# Bringing Experiment to the Foreground

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This book grows from a simple conviction: the principles of experimentation deserve center stage in introductory physics labs.

Physics laboratories offer the perfect setting for this approach. Their systems and theories strike that ideal balance—complex enough to be meaningful, yet simple enough that students can see the bones of experimental method beneath. The beauty of focusing on experimental principles is that it serves everyone in the room—future physicists certainly, but equally those bound for engineering, medicine, business, or the arts. Everyone benefits from understanding how we know what we claim to know.

The experimental landscape has transformed dramatically in recent decades. New instruments have played their part, but the computing revolution has fundamentally reimagined what’s possible. Analyses that once demanded weeks of calculation now happen instantaneously. Computer-controlled apparatus adjusts in real-time. Data visualization reveals patterns invisible to earlier generations of scientists.

Yet beneath these technological advances, the fundamental principles remain unchanged. In fact, understanding these principles may matter more now than ever before. Modern lab setups can create a kind of experimental black box—data flows in, answers flow out, but the phenomena themselves remain hidden behind layers of processing. Without a deep understanding of what happens at each stage, invisible flaws can produce seemingly valid but meaningless results. Surrendering experimental thinking to computers is a perilous path.

The textbook unfolds naturally through this territory. Chapter 1 establishes our experimental-centered approach to physics laboratories. Chapters 2-4 build the essential knowledge foundation—measurement theory, statistical thinking, and scientific methodology. Chapter 5 walks through practical experiment design with clarity and purpose, while Chapter 6 shows how to evaluate experimental results thoughtfully. Chapter 7 guides students through communicating their work effectively.

This textbook introduces material on computer-based experimental methods without losing sight of the principles that make them meaningful. The appendices offer deeper dives where needed, including mathematical foundations and a complete sample experiment that demonstrates the entire journey—from initial design questions through careful execution to the final research report.