

56th MEETING OF THE LNF SCIENTIFIC Committee – 5-6/11/2018

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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 of the SC:

- The proposal of DAPHNE as Test Facility (TF) has been translated to English and distributed to the Scientific Committee. In the meanwhile, a positive reaction from the INFN has been received; the next important step will be a workshop at the end of 2018. This might be followed up by a further workshop a year later, in order to converge on the most interesting projects to be proposed to the INFN management.
- The successful start of PADME data taking has been a major achievement for the lab in 2018 (see more details below); the impact on the SIDDARTHA schedule (a couple of months delay for the start of commissioning, with the main data run to start in Sep 2019) is considered to be acceptable.
- Since June 2018 more regular and structured meetings among the coordinators of the main activities at the lab have taken place; these are important to spot critical overlaps of resource requirements. This has already led to some improvements, eg. in efficiency of operations at SPARC-LAB, but further improvements are needed. A very detailed review of such items has been carried out at a recent Machine Advisory Committee meeting, with the report to appear soon.

- The LNF is preparing its own input to the European Strategy Update. Similarly, INFN is also working on its overall input: there the R&D for muon colliders (with interest relaunched by the LEMMA project initiated at LNF) will be highlighted, as well as the support for FCC, among other things.
- EUPRAXIA: not too many developments since the last SC meeting. The bid for the infrastructure project has been launched in the summer; end of November there will be an important EUPRAXIA collab. meeting in Frascati.
- The ATLAS and ALICE Phase-1 upgrades are proceeding well. For the Phase-2 ATLAS upgrade, it has been decided to focus on the ITK integration in a large clean room (CO2 cooling plant procurement launched)
- LNF is preparing an agreement with the Italian Space Agency (ASI) for building a clean room at LNF to host work on space equipment.
- The new small visitor centre has been inaugurated in the summer, which got impressive attention by media, politicians and the public. The SC visited this new center and was very positively impressed by the installations!
- The lab has obtained a grant from the local government (“LATINO”) that will help to foster tech. transfer and activities to sustain the local industry. In this context, LNF will offer lab infrastructure with special equipment to such industry (that typically would not have access to such infrastructure otherwise).
- Recently 36 persons have been hired on permanent contracts. However, the director highlights that these were already working at lab, but on non-permanent contracts. With this measure, the lab is now back at its level of permanent staff as of 2011.

The SC thanks for the report on the various items and congratulates the laboratory for the achievements since its last meeting. Besides the discussion on the various main topics (with more details reported below), the SC agrees upon the following points:

- From now on, the SC report shall be written in a somewhat more concise form (mostly bullet lists of observations and recommendations), and correspondingly be delivered to the lab more quickly than previously. This modus operandi is preferred over an immediate first oral feedback right at the end of the SC meeting, as has been requested by some LNF colleagues.

- *The SC would like to hear concrete follow-ups on the recommendations of its previous report at the subsequent meeting; i.e., the presentations at that meeting should contain answers/comments to the previous recommendations.*
- 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:
 - Theory at LNF
 - Axion searches
 - Outcome of the DAPHNE TF workshop
 - Status of PADME data taking
 - Status of SIDDARTHA commissioning
 - Status of ELI-NP (tbc)
 - LATINO

1. DAPHNE, KLOE, BTF, PADME and SIDDHARTA

General observations:

- The SC notes that the concerned staff is very busy: a large number of projects has to be run by a relatively small number of people. In particular, operations, technical and mechanical support appear to be stressed.
- An important concern is the ongoing or imminent loss of expertise (electronics, linac, magnets...) through the retirement of experienced members of staff.
- The SC underlines the importance of resource management via effective planning.

1.1 DAPHNE

Observations: IR preparation for SIDDHARTA-2

- IR magnets - new mechanical design aimed to improve field profile and stay-clear aperture.
- In order to reduce background on the detector, several iterations with ESRF are needed to shape the magnet case in order to fit the mechanical and magnetic requirements. A new beam pipe with tapered elliptical cross section has been designed to match the

SIDDHARTA-2 IR with a dedicated “Y” chamber beam pipe. Construction is in progress.

- Planning presented: QF construction, measurement, delivery, installation. The committee notes that this schedule appears tight for DAPHNE to be ready for commissioning on 5th March 2019. The new IR represents a major change, lots of care is needed in magnet characterisation, matching, and alignment.
- The maximum current stored in the e^+ beam is limited by the e-cloud induced effects – motivating the installation of horizontal FBK in the e^+ ring.
- A full program of consolidation and upgrades is being executed as detailed in the last SC meeting.
- Luminosity measurement systems have been presented – the SC considers them to be well covered.
- Recommissioning with beam is estimated to take (at least) 4 months with re-establishment of dynamic vacuum conditions foreseen to take a while. It will be vital to provide data to the SIDDHARTA-2 test set-up before summer (March – June) to allow timely roll-in of the full detector over the summer.
- Background is critical to SIDDHARTA-2 data taking, with the main contribution being local beam loss. The new IR design should certainly help things. Low background and stable running conditions are required by SIDDHARTA-2, the instantaneous and integrated luminosity are clearly defined.

Recommendations: IR preparation for SIDDHARTA-2

- *Recommissioning with beam will have to balance: re-scrubbing of the e^+ ring – with loss of electrodes; delivery to synchrotron light users; delivery of first luminosity to the SIDDHARTA-2 test set-up. It should be possible to satisfy the requirements by an appropriate choice of beam parameters. Peak performance is not a prerequisite for useful operation – full-on high current, high luminosity are not needed, particularly not initially.*
- *The optics appears fixed – parameters to adjust include: number of bunches; bunch intensity; bunch spacing (plus longitudinal parameters). Beam parameter sets for initial commissioning should be defined; intermediate; scrubbing; nominal ($1e32$); and pushed.*
- *Background signals to the machine and limits should be clarified, if not already done.*

- *A detailed commissioning with beam plan should be drawn up.*

Observations: DAPHNE-TF (proposal of a Test Facility)

- The SC has taken note, with appreciation, of the achievements to date. The machine is in good shape, as mentioned elsewhere in this report. Possible fields of interest have been enumerated and expanded on in the proposal. These foresee activities over a few months/year. A dedicated workshop will be organized in December 2018.
- The possible execution of a physics program with DAPHNE in TF mode has been presented – including use of DAPHNE as a stretcher ring – the SC notes that this could be interesting.
- IR magnets – a new mechanical design has been presented, aimed to improve the field profile and stay-clear aperture.

Recommendations: DAPHNE-TF

- *The SC highlights the significant commitment of such a possible facility and underlines that a portfolio operation scheme is not without risks. Therefore, the SC recommends to carry out a careful and detailed review of the feasibility, the program and cost estimates after the December workshop.*
- *The cost of operating a TF has to be carefully evaluated, including items such as maintenance, repairs, technical support, consolidation, problem resolution, energy costs, services, operational support (BI, RF, vacuum...), operations staff.*

1.2 KLOE

Observations:

- Nearly 40% of the 5.5/fb of data have now been reconstructed, and it is expected that the remaining data will be reconstructed within the next four months. In addition, a large MC production was launched, corresponding to about 1.3/fb. The simulation runs parallel to data reconstruction. The MC describes the data reasonably well, and the data quality looks good. Work is ongoing on the software for another round of reconstruction (which will start when the current processing finishes).
- Efforts on translating the DSTs into ROOT format continued. A lot of progress was made. An alternative data preservation strategy is to

directly translate the YBOS data into ROOT data structures. This is also being explored.

- A publication plan was presented, including the manpower and time estimates for the publication.
- A few selected analyses were presented, some with only KLOE-1 data but many with KLOE-2 data included. Good progress was evident in all of them.
- the computing was simplified significantly, and the maintenance need (and associated cost) was reduced.

Recommendations:

- *The list of remaining analyses and the associated manpower and timeline is very useful. It would be welcome if this list could be updated as time goes on.*
- *The translation to ROOT is very much appreciated. It would be good to finalize this, so that the next reconstruction version can produce the ROOT output.*
- *The SC invites the collaboration to make sure that the next version of data reconstruction includes all required improvements to support the KLOE-2 data analyses, so that this is the *final* version all papers can be based on.*

1.3 BTF

Observations

- The team has achieved a very busy driving through a tight schedule in order to build a second beam-line and experimental hall; consolidate the linac to extend its lifetime of 10 years; and restart with long positron pulses for the PADME run. The SC commends the care and diligence applied during linac set-up, in order to provide PADME with the requisite beam.
- There has been excellent progress with only small delays, leading to the successful completion of several milestones: installed the fast dipole; installed a 2-way thin vacuum chamber; installed the BTF-1 line in its final position; installed PADME; and subsequent beam commissioning. Run-1 started on 4th October 2018. It is highlighted that Italian SMEs successfully engaged.
- The SC would like to warmly congratulate all teams involved!

- **BTF-2** suffered from significant delays, but bidding is now complete and magnets are in construction; power supplies are ready. Infrastructure work has resumed after some difficulties: civil engineering is completed (apart from bunker construction), while projects for the upgrade of cooling and conditioning are under way. The final installation of BTF-2 and first beam are planned for next spring.
- Linac consolidation is essentially on schedule, including the following major items: linac modulator installation and commissioning; timing system upgrade; new control and interlock system; etc.

1.4 PADME

Observations:

- The SC is happy to see the PADME experiment installed and taking data, a lot of very hard work has been done by the collaboration and the team should be congratulated!
- The shift load is significant for the collaboration. The SC deems it a wise decision to include the PADME shift station in the machine control room. This allows machine people to help monitoring PADME during the night, and the SC commends the operators for this help in running the experiment.
- Physics reconstruction software for various detectors subsystems is ready.
- The SC supports the investigation of running PADME or its successor at DAFNE and looks forward to a more detailed proposal and presentation of the sensitivity reach.

Recommendations:

- *While the beam started in early October, the experiment is still commissioning systems. The data rate is about 2x higher than was planned for. The environmental background is higher than expected, preventing an efficient zero suppression. The collaboration is working on mitigating this issue, but alternative plans (e.g. requesting more network and computing resources) should be prepared.*

- *The experiment should be frozen and moved to data taking mode soon to be able to collect 10^{13} POT before DAFNE and SIDDHARTA installation in Spring 2019. The collaboration is confident that the luminosity could be further increased to collect enough data in the allotted time. If scientifically meaningful, alternatives such as additional beam time in July or PADME running together with SIDDHARTA should be investigated.*
- *The collaboration should start regular run coordination meetings.*
- *Detailed analysis, correlating quantities between detectors should start soon, including the reconstruction of known Standard Model processes to ensure that the detector is working correctly.*
- *An analysis coordinator overseeing the collaboration-wide analysis should be assigned and regular (e.g., weekly) analysis meetings should be started.*
- *A lot is being done by relatively few people — a few more senior LNF researchers should be strongly encouraged to join the collaboration and become involved in the data analysis.*

1.5 SIDDHARTA

Observations:

- The SIDDHARTA-2 team is ready to start the commissioning run in March 2019, employing a ^4He target and using 8 SDD modules out of a total of 48. Once the beam has reached good S/B conditions (at least as good as for the final phase of SIDDHARTA) the whole SIDDHARTA-2 setup will be installed. This is expected to happen in June 2019. The installation, debugging and calibration phase may take 4 weeks, which makes September 2019 to be a reasonable starting time for the definitive K- deuterium experiment.
- The collaboration is active in involving new institutions and in gathering new funds. At this stage, the additional manpower that these institutions and grants can provide is especially important.
- The team plans to use the SIDDARTHA-2 set-up to perform parasitic tests of detectors and crystal spectrometers during the running of the experiment. The committee regards this initiative as a positive way of optimizing the allocated beam time, but it is advised that these actions

are briefly described and documented for a better judgement of possible negative interferences with the experiment.

Recommendations:

- *The SC encourages the SIDDHARTA-2 and DAPHNE teams to maintain the tight collaboration towards achieving optimal beam conditions for the test run before summer 2019.*
- *The use of the SIDDHARTA-2 set-up for parasitic tests is a welcome initiative, which should be properly analyzed to discard possible unwanted interferences with the experiment. A document describing the details of these tests should be provided.*

2. SPARC_LAB and EUPRAXIA@SPARC_LAB activities

Observations:

- The committee is impressed by the progress since the last meeting and is pleased to see that previous recommendations were analyzed and implemented. Following these recommendations and with strong support of the laboratory, operation of the SPARC_LAB linac by accelerator department operators has started with two shifts per day, enabling 24h operation for certain modes. This saves time in the day that was used in the past for conditioning and other activities, allows for the linac to be ready first thing in the morning and maximizes experimental time. The unfortunate technical issue with a klystron has hampered progress and will delay experiments till next year.
- The committee is pleased to see continuous improvement with the FLAME laser operation. Remaining problems are being addressed and their solution will enable the planned laser-wakefield acceleration (LWFA) program. In the meanwhile, results were nevertheless obtained with laser ion acceleration and studies of laser pulse propagation in plasma. On the beam-driven program (PWFA) experimental results were obtained and include: energy loss parameters optimization, energy de-chirping by the plasma (important

for FEL operation), emittance preservation and optimization in plasma lenses.

- Plasma discharge studies continue, in particular regarding the effect of the plasma end plumes. The team is considering novel plasma sources. For example, a new project with the ministry of science and technology of the state of Israel has been started to develop plasma sources with curved plasma to guide in the fresh drive laser pulse. This could have important implication for staging of multiple plasmas. A new plasma interaction chamber has been designed and will be installed soon with non-charging, metallic restriction apertures. Plastic apertures were observed to charge and deflect the beam.
- Concerning EuPRAXIA@SPARC_LAB, an external review committee has been appointed, with kick-off meeting Nov. 27-28. The plan is for the committee to return a report before Summer 2019. A call for tender for the EuPRAXIA@SPARC_LAB building is open and a contract could possibly be awarded by the end of 2018. The team has expanded the EuPRAXIA@SPARC_LAB users community, which helps strengthening the scientific case of the proposal. The THz/mid-IR aspect of the proposal has also been strengthened with both narrow and broadband radiation synchronized with the FEL pulse. This enhances the capabilities of the facility. The committee is pleased to see a possible new structure of the EuPRAXIA project that makes EuPRAXIA@SPARC_LAB the pillar of the PWFA part of the project. LWFA simulations and development at Frascati continue in parallel.
- The future planning that was shown foresees that SPARC_LAB will continue operating for the next five years. The committee is pleased to learn that several SPARC_LAB scientific and technical team members have been awarded permanent staff contracts. This strengthens both SPARC_LAB and EuPRAXIA@SPARC_LAB activities.

Recommendations on SPARC_LAB:

- *The priorities of beam-driven versus laser-driven plasma acceleration experiments at SPARC_LAB should be reviewed with*

consideration of available resources, impact of R&D and the EuPRAXIA@SPARC_LAB goals.

- *The SPARC_LAB team should develop a list of science topics and measurements required to support the EuPRAXIA@SPARC_LAB proposal and to demonstrate critical feasibility issues.*
- *A beam-driven SPARC_LAB plasma accelerator setup should be operated over an extended period, for example one week, to demonstrate and test the required reliability and stability for EuPRAXIA@SPARC_LAB.*
- *Experimental results with plasma lens-based beam focusing and beam transport should be compared with focusing and transport by permanent magnet quadrupoles (PMQs).*
- *The laboratory management is encouraged to continue promoting SPARC_LAB and its activities as a critical lab activity in preparation for the EuPRAXIA@SPARC_LAB project.*

Recommendations on EuPRAXIA@SPARC_LAB :

- *The operation and personnel aspects of the EuPRAXIA@SPARC_LAB proposal should be further developed. These are key aspects for the operation of the facility.*
- *For the longer term, consider operation with two separate electron injectors for beam driver and beam witness. This is necessary for demonstrating the HEP application of a multi-staged, high energy plasma-based accelerator where driver and witness beams have independent features. It also allows much more flexibility. The required space should be reserved in the EuPRAXIA@SPARC_LAB layout from the start.*
- *The European aspects of EuPRAXIA@SPARC_LAB should be developed, including a clear view on moving from a national facility to a European facility. The possibility to define the facility from the start as a trans-national access facility, for example in the context of the ARIES European framework, should be considered.*
- *The major strategic building blocks of the EuPRAXIA@SPARC_LAB project should be defined more clearly, including for example an INFN component (a 1GeV, x-band based FEL) and a broader, more ambitious component (e.g. a 5GeV, plasma-based FEL requiring broad European support and funding).*
- *Since the outlook for the plasma-based FEL of the EuPRAXIA@SPARC_LAB project largely relies on start-to-end simulation results,*

it is recommended that (in particular) plasma simulation results be benchmarked with different simulation codes and, whenever possible, against experimental results.

3. Axion searches

Observations:

- The relatively new effort on axion searches at LNF may complement the work by PADME on dark photons.
- Current activities (e.g. QUAX) may have to be ended, depending on the outcome of the KLASH study.
- Because of the relevance of these efforts, the SC would like to schedule more in-depth discussions for the next SC meeting in May 2019.

Recommendations:

- *Several axion-search-related projects were presented in the open session. Since it is unclear how big the local effort could be, the SC suggests a clear, and coherent, focus on a main project.*
- *The SC encourages work on the KLASH CDR with a detailed study of the exclusion region to be compared to all other concurring experiments.*

4. Next Meetings

57th SC 9-10 May 2019 (note the change of dates/days!)

58th SC 11-12 November 2019