Searching for CP Violation in Charm Decays

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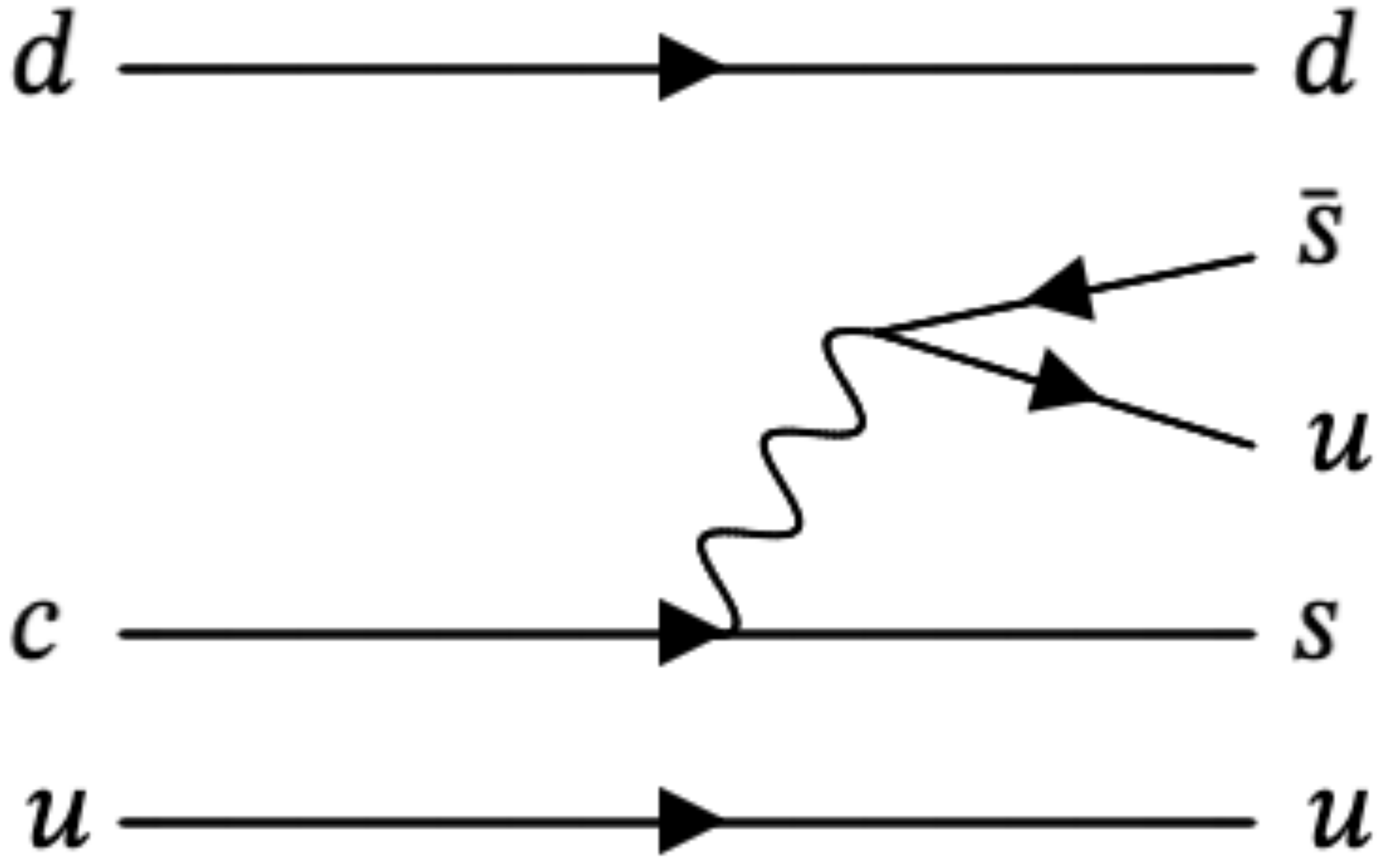
Introduction

- Baryogenesis- process by which more matter was produced than antimatter
- SM predicts some CP violation but not enough to explain the universe
- Predictions of CP violation in charm decays is very small, so any observation is potentially significant
- Additionally, charm quarks are important for testing QCD models

$\Lambda_c \to \Sigma K_S^0$

- This is a Cabibbo suppressed decay
  - If there are non-SM effects, they will potentially be easier to see
- We want to measure the branching ratio (how often this decay happens compared to other decays) and the α-induced asymmetry
- What is an α-induced asymmetry?



α-Induced Asymmetry

- Angular distribution of the decay is given by $\dfrac{\mathrm{d}N}{\mathrm{d}\cos\theta} = (1 + \alpha\cos\theta)\mathrm{d}\Omega$
  - So α is the slope of the $\cos\theta$ distribution
- We find α for both the matter and antimatter mode and find the asymmetry from $A_{CP}^{\alpha} = \dfrac{\alpha_{\Lambda_c^+} - \alpha_{\Lambda_c^-}}{\alpha_{\Lambda_c^+} + \alpha_{\Lambda_c^-}}$

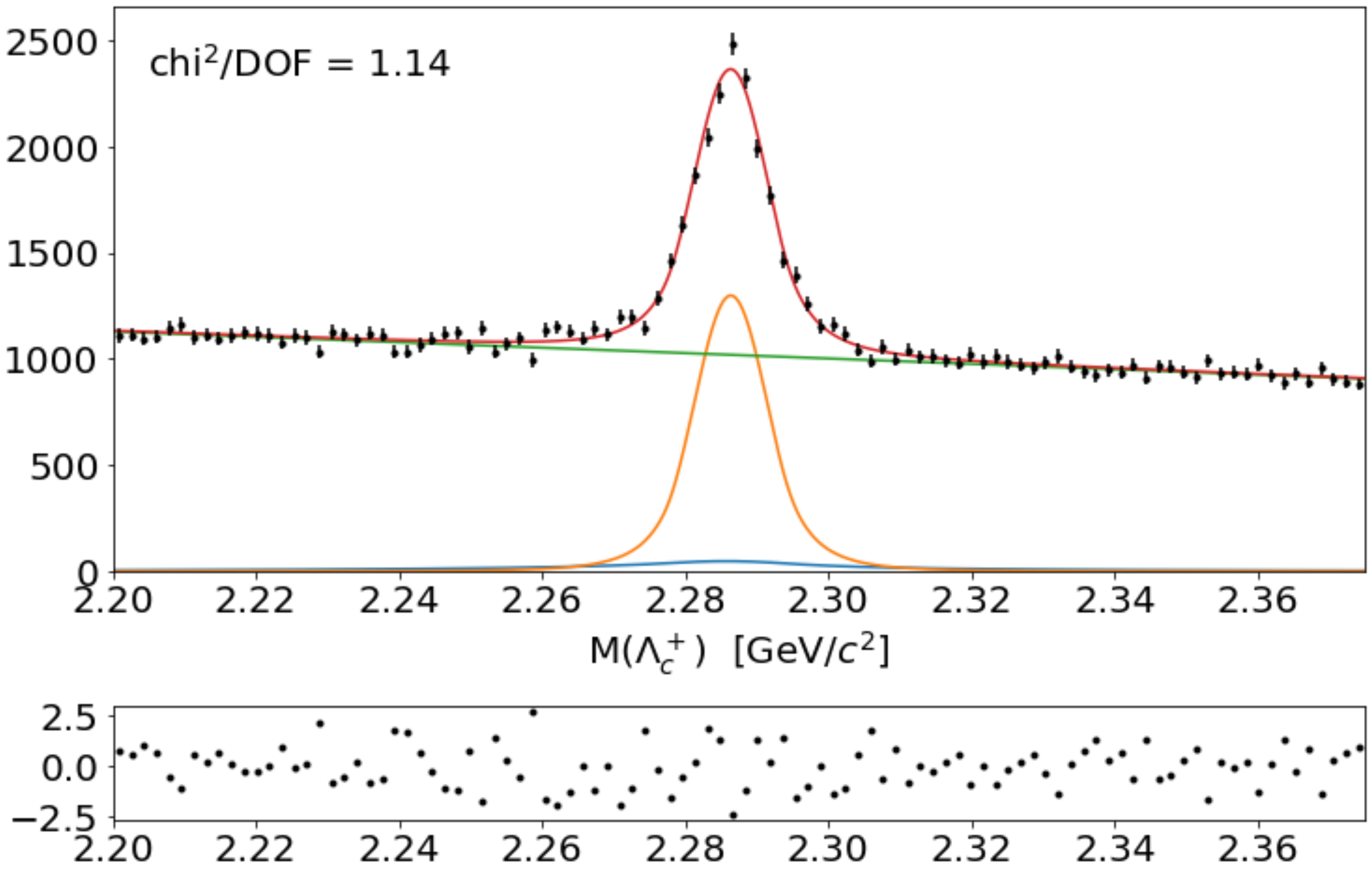
Monte Carlo Studies

- Currently working with Monte Carlo (MC) data that is simulated to mimic real data
  - We do this so we can made sure our analysis code is doing what we expect and to understand the uncertainties on our measurement
- We know exactly what parameters the MC data is created with, so we can check that we are getting the right answer

Integrated Fit

Signal Mode

Truth-matched signal: 10152 events

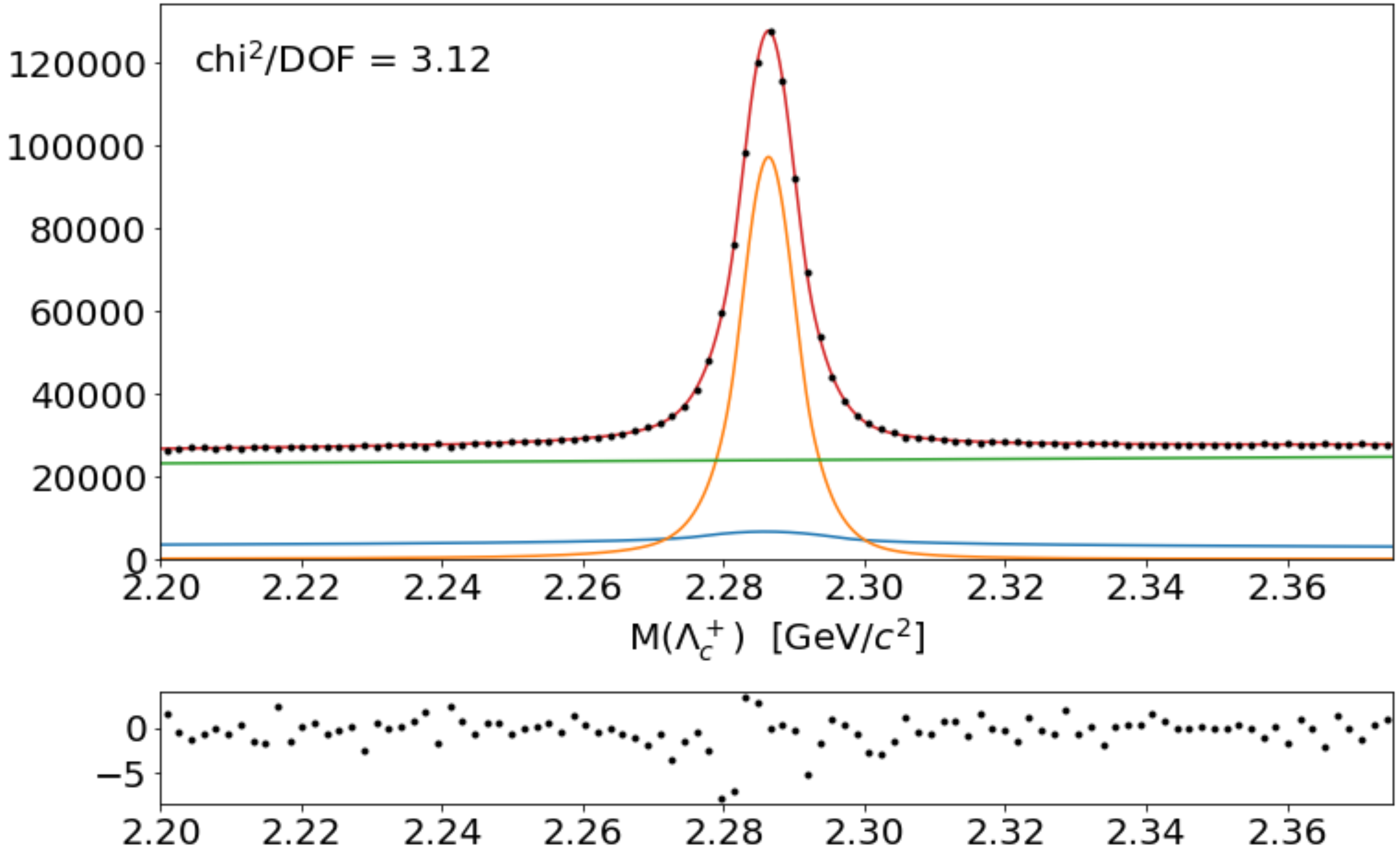


$$N(\Lambda_c \to \Sigma K_S) = 10412 \pm 188$$

Integrated Fit

Reference Mode

Truth-matched signal: 674134



$$N(\Lambda_c \to \Sigma\pi^+\pi^-) = 660800 \pm 1148$$

Branching Ratio

Result

$$BR(\Lambda_c \to \Sigma K_S^0) = \frac{N(\Lambda_c \to \Sigma K_S^0)\epsilon_{ref}}{N(\Lambda_c \to \Sigma\pi^+\pi^-)\epsilon_{sig}BF(K_S^0 \to \pi^+\pi^-)}$$

$$= \frac{10412 \times 0.240}{660800 \times 0.0977 \times 0.69} = 0.0560 \pm 0.0010$$

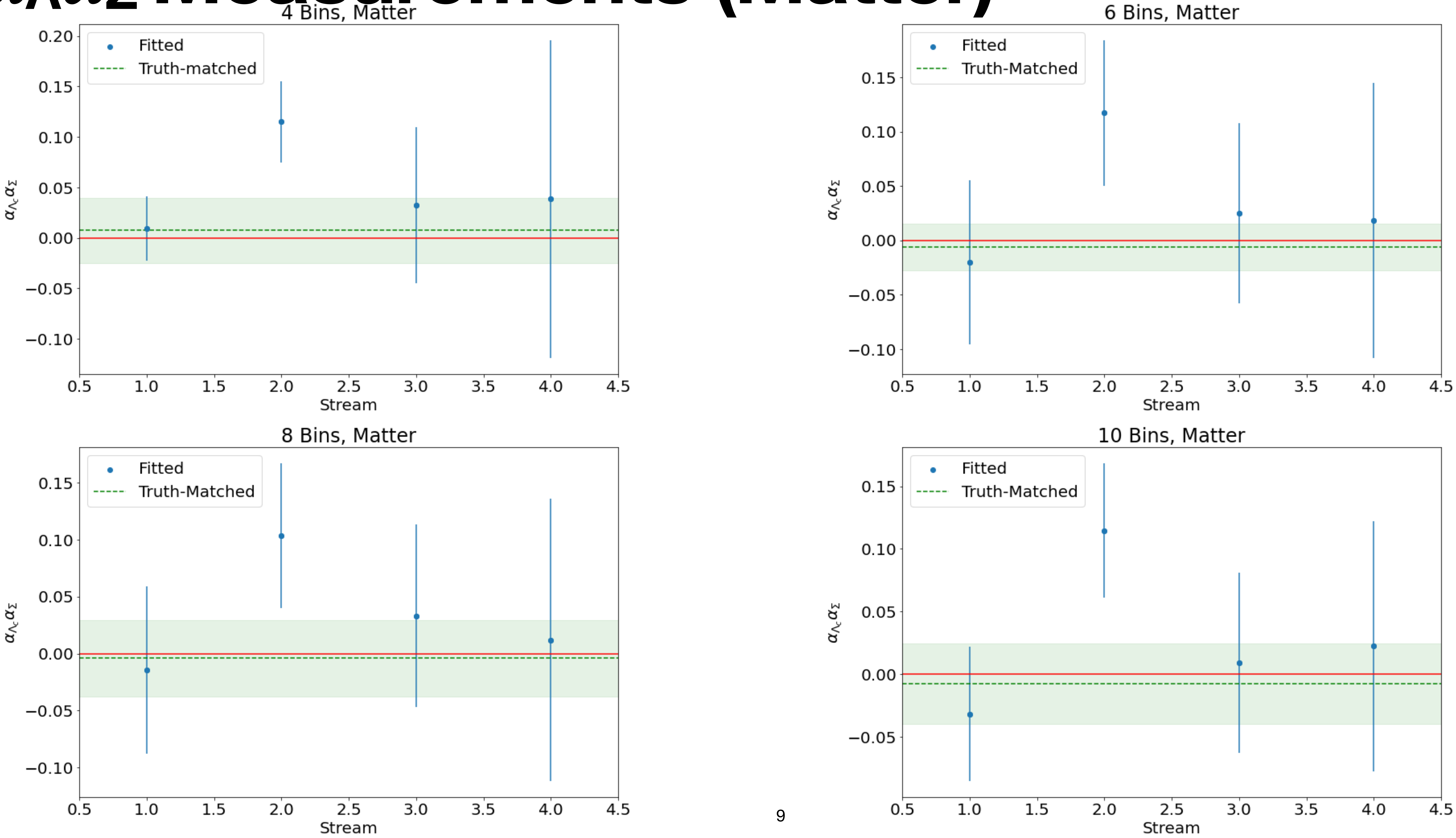
Taken from dec file

From dec file:

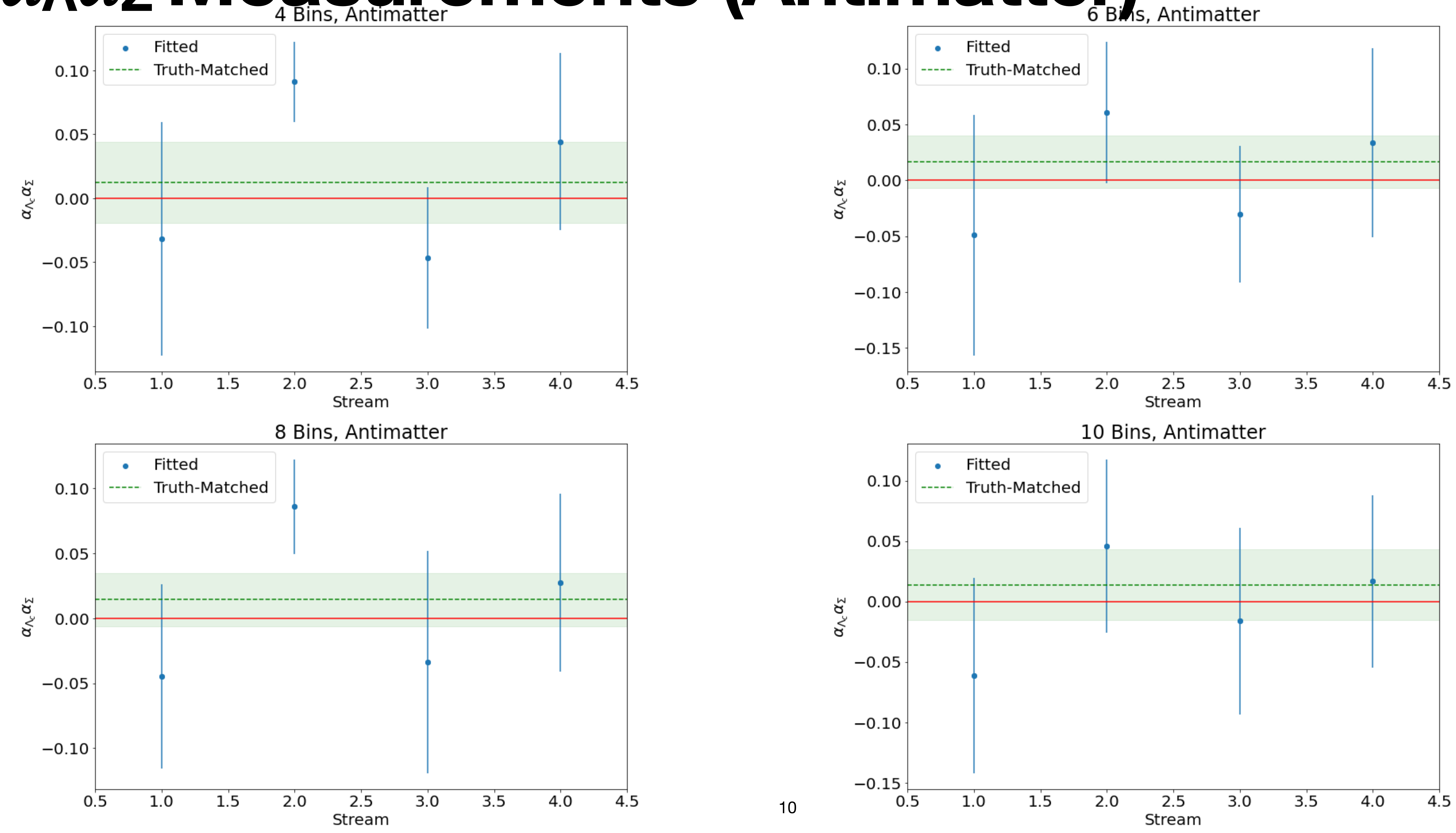
$$BR(\Lambda_c \to \Sigma K_S^0) = \frac{0.002}{0.036} = 0.0556$$

We are consistent!

$\alpha_\Lambda \alpha_\Sigma$ Measurements (Matter)



$\alpha_\Lambda \alpha_\Sigma$ Measurements (Antimatter)



Conclusion

- Our MC results are consistent with what we expect
- Next need to figure out the systematic uncertainties on our measurements
- Once that's done, we can start to look at real data