54[rd] MEETING OF THE LNF SCIENTIFIC Committee – 13-14/11/2017

The chair excused Jannis Kariotakis who could not attend the meeting.

The chair thanked Jannis Kariotakis, Steinar Stapnes, Lenny Rivkin and Andrei Golutvin who are serving for the last time as member of this committee, and welcomed Patrick Decowski, Guenther Dissertori, Beate Heineman and Mike Lamont as new members.

The LNF director informs the SC that he has set up a committee to study possible options for the running of DAPHNE between 2019, when the approved program ends, and the start of EUSPARC. One constraint is the commitment to run DAPHNE for synchrotron light for few months in the year. The idea is to have other small projects, compatible with the other commitments of the laboratory and with a reasonable cost versus benefit balance. In six months from now there will be a guided call for expression of interest.

In July the LNF director presented to the INFN executive board the status report of the EUSPARC project. A second presentation by Massimo Ferrario was given in October. The board received very positively the presentations and the documentation and gave the green light to go ahead with the project. The EUSPARC CDR is foreseen to be ready by the end of this year and will be evaluated by an international review board. LNF is going acquire a small enclave of 4000 m^2 at the border of the laboratory; this will give some more space for the works of the EUSPARC building and will reduce the shielding requirements. The bid for the project of the building is expected to start in December.

ELI-NP: the installation of the machine is still on hold. The EU commission is now involved in solving the complex situation of the conformity of the building with regard to the safety requirements needed to start the installation. Once the installation starts it will require resources from LNF to be deployed in Romania within a short space of time, potentially impacting the other programs of the laboratory.

Manpower: in the next five years, 60 people are retiring from the laboratory. A plan for their replacement has been prepared. In the medium term LNF will be allowed to hire 20 technicians and administrative staff. LNF have already filled 5 of the 6 positions opened for technologists; the 6^{th} will be filled before the end of the year.

1. DAΦNE, KLOE, PADME and SIDDHARTA

1.1 DAPHNE

The machine and its team continue to perform very well reaching all the milestones set for DAPHNE operation. An estimated integrated luminosity by the end of March 2018, (run IV) of 1.5 fb^{-1} will bring the total integrated luminosity above 6 fb^{-1} delivered to KLOE-2. The committee congratulates the DAPHNE team on the excellent and dedicated work underpinning these results.

In addition to the operational performance, the maintenance sessions during May and Summer were important. The May session covered the safety controls, control system, longitudinal feedback (power amplifiers), hydraulics system, C modulator thyratron change, BTF gun test and diagnostics and chiller unit maintenance. During the summer the cooling system, linac – gun cathode and overall checks, low level control system, magnets and power supplies, RF system, control and diagnostics systems were maintained.

The work to prepare for SIDDHARTA 2 has started and is substantial; a new vacuum chamber system and a completely new interaction region magnet system with permanent magnets and instrumentation are the most significant undertakings. These efforts are primarily motivated by the need to maximize the aperture in the interaction region.

The KLOE-2 detector must be removed together with the IR1 part of vacuum chamber and permanent magnets. Infrastructure changes are needed in the area. Work is also being prepared for vacuum components, clearing electrodes for e+ ring, and e-cloud mitigation.

The schedule for hardware changes, commissioning and start-up with physics for SIDDHARTA-2 early 2019 is tight. The combined experience with DAPHNE and earlier hardware adaptions of the interaction region give the team confidence that the timescale is achievable. From the machine side the luminosity to be expected for SIDDHARTA-2 is expected to be comparable to KLOE-2, with background conditions being optimized for the experiment.

The luminosity goal of SIDDHARTA-2 of 1 fb^{-1} in 2019 is reasonable, provided the machine can come back quickly into steady operation after the changes in 2018. In principle, the machine can deliver this luminosity in the order of 6 months of regular operation.

The operation of DAPHNE in the crab waist (CW) mode remains a novel solution. It will be important to keep up the machine development sessions until the end of the KLOE-2 running period in order to maximize understanding of the scheme. Similar considerations apply to maintenance of the general infrastructure and equipment.

It might be appropriate to revisit the IR optics having clearly established the required instantaneous luminosity of SIDDHARTA-2. Apparently, the IR is the aperture limit of DAPHNE in the present set-up. It might be possible to gain aperture, and thus operational efficiency, by relaxing the crossing-angle and beta*.

The switch from KLOE-2 will be an intense period for the teams involved; it will be important to manage carefully the planning and personnel needed for DAPHNE running, the changes for SIDDHARTA-2, machine commissioning, PADME exploitation and energy upgrade – and the possible addition of ELI.

The committee takes notes of the working group on future studies at DAPHNE including its injectors and BTF. A report is expected by the time of the next committee meeting. The resources needed to operate/adapt DAPHNE will be significant and on a similar timescale to the major efforts required for the SPARC-lab and BTF.

1.2 KLOE

KLOE-2 successfully continues data taking. DAPHNE in RUN IV has so far delivered 407 pb^{-1} of integrated luminosity, of which 81% has been acquired. Thus the data taking efficiency remains at the 80% level. A great effort is being taken to ensure a good understanding of the data quality. The committee is pleased to highlight the timely and stable calibration of the EMC, as well as the further improvement in understanding the alignment of the IT.

The analysis of collected data is progressing well. A few examples include the measurement of K_S lifetime and $K_S \rightarrow \pi e \nu$ analysis based on using the integrated IT + DC tracking and vertexing algorithms. Thanks to the recent advances, the accuracy in the proper lifetime measurement has increased by 50%. We also note a significant improvement in the accuracy of the vertex reconstruction demonstrated both in the semileptonic K_S final states and the final states with four hadrons such as $K_S K_L \rightarrow 4\pi$.

Unfortunately, no breakthrough has been achieved in understanding of the HET performance for the π^0 reconstruction in $\gamma\gamma$ events, which is a long-standing concern. An attempt has been made to understand the machine optics to evaluate what the acceptance of the HET is for tagging exclusive diphoton events. This analysis exhibited some differences between the simulated optics and the observation in the beam position monitors, indicating that the acceptance of the taggers might be smaller than what is computed with the simulated optics. Since the impact should be much reduced if only a hit in one arm is required, the single-arm analysis is of great importance. The collaboration has attempted to find a signal in both the single-arm events and in untagged events but so far no signal could be observed. It is now planned to perform a multivariate analysis to improve the signal to background ratio.

The committee has also reviewed the status of computing and reconstruction. The new version of the DC-IT integrated tracking and vertex reconstruction has been successfully tested and implemented. The reconstruction rate of ~10 pb^{-1} per day is approximately similar to the rate of data taking but it is too slow for the re-reconstruction of the whole data sample with the current computing resources.

1.3 PADME

The SC acknowledges the progress made by the PADME collaboration in the construction of the experiment. Most of the subdetector components have either been delivered/constructed or are in the process of being completed. The Mimosa beam monitor sensor is ready; the mechanics, cooling and carrier boards are currently under construction. The diamond target is being assembled and will be tested with a α-source in December. The charged particle veto, consisting of two scintillator bars, has been delivered to LNF.

The ECAL is composed of some 660 BGO crystals that are being reused from L3. They have been obtained and are being cut, polished and painted. Around fifty cut BGO crystals are already in hand, but there are some quality control issues at the external company where the cutting is being done. While it does not yet have an impact on the overall schedule, this has to be monitored. LNF has taken delivery of all 650 HZC PMTs necessary to readout the ECAL. These are presently being characterized at the Lab, to be finalized by mid-December. The order of 25 PbF_2 crystals for the small angle calorimeter has been placed with SICCAS as are the PMTs, delivery for both items is expected soon.

The magnet is ready and the field characterized. A TimePix3-based beam monitor is being developed The DAQ system is common to virtually all subsystems and is ready to be commissioned. Finally, the trigger is being completed; delivery of the final items is expected by the end of the year.

The schedule may be impacted by one subsystem currently being tendered: the vacuum vessel that is partly inserted into the magnet and that sits just before the ECAL. The current estimates are that this item may take significantly longer to build (3 months) than anticipated. Since the tender is not yet complete, it is unclear at this stage if this is a real concern.

Other than the vacuum vessel delivery uncertainty, the experiment is well on its way to be installed in the experimental hall. In order to complete final items like the ECAL and charged veto support structures, the support from the LNF workshop in the timeframe January-March 2018 will be necessary.

The PADME installation schedule depends on the installation of the new BTF beamline. The PADME magnet can be installed after the installation of the new DP-01 fast dipole in Jan/Feb 2018, but will require some additional movement in order to install the vacuum vessel, once delivered, in the experimental hall due to space constraints. The installation schedule between the new BTF infrastructure and the PADME experiment will need detailed coordination between the groups.

The present experimental schedule is to start the beam for PADME mid-April, after a 2-3 week LINAC beam tune in order to obtain 200 ns bunches, and run until the end of July. The plan is to resume the beam in November 2018, after the SIDDHARTA test run, and run until the end of 2018. Due to the different bunch lengths, the beams for PADME and SIDDHARTA are incompatible. The worry is therefore that any delay in the PADME schedule may affect the nominal program of collecting 10^{13} positrons on target over a six-month beam period.

On the physics case side, we observe that a recent analysis by the BaBar collaboration is nearly excluding the region of parameter space to be explored by the PADME experiment. The NA64 collaboration has even stronger claims on the exclusion of dark photons for values of the coupling not accessible to PADME. We think that it is urgent to understand if PADME can work on different dark photon production channels to enlarge its reach in the parameter space and compete with NA64.

The SC was happy to learn that collaboration with E. Nardi of the LNF theory group has started. The proposal is to collide positrons from DAPHNE on the PADME diamond target to produce dark photons at resonance and explore the recent ATOMKI ^{8}Be anomaly reported in the literature. We observe that the total width of the A’ dark photon is expected to be extremely small, possibly a few eVs. Thus, even if the positron beam were finely tuned to have an energy very close to produce A’ photons when colliding with the electrons (that are almost at rest) in the target, which is a challenge, the number of events would scale like Γ/σ, where σ is the energy spread in the positron beam — approximately 1 MeV. This holds for A’ photons with a mass O(10 MeV) if the beam energy is approximately O(100 MeV).

1.4 SIDDHARTA

The SIDDHARTA team is working within schedule to be ready for mounting the experiment on the second quarter of 2018: the final design of the beam pipe has been decided and ordered, the vacuum chamber is built, the cryogenic target has been tested (cooled and pressurized), 35 out of the needed 48 SDD's have been assembled and bonded (with 17 more expected by the end of 2017), and all the other elements of the apparatus (DAQ's, veto systems) will apparently be ready by the end of the first quarter of 2018.

The SIDDHARTA team recognizes a very good synergy and constructive feedback from their regular meetings with the DAPHNE accelerator division staff, aimed at finding the optimal geometry and beam delivery conditions for the experiment.

The crucial aspect is to secure enough qualified personnel for an efficient mounting and running of SIDDHARTA-2. This personnel is available but need to be offered longer-term positions to ensure the success of the experiment. A description of the specific tasks to be done, together with the personnel needs in each of them, should be provided to properly analyze and decide on the manpower request.

1.5 Recommendations

The SC congratulates the DAPHNE team on the excellent work behind the very good performance of the accelerator.

The SC recommends to keep well planned and scheduled maintenance periods throughout 2018-19 in order to keep the machine performing at *the same level as today.*

The SC believes it is important to invest in understanding co-existence of SIDDHARTA-2 and PADME running and change over-time to maximize the flexibility in the running schedule for the coming 2 years.

The SC recommends to monitor the progress of the changeover from KLOE-2 to SIDDHARTA-2 closely during 2018 and early 2019 to take appropriate corrective actions if delays are observed. The key milestones for the changeover and commissioning period should be defined (if not yet done) and monitored regularly.

The SC congratulates the KLOE-2 Collaboration for the smooth run of the experiment.

The SC recommends understanding the DAPHNE beam optics in detail, so that the HET acceptance of single- and double-arm events can be estimated enabling a cross section measurement for this process. This should be done before data taking finishes.

The SC recommends preparing a data processing plan of KLOE-2 for the next meeting. This should include an overall resource estimate and a plan of priorities, in case certain parts take priority. This should be motivated by the physics publication priorities, which should also be presented at the next meeting.

The SC recommends that the KLOE-2 Collaboration prepares a plan for data preservation.

The SC *congratulates the PADME team for the large progress shown and looks forward to receive a detailed study to understand the relevance of the resonant A' production in PADME.*

The SC congratulates the SIDDHARTA-2 Collaboration for the progress shown on the preparation of the detector.

The SC invites again the SIDDHARTA-2 collaboration to provide a description of the specific tasks to be done including preparation, running of the experiment and data analysis, together with the personnel needs in *each of them (a resource loaded schedule) so that the a proper evaluation can be done by the SC.*

2. SPARC_LAB activities

The committee was impressed by the various results and progress presented by the SPARC_LAB team. The experimental results include better performance of the plasma lens effect, both in the active and passive regime. These results confirm that emittance can be preserved upon focusing when the bunch samples the linear part of the lens radial field. They also include reconstruction of the phase space of the electron bunch produced by the FLAME LWFA. This reconstruction is possible from the simultaneous measurement of the bunch betatron radiation spectrum and energy spectrum. These results were published in Phys. Rev. AB.

Progress was made with the C-band accelerating structure and klystron that now increase the beam energy by 30 MeV (instead of the expected 50 MeV), enough for PWFA experiments. These single bunch experiments will include acceleration at various plasma densities. These will be followed by either two-bunch for FEL or comb acceleration experiments (March 2018).

Plasma capillaries with inputs with various tapering angles were fabricated to study the use of plasma ramps for bunch focusing and emittance preservation. Schemes were developed for the study of 10 to 30 cm long plasma capillary with multiple discharges. A special laboratory will be dedicated to plasma source development.

The FLAME laser is back in operation, though showing signs of aging that cause lower availability than expected. Electro-optic sampling for measurement of laser-produced proton bunches continues. The committee finds that the FLAME laser is indeed an aging piece of equipment that requires serious effort to maintain it and ensure it delivers pulses appropriate for the laboratory near and mid-term plans. Replacing the laser should also be considered, especially in the case of EuPRAXIA at LNF.

Start to end simulations were obtained including all elements and effects from the LWFA source to the FEL output. These first of a kind simulations show that lasing of the FEL in the water window should be possible. Simulations of a PWFA-FEL case (witness bunch only simulated start to end) were also performed and also show FEL lasing.

Significant progress was also made towards the future SPARC_LAB (EU-SPARC) that will be a candidate to host the EuPRAXIA project after its design phase will be completed. In particular progress was done on design of the building, as well as the various laboratory sections (linac, laser, plasma, undulator, user's experimental areas, etc). Bidding for the building construction could start before the end of the year. This progress is based on a CDR that should be completed by the end of the year and validated by an international committee of experts. The CDR is written by a large collaboration of Italian and international laboratories and universities. The SPARC_LAB team is an important partner of the EuPRAXIA design study. However, future plans geared towards hosting EuPRAXIA also include options to build a European level laboratory for users of radiation sources. This laboratory is based on a conventional X-band linac (1GeV) developed in strong collaboration with CERN and the newly approved European design study. Plans include production of FEL radiation driven by LWFA, PWFA and or conventional accelerator beams.

SPARC_LAB plans are also considered important by Elettra, the Italian synchrotron radiation source. SPARC_LAB plans are therefore of a high level and well integrated in the national and international context. Long term plans include reaching beam energies up to 5GeV, compatible with the EuPRAXIA goals.

2.1 Recommendations

The SC is looking forward to the EUSPARC CDR as well as to the continuous and sustained progress towards the future EUSPARC sustained by experimental and simulation results obtained at the current SPARC_LAB and the entire team.

The SC recommends producing a better plan for reaching the 5 GeV energy compatible with EuPRAXIA goals.

The SC strongly suggests to benchmark the various simulations with experimental results to increase the significance of the results. Simulations of the PWFA drive bunch should also be performed.

The SC recommends to have a plan for the long term replacement of the FLAME laser.

3. LHC experiments

LNF groups participate to the four large LHC experiments. All groups have a strong hardware characterization with the exception of the LHCb group where the participation to the data analysis is also large. The participation of LNF to the LHC upgrades is very visible.

ALICE-LNF is contributing to many aspects of the new Inner Tracking System Outer Layers, going from the reception, test and cutting of the Hybrids Integrated Circuits (HIC) with the pixel detectors to the mounting and testing of the staves. The production will start at the beginning of 2018 and will last about one year with possible leftover in the first month of 2019. The group is responsible for the measurement of the spectra of the π/K/p exploiting the excellent PID capabilities of the ALICE detector.

ATLAS-LNF is involved in three hardware projects. They play a central role in the construction of the New Small Wheels of the muon system with micromegas (phase 1); they are committed in the finalization and testing of part of the electronics of the Fast Track Trigger (phase 1); they are involved in the commissioning for the construction of one end-cap of the Inner Tracker pixel detector (phase 2). They participate with visibility to the Higgs to four leptons analysis and contribute to the implementation of the particle-flow algorithm in ATLAS. They maintain one of the ATLAS Tier2 and contribute to other computing activities including the ATLAS Virtual Organization management.

CMS-LNF is a smaller group compared to the other LHC-LNF groups. They contribute to the CMS muon system GEM and RPC detectors. They are committed to produce up to 20 GEM GE1/1 chambers in the next 30 weeks. They are involved in R&D for the GEM GE2/1 detector and on studies of new eco-friendly gas mixtures. They participate to the search for heavy resonances decaying into $\mu^+\mu^-$ pairs.

LHCb-LNF plays a central role in some LHCb flagship analyses like Bs to μμ and lepton flavor universality tests. They are committed to the muon system upgrade with responsibility of the MWPC spare production (finished), the production of the new muon readout boards (nODE) and the trigger software development. The first nODE has been produced in June and production will start soon. The group is also coordinating a program of fixed target at LHCb to be run in parallel with the collider mode.

3.1 Recommendations

The SC takes note with satisfaction of the large commitment of LNF in the upgrade of the LHC experiments. This large participation to the detector construction is not always accompanied by an equivalent commitment in data-analysis, which would make the LNF groups even more visible in their collaborations.

4. Outreach

LNF plays a leading role in INFN in bridging science and society. The Scientific Information and Dissemination Service (SIDS) comprises 5 staff, 3-4 young postdocs and many (~60) volunteers. It has a budget of 100 kEu/year. The group has on average 8000 contacts per year and in 2018 plans 15 outreach projects for students, teachers and general public. The service is organized in four sections. Communications is responsible of the official web site and of news and newsletters. Graphics&Photos manages the image database, historical photo collection, and event posters. Multimedia&Events produces video documentation, recording of lectures and public events, webstreaming and sets up big events and exibithions. Educational&Initiatives steers specific programs for primary schools (800/year) High Schools (400/year) High School Teachers (250/year) and General Public (3500/year).

A project for a new Science Center will start in 2018 in collaboration with University of Sassari architecture department and with special funds form INFN. The idea new is to have buildings where laboratories and outreach are mixed in a modern way, with windows to see the activities.
The plan is to have half space for clean rooms for future constructions and half space for visitor center. It can be open on Saturday and Sunday.

4.1 Recommendations

The SC is very impressed by the quality and quantity of the output of the SIDS group. This places LNF as one of the leading labs in science communication and outreach.

5. Next Meetings

55th SC 14-15 May 2018
56th SC 12-13 November 2018