R3B-UK Collaboration Meeting
10 November 2009
Daresbury Laboratory

Present: Roy Lemmon (**RL**), Martin Freer (**MF**), Marc Labiche (**ML**), Phil Woods (**PW**), Nick Ashwood (**NA**), Dan Watts (**DW**) - by phone, John Simpson (**JS**), Janet Sampson (**JAS**)

Apologies: Paul Nolan (**PN**), Marielle Chartier (**MC**) and Wilton Catford (**WC**)

1) Status of Si Tracker project, R3B and FAIR

RL summarised the status of the NUSTAR UK project as a whole and, in particular that to build the Si Tracker for R3B. It was noted that all of the Si Tracker capital and manpower requested was awarded except for the liquid hydrogen target. **RL** has already approached CEA-Saclay about the possibility of them taking on this task for R3B, as they have a great amount of experience in this area.

RL noted that the NUSTAR UK project is now 5.5 years in duration because of the 6 month delay to the start date (delayed from 1 October 2009 to 1 April 2010). **MF** asked how the delay affects the plans for R3B and whether other countries have similar delays.

RL said that the equipment grants in Germany from the BMBF are also delayed. **JS** confirmed this, saying that there is no BMBF money in Germany for equipment until the next three-year grant period starting in 2012. **RL** noted that grants have also been applied for in Spain (to build the calorimeter prototype), Sweden and other countries but not yet awarded. In his opinion, our delay is therefore not significant.

RL pointed out the important news that the GLAD superconducting dipole magnet, a central component of R3B, is now planned to be installed in Cave C initially for FRS experiments. **RL** said that the bending power of the current dipole magnet in Cave C (ALADIN) limits the incident beam energy useable in experiments to 400-500 AMeV. The new superconducting dipole magnet for R3B, GLAD, has a magnetic rigidity suitable for ^{132}Sn at 1 AGeV. It is being built in CEA-Saclay and is due for delivery in 2012. The installation of the infrastructure for the magnet has already started.

JS outlined the new modularised version of FAIR, as described in the FAIR White Paper. Currently there are five modules, with Modules 0-3 able to be built within the currently available funding. Some components of this are: SIS100 is in Module 0, the SuperFRS and the High Energy Cave are in Module 2. The Low Energy Cave is in Module 4 and therefore not included in the start-up plans. Any experiments that would use this cave will therefore have to share with R3B. The Low Energy Cave would cost 6 MEuro to build and it would obviously make a big difference to R3B if it was available as we would not have to share with HISPEC, DESPEC etc. **JS** noted that unofficially Horst Stocker, the director of GSI, has said that the LEB will exist. **PW** confirmed that this same information was presented at the recent NUSTAR Collaboration meeting in Dubna.

The current plan is for Modules 0 – 3 to be ready by 2016, so the SuperFRS and R3B to be ready for operations then. **JS** said that the last FAIR ISC voted to accept the modularised version, though he pointed out that the UK abstained from the vote. He also emphasised again that the UK is at present not contributing enough money for even a 1% share, which is required to be a partner in FAIR GmbH when created. FAIR is not officially considered to have started until the FAIR GmbH is

created. The money is now there but detailed contracts are still taking place. So **JS** doesn't know when the GmbH will finally be formed.

JS said that there will be a NUSTAR UK oversight committee twice per year as with all other Project Grants. **MF** asked if we knew whether we would have one this year, i.e. until 1 April 2010. This was not known.

Action: JS to ask Zsolt Podolyak whether he knows if we will have an oversight committee meeting this year.

2) Roles of Institutions

RL summarised the roles of the institutions in the Si Tracker project as envisaged at the time of the grant submission, highlighting situations where those roles have now changed. Four PDRA positions were awarded to help support and carry out these roles. Daresbury Laboratory is responsible for the electronics and mechanical design, with input to the simulations and Si testing. Originally Daresbury was to have the PDRA for simulations. However it was necessary to transfer this position to Birmingham as part of the NUSTAR bridging funds, where it supports **NA** as from 1 October 2009. Birmingham's main role will now be in simulations, working together with **ML** at Daresbury. The PDRA for Si testing, originally envisaged to be at Birmingham, will now be located at Daresbury later in the project. Rutherford Laboratory is responsible for the ASIC design and production. Edinburgh University is responsible for the Si prototyping, including testing, and a PDRA will be located there to support that. Liverpool University is responsible for the build of the Si tracker, with input to the electronics and mechanics. The PDRA located at Liverpool will support all aspects of the build in the clean-rooms there.

It was emphasised by several people that the roles of the PDRAs employed by the institutions to perform these tasks should, to some extent, be flexible if necessary and not strictly limited to the tasks to be performed. For example, Si testing may need to be performed by the PDRAs at both Birmingham and Daresbury.

3) Simulations

ML gave a short presentation on the status of the simulations for R3B using the packages R3BSim and R3BROOT. He noted that, up to now, there has not been too much activity on simulations for the Si Tracker. However, **NA** will now be the PDRA responsible for simulations together with **ML**.

R3BSim was developed by Hector Alvarez-Pol at the University of Santiago de Compostella and **ML** at Daresbury Laboratory. It uses the GEANT4 package and ROOT. R3BROOT has been developed by Denis Bertini and others at GSI and is based on the framework FAIRROOT. Denis Bertini basically translated the R3BSim code functionality to R3BROOT. Of the two packages, the R3B collaboration has decided to use R3BROOT for the reasons that it can use various simulation "engines" (VMC, GEANT3, GEANT4, FLUKA, etc.) and is fully supported by Denis Bertini's team at GSI. FAIRROOT is also the framework used for other major experiments at FAIR such as CBM and PANDA.

JS asked how the calorimeter CALIFA and the liquid hydrogen target designs will affect the simulations work. **ML** replied that enough is already known about the liquid hydrogen target for the simulations. He said that the simulations for CALIFA have essentially been focussed on gamma-ray detection and the design mostly influenced by the needed Doppler correction. It is therefore a high priority to simulate the response of CALIFA to protons and other light charged particles in case design changes need to be made. There is ample time for the design to be modified though.

A plan for the simulations to 1 April 2010 was discussed. The main aim is to reach a specification of the Si tracker that will enable the project to start properly on 1 April 2010 (e.g. ASIC design, Si detector prototype specification, etc.). **NA** will now work with **ML** on starting simulations with R3BROOT for the Si tracker, incorporating different geometries and event generators. We also need to collect a list of physics ideas – see Section 5) below. **MF** emphasised that we should start with simple cases, e.g. elastic scattering. Once we have implemented a reasonable geometry and simulated elastic scattering with this, then we should have another meeting to discuss the progress. The meeting date is yet to be fixed. However, we should aim to present a progress report on the simulations at the NUSTAR Annual Week 2010 at GSI from 1/3/10 – 10/3/10 so this sets a timescale.

JS discussed about the Technical Design Report (TDR) for R3B and how this relates to the simulations. He asked who is doing the TDR as this will drive the design, specification etc. **RL** replied that the plan is that there will be separate TDRs for different detectors of R3B, e.g. Calorimeter, Si Tracker, NeuLAND, etc. So we (the UK) would be responsible for the TDR for the Si Tracker and the simulations will be a key part of this. **JS** also said that it is likely a TDR approved by the FAIR management for the Si Tracker will be required if it is to be counted as an in-kind contribution to FAIR.

Action: JS and RL to confirm whether TDR is required for the Si Tracker by the FAIR Management.

4) Physics and Key Experiments

A roundtable discussion was held on physics we want to do with R3B, either using the Si Tracker or not.

MF talked about studying clustering in nuclei using the (p,pα) reaction, measuring spectroscopic factors and fragment momentum distributions. He also mentioned examining how deeply-bound states decay, e.g. via cluster states. He discussed the importance of doing giant resonance studies with the Si Tracker, for example GMR studies with the (α,α′) reaction, GDR and multiphonon studies. He emphasised that light particle identification in the Si tracker will be important, together with low detection thresholds. **RL** said that we should aim for the detector to work with the lowest detection thresholds possible as for elastic and inelastic scattering on light targets in inverse kinematics the target recoils typically emerge close to 90° in the laboratory with low energies.

PW discussed studies of the Gamow-Teller reaction, (d,^{2}He), which is of interest for nuclear astrophysics (electron capture). In this case, there could be two charged particles in the Si Tracker. These experiments would need a deuterium target and an incident beam energy of 100 AMeV. A difficulty would be the energy resolution achievable. In addition, he discussed studies of heavier nuclei relevant to the rp-process using electromagnetic breakup from a Pb target. This process has large cross-sections. A specific example was ^{70}Kr -> ^{69}Br + p. The forward-focussed kinematics means that the products may go through the dipole magnet rather than the Si Tracker situated at large angles.

Nevertheless, precise tracking of the products will be necessary. Since we are the only group within the R3B Collaboration who plan to make high position resolution Si detectors, it would make sense if we are able to ensure that some detectors can be used standalone at angles different to the Si Tracker.

RL described the (p,2p) and (p,pn) quasifree scattering studies that form a major motivation for building the Si tracker for R3B. These reactions are among the most important tools to study the single-particle structure of valence and deeply-bound states in nuclei and also the in-medium modification of nucleon properties. He emphasised that the present Cave C setup is limited in the incident beam energies with which the QFS studies can be performed to around 400 AMeV, due to the bending power of the dipole magnet ALADIN and the limitations of the target recoil detector, its particle identification, dynamic range and tracking capabilities. This restricts us to only studying valance nucleons in nuclei produced with fairly high intensities. The combination of the new target recoil detector we will construct and the new dipole magnet GLAD, will open up this area even using the presently available beams from the FRS. He also, however, noted the possible limitations on these studies that will result from using a recoil detector based on E-ΔE techniques (e.g. Si-CsI is currently envisaged) as protons can only be measured up to a total energy of 200 – 250 MeV. He described a possible solution where the recoil detector was based on a superconducting solenoid magnet and which would allow much higher protons energies to be measured. The total energies of the protons would be measured using the curvature of the tracks in the magnetic field. This is a technique that was already exploited in the HERMES recoil detector at DESY to measure proton energies of 1 GeV and above. Such a detector would allow the energies of protons from quasifree scattering reactions using the full energy beams from the SuperFRS of up to 2 AGeV to be measured enabling exclusive studies of high-momentum transfer reactions on deeply bound nucleons.

It was agreed that more detailed physics cases on each of the above ideas should be emailed to **RL** who will then compile them. The physics cases should contain key experiments and what type of event generators will be needed for the simulations.

Action – Everyone to email RL with more detail on the physics to be done with the Si Tracker. In particular, MF, PW and RL to expand on the cases mentioned above including key experiments. RL to compile the information and circulate.

5) Finance

JS pointed out that all institutions should now have had grant announcement letters detailing what was awarded to them. It was discussed that we need to definitively establish the funding given to each institution and check against what we requested and we need to profile when the money is expected and will be spent over the course of the project. This is particularly the case at Daresbury Laboratory where the financial system does not allow the carryover of funds from one financial year to the next.

Action: The PI of each institution to send RL details of their award. RL to compile into one master spreadsheet and circulate.

6) AOB

It was agreed that we should create an official webpage for R3B UK. NA and ML volunteered to work on this.

Action: NA and ML to create an official webpage for R3B UK.

7) Date of Next Meeting

To be fixed later dependent on progress in simulations.