



**Università degli Studi di Milano**  
**Jean Monnet Centre of Excellence**

“The impact of European Union Research and Innovation  
Policy upon Services of General Interest”

With the support of the Erasmus+ Programme of the European Union



# **Modulo 3**

# **Studio di casi**

# **Lezione 3.1**

## **CBA model for RI**

# THE USEFULNESS OF USELESS KNOWLEDGE

“From a practical point of view, intellectual and spiritual life is, on the surface, a useless form of activity... I shall concern myself with the **question of the extent** to which the pursuit of these useless satisfactions proves unexpectedly the source from which undreamed of **utility is derived**”

**Abraham Flexner**

Founding Director,  
Institute for Advanced Study, Princeton  
*The Usefulness of Useless Knowledge*  
1939

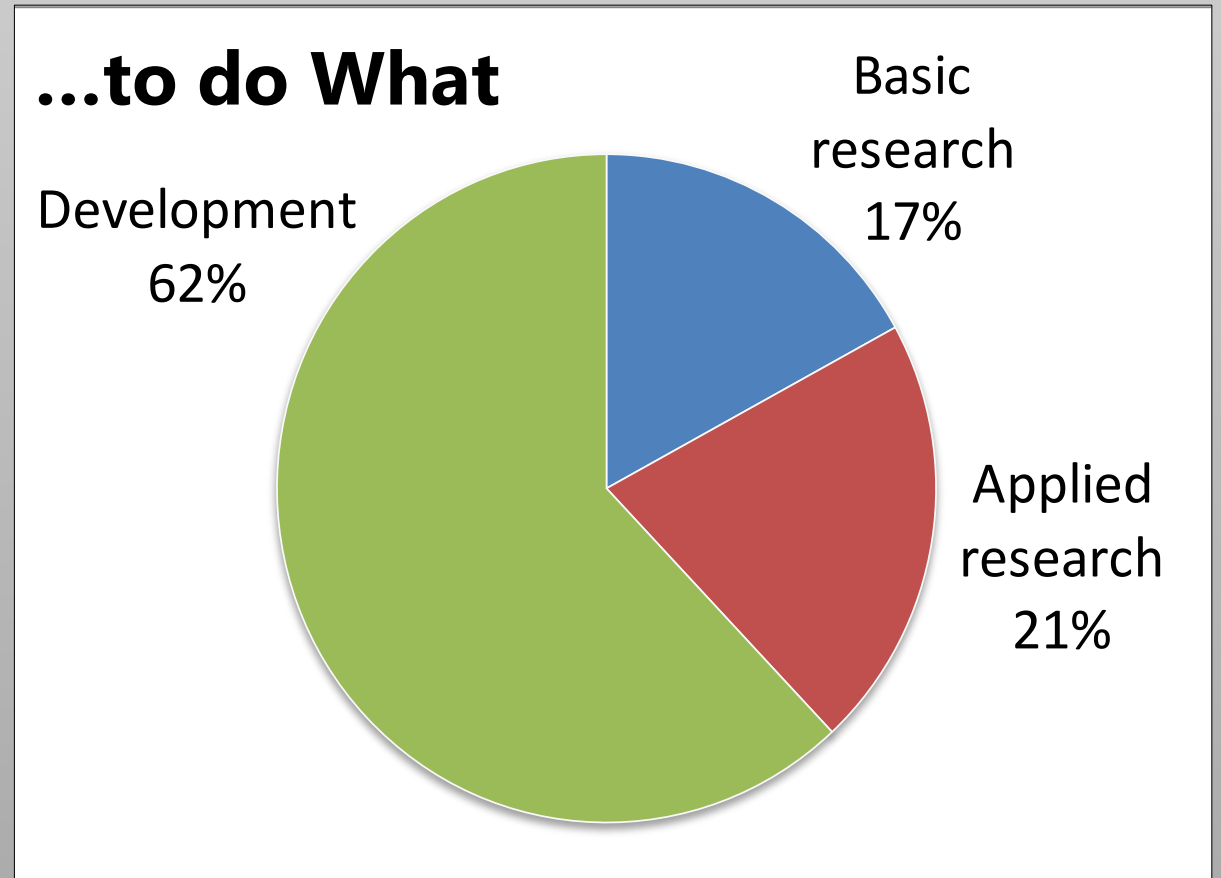
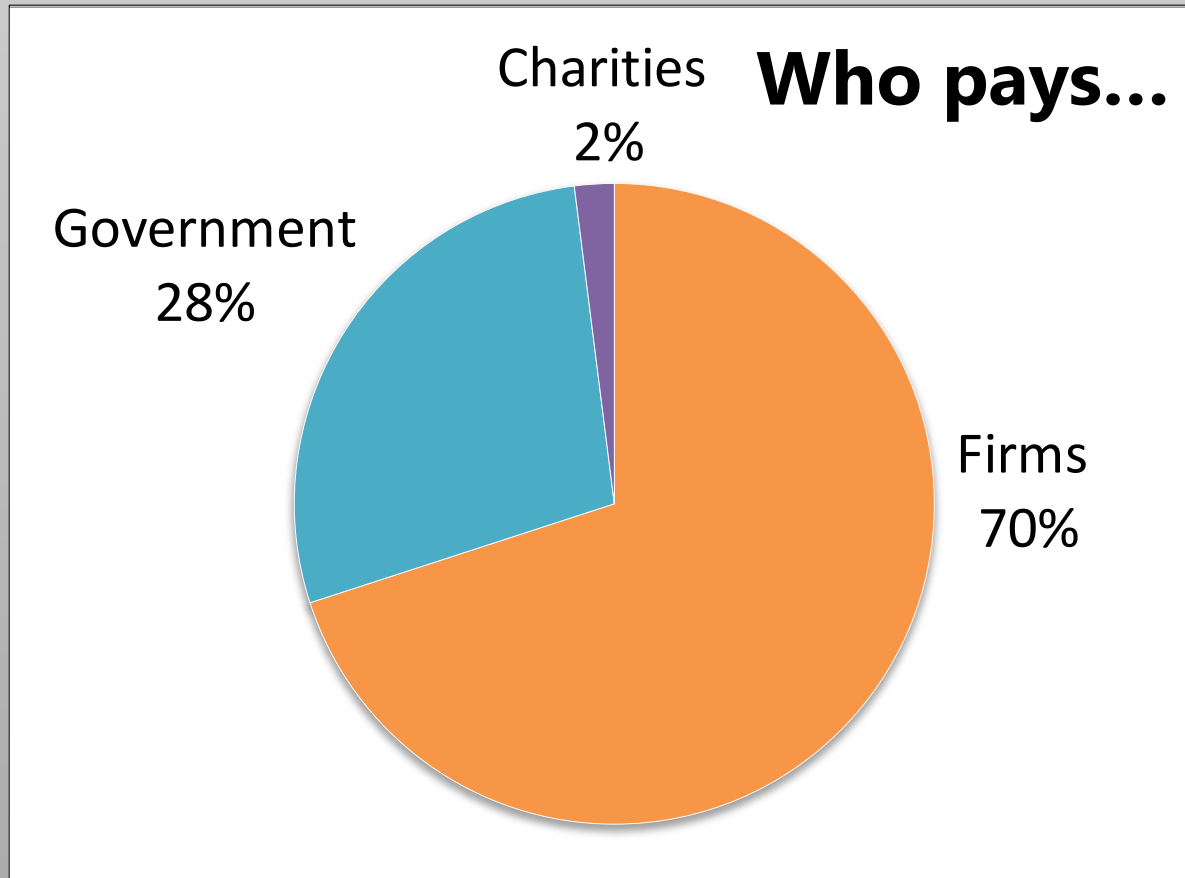


Courtesy of @InstituteForAdvancedStudy

# THE COSTS & BENEFITS OF SCIENCE

**Costs:** \$315 billion per year → \$250 per capita taxes (OECD)

**Benefits:** Wide → To be measured



# LITTLE SCIENCE, BIG SCIENCE... AND BEYOND



Courtesy of @TodayinScienceHistory

The 1962 Brookhaven National Laboratory Lectures by **Derek De Solla Price**, physicist and historian of science



# LITTLE SCIENCE: SMALL COSTS AND HUGE BENEFITS

## Galileo Galilei



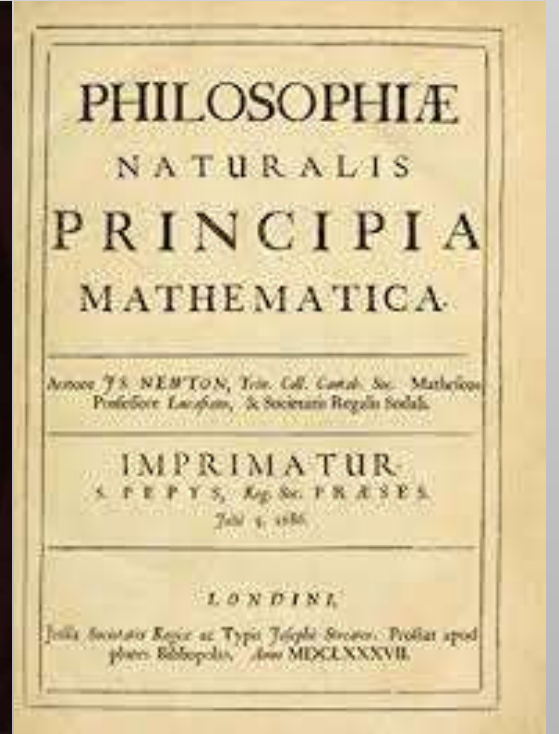
1564-1642



## Isaac Newton



1642-1726

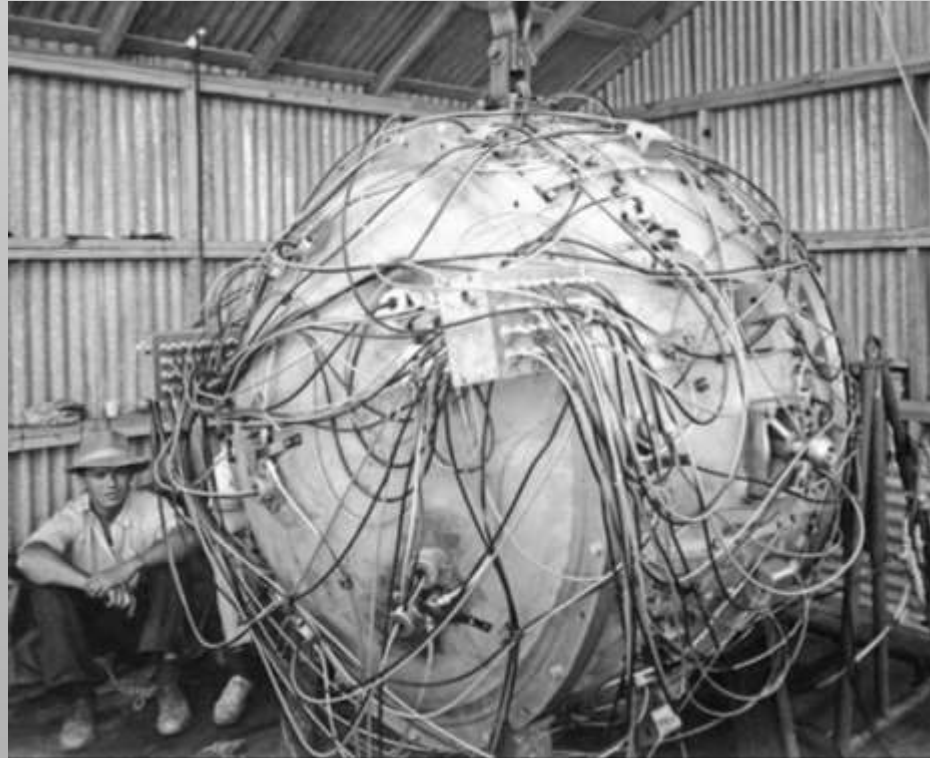


No CBA needed

# BIG SCIENCE FOR THE MILITARY: HUGE COSTS, UNCERTAIN BENEFITS

## The Manhattan Project

- Top-down
- Military-industrial complex
- National ownership
- Rigid mission and governance
- Political loyalty and secrecy



Courtesy of @RareHistoricalPhotos



Courtesy of @DennisD.McDonald'sWebSite

Gadget, the world's first atomic bomb

**CBA impossible**



# A NEW PARADIGM: RESEARCH INFRASTRUCTURES



**ESFRI**  
Roadmap

- Bottom-up
- Scientific communities
- Open science
- International coalitions
- Multiple users and shared governance
- Cosmopolitan ecosystem



Courtesy of @Airbnb

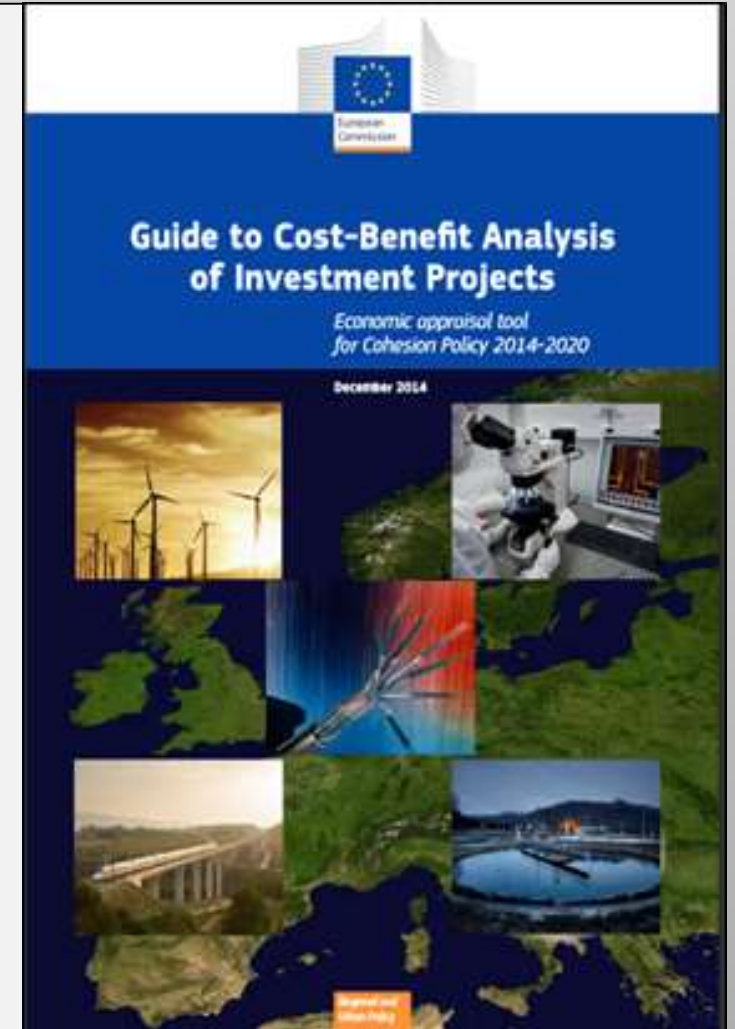
**CBA feasible and helpful**

The European Molecular Biology  
Laboratory (EMBL) *Heidelberg*



# THE COST BENEFIT ANALYSIS MODEL

- The expected net present value of the RI
- over the time horizon
- is defined as the difference between expected benefits
- including the citizens' willingness to pay for knowledge
- and social costs
- valued at shadow prices
- discounted at the social discount rate



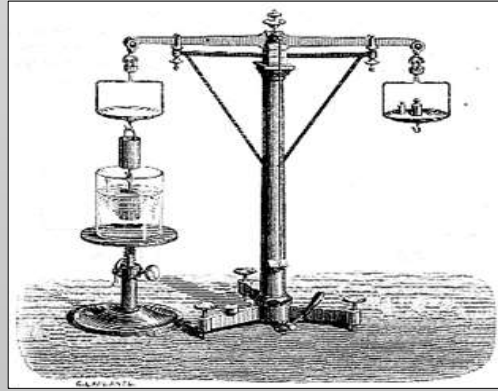
# MEASURING THE MEASURABLE

For example:

$$\sum_{j=1}^J \sum_{t=0}^T S_t \cdot \Pi_{jt}$$

## BENEFITS

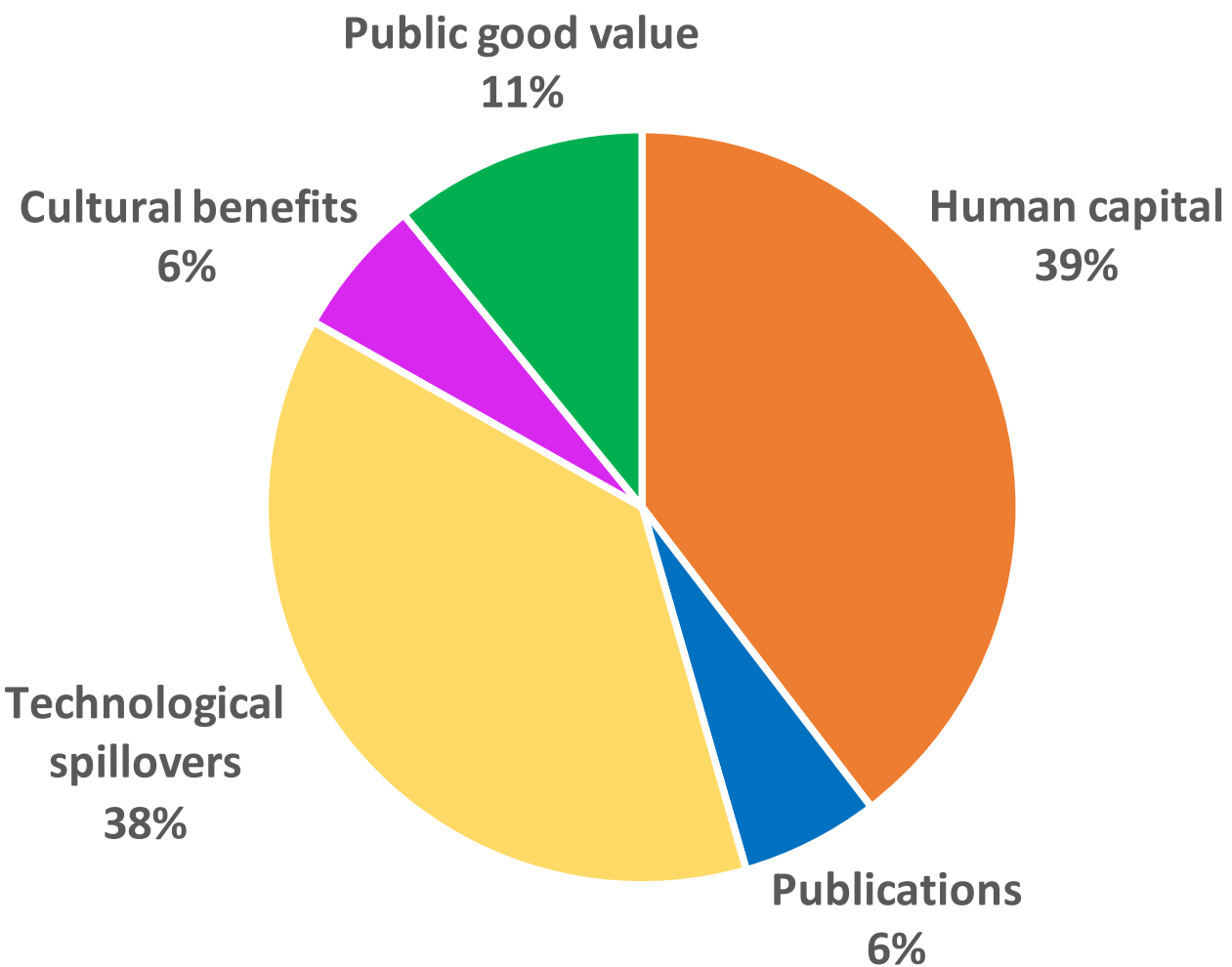
- Technological spillovers
- Scientific publications
- Human capital
- Benefits of innovation
- Cultural benefits
- Public good value



## COSTS

- Economic value of capital
- Labor cost of scientists
- Other staff costs
- Other operating costs
- Environmental impact

# THE NET BENEFITS OF HIGH LUMINOSITY LHC TO 2038



Net Present Value	2.2
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Benefit cost ratio	1.8
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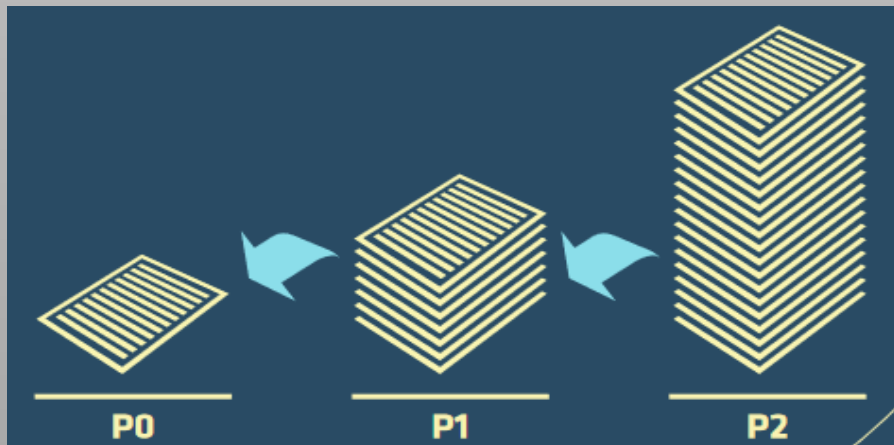
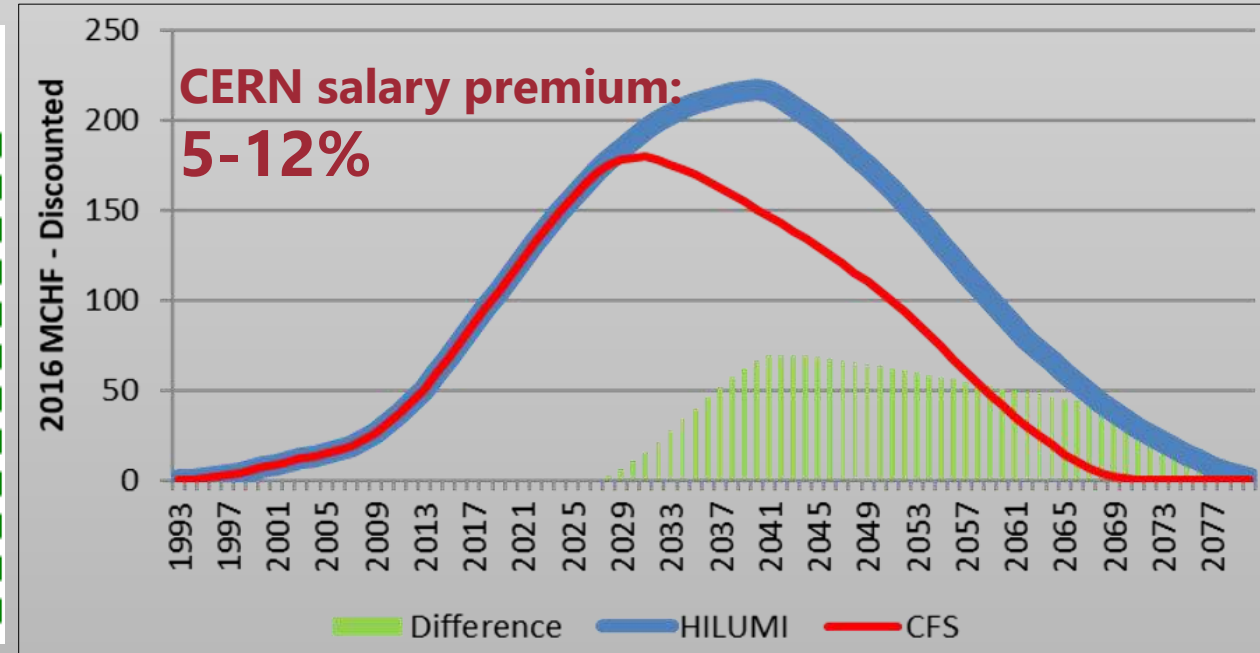
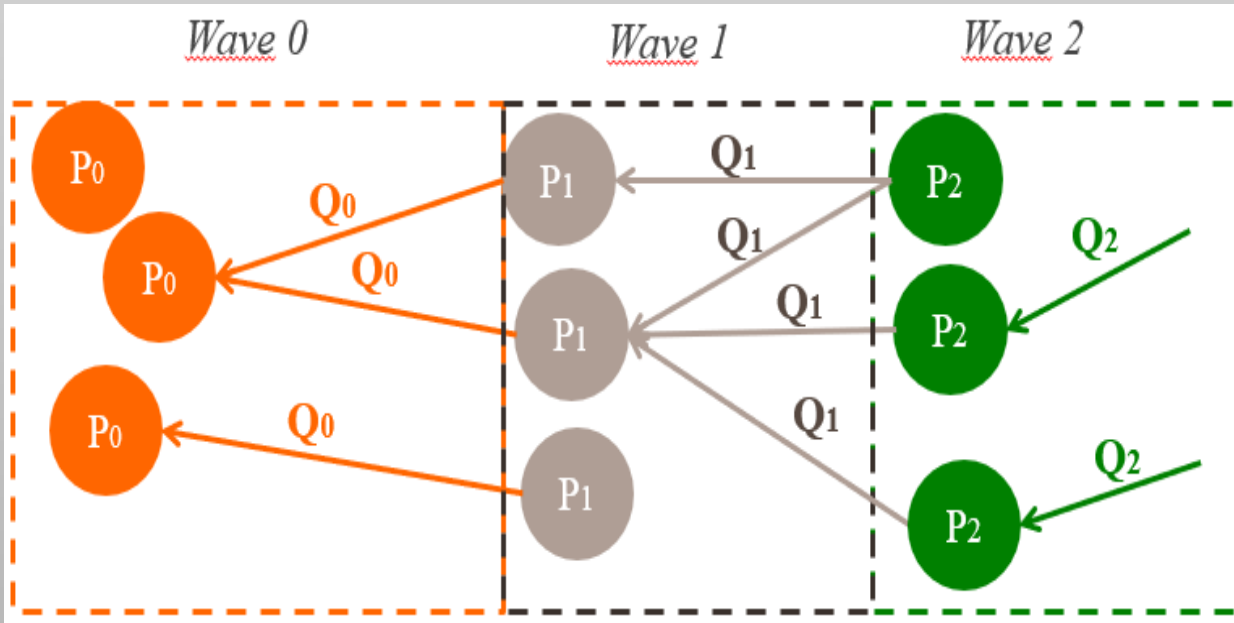
Courtesy of @CERN

Counterfactual: LHC without HL

# PUBLICATION FACTORIES AND HUMAN CAPITAL

Value = scientists' time

Value = skills acquired by ESR

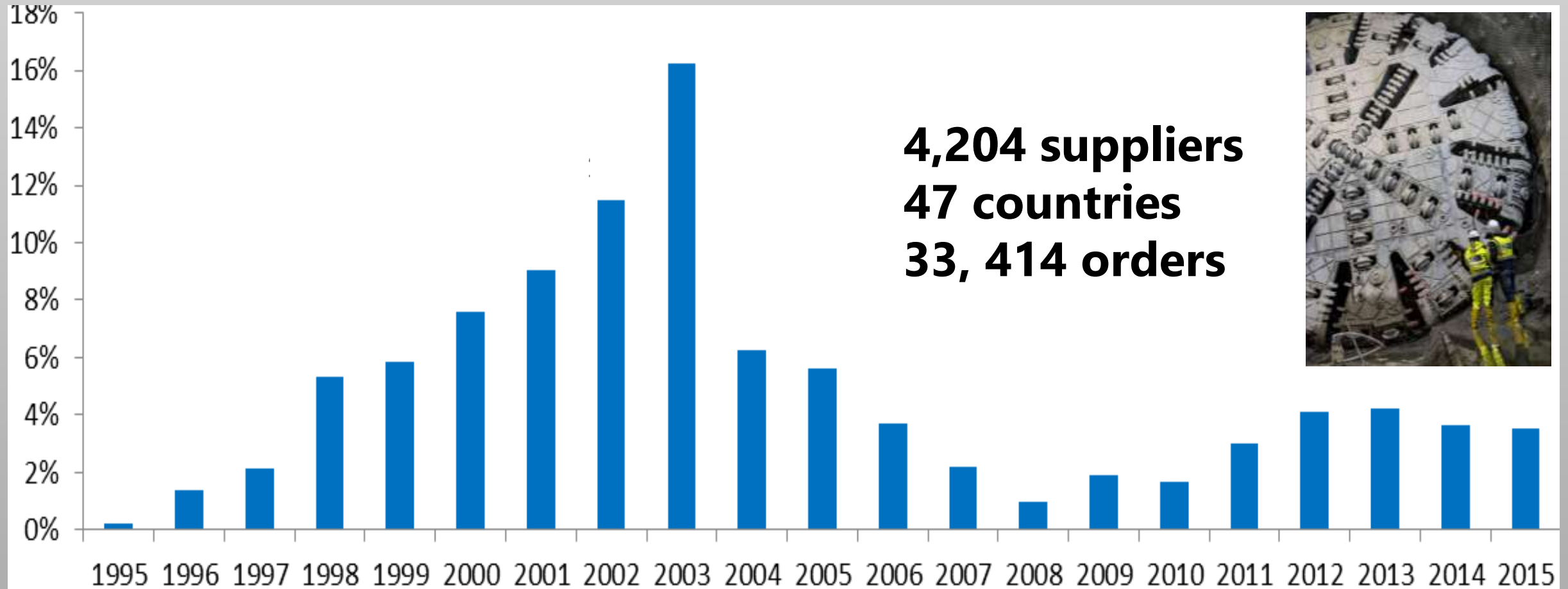


Courtesy of @CERNCourier



# LEARNING HUBS FOR FIRMS

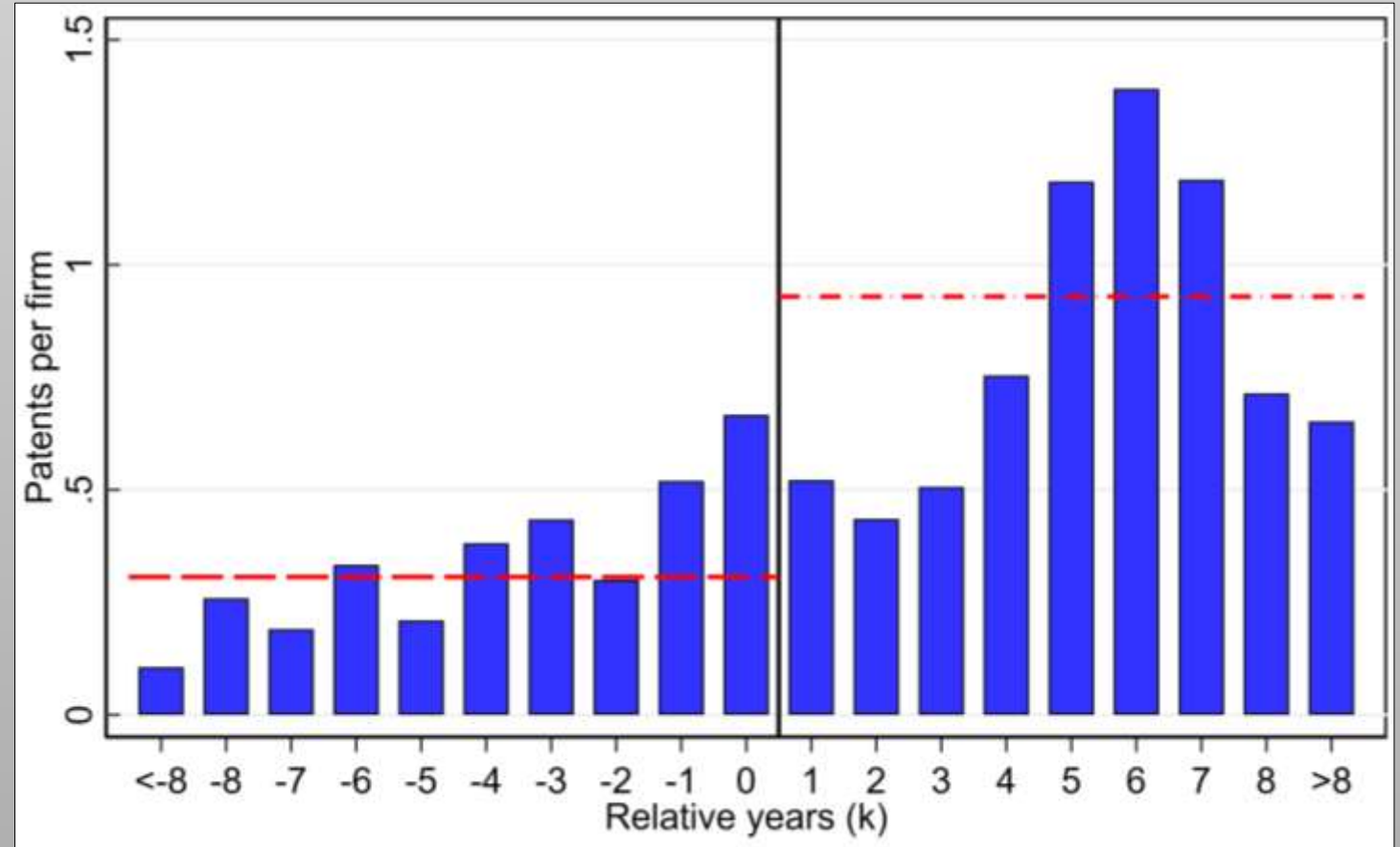
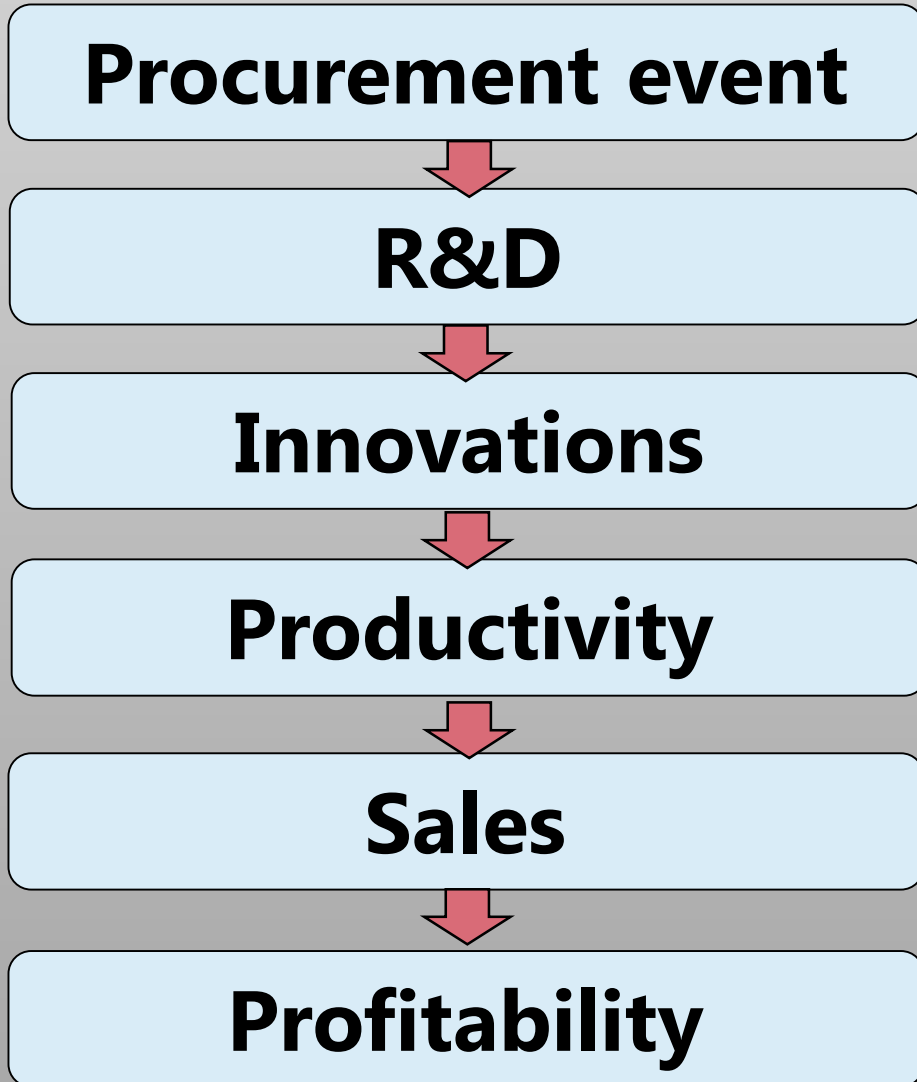
## The procurement activity of CERN 1995-2015



- Volume of the orders by year %; Orders > 10,000 CHF

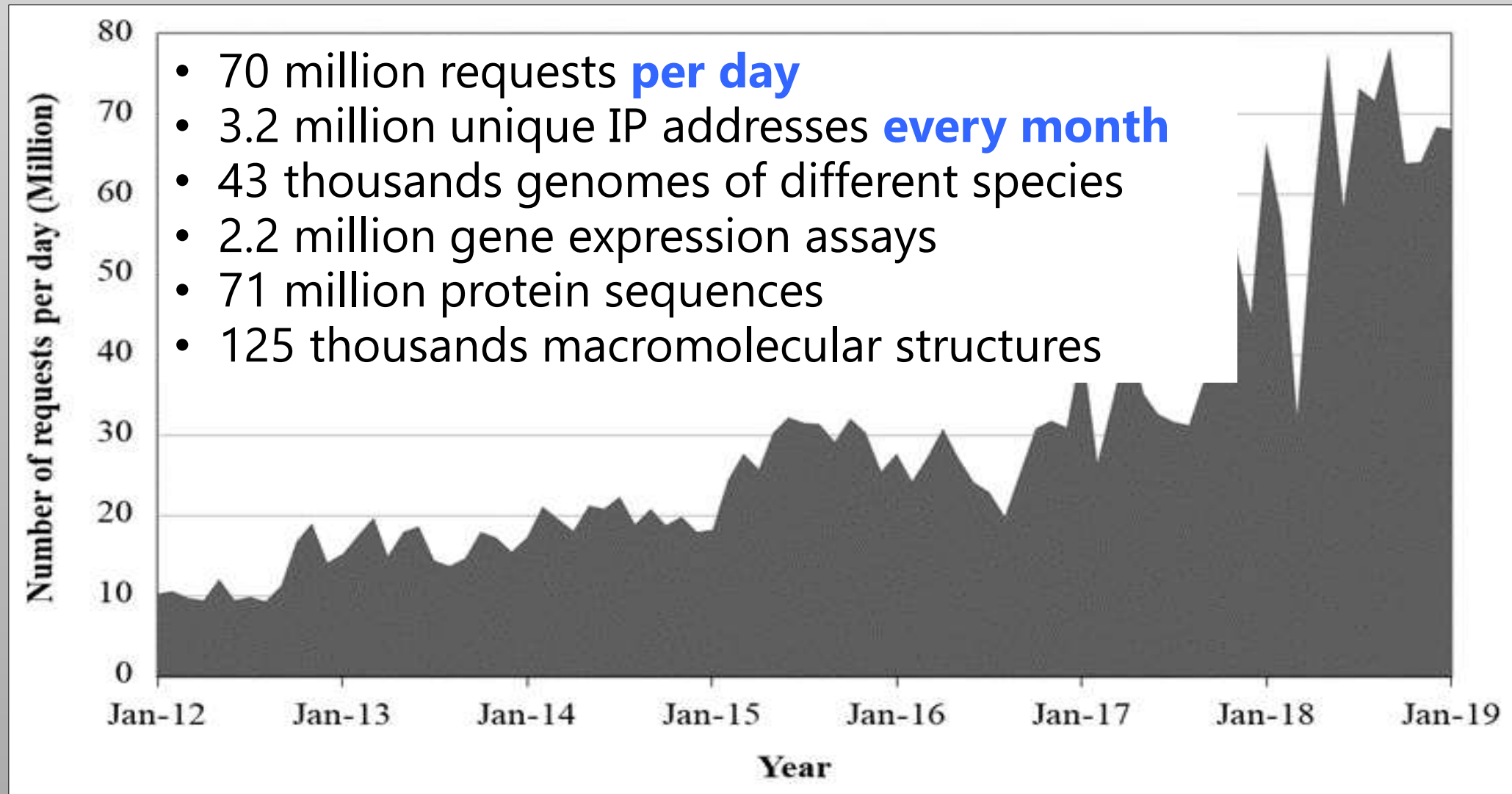
# TECHNOLOGICAL SPILLOVERS

Value = change of firms' economic performance



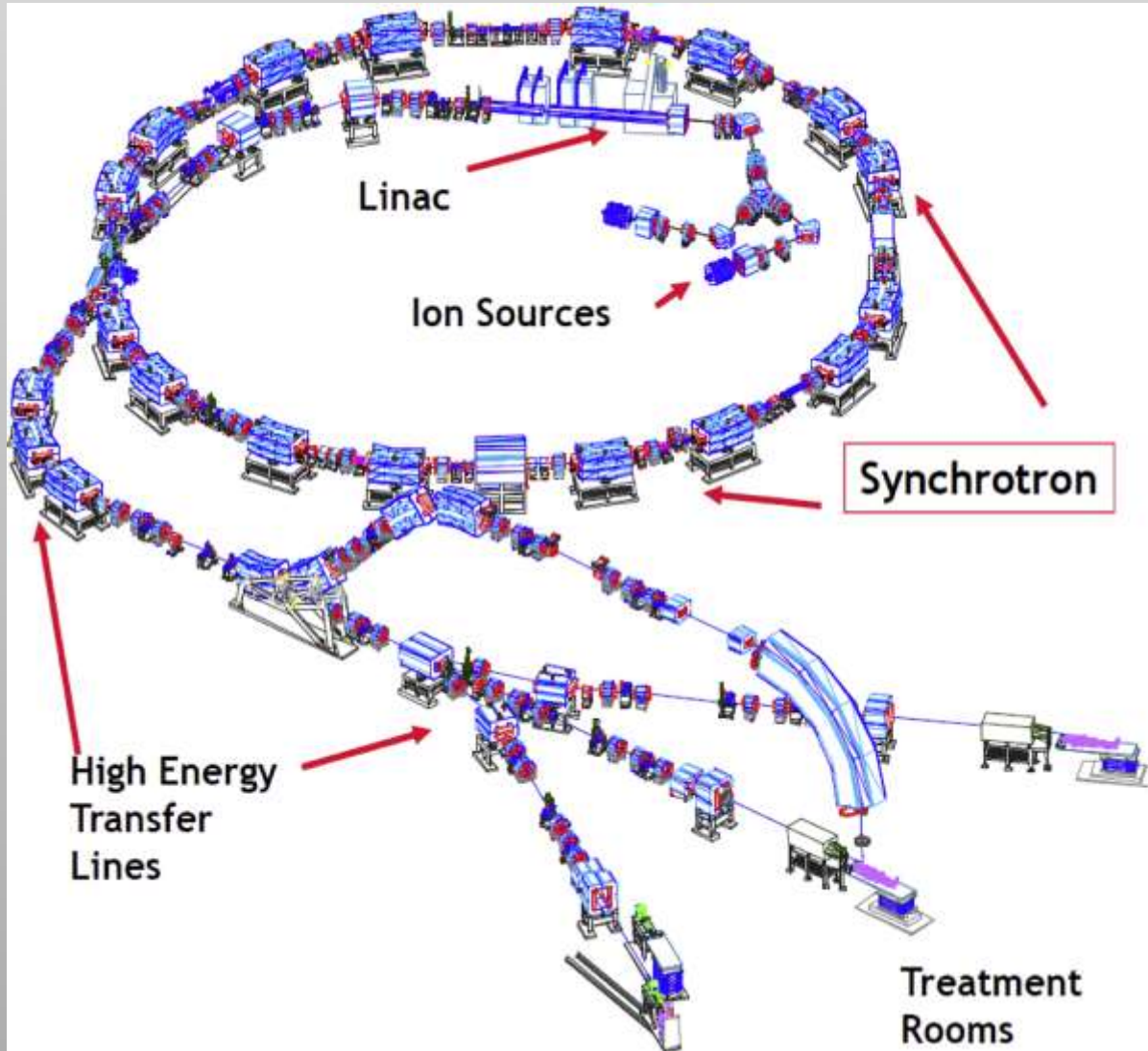
# TECHNOLOGICAL SPILLOVERS FROM BIG DATA

**Value = research time saved**



EMBL - European Bioinformatics Institute

# BENEFITS FROM INNOVATION: AN EXAMPLE



**Value = statistical lives saved**

## Tumor and other diseases treated:

 CHONDROSARCOMAS AND CHORDOMAS OF THE SKULL BASE AND COLUMN	 BRAIN STEM AND SPINAL CORD TUMORS	 SOFT TISSUES SARCOMAS	 BONE SARCOMAS INCLUDING OSTEOSARCOMAS & CHONDROSARCOMAS	 INTRACRANIAL MENINGIOMAS IN CRITICAL SEATS
 ORBITAL AND PERIORBITAL TUMORS INCLUDING OCULAR MELANOMA	 ADENOID CYSTIC CARCINOMA OF SALIVARY GLANDS	 PEDIATRIC SOLID TUMORS	 TUMORS IN PATIENTS AFFECTED BY GENETIC SYNDROMES	 RETREATMENT OF ALREADY RADIO TREATED AREAS
 PANCREATIC TUMORS (Pre-op treatment/locally advanced inoperable tumors treatment)	 HIGH RISK PROSTATE CANCER	 REIRRADIATION OF RECURRENCES OF RECTAL TUMORS	 SINONASAL TUMORS	 BRAIN TUMORS

National Centre For Oncological Hadrontherapy (CNAO)



# CULTURAL BENEFITS

**Value = travel cost method**

**1.5 million visitors  
per year**



Courtesy of @KennedySpaceCenter

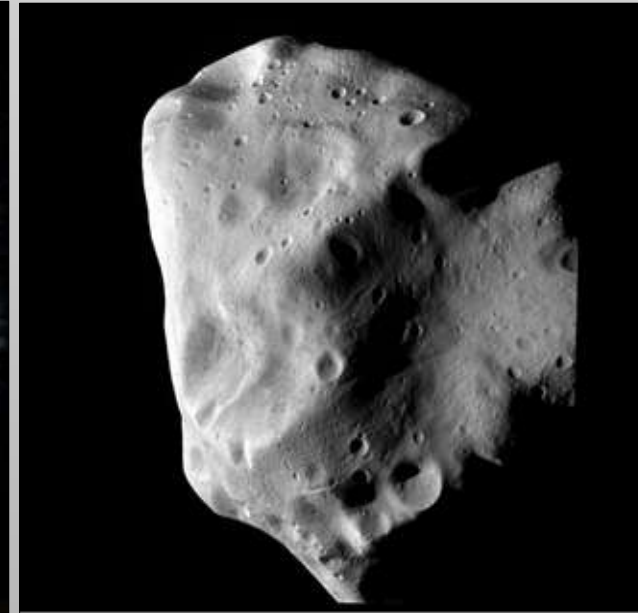
**The NASA Kennedy Space Center**

**Value = opportunity cost of time**



**INVADER ID**

Help us track changes in coastal environments by identifying marine invertebrates.



**HUBBLE ASTEROID HUNTER**

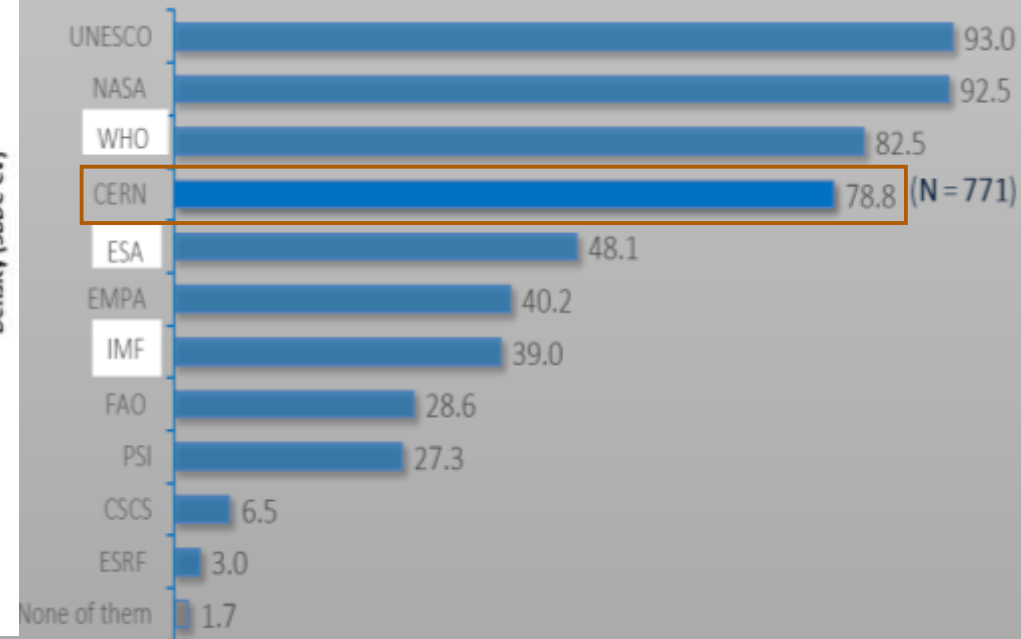
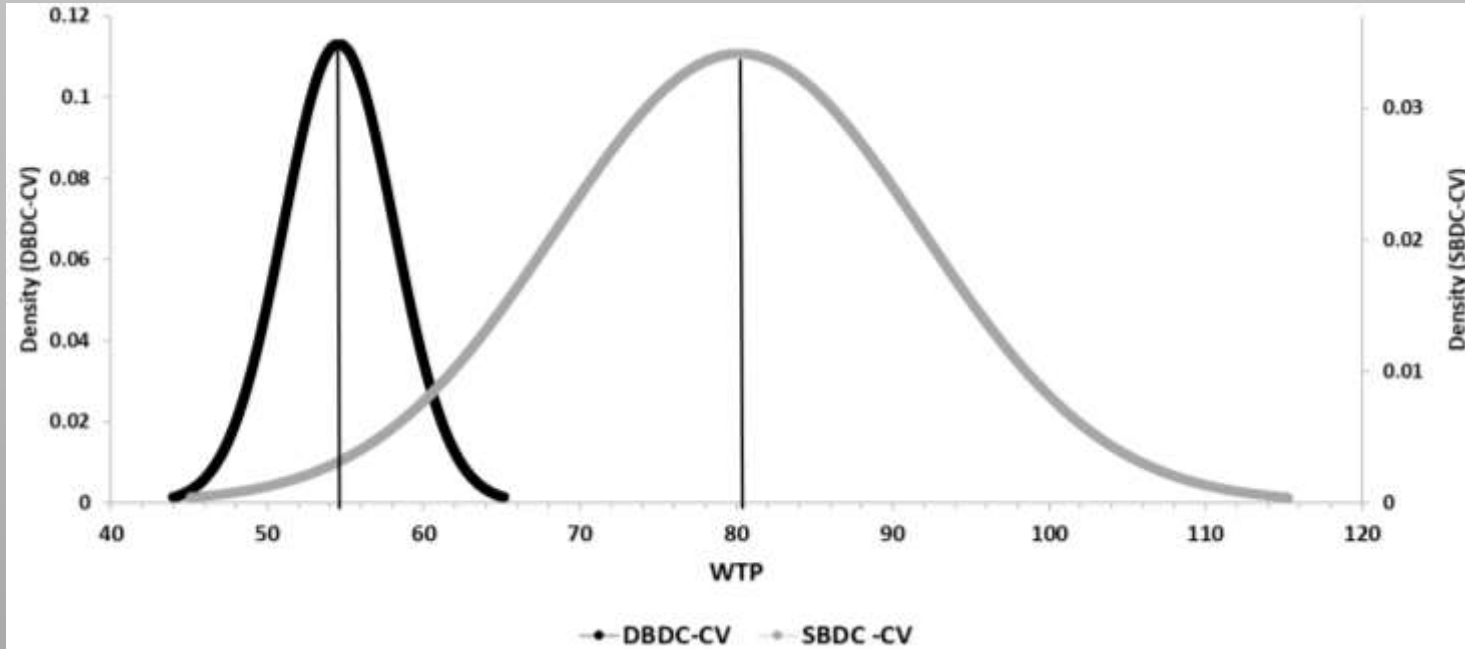
Help us find asteroids in images from the Hubble Space Telescope!

**Zooniverse**

# PUBLIC GOOD VALUE

## Value = Contingent Valuation Experiment

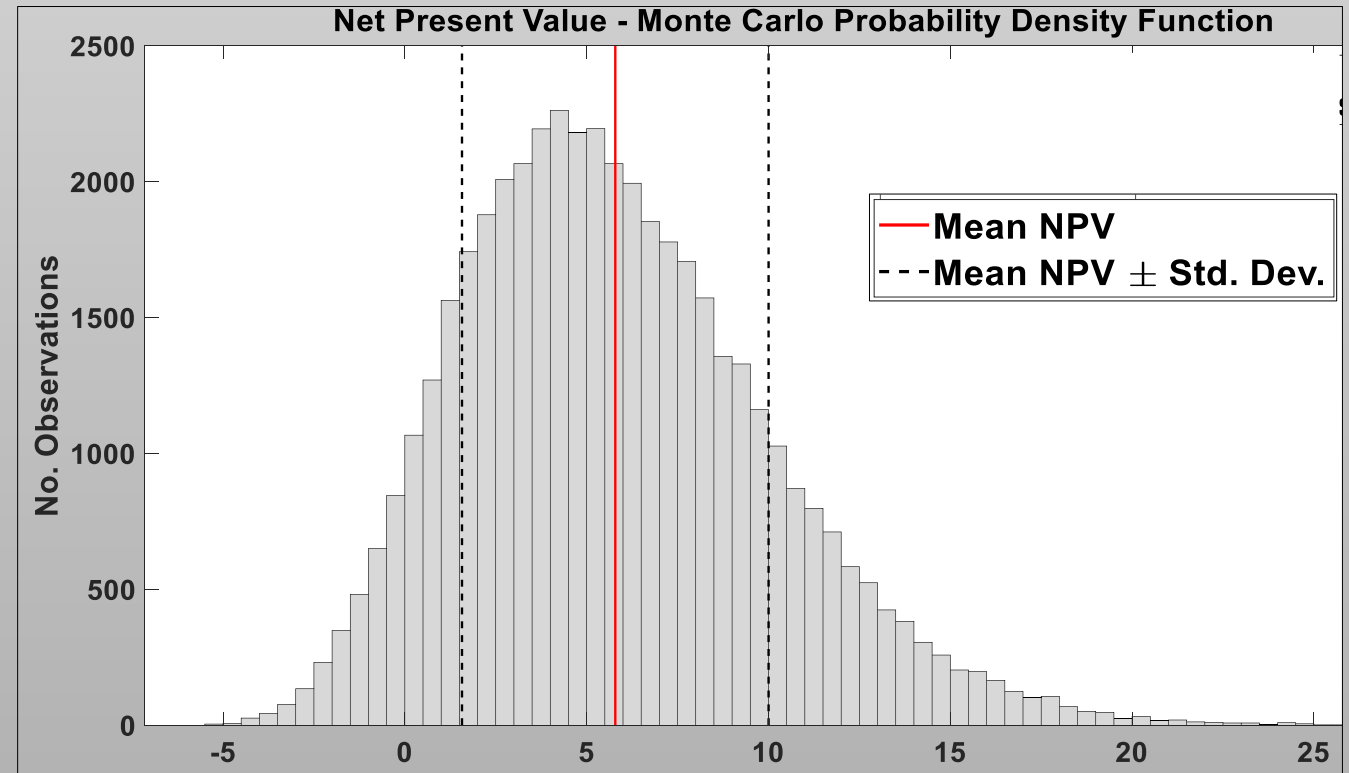
- CV experiments about CERN future accelerators
- Representative samples of citizens
- France: 1000 interviews
- Switzerland: 1000 interviews
- **Willingness-to-Pay CHF 54 > implicit taxation CHF 6**



# SUMMING UP: BENEFITS AND COSTS

## Stochastic Net Present Value of LHC + High Luminosity LHC

<b>Benefits</b> baseline	<b>25.6</b>
Scientific publications	0.6
Human capital	8.4
Technological spillovers	10.2
Cultural benefits	3.3
Public good value	3.1
<b>Costs</b> baseline	<b>22.3</b>
<b>Net Present Value</b> baseline	<b>3.3</b>



# CONCLUSIONS

- A new paradigm of science production
- Are Social Benefits > Costs?
- $B > C$  possible, even for basic research
- Measurable benefits:

**Technological Spillovers**  
**Human Capital**  
**Cultural Goods**

- Unmeasurable benefits: “Useless” Knowledge
- A gift from the current to the future generations
- We invest today in science
- They will discover tomorrow its use and value



Courtesy of @SKA



Courtesy of @SocietàItalianadipediatria