## Observation of the Decay $B^{+} \rightarrow K^{+} K^{-} \boldsymbol{\pi}^{+}$

B. Aubert, ${ }^{1}$ M. Bona, ${ }^{1}$ D. Boutigny, ${ }^{1}$ Y. Karyotakis, ${ }^{1}$ J. P. Lees, ${ }^{1}$ V. Poireau, ${ }^{1}$ X. Prudent, ${ }^{1}$ V. Tisserand, ${ }^{1}$ A. Zghiche, ${ }^{1}$ J. Garra Tico, ${ }^{2}$ E. Grauges, ${ }^{2}$ L. Lopez, ${ }^{3}$ A. Palano, ${ }^{3}$ M. Pappagallo, ${ }^{3}$ G. Eigen, ${ }^{4}$ B. Stugu, ${ }^{4}$ L. Sun, ${ }^{4}$ G. S. Abrams, ${ }^{5}$ M. Battaglia, ${ }^{5}$ D. N. Brown, ${ }^{5}$ J. Button-Shafer, ${ }^{5}$ R. N. Cahn, ${ }^{5}$ Y. Groysman, ${ }^{5}$ R. G. Jacobsen, ${ }^{5}$ J. A. Kadyk, ${ }^{5}$ L. T. Kerth, ${ }^{5}$ Yu. G. Kolomensky, ${ }^{5}$ G. Kukartsev, ${ }^{5}$ D. Lopes Pegna, ${ }^{5}$ G. Lynch, ${ }^{5}$ L. M. Mir, ${ }^{5}$ T. J. Orimoto, ${ }^{5}$ I. L. Osipenkov, ${ }^{5}$ M. T. Ronan, ${ }^{5, *}$ K. Tackmann, ${ }^{5}$ T. Tanabe, ${ }^{5}$ W. A. Wenzel, ${ }^{5}$ P. del Amo Sanchez, ${ }^{6}$ C. M. Hawkes, ${ }^{6}$ A. T. Watson, ${ }^{6}$ T. Held, ${ }^{7}$ H. Koch, ${ }^{7}$ M. Pelizaeus, ${ }^{7}$ T. Schroeder, ${ }^{7}$ M. Steinke, ${ }^{7}$ D. Walker, ${ }^{8}$ D. J. Asgeirsson, ${ }^{9}$ T. Cuhadar-Donszelmann, ${ }^{9}$ B. G. Fulsom, ${ }^{9}$ C. Hearty, ${ }^{9}$ T. S. Mattison, ${ }^{9}$ J. A. McKenna, ${ }^{9}$ A. Khan, ${ }^{10}$ M. Saleem,,${ }^{10}$ L. Teodorescu, ${ }^{10}$ V.E. Blinov, ${ }^{11}$ A.D. Bukin, ${ }^{11}$ V. P. Druzhinin, ${ }^{11}$ V. B. Golubev, ${ }^{11}$ A. P. Onuchin, ${ }^{11}$ S. I. Serednyakov, ${ }^{11}$ Yu. I. Skovpen, ${ }^{11}$ E. P. Solodov, ${ }^{11}$ K. Yu. Todyshev, ${ }^{11}$ M. Bondioli, ${ }^{12}$ S. Curry, ${ }^{12}$ I. Eschrich, ${ }^{12}$ D. Kirkby, ${ }^{12}$ A. J. Lankford, ${ }^{12}$ P. Lund, ${ }^{12}$ M. Mandelkern, ${ }^{12}$ E. C. Martin, ${ }^{12}$ D. P. Stoker, ${ }^{12}$ S. Abachi, ${ }^{13}$ C. Buchanan, ${ }^{13}$ S. D. Foulkes, ${ }^{14}$ J. W. Gary, ${ }^{14}$ F. Liu, ${ }^{14}$ O. Long, ${ }^{14}$ B. C. Shen, ${ }^{14, *}$ L. Zhang, ${ }^{14}$ H. P. Paar, ${ }^{15}$ S. Rahatlou, ${ }^{15}$ V. Sharma, ${ }^{15}$ J. W. Berryhill, ${ }^{16}$ C. Campagnari, ${ }^{16}$ A. Cunha, ${ }^{16}$ B. Dahmes,,$^{16}$ T. M. Hong, ${ }^{16}$ D. Kovalskyi, ${ }^{16}$ J. D. Richman, ${ }^{16}$ T. W. Beck, ${ }^{17}$ A. M. Eisner, ${ }^{17}$ C. J. Flacco, ${ }^{17}$ C. A. Heusch, ${ }^{17}$ J. Kroseberg, ${ }^{17}$ W. S. Lockman, ${ }^{17}$ T. Schalk, ${ }^{17}$ B. A. Schumm, ${ }^{17}$ A. Seiden, ${ }^{17}$ M. G. Wilson, ${ }^{17}$ L. O. Winstrom,,${ }^{17}$ E. Chen, ${ }^{18}$ C. H. Cheng, ${ }^{18}$ F. Fang, ${ }^{18}$ D. G. Hitlin, ${ }^{18}$ I. Narsky, ${ }^{18}$ T. Piatenko, ${ }^{18}$ F. C. Porter, ${ }^{18}$ R. Andreassen, ${ }^{19}$ G. Mancinelli, ${ }^{19}$ B. T. Meadows, ${ }^{19}$ K. Mishra, ${ }^{19}$ M. D. Sokoloff, ${ }^{19}$ F. Blanc, ${ }^{20}$ P. C. Bloom, ${ }^{20}$ S. Chen, ${ }^{20}$ W. T. Ford, ${ }^{20}$ J. F. Hirschauer,,${ }^{20}$ A. Kreisel, ${ }^{20}$ M. Nagel, ${ }^{20}$ U. Nauenberg, ${ }^{20}$ A. Olivas, ${ }^{20}$ J. G. Smith, ${ }^{20}$ K. A. Ulmer, ${ }^{20}$ S. R. Wagner,,${ }^{20}$ J. Zhang,${ }^{20}$ A. M. Gabareen, ${ }^{21}$ A. Soffer, ${ }^{21, \dagger}$ W. H. Toki, ${ }^{21}$ R. J. Wilson, ${ }^{21}$ F. Winklmeier, ${ }^{21}$ D. D. Altenburg, ${ }^{22}$ E. Feltresi, ${ }^{22}$ A. Hauke, ${ }^{22}$ H. Jasper, ${ }^{22}$ J. Merkel, ${ }^{22}$ A. Petzold,,$^{22}$ B. Spaan, ${ }^{22}$ K. Wacker, ${ }^{22}$ V. Klose, ${ }^{23}$ M. J. Kobel, ${ }^{23}$ H. M. Lacker, ${ }^{23}$ W.F. Mader, ${ }^{23}$ R. Nogowski, ${ }^{23}$ J. Schubert, ${ }^{23}$ K.R. Schubert, ${ }^{23}$ R. Schwierz, ${ }^{23}$ J. E. Sundermann, ${ }^{23}$ A. Volk, ${ }^{23}$ D. Bernard, ${ }^{24}$ G.R. Bonneaud, ${ }^{24}$ E. Latour, ${ }^{24}$ V. Lombardo, ${ }^{24}$ Ch. Thiebaux,,${ }^{24}$ M. Verderi, ${ }^{24}$ P. J. Clark, ${ }^{25}$ W. Gradl, ${ }^{25}$ F. Muheim, ${ }^{25}$ S. Playfer, ${ }^{25}$ A. I. Robertson, ${ }^{25}$ J. E. Watson, ${ }^{25}$ Y. Xie, ${ }^{25}$ M. Andreotti, ${ }^{26}$ D. Bettoni, ${ }^{26}$ C. Bozzi, ${ }^{26}$ R. Calabrese,,${ }^{26}$ A. Cecchi, ${ }^{26}$ G. Cibinetto, ${ }^{26}$ P. Franchini, ${ }^{26}$ E. Luppi, ${ }^{26}$ M. Negrini, ${ }^{26}$ A. Petrella, ${ }^{26}$ L. Piemontese, ${ }^{26}$ E. Prencipe, ${ }^{26}$ V. Santoro, ${ }^{26}$ F. Anulli, ${ }^{27}$ R. Baldini-Ferroli, ${ }^{27}$ A. Calcaterra, ${ }^{27}$ R. de Sangro, ${ }^{27}$ G. Finocchiaro, ${ }^{27}$ S. Pacetti, ${ }^{27}$ P. Patteri, ${ }^{27}$ I. M. Peruzzi, ${ }^{27, \ddagger}$ M. Piccolo, ${ }^{27}$ M. Rama,,${ }^{27}$ A. Zallo, ${ }^{27}$ A. Buzzo,,${ }^{28}$ R. Contri, ${ }^{28}$ M. Lo Vetere, ${ }^{28}$ M. M. Macri,,$^{28}$ M. R. Monge, ${ }^{28}$ S. Passaggio, ${ }^{28}$ C. Patrignani, ${ }^{28}$ E. Robutti, ${ }^{28}$ A. Santroni, ${ }^{28}$ S. Tosi, ${ }^{28}$ K. S. Chaisanguanthum, ${ }^{29}$ M. Morii, ${ }^{29}$ J. Wu, ${ }^{29}$ R. S. Dubitzky, ${ }^{30}$ J. Marks, ${ }^{30}$ S. Schenk, ${ }^{30}$ U. Uwer, ${ }^{30}$ D. J. Bard, ${ }^{31}$ P.D. Dauncey, ${ }^{31}$ R.L. Flack,,${ }^{31}$ J. A. Nash,,${ }^{31}$ W. Panduro Vazquez, ${ }^{31}$ M. Tibbetts, ${ }^{31}$ P. K. Behera, ${ }^{32}$ X. Chai, ${ }^{32}$ M. J. Charles, ${ }^{32}$ U. Mallik, ${ }^{32}$ V. Ziegler, ${ }^{32}$ J. Cochran, ${ }^{33}$ H. B. Crawley, ${ }^{33}$ L. Dong, ${ }^{33}$ V. Eyges, ${ }^{33}$ W. T. Meyer, ${ }^{33}$ S. Prell, ${ }^{33}$ E. I. Rosenberg, ${ }^{33}$ A.E. Rubin, ${ }^{33}$ Y. Y. Gao, ${ }^{34}$ A. V. Gritsan, ${ }^{34}$ Z. J. Guo, ${ }^{34}$ C. K. Lae, ${ }^{34}$ A. G. Denig, ${ }^{35}$ M. Fritsch, ${ }^{35}$ G. Schott, ${ }^{35}$ N. Arnaud, ${ }^{36}$ J. Béquilleux, ${ }^{36}$ A. D'Orazio, ${ }^{36}$ M. Davier, ${ }^{36}$ G. Grosdidier, ${ }^{36}$ A. Höcker, ${ }^{36}$ V. Lepeltier, ${ }^{36}$ F. Le Diberder, ${ }^{36}$ A. M. Lutz, ${ }^{36}$ S. Pruvot, ${ }^{36}$ S. Rodier, ${ }^{36}$ P. Roudeau, ${ }^{36}$ M. H. Schune, ${ }^{36}$ J. Serrano, ${ }^{36}$ V. Sordini, ${ }^{36}$ A. Stocchi, ${ }^{36}$ W.F. Wang, ${ }^{36}$ G. Wormser, ${ }^{36}$ D. J. Lange, ${ }^{37}$ D. M. Wright, ${ }^{37}$ I. Bingham, ${ }^{38}$ J. P. Burke, ${ }^{38}$ C. A. Chavez, ${ }^{38}$ I. J. Forster, ${ }^{38}$ J. R. Fry, ${ }^{38}$ E. Gabathuler, ${ }^{38}$ R. Gamet ${ }^{38}$ D. E. Hutchcroft, ${ }^{38}$ D. J. Payne, ${ }^{38}$ K. C. Schofield, ${ }^{38}$ C. Touramanis, ${ }^{38}$ A. J. Bevan, ${ }^{39}$ K. A. George, ${ }^{39}$ F. Di Lodovico, ${ }^{39}$ W. Menges, ${ }^{39}$ R. Sacco, ${ }^{39}$ G. Cowan, ${ }^{40}$ H. U. Flaecher, ${ }^{40}$ D. A. Hopkins, ${ }^{40}$ S. Paramesvaran, ${ }^{40}$ F. Salvatore, ${ }^{40}$ A.C. Wren, ${ }^{40}$ D. N. Brown, ${ }^{41}$ C. L. Davis,,${ }^{41}$ J. Allison, ${ }^{42}$
N.R. Barlow, ${ }^{42}$ R. J. Barlow, ${ }^{42}$ Y. M. Chia, ${ }^{42}$ C.L. Edgar, ${ }^{42}$ G.D. Lafferty, ${ }^{42}$ T. J. West, ${ }^{42}$ J. I. Yi, ${ }^{42}$ J. Anderson, ${ }^{43}$ C. Chen,,$^{43}$ A. Jawahery, ${ }^{43}$ D. A. Roberts, ${ }^{43}$ G. Simi, ${ }^{43}$ J. M. Tuggle, ${ }^{43}$ G. Blaylock, ${ }^{44}$ C. Dallapiccola, ${ }^{44}$ S. S. Hertzbach, ${ }^{44}$ X. Li, ${ }^{44}$ T. B. Moore, ${ }^{44}$ E. Salvati, ${ }^{44}$ S. Saremi, ${ }^{44}$ R. Cowan, ${ }^{45}$ D. Dujmic,,${ }^{45}$ P. H. Fisher, ${ }^{45}$ K. Koeneke, ${ }^{45}$ G. Sciolla, ${ }^{45}$ S. J. Sekula, ${ }^{45}$ M. Spitznagel, ${ }^{45}$ F. Taylor, ${ }^{45}$ R. K. Yamamoto, ${ }^{45}$ M. Zhao, ${ }^{45}$ Y. Zheng, ${ }^{45}$ S. E. Mclachlin,,${ }^{46, *}$ P. M. Patel, ${ }^{46}$ S. H. Robertson,,$^{46}$ A. Lazzaro, ${ }^{47}$ F. Palombo, ${ }^{47}$ J. M. Bauer, ${ }^{48}$ L. Cremaldi, ${ }^{48}$ V. Eschenburg, ${ }^{48}$ R. Godang, ${ }^{48}$ R. Kroeger, ${ }^{48}$
D. A. Sanders, ${ }^{48}$ D. J. Summers, ${ }^{48}$ H. W. Zhao, ${ }^{48}$ S. Brunet, ${ }^{49}$ D. Côté, ${ }^{49}$ M. Simard, ${ }^{49}$ P. Taras, ${ }^{49}$ F. B. Viaud, ${ }^{49}$
H. Nicholson, ${ }^{50}$ G. De Nardo, ${ }^{51}$ F. Fabozzi, ${ }^{51,8}$ L. Lista, ${ }^{51}$ D. Monorchio, ${ }^{51}$ C. Sciacca, ${ }^{51}$ M. A. Baak, ${ }^{52}$ G. Raven,,${ }^{52}$ H. L. Snoek, ${ }^{52}$ C. P. Jessop, ${ }^{53}$ K. J. Knoepfel, ${ }^{53}$ J. M. LoSecco, ${ }^{53}$ G. Benelli, ${ }^{54}$ L. A. Corwin, ${ }^{54}$ K. Honscheid,,${ }^{54}$ H. Kagan, ${ }^{54}$
R. Kass, ${ }^{54}$ J. P. Morris, ${ }^{54}$ A. M. Rahimi, ${ }^{54}$ J. J. Regensburger, ${ }^{54}$ Q. K. Wong, ${ }^{54}$ N. L. Blount,,${ }^{55}$ J. Brau, ${ }^{55}$ R. Frey, ${ }^{55}$ O. Igonkina, ${ }^{55}$ J. A. Kolb, ${ }^{55} \mathrm{M}$. Lu, ${ }^{55}$ R. Rahmat,${ }^{55}$ N. B. Sinev, ${ }^{55}$ D. Strom, ${ }^{55}$ J. Strube, ${ }^{55}$ E. Torrence, ${ }^{55}$ N. Gagliardi, ${ }^{56}$ A. Gaz,,${ }^{56}$ M. Margoni, ${ }^{56}$ M. Morandin, ${ }^{56}$ A. Pompili, ${ }^{56}$ M. Posocco, ${ }^{56}$ M. Rotondo, ${ }^{56}$ F. Simonetto, ${ }^{56}$ R. Stroili, ${ }^{56}$ C. Voci, ${ }^{56}$ E. Ben-Haim, ${ }^{57}$ H. Briand,,${ }^{57}$ G. Calderini, ${ }^{57}$ J. Chauveau, ${ }^{57}$ P. David, ${ }^{57}$ L. Del Buono, ${ }^{57}$ Ch. de la Vaissière, ${ }^{57}$ O. Hamon, ${ }^{57}$ Ph. Leruste,,${ }^{57}$ J. Malclès, ${ }^{57}$ J. Ocariz, ${ }^{57}$ A. Perez, ${ }^{57}$ J. Prendki, ${ }^{57}$ L. Gladney,${ }^{58}$ M. Biasini, ${ }^{59}$ R. Covarelli, ${ }^{59}$
E. Manoni, ${ }^{59}$ C. Angelini, ${ }^{60}$ G. Batignani, ${ }^{60}$ S. Bettarini, ${ }^{60}$ M. Carpinelli, ${ }^{60}$ R. Cenci, ${ }^{60}$ A. Cervelli, ${ }^{60}$ F. Forti, ${ }^{60}$ M. A. Giorgi, ${ }^{60}$ A. Lusiani, ${ }^{60}$ G. Marchiori, ${ }^{60}$ M. A. Mazur, ${ }^{60}$ M. Morganti, ${ }^{60}$ N. Neri, ${ }^{60}$ E. Paoloni, ${ }^{60}$ G. Rizzo, ${ }^{60}$ J. J. Walsh, ${ }^{60}$ M. Haire, ${ }^{61}$ J. Biesiada, ${ }^{62}$ P. Elmer, ${ }^{62}$ Y. P. Lau, ${ }^{62}$ C. Lu, ${ }^{62}$ J. Olsen, ${ }^{62}$ A. J. S. Smith, ${ }^{62}$ A. V. Telnov, ${ }^{62}$ E. Baracchini, ${ }^{63}$ F. Bellini, ${ }^{63}$ G. Cavoto, ${ }^{63}$ D. del Re, ${ }^{63}$ E. Di Marco, ${ }^{63}$ R. Faccini, ${ }^{63}$ F. Ferrarotto, ${ }^{63}$ F. Ferroni, ${ }^{63}$ M. Gaspero, ${ }^{63}$ P. D. Jackson, ${ }^{63}$ L. Li Gioi, ${ }^{63}$ M. A. Mazzoni, ${ }^{63}$ S. Morganti, ${ }^{63}$ G. Piredda, ${ }^{63}$ F. Polci, ${ }^{63}$ F. Renga, ${ }^{63}$ C. Voena, ${ }^{63}$ M. Ebert, ${ }^{64}$ T. Hartmann, ${ }^{64}$ H. Schröder, ${ }^{64}$ R. Waldi, ${ }^{64}$ T. Adye, ${ }^{65}$ G. Castelli, ${ }^{65}$ B. Franek, ${ }^{65}$ E. O. Olaiya, ${ }^{65}$ S. Ricciardi, ${ }^{65}$ W. Roethel, ${ }^{65}$ F. F. Wilson, ${ }^{65}$ S. Emery, ${ }^{66}$ M. Escalier, ${ }^{66}$ A. Gaidot, ${ }^{66}$ S. F. Ganzhur, ${ }^{66}$ G. Hamel de Monchenault, ${ }^{66}$ W. Kozanecki, ${ }^{66}$ G. Vasseur, ${ }^{66}$ Ch. Yèche, ${ }^{66}$ M. Zito, ${ }^{66}$ X. R. Chen, ${ }^{67}$ H. Liu, ${ }^{67}$ W. Park, ${ }^{67}$ M. V. Purohit, ${ }^{67}$ J. R. Wilson, ${ }^{67}$ M. T. Allen, ${ }^{68}$ D. Aston, ${ }^{68}$ R. Bartoldus, ${ }^{68}$ P. Bechtle, ${ }^{68}$ N. Berger, ${ }^{68}$ R. Claus, ${ }^{68}$ J. P. Coleman, ${ }^{68}$ M. R. Convery, ${ }^{68}$ J. C. Dingfelder, ${ }^{68}$ J. Dorfan, ${ }^{68}$ G. P. Dubois-Felsmann, ${ }^{68}$ W. Dunwoodie, ${ }^{68}$ R. C. Field, ${ }^{68}$ T. Glanzman, ${ }^{68}$ S. J. Gowdy, ${ }^{68}$ M. T. Graham, ${ }^{68}$ P. Grenier, ${ }^{68}$ C. Hast, ${ }^{68}$ T. Hryn'ova, ${ }^{68}$ W. R. Innes, ${ }^{68}$ J. Kaminski, ${ }^{68}$ M. H. Kelsey, ${ }^{68}$ H. Kim, ${ }^{68}$ P. Kim, ${ }^{68}$ M. L. Kocian, ${ }^{68}$ D. W. G. S. Leith, ${ }^{68}$ S. Li, ${ }^{68}$ S. Luitz, ${ }^{68}$ V. Luth, ${ }^{68}$ H. L. Lynch, ${ }^{68}$ D. B. MacFarlane, ${ }^{68}$ H. Marsiske, ${ }^{68}$ R. Messner, ${ }^{68}$ D. R. Muller, ${ }^{68}$ C. P. O’Grady, ${ }^{68}$ I. Ofte, ${ }^{68}$ A. Perazzo, ${ }^{68}$ M. Perl, ${ }^{68}$ T. Pulliam, ${ }^{68}$ B. N. Ratcliff, ${ }^{68}$ A. Roodman, ${ }^{68}$ A. A. Salnikov, ${ }^{68}$ R. H. Schindler, ${ }^{68}$ J. Schwiening, ${ }^{68}$ A. Snyder, ${ }^{68}$ J. Stelzer, ${ }^{68}$ D. Su, ${ }^{68}$ M. K. Sullivan, ${ }^{68}$ K. Suzuki, ${ }^{68}$ S. K. Swain, ${ }^{68}$ J. M. Thompson, ${ }^{68}$ J. Va'vra, ${ }^{68}$ N. van Bakel, ${ }^{68}$ A. P. Wagner, ${ }^{68}$ M. Weaver, ${ }^{68}$ W. J. Wisniewski, ${ }^{68}$ M. Wittgen, ${ }^{68}$ D. H. Wright, ${ }^{68}$ A. K. Yarritu, ${ }^{68}$ K. Yi, ${ }^{68}$ C. C. Young, ${ }^{68}$ P. R. Burchat, ${ }^{69}$ A. J. Edwards, ${ }^{69}$ S. A. Majewski, ${ }^{69}$ B. A. Petersen, ${ }^{69}$ L. Wilden, ${ }^{69}$ S. Ahmed, ${ }^{70}$ M. S. Alam, ${ }^{70}$ R. Bula, ${ }^{70}$ J. A. Ernst, ${ }^{70}$ V. Jain, ${ }^{70}$ B. Pan, ${ }^{70}$ M. A. Saeed, ${ }^{70}$ F. R. Wappler, ${ }^{70}$ S. B. Zain, ${ }^{70}$ M. Krishnamurthy, ${ }^{71}$ S. M. Spanier, ${ }^{71}$ R. Eckmann, ${ }^{72}$ J. L. Ritchie, ${ }^{72}$ A. M. Ruland, ${ }^{72}$ C. J. Schilling, ${ }^{72}$ R.F. Schwitters, ${ }^{72}$ J. M. Izen, ${ }^{73}$ X. C. Lou, ${ }^{73}$ S. Ye, ${ }^{73}$ F. Bianchi, ${ }^{74}$ F. Gallo, ${ }^{74}$ D. Gamba, ${ }^{74}$ M. Pelliccioni, ${ }^{74}$ M. Bomben, ${ }^{75}$ L. Bosisio, ${ }^{75}$ C. Cartaro, ${ }^{75}$ F. Cossutti, ${ }^{75}$ G. Della Ricca, ${ }^{75}$ L. Lanceri, ${ }^{75}$ L. Vitale, ${ }^{75}$ V. Azzolini, ${ }^{76}$ N. Lopez-March, ${ }^{76}$ F. Martinez-Vidal, ${ }^{76, \|}$ D. A. Milanes, ${ }^{76}$ A. Oyanguren, ${ }^{76}$ J. Albert, ${ }^{77}$ Sw. Banerjee, ${ }^{77}$ B. Bhuyan, ${ }^{77}$ K. Hamano, ${ }^{77}$ R. Kowalewski, ${ }^{77}$ I. M. Nugent, ${ }^{77}$ J. M. Roney, ${ }^{77}$ R. J. Sobie, ${ }^{77}$ T. J. Gershon, ${ }^{78}$ P. F. Harrison, ${ }^{78}$ J. Ilic, ${ }^{78}$ T. E. Latham, ${ }^{78}$ G. B. Mohanty, ${ }^{78}$ H. R. Band, ${ }^{79}$ X. Chen, ${ }^{79}$ S. Dasu, ${ }^{79}$ K. T. Flood, ${ }^{79}$ J. J. Hollar, ${ }^{79}$ P. E. Kutter, ${ }^{79}$ Y. Pan, ${ }^{79}$ M. Pierini, ${ }^{79}$ R. Prepost, ${ }^{79}$ S. L. Wu, ${ }^{79}$ and H. Neal ${ }^{80}$
(BABAR Collaboration)
${ }^{1}$ Laboratoire de Physique des Particules, IN2P3/CNRS et Université de Savoie, F-74941 Annecy-Le-Vieux, France
${ }^{2}$ Universitat de Barcelona, Facultat de Fisica, Departament ECM, E-08028 Barcelona, Spain
${ }^{3}$ Università di Bari, Dipartimento di Fisica and INFN, I-70126 Bari, Italy
${ }^{4}$ University of Bergen, Institute of Physics, N-5007 Bergen, Norway
${ }^{5}$ Lawrence Berkeley National Laboratory and University of California, Berkeley, California 94720, USA
${ }^{6}$ University of Birmingham, Birmingham, B15 2TT, United Kingdom
${ }^{7}$ Ruhr Universität Bochum, Institut für Experimentalphysik 1, D-44780 Bochum, Germany
${ }^{8}$ University of Bristol, Bristol BS8 1TL, United Kingdom
${ }^{9}$ University of British Columbia, Vancouver, British Columbia, Canada V6T $1 Z 1$
${ }^{10}$ Brunel University, Uxbridge, Middlesex UB8 3PH, United Kingdom
${ }^{11}$ Budker Institute of Nuclear Physics, Novosibirsk 630090, Russia
${ }^{12}$ University of California at Irvine, Irvine, California 92697, USA
${ }^{13}$ University of California at Los Angeles, Los Angeles, California 90024, USA
${ }^{14}$ University of California at Riverside, Riverside, California 92521, USA
${ }^{15}$ University of California at San Diego, La Jolla, California 92093, USA
${ }^{16}$ University of California at Santa Barbara, Santa Barbara, California 93106, USA
${ }^{17}$ University of California at Santa Cruz, Institute for Particle Physics, Santa Cruz, California 95064, USA
${ }^{18}$ California Institute of Technology, Pasadena, California 91125, USA
${ }^{19}$ University of Cincinnati, Cincinnati, Ohio 45221, USA
${ }^{20}$ University of Colorado, Boulder, Colorado 80309, USA
${ }^{21}$ Colorado State University, Fort Collins, Colorado 80523, USA
${ }^{22}$ Universität Dortmund, Institut für Physik, D-44221 Dortmund, Germany
${ }^{23}$ Technische Universität Dresden, Institut für Kern- und Teilchenphysik, D-01062 Dresden, Germany
${ }^{24}$ Laboratoire Leprince-Ringuet, CNRS/IN2P3, Ecole Polytechnique, F-91128 Palaiseau, France
${ }^{25}$ University of Edinburgh, Edinburgh EH9 3JZ, United Kingdom
${ }^{26}$ Università di Ferrara, Dipartimento di Fisica and INFN, I-44100 Ferrara, Italy
${ }^{27}$ Laboratori Nazionali di Frascati dell'INFN, I-00044 Frascati, Italy
${ }^{28}$ Università di Genova, Dipartimento di Fisica and INFN, I-16146 Genova, Italy
${ }^{29}$ Harvard University, Cambridge, Massachusetts 02138, USA

${ }^{30}$ Universität Heidelberg, Physikalisches Institut, Philosophenweg 12, D-69120 Heidelberg, Germany<br>${ }^{31}$ Imperial College London, London, SW7 2AZ, United Kingdom<br>${ }^{32}$ University of Iowa, Iowa City, Iowa 52242, USA<br>${ }^{33}$ Iowa State University, Ames, Iowa 50011-3160, USA<br>${ }^{34}$ Johns Hopkins University, Baltimore, Maryland 21218, USA<br>${ }^{35}$ Universität Karlsruhe, Institut für Experimentelle Kernphysik, D-76021 Karlsruhe, Germany<br>${ }^{36}$ Laboratoire de l'Accélérateur Linéaire, IN2P3/CNRS et Université Paris-Sud 11, Centre Scientifique d'Orsay, B. P. 34, F-91898 ORSAY Cedex, France<br>${ }^{37}$ Lawrence Livermore National Laboratory, Livermore, California 94550, USA<br>${ }^{38}$ University of Liverpool, Liverpool L69 7ZE, United Kingdom<br>${ }^{39}$ Queen Mary, University of London, E1 4NS, United Kingdom<br>${ }^{40}$ University of London, Royal Holloway and Bedford New College, Egham, Surrey TW20 OEX, United Kingdom<br>${ }^{41}$ University of Louisville, Louisville, Kentucky 40292, USA<br>${ }^{42}$ University of Manchester, Manchester M13 9PL, United Kingdom<br>${ }^{43}$ University of Maryland, College Park, Maryland 20742, USA<br>${ }^{44}$ University of Massachusetts, Amherst, Massachusetts 01003, USA<br>${ }^{45}$ Massachusetts Institute of Technology, Laboratory for Nuclear Science, Cambridge, Massachusetts 02139, USA<br>${ }^{46}$ McGill University, Montréal, Québec, Canada H3A $2 T 8$<br>${ }^{47}$ Università di Milano, Dipartimento di Fisica and INFN, I-20133 Milano, Italy<br>${ }^{48}$ University of Mississippi, University, Mississippi 38677, USA<br>${ }^{49}$ Université de Montréal, Physique des Particules, Montréal, Québec, Canada H3C $3 J 7$<br>${ }^{50}$ Mount Holyoke College, South Hadley, Massachusetts 01075, USA<br>${ }^{51}$ Università di Napoli Federico II, Dipartimento di Scienze Fisiche and INFN, I-80126, Napoli, Italy<br>${ }^{52}$ NIKHEF, National Institute for Nuclear Physics and High Energy Physics, NL-1009 DB Amsterdam, The Netherlands<br>${ }^{53}$ University of Notre Dame, Notre Dame, Indiana 46556, USA<br>${ }^{54}$ Ohio State University, Columbus, Ohio 43210, USA<br>${ }^{55}$ University of Oregon, Eugene, Oregon 97403, USA<br>${ }^{56}$ Università di Padova, Dipartimento di Fisica and INFN, I-35131 Padova, Italy<br>${ }^{57}$ Laboratoire de Physique Nucléaire et de Hautes Energies, IN2P3/CNRS, Université Pierre et Marie Curie-Paris 6, Université Denis Diderot-Paris 7, F-75252 Paris, France<br>${ }^{58}$ University of Pennsylvania, Philadelphia, Pennsylvania 19104, USA<br>${ }^{59}$ Università di Perugia, Dipartimento di Fisica and INFN, I-06100 Perugia, Italy<br>${ }^{60}$ Università di Pisa, Dipartimento di Fisica, Scuola Normale Superiore and INFN, I-56127 Pisa, Italy<br>${ }^{61}$ Prairie View A\&M University, Prairie View, Texas 77446, USA<br>${ }^{62}$ Princeton University, Princeton, New Jersey 08544, USA<br>${ }^{63}$ Università di Roma La Sapienza, Dipartimento di Fisica and INFN, I-00185 Roma, Italy<br>${ }^{64}$ Universität Rostock, D-18051 Rostock, Germany<br>${ }^{65}$ Rutherford Appleton Laboratory, Chilton, Didcot, Oxon, OX1 1 0QX, United Kingdom<br>${ }^{66}$ DSM/Dapnia, CEA/Saclay, F-91191 Gif-sur-Yvette, France<br>${ }^{67}$ University of South Carolina, Columbia, South Carolina 29208, USA<br>${ }^{68}$ Stanford Linear Accelerator Center, Stanford, California 94309, USA<br>${ }^{69}$ Stanford University, Stanford, California 94305-4060, USA<br>${ }^{70}$ State University of New York, Albany, New York 12222, USA<br>${ }^{71}$ University of Tennessee, Knoxville, Tennessee 37996, USA<br>${ }^{72}$ University of Texas at Austin, Austin, Texas 78712, USA<br>${ }^{73}$ University of Texas at Dallas, Richardson, Texas 75083, USA<br>${ }^{74}$ Università di Torino, Dipartimento di Fisica Sperimentale and INFN, I-10125 Torino, Italy<br>${ }^{75}$ Università di Trieste, Dipartimento di Fisica and INFN, I-34127 Trieste, Italy<br>${ }^{76}$ IFIC, Universitat de Valencia-CSIC, E-46071 Valencia, Spain<br>${ }^{77}$ University of Victoria, Victoria, British Columbia, Canada V8W 3P6<br>${ }^{78}$ Department of Physics, University of Warwick, Coventry CV4 7AL, United Kingdom<br>${ }^{79}$ University of Wisconsin, Madison, Wisconsin 53706, USA<br>${ }^{80}$ Yale University, New Haven, Connecticut 06511, USA<br>(Received 3 August 2007; published 28 November 2007)

We report the observation of charmless hadronic decays of charged $B$ mesons to the final state $K^{+} K^{-} \pi^{+}$. Using a data sample of $347.5 \mathrm{fb}^{-1}$ collected at the $\Upsilon(4 S)$ resonance with the $B A B A R$ detector, we observe $429 \pm 43$ signal events with a significance of $9.6 \sigma$. We measure the inclusive branching fraction $\mathcal{B}\left(B^{+} \rightarrow K^{+} K^{-} \pi^{+}\right)=[5.0 \pm 0.5($ stat $) \pm 0.5($ syst $)] \times 10^{-6}$. Inspection of the Dalitz plot of signal candidates shows a broad structure peaking near $1.5 \mathrm{GeV} / c^{2}$ in the $K^{+} K^{-}$invariant mass distribution. We find the direct $C P$ asymmetry to be consistent with zero.
$B$ meson decays to final states with even numbers of strange quarks or antiquarks are suppressed in the Standard Model. Such decays may proceed by the $b \rightarrow d$ loop (penguin) transition, or by other processes followed by $s \bar{s}$ production. Hadronic $b \rightarrow d$ penguin transitions have recently been observed [1,2], while examples of $s \bar{s}$ production have been seen in various $B$ decays [3-5]. Furthermore, Dalitz plot (DP) analyses of $B^{+} \rightarrow$ $K^{+} K^{+} K^{-}[6,7]$ and $B^{0} \rightarrow K^{+} K^{-} K^{0}[8]$ have seen anomalous excesses of events at low $K^{+} K^{-}$invariant masses, the origin of which has aroused considerable interest among theorists [9-13], as it is of great importance in the understanding of low energy spectroscopy [14]. Understanding the production mechanism of charmless $B$ decays to such multibody final states is therefore a priority.

The decay $B^{+} \rightarrow K^{+} K^{-} \pi^{+}$and charmless quasi-twobody $B$ decays resulting in this final state have not been previously observed. The current experimental upper limits are $\mathcal{B}\left(B^{+} \rightarrow K^{+} K^{-} \pi^{+}\right)<6.3 \times 10^{-6}[15], \mathcal{B}\left(B^{+} \rightarrow\right.$ $\left.\phi \pi^{+}\right)<2.4 \times 10^{-7}[16]$ and $\mathcal{B}\left(B^{+} \rightarrow K^{+} \bar{K}^{* 0}(892)\right)<$ $1.1 \times 10^{-6}$ [17], all at $90 \%$ confidence level. Such decays play an important role in analyses based on flavor SU(3) that can limit the allowed values of the deviation of $\sin \left(2 \beta^{\text {eff }}\right)$ measured in hadronic $b \rightarrow s$ penguin modes to the reference value obtained in $b \rightarrow c \bar{c} s$ transitions such as $B^{0} \rightarrow J / \psi K_{S}^{0}$ [18]. Various theoretical predictions give $\mathcal{B}\left(B^{+} \rightarrow \phi \pi^{+}\right) \leqslant \mathcal{O}\left(10^{-8}\right) \quad[19-23] \quad$ and $\quad \mathcal{B}\left(B^{+} \rightarrow\right.$ $\left.K^{+} \bar{K}^{* 0}(892)\right) \leq \mathcal{O}\left(10^{-6}\right) \quad[19-21,24,25]$. A recent phenomenological analysis gives a lower bound of $\mathcal{B}\left(B^{+} \rightarrow\right.$ $\left.K^{+} \bar{K}^{* 0}(892)\right) \geq 0.7 \times 10^{-6}$ [26].

We report herein the results of a search for the charmless hadronic decay $B^{+} \rightarrow K^{+} K^{-} \pi^{+}$[27]. The data used in this analysis, collected at the PEP-II asymmetric energy $e^{+} e^{-}$collider [28], consist of an integrated luminosity of $347.5 \mathrm{fb}^{-1}$ recorded at the $\Upsilon(4 S)$ resonance. In addition, $36.6 \mathrm{fb}^{-1}$ of data were collected 40 MeV below the resonance. These samples are referred to as on-resonance and off-resonance data, respectively. The on-resonance data sample contains (383.2 $\pm 4.2$ ) $\times 10^{6} B \bar{B}$ pairs [29].

The BABAR detector is described in detail elsewhere [30]. Charged particles are detected and their momenta measured with a five-layer silicon vertex tracker (SVT) and a 40 -layer drift chamber ( DCH ) inside a 1.5 T solenoidal magnet. Surrounding the DCH is a detector of internally reflected Cherenkov radiation (DIRC), designed for charged particle identification (PID). Energy deposited by electrons and photons is measured by a $\operatorname{CsI}(\mathrm{Tl})$ crystal electromagnetic calorimeter.

We select $B^{+} \rightarrow K^{+} K^{-} \pi^{+}$candidates by combining two charged kaon candidates of opposite sign with one charged pion candidate. Each track is required to have at least 12 hits in the DCH, to have a minimum transverse momentum of $100 \mathrm{MeV} / c$, and to be consistent with hav-
ing originated from the interaction region. Identification of charged pions and kaons is accomplished using energy loss ( $d E / d x$ ) information from the SVT and DCH, and the Cherenkov angle and number of photons measured by the DIRC for tracks with momenta above $700 \mathrm{MeV} / c$. We distinguish kaons from pions by applying criteria to the product of the likelihood ratios determined from these individual measurements. The efficiency for kaon selection is approximately $80 \%$ including geometrical acceptance, while the probability of misidentification of pions as kaons is below $5 \%$ up to a laboratory momentum of $4 \mathrm{GeV} / c$.

Continuum $e^{+} e^{-} \rightarrow q \bar{q}(q=u, d, s, c)$ events are the dominant background. To discriminate this type of event from signal, we use a neural network [31] that combines five variables: the ratio of the second order momentumweighted Legendre polynomial moment to that of the zeroth order; the absolute value of the cosine of the angle between the $B$ direction and the beam $(z)$ axis; the magnitude of the cosine of the angle between the $B$ thrust axis and the $z$ axis [all quantities calculated in the center-ofmass (c.m.) frame]; the product of the $B$ candidate's charge and the flavor of the recoiling $B$ as reported by a multivariate tagging algorithm [32]; and the boost-corrected proper time difference between the decays of the two $B$ mesons divided by its variance.

In addition to the neural network output ( $N N_{\text {out }}$ ), we distinguish signal from background events using two kinematic variables: the difference $\Delta E$ between the c.m. energy of the $B$ candidate and $\sqrt{s} / 2$, and the beam-energy substituted mass $m_{\mathrm{ES}}=\sqrt{s / 4-\mathbf{p}_{B}^{2}}$, where $\sqrt{s}$ is the total c.m. energy and $\mathbf{p}_{B}$ is the momentum of the candidate $B$ meson in the c.m. frame. We select signal candidates that satisfy $N N_{\text {out }}>0.29,5.272<m_{\text {ES }}<5.286 \mathrm{GeV} / c^{2}$ and $|\Delta E|<$ 0.075 GeV .

Another potentially large source of background arises from $B$ decays containing charm mesons and charmonia. We veto $B$ candidates with $K^{+} K^{-}$invariant mass within $-3 \sigma,+5 \sigma$ of the nominal $D^{0}$ mass, or with invariant mass of the $K^{-} \pi^{+}$system within $\pm 4 \sigma$ of the mass of the $J / \psi$ or $\psi(2 S)$ [33]. Here, $\sigma$ is $25 \mathrm{MeV} / c^{2}$ for $D^{0}$, and $21 \mathrm{MeV} / c^{2}$ for $J / \psi$ and $\psi(2 S)$. The asymmetric $D^{0}$ veto is chosen to remove backgrounds resulting from $\pi \rightarrow K$ misidentification. Charmonium contributions arise mainly from the leptonic decays of $J / \psi$ and $\psi(2 S)$, when one lepton is misidentified as a pion and the other as a kaon.

The efficiency for signal events to pass the selection criteria is $22.1 \%$, determined with a Monte Carlo (MC) simulation in which events uniformly populate the Dalitz plot. The only selection requirements that exhibit any strong dependency on the DP position are the track preselection (due to the reduced acceptance of low momentum tracks), and charm and charmonia vetoes. The average
number of $B$ candidates found per selected event is 1.12 . In events with multiple candidates we choose the one with the highest probability of a fit of the three tracks to a common vertex. In about $1 \%$ of signal events the $B$ candidate is misreconstructed due to one track being replaced with a track from the rest of the event. Such events are considered as a part of the signal component.

We study possible residual backgrounds from $B \bar{B}$ events using MC simulations. We find that these can be conveniently divided into three categories, each having similar shapes in $\Delta E$ and $m_{\mathrm{ES}}$. The first two ( $B \bar{B}_{1}$ and $B \bar{B}_{2}$ ) are dominated by specific decays, $B^{+} \rightarrow K^{+} \pi^{+} \pi^{-}$and $B^{+} \rightarrow$ $K^{+} K^{+} K^{-}$respectively. The third category ( $B \bar{B}_{3}$ ) contains the remainder of the $B \bar{B}$ background, and is mainly combinatoric in nature. Based on our MC studies, the total number of $B \bar{B}$ pairs in our data sample, and the branching fractions listed by $[33,34]$, we expect 69,255 , and 528 events from the three $B \bar{B}$ background categories, respectively.

In order to obtain the $B^{+} \rightarrow K^{+} K^{-} \pi^{+}$signal yield, we perform an unbinned extended maximum likelihood fit to the candidate events using three input variables: $m_{\mathrm{ES}}, \Delta E$ and $N N_{\text {out }}^{\prime}=1-\arccos \left(2 N N_{\text {out }}-1\right)$. The $N N_{\text {out }}^{\prime}$ variable is designed to allow simpler modeling of the strongly peaking structures near zero for continuum background and near one for signal. For each event category $j$ (signal, continuum background, or one of the three $B \bar{B}$ background components), we define a probability density function (PDF):

$$
\begin{equation*}
\mathcal{P}_{j}^{i} \equiv \mathcal{P}_{j}\left(m_{\mathrm{ES}}^{i}\right) \mathcal{P}_{j}\left(\Delta E^{i}\right) \mathcal{P}_{j}\left(N N_{\mathrm{out}}^{\prime i}\right) \tag{1}
\end{equation*}
$$

where $i$ denotes the event index. This form of the PDF is found to be valid since correlations among the input variables are small. The extended likelihood function is:

$$
\begin{equation*}
\mathcal{L}=\prod_{k} \exp \left(-n_{k}\right) \prod_{i}\left[\sum_{j} n_{j} \mathcal{P}_{j}^{i}\right] \tag{2}
\end{equation*}
$$

where $n_{j}$ is the yield belonging to the event category $j$.

The signal $m_{\mathrm{ES}}$ and $\Delta E$ shapes are parametrized with the sum of a Gaussian and a Crystal Ball function [35] and the sum of two Gaussians, respectively. We fix the shape parameters to the values obtained from the $B^{+} \rightarrow$ $K^{+} K^{-} \pi^{+}$phase space MC sample. The continuum background $m_{\mathrm{ES}}$ shape is described by the function $x \sqrt{1-x^{2}} \exp \left[-\xi\left(1-x^{2}\right)\right]$, with $x \equiv 2 m_{\mathrm{ES}} / \sqrt{s}$ and $\xi$ a free parameter [36], while the continuum $\Delta E$ shape is modeled with a linear function. The $m_{\mathrm{ES}}$ PDFs for two of the $B \bar{B}$ background components are a Gaussian $\left(B \bar{B}_{1}\right)$ and the sum of two Gaussians ( $B \bar{B}_{2}$ ) while those for the $\Delta E$ PDFs are the sum of a Gaussian and a linear function $\left(B \bar{B}_{1}\right.$ and $B \bar{B}_{2}$ ). The $B \bar{B}_{3}$ background category has the same functional forms as continuum in both $m_{\mathrm{ES}}$ and $\Delta E$, and discrimination between these categories is provided only by $N N_{\text {out }}^{\prime}$. We use one-dimensional histograms to describe all $N N_{\text {out }}^{\prime}$ distributions. These are obtained from MC samples for signal and the $B \bar{B}$ background categories, and, for the continuum background, from a combination of off-resonance data and on-resonance data in a continuum-dominated sideband of $m_{\mathrm{ES}}$ and $\Delta E$.

The free parameters of our fit are the signal and continuum yields, together with the $\xi$ parameter of the continuum $m_{\mathrm{ES}}$ shape and the slope of the continuum $\Delta E$ shape. All shape parameters and yields of the three $B \bar{B}$ background categories are fixed according to the MC expectations. All $N N_{\text {out }}^{\prime}$ shapes are fixed.

We test the fitting procedure by applying it to ensembles of simulated experiments where events are drawn from the PDF shapes as described above for all five categories of events. We repeat the exercise with $q \bar{q}$ events alone drawn from the PDF into which we embed signal and $B \bar{B}$ background events randomly extracted from the MC samples. We find negligible bias on the fitted signal yield in either case.

Using the fit described above to the 16143 candidate events, we find $429 \pm 43$ signal events and $14850 \pm 129$ $q \bar{q}$ background events. The results of the fit are shown in Fig. 1. Both the $m_{\mathrm{ES}}$ and $\Delta E$ distributions show clear signal

FIG. 1. Projections of candidate events onto (a) $m_{\mathrm{ES}}$ and (b) $\Delta E$ following a signal enhancing cut on the likelihood ratio calculated without the plotted variable. Points show the data, dark filled histograms show the $q \bar{q}$ background and light filled histograms show the $B \bar{B}$ background component.


FIG. 2. Efficiency-corrected Dalitz plot distribution of $B^{+} \rightarrow$ $K^{+} K^{-} \pi^{+}$decays, obtained with the ${ }_{s} \mathcal{P}$ lot technique [37]. Empty regions correspond to charm and charmonia vetoes while the area of the boxes is proportional to the number of events in that bin.
peaks. The statistical significance of the signal yield, calculated from the change in negative log likelihood with signal yield floated compared to that with signal yield fixed to zero is $12.6 \sigma$.

We obtain the inclusive branching fraction of $B^{+} \rightarrow$ $K^{+} K^{-} \pi^{+}$using the result of the fit to calculate signal probabilities for each candidate event [37]. These are divided by event-by-event efficiencies, that take the DP position dependence into account, and summed to obtain an efficiency-corrected signal yield. We further correct for the effect of the charm and charmonia vetoes, and divide by the total number of $B \bar{B}$ events in the data sample. The result is $\mathcal{B}\left(B^{+} \rightarrow K^{+} K^{-} \pi^{+}\right)=(5.0 \pm 0.5 \pm 0.5) \times$ $10^{-6}$, where the first error is statistical and the second is systematic. The systematic error arises due to uncertainties in the PDF shapes ( $2.8 \%$ ) including possible data-MC differences in the signal PDF shapes studied using a control sample of $B^{+} \rightarrow \bar{D}^{0} \pi^{+}, \bar{D}^{0} \rightarrow K^{+} \pi^{-}$; potential fit biases, dominated by the change in the result when the yields of the $B \bar{B}$ background components are floated ( $6.1 \%$ ); uncer-
tainties in the efficiency, due to tracking ( $2.4 \%$ ) and PID ( $4.2 \%$ ); uncertainty in the correction due to vetoes, arising from the nonuniform DP structure of the signal, and estimated from MC simulations with different resonant contributions ( $6.1 \%$ ); and the error in the number of $B \bar{B}$ pairs $(1.1 \%)$. The significance of the signal including systematic uncertainties is found to be $9.6 \sigma$ from the change in negative log likelihood with and without the signal component, while varying those sources of uncertainty that affect the signal yield (PDF shapes and yields of $B \bar{B}$ background components).

We also extract the direct $C P$ asymmetry in the inclusive signal yield by separately fitting $B^{-}$and $B^{+}$samples. The asymmetry is obtained using $\mathcal{A}_{C P}=\frac{N^{-}-N^{+}}{N^{-}+N^{+}}$where $N^{-}$ $\left(N^{+}\right)$is the fitted signal yield in the $B^{-}\left(B^{+}\right)$sample, corrected for efficiency and veto requirements. We find $\mathcal{A}_{C P}=0.00 \pm 0.10 \pm 0.03$, where the first error is statistical and the second systematic, including uncertainties in the $B \bar{B}$ background estimation (0.02) and possible detector asymmetry (0.02). Other possible sources of systematic error are found to be negligible.

The efficiency-corrected Dalitz plot for signal decays, obtained using event-by-event signal probabilities, is shown in Fig. 2. We have checked that this technique correctly reconstructs the signal DP distribution using MC simulations in which the $B^{+} \rightarrow K^{+} K^{-} \pi^{+}$events contain different structures. In the data, we see an excess of events at low $K^{-} \pi^{+}$invariant mass, and a large enhancement due to a broad structure at low $K^{+} K^{-}$invariant mass. To further clarify these structures, we show in Fig. 3 the respective invariant mass projections following requirements that remove low mass combinations on the other axis of the Dalitz plane. Approximately half of our signal events appear to originate from the structure at low $K^{+} K^{-}$invariant mass. We have studied the Dalitz plot distributions of the backgrounds, which are found to be consistent with expectations, and do not contain any structures that may explain the peak in the $K^{+} K^{-}$invariant mass distribution. Further interpretation of this structure


FIG. 3. Efficiency-corrected distributions of the $B^{+} \rightarrow K^{+} K^{-} \pi^{+}$signal candidates: (a) $m_{K^{-}} \pi^{+}$with $m_{K^{+} K^{-}}>2.0 \mathrm{GeV} / c^{2}$ and (b) $m_{K^{+} K^{-}}$with $m_{K^{-}} \pi^{+}>1.5 \mathrm{GeV} / c^{2}$. These projection plots are obtained with the ${ }_{s} \mathcal{P}$ lot technique [37].
and the rest of the $B^{+} \rightarrow K^{+} K^{-} \pi^{+}$Dalitz plot requires an amplitude analysis.

In summary, we have made the first measurement of the charmless hadronic $B$ decay branching fraction $\mathcal{B}\left(B^{+} \rightarrow\right.$ $\left.K^{+} K^{-} \pi^{+}\right)=[5.0 \pm 0.5($ stat $) \pm 0.5($ syst $)] \times 10^{-6}$. The $C P$ asymmetry is found to be consistent with zero. Inspection of the Dalitz plot of signal candidates shows a broad structure peaking near $1.5 \mathrm{GeV} / c^{2}$ in the $K^{+} K^{-}$ invariant mass distribution that is reminiscent of similar structures seen in other charmless multibody hadronic $B$ decays $[6-8,38]$. This is likely to be of great interest for the understanding of low energy hadronic bound states [14].

We are grateful for the excellent luminosity and machine conditions provided by our PEP-II colleagues, and for the substantial dedicated effort from the computing organizations that support $B A B A R$. The collaborating institutions wish to thank SLAC for its support and kind hospitality. This work is supported by DOE and NSF (USA), NSERC (Canada), CEA and CNRS-IN2P3 (France), BMBF and DFG (Germany), INFN (Italy), FOM (The Netherlands), NFR (Norway), MES (Russia), MEC (Spain), and STFC (United Kingdom). Individuals have received support from the Marie Curie EIF (European Union) and the A. P. Sloan Foundation.
*Deceased.
${ }^{\dagger}$ 'Present address: Tel Aviv University, Tel Aviv, 69978, Israel.
${ }^{\ddagger}$ Also with Università di Perugia, Dipartimento di Fisica, Perugia, Italy.
${ }^{\text {§ }}$ Also with Università della Basilicata, Potenza, Italy.
"Also with Universitat de Barcelona, Facultat de Fisica, Departament ECM, E-08028 Barcelona, Spain.
[1] B. Aubert et al. (BABAR Collaboration), Phys. Rev. Lett. 97, 171805 (2006).
[2] S. W. Lin et al. (Belle Collaboration), Phys. Rev. Lett. 98, 181804 (2007).
[3] A. Drutskoy et al. (Belle Collaboration), Phys. Lett. B 542, 171 (2002).
[4] P. Krokovny et al. (Belle Collaboration), Phys. Rev. Lett. 89, 231804 (2002).
[5] B. Aubert et al. (BABAR Collaboration), Phys. Rev. Lett. 98, 081801 (2007).
[6] A. Garmash et al. (Belle Collaboration), Phys. Rev. D 71, 092003 (2005).
[7] B. Aubert et al. (BABAR Collaboration), Phys. Rev. D 74, 032003 (2006).
[8] B. Aubert et al. (BABAR Collaboration), Phys. Rev. Lett. 99, 161802 (2007).
[9] P. Minkowski and W. Ochs, Eur. Phys. J. C 39, 71 (2005).
[10] A. Furman, R. Kaminski, L. Lesniak, and B. Loiseau, Phys. Lett. B 622, 207 (2005).
[11] H. Y. Cheng, C. K. Chua, and K. C. Yang, Phys. Rev. D 73, 014017 (2006).
[12] W. Wang, Y. L. Shen, Y. Li, and C. D. Lu, Phys. Rev. D 74, 114010 (2006).
[13] H. Y. Cheng, C. K. Chua, and A. Soni, Phys. Rev. D 76, 094006 (2007).
[14] E. Klempt and A. Zaitsev, arXiv:0708.4016.
[15] B. Aubert et al. (BABAR Collaboration), Phys. Rev. Lett. 91, 051801 (2003).
[16] B. Aubert et al. (BABAR Collaboration), Phys. Rev. D 74, 011102 (2006).
[17] B. Aubert et al. (BABAR Collaboration), Phys. Rev. D 76, 071103 (2007).
[18] Y. Grossman, Z. Ligeti, Y. Nir, and H. Quinn, Phys. Rev. D 68, 015004 (2003); G. Engelhard, Y. Nir, and G. Raz, Phys. Rev. D 72, 075013 (2005); G. Engelhard and G. Raz, Phys. Rev. D 72, 114017 (2005).
[19] C. W. Chiang, M. Gronau, Z. Luo, J. L. Rosner, and D. A. Suprun, Phys. Rev. D 69, 034001 (2004).
[20] D. S. Du, H. J. Gong, J.F. Sun, D. S. Yang, and G. H. Zhu, Phys. Rev. D 65, 094025 (2002); 66, 079904(E) (2002).
[21] M. Beneke and M. Neubert, Nucl. Phys. B 675, 333 (2003).
[22] S. Bar-Shalom, G. Eilam, and Y. D. Yang, Phys. Rev. D 67, 014007 (2003).
[23] A. K. Giri and R. Mohanta, Phys. Lett. B 594, 196 (2004).
[24] L. Guo, Q. G. Xu, and Z. J. Xiao, Phys. Rev. D 75, 014019 (2007).
[25] A. Ali, G. Kramer, and C. D. Lu, Phys. Rev. D 58, 094009 (1998).
[26] R. Fleischer and S. Recksiegel, Phys. Rev. D 71, 051501 (2005).
[27] Inclusion of the charge conjugate mode is implied except where explicitly stated otherwise.
[28] PEP-II Conceptual Design Report, SLAC Report No. SLAC-R-418, 1993.
[29] B. Aubert et al. (BABAR Collaboration), Phys. Rev. D 67, 032002 (2003).
[30] B. Aubert et al. (BABAR Collaboration), Nucl. Instrum. Methods Phys. Res., Sect. A 479, 1 (2002).
[31] A. Höcker et al., arXiv:physics/0703039.
[32] B. Aubert et al. (BABAR Collaboration), Phys. Rev. Lett. 89, 201802 (2002).
[33] W.M. Yao et al. (Particle Data Group), J. Phys. G 33, 1 (2006).
[34] E. Barberio et al. (Heavy Flavor Averaging Group (HFAG)), arXiv:0704.3575. Online update at http:// www.slac.stanford.edu/xorg/hfag.
[35] M. J. Oreglia, Ph.D. thesis, [SLAC Report No. SLAC-236, 1980, Appendix D]; J.E. Gaiser, Ph.D. thesis, [SLAC Report No. SLAC-255, 1982, Appendix F]; T. Skwarnicki, Ph.D. thesis, DESY [DESY Report No. F31-8602, 1986, Appendix E].
[36] H. Albrecht et al. (ARGUS Collaboration), Phys. Lett. B 241, 278 (1990).
[37] M. Pivk and F. R. Le Diberder, Nucl. Instrum. Methods Phys. Res., Sect. A 555, 356 (2005).
[38] B. Aubert et al. (BABAR Collaboration), Phys. Rev. D 72, 072003 (2005); 74, 099903(E) (2006)].

