47th MEETING OF THE LNF SCIENTIFIC COMMITTEE

The program of the open session of the SC meeting of November 14 was set up to review the status of DAΦNE and of its experimental program, summaries of technological and interdisciplinary research activities (CSN5) at LNF, the activities of the Beam Test Facility and the activities on the dissemination of scientific culture. The agenda included also a summary by Massimo Ferrario of the SPARC-LAB scientific committee meeting.

LNF is to be congratulated for the impressive progress on DAFNE consolidation and for attracting a substantial fraction of money made available by the ministry through the competition program (premiali).

INFN can help in the process of running down Cabibbo-Lab by offering a limited duration contract to the twelve people hired by the consortium. Important fraction of the premiali will go in consolidation of DAΦNE and Spark_Lab. INFN has to start a process to come to a decision of the medium-long term future of DAΦNE. A

possibility is the use of the DAΦNE as a test facility for accelerator R&D in an international context and for that INFN has to collect the international consensus and proposals.

The conclusion is that LNF should move quickly to a laboratory for acceleration physics at European level. Also important in this context INFN should come to a conclusion on what is Italy's flagship science project for the future – even if in the moment there is no fresh money in sight. Such a big project requires several years of preparation (and negotiations with several communities) anyway before money can be spent. Without such a decision it is impossible to motivate a sufficiently large number of experts to work out a technical proposal for a big project, and to prepare the grounds in terms of infrastructure and human resources. The committee would like to encourage the laboratory to investigate further an activity which would be the nucleus for a bigger project (like IRIDE 300-400 M€). We would like to encourage the LNF to think BIG – and such a spirit would be justified in view of the lab's world-class expertize demonstrated at DAΦNE and SPARC_Lab. R&D of 20 years for the next big particle physics accelerator is not unusual, but normally this happens in the wake of existing accelerator infrastructure running for science. It is hard to see how LNF can survive for 20 years with no science on site, and we would like to stress that we speak of science in more general sense, not restricting it only to particle physics. As an example we could mention the need for a joint strategy in the field of high gradient accelerators.

The committee was glad to hear that the situation with PhD positions in accelerator physics has improved this year, with 9 positions opened, 6 of which are paid by INFN fellowships. We propose that 2 – 3 topics each are to be defined in DAFNE and in SPARC_Lab. We still believe that approaching the students at the PhD level is too late in their academic education. We congratulate for the effort done in outreach with laboratory visits to LNF and/or attractive exercises at LNF accelerators. We suggested to establish a regular accelerator physics course on the master level at one of the universities, with some introductory lectures to be integrated in the bachelor level education program. This could be complemented with laboratory visits to LNF and/or attractive exercises at LNF accelerators.

1. DAΦNE, KLOE and SIDDHARTA

1.1 DAΦNE

L. Rivkin, J. Rossbach and L.Rolandi met members of the Accelerator Division to discuss the presentations of DAΦNE start-up and current status.

In her presentation on the status of the DAΦNE commissioning after the last shutdown Catia Milardi reported on a large number of upgrades and improvements that took place this year. Initial difficulties at the start-up of the machine included the problem with misaligned permanent magnet dipoles in the

interaction region (30 deg rotation error) that was finally corrected without having to remove the detector.
The committee was impressed by the good collaboration between the Accelerator Department and the KLOE detector people that teamed together in this effort that had all the hallmarks of a good detective story and was finally crowned with success. After the corrective action injection and beam storage were re-established quickly, single bunch currents of up to 22 mA have been achieved. Proceeding with multi-bunch injection allowed to make good progress in vacuum conditioning of the machine and to reach 1.2 A electron beam up to now.
Electron transfer line optics has been optimised, resulting in smaller transverse beam dimensions, improved injection matching and reducing the beam injection losses and thus e.g. lowering the radiation levels in the control room by an order of magnitude compared to the situation before the shutdown. In a further example of close collaboration between the machine and KLOE detector people a campaign of activation measurements was undertaken and the sources were identified. Transfer line parameters reproducibility and stability have been greatly improved. Furthermore, mechanical stability of the interaction region components was improved. Beam stability studies in the IR, utilising analysis of BPM signals showed marked improvement, the resonance moving up in frequency to 15 Hz and the vibrations amplitudes halved.
The ensuing difficulties with the positron production were traced to problems klystrons that caused a lot of maintenance activity. Several klystron changes and problems discovered in particular with the ceramic windows in the new tubes resulted in investigation of alternative suppliers that looks promising both on quality and price of the new tubes.
The situation has been finally improved to the point of storing about 400 mA of positrons. Nevertheless the operational reliability of this linac that is slowly showing its age needs to be further investigated and improved. The klystrons are run very close to their maximum power rating and the process of optimisation that could result in lower working point and thus higher reliability should continue. The fact that the linac has to deliver beam to the Beam Test Facility on a 24 hour basis points out the positive role played by this facility in this context.
The Committee again notes that the strength of the Accelerator Division is being reduced, particularly because of retirement and departure of high-level experienced staff. The remaining personnel are spread thinly over many projects and initiatives. The missing expertise due to continuing difficulties with hiring of new people prolonged the fight with initial start-up difficulties in DAΦNE. The steady increase in the average age of the personnel has to be stopped by attracting and training new young personnel. No new people at present can be hired without external funding. The committee is looking forward to the realisation of the promise of the new competitive funds that may correct this situation.
The committee was particularly glad to hear about the progress in combining the control rooms of DAΦNE and SPARC Lab for routine operation. Both activities have very clear idea of the immediate needs in terms of new hires and these show good balancing and possibility sharing of new resources.

1.2 KLOE

The members of the SC F. Bedeschi, G. Colangelo and A. Golutvin met with members of the Collaboration to discuss preparations for the data taking campaign in 2014.

The referees congratulate the KLOE team for the successful installation of the new sub-detectors. The work has been completed in time in accordance with the strict planning schedule.

Only a few connectivity problems (at the per mil level) have been observed. What requires more attention is the need to reduce the temperature in the vicinity of the read-out system for the QCALT. In order to reduce the dark current of the SiPM the temperature has to be brought down from the current 50° C to 25° C. The solution proposed by the KLOE team seems feasible.

The commissioning campaign is just being started. So currently it is difficult to provide any time estimate of this effort. We propose to review commissioning status at the next SC as well as consolidation of the integration of the new sub-detectors into the KLOE detector. At that time we should have a clear forecast on the integrated luminosity which can be collected during the next three years of data taking.

We have also reviewed the person-power requirements for the commissioning of the detector. In general, the situation looks reasonably healthy. A particular request has been expressed for full time involvement of the 3-4 hardware experts from the electronics workshop during the whole commissioning period.
For the three years term of data taking the person-power request has not changed compared to that expressed at the previous SC meeting. The collaboration is desperately looking for a few experts in particular in the areas of drift chamber operation, slow control and computing. Again we propose to review person-power situation at the next SC meeting. Following recommendations of the previous SC meeting the importance of the preparation of MoUs with the outside groups has been re-iterated.

Physics analysis of the KLOE data is progressing well. We have seen new published and preliminary results presented at the open session. The SC has been particularly impressed by the new measurement of the Dalitz plot of the $\eta \rightarrow 3\pi$ decay, important for the m_d-m_u mass difference.

1.3 SIDDHARTA

A. Gal and M. Taiuti met Catalina Curceanu and other members of the AMADEUS and SIDDHARTA Collaborations.

There were 2 talks in the open session about Siddharta and Amadeus also showing that many young people are producing results and giving a remarkable helping in KLOE.

The Collaboration understood that Siddharta2 is an approved experiment and they want to know when it will be on the floor preparing for data-taking. This is also important for keeping the Collaboration together.

Siddharta2 can measure the K^-D shift and width for the 1s level in addition to what they have already done for K^-atoms of hydrogen and isotopes of helium in Siddharta1. During the presentation in the open session a new proposal to use heavier targets was also shown. This proposal is circulating now within the community. If the Collaboration wants that the SC considers this proposal, they should present it officially.

The situation of the Amadeus experiment is unclear. There is a document describing the experiment, but its feasibility and scientific importance should be discussed and defended in an organized way. Much of what they have produced until now is interesting, but it must be seen in a more general context also comparing with the development that happened in the field in the recent years. Some results on similar science are coming from JParc, from JLab on photoproduced Lambda(1405) and from GSI in pp collisions by the HADES collaboration. The Amadeus collaboration should define their uniqueness showing for what they can do with stopped kaons and looking for final states that are unique for the Lambda(1405) and other channels, in particular concerning the isospin interference. A concern is that Amadeus has not published yet on important journals.

1.4 Recommendations

The SC recommends that LNF continue to put as first priority of the Laboratory the physics program of DAΦNE.

The committee recommends that the realisation of synergies of the two accelerator based activities should be a priority.

Given the persisting difficulties with the hiring process it may be prudent to carefully examine the possibilities for outsourcing.

KLOE/ DAΦNE commissioning should be given top priority, in particular for access to experts from the electronics workshop.

The SC recommends that the soon after the DAΦNE start-up attention is put to produce an assessment of the achievable level of luminosity and an official schedule including the running of the two experiments. The goal is to have the schedule six months after the start-up.

The SC notices that there is no MOU with the non-INFN groups participating in KLOE. The SC encourages the LNF director to propose and sign an MOU that regulates the participation of these groups also in view of the sharing of the responsibilities for the new run of DAΦNE.

The SC recommends the Amadeus collaboration to produce a document to be distributed to the SC with a discussion of the scientific goal of the experiment and a comparison with other facilities addressing the same science.

2. SPARC_Lab

THz source: THz generation is certainly a very rewarding option for SPARC_Lab. It comes (almost) for free and meets a demand growing quickly worldwide.

It was not quite clear to the SC how important an upgrade of **FLAME** to the Petawatt power level would be.

Impressive progress was achieved in terms of **synchronization**. The synchronization level between the FLAME-Laser and the electron beam is in the 50-100 fs range (rms). For the Thomson source 1 ps would be sufficient, but for laser-plasma acceleration with external injection 50 fs is a maximum where some initial experiments can be performed, but the critical experiments require < 10 fs rms stability. This means that even more efforts are needed in this field. The next important step foreseen is a feedback stabilized optical fiber transmission line, which is strongly supported by the committee.

2.2 Recommendations

THz source *: We suggest to work out more clearly and to focus on the stand-alone capabilities of SPARC_Lab in this respect (e.g. due to its unique electron double pulse capability) and to find out the specific science opportunities.*

Compare science with the foreseen upgrade of FLAME to Petawatt power to science with other PW lasers at other labs like e.g. Berkeley.

As it was pointed out previously, we remind once more of the need to publish a ***Technical Design Report*** *and to establish and maintain an adequate webpage. This would help running collaborations and could attract more of them.*

3. Summary of activities at LNF in technological and interdisciplinary research activities (CSN5)

After the review done one year ago the Committee expressed concerns about the fragmentation of the activities in tiny groups. Now the projects are reduced by a

factor two and this is very positive. More than half of the FTE is working on accelerator physics or connected activities in good synergy with the mission of the laboratory.

The other important and large activity is the R&D on satellite, lunar and planetary laser ranging. Although this activity is not in the INFN main science scope, it gives a valorisation of our knowledge. It receives important external funds on which it is possible to hire people. This activities is a plus for LNF, but is has to be monitored to avoid that it becomes a large activity growing independently from the control of the Laboratory.

Among the other activities, the hadron therapy activity seems marginal and the neutron source doesn't seem competitive with what is done at CERN.

However, there is an interest for the LNF to develop this neutron source done by the BTF group in collaboration with the radiation group. There is a common proposal in order to use the spare gun of the linac plus some accelerating structure to bring the neutron flux from 10^2 to 10^5 particles/s. The collaboration has just started and there is a large community of users for this.

The committee discussed also the overhead policy in the laboratory:
for those external funds with responsibility within LNF, a fraction of the overheads that INFN receives from them stays inside LNF. Averaging over last years about 50% of the Research money for LNF activities comes from INFN central budget whereas the rest is from external funds
While the funds coming from INFN are more stable and well structured, the funds from other sources are more difficult to handle.

3.1 Recommendations

The SC takes note with satisfaction that the activity of the LNF CNS5 groups is more focussed with respect to one year ago. Some 80% of the activities are concentrated on accelerator related R&D and laser ranging. It is important that the progress of all activities is monitored also locally comparing the resources given and the results produced.

4. Beam Test Facility

Presentation by Paolo Valente featured a very impressive set of activities mainly concentrated on detector calibration. The test beams are in high demand among many user groups from within the laboratory but also from external user community, as evidenced by substantial overbooking of the facility.
Large effort put in by the Accelerator Division in parallel to DAΦNE commissioning is acknowledged. In the last two years constant improvement of the facility has been undertaken, providing better service for the users. In this

context the committee appreciates significant synergies with the operation and development of the other accelerator facilities of this laboratory. The planned neutron source will add a large value to the facility.

The SC takes note that LNF is discussing a policy in order to allow scientists working on BTF signing papers produced by the users based on results obtained with specific tests at BTF.

5. Activities on the dissemination of scientific culture

The activities on dissemination of scientific culture are addressed to three targets

- **Students** of high schools (~ 200/year) come for stages of typically one week and are exposed to the various activities of the LAB. In addition there are guided tours with some 2700 high school students per year and 800 primary and secondary school students per year.
- **Teachers** (~ 200/year) follow a three days course with visits, working groups and plenary lessons.
- **General public**: LNF organizes some four public lectures (~ 400 participants) per year and one open day with some 1000 participants.

Student and teachers activities involve some 60 INFN tutors each.
The committee takes note on this important outreach activity and congratulates the small team (5 people) that make them possible.

6. From Previous Meetings

6.1 NAUTILUS Recommendations_SC_44

The SC recommends guaranteeing the run of NAUTILUS until VIRGO will restart after its upgrade, in spite of the limited sensitivity of the NAUTILUS detector compared to the interferometers.

SC_45: Nautilus will be kept running.

6.2 Theory Group Recommendations_SC_44

The SC recommends defining a clear strategy for the Theory Group of LNF. A working group with representatives from the Theory Group, the Lab management and theorists from nearby universities should be formed with the mandate to define and state this strategy for the medium/long term.
An effort should be made to increase the number of young people in the group: establishing collaborations/official agreements with nearby universities and possibly finding ways to finance more postdoc positions.

SC_45:Dosselli states that the preparation of the panel to review and to define the strategy is ongoing. It was decided to go up to 5 postdoc positions (a fraction of which will go to the theory group) reducing the money for foreign visitors.

6.3 Space Research at the SCF_LAB Recommendations_SC_44

The SC takes note that the group is making good use of existing infrastructures (eg. clean rooms) giving added value to the Laboratory also with external contracts.

6.4 PANDA Recommendation_SC_44

The SC acknowledges the good work done on the SST and is impressed by the very light design. The SC recommends that the participation of INFN to PANDA and to its funding is clarified before the start of the construction at LNF and takes note that CSN3 has a new scientific committee to better understand the scientific position of PANDA.

SC_45: The report of this new scientific committee was positive endorsing the participation of the Italian community to the project. However the funding (5MEu) situation is not clarified. Dosselli states that LNF will start the construction work on PANDA when the situation will be clear. R&D will continue.

SC_46: Taiuti has been invited in the SB of PANDA, otherwise no progress in the clarification of the funding.

6.5 BES Recommendations_SC_45

The SC takes note that the group is making good contribution to BES also in synergy with other hardware activities of the Laboratory. The SC notices that the size of this contribution is quite limited and configures more as the participation of a "Sezione" than as the participation of a Laboratory. See also the recommendation section 3.2.

6.6 NA62 Recommendation_SC_45

The SC takes note that the group is making good use of the structures of the Laboratory in order to contribute to an important experiment capable add new constraints the CKM matrix.

6.7 CNS5@LNF Recommendations_SC_45

The SC recommends that the LNF management, together with all involved people, define the common goals and the appropriate follow up process for each project.
The SC invites a new presentation of the summary of LNF CSN5 activities at the next meeting addressing some of the questions asked by the committee and showing the correlation between the LNF CNS5 activities and the needs of the Laboratory.

SC46: The LNF direction is trying to streamline the CSN5 activities in the lab even if this is not easy because of diversification already at national level. The SC iterates the importance of a new presentation at SC_47.

6.8 CNS1@LNF Recommendation_SC_45

The SC invites a presentation from KLOE of consequences of possible shortage of human resources for the commissioning, run and analyses of the KLOE-2 due to researchers migrating to different experiments.
The SC recommends the LNF management to tune the assignment of resources to CSN1 LNF groups privileging a) the internal core activities and b) the large and visible extramural activities, which have an impact on the local LNF infrastructures.
The goal of this request is to reduce to a minimum the Laboratory participation in small and less visible extramural activities with little return on the Laboratory.

6.9 CNS2@LNF Recommendation_SC_46

The SC takes note that in spite of the small size of the groups involved in these experiments, the impact of the LNF group has been large and the LNF groups made the difference in several experiments. The laboratory, with its local infrastructures can play even a more important role in INFN centered way.
LNF may benefit in increasing the participation is space experiments where INFN has quite a unique tradition, with the ambition of becoming a national INFN center providing specialized engineering support and infrastructure.

6.10 CNS3@LNF Recommendation_SC_46

The SC is impressed by the strength of the LNF participation to CNS3 activities: the contribution of the LNF groups to the scientific production of the Nuclear Scientific Community is of primary importance. Each group went much over the threshold of the participation for a good visibility. The only concern is that there is a group waiting for PANDA.