Measurement of the muon pair asymmetry in e^+e^- annihilation at $\sqrt{s}$ = 10.58 GeV

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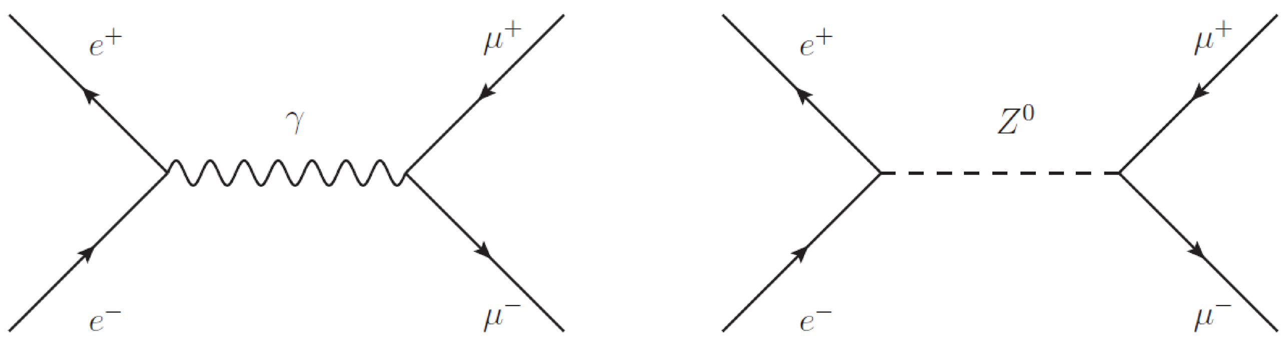
Muon pair asymmetry at Belle



The Standard Model predicts a forward-backward asymmetry A_{FB} of muons produced in the electroweak process $e^+e^-\rightarrow\mu^+\mu^-$. This asymmetry is caused by the interference between γ and Z^0 exchange at Born level.

The Born asymmetry at $\sqrt{s}$=10.58 GeV, far below the Z-pole, is about -0.7% where A_{FB} = (F-B)/(F+B) with F=N($\cos(\theta_\mu)\geq0$) and B=N($\cos(\theta_\mu)<0$) and θ_μ measured between incoming $e^-(e^+)$ and outgoing $\mu^-(\mu^+)$ in the center of mass system.

Event selection and analysis

Muon pairs from the process $e^+e^-\rightarrow\mu^+\mu^-$ have a clear signature of two back-to-back track in the center of mass system (see Fig. 1). Background processes are:

- radiative muon pairs
- two-photon muon pairs
- (radiative) tau pairs
- (radiative) Bhabha
- cosmics

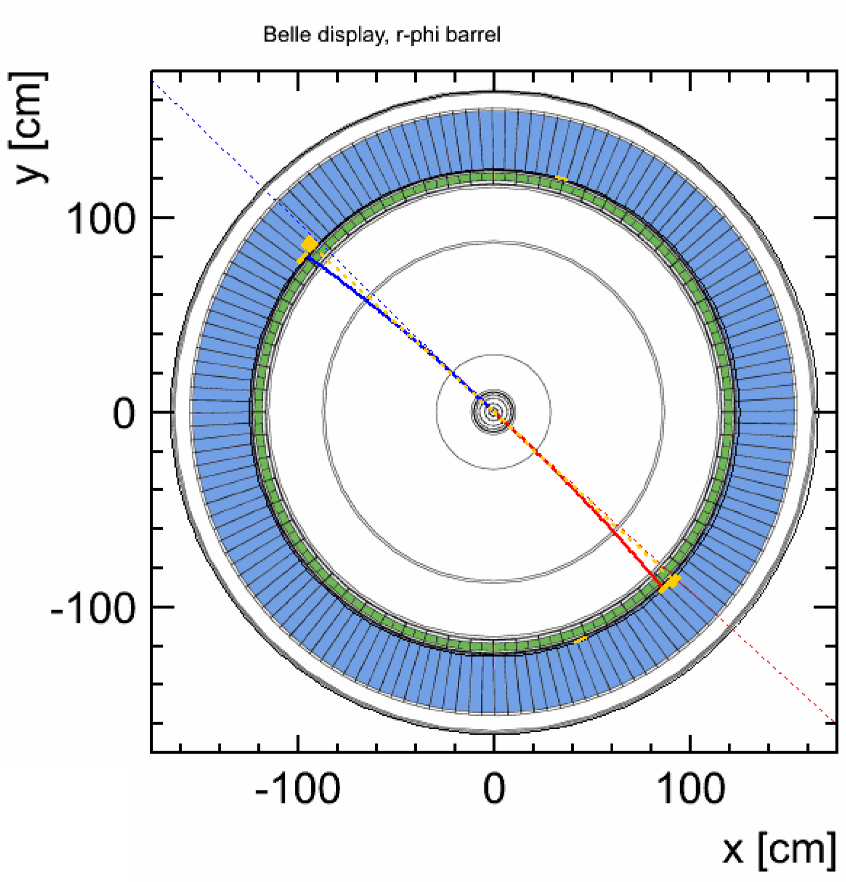


Fig. 1: Radiative muon pair (MC) with double final state radiation (FSR) and beam background photons in the Belle detector.

The signal efficiency (incl. acceptance and trigger) after kinematic cuts and particle identification at Belle is ~50% with negligible backgrounds apart from radiative muons.

The raw asymmetry is modified by QED effects, mainly initial state radiation (ISR) reducing $\sqrt{s}$ and ISR-FSR interference arising from $\gamma\gamma$ box-diagrams. QED effects up to $O(\alpha^2)\log(s/m_e^2)$ are corrected using Monte Carlo calculations. Weak corrections are absorbed into effective couplings.

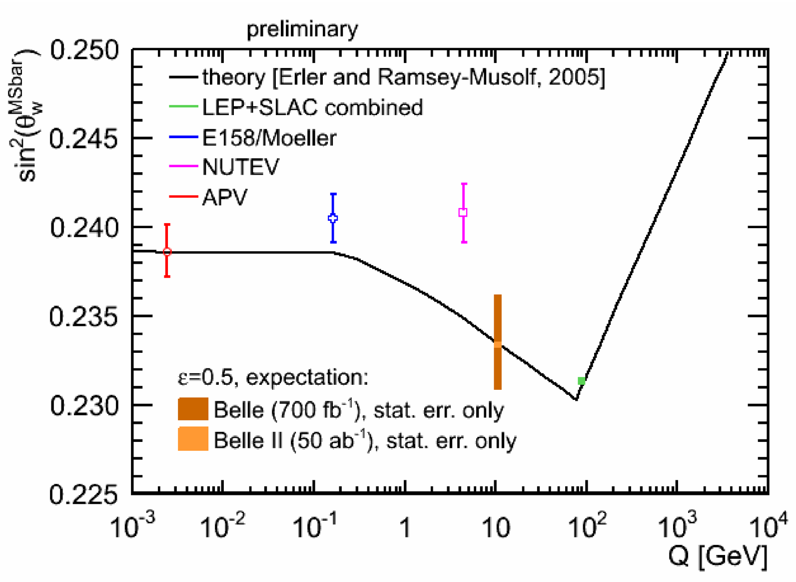


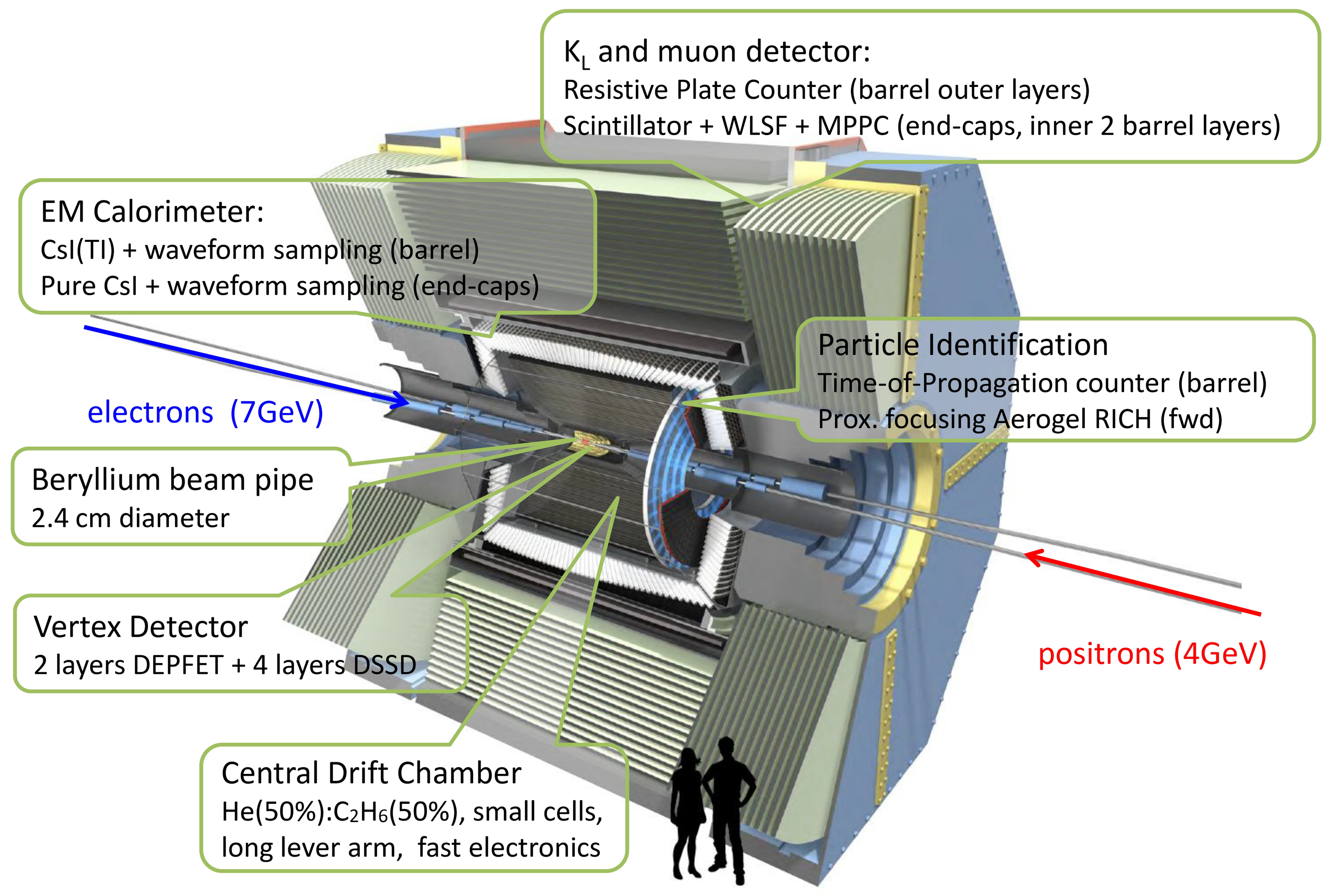
Fig. 2: SM prediction (MSbar) and measurements of $\sin^2(\theta_w)$. Belle symbols are shown at the SM value and only indicate the expected statistical error.

The muon pair asymmetry is related to the weak mixing angle (see Fig. 2). The weak mixing angle is energy dependent in the SM. Deviations from the predicted behavior hint to New Physics.

Unique Belle data set

The total dataset of Belle amounts to about 1ab^{-1}. About 700fb^{-1} of it were taken at $\sqrt{s}$=10.58 GeV (Y(4S)), yielding 770 million $B\bar{B}$ pairs and about 700 million muon pairs. The unique Belle dataset is preserved at mDST level (reconstructed data for analysis). One copy of these mDST files as well as several selections for specific physics processes and selected MC streams are duplicated at DESY (total ~300TB).

Towards Belle II and SuperKEKB



SuperKEKB is an upgrade project at KEK to increase the instantaneous luminosity to 8×10^{35} $cm^{-2}s^{-1}$, the final goal is to acquire 50ab^{-1} by the end of 2023.

The Belle detector will be upgraded to Belle II. The two innermost layers of the Belle II vertex detector (VXD) are realized as 75µm thick pixel detectors (PXD, see Fig. 3) to minimize multiple scattering and to cope with the high beam background induced occupancy. The basis of the CO_2-cooled PXD is the DEPFET pixel cell (PXD, see Fig. 4). The PXD is being planned and built by the European DEPFET collaboration which includes ten institutes from Germany. The DESY team is working on a mock up to verify and optimize the vertex detector cooling concept (see Fig. 5) and design a novel remote vacuum connection based on hydraulics (see Fig. 6).

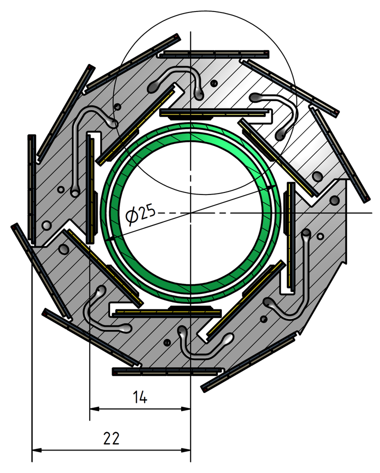


Fig. 3: Cross-sectional view of the cooling and support struc- ture of the PXD and the double- walled Be beampipe.

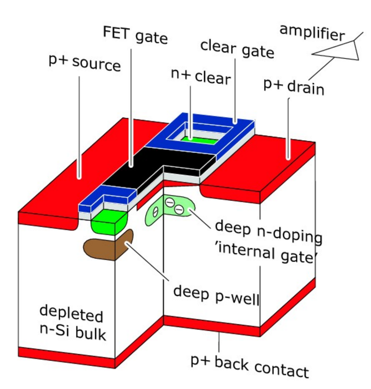


Fig. 4: Schematic drawing of a DEPFET (Depleted P-channel Field Effect Transistor) sensor.

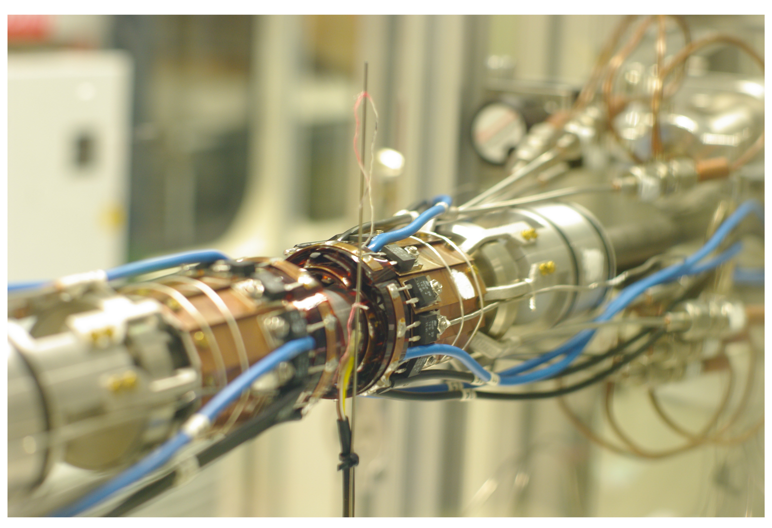


Fig. 5: Thermal mock up at DESY, zoom to the PXD region.

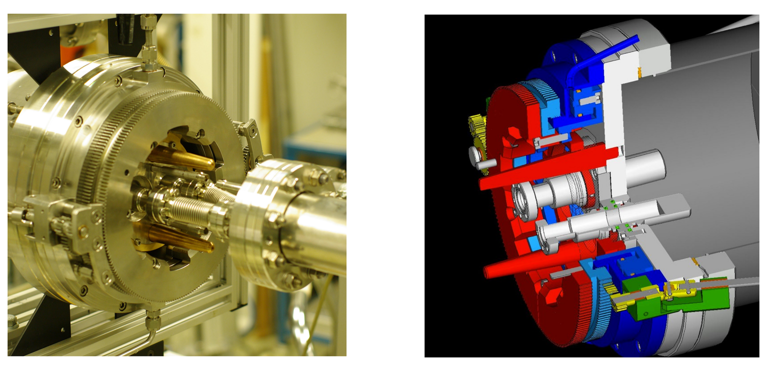


Fig. 6: Picture (left) and CAD drawing (right) of the mock up at DESY for the remote vacuum connection.