Analysis done with 10,000 signal M.C. events produced by evtgen

**Reconstruction and Fitting:**

- $D^0 \rightarrow K_S \pi^0$
- $D^0 \rightarrow K_L \pi^0$
- $D^0 \rightarrow K_S \pi^+ \pi^-$
- $D^0 \rightarrow K_L \pi^+ \pi^-$
D^0 \rightarrow K_S \pi^0

Reconstruction Procedure:

- $\pi^0$ made from mdstpi0
- $\pi^+$ made from mdstcharged
  - track and kind cut
  - mass cut, $\pm 3\sigma$ of mean in $M_{K_S}$ distribution
- $D^0$ made from $K_S$ and $\pi^0$
  - mass cut, $\pm 3\sigma$ of mean in $M_{D^0}$ distribution
- $D^*^+$ made from $D^0$ and $\pi_s^+$
- where $\pi^+_S$ is $\pi^+$ - (and used in making $K_S$) i.e. $K_S$ veto on $\pi^+$

- signal region is defined by

$$(0.143 < d\ell = M_{D^*_+} - M_{D^0} < 0.148)$$
Reconstructing $D^0 \rightarrow K_S^0 \pi^0$
$D^0 \rightarrow K_S \pi^0$ continues...

Fitting Procedure:

- $M_{KS}$ distribution before mass cut fitted as follows
  - background fitted to 1st order polynomial
    offset fixed at 0.4700
  - signal fitted to Gaussian

- $M_{D^0}$ distribution before mass cut fitted as follows
  - background fitted to falling exponential
    offset fixed at 1.1
  - signal fitted to Gaussian

- ’dm’ distribution before cut fitted as follows
- background fitted to threshold function
  offset fixed at $M_{\pi^+} = 0.13957 \text{GeV}$

- signal fitted to double Gaussian
  defines signal region for $\epsilon_{D^{*+}}$

• $M_{D^{*+}}$ distribution before mass cut fitted as follows

- background fitted to threshold function
  offset fixed at 1.9430 GeV

- signal fitted to Gaussian
Fitting $M_{K_S}$ and $M_{D_0}$ in $D^0 \rightarrow K_S \pi^0$

\[ \chi^2 \text{ for } 55 - 5 \text{ d.o.f., C.L.}=0.735\times10^{-10} \]

Errors Parabolic                     Minos
Function 1: Polynomial of Order 1
NORM 1.35506E+05 = 3136. - 3141. + 3141.
OFFSET 0.47000 = 0. - 0. + 0.
Function 2: Gaussian (sigma)
AREA 5001.4 = 83.21 - 84.06 + 84.12
MEAN 0.49784 = 3.7415E-05 - 3.7992E-05 + 3.8008E-05
SIGMA 2.14743E-03 = 4.1698E-05 - 4.1631E-05 + 4.2377E-05

Errors Parabolic                     Minos
Function 1: Exponential
NORM 35811. = 473.6 - 464.0 + 466.5
SLOPE 1.8706 = 3.2552E-02 - 3.0930E-02 + 3.1176E-02
OFFSET 1.1000 = 0. - 0. + 0.
Function 2: Gaussian (sigma)
AREA 1724.3 = 53.89 - 53.91 + 54.08
MEAN 1.8550 = 7.2797E-04 - 7.3486E-04 + 7.1608E-04
SIGMA 1.84211E-02 = 7.0585E-04 - 6.8615E-04 + 7.1394E-04
Fitting 'dm' and $M_{D^{*+}}$ in $D^0 \rightarrow K_S\pi^0$

**MINUIT $\chi^2$ Fit to Plot**

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**30.60**

File: ver4.mn.hbk
Plot Area Total/Fit: 1998.0 / 1998.0
Func Area Total/Fit: 1955.1 / 1955.1

$\chi^2$: 42.8 for 48 - 10 d.o.f.,
C.L.: 27.1%

<table>
<thead>
<tr>
<th>Errors</th>
<th>Parabolic</th>
<th>Minos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function 1: Threshold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NORM</td>
<td>2.01596E+08</td>
<td>6.8983E+08 ± 0.</td>
</tr>
<tr>
<td>OFFSET</td>
<td>0.13957</td>
<td>0.</td>
</tr>
<tr>
<td>POWER</td>
<td>1.3495</td>
<td>0.4976</td>
</tr>
<tr>
<td>COEFF1</td>
<td>230.39</td>
<td>197.8</td>
</tr>
<tr>
<td>COEFF2</td>
<td>-543.33</td>
<td>7720.</td>
</tr>
</tbody>
</table>

**Function 2: Two Gaussians (sigma)**

| AREA | 1421.1 | 43.60 | 43.72 | 0. |
| MEAN | 0.14458 | 4.3382E-05 | 4.6649E-05 | + 4.1544E-05 |
| SIGMA1 | 2.85123E-04 | 4.5437E-05 | 4.4493E-05 | + 4.9198E-05 |
| SIGMA2 | 0.74016 | 8.7299E-02 | 0.1019 | + 7.8818E-02 |
| SIG2/SIG1 | 2.2503 | 0.2944 | 0.2743 | + 0.3320 |

---

**MINUIT $\chi^2$ Fit to Plot**

---

**41.60**

File: ver4.mn.hbk
Plot Area Total/Fit: 1668.0 / 1668.0
Func Area Total/Fit: 1635.1 / 1635.1

$\chi^2$: 33.6 for 40 - 7 d.o.f.,
C.L.: 43.6%

<table>
<thead>
<tr>
<th>Errors</th>
<th>Parabolic</th>
<th>Minos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function 1: Threshold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NORM</td>
<td>2.86341E+05</td>
<td>6.1596E+05 ± 0.</td>
</tr>
<tr>
<td>OFFSET</td>
<td>1.9430</td>
<td>0.</td>
</tr>
<tr>
<td>POWER</td>
<td>0.81789</td>
<td>0.3691</td>
</tr>
<tr>
<td>COEFF1</td>
<td>-3.0453</td>
<td>40.70</td>
</tr>
<tr>
<td>COEFF2</td>
<td>-341.36</td>
<td>255.9</td>
</tr>
</tbody>
</table>

**Function 2: Gaussian (sigma)**

| AREA | 977.34 | 160.9 | 0. |
| MEAN | 2.0071 | 1.1537E-03 | 9.3440E-04 | + 6.6188E-04 |
| SIGMA | 1.30777E-02 | 1.2344E-03 | 0. |
| SIG2/SIG1 | 2.2503 | 0.2944 | 0.2743 | + 0.3320 |
$D^0 \rightarrow K_L\pi^0$

Reconstruction Procedure:

- $\pi^0$ made from mdstpi0
- $\pi^+$ made from mdstcharged
- $K_L$ and $D^0$ made from mdstklong and $\pi^0$
  - $D^0$ and $K_L$ mass constrained
  - imaginary solution for $p_{K_L}$ rejected
- $D^{*+}$ made from $D^0$ and $\pi_s^+$
  - where $\pi_s^+ =$ all $\pi^+$, no veto on $\pi^+$
  - signal region is defined by $\pm 3\sigma$ of mean in $M_{D^{*+}}$ distribution
Reconstructing $D^0 \rightarrow K_L \pi^0$
$D^0 \rightarrow K_L \pi^0$ continues...

Fitting Procedure:

- $M_{D^{*+}}$ distribution before mass cut fitted as follows
  
  - background fitted to threshold function
  offset fixed at 2.0040 GeV
  
  - signal fitted to Gaussian
  defines signal region for $\epsilon_{D^{*+}}$
**Fitting $M_{D^{*+}}$ in $D^0 \rightarrow K_L \pi^0$**

<table>
<thead>
<tr>
<th>Errors</th>
<th>Parabolic</th>
<th>Minos</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NORM</strong></td>
<td>1.06971E+07 ± 7.9746E+06 - 5.5999E+06 + 1.1896E+07</td>
<td></td>
</tr>
<tr>
<td><strong>OFFSET</strong></td>
<td>2.0040 ± 0. - 0. + 0.</td>
<td></td>
</tr>
<tr>
<td><strong>POWER</strong></td>
<td>0.58492 ± 0.1047 - 0.1037 + 0.1058</td>
<td></td>
</tr>
<tr>
<td><strong>COEFF1</strong></td>
<td>-61.353 ± 37.18 - 36.66 + 36.99</td>
<td></td>
</tr>
<tr>
<td><strong>COEFF2</strong></td>
<td>191.03 ± 1135. - 1123. + 1112.</td>
<td></td>
</tr>
<tr>
<td><strong>AREA</strong></td>
<td>1793.2 ± 111.2 - 109.0 + 113.8</td>
<td></td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>2.0100 ± 5.0858E-05 - 5.0548E-05 + 5.1036E-05</td>
<td></td>
</tr>
<tr>
<td><strong>SIGMA</strong></td>
<td>1.5723E-03 ± 6.2098E-05 - 6.0558E-05 + 6.3878E-05</td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing the fit of $M_{D^{*+}}$ in $D^0 \rightarrow K_L \pi^0$.](image)
$D^0 \rightarrow K_S \pi^+ \pi^-$

Reconstruction Procedure:

- $\pi^\pm$ made from mdstcharged
- $K_S$ made from mdstvee2
  - track and kind cut
  - mass cut, $\pm 3\sigma$ of mean in $M_{K_S}$ distribution
- $K^*-$ made from $K_S$ and $\pi_c^-$
  - where $\pi_c^-$ is $\pi^-$ with $K_S$ veto on it
  - mass cut, $\pm 3\sigma$ of mean in $M_{K^*-}$ distribution
- $D^0$ made from $K^*-$ and $\pi_c^+$
  - where $\pi_c^+$ is $\pi^+$ with $K_S$ veto on it
- mass cut, $\pm 3\sigma$ of mean in $M_{D^0}$ distribution

- $D^{*+}$ made from $D^0$ and $\pi_s^+$
  - where $\pi_s^+$ is $\pi^+$ with $K_S$ and $D^0$ veto on it
  - signal region is defined by $(0.143 < dm < 0.148)$
Reconstructing $D^0 \rightarrow K_S\pi^+\pi^-$

![Histograms showing distributions for $K_S$ mass, $K^*$ mass, $D^0$ mass, and $D^0$ mass after mass cut.](image)
Reconstructing $D^0 \rightarrow K_S \pi^+ \pi^-$ continues....
Fitting Procedure:

- $M_{K_S}$ distribution before mass cut fitted as follows
  - background fitted to 1st order polynomial
    offset fixed at 0.470
  - signal fitted to Gaussian

- $M_{K^*}$ distribution before mass cut fitted as follows
  - background fitted to threshold function
    offset fixed at 0.6400
  - signal fitted to Gaussian
    mean fixed at 0.89166 GeV, PDG mass of $K^*$

- $M_{D^0}$ distribution before mass cut fitted as follows
- background fitted to first order polynomial
  offset fixed at 1.8400
- signal fitted to Gaussian

• 'dm' distribution before cut fitted as follows
  - background fitted to threshold function
    offset fixed at \( M_{\pi^+} = 0.13957 \text{GeV} \)
  - signal fitted to double Gaussian
    difference in mean fixed to zero
    defines signal region for \( \epsilon_{D^{*+}} \)

• \( M_{D^{*+}} \) distribution before mass cut fitted as follows
  - background fitted to threshold function
    offset fixed at 1.9960 GeV
  - signal fitted to Gaussian
Fitting $M_{KS}$, $M_{K^{*-}}$ and $M_{D^0}$ in $D^0 \rightarrow K_S^{0} \pi^+\pi^-$
Fitting 'dm' and $M_{D^{*+}}$ in $D^0 \rightarrow K_S \pi^+ \pi^-$

**MINUIT $\chi^2$ Fit to Plot 40&0**

- File: ver3.mn.hbk
- Fit: 3
- Plot Area Total/Fit: 1795.0 / 1795.0
- Func Area Total/Fit: 1755.6 / 1755.6
- $\chi^2$: 39.9 for 48 - 9 d.o.f., C.L.: 43.1%

<table>
<thead>
<tr>
<th>Errors</th>
<th>Parabolic</th>
<th>Minos</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORM</td>
<td>32631. ± 1.1473E+05</td>
<td>- 0.</td>
</tr>
<tr>
<td>OFFSET</td>
<td>0.13957</td>
<td>- 0.</td>
</tr>
<tr>
<td>POWER</td>
<td>0.16477 ± 0.4849</td>
<td>- 0.</td>
</tr>
<tr>
<td>COEFF1</td>
<td>236.98 ± 236.4</td>
<td>- 0.</td>
</tr>
<tr>
<td>COEFF2</td>
<td>-17696. ± 1.0468E+04</td>
<td>- 0.</td>
</tr>
</tbody>
</table>

**Function 2: Two Gaussians (sigma)**
- AREA: 1405.7 ± 42.96 - 42.85 + 42.96
- MEAN: 0.14551 ± 1.3936E-05 - 1.3880E-05 + 1.3915E-05
- SIGMA1: 2.80317E-04 ± 4.1506E-05 - 3.7736E-05 + 4.2909E-05
- AR2/AREA: 0.57985 ± 9.9511E-02 - 0.1058 + 9.0990E-02
- DELM: 0. ± 0. - 0. + 0. |
- SIG2/SIG1: 2.4963 ± 0.2360 - 0.2210 + 0.2478

**MINUIT $\chi^2$ Fit to Plot 51&0**

- File: ver3.mn.hbk
- Fit: 3
- Plot Area Total/Fit: 1571.0 / 1571.0
- Func Area Total/Fit: 1542.3 / 1542.3
- $\chi^2$: 26.8 for 30 - 7 d.o.f., C.L.: 26.6%

<table>
<thead>
<tr>
<th>Errors</th>
<th>Parabolic</th>
<th>Minos</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORM</td>
<td>-21.181 ± 190.4</td>
<td>- 0.</td>
</tr>
<tr>
<td>OFFSET</td>
<td>1.9960</td>
<td>- 0.</td>
</tr>
<tr>
<td>POWER</td>
<td>12.833 ± 1.796</td>
<td>- 0.</td>
</tr>
<tr>
<td>COEFF1</td>
<td>3881.4 ± 2.8350E-02</td>
<td>- 0.</td>
</tr>
<tr>
<td>COEFF2</td>
<td>-74846.</td>
<td>- 0.</td>
</tr>
</tbody>
</table>

**Function 2: Gaussian (sigma)**
- AREA: 1550.5 ± 39.51 | - 0. | + 0. |
- MEAN: 2.0104 ± 1.3619E-04 | - 0. | + 0. |
- SIGMA: 5.22432E-03 ± 1.1992E-04 | - 0. | + 0. |
\[ D^0 \rightarrow K_L \pi^+ \pi^- \]

Reconstruction Procedure:

- **\( \pi^\pm \)** made from mdstcharged
- **\( K_L, K^{*-} \) and \( D^0 \)** made from mdstklong, \( \pi^+ \) and \( \pi^- \)
  - \( D^0 \) and \( K_L \) mass constrained
  - imaginary solution for \( p_{K_L} \) rejected
  - \( K^{*-} \) made from \( K_L \) and \( \pi^- \)
    mass cut, \( \pm 3\sigma \) of mean in \( M_{K^{*-}} \) distribution
  - \( D^0 \) made from \( K^{*-} \) and \( \pi^+ \)
- **\( D^{*-} \)** made from \( D^0 \) and \( \pi_s^+ \)
  - where \( \pi_s^+ = \pi^+ \) with \( D^0 \) veto on it
  - signal region is defined by \( \pm 3\sigma \) of mean in \( M_{D^{*-}} \) distribution
Reconstructing $D^0 \rightarrow K_L \pi^+ \pi^-$
Fitting Procedure:

- $M_{K^*-}$ distribution before mass cut fitted as follows
  - background fitted to threshold function
    offset fixed at 0.6300 GeV
  - signal fitted to Gaussian
    mean fixed at 0.89166 GeV, PDG mass of $K^{*-}$

- $M_{D^{*+}}$ distribution before mass cut fitted as follows
  - background fitted to threshold function
    offset fixed at 2.0040 GeV
  - signal fitted to Gaussian
    defines signal region for $\epsilon_{D^{*+}}$
Fitting $M_{K^{*-}}$ and $M_{D^{*+}}$ in $D^0 \rightarrow K_L \pi^+ \pi^-$