



Italian Physical Society

International School of Physics

“Enrico Fermi”

196^o Course

Metrology

A. Bettini

A. Bettini, Padua University and INFN

196° Course

Metrology

From physics fundamentals to quality of life

Directors

Massimo Inguscio - Università di Firenze and CNR (Italy)

Martin Milton - BIPM, Sèvres (France)

Patrizia Tavella - INRIM, Torino (Italy)

Module I: Metrology for Quality of Life (26 June to 29 June 2016)

Module II: Fundamentals of Metrology (30 June to 2 July 2016)

Module III: Physical Metrology and Fundamental Constants (3 July to 6 July 2016)

The teachers

(lectures and seminars)

Roberto Battiston - ASI, Roma (Italy)

Walter Bich - INRIM, Torino (Italy)

Vincent Delatour - LNE, Paris (France)

Michael de Podesta - NPL, Teddington (UK)

Nigel Fox - NPL, Teddington (UK)

Bernd Güttler - PTB, Braunschweig (Germany)

Andy Henson - BIPM, Sèvres (France)

Massimo Inguscio - Università di Firenze and CNR (Italy)

Beat Jeckelmann - METAS, Bern-Wabern (Switzerland)

Martin Milton - BIPM, Sèvres (France)

Francois Nez - LKB-CNRS, Université Pierre et Marie Curie, Paris (France)

William Phillips - NIST, Gaithersburg (USA)

Terry J. Quinn - BIPM, Sèvres (France)

Maria Luisa Rastello - INRIM, Torino (Italy)

Patrizia Tavella - INRIM, Torino (Italy)

Thomas Udem - Max-Planck-Institut, Garching (Germany)

Robert I. Wielgosz - BIPM, Sèvres (France)

Diederik Wiersma, LENS, Firenze and INRIM, Torino (Italy)

Carl Williams - NIST, Gaithersburg (USA)

Stephen Wise - NIST, Gaithersburg (USA)

The topics

•Module I:

- Metrology in chemistry*
- Food and safety*
- Biomarkers*
- Methods and materials for clinical measurements*
- Climate and air quality monitoring*
- Redefinition of the mole*

•Module II:

- The new International system of units*
- Fundamental constants*
- Quantum metrology*
- Nanotechnology for metrology*
- Measurement uncertainty*
- International metrology organization*

•Module III:

- Electrical metrology*
- The future of the mass standard*
- Temperature standard and mise en pratique*
- Optical frequency standards*
- Metrology in space*
- Light metrology*



Villa Monastero

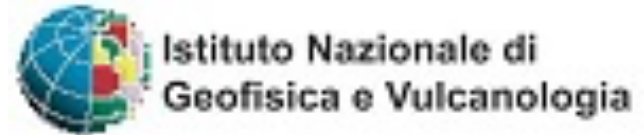
Villa Monastero, a property of the Province of Lecco, is one of the most interesting attractions of our territory thanks to its strategic location, its history, its landscape
Since 2004 its fourteen rooms can be visited following a charming itinerary.
The Villa offers rooms and facilities to hold meetings, conferences, etc

The Villa is surrounded by a spectacular and fascinating botanical garden which extends for two kilometres from Varenna to Fiumelatte, with several rare botanic species; it is visited yearly by about 50.000 people and offers recreation and learning opportunities thanks to the presence of many botanical species, both indigenous and exotic.



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Many thanks to for supporting the Varenna School



for supporting the 196° course



The origins of the Varenna school

1953.

President **Giovanni Polvani** creates The International School of Physics of Varenna

Polvani concluded his inaugural address of the first course, titled “Issues related to elementary particle detection, with special attention to cosmic radiation”, with the words:

“With the hope that this ‘dress rehearsal’ – being as it is in the hands of so outstanding scientists and followed by students with so impatient inquiring mind – might proceed worthily and fruitfully grow, I have the honour to declare open the 1953 summer course of the International School of Physics of the Italian Physical Society.”

Director: **Giampietro Puppi**

Lecturers includes: **Patrick Blackett, Cecil Powell, Beppo Occhialini, Hannes Halvén**

The mythical 1954



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1954. 2° course

The contribution from existing and planned accelerators to elementary particles physics

Director: Giampietro Puppi: *“For the time being let us content ourselves with elementary particles and more properly let us follow them in high-energy phenomena, in that fantastic world where everything happens in tiny volumes of space incredibly small and in time intervals extraordinarily short, involving however energies which, if macroscopically scaled, would appear as frightening”*



The “fantastic world

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Enrico Fermi and Werner Heisenberg gave the first two lectures of a series on the physics of pions and nucleons

Gilberto Bernardini, Bernard T. Feld gave a second group of lectures on photoproduction

Bruno Rossi lectured on fundamental particles and on the origin of cosmic rays

Particle accelerator projects at CERN, in the UK, in France and in Italy were illustrated by world experts

Varennna 1954



Salvini

Castagnoli

J. Steinberger

Puppi

Conversi

Leprince-Ringuet

Rossi

Fermi

G. Bernardini

Occhialini

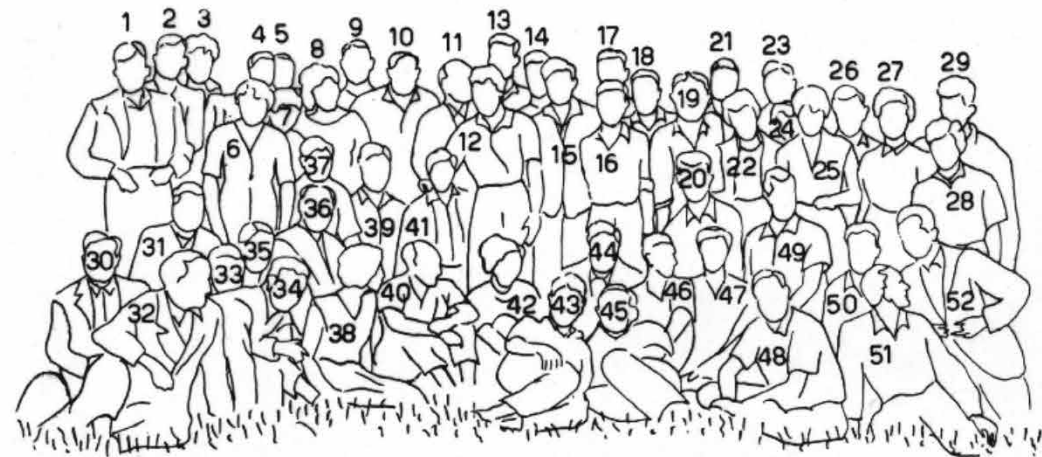
Borsellino

Polvani

A celebrated group photo 1954

Cresti

Rostagni



1. M. CRESTI - 2. M. DEUTSCHMANN - 3. B. PUPPI - 4. J. STEINBERGER - 5. N. DALLAPORTA - 6. I. POLVANI - 7. S. C. NASSAR - 8. A. ORKIN-LE-COURTOIS - 9. G. SALVINI - 10. C. CASTAGNOLI - 11. G. FOIANI - 12. A. ROGOZINSKY - 13. J. BRIZOT - 14. J. TREMBLEY - 15. M. CECOCARELLI - 16. M. PORTER - 17. P. GIACOMETTI - 18. K. KANDIAH - 19. G. WATAGHIN - 20. U. HABER-SCHAIM - 21. J. G. RÖDERER - 22. B. LOCATELLI - 23. K. GOTTFELD - 24. C. M. GARELLI - 25. C. DILWORTH-OCCHIALINI - 26. Y. FUJIMOTO - 27. L. TALLONE - 28. G. TOMASINI - 29. R. LEVI-SSETTI - 30. A. ROSTAGNI - 31. B. BRUNELLI - 32. A. BORSSELLINO - 33. G. FIDECARO - 34. P. CALDIROLA - 35. B. ROSSI - 36. G. POLVANI - 37. H. KEEFE - 38. G. CHINI - 39. M. G. K. MENON - 40. E. FERMI - 41. Y. GOLDSCHMIDT-CLEHMONT - 42. M. BRUN - 43. G. BERNARDINI - 44. G. PUPPI - 45. G. OCCHIALINI - 46. L. SCARSI - 47. B. VITALE - 48. M. CONVERSI - 49. G. QUARENI - A. BONETTI - 51. L. LEPRINCE-RINGUET - 52. B. T. FELD

Fermi

Fermi gave 16 lectures in Varenna on “**PIONS and NUCLEONS**” from 16th of July to 6th of August 1954

Fermi passed away on 28 November 1954

On the 6th of August 1955 President Polvani in an official commemorative ceremony in Varenna and Como in the presence of Fermi's wife, Mrs. Laura Fermi, and Fermi's sister, Mrs Maria Sacchetti, announced that the School would be named after Enrico Fermi



A bronze medallion with his low-relief effigy was unveiled in memory and in honour of Enrico Fermi at Villa Monastero

The porphy plaque

— 1954 - 53rd of his life —

“Here with quiet spirit among so many natural beauties, I revealed for the last time, to a rank of men of science, the ultimate and most remote elements in motion inside the atoms, with which I had already made my name immortal”



The Italian Physical Society Fermi Prize and Medal



The prestigious prize "Enrico Fermi" has been awarded starting from 2001, to commemorate the great scientist on the occasion of the centenary of his birth

The courses

196 courses
> 12000 participants
60 Nobel Prize winners



3-4 advanced courses held every summer and directed by eminent scientists in all topical fields of contemporary physics.

The proceedings have been published since the foundation of the school.

The electronic version of the Proceedings starting from 1995 is offered in open access to the individual SIF Members through the [Members Area](#).



Nobel Prize Winners in Varenna

Along the years several Nobel Prize Winners participated in the International School of Physics "Enrico Fermi" in Varenna as lecturers or directors.

Here is the list:

Name (prize awarded in year)	in Varenna
Serge Haroche (2012)	1992 - 2001 - 2008
David J. Wineland (2012)	1991 - 2001
Roy J. Glauber (2005)	1967 (director) - 1991
John L. Hall (2005)	1991 - 1992
Th. W. Hänsch (2005)	1975 - 1992 (director) - 1995 - 1998 - 2000 - 2006 (director)
A. J. Leggett (2003)	1987
Riccardo Giacconi (2002)	1965 - 1975 (director)
Eric A. Cornell (2001)	1991 - 1998 - 2001
Wolfgang Ketterle (2001)	1991 - 1998 - 2006 (director) 1991 - 1998 - 2006 (director)
Carl E. Wieman (2001)	1991 - 1992 - 1998 (director)
Robert B. Laughlin (1998)	2002
Steven Chu (1997)	1991 - 1992
C. Cohen-Tannoudj (1997)	1960 - 1991
William D. Phillips (1997)	1991 (director)-1995-1998-2000
Georges Charpak (1992)	1984
P.-Gilles de Gennes (1991)	1973 - 1996 -2003
Norman F. Ramsey (1989)	1991 - 2005
Wolfgang Paul (1989)	1965
Leon M. Lederman (1988)	1959 - 1964
Melvin Schwartz (1988)	1964
Jack Steinberger (1988)	1954 - 1964 - 1967 (director)
K. A. Müller (1987)	1956 - 1973 (director) - 2003
Klaus von Klitzing (1985)	2012
Carlo Rubbia (1984)	1987 - 1990
S. Chandrasekhar (1983)	1975
William A. Fowler (1983)	1965

Nicolaas Bloembergen (1981)	1963 - 1975 (director)
Arthur L. Schawlow (1981)	1963 - 1992
Sheldon Lee Glashow (1979)	1964
Abdus Salam (1979)	1971
Arno Allan Penzias (1978)	2004
Philip W. Anderson (1977)	1966 - 1983 - 1987
Sir Nevill F. Mott (1977)	1957
John H. van Vleck (1977)	1956
Aage Niels Bohr (1975)	1976 (director) - 1955
Ben Roy Mottelson (1975)	1960 - 1976 - 1992
Leo Esaki (1973)	1991
Leon Neil Cooper (1972)	1955
John R. Schrieffer (1972)	1957 - 1973 - 1983 - 1987 (director) - 1992 - 1997
Dennis Gabor (1971)	1958
Hannes O. G. Alfvén (1970)	1959 (director)
Louis E. F. Néel (1970)	1956
Luis Walter Alvarez (1968)	1964 (director)
Hans Albrecht Bethe (1967)	1984
Alfred Kastler (1966)	1956 - 1960
Charles Hard Townes (1964)	1955 - 1960 - 1963 (director)
Eugene Paul Wigner (1963)	1963 (director)
Donald Arthur Glaser (1960)	1953
Tsung-Dao (T.D.) Lee (1957)	1964 (director)
John Bardeen (1956)	1983
Willis Eugene Lamb (1955)	1963
Edwards Mills Purcell (1952)	1956
Cecil Frank Powell (1950)	1953
Patrick M. S. Blackett (1948)	1953
Wolfgang Pauli (1945)	1958
Isidor Isaac Rabi (1944)	1955
Enrico Fermi (1938)	1954
Paul A. M. Dirac (1933)	1972
Werner K. Heisenberg (1932)	1954
L.-V.P.R. de Broglie (1929)	1970

Varennna 1954. A quiz



*A recollection of Uri Haber-Schaim
Il Nuovo Saggiatore 27 n.1-2 2011*

*during a morning recess,
Rogozinsky, a participant
from France, posed the following
problem:*

A priest and a sexton took a walk. They saw three persons coming toward them. The sexton asked: “How old are these persons?”

The priest answered: “The product of their ages is 2450 and the sum of their ages is twice your age.”


The sexton thought for a minute and said: “ I need more information.”

The priest replied: “You are right. I am older than any of them.”

Upon which the sexton gave the ages of the three persons.

The question is: “What are the ages of the three persons, the priest and the sexton.”

...we missed the key to the solution. I suggested to Rogozinsky that he present the problem at lunch so that the whole group can hear it. He did. As soon as he finished we heard Fermi's voice: “Now let me see [...]” He explained what the key point is and proceeded to solve the problem within a minute.:



The scientific program of the course is excellent
I am sure you had and will have fascinating lectures
In a fascinating environment

*Have a fruitful and pleasant stay
in Varenna*