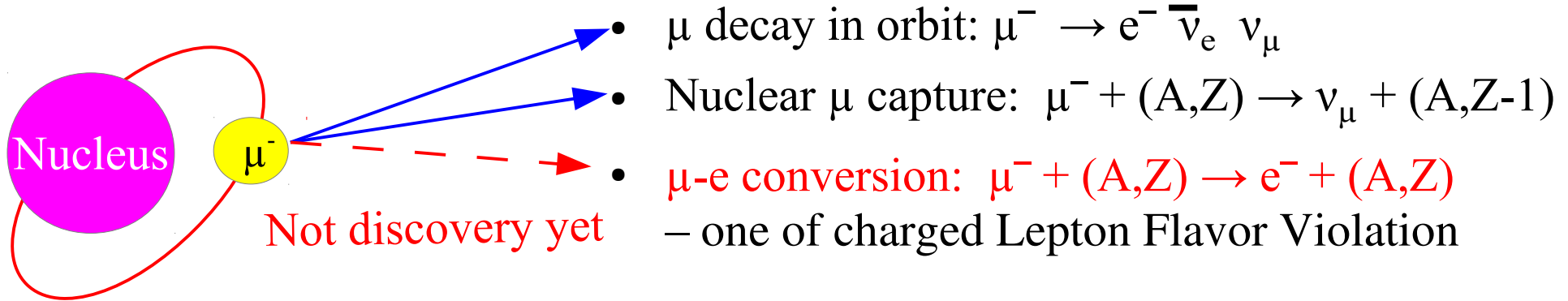# Research Experiences at DeeMe Experiment

Nguyen Minh Truong,
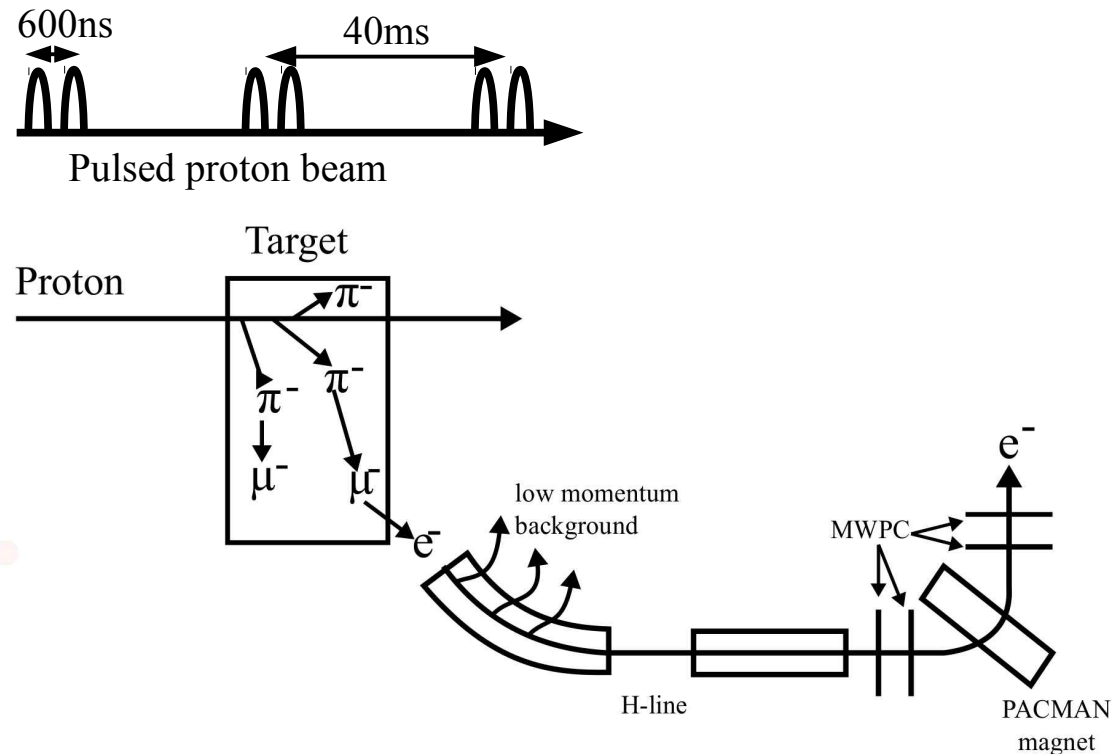
Sep. 14th 2017

Physics Montivation and DeeMe Exp.

1. When muon enters material

- μ decay in orbit: $\mu^- \rightarrow e^- \bar{\nu}_e \nu_\mu$
- Nuclear μ capture: $\mu^- + (A,Z) \rightarrow \nu_\mu + (A,Z-1)$
- μ-e conversion: $\mu^- + (A,Z) \rightarrow e^- + (A,Z)$
  – one of charged Lepton Flavor Violation

Nucleus μ⁻

Not discovery yet

2. DeeMe Experiment

600ns 40ms

Pulsed proton beam

Target

Proton π^- π^- π^- μ^- μ^- e^-

low momentum background

H-line

MWPC

e^-

PACMAN magnet
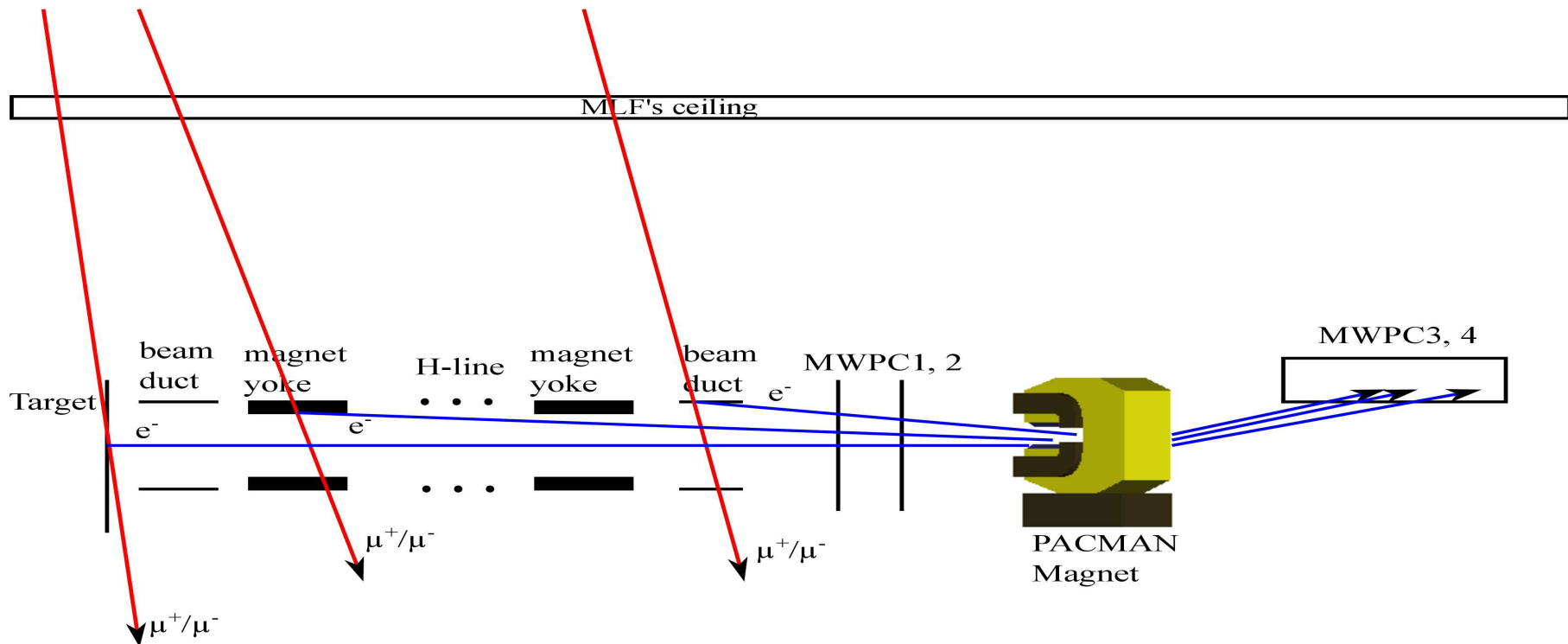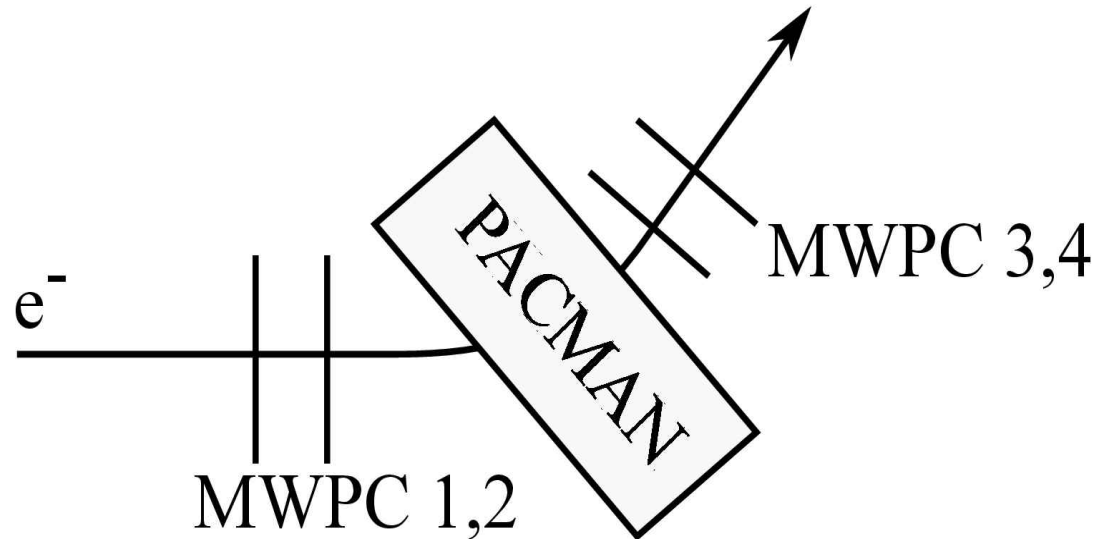
Estimate the Cosmic Rays Induced Background by MC simulation

1. One of potential background for DeeMe exp.

2. MWPCs are placed in horizontal
   → take coincidence of 4MWPCs to remove the most of cosmic ray background.

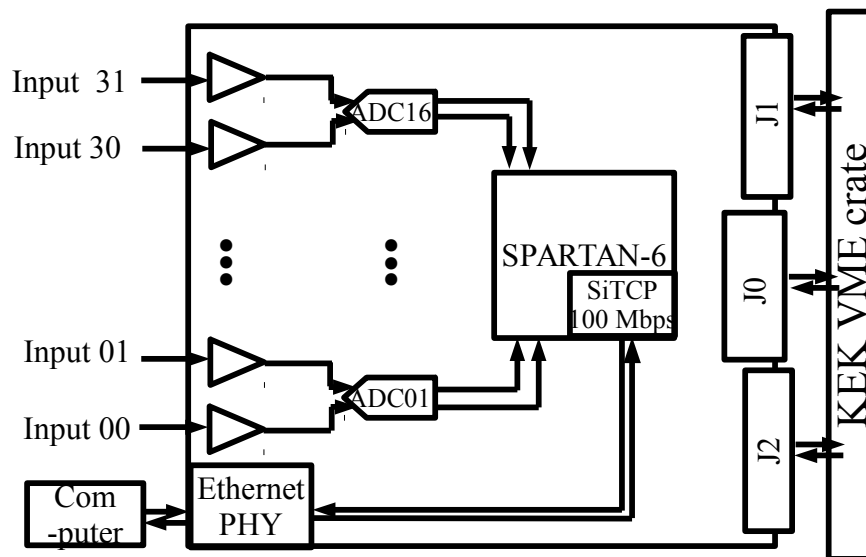3. Only background induced from cosmic rays in horizontal direction

FPGA-Based Data Compression and DAQ System

1. Record signal from MWPC for DeeMe experiment

2. Monitor cosmic rays induced background
   → time window for recording signal >170 μs

Hardware & Issuse of FADC Board

- 10-bits 100-MHz FADC board, hardware was developed by IGARASHI Youichi for TREK experiment

Issuse

- The maximum waveform lenth can be record ~ 81.9 μs
- Deadtime 50 ms

Solve the issuse
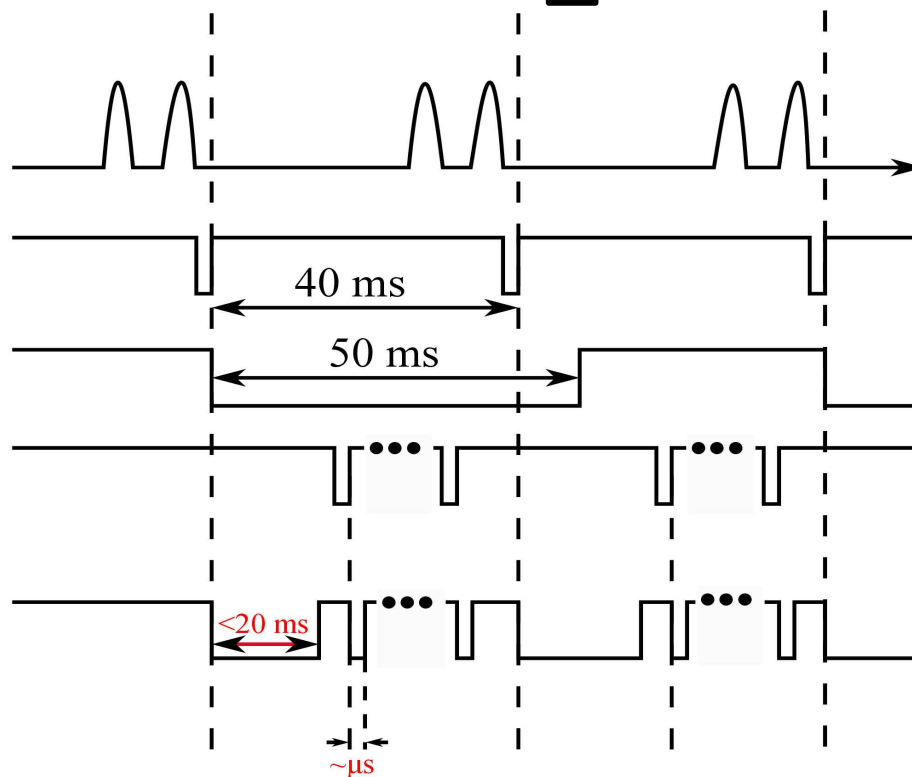
- Record 2 times of maximum waveform
- Reduce the deadtime

Reduce Deadtime → New Algorithm
"Adaptive Delta Compression Algorithm"

Delta $\Delta_{ADC} = ADC_n - ADC_{n-1}$

1. Lossless compression

2. Monitor noise level of waveform

3. Automatic decides the number of bits to encode the delta value

4. If delta size of any points is larger than the decided number of bits, use again raw data for only those data

Delta compression vs Adaptive Delta compression

waveform

no. of bits

can work

can not work

Delta compression

no. of bits

can work

Adaptive Delta compression
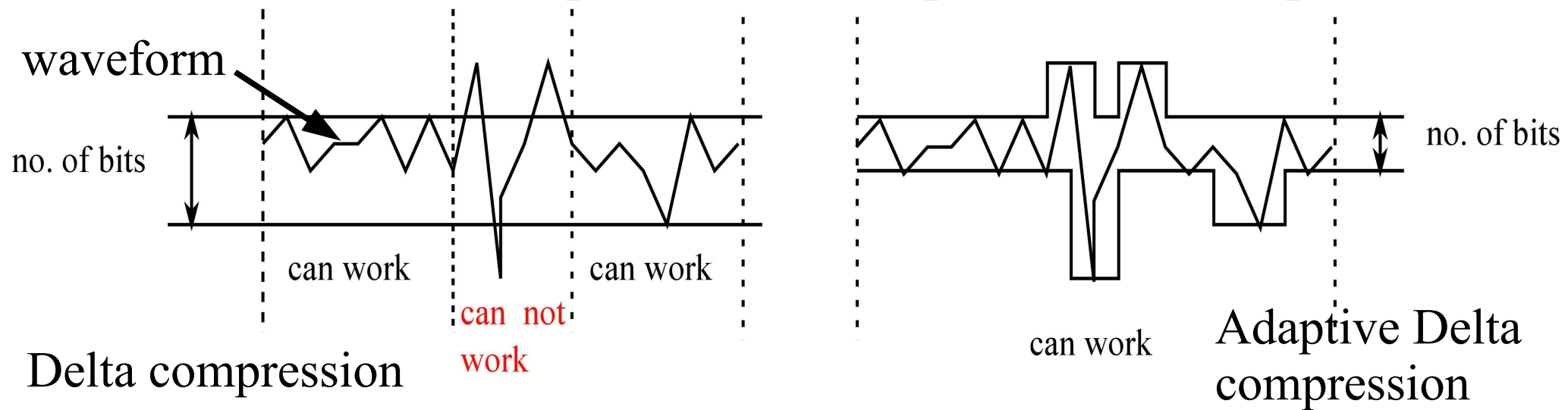
DAQ, Data Transfer and Network

Using high performance network switch to solve the head of line block problem

DAQ screen base on MIDAS

14 FADC boards

High performance network switch
Cisco Catalyst WS-C3850-24T-S

	MIDAS experiment "deeme"			Thu Feb 16 19:30:15 2017 Refr:3		
Stop	Pause	ODB	CNAF	Messages	ELog	Alarms	Programs	History	Config	Help

Trigger Scaler event

Run #5146	Running	Alarms: On	Restart: No	Data dir: /home/deeme/online/data2
Start: Thu Feb 16 19:23:33 2017			Running time: 0h06m42s	

Equipment	FE Node	Events	Event rate[/s]	Data rate[kB/s]	Analyzed
Trigger	kekvme@dmdaq01	1	0.0	0.0	N/A
Scaler	kekvme@dmdaq01	0	0.0	0.0	N/A
SiTCP_board17	feSiTCP17@dmdaq01	10011	25.0	2660.7	N/A
SiTCP_board07	feSiTCP07@dmdaq01	10011	25.0	2660.6	N/A
SiTCP_board16	feSiTCP16@dmdaq01	10011	25.0	2660.7	N/A
SiTCP_board04	feSiTCP04@dmdaq01	10011			
SiTCP_board02	feSiTCP02@dmdaq01	10011			
SiTCP_board12	feSiTCP12@dmdaq01	10011			
SiTCP_board03	feSiTCP03@dmdaq01	10011			
SiTCP_board15	feSiTCP15@dmdaq01	10011			
SiTCP_board05	feSiTCP05@dmdaq01	10011	25.0	2660.7	N/A
SiTCP_board06	feSiTCP06@dmdaq01	10011	25.0	2660.6	N/A
SiTCP_board10	feSiTCP10@dmdaq01	10011	25.0	2660.6	N/A
SiTCP_board11	feSiTCP11@dmdaq01	10011	25.0	2660.6	N/A
EB	Ebuilder@dmdaq01	10019	25.0	34535.8	N/A
SiTCP_board18	feSiTCP18@dmdaq01	10011	25.0	2660.9	N/A

DAQ system can run with 25Hz and 12 FADC boards

Summary and Discussion

1. Cosmic ray induced background is estimated for DeeMe exp.
   ~ 0.025 background/det. liver year

   → analysis time window 10 μs

   to achieve the 3σ significance => record the waveform > 170 μs

2. Build new firmware for FADC readout board
   + develop the new compression algorithm "adaptive delta compression"
   + Read out long data waveform ~ 80 μs
   + Small dead time ~ 18ms, maximum trigger rate is 50 Hz
                              → record upto 160 μs

3. Develop the DAQ system

   + Collect data of 12 FADC boards without network problem

Thanks for your attention