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# The CMS Offline WorkBook

Background information and **tutorials** on

- accessing computing resources
- using the software

for physics analysis within the CMS collaboration.

A subset of the CMS SW Offline Guide, the first-stop for both users and software developers.

## Related links:

### Chapter 1: Accounts and Registration

- 1.1 Introduction
- 1.2 Getting a Computing Account **UPDATED**
- 1.3 Your Computing Environment
- 1.4 CMS Computing Concepts: Programming, git, etc
- 1.5 Where to get help
- 1.6 Information for Newcomers

### Chapter 2: The Basics of CMS Offline Computing

- 2.1 Introduction
- 2.2 The CMS Computing Model
- 2.3 The CMSSW Application Framework

### Chapter 3: Getting Started with Data Analysis

- 3.1 Overview of Performing Analysis
- 3.2 Which CMSSW release to use
- 3.3 Exploring CMS Data
  - ◆ 3.3.1 Copy and Merge Files
  - ◆ 3.3.2 EDM tools to list event content and examine provenance
- 3.4 Fireworks Visualisation
  - ◆ 3.4.1 Fireworks User Guide
  - ◆ 3.4.2 Full Framework Event Display
  - ◆ 3.4.3 DDD Geometry
  - ◆ 3.4.4 Studying Particle Flow with Fireworks
  - ◆ 3.4.5 Projections User Guide
  - ◆ 3.4.6 Problems running Fireworks
  - ◆ 3.4.7 Archive of cmsShow release notes
- 3.5 Analysis in FWLite
  - ◆ 3.5.1 Getting Started with FWLite

- CMS Software Documentation Suite
  - ◆ Workbook (this document)
  - ◆ The CMS Offline SW Guide
  - ◆ Reference Manual [↗](#)
- Tutorial sessions
- Announcements to all CMS members [↗](#)

#### Newsbox:

March, 2018: Due to AFS phaseout at CERN, CMS recommends to **stop using AFS scratch space** (`~/scratchN`, `~/wN` directories) and move to either CERN EOSUSER [↗](#) or AFS workspace [↗](#).

Sept, 2017: The CMSSW release has been updated to `CMSSW_9_3_2`

**Provide [FEEDBACK](#) as you work through the workbook!** (Detailed instructions)

- ◆ 3.5.2 Event loop in FWLite: ROOT macros that analyze CMS data directly
- ◆ 3.5.3 Examples of FWLite macros
- ◆ 3.5.4 FWLite.Python (using PyROOT)
- 3.6 Collisions Data Analysis

## Chapter 4: CMSSW Framework in Data Analysis

- 4.1 Introduction: Use Cases
  - ◆ 4.1.1 More on CMSSW Framework
  - ◆ 4.1.2 Writing your own EDAnalyzer
  - ◆ 4.1.3 Introduction to the CMS Configuration Files
  - ◆ 4.1.4 Explore and edit full Framework Configuration Files with CMS configEditor
- 4.2 Physics Analysis Toolkit (PAT)
  - ◆ 4.2.1 Data Formats
  - ◆ 4.2.2 Workflow
  - ◆ 4.2.3 Configuration
  - ◆ 4.2.4 Tutorial
    - ◇ 4.2.4.1 Exercise 01: How to use the PAT Documentation
    - ◇ 4.2.4.2 Exercise 02: How to create a PAT Tuple
    - ◇ 4.2.4.3 Exercise 03: How to create a PAT Tuple via crab
    - ◇ 4.2.4.4 Exercise 04: How to analyse PAT Candidates
  - ◆ 4.2.5 Analysing Data with PAT
  - ◆ 4.2.6 Glossary
- 4.3 Particle Candidate Utilities and Framework Modules
- 4.4 Generator event format in AOD
- 4.5 MC Truth Matching
- 4.6 Accessing Trigger Information in Analysis
  - ◆ 4.6.1 Trigger Information in PAT
- 4.7 MiniAOD Data-Tier
- 4.8 NanoAOD Documentation

## Chapter 5: Using the Computing Resources

- 5.1 Chapter Overview -- Getting Started
- 5.2 Grid Computing Context
- 5.3 Data Analysis Work Flow
- 5.4 Locating Data Samples
- 5.5 Data Quality Monitoring (DQM) for physics analysis
- 5.6 Data Analysis with CRAB
  - ◆ 5.6.1 Most recent CRAB tutorial

- ◆ 5.6.2 CRAB Usage at CERN CAF
- 5.7 Data analysis with CMS Connect
- 5.8 Monitoring your Data Analysis with CMS Dashboard
- 5.9 The Role of T2 Resources
- 5.10 Transferring Data Files
- 5.11 Data Organization Explained
- 5.12 Organized Processing by Physics Groups
- 5.13 Using cmssh
- 5.14 Using Xrootd Service for Remote Data Access

**NEW**

## Appendices

- A.1 Remote Institution/Site Specific Information
  - A.2 Troubleshooting Guide
  - A.3 Basic Linux Commands
  - A.4 ROOT Basics
  - A.5 Introduction to SCRAMV1
  - A.6 About BuildFiles
  - A.7 Basic C++ in CMSSW context
- 

## ADVANCED TOPICS

### Chapter 6: Event Generation and Simulation

- 6.1 Thirty Second Introduction
- 6.2 Generating Monte Carlo events
- 6.3 How to Produce simu+digi Data from Generated Events
- 6.4 Standard Reconstruction
- 6.5 Simulating and Reconstructing events with Fast Simulation

### Chapter 7: Physics Object Analysis Examples

- 7.1 Introduction
- 7.2 Track Analysis
  - ◆ 7.2.1 Tracking in PAT
- 7.3 Vertex Reconstruction
  - ◆ 7.3.1 Offline Primary Vertex Finding
  - ◆ 7.3.2 Vertex Fitting Tutorial
  - ◆ 7.3.3 Vertexing in PAT
- 7.4 Electron Analysis
  - ◆ 7.4.1 Electron Analysis in PAT
- 7.5 Photon Analysis

- 7.6 Jet Analysis
- 7.7 MET Analysis
- 7.8 Muon Analysis
  - ◆ 7.8.1 Muon Analysis in PAT
- 7.9 B Tagging
  - ◆ 7.9.1 B-Tagging in PAT
- 7.10 Tau Tagging for PFJet

## Chapter 8: Statistics and Analysis Examples

- 8.0 How to Fit a Distribution
- 8.1 B Physics Analysis with MiniAOD
- 8.2 Electroweak Analysis with PAT
- 8.3 Exotica Analysis with PAT
- 8.4 Higgs Analysis with PAT
- 8.5 QCD Analysis with PAT
- 8.6 Top Quark Analysis with PAT
- 8.7 CMS Data Analysis School (CMSDAS)
- 8.8 CMS Physics Object School (CMSPOS)
- 8.9 Hands-on Advanced Tutorials (HATS)

## Chapter 9: Advanced Tools and Tasks

- 9.1 Introduction
- 9.2 Common EDM Utilities
- 9.3 Common Containers for EDM Objects
  - ◆ 9.3.1 OwnVector Container
  - ◆ 9.3.2 AssociationMap Container
  - ◆ 9.3.3 AssociationVector Container
- 9.4 Commonly used vector/matrix classes in CMSSW (GlobalPoint, GlobalVector)etc.
- 9.5 Writing your own framework objects to a file
- 9.6 How to Pick Events

## Chapter 10: Software Infrastructure

- 10.1 Installing CMS Software
- 10.2 Developing Software
- 10.3 Optimizing your Code
  - ◆ 10.3.1 Common Performance Issues
  - ◆ 10.3.2 Writing Autovectorizable Code

## Review status

Reviewer/Editor and Date (copy from screen)	Comments
MargueriteTonjes - 03 Oct 2017	rewrite of Ch. 1.2 and 7.10, updates and review of Ch. 5.4, 7.8, ongoing reviews, <b>UPDATED</b> listed for 2017 only

PetarMaksimovic - 02 Aug 2009	Complete rewrite of ch. 3 + reorganization of ch. 4 + cascading changes in ch.2
Main.Aresh - 21 Feb 2008	changed the index entry for chapter 4.5 (previously the text was 'Generator Particle Candidates')

Detailed comments 20-Dec-2012  Hide

Organizing SubSubSections in 3.4 Fireworks, the same information is kept as before, A.Morelos.

Responsible: SudhirMalik

Last reviewed by: KatiLassilaPerini - 28 Feb 2008

## Preferences

Show Topic Preferences...  Hide Topic Preferences...

### *Preferences:*

- Users allowed to change
  - ◆ Set ALLOWTOPICCHANGE = SudhirMalik, MargueriteTonjes

This topic: CMSPublic > WorkBook

Topic revision: r348 - 2019-06-11 - MargueriteTonjes



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