

Women physicists : their presence in the scientific institutions and their future

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1999-2002 INFN Equal Opportunity Committee



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2003

Italy : the Equal Opportunity Committees

- Labour contracts in Italy for the private and public sector require the institution of Comitati per le Pari Opportunita' aka CPO's
- Each Committee publishes a yearly report on the status of women in the given institution and evaluate whether there are gender inequalities among the workers [INFN statistics come from the work of CPO]
- The CPO's propose actions to the management to overcome inequalities

Why so few women in physics?

Why there are so few women in our profession

- In the past

but also

- In the present ?

Is it perhaps because women have problems with abstract thought ?

The same scarcity of women is observed in philosophy, but not in literature, or art

Why so few women?

Natural qualities for a scientist

:

- intelligence
- intuition
- ability to sustain concentrated intellectual efforts

are all equally present in men and women

The answer comes both from the **past** history of science and from the **present** structure of science and society

Outline

- A personal view with some **historical** considerations and facts
- Present day **statistics** on women in physics
- Why should we wish or need more women in the profession : **Human Resources** in Science & Technology in Europe
- A look at **barriers**
- Examples from **Italy** of what is being done
- Recommendations

The lost tribe of women in science: a personal view

The lack of participation of women to the development of science can be related to the **exclusion** of women from the **Universities** where modern science developed after the Renaissance , leaving the traditional settings

- the southern countries and
 - the courts

After the Renaissance : the migrations of science

- Science left the southern countries, after the process to Galileo, which indicated the inability of the Catholic Church to accept freedom of thought and guarantee scientific freedom
- Science also left the Courts and became University based

Women and science : from the Courts to the Universities

- As long as science was one of the activities patronized by the courts, women, as part of the noble families, sisters and daughters, even wives, could work alongside their brothers in scientific research: such was the case of Sophie Brahe, for instance
- In the 17th century science moved out of the Courts and became University based
- See for instance the case of Tycho Brahe, a favourite of the Emperor and a great nobleman himself, who had to abandon Uraniborg and seek protection with the German emperor because of the machinations and ostracism by the professors from the University of Copenhagen

Higher education, women and science the influence of the church

- During the Middle Ages, convents and monasteries were the places where poor and rich girls received their education
- The destruction by Henry VIII of convent schools where the female population, rich and poor, found their only teachers resulted in the absolute extinction of any systematic education of women for a long period [in England] From H. Mozans, Woman in Science, 1913, New York
- In Catholic Universities, in Italy in particular, it was different and in the 18th century there were famous women teachers at University of Bologna, like
 - Laura Bassi holding the Chair of Experimental Physics in 1776 and
 - Maria Gaetana Agnesi holding the Chair of Analytical Geometry in 1750
- By this time, however, the hub of scientific thought had moved from the South to the Middle and North of Europe

- Women, who had the possibility to do science as long as it was pursued within domestic walls, were excluded from the scientific process as this moved out from the castles to the universities
- About the same time, formal education for women after the dissolution of convents became much harder



modern science

women were left out of

Modern science prospered in the University settings in Northern Europe but women were not allowed to enter

Examples of (mostly **non**) access to higher education :

- In the USA
- In England
- In Sweden
- In Poland
- In Italy : a counterexample

Examples of University access policies in Northern Europe and the United States

In the USA

- The first public schools were founded in Boston in 1642, but girls were not admitted until 1789 and only to read and write (no math)
- Harvard College was founded in 1636 for "ye Indian and English youth" but women were not admitted
- The first women's college was Vassar college, founded in 1865
- At Harvard, Radcliffe College was officially incorporated in 1894, but women were not allowed to attend classes with Harvard students until 1943 (full merger only in 1999) and until 1967 girls were not allowed in some of the libraries (for instance Lamont Library) to avoid distracting the boys...

Examples of University access policies in Northern Europe and the United States

In the United Kingdom

- At Cambridge the first women's Colleges were founded in 1869 (Girton) and 1872 (Newnham)
- At Oxford the first women's College, Lady Margaret Hall, was founded in 1878
- At Durham the first female enrollment in the University was in 1896 (from M. Pennington)

Examples of University access policies in Northern Europe and the United States

In Sweden (from T. Sjostrand)

- 1870: women acquire the right to take "student exam", the official finishing exam of the "high school" (gymnasium) level of studies, that defined the standard of learning required to be admitted to universities in the first place
- 1873: women acquire the right to study and take exams at the universities, with the exception of theology and law, which followed much later
- 1880: the first woman is admitted to Lund University (she acquired a medical degree in 1892, as the second female doctor in the country)

Examples of University access policies in Northern Europe

In Poland (from M. Krawczyk)

- At the Jagellonian University in Kracow in the Philosophy Department in 1897/98 there were 94 women admitted as “free students” who did not have to pass the Matura
- University of Warsaw : The University was funded in 1816, women were admitted to the University after the first World War as the University reopened at the end of the war.
- The first woman professor at University of Warsaw was Cezaria Baudouin de Courtnenay-Ehrenkretz, Professor of Ethnography in 1934.

A counterexample from Italy :

Laura Bassi(1711-1778)

Laura Maria Caterina Bassi Verati - or Veratti (1711-1778) is perhaps the most illustrious of the women professors in Bologna. A brilliant lecturer in philosophy, she was appointed to the Chair of Experimental Physics in 1776 in the Institute for Science funded by Marsilli. She was considered by her contemporaries a woman of exceptional talents and was friends with many famous scientists and scholars, like Volta and Voltaire. She was also often criticized both scientifically as well as personally : it was said that she neglected to work on her publications because of family obligations as a wife and mother (she had many children and was socially prominent).



There have been many women in physics after they were openly admitted to higher education : a collection of names and photos can be found at

<http://www.ucla.edu/~cpw/>

Just a few



But they're still in a minority



What is happening now?

A look at some statistics from various countries on

- Graduation rates
- Hiring policy
- Career prospects

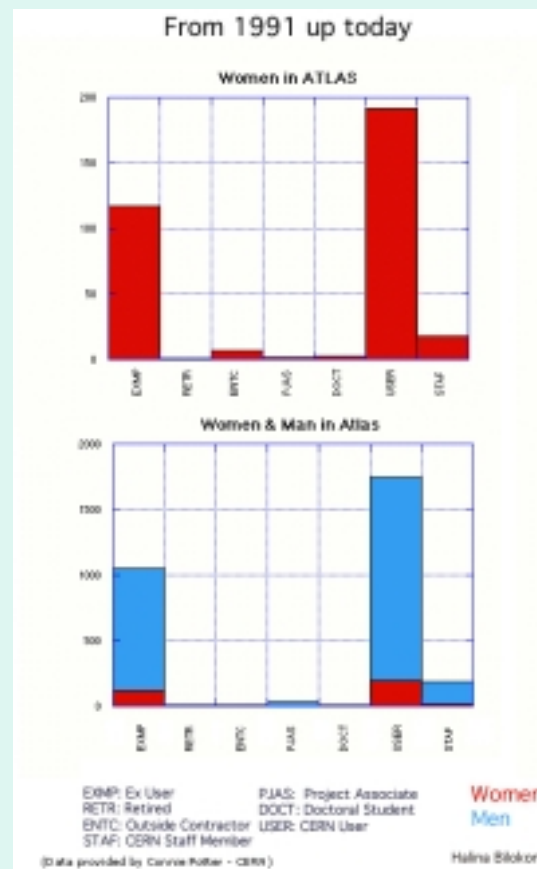
Some data from around the world

- **A global experiment : ATLAS**
- **USA**
- **CERN**
- **Europe**
- **Italy :**
 - CNR
 - INFN
 - Physics faculty in Italian Universities

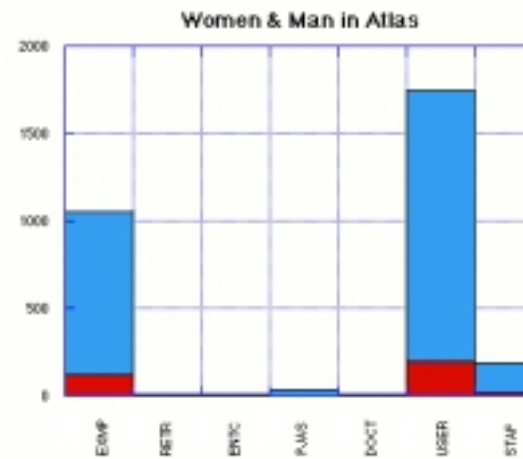
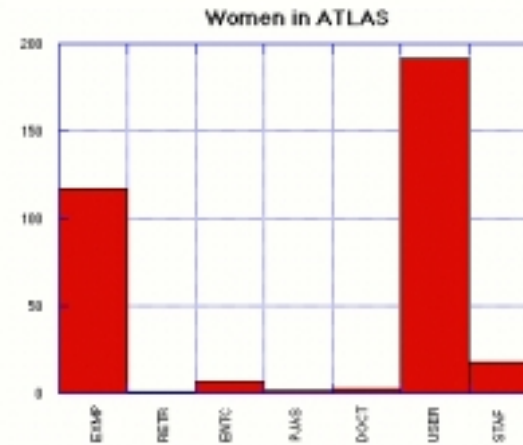
Women and man in the ATLAS experiment

USERS are scientists and technicians working at CERN but not employed by CERN

EXMP are all persons who have collaborated to ATLAS for a limited period of time, typically students and technicians



From 1991 up today



EXMP: Ex User
RETR: Retired
ENTC: Outside Contractor
STAF: CERN Staff Member
P.JAS: Project Associate
DOCT: Doctoral Student
USER: CERN User

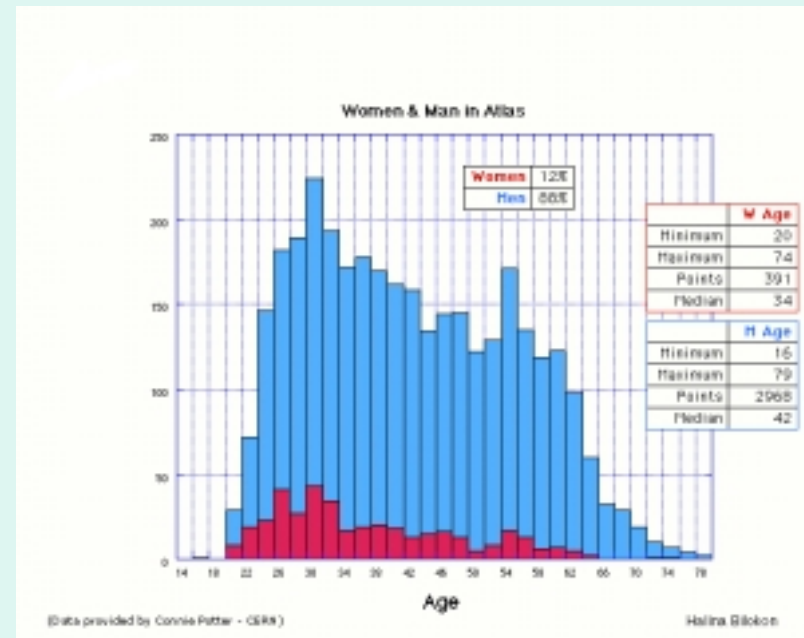
(Data provided by Connie Potter - CERN)

Women
Men

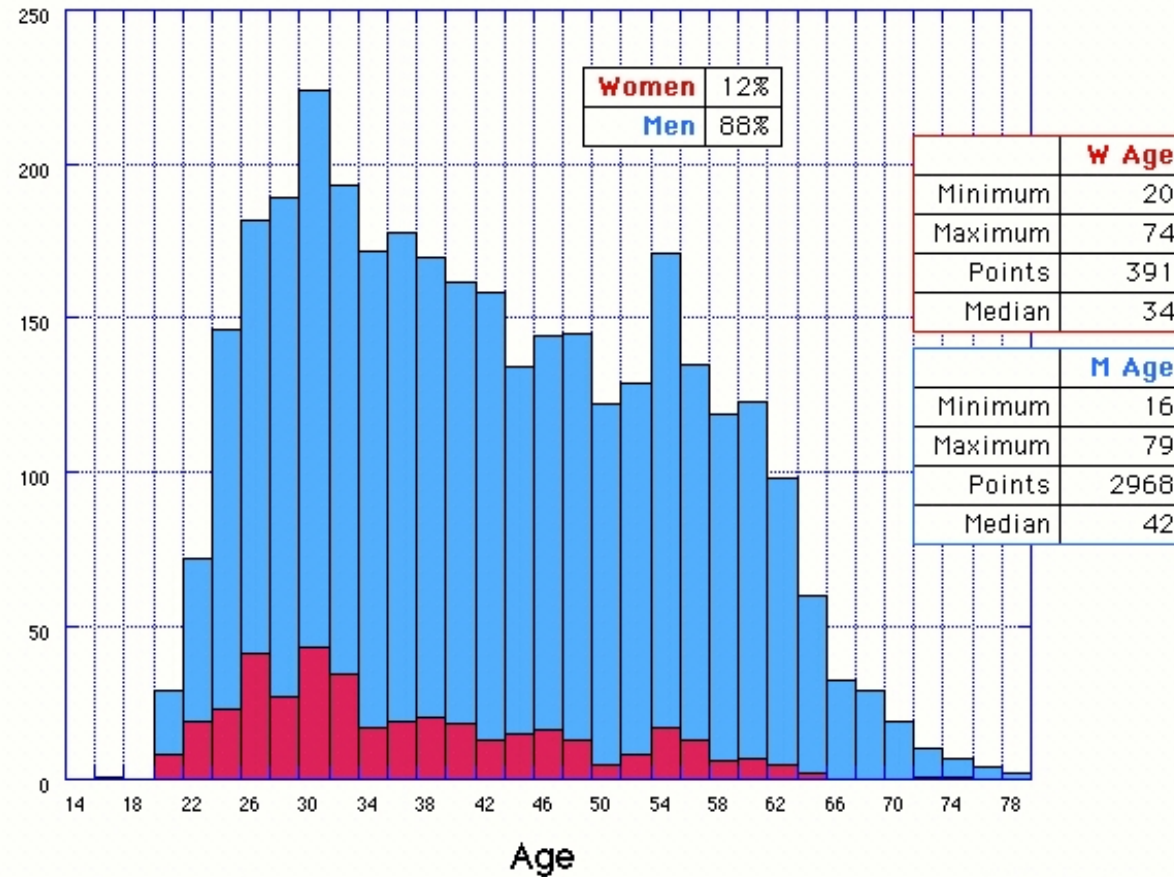
Halina Bilokon

ATLAS experiment : age distribution

- Women and men show somewhat similar age distributions
- Women are younger on the average : 34 vs 42 as median age



Women & Man in Atlas

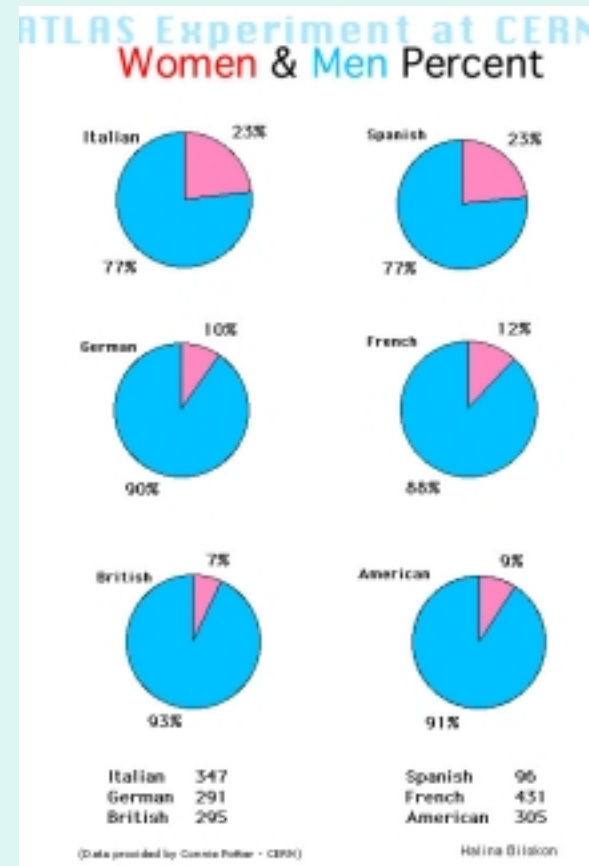


(Data provided by Connie Potter - CERN)

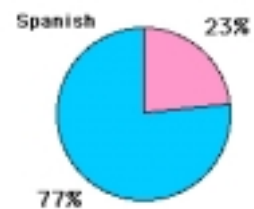
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Women in high energy physics : the ATLAS experiment

- ATLAS is a high energy physics experiment with world wide collaborations
- There are about 2000 physicists in ATLAS
- Italian and Spanish groups have the highest proportion of women



Women & Men Percent



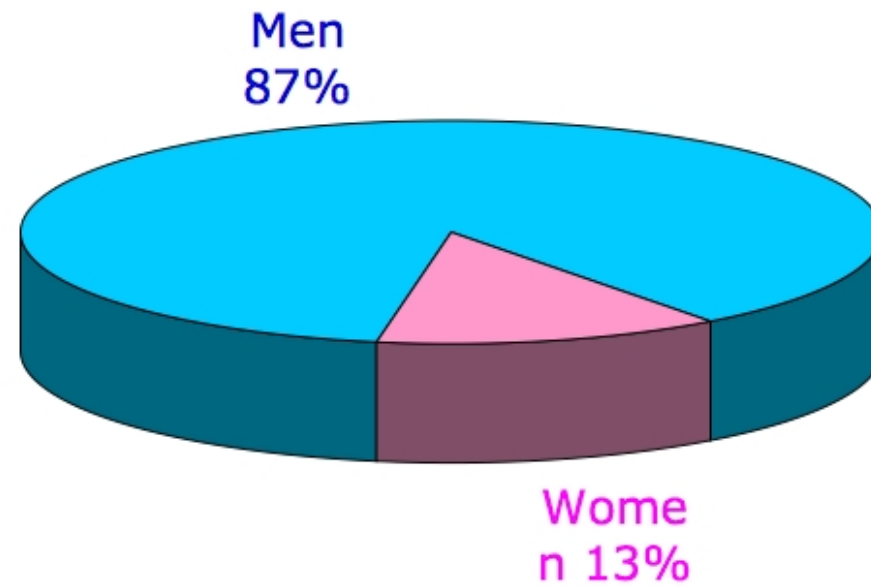
Italian 347
German 291
British 295

Spanish 96
French 431
American 305

(Data provided by Connie Potter - CERN)

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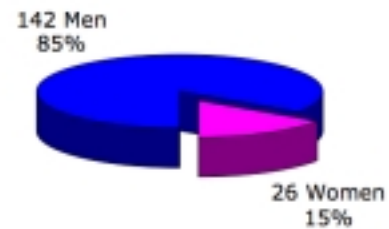
**Chinese People in Atlas
(2000)**



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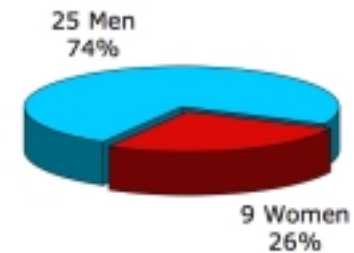
Women in ATLAS in the northern countries

Scandinavians in Atlas (2000)



Hanna Blomkvist - DPH-LSP

Finnish in Atlas (2000)



Hanna Blomkvist - DPH-LSP

Finnish in Atlas

	Men	Women	
Staff (Cern)	4	0	0%
User (Cern)	4	2	33%

Scandinavians in Atlas

	Men	Women	
Staff (Cern)	15	0	0%
User (Cern)	54	10	16%

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Data from the USA

- Data from National Science Foundation
 - Women in the work force in Science and Engineering (S&E)
 - Women in the physical sciences
 - Evolution of the percentage of women with physics degrees, Bachelor, Master and PhD
- Fermi Lab

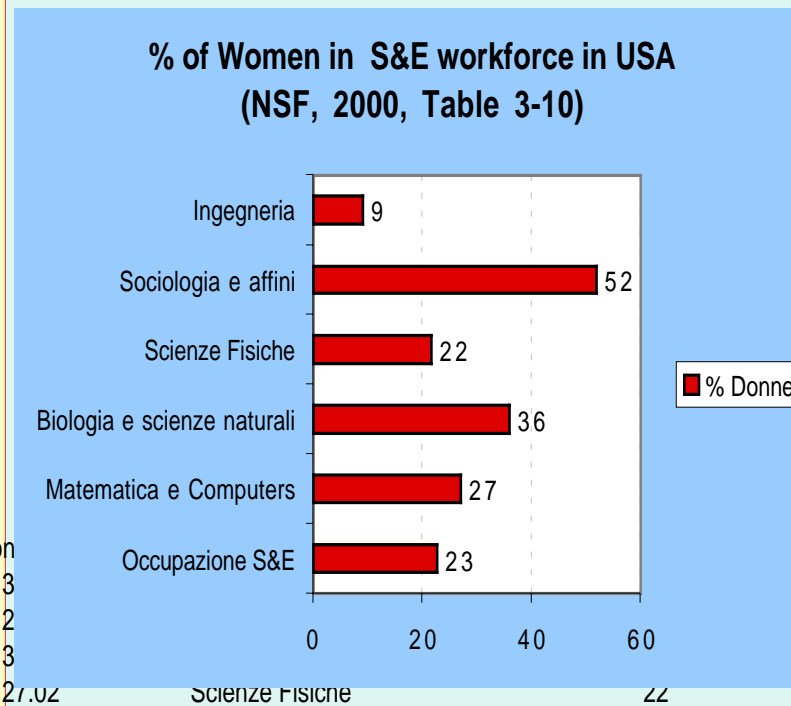
USA

National Science Foundation Science and Engineering Indicators 2000-Chpt.3

- The percentage of women in S&E during the last 10 years has slightly increased
- Differences in salaries among men and women are partly due to differences in graduation year : women in the work force are generally younger than men
- Women in the work force in S&E usually hold lower degrees than men
- Women are employed in part-time positions more often than men and more often in non S&E jobs
- Among physicists, 54% of the women and 55% of the men work in industry

Statistics from National Science Foundation USA

- In the USA women make up about 1/5 of the work force in Science&Engineering
- In 1997 women were 23% of all PhD holding engineers and scientist
- In 1995 they were 22%
- In 1993 they were 20%



Women physicists in the work force in the USA

The physical sciences include :

- Chemistry
- Geology
- Physics and Astronomy
- Secondary education
- Other

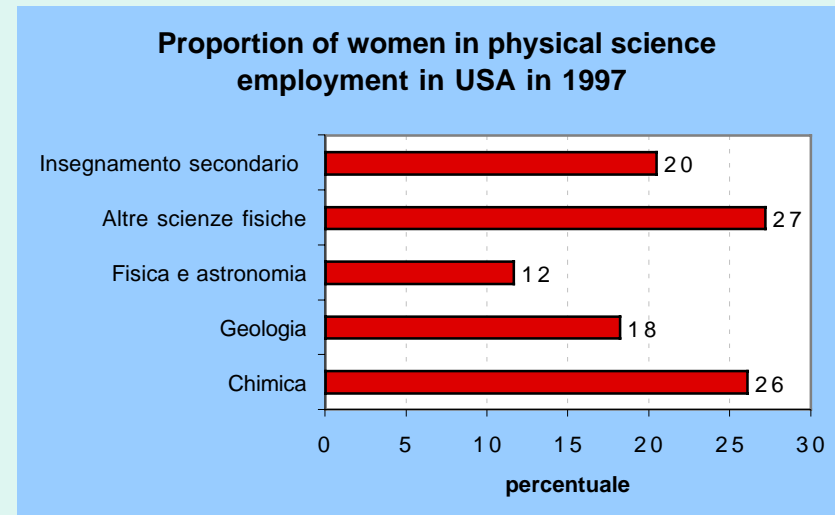
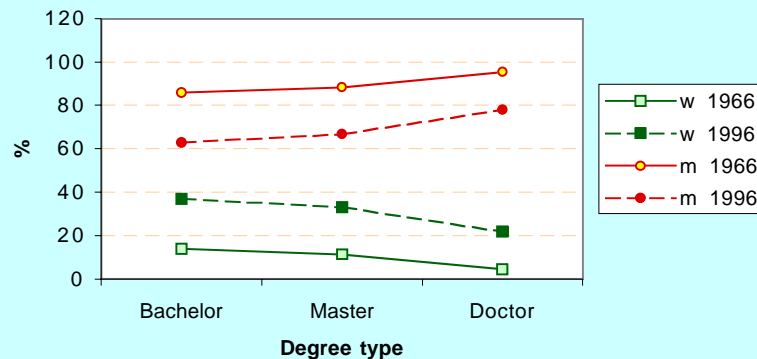


Fig. 5-1 e Table 5-1 from Women, Minorities and Persons with disabilities in science and Engineering : 1998

The scissor diagram in University education in USA (NSF 1998)

Gender Gap in university education in the physical sciences in USA



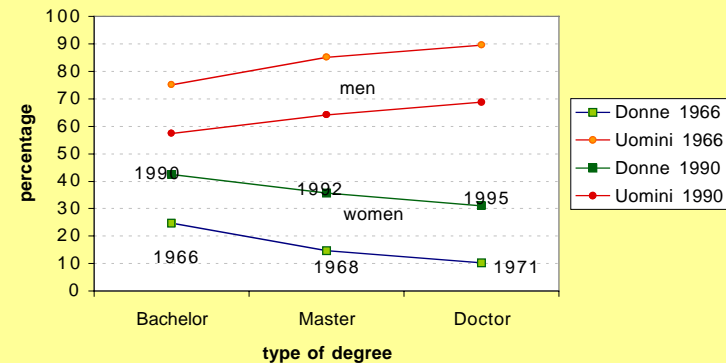
Data refer to Bachelor's, Master's and PhD in the same year 1966 or 1996

Table 2 from Entry and Persistence of Women and Minorities in College Science and Engineering Education, NCES

2000-601

Helsinki, 26th of May, 2003

USA NSF : time evolution in the percentage of women with S&E degrees in USA

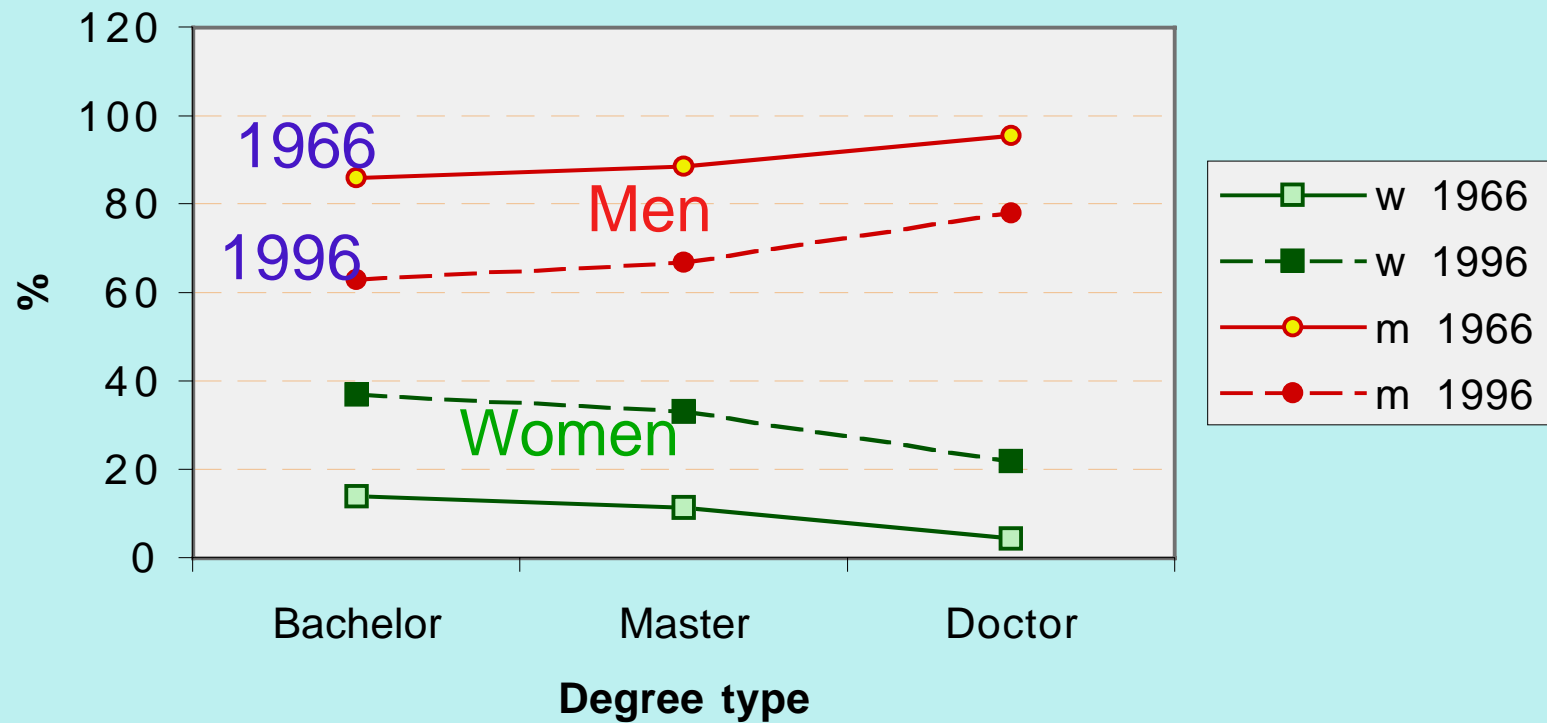


Data for Bachelor's, Master's, PhD refer to

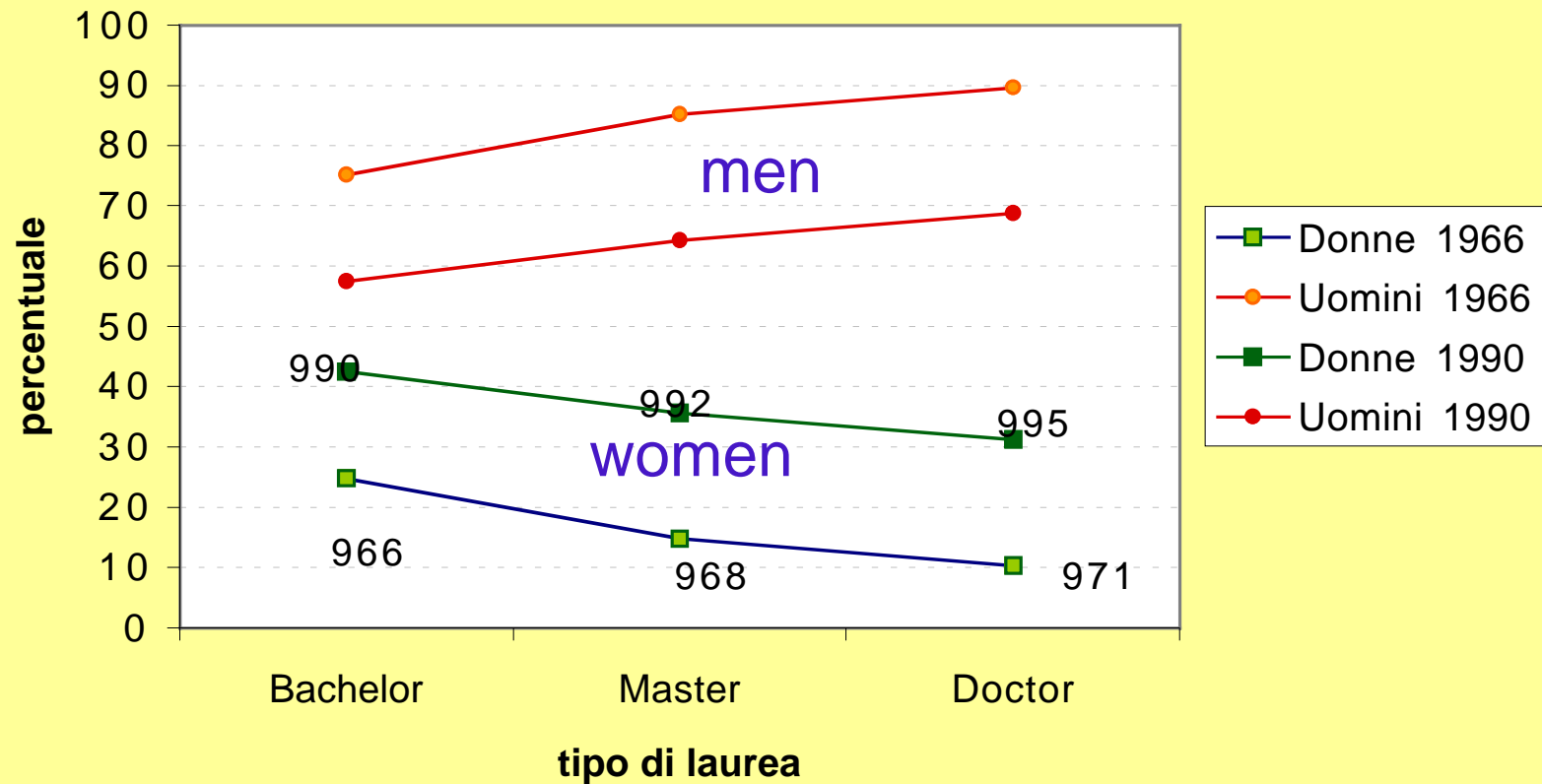
- 1966-68-71 where it says 1966
- 1990-92-95 where it says 1990

NSF - Women, Minorities, etc. 1998, Table 4-27

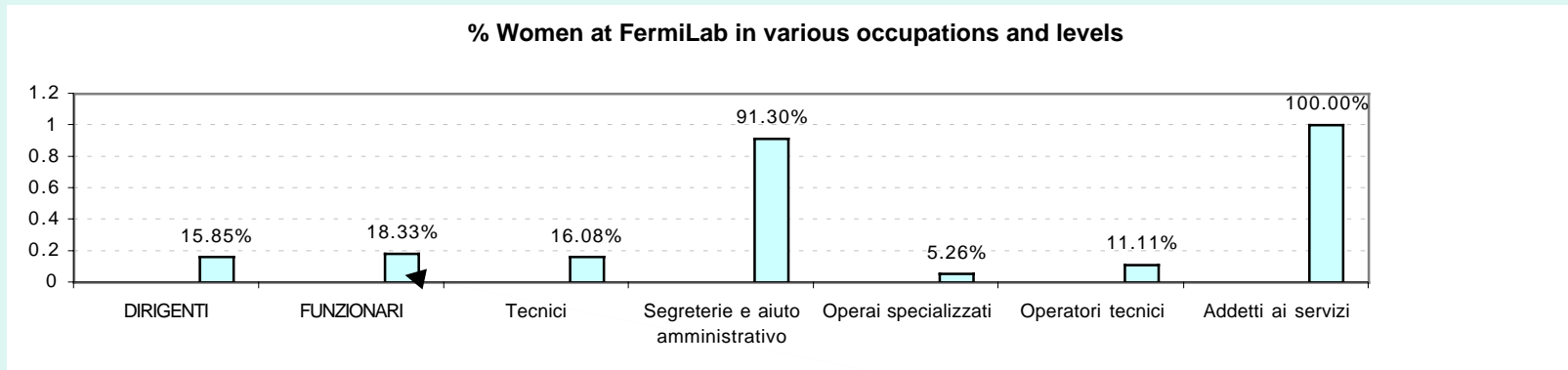
Gender Gap nell'educazione universitaria negli USA nelle scienze fisiche



USA NSF : evoluzione nella percentuale di donne laureate in S&E



Women in Fermi Lab, USA

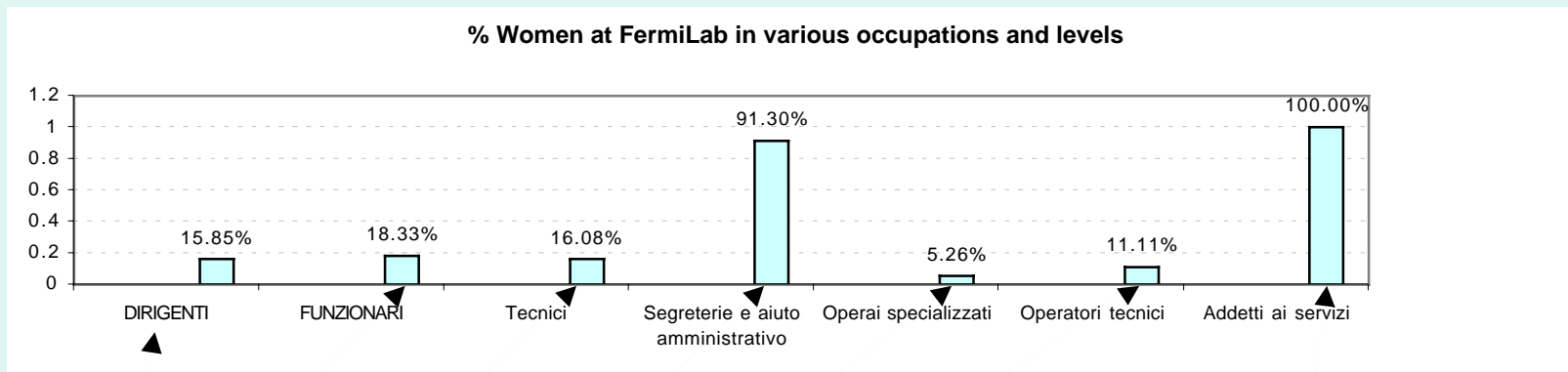


Women physicists are included among officers and are

☹️ 9.57 % of physicists

😊 17.16% of post-docs

FermiLab



Managers

Officers

Technicians

Administrative staff

Specialized workers

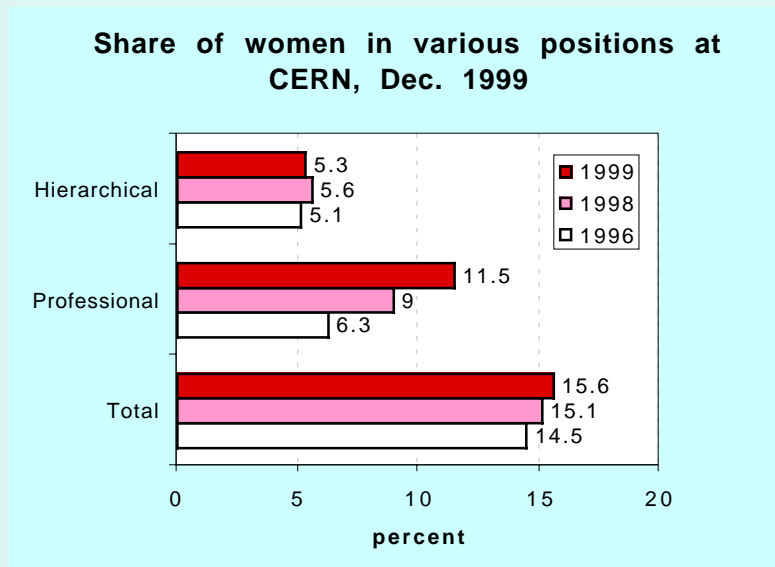
Technical operators

Services

Helsinki, 26th of May,
2003

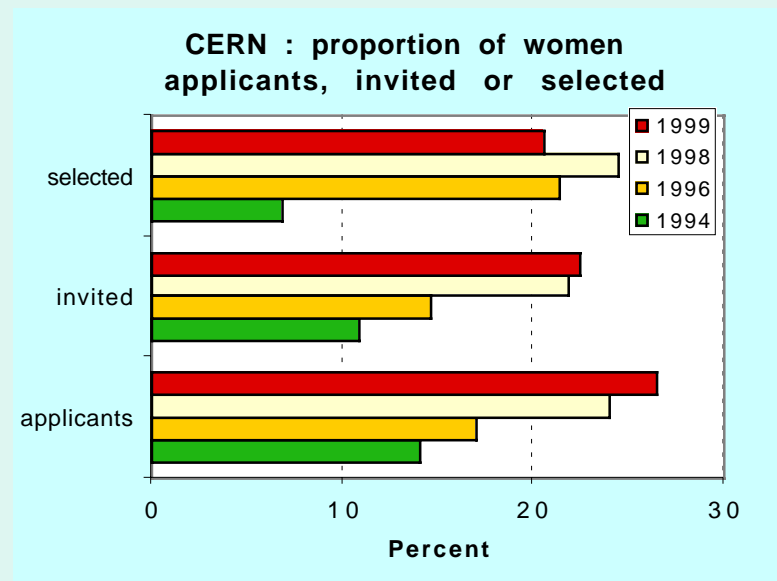
Data from CERN (1)

- At CERN the proportion of women in the management (hierarchical pos.) is low, even in comparison with Fermi Lab (in management ~15%)
- Among physicists and engineers (professional) it was low, but it is improving



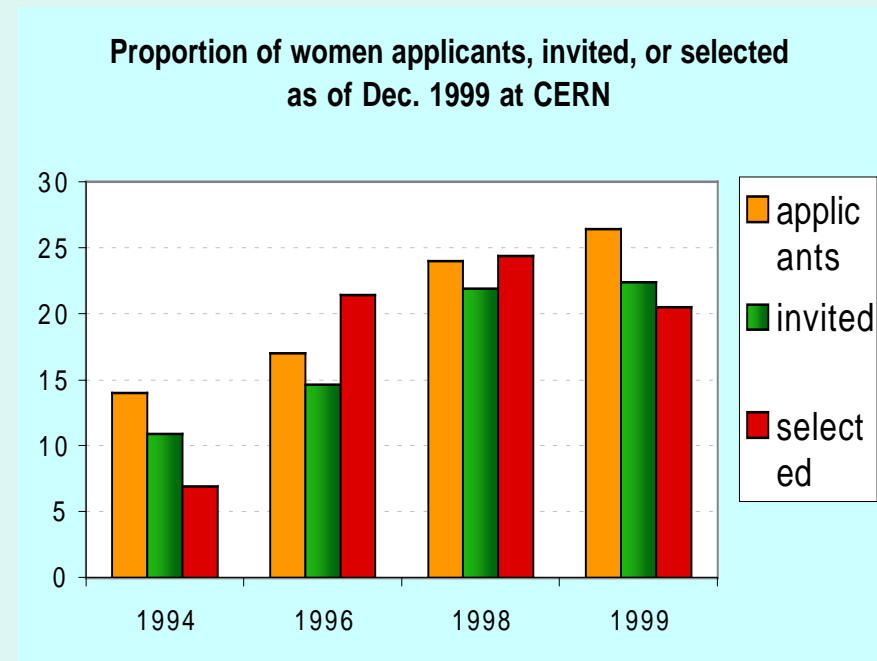
CERN (2)

- Among new entries in all positions, the proportion of women applicants has constantly increased since 1994
- The proportion of women invited is increasing but the rate of increase is slowing down
- The proportion of women among selected applicants is decreasing after an initial large increase relative to 1994



CERN (2bis)

- The ratio between applications and success is much better than in 1994 (applicants and those selected)
- But there may be a change back to previous low rates



The European Union

Women constitute less than 1/3 of the Science
and Engineering work force in EU



European Union

- Unit C5 Women and Science of the European Commission has constituted the Helsinki group and produced the first report on the percentage of women in the scientific professions in Europe ETAN Report (1999)
- REIST Report (2002) has looked in more depth into the data
- *Women in public research and higher education in Europe* by Ibrahim Lafia and Anna Larson, Statistics in Focus (2001) in the Table . N.B. University data include all disciplines

Table 1: Female researchers in the High Education sector and Government institutions, %, 1999

Countries	%	
	H.E. sector	Government Institutions
Austria	26	34
Be-Flemish	32	n.a.
Be-French	15	n.a.
Denmark	27	31
EU	29	n.a.
Finland	40	n.a.
France	29	31
Germany	19	n.a.
Greece	44	n.a.
Ireland	46	25
Italy	28	29
Netherlands	15	n.a.
Portugal	43	53
Spain	37	n.a.
UK	31	n.a.
USA	23	n.a.
Japan	19	11

European Union

- The proportion of women among university researchers in Italy: 31% vs. a European average of 23%
- Proportion of women researchers in government type institution in the natural sciences (EU average not available):
 - 31% Italy
 - 31% France
 - 26% Denmark
 - 35% Ireland
 - 26% Austria
 - 56% Portugal

What is happening now? In Italy

- There are no barriers to education
- women enrolment is around 50% of university students

but

- women researchers in public institutions are less than 30% of all researchers
- And much less in physics

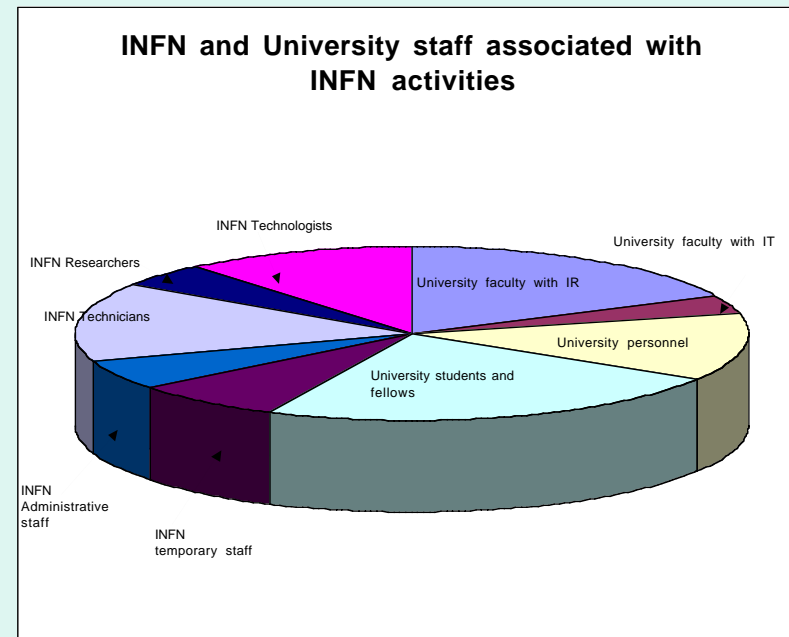
- 29% of researchers in public institutions are women
- 28 % of university researchers are women
- 31% of researchers in natural sciences are women (EU average 23%)
 - Mathematics
 - **Physics**
 - Chemistry
 - Computer sciences
 - Biology and earth sciences

The Istituto Nazionale di Fisica Nucleare (INFN): National Institute for Nuclear Physics

- Government funded Public Research Institution
- Annual budget 300 MEURO
- Funds fundamental research in nuclear, subnuclear and astroparticle physics

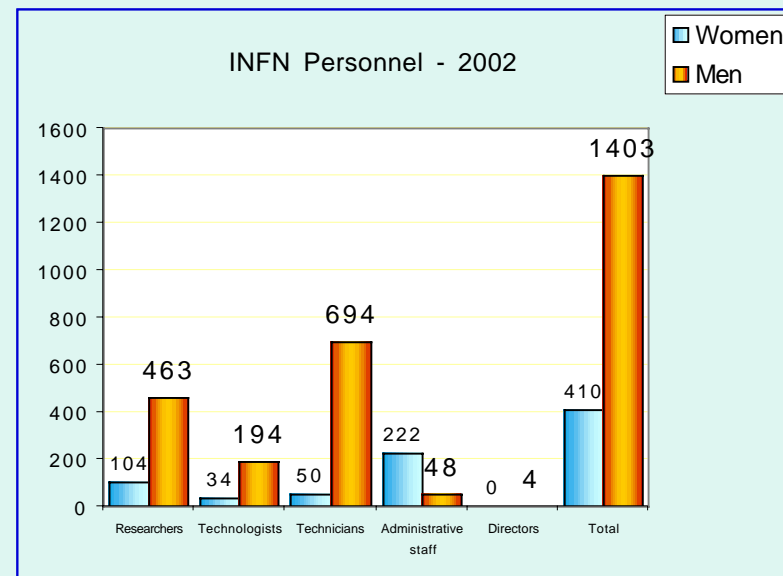
Particle physics

- Employs researchers and administrative personnel
- Funds university faculty for research in particle physics



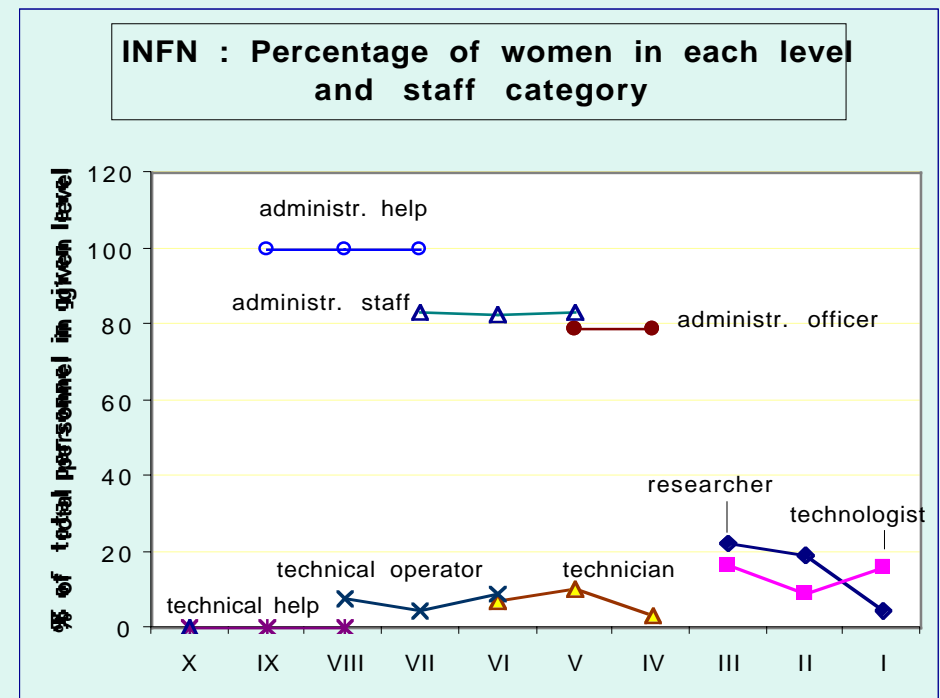
The Istituto Nazionale di Fisica Nucleare (INFN) Personnel and gender distribution

- Women are 23% of all personnel
- Personnel include
 - researchers
 - technologists (accelerator physicists, computer experts, etc.)
 - technicians (electronics, cryogenics, etc.)
 - Administrative staff
- Women are
 - 18% of researchers
 - 15% of technologists
 - 7% of technicians



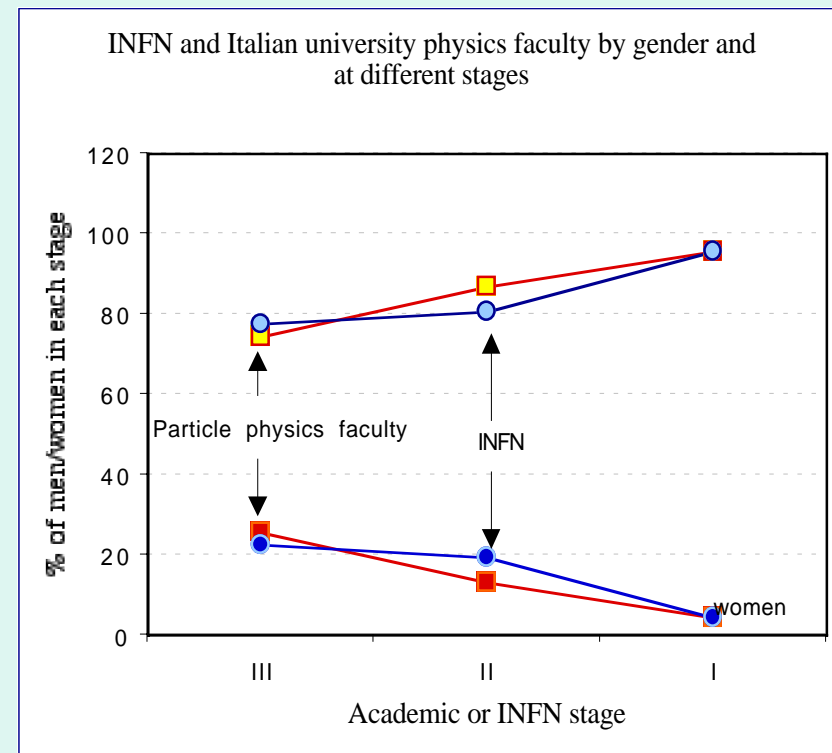
The Istituto Nazionale di Fisica Nucleare (INFN) : career levels and gender distribution

- In the technical and scientific positions women are always less than 20%
- Administrative positions below level III are mostly occupied by women
- Administrative positions at levels I,II and III are only occupied by men
- There are fewer and fewer women in the high research positions (level I)



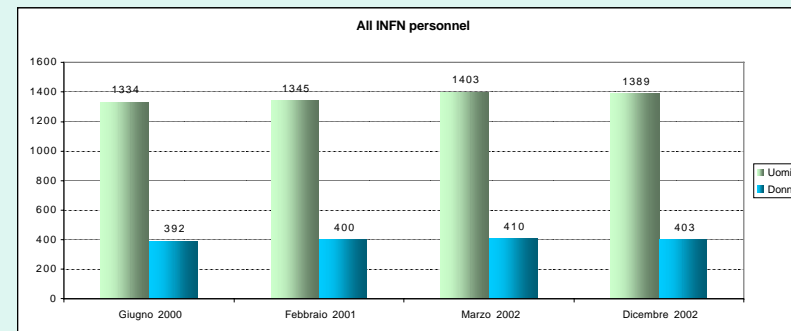
The scissor diagram for INFN and university women in particle physics

- INFN women physicists have poor career prospects
- About as poor as their university counterparts in particle physics funded by INFN
 - Percentage smaller for women in INFN at the beginning
 - Apparently better prospects at mid career
 - Just as bad at the end



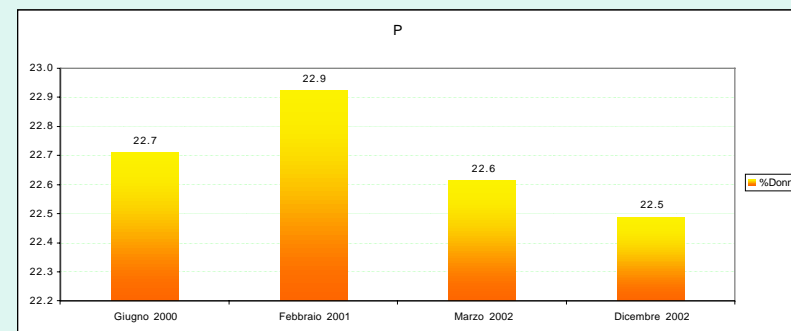
Women in INFN from 2000-2002

- The number of women in INFN has remained very stable, with even a very slight percentage decrease



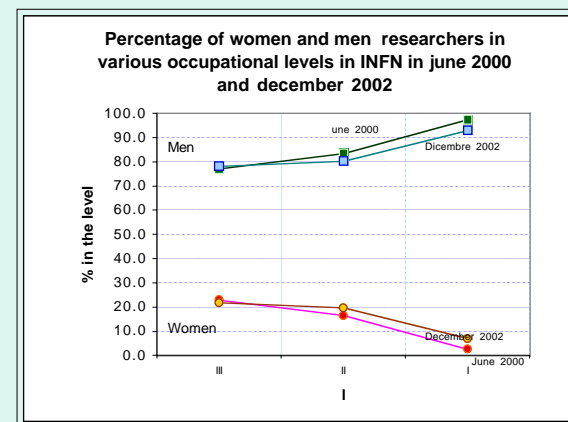
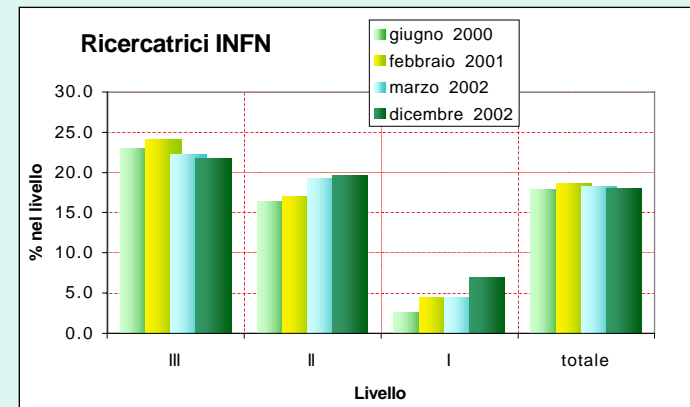
June 2000

December 2002

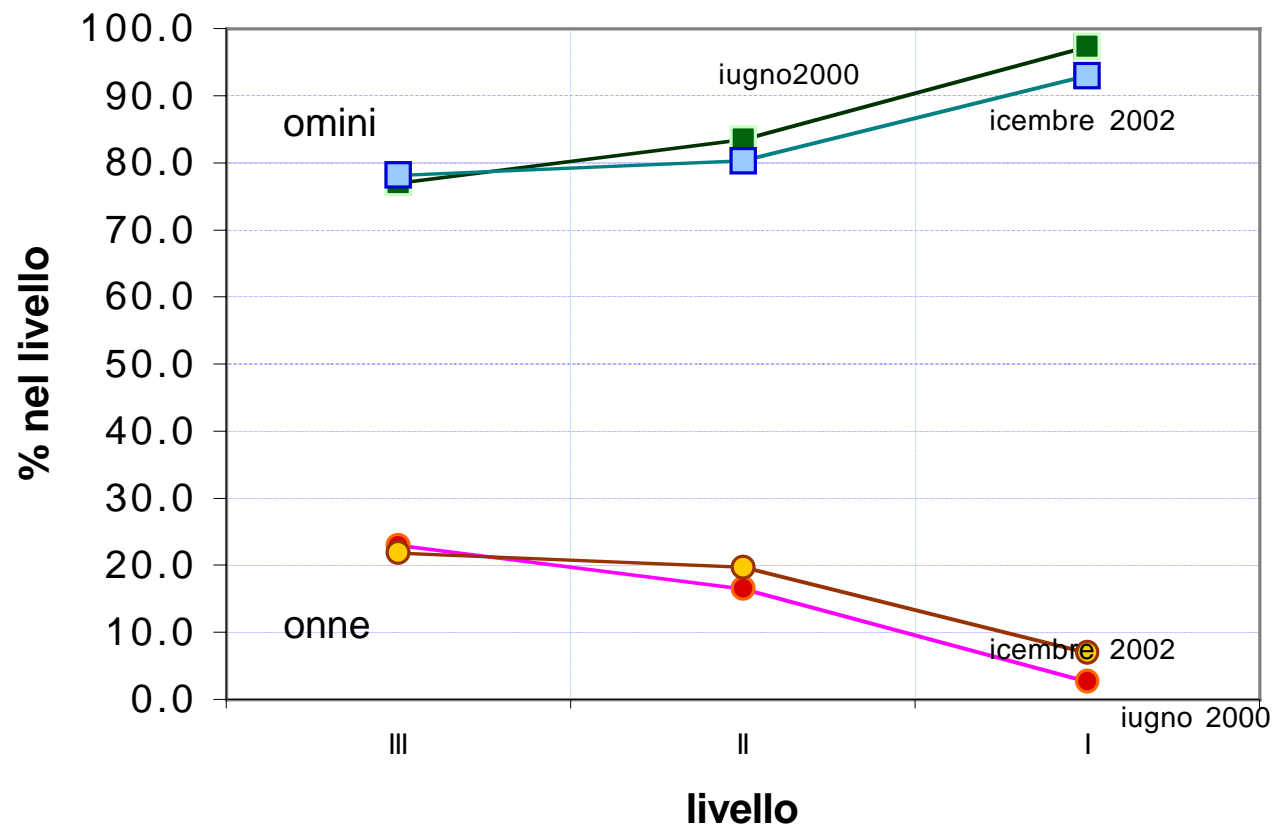


Career evolution in INFN

- More women have been promoted to higher positions
- Hiring shows a decrease of women
- In contrast with university degrees awarded to women



Percentage of women and men researchers in various occupational levels in INFN in june 2000 and december 2002



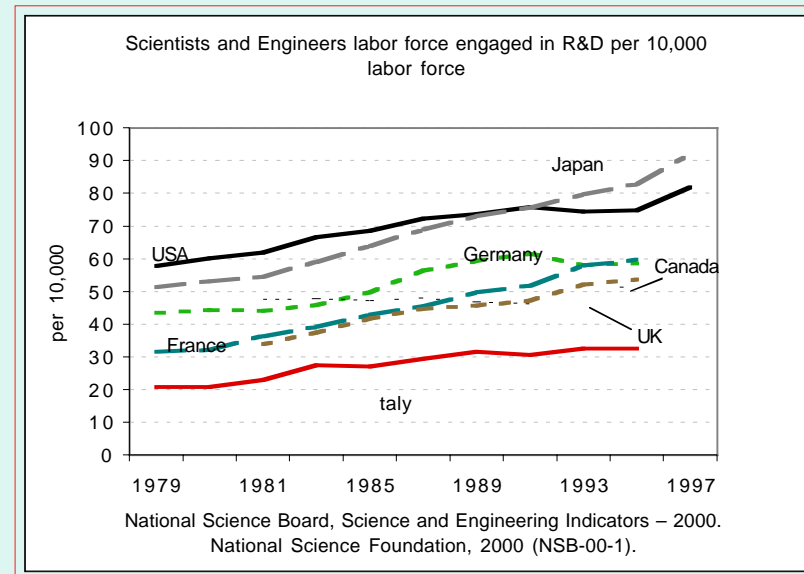
Should one worry about the low participation of women to science and technology professions?

Yes,
for economic
and social
reasons

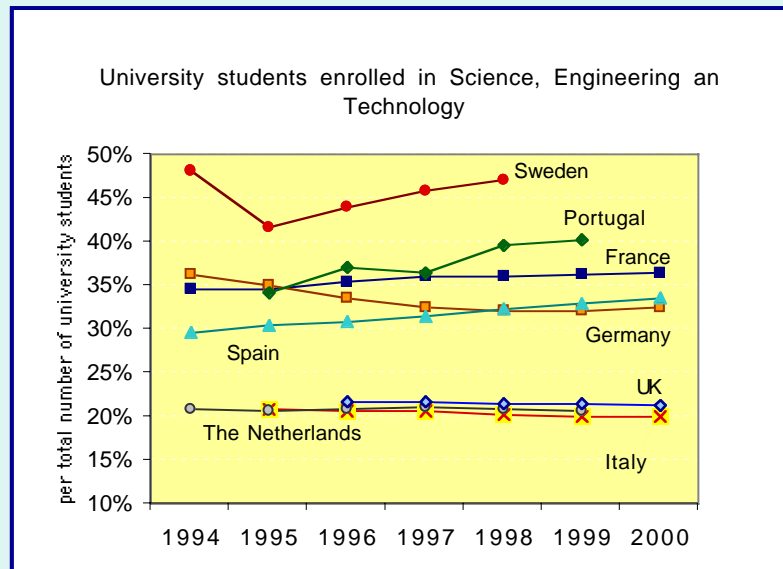
- A knowledge based society needs to increase participation to science and technology
- Untapped resources must be utilized
- Science is knowledge and control over the environment : women must have their share

Human resources in RTD in Science and Technology in Europe

- Scientists and Engineers constitute the basic human resources for a **knowledge** based economy
- Europe is lagging behind
Average annual growth of number of researchers is
 - For USA 6.21%
 - For EU 2.89%
 - For Japan 2.57%
 - For Italy 0.34%



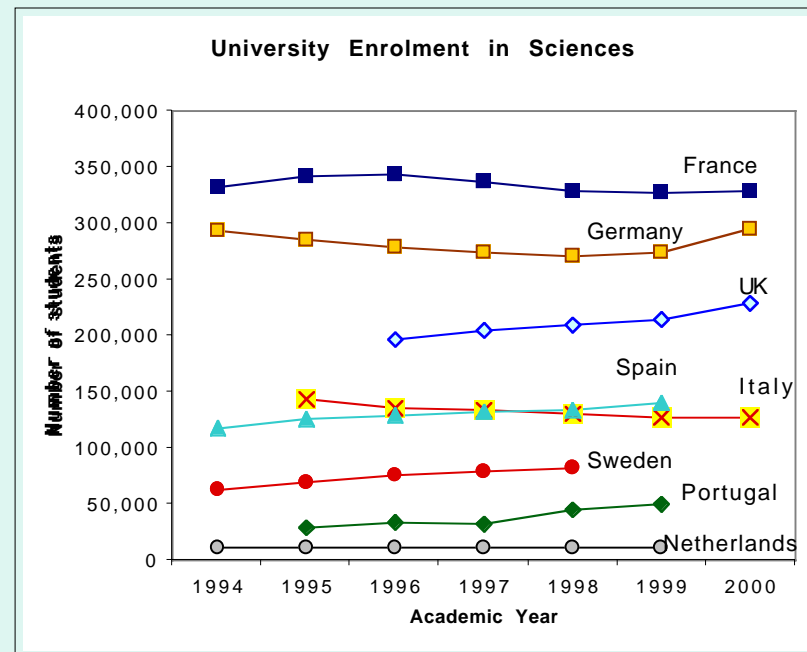
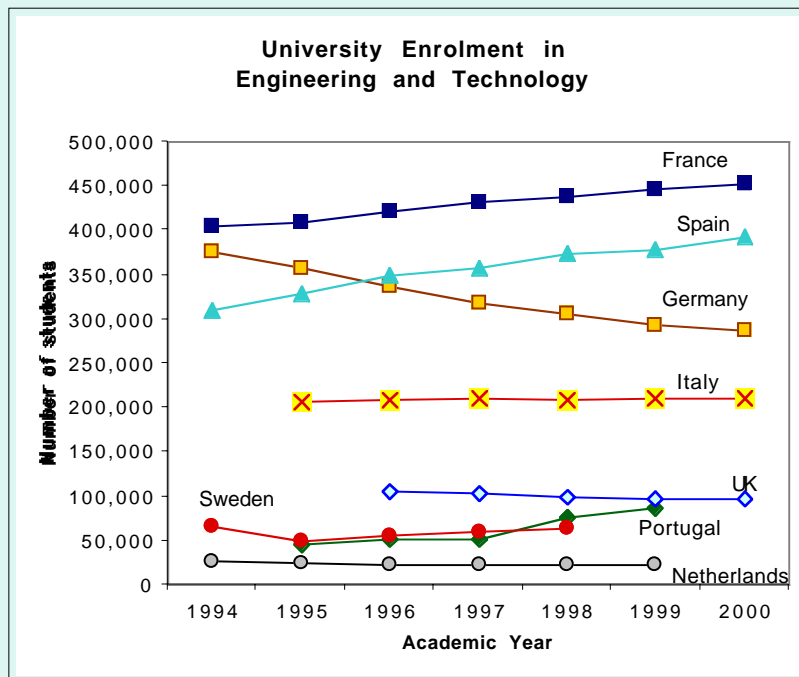
Human resources in RTD in Science and Technology in Europe



9 million
university students
for a selection of Member States
totaling 330
million people

- The main recruitment pool for scientists and engineers is from the higher education sector
- The percentage of of the population in tertiary education in the corresponding age group
 - EU-15 is less than 25%
 - USA is close to 40%
- Enrolment trend: very static in large countries



Undergraduate enrolment in Science, Engineering and Technology in Europe



Barriers to training and efficient development of human resources in RTD

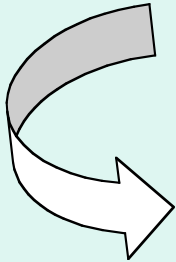
- Financial considerations
 - Research training requires considerable public and private investment
 - Teachers and Researchers salaries are often non-competitive with other jobs
- Mobility across disciplines and between countries and institutions is relatively low

 Last, but not the least :


Gender : there are clear gender imbalances in research


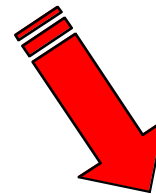
Why still so few women in physics : are there barriers specific to women ?

- Visible and
- Invisible Barriers



Elements playing a fundamental role in the **training** and **retaining** of a scientist :

- Role of mentors and teachers
- Emotional satisfaction and stability
- Institutional support



Women's specific life pattern requires specific actions

Invisible barriers

The glass ceiling :

(an experience common to women professionals, scientists or otherwise)

As a woman advances in the profession, she finds at a certain point that the sky has a limit : she will not go beyond

The glass wall :

(experienced as member of Equal Opportunities groups)

It separates the world of women groups from the usual world

The glass ceiling

A woman may become a professor, have a large number of well known publications, be as successful in what she does as her male colleagues, but unlike the same colleagues she may not be asked to chair Committees, to hold positions of power, to be called in the Academies, etc.

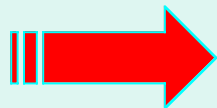
Often this happens since she does not know the rules : her success is not statistically significant and she has no access to peer counseling



Quotas may help
to force entrance in the Control Rooms
and learn the rules to win

The glass wall

- Very little of the discussions within women's committees leak through to the "other world", thus reducing the effectiveness of their actions



Women in the control room may bridge the gap

?Visible barriers

Drawbacks specific to women

For women wishing to follow the pattern of having both a family **and** a scientific career, there are **drawbacks** such as:

- In daily life women are hardly able to dedicate **all** their time to thought and study, as they are unwilling to ignore the emotional needs of family members
- Because of childbearing during the career forming years, women do not have the necessary professional mobility, often because of the **dual career** problem, as most of them are married to fellow scientists
- Myths that all great **discoveries** are done by scientists **before they turn 40**, whereas woman's biological clock urges her to have children before and during these years

In the arts one can invoke and obtain

A Room of One's Own

but in the Sciences ? One needs

- A Laboratory of one's own
- some fellow scientists
- Institutional support

Ways out?

Ways out?

- Quotas?
- Women in the decision room?
- Some actions in Italy

Are Italian women physicists in better position than others?

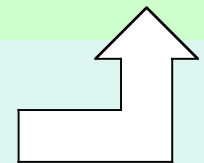
- There is the widespread idea that Italian women physicists are better off
- Science magazine in 1994 talks about *Warm climate for women in the Mediterranean*

Is this true?

Helsinki, 26th of May, 2003

Comparing Italy and UK physics faculty

University Physics faculty in Italy in 1999				Women in UK physics academia in 1996/97 from ETAN Report	
Position	Women	Total	% Women	Position	% Women
Researcher	187	757	25	Lecturer	9
Associate Prof.	142	963	15	senior lecturer	4
Full Professor	29	645	4★	professors	1★
Total	358	2365	15	Tot. reg. staff	5



Quotas and the Affirmative Action Plans of Italian public institutions : institutional support

- Both cultural and organizational actions are needed if the number of women researchers has to increase
- Italian law requires Positive Action Plans to be approved and deployed
- INFN has approved its own three year plan in December 2001

INFN Positive Action Plan

- To contribute to the image of a woman scientist
 - Insert women's contributions to science in Scientific Week programs and other cultural events
 - Prepare and distribute material on women scientists during high school student visits
 - Dedicate library sections to women's studies in National Laboratories

- **To ease harmonization between personal and professional life introduce**
 - Special economic support for child care
 - Flexible working hours
 - Home based office work via computer links
 - Code against mobbing and sexual harassment

The Plan of Positive Actions and the quotas for women in promotion and recruitment Committees

- All recruitments and promotion for researchers in INFN (CNR as well) take place through a national competition with 3-7 Committee members designated by the INFN Director's Board
- Prodi-Finocchiaro norm requires that such Committees be composed by **30% of women** :
- Satisfaction of this norm is one of the **objectives** of the Plan
- Such an objective is not easy to reach as there are too few women for highest level committees (4% in INFN)

Women in the decision room ?

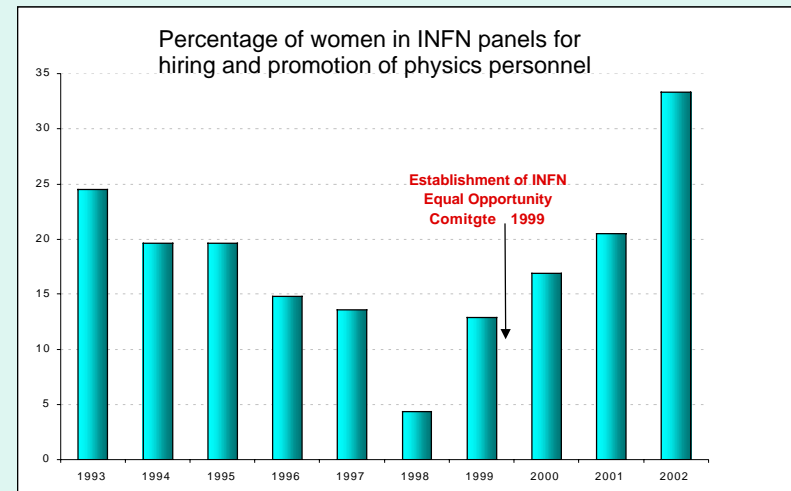
- INFN Board of Directors is constituted by 35 members
 - President
 - Executive Board
 - Directors of 4 National Laboratories
 - Directors of University Units
 - 4 Reps from Ministry of Research, Industry, Treasure



Only one
woman as representative
of a Ministry

Women in INFN promotion and hiring Committees

- The percentage of women in all promotion and hiring committees is close to 30% following the Prodi-Finocchiaro law
- This action was successfully pursued by the Equal Opportunity Committee



Conclusions and recommendations

- Society must fully exploit its human resource capital
- Women are the largest untapped resource in science and technology

- More women are needed in the *Control Rooms* to ease other women's entry
- Age barriers to women's entry and remaining in science must be removed at national and EU levels:
 - higher limits for fellowships for young researchers
 - Higher age limits for staff positions
 - Lift retirement age restrictions