EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Proposal to the ISOLDE and Neutron Time-of-Flight Committee

Re-commissioning of n_TOF EAR1

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The n_TOF Collaboration

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Abstract

The neutron time-of-flight facility n_TOF will be operational by July 2014 using simultaneously two beam lines with the same spallation target. The present shutdown has been used also to improve the already existing experimental area EAR1. Some of the modifications affect the characteristics of the neutron beam and therefore a re-commissioning is necessary. We propose a series of measurements to be performed at EAR1 as soon as beam becomes available.

Requested protons: 3.9×10^{18} protons on target
Experimental Area: EAR1

Introduction

The neutron time-of-flight facility n_TOF is currently undergoing important alterations. A second experimental area EAR2 at a short flight distance is under construction [1, 2]. At the same time, the existing experimental area EAR1 located at about 185 m from the spallation target is being modified on several points. Several of these modifications will affect directly the characteristics of the neutron beam. A re-commissioning is therefore needed.
From the modifications influencing the neutron beam, the re-alignment of the first collimator at 135 m is important for the available neutron flux. As observed by the measured beam profile the collimator was found to be misaligned by 1.9 cm horizontally and 0.75 cm vertically. The re-alignment will result in an significantly different neutron flux at EAR1. A second modification concerns the vacuum layout at the end of the beam line and is intended to improve the background conditions in EAR1. The 185 m vacuum was closed by a 0.5 mm thick Al window which was situated inside EAR1 and acted as a source of background. In the new configuration a 0.3 mm Al window will be situated just in front of the second collimator at 178 m, mounted on a reduced beam diameter flange. The vacuum is then maintained up to the inside EAR1 by an additional tube with thin kapton windows, in this way reducing the amount of in-beam material inside EAR1.
The present re-commissioning is focussed on determining the beam characteristics (flux, profile, and resolution), In addition we plan to measure the background of the BaF_2 TAC due to the influence of in-beam material (including in-beam detectors), and the response to the gamma-flash of several detectors, including the TAC with upgraded gated photomultipliers. Finally, long flight times covering the thermal neutron energy range will be within reach with the improved data acquisition system and will be explored, notably with C_6D_6 detectors. The present proposal does not foresee an extensive study to the origin and nature of the gamma flash, neither a detailed background mapping. This may be subject of a future proposal.

1 Determination of the neutron flux

An measurement of the neutron flux is possible only over a long time span and is routinely done with permanent in-beam detectors. Nevertheless we will perform a shorter flux measurement with the SiMon and MicroMegas flux detectors intended for EAR2 [2] together with the absolutely calibrated PTB flux detector. The PTB flux detector cannot be used in EAR2 because of the mass of ^{235}U which is too high, which would result in a too high instantaneous count rate. By performing a parallel measurement in EAR1 with the SiMon and MicroMegas flux detectors we will obtain a secondary standard which can then be used in EAR2. It has to be noted that all involved detectors use standard cross sections (^{6}Li(n,α), ^{10}B(n,α), ^{235}U(n,f)) and that for the purpose of absolute calibration only the relative count-rates are needed, and 2% counting statistics in 100 energy bins per decade is sufficient. The total number of protons requested for these measurements is $8 \cdot 10^{17}$ protons, as in the previous commissioning [3].

2 Determination of the neutron beam profile

A new transparent MicroMegas detector developed by CEA and IN2P3 with a segmented mesh and anode acting as a XY detector is currently being developed and will be used to measure the beam profile. Also a new flux detector, developed by INFN for EAR2, using a thin ^{6}Li layer sandwiched between two silicon strip detectors, may be used in parallel. The beam profile is needed to determine the neutron energy-dependent beam fraction intercepted by capture samples. In addition, it will give important information and nearly immediate feedback on the alignment of the collimation system. The requested number of $6 \cdot 10^{17}$ protons is the same as in the 2008 commissioning [3].

3 Determination of the resolution function

The response function of the neutron spectrometer in terms of the distribution in time-of-flight of a neutron with a given energy is commonly called the resolution function. Well known isolated resonances with small total widths are used for measurements aiming to validate the resolution function obtained from simulations. For this purpose we plan to use a 0.6 g/cm^2 thick ^{56}Fe sample together with the C_6D_6 detector setup. Similar to what was mentioned in ref. [3], in order to detect 1000 counts in the 181 keV resonance of ^{56}Fe, a number of $2.3 \cdot 10^{17}/\epsilon$ protons is needed. Taking $\epsilon = 0.2$ for the efficiency ϵ of C_6D_6 detector setup, this results in a total of $12 \cdot 10^{17}$ protons.

4 Determination of backgrounds on the capture detectors

The background measurements will be concentrated on the performance of the TAC in order to increase the upper limit of the exploitable energy range. Gated photo-multipliers are currently being investigated and if available, will be used in order to minimize the effect of the gamma flash.
For the C_6D_6 detector setup the background in the thermal region will be examined. For this new data acquisition modules are needed, which should span a time window of 100 ms with a 1 or 2 ns sampling frequency, for both the flux and the C_6D_6 detectors.
The influence of the presence of upstream in-beam material like the flux detectors will be studied in addition to several standard samples (empty, C, Au, ^{238}U).
The proposed measurements do not imply a detailed background study of all background components, but focus on the influence of unavoidable in-beam material on the BaF_2 and C_6D_6 capture detectors. A total of $4 \cdot 10^{17}$ protons is foreseen.

5 Determination of the response of detectors

A number of $5 \cdot 10^{17}$ protons is foreseen to test the response of previously used and new detectors, in particular at short times following the gamma flash, in order to evaluate the feasibility of future experiments. Such detectors may include $LaBr_3$ and NaI crystals, part of a CsI/Si array as well as HPGe detectors. Also the SiMon and MicroMegas will be tested as proton detectors in order to be used for (n,p) reactions. This may include runs with low intensity proton bursts.

6 Summary of requested protons

The following table summarizes the number of protons needed for the re-commissioning of EAR1. About 10% additional protons are scheduled as "unforeseen" accounting for possible additional measurements to be identified during data taking. It should be noted that the re-commissioning of EAR1 will be done in parallel with the commissioning of EAR2 but the total number of protons for EAR1 is about one third of that for EAR2.

Table 1: Summary of requested number of protons for the commissioning of EAR2.

measurement	#protons ($\times 10^{17}$ protons)
neutron flux	8
beam profile	6
resolution	12
backgrounds	4
detector tests	5
unforeseen	4
total #protons	**39**

References

[1] The n_TOF Collaboration. "Proposal for n_TOF Experimental Area 2 (EAR-2)". *CERN-INTC-2012-029 / INTC-O-015* (2012).

[2] The n_TOF Collaboration. "Commissioning of n_TOF EAR2". *CERN-INTC-2013-043 / INTC-P-399* (2013).

[3] The n_TOF Collaboration. "n_TOF new target commissioning and beam characterization". *CERN-INTC-2008-035 / INTC-P-249* (2008).