

The JUNO Collaboration

Angel Abusleme¹, Thomas Adam², Kai Adamowicz³, David Adey⁴, Shakeel Ahmad⁵, Rizwan Ahmed⁵, Timo Ahola⁶, Sebastiano Aiello⁷, Fengpeng An⁸, Guangpeng An⁴, Costas Andreopoulos⁹, Giuseppe Andronico⁷, João Pedro Athayde Marcondes de André², Nikolay Anfimov¹⁰, Vito Antonelli¹¹, Tatiana Antoshkina¹⁰, Burin Asavapibhop¹², Didier Auguste¹³, Margherita Buizza Avanzini¹⁴, Andrej Babic¹⁵, Jingzhi Bai^{4,85}, Weidong Bai⁸, Nikita Balashov¹⁰, Roberto Barbera⁷, Andrea Barresi¹⁶, Davide Basilico¹¹, Eric Baussan², Beatrice Bellantonio¹¹, Marco Bellato¹⁷, JeanLuc Beney¹⁸, Marco Beretta¹¹, Antonio Bergnoli¹⁷, Enrico Bernieri¹⁹, Nikita Bessonov¹⁰, David Biare¹⁰, Daniel Bick²⁰, Lukas Bieger²¹, Svetlana Biktmerova¹⁰, Thilo Birkenfeld³, David Blum²¹, Simon Blyth⁴, Sara Boarin¹⁶, Manuel Boehles²², Anastasia Bolshakova¹⁰, Mathieu Bongrand¹⁸, Aurélie Bonhomme², Clément Bordereau^{23,24}, Matteo Borghesi¹⁶, Augusto Brigatti¹¹, Timothee Brugiere², Riccardo Brugnera²⁵, Riccardo Bruno⁷, Jonas Buchholz^{24,18}, Antonio Budano¹⁹, Max Buesken³, Mario Buscemi⁷, Severino Bussino¹⁹, Jose Busto²⁶, Ilya Butorov¹⁰, Marcel Büchner²², Anatael Cabrera¹³, Barbara Caccianiga¹¹, Boshuai Cai⁸, Hao Cai²⁷, Xiao Cai⁴, Yanke Cai⁴, Yi-zhou Cai²⁸, Zhiyan Cai⁴, Stéphane Callier²⁴, Steven Calvez¹⁸, Antonio Cammi²⁹, Agustin Campeny³⁰, Dechang Cai³¹, Chuanya Cao⁴, Dewen Cao²⁸, Guofu Cao⁴, Jun Cao^{4,32}, Yaoqi Cao^{33,9}, Rossella Caruso⁷, Aurelio Caslini¹¹, Cédric Cerna²⁴, Vanessa Cerrone²⁵, Daniele Cesini⁷, Chi Chan³⁴, Jinfan Chang⁴, Yun Chang³⁵, Milo Charavet²⁰, Tim Charisse^{36,22}, Auttakit Chatrabhuti¹², Chao Chen⁴, Guoming Chen³⁷, Haitao Chen⁴, Haotian Chen⁴, Jiahui Chen⁸, Jian Chen⁸, Jing Chen⁸, Junyou Chen³⁷, Lihao Chen⁸, Mali Chen⁴, Mingming Chen⁴, Pingping Chen³⁸, Po-An Chen²³, Quanyou Chen³⁹, Shaomin Chen⁴⁰, Shenjian Chen²⁸, Shi Chen⁴¹, Shiqiang Chen²⁸, Sisi Chen⁴, Xin Chen^{28,4}, Xuan Chen⁴, Xurong Chen⁴², Yi-Wen Chen³⁴, Yiming Chen⁴, Yixue Chen⁴³, Yu Chen⁸, Ze Chen^{36,22}, Zelin Chen^{28,4}, Zhang Chen⁴, Zhangming Chen⁴⁴, Zhiyuan Chen^{4,45}, Zhongchang Chen⁴⁶, Zikang Chen⁸, Brian Cheng⁴⁷, Jie Cheng⁴³, Yaping Cheng⁴⁸, Yu Chin Cheng²³, Zhaokan Cheng⁴², Alexander Chepurinov^{49,50}, Alexey Chetverikov¹⁰, Davide Chiesa¹⁶, Pietro Chimenti⁵¹, Yen-Ting Chin²³, Pin-Jung Chiu²³, Po-Lin Chou³⁴, Ziliang Chu⁴, Artem Chukanov¹⁰, Neetu Raj Singh Chundawat^{4,45}, Anna Chuvashova¹⁰, Gérard

Claverie²⁴, Catia Clementi⁵², Barbara Clerbaux⁵³, Claudio Coletta¹⁶, Marta Colomer Molla⁵³, Flavio Dal Corso¹⁷, Daniele Corti¹⁷, Salvatore Costa⁷, Simon Csakli⁵⁴, Chenyang Cui⁴, Shanshan Cui⁴, Lorenzo Vincenzo D'Auria²⁵, Olivia Dalager⁴⁷, Jaydeep Datta⁵³, Luis Delgadillo Franco^{4,45}, Jiawei Deng²⁷, Zhi Deng⁴⁰, Ziyang Deng⁴, Wilfried Depnering²², Hanna Didenko⁵⁵, Xiaoyu Ding³⁹, Xuefeng Ding⁴, Yayun Ding⁴, Bayu Dirgantara⁵⁶, Carsten Dittrich⁵⁴, Sergey Dmitrievsky¹⁰, David Doerflinger⁵⁴, Tadeas Dohnal⁵⁵, Maria Dolgareva¹⁰, Dmitry Dolzhikov¹⁰, Chuanshi Dong⁴, Haojie Dong⁴, Jianmeng Dong⁴⁰, Lan Dong⁴, Damien Dornic²⁶, Evgeny Doroshkevich⁵⁰, Wei Dou⁴⁰, Marcos Dracos², Olivier Drapier¹⁴, Tobias Drohmann^{54,85}, Frédéric Druillol²⁴, Ran Du⁴, Shuxian Du⁵⁷, Yujie Duan²⁷, Katherine Dugas⁴⁷, Stefano Dusini¹⁷, Hongyue Duyang³⁹, Martin Dvorak⁵⁵, Jessica Eck²¹, Timo Enqvist⁶, Heike Enzmann²², Andrea Fabbri¹⁹, Ulrike Fahrenholz⁵⁴, Lukas Fajt¹⁵, Donghua Fan⁵⁸, Lei Fan⁴, Liangqianjin Fan⁴, Can Fang³⁷, Jian Fang⁴, Wenxing Fang⁴, Marco Fargetta⁷, Elia Stanesco Farilla¹⁹, Anna Fatkina¹⁰, Laurent Favart⁵³, Dmitry Fedoseev¹⁰, Zhengyong Fei⁴, Franz von Feilitzsch⁵⁴, Vladko Fekete¹⁵, Li-Cheng Feng³⁴, Qichun Feng⁵⁹, Shaoting Feng⁴⁶, Giovanni Ferrante¹⁶, Federico Ferraro¹¹, Daniela Fetzter²², Giovanni Fiorentini⁶⁰, Andrey Formozov¹¹, Marcellin Fotzé², Amélie Fournier²⁴, Sabrina Franke⁵⁴, Arran Freegard⁴⁴, Florian Fritsch², Ying Fu^{4,45}, Haonan Gan⁶¹, Feng Gao^{53,3}, Ruixuan Gao⁸, Ruohan Gao⁶², Shijiao Gao⁵⁴, Alberto Garfagnini²⁵, Gerard Gaudiot², Arsenii Gavrikov²⁵, Raphaël Gazzini²⁴, Christoph Genster^{63,3}, Diwash Ghimire⁴⁴, Marco Giammarchi¹¹, Agnese Giaz²⁹, Gianfranco Giordano^{64,85}, Nunzio Giudice⁷, Franco Giuliani⁴⁴, Alexandre S. Göttel^{63,3}, Maxim Gonchar¹⁰, Guanda Gong^{4,45}, Guanghua Gong⁴⁰, Hui Gong⁴⁰, Michel Gonin¹⁴, Oleg Gorchakov¹⁰, Yuri Gornushkin¹⁰, Marco Grassi²⁵, Christian Grewing⁶⁵, Maxim Gromov^{49,10}, Vasily Gromov¹⁰, Minhao Gu⁴, Xiaofei Gu⁵⁷, Yu Gu⁶⁶, Mengyun Guan⁴, Yuduo Guan⁴, Nunzio Guardone⁷, Rosa Maria Guizzetti²⁵, Cong Guo⁴, Jingyuan Guo⁸, Wanlei Guo⁴, Yuhang Guo^{67,4}, Paul Hackspacher²², Caren Hagner²⁰, Hechong Han⁴, Ran Han⁴³, Xiao Han⁴, Yang Han⁸, Zigu Han⁴, Chuanhui Hao⁴⁰, Jiajun Hao⁴, Vidhya Thara Hariharan²⁰, JinCheng He⁴³, Jinhong He²⁷, Miao He⁴, Mingtao He³¹, Wei He⁴, Xinhai He⁴, Ziou He^{33,9}, Tobias Heinz²¹, Dominikus Hellgartner⁵⁴, Patrick Hellmuth²⁴, Shilin Heng⁵⁷, Yuekun Heng⁴, Rafael Herrera³⁰, Daojin Hong³⁷, YuenKeung

Hor⁸, Shaojing Hou⁴, Zhilong Hou⁴, Fatima Houria¹¹, Yee Hsiung²³, Bei-Zhen Hu⁶⁸, Hang Hu⁸, Hao Hu⁴, Jianrun Hu⁸, Jun Hu⁴, Peng Hu⁴, Tao Hu⁴, Wei Hu⁴, Yuxiang Hu⁴, Zhuojun Hu⁸, Chunhao Huang⁸, Guihong Huang⁵⁸, Hanyu Huang⁴⁴, Hexiang Huang⁴, Jinhao Huang⁴, Junlin Huang⁶⁶, Junting Huang⁴⁴, Kairui Huang⁴, Kaixuan Huang⁸, Qinhua Huang^{2,14}, Shengheng Huang⁵⁸, Tao Huang⁸, Wenhao Huang³⁹, Xiaozhong Huang²⁸, Xin Huang⁴, Xingtao Huang³⁹, Yongbo Huang³⁷, Lian-Chen Huang⁶⁹, Jiaqi Hui⁴⁴, Lei Huo⁵⁹, Cédric Huss²⁴, Safeer Hussain⁵, Leonard Imbert¹⁸, Antonio Insolia⁷, Ara Ioannisian⁷⁰, Daniel Ioannisyan⁷⁰, Ammad Ul Islam¹⁹, Roberto Isocrate¹⁷, Adrienne Jacobi⁴⁷, Arshak Jafar²², Beatrice Jelmini²⁵, Kuo-Lun Jen³⁴, Ignacio Jeria¹, Soeren Jetter⁴, Xiangpan Ji⁷¹, Xiaolu Ji⁴, Xingzhao Ji⁸, Huihui Jia⁷¹, Junji Jia²⁷, Yi Jia⁴, Cailian Jiang²⁸, Chengbo Jiang⁴³, Guangzheng Jiang⁷², Junjie Jiang⁴⁴, Wei Jiang⁴, Xiaoshan Jiang⁴, Xiaozhao Jiang⁴, Yijian Jiang⁴³, Yixuan Jiang⁴, Yue Jiang⁵⁹, Ruyi Jin⁴, Shuzhu Jin⁴, Xiaoping Jing⁴, Cécile Jollet²⁴, Liam Jones^{9,33}, Jari Joutsenvaara⁶, Sirichok Jungthawan⁵⁶, Philipp Kampmann³⁶, Markus Kaiser²⁰, Leonidas Kalousis², Bowen Kan⁴, Li Kang³⁸, Michael Karagounis⁶⁵, Rebin Karaparambil², Matej Karas¹⁵, Narine Kazarian⁷⁰, Amir Khan⁸, Amina Khatun^{53,15}, Khanchai Khosonthongkee⁵⁶, Florian Kiel³, Patrick Kinz³⁴, Denis Korablev¹⁰, Konstantin Kouzakov⁴⁹, Alexey Krasnoperov¹⁰, Zinovy Krumshteyn^{10,85}, Andre Kruth⁶⁵, Tim Kuhlbusch³, Sergey Kuleshov³⁰, Sindhuja Kumaran⁴⁷, Chun-Hao Kuo⁶⁹, Nikolay Kutovskiy¹⁰, Pasi Kuusiniemi⁶, Loïc Labit², Tobias Lachenmaier²¹, Haojing Lai⁴⁴, ToUyen LamThi³⁴, Philipp Landgraf⁵⁴, Cecilia Landini¹¹, Lorenzo Lastrucci²⁵, Fedor Lazarev⁴⁹, Sébastien Leblanc²⁴, Victor Lebrin¹⁸, Matthieu Lecocq²⁴, Priscilla Lecomte², Frederic Lefevre¹⁸, Liping Lei⁴⁰, Ruiting Lei³⁸, Xiangcui Lei⁴, Rupert Leitner⁵⁵, Petr Lenskii¹⁰, Jason Leung³⁴, Bo Li⁴, Chao Li³⁹, Daozheng Li⁴, Demin Li⁵⁷, Dian Li⁴, Fei Li⁴, Fule Li⁴⁰, Gaoshuang Li^{57,4}, Gaosong Li⁴, Haitao Li⁸, Hongjin Li⁴, Huang Li⁴, Huiling Li³⁹, Jiajun Li⁸, Jiaqi Li⁸, Jin Li⁴, Kaijie Li⁸, Meiou Li⁵⁸, Mengzhao Li⁴, Min Li², Nan Li⁷³, Qingjiang Li⁷³, Quanlin Li⁴, Ruhui Li⁴, Rui Li⁴⁴, Shanfeng Li³⁸, Shuaijie Li⁸, Shuo Li²⁸, Tao Li⁸, Teng Li³⁹, Weidong Li⁴, Weiguo Li^{4,85}, Xiaomei Li⁷⁴, Xiaonan Li^{45,4}, Xiwen Li⁴, Xinying Li⁷¹, Yang Li⁴, Yawen Li⁴, Yi Li³⁸, Yichen Li⁴, Yifan Li⁴, Yingke Li³⁷, Yuanxia Li⁴, Yufeng Li⁴, Zepeng Li⁴, Zhaohan Li⁴, Zhibing Li⁸, Zhiwei Li⁴⁸, Zi-Ming Li⁵⁷, Ziyuan Li⁸,

Zonghai Li²⁷, An-An Liang³⁴, Jing Liang⁴, Jingjing Liang³⁷, Jiajun Liao⁸, Minghua Liao⁸, Yilin Liao⁴⁴, Yuzhong Liao⁶¹, Daniel Liebau⁶⁵, Ayut Limphirat⁵⁶, Sukit Limpijumnong⁵⁶, Bo-Chun Lin³⁴, Guey-Lin Lin³⁴, Jiming Lin³¹, Shengxin Lin³⁸, Tao Lin⁴, Xianhao Lin²⁸, Xingyi Lin³⁷, Yen-Hsun Lin³⁴, Jiacheng Ling⁸, Jiajie Ling⁸, Xin Ling⁴, Ivano Lippi¹⁷, Caimei Liu⁴, Fang Liu⁴³, Fengcheng Liu⁴³, Gang Liu⁴, Haidong Liu⁵⁷, Haotian Liu²⁷, Hongbang Liu³⁷, Hongjuan Liu⁷⁵, Hongtao Liu⁸, Hongyang Liu⁴, Hu Liu⁸, Hui Liu⁶⁶, Jianglai Liu^{44,76}, Jianli Liu⁵⁹, Jiaxi Liu⁴, Jin'gao Liu⁶², Jinchang Liu⁴, Jinyan Liu⁷¹, Kainan Liu⁵⁸, Lei Liu⁴, Libing Liu⁴, Mengchao Liu⁴, Menglan Liu⁸, Min Liu⁷⁵, Qishan Liu⁴, Qian Liu⁴¹, Qin Liu⁷⁷, Runxuan Liu^{36,3}, Shenghui Liu⁴, Shuangyu Liu⁴, Shubing Liu⁴, Shulin Liu⁴, Wanjin Liu⁴, Xiaowei Liu⁸, Ximing Liu⁷¹, Xinkang Liu³⁹, Xiwen Liu³⁷, Xuewei Liu⁴⁰, Yan Liu⁴, Yankai Liu⁶⁷, Yin Liu³⁹, Yiqi Liu⁴⁰, Yuanyuan Liu⁷¹, Yuexiang Liu⁴, Yunzhe Liu⁴, Zhen Liu⁴, Zhipeng Liu⁴, Zhuo Liu⁴, Domenico Lo Presti⁷, Salvatore Loffredo¹⁹, Lorenzo Loi²⁹, Paolo Lombardi¹¹, Claudio Lombardo⁷, Yongbing Long⁵⁸, Fabio Longhitano⁷, Kai Loo⁶, Sebastian Lorenz^{20,22}, Selma Conforti Di Lorenzo²⁴, Chuan Lu⁶¹, Fan Lu⁴³, Haoqi Lu⁴, Jiashu Lu⁴, Junguang Lu⁴, Meishu Lu⁵⁴, Peizhi Lu⁸, Shuxiang Lu⁵⁷, Xianghui Lu³¹, Xianguo Lu³³, Xiaoxu Lu⁴, Xiaoying Lu⁴, Bayarto Lubsandorzhiev⁵⁰, Sultim Lubsandorzhiev⁵⁰, Livia Ludhova^{36,22}, Arslan Lukanov⁵⁰, Daibin Luo⁴, Fengjiao Luo⁷⁵, Guang Luo⁸, Jianyi Luo⁵⁸, Pengwei Luo⁸, Shu Luo⁷⁸, Tao Luo⁴, Wuming Luo⁴, Xiaojie Luo⁴, Xiaolan Luo⁴, Zhipeng Lv⁶⁷, Vladimir Lyashuk⁵⁰, Bangzheng Ma³⁹, Bing Ma⁵⁷, Na Ma⁴, Qiumei Ma⁴, Si Ma⁴, Wing Yan Ma³⁹, Xiaoyan Ma⁴, Xubo Ma⁴³, Santi Maensiri⁵⁶, Jingyu Mai⁸, Romain Maisonnobe¹⁸, Marco Malabarba^{36,22}, Yury Malyshekin^{36,22}, Roberto Carlos Mandujano⁴⁷, Fabio Mantovani⁶⁰, Xin Mao⁴⁸, Yajun Mao⁷⁹, Stefano M. Mari¹⁹, Cristina Martellini¹⁹, Agnese Martini⁶⁴, Jacques Martino¹⁸, Johann Martyn²², Matthias Mayer⁵⁴, Davit Mayilyan⁷⁰, Worawat Meevasana⁵⁶, Artur Meinusch²², Qingru Meng⁵⁷, Yue Meng⁴⁴, Anita Meraviglia^{36,3}, Anselmo Mereaglia²⁴, Emanuela Meroni¹¹, David Meyhöfer²⁰, Jian Min⁴, Lino Miramonti¹¹, Nikhil Mohan^{36,3}, Salvatore Monforte⁷, Paolo Montini¹⁹, Michele Montuschi⁶⁰, Nikolay Morozov¹⁰, Iwan Morton-Blake⁷⁶, Xiangyi Mu⁴, Pavithra Muralidharan⁶⁵, Lakshmi Murgod^{4,45}, Axel Müller²¹, Thomas Mueller¹⁴, Massimiliano Nastasi¹⁶, Dmitry V. Naumov¹⁰, Elena Naumova¹⁰, Diana Navas-Nicolas¹³, Igor

Nemchenok¹⁰, Elisabeth Neuerburg³, VanHung Nguyen³⁴, Dennis Nielinger⁶⁵, Alexey Nikolaev⁴⁹, Feipeng Ning⁴, Zhe Ning⁴, Yujie Niu⁴, Stepan Novikov¹⁰, Hiroshi Nunokawa⁸⁰, Lothar Oberauer⁵⁴, Juan Pedro Ochoa-Ricoux^{47,30}, Samantha Cantu Olea⁴⁷, Sebastian Olivares⁸¹, Alexander Olshevskiy¹⁰, Domizia Orestano¹⁹, Fausto Ortica⁵², Rainer Othegraven²², Yifei Pan⁸, Alessandro Paoloni⁶⁴, Nina Parkalian⁶⁵, George Parker²², Sergio Parmeggiano¹¹, Achilleas Patsias³, Teerapat Payupol¹², Viktor Pec⁵⁵, Davide Pedretti¹⁷, Yatian Pei⁴, Luca Pelicci¹¹, Nicomede Pelliccia⁵², Anguo Peng⁷⁵, Haiping Peng⁷⁷, Yu Peng⁴, Zhaoyuan Peng⁴, Elisa Percalli¹¹, Willy Perrin², Frédéric Perrot²⁴, Pierre-Alexandre Petitjean⁵³, Fabrizio Petrucci¹⁹, Min Pi²⁷, Oliver Pilarczyk²², Ruben Pompilio¹¹, Artyom Popov⁴⁹, Pascal Poussot², Stefano Pozzi¹⁶, Wathan Pratumwan⁵⁶, Ezio Previtali¹⁶, Sabrina Prummer⁵⁴, Fazhi Qi⁴, Ming Qi²⁸, Xiaohui Qi⁴, Sen Qian⁴, Xiaohui Qian⁴, Zhen Qian⁸, Liqing Qin⁴, Zhonghua Qin⁴, Shoukang Qiu⁷⁵, Manhao Qu⁵⁷, Zhenning Qu⁴, Muhammad Usman Rajput⁵, Shivani Ramachandran³, Gioacchino Ranucci¹¹, Neill Raper⁸, Reem Rasheed²⁴, Thomas Raymond², Alessandra Re¹¹, Henning Rebber²⁰, Abdel Rebi²⁴, Bin Ren³⁸, Shanjun Ren⁴, Yuhan Ren⁴, Andrea Rendina⁷, Cristobal Morales Reveco^{36,3,22}, Taras Rezinko¹⁰, Barbara Ricci⁶⁰, Luis Felipe Piñeres Rico², Mariam Rifai^{36,3,22}, Markus Robens⁶⁵, Mathieu Roche²⁴, Narongkiat Rodphai^{4,12}, Fernanda de Faria Rodrigues⁴, Lars Rohwer²⁰, Aldo Romani⁵², Vincent Rompel⁵⁴, Bedřich Roskovec⁵⁵, Xiangdong Ruan³⁷, Xichao Ruan⁷⁴, Peter Rudakov⁴⁹, Saroj Rujirawat⁵⁶, Arseniy Rybnikov¹⁰, Andrey Sadovsky^{10,85}, Sahar Safari²², Giuseppe Salamanna¹⁹, Deshan Sandanayake², Simone Sanfilippo¹⁹, Anut Sangka⁸², Nuanwan Sanguansak⁵⁶, Ujwal Santhosh^{36,22}, Giuseppe Sava⁷, Utane Sawangwit⁸², Julia Sawatzki⁵⁴, Michaela Schever³, Jacky Schuler², Cédric Schwab², Konstantin Schweizer⁵⁴, Dmitry Selivanov¹⁰, Alexandr Selyunin¹⁰, Andrea Serafini¹⁷, Giulio Settanta⁶³, Mariangela Settimo¹⁸, Muhammad Ikram Shahzad⁵, Yanjun Shan⁸³, Junyu Shao⁴, Zhuang Shao⁶⁷, Anurag Sharma²¹, Vladislav Sharov¹⁰, Arina Shaydurova¹⁰, Wei Shen⁴, Gang Shi⁴⁰, Hangyu Shi⁸, Hexi Shi³⁶, Jingyan Shi⁴, Yanan Shi⁴, Yongjiu Shi⁴⁰, Yuan Shi⁴, Dmitrii Shpotya¹⁰, Yike Shu⁴, Yuhan Shu⁴, She Shuai⁵⁷, Vitaly Shutov¹⁰, Andrey Sidorenkov^{50,4}, Randhir Singh^{4,45}, Apeksha Singhal³⁶, Chiara Sirignano²⁵, Jaruchit Siripak⁵⁶, Monica Sisti¹⁶, Maciej Slupecki⁶, Mikhail Smirnov²⁰, Oleg Smirnov¹⁰,

Thiago Sogo-Bezerra¹⁸, Michael Soiron³, Sergey Sokolov¹⁰, Julanan Songwadhana⁵⁶, Boonrucksar Soonthornthum⁸², Felix Sorgenfrei²⁰, Albert Sotnikov¹⁰, Mario Spinetti⁶⁴, Warintorn Sreethawong⁵⁶, Achim Stahl³, Luca Stanco¹⁷, Korbinian Stangler⁵⁴, Konstantin Stankevich⁴⁹, Hans Steiger^{54,22}, Jochen Steinmann³, Malte Stender²⁰, Tobias Sterr²¹, David Stipp²², Matthias Raphael Stock⁵⁴, Virginia Strati⁶⁰, Mikhail Strizh^{49,50}, Alexander Studenikin⁴⁹, Katharina von Sturm²⁵, Aoqi Su⁵⁷, Jun Su⁸, Yuning Su⁸, Gongxing Sun⁴, Guangbao Sun²⁷, Hansheng Sun⁴, Lijun Sun⁴, Liting Sun⁴, Mingxia Sun^{4,41}, Shifeng Sun⁴³, Xilei Sun⁴, Yongzhao Sun⁴, Yunhua Sun⁴, Yuning Sun⁸, Zhanxue Sun⁸⁴, Zhengyang Sun⁷⁶, Narumon Suwonjandee¹², Troy Swift³, Michal Szelezniak², Dušan Štefánik¹⁵, Fedor Šimkovic¹⁵, Ondřej Šrámek⁵⁵, Dmitriy Taichenachev¹⁰, Christophe De La Taille²⁴, Akira Takenaka⁸, Hongnan Tan⁴, Xiaohan Tan³⁹, Haozhong Tang⁴, Jian Tang⁸, Jingzhe Tang³⁷, Qiang Tang⁸, Quan Tang⁷⁵, Xiao Tang⁴, Jihua Tao⁸⁴, Eric Theisen²², Minh Thuan Nguyen Thi³⁴, Renju Tian⁴, Yuxin Tian⁷⁶, Alexander Tietzsch²¹, Igor Tkachev⁵⁰, Tomas Tmej⁵⁵, Marco Danilo Claudio Torri¹¹, Francesco Tortorici⁷, Konstantin Treskov¹⁰, Andrea Triossi²⁵, Giancarlo Troni¹, Wladyslaw Trzaska⁶, Andrei Tsaregorodtsev²⁶, Alexandros Tsagkarakis³, Yu-Chen Tung⁶⁹, Cristina Tuve⁷, Nikita Ushakov⁵⁰, Guillaume Vanroyen¹⁸, Nikolaos Vassilopoulos⁴, Carlo Venettacci¹⁹, Giuseppe Verde⁷, Maxim Vialkov⁴⁹, Benoit Viaud¹⁸, Cornelius Moritz Vollbrecht^{36,3}, Vit Vorobel⁵⁵, Dmitriy Voronin⁵⁰, Lucia Votano⁶⁴, Stefan van Waasen⁶⁵, Stefan Wagner⁸⁰, Pablo Walker³⁰, Jiawei Wan²⁸, Andong Wang⁸⁴, Caishen Wang³⁸, Chung-Hsiang Wang³⁵, Cui Wang⁷¹, Derun Wang⁴, En Wang⁵⁷, Guoli Wang⁵⁹, Hanwen Wang⁴, Hongxin Wang²⁸, Huanling Wang⁴, Jiabin Wang³⁹, Jian Wang⁴, Jun Wang⁸, Ke Wang⁴⁶, Kunyu Wang⁴, Lan Wang⁴, Li Wang^{57,4}, Lu Wang⁴, Meifen Wang⁴, Meng Wang³⁹, Meng Wang⁷⁵, Mingyuan Wang⁴, Qianchuan Wang²⁷, Ruiguang Wang⁴, Sibo Wang⁴, Siguang Wang⁷⁹, Tianhong Wang⁵⁹, Tong Wang⁴, Wei Wang⁸, Wei Wang²⁸, Wenshui Wang⁴, Wenwen Wang²⁸, Wenyuan Wang³⁹, Xi Wang⁷³, Xiangyue Wang⁸, Xuesen Wang⁸, Yangfu Wang⁴, Yaoguang Wang³⁹, Yi Wang⁴⁰, Yi Wang⁵⁸, Yi Wang⁴, Yifang Wang⁴, Yuanqing Wang⁴⁰, Yuman Wang²⁸, Yuyi Wang⁴⁰, Zhe Wang⁴⁰, Zheng Wang⁴, Zhigang Wang⁴, Zhimin Wang⁴, Zongyi Wang⁴⁰, Apimook Watcharangkool⁸², Junya Wei³⁹, Jushang Wei³⁹, Lianghong Wei⁴, Wei Wei⁴, Wei Wei³⁹, Wenlu

Wei⁴, Yadong Wei³⁸, Yuehuan Wei⁸, Zhengbao Wei³⁷, Marcel Weifels³, Kaile Wen⁴, Liangjian Wen⁴, Yijie Wen⁴, Jun Weng⁴⁰, Christopher Wiebusch³, Rosmarie Wirth^{36,22}, Steven Chan-Fai Wong⁸, Bjoern Wonsak²⁰, Baona Wu²⁸, Bi Wu⁸, Chengxin Wu⁸, Chia-Hao Wu³⁴, Chin-Wei Wu³⁴, Diru Wu⁴, Fangliang Wu²⁸, Jianhua Wu⁴, Qun Wu³⁹, Shuai Wu⁴, Wenjie Wu⁴², Yinhui Wu⁴, Yiyang Wu⁴⁰, Zhaoxiang Wu⁴, Zhi Wu⁴, Zhongyi Wu⁴⁷, Michael Wurm²², Jacques Wurtz², Christian Wysotzki³, Yufei Xi⁶¹, Jingkai Xia⁴, Shishen Xian⁷⁶, Ziqian Xiang⁴⁴, Fei Xiao⁴, Pengfei Xiao⁴, Tianying Xiao³⁷, Xiang Xiao⁸, Wan Xie⁴, Wei-Jun Xie³⁴, Xiaochuan Xie³⁷, Yijun Xie⁴, Yuguang Xie⁴, Zhangquan Xie⁴, Zhao Xin⁴, Zhizhong Xing⁴, Benda Xu⁴⁰, Cheng Xu⁷⁵, Chuang Xu⁴⁰, Donglian Xu^{76,44}, Fanrong Xu⁶⁶, Hangkun Xu⁴, Jiayang Xu⁴, Jie Xu⁶², Jilei Xu⁴, Jinghuan Xu³⁷, Lingyu Xu⁴, Meihang Xu⁴, Shiwen Xu⁴, Xunjie Xu⁴, Ya Xu⁸³, Yin Xu⁷¹, Yu Xu^{63,3}, Dongyang Xue⁴⁰, Jingqin Xue⁴, Baojun Yan⁴, Liangping Yan⁴, Qiyu Yan^{41,33}, Taylor Yan⁵⁶, Tian Yan⁴, Wenqi Yan⁴, Xiongbo Yan⁴, Yupeng Yan⁵⁶, Anbo Yang⁴, Caihong Yang⁴, Changgen Yang⁴, Chengfeng Yang⁸, Dikun Yang⁴⁶, Dingyong Yang⁴, Fengfan Yang⁴, Haibo Yang²⁸, Huan Yang⁴, Jie Yang⁵⁷, Jize Yang⁸, Kaiwei Yang⁴, Lei Yang³⁸, Mengting Yang³⁹, Pengfei Yang⁸, Xiaoyu Yang⁴, Xuhui Yang⁴, Yi Yang⁴, Yichen Yang⁴, Yifan Yang⁵³, Yixiang Yang⁴, Yujiao Yang⁷¹, Yuzhen Yang²⁸, Zekun Yang^{39,9}, Haifeng Yao⁴, Li Yao⁴, Jiaxuan Ye⁴, Mei Ye⁴, Xingchen Ye²⁷, Ziping Ye⁷⁶, Ugur Yegin⁶⁵, Frédéric Yermia¹⁸, Peihuai Yi⁴, Rattikorn Yimnirun⁵⁶, Jilong Yin⁴, Na Yin³⁹, Weiqing Yin⁴, Xiangwei Yin⁴, Xiaohao Yin⁸, Sivaram Yogathasan³, Zhengyun You⁸, Boxiang Yu⁴, Chiye Yu³⁸, Chunxu Yu⁷¹, Guangyou Yu²⁸, Guojun Yu²⁸, Hongzhao Yu^{4,8}, Miao Yu²⁷, Peidong Yu⁴, Simi Yu⁵⁸, Xianghui Yu⁷¹, Yang Yu⁴, Zeyuan Yu⁴, Zezhong Yu⁴, Cenxi Yuan⁸, Chengzhuo Yuan⁴, Zhaoyang Yuan^{4,8}, Zhenxiong Yuan⁴⁰, Ziyi Yuan²⁷, Baobiao Yue⁸, Noman Zafar⁵, André Zambanini⁶⁵, Jilberto Zamora⁸¹, Matteo Zanetti¹⁶, Vitalii Zavadskyi¹⁰, Fanrui Zeng³⁹, Pan Zeng⁴⁰, Shan Zeng⁴, Tingxuan Zeng⁴, Yuda Zeng⁸, Yujie Zeng⁸, Liang Zhan⁴, Aiqiang Zhang⁴⁰, Bin Zhang⁵⁷, Binting Zhang⁴, Chengcai Zhang⁴, Enze Zhang⁴, Feiyang Zhang⁴⁴, Guoqing Zhang⁴, Haiqiong Zhang⁴, Han Zhang^{4,41}, Hangchang Zhang⁴, Haosen Zhang⁴, Honghao Zhang⁸, Hongmei Zhang⁴, Jialiang Zhang²⁸, Jiawen Zhang⁴, Jie Zhang⁴, Jin Zhang³⁷, Jingbo Zhang⁵⁹, Jinnan Zhang⁴, Junwei Zhang³⁷, Kun Zhang⁴, Lei Zhang²⁸, Mingxuan

Zhang⁴, Mohan Zhang⁴, Peng Zhang⁴, Ping Zhang⁴⁴, Qingmin Zhang⁶⁷, Rongping Zhang⁴, Rui Zhang²⁸, Shaoping Zhang⁴, Shiqi Zhang⁸, Shu Zhang⁸, Shuihan Zhang⁴, Siyuan Zhang³⁷, Tao Zhang⁴⁴, Xiaofeng Zhang⁴, Xiaomei Zhang⁴, Xin Zhang⁴, Xu Zhang⁴, Xuan Zhang⁴, Xuantong Zhang⁴, Xuesong Zhang⁸, Xueyao Zhang³⁹, Yan Zhang⁴, Yibing Zhang^{4,45}, Yinhong Zhang⁴, Yiyu Zhang⁴, Yizhou Zhang⁴, Yongjie Zhang⁴, Yongpeng Zhang⁴, Yu Zhang⁴, Yuanyuan Zhang⁷⁶, Yue Zhang³⁹, Yueyuan Zhang⁴, Yumei Zhang⁸, Yuning Zhang⁴¹, Zhenyu Zhang²⁷, Zhicheng Zhang³⁹, Zhijian Zhang³⁸, Zhixuan Zhang⁴⁴, Baoqi Zhao⁴, Fengyi Zhao⁴², Jie Zhao⁴, Liang Zhao⁸³, Mei Zhao⁴, Rong Zhao⁸, Runze Zhao^{4,45}, Shujun Zhao⁵⁷, Tianchi Zhao⁴, Tianhao Zhao⁴, Yubin Zhao⁴, Dongqin Zheng⁶⁶, Hua Zheng³⁸, Xiangyu Zheng⁷¹, Yangheng Zheng⁴¹, Weili Zhong⁴, Weirong Zhong⁶⁶, Albert Zhou⁴, Guorong Zhou⁵⁸, Li Zhou⁴, Lishui Zhou⁴⁶, Min Zhou⁴, Shun Zhou⁴, Tong Zhou⁴, Xiang Zhou²⁷, Xing Zhou⁴, Yan Zhou⁴⁰, Haiwen Zhu²⁷, Jiang Zhu⁸, Jingsen Zhu⁸, Jingyu Zhu⁴², Kangfu Zhu⁶⁷, Kejun Zhu⁴, Zhihang Zhu⁴, Ivan Zhutikov¹⁰, Bo Zhuang⁴, Honglin Zhuang⁴, Liang Zong⁴⁰, Jiaheng Zou⁴, Sebastian Zwickel⁵⁴, Jan Züfle²¹,

Affiliations:

¹ Pontificia Universidad Católica de Chile, Santiago, Chile. ² IPHC, Université de Strasbourg, CNRS/IN2P3, F-67037 Strasbourg, France. ³ III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany. ⁴ Institute of High Energy Physics, Beijing, China. ⁵ Pakistan Institute of Nuclear Science and Technology, Islamabad, Pakistan. ⁶ University of Jyväskylä, Department of Physics, Jyväskylä, Finland. ⁷ INFN Catania and Dipartimento di Fisica e Astronomia dell'Università di Catania, Catania, Italy. ⁸ Sun Yat-sen University, Guangzhou, China. ⁹ The University of Liverpool, Department of Physics, Oliver Lodge Laboratory, Oxford Str., Liverpool L69 7ZE, UK, United Kingdom. ¹⁰ Joint Institute for Nuclear Research, Dubna, Russia. ¹¹ INFN Sezione di Milano and Dipartimento di Fisica dell'Università di Milano, Milano, Italy. ¹² High Energy Physics Research Unit, Faculty of Science, Chulalongkorn University, Bangkok, Thailand. ¹³ IJCLab, Université Paris-Saclay, CNRS/IN2P3, 91405 Orsay, France. ¹⁴ LLR, École Polytechnique, CNRS/IN2P3, F-91120 Palaiseau, France. ¹⁵ Comenius University Bratislava, Faculty of Mathematics, Physics and Informatics, Bratislava, Slovakia. ¹⁶ INFN Milano Bicocca and University of Milano Bicocca, Milano, Italy. ¹⁷ INFN Sezione di Padova, Padova, Italy. ¹⁸ SUBATECH, Nantes Université, IMT Atlantique, CNRS/IN2P3, Nantes, France. ¹⁹ Dipartimento di Matematica e Fisica, Università Roma Tre and INFN Sezione Roma Tre, Roma, Italy. ²⁰ Institute of Experimental Physics, University of Hamburg, Hamburg, Germany. ²¹ Eberhard Karls Universität Tübingen, Physikalisches Institut, Tübingen, Germany. ²² Institute of Physics and EC PRISMA⁺, Johannes Gutenberg Universität Mainz, Mainz, Germany. ²³ Department of Physics, National Taiwan University, Taipei. ²⁴ Univ. Bordeaux, CNRS, LP2I, UMR 5797, F-33170 Gradignan, France. ²⁵ Dipartimento di Fisica e Astronomia dell'Università di Padova and INFN Sezione di Padova, Padova, Italy. ²⁶ Aix Marseille Univ, CNRS/IN2P3, CPPM, Marseille, France. ²⁷ School of Physics and Technology, Wuhan University, Wuhan, China. ²⁸ Nanjing University, Nanjing, China. ²⁹ INFN Milano Bicocca and Politecnico di Milano, Milano, Italy. ³⁰ Millennium Institute for SubAtomic Physics at the High-energy

Frontier (SAPHIR), ANID, Chile. ³¹ China Nuclear Power Technology Research Institute Co., Ltd., China. ³² New Cornerstone Science Laboratory, Institute of High Energy Physics, Beijing, China. ³³ University of Warwick, Coventry, CV4 7AL, United Kingdom. ³⁴ Institute of Physics, National Yang Ming Chiao Tung University, Hsinchu. ³⁵ National United University, Miao-Li. ³⁶ GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstr. 1, D-64291 Darmstadt, Germany. ³⁷ Guangxi University, Nanning, China. ³⁸ Dongguan University of Technology, Dongguan, China. ³⁹ Shandong University, Jinan, and Key Laboratory of Particle Physics and Particle Irradiation of Ministry of Education, Shandong University, Qingdao, China. ⁴⁰ Tsinghua University, Beijing, China. ⁴¹ University of Chinese Academy of Sciences, Beijing, China. ⁴² Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou, China. ⁴³ North China Electric Power University, Beijing, China. ⁴⁴ School of Physics and Astronomy, Shanghai Jiao Tong University, Shanghai, China. ⁴⁵ Kaiping Neutrino Research Center, Guangdong, China. ⁴⁶ Department of Earth and Space Sciences, Southern University of Science and Technology, Shenzhen, China. ⁴⁷ Department of Physics and Astronomy, University of California at Irvine, Irvine, CA, USA. ⁴⁸ Beijing Institute of Spacecraft Environment Engineering, Beijing, China. ⁴⁹ Lomonosov Moscow State University, Moscow, Russia. ⁵⁰ Institute for Nuclear Research of the Russian Academy of Sciences, Moscow, Russia. ⁵¹ Universidade Estadual de Londrina, Londrina, Brazil. ⁵² INFN Sezione di Perugia and Dipartimento di Chimica, Biologia e Biotecnologie dell'Università di Perugia, Perugia, Italy. ⁵³ Université Libre de Bruxelles, Brussels, Belgium. ⁵⁴ Technische Universität München, München, Germany. ⁵⁵ Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic. ⁵⁶ Suranaree University of Technology, Nakhon Ratchasima, Thailand. ⁵⁷ School of Physics, Zhengzhou University, Zhengzhou, China. ⁵⁸ Wuyi University, Jiangmen, China. ⁵⁹ Harbin Institute of Technology, Harbin, China. ⁶⁰ Department of Physics and Earth Science, University of Ferrara and INFN Sezione di Ferrara, Ferrara, Italy. ⁶¹ Institute of Hydrogeology and Environmental Geology, Chinese Academy of Geological Sciences, Shijiazhuang, China. ⁶² China University of Geosciences,

Beijing, China. ⁶³ Forschungszentrum Jülich GmbH, Nuclear Physics Institute IKP-2, Jülich, Germany. ⁶⁴ Laboratori Nazionali di Frascati dell'INFN, Roma, Italy. ⁶⁵ Forschungszentrum Jülich GmbH, Central Institute of Engineering, Electronics and Analytics - Electronic Systems (ZEA-2), Jülich, Germany. ⁶⁶ Jinan University, Guangzhou, China. ⁶⁷ Xi'an Jiaotong University, Xi'an, China. ⁶⁸ Department of Electro-Optical Engineering, National Taipei University of Technology, Taipei. ⁶⁹ Department of Physics, National Kaohsiung Normal University, Kaohsiung. ⁷⁰ Yerevan Physics Institute, Yerevan, Armenia. ⁷¹ Nankai University, Tianjin, China. ⁷² Chengdu University of Technology, Chengdu, China. ⁷³ College of Electronic Science and Engineering, National University of Defense Technology, Changsha, China. ⁷⁴ China Institute of Atomic Energy, Beijing, China. ⁷⁵ University of South China, Hengyang, China. ⁷⁶ Tsung-Dao Lee Institute, Shanghai Jiao Tong University, Shanghai, China. ⁷⁷ University of Science and Technology of China, Hefei, China. ⁷⁸ Xiamen University, Xiamen, China. ⁷⁹ School of Physics, Peking University, Beijing, China. ⁸⁰ Pontificia Universidade Católica do Rio de Janeiro, Rio de Janeiro, Brazil. ⁸¹ Universidad Andres Bello, Fernandez Concha 700, Chile. ⁸² National Astronomical Research Institute of Thailand, Chiang Mai, Thailand. ⁸³ Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China. ⁸⁴ East China University of Technology, Nanchang, China. ⁸⁵ Deceased.