Ultra-long MicroStrip Gas Counter for Spallation Neutron Source Facilities

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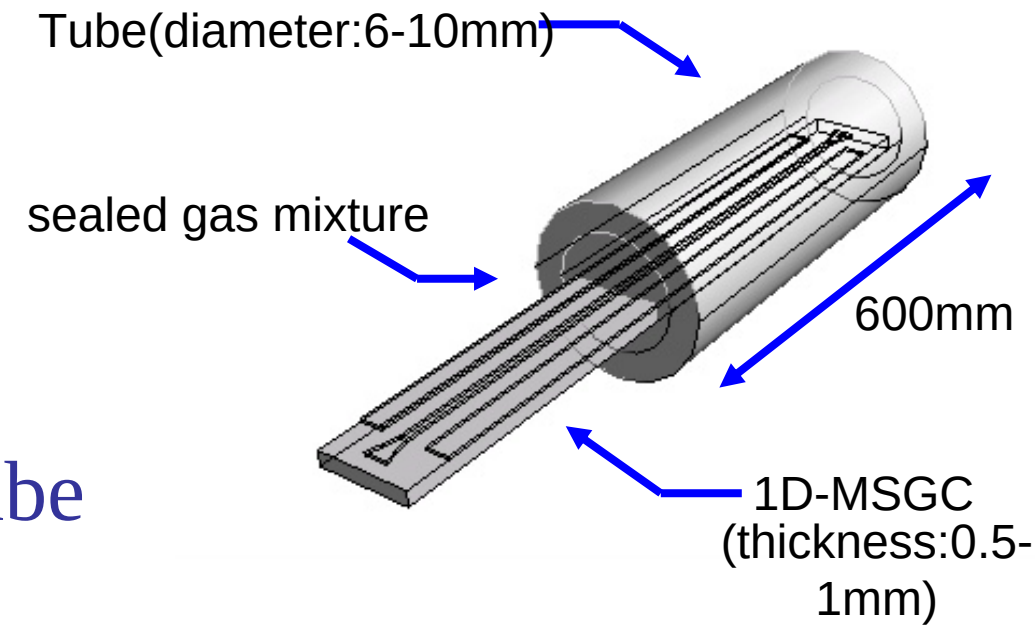
Purpose

- High-counting rate and high-resolution neutron detectors are required for the J-PARC neutron scattering facility.
- Low-cost reliable modules for neutron spectrometers

Reconsideration of Linear PSD

- Fast He-3 tubes
- Replace anode wires with high-tech plate
- Easy to maintain



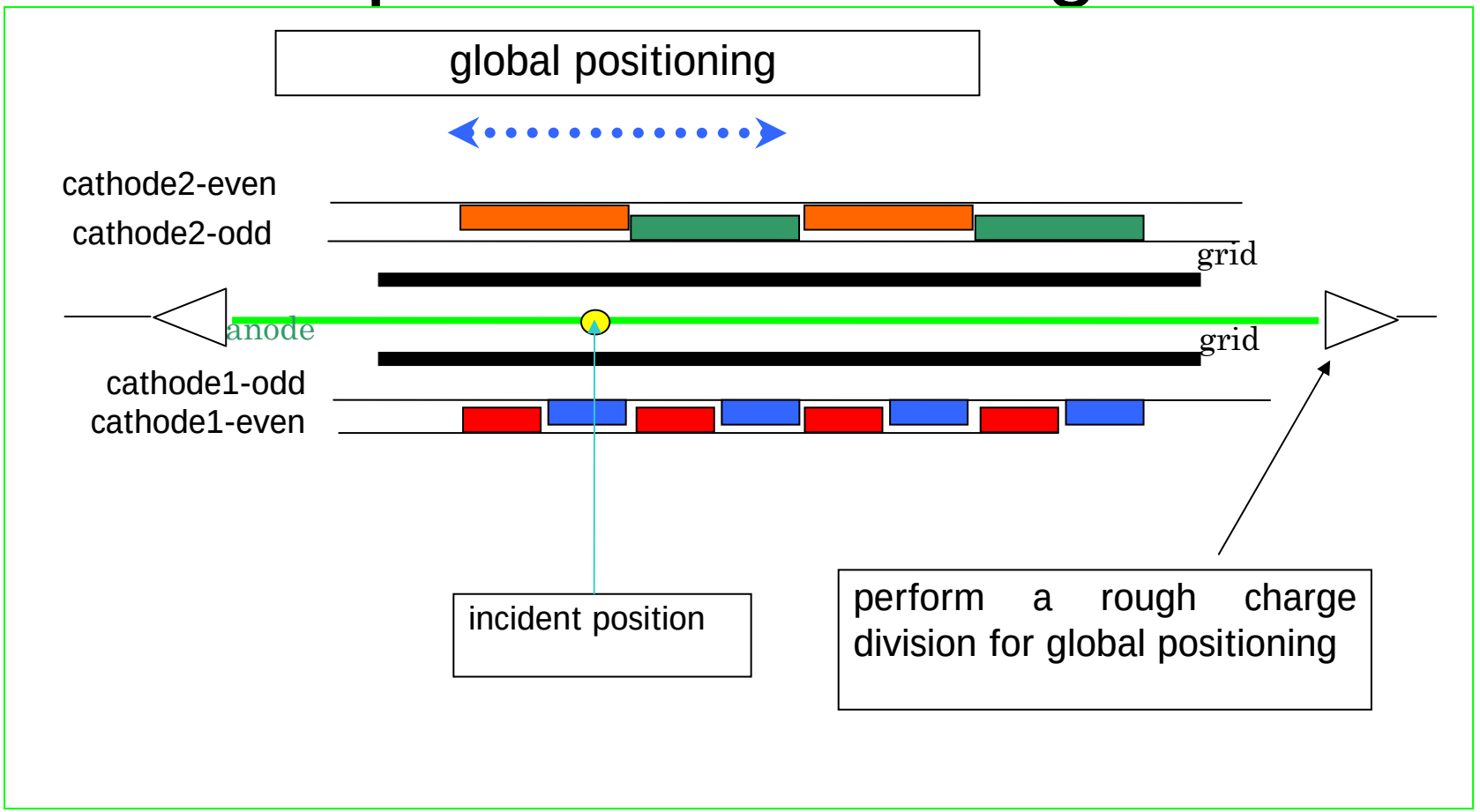
MSTube

- Simple replacement of anode wires with anode strips is easy, but

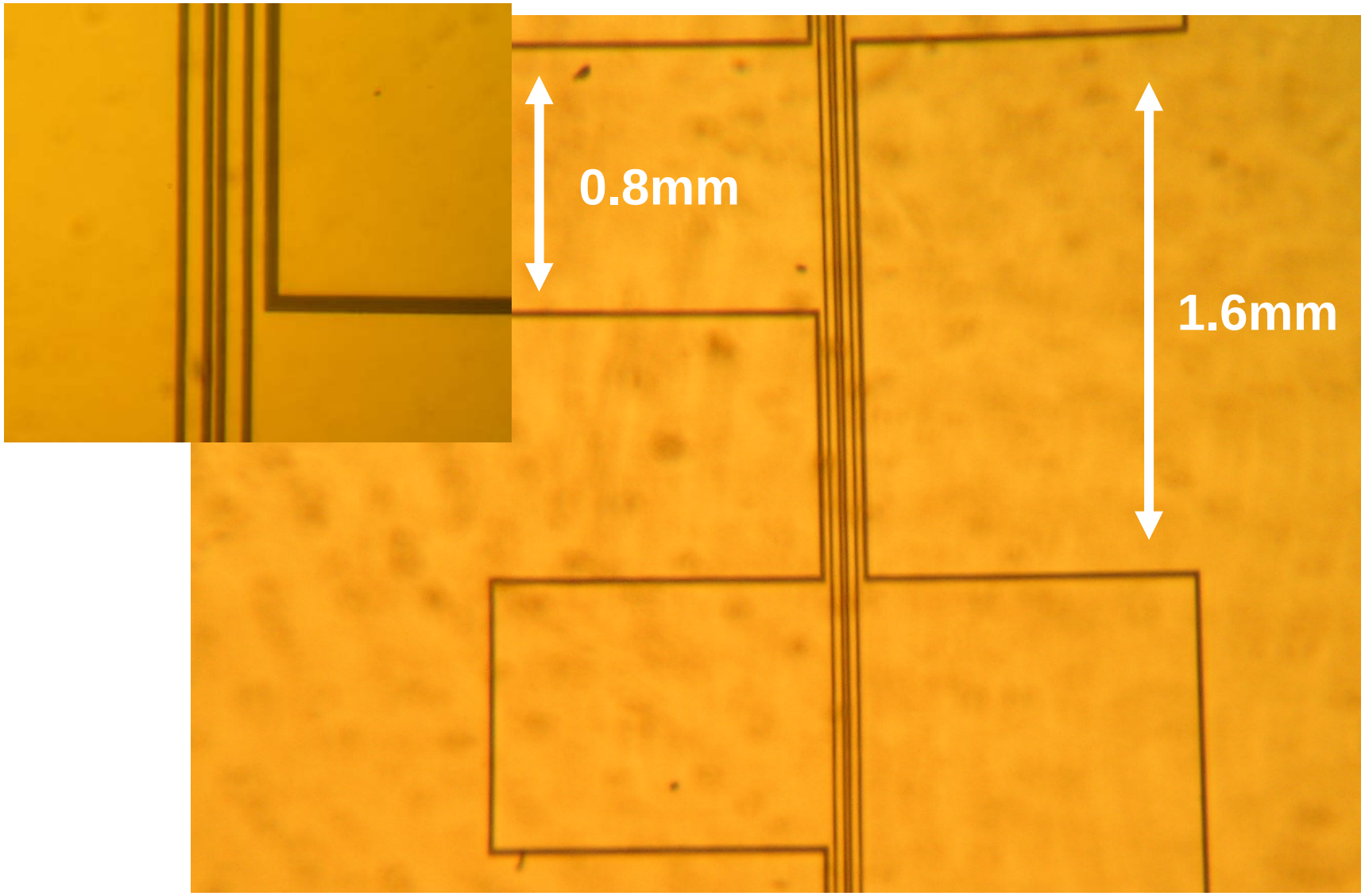
  RESISTIVE CHARGE DIVISION METHOD is not compatible with High counting rate operation

- Take advantage of microstrip plate
  - Cathode signal is usable.

The use of cathode signal to position encoding

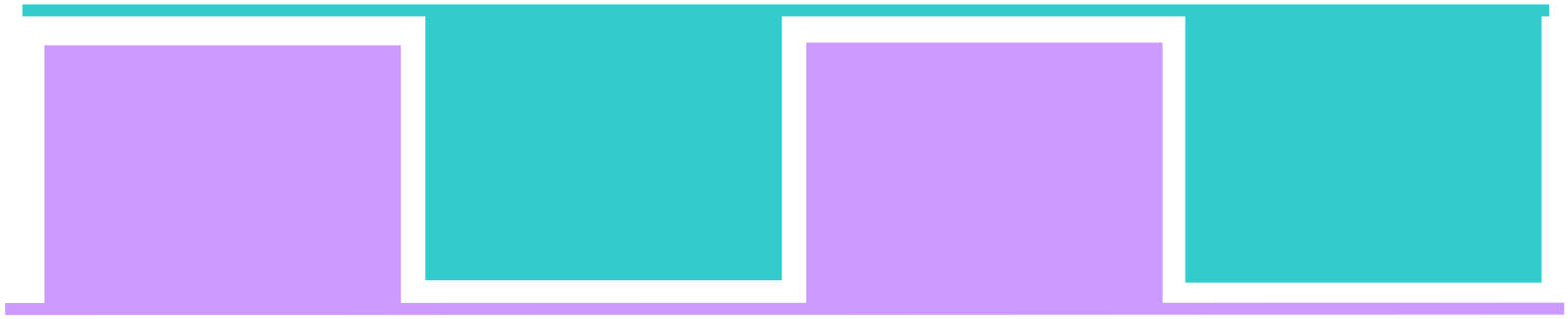


8cm long test plate

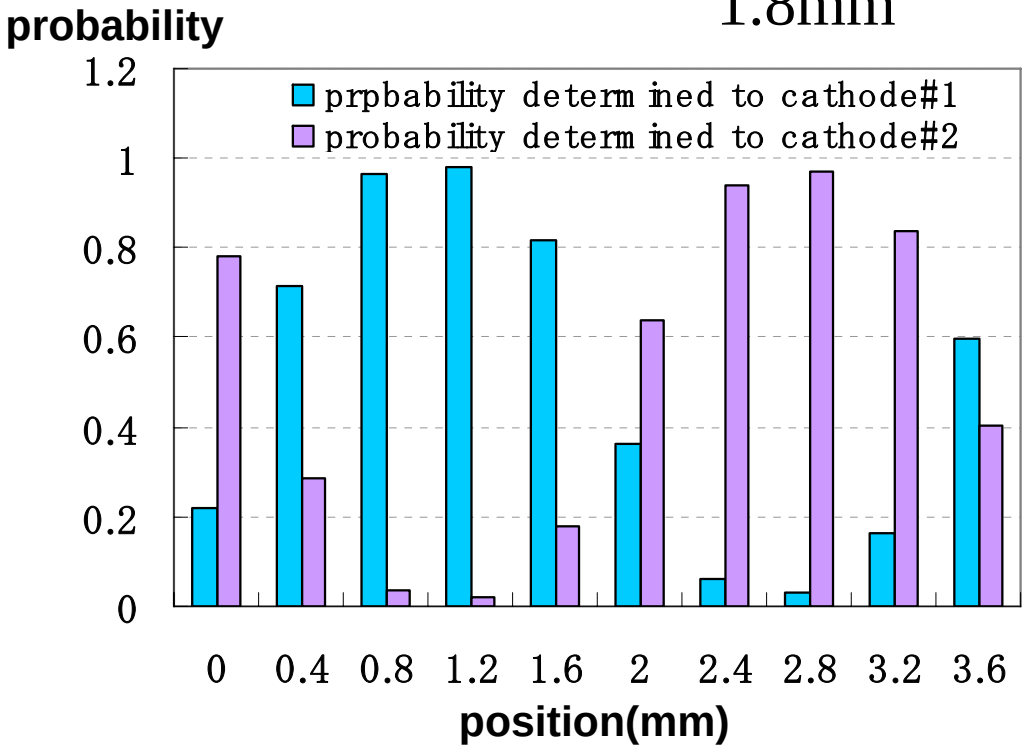


Neutron beam test

Electrode pattern



1.8mm

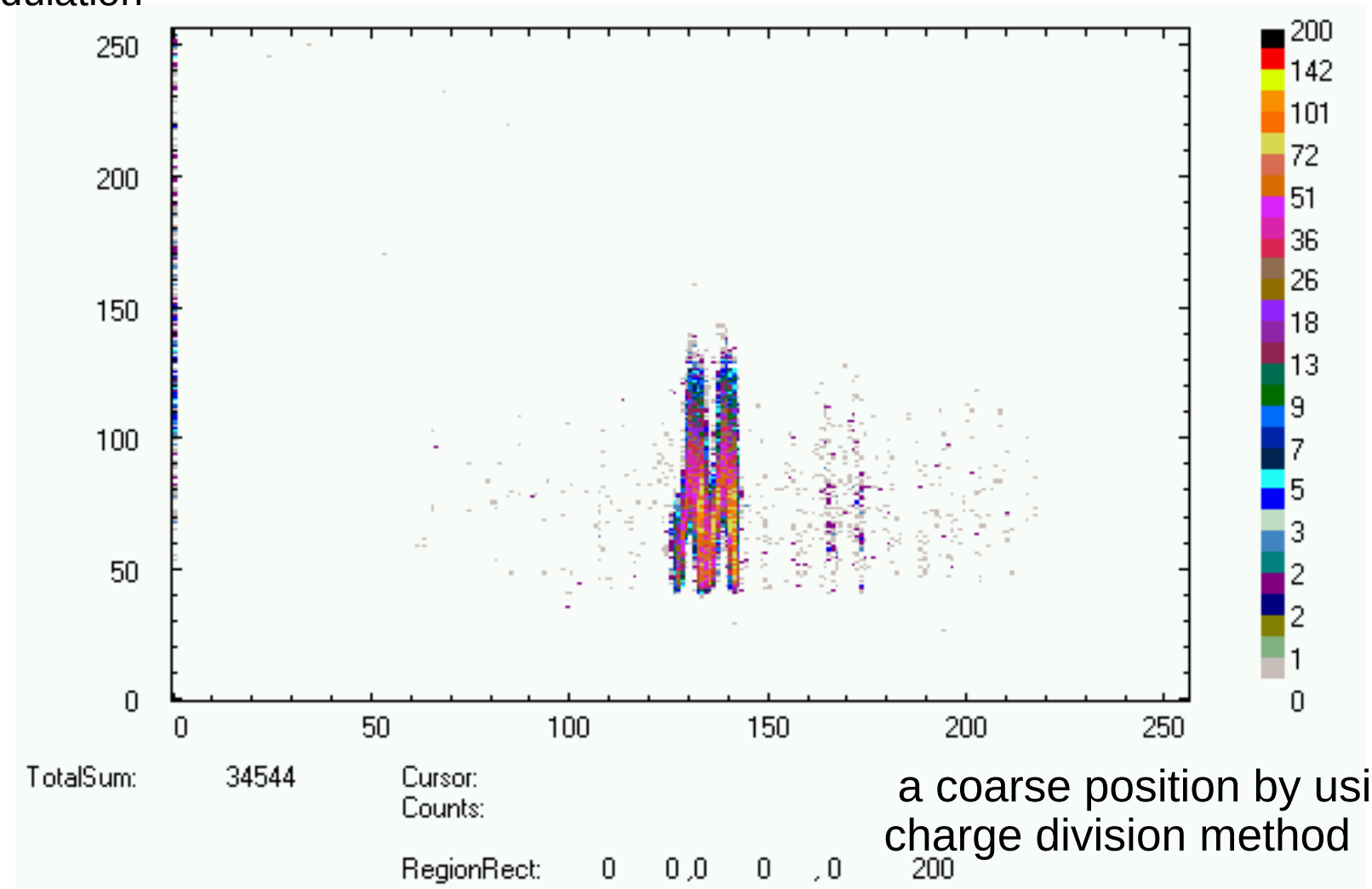


CF_4 4bar
^3He 0.3bar

Distortion free
High resolution

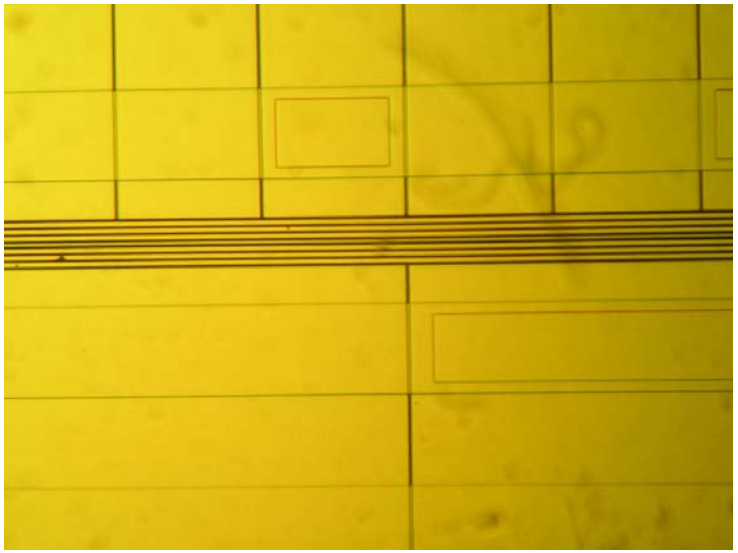
Trace (800um)

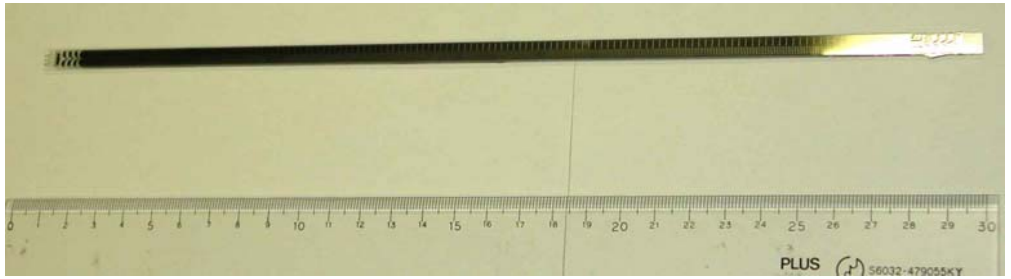
Cathode modulation



a coarse position by using charge division method

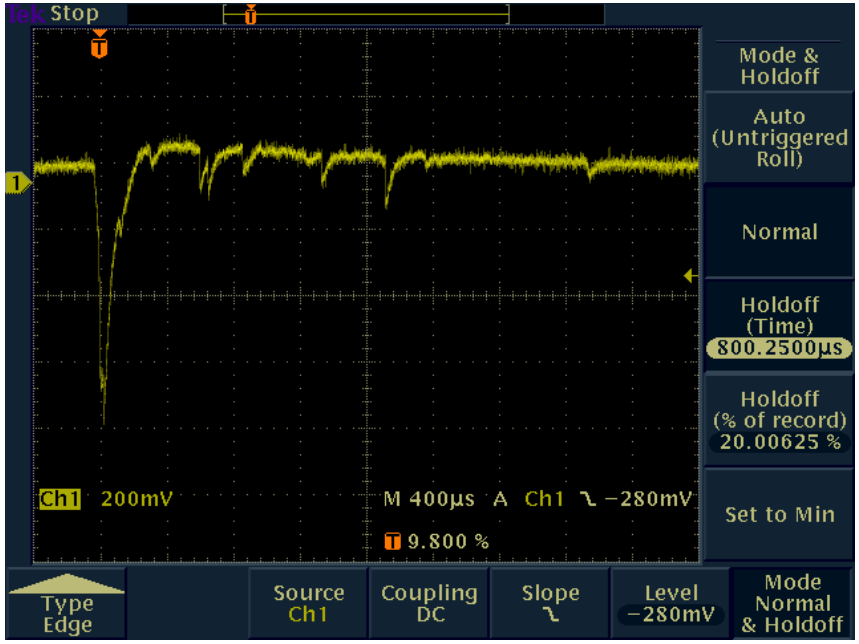
Plate

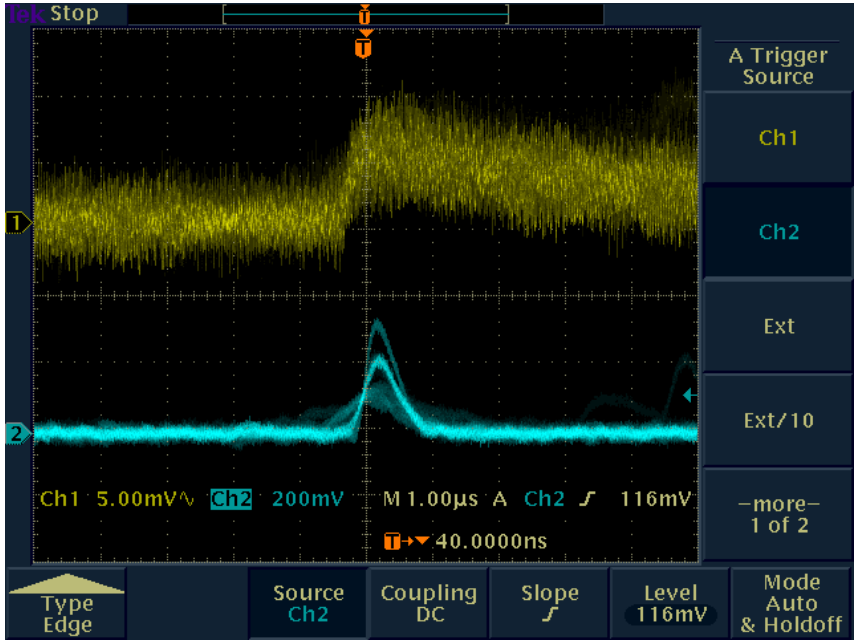




328mm long 16mm wide 32mm H He-3：3 atm CF4： 2 atm

Neutron beam test

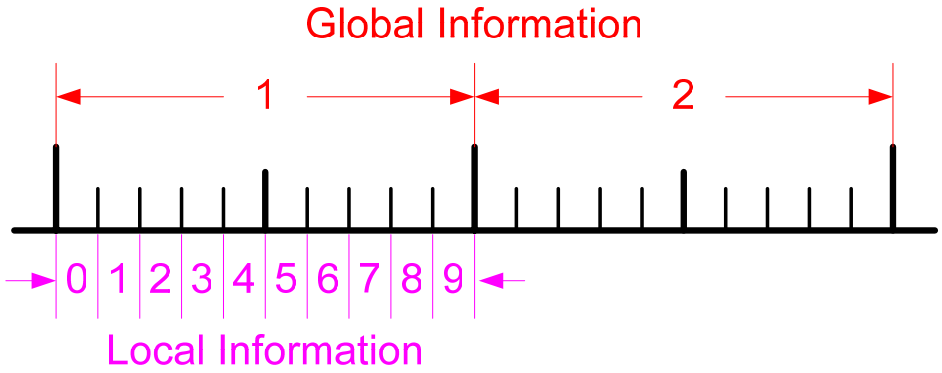




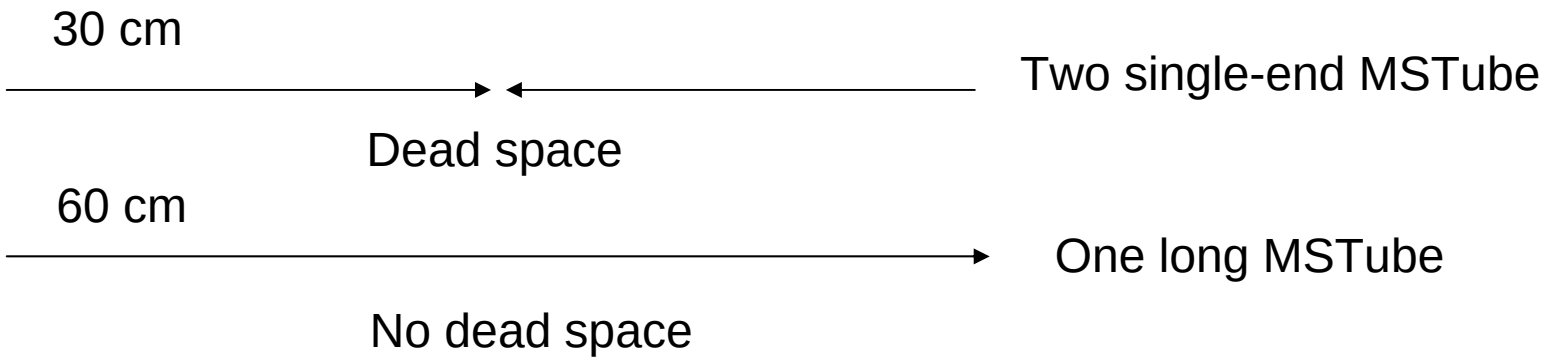
Global-Local Grouping (GLG) Method

The principal of G-LG method is using global and local signals to locate the position :

- **Global information is used to define the coarse position**
- **Local information is used to define the fine position in the coarse position**



Development of Long MSTube



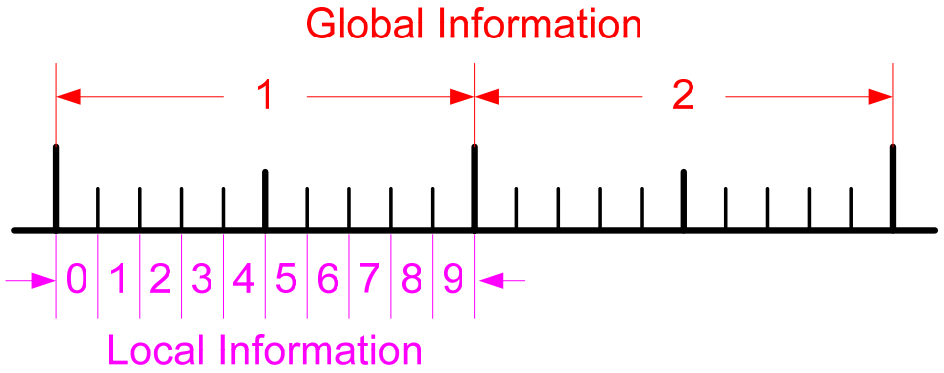
Futaba electric has a special very long exposure process used for linear scale (Up to 3 m).

- Resistive charge division requires high gas gain
- Single-end packaging is preferable
- Extension of cathode signal encoding method with GLG method

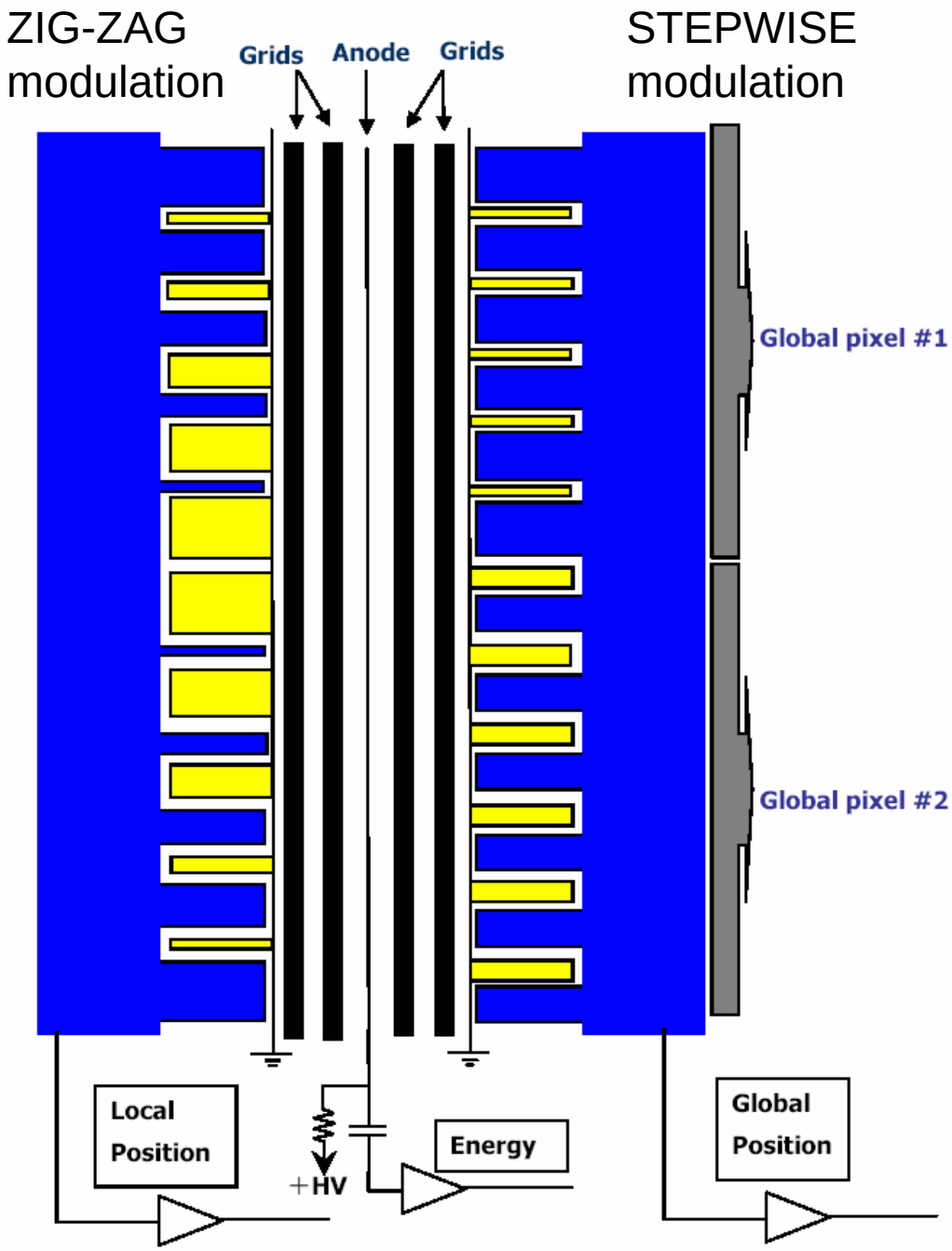
Global Local Grouping (GLG) Method

Separate total charge into two parts: Global and Local

- **Global information is used to obtain coarse position**
- **Local information is used to obtain fine position**



New Micropattern Global-Local Charge Division



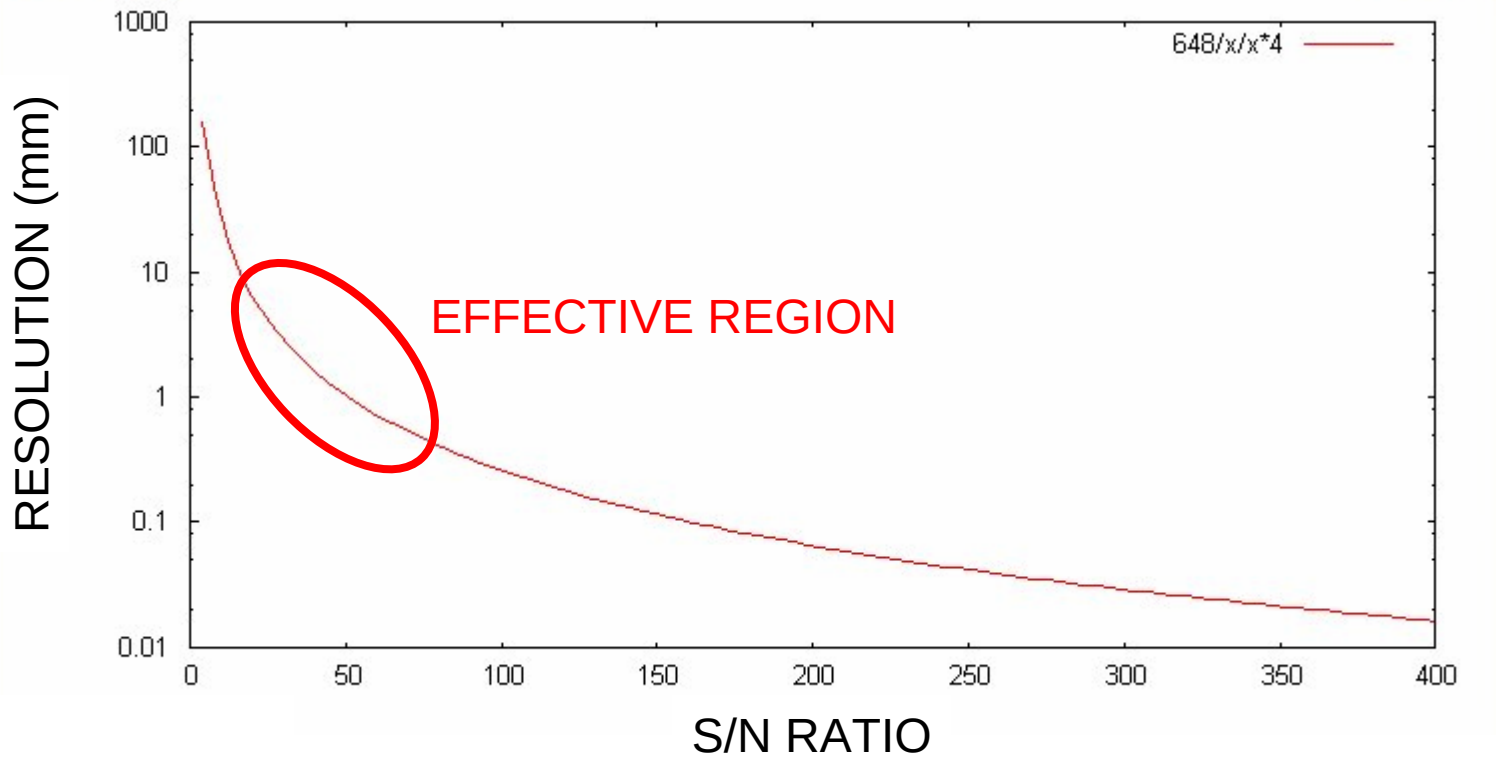
Let us assume
Total length: 640 mm
S/N = 40:1

Achievable resolution = 640/40
→ Δx= 16mm
Half cathode S/N = 20:1
→ Δx= 32mm
The other half cathode S/N = 20:1
→ Δx = 1.6mm

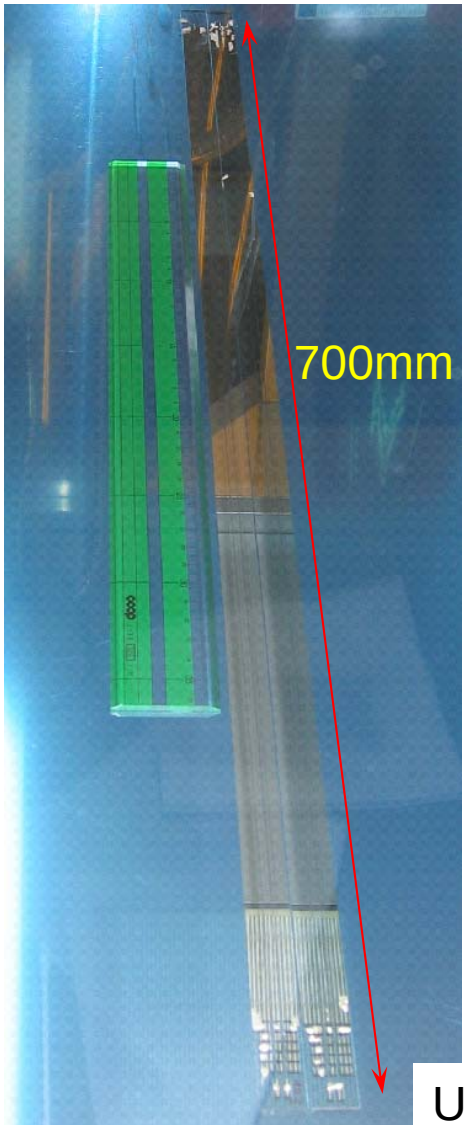
x 10 resolution is expected

Zig-Zag + Stepwise -> Pseudo gray code encoding

ACHIEVABLE RESOLUTION vs S/N RATIO

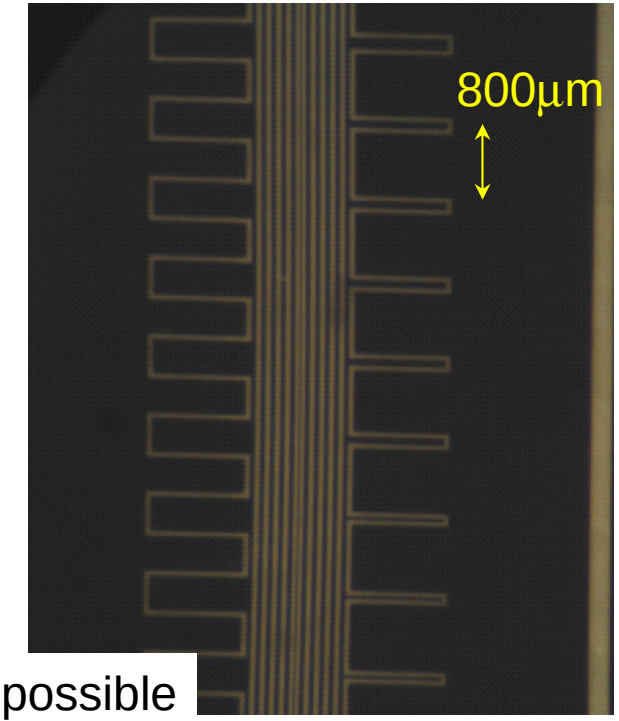


Test plate



- Sensitive length ~ 648 mm.
- 2 or 4 Anodes (3mm pitch) and 4 grids.
- Global pitch ~ 35mm.
- Global – Local pad layout

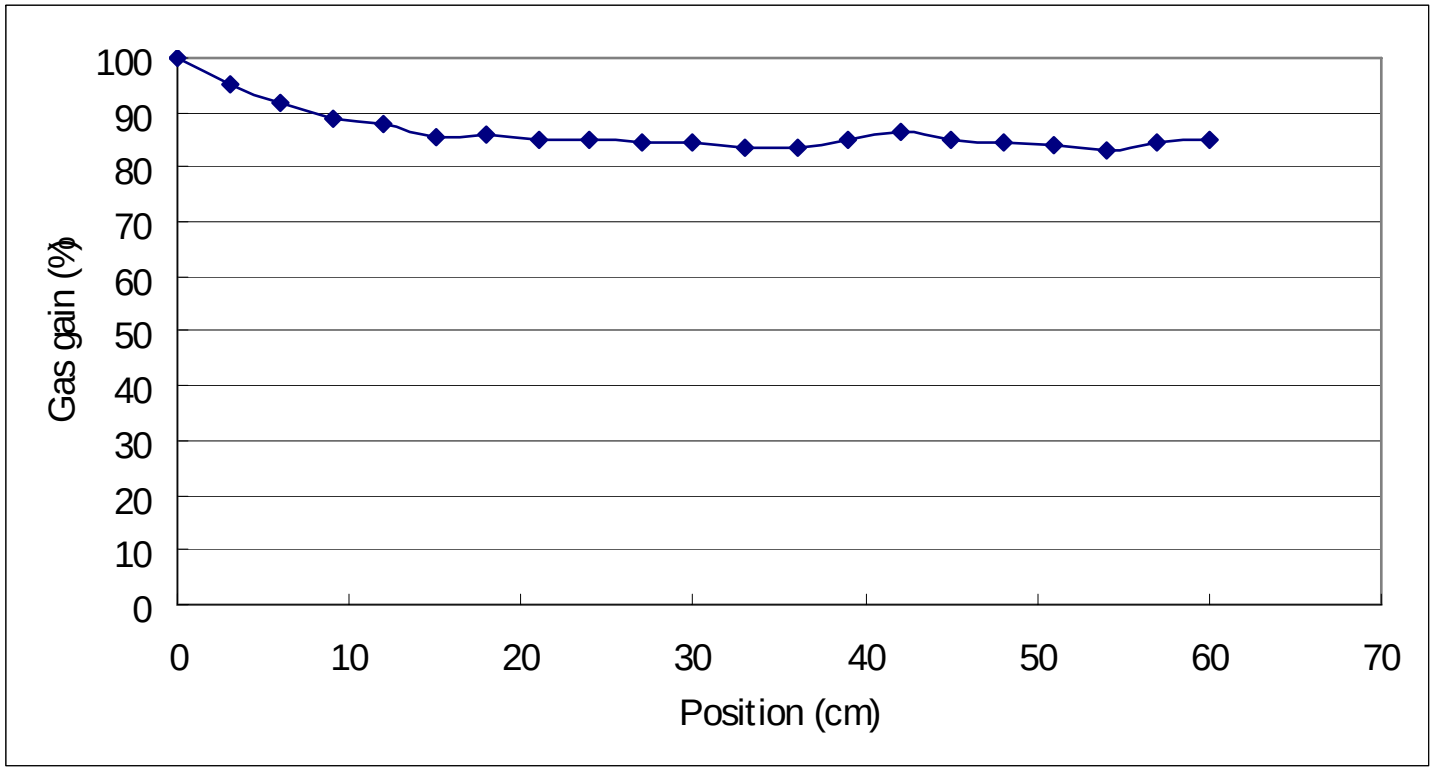
Global



Local

UP TO ~3m is possible

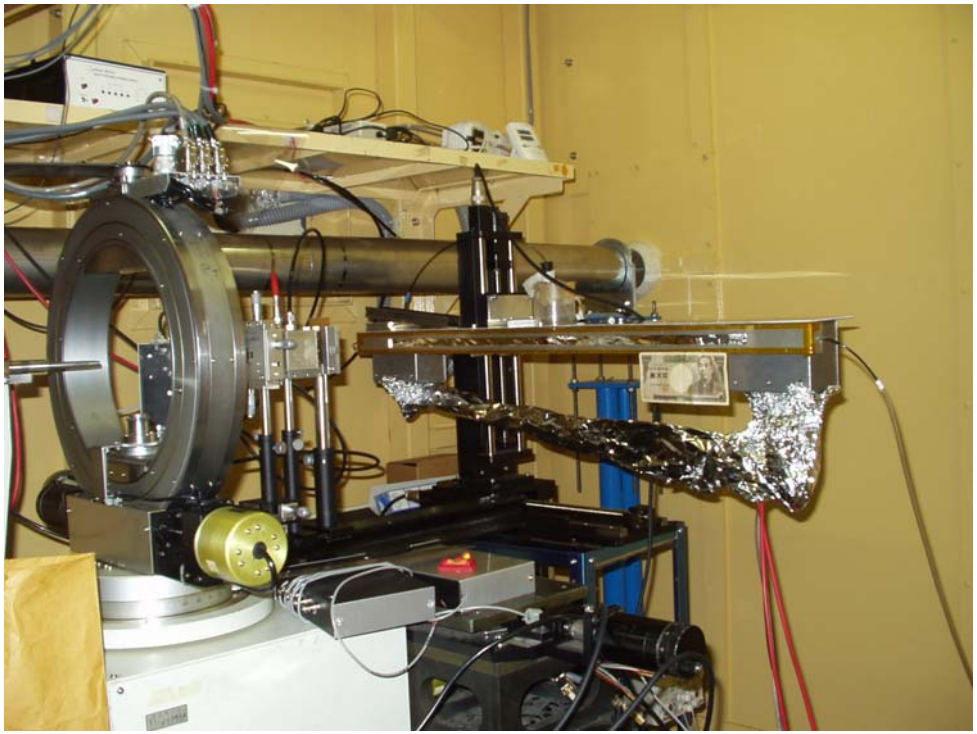
First lot had high anode resistance problem



- **17% of gain difference.**
- **Rise time greatly varied with position (from 0.3 to 5us.).**

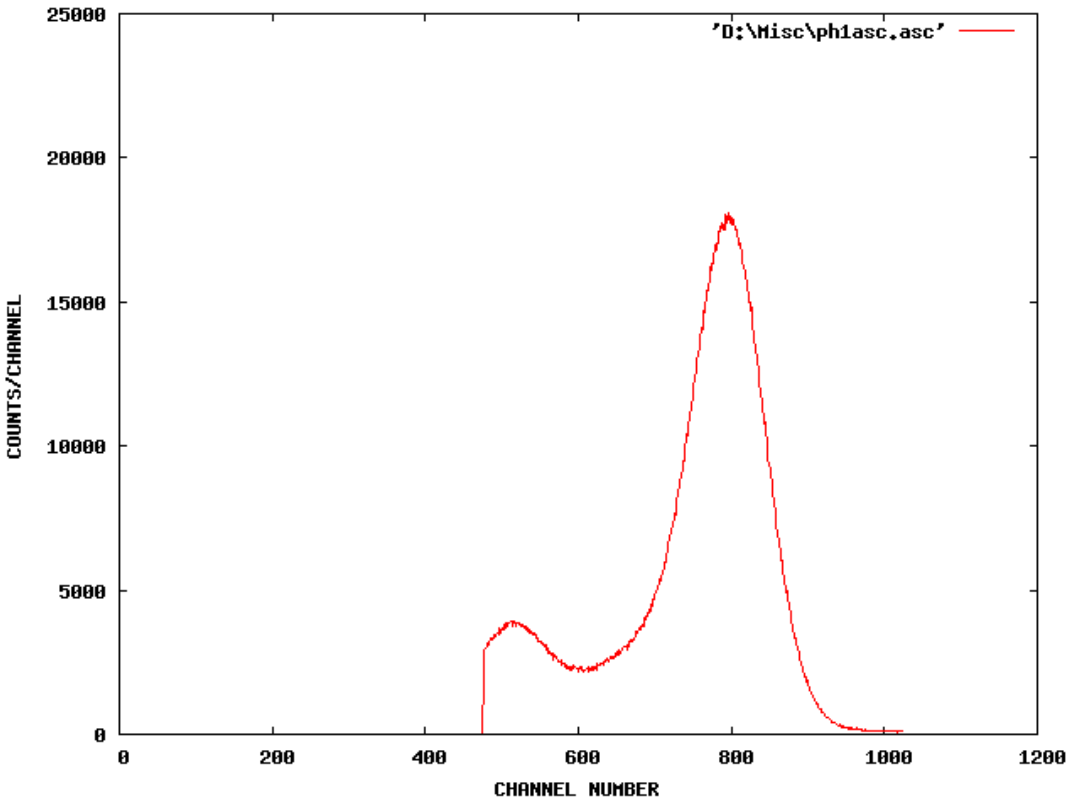
→ Reduced to 1/5 in the second lot

Synchrotron Experiments



- Tested at KEK Photon Factory, BL-14A.
- bBeam energy 8keV.
- Beam size 400umϕ.

Energy resolution

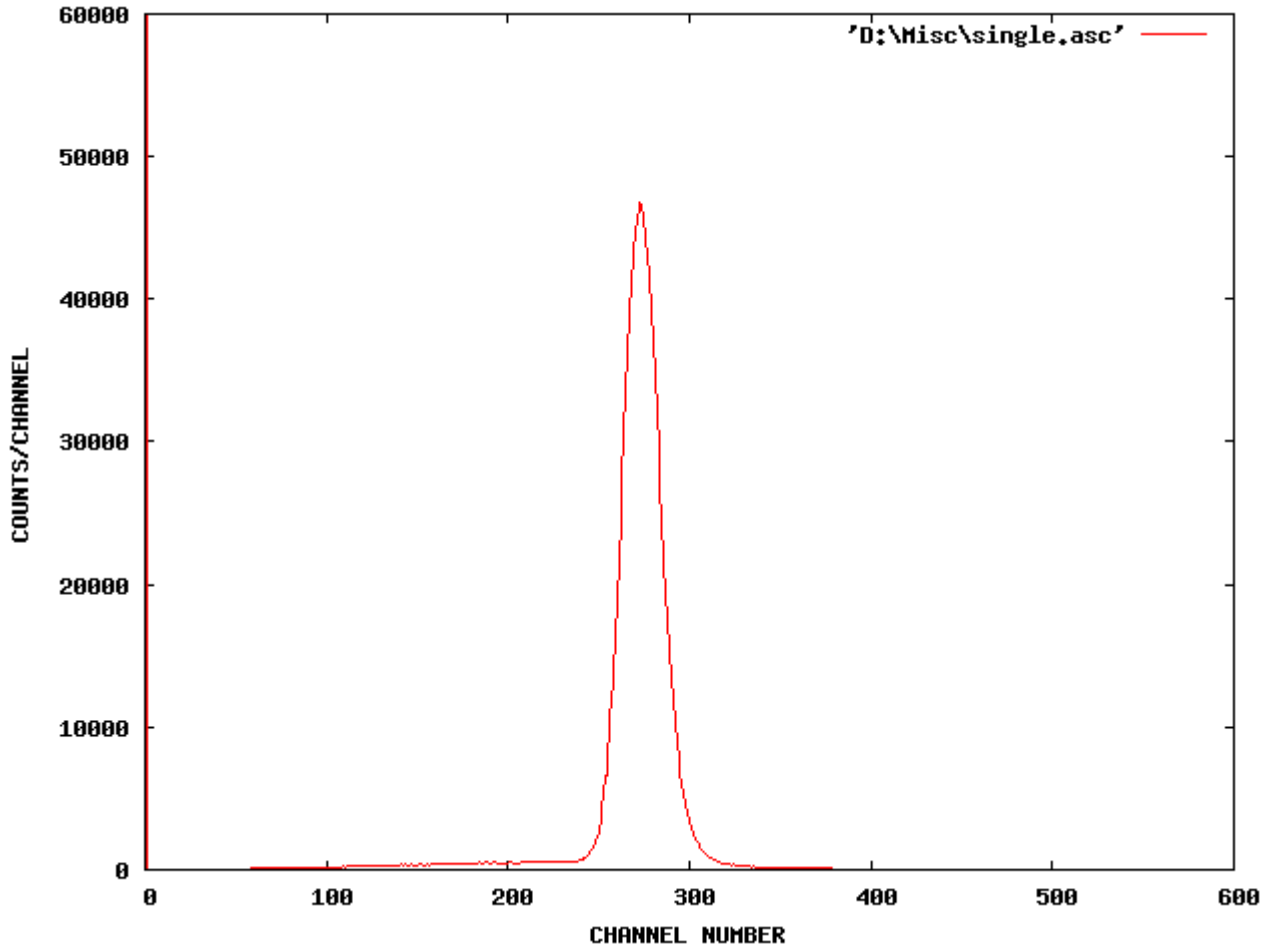


8keV X-rays

Gas gain: 6000

13.3% (FWHM)

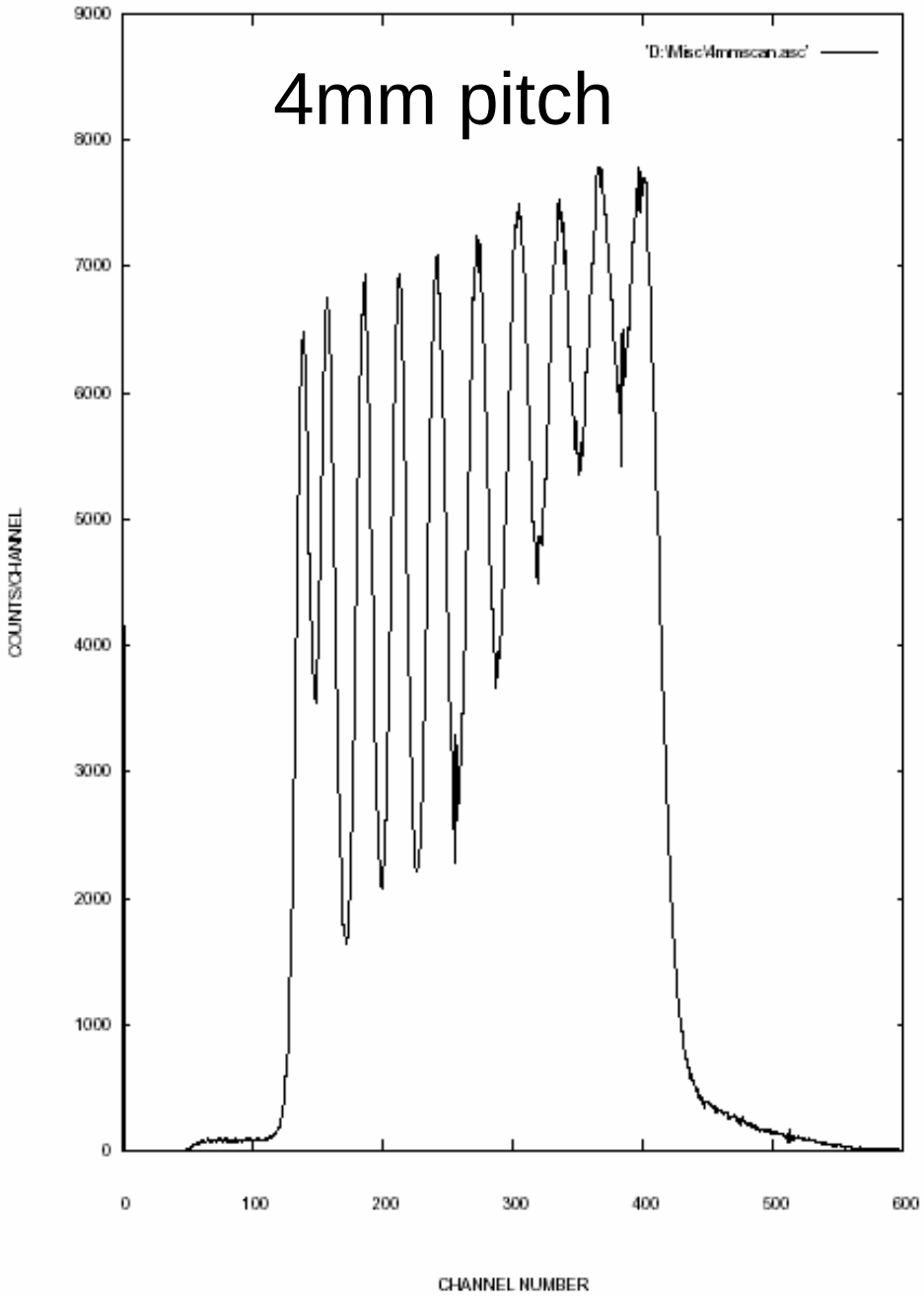
Global position spectrum



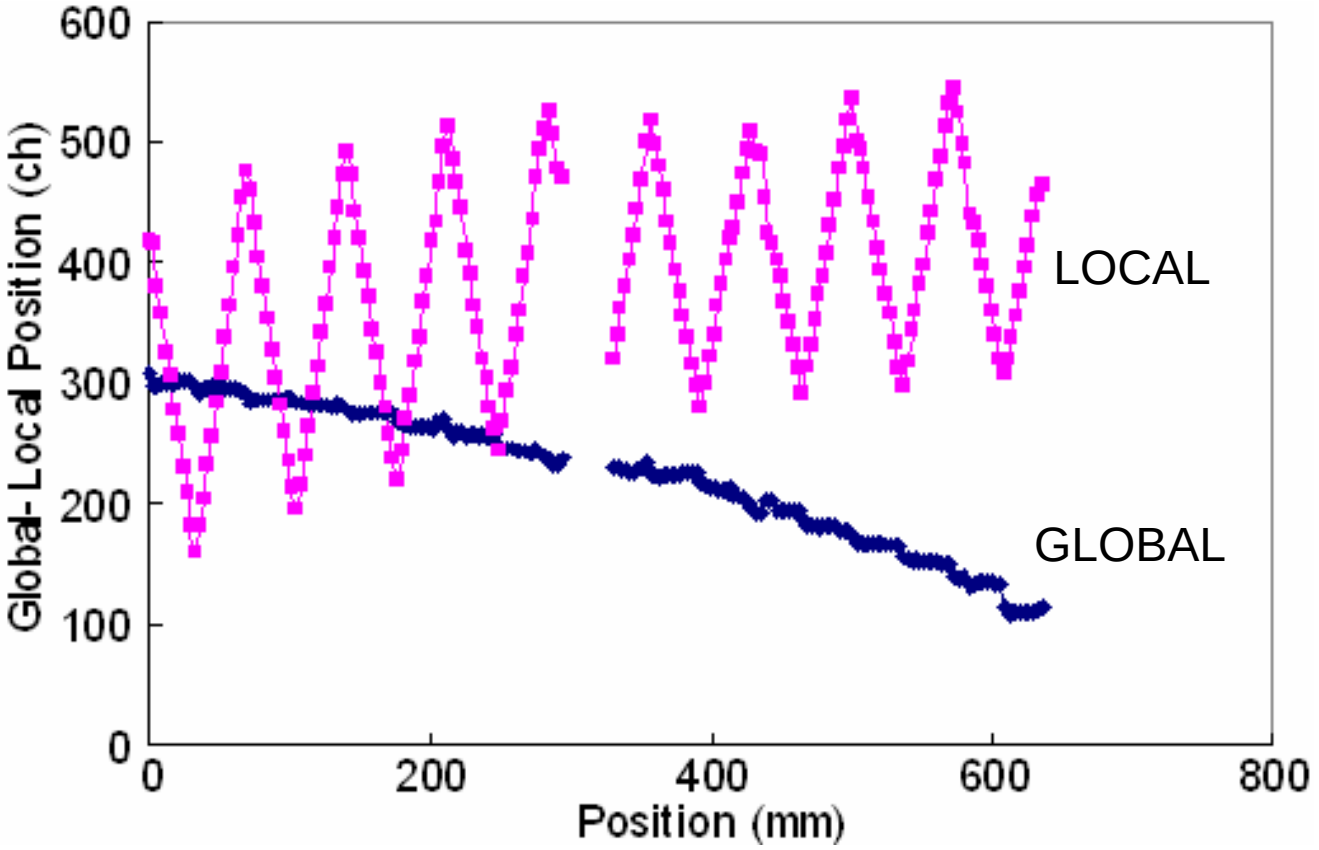
68mm FWHM

Local scan test

1-4 mm (FWHM) resolution



Global - Local relationship



Improvement of the detector

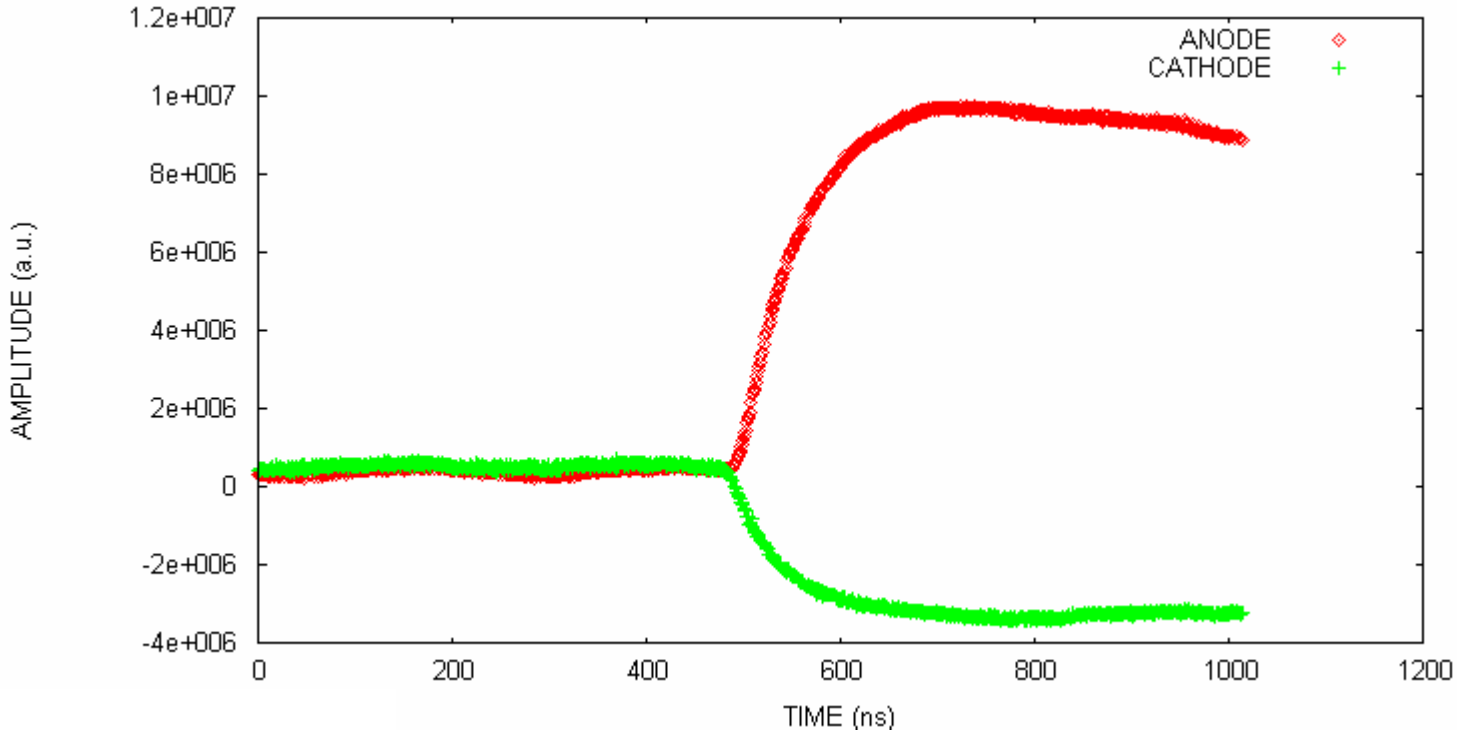
- Divide global to ½ → x 4 resolution
- 2nd lot

FIRST NEUTRON BEAM TEST with second lot

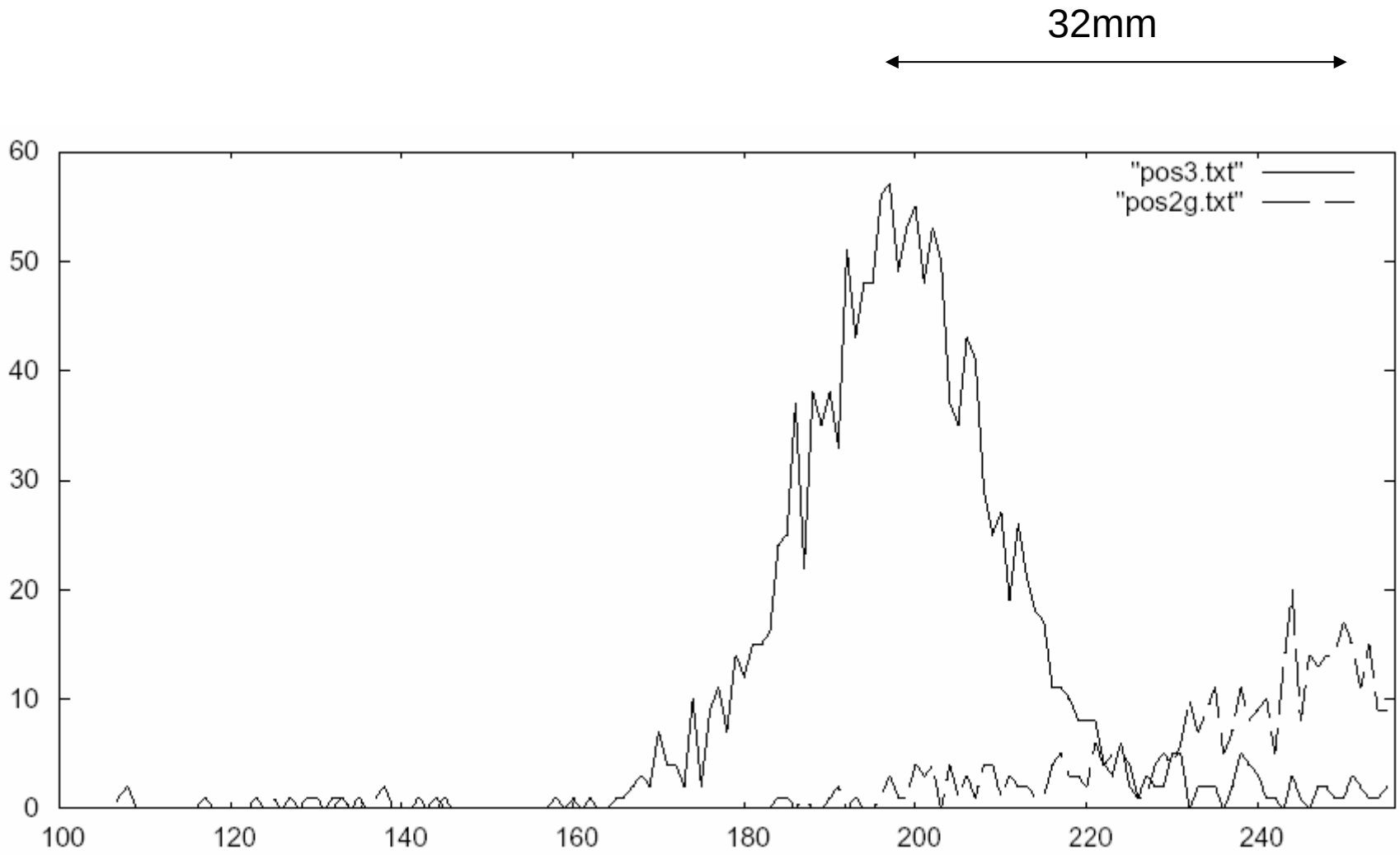
- ^{3}He 0.5bar + CF_4 2.5 bar

GAS GAIN > 300

CHARGE SENSITIVE AMPLIFIER OUTPUT SIGNAL

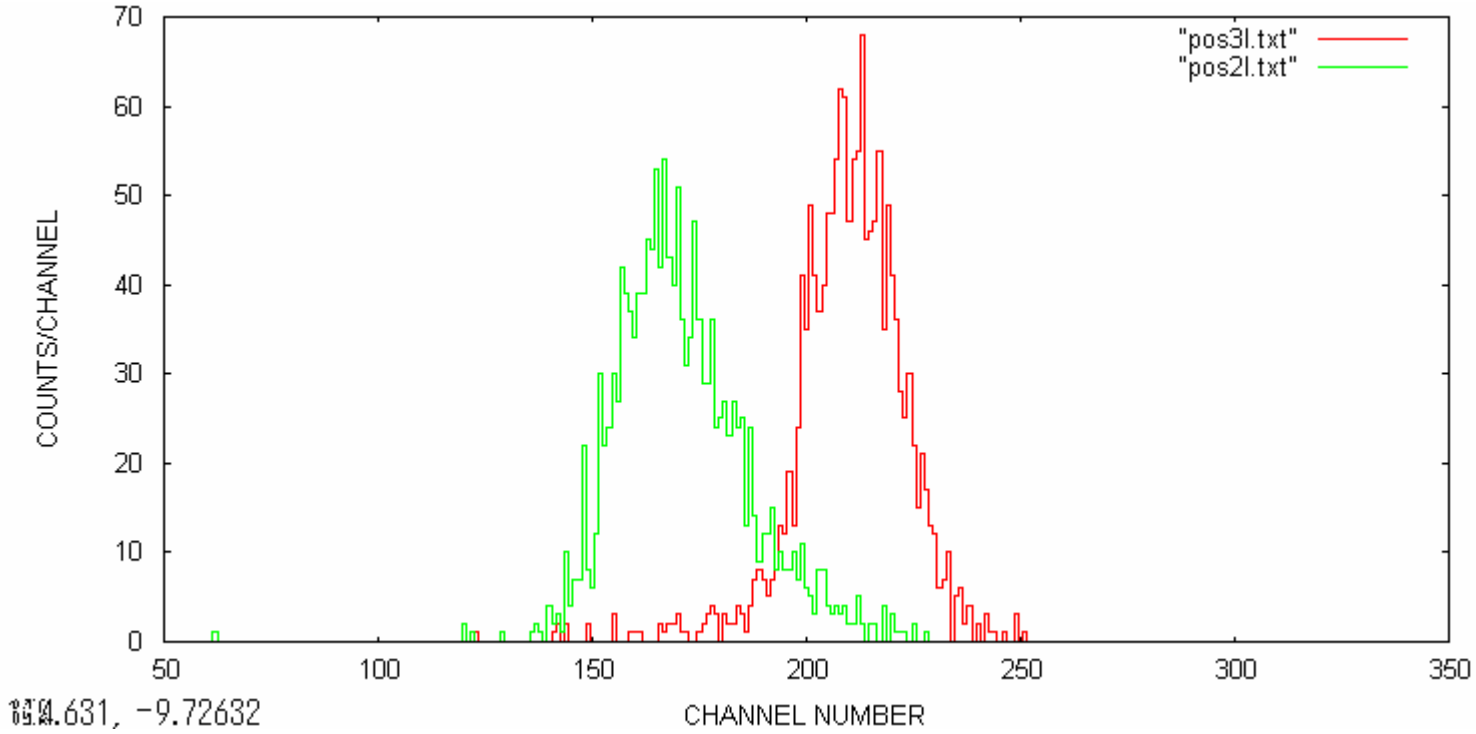


GLOBAL POSITION TEST



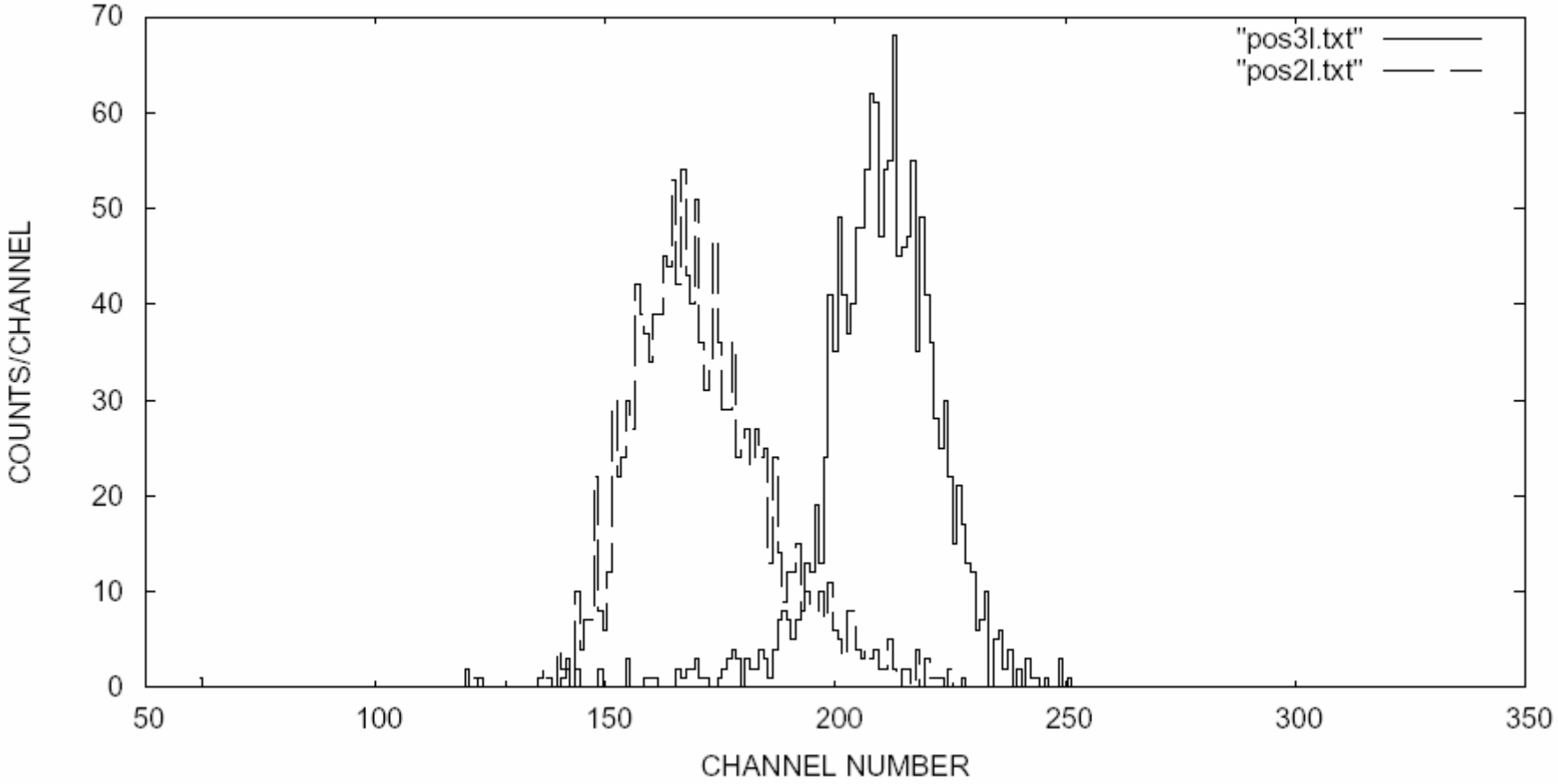
LOCAL POSITION TEST

8mm



Summary

- A new 1-D microstrip gas counter using global-local charge division method is developed.b
- 64cm long tube is fabricated and successfully tested with a neutron beam.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"pos2l.txt"
COUNTS/CHANNEL
CHANNEL NUMBER
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10
20
30
40
50
60
70
50
100
150
200
250
300
350