Performance study of the TOP counter for the Belle II experiment

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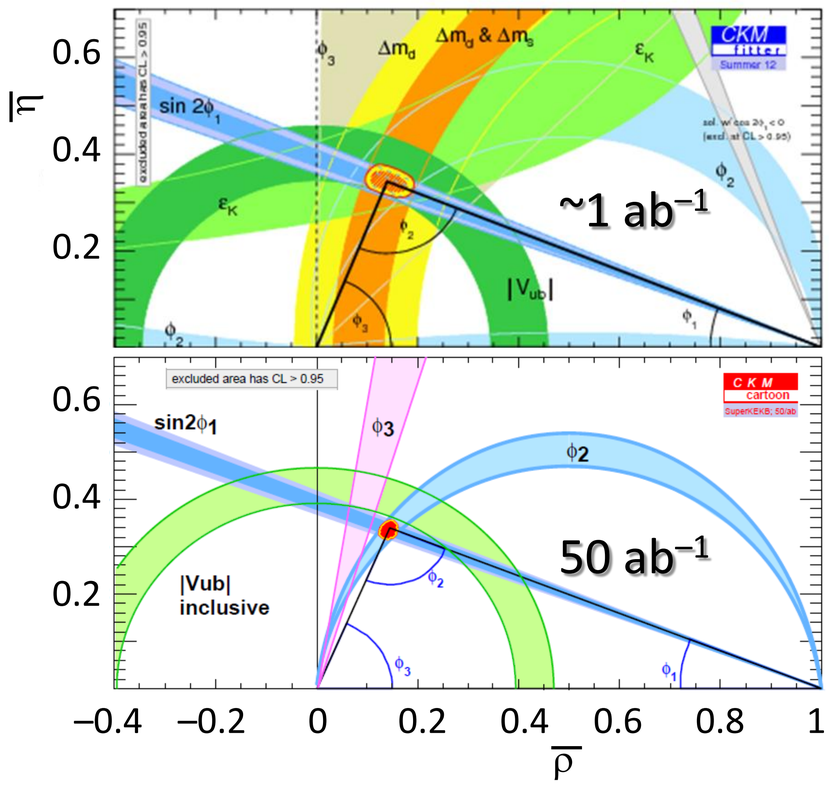
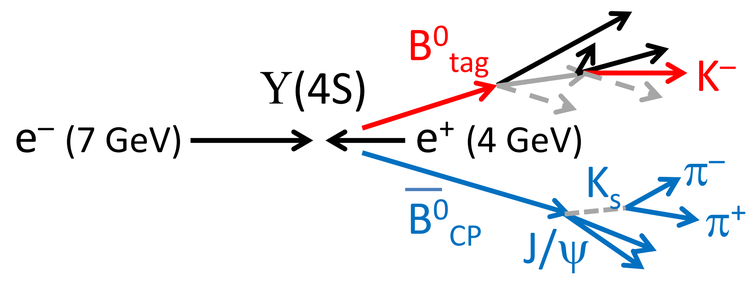
Belle II experiment

Elucidate new physics beyond the Standard Model

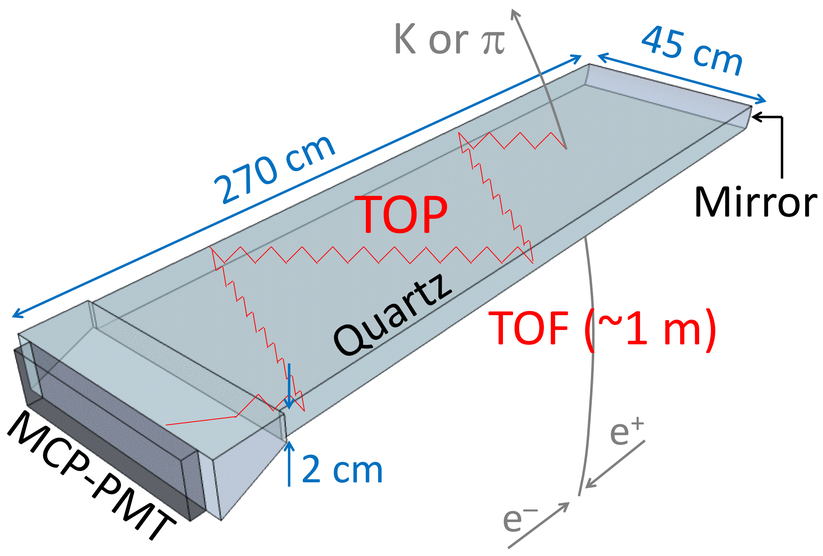
e.g. CKM unitarity test

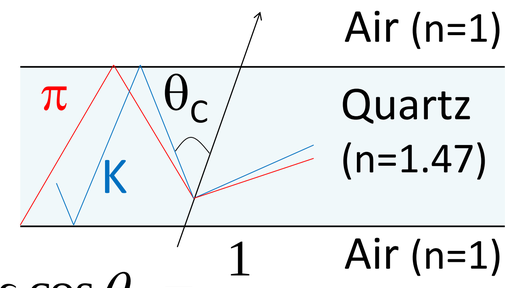




Time-Of-Propagation (TOP) counter

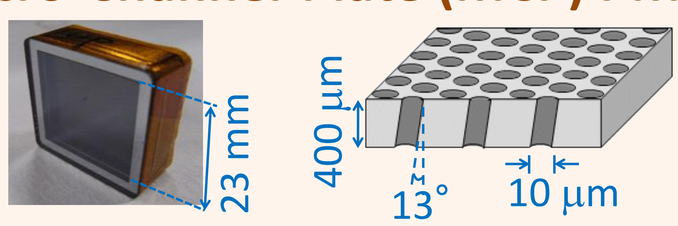
Ring-imaging Cherenkov detector for K/π identification, which is essential for Belle II



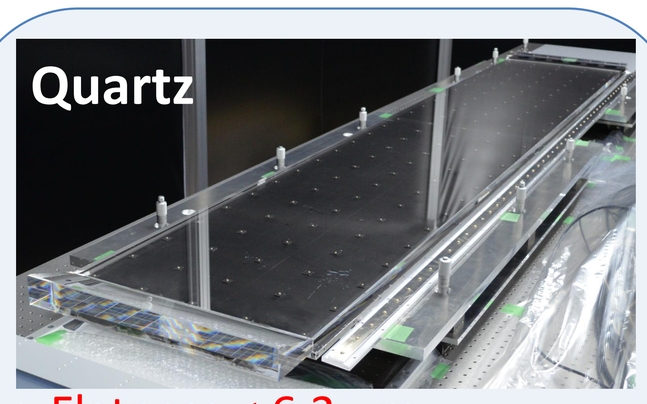


$$\mathrm{TOP} \propto \cos\theta_C = \frac{1}{n\beta}$$

Micro-Channel-Plate (MCP) PMT



- QE > 24% (@380 nm)
- TTS ~ 40 ps
- Gain 2 x 10^6 @ ~3.4 kV

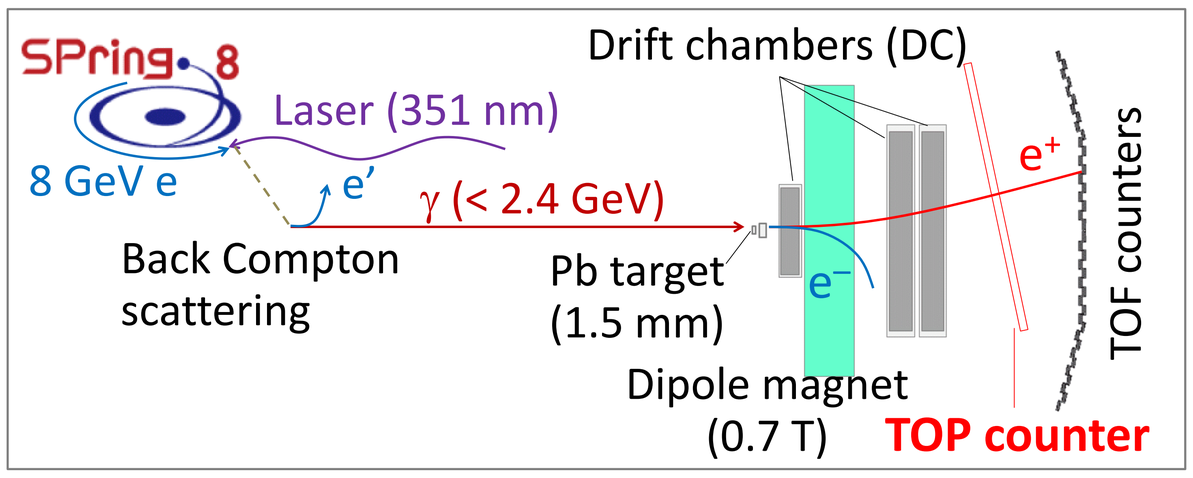


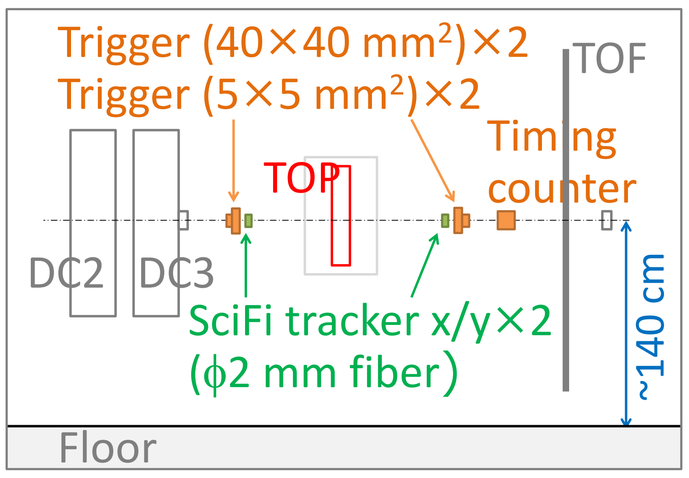
- Flatness < 6.3 μm
- Perpendicularity < 20 arcsec
- Parallelism < 4 arcsec
- Roughness < 5 Å (RMS)

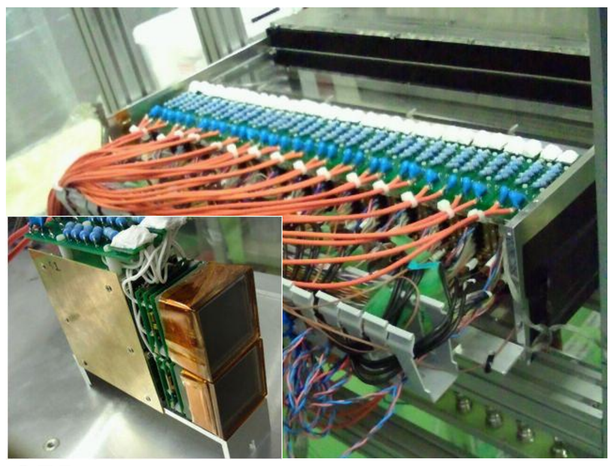
(for the largest surfaces)

Beam test at LEPS (Laser Electron Photon beamline at SPring-8)

Tested a prototype TOP counter (almost the final design) with the 2 GeV/c e⁺ beam

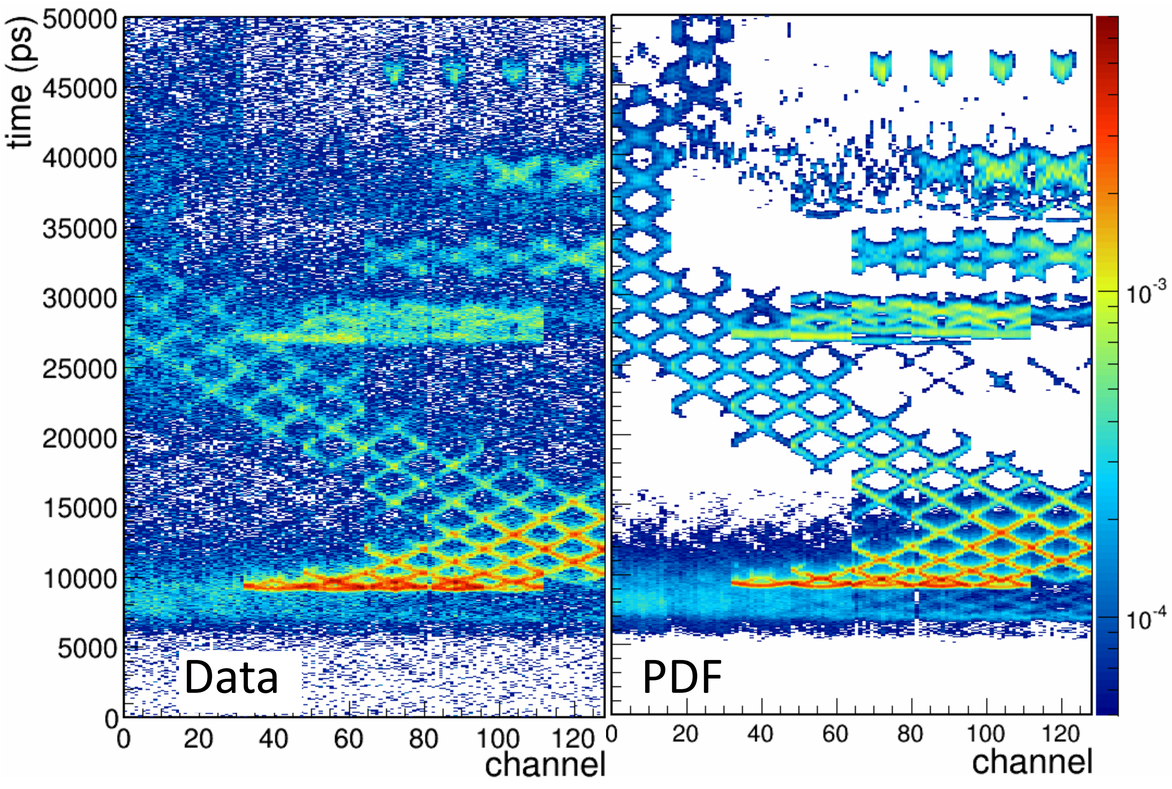


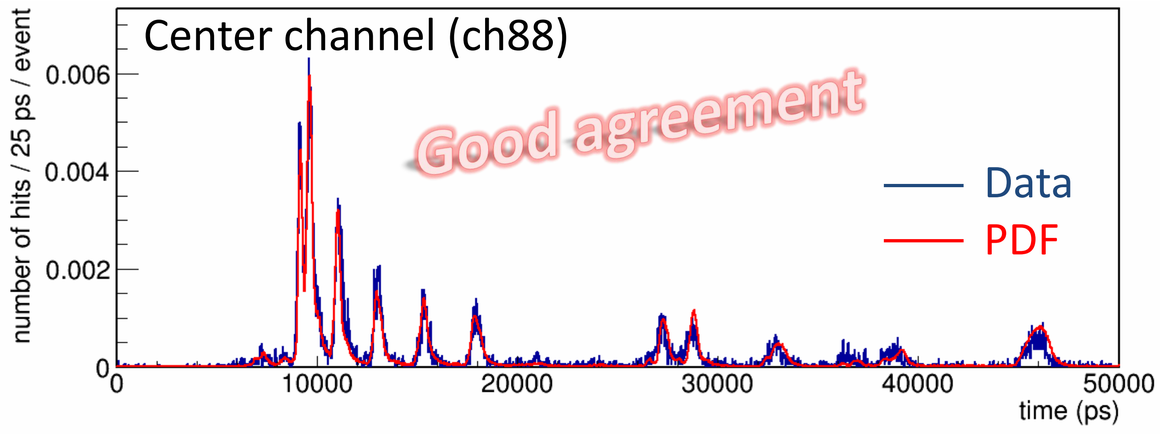




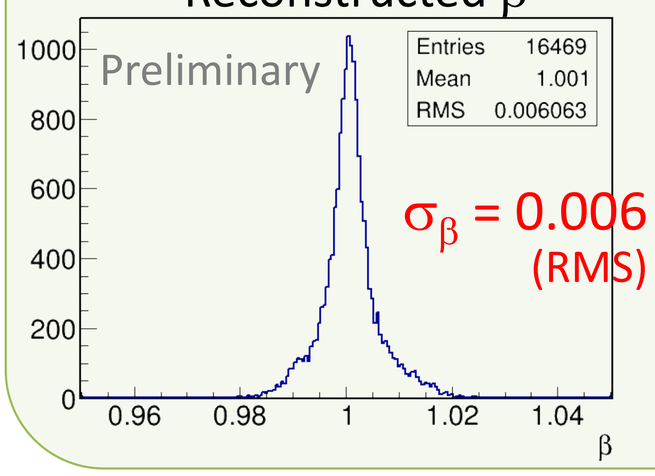
CFD (Constant Fraction Discriminator) and CAEN VME TDC (V1290A)

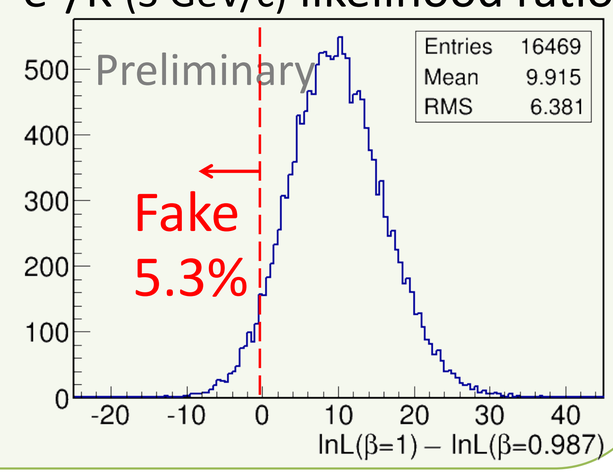
Cherenkov pattern measured by the TOP counter



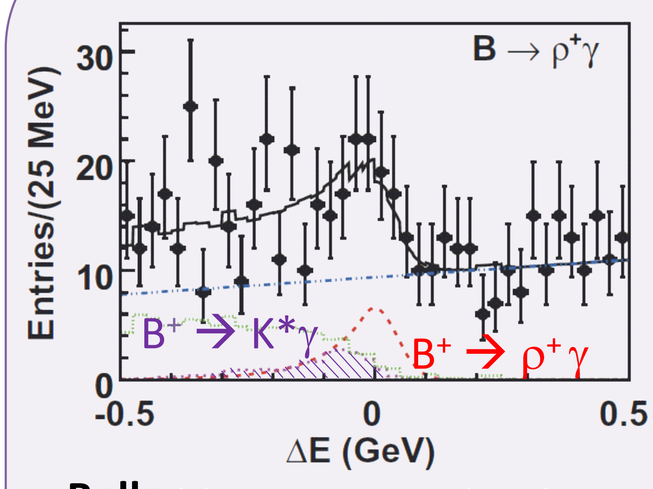


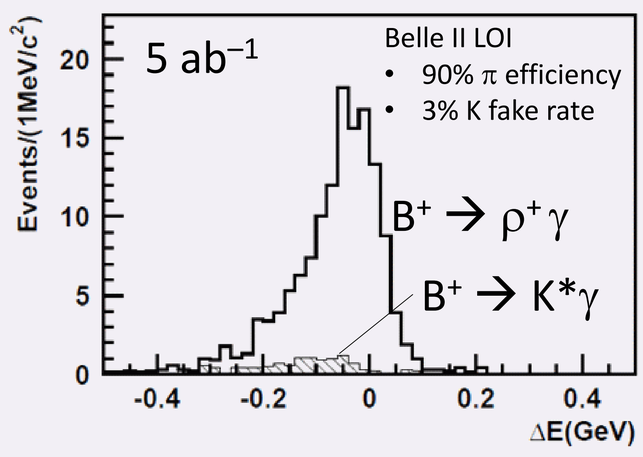
Event-by-event likelihood analysis





Expected physics performance





Belle (Phys. Rev. Lett. 101 (2008) 111801

- 86% π efficiency
- 8.3% K fake rate

Belle II

- 92.6% π efficiency
- 4% K fake rate