GRID AND CLOUD COMPUTING - CONCEPTS AND PRACTICAL APPLICATIONS

WORKSHOP 192 INTERNATIONAL SCHOOL OF PHYSICS "ENRICO FERMI"

25 – 30 July 2014

Directors
Federico Carminati, Latchezar Betev

Assistant
Alina Grigoras

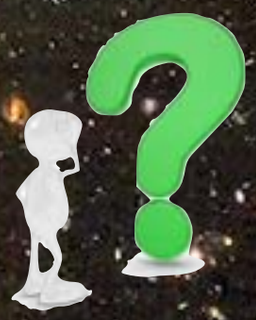
CERN, Geneva, Switzerland

PRACTICAL INFO

- Lunches are taken at the buffet lunch inside the school on the lakefront
- Dinners are free, apart
  - This evening (welcome dinner) Villa Cipressi
  - Tuesday 29 (farewell dinner) Villa Monastero

SCHOOL SCHEDULE

	Friday 25 July	Saturday 26 July	Sunday 27 July	Monday 28 July	Tuesday 29 July	Wednesday 30 July
9.00-9.30 9.30-10.30	Carminati Bird	Duellmann	Livny	Breton	Newman	Shiers
10.30-11.00	Break					
11.00-12.30	Bird	Duellmann	Livny	Breton	Newman	Shiers
12.30-16.00	Lunch					Departure
16.00-17.00	Maffioletti	Legrand	Round table	Salomoni	Barczyk	
17.00-17.30	Break					
17.30-19.00	Maffioletti	Legrand	Round table	Salomoni	Barczyk	



What is the place of matter in the universe

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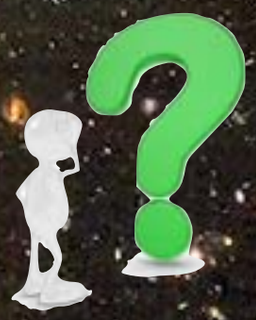
Elementary particles
0,2%



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(neutrinos, neutralinos,…)
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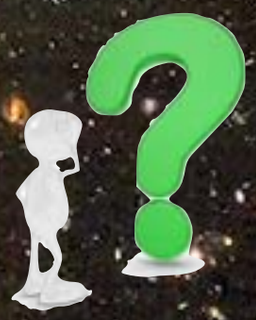
Dark energy
(Vacuum energy,...)
66%



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We ignore most things about the 4% of the Universe

But we do not even know of what the remaining 96% is made of


LOST
CONFUSED
UNCLEAR
PERPLEXED
DISORIENTED
BEWILDERED

If you do not
know what you are
doing do not push
these buttons

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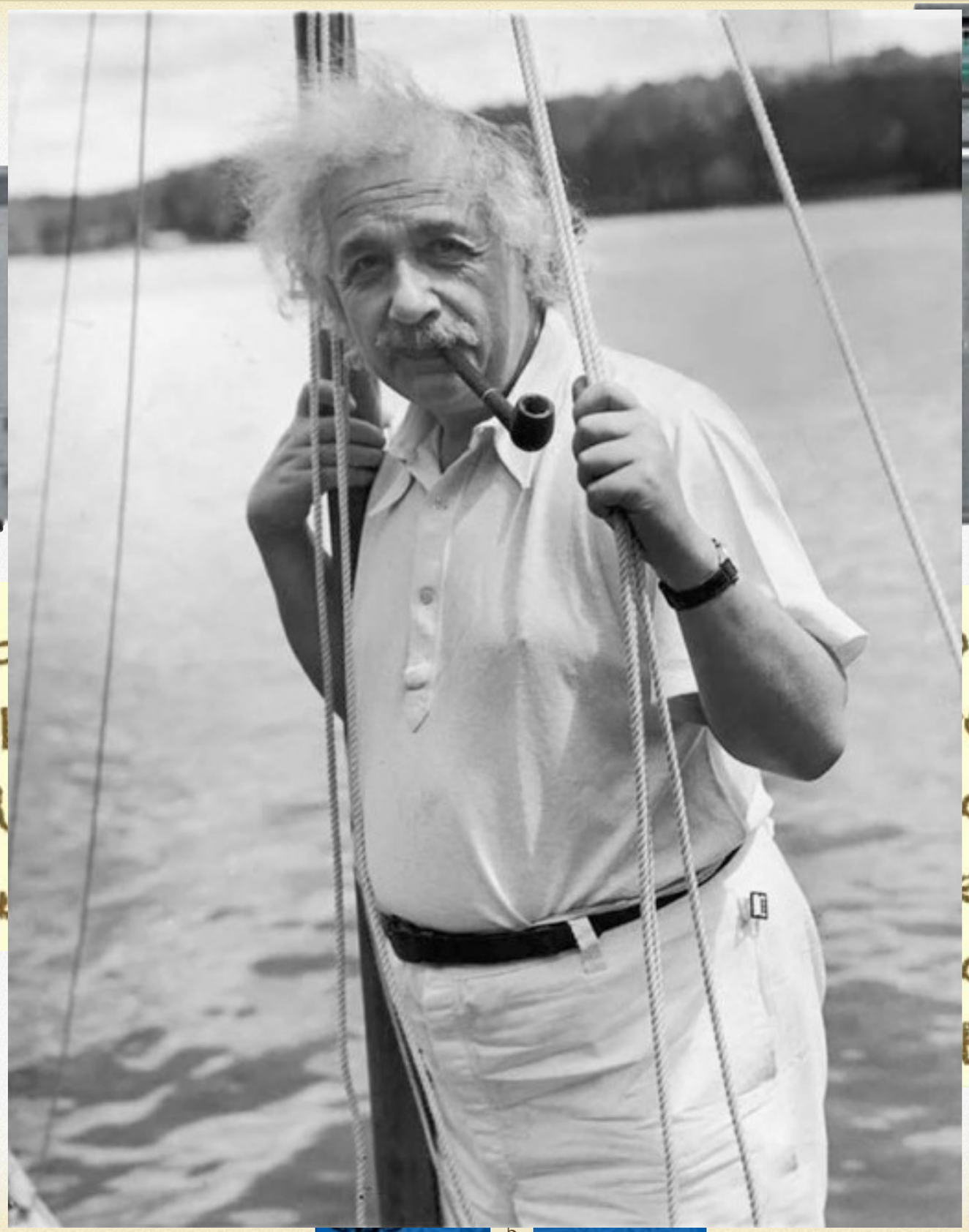
If we knew what it was we were doing, it would not be called research, would it? Albert Einstein



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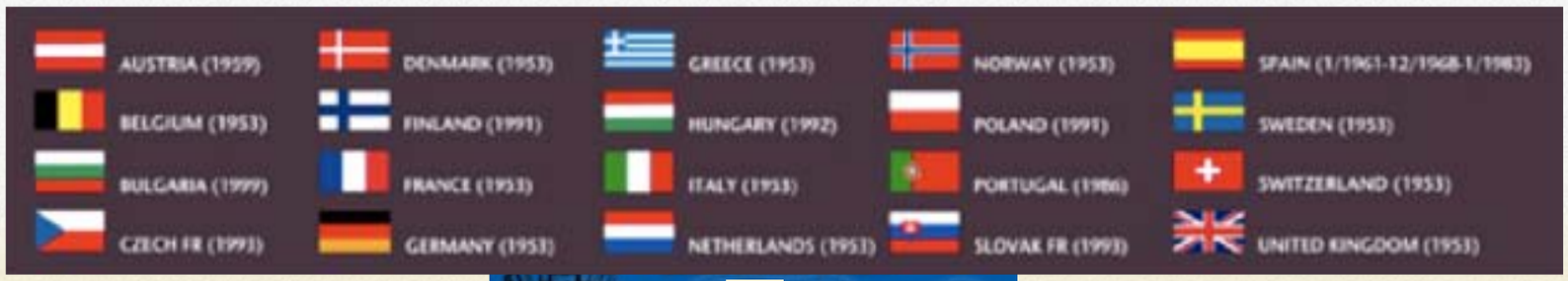
20 EUROPEAN MEMBER STATES



THE MISSION OF CERN

- Push forward the frontiers of knowledge
  - The secrets of the Big Bang
  - Origin of mass
- 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

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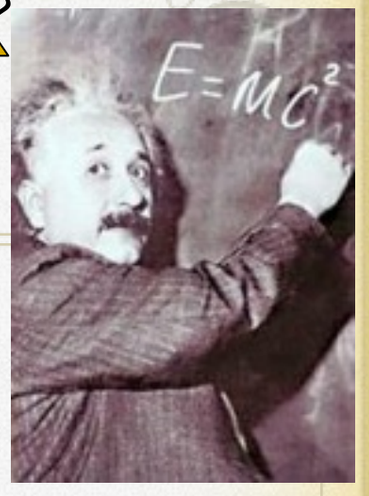

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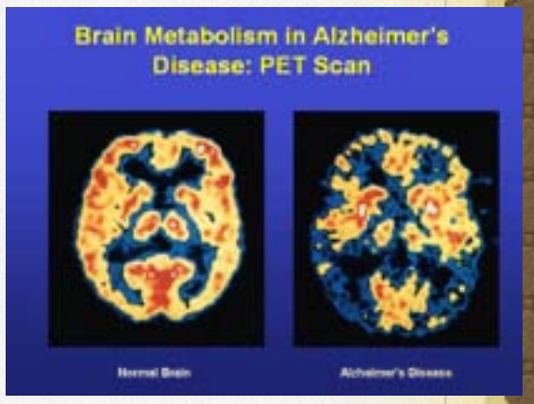

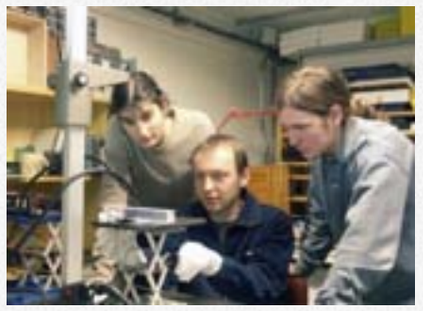

LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS 7 km
SUISSE
FRANCE
ALICE
CMS

Exploration of a new energy frontier in p-p and Pb-Pb collisions

Tools: LHC and Detectors

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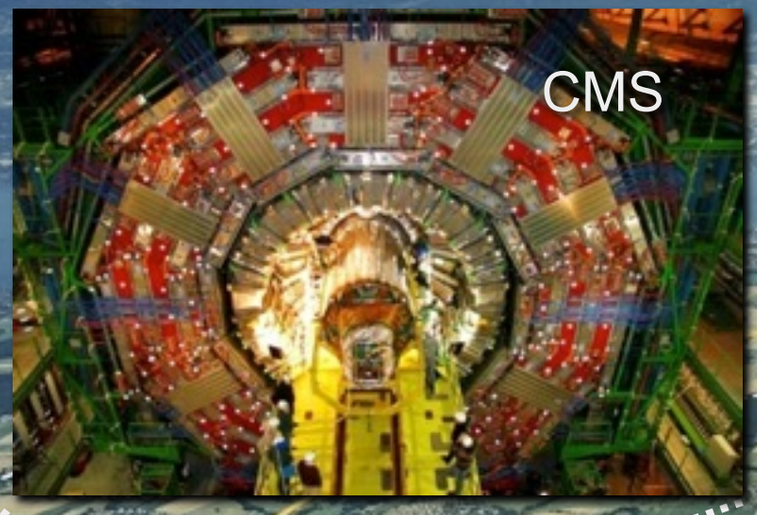

LHCb

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General Purpose, proton-proton, heavy ions

Discovery of new physics: Higgs, SuperSymmetry

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CERN

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pp, B-Physics, CP Violation
(matter-antimatter symmetry)

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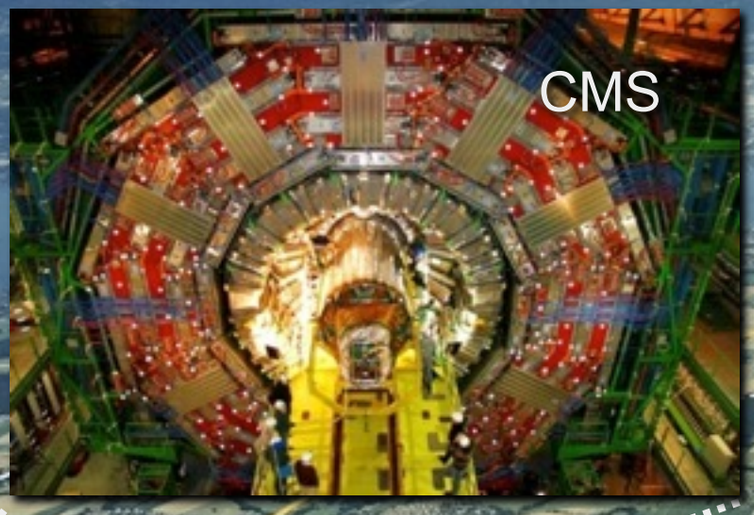

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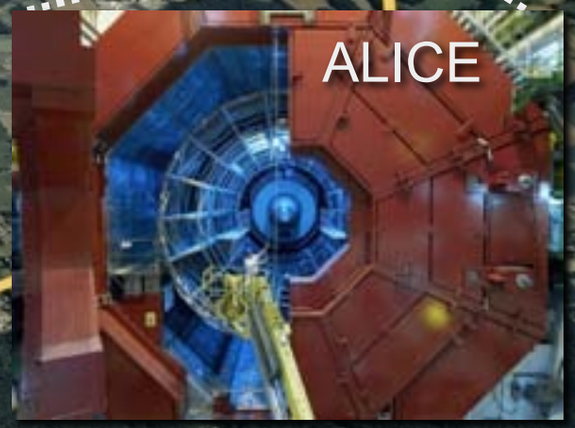

Heavy ions, pp
(state of matter of early universe)

10 500 USERS

Distribution of All CERN Users by Nationality on 14 January 2014

MEMBER STATES	6352
Austria	99
Belgium	106
Bulgaria	75
Czech Republic	202
Denmark	53
Finland	87
France	751
Germany	1150
Greece	152
Hungary	68
Israel	51
Italy	1686
Netherlands	153
Norway	61
Poland	229
Portugal	109
Slovakia	88
Spain	337
Sweden	75
Switzerland	180
United Kingdom	640

OBSERVERS	2571
India	220
Japan	244
Russia	982
Turkey	146
USA	979

CANDIDATE FOR ACCESSION	
Romania	118

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP	
Serbia	41

OTHERS																	
Afghanistan	1	Bolivia	3	Cuba	7	Iran	28	Madagascar	4	Philippines	1	Tunisia	6
Albania	2	Bosnia & Herzegovina	1	Cyprus	16	Ireland	22	Malaysia	15	Saudi Arabia	3	Ukraine	55
Algeria	8	Brazil	108	Ecuador	3	Jordan	2	Mauritius	1	Senegal	1	Uzbekistan	4
Argentina	11	Cameroon	1	Egypt	19	Kazakhstan	1	Mexico	64	Singapore	2	Venezuela	9
Armenia	25	Canada	134	El Salvador	1	Kenya	1	Montenegro	3	Sint Maarten	2	Viet Nam	9
Australia	25	Cape Verde	1	Estonia	16	Korea, D.P.R.	1	Morocco	12	Slovenia	27	Zimbabwe	2
Azerbaijan	8	Chile	12	Georgia	36	Korea Rep.	117	Nepal	5	South Africa	16		
Bangladesh	4	China	280	Gibraltar	1	Kuwait	1	New Zealand	7	Sri Lanka	5		
Belarus	47	China (Taipei)	45	Hong Kong	1	Lebanon	12	Pakistan	41	Syria	2	**1415**	
		Colombia	30	Iceland	4	Lithuania	19	Palestine (O.T.).	4	Thailand	12		
		Croatia	35	Indonesia	1	Luxembourg	4	Peru	8	T.F.Y.R.O.M.	1		

Some history of scale…

Date	Collaboration sizes	Data volume, archive technology
Late 1950's	2-3	Kilobits, notebooks
1960's	10-15	kB, punchcards
1970's	~35	MB, tape
1980's	~100	GB, tape, disk
1990's	700-800	TB, tape, disk
2010's	~3000	PB, tape, disk

For comparison:
1990's: Total LEP data set ~few TB
Would fit on 1 tape today

Today: 1 year of LHC data ~30 PB

A COMPUTING BRAIN

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- Register ~ 30 million GB/y at the pace of up to 4GB/s

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- Register ~ 30 million GB/y at the pace of up to 4GB/s
- Analyse data as soon as taken with 250,000 powerful computers in 170 centres and 40 countries
- Distribute to physicists all around the world the data

A COMPUTING BRAIN

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The Conquest of Space

A COMPUTING BRAIN

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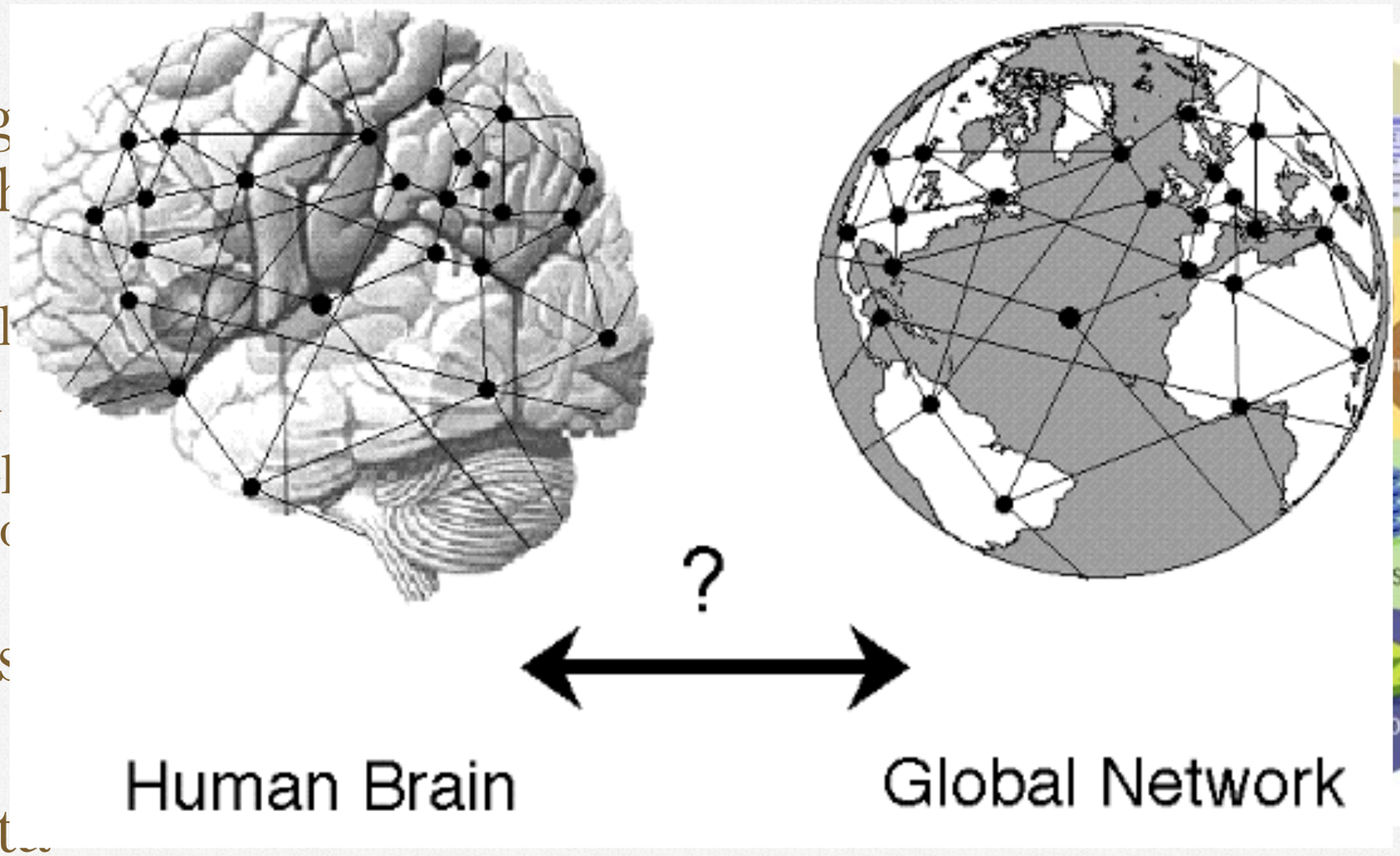

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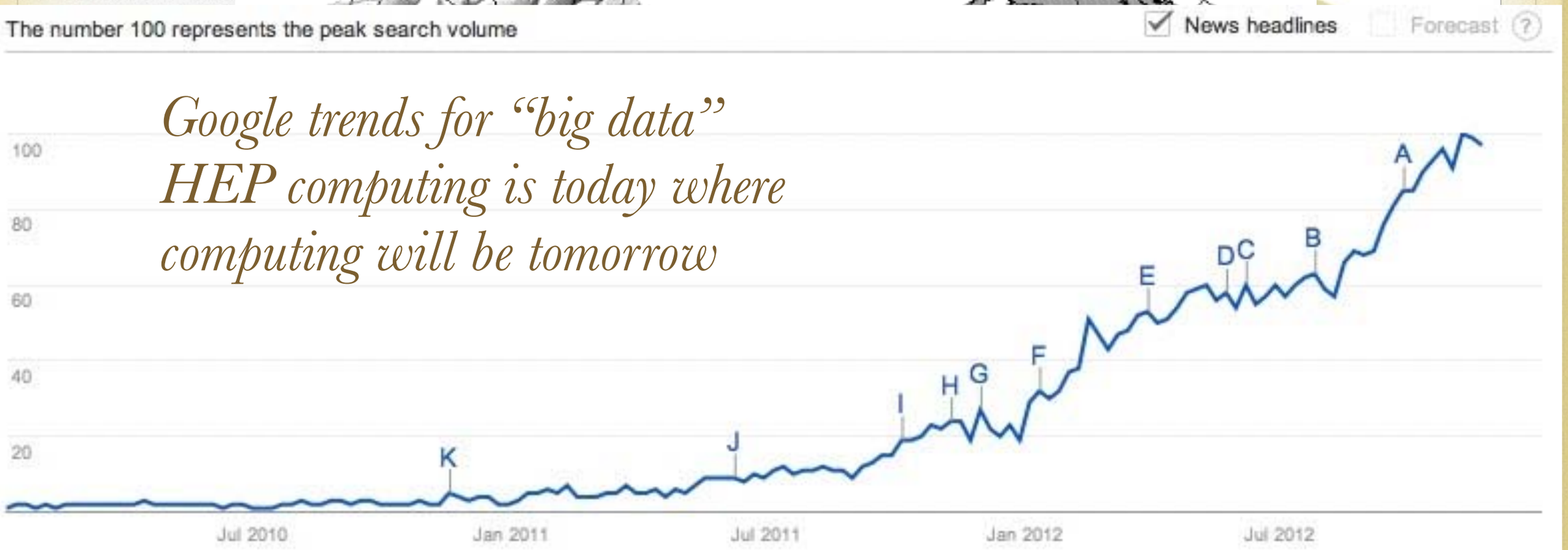

Google trends for "big data"
HEP computing is today where computing will be tomorrow

Human Brain

Global Network

dat...

WLCG: A global collaboration…

Tier-0 (CERN):
- Data recording
- Initial data reconstruction
- Data distribution

Tier-1 (11 centres):
- Permanent storage
- Re-processing
- Analysis

Tier 0 Tier 1

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From testing to data:

Independent Experiment Data Challenges

Service Challenges proposed in 2004

To demonstrate service aspects:

- -Data transfers for weeks on end
- -Data management
- -Scaling of job workloads
- -Security incidents ("fire drills")
- -Interoperability
- -Support processes

- Focus on real and continuous production use of the service over several years (simulations since 2003, cosmic ray data, etc.)
- Data and Service challenges to exercise all aspects of the service – not just for data transfers, but workloads, support structures etc.

2004: e.g. DC04 (ALICE, CMS, LHCb)/DC2 (ATLAS) in 2004 saw first full chain of computing models on grids

2005: SC1 Basic transfer rates

2005: SC2 Basic transfer rates

2006: SC3 Sustained rates, data management, service reliability

2007: SC4 Nominal LHC rates, disk→ tape tests, all Tier 1s, some Tier 2s

2008: CCRC'08 Readiness challenge, all experiments, ~full computing models

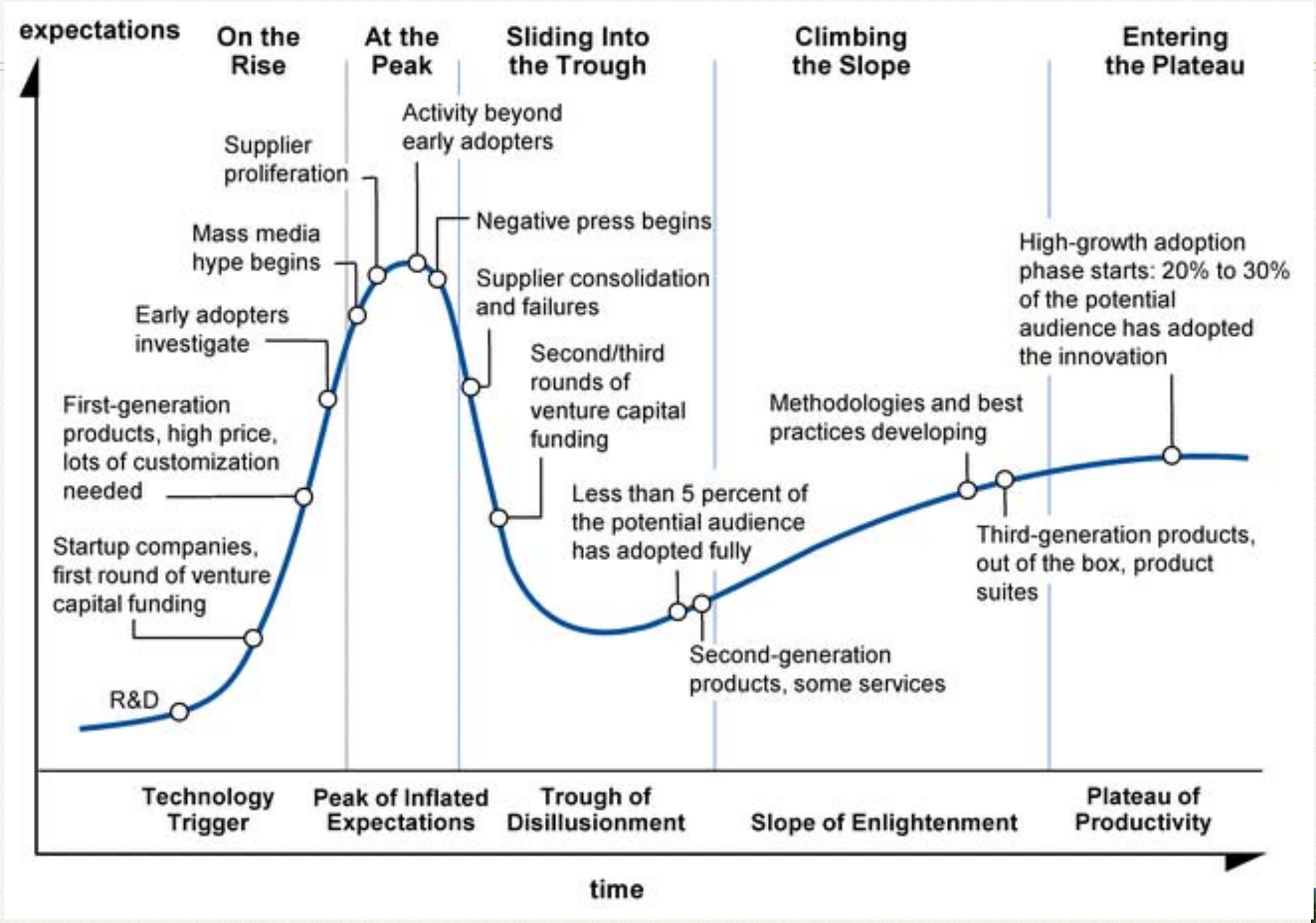
2009: STEP'09 Scale challenge, all experiments, full computing models, tape recall + analysis

2010

WHERE ARE WE NOW?

- The Grid for HEP simply works… and thanks to it we have discovered the Higgs Boson
- However the Grid has not generated a viable commercial model
- HEP remains the major (or rather the only?) user of the Grid
- Why is that so?

THE GARTNER HYPE CYCLE



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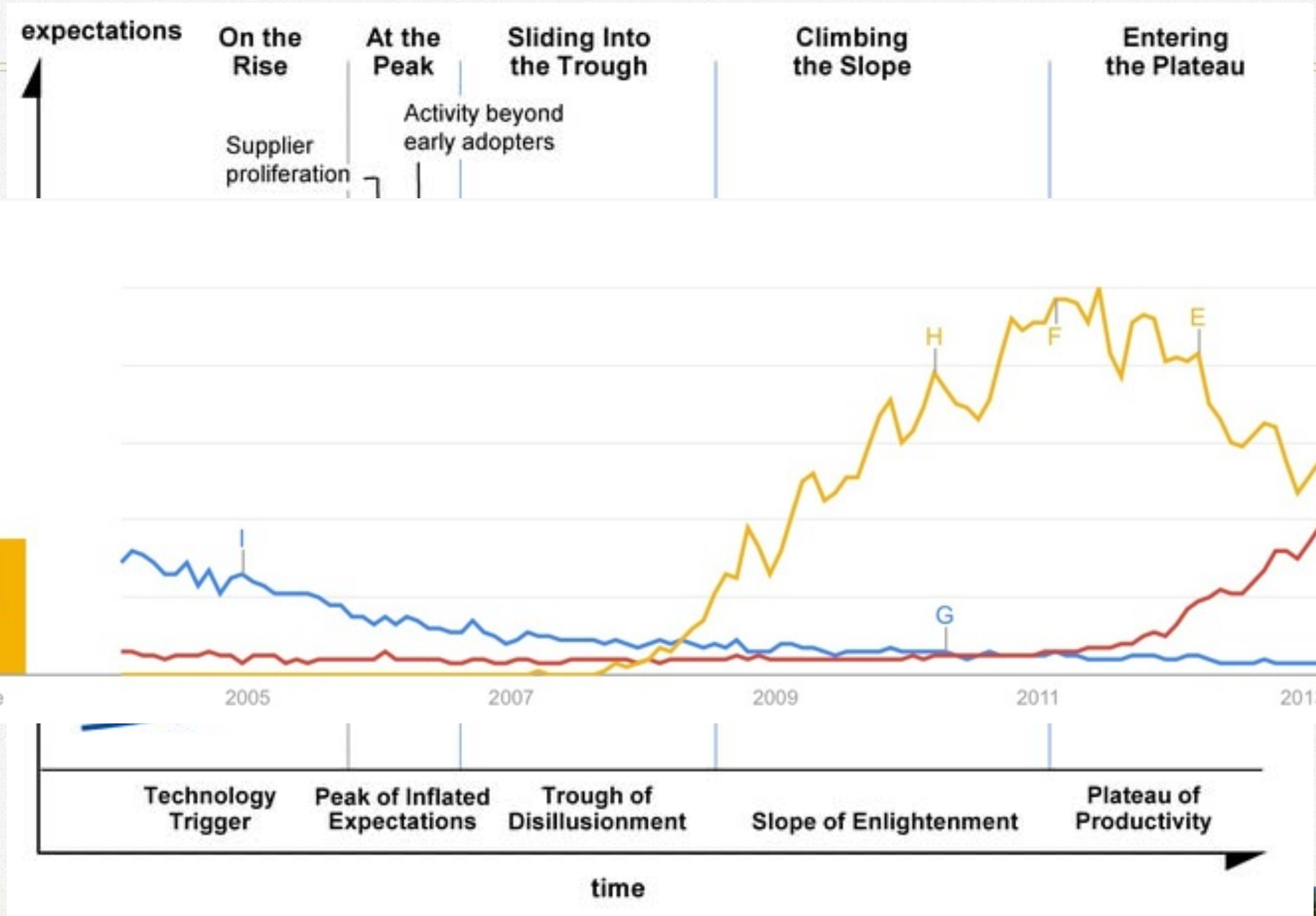
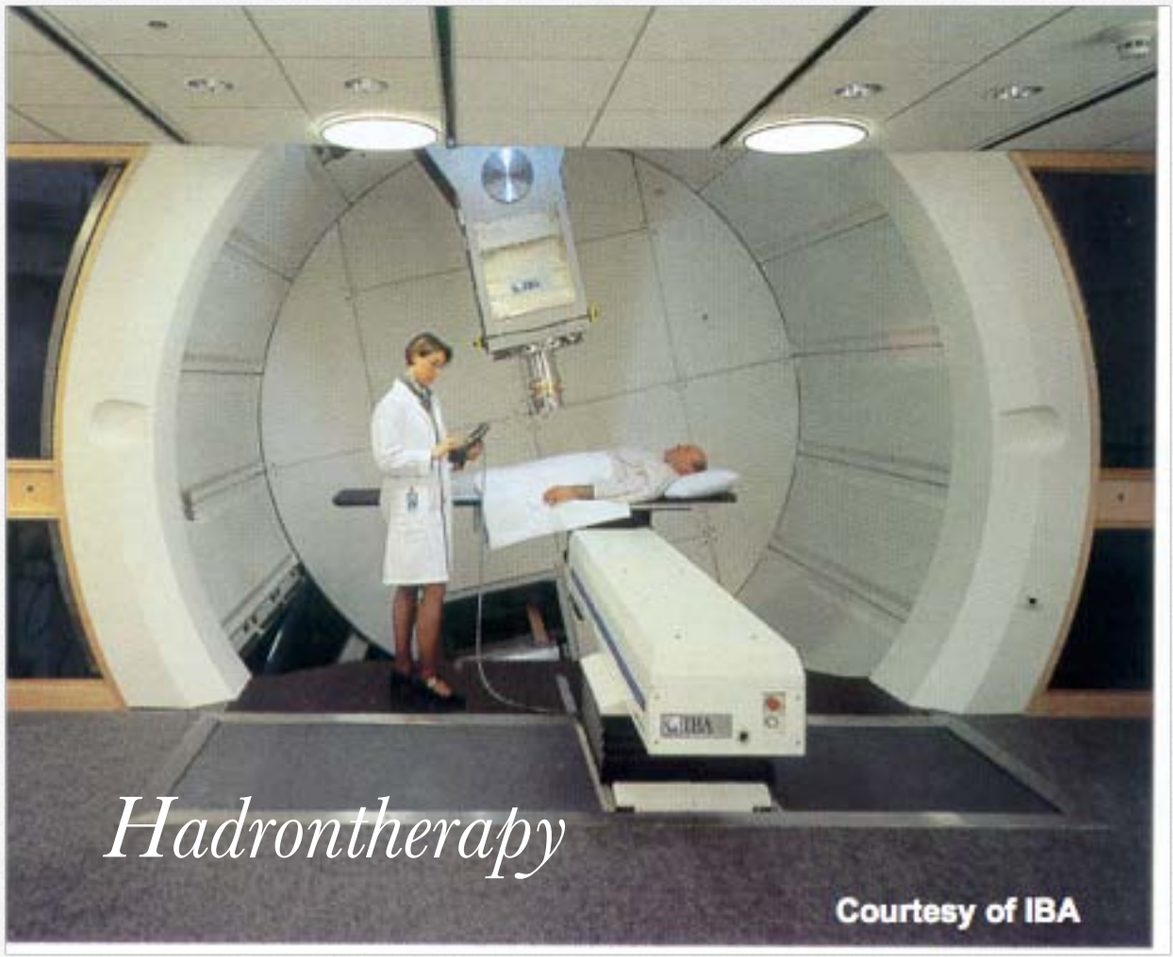


CLOUDS AT THE HORIZON

- The hype has now moved to a new concept, the Cloud
- Part of the change is just branding and naming
- Part is the reuse of the Grid technologies in a more viable economic model
- The problem of data remains essential for HEP
- It will soon be for all other disciplines
  - Sensors are ubiquitary

ACCELERATORS DEVELOPED BY PHYSIC LAB ARE USED IN HOSPITALS



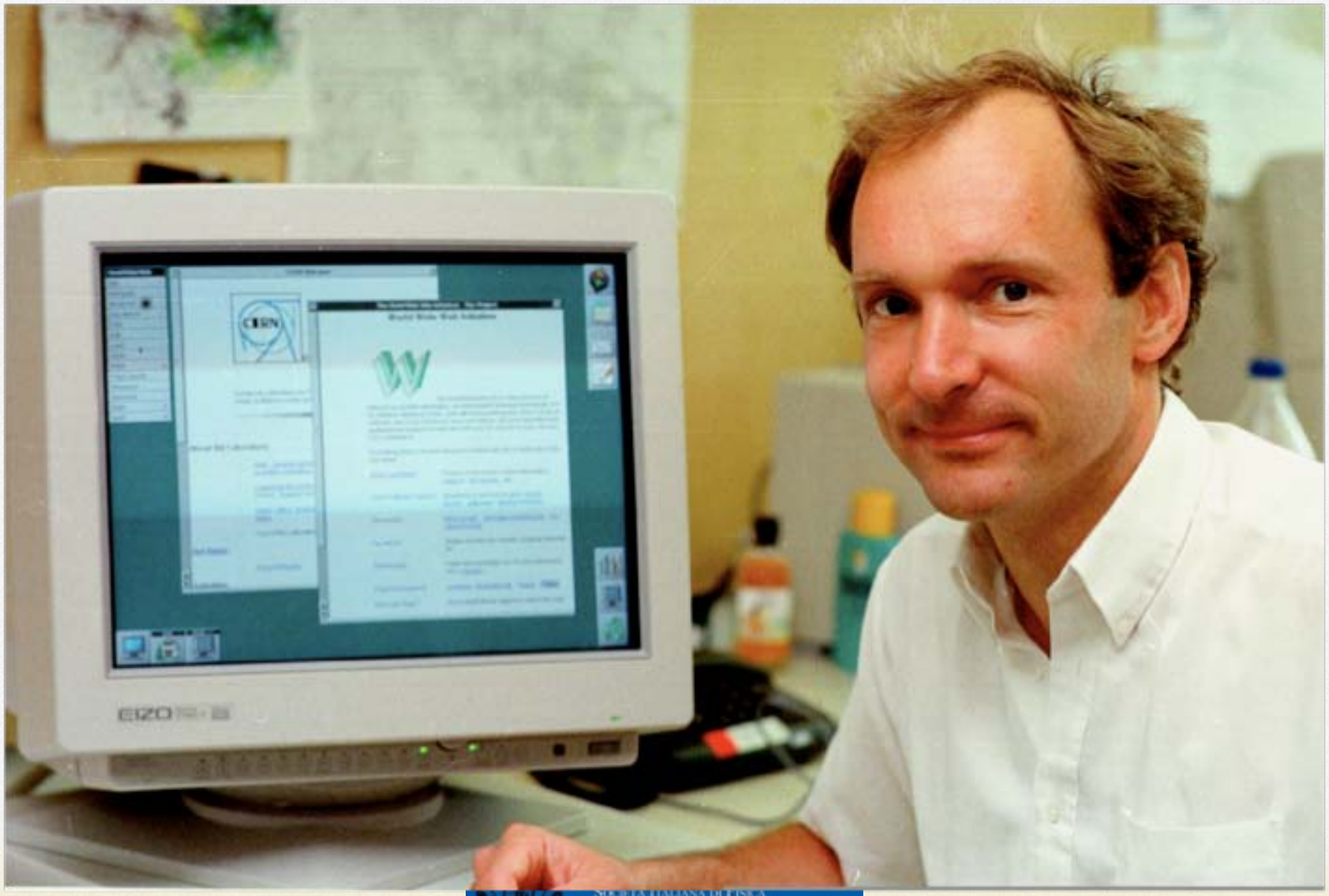
Hadrontherapy

9000 accelerators out of 170,000 in the world are used for medicine

DETECTORS DEVELOPED IN PHYSIC LABS ARE USED FOR MEDICAL IMAGING

PET (Positron Emission Tomography) allowing localisation of certain tumors uses F18 isotope produced in accelerators, antimatter and detectors developed by physics.

WHO DOES NOT KNOW THE WEB?



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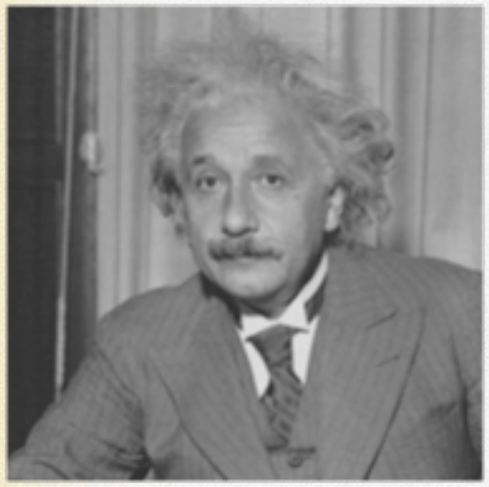

Relativity

Without relativity correction for time expansion the error would be tens of meters after 5 minutes of motion

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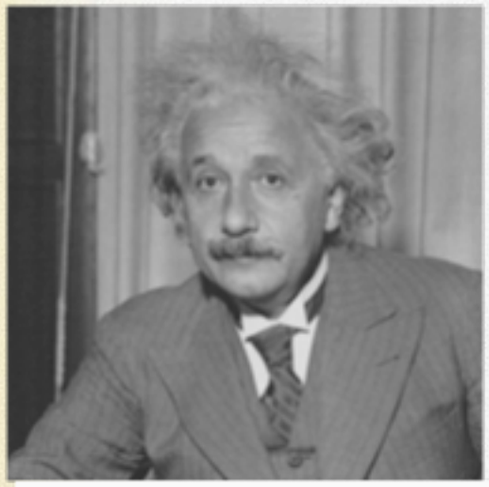

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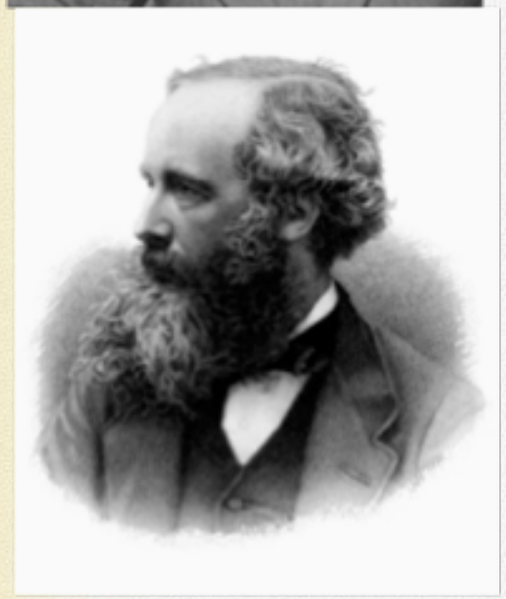

Electromagnetism

Portable phones use electromagnetic waves

THANKS FOR YOUR ATTENTION