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### Authors

Aubert, B  
Barate, R  
Bona, M  
et al.

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## Study of $B \rightarrow D^{(*)} D_{s(J)}^{(*)}$ decays and measurement of $D_s^-$ and $D_{sJ}(2460)^-$ branching fractions

B. Aubert,<sup>1</sup> R. Barate,<sup>1</sup> M. Bona,<sup>1</sup> D. Boutigny,<sup>1</sup> F. Couderc,<sup>1</sup> Y. Karyotakis,<sup>1</sup> J. P. Lees,<sup>1</sup> V. Poireau,<sup>1</sup> V. Tisserand,<sup>1</sup> A. Zghiche,<sup>1</sup> E. Grauges,<sup>2</sup> A. Palano,<sup>3</sup> M. Pappagallo,<sup>3</sup> J. C. Chen,<sup>4</sup> N. D. Qi,<sup>4</sup> G. Rong,<sup>4</sup> P. Wang,<sup>4</sup> Y. S. Zhu,<sup>4</sup> G. Eigen,<sup>5</sup> I. Ofte,<sup>5</sup> B. Stugu,<sup>5</sup> G. S. Abrams,<sup>6</sup> M. Battaglia,<sup>6</sup> D. N. Brown,<sup>6</sup> J. Button-Shafer,<sup>6</sup> R. N. Cahn,<sup>6</sup> E. Charles,<sup>6</sup> C. T. Day,<sup>6</sup> M. S. Gill,<sup>6</sup> Y. Groyzman,<sup>6</sup> R. G. Jacobsen,<sup>6</sup> J. A. Kadyk,<sup>6</sup> L. T. Kerth,<sup>6</sup> Yu. G. Kolomensky,<sup>6</sup> G. Kukartsev,<sup>6</sup> G. Lynch,<sup>6</sup> L. M. Mir,<sup>6</sup> P. J. Oddone,<sup>6</sup> T. J. Orimoto,<sup>6</sup> M. Pripstein,<sup>6</sup> N. A. Roe,<sup>6</sup> M. T. Ronan,<sup>6</sup> W. A. Wenzel,<sup>6</sup> M. Barrett,<sup>7</sup> K. E. Ford,<sup>7</sup> T. J. Harrison,<sup>7</sup> A. J. Hart,<sup>7</sup> C. M. Hawkes,<sup>7</sup> S. E. Morgan,<sup>7</sup> A. T. Watson,<sup>7</sup> K. Goetzen,<sup>8</sup> T. Held,<sup>8</sup> H. Koch,<sup>8</sup> B. Lewandowski,<sup>8</sup> M. Pelizaeus,<sup>8</sup> K. Peters,<sup>8</sup> T. Schroeder,<sup>8</sup> M. Steinke,<sup>8</sup> J. T. Boyd,<sup>9</sup> J. P. Burke,<sup>9</sup> W. N. Cottingham,<sup>9</sup> D. Walker,<sup>9</sup> T. Cuhadar-Donszelmann,<sup>10</sup> B. G. Fulsom,<sup>10</sup> C. Hearty,<sup>10</sup> N. S. Knecht,<sup>10</sup> T. S. Mattison,<sup>10</sup> J. A. McKenna,<sup>10</sup> A. Khan,<sup>11</sup> P. Kyberd,<sup>11</sup> M. Saleem,<sup>11</sup> L. Teodorescu,<sup>11</sup> V. E. Blinov,<sup>12</sup> A. D. Bukin,<sup>12</sup> V. P. Druzhinin,<sup>12</sup> V. B. Golubev,<sup>12</sup> A. P. Onuchin,<sup>12</sup> S. I. Serednyakov,<sup>12</sup> Yu. I. 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Eckhart,<sup>22</sup> A. Soffer,<sup>22</sup> W. H. Toki,<sup>22</sup> R. J. Wilson,<sup>22</sup> F. Winklmeier,<sup>22</sup> Q. Zeng,<sup>22</sup> D. D. Altenburg,<sup>23</sup> E. Feltresi,<sup>23</sup> A. Hauke,<sup>23</sup> H. Jasper,<sup>23</sup> B. Spaan,<sup>23</sup> T. Brandt,<sup>24</sup> V. Klose,<sup>24</sup> H. M. Lacker,<sup>24</sup> W. F. Mader,<sup>24</sup> R. Nogowski,<sup>24</sup> A. Petzold,<sup>24</sup> J. Schubert,<sup>24</sup> K. R. Schubert,<sup>24</sup> R. Schwierz,<sup>24</sup> J. E. Sundermann,<sup>24</sup> A. Volk,<sup>24</sup> D. Bernard,<sup>25</sup> G. R. Bonneaud,<sup>25</sup> P. Grenier,<sup>25,\*</sup> E. Latour,<sup>25</sup> Ch. Thiebaux,<sup>25</sup> M. Verderi,<sup>25</sup> D. J. Bard,<sup>26</sup> P. J. Clark,<sup>26</sup> W. Gradl,<sup>26</sup> F. Muheim,<sup>26</sup> S. Playfer,<sup>26</sup> A. I. Robertson,<sup>26</sup> Y. Xie,<sup>26</sup> M. Andreotti,<sup>27</sup> D. Bettoni,<sup>27</sup> C. Bozzi,<sup>27</sup> R. Calabrese,<sup>27</sup> G. Cibinetto,<sup>27</sup> E. Luppi,<sup>27</sup> M. Negri,<sup>27</sup> A. Petrella,<sup>27</sup> L. Piemontese,<sup>27</sup> E. Prencipe,<sup>27</sup> F. Anulli,<sup>28</sup> R. Baldini-Feroli,<sup>28</sup> A. Calcaterra,<sup>28</sup> R. de Sangro,<sup>28</sup> G. Finocchiaro,<sup>28</sup> S. Pacetti,<sup>28</sup> P. Patteri,<sup>28</sup> I. M. Peruzzi,<sup>28,†</sup> M. Piccolo,<sup>28</sup> M. Rama,<sup>28</sup> A. Zallo,<sup>28</sup> A. Buzzo,<sup>29</sup> R. Capra,<sup>29</sup> R. Contri,<sup>29</sup> M. Lo Vetere,<sup>29</sup> M. M. Macri,<sup>29</sup> M. R. Monge,<sup>29</sup> S. Passaggio,<sup>29</sup> C. Patrignani,<sup>29</sup> E. Robutti,<sup>29</sup> A. Santroni,<sup>29</sup> S. Tosi,<sup>29</sup> G. Brandenburg,<sup>30</sup> K. S. Chaisanguanthum,<sup>30</sup> M. Morii,<sup>30</sup> J. Wu,<sup>30</sup> R. S. Dubitzky,<sup>31</sup> J. Marks,<sup>31</sup> S. Schenk,<sup>31</sup> U. Uwer,<sup>31</sup> W. Bhimji,<sup>32</sup> D. A. Bowerman,<sup>32</sup> P. D. 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Cheng,<sup>38</sup> D. J. Lange,<sup>38</sup> D. M. Wright,<sup>38</sup> C. A. Chavez,<sup>39</sup> I. J. Forster,<sup>39</sup> J. R. Fry,<sup>39</sup> E. Gabathuler,<sup>39</sup> R. Gamet,<sup>39</sup> K. A. George,<sup>39</sup> D. E. Hutchcroft,<sup>39</sup> D. J. Payne,<sup>39</sup> K. C. Schofield,<sup>39</sup> C. Touramanis,<sup>39</sup> A. J. Bevan,<sup>40</sup> F. Di Lodovico,<sup>40</sup> W. Menges,<sup>40</sup> R. Sacco,<sup>40</sup> C. L. Brown,<sup>41</sup> G. Cowan,<sup>41</sup> H. U. Flaecher,<sup>41</sup> D. A. Hopkins,<sup>41</sup> P. S. Jackson,<sup>41</sup> T. R. McMahon,<sup>41</sup> S. Ricciardi,<sup>41</sup> F. Salvatore,<sup>41</sup> D. N. Brown,<sup>42</sup> C. L. Davis,<sup>42</sup> J. Allison,<sup>43</sup> N. R. Barlow,<sup>43</sup> R. J. Barlow,<sup>43</sup> Y. M. Chia,<sup>43</sup> C. L. Edgar,<sup>43</sup> M. P. Kelly,<sup>43</sup> G. D. Lafferty,<sup>43</sup> M. T. Naisbit,<sup>43</sup> J. C. Williams,<sup>43</sup> J. I. Yi,<sup>43</sup> C. Chen,<sup>44</sup> W. D. Hulsbergen,<sup>44</sup> A. Jawahery,<sup>44</sup> C. K. Lae,<sup>44</sup> D. A. Roberts,<sup>44</sup> G. Simi,<sup>44</sup> G. Blaylock,<sup>45</sup> C. Dallapiccola,<sup>45</sup> S. S. Hertzbach,<sup>45</sup> X. Li,<sup>45</sup> T. B. Moore,<sup>45</sup> S. Saremi,<sup>45</sup> H. Staengle,<sup>45</sup> S. Y. Willocq,<sup>45</sup> R. Cowan,<sup>46</sup> K. Koeneke,<sup>46</sup> G. Sciolla,<sup>46</sup> S. J. Sekula,<sup>46</sup> M. Spitznagel,<sup>46</sup> F. Taylor,<sup>46</sup> R. K. Yamamoto,<sup>46</sup> H. Kim,<sup>47</sup> P. M. Patel,<sup>47</sup> C. T. Potter,<sup>47</sup> S. H. Robertson,<sup>47</sup> A. Lazzaro,<sup>48</sup> V. Lombardo,<sup>48</sup> F. Palombo,<sup>48</sup> J. M. Bauer,<sup>49</sup> L. Cremaldi,<sup>49</sup> V. Eschenburg,<sup>49</sup> R. Godang,<sup>49</sup> R. Kroeger,<sup>49</sup> J. Reidy,<sup>49</sup> D. A. Sanders,<sup>49</sup> D. J. Summers,<sup>49</sup> H. W. Zhao,<sup>49</sup> S. Brunet,<sup>50</sup> D. Côté,<sup>50</sup> M. Simard,<sup>50</sup> P. Taras,<sup>50</sup> F. B. Viaud,<sup>50</sup> H. Nicholson,<sup>51</sup> N. Cavallo,<sup>52,‡</sup> G. De Nardo,<sup>52</sup> D. del Re,<sup>52</sup> F. Fabozzi,<sup>52,‡</sup> C. Gatto,<sup>52</sup> L. Lista,<sup>52</sup> D. Monorchio,<sup>52</sup> P. Paolucci,<sup>52</sup> D. Piccolo,<sup>52</sup> C. Sciacca,<sup>52</sup> M. Baak,<sup>53</sup> H. Bulten,<sup>53</sup> G. Raven,<sup>53</sup> H. L. Snoek,<sup>53</sup> C. P. Jessop,<sup>54</sup> J. M. LoSecco,<sup>54</sup> T. Allmendinger,<sup>55</sup> G. Benelli,<sup>55</sup> K. K. Gan,<sup>55</sup> K. Honscheid,<sup>55</sup> D. Hufnagel,<sup>55</sup> P. D. Jackson,<sup>55</sup> H. Kagan,<sup>55</sup> R. Kass,<sup>55</sup> T. Pulliam,<sup>55</sup> A. M. Rahimi,<sup>55</sup> R. Ter-Antonyan,<sup>55</sup> Q. K. Wong,<sup>55</sup> N. L. Blount,<sup>56</sup> J. Brau,<sup>56</sup> R. Frey,<sup>56</sup> O. Igonkina,<sup>56</sup> M. Lu,<sup>56</sup> R. Rahmat,<sup>56</sup> N. B. Sinev,<sup>56</sup> D. Strom,<sup>56</sup> J. Strube,<sup>56</sup> E. Torrence,<sup>56</sup> F. Galeazzi,<sup>57</sup> A. Gaz,<sup>57</sup> M. Margoni,<sup>57</sup> M. Morandin,<sup>57</sup> A. Pompili,<sup>57</sup> M. Posocco,<sup>57</sup> M. Rotondo,<sup>57</sup>

F. Simonetto,<sup>57</sup> R. Stroili,<sup>57</sup> C. Voci,<sup>57</sup> M. Benayoun,<sup>58</sup> J. Chauveau,<sup>58</sup> P. David,<sup>58</sup> L. Del Buono,<sup>58</sup> Ch. de la Vaissière,<sup>58</sup> O. Hamon,<sup>58</sup> B. L. Hartfiel,<sup>58</sup> M. J. J. John,<sup>58</sup> Ph. Leruste,<sup>58</sup> J. Malcèlès,<sup>58</sup> J. Ocariz,<sup>58</sup> L. Roos,<sup>58</sup> G. Therin,<sup>58</sup> P. K. Behera,<sup>59</sup> L. Gladney,<sup>59</sup> J. Panetta,<sup>59</sup> M. Biasini,<sup>60</sup> R. Covarelli,<sup>60</sup> M. Pioppi,<sup>60</sup> C. Angelini,<sup>61</sup> G. Batignani,<sup>61</sup> S. Bettarini,<sup>61</sup> F. Bucci,<sup>61</sup> G. Calderini,<sup>61</sup> M. Carpinelli,<sup>61</sup> R. Cenci,<sup>61</sup> F. Forti,<sup>61</sup> M. A. Giorgi,<sup>61</sup> A. Lusiani,<sup>61</sup> G. Marchiori,<sup>61</sup> M. A. Mazur,<sup>61</sup> M. Morganti,<sup>61</sup> N. Neri,<sup>61</sup> E. Paoloni,<sup>61</sup> G. Rizzo,<sup>61</sup> J. Walsh,<sup>61</sup> M. Haire,<sup>62</sup> D. Judd,<sup>62</sup> D. E. Wagoner,<sup>62</sup> J. Biesiada,<sup>63</sup> N. Danielson,<sup>63</sup> P. Elmer,<sup>63</sup> Y. P. Lau,<sup>63</sup> C. Lu,<sup>63</sup> J. Olsen,<sup>63</sup> A. J. S. Smith,<sup>63</sup> A. V. Telnov,<sup>63</sup> F. Bellini,<sup>64</sup> G. Cavoto,<sup>64</sup> A. D’Orazio,<sup>64</sup> E. Di Marco,<sup>64</sup> R. Faccini,<sup>64</sup> F. Ferrarotto,<sup>64</sup> F. Ferroni,<sup>64</sup> M. Gaspero,<sup>64</sup> L. Li Gioi,<sup>64</sup> M. A. Mazzoni,<sup>64</sup> S. Morganti,<sup>64</sup> G. Piredda,<sup>64</sup> F. Polci,<sup>64</sup> F. Safai Tehrani,<sup>64</sup> C. Voena,<sup>64</sup> M. Ebert,<sup>65</sup> H. Schröder,<sup>65</sup> R. Waldi,<sup>65</sup> T. Adye,<sup>66</sup> N. De Groot,<sup>66</sup> B. Franek,<sup>66</sup> E. O. Olaiya,<sup>66</sup> F. F. Wilson,<sup>66</sup> S. Emery,<sup>67</sup> A. Gaidot,<sup>67</sup> S. F. Ganzhur,<sup>67</sup> G. Hamel de Monchenault,<sup>67</sup> W. Kozanecki,<sup>67</sup> M. 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Libby,<sup>69</sup> S. Luitz,<sup>69</sup> V. Luth,<sup>69</sup> H. L. Lynch,<sup>69</sup> D. B. MacFarlane,<sup>69</sup> H. Marsiske,<sup>69</sup> R. Messner,<sup>69</sup> D. R. Muller,<sup>69</sup> C. P. O’Grady,<sup>69</sup> V. E. Ozcan,<sup>69</sup> A. Perazzo,<sup>69</sup> M. Perl,<sup>69</sup> B. N. Ratcliff,<sup>69</sup> A. Roodman,<sup>69</sup> A. A. Salnikov,<sup>69</sup> R. H. Schindler,<sup>69</sup> J. Schwiening,<sup>69</sup> A. Snyder,<sup>69</sup> J. Stelzer,<sup>69</sup> D. Su,<sup>69</sup> M. K. Sullivan,<sup>69</sup> K. Suzuki,<sup>69</sup> S. K. Swain,<sup>69</sup> J. M. Thompson,<sup>69</sup> J. Va’vra,<sup>69</sup> N. van Bakel,<sup>69</sup> M. Weaver,<sup>69</sup> A. J. R. Weinstein,<sup>69</sup> W. J. Wisniewski,<sup>69</sup> M. Wittgen,<sup>69</sup> D. H. Wright,<sup>69</sup> A. K. Yarritu,<sup>69</sup> K. Yi,<sup>69</sup> C. C. Young,<sup>69</sup> P. R. Burchat,<sup>70</sup> A. J. Edwards,<sup>70</sup> S. A. Majewski,<sup>70</sup> B. A. Petersen,<sup>70</sup> C. Roat,<sup>70</sup> L. Wilden,<sup>70</sup> S. Ahmed,<sup>71</sup> M. S. Alam,<sup>71</sup> R. Bula,<sup>71</sup> J. A. Ernst,<sup>71</sup> V. Jain,<sup>71</sup> B. Pan,<sup>71</sup> M. A. Saeed,<sup>71</sup> F. R. Wappler,<sup>71</sup> S. B. Zain,<sup>71</sup> W. Bugg,<sup>72</sup> M. Krishnamurthy,<sup>72</sup> S. M. Spanier,<sup>72</sup> R. Eckmann,<sup>73</sup> J. L. Ritchie,<sup>73</sup> A. Satpathy,<sup>73</sup> C. J. Schilling,<sup>73</sup> R. F. Schwitters,<sup>73</sup> J. M. Izen,<sup>74</sup> I. Kitayama,<sup>74</sup> X. C. Lou,<sup>74</sup> S. Ye,<sup>74</sup> F. Bianchi,<sup>75</sup> F. Gallo,<sup>75</sup> D. Gamba,<sup>75</sup> M. Bomben,<sup>76</sup> L. Bosisio,<sup>76</sup> C. Cartaro,<sup>76</sup> F. Cossutti,<sup>76</sup> G. Della Ricca,<sup>76</sup> S. Dittongo,<sup>76</sup> S. Grancagnolo,<sup>76</sup> L. Lanceri,<sup>76</sup> L. Vitale,<sup>76</sup> V. Azzolini,<sup>77</sup> F. Martinez-Vidal,<sup>77</sup> Sw. Banerjee,<sup>78</sup> B. Bhuyan,<sup>78</sup> C. M. Brown,<sup>78</sup> D. Fortin,<sup>78</sup> K. Hamano,<sup>78</sup> R. Kowalewski,<sup>78</sup> I. M. Nugent,<sup>78</sup> J. M. Roney,<sup>78</sup> R. J. Sobie,<sup>78</sup> J. J. Back,<sup>79</sup> P. F. Harrison,<sup>79</sup> T. E. Latham,<sup>79</sup> G. B. Mohanty,<sup>79</sup> H. R. Band,<sup>80</sup> X. Chen,<sup>80</sup> B. Cheng,<sup>80</sup> S. Dasu,<sup>80</sup> M. Datta,<sup>80</sup> A. M. Eichenbaum,<sup>80</sup> K. T. Flood,<sup>80</sup> J. J. Hollar,<sup>80</sup> J. R. Johnson,<sup>80</sup> P. E. Kutter,<sup>80</sup> H. Li,<sup>80</sup> R. Liu,<sup>80</sup> B. Mellado,<sup>80</sup> A. Mihalji,<sup>80</sup> A. K. Mohapatra,<sup>80</sup> Y. Pan,<sup>80</sup> M. Pierini,<sup>80</sup> R. Prepost,<sup>80</sup> P. Tan,<sup>80</sup> S. L. Wu,<sup>80</sup> Z. Yu,<sup>80</sup> and H. Neal<sup>81</sup>

(BABAR Collaboration)

<sup>1</sup>Laboratoire de Physique des Particules, F-74941 Annecy-le-Vieux, France

<sup>2</sup>Universitat de Barcelona, Facultat de Física Dept. ECM, E-08028 Barcelona, Spain

<sup>3</sup>Università di Bari, Dipartimento di Fisica and INFN, I-70126 Bari, Italy

<sup>4</sup>Institute of High Energy Physics, Beijing 100039, China

<sup>5</sup>University of Bergen, Institute of Physics, N-5007 Bergen, Norway

<sup>6</sup>Lawrence Berkeley National Laboratory and University of California, Berkeley, California 94720, USA

<sup>7</sup>University of Birmingham, Birmingham, B15 2TT, United Kingdom

<sup>8</sup>Ruhr Universität Bochum, Institut für Experimentalphysik I, D-44780 Bochum, Germany

<sup>9</sup>University of Bristol, Bristol BS8 1TL, United Kingdom

<sup>10</sup>University of British Columbia, Vancouver, British Columbia, Canada V6T 1Z1

<sup>11</sup>Brunel University, Uxbridge, Middlesex UB8 3PH, United Kingdom

<sup>12</sup>Budker Institute of Nuclear Physics, Novosibirsk 630090, Russia

<sup>13</sup>University of California at Irvine, Irvine, California 92697, USA

<sup>14</sup>University of California at Los Angeles, Los Angeles, California 90024, USA

<sup>15</sup>University of California at Riverside, Riverside, California 92521, USA

<sup>16</sup>University of California at San Diego, La Jolla, California 92093, USA

<sup>17</sup>University of California at Santa Barbara, Santa Barbara, California 93106, USA

<sup>18</sup>University of California at Santa Cruz, Institute for Particle Physics, Santa Cruz, California 95064, USA

<sup>19</sup>California Institute of Technology, Pasadena, California 91125, USA

<sup>20</sup>University of Cincinnati, Cincinnati, Ohio 45221, USA

<sup>21</sup>University of Colorado, Boulder, Colorado 80309, USA

<sup>22</sup>Colorado State University, Fort Collins, Colorado 80523, USA

<sup>23</sup>Universität Dortmund, Institut für Physik, D-44221 Dortmund, Germany

<sup>24</sup>Technische Universität Dresden, Institut für Kern- und Teilchenphysik, D-01062 Dresden, Germany

- <sup>25</sup>*Ecole Polytechnique, LLR, F-91128 Palaiseau, France*
- <sup>26</sup>*University of Edinburgh, Edinburgh EH9 3JZ, United Kingdom*
- <sup>27</sup>*Università di Ferrara, Dipartimento di Fisica and INFN, I-44100 Ferrara, Italy*
- <sup>28</sup>*Laboratori Nazionali di Frascati dell'INFN, I-00044 Frascati, Italy*
- <sup>29</sup>*Università di Genova, Dipartimento di Fisica and INFN, I-16146 Genova, Italy*
- <sup>30</sup>*Harvard University, Cambridge, Massachusetts 02138, USA*
- <sup>31</sup>*Universität Heidelberg, Physikalisches Institut, Philosophenweg 12, D-69120 Heidelberg, Germany*
- <sup>32</sup>*Imperial College London, London, SW7 2AZ, United Kingdom*
- <sup>33</sup>*University of Iowa, Iowa City, Iowa 52242, USA*
- <sup>34</sup>*Iowa State University, Ames, Iowa 50011-3160, USA*
- <sup>35</sup>*Johns Hopkins University, Baltimore, Maryland 21218, USA*
- <sup>36</sup>*Universität Karlsruhe, Institut für Experimentelle Kernphysik, D-76021 Karlsruhe, Germany*
- <sup>37</sup>*Laboratoire de l'Accélérateur Linéaire, IN2P3-CNRS et Université Paris-Sud 11, Centre Scientifique d'Orsay, B.P. 34, F-91898 ORSAY Cedex, France*
- <sup>38</sup>*Lawrence Livermore National Laboratory, Livermore, California 94550, USA*
- <sup>39</sup>*University of Liverpool, Liverpool L69 7ZE, United Kingdom*
- <sup>40</sup>*Queen Mary, University of London, E1 4NS, United Kingdom*
- <sup>41</sup>*University of London, Royal Holloway and Bedford New College, Egham, Surrey TW20 0EX, United Kingdom*
- <sup>42</sup>*University of Louisville, Louisville, Kentucky 40292, USA*
- <sup>43</sup>*University of Manchester, Manchester M13 9PL, United Kingdom*
- <sup>44</sup>*University of Maryland, College Park, Maryland 20742, USA*
- <sup>45</sup>*University of Massachusetts, Amherst, Massachusetts 01003, USA*
- <sup>46</sup>*Massachusetts Institute of Technology, Laboratory for Nuclear Science, Cambridge, Massachusetts 02139, USA*
- <sup>47</sup>*McGill University, Montréal, Québec, Canada H3A 2T8*
- <sup>48</sup>*Università di Milano, Dipartimento di Fisica and INFN, I-20133 Milano, Italy*
- <sup>49</sup>*University of Mississippi, University, Mississippi 38677, USA*
- <sup>50</sup>*Université de Montréal, Physique des Particules, Montréal, Québec, Canada H3C 3J7*
- <sup>51</sup>*Mount Holyoke College, South Hadley, Massachusetts 01075, USA*
- <sup>52</sup>*Università di Napoli Federico II, Dipartimento di Scienze Fisiche and INFN, I-80126, Napoli, Italy*
- <sup>53</sup>*NIKHEF, National Institute for Nuclear Physics and High Energy Physics, NL-1009 DB Amsterdam, The Netherlands*
- <sup>54</sup>*University of Notre Dame, Notre Dame, Indiana 46556, USA*
- <sup>55</sup>*Ohio State University, Columbus, Ohio 43210, USA*
- <sup>56</sup>*University of Oregon, Eugene, Oregon 97403, USA*
- <sup>57</sup>*Università di Padova, Dipartimento di Fisica and INFN, I-35131 Padova, Italy*
- <sup>58</sup>*Universités Paris VI et VII, Laboratoire de Physique Nucléaire et de Hautes Energies, F-75252 Paris, France*
- <sup>59</sup>*University of Pennsylvania, Philadelphia, Pennsylvania 19104, USA*
- <sup>60</sup>*Università di Perugia, Dipartimento di Fisica and INFN, I-06100 Perugia, Italy*
- <sup>61</sup>*Università di Pisa, Dipartimento di Fisica, Scuola Normale Superiore and INFN, I-56127 Pisa, Italy*
- <sup>62</sup>*Prairie View A&M University, Prairie View, Texas 77446, USA*
- <sup>63</sup>*Princeton University, Princeton, New Jersey 08544, USA*
- <sup>64</sup>*Università di Roma La Sapienza, Dipartimento di Fisica and INFN, I-00185 Roma, Italy*
- <sup>65</sup>*Universität Rostock, D-18051 Rostock, Germany*
- <sup>66</sup>*Rutherford Appleton Laboratory, Chilton, Didcot, Oxon, OX11 0QX, United Kingdom*
- <sup>67</sup>*DSM/Dapnia, CEA/Saclay, F-91191 Gif-sur-Yvette, France*
- <sup>68</sup>*University of South Carolina, Columbia, South Carolina 29208, USA*
- <sup>69</sup>*Stanford Linear Accelerator Center, Stanford, California 94309, USA*
- <sup>70</sup>*Stanford University, Stanford, California 94305-4060, USA*
- <sup>71</sup>*State University of New York, Albany, New York 12222, USA*
- <sup>72</sup>*University of Tennessee, Knoxville, Tennessee 37996, USA*
- <sup>73</sup>*University of Texas at Austin, Austin, Texas 78712, USA*
- <sup>74</sup>*University of Texas at Dallas, Richardson, Texas 75083, USA*
- <sup>75</sup>*Università di Torino, Dipartimento di Fisica Sperimentale and INFN, I-10125 Torino, Italy*
- <sup>76</sup>*Università di Trieste, Dipartimento di Fisica and INFN, I-34127 Trieste, Italy*
- <sup>77</sup>*IFIC, Universitat de Valencia-CSIC, E-46071 Valencia, Spain*
- <sup>78</sup>*University of Victoria, Victoria, British Columbia, Canada V8W 3P6*
- <sup>79</sup>*Department of Physics, University of Warwick, Coventry CV4 7AL, United Kingdom*

\* Also at Laboratoire de Physique Corpusculaire, Clermont-Ferrand, France

† Also with Università di Perugia, Dipartimento di Fisica, Perugia, Italy

‡ Also with Università della Basilicata, Potenza, Italy

<sup>80</sup>University of Wisconsin, Madison, Wisconsin 53706, USA<sup>81</sup>Yale University, New Haven, Connecticut 06511, USA

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We present branching fraction measurements of 12  $B$  meson decays of the form  $B \rightarrow D^{(*)}D_{s(J)}^{(*)}$ . The results are based on  $Y(4S)$  decays in  $B\bar{B}$  pairs. One of the  $B$  mesons is fully reconstructed and the other decays to two charm mesons, of which one is reconstructed, and the mass and momentum of the other is inferred by kinematics. Combining these results with previous exclusive branching fraction measurements, we determine  $\mathcal{B}(D_s^- \rightarrow \phi\pi^-) = (4.62 \pm 0.36_{\text{stat.}} \pm 0.51_{\text{syst.}})\%$ ,  $\mathcal{B}(D_{sJ}(2460)^- \rightarrow D_s^{*-}\pi^0) = (56 \pm 13_{\text{stat.}} \pm 9_{\text{syst.}})\%$  and  $\mathcal{B}(D_{sJ}(2460)^- \rightarrow D_s^- \gamma) = (16 \pm 4_{\text{stat.}} \pm 3_{\text{syst.}})\%$ .

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In this paper we present the study of charged and neutral  $B$  mesons decaying to two charm mesons, i.e.  $\bar{B} \rightarrow D_{\text{meas}}D_X$  [1].  $D_{\text{meas}}$  represents a fully reconstructed  $D^{(*)+,0}$  or  $D_s^{(*)-}$  meson, and the mass and momentum of the  $D_X$  are inferred from the kinematics of the two-body  $B$  decay. This study allows measurements of  $B$  branching fractions without any assumption on the decays of the  $D_X$ . Measurements of these two-body branching fractions can provide tests of the factorization of the decay amplitudes [2] in the high momentum transfer regime [3]. From two separate classes of events with  $D_{\text{meas}} = D_s^{(*)-}$  and with  $D_X = D_s^{(*)-}$  we measure the branching fraction of  $D_s^- \rightarrow \phi\pi^-$ , which has important implications for a wide range of  $D_s$  and  $B$  physics. Furthermore, we select final states with  $D_X = D_{sJ}(2460)^-$  and combine with the *BABAR* measurements of  $\mathcal{B}(\bar{B} \rightarrow D^{(*)+,0}D_{sJ}(2460)^-) \times \mathcal{B}(D_{sJ}(2460)^- \rightarrow D_s^{*-}\pi^0)$  and  $\mathcal{B}(B \rightarrow D^{(*)+,0}D_{sJ}(2460)^-) \times \mathcal{B}(D_{sJ}(2460)^- \rightarrow D_s^- \gamma)$  [4], thus extracting for the first time the absolute branching fractions of this recently observed state [5].

This analysis uses  $Y(4S) \rightarrow B\bar{B}$  events in which either a  $B^+$  or a  $B^0$  meson decays into a fully reconstructed hadronic final state ( $B_{\text{reco}}$ ). The measurements are based on an integrated luminosity of  $210.5 \text{ fb}^{-1}$  recorded at the  $Y(4S)$  resonance with the *BABAR* detector at the PEP-II asymmetric-energy  $e^+e^-$  collider operating near the  $Y(4S)$  resonance. An additional  $21.7 \text{ fb}^{-1}$  recorded 40 MeV below the resonance (*off-resonance*) are used to evaluate backgrounds. The *BABAR* detector is described in detail elsewhere [6]. Charged-particle trajectories are measured by a vertex tracker with 5 double-sided layers and a 40-layer drift chamber, both operating in a 1.5-T magnetic field of a superconducting solenoid. Charged-particle identification is provided by the specific energy loss ( $dE/dx$ ) in the tracking devices and by an internally reflecting ring-imaging Cherenkov detector. Photons are detected by a CsI(Tl) electromagnetic calorimeter. We use Monte Carlo simulations (MC) of the *BABAR* detector based on GEANT4 [7] to optimize selection criteria and determine selection efficiencies.

To reconstruct a large sample of  $B$  mesons, the hadronic decays  $B_{\text{reco}} \rightarrow \bar{D}Y^+$ ,  $\bar{D}^*Y^+$  are selected. Here, the system  $Y^+$  consists of hadrons with a total charge of +1, com-

posed of  $n_1\pi^+n_2K^+n_3K_S^0n_4\pi^0$ , where  $n_1 + n_2 \leq 5$ ,  $n_3 \leq 2$ , and  $n_4 \leq 2$ . We reconstruct  $D^{*-} \rightarrow \bar{D}^0\pi^-$ ;  $\bar{D}^{*0} \rightarrow \bar{D}^0\pi^0, \bar{D}^0\gamma$ ;  $D^- \rightarrow K^+\pi^-\pi^-$ ,  $K^+\pi^-\pi^-\pi^0$ ,  $K_S^0\pi^-$ ,  $K_S^0\pi^-\pi^0$ ,  $K_S^0\pi^-\pi^-\pi^+$ ;  $\bar{D}^0 \rightarrow K^+\pi^-$ ,  $K^+\pi^-\pi^0$ ,  $K^+\pi^-\pi^-\pi^+$ ,  $K_S^0\pi^+\pi^-$ ; and  $K_S^0 \rightarrow \pi^+\pi^-$ . The kinematic consistency of  $B_{\text{reco}}$  candidates is checked with two variables, the beam energy-substituted mass  $m_{\text{ES}} = \sqrt{s/4 - \vec{p}_B^2}$

and the energy difference  $\Delta E = E_B - \sqrt{s}/2$ . Here  $\sqrt{s}$  is the total energy in the  $Y(4S)$  center-of-mass (CM) frame, and  $\vec{p}_B$  and  $E_B$  denote the momentum and energy of the  $B_{\text{reco}}$  candidate in the same frame. The resolution on  $\Delta E$  is measured to be  $\sigma_{\Delta E} = 10\text{--}35 \text{ MeV}$ , depending on the decay mode, and we require  $|\Delta E| < 3\sigma_{\Delta E}$ .

For each reconstructed  $B$  decay mode, the purity  $\mathcal{P}$  is estimated as the ratio of the number of signal events with  $m_{\text{ES}} > 5.27 \text{ GeV}/c$  to the total number of events in the same range, and is evaluated on data. We only use modes for which  $\mathcal{P}$  exceeds a decay-mode dependent threshold in the range of 9% to 24%. In events with more than one  $B_{\text{reco}}$  we select the decay mode with the highest purity. On average, we reconstruct one signal  $B_{\text{reco}}$  candidate in 0.3% (0.5%) of the  $B^0\bar{B}^0$  ( $B^+B^-$ ) events.

The selected sample of  $B_{\text{reco}}$  is used as normalization for the determination of the branching fractions. It is contaminated by  $e^+e^- \rightarrow q\bar{q}$  ( $q = u, d, s, c$ ) events and by other  $Y(4S) \rightarrow B^0\bar{B}^0$  or  $B^+B^-$  decays, in which the  $B_{\text{reco}}$  is mistakenly reconstructed from particles coming from both  $B$  mesons in the event. To significantly reduce the  $e^+e^- \rightarrow q\bar{q}$  background we require the angle  $\theta_{TB}^*$ , defined in the CM frame, between the thrust axis [8] of the  $B_{\text{reco}}$  and the thrust axis of all charged and neutral particles in the event excluding the ones that form the  $B_{\text{reco}}$ , to satisfy the requirement  $|\cos\theta_{TB}^*| < 0.7$ .

On this signal-enriched sample (Fig. 1), the contributions from the background are estimated as the sum of three components: the  $e^+e^- \rightarrow q\bar{q}$ , the  $B^0\bar{B}^0$ , and the  $B^+B^-$  events. The shapes of these background distributions are taken from MC simulation. The normalization of the  $e^+e^- \rightarrow q\bar{q}$  background is taken from *off-resonance* data, scaled by the luminosity. The normalization of the  $B^0\bar{B}^0, B^+B^-$  components are instead obtained by means of a  $\chi^2$  fit to the  $m_{\text{ES}}$  distribution in the sideband region ( $5.21 \text{ GeV}/c^2 < m_{\text{ES}} < 5.26 \text{ GeV}/c^2$ ). The background

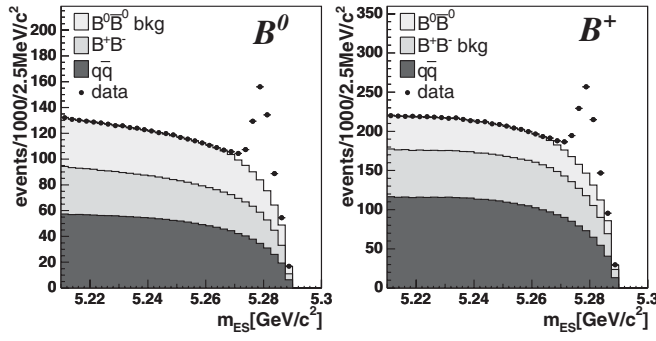


FIG. 1. Distributions in  $m_{ES}$  for the  $B_{reco}$  sample. The background contributions, determined as described in the text, are overlaid.

contamination in the signal region ( $m_{ES} > 5.27 \text{ GeV}/c^2$ ) is extrapolated and subtracted from the data to estimate the signal yield. After correcting for the  $|\cos\theta_{TB}^*|$  cut efficiency estimated in the MC, the size of the total sample of fully reconstructed  $B$  decays is  $N_{B_{reco}^0} = (2.90 \pm 0.01_{stat.}) \times 10^5$  and  $N_{B_{reco}^+} = (4.63 \pm 0.01_{stat.}) \times 10^5$ .

From the charged tracks and the neutral clusters that do not belong to the  $B_{reco}$  we reconstruct the charmed mesons ( $D_{meas}$ ) in the modes  $D^0 \rightarrow K^- \pi^+$ ,  $K^- \pi^+ \pi^0$ ,  $K^- \pi^+ \pi^- \pi^+$ ;  $D^+ \rightarrow K^- \pi^+ \pi^+$ ,  $D^+ \rightarrow K_S^0 \pi^+$ ; and  $D_s^- \rightarrow \phi \pi^-$  ( $\phi \rightarrow K^+ K^-$ ),  $K_S^0 K^-$  ( $K_S^0 \rightarrow \pi^+ \pi^-$ ), and  $K^{*0} K^-$  ( $K^{*0} \rightarrow K^+ \pi^-$ ). We select  $\phi$  and  $K^{*0}$  candidates with a reconstructed mass within  $15 \text{ MeV}/c^2$  and  $70 \text{ MeV}/c^2$  from their nominal values [9], respectively. The  $D^*$  candidates are reconstructed in the decay modes  $D^{*+} \rightarrow D^0 \pi^+$ ,  $D^+ \pi^0$ ,  $D^{*0} \rightarrow D^0 \pi^0$ ,  $D^0 \gamma$ , and  $D_s^{*-} \rightarrow D_s^- \gamma$ . We require the reconstructed masses of the  $D^0$ ,  $D^+$ , and  $D_s^-$  candidates and the differences  $\Delta m$  between the masses of the  $D^*$  and  $D$  candidates to be within 1.5–3 times its measured resolution from their nominal values [9], depending on the background level.

We apply further selection criteria to enhance the signal contributions in the sample. For  $D^{(*)+}D_X^-$  and  $D_s^{(*)-}D_X^+$  we consider neutral  $B_{reco}$  candidates while for  $D^{(*)0}D_X^-$  and  $D_s^{(*)-}D_X^0$  we require positive charged  $B_{reco}$  candidates. We suppress background from  $B \rightarrow D^{(*)}l\nu$ , while keeping events with a semileptonic  $D_X$  decay, by rejecting any event with a remaining identified lepton with the appropriate charge and a momentum in the  $B$  rest frame ( $p^*$ ) greater than  $1 \text{ GeV}/c$ . In order to minimize the contamination of the modes with a  $D^*$  to the modes with a  $D$  meson, we assign the events consistent with both the hypotheses ( $B \rightarrow DD_X$  and  $B \rightarrow D^*D_X$ ) to the  $D^*$  sample.

The invariant mass of  $D_X$  ( $m_X$ ) is derived from the missing four-momentum  $p_X = p_{Y(4S)} - p_{B_{reco}} - p_{D_{meas}}$ , where all momenta are measured in the laboratory frame. The  $m_X$  resolution is improved by a global  $Y(4S)$  kinematic fit [10] that includes beam position and energy information and constrains the masses and decay vertices

of the  $D_{meas}$ . The  $\chi^2$  of this fit is used to reduce the combinatorial background. We remove reconstructed  $D$  mesons with  $\chi^2$  probability smaller than 0.1%.

Of the selected events, 3–6% (9–30%) contain multiple  $D_{(s)}$  ( $D_{(s)}^*$ ) candidates. We retain those in the  $D_{meas}$  decay mode with the lowest combinatorial background. If there are multiple candidates with the same decay mode, we select the one with the lowest value of  $|m_D - m_{PDG}|$  and  $(m_{D_{meas}} - m_{PDG})^2/\sigma_{m_{D_{meas}}}^2 + (\Delta m - \Delta m_{PDG})^2/\sigma_{\Delta m}^2$  for  $D_{(s)}$  and  $D_{(s)}^*$  respectively, where  $m$  is the reconstructed mass of the  $D_{meas}$  candidate and the subscript  $PDG$  indicates nominal values [9].

Finally, we consider only candidates in the range  $1.65 \text{ GeV}/c^2 < m_X < 2.71 \text{ GeV}/c^2$  for the  $D^{(*)+}/D_X^-$  modes and  $1.68 \text{ GeV}/c^2 < m_X < 2.31 \text{ GeV}/c^2$  for  $D_s^{(*)-}D_X^+$ . These ranges were chosen to minimize the total uncertainty introduced by the background shape and normalization.

The yield of each decay mode is extracted from the  $m_X$  distribution by a binned  $\chi^2$  fit of a sum of  $n_{sig}$  signal contributions ( $N^{sig}$ ) and the total background contribution ( $N^{bkg}$ ), which is a sum of the combinatorial background, other  $B \rightarrow D_{(s)}^{(*)}D_X$  decays, and  $D_{(s)}^{(*)} - D_{(s)}$  crossfeed, to the experimental data. The signal and background distributions are histograms taken from MC simulation. For  $D^0D_X$  we also weight the background shape with a second order polynomial function whose parameters are fitted on data. In the case of  $D^{(*)+}/D_X^-$  modes we consider three signal components:  $D^{(*)+}/D_s^-$ ,  $D^{(*)+}/D_s^{*-}$ , and  $D^{(*)+}/D_{s,J}(2460)^-$ , while in the case of  $D_s^{(*)-}D_X^+$  modes we consider two signal components:  $D_s^{(*)-}D^{+0}$  and  $D_s^{(*)-}D^{*+0}$ . The  $\chi^2$  is defined as:

$$\chi^2(C_j, C_{bkg}) = \sum_i \left( \frac{N_i^{meas} - \mu_i(C_j, C_{bkg})}{\sqrt{\delta N_i^{meas^2} + \delta N_i^{MC^2}}} \right)^2$$

where  $N_i^{meas}$  is the number of observed events in bin  $i$ ,  $\mu_i$  corresponds to  $\mu_i = \sum_{j=1, n_{sig}} C_j N_{ij}^{sig} + C_{bkg} N_i^{bkg}$ , the index  $j$  denotes the signal component, and  $\delta N_i^{meas}$  and  $\delta N_i^{MC}$  are the statistical uncertainties for data and MC samples, respectively. The relative normalizations of each component ( $C_j$  and  $C_{bkg}$ ) are allowed to vary in the fit. The measured  $m_X$  distributions and the results of the fits are shown in Fig. 2.

The branching fractions are extracted as  $\mathcal{B}(f) = N_{fit}/(\varepsilon N_{B_{reco}})$ , where  $N_{fit}$  is the number of signal events obtained from the fit to the  $m_X$  distribution for a given mode and  $\varepsilon$ , which includes the intermediate branching fractions of  $D_{meas}$  and its decay products, is the selection efficiency estimated using MC simulation.

The dominant systematic uncertainties originate from the lack of knowledge of the correct shapes used in the  $m_X$  fit, and from the determination of efficiencies (because of

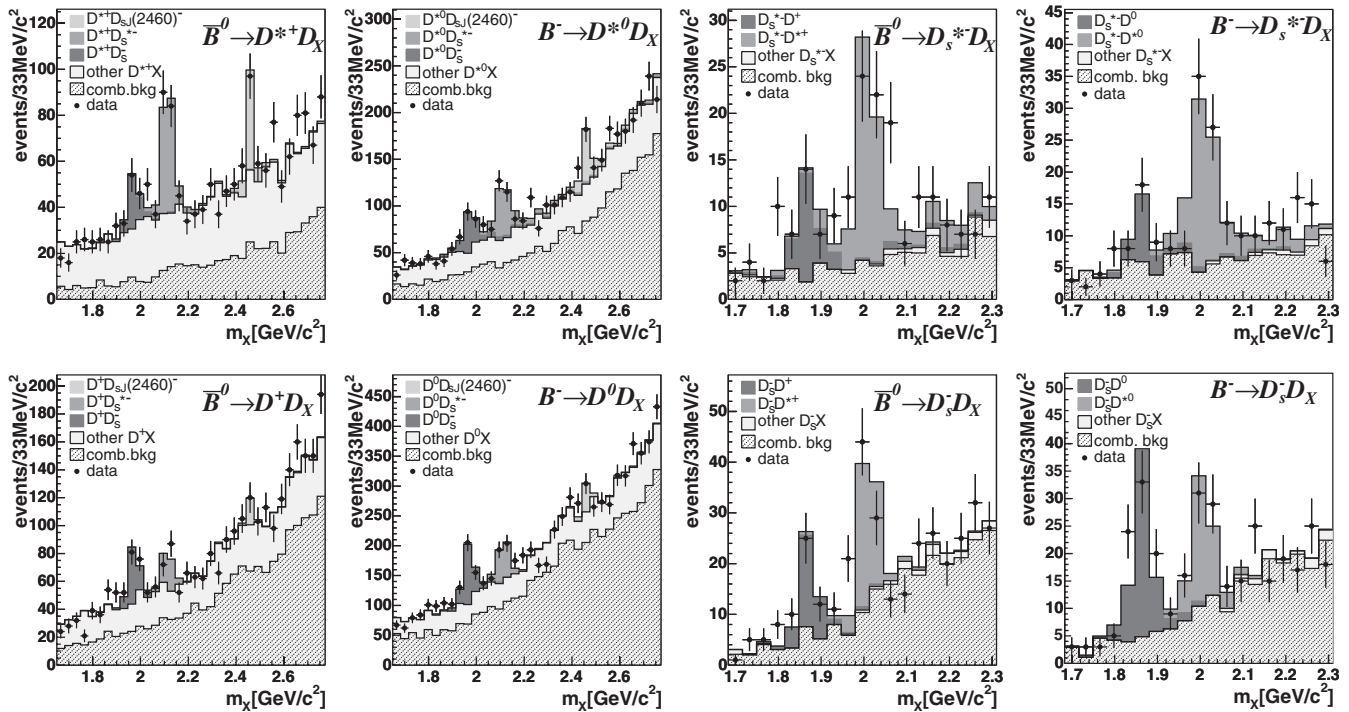


FIG. 2. Distributions of  $m_X$ . Fitted  $\bar{B} \rightarrow D^{(*)+,0} D_s^{*-}$  and  $\bar{B} \rightarrow D^{(*)+,0} D_{sJ}(2460)^-$  signal contributions and background components, determined as described in the text, are overlaid to the data points.

the limited MC statistics). These uncertainties range from 5.6% to 25%, depending on the mode. The systematic uncertainties due to the determination of  $N_{B_{\text{reco}}}$  and to the differences between data and MC in the composition of the reconstructed  $B_{\text{reco}}$  modes range between 3.7% and 6.7% for  $B^0$ , and between 3.5% and 9.0% for  $B^+$  depending on the mode under study. Other uncertainties come from track reconstruction efficiency (1.4% per track and 2.2% per soft pion),  $\gamma$  and  $\pi^0$  efficiencies (3.0% per  $\pi^0$  and 1.8% per  $\gamma$ ), and kaon identification (2% per kaon). The uncertainties due to branching fraction measurements for exclusive  $D_s^{(*)}$  decays [9] contribute between 3.0% and 7.4%, depending on the mode. We check the uncertainties introduced by the  $\chi^2$  cut of the kinematic fit by comparing data and MC control samples for  $B \rightarrow D^{(*)} l \nu$  obtained with all previously mentioned cuts except for the  $p^* > 1$  GeV/c criterion applied. The statistical uncertainty of this comparison is used as the systematic uncertainty (between 0.5% and 2.3%).

We combine the 16 measurements of  $B \rightarrow D^{(*)} D_{s(J)}^{(*)}$  to obtain the eight branching fractions for these modes and  $\mathcal{B}(D_s^- \rightarrow \phi \pi^-)$  in a  $\chi^2$  fit. In this combination the ratios  $\mathcal{B}(D_s^- \rightarrow K^{*0} K^-) / \mathcal{B}(D_s^- \rightarrow \phi \pi^-)$  and  $\mathcal{B}(D_s^- \rightarrow K_S^0 K^-) / \mathcal{B}(D_s^- \rightarrow \phi \pi^-)$ , included in the efficiency calculation when  $D_{\text{meas}} = D_s^{(*)-}$ , are fixed [9], while  $\mathcal{B}(D_s^- \rightarrow \phi \pi^-)$  is a free parameter. The MC model used to generate the  $D_s^- \rightarrow K^+ K^- \pi^-$  decays does not include any interference among the different final states ( $\phi \pi^-$ ,  $K^{*0} K^-$ ,

$f_0(980) \pi^-$ , ...). Correlated and uncorrelated uncertainties are properly taken into account in the covariance matrix. The results of this fit are given in the last column of Table I.

We further combine the results of this analysis with  $\bar{B} \rightarrow D^{(*)+,0} D_s^{*-}$  exclusive branching fractions from [11–14] and the BABAR results for  $\mathcal{B}(\bar{B} \rightarrow D_{sJ}(2460)^- D^{(*)})$  [4], obtaining the following branching fractions:

$$\mathcal{B}(D_{sJ}(2460)^- \rightarrow D_s^{*-} \pi^0) = (56 \pm 13_{\text{stat.}} \pm 9_{\text{syst.}})\%,$$

$$\mathcal{B}(D_{sJ}(2460)^- \rightarrow D_s^- \gamma) = (16 \pm 4_{\text{stat.}} \pm 3_{\text{syst.}})\%,$$

$$\mathcal{B}(D_s^- \rightarrow \phi \pi^-) = (4.62 \pm 0.36_{\text{stat.}} \pm 0.50_{\text{syst.}})\%.$$

In conclusion, we have measured the branching fractions for the decays  $\bar{B} \rightarrow D^{(*)+,0} D_s^{*-}$ . These are consistent with the existing measurements [9] and, in several cases, have a significantly smaller uncertainty. The combination of these results with the existing measurements provide the branching fraction for  $D_s^- \rightarrow \phi \pi^-$ , which is also consistent with the most recent measurement [15] and confirms a larger value compared to the previous world average [9]. We have extracted the absolute branching fractions for  $\bar{B} \rightarrow D^{(*)+,0} D_{sJ}(2460)^-$ , thus allowing the first measurement of the  $D_{sJ}(2460)^-$  decay rates. Our results show that the  $D_{sJ}(2460)^-$  meson decays via photon or  $\pi^0$  emission to  $D_s^{*-}$  in  $(72 \pm 19)\%$  of the cases.

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STUDY OF  $B \rightarrow D^{(*)}D_{s(J)}^{(*)}$  DECAYS AND MEASUREMENT OF  $D_s^-$  AND... PHYSICAL REVIEW D **74**, 031103(R) (2006)TABLE I. Event yields ( $N_{\text{fit}}$ ), efficiencies ( $\varepsilon$ ), and branching fractions ( $\mathcal{B}$ ) for pairs of detected decay modes, separately and combined. In this combination we use only the results in this paper.  $\mathcal{B}(D_s^- \rightarrow \phi\pi^-)$  is a free parameter and is also reported in the table. The first uncertainty on  $\mathcal{B}$  is statistical, the second is systematic. The parameter  $k$  corresponds to  $k = 3.6\% / (\mathcal{B}(D_s^- \rightarrow \phi\pi^-))$ .

| Decay mode                                    | $D_{\text{meas}}$ | $N_{\text{fit}}$ | $\varepsilon(\%)$ | $\mathcal{B}(\%)$                  | Combined $\mathcal{B}(\%)$ |
|---|-------------------|------------------|-------------------|------------------------------------|----------------------------|
| $\bar{B}^0 \rightarrow D_s^- D^+$             | $D^+$             | $86 \pm 17$      | $3.29 \pm 0.16$   | $0.90 \pm 0.18 \pm 0.14$           | $0.64 \pm 0.13 \pm 0.10$   |
|   | $D_s^-$           | $39 \pm 9$       | $1.79 \pm 0.12$   | $(0.74 \pm 0.17 \pm 0.13) \cdot k$ |                            |
| $\bar{B}^0 \rightarrow D_s^{*-} D^+$          | $D^+$             | $63 \pm 19$      | $3.24 \pm 0.16$   | $0.67 \pm 0.20 \pm 0.11$           | $0.69 \pm 0.16 \pm 0.09$   |
|   | $D_s^{*-}$        | $30 \pm 9$       | $0.91 \pm 0.08$   | $(1.15 \pm 0.33 \pm 0.26) \cdot k$ |                            |
| $\bar{B}^0 \rightarrow D_s^- D^{*+}$          | $D^{*+}$          | $48 \pm 13$      | $2.86 \pm 0.13$   | $0.57 \pm 0.16 \pm 0.09$           | $0.71 \pm 0.13 \pm 0.09$   |
|   | $D_s^-$           | $68 \pm 12$      | $1.63 \pm 0.10$   | $(1.42 \pm 0.26 \pm 0.20) \cdot k$ |                            |
| $\bar{B}^0 \rightarrow D_s^{*-} D^{*+}$       | $D^{*+}$          | $129 \pm 18$     | $2.68 \pm 0.09$   | $1.65 \pm 0.23 \pm 0.19$           | $1.68 \pm 0.21 \pm 0.19$   |
|   | $D_s^{*-}$        | $84 \pm 14$      | $0.86 \pm 0.05$   | $(3.38 \pm 0.60 \pm 0.61) \cdot k$ |                            |
| $B^- \rightarrow D_s^- D^0$                   | $D^0$             | $214 \pm 28$     | $3.46 \pm 0.11$   | $1.33 \pm 0.18 \pm 0.32$           | $0.92 \pm 0.14 \pm 0.18$   |
|   | $D_s^-$           | $66 \pm 10$      | $1.28 \pm 0.07$   | $(1.11 \pm 0.17 \pm 0.17) \cdot k$ |                            |
| $B^- \rightarrow D_s^{*-} D^0$                | $D^0$             | $160 \pm 31$     | $3.71 \pm 0.12$   | $0.93 \pm 0.18 \pm 0.19$           | $0.77 \pm 0.15 \pm 0.13$   |
|   | $D_s^{*-}$        | $26 \pm 10$      | $0.64 \pm 0.05$   | $(0.87 \pm 0.33 \pm 0.16) \cdot k$ |                            |
| $B^- \rightarrow D_s^- D^{*0}$                | $D^{*0}$          | $152 \pm 29$     | $2.69 \pm 0.10$   | $1.21 \pm 0.23 \pm 0.20$           | $0.76 \pm 0.15 \pm 0.13$   |
|   | $D_s^-$           | $52 \pm 11$      | $1.33 \pm 0.07$   | $(0.82 \pm 0.18 \pm 0.10) \cdot k$ |                            |
| $B^- \rightarrow D_s^{*-} D^{*0}$             | $D^{*0}$          | $216 \pm 33$     | $2.73 \pm 0.07$   | $1.70 \pm 0.26 \pm 0.24$           | $1.62 \pm 0.22 \pm 0.18$   |
|   | $D_s^{*-}$        | $90 \pm 15$      | $0.82 \pm 0.04$   | $(2.38 \pm 0.41 \pm 0.31) \cdot k$ |                            |
| $D_s^- \rightarrow \phi\pi^-$                 | —                 | —                | —                 | —                                  | $4.58 \pm 0.48 \pm 0.68$   |
| $\bar{B}^0 \rightarrow D_{sJ}(2460)^- D^+$    | $D^+$             | $27 \pm 16$      | $3.61 \pm 0.27$   | $0.26 \pm 0.15 \pm 0.07$           |                            |
| $\bar{B}^0 \rightarrow D_{sJ}(2460)^- D^{*+}$ | $D^{*+}$          | $64 \pm 15$      | $2.51 \pm 0.15$   | $0.88 \pm 0.20 \pm 0.14$           |                            |
| $B^- \rightarrow D_{sJ}(2460)^- D^0$          | $D^0$             | $75 \pm 18$      | $3.78 \pm 0.24$   | $0.43 \pm 0.16 \pm 0.13$           |                            |
| $B^- \rightarrow D_{sJ}(2460)^- D^{*0}$       | $D^{*0}$          | $147 \pm 34$     | $2.81 \pm 0.14$   | $1.12 \pm 0.26 \pm 0.20$           |                            |

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