n_TOF Collaboration Meeting

Bologna, Thursday, November 28, 2013

Opening

The meeting is opened at 08:50 by EC as he gives an overview of the day's discussions. Minutes are taken by AT.

Material is available on INDICO at: https://indico.cern.ch/conferenceDisplay.py?confId=275569

Status of the EAR-2 project (E. Chiaveri)

EC begins by showing a series of images of the construction site, starting from the work in the spring of 2013 to this day. The civil engineering work will be completed before the end of the year, including finishing works and landscaping. There will be some delay concerning the ventilation system: work will be ongoing while the installation of the EAR is happening in June 2014. The preparatory work for the electrical supply is done and the connection can be made at any time when access to the bunker is given to the relevant group. Assembly of the permanent sweeping magnet (0.3 Tm) is well under way and should be completed by the end of the year. Simulation work will be presented in the corresponding talks, while a dedicated talk on the beam line configuration is scheduled for later today. Installation of the beam line is foreseen for March 2014. Some elements are already in construction, other designs need to be finalised. Optimisation of the shielding of the ISR area is still an ongoing investigation. Several 3-D views of the beam line and bunker are shown. The general planning is on schedule, despite the aforementioned delay with the installation of the ventilation system. The 2014 run is expected to last between July 10 and December 15. The design of the baskets for irradiations near the target is ongoing, but is not an urgent priority. A summary of challenges for the operation of EAR-2 is presented, concerning issues arising from the vertical beam, the complicated changes of setup, safety issues etc., especially as intervention possibilities will be limited after installation. EAR-2 will be ready for commissioning at the end of June.

In the following discussion, PW asks whether it is confirmed that the position of the samples will be at 1.5m and whether there will be flexibility in this respect. This still seems to be a reasonable choice for practical reasons, also considering the presence of monitoring systems etc. NC points out it would be difficult to run parallel (n,α) and (n,γ) measurements.

Status of EAR-2 simulations (S. Barros)

SB presents several sets of simulations covering different aspects of EAR-2.

<u>Gap material around the 2nd collimator</u>

Several setups were studied with a view to reducing backgrounds. The setup with B_4C seems to provide the lowest background. There is a factor of 3 change in the beam halo between different setups. In general, setups with boron are better than the ones with lithium concerning neutrons outside the beam. Background gammas on the other hand are suppressed in the lithium setups.

2nd collimator and block material

The lowest neutron background is present for the “all B” or “B+^{6}Li” setups. A factor of 3 change in halo between boron and lithium is expected. The off-beam gammas are similar between all setups.

C6D6

Beam interactions with mylar windows and samples were studied, also in relation to the collimator material. A figure of merit has been developed accounting for the distances between windows, samples and detectors.

Capture setup

Two configurations studied for the collimator design, to get a final beam radius of 1cm with the minimum possible halo.

Fission setup

The goal was to obtain a neutron halo of 6cm radius with a 3.3cm radius flat beam profile. The aperture of the block in the ground needs to be optimised to reduce the background.

In the following discussion, LTG asks whether the decay of pions was taken into account. VV answers that everything was included in the particle transport. CG remarks on the C6D6 simulations that the radius of the gammas goes up to 5cm, not 2.5cm like the neutrons: does this mean the detectors will need to be placed at 5cm from the beam? This is twice than in EAR-1, meaning 4 times less efficiency. He suggests to perform simulations with the detectors at a closer distance, because this would influence the projected proton budget for measurements. FG remarks that there is a big background and VV agrees, but does not see a way to strongly reduce it without worsening the beam profile. Re-arranging the positioning of e.g. the Si monitor could help, since the background is due to neutrons scattered inside the collimator so it is better to be closer to the opening. NC remarks that a more serious concern is not the out of beam backgrounds but the in-beam gammas that will be scattered by the samples and enter the detectors. VV remarks that there is no boron layer towards EAR-2 to suppress the 2.2MeV rays. CG points out that in terms of neutron to gamma ratio, the situation is comparable to EAR-1. EC strongly remarks that a decision is due very soon, since the components need to be produced in time. More detailed simulations are needed. VV says that it will not be possible to have the most detailed results before March, not least because a detailed geometry is much more CPU-intensive. NC says that it is more appropriate to make the proposals after the commissioning, because anyway simulations cannot always be trusted; we should first learn how the area works. A possible compromise could be to submit Letters of Intent instead of proposals. EG raises the point of the γ-flash in EAR-1: is it expected to be lower in EAR-2? CW answers this is indeed the case concerning the in-beam gammas, as already presented in the EAR-2 proposal.

Outlook on MCNP simulation for EAR-2 at CIEMAT (E. Mendoza on behalf of D. Cano-Ott)

An MCNPX geometry of the full EAR-2 facility has been created, including all components and is ready and available for additional and auxiliary simulations. A few preliminary calculations have been performed to study the neutron and photon flux around the beam axis in the experimental area.

FG asks if the interest is to compare with the FLUKA simulations, since the geometry is the same. He remarks it could be a useful cross-check. EM answers that it could be done. VV agrees it would be a good idea. The MCNP source (neutrons) are the FLUKA results provided by VV. NC comments that photons should also be added and VV answers that the data is already available.

EAR-2 Beam Line - Report on the Status (C. Weiss)

CW presents a schematic overview of the full EAR-2 facility, from the target to the experimental area. Several considerations have to be made concerning exchangeable components for different measurements, backgrounds, optimised neutron fluence, dose rate in the ISR area, setup flexibility and beam alignment. Feasibility of all these measures has to be confirmed.

The vacuum chambers that will be present along the line are shown, including one close to the target to allow for irradiation of materials and components, one at the 2nd collimator to allow for the insertion of the collimator and to optimize shielding, one for the SiMon and one at the beam dump to insert shielding material to reduce neutron backscattering. The proposed design of these components is shown.

Two collimators will be present along the line. The first one (1m in iron) will be cylindrical, 20cm in diameter and placed immediately below (before) the sweeping magnet. The 1st collimator will be removed for fission measurements. The 2nd one will be conical and will have different diameters for capture and fission measurements and is located immediately under the floor of the experimental area. It will be inserted into a steel vacuum vessel, will have a 2m long steel section and a 1m long PE section (with boron or lithium). Unfortunately, for technical reasons, a conical collimator cannot be machined. A multi-step design will be used instead.

The shielding of the beam line is critical to maintain the dose rate in the ISR area at acceptable levels. Shielding will be present practically along the whole beam line, including concrete, and an iron collar at the level of the 1st collimator, while empty space will be filled with steel spheres. An additional layer of shielding will be installed on the floor of the experimental area (20 cm false floor) and below the beam dump. The shielding to be included between the target and the service gallery is shown. The proposed design of the concrete shielding components is presented, followed by details of the shielding at the level of the 2nd collimator.

The filter box will be installed in the service gallery, above the sweeping magnet. The samples to be included are under discussion and may include some additional samples compared to EAR-1. Input from the collaboration on the final choice of filters is invited.

There are design constraints for the beam dump. These concern radioprotection requirements and load limits imposed by civil engineering. These need to be adapted to background requirements for physics. The current proposed design is presented, and includes PE inserts (with boron or lithium) to reduce backscattering. These components will be exchangeable for different measurements. The main block will be in iron.

An overview of the capture setup is shown, including the sample exchanger, vacuum windows, vacuum valve, silicon monitor chamber, detector support frame and vacuum tubes. The top part of the beam line for capture and fission setups will have to be dismounted before the crane can be used to change the collimators. The procedure to change for capture to fission setup is expected to require 4-5 days.

Concerning the use of boron or lithium in the PE the choice will be based on simulations.

Additional issues to decide are the detector supports, equipment etc.

Discussion

PM remarks on the thick slab shown as a support for detectors. It si pointed out that this is not a final design. LTG remarks that the beam for fission in EAR-2 does not need to be of the size in EAR-1. NC repeats his comment that only one collimator should be foreseen for both capture and fission measurements with the parameters considered for the fission setup. CG remarks that the length of all the monitoring detectors placed after the 2nd collimator (SiMon etc.) should be minimized. EG asks if the walls will be covered, and if there will be Al all around as in EAR-1. This should not be the case. FG asks whether there will be a contribution to the background from the steel spheres and whether the addition of B_4C would be appropriate. CW replies that this seems to be the presented design seems to be the best. NC asks if the shutter in EAR-2 will be interlocked with the access. The answer is affirmative, which would seem to mitigate the danger of objects falling into the shaft. At the same time, this will not be a fast valve, so it will not serve to protect the setup from sudden loss of vacuum due to broken windows etc. Concerning filters, CM states that Cd would be a useful addition, while S and Al are less likely to be of use.

EAR-1 Beam Line - Report on the Status (O. Aberle)

OA presents an overview of interventions in the EAR-1 beam line.

Concerning the intervention to address the misalignment of the 1st collimator, the setup will be changed to allow it to be moved to optimise the position. The position of the collimator will be moved by 20cm downstream to accommodate the bellow that will precede it. The collimator will be disassembled in December and put in place in February with the new design.

Maintenance on the filter box is taking place on various components (supports, hydraulics etc.). A list of the samples and available slots is shown. Requests for changes should be forward to CW.

The vacuum window before EAR-1 is to be moved before the 2nd collimator, in order to replace the thick (0.5mm) aluminium window in the area with a thin kapton window. The gap in the EAR-1 wall will be reduced to 10cm diameter to reduce background from the collimator. The proposed design and location of the window (0.3mm aluminium) is shown. A fast valve will be placed at the same position. A chamber for transmission measurements could be added in this position.

The access system is being fully renewed. A new access zone has been created and members of the collaboration should check and apply for this new access, since the old one will expire soon. Online safety courses may be necessary.

Consolidation of the sweeping magnet is not straightforward, due to the scarcity of spare parts for old components, especially for the power supply. Connecting the magnet with the new DAQ is also a goal that is being pursued.

The storage spaces have been cleaned up and reorganised.

FG remarks that the transmission chamber could extend the capabilities of the facility. FK notes that the old W sample could be replaced with a thicker one. NC reminds that it was discussed in the past to replace a part of the tube with a non-conducting material to address the possible RF issue. This should be further studied. EM asks about the alignment of the experimental setups. OA responds that the survey people will be re-mapping the area from the target to the experimental area, which should mitigate past problems. EM adds that a system to easily replace tubes would be very useful. CG remarks that such a system is under considerations using laser markers.

DAQ consolidation for EAR-1 and EAR-2 (A. Hernandez Prieto and A. Masi)

A. Masi - n_ToF Experiment DAQ Hardware/Software Upgrade

AM describes the mandate, structure and activities of the group that will be supporting the hardware and software upgrade and operation of the new n_TOF DAQ. It is important to highlight that there will be continuous 24h support during operation of the facility to address any unexpected hardware or software issues.

The DAQ cards to be used at n_TOF are being tested, accounting for the various type of detectors that are foreseen to be used. Details on the specifications of the DAQ cards are given, along with the evaluation criteria for the final choice. The goal is to choose an industrial standard that will be supported for at least 10 years. The cards will be purchased by the 2nd quarter of 2014.

A person is working on the upgrade of all the web interfaces of n_TOF. Installation of all electronics, racks etc. is also part of this mandate. In order to better accomplish all goals, requests by the collaboration should be addressed to SM.

An overview of the software upgrades is presented. The middleware is being prepared to better handle information coming from many different platforms (vacuum, magnets, etc.). This will allow better modularity and integration of other devices. A new n_TOF Control Center Application is being built, inspired by corresponding LHC software. This will summarise all the main parameters of the experiment, alarms, warnings etc. A simple online data analysis will be performed to check the acquired data in almost real time. A few demonstrative screenshots are shown. In general, the software is being reorganised to better match well-established good practices at CERN.

At the same time, the logging system is being upgraded to keep track and archive the changes of all parameters. This information can be kept separate and correlated later with the data, or can be included in the raw data; this is to be decided.

All the work is going according to planning and the new DAQ should be ready for commissioning in May 2014.

A. Hernandez - Towards new Graphical User Interfaces for nTOF experiment

AH presents the new GUI configuration that will be available at n_TOF and to the person on shift.

The GUI will be independent from the DAQ: a crash of the GUI will not influence the data acquisition. The layout of the screens in the control room is shown. Screenshots detailing the main features of the

GUI are shown (see slides), including the warnings that will be prominently displayed. An interface to include comments in the electronic logbook is foreseen.

Some common controls will be grouped in one screen (e.g. beam parameters, start/stop etc.) The vistars (PS, EAR-1/2 slow parameters) will be displayed on a separate screen. A full info vistar will be available where all parameters will be accessible, along with their historical values.

An “Expert” mode will also be available, including high-voltage configuration etc. An event display will again be available to look at the raw data, both as a widget in the expert GUI and as a separate “application”.

Discussion

In the subsequent discussion, NC asks what routine will be used in the preliminary analysis. Additional information will be given in the upcoming talk by CG. LTG makes a remark on the DAQ module synchronisation and on slow control of e.g. the gas circulation system for the PPAC; could this be integrated? AM answers it should be possible since the DIM framework can handle multiple platforms, but this is something that needs to be discussed in advance. VV asks if it would be possible to connect externally to monitor a measurement only as a viewer. The answer by AM is affirmative. Finally, the position information of the sample exchanger should also be integrated.

Outlook on the RAW2DST2ROOT for n_TOF-Phase3 (C. Guerrero)

There are three levels of data at n_TOF. The binary raw data with the appropriate headers, the DST files (headers + reduced data with individual signal parameters obtained with the pulse analysis) and ROOT files containing the signal information in a format appropriate for analysis.

Several weaknesses are identified in the present system, concerning traceability, integration of new detectors etc. and the fact that there is only one version number for all detectors.

The present software is being backed-up and a doxygen documentation framework is in place. An SVN repository will be used to keep track of changes. When analysing the raw data, DSTs and ROOT files will be created automatically at the same time. The framework is moving to 64bits. The number/types of raw data analysis routines will be reduced.

A reliability test of the new system should be performed in April 2014. Tools will be available to users to more easily develop raw data analysis routines. The final production of DST/ROOT files will still be centralised. For future experiments, CW will be responsible. CG will still support the present system for previous measurements.

Discussion

NC asks if it will be possible to test this new system in time. CG answers that each change is tested on available data to check for problems. AM points out that this would be the time to eventually integrate additional slow parameters to the files. Furthermore, LTG points out the availability of the files and the delay at getting the DST files. CG points out that we cannot speed up the retrieval of data from tape on CASTOR.

Detailed planning for commissioning for EAR-1 and EAR-2 (F. Gunsing)

EAR-1 commissioning

Changes in the beamline e.g. 1^{st} collimator alignment, reduction of final vacuum tube, new window require a recommissioning for the beam profile, resolution function, backgrounds, response of existing/new detectors.

Note: Only a short summary of individual measurements is given in the minutes; details (e.g. proton allocation etc.) can be found in the slides.

The beam profile can be studied with the new transparent XY Micromegas, the new silicon monitor with ^{6}Li and PPACs. For the resolution function several measurements need to take place, also to improve on old measurements. Backgrounds in the TAC and the C6D6 should be measured and understood under the new conditions. For the detector response, several current and future detectors should be tested.

FG proposes that the acquisition time be extended from the present 80ms to include the thermal point. A thick Pb/Bi filter could decrease the in-beam gammas. The EAR configuration should always be recorded in the logbook. A reference positioning grid in the experimental area would be very useful.

NC remarks that the proton allocation for the resolution function is too high; the measurement of U could be removed. Additionally, a full campaign for the neutron flux should be repeated, considering all the changes in the beam line and the moderator circuit, where the boron content might be slightly different, as MC points out. The PTB chamber should probably be reused. LTG remarks that even with the capture collimator the low energy part of the flux can be measured with PPACs. Furthermore, the PPACs cannot give the absolute value, so the PTB is necessary.

EAR-2 commissioning

The proposal made to the INTC was approved (also by the Research Board). The proton allocation is already fixed.

Optimizing changes in EAR-2 (collimator setups etc.) is critical, so as to change only once during commissioning.

A mapping of backgrounds with off-beam detectors should be performed. Different setups (nothing in beam, material in beam e.g. windows, flux detectors, samples) in various combinations should be studied in order to identify and quantify individual contributions. Detectors for neutrons and gammas should be used, such as ^{3}He, CR-39, PPAC and MGAS outside the beam, ^{6}Li glass, Timepix, BC501 etc. for neutrons, C6D6, $LaBr_3$ etc., HPGe and others for the gammas.

Neutron flux measurements would be performed with PPACs, MGAS, the new SiMon, PTB (or with PPAC/MGAS calibrated at PTB) and activation of gold foils.

The beam profile would be measured with the new transparent XY-MGAS, the new SiMon with ^{6}Li (dedicated measurement), new PPAC, CR39 and beam halo measurements with Au activation.

Detector responses of various detectors should be tested and cross section validation measurement should be performed.

Discussion
NC remarks that there is no serious reason to determine the backgrounds in a grid including positions where there will be no measurements. FG replies that the grid is to be defined, and that we can decide to adapt it to actual needs.

CG points out that it may be difficult to obtain all the necessary samples for all the commissioning measurements. This should be set in motion soon. A comprehensive table should be put together.

AH remarks that the number of channels for a segmented SiMon could be a problem, because only a small number of channels is foreseen for SiMon.

Neutron capture at the s-process branching points ^{147}Pm, ^{171}Tm, ^{204}Tl and ^{79}Se (C. Guerrero)

CG presents the proposal for resonance and Maxwellian capture cross section of isotopes of the s-process. This is planned to be presented to the next INTC (at least for two isotopes). CG thanks the PSI group for the contribution to the preparation of the samples and ILL for the irradiations.

The motivation of the measurements is presented, as well as a literature overview which highlights the need for this campaign. Details on the samples are given, from the material to manufacturing the pellets to the irradiations to produce the desired isotopes, chemically separate them and produce the final samples. The isotopes are already decaying (around 2.5y half-life), so the experiment should take place early in the new n_TOF campaign.

The experiment would be performed with C6D6 detectors or the TAC. Depending on γ-flash and neutron sensitivity in the TAC and balancing with efficiency concerns and worse background discrimination in the C6D6 a final choice of detectors will be made. Expected count rates and backgrounds are presented for each isotope. The specific objectives for each isotope, in terms of energy range, resonances and desired uncertainties are shown.

A summary table of the measurements, possible detectors and proton requests is included in the slides.

Discussion
NC asks on the assumptions for the efficiency. CG discusses the point, also comparing between C6D6 and the TAC.

Testing fission tagging with C6D6 detectors in EAR-2 (E. Mendoza on behalf of D. Cano-Ott)

The proposal to measure the capture cross section of ^{235}U and ^{239}Pu by fission tagging with the C6D6 (instead of the TAC) is presented by EM. An overview of the motivation is given, along with a literature overview. An estimate of count rates and backgrounds is presented. The technique is used for the first time, but there is confidence that it will provide a tool for interesting measurements. A test in EAR-2 is proposed to validate it.

LTG remarks that the efficiency of the fission chamber is not 100% and we need to estimate this to make the subtraction from the gamma component recorded in the C6D6. This should be estimated better than 1%. CG reports that the problem was solved in the past in the TAC by looking at multiplicities etc. This can be estimated in the TAC and then the value would be used for the actual measurement.

Destruction of the cosmic γ-ray emitter ^{26}Al by neutron induced reactions (C. Lederer)

The astrophysical motivation for the measurement is presented. The ^{26}Al present in the galaxy can be mapped and is associated with stellar activity. Significant discrepancies exist in the available data of the ^{26}Al(n,p) and ^{26}Al(n,p) cross sections.

The measurement would be performed with Si detectors. A test run took place in 2012, followed by a LoI accepted by the INTC to have a parasitic measurement in EAR-1. A study of this reaction has begun at GELINA with the DSSD of the Edinburgh group. Some data highlighting the detector performance from these tests is presented. For the experiment in EAR-2, an appropriate chamber would be constructed, particles would be identified by a ΔE/E telescope, neutrons would be monitored with ^{10}B or ^{6}Li. Count rate estimates are shown. The measurement could run in parallel since the samples will be very thin and the setup could be used for other (n,cp) measurements at n_TOF, e.g. ^{7}Be(n,p).

CG remarks that at 30 and 80keV it may be difficult to see resonances. A convolution with the resolution function is recommended.

Prospects for STEFF at EAR-2 (G. Smith)

GS presents the STEFF setup, which is a fission fragment spectrometer coupled with neutron/gamma detector arrays. This was already presented at the last meeting in Manchester. The methodology to calculate the fragment mass is described, followed by the pulse analysis.

The setup was installed at ILL for a measurement on ^{235}U with the thermal neutron flux available. The target is a critical element of the experiment and improvements need to be made on this aspect, especially with a view of reducing the backing thickness. The primary aim of the ILL measurement was to obtain data on gamma emission, and this was done as function of mass and fragment energy with NaI detectors. Monte Carlo simulations of the gamma decay were performed. GEANT4 was used to obtain the NaI response functions. Using multiplicities, it was possible to obtain the total gamma ray sum energy.

Although bulky, STEFF could fit into EAR-2. Additional detectors are foreseen to be added to the setup for an eventual measurement. Rate calculations for the measurement have been performed and summarised; the rate should be sufficient for the measurement. Various improvements are foreseen on the setup during the next year. It will be important to check the response of the NaI detectors to the γ-flash.

RV asks how the issue of multiple hits in the NaI detectors is sorted out. GS replies this is based on GEANT4 simulations. After a question by CG, GS replies that the energy range of interest is up to a few MeV. The upper limit is still not clear also depending on the response to the γ-flash.

^{35}Cl(n,p) and ^{14}N(n,p) proposals for EAR-1 and EAR-2 (J. Praena)

The motivation in the areas of astrophysics and medicine is presented, especially focusing on neutron capture therapy. An overview of available data is given on the two isotopes, along with count rate estimates. ^{14}N should be measured in EAR-2.

It will be difficult to measure with SiMon and MGAS due to noise at low amplitudes in the present situation. The electronics would have to be improved before the measurement can be performed. Some beam time at the end of 2014 would be helpful to test the setup. This could run in parallel. The goal would be for the two proposals to be submitted to the INTC in February 2015.

NC points out that the system proposed by CL in her preceding talk could also be used for this experiment. This will be investigated.

Measurement of the neutron capture cross-sections of ^{53}Mn at EAR2 (R. Dressler)

The motivation for the measurement is presented. The two previous measurements are at the thermal point and are discrepant. The sample can be produced utilising isotopes produced within the framework of the target irradiation programme at PSI. 3x10^{19} atoms of ^{53}Mn are expected to be collected. Around one third would be lost during the chemical separation. A preliminary estimate of the count rate has been performed. The contribution of other contaminants and the backings has been estimated. Two possible options exist for the backing. Mass separation could be performed at ISOLDE, with about two months operation time. In the end, we could have about 5x10^{17} atoms of ^{53}Mn. This would greatly improve the experimental conditions. The proposal could be submitted to the INTC this spring.

Helium production in tungsten relevant to divertors in future fusion reactors (D. Jenkins)

DJ presents an overview of the motivation of this research, which relates to material damage within the context of fusion reactors. In particular, the production of helium in materials due to neutron irradiation can alter the mechanical properties of the materials leading to hardware failure. Data on reactions in W are not well known enough to make accurate predictions on the survivability of the material. Important discrepancies are present. The Si detector option seems best. A proposal is not coming soon, as several points still need to be investigated. A future perspective concerns the breeding of tritium in fusion reactor components.

GS points out that scattered neutrons hitting the detector setup could induce a background that cannot easily be distinguished from the actual signals.

The (n, α) reaction cross section measurement for light isotopes (V. Khryachkov)

VK presents the motivation for (n,α) measurements of light isotopes, as they relate to reactor studies, standards (boron), calibration of neutron sources (^{16}O), astrophysics, dosimetry etc. As an example, the talk will focus on ^{16}O. Evaluations show significant discrepancies above 6-7MeV. Experimental issues regard detectors, samples and the neutron source. Details on these experimental challenges are given. A schematic view of the experimental setup at Obninsk is shown, followed by examples of the detector signals. Details are given on the particle identification. Results obtained are compared with ENDF; significant differences are observed above a few MeV. A measurement at n_TOF would allow to resolve resonances not presently accessible.

Nuclear physics for energy production and waste transmutation (S. Leray)

SL delivers an invited overview talk on nuclear physics activities within the more general framework of nuclear energy production and waste transmutation (see slides).