

# $\Sigma_c(2455)$

$$I(J^P) = 1(\frac{1}{2}^+) \text{ Status: } ****$$

The angular distribution of  $B^- \rightarrow \Sigma_c(2455)^0 \bar{p}$  favors  $J = 1/2$  (as the quark model predicts).  $J = 3/2$  is excluded by more than four standard deviations; see AUBERT 08BN.

## $\Sigma_c(2455)$ MASSES

The masses are obtained from the mass-difference measurements that follow.

### $\Sigma_c(2455)^{++}$ MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>
<b>2453.97 ± 0.14 OUR FIT</b>	

### $\Sigma_c(2455)^+$ MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>
<b>2452.65<sup>+0.22</sup><sub>-0.16</sub> OUR FIT</b>	

### $\Sigma_c(2455)^0$ MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>
<b>2453.75 ± 0.14 OUR FIT</b>	

## $\Sigma_c(2455) - \Lambda_c^+$ MASS DIFFERENCES

### $m_{\Sigma_c(2455)^{++}} - m_{\Lambda_c^+}$

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>167.510 ± 0.017 OUR FIT</b>				
<b>167.510 ± 0.022 OUR AVERAGE</b>				
167.51 ± 0.01 ± 0.02	36k	LEE	14	BELL $e^+e^-$ at $\Upsilon(4S)$
167.44 ± 0.04 ± 0.12	13.8k	AALTONEN	11H	CDF $p\bar{p}$ at 1.96 TeV
167.4 ± 0.1 ± 0.2	2k	ARTUSO	02	CLE2 $e^+e^- \approx \Upsilon(4S)$
167.35 ± 0.19 ± 0.12	461	LINK	00C	FOCS $\gamma A, \bar{E}_\gamma$ 180 GeV
167.76 ± 0.29 ± 0.15	122	AITALA	96B	E791 $\pi^- N$ , 500 GeV
167.6 ± 0.6 ± 0.6	56	FRABETTI	96	E687 $\gamma Be, \bar{E}_\gamma \approx 220$ GeV
168.2 ± 0.3 ± 0.2	126	CRAWFORD	93	CLE2 $e^+e^- \approx \Upsilon(4S)$
167.8 ± 0.4 ± 0.3	54	BOWCOCK	89	CLEO $e^+e^-$ 10 GeV
168.2 ± 0.5 ± 1.6	92	ALBRECHT	88D	ARG $e^+e^-$ 10 GeV
167.4 ± 0.5 ± 2.0	46	DIESBURG	87	SPEC $nA \sim 600$ GeV

• • • We do not use the following data for averages, fits, limits, etc. • • •

167 ± 1	2	JONES	87	HBC	$\nu p$ in BEBC
166 ± 1	1	BOSETTI	82	HBC	See JONES 87
168 ± 3	6	BALTAY	79	HLBC	$\nu$ Ne-H in 15-ft
166 ± 15	1	CAZZOLI	75	HBC	$\nu p$ in BNL 7-ft

$$m_{\Sigma_c(2455)^+} - m_{\Lambda_c^+}$$

VALUE (MeV)	EVTs	DOCUMENT ID	TECN	COMMENT
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**166.19<sup>+0.16</sup><sub>-0.08</sub> OUR FIT**

**166.19<sup>+0.15</sup><sub>-0.08</sub> OUR AVERAGE**

166.17 ± 0.05 <sup>+0.16</sup> <sub>-0.07</sub>		YELTON	21	BELL	$e^+e^-$ at $\Upsilon(nS)$
166.4 ± 0.2 ± 0.3	661	AMMAR	01	CLE2	$e^+e^- \approx \Upsilon(4S)$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
168.5 ± 0.4 ± 0.2	111	CRAWFORD	93	CLE2	See AMMAR 01
168 ± 3	1	CALICCHIO	80	HBC	$\nu p$ in BEBC-TST

$$m_{\Sigma_c(2455)^0} - m_{\Lambda_c^+}$$

VALUE (MeV)	EVTs	DOCUMENT ID	TECN	COMMENT
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**167.290 ± 0.017 OUR FIT**

**167.290 ± 0.022 OUR AVERAGE**

167.29 ± 0.01 ± 0.02	32k	LEE	14	BELL	$e^+e^-$ at $\Upsilon(4S)$
167.28 ± 0.03 ± 0.12	15.9k	AALTONEN	11H	CDF	$p\bar{p}$ at 1.96 TeV
167.2 ± 0.1 ± 0.2	2k	ARTUSO	02	CLE2	$e^+e^- \approx \Upsilon(4S)$
167.38 ± 0.21 ± 0.13	362	LINK	00C	FOCS	$\gamma A, \bar{E}_\gamma$ 180 GeV
167.38 ± 0.29 ± 0.15	143	AITALA	96B	E791	$\pi^- N$ , 500 GeV
167.8 ± 0.6 ± 0.2		ALEEV	96	SPEC	$n$ nucleus, 50 GeV/c
166.6 ± 0.5 ± 0.6	69	FRABETTI	96	E687	$\gamma Be, \bar{E}_\gamma \approx 220$ GeV
167.1 ± 0.3 ± 0.2	124	CRAWFORD	93	CLE2	$e^+e^- \approx \Upsilon(4S)$
168.4 ± 1.0 ± 0.3	14	ANJOS	89D	E691	$\gamma Be$ 90–260 GeV
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
167.9 ± 0.5 ± 0.3	48	<sup>1</sup> BOWCOCK	89	CLEO	$e^+e^-$ 10 GeV
167.0 ± 0.5 ± 1.6	70	<sup>1</sup> ALBRECHT	88D	ARG	$e^+e^-$ 10 GeV
178.2 ± 0.4 ± 2.0	85	<sup>2</sup> DIESBURG	87	SPEC	$nA \sim 600$ GeV
163 ± 2	1	AMMAR	86	EMUL	$\nu A$

<sup>1</sup>This result enters the fit through  $m_{\Sigma_c^{++}} - m_{\Sigma_c^0}$  given below.

<sup>2</sup>See the note on DIESBURG 87 in the  $m_{\Sigma_c^{++}} - m_{\Sigma_c^0}$  section below.

## $\Sigma_c(2455)$ MASS DIFFERENCES

$$m_{\Sigma_c(2455)^{++}} - m_{\Sigma_c(2455)^0}$$

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
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**0.220 ± 0.013 OUR FIT**

**0.221 ± 0.014 OUR AVERAGE**

0.22 ± 0.01 ± 0.01	LEE	14	BELL	$e^+e^-$ at $\Upsilon(4S)$
0.2 ± 0.1 ± 0.1	ARTUSO	02	CLE2	$e^+e^- \approx \Upsilon(4S)$
– 0.03 ± 0.28 ± 0.11	LINK	00C	FOCS	$\gamma A, \bar{E}_\gamma$ 180 GeV
0.38 ± 0.40 ± 0.15	AITALA	96B	E791	$\pi^- N$ , 500 GeV
1.1 ± 0.4 ± 0.1	CRAWFORD	93	CLE2	$e^+e^- \approx \Upsilon(4S)$
– 0.1 ± 0.6 ± 0.1	BOWCOCK	89	CLEO	$e^+e^-$ 10 GeV
1.2 ± 0.7 ± 0.3	ALBRECHT	88D	ARG	$e^+e^- \sim 10$ GeV

● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●

−10.8 ±2.9 <sup>3</sup>DIESBURG 87 SPEC  $nA \sim 600$  GeV

<sup>3</sup>DIESBURG 87 is completely incompatible with the other experiments, which is surprising since it agrees with them about  $m_{\Sigma_c(2455)^{++}} - m_{\Lambda_c^+}$ . We go with the majority here.

**$m_{\Sigma_c(2455)^+} - m_{\Sigma_c(2455)^0}$**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
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−1.10<sup>+0.16</sup><sub>−0.08</sub> OUR FIT

• • • We do not use the following data for averages, fits, limits, etc. • • •

1.4 ±0.5 ±0.3	CRAWFORD	93	CLE2	See AMMAR 01
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**$\Sigma_c(2455)$  WIDTHS**

**$\Sigma_c(2455)^{++}$  WIDTH**

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
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**1.89<sup>+0.09</sup><sub>−0.18</sub> OUR AVERAGE** Error includes scale factor of 1.1.

1.84 ±0.04 <sup>+0.07</sup> <sub>−0.20</sub>	36k	LEE	14	BELL	$e^+e^-$ at $\Upsilon(4S)$
2.34 ±0.13 ±0.45	13.8k	AALTONEN	11H	CDF	$p\bar{p}$ at 1.96 TeV
2.3 ±0.2 ±0.3	2k	ARTUSO	02	CLE2	$e^+e^- \approx \Upsilon(4S)$
2.05 <sup>+0.41</sup> <sub>−0.38</sub> ±0.38	1110	LINK	02	FOCS	$\gamma A, \bar{E}_\gamma \approx 180$ GeV

**$\Sigma_c(2455)^+$  WIDTH**

VALUE (MeV)	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
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**2.3 ±0.3 ±0.3** YELTON 21 BELL  $e^+e^-$  at  $\Upsilon(nS)$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<4.6	90	661	AMMAR	01	CLE2	$e^+e^- \approx \Upsilon(4S)$
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**$\Sigma_c(2455)^0$  WIDTH**

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
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**1.83<sup>+0.11</sup><sub>−0.19</sub> OUR AVERAGE** Error includes scale factor of 1.2.

1.76 ±0.04 <sup>+0.09</sup> <sub>−0.21</sub>	32k	LEE	14	BELL	$e^+e^-$ at $\Upsilon(4S)$
1.65 ±0.11 ±0.49	15.9k	AALTONEN	11H	CDF	$p\bar{p}$ at 1.96 TeV
2.6 ±0.5 ±0.3		AUBERT	08BN	BABR	$B^- \rightarrow \bar{p}\Lambda_c^+\pi^-$
2.5 ±0.2 ±0.3	2k	ARTUSO	02	CLE2	$e^+e^- \approx \Upsilon(4S)$
1.55 <sup>+0.41</sup> <sub>−0.37</sub> ±0.38	913	LINK	02	FOCS	$\gamma A, \bar{E}_\gamma \approx 180$ GeV

**$\Sigma_c(2455)$  DECAY MODES**

$\Lambda_c^+\pi$  is the only strong decay allowed to a  $\Sigma_c$  having this mass.

Mode	Fraction ( $\Gamma_j/\Gamma$ )
$\Gamma_1 \Lambda_c^+\pi$	$\approx 100\%$

## $\Sigma_c(2455)$ REFERENCES

YELTON	21	PR D104 052003	J. Yelton <i>et al.</i>	(BELLE Collab.)
LEE	14	PR D89 091102	S.-H. Lee <i>et al.</i>	(BELLE Collab.)
AALTONEN	11H	PR D84 012003	T. Aaltonen <i>et al.</i>	(CDF Collab.)
AUBERT	08BN	PR D78 112003	B. Aubert <i>et al.</i>	(BABAR Collab.)
ARTUSO	02	PR D65 071101	M. Artuso <i>et al.</i>	(CLEO Collab.)
LINK	02	PL B525 205	J.M. Link <i>et al.</i>	(FNAL FOCUS Collab.)
AMMAR	01	PRL 86 1167	R. Ammar <i>et al.</i>	(CLEO Collab.)
LINK	00C	PL B488 218	J.M. Link <i>et al.</i>	(FNAL FOCUS Collab.)
AITALA	96B	PL B379 292	E.M. Aitala <i>et al.</i>	(FNAL E791 Collab.)
ALEEV	96	JINRRC 3-77 31	A.N. Aleev <i>et al.</i>	(Serpukhov EXCHARM Collab.)
FRABETTI	96	PL B365 461	P.L. Frabetti <i>et al.</i>	(FNAL E687 Collab.)
CRAWFORD	93	PRL 71 3259	G. Crawford <i>et al.</i>	(CLEO Collab.)
ANJOS	89D	PRL 62 1721	J.C. Anjos <i>et al.</i>	(FNAL E691 Collab.)
BOWCOCK	89	PRL 62 1240	T.J.V. Bowcock <i>et al.</i>	(CLEO Collab.)
ALBRECHT	88D	PL B211 489	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
DIESBURG	87	PRL 59 2711	M. Diesburg <i>et al.</i>	(FNAL E400 Collab.)
JONES	87	ZPHY C36 593	G.T. Jones <i>et al.</i>	(CERN WA21 Collab.)
AMMAR	86	JETPL 43 515	R. Ammar <i>et al.</i>	(ITEP)
		Translated from ZETFP 43 401.		
BOSETTI	82	PL 109B 234	P.C. Bosetti <i>et al.</i>	(AACH3, BONN, CERN+)
CALICCHIO	80	PL 93B 521	M. Calicchio <i>et al.</i>	(BARI, BIRM, BRUX+)
BALTAY	79	PRL 42 1721	C. Baltay <i>et al.</i>	(COLU, BNL) I
CAZZOLI	75	PRL 34 1125	E.G. Cazzoli <i>et al.</i>	(BNL)

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