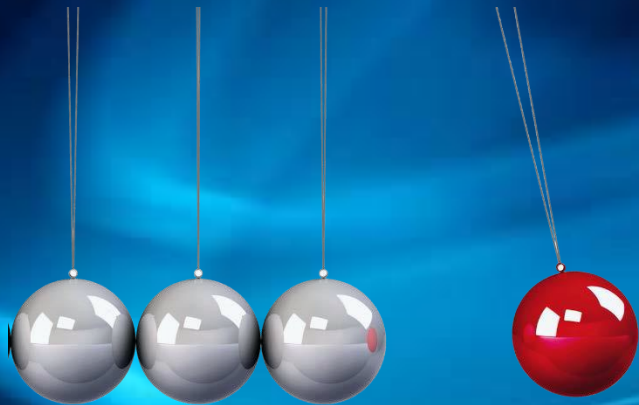




IMPACT of science on society and sustainable development

showcased by CERN



Barbora Bruant Gulejova

The importance of physics to the economies of Europe

Executive summary of an analysis prepared

by Cebr - Centre for Economics and Business Research for the European Physical Society



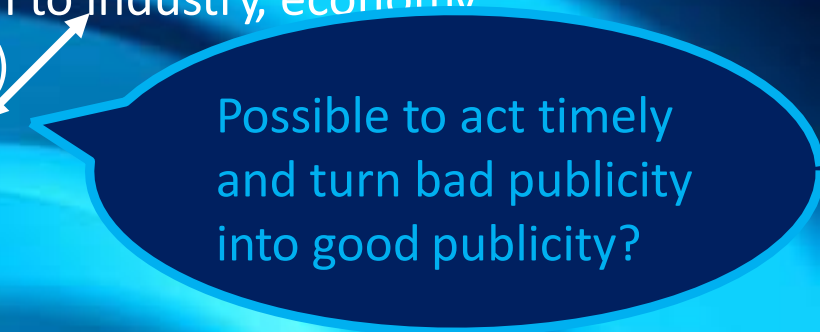
January 2013

European Physical Society



Motivation

- ❖ Important to see **the whole picture**
combining points of view / interests / drivers of all stakeholders
 - Scientists – curiosity, knowledge
 - Funders/decision makers/politicians – impact on society, return to industry, economy, education (– hopefully!)
 - Media / opinion makers – sensations, interesting information +
 - General public – what is it good for -how it influences their lives
 - Young generations – is it cool? Fun? Inspiration/motivation – important for their future

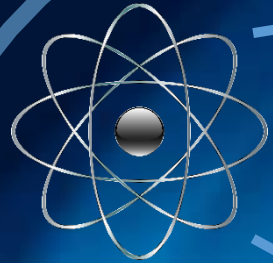


Possible to act timely and turn bad publicity into good publicity?

Motivation

Everything is interconnected...

Academia
Research



Education,
Communication,
Outreach



Relations with
stakeholders
International
relations
Decision makers, ...



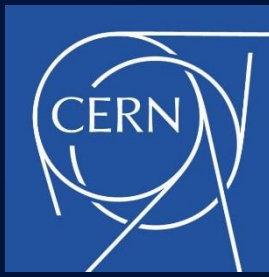
Knowledge
transfer
Innovations



Economy
Industry
Business



The impact of CERN



- ❑ Scientific knowledge
- ❑ Innovation, knowledge transfer and the economy
- ❑ International collaboration
- ❑ Education and outreach

Open Science



“CERN’s commitments to carry out purely fundamental research and to make all of its work public have ensured peaceful collaboration between scientists, from all countries.” Rolf Heuer, former CERN DG

❖ CERN provides open access to scientific publications, data and technologies free of charge



❖ Participates in the Open Source Software (OSS) initiative: bringing benefits like costs savings, improved reliability and adaptability

- CERN-extended model is Open Hardware Licences (OHL): knowledge-exchange in wide community of electronic designers

❖ SCOAP3 – Sponsoring Consortium for Open Access Publishing in Particle Physics

- open access peer reviewed journals – CERN papers

Digital Library Service - institutional repository, a disciplinary repository for the HEP and ILC community



Innovation, Knowledge transfer, Economy

Fundamental research at CERN is driver of innovation!

- ❖ CERN actively engages with experts in science, technology, industry to transfer its technology and know-how to accelerate innovation
 - in 2015 know-how disseminated to 100 external partners (industry, labs, universities,...
- ❖ Knowledge Transfer group provides: advice, support, training, consultancy, network and infrastructure to ease KT, encouraging entrepreneurship, spin-offs, public-private R&D partnerships...
- ❖ CERN established a network of 9 Business Incubation Centres (BICs) throughout its Member States to assist entrepreneurs and small technology businesses in taking CERN technologies and expertise to the market
- ❖ There are currently 18 start-ups and spin-offs using CERN technologies with applications in domains as diverse as biotechnology, the oil and gas industry and material science



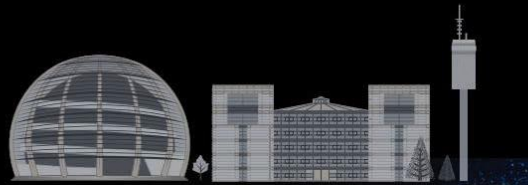
Innovation, Knowledge transfer, Economy

Fundamental research at CERN is driver of innovation!



CERN openlab

- ❖ CERN Openlab has partnership with leading ICT companies (Huawei, Intel, Oracle, Siemens) who profit from Big Data storage and analysis and test their latest products



Doing business with **CERN**

- ❖ 50% of CERN's budget (500 MCHF) is invested into contracts with industry in its member states (R&D, know-how, experiences, methods brought back to the home countries + increased turn-over of companies)

- ❖ There are thousands of particle accelerators and detectors (originally invented as tools for research) in operation in the world of which only small percentage is used in basic research - applications from medical diagnosis, therapy to computer chip manufacture



(accelerators for society)

Innovation, Knowledge transfer, Economy

Ambitious scientific goals of PP require cutting edge instruments and innovative technologies that have many applications in many fields...



- ❖ WWW invention at CERN (1993) driven by need of better communication of scientist worldwide:
HUGE IMPACT: - # of internet users from 14 millions to 3.2 billions from 1993 till 2015
- contribution to 2,9% of world global GDP ~ 1672 billion US\$ (in 2011)

- ❖ World-wide LHC computing grid: 500 000 CPUs and 500 PB of data storage
> 200 computer centers in 35 countries

- ❖ CERN was pioneer in breakthrough technologies, such as touchscreen

- ❖ Inspiration for solar cells technology based on ultra high vacuum

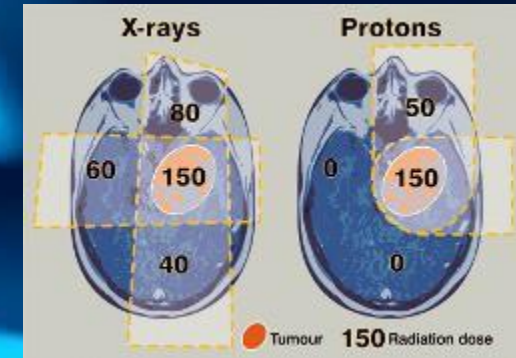


Innovation, Knowledge transfer, Economy

“CERN contributes to medical applications, with the goal of providing solutions to societal health challenges.” Fabiola Gianotti, CERN Director-General

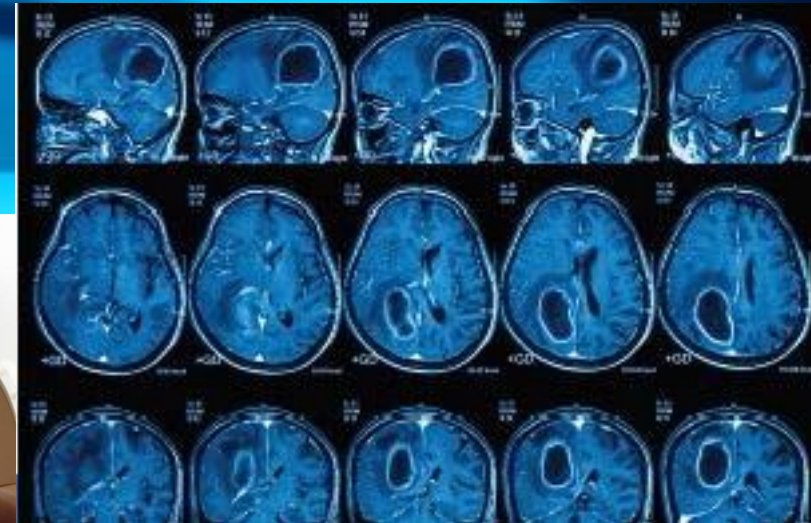
❖ Hadron therapy (HT)

- treating tumours with beams of protons and light ions reducing the radiation exposure of healthy tissue
- 3 HT centres in Europe built in collaboration with CERN
- CERN supports development of miniature linear accelerators for proton therapy



❖ Medical imaging: PET, MRI and others...

- PET using new type of dense scintillating crystals
- CERN has pioneer contribution to forerunner of PET
- PET and MRI imaging combined in single device thanks to new generation of CERN detectors



Innovation, Knowledge transfer, Economy

Medical applications and more...

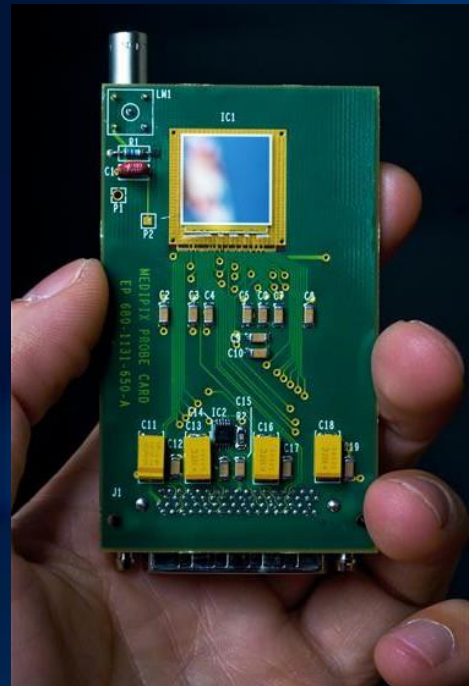
- ❖ Software for simulating particles interactions in detectors
 - used to calculate precise radiation dose for cancer treatment
 - space applications



Nice videos available:

<https://www.youtube.com/watch?v=XHpwMsutr-4>
<https://www.youtube.com/watch?v=MS590Xtq9M4>

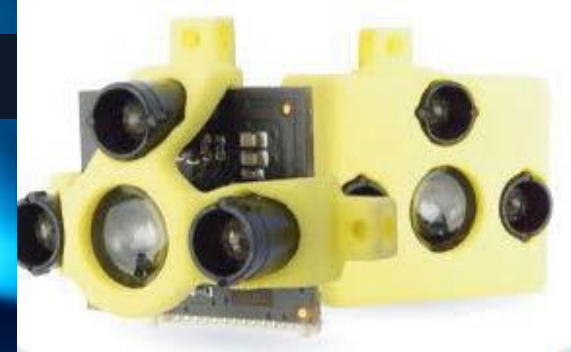
- ❖ Pixel detector technologies "Medipix"
 - medical diagnostics
 - industrial processes
 - X-ray based material analysis (X-rays by detectors invented by Charpak in 1968 need fraction of dose required by photographic methods)
 - International Space Station



Innovation, Knowledge transfer, Economy

And many more applications in many fields...

- ❖ **TERABEE** – sensor technology used in drones to explore places with difficult access



spin-off



❖ **INVENIO** – digital library and document repository used by providing cloud based digital library system for UN

TIND

- ❖ **CLOUD** experiment could be mentioned: exploring the influence of cosmic rays on cloud formation in the Earth's atmosphere giving improved climate models



– dosimeters



- ❖ **UNOSAT** satellite analysis technology hosted at CERN and supported by CERN IT infrastructure



CERN MODEL

- ❖ Model for global cooperation and opened the way for other institutions that combine scientific excellence with science diplomacy.
- ❖ Spirit of open access, collaboration, tolerance and freedom of thought
 - CERN model serves as a 'blueprint' for open global collaboration
 - evokes calls for similar multinational research effort in other fields (CERN for oceans, human brain research, genomics, agricultural science).



Big multinational companies ask how 4000 physicists, engineers and technicians of more than 110 nationalities, different languages, cultural and educational backgrounds manage to build LHC... ????

- ❖ The successful and efficient management of Big, Global project as LHC lies in **SHARED PASSION FOR “NOBLE VALUES” (KNOWLEDGE)** and a common goal that draws collaborators together.

- ❖ “CERN model, UN and Global Public Goods” conference in UN in 2015

Science for peace

“CERN is a concrete example of worldwide, international cooperation and a concrete example of peace. The place which makes, in my opinion, better scientists, but also better people”

Fabiola Gianotti, CERN DG

- ❖ 16000 scientists from more than 110 nationalities work on research at CERN together in peace, irrespective of their religion or system of government, some from countries that are opponents at the political stage
- ❖ CERN - more than 60 years building peace through science.

☺ All important decision are being made in cafeteria!



Education

High school students and teachers

- **70 000 school children** visit CERN every year
- **10 000 teachers** have been trained at CERN since 2006 impacting more than a **million students**
- **4000 school students** each year perform hands-on experiments on modern physics at CERN S'Cool LAB
- **200-300 teams from schools** around the world engages in “Beamline for Schools” competition
- **15000 pupils in 46 countries** analyse real LHC data through “International Masterclasses”



Outreach

Visits and Exhibitions

- ❖ 120 000 visitors per year
(half-day guided tour at CERN)



- ❖ 25 heads of state and 168 ministers made protocol visits between 2011 and 2015



- ❖ CERN travelling exhibitions:
76 locations in 15 countries
> million visitors from MS



Outreach

MEDIA



- **500 visits by world media** per year
- **166 000 articles related to CERN** published in world's newspapers with 9.9 billion of potential readers
- **20 000 sessions per day** and **4.3 million unique visitors** yearly at CERN website
- **2 million mentions of CERN** per year on social media (Twitter, Facebook)



ARTS at CERN

- bringing Arts and Science closer
- attracting brilliant artists for 1-3 month residencies



UN Sustainable Development Goals (SDGs)

❖ 2030 Agenda for Sustainable Development, adopted by world leaders to transform our world



❖ 17 Sustainable Development Goals (SDGs)

- came into force in 2016
- each one with specific targets to be met over the next 15 years
- to end poverty, protect the planet and ensure prosperity for all

❖ CERN is de-facto contributing to the implementation of five SDGs

