BIFROST – Integrated testing and hot commissioning

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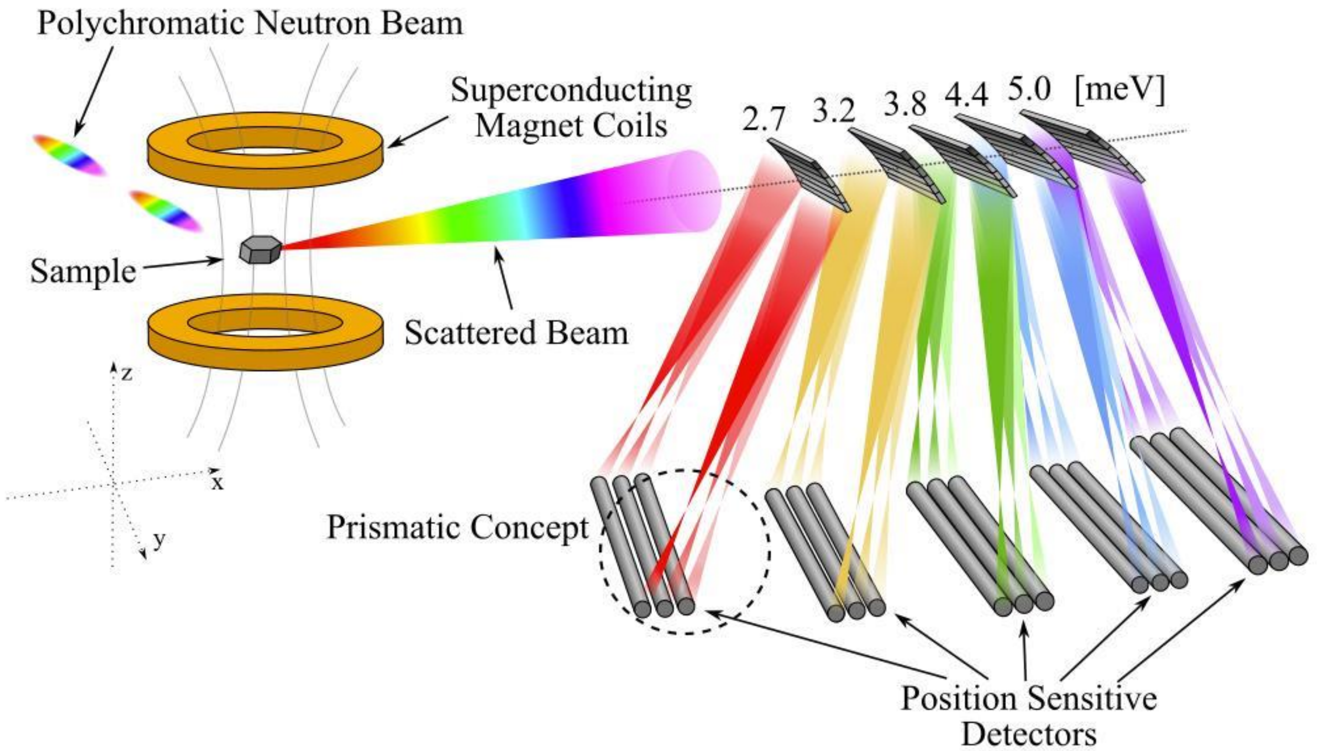
BIFROST: Methodology in time and space

Physical premise 1: The analysers reflect a known neutron energy to the detector

Physical premise 2: We know all flight paths before and after the sample

This is ensured by the design



Methodology:

- You record a neutron detection event at detector Y, position X at time t
- Coordinates X and Y gives you the scattering angle (if you know the tank position!)
- Since you know the scattered energy (velocity) and the flight path, *we calculate the scattering time.*
- Knowing the scattering time, *we can calculate the incident velocity of neutron and hence its energy*
- ***The uncertainty of the flight time determines how well we can determine this velocity***

BIFROST: Integrated testing

- From SAT tests, we knew the components worked in isolation. Minor issues were known
- The point was to test the interfaces, of which there are many
- ***For motors:***
  - Motor controller – timing system
  - Motor controller – EPICS – NICOS
  - Motor controller – EPICS – Kafka – nexus
- ***For detectors:***
  - Digitizer to RMM
  - RMM to EFU
  - RMM to reference pulse timing system
  - EFU to Kafka to Nexus
  - EFU to NICOS
- ***Choppers***
  - CHIC to reference pulse timing system
  - CHIC – EPICS – NICOS
  - CHIC – EPICS – Kafka – nexus
- ***Sample environment (not in BIFROST scope)***
  - Live visualization in NICOS
  - Monitoring cryogen levels, magnet temperature
  - Information for users in the nexus file (Sensor type, cryostat type, needle valve setting and flow
- ***Mechanical interfaces***
  - Installing sample environment (pipes, sensor cables, pumping cart
  - Limit switch information
  - ***Real*** limits of motion

BIFROST: Example 1 – divergence jaws

- Verify the you can move motors from the hutch
- That their readback values are displayed in NICOS
- That you can see and set limits in NICOS
- In this case, the TwinCAT limits are the relevant ones for NICOS, so we relinquished having a mechanical limit switch alarm (for now)
- Everything should be timestamped, streamed and stored

2.8 Verify that the positioning readback values of the right and left slit of divergence jaw 1 and slit positioning set values can be monitored and shown in NICOS

☐N/A ☑Pass ☐Fail ☐Remark:

2.9 Verify that the 4 limit switches of divergence jaw 1 (in/out for right slit, and in/out for left slit) being engaged can be seen in NICOS and that a message is displayed

☑N/A ☐Pass ☐Fail ☐Remark: No limit switch in NICOS due to TwinCAT limits - agreed by everyone

2.10 Verify that a divergence jaw 1 opening parameter (in mm) can be set from NICOS, and that the individual slit set and readback values are set accordingly

☐N/A ☑Pass ☐Fail ☐Remark:

2.11 Verify that the divergence jaw 1 opening parameter (in mm) readback value is timestamped and streamed via Kafka

☐N/A ☑Pass ☐Fail ☐Remark:

BIFROST: Example 2 – choppers

- The instrument scientist writing the test plan was not fully aware on how much work it takes to allow a fast asymmetric disc to run at a specific frequency. We changed the scope to allow 126 Hz which is the only mode of operation (max speed, always)
- This test went very well, continuous communication between chopper group and ECDC. Live visualization ready, working. Minor details to be ironed out.

Part D: Speed test with finite phasing wrt reference pulse – up to 126 Hz

Note: **Here we will put a time delay to the reference pulse to represent a phase shift at 14 Hz.**

1.8 Disc 1 (PSC-101, closest to the target) is spun at 14, 28, 42, 56, 70, 84, 98, 112, 126 Hz, disc is phased at 180 degrees and the phase error is smaller than ±1 μs FWHM.

☐N/A ☒Pass ☐Fail ☐Remark:

1.9 Disc 2 (PSC-102, furthest from the target) is spun at 14, 28, 42, 56, 70, 84, 98, 112, 126 Hz, disc is phased at 180 degrees and the phase error is smaller than ±1 μs FWHM.

☐N/A ☒Pass ☐Fail ☐Remark:

Part F: Comments by the chopper group

We agreed only to run the PSC at 14 Hz and 126 Hz, as these are the only relevant frequencies for operation.

Phase delay adjustment takes around 30 seconds

FWHM is a bad metric for error, since jitter distribution is non-gaussian and asymmetric. StdDev is below 300 ns

To-do: We need a defined leading edge of the chopper discs, to define the opening angle.

The two phase delays, in degrees, define the pulse width. The pulse mean time should be adjusted relative to facility reference pulse. Could be a potential change of NICOS variable for reasons of convenience.

BIFROST: Example 3 – sample and detector motion sys

- Motion control done by CMCA group
- Everything integrated in EPICS and tested, CMCA and ECDC continuously communicates
- Integration in NICOS very fast and painless
- Few minor bugs ironed out on the spot, but the system just works

3.3 Confirm, by testing the whole travel range, that the tank limit switches being engaged can be seen in NICOS and that a message is displayed

☐N/A ☒Pass ☐Fail ☐Remark:

3.4 Confirm the tank overtravel limit switches being engaged can be seen in NICOS and that an indication is given to the NICOS user

☐N/A ☒Pass ☐Fail ☐Remark:

3.5 Confirm, by testing the whole travel range, that the tank collision avoidance switch being engaged can be seen in NICOS and that a message is displayed

☐N/A ☒Pass ☐Fail ☐Remark:

3.6 Confirm that the tank TwinCAT motion limits can be read in NICOS

☐N/A ☒Pass ☐Fail ☐Remark:

3.7 Confirm that tank motion soft limits can be in NICOS and that these soft limits prevent the tank from moving beyond the TwinCAT limits

☐N/A ☒Pass ☐Fail ☐Remark:

4.3 Perform a cool down of the filter, and test if the temperature sensor values stabilize

☐N/A ☒Pass ☐Fail ☐Remark:

4.4 Test that a warning threshold can be set in NICOS, one one of the 5 temperature sensors displaying a warning message that the filter is about to warm up, once the nitrogen is used up

☐N/A ☐Pass ☒Fail ☒Remark: Warning will be implemented and tested before SAR

4.5 Test that as similar warning threshold can be set in NICOS for the filter unit temperature

☐N/A ☐Pass ☒Fail ☒Remark: Warning will be implemented and tested before SAR,

test postponed due to lack of rigging

BIFROST: Example 4 – Detectors

- Detector system is complex, but works
- Turning everything on involves several people
- We need to tweak some firmware settings
- Testing timing seems important
- A long term stability test would be beneficial, but not in scope
- Everyone works in unison to an impressive degree

3.11 Using a pulse generator, synchronized with the reference pulse, input signals into the R5560 with known timing, and double check that the correct timing signal is forwarded to the EFU

☐N/A ☐Pass ☐Fail ☒Remark: This is essentially a test of the RMM firmware in general, which would need more preapartion. We propose to keep the test but put it on the punch-list for being prioritized later

4.2 In as built setup: Test correct assignment of detector modules numbers, by manually disconnecting chosen detectors from each of the 3 DAC boards on the R5560

☐N/A ☒Pass ☐Fail ☐Remark:

4.3 Test/verify that the data format is as expected and written in the BIFROST ICD

☐N/A ☒Pass ☐Fail ☐Remark:

4.4 Verify the correct assignment of A and B by disconnecting selected cables from the preamps directly

☐N/A ☒Pass ☐Fail ☐Remark:

4.5 Using RP neutrons, verify the EFU debugging function, where sampling of raw (A, B) is forwarded to and received by Kafka for a fraction of the events.

☐N/A ☒Pass ☐Fail ☐Remark:

4.6 Using RP neutrons and the EFU debugging function, verify that an upper threshold for A+B can be set and works.

☐N/A ☒Pass ☐Fail ☐Remark:

4.7 Using RP neutrons, test the EFU logical map

☐N/A ☒Pass ☐Fail ☐Remark:

4.8 Using RP neutrons, test that the EFU receives data from all three rings

☐N/A ☒Pass ☐Fail ☐Remark:

4.9 Using RP neutrons, test that the tube boundaries can be set in the EFU in a way to remove spark signals from the post-EFU output

☐N/A ☒Pass ☐Fail ☐Remark:

BIFROST: Example 5 – monitors

- Monitors not ready for hot commissioning
- All the pieces are ready, most of it tested in Utgård
- Firmware ready and tested
- EFU ready
- NICOS aggregation ready
- Challenges with ring infrastructure
- Challenges with DAQ board
- A few hardware issues on the fission monitor to iron out
- Most tests yet to be made.
- Common monitor project has done an impressive job
- Everyone dedicated and self-driven to get this done

- IMO: Most of this should be done before SRR, with minor deferments until BOT

ITEM	DESCRIPTION
1	Put all 4 units in a ring
2	Test the slow control of CASCADE
3	Test the slow control of fission
4	Test backend rack UPS and PDU control
5	Modify and test R5560 firmware for Bragg peak monitor
6	Test EFU functionality for fission monitor
7	Test EFU functionality for CASCADE
8	Confirm data format for fission and CASCADE using on site DAQs
9	Verify time stamping for fission and CASCADE
10	EFU for Bragg peak monitor
11	Verify data aggregation fission and CASCADE
12	Test that aggregated data can be saved
13	Test that a 14 Hz integrated count number for fission and CASCADE can be broadcast over Kafka
14	Verify that NICOS can count against fission and CASCADE 14 Hz integrated count numbers
15	Release ICD and firmware documentation

16	Debug bit/cropping problem in IBM DAQ	e)	ECDC and DetG and ICS	BOT
17	Finalize the firmware of the CASCADE monitor	e)	DetG and ECDC	BOT

BIFROST: Example 5 – monitors

- Monitors not read
- All the pieces are
- Firmware ready a
- EFU ready
- NICOS aggregati
- Challenges with r
- Challenges with D
- A few hardware is
- Most tests yet to
- Common monitor
- Everyone dedicat

Monitors are among the most critical components of the beamline for hot commissioning, as they validate the beam and the primary flight path serving as a basis for all other analysis

ITEM	DESCRIPTION
1	Put all 4 units in a ring
2	Test the slow control of CASCADE
	ntrol of fission
	UPS and PDU control
	5560 firmware for Bragg peak
	lity for fission monitor
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	at for fission and CASCADE using
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	k monitor
	ation fission and CASCADE
	ed data can be saved
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16	Debug bit/cropping problem in IBM DAQ	e)	ECDC and DetG and ICS	BOT
17	Finalize the firmware of the CASCADE monitor	e)	DetG and ECDC	BOT

- IMO: Most of this should be done before SRR, with minor deferments until BOT

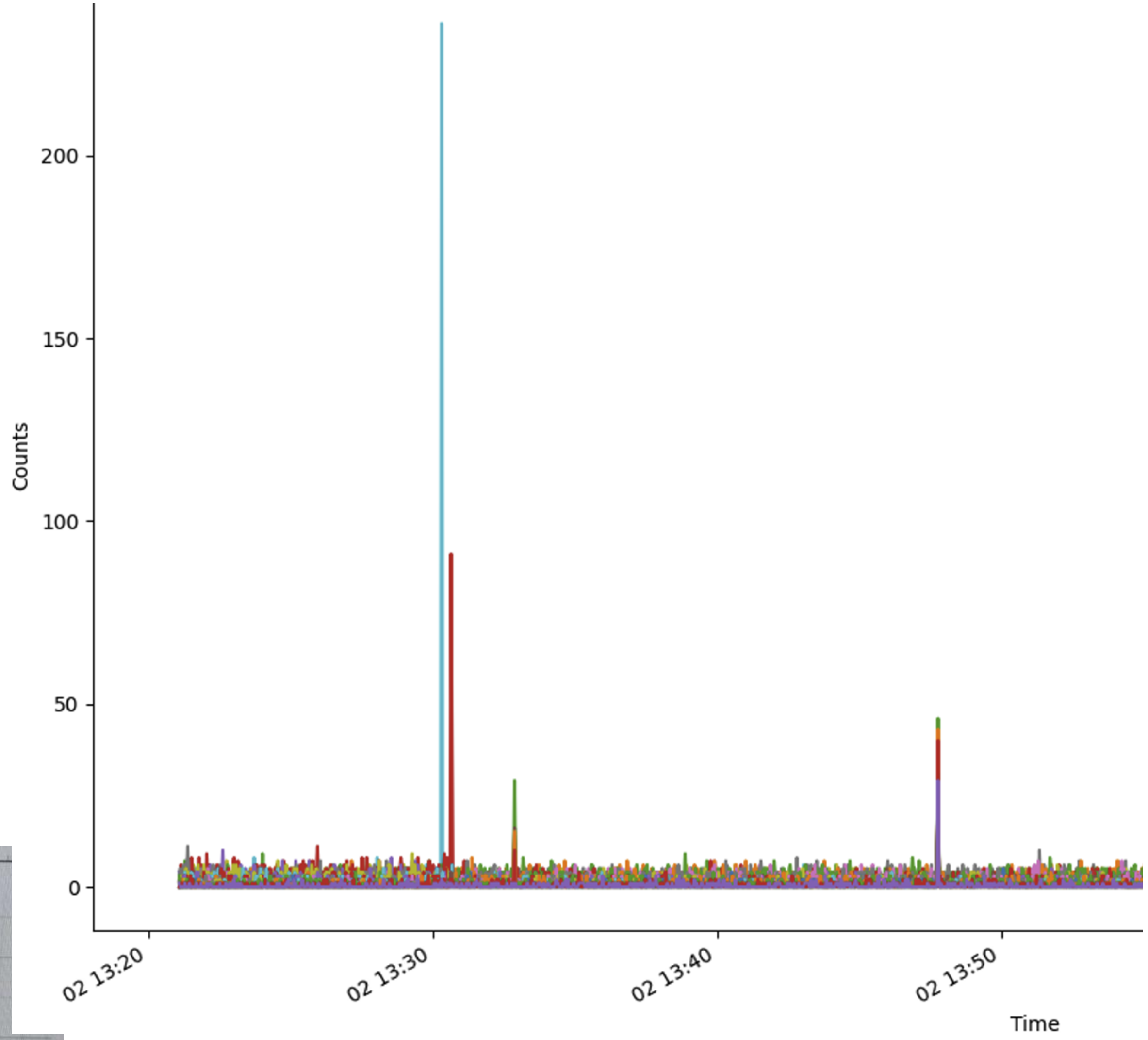
BIFROST: Detector grounding issues

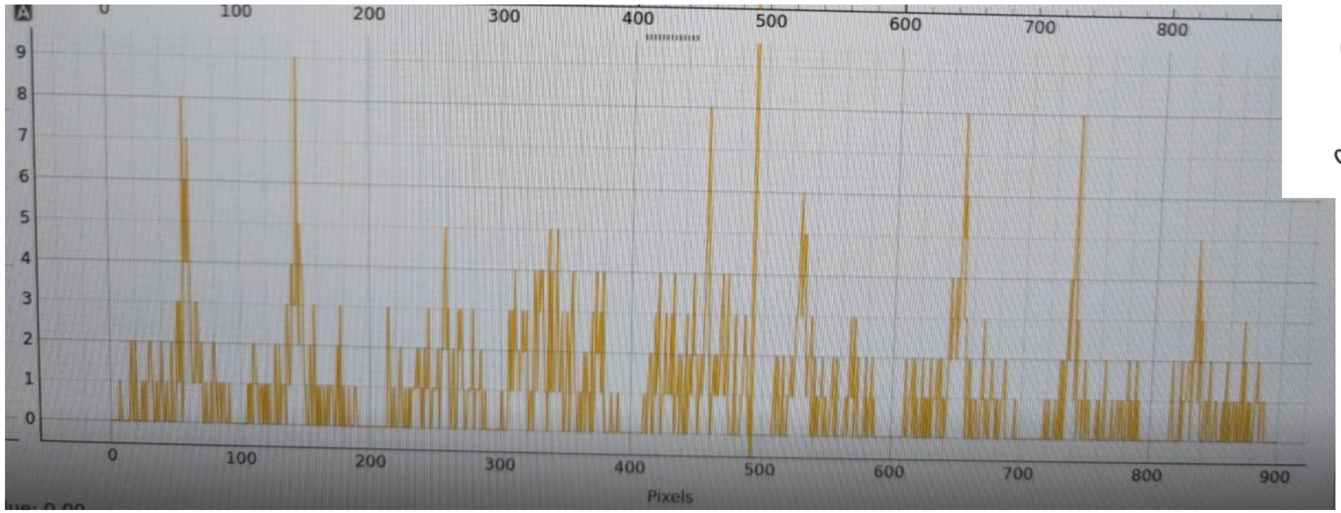
Problem: Electrical noise propagates from outside to the detectors

- We did not see this when operating the detector system from the power supply in the E02 hall

- It is seen as events in the middle of the tubes they cannot be masked out

- They come bunched in time, around 10-100 ‘events’ pr bunch.



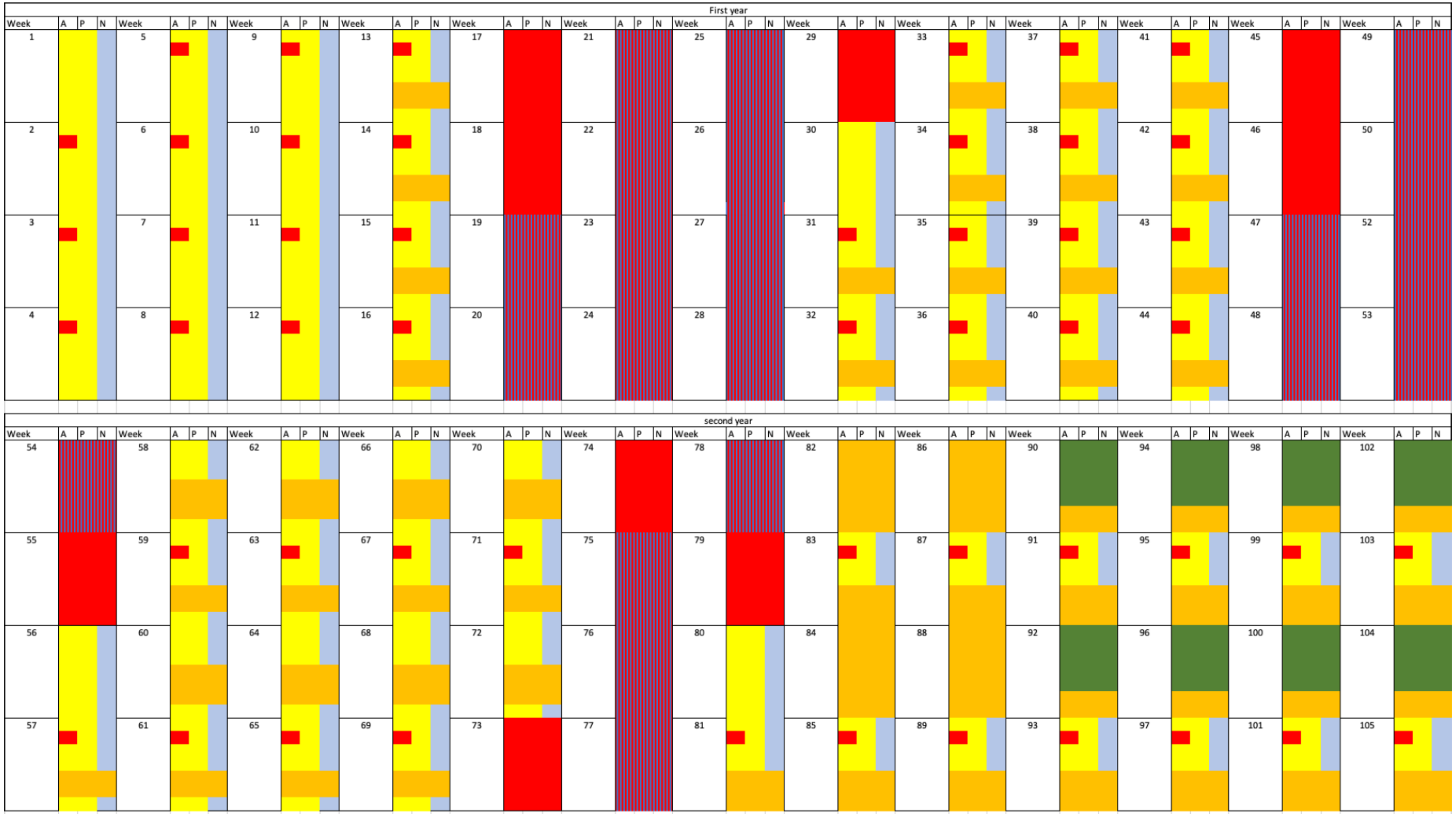


Having this noise in HC and user operation would make it difficult to be ready for SOUP.

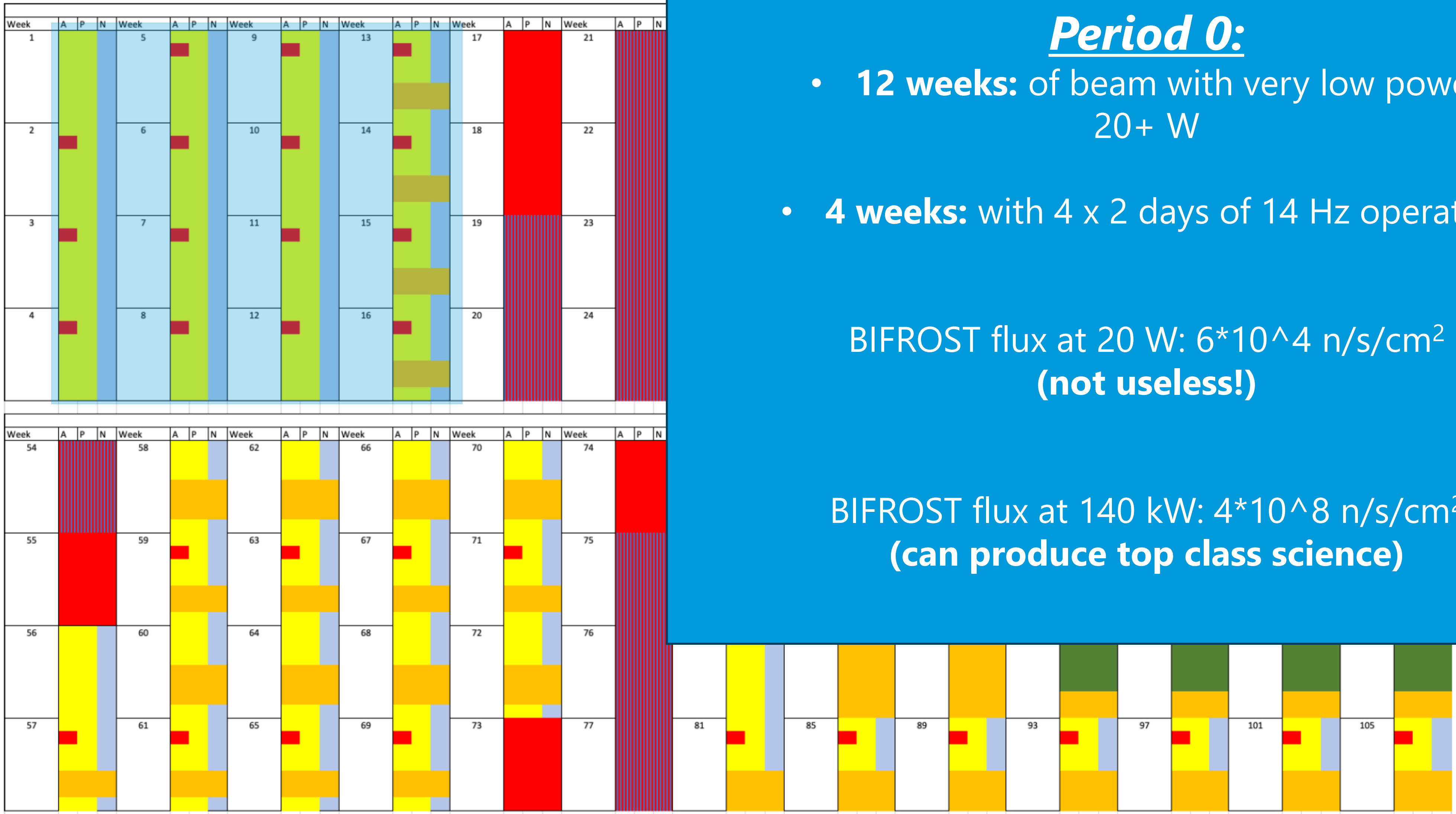
BIFROST: Key NITs for hot comms

- Most monitor NITs (as per previous slide)
- Sample environment integration NITs (not scope)
- RMM timing test (260)
- Gauge level integration (256-257)
- Energize hatch cabinet (248)
- Pneumatics error handling (234)
- Time stamping for motor positions (246)
- Spectrometer poly (230)
- E01 handrails, shielding & more (244, 226-229)
- **Instrument earthing system** (31)

ESS plan: Yellow is accelerator running, orange is 'useful' beam



ESS plan: Yellow is accelerator running, orange is 'useful' beam



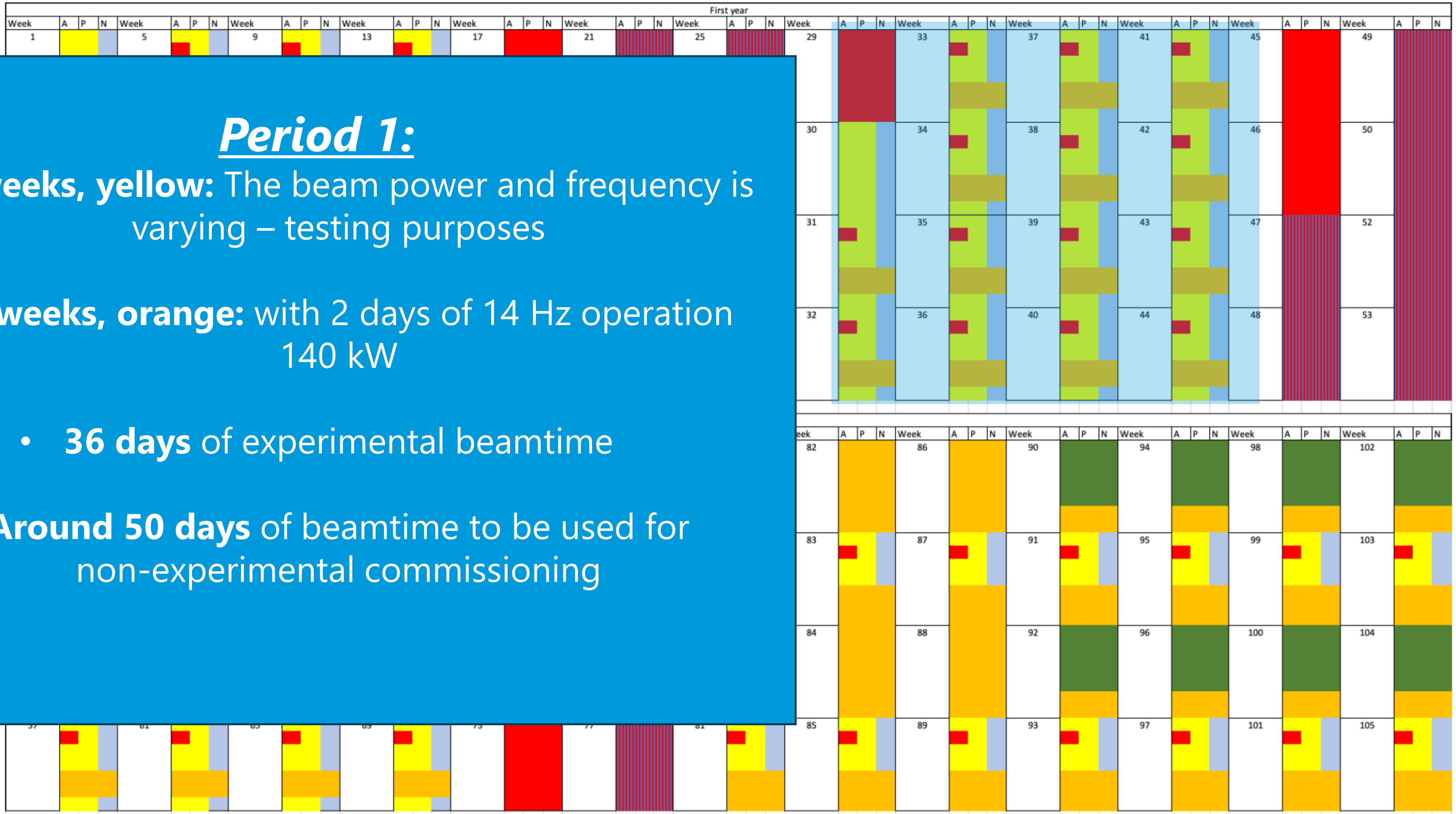
Period 0:

- **12 weeks:** of beam with very low power 20+ W
- **4 weeks:** with 4 x 2 days of 14 Hz operation

BIFROST flux at 20 W: 6*10^4 n/s/cm^2
(not useless!)

BIFROST flux at 140 kW: 4*10^8 n/s/cm^2
(can produce top class science)

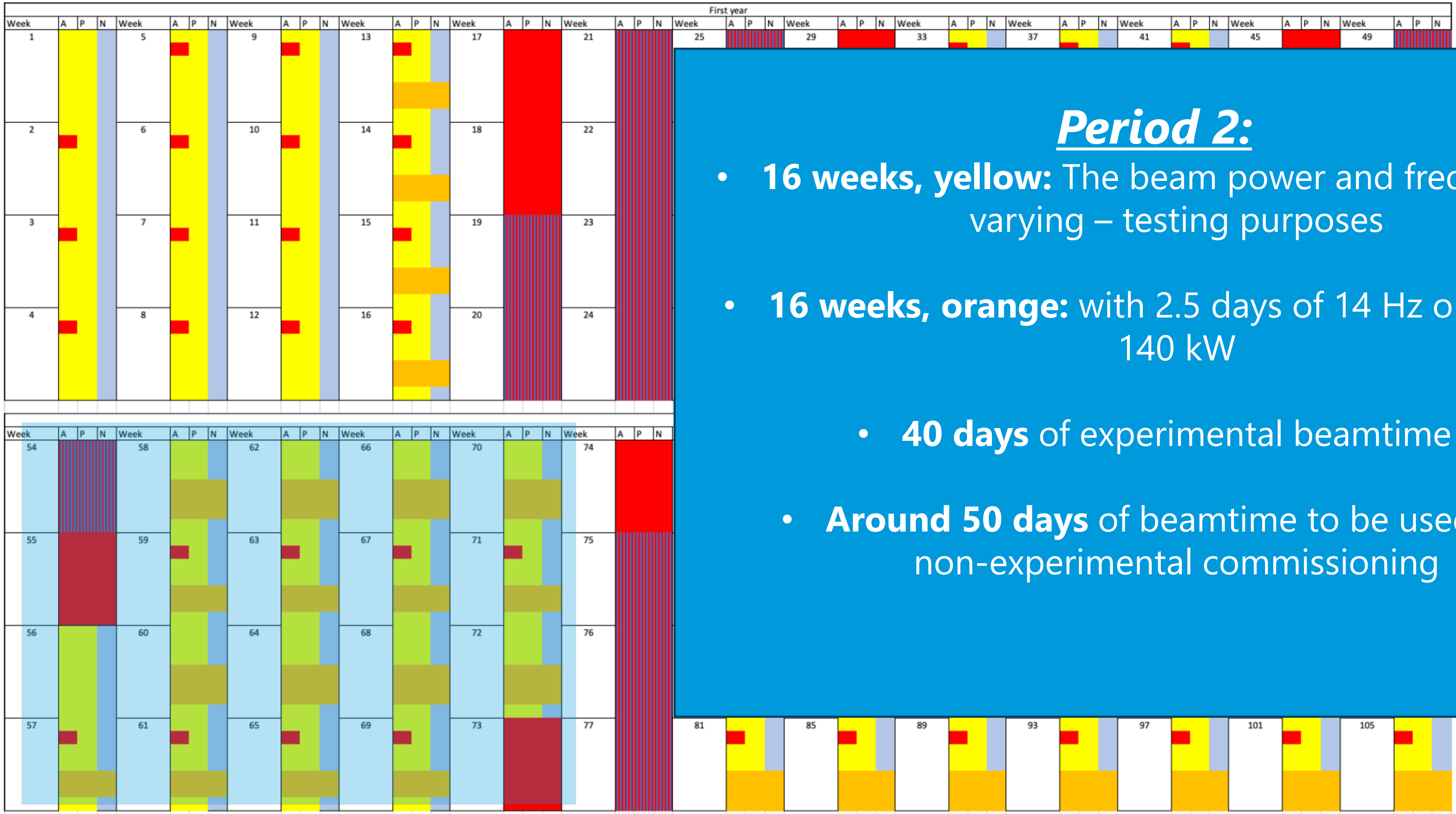
ESS plan: Yellow is accelerator running, orange is 'useful' beam



Period 1:

- **18 weeks, yellow:** The beam power and frequency is varying – testing purposes
- **18 weeks, orange:** with 2 days of 14 Hz operation 140 kW
- **36 days** of experimental beamtime
- **Around 50 days** of beamtime to be used for non-experimental commissioning

ESS plan: Yellow is accelerator running, orange is ‘useful’ beam



Period 2:

- **16 weeks, yellow:** The beam power and frequency is varying – testing purposes
- **16 weeks, orange:** with 2.5 days of 14 Hz operation 140 kW
- **40 days** of experimental beamtime
- **Around 50 days** of beamtime to be used for non-experimental commissioning

ning, orange is ‘useful’

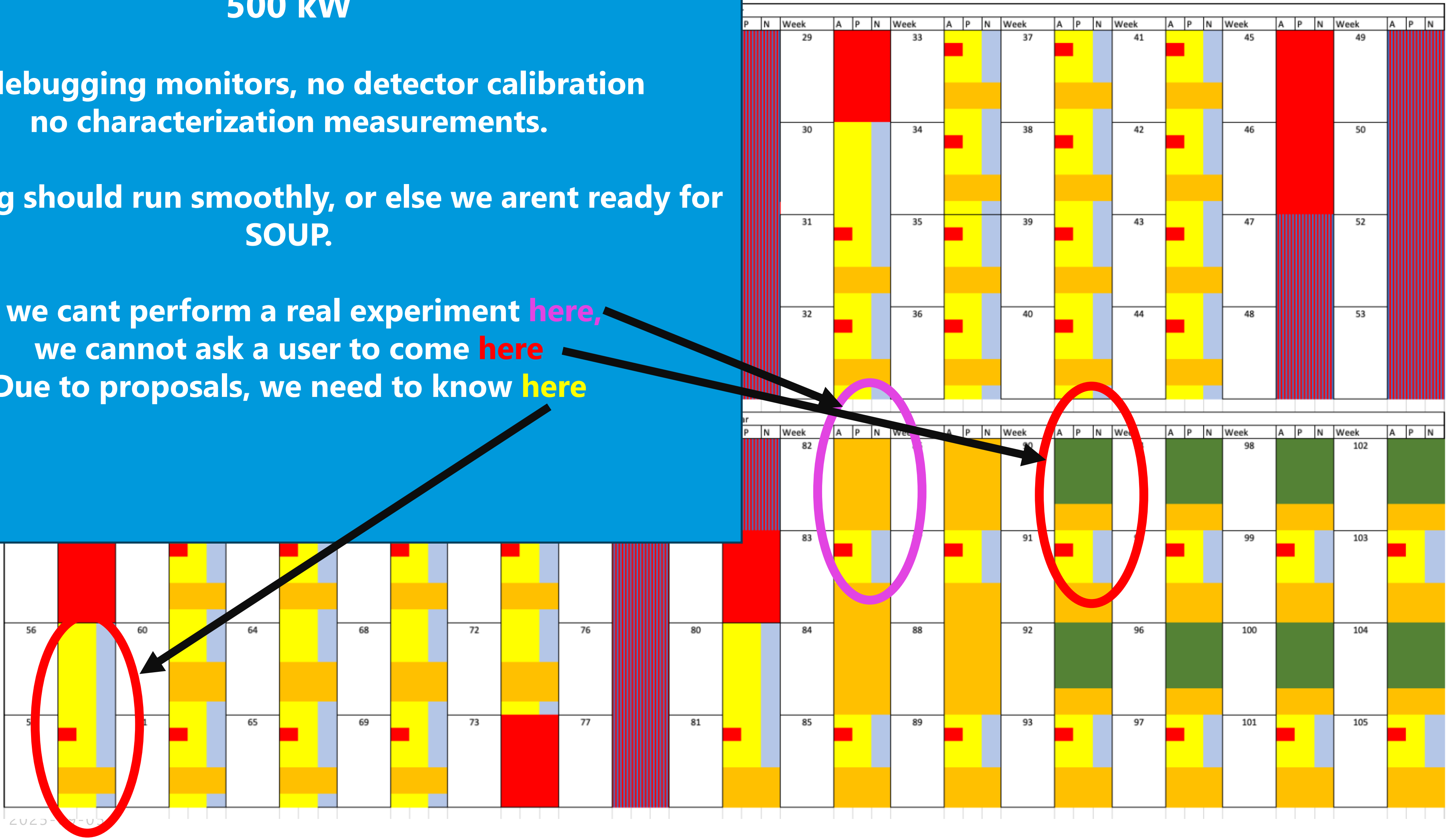
Period 3 - early science:

8 weeks – 5.5 experimental beamdays pr week
500 kW

No debugging monitors, no detector calibration
no characterization measurements.

Everything should run smoothly, or else we arent ready for SOUP.

If we cant perform a real experiment here,
we cannot ask a user to come here
Due to proposals, we need to know here



ESS plan: using the accelerator commissioning time

Non-experimental commissioning tasks could be:

- Detector boundary definition (illuminate vanadium rod and count)
- Detector firmware tweaking
- Measure a Bragg peak
- If we get 5 us pulses – initial flight path calibration from moderator to sample

Experimental commissioning tasks are described in the following but are defined by

- The need for the full pulse to populate the wavelength band
- The need for high flux to generate statistics in low efficiency monitors
- The need for 14 Hz operation to test the work flow for data reduction, initial analysis and calibration

BIFROST: Start of HC

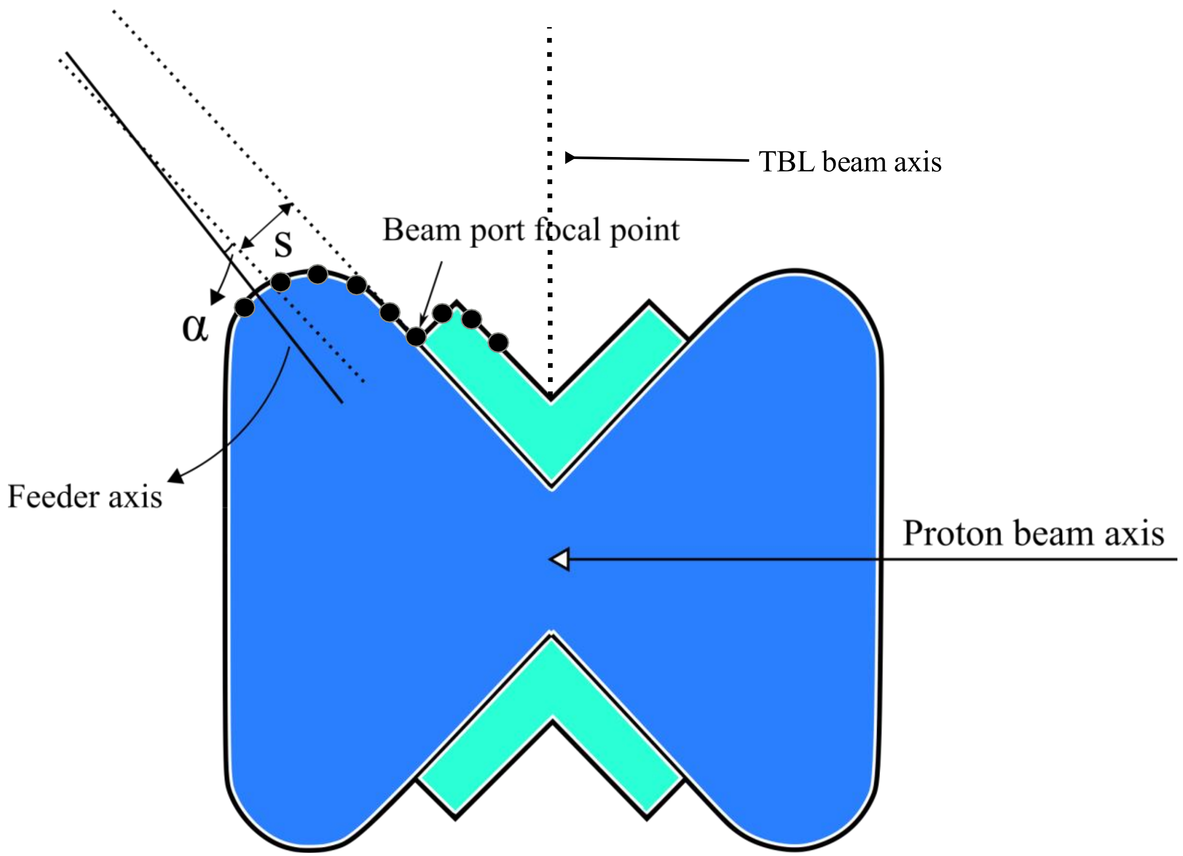
- Confirm radiation levels with RP – hopefully only
  2 days of 140 kW beam

For the guide shielding:

- Using AUB, measure the dose rate outside the guide shielding at 20 places in the D03 hall, near shielding interfaces and dog-legs, and calculate the average and scale to beam power
- Using AUB, measure the dose rate outside the guide shielding at 20 places in the E02 hall, near shielding interfaces and dog-legs, and calculate the average and scale to beam power

For the cave shielding:

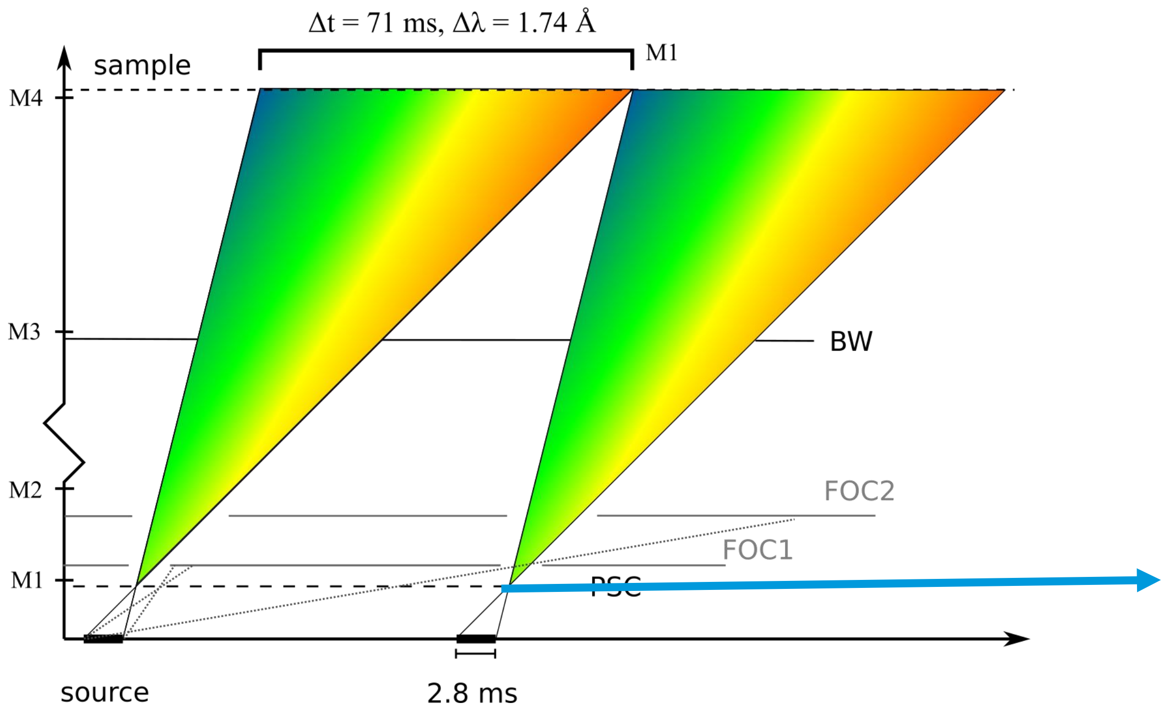
- Using AUB, measure the dose rate at 20 places on the outside of the cave in the E02 hall, near shielding interfaces and dog-legs, and calculate the average and scale to beam power
- Using the electronic and remotely read out dosimeter in the BIFROST cave, place the B4C attenuator in the beam and place a cadmium sheet at the sample position. This gives the gamma dose rate of the H2 scenario *inside the cave*, scaled down by the attenuator and the beam power. This should be used to benchmark the cave shielding calculations, spotting potential problems well before 5 MW is reached. It could also be used by RP as an empirical estimate of worst-case radiation levels inside the cave.

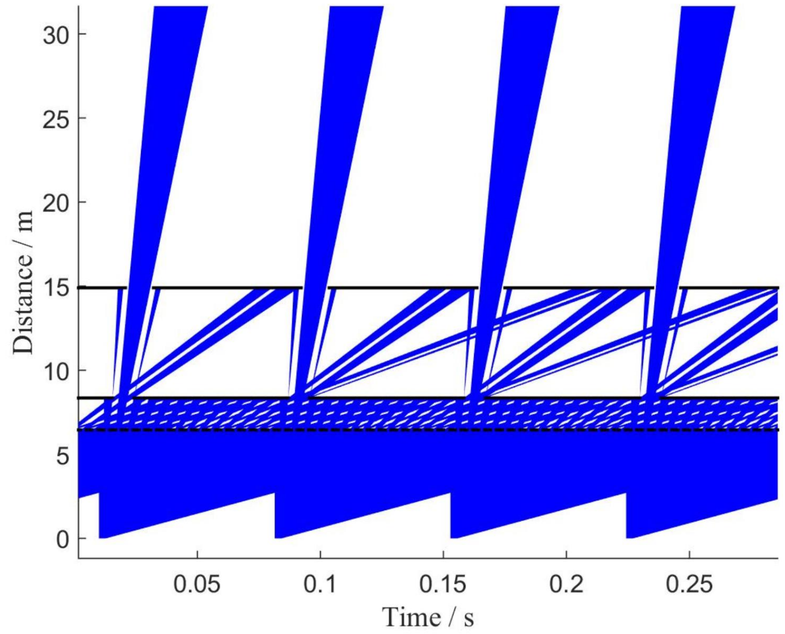


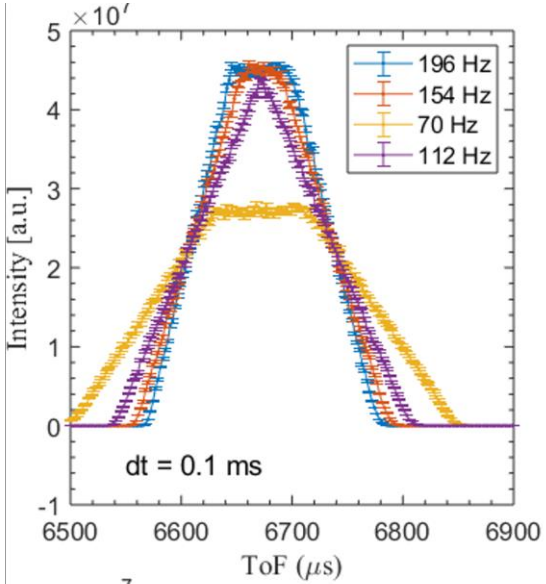
ESS plan: using the accelerator commissioning time

- PSC sets the 'real' T0 for the instrument and the wavelength band

- Pulse timing and shaping needs experimental confirmation to make sure we understand the time delays between reference pulse, proton pulse and 'PSC phase'





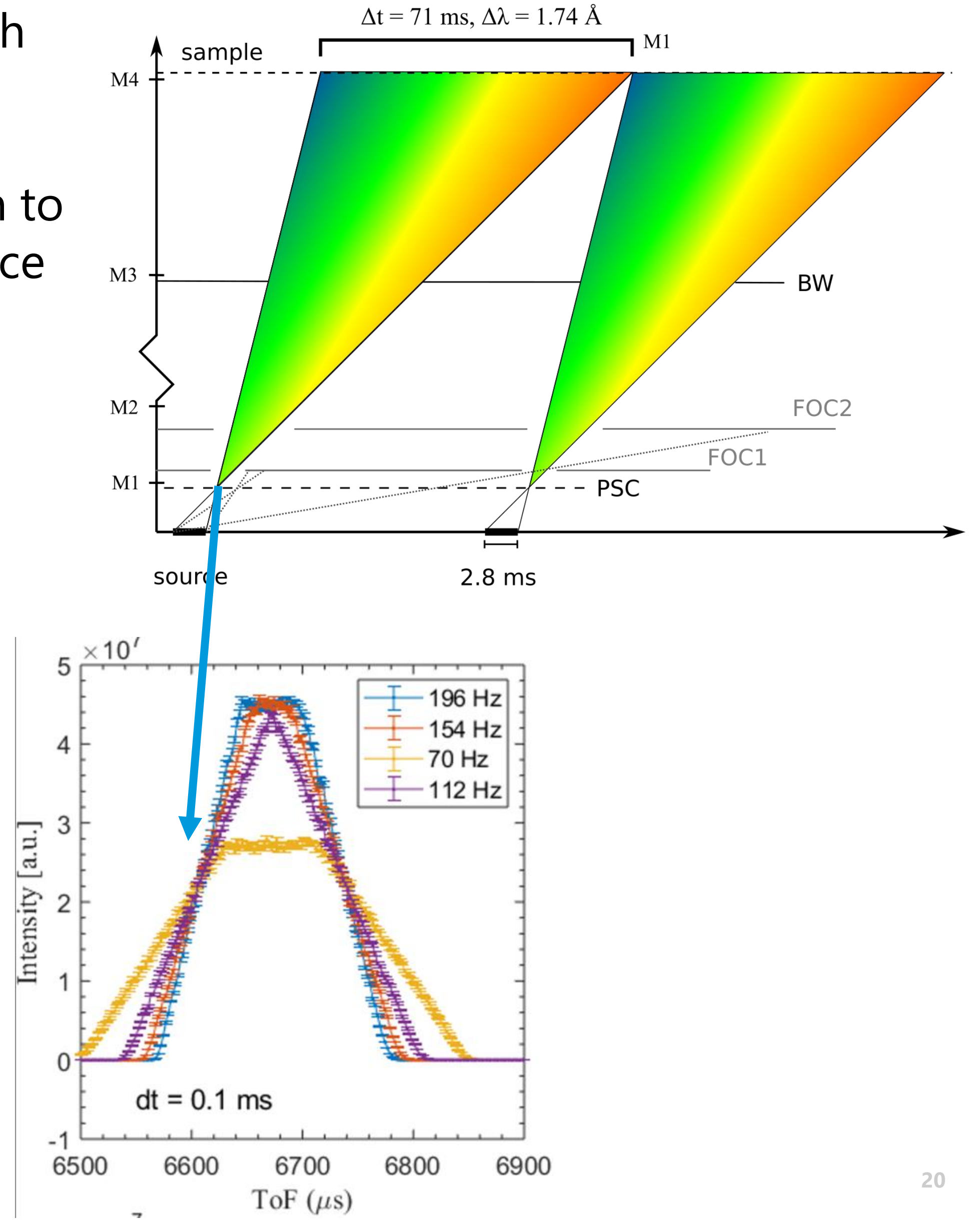


ESS plan: PSC chopper and fission monitor

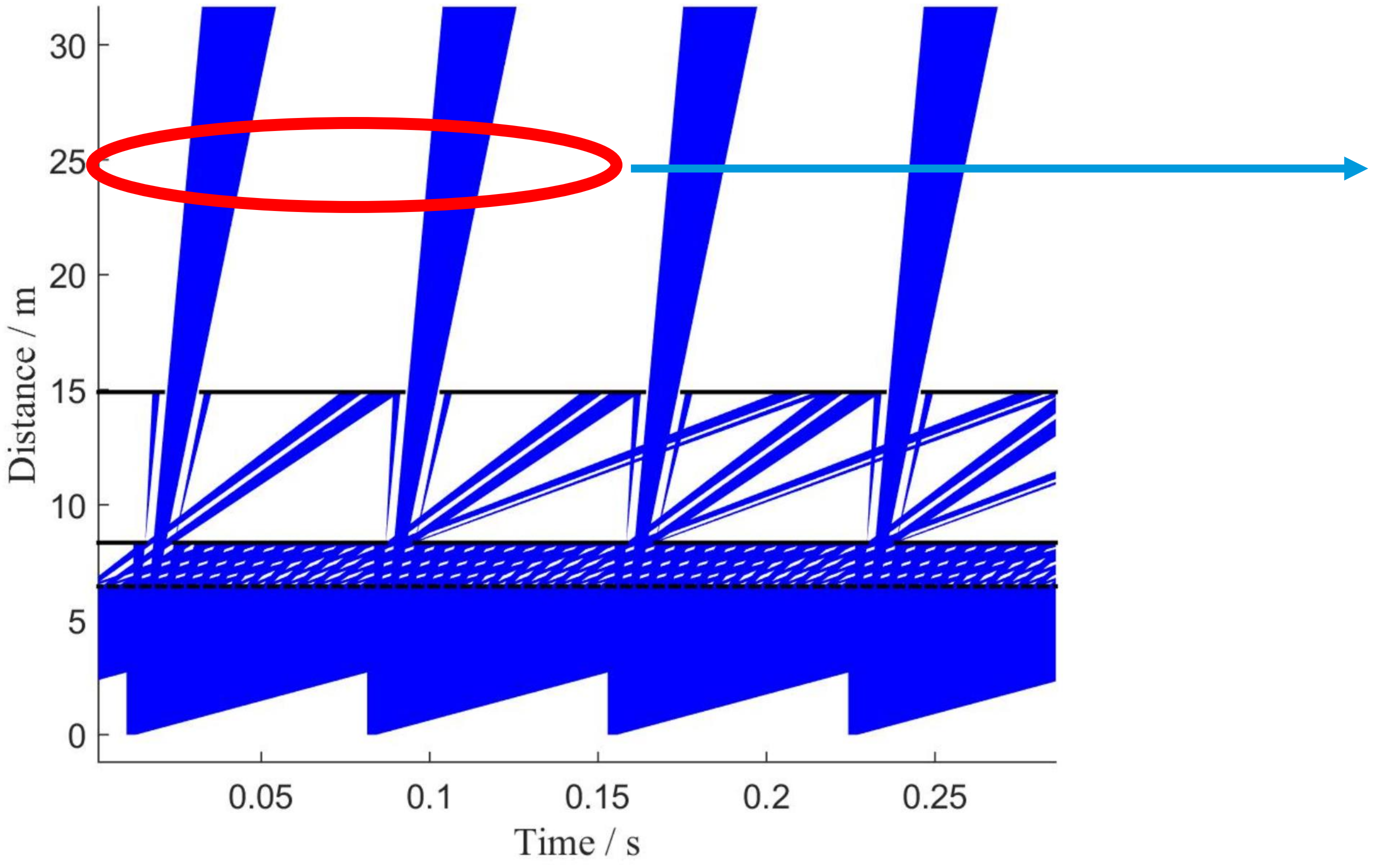
- PSC sets the ‘real’ T0 for the instrument and the wavelength band

- Pulse timing and shaping needs experimental confirmation to make sure we understand the time delays between reference pulse, proton pulse and ‘PSC phase’

- ***<u>To-do with fission monitor:</u>***
  - Measure fast neutron spectrum with closed PSC
  - Measure total neutron spectrum with open PSC
  - Slowly block the guide with the disc to confirm the phase of the edge (both discs)
  - Confirm 14 Hz cutoff time for both discs
  - At 126 (210) Hz, confirm 0.1 ms peak shape
  - Scan the PSC phase at 126 Hz
  - Try to validate spectrum



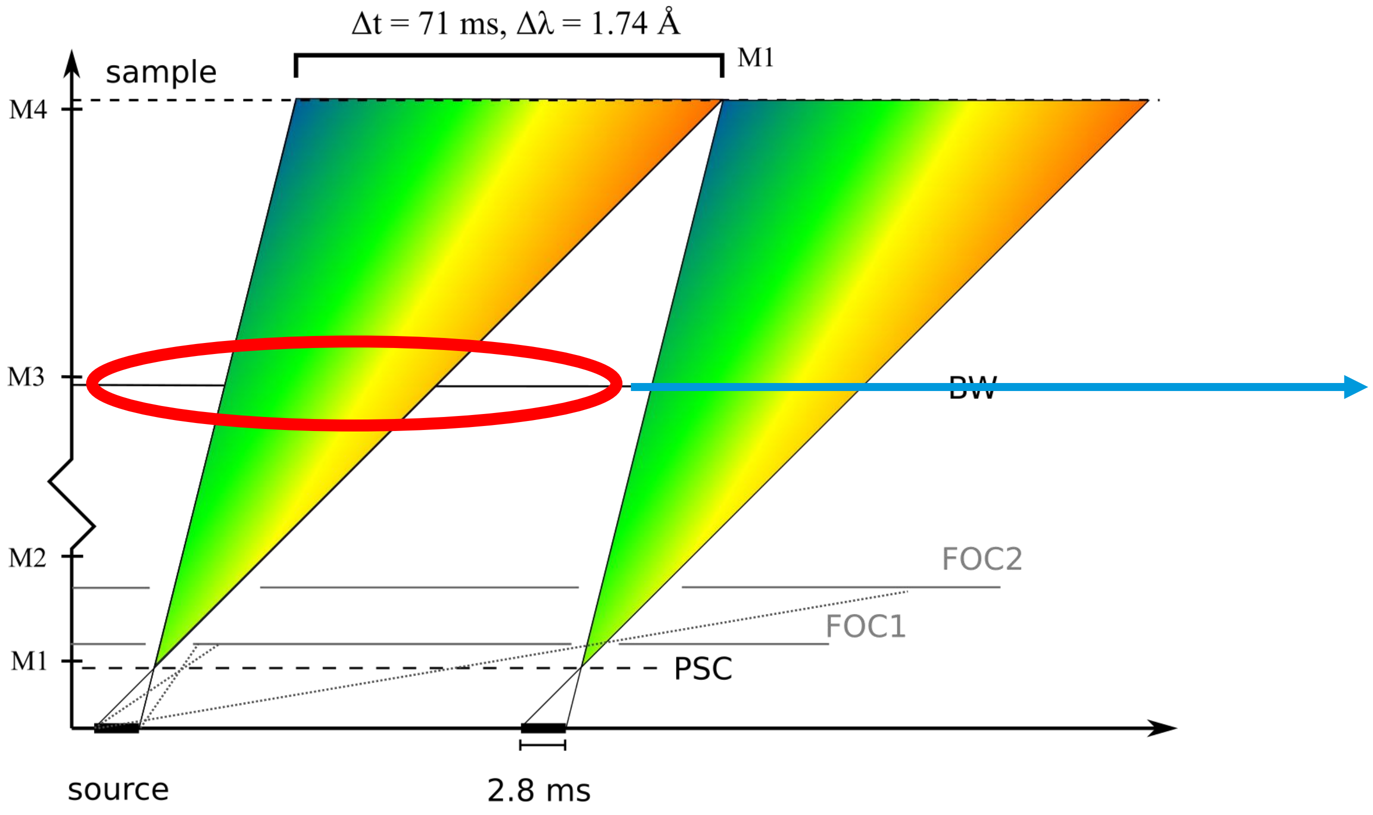
BIFROST: ToF front end – why we need the PSC



<u>Spend time with M2 to:</u>

- Identify parasite frames
- Make sure they are suppressed when FOCs are in phase
- Experimentally confirm phasing of PSCs and FOCs over long time scales

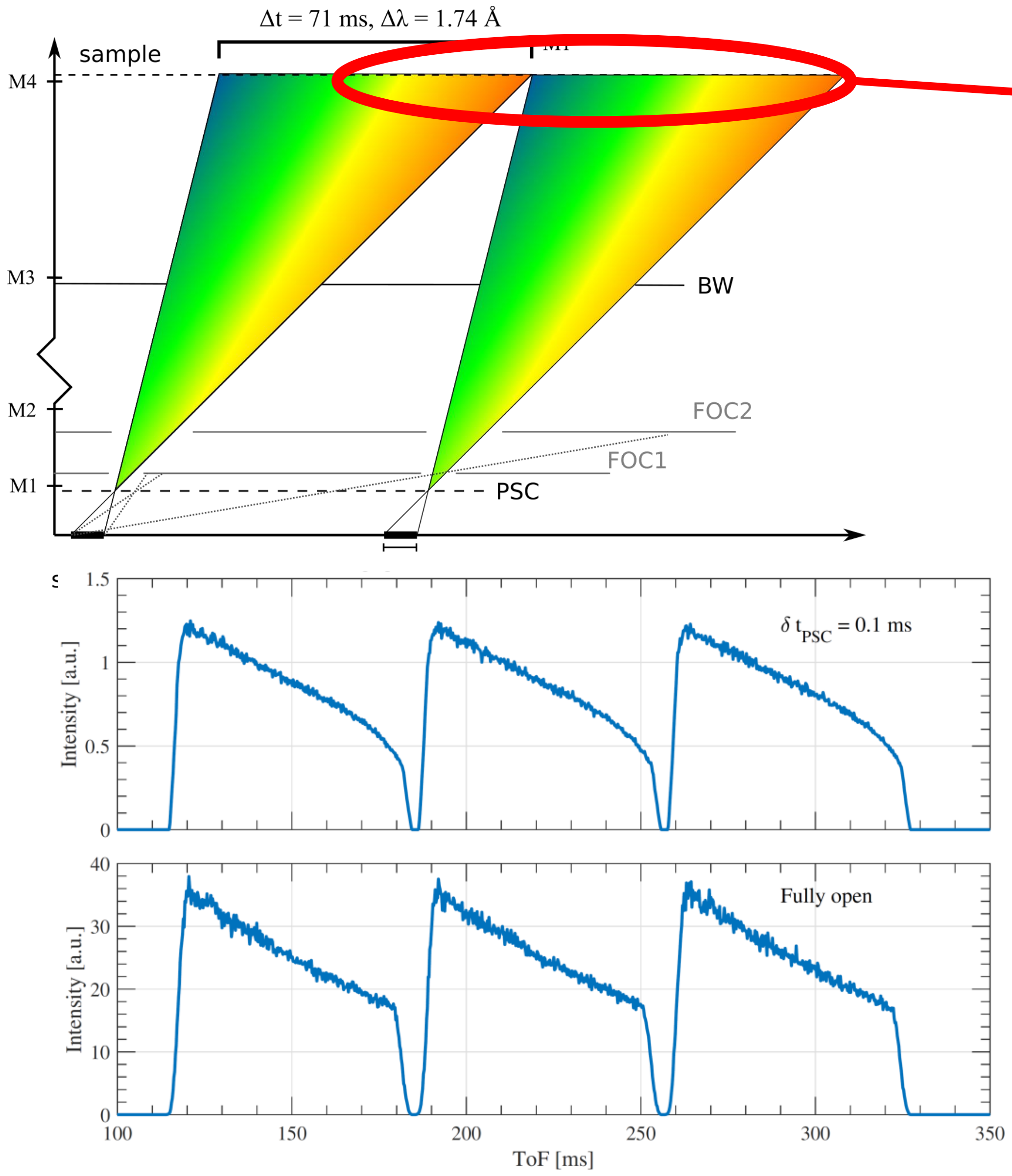
BIFROST: ToF front end – why we need the PSC

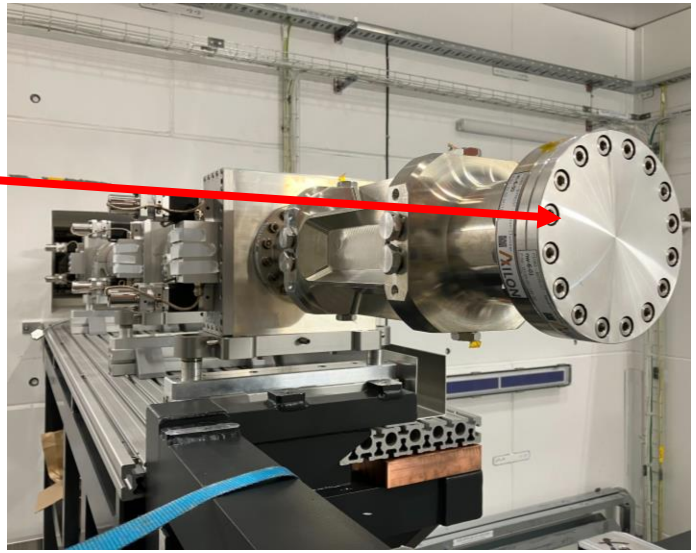


Spend time with M3 to:

- Confirm pulse width
- BWC opening and closing times defining the useful wavelength band

BIFROST: ToF front end – why we need the PSC

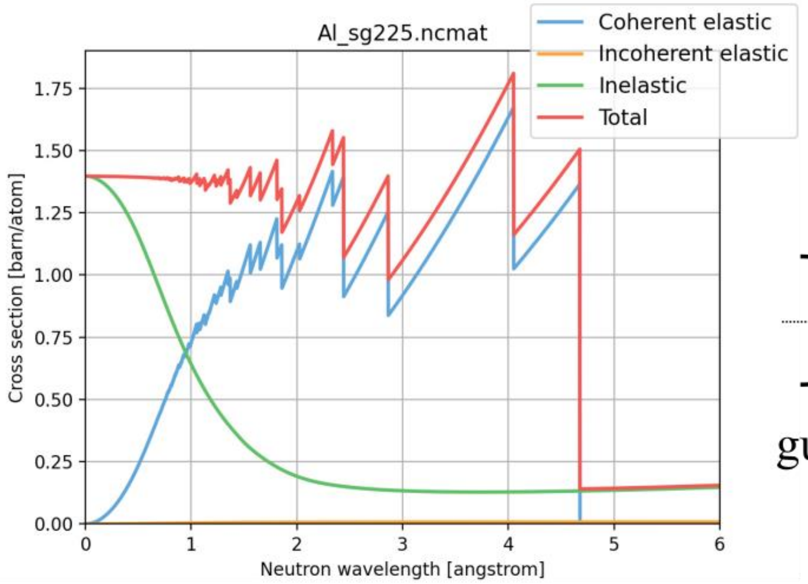


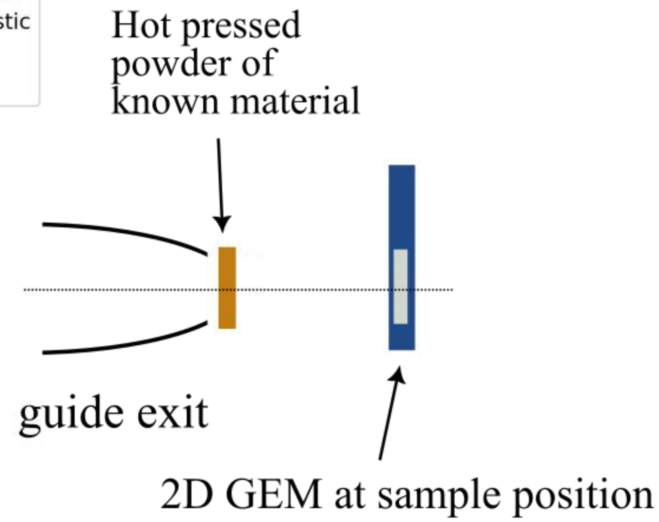


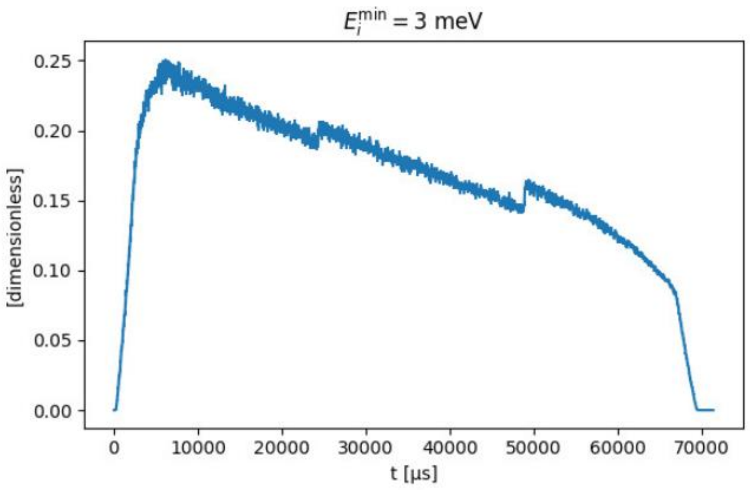
Spend time with M4 to:

- Confirm gap between pulses and record high stats spectra for all wavelength bands and chopper opening times.
- Identify aluminum Bragg edges and preliminarily calibrate primary flight path
- Use 2D mode on sample position, and measure the beam spot

BIFROST: Primary flight path calibration

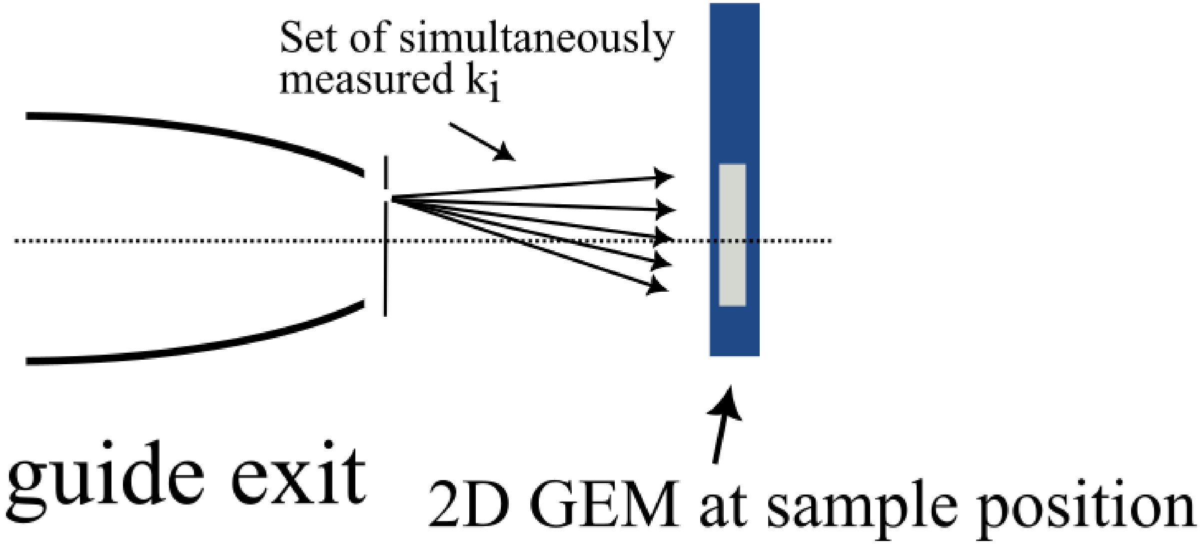


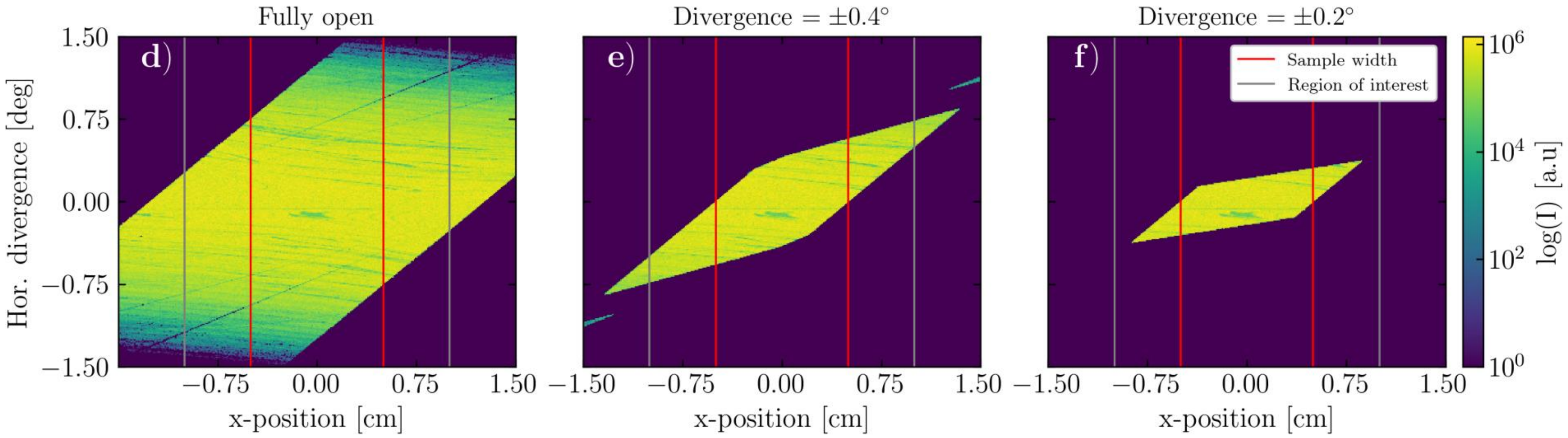




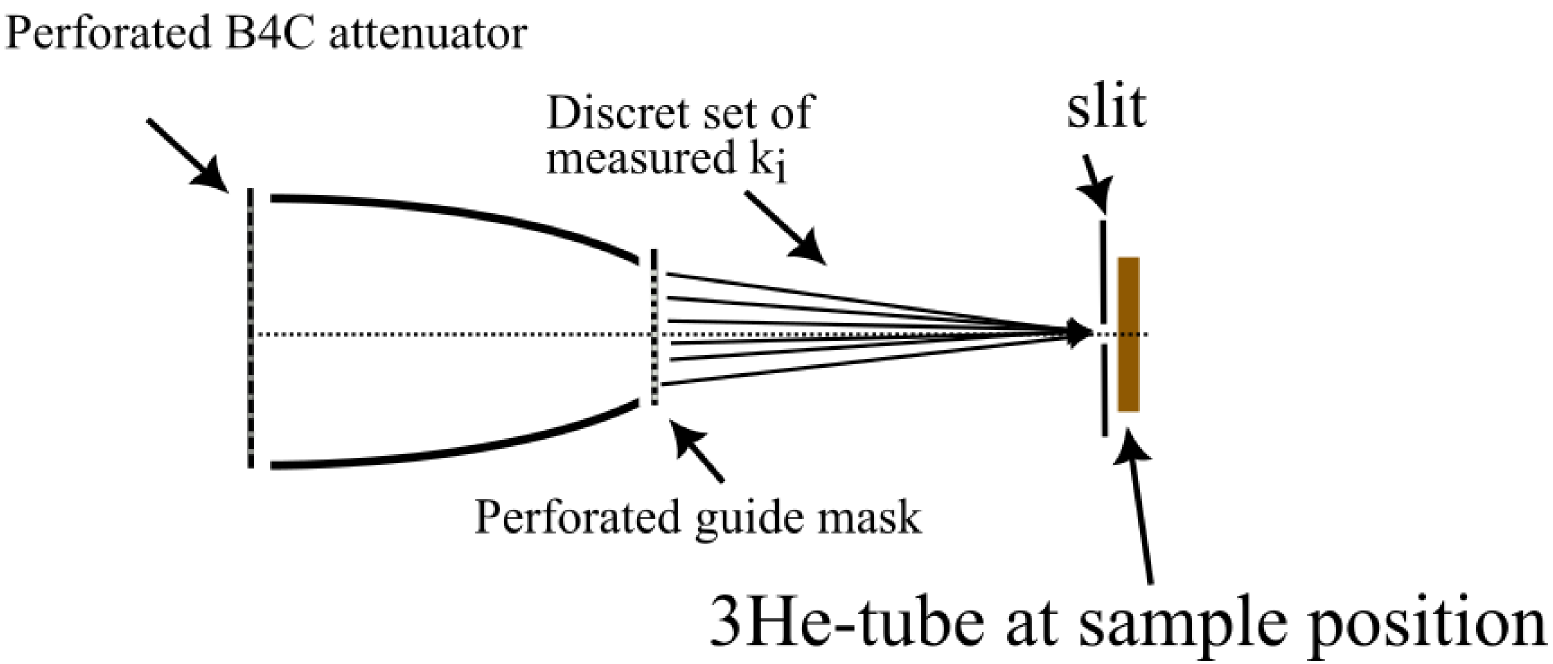
- Use Bragg edges of known material to calibrate primary flight path, with and without PSC

BIFROST: Nice-to-haves: Guide characterization and divergence profile



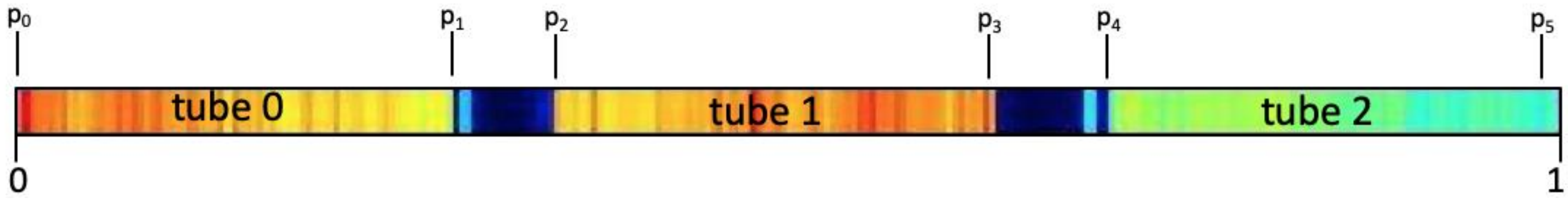


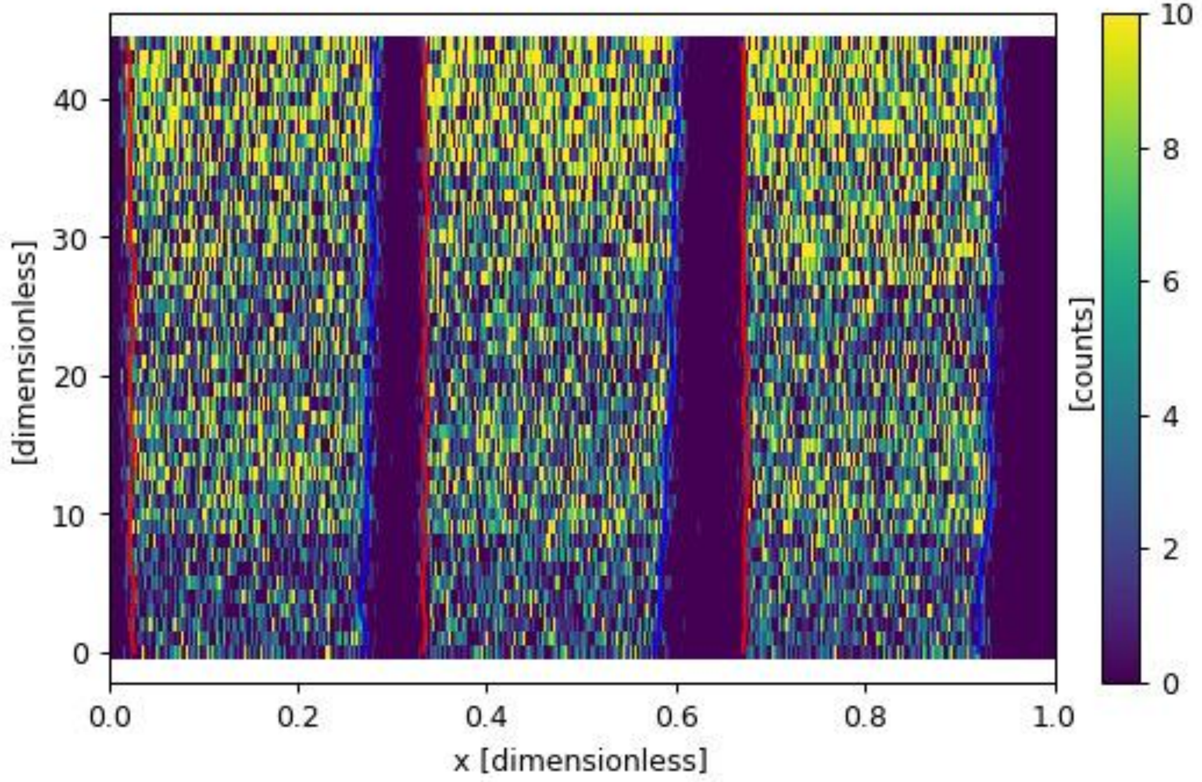
BIFROST: Flux measurements



- The absolute flux is an important parameter to judge experiment feasibility. Use gold foil measurements, or use attenuation. Cross calibrate with 1/lambda efficiency of monitors.

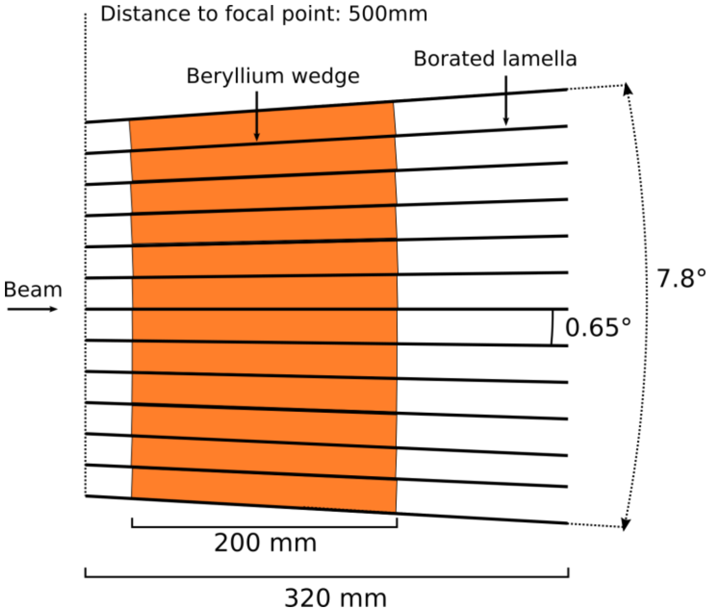
BIFROST: Detector characterization (Does not need 14 Hz)

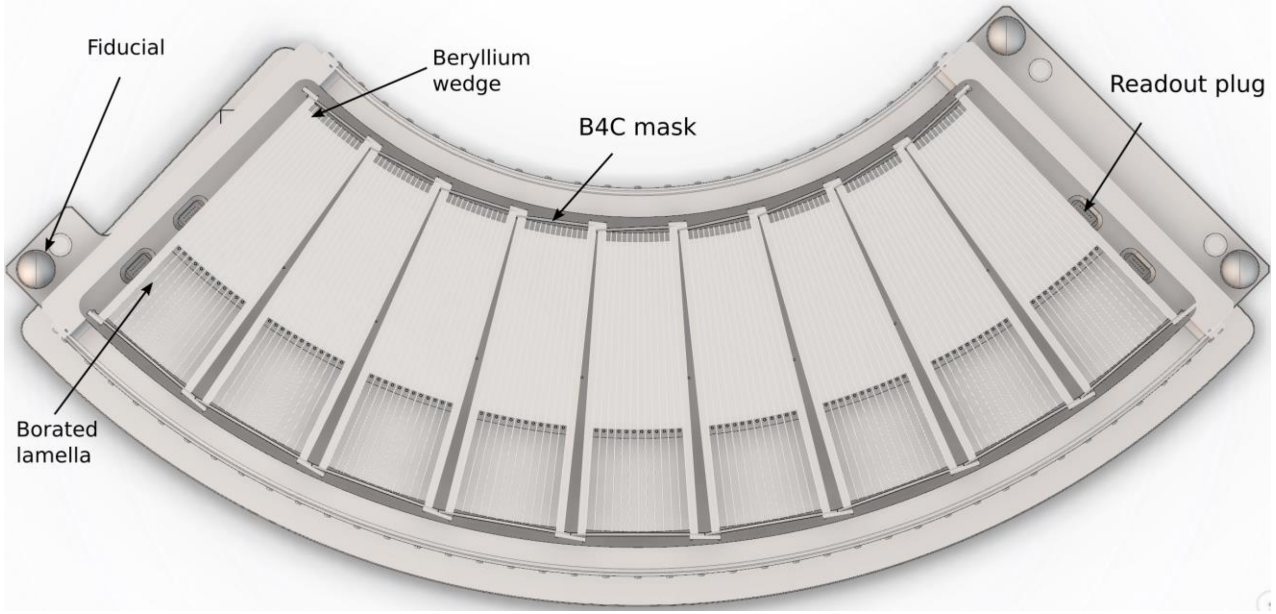




- Detector boundary calibration.
- Using a high statistics data-set, identify
  the boundaries of the detector tubes

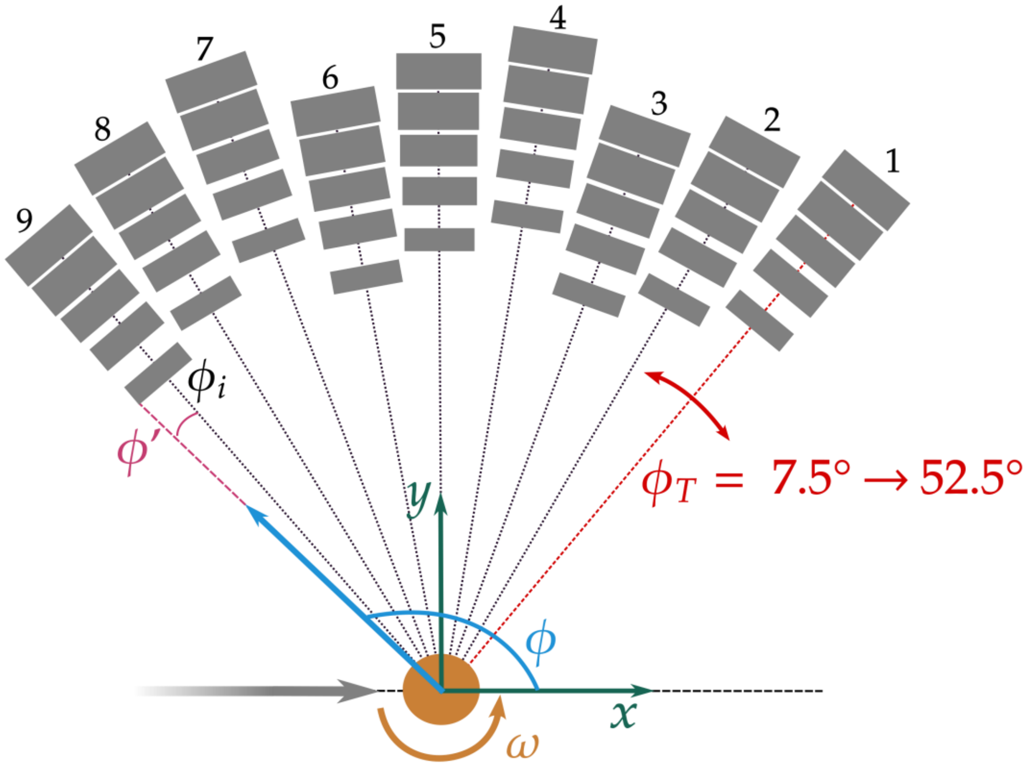
BIFROST: Filter characterization (Does not need 14 Hz)





- Scanning a point sample, measure the transmission function of the filter,for all 9 units. Identify differences, keep records for user

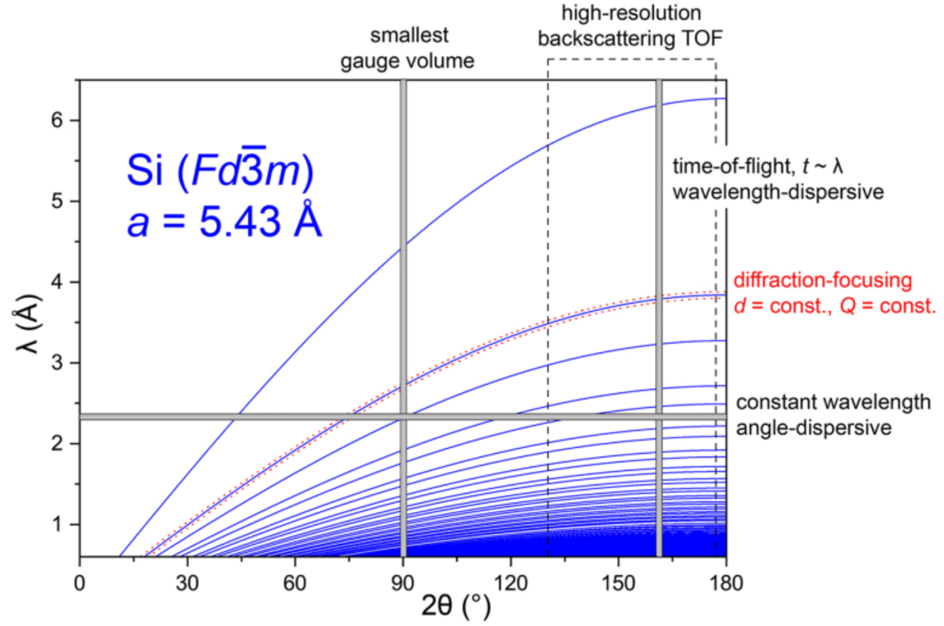
BIFROST: ToF front end – why we need the PSC

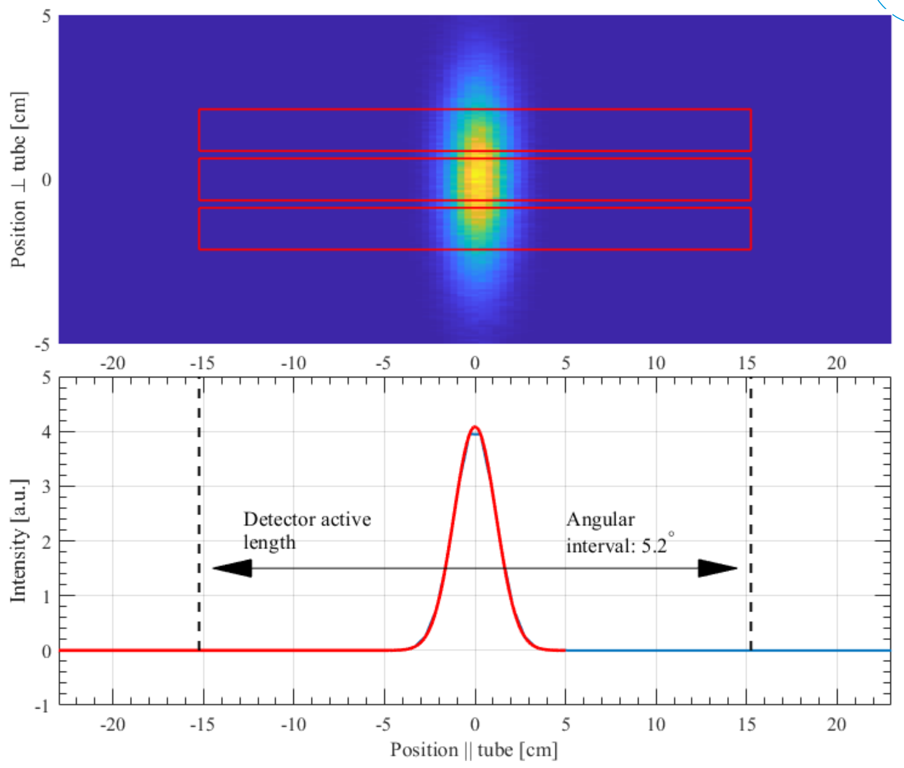


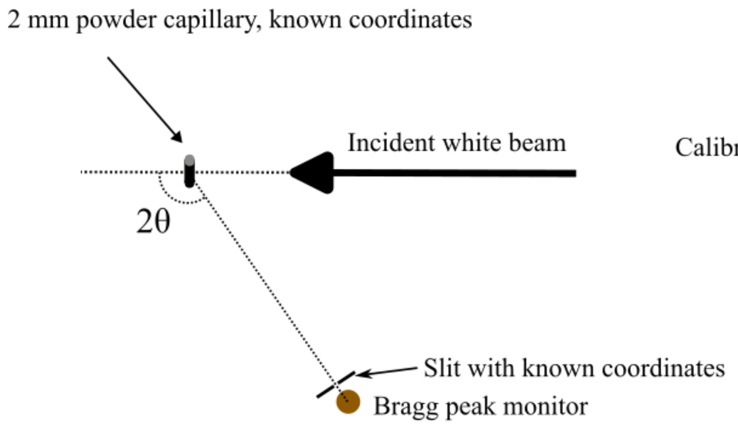
Reminder:

- Each individual analyser is slightly misaligned
- Each detector triplet is slightly misaligned
- The tank angle to the beam has been indirectly measured with SAM, but physically there might be things unaccounted for (coating quality, bad guide alignment

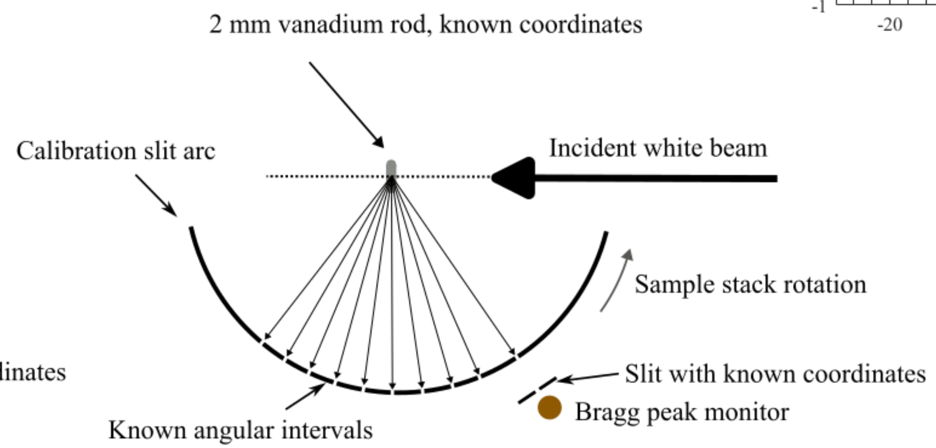
BIFROST: Backend angle calibration







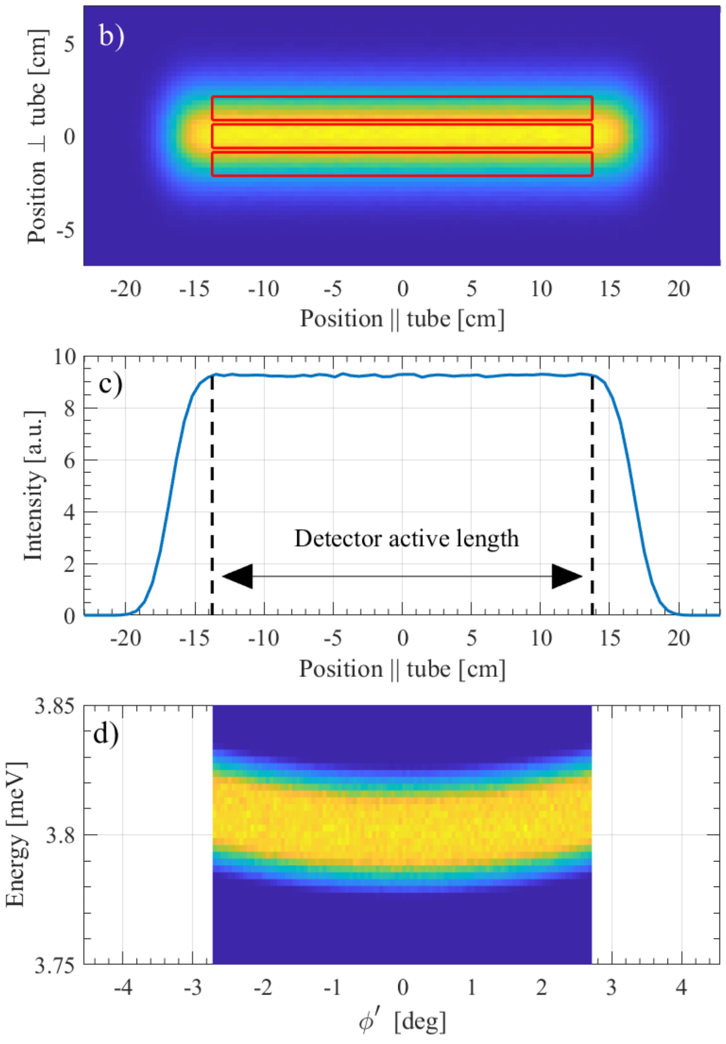
Overall A4 calibration



Channel specific A4-calibration

- Use a set of masks to create scattered beams of known scattering angle

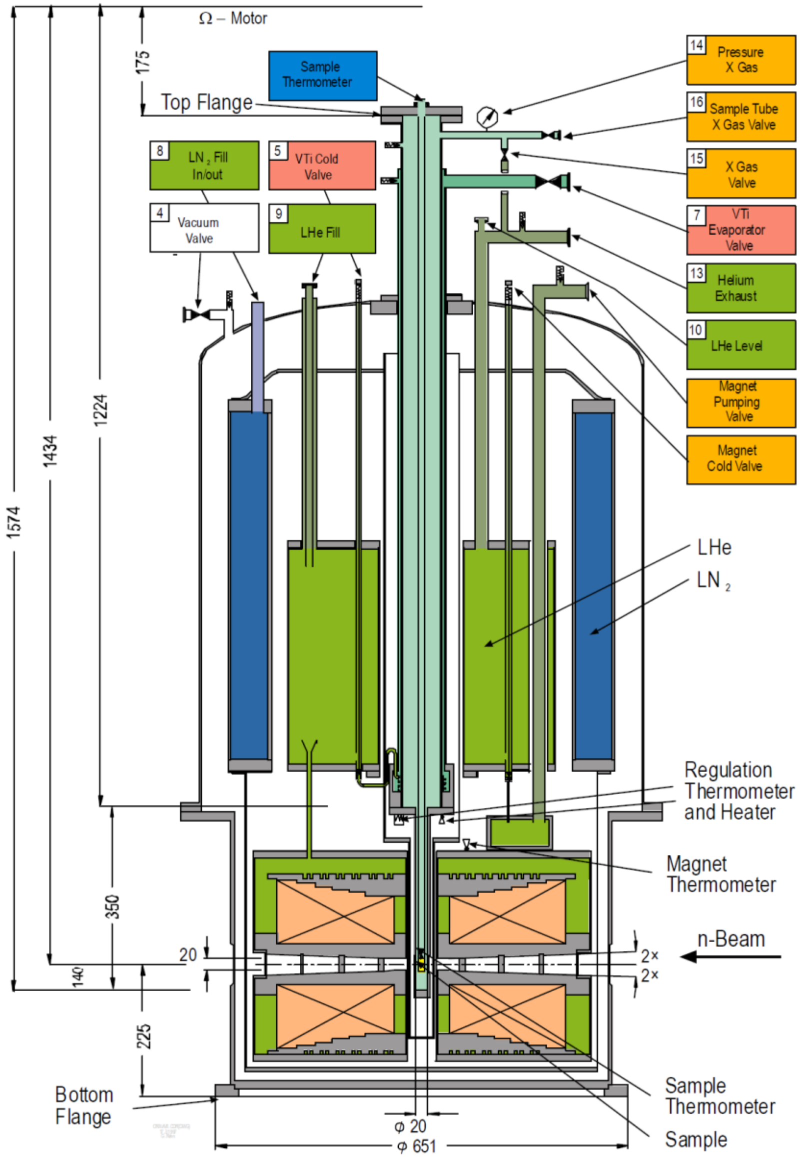
BIFROST: ToF front end – why we need the PSC



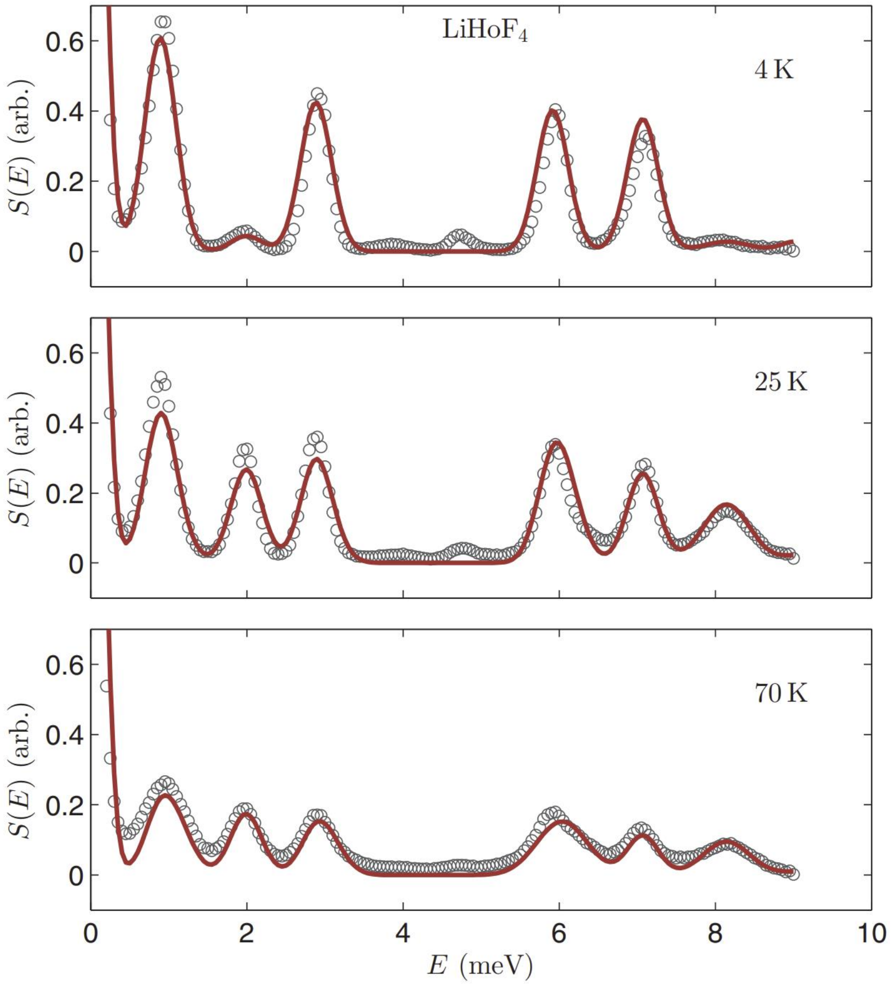
- Calibrate overall efficiency of Be-filter, analyser, detector system, using a V-sample and 4pi scattering.
- To be used for pixel normalization
- Calibrate E_f with known flat mode scatterer (not trivial to find)

BIFROST: Sample environment

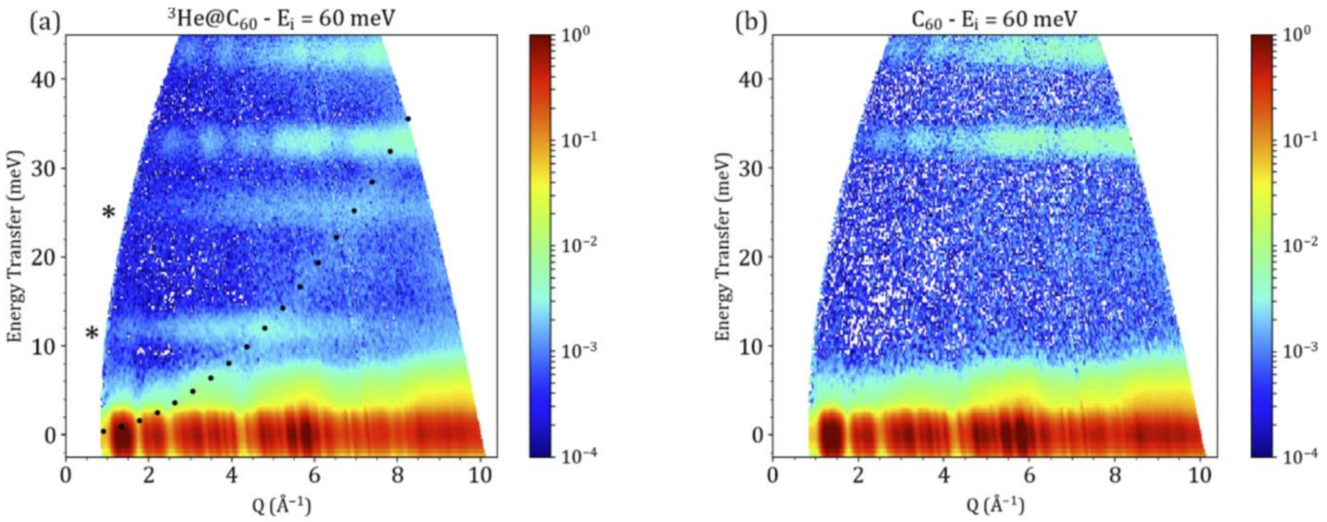
- Characterize sample environment
- Background/normalization
- Spurions
- Play with slits and jaws,



BIFROST: Crystal field levels – reproduce known physics
Confirms energy transfer determination



- Reproducing known CEF level positions from literature is important, ensure non-dispersive levels to make things simple



BIFROST: Crystal field levels – reproduce known physics
Confirms energy transfer determination

- Do the same for very low energies, reproducing results from IN16B calibrations if possible. May only work for 1 or 2 analyser banks but well worth it

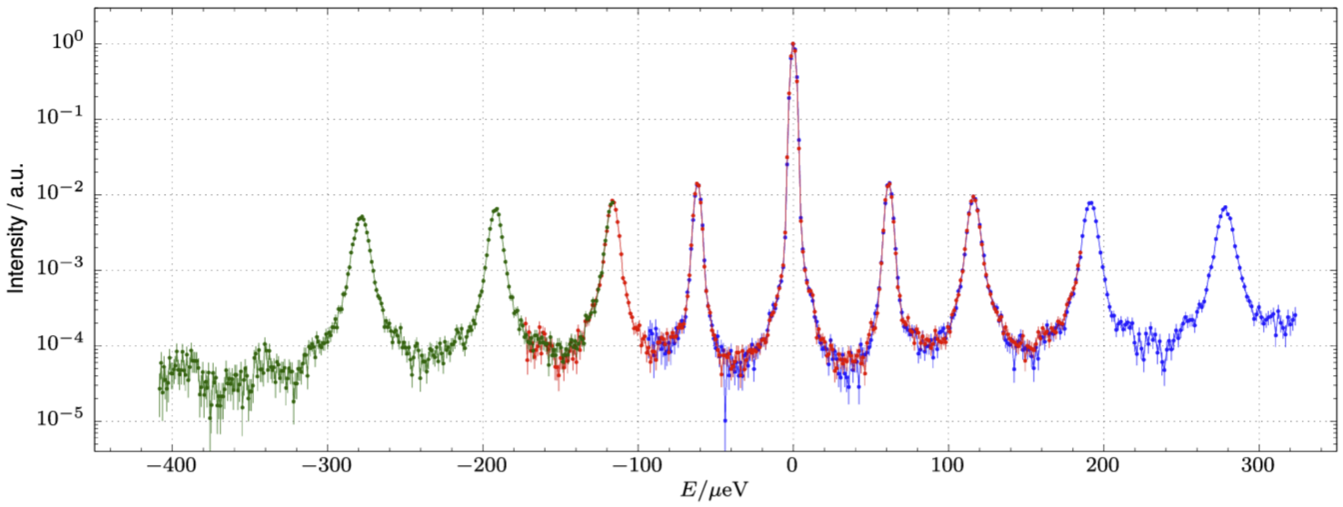


Fig. 1. Neutron scattering spectrum recorded on γ-picoline-N-oxide at $T = 1.8$ K with BATS on IN16B summed over all detectors. Three consecutive measurements with different offsets of the observed energy transfer window are shown in different colors. The energy resolution FWHM at the elastic peak is 3.8 μeV. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

BIFROST: Crystal field levels – reproduce known physics
Confirms energy transfer determination

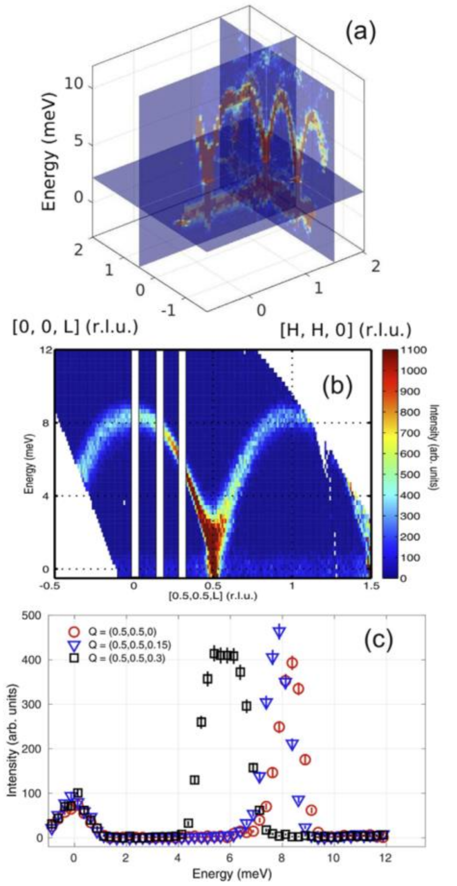
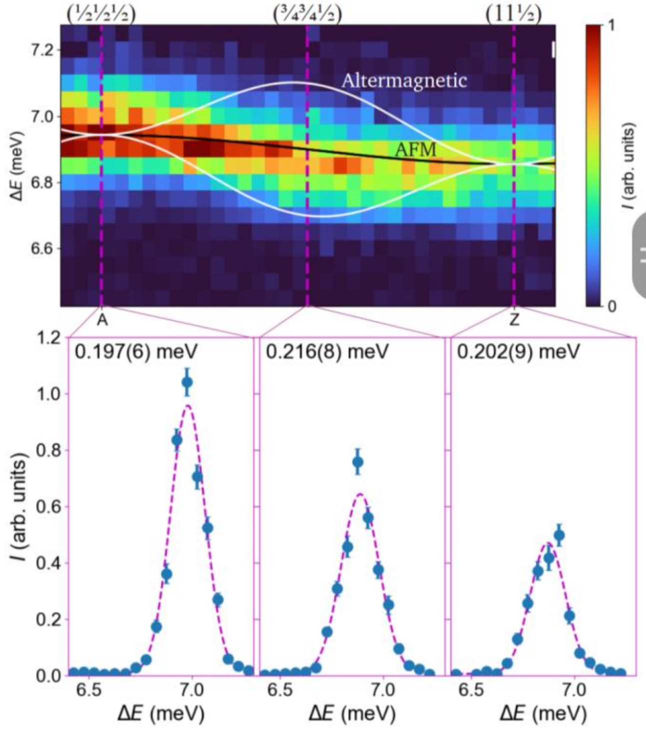


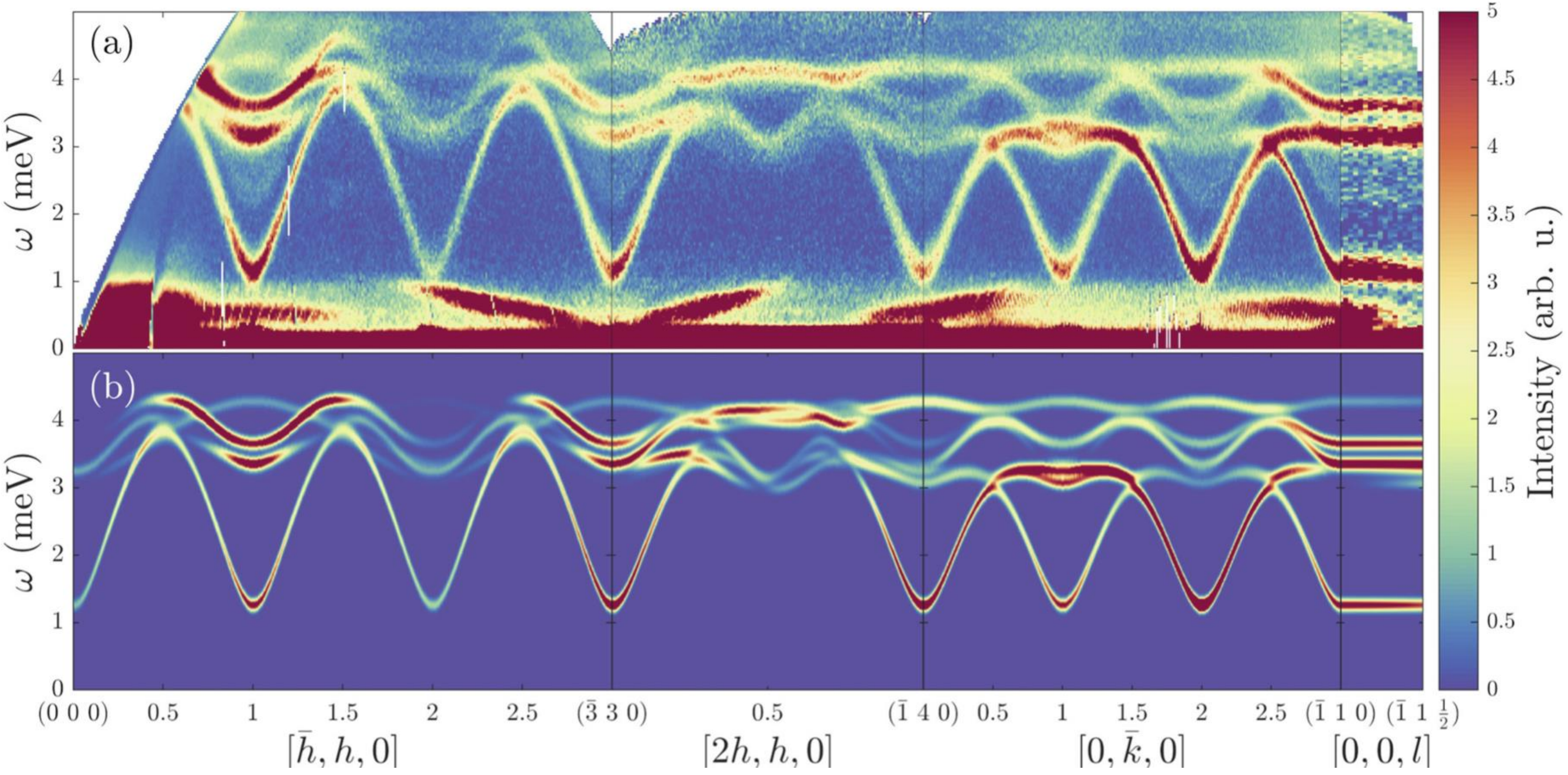
Fig. 4. Plots of data from the experiment on $RbMnF_3$. Panel (a) shows a screen-shot of the sliceomatic feature of Horace, which allows visualization of 3D cuts. Panel (b) shows a 2D slice in the (0.5, 0.5, L) – Energy plane. The white lines show regions where 1D cuts were taken. Panel (c) shows three 1D cuts for $L=0$ (red circles), $L=0.15$ (blue triangles), and $L=0.3$ (black squares). (For interpretation of the references to color in this figure caption, the reader is referred to the web version of this paper.)



- Reproduce the dispersive excitation of well known systems that have been studied to death. MnF2 is both a good and bad candidate

With BIFROST one should remember the limitations of the literature experiments

BIFROST: Reproduce complex dynamics measured on old direct geometry ToF machnies (IN5)



Rough plan assuming nothing goes wrong (Periods 0 and 1)

Schedule after BoT:

- **12 weeks accelerator testing**: Define detector edges, measure Bragg peaks, first normalization scans
- **4 weeks** – 8 beam days: PSC, FOCs and BW (M1-M3)

14 week shutdown

18 weeks:, 2 days pr week (Period 1):

- Week 1-3: Sample spectrum, flight path calibration, jaw and slit characterization
- Week 4-7: Initial flux measurement, normalization measurements, attenuator tests
- Week 8-10: Golf foil measurements, Charge division tests
- Week 11-12: Be-filter calibration, tank scattering angle
- Week 13-14: Final energy calibration
- Week 15-18: Cross talk shielding, Secondary spectrometer normalization, sample environment tests

11 week shutdown

Rough plan assuming nothing goes wrong (Period 2)

<u>Benchmarking experiments and/or early science:</u>

<u>16 weeks 140+ kW, 2.5 day pr week:</u>

- <u>Week 1-2: Elastic line and flat modes below 10 and around 30 meV</u>
- <u>Week 2: Low energy flat modes</u>
- <u>Week 3-5: Simple dispersion</u>
- <u>Week 6-8: Intensity and normalization validation</u>
- <u>Week 9-12: Verifying complex dispersion</u>
- <u>Week 13-16: Conducting experiments on the border of first science</u>

Rough plan assuming nothing goes wrong (Period 3)

Early science (Period 3). Workshop gave us 75 ideas, we select a projects within key areas

8 weeks 570 kW, 5 day bunches

- Week 1 Best easy proposal
- Week 2: Second best easy proposal
- Week 3: Best high resolution proposal
- Week 4: Second best high resolution proposal
- Week 5: Best mapping proposal
- Week 6: Second best mapping proposal
- Week 7: Best pressure proposal
- Week 8: Second best pressure proposal

Rough plan assuming nothing goes wrong (Period 3)

Early science (Period 3). Workshop gave us 75 ideas, we select a projects within key areas

8 weeks 570 kW, 5 day bunches

- Week 1 Best easy proposal
- Week 2: Second best easy proposal
- Week 3: Best high resolution proposal
- Week 4: Second best high resolution proposal
- Week 5: Best mapping proposal
- Week 6: Second best mapping proposal
- Week 7: Best pressure proposal
- Week 8: Second best pressure proposal

- Pressure is on, we don't have the luxury of perfectionism
- People have excellent ideas for using BIFROST. Every wasted week is a world class experiment not being done.

BIFROST: Ressources and personal (likely misguided) expectations

For the commissioning period of the primary spectrometer, we need

- 50 % Chopper engineer
- 50 % Monitor detector scientist
- 50 % EC/DC NICOS and EFU assistance
- 20 % Motion control engineer
- 30 % Technician

For the secondary spectrometer commissioning period, we need

- 50 % Detector scientist (monitor and He-3)
- 50 % EC/DC NICOS and EFU assistance
- 50 % Motion control engineer
- 30 % Technician

- We expect only the core team to be available 24/7 during beam days
- During work hours, it seems crucial to have manpower to resolve issues quickly and move on to the next test and the next problem.
- Prefer to have people ready, at the same time, during the day to fix things, rather than have people ready to restate a problem at 2:00 AM.

Thank you for your attention

Core team:

Lead instrument scientist: Rasmus Toft-Petersen (DTU/ESS)
Lead engineer: Liam Whitelegg (ESS)
Instrument data scientist: Greg Tucker (ESS)

Kristine Krighaar (KU)
Jonas Okkels Birk (KU)
Nicolai Lindaa Amin (DTU)
Bjørn Hauback (IFE)
Philippe Bourges (LLB)
Christof Niedermayer (PSI)
Daniel Mazzone (PSI)
Henrik Rønnow (EPFL
Kim Lefmann (KU)
Niels Bech Christiensen (DTU)

Partners:

DTU Danmarks Tekniske Universitet
LLB Orphée Laboratoire Léon Brillouin
PAUL SCHERRER INSTITUT PSI
IFE Institute for Energy Technology

BIFROST: Hot commissioning risks

<u>Non-exhaustive list of hot commissioning risks:</u>

- **Spending the first few months solving one or two large problems** that could have been fixed without neutrons, eating away early science time
  Proposed mitigation: Continously run the system after TG5.

- **Having too many small we-can-solve-this-later problems**, making everything sluggish, focusing component specific tech issues, which then takes precedence of the larger goal of understanding the beamline.
  Proposed mitigation: Prioritize solving at least some of these

- **Unempowered core team**: Being unable to powercycle an ADC with outcalling an electrician, getting a sample holder made/adapted on a day-to-day basis, needing 4 specialists to turn on the detector system, not having remote access to view and control the instrument, not being able to crane a dewar or a pumping stand after 15:00
  Proposed mitigation: Make sure the IS and IOE can do these things. Train them on operating every aspect of the beamline.

- **Insufficent live visualization**: Our data files are going to be large and and complex. Relying on post-processing would tie staff down writing scripts for everything. Live visualization has to work for the user anyway, and will aloow more people to help
  Proposed mitigation: Continue working with DRAM to get this ready and tested

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BIFROST: Hot commissioning collegiality

A few suggestions:

- **Include other instrument scientists from the division in the hot commissioning.** We could try to find a good model for this. They should not become experts on the instrument, but user operation entails that we can teach a user to operate the instrument in 1-2 hours.

- **Meet with technology teams every week, presenting the problems encountered** and a plan for solving the issues.

- **We could create a small cross-divisional working group** focused on the neutron scattering aspect, discussing data and methods. Emphasis on small, only IS' and IDS', from the first instruments commissioning. No managers, planners or coordinators. We discuss Bragg edges, chopper phasing, and how to filter pulses etc.

- **A meeting similar to the NSS-T1 PM meeting including management** where condensed and filtered points are discussed in a limited forum

- **Common calibration hardware** where we use the same equipment to do the same measurements on all instruments – faciliating higher quality comparisons and quicker characterization.

BIFROST: More?