

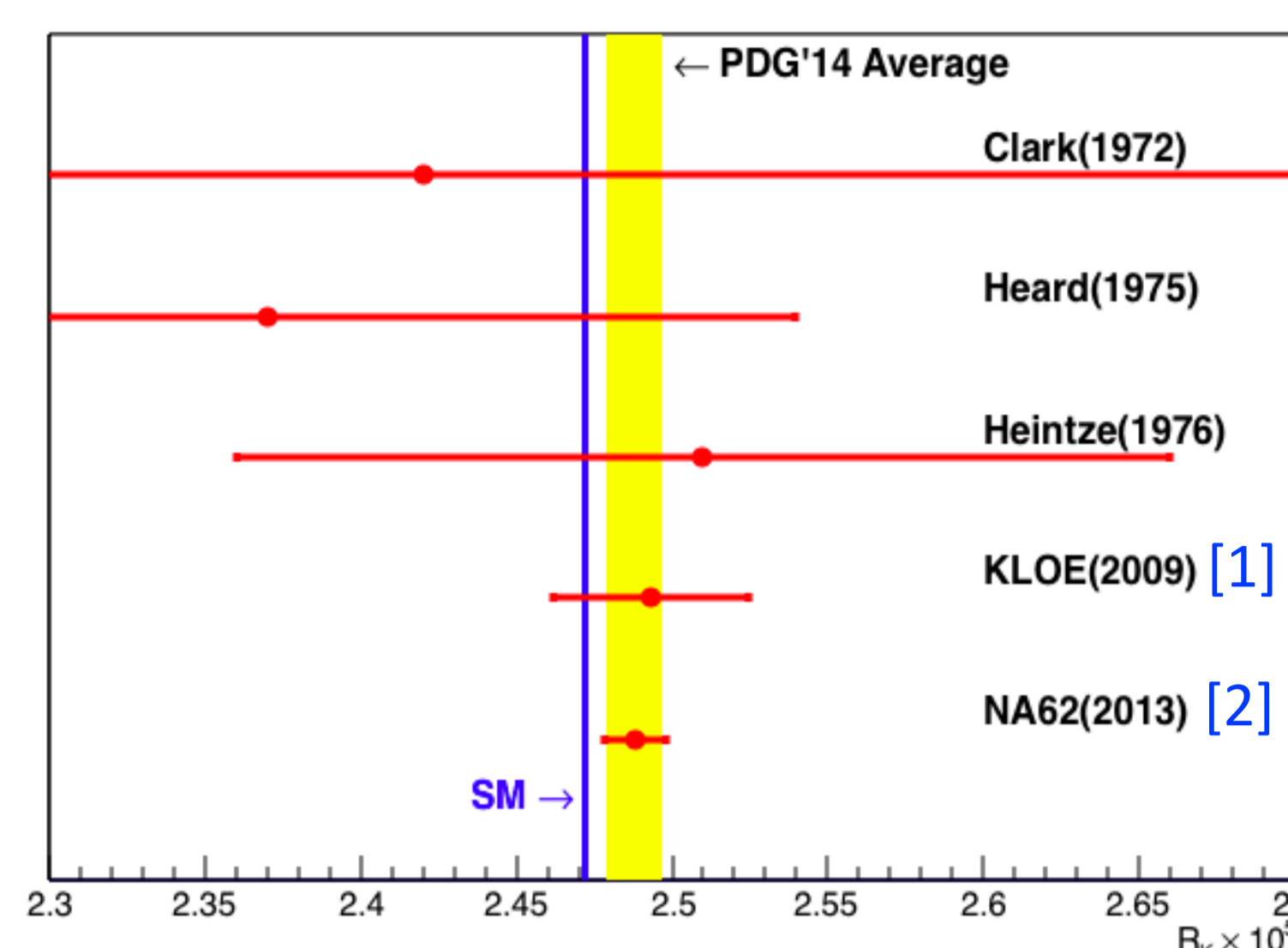
Search for lepton universality violation in J-PARC E36 Experiment

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Abstract

The J-PARC E36 experiment aims to search for a lepton universality violation in the ratio of decay widths, $R_K = \Gamma(K^+ \rightarrow e^+ \nu) / \Gamma(K^+ \rightarrow \mu^+ \nu)$, by adopting a stopped K^+ beam method. A structure dependent (SD) radiative $K^+ \rightarrow e^+ \nu \gamma (K_{e2\gamma})$ decay is one of serious backgrounds to deduce the R_K value. The SD $K_{e2\gamma}$ branching ratio and its decay form factor are successfully determined in the analysis.

Lepton Universality



$$K^+ \rightarrow l^+ \nu_l (K_{l2})$$

$$\Gamma(K_{l2}) = |g_l|^2 (G^2/8\pi) f_K^2 m_K m_l^2 \{1 - (m_l^2/m_K^2)\}^2$$

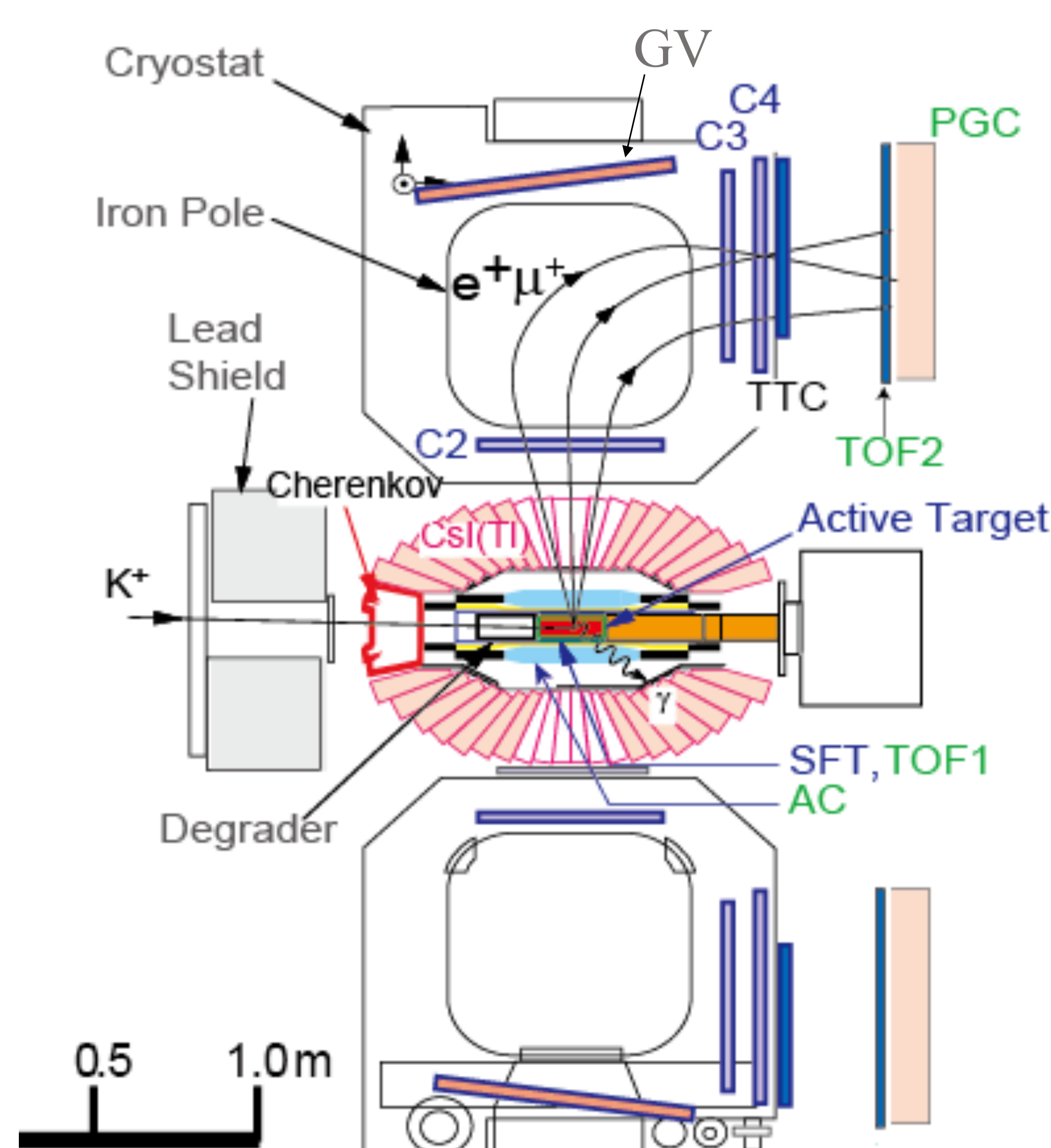
$$R_K^{SM} = \frac{\Gamma(K^+ \rightarrow e^+ \nu_e)}{\Gamma(K^+ \rightarrow \mu^+ \nu_\mu)} \quad g_e = g_\mu?$$

$$= \frac{m_e^2 (m_K^2 - m_e^2)^2}{m_\mu^2 (m_K^2 - m_\mu^2)^2} (1 + \delta_r)$$

helicity suppression radiative correction

$$= (2.477 \pm 0.001) \times 10^{-5}$$

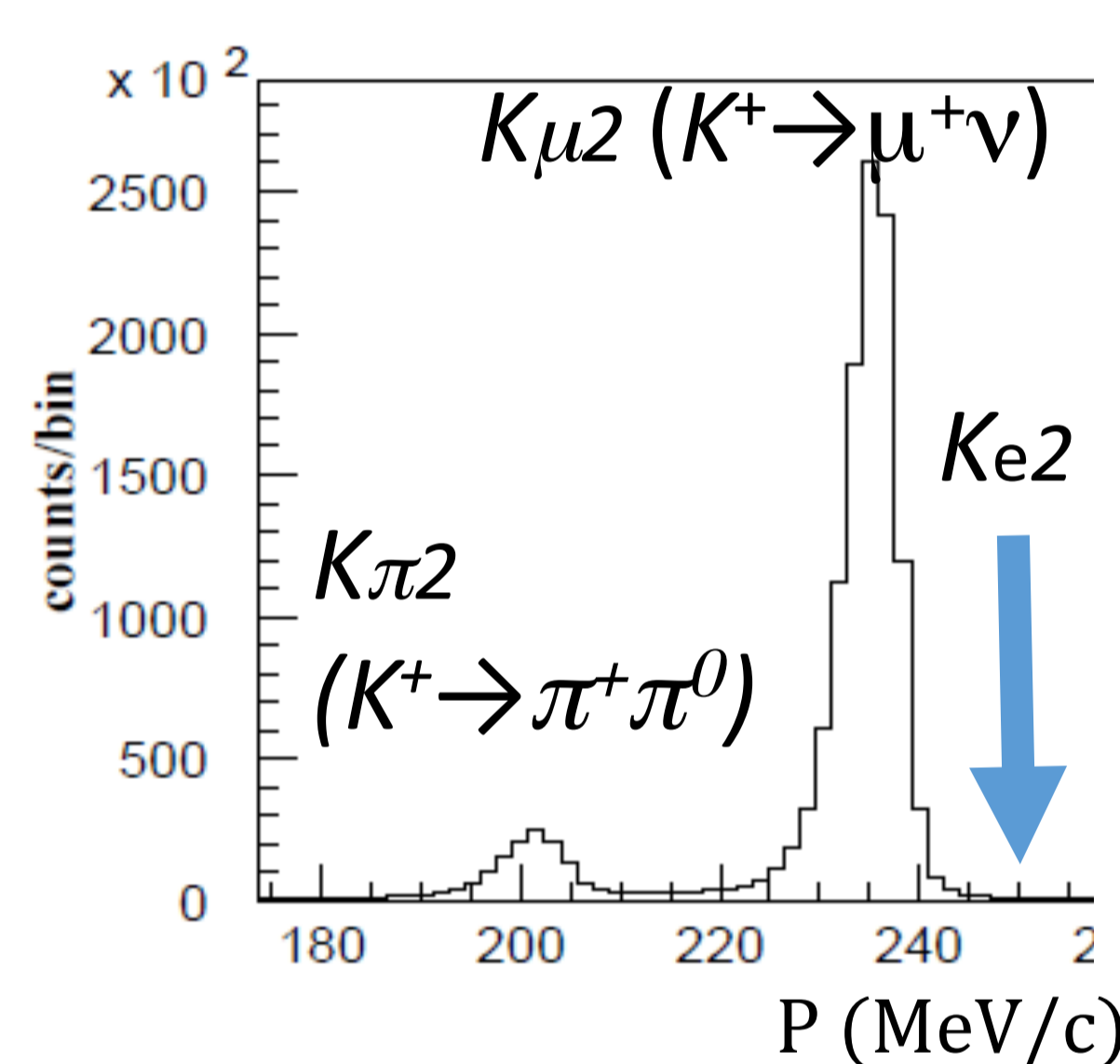
J-PARC E36 experiment [3]



Specification

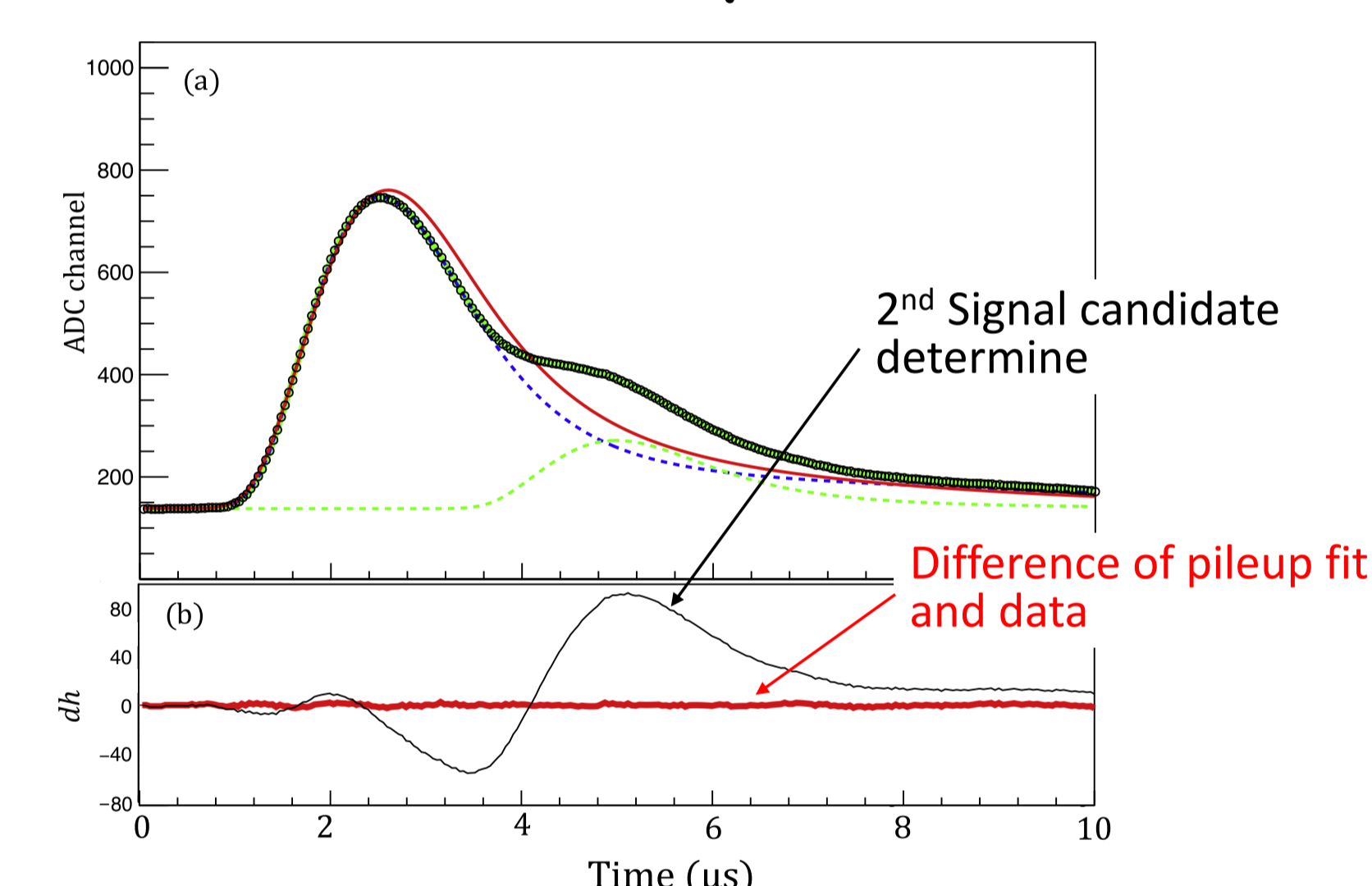
- Stopping positive kaon system at J-PARC, Japan
- E36 detector based 12 sector toroidal magnet system
- Phys data taking until Dec. 2015
- e^+/μ^+ PID with TOF + AC + PGC
- γ detected by CsI(Tl) + GV
- Lepton tracking using Target + SFT + C2-4 chambers

Momentum Reconstruction



- $K_{\mu 2}$, $K_{\pi 2}$ are familiar decay channel.
- These channel are used for calibration.

CsI(Tl) photon detector Waveform analysis



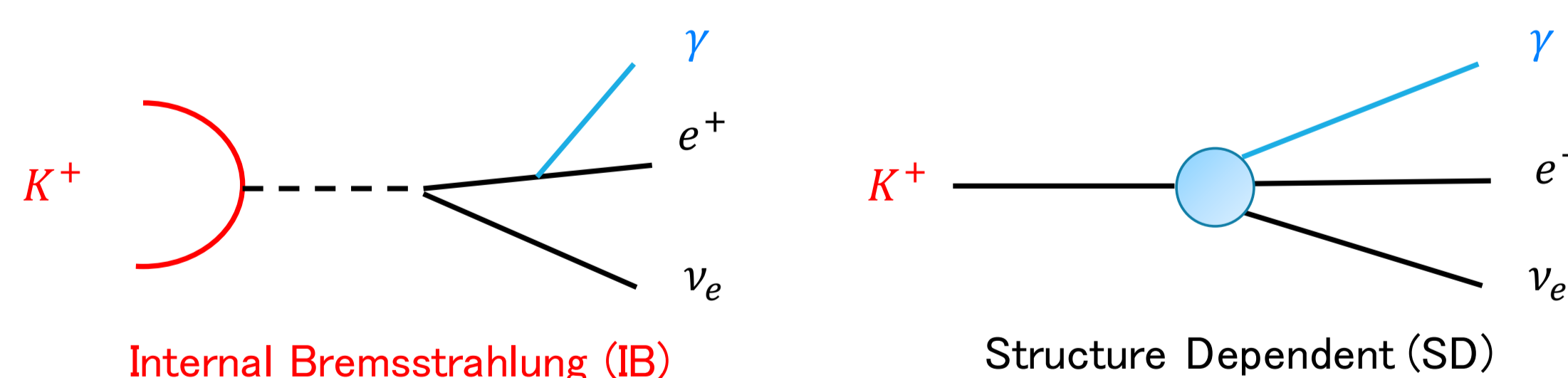
- Waveform model was developed [4].
- Pileup correction was success.
- $\sigma_E \sim 2.6\% @ 153 \text{ MeV}$, $\sigma_T \sim 10 \text{ ns}$

R_K and SD $K_{e2\gamma}$ study

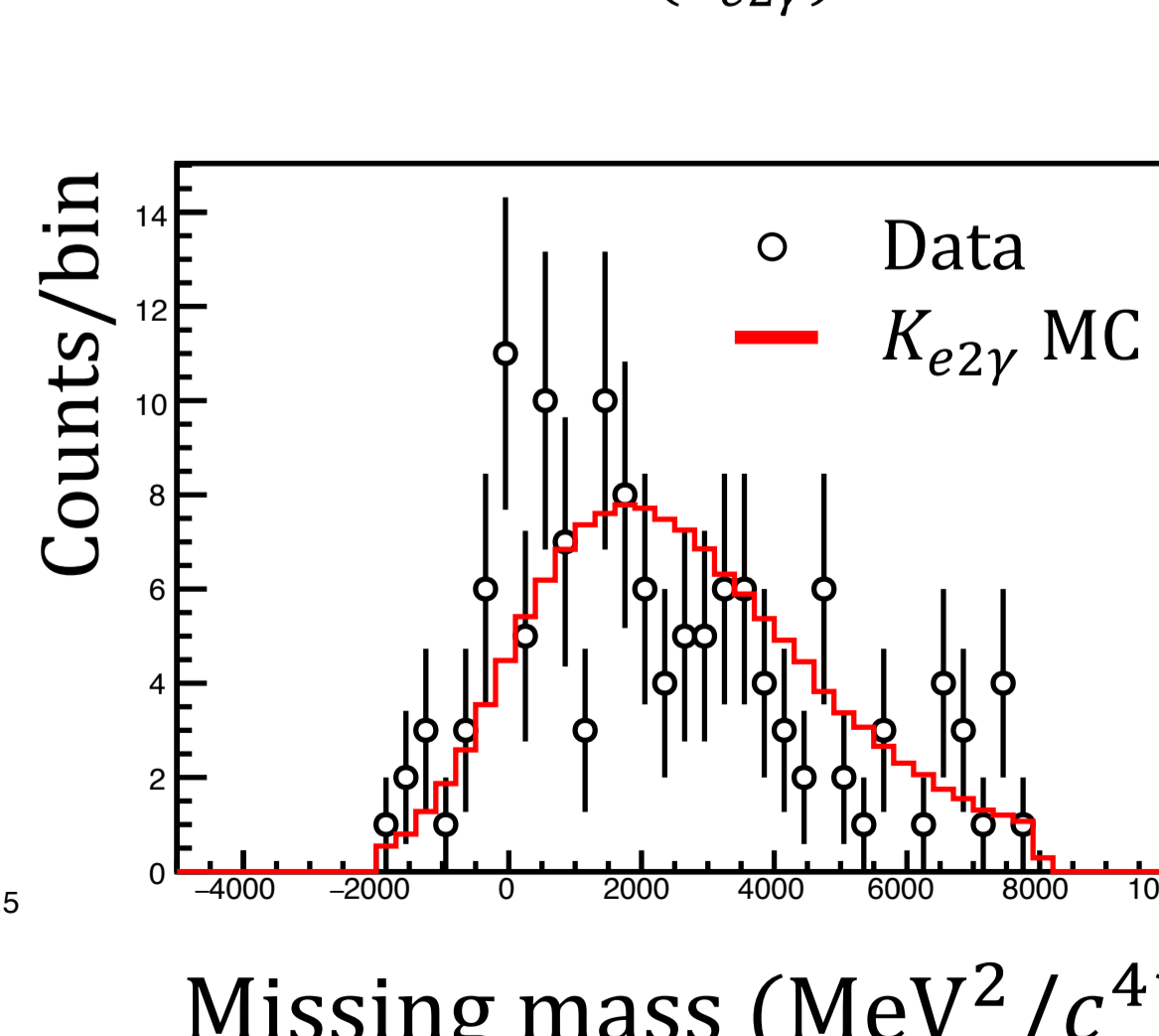
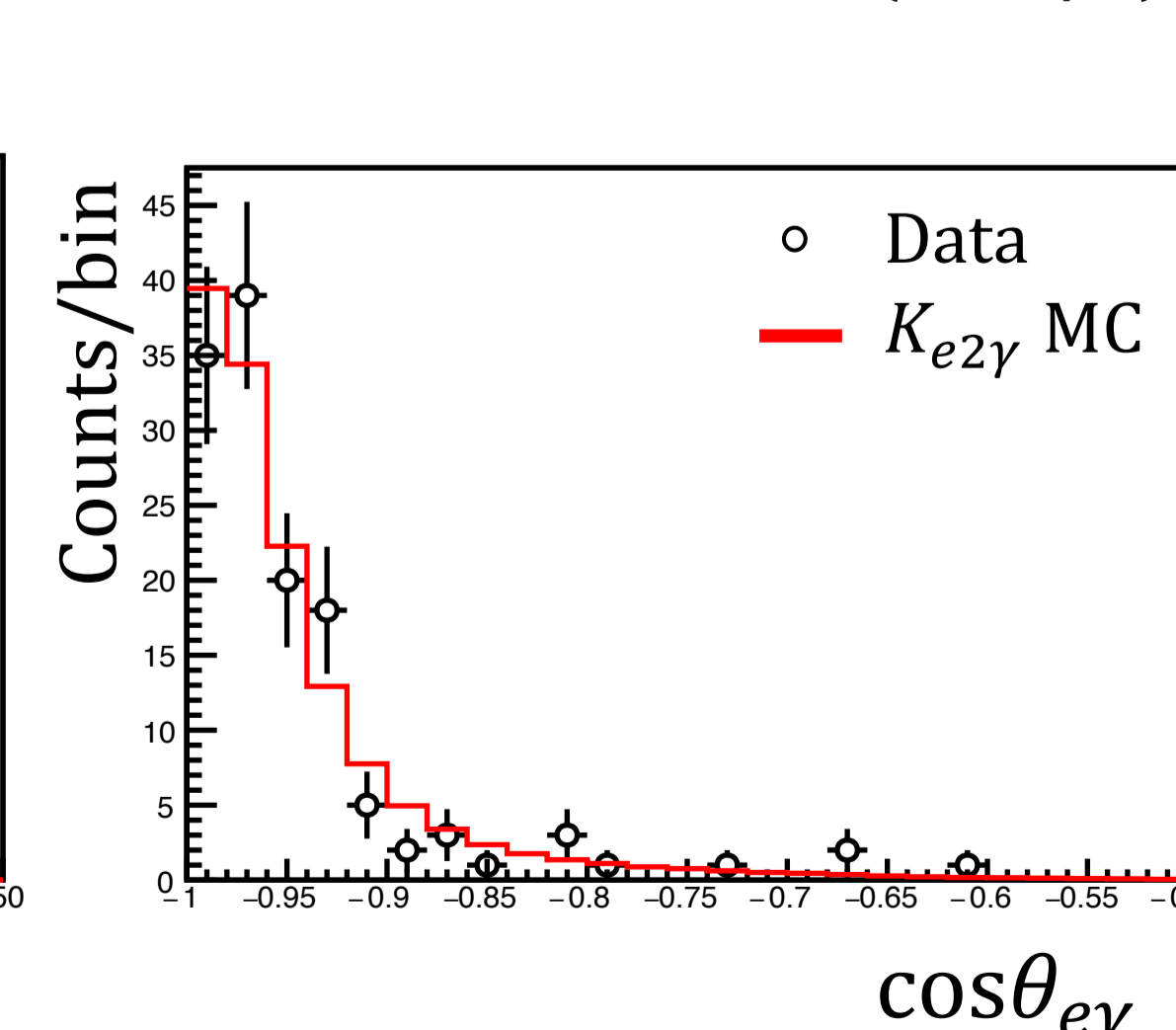
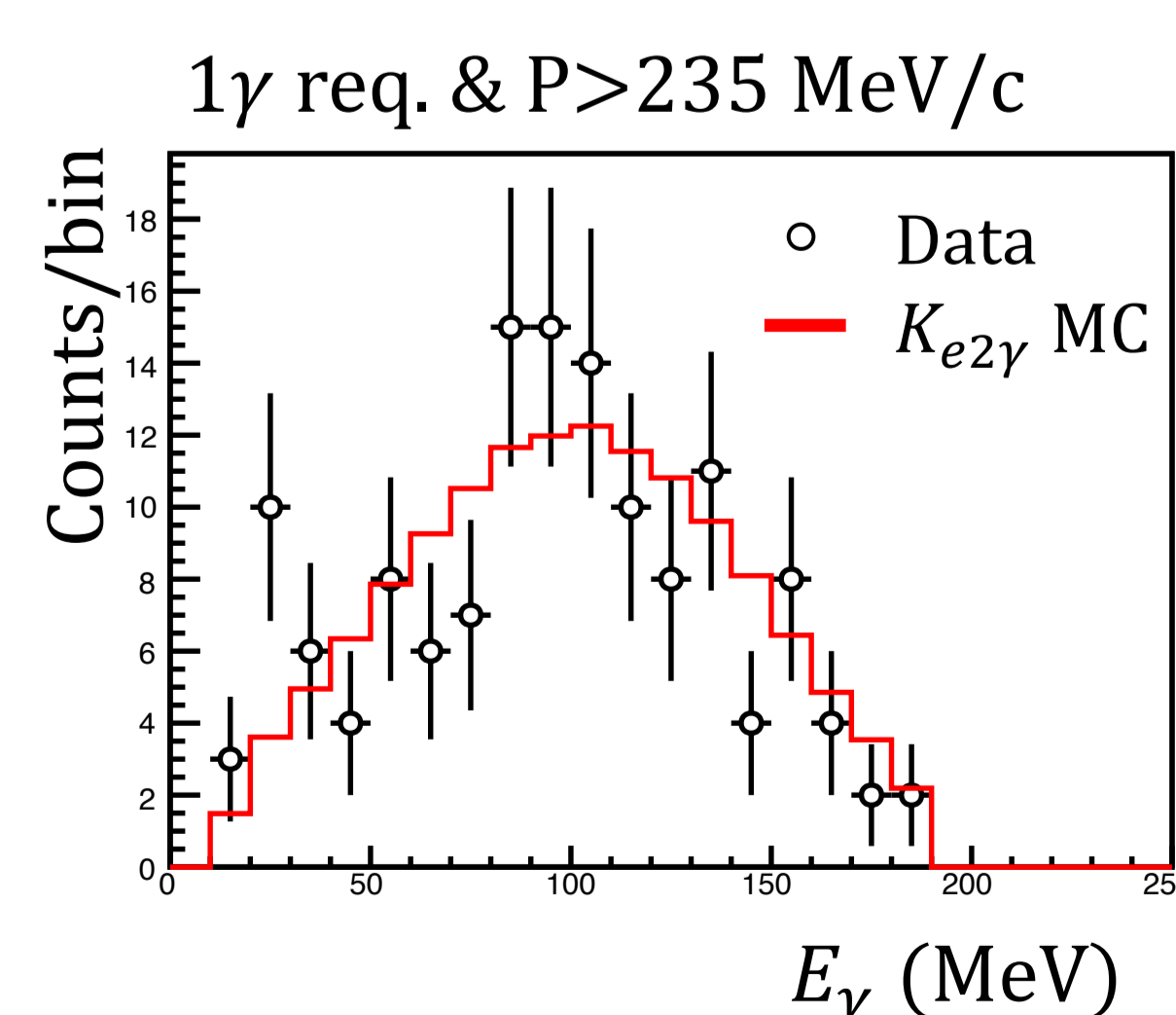
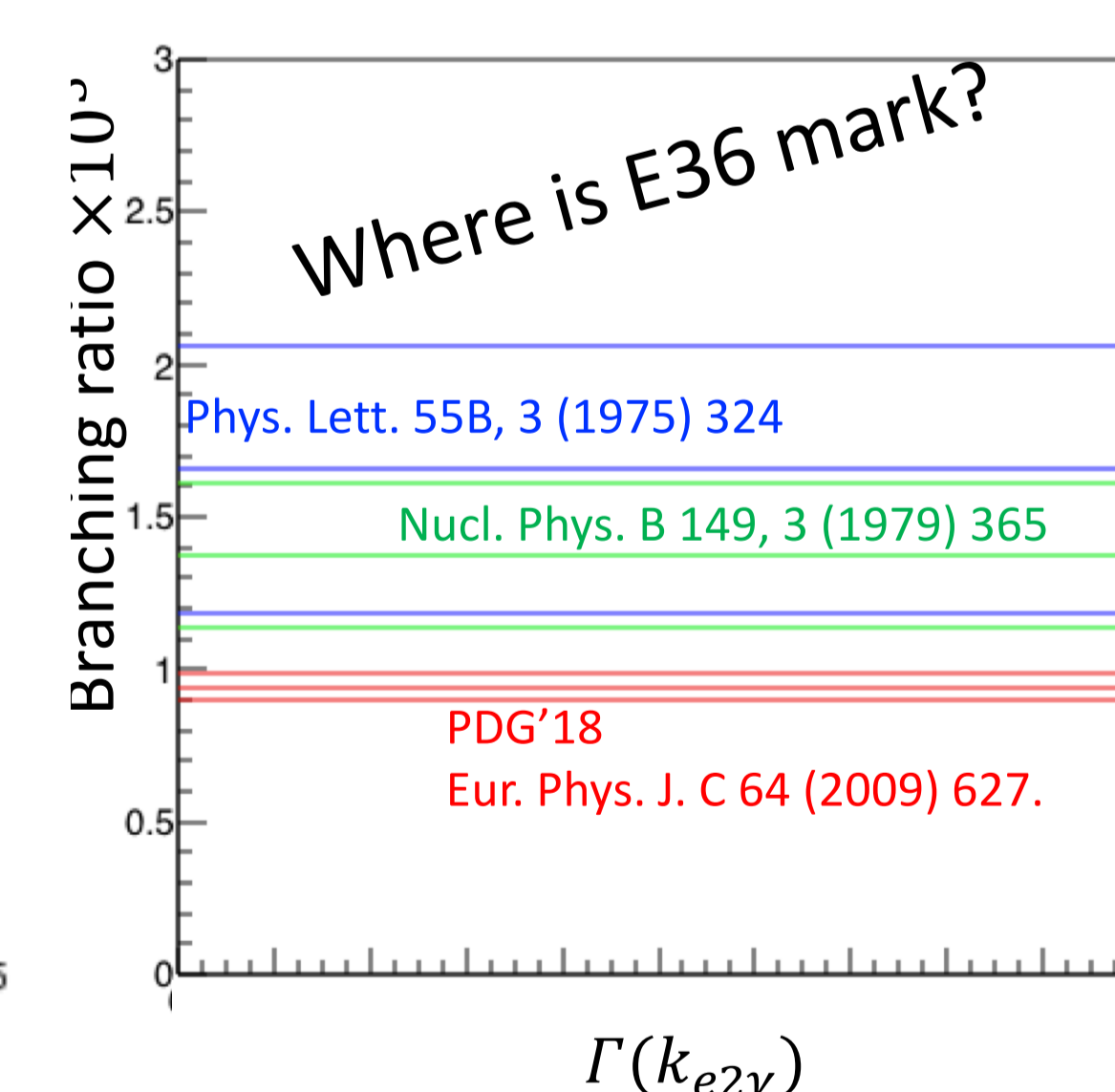
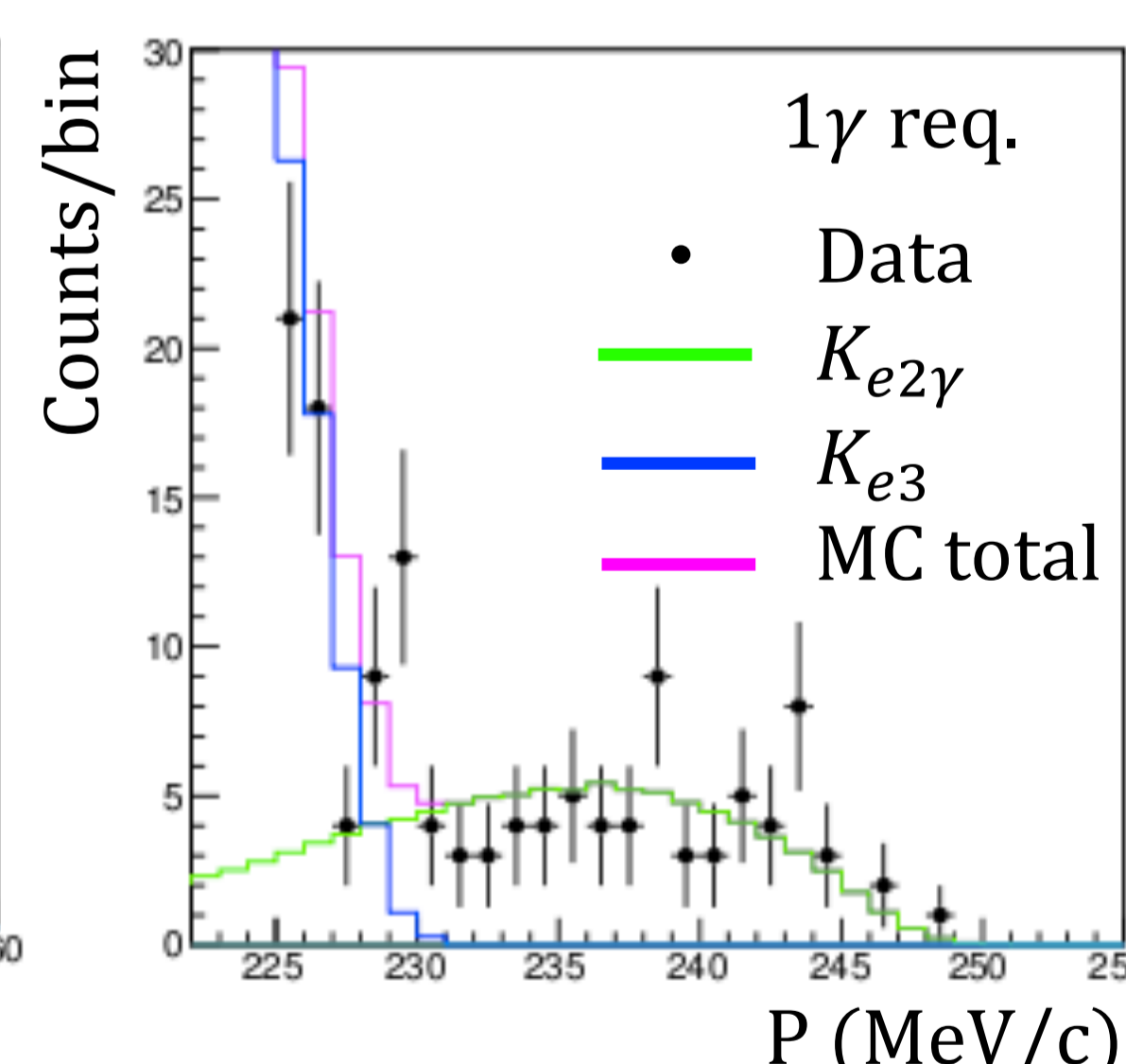
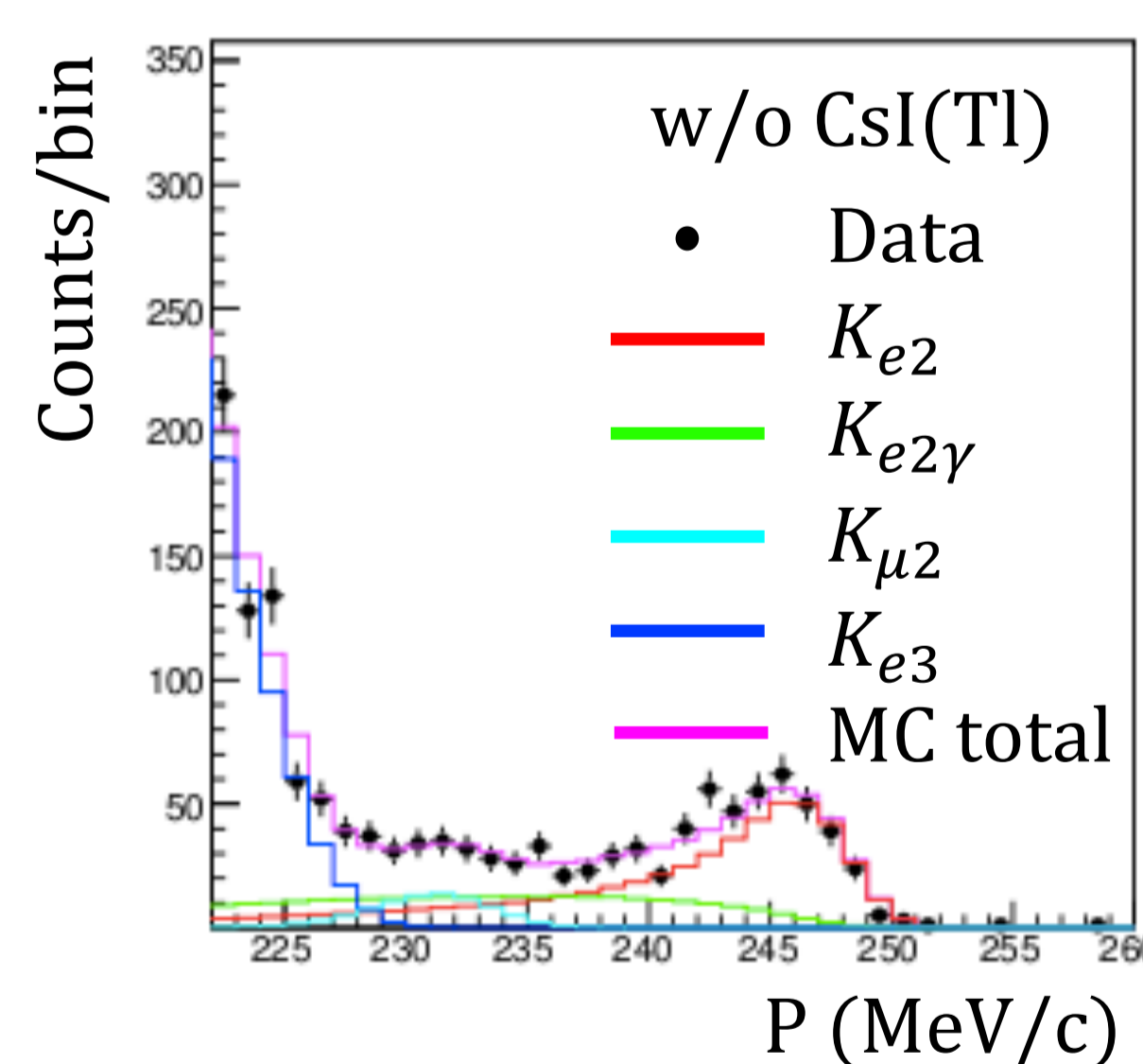
Critical background

$$R_K^{SM} = \frac{\Gamma(K_{e2}) + \Gamma(K_{e2\gamma}(IB))}{\Gamma(K_{\mu 2}) + \Gamma(K_{\mu 2\gamma}(IB))}$$

Background: $K_{e2\gamma}$ (SD)
 $K_{e2\gamma}: K^+ \rightarrow e^+ \nu_e \gamma$



- $K_{e2\gamma}$ (SD) (0γ) contaminate to R_K calculation.
- R_K determine should be corrected $K_{e2\gamma}$ (SD).
- $K_{e2\gamma}$ (SD) status (Br, λ) is studied precisely.
- In $K_{e2\gamma}$ (SD)
 - E_γ tends to 100~200 MeV.
 - $\theta_{e\gamma}$ tends to 150~180 deg.



Summary

E36 exp. aims to $e^+ - \mu^+$ LUV test by R_K measurement. Critical BG is $K_{e2\gamma}$ SD event. Our detector has observed familiar kaon decay channel which is consistent with MC. So, we ready to determine a branching ratio and form factor for $K_{e2\gamma}$ in used these spectra. Then, Applying the BG correction, R_K would be determine carefully.

Reference

- [1] Europ. Phys. J. C 64 (2009) 627.
- [2] Phys. Lett. B 719 (2013) 326.
- [3] Proc. Scie., PoS(KAON13)014, 2013.
- [4] Nucl. Instr. Meth. A 901 (2018) 1.