PARTICLE DETECTORS

Second Edition

The scope of the detection techniques in particle detectors is very wide, depending on the aim of the measurement. Each physics phenomenon can be used as the basis for a particle detector. Elementary particles have to be identified with various techniques, and relevant quantities like time, energy, and spatial coordinates have to be measured. Particle physics requires extremely high accuracies for these quantities using multipurpose installations as well as dedicated experimental set-ups. Depending on the aim of the measurement, different effects are used. Detectors cover the measurement of energies from very low energies (micro-electron-volts) to the highest of energies observed in cosmic rays.

Describing the current state-of-the-art instrumentation for experiments in high energy physics and astroparticle physics, this new edition covers track detectors, calorimeters, particle identification, neutrino detectors, momentum measurement, electronics and data analysis. It also discusses up-to-date applications of these detectors in other fields such as nuclear medicine, radiation protection and environmental science. Problem sets have been added to each chapter and additional instructive material has been provided, making this an excellent reference for graduate students and researchers in particle physics. This title, first published in 2008, has been reissued as an Open Access publication on Cambridge Core.

Claus Grupen is Professor Dr in the Department of Physics at Siegen University. He was awarded the Special High Energy and Particle Physics Prize of the European Physical Society for establishing the existence of the gluon in independent and simultaneous ways, as member of the PLUTO experiment at DESY in 1995.

Boris Shwartz is a Leading Researcher at the Budker Institute of Nuclear Physics. He has worked on the development and construction of the detectors used in several projects, including the KEDR and CMD-2 detectors, and WASA and Belle experiments.

Published online by Cambridge University Press

CAMBRIDGE MONOGRAPHS ON PARTICLE PHYSICS, NUCLEAR PHYSICS AND COSMOLOGY 26

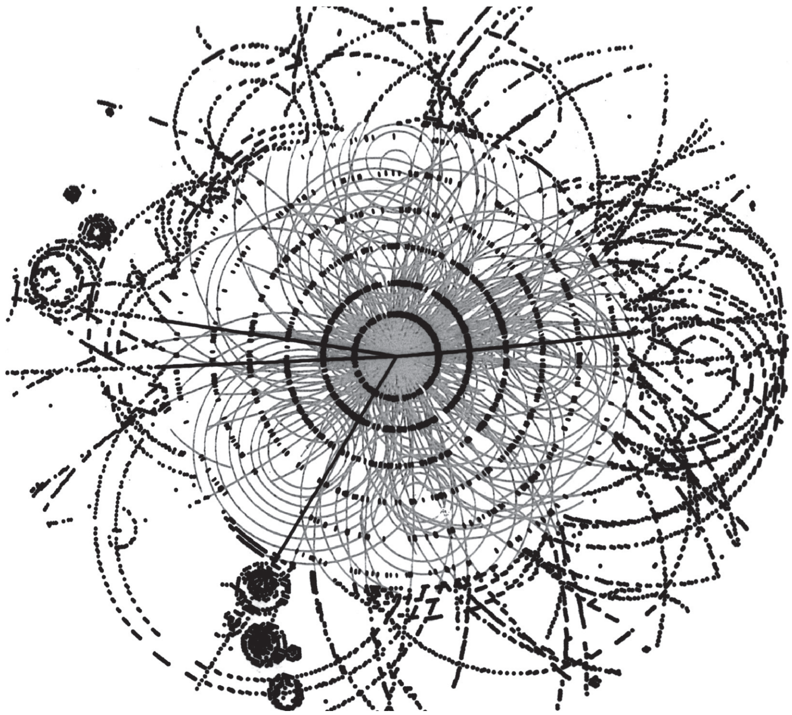
General Editors: T. Ericson, P.V. Landshoff

1. K. Winter (ed.): *Neutrino Physics*
2. J. F. Donoghue, E. Golowich and B. R. Holstein: *Dynamics of the Standard Model*
3. E. Leader and E. Predazzi: *An Introduction to Gauge Theories and Modern Particle Physics, Volume 1: Electroweak Interactions, the 'New Particles' and the Parton Model*
4. E. Leader and E. Predazzi: *An Introduction to Gauge Theories and Modern Particle Physics, Volume 2: CP-Violation, QCD and Hard Processes*
5. C. Grupen: *Particle Detectors*
6. H. Grosse and A. Martin: *Particle Physics and the Schrödinger Equation*
7. B. Anderson: *The Lund Model*
8. R. K. Ellis, W. J. Stirling and B. R. Webber: *QCD and Collider Physics*
9. I. I. Bigi and A. I. Sanda: *CP Violation*
10. A. V. Manohar and M. B. Wise: *Heavy Quark Physics*
11. R. K. Bock, H. Grote, R. Frühwirth and M. Regler: *Data Analysis Techniques for High-Energy Physics, Second Edition*
12. D. Green: *The Physics of Particle Detectors*
13. V. N. Gribov and J. Nyiri: *Quantum Electrodynamics*
14. K. Winter (ed.): *Neutrino Physics, Second Edition*
15. E. Leader: *Spin in Particle Physics*
16. J. D. Walecka: *Electron Scattering for Nuclear and Nucleon Scattering*
17. S. Narison: *QCD as a Theory of Hadrons*
18. J. F. Letessier and J. Rafelski: *Hadrons and Quark-Gluon Plasma*
19. A. Donnachie, H. G. Dosch, P. V. Landshoff and O. Nachtmann: *Pomeron Physics and QCD*
20. A. Hoffmann: *The Physics of Synchrotron Radiation*
21. J. B. Kogut and M. A. Stephanov: *The Phases of Quantum Chromodynamics*
22. D. Green: *High P_T Physics at Hadron Colliders*
23. K. Yagi, T. Hatsuda and Y. Miake: *Quark-Gluon Plasma*
24. D. M. Brink and R. A. Broglia: *Nuclear Superfluidity*
25. F. E. Close, A. Donnachie and G. Shaw: *Electromagnetic Interactions and Hadronic Structure*
26. C. Grupen and B. A. Shwartz: *Particle Detectors, Second Edition*

Published online by Cambridge University Press

Published online by Cambridge University Press

Simulation of a Higgs-boson production in proton–proton interactions in the ATLAS experiment at the Large Hadron Collider (LHC) at CERN. The Higgs decays into a pair of Z bosons, each of which decays in turn into muons pairs. The four muons are indicated by the four straight lines. The hadronic background originates from the interactions of spectator quarks and other interactions in the same beam crossing.
(With permission of the CERN photo archive.)



Published online by Cambridge University Press

PARTICLE DETECTORS

Second Edition

CLAUS GRUPEN
University of Siegen

BORIS SHWARTZ
Budker Institute of Nuclear Physics, Novosibirsk

with contributions from
HELMUTH SPIELER, *Lawrence Berkeley National Laboratory*
SIMON EIDELMAN, *Budker Institute of Nuclear Physics, Novosibirsk*
TILO STROH, *University of Siegen*

CAMBRIDGE
UNIVERSITY PRESS

Published online by Cambridge University Press

CAMBRIDGE
UNIVERSITY PRESS

Shaftesbury Road, Cambridge CB2 8EA, United Kingdom

One Liberty Plaza, 20th Floor, New York, NY 10006, USA

477 Williamstown Road, Port Melbourne, VIC 3207, Australia

314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi – 110025, India

103 Penang Road, #05-06/07, Visioncrest Commercial, Singapore 238467

Cambridge University Press is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

We share the University's mission to contribute to society through the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781009401494

DOI: 10.1017/9781009401531

© Claus Grupen and Boris Shwartz 2008

This work is in copyright. It is subject to statutory exceptions and to the provisions of relevant licensing agreements; with the exception of the Creative Commons version the link for which is provided below, no reproduction of any part of this work may take place without the written permission of Cambridge University Press.

An online version of this work is published at doi.org/10.1017/9781009401531 under a Creative Commons Open Access license CC-BY-NC-ND 4.0 which permits re-use, distribution and reproduction in any medium for non-commercial purposes providing appropriate credit to the original work is given. You may not distribute derivative works without permission. To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-nd/4.0

All versions of this work may contain content reproduced under license from third parties. Permission to reproduce this third-party content must be obtained from these third-parties directly.

When citing this work, please include a reference to the DOI 10.1017/9781009401531

First published 2008
Reissued as OA 2023

A catalogue record for this publication is available from the British Library.

ISBN 978-1-009-40149-4 Hardback
ISBN 978-1-009-40151-7 Paperback

Cambridge University Press & Assessment has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

Published online by Cambridge University Press