Muon Identification in RS Prototype (Model Data) on behalf of RS team

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Formulation of Problem

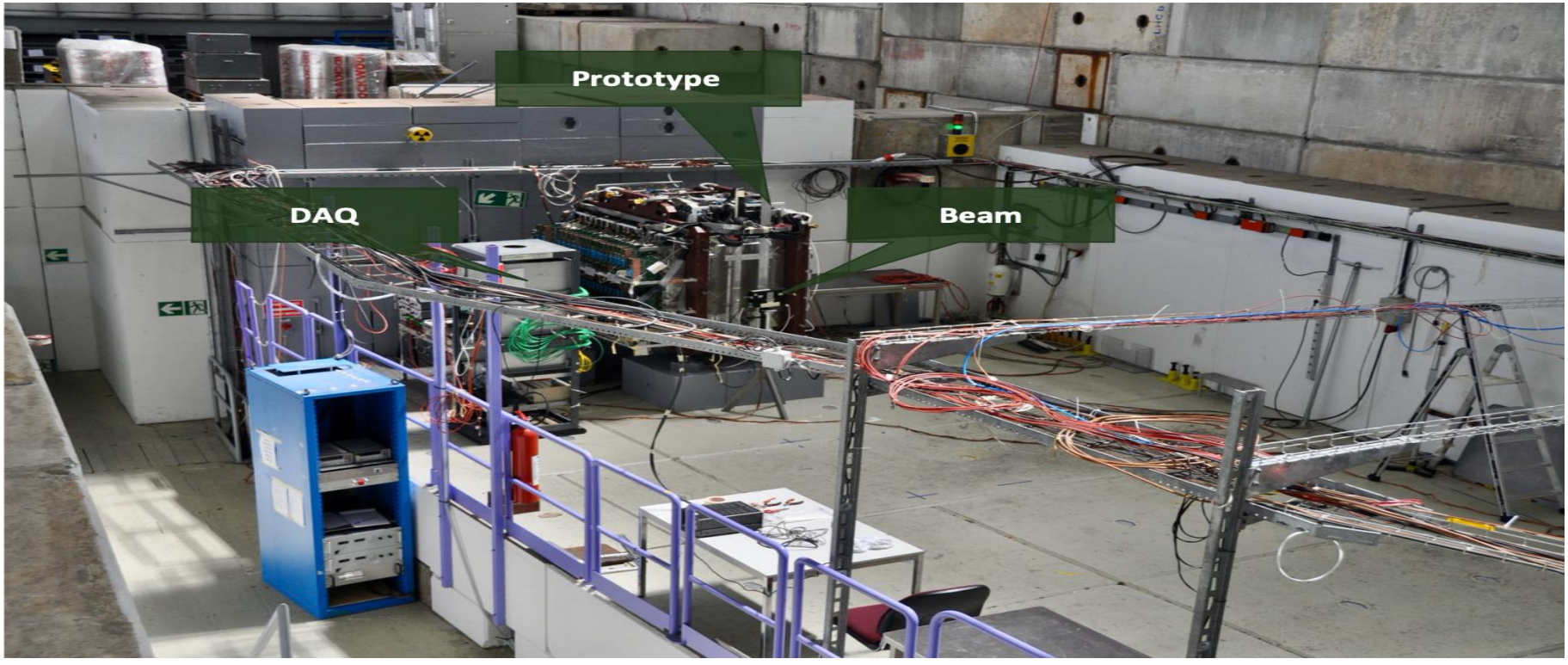
Topic of Presentation: Identification Of Muons on Hadron Background in the Range (2—14)GeV/c

Both Muons and Hadrons(here only Protons and Pions considered) have electromagnetic interaction, so it is impossible to find a signal to seperate muons from hadrons with 100% accuracy!

So, the aim is **We should seek the rule, giving minimal fraction of wrong decisions**

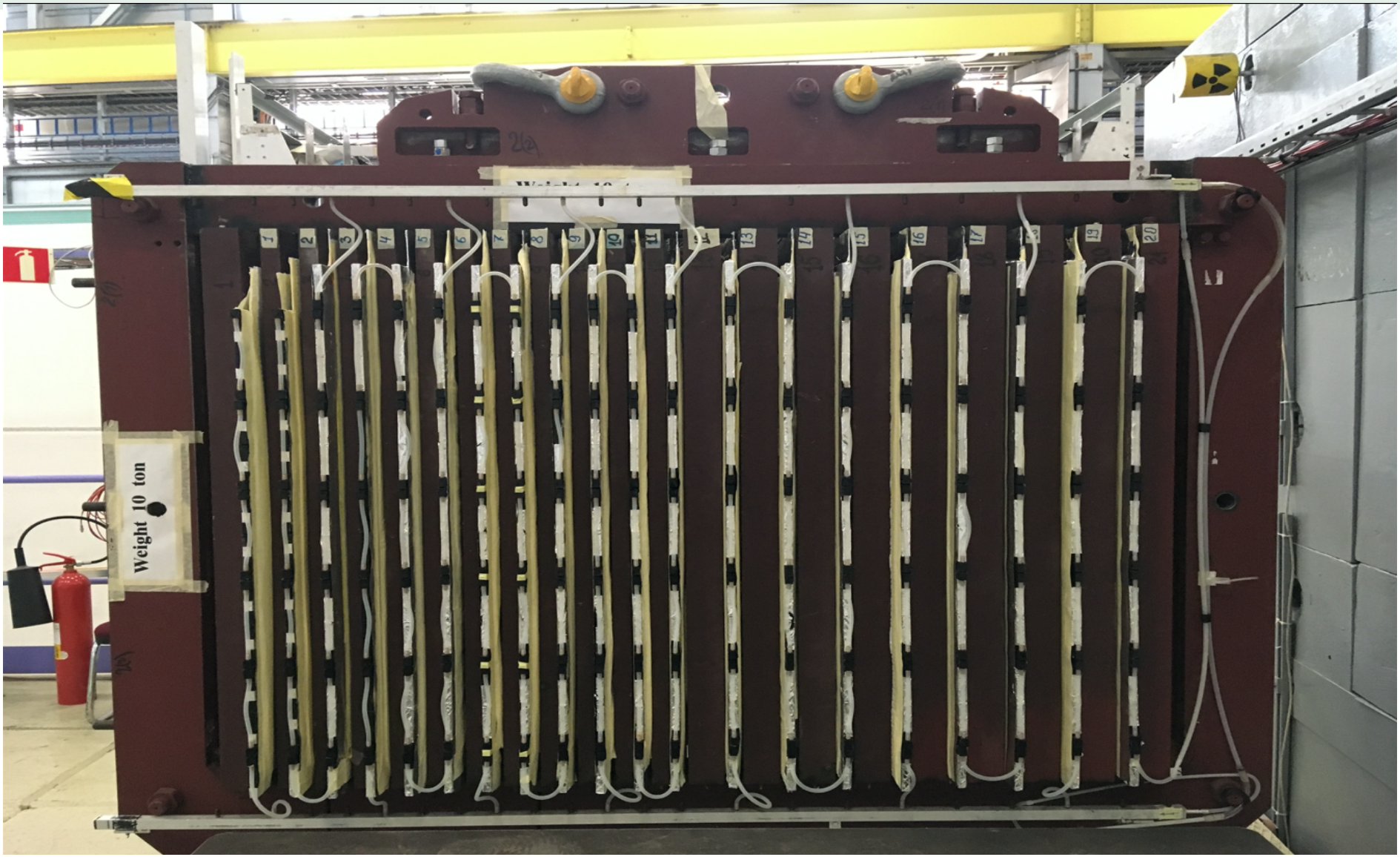
What is a Future Spd RS system ? It will be of two main parts: barrel and end-caps. Each of them will be assembled of iron plates of thickness 30mm for barrel part and 60mm for end caps. Total contents of sampling material is about 4 nuclear length. Detailed structure of RS sytem will be in a future TDR document.

RS Prototype at CERN



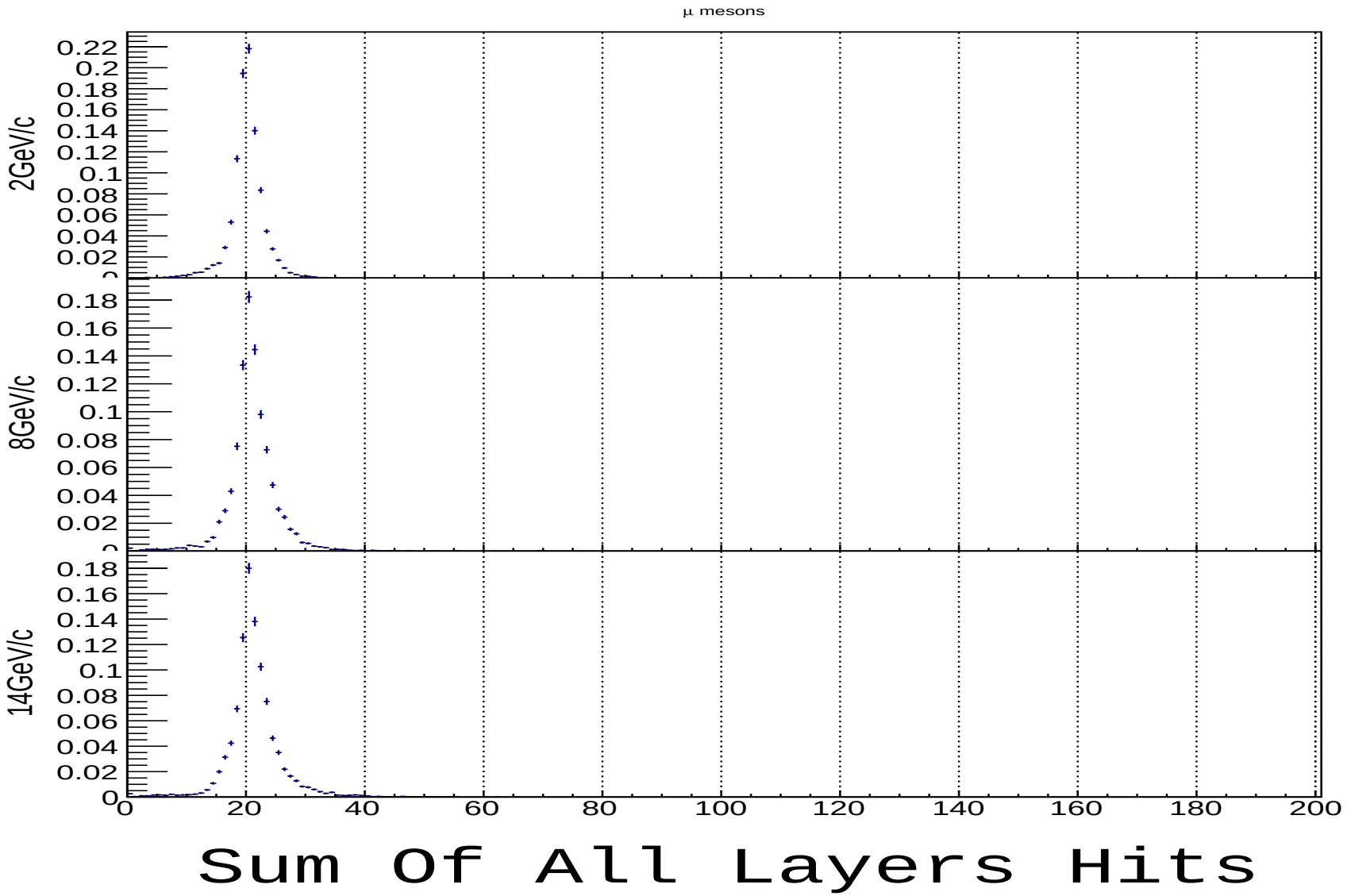
In our model study Prototype had 12 Layers of 30mm and 8 of 60mm thickness of iron.In the space between each of them(size 35mm) MDT were mounted having 96 signal wires separated one after another by 10mm.We analysed detector response in terms of hit numbers(discrete information!). Momentum Range (2—14)GeV/c with steps 2GeV/c for muons,protons and pions.Number of simulated events for each momentum and type was 10000

RS Prototype at CERN,continued

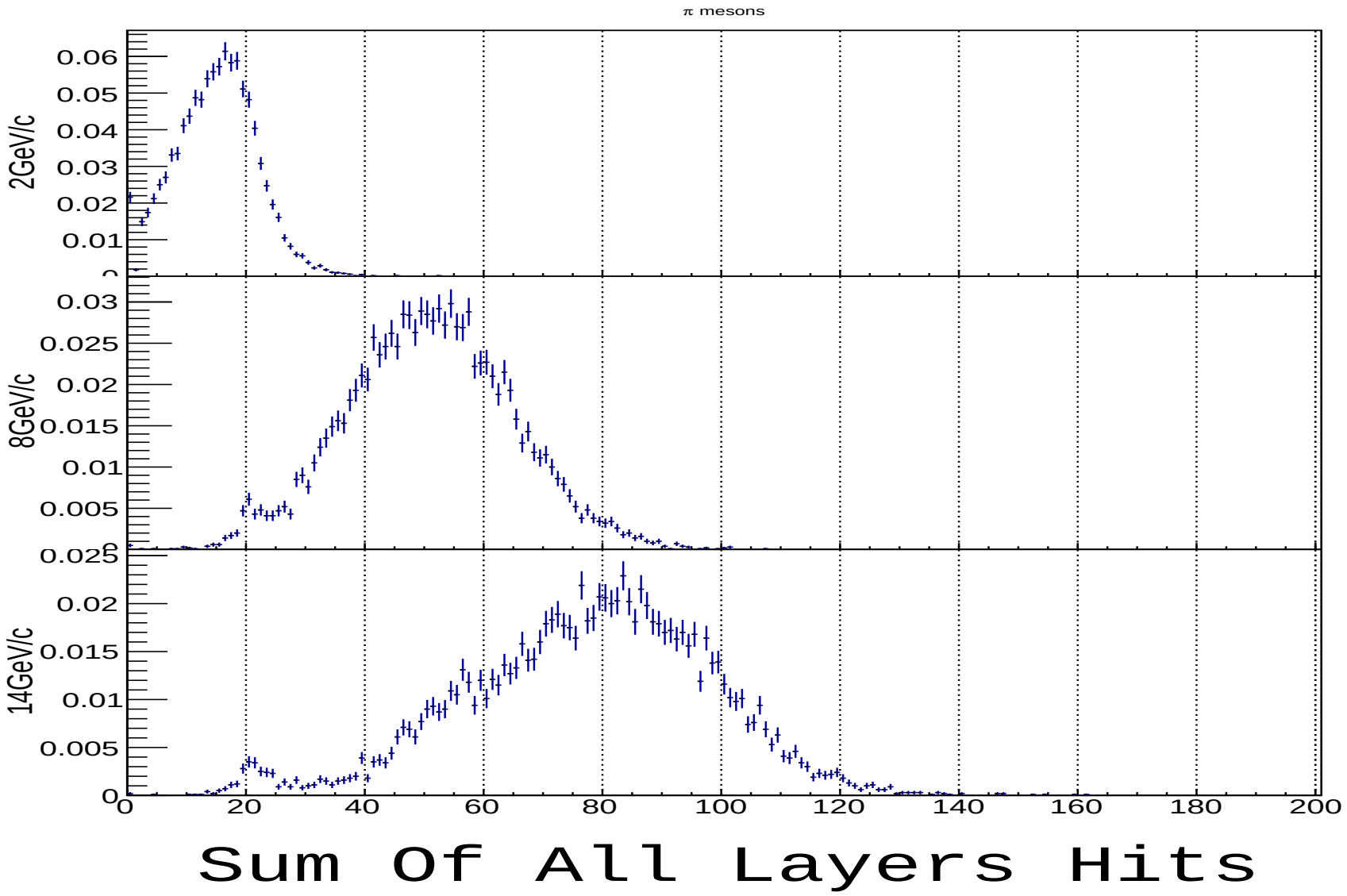


Side View of Prototype

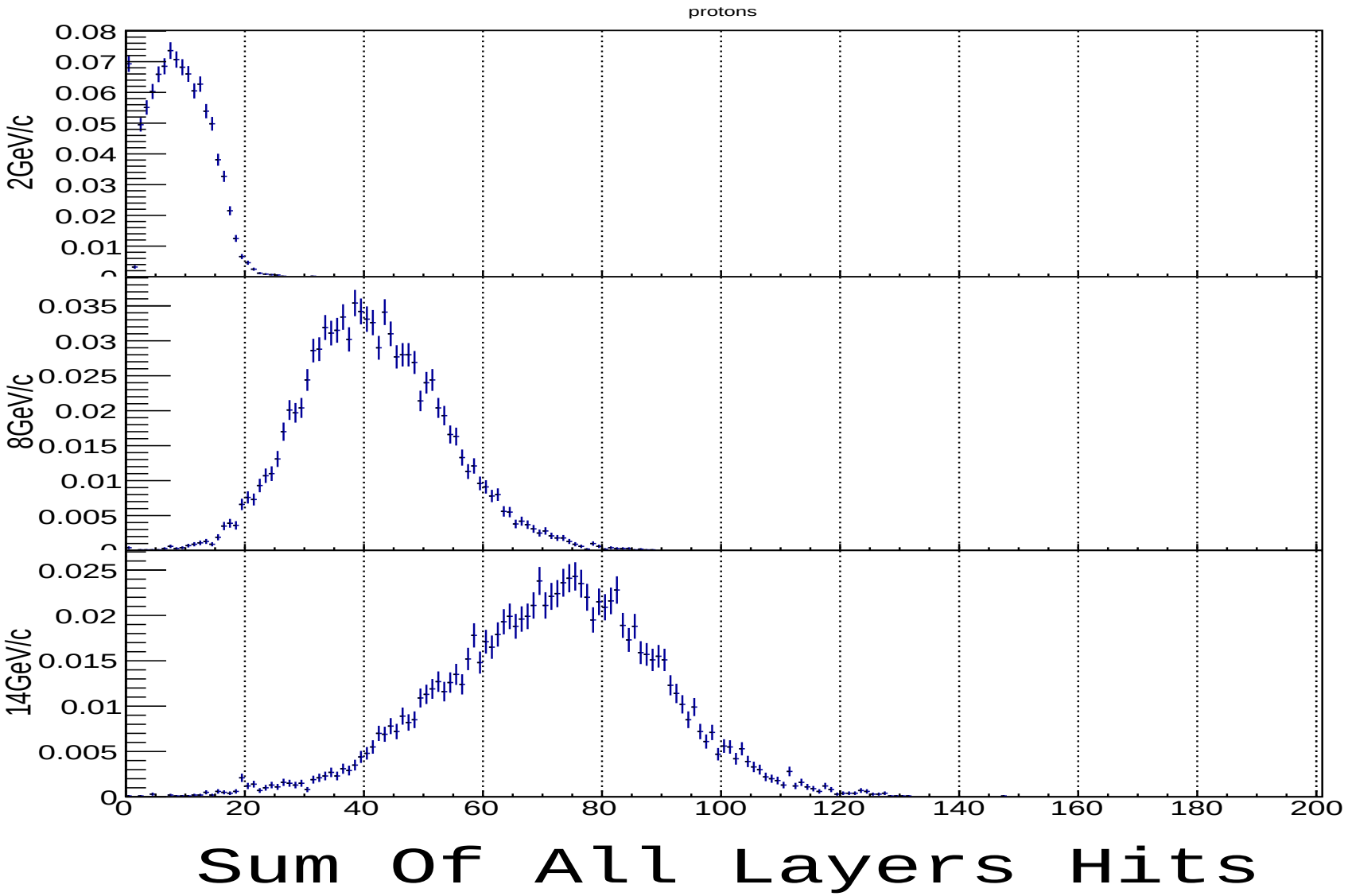
Number Of Hits Summed up Over All Layers,Muons



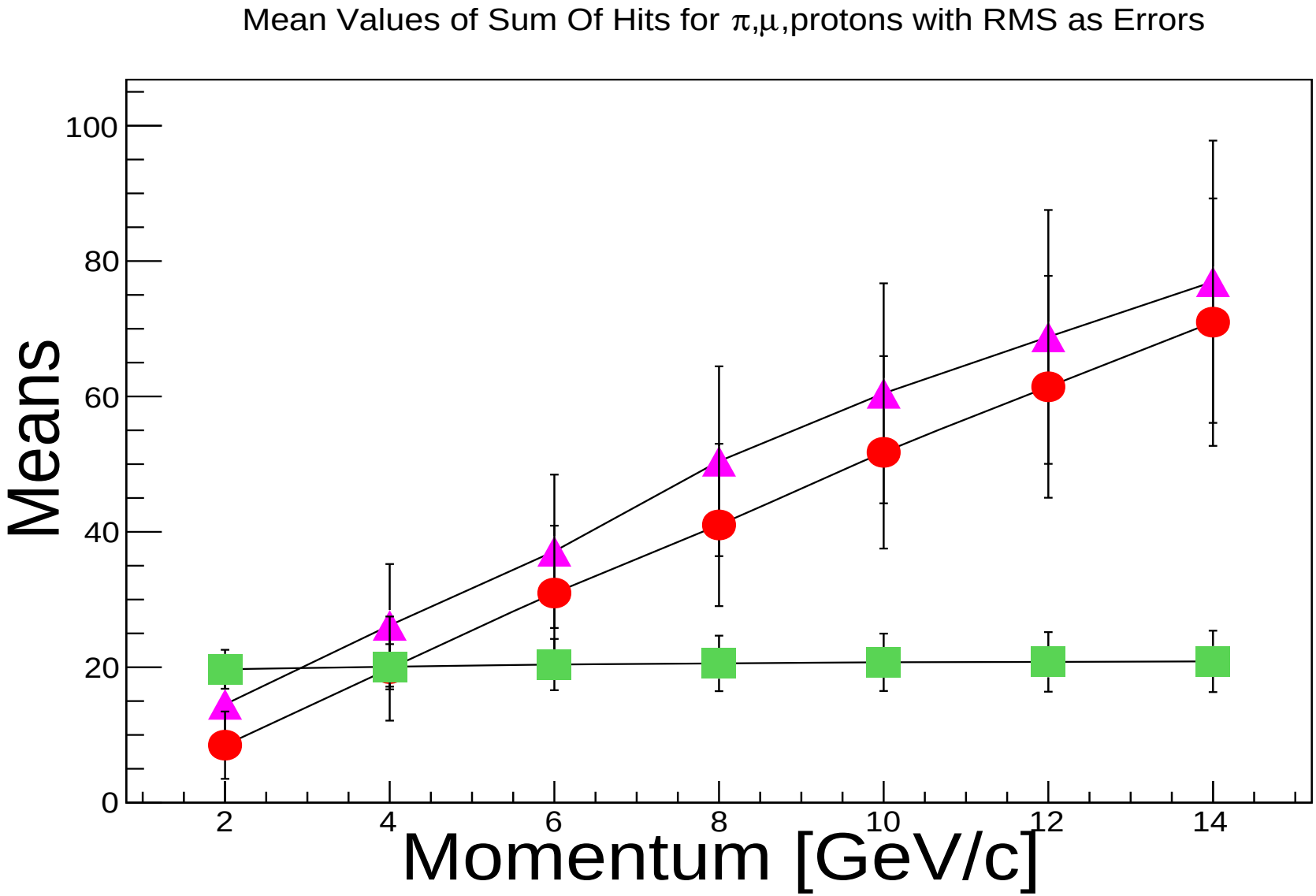
Number Of Hits Summed up Over All Layers,Pions



Number Of Hits Summed up Over All Layers,Protons



Hit Means And RMS

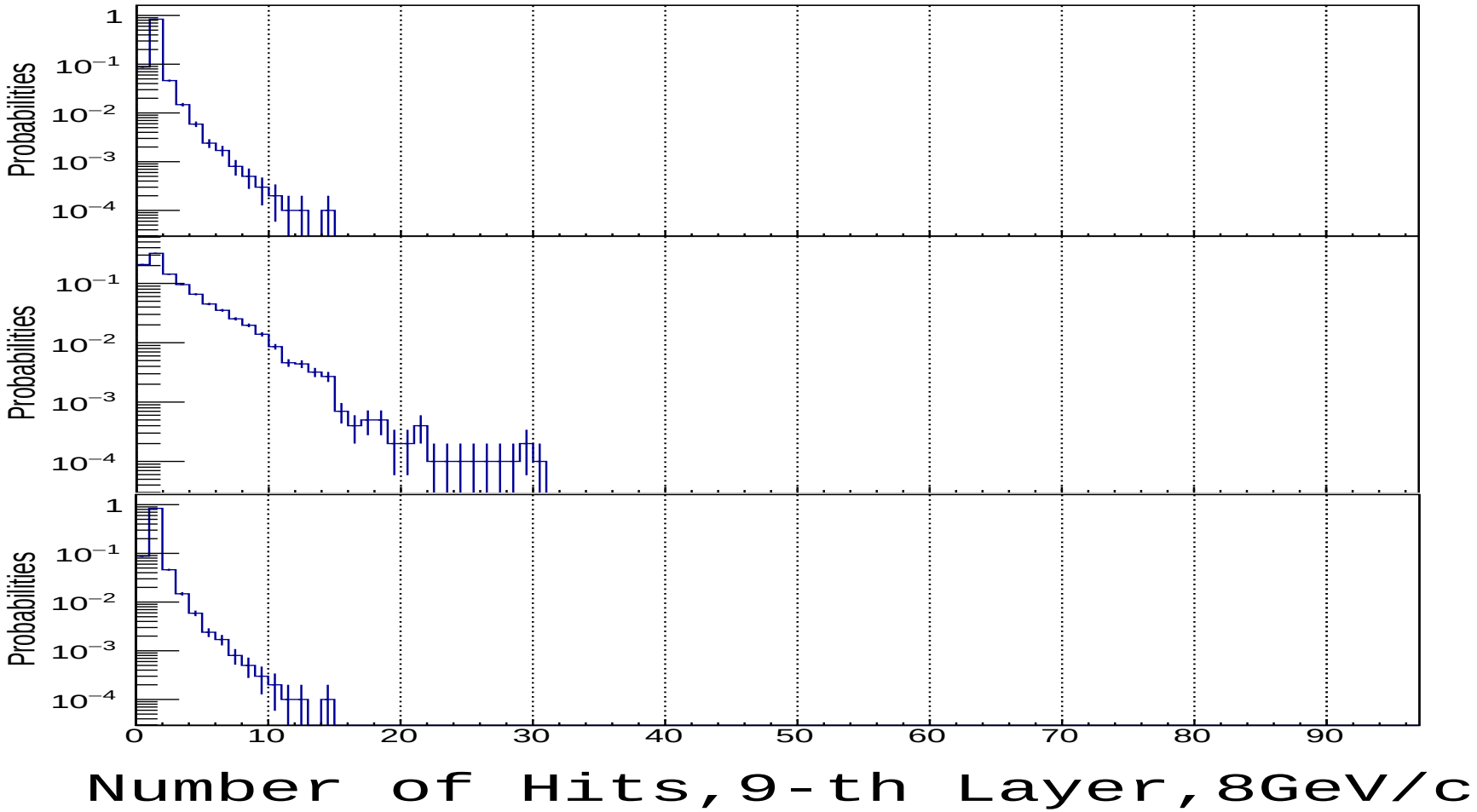


Means and RMS's. Squares for muons, circles for protons, triangles for pions

Decision Function, Logic Of Analysis

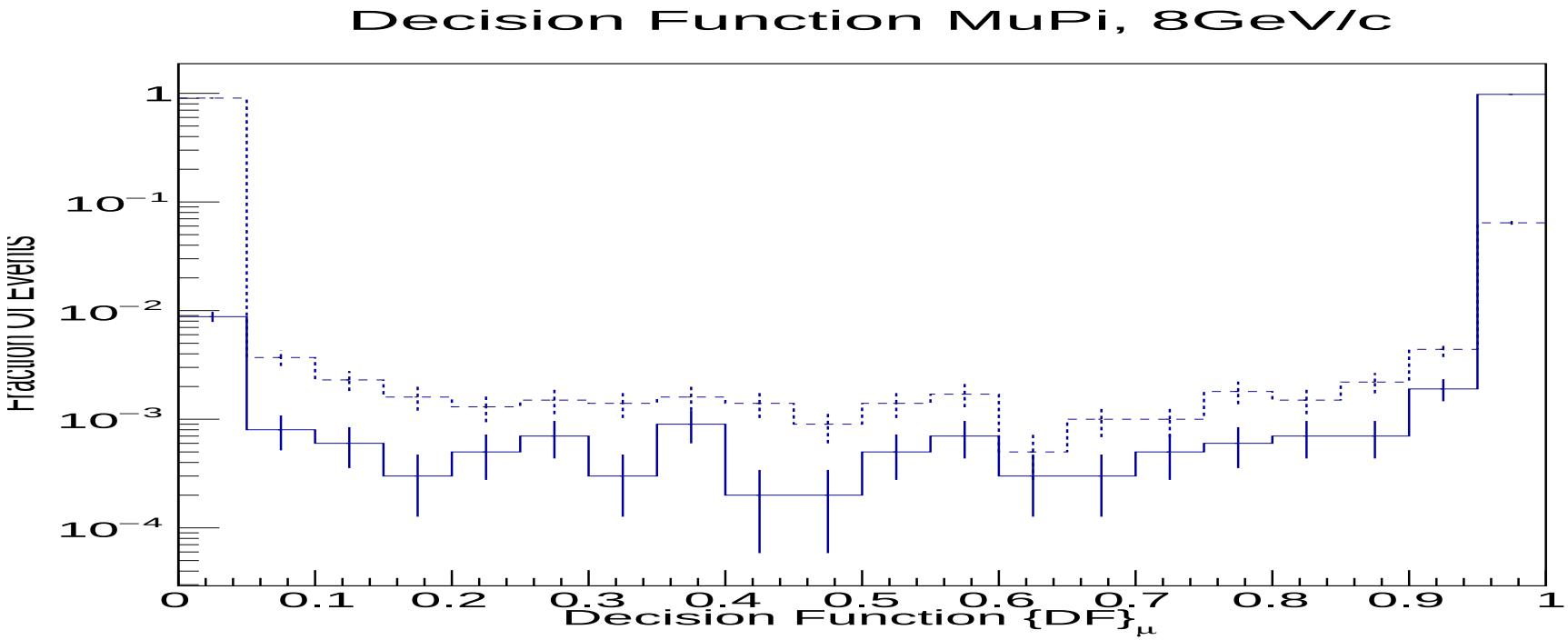
Goal : Having a set of Hits in a Layer $\{n^l\}$(l - Layer,n^l — a number in l-th Layer) what is the probability of its generation by muon?
Answer: To every n^l we can put in correspondence some probability p_n^l in asymptotic limit and to hit set $\{n^l\}$ a probability set $\{p_n^l\}$.
Assuming the beam consists of muons,protons,pions(with fractions W_μ, W_p, W_π, $W_\mu + W_p + W_\pi = 1$,usually unknown!),
Likelihood Function of Hits generation by muon will be $L_\mu = \prod_{l=1}^{20} p_n^l$.
Then $DF_\mu = W_\mu \cdot L_\mu/(W_\mu \cdot L_\mu + W_p \cdot L_p + W_\pi \cdot L_\pi)$ is the probability that it was generated by muon.
Usually we are forced to assume that all 3-types of particle are of equal probabilities and in such a case we have for this probability $DF_\mu = L_\mu/(L_\mu + L_p + L_\pi)$.
From now on we call this probability as a **Decision Function Of Muon** — $0 < DF_\mu < 1$

Probabilities as an example



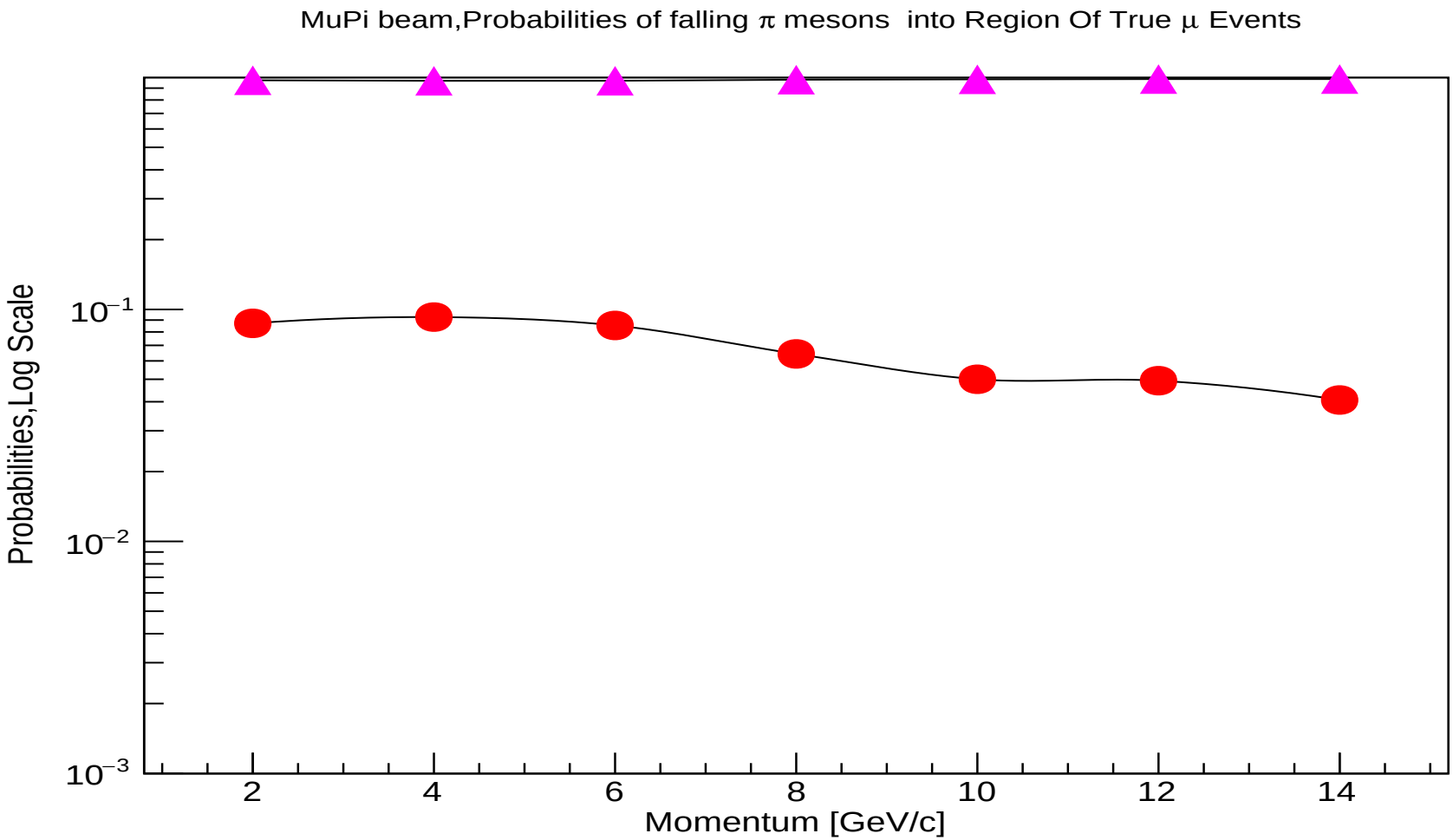
Muons,Protons,Pions— From Top to Bottom

Beam with Muons and Pions in equal Fractions



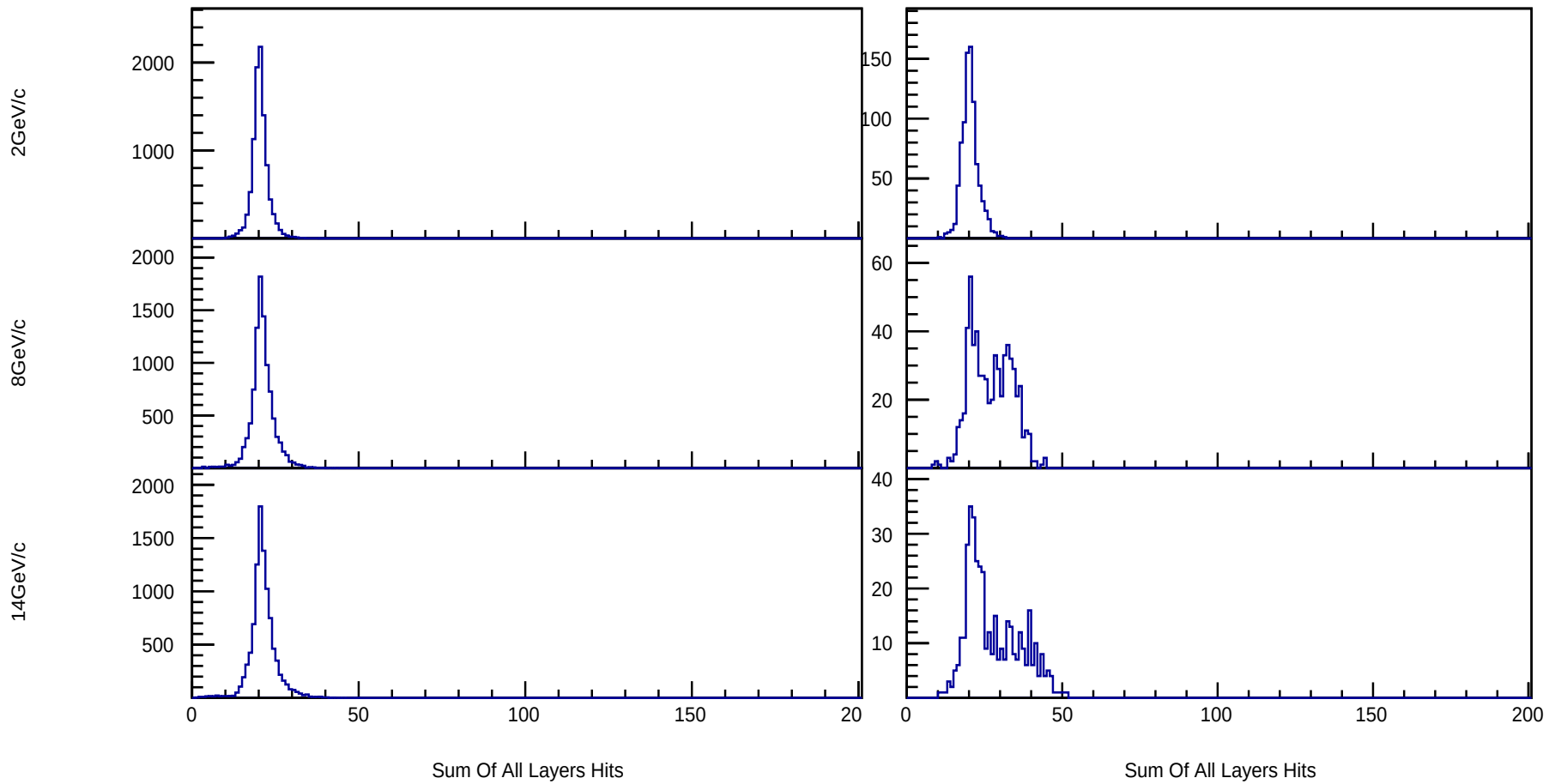
Values Of $DF_\mu = L_\mu/(L_\mu + L_\pi)$ supposing that beam consists of Muon and Pions In Equal Parts. Solid Line — for muons, dashed — for pions **To the right bin ($DF_\mu > 0.95$) $\approx 95\%$ of muons falling with the admixture of pions $\approx 5\%$!**

Admixture Of Pions, Identified As Muons, $DF_\mu > 0.95$



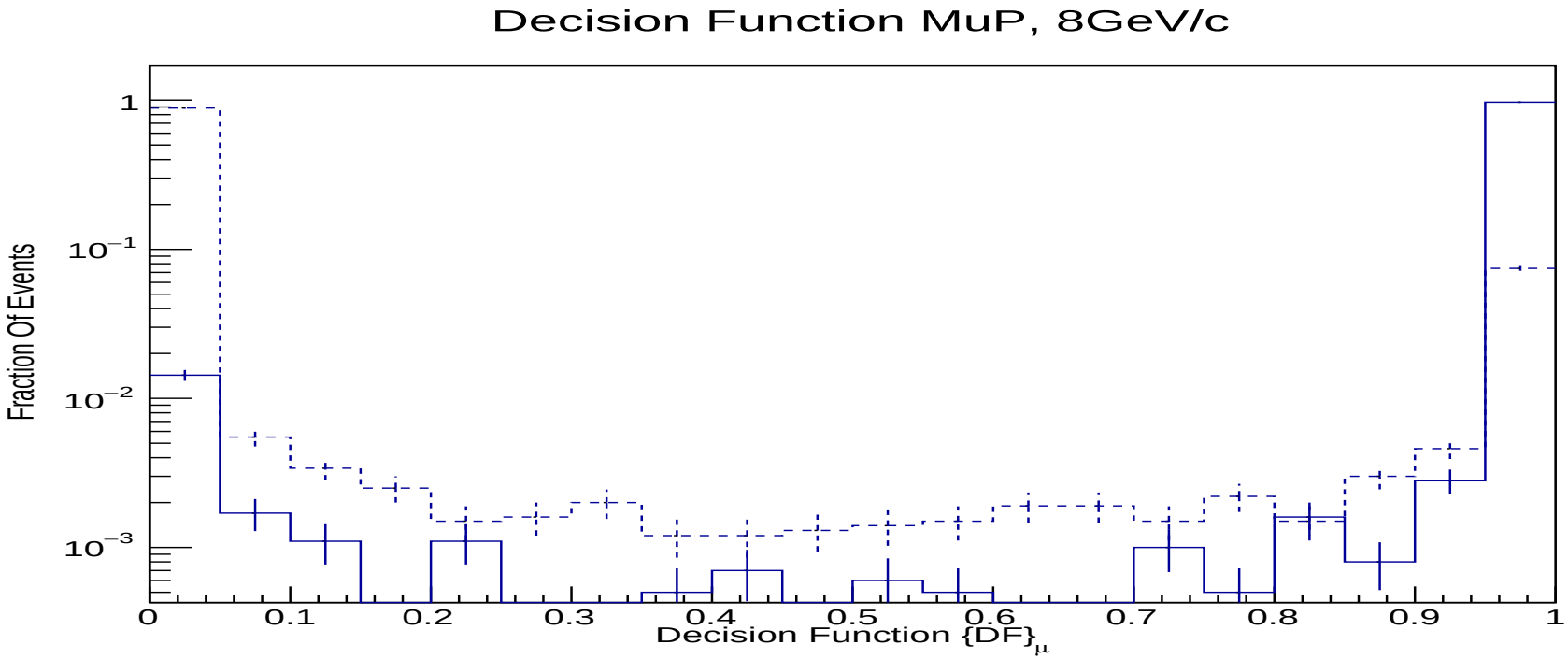
Fraction of Muons(triangles) versus admixture of pions(circles)

Hit Distribution Of Muons And Pions , $DF_\mu > 0.95$



Left 3 pictures — for muon, Right ones — for pions

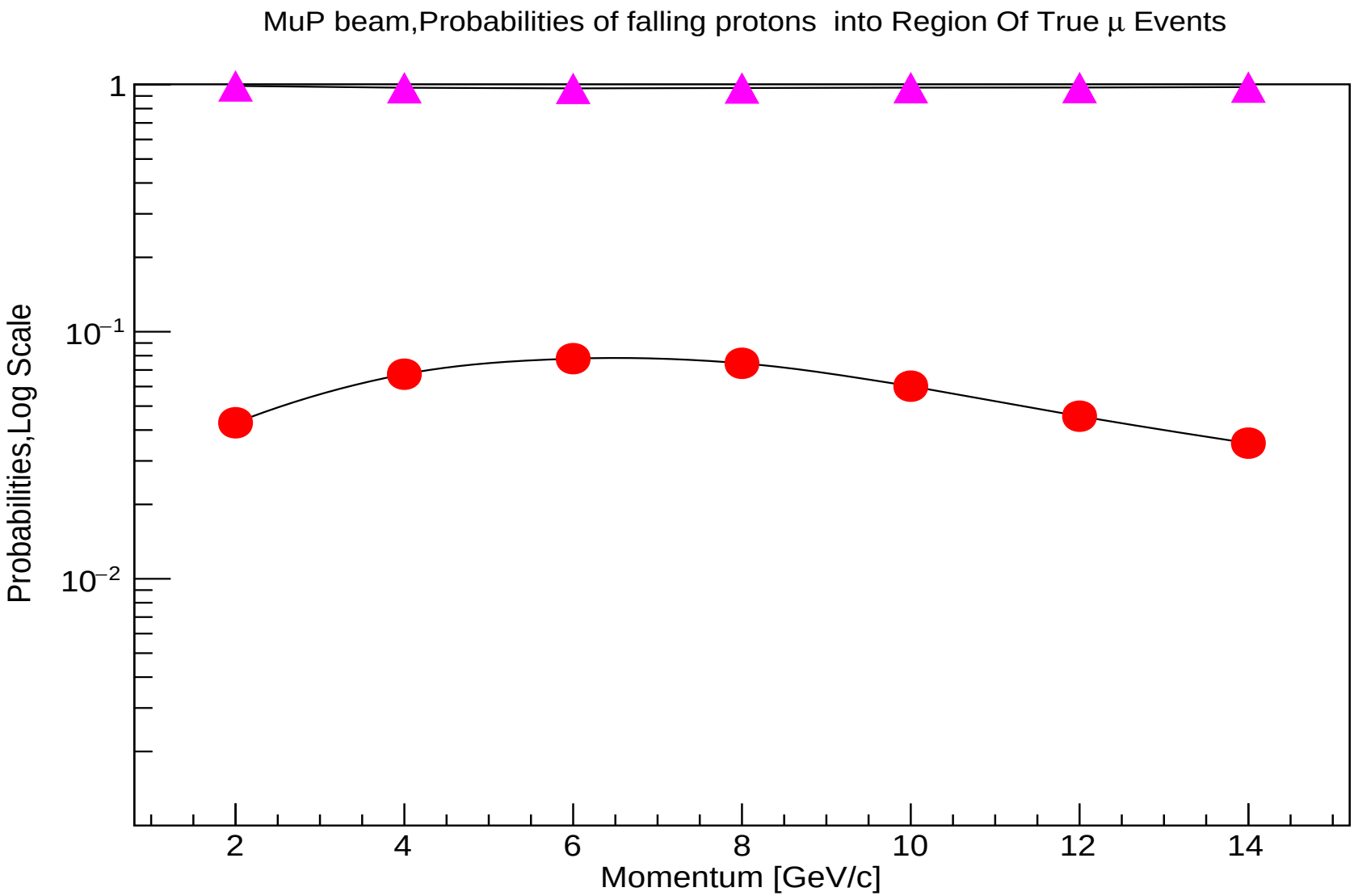
Beam : Muon and Protons In Equal Parts



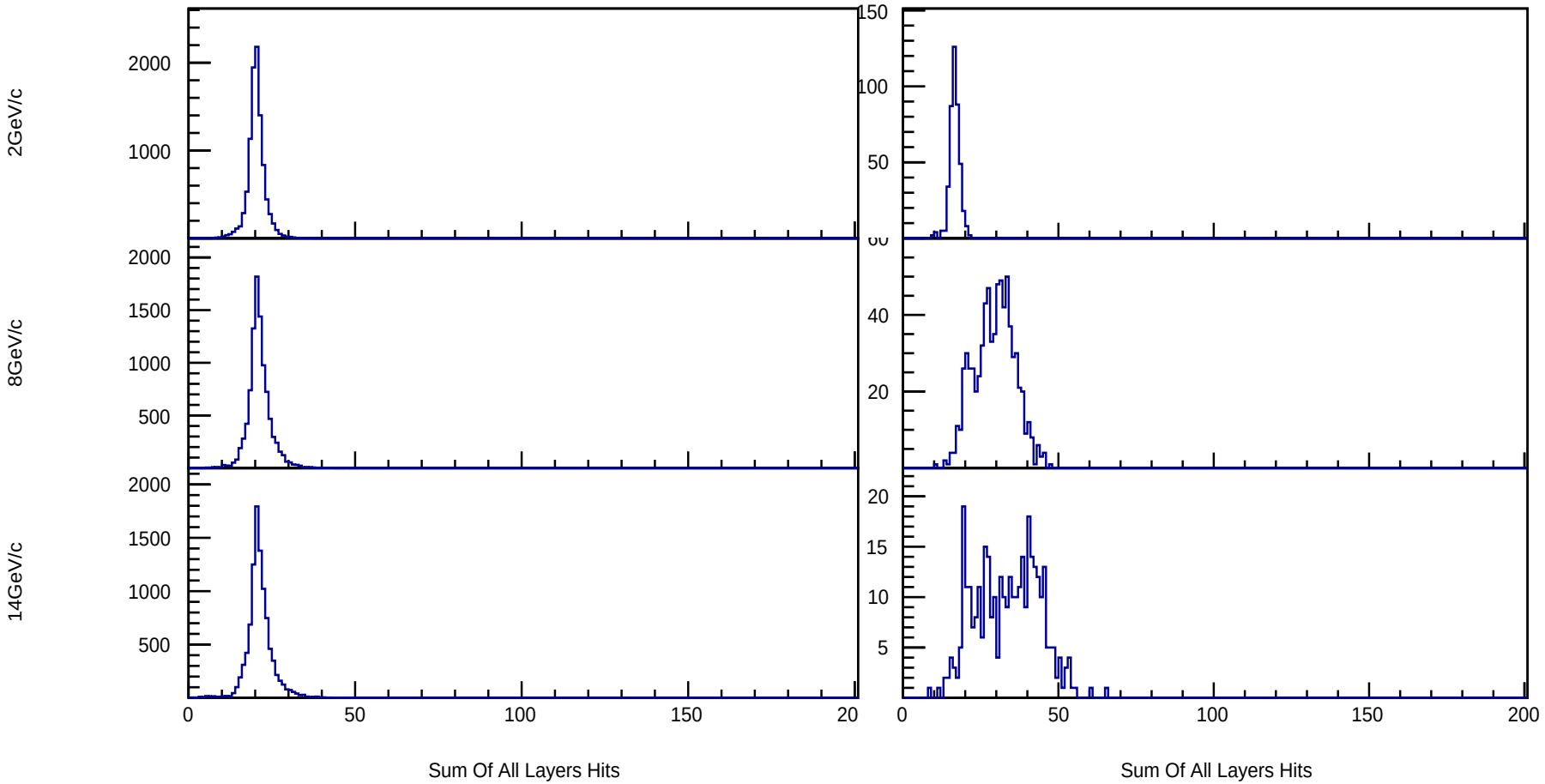
Model experiment - Values Of $DF_\mu = L_\mu/(L_\mu + L_p)$ supposing that beam consists of Muon and Protons In Equal Parts. Solid Line — for muons, dashed — for protons

To the right bin ($DF_\mu > 0.95$) $\approx 97\%$ of muons falling with the admixture of protons $\approx 3\%$!

Separation Of Muon Of Protons for $DF_\mu > 0.95$



Hit Distribution Of Muons And Protons, $DF_\mu > 0.95$



Left 3 pictures — for muon, Right ones — for protons

What is further?

Model data: Is There Any Potential For Improving? <– In principle yes — to decrease level of wrong decision(slides— 13,16)
A Lot of programming efforts!

Real data:

Certainly this the most important!A Lot of experimental and programming efforts!

Necessary ingredients:

- More experimental data on prototype
- Tuning Monte Carlo Model!