51st MEETING OF THE LNF SCIENTIFIC Committee - 23/5/2016

During the closed session the chair welcomed Ralph Assman, new member of the committee. He also thanked Andrea Longhin, who is stepping down as scientific secretary being replaced by Marianna Testa. The chair excused Lenny Rivkin who could not attend the meeting.

The general funding situation of INFN is with the usual uncertainties and delays. INFN benefits from extra premium funding from the government, both from the evaluation of performance and from submitted proposals. Despite this situation INFN saved some money for investment in infrastructures of new projects. Part of it is available for LNF.

Several (73) research positions will be opened very soon with no pre-allocation to the structures (Laboratories or Sezioni). Also 24 positions for engineers and 5 for technicians (1 to LNF).

1. DAΦNE, KLOE and SIDDHARTA

1.1 DAPHNE

The performance of DAPHNE has continued to improve and has now reached impressive stability (typically close to 80% uptime) and luminosity figures (max hourly, daily and weekly at 0.63, 14 and 76 pb^{-1}).
The run II target of delivering 1.5 fb^{-1} by the end of July is already reached and in the last three months the peak fill luminosity has routinely been at or above 2 10^{32} cm^{-2} s^{-1}. The background conditions are also well controlled and stable. The committee is very pleased to see the progress and status, and wants to congratulate the Daphne team for the excellent work behind these results.

The two largest problems encountered have been overall water supply shortage/stoppages and an injection kicker feed-through failure leading to a vacuum problem. Detailed beam dynamics studies and improvements to ease the operation have naturally been given lower priority to deal with these more fundamental problems.

Beam-dynamics studies/tuning have the potential for some minor further improvements but the focus is now on stable running and controlling/handling/preventing infrastructure problems of the type above, potentially affecting the integrated luminosity more severely. The committee agrees that consolidating the machine to ensure the integrated luminosity is the first priority. This consolidation ranges from overall issues as cooling water, to specific replacements, improvements or spares. Examples are power-supplies, control system improvements, modulator replacements, etc.

The team size remains critically small and creative use of personnel from other projects available part time for Daphne operation has been needed to keep the facility operational. One new accelerator physicist is recently hired for two years.

Concerning the interplay between the planned BTF facility improvements the Daphne consolidation budget and BTF upgrade budget are well coordinated, and the personnel planning and schedules well integrated. As such, the BTF upgrade plans can help increasing the reliability of the linac part of the Daphne facility as well.

Another possible source of conflicts to be watched for is from the ELI-NP involvement where the building delivery suffers a 1.5 year delay, increasing the pressure on a likely very intense installation period in 2017. Even though the personnel involved is mostly engineers and technicians, there is a potential conflict with smooth operation of Daphne and the underlying infrastructure.

Initial exchanges with SIDDHARTA-2 concerning the detailed configuration of the collision point have just started. Open questions concerning the space available, the low beta quads (possibly using new permanent magnets) and the status of the detailed technical drawings - to mention some issues - need to be resolved.

1.2 KLOE

KLOE-2 is currently in the process of steady data taking. DAPHNE has delivered more than 1.5 fb^{-1} of data, in perfect agreement with the luminosity delivery plan. In order to maximize the luminosity taken at the ϕ resonance, a dedicated energy scan has been performed in order to precisely identify the peak energy. This has resulted in a shift of the central RF frequency. Further improvements of the data taking efficiency are ongoing. The average data taking efficiency has reached 82%, exceeding the efficiency demonstrated in RUN 1 by 5%. This gives further confidence in the aim of collecting ~5 fb^{-1} of data by the end of 2017.

KLOE-2 is currently fully operational and taking data with all sub-detectors. Safe operation remains the highest priority and is receiving continuous attention. Measures have been taken to operate the Inner Tracker in a safer mode; the spares for the FEE ADC/TDC boards of the calorimeter are being prepared.

Data quality survey and online monitoring are in place to ensure good data quality at the offline level. The progress in understanding the reconstruction and the selection efficiencies for the key physics channels is however slower than anticipated at the previous SC meeting. The calibration and alignment of the Inner Tracker, and the HET performance for the π^0 selection in $\gamma\gamma$ events are of particular concern. The referees therefore express a worry that the KLOE-2 performance for the key physics channels has not yet been demonstrated. This is a very important milestone to be met for the planning of next year DAPHNE operation. We therefore recommend that the KLOE-2 collaboration prepares by the end of August a written report on the validation of the IT and the HET performance with data. Such a deadline is set in view of the INFN Gruppo 1 meeting in September. We also expect written updates, wherever necessary, before the next scientific committee meeting.

A significant effort has been invested in reducing the specific data volume bringing it at an affordable level with the tape drives based on new technology and extended computing power. The data storage speed has been increased by a factor of three. In addition, the reconstruction capability currently exceeds the data-taking rate, such that the past runs can be reconstructed during KLOE running time. The new reconstruction of data will be based on the new calibration constants, obtained in particular for the IT and the HET detectors, and is planned for September.

Referees have reviewed the plan of the KLOE-2 milestones. In general, the milestones are on schedule. The KLOE-2 physics workshop is moved to October, which gives a possibility to confirm the physics prospects with new data.

Meanwhile KLOE continues to provide valuable physics results based on the analysis of existing data. Since the last SC meeting three new papers have been published, and three more analyses are in the pipeline.

The overall situation with manpower in KLOE-2 has been significantly improved since last SC meeting by the two new post-doc positions and the two post-doc positions as replacements. There was no request for extra manpower from KLOE-2. The referees however feel that support from the LNF management would be helpful in finding external experts who could, at least for a limited time, speed up the tracker alignment.

In conclusion, the referees support the KLOE-2 requirement to collect a minimum of 5 fb^{-1} of integrated luminosity.

1.3 Siddharta

There has been substantial progress on the preparation of the SIDDHARTA-2 experiment since the last SC meeting.

A technical report for the SIDDHARTA-2 setup was provided. The suppression of background is one of the major concerns of the collaboration and the improvements of the new setup focus mostly on this aspect. A new trigger configuration, the installation of a second veto layer, and the use of new SDD-chips with denser packing, allowing for gaining at least one order of magnitude in the signal to background ratio with respect to SIDDHARTA, making the measurement of the K-lines of kaonic deuterium atoms possible. This finding was corroborated by Monte Carlo simulations of the new apparatus, assuming theoretical estimates for K-d yields that are one order of magnitude below the measured K-p ones. The simulations are validated by the excellent agreement of the Monte Carlo simulation of the kaonic hydrogen spectrum with the measurements by SIDDHARTA.

The SIDDHARTHA-2 team expressed their satisfaction for the start of the preparation of the plan for the installation of the experiment. There was collaborative attitude and advancement. It is important to consolidate some manpower in order to secure the expertise and know-how gained during the running of SIDDHARTA and, especially, during the preparation of SIDDARTHA-2.

In the closed session recent progress on the analysis of KLOE data for the AMADEUS/KLOE2 collaboration was presented. The analysis of the $\Sigma^0 p$ invariant mass spectrum allowed for the determination of K^--2N absorption processes, and also showed the potential presence of a K^-pp bound state. These results have recently been published in Phys. Lett. B. Preliminary results on K^--4N absorbtion process in ^{4}He and ^{12}C, as well as plans for providing the $K^-p \rightarrow \Sigma^0 p^0$ cross section at the low momentum K^- produced at DAFNE were discussed.

1.4 Recommendations

We recommend as the first priority for DAPHNE the consolidation of the machine and the maximization of the integrated luminosity. The committee supports the KLOE-2 requirement to collect a minimum of 5 fb^{-1} of integrated luminosity.

We recommend that the KLOE-2 collaboration prepare a written report on the validation of the IT and the HET performance with data by the end of August.

Concerning the technical plan for installing SIDDHARTA2, we recommend to establish clear responsibilities on each side for exchange of material and information. We would like to see a baseline configuration and a plan at the next SC meeting in November, with the understanding that there will still be details to work out during the winter.

The machine conditions and the SIDDHARTA efficiency for data-taking remain a critical item to be clarified in order to make a correct assessment of the time needed for the SIDDHARTA2 run.

2. SPARC_LAB activities

The committee would like to congratulate the SPARC_LAB team for the progress since the last meeting. Progress was made on the laboratory facility and preparedness for future experiments as well as on the scientific front.

Much progress was made towards plasma wakefield acceleration (PWFA) experiments. The chamber containing the 3-cm capillary plasma source was installed in the beam line. Preliminary plasma experiments have shown focusing of the electron bunch by the plasma (magnetic focusing). However, issues with the C-band klystron, with the last focusing quadrupoles, as well as with the gun photo-cathode low QE have and may hinder COMB-PWFA experiments (bunch not dense enough). These issues should be resolved soon. Electron beam alignment issues have been solved.

The team has devised a two-bunch experiment that will probably already show interesting results. The accelerated bunch could even have low enough emittance and energy spread to lase in the FEL undulator already existing downstream from the plasma. Lasing was observed with linac bunches with properties similar to those expected from the PWFA. Lasing would be a very significant result for the field of plasma-based accelerators and their application to FELs. In addition the team is considering replacing focusing quadrupoles before the plasma (to focus the bunch(es) into the plasma) and after the plasma (to recapture the bunch(es)) by plasma focusing elements.

PWFA experiments are scheduled for the weeks following this meeting and very interesting results are anticipated for the next committee meeting. Issues with the laser FLAME have been identified (pump lasers, compressor misalignment) and performances improved. Pump lasers will be sequentially sent to Amplitude Technologies for refurbishing without significantly perturbing the experimental program. Re-alignment has increased the pulse energy within the focal spot to 40-60%. Better results (up to 80%) are expected with the use of the deformable mirror and will be needed for acceleration in a capillary discharge and for Compton backscattering experiments.

The laser was used for two plasma experiments. The first one is a LWFA experiment that has produced self-trapped electrons with energies up to 170 MeV (though not with a narrow energy spectrum). The second one is a TNSA-proton acceleration experiment in which it was shown using EOS measurements that narrower electron bunch features can be produced by using tip-shaped targets rather than flat or blade targets. Narrow electron features may be the sign of better proton acceleration. The electrons had few MeV energies.

A new, single shot diagnostic to measure the emittance of the electron bunch produced by a LWFA has been devised. It is a “pepper-pot” measurement of the optical transition radiation emitted by the bunch. Single shot capability is essential when the reproducibility required by quadrupole scan or other emittance measurement techniques is not met.

A fiber-based synchronization system between the RF-gun photo-cathode drive laser and the FLAME laser was installed and commissioned. The current coaxial cable system reaches an ~50 fs jitter, a value closer to 10 fs is expected with the optical system. This synchronization is essential for external injection experiments in a LWFA as well as for Compton back-scattering experiments (though with less stringent requirements). It also opens the door for pump-probe experiments using the various particle and photon pulses available at SPACR_LAB. Availability of multiple and synchronized particle and photon beams is one of the major strengths of

SPARC_LAB. The new interaction chamber for Compton back-scattering experiments is on site and ready to be installed.

The short electron bunch produced by the linac generates coherent transition radiation (CTR) in the THz frequency range when traversing a thin metallic foil. This radiation was successfully used to observe electromagnetic-induced transparency in a topological insulator, in close collaboration with external users. These measurements led to a Nature Photonics publication and illustrate the ability of the SPARC_LAB to host user's oriented experiments as well as to produce top scientific publications. This experiment also showed very important dynamics between SPARC_LAB and the users in terms of defining and satisfying mutual needs. Plans are developed to take the THz radiation out of the linac bunker to a separate THz user facility, not hindered by linac X-ray radiation and thus much more accessible and flexible.

The progress made shows that the bricks for building the future of the SPARC_LAB exist. The long-term plan outlined in the previous meetings of this committee consists in getting SPARC_LAB ready for a bid for the site choice of the EuPraxia study for European center for a plasma-based, compact FEL. While this is a bet, the laboratory should become a significant research and user facility for plasma-based acceleration and radiation generation (from the THz to the X-ray frequency range).

The laboratory and the committee recognize that this plan requires immediate action to define a scientific plan, identify needs in terms of personnel, and building and scientific equipment. The time scale for readiness is 2017-2019 in order to apply for ESFRI funding in 2018-2020. This effort has already started.

The committee very strongly urges SPARC_LAB and the laboratory management to better define characteristics for a new building (compatible with a facility recommended by the EuPraxia design study). This is the longest lead item on the long-term project. The committee also strongly recommends that local government resources be identified to complement INFN funding of the long-term project. Strong political activity is also required in order to generate government support for the project towards its inclusion in the ESFRI roadmap.

The committee and the laboratory director have set up a web-based meeting between the regular (every six months) committee meetings. These meetings will be between the SPARC_LAB scientific coordinator, the laboratory director, the chair of the SC and the committee members specifically reviewing SPARC_LAB (Assmann, Muggli). The first such meeting is scheduled for September 14, 2016. The format will be a review of the actions identified during the previous meeting as well as new elements brought by SPARC_LAB.

2.1 Recommendations

The committee very strongly urges SPARC_LAB and the laboratory management to better define characteristics for a new building (compatible with a facility recommended by the EuPraxia design study). This is the longest lead item on the long-term project and its preparation should start soon. The committee invites the LNF management to consider to start this part of the project even before a complete funding scenario exists.

The committee also strongly recommends that local government resources or other resources be identified to complement INFN funding of the long-term project. Strong political activity is also required in order to generate government support for the project towards its inclusion in the ESFRI roadmap.

The SC encourages again the SPARC_LAB team to make a list of milestones that they consider as required to maximize the readiness of the laboratory to be the host of a European facility. This list could be discussed in the meeting in September.

3. BTF UPGRADE

BTF continues to be a successful story for LNF. The projected activity for 2016 is of 240 days of beam and a ratio of 1.5 between requests and delivered involving hundreds of users.

The Conceptual Design Report for the upgrade has been published (arXiv:1603.05651) to extend the range of application for the LINAC beam extracted to the BTF lines for hosting fundamental physics experiments and for providing electron irradiation also for industrial users.

The upgrades include a second beam line, a consolidation of the LINAC, an extension of the pulse width, a refurbishment of the control and timing system and new telescope with high resolution.

3.1 Recommendations

The SC congratulates the BTF staff for the very successful operation of the facility and looks forward to a smooth funding plan for the upgrades compatible with the schedule of PADME.

4. PADME

The experiment has been approved and funded. They aim at a technical run in late 2017 and a physics run in 2018. The various detector elements are in preparation. A prototype of the target has been tested. The SPS transport magnet has been delivered at LNF and tested. The scintillators for the charged particle veto have been produced. The design for the vacuum vessel has been completed. The authorization to re-use the crystals of the L3 calorimeter for the PADME calorimeter has been obtained and a plan for their recovery has been established.

4.1 Recommendations

The SC takes note with satisfaction of the approval and funding of the experiment. The schedule for the detector construction is quite aggressive and will require support form the Laboratory. It is important that PADME be ready to take data when KLOE will stop the data taking in order to efficiently use the gap between the end of KLOE and the start of SIDDHARTA.

The SC notices that many LNF staff are presently involved on PADME only for a small (less than 50%) fraction of their time. The SC expects that this fraction increase very soon, well before the next meeting of the SC, in order to be ready for the technical run in 2017.

5. SCF-LAB

The **S**atellite/Lunar/GNSS laser ranging **C**haracterization **F**acility **LAB**oratory group operates in key partnerships with ASI and NASA. Their research is mainly funded with grants from ASI, ESA and NASA and there is only one LNF staff involved. They operate an LNF based facility to simulate in laboratory the conditions in space. They participate to laser-ranged tests for General Relativity and gravitational physics based on reflectors on the Moon and on Mars and its satellites.

5.1 Recommendations

The SC takes note of this interesting and successful activity that is somewhat aside of the main stream of the Laboratory.

The SC recommends that the cost to the Laboratory of this activity is evaluated with a model that includes overhead on the workshops and on the administrative services.

6. Nautilus

Nautilus has been running at LNF since 96. It is concluding now its 13 years long science run started in 2003. Nautilus established three records: a) Coldest massive detector for more than 20 years with 2.5 tons at 90 mK; b) First acoustic detection of cosmic rays proving the Cabibbo thermo-acoustic theory; c) Longest science run for GW detectors with 13 years of continuous data taking. Nautilus was active during the observation of GW150914, however the signal was too small to be detected by the antenna.

The committee congratulates Nautilus for having pursued this important science topic for so many years and Ligo and Virgo for the first direct observation of a GW.

During the next three years Ligo and Virgo will be active only for 50% of the time. The physics case to postpone the shutdown of Nautilus until 2019 was discussed. This extension should be in agreement with the resources (manpower and operation funds) needed to keep it operational.

6.1 Recommendations

The committee notice that the physics case has not been quantified. This discussion should be deferred to Gruppo II where a decision to shut down Nautilus was already taken before the schedule of future Ligo and Virgo operations was made public.

7. Next Meetings

52nd SC 21-22 November 2016
53rd SC 8-9 May 2017
54th SC 13-14 November 2017