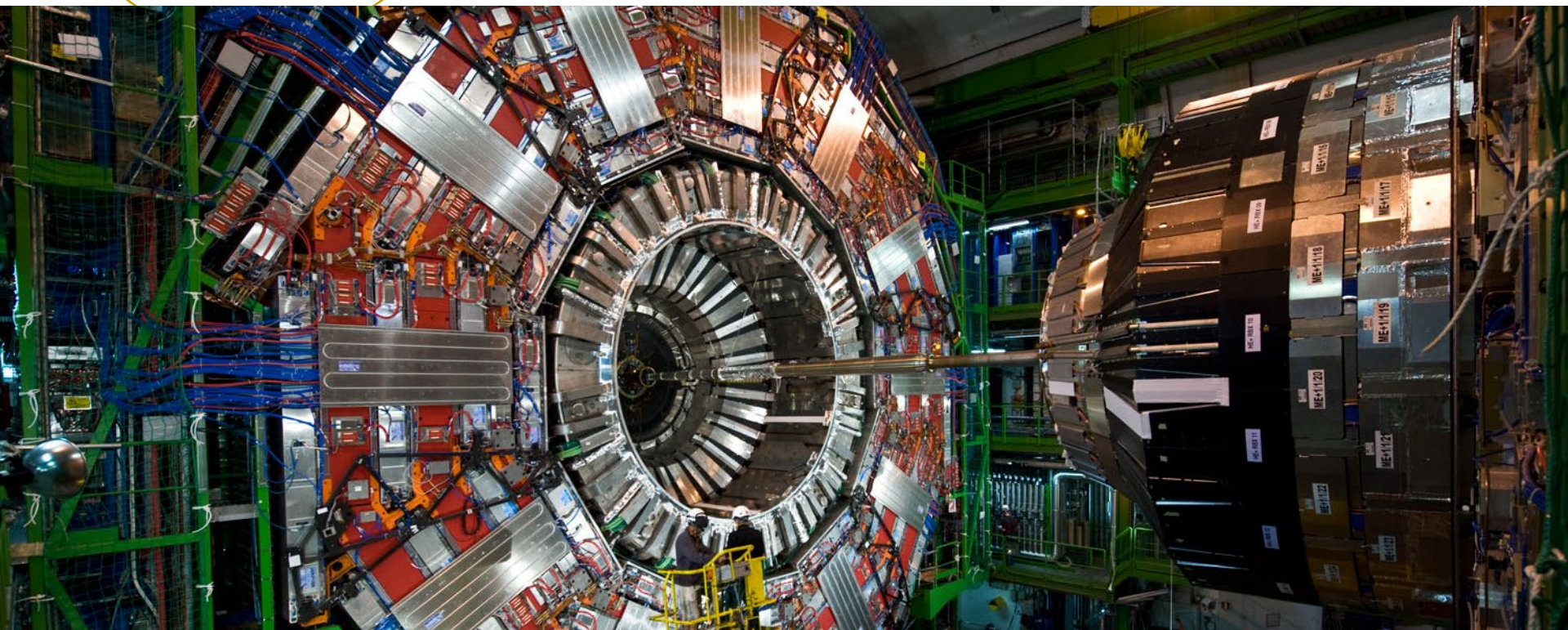
Riccardo Paramatti
Università Sapienza and INFN Roma
Aula Amaldi - 16/10/2019

Particle and Astroparticle Physics Curriculum (LM-17)



Let's start with recent Nobel Prizes in Physics

- 2013 Nobel in Physics to P. Higgs and F. Englert after the discovery of the Higgs Boson by Atlas and CMS Collaboration.
- 2017 Nobel in Physics to R. Weiss, B.C. Barish and Kip S.Thorne after the first ever detection of gravitational waves by the LIGO/Virgo Collaboration.

Several courses of the Particle and Astroparticle Physics curriculum are given by researchers of the Rome Physics Department who are members of the mentioned experimental collaborations and directly contributed to these fundamental discoveries.

Master Degree in Physics (Class LM-17)

- The Particle and Astroparticle (PAP) curriculum of LM-17 is taught in English.
  The aim is twofold:
  - facilitate the entry in the research field
  - allow foreign student attendance
- Excellent opportunity to complete the master degree with a thesis project in an international laboratory in the world.

- A.A. 2019/20: renovated curriculum. Two main innovations:
  - All courses are 6 CFU (except Physics Lab. II – 9 CFU)
  - Five elective courses (was 4 until last year)

Corso di laurea in Fisica (LM-17) - Curriculum Particle and Astroparticle Physics

N.	Insegnamenti	CFU	anno	sem.	SSD	eng	ambito
1	Relativistic Quantum Mechanics	6	1	1	FIS/02	Y	caratt.
2	Electroweak interactions	6	1	1	FIS/02	Y	caratt.
3	Condensed Matter Physics	6	1	1	FIS/03	Y	caratt.
4	Elective (within group B)	6	1 / 2	1 / 2		Y	aff.-int.
5	Physics Laboratory I (propedeutic teaching to Physics Laboratory II)	6	1	1	FIS/01	Y	caratt.
6	Particle Physics	6	1	2	FIS/04	Y	caratt.
7	Mathematical Physics	6	1	2	MAT/07	Y	aff.-int.
8	Elective (within group A)	6	1 / 2	1 / 2	FIS/01	Y	caratt.
9	Elective (free choice)	6	1	2		Y	
10	Physics Laboratory II	9	1	2	FIS/01	Y	caratt.
11	English language	4	1	2		Y	AAF
12	Elective (within group B)	6	1 / 2	1 / 2		Y	aff.-int.
13	Elective (free choice)	6	2	1		Y	
14	Internship	3	2	1		Y	AAF
15	Thesis Project	38	2	2		Y	AAF

CFU = number of credits

SSD: Settore Scientifico Disciplinare

- FIS: Physics course
  - FIS/01: experimental physics
  - FIS/02: theoretical physics
  - FIS/03: condensed matter physics
  - FIS/04: nuclear and subnuclear physics
- MAT: Mathematics course

The student plan must have at least 12 CFUs not labelled FIS, as for instance INF (Computer science), MAT, CHIM (Chemistry), BIO (Biology) including 6 CFUs of Mathematical Physics.

Courses of Particle and Astroparticle Physics curriculum

first semester, first year

1	Relativistic Quantum Mechanics	6	1	1	FIS/02
2	Electroweak interactions	6	1	1	FIS/02
3	Condensed Matter Physics	6	1	1	FIS/03
4	Elective (within group B)	6	1 / 2	1 / 2	
5	Physics Laboratory I (propedeutic teaching to Physics Laboratory II)	6	1	1	FIS/01

Mandatory courses:

- Relativistic Quantum Mechanics: prof. Roberto Bonciani (compressed course ending at the beginning of November)
- Electroweak interactions: prof. Guido Martinelli (starting just after end of RQM)
- Condensed Matter Physics: prof. Sergio Caprara
- Physics Laboratory I: prof. Gianluca Cavoto

Suggested elective course: Computing Methods for Physics (INF/01), prof. Shahram Rahatlou

Courses of Particle and Astroparticle Physics curriculum

second semester, first year

6	Particle Physics	6	1	2	FIS/04
7	Mathematical Physics	6	1	2	MAT/07
8	Elective (within group A)	6	1 / 2	1 / 2	FIS/01
9	Elective (free choice)	6	1	2	
10	Physics Laboratory II	9	1	2	FIS/01

Mandatory courses:

- Particle Physics: prof. Paolo Bagnaia
- Mathematical Physics (MAT)
- Physics Laboratory II: prof. Gianluca Cavoto

An elective course within group A. In this semester:

- Detectors and Accelerators in Particle Physics: prof. Stefano Giagu
- Methods in Experimental Particle Physics: prof. Antonio Di Domenico

An elective course (free choice)

Courses of Particle and Astroparticle Physics curriculum

first semester, second year

12	Elective (within group B)	6	1 / 2	1 / 2
13	Elective (free choice)	6	2	1

- Although it is suggested to plan two exams in the second year, moving one exam from first to second year (or viceversa) is allowed.
- The two free choices should preserve the consistency of the course plan; courses in italian can be selected as free choice.

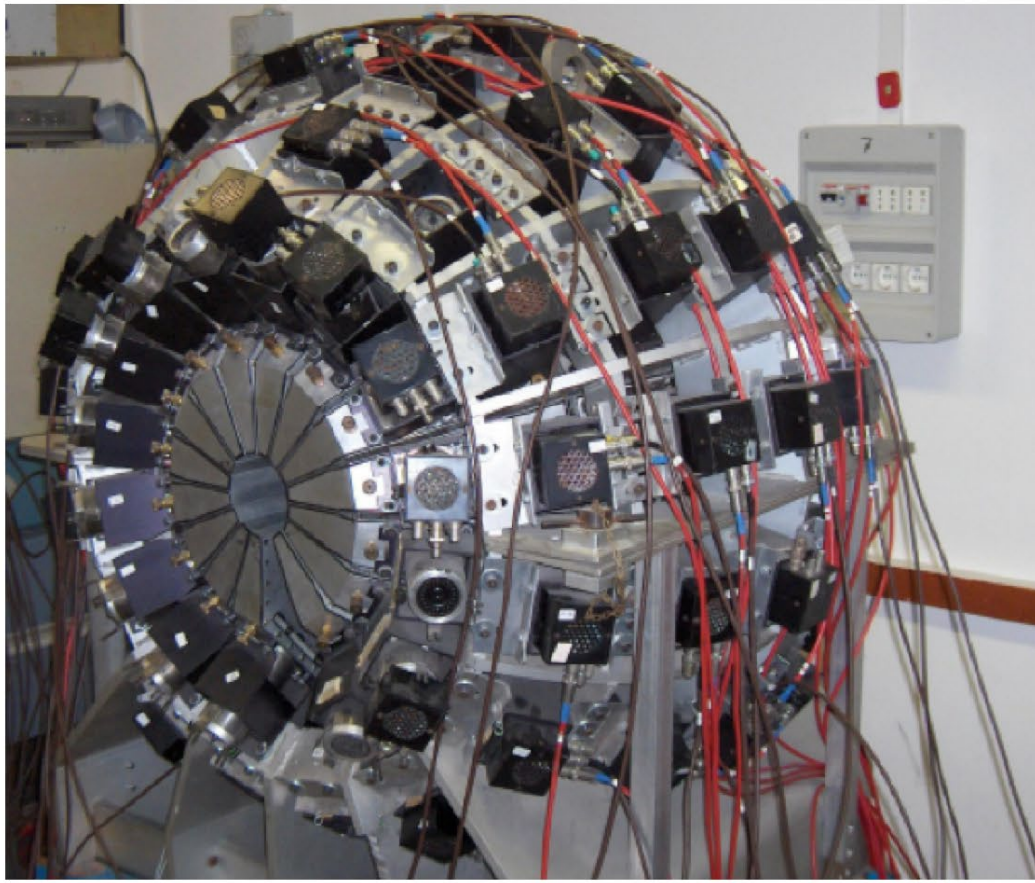
Courses of Particle and Astroparticle Physics curriculum

Gruppo B (aff.-int.) **(*) also Gruppo A**

1	Computing Methods for Physics	6	1	1	INF/01
2	Computer Architecture for Physics	6	1	2	INF/01
3	Detectors and Accelerators in Particle Physics (*)	6	1	2	FIS/01
4	Methods in Experimental Particle Physics (*)	6	1	2	FIS/01
5	Nuclear Physics	6	1	2	FIS/04
6	Quantum Electrodynamics	6	1	2	FIS/02
7	Collider Particle Physics (*)	6	2	1	FIS/01
8	Current Topics in Particle Physics (*)	6	2	1	FIS/01
9	Experimental Gravitation (*)	6	2	1	FIS/01
10	Medical Applications of Physics (*)	6	2	1	FIS/01
11	Particle and astroparticle Physics (*)	6	2	1	FIS/01
12	Quantum Field Theory	6	2	1	FIS/02
13	Solid State Sensors (*)	6	2	1	FIS/01
14	Weak Interactions in the Standard Model and beyond	6	2	1	FIS/02

Physics Laboratory (Cavoto)

- Physics Lab. I is preparatory to Physics Lab. II. Both mandatories.
- facebook page
- Content of the course:
  - Interaction of radiation with matter
  - Gas, semiconductor, scintillation detectors
  - Spectrometers, calorimeters, Cherenkov counters
  - Signal formation & electronics
  - Statistics for data analysis
- In Physics Lab. II:
  - Realization of a small scale experiment in groups of few students.

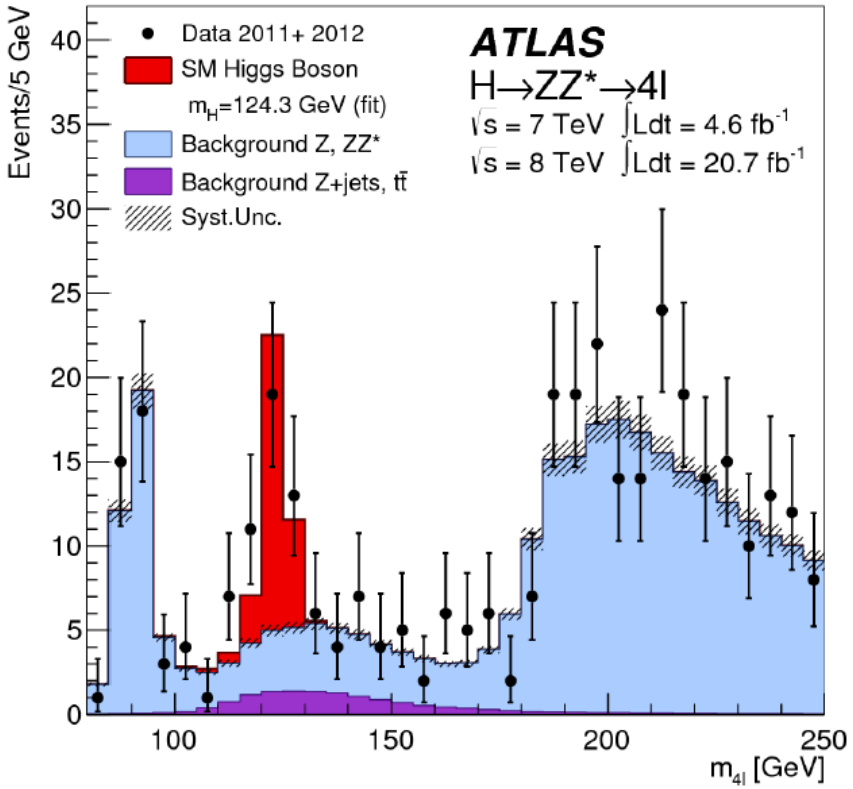


Particle Physics and Collider Particle Physics (Bagnaia)

- Particle Physics is a first year mandatory course. (web page)
- Collider Particle Physics is a second year elective course. (web page)
- Program of the courses:

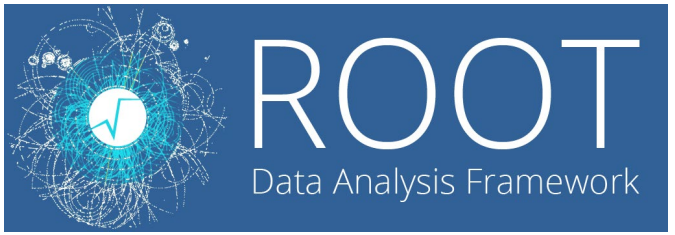
1 - The static quark model
2 - The hadron structure
3 - Heavy flavors
4 - Weak interactions
5 - The K^0 meson
6 - The Standard Model
7 - High energy neutrino interactions

8 - Hadron Colliders
9 - The CERN $Sp\bar{p}S$: W and Z discovery
10 - The CERN LEP : precision e^+e^- physics
11 - Searches and limits
12 - The CERN LHC : a) machine and detectors - b) the Higgs discovery

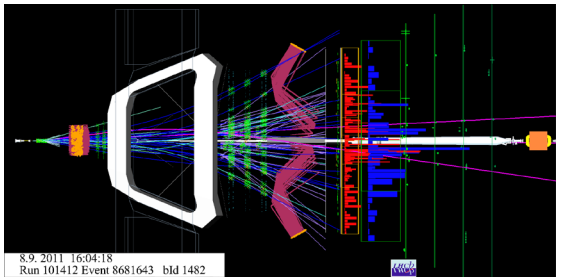


Elective courses

- Computing Methods for Physics
  - C++, machine leaning, Python with examples taken from LHC data analysis.
  - web page



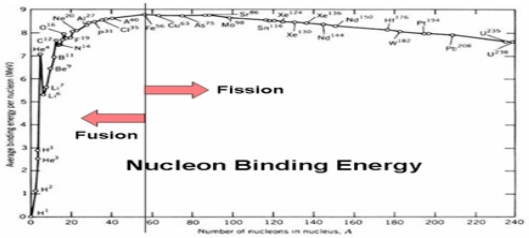
- Methods in Experimental Particle Physics
  - How experiments are designed & how data are analyzed: logic and design of the experiment, quantities to measure, advanced statistics
  - web page



- Detectors and Accelerators for Particle Physics
  - Advanced course on detectors: HEP & neutrino detectors, Medical Physics & neutron detectors, Basics of accelerator technique
  - web page

Elective courses

- Nuclear physics (prof. Sandro de Cecco)
  - Nuclear models, nuclear reactions, fission and fusion, nuclear astrophysics
  - More infos on GOMP by the end of this week.



- Particle and Astroparticle Physics (prof. Antonio Capone)
  - Problematics in High Energy Cosmic Rays (HECR) physics, study of experiments acting, or under construction, in the HECR field, open problems: antimatter, dark matter, neutrino properties.
  - web page
- Experimental Gravitation (prof. Fulvio Ricci)
  - Current status of the experimental search for Gravitational Waves(GW), experimental bases of Gravitation, effects of GW on matter, GW detectors and source of noise in detectors.
  - web page

Elective courses

- Current Topics in Particle Physics (prof. Gentile)
  - Advanced course of particle physics. Hadron colliders physics: heavy ions and pp, indirect Dark Matter search, neutrino or astroparticle physics
  - web page
- Medical application of Physics (proff. Saini and Pani)
  - Imaging techniques and instrumentation, nuclear magnetic resonance (MRI), PET, radio-guided surgery, hadronteraphy.
  - web page
- Computer Architecture for Physics (proff. Lonardo and Biagioni)
  - Introduction to hardware, logic design; processor architecture.
  - web page
- Solid state sensors (new course starting in A.A.2020/21)

New web site:

https://web.infn.it/area-particelle-roma/

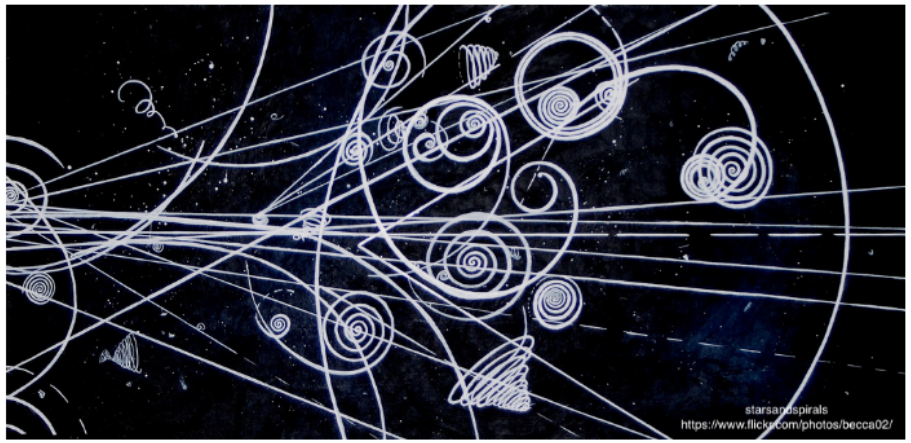
Particle and Astroparticle Physics

Dipartimento di Fisica - Sapienza Università di Roma

This page collects information on the Particle and Astroparticle Physics group of the Sapienza University of Rome.

The Particle and Astroparticle Physics group comprises various reasearch teams involved in many experiments in the **Particle physic, Astroparticle physics and Gravitational waves** areas.

Information on programs and courses for master students and opportunities for master theses are available **here**.



- The site collects recommended courses for different specializations of the master student program.

Suggested specializations.

EXPERIMENTAL PARTICLE PHYSICS

- 1st year, 1st semester: Computing Methods for Physics
- 1st year, 2nd semester: Detectors and Accelerators in Particle Physics
- 1st year, 2nd semester: Methods in Experimental Particle Physics
- 2nd year, 1st semester: Collider Particle Physics
- 2nd year, 1st semester: one course among Current Topics in Particle Physics and Solid State Sensors

ASTROPARTICLE AND GRAVITATIONAL WAVES

- 1st year, 1st semester: Computing Methods for Physics
- 1st year, 2nd semester: Detectors and Accelerators in Particle Physics
- 1st year, 2nd semester: one course chosen among Methods in Experimental Particle Physics and Nuclear Physics
- 2nd year, 1st semester: Particle and Astroparticle Physics
- 2nd year, 1st semester: Experimental Gravitation

Suggested specializations.

PHENOMENOLOGY

- 1st year, 1st semester: Computing Methods for Physics
- 1st year, 2nd semester: one course chosen among Methods in Experimental Particle Physics and Nuclear Physics
- 1st year, 2nd semester: Quantum Electrodynamics
- 2nd year, 1st semester: Quantum Field Theory
- 2nd year, 1st semester: Weak Interactions in the Standard Model and beyond

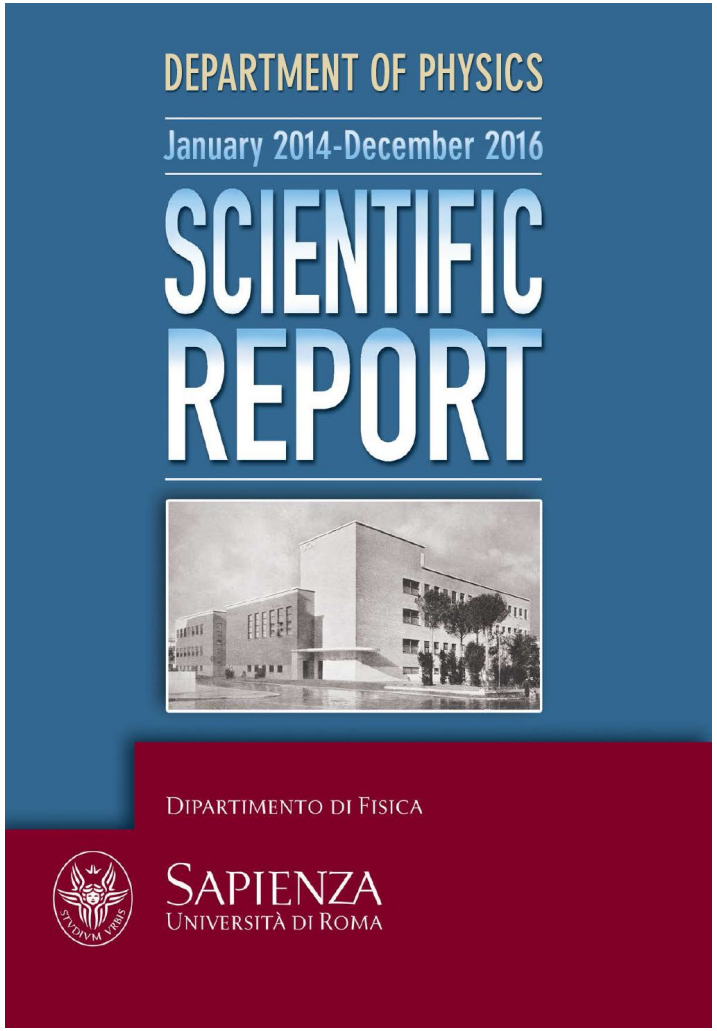
APPLIED PHYSICS

- 1st year, 1st semester: Computing Methods for Physics
- 1st year, 2nd semester: one course chosen among Detectors and Accelerators in Particle Physics, Methods in Experimental Particle Physics, and Nuclear Physics
- 1st year, 2nd semester: Computer Architecture for Physics
- 2nd year, 1st semester: Medical Applications of Physics
- 2nd year, 1st semester: Solid State Sensors

Few final remarks…

- More information about ongoing researches in the Scientific Report of Department of Physics (link).
  Pages 84-126 dedicated to particle and astroparticle physics.

- Further practical infos:
  https://corsidilaurea.uniroma1.it/it/corso/2019/30055/programmazione



Questions on PAP curriculum:

riccardo.paramatti@uniroma1.it

tel 0649694250

office 202F, Marconi building