Dual Readout Calorimeter

Total absorption with homogeneous cal.

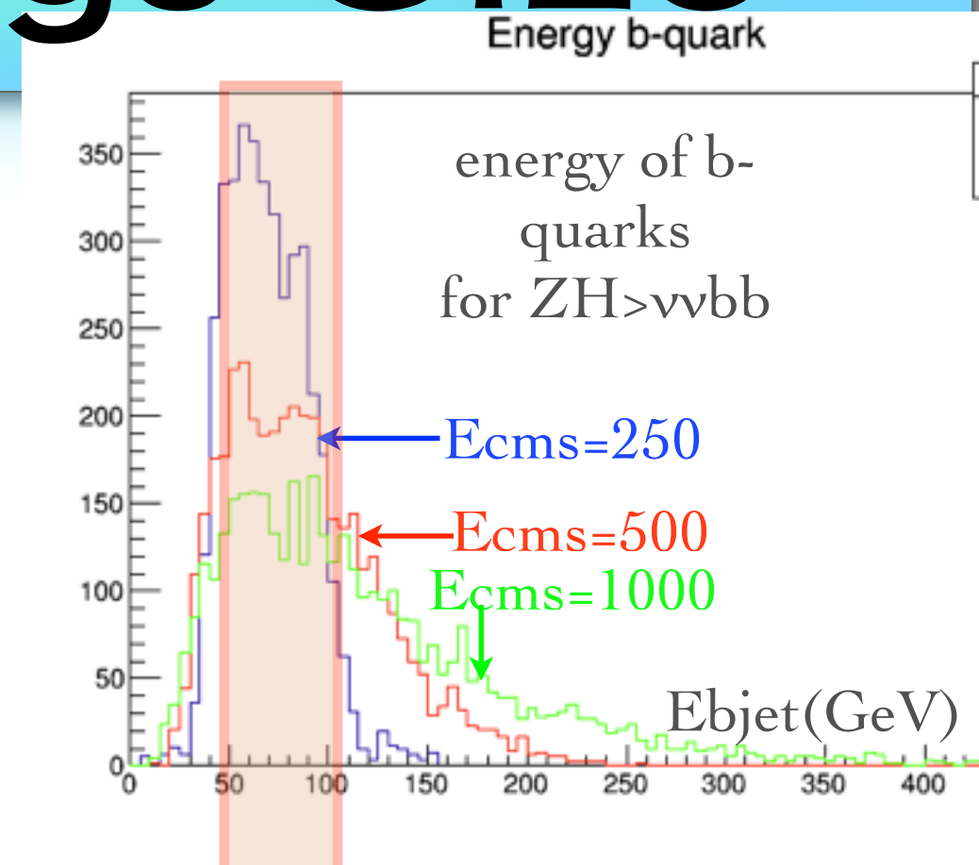
Tohru Takeshita - Shinshu

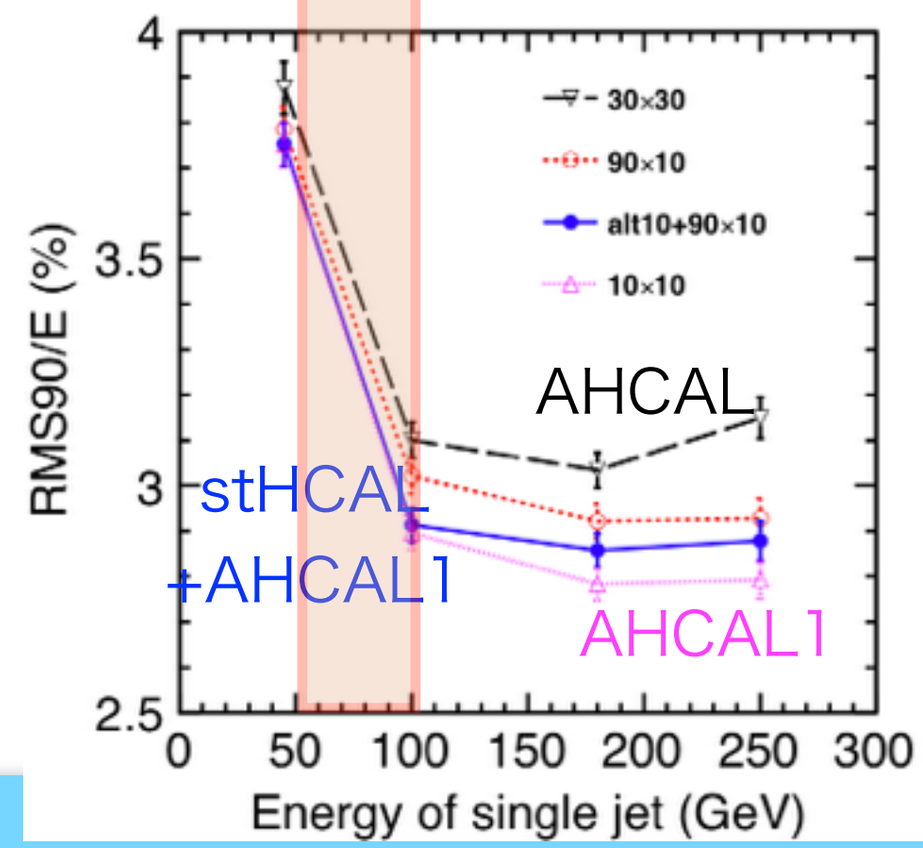
AFAD2018@Daejong

a relation between energy deposit and track length with simulation

bbjes from Higgs @ILC

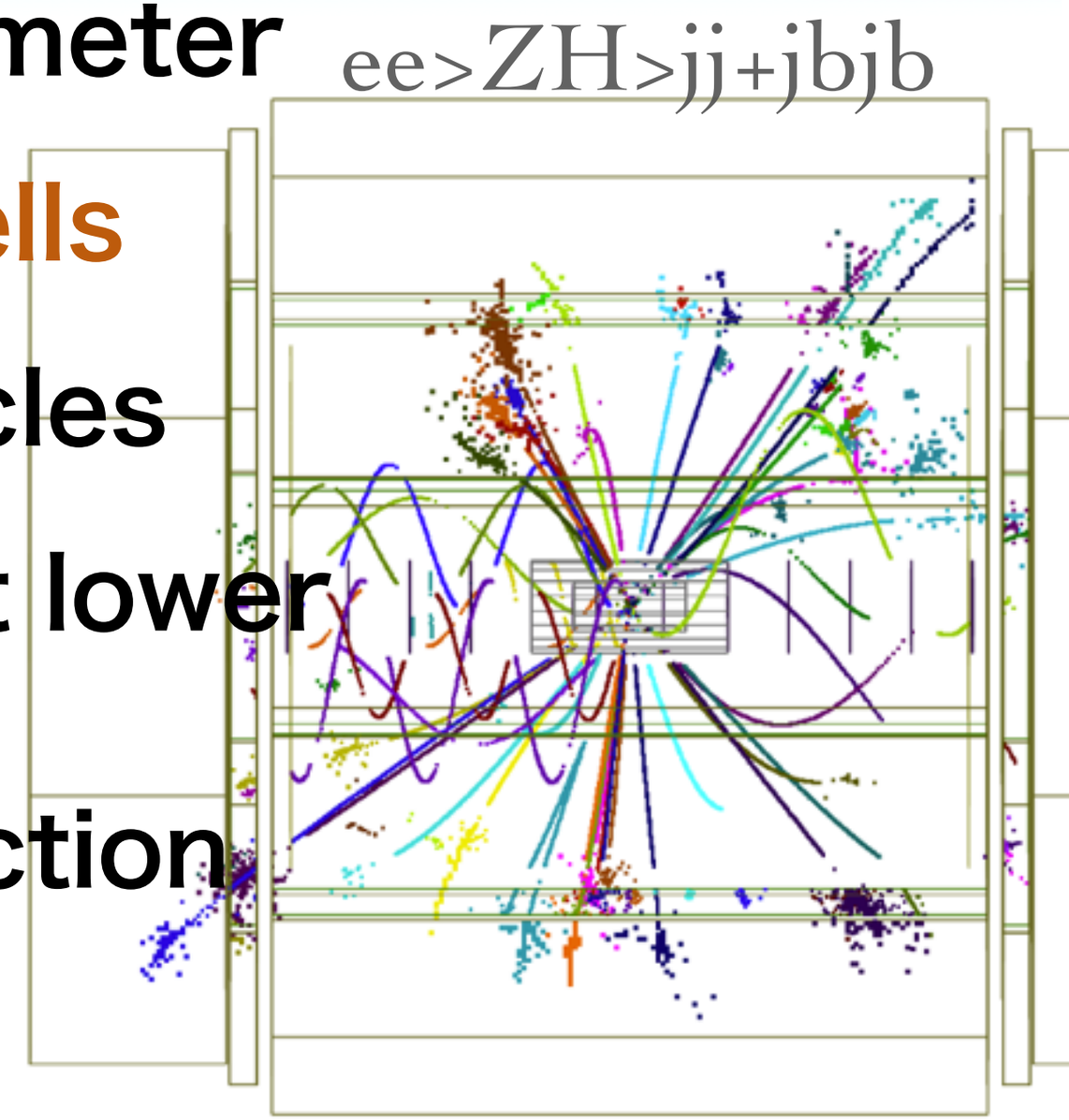
- Ebjet~50-100GeV at ILC
- Energy Resolution of Jets (JER) PFA is poor
- due to HCAL E-resolution
- PFA does work well at higher energies
- improve Ereso. in the energy region





Particle Flow Algorithm

- PFA requires 3D calorimeter
- with fine segmented cells
- to separate each particles
- ER of HCAL is worse at lower energies, because of sampling in depth direction
- to improve this
- measure total hadrons

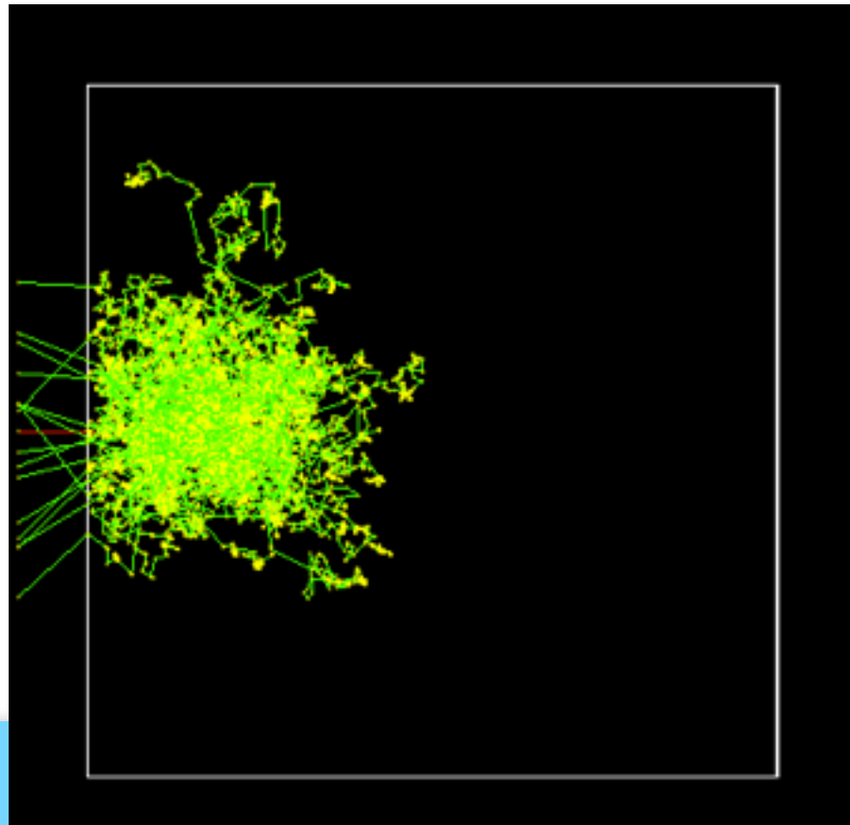


ILD at 250GeV

total measurements

- time cut <100ns
- **GEANT4 simulation 2mx2mx2m**
  - absorber : PbWO4
- **two measures from the calorimeter**
  - Hadron model = FTFP-BERT
- **Labs ：Track length ∝ Cherenkov**
- **Eabs ：dEdx ∝ scintillation**

PbWO4

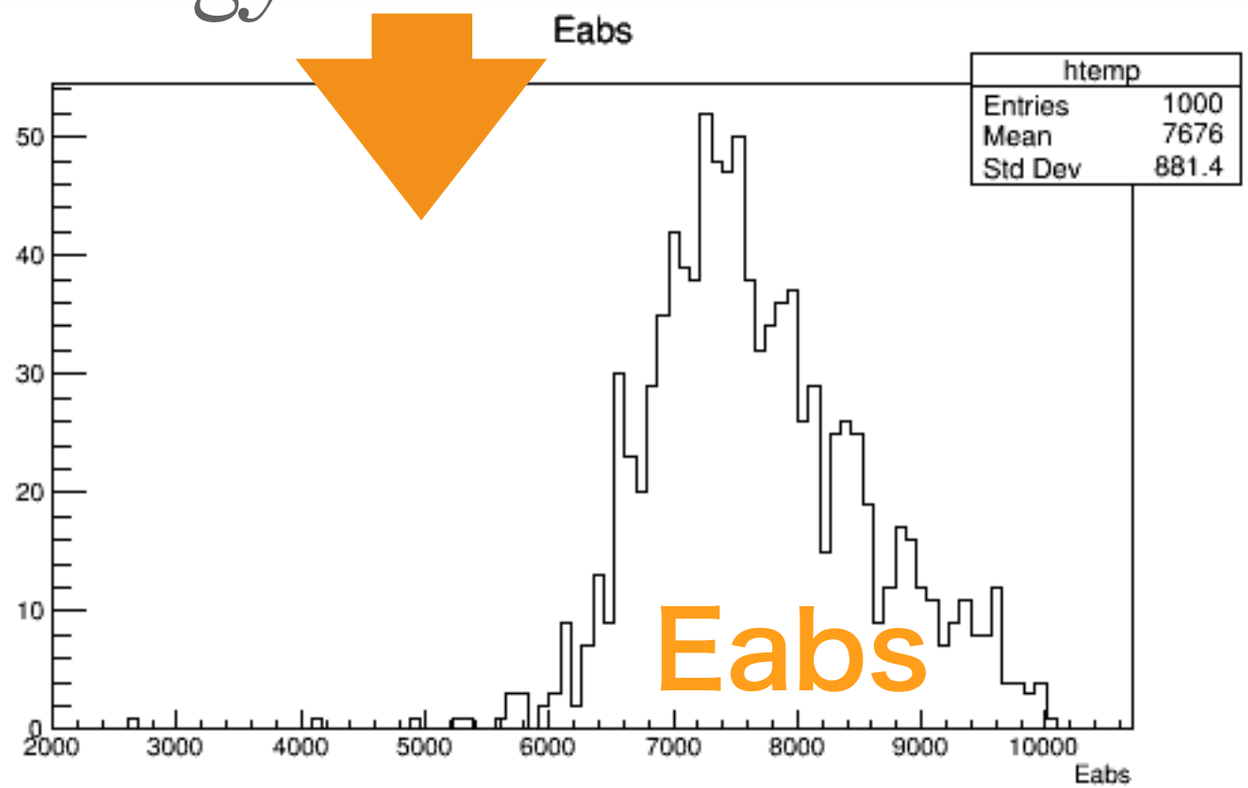


5

green lines
are neutrons

Eabs and Labs for 10GeV pi

energy sum



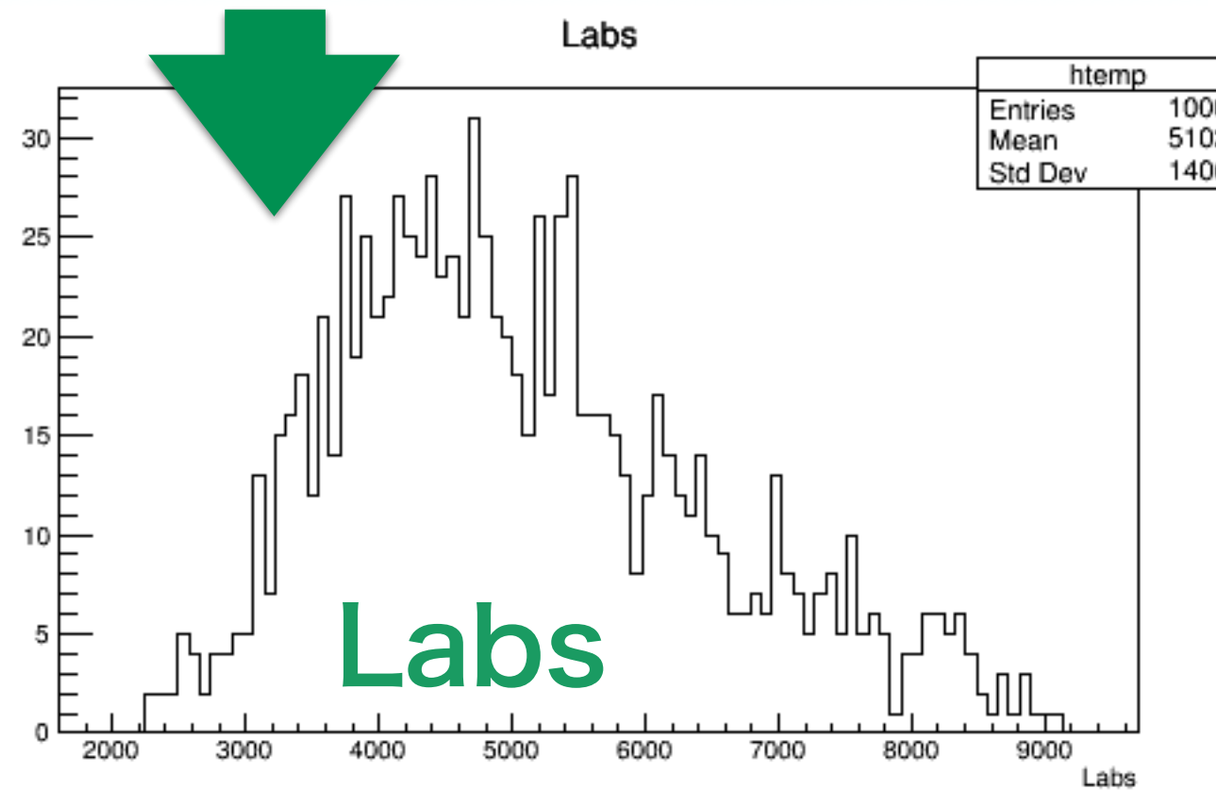
(MeV)

resolution~11%

Ebas=sum of energy deposit

~ sum of scintillation lights in PbWO4

Cherenkov sum



(mm

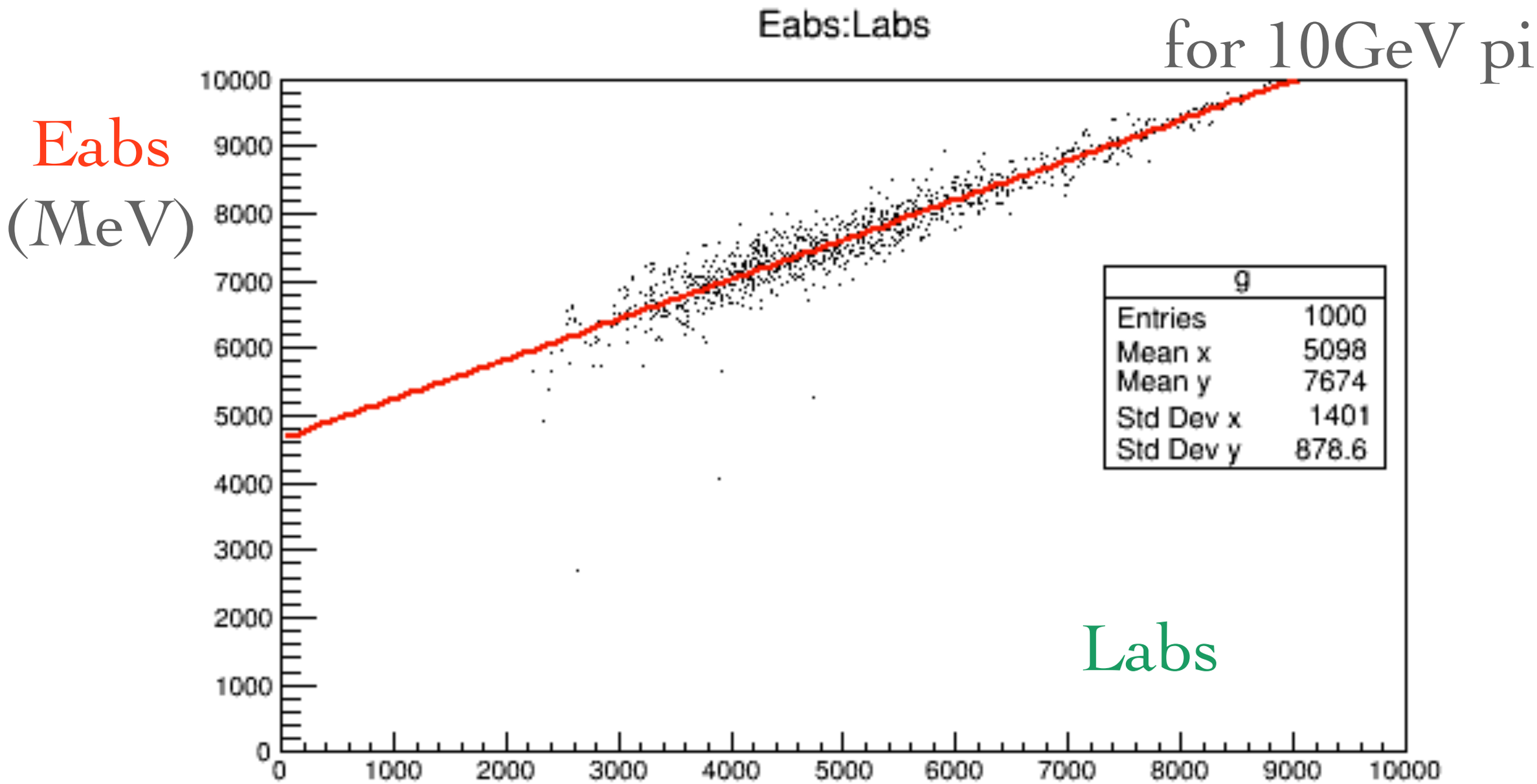
resolution~26%

Lbas= sum of track lengh

~ sum of Cherenkov lights in PbWO4

Eabs vs Labs

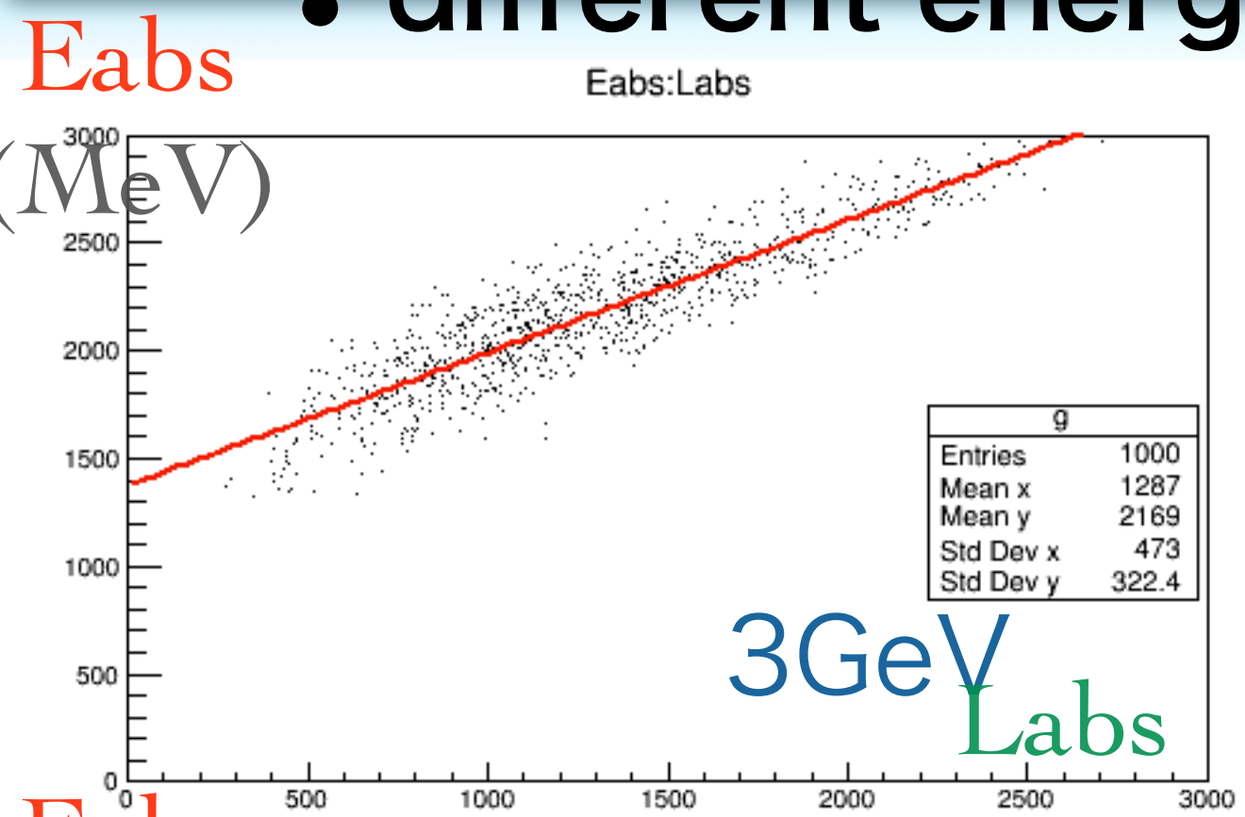
- strong collation between Eabs vs Labs

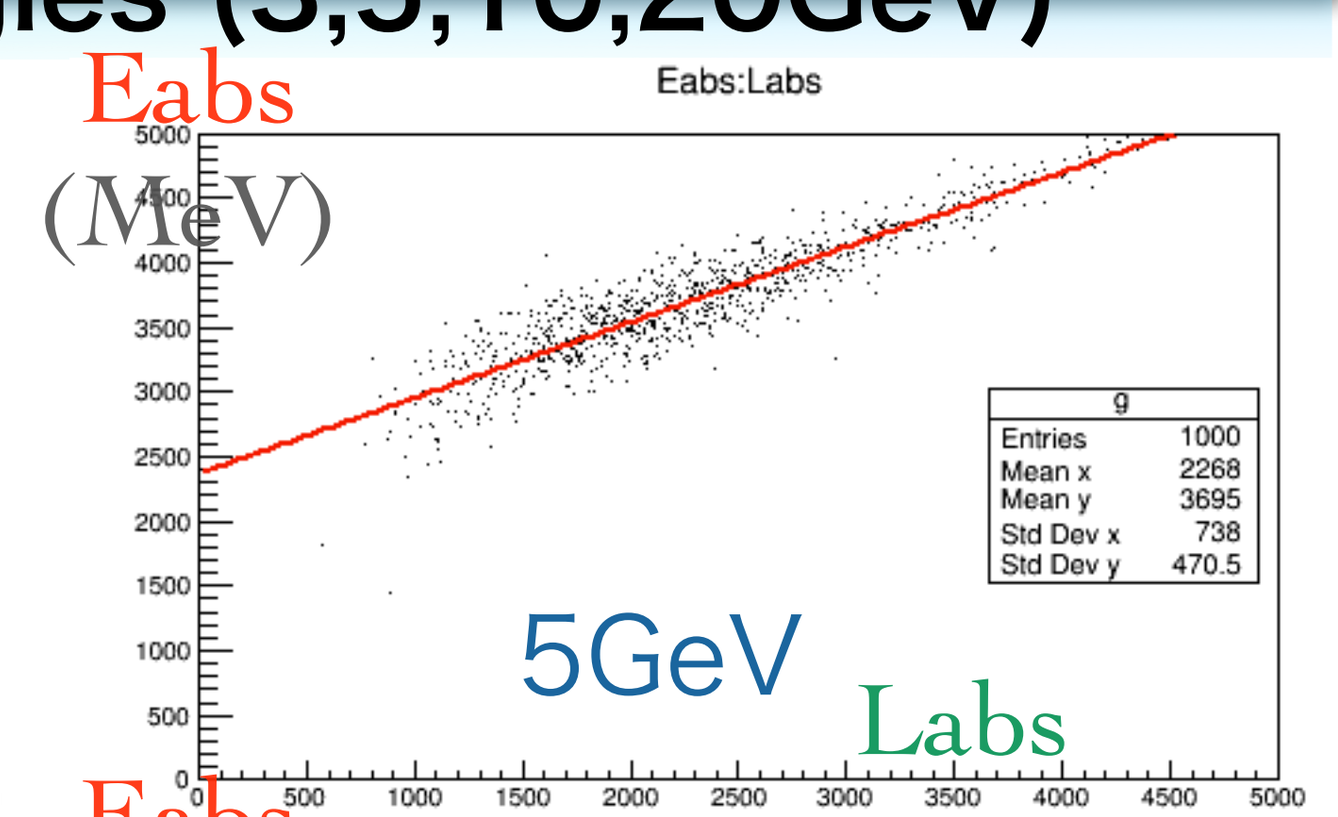


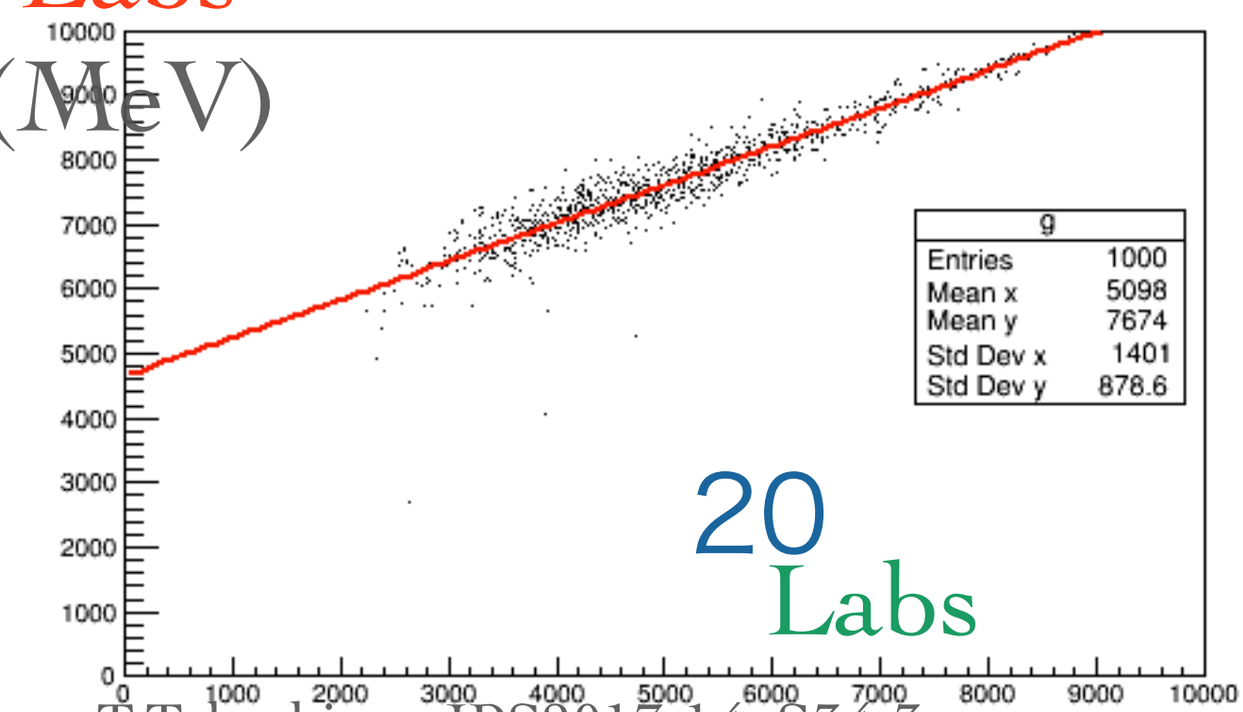
- with constant term in Eabs

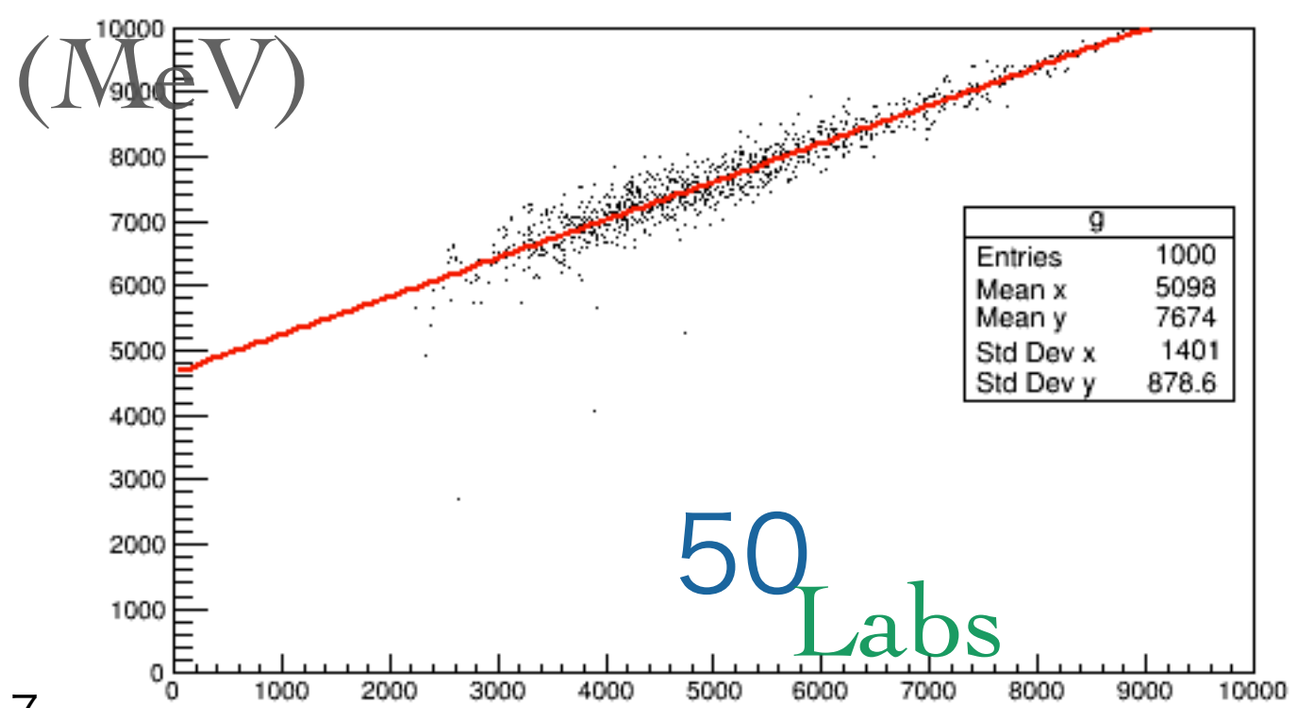
Eabs vs Labs for pi

- different energies (3,5,10,20GeV)





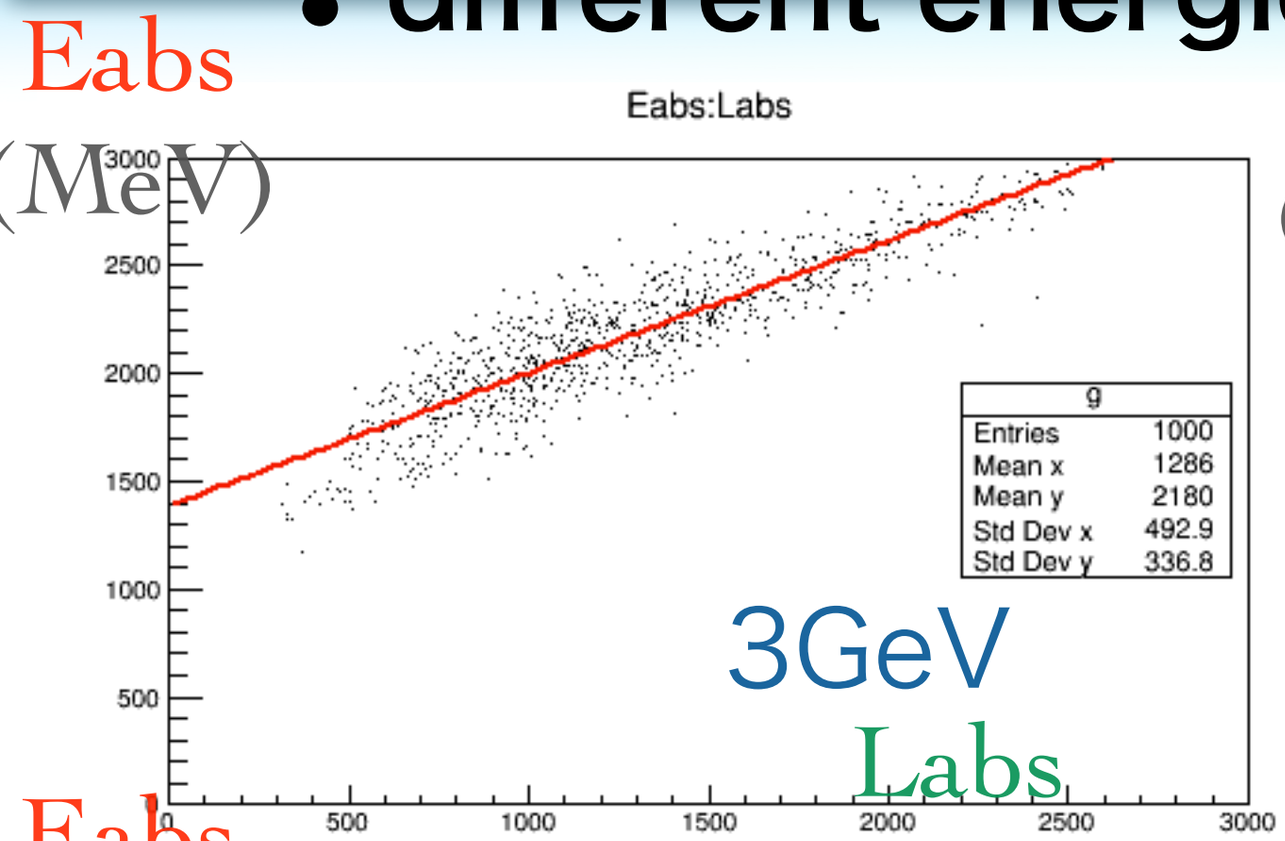


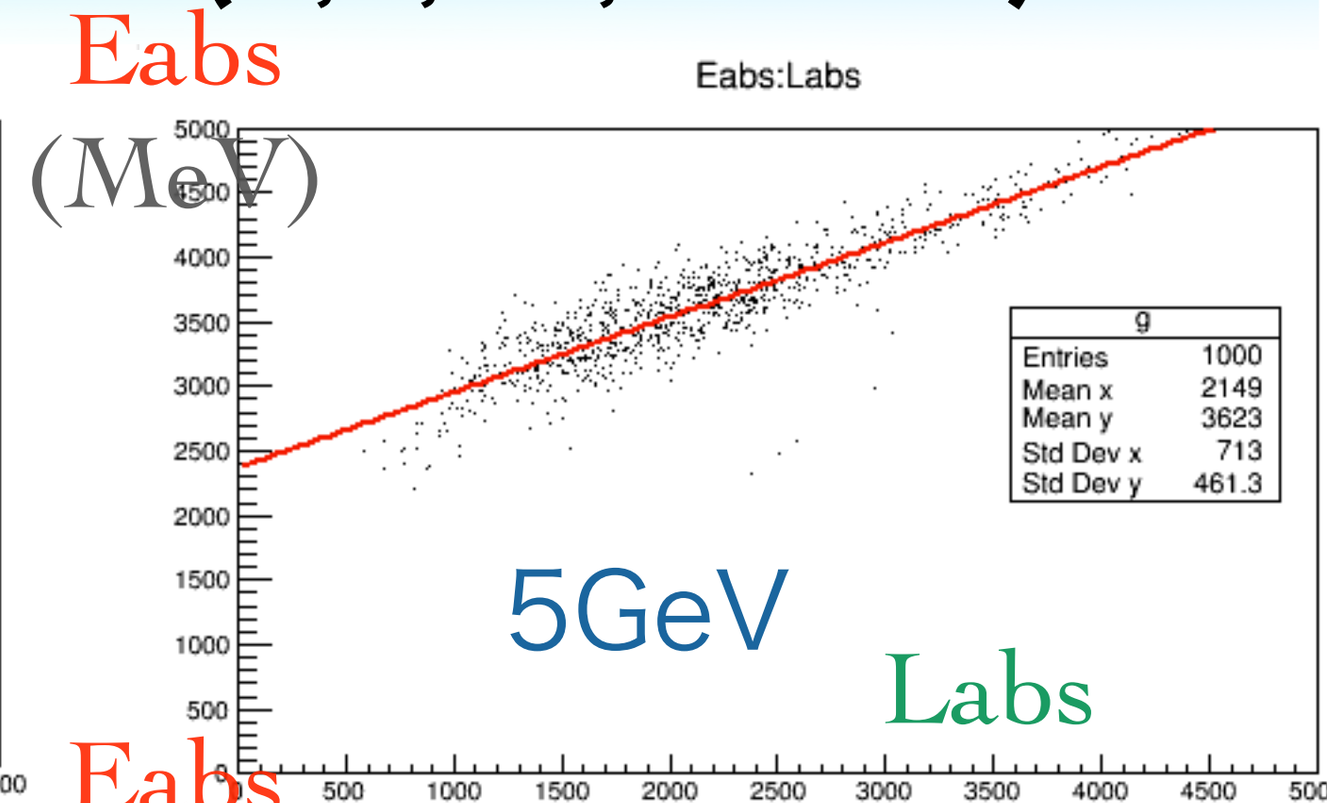


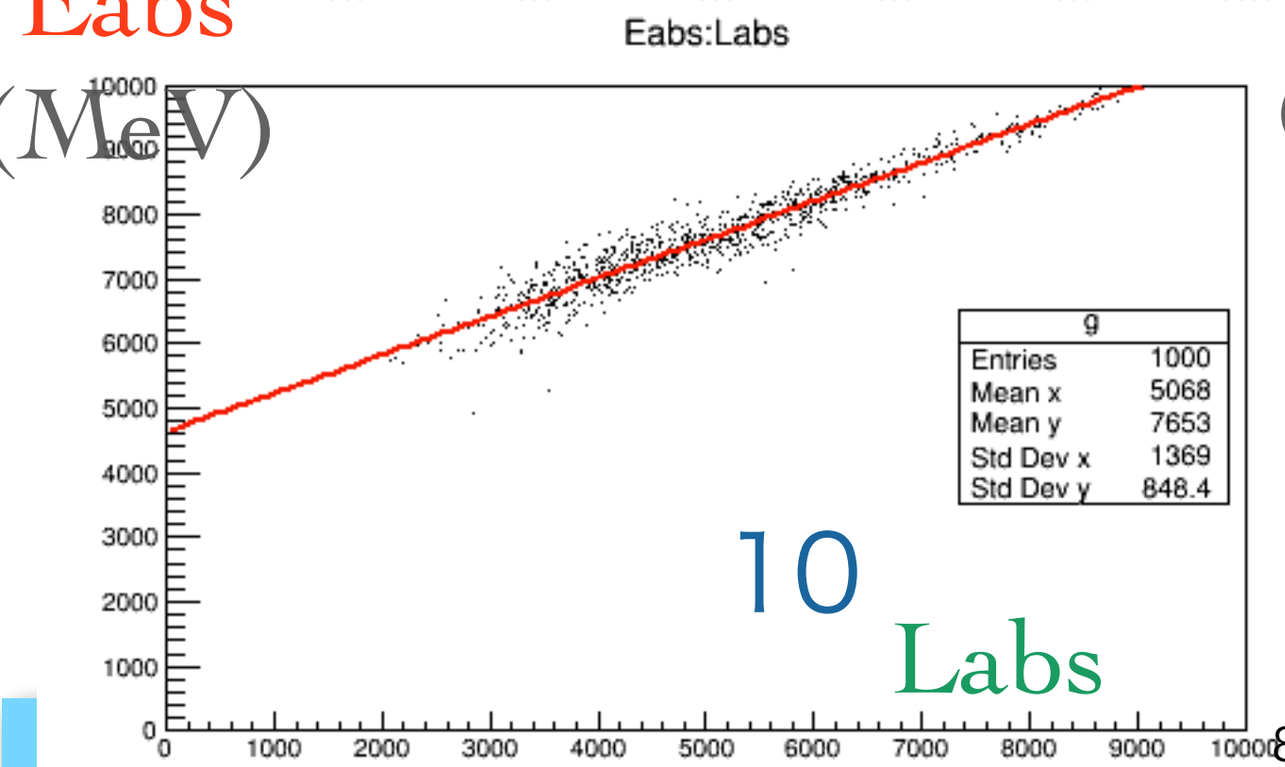
T.Takeshita : JPS2017-14pS34-3

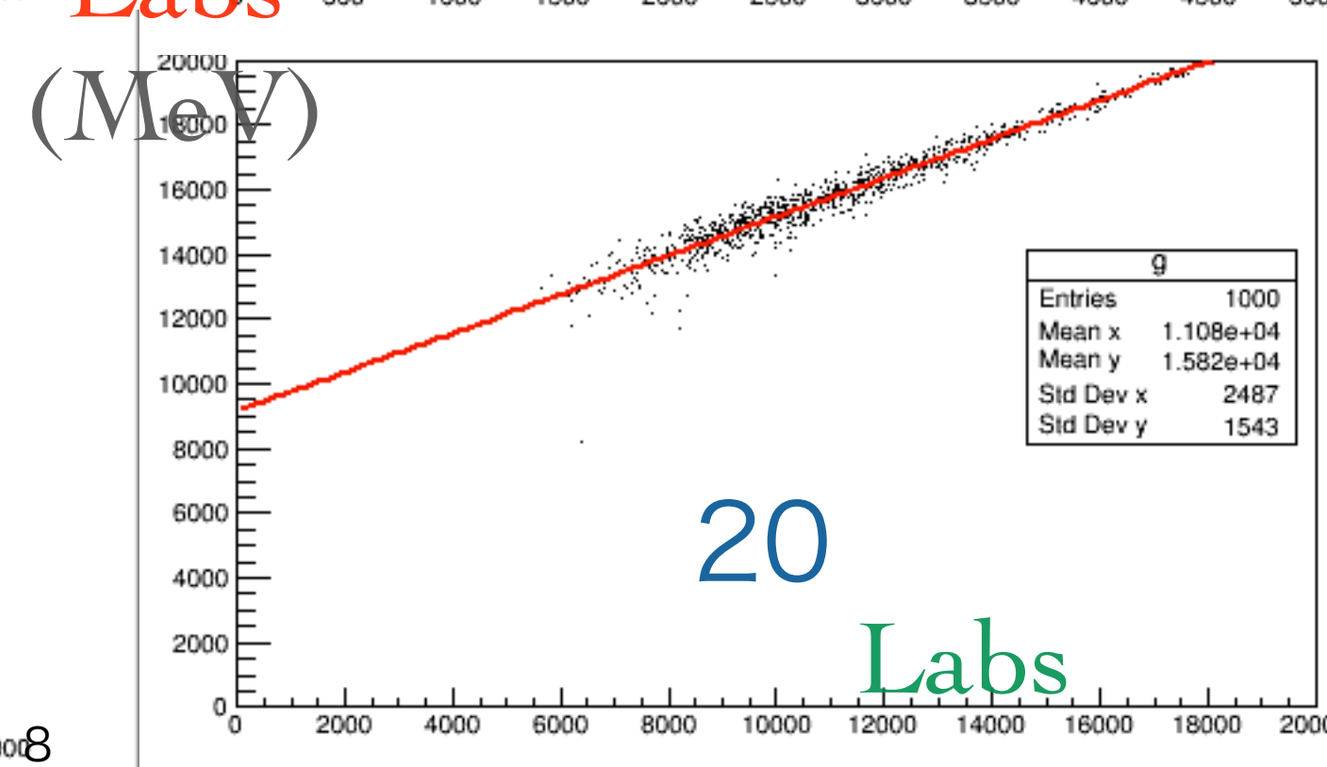
Eabs vs Labs for pi

- different energies (3,5,10,20GeV)







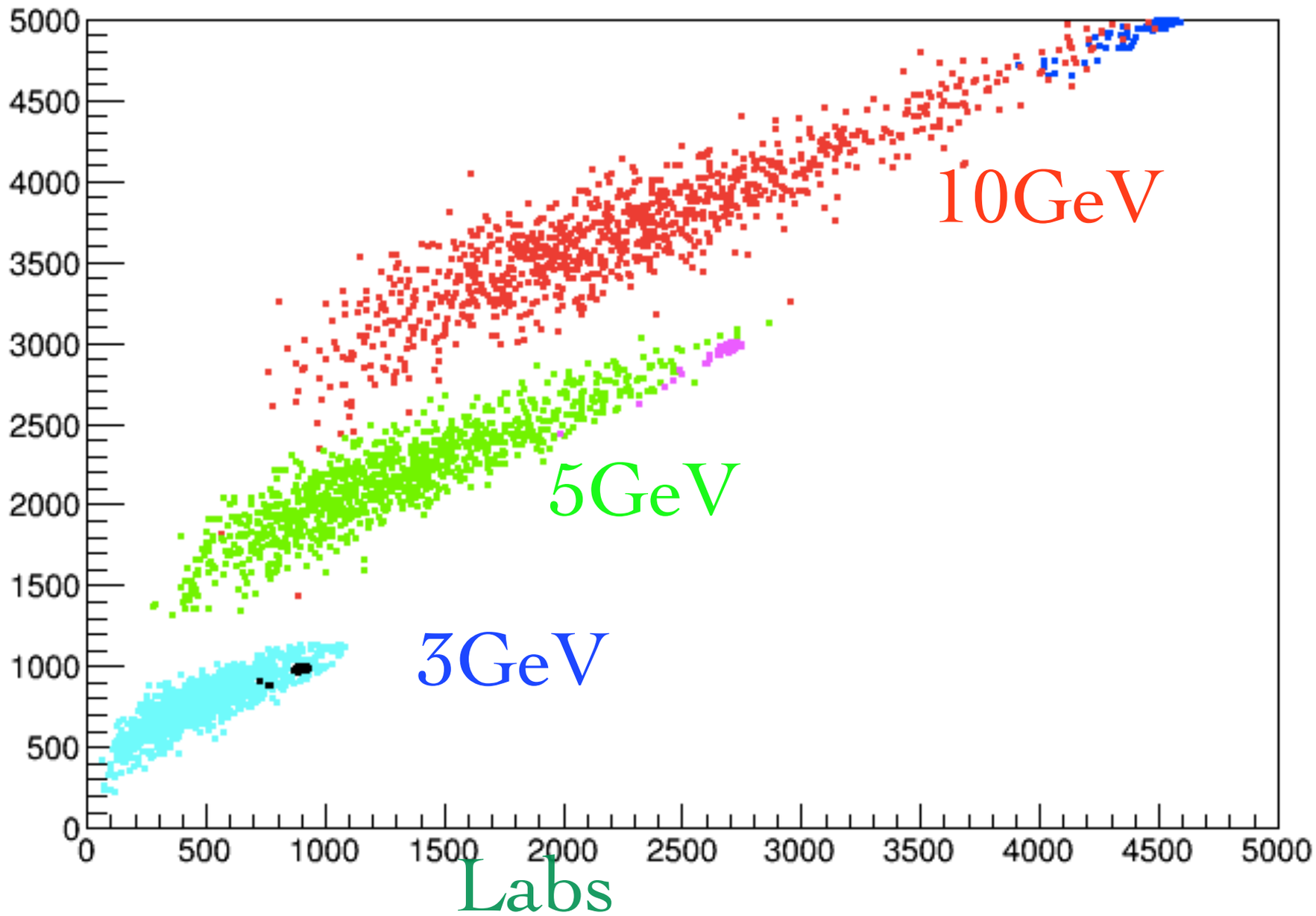


Eabs vs Labs

constant slopfor pi+ and e-

Eabs
MeV

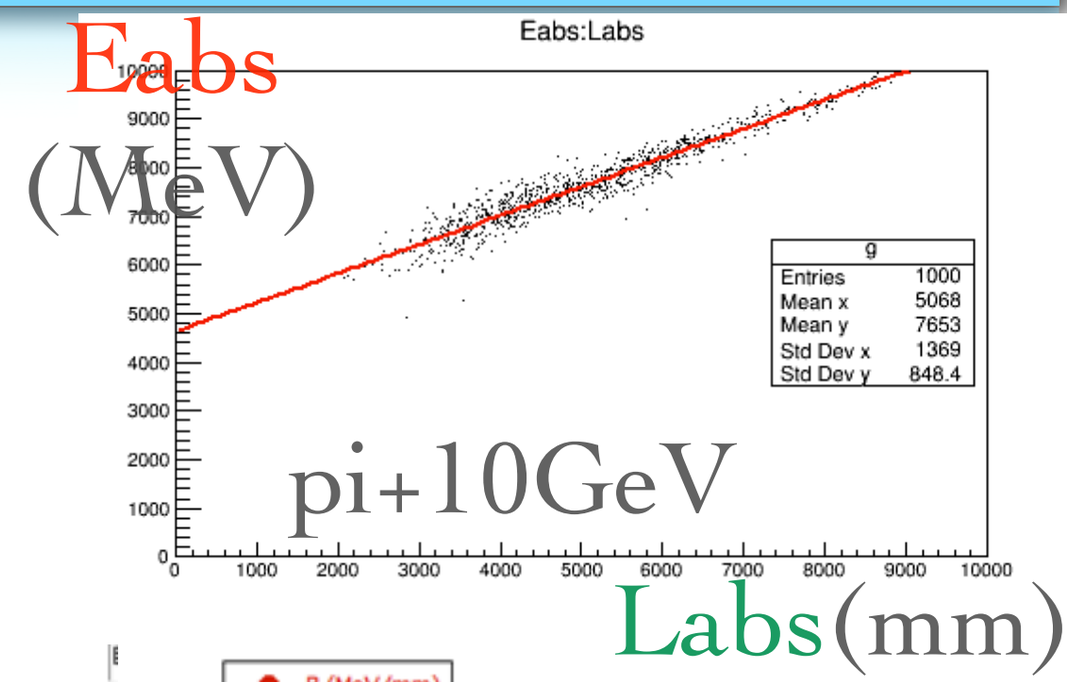
mm



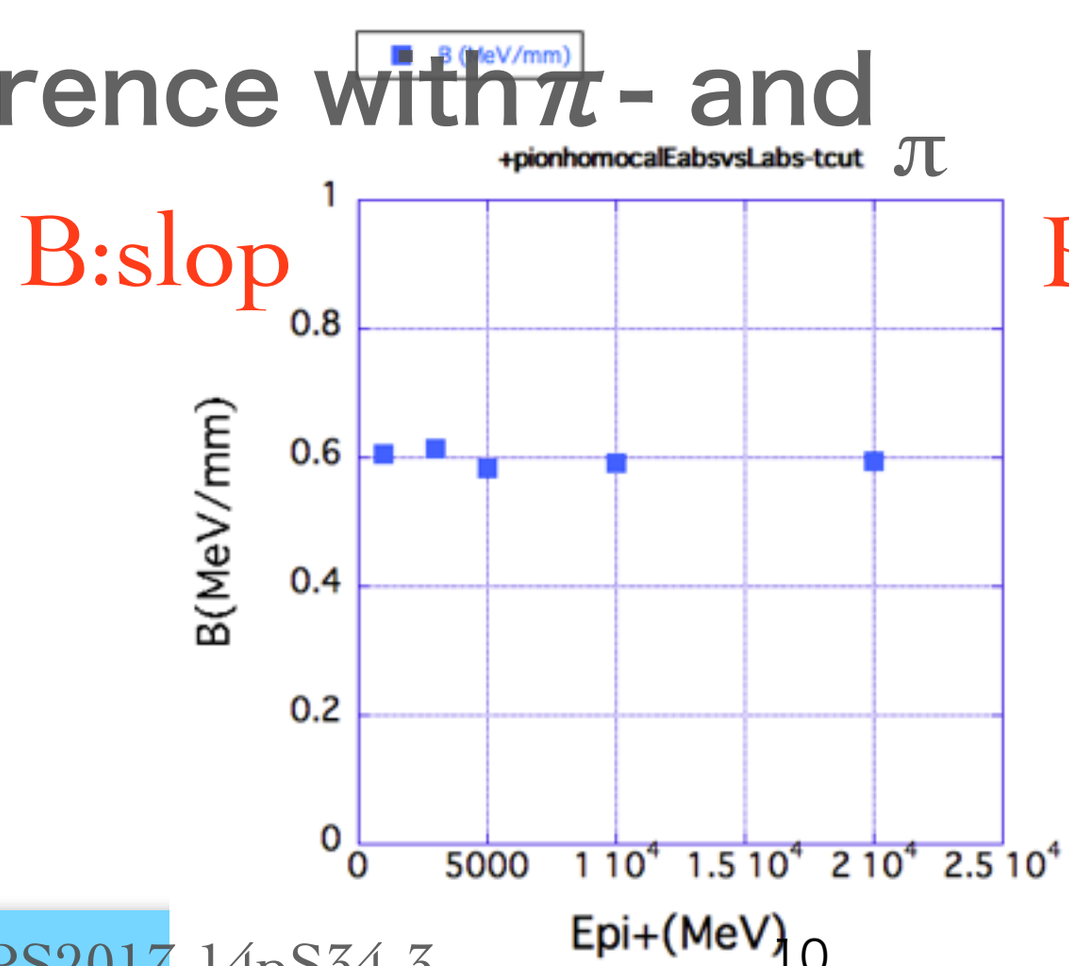
slop of EabsvsLabs

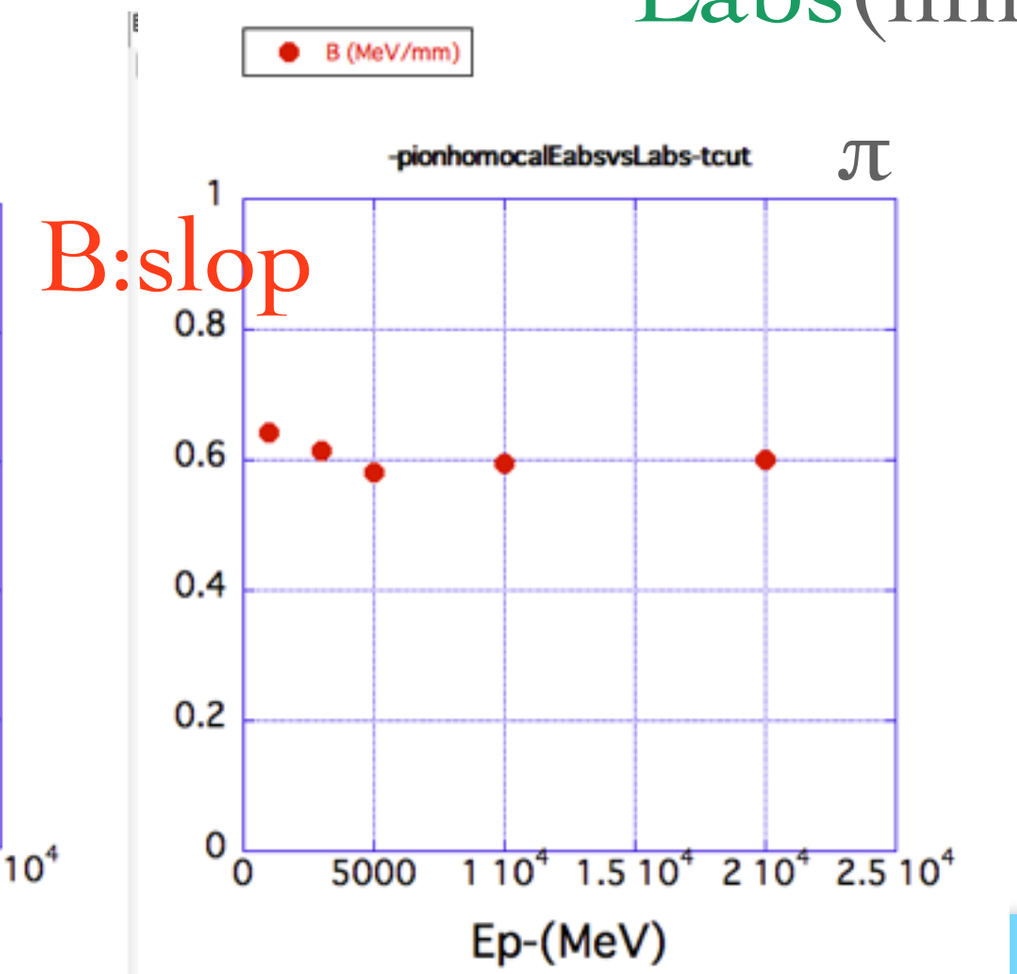
- when fitted with 1st order
  Eabs=
- slop=B is constant for all energies

E>1GeV



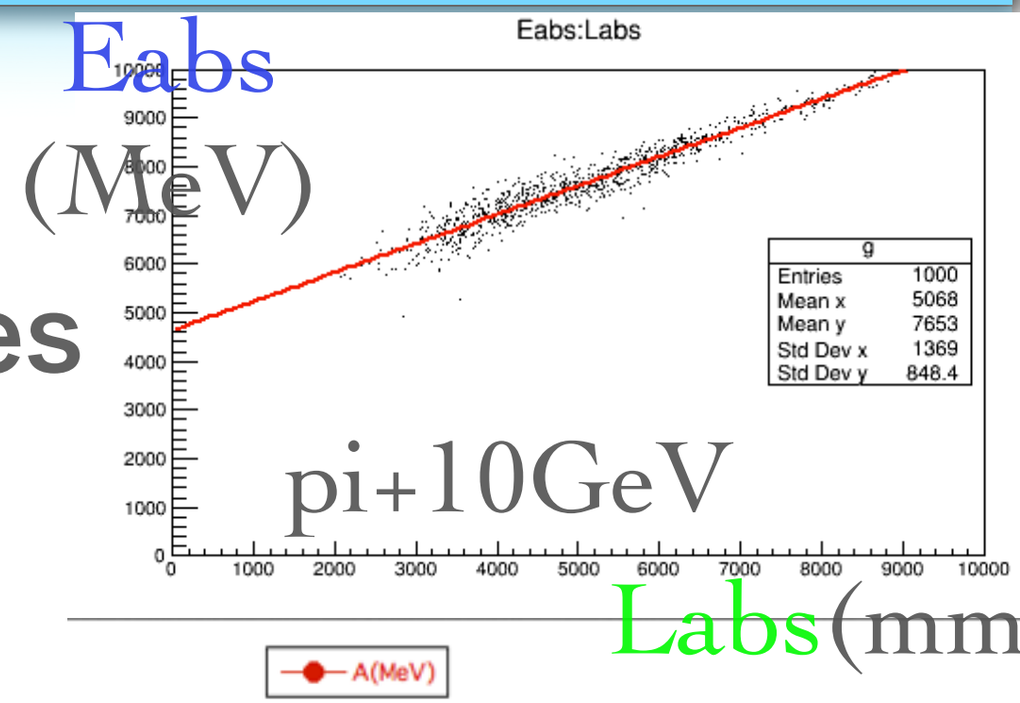
- no difference with π- and π

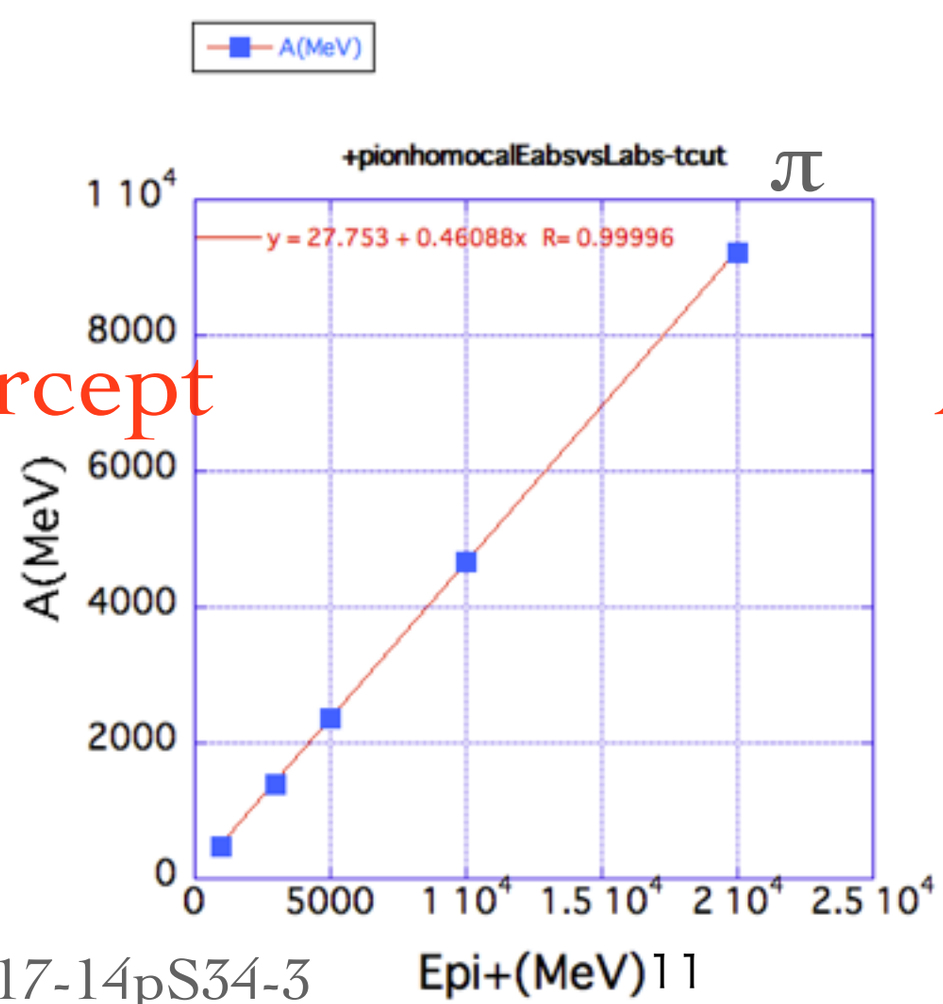


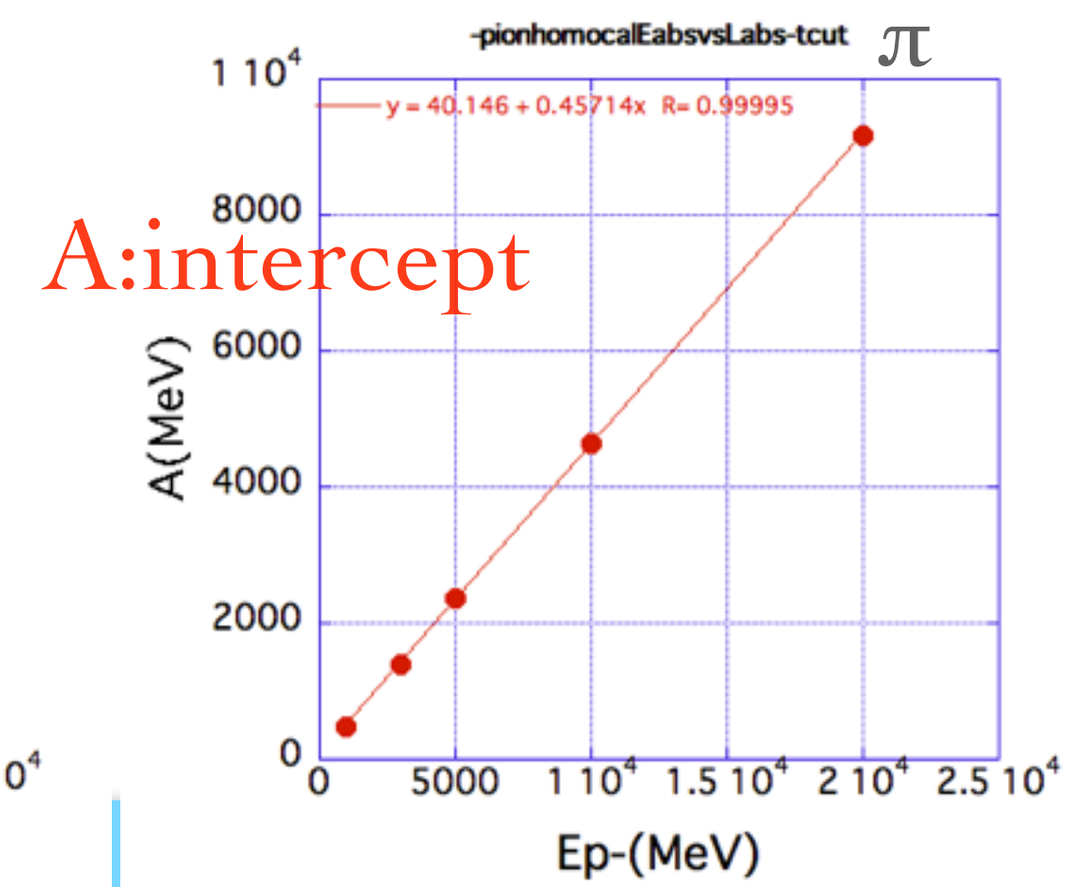


intercept of fitted line

- intercept (cut) A(E) is
  Eabs=A(E)+
- linear with injected energies
- same to π- and π+
- good



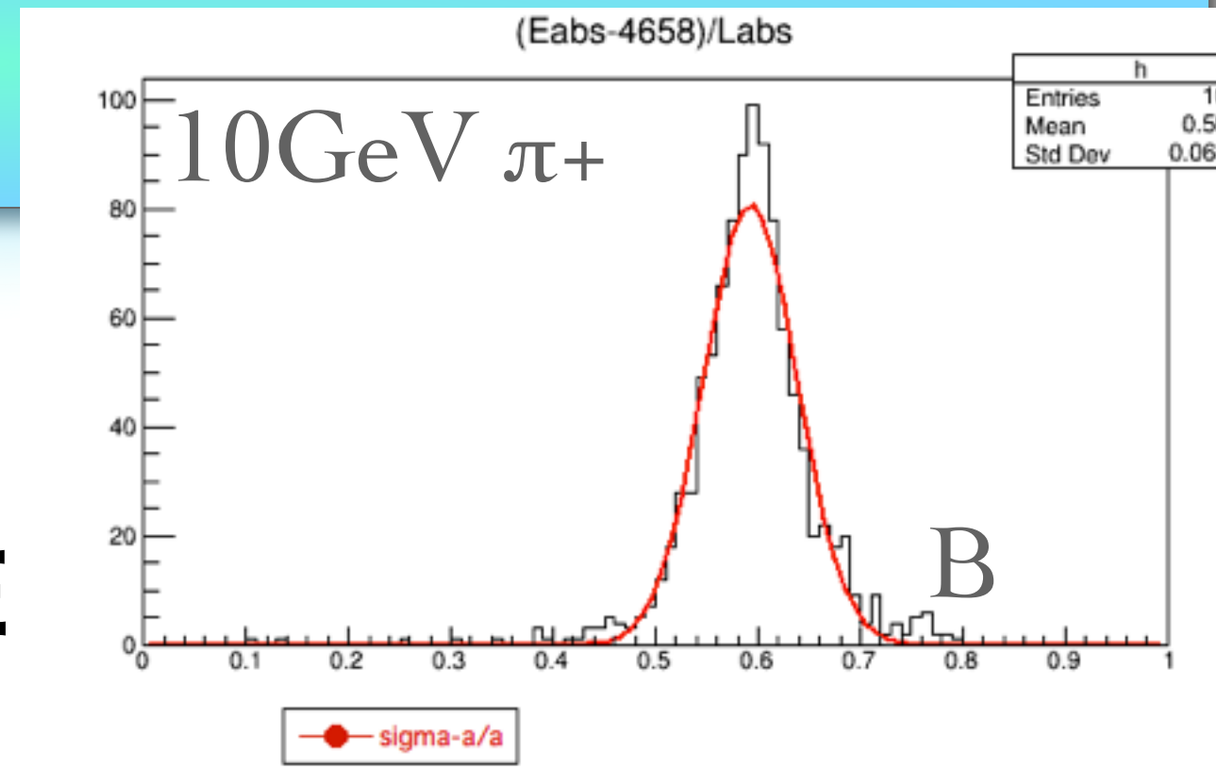


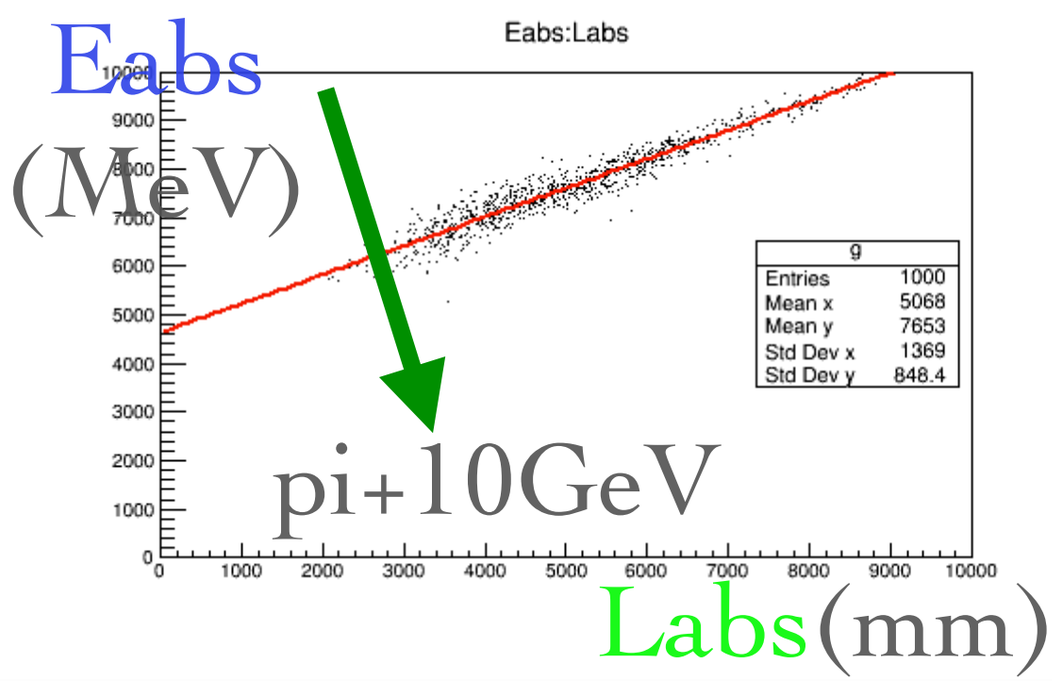


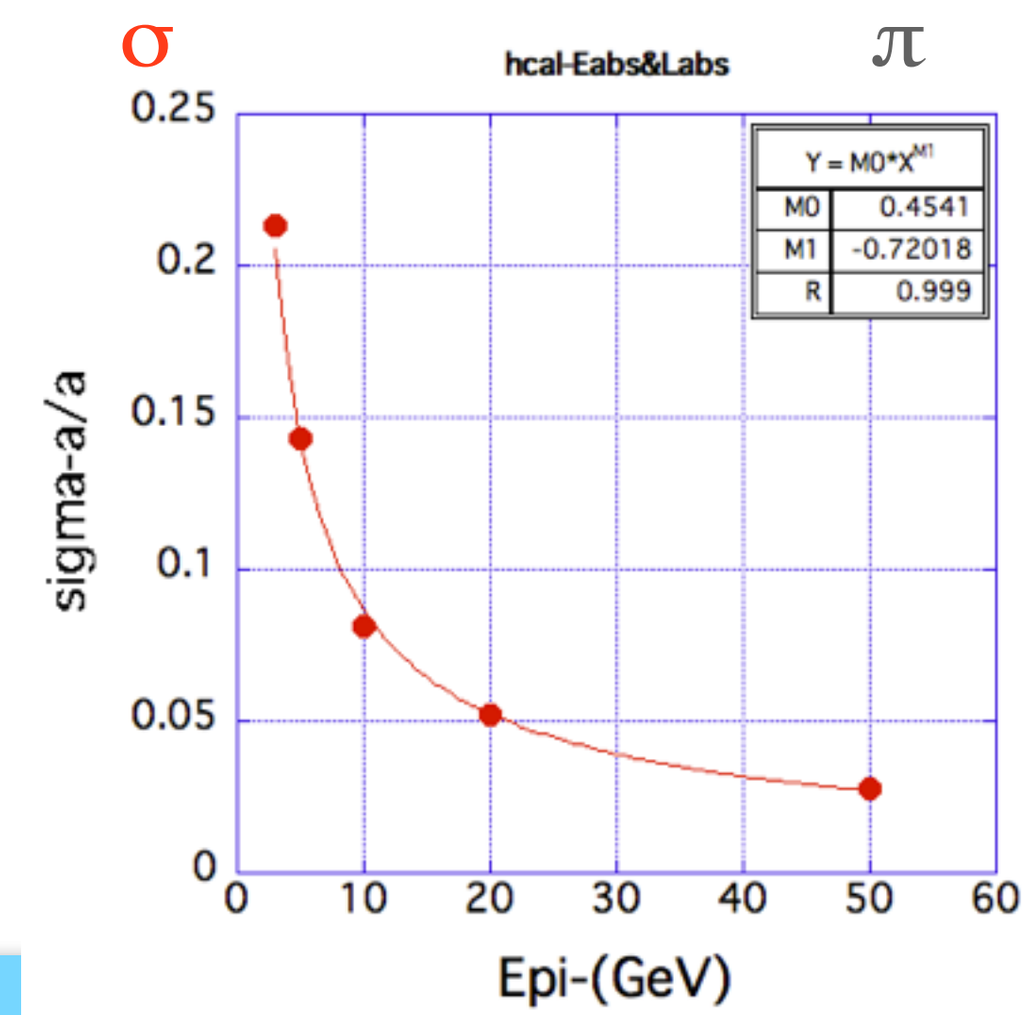
Resolution

Eabs=A(E)+B*

- B=(Eabs-A(E))/Labs
- B is independent of E
- resolution of the calorimeter ~ σ_B/B





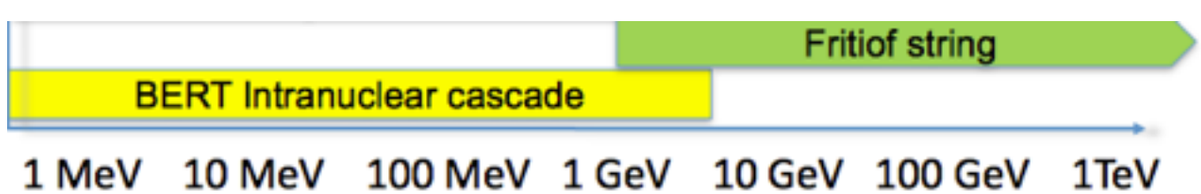


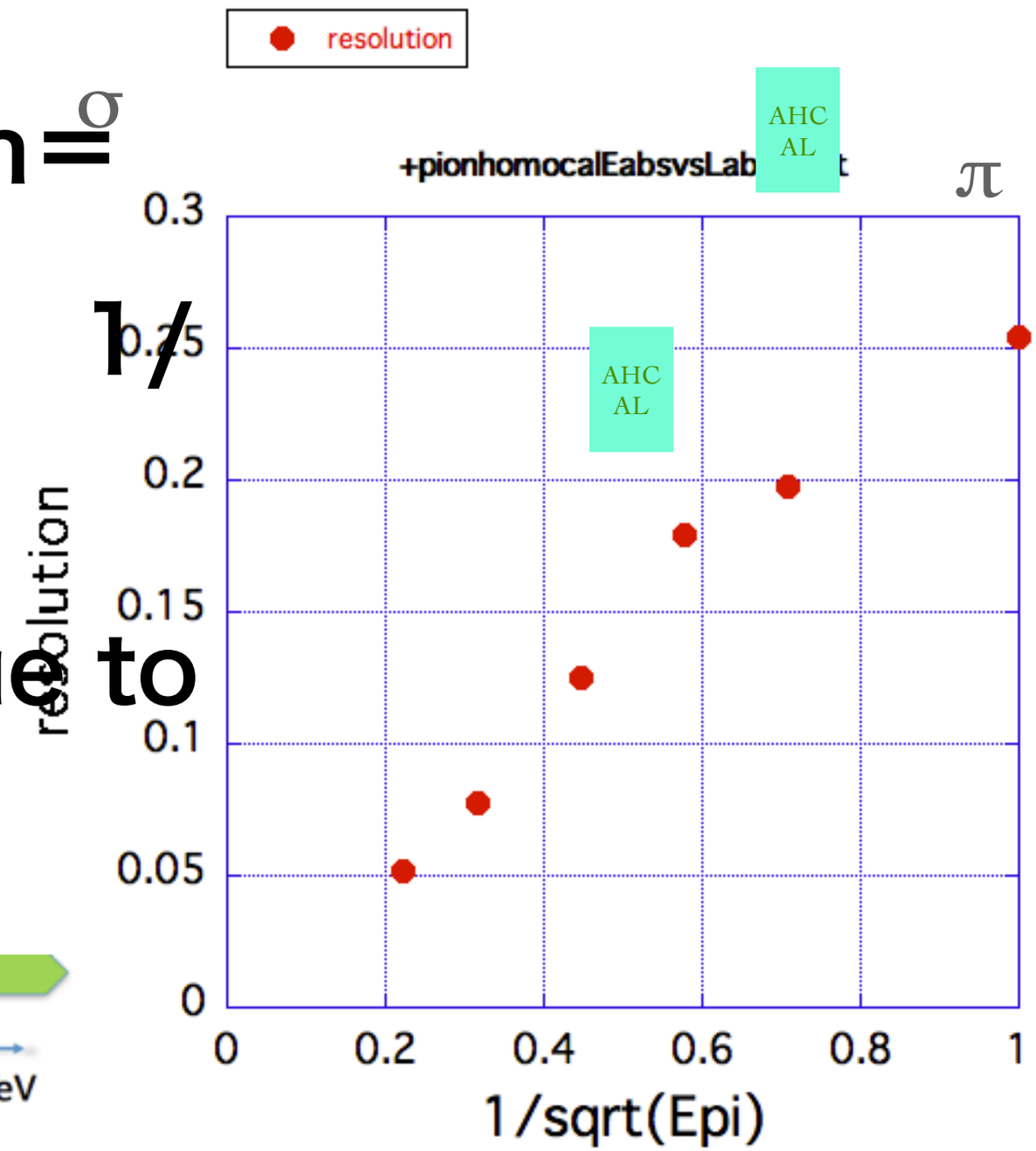
Energy resolution

AHC AL

Eabs=A(E)+B*

- energy resolution = σ
- "σ_B/B" scales in 1/ sqrt(E(GeV))
- kink at ~5GeV due to π
- Hadron model



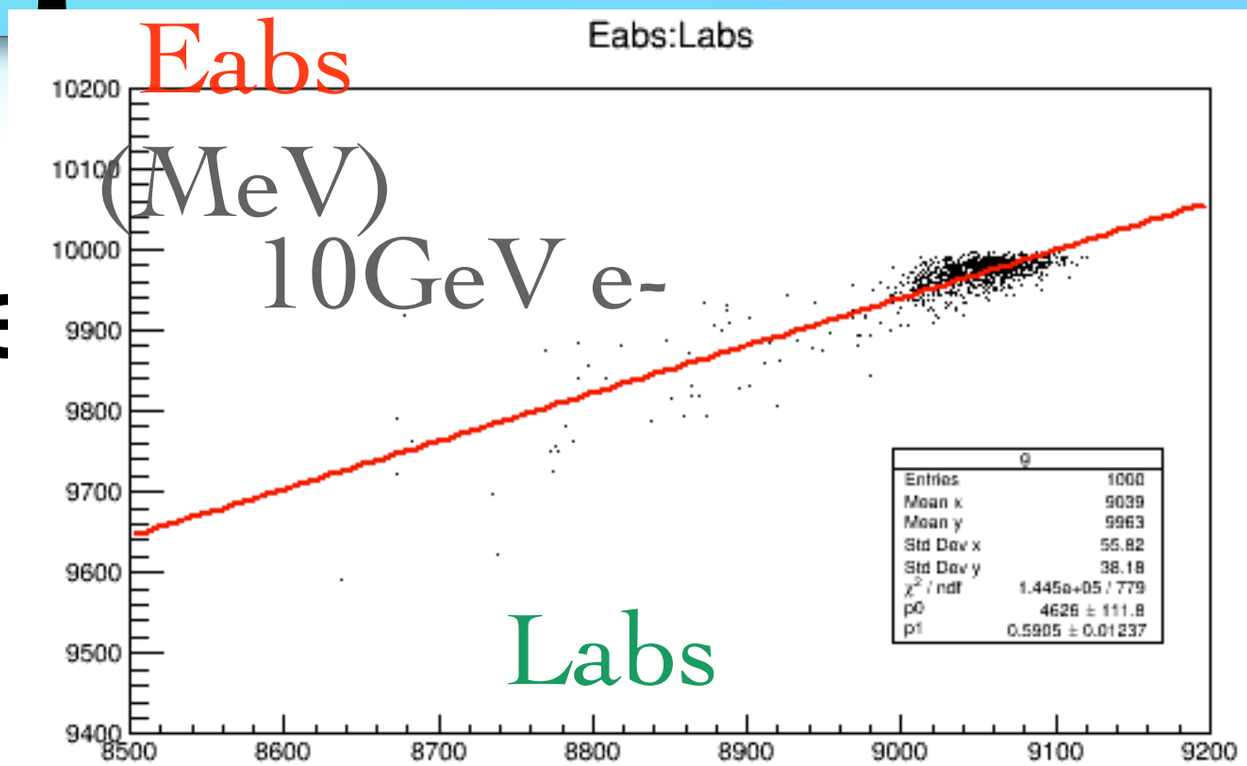


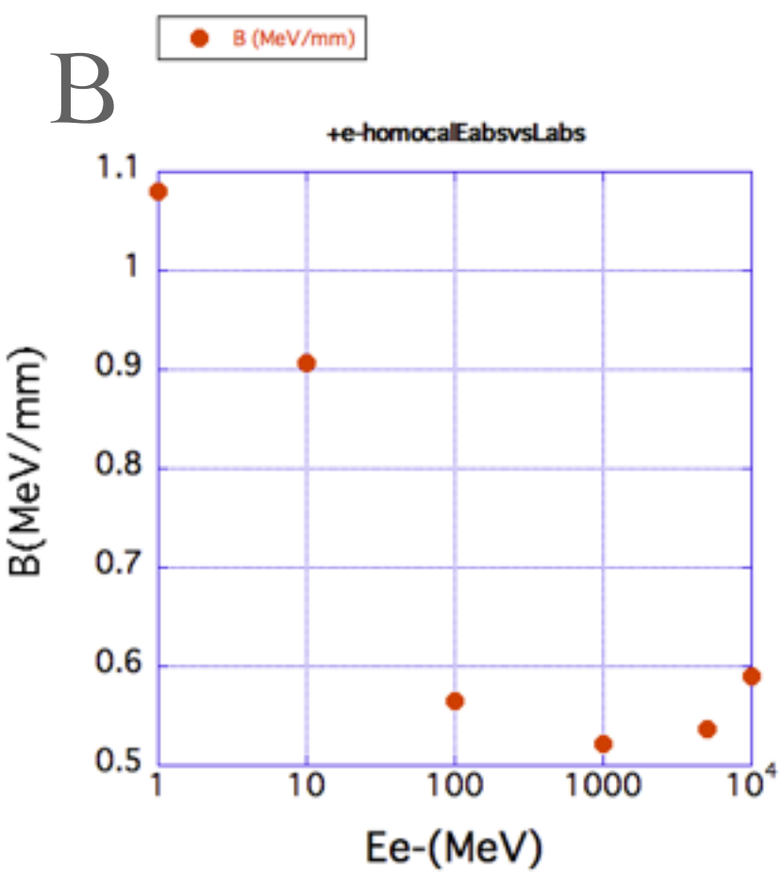
50,20,10,5, 3 ,1

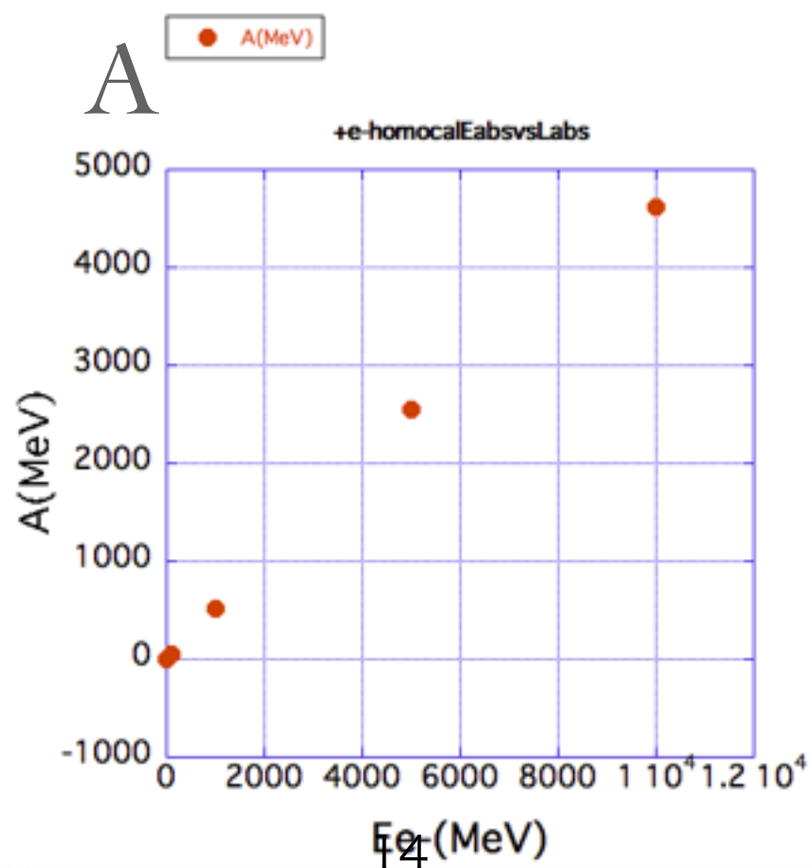
EM response

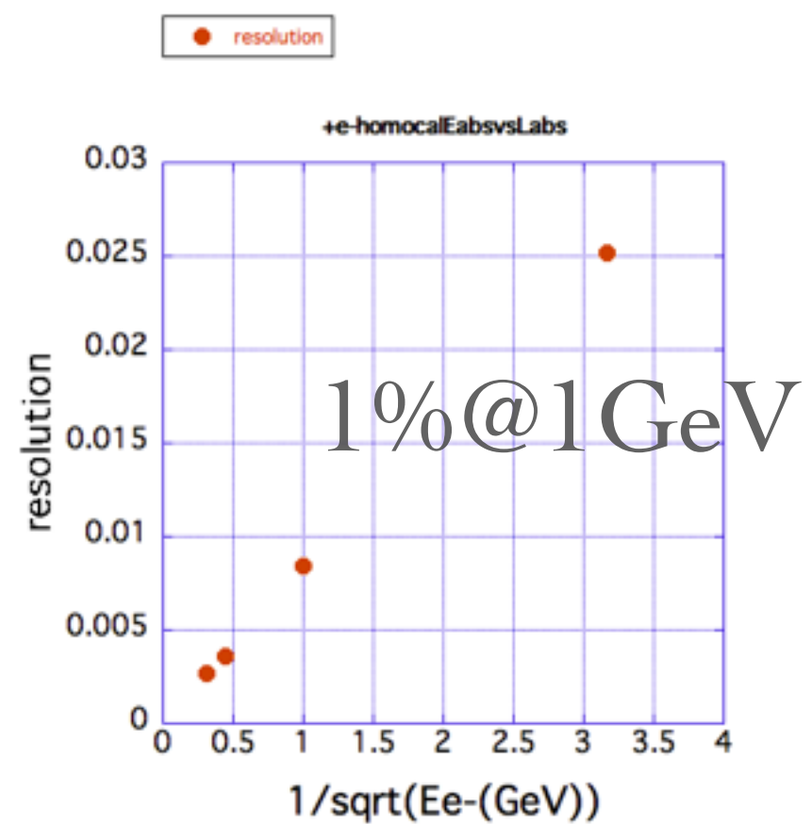
Eabs=A(E)+B*

- Eabs vs Labs :
- A(E) shows good line
- B is const. at E>100MeV
- B is same as ~ π+-









how to measure

- energy
- from E
- use he
- Eabs ~
- Labs ~
- MPPC-
- MPPC

test with electrons

Eabs=A(E)+B*

- for electron EM shower
- PbWO4 with air and glue coupling tested

σ

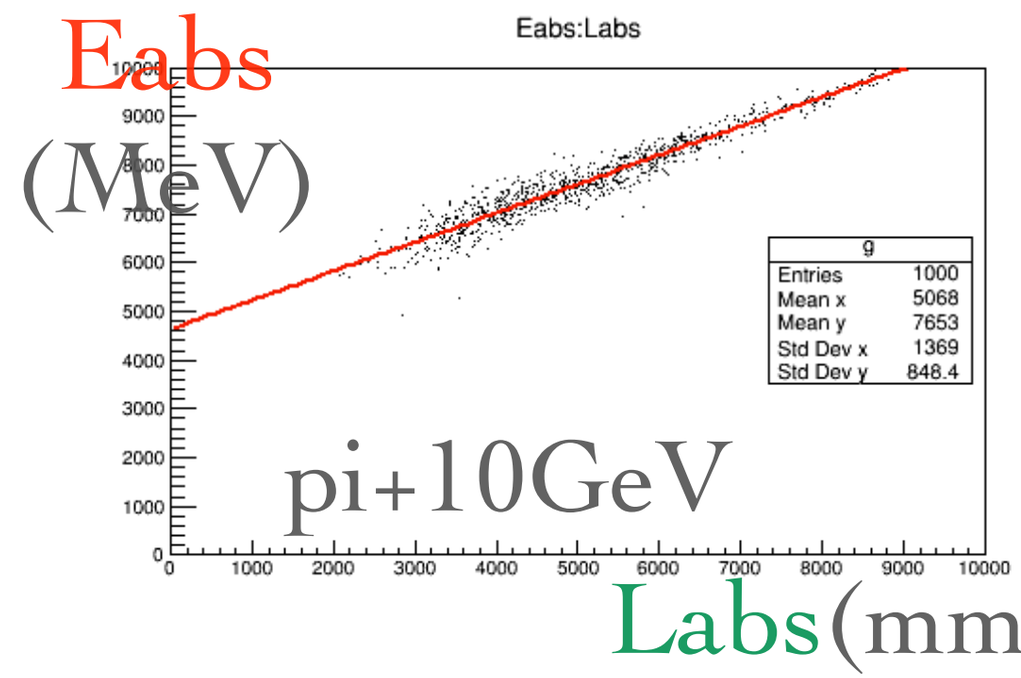
e+

a plot will come

GeV

summary and outlook

- homogeneous calorimeter is simulated
- found a relation between Eabs and Labs



- super energy resolution
- Eabs ~ scintillation light
- Labs ~ track length
- test calorimeter with PbWO4

PbWO4

Scintillation properties of lead tungstate (PbWO4) crystals:

Density ($g.cm^{-3}$)	8.28
Radiation length (cm)	0.92
Decay constant (ns)	6/30
Emission peak (nm)	440/530
Light yield (% that of NaI:Tl)	0.5
Melting point (°C)	1123
Hardness (Mho)	/
refractive Index	2.16
Hygroscopicity	none
Cleavage	101