Novel Large Aperture EBCCD

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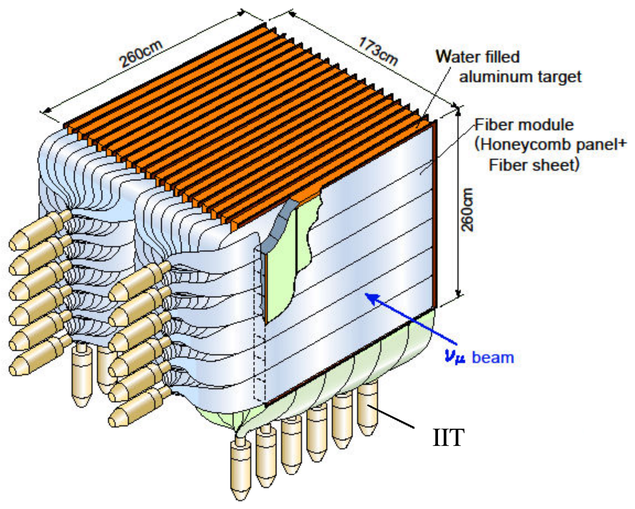
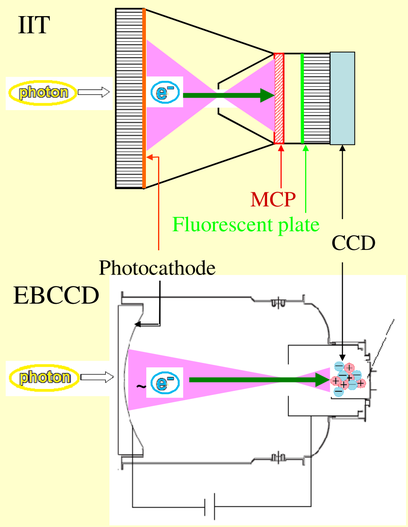
1. Motivation of development



SciFi detector of K2K 24 IITs (φ10cm photocathode) and φ0.7mm fiber were used.

As a same kind of photosensor as EBCCD, IIT has been used so far in particle physics experiments.

For example,
the K2K SciFi detector
[K2K Collab., A.Suzuki, et al., NIM **A453**(2000) 165-176]
- Many channel readout (11k fibers/IIT)
- 1pe detection (high gain).



Electron multiplication is fluctuated at MCP and fluorescent plate.

Accelerated photoelectrons directly reach CCD and multiplied.
→ No fluctuation in multiplication in principle

Good linearity between input and output is expected.

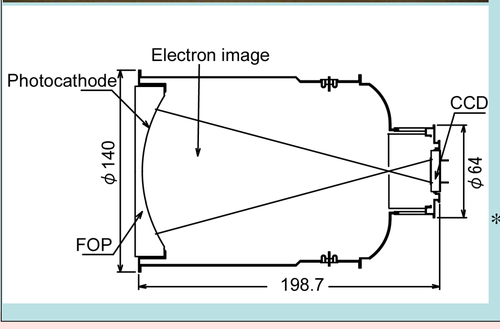
But low gain so far …

Therefore,

high gain & large aperture EBCCD is desired!

If such one is used for readout of a scintillating fiber detector like the K2K SciFi detector,
- Good linearity in ***dE/dX*** measurement gives good PID**.**
- Many channels can be read out at one time.

2. Specification

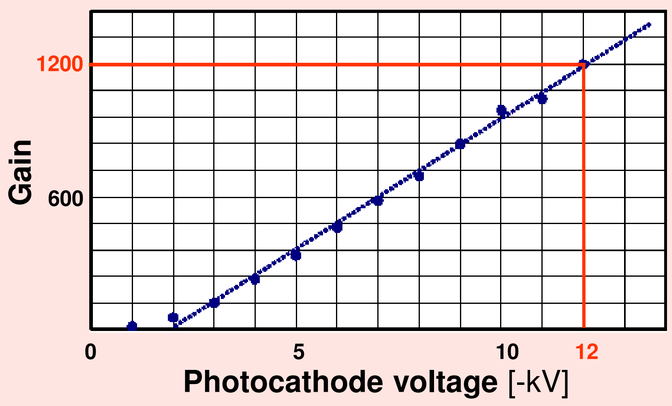


Parameters		Description / Value	Unit
Spectral response		300 to 650	nm
Photo-cathode	Material	Bi-alkali	--
	Effective area	46 × 36	mm
Window material		Fiber optic plate (FOP)	--
Magnification		1/5	--
Target	Type	FT-CCD	--
	Effective area	9.0(H) ×6.7(V)	mm
	# of pixels	640(H) × 480(V)	--
	Pixel size	14 × 14	μm

* This large aperture was achieved by electron demagnification.

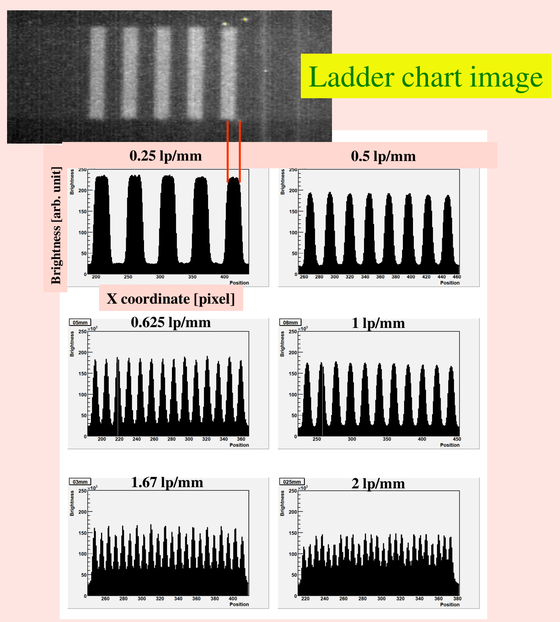
3. Performance

3-1 HV endurance



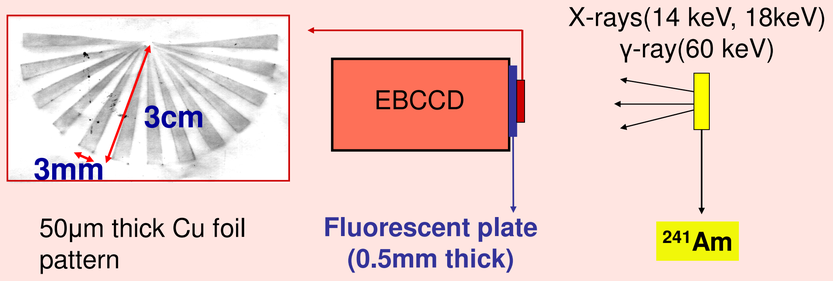
3.2 Spatial resolution

(1) Estimation from ladder chart images



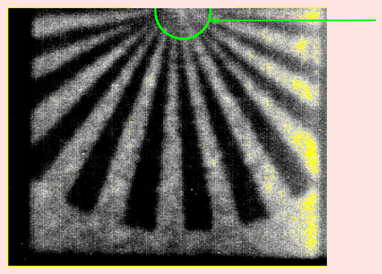
Brightness distributions : **We can see clear peaks and valleys up to 2 line pairs/mm (corresponds to 3.5 × CCD pixel size).**

(2) Estimation from an Cu foil pattern image on a fluorescent plate Irradiated with X-rays & γ-ray



50μm thick Cu foil pattern

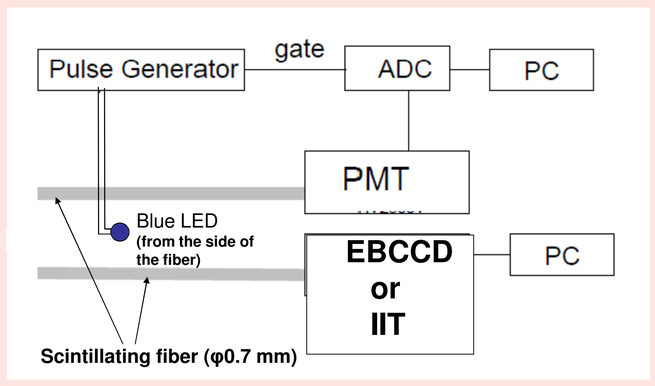
Fluorescent plate (0.5mm thick)

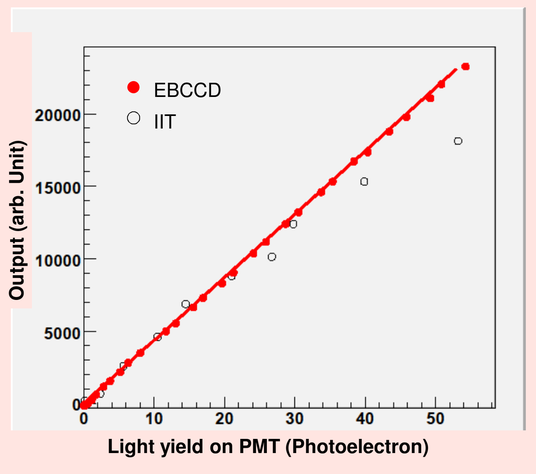


Gaps between neighboring foils are ~0.25mm here

We could see gaps of ~0.25mm, corresponding to 2 lp/mm

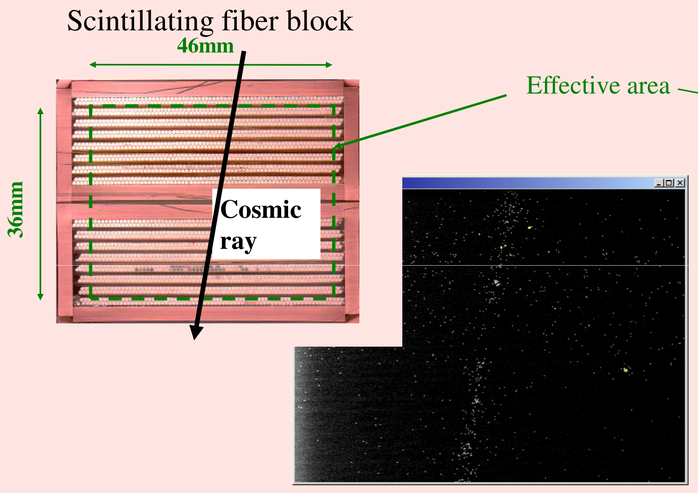
3-3. Linearity between input & output



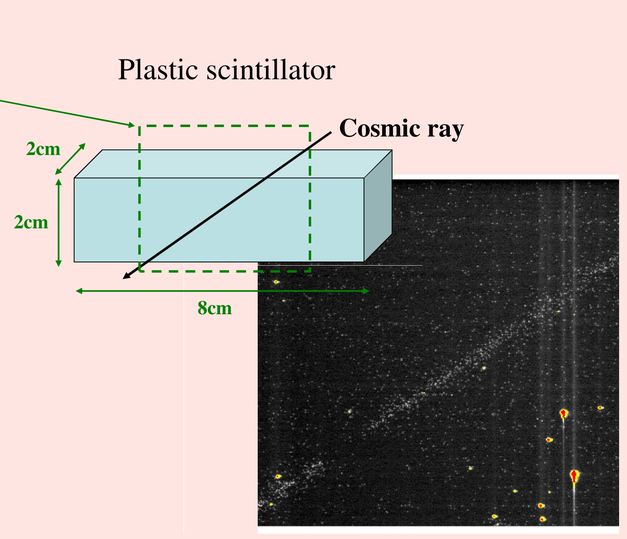


EBCCD shows the better linearity

3-4 Cosmic-ray detection



Cosmic-ray image by the scintillating fiber block



Cosmic-ray image by plastic scintillator

4. Summary

Large aperture EBCCD was produced.
photocathode φ10cm. The 1st one with such a large aperture.

Some basic performances were measured.
- **HV endurance --- up to –12kV (Gain vs HV showed good linearity.)**
- **spatial resolution --- better than 2 lp/mm**
- **good linearity between input and output (better linearity than that of IIT)**
- **cosmic ray track detection --- OK!**

Next plan
neutron detection with a scintillator
→ **Non destructive inspection by neutron beam**