Introduction to experimental particle physics

Contributions to the field of experimental particle physics have been accumulating in the literature over the past 40 years and now compose a vast but scattered array of reports and monographs. This book ties together the most important experimental topics into a brief but balanced overview.

The author first gives a review of particle physics and discusses electromagnetic and nuclear interactions. He then goes on to discuss three nearly universal aspects of particle physics experiments: beams, targets, and fast electronics. The second part of the book treats in detail the properties of various types of particle detectors, such as scintillation counters, Cerenkov counters, proportional chambers, drift chambers, sampling calorimeters, and specialized detectors. Wherever possible the author attempts to enumerate the advantages and disadvantages of each detector, and to specify the factors that limit a detector's performance. Finally, the author discusses aspects of specific particle physics experiments, such as properties of triggers, types of measurements, spectrometers, and the integration of detectors into a coherent system.

Throughout the book, the author has attempted to begin each chapter with a discussion of the basic principles involved and follow it by selective examples. Although it is not meant to be a complete survey of experimental particle physics, nevertheless, this book contains much practical information to provide readers with sufficient background in the subject. It will be a useful reference for particle physicists, nuclear physicists, and graduate students studying these topics.

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Preface

I have felt for some time that there should be a book that briefly ties together the most important topics in experimental particle physics. The biggest difficulty I have encountered in trying to do this is not that information concerning this subject is lacking, but rather that so much of it exists. Reports on experimental techniques and devices can be found scattered through specialized monographs, conference proceedings, data compilations, review papers, and journal articles. I have had to make enumerable, arbitrary selections in order to produce what I hope is a balanced overview of the subject in a book of reasonable length. I hope that the final product will be useful to graduate students and to others interested in an introduction to the subject and as a reference for practitioners in the field.

The first three chapters give an overview of the subject and discuss the electromagnetic and nuclear interactions of particles. A knowledge of particle interactions is necessary for an understanding of how detectors work, besides being interesting in their own right. The next three chapters are concerned with three nearly universal aspects of particle physics experiments: beams, targets, and fast electronics. Chapters 7 through 12 contain more detailed discussions of various types of detectors. Whenever possible I have attempted to enumerate the advantages and disadvantages of each detector and to specify the factors that limit its performance. The last three chapters are concerned with integrating detectors into a coherent system. A number of examples of specific experiments are given in the last chapter.

Most of the chapters begin with a discussion of basic principles and are followed with selective examples. I have made no attempt to completely survey all the contributions that have been made to each topic. After

nearly 40 years the literature is so vast that even if someone contemplated such a project, it would probably require a dozen volumes the size of this one. Although I have included a great deal of practical information, no one should expect to be able to go out and build a detector after reading this book. The successful application of experimental physics almost always requires a period of apprenticeship with an experienced tutor. I do hope, however, that the reader will gain sufficient background to at least start "asking the right questions."

As regards the references, in most cases I have adopted the philosophy of quoting recent articles that I believe contained sufficient details to be useful to an uninitiated reader, rather than making literature searches back to the original papers. Since this book is neither a review paper nor a history, I have preferred this method because the referenced material usually illustrates current applications and techniques and because the reader can always use the references in the cited paper as a starting point for a search if so inclined.

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R. C. Fernow