This lecture series is a review of modern experimental techniques and the results obtained at the LHC. The CMS case will be treated as an example and compared to other LHC detectors (collaboration efforts). The lectures are addressed to 2nd and 3rd cycle students interested in particle physics.

In the series of lectures the following topics will be covered:

I. Introduction (4h)
1) From conception to the Higgs boson discovery
1.1) Motivation for the LHC
1.2) Conception of the LHC and its detectors
1.3) State of the art at the end of LEP and Tevatron
1.4) First results and the discovery of the Higgs boson
2) What can be studied at the LHC
2.1) Uniqueness of the LHC and its experiments
2.2) Main physics topics
3) The CMS detector (a case study)
3.1) Design
3.2) Trigger
3.3) Sub-detectors
3.4) Event reconstruction: the particle-flow technique
3.5) Beyond design

II. Higgs boson physics (8h)
1) Introduction to the Higgs boson
2) Precise measurements with bosonic decay channels
3) Yukawa couplings between the Higgs boson and fermions
4) Results with combination of measurements
5) Rare processes

III. Searches Beyond Standard Model (6h)
1) Supersymmetry
2) Exotica: prompt particles
3) Exotica: long-living particles
4) Dark Matter

IV. Vector Boson Scattering & other precise electroweak measurements (8h)
1) Introduction to Vector Boson Scattering (VBS)
2) Overview of VBS experimental results from CMS
3) Selective review of non-VBS electroweak physics at CMS
4) Effective field theories and their implementation in data analysis

V. Future of accelerator physics (2h)
1) Preparations to Run 3 of the LHC
2) Preparations to the High Luminosity LHC
3) Future accelerators

Exam: a short (~20') presentation of one publication related to discussed topics (selected from a predefined list).

It is assumed: the knowledge of the special theory of relativity (kinematics and relativistic dynamics), and the basics of quantum mechanics and physics of elementary particles.