

Super*B* Detector Technical Design Report

Abstract

In this Technical Design Report (TDR) we describe the Super*B* detector to be installed on the Super*B* e^+e^- high luminosity collider. The Super*B* asymmetric collider, foreseen to be constructed on the Tor Vergata campus near the INFN Frascati National Laboratory, is designed to operate both at the $\Upsilon(4S)$ energy in the center of mass with a luminosity of $10^{36} \text{ cm}^{-2}\text{s}^{-1}$ and at the τ /charm production threshold with a luminosity of $10^{35} \text{ cm}^{-2}\text{s}^{-1}$. This high luminosity, producing a data sample about a factor 100 larger than present *B* Factories would allow investigation of new physics effects in rare decays, CP Violation and Lepton Flavour Violation. This document details the detector design presented in the Conceptual Design Report (CDR) in 2007. The R&D and engineering studies performed to arrive at the full detector design are described, and an updated cost estimate is presented.

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Preface

Flavour physics not only provides insight in the physics of the standard model but also offers great discovery potential for new physics processes, as the B-Factories experiments, *BABAR* at SLAC and Belle at KEK, have demonstrated very effectively. Increasing the luminosity has been identified from the very beginning as the key element to extend the physics reach of these machines. Since 2003 a group of physicists began to explore the physics potential of very high luminosity B-Factory machines. An upgrade of the the PEP-II accelerator was initially investigated; then the *BABAR* and Belle community started in 2004 a series of joint workshops in Hawaii to examine the physics potential and possible machine designs, introducing concepts such as the nano-beam scheme and the crab waist techniques. The Super*B* Project was formally born in 2005 when INFN inserted in its three-years planning document the intention of building a high luminosity flavour factory in the Frascati area. In the course of the years Super*B* has evolved from an intention into a full-fledged project, with a Conceptual Design Report published in 2007, progress reports in 2009, and a formal collaboration structure setup in 2010 with hundreds of members from several countries. All aspects of the project, physics potential, accelerator design, detector design, successfully passed several international reviews setup by INFN. In 2010 Super*B* was inserted in the Italian Research Ministry National Research Plan as Flagship Project, and a good fraction of the required funds were allocated, although not the full amount. The decision to build Super*B* on the land of the University of Rome Tor Vergata lead, in 2011, to the formation of the Cabibbo Laboratory consortium between INFN and TorVergata, with the explicit mission of constructing and managing a new research infrastructure for flavour physics. A ministerial cost and schedule review of the accelerator project was held in fall 2012. A combination of a more realistic cost estimates and the unavailability of funds due of the global economic climate lead to a formal cancelation of the project on Nov 27, 2012.

The community who had been committed to the project for so long, although devastated by the sudden cancelation, decided to try to preserve and document as much as possible of the work done in Super*B*, both to retain a lasting trace of the committment of the group and, more importantly, to provide a written basis of the technical achievements for the use of future scientific endeavours. It is in this spirit that this Detector Technical Design Report, whose preparation was quite advanced at the time of the cancelation of the project, has been completed and is being published. We felt that the tone and grammar of the text should remain that of a project that will be built and that of a project that would have been built. Therefore we kept the assertiveness and optimism of a community that was expecting to start constructing the machine and experiment within a few months. We sincerely hope that it can be of use to the scientific community.

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