Lezione 3.2
Application of the model

The Large Hadron Collider (LHC)

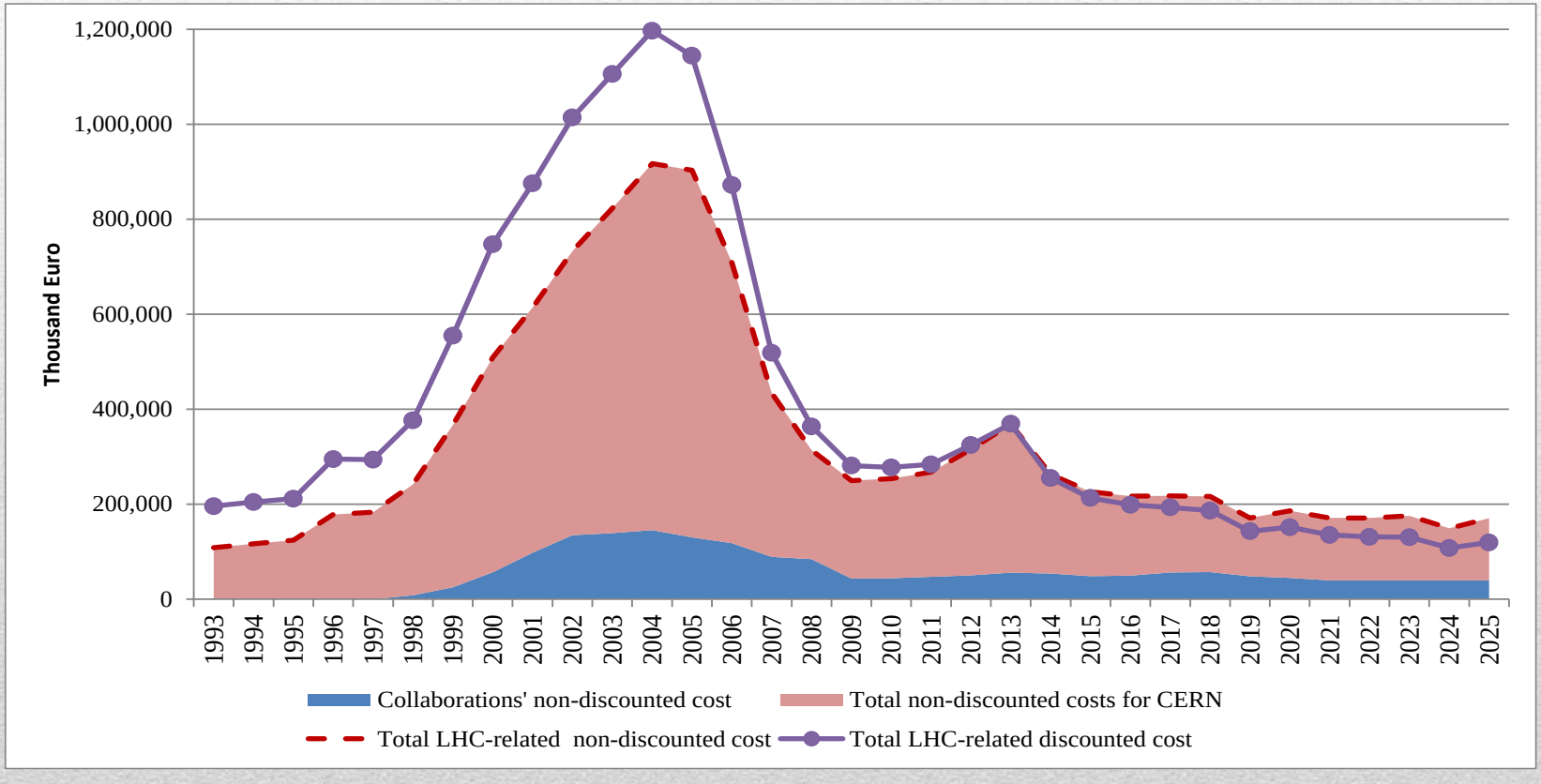
- It was built (1993-2008) by CERN.
- It is located in a **27 km-long** underground tunnel near Geneva.
- In operation since 2009, its main goal was achieved thanks to the discovery of the **Higgs boson** in 2013.

PARAMETERS FOR THE CBA

TIME HORIZON	**33 years: 1993 - 2025**
UNIT OF ANALYSIS	the LHC and its experimental facilities
SOCIAL DISCOUNT RATE	3% in real terms (adopted by the EC CBA Guide, 2014)
SHADOW PRICES	Proxied by marginal WTP or marginal costs
COUNTERFACTUAL	Business as usual scenario
QUASI-OPTION VALUE	assumed 0
NEGATIVE EXTERNALITIES	assumed 0

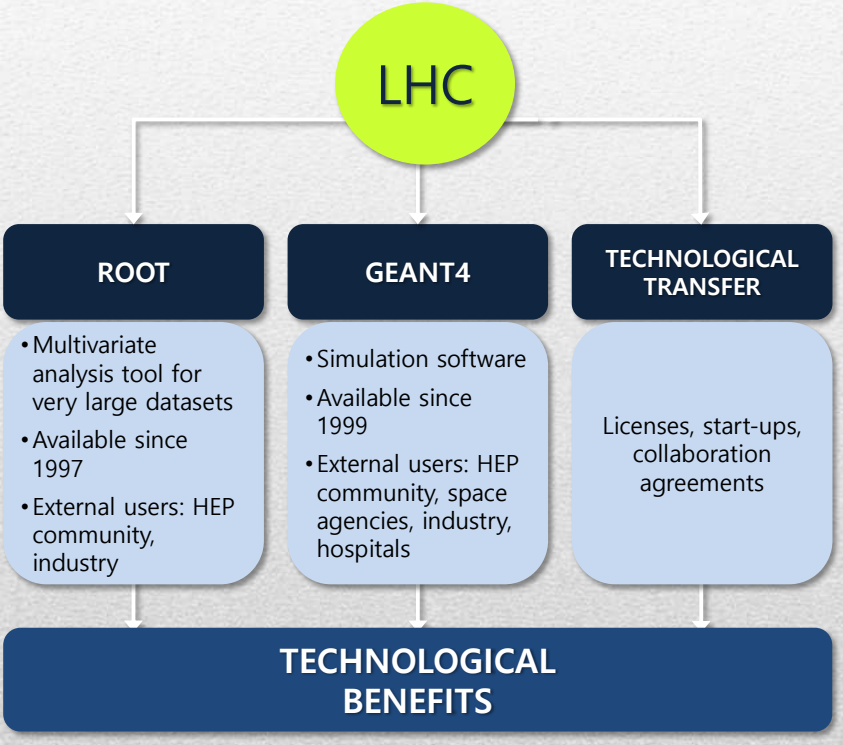
LHC: Costs

Total discounted and non-discounted LHC costs covered by CERN and collaborations, including in-kind, by year (1993-2025; thousand euro)



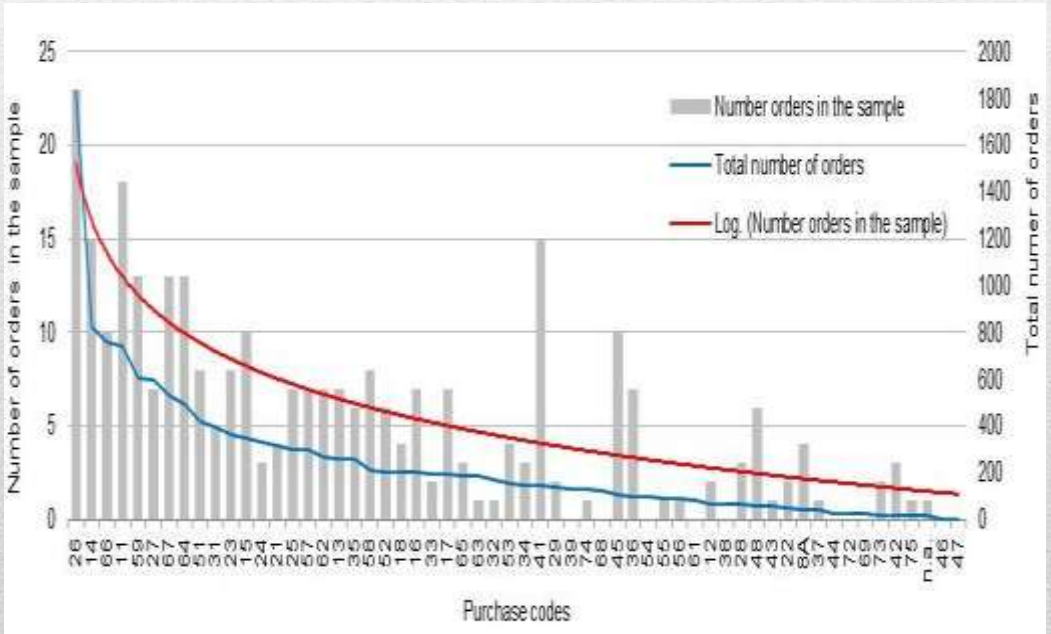
LHC: Technological Spillovers

Benefits to software users



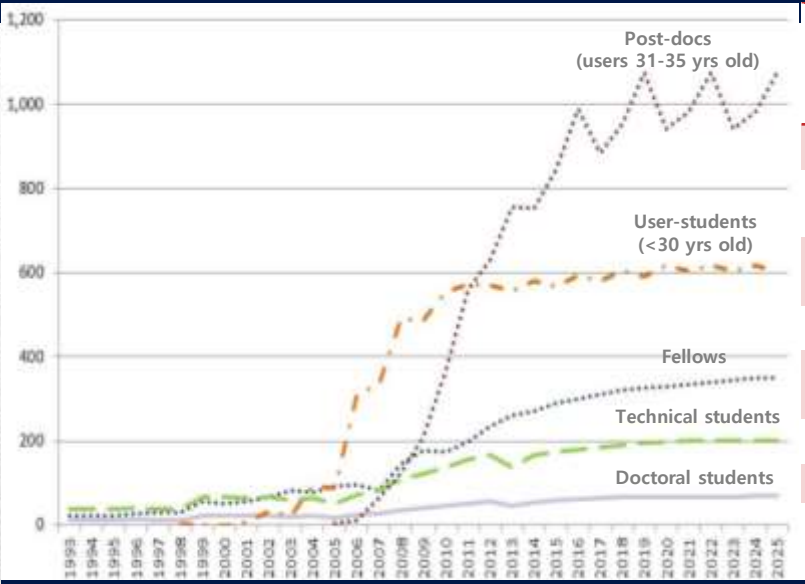
Benefits to suppliers

Sample of 300 orders by purchase code Compared with all LHC orders



LHC: Human capital formation

TYPES AND NUMBER OF PEOPLE BENEFITTING FROM TRAINING



TYPES AND QUANTITIES OF PEOPLE BENEFITTING FROM TRAINING

Variable	Number over the 1993-2025 period	Average staying at CERN
CERN fellows working on LHC	5,873	2 years
CERN technical students working on LHC	3,940	1 year
CERN doctoral students working on LHC	1,332	3 years
User-students working on LHC	14,225	3 years
Post-doc researchers (users) working on LHC	11,301	2 years
TOTAL	36,671	

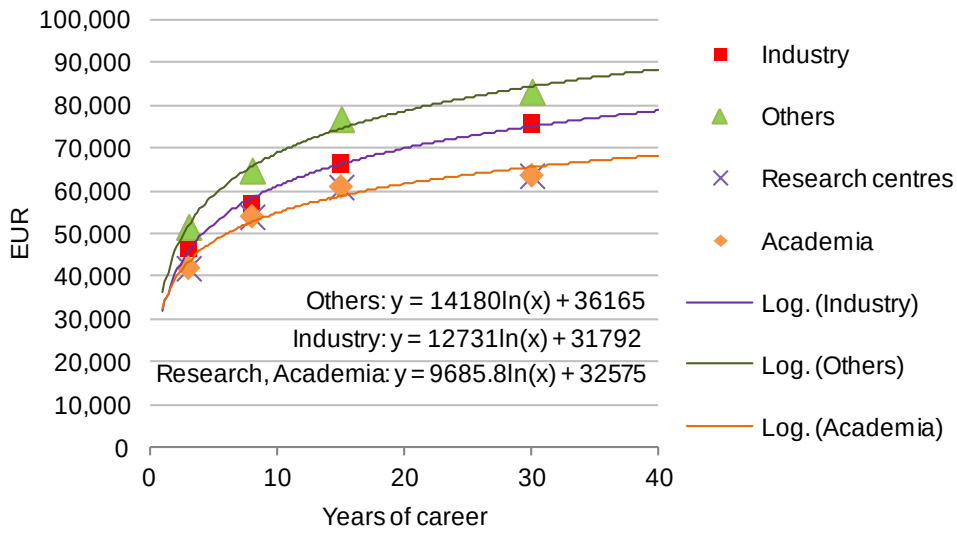
Sources: - CERN personnel statistics; - Interviews to CERN staff

Main assumptions: - Future number of beneficiaries; - Number of users-students and post-docs among users (assumed based on their age group); - Incoming number of user-students and post docs

ASSUMED DISTRIBUTION OF FORMER LHC STUDENTS BY PROFESSIONAL SECTOR

Sector	CERN fellows	CERN technical students	CERN doctoral students	User-students and post-docs
Industry	20%	45%	20%	20%
Others (computing, finance, public administration, …)	20%	45%	20%	20%
Research centres	30%	5%	30%	30%
Academia	30%	5%	30%	30%
TOTAL	100%	100%	100%	100%

ESTIMATION OF FUTURE AVERAGE SALARIES



DETERMINING THE RETURN TO SALARY DUE TO LHC TRAINING

Sector	SALARY EFFECT (1): CERN fellows, doctoral students, user students, post-docs	SALARY EFFECT (1): CERN technical students	SALARY BONUS FOR JOB EFFECT (2)
Research centres Academia Industry Others (computing, financial, …)	9.3%		2.5%

(1) Survey to 192 former LHC students (out of a total survey to 385 students and former students): declared salary impact of the experience at LHC on their current salary

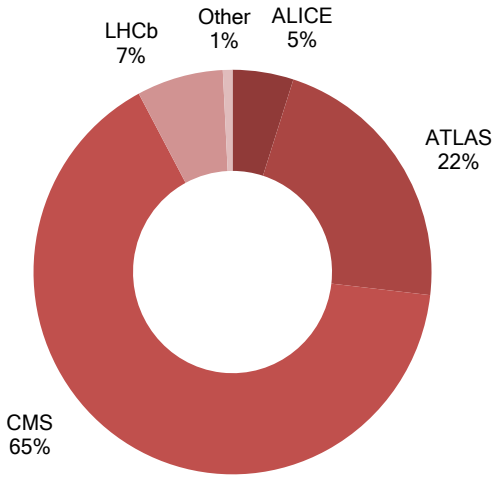
(2) Own assumption based on survey results and Payscale salaries

Main source:
Findings from the survey to LHC current and former students

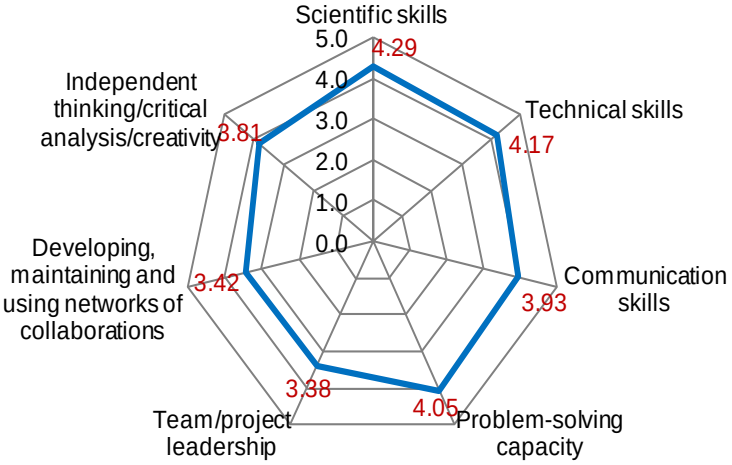
Main assumptions:
- Same economic return regardless of the professional sector and type of student
- Same return over the entire work career (40 yrs)

LHC: Human capital formation

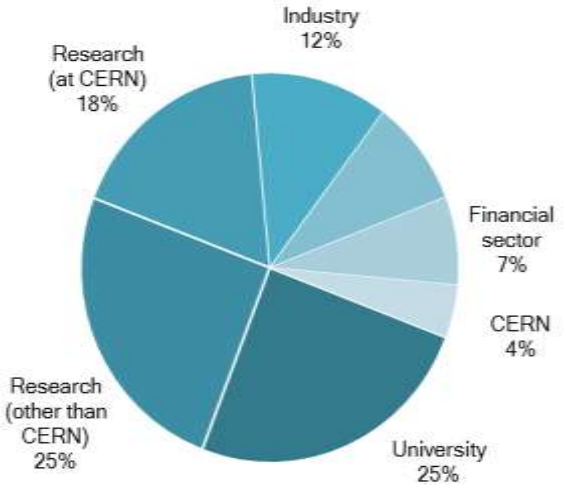
SHARE OF RESPONDENTS BY EXPERIMENT



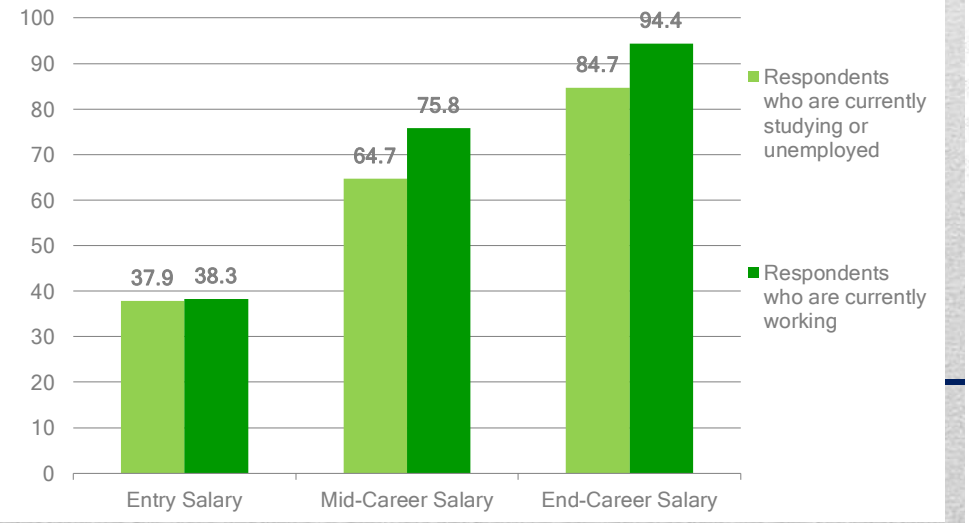
SKILLS IMPROVED THANKS TO THE LHC EXPERIENCE. AVERAGE JUDGEMENT



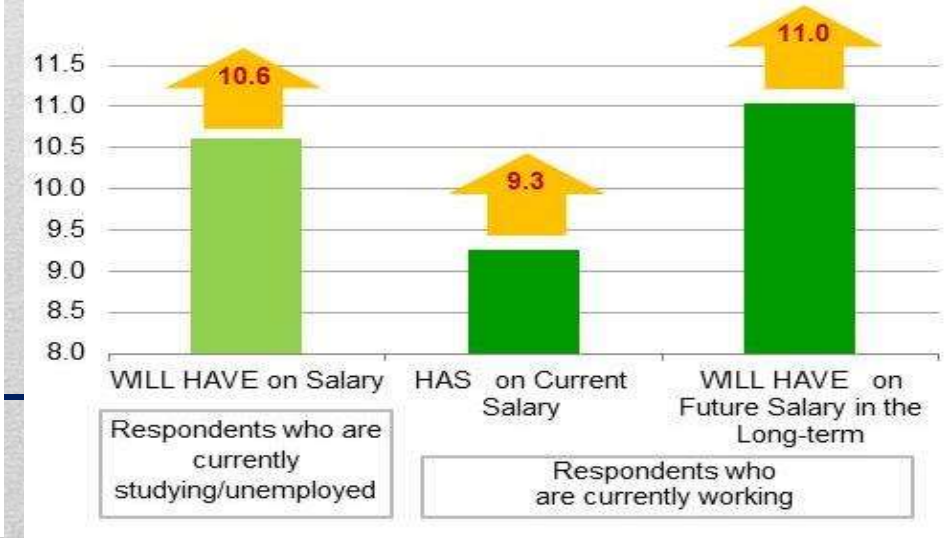
AN OVERVIEW OF CURRENT EMPLOYMENT SECTOR. SHARE OF RESPONDENTS



AVERAGE SALARY EVOLUTION: A COMPARISON BETWEEN THE TWO GROUPS OF RESPONDENTS (THOUSAND EUR)



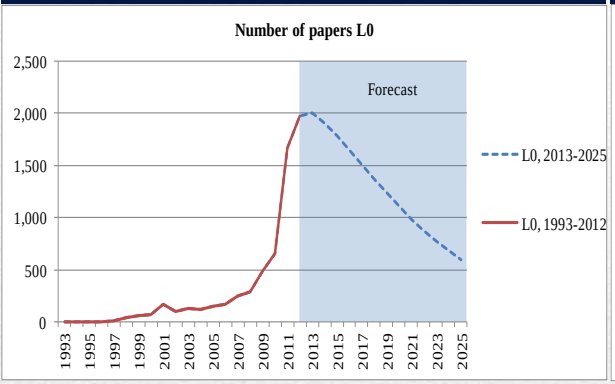
THE IMPACT OF LHC EXPERIENCE ON SALARY (%)



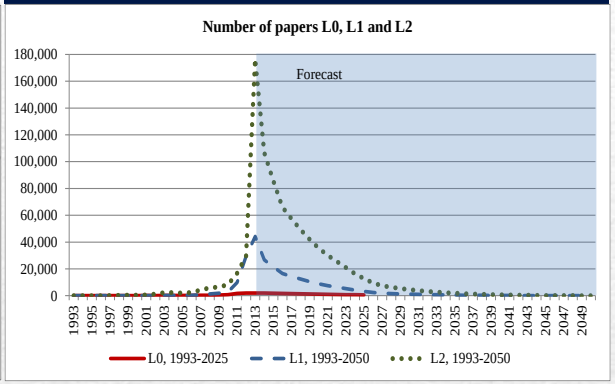
Celebrating the 1 Millionth Paper

LHC: Knowledge Output

PAPERS PRODUCED BY LHC USERS (L0)



PAPERS PRODUCED BY NON-LHC USERS (L1 & L2)



VALUATION

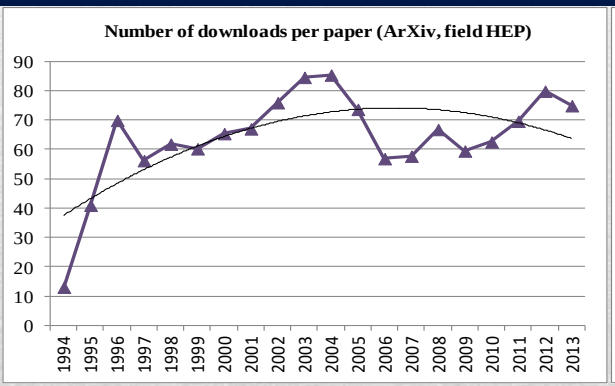
Unit economic value of papers L1

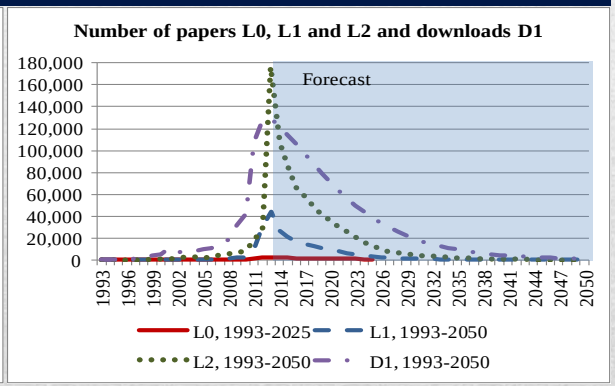
	Value	Source
Number of references in paper L1	35	Own assumption, based on an analysis of 41 research journals by Abt and Garfield (2002)
Share of time dedicated to research	65%	Own assumption. The remainder is for teaching and other non scientific activities
Number of paper (published and non) per year	3.5	Own assumption. It represents the number of papers to wich a scientist gives a real contribution
Average annual gross salary	59,289 €	Own elaboration based on PayScale data. It is the average salary for a scientists working in research centres and academia in the USA
Unit production cost per paper L1	315 € = (59,289 € * 65%/3.5/35)	Own estimation, based on the approach suggested by Florio and Sirtori (2014)

Unit economic value of citations and downloads

	Value	Source
Working hours per year	1,800 = 225 working days * 8 hours/day	Own assumption
Average hourly gross salary	33 € = 59,289/1,800	Own estimation
Hours per citation	3	Own assumption
Hours per download	3	Own assumption
Value of one citation L1 and L2	99 € = 33 € * 3	Own estimation, based on Florio and Sirtori (2014)
Value of one L0 paper downloaded but non cited	99 € = 33 € * 3	Own estimation, based on Florio and Sirtori (2014)

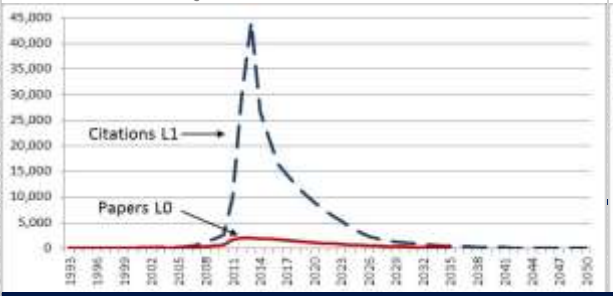
DOWNLOADS OF LHC PAPERS (D1)



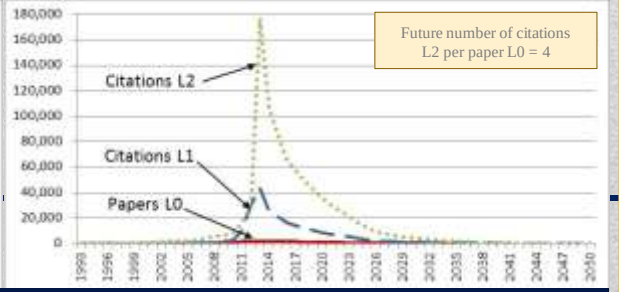


TRACKING THE KNOWLEDGE OUTPUTS

Quantification of citations L1

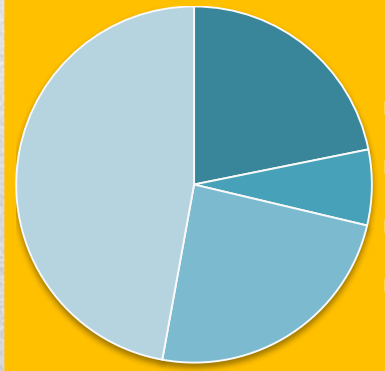


Quantification of citations L2



Source: Preliminary scientometric analysis of INSPIRE database of papers and citations

OUR RESULTS



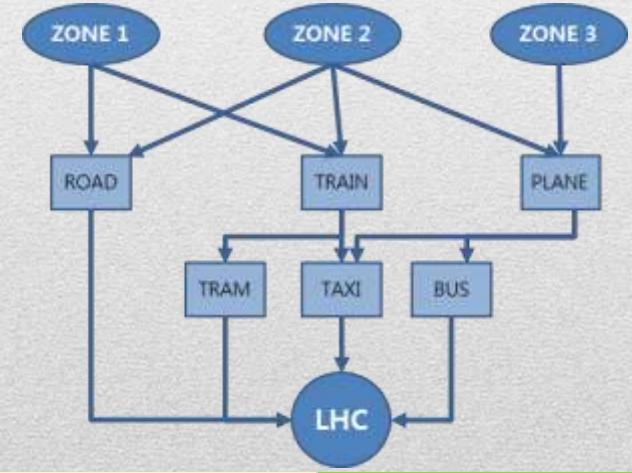
- **Present value of papers L1**
- **Present value of citations L1**
- **Present value of citations L2**
- **Present value of downloads**

Except L_0

LHC: Cultural Effects

TRAVEL ZONES CONSIDERED

VALUATION THROUGH THE TRAVEL COST METHOD

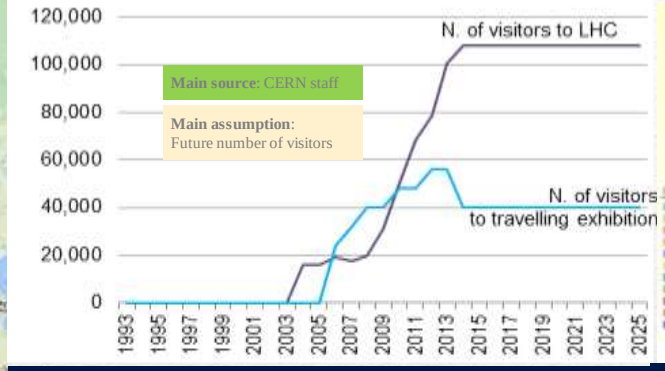


Main assumption:
- % of visitors by mode of transport
- Travel cost by zone

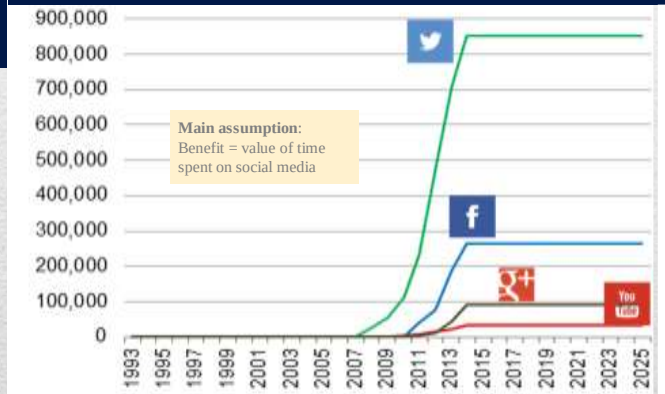
Source:
HEATCO values of travel time by modes of transport

Origin zone	Radius distance from CERN	Share of visitors	Source/ Assumption
Zone 1	500 km	24%	CERN
Zone 2	500-1,500 km	50%	Own assumption
Zone 3	Beyond 1,500 km	26%	Own assumption

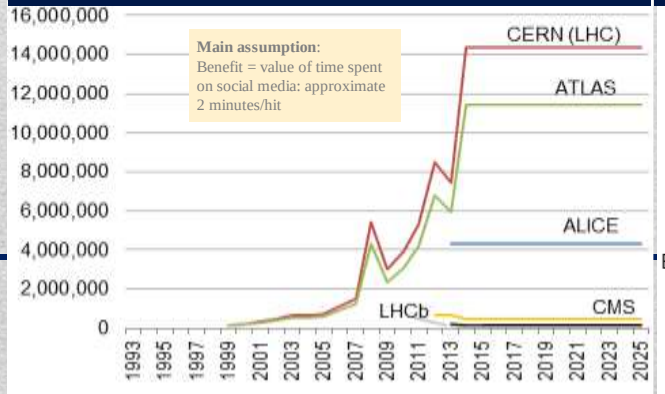
BENEFITS TO PERSONAL VISITORS: QUANTIFICATION OF VISITORS



BENEFIT FOR SOCIAL MEDIA USERS

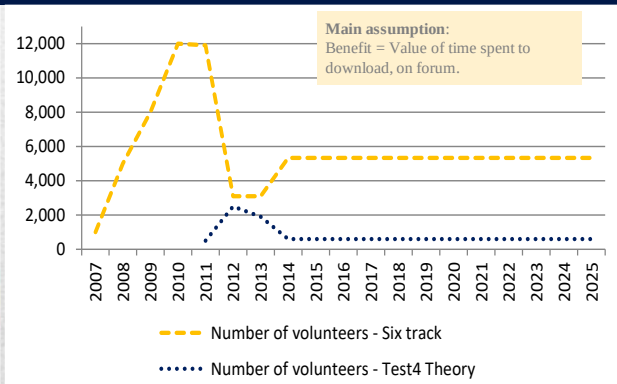


BENEFIT FOR WEBSITE VISITORS

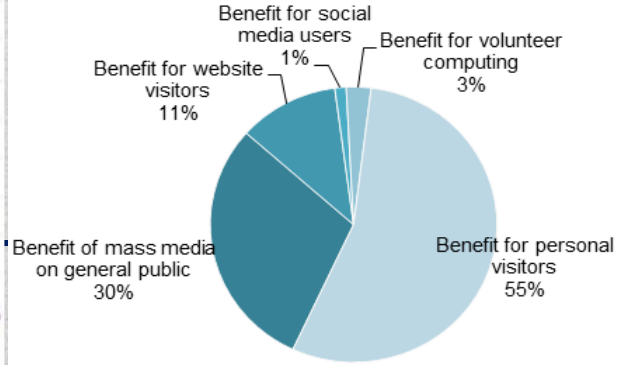


MASS MEDIA BENEFITS: NEWS BY MEDIA CHART

BENEFIT FOR VOLUNTEER COMPUTING



SHARE OF BENEFITS BY TYPE OF OUTREACH ACTIVITY

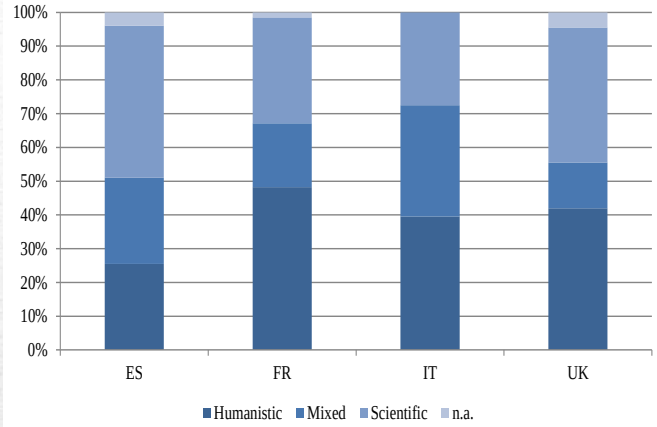


APPLICATIONS OF THE MODEL: LHC

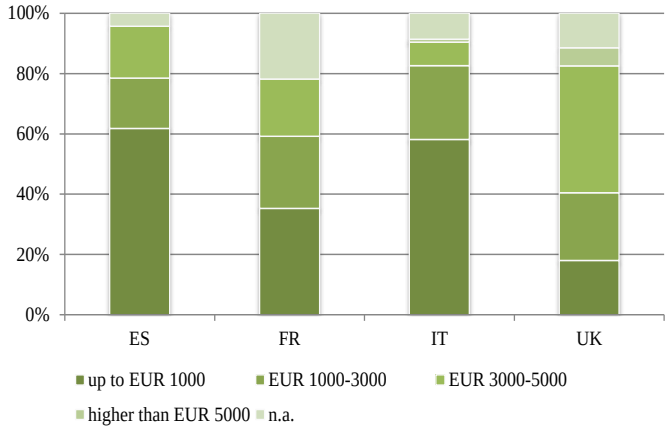
LHC: results from a contingent valuation

GENDER	Number
Female	*581*
Male	*446*
Total	*1027*
COUNTRY	**Number**
Italy	*422*
Spain	*204*
France	*201*
UK	*200*
Total	*1027*
YEARS	**Number**
19-25 years	*875*
26-30 years	*95*
31-35 years	*34*
Over 35 years	*20*
n.a.	*3*
Total	*1027*

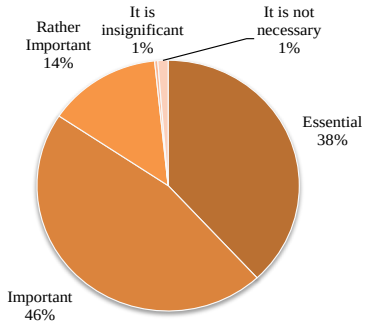
RESPONDENTS BY UNIVERSITY DEGREE



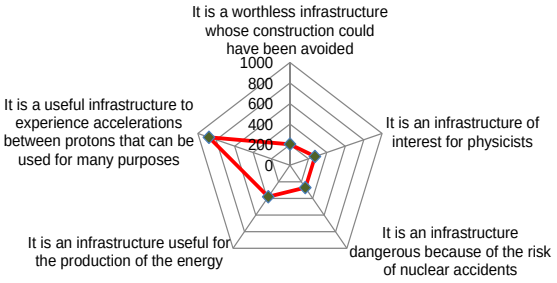
RESPONDENTS BY LEVEL OF HOUSEHOLD INCOME



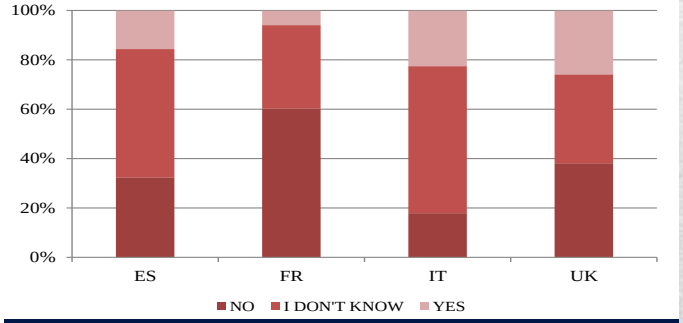
RATING THE IMPORTANCE TO FINANCE RDI



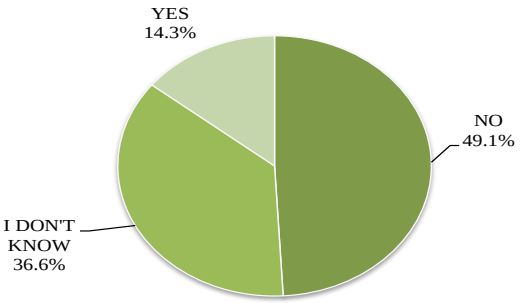
WHAT IS THE UTILITY OF THE LHC



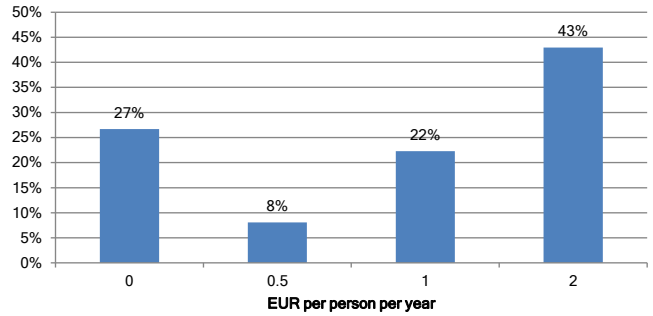
WILLINGNESS TO PAY FOR LHC



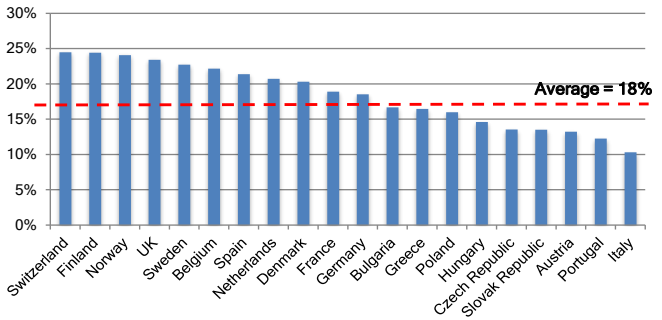
WTP TO PAY *UNA TANTUM*



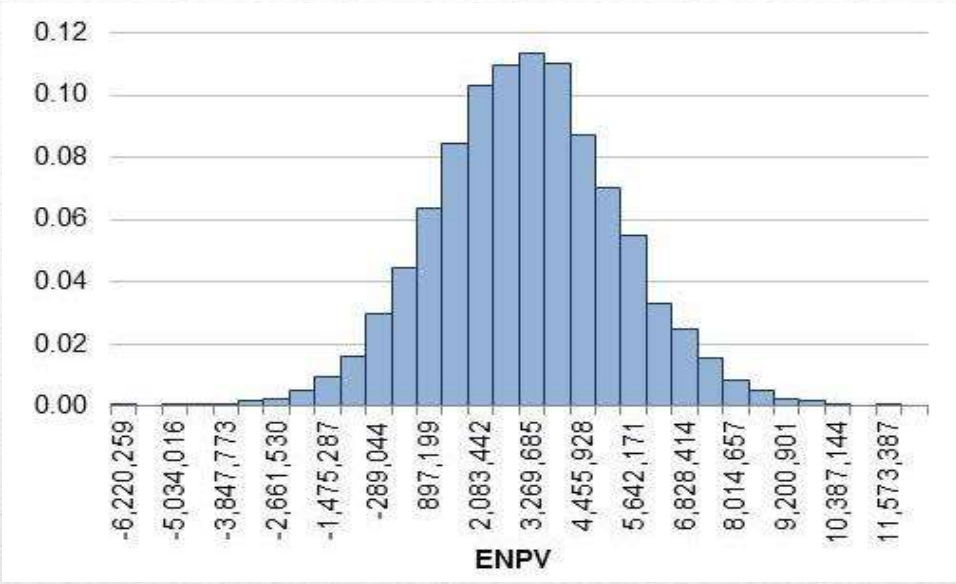
AVERAGE ANNUAL WTP

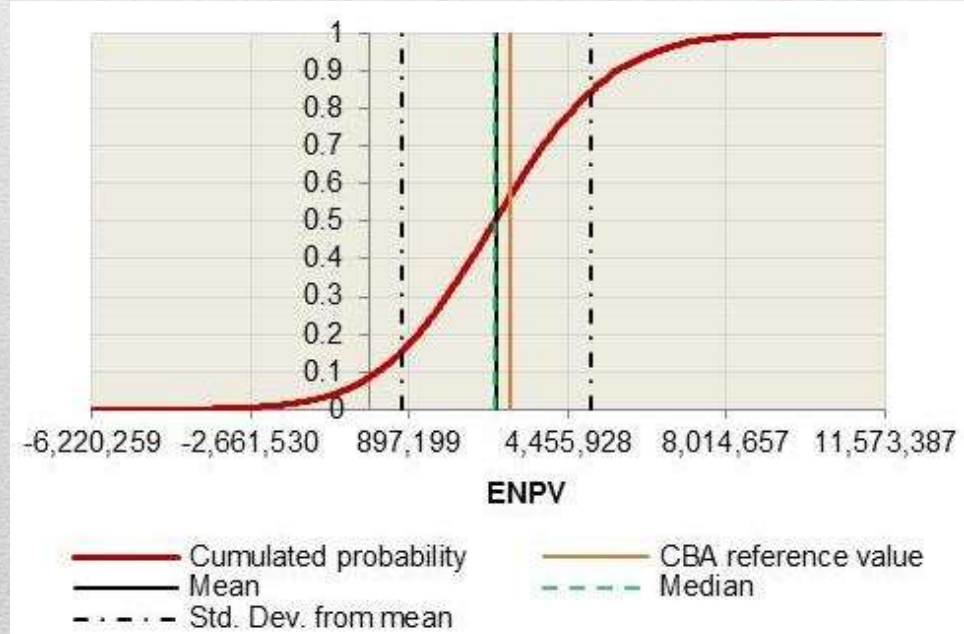


SHARE OF ADULT POPULATION (18-74 YEARS OLD) WITH AT LEAST TERTIARY EDUCATION



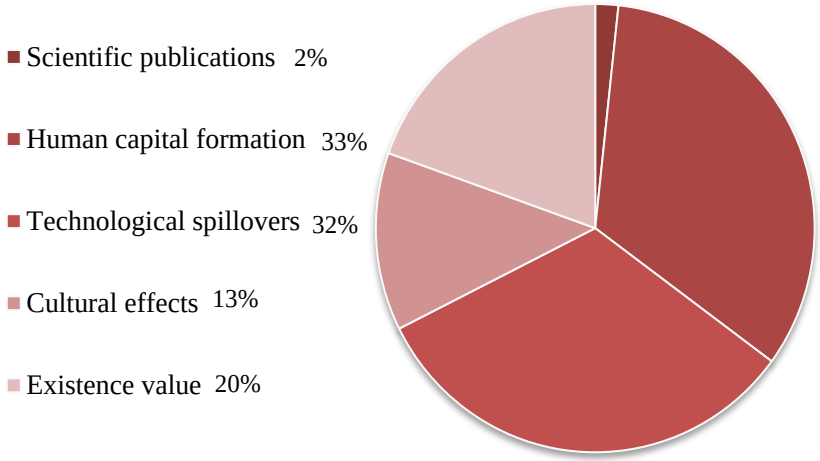
LHC: CBA results





PROBABILITY DISTRIBUTION OF THE LHC NET PRESENT VALUE

Own estimate of the Present Value PDF resulting from a Monte Carlo simulation (10,000 random extractions)



Estimated parameters of distribution	
Mean	2,855,528
Median	2,825,860
Standard Deviation	2,134,763
Minimum	-6,220,259
Maximum	11,573,387
Estimated probabilities	
Pr. ENPV ≤ 0	0.086