

The background is a deep blue with numerous bright, white and light blue streaks and trails radiating from various points, creating a sense of dynamic movement and energy, reminiscent of particle tracks in a detector or light trails in space.

# Fundamental Research and Sustainable Future

CERN: 60 Years of Research and Discoveries

Madrid, October 28, 2013

Rolf Heuer

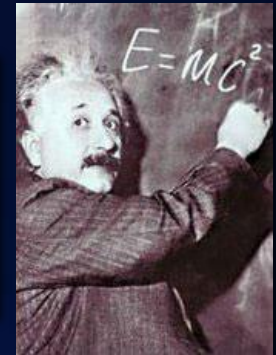
CERN



# The Mission of CERN

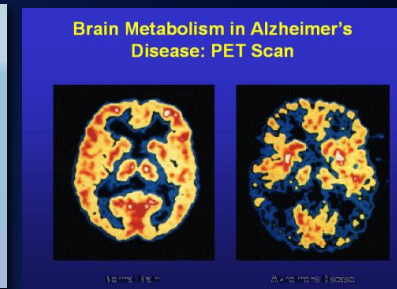
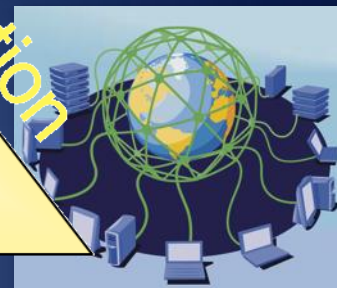
## ❑ Push forward the frontiers of knowledge

E.g. the secrets of the Big Bang - what was the matter like within the first moments of the Universe's existence?



## ❑ Develop new technologies accelerators and detectors

Information technology  
Medicine - diagnosis and therapy



# Paradigm shifts .....



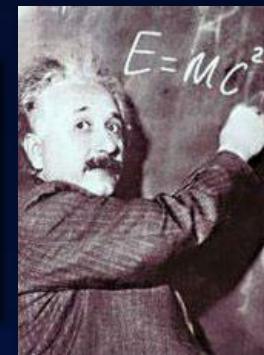




# The Mission of CERN

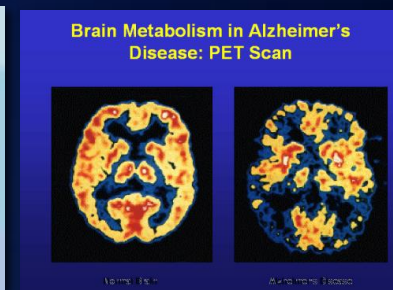
## ■ Push forward the frontiers of knowledge

E.g. the secrets of the Big Bang ...what was the matter like within the first moments of the Universe's existence?



## ■ Develop new technologies for accelerators and detectors

Information technology - the Web and the GRID  
Medicine - diagnosis and therapy



## ■ Train scientists and engineers of tomorrow



## ■ Unite people from different countries and cultures



# CERN was founded 1954: 12 European States

“Science for Peace”

## Today: 20 Member States

~ 2300 staff  
~ 1280 other paid personnel  
~ 11000 users  
Budget (2013) ~1000 MCHF

**Member States:** Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom

**Candidate for Accession:** Romania

**Associate Members in Pre-Stage to Membership:** Israel, Serbia

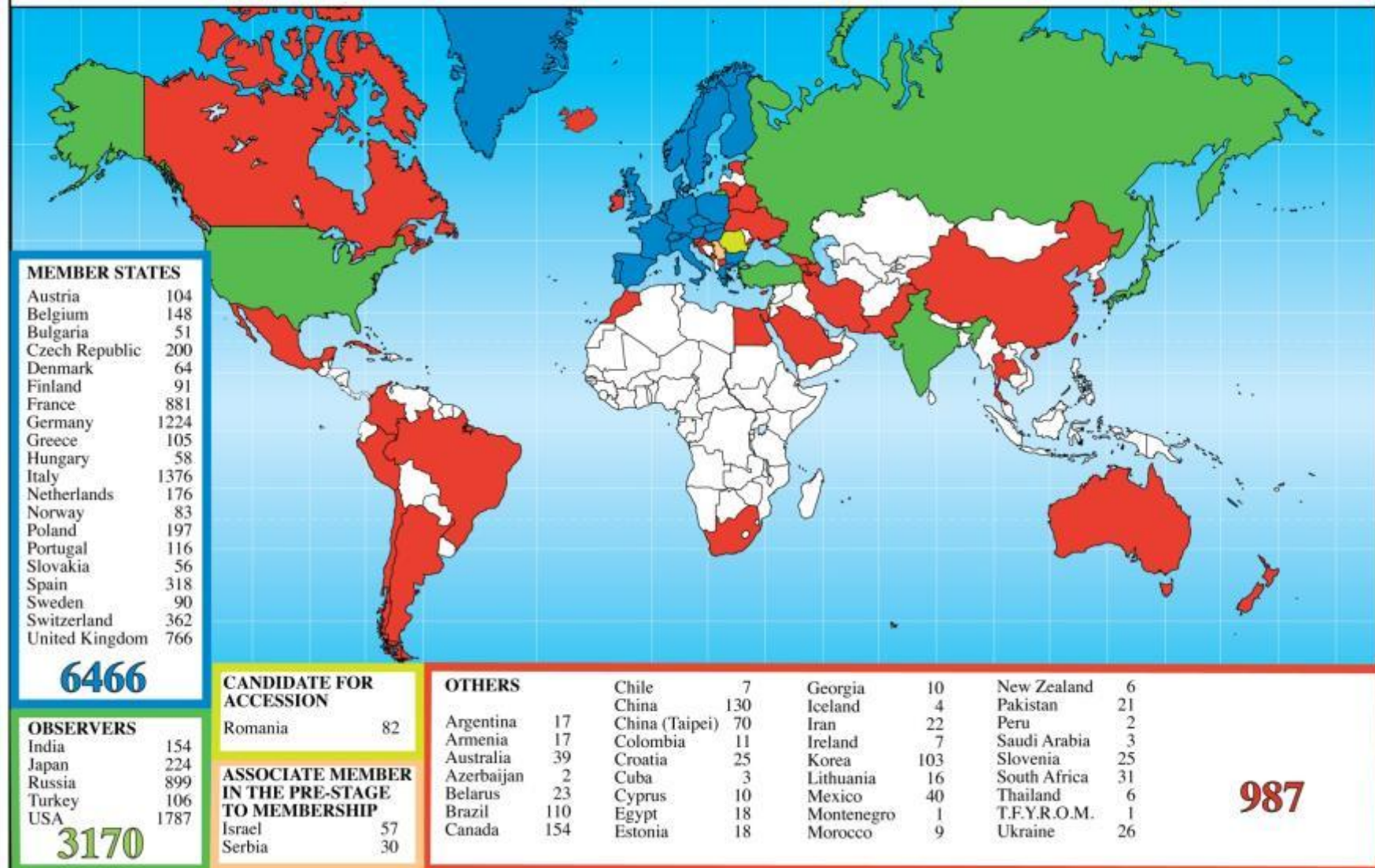
**Applicant States for Membership or Associate Membership:** Brazil, Cyprus, Pakistan, Russia, Slovenia, Turkey, Ukraine

**Observers to Council:** India, Japan, Russia, Turkey, United States of America; European Commission and UNESCO



# Science is getting more and more global

## Distribution of All CERN Users by Location of Institute on 2 September 2013



# How Do We Manage This?

Contrary to popular belief, our community is rather elementary:

- It has simple rules, honed by centuries of practice
- It shares a common vision and a common set of values
- It is based on **collaboration AND competition**

Science is intrinsically **not democratic** (can't decide who is right by vote!) and therefore it has to be performed **with the most democratic tools:**

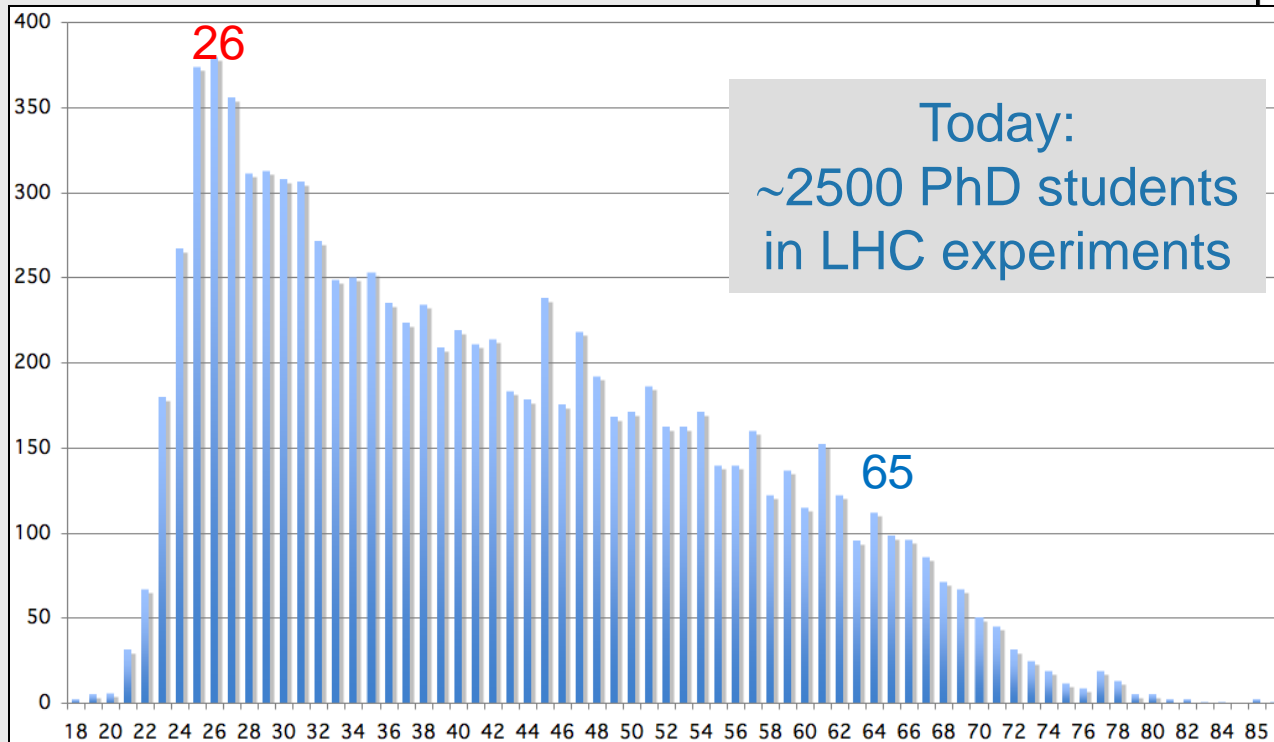
- Freedom of expression
- Peer reviewing
- Independency from political orientation, religion, social status, etc...



# Age Distribution of Scientists

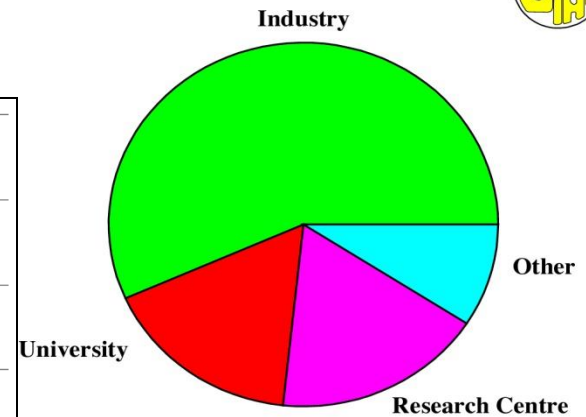
- and where they go afterwards

Survey in March 2009



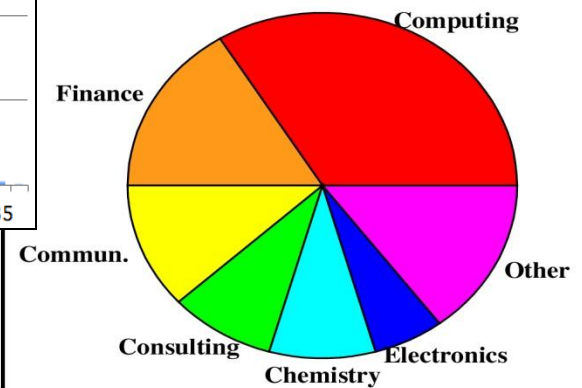
They do not all stay: where do they go?

Status of 1998 (120 PhD's total)



Whereabouts of PhD's

Status of 1998 (68 PhD's total)



Whereabouts of PhD's in Industry





# The scientists/engineers

Despite the usual cinematographic representation, in general we DO NOT

- Wear white lab coats
- Live in ivory towers
- Find a revolutionary result every second day (scientist=genius)

We are a pragmatic community capable to address in a very material way grand and (apparently) immaterial questions, knowing that for every answer we might find, we will open more and unpredicted questions.

(we definitely prefer to be Ministers of Doubt than Kings of Truth: ubi dubium, ibi libertas)

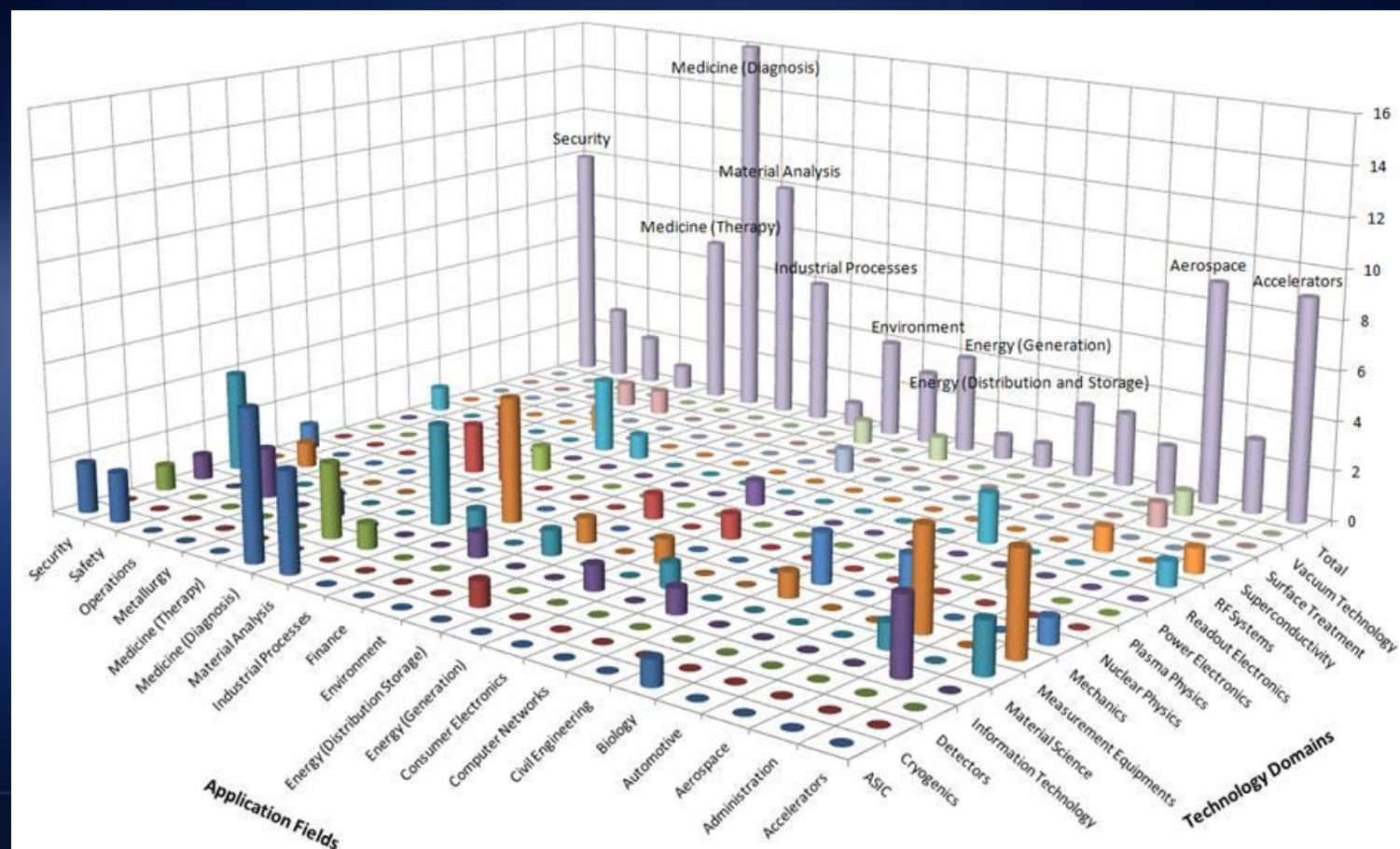
# How can you manage such a community?

Need individualized, enabling and integrated structures **within supporting infrastructure to:**

- Allow everybody to keep his/her 5% of dream (i.e. the own original contribution to the advancement of Science), while operating in a very large symphony orchestra.
- Encourage the emergence of gifted performers/soloists
- Foster a leadership based on credibility and consensus more than on authority

# Only abstract speculations???

Cutting edge Research Infrastructures play a key role in a knowledge driven society





# Medical Application as an Example of Particle Physics Spin-off

Combining Physics, ICT, Biology and Medicine to fight cancer

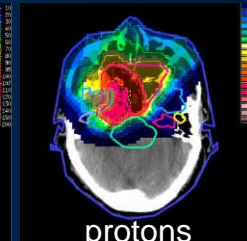
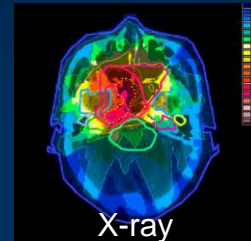
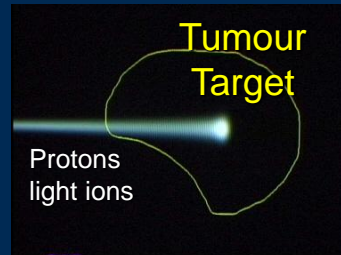


## Hadron Therapy

Accelerating particle beams

~30'000 accelerators worldwide

~17'000 used for medicine



Leadership in Ion Beam Therapy now in Europe and Japan

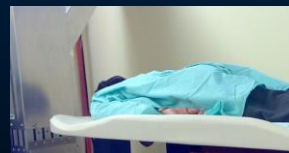
>70'000 patients treated worldwide (30 facilities)

>21'000 patients treated in Europe (9 facilities)

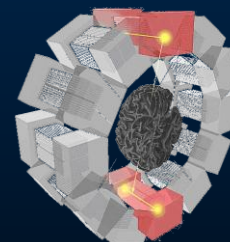


## Imaging

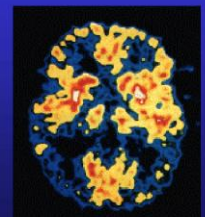
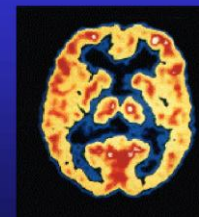
Clinical trial in Portugal for new breast imaging system (ClearPEM)



## PET Scanner



Brain Metabolism in Alzheimer's Disease: PET Scan



Detecting particles

# Cern as the central hub of a network

CERN is **your** laboratory:

how can we maximize its benefits for the member states?

Create/maintain at the national level research infrastructures and integrate them in a network, enabling:

- Brain circulation
- Knowledge and Technology Transfer
- Industrial applications
- Training
- Cross fertilization

# The importance of physics to the economies of Europe

## Report by Cebr

Centre for Economics and Business Research  
for the European Physical Society

- Recent study commissioned by EPS to an independent agency (CEBR)
- EU 27 + Switzerland + Norway
- **Period 2007-2010**
- Based on Eurostat data
- Using the European definition for activity classification

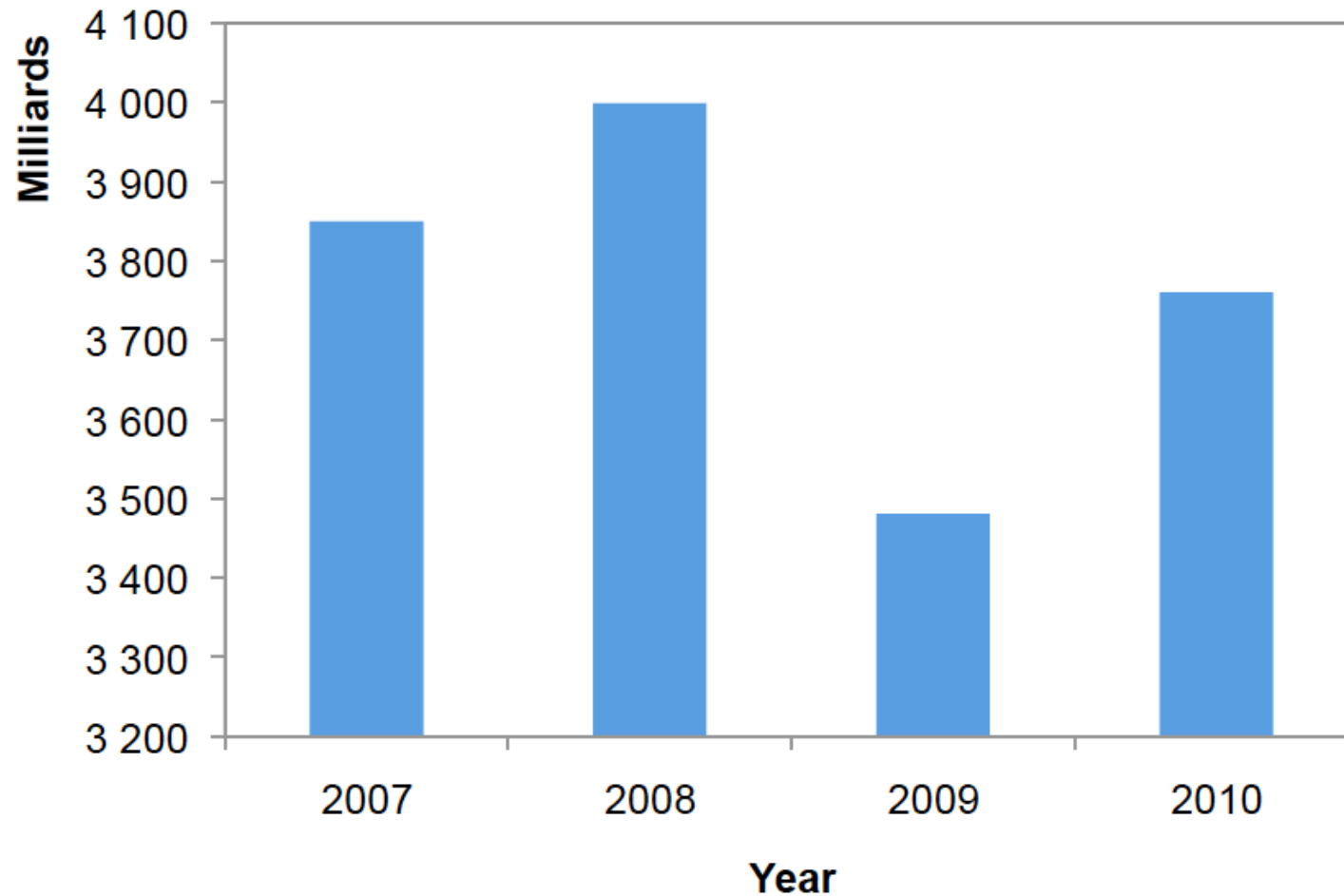




# Turnover

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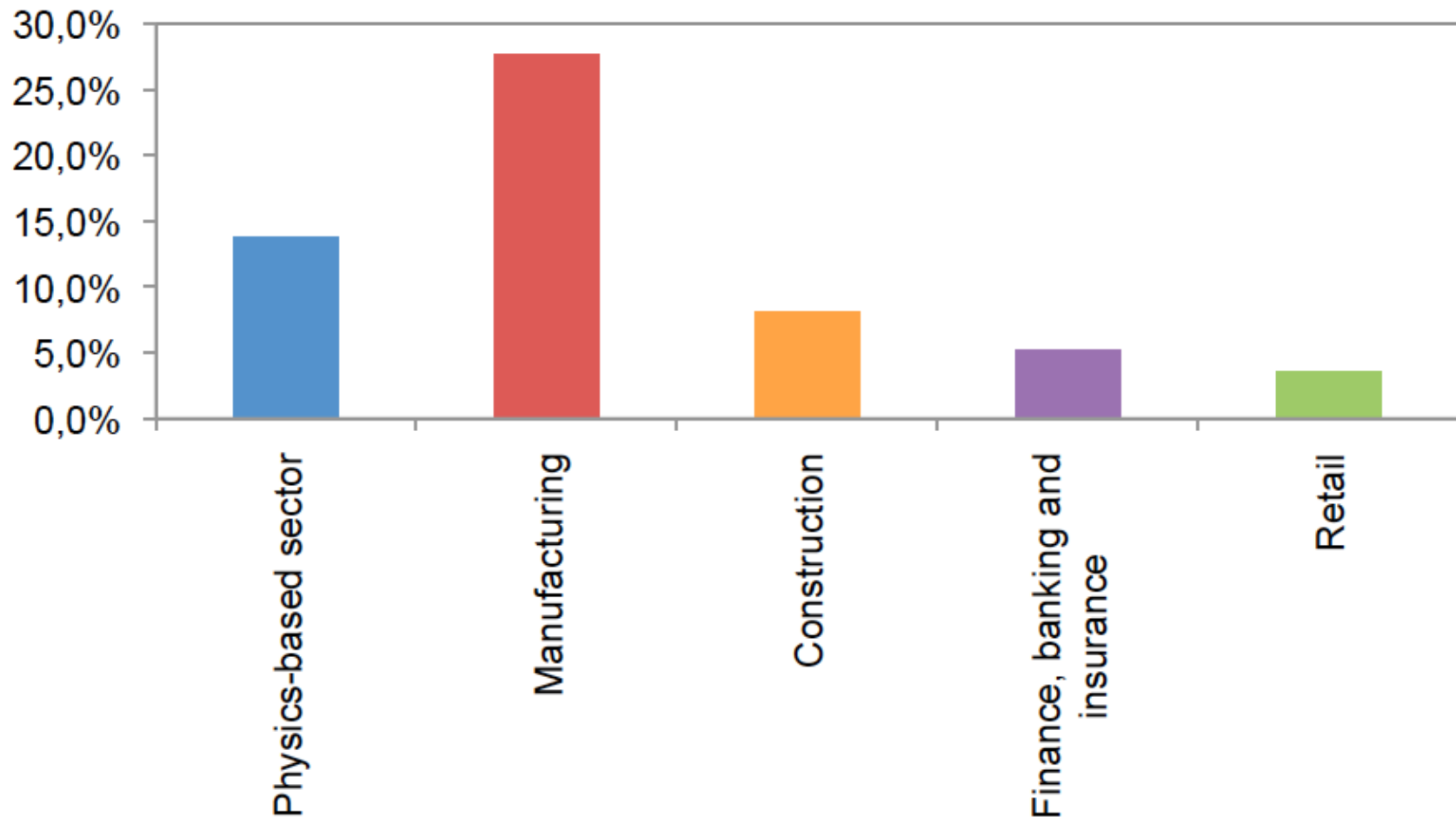
**Figure 1: Turnover in physics-based industries, € current prices**



*Source: Eurostat Structural Business Statistics (SBS), Cebr analysis*

# Comparisons

**Figure 18: Selected sectors' shares of EU27-wide output at basic prices**

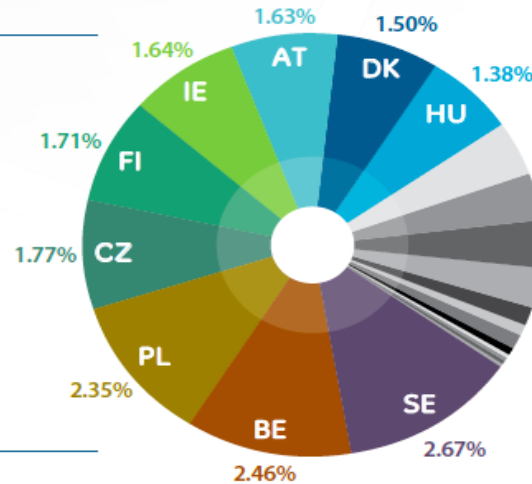
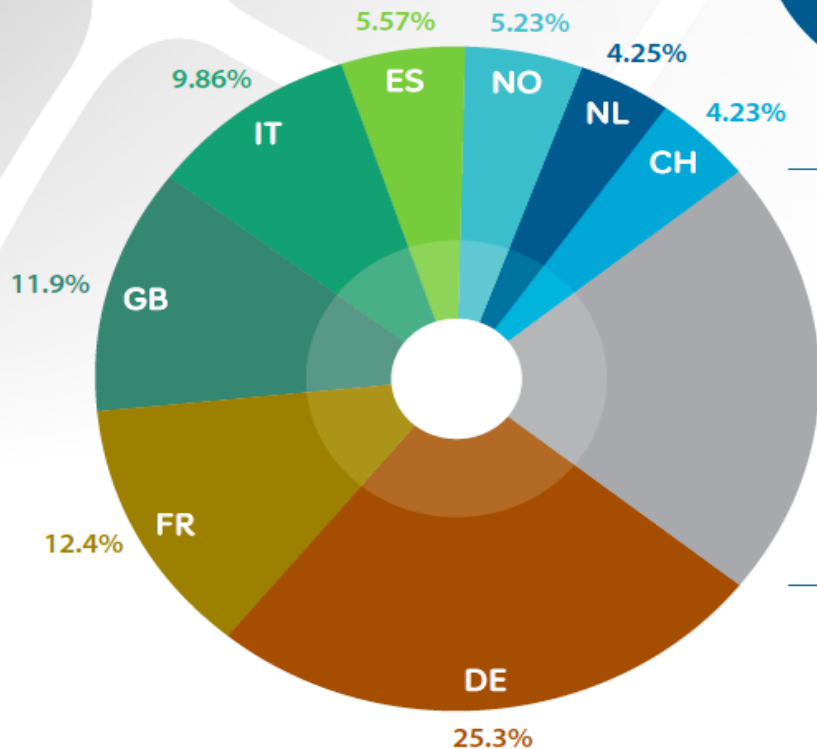


*Source: Eurostat ESA95 Input-Output Tables, Eurostat SBS; Cebr analysis*

# Turnover by country

**FIGURE 1**

Contribution of the different countries in Europe to turnover from physics-based industries (using 2010 data where the total turnover is €3.76 trillion).



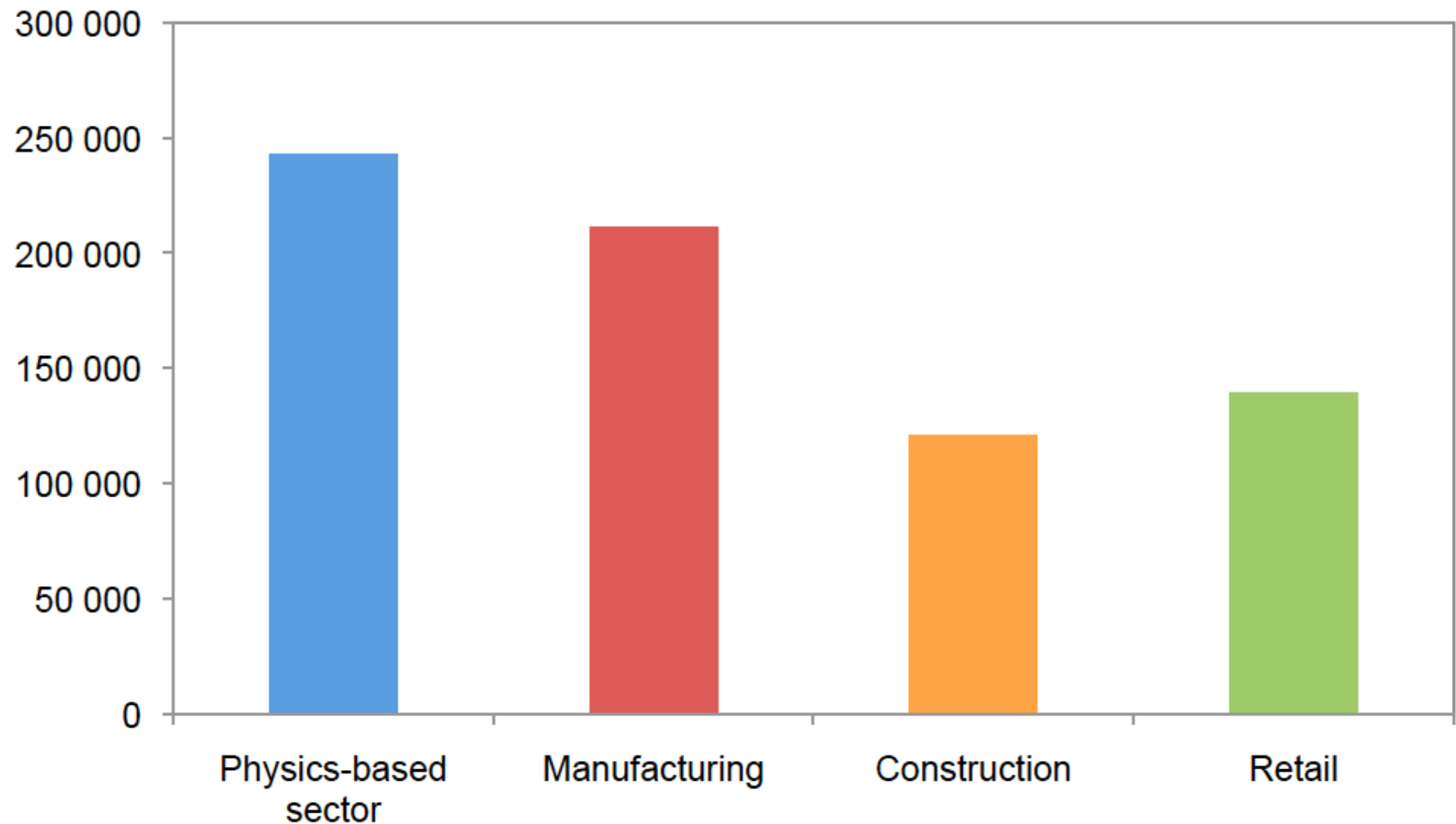
PT	0.85%
RO	0.80%
SK	0.77%
GR	0.61%
SI	0.30%
BG	0.22%
LU	0.20%
EE	0.11%
LT	0.08%
LV	0.06%
CY	0.06%
MT	0.02%

**PHYSICS CONTRIBUTES SIGNIFICANTLY  
TO THE ECONOMIES OF EUROPEAN COUNTRIES  
AND TO THE EUROPEAN ECONOMY AS A WHOLE**



# Productivity

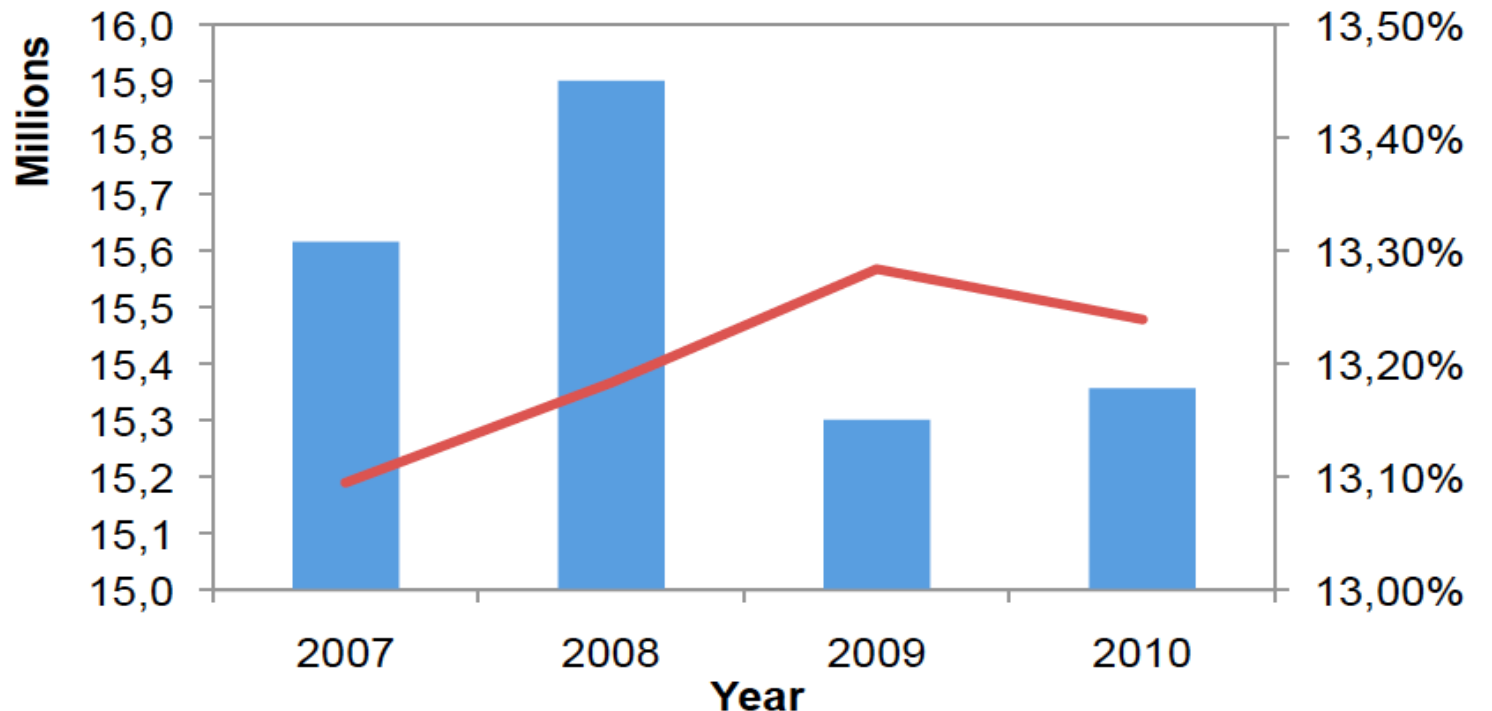
**Figure 5: Turnover per person employed in selected European sectors, average over 2007-10, € current prices**



*Source: Eurostat SBS, Cebr analysis*

# Employment

Figure 6: Physics-based employment in Europe, 2007-10



- Number of persons employed in physics based sectors (left axis)
- Physics-based employment as % of total business economy employment (right axis)

# Multipliers

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- **EU27 Physics-based GVA multiplier = 2.49**
  - **Direct = 1, Indirect = 1.28, Induced = .21**
  
- **EU27 Physics based job multiplier = 2.73**
  - **Direct = 1, Indirect = 1.45, Induced = .28**

## To conclude....

- The relationship between basic research and sustainable progress is fundamental (contrary to common belief, technology does not sustain itself on the long term)
- In a globalized world, **knowledge** is becoming the most important asset.
- Developed countries are about to make a major strategic error by underestimating the value of fundamental research ( whereas emerging countries are doing the opposite and catching up fast)