

Measurement of charm production cross sections in e^+e^- annihilation

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Motivation

- e^+e^- hadronic cross sections to final states with charm meson pairs are of special interest because they provide information on the spectrum of $J^{PC} = 1^{--}$ charmonium states above the open-charm threshold, which is poorly understood. [Phys. Rev. D 72, 017501 \(2005\)](#).
- Y states, such as Y(4008), Y(4260), Y(4360), Y(4630), Y(4660), have been reported in initial state radiation process $e^+e^- \rightarrow \gamma_{ISR} \pi^+ \pi^- J/\psi$
[Phys. Rev. Lett. 95, 142001 \(2005\)](#).
- A study of the production cross section of the charm meson pairs which considers radiative correction could help us understand the structure of these charmoniumlike states well.

BOSS version and data samples

- Boss version : 6.6.4.p01 and 6.6.5.p01
- BESIII experimental data:
using data samples taken at 14 center-of-mass energies from 3890 to 4390MeV
- Inclusive MC : DD @4.26GeV with boss version 6.6.4.p01

Event selection

$$\bar{D}^0 \rightarrow K^+ \pi^-$$

- Charged tracks:

$$|R_{xy}| < 1.0\text{cm}; |Z_0| < 10.0\text{cm}; |\cos \theta| < 0.93; \text{nGood} \geq 2;$$

- PID:

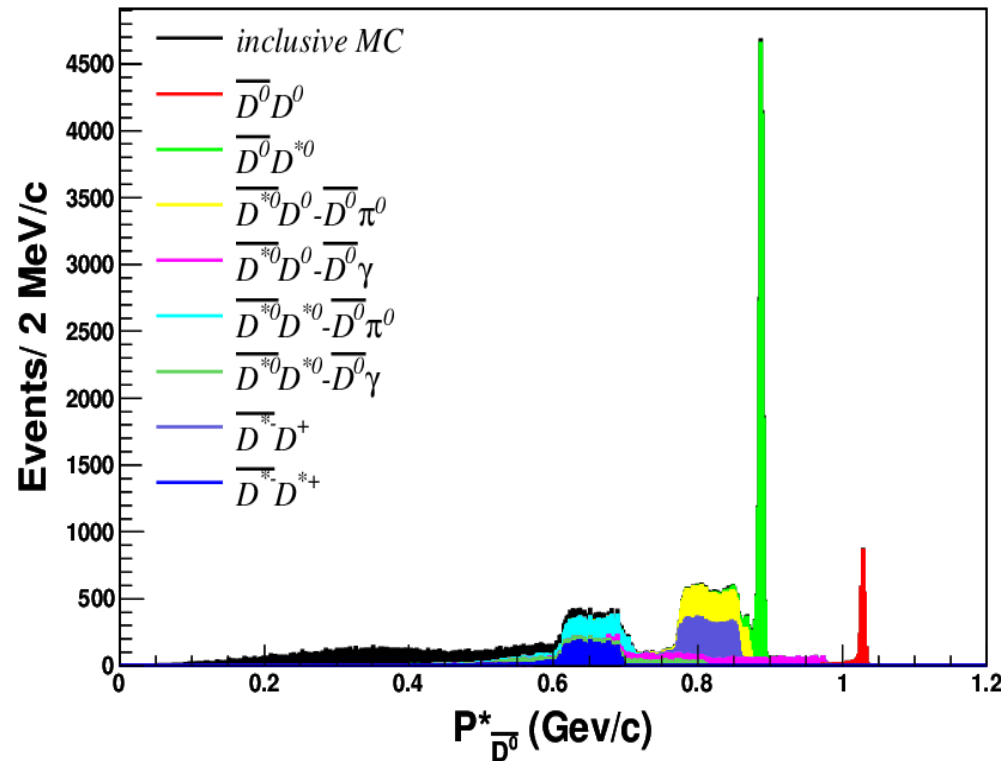
$$\pi: \text{prob}(\pi) > \text{prob}(K) > \text{prob}(p) > 0.1\%$$

$$K: \text{prob}(K) > \text{prob}(\pi) > \text{prob}(p) > 0.1\%$$

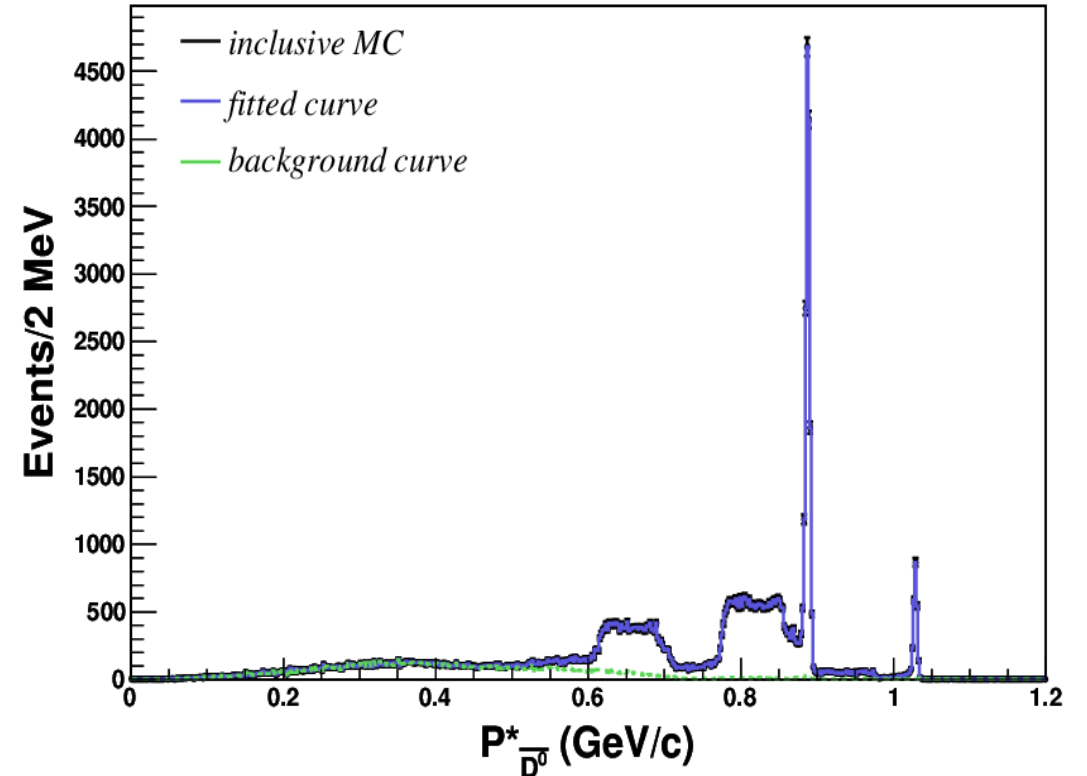
- Vertex fit

Input-Output check

Momentum spectra in inclusive MC at 4260MeV for $\bar{D}^0 \rightarrow K^+ \pi^-$

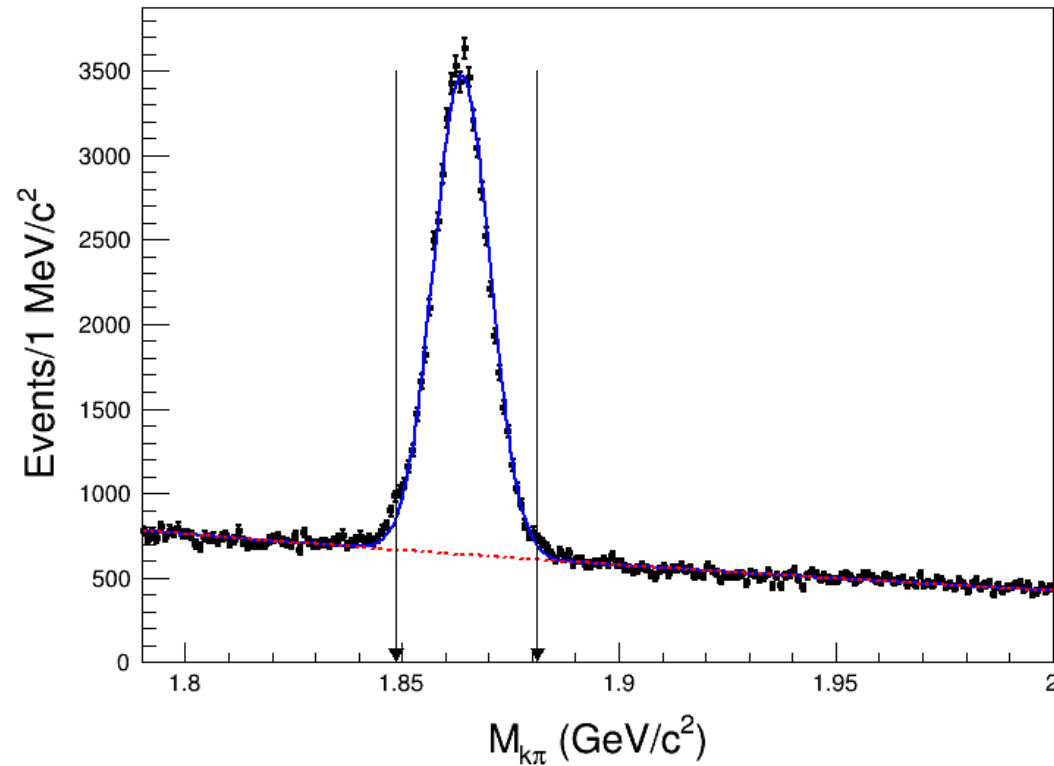


Use MC truth to read all charm meson pairs events

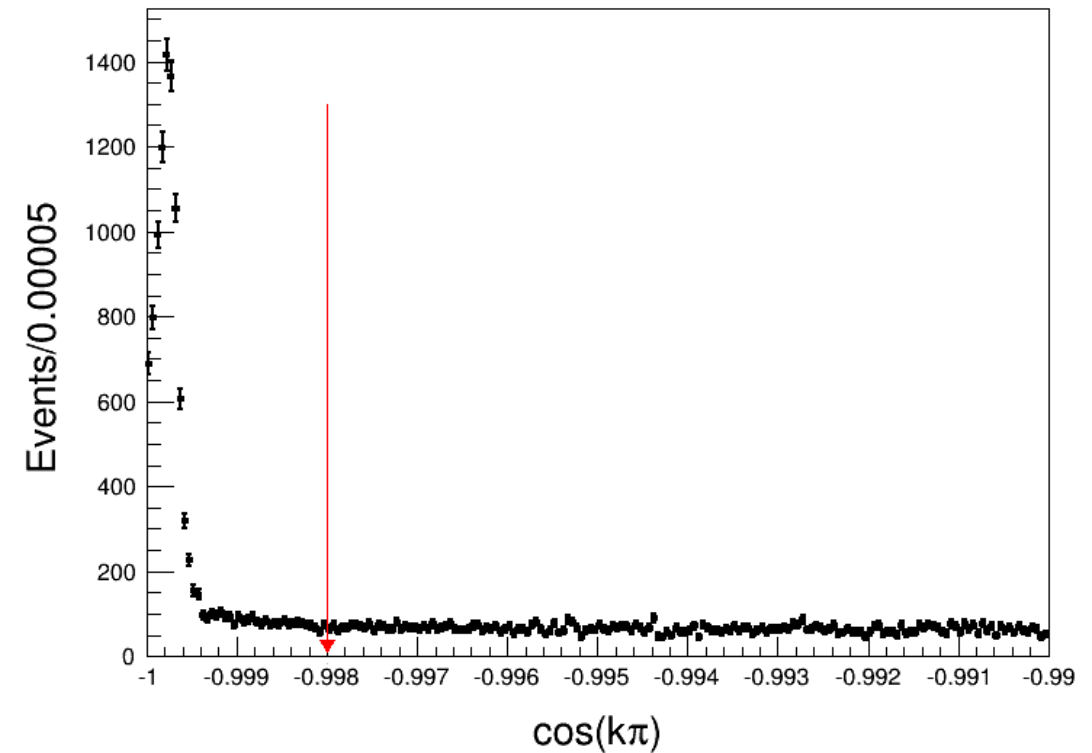


The reliability of fit is confirmed by difference between fit results and MC truth results within one standard deviation.

Some distributions of observable quantity in data

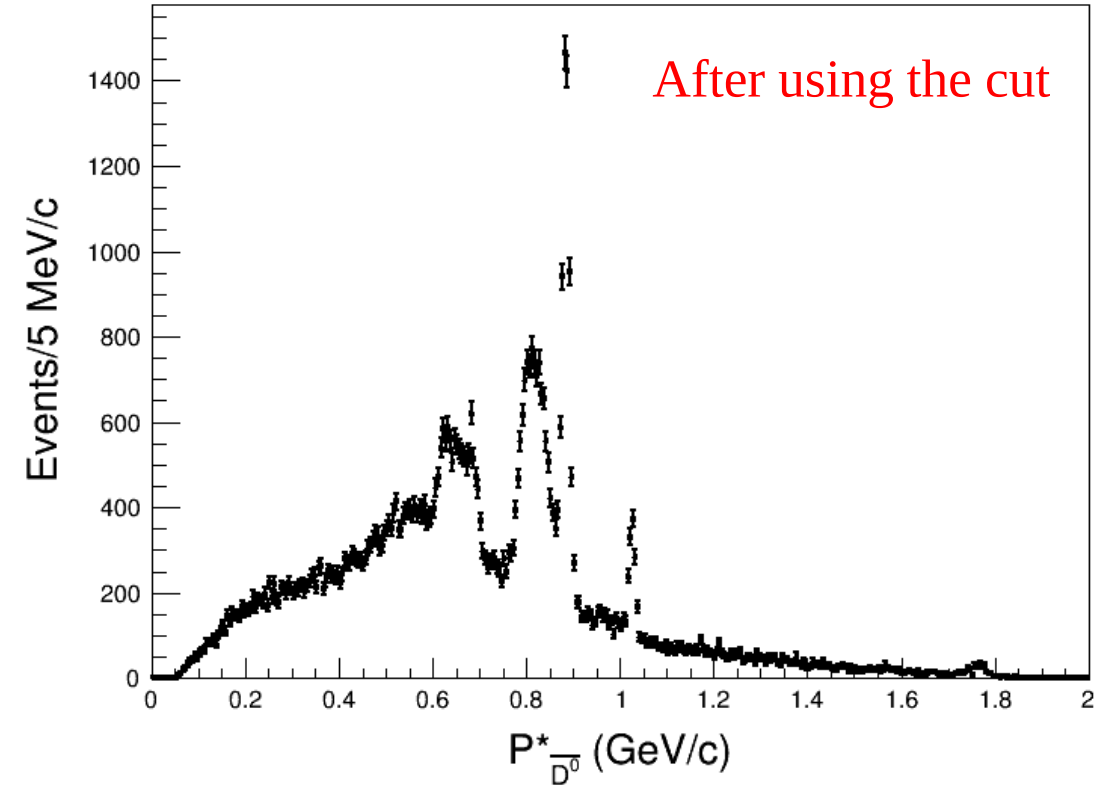
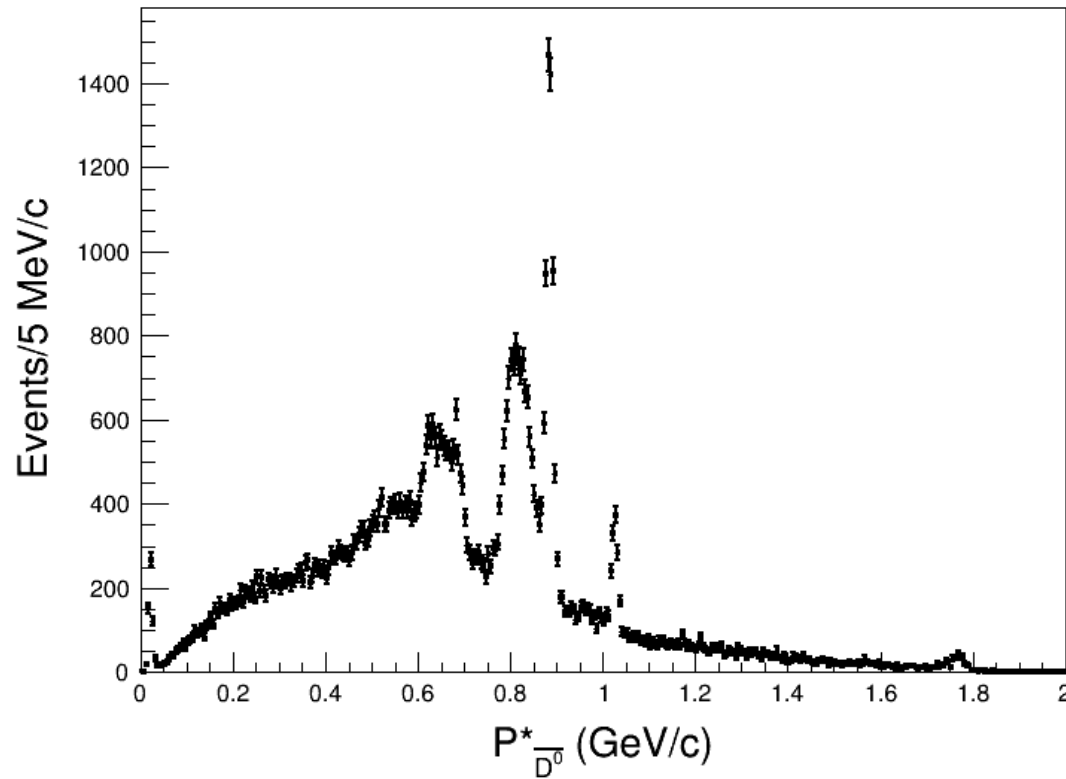


Invariant mass spectra in data at 4260 MeV for $\bar{D}^0 \rightarrow K^+\pi^-$



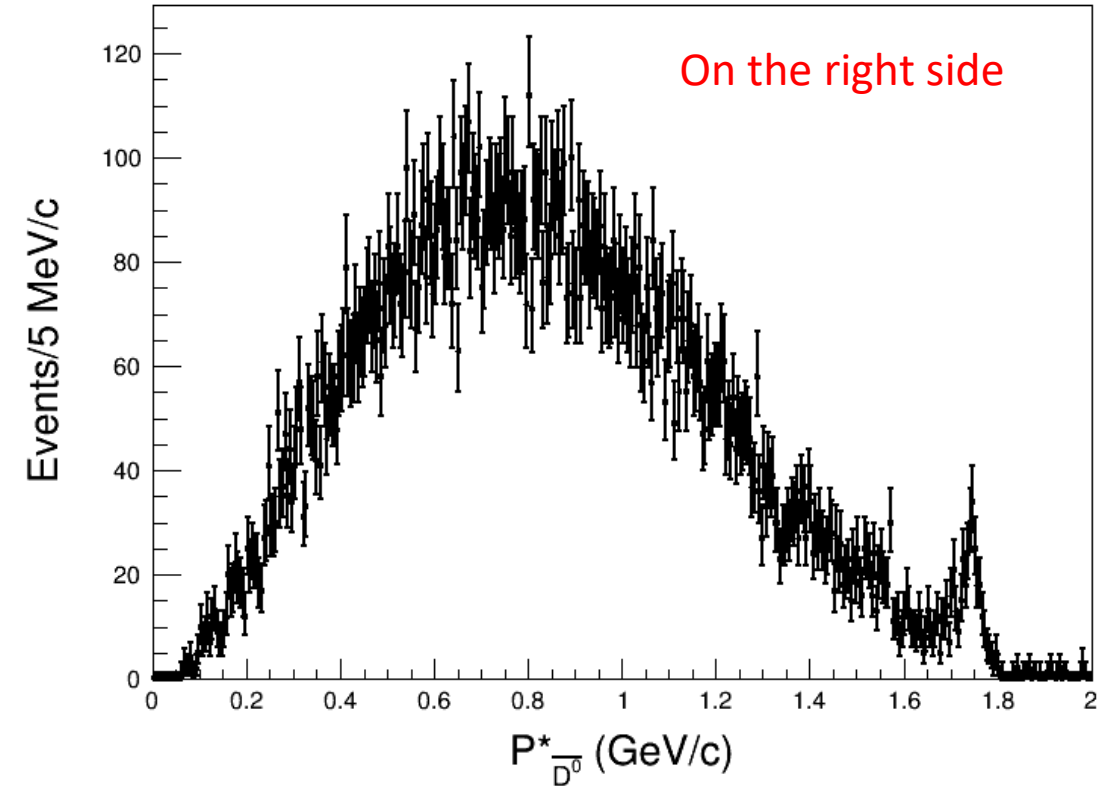
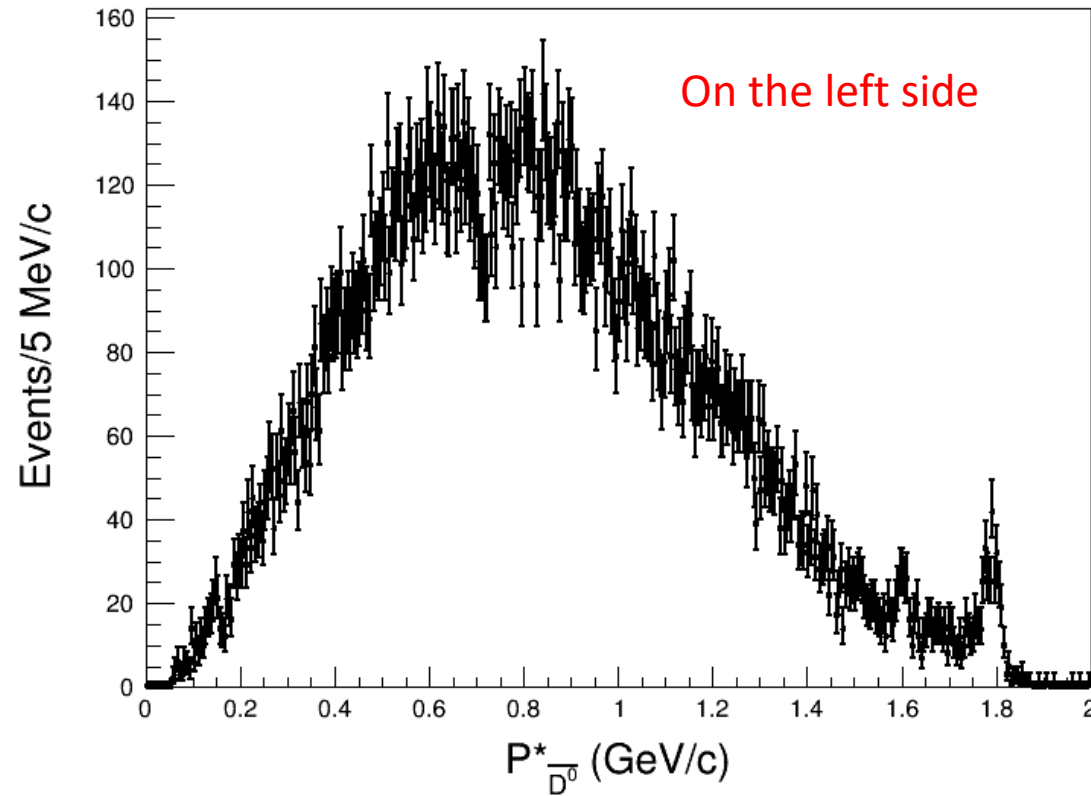
Cosine of angle between K^+ and π^- in data at 4260 MeV

Use the cut that cosine of angle between K^+ and π^- greater than -0.998 to remove the peak events at 0.02GeV/c. the cut efficiency is 97.86%



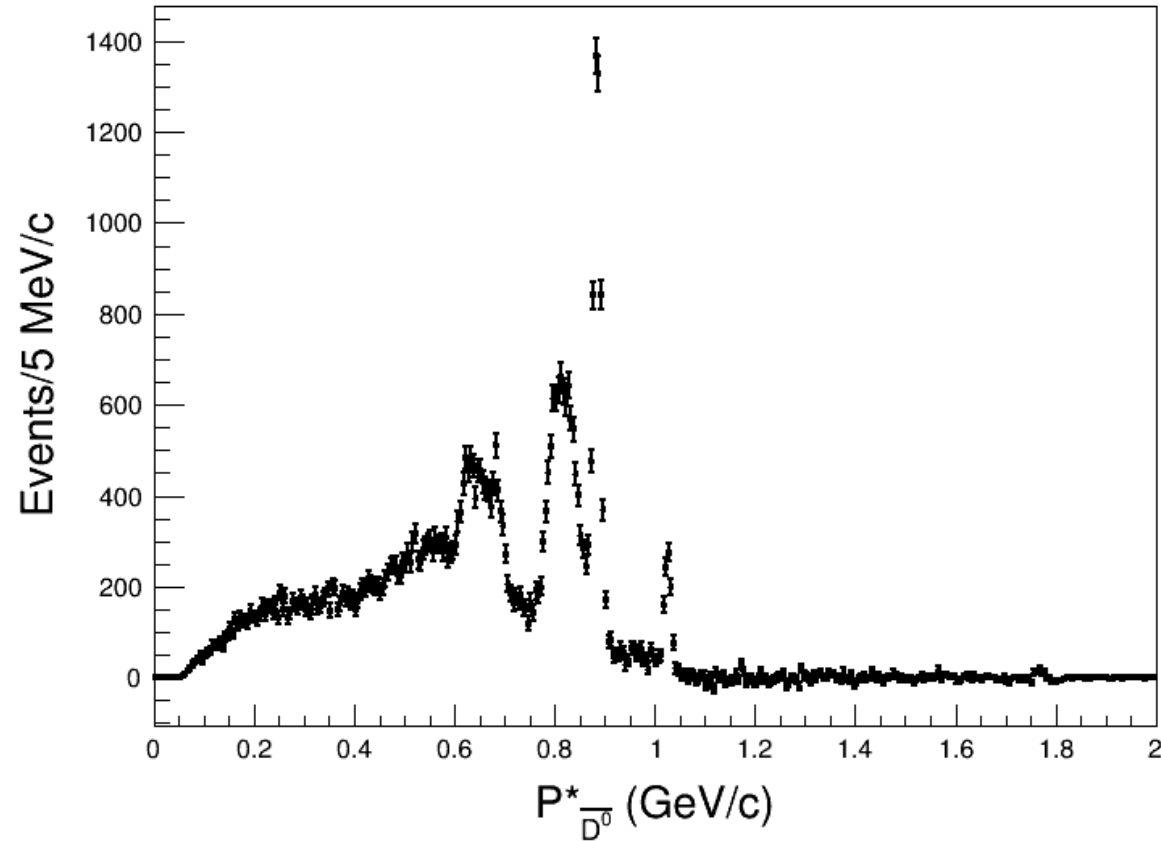
Momentum spectra in data at 4260MeV for $\bar{D}^0 \rightarrow K^+ \pi^-$ with invariant masses within 32.5MeV of the nominal value

Having used the cut that cosine of angle between K^+ and π^- greater than -0.998

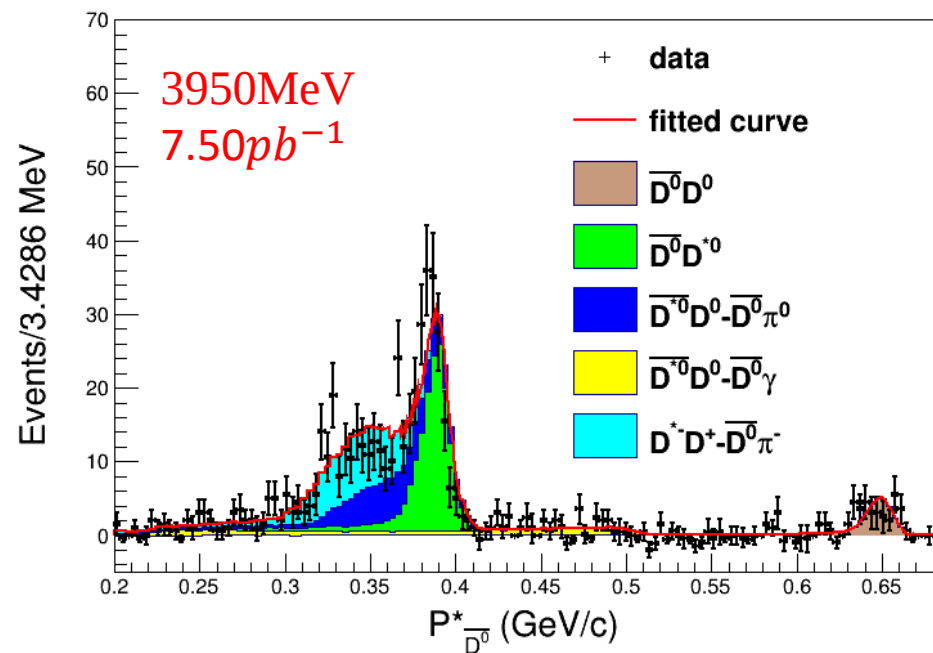
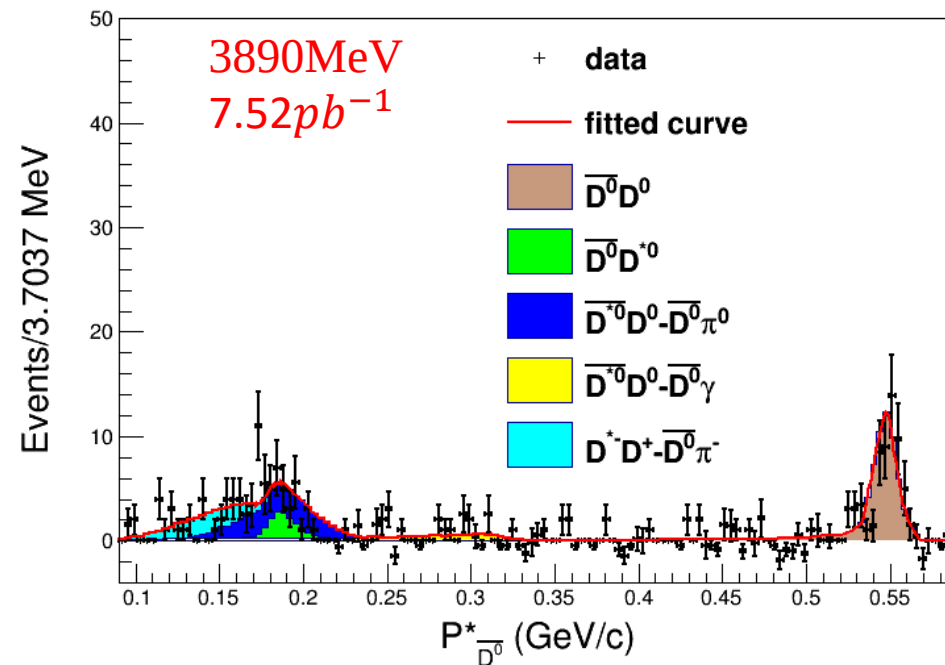
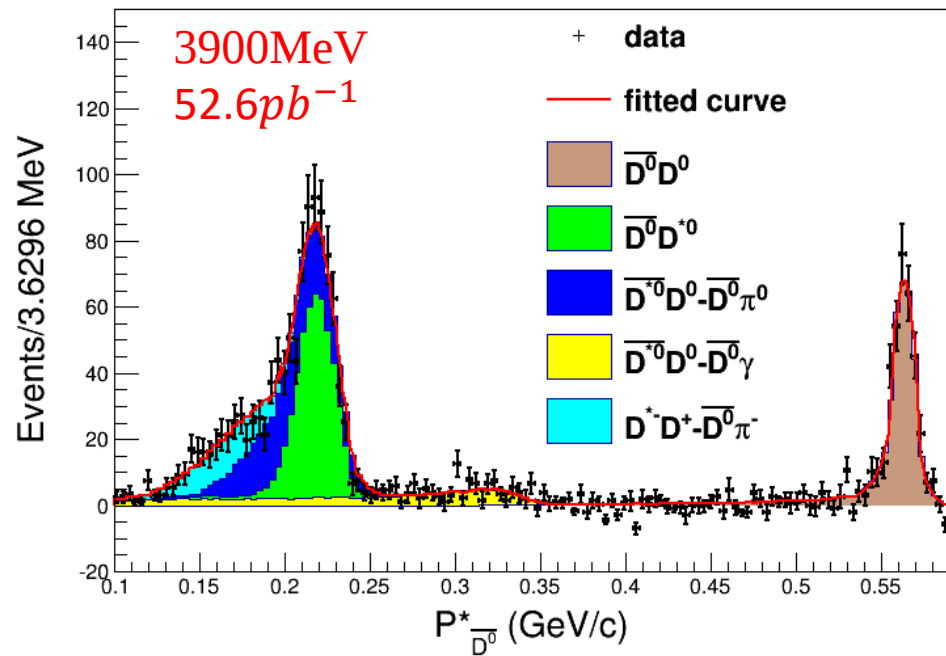


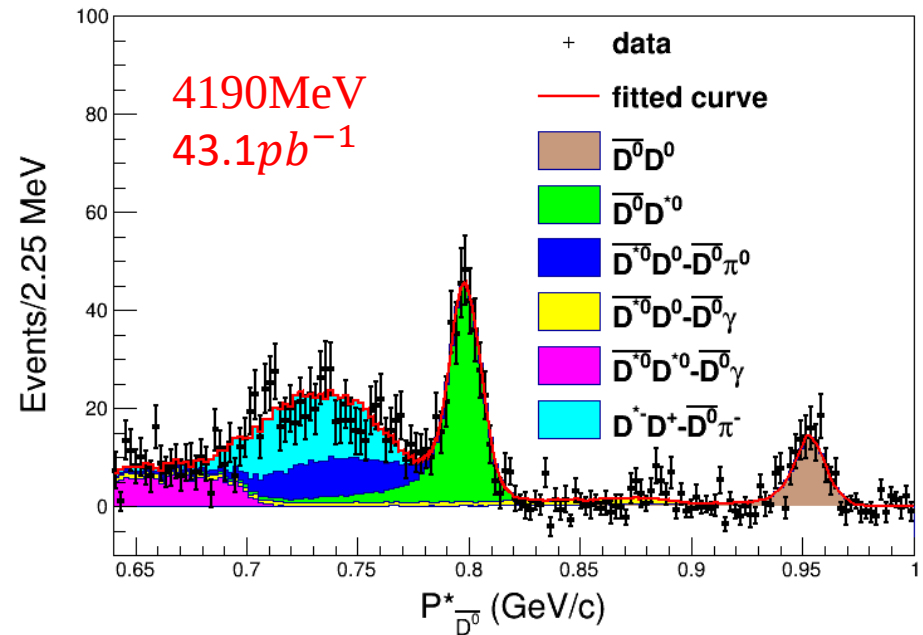
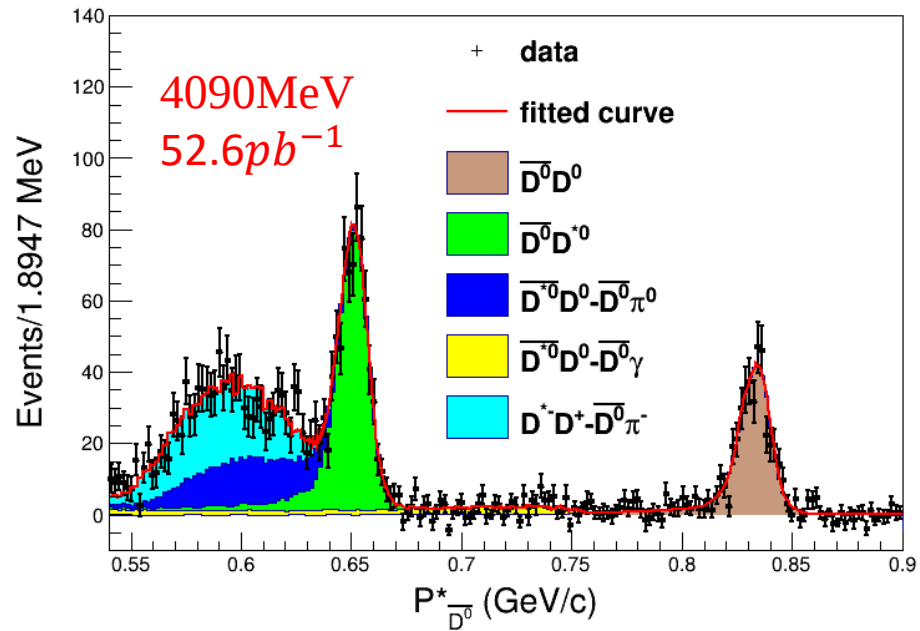
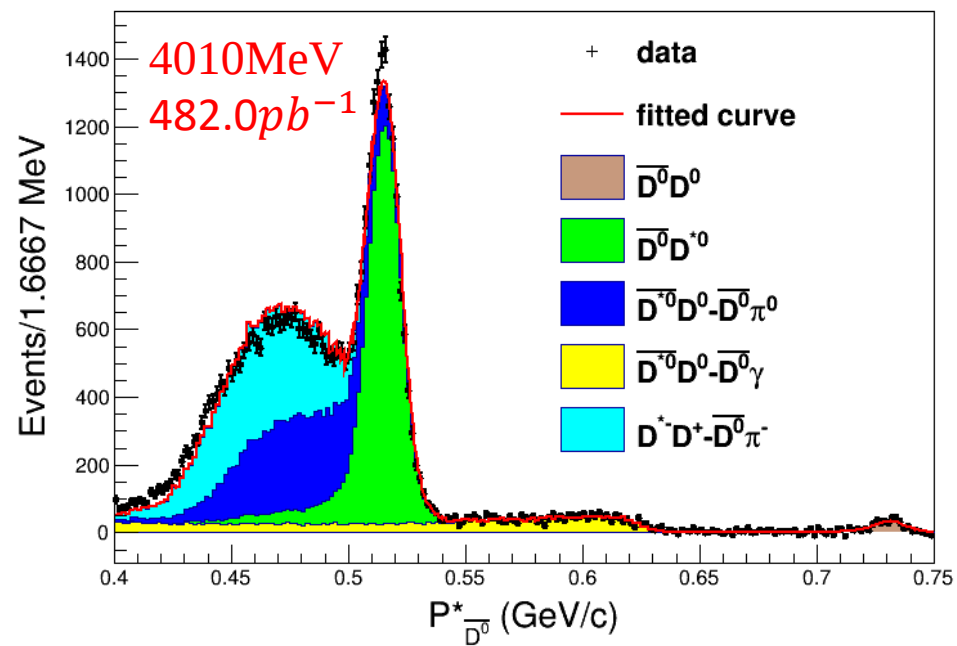
Sideband regions are taken on both sides of the expected signal

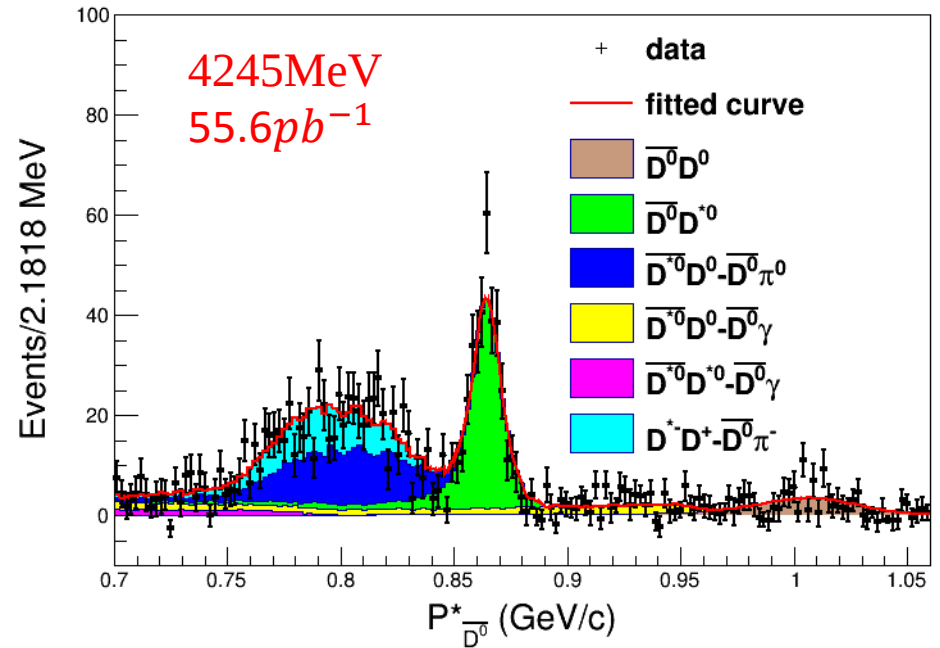
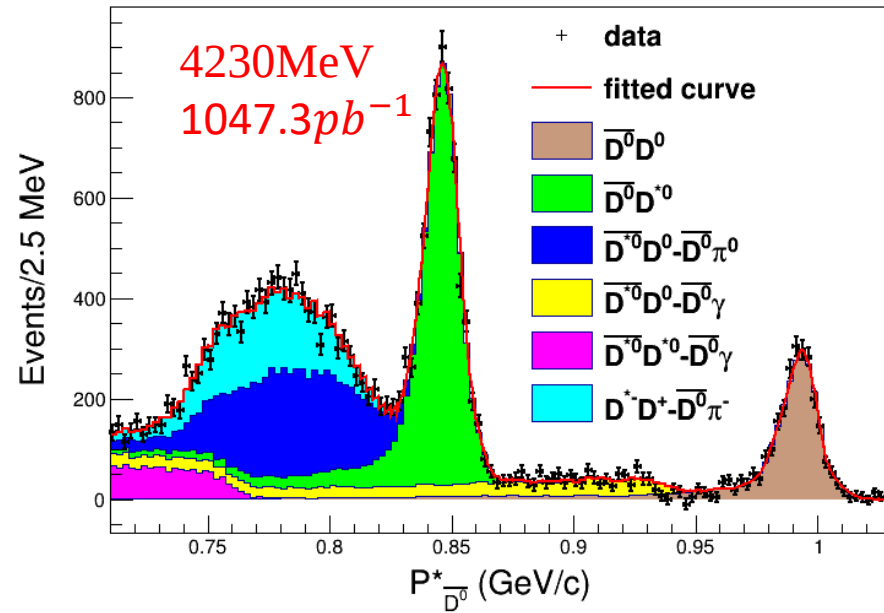
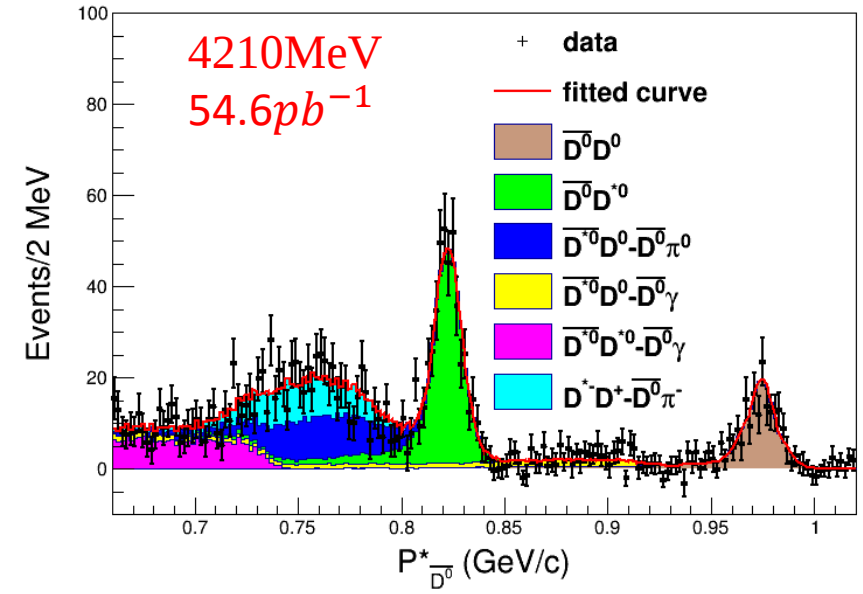
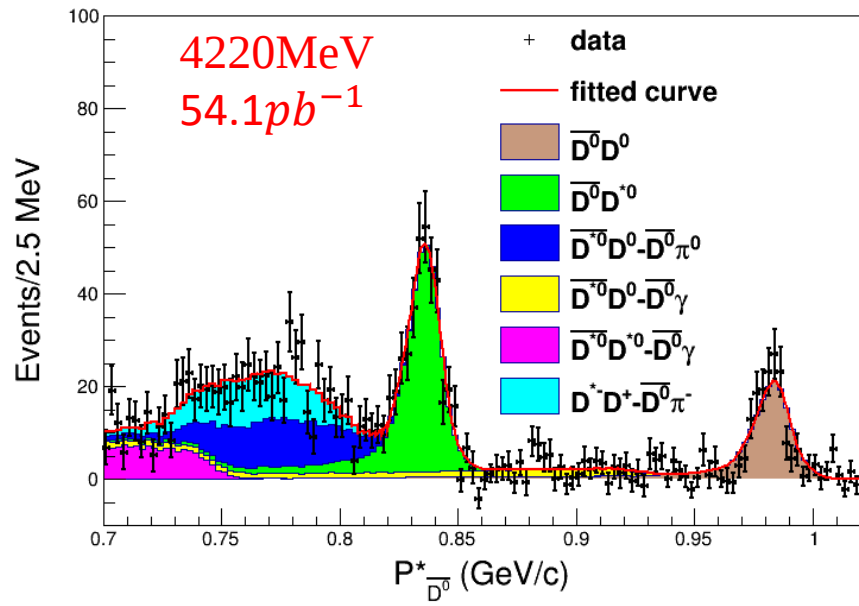
Backgrounds are estimated with a sideband technique

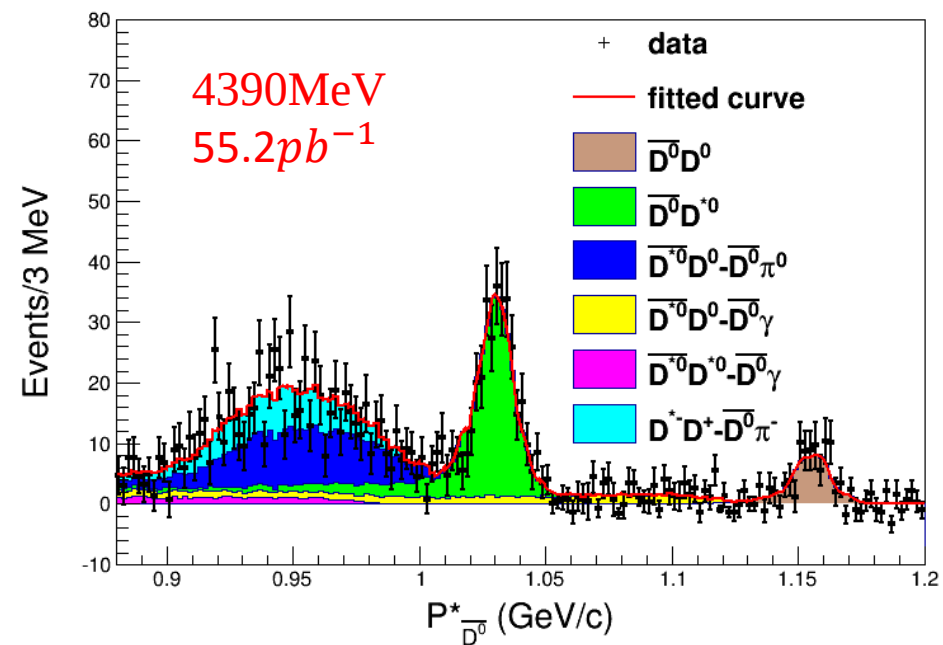
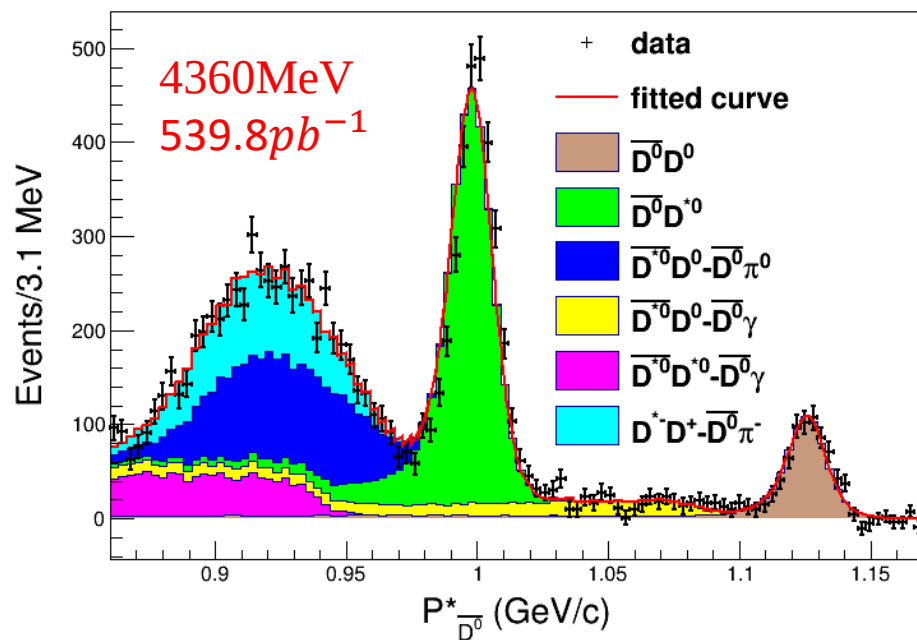
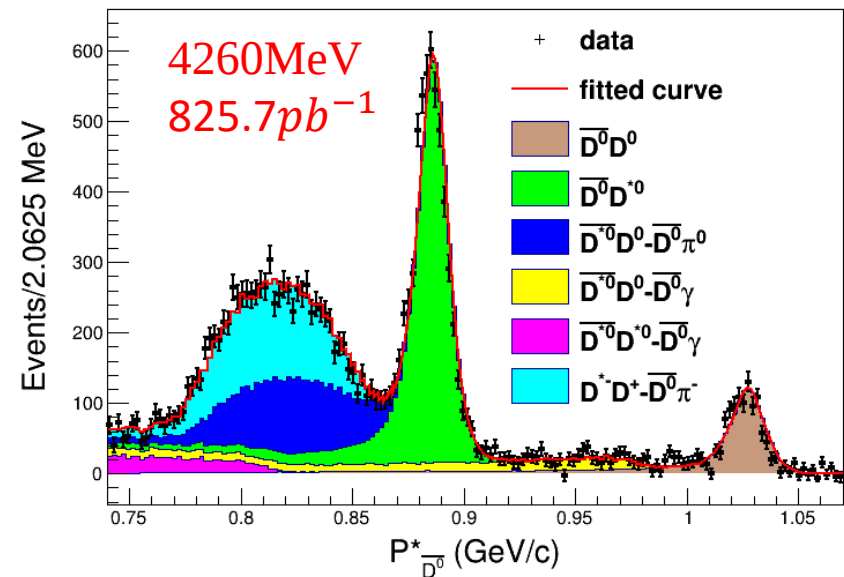
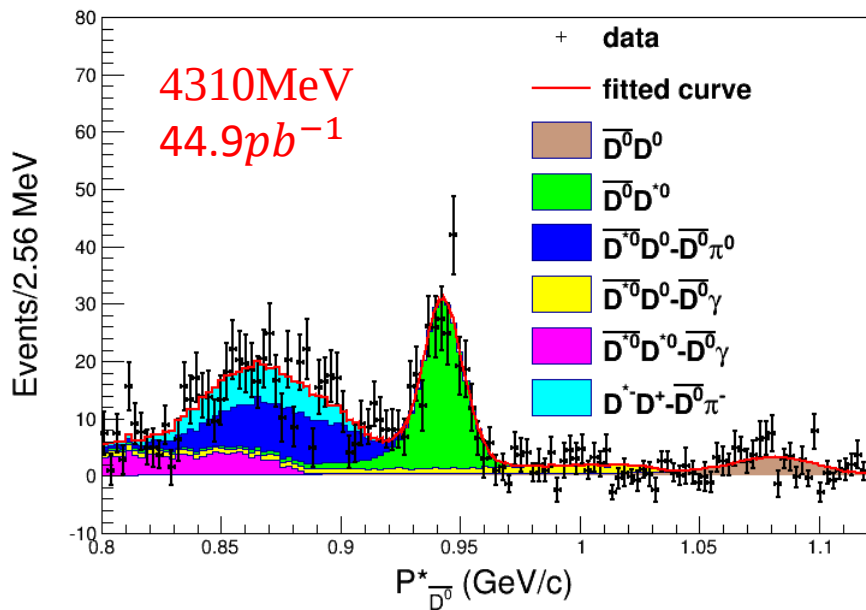


Momentum spectra in data at 4260MeV for $\bar{D}^0 \rightarrow K^+\pi^-$ with invariant masses within 32.5MeV of the nominal value







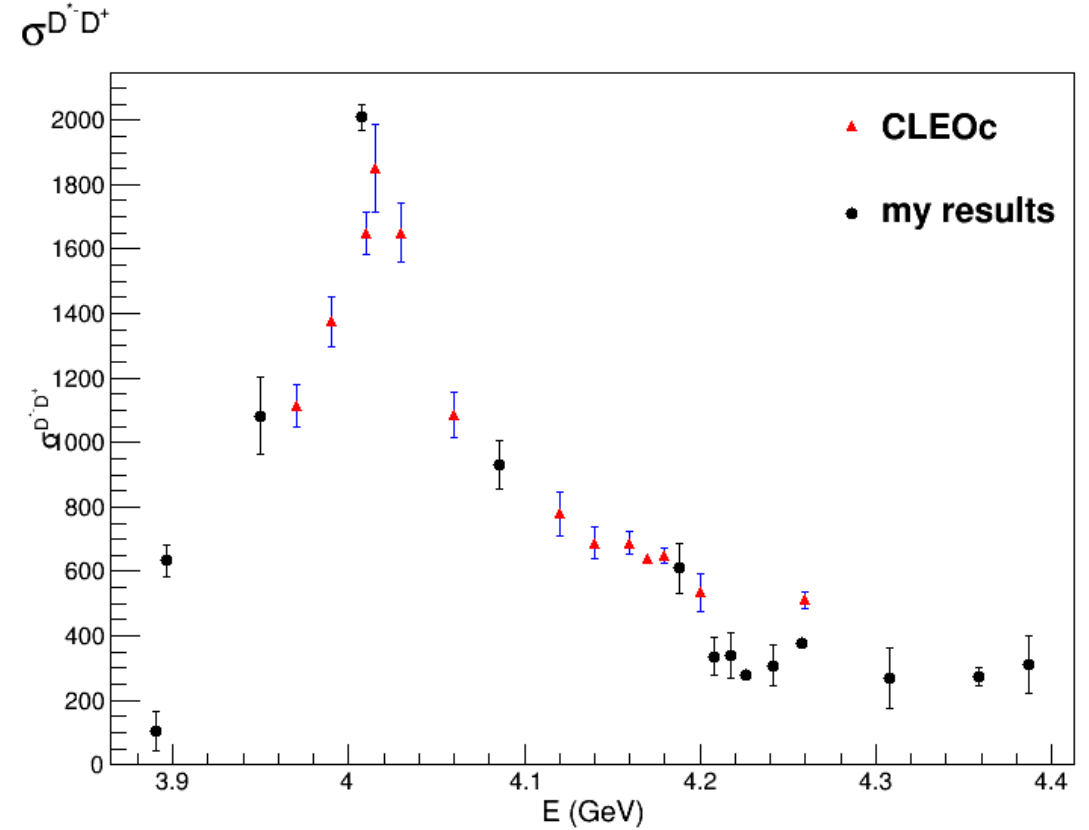
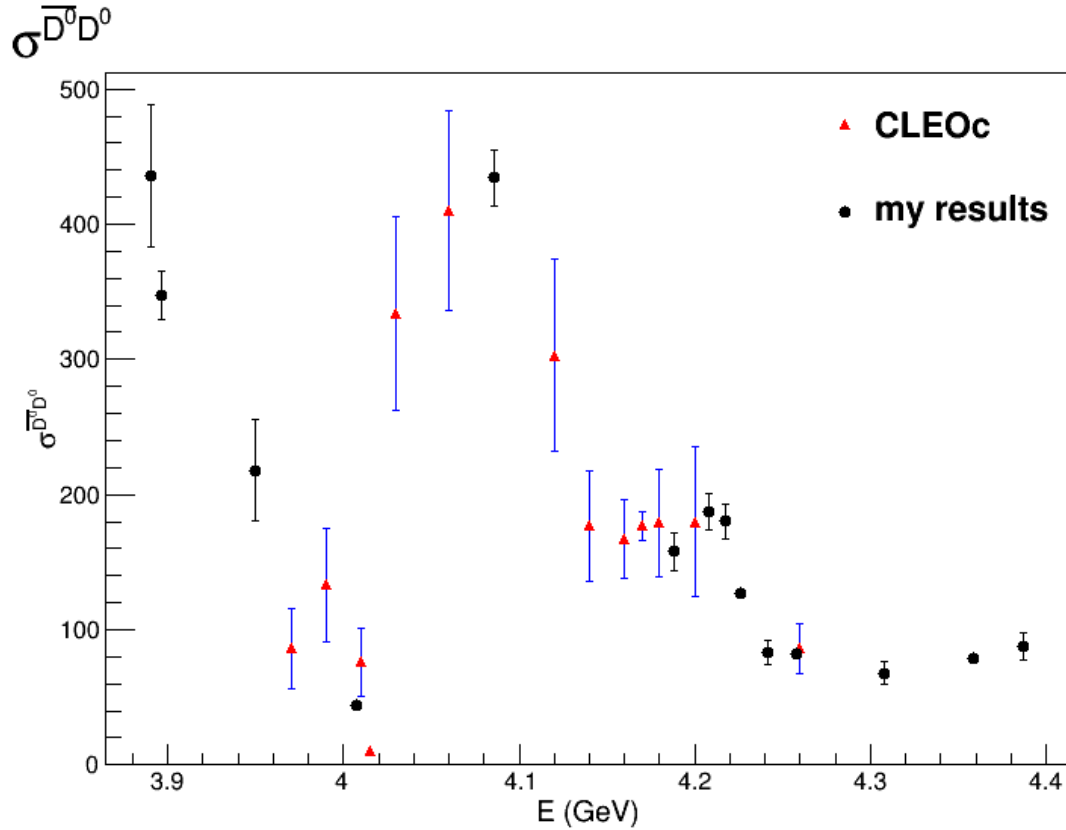


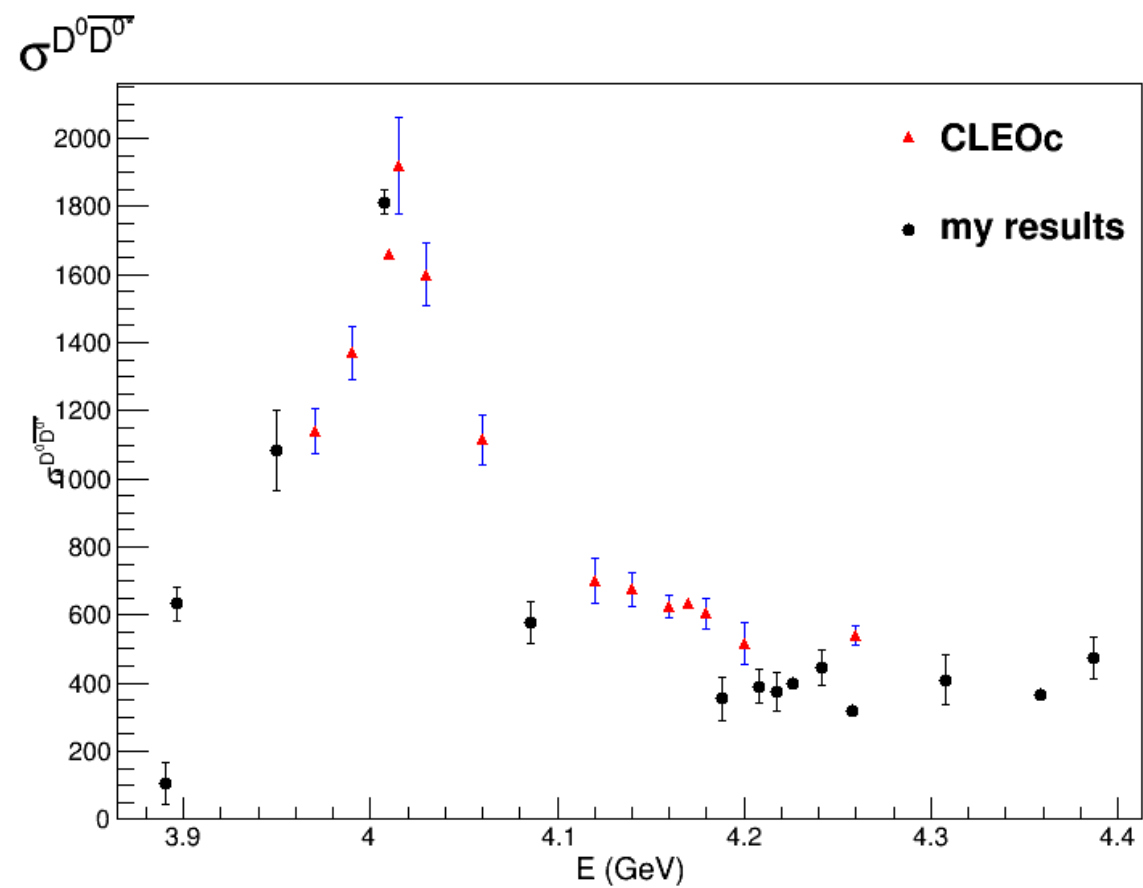
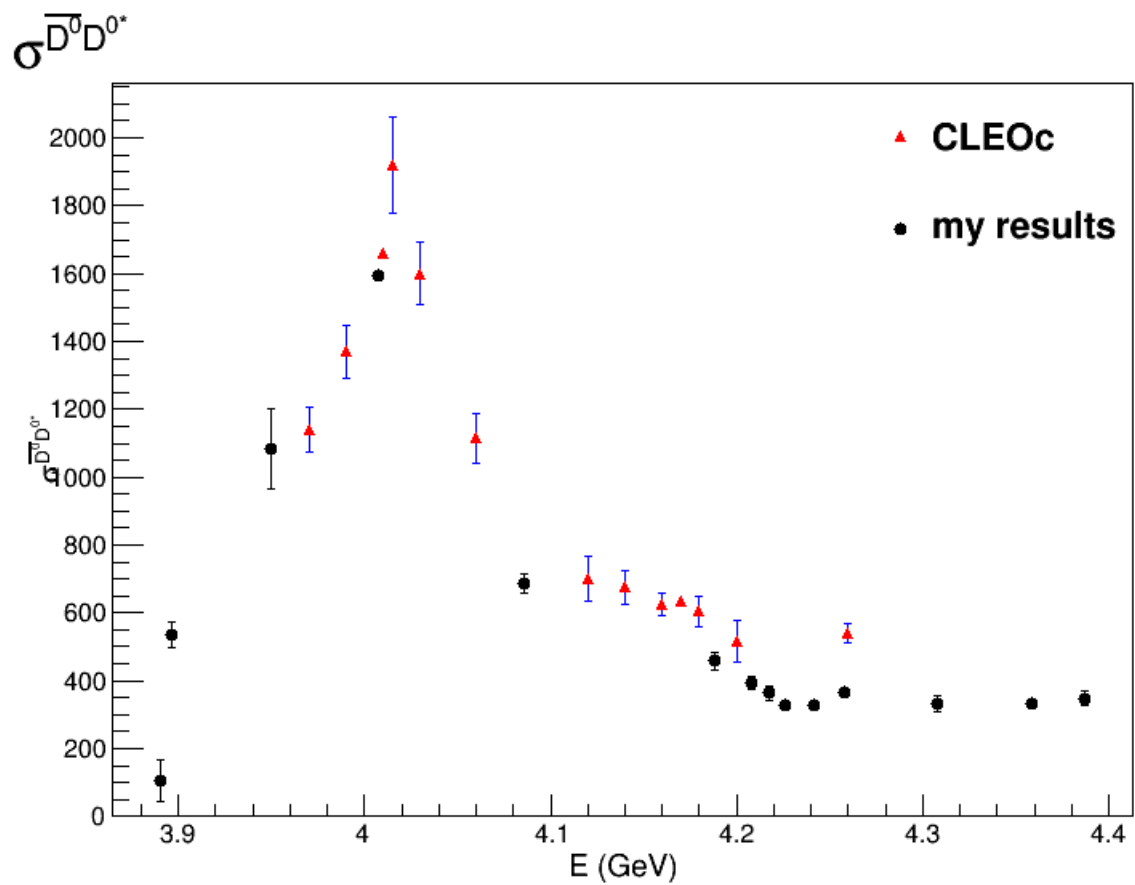
Fit results

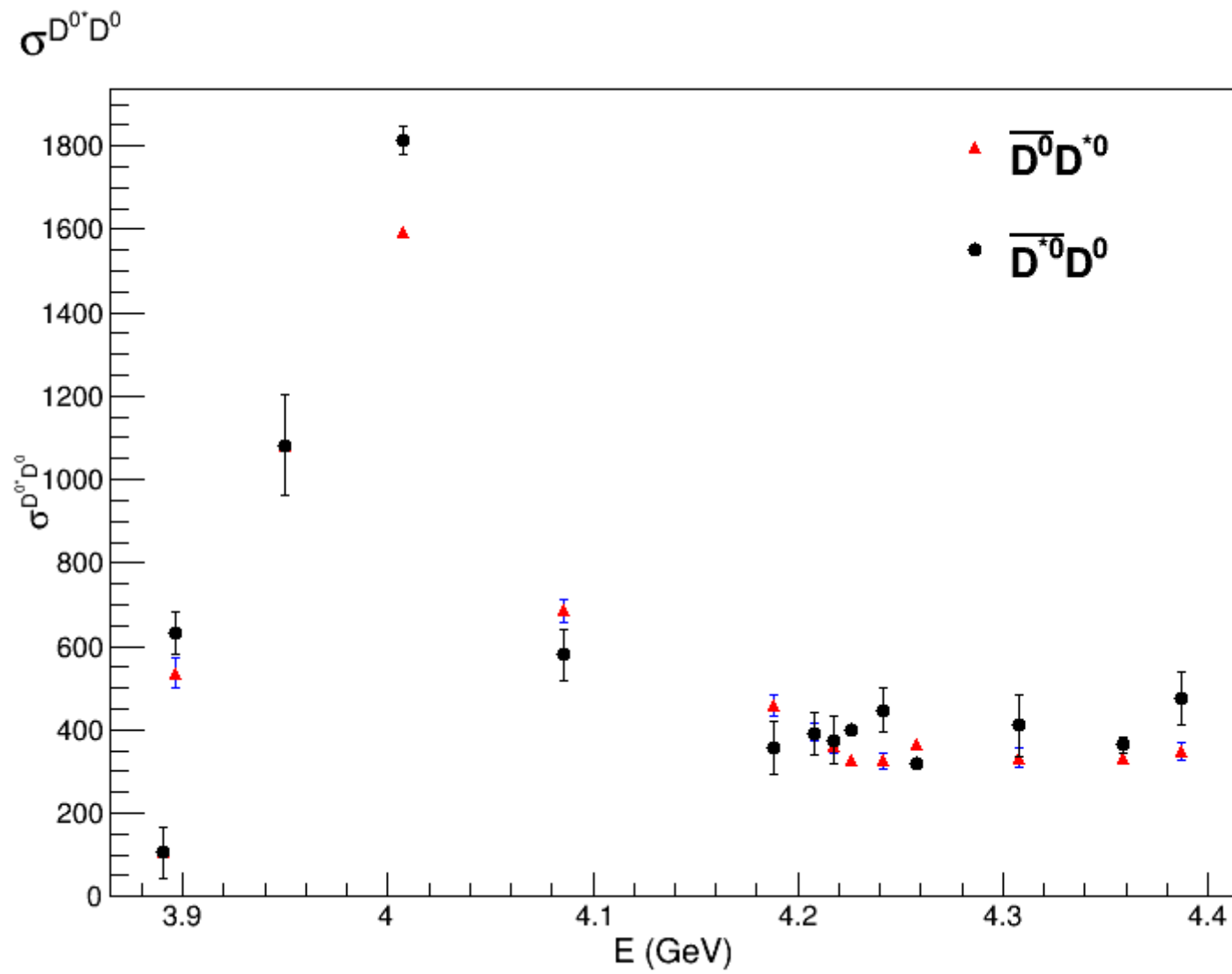
Mode	3890MeV	3900MeV	3950MeV	4010MeV	4090MeV	4190MeV	4210MeV
$e^+e^- \rightarrow \overline{D^0}D^0 \rightarrow k^+\pi^-D^0$	67.95+-8.24	379.85+-19.56	35.12+-6.01	409.65+-20.49	448.49+-21.51	149.34+-13.13	228.80+-16.29
$e^+e^- \rightarrow \overline{D^0}D^{0*} \rightarrow k^+\pi^-D^{0*}$	14.20+-8.09	487.75+-34.03	166.97+-18.47	14464.2+-148.01	801.22+-32.42	455.64+-24.99	504.72+-25.50
$e^+e^- \rightarrow \overline{D^{0*}}D^0 \rightarrow \overline{D^0}\pi^0D^0 \rightarrow k^+\pi^-\pi^0D^0$	43.34+-8.7	372.16+-29.28	108.69+-19.21	10679.5+-199.49	434.41+-45.68	231.92+-41.40	323.46+-40.75
$e^+e^- \rightarrow \overline{D^{0*}}D^0 \rightarrow \overline{D^0}\gamma D^0 \rightarrow k^+\pi^-\gamma D^0$	20.79+-4.17	180.58+-14.21	57.15+-10.10	4355.71+-81.36	165.27+-17.38	98.63+-17.61	139.95+-17.63
$e^+e^- \rightarrow D^{*-}D^+ \rightarrow \overline{D^0}\pi^-D^+ \rightarrow k^+\pi^-\pi^-D^+$	26.69+-7.57	182.37+-22.64	145.75+-23.29	12032.9+-234.03	691.91+-56.55	395.33+-50.26	281.11+-49.27
χ^2/NDF	1.778	1.282	1.329	2.242	1.167	1.202	0.8725

Mode	4220MeV	4230MeV	4245MeV	4260MeV	4310MeV	4360MeV	4390MeV
$e^+e^- \rightarrow \overline{D^0}D^0 \rightarrow k^+\pi^-D^0$	216.31 +- 15.97	2990.07 +- 59.66	112.82 +- 12.27	1704.07 +- 47.75	103.05 +- 12.73	971.37 +- 36.19	97.38 +- 10.80
$e^+e^- \rightarrow \overline{D^0}D^{0*} \rightarrow k^+\pi^-D^{0*}$	429.73 +- 24.09	7448.59 +- 101.61	406.18 +- 23.13	6273.87 +- 92.00	291.15 +- 20.23	3540.86 +- 68.75	400.5 +- 23.90
$e^+e^- \rightarrow \overline{D^{0*}}D^0 \rightarrow \overline{D^0}\pi^0D^0 \rightarrow k^+\pi^-\pi^0D^0$	280.07 +- 42.77	5783.41 +- 183.37	357.73 +- 42.81	3494.81 +- 154.09	228.33 +- 40.76	2482.61 +- 127.58	339.25 +- 44.35
$e^+e^- \rightarrow \overline{D^{0*}}D^0 \rightarrow \overline{D^0}\gamma D^0 \rightarrow k^+\pi^-\gamma D^0$	111.69 +- 17.05	2263.63 +- 71.77	153.9 +- 18.42	1417.77 +- 62.51	90.47 +- 16.15	940.26 +- 48.32	135.22 +- 17.68
$e^+e^- \rightarrow D^{*-}D^+ \rightarrow \overline{D^0}\pi^-D^+ \rightarrow k^+\pi^-\pi^-D^+$	257.61 +- 52.71	4020.35 +- 223.12	249.35 +- 51.2	4239.9 +- 192.16	101.50 +- 21.67	1867.94 +- 187.68	220.80 +- 64.11
χ^2/NDF	1.222	1.211	1.253	1.521	1.388	2.327	1.151

Compare CLEOc results with mine







Next to do

- Run other XYZ and R-scan data samples.
- Get the distribution that observed cross sections for $e^+e^- \rightarrow \overline{D}^0 D^0, \overline{D}^0 D^{0*}$ and $D^{*-} D^+$ as a function of center-of-mass energy.
- Iterate the radiative correction procedure with our own measurement until this procedure converges.