Track 6: experimental questions

- Is constructive interference in $K_L \to \pi^0 \ell^+ \ell^-$ really favoured by theory and why?
- For $K_L \to \pi^0 \ell^+ \ell^-$, there is the indirect CPV contribution in addition to the direct one. Experimentally, how can one resolve these two contributions?

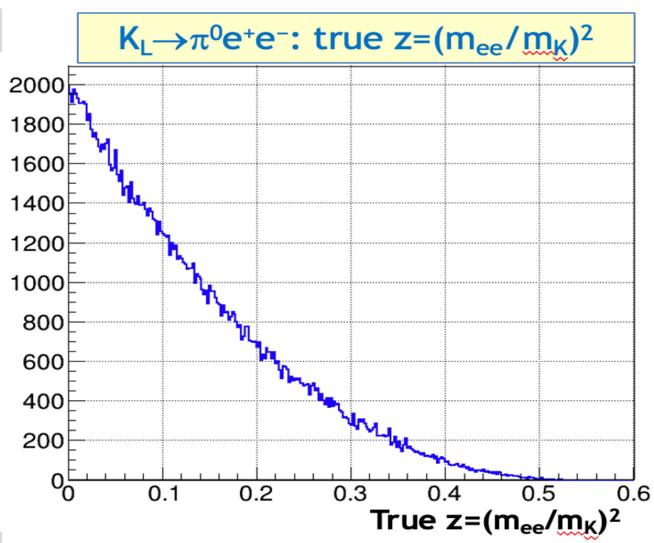
$$\mathcal{B}_{\rm SM}(K_L \to \pi^0 e^+ e^-) = \left(15.7|a_S|^2 \pm 6.2|a_S|\left(\frac{\text{Im}\,\lambda_t}{10^{-4}}\right) + 2.4\left(\frac{\text{Im}\,\lambda_t}{10^{-4}}\right)^2\right) \times 10^{-12},$$

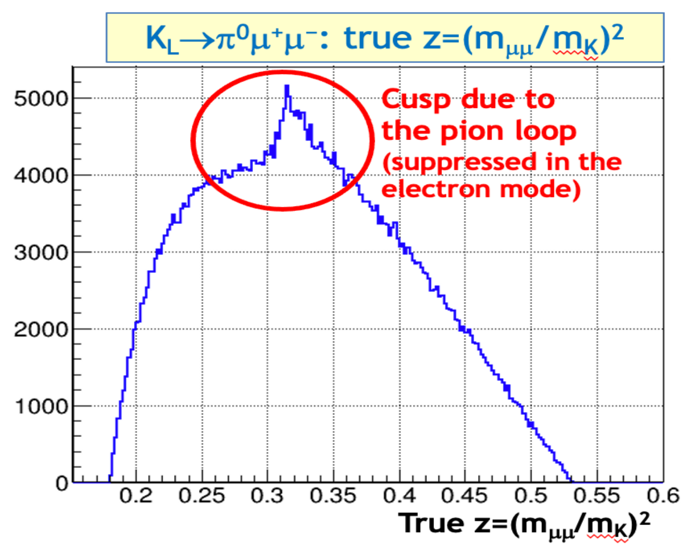
$$\mathcal{B}_{\rm SM}(K_L \to \pi^0 \mu^+ \mu^-) = \left(3.7|a_S|^2 \pm 1.6|a_S|\left(\frac{\text{Im}\,\lambda_t}{10^{-4}}\right) + 1.0\left(\frac{\text{Im}\,\lambda_t}{10^{-4}}\right)^2 + 5.2\right) \times 10^{-12}.$$

(CPV+INT+DCPV+CPC)

$\lambda_t = V_{ts}^* V_{td}$

$\text{Im}(\lambda_t) = 1.4\times10^{-4}$



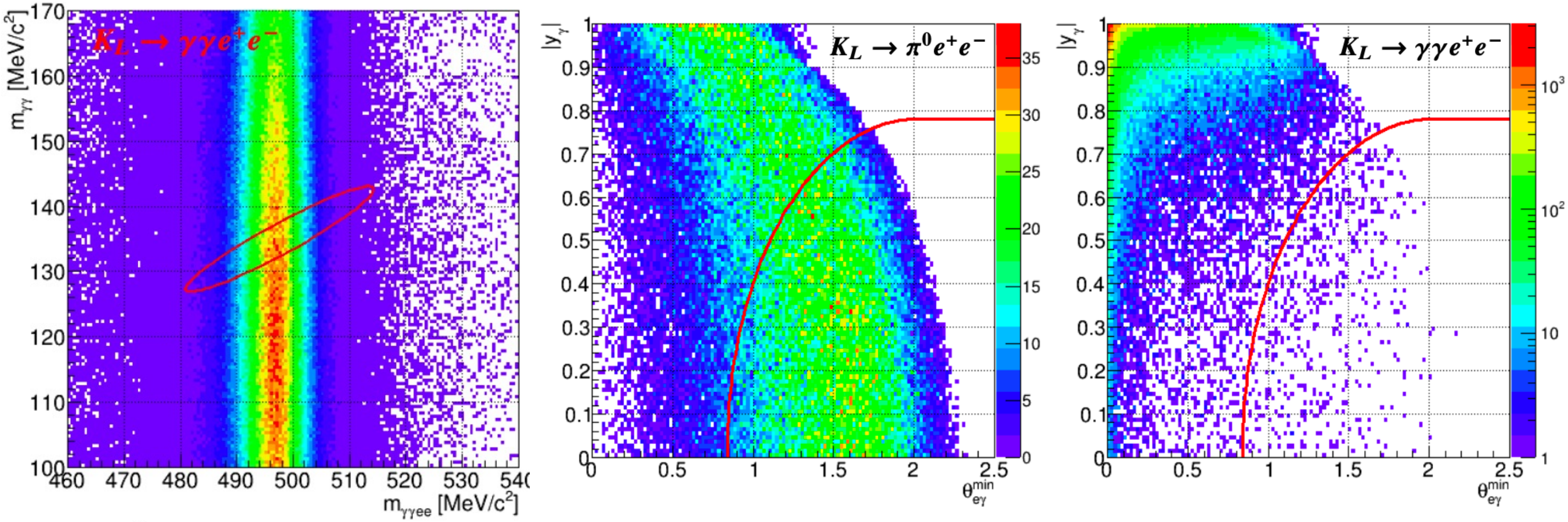


Track 6: experimental questions

- For $K_L \to \pi^0 \ell^+ \ell^-$, there is the irreducible Greenlee "radiative Dalitz" background. What is the expected **S/B** assuming is the Standard Model prediction?

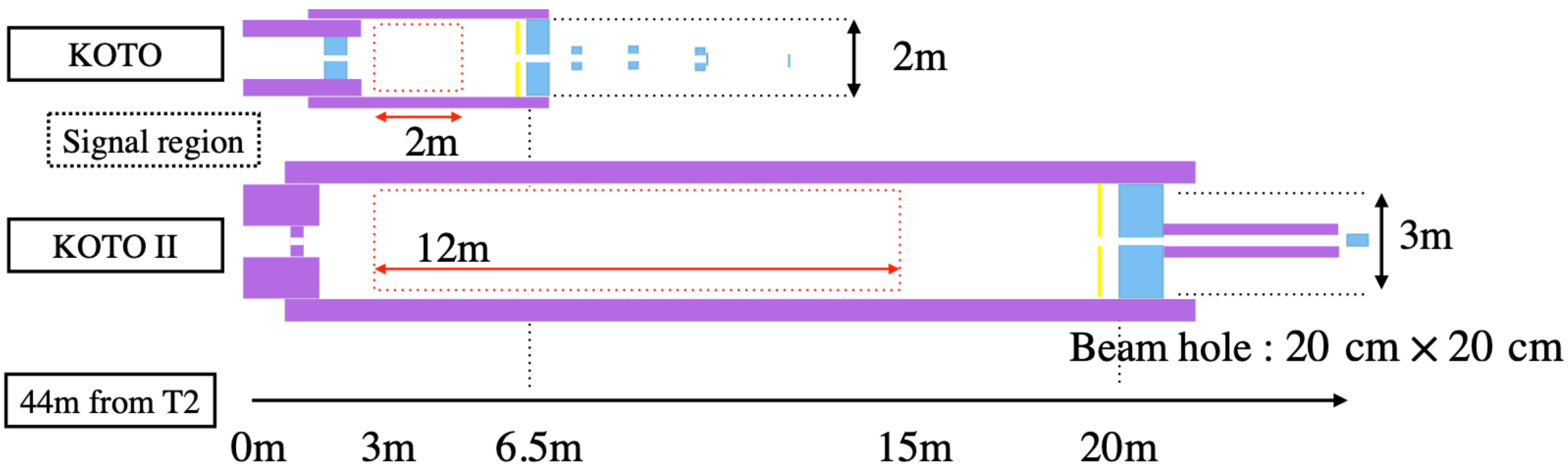
HIKE Phase 2 proposal

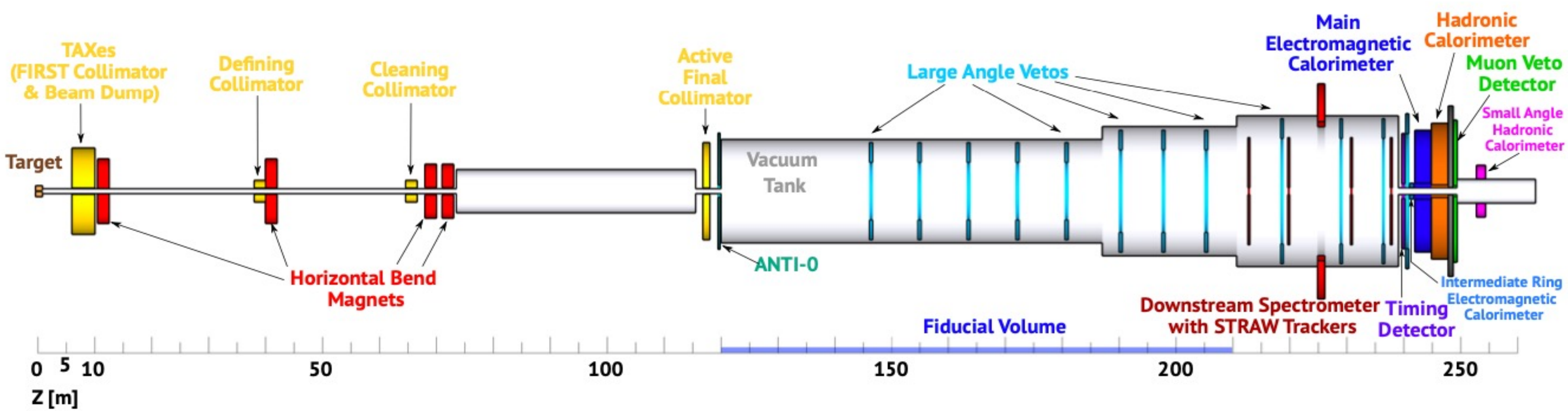
Number of spills	3×10^6			
Protons on target	6×10^{19}			
K_L decays in FV	1.9×10^{14}			
Mode	N_S	N_B	$N_S/\sqrt{N_S+N_B}$	$\delta\mathcal{B}/\mathcal{B}$
$K_L \to \pi^0 e^+ e^-$	70	83	5.7	18%
$K_L \to \pi^0 \mu^+ \mu^-$	100	53	8.1	12%



Track 6: experimental questions

- How does KOTO-II differ experimentally to HIKE?
  Why are they so different?
- Can KOTO-II measure $K_L \to \pi^0 \ell^+ \ell^-$? What else apart from $K_L \to \pi^0 \nu\nu$ can KOTO-II measure?





Track 6: experimental questions

- What will the final results of KOTO in all channels considered be? What can KOTO-II add to it? Precision? Or also more channels? Which channels can KOTO-II observe/measure that KOTO could not?

[2γ+invisible] $K_L \to \pi^0 \nu\nu$, similarly $K_L \to \pi^0 X_{inv}$
KOTO: SES~(5-8)e-11, BG level~1-2 (to be improved)
KOTO II: SES~8.5e-13; 35 SM signal, 33 BG; dBR/BR~23%

[4γ] $K_L \to XX$, $X \to 2\gamma$
KOTO2018: <(1-4)e-7 @40<MX<110MeV, <(1-2)e-6 @210<MX<240MeV, BG~0.6

[4γ+invisible] $K_L \to \pi^0 \pi^0 X_{inv}$
E391a: <4.7e-5
KOTO: Maybe BG limited

[6γ] $K_L \to \pi^0 \pi^0 X$, $X \to 2\gamma$ (peak search in m_{56} distribution in the tail of π^0 from $3\pi^0$)
E391a: <(0.2-1)e-6 @194<MX<219MeV
KOTO: investigating

[3γ] $K_L \to \pi^0 \gamma$
KOTO2016-18: <1.7e-7, BG~0.3

[4EM] $K_L \to \pi^0 e^+ e^-$
KOTO: will take data for feasibility study for KOTO II
KOTO II: under discussion

Track 6: experimental questions

- Are there common detector elements for HIKE and KOTO-II to develop a feasible R&D programme?
- Why is a **400 GeV** proton beam (**75 GeV/c** kaons) good for K^+ physics? How does it compare to the J-PARC stopped K^+ beam?
- Why is a pp collider (LHCb) is good for kaons?
- How do we push forward neutral kaon programmes?
- J-PARC: how can we enlarge the international collaboration for KOTO-II?
- CERN: same question for HIKE.