Beam Monitors Status and a Proposal for a Common Project

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Et al.

Thanks for the detector group at ISIS and SNS
Thanks to the instruments team for their inputs
Thanks to the manufacturers for their openness

Fatima left ESS on 31.8.

Presently there is no individual point of contact for Beam Monitors

Her position was enabled by BrightnESS

www.europeanspallationsource.se

IKON 11 September 2018

Beam Monitors at ESS: Role of Detector Group

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- Long Term Beam monitor support falls within the remit of Detector group
- Development and support of beam monitors was cut under scope setting realignments in 2014-2016

- We will provide a market survey of what is available now ✓
- We will provide a draft set of recommendations and guidelines *Soon*
- We will provide advice and help on *a best effort basis*
- *Development: we will prioritise the most difficult environments. This will be done on best effort, with limited resources available*

- Beam monitor readout: This will be a standard ESS choice that the instrument should take ✓
- Aim: a maintainable, integratable suite of beam monitors
- We will recommend the lowest cost option(s)

- Beam Monitors: If an instrument wishes that we provide the beam monitors, we are open to discuss this transfer of scope. !
- The more instruments do this, the greater economies of scale possible

Information available

Market Survey

- F. Issa et al., Characterization of thermal neutron beam monitors, Phys. Rev. Accel. Beams 20, 092801 (2017) DOI:https://doi.org/10.1103/PhysRevAccelBeams.20.092801

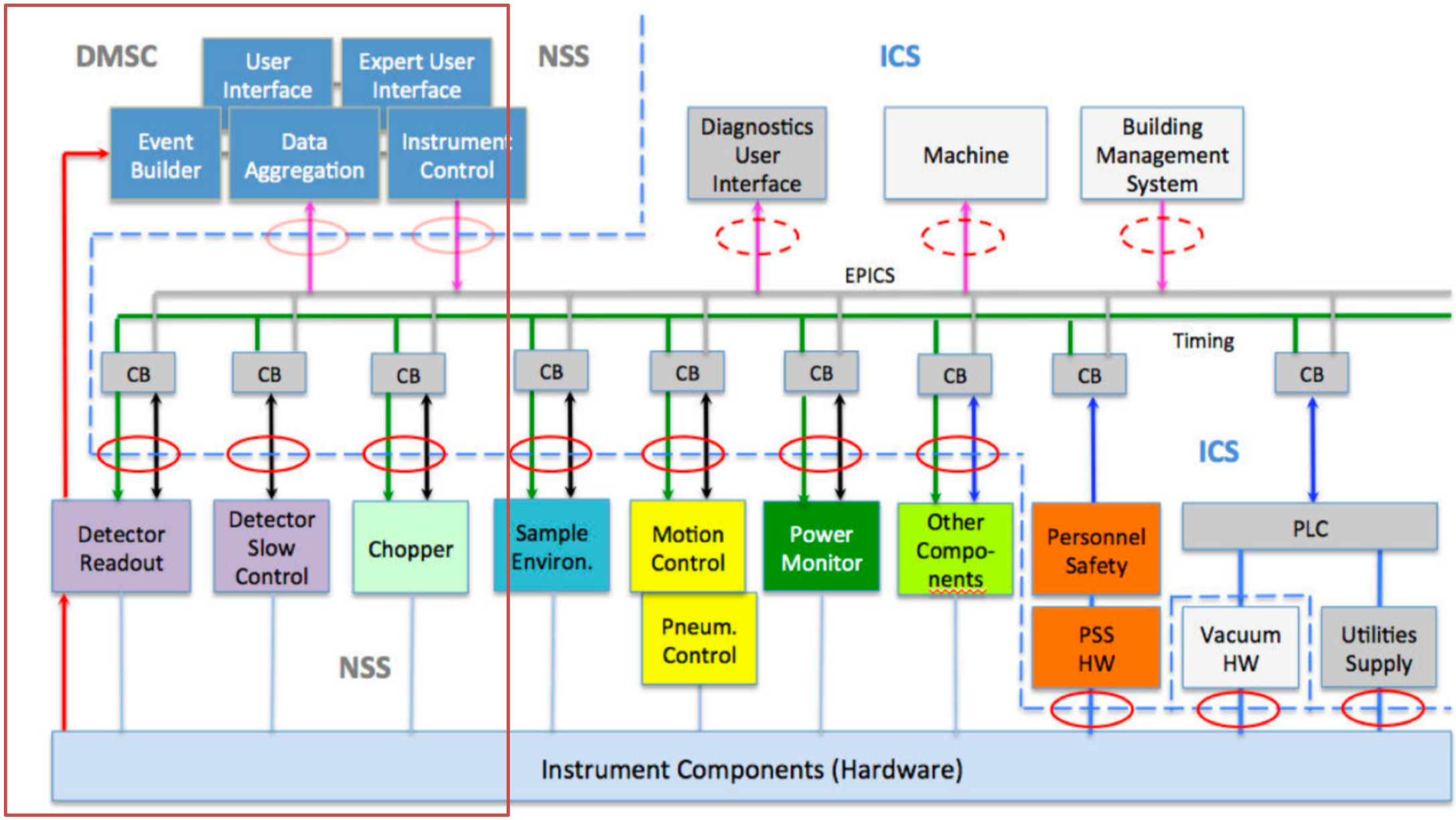
Status

- Beam Monitor Guidelines: Fatima's talk at the February IKON satellite on Detectors and DAQ
- https://indico.esss.lu.se/event/971/contributions/7732/attachments/7600/10786/IKON14_Beam_monitor_sub.pptx

- Recent IKON meetings:
  - Talks on Beam Monitors with GEMs and In-Beam Monitors
  - https://indico.esss.lu.se/event/971/ (Feb18)
  - https://indico.esss.lu.se/event/858/timetable/#20170927.detailed (Sep17)
  - And previous IKONs

Beam Monitor Readout

Vertical Integration Tests at HZB: ESS Controls and Readout Architecture



Tested: Vertical integration and commissioning

V20 test at HZB

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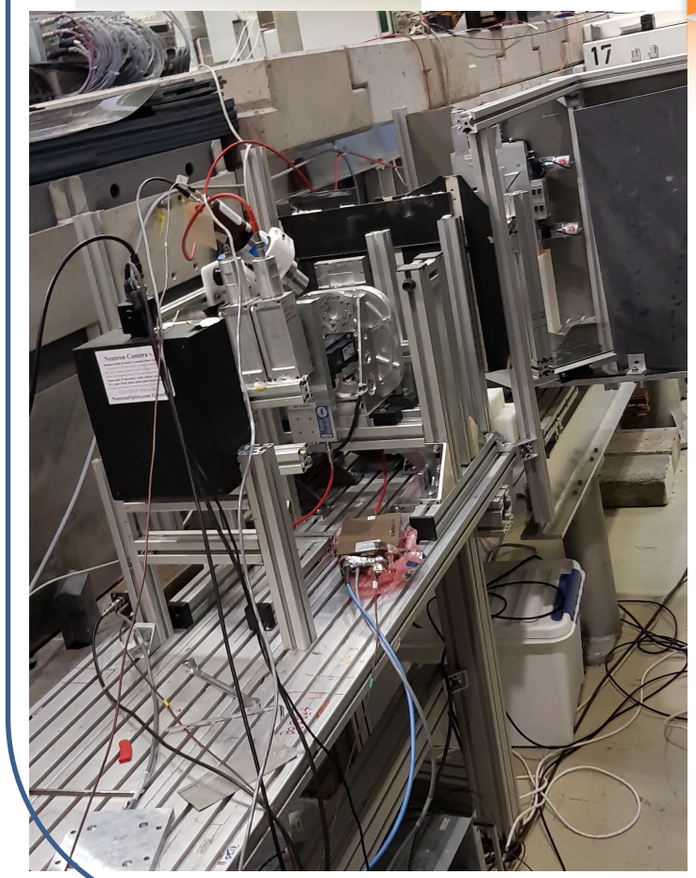
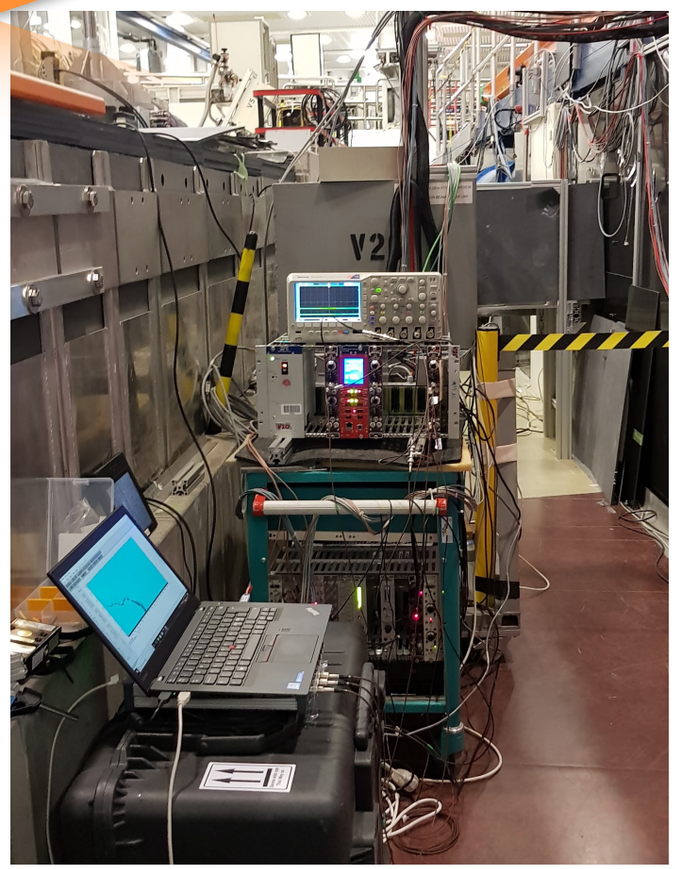
Beam monitor

Front end AMP



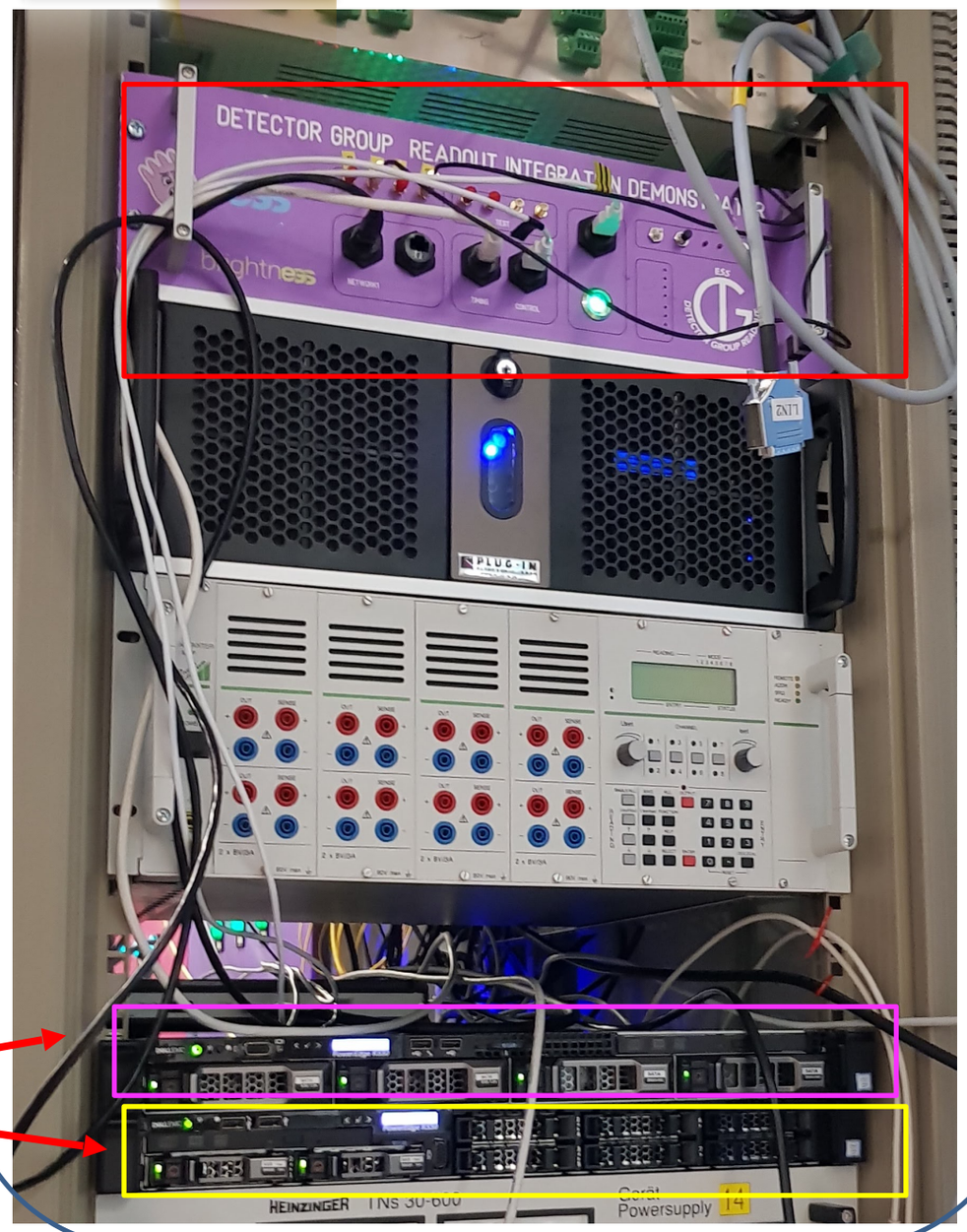


Timing EPICS

DAQ

DMSC

Event formation

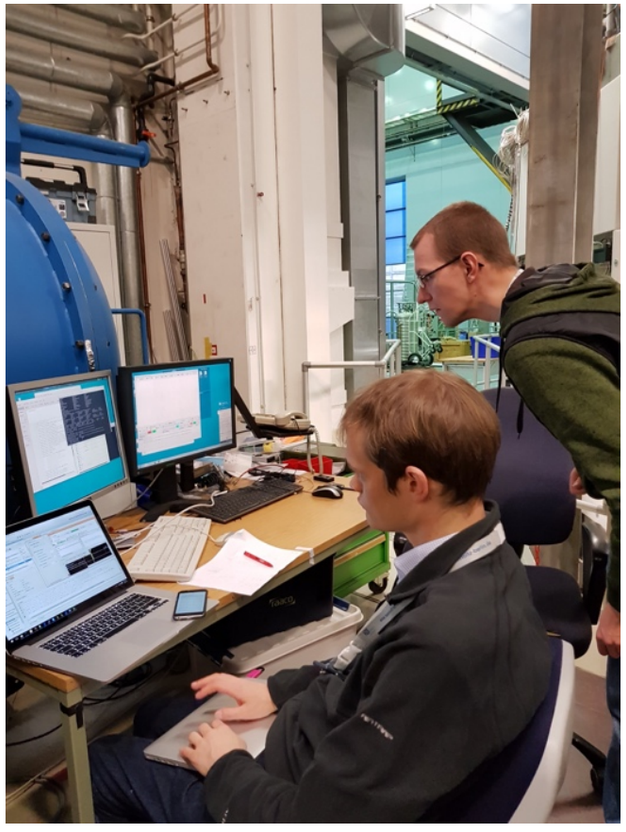


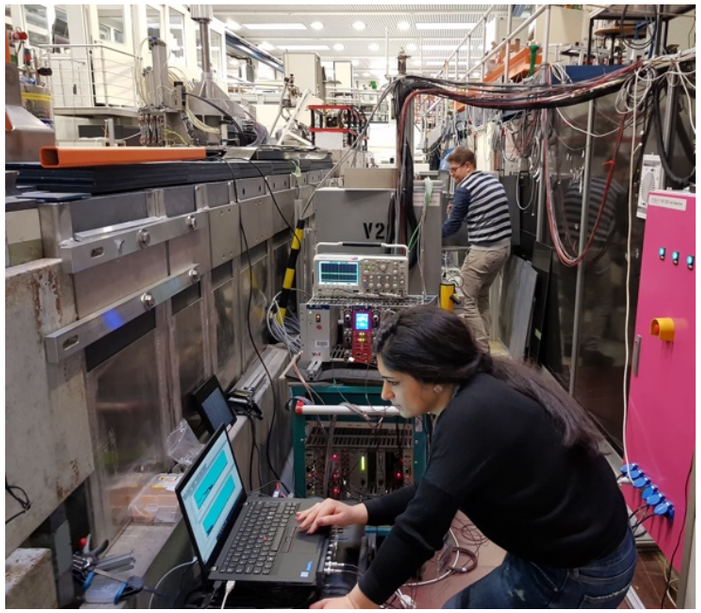
DMSC and ICS

BM electronics several options (for more details see Scott talk at IKON13):

- ✓ Integration Demonstrator (Done)
- ❑ Talin
- ❑ Talin ++
- ❑ Standard detector readout (especially for 1D/2D monitors)

V20 test at HZB





V20 test at HZB-Berlin:

- ❑ Detector Group
- ❑ Chopper Group
- ❑ DMSC
- ❑ ICS

Vertical Integration Tests at HZB: ESS Controls and Readout Architecture

HZB Helmholtz Zentrum Berlin

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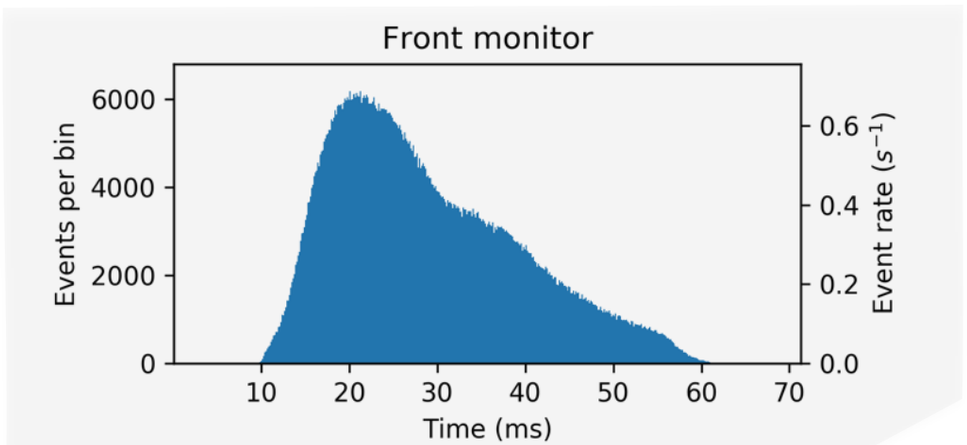
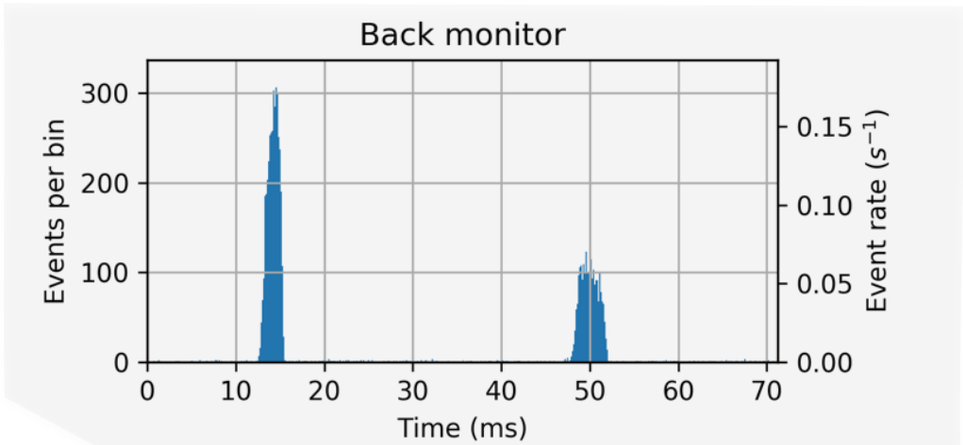
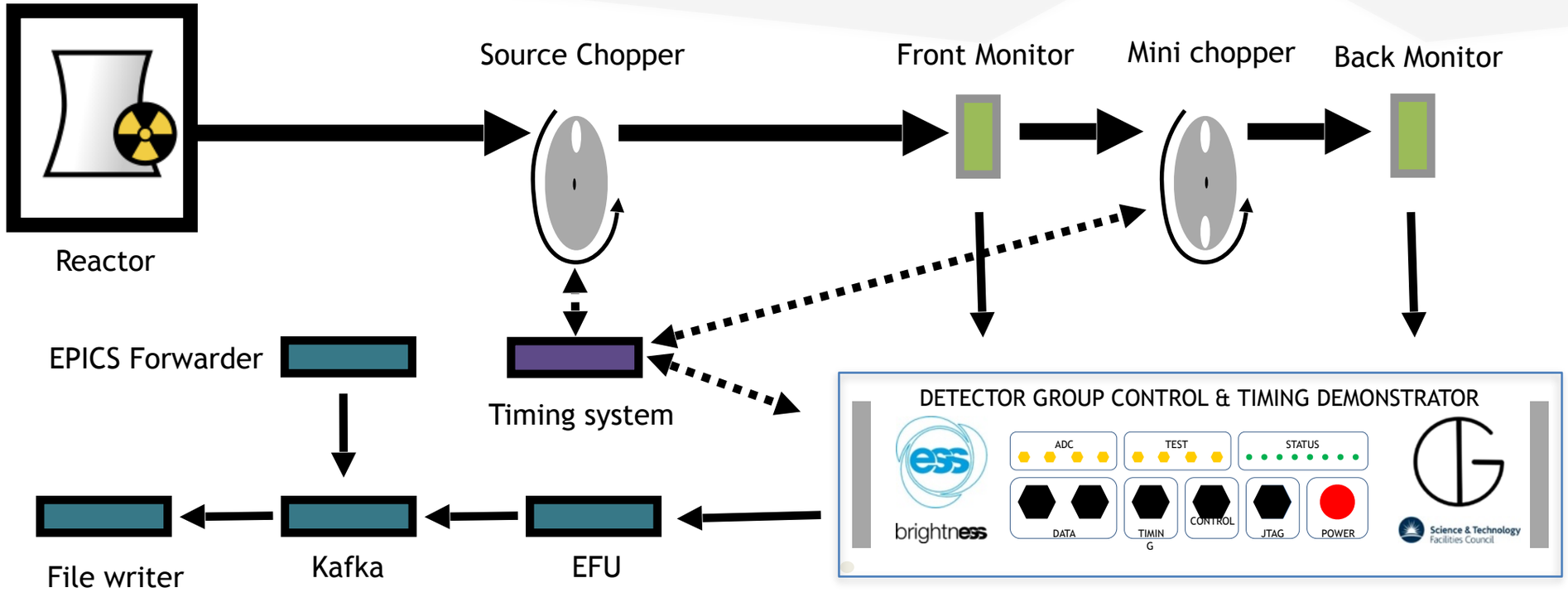
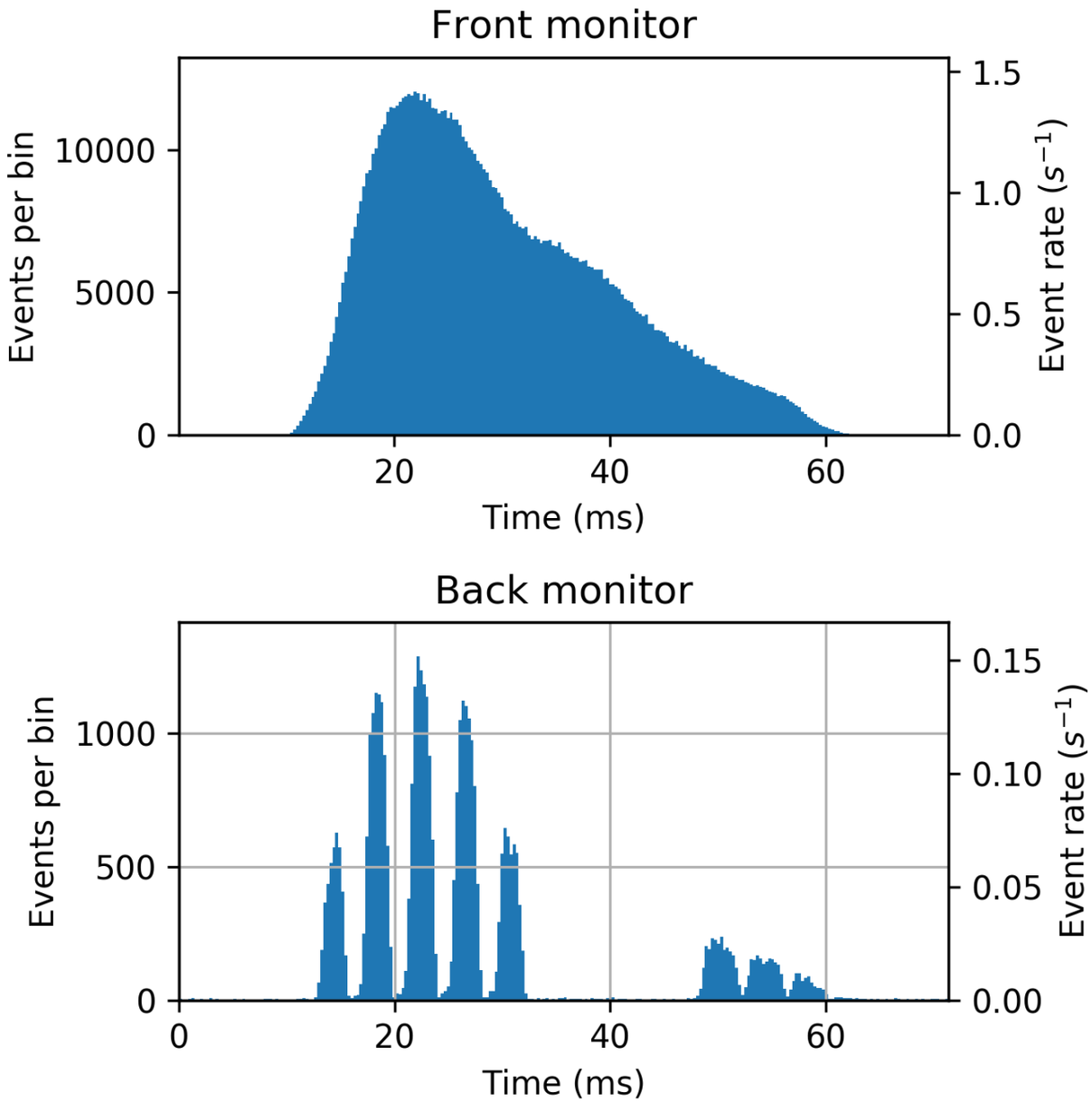


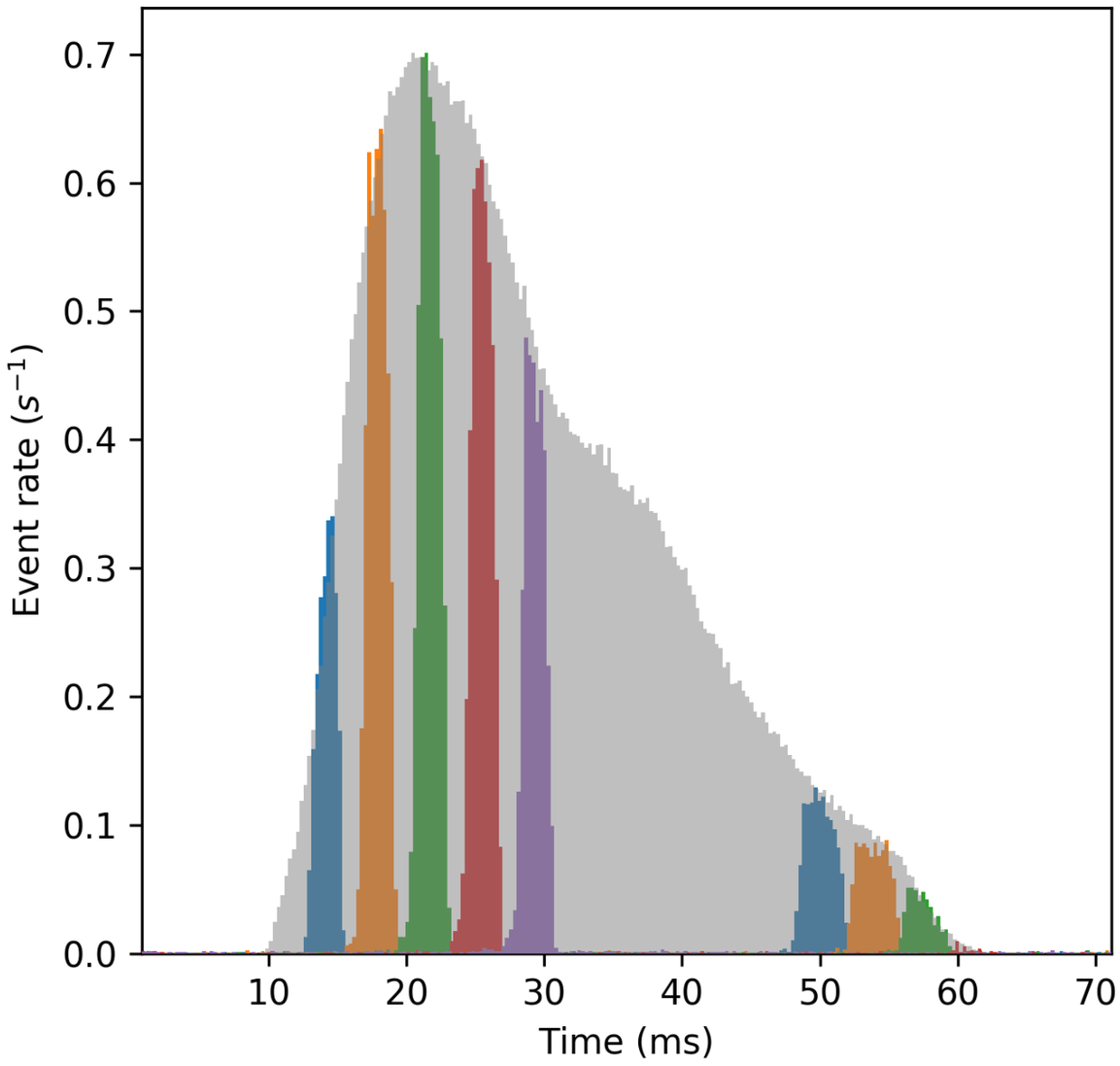




NICOS Networked Instrument COntrol System

Test Results: Neutron monitor data





Overnight experiment using NICOS user interface

Prototype Beam Monitor Readout Exists

Need for Beam Monitors

Bunker

- There is a need to understand what is coming from the beam extraction
- The low-dimensional moderator is very alignment sensitive
- What is coming out of the monolith is the first question to ask
- A continual measurement allows long term performance to be understood, and improved

Guides

- The level of complexity of ESS instruments means that there is a greater need for diagnostics for commissioning
- There is also a need for diagnostics for enabling fault-finding
- Some level of measurement of monitoring of the chopper cascade is needed

Before and after sample

- In general the requirements and use-case for operation of the instruments have not been written down in detail
- Requirements will be complex and need detailed consideration
- **Rasmus Toft-Petersen is organising a meeting on this, Friday, 9-12 at the ESS site “Amazon"**
- Please contact him if you would like to attend

Beam monitors per zone: prioritise bunker and guides first

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Challenges

radiation hardness
Saturation

mechanical integration
attenuation

attenuation
scattering

Use-cases and requirements to be developed based upon instrument needs

scattering

Bunker area

Guideline

Sample area

n-camera

Beam stop

“Flux” BM

“Flux” BM

“Position sensitive” BM

“Position sensitive” Transmission BM

F(t)

F(t)

F(t)
F(x,y,t)

F(x,y) **F(t)**
F(x,y,t)

Flux (x,y,t)

10^{10} - 10^{12} n/cm².s

10^{7}- 10^{10} n/cm².s

Neutron Flux at various locations

Very different challenges and requirements

Beam monitors per zone

Challenges

radiation hardness
Saturation

GEM (CNR, CDT)
Fission Chamber
Ionisation

mechanical integration
attenuation

Ideally Parasitic?

Scint Fibres
Vd Foils
Gamma off choppers
Thinned monitor
In-Beam Monitor

attenuation
scattering

Use-cases and requirements to be developed based upon instrument needs

scattering

Flux (x,y,t)

Bunker area

Guideline

Sample area

n-camera

Beam stop

"Flux" BM

"Flux" BM

"Position sensitive" BM

"Position sensitive" Transmission BM

F(t)

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F(x,y) **F(t)**
F(x,y,t)

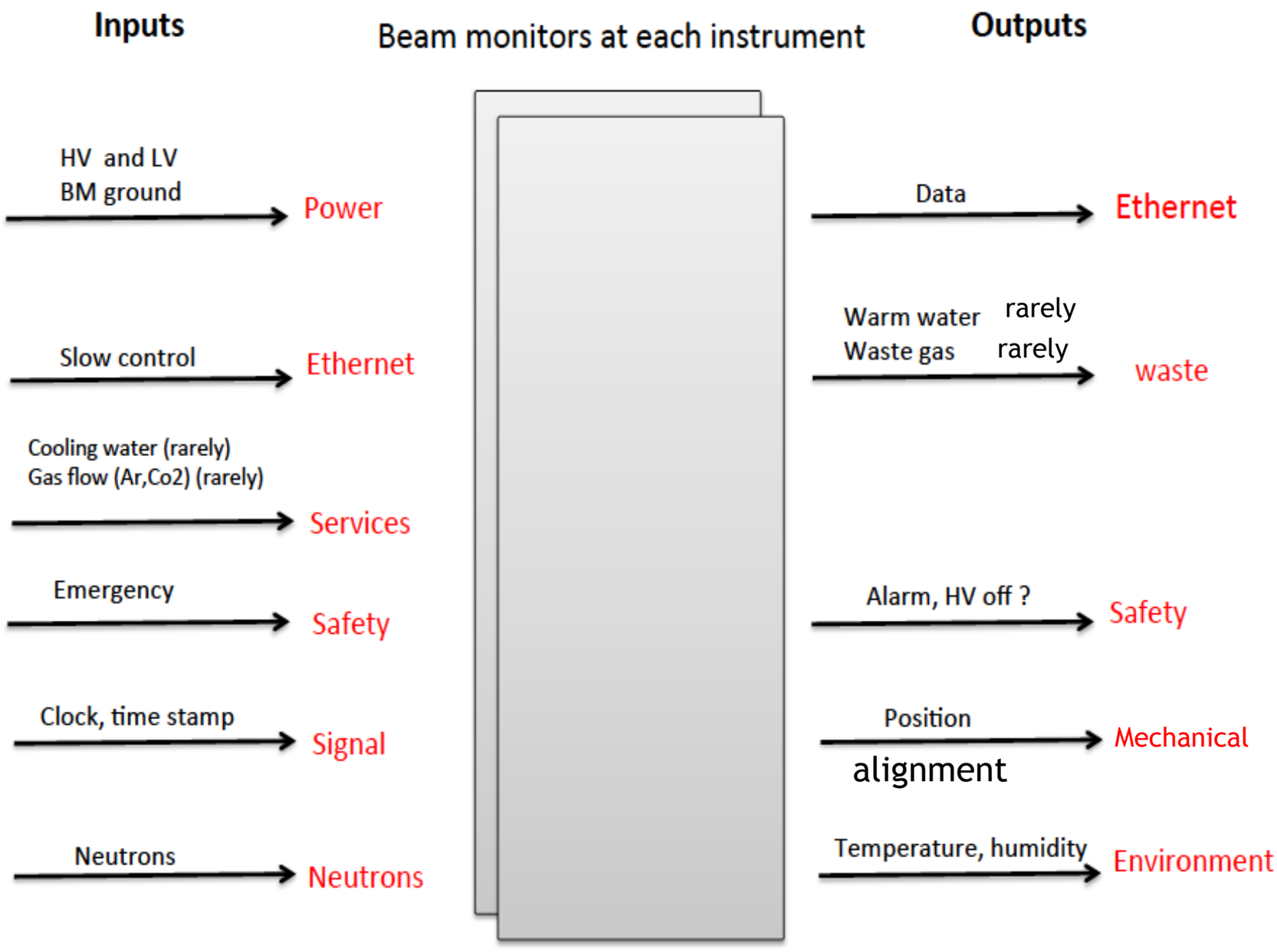
10^{10} - 10^{12} n/cm^2.s

10^{7}- 10^{10} n/cm^2.s

Neutron Flux at various locations

Very different challenges and requirements

Beam monitor system Integration



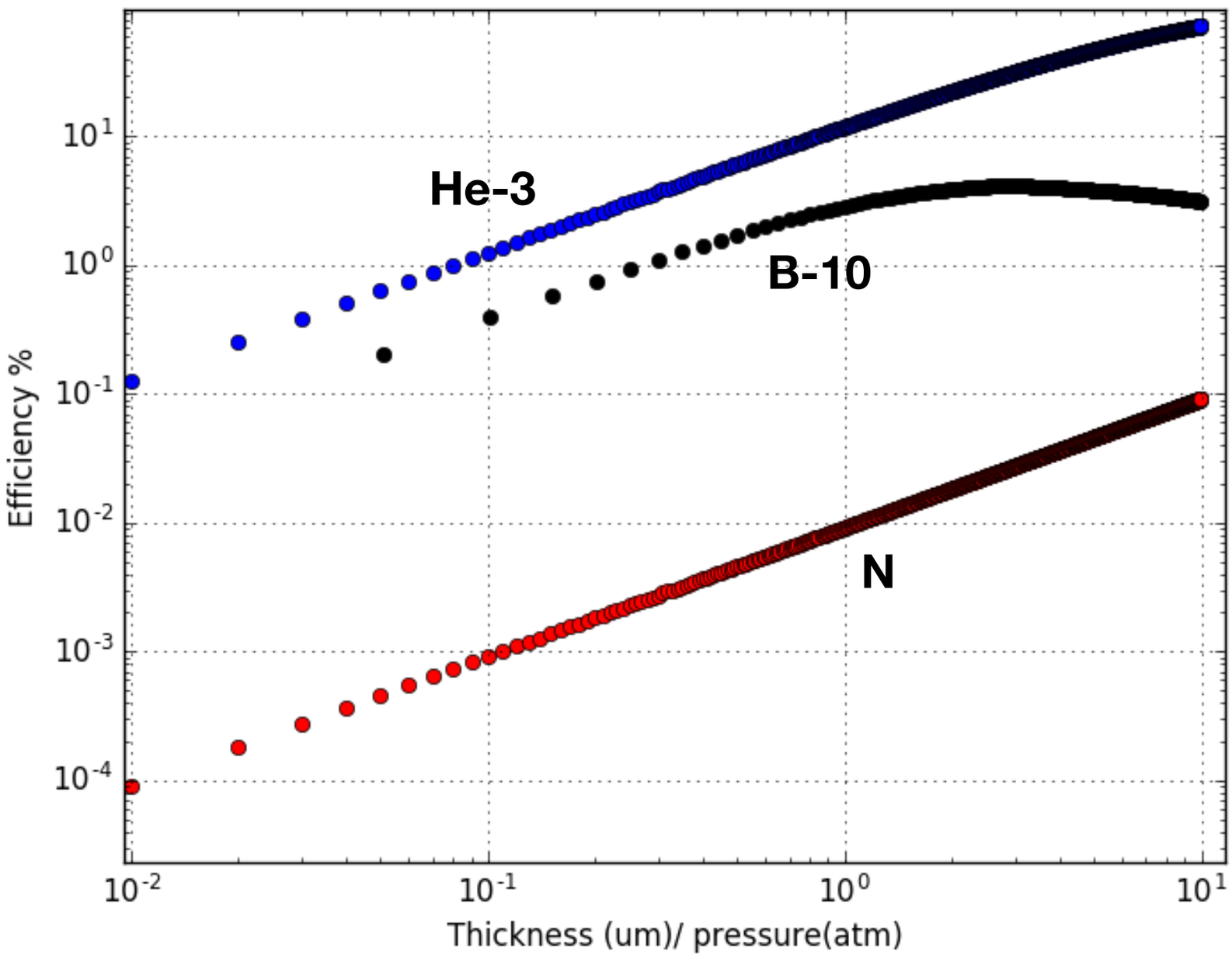
Rates (eg SANS Transmission Monitor)

- Detector placed at zero angle to be used for data normalisation
- Requirements for detection efficiency and spatial resolution to be provided by instrument teams
- Eg K. Kanaki et al, Detector rates for the Small Angle Neutron Scattering instruments at the European Spallation Source, JINST 13 (2018) P07016, doi:10.1088/1748-0221/13/07/P07016, bitbucket, arxiv:1805.12334

config	global average incident rate	global peak incident rate
1	911 MHz	3.6 GHz
2	193 MHz	785 MHz
3	78 MHz	219 MHz

- What should the efficiency be? Current rather than counting mode?

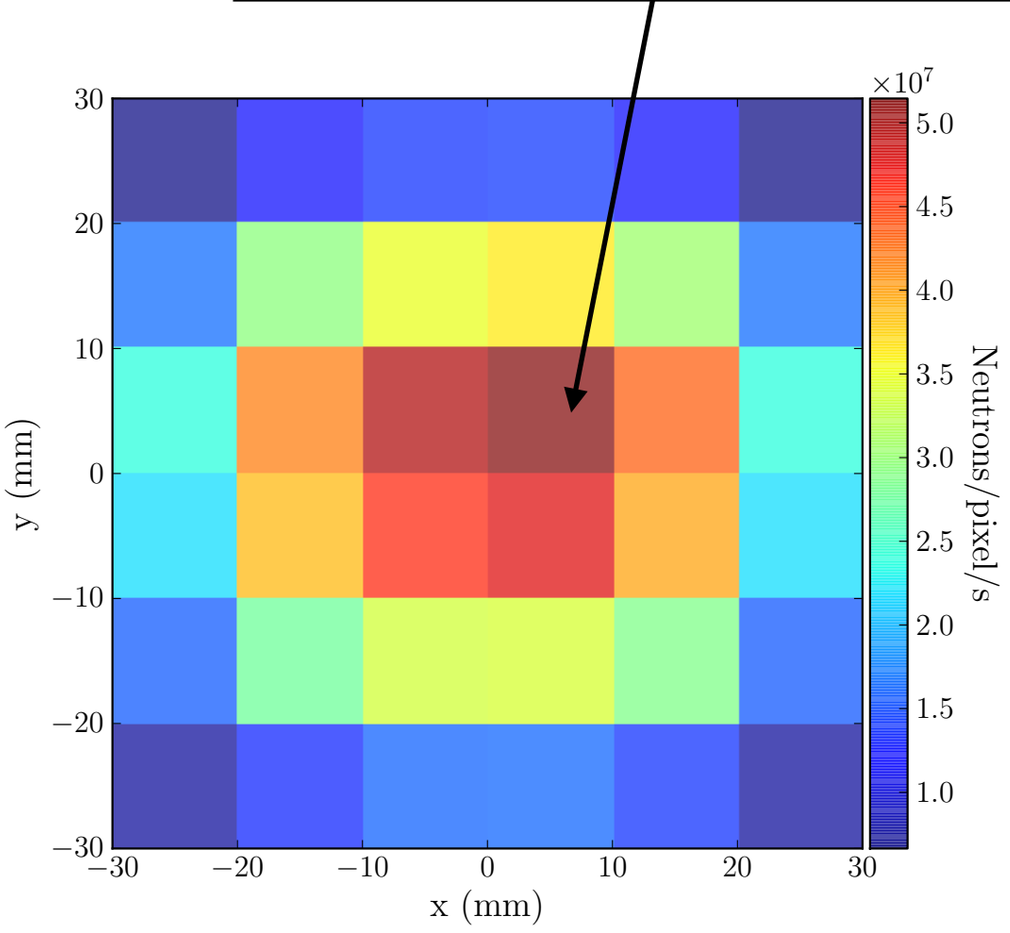
Efficiency

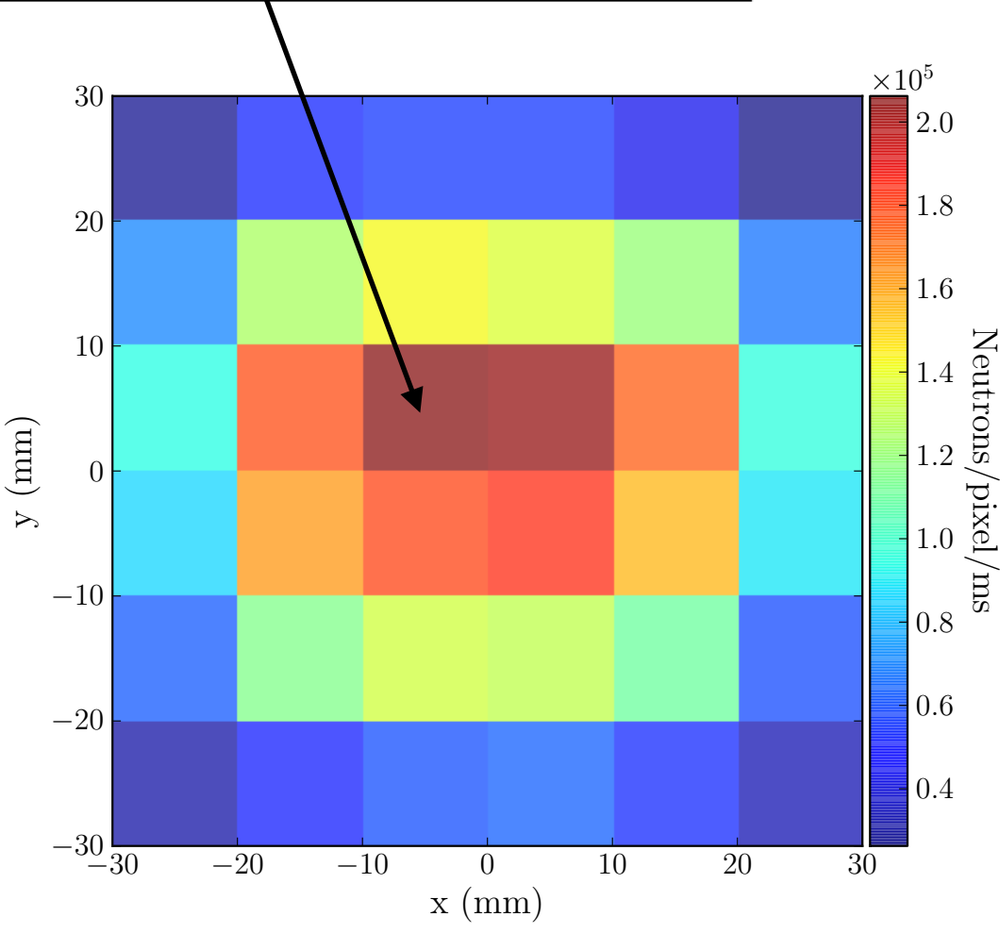


- Efficiencies can be reduced
- At some point secondary processes may become important
- Background discrimination may be competitive
- Getting the balance S:B is complex
- A very large dynamic range is needed

Local incident rates for TM

config	local average incident rate /cm^2 /9mm^2 /wire	local peak incident rate /cm^2 /9mm^2 /wire
1	52 / 5 / 95 MHz	206 / 22 / 385 MHz
2	30 / 4 / 37 MHz	134 / 19 / 154 MHz
3	17 / 3 / 20 MHz	49 / 11 / 81 MHz





Source Power ramp up *from NSS Master Schedule (V4.0 – 11th May 2018)*

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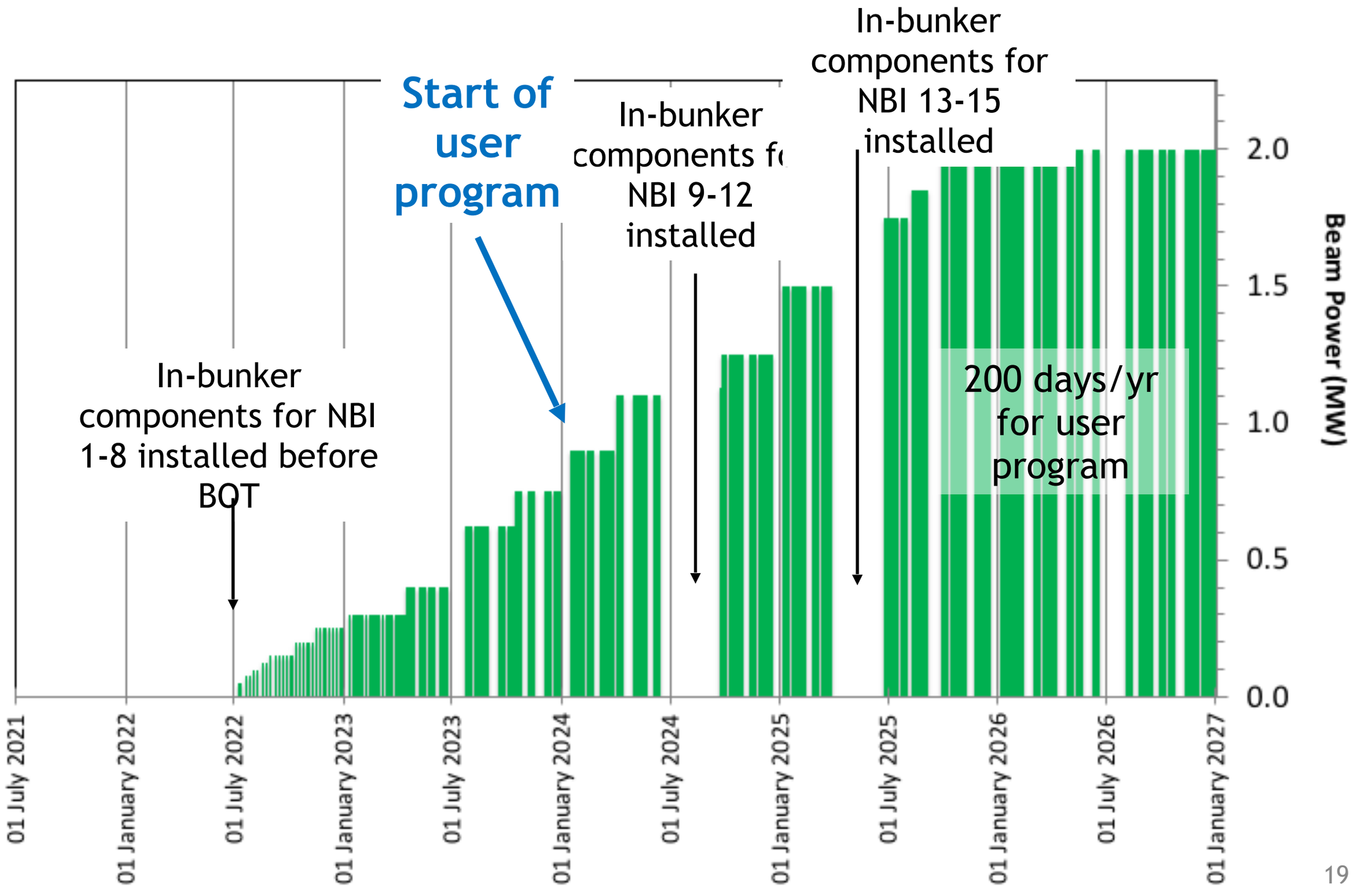
(Work in progress: - discussion with Accelerator & Target Project teams is ongoing)



Proposal for Common Project on Beam Monitors

Proposal for Beam Monitor Common Project

Why?

- Beam Monitors are a common item across instruments.
- Given the high multiplicity of equipment on ESS instruments, they will be correspondingly more important
- Most of the functionality is common: instantaneous flux monitoring, commissioning, diagnostics, long term performance
- The operational details and installation, commissioning is similarly common
- A large amount of NRE will (are?) be performed per instrument, which can be down at lower cost centrally
- The aim of this project is to save on total costs for the instruments from beam monitors

Scope of Proposed Common Project

Common project to be managed by ESS detector group.
The project has 2 phases: a design phase and a provision phase:

- **Phase 1: Design Phase.**
  - This will provide a design to define a minimal beam monitor system capable of commissioning and operating the instrument. It will provide additionally diagnostic information for fault analysis, and a dataset to allow long term monitoring and enhancement of performance. *It will fulfil science case of instrument.*
  - The design is for 0-1MW of ESS source power. There may be limits on full functionality at 2MW
  - Outcomes: detailed requirements and choices for each instrument participating, detailed engineering design, working schedule, detailed resources&costing planning
- There will be a milestone review near to the end of Phase 1, to allow instruments to decide whether to process with phase 2.
- **Phase 2: Provision Phase.**
  - This is the implementation of the first phase. This means the provision of beam monitors, their installation and cold commissioning.

Proposal for Beam Monitor Common Project

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Schedule

- Phase 1: Duration of 1 year from the start of the common project and when labour resources are secured and in place
- Phase 2: As needed by installation schedule. Priority given to inaccessible locations and early instruments. A detailed working schedule will be one of the outcomes of phase 1.

Resources

Costs are total: the more instruments participate, the lower the cost.
The main cost is a level-of-effort person responsible for beam monitors

- **Phase 1: Design Phase.**
  - 1 PY detector expert
  - 0.25 PY engineering effort (0.25 PY engineering effort is assumed in already completed effort from instruments)
  - 20 kEUR Misc. costs.
- **Phase 2: Provision Phase.**
  - A detailed costing and resourcing will be an outcome of phase 1.
  - The cost target is <10 kEUR/monitor.
  - The labour envelope of <1PM/monitor.
  - The labour target is 0.5 PM/monitor

Proposal for Beam Monitor Common Project

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Expectations

- Instruments need to have monitoring at the bunker, along the guides, near the sample (before and after)
- In the *bunker*, candidate monitors exist. Detailed testing for robustness and operational performance (against background) is needed. Engineering is needed for remote handling.
- Along the *guides*, monitoring the gamma emission from choppers is a fully parasitic method. Engineering for implementation (defining line-of-sight and background shielding) and insensitivity against background is needed.
- *Before and after the sample*, candidate monitors exist. Most of all, careful matching of operational and commissioning requirements is needed to ensure that the monitors chosen match the needs of the instruments. Robustness, insensitivity against background, and unwanted scattering need to be evaluated.

Questions and Comments?

brightness