

# Total Measurement Calorimeter TMC

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Introduction

( physics )

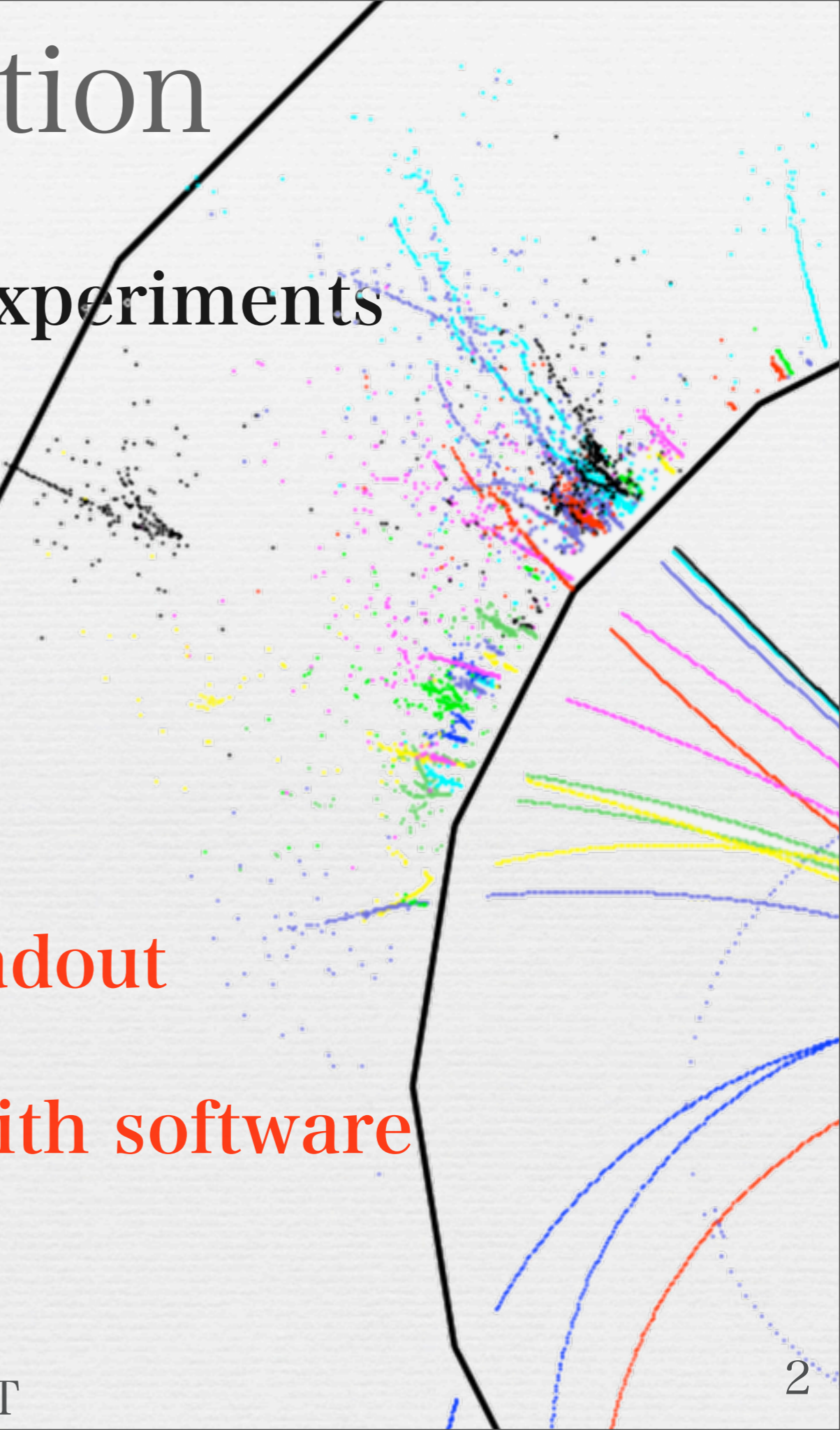
TMC

test results

future plan

# Introduction

- Next generation collider experiments
- HE Jets from Z/W,g,t/b,H
- Best Jet energy resolution
- $\sigma_j/E_j \sim$  **Hadron E resolution**
- two ideas : PFA / **Dual Readout**
- **PFA : fine segmentation with software**



# Dual Readout

- jet energy measurement : hadron calorimetry
  - charged  $\pi^{+-}$  : pure hadronic contents : small  
small energy loss due to dE/dx
  - neutral  $\pi^0$  : EM shower : large contribution
  - with large fluctuation 5-95% of Ejet
  - Dual readout
    - scintillation (charged) & Cherenkov (EM)
- pure Hadron + EM\*weight >to have better resol.

$\pi^{+-}$

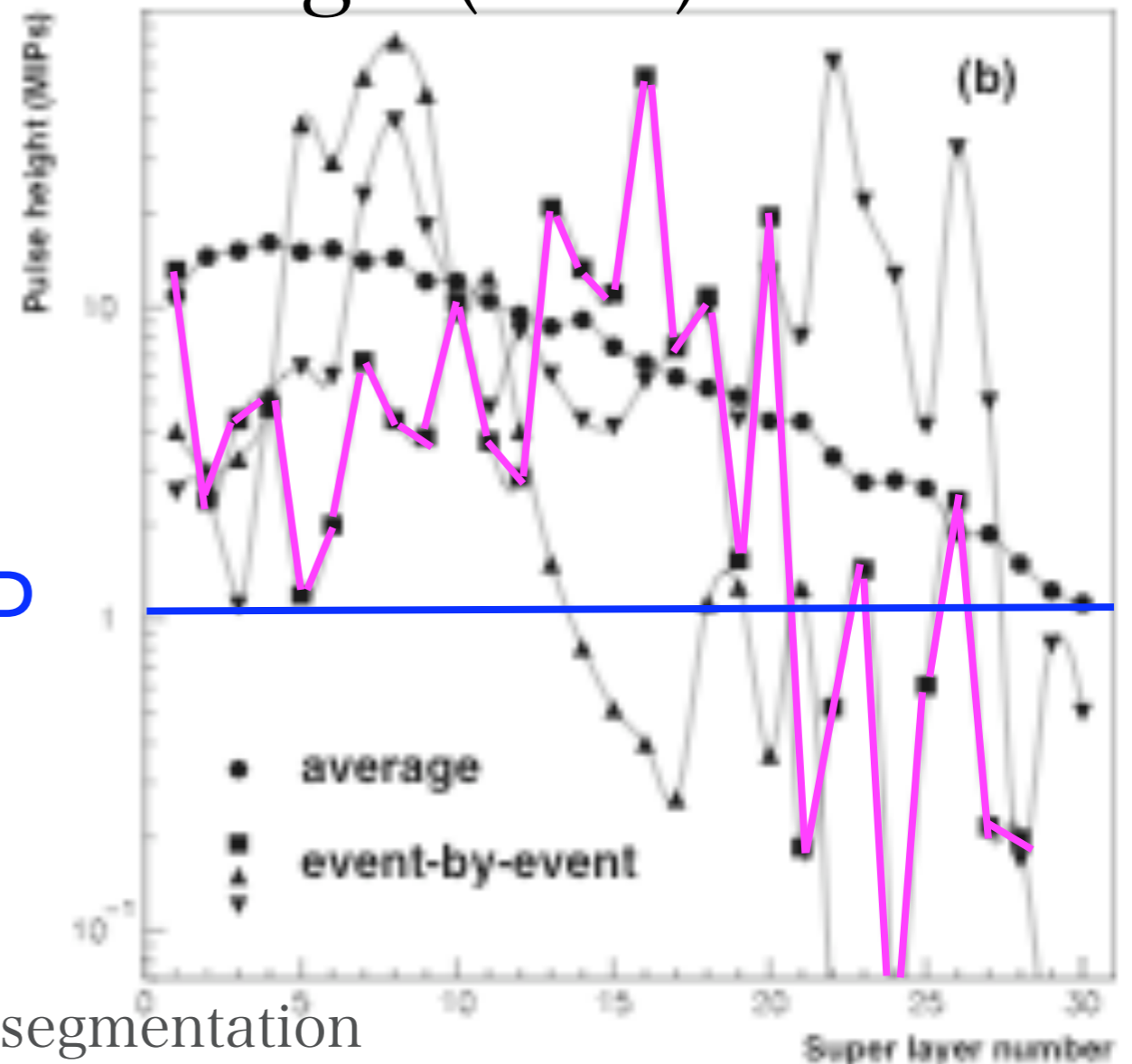
$\pi^0$

# Hadron Shower

- long interaction length  $> \sim 10\text{cm}$
  - large fluctuation due to  $\pi^0$  production
- pulse height(MIP)

$\pi^-$  4GeV data  
30 superlayer  
(Lead 8mm/scint.  
2mm)x4

1 MIP

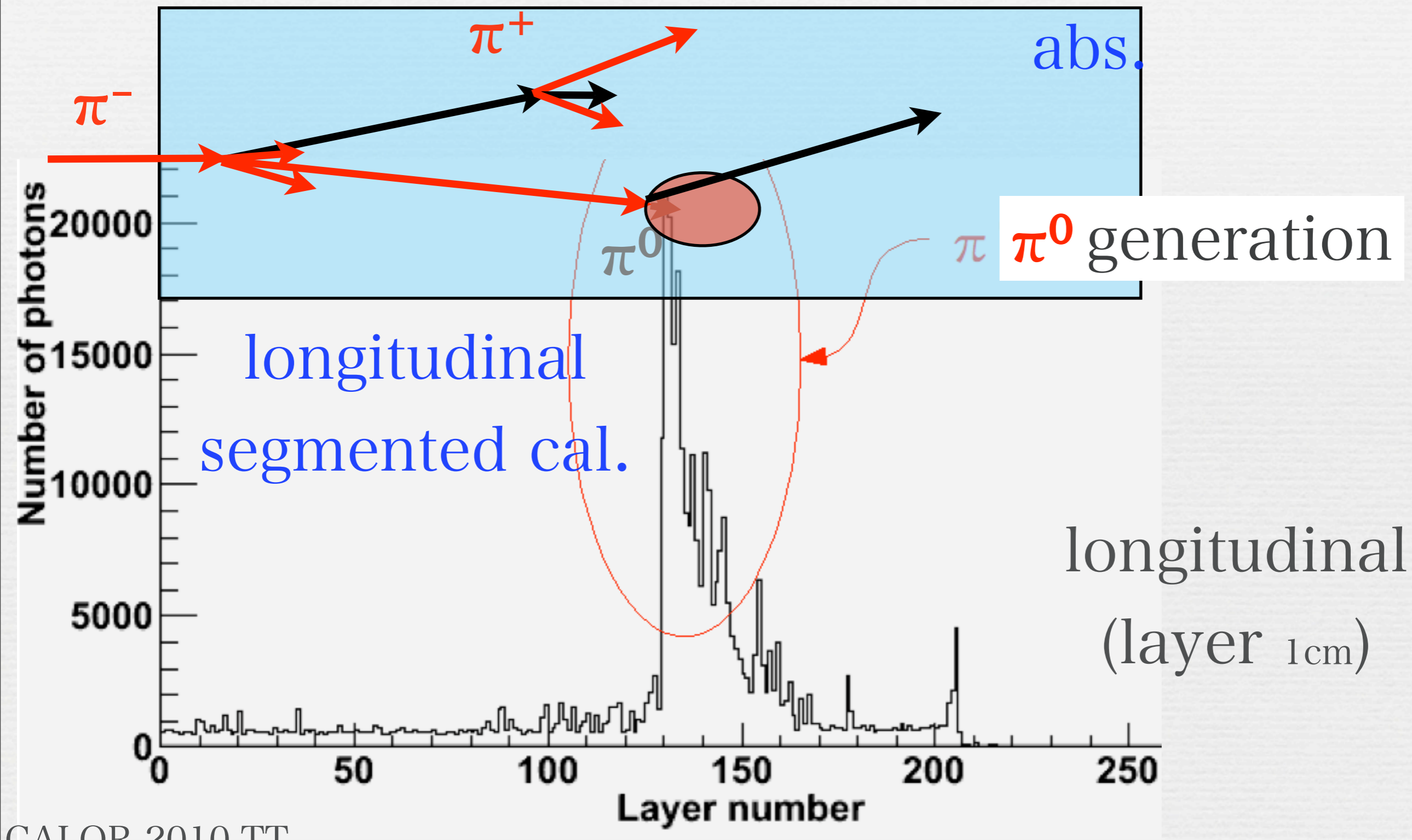


longitudinal segmentation  
CALOR-2010-TT

superlayer #

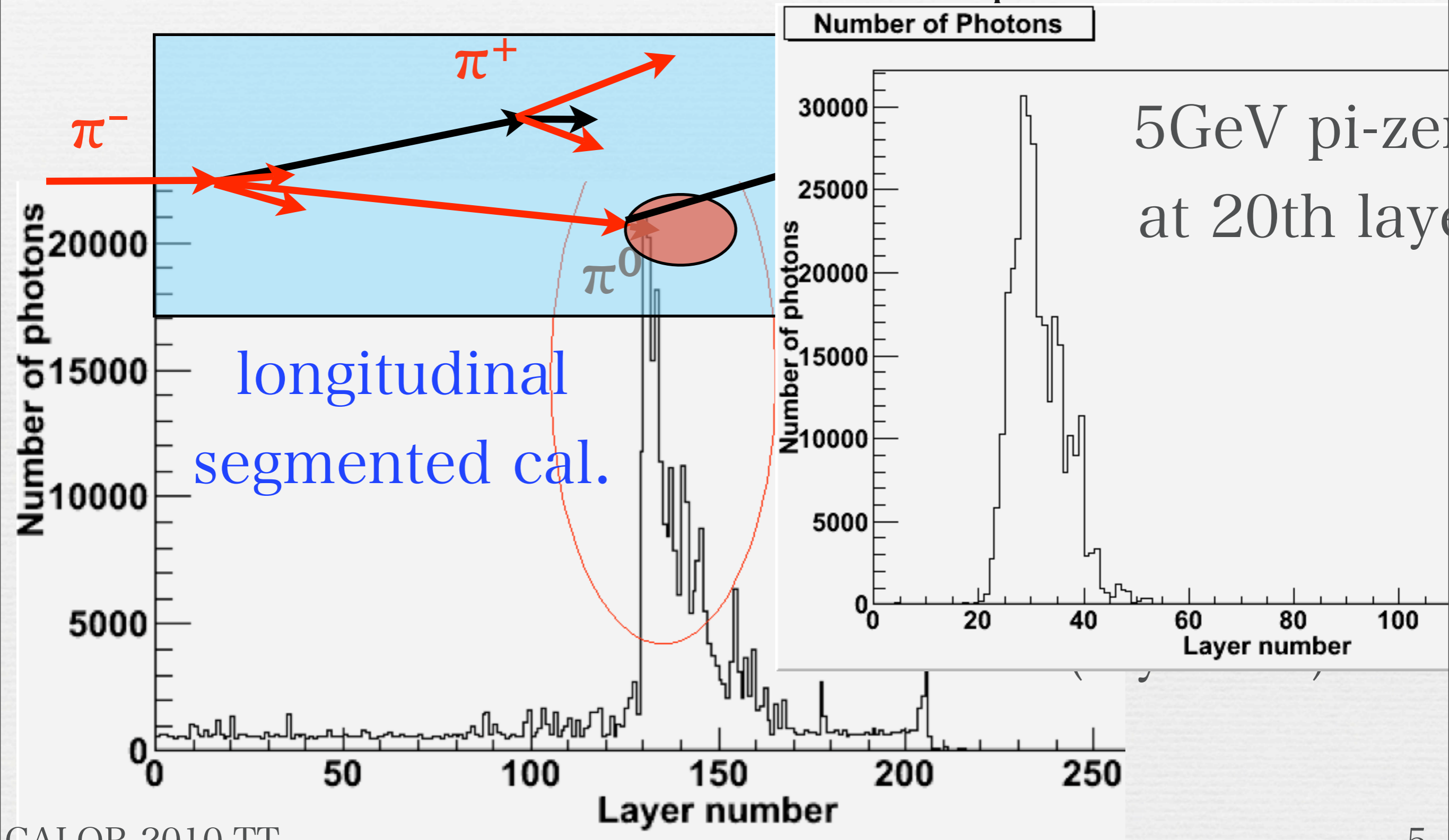
# Hadron Interaction

- a simulated event with a neutral pion



# Hadron Interaction

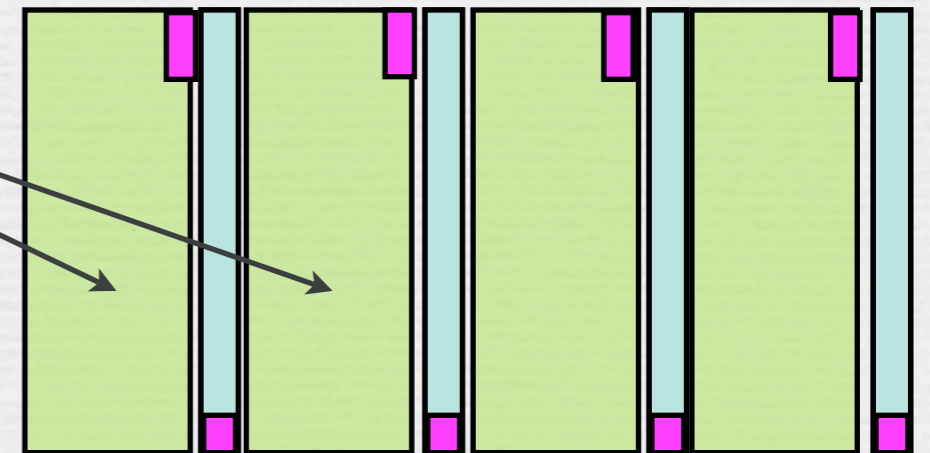
- a simulated event with a neutral pion



# Total Measurement idea

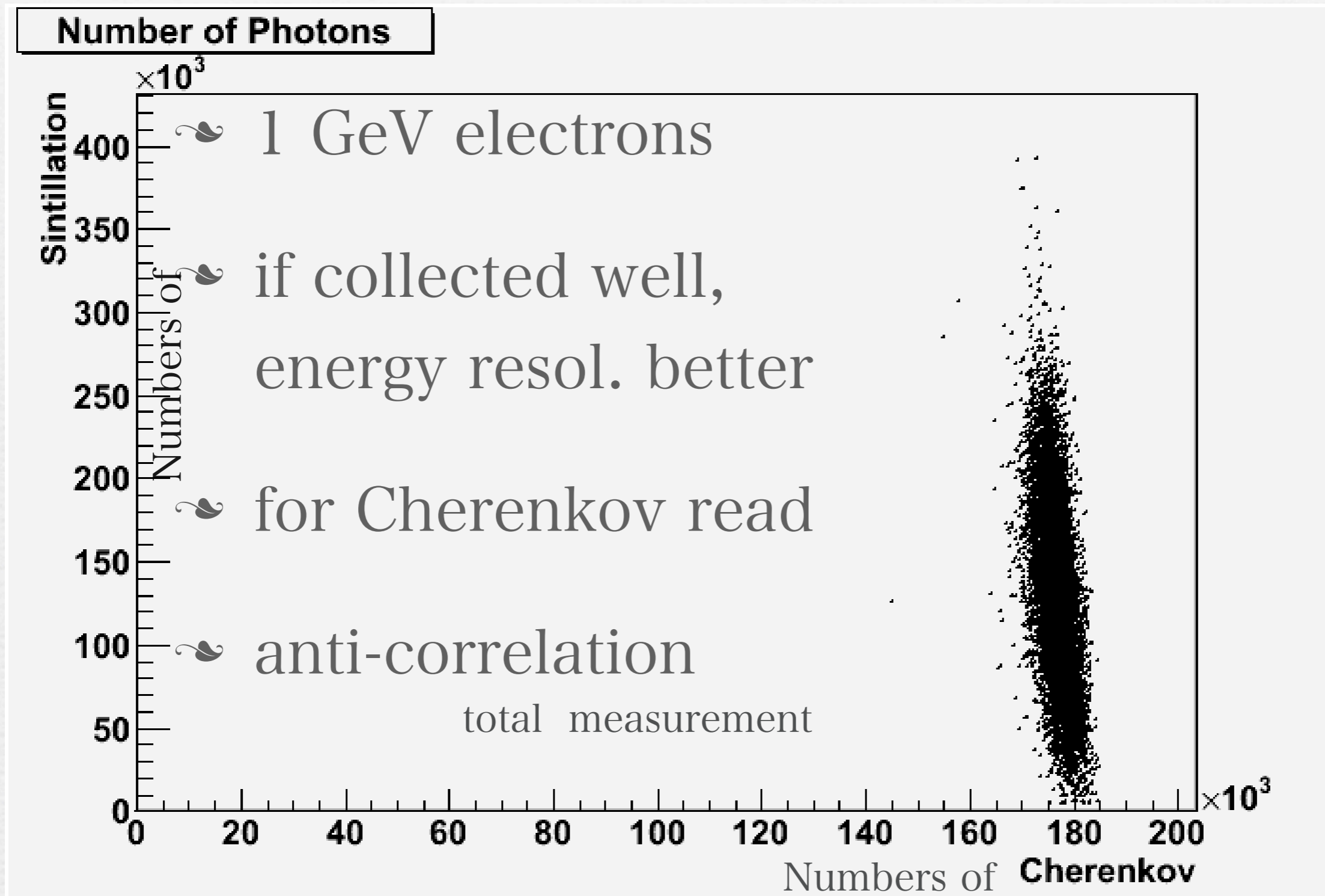
- information from absorbers with Cherenkov
- sandwich structure : longitudinal segmented
- reduce large fluctuation by finding pi-zero
- scintillator : charged & neutron detection  
heavy trans. mat. PbF2, LG,,,
- absorber : Cherenkov light : total measure.
- can act as ECAL as well  
good E resol.

silicon photo sensor



# as an EM CAL.

- excellent E resolution  $\sim 5\%/\sqrt{E}$
- simulated electrons in case of Lead glass



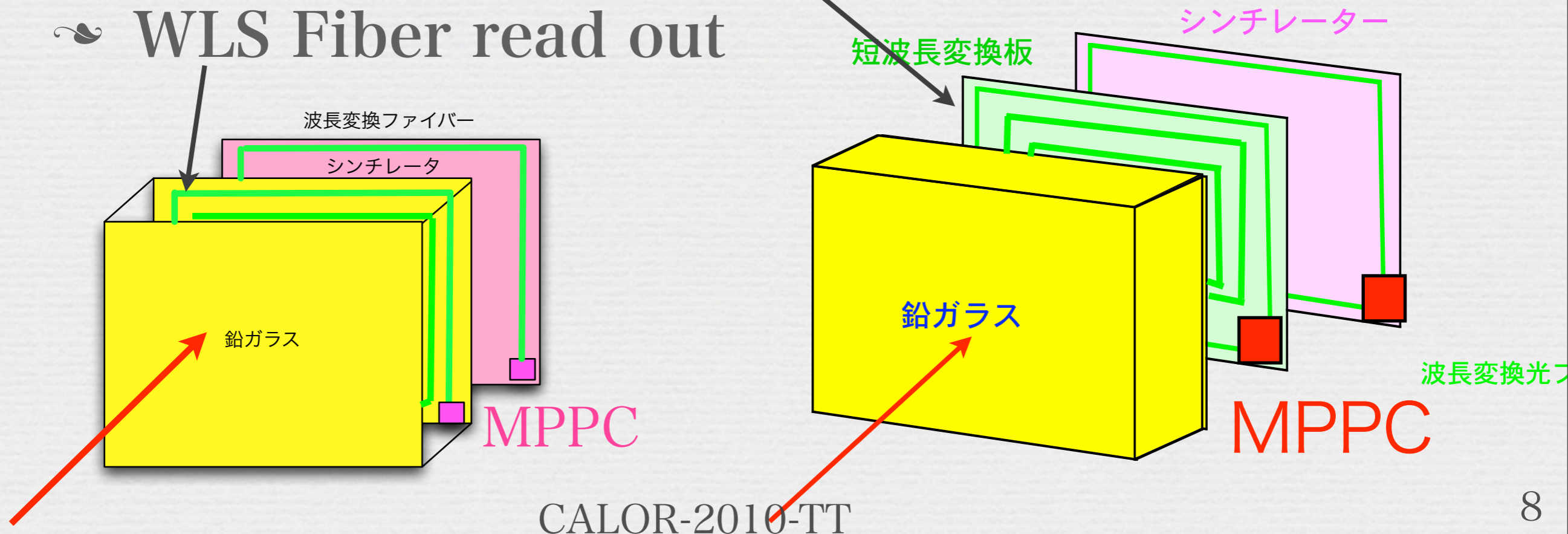


# Read out from absorber

- ✧ absorber : Lead glass  $\rho \sim 6\text{g/cm}^3$   $\lambda \sim 25\text{cm}$
- ✧ Cherenkov light read out : small # of lights

- ✧ WLS plate read out

- ✧ WLS Fiber read out



# Read out from absorber

☞ groove WLSFiber in LG by T.Zhao et al.

☞ test with CR muons :  $2.4 \pm 0.5$  p.e.

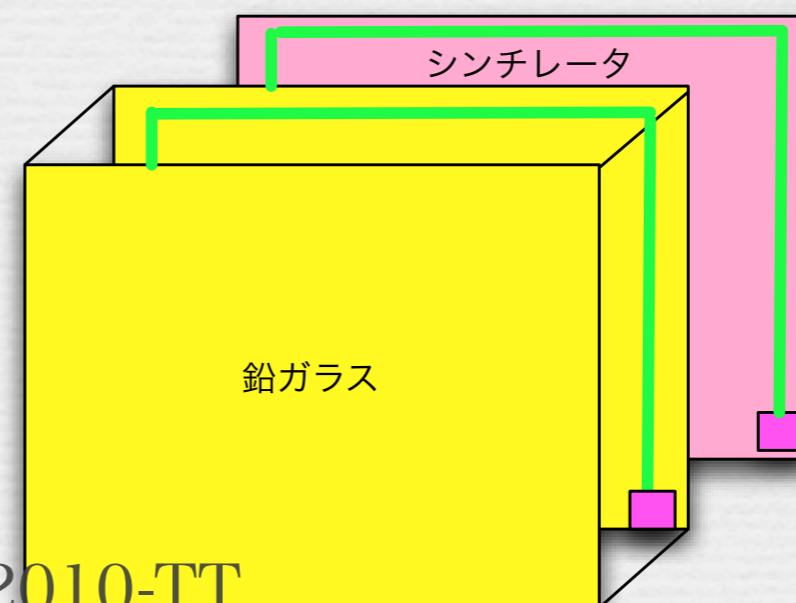
10% light

☞ scintillator :  $27 \pm 4$  p.e.

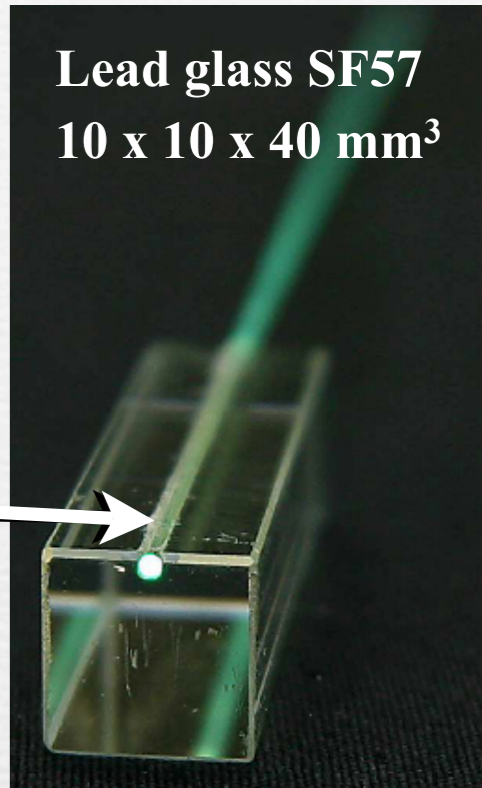
☞ 5cm x 13 cm x 13cm LG  $\rho=5.5$  : SF57

波長変換ファイバー

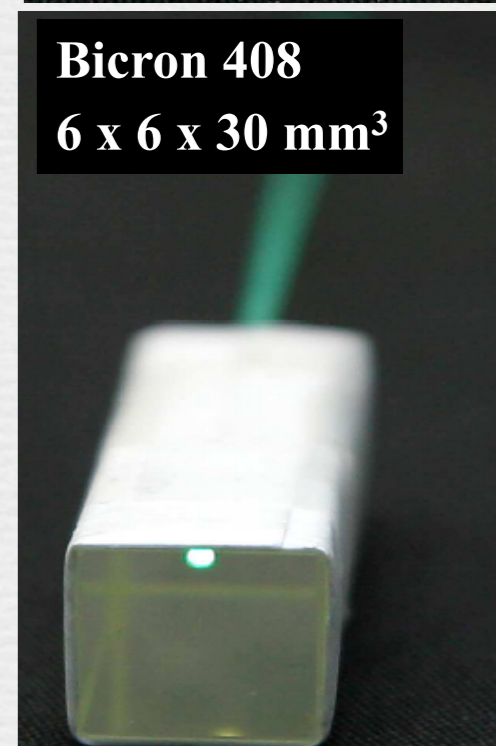
☞ PbF2  $\rho=7.8$



Lead glass SF57  
10 x 10 x 40 mm<sup>3</sup>

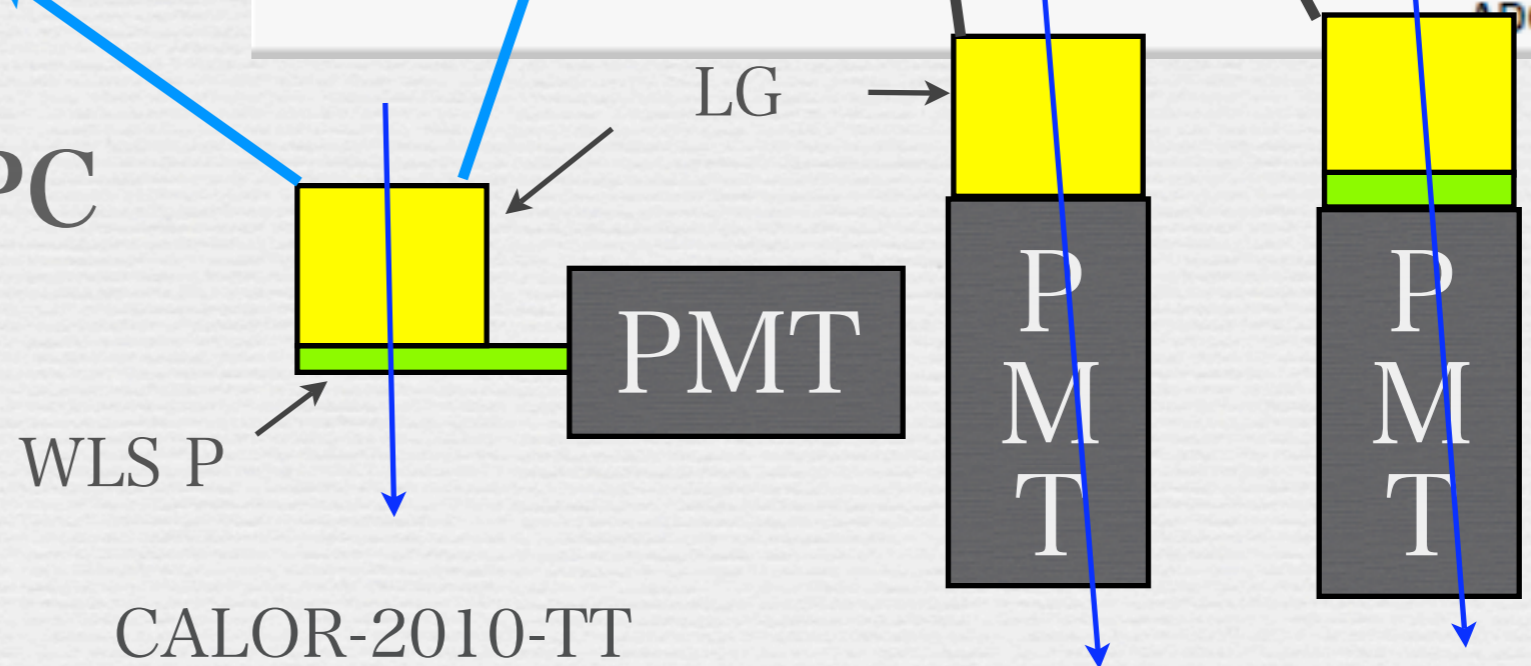
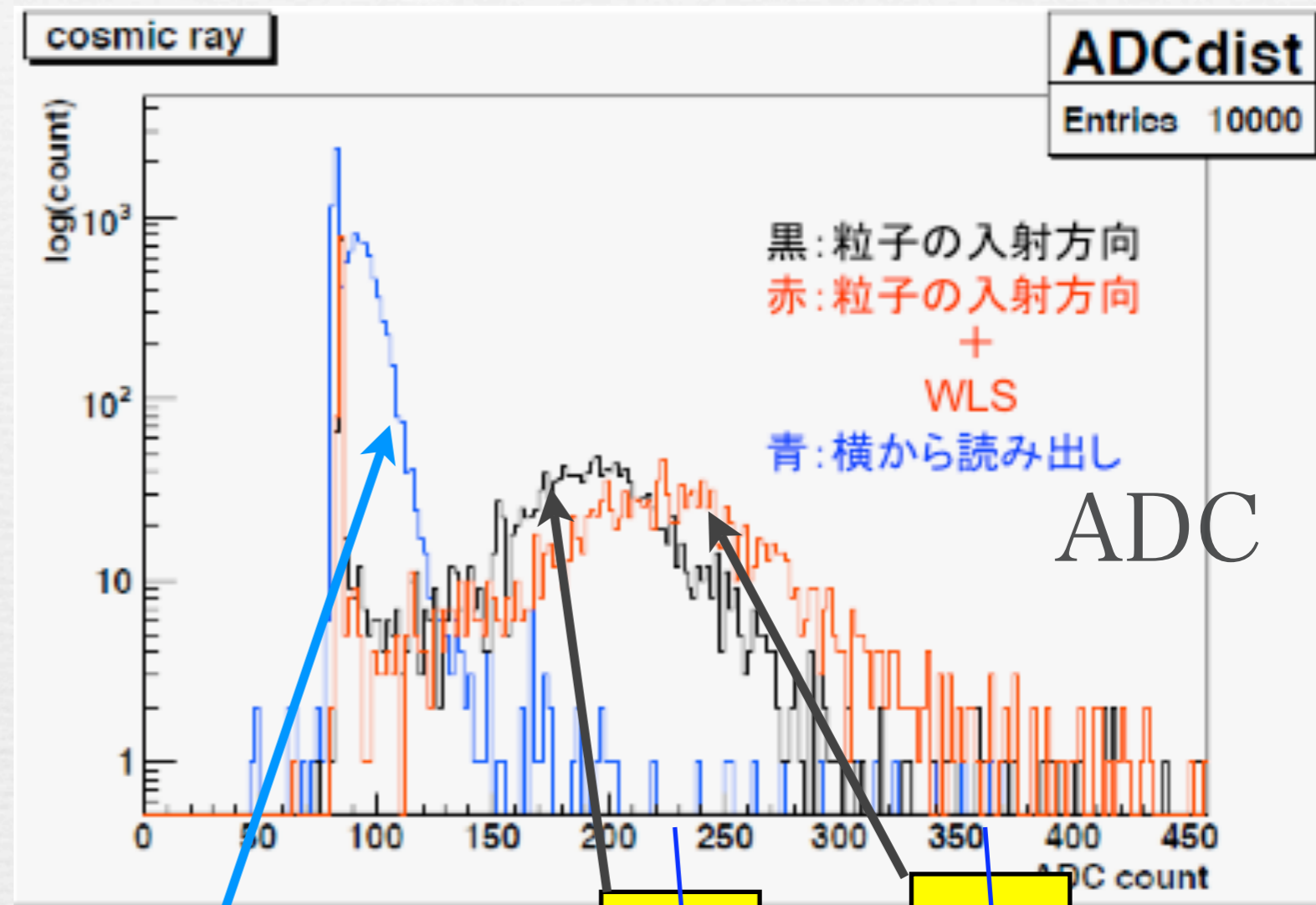


Bicron 408  
6 x 6 x 30 mm<sup>3</sup>



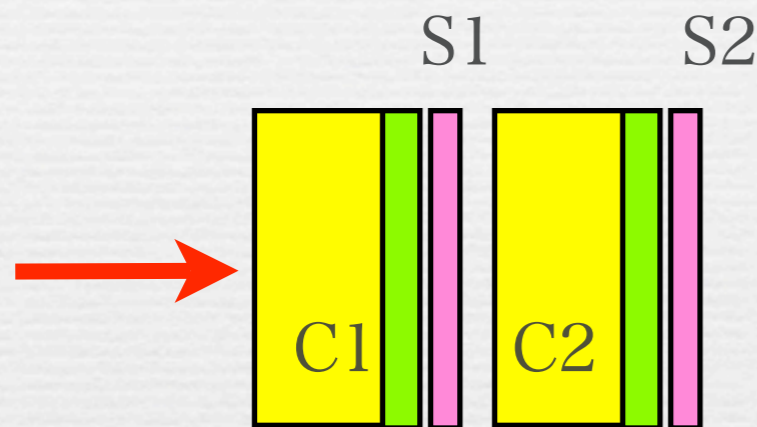
# Cherenkov light R/O

- ☛ LG 4cm+PMT
- ☛ WLS plate
- ☛ CR muons
- ☛ amount of light  
~a few of p.e.
- ☛ test with MPPC



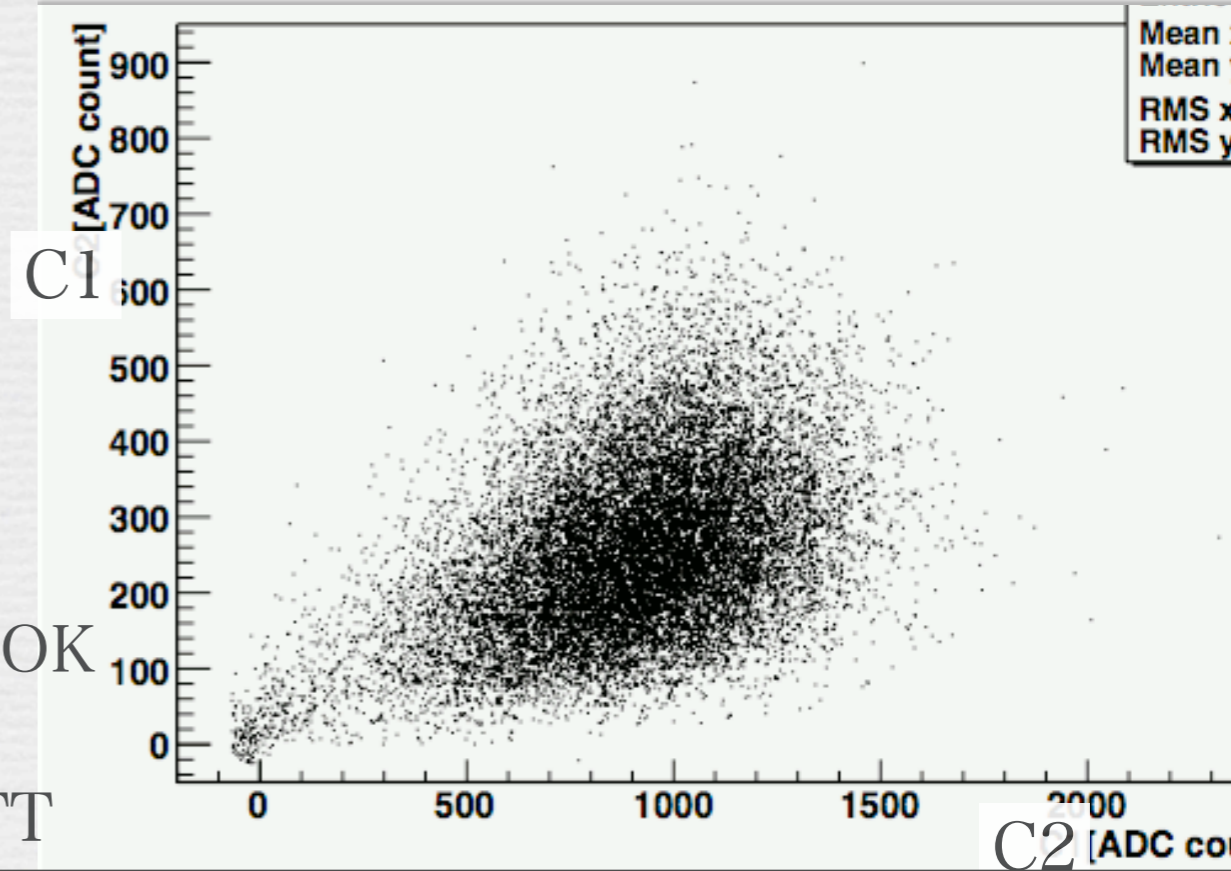
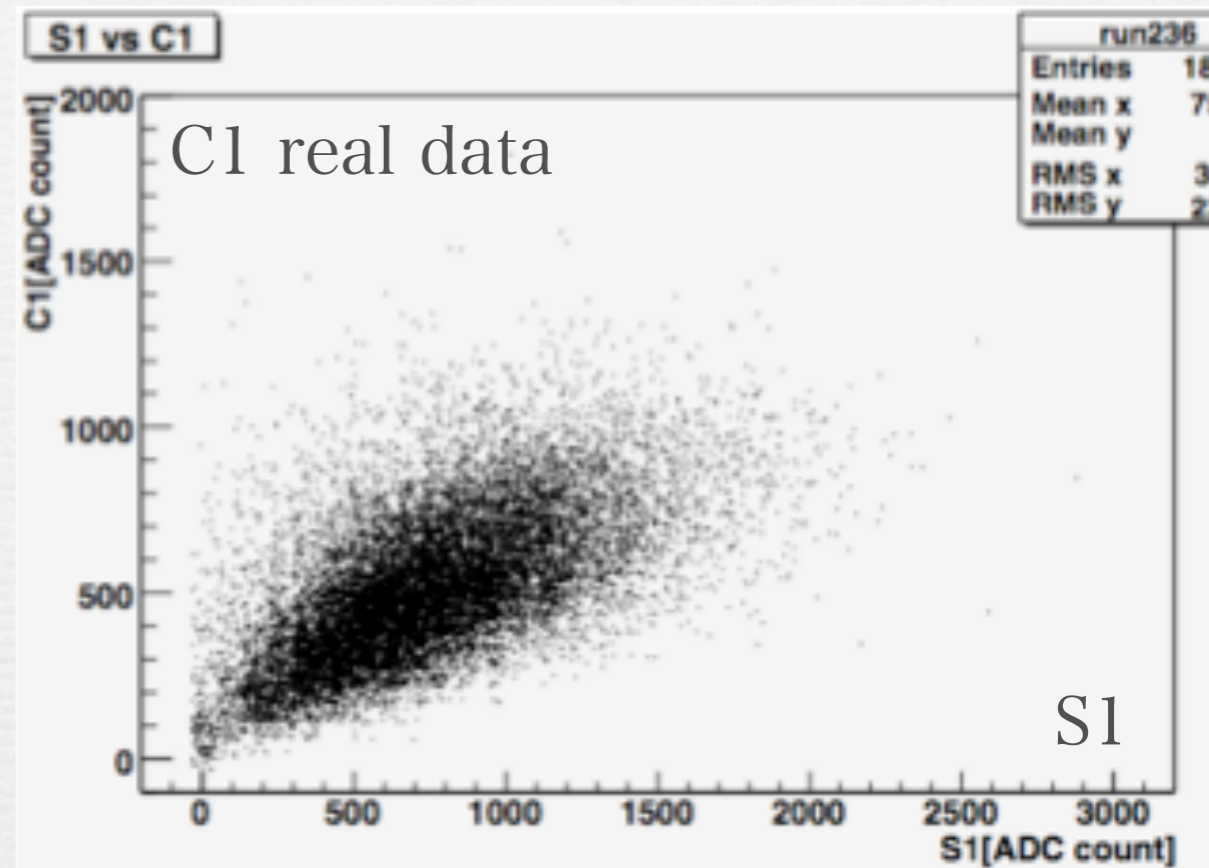
# EM shower det.

- two LGs & scintillators
- 3GeV electrons @FFTB



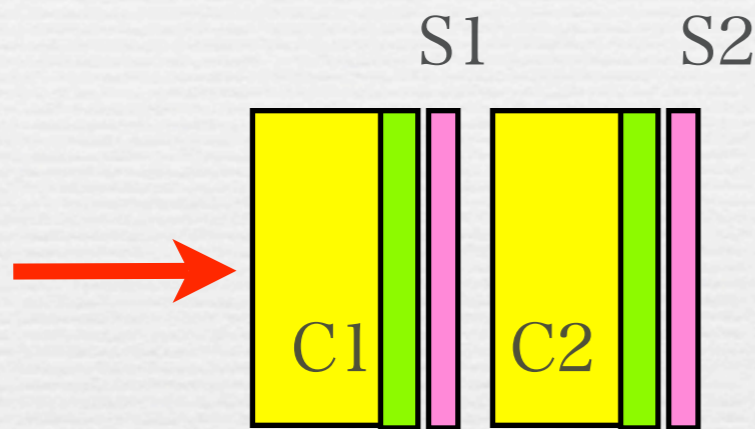
EM shower  
by Cherenkov is OK

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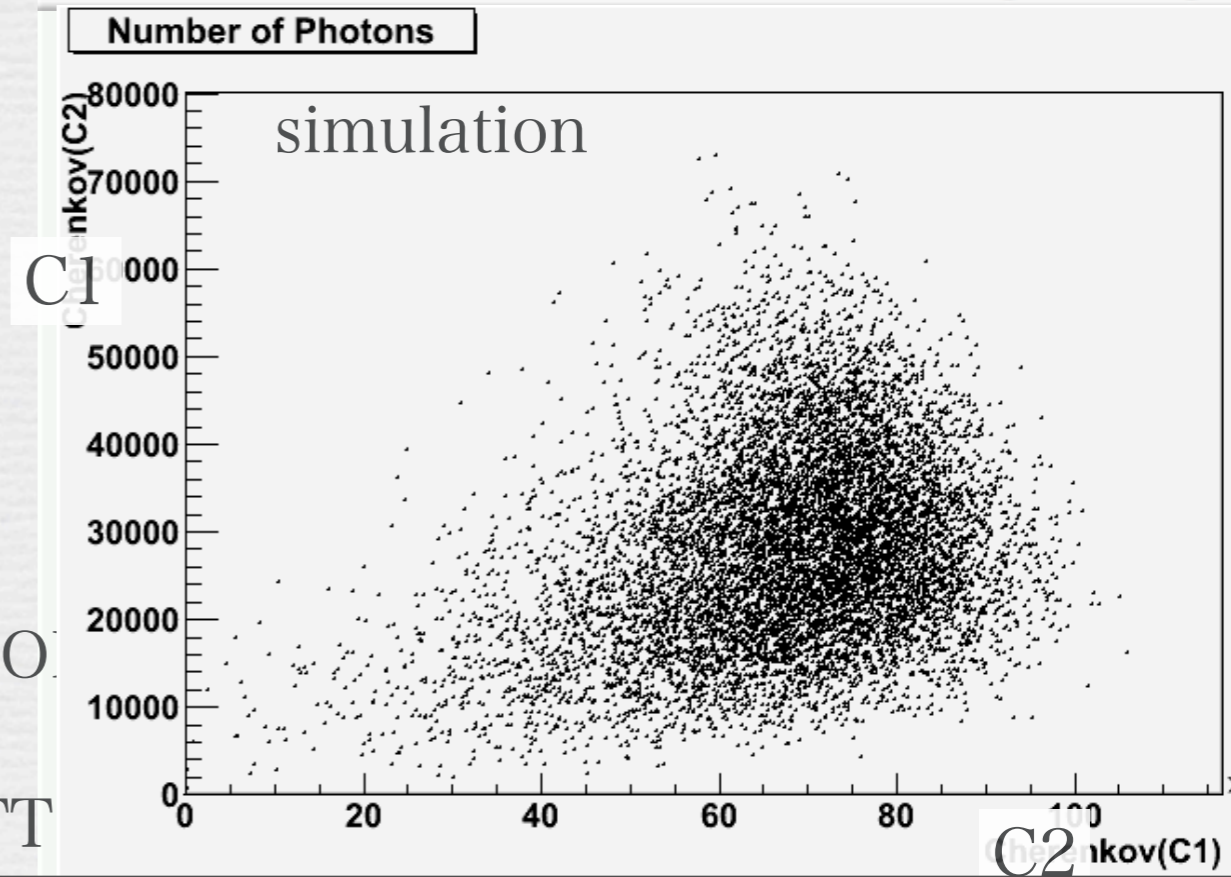
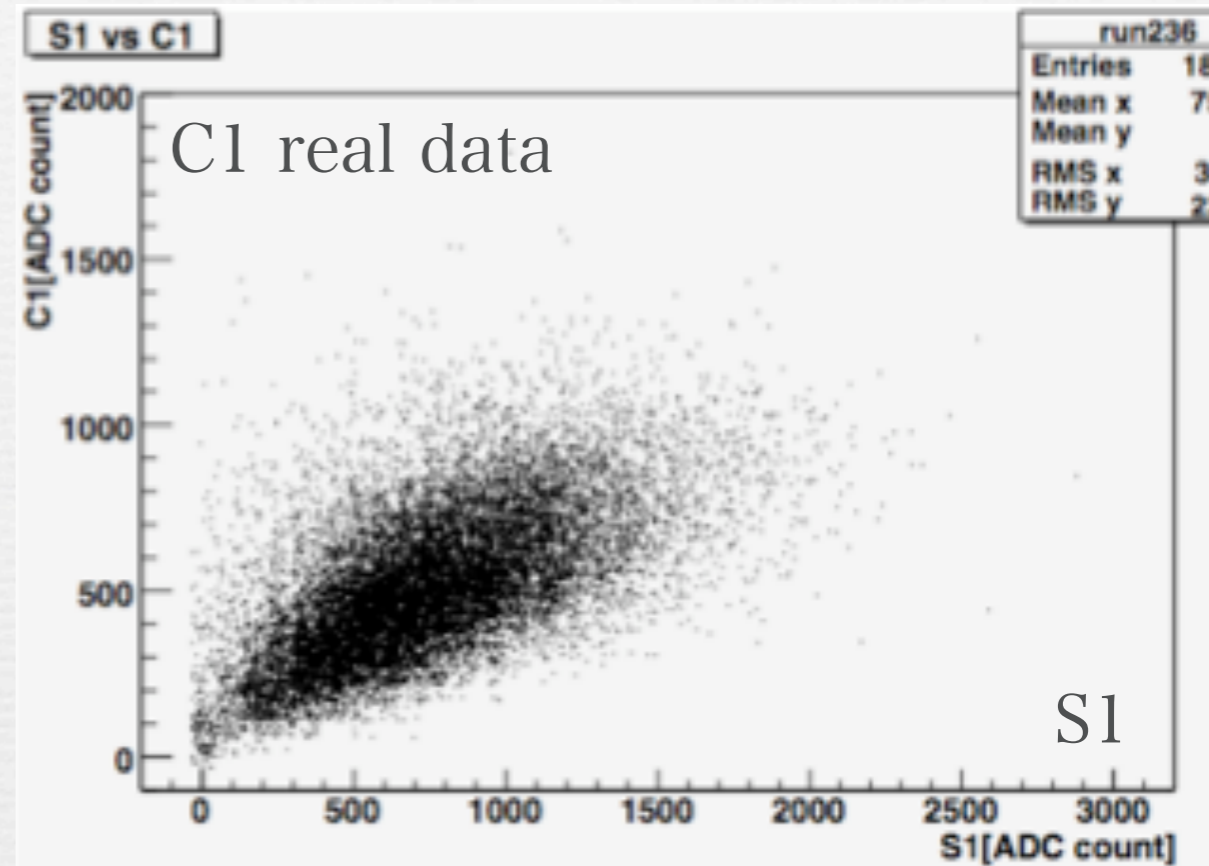
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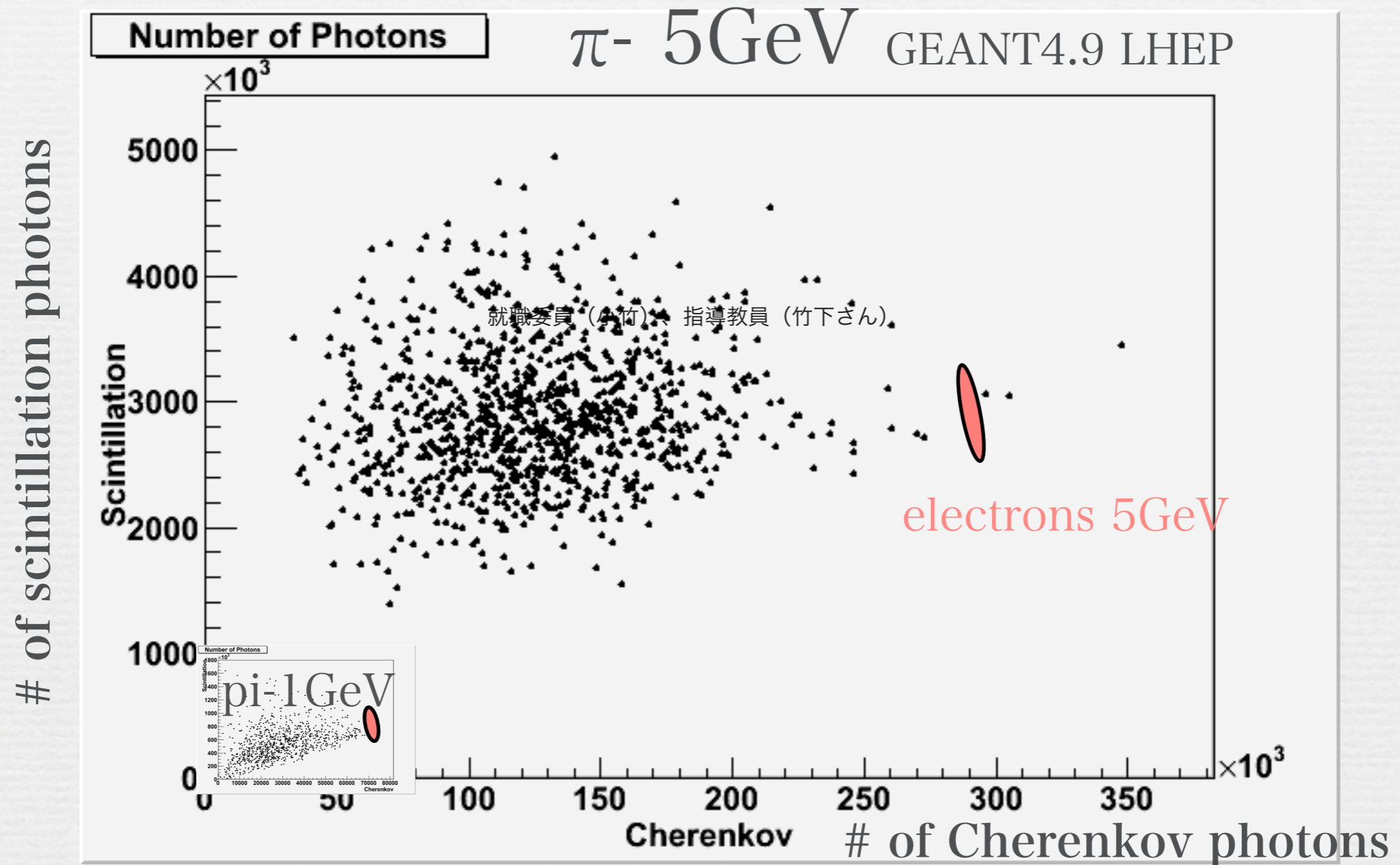
EM shower  
by Cherenkov is O

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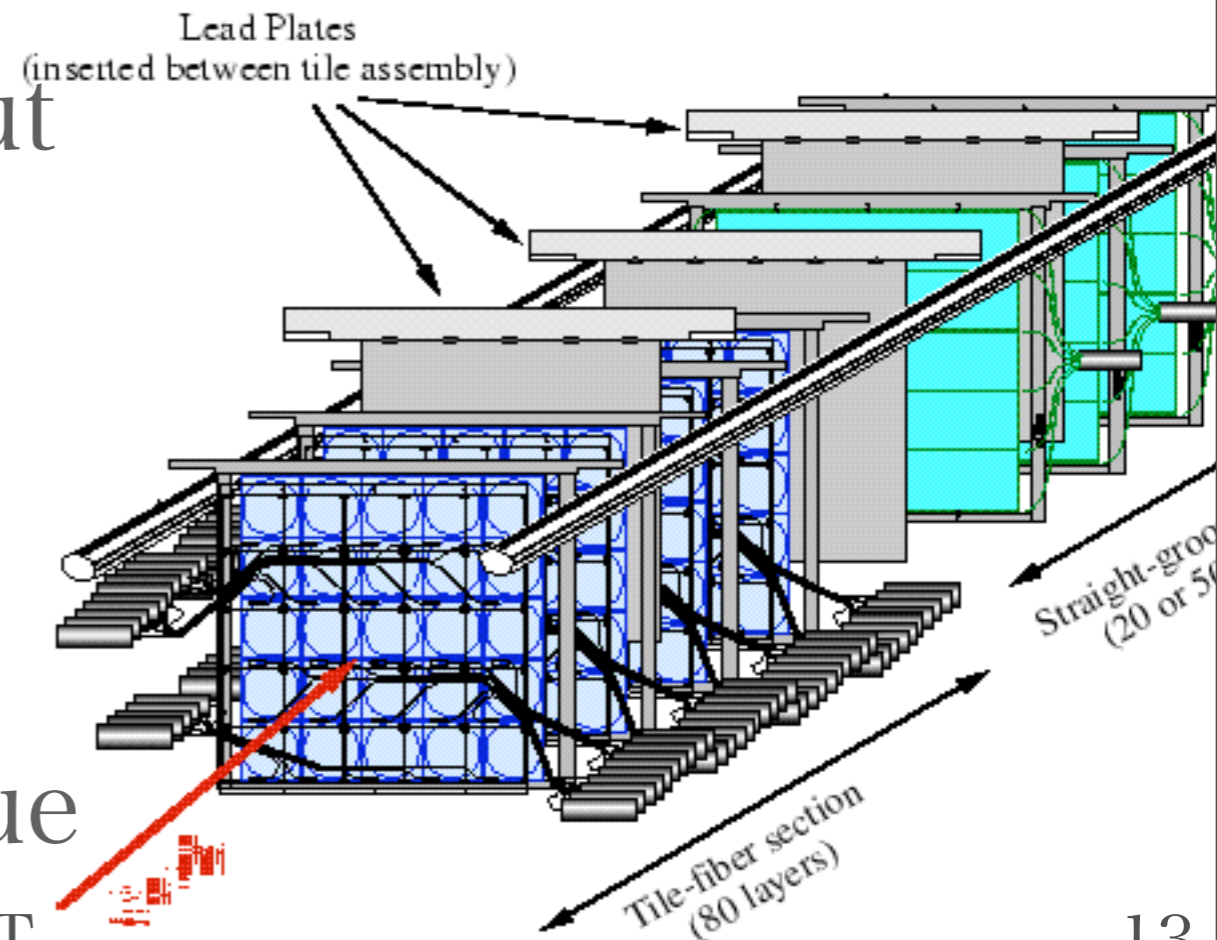
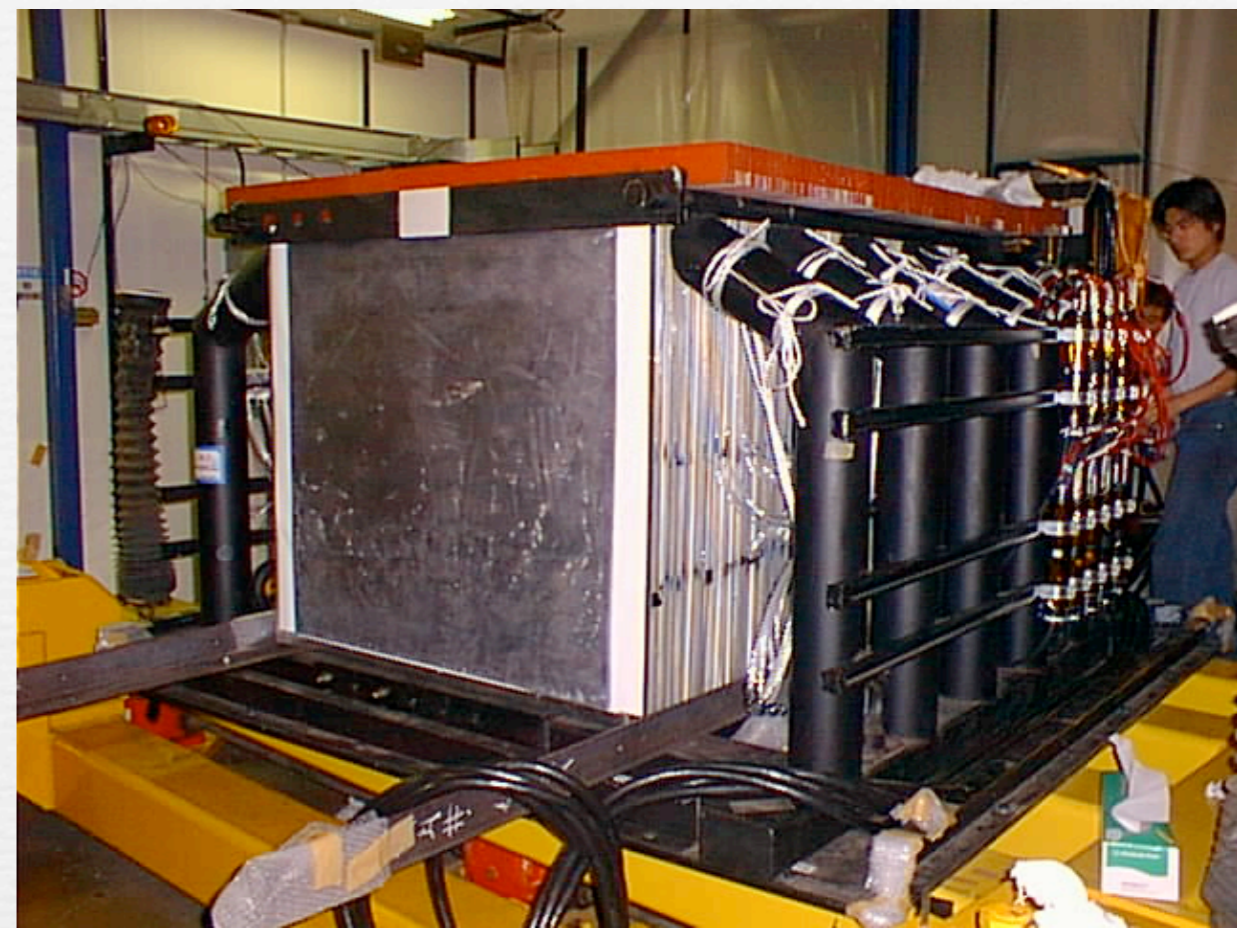
# simulations

- simulation with hadrons & electrons



# future plan

- 1m<sup>3</sup> detector
- with LGs from old experiments
- scintillators : MPPC read out enables us to read **every** layers
- **fine longitudinal segmentation** is the key issue



# summary

- Total Measurement Calorimeter
- with **longitudinal segmentation**
- Absorber info. for Cherenkov EM shower
- scintillator for charged pions and **neutrons**
- challenge : Cherenkov light measurement by a PPD
- identification of neutral pions in HCAL event by event basis

多謝



# pi-zero detection

## Cherenkov vs Scintillation

10mm vs 5 mm

## by tuning thickness of Cerenkov

5GeV pi-zero at 20th layer

