PROCEEDINGS OF SCIENCE

Summary Talk

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This paper will present some necessarily personally biased highlights of the ICHEP 2010 Conference, accompanied by a vision of the field of High Energy Physics.

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[1] Speaker

1. Introduction

This conference was marked by a richness of presentations made by young talented participants evidencing the vitality of the field, by the firsts results of the LHC showing that High Energy Physics is entering a new era and by a vibrant address from the President of the French Republic, Nicolas Sarkozy demonstrating the interest for our field at the highest political level.

2.Vitality of the field

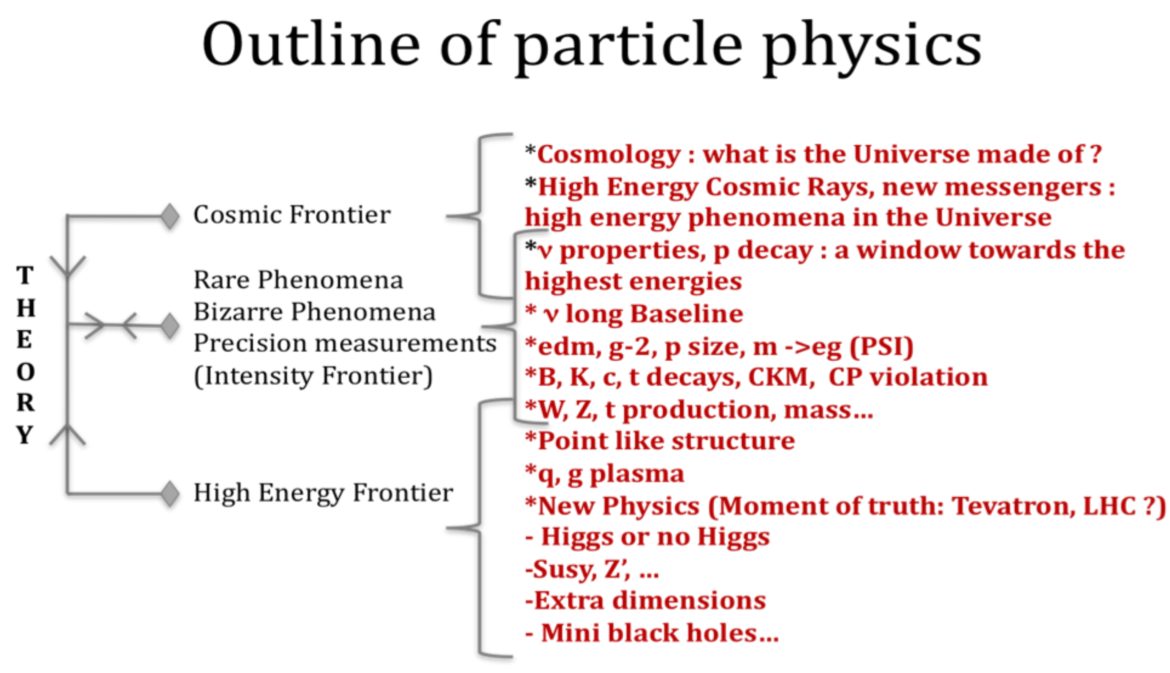
It is commonly admitted that Particle Physics is progressing along 3 main avenues

-The Cosmic frontier including cosmology, high-energy new messengers on the Universe, neutrino properties and proton decay

- The Intensity Frontier including Neutrino Physics and rare Phenomena

- The High Energy Frontier with presently the results of the Tevatron in Fermilab and the first results of the LHC. In the future LHC will dominate this area while preparing for a future lepton collider.

This is shown in the figure below



Many results were presented at the edge of these three frontiers. They are briefly reviewed in the next three sections.

2.1 The Cosmic Frontier

This is now the so-called domain of Astroparticle Physics.

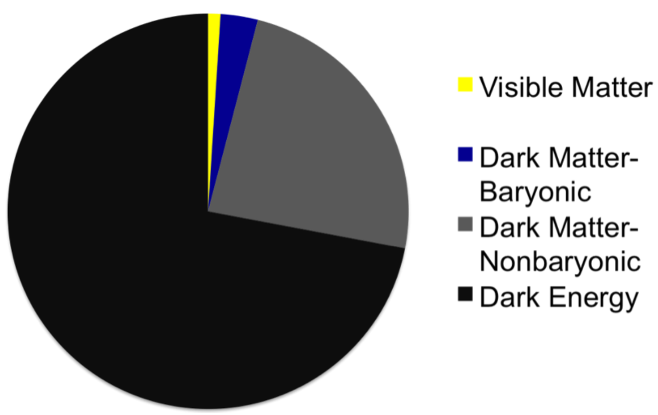
Astroparticle Physics stands on the threshold of a new era of discovery. The scientific scope of the field extends over vast distance scales – from the realm of elementary particles to the outer reaches of the observable universe – marking the intersection of cosmology, astrophysics, particle physics and nuclear physics. Major research challenges fall within the compass of the Astroparticle Physics, notably, understanding the properties of dark matter and dark energy, exploring the potential unification of the fundamental forces of nature or studying the highest energy cosmic phenomena. Researchers are addressing these challenges by studying some of the rarest elementary particle interactions/decays in underground laboratories, or observing the most energetic phenomena in the Universe via the detection of high-energy cosmic rays and gravitational waves. They are investigating the limits of the stability of the proton, and exploring the cosmological and astrophysical role of neutrinos. A new generation of proposed instruments (located underground, underwater, on the Earth's surface, in the atmosphere, and in space) promises to deliver important results based on enhanced sensitivity and resolution.

The domain can be characterized by the 3 main questions which develop in global effort:

1. What is the Universe made of?
   - 1.a Dark matter
   - 1.b Dark energy

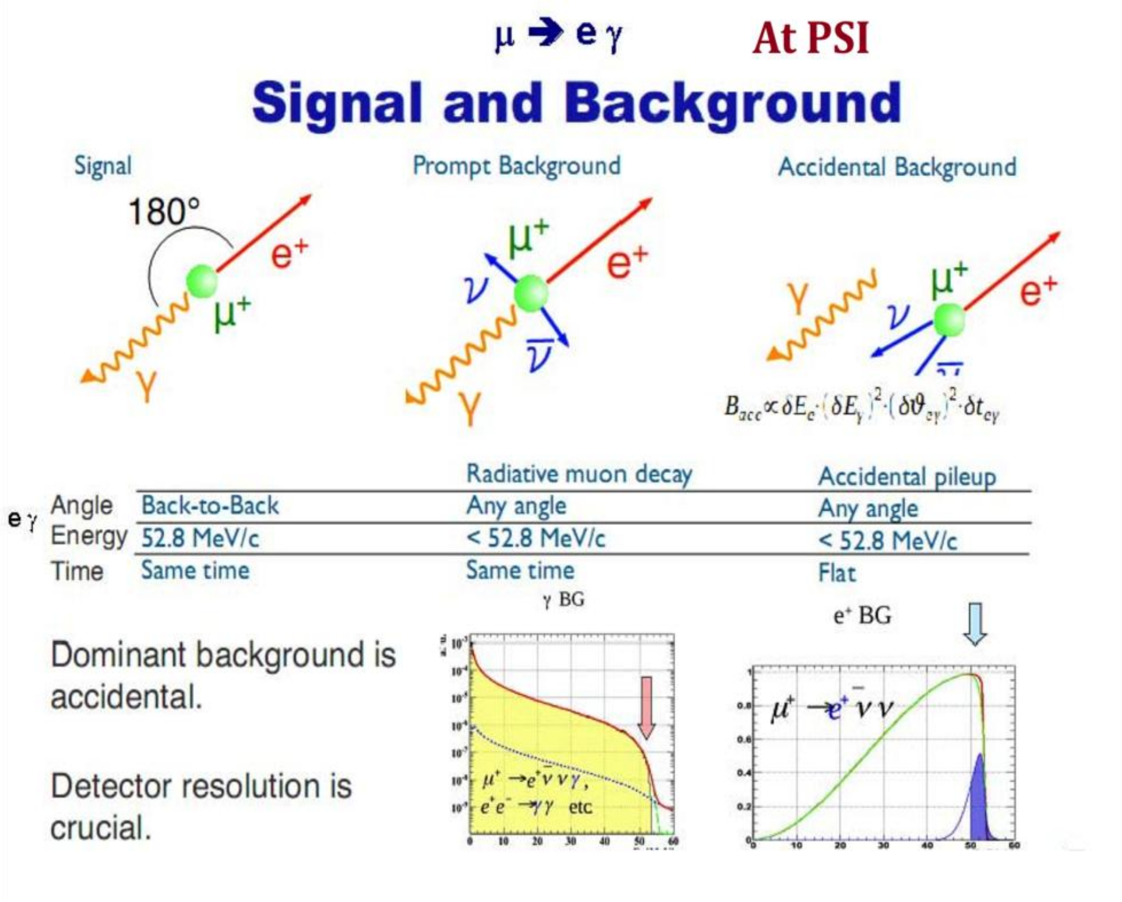
2. What is the role of high-energy phenomena in the Universe?
   - 2.a High-energy messengers: charged particles, gamma rays, neutrinos
   - 2.b Gravitational waves

3. What is the nature of matter and interactions at the highest energies?
   - 3.a Neutrino mass
   - 3.b Proton decay and neutrino mixing



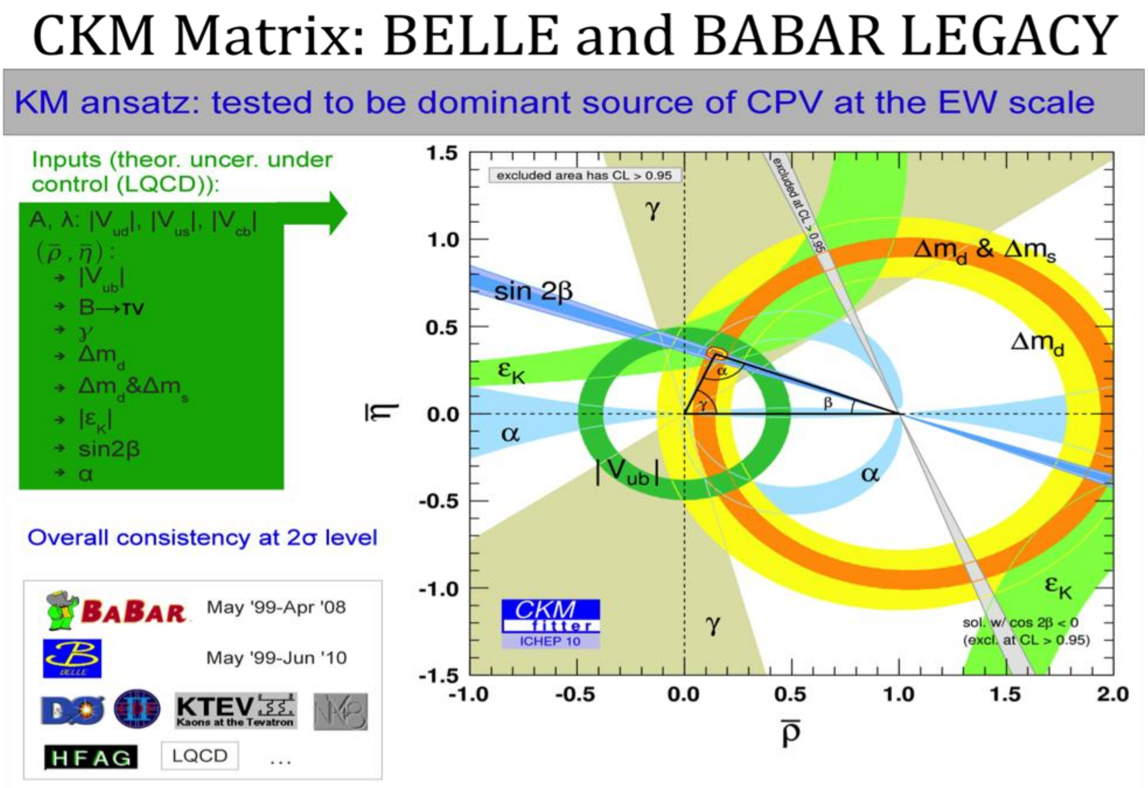
2.2 The intensity Frontier

Particle physics experiments at the Intensity Frontier explore fundamental particles and forces of nature using intense particle beams and highly sensitive detectors or searching for rare phenomena in nature. One of the ways that researchers search for signals of new physics is to observe rarely interacting particles or rare phenomena, or do precision measurements. This is illustrated by the measurements of neutrino properties (mass, nature, oscillations, mixing), the electric dipole moment of the neutron, the measurement of the proton size, the search for rare decays like the decay $\mu \rightarrow e\gamma$.



B physics is rich of precision measurements connected to the understanding of CP violation and matter-antimatter asymmetry. High precision measurements of Standard Model parameters, g-2 experiments and W and Top masses bridge the intensity frontier to the high-energy frontier. Some of these experiments search for evidence of the process theorists hypothesize allowed our universe full of matter to bloom rather than being annihilated by an equal amount of antimatter created in the big bang. Other experiments seek to observe rare processes that can give researchers a glimpse of unknown particles and unobserved interactions.

This intensity frontier physics is developing vigorously with the prospects of new generations of high intensity proton machines and targets, of high intensity neutrino beams, of super B factory and of new generations of double beta decay neutrinoless experiments, of electric dipole moment of the neutron and g-2 measurements.



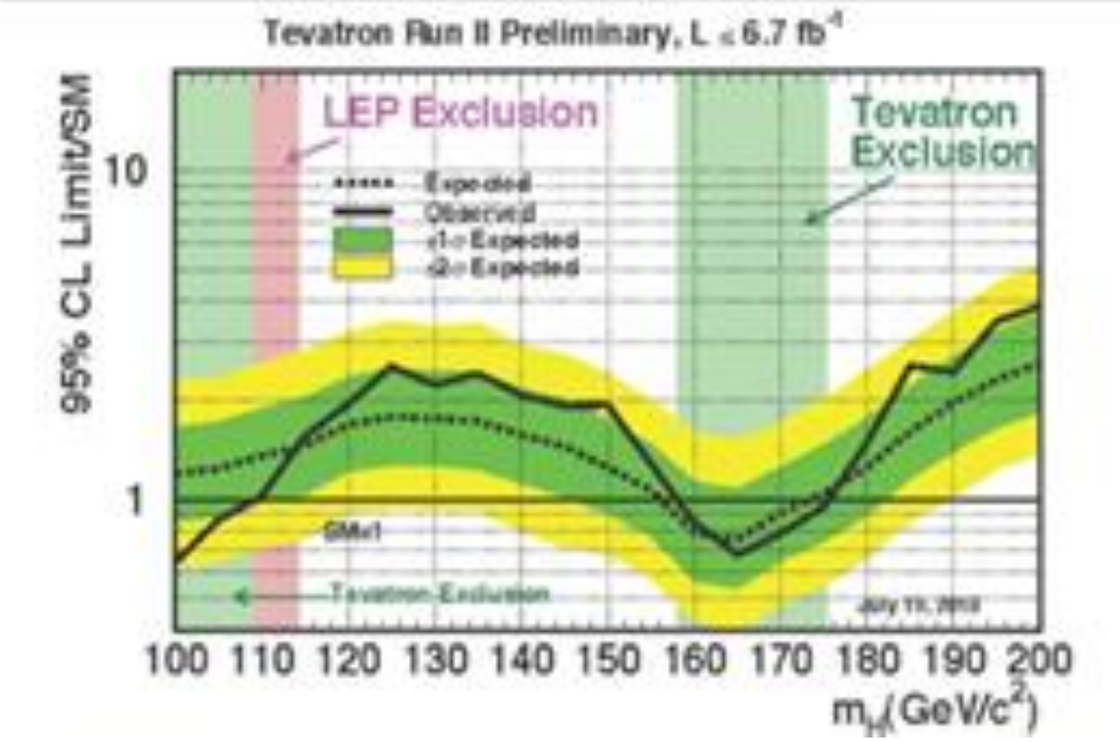
2.3 The High Energy Frontier

Many results from the Tevatron on W, Z and top mass measurements have been reported. Together with the Intensity Frontier experiments, we have now a very impressive ensemble of measurements which comfort the Standard Model with very high precision (% level) despite few 2 to 3 standard deviations departure in some measurements. The missing piece to the Standard Model, the Higgs boson, if Standard Model like, should be light (<180 Gev/c^2) according to the predictions inferred from the precision measurements of the Standard Model parameters. Direct search of the Higgs particle is proceeding very well with the Tevatron, some mass range being already excluded.

The paradigm remains the same:

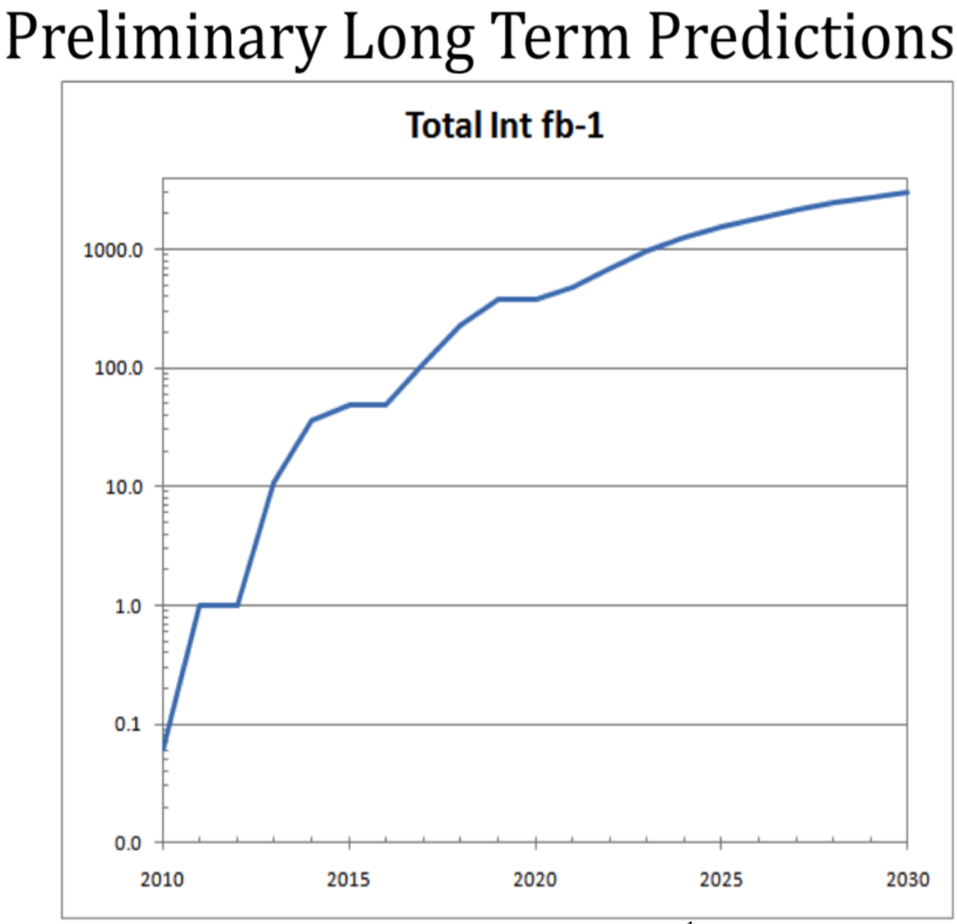
- The Higgs boson, if Standard Model like should be discovered maybe at the Tevatron and certainly at the LHC
- If there is no Standard Model Higgs, there must be a symmetry breaking mechanism beyond the Standard Model which should be discovered at LHC
- LHC should also help to understand the origin of the symmetry breaking hierarchy (electroweak scale compared to Grand Unified Theory scale). Is it a fine tuning only mechanism or is it due to new physics beyond the Standard Model?

The first results from LHC presented at the Conference are already entering a new exploratory region of Physics.



3.Entering a new era with LHC

The prospects for LHC were presented. The nominal energy should be attained by 2013, the nominal integrated luminosity by 2020. The LHC is expected to run between 2020 and 2030 to reach an integrated luminosity ten times the nominal one.



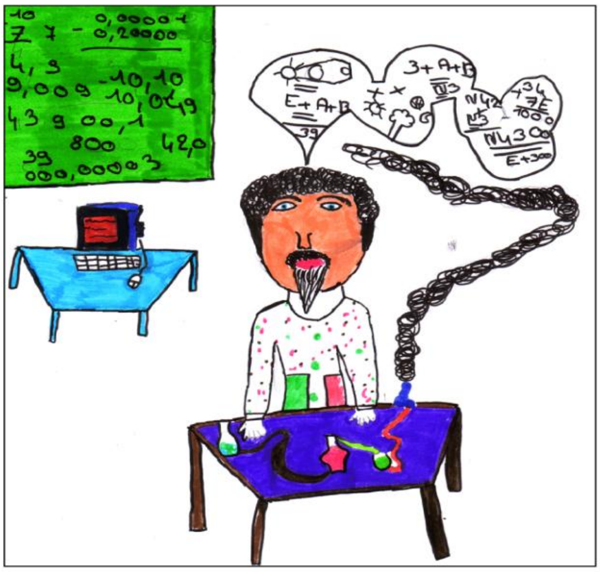
Already now beautiful results were presented with 350 nb^{-1} integrated luminosity: the rediscovery of the Standard Model, the observation of the world highest energy jets and already some limits on possible new physics, meaning that the LHC is entering new territories never explored.

4.A vision of Particle Physics

First we had with the highly inspired welcome address of President Nicolas Sarkozy a rich vision of what means particle physics at the highest political level and I invite you to read the full address at this web-site [1].

Another vision can also be obtained from the visits of CERN by children who were asked to produce a drawing on their vision of what is a physicist. You can find the drawings on the web-site [2].

With these two visions, Particle Physics can contemplate a bright future.



Un physicien fait des milliers de calculs et cherche ce qu'il y a après l'espace. *Lise*

Dessine-moi un physicien

Un physicien cherche le pourquoi du pourquoi.

Clément

www.cern.ch/dessine-moi-un-physicien

References

[1] http://www.ichep2010.fr/Allocution_N-Sarkozy.html

[2] http://www.cern.ch/dessine-moi-un-physicien