

PDF hosted at the Radboud Repository of the Radboud University Nijmegen

The following full text is a publisher's version.

For additional information about this publication click this link.

<http://hdl.handle.net/2066/128823>

Please be advised that this information was generated on 2021-06-14 and may be subject to change.

Measurement of Time-Dependent CP -Violating Asymmetries in $B^0 \rightarrow K^{*0} \gamma (K^{*0} \rightarrow K_S^0 \pi^0)$ Decays

B. Aubert,¹ R. Barate,¹ D. Boutigny,¹ F. Couderc,¹ J.-M. Gaillard,¹ A. Hicheur,¹ Y. Karyotakis,¹ J. P. Lees,¹ V. Tisserand,¹ A. Zghiche,¹ A. Palano,² A. Pompili,² J. C. Chen,³ N. D. Qi,³ G. Rong,³ P. Wang,³ Y. S. Zhu,³ G. Eigen,⁴ I. Ofte,⁴ B. Stugu,⁴ G. S. Abrams,⁵ A. W. Borgland,⁵ A. B. Breon,⁵ D. N. Brown,⁵ J. Button-Shafer,⁵ R. N. Cahn,⁵ E. Charles,⁵ C. T. Day,⁵ M. S. Gill,⁵ A. V. Gritsan,⁵ Y. Groysman,⁵ R. G. Jacobsen,⁵ R. W. Kadel,⁵ J. Kadyk,⁵ L. T. Kerth,⁵ Yu. G. Kolomensky,⁵ G. Kukartsev,⁵ G. Lynch,⁵ L. M. Mir,⁵ P. J. Oddone,⁵ T. J. Orimoto,⁵ M. Pripstein,⁵ N. A. Roe,⁵ M. T. Ronan,⁵ V. G. Shelkov,⁵ W. A. Wenzel,⁵ M. Barrett,⁶ K. E. Ford,⁶ T. J. Harrison,⁶ A. J. Hart,⁶ C. M. Hawkes,⁶ S. E. Morgan,⁶ A. T. Watson,⁶ M. Fritsch,⁷ K. Goetzen,⁷ T. Held,⁷ H. Koch,⁷ B. Lewandowski,⁷ M. Pelizaeus,⁷ M. Steinke,⁷ J. T. Boyd,⁸ N. Chevalier,⁸ W. N. Cottingham,⁸ M. P. Kelly,⁸ T. E. Latham,⁸ F. F. Wilson,⁸ T. Cuhadar-Donszelmann,⁹ C. Hearty,⁹ N. S. Knecht,⁹ T. S. Mattison,⁹ J. A. McKenna,⁹ D. Thiessen,⁹ A. Khan,¹⁰ P. Kyberd,¹⁰ L. Teodorescu,¹⁰ A. E. Blinov,¹¹ V. E. Blinov,¹¹ V. P. Druzhinin,¹¹ V. B. Golubev,¹¹ V. N. Ivanchenko,¹¹ E. A. Kravchenko,¹¹ A. P. Onuchin,¹¹ S. I. Serednyakov,¹¹ Yu. I. Skovpen,¹¹ E. P. Solodov,¹¹ A. N. Yushkov,¹¹ D. Best,¹² M. Bruinsma,¹² M. Chao,¹² I. Eschrich,¹² D. Kirkby,¹² A. J. Lankford,¹² M. Mandelkern,¹² R. K. Mommsen,¹² W. Roethel,¹² D. P. Stoker,¹² C. Buchanan,¹³ B. L. Hartfiel,¹³ S. D. Foulkes,¹⁴ J. W. Gary,¹⁴ B. C. Shen,¹⁴ K. Wang,¹⁴ D. del Re,¹⁵ H. K. Hadavand,¹⁵ E. J. Hill,¹⁵ D. B. MacFarlane,¹⁵ H. P. Paar,¹⁵ Sh. Rahatlou,¹⁵ V. Sharma,¹⁵ J. W. Berryhill,¹⁶ C. Campagnari,¹⁶ B. Dahmes,¹⁶ S. L. Levy,¹⁶ O. Long,¹⁶ A. Lu,¹⁶ M. A. Mazur,¹⁶ J. D. Richman,¹⁶ W. Verkerke,¹⁶ T. W. Beck,¹⁷ A. M. Eisner,¹⁷ C. A. Heusch,¹⁷ W. S. Lockman,¹⁷ G. Nesom,¹⁷ T. Schalk,¹⁷ R. E. Schmitz,¹⁷ B. A. Schumm,¹⁷ A. Seiden,¹⁷ P. Spradlin,¹⁷ D. C. Williams,¹⁷ M. G. Wilson,¹⁷ J. Albert,¹⁸ E. Chen,¹⁸ G. P. Dubois-Felsmann,¹⁸ A. Dvoretzki,¹⁸ D. G. Hitlin,¹⁸ I. Narsky,¹⁸ T. Piatenko,¹⁸ F. C. Porter,¹⁸ A. Ryd,¹⁸ A. Samuel,¹⁸ S. Yang,¹⁸ S. Jayatilake,¹⁹ G. Mancinelli,¹⁹ B. T. Meadows,¹⁹ M. D. Sokoloff,¹⁹ T. Abe,²⁰ F. Blanc,²⁰ P. Bloom,²⁰ S. Chen,²⁰ W. T. Ford,²⁰ U. Nauenberg,²⁰ A. Olivas,²⁰ P. Rankin,²⁰ J. G. Smith,²⁰ J. Zhang,²⁰ L. Zhang,²⁰ A. Chen,²¹ J. L. Harton,²¹ A. Soffer,²¹ W. H. Toki,²¹ R. J. Wilson,²¹ Q. L. Zeng,²¹ D. Altenburg,²² T. Brandt,²² J. Brose,²² M. Dickopp,²² E. Feltresi,²² A. Hauke,²² H. M. Lacker,²² R. Müller-Pfefferkorn,²² R. Nogowski,²² S. Otto,²² A. Petzold,²² J. Schubert,²² K. R. Schubert,²² R. Schwierz,²² B. Spaan,²² J. E. Sundermann,²² D. Bernard,²³ G. R. Bonneaud,²³ F. Brochard,²³ P. Grenier,²³ S. Schrenk,²³ Ch. Thiebaux,²³ G. Vasileiadis,²³ M. Verderi,²³ D. J. Bard,²⁴ P. J. Clark,²⁴ D. Lavin,²⁴ F. Muheim,²⁴ S. Playfer,²⁴ Y. Xie,²⁴ M. Andreotti,²⁵ V. Azzolini,²⁵ D. Bettoni,²⁵ C. Bozzi,²⁵ R. Calabrese,²⁵ G. Cibinetto,²⁵ E. Luppi,²⁵ M. Negrini,²⁵ L. Piemontese,²⁵ A. Sarti,²⁵ E. Treadwell,²⁶ R. Baldini-Ferrolli,²⁷ A. Calcaterra,²⁷ R. de Sangro,²⁷ G. Finocchiaro,²⁷ P. Patteri,²⁷ M. Piccolo,²⁷ A. Zallo,²⁷ A. Buzzo,²⁸ R. Capra,²⁸ R. Contri,²⁸ G. Crosetti,²⁸ M. Lo Vetere,²⁸ M. Macri,²⁸ M. R. Monge,²⁸ S. Passaggio,²⁸ C. Patrignani,²⁸ E. Robutti,²⁸ A. Santroni,²⁸ S. Tosi,²⁸ S. Bailey,²⁹ G. Brandenburg,²⁹ M. Morii,²⁹ E. Won,²⁹ R. S. Dubitzky,³⁰ U. Langenegger,³⁰ W. Bhimji,³¹ D. A. Bowerman,³¹ P. D. Dauncey,³¹ U. Egede,³¹ J. R. Gaillard,³¹ G. W. Morton,³¹ J. A. Nash,³¹ M. B. Nikolich,³¹ G. P. Taylor,³¹ M. J. Charles,³² G. J. Grenier,³² U. Mallik,³² J. Cochran,³³ H. B. Crawley,³³ J. Lamsa,³³ W. T. Meyer,³³ S. Prell,³³ E. I. Rosenberg,³³ J. Yi,³³ M. Davier,³⁴ G. Grosdidier,³⁴ A. Höcker,³⁴ S. Laplace,³⁴ F. Le Diberder,³⁴ V. Lepeltier,³⁴ A. M. Lutz,³⁴ T. C. Petersen,³⁴ S. Plaszczynski,³⁴ M. H. Schune,³⁴ L. Tantot,³⁴ G. Wormser,³⁴ C. H. Cheng,³⁵ D. J. Lange,³⁵ M. C. Simani,³⁵ D. M. Wright,³⁵ A. J. Bevan,³⁶ C. A. Chavez,³⁶ J. P. Coleman,³⁶ I. J. Forster,³⁶ J. R. Fry,³⁶ E. Gabathuler,³⁶ R. Gamet,³⁶ R. J. Parry,³⁶ D. J. Payne,³⁶ R. J. Sloane,³⁶ C. Touramanis,³⁶ J. J. Back,^{37,*} C. M. Cormack,³⁷ P. F. Harrison,^{37,*} F. Di Lodovico,³⁷ G. B. Mohanty,^{37,*} C. L. Brown,³⁸ G. Cowan,³⁸ R. L. Flack,³⁸ H. U. Flaecher,³⁸ M. G. Green,³⁸ P. S. Jackson,³⁸ T. R. McMahon,³⁸ S. Ricciardi,³⁸ F. Salvatore,³⁸ M. A. Winter,³⁸ D. Brown,³⁹ C. L. Davis,³⁹ J. Allison,⁴⁰ N. R. Barlow,⁴⁰ R. J. Barlow,⁴⁰ M. C. Hodgkinson,⁴⁰ G. D. Lafferty,⁴⁰ A. J. Lyon,⁴⁰ J. C. Williams,⁴⁰ A. Farbin,⁴¹ W. D. Hulsbergen,⁴¹ A. Jawahery,⁴¹ D. Kovalskyi,⁴¹ C. K. Lae,⁴¹ V. Lillard,⁴¹ D. A. Roberts,⁴¹ G. Blaylock,⁴² C. Dallapiccola,⁴² K. T. Flood,⁴² S. S. Hertzbach,⁴² R. Kofler,⁴² V. B. Koptchev,⁴² T. B. Moore,⁴² S. Saremi,⁴² H. Staengle,⁴² S. Willocq,⁴² R. Cowan,⁴³ G. Sciolla,⁴³ F. Taylor,⁴³ R. K. Yamamoto,⁴³ D. J. J. Mangeol,⁴⁴ P. M. Patel,⁴⁴ S. H. Robertson,⁴⁴ A. Lazzaro,⁴⁵ F. Palombo,⁴⁵ J. M. Bauer,⁴⁶ L. Cremaldi,⁴⁶ V. Eschenburg,⁴⁶ R. Godang,⁴⁶ R. Kroeger,⁴⁶ J. Reidy,⁴⁶ D. A. Sanders,⁴⁶ D. J. Summers,⁴⁶ H. W. Zhao,⁴⁶ S. Brunet,⁴⁷ D. Côté,⁴⁷ P. Taras,⁴⁷ H. Nicholson,⁴⁸ F. Fabozzi,^{49,†} C. Gatto,⁴⁹ L. Lista,⁴⁹ D. Monorchio,⁴⁹ P. Paolucci,⁴⁹ D. Piccolo,⁴⁹ C. Sciacca,⁴⁹ M. Baak,⁵⁰ H. Bulten,⁵⁰ G. Raven,⁵⁰ H. L. Snoek,⁵⁰ L. Wilden,⁵⁰ C. P. Jessop,⁵¹ J. M. LoSecco,⁵¹ T. A. Gabriel,⁵² T. Allmendinger,⁵³ B. Brau,⁵³ K. K. Gan,⁵³ K. Honscheid,⁵³ D. Hufnagel,⁵³ H. Kagan,⁵³ R. Kass,⁵³ T. Pulliam,⁵³ A. M. Rahimi,⁵³ R. Ter-Antonyan,⁵³ Q. K. Wong,⁵³ J. Brau,⁵⁴

R. Frey,⁵⁴ O. Igonkina,⁵⁴ C. T. Potter,⁵⁴ N. B. Sinev,⁵⁴ D. Strom,⁵⁴ E. Torrence,⁵⁴ F. Colecchia,⁵⁵ A. Dorigo,⁵⁵ F. Galeazzi,⁵⁵ M. Margoni,⁵⁵ M. Morandin,⁵⁵ M. Posocco,⁵⁵ M. Rotondo,⁵⁵ F. Simonetto,⁵⁵ R. Stroili,⁵⁵ G. Tiozzo,⁵⁵ C. Voci,⁵⁵ M. Benayoun,⁵⁶ H. Briand,⁵⁶ J. Chauveau,⁵⁶ P. David,⁵⁶ Ch. de la Vaissière,⁵⁶ L. Del Buono,⁵⁶ O. Hamon,⁵⁶ M. J. J. John,⁵⁶ Ph. Leruste,⁵⁶ J. Malcles,⁵⁶ J. Ocariz,⁵⁶ M. Pivk,⁵⁶ L. Roos,⁵⁶ S. T'Jampens,⁵⁶ G. Therin,⁵⁶ P. F. Manfredi,⁵⁷ V. Re,⁵⁷ P. K. Behera,⁵⁸ L. Gladney,⁵⁸ Q. H. Guo,⁵⁸ J. Panetta,⁵⁸ F. Anulli,^{27,59} M. Biasini,⁵⁹ I. M. Peruzzi,^{27,59} M. Pioppi,⁵⁹ C. Angelini,⁶⁰ G. Batignani,⁶⁰ S. Bettarini,⁶⁰ M. Bondioli,⁶⁰ F. Bucci,⁶⁰ G. Calderini,⁶⁰ M. Carpinelli,⁶⁰ F. Forti,⁶⁰ M. A. Giorgi,⁶⁰ A. Lusiani,⁶⁰ G. Marchiori,⁶⁰ F. Martinez-Vidal,⁶⁰ M. Morganti,^{60,‡} N. Neri,⁶⁰ E. Paoloni,⁶⁰ M. Rama,⁶⁰ G. Rizzo,⁶⁰ F. Sandrelli,⁶⁰ J. Walsh,⁶⁰ M. Haire,⁶¹ D. Judd,⁶¹ K. Paick,⁶¹ D. E. Wagoner,⁶¹ N. Danielson,⁶² P. Elmer,⁶² Y. P. Lau,⁶² C. Lu,⁶² V. Miftakov,⁶² J. Olsen,⁶² A. J. S. Smith,⁶² A. V. Telnov,⁶² F. Bellini,⁶³ G. Cavoto,^{62,63} R. Faccini,⁶³ F. Ferrarotto,⁶³ F. Ferroni,⁶³ M. Gaspero,⁶³ L. Li Gioi,⁶³ M. A. Mazzoni,⁶³ S. Morganti,⁶³ M. Pierini,⁶³ G. Piredda,⁶³ F. Safai Tehrani,⁶³ C. Voena,⁶³ S. Christ,⁶⁴ G. Wagner,⁶⁴ R. Waldi,⁶⁴ T. Adye,⁶⁵ N. De Groot,⁶⁵ B. Franek,⁶⁵ N. I. Geddes,⁶⁵ G. P. Gopal,⁶⁵ E. O. Olaiya,⁶⁵ R. Aleksan,⁶⁶ S. Emery,⁶⁶ A. Gaidot,⁶⁶ S. F. Ganzhur,⁶⁶ P.-F. Giraud,⁶⁶ G. Hamel de Monchenault,⁶⁶ W. Kozanecki,⁶⁶ M. Langer,⁶⁶ M. Legendre,⁶⁶ G. W. London,⁶⁶ B. Mayer,⁶⁶ G. Schott,⁶⁶ G. Vasseur,⁶⁶ Ch. Yèche,⁶⁶ M. Zito,⁶⁶ M. V. Purohit,⁶⁷ A. W. Weidemann,⁶⁷ J. R. Wilson,⁶⁷ F. X. Yumiceva,⁶⁷ D. Aston,⁶⁸ R. Bartoldus,⁶⁸ N. Berger,⁶⁸ A. M. Boyarski,⁶⁸ O. L. Buchmueller,⁶⁸ R. Claus,⁶⁸ M. R. Convery,⁶⁸ M. Cristinziani,⁶⁸ G. De Nardo,⁶⁸ D. Dong,⁶⁸ J. Dorfan,⁶⁸ D. Dujmic,⁶⁸ W. Dunwoodie,⁶⁸ E. E. Elsen,⁶⁸ S. Fan,⁶⁸ R. C. Field,⁶⁸ T. Glanzman,⁶⁸ S. J. Gowdy,⁶⁸ T. Hadig,⁶⁸ V. Halyo,⁶⁸ C. Hast,⁶⁸ T. Hryn'ova,⁶⁸ W. R. Innes,⁶⁸ M. H. Kelsey,⁶⁸ P. Kim,⁶⁸ M. L. Kocian,⁶⁸ D. W. G. S. Leith,⁶⁸ J. Libby,⁶⁸ S. Luitz,⁶⁸ V. Luth,⁶⁸ H. L. Lynch,⁶⁸ H. Marsiske,⁶⁸ R. Messner,⁶⁸ D. R. Muller,⁶⁸ C. P. O'Grady,⁶⁸ V. E. Ozcan,⁶⁸ A. Perazzo,⁶⁸ M. Perl,⁶⁸ S. Petrak,⁶⁸ B. N. Ratcliff,⁶⁸ A. Roodman,⁶⁸ A. A. Salnikov,⁶⁸ R. H. Schindler,⁶⁸ J. Schwiening,⁶⁸ G. Simi,⁶⁸ A. Snyder,⁶⁸ A. Soha,⁶⁸ J. Stelzer,⁶⁸ D. Su,⁶⁸ M. K. Sullivan,⁶⁸ J. Va'vra,⁶⁸ S. R. Wagner,⁶⁸ M. Weaver,⁶⁸ A. J. R. Weinstein,⁶⁸ W. J. Wisniewski,⁶⁸ M. Wittgen,⁶⁸ D. H. Wright,⁶⁸ A. K. Yarritu,⁶⁸ C. C. Young,⁶⁸ P. R. Burchat,⁶⁹ A. J. Edwards,⁶⁹ T. I. Meyer,⁶⁹ B. A. Petersen,⁶⁹ C. Roat,⁶⁹ S. Ahmed,⁷⁰ M. S. Alam,⁷⁰ J. A. Ernst,⁷⁰ M. A. Saeed,⁷⁰ M. Saleem,⁷⁰ F. R. Wappler,⁷⁰ W. Bugg,⁷¹ M. Krishnamurthy,⁷¹ S. M. Spanier,⁷¹ R. Eckmann,⁷² H. Kim,⁷² J. L. Ritchie,⁷² A. Satpathy,⁷² R. F. Schwitters,⁷² J. M. Izen,⁷³ I. Kitayama,⁷³ X. C. Lou,⁷³ S. Ye,⁷³ F. Bianchi,⁷⁴ M. Bona,⁷⁴ F. Gallo,⁷⁴ D. Gamba,⁷⁴ C. Borean,⁷⁵ L. Bosisio,⁷⁵ C. Cartaro,⁷⁵ F. Cossutti,⁷⁵ G. Della Ricca,⁷⁵ S. Dittongo,⁷⁵ S. Grancagnolo,⁷⁵ L. Lanceri,⁷⁵ P. Poropat,^{75,§} L. Vitale,⁷⁵ G. Vuagnin,⁷⁵ R. S. Panvini,⁷⁶ Sw. Banerjee,⁷⁷ C. M. Brown,⁷⁷ D. Fortin,⁷⁷ P. D. Jackson,⁷⁷ R. Kowalewski,⁷⁷ J. M. Roney,⁷⁷ R. J. Sobie,⁷⁷ H. R. Band,⁷⁸ S. Dasu,⁷⁸ M. Datta,⁷⁸ A. M. Eichenbaum,⁷⁸ M. Graham,⁷⁸ J. J. Hollar,⁷⁸ J. R. Johnson,⁷⁸ P. E. Kutter,⁷⁸ H. Li,⁷⁸ R. Liu,⁷⁸ A. Mihalyi,⁷⁸ A. K. Mohapatra,⁷⁸ Y. Pan,⁷⁸ R. Prepost,⁷⁸ A. E. Rubin,⁷⁸ S. J. Sekula,⁷⁸ P. Tan,⁷⁸ J. H. von Wimmersperg-Toeller,⁷⁸ J. Wu,⁷⁸ S. L. Wu,⁷⁸ Z. Yu,⁷⁸ M. G. Greene,⁷⁹ and H. Neal⁷⁹

(The *BABAR* Collaboration)

¹Laboratoire de Physique des Particules, F-74941 Annecy-le-Vieux, France

²Università di Bari, Dipartimento di Fisica and INFN, I-70126 Bari, Italy

³Institute of High Energy Physics, Beijing 100039, China

⁴University of Bergen, Inst. of Physics, N-5007 Bergen, Norway

⁵Lawrence Berkeley National Laboratory and University of California, Berkeley, California 94720, USA

⁶University of Birmingham, Birmingham, B15 2TT, United Kingdom

⁷Ruhr Universität Bochum, Institut für Experimentalphysik 1, D-44780 Bochum, Germany

⁸University of Bristol, Bristol BS8 1TL, United Kingdom

⁹University of British Columbia, Vancouver, BC, Canada V6T 1Z1

¹⁰Brunel University, Uxbridge, Middlesex UB8 3PH, United Kingdom

¹¹Budker Institute of Nuclear Physics, Novosibirsk 630090, Russia

¹²University of California at Irvine, Irvine, California 92697, USA

¹³University of California at Los Angeles, Los Angeles, California 90024, USA

¹⁴University of California at Riverside, Riverside, California 92521, USA

¹⁵University of California at San Diego, La Jolla, California 92093, USA

¹⁶University of California at Santa Barbara, Santa Barbara, California 93106, USA

¹⁷University of California at Santa Cruz, Institute for Particle Physics, Santa Cruz, California 95064, USA

¹⁸California Institute of Technology, Pasadena, California 91125, USA

¹⁹University of Cincinnati, Cincinnati, Ohio 45221, USA

²⁰University of Colorado, Boulder, Colorado 80309, USA

²¹Colorado State University, Fort Collins, Colorado 80523, USA

- ²²*Technische Universität Dresden, Institut für Kern- und Teilchenphysik, D-01062 Dresden, Germany*
²³*Ecole Polytechnique, LLR, F-91128 Palaiseau, France*
²⁴*University of Edinburgh, Edinburgh EH9 3JZ, United Kingdom*
²⁵*Università di Ferrara, Dipartimento di Fisica and INFN, I-44100 Ferrara, Italy*
²⁶*Florida A&M University, Tallahassee, Florida 32307, USA*
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*
³¹*Imperial College London, London, SW7 2AZ, United Kingdom*
³²*University of Iowa, Iowa City, Iowa 52242, USA*
³³*Iowa State University, Ames, Iowa 50011-3160, USA*
³⁴*Laboratoire de l'Accélérateur Linéaire, F-91898 Orsay, France*
³⁵*Lawrence Livermore National Laboratory, Livermore, California 94550, USA*
³⁶*University of Liverpool, Liverpool L69 7ZE, United Kingdom*
³⁷*Queen Mary, University of London, E1 4NS, United Kingdom*
³⁸*University of London, Royal Holloway and Bedford New College, Egham, Surrey TW20 0EX, United Kingdom*
³⁹*University of Louisville, Louisville, Kentucky 40292, USA*
⁴⁰*University of Manchester, Manchester M13 9PL, United Kingdom*
⁴¹*University of Maryland, College Park, Maryland 20742, USA*
⁴²*University of Massachusetts, Amherst, Massachusetts 01003, USA*
⁴³*Massachusetts Institute of Technology, Laboratory for Nuclear Science, Cambridge, Massachusetts 02139, USA*
⁴⁴*McGill University, Montréal, QC, Canada H3A 2T8*
⁴⁵*Università di Milano, Dipartimento di Fisica and INFN, I-20133 Milano, Italy*
⁴⁶*University of Mississippi, University, Mississippi 38677, USA*
⁴⁷*Université de Montréal, Laboratoire René J. A. Lévesque, Montréal, QC, Canada H3C 3J7*
⁴⁸*Mount Holyoke College, South Hadley, Massachusetts 01075, USA*
⁴⁹*Università di Napoli Federico II, Dipartimento di Scienze Fisiche and INFN, I-80126, Napoli, Italy*
⁵⁰*NIKHEF, National Institute for Nuclear Physics and High Energy Physics, NL-1009 DB Amsterdam, The Netherlands*
⁵¹*University of Notre Dame, Notre Dame, Indiana 46556, USA*
⁵²*Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA*
⁵³*Ohio State University, Columbus, Ohio 43210, USA*
⁵⁴*University of Oregon, Eugene, Oregon 97403, USA*
⁵⁵*Università di Padova, Dipartimento di Fisica and INFN, I-35131 Padova, Italy*
⁵⁶*Universités Paris VI et VII, Laboratoire de Physique Nucléaire et de Hautes Energies, F-75252 Paris, France*
⁵⁷*Università di Pavia, Dipartimento di Elettronica and INFN, I-27100 Pavia, Italy*
⁵⁸*University of Pennsylvania, Philadelphia, Pennsylvania 19104, USA*
⁵⁹*Università di Perugia, Dipartimento di Fisica and INFN, I-06100 Perugia, Italy*
⁶⁰*Università di Pisa, Dipartimento di Fisica, Scuola Normale Superiore and INFN, I-56127 Pisa, Italy*
⁶¹*Prairie View A&M University, Prairie View, Texas 77446, USA*
⁶²*Princeton University, Princeton, New Jersey 08544, USA*
⁶³*Università di Roma La Sapienza, Dipartimento di Fisica and INFN, I-00185 Roma, Italy*
⁶⁴*Universität Rostock, D-18051 Rostock, Germany*
⁶⁵*Rutherford Appleton Laboratory, Chilton, Didcot, Oxon, OX11 0QX, United Kingdom*
⁶⁶*DSM/Dapnia, CEA/Saclay, F-91191 Gif-sur-Yvette, France*
⁶⁷*University of South Carolina, Columbia, South Carolina 29208, USA*
⁶⁸*Stanford Linear Accelerator Center, Stanford, California 94309, USA*
⁶⁹*Stanford University, Stanford, California 94305-4060, USA*
⁷⁰*State University of New York, Albany, New York 12222, USA*
⁷¹*University of Tennessee, Knoxville, Tennessee 37996, USA*
⁷²*University of Texas at Austin, Austin, Texas 78712, USA*
⁷³*University of Texas at Dallas, Richardson, Texas 75083, USA*
⁷⁴*Università di Torino, Dipartimento di Fisica Sperimentale and INFN, I-10125 Torino, Italy*
⁷⁵*Università di Trieste, Dipartimento di Fisica and INFN, I-34127 Trieste, Italy*
⁷⁶*Vanderbilt University, Nashville, Tennessee 37235, USA*
⁷⁷*University of Victoria, Victoria, BC, Canada V8W 3P6*
⁷⁸*University of Wisconsin, Madison, Wisconsin 53706, USA*
⁷⁹*Yale University, New Haven, Connecticut 06511, USA*

(Received 31 May 2004; published 8 November 2004)

We present a measurement of the time-dependent CP -violating asymmetries in $B^0 \rightarrow K^{*0}\gamma(K^{*0} \rightarrow K_S^0\pi^0)$ decays based on $124 \times 10^6 Y(4S) \rightarrow B\bar{B}$ decays collected with the $BABAR$ detector at the PEP-II asymmetric-energy B Factory at the Stanford Linear Accelerator Center. In a sample containing 105 ± 14 signal decays, we measure $S_{K^{*0}\gamma} = 0.25 \pm 0.63 \pm 0.14$ and $C_{K^{*0}\gamma} = -0.57 \pm 0.32 \pm 0.09$, where the first error is statistical and the second, systematic.

DOI: 10.1103/PhysRevLett.93.201801

PACS numbers: 13.20.He, 11.30.Er

The recent data [1] from the B factory experiments have provided strong evidence that the quark mixing mechanism in the standard model (SM), encapsulated in the Cabibbo-Kobayashi-Maskawa (CKM) matrix [2], is the dominant source of CP violation in the quark sector. Nonetheless, decays which originate from radiative loop processes, such as $b \rightarrow s\gamma$, may exhibit significant deviations from the SM due to new physics contributions. In this Letter we report the first measurement of time-dependent CP -violating (CPV) asymmetries in a $b \rightarrow s\gamma$ process through the exclusive decay $B^0 \rightarrow K^{*0}\gamma$, where $K^{*0} \rightarrow K_S^0\pi^0$ [3]. Atwood, Gronau, and Soni were the first to point out that such a measurement probes the polarization of the photon [4], which is dominantly left handed (right handed) for $b \rightarrow s\gamma$ ($\bar{b} \rightarrow \bar{s}\gamma$) in the SM but is mixed in various new physics scenarios. The exclusive decays $B^0 \rightarrow (K_S^0\pi^0)\gamma_R$ and $\bar{B}^0 \rightarrow (K_S^0\pi^0)\gamma_L$ are orthogonal transitions and are the dominant decays in the SM. Therefore the CPV asymmetry due to interference between decays with or without mixing is expected to be very small, $\approx 2(m_s/m_b)\sin 2\beta$, where m_s and m_b are the s -quark and b -quark masses and $\beta \equiv \arg(-V_{cd}V_{cb}^*/V_{td}V_{tb}^*)$. Any significant deviation would indicate phenomena beyond the SM.

The $B^0 \rightarrow K^{*0}\gamma$ decays have been previously explored by the CLEO [5], $BABAR$ [6], and Belle collaborations [7], who reported measurements of branching fractions and the direct CP and isospin asymmetries. The measurements reported in this Letter are based on $124 \times 10^6 Y(4S) \rightarrow B\bar{B}$ decays collected in 1999–2003 at the PEP-II e^+e^- collider at the Stanford Linear Accelerator Center with the $BABAR$ detector, which is fully described in Ref. [8]. For the extraction of the time dependence of $B^0 \rightarrow K^{*0}\gamma(K^{*0} \rightarrow K_S^0\pi^0)$ decays, we adopt an analysis approach that closely follows our recently published measurement of CPV asymmetries in the decay $B^0 \rightarrow K_S^0\pi^0$ [9]. There we established a technique of vertex reconstruction for B decay modes to final states containing a $K_S^0 \rightarrow \pi^+\pi^-$ decay and other neutral particles but no primary charged particles at the B decay vertex.

We search for $B^0 \rightarrow K^{*0}\gamma(K^{*0} \rightarrow K_S^0\pi^0)$ decays in hadronic events, which are selected based on charged particle multiplicity and event topology. We reconstruct $K_S^0 \rightarrow \pi^+\pi^-$ candidates from pairs of oppositely charged tracks, detected in the silicon vertex detector (SVT) and/or the central drift chamber (DCH). We require that these tracks originate from a vertex which is more than

0.3 cm from the primary vertex and that the resulting candidates have a $\pi^+\pi^-$ invariant mass between 487 and 508 MeV/ c^2 . We form $\pi^0 \rightarrow \gamma\gamma$ candidates from pairs of photon candidates in $BABAR$'s electromagnetic calorimeter (EMC) which are not associated with any charged tracks, carry a minimum energy of 30 MeV, and possess the expected lateral shower shape. We require that the $\gamma\gamma$ combination has an energy greater than 200 MeV and an invariant mass between 115 and 155 MeV/ c^2 . We reconstruct candidate $K^{*0} \rightarrow K_S^0\pi^0$ decays from $K_S^0\pi^0$ combinations with invariant mass in the range $0.8 < M(K_S^0\pi^0) < 1.0$ GeV/ c^2 . For photons originating from the B decay, we select clusters in the EMC which are isolated by 25 cm from all other energy deposits and are inconsistent with $\pi^0 \rightarrow \gamma\gamma$ or $\eta \rightarrow \gamma\gamma$ decays [6].

We identify $B^0 \rightarrow K^{*0}\gamma$ decays in $K^{*0}\gamma$ combinations using two nearly independent kinematic variables: the energy-substituted mass $m_{ES} = \sqrt{(s/2 + \mathbf{p}_i \cdot \mathbf{p}_B)^2/E_i^2 - p_B^2}$ and the energy difference $\Delta E = E_B^* - \sqrt{s}/2$. Here (E_i, \mathbf{p}_i) and (E_B, \mathbf{p}_B) are the four-vectors of the initial e^+e^- system and the B candidate, respectively, \sqrt{s} is the center-of-mass energy, and the asterisk denotes the center-of-mass (c.m.) frame. For signal decays, the m_{ES} distribution peaks near the B mass with a resolution of 3.5 MeV/ c^2 , and ΔE peaks near 0 MeV with a resolution of 50 MeV. Both m_{ES} and ΔE exhibit a low-side tail from energy leakage in the EMC. For the study of CPV asymmetries, we consider candidates within $5.2 < m_{ES} < 5.3$ GeV/ c^2 and $|\Delta E| < 300$ MeV, which includes the signal as well as a large ‘‘sideband’’ region for background estimation. When more than one candidate is found in an event, we select the combination with the π^0 mass closest to the nominal π^0 value, and if ambiguity persists, we select the combination with the K_S^0 mass closest to the nominal K_S^0 value.

The sample of candidate events selected by the above requirements contains significant background contributions from continuum $e^+e^- \rightarrow q\bar{q}$ [$q = (u, d, s, c)$], as well as random combinations from other B meson decays (mostly from other $b \rightarrow s\gamma$ decays [6]). We suppress both of these backgrounds by taking advantage of the expected angular distribution of the decay products of these processes. Angular momentum conservation restricts the K^{*0} meson in the $B^0 \rightarrow K^{*0}\gamma$ decay to transversely polarized states, which leads to an angular distribution of $\sin^2\theta_H$ for the decay products, where θ_H is the angle between the K_S^0 and the B meson directions in the K^{*0} rest frame.

Monte Carlo studies show that the background candidates peak near $\cos\theta_H = -1$. We require $\cos\theta_H > -0.6$, resulting in rejection of 68% of $B\bar{B}$ and 48% of continuum background candidates, while retaining 91% of the signal.

We exploit topological variables to further suppress the continuum backgrounds, which in the c.m. frame tend to retain the jet-like features of the $q\bar{q}$ fragmentation process, as opposed to spherical $B\bar{B}$ decays. In the c.m. system we calculate the angle θ_S^* between the sphericity axis of the B candidate and that of the remaining particles in the rest of the event. While $|\cos\theta_S^*|$ is highly peaked near 1 for continuum background, it is nearly uniformly distributed for $B\bar{B}$ events. We require $|\cos\theta_S^*| < 0.9$, eliminating 58% of the continuum events. We also employ an event-shape Fisher discriminant in the maximum-likelihood fit (described below) from which we extract the CPV measurements. This variable is defined as $\mathcal{F} = 0.53 - 0.60L_0 + 1.27L_2$, where $L_j \equiv \sum_{i \in \text{ROE}} |\mathbf{p}_i| |\cos\theta_i^*|^j$, \mathbf{p}_i^* is the momentum of particle i in the c.m. system, and θ_i^* is the angle between \mathbf{p}_i^* and the sphericity axis of the B candidate.

The above selections yield 1916 $B^0 \rightarrow K^{*0}\gamma$ ($K^{*0} \rightarrow K_S^0\pi^0$) candidates. We extract our measurements from this sample using an unbinned maximum-likelihood fit to kinematic (m_{ES} , ΔE , and K^{*0} mass), event shape (\mathcal{F}), flavor tag, and time-structure variables (described below). As input to the fit, we parameterize the probability distribution functions (PDF) describing the observables of signal and $B\bar{B}$ background events using either more copious fully-reconstructed B decays in data or simulated samples. For the continuum background, we select the functional form of the PDFs describing each fit variable in data using the sideband regions of the other observables where the $q\bar{q}$ background dominates. We include these regions in the fitted sample and simultaneously extract the parameters of the background PDFs along with the CPV measurements. We fit 105 ± 14 signal and 19 ± 15 other B decays in the selected sample. This signal yield is consistent with expectations from the previous measurements of the branching fractions [5–7]. Figure 1 displays the m_{ES} and $M_{K^{*0}}$ distributions for signal-enhanced sub-

samples of these events, selected using the PDFs employed in the fit (see below).

For each $B^0 \rightarrow K^{*0}\gamma$ candidate, we examine the remaining tracks and neutral particles in the event to determine if the other B in the event B_{tag} decayed as a B^0 or a \bar{B}^0 (flavor tag). Time-dependent CPV asymmetries are determined by reconstructing the distribution of the proper decay time difference $\Delta t \equiv t_{CP} - t_{\text{tag}}$. At the $Y(4S)$ resonance, the distribution of Δt follows

$$P_{\bar{B}^0}^{B^0}(\Delta t) = \frac{e^{-|\Delta t|/\tau}}{4\tau} \{1 \pm [S_f \sin(\Delta t \Delta m_d) - C_f \cos(\Delta t \Delta m_d)]\}, \quad (1)$$

where the upper (lower) sign corresponds to B_{tag} decaying as B^0 (\bar{B}^0), τ is the B^0 lifetime, Δm_d is the mixing frequency, and S_f and C_f are the magnitude of the mixing-induced and direct CPV asymmetries, respectively. As stated above, in the SM we expect $S_{K^{*0}\gamma} \approx 2(m_s/m_b)\sin 2\beta \approx 0.05$. We expect $C_{K^{*0}\gamma} = -A_{K^{*0}\gamma}$, the direct CP asymmetry measured in the self-tagging and more copious $B^0 \rightarrow K^{*0}\gamma$ ($K^{*0} \rightarrow K^+\pi^-$) decay.

We use a neural network to determine the flavor T of the B_{tag} meson from kinematic and particle identification information [10]. Each event is assigned to one of five mutually exclusive tagging categories, designed to combine flavor tags with similar performance and Δt resolution. We parameterize the performance of this algorithm in a data sample (B_{flav}) of fully-reconstructed $B^0 \rightarrow D^{(*)-}\pi^+/\rho^+/a_1^+$ decays. The average effective tagging efficiency obtained from this sample is $\mathcal{Q} = \sum_c \epsilon_S^c (1 - 2w^c)^2 = 0.288 \pm 0.005$, where ϵ_S^c and w^c are the efficiency and mistag probabilities, respectively, for events tagged in category c . In each tagging category, we extract the fraction of events ($\epsilon_{q\bar{q}}^c$) and the asymmetry in the rate of B^0 and \bar{B}^0 tags in the continuum background events in the fit to the data.

We compute the proper time difference Δt from the known boost of the e^+e^- system and the measured $\Delta z = z_{CP} - z_{\text{tag}}$, the difference between the reconstructed decay vertex positions of the $B^0 \rightarrow K^{*0}\gamma$ and B_{tag} candidate

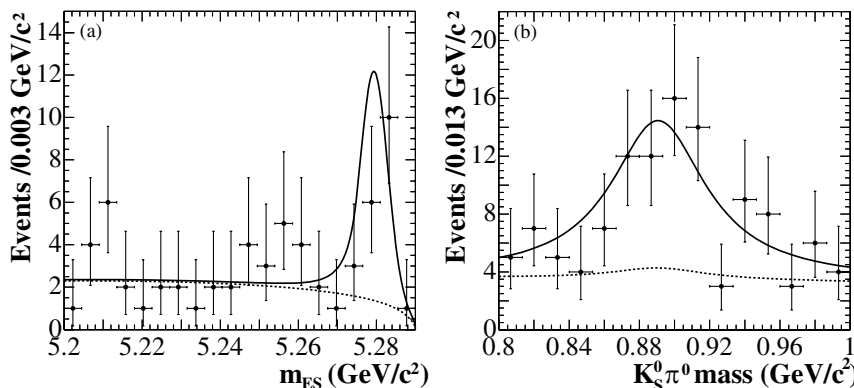


FIG. 1. Distribution of (a) m_{ES} and (b) $M_{K^{*0}}$ for events enhanced in signal decays. The dashed and solid curves represent the background and signal-plus-background contributions, respectively, as obtained from the maximum-likelihood fit to the full data sample. The selection technique is described in the text.

along the boost direction (z). A description of the inclusive reconstruction of the B_{tag} vertex using tracks in the rest of the event (ROE) is given in Ref. [10]. Replicating the vertexing technique developed for $B^0 \rightarrow K_S^0 \pi^0$ decays [9], we determine the decay point z_{CP} for $B^0 \rightarrow K^{*0} \gamma (K^{*0} \rightarrow K_S^0 \pi^0)$ candidates from the intersection of the K_S^0 trajectory with the interaction region. This is accomplished by constraining the B vertex to the interaction point (IP) in the plane transverse to the beam, which is determined in each run from the spatial distribution of vertices from two-track events. We combine the uncertainty in the IP position, which follows from the size of the interaction region (about $200 \mu\text{m}$ horizontal and $4 \mu\text{m}$ vertical), with the root mean square (RMS) of the transverse B flight length distribution (about $30 \mu\text{m}$) to assign an uncertainty to the IP constraint.

Simulation studies indicate that $B^0 \rightarrow K^{*0} \gamma (K^{*0} \rightarrow K_S^0 \pi^0)$ decays exhibit properties which are characteristic of the IP vertexing technique, namely, that the per-event estimate of the error on Δt , $\sigma_{\Delta t}$, reflects the expected dependence of the z_{CP} resolution on the K_S^0 flight direction and the number of SVT layers traversed by its decay daughters. Though the fit extracts $C_{K^* \gamma}$ from all flavor tagged signal decays, we only allow 68% of these events to contribute to the measurement of $S_{K^* \gamma}$. This subset consists of candidates which are composed of K_S^0 decays with at least one hit in the SVT on both tracks and pass the

quality requirements of $\sigma_{\Delta t} < 2.5 \text{ ps}$ and $|\Delta t| < 20 \text{ ps}$. For 66% of this subset, both tracks have hits in the inner three SVT layers, which results in a mean Δt resolution that is comparable to decays with the vertex directly reconstructed from charged particles originating at the B decay point [10]. In the remainder of the subset, the resolution is nearly 2 times worse.

We obtain the PDF for the time-dependence of signal decays from the convolution of Eq. (1) with a resolution function $\mathcal{R}(\delta t \equiv \Delta t - \Delta t_{\text{true}}, \sigma_{\Delta t})$. The resolution function is parameterized as the sum of a ‘‘core’’ and a ‘‘tail’’ Gaussian function, each with a width and mean proportional to the reconstructed $\sigma_{\Delta t}$, and a third Gaussian centered at zero with a fixed width of 8 ps [10]. Using simulated data, we have verified that the parameters of $\mathcal{R}(\delta t, \sigma_{\Delta t})$ for $B^0 \rightarrow K^{*0} \gamma$ decays and the $B\bar{B}$ backgrounds are similar to those obtained from the B_{flav} sample, even though the distributions of $\sigma_{\Delta t}$ differ considerably. Therefore, we extract these parameters from a fit to the B_{flav} sample. We find that the Δt distribution of continuum background candidates is well described by a delta function convoluted with a resolution function with the same functional form as used for signal events. We determine the parameters of the background function in the fit to the $B^0 \rightarrow K^{*0} \gamma (K^{*0} \rightarrow K_S^0 \pi^0)$ data set.

To extract the CPV asymmetries we maximize the logarithm of the likelihood function

$$\begin{aligned} \mathcal{L}(S_f, C_f, N_h, f_h, \epsilon_{q\bar{q}}^c, \vec{\alpha}) = & \frac{e^{-(N_S + N_{B\bar{B}} + N_{q\bar{q}})}}{(N_S + N_{B\bar{B}} + N_{q\bar{q}})!} \prod_{i \in \text{w}/\Delta t} [N_S f_S \epsilon_S^c \mathcal{P}_S(\vec{x}_i, \vec{y}_i; S_f, C_f) + N_{B\bar{B}} f_{B\bar{B}} \epsilon_{B\bar{B}}^c \mathcal{P}_{B\bar{B}}(\vec{x}_i, \vec{y}_i) \\ & + N_{q\bar{q}} f_{q\bar{q}} \epsilon_{q\bar{q}}^c \mathcal{P}_{q\bar{q}}(\vec{x}_i, \vec{y}_i; \vec{\alpha})] \prod_{i \in \text{w}/\Delta t} [N_S (1 - f_S) \epsilon_S^c \mathcal{P}'_S(\vec{y}_i; C_f) + N_{B\bar{B}} (1 - f_{B\bar{B}}) \epsilon_{B\bar{B}}^c \mathcal{P}'_{B\bar{B}}(\vec{y}_i) \\ & + N_{q\bar{q}} (1 - f_{q\bar{q}}) \epsilon_{q\bar{q}}^c \mathcal{P}'_{q\bar{q}}(\vec{y}_i; \vec{\alpha})], \end{aligned}$$

where the second (third) factor on the right hand side is the contribution from events with (without) Δt information. The vectors \vec{x}_i and \vec{y}_i represent the time-structure and remaining observables, respectively, for event i . The PDFs

$$\begin{aligned} \mathcal{P}_h(\vec{x}_i, \vec{y}_i) = & P_h(m_{\text{ES},i}) P_h(\Delta E_i) P_h(\mathcal{F}_i) P_h(M_{K^{*0},i}) \\ & \times P_h^c(\Delta t_i | \sigma_{\Delta t,i}, T_i) \end{aligned}$$

and

$$\mathcal{P}'_h(\vec{y}_i) = P_h(m_{\text{ES},i}) P_h(\Delta E_i) P_h(\mathcal{F}_i) P_h(M_{K^{*0},i}) P_h^c(T_i)$$

are the products of the PDFs described above for hypothesis h of signal (S), $B\bar{B}$ background ($B\bar{B}$), and continuum background ($q\bar{q}$). Along with the CPV asymmetries S_f and C_f , the fit extracts the yields N_S , $N_{B\bar{B}}$, and $N_{q\bar{q}}$, the fractions of events with Δt information f_S and $f_{q\bar{q}}$, and the parameters $\vec{\alpha}$ which describe the background PDFs. We determine ϵ_B^c and $f_{B\bar{B}}$ in simulated $B\bar{B}$ decays to all final states.

The fit to the data sample yields $S_{K^* \gamma} = 0.25 \pm 0.63 \pm 0.14$ and $C_{K^* \gamma} = -0.57 \pm 0.32 \pm 0.09$, where the uncertainties are statistical and systematic, respectively. The fit reports a correlation of 1% between these parameters. The systematic uncertainties are described below. The result for $C_{K^* \gamma}$ is consistent with a fit that does not employ Δt information. Since the present measurements of $A_{K^{*0} \gamma}$ [6,7] are consistent with zero, we also fit the data sample with $C_{K^* \gamma}$ fixed to zero and obtain $S_{K^* \gamma} = 0.25 \pm 0.65 \pm 0.14$.

The event selection criteria employed to isolate signal-enhanced samples displayed in Fig. 1 are based on a cut on the likelihood ratio $R = \mathcal{P}_S / (\mathcal{P}_S + \mathcal{P}_{B\bar{B}} + \mathcal{P}_{q\bar{q}})$ calculated without the displayed observable. The dashed and solid curves indicate background and signal-plus-background contributions, respectively, as obtained from the fit but corrected for the selection efficiency of R . Figure 2 shows distributions of Δt for B^0 - and \bar{B}^0 -tagged events, and the asymmetry

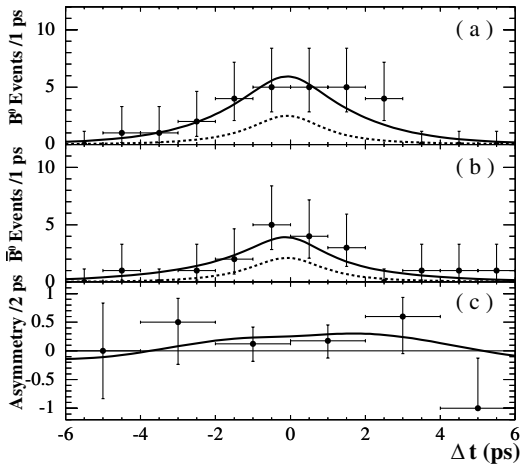


FIG. 2. Distributions of Δt for events enhanced in signal decays with B_{tag} tagged as (a) B^0 or (b) \bar{B}^0 , and (c) the resulting asymmetry $\mathcal{A}_{K^*0,\gamma}(\Delta t)$. The dashed and solid curves represent the fitted background and signal-plus-background contributions, respectively, as obtained from the maximum-likelihood fit. The raw asymmetry projection corresponds to approximately 38 signal and 19 background events.

$\mathcal{A}_{K^*0,\gamma}(\Delta t) = [N_{B^0} - N_{\bar{B}^0}]/[N_{B^0} + N_{\bar{B}^0}]$ as a function of Δt , also for a signal-enhanced sample.

We consider several sources of systematic uncertainties related to the level and possible asymmetry of the background contribution from $B\bar{B}$ decays other than our signal. We estimate the impact of potential biases in the determination of the $B\bar{B}$ background rate to lead to a systematic uncertainty of 0.04 (0.05) on $S_{K^*\gamma}$ ($C_{K^*\gamma}$). We estimate an uncertainty of 0.12 (0.03) due to potential CPV asymmetries in the $B\bar{B}$ backgrounds and 0.02 (0.06) due to possible asymmetries in the rate of B^0 versus \bar{B}^0 tags in continuum backgrounds. We quantify possible systematic effects due to the vertexing method in the same manner as Ref. [9], estimating systematic uncertainties of 0.04 (0.02) due to the choice of resolution function, 0.04 (<0.01) due to the vertexing technique, and 0.03 (0.01) due to possible misalignments of the SVT. Finally, we include a systematic uncertainty of 0.02 (0.02) due to tagging asymmetries in the signal and 0.02 (0.02) due to imperfect knowledge of the PDFs used in the fit.

In summary, we have performed a measurement of the time-dependent CPV asymmetry $S_{K^*\gamma}$ and the direct-CP

violating asymmetry $C_{K^*\gamma}$ from $B^0 \rightarrow K^{*0}\gamma$ ($K^{*0} \rightarrow K_S^0\pi^0$) decays. Our measurement is consistent with the SM expectation of very small CPV asymmetries.

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 *BABAR*. The collaborating institutions wish to thank SLAC for its support and kind hospitality. This work is supported by DOE and NSF (U.S.A), NSERC (Canada), IHEP (China), CEA and CNRS-IN2P3 (France), BMBF and DFG (Germany), INFN (Italy), FOM (The Netherlands), NFR (Norway), MIST (Russia), and PPARC (United Kingdom). Individuals have received support from CONACyT (Mexico), A. P. Sloan Foundation, Research Corporation, and Alexander von Humboldt Foundation.

*Present address: Department of Physics, University of Warwick, Coventry, United Kingdom.

†Also at Università della Basilicata, Potenza, Italy.

‡Also at IFIC, Instituto de Física Corpuscular, CSIC-Universidad de Valencia, Valencia, Spain.

§Deceased.

- [1] *BABAR* Collaboration, B. Aubert, Phys. Rev. Lett. **87**, 091801 (2001); *BELLE* Collaboration, K. Abe, Phys. Rev. Lett. **87**, 091802 (2001).
- [2] N. Cabibbo, Phys. Rev. Lett. **10**, 531 (1963); M. Kobayashi and T. Maskawa, Prog. Theor. Phys. **49**, 652 (1973).
- [3] Unless explicitly stated, charge conjugate decay modes are assumed throughout this Letter.
- [4] D. Atwood, M. Gronau, and A. Soni, Phys. Rev. Lett. **79**, 185 (1997).
- [5] *CLEO* Collaboration, T.E. Coan, Phys. Rev. Lett. **84**, 5283 (2000).
- [6] *BABAR* Collaboration, B. Aubert, Phys. Rev. Lett. **88**, 101805 (2002).
- [7] *Belle* Collaboration, M. Nakao, Phys. Rev. D **69**, 112001 (2004).
- [8] *BABAR* Collaboration, B. Aubert, Nucl. Instrum. Methods Phys. Res., Sect. A **479**, 1 (2002).
- [9] *BABAR* Collaboration, B. Aubert, Phys. Rev. Lett. **93**, 131805 (2004).
- [10] *BABAR* Collaboration, B. Aubert, Phys. Rev. D **66**, 032003 (2002).