Upgrade Plan of KEKB and Belle

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With the success of B-factory experiments, which have successfully made the firm confirmation of the theory by Kobayashi and Maskawa to explain the CP violation, the next challenge is to find New Physics (NP) beyond the Standard Model (SM). For this purpose, we propose the Super-KEKB/Belle experiment. The target integrated luminosity is 50 ab^{-1}, that is about 50 times higher than the present. Such large data set will enable us to explore NP in complementary way to the LHC experiments. For instance, it provides;

- Determination of $\sin2\phi_1^{eff}$ in $b\to s$ penguin decays such as $B\to\phi K^0$, $\eta' K^0$ and $K_sK_sK_s$ with the resolution of 0.02－0.04, by which we can clarify the ΔS problem.
- Determination of the branching fraction for the $B\to\tau\nu$ and $D\tau\nu$ with 3% error, by which we can constrain the charged Higgs up to 0.5－1 TeV for large $\tan\beta$ region.
- Search for lepton flavor violating τ decays, such as $\tau\to\mu\gamma$, $\mu\eta$, and $\mu\mu\mu$, down to the order of 10^{-9} in the branching fraction.
- Determination of CKM parameters with ultimate precision, by which we can perform model-independent NP search.

Also from the point of view of hadron physics, the Super KEKB/Belle will provide unique opportunity to study exotic states; determination of properties (spin, parity etc.) for found states, and search for new states, including charmonium-like mesons with strangeness, bottomonium-like mesons etc.

The target peak luminosity of the Super-KEKB is $8\times10^{35}cm^{-2}s^{-1}$. This will be achieved by increasing the beam currents (e+/e-: 1.7/1.4 A $\to$ 9.4/4.1 A), by decreasing the vertical β at the IP (e+/e-: 6.5/5.9mm $\to$ 3.0/3.0mm), and by increasing the beam-beam parameter (ξ_y, 0.059 $\to$ 0.24). In order to reduce the electron clouds produced by synchrotron lights from increased beam currents, new beam pipes with ante-chambers will be installed for the whole ring. The vertical β will be reduced by moving the final quardupole magnets closer to the IP. The most critical technology is the Crab crossing, in which the beam bunches are tilted by a special cavity called Crab cavity, and collide each other in the head-on condition. This collision scheme is being tested at the present KEKB, with a test Crab cavity installed for each LER and HER rings. We have already observed an increase of ξ_y (0.055$\to$0.088) with the Crab crossing scheme. However, the improvement factor is not as high as the expectation, and the specific luminosity decreases more rapidly than expected with the increase of the bunch currents. We need more time to understand the reasons.

As for the Super-Belle detector, in order to overcome the increase of background (by factor of 20), we plan to upgrade each sub-detector; SVD with 6-layer configuration with the innermost two layers made by pixel detectors, CDC with smaller cell size, CsI calorimeter with pure-CsI in the endcap and wave form sampling for both barrel and endcap, KLM with scintillator with Si-PM readout for the endcap. We also replace the PID with newly developed ring-imaging based Cherenkov detectors, the TOP counter for the barrel and the aerogel RICH for the endcap. We install new dead-time free readout systems. The detector design will be finalized by the end of 2009.

A possible scenario is the following. We plan to have three-year shutdown of the facility from 2010 to 2012 for construction of Super-KEKB/Belle, start the new experiment from 2013, accumulate $10ab^{-1}$ around 2016, and reach the goal of $50ab^{-1}$ by 2020. In order to prepare for the upgrade, we are forming the new collaboration. Details of the upgrade can be found in http://superb.kek.jp/, and references shown there..

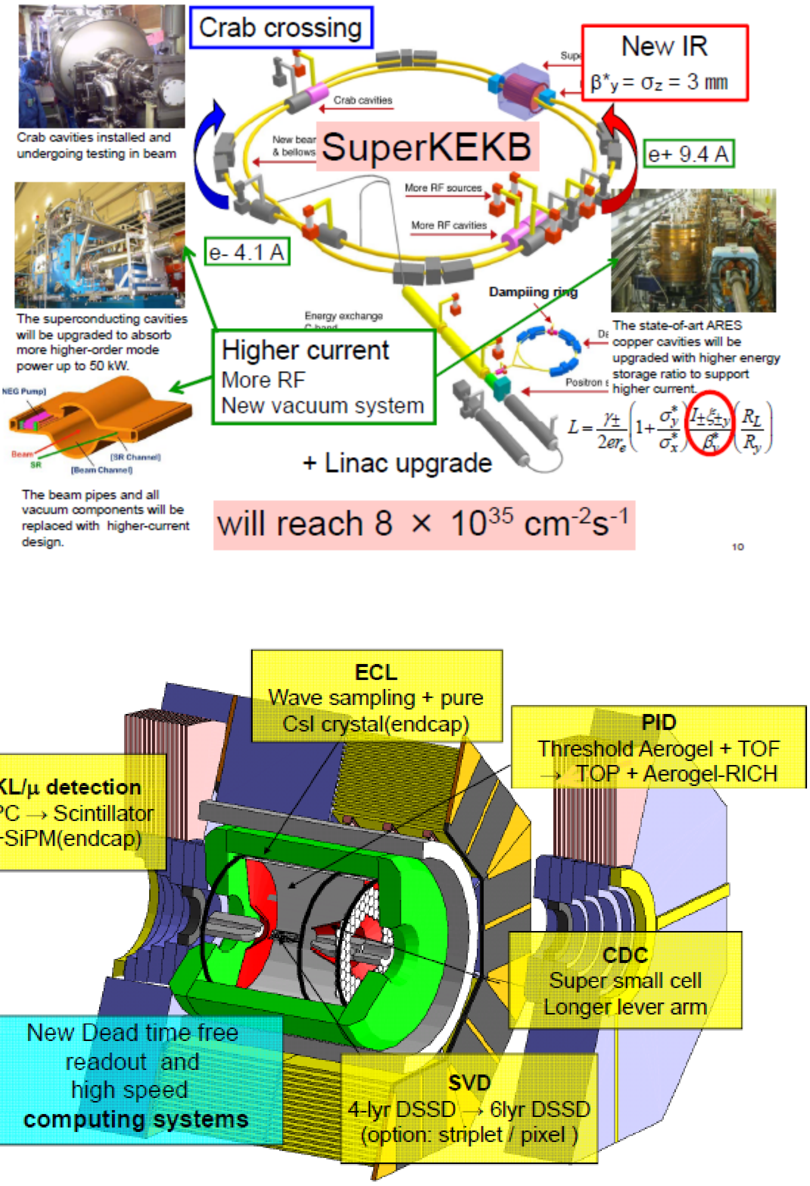

Figure: Super-KEKB (top) and Super-Belle (bottom).