The Use of Multiwire Proportional Counters to Select and Localize Charged Particles

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Contents

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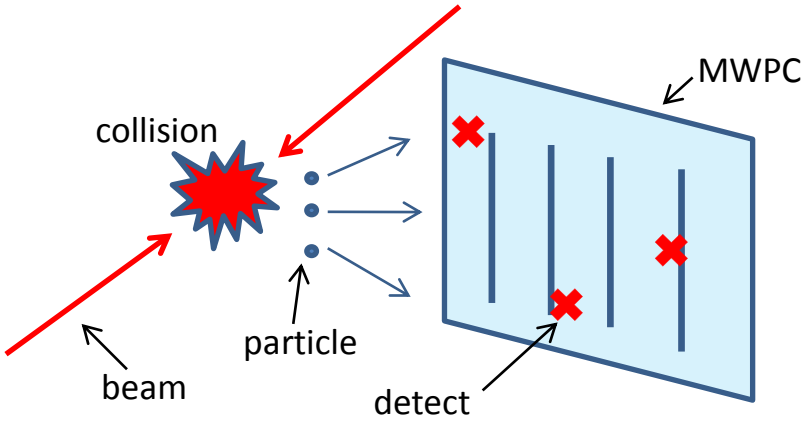
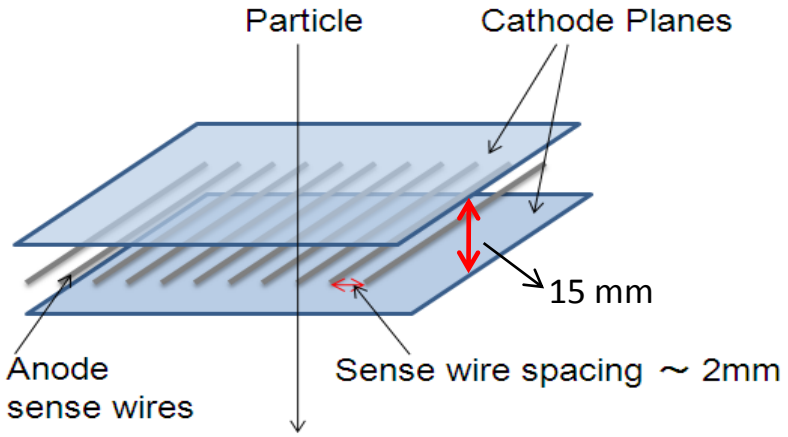
1. What is MWPC(MultiWire Proportional Counters)?

MWPC is a detector of the incident position of charged particles, which is developed by Charpak In 1968.





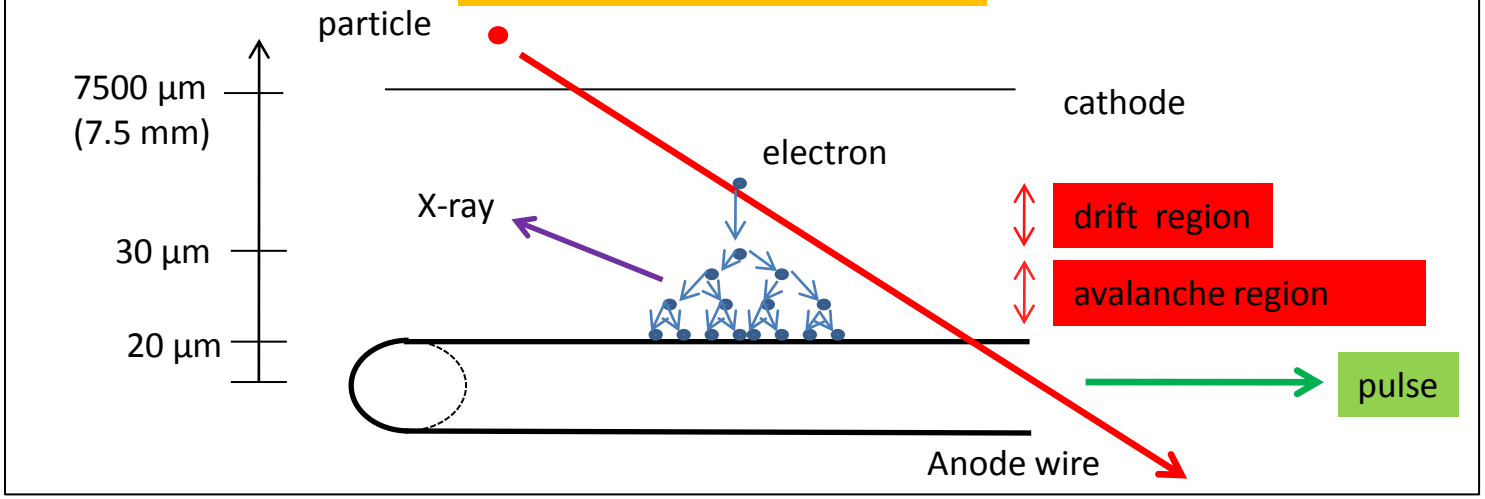
MWPC is made of a plane of independent wires in parallel and in same interval placed between two plane electrodes, the anode wires of MWPC act as independent proportional counters.

→ after development, MWPC is exploited in many experiments of elementary particles and an atomic nucleus

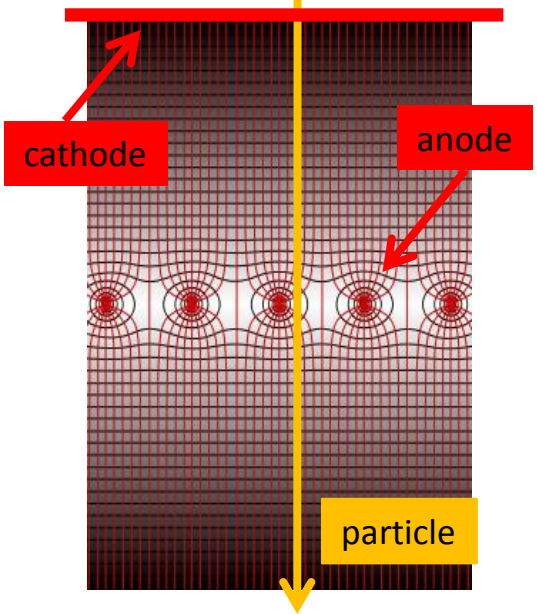
→ in 1992 Charpak received a Nobel Prise in physics

2. Method of detection

A flow chart of detection



Equipotentials in a chamber



1. Formation of primary ionization electrons.
2. The electrons drift along the electric field lines.
3. Avalanche take place near the anode wire.
4. Output from an anode wire.

- Selecting of applied voltage -

By setting applied voltage up from 1400 V to 1650 V,
each wire works as an independent proportional counter.

→ The region of operation of MWPC is the proportional region.

< features of the proportional region >

- partial discharge
- high amplification

→ output from only the nearest wire
from the incident position of particles

- Selecting of gas -

Ex 1. argon + pentane
Ex 2. argon + heptane

- reason of selection of argon

- low value of W
  → increase of the numbers of primary electrons
- low threshold for proportional amplification
  → high amplification

} high pulse height

- reason of selection of pentane and heptane

-absorption of ultraviolet quanta
  → preventing of propagation

} output from single wire

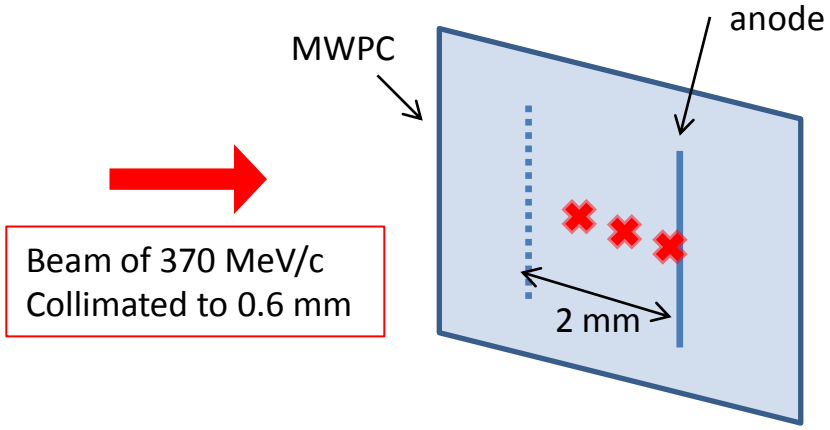
→ acquisition of gas amplification factor of 10^5

Pulse height
100 mV

3. Measurement of the properties of MWPC

< pulse height as a function of distance from the wire >

Experiment content

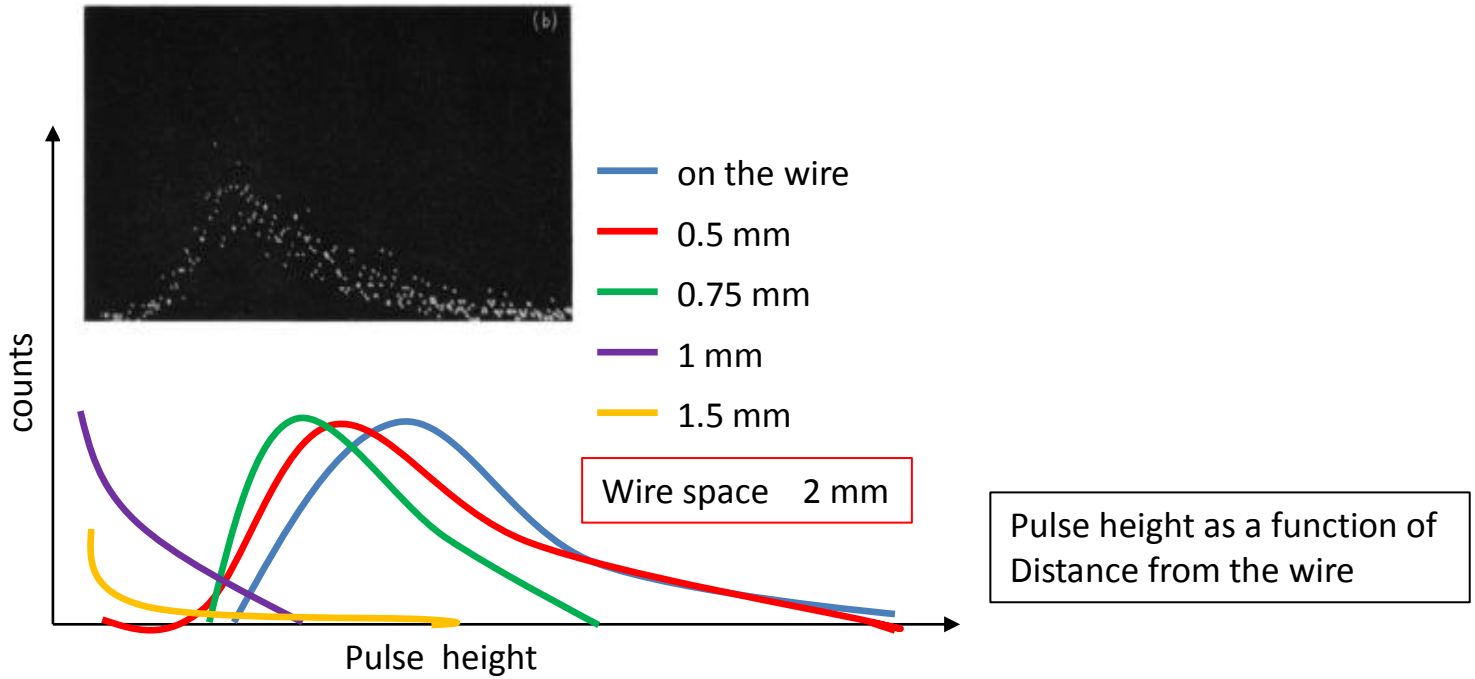


- A beam of protons incidents on MWPC
  as they vary the distance from the wire.

- Distance : on the wire, 0.5 mm, 0.75 mm, 1 mm and 1.5 mm

- Measurement : pulse height

Result



On the wire ～ 0.75 mm : a lot of high pulse height

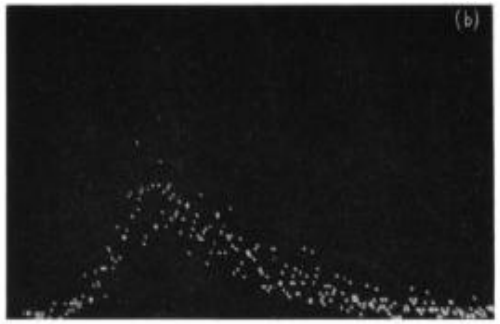
→ signal of incident particles

1 mm ～ 1.5 mm : a lot of low pulse height

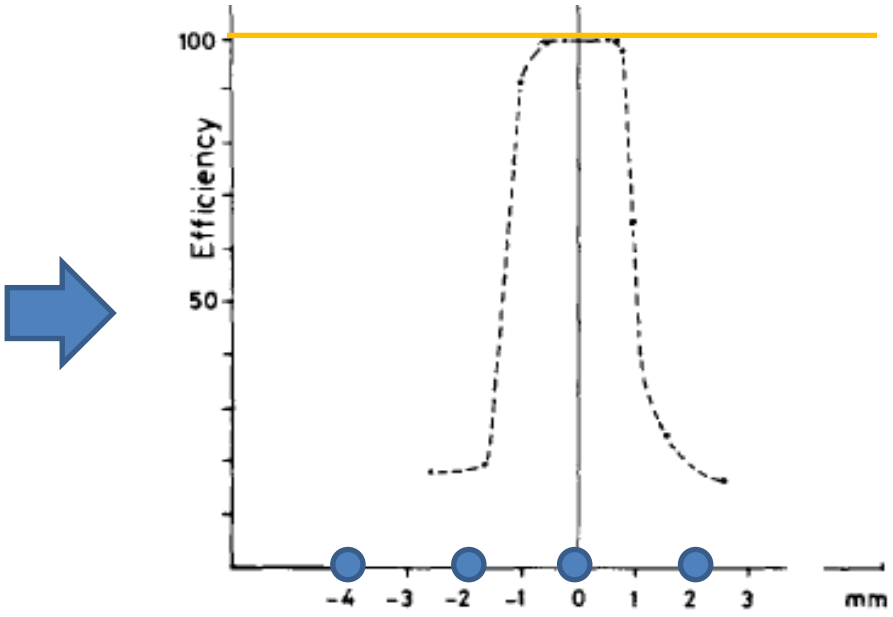
→ signal of noise

Thanks to high amplification in proportional region,
MWPC can distinguish between signal of particles and signal of noise.

< efficiency >



Pulse height as a function of
Distance from the wire



Efficiency of detection
as a function of position

To get the high efficiency near the wire,
low discrimination level was set up.

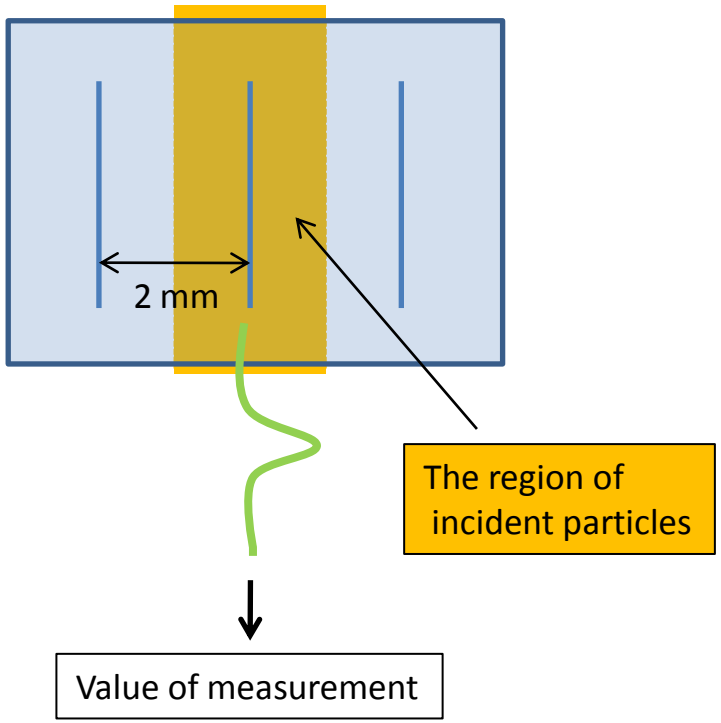
→ Incident particles up to 0.75 mm from the wire
can be detected with an efficiency close to 100 %.

< localization >

Thanks to operate in proportional region,
output from single wire can be gotten.

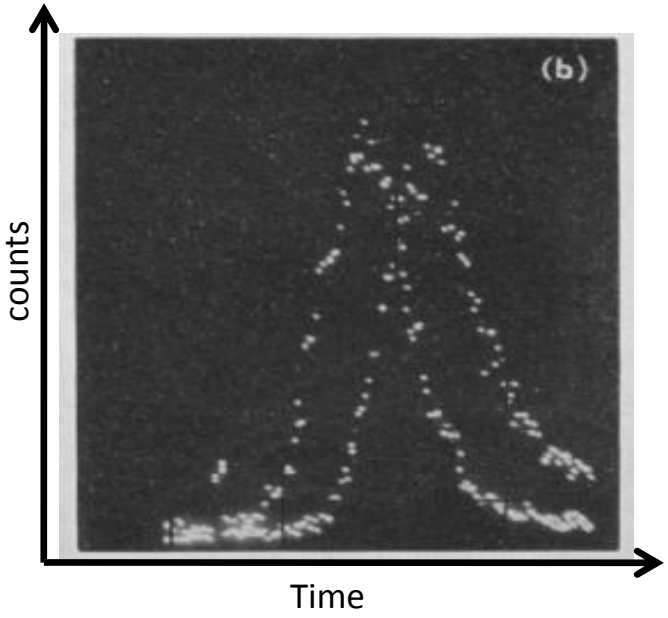
→ maximum error is 1 mm. (wire space : 2 mm)

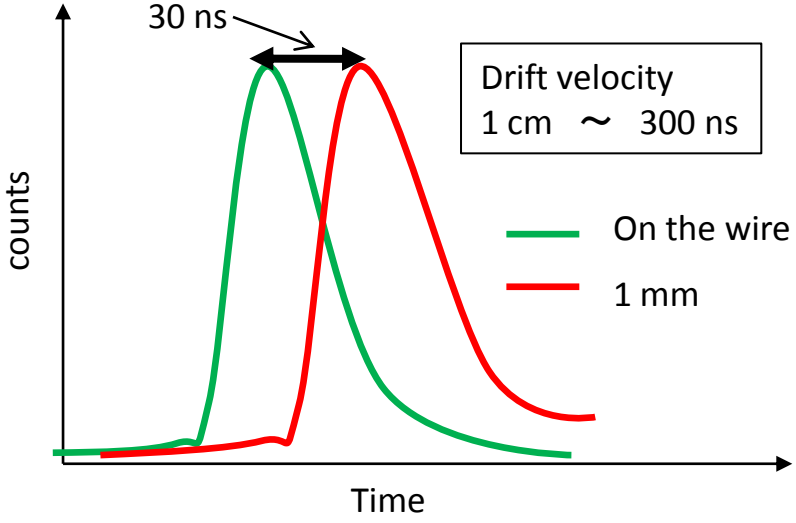
Error = | value of measurement − the position of incident particles |



→ Localization of the position between the wire is possible, making use of the arrival time of the pulse (time delay).

Time delay - idea to Drift Chamber -





Delay in the pulse as a function of the Distance wire - particle

content

A beam of protons incidents on MWPC as they vary the distance from the wire.

- Distance : on the wire and 1 mm

-measurement : time interval between the traversal of MWPC by the electron and the detection on the wire

result

Time distribution is shifted on the right side as incident position of particles go away from the wire.

→ time delay

Reason : the difference of drift-distance

To better spatial resolutions,
making use of time delay
→ to Drift Chamber

4. summary

- Each wire of MWPC acts as an independent proportional counter.
- With argon-pentane and argon-heptane mixtures, high amplification is possible.
- Incident particles up to 0.75 mm from the wire can be detected with an efficiency close to 100 %.
- The maximum error of localization of the position of incident particles is 1 mm.
- Time delay may be exploited to get better spatial resolutions.