Notes on meeting with KLOE-2 representatives
LNF, 22 April 2008

Present: Caterina Bloise, Fabio Bossi, Antonio Di Domenico, Paolo Franzini, Juliet Lee-Franzini, Stefano Miscetti, Antonio Ranieri.

Collaboration news

- A group from the University of Calabria (Cosenza) has joined the collaboration and will contribute in the areas of mechanics and electronics for the inner tracker.
- A group from Warsaw University may join, and is particularly interested in quantum interferometry.
- The collaboration has gained two students from Krakow and one from Uppsala.
- T. Lomtadze (Pisa) will help with detector installation. Lomtadze was site manager during the original KLOE roll-in (1998-99).
- Informal contacts are underway with French and US institutions for R&D on forward calorimetry.
- The collaboration has nominated the following people to cover official positions:
    - Technical manager: S. Miscetti
    - Deputy technical manager: P. Branchini
    - Physics coordinator: C. Bloise
- Next KLOE-2 meeting is 8-9 May. The status of subdetector projects and machine and roll-in strategy will be discussed.

Financial issues and interaction with CSN1

CSN1 approved about 1 M€ for KLOE-2 startup (Step 0) in September 2007, to be disbursed *sub judice* to success of the machine experiment. In April 2008, CSN1 released 50 k€ for of this sum for the purchase of new DAQ machines. Release of the remaining funds will be discussed at the CSN1 meeting of 30 June – 1 July 2008.

Step-0 preparations

KLOE-2 intends to be ready to enter by early 2009 at the latest.

The upgrade procedure for the front-end electronics (FEE) is as follows:
- Set up FEE test stand.
- Purchase lacking spare FEE components.
    - These components can no longer be purchased new. It may be possible to find used equipment via brokers.
    - If needed electronic components cannot be obtained, KLOE is able to run (and is at the moment acquiring cosmic rays), but there are no spare boards available.
- Test Motorola CPUs in the DAQ front end.

- Clean up existing electronics and install new components.

The upgrade procedure for the beam pipe is as follows:

- Extract the present interaction region.
  Tools and procedures already exist, so this is relatively simple.
- Modify the existing beam pipe for construction of the new IR.
  No Italian firm can work beryllium alloy; pipe may have to be modified by the original US supplier. This will take at least 6 months, so the work on the pipe is the critical step.
- Re-insert the pipe.
- After the pipe is re-inserted, operations can be resumed within a week. Work on the IP from the standpoint of the detector and the machine is fairly independent, and can mainly proceed in parallel.

Discussion about Step-0 plans

The Committee members ask the following questions:

- When will KLOE go in?
- Will KLOE go in even if there is no clear idea of what the luminosity is?
- Does KLOE consider a factor of three gain in luminosity to be an absolute condition for going in?
- Is there enough manpower for Step 0?

The following points emerge from the discussion:

- KLOE considers the integrated luminosity target to be 5 fb^{-1}/yr. If the improvement in luminosity is near to, but not quite, a factor of three, KLOE will take it.
- At the moment, 7 pb^{-1}/day has been seen (i.e., this is a peak value)
- In the last few months of 2005 running, daily integrated luminosity was 10 pb^{-1}/day peak and 7 pb^{-1}/day average.
- KLOE asks the Committee members to support their request to DAΦNE to plan for continuous running periods e.g. during weekends so that machine performance can be better judged.
- Manpower resources are sufficient for Step 0.

Step-1 preparations for calorimeter upgrade

The plan is to evaluate the improvement in cluster reconstruction, and thus event ID, that would be obtained by replacing the current PMTs with newer models. The new tubes have the same format as the old ones, but the photocathodes have 50% higher quantum efficiency. KLOE-2 is participating in Hamamatsu R&D on high-quantum-efficiency PMTs. Hamamatsu has obtained factor-of-two increases in quantum efficiency, but only for tubes with a metal package. The 50% gain refers to the HQE version of the KLOE tube (with glass package and fine-mesh dynodes).

Visit to $\gamma\gamma$ tagger prototype laboratory
Annalisa D'Angelo

The Committee saw a mechanical assembly with a $\gamma\gamma$ tagger from GRAAL experiment at ESRF. The instrument consists of a 128-strip silicon microstrip detector (300 μm pitch) and a scintillation hodoscope. The instrument shown was basically used to explain and discuss integration with the machine and experiment. The low-energy taggers (LET) will require a significantly different design that will integrate with the forward calorimeter. There is significant work needed to design the LET detectors, but, with some constraints, the technical decisions can be made within the KLOE-2 collaboration. The high-energy taggers (HET) should be installed for Step 0 and would allow studies of the process $e^+e^- \to e^+e^-\pi^0\pi^0$ at threshold. The HET detectors are simple, and more similar to the GRAAL detectors, but they must integrate with the DAFNE vacuum chamber in the bends without compromising machine performance.

Visit to GEM tracker prototype laboratory
Danilo Domenici

The Committee saw a complete, one-layer prototype of a cylindrical GEM inner tracker with diameter equal to that for the inner layer of the GEM tracker to be used in the experiment. The current prototype is shielded using a copper foil that is not intended for use in the experiment. The total thickness per GEM layer without this foil is 0.3% X_0. Although prototyping is advanced, much work remains to be done. The GEM tracker is intended for installation in Step 1, perhaps in early 2010.

Visit to KLOE computing center
Paolo Santangelo

The Committee saw the current KLOE Gigaswitch and online machines, the offline machines, and the older of the two KLOE data storage systems. The smaller library has 5400 slots for 60 GB cartridges, for a maximum capacity of about 320 TB. The larger library, located in the LNF computing center, has 3600 slots for 300 GB cartridges, for a maximum capacity of about 1080 TB. The drives may be upgraded to store up to 1000 GB per cartridge. Two of the earliest upgrades to be implemented will involve replacement of the online farm machines and expansion of the library. The current online machines are 4 × 300 MHz SMPs from the late 1990s. The machines might be able to handle as much as a factor-of-two increase over the final KLOE luminosity, but are completely obsolete and should be replaced. An additional 900 TB of storage capacity in the tape library will be needed for Step 0 on day one, as the library is essentially full. This additional space can be obtained by i) upgrading the tape drives in the newer library, providing 200 GB/cartridge for 2100 existing cartridges (400 additional TB); ii) adding 500 new 1-TB cartridges (500 additional TB). Upgrades to computing can be done in an incremental way, as was done during past KLOE running. The library expansion is critical, however; it also represents the most significant contribution to the upgrade costs.

Visit to FEE test bench
Antonio Passeri

The test station is up and running, and ready to be put to use in diagnosing older boards and creating spares.

Visit to forward calorimetry prototype laboratory
Stefano Miscetti

The forward calorimeter upgrade includes two detectors: a compact crystal detector (CCALT) at the lowest angles (in front of the inner quadrupole), and a photon veto covering the space between the inner and outer quadrupoles (QCALT). For discrimination of decay photons from accidentals, both systems must have good timing resolution. For CCALT, this implies the use of innovative solutions like LYSO, which combines rapid scintillation times with good light yield. QCALT will use square scintillating tiles (e.g., 5 cm × 5 cm × 5 mm) with readout via WLS fiber threaded through a groove inscribing a circle in the square tile, coupled to a silicon photomultiplier. The Committee saw prototype materials being tested: scintillating tiles and fibers and silicon photomultipliers. Yields of 24 pe/MeV have been observed for the scintillator/fiber combination. At the moment, there is no detailed mechanical design. The Committee also saw small LYSO crystals being tested with cosmic rays.

Notes on meeting with DAΦNE representatives
LNF, 22 April 2008

Present: Catia Milardi, Miro Preger, Pantaleo Raimondi

The Committee members ask:

- How well is the machine is working?
- How well will the potential performance of the machine be known by the time of the CSN1 meeting of 30 June – 1 July?

As stated at the CSN1 meeting of 7-8 April, the integrated luminosity goals per month for SIDDHARTA start-up were as follows:

Period	Goal	Obtained
Jan 2008	1×10^{32} cm^{-2}s^{-1}/50 pb^{-1}	1×10^{31} cm^{-2}s^{-1}/0 pb^{-1}
Feb 2008	2×10^{32} cm^{-2}s^{-1}/100 pb^{-1}	2×10^{31} cm^{-2}s^{-1}/0 pb^{-1}
Mar 2008	3×10^{32} cm^{-2}s^{-1}/200 pb^{-1}	1×10^{32} cm^{-2}s^{-1}/0 pb^{-1}
Apr 2008	4×10^{32} cm^{-2}s^{-1}/300 pb^{-1}	2×10^{32} cm^{-2}s^{-1}/50 pb^{-1}

Accounting for the fact that the integrated luminosity obtained in April refers to only part of the month, the above table suggests that DAΦNE commissioning is roughly two months behind schedule. On the positive side, the pre-upgrade peak luminosity has been reproduced, with much lower currents. The specific luminosity (normalized to current) is a higher by a factor of three than it was before the upgrade.

Numerous problems contributed to the delay. Most were of a standard variety (e.g., problems with vacuum, problems with new kickers initially not operating according to specifications). Thus far, the problems have not been intractable, but optimization of machine has been characterized by a series of bottlenecks.

While the crabbed waist concept has proven to be a success in terms of geometric luminosity, there are more difficult issues with beam dynamics. Beam lifetimes have been much shorter than expected. At startup, lifetimes of 300-400 s were for currents of 1A, as opposed to the typical value for good running in the past, τ = 1500 s. Currently, τ = 1000 sec; although lifetimes remain smaller than expected there has been much progress. With the new beam geometry, the bunch length is shorter, and the Touschek lifetime (from intra-bunch scattering) is intrinsically shorter. Initially, faulty beam diagnostics led to running with beams much too flat, which was responsible for the very short lifetimes. DAΦNE is working to find the optimum balance between lifetime and peak luminosity.

At startup, currents in the positron machine were limited to 400 mA. Solenoid windings were installed in sections of the positron machine. This confines the residual electron cloud to the area near the vacuum chamber walls and helps to stabilize the beam in both the horizontal and vertical planes. To the extent that the solenoids help to keep the amplitude of the instabilities within the dynamic range of the feedback system, an extra benefit is obtained from their use.

The vacuum has been improving with machine operation. A leak in the electron machine led to the loss of four days of running. Heaters were added to increase the speed of vacuum conditioning.

There are some problems with ion trapping in the electron machine. The ion-clearing electrodes (ICEs) were removed in 2006 because they were increasing the impedance of the vacuum chamber and contributing to vertical beam blow-up. Most ICEs were broken in any case. At present, 90-bunch operation provides a gap of 30 bunches (100 ns) to allow ions to clear. When the vacuum is in better shape, it should be possible to go to 110-bunch operation, resulting in a 20% gain in luminosity with no negative side effects.

The Committee members inquire as to by what date one might reasonably expect that SIDDHARTA will have collected the 1 fb^{-1} requested. DAΦNE has delivered 60-70 pb^{-1} to SIDDHARTA at the moment. At startup, background levels were very high. Although progress has been made on reducing the background, rates remain higher than they were for the main sequence of DEAR running by a factor of about 100. SIDDHARTA is not shielded as well as DEAR was, so it is not clear how much of this can be ascribed to machine conditions. The worsening of the background as observed in the kaon monitor is less significant, but the geometry of the kaon monitor was also changed in the upgrade from SIDDHARTA to DEAR.

As discussed with KLOE, the Committee members suggest to the DAΦNE personnel that some running under stable conditions is necessary to provide understanding of the potential operational stability and machine performance. P. Raimondi responds in particular that, while that is the current goal, e.g., for weekend operations, it is not always possible to realize stable conditions. As an example, stable running during a recent weekend was frustrated by the need to heat the vacuum chamber in the electron machine after a leak had been repaired. More generally, the sheer cost of running the machine (300 k€/month) is an impediment to stable running until acceptable data-taking conditions (i.e., background levels) for SIDDHARTA can be obtained.

The potential for improvements in machine performance may be summarized thus:

- The lifetime may be increased by 30% before reaching the Touschek limit, as a result of vacuum conditioning.
- Going from 90- to 110-bunch operation should increase the luminosity by 20%
- The optimal balance between longer lifetimes and higher peak luminosity needs to be reached.
- Currents are increasing: in a recent test with 1.4 A in the e^- machine, the luminosity was 10 pb^{-1}/day for two hours.

The above in combination could lead to a factor of two increase in integrated luminosity over the present ~7 pb^{-1}/day within a reasonably short period of time.

P. Raimondi sees the following as conditions to be met before attempting a 10-15 day production test run:

- SIDDHARTA must be fully installed and ready
- Acceptable background levels must be achieved
- There must be a reasonable expectation that 300 pb^{-1}/month can be achieved.

These conditions might be satisfied by June.

Conclusions after the visit

The accelerator

The status is described in the text above. The crabbed waist principle seems to work but the ramp-up in accelerator performance is slower than expected, and roughly two months behind. Progress is continuous but in many small steps; there is no silver bullet.

KLOE-2

For KLOE-2 to go in late 2008 or early 2009 we see the following issues regarding the points for step-0 in the roll-in proposal (LNF–07/19 (IR)).

1. Insertion of the new interaction region inside KLOE

This carries the largest risk for a timely roll-in. The construction of the new beam-pipe is not a responsibility of the KLOE-2 collaborations, but KLOE-2's readiness clearly depends on it. It will take at least six months to get constructed since it has to be done by a US company.

2. Installation of the new DAQ components: Level-2 (L2) and Level-3 (L3) CPUS, run-control (RC) and slow-control servers, optical Gigabit Ethernet link for L2 to RC connection

From the funding, conditioned on the DAΦNE performance, the part needed for the Level-2 CPUs has been released, and these purchases are being done. This is therefore not any longer a time-critical issue.

Concerning the other items, please look at point 4 below.

3. Production of the minimal set of FEE spares, necessary for a safe and efficient run

The detector is fully equipped and with very few dead channels. The work towards getting the necessary spares is well underway. This item is therefore not critical.

4. Upgrade of the Computing System, to cope with the larger data set

This can be approached as a smooth continuous upgrade as the rate and data volume increase during the coming runs. The data storage is the first that needs to be tackled.

5. Installation of the outer pair of γγ-taggers (HET)

It is today at a conceptual stage. The detector-system as such is not complicated but the influence on the accelerator is not clear since it will require a modified vacuum-pipe. We therefore think that the HET is rather for a somewhat later stage.

KLOE-2; step-1

The detector development for the items specific for step-1 are at the moment in a R&D or early R&D stage, which is natural given the time-scale.

The Inner Tracker

It is in a R&D stage and is being developed with good progress in a nice set-up.

A critical issue for the final detector is the amount of material. This will in the end very likely depend on the mechanical engineering of the device and its robustness against noise. These system issues have therefore to be addressed with a state-of-the-art approach.