

Search for exclusive photoproduction of $Z_c^\pm(3900)$ at COMPASS

C. Adolph^h, R. Akhunzyanov^g, M.G. Alexeev^{aa}, G.D. Alexeev^g, A. Amoroso^{aa,ac}, V. Andrieux^v, V. Anosov^g, A. Austregesilo^{j,q}, B. Badełek^{ae}, F. Balestra^{aa,ac}, J. Barth^d, G. Baum^a, R. Beck^c, Y. Bedfer^v, A. Berlin^b, J. Bernhard^m, K. Bicker^{j,q}, E.R. Bielert^j, J. Bieling^d, R. Birsa^y, J. Bisplinghoff^c, M. Bodlak^s, M. Boer^v, P. Bordalo^{l,1}, F. Bradamante^{x,y}, C. Braun^h, A. Bressan^{x,y,*}, M. Bücheleⁱ, E. Burtin^v, L. Capozza^v, M. Chiosso^{aa,ac}, S.U. Chung^{q,2}, A. Cicuttin^{z,y}, M.L. Crespo^{z,y}, Q. Curiel^v, S. Dalla Torre^y, S.S. Dasgupta^f, S. Dasgupta^y, O.Yu. Denisov^{ac}, S.V. Donskov^u, N. Doshita^{ag}, V. Duic^x, W. Dünnweber^p, M. Dziewiecki^{af}, A. Efremov^g, C. Elia^{x,y}, P.D. Eversheim^c, W. Eyrich^h, M. Faessler^p, A. Ferrero^v, A. Filin^u, M. Finger^s, M. Finger Jr.^s, H. Fischerⁱ, C. Franco^l, N. du Fresne von Hohenesche^{m,j}, J.M. Friedrich^q, V. Frolov^j, F. Gautheron^b, O.P. Gavrichtchouk^g, S. Gerassimov^{o,q}, R. Geyer^p, I. Gnesi^{aa,ac}, B. Gobbo^y, S. Goertz^d, M. Gorzellikⁱ, S. Grabmüller^q, A. Grasso^{aa,ac}, B. Grube^q, T. Grussenmeyerⁱ, A. Guskov^{g,*}, F. Haas^q, D. von Harrach^m, D. Hahne^d, R. Hashimoto^{ag}, F.H. Heinsiusⁱ, F. Herrmannⁱ, F. Hinterberger^c, Ch. Höppner^q, N. Horikawa^{r,4}, N. d'Hose^v, S. Huber^q, S. Ishimoto^{ag,5}, A. Ivanov^g, Yu. Ivanshin^g, T. Iwata^{ag}, R. Jahn^c, V. Jary^t, P. Jasinski^m, P. Jörgⁱ, R. Joosten^c, E. Kabuß^m, B. Ketzer^{q,6}, G.V. Khaustov^u, Yu.A. Khokhlov^{u,7}, Yu. Kisselev^g, F. Klein^d, K. Klimaszewski^{ad}, J.H. Koivuniemi^b, V.N. Kolosov^u, K. Kondo^{ag}, K. Königsmannⁱ, I. Konorov^{o,q}, V.F. Konstantinov^u, A.M. Kotzinian^{aa,ac}, O. Kouznetsov^g, M. Krämer^q, Z.V. Kroumchtein^g, N. Kuchinski^g, F. Kunne^{v,*}, K. Kurek^{ad}, R.P. Kurjata^{af}, A.A. Lednev^u, A. Lehmann^h, M. Levillain^v, S. Levorato^y, J. Lichtenstadt^w, A. Maggiora^{ac}, A. Magnon^v, N. Makke^{x,y}, G.K. Mallot^j, C. Marchand^v, A. Martin^{x,y}, J. Marzec^{af}, J. Matousek^s, H. Matsuda^{ag}, T. Matsudaⁿ, G. Meshcheryakov^g, W. Meyer^b, T. Michigami^{ag}, Yu.V. Mikhailov^u, Y. Miyachi^{ag}, A. Nagaytsev^g, T. Nagel^q, F. Nerling^m, S. Neubert^q, D. Neyret^v, V.I. Nikolaenko^u, J. Novy^t, W.-D. Nowakⁱ, A.S. Nunes^l, A.G. Olshevsky^g, I. Orlov^g, M. Ostrick^m, R. Panknin^d, D. Panzneri^{ab,ac}, B. Parsamyan^{aa,ac}, S. Paul^q, D.V. Peshekhonov^g, S. Platchkov^v, J. Pochodzalla^m, V.A. Polyakov^u, J. Pretz^{d,8}, M. Quaresima^l, C. Quintans^l, S. Ramos^{l,1}, C. Regaliⁱ, G. Reicherz^b, E. Rocco^j, N.S. Rossiyskaya^g, D.I. Ryabchikov^u, A. Rychter^{af}, V.D. Samoylenko^u, A. Sandacz^{ad}, S. Sarkar^f, I.A. Savin^g, G. Sbrizzai^{x,y}, P. Schiavon^{x,y}, C. Schillⁱ, T. Schlüter^p, K. Schmidt^{i,3}, H. Schmieden^d, K. Schönning^j, S. Schopfererⁱ, M. Schott^j, O.Yu. Shevchenko^{g,19}, L. Silva^l, L. Sinha^f, S. Sirtlⁱ, M. Slunecka^g, S. Sosio^{aa,ac}, F. Sozzi^y, A. Srnka^e, L. Steiger^y, M. Stolarski^l, M. Sulc^k, R. Sulej^{ad}, H. Suzuki^{ag,4}, A. Szabelski^{ad}, T. Szameitat^{i,3}, P. Sznajder^{ad}, S. Takekawa^{aa,ac}, J. ter Wolbeek^{i,3}, S. Tessaro^y, F. Tessarotto^y, F. Thibaud^v, S. Uhl^q, I. Uman^p, M. Virius^t, L. Wang^b, T. Weisrock^m, M. Wilfert^m, R. Windmolders^d, H. Wollny^v, K. Zaremba^{af}, M. Zavertyaev^o, E. Zemlyanichkina^g, M. Ziembicki^{af}, A. Zink^h

^a Universität Bielefeld, Fakultät für Physik, 33501 Bielefeld, Germany⁹

^b Universität Bochum, Institut für Experimentalphysik, 44780 Bochum, Germany^{9,16}

^c Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, 53115 Bonn, Germany⁹

^d Universität Bonn, Physikalisches Institut, 53115 Bonn, Germany⁹

^e Institute of Scientific Instruments, AS CR, 61264 Brno, Czech Republic¹⁰

^f Matrivani Institute of Experimental Research & Education, Calcutta 700 030, India¹¹

- ^g Joint Institute for Nuclear Research, 141980 Dubna, Moscow Region, Russia ¹²
^h Universität Erlangen–Nürnberg, Physikalisches Institut, 91054 Erlangen, Germany ⁹
ⁱ Universität Freiburg, Physikalisches Institut, 79104 Freiburg, Germany ^{9,16}
^j CERN, 1211 Geneva 23, Switzerland
^k Technical University in Liberec, 46117 Liberec, Czech Republic ¹⁰
^l LIP, 1000-149 Lisbon, Portugal ¹³
^m Universität Mainz, Institut für Kernphysik, 55099 Mainz, Germany ⁹
ⁿ University of Miyazaki, Miyazaki 889-2192, Japan ¹⁴
^o Lebedev Physical Institute, 119991 Moscow, Russia
^p Ludwig-Maximilians-Universität München, Department für Physik, 80799 Munich, Germany ^{9,15}
^q Technische Universität München, Physik Department, 85748 Garching, Germany ^{9,15}
^r Nagoya University, 464 Nagoya, Japan ¹⁴
^s Charles University in Prague, Faculty of Mathematics and Physics, 18000 Prague, Czech Republic ¹⁰
^t Czech Technical University in Prague, 16636 Prague, Czech Republic ¹⁰
^u State Scientific Center Institute for High Energy Physics of National Research Center ‘Kurchatov Institute’, 142281 Protvino, Russia
^v CEA IRFU/SPhN Saclay, 91191 Gif-sur-Yvette, France ¹⁶
^w Tel Aviv University, School of Physics and Astronomy, 69978 Tel Aviv, Israel ¹⁷
^x University of Trieste, Department of Physics, 34127 Trieste, Italy
^y Trieste Section of INFN, 34127 Trieste, Italy
^z Abdus Salam ICTP, 34151 Trieste, Italy
^{aa} University of Turin, Department of Physics, 10125 Turin, Italy
^{ab} University of Eastern Piedmont, 15100 Alessandria, Italy
^{ac} Torino Section of INFN, 10125 Turin, Italy
^{ad} National Centre for Nuclear Research, 00-681 Warsaw, Poland ¹⁸
^{ae} University of Warsaw, Faculty of Physics, 00-681 Warsaw, Poland ¹⁸
^{af} Warsaw University of Technology, Institute of Radioelectronics, 00-665 Warsaw, Poland ¹⁸
^{ag} Yamagata University, Yamagata 992-8510, Japan ¹⁴

ARTICLE INFO

Article history:

Received 29 July 2014

Received in revised form 25 November 2014

Accepted 27 January 2015

Available online 30 January 2015

Editor: M. Doser

Keywords:

COMPASS

 $Z_c(3900)$

Photoproduction

Tetraquark

ABSTRACT

A search for the exclusive production of the $Z_c^\pm(3900)$ hadron by virtual photons has been performed in the channel $Z_c^\pm(3900) \rightarrow J/\psi\pi^\pm$. The data cover the range from 7 GeV to 19 GeV in the centre-of-mass energy of the photon–nucleon system. The full set of the COMPASS data set collected with a muon beam between 2002 and 2011 has been used. An upper limit for the ratio $BR(Z_c^\pm(3900) \rightarrow J/\psi\pi^\pm) \times \sigma_{\gamma N \rightarrow Z_c^\pm(3900)N} / \sigma_{\gamma N \rightarrow J/\psi N}$ of 3.7×10^{-3} has been established at the confidence level of 90%.

© 2015 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>). Funded by SCOAP³.

* Corresponding authors.

E-mail addresses: Andrea.Bressan@cern.ch (A. Bressan), Alexey.Guskov@cern.ch (A. Guskov), Fabienne.Kunne@cern.ch (F. Kunne).

¹ Also at Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal.

² Also at Department of Physics, Pusan National University, Busan 609-735, Republic of Korea and at Physics Department, Brookhaven National Laboratory, Upton, NY 11973, USA.

³ Supported by the DFG Research Training Group Programme 1102 ‘Physics at Hadron Accelerators’.

⁴ Also at Chubu University, Kasugai, Aichi 487-8501, Japan.

⁵ Also at KEK, 1-1 Oho, Tsukuba, Ibaraki 305-0801, Japan.

⁶ Present address: Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, 53115 Bonn, Germany.

⁷ Also at Moscow Institute of Physics and Technology, Moscow Region, 141700, Russia.

⁸ Present address: RWTH Aachen University, III. Physikalisches Institut, 52056 Aachen, Germany.

⁹ Supported by the German Bundesministerium für Bildung und Forschung.

¹⁰ Supported by Czech Republic MEYS Grants ME492 and LA242.

¹¹ Supported by SAIL (CSR), Govt. of India.

¹² Supported by CERN-RFBR Grants 08-02-91009 and 12-02-91500.

¹³ Supported by the Portuguese FCT – Fundação para a Ciência e Tecnologia, COMPETE and QREN, Grants CERN/FP/109323/2009, CERN/FP/116376/2010 and CERN/FP/123600/2011.

¹⁴ Supported by the MEXT and the JSPS under the Grants No. 18002006, No. 20540299 and No. 18540281; Daiko Foundation and Yamada Foundation.

¹⁵ Supported by the DFG cluster of excellence ‘Origin and Structure of the Universe’ (www.universe-cluster.de).

¹⁶ Supported by EU FP7 (HadronPhysics3, Grant Agreement number 283286).

¹⁷ Supported by the Israel Science Foundation, founded by the Israel Academy of Sciences and Humanities.

The $Z_c^\pm(3900)$ state was recently discovered by the BES-III and Belle Collaborations in $e^+e^- \rightarrow \pi^+\pi^- J/\psi$ reactions at $\sqrt{s} = 4.26$ GeV [1,2] via the decay channel

$$Z_c^\pm(3900) \rightarrow J/\psi\pi^\pm. \quad (1)$$

It has been interpreted as a tetraquark state [3–6], although other explanations like a molecular state [7–11], a cusp effect [12] and an initial-single-pion-emission mechanism [13] were also proposed. According to the vector meson dominance (VMD) model, a photon may behave like a J/ψ so that a $Z_c^\pm(3900)$ can be produced by the interaction of an incoming photon with a virtual charged pion provided by the target nucleon

$$\gamma N \rightarrow Z_c^\pm(3900)N. \quad (2)$$

The corresponding diagram is shown in Fig. 1a.

Based on the VMD model, the authors of Ref. [14] predict a sizable cross section of the reaction in Eq. (2) for $\sqrt{s_{\gamma N}} \sim 10$ GeV. Under the assumption that the decay channel of Eq. (1) is dominant and that the total width Γ_{tot} of the $Z_c^\pm(3900)$ particle is $46 \text{ MeV}/c^2$, as measured by BES-III, the cross section reaches a maximum value of 50 nb to 100 nb at $\sqrt{s_{\gamma N}} = 7$ GeV. The J/ψ

¹⁸ Supported by the Polish NCN Grant DEC-2011/01/M/ST2/02350.

¹⁹ Deceased.

Download English Version:

<https://daneshyari.com/en/article/1849154>

Download Persian Version:

<https://daneshyari.com/article/1849154>

[Daneshyari.com](https://daneshyari.com)