

Minutes of the meeting of SPIRAL2 Scientific Advisory Committee (SAC) held in Caen on January 28-29, 2010

Present: N. Alamanos, B. Blank, G. De Angelis, W. Gelletly, D. Guillemaud-Mueller, M.N. Harakeh (Chair), W. Henning, F. Iachello, W. Mittig, T. Motobayashi, H. Stöcker, D. Vernhet; ex-officio: N. Alahari, S. Galès, M. Lewitowicz

Absent with notification: B. Jonson

Open session

The open session of the SPIRAL2 SAC took place on Thursday 28 January where several presentations were given starting with a talk by Marek Ploszajczak who gave an overview of the theoretical activities and developments which may impact on the SPIRAL2 scientific programme and outlined his views on how this could be strengthened both from the science point of view as well as the forming of groups and collaborations with increased project funding. Two new technical projects were presented: HELIOS, a superconducting magnetic solenoid for high resolution studies of nuclear structure in reactions performed in inverse kinematics with radioactive beams, and NEDA, a neutron detector array to be used in conjunction with AGATA, EXOGAM2 and PARIS. Several status reports of the SPIRAL2 instrumentation projects were given outlining the latest developments and progress made on these projects since the last SAC meeting. The programme for the open and closed sessions of the SAC is given in the appendix.

The SAC was very much impressed by the progress made on all fronts. Many of the instrumentation projects have reached an advanced stage that a technical design report could be available soon on basis of which funding could be requested. The SAC is also pleased to see that new instrumentation projects are being brought in by new collaborations with either a complementary function with respect to existing instrumentation projects or filling a deficiency in existing ones. The SAC would like to congratulate the collaborations on the important progress that has been made and the GANIL Directorate for helping create an atmosphere of optimism leading to an enthusiastic functioning of the collaborations.

Closed session

1. Status of the SPIRAL2 Project

The closed session started by a presentation of the status of the SPIRAL2 project by Marcel Jacquemet, the project leader of SPIRAL2. Aside from some insignificant delays, the construction of Phase 1 of SPIRAL2 seems to be on schedule. The various parts of the SPIRAL2 accelerator are being developed at various participating IN2P3 and CEA labs. The construction of the building should start in the middle of 2010. After the completion of the building, assembly of the accelerator parts including ion sources and beam lines could proceed very quickly allowing to have first beams in February 2012. On the question whether the schedule is not too optimistic, M. Jacquemet answered that if the construction permit (related to the safety licensing) is delivered without delay the timeline looks realistic for the project management. The SAC discussed these developments and is pleased to see that the SPIRAL2 management is keeping to

its tight schedule in spite of the complexity of issues that arise in such a project, and it congratulates the management on the progress made so far.

2. *Recommendations for Theory for SPIRAL2*

The SAC found the case presented for nuclear theory for SPIRAL2 compelling. Recent advances in computing power have opened up the possibility to more global approaches of existing theories and models (Mean-field Theory and Shell Model). Also, advances have been made in connecting the nucleon-nucleon interaction with the fundamental theory of strong interactions (QCD) through an effective field theory (EFT) and in using effective interactions for *ab initio* calculations of properties of light nuclei through Green's function Monte Carlo methods. However, challenges still remain in providing a fully microscopic theory of medium-mass and heavy nuclei of interest to SPIRAL2. Also, the microscopic theory of nuclear reactions (both direct, especially transfer, and compound-nucleus reactions) at low and intermediate energies needs to be revisited in view of the strong coupling to the continuum in weakly bound systems.

This situation calls for a two-prong nuclear theory programme, one centred on computationally oriented physics (Density Functional Theory, Shell Model, etc.) and one centred on developing new concepts and ideas for attacking the complex many-body problems which will be encountered at SPIRAL2 (theory of weakly bound systems, molecular-dynamics methods, bosonisation methods, symmetry-oriented approaches, etc.).

The SAC suggests that a possible approach to theory at SPIRAL2 is to strengthen the already existing theory group at GANIL with additional post-doctoral and doctoral student positions, and to coordinate the theory activities in the physics of SPIRAL2 with those already existing both at the National (Orsay, Bordeaux, Strasbourg, ...) and International (GSI-FAIR, Jyväskylä,...) level. The post-doctoral fellows and doctoral students could then move to take up permanent positions at various universities in France and elsewhere in Europe forming the basis for research in the physics of SPIRAL2 in the second part of this decade and beyond. This clearly requires stronger collaborations with universities and a stronger interaction between theorists and experimentalists. Furthermore, it may be advisable to create funds of several hundred thousand Euros that could be matched by the regional authorities. This could be used in project-oriented funding to allow theory groups across France, and possibly internationally, to partake strongly in the physics research objectives of GANIL and to strengthen their efforts in that direction.

The SAC also suggests that a coordination of theory activities (national and international) could be best achieved by the formation of a consortium for an international graduate school and recommends that GANIL makes an additional effort to tie French students interested in the physics of SPIRAL2 into international activities in this area taking place in Europe, the USA and Japan, such as summer programmes, lecture weeks, workshops for graduates, including special times at the European Centre for Theoretical Nuclear Physics (ECT*) in Trento, Italy, and at the Institute for Nuclear Theory (INT) in Seattle, Washington, USA.

3. *Evaluation of new proposals for SPIRAL2 Detectors: HELIOS and NEDA*

NEDA report:

The NEDA neutron detector array was presented for the first time at the SPIRAL2 SAC meeting. It addresses the design study for a neutron detector to be used as an ancillary detector for PARIS

and for the AGATA/EXOAM2 germanium arrays. The collaboration presented simulations of different types of liquid scintillators and is planning to test some of them in the near future. The main objective is to identify liquid scintillators capable of providing an energy response. In parallel, the collaboration will continue simulations in order to define the unitary cell size and the appropriate geometry. The collaboration has also started to investigate the electronics issues in collaboration with EXOGAM2.

The SAC welcomes this initiative. On many occasions it has expressed its desire to see the development of an appropriate neutron detector for SPIRAL2 experiments.

However, many questions still remain open, for instance, the energy resolution of the apparatus. Is it a spectroscopy-oriented detector or not? What is the energy threshold of the device? Could it be much lower than has been presented (0.5 MeV)? What is its capability for discriminating $1n$ and $2n$ channels? What are the advantages of this new array compared to existing neutron detectors?

The SAC encourages the collaboration to continue thoroughly the development of the device. It hopes that the collaboration will be strengthened with new physicists and expects to evaluate the progress made in the definition of NEDA in one of its future meetings.

HELIOS report:

The HELIOS project was presented for the first time to the SPIRAL2 SAC. HELIOS is a solenoid plus a detection system for direct reactions in inverse kinematics with radioactive beams from SPIRAL2. The setup presented seems to be very well suited for experiments at SPIRAL2 and most likely adds an important setup to the instrumentation of SPIRAL2. Compared with the conventional recoil detection without magnetic field, separation of the final states is larger and hence a better Q-value resolution is expected. For some reaction channels, a large coverage in the angular region that is most sensitive for a certain ℓ -transfer can also be achieved. Therefore, the SAC appreciates strongly and welcomes this new initiative. However, some overlap in terms of the possible experimental programme with equipment like GASPARD and ACTAR seems to exist.

In a more elaborate letter of intent for the next meeting, the HELIOS collaboration is encouraged to work out the complementarity and/or synergy of HELIOS with respect to these setups. Simulations should also be performed with realistic beam emittance, which could be larger than for stable beams, to get efficiency curves, resolutions etc. In addition, the use of cryogenic targets should be investigated. The possibility to shift the target to the exit of the solenoid to allow for γ -ray detection in coincidence with recoil particles could be looked into. Finally, the option to move HELIOS from the G2 to the G1 cave to install it in front of VAMOS (or in G3 in front of SPEG) should be investigated.

The meeting was stopped at around 19:30 and continued at 09:00 the second day (Friday).

4. *Evaluation of status reports of the SPIRAL2 detectors*

GASPARD status report:

The SAC appreciates the progress made by the collaboration to finalise the simulation tools and the mechanical design and also the efforts made to restructure the project management and to look to possible synergies. The progress in the definition of the day-one experiments is also well

taken. Since now the simulation tools are defined, the SAC encourages the collaboration to provide next time full simulations of the performances of the apparatus as well as of the proposed day-one experiments, *e.g.* the proposed study of the pygmy dipole resonance that involves high-energy γ -ray energies of around 10 MeV and for the case of transfer to low-lying states where γ -ray energies of sub-MeV to a few MeV are involved.. Moreover, the SAC appreciates the R&D done on the solid hydrogen target and encourages the group to finalise the tests.

It should be noted that several different approaches with similar goals, *i.e.* recoil particle detection for direct reactions in inverse kinematics, are proposed including the new proposal HELIOS. Differences in the performance and suitable specific physics cases should be clarified. For structure of pygmy dipole resonance, a physics case the collaboration gives, the single-particle strengths studied by the (d,p) reaction can investigate the 1p-1h components of the resonance built on the 1h ground state of the projectile nucleus. Thorough understanding may be reached by studying the other possible 1p-1h and possibly also 2p-2h components by some other means.

Neutrons for science (NFS) status report:

The SAC was encouraged by the progress made in enlarging the collaboration. The new members will widen the range of interests and expertise of the participants. From the report it was evident that the collaboration had paid attention to the comments made after previous meetings. In particular, problems related to scattering from the collimators and the air in the experimental hall are obviously being addressed with simulations. We shall expect to see the fruits of this work and the proposed solutions at the next SAC meeting. The optics of the beam line is also important and it is welcome news that solutions have been found that will deliver beams that satisfy the specifications. The SAC encourages the collaboration to continue to press ahead to produce a suitable design of the beam line, collimators etc. as soon as possible.

PARIS status report:

The SAC is pleased to see that the GASPARD and PARIS collaborations proposed one experiment where the integrated GASPARD and PARIS detectors are used. The SAC also welcomes the suggestion that a LoI detailing the cases where GASPARD and PARIS could be used jointly will be submitted for the next SAC meeting, including the study of the structure of the pygmy dipole resonance in the region of ^{132}Sn , which is quite interesting and seems feasible.

The main drive behind PARIS is the study of IVGDR at high temperatures and angular momenta. It is proposed to address two instabilities - the Jacobi and the Poincaré transitions – using the IVGDR as a probe and PARIS as γ -ray detection array. The SAC encourages the PARIS collaboration to pursue these ideas further including the coupling to the gas-filled mode of VAMOS or to the Krakow Recoil Filter Detector (RFD) to optimise detection of the heavy fusion-evaporation recoils, while rejecting the direct beam.

The SAC is also satisfied that the PARIS collaboration has reached a conclusion regarding the crystal shape, *i.e.* rectangular, because of the possibility of packing a few (4 or 9) crystals into one cluster which would allow to have variable geometries (quasi-cubic, quasi-spherical, wall-like) to be optimally chosen for different physics cases.

The SAC endorses the main questions put forward by the collaboration to be solved and presented in the next report: How to build a cluster? How to build spherical-like and cubic-like

arrays? How to integrate PARIS within S3? How to integrate PARIS with GASPARD? What will be the efficiency and response function of PARIS in all of the geometries? These are indeed essential questions that need to be solved to achieve the progress towards an optimally functioning PARIS detector within the SPIRAL2 facility. The integration of GASPARD will require also simulations to estimate the total efficiencies of γ -ray detection for low and high energy γ -rays. The SAC asks the collaborations to perform simulations for the proposed PDR experiment which involves γ -ray energies of around 10 MeV and for the case of transfer to low-lying states where γ -ray energies of sub-MeV to a few MeV are involved.

S3 status report:

The SAC was impressed by the quantity and quality of the work performed by an excellent team. Classical as well as new original solutions were elaborated for the optical elements. Flexible multipole elements appeared as essential to achieve the best performance of the separator-spectrometer. The SAC recommends a very careful choice of the solution that preserves the maximum quality and flexibility for a long term use of this important device.

The significant contributions foreseen from Bulgaria, India and Poland who joined the collaboration shows the dynamics of the S3 community.

The funding issues should be clarified as soon as possible, in order not to compromise the tight schedule of construction. This goes together with more precise cost estimates that may depend on the technical solutions chosen.

EXOAM2 status report:

The SAC shares the view made in the report of the last meeting held on 11 September 2009:

Efforts for developing the resistive preamplifier, new time-stamp event builder and simulation on pulse-shape analysis for position sensing are highly appreciated.

The SAC recognises that the electronics development for higher capability for data throughput is in progress, and the first prototype of the front-end electronics is almost ready.

Developing a trigger system called GTS following AGATA development for common use in the future SPIRAL2 detectors including EXOAM2 is encouraged, hoping that it helps to realise high performance of EXOAM2 with minimum overall-cost and manpower. In this respect, the SAC is satisfied that the manpower problem has been solved and asks the collaboration to emphasise the synergies with NEDA and PARIS.

ACTAR status report:

The SAC appreciated very much the real and continuing progress made by the collaboration. Since the last Scientific Council, quite a few important milestones have been achieved and most of the recommendations have been addressed. In particular, the SAC congratulates the collaboration for the developments of the General Electronics for TPCs that was funded through an ANR grant and included is SPIRAL2PP. The SAC acknowledged also the two MoUs that have been defined: one associated with the GET electronics and close to completion, the other more general which should be finalised this year. The SAC was very pleased to see the latest developments on the detector design, and encourages the collaboration to perform simulations for

heavy fission fragments within the geometry chosen, including the response to delta electrons, although the main objective of ACTAR is to look at exotic beams.

The **DESIR facility** status report:

The DESIR Collaboration presented a progress report about work done since the last SAC meeting (September, 2009). The work has focused on two key activities: i) the design and detailed simulations of the High Resolution Spectrometer (HRS) for a clean selection of the low-energy radioactive beam; the HRS is of importance to both, DESIR and the injection into CIME for post acceleration; ii) work on the gas-filled RFQ cooler at the entrance to the HRS to reduce the emittance of the beam to be analysed; this work included design, detailed characterisation and validation of numerical model simulations (with space charge), and partial fabrication of main elements of the device (now labelled SHIRaC).

The DESIR Collaboration in close contact with the SPIRAL2 Management initiated discussions with the Saclay services in order to perform detailed radioprotection calculations for the DESIR facility. The SAC encourages the SPIRAL2 Management to finalise an agreement as soon as possible.

In addition, the collaboration reported about discussions to use a fully electrostatic beam transport system from the HRS to DESIR, possibly in collaboration with the Bhabha Institute (Mumbai). Since this is a well-established approach at existing facilities the SAC encourages the collaboration to pursue this venue.

The SAC is impressed by the high-level, experienced expert group involved in the design of the HRS and finds the proposed “alpha”-shape solution very attractive. The work on SHIRaC is equally impressive, in particular in view of the expectation that the design will work in the microampere range.

There was no new information on the experimental stations in the future DESIR hall. This is awaiting design of the building and the availability of space. It is worthwhile to notice though that a substantial fraction of the anticipated equipment is already available at participating laboratories and fairly easily implemented, once the building and infrastructure were available.

This entices the SAC to make a broader recommendation: the DESIR collaboration is a scientifically strong community; the involvement of experienced international experts in several of the key technical components is highly appreciated; the research programme previously presented is excellent; the technical configuration (HRS, SHIRaC, etc.) now proposed is very convincing and the SAC expects that it is consolidated in further studies. It appears prudent that at this point the DESIR facility, proposed for phase 2 of the SPIRAL2 project, be made part of the official project and as such supported by the French agencies. The DESIR collaboration has the potential to be the carrier of a broad and scientifically strong international involvement in the research programme at SPIRAL2.

FAZIA status report:

The SAC was impressed by the quality of the results on particle identification achieved. These results are of unprecedented quality. To obtain these results, selected Si-slices were used. The question of mass-production of such detectors still remains open. The radiation damage of these detectors was measured and quantified. This is an important problem, also in regard to the question of mass-production of the Si-detectors. The effects of changes (in amplitude and rise time) of the pulse-height defect were investigated. This is a well-known inherent phenomenon for

semi-conductor detectors, but the fluence-dependent changes require extensive monitoring and calibration compensation. This was not discussed in detail for the specifics of FAZIA. Some experimental examples, typical for SPIRAL2 conditions, i.e. beam energy, beam species, etc., should be elaborated in order to quantify the importance of radiation damage under SPIRAL2 conditions. The dependence of the identification matrices as a function of radiation dose, and consequently as a function of running time during an experiment, should be evaluated. The SAC hopes that this will be given more attention in the presentation of the status report during the next SAC meeting.

5. *Follow-up of the LoI for Day 1 experiments with SPIRAL2 Phase 1*

Due to time pressure it was not possible to get the updated LoIs for Day 1 experiments with SPIRAL2 Phase 1 for the present SAC meeting. However, all spokespersons have indicated that the LoIs will be updated following the comments from the SAC and would be submitted for evaluation in the next SAC meeting.

6. *Preparation for the LoI for Day 1 experiments with SPIRAL2 Phase 2 (with RIB)*

After some discussion it was agreed that a letter will be sent out to the community in the beginning of March to ask them to think about possible letters of intent for Day 1 SPIRAL2 Phase 2 and come up with some beams that would be important for their projects. Following this the SPIRAL2 project team will come up with a list of RIBs that will be available first (taking into account as much as possible the wishes of the community) and give an approximate date of availability of these beams for experiments. These proposed lists and date will be validated by SPIRAL2 Project leader and Director of GANIL by end of May 2010.

A Call for Letters of Intent for Day 1 SPIRAL2 Phase 2 Experiments (with RIBs) will be launched at the beginning of June 2010 by the SAC, encouraging the collaborations to organise collaboration workshops early enough to define and write the LoIs before the dead-line for LoI submission in the middle of December 2010. These LoIs will be evaluated together with the status reports of the instrumental projects during the SAC meeting on 26-28 January 2011 (see below).

7. *Topics, date and place of the next meeting*

The **next meeting** of SPIRAL2-SAC will be on 24-25 June 2010 at GANIL. During this meeting the follow-up of the LoIs Day 1 Phase 1 and of the Theory for SPIRAL2 as well as some status reports for the instrumentation projects will be on the agenda. The SAC meeting following that will take place during the SPIRAL2 Week in Caen in January 2011, and will be on the days 26-28 January 2011. During this meeting the LoIs for Day 1 experiments with SPIRAL2 Phase 2 will be considered together with the status reports for the instrumentation projects.

8. *AOB*

No other points on the agenda the meeting was closed at around 11:30.

Annex 1

Agenda of the SPIRAL2 SAC meeting on January 28-29, 2010

Thursday January 28th at Memorial Museum, Caen

11:30 - 16:35 SAC Open Session (in the framework of the SPIRAL2 Week)
Memorial Museum, Caen, Conference Hall

11:30 - 13:10 Theory for SPIRAL2 and new proposals for SPIRAL2 Detectors

11:30 - 12:10 Theory for SPIRAL 2 - M. Ploszajczak (25'+15')

12:10 - 12:40 HELIOS project for SPIRAL2 - B. Back (20'+10')

12:40 - 13:05 NEDA neutron detector - J.J. Valiente Dobon (20'+5')

13:05 - 14:30 Lunch

14:30 - 16:35 Status of the SPIRAL2 Detectors

14:30 - 14:55 ACTAR - P. Roussel-Chomaz (20'+5')

14:55 - 15:20 DESIR - D. Lunney (20'+5')

15:20 - 15:45 EXOGAM2 - G. de France (20'+5')

15:45 - 16:10 FAZIA - G. Poggi (20'+5')

16:10 - 16:35 S3 - J. Nolan (20'+5')

17:00 - 19:30 SAC Closed Session

Memorial Museum, Caen (Salle des Animations)

1. Status of the SPIRAL2 Project - M. Jacquemet (20'+10')

2. Recommendations for Theory for SPIRAL2

3. Evaluation of new proposals for SPIRAL2 Detectors: HELIOS and NEDA

20:00 Dinner

Friday January 29th at GANIL (Alpha Meeting Room)

9:00 - 12:00 SAC Closed Session

4. Evaluation of status reports of the SPIRAL2 detectors

5. Follow-up of the LoI for Day 1 experiments with SPIRAL2 Phase 1

6. Preparation for the LoI for Day 1 experiments with SPIRAL2 Phase 2 (with RIB)

7. Topics, date and place of the next meeting

8. AOB

12:00-14:00 Lunch