Le futur de la physique aux collisionneurs au LPNHE

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Standard Model of

FUNDAMENTAL PARTICLES AND INTERACTIONS

The Standard Model is a quantum theory that summarizes our current knowledge of the physics of fundamental particles and fundamental interactions (interactions are manifested by forces and by decay rates of unstable particles).

FERMIONS

matter constituents
spin = 1/2, 3/2, 5/2, ...

Leptons spin = 1/2

Flavor	Mass GeV/c²	Electric charge
ν_L lightest neutrino*	$(0-0.13)\times10^{-9}$	0
e electron	0.000511	−1
ν_M middle neutrino*	$(0.009-0.13)\times10^{-9}$	0
μ muon	0.106	−1
ν_H heaviest neutrino*	$(0.04-0.14)\times10^{-9}$	0
τ tau	1.777	−1

Quarks spin = 1/2

Flavor	Approx. Mass GeV/c²	Electric charge
u up	0.002	2/3
d down	0.005	−1/3
c charm	1.3	2/3
s strange	0.1	−1/3
t top	173	2/3
b bottom	4.2	−1/3

*See the neutrino paragraph below.

Spin is the intrinsic angular momentum of particles. Spin is given in units of $\hbar$, which is the quantum unit of angular momentum where $\hbar = h/2\pi = 6.58\times10^{-25}$ GeV s $=1.05\times10^{-34}$ J s.

Electric charges are given in units of the proton's charge. In SI units the electric charge of the proton is 1.60×10^{-19} coulombs.

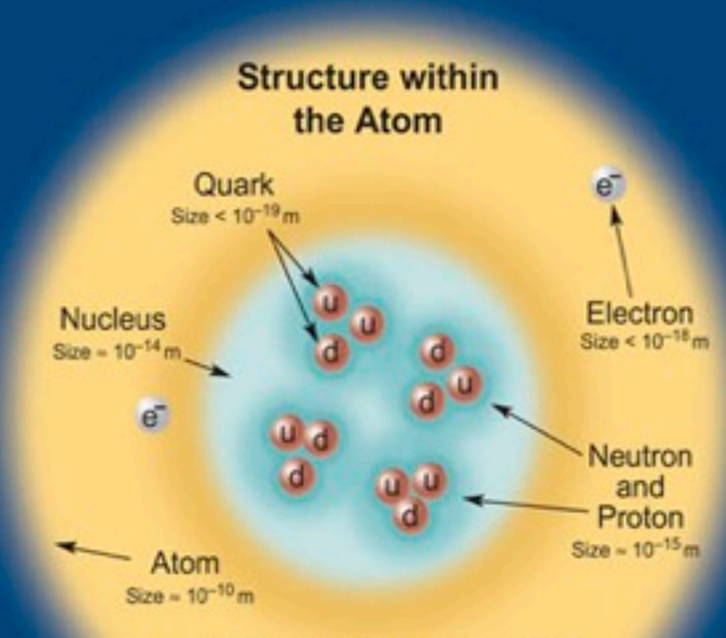
The energy unit of particle physics is the electronvolt (eV), the energy gained by one electron in crossing a potential difference of one volt. **Masses** are given in GeV/c² (remember $E = mc^2$) where 1 GeV = 10^9 eV $=1.60\times10^{-10}$ joule. The mass of the proton is 0.938 GeV/c² $= 1.67\times10^{-27}$ kg.

Neutrinos

Neutrinos are produced in the sun, supernovae, reactors, accelerator collisions, and many other processes. Any produced neutrino can be described as one of three neutrino flavor states ν_e, ν_μ, or ν_τ, labelled by the type of charged lepton associated with its production. Each is a defined quantum mixture of the three definite mass neutrinos ν_L, ν_M, and ν_H for which currently allowed mass ranges are shown in the table. Further exploration of the properties of neutrinos may yield powerful clues to puzzles about matter and antimatter and the evolution of stars and galaxy structures.

Matter and Antimatter

For every particle type there is a corresponding antiparticle type, denoted by a bar over the particle symbol (unless + or − charge is shown). Particle and antiparticle have identical mass and spin but opposite charges. Some electrically neutral bosons (e.g., Z^0, γ, and $\eta_c = c\bar{c}$ but not $K^0 = d\bar{s}$) are their own antiparticles.



If the proton and neutrons in this picture were 10 cm across, then the quarks and electrons would be less than 0.1 mm in size and the entire atom would be about 10 km across.

BOSONS

force carriers
spin = 0, 1, 2, ...

Unified Electroweak spin = 1

Name	Mass GeV/c²	Electric charge
γ photon	0	0
W^-	80.39	−1
W^+ (W bosons)	80.39	+1
Z^0 Z boson	91.188	0

Strong (color) spin = 1

Name	Mass GeV/c²	Electric charge
g gluon	0	0

Color Charge

Only quarks and gluons carry "strong charge" (also called "color charge") and can have strong interactions. Each quark carries three types of color charge. These charges have nothing to do with the colors of visible light. Just as electrically-charged particles interact by exchanging photons, in strong interactions, color-charged particles interact by exchanging gluons.

Quarks Confined in Mesons and Baryons

Quarks and gluons cannot be isolated – they are confined in color-neutral particles called **hadrons**. This confinement (binding) results from multiple exchanges of gluons among the color-charged constituents. As color-charged particles (quarks and gluons) move apart, the energy in the color-force field between them increases. This energy eventually is converted into additional quark-antiquark pairs. The quarks and antiquarks then combine into hadrons; these are the particles seen to emerge.

Two types of hadrons have been observed in nature **mesons** $q\bar{q}$ and **baryons** qqq. Among the many types of baryons observed are the proton (uud), antiproton ($\bar{u}\bar{u}\bar{d}$), neutron (udd), lambda Λ (uds), and omega Ω^- (sss). Quark charges add in such a way as to make the proton have charge 1 and the neutron charge 0. Among the many types of mesons are the pion π^+ ($u\bar{d}$), kaon K^- ($s\bar{u}$), B^0 ($d\bar{b}$), and η_c ($c\bar{c}$). Their charges are +1, −1, 0, 0 respectively.

Properties of the Interactions

The strengths of the interactions (forces) are shown relative to the strength of the electromagnetic force for two u quarks separated by the specified distances.

Property		Gravitational Interaction	Weak Interaction (Electroweak)	Electromagnetic Interaction	Strong Interaction
Acts on:		Mass – Energy	Flavor	Electric Charge	Color Charge
Particles experiencing:		All	Quarks, Leptons	Electrically Charged	Quarks, Gluons
Particles mediating:		Graviton (not yet observed)	W^+ W^- Z^0	γ	Gluons
Strength at	10^{-18} m	10^{-41}	0.8	1	25
	3×10^{-17} m	10^{-41}	10^{-4}	1	60

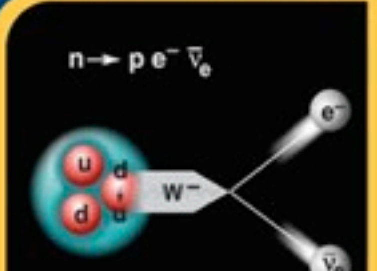
Visit the award-winning web feature *The Particle Adventure* at

ParticleAdventure.org

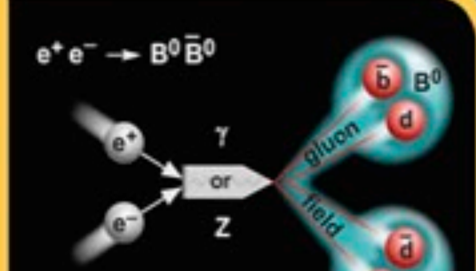
This chart has been made possible by the generous support of:
U.S. Department of Energy
U.S. National Science Foundation
Lawrence Berkeley National Laboratory

Particle Processes

These diagrams are an artist's conception. Blue-green shaded areas represent the cloud of gluons.



A free neutron (udd) decays to a proton (uud), an electron, and an antineutrino via a virtual (mediating) W boson. This is neutron β (beta) decay.



An electron and positron (antielectron) colliding at high energy can annihilate to produce $\bar{B}^0$ and B^0 mesons via a virtual Z boson or a virtual photon.

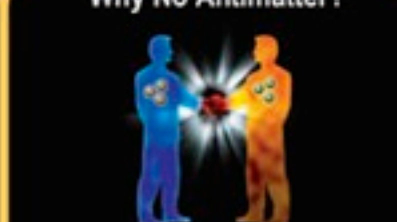
Unsolved Mysteries

Driven by new puzzles in our understanding of the physical world, particle physicists are following paths to new wonders and startling discoveries. Experiments may even find extra dimensions of space, mini-black holes, and/or evidence of string theory.

Universe Accelerating?

The expansion of the universe appears to be accelerating. Is this due to Einstein's Cosmological Constant? If not, will experiments reveal a new force of nature or even extra (hidden) dimensions of space?

Why No Antimatter?



Matter and antimatter were created in the Big Bang. Why do we now see only matter except for the tiny amounts of antimatter that we make in the lab and observe in cosmic rays?

Dark Matter?

Invisible forms of matter make up much of the mass observed in galaxies and clusters of galaxies. Does this dark matter consist of new types of particles that interact very weakly with ordinary matter?

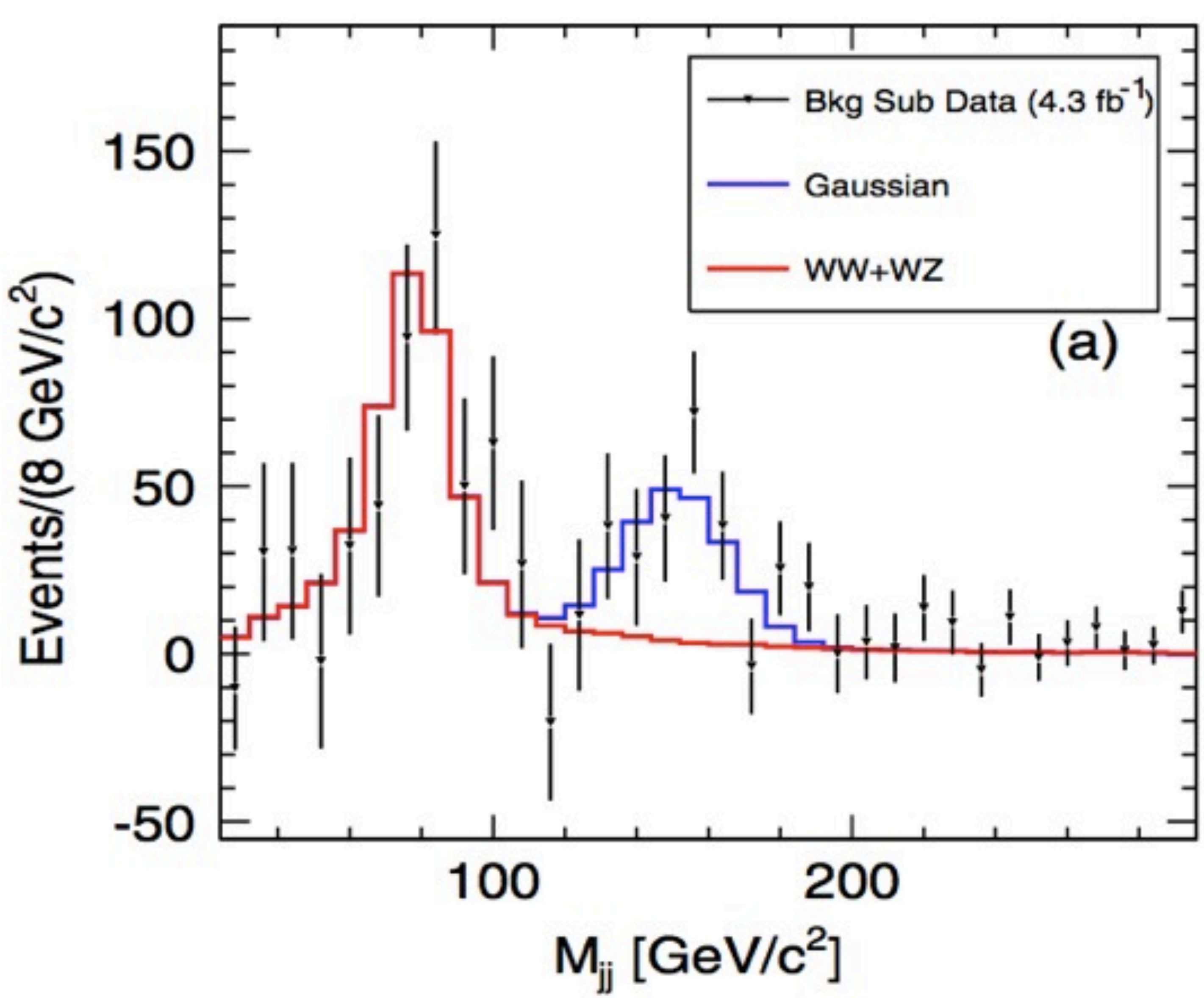
Origin of Mass?

In the Standard Model, for fundamental particles to have masses, there must exist a particle called the Higgs boson. Will it be discovered soon? Is supersymmetry theory correct in predicting more than one type of Higgs?

Quelques réponses juste derrière le coin?

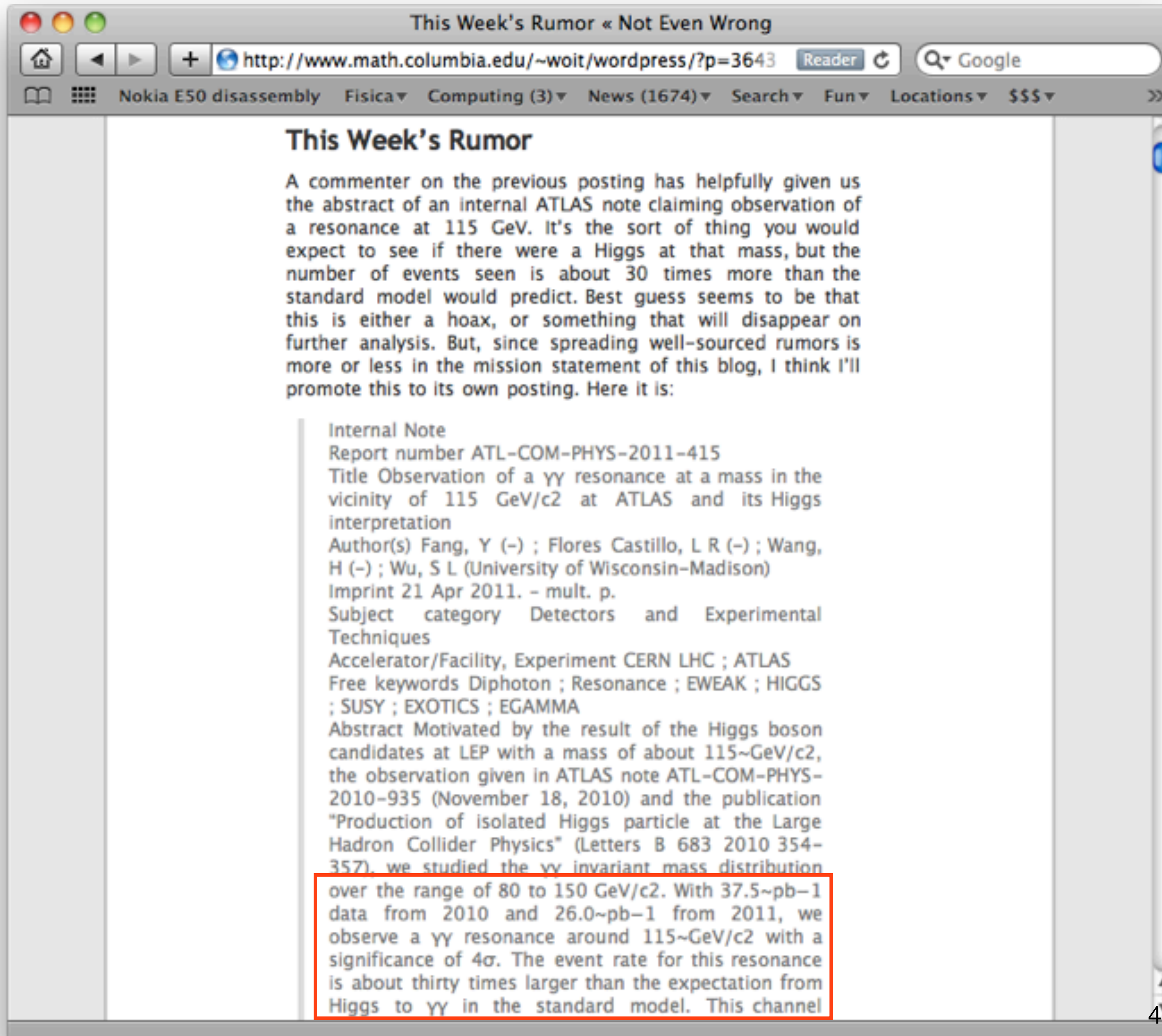
PRL **106**, 171801 (2011) PHYSICAL REVIEW LETTERS week ending 29 APRIL 2011

Invariant Mass Distribution of Jet Pairs Produced in Association with a *W* Boson in $p\bar{p}$ Collisions at $\sqrt{s} = 1.96$ TeV



Certains (malheureusement) pas encore ...

"I think I've found the Higgs boson!"



This Week's Rumor « Not Even Wrong

http://www.math.columbia.edu/~woit/wordpress/?p=3643

Nokia E50 disassembly   Fisica ▾   Computing (3) ▾   News (1674) ▾   Search ▾   Fun ▾   Locations ▾ $$$ ▾

This Week's Rumor

A commenter on the previous posting has helpfully given us the abstract of an internal ATLAS note claiming observation of a resonance at 115 GeV. It's the sort of thing you would expect to see if there were a Higgs at that mass, but the number of events seen is about 30 times more than the standard model would predict. Best guess seems to be that this is either a hoax, or something that will disappear on further analysis. But, since spreading well-sourced rumors is more or less in the mission statement of this blog, I think I'll promote this to its own posting. Here it is:

> Internal Note
> Report number ATL-COM-PHYS-2011-415
> Title Observation of a $\gamma\gamma$ resonance at a mass in the vicinity of 115 GeV/c2 at ATLAS and its Higgs interpretation
> Author(s) Fang, Y (-) ; Flores Castillo, L R (-) ; Wang, H (-) ; Wu, S L (University of Wisconsin-Madison)
> Imprint 21 Apr 2011. - mult. p.
> Subject category Detectors and Experimental Techniques
> Accelerator/Facility, Experiment CERN LHC ; ATLAS
> Free keywords Diphoton ; Resonance ; EWEAK ; HIGGS ; SUSY ; EXOTICS ; EGAMMA
> Abstract Motivated by the result of the Higgs boson candidates at LEP with a mass of about 115~GeV/c2, the observation given in ATLAS note ATL-COM-PHYS-2010-935 (November 18, 2010) and the publication "Production of isolated Higgs particle at the Large Hadron Collider Physics" (Letters B 683 2010 354-357), we studied the $\gamma\gamma$ invariant mass distribution over the range of 80 to 150 GeV/c2. With 37.5~pb−1 data from 2010 and 26.0~pb−1 from 2011, we observe a $\gamma\gamma$ resonance around 115~GeV/c2 with a significance of 4σ. The event rate for this resonance is about thirty times larger than the expectation from Higgs to $\gamma\gamma$ in the standard model. This channel

Quels collisionneurs pour l’avenir?

IL NUOVO CIMENTO   VOL. 105 B, N. 1   Gennaio 1990

Particle Accelerators in High Earth Orbit.

R. VARLEY
Graduate Center, City University of New York - New York, N.Y.

R. G. HOHLFELD and G. SANDRI
Boston University Center for Space Physics & College of Engineering - Boston, MA

R. LOVELACE
Cornell University, Department of Applied & Engineering Physics - Ithaca, N.Y.

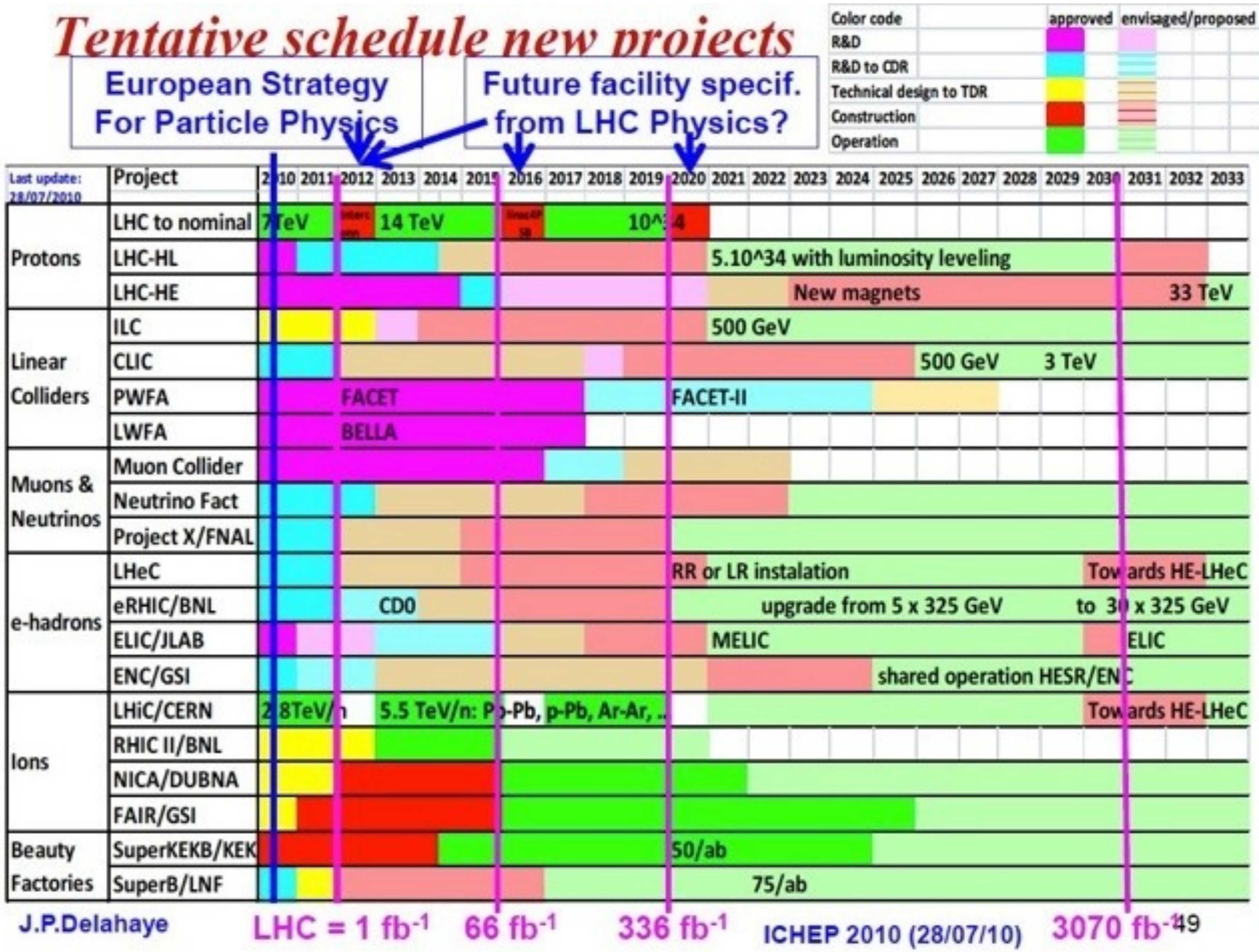
C. CERCIGNANI
Politecnico di Milano - Milano

(ricevuto il 2 Maggio 1989)

Summary. — Physical constraints on the design of particle accelerators suggest that accelerators with energies in excess of 100 TeV should be constructed in space. Numerous advantages for the design of such an accelerator obtain from its location in space, where microgravity limits stress on its structure, and high vacuum and cryogenic temperatures are easily available. Major issues relevant to the design and cost of such an accelerator in space are identified in this paper.

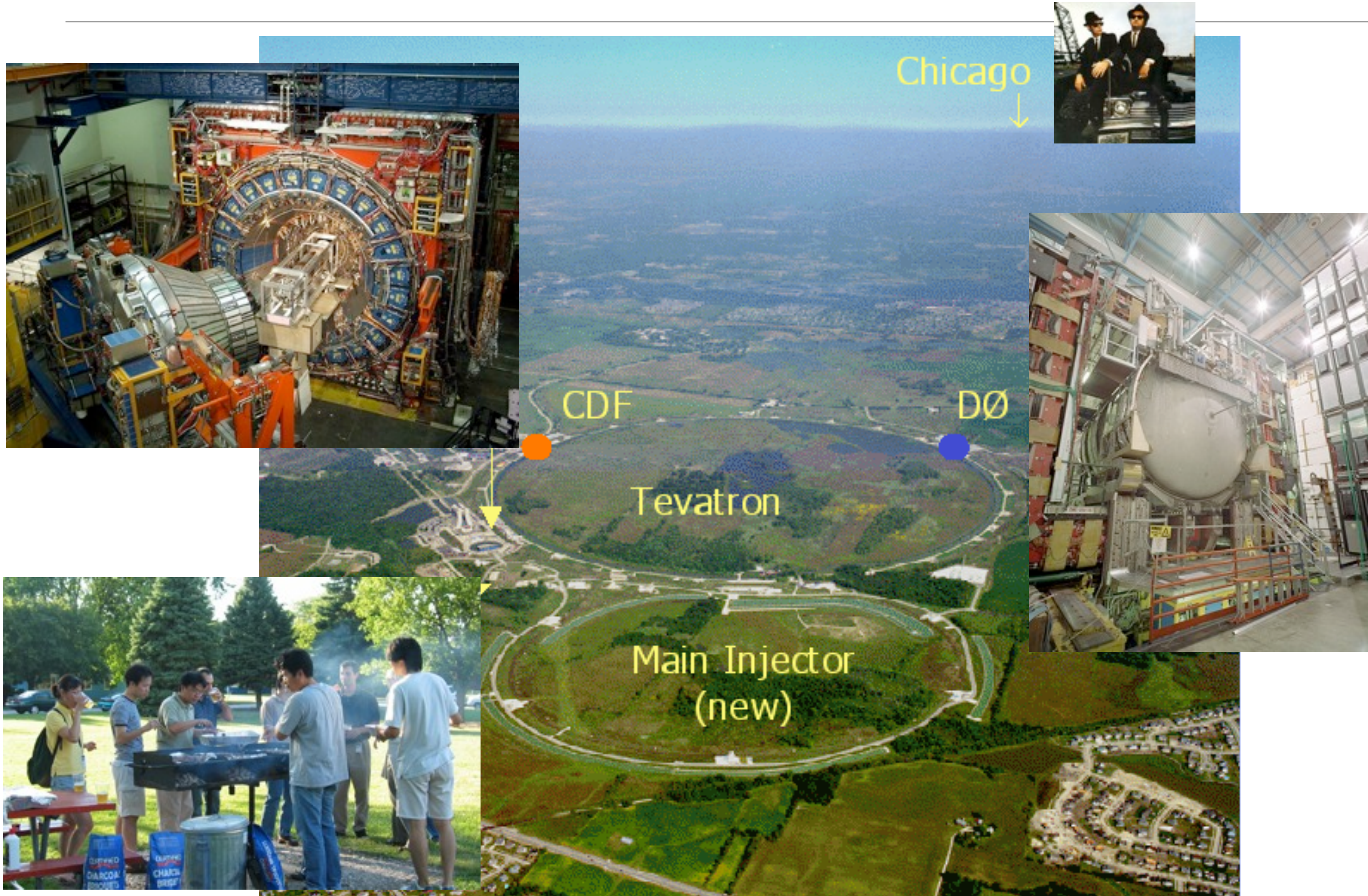
PACS 06.70 – General instrumentation.
PACS 29.15 – Electrostatic, collective, and linear particle accelerators.

Beaucoup (au moins sur papier) de projets + réalistes

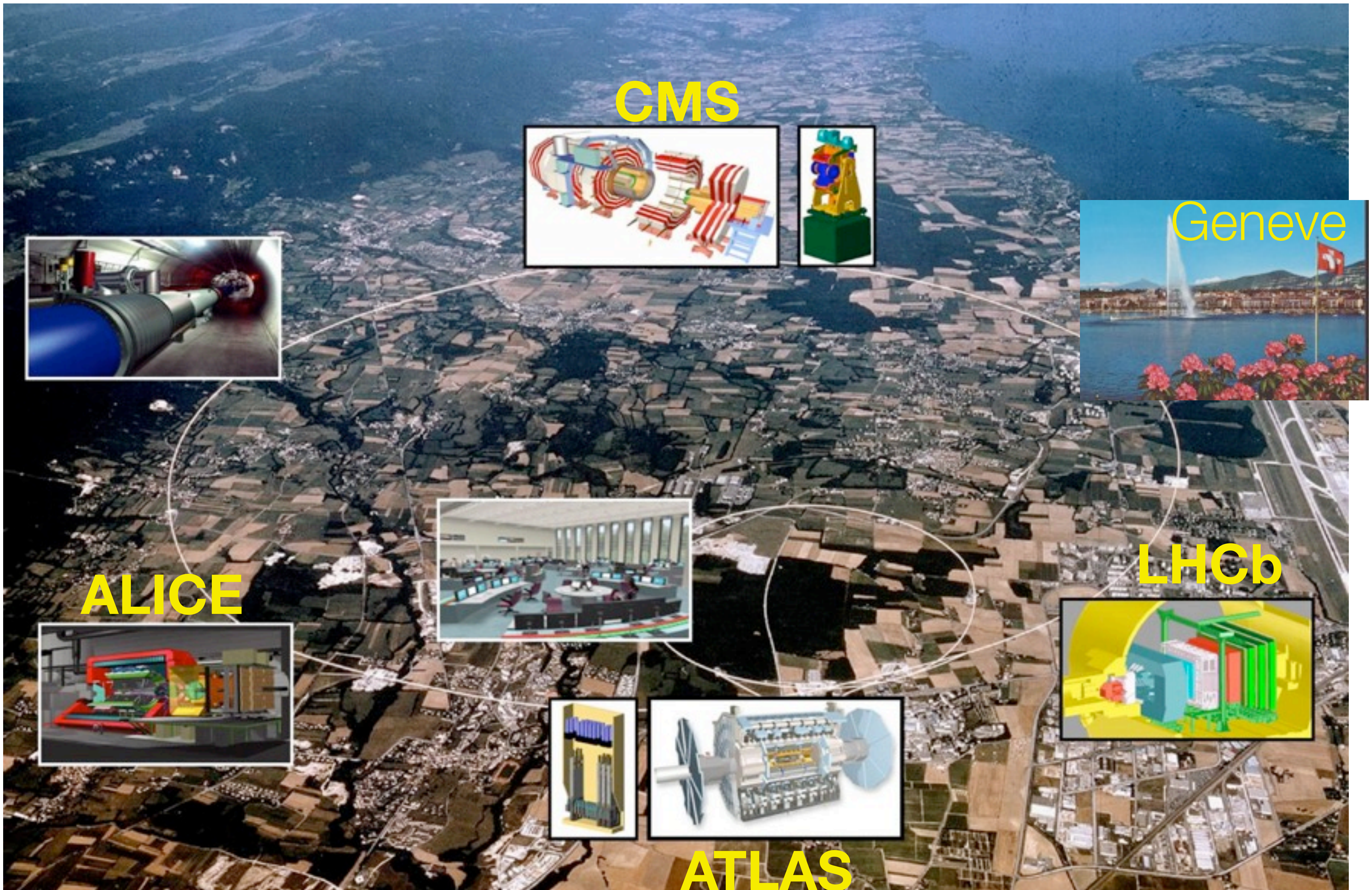


Tevatron

- prise de données va terminer cette année..
- ... mais encore quelques années d'analyse intense

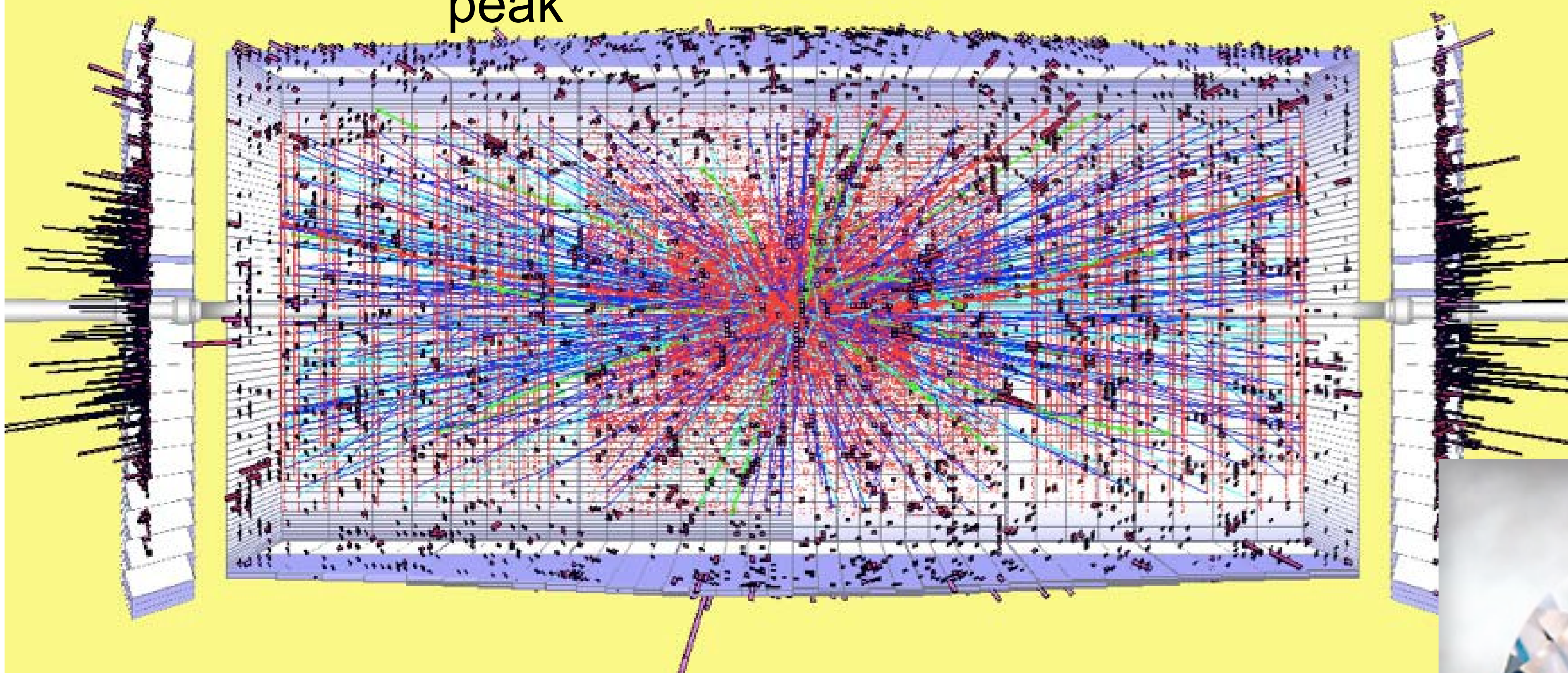


LHC ...



... et son évolution sLHC (s=”super”)

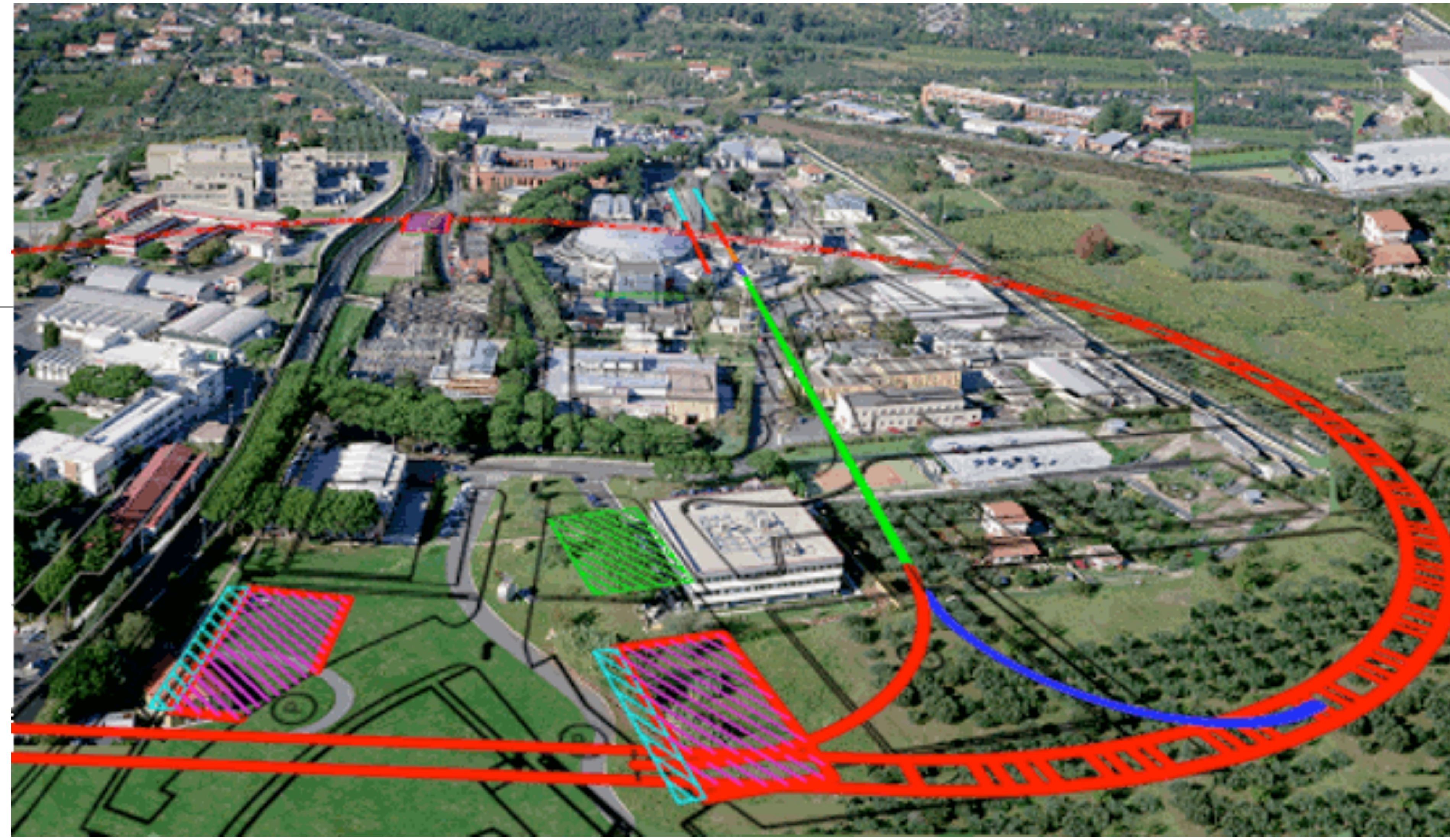
$L_{peak} \sim 1x10^{35}$ cm^{-2} s^{-1}



100 evts / BC   12.5 ns spacin

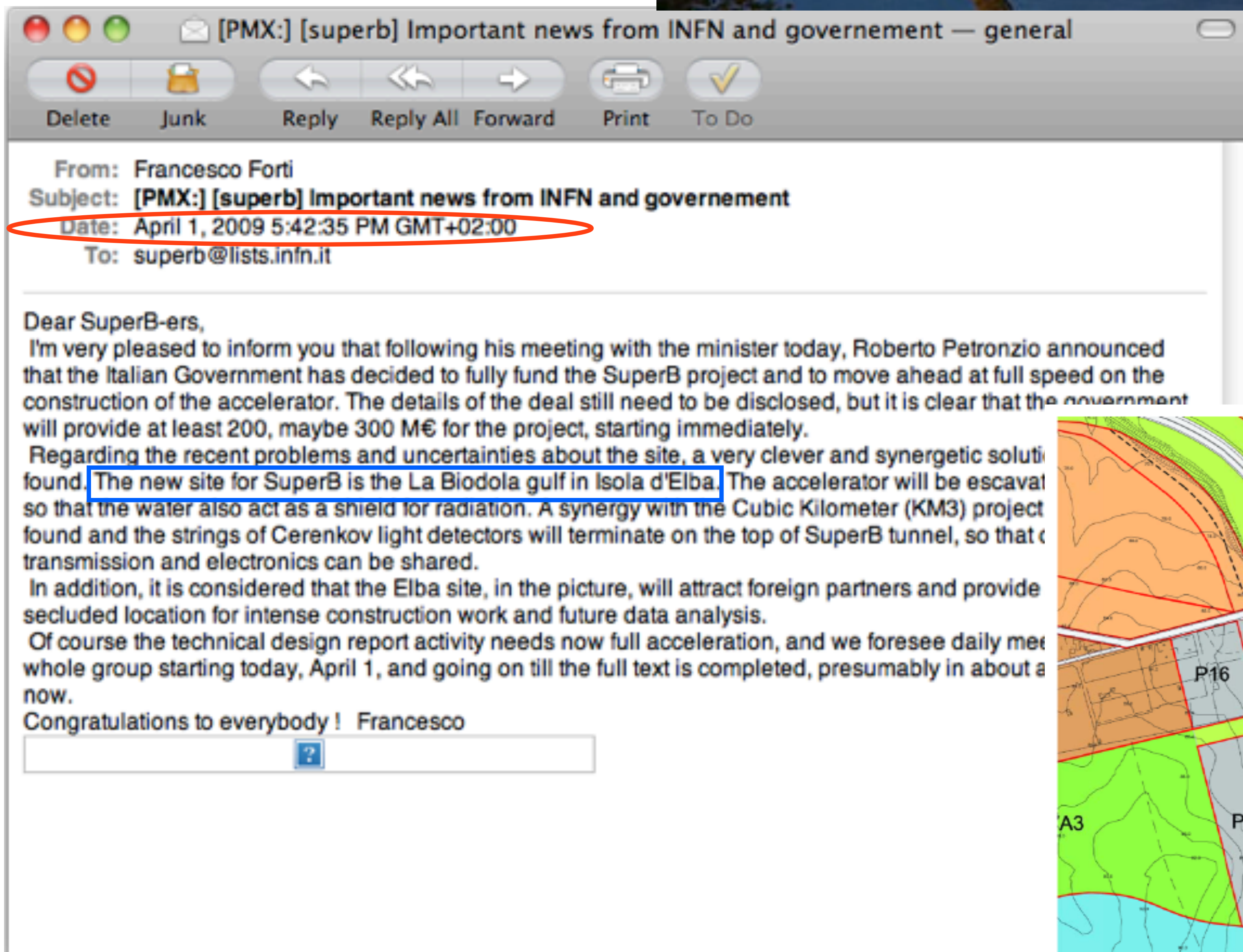
- ameliorations technologiques/nouveaux matériaux (diamants?)

SuperB



- collisionneur e+e- (tres haute intensité) proposé a partir de 2004-2005
- coût ~ O(500Meuro)
  - partie importante des fonds alloues par le gouvernement italien (?)
- 1ere réunion officielle de la collaboration SuperB en in June 2011
- pourrait prendre des données depuis quelques années in 2021

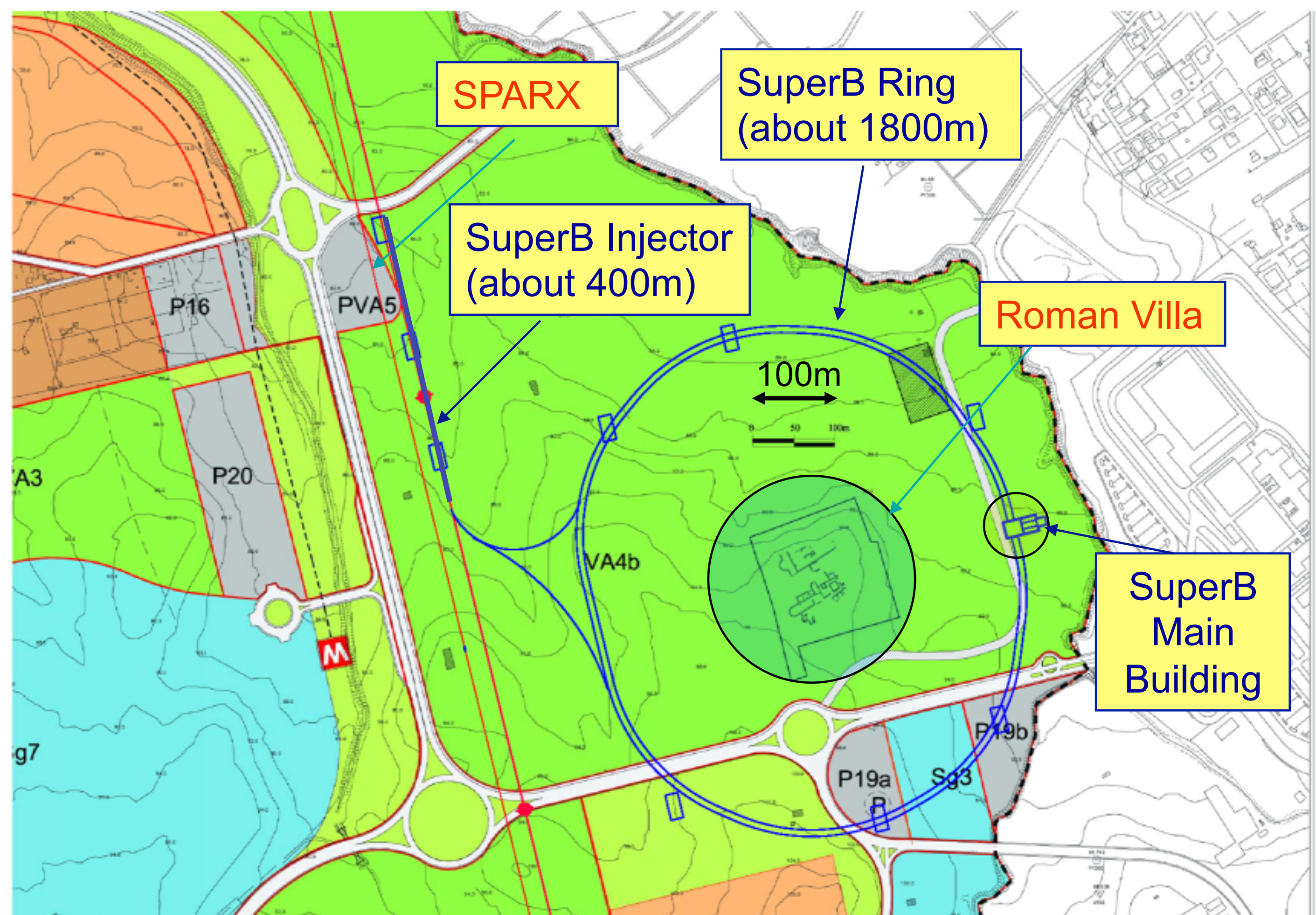
SuperB: ou?


[PMX:] [superb] Important news from INFN and governement — general

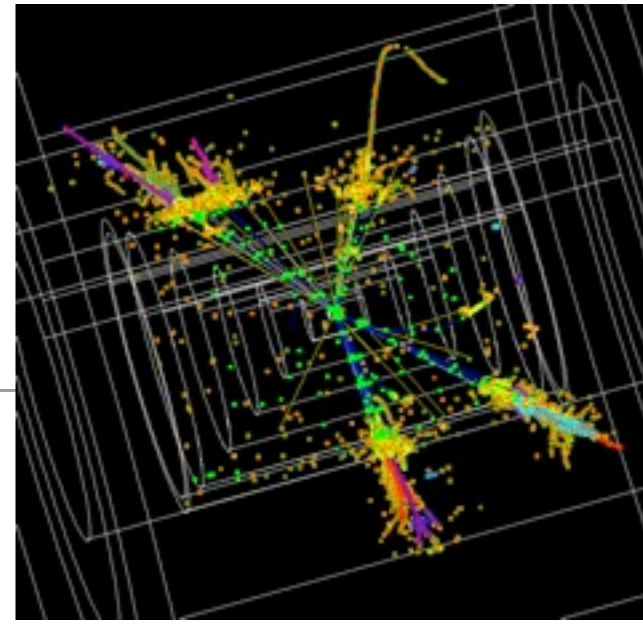
Delete Junk Reply Reply All Forward Print To Do

From: Francesco Forti
Subject: **[PMX:] [superb] Important news from INFN and governement**
Date: April 1, 2009 5:42:35 PM GMT+02:00
To: superb@lists.infn.it

Dear SuperB-ers,
I'm very pleased to inform you that following his meeting with the minister today, Roberto Petronzio announced that the Italian Government has decided to fully fund the SuperB project and to move ahead at full speed on the construction of the accelerator. The details of the deal still need to be disclosed, but it is clear that the government will provide at least 200, maybe 300 M€ for the project, starting immediately.
Regarding the recent problems and uncertainties about the site, a very clever and synergetic soluti found. The new site for SuperB is the La Biodola gulf in Isola d'Elba. The accelerator will be escavat so that the water also act as a shield for radiation. A synergy with the Cubic Kilometer (KM3) project found and the strings of Cerenkov light detectors will terminate on the top of SuperB tunnel, so that transmission and electronics can be shared.
In addition, it is considered that the Elba site, in the picture, will attract foreign partners and provide secluded location for intense construction work and future data analysis.
Of course the technical design report activity needs now full acceleration, and we foresee daily mee whole group starting today, April 1, and going on till the full text is completed, presumably in about a now.
Congratulations to everybody ! Francesco



Linear Collider



- quelques victimes..

JLC

Electron-Positron Linear Collider Project

NLC

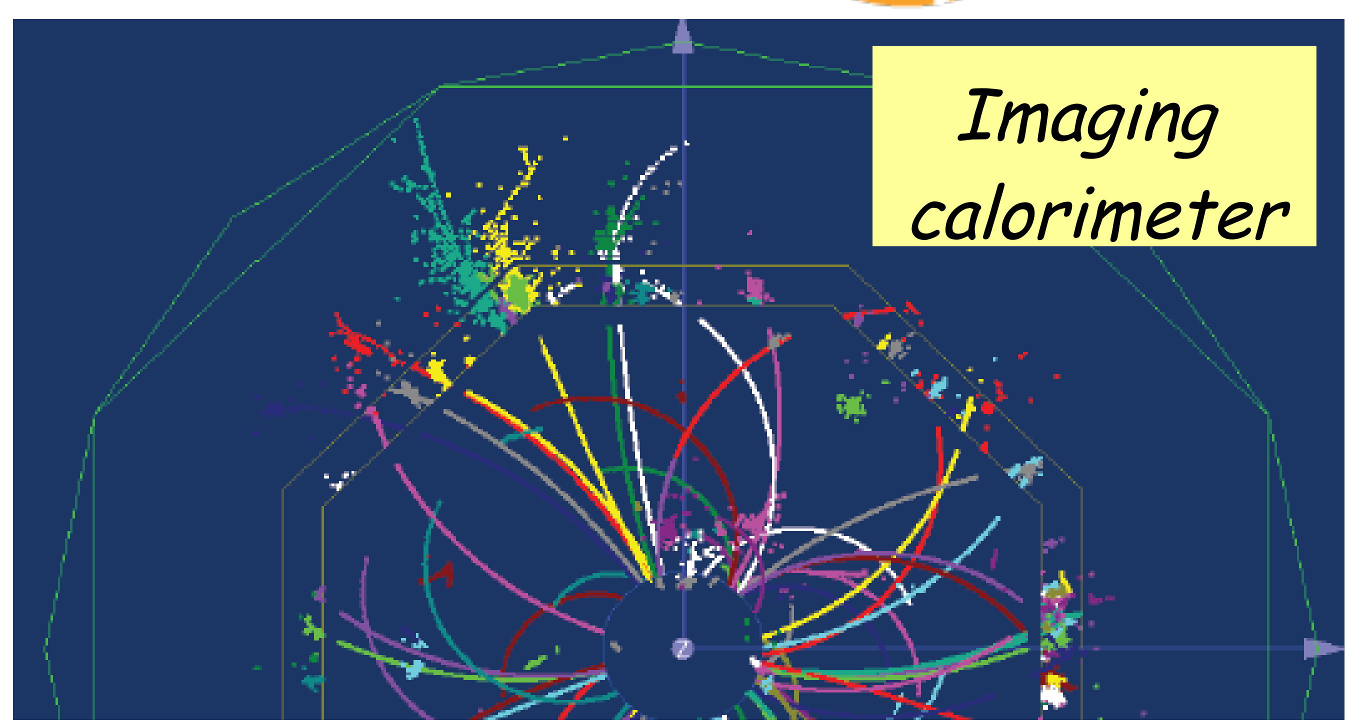
- quelques survivants...

ilc

clic

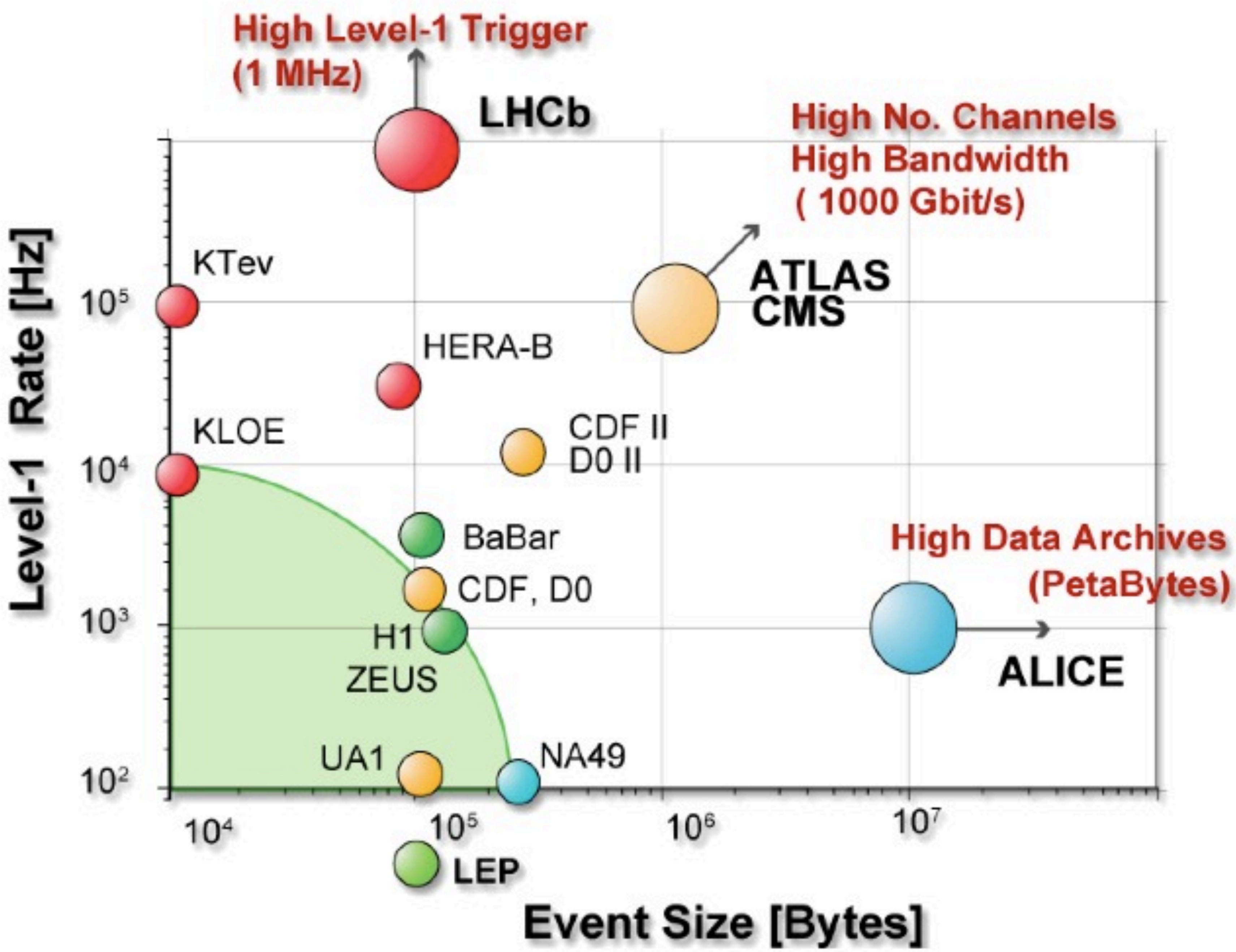
    - qui va gagner à la fin?

- intense R&D dans le futur...



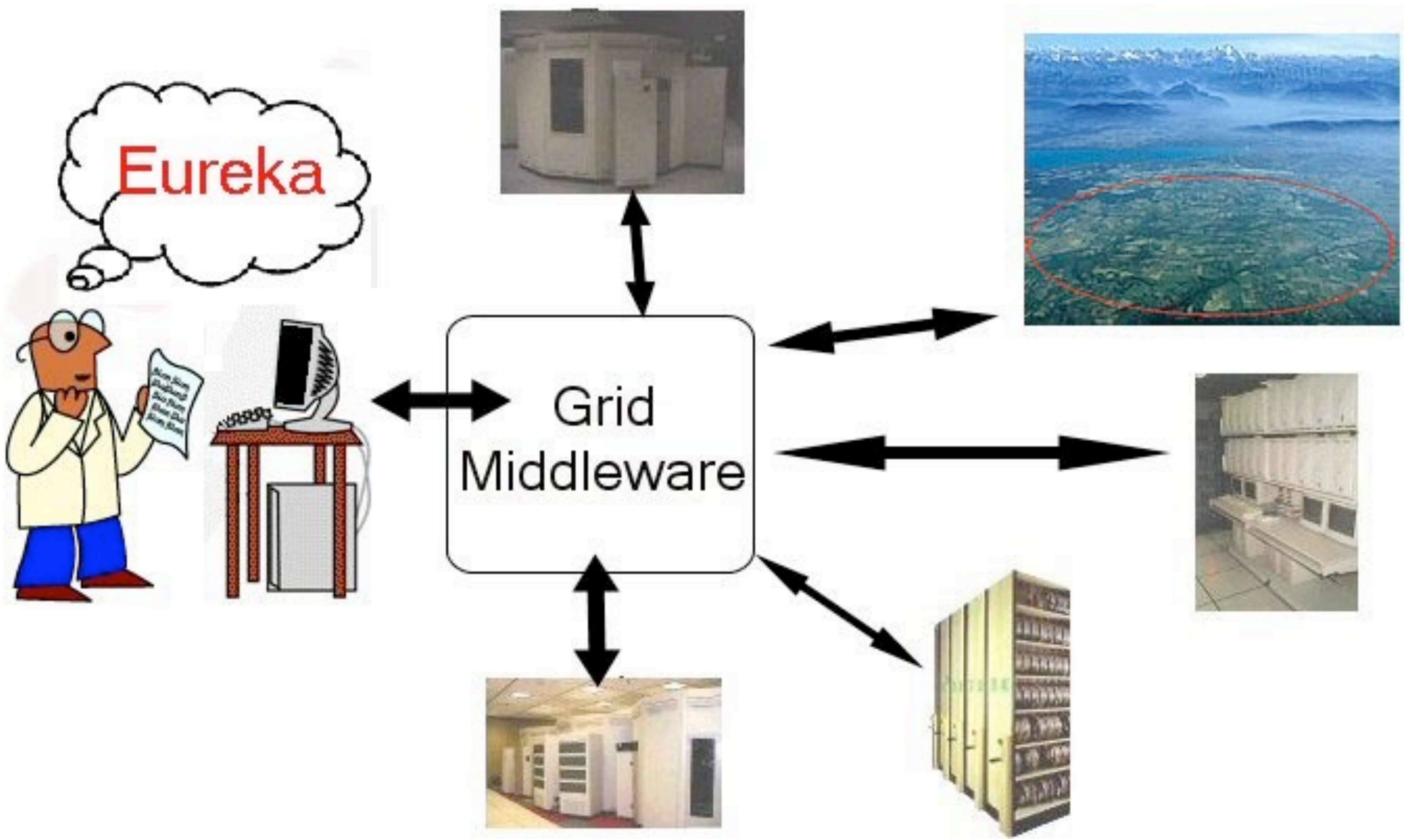
L'avenir de l'analyse des données: GRID?

- Lots de données de plus en plus grands nécessitent processeurs de plus en plus puissants et beaucoup + espace de stockage => distributed computing



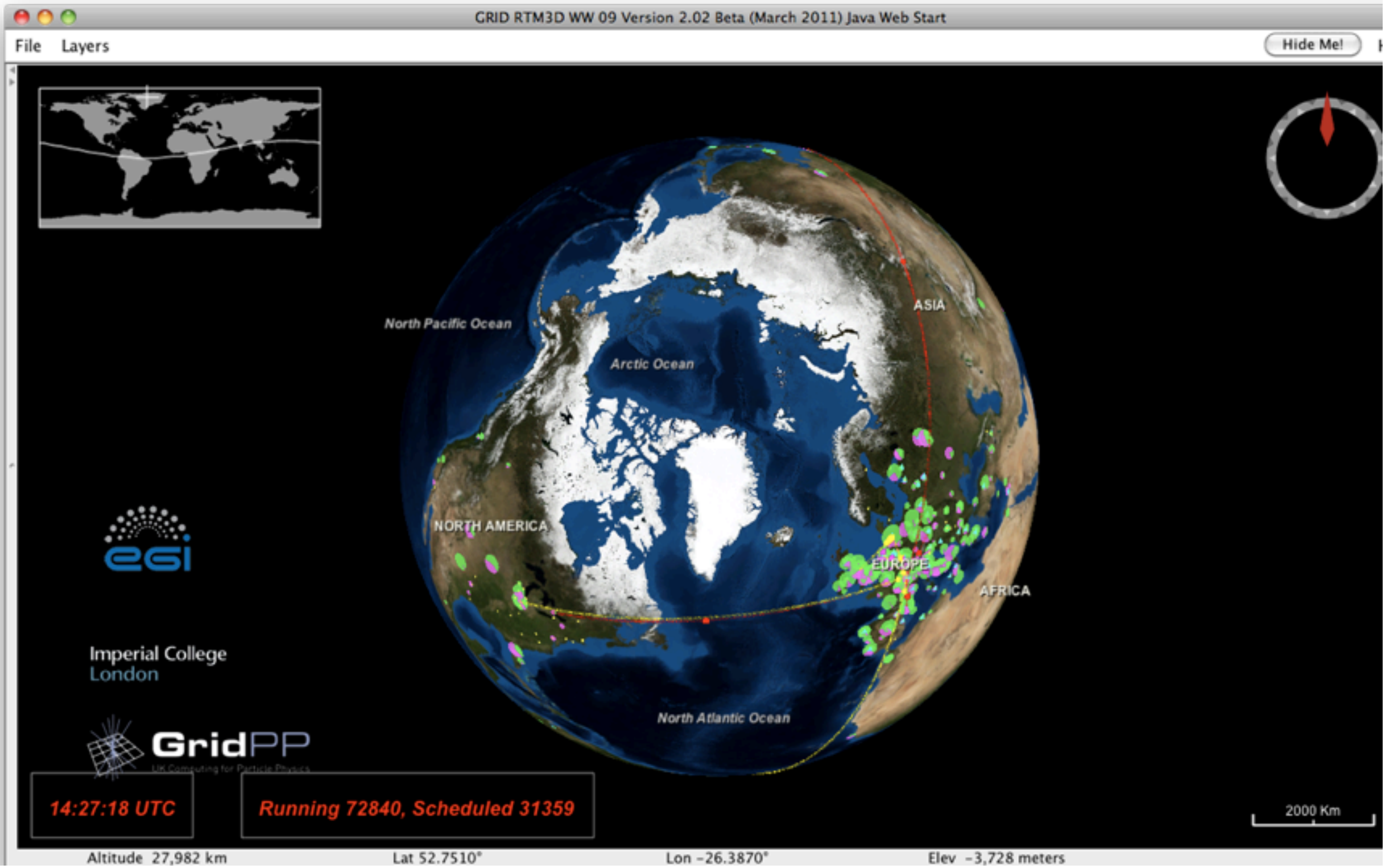
L’avenir de l’analyse des données: GRID?

- Analyse distribuée raisonnablement simple et efficace avec l’infrastructure de la grille

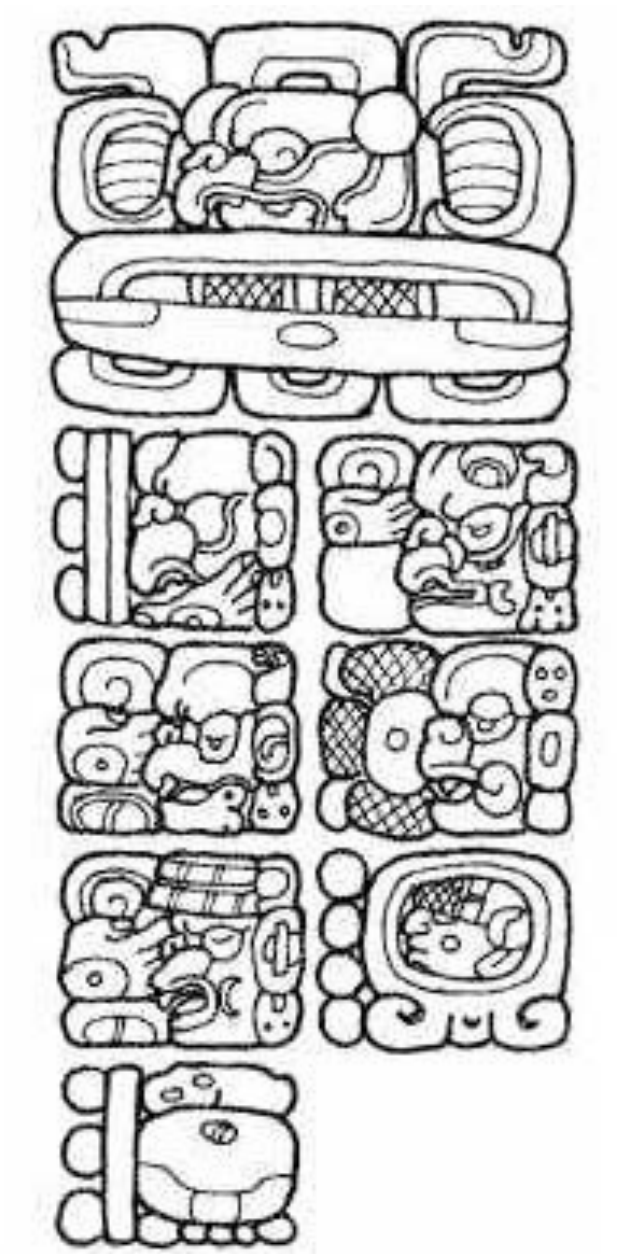


Encore plus de points verts à l'avenir ...

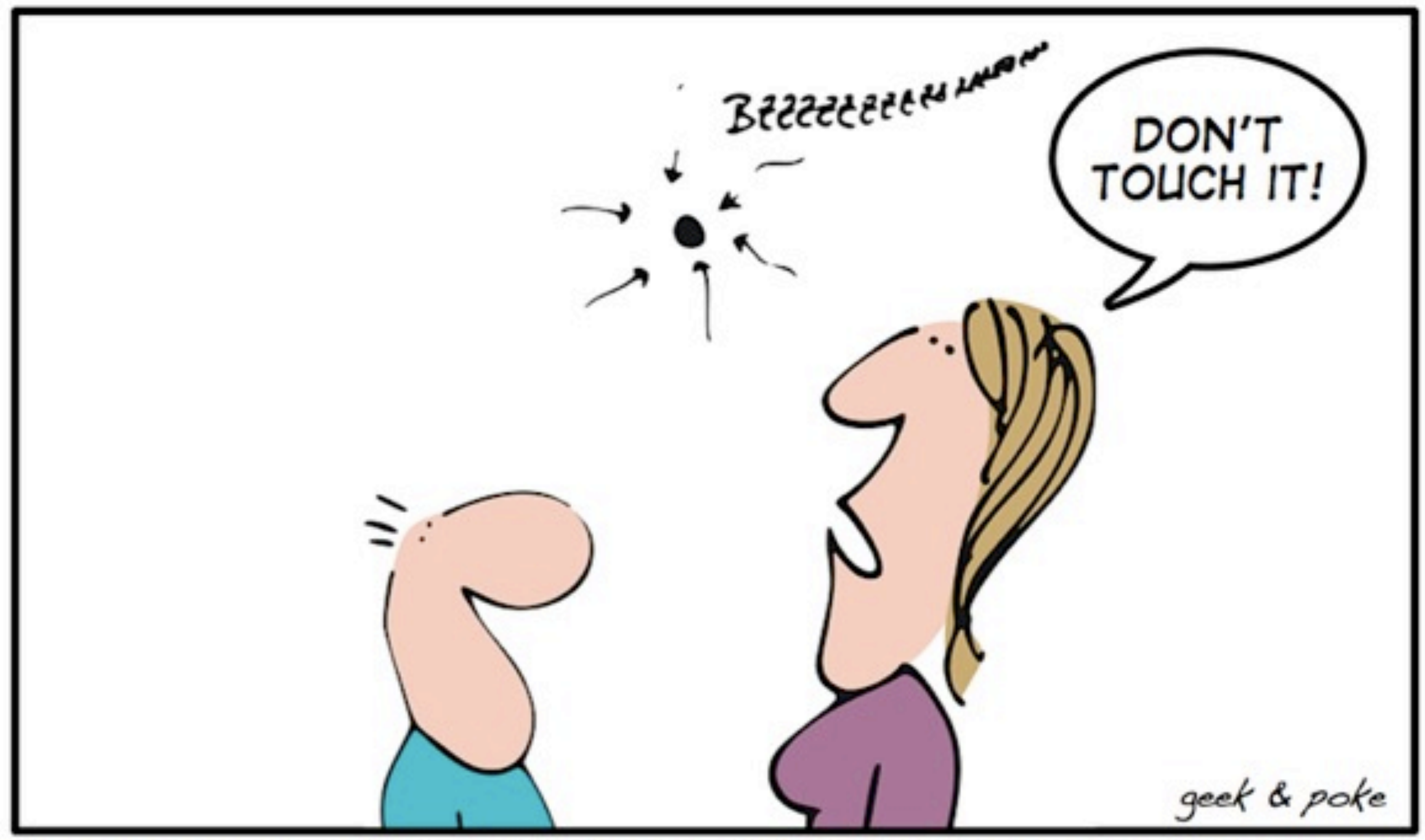
- ... pas seulement pour l'analyse des données du LHC



En espérant vous revoir en 2021...



August 13, 3114 BC,
day 'zero' of the Maya calendar.
This reads 13 Baktun, 0 Katun,
0 Tun, 0 Uinal, 0 Kin, 4-Ahau 8-Cumku.



NOW THAT THE LARGE HADRON COLLIDER HAS STARTED WE CAN WATCH THE FIRST BLACK HOLES HANGING AROUND IN THE WILD

... je vous remercie!

Je vous demande pardon pour mon français macaronique!