

# $D_1(2420)^0$

$I(J^P) = \frac{1}{2}(1^+)$   
*I* needs confirmation.

## $D_1(2420)^0$ 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.

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>2421.4±0.6 OUR FIT</b> Error includes scale factor of 1.2.				
<b>2421.1±0.7 OUR AVERAGE</b> Error includes scale factor of 1.2.				
2423.1±1.5 <sup>+0.4</sup> <sub>-1.0</sub>	2.7k	<sup>1</sup> ABRAMOWICZ13	ZEUS	$e^\pm p \rightarrow D^{(*)+} \pi^- X$
2420.1±0.1±0.8	103k	DEL-AMO-SA..10P	BABR	$e^+ e^- \rightarrow D^{*+} \pi^- X$
2426 ±3 ±1	151	ABE	05A BELL	$B^- \rightarrow D^0 \pi^+ \pi^- \pi^-$
2421.4±1.5±0.9		<sup>2</sup> ABE	04D BELL	$B^- \rightarrow D^{*+} \pi^- \pi^-$
2421 <sup>+1</sup> <sub>-2</sub> ±2	286	AVERY	94C CLE2	$e^+ e^- \rightarrow D^{*+} \pi^- X$
2422 ±2 ±2	51	FRABETTI	94B E687	$\gamma Be \rightarrow D^{*+} \pi^- X$
2428 ±3 ±2	279	AVERY	90 CLEO	$e^+ e^- \rightarrow D^{*+} \pi^- X$
2414 ±2 ±5	171	ALBRECHT	89H ARG	$e^+ e^- \rightarrow D^{*+} \pi^- X$
2428 ±8 ±5	171	ANJOS	89C TPS	$\gamma N \rightarrow D^{*+} \pi^- X$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
2420.5±2.1±0.9	3110±340	<sup>3</sup> CHEKANOV	09 ZEUS	$e^\pm p \rightarrow D^{*+} \pi^- X$
2421.7±0.7±0.6	7.5k	ABULENCIA	06A CDF	1900 $p\bar{p} \rightarrow D^{*+} \pi^- X$
2425 ±3	235	<sup>4</sup> ABREU	98M DLPH	$e^+ e^-$

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

<sup>2</sup> Fit includes the contribution from  $D_1^*(2430)^0$ .

<sup>3</sup> Calculated using the mass difference  $m(D_1^0) - m(D^{*+})_{PDG}$  reported below and  $m(D^{*+})_{PDG} = 2010.27 \pm 0.17$  MeV. The 0.17 MeV uncertainty of the PDG mass value should be added to the experimental uncertainty of 0.9 MeV.

<sup>4</sup> No systematic error given.

## $m_{D_1^0} - m_{D^{*+}}$

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.

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>411.1±0.6 OUR FIT</b> Error includes scale factor of 1.2.				
<b>411.5±0.8 OUR AVERAGE</b>				
410.2±2.1±0.9	3110±340	CHEKANOV	09 ZEUS	$e^\pm p \rightarrow D^{*+} \pi^- X$
411.7±0.7±0.4	7.5k	ABULENCIA	06A CDF	1900 $p\bar{p} \rightarrow D^{*+} \pi^- X$

## $D_1(2420)^0$ WIDTH

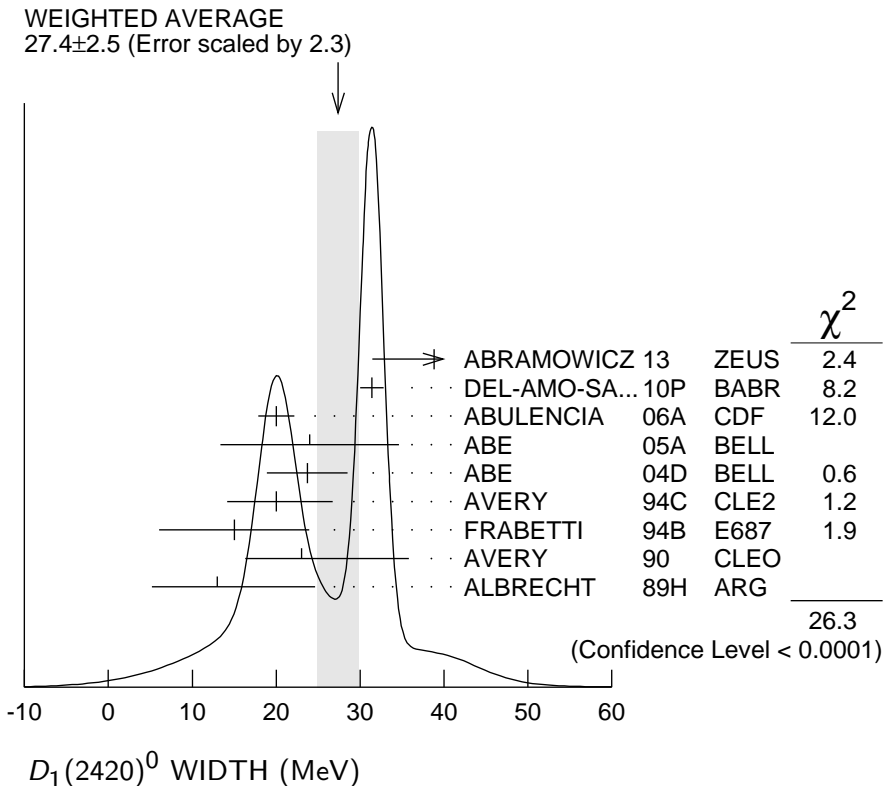
VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
<b>27.4 ± 2.5 OUR AVERAGE</b>	Error includes scale factor of 2.3. See the ideogram below.			
38.8 ± 5.0 <sup>+1.9</sup> <sub>-5.4</sub>	2.7k	<sup>5</sup> ABRAMOWICZ13	ZEUS	$e^\pm p \rightarrow D^{(*)+} \pi^- X$
31.4 ± 0.5 ± 1.3	103k	DEL-AMO-SA...10P	BABR	$e^+ e^- \rightarrow D^{*+} \pi^- X$
20.0 ± 1.7 ± 1.3	7.5k	ABULENCIA 06A	CDF	1900 $p\bar{p} \rightarrow D^{*+} \pi^- X$
24 ± 7 ± 8	151	ABE	05A	BELL $B^- \rightarrow D^0 \pi^+ \pi^- \pi^-$
23.7 ± 2.7 ± 4.0		<sup>6</sup> ABE	04D	BELL $B^- \rightarrow D^{*+} \pi^- \pi^-$
20 <sup>+6</sup> <sub>-5</sub> ± 3	286	AVERY	94C	CLE2 $e^+ e^- \rightarrow D^{*+} \pi^- X$
15 ± 8 ± 4	51	FRABETTI	94B	E687 $\gamma Be \rightarrow D^{*+} \pi^- X$
23 <sup>+8</sup> <sub>-6</sub> <sup>+10</sup> <sub>-3</sub>	279	AVERY	90	CLEO $e^+ e^- \rightarrow D^{*+} \pi^- X$
13 ± 6 <sup>+10</sup> <sub>-5</sub>	171	ALBRECHT	89H	ARG $e^+ e^- \rightarrow D^{*+} \pi^- X$

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

53.2 ± 7.2 <sup>+3.3</sup> <sub>-4.9</sub>	3110 ± 340	CHEKANOV 09	ZEUS	$e^\pm p \rightarrow D^{*+} \pi^- X$
58 ± 14 ± 10	171	ANJOS 89C	TPS	$\gamma N \rightarrow D^{*+} \pi^- X$

<sup>5</sup> From the combined fit of the  $M(D^+ \pi^-)$  and  $M(D^{*+} \pi^-)$  distributions. and  $A_{D_2}$  fixed to the theoretical prediction of  $-1$ .

<sup>6</sup> Fit includes the contribution from  $D_1^*(2430)^0$ .



## $D_1(2420)^0$ DECAY MODES

$\bar{D}_1(2420)^0$  modes are charge conjugates of modes below.

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $D^*(2010)^+ \pi^-$	seen
$\Gamma_2$ $D^0 \pi^+ \pi^-$	seen
$\Gamma_3$ $D^0 \rho^0$	
$\Gamma_4$ $D^0 f_0(500)$	
$\Gamma_5$ $D_0^*(2400)^+ \pi^-$	
$\Gamma_6$ $D^+ \pi^-$	not seen
$\Gamma_7$ $D^{*0} \pi^+ \pi^-$	not seen

## $D_1(2420)^0$ BRANCHING RATIOS

$\Gamma(D^*(2010)^+ \pi^-)/\Gamma_{\text{total}}$					$\Gamma_1/\Gamma$
<u>VALUE</u>		<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>seen</b>		ACKERSTAFF	97W OPAL	$e^+ e^- \rightarrow D^{*+} \pi^- X$	
<b>seen</b>		AVERY	90 CLEO	$e^+ e^- \rightarrow D^{*+} \pi^- X$	
<b>seen</b>		ALBRECHT	89H ARG	$e^+ e^- \rightarrow D^* \pi^- X$	
<b>seen</b>		ANJOS	89C TPS	$\gamma N \rightarrow D^{*+} \pi^- X$	
$\Gamma(D^+ \pi^-)/\Gamma(D^*(2010)^+ \pi^-)$					$\Gamma_6/\Gamma_1$
<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;0.24</b>	90	AVERY	90 CLEO	$e^+ e^- \rightarrow D^+ \pi^- X$	

## $D_1(2420)^0$ 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,  $\theta_h$ , distribution varies like  $1 + A_{D_1} \cos^2 \theta_h$ , where  $\theta_h$  is the angle in the  $D^*$  rest frame between the two pions emitted by the  $D_1 \rightarrow D^* \pi$  and the  $D^* \rightarrow D \pi$ .

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

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>5.73 ± 0.25 OUR AVERAGE</b>				
7.8 $^{+6.7}_{-2.7}$ $^{+4.6}_{-1.8}$	2.7k	<sup>7</sup> ABRAMOWICZ13	ZEUS	$e^\pm p \rightarrow D^{(*)+} \pi^- X$
5.72 ± 0.25	103k	DEL-AMO-SA..10P	BABR	$e^+ e^- \rightarrow D^{*+} \pi^- X$
5.9 $^{+3.0}_{-1.7}$ $^{+2.4}_{-1.0}$		CHEKANOV	09 ZEUS	$e^\pm p \rightarrow D^{*+} \pi^- X$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
3.8 ± 0.6 ± 0.8		<sup>8</sup> AUBERT	09Y BABR	$B^+ \rightarrow D_1^0 \ell^+ \nu_\ell$
2.74 $^{+1.40}_{-0.93}$		<sup>9</sup> AVERY	94C CLE2	$e^+ e^- \rightarrow D^{*+} \pi^- X$

<sup>7</sup> 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  $\bar{S}$ -wave mixing possible.

<sup>8</sup> Assuming  $\Gamma(\Upsilon(4S) \rightarrow B^+ B^-) / \Gamma(\Upsilon(4S) \rightarrow B^0 \bar{B}^0) = 1.065 \pm 0.026$  and equal partial widths and helicity angle distributions for charged and neutral  $D_1$  mesons.

<sup>9</sup> Systematic uncertainties not estimated.

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## $D_1(2420)^0$ REFERENCES

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DEL-AMO-SA... 10P	PR D82 111101	P. del Amo Sanchez <i>et al.</i>	(BABAR Collab.)
AUBERT 09Y	PRL 103 051803	B. Aubert <i>et al.</i>	(BABAR Collab.)
CHEKANOV 09	EPJ C60 25	S. Chekanov <i>et al.</i>	(ZEUS Collab.)
ABULENCIA 06A	PR D73 051104	A. Abulencia <i>et al.</i>	(CDF Collab.)
ABE 05A	PRL 94 221805	K. Abe <i>et al.</i>	(BELLE Collab.)
ABE 04D	PR D69 112002	K. Abe <i>et al.</i>	(BELLE Collab.)
ABREU 98M	PL B426 231	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ACKERSTAFF 97W	ZPHY C76 425	K. Ackerstaff <i>et al.</i>	(OPAL Collab.)
AVERY 94C	PL B331 236	P. Avery <i>et al.</i>	(CLEO Collab.)
FRABETTI 94B	PRL 72 324	P.L. Frabetti <i>et al.</i>	(FNAL E687 Collab.)
AVERY 90	PR D41 774	P. Avery, D. Besson	(CLEO Collab.)
ALBRECHT 89H	PL B232 398	H. Albrecht <i>et al.</i>	(ARGUS Collab.) JP
ANJOS 89C	PRL 62 1717	J.C. Anjos <i>et al.</i>	(FNAL E691 Collab.)

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