FINDINGS AND RECOMMENDATIONS

1 THE PRESENT PROGRAM

1.1 DAΦNE

The Committee heard a comprehensive report on the present status of DA□NE, following numerous changes and improvements carried out during the shutdown for installation of FINUDA. These include the removal of the broken ion-clearing electrodes that have improved the qualities of the electron beam.

The present level of performance of DAΦNE is at the level of 3 pb^{-1}/day, significantly below the maximum that was achieved in the preceding KLOE run, about 10 pb^{-1}/day. To a large extent this is understandable and to be expected: less than one month since first collisions, the normal processes of vacuum conditioning and tuning up the machine in a substantially modified configuration are still in progress. Nevertheless, the committee is concerned that the main factor presently limiting luminosity is not understood. This is a fast horizontal instability that limits the total positron beam current to about 0.75 A (to be compared with 1.3 A in the preceding run).

While the instability exhibits some of the characteristics of the electron cloud effect, some observations suggest other interpretations. As so often in DAΦNE, the wigglers play a significant role. Measurements to understand their multipolar components have led to new magnetic field settings that should minimise nonlinear effects as well as reducing power consumption. The instability seems to be related to the orbit in the wigglers. Systematic study must continue to clarify the nature of the instability without which there can be no guarantee that the luminosity will reach previous levels.

Presently, about 20 % of beam time is devoted to machine development studies. This is probably close to the optimum. However if there is no improvement in the stored positron current soon, it may be worth devoting additional time to a concentrated effort to clearly identify the cause of the instability and implement the best available counter-measures.

As summarised in the presentation, there are good hopes to gain some factors in luminosity from a change in the optics of IP1 (to reduce parasitic beam-beam effects), increasing the number of bunches (as vacuum conditioning progresses) and the continual tuning and upgrading of the feedback systems.

1.2 KLOE

KLOE has now finished data taking and is out of the beam. The experiment has a total integrated luminosity of ~ 2.5 fb^{-1}. The results presented up to now are based on the integrated luminosity of 0.45 fb^{-1}, corresponding to data recorded during 2001-2002. The KLOE experiment is a central part of the LNF program and the bulk of its results are to be obtained during the next years by analyzing the complete integrated luminosity.

The Committee acknowledges the publication of the following results (all with 2001-02 data):

- $\phi \rightarrow f^0\gamma \rightarrow (\pi^0\pi^0/\pi^+\pi^-)\,\gamma$, where different theoretical models are studied
- $K^\pm \rightarrow \mu\nu(\gamma)$, relevant for the measurement of the Cabibbo angle
- tests of CPT , of the Bell- Steinberger relation, and measurements of Im(x-)

Close to publication are also results on η, η' physics, dealing with: precise η mass measurements, (where preliminary measurements were presented), the first measurement of the gluon content of the η', and accurate measurements of the Dalitz plot slopes in $\eta \rightarrow 3\pi$. We also look forward to the determination of the hadronic cross section $d\sigma(\pi\pi\gamma)/dM(\pi\pi)$ through the radiative return method, with photons detected at large angle.

In the findings from the 32nd Committee meeting it was stated: "We also look forward to the measurements of $K^+ \rightarrow \pi^0 l\nu$, the K^+ lifetime,… which are expected to be finalized very soon. Measurements of $K_S \rightarrow \gamma\gamma$ and $K_S \rightarrow 3\pi^0$ are also coming along"; this comment should stay since those results were not finalized by the 33rd meeting.

The findings from the 32nd meeting also stated "the committee endorses KLOE's request for the needed increments of the computing resources". The Committee was pleased to learn at the 33rd meeting that 20 TB data storage has been installed and 30 TB is to be delivered in the near future. With this and other installations KLOE seems to have the needed computing infrastructure. The KLOE computing is staffed by 1.5 physicists, 1 technician and one undergraduate computer science student. The expiry of the latter's fellowship in 2007 would pose a problem if the position were lost.

The major concern for KLOE is the pool of researchers needed to analyze the complete integrated luminosity. Since the accumulated data span several years, calibrations and estimates of systematic errors must be evaluated with great care for each of the time intervals of the recorded data. The collaboration is facing a major analysis effort. The number of involved people decreased from 61 (22) in 2001 to 37 (20) in 2007 for the collaboration (at LNF). However, the effort devoted to KLOE in 2007 is rather 25 FTE for the whole collaboration and 15 FTE at LNF, due to the upgrade activities for KLOE-2. Therefore the collaboration is facing its largest analysis effort to produce the bulk of the results of the entire KLOE program, with a reduced number of researchers. An added concern is that five KLOE people at LNF may disappear in the near future, which would bring the LNF FTEs from 15 to 10, clearly an inadequate size for the LNF contingent.

The Committee recommends that LNF management find ways to maintain 15 people in the KLOE effort at LNF, and that the laboratory explore means to help them obtain the complete and final KLOE results based on the full integrated luminosity.

1.3 FINUDA

After the roll-in of FINUDA on July 18, the debugging was completed by November 19. The main problem encountered was a leak from the helium bag that fills the magnetic volume. This is now reduced to a tolerable level and it is hoped that it will remain stable for the whole run. However the committee is worried about the evolution of the leak, because a more radical repair, if needed, might require a 6-week interruption of data-taking.

The group is already taking good data and is looking forward to a reduction of the background and to higher luminosity in order to reach the goal of 1 fb^{-1}. They want to take cosmic-ray data without B-field during the Christmas shutdown in order to align the vertex detector, which will be very useful for a ‘quasi-online’ analysis of the data on hypernuclear transitions.

On the physics side, the most important news from the nuclear physics world since the 32^{nd} SC meeting is the withdrawal of the claim of Deeply Bound Kaon-nuclear States (DBKS) from KEK-PS-E471, after reanalysis in a new experiment with larger statistics.
In the meanwhile, two papers were published by FINUDA. The document on the plans for physics analysis that was requested of FINUDA was favourably received. The collaboration seems organized for a rapid analysis of the two main subjects (DBKS and Hypernuclei).

The Committee stressed that on the short time-scale the FINUDA effort should focus on these two main subjects, and requests a short report on the status of the data taking and of the data analysis by the end of February.

1.4 SIDDHARTA

Building upon the DEAR experience, the SIDDHARTA experiment aims to perform Kaonic hydrogen and deuterium spectroscopy with eV precision. Essential to these goals are the clean $\phi \rightarrow K^+K^-$ event topology and the regular (daily) calibration of the Silicon Drift Detectors (SSDs). The former should allow SIDDHARTA to reduce the background by more than two orders of magnitude compared to DEAR; the latter should improve the energy measurement accuracy by one order of magnitude.

Presently the SIDDHARTA collaboration has more than the required 72 state-of-the-art SDDs in hand; the final front-end electronics chips are due to arrive by the end of November[1]. Using pre-series electronics, the performance of eight SDDs has been evaluated in great detail in Vienna demonstrating the eV precision and stability. Moreover, an impressive quality control and quality assurance procedure for the SDDs has been established. It is expected that around April 2007 all twelve so-called SDD sub-units, each with six SDDs i.e. 72 SDDs total, will be available. The design of the mechanical support system is basically ready (Frascati), small parts are manufactured in house whereas larger parts will be sub-contracted in early 2007. The cryogenic target gas cell has been successfully pressure tested and several units will be available soon as well. The DAQ system consists of off-the-shelf items and poses no schedule risks. Hence all components comprising the SIDDHARTA detector will be available by the time the crabbed-waist IP is ready (fall 2007). To make this more transparent the SIDDHARTA collaboration is encouraged to make a milestone schedule.

During the running in of DAΦNE with the CW scheme, the SIDDHARTA collaboration is concerned about high background conditions. To minimize damage, particularly to SDDs, it may be wise to initially operate SIDDHARTA with only one SDD sub-unit (six SDDs). Hopefully DAΦNE will reach stable operation in early 2008, at which moment the real

[1] They arrived at LNF on November 29.

SIDDHARTA run can start with all twelve SDD sub-units. The SIDDHARTA experiment is expected to run throughout 2008. The collaboration considers the AMADEUS experiment the logical step following SIDDHARTA.

2 THE FUTURE PROGRAM.

2.1 PLANS FOR THE DAΦNE LUMINOSITY UPGRADE

Since the last meeting of the Committee, the plans for the future of DAΦNE have evolved considerably. Work on the DANAE upgrade of energy and luminosity, based on established principles, has been suspended to concentrate resources on a luminosity-only upgrade, based on the crabbed-waist (CW) scheme. This should be in place for the SIDDHARTA run starting at the end of 2007.

The Committee is pleased that a draft technical report (DAΦNE Technical Note G-68) documenting the proposal, is now available, in response to the recommendations of the last meeting. It documents the arguments, calculations, and simulations supporting the proposal and makes clear that the potential gains are two-fold: not only the enhanced performance but also a reduction in the cost and complexity of the next generation of e^+e^- factories. Furthermore, these gains factorise into several more-or-less independent steps. Relaxing the requirement of very short bunches is particularly significant although it remains to be seen if the very small vertical beam sizes predicted—and required—can be realized.

Since the luminosity upgrade also depends on boosting the positron current, it is all the more important to understand and overcome the present limit in DAΦNE.

Accordingly, the Committee supports the laboratory's bold decision to push ahead with this innovative scheme. Despite the inevitable component of risk, our opinion is that the relatively modest investment in this upgrade of DAΦNE is thoroughly justified.

In the meantime the Committee recommends that a peer review meeting to examine the principles and implementation of the scheme should be organized as soon as practically feasible.

The hardware procurement and modifications are well in hand and should be completed on time so one can expect the projected start-up date to be maintained.

Vacuum conditioning and re-commissioning of the machine with a completely new type of interaction region and subsequent performance optimisation will necessarily be a learning process and take some time. A definitive evaluation of the success of the scheme should be possible by Spring 2008.

2.2 THE EXPERIMENTS OF THE NEXT PHASE

2.2.1 KLOE2

The expression of interest for KLOE2 was evaluated by the Committee, at its 32nd meeting. The collaboration was then encouraged to proceed with its preparatory work for the envisaged detector upgrade.

All material funding needed at LNF for the detector R&D has been approved by INFN. The technology for the vertex detector was chosen to be based on GEM's. The Committee learned that a significant effort is also needed for a revision of trigger, slow control, data handling and the High Voltage system. These revisions are mandatory for KLOE2 to go in for a first CW run already in 2009. Other revisions may also be desirable.

The Committee assessed that the calorimeter read-out with higher granularity can be deployed in 2009, while such a schedule for the new vertex detector appears challenging.

The major issue is the available human resources. The collaboration has to grow to be able to do the required detector R&D, the necessary system revisions, and the software effort. However, the collaboration will also need a dedicated engineering support at LNF for a collaboration effort to be sustainable. Two other experiments, AMADEUS and DANTE, wish to use KLOE2 for their physics goals. The Committee reaffirms its support of such intentions, but must stress that this implies the need that these proponents contribute to the general effort of KLOE2 as well. The Committee was pleased to learn that this collaboration has started with AMADEUS.

To effectively communicate to collaborators and LNF management the needs for the next phase, and eventually to distribute the work, an inventory of the required tasks is needed. The Committee was pleased to learn that this is under preparation.

All in all, the Committee thinks that several measures are needed for KLOE2 to be staffed at a required level: i) The collaboration has to grow. One way could be to partially, or fully, integrate the proponents of other physics projects that want to use KLOE2; ii) A kernel of dedicated engineers and physicists are needed at LNF to make it possible to increase the collaborative effort on all aspects of KLOE2.

2.2.2 AMADEUS and KLONE

The AMADEUS collaboration aims to investigate deeply bound Kaonic states in nuclear matter. The experiment builds upon the past DEAR and forthcoming SIDDHARTA experience.

To achieve this, AMADEUS envisages using the (upgraded) KLOE detector supplemented with a Helium gas target and several fiber layers surrounding the DAΦNE beam pipe, to track the $K^{\pm}$. The Committee supports this dual use of KLOE-2, in view of maximizing the physics output in times when both manpower and material budgets are under pressure. AMADEUS and KLOE are encouraged to also work together on the tracker surrounding the AMADEUS target assembly, irrespective of whether the TPC option or the multiple cylindrical GEM detector layer option is chosen.

The KLOE and AMADEUS collaboration has already begun with the KLONE project, in which the two teams jointly measured the neutron efficiency of the KLOE calorimeter. The measurement campaign was very successful, and demonstrated a neutron detection efficiency 3-4 times greater than estimated just from the amount of scintillator in the calorimeter. Both collaborations are congratulated for their exemplary synergy, and are encouraged to complete the KLONE measurements in the low-energy range.

Furthermore the AMADEUS collaboration performed detailed simulations of the formation of K^--nuclear cluster events in interactions with the KLOE drift chamber Helium, using existing KLOE simulation programs. In all this they receive good support of KLOE team members.

However, one aspect of the joint program is progressing less speedily than anticipated in the previous LNFSC meeting: the search for deeply bound K^--nuclear cluster events formed in interactions with the helium of the KLOE drift chamber in available KLOE data. This analysis is waiting for the reprocessing of KLOE data to use the correct bad wire maps, which may be available in May 2007. If possible, action should be taken to allow this investigation to take place earlier, because of the interest in complementary results bearing on the existence or not of DBKS.

Even in case of a null result, the AMADEUS setup at DAΦNE looks like a promising approach on the issue of K^--nuclear cluster events.

2.2.3 DANTE

Unlike AMADEUS, the DANTE proposal to measure the magnitude and phases of the proton and the neutron form factors (FF) must wait for a new collider in the 2 GeV c.m.s energy range. Whereas the measurement of the FF moduli can be fitted into a c.m.s. energy scan, the measurement of the phases requires a dedicated setup with a carbon polarimeter, and a fairly large integrated luminosity (about 2.5 fb^{-1}, as presented in the open session).

In its 32nd meeting, the Committee considered the measurement of the form factors and their phases a very desirable element of the physics program of a future higher-energy collider, as underscored also by the large international participation in the DANTE LoI. This support is reaffirmed in the 33rd meeting, particularly taking again note of the interest of the DANTE participants in the full physics program at energies above the ϕ.

Despite the current uncertainty on the higher-energy collider plans, the DANTE collaboration is encouraged to strengthen its contacts with KLOE2, with the immediate aim of remaining available to participate in the planning of the detector upgrades relevant to the high-energy runs. This will help in establishing the conditions for a run dedicated to the form factor measurements.

2.3 THE COLLIDER FOR THE NEXT PHASE

If the CW scheme is successful, it should open up new avenues for the energy upgrade of DAΦNE that may be preferable to the approach of the DANAE proposal. While the Committee appreciates that the Accelerator Division has a heavy workload in the coming year, it is clearly very important for the medium-term planning of the laboratory to outline the conceptual design of an energy upgrade as soon as possible.

This new situation triggered the Committee to make a broad reappraisal of options for the accelerator and experimental program that should follow the current short-term plan. The Committee's findings can be summarized as follows:

A successful CW upgrade promises a rich physics program on the ϕ resonance, which might bring the originally planned 50 fb-1 in about four years, beginning in 2009. This program can already count on the substantial and very useful contributions of the SIDDHARTA–AMADEUS groups. However the human resources to realize the KLOE upgrades needed for this phase do not appear sufficient for the timely exploitation of the upgrade.

In its 32nd meeting, the Scientific Committee endorsed the proposal of a higher-energy collider, as well as the LoI of the KLOE collaboration which includes an extended physics program at energies above the ϕ. A new collider design capitalizing on the CW scheme would be the best way to bring about these developments.

The broad physics program of such a facility, including the upgraded KLOE2 detector, would span at least 10 years into the future. The Committee also noted that a luminosity higherthan $10^{32}/cm^2s$ in the high-energy regime would make its physics program significantly more attractive and internationally competitive. This prospect would make it easier to increase participation from within the Laboratory and from external, preferably international, collaboration.

The optimal strategy to achieve these goals should consist of the almost simultaneous presentation of a high-energy, high-luminosity machine design and of a broad collaboration that would address all these physics themes with one suitably upgraded KLOE detector, usable in somewhat different layouts. The Committee encourages the laboratory management, the accelerator division and the interested physicists to further specify their program on a time scale of less than one year. This program must assume the success of the CW scheme. The committee recommends that planning for a higher-energy machine be pursued with high priority.

3 OTHER MATTERS

3.1 Accelerator Division

The Committee notes with satisfaction that the capabilities of the Beam Test Facility have been enhanced with a new power supply (which has more than doubled its duty cycle and achieved independence from DAΦNE operation). The new tagged photon source will open up new applications.

The lack of prospects for recruitment and renewal of limited duration contracts remains a serious problem that must be addressed if the commitments and programs of the Accelerator Division (DAΦNE, CNAO, the future collider, SPARC, CTF3, the future SPARCX, etc.) are to be met.

3.2 SPARC

The Committee congratulates the SPARC team on their recent outstanding results on high brightness electron beam generation showing a spatial variation of the electron beam emittance in excellent detailed agreement with theoretical predictions of the interplay between space charge effects and the transition from laminar flow to a thermal beam distribution. These results were obtained thanks to the creation, for the first time, of UV laser pulses with very short (picosecond scale) rise times, laser-cleaning of the cathode, innovative instrumentation (the moveable "emittance-meter") and other developments.
This is a very promising beginning to a new field of free-electron laser research at LNF. The Committee looks forward to further results as the SPARC installation is extended and completed.

3.3 The LNF Theory group

The activities of the Theory group, with particular emphasis on the area of particle phenomenology and condensed matter, were reviewed in the closed session by G. Isidori and C. Natoli. The group includes 9 permanent staff members, distributed over several different subfields of theoretical physics, ranging from string theory to condensed matter, and including flavor physics, BSM, astroparticle physics, and strong interactions at high temperature and finite density. A few additional non-permanent positions are filled using support both from INFN and from external sources, like EU networks. Furthermore, a recently introduced program of Spring and Summer visitors has been very successful in bringing to the Laboratory several experienced researchers, over the past two years.
The committee congratulates the Theory group for the excellent quality of its work, which is recognized at the international level, and for the organization of the numerous successful Schools and Workshops regularly held at the LNF.

However the strength of the group may be severely diminished by the retirement of four of the current staff in the next two years. The subjects affected include particle phenomenology, condensed matter, and field theory. The Committee strongly recommends to maintain, if not all, at least 3 of these positions, and to take the opportunity to strengthen the areas most critical to the success of the experimental program of the LNF, both in house and in other labs. This should include at least two positions for particle physics, covering the areas of flavor physics and collider phenomenology, and one position in condensed matter and physics with the light sources. The very valuable visitor program should be maintained, and strengthened if possible.

3.4 Broadening the scope of the Scientific Committee's reviews

In recent meetings, the Scientific Committee addressed themes independent of particle physics programs but relying on local accelerators (such as gravitational wave detection and synchrotron light at the last meeting). At the request of one of the committee members, it was discussed whether to also bring under review the LNF particle physics projects that use external facilities, like LHC-related work. Such reviews took place in the past.

This proposal was favourably received by the Committee and laboratory management alike, in view of the fact that these programs involve the vast majority of the LNF particle physicists. Knowledge of these programs should also help in placing in context the recommendations regarding the locally-based programs. The Committee's current field of expertise appears well-matched to these broadened reviews. Therefore the proposal to review externally-directed particle physics activities was adopted.

Of course, this expanded charge requires longer meetings. Tentatively, the next meeting will be organized with a one-day open session and a one-day closed session.