How do particle physicists learn the programming concepts they need?

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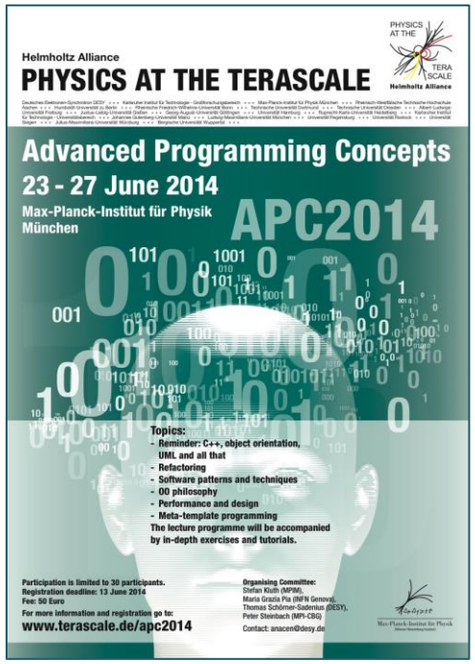
The ability to **judge**, **use** and **develop** code **efficiently** and **successfully** is a **key ingredient in modern particle physics.**

Nevertheless, despite the consensus on this appraisal in the HEP community, many concepts and techniques that are essential to working effectively in HEP experiments are not covered in university studies, and limited opportunities are available to students to learn them after that.

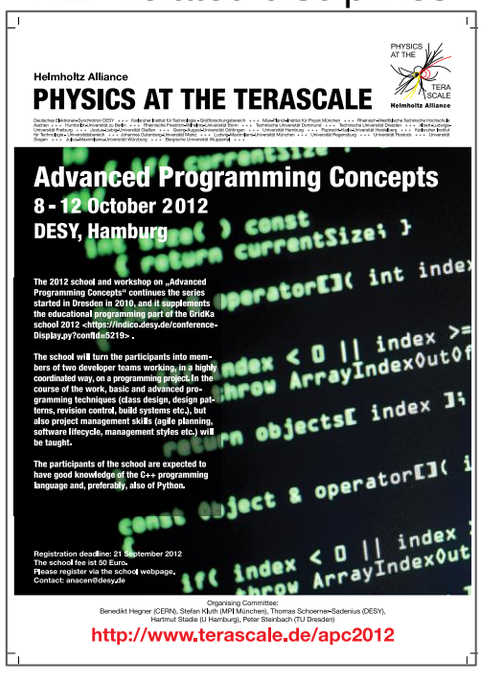
The **Advanced Programming Concepts** workshop addresses the needs of programming knowledge that **"normal"** young particle physicists experience experience in their **everyday activity** in HEP experiments, such as physics analysis and detector development**.** It differs from other computing schools for physicists, as it bridges the yet unfilled gap between beginner courses and core developer training.

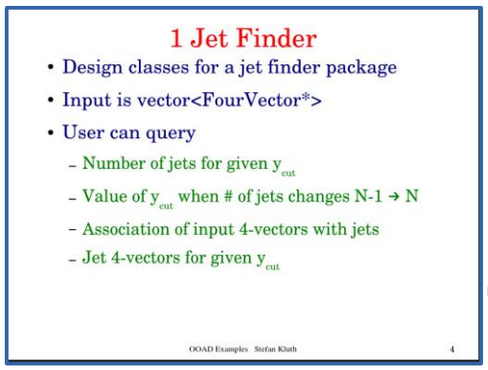
The program introduces basic and advanced **programming techniques**, along with elements of the **software development process** and **project management** skills.

It encompasses lectures, extensive hands-on practice and open discussions. Focus is on **concepts** and **methods**, not only on technology. Emphasis is given to working effectively with existing code and to building a basis for further self-improvement in the field.



4 workshops in 4 years,
138 participants
across experiments and HEP related disciplines





Software Design

It plays a fundamental role in the software development process and is instrumental to many critical aspects in the life-cycle of an experiment. Transparency of software design enables the validation of physics results, contributes to the effective use of human and computational resources, facilitates the evolution and the maintainability of the software. Nevertheless, young physicists seldom receive an education in software design.

- **Principles of Object Oriented Design**
- **UML**
- **Design Patterns**

Dealing with Existing Software

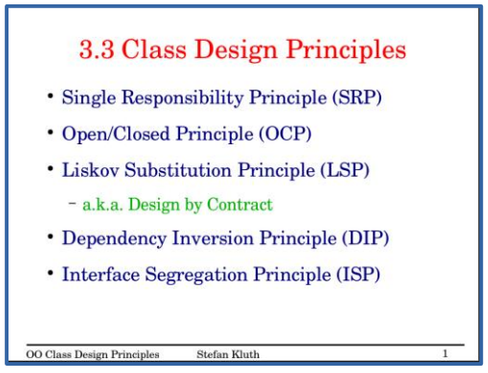
The workshop addresses the situation that students most commonly face in HEP experiments: using the code of others. They learn methods and techniques to work effectively with legacy code and to improve it.

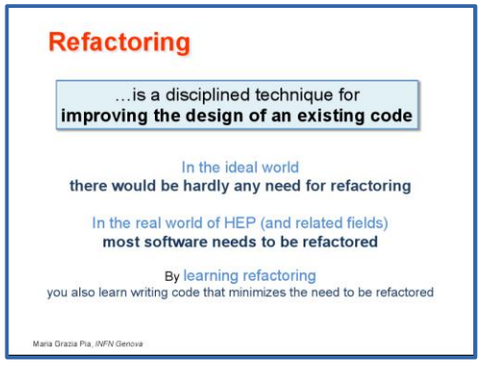
- **Refactoring**

Programming Techniques

Some advanced programming techniques are introduced with the support of live coding sessions.

- **Design and Performance**
- **Meta-template programming**





"This workshop should be on everyone's curriculum in Particle Physics."

A participant of the 2014 APC School