

# T-995 Muon Detector/Tail Catcher R&D Using Strip- scintillator and Pixelated Photon Detectors

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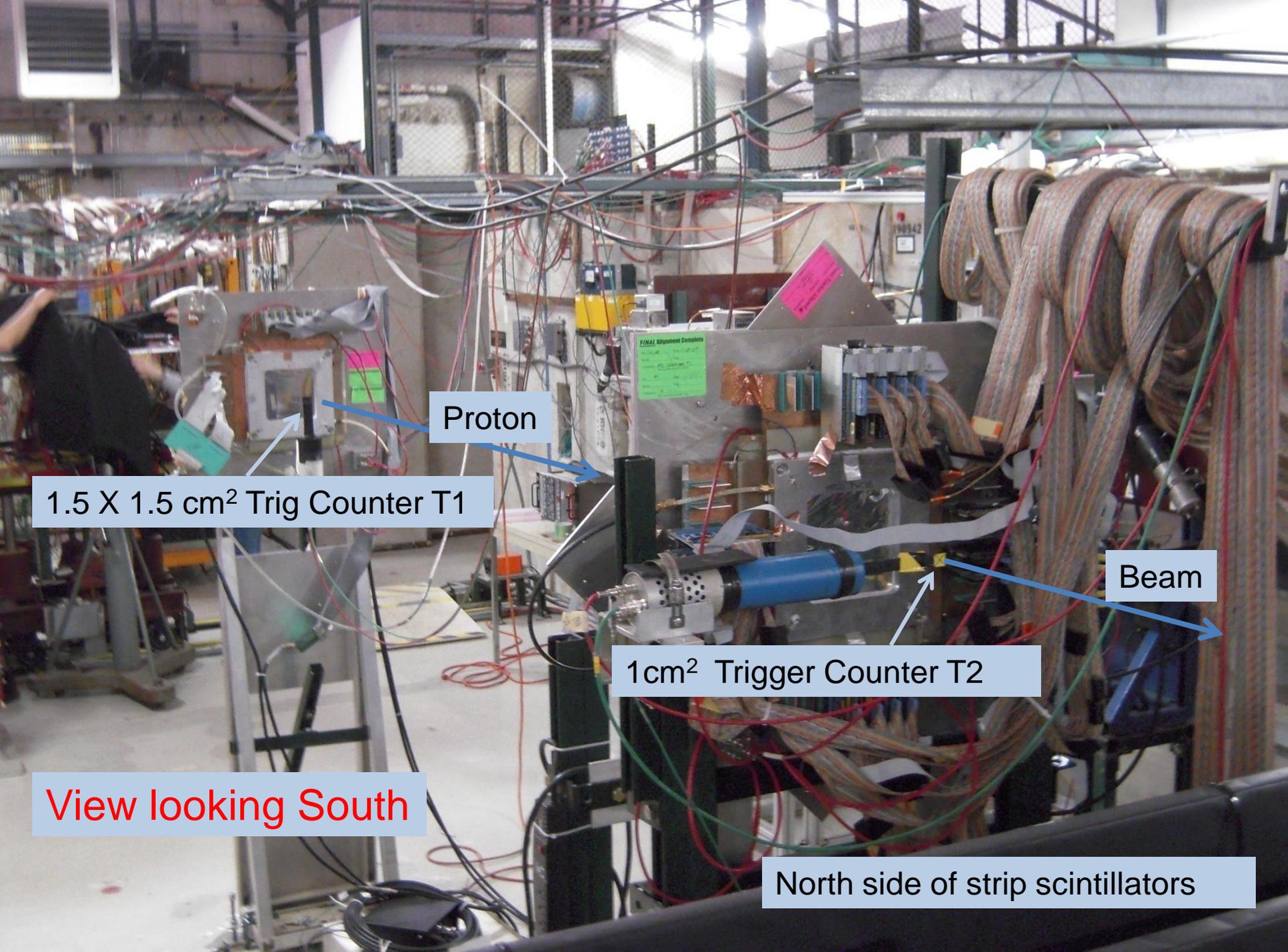
P. Karchin, A. Gutierrez

Wayne State University

# Our Mascot



On his way  
to MTest!



Proton

1.5 X 1.5 cm<sup>2</sup> Trig Counter T1

1cm<sup>2</sup> Trigger Counter T2

Beam

View looking South

North side of strip scintillators

2 Layers - 1 mm spacing MWPCs

Proton Beam

Looking North  
(Downstream)

8.3 cm

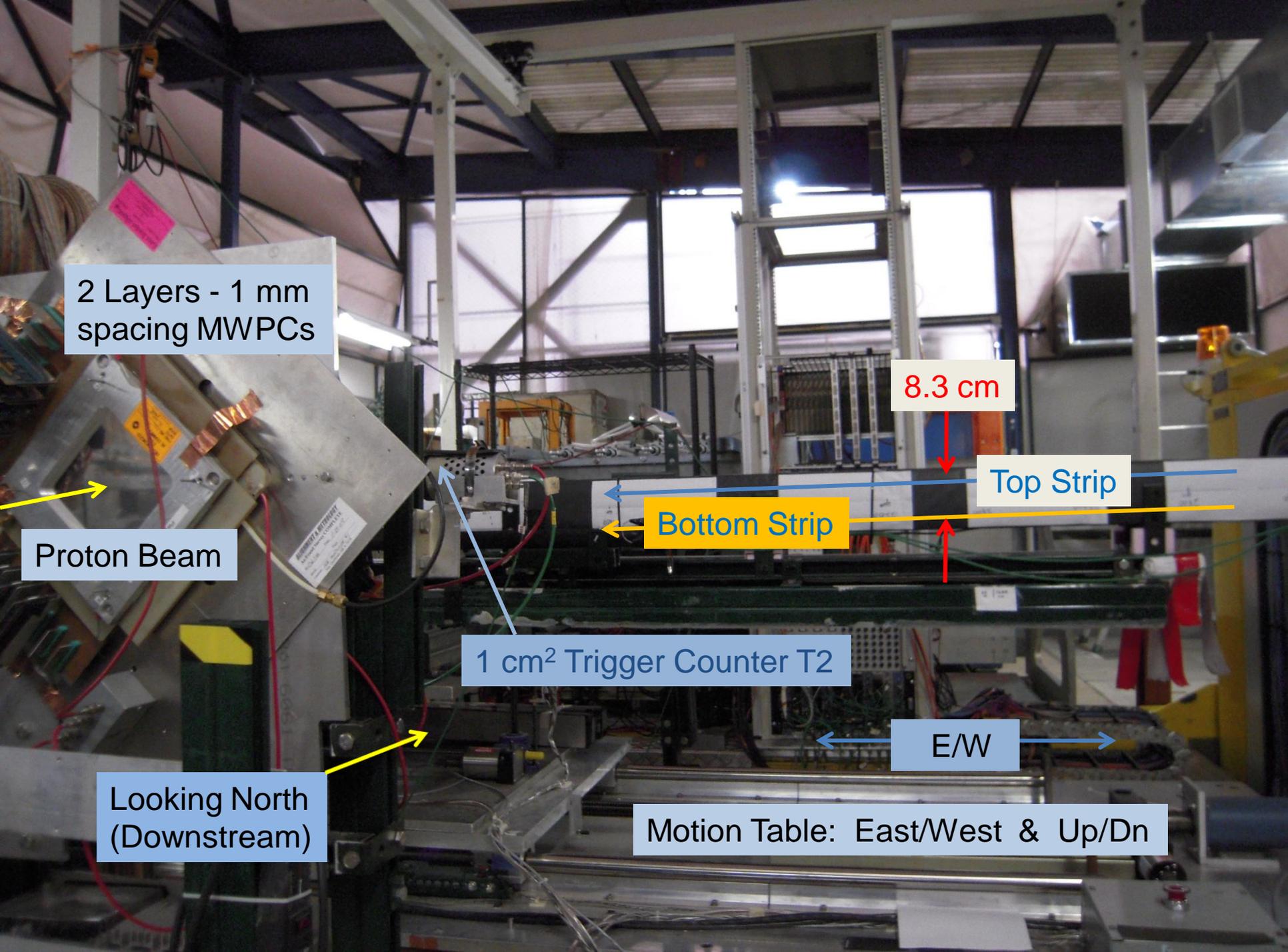
Top Strip

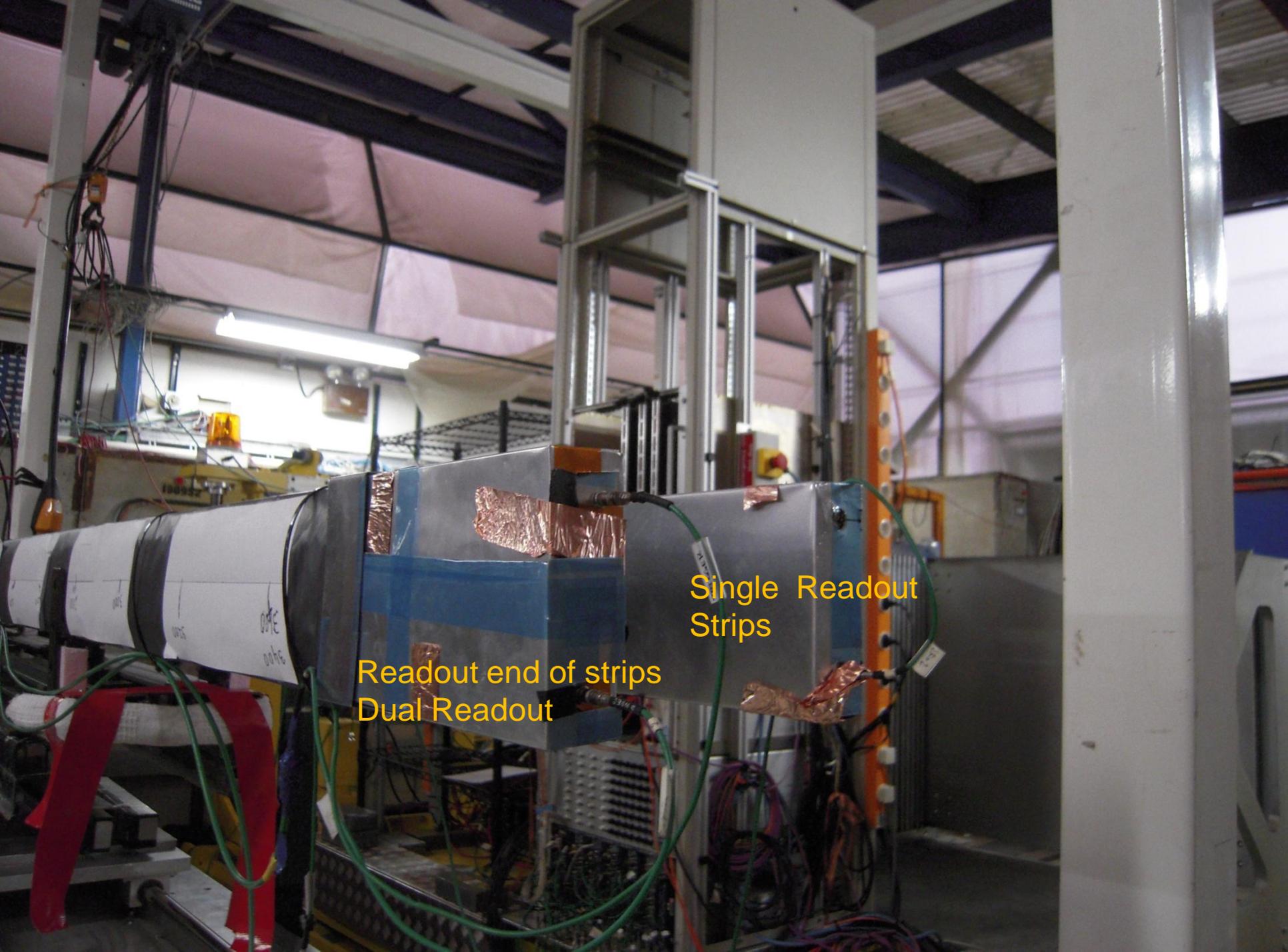
Bottom Strip

1 cm<sup>2</sup> Trigger Counter T2

E/W

Motion Table: East/West & Up/Dn



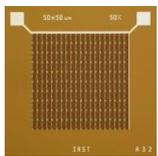


Single Readout Strips

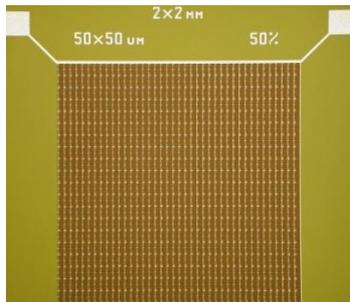
Readout end of strips  
Dual Readout

# INFN/IRST C. Piemonte G. Pauletta INFN/Udine

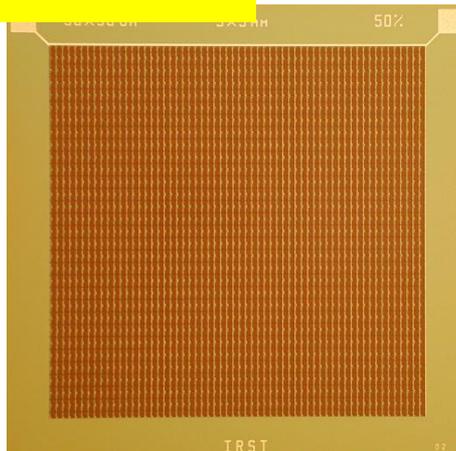
June 13<sup>th</sup>, 2007, Perugia



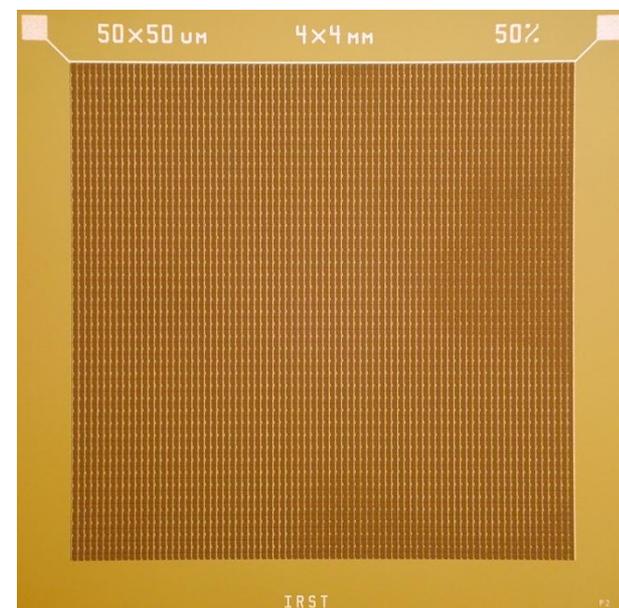
1x1mm



2x2mm



3x3mm (3600 cells)



4x4mm (6400 cells)

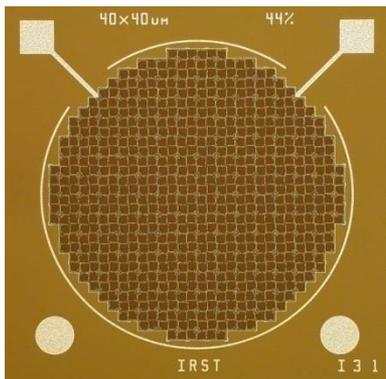
## increased fill factor:

$40\mu\times 40\mu \Rightarrow 44\%$

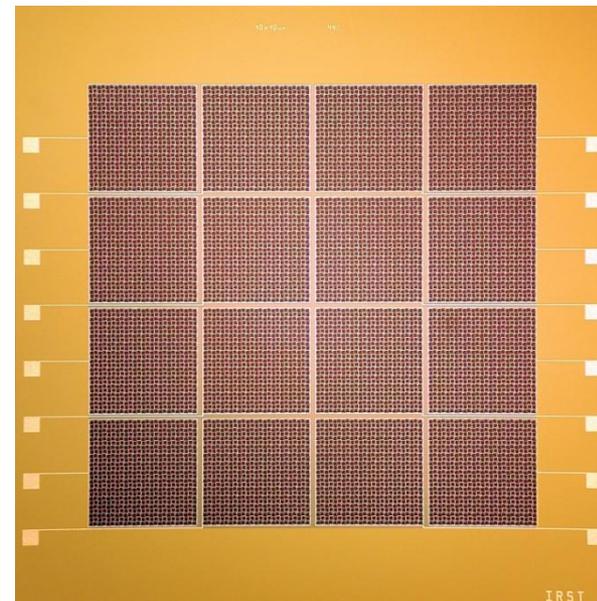
$50\mu\times 50\mu \Rightarrow 50\%$

$100\mu\times 100\mu \Rightarrow 76\%$ ;

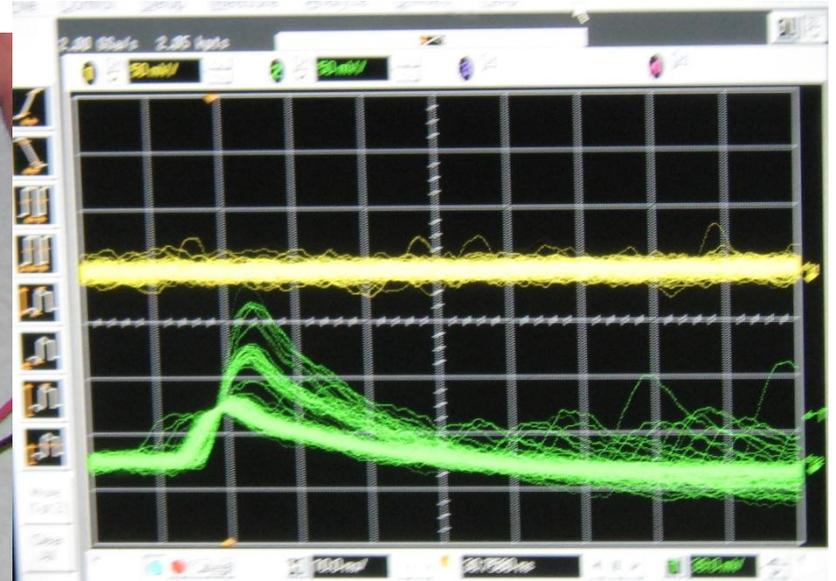
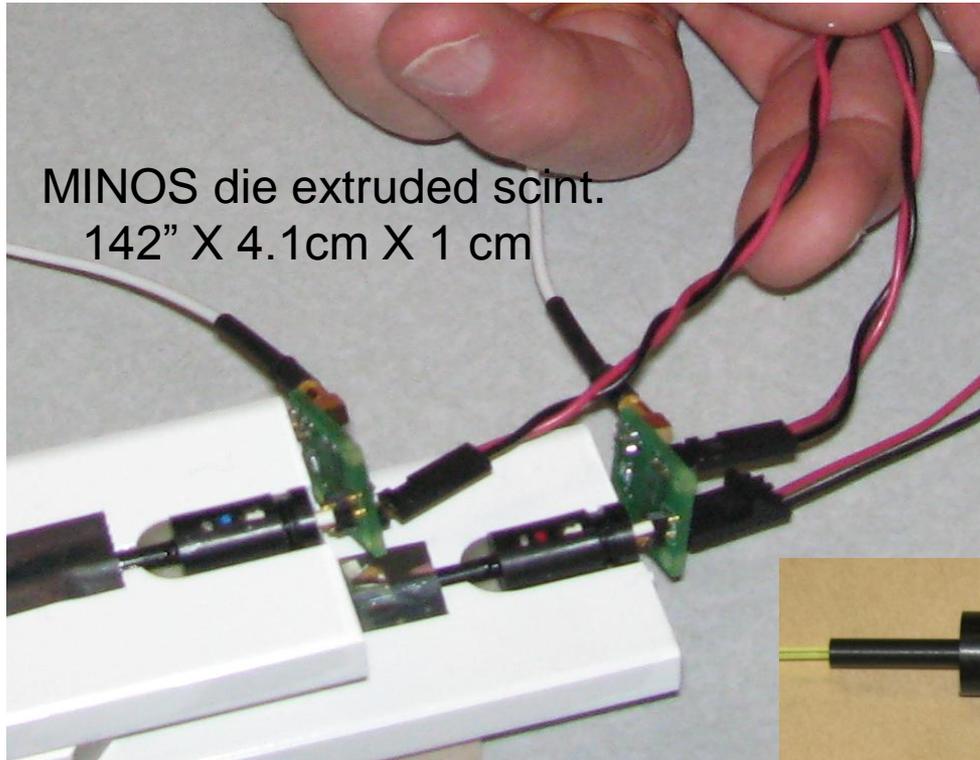
Circular Array 1.2mm dia.  
~ 650 pixels  $40 \times 40 \mu^2$



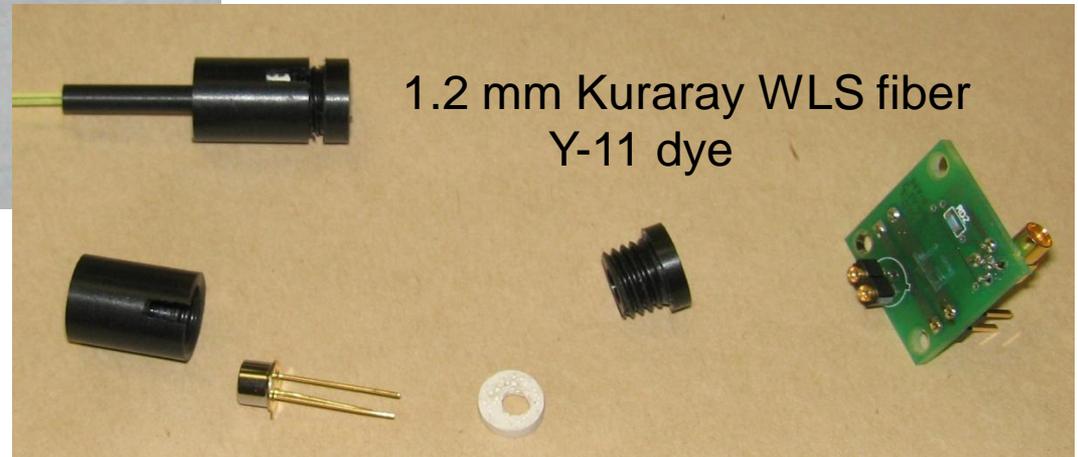
Giovanni Pauletta



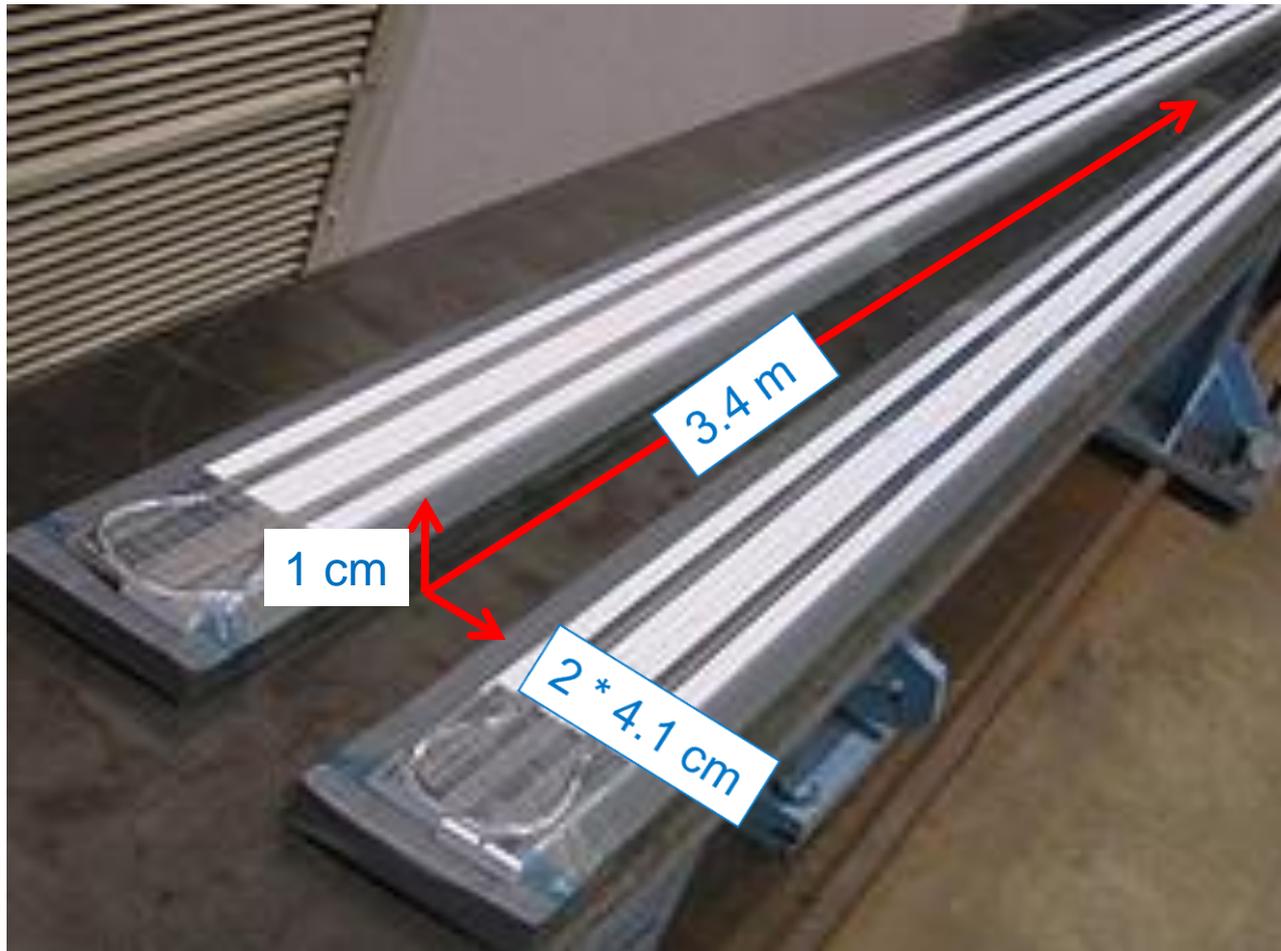
# Pixelated Si Photo-detector Tests @ Notre Dame



**Two strips w/ WLS fiber, HPK  
MPPC, plastic holder assembly  
+ front-end card & connectors**



# Scintillator Strips mounted side-by-side with 1.2mm dia. WLS fiber U-turn



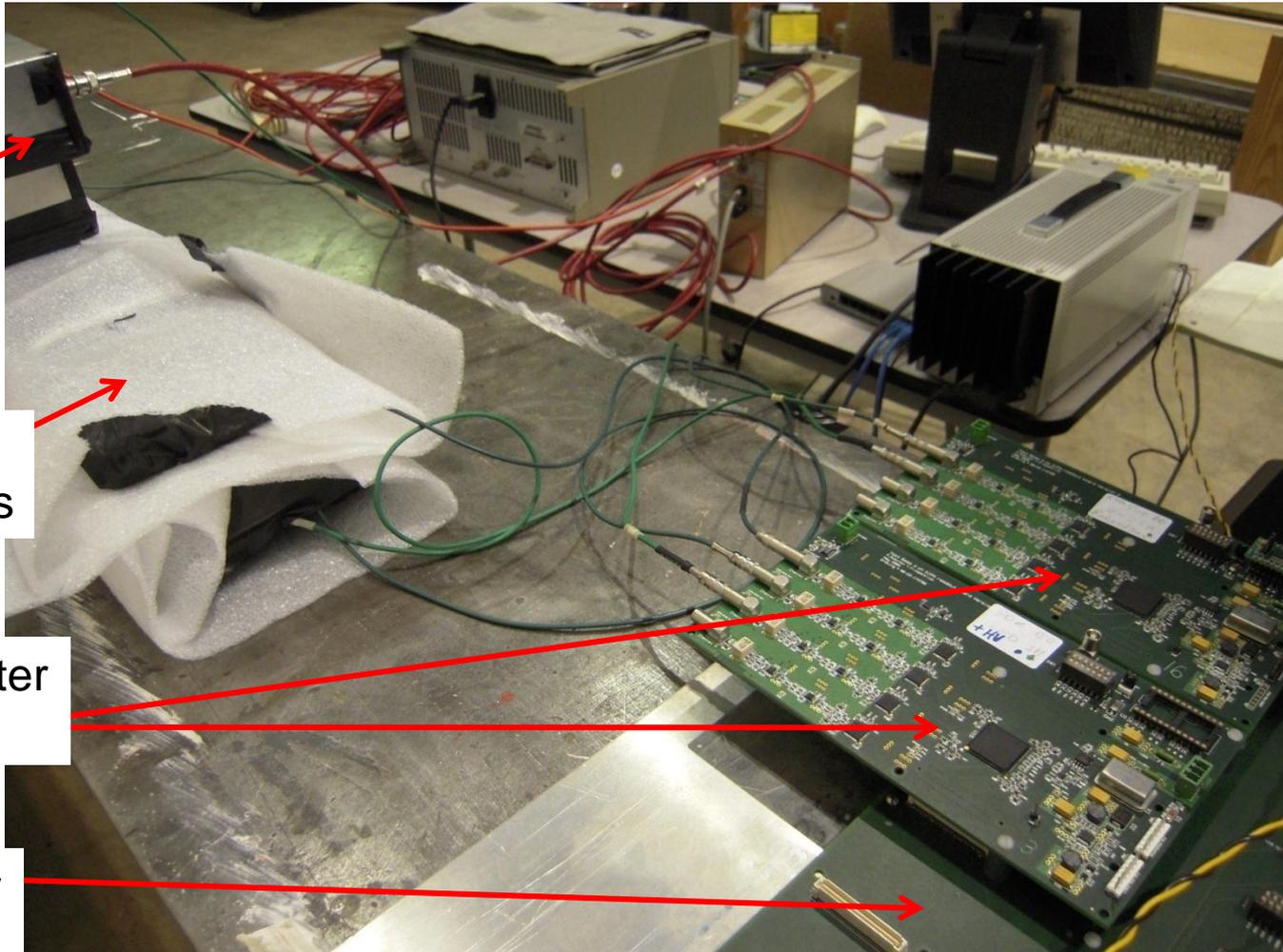
# Test Beam 4 channel electronics: TB4

Cosmic Ray  
Trigger  
Counters

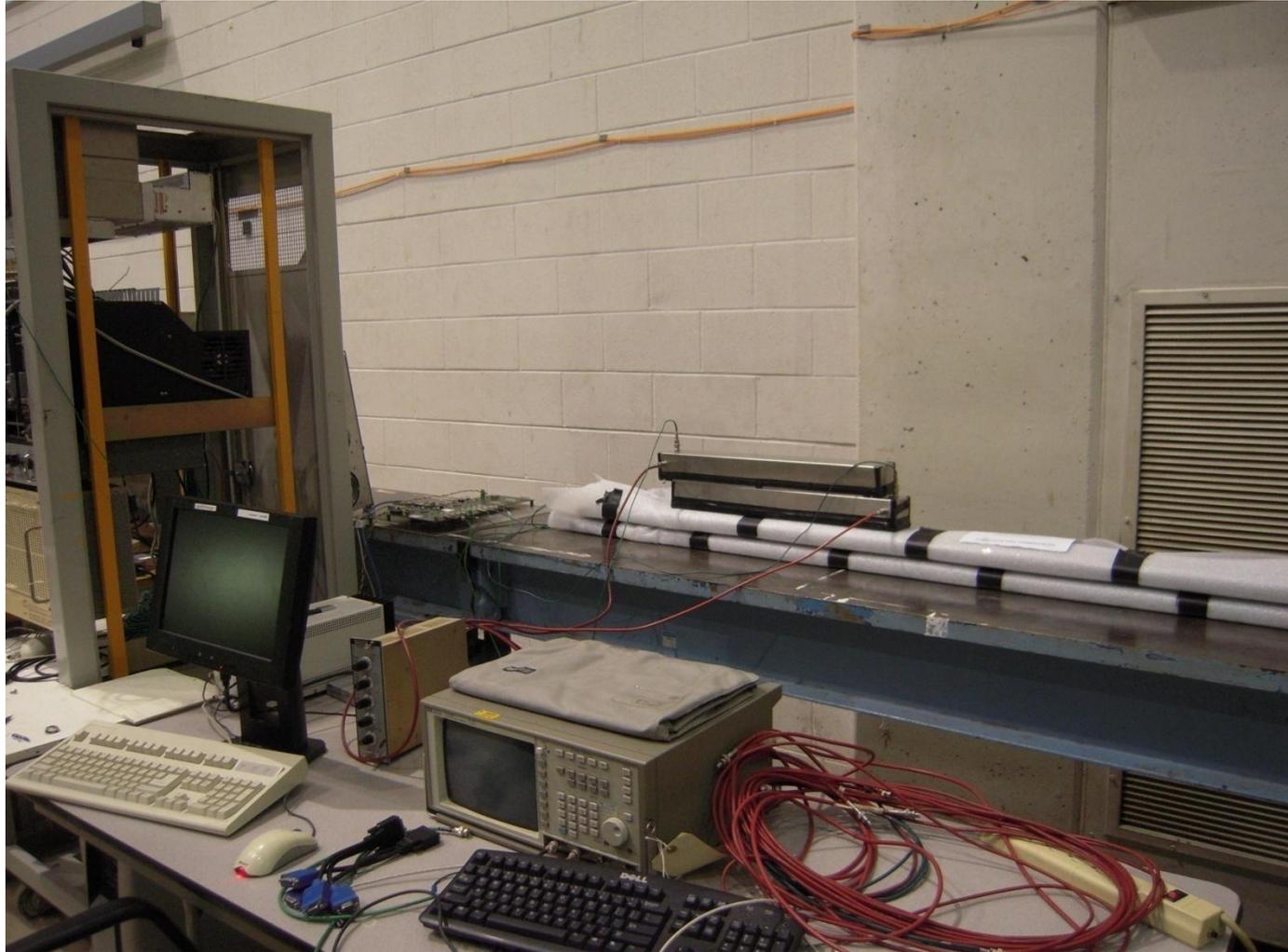
Strip  
Scintillators

TB4 Daughter  
Boards

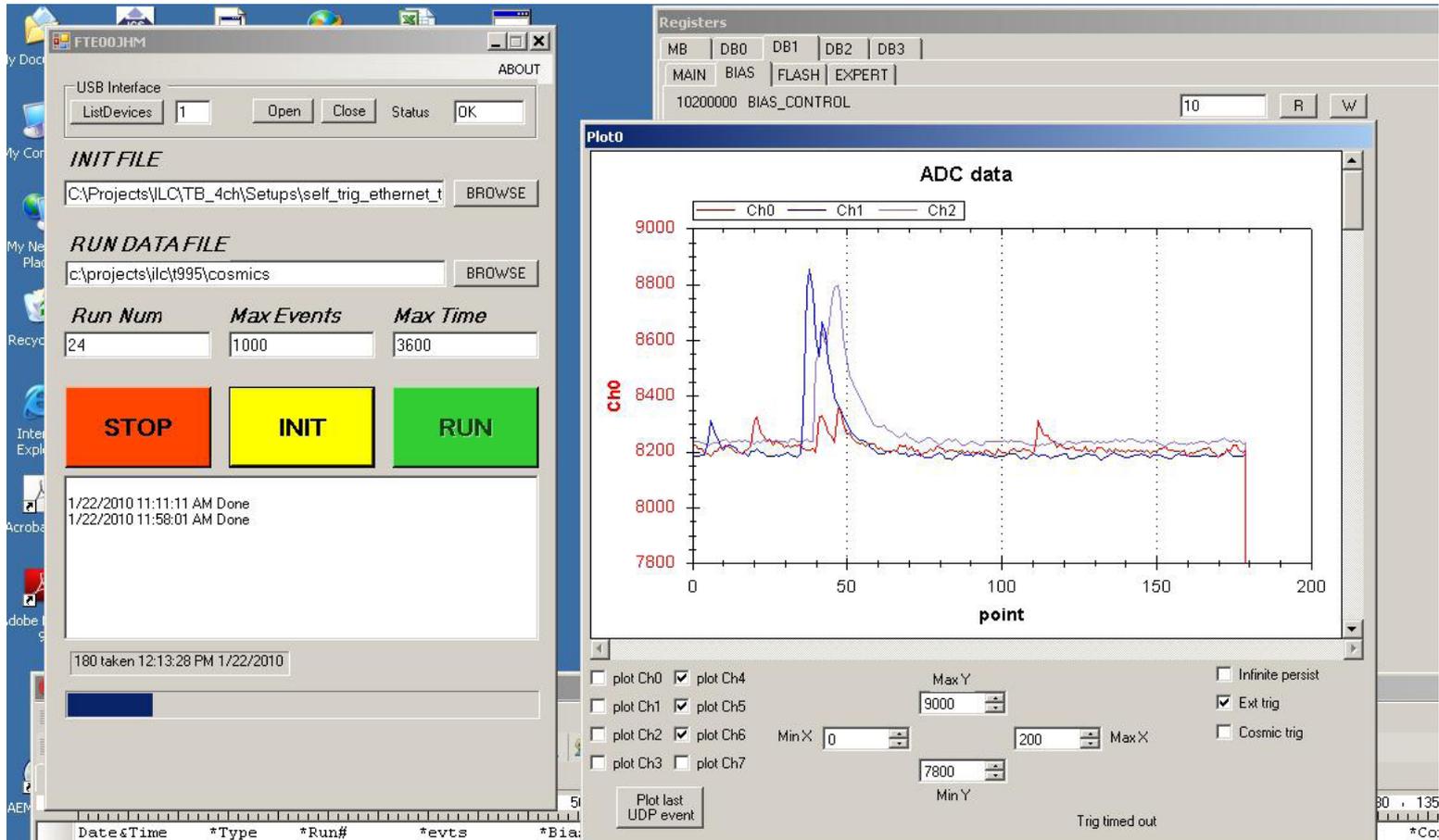
TB4 Mother  
Board



# Cosmic Ray Test at D0

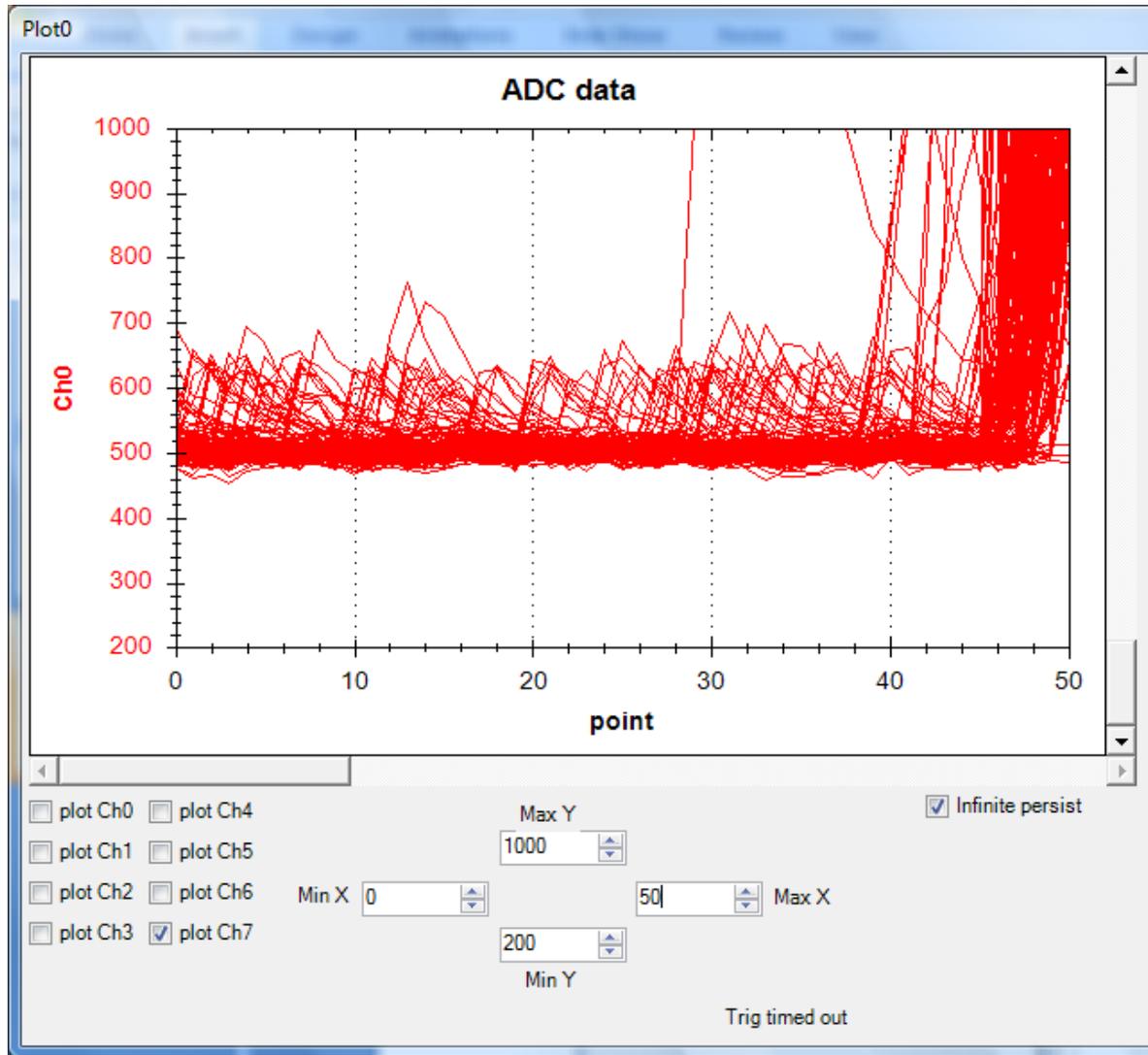


# TB4 Set-up at D0 ; Cosmic Rays



180 digitizations \* 4.708ns = 847ns . Small pulses and Large pulses!

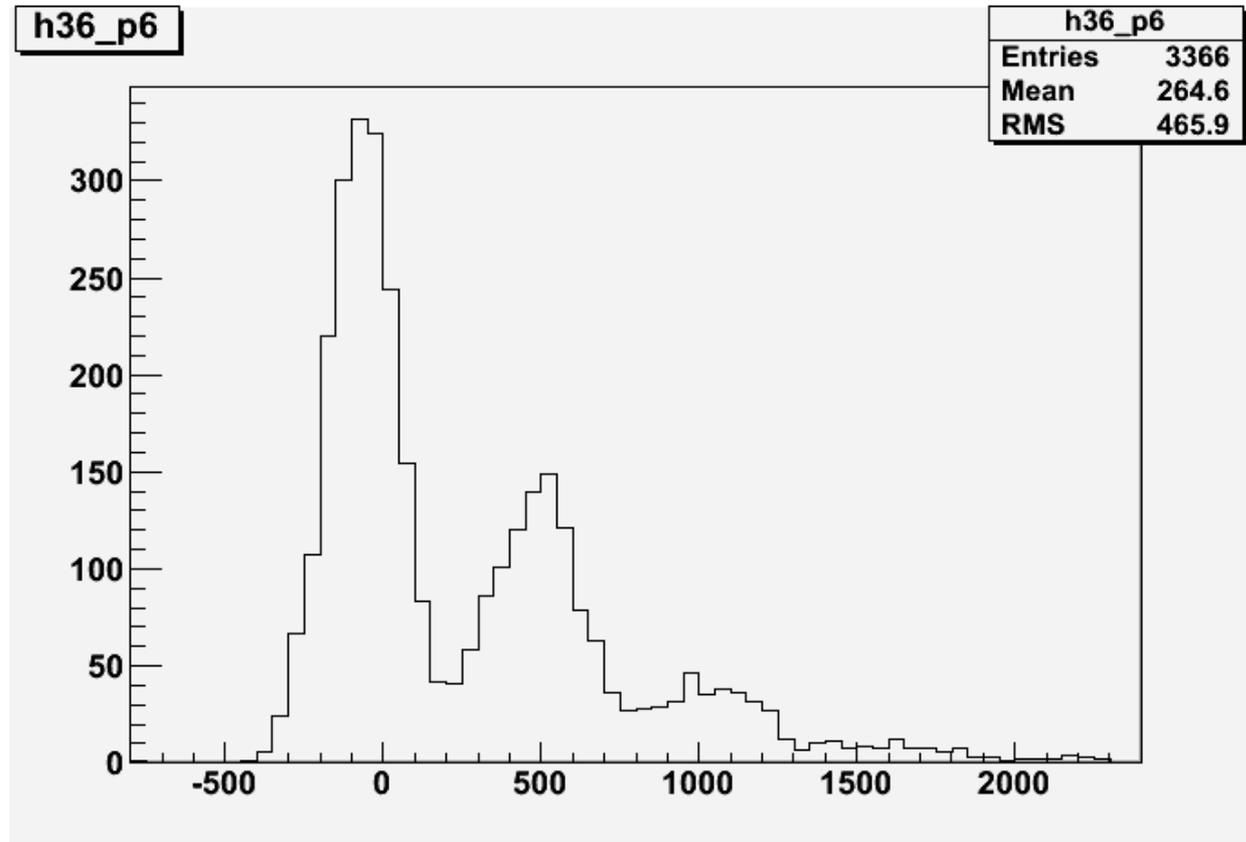
# MTest "Front Porch" data (~165ns)



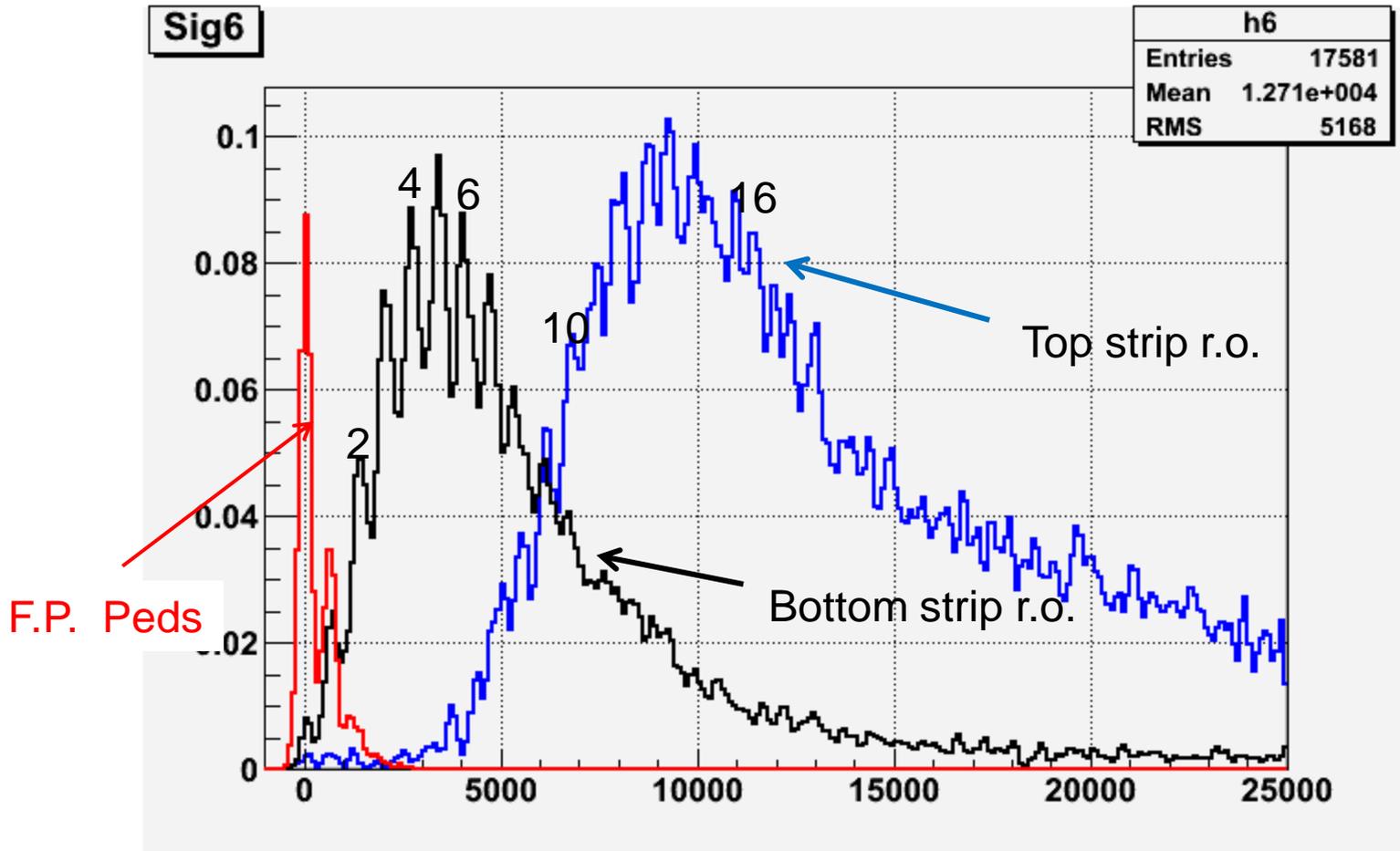
Base-line noise  
plus one or two  
electrons.

Provides a  
calibration.

# Front Porch Calibration



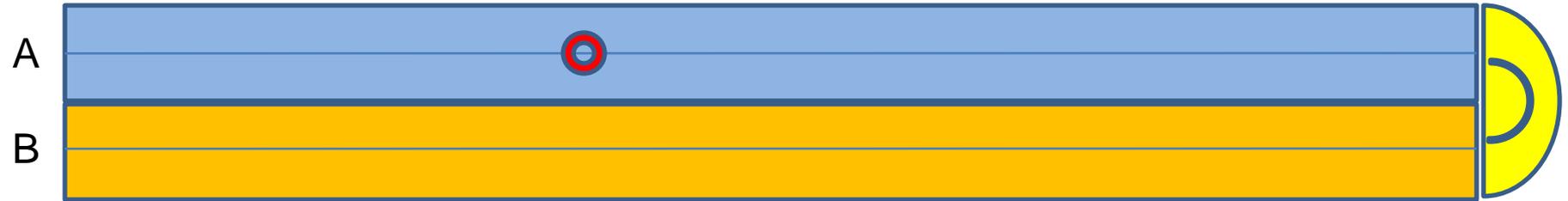
Beam in the top strip 10 cm from readout end.



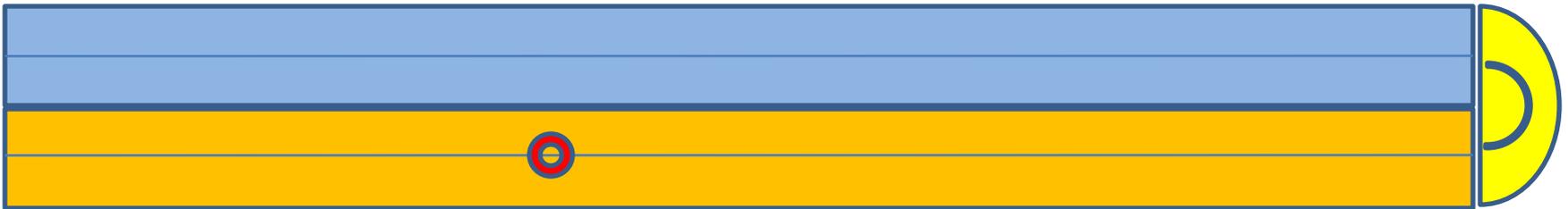
Runs 5045 and 5046 2/20/2010

# Dual Strip Readout

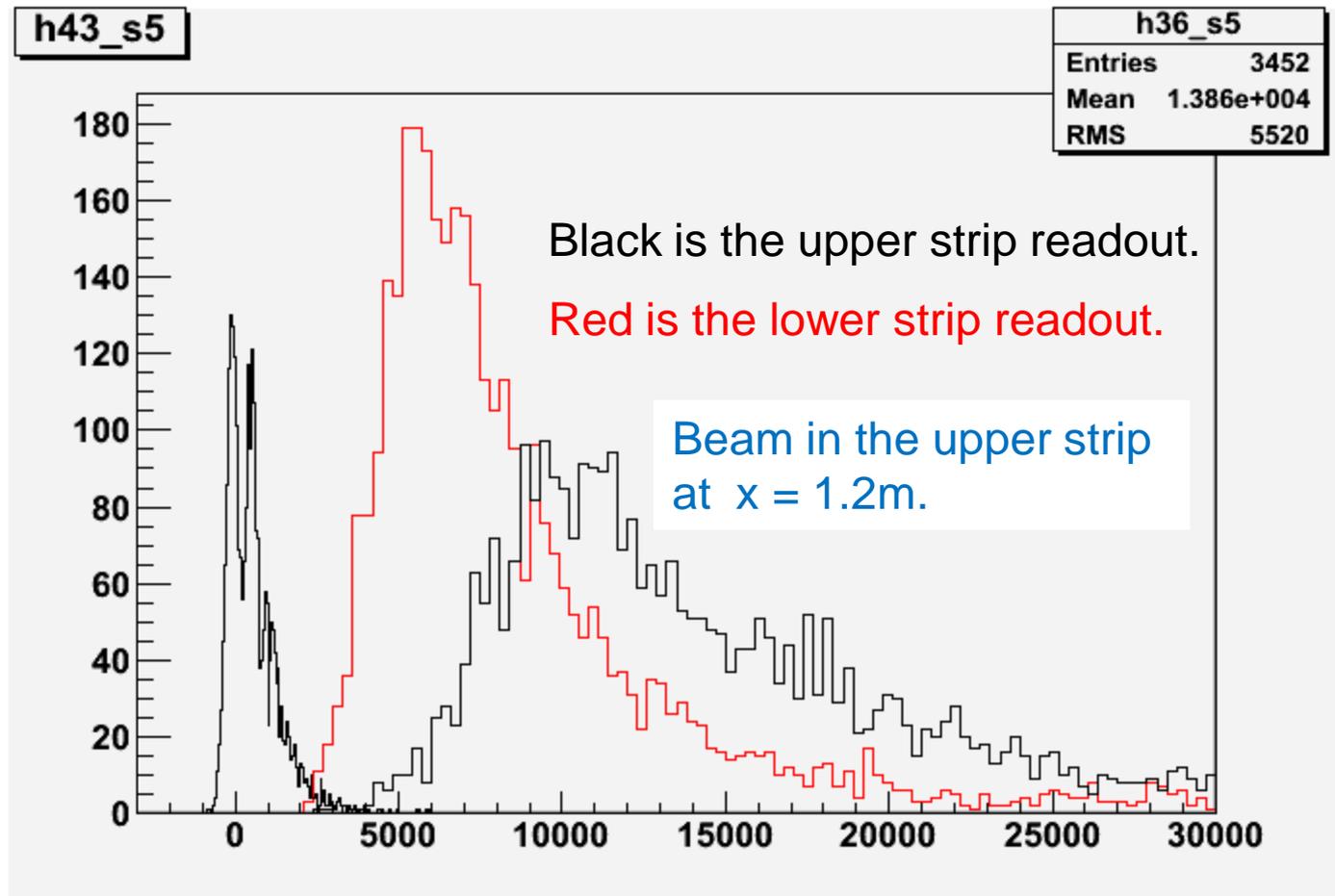
Beam in the top strip



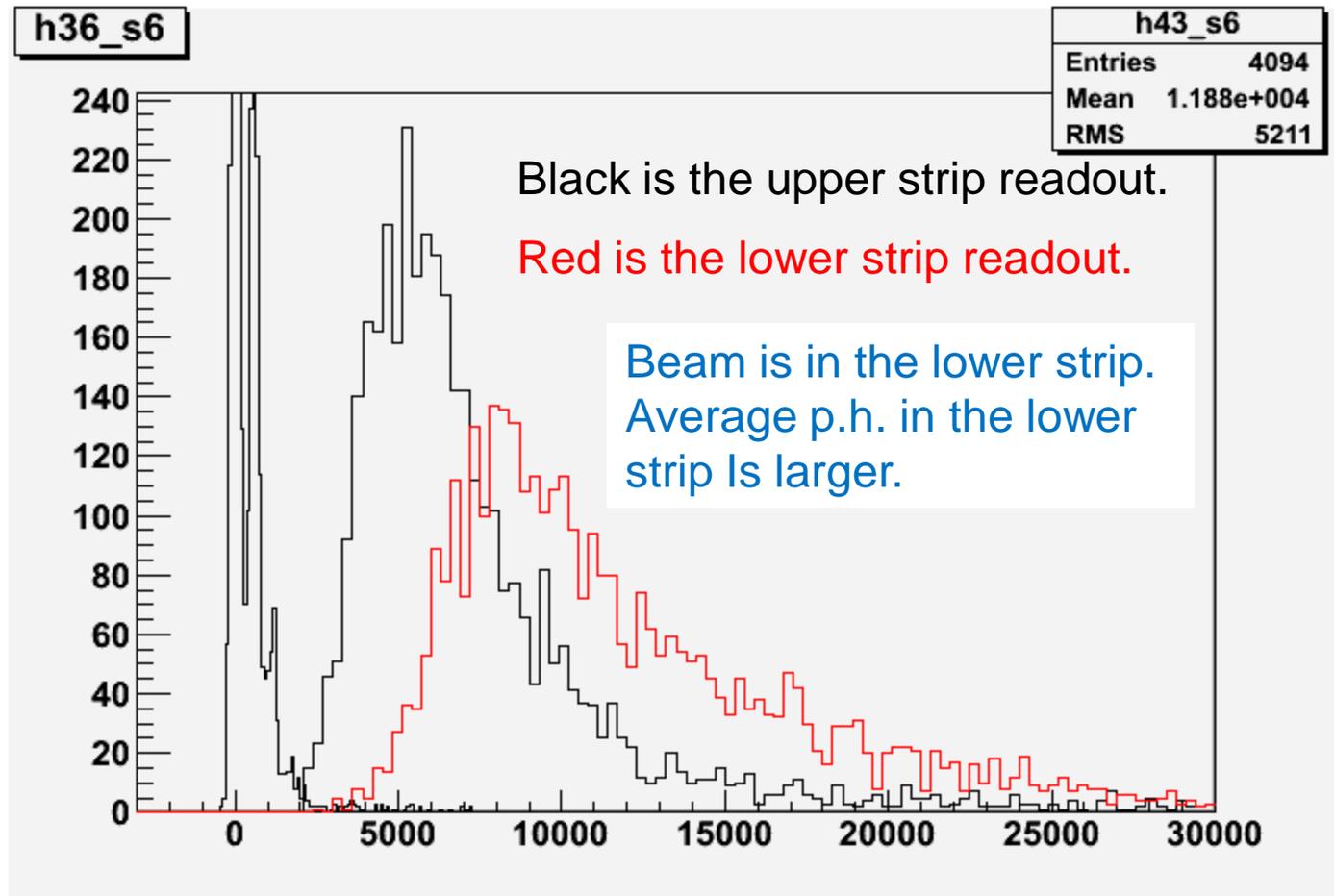
Beam in the bottom strip



# Top and Bottom Strip Comparison

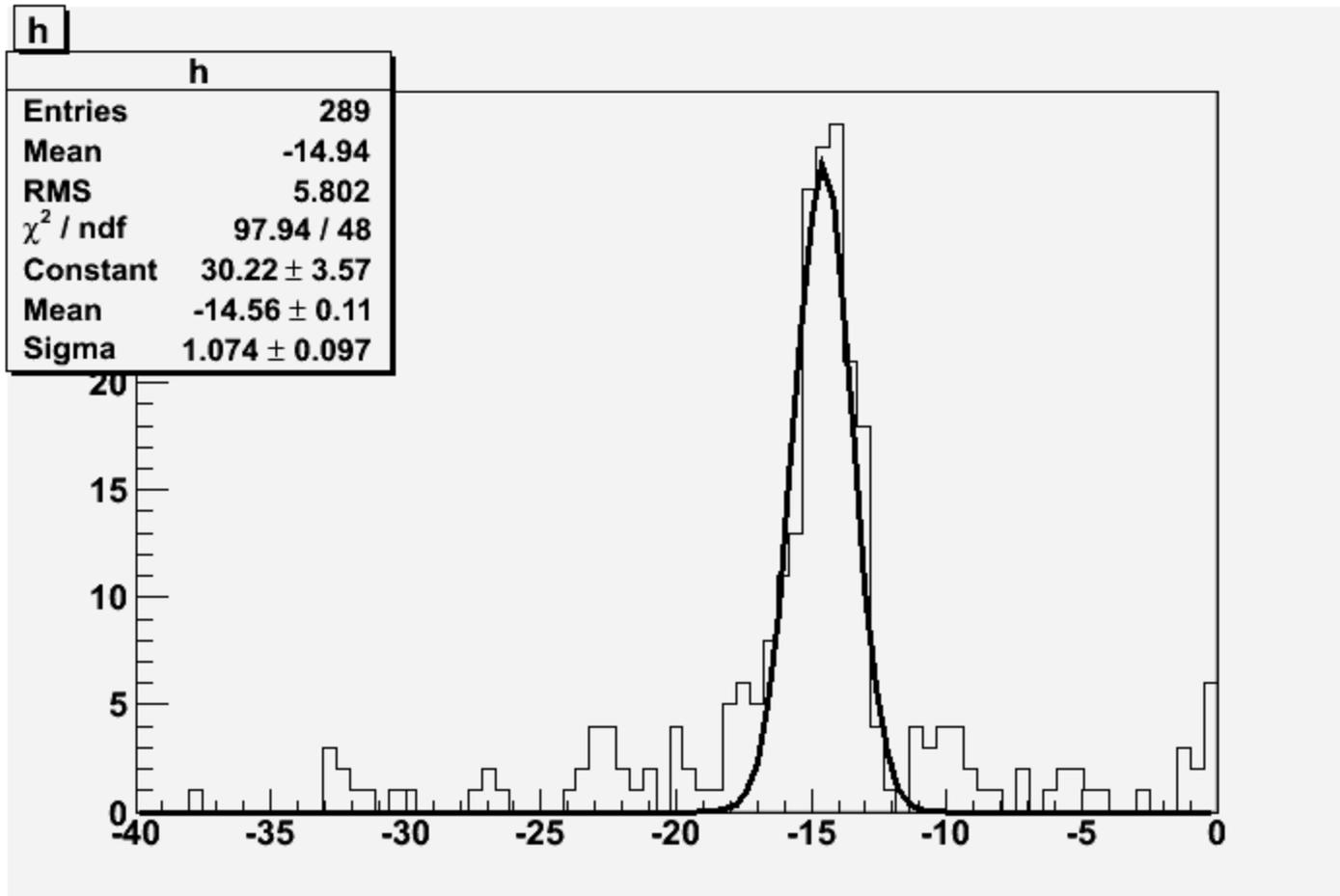


# Beam in the lower strip at $x = 120$ cm



# What is the $\Delta$ (time of arrival)?

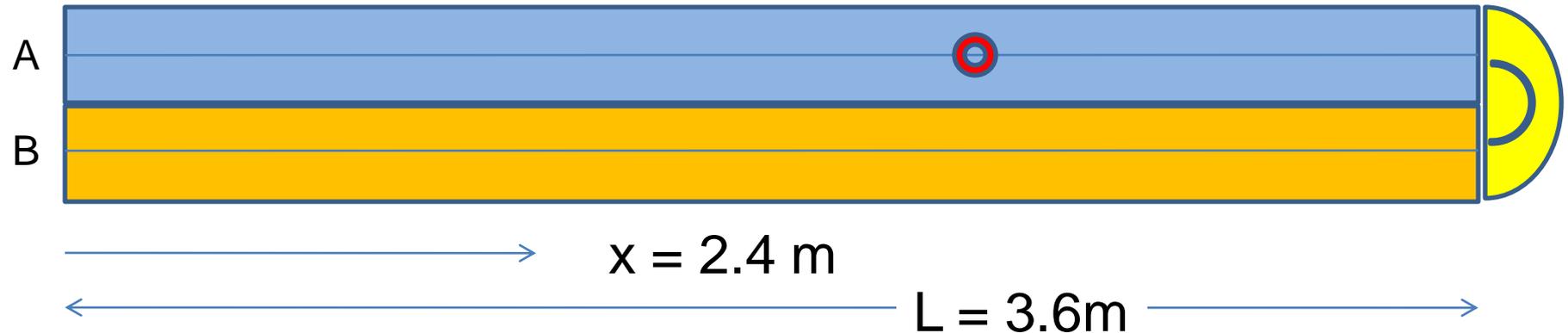
Ch(5)lower - Ch(6) upper time diff.



Or we can calculate the speed of light in the WLS/scintillator since we know the nominal distances and our graph gives a time difference of 14.8 ns.

# Dual Strip Readout

Beam in the top strip



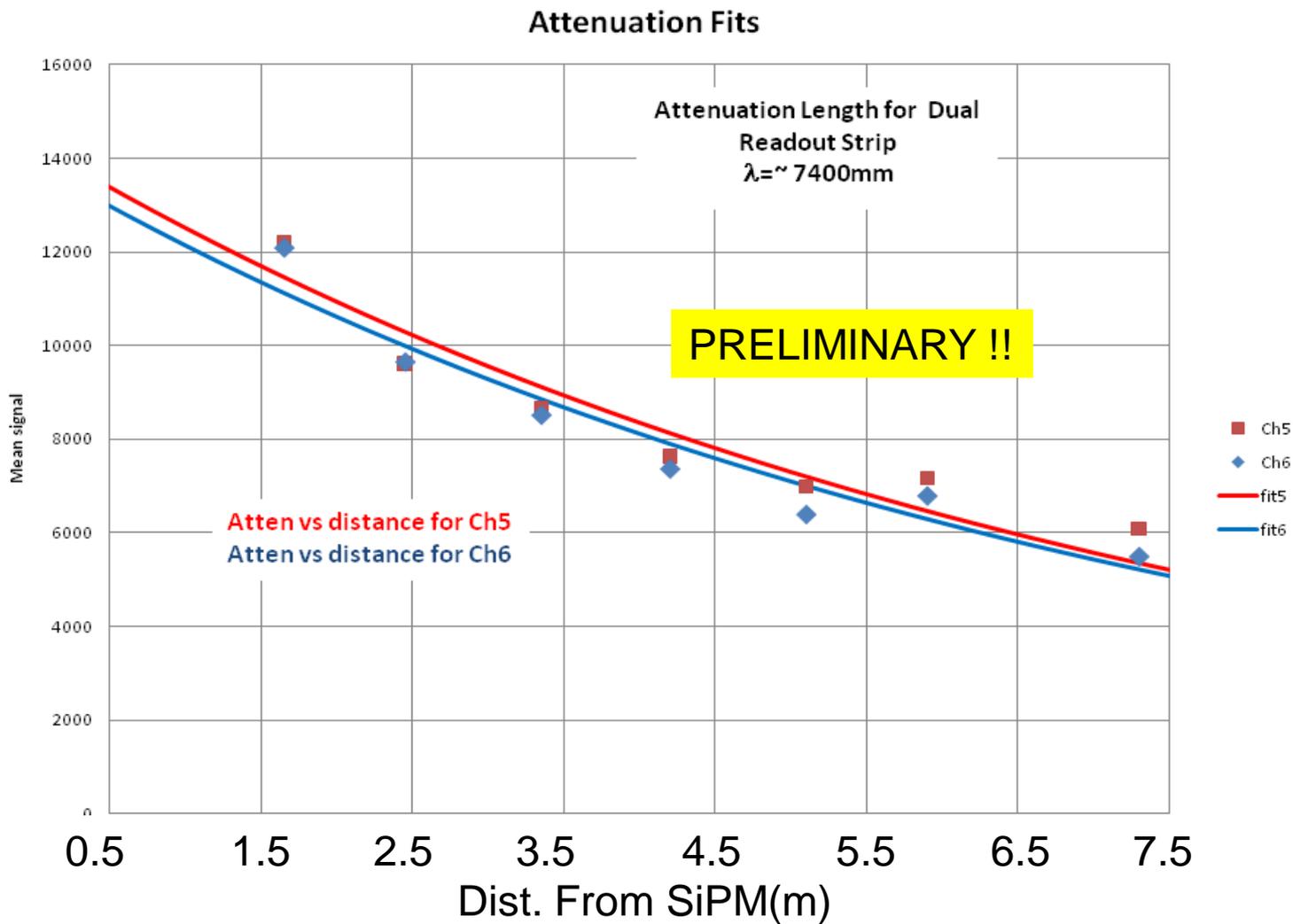
For beam in the top strip the top distance is 2.4 m. For beam in the top strip, the bottom readout distance is  $3.6\text{m} + 0.25\text{m} + 1.2\text{m} = 5.05\text{m}$ .

The distance difference is:  $5.05 - 2.4 = 2.65 \text{ m}$ .

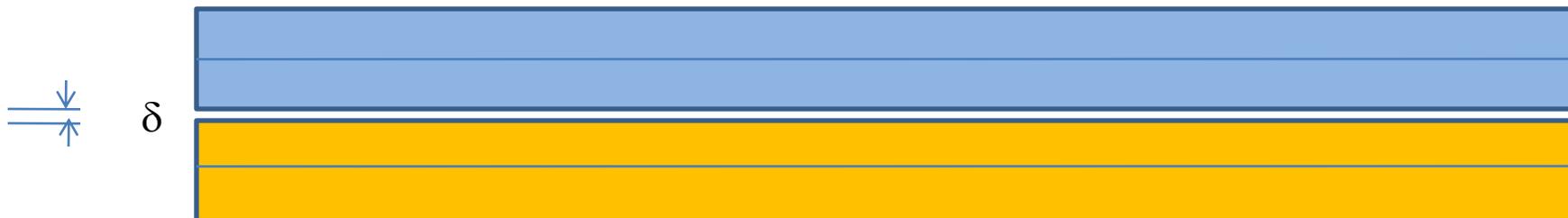
$$c(\text{effective}) = 265\text{cm} / 14.8 \text{ ns} = 18 \text{ cm/ns}$$

For D0's fiber tracker:  $c(\text{eff.}) \sim 17 \text{ cm/ns}$

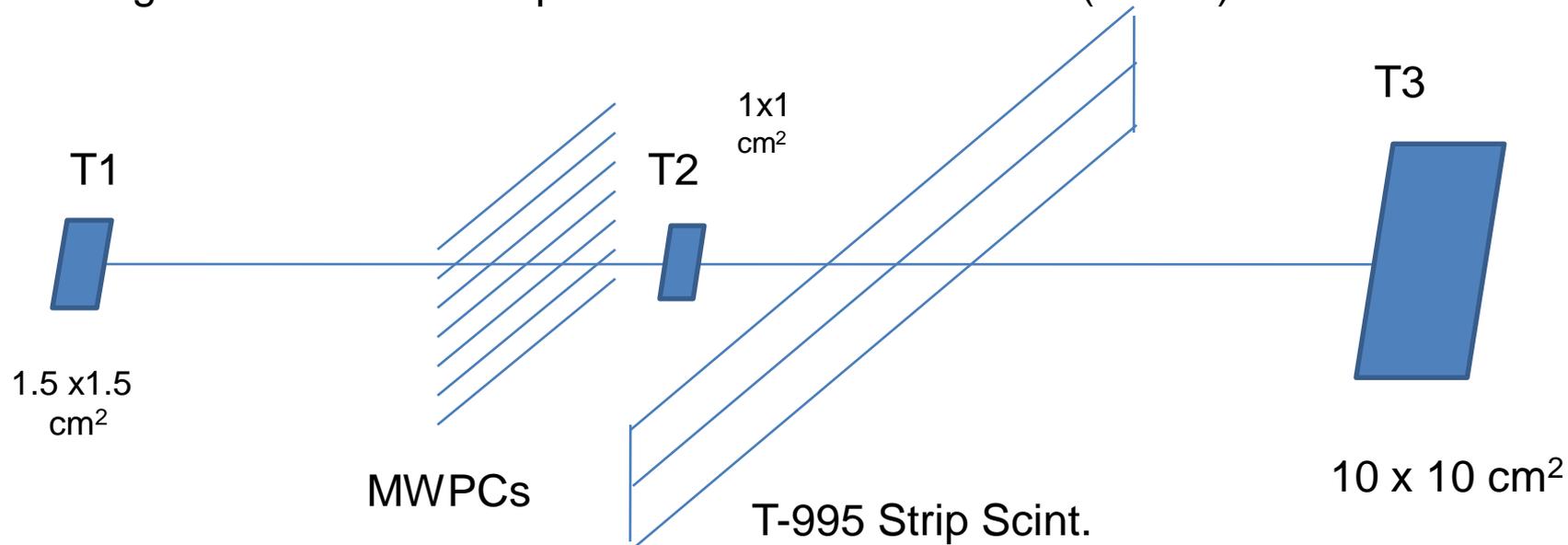
# WLS Attenuation Length



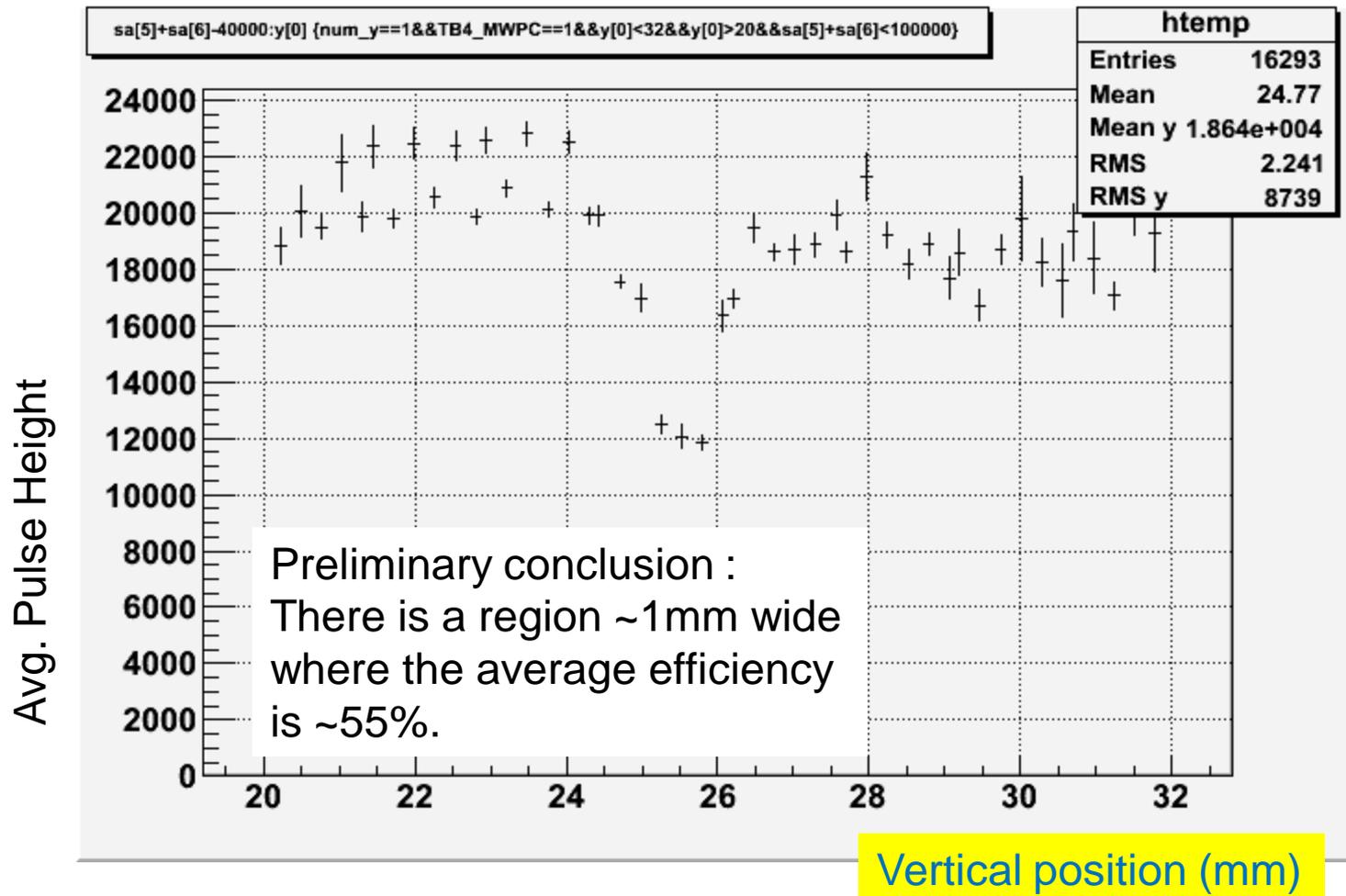
# Preliminary meas. of the inter-strip inefficiency



Method: Use two 1 mm spacing MWPC horizontal wire planes upstream of the strip scintillator counters to measure the vertical position of beam tracks that pass through the scintillator strips. Take data as the beam ( $\sim 1\text{cm}$ ) scans the crack.



# Vertical Scan of Inter-strip Crack

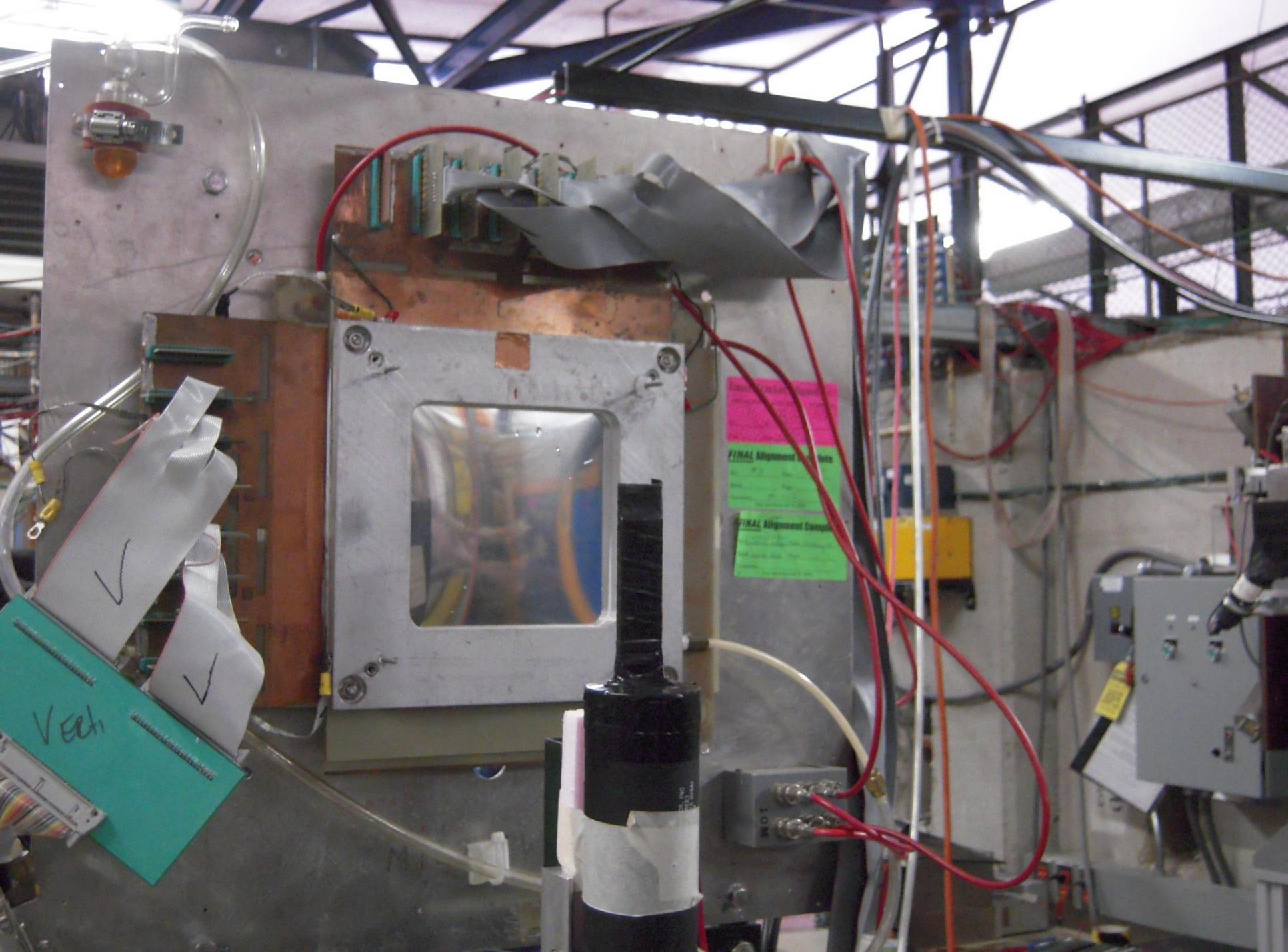


# Summary/Conclusions

- The TB4 front-end and data acquisition electronics works very well. Of course it helps to have the architect in residence!
- The pixelated photon detectors (PPDs) have worked very well. Seeing many photo-peaks is exciting and useful. We have adequate signal, but more data analyses are needed to write a NIM paper.
- Calibration using noise pulses works well. The “no threshold” noise of ~ few MHz does not seem to be a problem for muon detectors.
- MTest is a good facility. We have appreciated the significant help from our MTest hosts, techs, etc.
- We have more measurements to make and additional hardware to test.

Special thanks to FBK/IRST for pixelated photon detectors.





Lab Book  
Date: \_\_\_\_\_  
Time: \_\_\_\_\_  
Operator: \_\_\_\_\_

FINAL Alignment Complete

FINAL Alignment Complete

V

V

Veeh

PROT

Control Panel with various knobs and switches, and a yellow label.

