

# 59<sup>th</sup> MEETING OF THE LNF SCIENTIFIC Committee – 7/5/2020

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For the first time, the regular meeting of the Scientific Committee (SC) was held as video-conference only, for both the open and closed sessions. This was because of the exceptional Covid19 pandemic situation, that did not allow for a regular on-site meeting to be organized. The presentations of the open session can be found on this indico page:

<https://agenda.infn.it/event/22603/timetable/#20200507.detailed>

After opening of the meeting by the chair, the LNF director gives a short overview of the main events and issues that arose since the last meeting, obviously dominated by the Covid19 situation:

- The mid-term meeting of the SC, in Feb2020, was considered very useful, it helped shape the plans for the year. Unfortunately, these plans were mostly rendered obsolete in early March (week of March 10) by the required lock-down of the lab (that is still continuing) and correspondingly of all operations.
- While during normal operations ~400 people work in the lab, during the lock-down period only 30-40 people were allowed on-site, to ensure basic services and maintenance of infrastructure.
- The machines were put into safe mode and stayed in these conditions up to Easter. Just before the Easter weekend the planning and preparation for restart operations were initiated (such as acquiring protective material etc), and a lessons-learned package started to be prepared.
- Currently, the number of people onsite is being ramped up in a controlled manner, with access priority given to personnel relevant

for the DAFNE and BTF restart. The remaining personnel worked in home office and continues to do so. The home-office situation was characterized by enhanced outreach and educational activities of the personnel, for which it should be commended!

- On a positive note, the lab did not suffer from even a single infection.
- Regarding the scientific activities since the last regular SC meeting and its midterm gathering in February, in particular concerning DAFNE-BTF-SIDDHARTA:
  - Up to the first week of March the operations were in full swing and following pretty closely the plan that had been agreed upon during the midterm meeting.
  - However, triggered by the lock-down and the changed boundary conditions, the lab involved all relevant stakeholders in a discussion for redefining the main plan, that takes into account the safety-related limitations of DAFNE operations and that gives priority to the BTF restart.
  - More concretely, PADME should receive beam towards the end of June/beg. of July, after a period of ~7 weeks (increased compared to the original schedule because of the special working conditions) for restarting the LINAC operations.
  - Then PADME should run during summer, maybe even in August (to be seen how much the meteorological and consequently environmental conditions will allow for this), up to September.
  - All this moves the start of the SIDDHARTINO run to October, followed immediately by the SIDDHARTA run up to the end of 2020 and continued throughout 2021.
  - All involved parties agreed to this plan and also the SC considers this to be a justified and reasonable change of baseline. The SC also takes note of the very clear and strong commitment of the lab to complete the PADME and SIDDHARTA programs.
- The director reported on a number of positive developments in the area of SPARCLAB/EUPRAXIA (see also in the report below), such as the best (most efficient) weeks of running ever, achieved around end of February and then abruptly stopped by the lockdown. Some very interesting highlights in terms of plasma acceleration results have been achieved. Very importantly, a substantial financial support by the government, for EUPRAXIA infrastructure and hardware, has been received.

- As reported in the last SC meeting in Nov19, the KLOE magnet will be transported to FNAL; in return, FNAL has shown interest in the undulators of EuPRAXIA.
- Hiring situation in the lab: in May the hiring of three further technical positions for the accelerator division (diagnostics and control) will be completed; this will definitely help for the imminent turn-over of key personnel. Six additional technical positions are foreseen in this division, while earlier in 2020 and in 2019 other positions (2 for SPARC\_LAB, 1 for computing) have been secured. The director has presented an overall hiring plan for the next three years to the INFN management, which foresees ~15 additional positions. This plan and the corresponding negotiations with INFN will have to be pursued in the future. The director also has asked for extra resources (laser, plasma and tech. experts) in order to secure the preparation of the EuPRAXIA TDR, a key milestone for the lab.  
There is good news in terms of personnel in the theory division, with a few young theorists joining the group soon.  
Finally, new particle physicists will need to be hired to support the ATLAS, LHCb activities and other lab-internal experiments.
- A very positive news is that the Crab Waist collision scheme, invented at the lab, has very recently been set up successfully at Super KEK and turns out to deliver the expected enhancement in luminosity. The lab and all involved scientists have to be commended for this!
- The director informs the SC that the lock-down also affected the procedures related to finding his successor. In fact, Pierluigi Campana will take on new responsibilities within INFN. The search for a successor should be resumed in June and possibly be completed sometime during the summer.
- Besides identifying a new director, there will also be the need to find successors of SC members, in particular for Patric Muggli and Ralph Assmann. **The director, the chair of the SC and the other SC members express their gratitude to Patric and Ralph for their great service to the SC and the entire lab!**
- **Finally, the chair of the SC expresses, in the name of the entire SC, his deep appreciation for the very pleasant collaboration with the outgoing director throughout these recent years, and for the fantastic efforts that the director has invested in order to build the foundations for a bright future of the lab; the chair wishes Pierluigi lots of success and fun in his future activities, and is**

**looking forward to a “traditional” SC dinner with him and the committee, in person (!), in a hopefully not so distant future.**

The SC thanks the lab and all involved people for the clear presentations during the public (and very well attended!) video session and for the open and constructive discussions during the closed meeting.

Among other regular topics, the SC would like to hear presentations (and possibly have in-depth discussions with the proponents) on the following projects/items at the next meeting(s):

- Status of and details on the DAFNE-TF proposal
- ATLAS ITK, status of Phase-1 upgrades (ATLAS, ALICE), BELLE2 and MU2E
- Follow-up on the Axion activities

## **1. DAΦNE, SIDDHARTA, BTF, PADME and KLOE**

### **1.1 DAFNE – BTF – SIDDHARTINO**

#### **Findings DAFNE:**

DAFNE performance in January was hit by poor up time, in particular because of a klystron fault followed by a fault on the replacement. Up time in this period before the COVID shutdown was around 52%. Besides the klystron issues, other contributions came from: water leak from wiggler hoses (a reoccurring issue); vacuum leak on damaged flange.

Despite the poor up time, good progress was made with beam. The excessive coupling noted previously was traced to systematic rotational error on IR quadrupoles. Following correction, all key beam parameters look reasonable (beat beating, chromaticity, dispersion, energy acceptance etc.). Beam currents are reasonable, vacuum conditioning is still ongoing, with positrons lagging as expected.

In the middle of January, the first collision tests took place, enabling tests on the CCAL-T luminosity monitor; collimator optimization; low current vertical beam-beam scan. The latter provided a first look at the cross-

calibration of machine and experiment luminosity measurements. Scans indicated beam sizes at interaction point commensurate with expectations.

The Crab Waist scheme had been deployed (4 PMQF quads had to be moved, new CW optics applied). Good progress made towards full commissioning. CW optics features outlined, and optimization detailed (coupling, closed orbit, feedbacks, local orbit bumps, chromaticity). Some adjustments remain to be completed.

Restart ongoing with priority given to establishing BTF to PADME for the next seven weeks or so. DAFNE operations should resume by the second half of October. In the meantime, several activities have been planned starting after the required PADME installations.

A Consolidation and Development Plan was outlined (wiggler leaks, vacuum, power supplies, magnetic characterization of PMQF, alignment, control system and diagnostics, luminosity monitor improvements). The main ring optics require the development of a lattice model for the new PMQFs, once the magnetic measurements are available. Background simulations might also be performed. The DAFNE program has to deal with the well-known lack of dedicated manpower and it is not clear that everything specified in the plan can be tackled.

### **Findings BTF:**

- Recovery from Be window failure completed; reinstallation of BTF line almost completed with subsystem and services testing ongoing.
- Vacuum safety system hopefully completed by the beginning of June.
- Mylar window tests performed; from the point of view of mechanical and vacuum performances, 125  $\mu\text{m}$  Mylar windows demonstrate reliability and maintenance feasibility. FLUKA simulations for Mylar window robustness to beam exposure ongoing.
- BTF2 progressing well.

A detailed BTF planning was shown, the aim is to restart with long primary positron bunches for PADME in the first week of July. PADME requires around 2 months of sustained running, spanning the summer period (the summer stop to be confirmed). A summer time BTF run has never been tried before. Requisite Linac & BTF cooling and ventilation may be tested in

June/July. One must also consider personnel and shift worker vacation normally foreseen during this period.

BTF2 installation will start at the end of PADME run, probably after the SIDDHARTINO re-start and is slated to finish by the end of October. After BTF2 installation, commissioning will start and could take two to three months, given this, BTF2 beam should not be expected before December.

### **Findings LINAC:**

- Linac operations clearly impacted by end-of-life klystron replacement followed by subsequent issues and, consequently, another replacement. A detailed post-mortem analysis of these klystron problems is clearly important.
- Consolidation programme performed (HVPS, modulator electronics, improved maintenance and diagnostics...).
- Restarted conditioning after LINAC tunnel installation for BTF on June 1<sup>st</sup>.

### **Observations:**

The DAFNE team is to be commended for the good progress given the less than optimal up time. The experiments' teams appear to have made use of the enforced hiatus and are in good shape for the execution of the planned experimental programmes.

The low up time is worrisome; the experiments need quality data to be delivered under optimum conditions over a sustained period, the required duration of which is well defined. Low up time clearly cuts into experimental programmes with inevitable knock-on, making longer term planning difficult. At the same time, the committee recognizes that resources are limited, and that all efforts are being made to prioritize maintenance and consolidation activities. The technical division does, however, appear to be overloaded.

The PADME running period spanning the summer months is entering new territory and the response to up time problems during this period could well be less than nominal.

### **Recommendations DAFNE-LINAC-BTF:**

- *Difficult times but the SC would encourage a resource-loaded planning for consolidation and other foreseen Linac/BTF/DAFNE activities over the coming months with appropriate prioritization.*
- *The SC recommends folding in realistic machine up time and contingency into time estimates for the experiment's running periods. In particular, consider the impact of PADME not getting enough data over the challenging summer period.*

### **Findings SIDDHART(A/INO):**

The SIDDHARTA team had made good progress towards the preparation of the Phase 1 SIDDHARTINO commissioning run in March 2020, which unfortunately could not start due to the COVID crisis. In particular:

- The calibration of the SDD's was optimized, expanding the X-ray energy performance to cover a (4 - 14 keV) range.
- Luminosity checks were performed, obtaining an excellent match between the SIDDHARTA-2 luminosity monitor and the Kaon-trigger monitor. This matching provides, as a side bonus, a measurement of the Phi production cross section.
- The SIDDHARTA-2 luminosity measurements were cross-checked with those of the DAFNE CCAL-T luminosity monitor, finding a very good agreement.
- A performance protocol has been designed and checked with the SIDDHARTA parameters, so that it is ready for comparison as reference when the beam collisions for SIDDHARTA-2 will start.
- The new scenario foresees to start delivering beam for SIDDHARTINO by mid-October 2020 and let it run towards the end of the year, with the goal of optimizing the conditions to meet a S/B of at least 100/1 in the K-4He test measurement. During this commissioning period, the team plans to run parasitic tests with HPGe (High Purity Germanium detectors), which aim at contributing to a more precise measurement of the kaon mass.

The installation of the full complement of 48 SDD arrays for Phase 2 (SIDDHARTA-2) targeting kaonic deuterium is foreseen to take place in early 2021, followed by data taking up to an estimated integrated luminosity of 800 pb<sup>-1</sup>.

## 1.2 PADME

### Findings PADME:

- The PADME collaboration is planning for a 2-month long RUN-2 starting in July. Before this can happen, a number of subdetectors need to be fixed or upgraded. The collaboration has prepared a detailed plan with the various hardware items, and their priorities, that need to be done starting in May. Due to travel restrictions, only Roma and LNF personnel will be able to be onsite. The BTF team also needs to update their systems in the same confined space and this will require close coordination to avoid overcrowding. The COVID-related rules will impact RUN-2 operations. Shifts can be done remotely by the full collaboration. It may require Roma people to be locally available for experimental interventions.
- The collaboration has continued improving the data reconstruction. Correlations between various detector subsystems are being done and the matching of data and MC is improving. A better simulation of pile-up may further improve data and MC agreement.
- The first technical paper on target performance has been published and three other papers related to PADME commissioning, the ECal, and trigger and timing are in preparation. The  $ee \rightarrow \gamma\gamma$  cross section paper with RUN-1 data is scheduled for early 2021, other phenomenological papers are to follow.

### Recommendations PADME:

- *The SC is happy to see PADME's flexible proposal and recommends merging it with a similar BTF schedule.*
- *While the SC is very happy to see PADME publications being written, it would encourage the collaboration to focus especially on the timely release of physics results.*
- *The SC would like to see a more detailed proposal and sensitivity reach for running PADME at DAFNE.*

## 1.3 KLOE

### Observations:

- The KLOE experiment has completed the software development for the data reconstruction and started reconstructing the full dataset (8/fb) with the final software and calibration, DBV-40. Several



important improvements were made, and the SC congratulates KLOE for having achieved this important milestone. With the current rate of about 30/pb per day, and assuming no major downtimes, the task should be finished by the end of 2020. In addition, a large amount of MC simulation has also been produced.

- As for physics analyses, since the last meeting one new paper has been published on the branching ratio  $K_S \rightarrow \pi\mu\nu$ , which is the first measurement of this quantity and agrees within the uncertainty (of about 5%) with the Standard Model expectation. The SC congratulates on this paper which constitutes an interesting test of lepton flavor universality.
- Another eight analyses are ongoing. For instance, significant progress has been reported in the so-called HET analysis, searching for a signal of  $\gamma\gamma \rightarrow \pi^0$ , including the development of a blinding strategy as also recommended last time. Furthermore progress was reported on the CPT test with  $K_S K_L \rightarrow \pi^\pm e^\mp \nu + \pi\pi/3\pi^0$ , the first measurement of the rare decay  $K_S \rightarrow \pi^0 \pi^+ \pi^-$ , the measurement of  $\eta \rightarrow \pi^0 \gamma$  (where there is a tension between the earlier KLOE result and other experiments) and a search for a new dark force mediator called B boson.

#### **Recommendations KLOE:**

- *In all cases of ongoing data analyses, there is good progress and the SC recommends to keep going and to advance these important results further.*

## **2. SPARC\_LAB and EUPRAXIA@SPARC\_LAB activities**

#### **Observations:**

- The committee congratulates the SPARC\_LAB team on continuous progress, both with the experimental program in support and preparation of the EuPRAXIA@SPARC\_LAB project. It is also pleased to see that its previous recommendations were deemed appropriate and are followed by the team. Scientific progress is exemplified by the list of publications.
- The SABINA project is making headways, in particular with the planned acquisition of a new photo-cathode drive laser with suitable parameters for the FEL application.

- SPARC\_LAB demonstration of acceleration of a witness bunch with very small relative energy spread and reasonable emittance, though with low energy gain, is a significant step forward that will allow the team to start on beam transport to, and radiation into the SPARC\_LAB undulator. The plasma discharge reproducibility was shown to greatly improve when laser-triggered. This is another significant step towards an accelerator for applications, FEL in this case. Moving to longer plasma, allowing for larger energy gains is also significant. Other results collected during this time were not formally presented, but were in the additional slides. Facility up time was also better than during the previous period, despite the lock down.
- Studies of FLAME laser beam guiding in a capillary have started. However, AC problems have hampered progress and made the up time quite low.
- Long term funding for the EuPRAXIA project was acquired, which secures its construction and future. Building construction contract is about to be settled and should quickly lead to start of construction. Optimization of the linac parameters and length are ongoing with more and more realistic plans. Though the ESFRI application has been delayed, preparation is going well and international support is expected for the formal process. All of this represents progress towards the TDR.
- The committee is looking forward to continued progress.

#### **4. Next Meetings**

60<sup>th</sup> SC 16-17 Nov 2020

61<sup>st</sup> SC 6-7 May 2021