$D_1(2420)$

$I(J^P) = \frac{1}{2}(1^+)$

$D_1(2420)$ MASS

The fit includes $D^\pm$, D^0, $D_s^\pm$, $D^{*\pm}$, D^{*0}, $D_s^{*\pm}$, $D_1(2420)^0$, $D_2^*(2460)^0$, and $D_{s1}(2536)^\pm$ mass and mass difference measurements.

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
2422.1±0.6 OUR FIT Error includes scale factor of 1.7.						
2422.1±0.8 OUR AVERAGE Error includes scale factor of 2.1. See the ideogram below.						
2424.8±0.1±0.7	79k	[1] AAIJ	20D	LHCB	0	$B^- \to D^{*+}\pi^-\pi^-$
2427.2±1.0±1.2	4207	ABLIKIM	20P	BES3	+	$e^+e^- \to D^+D^-\pi^+\pi^-$
2419.6±0.1±0.7	210k	AAIJ	13CC	LHCB	0	$pp \to D^{*+}\pi^- X$
$2423.1\pm1.5^{+0.4}_{-1.0}$	2.7k	[2] ABRAMOWICZ	13	ZEUS	0	$e^\pm p \to D^{(*)+}\pi^- X$
$2421.9\pm4.7^{+3.4}_{-1.2}$	759	[3] ABRAMOWICZ	13	ZEUS	+	$e^\pm p \to D^{(*)0}\pi^+ X$
2420.1±0.1±0.8	103k	DEL-AMO-SA...	10P	BABR	0	$e^+e^- \to D^{*+}\pi^- X$
2426 ±3 ±1	151	ABE	05A	BELL	0	$B^- \to D^0\pi^+\pi^-\pi^-$
2421 ±2 ±1	124	ABE	05A	BELL	+	$\overline{B}^0 \to D^+\pi^+\pi^-\pi^-$
2421.4±1.5±0.9		[4] ABE	04D	BELL	0	$B^- \to D^{*+}\pi^-\pi^-$
$2421\ ^{+1}_{-2}\ \pm2$	286	AVERY	94C	CLE2	0	$e^+e^- \to D^{*+}\pi^- X$
2425 ±2 ±2	146	BERGFELD	94B	CLE2	+	$e^+e^- \to D^{*0}\pi^+ X$
2422 ±2 ±2	51	FRABETTI	94B	E687	0	$\gamma\text{Be} \to D^{*+}\pi^- X$
2428 ±3 ±2	279	AVERY	90	CLEO	0	$e^+e^- \to D^{*+}\pi^- X$
2414 ±2 ±5	171	ALBRECHT	89H	ARG	0	$e^+e^- \to D^{*+}\pi^- X$
2428 ±8 ±5	171	ANJOS	89C	TPS	0	$\gamma N \to D^{*+}\pi^- X$
2443 ±7 ±5	190	ANJOS	89C	TPS	+	$\gamma N \to D^0\pi^+ X^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
2420.5±2.1±0.9	3.1k	[5] CHEKANOV	09	ZEUS	0	$e^\pm p \to D^{*+}\pi^- X$
2421.7±0.7±0.6	7.5k	ABULENCIA	06A	CDF	0	1900 $p\overline{p} \to D^{*+}\pi^- X$
2425 ±3	235	[6] ABREU	98M	DLPH	0	e^+e^-

[1] From a full four-body amplitude analysis of the $B^- \to D^{*+}\pi^-\pi^-$ decay.

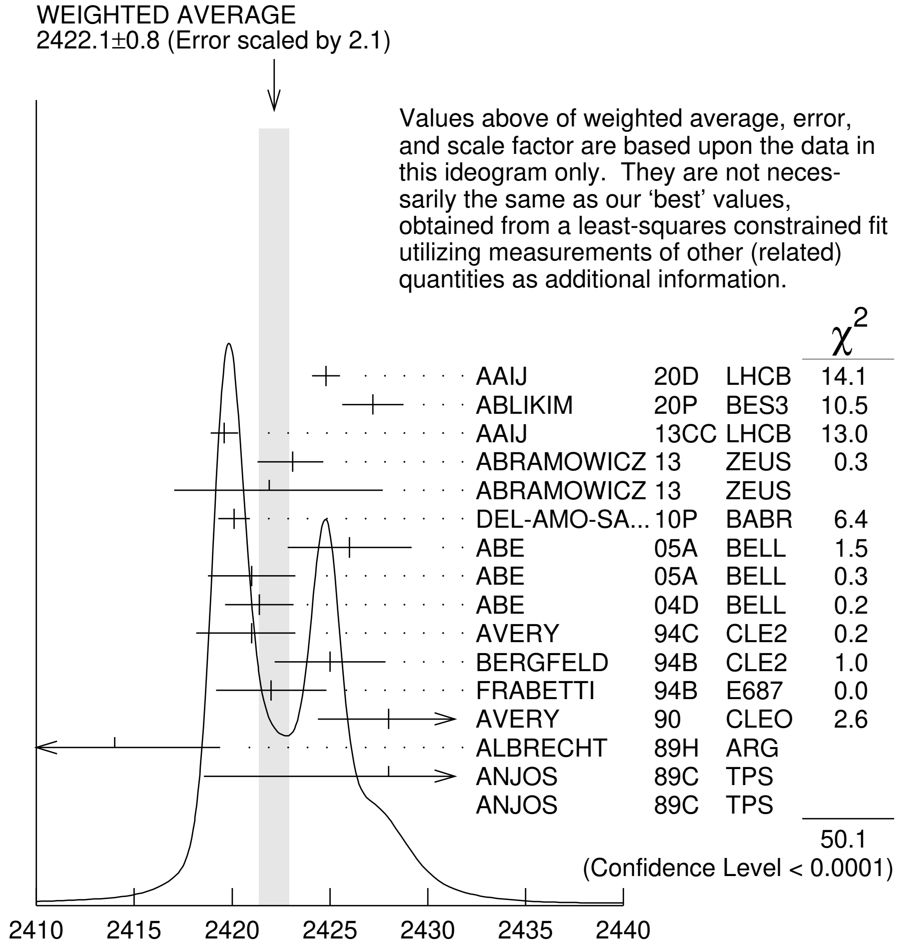
[2] From the combined fit of the $M(D^+\pi^-)$ and $M(D^{*+}\pi^-)$ distributions. and A_{D_2} fixed to the theoretical prediction of -1.

[3] From the fit of the $M(D^0\pi^+)$ distribution. The widths of the D_1^+ and D_2^{*+} are fixed to 25 MeV and 37 MeV, and A_{D_1} and A_{D_2} are fixed to the theoretical predictions of 3 and -1, respectively.

[4] Fit includes the contribution from $D_1^*(2430)^0$.

[5] Calculated using the mass difference $m(D_1^0) - m(D^{*+})_{PDG}$ reported below and $m(D^{*+})_{PDG}$ = 2010.27 ± 0.17 MeV. The 0.17 MeV uncertainty of the PDG mass value should be added to the experimental uncertainty of 0.9 MeV.

[6] No systematic error given.



$D_1(2420)$ mass (MeV)

$m_{D_1(2420)^0} - m_{D^{*+}}$

The fit includes $D^{\pm}$, D^0, $D_s^{\pm}$, $D^{*\pm}$, D^{*0}, $D_s^{*\pm}$, $D_1(2420)^0$, $D_2^*(2460)^0$, and $D_{s1}(2536)^{\pm}$ mass and mass difference measurements.

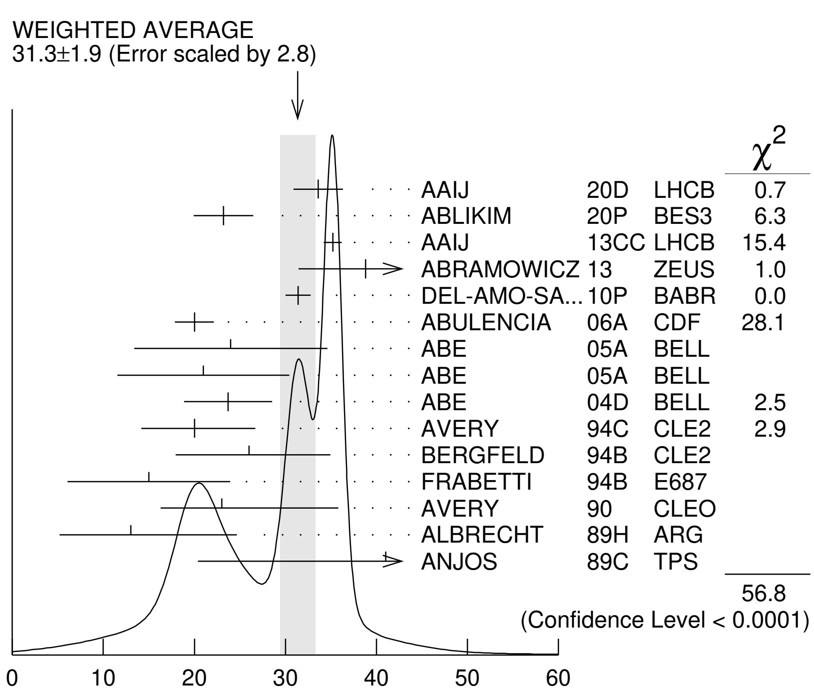
VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
411.8±0.6 OUR FIT	Error includes scale factor of 1.7.				
411.5±0.8 OUR AVERAGE					
410.2±2.1±0.9	3.1k	CHEKANOV	09	ZEUS	$e^{\pm} p \rightarrow D^{*+} \pi^- X$
411.7±0.7±0.4	7.5k	ABULENCIA	06A	CDF	1900 $p\overline{p} \rightarrow D^{*+} \pi^- X$

$m_{D_1(2420)^{\pm}} - m_{D_1(2420)^0}$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
$\mathbf{4^{+2}_{-3}\pm3}$	BERGFELD	94B	CLE2	$e^+ e^- \rightarrow$ hadrons

$D_1(2420)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
31.3± 1.9 OUR AVERAGE		Error includes scale factor of 2.8. See the ideogram below.				
$33.6 \pm 0.3 \pm 2.7$	79k	[1] AAIJ	20D	LHCB	0	$B^- \to D^{*+}\pi^-\pi^-$
$23.2 \pm 2.3 \pm 2.3$	4207	ABLIKIM	20P	BES3	+	$e^+e^- \to D^+D^-\pi^+\pi^-$
$35.2 \pm 0.4 \pm 0.9$	210k	AAIJ	13CC	LHCB	0	$pp \to D^{*+}\pi^- X$
$38.8 \pm 5.0^{+1.9}_{-5.4}$	2.7k	[2] ABRAMOWICZ	13	ZEUS	0	$e^\pm p \to D^{(*)+}\pi^- X$
$31.4 \pm 0.5 \pm 1.3$	103k	DEL-AMO-SA...	10P	BABR	0	$e^+e^- \to D^{*+}\pi^- X$
$20.0 \pm 1.7 \pm 1.3$	7.5k	ABULENCIA	06A	CDF	0	1900 $p\overline{p} \to D^{*+}\pi^- X$
$24 \pm 7 \pm 8$	151	ABE	05A	BELL	0	$B^- \to D^0\pi^+\pi^-\pi^-$
$21 \pm 5 \pm 8$	124	ABE	05A	BELL	+	$\overline{B}^0 \to D^+\pi^+\pi^-\pi^-$
$23.7 \pm 2.7 \pm 4.0$		[3] ABE	04D	BELL	0	$B^- \to D^{*+}\pi^-\pi^-$
$20^{+6}_{-5} \pm 3$	286	AVERY	94C	CLE2	0	$e^+e^- \to D^{*+}\pi^- X$
$26^{+8}_{-7} \pm 4$	146	BERGFELD	94B	CLE2	+	$e^+e^- \to D^{*0}\pi^+ X$
$15 \pm 8 \pm 4$	51	FRABETTI	94B	E687	0	$\gamma \mathrm{Be} \to D^{*+}\pi^- X$
$23^{+8}_{-6}{}^{+10}_{-3}$	279	AVERY	90	CLEO	0	$e^+e^- \to D^{*+}\pi^- X$
$13 \pm 6^{+10}_{-5}$	171	ALBRECHT	89H	ARG	0	$e^+e^- \to D^{*+}\pi^- X$
$41 \pm 19 \pm 8$	190	ANJOS	89C	TPS	+	$\gamma N \to D^0\pi^+ X^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$53.2 \pm 7.2^{+3.3}_{-4.9}$	3.1k	CHEKANOV	09	ZEUS	0	$e^\pm p \to D^{*+}\pi^- X$
$58 \pm 14 \pm 10$	171	ANJOS	89C	TPS	0	$\gamma N \to D^{*+}\pi^- X$



$D_1(2420)$ WIDTH (MeV)

[1] From a full four-body amplitude analysis of the $B^- \to D^{*+}\pi^-\pi^-$ decay.
[2] From the combined fit of the $M(D^+\pi^-)$ and $M(D^{*+}\pi^-)$ distributions. and A_{D_2} fixed to the theoretical prediction of -1.
[3] Fit includes the contribution from $D_1^*(2430)^0$.

$D_1(2420)$ DECAY MODES

$\overline{D}_1(2420)$ modes are charge conjugates of modes below.

	Mode	Fraction (Γ_i/Γ)
Γ_1	$D^*(2007)^0\pi$	seen
Γ_2	$D\pi^+\pi^-$	
Γ_3	$D\rho^0$	
Γ_4	$Df_0(500)$	
Γ_5	$D_0^*(2300)^0\pi$	
Γ_6	$D^0\pi$	
Γ_7	$D^*\pi^+\pi^-$	

$D_1(2420)$ BRANCHING RATIOS

$\Gamma(D^*(2007)^0\pi)/\Gamma_{\text{total}}$ — Γ_1/Γ

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
seen	ACKERSTAFF	97W	OPAL	0	$e^+e^- \to D^{*+}\pi^- X$
seen	AVERY	90	CLEO	0	$e^+e^- \to D^{*+}\pi^- X$
seen	ALBRECHT	89H	ARG	0	$e^+e^- \to D^*\pi^- X$
seen	ANJOS	89C	TPS	0	$\gamma N \to D^{*+}\pi^- X$
seen	ANJOS	89C	TPS	+	$\gamma N \to D^0\pi^+ X^0$

$\Gamma(D^0\pi)/\Gamma(D^*(2007)^0\pi)$ — Γ_6/Γ_1

VALUE	CL%	DOCUMENT ID		TECN	CHG	COMMENT
<0.18	90	BERGFELD	94B	CLE2	+	$e^+e^- \to$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.24	90	AVERY	90	CLEO	0	$e^+e^- \to D^+\pi^- X$

$D_1(2420)$ POLARIZATION AMPLITUDE A_{D_1}

A polarization amplitude A_{D_1} is a parameter that depends on the initial polarization of the D_1 and is sensitive to a possible S-wave contribution to its decay. For D_1 decays the helicity angle, θ_h, distribution varies like $1 + A_{D_1}\cos^2\theta_h$, where θ_h is the angle in the D^* rest frame between the two pions emitted by the $D_1 \to D^*\pi$ and the $D^* \to D\pi$.

Unpolarized D_1 decaying purely via D-wave is predicted to give $A_{D_1} = 3$.

VALUE	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
5.73±0.25 OUR AVERAGE					
$7.8\ ^{+6.7}_{-2.7}\ ^{+4.6}_{-1.8}$	2.7k	[1] ABRAMOWICZ13	ZEUS	0	$e^\pm p \to D^{(*)+}\pi^- X$

5.72 ± 0.25	103k		DEL-AMO-SA...	10P	BABR	0	$e^+ e^- \rightarrow D^{*+} \pi^- X$
$5.9\ ^{+3.0}_{-1.7}\ ^{+2.4}_{-1.0}$			CHEKANOV	09	ZEUS	0	$e^{\pm} p \rightarrow D^{*+} \pi^- X$

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

3.30 ± 0.48	210k	[2] AAIJ	13CC	LHCB	0	$p p \rightarrow D^{*+} \pi^- X$
$3.8\ \pm 0.6\ \pm 0.8$		[3] AUBERT	09Y	BABR	0	$B^+ \rightarrow D_1^0 \ell^+ \nu_\ell$
$3.8\ \pm 0.6\ \pm 0.8$		[3] AUBERT	09Y	BABR	+	$B^0 \rightarrow D_1^- \ell^+ \nu_\ell$
$2.74^{+1.40}_{-0.93}$		[4] AVERY	94C	CLE2	0	$e^+ e^- \rightarrow D^{*+} \pi^- X$

[1] From the combined fit of the $M(D^+ \pi^-)$ and $M(D^{*+} \pi^-)$ distributions. and A_{D_2} fixed to the theoretical prediction of -1. A pure *D*-wave not excluded although some *S*-wave mixing possible.

[2] Systematic uncertainty not estimated. Resonance parameters fixed.

[3] Assuming $\Gamma(\Upsilon(4S) \rightarrow B^+ B^-)$ / $\Gamma(\Upsilon(4S) \rightarrow B^0 \overline{B}^0) = 1.065 \pm 0.026$ and equal partial widths and helicity angle distributions for charged and neutral D_1 mesons.

[4] Systematic uncertainties not estimated.

$D_1(2420)$ REFERENCES

AAIJ	20D	PR D101 032005	R. Aaij *et al.*	(LHCb Collab.)
ABLIKIM	20P	PL B804 135395	M. Ablikim *et al.*	(BESIII Collab.)
AAIJ	13CC	JHEP 1309 145	R. Aaij *et al.*	(LHCb Collab.)
ABRAMOWICZ	13	NP B866 229	H. Abramowicz *et al.*	(ZEUS Collab.)
DEL-AMO-SA...	10P	PR D82 111101	P. del Amo Sanchez *et al.*	(BABAR Collab.)
AUBERT	09Y	PRL 103 051803	B. Aubert *et al.*	(BABAR Collab.)
CHEKANOV	09	EPJ C60 25	S. Chekanov *et al.*	(ZEUS Collab.)
ABULENCIA	06A	PR D73 051104	A. Abulencia *et al.*	(CDF Collab.)
ABE	05A	PRL 94 221805	K. Abe *et al.*	(BELLE Collab.)
ABE	04D	PR D69 112002	K. Abe *et al.*	(BELLE Collab.)
ABREU	98M	PL B426 231	P. Abreu *et al.*	(DELPHI Collab.)
ACKERSTAFF	97W	ZPHY C76 425	K. Ackerstaff *et al.*	(OPAL Collab.)
AVERY	94C	PL B331 236	P. Avery *et al.*	(CLEO Collab.)
BERGFELD	94B	PL B340 194	T. Bergfeld *et al.*	(CLEO Collab.)
FRABETTI	94B	PRL 72 324	P.L. Frabetti *et al.*	(FNAL E687 Collab.)
AVERY	90	PR D41 774	P. Avery, D. Besson	(CLEO Collab.)
ALBRECHT	89H	PL B232 398	H. Albrecht *et al.*	(ARGUS Collab.) JP
ANJOS	89C	PRL 62 1717	J.C. Anjos *et al.*	(FNAL E691 Collab.)