\( \Lambda_c(2595)^+ \)

\[ I(\mathcal{J}^P) = 0(\frac{1}{2}^-) \] Status: ***

The \( \Lambda_c^+ \pi^+ \pi^- \) mode is largely, and perhaps entirely, \( \Sigma_c \pi \), which is just at threshold; since the \( \Sigma_c \) has \( \mathcal{J}^P = 1/2^+ \), the \( \mathcal{J}^P \) here is almost certainly \( 1/2^- \). This result is in accord with the theoretical expectation that this is the charm counterpart of the strange \( \Lambda(1405) \).

\( \Lambda_c(2595)^+ \) MASS

The mass is obtained from the \( \Lambda_c(2595)^+-\Lambda_c^+ \) mass-difference measurements below.

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>DOCUMENT ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>2592.25\pm0.28 OUR FIT</td>
<td></td>
</tr>
</tbody>
</table>

\( \Lambda_c(2595)^+ - \Lambda_c^+ \) MASS DIFFERENCE

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>EVTS</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>305.79\pm0.24 OUR FIT</td>
<td></td>
<td>AALTONEN 11H CDF</td>
<td>p\overline{p} at 1.96 TeV</td>
<td></td>
</tr>
<tr>
<td>305.79\pm0.14\pm0.20</td>
<td>3.5k</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>\bullet \bullet \bullet We do not use the following data for averages, fits, limits, etc. \bullet \bullet \bullet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>305.6 \pm 0.3</td>
<td>1 BLECHMAN 03</td>
<td>Threshold shift</td>
<td></td>
<td></td>
</tr>
<tr>
<td>309.7 \pm 0.9 \pm 0.4</td>
<td>19</td>
<td>ALBRECHT 97 ARG</td>
<td>( e^+ e^- \approx 10 \text{ GeV} )</td>
<td></td>
</tr>
<tr>
<td>309.2 \pm 0.7 \pm 0.3</td>
<td>14 \pm 4.5</td>
<td>FRABETTI 96 E687</td>
<td>( \gamma \text{Be}, E\gamma \approx 220 \text{ GeV} )</td>
<td></td>
</tr>
<tr>
<td>307.5 \pm 0.4 \pm 1.0</td>
<td>112 \pm 17</td>
<td>EDWARDS 95 CLE2</td>
<td>( e^+ e^- \approx 10.5 \text{ GeV} )</td>
<td></td>
</tr>
</tbody>
</table>

\( \Lambda_c(2595)^+ \) WIDTH

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>EVTS</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.59\pm0.30\pm0.47</td>
<td>3.5k</td>
<td>2 AALTONEN 11H CDF</td>
<td>p\overline{p} at 1.96 TeV</td>
<td></td>
</tr>
<tr>
<td>\bullet \bullet \bullet We do not use the following data for averages, fits, limits, etc. \bullet \bullet \bullet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.9 \pm 2.9^{+1.8}_{-2.1} \pm 1.4</td>
<td>19</td>
<td>ALBRECHT 97 ARG</td>
<td>( e^+ e^- \approx 10 \text{ GeV} )</td>
<td></td>
</tr>
<tr>
<td>3.9 \pm 1.4^{+2.0}_{-1.2} \pm 1.0</td>
<td>112 \pm 17</td>
<td>EDWARDS 95 CLE2</td>
<td>( e^+ e^- \approx 10.5 \text{ GeV} )</td>
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</tr>
</tbody>
</table>

\( \Lambda_c(2595)^+ \) treats the three charged modes \( \Lambda_c(2595)^+ \rightarrow \Sigma_c(2455)^{++} \pi^- \), \( \Sigma_c(2455)^{++} \pi^0 \), \( \Sigma_c(2455)^0 \pi^+ \) separately in terms of a common coupling constant \( h_2 \) and obtains \( h_2^2 = 0.36 \pm 0.08 \). From this the width is determined.
\( \Lambda_c(2595)^+ \) DECAY MODES

\( \Lambda_c^+ \pi \pi \) and its submode \( \Sigma_c(2455) \pi \) — the latter just barely — are the only strong decays allowed to an excited \( \Lambda_c^+ \) having this mass; and the submode seems to dominate.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Fraction (( \Gamma_f/\Gamma ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Gamma_1 )</td>
<td>( \Lambda_c^+ \pi^+\pi^- )</td>
</tr>
<tr>
<td>( \Gamma_2 )</td>
<td>( \Sigma_c(2455)^{++} \pi^- )</td>
</tr>
<tr>
<td>( \Gamma_3 )</td>
<td>( \Sigma_c(2455)^0 \pi^+ )</td>
</tr>
<tr>
<td>( \Gamma_4 )</td>
<td>( \Lambda_c^+ \pi^+\pi^- ) 3-body</td>
</tr>
<tr>
<td>( \Gamma_5 )</td>
<td>( \Lambda_c^+ \pi^0 )</td>
</tr>
<tr>
<td>( \Gamma_6 )</td>
<td>( \Lambda_c^+ \gamma )</td>
</tr>
</tbody>
</table>

[a] See AALTONEN 11H, Fig. 8, for the calculated ratio of \( \Lambda_c^+ \pi^0 \pi^0 \) and \( \Lambda_c^+ \pi^+\pi^- \) partial widths as a function of the \( \Lambda_c(2595)^+ - \Lambda_c^+ \) mass difference. At our value of the mass difference, the ratio is about 4.

[b] A test that the isospin is indeed 0, so that the particle is indeed a \( \Lambda_c^+ \).

\( \Lambda_c(2595)^+ \) BRANCHING RATIOS

\( \Gamma(\Sigma_c(2455)^{++}\pi^-)/\Gamma(\Lambda_c^+\pi^+\pi^-) \)

<table>
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<tr>
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<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.36 ± 0.10 OUR AVERAGE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.37 ± 0.12 ± 0.13</td>
<td>ALBRECHT 97</td>
<td>ARG</td>
<td>( e^+ e^- \approx 10 \text{ GeV} )</td>
</tr>
<tr>
<td>0.36 ± 0.09 ± 0.09</td>
<td>EDWARDS 95</td>
<td>CLE2</td>
<td>( e^+ e^- \approx 10.5 \text{ GeV} )</td>
</tr>
</tbody>
</table>

\( \Gamma(\Sigma_c(2455)^0\pi^+)/\Gamma(\Lambda_c^+\pi^+\pi^-) \)

<table>
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<tr>
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<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.37 ± 0.10 OUR AVERAGE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.29 ± 0.10 ± 0.11</td>
<td>ALBRECHT 97</td>
<td>ARG</td>
<td>( e^+ e^- \approx 10 \text{ GeV} )</td>
</tr>
<tr>
<td>0.42 ± 0.09 ± 0.09</td>
<td>EDWARDS 95</td>
<td>CLE2</td>
<td>( e^+ e^- \approx 10.5 \text{ GeV} )</td>
</tr>
</tbody>
</table>

\[ \left[ \Gamma(\Sigma_c(2455)^{++}\pi^-) + \Gamma(\Sigma_c(2455)^0\pi^+ \right] / \Gamma(\Lambda_c^+\pi^+\pi^-) \]

\( (\Gamma_2 + \Gamma_3)/\Gamma_1 \)

<table>
<thead>
<tr>
<th>VALUE</th>
<th>CL %</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.66 ± 0.13 ± 0.07</td>
<td>ALBRECHT 97</td>
<td>ARG</td>
<td>( e^+ e^- \approx 10 \text{ GeV} )</td>
<td></td>
</tr>
<tr>
<td>&gt;0.51</td>
<td>90</td>
<td>3 FRABETTI 96</td>
<td>E687</td>
<td>( e^+ e^- \approx 220 \text{ GeV} )</td>
</tr>
</tbody>
</table>

\[ \Gamma(\Lambda_c^+\pi^0)/\Gamma(\Lambda_c^+\pi^+\pi^-) \]

\( \Lambda_c^+ \pi^0 \) decay is forbidden by isospin conservation if this state is in fact a \( \Lambda_c^+ \).

<table>
<thead>
<tr>
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<th>CL %</th>
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<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;3.53</td>
<td>90</td>
<td>EDWARDS 95</td>
<td>CLE2</td>
<td>( e^+ e^- \approx 10.5 \text{ GeV} )</td>
</tr>
</tbody>
</table>
\[ \Gamma(\Lambda_c^+ \gamma)/\Gamma(\Lambda_c^+ \pi^+ \pi^-) \quad \Gamma_6/\Gamma_1 \]

<table>
<thead>
<tr>
<th>Value</th>
<th>CL%</th>
<th>Document ID</th>
<th>TECN</th>
<th>Comment</th>
</tr>
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<tbody>
<tr>
<td>&lt;0.98</td>
<td>90</td>
<td>EDWARDS 95</td>
<td>CLE2</td>
<td>( e^+ e^- \approx 10.5 \text{ GeV} )</td>
</tr>
</tbody>
</table>

**\( \Lambda_c(2595)^+ \) References**

| AALTONEN  | 11H | PR D84 012003 | T. Aaltonen et al. | (CDF Collab.) |
| BLECHMAN   | 03  | PR D67 074033 | A.E. Blechman et al. | (JHU, FLOR) |
| ALBRECHT   | 97  | PL B402 207  | H. Albrecht et al. | (ARGUS Collab.) |
| FRABETTI    | 96  | PL B365 461  | P.L. Frabetti et al. | (FNAL E687 Collab.) |
| EDWARDS    | 95  | PRL 74 3331  | K.W. Edwards et al. | (CLEO Collab.) |