# Performance study of a large 1x1 m^2 MRPC with strip readouts
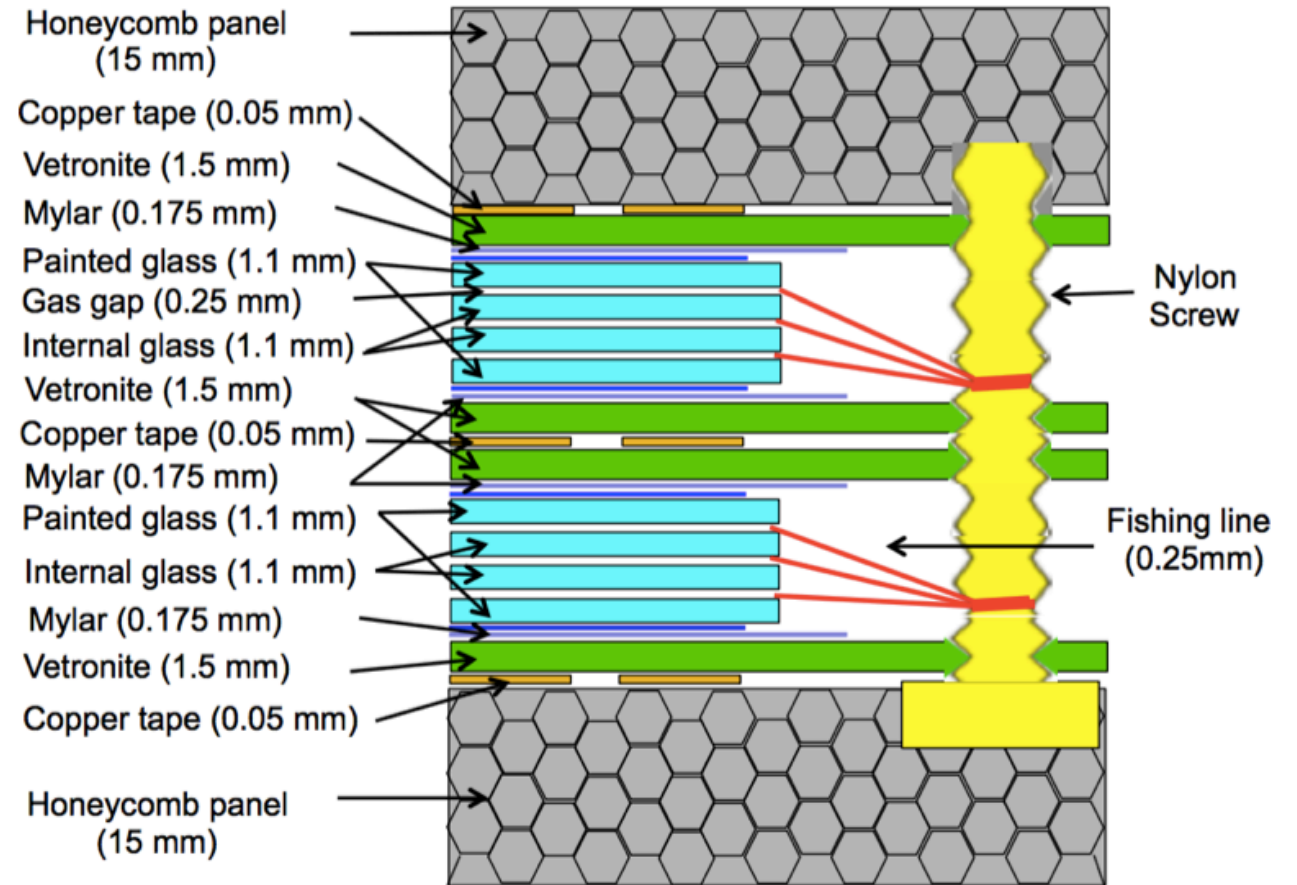
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1. Chamber design

- Double stacks of 3 gaps(6gaps in total) with 250μm of spacer

- Strip: 90cm(length) x 9mm(width) with 2mm between strips

- Readout type
  - Both-ends readout: 24 strips
  - One-end readout with 2 strips connected by LEMO cable: 12 pairs

- Input & output gas capillaries
  - Teflon pipe of Ø0.8mm for uniform gas flow
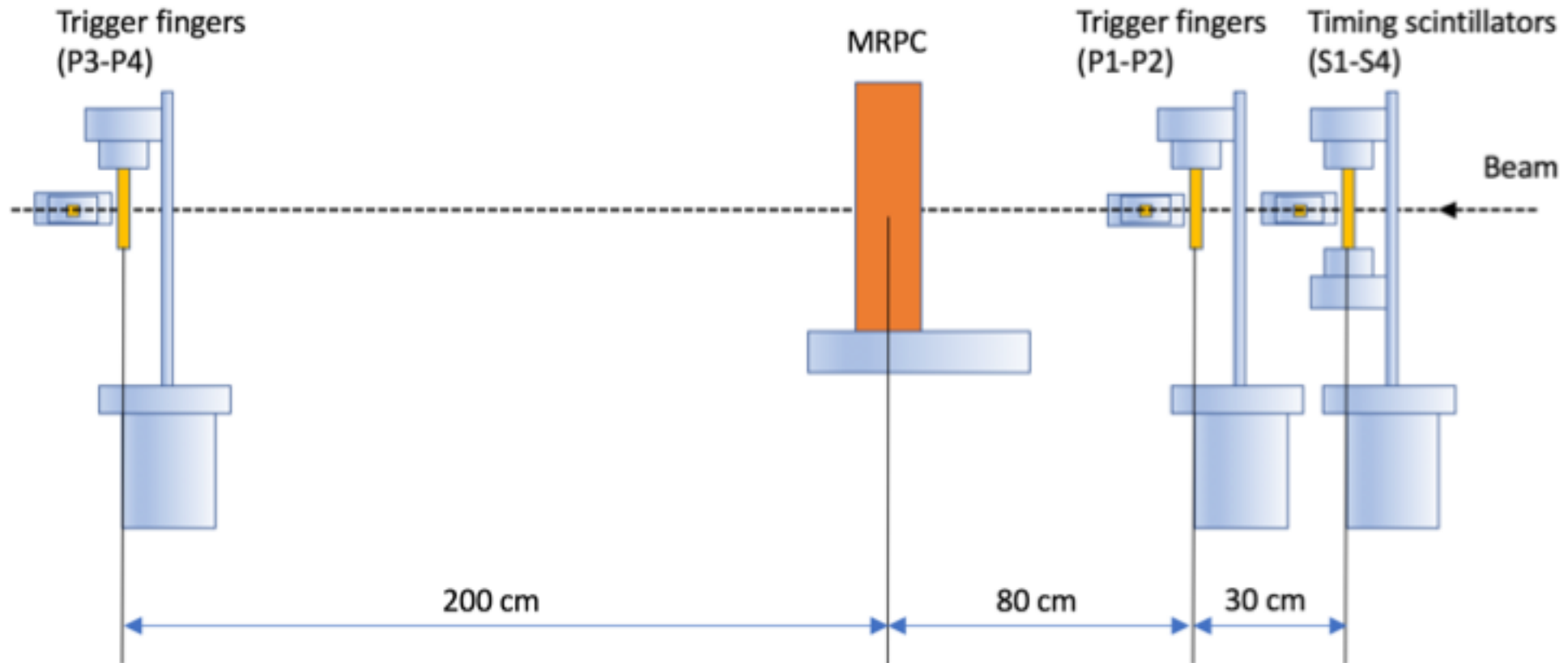
Single
24 strips

LEMO
24 strips
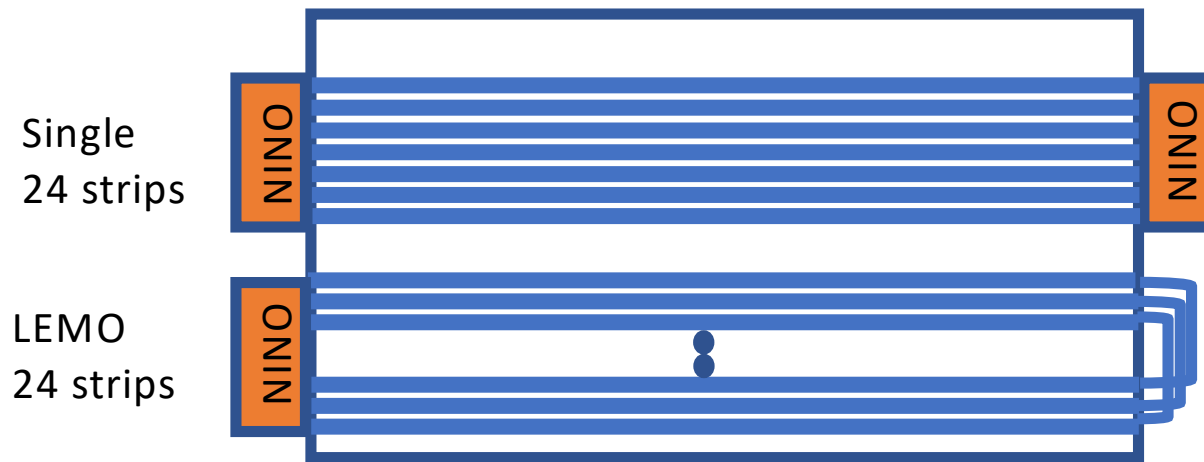
2. Cross-section view

- Double stacks
  - Reduced HV
  - One layer of strips in the middle
  - Sealing for gas gap
    - Enclosed the side(Nylon screw) of gap by using Teflon pieces and silicon.
   - Sealing was not well done on the readout side because of flat cables.

Honeycomb panel (15 mm)
Copper tape (0.05 mm)
Vetronite (1.5 mm)
Mylar (0.175 mm)
Painted glass (1.1 mm)
Gas gap (0.25 mm)
Internal glass (1.1 mm)
Vetronite (1.5 mm)
Copper tape (0.05 mm)
Mylar (0.175 mm)
Painted glass (1.1 mm)
Internal glass (1.1 mm)
Mylar (0.175 mm)
Vetronite (1.5 mm)
Copper tape (0.05 mm)
Honeycomb panel (15 mm)

Nylon Screw

Fishing line (0.25mm)

3. T10 beam facility

- Pion beam of 6 GeV/c
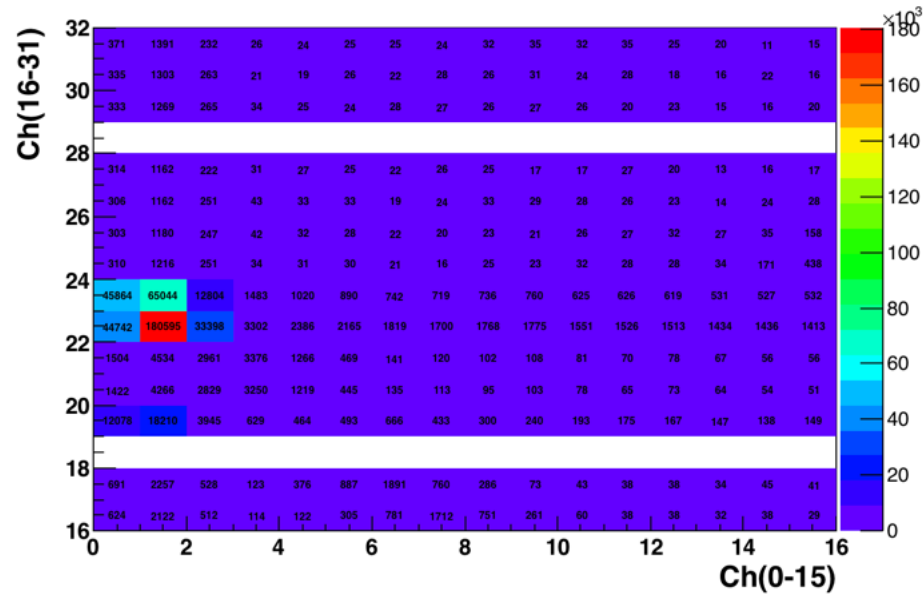- Timing scintillators Resolution ~ 40 ps
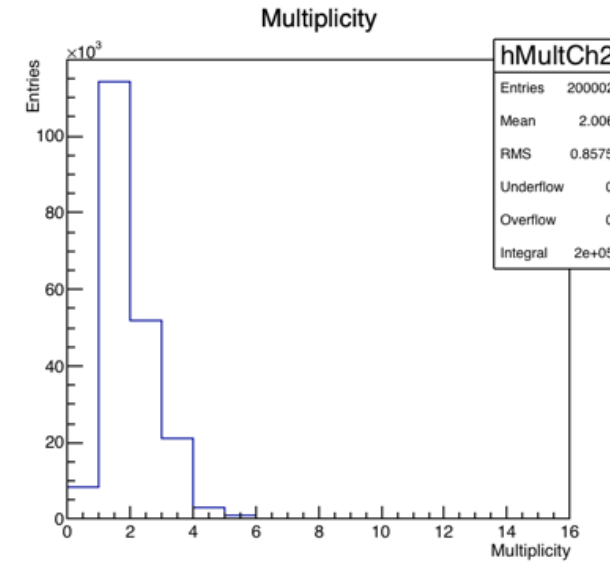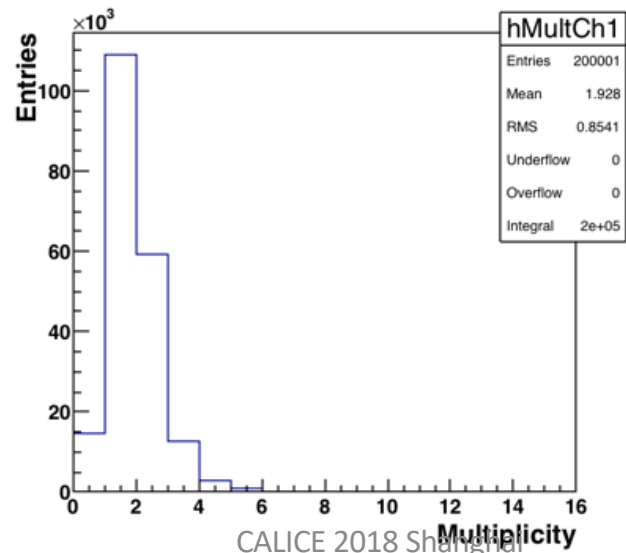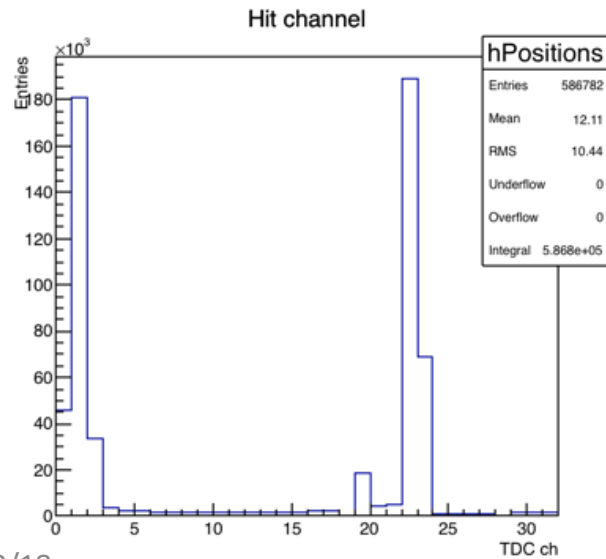- Tigger Scintillators: 1x1 cm^2 & 2x2 cm^2

4. Efficiency & Dark current
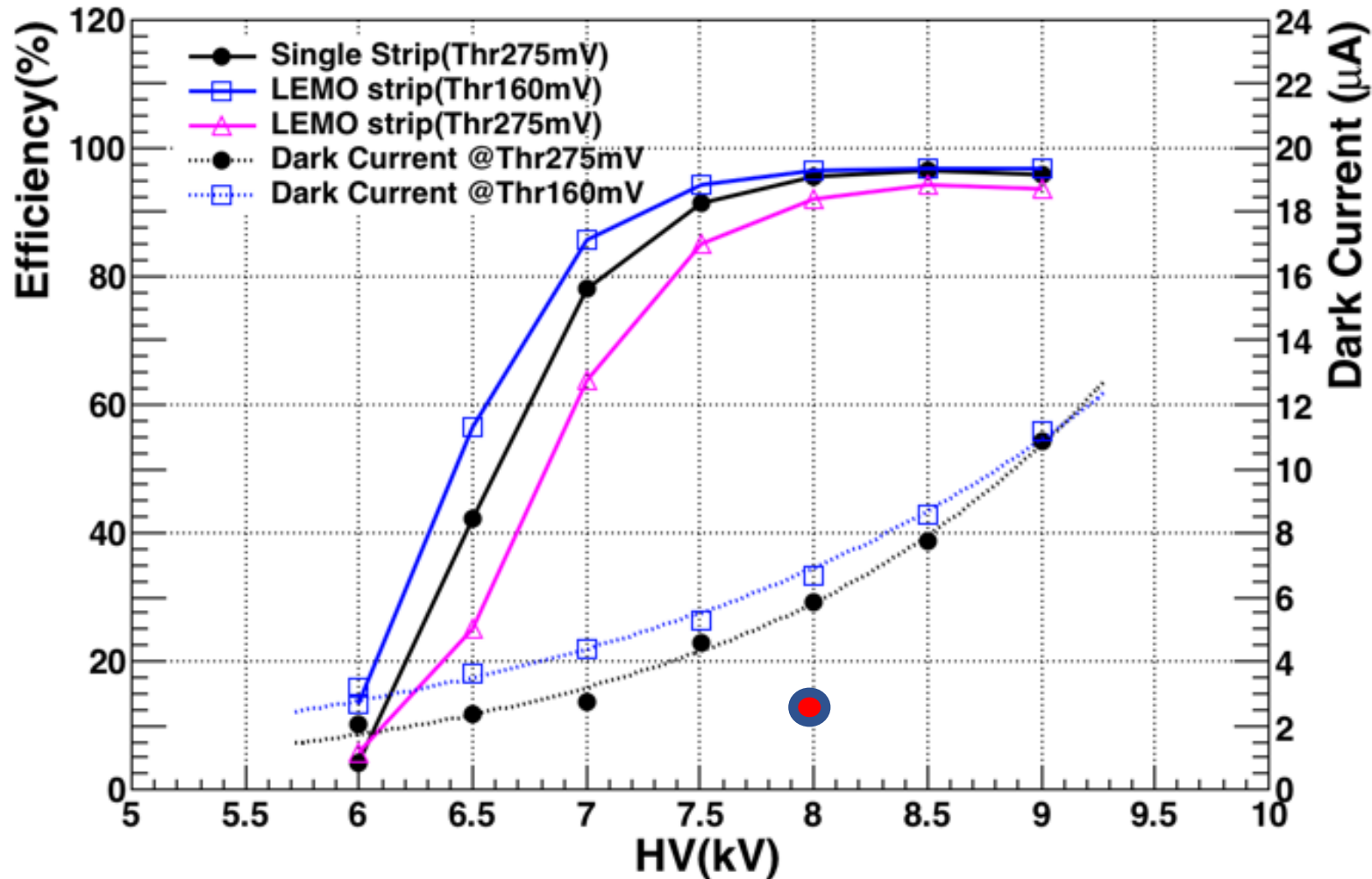
- Particle flux: ~2kHz/cm^2
- Single strip @ thr=275mV
  - Efficiency > 95%@8kV
- LEMO strip@8kV
  - Eff. > 95% (thr=160mV)
    - Noise (oscillation)
  - Eff. > 93% (thr=275mV)
- Dark Current < 2.5µA@8kV at time passes

5. Hits & cluster

- Hit on TDC channels
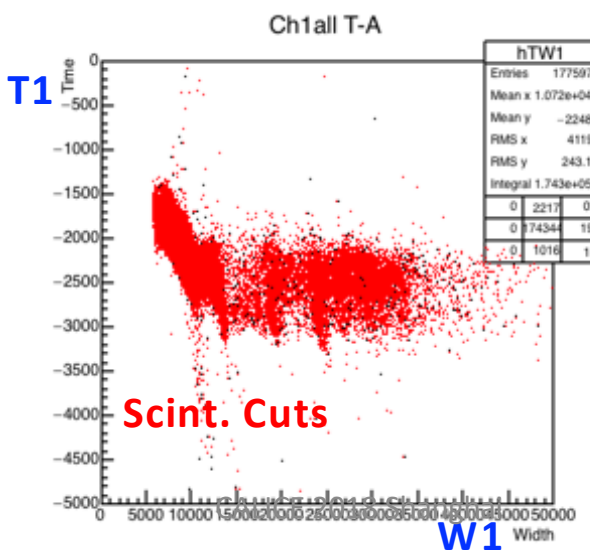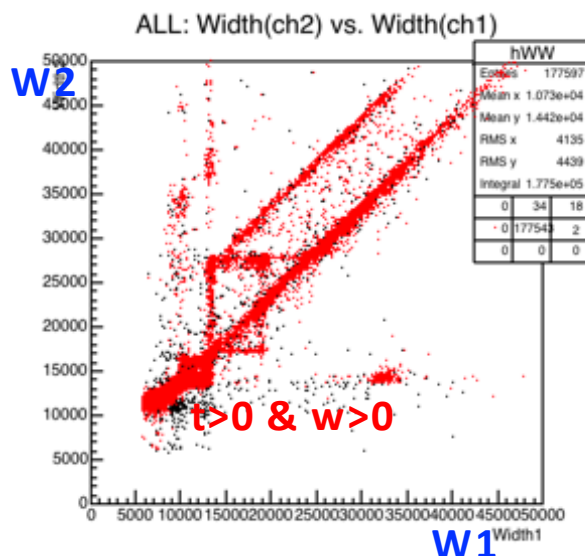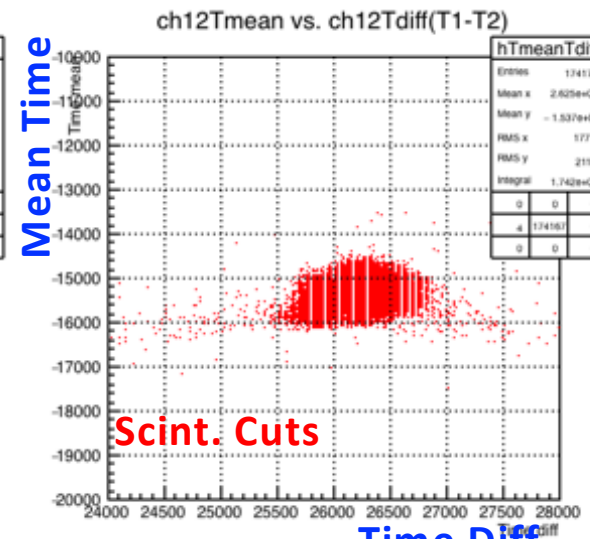- Mean cluster size ~ 2
- n.b.
  - ch1(TDC0-15)
  - ch2(TDC(16-31)
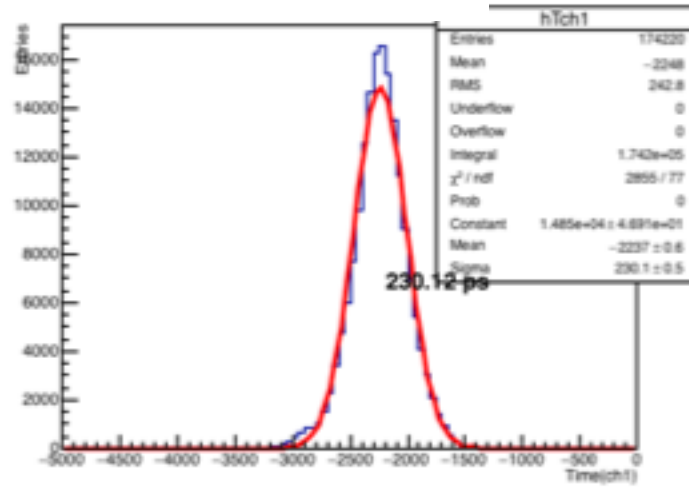
6. Single Strip: Time & Width
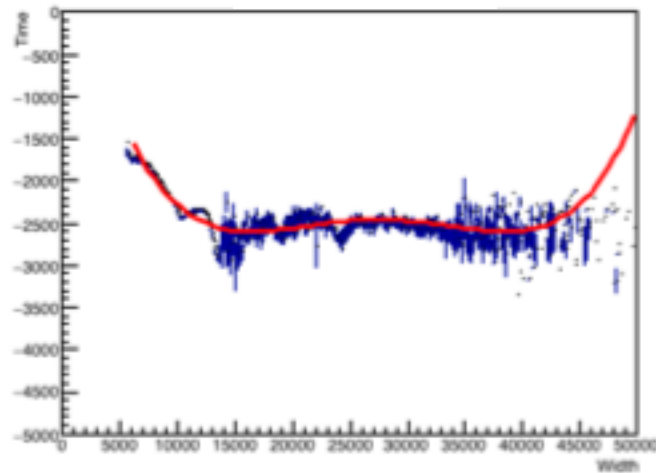## (200k events@8kV)
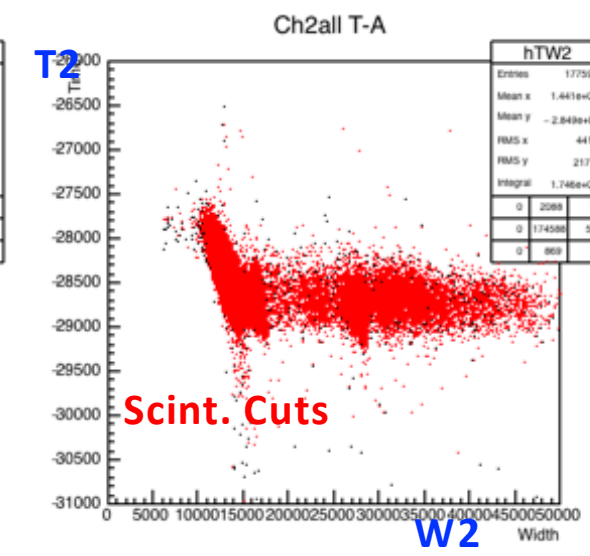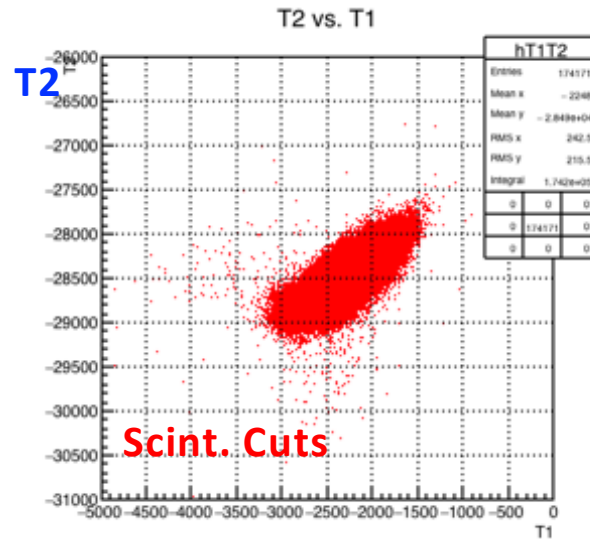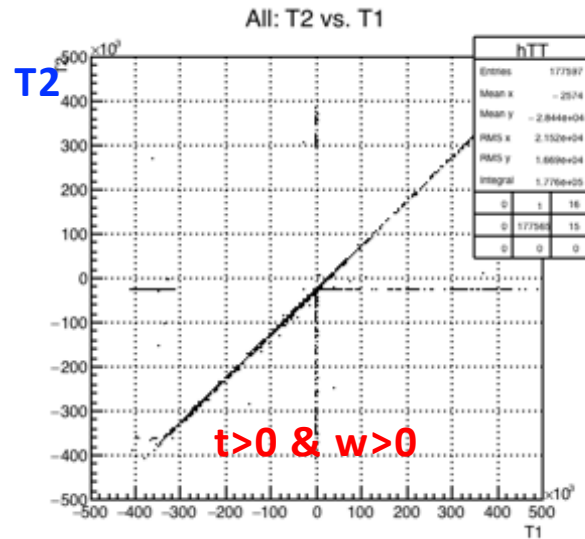
7. T-A correction

Uncorr. Time

Width
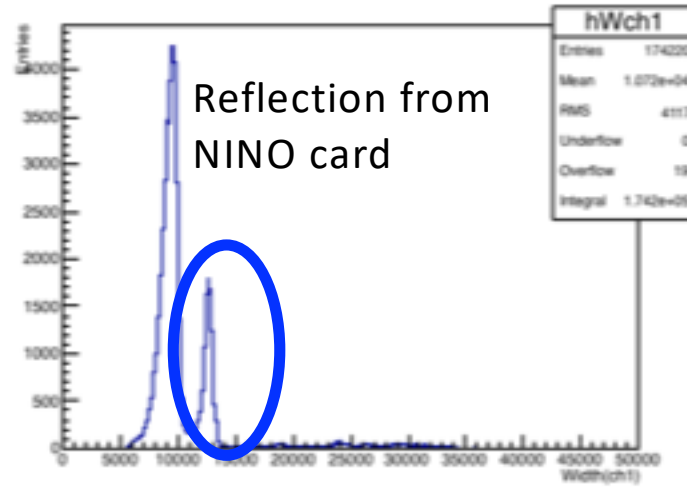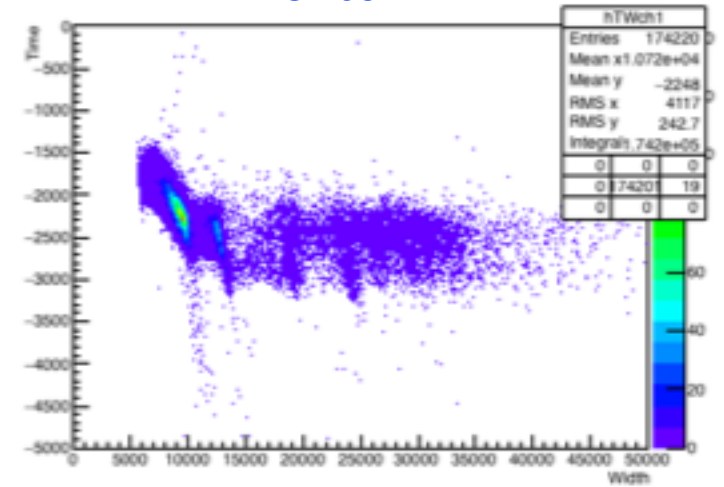
Reflection from NINO card

Uncorr. T-A

4th order fit

Corr. T-A

Gaussian Fit

230.12 ps

Time Resol. = 130.98 ps (136.93 ps)

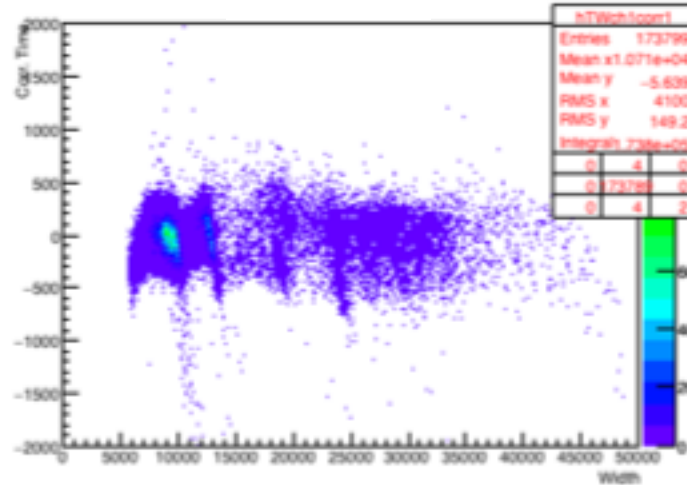# 7-1 LEMO strip: on the beam

Uncorr. Time

Width

Reflection from LEMO & NINO card

Uncorr. T-A

4th order fit

Corr. T-A

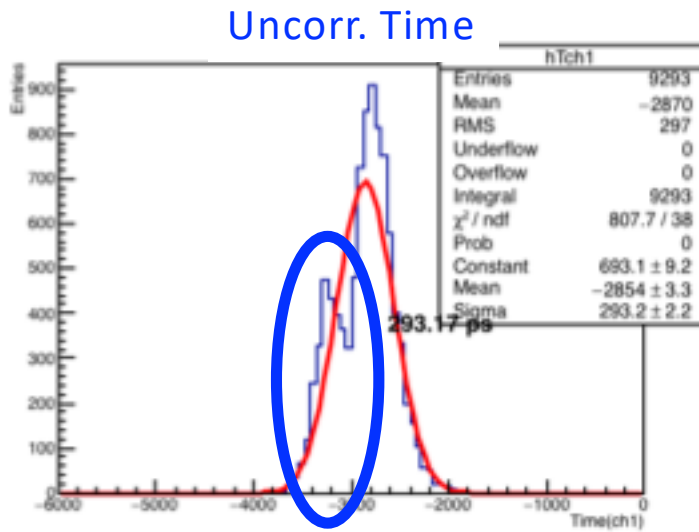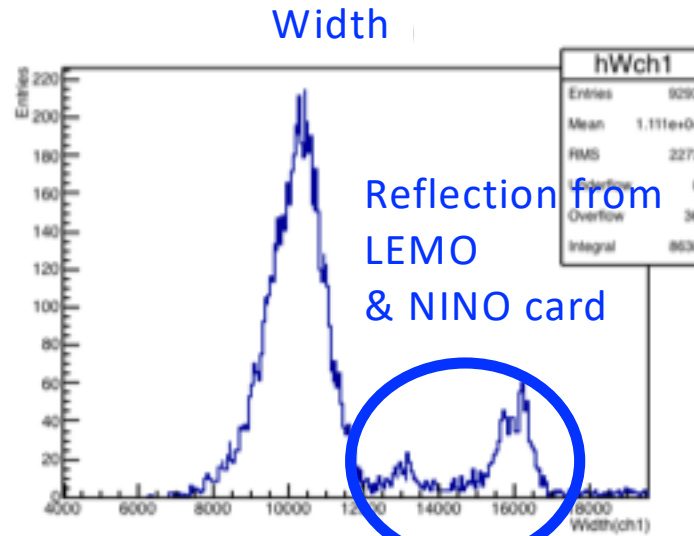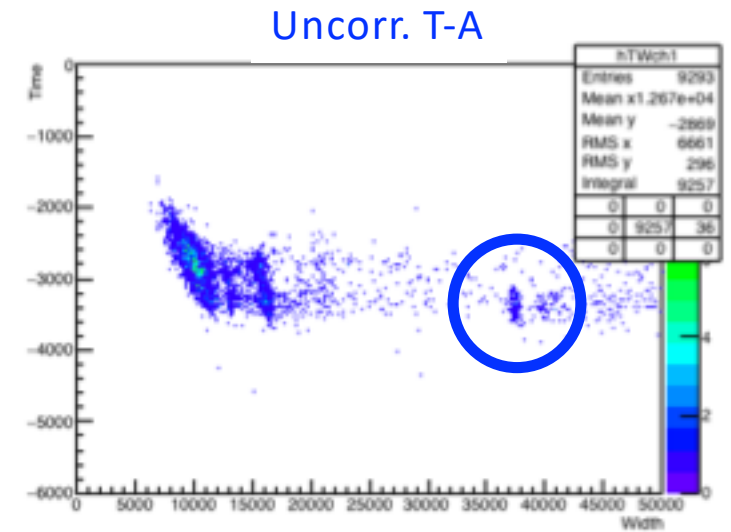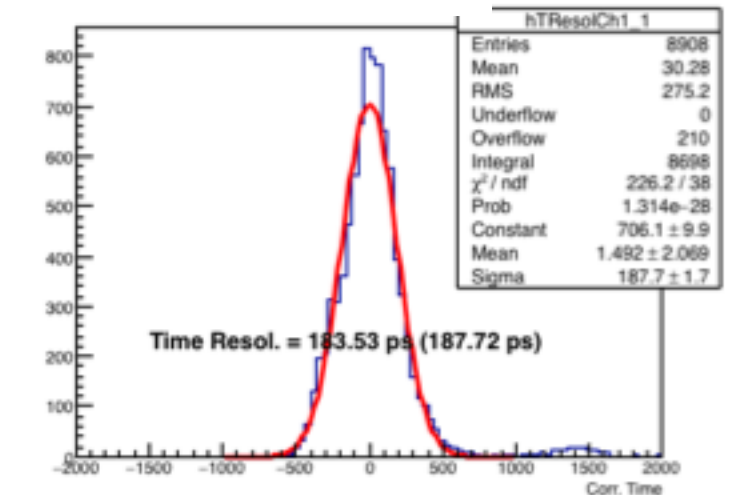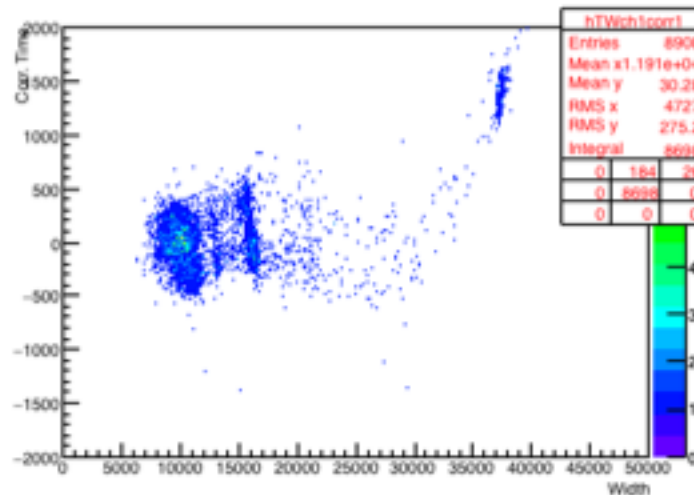Gaussian Fit

Time Resol. = 183.53 ps (187.72 ps)
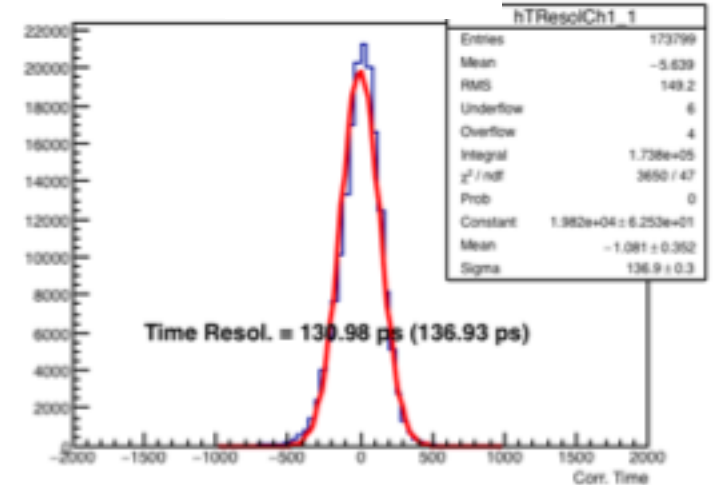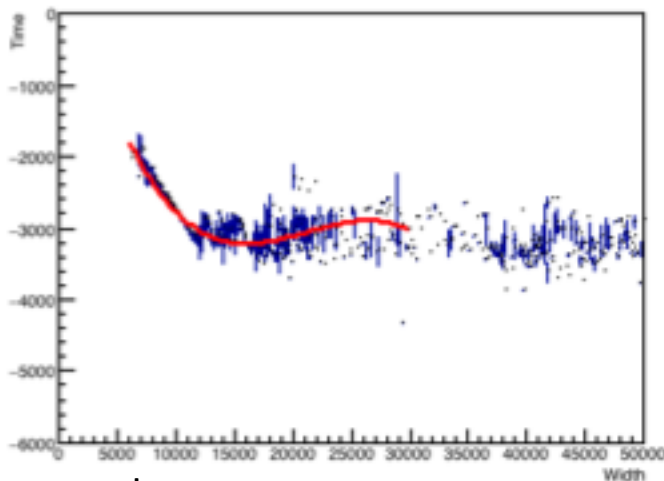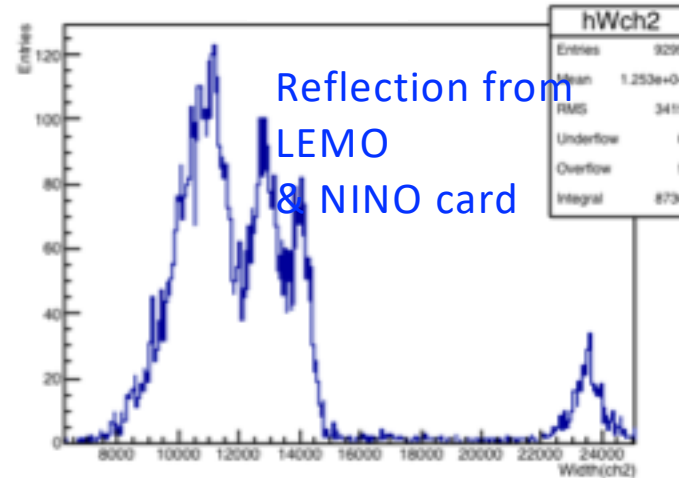
- 2nd peak, ~0.8ns advanced compared to the main peak
- Only for the strip on the beam, Noise? or Oscillation? → impair the time resolution

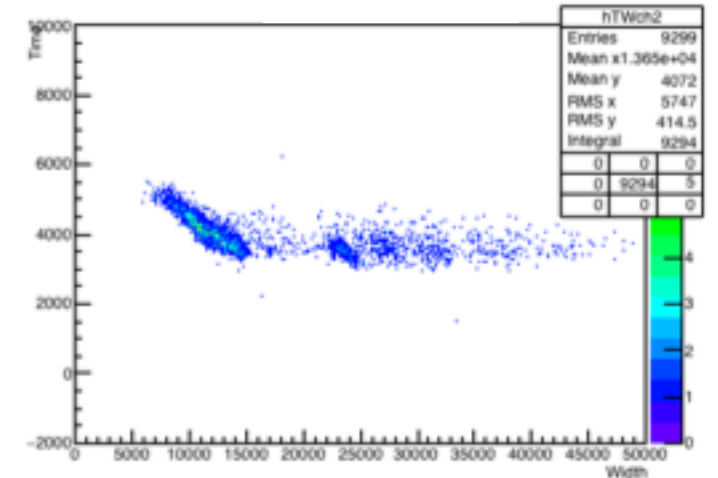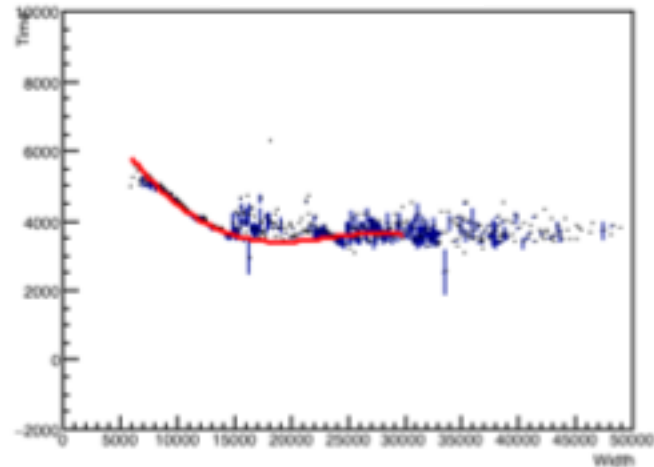# 7-2 LEMO strip: connected by LEMO cable

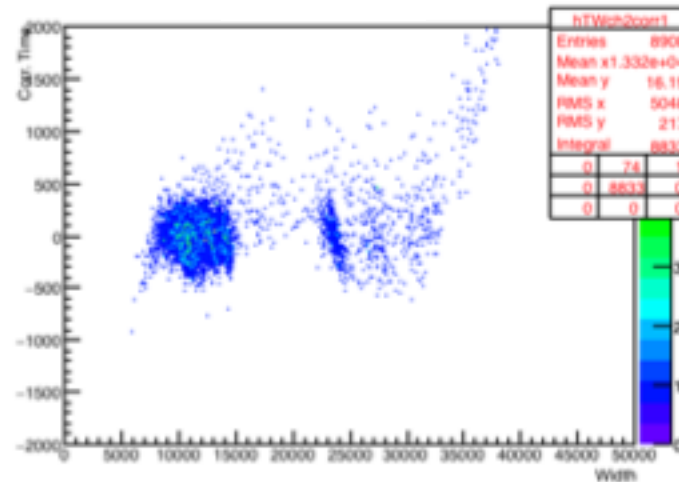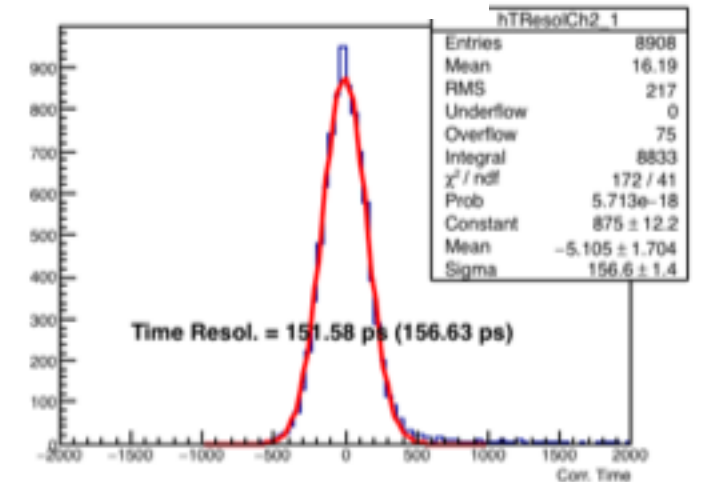### Uncorr. Time
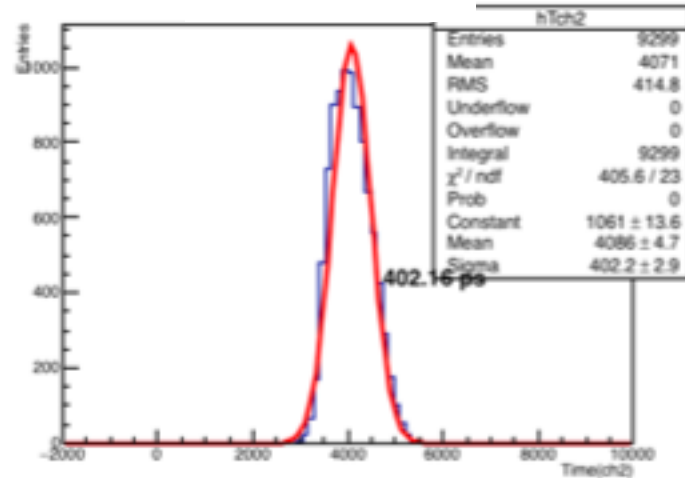
Width

Reflection from
LEMO
& NINO card

Uncorr. T-A

4th order fit

Corr. T-A

Gaussian Fit

Time Resol. = 151.58 ps (156.63 ps)

8. Time Resolution

Time Resolution

Legend:
- ● Single strip (Thr275mV, full fit)
- ○ Single strip (Thr275mV, narrow fit)
- □ LEMO strip Ch1 (Thr160mV)
- ■ LEMO strip Ch2 (Thr160mV)
- △ LEMO strip Ch1 (Thr275mV)
- ▲ LEMO strip Ch2 (Thr275mV)
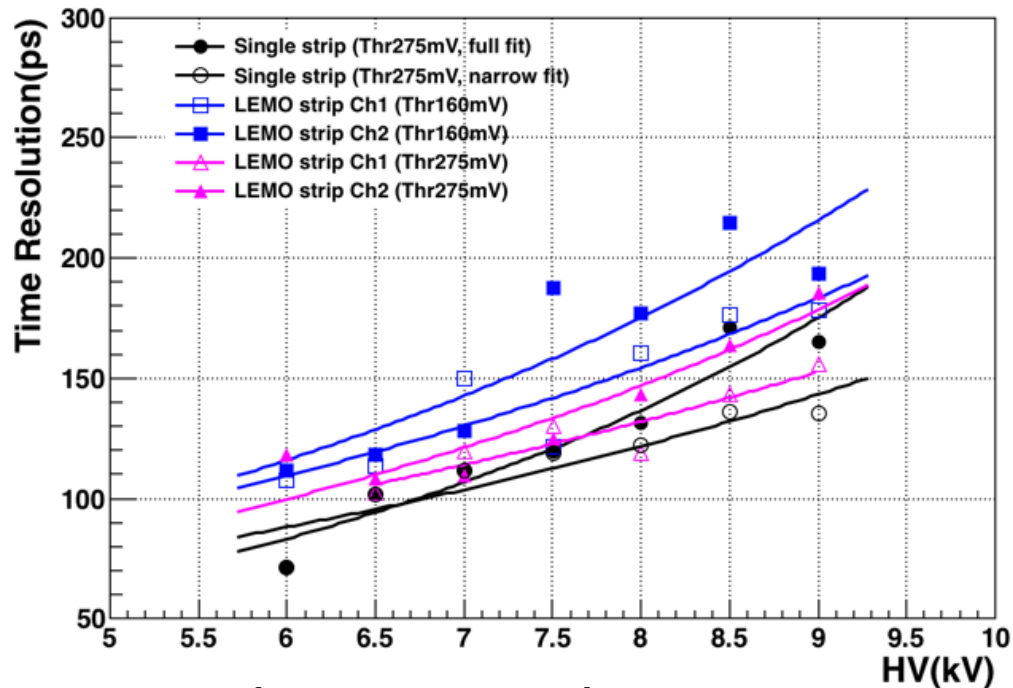
- Single strip @8kV
  - 130ps of time resolution
- LEMO strip @8kV
  - Ch1: 160ps
  - Ch2: < 200ps

Mean Time Resolution

Legend:
- ● Single strip (Thr275mV)
- □ LEMO strip (Thr160mV)
- △ LEMO strip (Thr275mV)
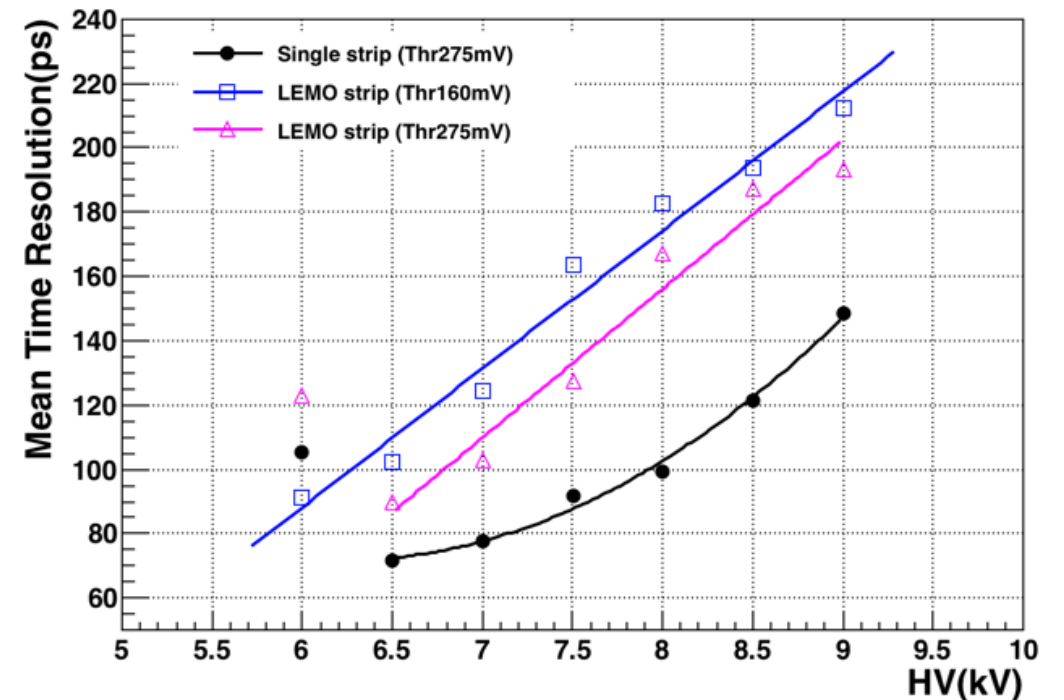
- Single strip @ 8kV
  - 100ps of time resolution
- LEMO strip @8~8.50kV
  - Ch1: 160ps
  - Ch2: < 200ps
  - Prone to noise & reflection

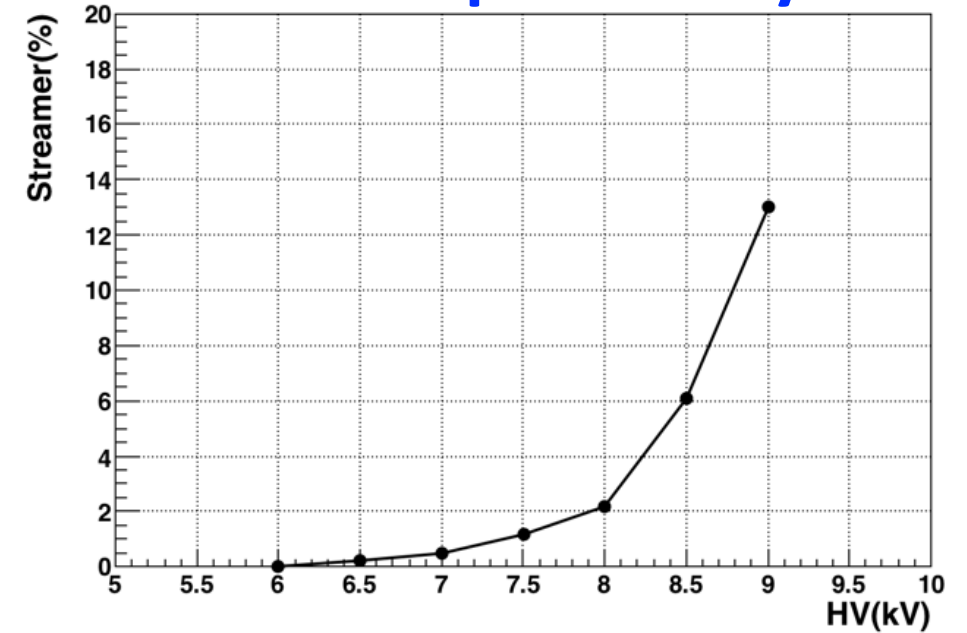# 9. Position Resolution & Streamer probability

Position Resolution

Streamer probability
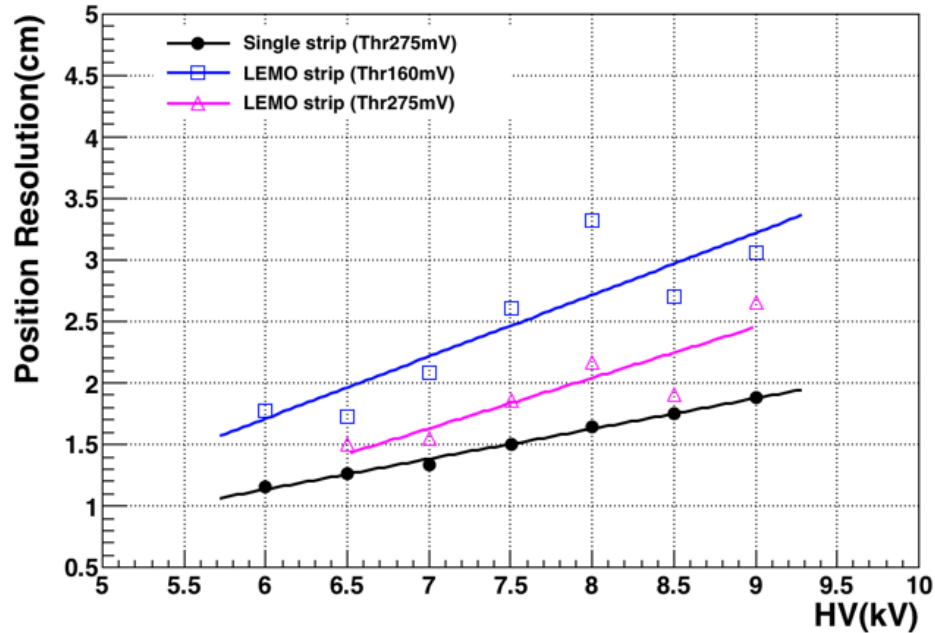
- Single strip ~ 1.7 cm
- LEMO strip
  - Ch1: 160 ~ 2.2cm
  - Ch2: < 3cm
  - Affected by noise or reflection

- Streamer probability
  - Hit > 3 strips.

10-1 x-position scan

Efficiency
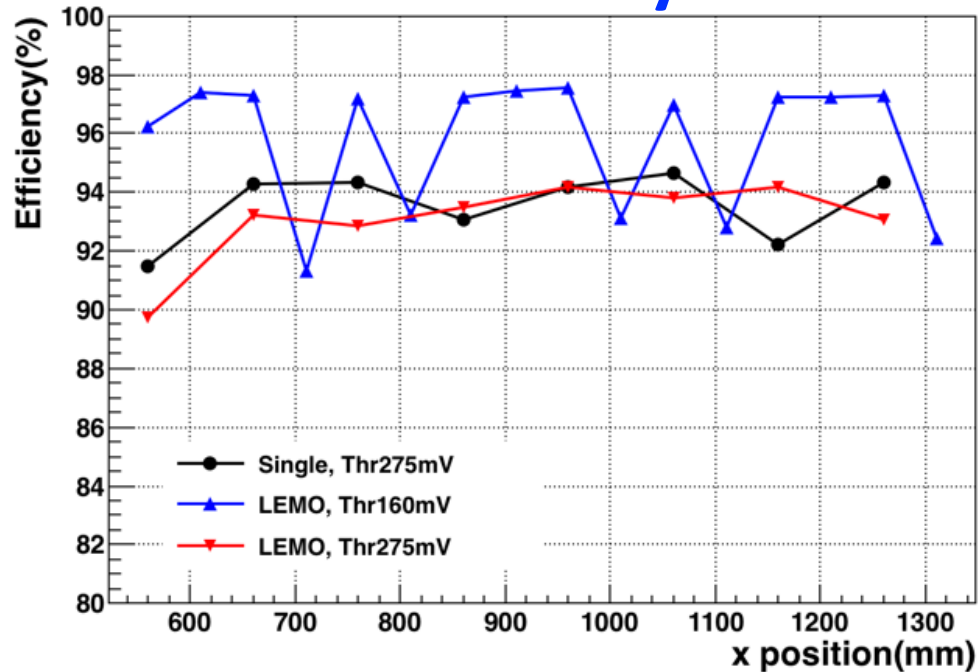
Time Resolution

- Depends on threshold values
- More than 93% for both strips
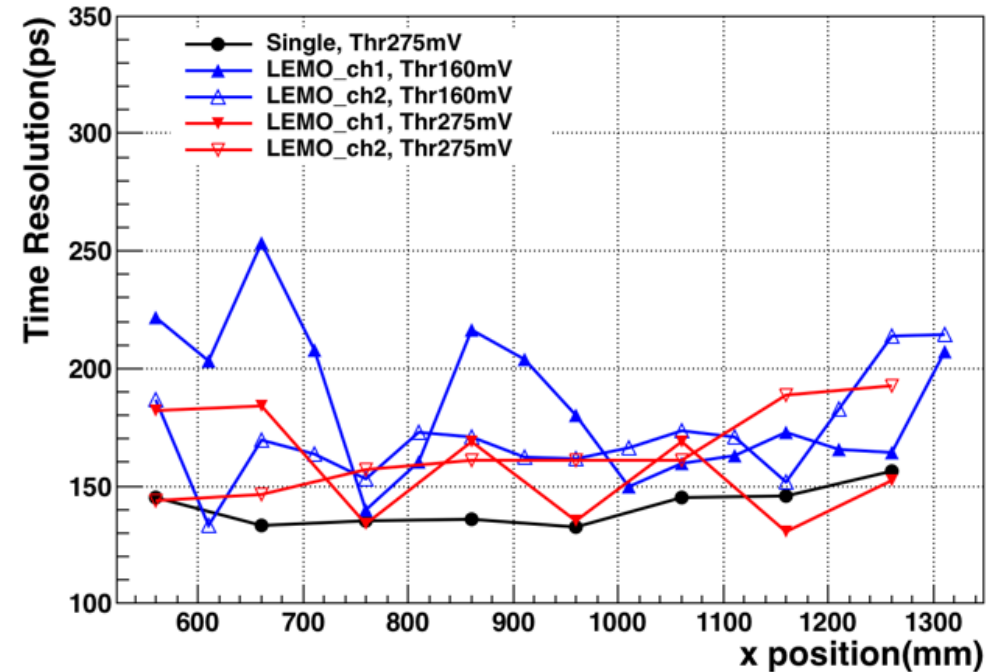
- Single strip ~ 130ps
- LEMO strip
  - Ch1: ~170ps
  - Ch2: <200ps

10-2 x-position scan

Mean Time Resolution

Position Resolution
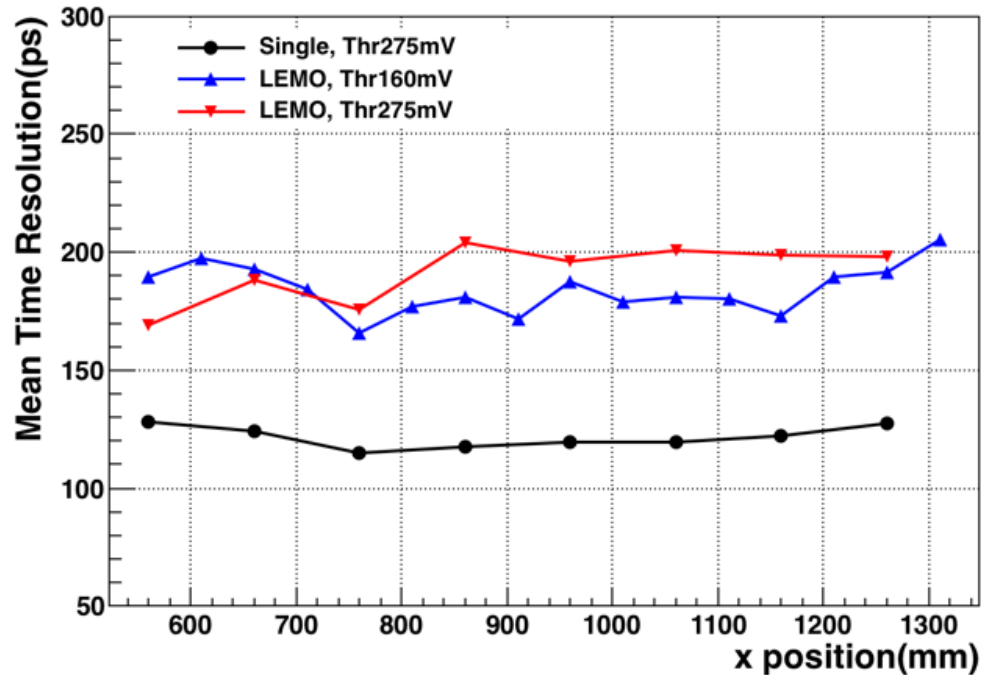
- Single strip: 120ps
- LEMO: < 200ps
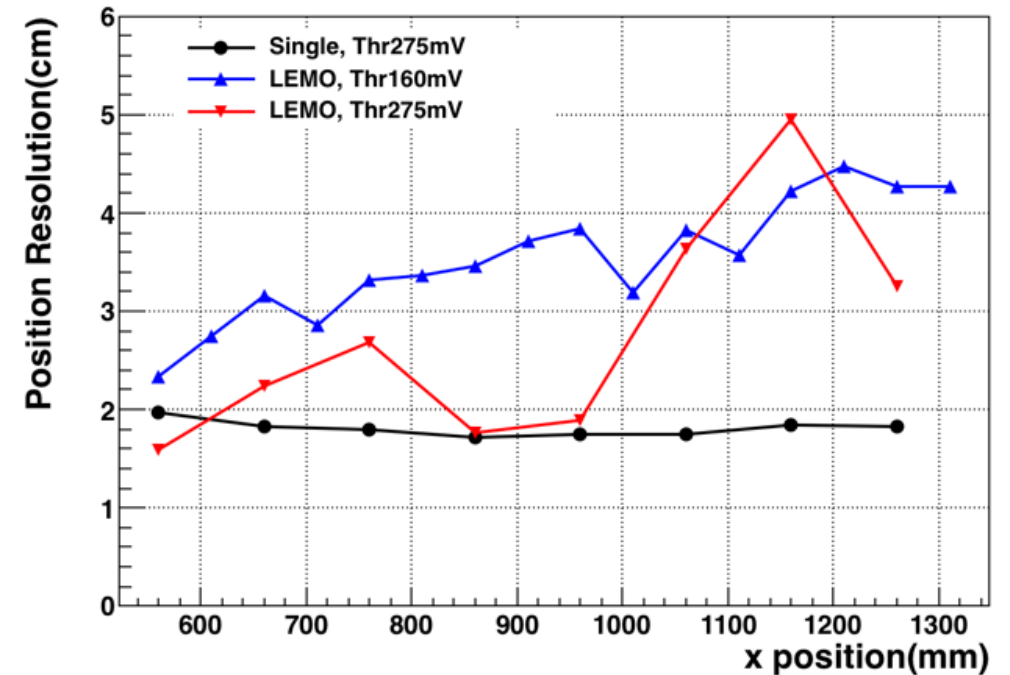
- Single strip: uniform ~ 1.9cm
- LEMO:
  - Increase when the beam moves to Ch1
  - 2 ~ 4.5 cm

Summary

- Tested ideas
  - Readout at both ends(single strip)
    - ✓ Good performance for efficiency & time resolution
  - Readout at one side with a pair of strips connected by LEMO cable
    - ✓ Reflection signal from Impedance mismatching
  - Sealing gaps entirely to reduce gas use and improve gas flow
    - ✓ Looks work but still need technical improvement, complete sealing and easy assembly
  - Prone to suffer from noise because of the large chamber size
- To be improved
  - Reduce noise level and oscillation
  - Reduce reflection signal from Impedance mismatching between strip, LEMO cable and NINO card