OPEN ACCESS
IOP Publishing
Journal of Physics G: Nuclear and Particle Physics
J. Phys. G: Nucl. Part. Phys. **46** (2019) 045001 (155pp)
https://doi.org/10.1088/1361-6471/aade3d

Technical design report for the $\overline{\text{P}}$ANDA Barrel DIRC detector*

B Singh[1], W Erni[2], B Krusche[2], M Steinacher[2], N Walford[2], B Liu[3], H Liu[3], Z Liu[3], X Shen[3], C Wang[3], J Zhao[3], M Albrecht[4], T Erlen[4], F Feldbauer[4], M Fink[4], M Fritsch[4], J Haase[4], F H Heinsius[4], T Held[4], T Holtmann[4], I Keshk[4], H Koch[4], B Kopf[4], M Kuhlmann[4], M Kümmel[4], S Leiber[4], M Mikirtychyants[4], P Musiol[4], A Mustafa[4], M Pelizäus[4], A Pitka[4], J Pychy[4], M Richter[4], C Schnier[4], T Schröder[4], C Sowa[4], M Steinke[4], T Triffterer[4], U Wiedner[4], M Ball[5], R Beck[5], C Hammann[5], B Ketzer[5], M Kube[5], P Mahlberg[5], M Rossbach[5], C Schmidt[5], R Schmitz[5], U Thoma[5], M Urban[5], D Walther[5], C Wendel[5], A Wilson[5], A Bianconi[6], M Bragadireanu[7], D Pantea[7], B Patel[8], W Czyzycki[9], M Domagala[9], G Filo[9], J Jaworowski[9], M Krawczyk[9], E Lisowski[9], F Lisowski[9], M Michałek[9], P Poznański[9], J Płażek[9], K Korcyl[10], A Kozela[10], P Kulessa[10], P Lebiedowicz[10], K Pysz[10], W Schäfer[10], A Szczurek[10], T Fiutowski[11], M Idzik[11], B Mindur[11], K Swientek[11], J Biernat[12], B Kamys[12], S Kistryn[12], G Korcyl[12], W Krzemien[12], A Magiera[12], P Moskal[12], A Pyszniak[12], Z Rudy[12], P Salabura[12], J Smyrski[12], P Strzempek[12], A Wronska[12], I Augustin[13], R Böhm[13], I Lehmann[13], D Nicmorus Marinescu[13], L Schmitt[13], V Varentsov[13], A Ali[14], M Al-Turany[14], A Belias[14], H Deppe[14], N Divani Veis[14], R Dzhygadlo[14], H Flemming[14], A Gerhardt[14], K Götzen[14], A Gromliuk[14], L Gruber[14], R Hohler[14], G Kalicy[14], R Karabowicz[14], R Kliemt[14], M Krebs[14], U Kurilla[14], D Lehmann[14], S Löchner[14], J Lühning[14], U Lynen[14], F Nerling[14], H Orth[14], M Patsyuk[14], K Peters[14], T Saito[14], G Schepers[14], C J Schmidt[14], C Schwarz[14], J Schwiening[14,66], A Täschner[14], M Traxler[14], C Ugur[14], B Voss[14], P Wieczorek[14], A Wilms[14], M Zühlsdorf[14], V Abazov[15], G Alexeev[15], V A Arefiev[15], V Astakhov[15], M Yu Barabanov[15], B V Batyunya[15], Y Davydov[15], V Kh Dodokhov[15], A Efremov[15], A Fechtchenko[15],

* The use of registered names, trademarks, etc in this publication does not imply, even in the absence of specific statement, that such names are exempt from the relevant laws and regulations and therefore free for general use.

A G Fedunov[15], A Galoyan[15], S Grigoryan[15], E K Koshurnikov[15], Y Yu Lobanov[15], V I Lobanov[15], A F Makarov[15], L V Malinina[15], V Malyshev[15], A G Olshevskiy[15], E Perevalova[15], A A Piskun[15], T Pocheptsov[15], G Pontecorvo[15], V Rodionov[15], Y Rogov[15], R Salmin[15], A Samartsev[15], M G Sapozhnikov[15], G Shabratova[15], N B Skachkov[15], A N Skachkova[15], E A Strokovsky[15], M Suleimanov[15], R Teshev[15], V Tokmenin[15], V Uzhinsky[15], A Vodopianov[15], S A Zaporozhets[15], N I Zhuravlev[15], A Zinchenko[15], D Branford[16], D Glazier[16], D Watts[16], M Böhm[17], A Britting[17], W Eyrich[17], A Lehmann[17], M Pfaffinger[17], F Uhlig[17], S Dobbs[18], K Seth[18], A Tomaradze[18], T Xiao[18], D Bettoni[19], V Carassiti[19], A Cotta Ramusino[19], P Dalpiaz[19], A Drago[19], E Fioravanti[19], I Garzia[19], M Savrie[19], V Akishina[20], S Gorbunov[20], I Kisel[20], G Kozlov[20], M Pugach[20], M Zyzak[20], P Gianotti[21], C Guaraldo[21], V Lucherini[21], A Bersani[22], G Bracco[22], M Macri[22], R F Parodi[22], K Biguenko[23], K T Brinkmann[23], V Di Pietro[23], S Diehl[23], V Dormenev[23], M Düren[23], E Etzelmüller[23], K Föhl[23], M Galuska[23], E Gutz[23], C Hahn[23], A Hayrapetyan[23], M Kesselkaul[23], K Kreutzfeldt[23], W Kühn[23], T Kuske[23], J S Lange[23], Y Liang[23], V Metag[23], M Moritz[23], M Nanova[23], R Novotny[23], T Quagli[23], S Reiter[23], A Riccardi[23], J Rieke[23], C Rosenbaum[23], M Schmidt[23], R Schnell[23], H Stenzel[23], U Thöring[23], M N Wagner[23], T Wasem[23], B Wohlfahrt[23], H G Zaunick[23], E Tomasi-Gustafsson[24], D Ireland[25], G Rosner[25], B Seitz[25], P N Deepak[26], A Kulkarni[26], A Apostolou[27], M Babai[27], M Kavatsyuk[27], P J Lemmens[27], M Lindemulder[27], H Loehner[27], J Messchendorp[27], P Schakel[27], H Smit[27], M Tiemens[27], J C van der Weele[27], R Veenstra[27], S Vejdani[27], S Vejdani[27], K Dutta[28], K Kalita[28], A Kumar[29], A Roy[29], H Sohlbach[30], M Bai[31], L Bianchi[31], M Büscher[31], L Cao[31], A Cebulla[31], R Dosdall[31], A Erven[31], V Fracassi[31], A Gillitzer[31], F Goldenbaum[31], D Grunwald[31], A Herten[31], Q Hu[31], L Jokhovets[31], G Kemmerling[31], H Kleines[31], A Lai[31], A Lehrach[31], R Nellen[31], H Ohm[31], S Orfanitski[31], D Prasuhn[31], E Prencipe[31], J Pütz[31], J Ritman[31], E Rosenthal[31], S Schadmand[31], T Sefzick[31], V Serdyuk[31], G Sterzenbach[31], T Stockmanns[31], P Wintz[31], P Wüstner[31], H Xu[31], S Li[32], Z Li[32], Z Sun[32], H Xu[32], V Rigato[33], L Isaksson[34], P Achenbach[35], A Aycock[35], O Corell[35], A Denig[35], M Distler[35], M Hoek[35], A Karavdina[35], W Lauth[35], Z Liu[35], H Merkel[35], U Müller[35], J Pochodzalla[35], S Sanchez[35], S Schlimme[35], C Sfienti[35], M Thiel[35], H Ahmadi[36],

S Ahmed[36], S Bleser[36], L Capozza[36], M Cardinali[36], A Dbeyssi[36], M Deiseroth[36], A Ehret[36], B Fröhlich[36], D Kang[36], D Khaneft[36], R Klasen[36], H H Leithoff[36], D Lin[36], F Maas[36], S Maldaner[36], M Martínez[36], M Michel[36], M C Mora Espí, C Morales Morales[36], C Motzko[36], O Noll[36], S Pflüger[36], D Rodríguez Piñeiro[36], A Sanchez-Lorente[36], M Steinen[36], R Valente[36], M Zambrana[36], I Zimmermann[36], A Fedorov[37], M Korjik[37], O Missevitch[37], A Balashoff[38], A Boukharov[38], O Malyshev[38], I Marishev[38], P Balanutsa[39], V Balanutsa[39], V Chernetsky[39], A Demekhin[39], A Dolgolenko[39], P Fedorets[39], A Gerasimov[39], V Goryachev[39], V Chandratre[40], V Datar[40], D Dutta[40], V Jha[40], H Kumawat[40], A K Mohanty[40], A Parmar[40], A K Rai[40], B Roy[40], G Sonika[40], C Fritzsch[41], S Grieser[41], A K Hergemöller[41], B Hetz[41], N Hüsken[41], A Khoukaz[41], J P Wessels[41], K Khosonthongkee[42], C Kobdaj[42], A Limphirat[42], P Srisawad[42], Y Yan[42], E Antokhin[43], A Yu Barnyakov[43], M Barnyakov[43], K Beloborodov[43], V E Blinov[43], V S Bobrovnikov[43], I A Kuyanov[43], K Martin[43], A P Onuchin[43], S Pivovarov[43], E Pyata[43], S Serednyakov[43], A Sokolov[43], Y Tikhonov[43], A E Blinov[44], S Kononov[44], E A Kravchenko[44], E Atomssa[45], R Kunne[45], D Marchand[45], B Ramstein[45], J van de Wiele[45], Y Wang[45], G Boca[46], S Costanza[46], P Genova[46], P Montagna[46], A Rotondi[46], M Bodlak[47], M Finger[47], M Finger[47], A Nikolovova[47], M Pesek[47], M Peskova[47], M Pfeffer[47], I Prochazka[47], M Slunecka[47], P Gallus[48], V Jary[48], J Novy[48], M Tomasek[48], M Virius[48], V Vrba[48], V Abramov[49], N Belikov[49], S Bukreeva[49], A Davidenko[49], A Derevschikov[49], Y Goncharenko[49], V Grishin[49], V Kachanov[49], V Kormilitsin[49], A Levin[49], Y Melnik[49], N Minaev[49], V Mochalov[49], D Morozov[49], L Nogach[49], S Poslavskiy[49], A Ryazantsev[49], S Ryzhikov[49], P Semenov[49], I Shein[49], A Uzunian[49], A Vasiliev[49], A Yakutin[49], U Roy[50], B Yabsley[51], S Belostotski[52], G Gavrilov[52], A Izotov[52], S Manaenkov[52], O Miklukho[52], D Veretennikov[52], A Zhdanov[52], K Makonyi[53], M Preston[53], P E Tegner[53], D Wölbing[53], T Bäck[54], B Cederwall[54], S Godre[55], F Balestra[56], F Iazzi[56], R Introzzi[56], A Lavagno[56], J Olave[56], A Amoroso[57], M P Bussa[57], L Busso[57], M Destefanis[57], L Fava[57], L Ferrero[57], M Greco[57], J Hu[57], L Lavezzi[57], M Maggiora[57], G Maniscalco[57], S Marcello[57], S Sosio[57], S Spataro[57], D Calvo[58], S Coli[58], P De Remigis[58], A Filippi[58], G Giraudo[58], S Lusso[58], G Mazza[58], M Mignone[58], A Rivetti[58], R Wheadon[58], R Birsa[59], F Bradamante[59], A Bressan[59], A Martin[59], H Calen[60], W Ikegami Andersson[60],

T Johansson[60], A Kupsc[60], P Marciniewski[60], M Papenbrock[60], J Pettersson[60], K Schönning[60], M Wolke[60], B Galnander[61], J Diaz[62], V Pothodi Chackara[63], A Chlopik[64], G Kesik[64], D Melnychuk[64], B Slowinski[64], A Trzcinski[64], M Wojciechowski[64], S Wronka[64], B Zwieglinski[64], P Bühler[65], J Marton[65], D Steinschaden[65], K Suzuki[65], E Widmann[65], S Zimmermann[65] and J Zmeskal[65]

[1] Aligarth Muslim University, Physics Department, Aligarth, India
[2] Universität Basel, Basel, Switzerland
[3] Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, People's Republic of China
[4] Ruhr-Universität Bochum, Institut für Experimentalphysik I, Bochum, Germany
[5] Rheinische Friedrich-Wilhelms-Universität Bonn, Bonn, Germany
[6] Universitá di Brescia, Brescia, Italy
[7] Institutul National de C&D pentru Fizica si Inginerie Nucleara 'Horia Hulubei', Bukarest-Magurele, Romania
[8] P.D. Patel Institute of Applied Science, Department of Physical Sciences, Changa, India
[9] University of Technology, Institute of Applied Informatics, Cracow, Poland
[10] IFJ, Institute of Nuclear Physics PAN, Cracow, Poland
[11] AGH, University of Science and Technology, Cracow, Poland
[12] Instytut Fizyki, Uniwersytet Jagiellonski, Cracow, Poland
[13] FAIR, Facility for Antiproton and Ion Research in Europe, Darmstadt, Germany
[14] GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany
[15] Veksler-Baldin Laboratory of High Energies (VBLHE), Joint Institute for Nuclear Research, Dubna, Russia
[16] University of Edinburgh, Edinburgh, United Kingdom
[17] Friedrich Alexander Universität Erlangen-Nürnberg, Erlangen, Germany
[18] Northwestern University, Evanston, United States of America
[19] Universitá di Ferrara and INFN Sezione di Ferrara, Ferrara, Italy
[20] Frankfurt Institute for Advanced Studies, Frankfurt, Germany
[21] INFN Laboratori Nazionali di Frascati, Frascati, Italy
[22] INFN Sezione di Genova, Genova, Italy
[23] Justus Liebig-Universität Gießen II. Physikalisches Institut, Gießen, Germany
[24] IRFU, CEA, Université Paris-Saclay, Gif-sur-Yvette Cedex, France
[25] University of Glasgow, Glasgow, United Kingdom
[26] Birla Institute of Technology and Science, Pilani, K K Birla Goa Campus, Goa, India
[27] KVI-Center for Advanced Radiation Technology (CART), University of Groningen, Groningen, Netherlands
[28] Gauhati University, Physics Department, Guwahati, India
[29] Indian Institute of Technology Indore, School of Science, Indore, India
[30] Fachhochschule Südwestfalen, Iserlohn, Germany
[31] Forschungszentrum Jülich, Institut für Kernphysik, Jülich, Germany
[32] Chinese Academy of Science, Institute of Modern Physics, Lanzhou, People's Republic of China
[33] INFN Laboratori Nazionali di Legnaro, Legnaro, Italy
[34] Lunds Universitet, Department of Physics, Lund, Sweden
[35] Johannes Gutenberg-Universität, Institut für Kernphysik, Mainz, Germany
[36] Helmholtz-Institut Mainz, Mainz, Germany
[37] Research Institute for Nuclear Problems, Belarus State University, Minsk, Belarus
[38] Moscow Power Engineering Institute, Moscow, Russia

[39] Institute for Theoretical and Experimental Physics, Moscow, Russia
[40] Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai, India
[41] Westfälische Wilhelms-Universität Münster, Münster, Germany
[42] Suranaree University of Technology, Nakhon Ratchasima, Thailand
[43] Budker Institute of Nuclear Physics, Novosibirsk, Russia
[44] Novosibirsk State University, Novosibirsk, Russia
[45] Institut de Physique Nucléaire, CNRS-IN2P3, Univ. Paris-Sud, Université Paris-Saclay, F-91406, Orsay cedex, France
[46] Dipartimento di Fisica, Universitá di Pavia, INFN Sezione di Pavia, Pavia, Italy
[47] Charles University, Faculty of Mathematics and Physics, Prague, Czechia
[48] Czech Technical University, Faculty of Nuclear Sciences and Physical Engineering, Prague, Czechia
[49] Institute for High Energy Physics, Protvino, Russia
[50] Sikaha-Bhavana, Visva-Bharati, WB, Santiniketan, India
[51] University of Sidney, School of Physics, Sidney, Australia
[52] National Research Centre 'Kurchatov Institute' B. P. Konstantinov Petersburg Nuclear Physics Institute, Gatchina, St. Petersburg, Russia
[53] Stockholms Universitet, Stockholm, Sweden
[54] Kungliga Tekniska Högskolan, Stockholm, Sweden
[55] Veer Narmad South Gujarat University, Department of Physics, Surat, India
[56] Politecnico di Torino and INFN Sezione di Torino, Torino, Italy
[57] Universitá di Torino and INFN Sezione di Torino, Torino, Italy
[58] INFN Sezione di Torino, Torino, Italy
[59] Universitá di Trieste and INFN Sezione di Trieste, Trieste, Italy
[60] Uppsala Universitet, Institutionen för fysik och astronomi, Uppsala, Sweden
[61] The Svedberg Laboratory, Uppsala, Sweden
[62] Instituto de Física Corpuscular, Universidad de Valencia-CSIC, Valencia, Spain
[63] Sardar Patel University, Physics Department, Vallabh Vidynagar, India
[64] National Centre for Nuclear Research, Warsaw, Poland
[65] Österreichische Akademie der Wissenschaften, Stefan Meyer Institut für Subatomare Physik, Wien, Austria

E-mail: j.schwiening@gsi.de

Received 17 November 2017, revised 13 April 2018
Accepted for publication 31 August 2018
Published 28 February 2019

Abstract

The $\overline{\mathrm{P}}$ANDA (anti-Proton ANnihiliation at DArmstadt) experiment will be one of the four flagship experiments at the new international accelerator complex FAIR (Facility for Antiproton and Ion Research) in Darmstadt, Germany. $\overline{\mathrm{P}}$ANDA will address fundamental questions of hadron physics and quantum chromodynamics using high-intensity cooled antiproton beams with momenta between 1.5 and 15 GeV/c and a design luminosity of up to $2 \times 10^{32}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$. Excellent particle identification (PID) is crucial to the success of the $\overline{\mathrm{P}}$ANDA physics program. Hadronic PID in the barrel region of the target spectrometer will be performed by a

[66] Author to whom any correspondence should be addresed.