A more precise mass measurement of the Λ_c baryon

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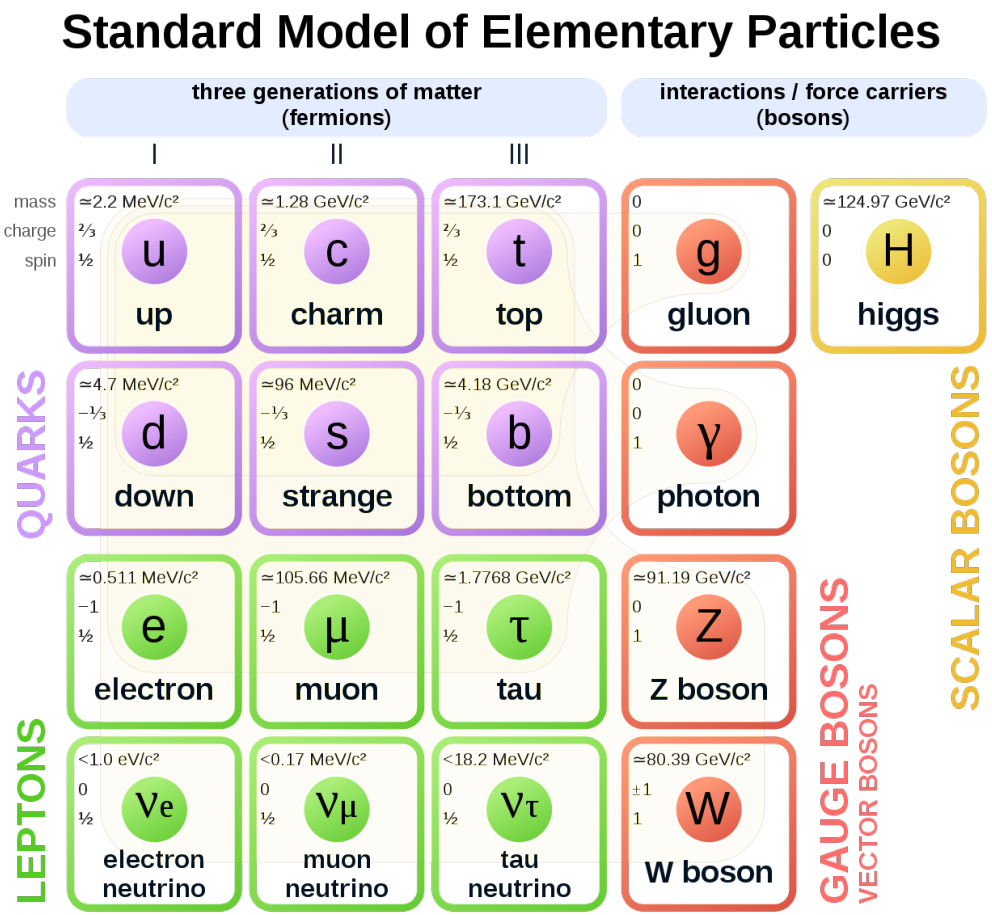
Standard Model



- Hadrons: Particles composed of quarks
- Baryons: Three quarks or anti-quarks
- Mesons: Quark/anti-quark pair
- Λ_c^+ composed of up,down, and charm quark

Figure: Modern classification of elementary particles[2]

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Background of the LHCb collaboration

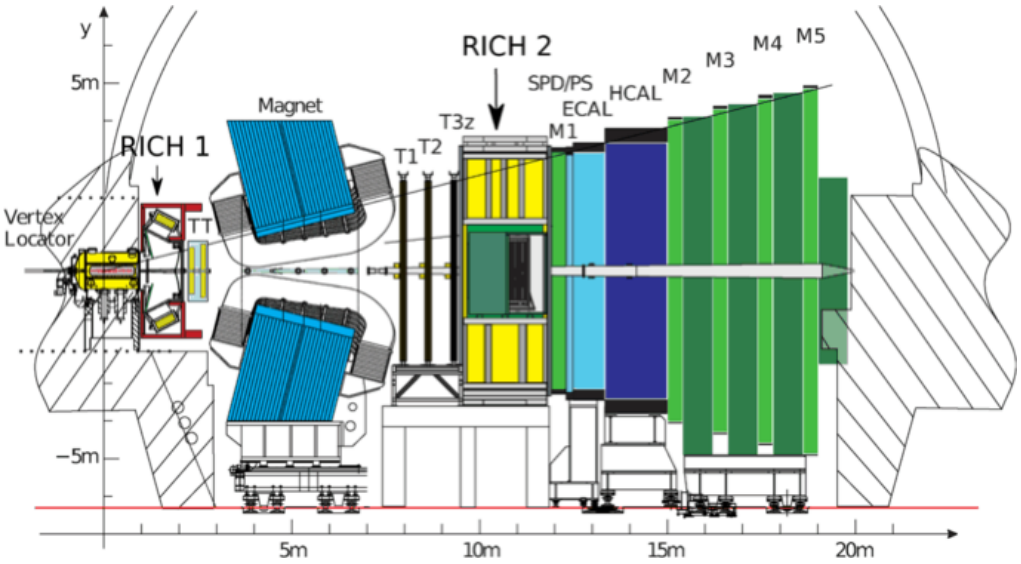

Figure: Cross section view of LHCb Detector[1]

- Single-arm forward spectrometer
- Primarily observes beauty and charm hadron decays
- Used to study CP violation

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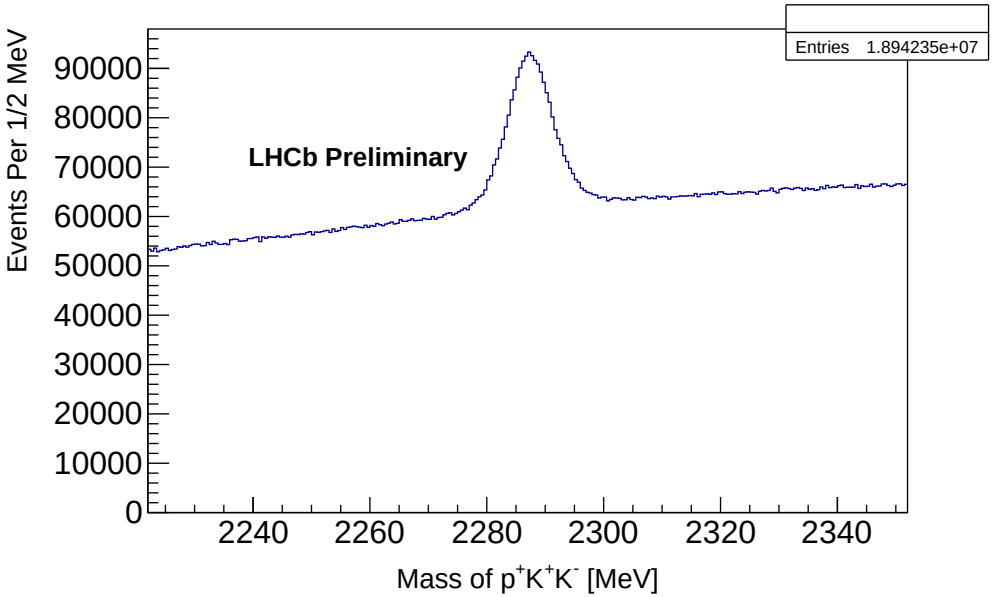
Analysis goal and procedure



Goal: Create sample of $\Lambda_c \to pK^+K^-$ events with high statistical precision.

Procedure: Set selection criteria on decay kinematics and particle identification.

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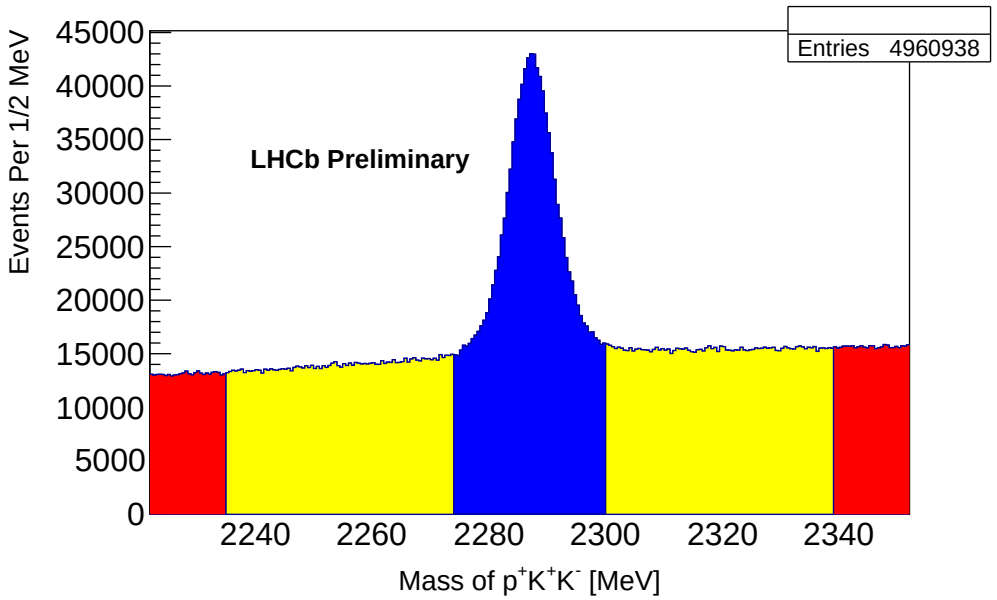
Preliminary cuts on ProbNN variables



ProbNN Preliminary Cuts	
Variable	Cut
Proton_ProbNNp	> 0.6
Product of ProbNNx	> 0.4

- Ensuring each event includes a p, K^+, and K^-
- ProbNNx: Probability of charged track being a specific hadron

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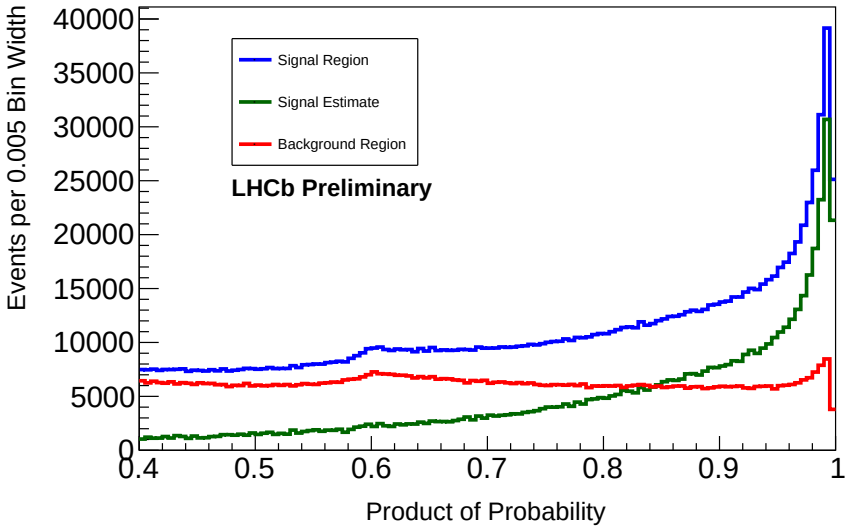
Further cuts on ProbNN variables



PID Cuts	
Variable	Cut
Proton_ProbNNp	> 0.9
Product of ProbNNx	> 0.8

- Improving signal:background while maintaining statistical significance
- Remove regions where background is greater than signal.

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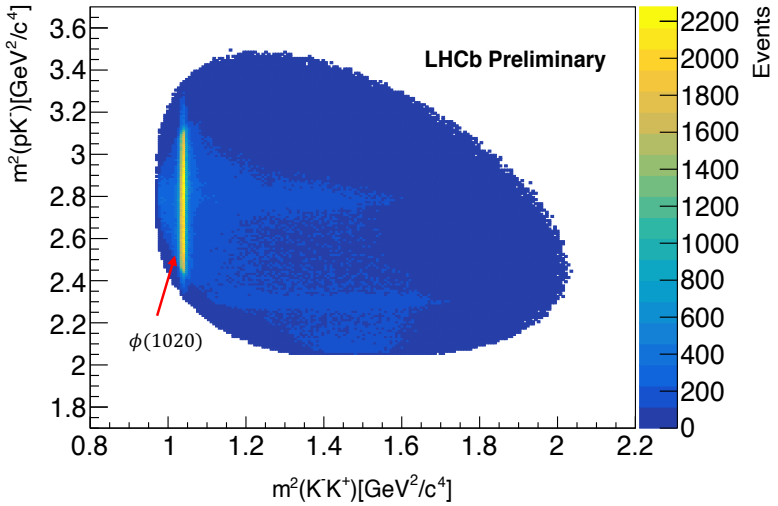
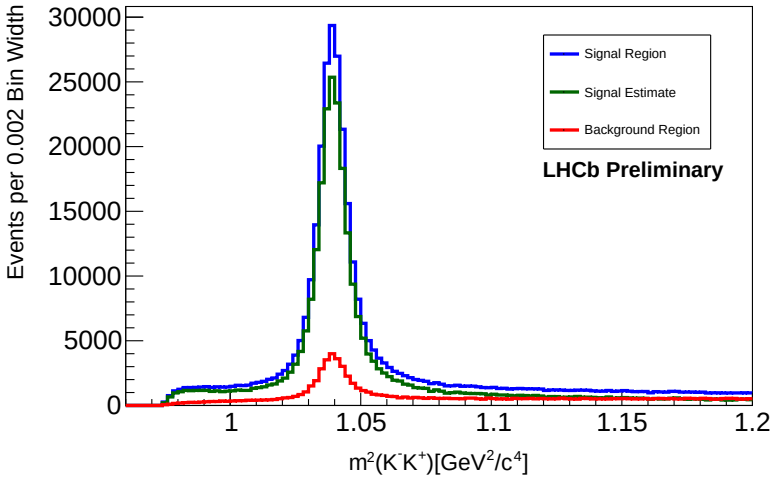
Cuts on decay kinematics





- Dalitz Plot: Visualization of resonances between final-state particles
- $\phi(1020) \rightarrow K^+K^-$ is a possible resonance in decay
- Most signal events have intermediate $\phi(1020)$

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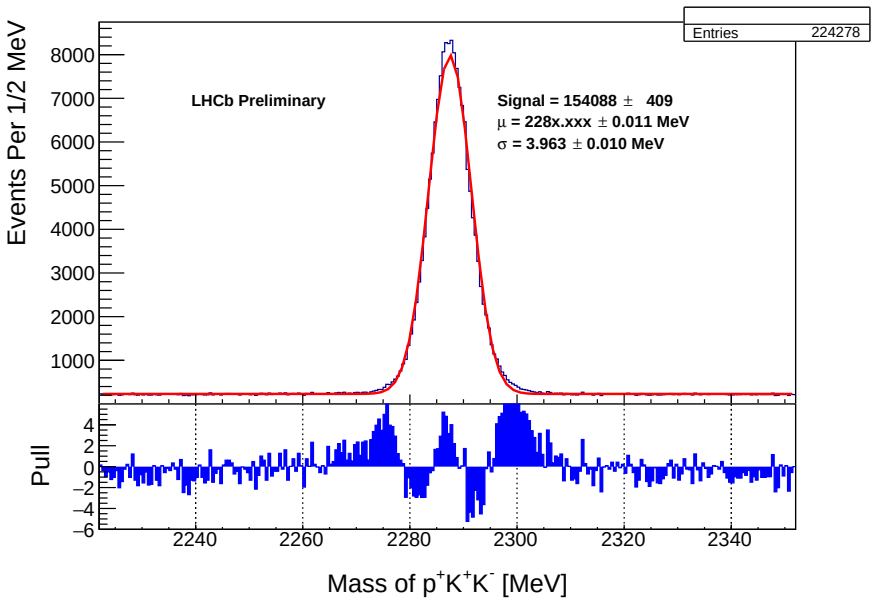
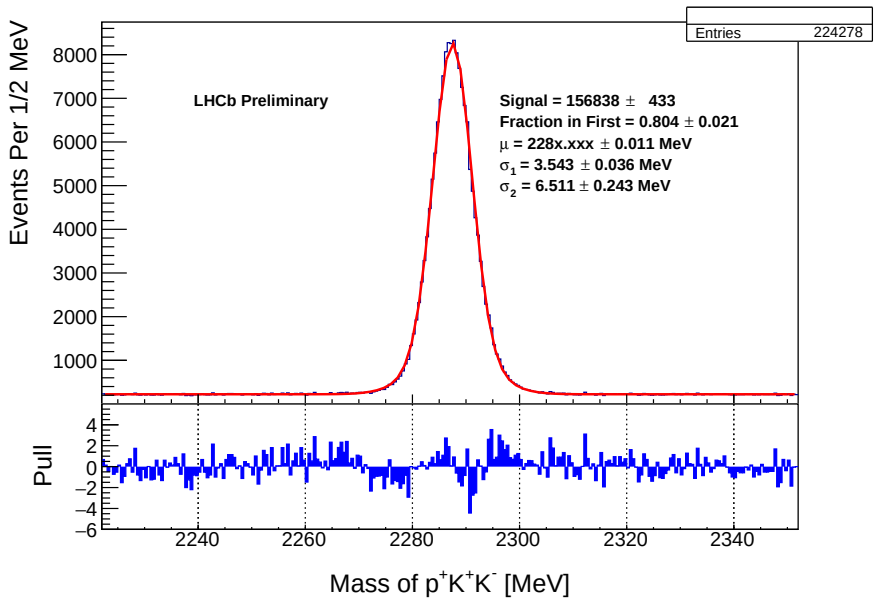
Fitting

Single Gaussian Signal + Linear Background



Double Gaussian Signal + Linear Background



Pull: Visualization of a fit's quality at each bin center.

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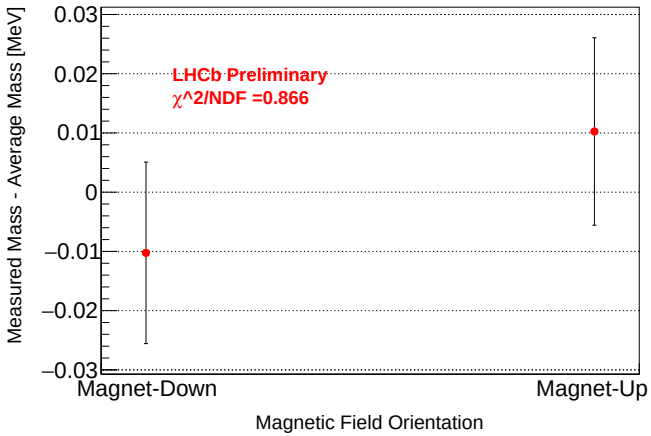
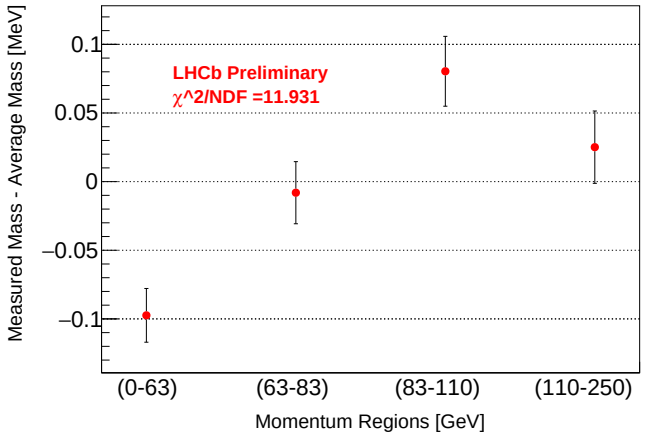
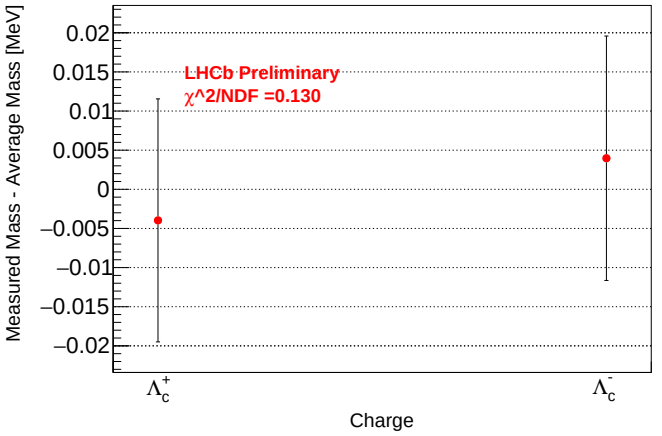
Systematic uncertainties

(After momentum corrections)







Equation for Systematic Error

$$\sigma_{sys} = \sigma_{stat}\sqrt{1 - \chi^2/NDF}$$

Total Systematic Error

$0.036\,\mathrm{MeV}/c^2$

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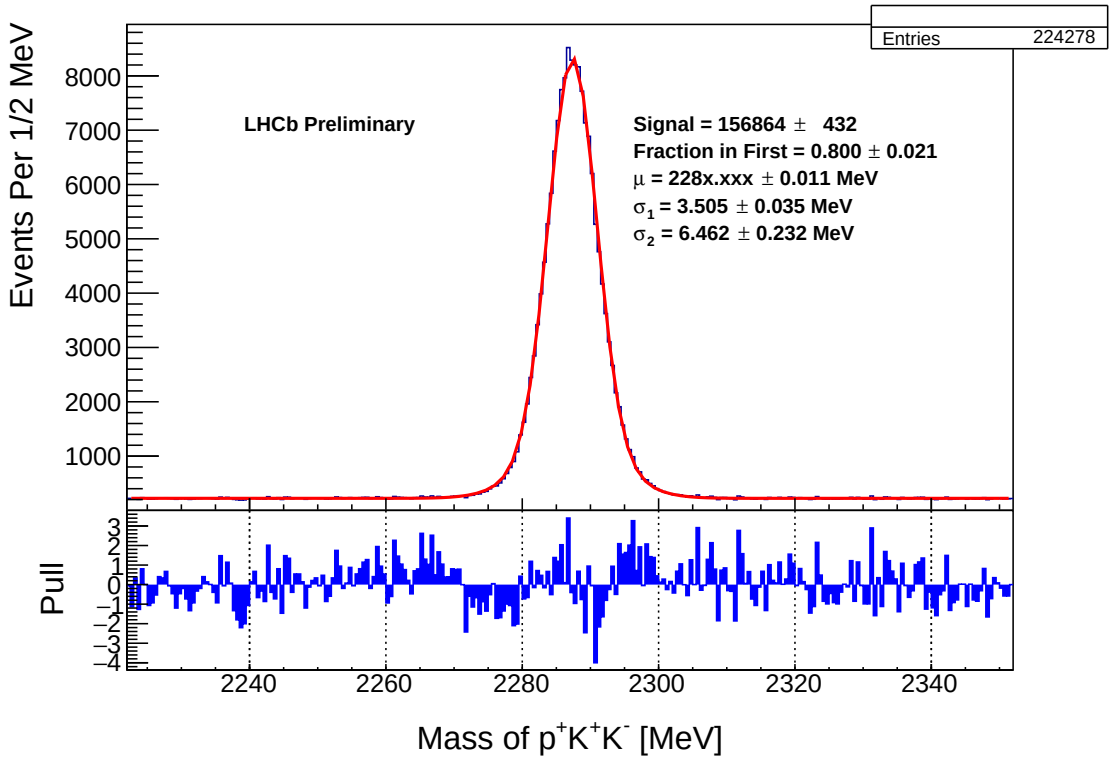
Results



Analysis Measurement: $(228x.xx \pm 0.05 \pm ??)\,\mathrm{MeV}/c^2$

Current PDG Value: $(2286.46 \pm 0.14)\,\mathrm{MeV}/c^2$

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Future Work & References

- Test different fit functions
- Vary bin sizes
- Study momentum correction dependence

1. LHCb collaboration, A.A Alves Jr. *et al., The LHCb detector at the LHC,* JINST **3** (2008) S08005
2. Standard Model of Elementary Particles. Courtesy to Wikipedia: 'Standard Model of Elementary Particles' by Cush-Own work by uploader, PBS NOVA, Fermilab, Office of Science, United States Department of Energy, Particle Data Group.

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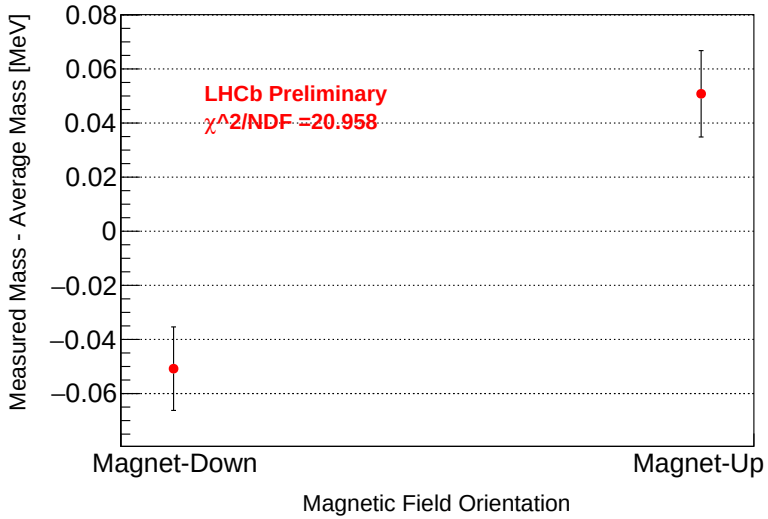
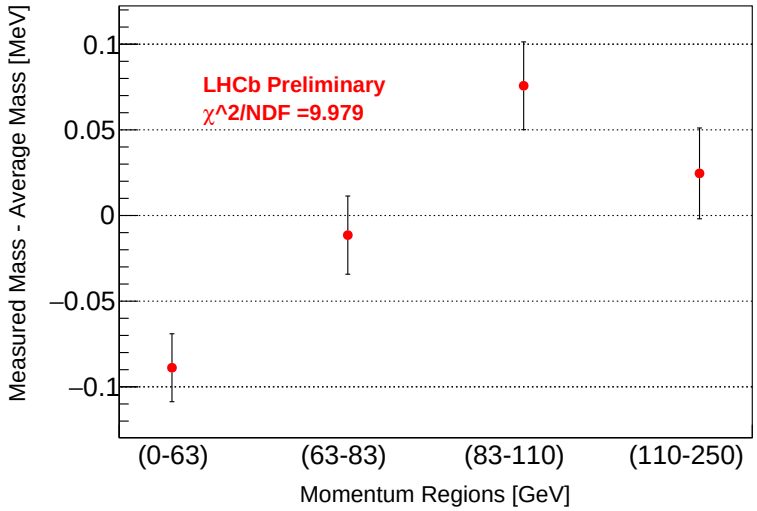
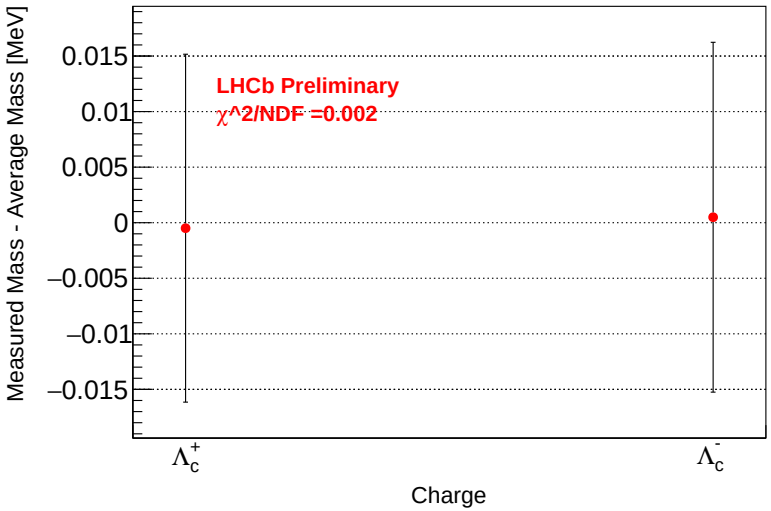
Systematic uncertainties







Total Systematic Error

$0.05974 \mathrm{MeV}/c^2$

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