Studing of non-linearity of TileCals modules

TileCal Calibration
Tile 2002-2003 testbeam

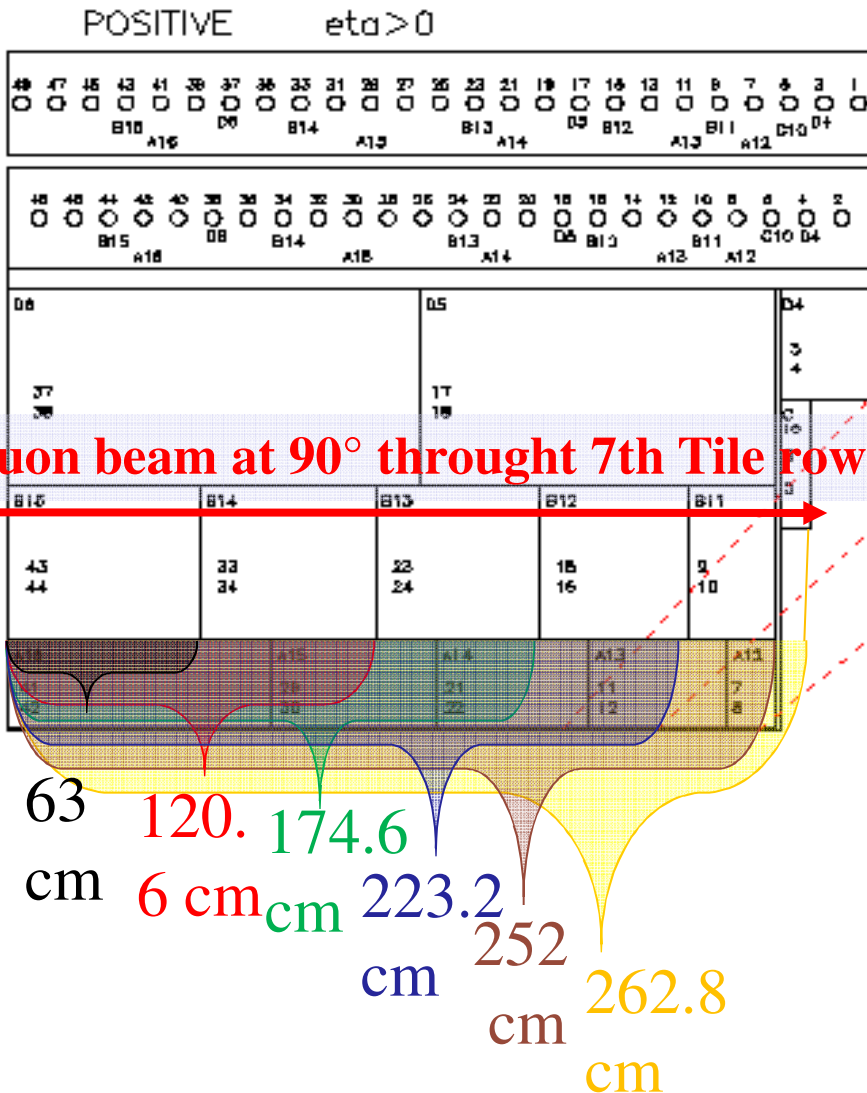Lucia Batkova, Lukas Pribyl

1/3   Analysis:

Motivation:

- Energy deposited by muon depends non-linearly on muon path lenght for all studed muon signal definitions (mop, TM, mean).

- In order to compare signals from tile cells we must first correct for this non-linearity using MC

- In this study we compare TB data and MC to see whether MC describes TB data with a good precision and could be used for the non-linearity correction

- Signal's non-linearity :

  - TM97.5, mean, mop

- Signal's non-linearity compared for MC:

  - 20 GeV, 50 GeV, 180 GeV

- Goal: to reach good agreement between signal's non-linearity in MC simulations and data from TB

Analysis:

POSITIVE   eta > 0

Muon beam at 90° throught 7th Tile row

63 cm   120.6 cm   174.6 cm   223.2 cm   252 cm   262.8 cm

➤ Athena Release 15.0.0 was used to MC simulation of each tilerow of EB(D0) module (180 GeV muons at 90°)

➤ From TB data were used:

  • July02 (+EB module IFA42)
 • June02 (+EB module IFA59)
  • July03 (+EB, LB)

➤ Muon beam at 90° to +EB/LB modul (TB data), to +EBD/BA-C module (MC).

➤ tile row **# 7** is presented

Analysis:

Cuts used in TB data:

1. Beam chambers (S1cou, S3cou, Xcha2-Xch1, Ycha2-Ycha1, Ximp, Yimp)

– In level 2σ

1. Condition $E_{dep\ per\ cell} > 1\sigma_{noise}$ must be satisfied

(for each cell individually)

– $1\sigma_{noise}$ was obtained from spectrum of noise fitted by Gauss

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1/2   Muon signal / muon path length expressed by TM97.5
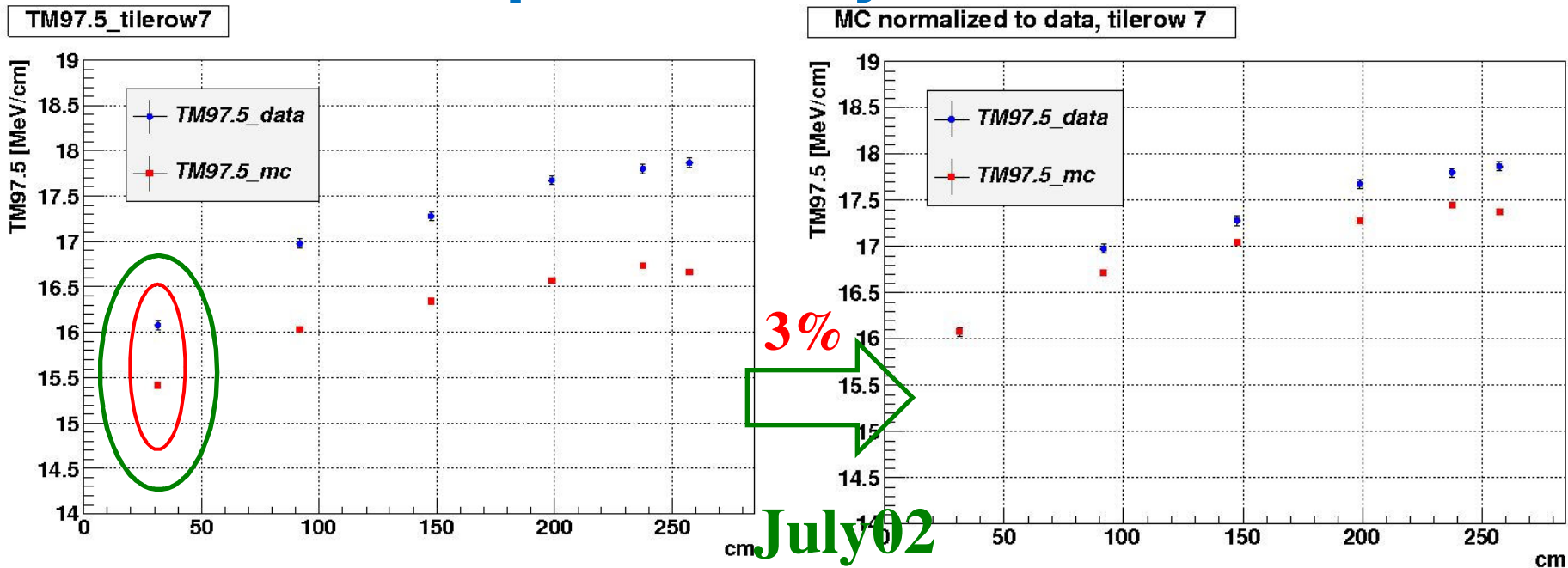
- Effect of first cell –> signal of first cell is lower than other
  => Data Preparation (2-Jul-08) - Uniformity with 90 deg muons (Tomas, Ana)
- MC normalized to data at ~ 63 cm.
- Muon signal summed from cells (both PMTs) in tile row.
- After normalization MC to data residual difference less ~ 3%.

2/2 Muon signal / muon path length expressed by TM97.5
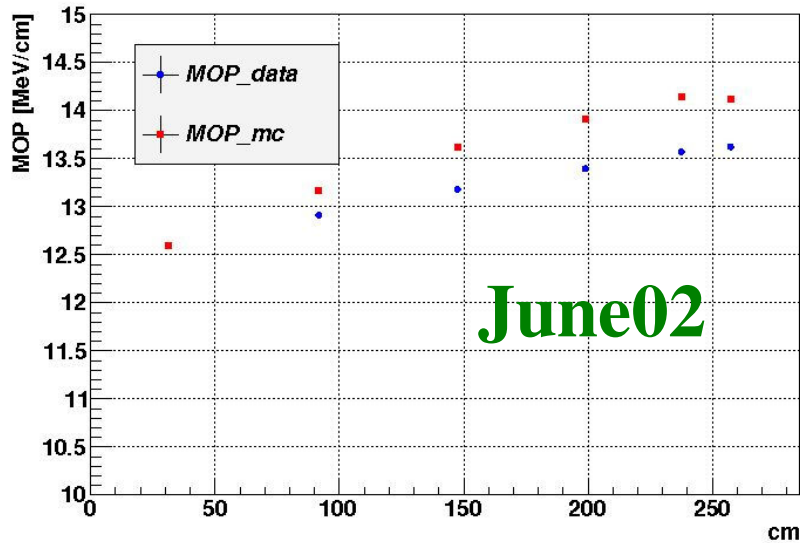

MC normalized to data, tilerow 7

June02
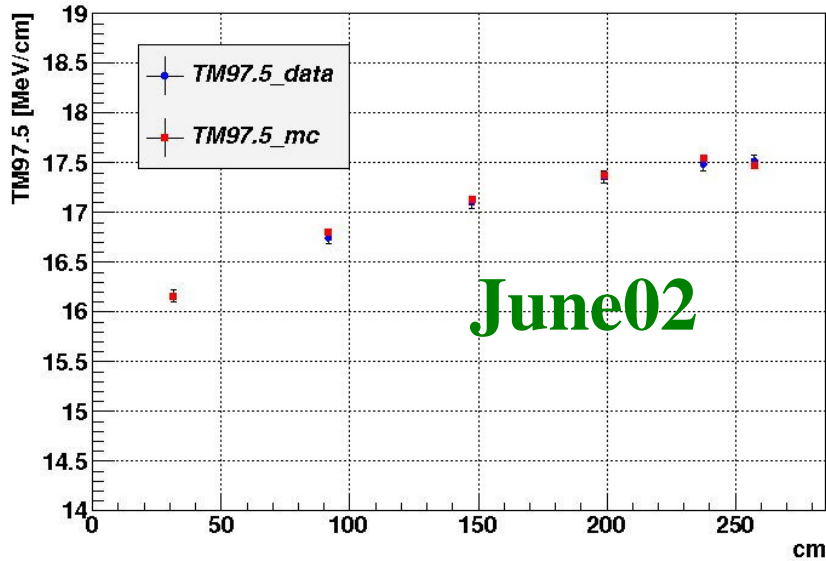
MC normalized to data, tilerow 7
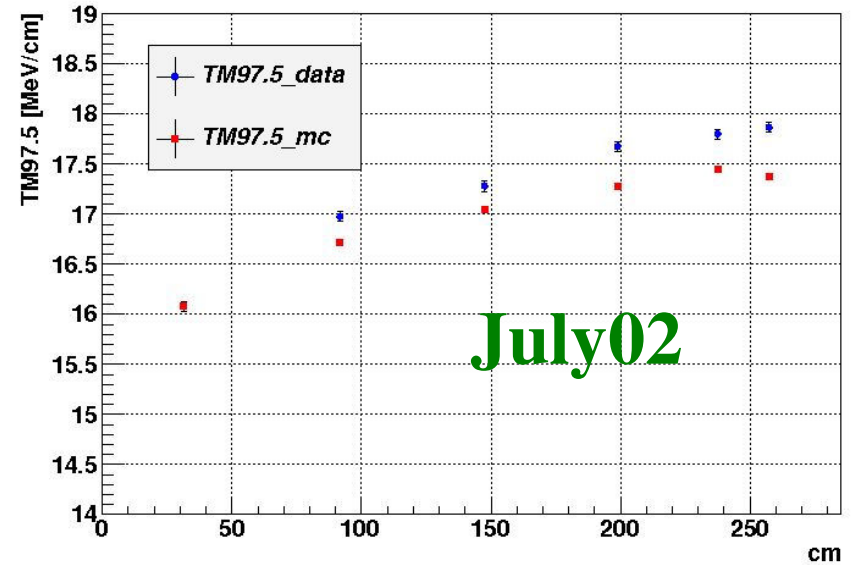
July02

July03

TM97.5 = 2.5% the highest energy events are truncated

- After normalization MC to data residual difference
- June02 ~ 1%.
- July02 ~ 3%.
- July03 ~ 2%.
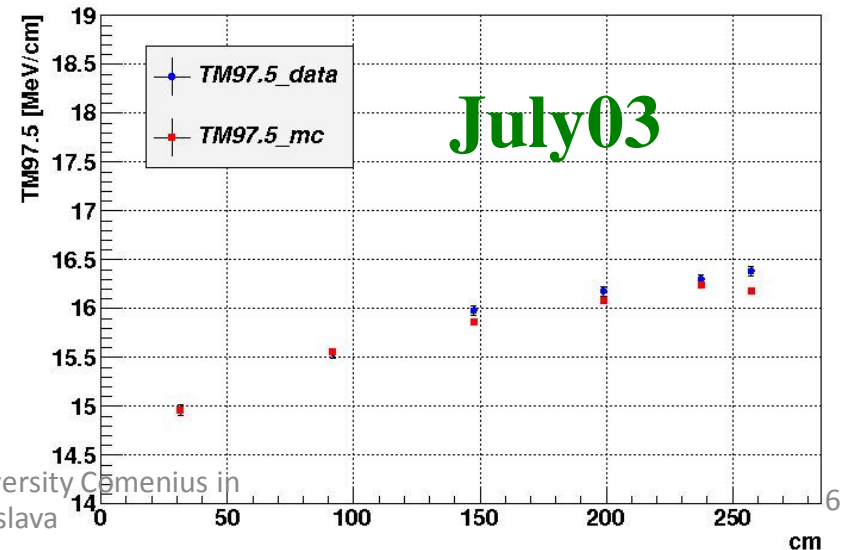
Muon signal / muon path length expressed by **Mop**

MC normalized to data, tilerow 7
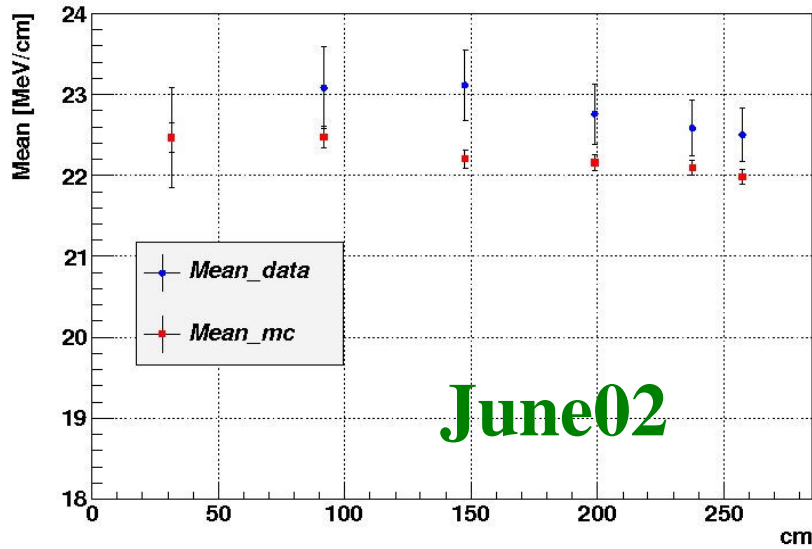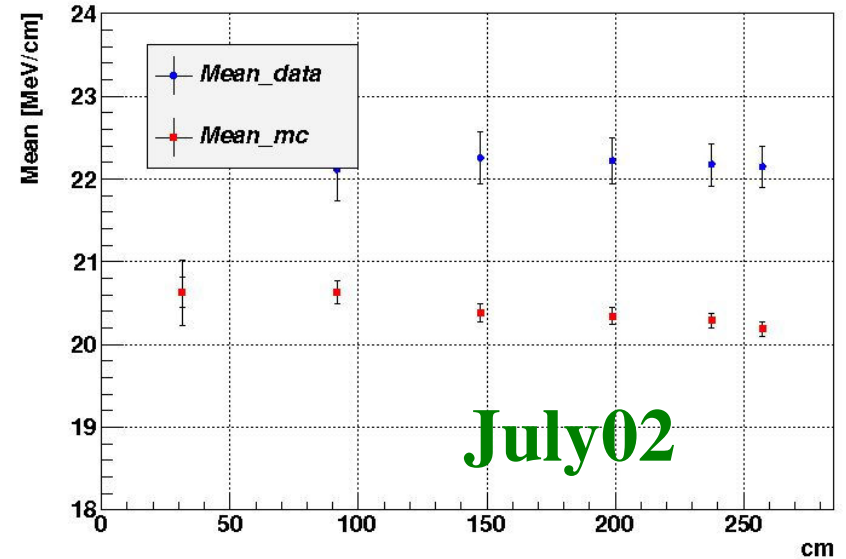
June02

MC normalized to data, tilerow 7
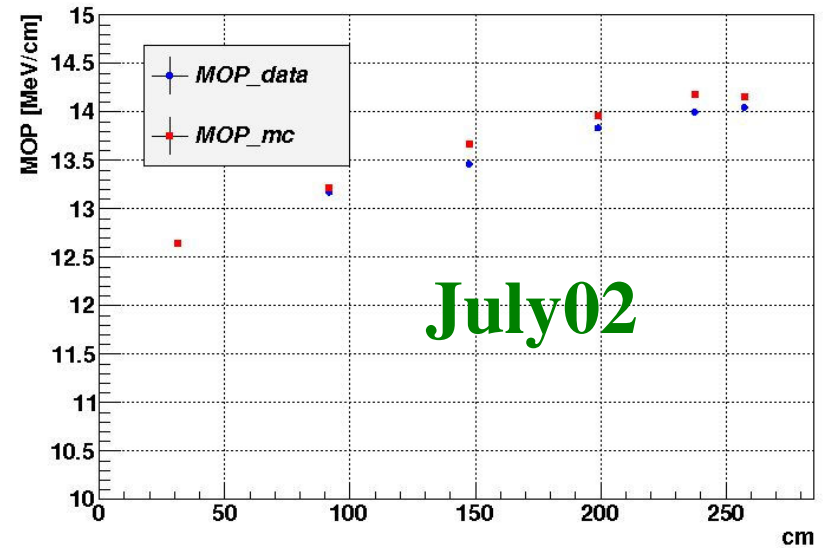
July02

Mop is obtained:

- convolution L*G fit

  • After normalization MC to data residual difference

  • June02 ~ 5%

  • July02 ~ 2%

  • July03 ~ 2%

July03

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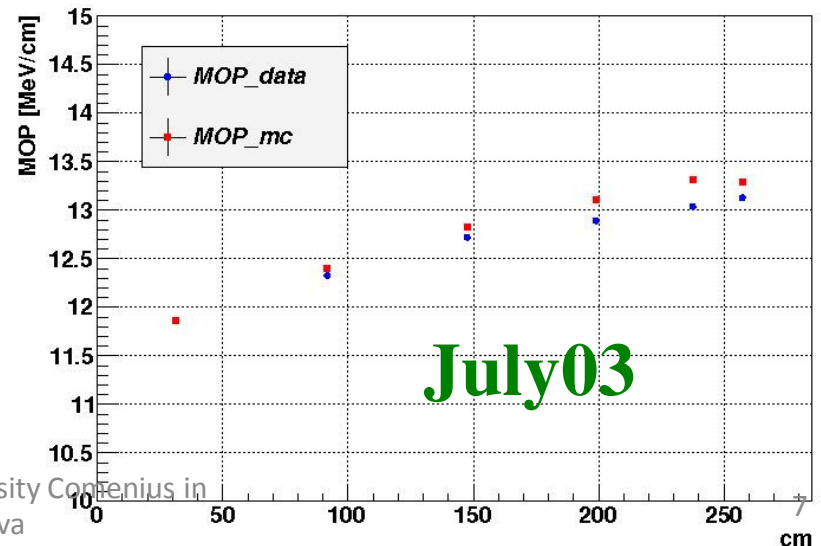
Muon signal / muon path length expressed by mean

MC normalized to data, tilerow 7

June02

MC normalized to data, tilerow 7

July02

- MC normalized to data at ~ 63 cm.
- Residual difference between MC and data ~ 7%

July03
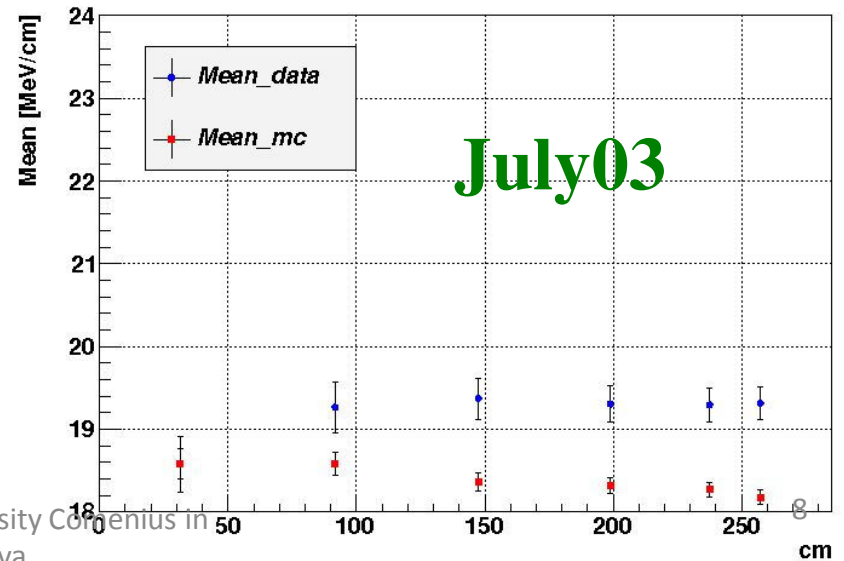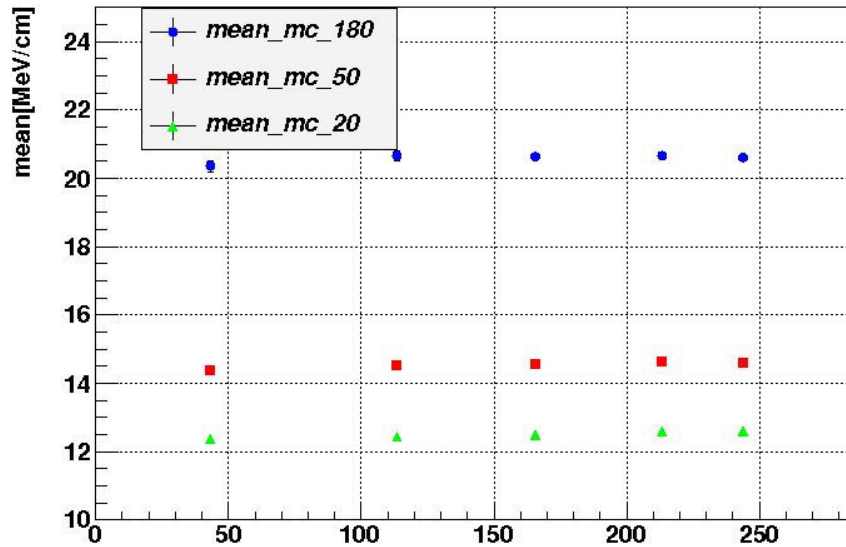
Summary: 3 definition for 3 period
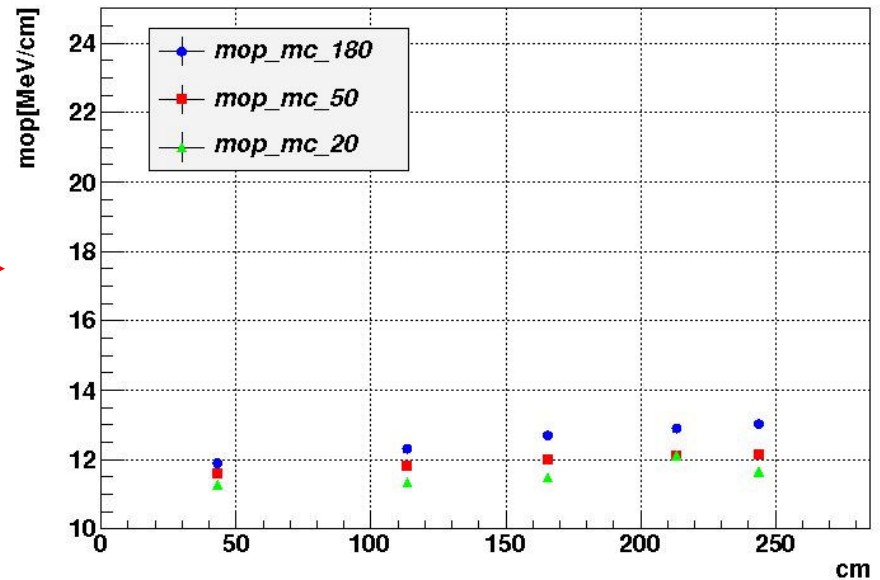
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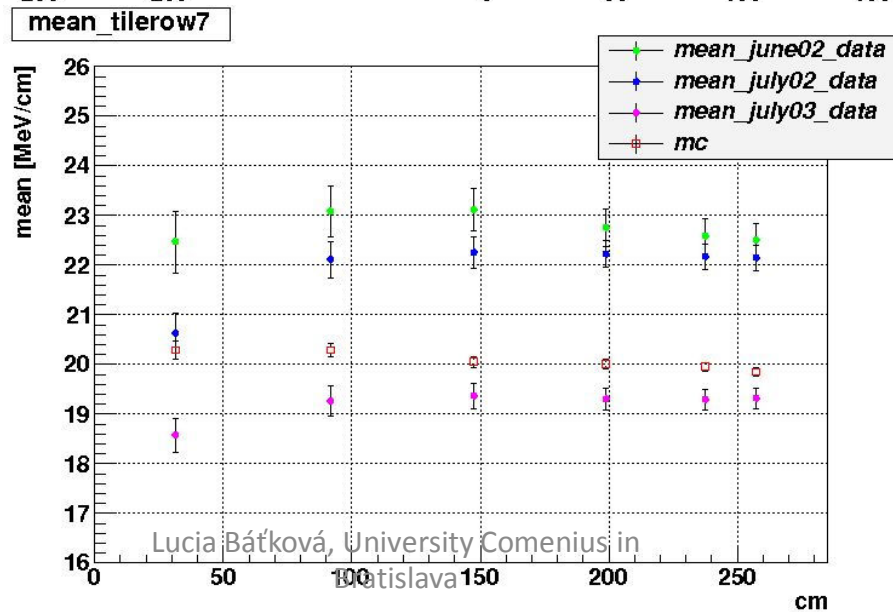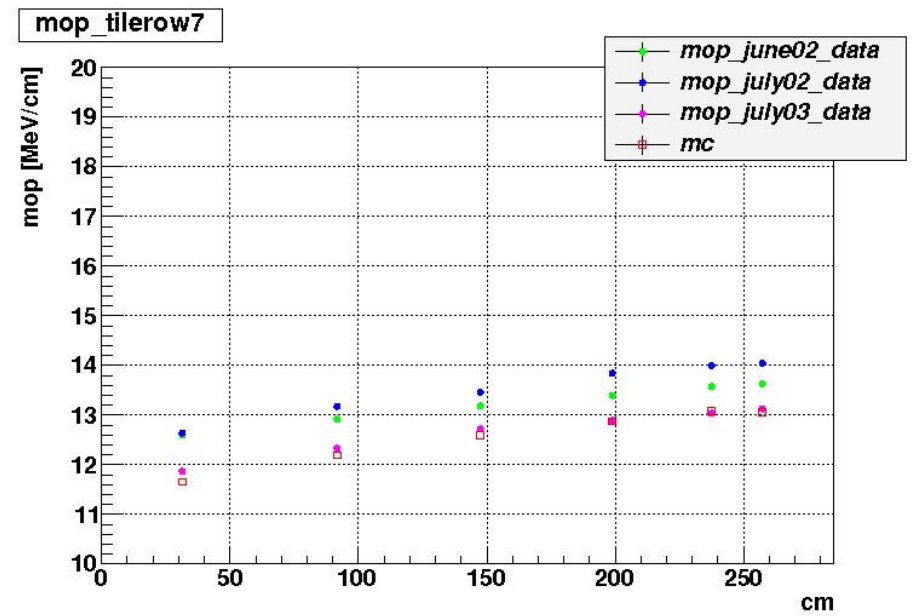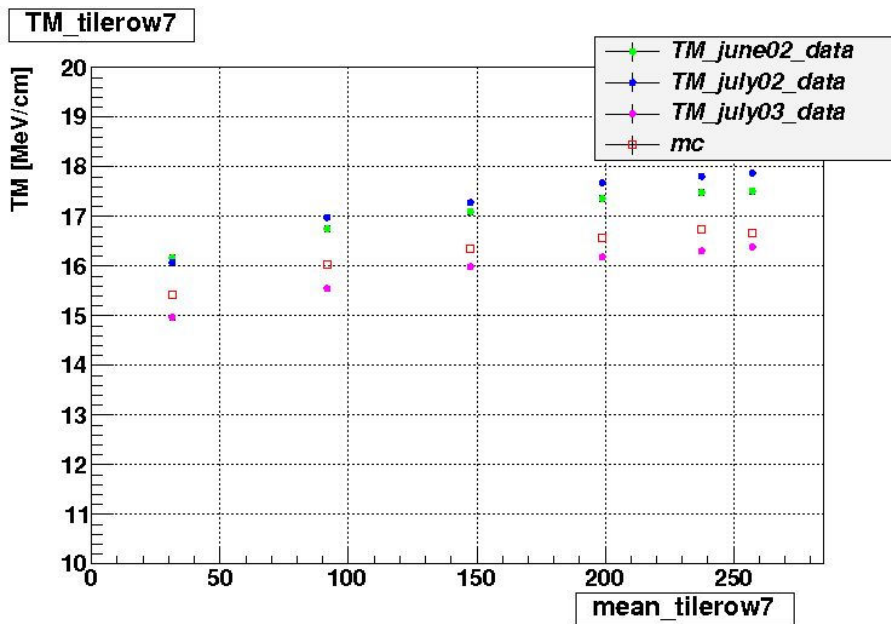
Signal's non-linearity vs. energies (MC only)

mean_tr2 muon of different energies

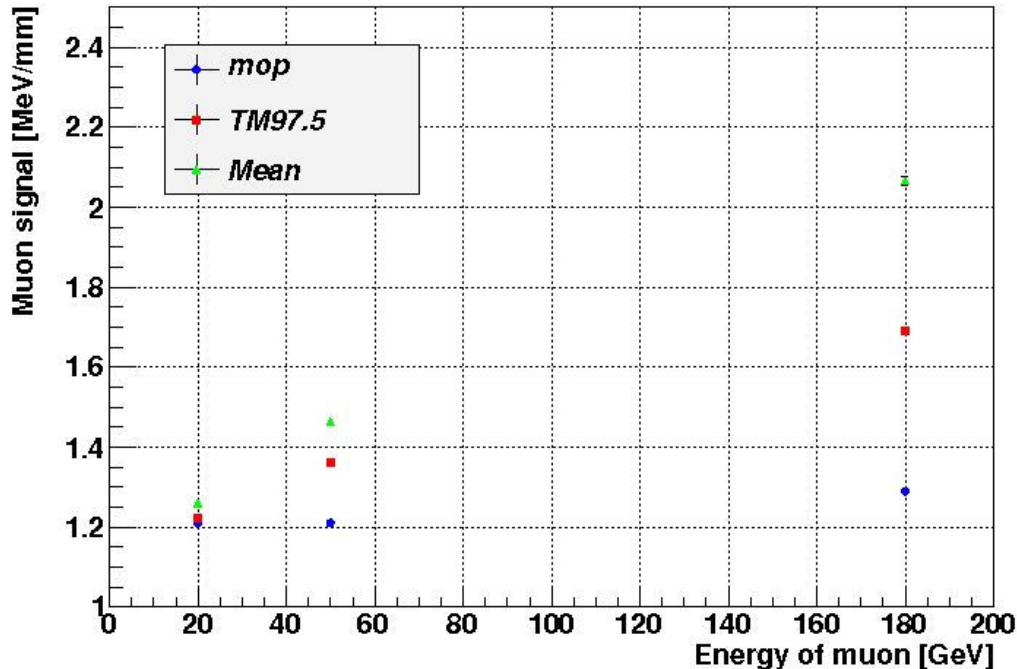mop_tr2 muon of different energies

TM_tr1 muon of different energies
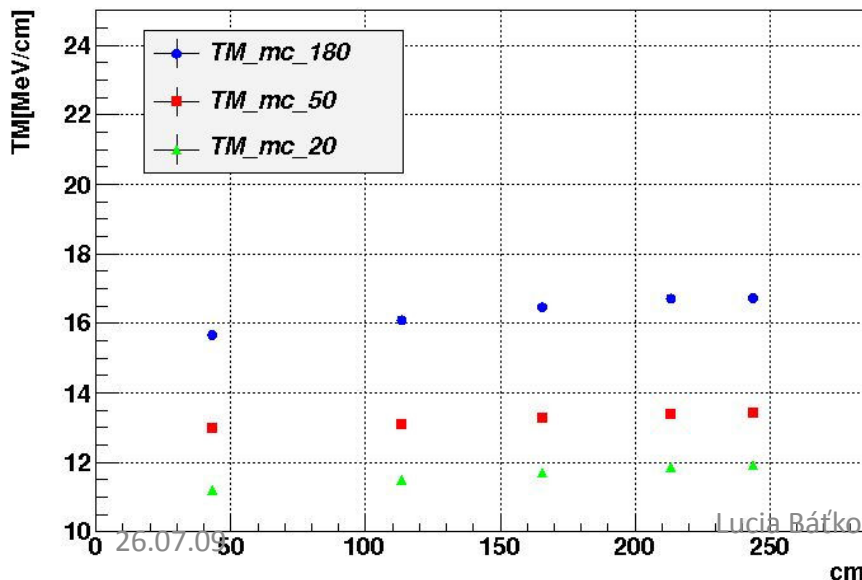
Tile row 2 – only result from MC
→ mop is least dependent on energy of muon

- Ionization losses mostly contribute to curve under mop
- Radiation losses contribute to right half of curve which are account to mean and TM97.5

Muon signal vs. deposited energy (only MC)

Signal muon vs E for tilerow2

Energy [GeV]	Mean	Mop	TM97,5
20	1.258	1.211	1.221
50	1.462	1.21	1.360
180	2.066	1.29	1.690
180/20	1.64	1.11	1.44

- Values obtained in 235.8 cm muon path length (similar path length which pass projective muon in EB), tilerow # 2

- Mop is least dependent on muon momentum of energy.
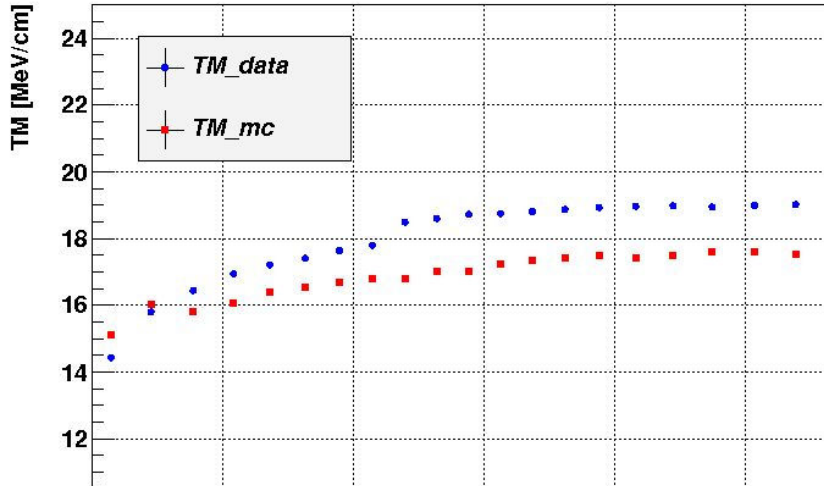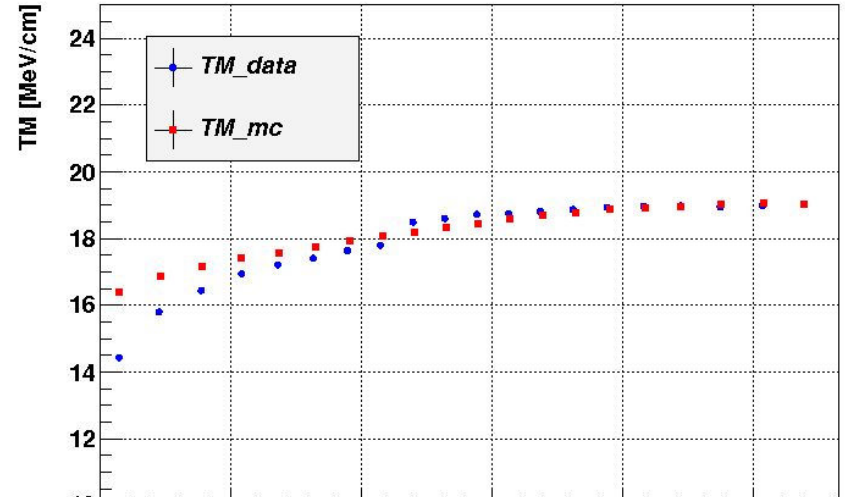
- It could be used in analysis of cosmic muon

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Muon signal in LB module
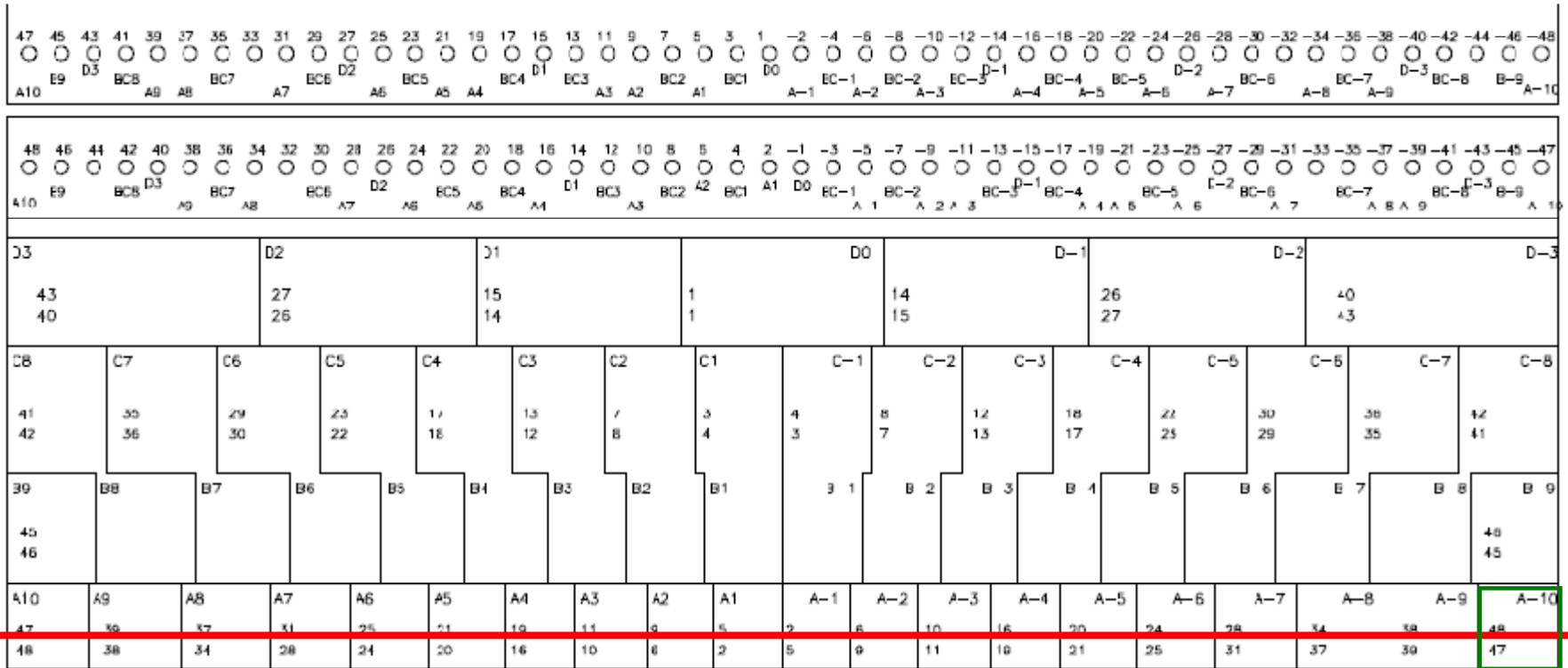
- **Muon beam at 90° throught 2nd Tile row**
- MC normalized to data at the end of LB module

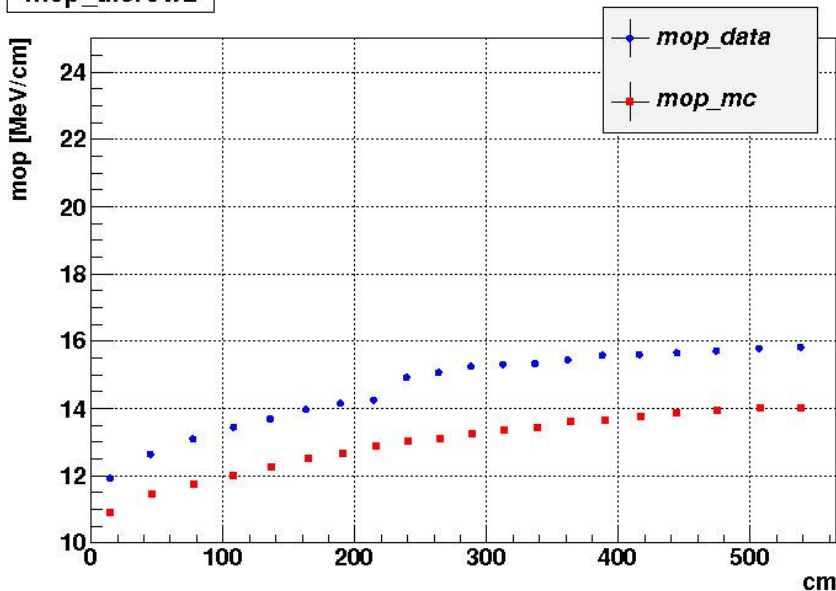# Muon signal / muon path length expressed by TM97.5 and Mop

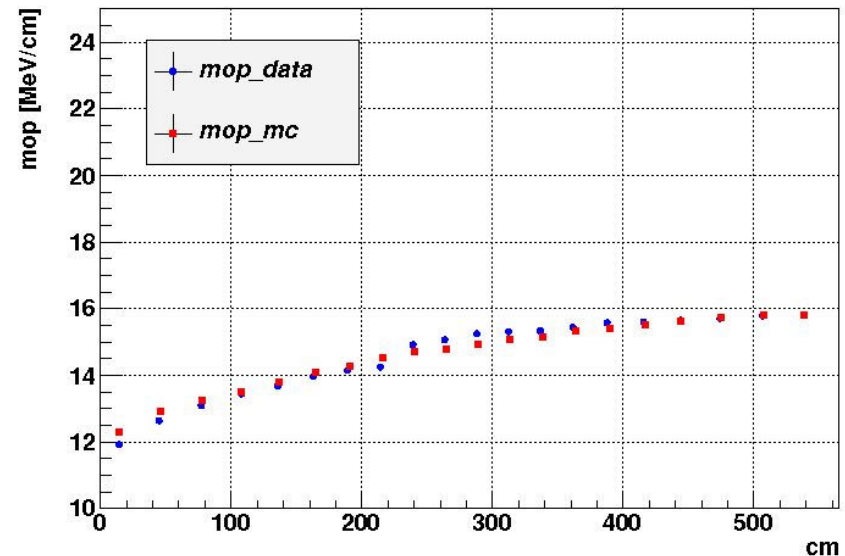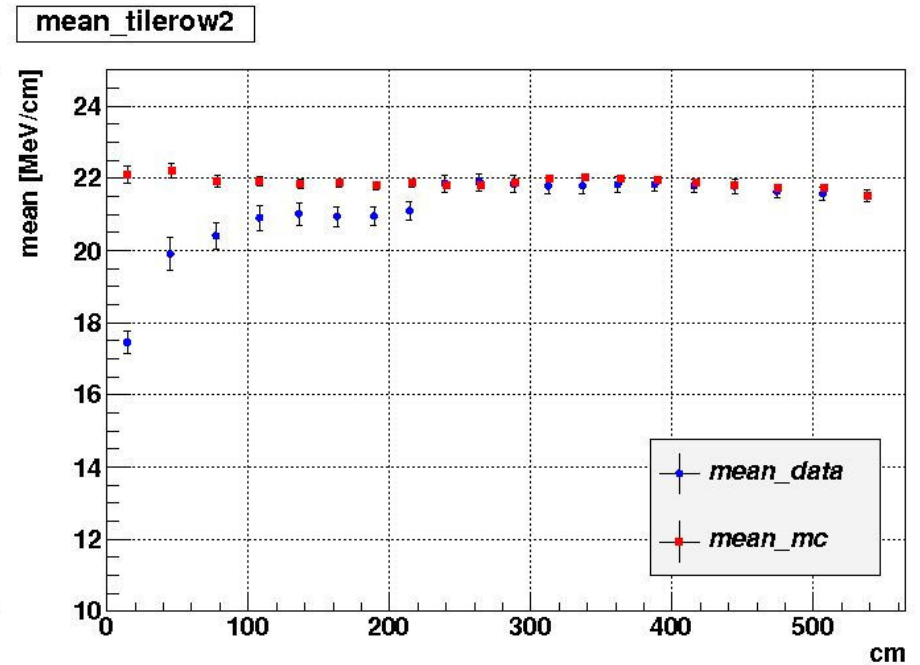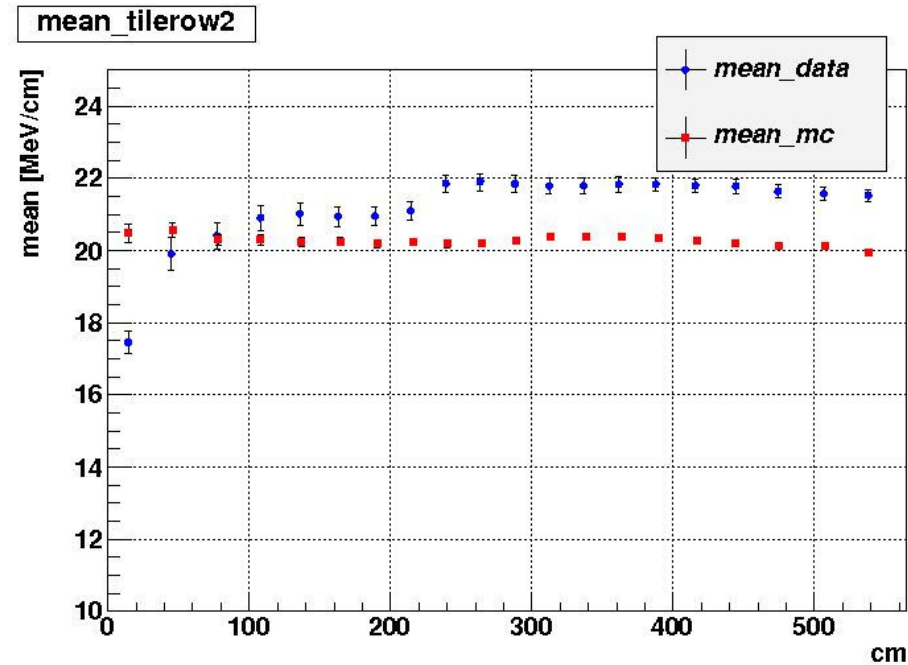# Muon signal / muon path length expressed by mean

- Mop looks like the most stable signal definition also for LB module
- One can reach the best agreement between TB data and MC for mop as signal definition
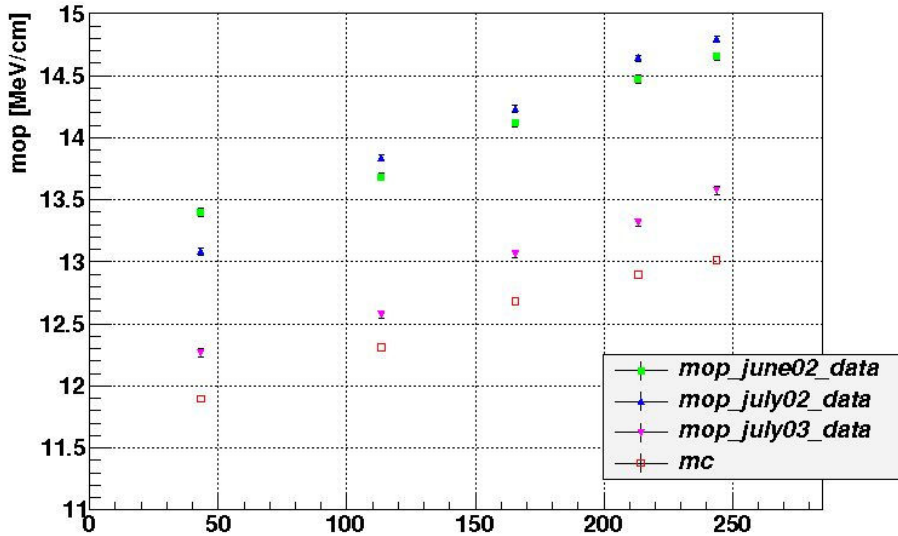
Conclusions and plans:

1. In order to correct for muon signal (TM97.5, MOP, mean) path length non-linearity (~ 10% or more) a good agreement between these non-linearities observed in MC and real data must be reached.

❖ **TM97.5 and MOP is least dependent:**

- On muon path length (Residual difference ~ 3 %)

- For both EB and LB

❖ **MOP is least dependent:**

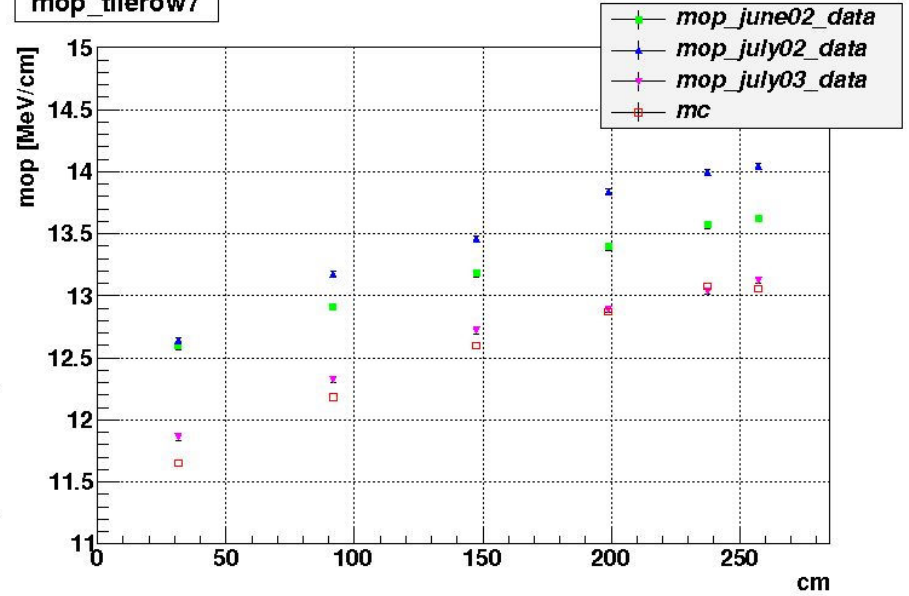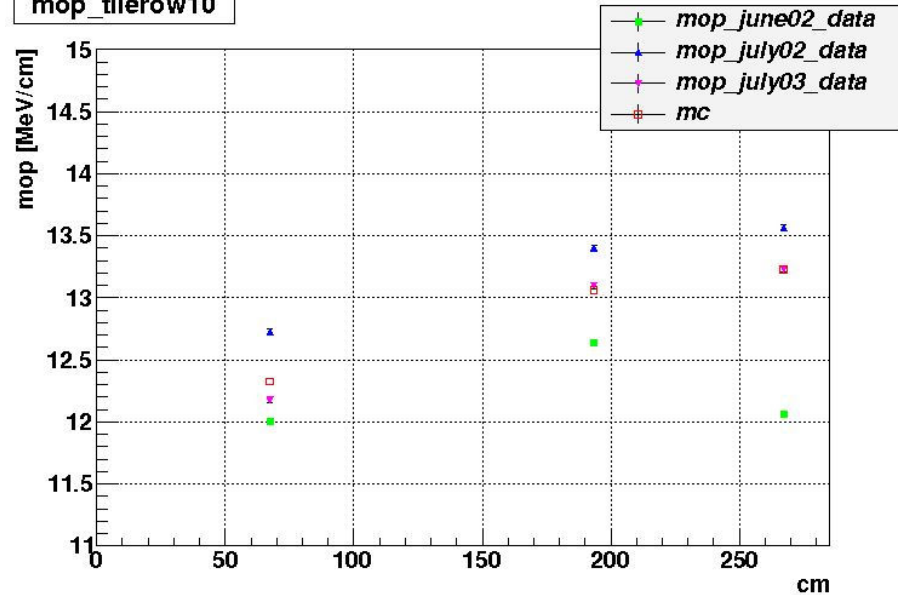- On energy 20-180 GeV difference 11% for (EB)

1. Write a note

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Muon signal Mop

Muon signal TM97.5
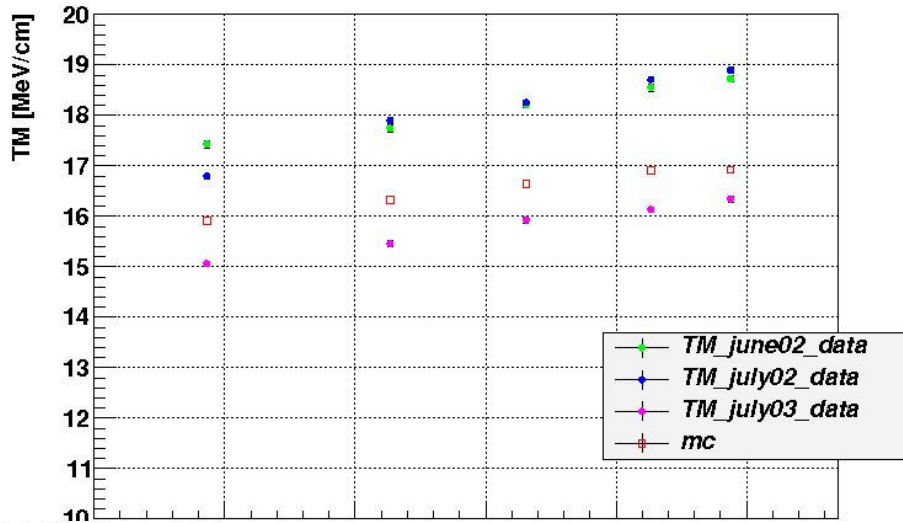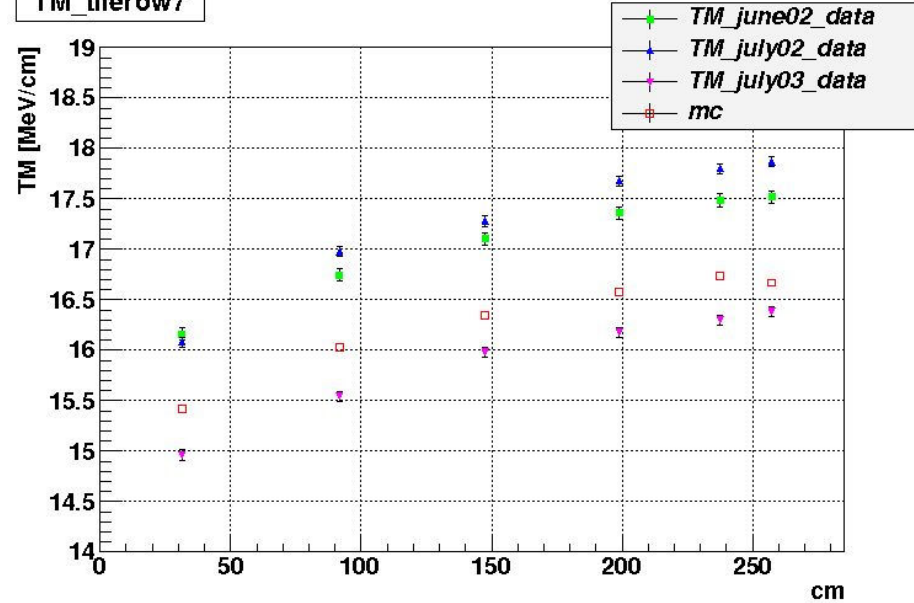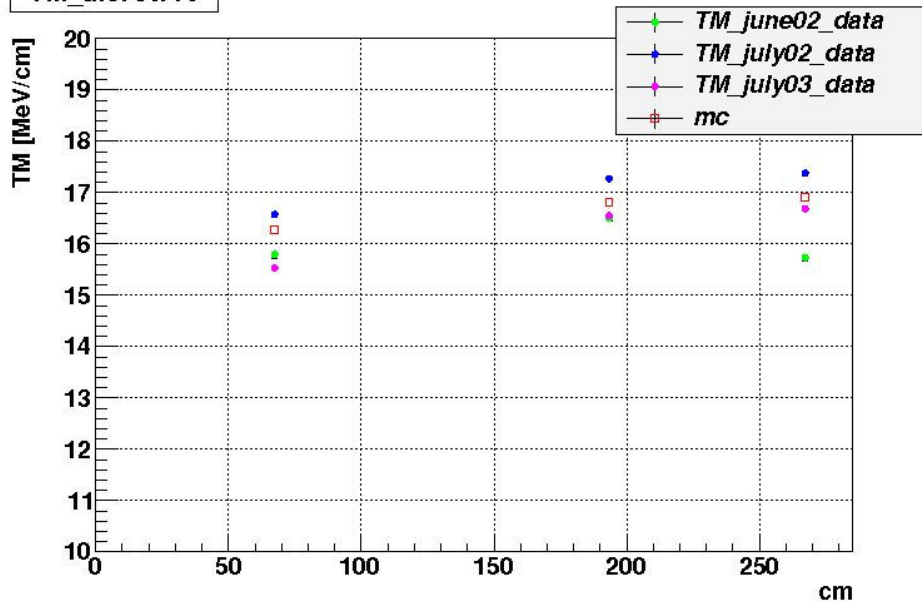
Muon signal mean

Muon signal / muon path length