The Transparent MSGC

Study on transparent electrode ITO-MSGC for Gas Proportional Scintillation Counter

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MPGD'09 June 13th 2009@Crete, Greece

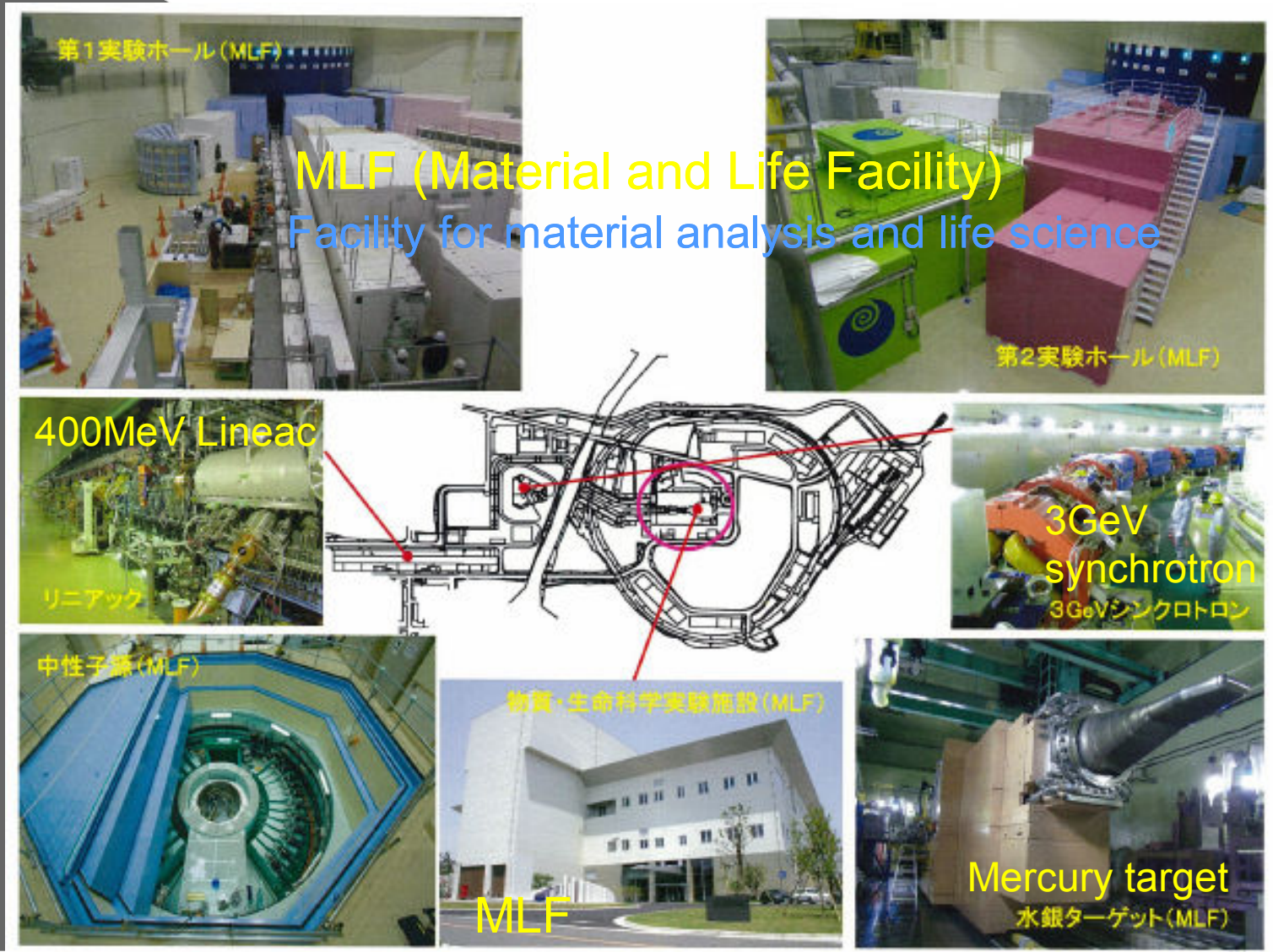
Outline

- Introduction
- Multi-Grid MSGC (M-MSGC)
- Active scintillation method
- Fabrication of transparent M-MSGC (ITO)
- Test results in X-ray
- Summary

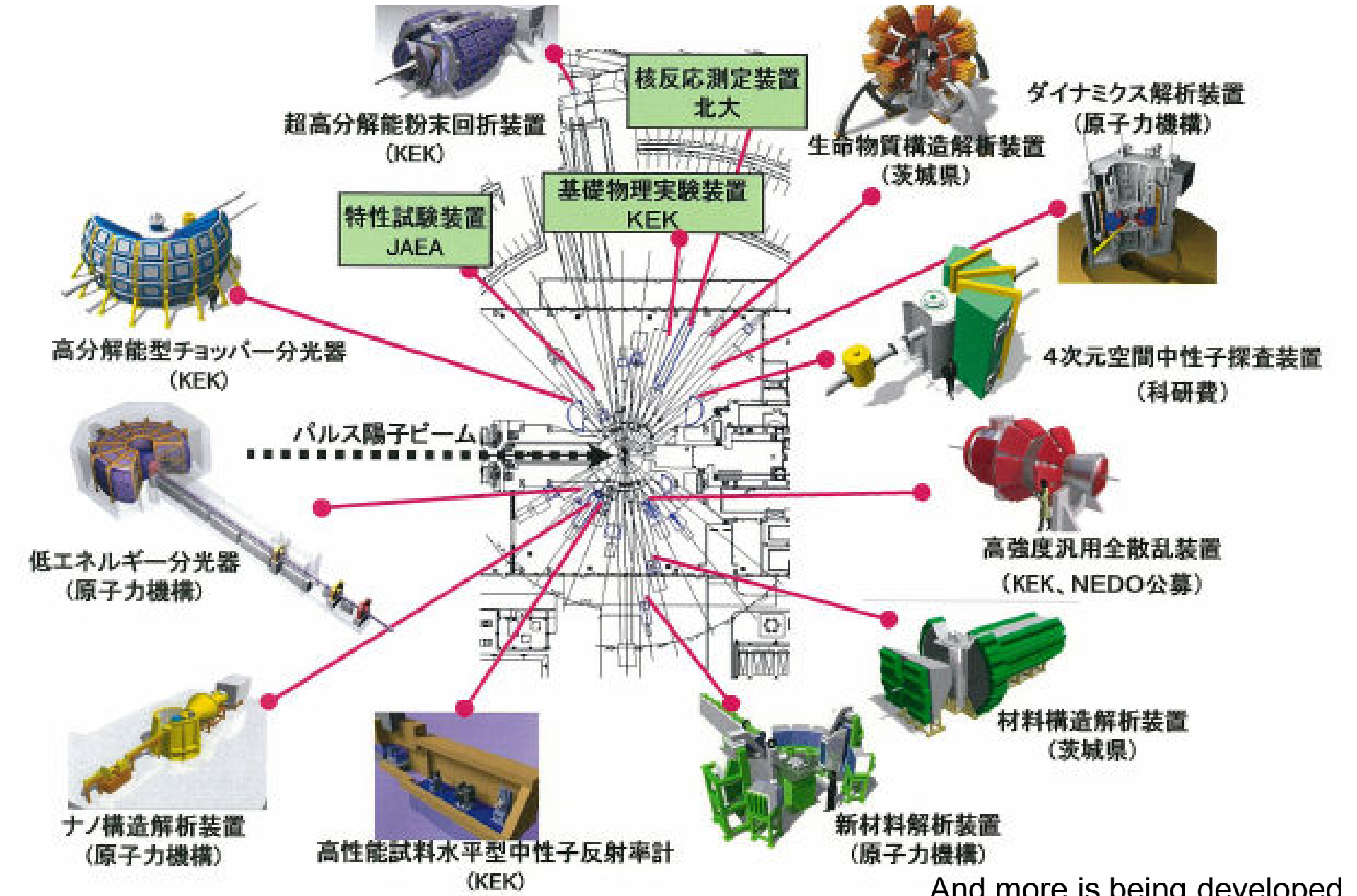
1. Introduction

J-PARC (Japan Proton Accelerator Research Complex)

Overview



MLF spectrometers

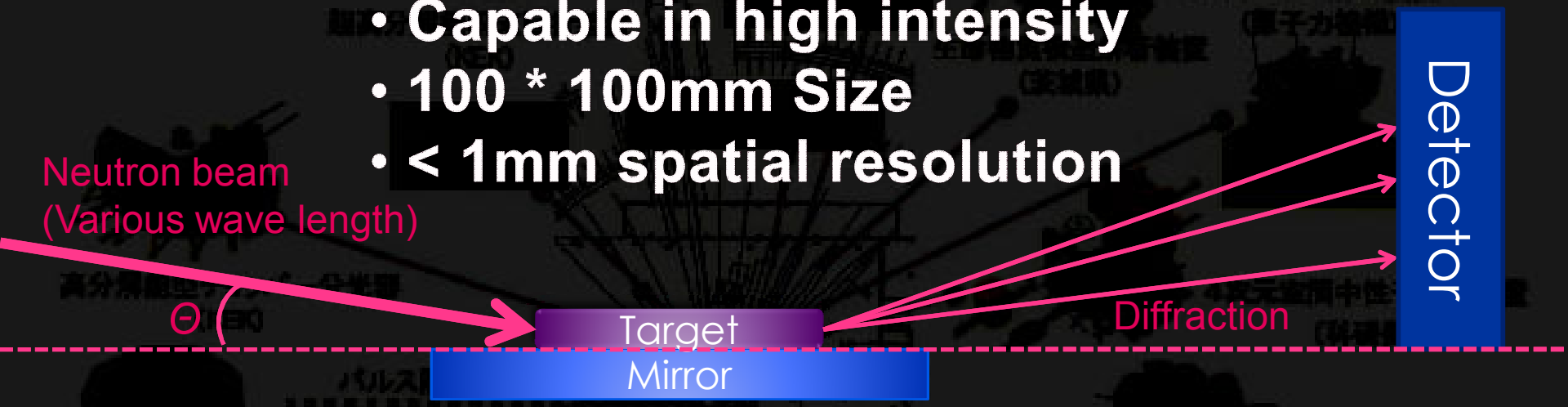


And more is being developed

MLF spectrometers

Detectors are required to be…

- **Capable in high intensity**
- **100 * 100mm Size**
- **< 1mm spatial resolution**



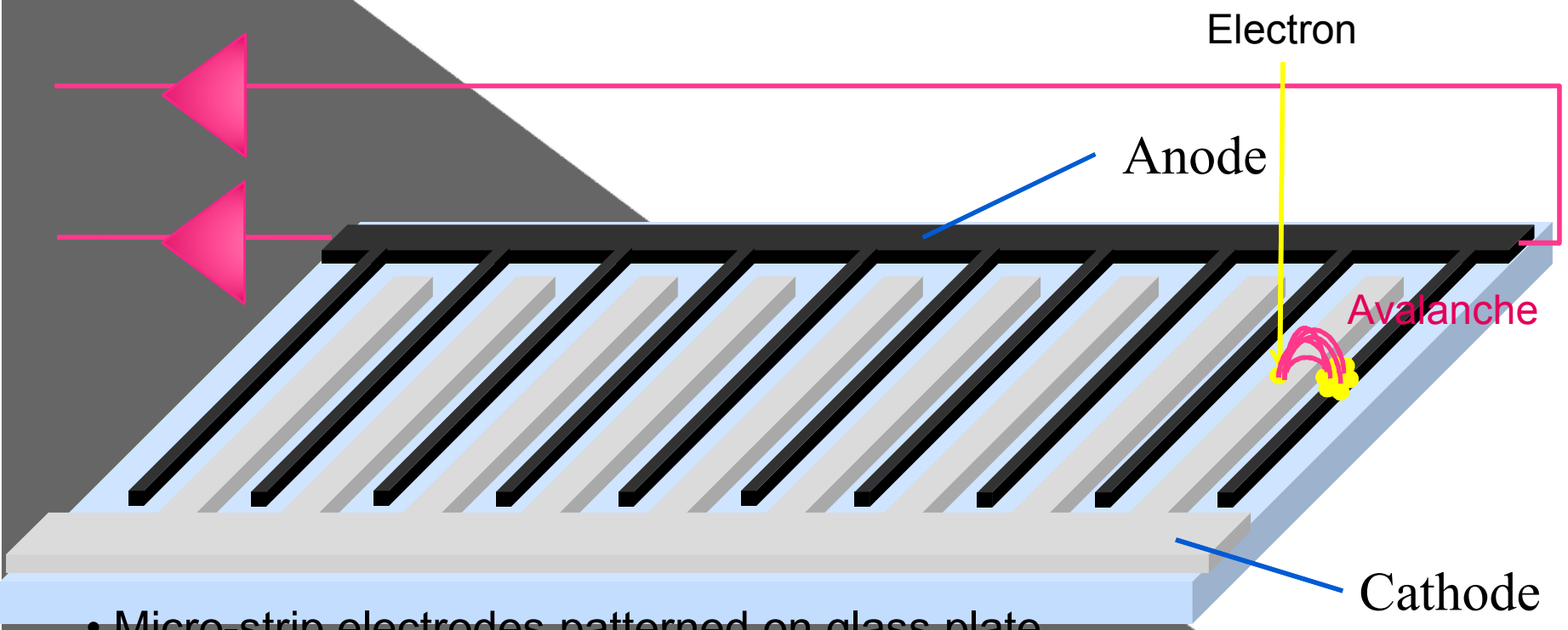
Diagrammatic sketch of Refelctrometer

Neutron Reflectrometer

A facility to analysis materials with reflection of neutrons

2. Multi-Grid MSGC (M-MSGC)

Diagrammatic sketch MSGC (Micro Strip Gas Counter)

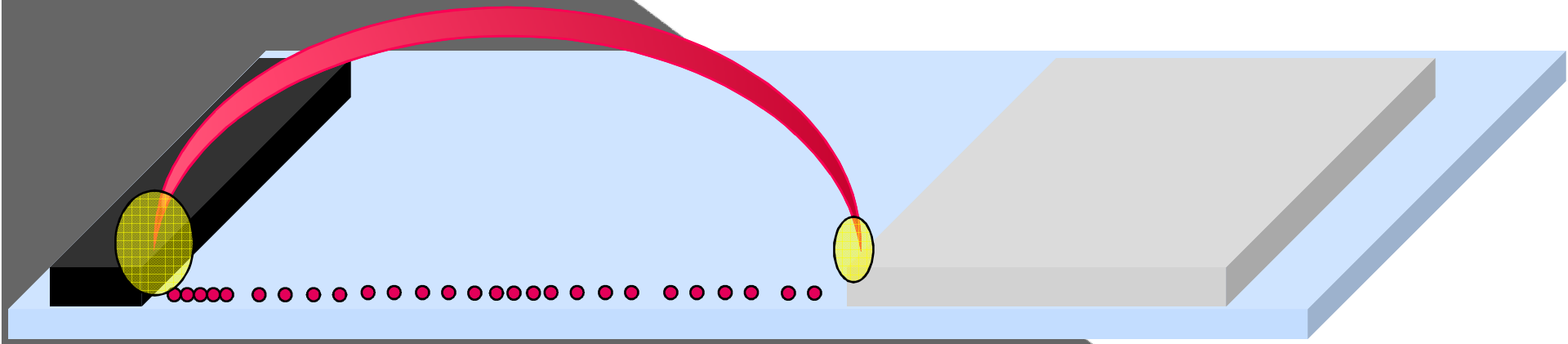


- Micro-strip electrodes patterned on glass plate
- <100μm between anode & cathode
- Up to 1600V between each strips
- Electron is multiplied with avalanche and produces charge
- Charge division readout method for 1D position detection
- 2D position detection by layering 2 plates

MSGC (Micro Strip Gas Counter)

Good

- High count rate
- Low cost
- Could be used with high pressure gas



Anode

Cathode

Bad

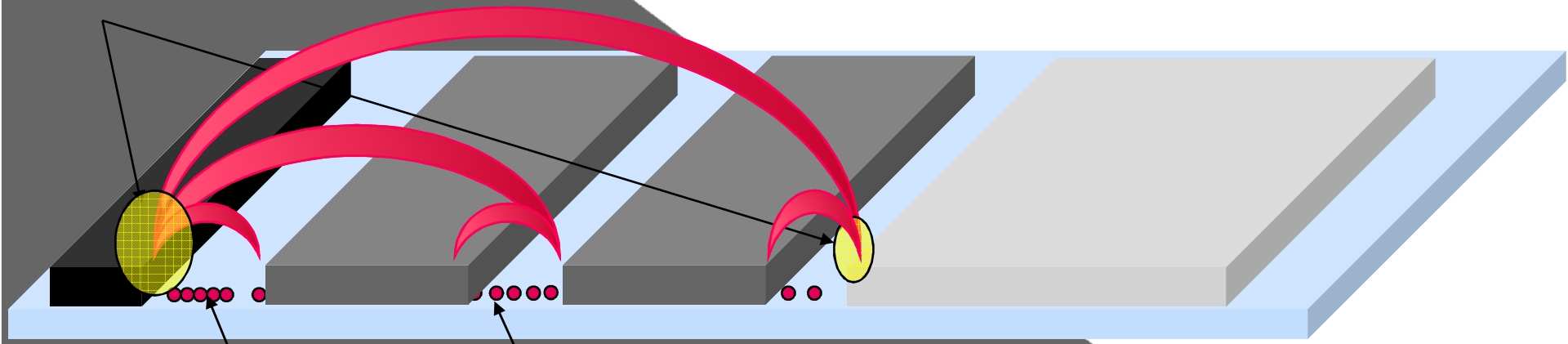
- Charge up causes decrease of gas gain
- Damage caused by sudden discharge
- Bad in stability

Multi-grid-type MSGC (M-MSGC)

~~Bad~~

- ~~Charge up causes decrease of gas gain~~
- ~~Damage caused by sudden discharge~~
- ~~Bad in stability~~

Separation of two strong electric fields



Anode Grid1 Grid2 ··· Cathode

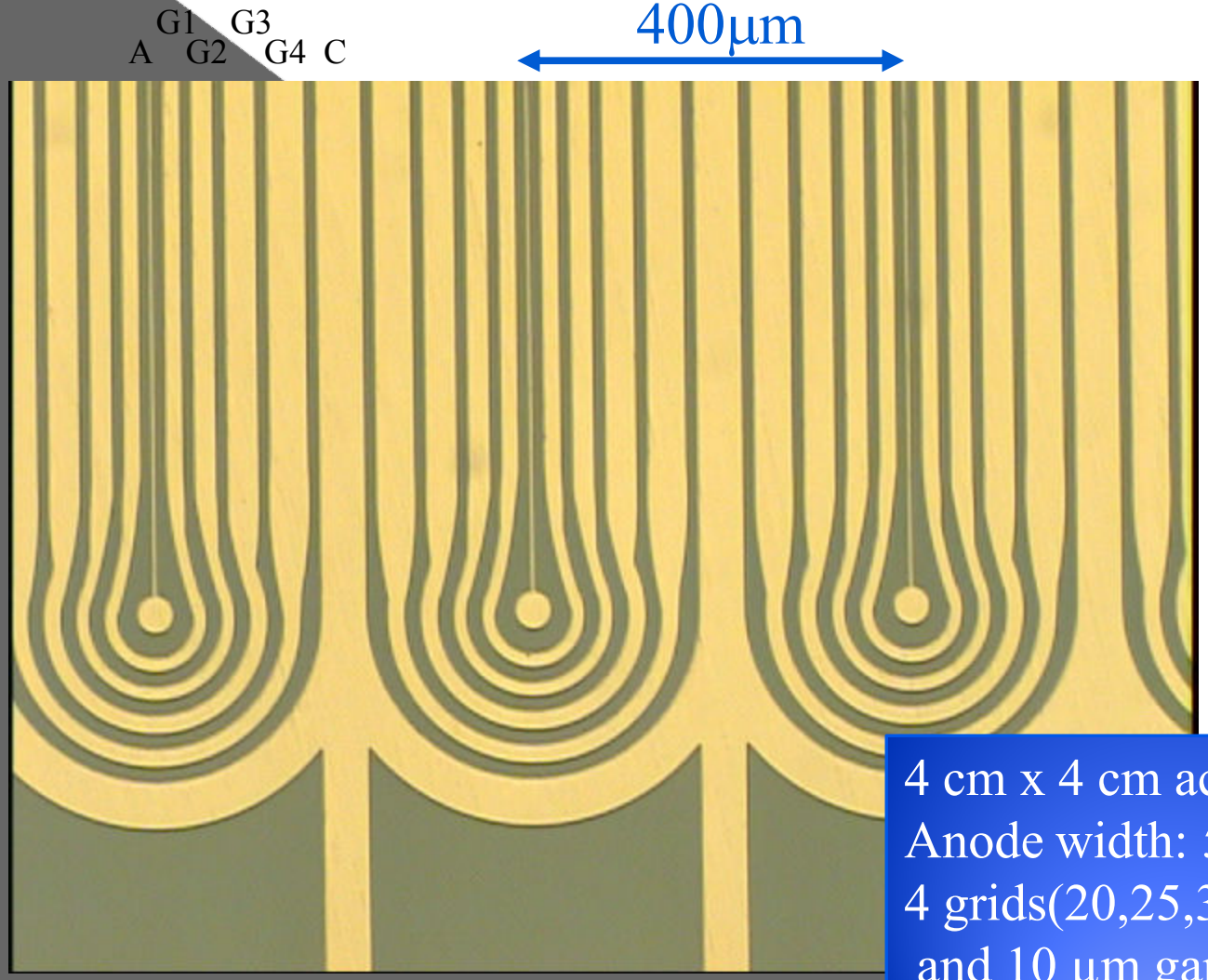
$V_{anode} > V_{grid1} > V_{grid2} > V_{cathode}$

Small surface charge

Low surface resistance

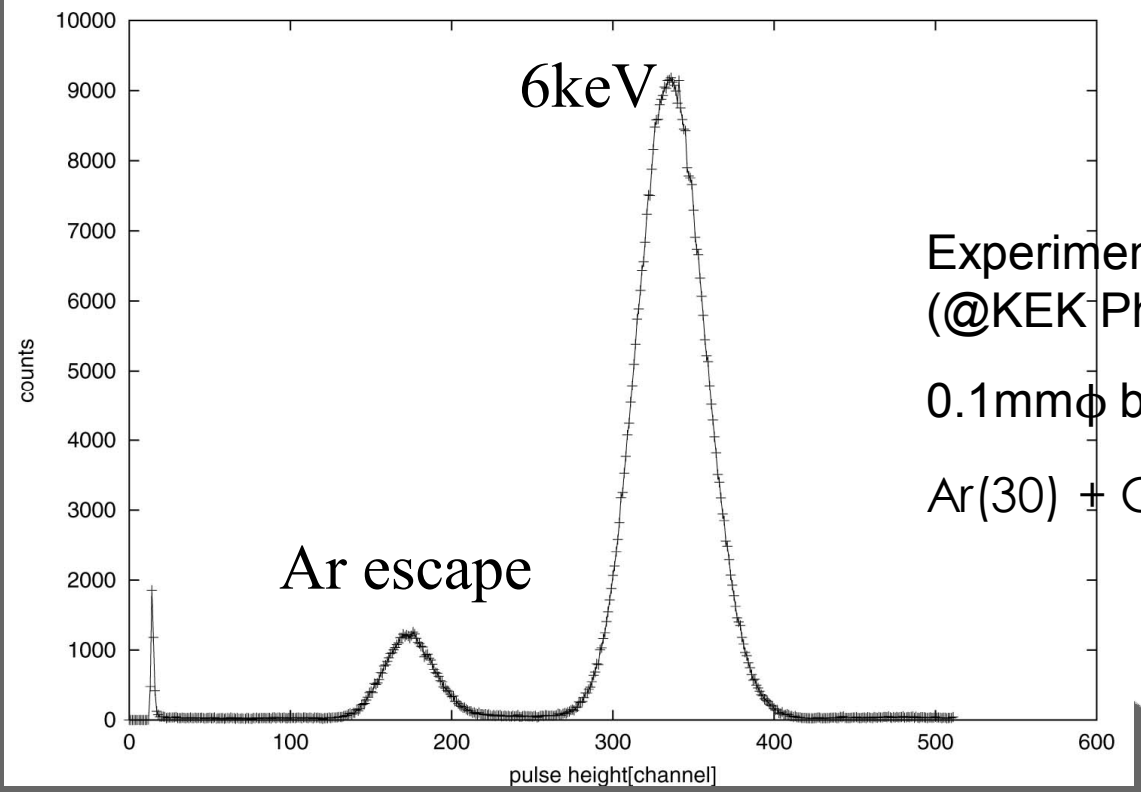
Avoid charge-up and sudden discharge

A test plate consists of 4 grids + anode + cathode



4 cm x 4 cm active area
Anode width: 5 μm
4 grids(20,25,35,42.5μm)
and 10 μm gaps

Pulse Height Spectrum for 6keV X-rays



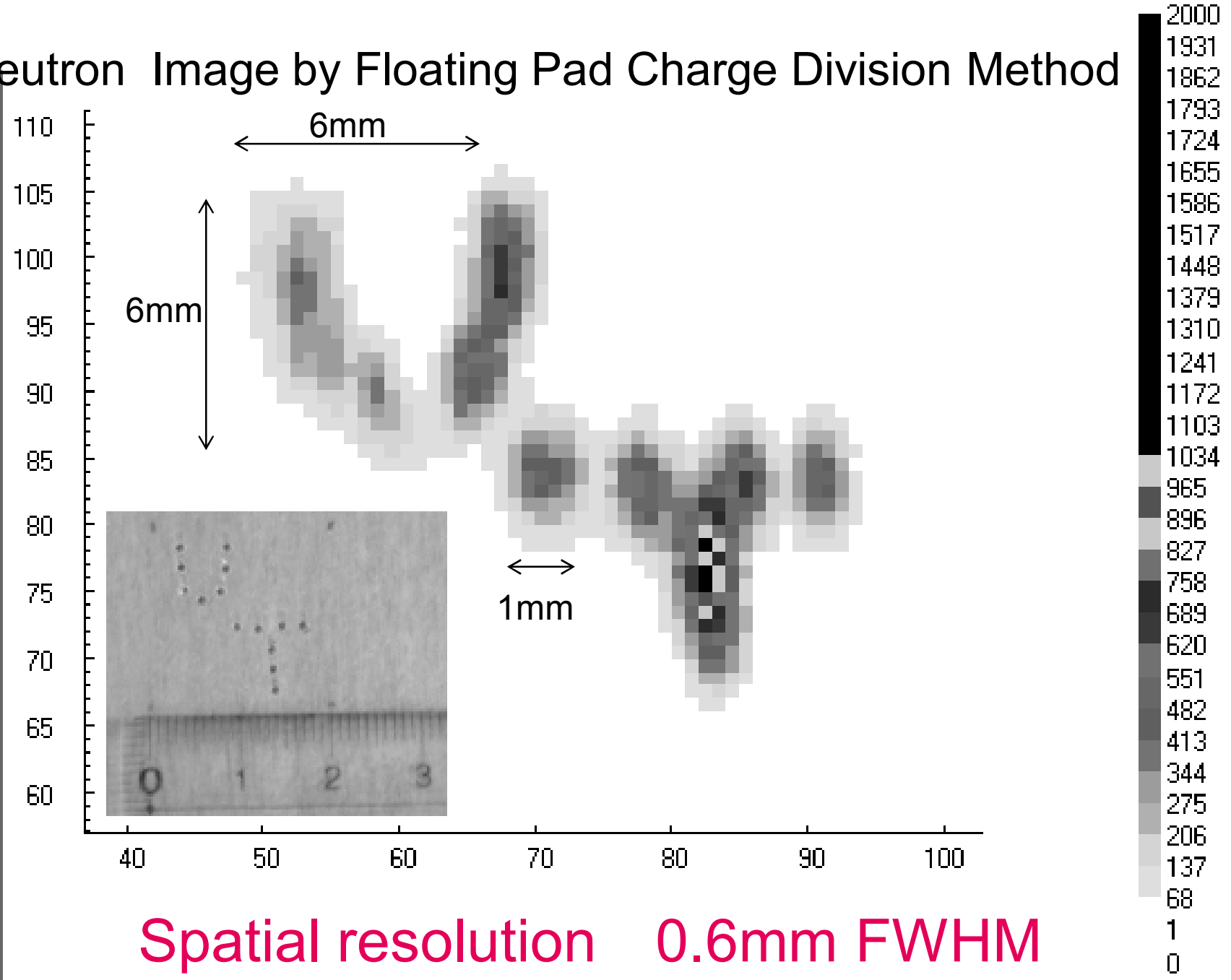
Experiment is done with 6keV X-ray (@KEK Photon Factory)

0.1mmϕ beam, 400cps/mm^2

Ar(30) + CH_4(70%)@ 1 atm

Obtained energy resolution was 14.6% FWHM.
(Gas gain =3000)

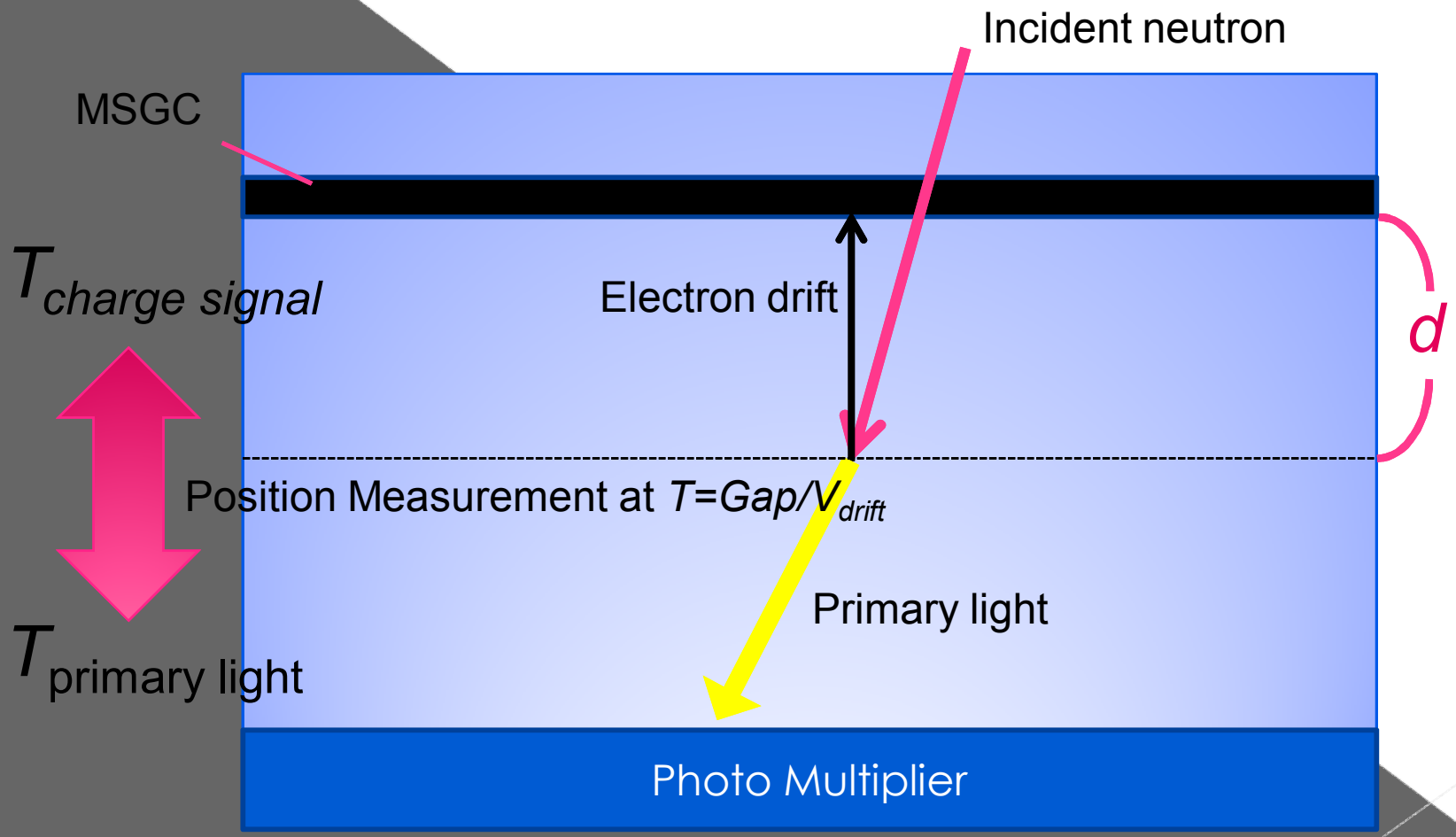
Neutron Image by Floating Pad Charge Division Method



Spatial resolution 0.6mm FWHM

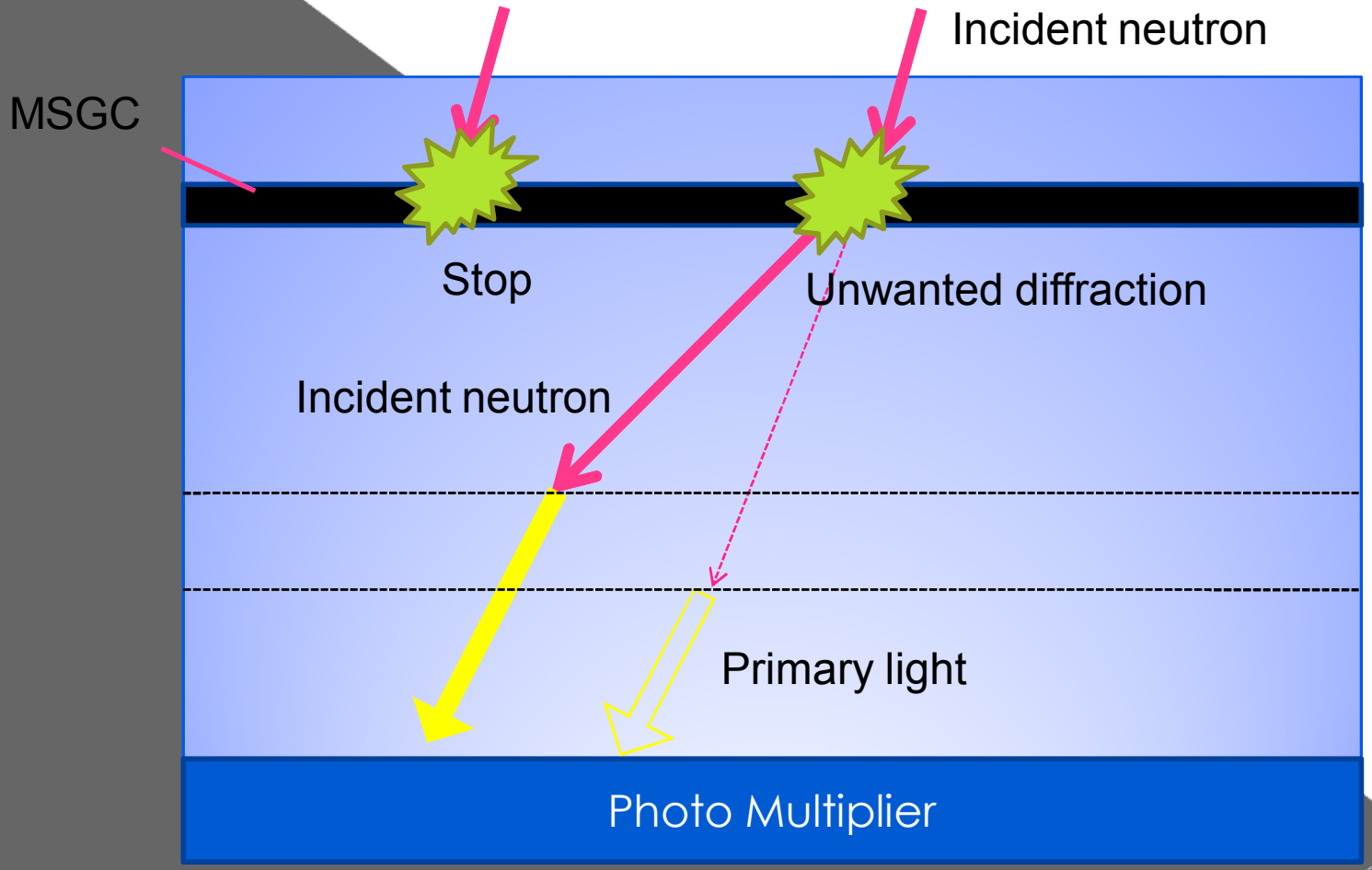
3. Active scintillation

Active scintillator method (proposed in MILAND)



Primary light signal enables to calculate the depth of interaction information, and reduce parallax error

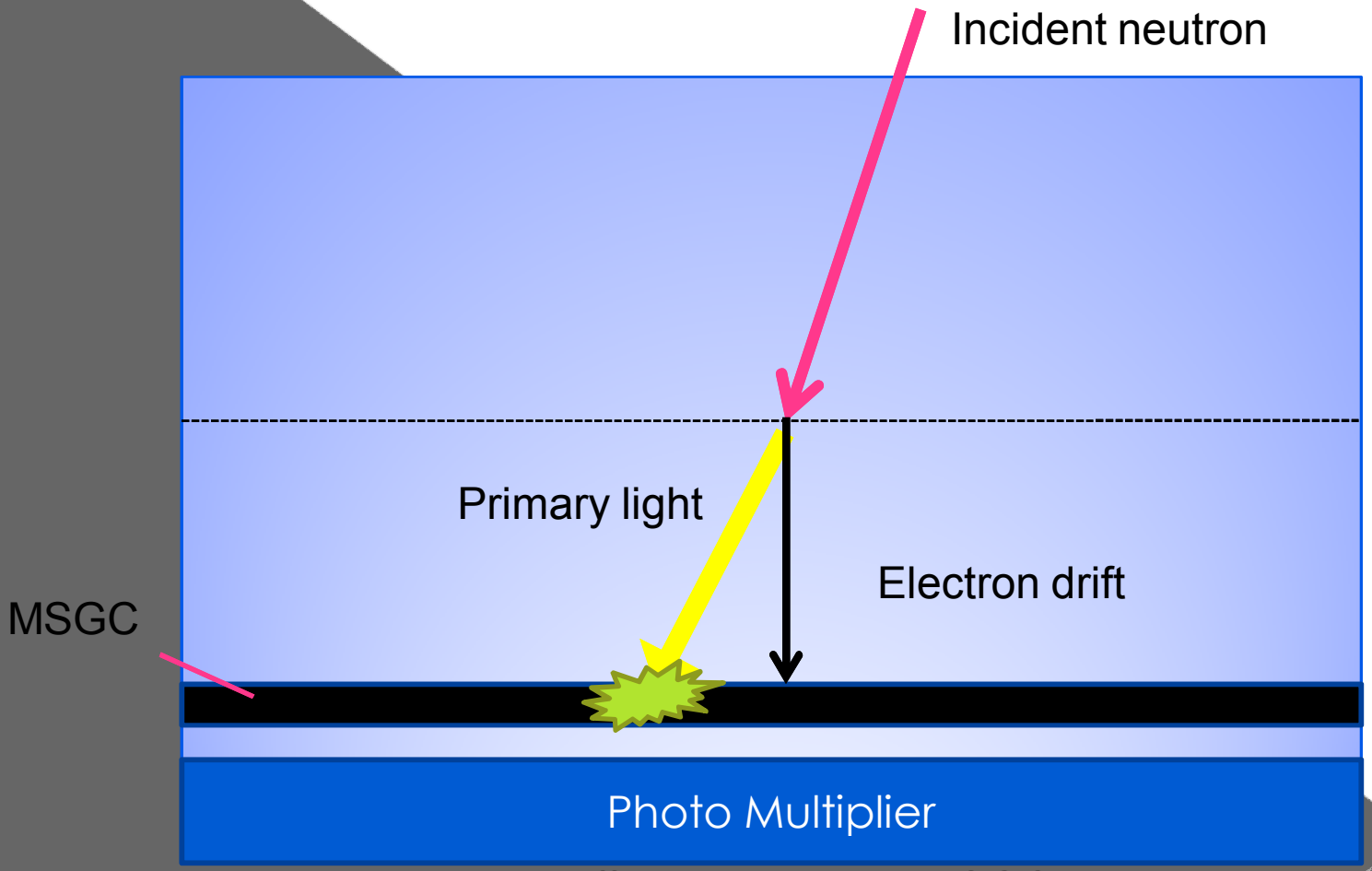
Problems of conventional method



Since neutrons have to go through the MSGC, unwanted diffractions and stops can be caused.

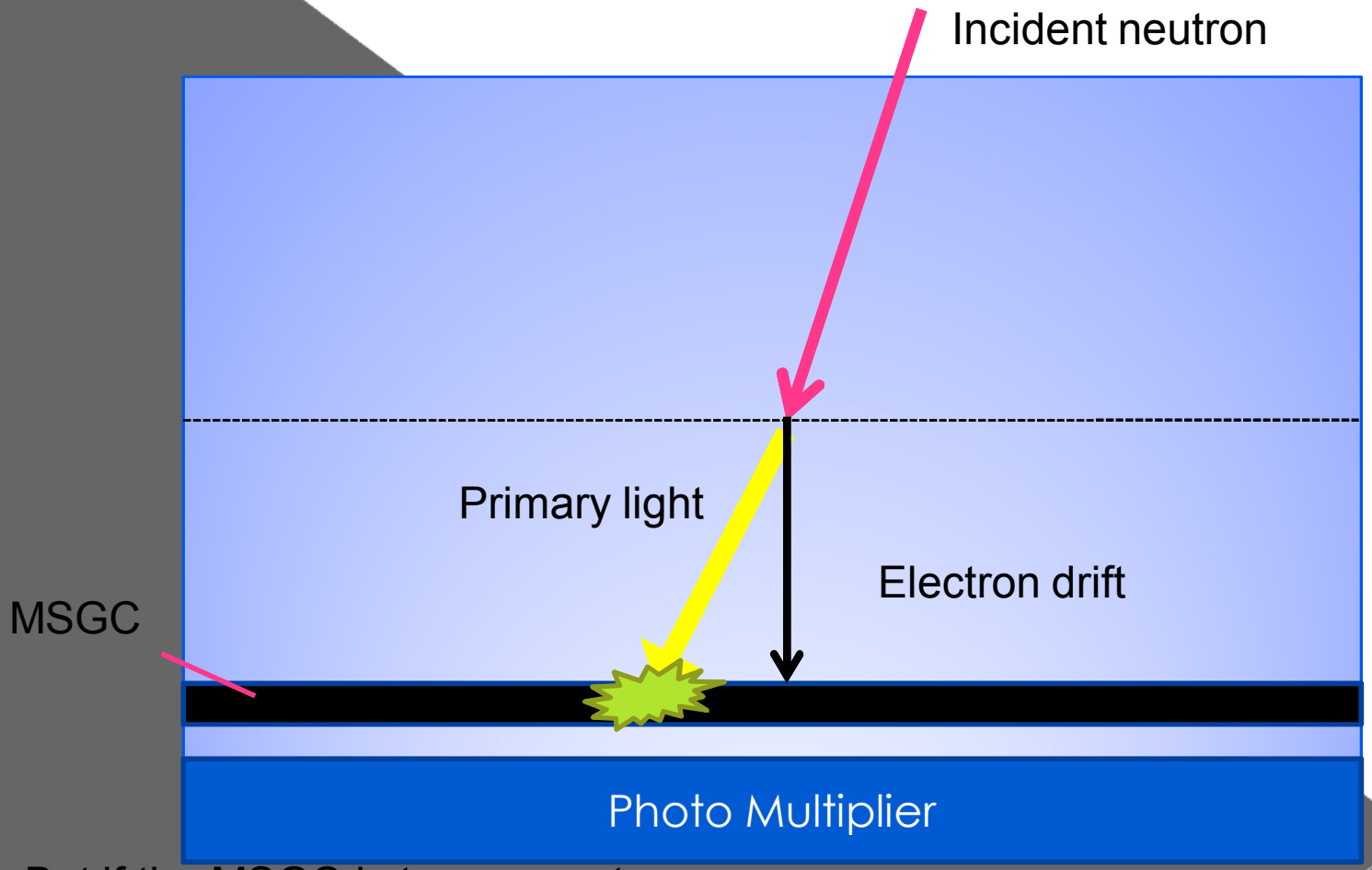
~~Position Measurement at T=Gap/V_{drift}~~

Problems of conventional method



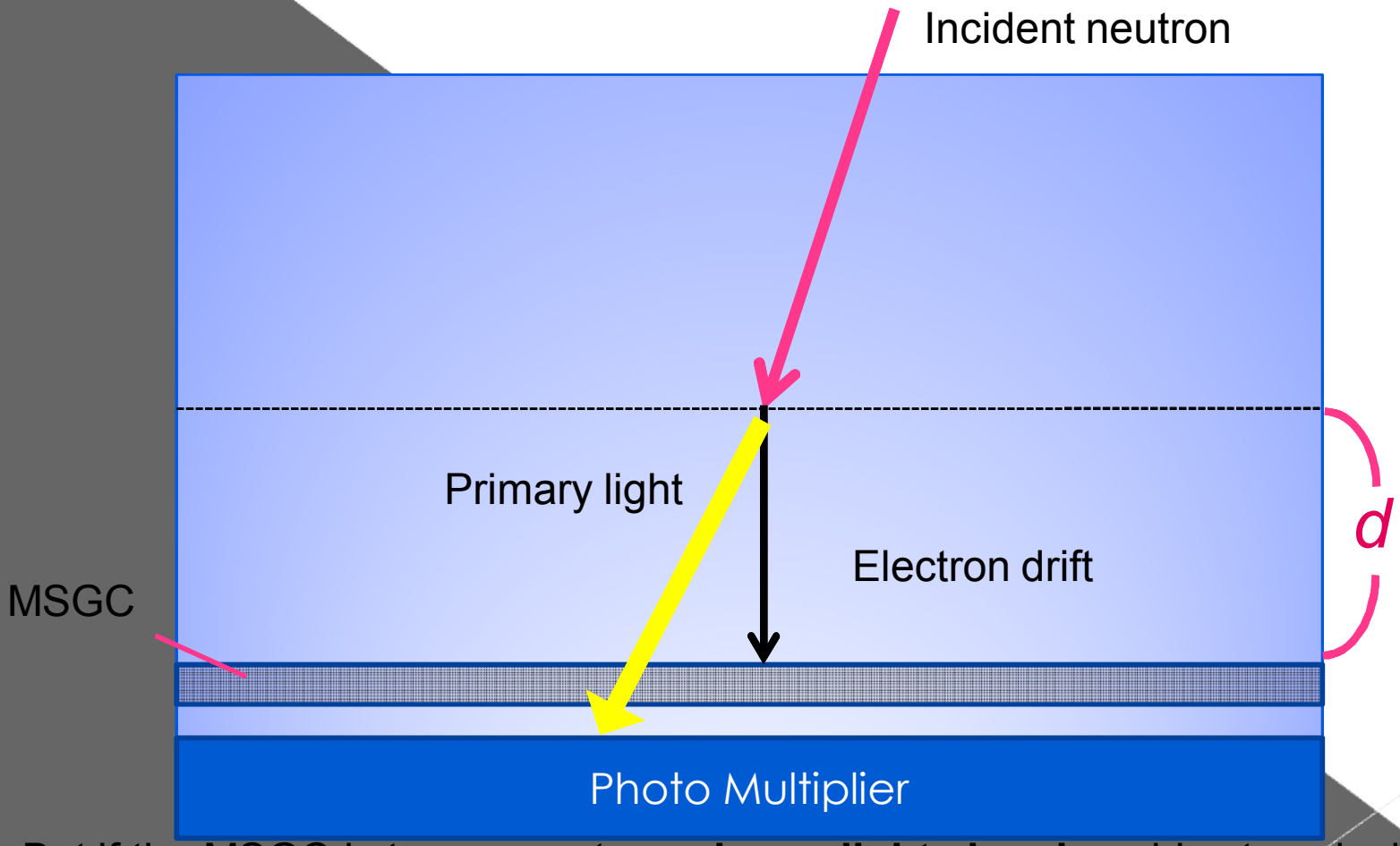
In order to avoid unwanted diffraction or stop, MSGC should be under the conversion area. However, since ordinary MSGC's are not transparent, primary light cannot get to PMT.

Problems of conventional method



But if the MSGC is transparent…,

Problems of conventional method



But if the MSGC is transparent…, **primary light signal** enables to calculate the depth of interaction information, and **reduce parallax error without worrying about the unwanted diffraction**

4. ITO - The transparent MSGC

ITO MSGC

- ITO(Indium Tin Oxide) is known as a transparent conductive material used for LCD display.
- Optical transmission is 80-90%.
- We fabricated a multi-grid-type MSGC using ITO.
- OA10 glass substrate
- 170nm thick ITO layer
- Use with Ar/CF_4 gas for efficient GSPC

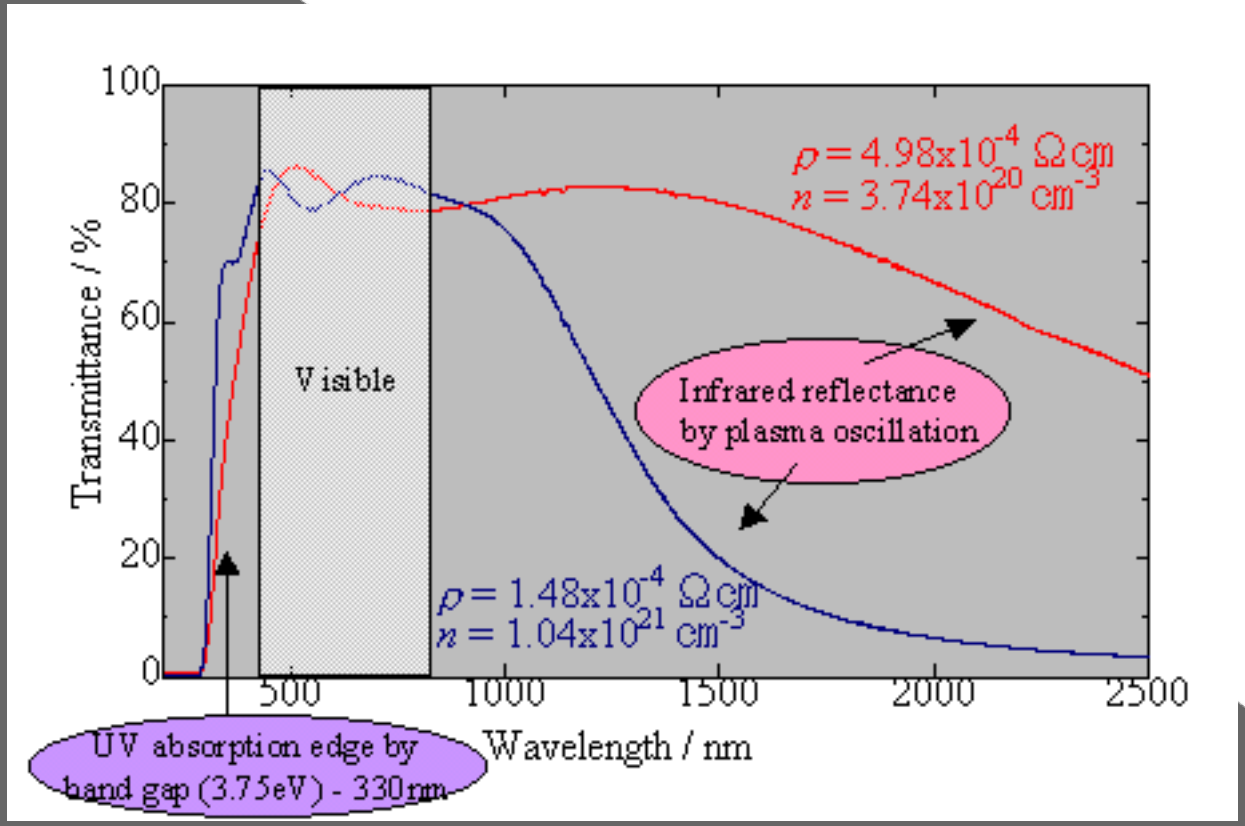
This is ITO MSGC

If you have super excellent eyes, may be you can see…

Picture of ITO MSGC

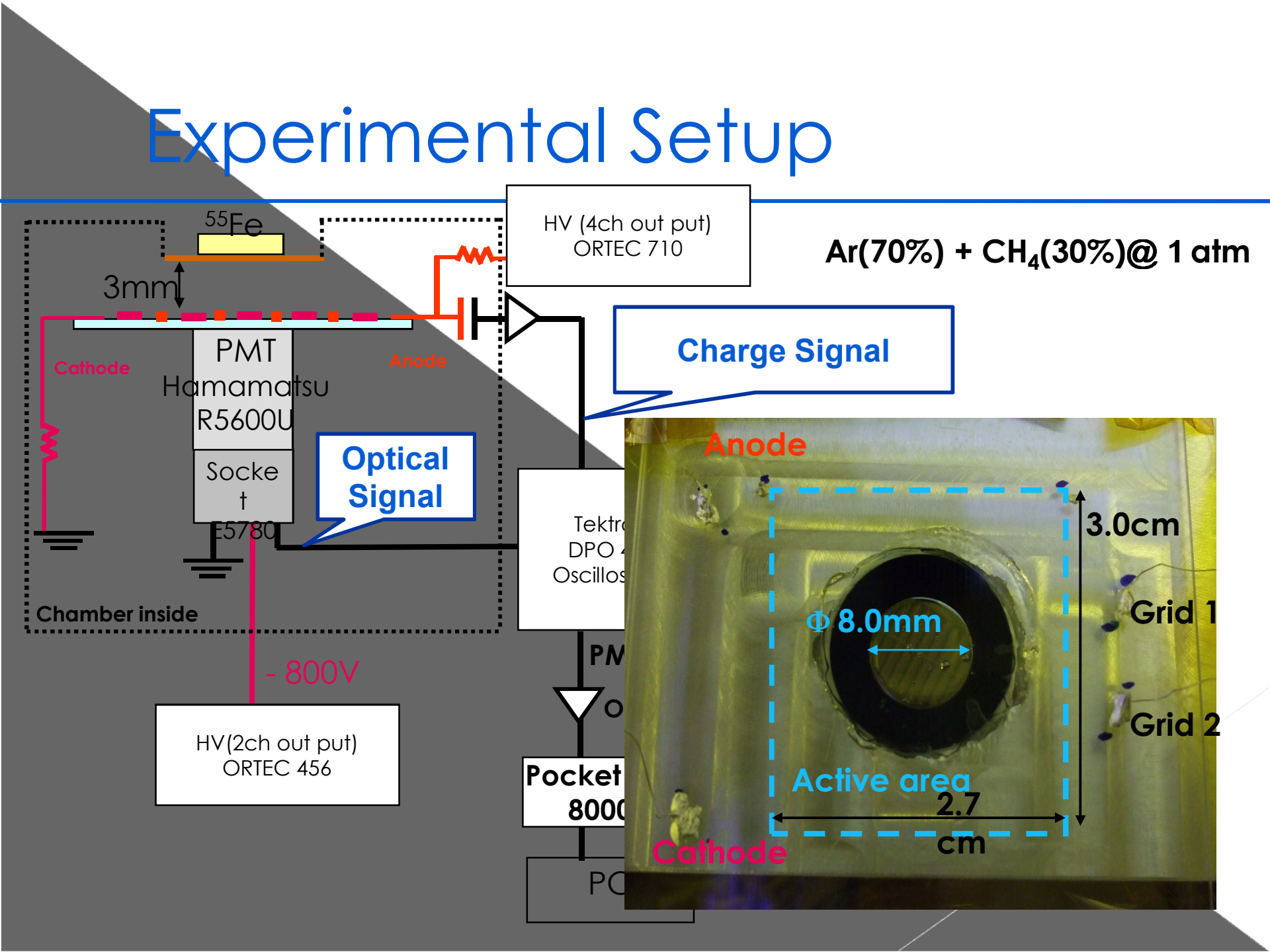
ITO version of M-MSGC
Electrode pattern is same as our conventional M-MSGC

Transmissivity of ITO

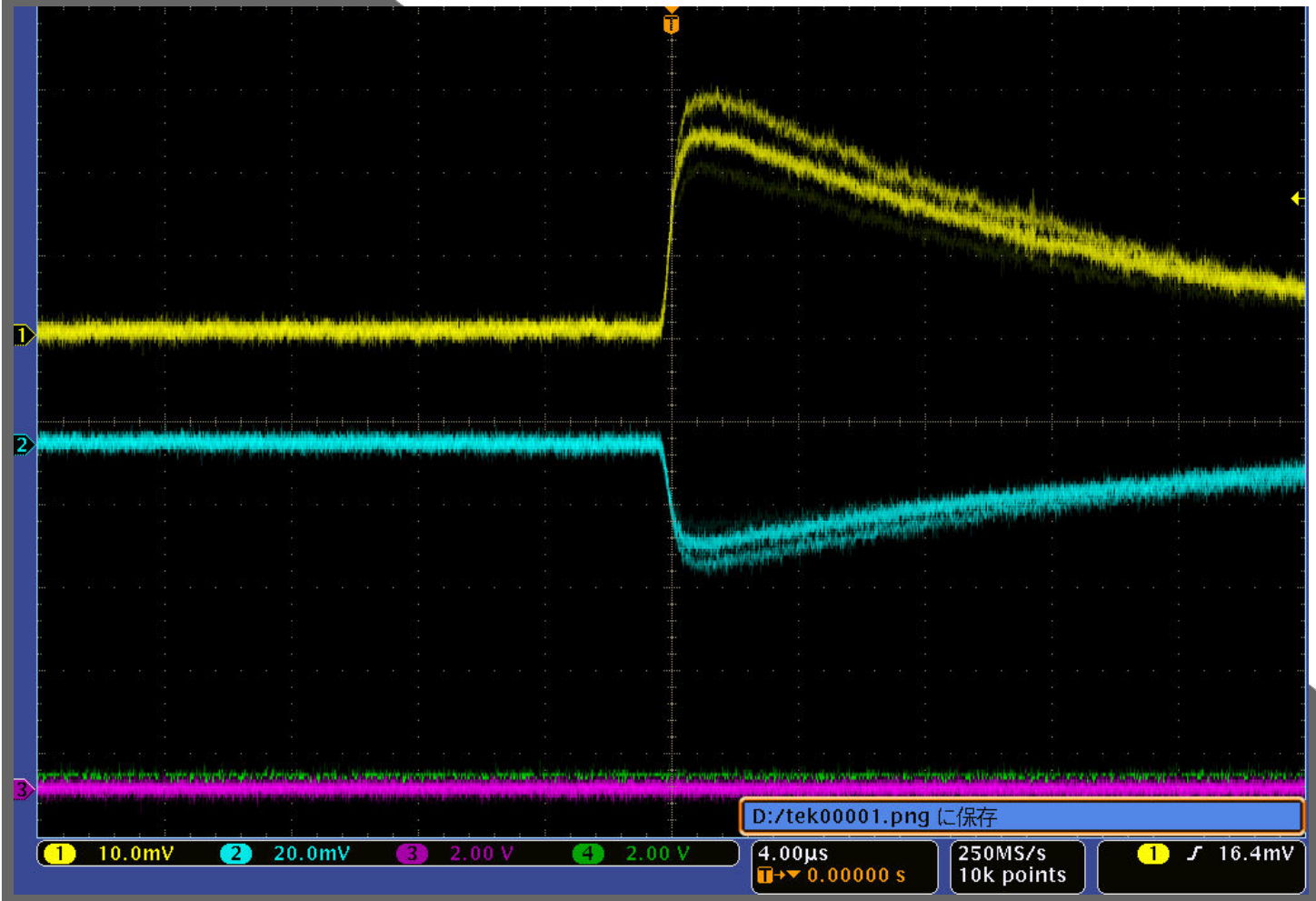


5. Test results with X-rays

Experimental Setup



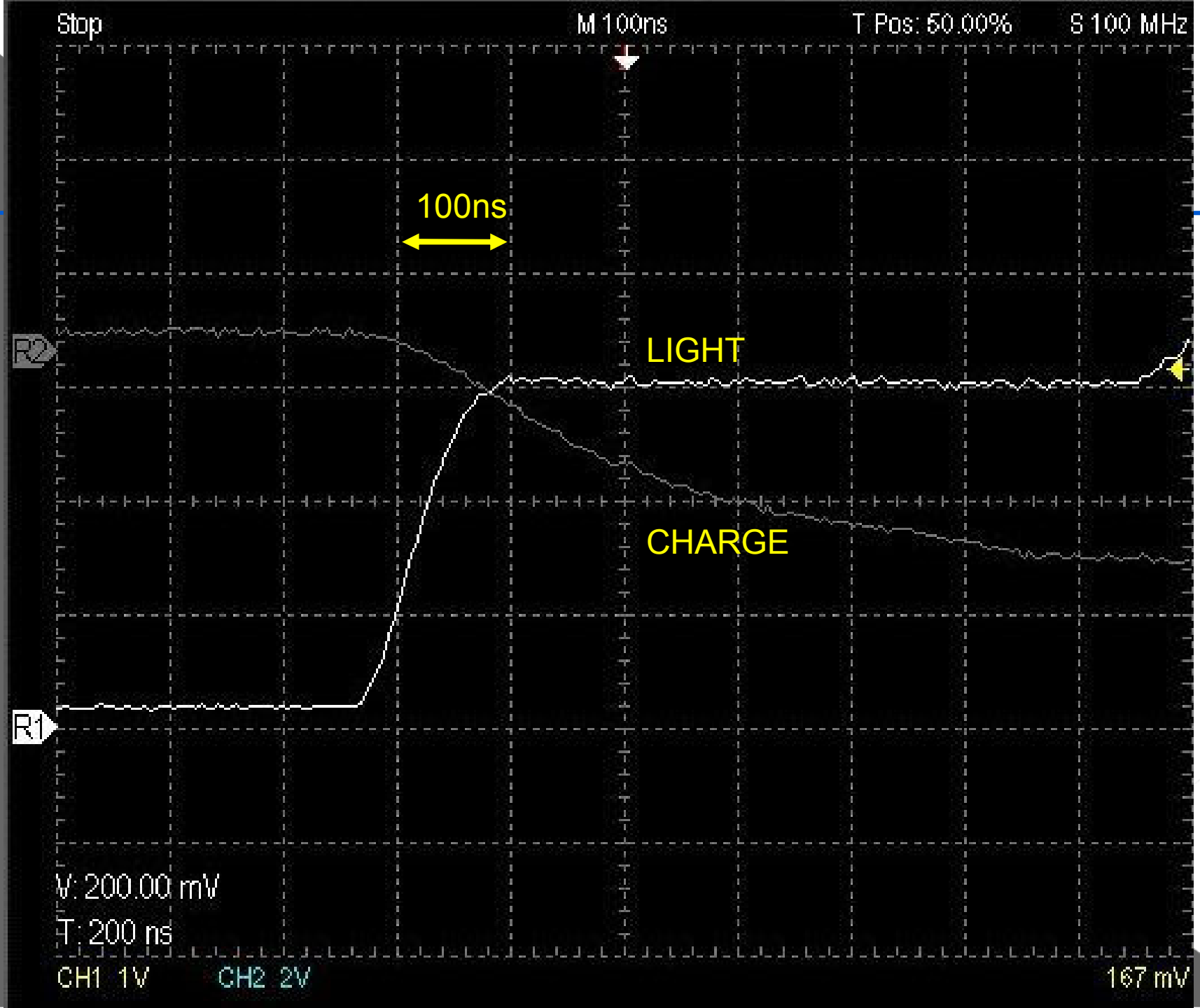
Test of operation as a proportional counter



ANODE signal

CATHODE signal

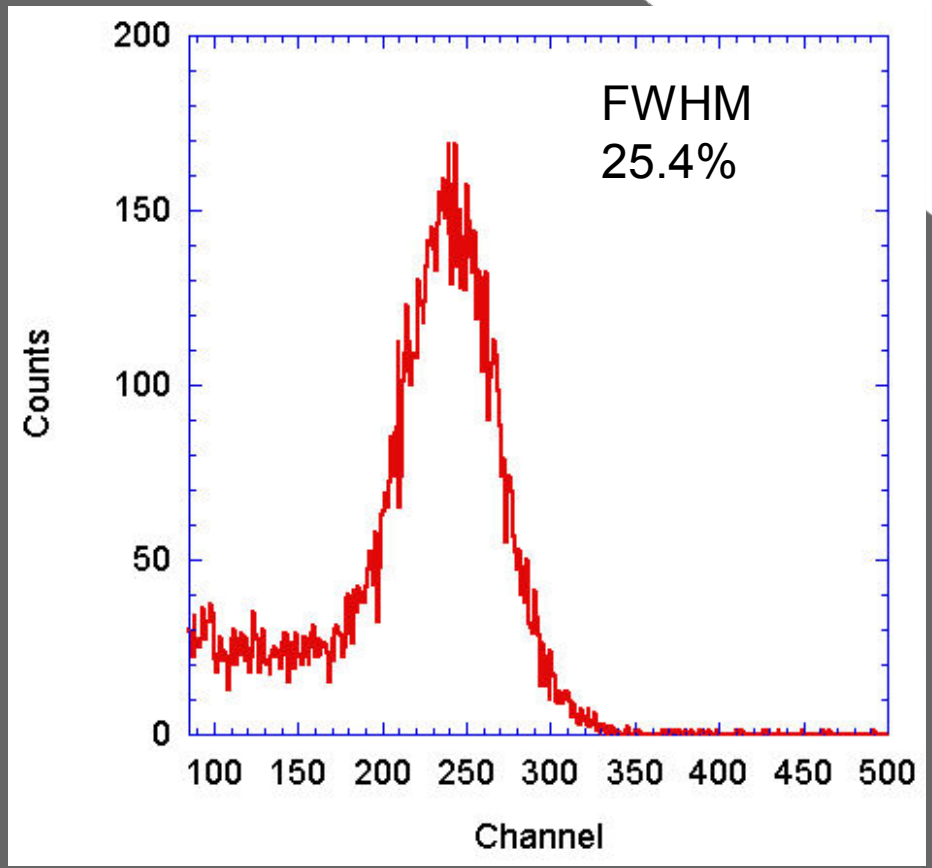
Ar 70% + CH_4 30%


Stop
M 100ns
T Pos: 50.00%
S 100 MHz
100ns
LIGHT
CHARGE
R2
R1
V: 200.00 mV
T: 200 ns
CH1 1V
CH2 2V
167 mV

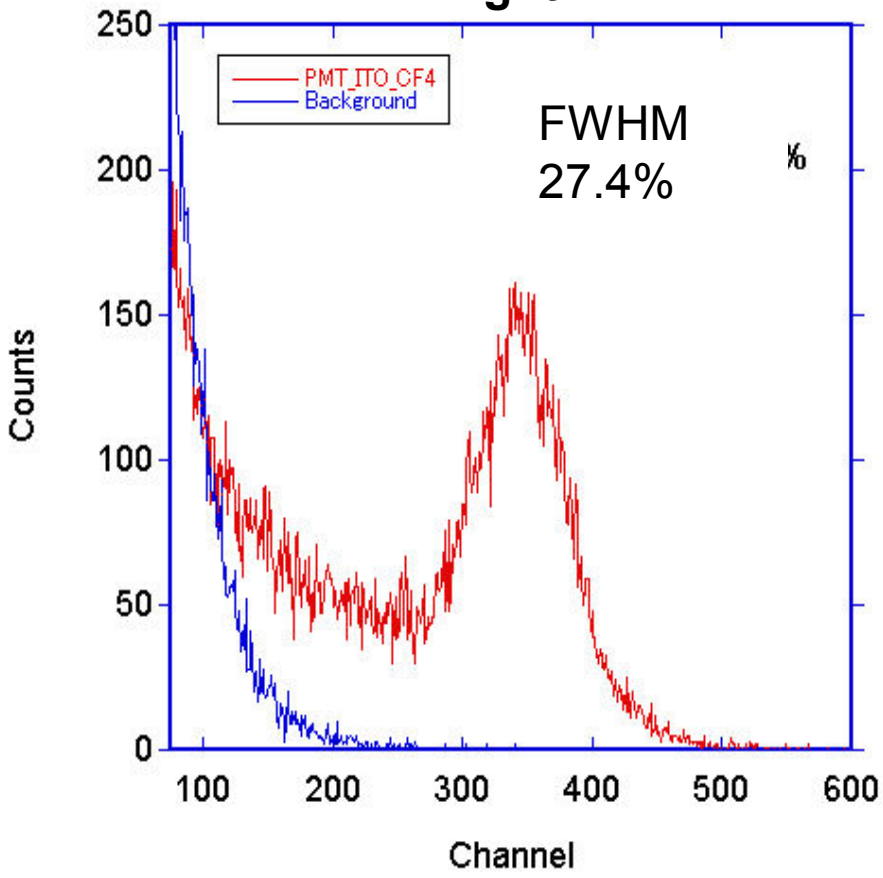
ITO M-MSGC

Obtained energy spectra

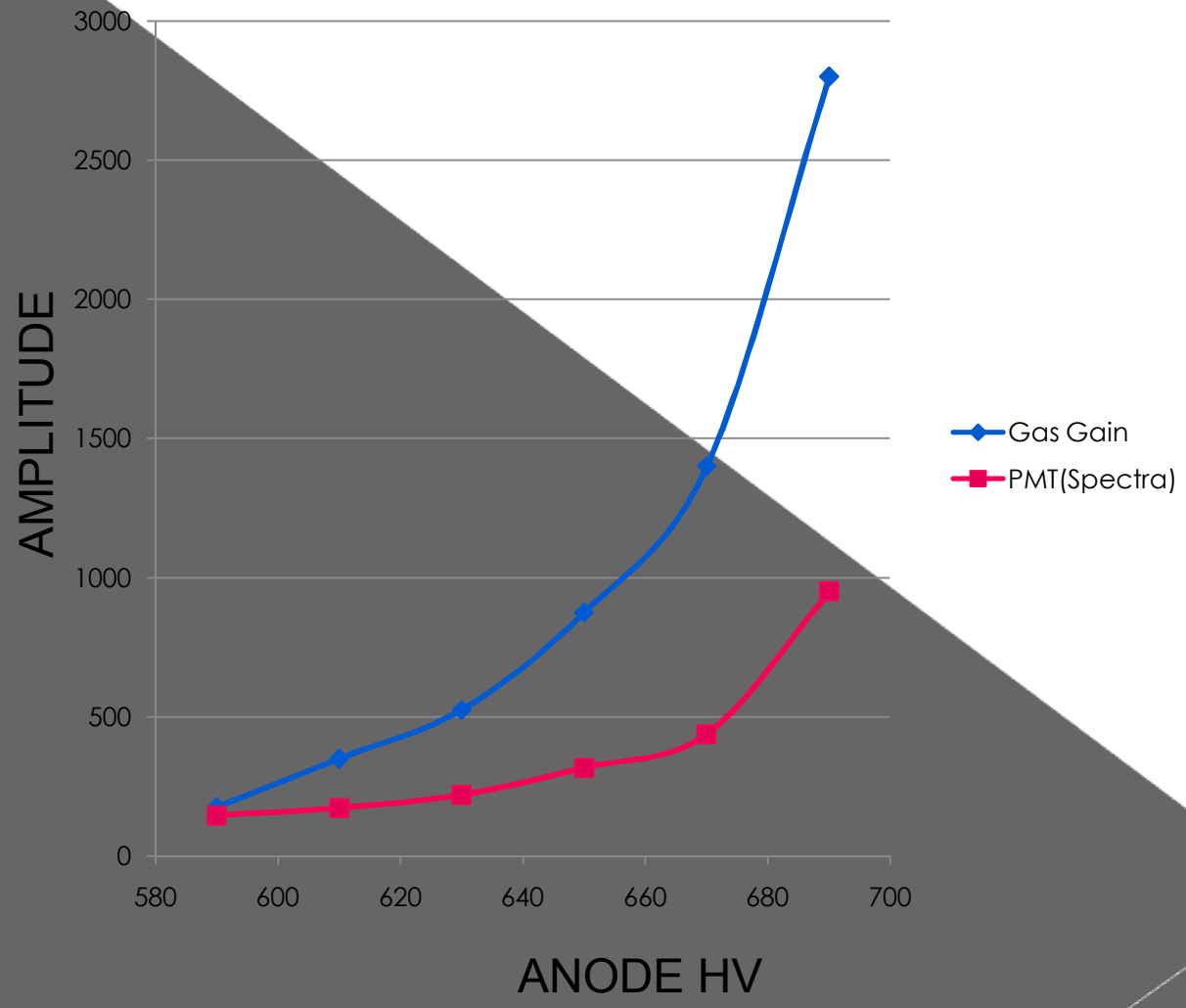
Charge



Light



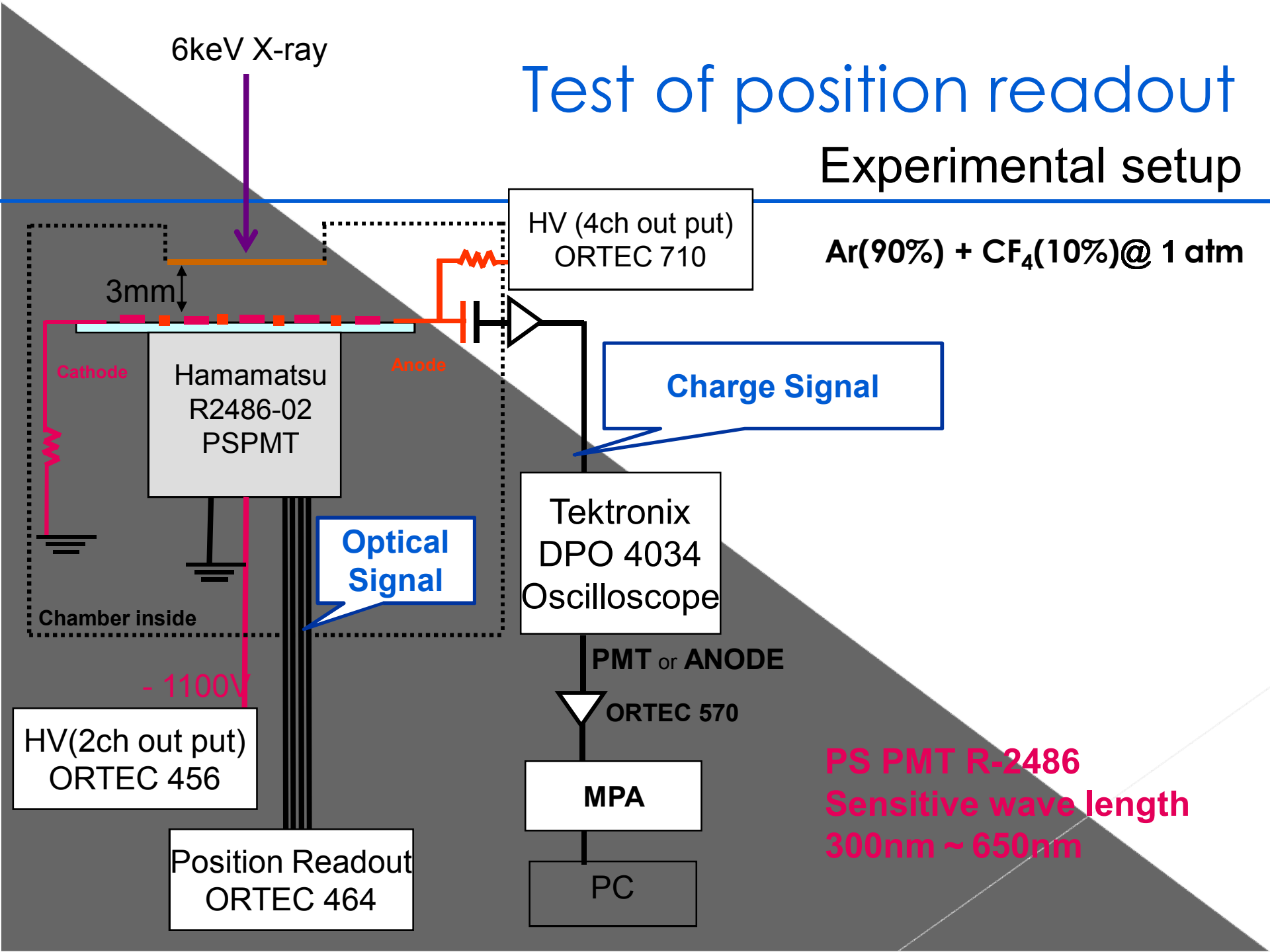
Gas gain & PMT Spectra



5.2. Position Scan with 6keV X-ray beam

Test of position readout

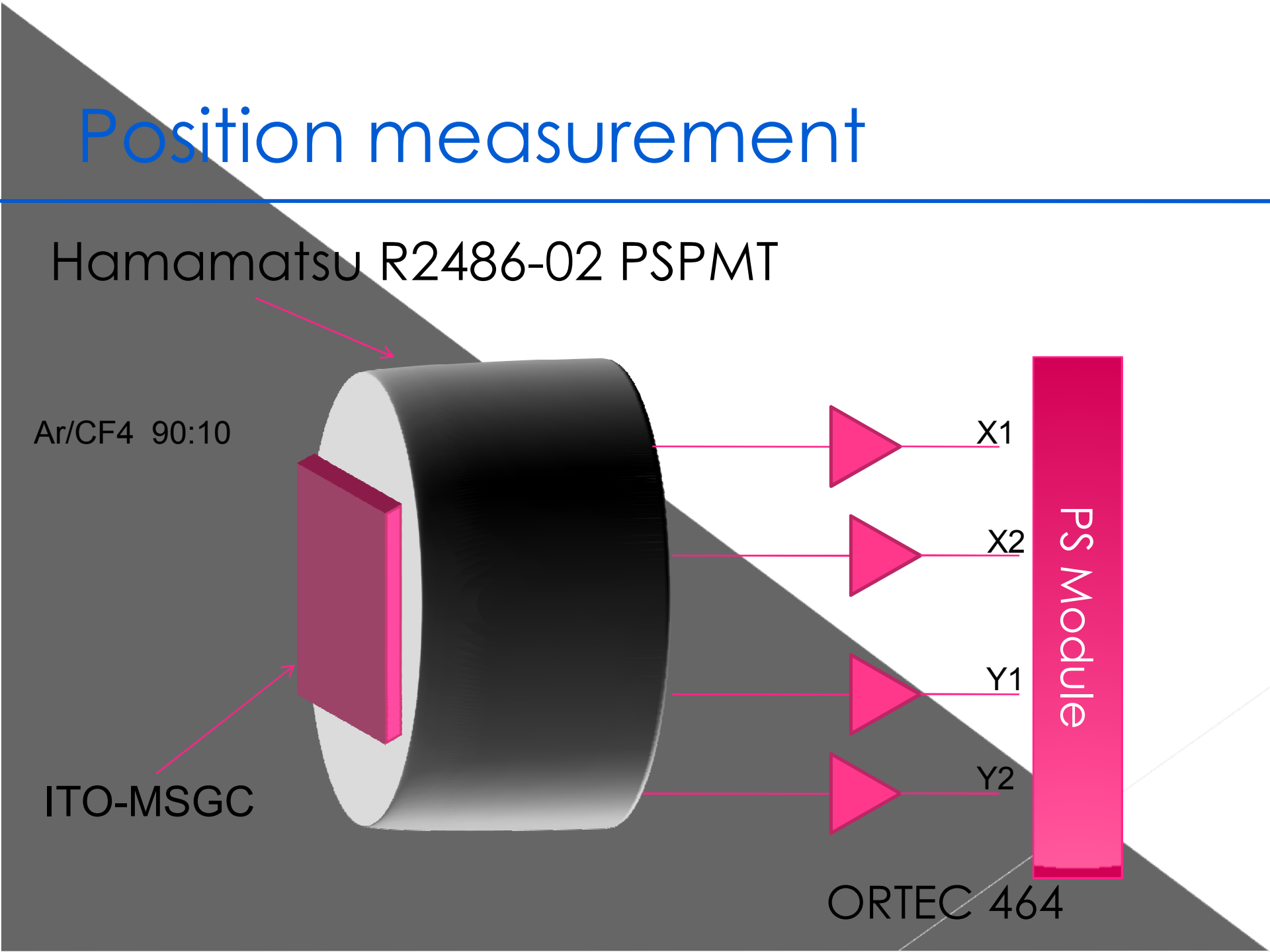
Experimental setup



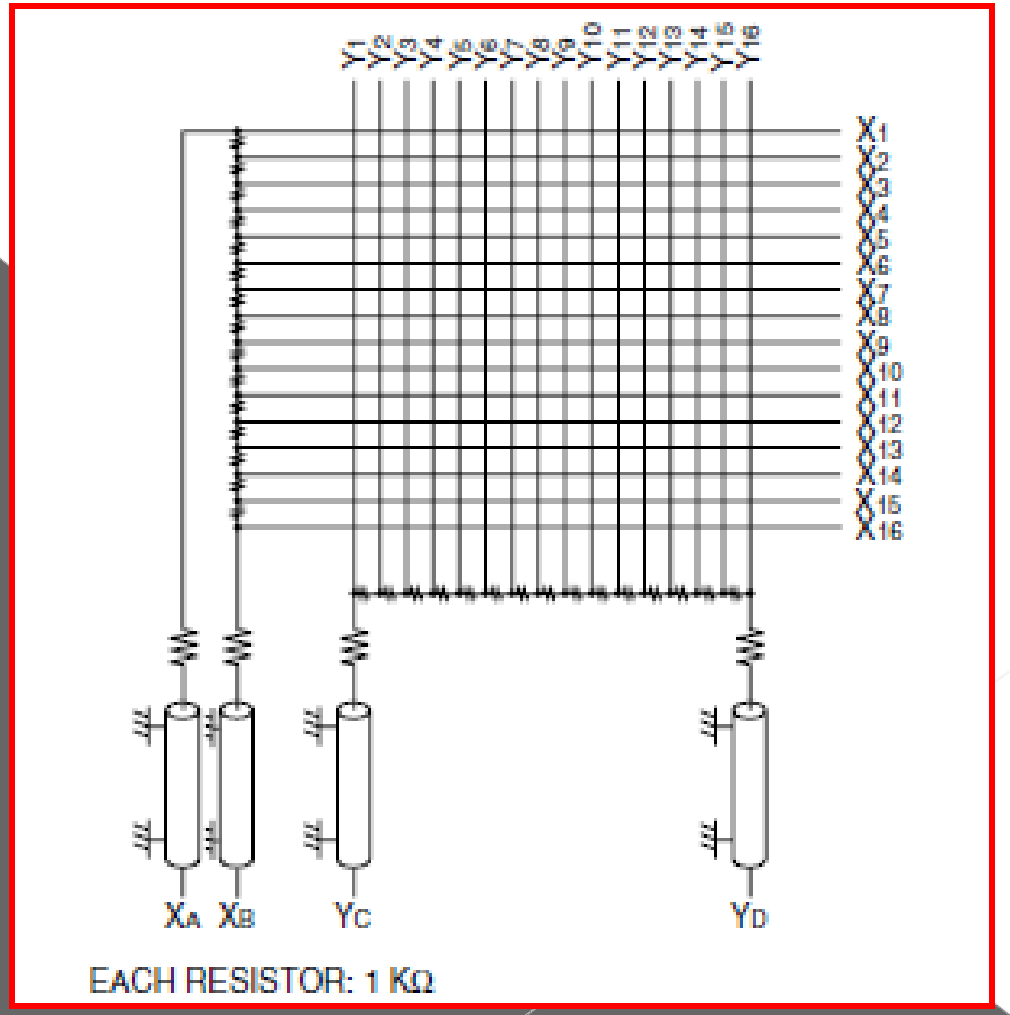
Ar(90%) + CF_4(10%)@ 1 atm

PS PMT R-2486
Sensitive wave length
300nm ~ 650nm

Position measurement

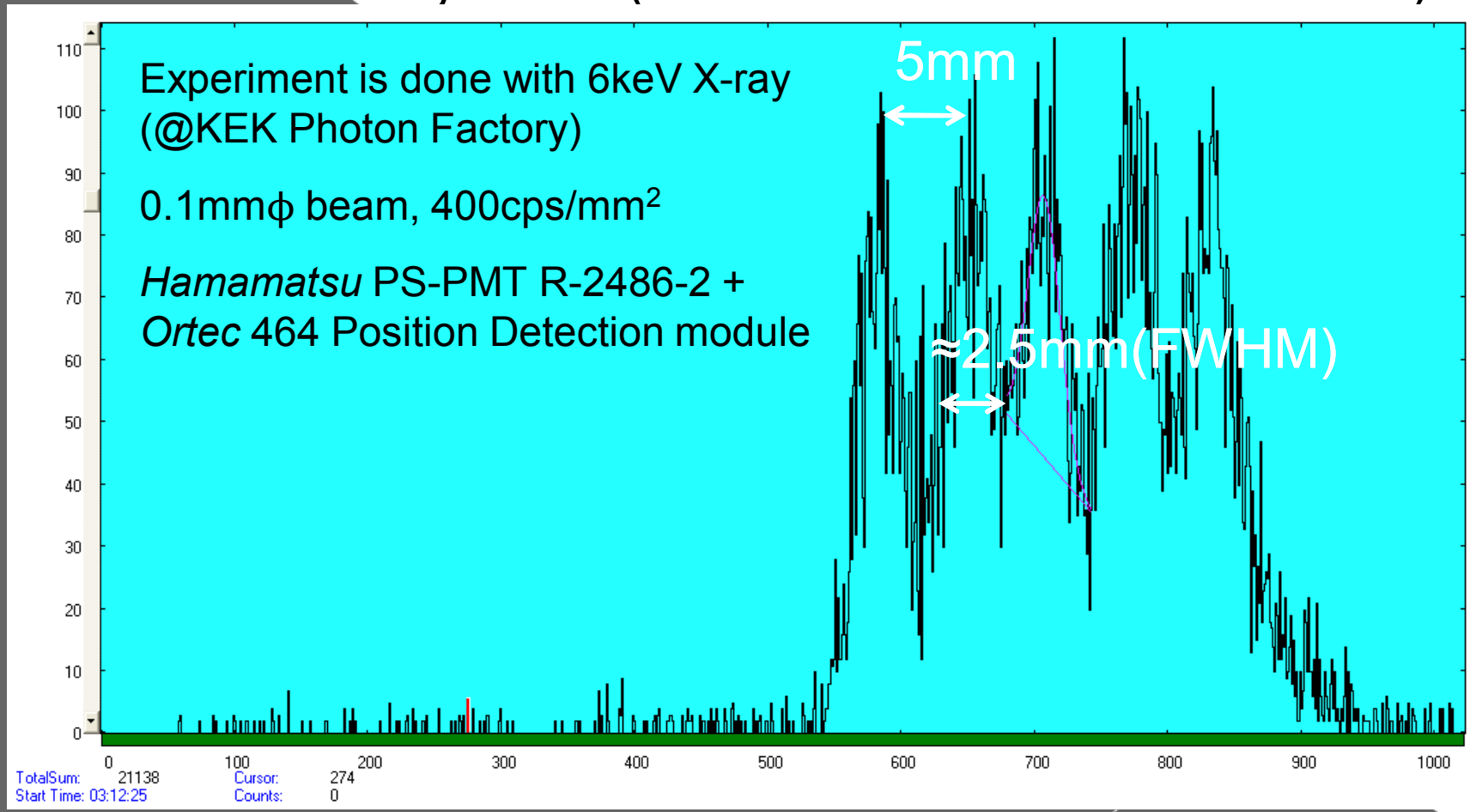


Schematic of Hamamatsu PS-PMT R-2486-2

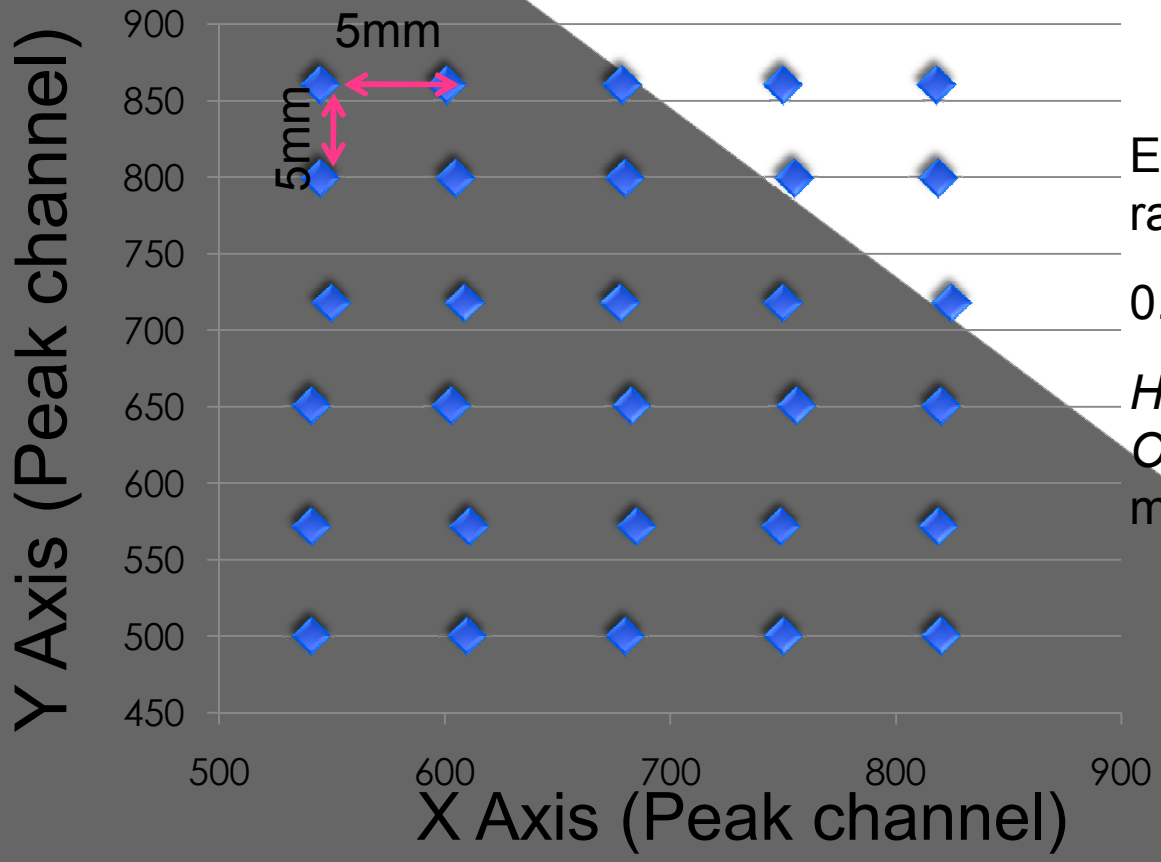


5mm Position scanned result obtained with PSPMT

6keV collimated X-ray beam (scanned in 25mm * 25mm area)



Results of position scan by 5mm

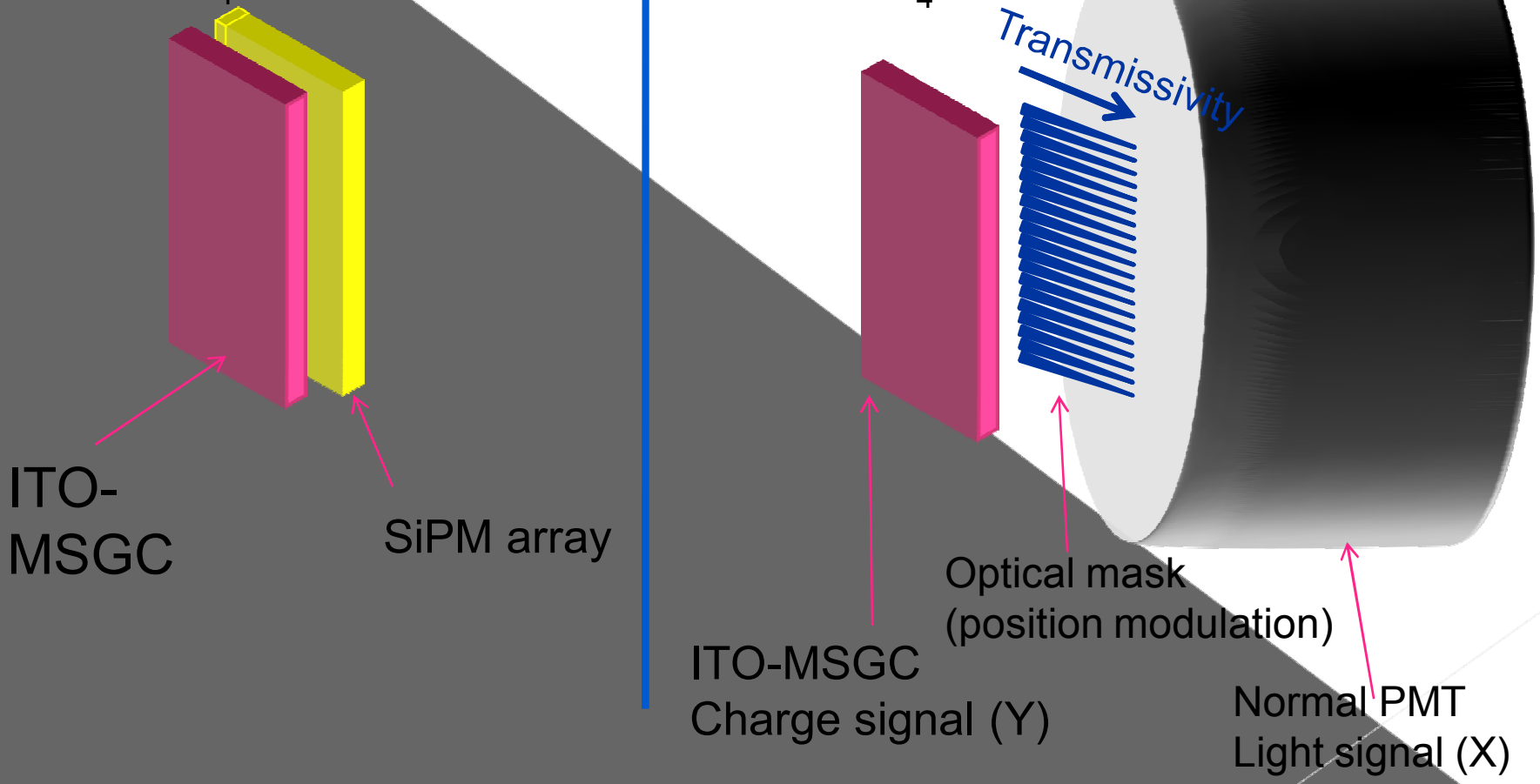


Experiment is done with 6keV X-ray (@KEK Photon Factory)

0.1mmϕ beam, 400cps/mm^2

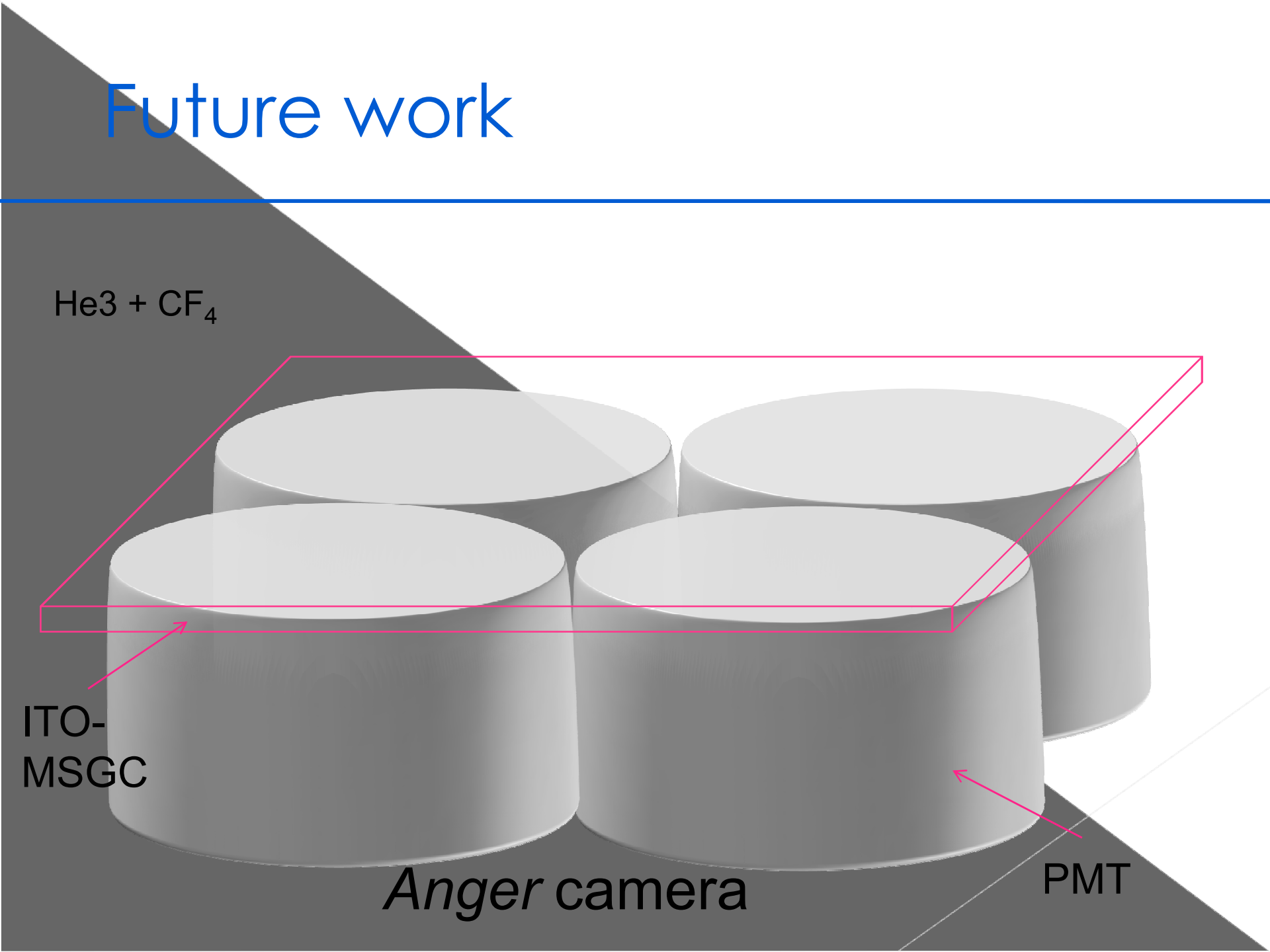
Hamamatsu PS-PMT R-2486-2 + *Ortec* 464 Position Detection module

Future work



Use both of charge/optical signal for position detection

Future work



Summary

- ITO M-MSGC has been fabricated and tested with 6keV X-rays.
- Position sensing by optical signal has been demonstrated.
- Active scintillation could be a solution for higher spatial resolution
- Optics for better light collection should be considered.

Thank you

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2D Multi-Grid-Type MSGC by induced charge sensing

- Place FLOATING pads close to cathode
- Positive Ions stay on pads
- Pad charge can be read out through substrate