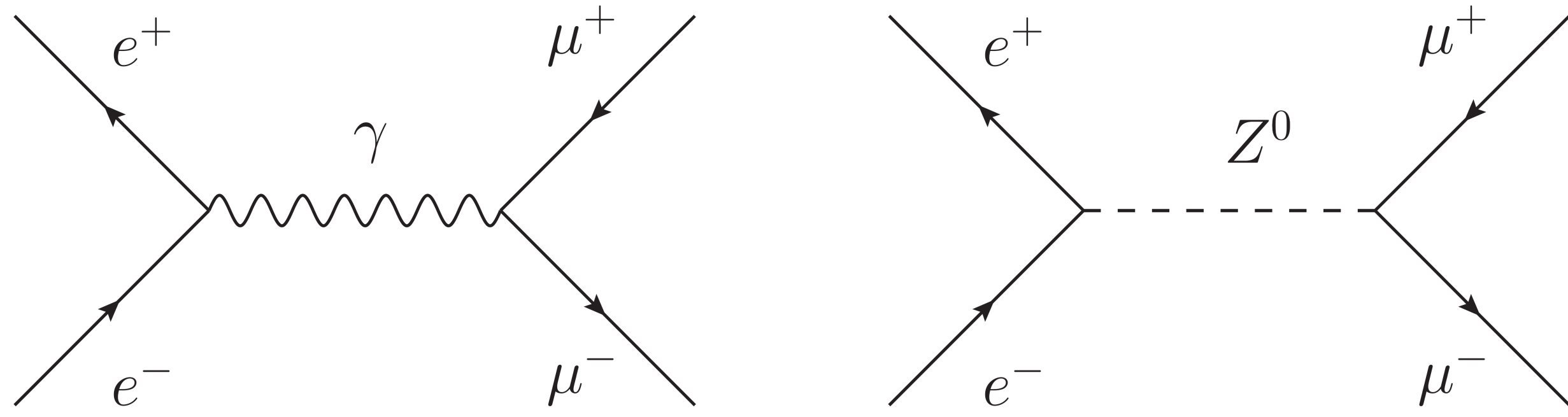


Towards a precision measurement of the muon pair asymmetry in e^+e^- annihilation at $\sqrt{s} = 10.58$ GeV

Torben Ferber (DESY)

Muon pair asymmetry A_{FB} 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 .

$$A_{FB} = \frac{N(\cos(\theta) \geq 0) - N(\cos(\theta) < 0)}{N(\cos(\theta) \geq 0) + N(\cos(\theta) < 0)}$$

$$\bullet A_{FB}(\sqrt{s}=10.58\text{GeV}) \approx -0.75\%$$

$$\bullet \text{Belle: (stat. uncertainty only) with } 7 \times 10^8 \text{ muon pairs:} \\ \rightarrow \sigma_{\text{stat}}(A_{FB})/A_{FB} \approx 1\%$$

Event selection

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

- radiative muon pairs
- $e^+e^- \rightarrow e^+e^-\mu^+\mu^-$
- (radiative) tau pairs
- (radiative) Bhabha
- cosmes

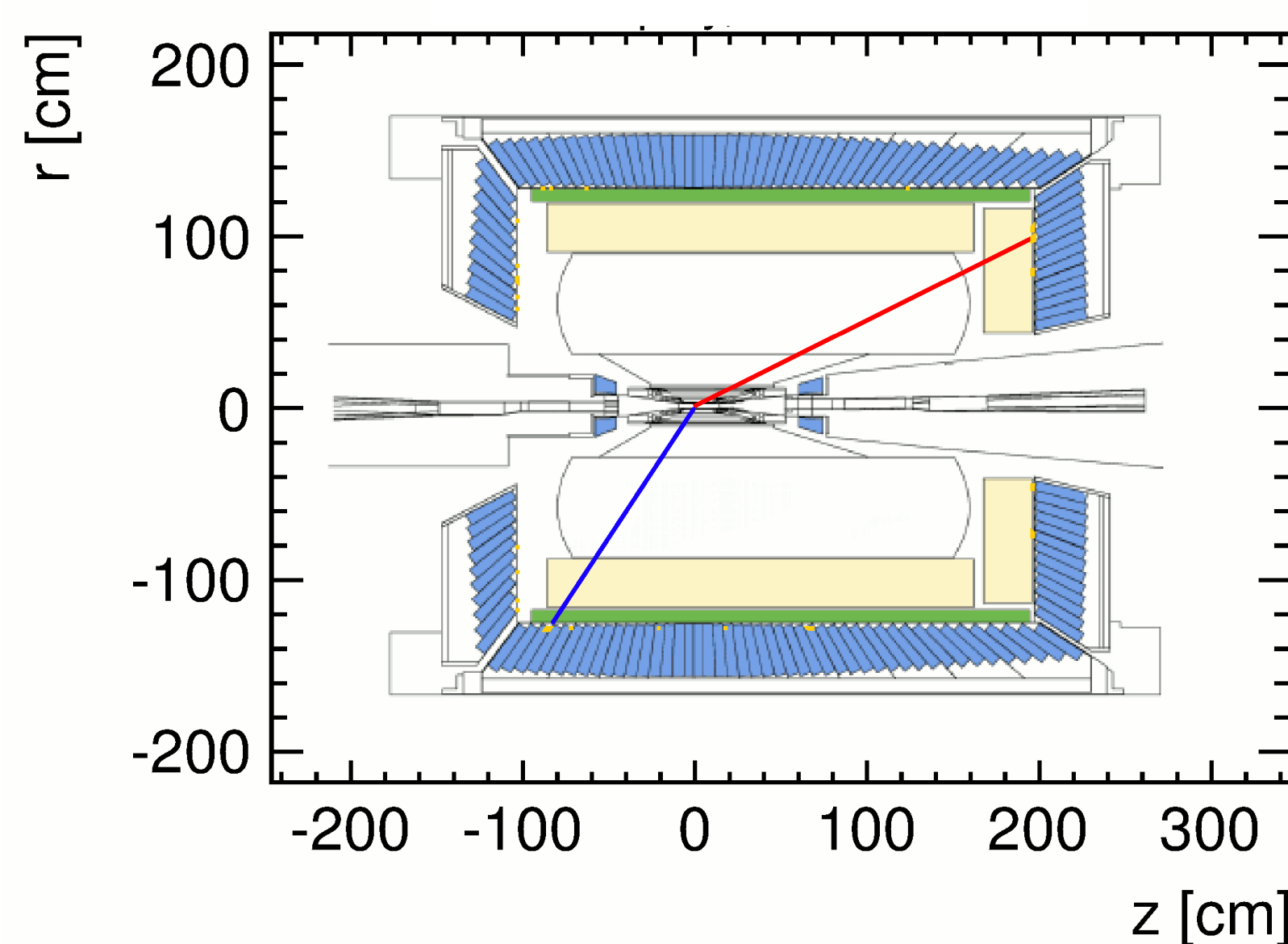


Fig. 2: Muon pair (MC) without ISR or FSR photons. The muon tracks are not back-to-back in the lab system.

Efficiency

Incl. acceptance and trigger, kinematic cuts and particle identification: $\epsilon \approx 50\%$

Rad. Corrections

The raw asymmetry is modified mainly by $\gamma\gamma$ box-diagrams.

QED effects are corrected using Monte Carlo calculations.

Weak corrections are absorbed into effective couplings.

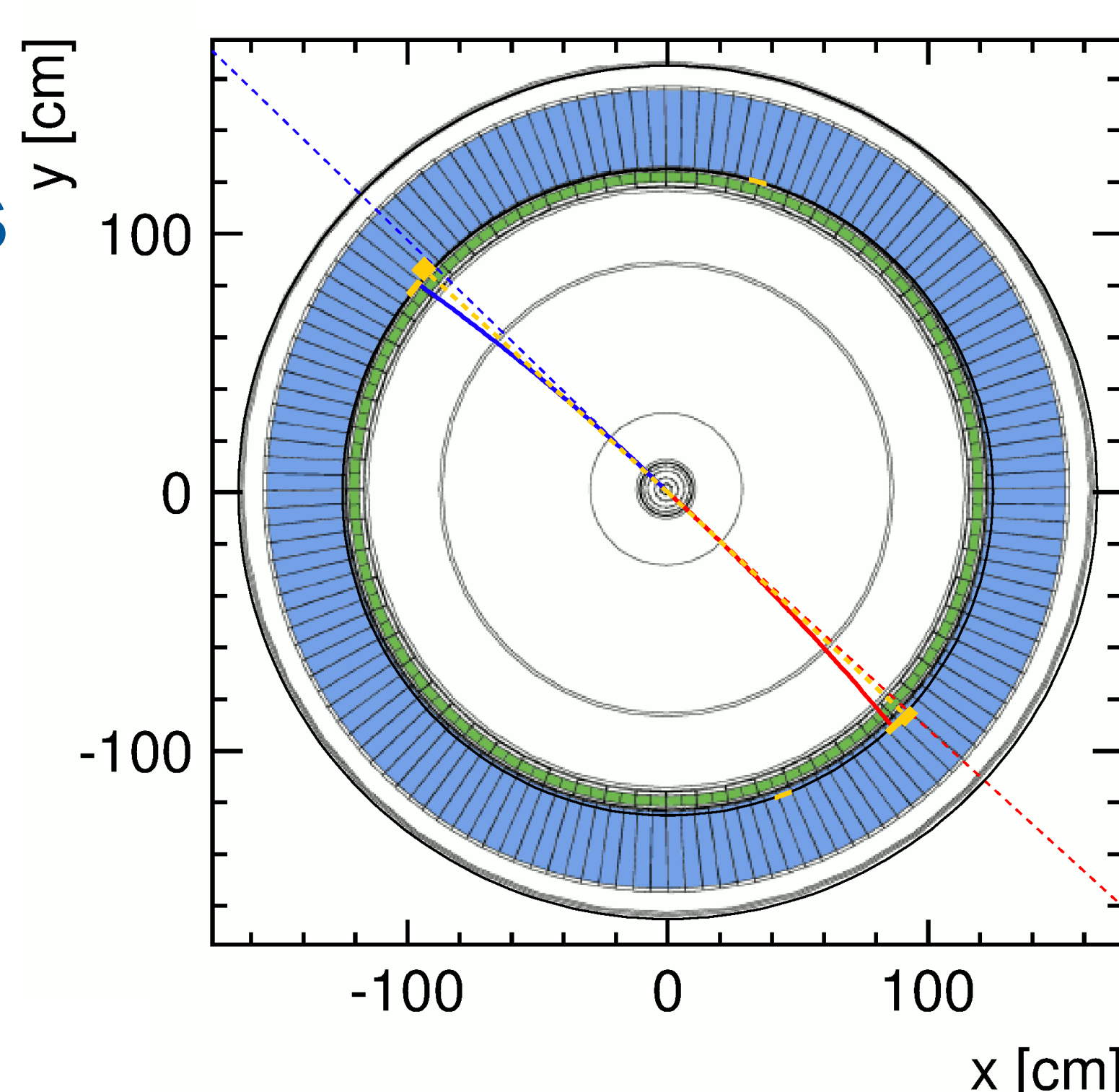


Fig. 3: Radiative muon pair (MC) with double final state radiation (FSR) and beam background photons in the Belle detector.

Precision test of the Standard Model

The muon pair asymmetry A_{FB} is precisely predicted by the Standard Model (SM) \rightarrow For $\sqrt{s}=10.58$ GeV:

$$A_{FB}(s) \approx -\frac{3\rho G_F}{4\sqrt{2}\pi\alpha} \frac{sM_Z^2}{s - M_Z^2} g_A^e g_A^\mu$$

Compare the differential cross section $d\sigma/d\cos(\theta^{\text{CM}})$ to the SM prediction, extract $\rho \rightarrow$ Sensitivity to new physics at low Q^2 , complementary to searches for parity-violation

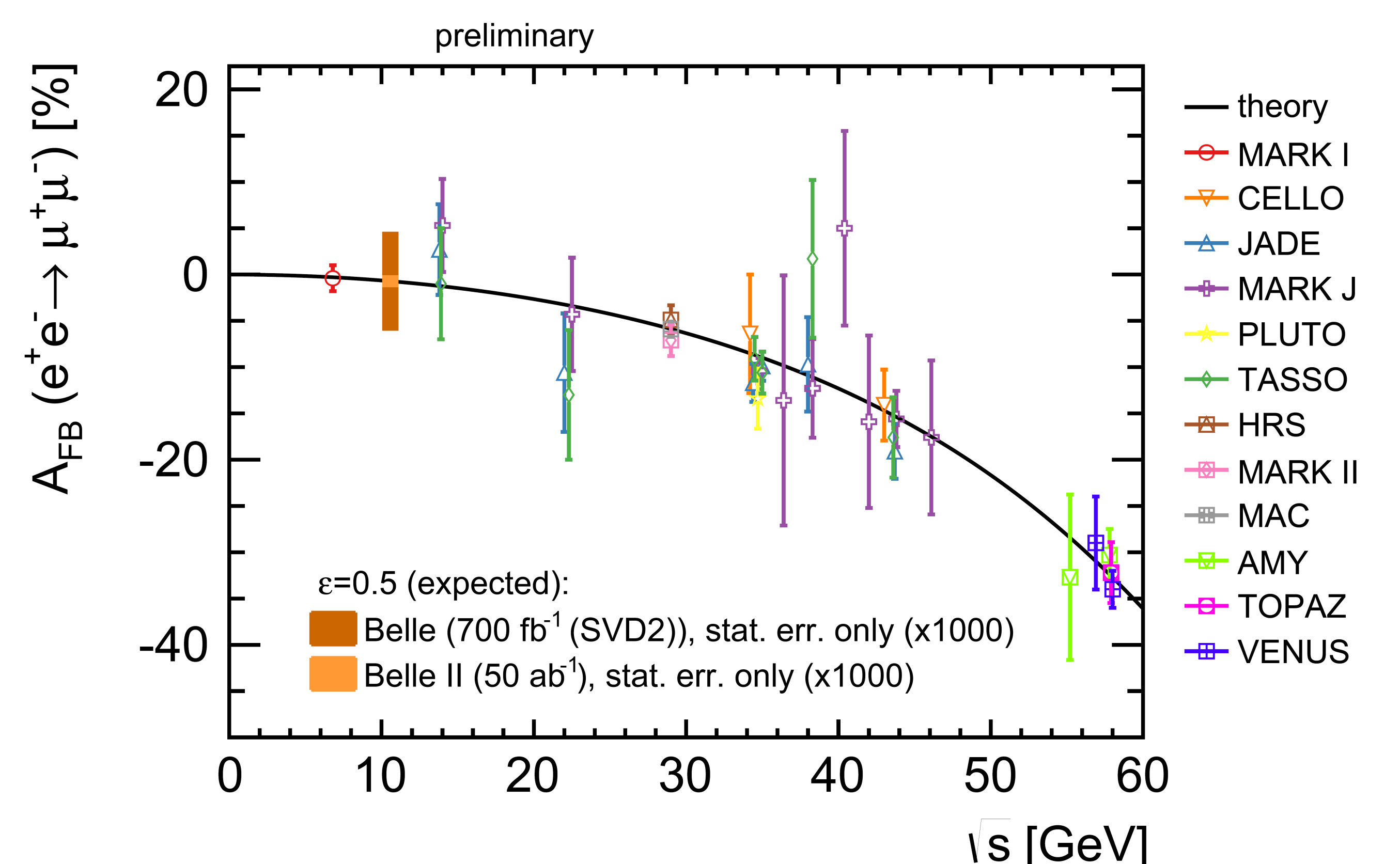
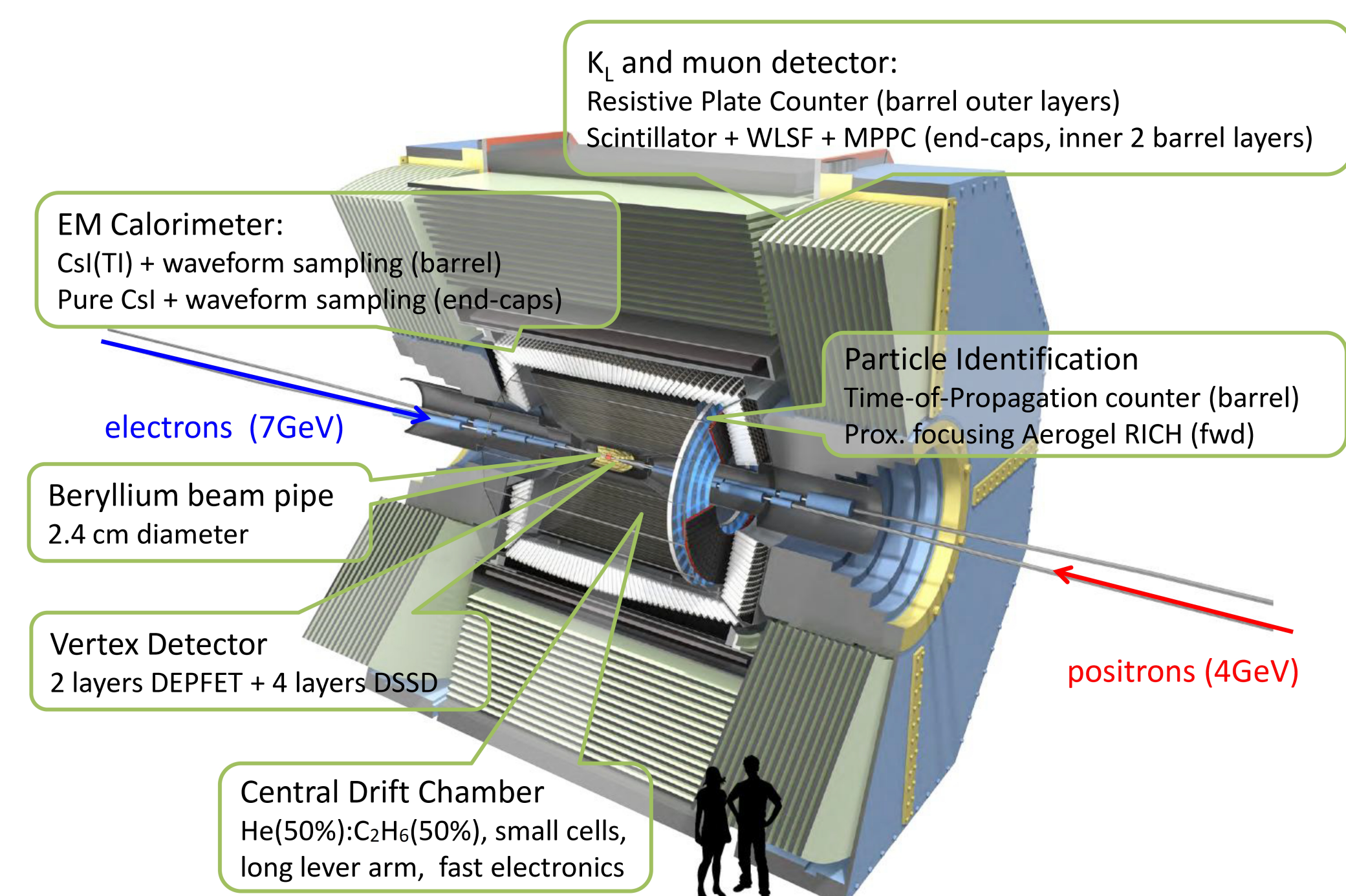


Fig. 1: SM prediction and measurements of A_{FB} . Belle and Belle II symbols are shown at the SM value and only indicate the expected statistical uncertainty ($\times 1000$).

Upgrade: Belle II and SuperKEKB



$$50\text{ab}^{-1} \text{ by the end of 2023} \rightarrow \sigma_{\text{stat}}(A_{FB})/A_{FB} \approx 0.1\%$$

Unique Belle data set at DESY

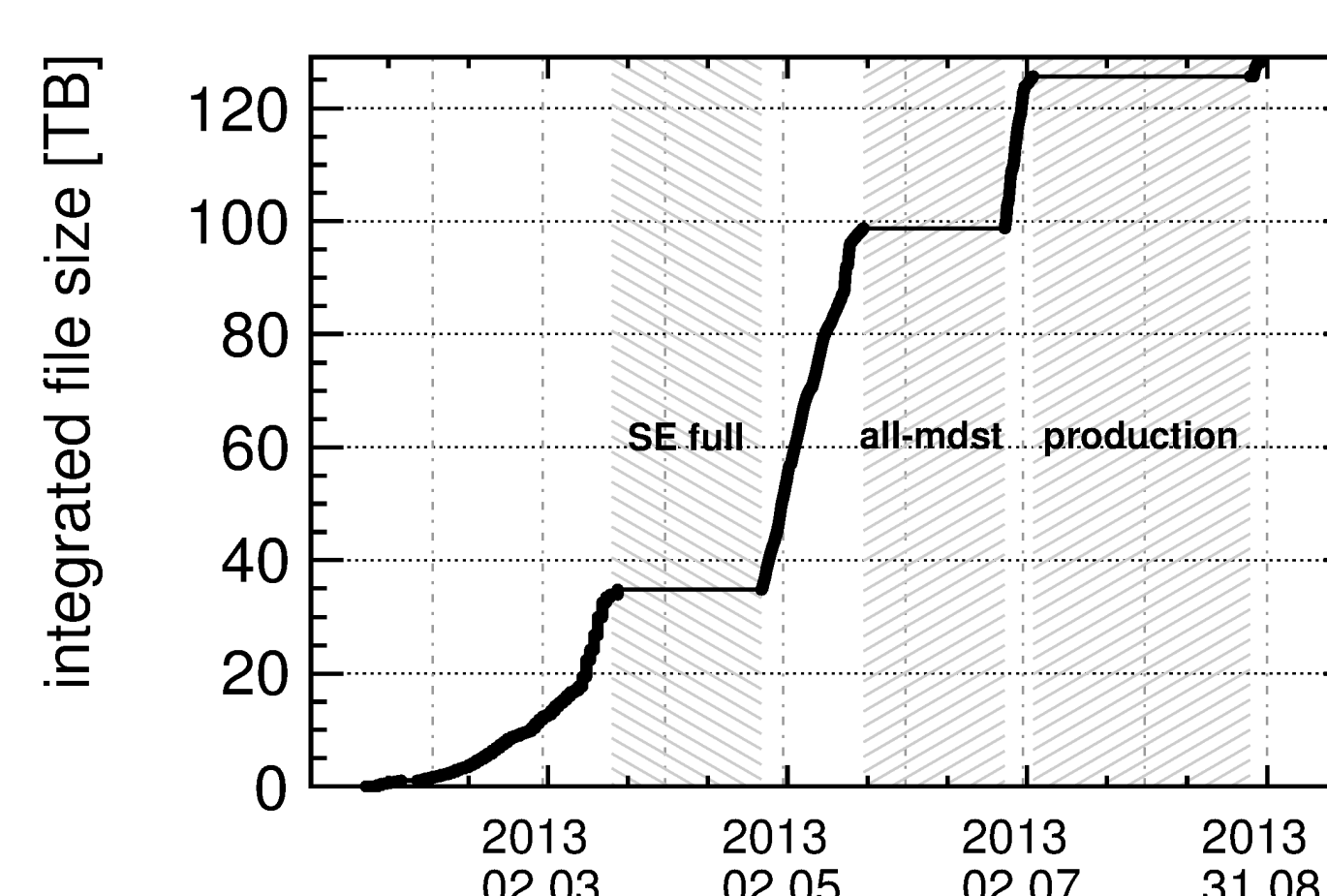


Fig. 4: Transfer of Belle data from KEK to DESY.

• $\sim 700\text{fb}^{-1}$ "mDST" Belle data copied to DESY (data preservation)

• MC for A_{FB} and skimmed data for further analysis

$\rightarrow 300\text{TB}$ on dCache to be analyzed at the NAF