Waveform digitization techniques in K_L experiments

03/06/2008 NP08 @ Mito
E14 collaboration
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$$K_L \rightarrow \pi^0 \nu \bar{\nu}$$

feynman diagram of $K_L \rightarrow \pi^0 \nu \bar{\nu}$
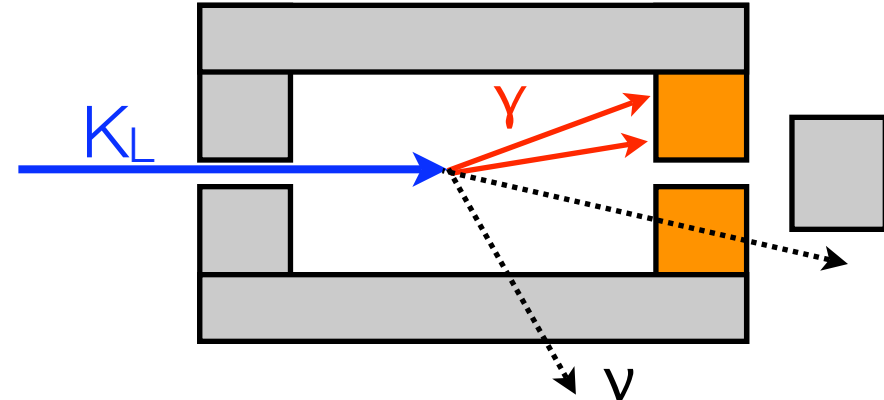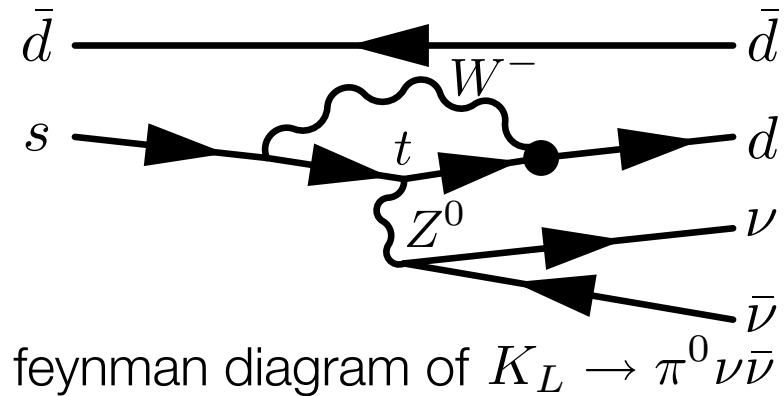
- Golden Mode

  - small theoretical uncertainty : confirm Standard Model

  - penguin/box diagram : sensitive to New Physics

- experimental method

  - require 2 photons in calorimeters

  - require no other particles detected

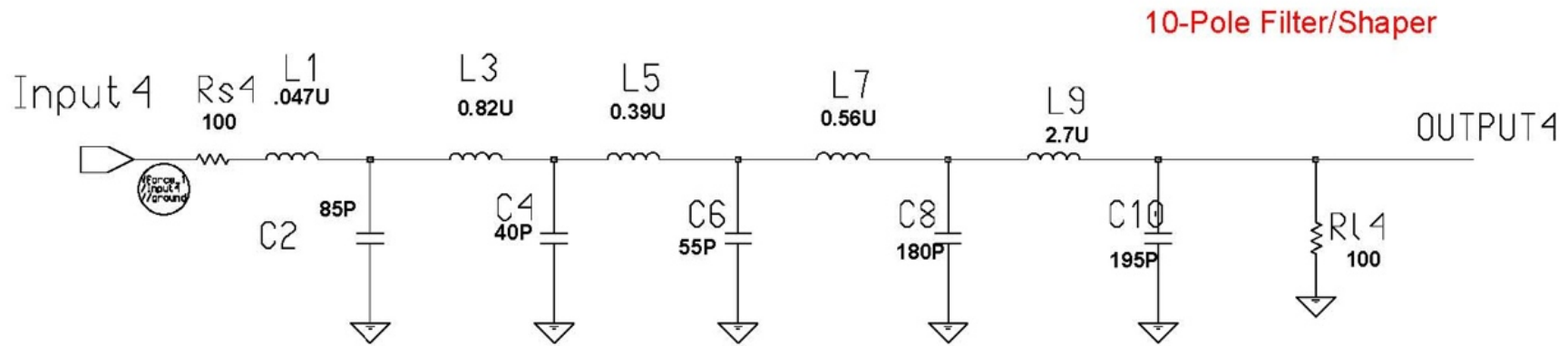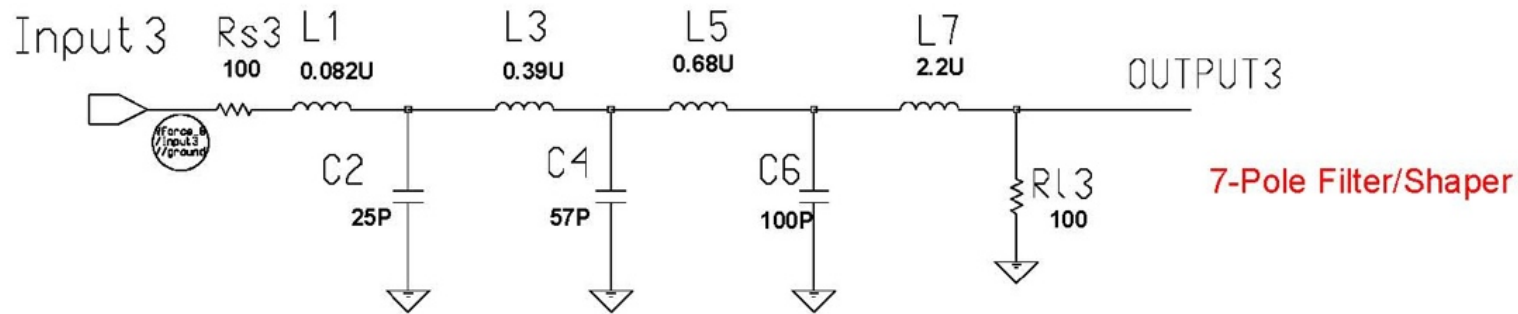- Goal @ Phase-2 : > 100 SM events

  - sensitivity ~ 10^{-13}-10^{-14}

Kaon experiments : Phase-2

- Intensity Frontier ⇔ Energy Frontier (~ LHC, ILC)

- To achieve such a high sensitivity ...

  - strongly reject BGs

    - overlapping/pileup due to such a high hit rate

  - trigger-less data taking system

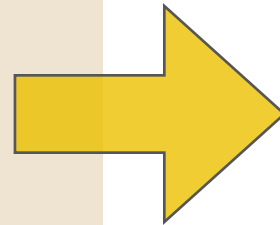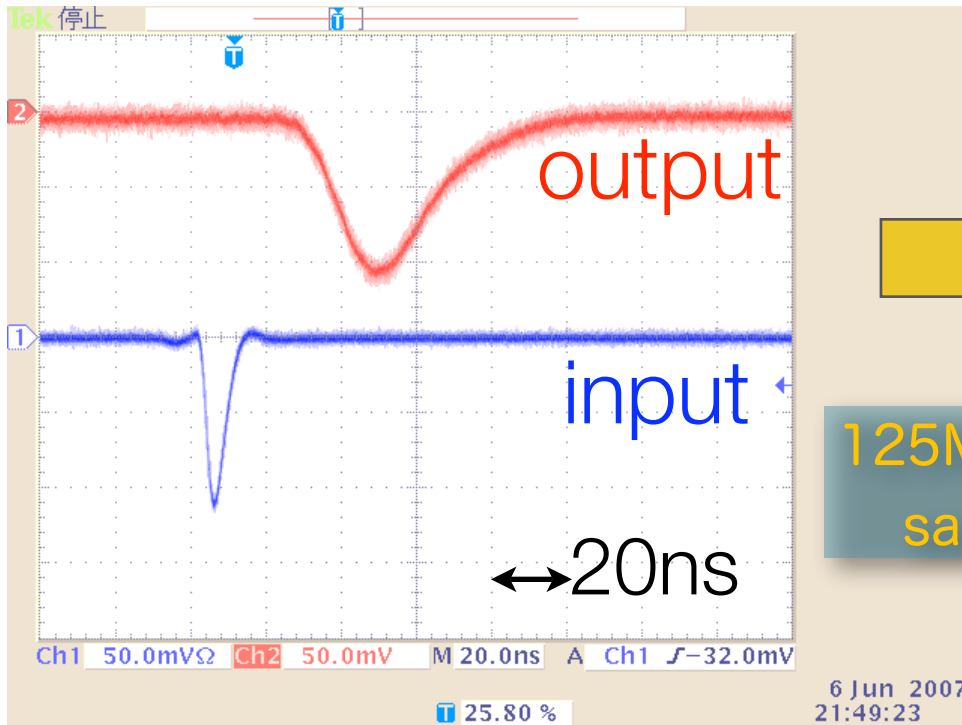➡ Waveform digitization techniques ~ Flash ADC is one way to solve

Waveform digitization @ Phase-1
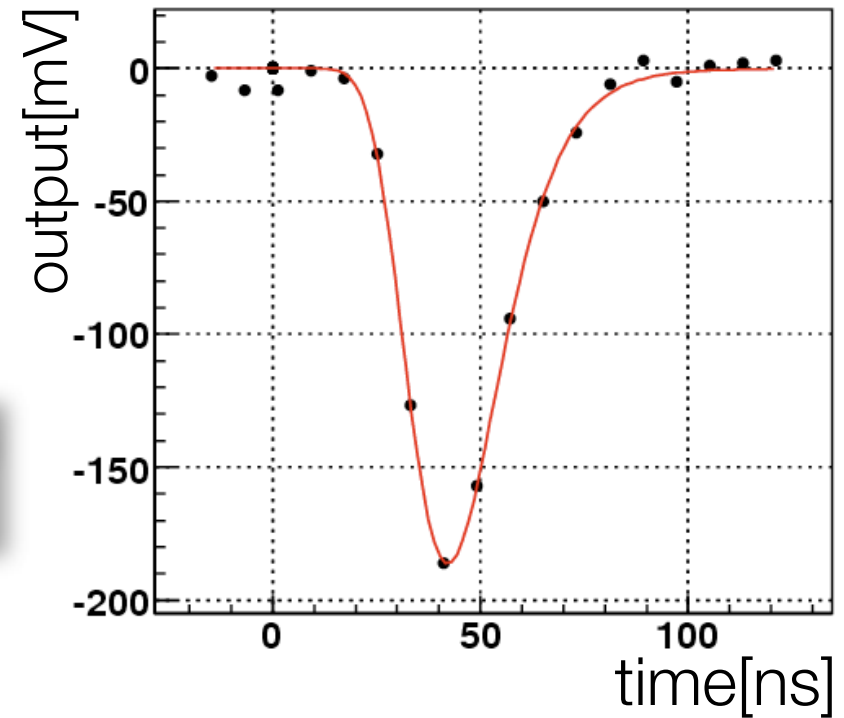
- 125MHz FADC readout through Bessel Filter

Waveform digitization @ Phase-1

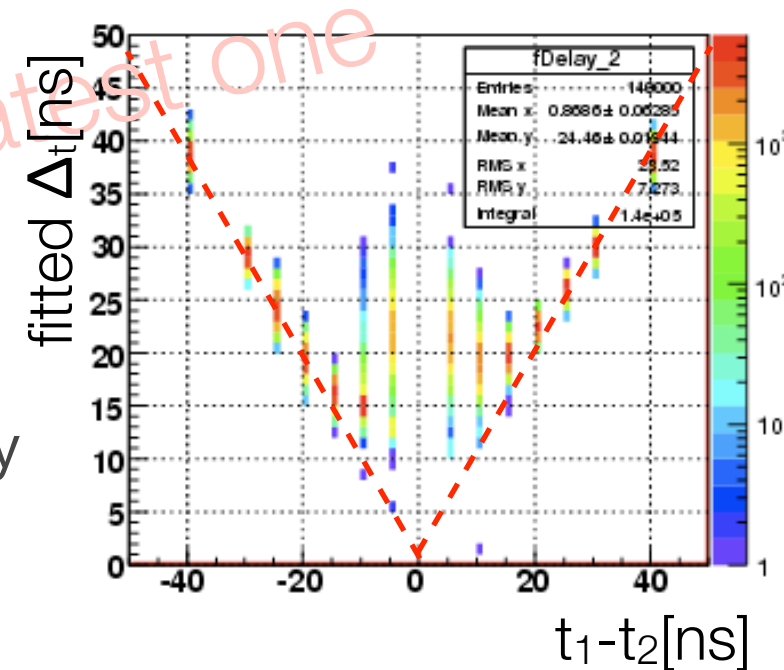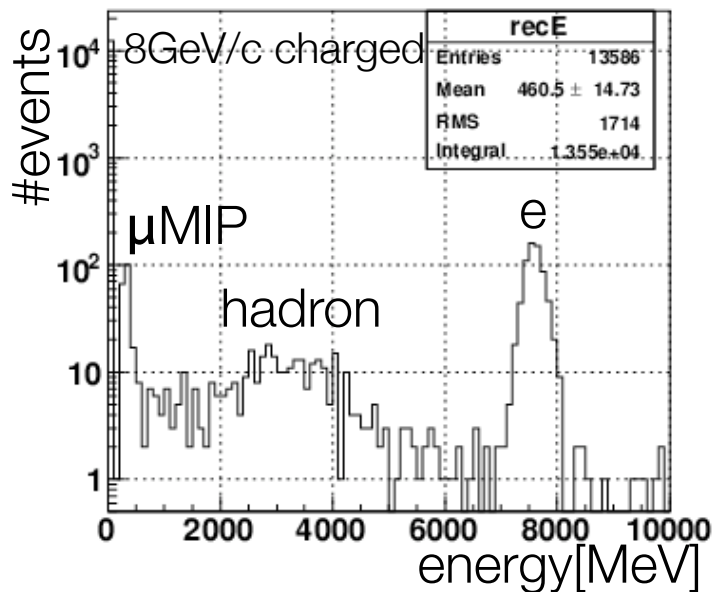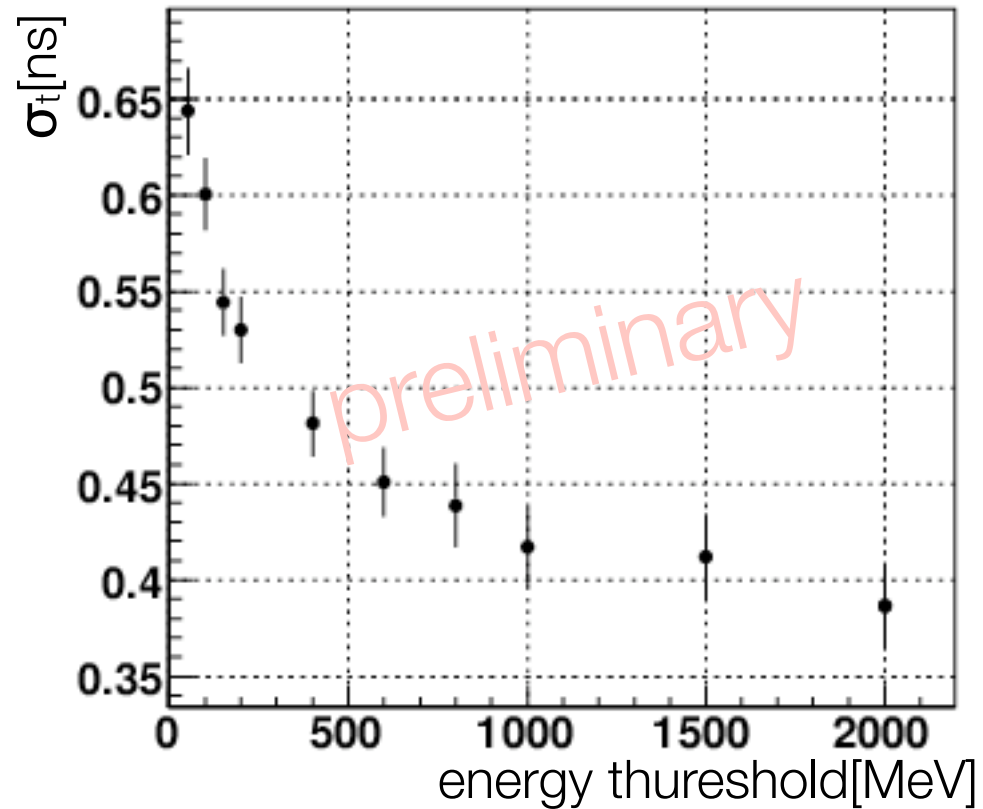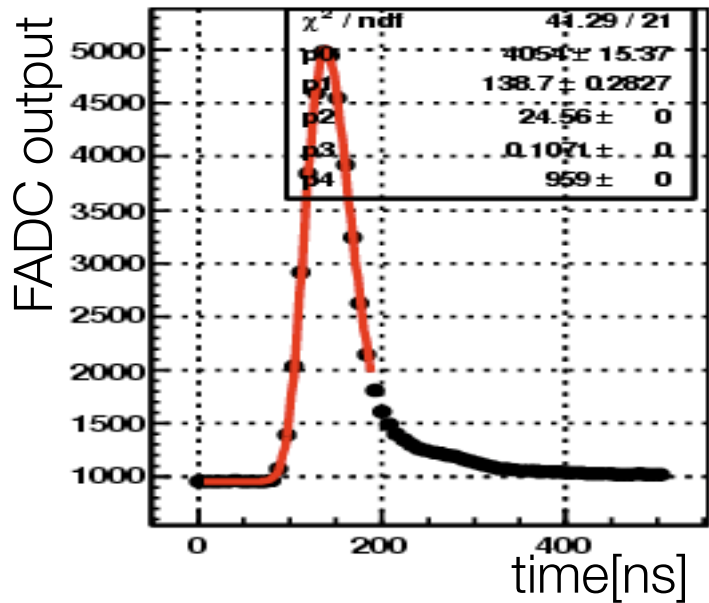- 125MHz FADC readout through Bessel Filter

performance evaluation (1) - function generator -

- test with function generator

  (photo statistics is not included)

- resolution

  - time resolution σ_t : 0.25 [ns] @ 300mV

  - energy resolution σ_E/E : 1.3% @ 300mV

- 2 pulse separation

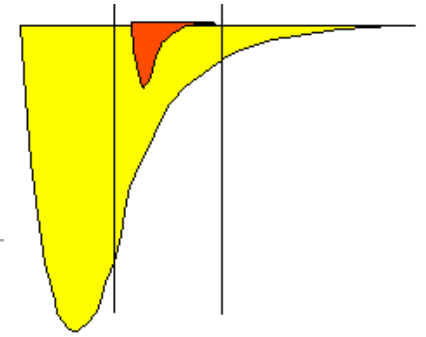 - can measure each energy/timing correctly unless they hit within ~20ns

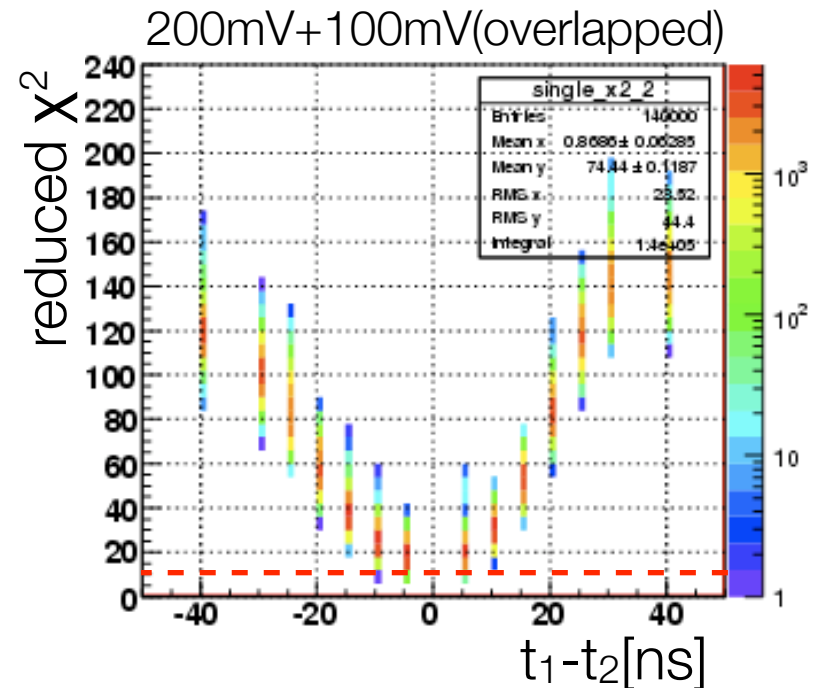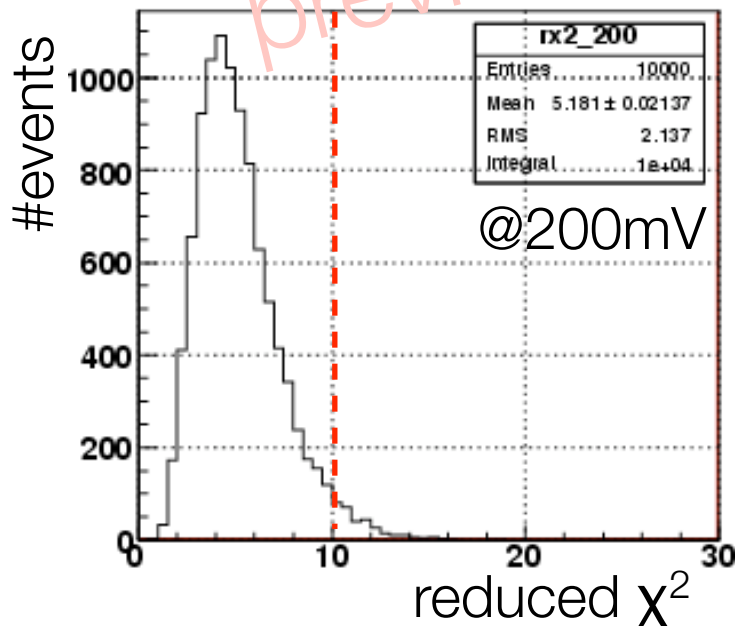# performance evaluation (2) - beam test @ FNAL -

overlap/pileup events

- Broadening pulse shapes may cause overlap/pileup event

- hit rate @ around beam hole ~ 1MHz

  (scale from E14 Step1)

- can be rejected even if it comes within 20ns

@200mV

reduced χ^2

200mV+100mV(overlapped)

reduced χ^2

$t_1 - t_2$[ns]

Summary

- Intensity frontier experiments @ J-Parc Phase-2

- Waveform digitization techniques ~ FADC is powerful tool especially for high intensity experiments

- "Bessel filter and 125MHz FADC" readout system is planned and developed for E14 @ J-Parc Phase-1

- overlap/pileup effect may cause detection inefficiency especially for high intensity experiments @ J-Parc Phase-2

- we should study the overlap/pileup effect