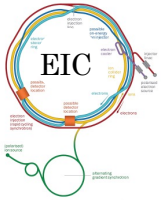
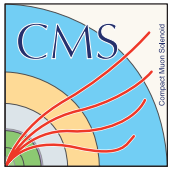
Training and onboarding initiatives in HEP





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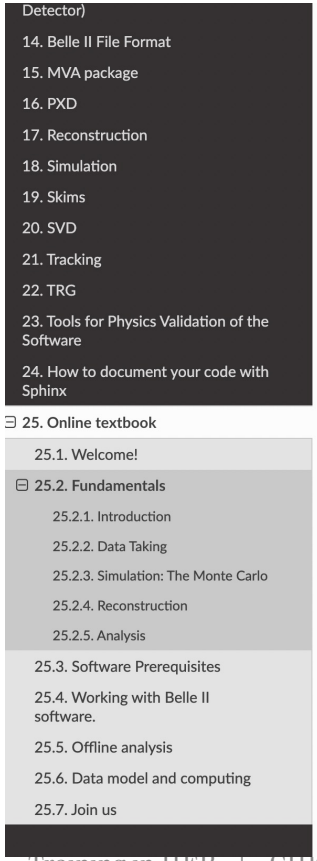
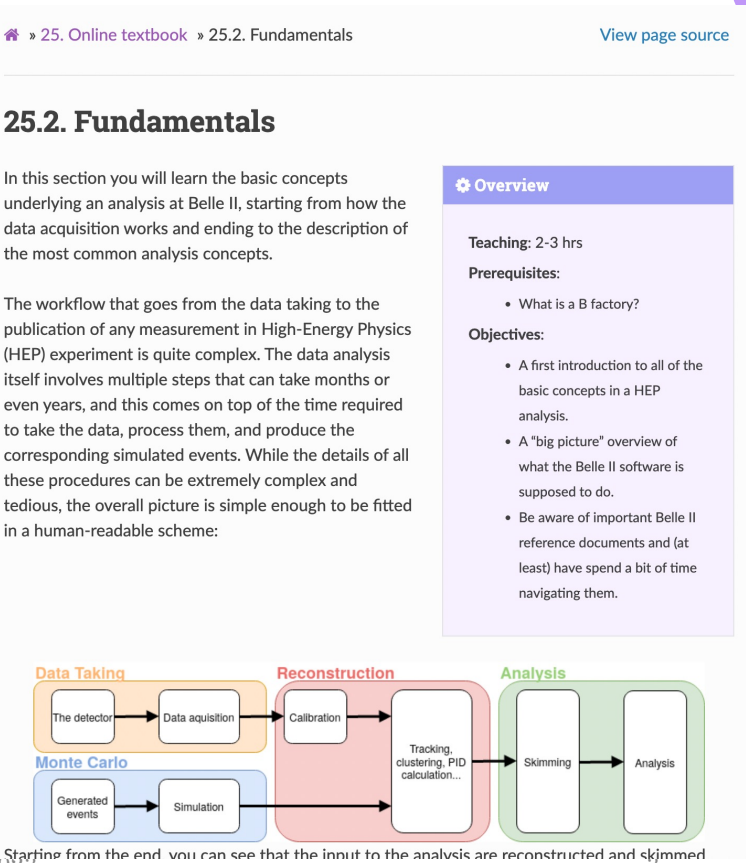
How do experiments teach analysis software?

- The software is different, but the **goals** and **challenges** are common
  - Train new collaboration members on analysis software tools to enable the physics goals of each experiment
- HSF Data Analysis Working Group (DAWG) and HSF Training Group hosted a discussion in summer 2022
  - Presentations from CMS, ATLAS, LHCb, Belle II, EIC, DUNE
  - Opportunity to learn from each other and share experiences
- Here focusing on experiment-specific training. See talk tomorrow for experiment-independent training initiatives in HSF

Belle II online textbook

- Focus on **self-study** as the primary training mode: https://training.belle2.org/
- Comprehensive onboarding experience, covering basic physics knowledge and collaborative tools to software prerequisites and grid job submissions





Belle II online textbook

- Hosted directly in the Belle II software framework repository, rendered via Sphinx
  - Plain text files in rst format
- Training materials are linked to relevant parts of the technical documentation (API documentation)
  - Teaching newcomers to use these resources is an objective in itself
  - Points intermediate learners to in-depth resources without sacrificing clarity
- **Unit testing** keeps materials up-to-date
  - No pull request can be merged without updating the relevant training material

LHCb StarterKit

- An introductory workshop aimed at young PhDs and advanced masters
  - No prior knowledge needed
  - 2 days: bash, gitlab and python (incl PyHEP)
  - 3 days : LHCb software
- Emphasizes **peer-to-peer instruction**: facilitators are mainly PhDs and young postdocs
  - Easier to ask questions to peers rather than senior collaboration members
  - Needs of newcomers are well-known to PhD students
  - Networking to improve the cohesion of early-career scientists within the collaboration
  - Fresh eyes each year helps keep materials up-to-date and relevant
- Pre-covid: 100 participants, in-person, including social events
- Post-covid: hybrid format is a hit, but networking is difficult for online-only participants

LHCb additional training resources

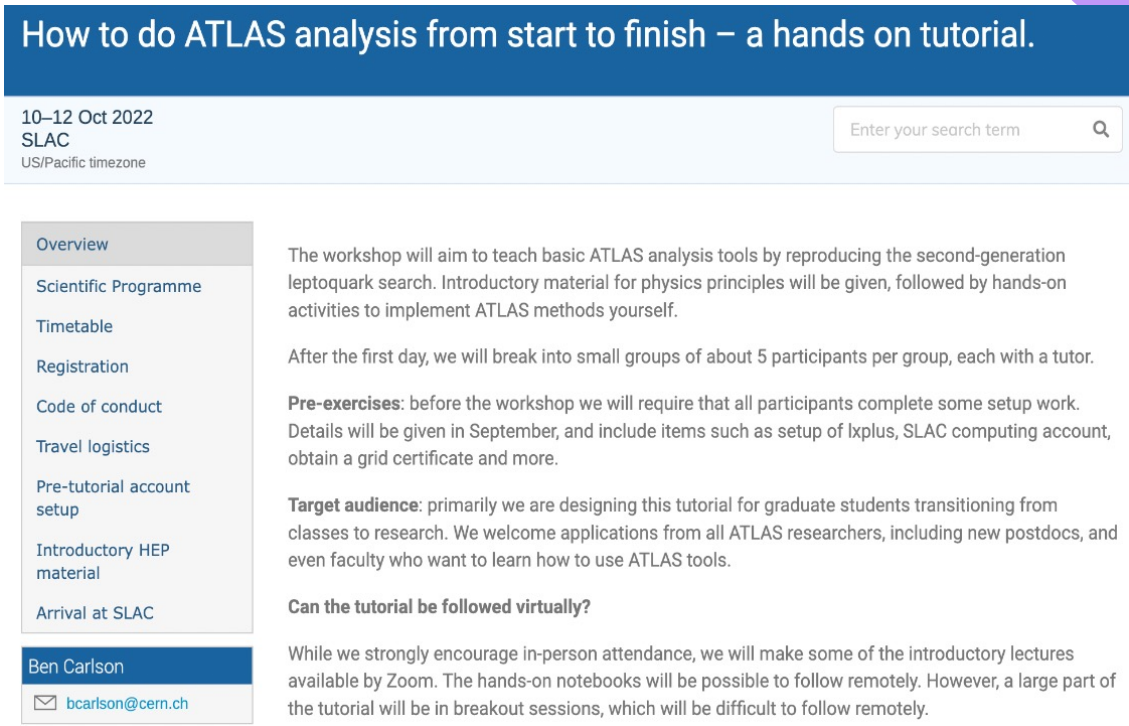
- ImpactKit: More advanced training, building on the Starterkit
  - 4 days: trigger lines development, local and custom MC, etc
  - Last held in 2021 + series of online talks in 2020
- Standalone lectures:
  - LHCb-UK student talks: explain a single aspect of the LHCb machine or LHCb analyses
  - StarterTalk: hour-long lecture on LHCb topics during LHCb collaboration week
- LHC Glossary: community-driven effort to define jargon and acronyms

ATLAS software tutorials

- Offered 3-4 times per year, coupled to the ATLAS Induction Day
- Targeting new PhD students, postdocs, and faculty
- Covers primary software necessary for data analysis
  - Setting up CERN computing accounts, grid credentials, etc.
  - Core analysis software framework, data formats, analysis workflows, tools for finding and accessing data, statistical tools
- Post-covid: moving to a **hybrid format**
  - Live lectures for those attending in-person or synchronously via Zoom
  - Videos/slides available for anyone attending asynchronously
  - Combined live Q&A session at 15:00 CEST
  - Hands-on exercise help conducted in-person and on Discord

ATLAS software tutorials: new format!

- **New tutorial design,** first tested in October 2022
- Interactive, hands-on and project-based structure with the aim of conducting end-to-end physics analysis
  - Working in teams (4-6 people) to perform a search for second-generation leptoquarks from start to finish
- See dedicated poster presentation



CMS Data Analysis Schools (DAS)

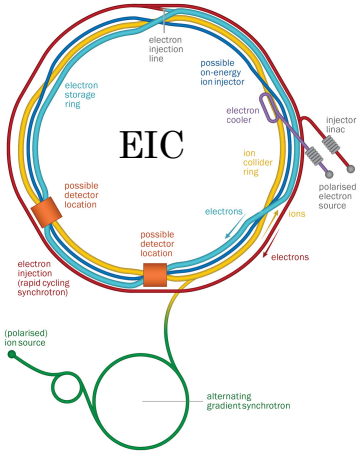
Weeklong schools held 2-3x per year since 2011, with ~50-70 students, 50 facilitators

Emphasizes hands-on exercises and networking

- **Pre-exercises:** mandatory setup before start of the school
- **Lectures:** introduction to LHC, CMS physics, detector, software/analysis etc.
- **Short Exercises:** about physics objects and basic analysis ingredients
- **Long Exercises:** students are assigned to teams and go through a full physics analysis
- **Mini-Symposium:** presentation of results from all teams

CMS Hands-on Tutorial Sessions (HATS)

- 15-20 per year since 2013, generally hybrid with video recordings and transcripts
- Focused tutorials:
  - Specific physics objects (jets, MET, electrons, etc.)
  - Tools for data analysis (Git, uproot, ML, etc.)
- Offered at Fermilab LPC (LHC Physics Center) in Spring/ Summer, but is a useful reference year-round
- Shifting to Carpentries format to simplify maintenance



EIC software development

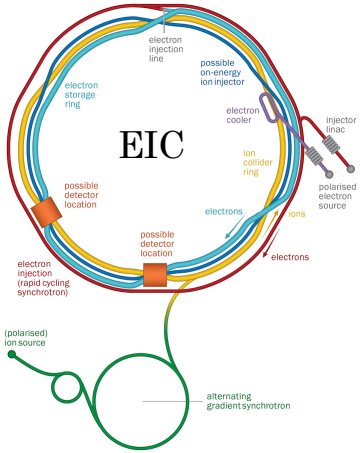
- Ongoing initiatives to organize EIC collaboration around a single software stack, focusing on **user-centered design**
- See EIC overview talk this afternoon!

User-Centered Design:
- State of Software Survey
- Follow-up Focus Groups
- Develop Testing Community

Discoverable Software:
- Single Point of Entry (~ key4hep)
- Feasible Option for >80% of EIC Simulations and Analyses

Workflows:
- Template Repositories for Key Analyses
- Template Repositories and Validation Workflows

Data and Analysis Preservation:
- User Analysis Code/Software Registry
- Tutorials on Reproducible Analyses



EIC software training

- Online interactive tutorials (recorded) at start of detector proposal development, ~30 users per tutorial per collaboration
- Online **interactive sessions** at the annual Center for Frontiers in Nuclear Science (CFNS) Summer School on the Physics of the Electron-Ion Collider, ~30 users per year
- Regular **office hours** (up to 3 times per week): inexpensive way to support and train users, get early feedback, and do an hour of work if no one shows
- Also developing **topical guides** for intermediate users to explore additional functionality

DUNE

- Currently running prototype detectors, with the full detector operation starting in 2029
- New users need to know how to run and modify the reconstruction and simulation algorithms, not just run final sample analysis
- Synchronous tutorials are offered 2-3 times per year
  - Using HSF Software Carpentries format
  - Serves a secondary role of allowing new members to form connections
  - Dedicated presentation for more details
- Need to expand infrastructure for advanced training in physics specific topics

Common challenges and varied solutions

- Balancing synchronous vs asynchronous training materials
  - Hybrid or self-study or in-person
- Maintaining up-to-date training materials
  - Unit tests or regular updates before tutorials
- Advertising documentation so it's clear where to look for answers to more advanced questions
  - Sphinx vs ReadTheDocs vs Doxygen vs Twikis
- Designing training materials *while* developing the software stack
- Keeping the training fun and engaging
  - Social events, teamwork, lots of hints and partial solutions

Lots to be learned from each other!

Thank you

Come join our discussions!

HSF Data Analysis working group: https://hepsoftwarefoundation.org/workinggroups/dataanalysis.html

HSF Training working group: https://hepsoftwarefoundation.org/workinggroups/training.html

See the dedicated talk tomorrow!