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Memorandum from the OPERA Collaboration to the CERN SPSC

The OPERA Collaboration has recently held a Workshop (10 September, LNGS) to address the issue of the experiment landscape, in view of its future running in the CNGS beam. The outcome of this Workshop is briefly summarized in the following with some conclusions and requests.

Introduction and physics reach

The OPERA Proposal was approved by CERN with a request of 5 years of CNGS running at the average intensity of 4.5×10^{19} pot/year, for a total of 22.5×10^{19} pot required to fulfill the physics goal of τ-appearance discovery. In addition to a detector mass ~30% larger than the present one, this request relied on the assumption of realistic performance of the CERN accelerator complex and on a typical run duration of 200 days/year. So far, such a beam performance has not yet been met. However, it is worth stressing that a rather close intensity score could have been obtained this year in the case of a ~200 days long running period.

If we consider the first CNGS technical run of 2006, the extremely unlucky 2007 run, the first production run of 2008 (~1.8×10^{19} pot), the reasonably expected score of 3.0-3.5 $\times 10^{19}$ pot for 2009, and a 2010 run with extended duration (one extra month at the beginning of the running period) worth ~4×10^{19} pot, CNGS and the experiment would have been running for 5 years with a total integrated intensity lower than one half of that of the Proposal. For completeness, we note that the fraction of the OPERA target installed was 0% in 2006, ~40% in 2007, 98% in 2008 and 100% (1.25 kton) in 2009.

Given these considerations, the above mentioned Workshop on the future of OPERA was meant to evaluate to what extent the experiment could realistically and profitably keep running for the future, under which conditions of detectors and LNGS infrastructure, and with which support from CERN and from the various groups and funding agencies.

Concerning the role of the experiment in the framework of the international projects on neutrino oscillations, it is clear that there is great interest in the experiment's expected results. Direct appearance of neutrino oscillations is still missing, and OPERA is the only worldwide project dedicated to such a measurement. Recently, the scientific debate has put forward specific neutrino mixing scenarios for which quantitative statements from OPERA are eagerly awaited. However, a conclusive result from OPERA must come timely with respect to the expected outcome of the next generation experiments on neutrino oscillations.

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Last but not least, OPERA is the only neutrino beam experiment in Europe and one of the very few running neutrino experiments in the world, with the recognized role in maintaining a motivated community of neutrino physicists very active and productive, and in fostering a new generation of scientists to be prepared for future international enterprises.

The OPERA physics reach, namely a statistically significant discovery of τ–appearance, is essentially limited by the collection of the design beam integrated intensity. The expected low background of the experiment makes OPERA capable of providing soon quite meaningful results whose significance will depend on the available data sets and on the actual physics scenario. As a side remark, we also explored the potentialities of non-oscillation physics. Such subjects, already being actively studied within the Collaboration, are expected to profit from a longer lifetime of the underground detector. We can mention, for instance, the measurement of the cosmic-ray muon charge ratio, where OPERA can play a leading role due to the presence of the magnetic field in its spectrometers and of the large slant depth of the Hall C of LNGS. In addition to cosmic-ray physics OPERA will also address other specific neutrino physics subjects such as the measurement of the neutrino velocity.

Detector status (emulsions, electronics detectors, facilities)

A first point addressed in the Workshop has been the status of the detector, and notably of the emulsions, in view of an extended neutrino run. We have conducted specific measurements with "old" bricks (namely those built and installed at first in the detector) and with emulsions recently placed in a test beam and subject to a so-called "acceleration aging procedure". The latter procedure allows to artificially increasing the "age" of the emulsions by exposing them to controlled temperature conditions. The experimental data show no degradation of the emulsion performance, in terms of sensitivity and fog, and tolerable effects due to the brick lead radioactivity. Efficient running conditions can be safely anticipated, certainly until 2012 (see the Conclusions).

A related issue is the availability of sufficient scanning power over a long period. The scanning power will likely not be a limiting factor for the next years. Existing scanning laboratories in Europe and Japan are consolidating their performance and are expected to soon implement methods to further improve their technical capabilities (more powerful microscope components, faster CCDs and electronics, perfected software algorithms, increased experience with scanning, commissioning of new microscopes, etc.). In addition, new laboratories will shortly contribute to the joint Collaboration effort: Ankara (2010), JINR Dubna (2009), Toho (2010). It is important to grant continuous support from the funding agencies in keeping the qualified manpower for scanning and allow for the involvement of young physicists in the analysis of the emulsion data.

Concerning the electronics apparatus, a careful survey of all detectors has yielded a common outcome: all devices could well stand several more years of running, provided that periodic maintenance could be assured and that an adequate number of spare components will be soon purchased and stored, given the natural difficulty in procuring "old" electronics or mechanical components after several years from construction. Similar considerations apply to the brick handling facilities at LNGS (BMS, X-ray marking, emulsion development). The main issue will be manpower and a careful planning of maintenance operations.

The CNGS beam

As mentioned above, the present limiting factor for the experiment sensitivity is the CNGS intensity. The Collaboration looks forward to getting soon the "Multi Turn Extraction" operational. This should improve the stability of operation of the accelerator facility and might allow an intensity boost up to 2.4×10^{13} protons per extraction, or more. This gain, in addition to a higher reliability of the operation, could balance the possible drawbacks due to the simultaneous operation of the CNGS with the LHC (filling of the machine). Another point to stress is the need of longer CNGS runs, with the aim of getting closer to the nominal 200 days/year running period.

Conclusions

Finally, the Collaboration addressed the status and the prospects of the various groups, first of all in relation to their continuing interest in the project, but also in view of the projected available resources, both for manpower and for the required financial contribution to the rather expensive M&O funding.

It came clear that the OPERA Collaboration is very positive towards the continuation of the project beyond the 2006-2010 period and committed to successfully conduct and conclude the experiment as outlined in the Proposal. If one also considers the technical issues presented above and the expected evolution of the physics scenario in the next few years, it is rather natural assuming that an extension of the project beyond the 5 years of CNGS operation (2006-2010) is, on the one hand, realistic and, on the other hand, necessary to fulfill the physics goal.

The above considerations materialize in the proposal and in the motivated commitment from the Collaboration of running in the CNGS beam over 2011 and 2012, under the condition that CERN will provide by then an integrated intensity comparable with the nominal run (22.5×10^{19} pot). This must be backed by adequate long-term support from the other funding agencies, also taking into account that one-two more years beyond 2012 could be needed to complete all the data analyses.

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