36^{th} MEETING OF THE LNF SCIENTIFIC COMMITTEE

FINDINGS AND RECOMMENDATIONS

The 36^{th} meeting mainly focused on the status and the outlook of the upgraded DAΦNE collider and the planning of its experimental program. Specific recommendations were made on the running and/or installation of three DAΦNE experiments: they are recorded in this document.

The Committee also reviewed two external activities belonging to the LNF external program: the LARES and the BaBar experiments. A talk by P. Raimondi described the status of the design of a Super B-factory. The status of the SPARC and SPARX projects was discussed in closed session.

The Committee welcomed a new member, C. Matteuzzi, who joins it as chair of the Beam Test Facility Committee.

1 THE DAΦNE PROGRAM: STATUS AND RECOMMENDATIONS

1.1 DAΦNE UPGRADE: PERFORMANCE AND OUTLOOK

DAΦNE has now operated for a few months with the new scheme of colliding beams with large Piwinski angle and crab-waist compensation. The commissioning of the new configuration, with the prototype SIDDHARTHA experiment is about two months behind the expected schedule. While peak luminosities have exceeded previous records by up to 40%, daily integrated luminosities are not yet up to previous operational levels and backgrounds are high. These are grounds for serious concern. On the other hand, analysis of the present situation (see below) shows that there are also rational grounds for optimism. Not least among these is the fact that the principle of crab-waist compensation has been shown to work; this must be recognised as a major advance in the long history of fighting the beam-beam effect in e^+e^- colliders. It is also an important step towards validation of the SuperB design concepts.

The evaluation of performance has been complicated by discrepancies among the luminosity monitors and the high backgrounds. These differences need to be ironed out. The Committee supports the request of the Accelerator Division for more data (kaon monitor rates) to be made available online.

The backgrounds in SIDDHARTHA are understood as being mainly off-energy particles created by Touschek scattering. These backgrounds were anticipated in the upgrade proposal (see DAΦNE Technical Note G-68 (2006)). However it appears that the existing scrapers are less efficient than expected. This is at least partly because they do not have the necessary range of movement to close tightly enough on the smaller beams. This limits the horizontal beam size in the interaction region quadrupoles and is an important factor determining the attainable β^*.

It should be clarified whether new scrapers could be more effective without detrimental side-effects, such as an increase in impedance. If this looks promising, they could be considered for installation at a time when they do not incur additional costs in vacuum conditioning time (i.e., after the SIDDHARTHA run). In the meantime, there may be some scope for improving efficiency, e.g., with orbit bumps at the present scrapers.

As in the past, the lattice non-linearities may also affect the Touschek lifetime and background. However experimental study of the beam tails is difficult with the present scrapers.

Alignment of the crab sextupoles is well under control. Despite their being an order of magnitude stronger than the regular arc sextupoles, their potentially severe perturbation of the linear optics of the rings has been nullified by beam-based measurements. We can accordingly withdraw our previous suggestion that high-precision moveable supports might be installed.

The linear optics and dispersion functions of the rings have been measured and found close to the design specifications, but further reduction of beta-beating should improve performance.

The low-intensity beam cross-sectional areas at the interaction point are both about twice the design values. This is partly a consequence of the limit on β^* from backgrounds, but betatron coupling is not yet low enough.

Single-beam multi-bunch effects such as ion-trapping and electron cloud are also important limits on present performance. The clear identification of the electron cloud in the positron ring (following the replacement of vacuum bellows), and its partial cure using solenoid windings, has cleared up a long-standing apparent difference between DAΦNE and other machines. Further windings, where possible, are expected to be beneficial. Further vacuum conditioning should help with the ion effects on the electron beam.

The Committee notes the important progress made in equipping DAΦNE with a uniform set of advanced state-of-the-art transverse feedback systems and upgraded software. These have allowed record positron currents to be achieved. However, the systems are (naturally) already working close to their limits; the technical possibilities and benefits of increasing their power should be considered.

The benefits of the new vacuum bellows design, the new injection kicker design and the removal of ion clearing electrodes are clear. The impedance has been reduced to the point where bunch lengthening is substantially reduced and is now very similar for both beams.

Finally, the effect of the crab-waist compensation is striking. As we were able to observe directly in the control room, excitation of the sextupoles on either or both beams reduces the corresponding beam sizes in collision, as predicted.

Turning to the outlook for near-term operations, after the full installation of SIDDHARTHA (early June 2008), a transition to regular operation and steadier accumulation of integrated luminosity is foreseeable. If the best present performance of 0.5 pb^{-1}/h can be efficiently sustained, then a monthly integrated luminosity of about 250 pb^{-1} should be achievable. However, time must still be devoted to incremental tuning and well-planned machine development sessions to increase luminosity and reduce backgrounds. Further improvements, which one can reasonably hope for at this stage, would be required to reach the goal of

5 fb^{-1}/year. In the longer term, operation with a solenoidal detector – with its much greater background diagnostic capabilities – will be helpful in simultaneously optimizing luminosity and data-taking conditions.

The installation of stronger crab sextupoles (with a maximum integrated strength of 25 m^{-2} as opposed to the present 18 m^{-2}) will allow the crab-waist compensation to be pushed somewhat further, with some potential gain in performance. Nevertheless it is a pity that the full compensation strength of 36 m^{-2} will not be available as it probably precludes the possibility of testing the prediction of an optimum compensation at an intermediate value around 30 m^{-2}.

In view of the next experimental run, we note that much potential luminosity is presently lost because SIDDHARTHA cannot log data while one beam is injected and the other decays in intensity from its peak value. As discussed at the previous meeting, the implementation of separate injection beam lines for the two beams would allow top-up injection, keeping the currents of both beams closer to their maximum values. Since the injection rates would be lower, this could well be compatible with data-taking and significantly increase integrated luminosity. Measures to improve injection efficiency and backgrounds may also help. The Committee recommends that a quantitative estimate of the benefits, the cost, resource allocations, the hardware and other changes required to implement such a scheme be documented, with due attention to questions of radiation protection. This will confirm whether this is the highest priority upgrade now in prospect.

As discussed at the last meeting, future experiments will superimpose an experimental solenoid on the new interaction region and require a strategy for betatron coupling compensation compatible with the large crossing angle, small permanent-magnet quadrupoles, and crab-waist compensation. A detailed solution to this problem is not yet available but is likely to impose strong constraints linking the compensating solenoids, the low-beta quadrupoles, the orbit, and the aperture. It has become apparent since the 36th Committee meeting that these constraints might imply substantial changes to the interaction region hardware. A single operating value for the experimental solenoid field will have to be chosen and there is a strong incentive to make it as low as possible in order to minimise the complexity and cost of the new configuration.

Once a satisfactory solution has been found at the level of beam optics, the committee strongly urges the preparation of a technical document describing the further modifications of the interaction region including costs and implementation schedule. Only when all this information is available will it be possible to assess whether the luminosity gains achievable in operation with SIDDHARTHA can be reproduced with another detector. This will allow the laboratory management to confirm planning for the next run in 2009.

1.2 SIDDHARTA

The committee was once again impressed by the presentation of the SIDDHARTA progress report. The day-one work schedule including installation of the kaon trigger, SDD tuning, and a first run with kaonic nitrogen was performed according to plan in February and March 2008. However, in the upgraded DAΦNE configuration, the measured background turns out to be about a hundred times larger than what the previous DEAR experiment had to deal with. This would put the original goal of SIDDHARTA as a precision experiment in question.

With improved beam tuning and lead shielding, a background reduction by about a factor of two could be achieved. But even after additional improvements by another factor of two, the expected signal-to-background ratio is 1:5 instead of 5:1 as previously foreseen. As a consequence, the expected precision for kaonic hydrogen (with an integrated luminosity of 400 pb^{-1}) would be ±10 eV for the energy shift and ± 35 eV for the width, rather than the original aim of a few eV.

Further improvements in the shielding might gain another factor of two in background reduction. Nevertheless this would still not make it possible to perform a kaonic deuterium measurement at a meaningful level of precision. It is felt that this situation would be in contrast with the excellent technical achievements and progress made by the SIDDHARTA group.

While the reported level of accuracy for the kaonic hydrogen measurement is acceptable as a compromise under present conditions, all efforts should be made to improve on the background issue such that SIDDHARTA can proceed with the perspective of approaching its previous goals. In particular, the kaonic deuterium measurement should not be sacrificed, because it is the novel and crucial cornerstone of the SIDDHARTA proposal. Without it there would be no complete determination of antikaon-nucleon scattering lengths which play a key role in setting much needed accurate constraints for the theory of the low-energy KN interactions.

SIDDHARTA is prepared for full installation in early June 2008. The previously reported beam time requests amounted to 100 pb^{-1} for setup and tuning, 400 pb^{-1} for the kaonic hydrogen measurement, and 600 pb^{-1} for the first measurement of kaonic deuterium. However, these requests were made under the assumption of running conditions which are not currently realized.

It is recommended that a tuning period follow the full setup, until stable conditions are reached and the signal-to-background ratio is better than 1:5. The 400 pb^{-1} should be considered as a minimum requirement along with further reduction of background aiming to reach at least $S/B \approx 1:1$ (corresponding to 1:5 for kaonic deuterium). Under these conditions, 600 pb^{-1} for the first kaonic deuterium measurement appears as the minimum necessary integrated luminosity.

1.3 KLOE AND KLOE-2

The Committee learned about the excellent progress in the analysis of the KLOE data. Several new papers have been published since the 35^{th} meeting of the Committee. For kaon physics, these are:

- The absolute branching ratios for charged-K decay to charged lepton, π^0, and neutrino, for decays to e and μ.
- The absolute branching ratio for K^+ decay to π^+ and π^0
- The charged K lifetime measured with two methods giving consistent results
- Form-factor slopes for K_L decays to charged π, μ, and ν.
- All the main branching ratios of K_S, K_L, and K^+; K_L and K^+ lifetimes, and form-factor parameters for semileptonic K_L decays have been brought together in one publication giving a combined V_{us} determination consistent with unitarity of the first row of the CKM matrix. These measurements also demonstrate lepton universality. The purely leptonic kaon decays allow the exclusion of a region in the charged Higgs mass – tan(β) plane.
- The branching ratio of K_S to $\gamma\gamma$ has been measured with the full integrated luminosity, and has been published since the last meeting. It agrees exactly with the leading chiral perturbation theory contributions.

In the area of scalar and pseudoscalar mesons, a determination of the η mass has been published, as has a Dalitz plot analysis of η decay to π^+, π^-, and π^0.

The hadronic contribution to the muon magnetic moment has to be calculated from measurements on e^+e^- annihilation to hadrons or from τ decays. KLOE measures the former for different energies thanks to initial state radiation. Results with improved systematic errors were presented. More analysis is in progress, but needs some strengthening in manpower.

The Committee congratulates KLOE for all these new publications, which again demonstrate the superb apparatus and excellent competence of the Collaboration. The Committee looks forward to the forthcoming publication of the coming papers that were presented at the meeting.

The KLOE referees visited KLOE-2 on 22 April; the report from this visit has been distributed. Of the funding conditioned on DAΦNE performance, the part needed for the Level-2 CPUs has been released, and the needed equipment is being purchased. This is therefore no longer a time-critical issue. Modifying the existing beam pipe to suit the new interaction region requires careful timing. However, this subproject seems to be on the right track. The conclusion is that KLOE-2 can be ready to roll in at the beginning of 2009.

The collaboration stated in their roll-in proposal that they wish KLOE to be installed when DAΦNE performs at the level of 5 fb^{-1}/year. On the other hand, the best feedback and incentive for the DAΦNE improvement would probably be a rolled-in KLOE-2. As noted above, DAΦNE's performance today is probably consistent with 3 fb^{-1}/year, or 250 pb^{-1}/month. The Committee thinks that the optimal approach for DAΦNE and KLOE-2 would be that KLOE-2 goes in sooner rather than later even if the wish for 5 fb^{-1}/year has not yet been achieved.

More specific recommendations are given below.

1.4 FINUDA

Since the 35th Committee meeting, the FINUDA Collaboration has vigorously continued analyzing the data from the last run, in which an integrated luminosity of 1 fb^{-1} was recorded. We acknowledge the effort made by the FINUDA collaboration on the analysis and understanding of the data in the last six months. In particular, it is important to stress that:

- the calibration and alignment are almost finished
- in the hypernuclear spectroscopy program, the collaboration has been able to correlate the negative pion from the formation of a hypernucleus to:
    - the proton from non-mesonic weak decays, with comparisons to models
    - the low-momentum π^- from mesonic weak decays
- the collaboration has performed a detailed analysis of the Λ momentum spectrum, wherein the higher part of the spectrum contains the "interesting" events, i.e., those associated with K^- multi-nucleon absorption
- a very interesting search of neutron-rich hypernuclei has been conducted, in particular of ${}^{6}_{\Lambda}H$ produced in association with a π^+

In addition, several papers have been published, and more will be published soon, on Λd and Λt production and on the measurement of the proton spectrum in non-mesonic weak decays. The Committee is very positively impressed by the quantity and quality of the recent work by the FINUDA collaboration and by its interesting new results.

The collaboration has presented a proposal to re-install the apparatus in IP2 in order to take additional data for an integrated luminosity of 3 fb^{-1}. This new run would have to take place within 2009 if possible and in any case would have to precede the KLOE 2 roll-in in order to obtain data on K-nucleus interactions before the competing programs in JPARC, which will have the benefit of higher data rates.

The new FINUDA proposal presents a carefully thought-out plan, in which a judicious choice of nuclear targets would permit the collaboration to obtain statistically significant signals on several types of final states where interesting hints are present. In keeping with the recommendations of the SC at its 35th meeting, the proposal stresses several areas in which the experiment could make useful contributions, independently of the outcome of the DBKNS issue. Undoubtedly the proposed data-taking period would be fruitful. In addition, there is no doubt that the detector can be readied in time for installation in 2009.

1.5 RECOMMENDATIONS FOR THE NEXT STEPS OF THE DAΦNE EXPERIMENTS

The following recommendations concern the running time and/or the installation of the DAΦNE experiments, clarifying or completing the statements made in the preceding sections.

SIDDHARTA:

All efforts should be made to provide to SIDDHARTA the luminosity and background conditions that will allow the collaboration to measure the kaonic hydrogen atom level shift and width with errors no greater than 10 eV and 35 eV respectively. This is expected to require 400 fb^{-1} as originally proposed.

The analogous quantities for the kaonic deuterium atom constitute a completely new measurement and require better signal/background conditions than those currently achieved. The Committee strongly recommends that all efforts be made to obtain a significant measurement of these quantities, which represent a crucial component of SIDDHARTA's scientific program.

Based on an expectation of a sustained rate of about 250 pb^{-1}/month together with improved backgrounds sometime before the end of 2008, it is assumed that SIDDHARTA data taking can be completed sometime during the spring of 2009.

FINUDA and KLOE 2:

The two experiments are in competition for installation after the completion of SIDDHARTA. For either experiment, a period of further machine tuning will be necessary in order to re-optimize the optics and the backgrounds to compensate for the detector's magnetic field. However this re-optimization will benefit from the information that either detector can provide.

Both detectors can be ready to be installed in 2009, and technically would not need a go-ahead signal at the time of the 36th SC but only about 6 months before the roll-in date. However there are financial deadlines that (particularly in the case of KLOE-2) require decisions on an earlier time scale.

It is assumed here that at the time of the SIDDHARTA roll-out the sustainable integrated luminosity rates will be in the range of 3 to 5 fb^{-1} per year of operation, leading to an estimate of about one year for a 3 fb^{-1} exposure of FINUDA (allowing for the re-optimization time). However, running FINUDA also requires 4 to 5 months to switch the interaction region from IP1 to IP2, and a similar time for the opposite switch to IP1 that would be required for subsequent IP1 running of KLOE-2. (In contrast, KLOE-2 could be installed in IP1 in a matter of weeks after the decommissioning of SIDDHARTA). If FINUDA were to be installed in 2009, KLOE would not be installed before 2011. This time scale is incompatible with the KLOE-2 physics program, which provides the main motivation of the DAΦNE experimental program.

Based on these considerations the Committee does not recommend the installation of FINUDA following the completion of SIDDHARTA, but recommends the prompt installation of KLOE at that time. A condition on this recommendation is that KLOE-2 affirm its commitment to roll in on schedule regardless of the luminosity reached at that time. It is recommended that the situation be reviewed after KLOE-2 has accumulated data for about 3 fb^{-1}.

In view of the information that became available after the meeting regarding the constraints on the interaction region design and its hardware – possibly also involving the geometry of the vacuum pipe – the timing of these recommendations may need revision. In particular, KLOE-2 should freeze the changes to the design of their vacuum pipe and proceed to implement them only after the beam optics at the IP have been fully calculated and documented. As already pointed out, the experimenters are advised to work out with the Accelerator Division the best compromise between sufficiently high magnetic field and simplicity of the interaction region geometry.

1.6 THE AMADEUS PROPOSAL

The committee met with representatives of the collaboration and discussed two distinct activities:

1. analysis of K^- interactions in the already existing KLOE data sample (2 fb^{-1}) in search of DBKNS;
2. detector R&D for and planning of the AMADEUS experiment.

Analysis of the KLOE data sample

To date 1.1 fb^{-1} of the available 2 fb^{-1} KLOE data sample have been analyzed. The main thrust of the analysis is on the observation of K^- capture on ^4He in the KLOE drift chamber gas leaving a (K^-ppn) state and a neutron. The (K^-ppn) state decays into a proton and a Λ, which subsequently decays into $p\pi^-$. The full analysis chain has been exercised (in a surprisingly short time!) demonstrating not only the superb quality of the KLOE detector, but also the eagerness of the AMADEUS team as well as the excellent support provided by the KLOE collaboration. Regretfully, no sign of momentum balance between the scattered neutron and the hypothetical (K^-ppn) DBKNS could be shown. Before drawing conclusions the following aspects of the analysis must be further investigated:

- The resolution on the neutron energy (extracted from either TOF or energy deposits) must be determined. The committee welcomes the joint KLOE-AMADEUS tests in Uppsala later this year;
- Clear separation between K^- captures in the drift chamber gas and K^- captures in the drift chamber wall using the (K^-ppn) bound state formation point instead of the Λ-decay vertex;
- The relative likelihood of capture on ^4He in the KLOE drift chamber gas as opposed to capture on carbon nuclei as in isobutane.

In addition, the full KLOE data sample should be brought to bear and more channels should be looked at (including perhaps those with a less specific signature). It is important that this group and FINUDA investigate the very conspicuous differences in the Λ momentum spectra that they separately observe. The referees expect that these issues will be addressed in the next meeting.

Despite the lack of DBKNS evidence, other very interesting publication quality results are within reach, *e.g.* the Λ- and Σ^0-mass determinations as well as the search for $\Lambda(1405)/\Lambda(1420)$ states in the $\Sigma^0\pi^0$ decay invariant-mass spectrum (where $\Sigma^0 \rightarrow \Lambda\gamma$ and $\pi^0 \rightarrow \gamma\gamma$). Regarding the latter, the Committee suggests to use kinematic fitting and to extend the analysis to include the $\Sigma^+\pi^-$ and $\Sigma^-\pi^+$ channels as well.

The Committee members congratulate the AMADEUS team on the impressive progress achieved as well as on their good collaboration with the KLOE Collaboration. The Committee feels that, as a DBKNS analysis feasibility study, the AMADEUS team is approaching the maximum that can be achieved with the KLOE data sample.

AMADEUS

The lack of evidence of DBKNS production (so far, at least) is not surprising given the low expected K^- capture rate in KLOE, even if the controversial DBKNS are there to be found. To firmly conclude on the existence or non-existence of the DBKNS is the primary aim of the AMADEUS collaboration (and the main justification for AMADEUS-1).

At the current time, the AMADEUS Collaboration is firmly established. They submitted a clear proposal for AMADEUS-1, characterized by the implementation of a kaon trigger and a target cell immediately surrounding the (to be replaced KLOE) beam pipe to collect 3.5 to 4 fb^{-1}. The purpose of this run is to settle the issue of the existence of DBKNS. The proposal is to use the minimally upgraded KLOE-2 setup, directly following the first KLOE-2 run.

Depending on the findings of AMADEUS-1 the collaboration considers a continuation, named AMADEUS-2, aiming to collect 10-20 fb^{-1}. Discussions about AMADEUS-2 were deemed premature at this stage, both by the Committee referees and by the AMADEUS representatives themselves.

The preparations for AMADEUS-1 are well advanced. In particular:

- The kaon trigger is in the R&D phase (fibres, light detectors) but already shows excellent performance. The final setup (double layer) is expected to be available by mid-2009.
- The cryogenic target cell will also be available by this time, and given the world-class expertise of the Vienna group in this field, the committee members anticipate no problems.
- The beam pipe is a joint KLOE-DAΦNE-AMADEUS effort and despite being delicate, it raises no major concern.

The more critical activities are to acquire experience in operating the KLOE-0 detector as well as to more generally contribute to KLOE such that a mutually beneficially cooperation can be established leading eventually to an MoU. The committee was very pleased to see that AMADEUS people are already contributing to KLOE DAQ, electronics, and trigger activities.

Monte Carlo simulations have been presented in earlier meetings. Nevertheless, it would be useful to have an update at the next Committee meeting in the light of the results of the analysis of the KLOE data presented above.

Concerning the AMADEUS-1 request to take data at DAΦNE directly following the first KLOE run, the committee endorses this request under the provision that the AMADEUS and KLOE teams reach agreement on a collaboration MoU.

2 EXTERNAL PROGRAM PRESENTATIONS

Two activities that involve significant human and technical resources were reviewed in this meeting.

2.1 LARES

LARES (LAser RElativity Satellite) is an experiment that will make high-precision measurements of effects of General Relativity (GR) by means of satellite laser telemetry (SLR). The initiative is a US-Italian collaboration involving the Italian space agency (ASI), US collaborators, and substantial participation from LNF and the University of Rome I. The principal investigator (from the University of Lecce) has a proven track record in the field, having led the two previous satellite experiments mentioned below.

The main experimental goal is a verification of the Lens-Thirring effect – the dragging of the frame of reference of a test mass (the satellite) due to the Earth's angular momentum – with about 1% accuracy, where 10% was previously achieved. This will permit a search for effects beyond Einstein's GR. The measurement tool – laser ranging – has been established since the first Moon expeditions and has greatly evolved since. The target of laser ranging is a passive satellite designed to reduce the errors of previous measurements, obtained with the LAGEOS I and LAGEOS II satellites. These satellites are spheres incorporating a large number of retro-reflectors. LARES is made of very high-density material (a tungsten alloy), which minimizes the surface area and the associated errors due to heating by the Sun.

The mission was approved as an INFN experiment in 2007 and received the financial go-ahead by ASI in early 2008. LNF has developed a dedicated facility in order to perform the delicate thermal and optical measurements that verify the adequacy of the satellite for its mission in its space environment. This experiment, whose cost is small compared to that of space experiments of similar physics reach, has stimulated challenging theoretical and technological work at LNF and is paving the way for possible future initiatives in space science at LNF. The Committee has not examined the needs of this activity in detail (a clean room is one request) but does recommend that these scientifically worthwhile efforts be supported by Lab management.

2.2 BABAR

The LNFSC acknowledges the extraordinarily refined measurements done by the BaBar Collaboration and in particular by the LNF BaBar group, which is very active and relevant within the Collaboration at large. The importance of the BaBar results is clearly seen when looking at the Particle Data Group reviews, where the results from B-factories occupy one third of the full book. The total data collected until September 2007 amount to 470 million $B\overline{B}$, 630 million $c\overline{c}$ and 440 million $\tau\overline{\tau}$ events; Run 7 (Dec 07 – Apr 08) has scanned below and above the Y(4S) to study physics issues other than CKM unitarity, such as lepton universality, spectroscopy, and exotic bottomonium states.

BaBar tests CKM unitarity by measuring the angles β and γ. The results discussed by Giuseppe Finocchiaro in a very brilliant presentation include an update on the measurement of *sin 2β* from $b \rightarrow c\overline{c}s$ in all possible exclusive channels, which leads to a particularly accurate determination of this quantity. Also the determination of γ from Dalitz plot analyses in $B \rightarrow DK$ are competitive with the BELLE measurement.

The Babar LNF Group has attempted to extract measurements from the theoretically more involved channel $B^0 \rightarrow D^{*+}D^{*-}$. Due to hadronic uncertainties, this channel does not provide a golden mode to test the CKM matrix, but it is also useful for our understanding of hadronic models. Furthermore, an accurate experimental analysis is required to reconstruct a pure CP eigenstate.

An accurate determination of $(g\text{-}2)_\mu$ requires the knowledge of the inclusive hadronic cross section, $\sigma(e^+e^-\rightarrow \text{hadrons})$. Thereffore, the study of initial state radiation at the Y(4S) leading to the cross section $e^+e^- \rightarrow KK\pi, KK\eta$ is particularly useful.

The Committee congratulates the LNF BaBar group for its achievements and for the relative importance of their work in this large and very competitive collaboration. This group now faces the challenge of re-orienting its activities sooner than expected, due to the premature shutdown of PEP-II. The group deserves the help of the Lab in making this transition in a timely manner.

3. FUTURE COLLIDERS AT LNF

In the open session, P. Raimondi presented the current status of the proposal to build a super B factory on the grounds of the Rome – Tor Vergata campus. This collider aims at improving on the luminosity goals of the Super KEKB project with significantly lower stored currents and correspondingly lower wall power. This ambitious performance goal is based on the large Piwinski angle/crabbed-waist concept implemented at DAΦNE. The project is being pursued with significant participation from SLAC – whose contribution would include part of the decommissioned PEP-II hardware – and is dependent on further international collaboration.

The LNF Scientific Committee has not been asked for feedback; however, the Committee must follow the developments of this project because of its obvious overlap with the LNF Accelerator Division activities and the implications for any other e^+e^- collider that might be built on the LNF site.

In the closed session, some attention was devoted to the alternative possibility of building on the Frascati site a lower-energy collider, such as a fully rebuilt DAΦNE or a τ-charm factory, either of which would be designed to maximally exploit the new IP designs in order to reach unprecedentedly high luminosities. There was agreement that any such initiative needs the strong backing of a community of physicists. Therefore the Director was encouraged to explore the interest into such proposals.

4. STATUS OF SPARC / SPARX; ACCELERATOR DIVISION MATTERS

No talks on SPARC and SPARX were given at the 36th SC meeting. However, the Committee referee (Joerg Rossbach, JR) met with the SPARC/SPARX representatives M. Ferrario and L. Palumbo on 19 May 2008, discussed in detail a number issues related to these projects, and gave the following report.

4.1 SPARC

SPARC is making good progress and has an excellent, highly motivated team. The organization works smoothly, and the team is well integrated into an international environment. The project receives adequate support within LNF, and is supported within the INFN budget for the next three years.

The electron beam has been transported (and accelerated) up to the entrance of the undulator section, and all the beamline components (like accelerator, quadrupoles, position monitors, screens and emittance measurement) have been smoothly commissioned. The RF deflector works, and first longitudinal RF compression (i.e. without using a magnetic chicane) has been observed. The quantum efficiency is under control, after solving some initial vacuum problems. There is a delay of only a couple of weeks in closing the undulator vacuum, mainly due to delayed delivery of hardware, but up to now no scientific or technical show stopper has arisen towards reaching the design goals. The charge fluctuations from the gun are below 3%, and the stability of beam energy at the end of the linac is better than 0.3%, both numbers being better than specs.

SPARC has a very rich and ambitious program ahead, demonstrating that the key technology needed for SPARX is at hand, and driving the state-of-the-art of high-gain FELs further ahead. This requires careful planning and allocation of priorities. JR was pleased to be shown a schedule for SPARC operation for the next 12 months that includes the following sequence: technical linac commissioning, undulator commissioning, beam matching, demonstration and study of FEL gain in SASE mode, velocity bunching (this will have to go in parallel with FEL studies), seeding, studies on operating the FEL in ‘single spike’ mode, and test of the ‘laser comb’ idea.

The experiments using the FLAME laser (PLASMONX) will be starting, independently of SPARC at first, until the installation of a Compton-backscattering experiment that involves the SPARC electron beam. This is scheduled after the above commissioning steps within a three-year plan.

It was agreed that SPARC will have to demonstrate essentially all the injector modes considered for SPARX. Thus, in particular, the bunch charge at SPARC should be variable between 1 nC and some 50 pC (see next section), which is rather demanding in terms of dynamic range and sensitivity of beam diagnostics. JR pointed out that the issue of producing photon pulses of 10-20 fs length should be given much (maybe more) attention.

There was a consensus that some user operation at SPARC should be initiated rather soon since it would be the best way of nurturing the type of in-house FEL user competence (including photon diagnostics) that will be indispensable for SPARX. Preliminary discussions in this direction are under way and have been strongly encouraged by JR.

Finally, JR felt that a program for timing and synchronization at the fs level would be worthwhile setting up, in particular in view of SPARX.

4.2 SPARX

It was agreed that a short-pulse option, delivering photon pulses of 10-20 fs duration FWHM, will be essential for the SPARX proposal. The scenario foreseen is to run with a 50 pC bunch, compressed down to some 100 fs FWHM. With a little modification of the rf phase settings, one should then be able to generate an even shorter spike (10-20 fs) within only part of the bunch charge contributing to lasing. The extreme form of such operation mode, similar to what is done at FLASH, would be a fall-back solution for reaching short pulses at high bunch charge.

Presently, the SPARX design foresees two stages, the first one aiming at 1.25 GeV delivering a minimum of 5 nm wavelength at the first harmonics. JR suggested to consider for the first phase a somewhat higher beam energy (e.g. 1.5 GeV) in order to safely reach the water window (< 4.3nm) which might be extremely attractive for users. Also, this way SPARX would reach a wavelength regime not accessible to FLASH in the first harmonics.

The SPARX design is continuously being discussed with >100 scientists/potential users, including the bioscience community. L. Palumbo regularly takes part in meetings of the Italian synchrotron radiation community (the next is in June, in Palermo). A workshop on the SPARX science program is planned for 2009.

For its timely realization it is of the highest priority that the SPARX consortium be formed as soon as possible.

4.3 ACCELERATOR DIVISION MATTERS

The staff of the Accelerator Department continue to be overstretched to the point where potentially useful work (e.g., reliability of the injection system) cannot be undertaken. The dearth of new younger staff is a major worry, particularly in view of the laboratory's potential for future world-class projects.

This is true in the photon science sector as well. It was discussed in which way students can be attracted. For instance, an interdisciplinary graduate school could be initiated. L.Palumbo pointed out that preliminary discussion on such a plan are already under way among the three universities Roma I (La Sapienza), Roma II (Tor Vergata), Roma III.

The possibility of expanding on the LNF Spring School by holding additional lecture series at the Lab, in conjunction with the area universities, was also discussed.