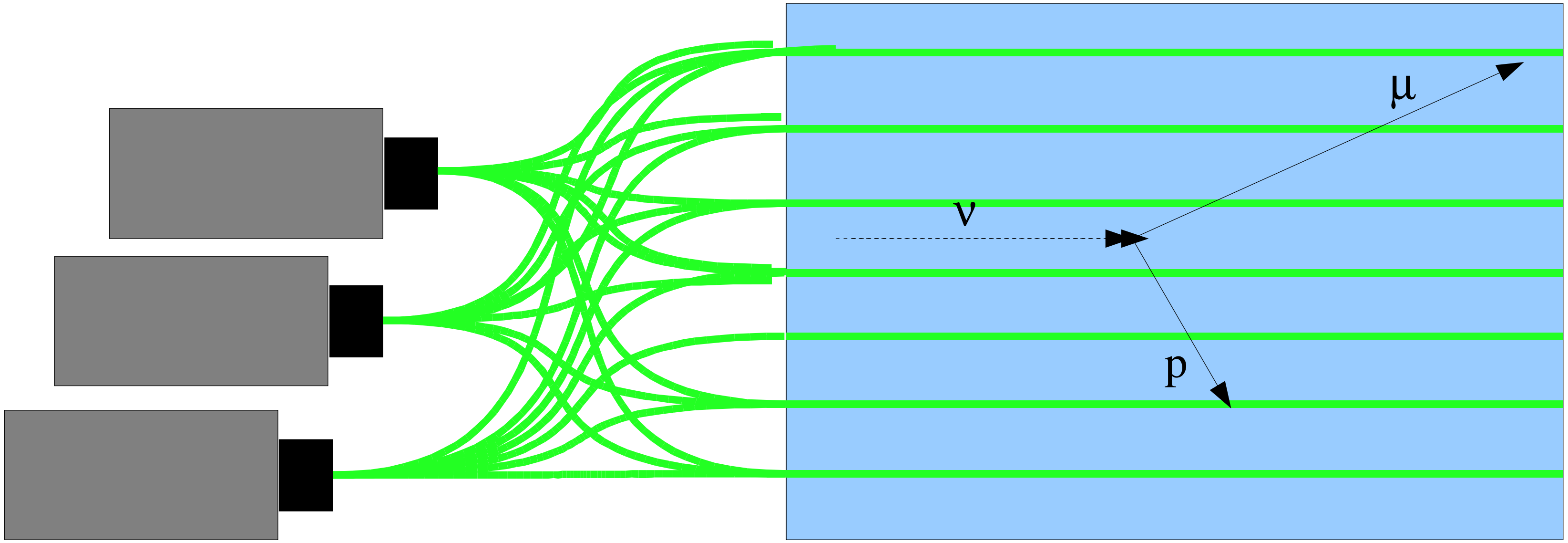
ICCD* Readout for Neutrino Detectors



* Image-Intensifed CCD camera

ICCDs for Neutrino Detectors: Overview

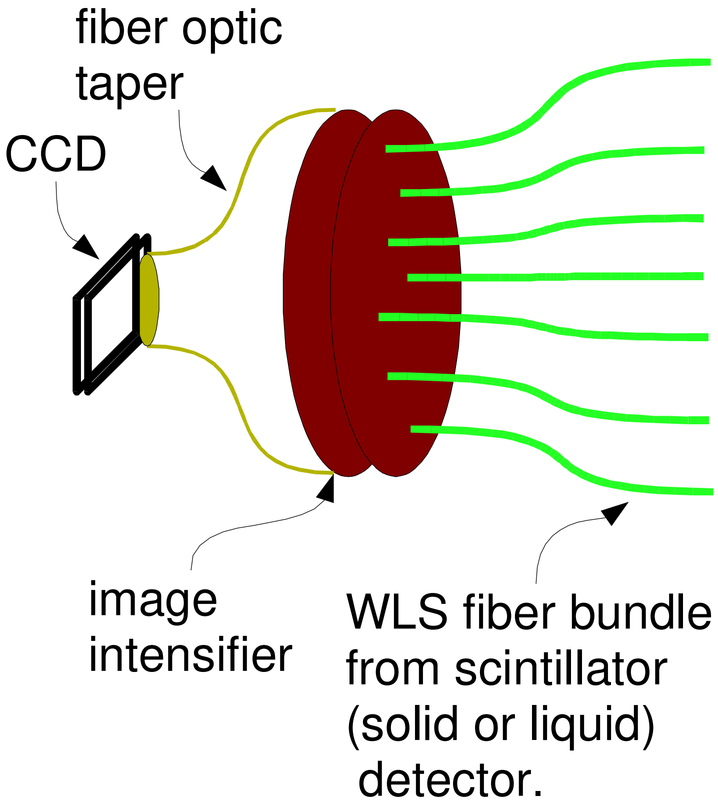
An Image Intensified CCD system to read out many WLS fibers.

WLS fibers: 1-2mm dia

image intensifier (IIT):
- 2-3 stages of Gen II (MCP)
- gain ~10^7-10^8
- input: light-sensitive photocathode
- output: phosphor screen
- can be gated down to ~10 ns
- "commodity" item (used for night-vision)

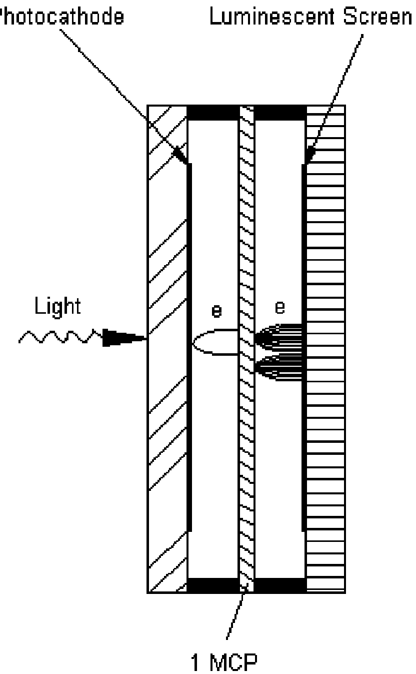
fiber optic taper:
- reduces IIT output to CCD size
- may be used between stages of IIT for image demagnification

CCD (or CMOS):
- light amplification is in IIT, can use "commodity" CCD (no cooling necessary)
- ~15Hz readout speed

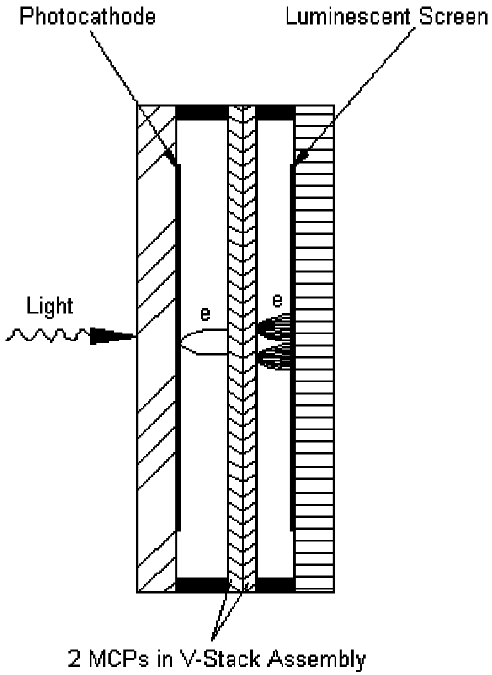


ICCDs: Image Intensifers

Gen II IITs (multichannel plates):



1-stage



2-stage

ICCD Readout for Neutrino Detectors:

Advantages:

- inexpensive
- simple (readout is single data stream from each camera)

Disadvantages:

- no time information (but IITs may be gated)
- slow (~15 Hz, not a problem for a pulsed beam)
- triggering difficult (but not a problem for a pulsed beam)

Challenges:

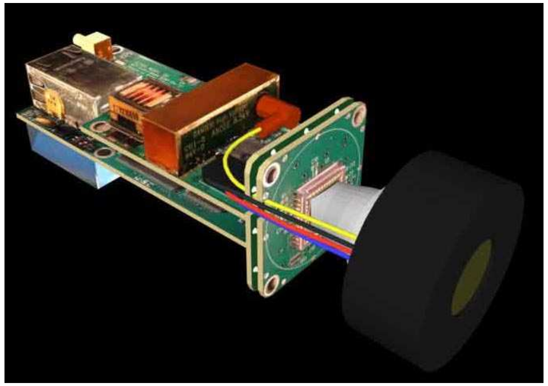
- need to determine optimum IIT size and how to best demagnify image onto CCD (use fiber optic tapers? , electrostatic IIT?)
- sensitivity, stability, noise, dynamic range... all need to be demonstrated

Work on understanding these issues is currently underway

ICCD Readout for Neutrino Detectors:

An inexpensive IIT-CCD under study:
Elphel 313 Gated, Intensified, Network Camera

- programmable, runs LINUX w/GNU software
- readout through 100Mb enet at 15 Hz
- IIT can be gated down to 10ns
- uses CMOS chip (not CCD)
- ~$3400 wo/IIT



Elphel 313
Gated, Intensified,
Network Camera

ICCD Readout: Price Estimates

IITs:

- ~$3-$10/sq mm 18mm dia - $2600, 80mm dia - $17k
- assume 1.5mm dia fibers, need 2.25 sq mm/fiber for 1st stage IIT
- use fiber optic taper to couple 1st stage (large IIT) to 2 stage (smaller)

Fiber optic tapers:

- ~$0.5-$2k (?) each

Camera:

- $3.5k for network camera

E.g.: Assume 20,000 1.5mm fibers, use 10 cameras with 80mm 1st stage IIT coupled to 18mm 2nd stage IIT

- 10 - 80mm IITs	$170k	
- 10 - 18mm IITs	$ 26k	
- 20 - fiber optic tapers	$ 30k	
- 10 - network cameras	$ 35k	
total	$261k	$13/channel

Note: prices quoted are for 1 unit, volume savings may apply

ICCD Readout: Summary

- Image Intensifiers with CCD readout has the potential to provide simple, inexpensive readout of fiber-based neutrino detectors

- However, many details need to be worked out to demonstrate a viable system

- Work is underway to do this