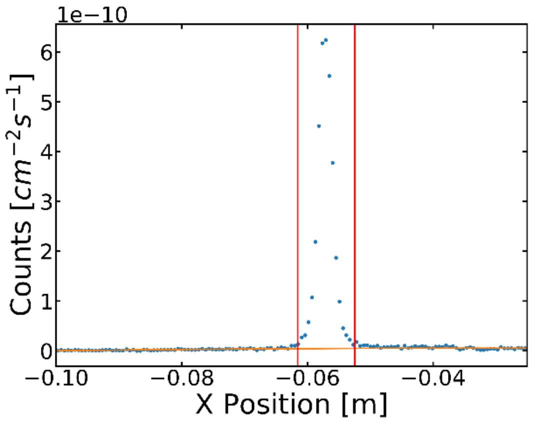
Data reduction

Reflectometry on a bare silicon block

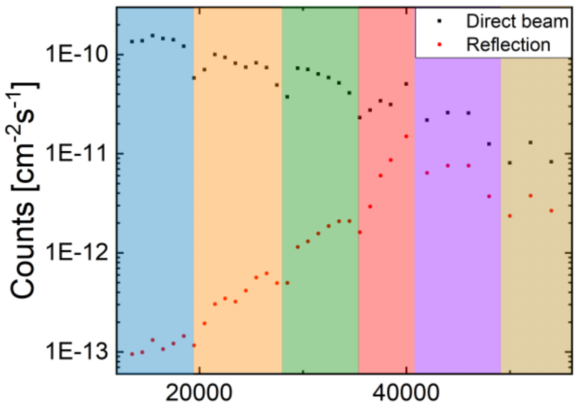
Masking

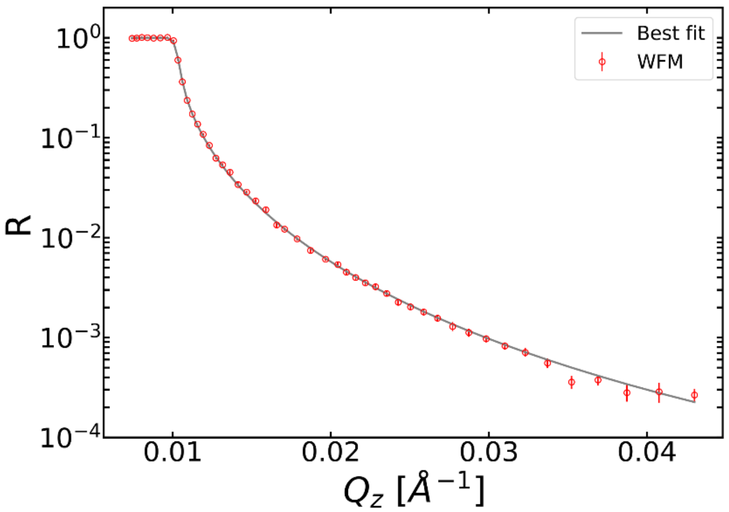


Background correction



Normalization





Reduction was completely done for reflectometry experiment

1. Masking of 2D image
2. Background correction for each individual time bin
3. Normalization to direct beam

Conclusion

V20 was an operational ESS instrument between 2015-2019

- Allowed to test – and optionally integrate – neutron components
- Vertical integration platform for ESS: emulated the infrastructure of future ESS instruments
- Data acquisition and live view
- Development of data reduction routines needed for ESS (emphasis on WFM stitching)

Involved people

EUROPEAN SPALLATION SOURCE

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