Women and diversity in Physics: Are we there yet?

Pauline Gagnon,
formerly from Indiana University/CERN

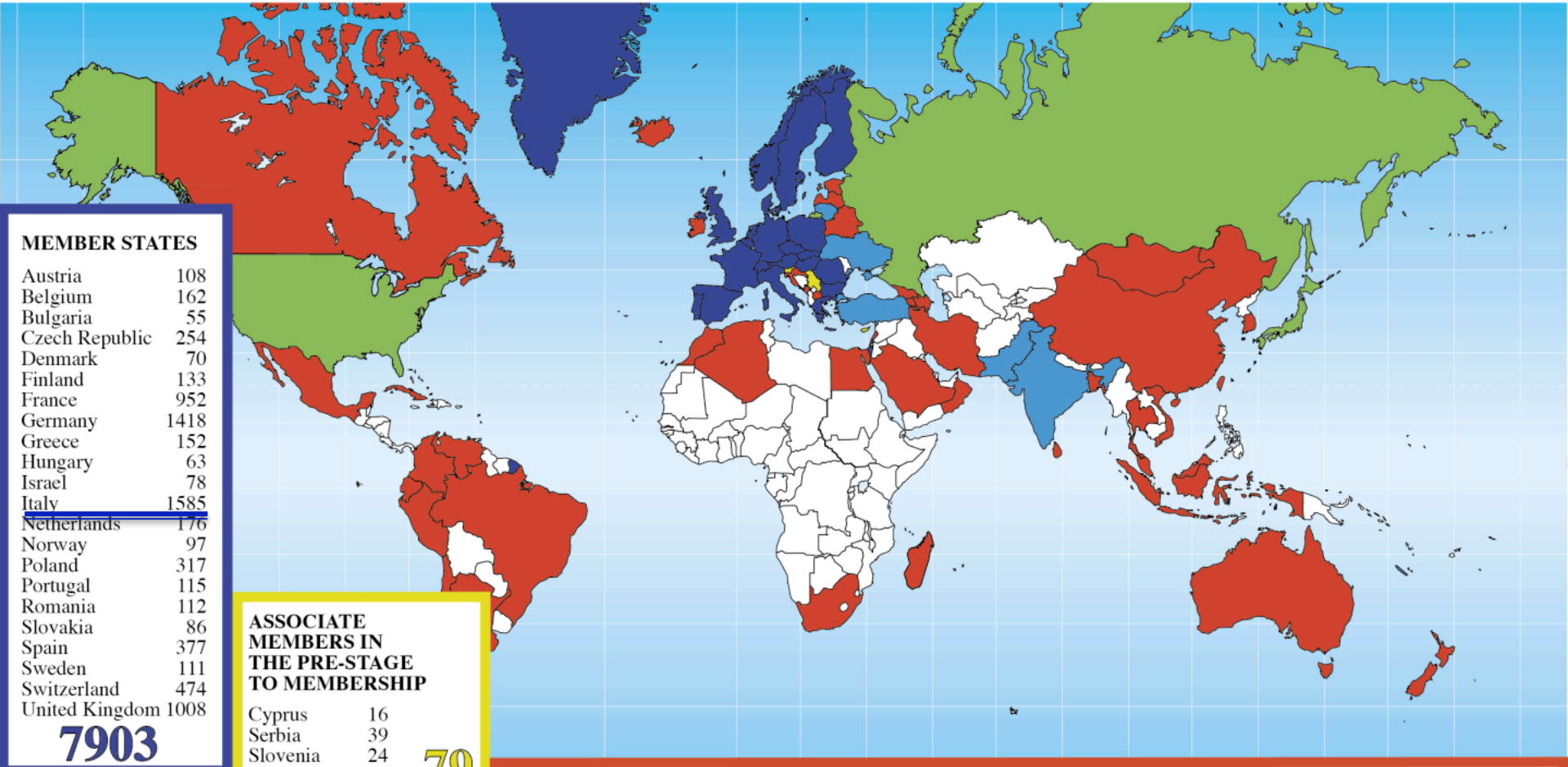
Outline

1. Statistics from CERN
2. World wide survey
3. Why is it so?
4. Solutions

CERN: European Laboratory for Particle Physics (Geneva, Switzerland)

- CERN hires about 2500 people, mostly technical and administrative staff + 1000 fellows and students
- As of Jan 2018, 13 400 scientists from 78 different countries participate in the research
- 4 large experiments (1000-3000 scientific authors) on the Large Hadron Collider
- Scientists of 111 nationalities are present at CERN

Distribution of All CERN Users by Location of Institute on 24 January 2018



MEMBER STATES

Austria	108
Belgium	162
Bulgaria	55
Czech Republic	254
Denmark	70
Finland	133
France	952
Germany	1418
Greece	152
Hungary	63
Israel	78
Italy	1585
Netherlands	176
Norway	97
Poland	317
Portugal	115
Romania	112
Slovakia	86
Spain	377
Sweden	111
Switzerland	474
United Kingdom	1008

7903

ASSOCIATE MEMBERS 446

India	221
Lithuania	21
Pakistan	38
Turkey	129
Ukraine	37

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP

Cyprus	16
Serbia	39
Slovenia	24

79

OBSERVERS

Japan	285
Russia	1099
USA	2070

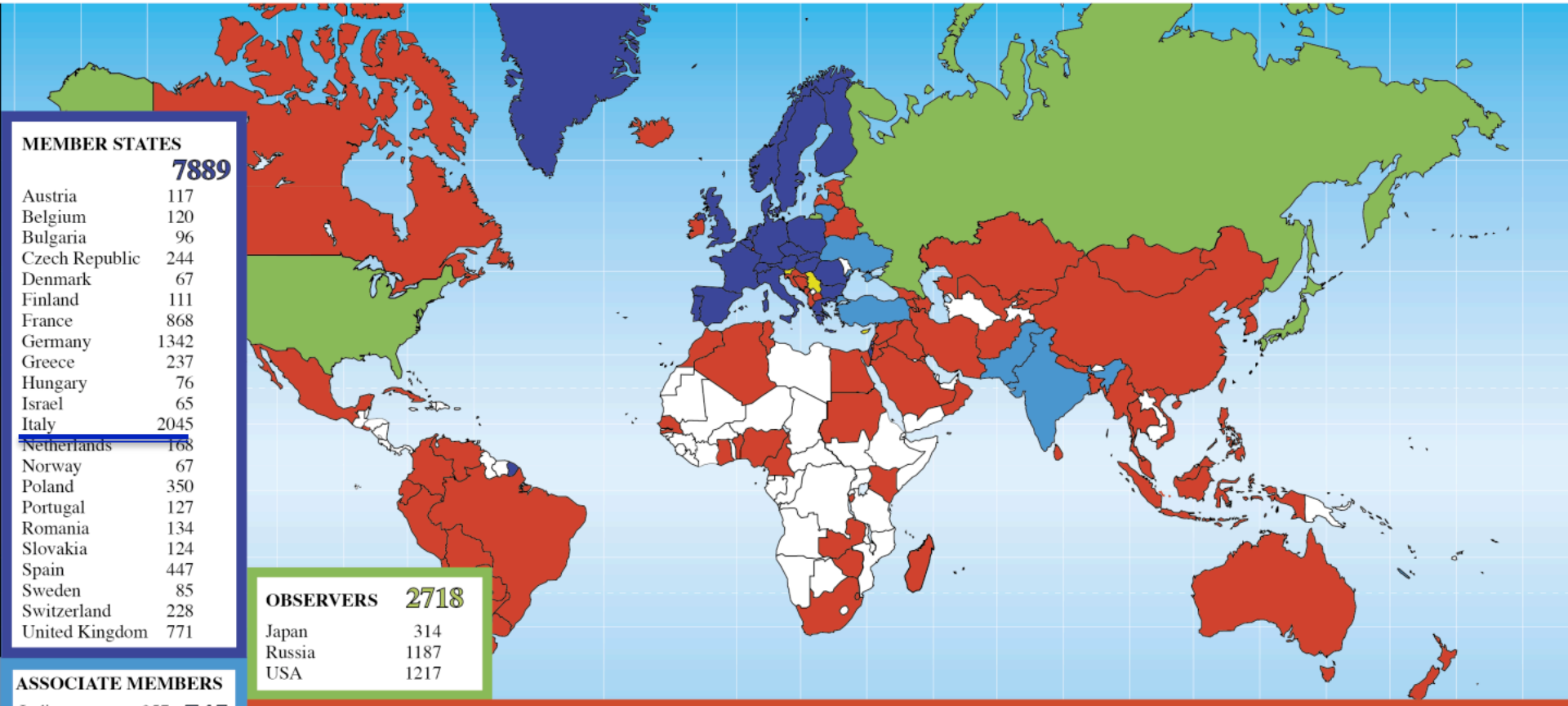
3454

OTHERS

Algeria	1	Chile	23	Iceland	2	Mexico	64	Sri Lanka	3
Argentina	20	China	283	Indonesia	7	Mongolia	2	T.F.Y.R.OM	2
Armenia	14	Colombia	27	Iran	26	Montenegro	7	Taiwan	68
Australia	36	Croatia	31	Ireland	10	Morocco	12	Thailand	19
Azerbaijan	5	Cuba	3	Korea	166	New Zealand	7	Venezuela	1
Bangladesh	3	Ecuador	4	Latvia	1	Oman	4	Viet Nam	1
Belarus	24	Egypt	25	Lebanon	10	Peru	3		
Brazil	135	Estonia	18	Madagascar	3	Saudi Arabia	1		
Canada	190	Georgia	28	Malaysia	7	Singapore	3		
		Hong Kong	19	Malta	8	South Africa	81		

1407

Distribution of All CERN Users by Nationality on 24 January 2018



MEMBER STATES **7889**

Austria	117
Belgium	120
Bulgaria	96
Czech Republic	244
Denmark	67
Finland	111
France	868
Germany	1342
Greece	237
Hungary	76
Israel	65
Italy	2045
Netherlands	168
Norway	67
Poland	350
Portugal	127
Romania	134
Slovakia	124
Spain	447
Sweden	85
Switzerland	228
United Kingdom	771

OBSERVERS **2718**

Japan	314
Russia	1187
USA	1217

ASSOCIATE MEMBERS **745**

India	357
Lithuania	35
Pakistan	65
Turkey	173
Ukraine	115

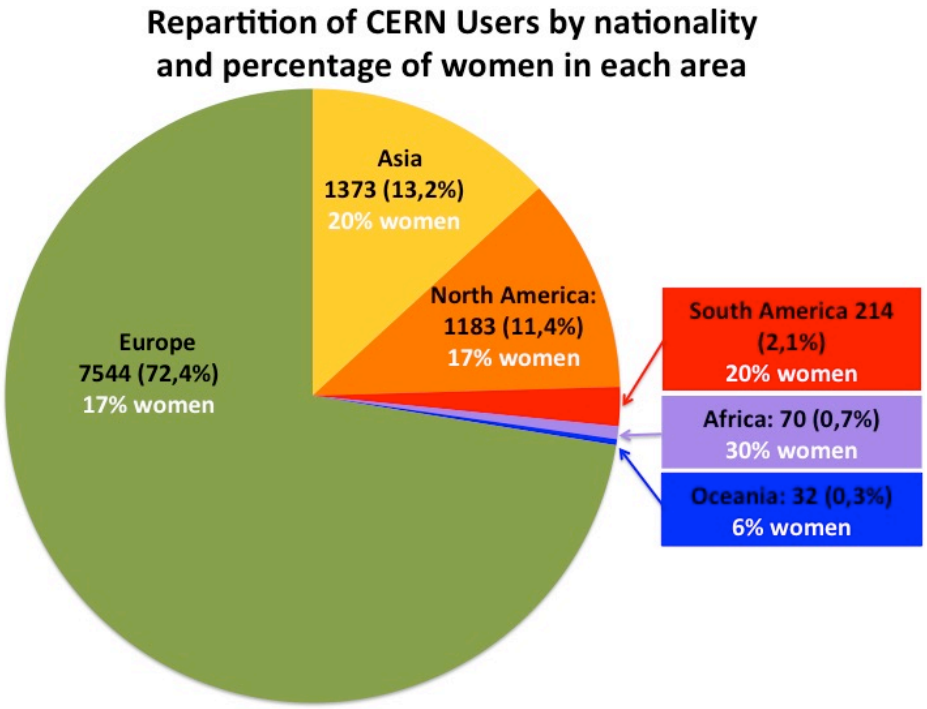
ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP **118**

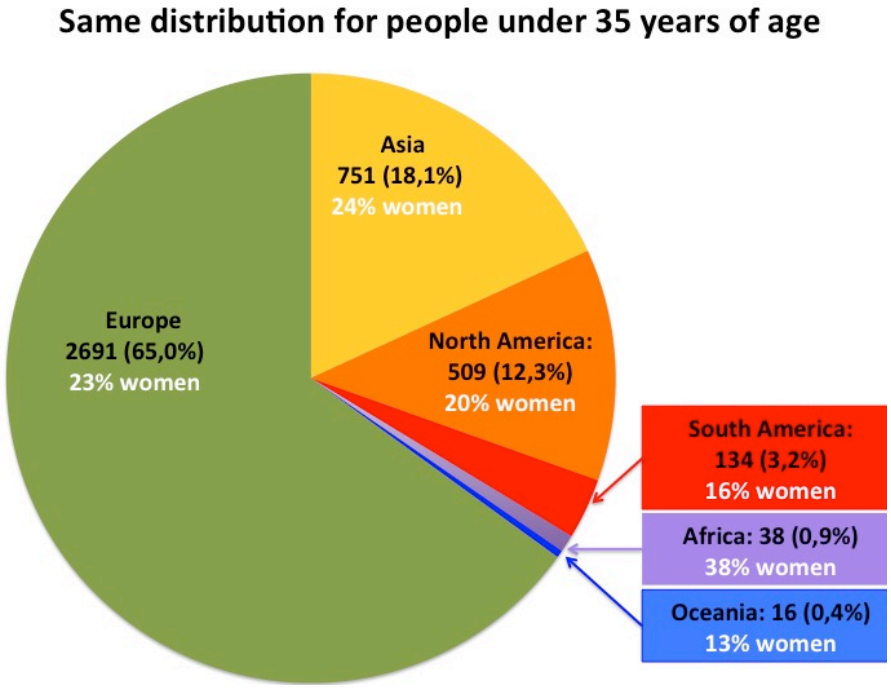
Cyprus	26
Serbia	57
Slovenia	35

OTHERS **1872**

Afghanistan	1	Bolivia	4	Egypt	31	Kazakhstan	5	Mongolia	2	Philippines	3	Thailand	22
Albania	3	Bosnia & Herzegovina	2	El Salvador	1	Kenya	3	Montenegro	11	Saint Kitts and Nevis	1	T.F.Y.R.O.M.	2
Algeria	14	Brazil	135	Estonia	15	Korea Rep.	185	Morocco	20	Saudi Arabia	2	Tunisia	5
Argentina	27	Burundi	1	Georgia	46	Kyrgyzstan	1	Myanmar	1	Senegal	1	Uruguay	1
Armenia	19	Cameroon	1	Ghana	1	Latvia	2	Nepal	10	Singapore	4	Uzbekistan	4
Australia	31	Canada	161	Hong Kong	1	Lebanon	23	New Zealand	5	South Africa	56	Venezuela	10
Azerbaijan	10	Chile	20	Iceland	3	Luxembourg	2	Nigeria	3	Sri Lanka	6	Viet Nam	13
Bangladesh	11	China	510	Indonesia	11	Madagascar	4	North Korea	1	Sudan	1	Zambia	1
Belarus	48	Colombia	45	Iran	51	Malaysia	15	Oman	3	Swaziland	1	Zimbabwe	2
Benin	1	Croatia	41	Iraq	1	Malta	9	Palestine (O.T.).	7	Syria	1		
		Cuba	12	Ireland	16	Mauritius	1	Paraguay	2	Taiwan	51		
		Ecuador	6	Jordan	1	Mexico	82	Peru	7				

Racial diversity at CERN (2014)

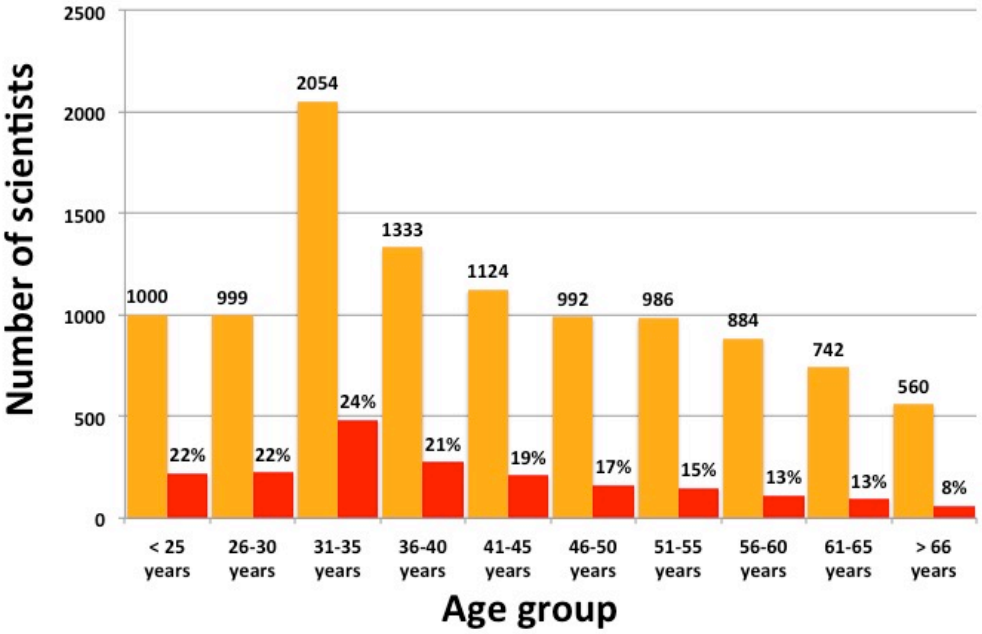




% of women at CERN: 17.5% in 2014; 19.3% as of Jan 2018

AT CERN, roughly 80% of all scientists are male and 80% are white

18% female scientists at CERN as of 31 December 2015



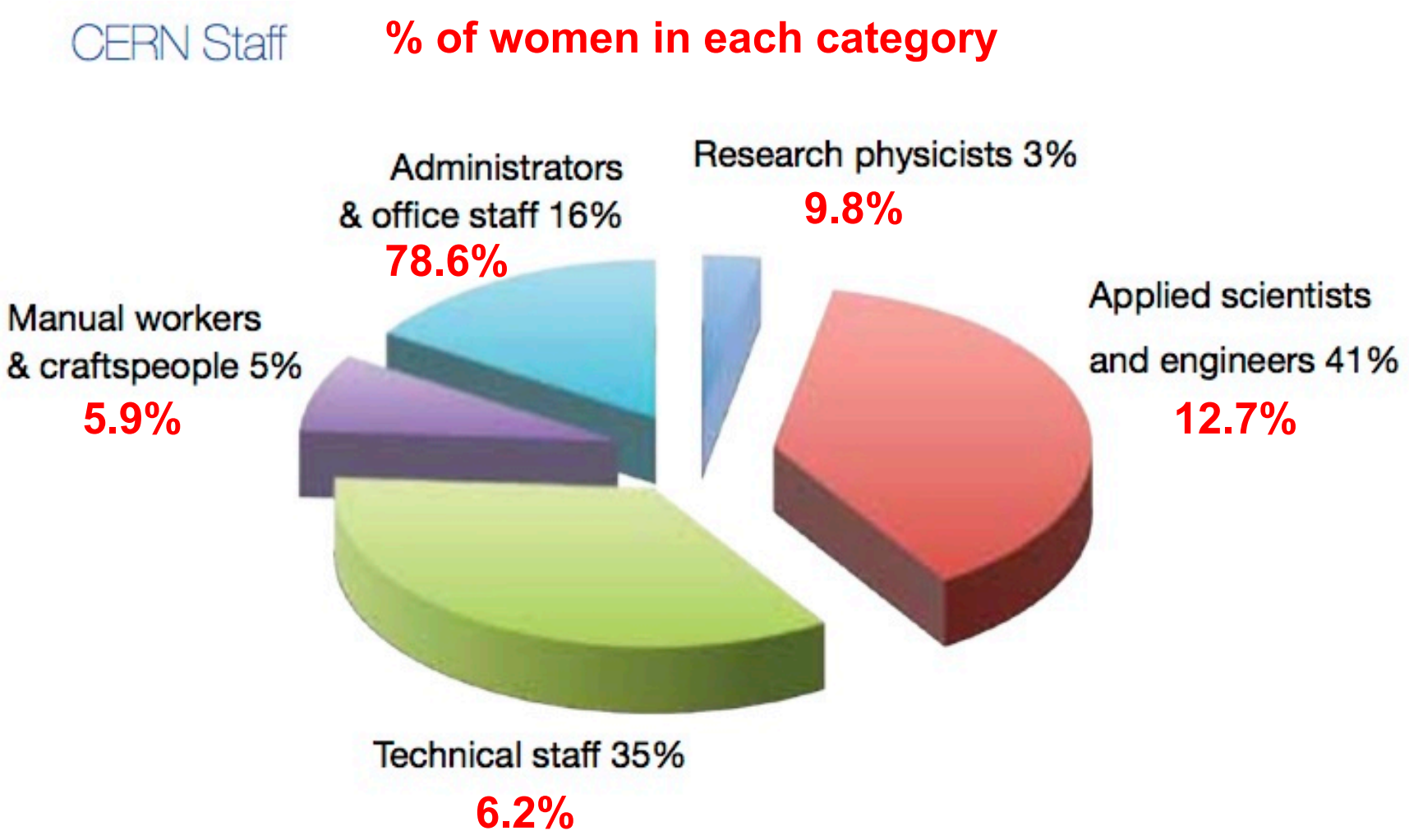
Average age (1 Sept 2014):
37 for women; 42 for men

- above the age of 50:
12.7% women

- below the age of 35:
22.5% women

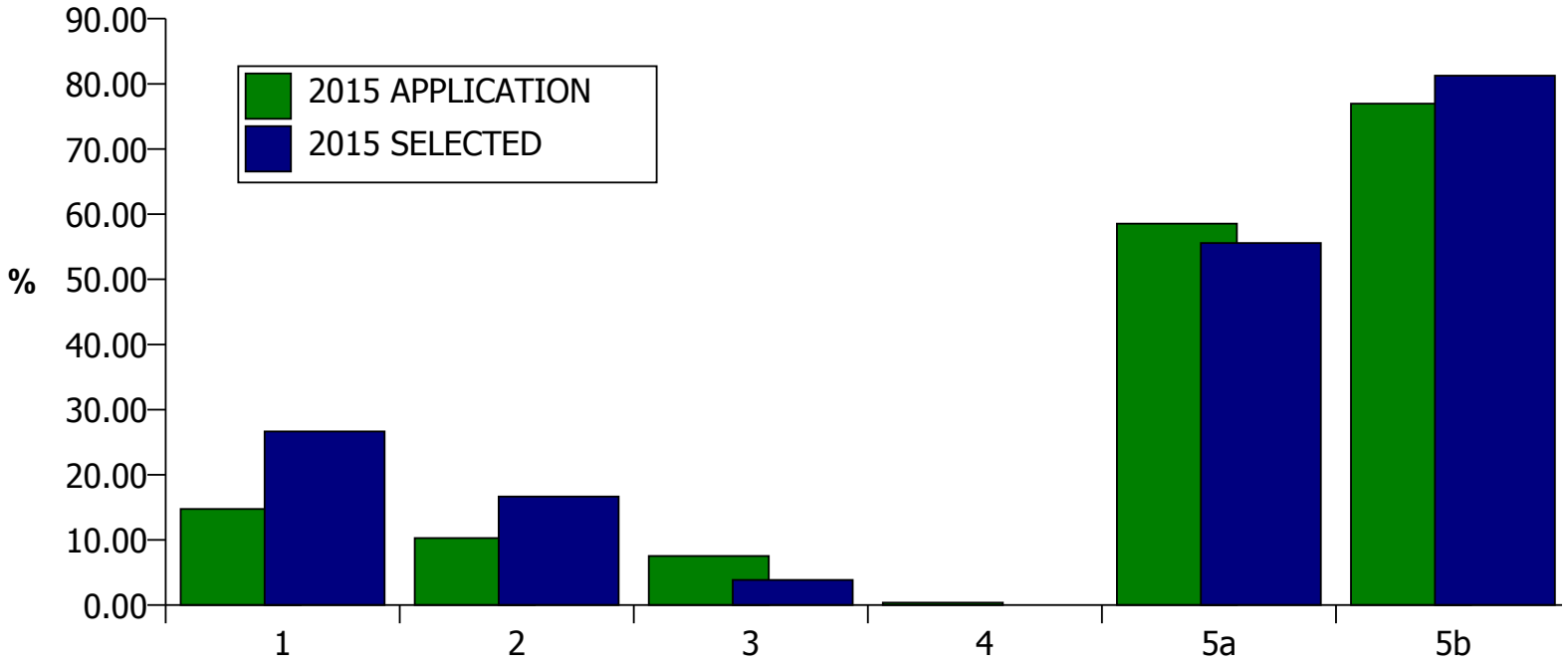
Many more young women needed to raise the average

CERN staff


CERN Staff
% of women in each category
Administrators & office staff 16%
78.6%
Research physicists 3%
9.8%
Manual workers & craftspeople 5%
5.9%
Applied scientists and engineers 41%
12.7%
Technical staff 35%
6.2%

Recruitment of CERN staff in 2015

Figure 30: Female Candidates Applied and Selected by Professional Category



Professional Categories	1. Research Physicists	2. Scientific & Eng. work	3. Technical work	4. Manual work	5a. Prof. Admin. work	5b. Office and Admin. work

Percentages of women among CERN scientists by nationality and affiliation

Italy (2014)	% of CERN scientists	% of women	% women below 35 years of age
by nationality	12.5 %	23.1 %	29.2 %
by affiliation	12.0 %	20.7 %	30.4 %
		CERN: 17.5 %	

- **% by nationality: reflects education practices**
- **% by affiliation: reflects hiring practices**

- In 2018: 1813 Italian research scientists at CERN = **15.1 %** of CERN Users
- In 2018: 1312 research scientists hired by Italian institutes = **11.9 %** of CERN Users

% of women at CERN by nationality above CERN average (17.5%) - Sept 2014

CERN Users by nationality	% of women	% of women below 35 year	% of people below 35 year	Total number of scientists at CERN
Turkey	33%	40%	59%	159
Norway	29%	33%	41%	59
Greece	28%	32%	38%	152
South Africa	28%	44%	50%	18
Romania	26%	30%	36%	121
Belgium	25%	25%	54%	109
Spain	25%	31%	38%	323
Sweden	24%	36%	39%	71
Italy	23%	31%	29%	1666
India	23%	26%	52%	214
Bulgaria	22%	44%	22%	74
China	22%	23%	72%	302
Portugal	20%	21%	45%	104
Brasil	20%	12%	54%	111
South Korea	19%	23%	49%	115
Finland	19%	21%	30%	79
Mexico	19%	28%	58%	69
Poland	19%	16%	39%	247

Using only countries with > 50 people (except for SA)

% of women at CERN by nationality below CERN average - Sept 2014

CERN Users by nationality	% of women	% of women below 35 year	% of people below 35 year	Total number of scientists at CERN
France	17%	25%	26%	731
Slovakia	17%	21%	51%	102
Canada	16%	22%	48%	141
Israel	15%	29%	33%	52
United States	14%	18%	41%	973
Germany	14%	19%	47%	1095
Switzerland	14%	18%	31%	177
United Kingdom	12%	17%	46%	633
Hungary	12%	22%	34%	67
Russia	11%	18%	22%	951
Austria	11%	15%	33%	81
Nederlands	10%	28%	25%	144
Ukraine	10%	14%	58%	60
Denmark	9%	21%	36%	53
Czech Republic	9%	10%	51%	216
Japan	7%	8%	47%	253

Using only countries with more than 50 people

Is the fraction of women related to the salary level?

Higher % of women

1. Countries with lower salaries:

- Turkey, Greece, Romania, Bulgaria, Spain, Italy, India

2. Better recruitment policies

- Norway, Sweden and Finland

Lower % of women

1. Countries with higher salaries:

- Japan, Austria, Switzerland, USA, Germany, Canada, Denmark,

Scientists directly hired by CERN

2. Ex-communist countries:

- Ukraine, Russia, Czech Republic, Hungary, Slovakia

Better representation of women

- Women now in high profile positions
  - Fabiola Gianotti, now CERN Director General
  - Persis Drell, first woman lab director at SLAC
  - Young-Kee Kim was Fermilab Deputy Director
- Many women at all levels in key positions in all the experiments

Fabiola Gianotti, CERN Director General

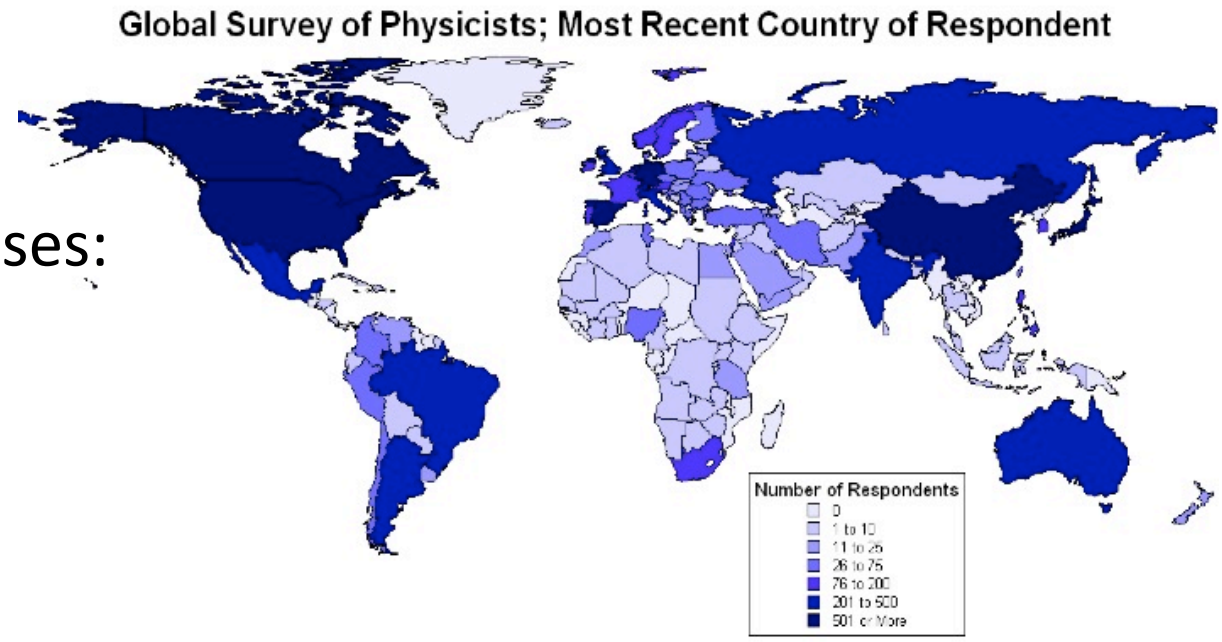
Representation is only one aspect

Are women treated equally?

Third Survey from American Institute of Physics: Are women's experiences in physics different from men's?

- 14932 responses
- 130 countries

- Language of responses:
  - 60% English
  - 11% German
  - 11% Spanish
  - 7% Japanese
  - 5% Chinese
  - 3% French
  - 2% Russian
  - 1% Arabic



Error margin on answers around 0.5%

Participation in various activities (%)

% Yes	Less Developed		Very Highly Developed	
	Women	Men	Women	Men
Given a talk at a conference as an invited speaker	51	67	58	73
Attended a conference abroad	75	81	83	87
Conducted research abroad	54	71	61	69
Acted as a boss or manager	38	53	46	61
Served as editor of a journal	16	24	11	19
Served on committees for grant agencies	22	37	26	36
Served on important committees at your institute or company	50	62	48	60
Served on an organizing committee for a conference in your field	48	59	48	55
Advised undergraduate students	82	84	69	74
Advised graduate students	63	77	58	70
Served on thesis or dissertation committees (not as an advisor)	52	66	37	52

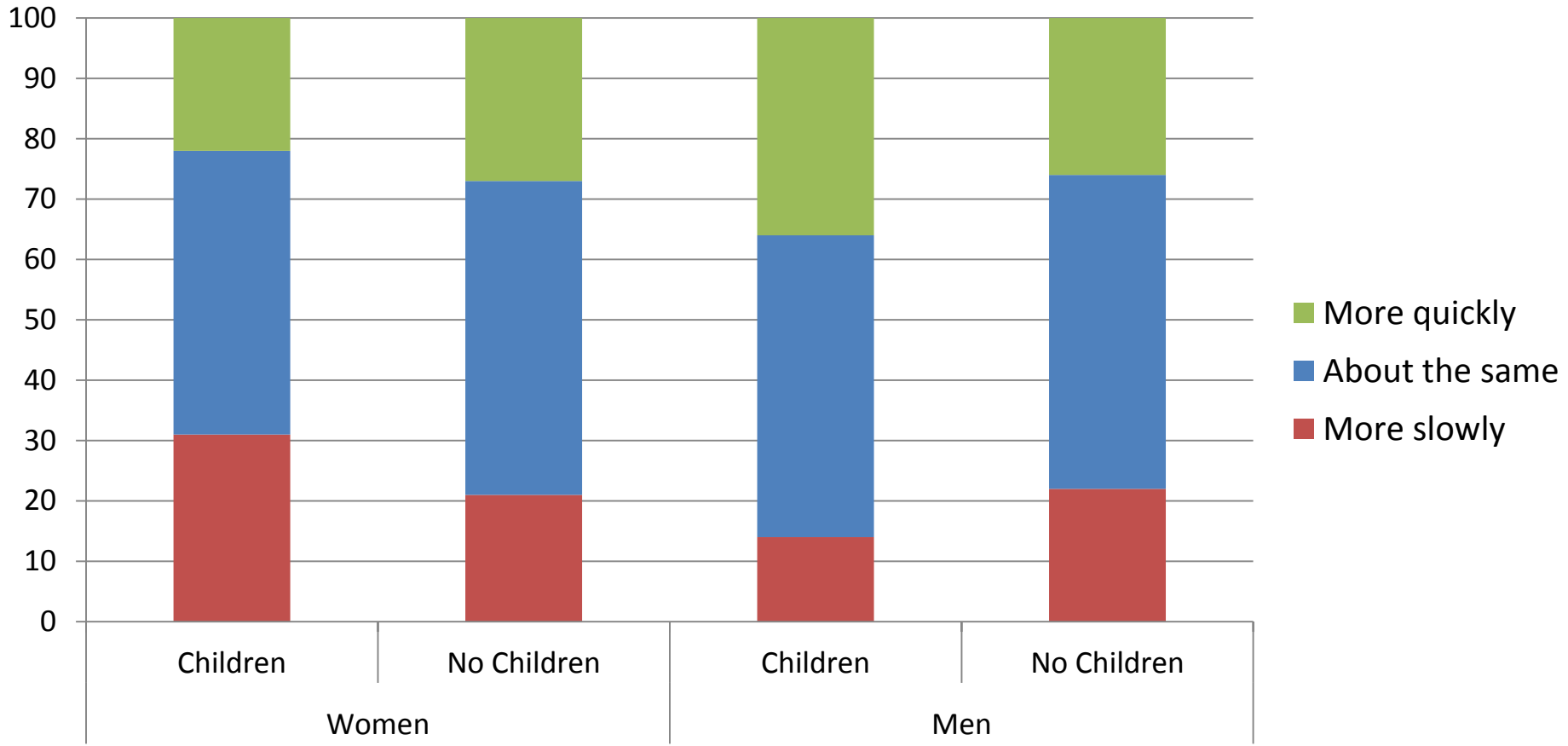
Women are statistically significantly disfavored

Do you have enough resources?

% Yes	Less Developed		Very Highly Developed	
	Women	Men	Women	Men
Funding	34	51	52	60
Office space	64	74	72	77
Lab space	42	47	46	52
Equipment	42	49	58	64
Travel money	31	47	57	64
Clerical support	22	38	30	43
Employees or students	42	53	33	43

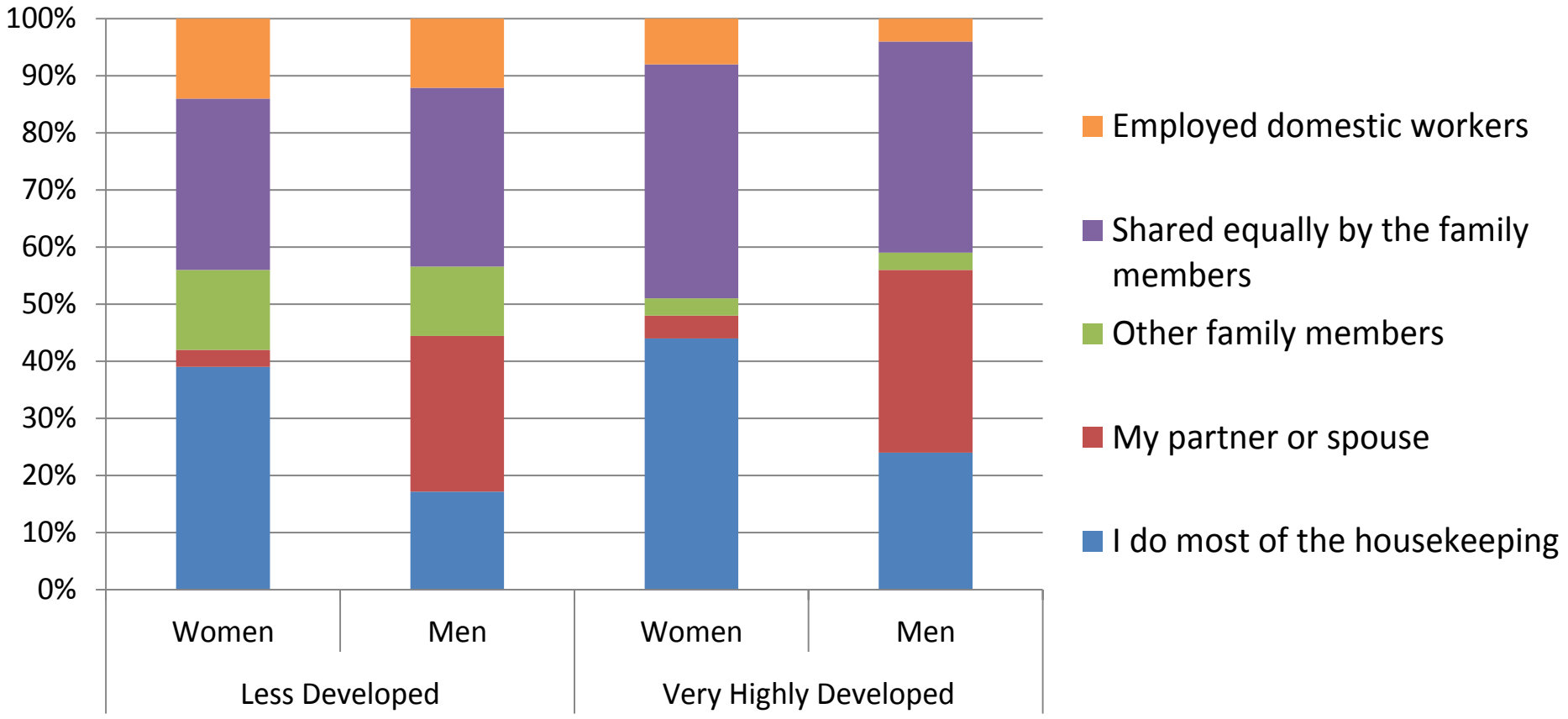
On all accounts, women are significantly disadvantaged

Compared to your colleagues, how quickly have you progressed in your career?



Fathers are advantaged while mothers answered "slower" twice as often

Who does the housework?



Women answered "me" twice as often

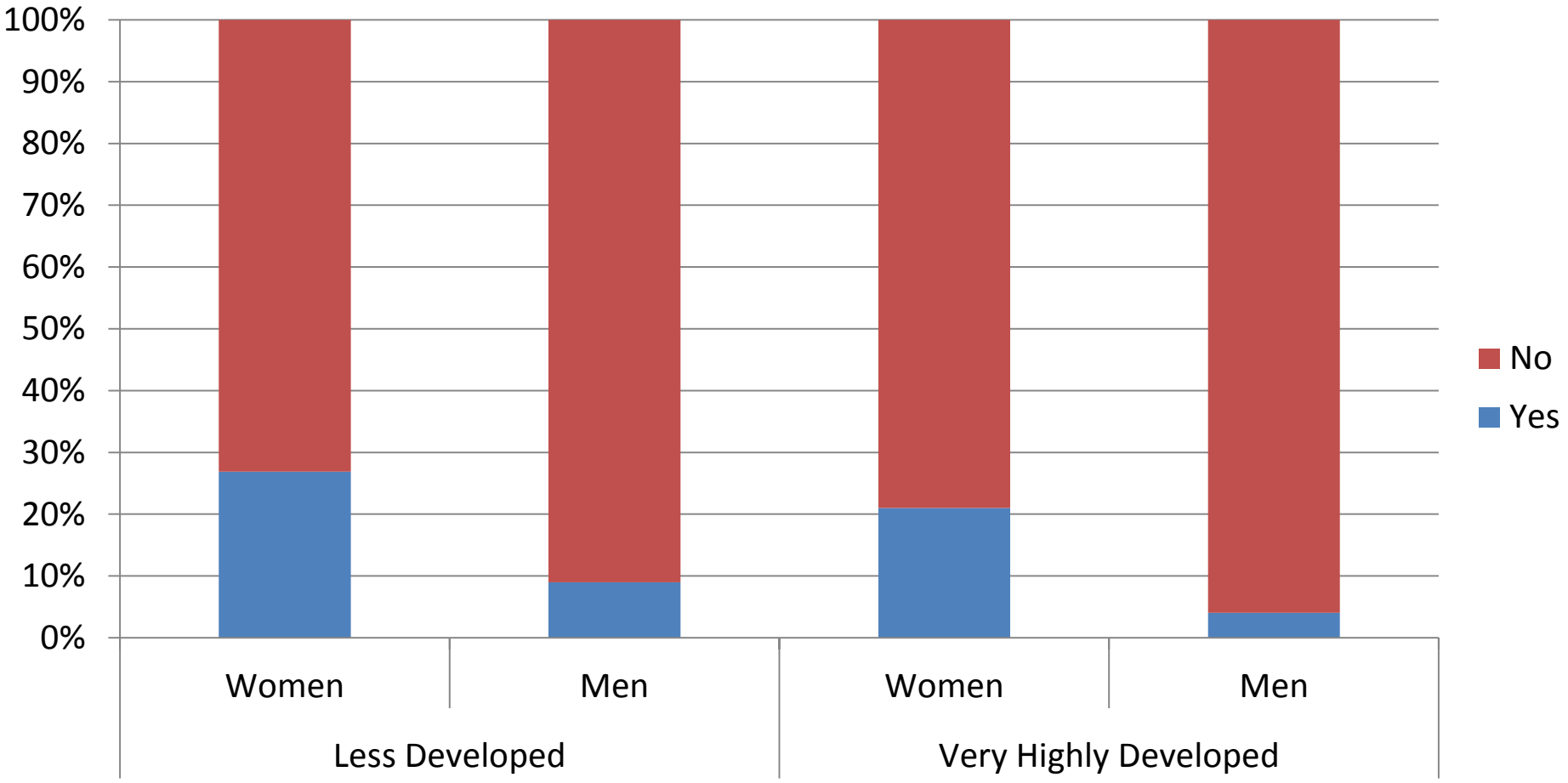
Men answered "my spouse" 10 times more

How did your work or career change because you are a parent?

	Women	Men
I chose a less demanding or more flexible work schedule	39	20
I changed my employer or field of employment	7	4
I spent significantly less time at work	35	18
I was more productive and efficient at work	29	15
My career or rate of promotion slowed significantly	34	9
I became a stay at home parent	6	1
My work or career did not change significantly	**32**	**65**

% of affected women: 2 - 4 times larger than men

Did your employer assign to you less challenging work when you became a parent?



3 times more women said yes than men

Summary of the American Institute of Physics study

Percentage of YES	Less developped countries		Very developped countries	
	Women	Men	Women	Men
Access to professionnal activities	50%	62%	50%	58%
Sufficient resources	40%	51%	48%	58%
Career affected by children	58%	50%	53%	41%
Assumed domestic tasks	39%	17%	44%	24%
Less challenges for parents	27%	9%	21%	4%

Should we conclude:
More women but same old deal?

Why is it so?

Problem is social and political

- No scientific test has ever established the intellectual superiority of men or white people
- But these ideas prevail for historical and political reasons
- Those stereotypes need to be addressed
  - Within the majority group
  - Within the minority group: the stereotypes are often internalised

What's the best way to attract more diversity in physics?

PRiSE study: from Zahra Hazari, Philip Sadler, Gerhard Sonnert and Marie-Claire Shanahan
http://blogs.scientificamerican.com/guest-blog/2011/03/29/can-we-declare-victory-for-women-in-their-participation-in-science-not-yet/ (tested 7505 students)

- Students who pursue studies in physics need a strong "physics identity":
  - Students must feel good at it
  - Students must believe in their own abilities
  - Reinforced by support from peers, teachers, family and society

- This is true for all students, but students from minority groups have lower self-esteem, contributing to the difficulties they can encounter in physics.

What helps build a strong "physics identity"

Students like:

- Opportunities for peer teaching
- Encouragement from teachers
- Hear the benefits of being a scientist

Teachers could:

- Discuss cutting-edge physics topics
- Encourage questions from students
- Address students' beliefs about the world

Common strategies to encourage female students

- having an all-girl physics class
- having a female physics teacher
- having female scientist guest speakers in physics class
- discussing the work of female scientists in physics class
- discussing the underrepresentation of women in physics class

The PriSE study discovered that only one of these activities had an effect on strengthening "physics identity"

One classroom experience makes a huge difference

The explicit discussion of under-representation of women in science.

- Talking about the fact that there are few women in physics helps young women realize that the problem comes from society, not from them
- Female students who had these discussions in high school had significantly stronger physics identities
- These discussions had no adverse impact on young men

Impostor syndrome

- Describes highly successful women who have difficulty internally recognizing their own achievements.
- Believe they don't really belong to the field, that their success is only due to chance or hard work, not ability.
- Less likely to occur when students are mentored

Imposter Syndrome Measure	Women generally	Response Indicates …
Sometimes, I am afraid others will discover how much knowledge or ability I lack.**	Agree	Imposter syndrome
The major cause of success in my life is my high ability.*	Disagree	Imposter syndrome
I feel highly confident that I will succeed in my future career.**	Disagree	Imposter syndrome

*p<.05
**p<.01

Performing according to expectations

Stereotype threat

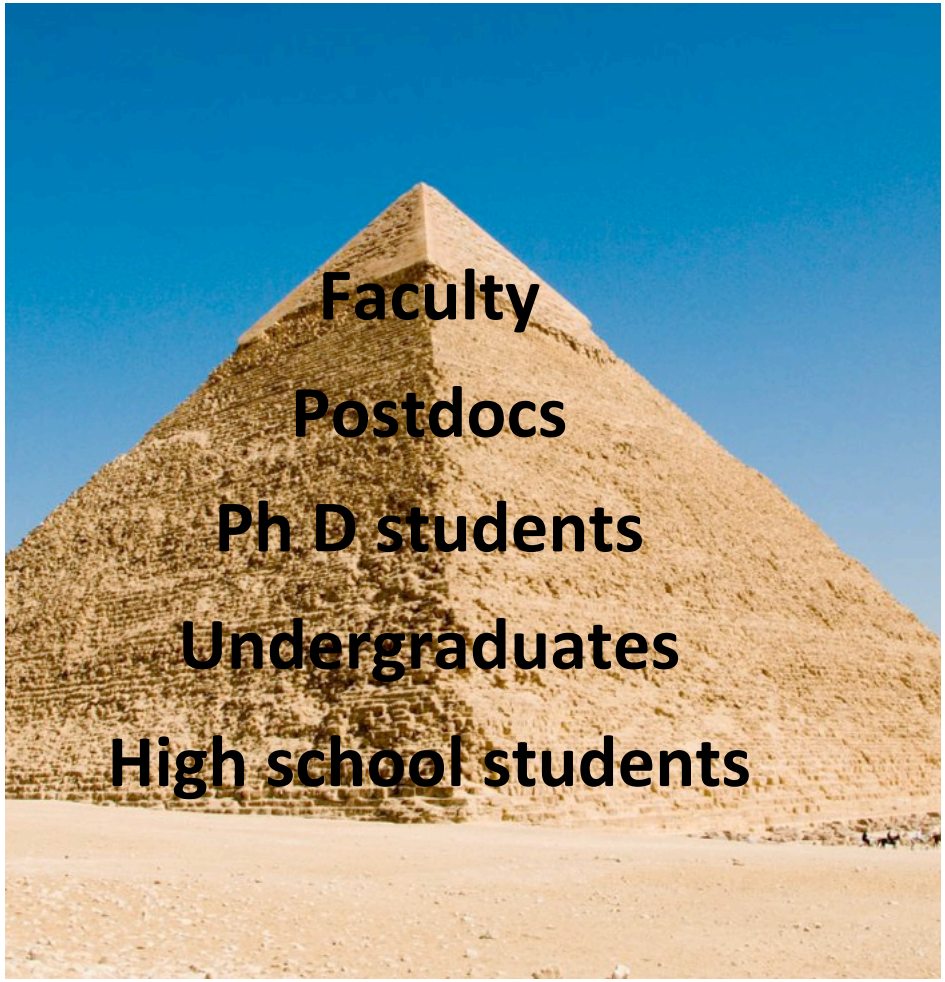
Mentioning how members of a minority group perform wrt the majority group prior to a test influences the outcome

Stereotype boost

Members of the majority group perform better if the superiority of this group is mention prior to the test

So what can be done?

Hard to recruit at the top!



Let's move to the 21st century!

To attract more people from minority groups

- Discuss the origin of discrimination
- Build strong “physics identity”
- Fight stereotypes at all levels
- Provide role models for minority groups
- Provide mentors to all young people

To hire more people from minority groups

- Anonymous job applications
- Spousal considerations
- Equitable parental leaves

To retain more people from minority groups

- Provide mentors for young people starting their careers
- Have broad discussions about minorities issues at large scientific meetings
- Hold scientific meetings for members of minority groups
  - done in Germany and Nederland for women;
  - done by National Society of Black Physicists in the US
  - efforts to implement it for LGBT physicists in the US

Some great initiatives

African School of Fundamental Physics

African School of Fundamental Physics

- 2010: Stellenbosch
- 2012: Kumasi, Ghana
- 2014: Dakar, Senegal
- 2016: Kigali, Rwanda; 1-19 August
- 2018: Windhoek, Namibia; 30 June-14 July

http://www.africanschoolofphysics.org/

Some activities of CERN women physicists

- Mailing list
- Weekly lunch
- Support women candidates
- Raised funds to bring 2 Iranian women to CERN Summer School in 2012
- List of female experts for CERN Summer School
- Hands-on workshops for high school girls
- Lab-wide event on 8 March 2010

International Women's Day 2010 at CERN

Activities of the LGBT group at CERN

- Established in 2010
- Got CERN support in 2013
- Mailing list
- Weekly lunch + evening out
- Advise CERN Diversity group
- Organized lab-wide event for IDAHOT since 2016

Fight stereotypes at all levels

Teachers:

- Strengthen "physics identity"
- Encourage class discussions on origin of discrimination

Institutions

- Produce diverse and inclusive documents
- Implement anonymous job application process
- Implement equal parental leaves
- Offer same salary for equal education and experience level
- Disclose salary

Scientific associations

- Discuss diversity issues at large scientific meetings
- Organize scientific meetings for minority groups

Conclusion

- More women in physics and high energy physics but could still be more welcoming to all minority groups
- Clear gender-based difference in opportunities worldwide
- Reinforcing “physics identity” helps recruiting more young people in general but also from minority groups
- Discussing the poor representation of women and minorities in physics helps strengthening “physics identity”

Thank you for your attention

Pauline.Gagnon@cern.ch