THE *SuperB* ACCELERATOR PROJECT

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1 Introduction

The scientific success of heavy quark factories (PEP-II at SLAC and KEKB at KEK) in probing new physics scenarios at still unexplored energies through the enormous sensitivity to rare decays deliverable by large luminosity machines and the increasing R&D activity related to future linear electron nano-beam machines that could be better developed through the construction of a nano-beam based machine were the motivations to promote the project of a high luminosity B-factory, called *SuperB*. A number of steps, from the completion of a Conceptual Design Report, issued in 2007, signed by 320 physicists belonging to 85 institutions from 16 countries and successfully evaluated by an international committe to the launch of the Technical Design Report effort, were performed together with a constant parallel development of the users scientific community. In 2010 progress reports with updates from Detector, Accelerator and Physics were published.

The Italian financial support was given within the "flagship project financial plan" at the end of 2010 and endorsed by CIPE, the inter-ministerial body for main infrastructures, in Spring 2011. The governance of the project, following the model of main research European infrastructures, was based on a Consortium, constituted in this case according to the Italian law, funded in a large share by public funds, but able to include memberships and contributions from international partners. The accelerator Consortium was named after Nicola Cabibbo for his pioneering work in weak interactions and for opening what today is called flavor physics. The Consortium founders were the INFN and the University of Rome Tor Vergata whose campus was chose by a bilateral agreement to host the infrastructure. The consortium statute also foresees regular costing review with the first not later than a year from constitution on October 7 2011.

2 Year 2012 activity

In 2012 the activity by the *SuperB* collaboration has been focused on producing a costing document for the Finance Committee of the Nicola Cabibbo Laboratory, which was appointed by the Italian Minister of Research and University to make an evaluation of the final cost of the project.

A small group of physicists and engineers from INFN-LNF, INFN-Genova and INFN-LNS (Catania), under the supervision of Ing. C. Sanelli, has spent several months to evaluate the cost of each single accelerator component, based on the latest design (2011). The possibility to drive a SASE X-ray FEL using the 6 GeV electron linac foreseen by the *SuperB* project, working in parasitic mode with respect to the collider operation, has been also considered and a preliminary design study has been delivered. Some modification of the *SuperB* linac layout resulted to be necessary in order to produce the high brightness beam required for this specific application thus producing an additional cost with respect to baseline *SuperB* linac design. In addition a 100 m long undulator chain has to be considered together with a suitable downstream experimental hall. The Committee declared that this is a scientifically and economically attractive option.

A Work Breakdown Structure (WBS) has been built which describes:

- the cost for each component of the *SuperB* accelerator complex at Tot Vergata;
- the cost of civil infrastructures;
- the cost of personnel, spare equipment and contingency.

A planning with personnel and project timeline was also provided. The cost estimate was carried out by the leaders of the accelerator and technical systems: Main Rings, Radio Frequency, Diagnostics and instrumentation, Feedbacks, Vacuum, Injection system (including: Sources, Linacs, Damping Ring, Transfer Lines), XFEL option, Power supplies, Normal conducting magnets, Supraconducting magnets and solenoids, HVAC and fluids, Cryogenics, Electrotechnics, Mechanics, Controls, Civil engineering, Safety, Radioprotection.

The Total Project Cost is the sum of many different items:

- Accelerator cost
- Area preparation cost
- Civil Engineering cost
- PEP-II components re-utilization cost
- Personnel cost
- Contingency
- Spare parts

The first three items, Accelerator, Area preparation and Civil Engineering costs have been evaluated according to the WBS, where different parts or components of the accelerators, related buildings and their infrastructures have been individually identified. An extremely detailed WBS normally does not exceed 8 digits. In the *SuperB* case we got generally 6 digits, this can be considered equivalent to a confidence level of about 90-95%. Single components of a system or plant have been identified, their quantities have been defined and, once the cost of the single unit has been evaluated, the system or plant cost has been determined. The unit cost of a single component has been determined in three different ways. In the first, the responsible of the related activity has contacted one or more companies to quote an updated price. In some cases only one firm gave the quotation, but where more quotations were available, the more convenient one has been considered. This was true for the commercially available components and systems. In the second way, for those parts of the accelerators not commercially available, the quotation has been derived from previous similar realization. This is the case for custom vacuum chambers or diagnostics components: their cost has been derived from the experience gained by the recent construction of the Pavia hadro-therapy accelerator CNAO. A third way is the analytic approach where, based on the working group expertise, the cost is reconstructed form basic row material costs. A special case has been made for magnets, in particular for the main rings, whose cost has also been evaluated in two different ways. The two method gave small differences of the order of few per cent. The same independent groups evaluated and excluded on economic and functionality considerations the option of reusing PEP-II magnets.

The committee in its final report has underlined the high quality of the work that was presented. In the following is a short summary of the conclusions:

"The project team presented a comprehensive and detailed cost estimate for the project. The WBS approach of assessing the cost is systematic and carried out at a level sufficient to assure

more than 90% completeness. We found the cost estimate to be broadly credible. We believe that the scale of the cost is roughly correct, and is sufficiently sound to enable decisions to be taken on funding for the project. The committee wishes to underline the high quality of the work that was presented, especially considering the very limited manpower and resources allocated to a project of this size. The committee feels that we are facing a very critical point of the project and decisions have to be taken quickly on the funding and on the support to the project by national laboratories. Without that, the technical advance of international competitors will increase, putting in serious danger the scientific case of *SuperB*."

The Committee report was presented to the Minister of Research and Education in December 2012. The budget already allocated for the Flagship Project *SuperB* was not sufficient to guarantee the needed resources.

However it was suggested that a downscaling of the accelerator to a smaller size and lower energy should be pursued in order to estimate if its cost could be covered by the available budget.

It has been then decided that the *SuperB* team, with the technical personnel hired by the Cabibbo Laboratory, will be involved in 2013 in the design of a smaller collider, working in the Tau/Charm energy range, which could meet all the requirements and also be compatible with the Flagship Project already approved, since it was planned that the *SuperB* collider could be operated at the Tau/Charm energy for high precision rare measurements, as for example the Lepton Flavor Violation.

3 Publications in 2012

1. M.E. Biagini, " Overview of B-Factories ", Invited talk at the 3rd International Particle Accelerator Conference IPAC 2012, New Orleans, USA, May 2012.

2. S.M. Liuzzo, M.E. Biagini, P. Raimondi et al, "Tests of low emittance tuning techniques at SLS and DAΦNE", Proceedings of 3rd International Particle Accelerator Conference IPAC 2012, New Orleans, USA, May 2012.

3. S.M. Liuzzo, M.E. Biagini (INFN/LNF), Y. Papaphilippou (CERN) , T. Demma (LAL) ,P. Raimondi (ESRF), "Frequency map analysis for *SuperB*", Proceedings of 3rd International Particle Accelerator Conference IPAC 2012, New Orleans, USA, May 2012.

4. S. Guiducci, A. Bacci, M. E. Biagini, R. Boni, M. Boscolo et al., "Baseline design of the *SuperB* factory injection system ", Proceedings of 3rd International Particle Accelerator Conference IPAC 2012, New Orleans, USA, May 2012.

5. D. Alesini et al., "A possible hard X-Ray FEL with the SuperB 6 GeV Electron Linac, INFN-12-14/LNF, 2012.

6. M. Ferrario, on behalf of the XFEL@SuperB collaboration, "Additional cost estimate for the XFEL option", June 2012.