High rate capability of gas ionization chamber with flash ADC

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Collaborators...

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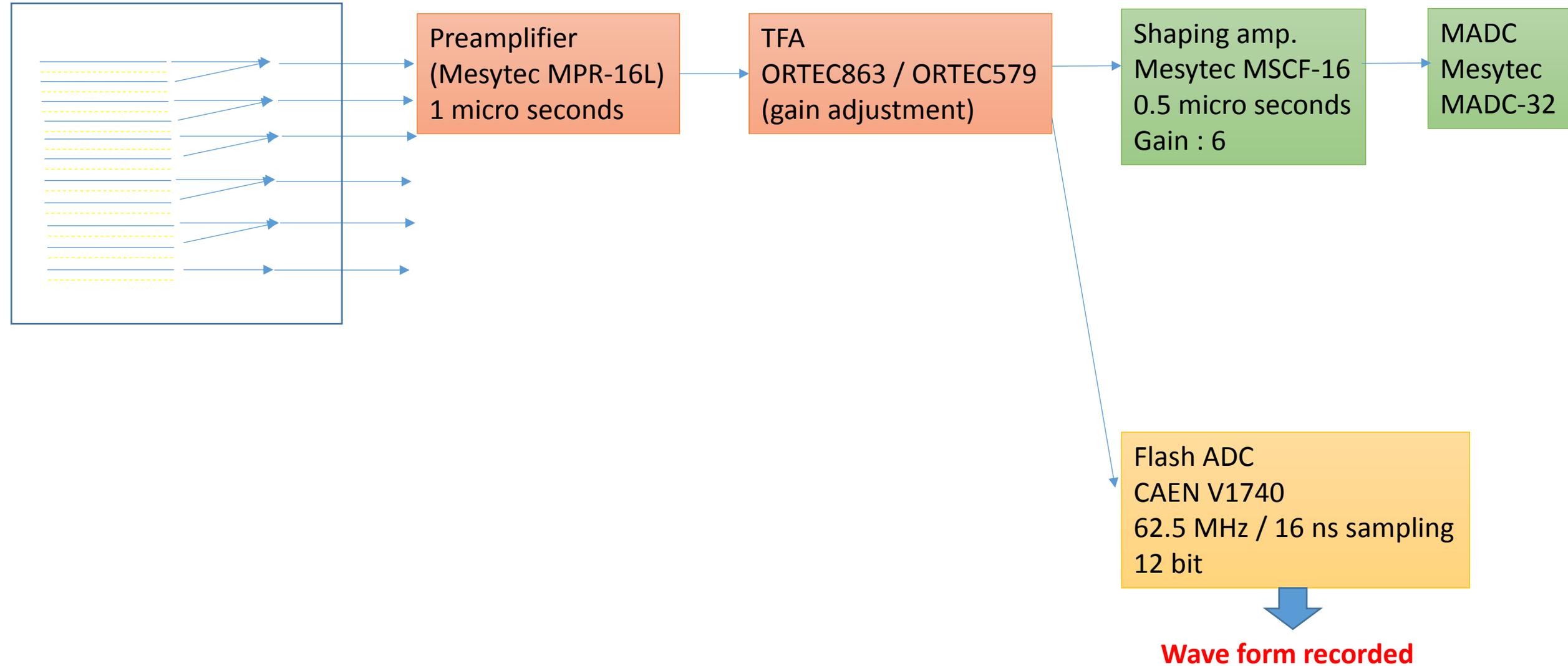
Introduction

- Goal
  - Removing contributions from pile up noises from the signals for ionization chamber irradiated a high rate RI beam with an intensity of around **a few 10^5 cps**

    ($\leftarrow\rightarrow$ a conventional way: preamp + shaper $\rightarrow$ high rejection rate (33% survival rate @ the above intensity)
  - Establish the method and apply it to other detectors in the beam line

Ion chamber (D. Nishimura, Tokyo University of Science)

- Atomospheric pressure
- Voltage +400V
- Gas : try two kinds P10 and CF4
- Length : 440 mm
- Drift length : 2 cm ($\rightarrow$ drift time : 360 – 400 ns at this voltage)
- Active area : 200 mm phi

- Resolution achieved with a low rate and without digitizer
  5 sigma separation for Z~50 @ ~ 200 MeV/u

Electronics & DAQ
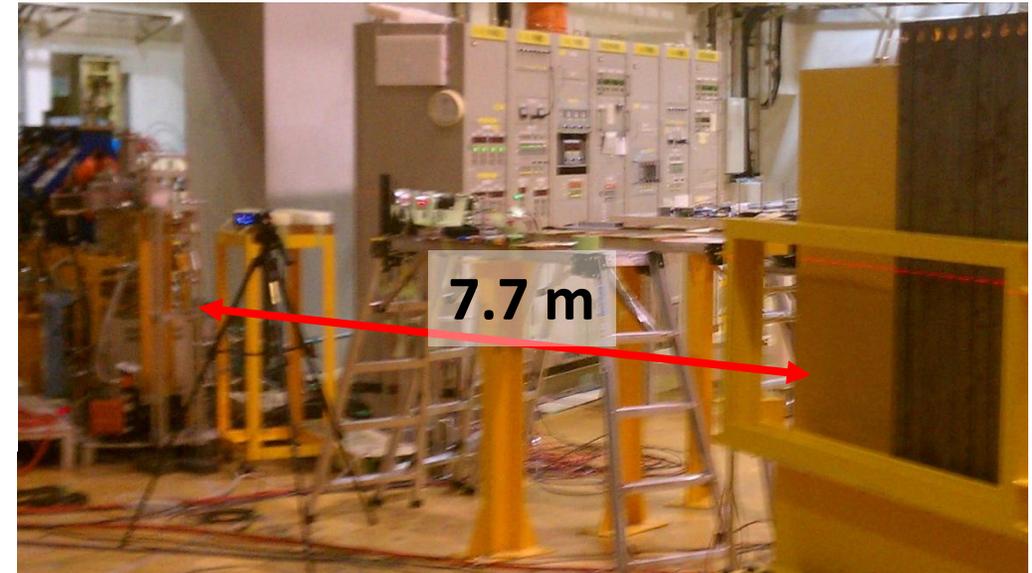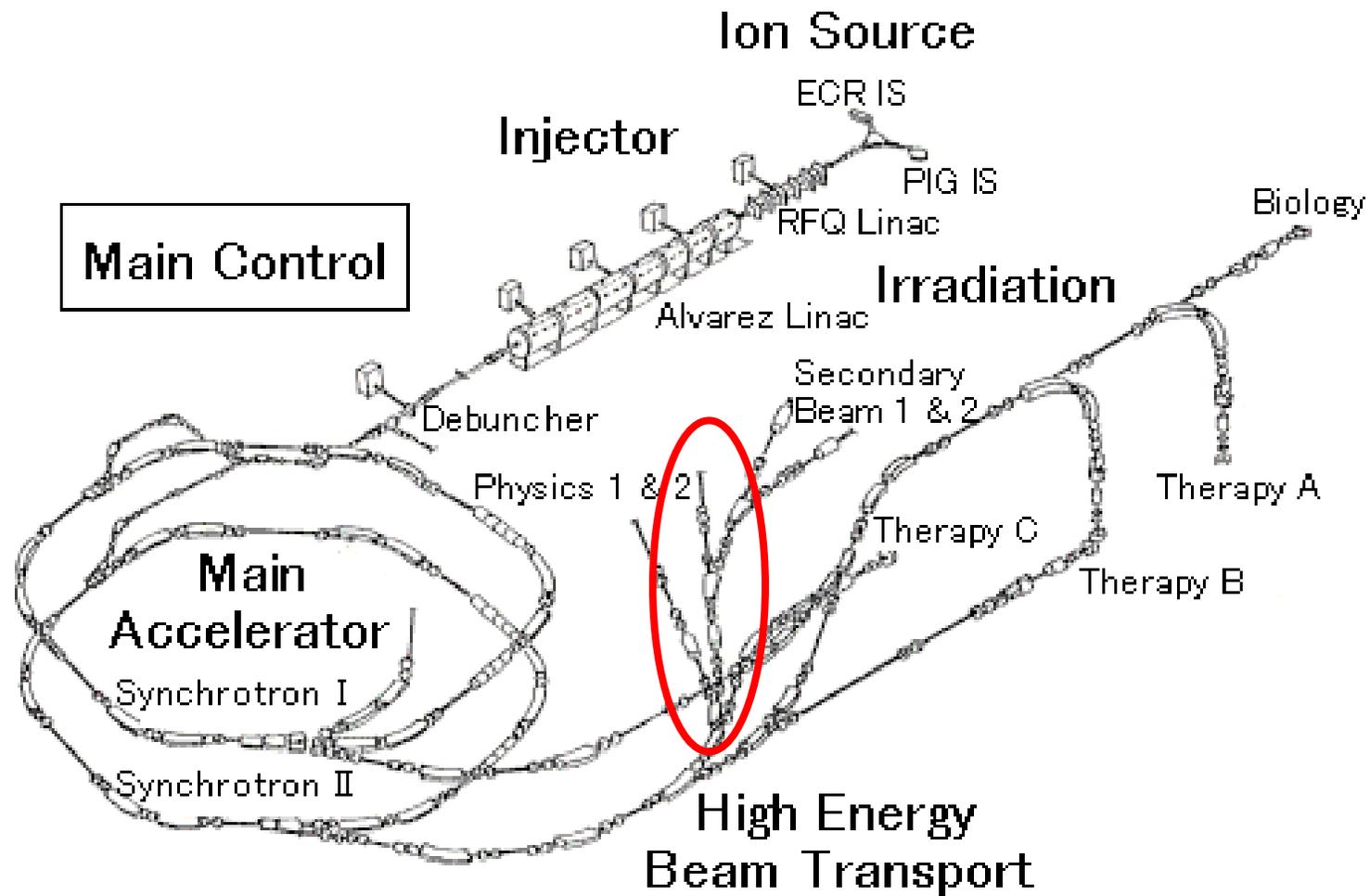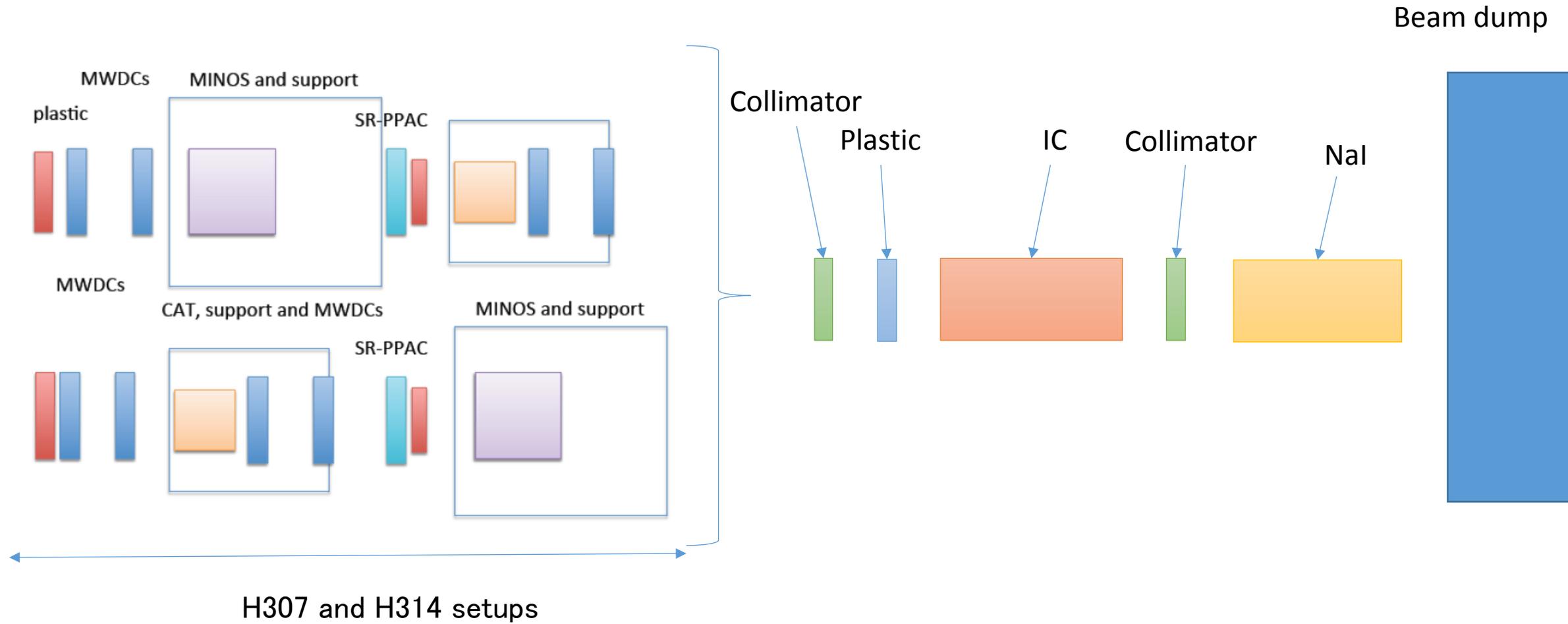
Preamplifier
(Mesytec MPR-16L)
1 micro seconds

TFA
ORTEC863 / ORTEC579
(gain adjustment)

Shaping amp.
Mesytec MSCF-16
0.5 micro seconds
Gain : 6

MADC
Mesytec
MADC-32

Flash ADC
CAEN V1740
62.5 MHz / 16 ns sampling
12 bit

Wave form recorded

Beams

- Ne beam @ 180 A MeV ~50k, ~150k, 600k, 1.5M ppp
- Xe beam @ 200 AMeV ~10k, ~50k, ~500k ppp
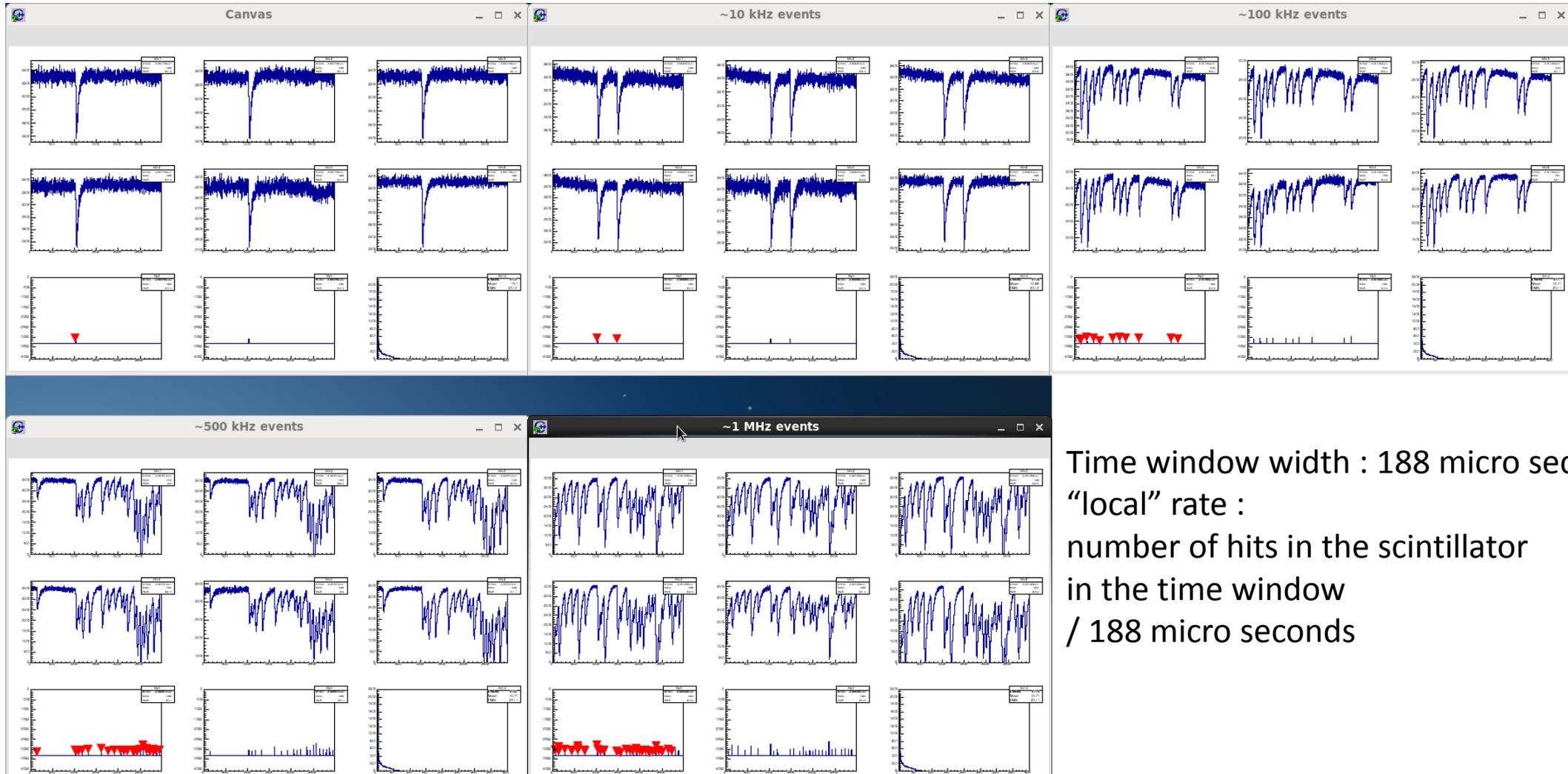
- Spill interval and width : 3 and 1 s

Beam line

Ion Source
ECR IS
Injector
PIG IS
RFQ Linac
Main Control
Biology
Irradiation
Alvarez Linac
Debuncher
Secondary
Beam 1 & 2
Physics 1 & 2
Therapy A
Main
Accelerator
Therapy C
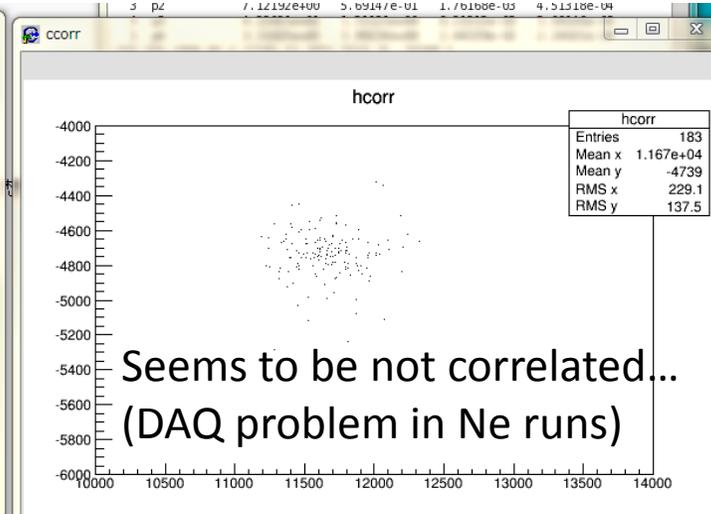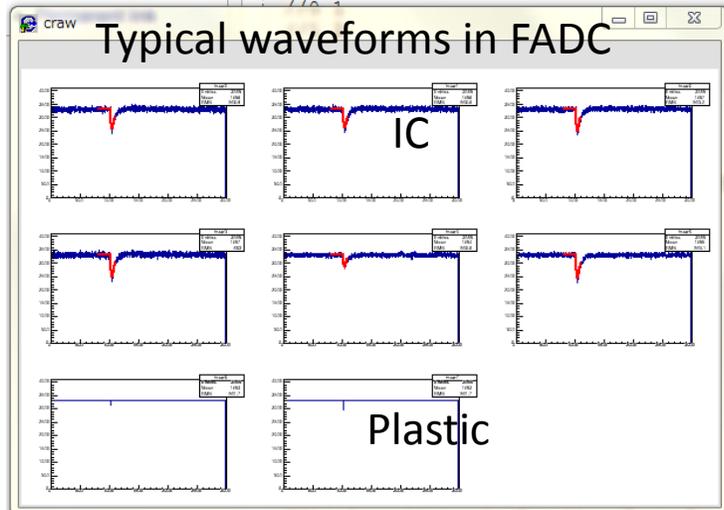Synchrotron I
Therapy B
Synchrotron II
High Energy
Beam Transport

7.7 m

Setup
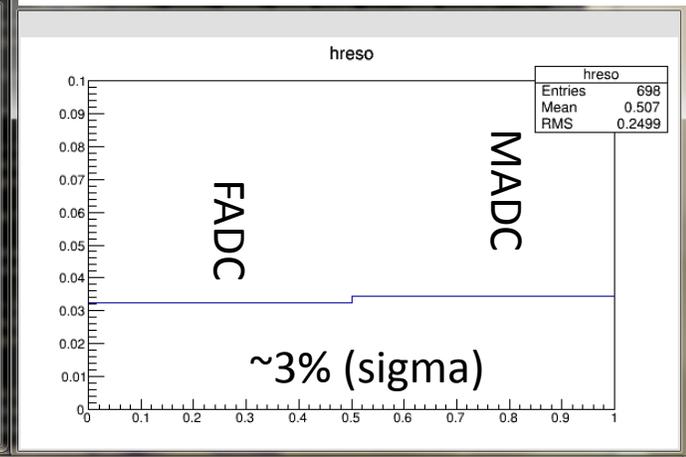
Typical recorded waveforms
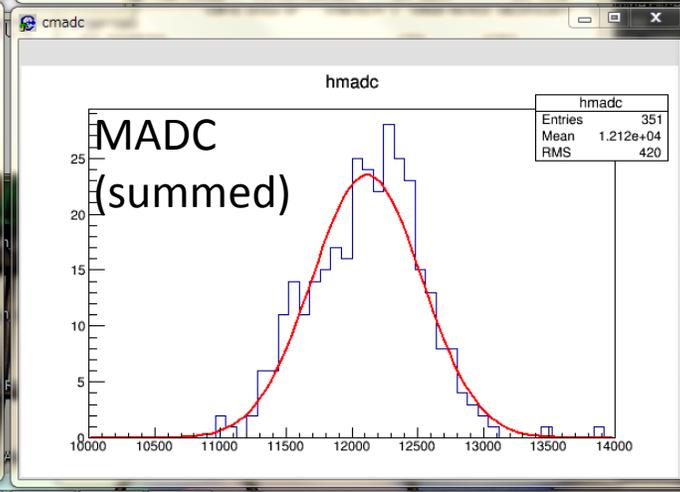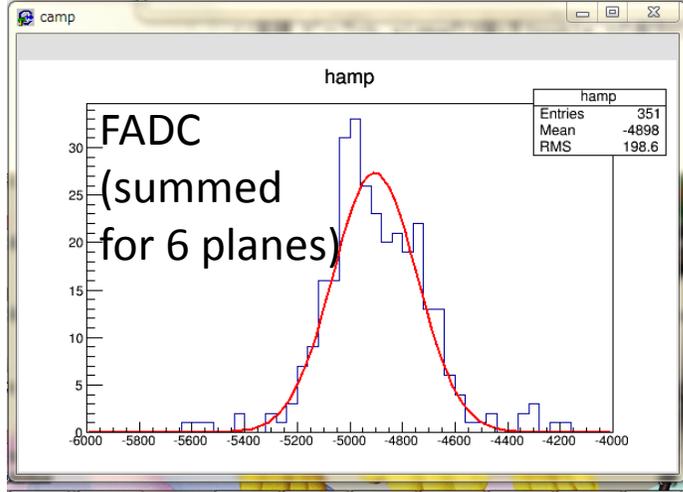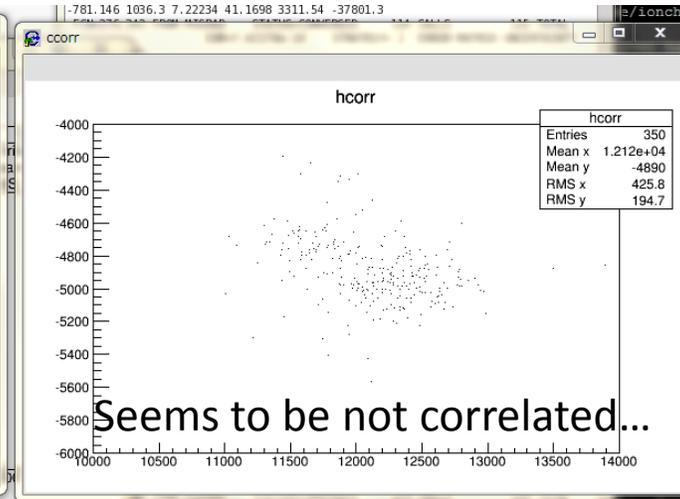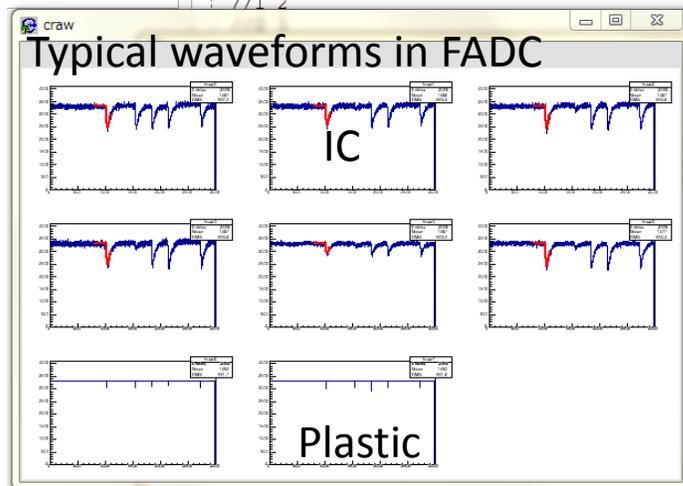# and "local" beam rate definition

Time window width : 188 micro seconds
"local" rate :
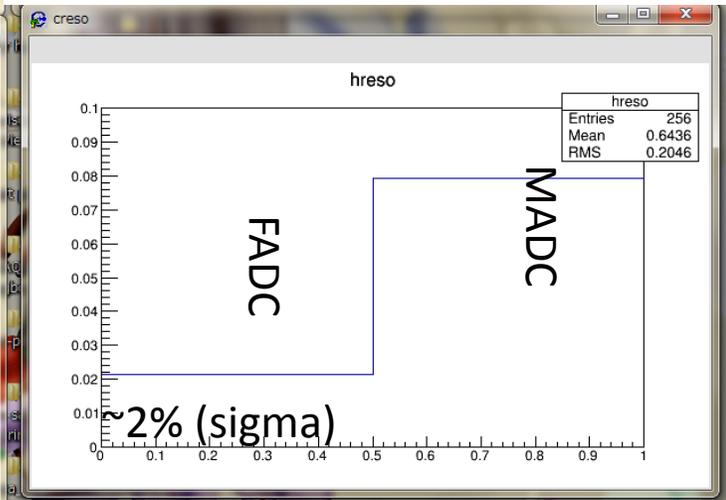number of hits in the scintillator
in the time window
/ 188 micro seconds

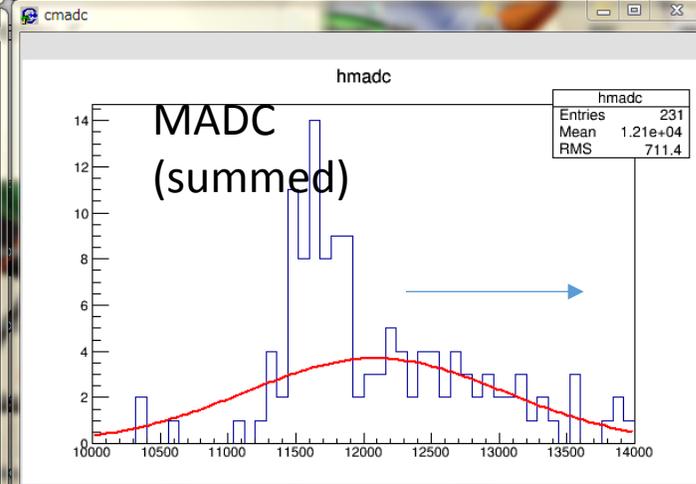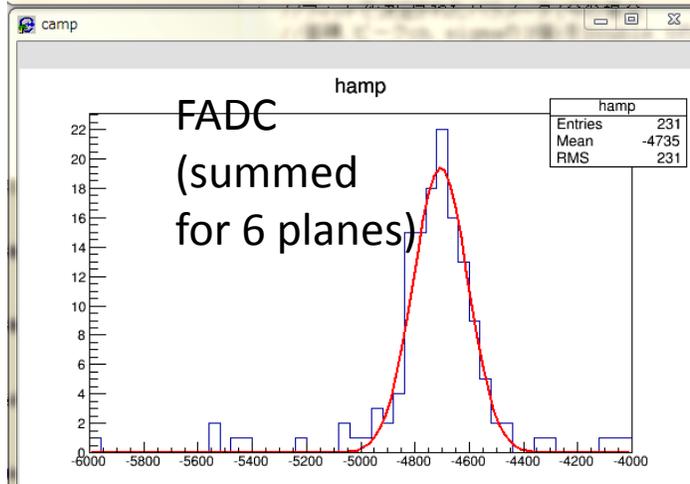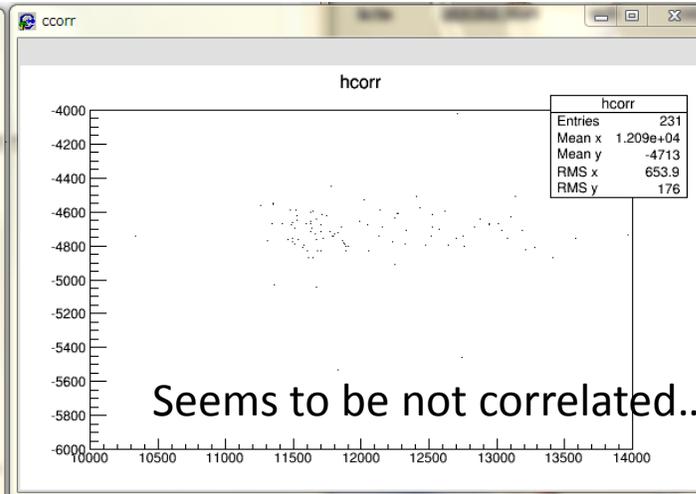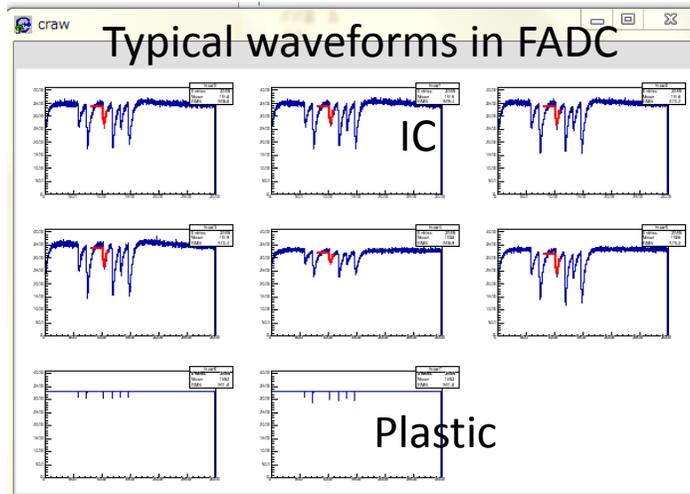# @ 50 kppp, HV(IC)=400 V, Preamp 1 micro sec., 20Ne @ 180 AMeV, P10 gas (RUN149)
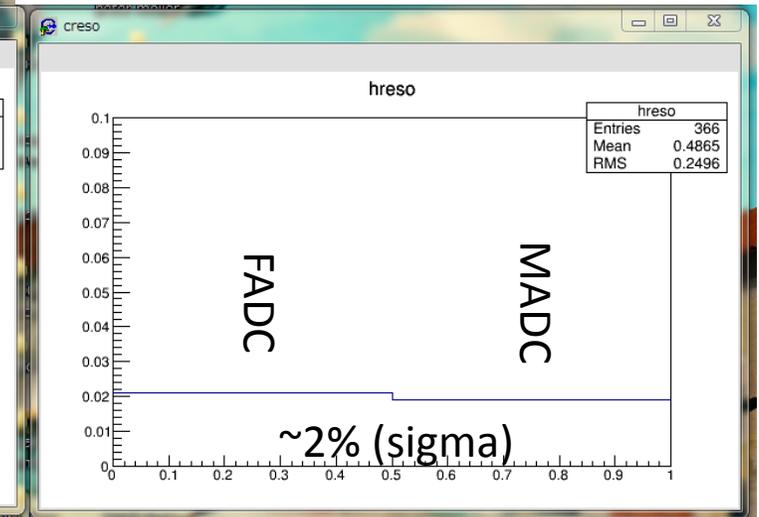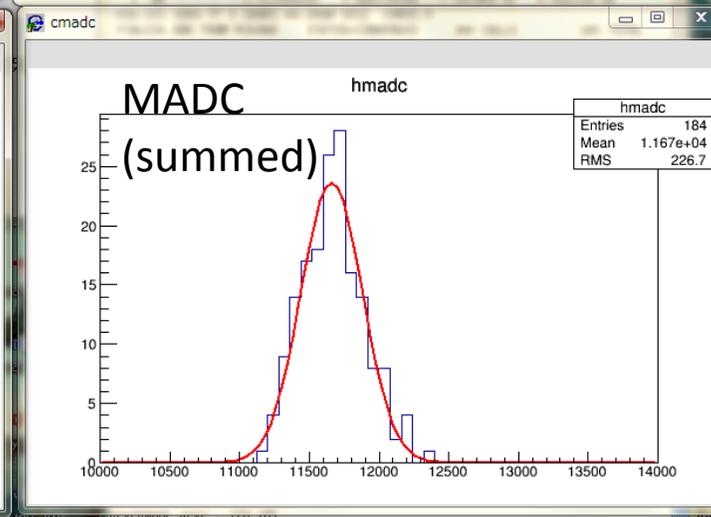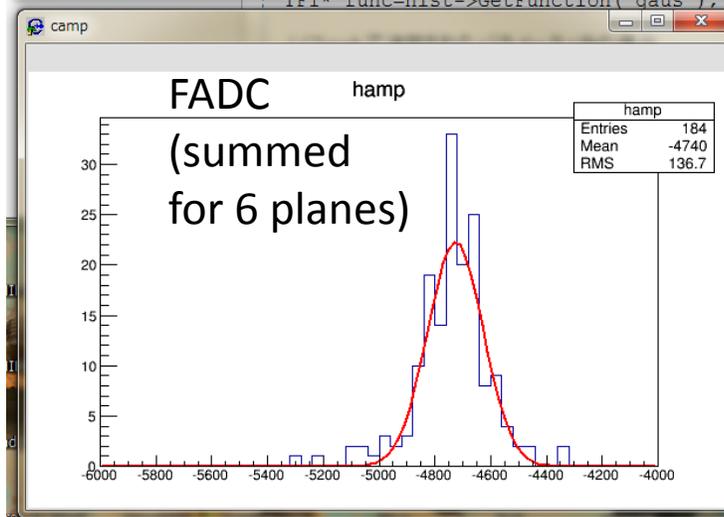
@ 150 kppp, HV(IC)=400 V, Preamp 1 micro sec., 20Ne @ 180 AMeV, P10 gas (RUN163)

@ 600 kppp, HV(IC)=400 V, Preamp 1 micro sec., 20Ne @ 180 AMeV, P10 gas (RUN162)

@ 1.5 Mppp, HV(IC)=400 V, Preamp 1 micro sec., 20Ne @ 180 AMeV, P10 gas (RUN161)

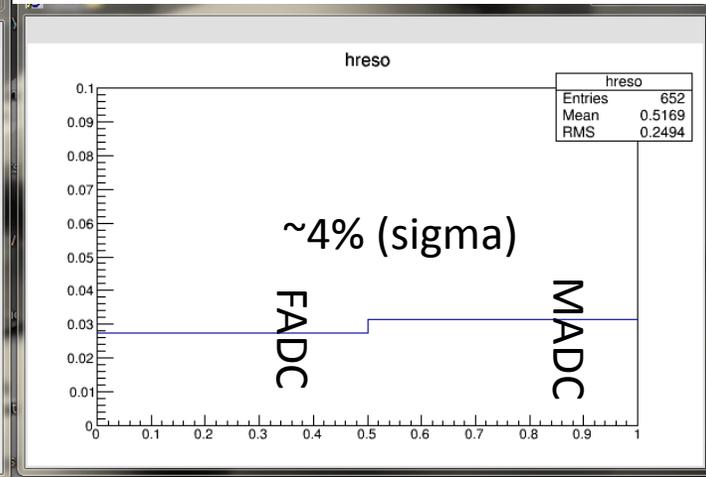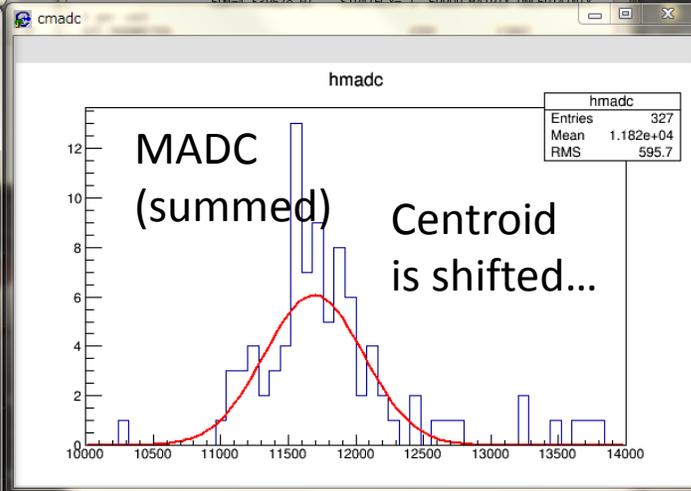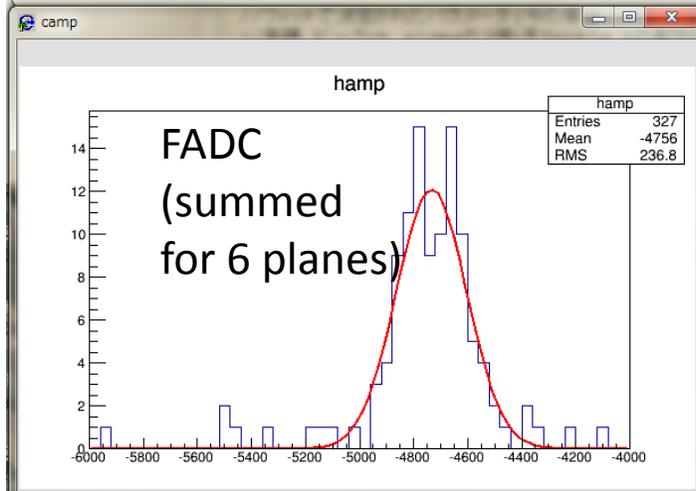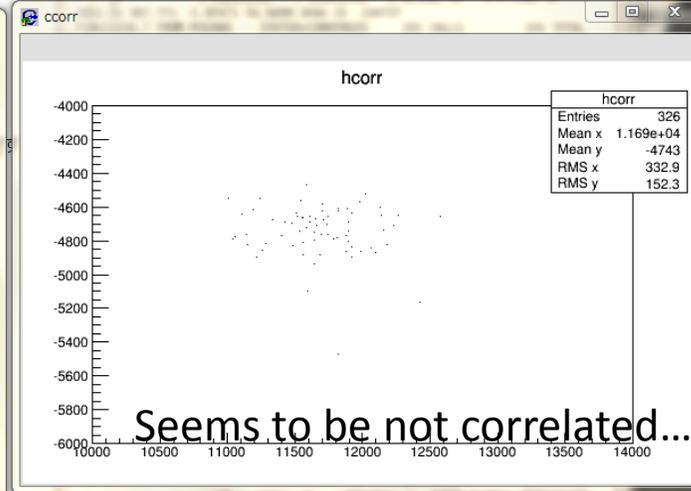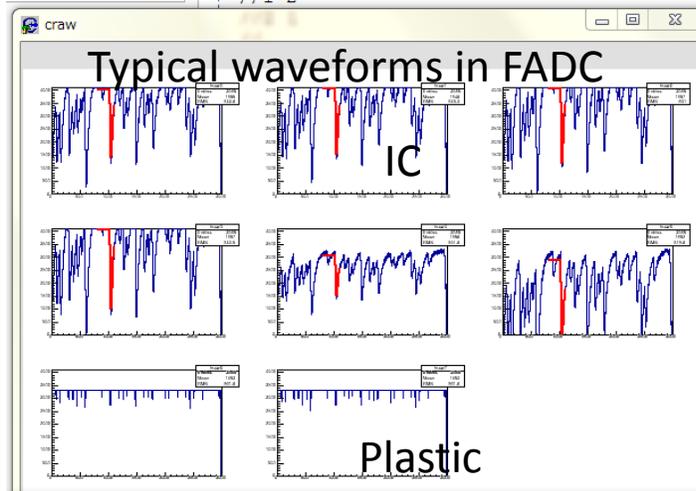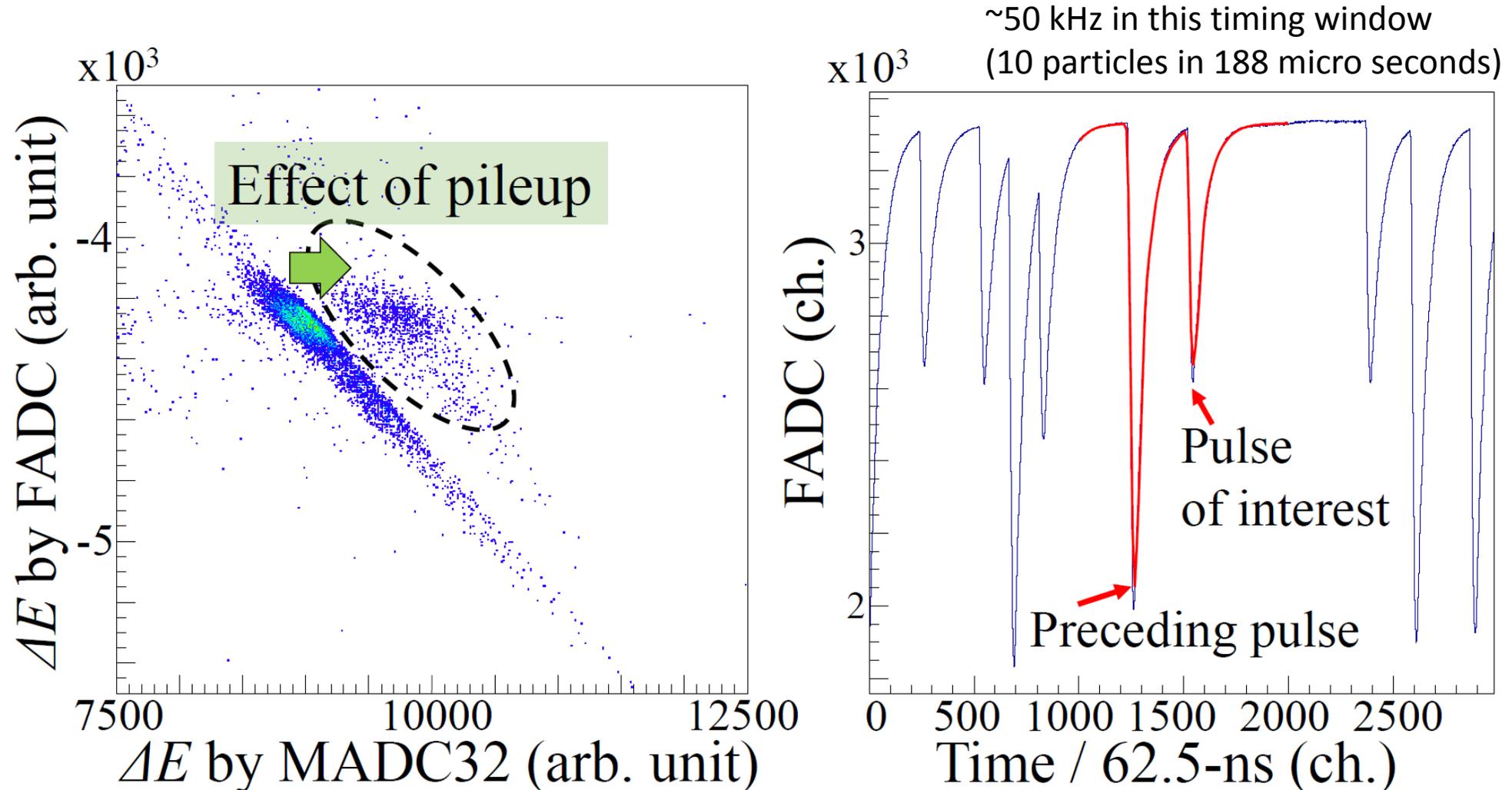# Xe @ 50 kppp (DAQ synchronization fixed…)

Summary & outlook

- IC readout : preamp time constant 1 micro seconds + 62.5 ns sampling rate with 12 bit FADC

  →

- Gives a resolution similar to the method using preamp. + shaping amp + peak-sensitive ADC

- Save pile up events up to ~100 kHz

- Energy resolution in Xe runs will be evaluated
- $>5 \times 10^5$ Hz
- → preamplifier with 1 micro seconds (drift time ~400 ns) is not enough (large baseline shift / saturation)
- → The limit of this method (drift along the beam direction)
- → Segmentation, vertical drift, …
- Fast data throughput