EuCARD²

The Italian synergies between Universities and Laboratories

M. Biagini, INFN-LNF (presently @ LAL)

Universities meet Laboratories

LAL, 3-4 November 2016

LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

Overview

- This talk will use the material already presented in 2014 by M. Migliorati (Rome La Sapienza University) with some updates
- The activity for physics dissemination & outreach at the INFN-LNF is also presented

Accelerator Physics in Italy

- **INFN** (~130 pp): 18 + 4 Nat. Labs
- **TRIESTE SYNCHROTRON** (~60)
- **CNAO** (~30)
- **UNIVERSITIES** (~10)
- **CEDAD** (~10)
- **ENEA** (~4)
- **COMUNITY of about 240 pp**

INFN
- LNF
- LNS
- LNL
- LNGS
- Milano (2) + LASA
- Trento
- Padova
- Genova
- Pisa
- Bologna
- Ferrara
- Firenze + LABEC
- Roma (2)
- Napoli
- Lecce
- Bari
- Cosenza
- Catania

(~130 pp)

CNAO
- Pavia (30 pp)

ENEA
- Frascati (4 pp)

TRIESTE
- Trieste (60 pp)

CEDAD
- Lecce (10 pp)

Available accelerators

- **LNL:** CN, AN2000, Tandem-XTU, PIAVE, ALPI
- **LNF:** DAFNE, SPARC-LAB
- **LNS:** TANDEM, Cyclotron
- **Trieste:** ELETTRA, FERMI
- **CNAO:** Hadrotherapy Synchrotron
- **Firenze:** LABEC - Tandetron
- **Lecce:** CEDAD - Tandetron

ACCELERATOR PROJECTS
SPES, FEL, TOP-IMPLART, STAR, ELI-NP…

COLLABORATIONS IN PROJECTS OF EUROPEAN & INTERNATIONAL ACCELERATORS

AP courses at University

- Several AP courses are held at Italian Universities, most of them held by non-AP experts
- *Laurea Magistrale** in Physics at:
  - Torino, Genova, Milano, Padova, Pisa, Roma La Sapienza, Roma Tor Vergata, Napoli
- *Laurea Magistrale** in Electronic and Telecommunication Engineering at Trieste
- *Laurea Magistrale** in Electronic Engineering at Roma La Sapienza: course on *"Accelerator Physics and Relativistic Electrodynamics"*
- *Laurea Magistrale** in Nuclear Physics at Catania
- *Laurea Triennale*** in Physics at Catania
- *Laurea Triennale*** in Physics at Roma 3 (started 2016)

***Laurea Magistrale is equivalent to a Master degree**
****Laurea Triennale is equivalent to a Bachelor degree**

PhD courses

- AP courses for PhD students are held in
  - Pavia: 1 grant from CNAO for a PhD student in Physics
  - Pisa: PhD students in Physics
  - Roma3: PhD students in Physics (started 2014)

- Dedicated PhD on AP science at Roma La Sapienza:
  - PhD in "Applied Electromagnetism" with orientation "*Accelerators*"
  - PhD positions in "*Accelerator Physics*" (started in 2012) but only 6 grants (by INFN)

INFN/Rome La Sapienza PhD

- Coordinated by a non-AP expert of Rome University:
  - 2012: 4 students
  - 2013: 8 students
  - 2014: 8 students
  - 2015: 9 students
  - 2016: 11 students ?
- Many students apply for AP PhD, but some of them prefer to switch to particle physics when possible
- Not all students receive INFN grants
- Teachers are experts in AP from Italian and foreign Universities/Labs
- Every year topics are different
- Most of the students “work” at CERN or at SPARC-Lab in Frascati

Courses and Seminars

2016

Courses:

M. Migliorati
"Longitudinal and transverse beam dynamics in Circular Accelerators" (6 credits)
Program.
Start date: 18/10/2016
End date: 22/12/2016
Monday 8:30 - 12:00
Tuesday 8:30 - 9:45
Where: Dip SBAI, Univ. di Roma "La Sapienza"

Seminars:

NEW

****

Sorgenti Thomson/Compton e collisori fotonici
Luca Serafini
20, 21, 27 e 28 Ottobre 2016
Laboratori Nazionali di Frascati

Acceleratori per neutroni
Andrea Pisent
2, 3 e 4 Novembre 2016
Laboratori Nazionali di Frascati

Tecniche di analisi neutroniche
Antonino Pietropaolo
10 e 11 Novembre 2016
Laboratori Nazionali di Frascati

High Intensity Lasers
Massimo Petrarca
24 e 25 Novembre 2016
1 e 2 Dicembre 2016
Laboratori Nazionali di Frascati
****

Paolo Valente (INFN Roma) ***"Conventional LINACs"*** 6hr

- 1st lecture: Principles of linear accelerators
  18/05/2016, hr 15-17, Aula Conversi
- 2nd lecture: Applications of linear accelerators
  20/05/2016, hr 15-17, Aula Conversi
- 3rd lecture: Applications of linear accelerators (2)
  26/05/2016, hr 16-18, Aula Rasetti

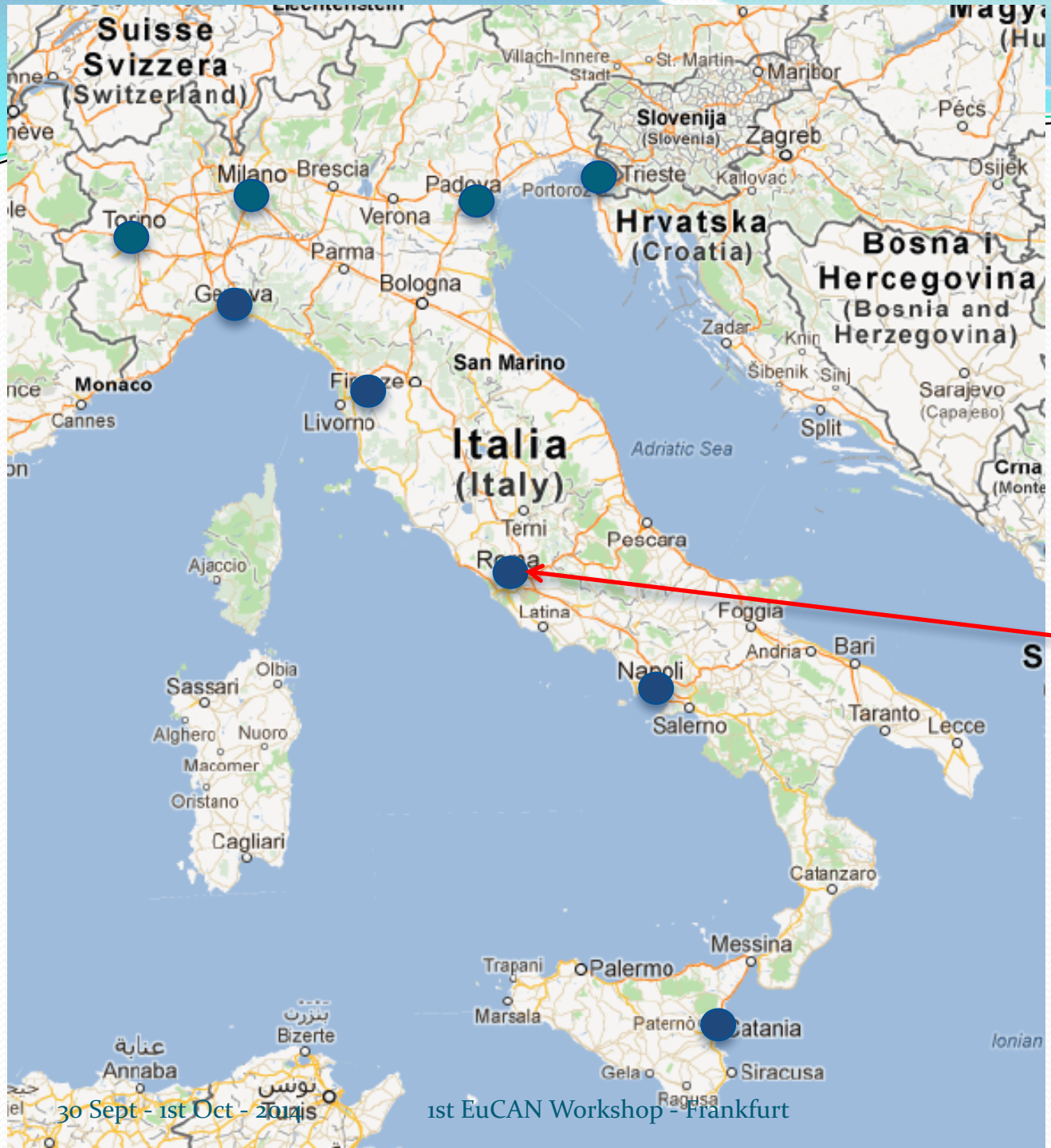
Catia Milardi (INFN LNF) ***"The Physics of DAPHNE"*** 6hr

- 1st lecture: Introduction to the Physics of Circular Particle Accelerators
  26/05/2016, hr 14-16, Aula Rasetti
- 2nd lecture: Beam-beam in Lepton Colliders
  31/05/2016, hr 14-16, Aula Rasetti
- 3rd lecture: DAFNE experience with the Crab-Waist Collision Scheme
  06/06/2016, hr 14-16, Aula Rasetti

Yannis Papaphilippou ***"Non Linear Beam Dynamics"*** 8hr

- The dynamics of non-linear differential equations and their application to accelerator dynamics - 20 June, hr 14-16, Aula Rasetti
- Hamiltonian formalism applied to beam dynamics, perturbation theory, onset of chaos - 21 June, hr 14-16, Aula Rasetti
- Advanced topics of non-linear beam dynamics, including Lie formalism, symplectic integrators and normal forms - 22 June, hr 14-16, Aula Rasetti
- Modern tools for studying non-linear beam dynamics in simulations and measurements with an emphasis to frequency map analysis - 23 June, hr 14-16, Aula Rasetti

Sandro Rossi (CNAO, PV) ***"Accelerators for Hadrotherapy"***
July 4 and July 11 - hr 15-17, Aula Rasetti
July 5 e July 12 - hr 10-12, Aula Rasetti
Click here to open the complete programme.



COURSES IN ACCELERATOR PHYSICS IN UNIVERSITIES

DOCTORATE IN ACCELERATOR PHYSICS (with INFN grants)

Summary for AP in Italian University:

- 2 courses Laurea Triennale
- 9 courses optional + 1 mandatory (La Sapienza) Laura Magistrale
- 6 Universities where PhD students can choose Accelerator Physics
- 1 University with dedicated Doctorate in Accelerator Physics

- In Italy there is not a Master degree in Accelerator Physics → not easy to have students for thesis work

- In order to reinforce some Italian initiatives, it would be useful to activate an Erasmus program on Accelerator Physics

- Lectures at International Schools:
  - JUAS - Joint Universities Accelerator School (10 weeks)
  - CAS - CERN Accelerator School (1-2 weeks)
  - USPAS (US Particle Accelerator School)
  - Euroschool on Exotic Beams (1 week)
  - Helmholtz Graduate School for Hadron and Ion Research: Lecture Week on Accelerator Physics

Coordination groups on Accelerator Physics and Technology

In Europe and in USA the Accelerator Physics communities are organized within:

EPS - Accelerator Group http://epac.web.cern.ch/EPAC/EPS-AG/Welcome.html

APS – Division of Physics of Beams
http://www.aps.org/units/dpb/index.cfm

National organizations were born in France, U.K, Japan, and other groups are very active in Germany and in other parts of Europe

https://www.sfpnet.fr/thematiques
http://www.iop.org/activity/groups/subject/pab/index.html
http://www.jps.or.jp/english/concept.html

In Italy a coordination between the AP community has been foreseen but has a slow start and still needs some push

ANVUR and Qualification

- ANVUR is the National Agency for Evaluation of University and Research. It sets the parameters to obtain the national qualification to be professor in Italian Universities
- This system for the evaluation of the quality of the research (VQR) started in 2012, and the chosen parameters have pointed out several issues for the Italian community of Accelerator Physics:
  - Difficulties in recognition of the scientific production due to the use of two catalogues, WOS and SCOPUS, in the evaluation of the research
  - Several publications are on the proceedings of International Conferences published on JACoW which, so far, were not included in WOS (SCOPUS started to include JACoW proceedings, but not completely … why not WOS**???**)
  - Risk of limited career opportunities and access to research funds

National qualification

Particle Accelerators are included in sector 02/A1:
Experimental Physics of Fundamental Interactions

02/A1	# art 2002-12	# tot cit/year	h-index	h-c
Associate Prof.	**59,5**	**104.8**		**18**
Full Prof.	**78**	**105.0**		**22**
CMS Collab	462	244,5	20	30
ATLAS Collab	519	144,7	19	28
BABAR Collab	528	908,7	46	36
10 researchers @ LNF	61	12,9	8	
10 researches @ CERN	55	11,6	7	
10 researches @ SLAC	77	38,0	13	

Data of CMS, ATALS, BABAR collaborations refer to the **last 10 years**.

The last 3 lines are averages over 10 accelerator physicists, considering the **entire scientific production**. The number of articles is the mean value of all the articles reviewed on WOS for each of the accelerator physicists considered.

Science dissemination at LNF

Frascati National Laboratories dissemination & outreach activities

- Accelerator laboratory in the framework of EDIT (Excellence in Detector and Instrumentation Technologies)

- Special dissemination & outreach activities addressed to:
  - High school teachers
  - High school students
  - Large public
  - Kids (elementary and middle school)

- Short time stages in the Labs, lectures and visit to the LNF accelerators and detectors

EDIT (Excellence in Detector and Instrumentation Technologies) school

- ***EDIT*** is a International School devoted to young researchers, in their graduate studies or in their first year as post docs, seeking to acquire a deeper knowledge on the major aspects of detectors and instrumentation technologies
- It provides a diversified program that integrates topical academic courses with hands-on laboratories
- The practice-oriented approach of the school is particularly profitable for physicists with limited hardware experience, as they can explore the performance and limitations of the technologies which are used in state-of-the-art experiments and understand technologies beyond their immediate circle to a broader view
- 4 editions: 2011 at CERN, 2012 Fermilab, 2013 KEK, 2015 LNF

EDIT

SCHOOL PROGRAM

The EDIT symposium Scientific Agenda will offer:

- a series of Plenary lectures
- 8 days of hands-on lectures and laboratory courses
- in-depth tours of working facilities

Students are gathered into 8 groups of 6 students each, 48 students total.
Each group follows a program, covering all topics offered, with hands-on lectures interleaved with laboratory courses on the following topics:

- Accelerator Physics
- DAQ and Trigger Systems
- Detectors for calorimetry
- Gaseous tracking detectors
- Electronics for Particle Detectors
- Synchrotron Radiation applications
- Solid-state detectors
- Laser Ranging space characterization

Accelerator laboratory @ EDIT

Excellence in Detectors and Instrumentation Technologies

INFN - Laboratori Nazionali di Frascati, Italy October 20-29, 2015

An Accelerator Laboratory has been organized for this international school last year
The aim is to repeat it on a regular basis for PhD students and other students

Accelerator Laboratory

CONVENERS A. Gallo (LNF), E. Chiadroni (LNF)

TUTORS D. Alesini (LNF), M. Bellaveglia (LNF), S. Bini (LNF), F. Cardelli (INFN-RM1), F. Cioeta (LNF), S. Guiducci (LNF), F. Iungo (LNF), G. Kube (DESY), C. Ligi (LNF), A. Mostacci (LNF), L. Piersanti (LNF), L. Sabbatini (LNF), A. Vannozzi (LNF), K. Wittenburg (DESY)

LOCATION Acc. Lab. (pulsed magnet lab, Bd.2), Vacuum Lab. (Bd.5b), SPARC hall and Control room (Bds.6, 6a)

The Accelerator Laboratory aims to give to the students a practical background on the main subsystems forming a particle accelerator, i.e. Radio-Frequency accelerating structures, vacuum and magnets technology, electron beam diagnostics.
The laboratory consists of four classes in which students will be introduced to basic concepts and will acquire experimental skills through "hands on" activities on:

1. Measurements on RF cavities
2. Characterization of a quadrupole magnet
3. Characterization of instrumentation for transverse and longitudinal beam diagnostics
4. Measurements on vacuum systems and visit to the SPARC_LAB test facility

IMPORTANT DATES

APPLICATION DEADLINE

JUNE 30, 2015

PARTICIPANT SELECTION

JULY 31, 2015

CALL FOR POSTER ABSTRACT

SEPTEMBER 1, 2015 — SEPTEMBER 30, 20

SCHOOL "OPEN DOORS"

OCTOBER 20, 2015 — OCTOBER 29, 201

PHOTO GALLERY
Discover EDIT 2015

VIDEO & INTERVIEWS
Watch now

The accelerator courses

1. **Measurements on RF cavities** (A. Gallo, M. Bellaveglia, A. Mostacci, L. Piersanti)

   The purpose of this class is to introduce RF acceleration concepts, focusing on standing wave (SW) cavities and travelling wave (TW) sections, with some hints on RF power sources and controls.
   A first experimental activity will concern the bench characterization of a resonant SW accelerating cavity. In particular the resonance frequency and the Q-factor of the accelerating mode, and of few high order modes, will be measured. Time domain response to an RF pulse and cavity filling time will be also measured.
   In a second experimental activity a TW accelerating section will be characterized through frequency domain measurements of the fundamental band and measurements of the attenuation coefficient in both frequency and time domains.
   Time domain response to an RF pulse, filling time and group delay will be also measured.

2. **Characterization of a quadrupole magnet** (F. Iungo, S. Guiducci, C. Ligi, L. Sabbatini, A. Vannozzi)

   This class will be introduced by a theoretical excursus concerning particle accelerator magnets, lattice, transport matrices and beta functions, during which the students will also compare theoretical calculation of a particle trajectory inside a magnetic field versus a simulation of the real case. The experimental activity will concern longitudinal and transverse B-field profile measurements of a quadrupole magnet. Measurement data will be analyzed to extrapolate the magnet integral parameters used in the accelerator lattice design.

3. **Characterization of instrumentation for transverse and longitudinal beam diagnostics** (G. Kube, E. Chiadroni, K. Wittenburg)

The problem of measuring small transverse beam sizes (of the order of tens of μm and smaller) and short time duration (~ sub-ps), together with an accurate positioning, is particularly crucial for both colliders and linac-driven Free-Electron Lasers.
The purpose of this tutorial is to provide students with a basic knowledge of the techniques used to retrieve both transverse and longitudinal beam size and become familiar with the instrumentation used.

In the first exercise a laser beam will be set up in order to "simulate" a particle beam. The purpose of this experiment is the measurement of beam profile, in order to determine both beam size and divergence, allowing the retrieval of beam emittance.

The second exercise concerns the characterization of a beam position monitor (BPM). A BPM test-stand, consisting of a wire scanner assembly, will be set up. An RF signal applied to the wire will simulate the beam. The position distortion will be measured for different pickup types, allowing a mapping of beam position.

In the third exercise students will characterize and test a Michelson interferometer, used in electron beam diagnostics to retrieve the longitudinal size. The spectrum of a Globar source will be measured and discussed.

4. **Measurements on vacuum systems and visit to the SPARC_LAB test facility** (D. Alesini, S. Bini, F. Cioeta, M. Bellaveglia, E. Chiadroni, A. Gallo)

After a theoretical introduction to the basics concepts of vacuum theory and technology applied to particle accelerators, the various components of an accelerator vacuum system such as pumps, vacuum gauges, mass spectrometers and instrumentation will be described. The students will learn about the basic working principles of all types of high-vacuum and ultra-high vacuum pumps. Furthermore, students will carry out an experimental activity consisting in a complete pumping of a small vacuum chamber, including leak detection, pre-vacuum, high vacuum and residual gas characterization with a vacuum spectrometer. Practical experience of vacuum impedance, outgassing concepts and design vacuum system strategy to meet accelerator requirements will be also discussed. The lesson will conclude with a visit to the SPARC_LAB facility.

High school teachers

INCONTRI DI FISICA 2.0: A REFRESHER COURSE ON MODERN PHYSICS

The INFN National Laboratory of Frascati open their XVI edition of **Incontri di Fisica** (**IdF 2.0 – 2016**), a refresher course on Modern Physics addressed to high school teachers from all over Italy.

This is year the course presents a brand new approach: the 200 teachers who enrolled will have a chance to choose among two different paths:

– IDF course 2.0 (e-learning + attendance at LNF)

– IDF course (attendance at LNF)

The IDF course 2.0 will be available in a *blended* modality, in collaboration with the University G. Marconi.

The lectures, shared by both paths, will take place at LNF from **October 5 to October 7, 2016.**

During the three days, teachers will work with our researchers, technologists and technicians.

TEACHERS' PROGRAMS

The National Institute of Nuclear Physics (INFN) is considered by the Italian law (art. 1 comma 2, D.M. 177 del 10/7/2000) a qualified subject for the training and education of school staff, just like University, IRRSAE and C.U. (Consorzi Universitari and interuniversitari)

The National Laboratory of Frascati (INFN-LNF) organizes refresher courses for high school teachers from all over Italy, aimed to:

- promote Modern Physics teaching in high school;
- encourage the teachers to keep up with the developments of physics;
- increase the exchange of knowledge and experiences between teachers and researchers.

Our courses are recognized by the Ministry and allow an exemption from school teaching.

High school students

STUDENTS PROGRAM

The [educational] student programs are addressed to senior students from Italian and foreign High Schools.
The students, selected by their teachers according to their scholastic curriculum, talents and personal motivation, will be included in the research activities of the LNF. They will spend some time with the LNF experimental groups who offered their availability, acquiring knowledge of the work methodologies specific to the research world and learning to use state-of-the-art tools and techniques, under the supervision of researchers and technicians. They will also learn how to work in a team, produce data to analyze and present reports in public.

School tutors will arrange the **Stages** and **Educational Paths**' program with the LNF tutors, and will prepare their students to engage in the stage experience. That way, the stages represent for the participants a unique study experience in an environment of research and open laboratory, as well as an opportunity for university and/or work orientation.

A the end of the stage, the students will receive a certificate of attendance.

Stages Topics: Electronics, IT, Mechanics, Detectors, Environmental Physics, Science Communication, Superconductivity, Quantum Mechanics, Modern Physics, Nanotechnology, Data Analysis, Theoretical Physics, Electromagnetism and circuits, Accounting and management.
Educational Paths: Physics of elementary particles and Cosmology, Quantum Mechanics, Physics of particles accelerators and their possible application, Theory of Relativity, Standard Model and fundamental forces.

Elementary and middle school kids

INFN Istituto Nazionale di Fisica Nucleare Laboratori Nazionali di Frascati

[edu] kids

HOME PROGETTI CONTENUTI SPECIALI PHOTOS CONTATTI

La fisica disegnata dai bambini - *Big Bang (Andrea, 5 anni)*

Tell about the Universe program: lectures on antimatter, LHC, supernovae… by LNF researchers

A.S. 16/17

IO DICO L'UNIVERSO

Dire, raccontare, spiegare l'Universo ai più piccoli, è la sfida del progetto di divulgazione e comunicazione scientifica **"Io dico l'Universo"**.

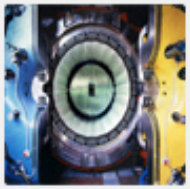
Cerchiamo di spiegare la scienza "difficile", quella dell'antimateria, delle supernovae, di LHC, senza formule o schemi complicati ma raccontando in modo chiaro e accattivante alcune delle idee che sono alla base della fisica moderna.

Il progetto è rivolto prevalentemente agli studenti delle scuole elementari e medie, e si avvale della collaborazione di ricercatori e tecnologi dei LNF

COME PARTECIPARE | ITINERARIO VISITA AI LABORATORI

Il percorso della visita guidata può variare in base alle disponibilità e agli impegni dei gruppi di ricerca LNF.

DAΦNE



KLOE

SPARC-LAB

AdA

Anello di Accumulazione

Nautilus

Rivelatore di onde gravitazionali

Visit to the accelerators and detectors at LNF

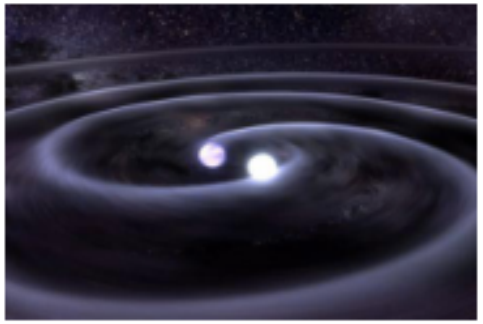
Frascati's public library lectures for kids

Le Meraviglie dell'universo per ragazzi curiosi - Magic Kids

Dall'atomo ai buchi neri

A cura di: Dott.ssa **Catalina Curceanu** (Ricercatrice presso INFN – Frascati)

Riservato ai ragazzi delle Scuole



Le Meraviglie dell'universo per ragazzi curiosi - Magic Kids

Acceleratori: dall'universo alla cura dei tumori

A cura di: Dott.ssa **Catalina Curceanu** (Ricercatrice presso INFN – Frascati)

ebook “From here to the Big Bang”

E-BOOK "FROM HERE TO THE BIG BANG"

Since almost twenty years primary and junior high schools have been visiting the Frascati National Laboratories (LNF) of the Italian National Institute of Nuclear Physics (INFN), welcomed by willing searchers who accompany them to explore the experimental areas.

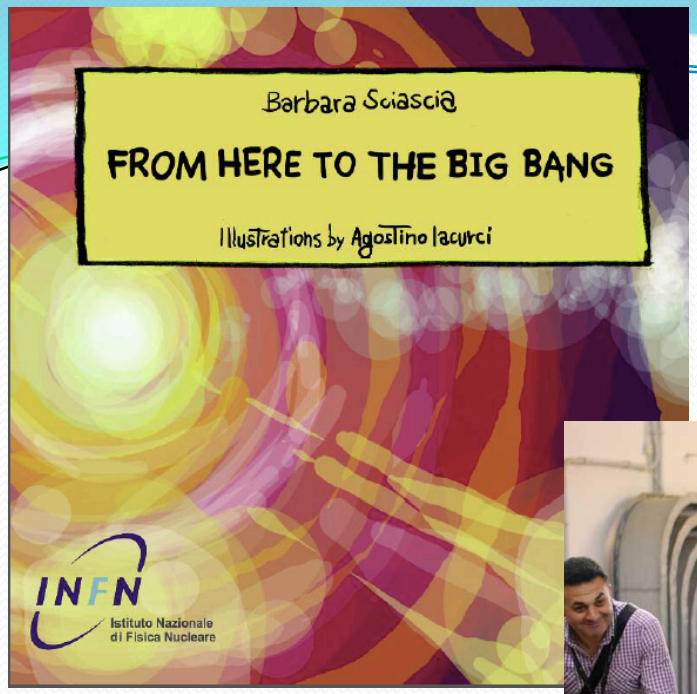
From Here to the Big Bang arose from a lecture given on the platform in front of the KLOE experiment during the 2007 European Researchers' Night. The challenge was to write a book that would explain "hard science" to children trying to satisfy, at least in part, the curiosity they express in a thousand questions: "But how can scientists see what you can't see?" or "how did scientists dream up the idea of the Big Bang?" And again, "But what's the point of all this research?"

The curiosity of children about the phenomena that surround us is for all of us a source of constant inspiration and commitment to improve, with the secret hope that one of them, as an adult, wants to continue studying the fascinating secrets that nature hides.

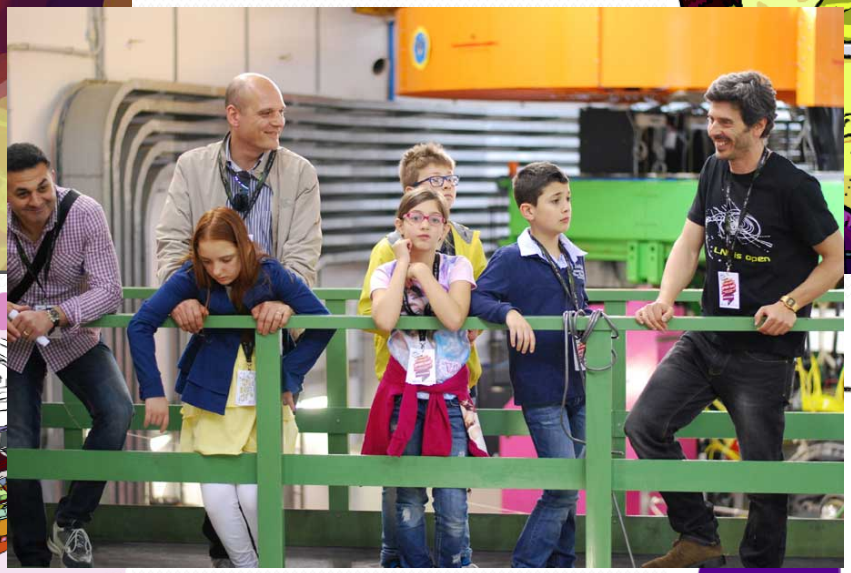
Pierluigi Campana, Director of the Laboratori Nazionali di Frascati

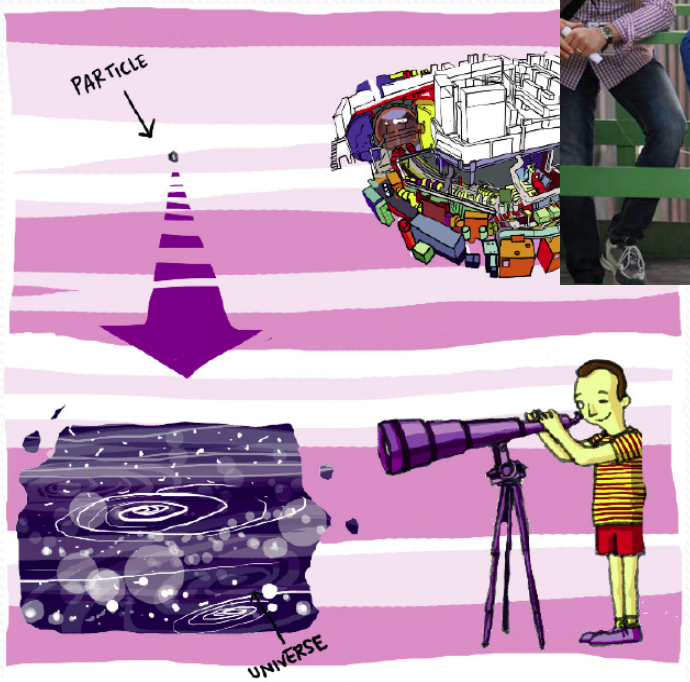
Free download in 3 languages

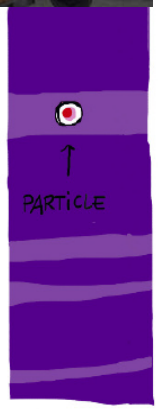
Free download in Italian, English and French.

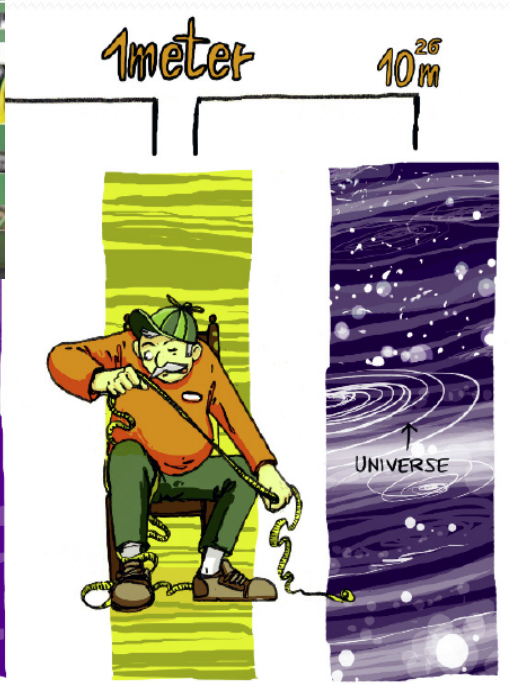

Barbara Sciascia
FROM HERE TO THE BIG BANG
Illustrations by Agostino Iacurci
INFN
Istituto Nazionale di Fisica Nucleare


MAGICIAN
MAD SCIENTIST
WOMAN SCIENTIST
MAN SCIENTIST




PARTICLE
UNIVERSE


PARTICLE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10^26 m
UNIVERSE

Conclusions

- The long lasting tradition in Particle Accelerators in Italy continues with young scientists giving important contributions to new ideas, new technologies and new machines
- A community of about 240 researchers are engaged in leading projects in IT/ EU/Int. with the capacity to attract resources from National and European Projects
- Weak presence of structured courses in Italian universities (lack of a Master degree)
- Where there are courses, AP is usually taught by an experimental physicist not an expert in AP, which are mostly "confined" in National Laboratories, with few chances to teach in University
- This is slowly improving with the help of INFN, but it will take time
- Italian evaluation system for the quality of the research and for national qualification can limit access to funding/career progression
- A coordination group on the Accelerator Physics and Technology is being established to support the Particle Accelerators community in Italy
- At LNF we try to get students (even very young!) to love science and attract them to Accelerator Physics

PSPA @ LAL

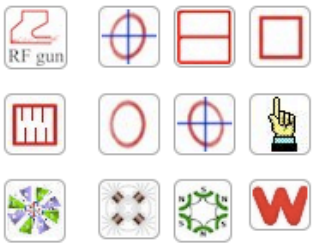
- **PSPA (Plateforme de Simulation Pour les Accélérateurs) is a user-friendly interactive web-based platform being built at IN2P3-LAL (supported by Paris-Saclay University) for the design of accelerators**
- PSPA aims at containing the tools to make a start-to-end simulation of an accelerator, and run interactively most commonly used simulations codes available worldwide, so optimizing the work of an accelerator designer by:
  - factoring once and for all the time-consuming and error prone process of translating data formats between the various codes involved in the modelling of a machine
  - controlling the repeated execution of these models by easily varying some parameter and managing the associated data
  - provide a convenient mean for testing different physical models for a given part of an accelerator

PSPA @ LAL

- The objective is that each simulation code is available in the form of a "***black box***", so being completely transparent to the user who is free to choose among different ones, which are usually run standalone, the more suitable to his needs and to make easy comparisons between codes
- Users can either interactively design any accelerator just by adding components like bricks, still choosing and varying their parameters, or load an "existing" machine. Once described the machine layout, it is possible to define "*regions*" where the suitable simulation code can be selected
- **Last but not least it will allow for AP training of University or PhD students**

An example

Accelerator elements



SectorList

- s00
- ka1
- ma
- -ma
- kb
- -kb
- ma
- -ma
- ka2

Edit sector | Machine: hexa

my accelerator  PLOTTING

run number 0

machine content

s00 | ka1 | ma | -ma | kb | -kb | ma | -ma | ka2

construct machine

all | add | remove

expand machine

computing blocks

FROM: b00 TO: sept2 ACTION: Twiss Statement METHODS: madx + -

output

Search

/usr/local/Database_PSPA/pspa.users/guest/ is your private directory
sauvegarde
restauration:: hexa : restauration terminee

Availabe codes at present in PSPA

PARMELA

(Phase and Radial Motion in Electron Linear Accelerators)

http://laacg.lanl.gov/laacg/services/serv_codes.phtml

TRANSPORT
A COMPUTER PROGRAM FOR DESIGNING
CHARGED PARTICLE BEAM TRANSPORT SYSTEMS

http://lss.fnal.gov/cgi-bin/find_paper.pl?nal-091

ASTRA

A Space Charge Tracking Algorithm

http://www.desy.de/~mpyflo/

http://madx.web.cern.ch/madx/

elegant

http://www.aps.anl.gov/Accelerator_Systems_Division/Accelerator_Operations_Physics/software.shtml

http://acc-physics.kek.jp/SAD/

(not yet working)

BETA

http://irfu.cea.fr/Sacm/logiciels/index6.php