NODE=M253

$D_1(2420)$

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

$D_1(2420)$ MASS

NODE=M253M

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.

NODE=M253M

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
2422.1±0.6 OUR FIT Error includes scale factor of 1.7. [2422.1 ± 0.6 MeV OUR 2023 FIT Scale factor = 1.7]						NEW
2422.1±0.8 OUR AVERAGE Error includes scale factor of 2.1. See the ideogram below.						
$2424.8 \pm 0.1 \pm 0.7$	79k	[1] AAIJ	20D	LHCB	0	$B^- \to D^{*+}\pi^-\pi^-$
$2427.2 \pm 1.0 \pm 1.2$	4207	ABLIKIM	20P	BES3	+	$e^+e^- \to D^+D^-\pi^+\pi^-$ OCCUR=2
$2419.6 \pm 0.1 \pm 0.7$	210k	AAIJ	13CC	LHCB	0	$pp \to D^{*+}\pi^- X$
$2423.1 \pm 1.5^{+0.4}_{-1.0}$	2.7k	[2] ABRAMOWICZ	13	ZEUS	0	$e^{\pm}p \to D^{(*)+}\pi^- X$
$2421.9 \pm 4.7^{+3.4}_{-1.2}$	759	[3] ABRAMOWICZ	13	ZEUS	+	$e^{\pm}p \to D^{(*)0}\pi^+ X$ OCCUR=2
$2420.1 \pm 0.1 \pm 0.8$	103k	DEL-AMO-SA..	10P	BABR	0	$e^+e^- \to D^{*+}\pi^- X$
$2426 \pm 3 \pm 1$	151	ABE	05A	BELL	0	$B^- \to D^0\pi^+\pi^-\pi^-$
$2421 \pm 2 \pm 1$	124	ABE	05A	BELL	+	$\overline{B}{}^0 \to D^+\pi^+\pi^-\pi^-$ OCCUR=2
$2421.4 \pm 1.5 \pm 0.9$		[4] ABE	04D	BELL	0	$B^- \to D^{*+}\pi^-\pi^-$
$2421\ ^{+1}_{-2} \pm 2$	286	AVERY	94C	CLE2	0	$e^+e^- \to D^{*+}\pi^- X$
$2425 \pm 2 \pm 2$	146	BERGFELD	94B	CLE2	+	$e^+e^- \to D^{*0}\pi^+ X$ OCCUR=2
$2422 \pm 2 \pm 2$	51	FRABETTI	94B	E687	0	$\gamma\,\mathrm{Be} \to D^{*+}\pi^- X$
$2428 \pm 3 \pm 2$	279	AVERY	90	CLEO	0	$e^+e^- \to D^{*+}\pi^- X$
$2414 \pm 2 \pm 5$	171	ALBRECHT	89H	ARG	0	$e^+e^- \to D^{*+}\pi^- X$
$2428 \pm 8 \pm 5$	171	ANJOS	89C	TPS	0	$\gamma N \to D^{*+}\pi^- X$
$2443 \pm 7 \pm 5$	190	ANJOS	89C	TPS	+	$\gamma N \to D^0\pi^+ X^0$ OCCUR=2
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$2420.5 \pm 2.1 \pm 0.9$	3.1k	[5] CHEKANOV	09	ZEUS	0	$e^{\pm}p \to D^{*+}\pi^- X$
$2421.7 \pm 0.7 \pm 0.6$	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. NODE=M253M;LINKAGE=B

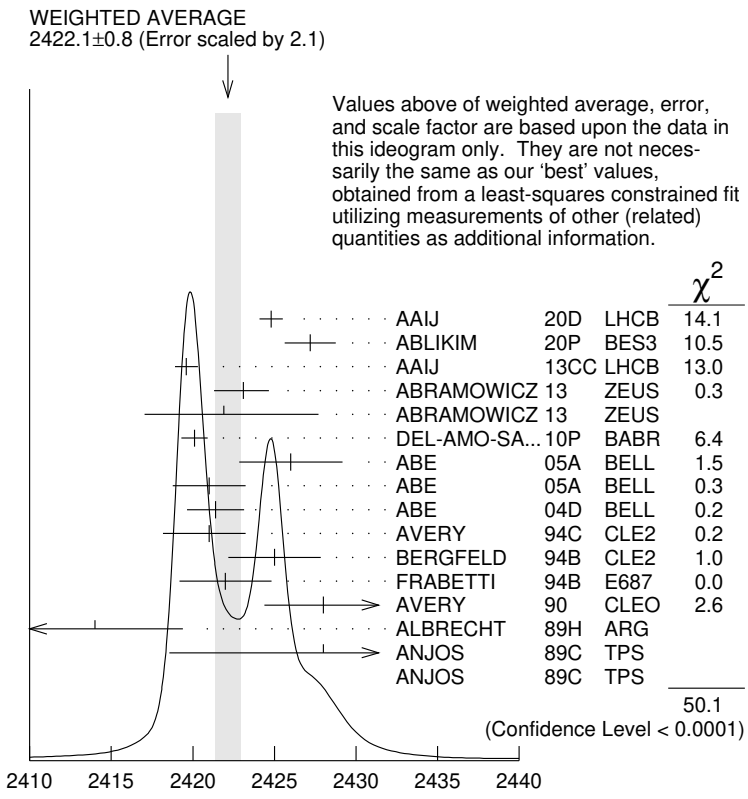
[2] From the combined fit of the $M(D^+\pi^-)$ and $M(D^{*+}\pi^-)$ distributions. and A_{D_2} fixed to the theoretical prediction of -1. NODE=M253M;LINKAGE=AR

[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. NODE=M253M;LINKAGE=BA

[4] Fit includes the contribution from $D_1^*(2430)^0$. NODE=M253M;LINKAGE=AB

[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. NODE=M253M;LINKAGE=CH

[6] No systematic error given. NODE=M253M;LINKAGE=K



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

NODE=M253DM

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.

NODE=M253DM

NODE=M253DM

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
411.8±0.6 OUR FIT Error includes scale factor of 1.7. [411.8 ± 0.6 MeV OUR 2023 FIT Scale factor = 1.7]					NEW
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 $p\overline{p} \rightarrow D^{*+}\pi^- X$

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

NODE=M253DMC

NODE=M253DMC

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

$D_1(2420)$ WIDTH

NODE=M253W

NODE=M253W

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± 0.3± 2.7	79k	[1] AAIJ	20D	LHCB	0	$B^- \rightarrow D^{*+}\pi^-\pi^-$
23.2± 2.3± 2.3	4207	ABLIKIM	20P	BES3	+	$e^+e^- \rightarrow D^+D^-\pi^+\pi^-$
35.2± 0.4± 0.9	210k	AAIJ	13CC	LHCB	0	$pp \rightarrow D^{*+}\pi^- X$
$38.8\pm 5.0^{+1.9}_{-5.4}$	2.7k	[2] ABRAMOWICZ	13	ZEUS	0	$e^{\pm} p \rightarrow D^{(*)+}\pi^- X$
31.4± 0.5± 1.3	103k	DEL-AMO-SA..	10P	BABR	0	$e^+e^- \rightarrow D^{*+}\pi^- X$
20.0± 1.7± 1.3	7.5k	ABULENCIA	06A	CDF	0	1900 $p\overline{p} \rightarrow D^{*+}\pi^- X$
24 ± 7 ± 8	151	ABE	05A	BELL	0	$B^- \rightarrow D^0\pi^+\pi^-\pi^-$
21 ± 5 ± 8	124	ABE	05A	BELL	+	$\overline{B}^0 \rightarrow D^+\pi^+\pi^-\pi^-$
23.7± 2.7± 4.0		[3] ABE	04D	BELL	0	$B^- \rightarrow D^{*+}\pi^-\pi^-$
$20\ ^{+6}_{-5}$ ± 3	286	AVERY	94C	CLE2	0	$e^+e^- \rightarrow D^{*+}\pi^- X$

OCCUR=2

OCCUR=2

26	$^{+\ 8}_{-\ 7}$	± 4	146	BERGFELD	94B	CLE2	+	$e^+e^- \to D^{*0}\pi^+X$	OCCUR=2
15	± 8	± 4	51	FRABETTI	94B	E687	0	$\gamma\text{Be} \to D^{*+}\pi^-X$	
23	$^{+\ 8}_{-\ 6}$	$^{+10}_{-\ 3}$	279	AVERY	90	CLEO	0	$e^+e^- \to D^{*+}\pi^-X$	
13	± 6	$^{+10}_{-\ 5}$	171	ALBRECHT	89H	ARG	0	$e^+e^- \to D^{*+}\pi^-X$	
41	±19	± 8	190	ANJOS	89C	TPS	+	$\gamma N \to D^0\pi^+X^0$	OCCUR=2

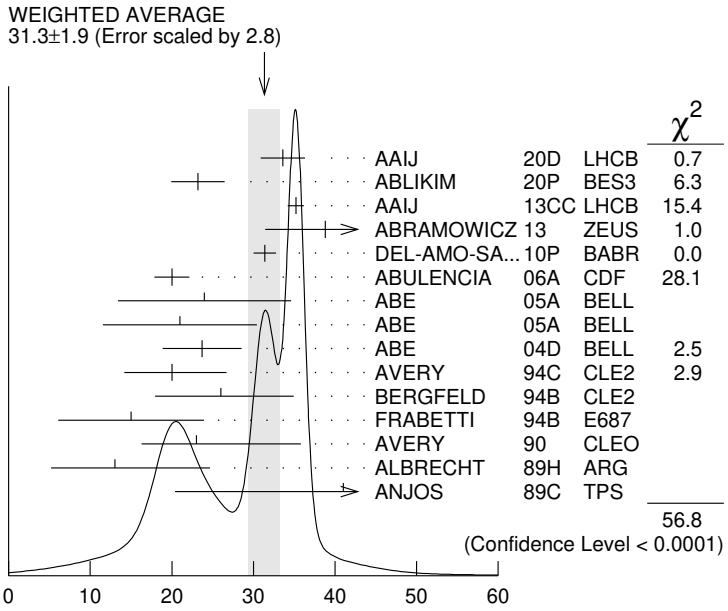
• • • We do not use the following data for averages, fits, limits, etc. • • •

53.2±	$7.2^{+\ 3.3}_{-\ 4.9}$	3.1k	CHEKANOV	09	ZEUS	0	$e^\pm p \to D^{*+}\pi^-X$	
58	±14	±10	171	ANJOS	89C	TPS	0	$\gamma N \to D^{*+}\pi^-X$

[1] From a full four-body amplitude analysis of the $B^- \to D^{*+}\pi^-\pi^-$ decay. NODE=M253W;LINKAGE=B

[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. NODE=M253W;LINKAGE=AR

[3] Fit includes the contribution from $D_1^*(2430)^0$. NODE=M253W;LINKAGE=AB



$D_1(2420)$ DECAY MODES

NODE=M253215;NODE=M253

$\overline{D}_1(2420)$ modes are charge conjugates of modes below. NODE=M253

	Mode	Fraction (Γ_i/Γ)	
Γ_1	$D^*(2007)^0\pi$	seen	DESIG=1
Γ_2	$D\pi^+\pi^-$		DESIG=3
Γ_3	$D\rho^0$		DESIG=4
Γ_4	$Df_0(500)$		DESIG=5
Γ_5	$D_0^*(2300)^0\pi$		DESIG=6
Γ_6	$D^0\pi$		DESIG=2
Γ_7	$D^*\pi^+\pi^-$		DESIG=7

$D_1(2420)$ BRANCHING RATIOS

NODE=M253220

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

NODE=M253R01

VALUE	DOCUMENT ID		TECN	CHG	COMMENT	NODE=M253R01
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	+	$\gamma N \to D^0\pi^+X^0$	OCCUR=2

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

NODE=M253R02
NODE=M253R02

VALUE	CL%	DOCUMENT ID		TECN	CHG	COMMENT
<0.18	90	BERGFELD	94B	CLE2	+	$e^+e^- \to$ hadrons

OCCUR=2

• • • 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}

NODE=M253PAH

NODE=M253PAH

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 $A_{D_1} = 3$.

NODE=M253PAH

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	$e^+e^- \to D^{*+}\pi^-X$
$5.9\ ^{+3.0}_{-1.7}\ ^{+2.4}_{-1.0}$		CHEKANOV	09	ZEUS	0	$e^\pm p \to D^{*+}\pi^-X$

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

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

OCCUR=2

[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.

NODE=M253PAH;LINKAGE=AR

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

NODE=M253PAH;LINKAGE=A

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

NODE=M253PAH;LINKAGE=AU

[4] Systematic uncertainties not estimated.

NODE=M253PAH;LINKAGE=AV

$D_1(2420)$ REFERENCES

NODE=M253

AAIJ	20D	PR D101 032005	R. Aaij *et al.*	(LHCb Collab.)	REFID=60253
ABLIKIM	20P	PL B804 135395	M. Ablikim *et al.*	(BESIII Collab.)	REFID=60395
AAIJ	13CC	JHEP 1309 145	R. Aaij *et al.*	(LHCb Collab.)	REFID=55581
ABRAMOWICZ	13	NP B866 229	H. Abramowicz *et al.*	(ZEUS Collab.)	REFID=54743
DEL-AMO-SA...	10P	PR D82 111101	P. del Amo Sanchez *et al.*	(BABAR Collab.)	REFID=53534
AUBERT	09Y	PRL 103 051803	B. Aubert *et al.*	(BABAR Collab.)	REFID=52929
CHEKANOV	09	EPJ C60 25	S. Chekanov *et al.*	(ZEUS Collab.)	REFID=52733
ABULENCIA	06A	PR D73 051104	A. Abulencia *et al.*	(CDF Collab.)	REFID=51054
ABE	05A	PRL 94 221805	K. Abe *et al.*	(BELLE Collab.)	REFID=50755
ABE	04D	PR D69 112002	K. Abe *et al.*	(BELLE Collab.)	REFID=50011
ABREU	98M	PL B426 231	P. Abreu *et al.*	(DELPHI Collab.)	REFID=46315
ACKERSTAFF	97W	ZPHY C76 425	K. Ackerstaff *et al.*	(OPAL Collab.)	REFID=45788
AVERY	94C	PL B331 236	P. Avery *et al.*	(CLEO Collab.)	REFID=44096
BERGFELD	94B	PL B340 194	T. Bergfeld *et al.*	(CLEO Collab.)	REFID=44099
FRABETTI	94B	PRL 72 324	P.L. Frabetti *et al.*	(FNAL E687 Collab.)	REFID=43687
AVERY	90	PR D41 774	P. Avery, D. Besson	(CLEO Collab.)	REFID=41013
ALBRECHT	89H	PL B232 398	H. Albrecht *et al.*	(ARGUS Collab.) JP	REFID=41001
ANJOS	89C	PRL 62 1717	J.C. Anjos *et al.*	(FNAL E691 Collab.)	REFID=40737