Wrong Sign D^0 Decays

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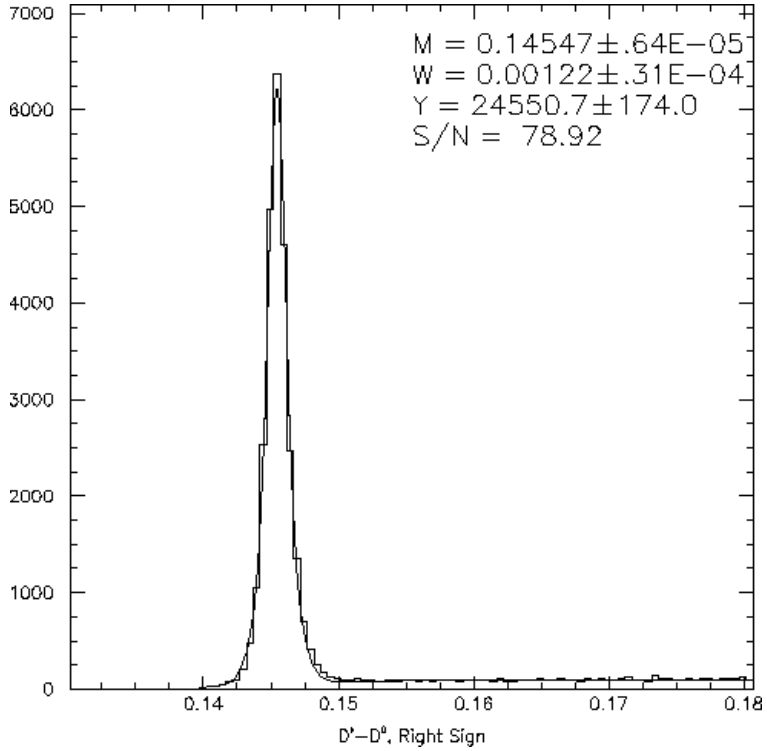
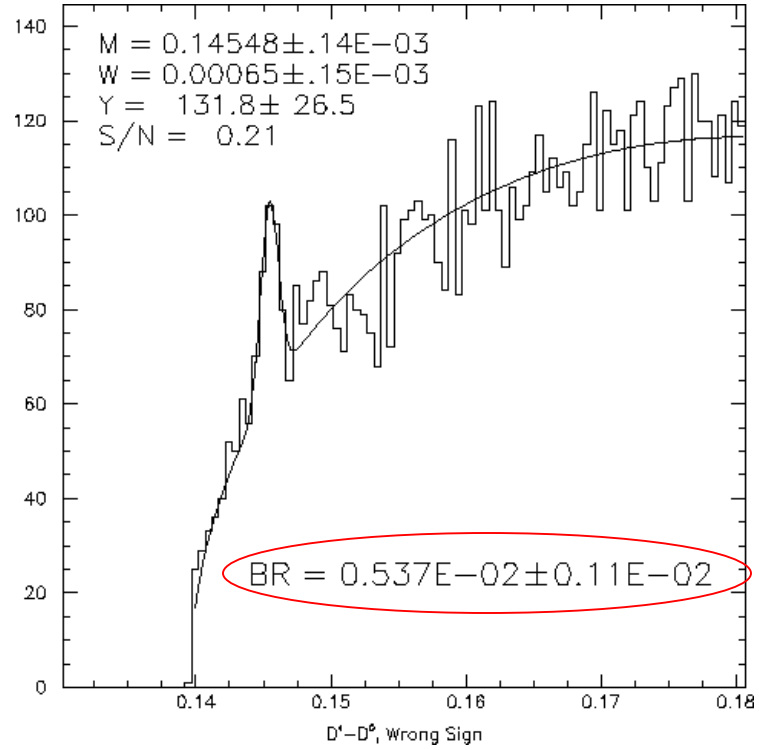
New Study Using D^0 **g** $K\pi$

Baseline Cuts

- $L/\sigma > 5$
- Isolation 1 < 10%
- Multiplicity of Primary > 2
- Primary Vertex in Target > -1σ
- Confidence Level of π as μ < 1%
- K π Asymmetry < 70%
- Pionicity > 2
- Kaonicity > 2
- Pionicity+Kaonicity > 8





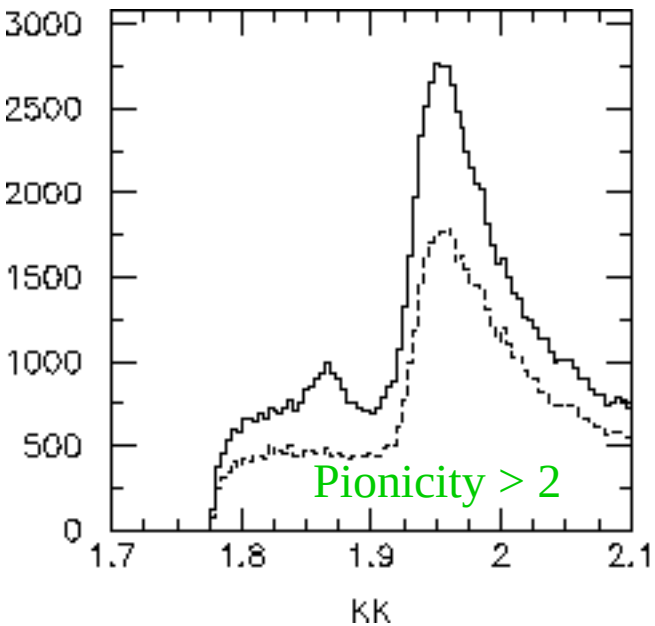
Non-$K^+\pi^-$ Sources of Wrong Sign D* Peak

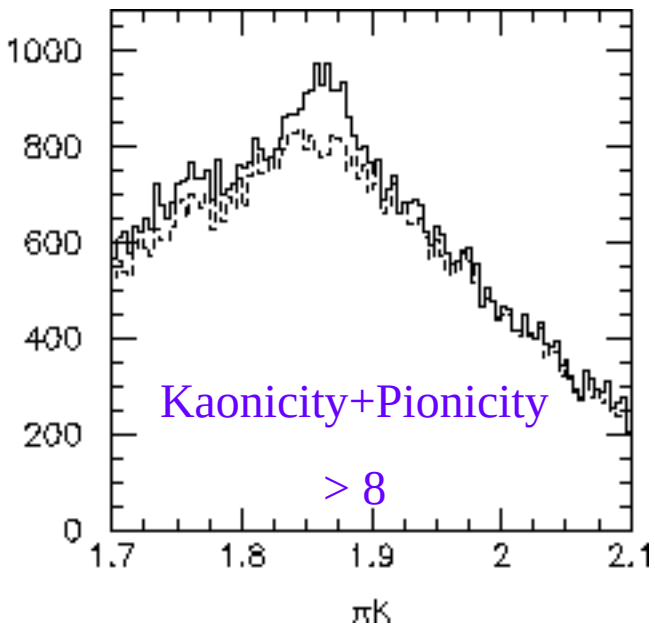
Double Misidentification

- D^0 **g** $K^-\pi^+$
- D^0 **g** $K^-\pi^+\pi^0$
- D^0 **g** $K^-\mu\nu$
- D^0 **g** $K^-e\nu$

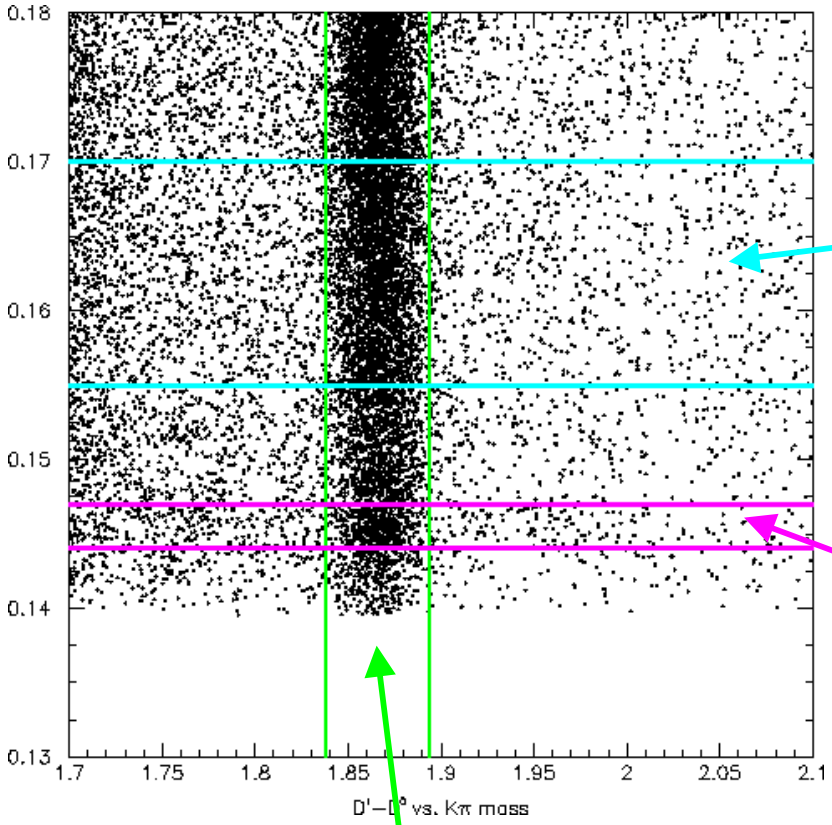
Single Misidentification

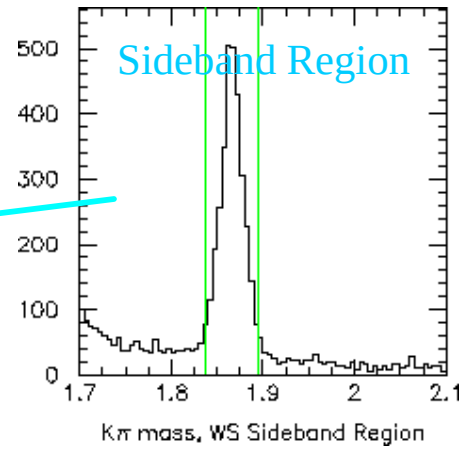
- D^0 **g** K^-K
- D^0 **g** $\pi^+\pi^-$
- D^0 **g** $K^-K\pi^0$
- D^0 **g** $\pi^+\pi^-\pi^0$



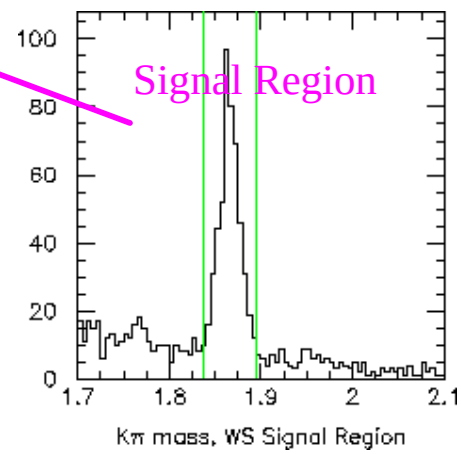


Another Method: Sideband Subtraction (Sort of…)

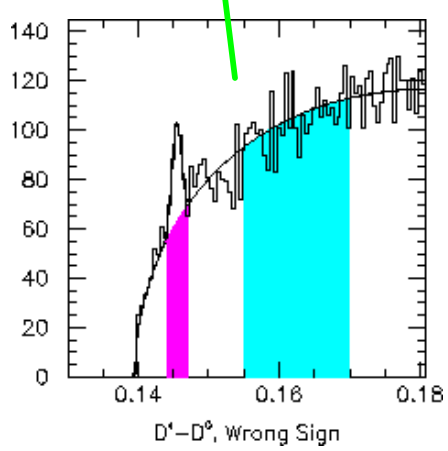




Use a sideband from the D^*-D^0 mass difference plot…

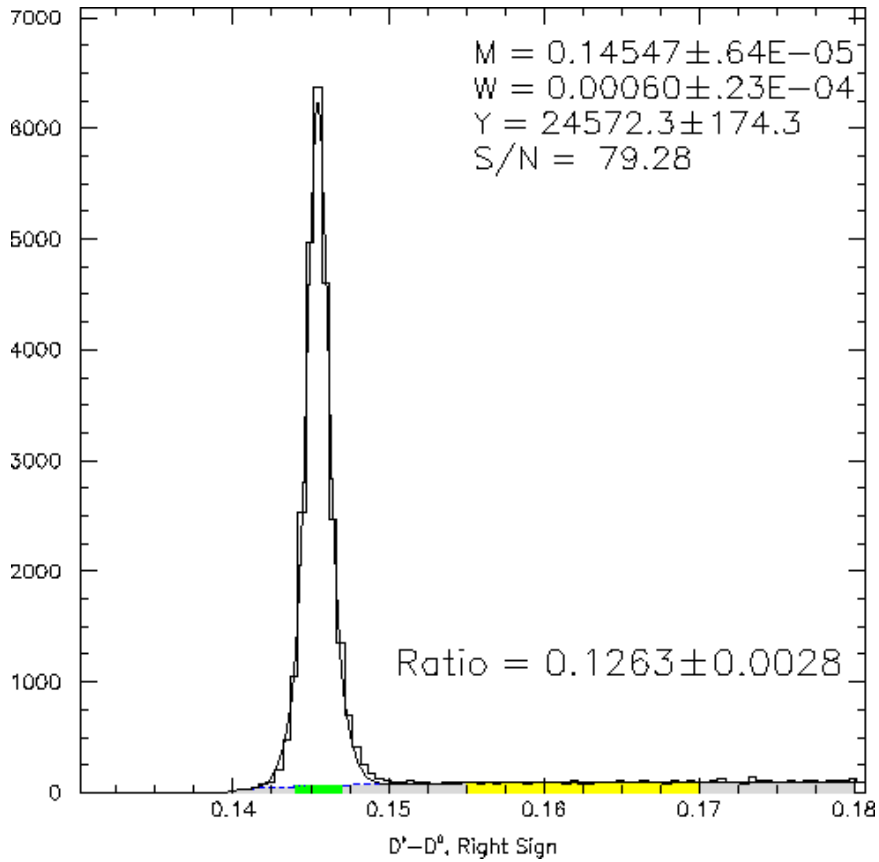


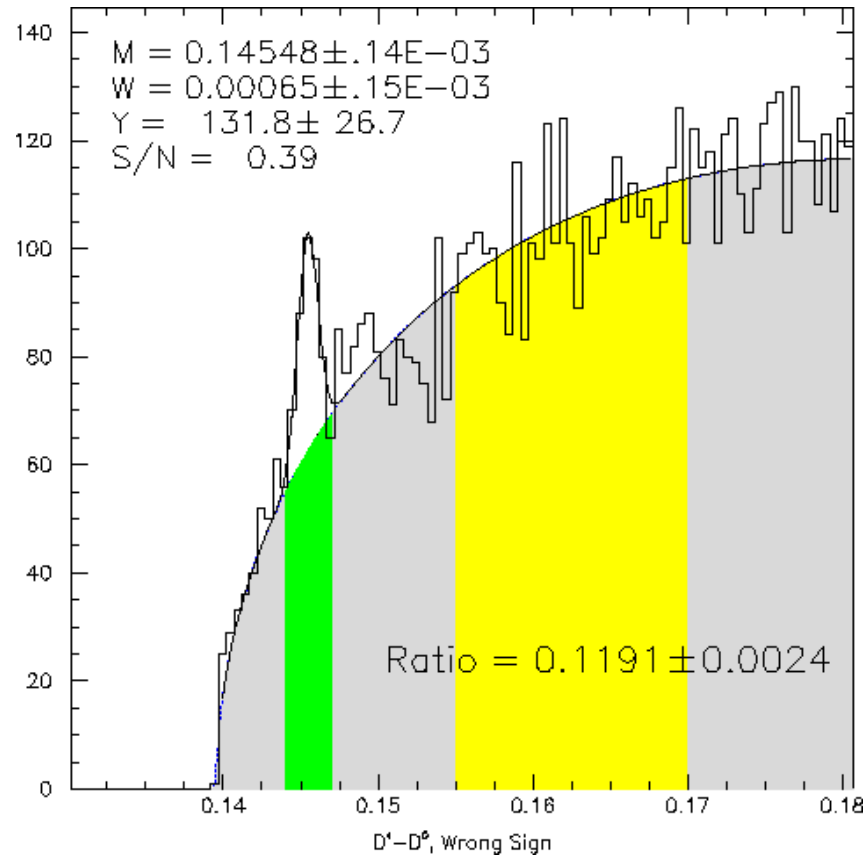
to subtract off the background D^0 from the signal region.



$$Yield_{WS} = Yield_{SR} - Yield_{SB} \times Ratio_{BGs}$$

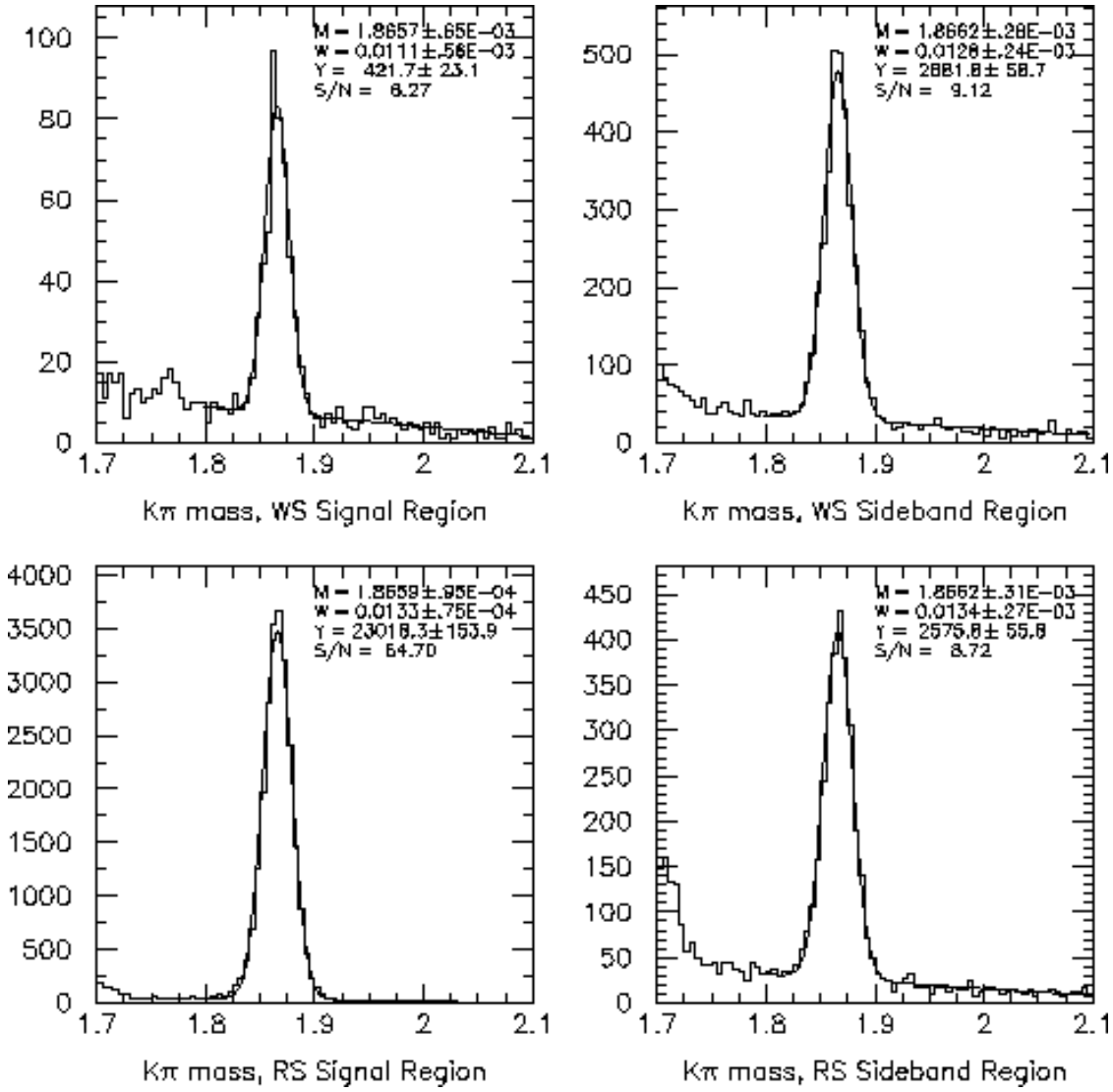
Use the Fit Function to Scale the Subtraction Region





$$\text{Ratio} = \frac{\int_{Signal_region} Background}{\int_{Sideband_region} Background}$$

Calculate the Branching Ratio

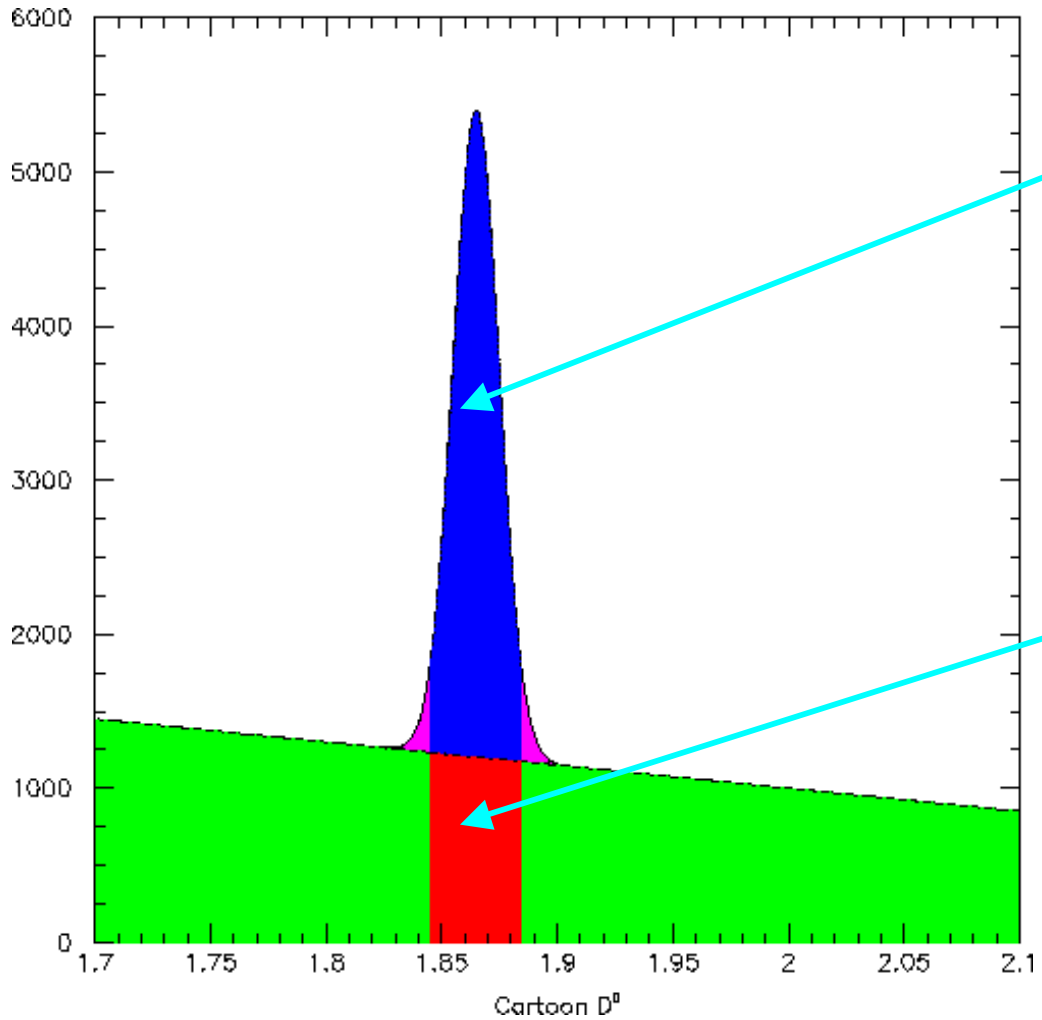


$$BR = \frac{421.7 - 2881.8 \times 0.1191}{23018.3 - 2575.8 \times 0.1263}$$

$$= \frac{78.5 \pm 25.1}{22693.0 \pm 154.2}$$

$$= 0.0035 \pm 0.0011$$

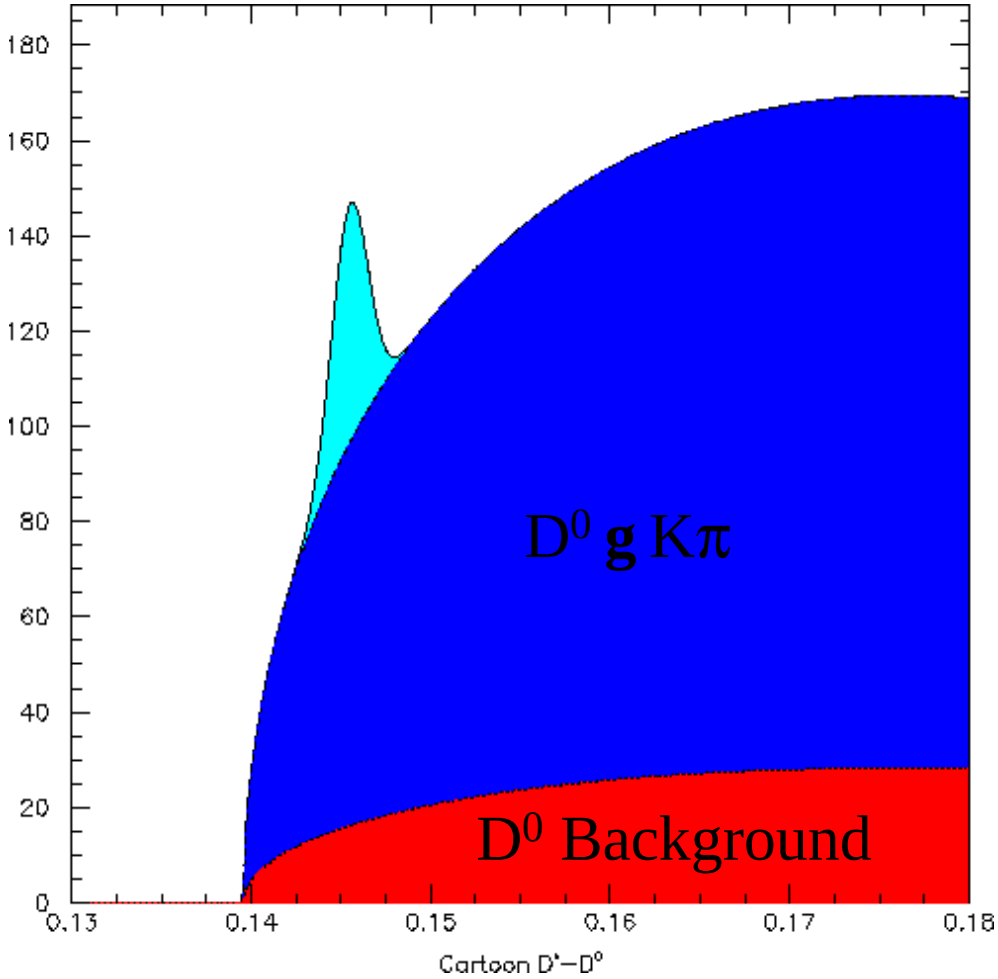
Two Types of Background Under D*



Real D^0 **g** $K\pi$

Background Under D^0

Two Types of Background (Continued)



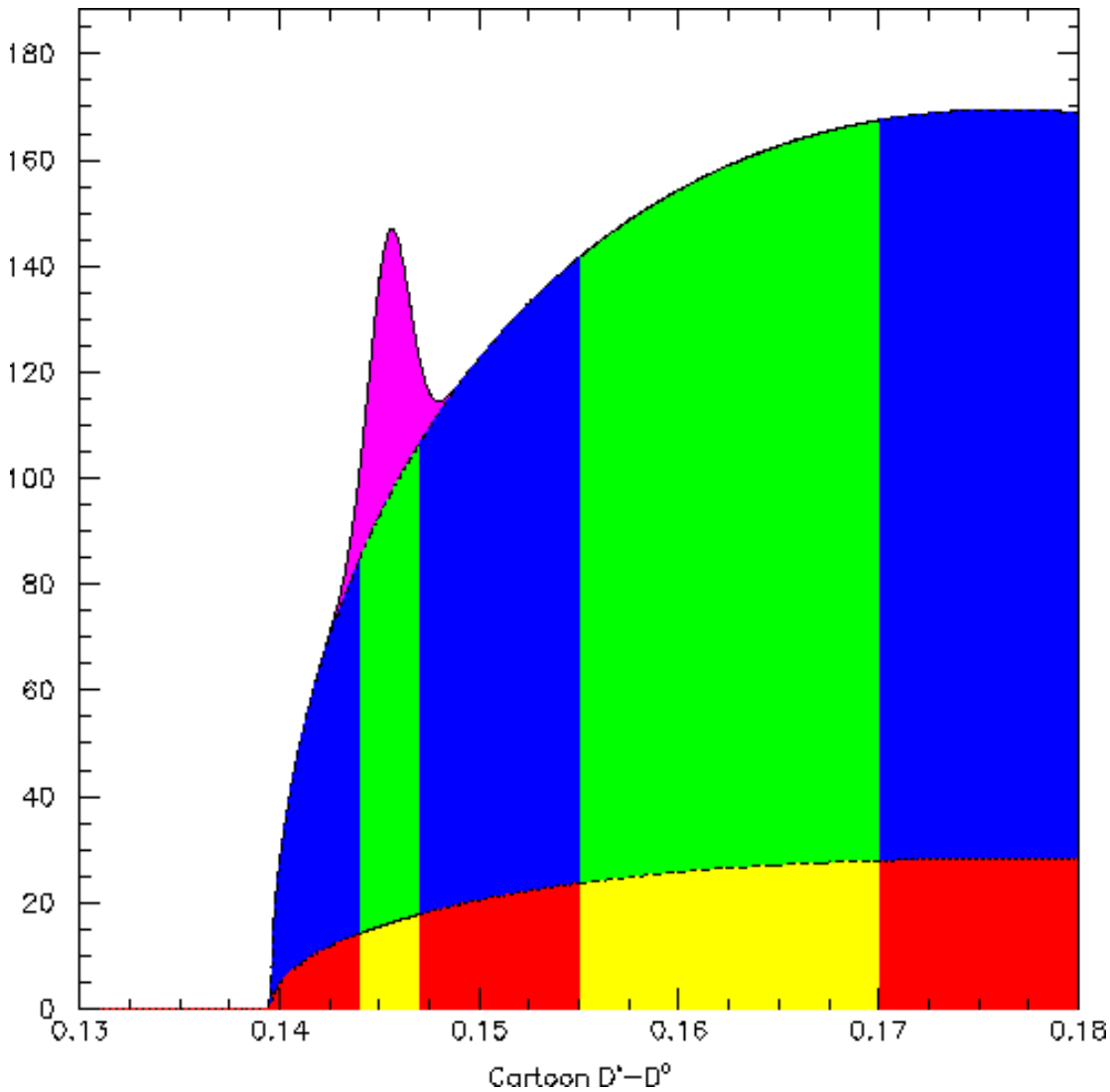
D^0 **g** $K\pi$

Real D^0 **g** $K\pi$ with combinatorial soft π

D^0 Background

Not D^0 **g** $K\pi$, with combinatorial soft π

Sideband Subtraction Hinges on the Ratio of Background Types



If the ratio of background types is the same in the sideband region as it is in the background portion of the signal region then the D^0 yield subtraction is safe.

Study of the Stability of Background Type Ratio

The D^0 and non-D^0 background ratio is essentially the signal to noise ratio. In this study, the sideband region is divided in 5 MeV sections and we see that the signal to noise is stable.

Low (GeV)	High (GeV)	Sign	S/N	Yield	Ratio	Yield* Ratio
0.155	0.160	RS	9.06	825.4	0.3975	328.1
0.160	0.165	RS	8.23	858.4	0.3755	322.3
0.165	0.170	RS	9.02	893.9	0.3652	326.5
0.170	0.175	RS	8.27	979.5	0.3631	355.6
0.155	0.160	WS	9.42	886.2	0.3826	339.1
0.160	0.165	WS	9.36	979.2	0.3546	347.2
0.165	0.170	WS	8.94	1023.1	0.3376	345.4
0.170	0.175	WS	8.41	1052.9	0.3276	336.1

Systematic Studies: Different Fits and Binning

- I tried two background parameterizations:

$$f(x) = \sqrt{x - m_p} \times (a + bx)$$

$$f(x) = a(x - m_p)^{1/2} + b(x - m_p)^{3/2}$$

Both gave the same ratio, but the first parameterization gives slightly smaller errors.

- I varied the binning:

Bin Width	Offset	Ratio
0.5 MeV	+0.1 MeV	0.1189
0.5 MeV	-0.1 MeV	0.1189
0.5 MeV	+0.2 MeV	0.1191
0.5 MeV	-0.2 MeV	0.1193
1.0 MeV	0.0 MeV	0.1160

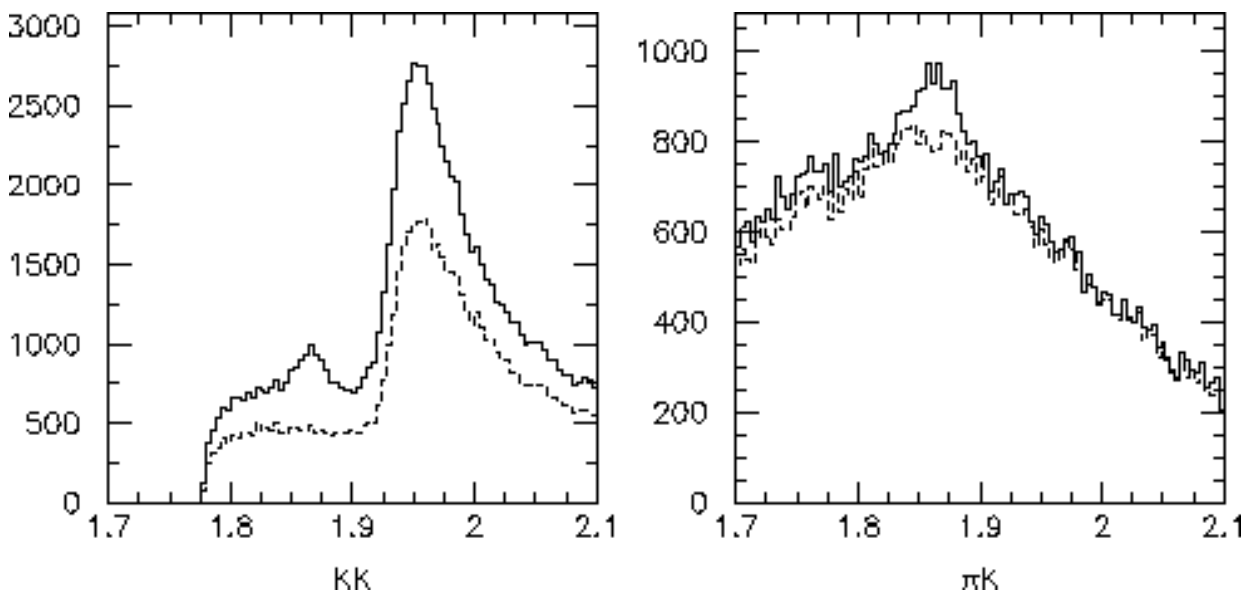
Systematic Study: Different Cut Sets

I tried relaxing the vertex cuts…

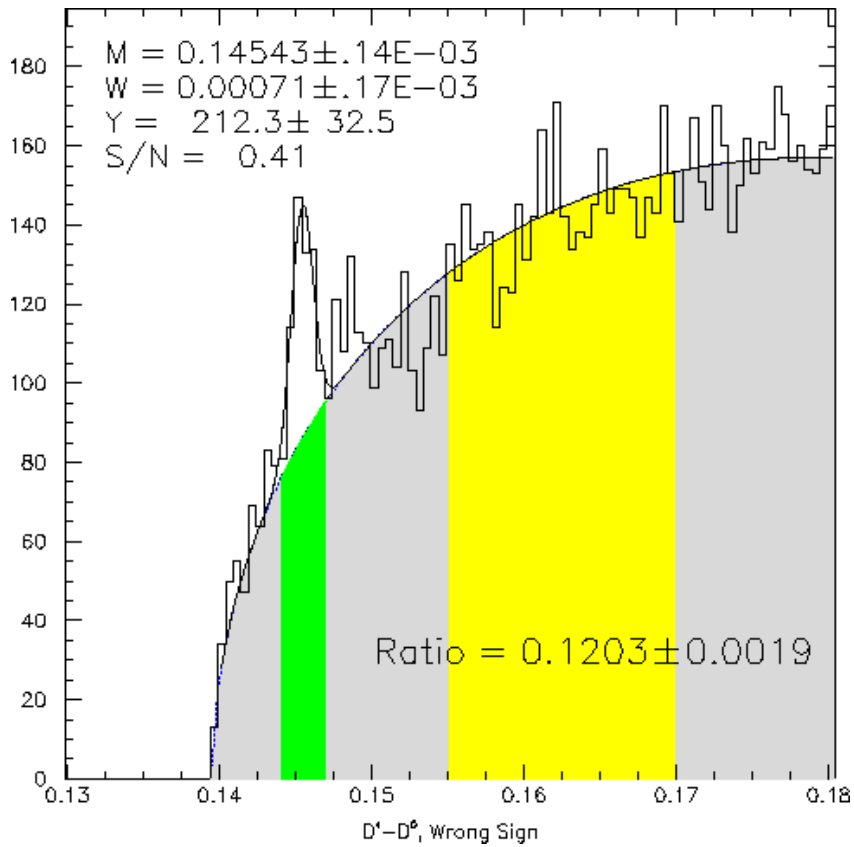
$$BR = \frac{82.7 \pm 40.4}{28939.2 \pm 175.9} = 0.0029 \pm 0.0014$$

I tried Wobs cuts that only target specific reflections…

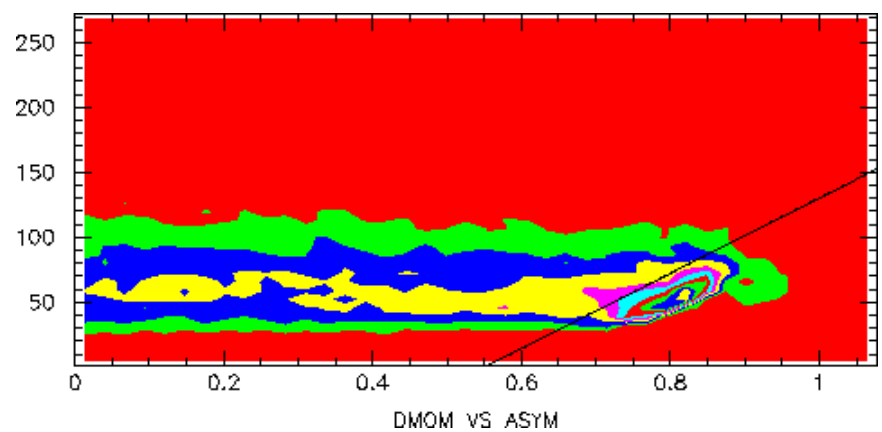
$$BR = \frac{130.1 \pm 29.5}{30715.2 \pm 182.6} = 0.0042 \pm 0.0096$$



The Cut Set With the Best Errors



- Targeted Wobs Cuts
- Momentum Dependant Asymmetry Cut
- Typical Vertex Cuts



$$BR = \frac{134.3 \pm 30.7}{32945.0 \pm 184.1} = 0.00408 \pm 0.00093$$

Future Work (Conclusion)

- Monte Carlo to understand the background ratio.
- Increase the sample size by loosening cuts.
  - Study L/σ down to 3. The skim I'm using has a cut at $L/\sigma > 5$.
  - Study Kanonicity down to 0. The skim cut is ½.