Primary Proton Beam Profile Monitors -Segmented Secondary Emission Monitor-

Outline

- Introduction
- Beam test at the KEK-PS Neutrino Beamline
- Summary

Introduction

Desired Performance of profile monitors
at the J-PARC Neutrino beamline

High intensity proton beam induces large radiation dose.

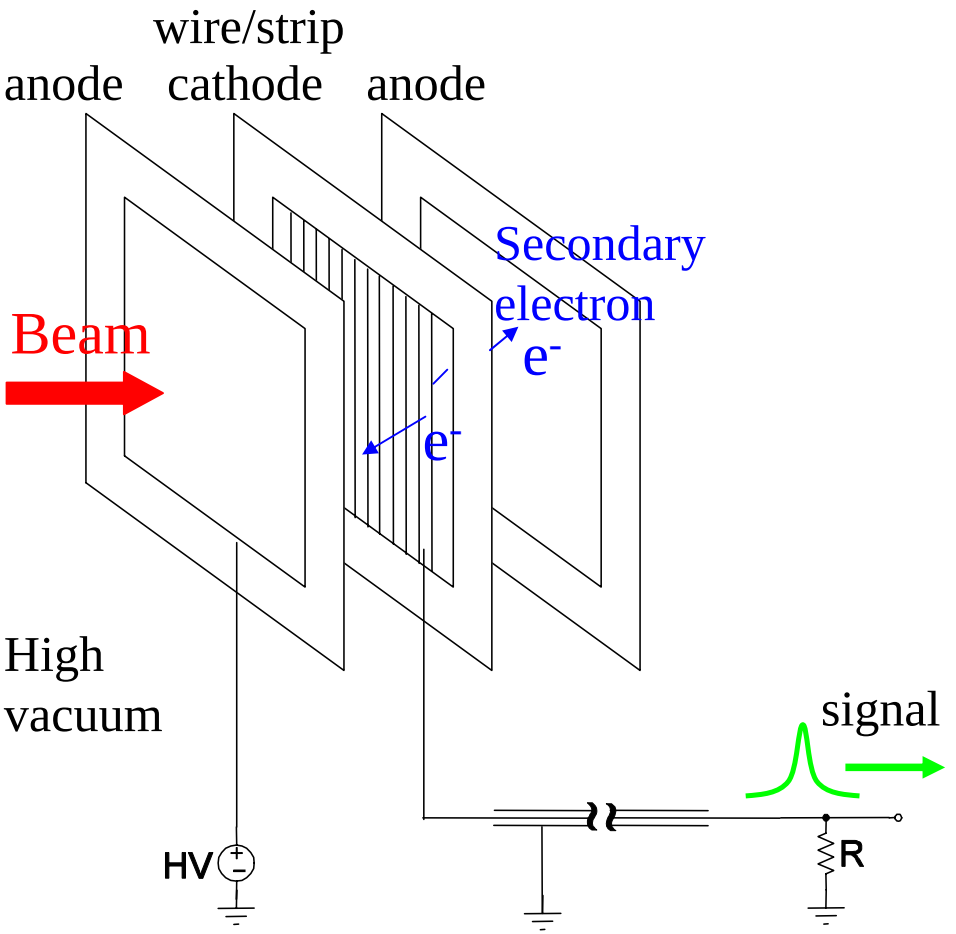
⇒ Low material, long lifetime, easy to be maintained
(In case of SSEM, movable structure will be required.)

Dynamic range : Applied to beam intensity in the beginning of experiment. (10^{12} ～10^{14} protons/pulse)

Profile measurement resolusion required about 1~2mm.

Principle of SSEM

SEM (Secondary Emission Monitor)



J-PARCでのビームに対応するため、
Cathode電極の材質と形状などを検討。

SSEM - Beam test : Purpose -

Requirement for SEM cathode materials

High efficiency of the secondary electron emission

Low amount of materials interrupting the beam

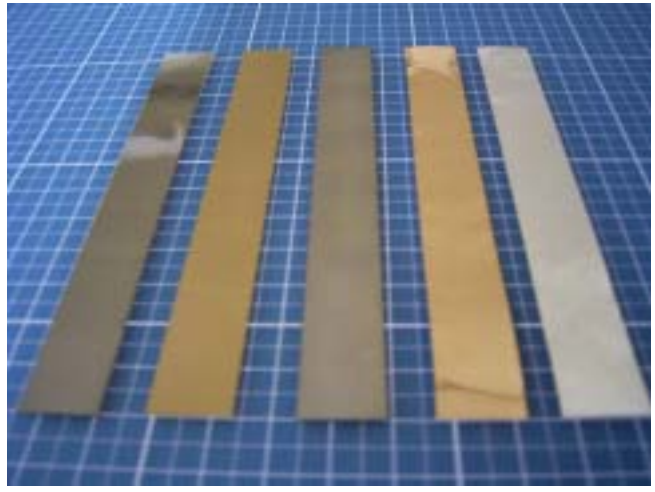
Resistant to heat and sputtering

Etc…

we carried out the beam test at the K2K neutrino beamline.

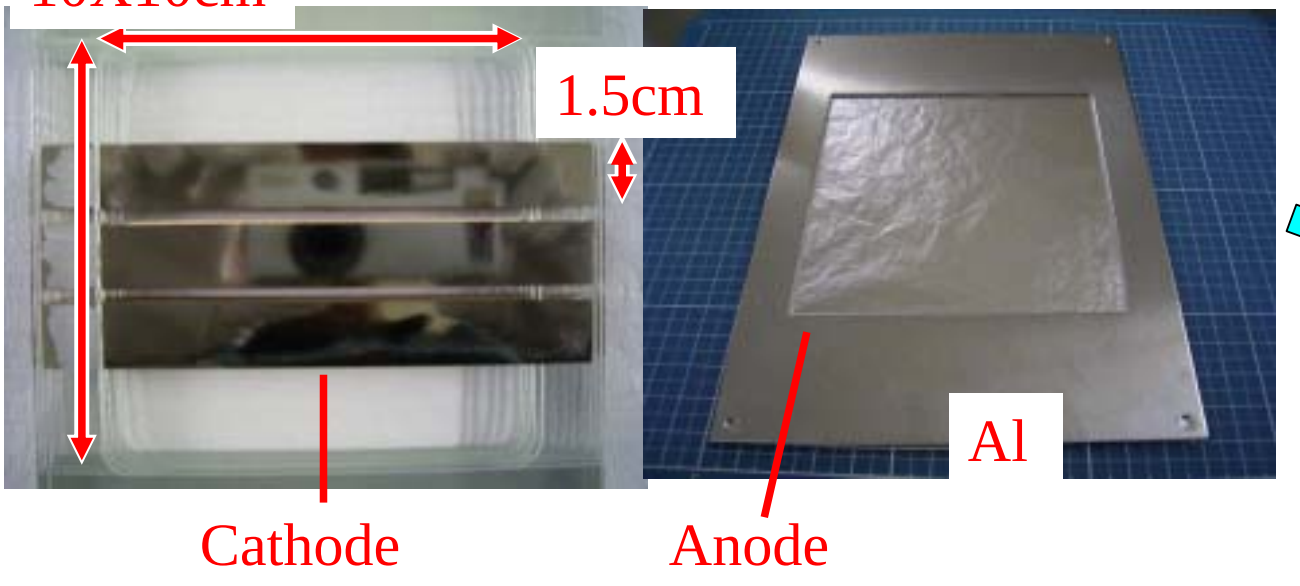
- Check the basic response of SSEM with K2K proton beam (~6×10^{12} protons/pulse)
- Compare the difference of signal intensity among 5 cathode materials.

Materials of cathode



W Cu-Be Ti Cu Al

SSEM - Beam test : Setup -

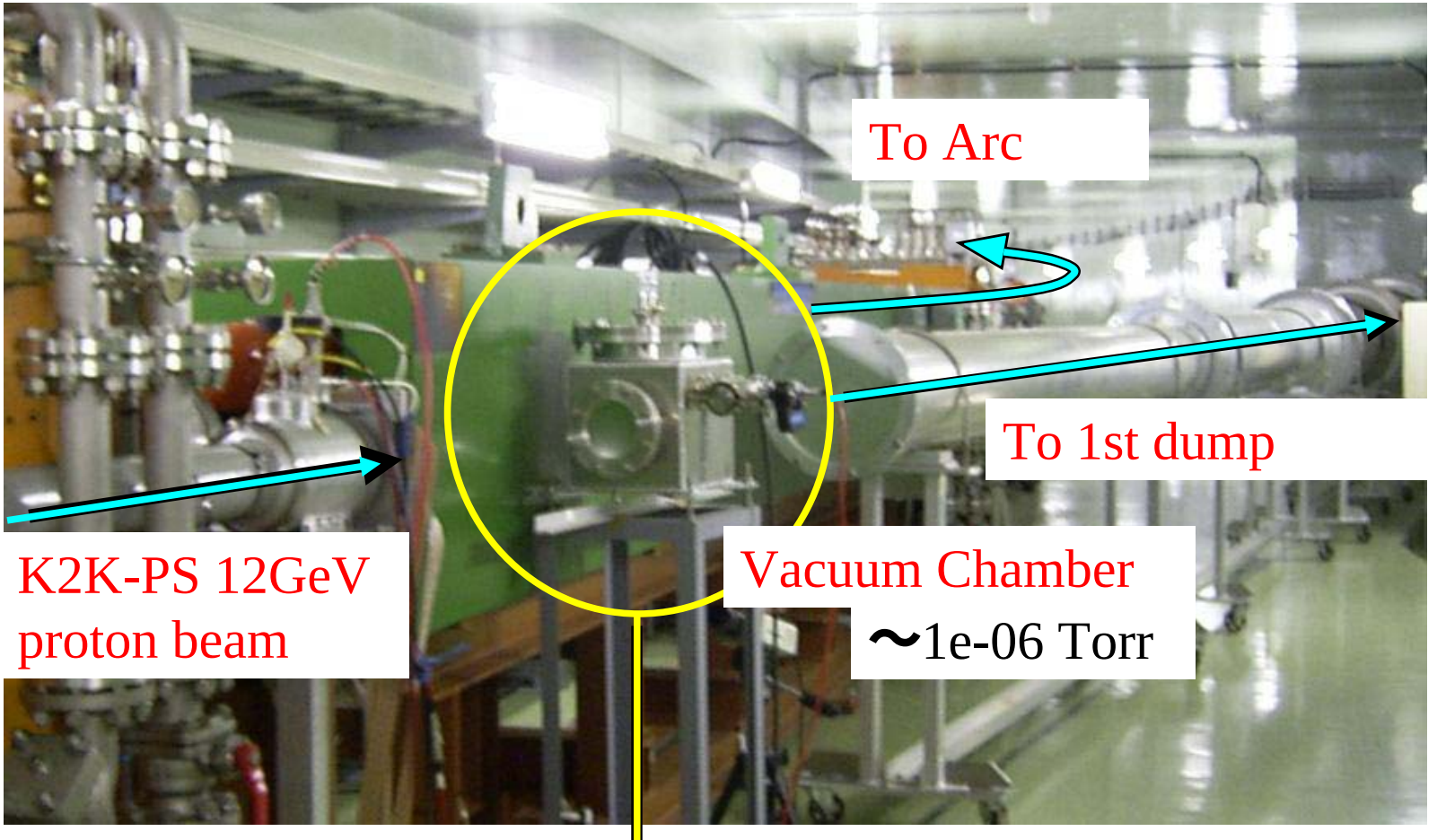


Placed alternatively at intervals of 7mm.

Beam size : vertical size ~4cm
: horizontal size ~2cm

Width of strip = 1.5cm. → require several nC/channel.

SSEM - Beam test : Setup -



～150m、Twisted pair cable ➡ Oscilloscope/ ADC

SSEM - Beam test : Basic responses -

anode voltage dependence of the signal height

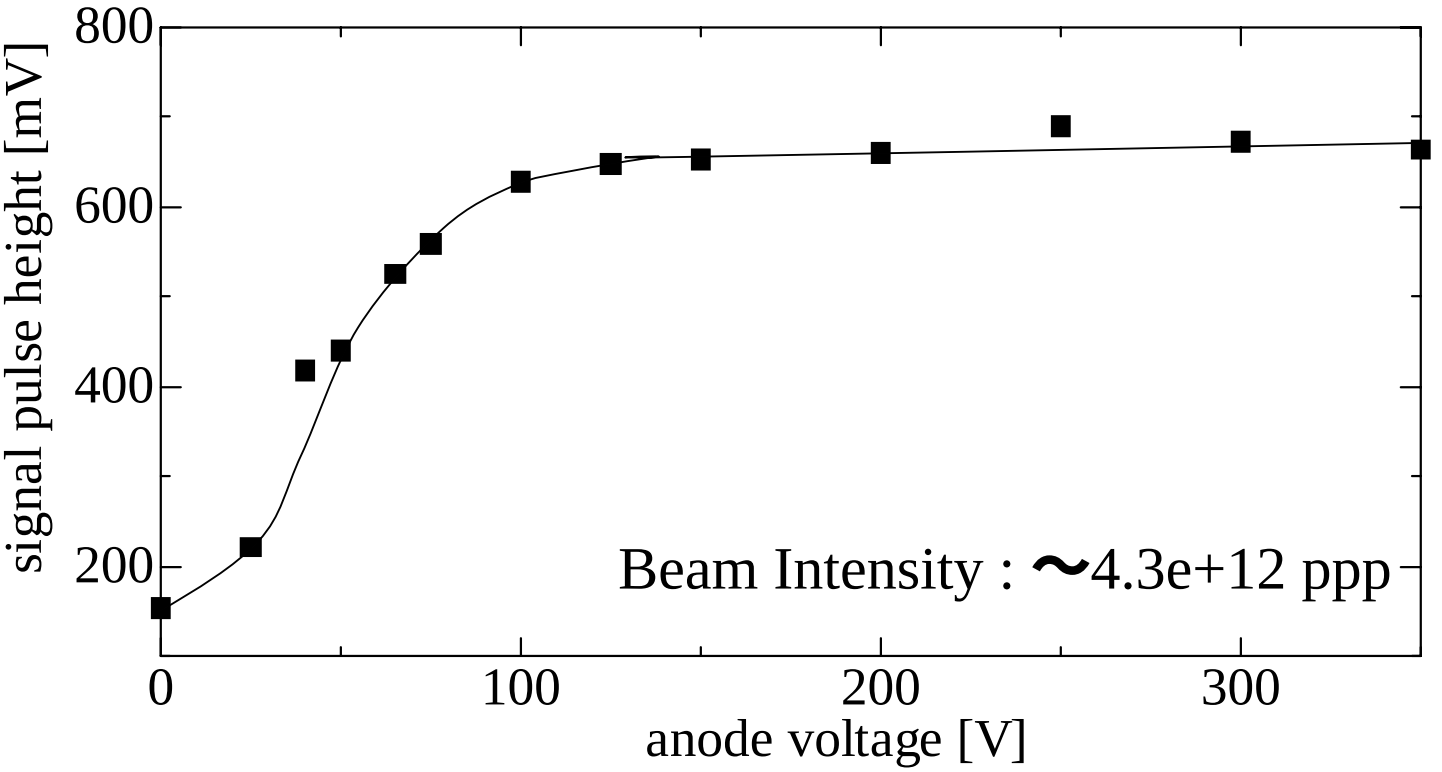


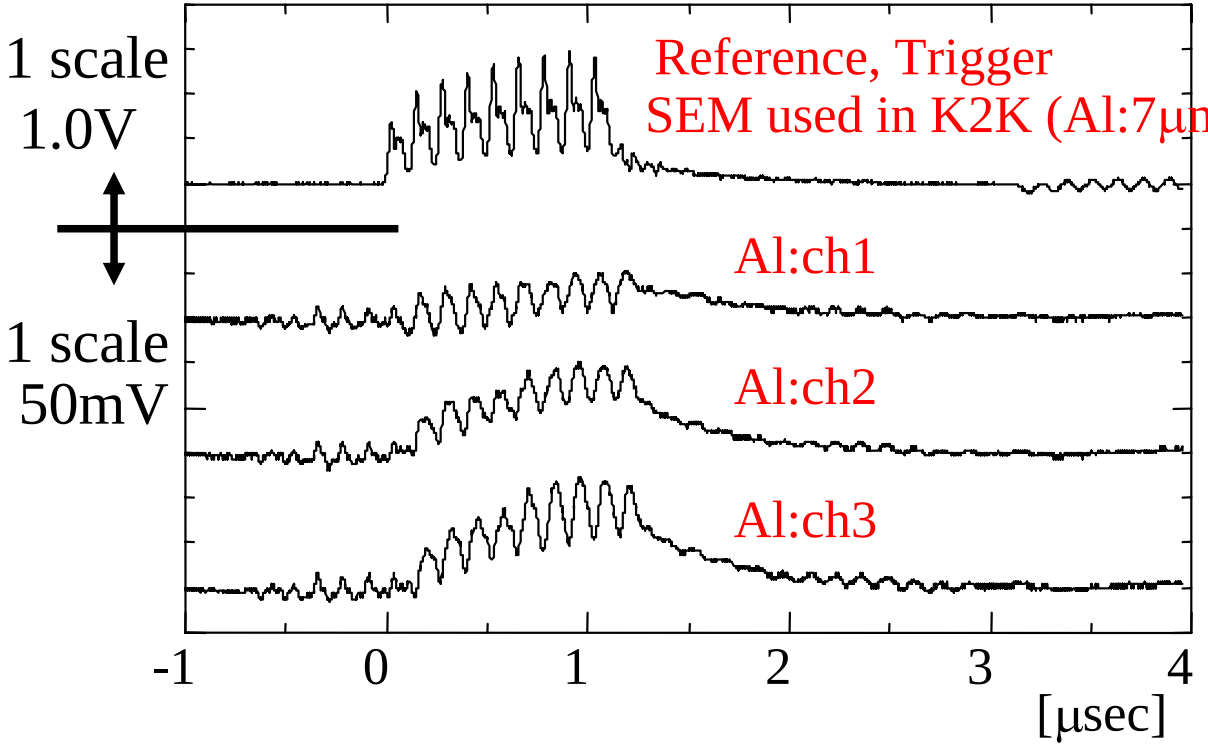
Fig : Cu : ch2(center) pulse height

Confirm one basic response :
Signal height was saturated around 100V.

Hereafter, we set the anode voltage to be 200V.

SSEM - Beam test : Basic responses -

Measured signal wave form (oscilloscope)

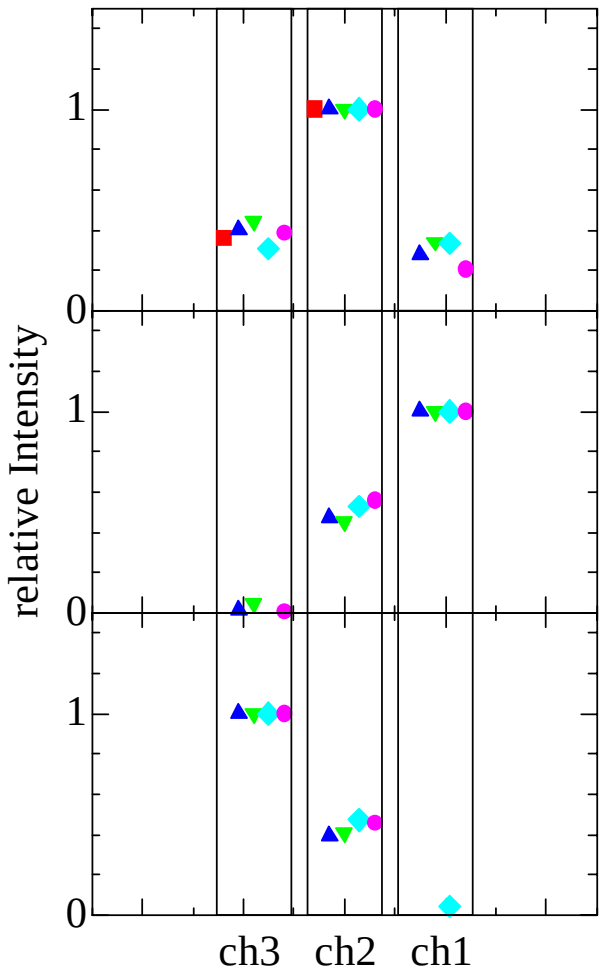


Vacuum:
~1e-06 Torr

Anode voltage 200V

9 peak structure can be seen. (K2K beam: 9bunch/1pulse)

SSEM Beam test : Basic responses -



Change the beam position from lower to upper.

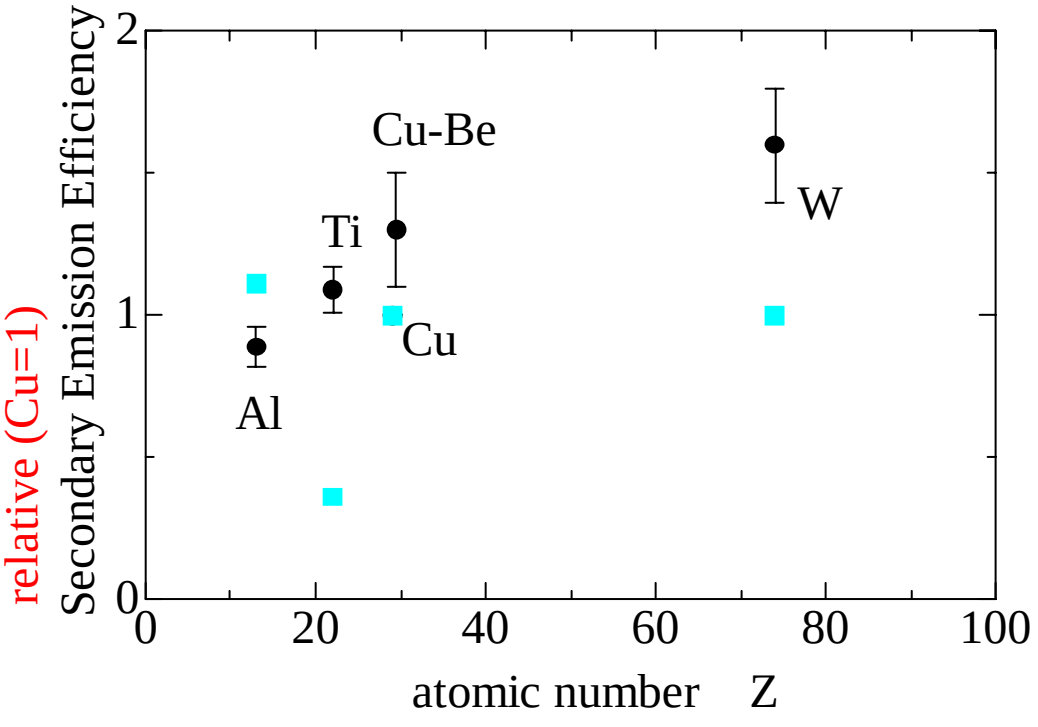
Figure shows the relative intensity to the highest channel in each material.

In the measured profiles, there are clear response to the beam positions.

Beam profile does not depend on the cathode materials.

SSEM - difference in cathode materials -

Secondary emission efficiencies for the different cathode materials.



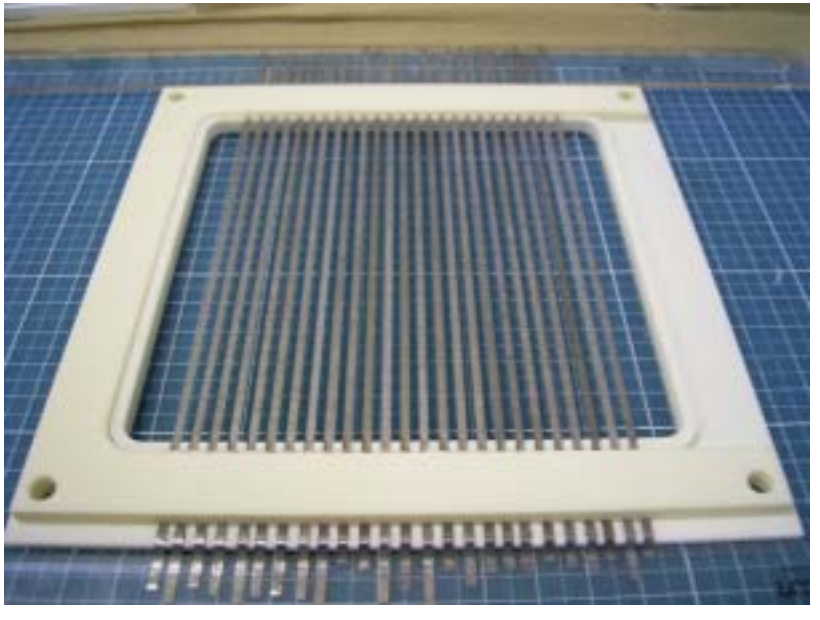
All measured secondary emission efficiencies are in the same order.

■ : result of the 70MeV electron beam experiment at SLAC.
NIM 39 (1966)p.303

Tungsten is 4 times larger than aluminum in interaction length. → Light materials, like Al ,Ti, are preferable.

SSEM - test of fine segmented cathode -

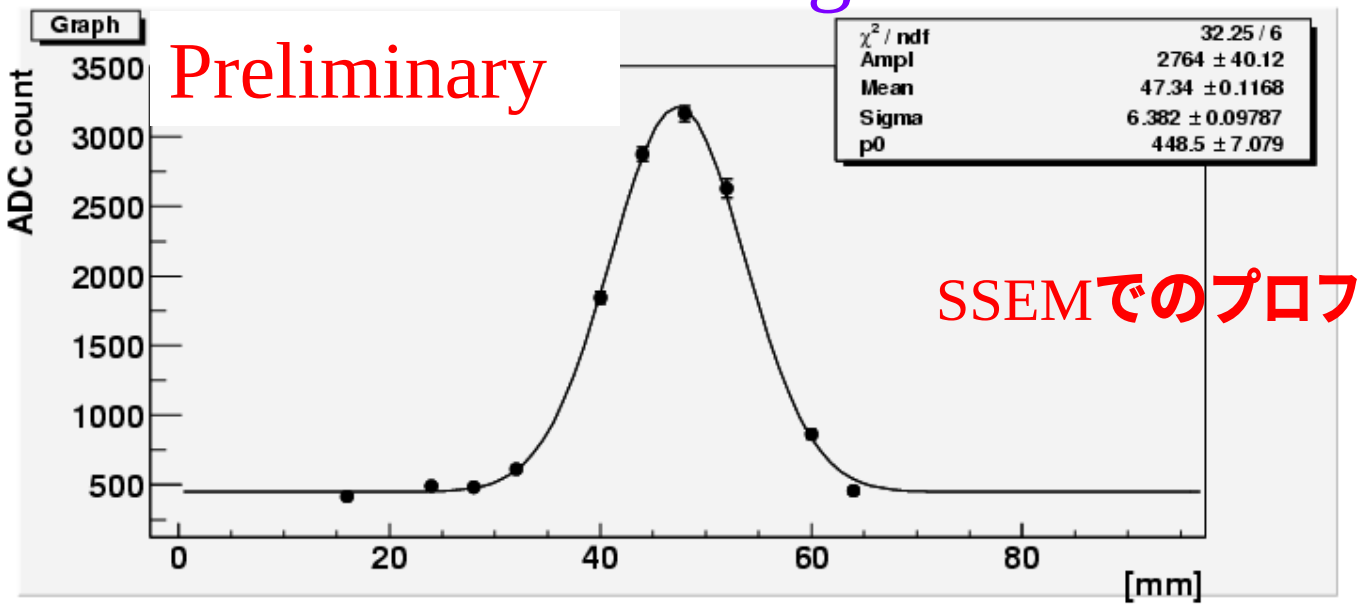
現在、Cathode電極を多ch化し、K2KのDAQを用いてプロファイル測定のテストを行っている。



Ti strip(2mm幅)

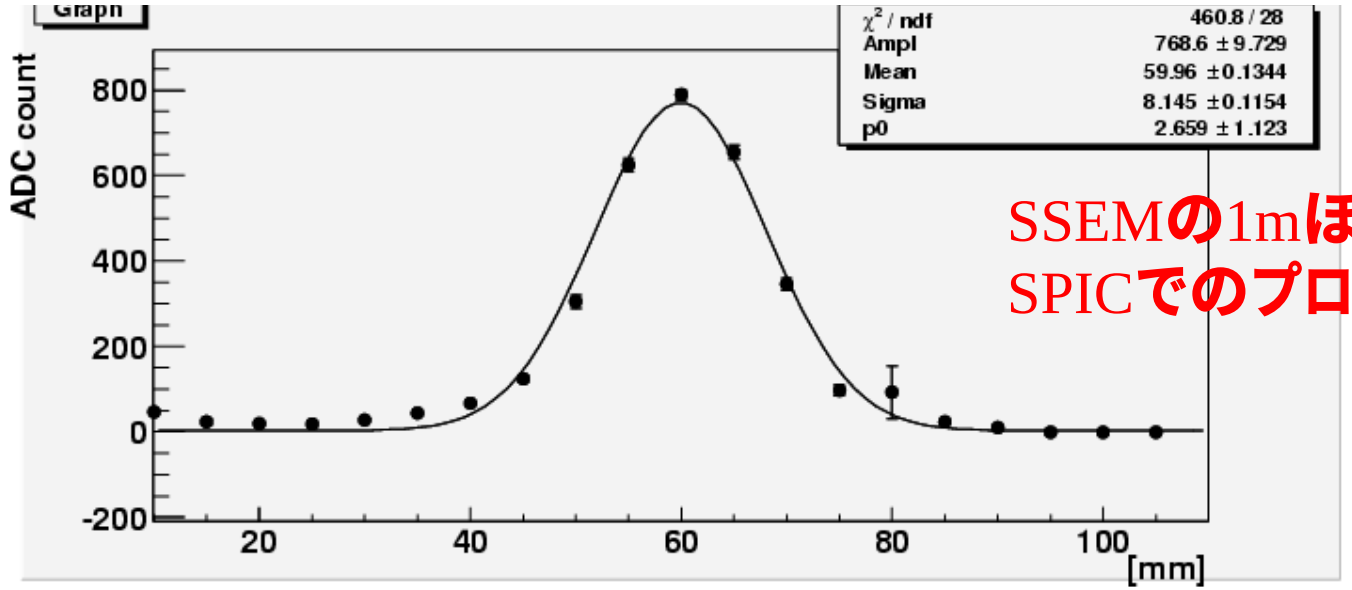
SSEM - test of fine segmented cathode -

Preliminary



SSEMでのプロファイル

σ_x ~ 6.4 [mm]



SSEMの1mほど手前の
SPICでのプロファイル

σ_x ~ 8.1 [mm]

Summary

In this beam test at the K2K Neutrino Beamline

- We confirmed the basic responses of SSEM.

- Secondary emission efficiencies are in the same order in 5 cathode materials.
  → In terms of interaction length, Al or Ti is preferable.

- We test the fine segmented cathode electrodes, like Ti strip(2mm).

  →Beam profile appeared to be measured.
  We need more detailed study.