IKON19

BEAM MONITORS COMMON PROJECT

REPORT FOR IKON19

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1. STATUS OF OFFERS TO INSTRUMENTS

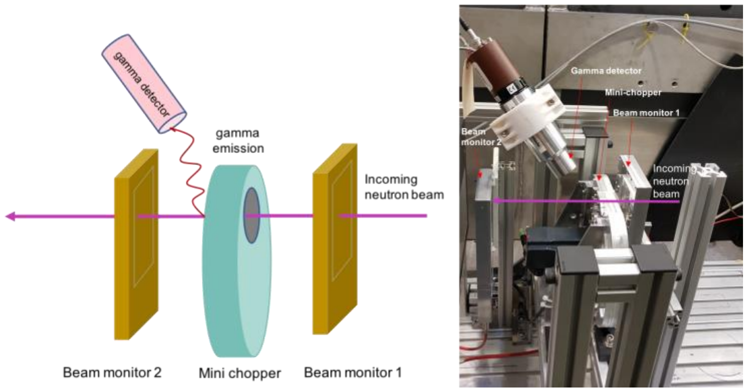
- ODIN offer accepted, preparing for chopper IDR and BM interfaces in the middle of September
- NMX offer accepted
- ESTIA offer accepted and TG3 documentation provided on the readout of their bunker monitor. Ready for procurement of equipment from January 2021.
- BIFROST offer sent, comments received and new offer will be sent before IKON19.
- Rest of offers are in preparation. Focus is given on the participants of the first 8 instruments.

2. V-BASED MONITOR

The V-based monitor results were published in the Physical Review Accelerators and Beams (arXiv:2002.10108v1, PRAB 23 (2020) 072901). The focus is on limits of operation with respect to background and the extraction of absolute neutron flux. The results indicate that the V-monitor will work as intended, as it can reliably reconstruct the absolute neutron beam flux. The systematics are well understood and can be now controlled. This gives confidence the performance and operation can be assured with a solid engineering design. The results were presented in detail at IKON18.

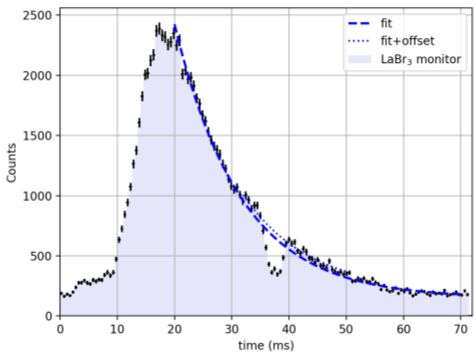
3. FULLY PARASITIC BEAM MONITOR – PROOF-OF-CONCEPT

The proof-of-concept for a fully parasitic monitor based on γ detection from the boron coating of a chopper disk has been accepted by Europhysics Letters and is pending publication (arXiv:2004.07336). The results imply that this approach has good potential for diagnostics of chopper operation. The sketch and photo below show the setup at V20. Two classical beam monitors are placed before and after the mini-chopper and a $LaBr_3$ scintillator is facing the chopper at a favourable angle. All monitors collect time-stamped data.

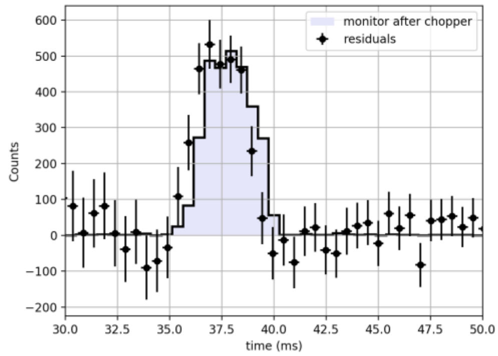


Sketch and photo of the parasitic monitor at V20.

The figures below show the raw neutron pulse as seen from the scintillator with a gap during the time that the chopper disk was open (left) and the residuals from a fit on the left plot compared to the raw measurement of the downstream monitor (right).



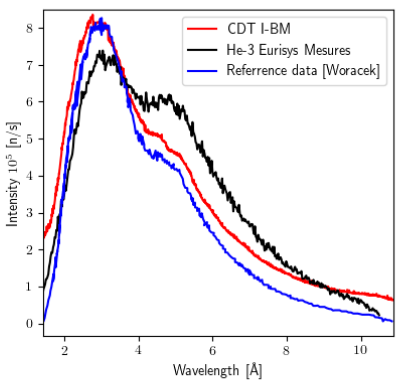
Time-resolved measurement with the $LaBr_3$ scintillator. The gap between 35-40 ms represents the time window when the chopper window is open.



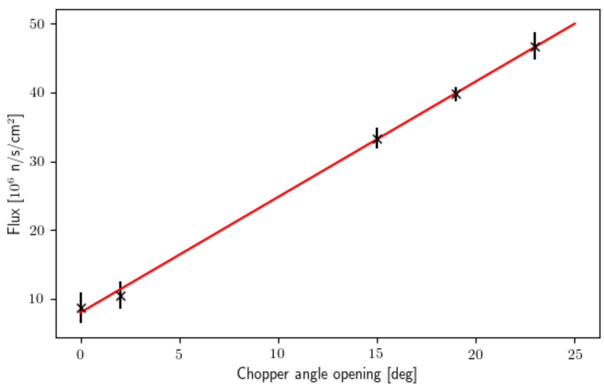
The residuals from the left plot compared to the measurement of the downstream monitor.

4. BEAM MONITOR BASED ON IONISATION CHAMBER PRINCIPLE

The analysis of the ionisation chamber (I-BM) data has concluded. A draft article is being finalised, in collaboration with the supplier of the monitor (CDT). It presents the evaluation of such a device for a neutron beam monitoring application, based on data collected in summer 2019 at V20. The CDT I-BM demonstrated good linearity, timing capability for various flux ranges, sensitivity to neutrons within the V20 range of 0.6-10 Å and pulse-by-pulse monitoring capability. Adjustability of the design was discussed and stability and attenuation are subject to future measurements.



Wavelength distribution with I-BM compared to other reference measurements.

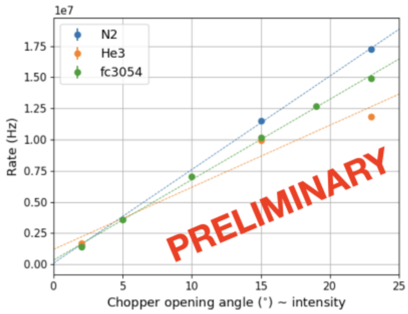


Absolute flux of I-BM as a function of chopper settings at V20.

Photo of the ionisation beam monitor from CDT.

5. DATA ANALYSIS OF TOF CHARACTERISTICS

The last available data set taken at V20 in 2019 is being analysed. Five monitor technologies were exposed to the beam and time-stamped data were collected. A first glimpse of the data was shown at IKON17. The effort is focusing on producing absolute fluxes for white neutron spectra, understanding TOF characteristics and chopper function, as well time-dependent response with respect to the environmental conditions and the reactor power. With this data analysis complete, the performance of all selected monitors is understood.

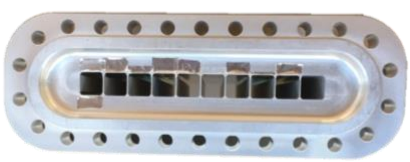


Absolute beam intensities as a function of chopper settings for 3 beam monitors, a ^{3}He-based, a N_2-based and a fission chamber.

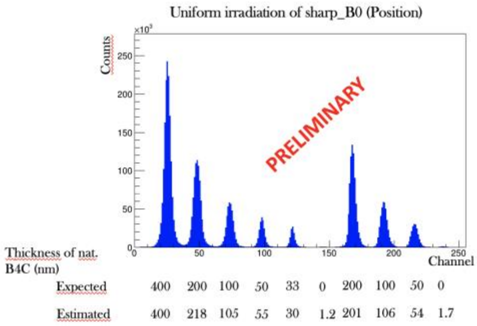
6. MULTITUBE BEAM MONITOR FROM ILL

Two additional beam monitors have been assembled, bringing a total to 4 devices being tested during the current reactor cycle at ILL. The first two are destined for local instruments. The other two provide 1D information. One of them is equipped with Boron layers of different thicknesses, created as thin Al foils coated at the ESS Linköping coating facility. This leads to cells with distinct detection efficiencies. Preliminary rate tests indicate that data can be acquired at 330 kHz with a 2% event loss. A detailed operational parameter scan is performed and further analysis is expected to conclude in the coming months about the optimal conditions for achieving the highest counting rates.

Thin Al foils coated with various B_4C thicknesses. They are folded and fixed inside the MultiTube monitor cells.



MultiTube beam monitor with the coated foils in place.



Events for the various cells of the MultiTube, equipped with varying B_4C thicknesses.

7. NEWS FROM SUPPLIERS

Over the summer a good amount of interactions took place with CASCADE Detector Technologies GmbH (CDT), the supplier of the ionisation beam monitor for the common project, as well for DREAM and MAGiC. A new engineering design has incorporated our requirements for space, connectivity and interfaces. An agreement has been reached that the design will be common for all ESS instruments who adopt the technology. The only free parameter is the B_4C coating thickness of the cathode, which determines the detection efficiency and for the sake of simplicity it should be reduced to 2-3 values in total to allow for coating time optimisation. The design allows for an easy replacement of the coated cathode, enabling the adjustment of the efficiency at higher power values of the ESS source.

8. RESOURCES OF THE PROJECT

After Anders Lindh Olsson's departure at the end of 2019, two more people are going to or have already left the project. Vendula Maulerová has already left ESS and is temporarily employed as a consultant until 31 October 2020. Ioannis Apostolidis has already started another position within NSS since August 2021. Steven Alcock remains available for electronics support per demand. Kalliopi Kanaki is dedicating up to 40% of her time. Given this situation the progress of the project will slow down further, as it is subject to recruitment approvals. The issue has been raised to NSS management.

9. MISCELLANEOUS

- A TG3 review document is released (CHESS ID: ESS-2505100) for non-participating instruments in the common project.
- Based on the former, two CTV reviews have already taken place for the DREAM and MAGIC beam monitors.
- A regular biweekly meeting with Andrew Jackson has been set up to provide updates on the progress of the BM common project and address questions that arise from instruments.