$\Lambda_c(2593)^+$

$I(J^P) = 0(\frac{1}{2}^-)$ Status: ∗∗∗

Seen in $\Lambda_c^+ \pi^+ \pi^-$ but not in $\Lambda_c^+ \pi^0$, so this is indeed an excited Λ_c^+ rather than a Σ_c^+. The $\Lambda_c^+ \pi^+ \pi^-$ mode is largely, and perhaps entirely, $\Sigma_c \pi$, which is just at threshold; thus (assuming, as has not yet been proven, that the Σ_c has $J^P = 1/2^+$) the 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 $\Lambda(1405)$.

$\Lambda_c(2593)^+$ MASS

The mass is obtained from the $\Lambda_c(2593)^+$–Λ_c^+ mass-difference measurements below. But the mass may be 2 or 3 MeV lower: see the footnote to BLECHMAN 03 in the next data block.

VALUE (MeV)	*DOCUMENT ID*
2595.4±0.6 OUR FIT	Error includes scale factor of 1.1.

$\Lambda_c(2593)^+ - \Lambda_c^+$ MASS DIFFERENCE

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
308.9±0.6 OUR FIT	Error includes scale factor of 1.1.				
308.9±0.6 OUR AVERAGE	Error includes scale factor of 1.1.				
309.7±0.9±0.4	19	ALBRECHT	97	ARG	$e^+e^- \approx$ 10 GeV
309.2±0.7±0.3	14	[1] FRABETTI	96	E687	γBe, $\overline{E}_\gamma \approx$ 220 GeV
307.5±0.4±1.0	112	[2] EDWARDS	95	CLE2	$e^+e^- \approx$ 10.5 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
305.6±0.3		[3] BLECHMAN	03		Threshold shift

[1] FRABETTI 96 claims a signal of 13.9 ± 4.5 events.

[2] EDWARDS 95 claims a signal of 112.5 ± 16.5 events in $\Lambda_c^+ \pi^+ \pi^-$.

[3] BLECHMAN 03 finds that a more sophisticated treatment than a simple Breit-Wigner for the proximity of the threshold of the dominant decay, $\Sigma_c(2455)\pi$, lowers the $\Lambda_c(2593)^+ - \Lambda_c^+$ mass difference by 2 or 3 MeV.

$\Lambda_c(2593)^+$ WIDTH

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
$\mathbf{3.6^{+2.0}_{-1.3}}$ **OUR AVERAGE**					
$2.9^{+2.9}_{-2.1}{}^{+1.8}_{-1.4}$	19	ALBRECHT	97	ARG	$e^+e^- \approx$ 10 GeV
$3.9^{+1.4}_{-1.2}{}^{+2.0}_{-1.0}$	112	EDWARDS	95	CLE2	$e^+e^- \approx$ 10.5 GeV

$\Lambda_c(2593)^+$ 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 Λ_c^+ having this mass; and the submode seems to dominate.

	Mode	Fraction (Γ_i/Γ)
Γ_1	$\Lambda_c^+ \pi^+ \pi^-$	[a] ≈ 67 %
Γ_2	$\Sigma_c(2455)^{++} \pi^-$	24 ± 7 %
Γ_3	$\Sigma_c(2455)^0 \pi^+$	24 ± 7 %
Γ_4	$\Lambda_c^+ \pi^+ \pi^-$ 3-body	18 ± 10 %
Γ_5	$\Lambda_c^+ \pi^0$	[b] not seen
Γ_6	$\Lambda_c^+ \gamma$	not seen

[a] Assuming isospin conservation, so that the other third is $\Lambda_c^+ \pi^0 \pi^0$.

[b] A test that the isospin is indeed 0, so that the particle is indeed a Λ_c^+.

$\Lambda_c(2593)^+$ BRANCHING RATIOS

$\Gamma(\Sigma_c(2455)^{++}\pi^-)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ — Γ_2/Γ_1

VALUE	DOCUMENT ID		TECN	COMMENT
0.36±0.10 OUR AVERAGE				
0.37±0.12±0.13	ALBRECHT	97	ARG	$e^+e^- \approx$ 10 GeV
0.36±0.09±0.09	EDWARDS	95	CLE2	$e^+e^- \approx$ 10.5 GeV

$\Gamma(\Sigma_c(2455)^0\pi^+)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ — Γ_3/Γ_1

VALUE	DOCUMENT ID		TECN	COMMENT
0.37±0.10 OUR AVERAGE				
0.29±0.10±0.11	ALBRECHT	97	ARG	$e^+e^- \approx$ 10 GeV
0.42±0.09±0.09	EDWARDS	95	CLE2	$e^+e^- \approx$ 10.5 GeV

$[\Gamma(\Sigma_c(2455)^{++}\pi^-)+\Gamma(\Sigma_c(2455)^0\pi^+)]/\Gamma(\Lambda_c^+\pi^+\pi^-)$ — $(\Gamma_2+\Gamma_3)/\Gamma_1$

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.66^{+0.13}_{-0.16}\pm0.07$		ALBRECHT	97	ARG	$e^+e^- \approx$ 10 GeV
>0.51	90	[4] FRABETTI	96	E687	γ Be, $\overline{E}_\gamma \approx$ 220 GeV

[4] The results of FRABETTI 96 are consistent with this ratio being 100%.

$\Gamma(\Lambda_c^+\pi^0)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ — Γ_5/Γ_1

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<3.53	90	EDWARDS	95	CLE2	$e^+e^- \approx$ 10.5 GeV

$\Gamma(\Lambda_c^+\gamma)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ — Γ_6/Γ_1

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.98	90	EDWARDS	95	CLE2	$e^+e^- \approx$ 10.5 GeV

$\Lambda_c(2593)^+$ REFERENCES

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.)