53rd MEETING OF THE LNF SCIENTIFIC Committee – 9-10/5/2017

The chair excused Ralph Assman, Jannis Kariotakis and Steiner Stapnes who could not attend the meeting.

The chair thanked Gilberto Colangelo, who is serving for the last time as member of this committee, and welcomed Antonello Polosa as new member.

The INFN budget for 2017 is composed by a direct allocation of 230 MEu, that is the same as last year, plus a fraction of the 30 MEu of *premiali* on international project, shared with other research institutions. The assignment of *premiali* is based 70% on the evaluation of the INFN compared to the other institutions and 30% on the ranking of the projects. The assignment of the *premiali* will be known during next month. One of the projects in priority is about SPARC_LAB. INFN is ranked first among the research institutes.

The law for the simplification in the public administration was approved at the end of last year and now there is an easier path to open new permanent positions: only one level of approval and no limitation in the number the new positions, beyond the 80% fraction of the total budget assigned to personnel. INFN is presently around 50%. There is an opening for 50 positions for technicians and for the administration, of which 7 positions will go to LNF. The recruitment for new researcher positions is over: only one researcher involved in SPARC_LAB activity has chosen LNF as place of work.

There is a worry about losing people in the turnover. Temporary positions are already in the system and will be converted to staff, while it is difficult to maintain the same number of temporary positions, which depends on the availability of external contracts. There will be hiring of administrative and technical staff in the near future, however in the laboratory there are several technologist on temporary positions and nothing is foreseen for their recruitment at the moment.

1. DAΦNE, KLOE, PADME and SIDDHARTA

1.1 DAPHNE

The good performance of DAPHNE has continued through the run III, resulting in the total integrated luminosity of 4.6 fb^{-1} delivered and 3.7 fb^{-1} collected by the KLOE-2 detector. The delivered luminosity is somewhat above the target performance curve. Continuing with this performance in the next months will permit KLOE-2 to collect more than 5 fb^{-1} before the end of its run.

The performance of the accelerator is very impressive. The operation has been consistent and reliable with average uptime in excess of 75%. The availability of the accelerator and of the infrastructures allows for large integrated luminosity to be collected. This is the result of the consistent and large consolidation program done on the accelerator.

The consolidation program has continued in the recent past including a new protocol for the electrons/positrons switching aiming at shorter switch time and the upgrade of longitudinal feedback systems.

Plans to further test the crab waist scheme are well advanced with short tests possible before the summer shutdown. Additional tests could be performed at the end of KLOE-2 run as well as after the detector roll-out.

DAPHNE will shut down soon for scheduled maintenance between May 15th and May 26th and will continue to run till March 31st 2018 with the usual August interruption and other small scheduled maintenance periods.

The preparation of the new interaction region for Siddharta proceeds on schedule and the funds for the hardware changes have been allocated.

The schedule of DAPHNE is defined till the end of the Siddharta run in 2019. It is now time to discuss the future of DAPHNE and its infrastructures: DAPHNE is a unique structure in the world to study accelerator aspects of high luminosity colliders. There are already proposals for new studies by the LNF accelerator division and a call should be open to the large community.

1.2 KLOE

KLOE-2 is currently in the process of steady data taking with the fully operational KLOE-2 detector. The 3.7 fb^{-1} acquired by KLOE-2 represent about 70% of the data sample to be collected by March 2017. The averaged data taking efficiency is stable and stays at the level of 82% as firmly established during the Run II.

Further progress has been achieved in improving the KLOE-2 performance for the key detector components such as electromagnetic calorimeter (EMC) and combined IT-DC tracking. The new EMC calibration is ongoing. All collected data have been re-calibrated, and show much improved agreement between data and Monte Carlo expectation. A great effort has been made to improve combined IT/DC track and vertex reconstruction using refined alignment and calibration parameters. The already reached accuracy is very close to the expected target as has been demonstrated with data.

The performance of HET, in its application for the reconstruction of π^0 produced in $\gamma\gamma$-events, remains a long-standing concern. Preliminary analysis of 550 pb^{-1} of data using double-arm and single-arm tagging shows no evidence for π^0 signal. A lack of matching between the KLOE EMC and the small acceptance of HET for $\gamma\gamma$ - events can be caused by the transport of the off-energy electrons and positrons along DAFNE, which is being currently studied.

Good and stable data quality has been demonstrated for the benchmark channels in the final states with neutrals ($\phi \rightarrow \eta\gamma$ with $\eta \rightarrow 3\pi^0$) and charged particles ($K_S \rightarrow \pi^+\pi^-$). New reconstruction version, including improved IT and vertex reconstruction, has been released and tested on data, and is currently being used for data analysis. The search for $K_S \rightarrow 3\pi^0$ decay has started with new data, preliminary analysis of 300 pb^{-1} shows a sensitivity comparable to that achieved with KLOE.

Overall very good progress has been achieved.

1.3 PADME

The design of the main components of the PADME setup, including the target area and vacuum vessel, the diamond target and readout electronics, the scintillator-based veto detectors mechanics and electronics, the BGO calorimeter (readout and tools required for the construction), has been completed.

Less design work is needed for the small angle calorimeter: details are now being studied by the Debrecen group who recently joined the collaboration. PbF_2 crystals, with better transparency cut-off with respect to the originally planned SF57 ones are being studied. Due to its small size (25 crystals), the final detector will not impact on the installation. It will be positioned outside the vacuum.

The diamond target is ready, as well as the vacuum interface and readout electronics. The vacuum tests have been performed. The final carrier board for the diamond sensor has been designed and is currently being produced.

The calorimeter BGO crystals have been recuperated, selected and annealed at CERN, shipped to the Italian company that will perform the machining, gluing of the PMT's and painting. The tender for the 650 PMT's has been assigned to HZC Photonics, and the tubes will be shipped in the next months, although some delays might occur. The tender for the readout digitizer boards and high voltage supply has also been completed.

The R&D on the scintillator-based detector for positron veto in vacuum has been completed, and the results of the April test-beam at BTF are very positive: 700 ps timing resolution and practically full efficiency have been measured, validating the readout board based on the MU2E design.

Calorimeter studies have been completed, energy resolutions of 2% at 1 GeV, as expected from the L3 results, have been obtained, with satisfactory noise, optical cross-talk and timing efficiency. Results from the test-beams have been published and more are under preparation. The assembly procedure has been elaborated, and the calibration with cosmic rays is now ready.

The DAQ and computing infrastructure is also ready, and the software, including the Run control and database interface has been made available to the MU2E group for their R&D.

The study of the physics performance of the apparatus is slightly lagging behind. For the time being, events with dark photons initiated by e^+e^- interactions (with positrons from the DAFNE beam and electrons from target) are better studied and understood than dark-photon-strahlung channels. Signal to background studies should be refined and a closer collaboration with interested theorists might be desirable.

The PADME dipole should enter the BTF hall before the installation of the BTF new lines, so that most of the operations for PADME installation will be performed independently. It would be ideal to complete the PADME setup before setting up the new BTF lines.

1.4 SIDDHARTA

The definition of the DAPHNE schedule for up to 2019 has been crucial for injecting moral and momentum to the Siddharta team. Their members are meeting periodically with the DAPHNE staff to fine-tune the design details of some components. These meetings are not only being regarded as extremely convenient, but are already being very fruitful in ensuring the proper development of the experiment. Indeed, the Siddartha-2 experiment is progressing as planned and no problems or other issues are now foreseen that could jeopardize its installation at DAPHNE by the beginning of 2018, as scheduled.

The team is receiving regular funds by the Commissione Nazionale III, as well as other external support (mostly from the Austrian Science Fund) in terms of a few PhD or post-doc positions and travel money. The main worry is to secure some expertise personnel for beam time handling and for data analysis.

1.4 Recommendations

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

The SC recommends again as the first priority for DAPHNE the consolidation of the machine and the maximization of the integrated luminosity.

The SC recommends that LNF directorate discuss at the next meeting plans for the future period of DAPHNE beyond what foreseen by the present schedule.

The SC congratulates the KLOE-2 Collaboration for the smooth run of the experiment and the progress shown in understanding the tracking and the electromagnetic calorimeter.

The SC recommends that the KLOE-2 Collaboration prepares for the next SC committee a plan of forthcoming publications with new data and

preliminary estimations of the expected sensitivity for the key channels, in particular for the gamma-gamma physics program also in view of the current difficulties with the HET detector.

The SC congratulates the PADME team for the large progress shown and welcomes that the team is reinforced with senior staff from the laboratory that will play a key role also in the procurement and installation phase. The possible interference between the BTF upgrade and PADME should be clarified in the details.

It would be interesting to fully understand to what extent PADME (and its possible future upgrades) will compare with competing experiments on the physics channels of interest.

The SC congratulates the Siddharta Collaboration for the progress shown on the preparation of the detector.

The SC invites 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 is impressed by the progress at the SPAC_LAB since the last meeting. The up time of the experiment has increased since last year. Systematic and detailed studies of an active plasma lens have been conducted and will continue. This is important to determine whether such a compact and strong beam optics element is suitable for inclusion in an actual beam line. If so, it could be tailored to match the beam into the plasma and maintain the beam emittance upon focusing. The plasma lens results, as well any many others have led to significant scientific publications in refereed journals.

The experimental plan calls for plasma wakefield experiments. However, issues with the C-band klystron modulator may delay the scientific program. One possibility to overcome this limitation is to remove the C-

band structure and move the plasma upstream at a location where the beam can be matched to the plasma at some 86 MeV energy versus the expected 150 MeV. This is also motivated by the fact that there is probably little to learn from operating with the C-band accelerating cavity.

The committee strongly supports the exploration of the use of x-band structures in close collaboration with CERN. An x-band acceleration structure could be used in place of the C-band structure at SPARC_LAB. In addition, x-band structures operating at ~50 MV/m gradient and later at 100 MV/m are the compact solution to minimize the linac length, maximize the beam energy and the space available for experiments in the context of EU_SPARC and EuPraxia@SPARC. The common development of an x-band linac is also strongly supported by CERN in the context of the CLEAR project and possibly in collaboration with AWAKE.

The committee strongly supports the development of the new facility with an option to become the site chosen by EuPraxia to become the facility where the plasma-based design will be realized (EuPraxia@SPARC), at the same time as an option for a conventional FEL facility at the water window photon energy (3nm). The stated plan to produce a CDR for the July 2017 time frame seems to be ambitious. However, a non-reviewed version could be submitted at that time and a fully reviewed version submitted after the Summer.

The committee is pleased to see that the FLAME activities have resumed and strongly encourages experiments on external injection of electrons in a FLAME-driven LWFA. The committee also recommends continuing experiments on proton acceleration using the flame laser pulse and solid targets. These experiments provide diagnostics development and bring interesting and novel ideas, not to mention quality publications.

While the progress on the conception and plans of the new building for SPARC has not been discusses at this meeting (it was extensively at the intermediate meeting three months ago), the committee clearly encourages the timely pursuit of this very important part of the project and takes note that an agreement was done with the faculty of architecture of Sassari for the design of the building.

2.1 Recommendations

The SC strongly suggests studying with simulations and equipment survey the possibility to remove the C-band structure in the setup for the plasma wakefield experiment.

The SC recommends that the CDR for the new facility be written with the possibility to include Thompson and THz capabilities.

The SC recommends continuing experiments on proton acceleration using the flame laser pulse and solid targets.

3. Micro Pattern Gas Detectors

LNF has large expertise in Micro Pattern Gas Detectors, including the construction of the LHCb planar triple gem for the muon trigger system and the KLOE2 cylindrical triple gem. The group is involved in the construction of the micromegas for the ATLAS New Small Wheel of the muon system, the large area triple gem for the CMS muon system and the BES cylindrical triple gem. They are pursuing R&D on a new detector concept, conceived at LNF, the Micro Resistive Well (μ-RWELL) that is proposed for CMS and LHCb.

The new device has a simplified construction and assembly procedures and good stability under heavy irradiation, resulting in a cost effective and easy to operate detector to cover efficiently large areas. Tests done with small prototypes show good rate capability (> 1 MHz/cm^2), space resolution below 60 μm and time resolution below 6 ns. Large prototypes are being constructed and tested also in collaboration with industry.

3.1 Recommendations

The SC congratulates the group involved for the results obtained with μ-RWELL prototypes and suggests to look for possible application of this technology also outside HEP.

4. CNS2 Activities

The CNS2 groups of LNF are involved in four types of activities.

- Gravitation experiments with quite a large group of more than 7 FTEs, mainly funded with external contracts.

Small participation in terms of FTEs (ranging from 0.1 to 2) to

- The QUAX experiment on axions search,
- Three neutrino experiments (Juno, KM3 and Cuore)
- Three cosmic ray experiments (Jem-EUSO, Wizard, Limadou).

In some cases the participation is limited at technological contributions of LNF services like cryogenics, SC resonant cavities and mechanical services. In other cases LNF is committed to the delivery of large subsystems like the Top Tracker electronics of the JUNO experiment. LNF has the national coordination of the INFN participation to Jem-EUSO.

4.1 Recommendations

The SC notices that the activity of the gravitation experiments group is well established, however the group seems to be operated quite autonomously from the Laboratory. This situation will be clarified with the completion of the agreement with ASI on the use of LNF resources.

The SC believes that the participation of LNF with very limited research staff of the Laboratory in large external experiments is not useful for the Laboratory and also sub-optimal for the researchers involved. The exception is the use of the LNF unique technical competences for other INFN programs (Cuore, Dark Side). The SC wonders if it possible to change this situation, after the completion of the engagements already taken, with the involvement of the staff in other large projects of the laboratory.

5. PMu2e

LNF is involved in the PMu2e with a group of 9 FTEs, including 8 researchers, with large responsibility on the calorimeter system including the leadership of the project, design prototyping & construction, quality assurance of crystals and sensors, electronics and mechanics and Laser calibration system.

After the design and approval phase the project is now in the procurement phase of the most costly items (crystals and photo-sensors) and a large size prototype of the disk with final components (module zero) has been recently completed.

The calorimeter is progressing quickly and in schedule toward construction.

5.1 Recommendations

The SC is impressed by the nice results presented and congratulates the LNF PMu2e group for the completion of module zero.

6. BESIII

The new cylindrical triple gem is under construction after a prototyping phase. The electronic instrumentation is being designed or under procurement. An installation readiness review is scheduled for January 2018 and the installation of the chamber in BESIII is foreseen in 2018.

The Italian BESIII groups are involved in analyses aiming to measure the relative phase between J/ψ strong and electromagnetic amplitudes, and similarly for the ψ(2S) with a dedicated run. They are also involved in intriguing studies of the XYZ states above the DDbar threshold where the spectroscopy is not predicted by the quark model.

6.1 Recommendations

The SC congratulates the BESIII for the progress on the cylindrical GEM project and recommends continuing the technical support to the group preparing for the installation in 2018.

In few years from now the new FNAL g-2 experiment will produce a more precise measurement of the muon anomaly Δa_{μ}. A more precise value of the contribution to Δa_{μ} from hadronic vacuum polarization (hvp) will be needed for the test of consistency with the SM prediction. KLOE2 and BESIII data give important experimental input to the determination of hvp and LNF is involved in both of them. It is a pity that LNF does not participate directly to this important program for the determination of the hvp.

7. Next Meetings

We decided to anticipate by one day the date of the next SC meeting.

54th SC 13-14 November 2017