

Course on Physics at the LHC 2022



Report of Contributions

Contribution ID: 1

Type: **not specified**

Experimental program at the LHC

Wednesday 2 March 2022 17:00 (1h 30m)

- 1\.. Introduction to the Course. Objectives. Plan of lectures. Additional information.
- 2\.. The LHC physics case. In a few slides review what are the main motivations for the LHC program. Short reminder of SM.
- 3\.. The LHC experimental program. The LHC machine. The experiments. Basic comparison CMS, ATLAS, LHCb and Alice.
- 4\.. Experimental challenges: Cross-sections, rates. Trigger. Pile-up. Radiation.

Presenter: VARELA, João (LIP)

Contribution ID: 2

Type: **not specified**

Introduction to collisions at LHC

Thursday 3 March 2022 17:00 (1h 30m)

- 1\.. Hadron interactions. A few reminders (kinematics, etc.). Proton-proton scattering. Hard scattering.
- 2\.. QCD and parton densities. Lepton-proton scattering. Scaling violation.
- 3\.. Monte Carlo generators. Parton showers: fragmentation and hadronization.
- 4\.. Luminosity and cross-section measurements. Ingredients for cross-section measurement. Luminosity.
- 5\.. QCD and jet physics. Higher orders. Jet algorithms. Jet energy scale. Jet cross-section measurements.

Presenter: VARELA, João (LIP)

Contribution ID: 3

Type: **not specified**

Detectors 1

Monday 7 March 2022 17:00 (1h 30m)

- \- Particles and their decays into stable particles.
- \- Detector layout, geometry, particle flow
- \- Tracking:
- \- Silicon (solid-state) trackers.
- \- Track reconstruction, momentum measurement.
- \- Muon detectors.

Presenter: VIEIRA DE CASTRO FERREIRA DA SILVA, Pedro (CERN)

Contribution ID: 4

Type: **not specified**

Detectors 2

Wednesday 9 March 2022 17:00 (1h 30m)

- \- Calorimetry:
- \- Electromagnetic and hadronic showers.
- \- Energy reconstruction and resolution.
- \- Jets and missing energy.
- \- Trigger:
- \- Level-1 latency and pipelining.
- \- HLT: configuration flexibility and efficiency.

Presenter: VIEIRA DE CASTRO FERREIRA DA SILVA, Pedro (CERN)

Contribution ID: 5

Type: **not specified**

Standard Model processes

Monday 14 March 2022 17:00 (1h 30m)

An overview of SM processes (excluding those that are explicitly covered in the following lectures, i.e. Top, B, Higgs)

Presenters: HOLLAR, Jonathan (LIP); HOLLAR, Jonathan (LIP)

Contribution ID: 6

Type: **not specified**

Statistics 1

Wednesday 16 March 2022 17:00 (1h 30m)

- \- Basics of probability
- \- Errors
- \- Probability density functions
- \- The likelihood principle
- \- Hypothesis testing
- \- Basics of multivariate algorithms

Presenter: VISCHIA, Pietro (LIP/IST)

Contribution ID: 7

Type: **not specified**

Statistics 2

Friday 18 March 2022 17:00 (1h 30m)

- \- Basics of probability
- \- Errors
- \- Probability density functions
- \- The likelihood principle
- \- Hypothesis testing
- \- Basics of multivariate algorithms

Presenter: VISCHIA, Pietro (LIP/IST)

Contribution ID: 8

Type: **not specified**

Top Physics 1

Monday 21 March 2022 17:00 (1h 30m)

Top quark physics:

- \- Introduction
- \- Discovery
- \- Tevatron vs LHC
- \- Objects used in Top quark events
- \- Heavy flavor tagging and mis-tagging
- \- Top quark production (cross section, differential cross section)

Presenter: GALLINARO, Michele (IST and LIP Lisbon)

Contribution ID: 9

Type: **not specified**

Top Physics 2

Wednesday 23 March 2022 17:00 (1h 30m)

Top quark properties and decays:

- \- Properties: mass, mass difference, charge asymmetry, spin correlation
- \- Decay: branching ratios (τ_{top} , heavy flavor content of $t\bar{t}$ events, V_{tb})

Top quark studies in the search for New Physics:

- \- New particles decaying to top quarks
- \- BSM top decays
- \- Top-like signatures
- \- Boosted top
- \- Top-tagging

Presenter: GALLINARO, Michele (LIP)

Contribution ID: **10**

Type: **not specified**

Top Physics 3

Monday 28 March 2022 17:00 (1h 30m)

Single top quark and rare decays:

- \- Single Top quark
- \- The Wtb vertex structure within and beyond the SM
- \- Rare decays of top quarks (Flavor Changing Neutral Current)

Presenter: ONOFRE, António (LIP)

Contribution ID: **11**

Type: **not specified**

Higgs Physics 1

Monday 4 April 2022 17:00 (1h 30m)

Introduction

Reminder of some shortcomings of the SM: masses, WW scattering.

The Higgs mechanism. Production and decay of the Higgs boson at colliders: LEP, Tevatron and LHC.

Previous searches at LEP and the Tevatron.

Presenters: GONCALO, Ricardo; GONÇALO, Ricardo (U. Coimbra/LIP)

Contribution ID: **12**

Type: **not specified**

Higgs Physics 2

Wednesday 6 April 2022 17:00 (1h 30m)

Discovery of the Higgs boson in the different final states:
Algorithms, challenges, tools,
combination of results

Presenters: SILVA, Pedro (LIP); VIEIRA DE CASTRO FERREIRA DA SILVA, Pedro (CERN)

Contribution ID: **13**

Type: **not specified**

Higgs Physics 3

Monday 11 April 2022 17:00 (1h 30m)

Case-study of the $H \rightarrow b\bar{b}$ search, $H \rightarrow b\bar{b}$ observation

Algorithms, challenges, tools

Higgs measurements with $H \rightarrow b\bar{b}$

Presenters: COSTA BATALHA PEDRO, Rute (LIP Laboratorio de Instrumentacao e Fisica Experimental de Particulas (PT)); PEDRO, Rute (LIP)

Contribution ID: **14**

Type: **not specified**

Higgs Physics 4

Wednesday 13 April 2022 17:00 (1h 30m)

- \- Search for new physics in the Higgs sector.
- \- The Higgs boson and processes beyond the SM.
- \- Extensions of the SM, minimal and non-minimal extensions.
- \- High mass searches.
- \- MSSM Higgs searches: neutral, charged.
- \- Light pseudoscalar, resonant and non-resonant Higgs pair production.

Presenter: GALLINARO, Michele (LIP)

Contribution ID: 15

Type: **not specified**

SUSY 1

Monday 18 April 2022 17:00 (1h 30m)

- General introduction SUSY
- Description of the soft SUSY lagrangian
- Phenomenological introduction to SUSY particles I: Squarks, gluino, sleptons, charginos, neutralinos, higgs
- Phenomenological introduction to SUSY particles II: Squarks, gluino, sleptons, charginos, neutralinos, higgs
- Searches of SUSY particles at past accelerators & LHC I

Recommended reading:

1/ "SuSY and such", S. Dawson, arxiv:hep-ph/9612229

2/ "A Supersymmetry primer", S. P. Martin, arxiv:hep-ph/9709356

Presenter: BARGASSA, Pedrame (LIP)

Contribution ID: **16**

Type: **not specified**

SUSY 2

Wednesday 20 April 2022 17:00 (1h 30m)

- Searches of SUSY particles at past accelerators & LHC II

Presenter: BARGASSA, Pedrame (LIP)

Contribution ID: 17

Type: **not specified**

Exotic processes and Dark Matter

Wednesday 4 May 2022 17:00 (1h 30m)

Searches for exotic particles and for Dark Matter candidates are discussed.

Presenter: GALLINARO, Michele (LIP)

Contribution ID: **18**

Type: **not specified**

Flavour anomalies and BSM

Tuesday 10 May 2022 17:00 (1h 30m)

The so-called flavor anomalies are introduced.

BSM through precision. Rare decays and FCNCs. Anomalies and Lepton Flavour Universality violation.

Presenter: GALLINARO, Michele (LIP)

Contribution ID: **19**

Type: **not specified**

Polarization measurements

Wednesday 11 May 2022 17:00 (1h 30m)

Presenter: FACCIOLI, Pietro (LIP)

Contribution ID: **20**

Type: **not specified**

Future endeavors in Particle Physics

Monday 23 May 2022 17:00 (1h 30m)

Future endeavors in particle physics, both the High-Luminosity phase of the LHC and plans for future accelerators in particle physics are presented.

Presenter: VARELA, João (LIP)

Contribution ID: 21

Type: **not specified**

Search for CP violation in $t\bar{t}H$ and tH production in multilepton channels at 13 TeV

Friday 17 June 2022 10:30 (20 minutes)

CMS-PAS-HIG-21-006: <http://cds.cern.ch/record/2803420>

Presenter: ABEDINNIA, Atiye

Session Classification: Final evaluation

Contribution ID: 22

Type: **not specified**

High-precision measurement of the W boson mass with the CDF II detector

Friday 17 June 2022 11:00 (20 minutes)

Nature 376 (2022) 170: <https://www.science.org/doi/10.1126/science.abk1781>

Presenter: SORAIA DA SILVA MENDES, Tatiana

Session Classification: Final evaluation

Contribution ID: 23

Type: **not specified**

Direct observation of the dead-cone effect in quantum chromodynamics

Friday 17 June 2022 11:30 (20 minutes)

Nature 605 (2022) 440: <https://www.nature.com/articles/s41586-022-04572-w>

Presenter: DUARTE, André

Session Classification: Final evaluation

Contribution ID: 24

Type: **not specified**

Search for nonresonant Higgs boson pair production in final states with two bottom quarks and two tau leptons in proton-proton collisions at 13 TeV

Friday 17 June 2022 12:00 (20 minutes)

CMS-HIG-20-010: <http://cds.cern.ch/record/2803419>

Presenter: MOHEBTASH, Zahra

Session Classification: Final evaluation

Contribution ID: 25

Type: **not specified**

Precision measurement of the W boson decay branching fractions in proton-proton collisions at 13 TeV

Friday 17 June 2022 14:00 (20 minutes)

arXiv:2201.07861: <https://arxiv.org/abs/2201.07861>

Presenter: SOARES, Guilherme

Session Classification: Final evaluation

Contribution ID: 26

Type: **not specified**

Search for charged Higgs bosons produced in vector boson fusion processes and decaying into vector boson pairs in proton-proton collisions at 13 TeV

Friday 17 June 2022 14:30 (20 minutes)

EPJC 81 (2021) 723: <https://arxiv.org/abs/2104.04762>

Presenter: DOS SANTOS FERNANDES , Nuno

Session Classification: Final evaluation

Contribution ID: 27

Type: **not specified**

Search for dark photons in Higgs boson production via vector boson fusion in proton-proton collisions at 13 TeV

Friday 17 June 2022 10:00 (20 minutes)

JHEP 03 (2021) 011: <https://arxiv.org/pdf/2009.14009.pdf>

Presenter: TEIXEIRA BOTO, Rafael Filipe

Session Classification: Final evaluation

Contribution ID: 28

Type: **not specified**

Measurements of production cross sections of polarized same-sign W boson pairs in association with two jets in proton-proton collisions at 13 TeV

Friday 17 June 2022 12:30 (20 minutes)

<https://arxiv.org/abs/2009.09429>

Presenter: BASHIRI , Sima

Session Classification: Final evaluation