Symmetries in the subatomic world (P1)

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Why do we study symmetries ?

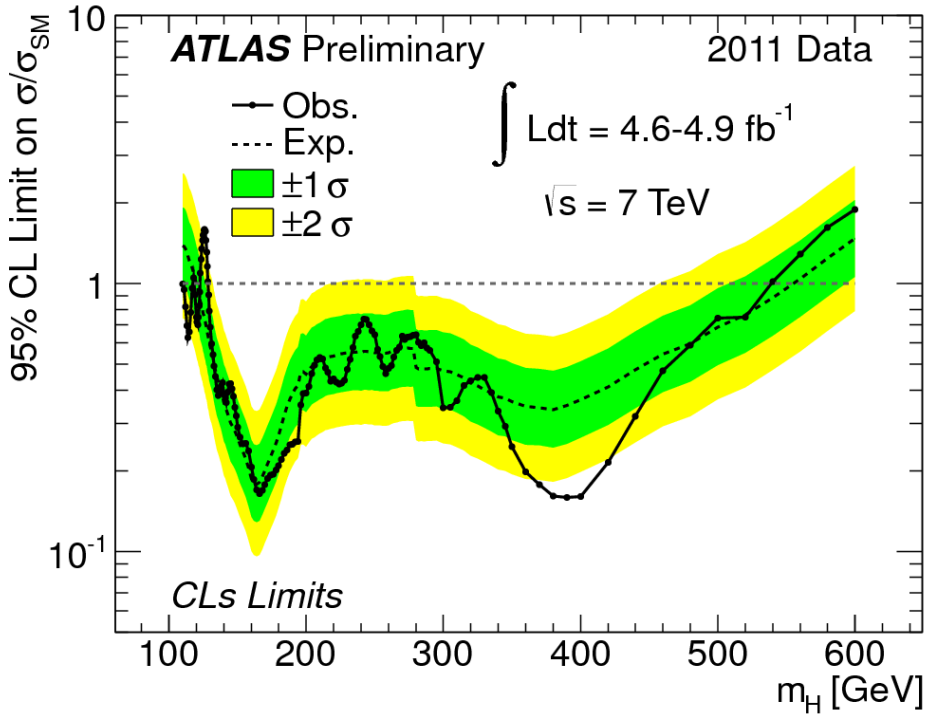
- Symmetry is the fundament of particle physics: basis for the construction of the Standard Model:
  - Built in the 60-70's
  - Thorough tests in particular at LEP
  - Continue to be scrutinized at the current colliders

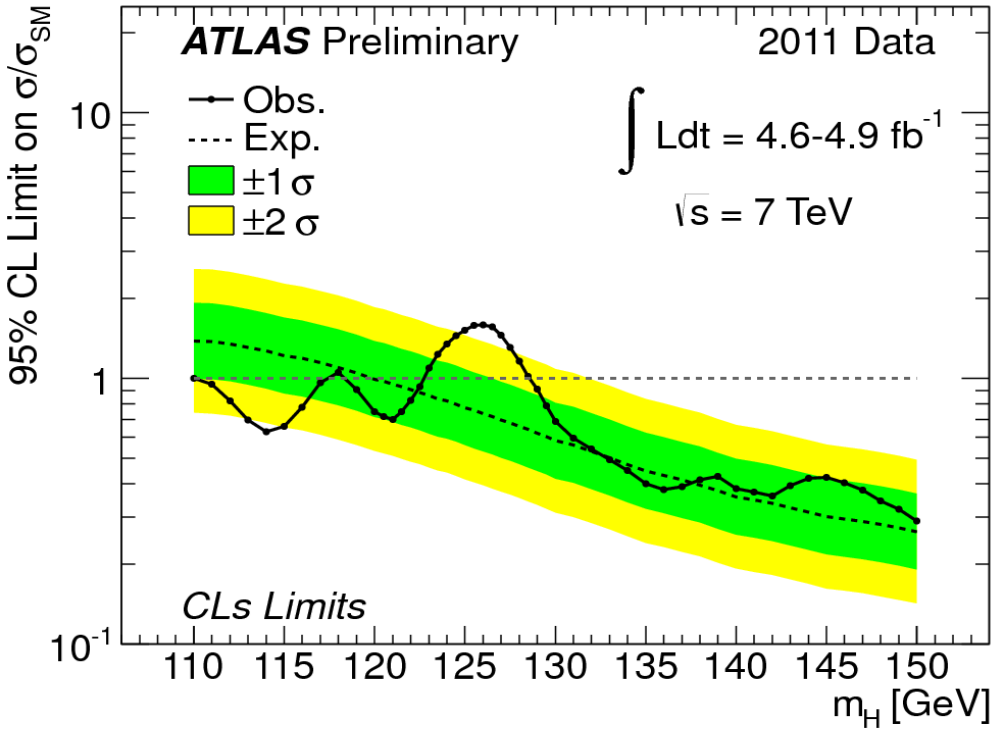
- But we know that the Standard Model is not the whole story:
  - Missing piece: the Higgs particle
  - Explanation of the observed matter/anti-matter asymmetry
  - No dark matter candidate
  - Description of neutrino masses
  - Link to gravitation

Symmetries Today

- Main scientific questions in particle physics currently:
  - Understand the mechanism of spontaneous symmetry breaking of the electroweak interaction : understand the generation of masses

    Does the Higgs boson exist ? And if so, is it standard-model like ?

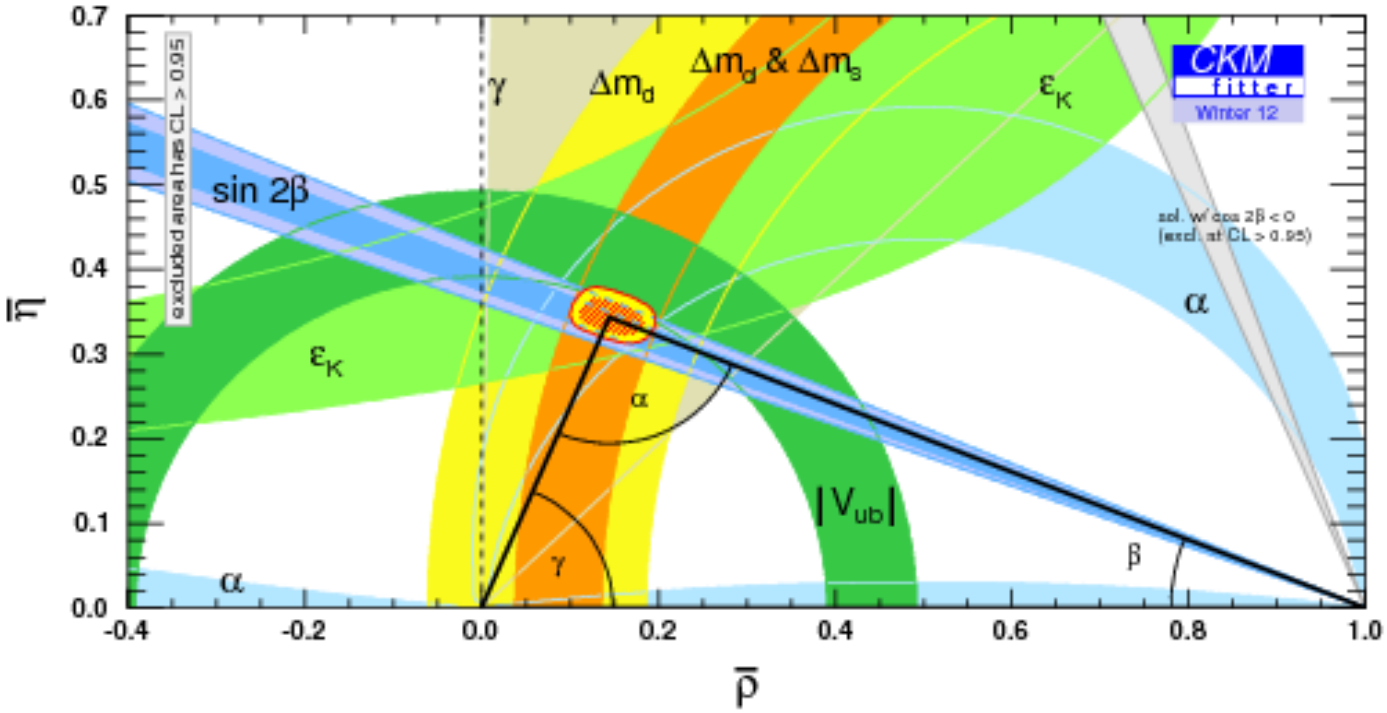




Symmetries Today

- Main scientific questions in particle physics currently:
  - Understand the asymmetry between matter and antimatter

    Symmetry violation between quark and antiquark or in the neutrinos sector. Study of the antihydrogen atom.

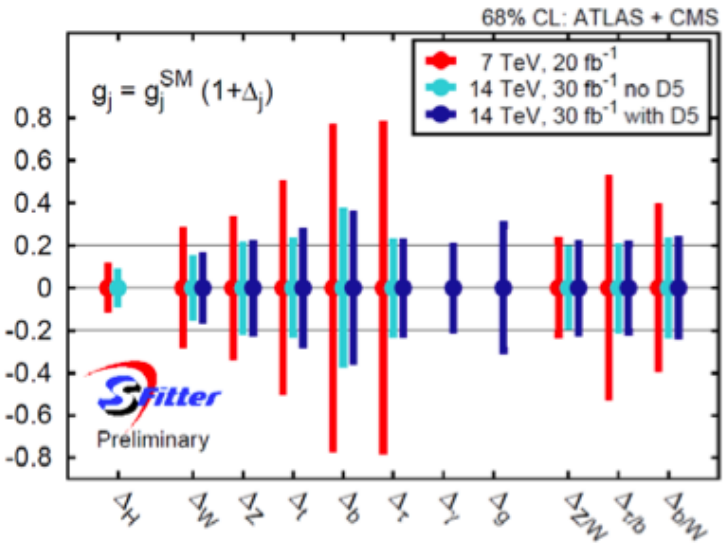


Physique des 2 Infinis et des Origines

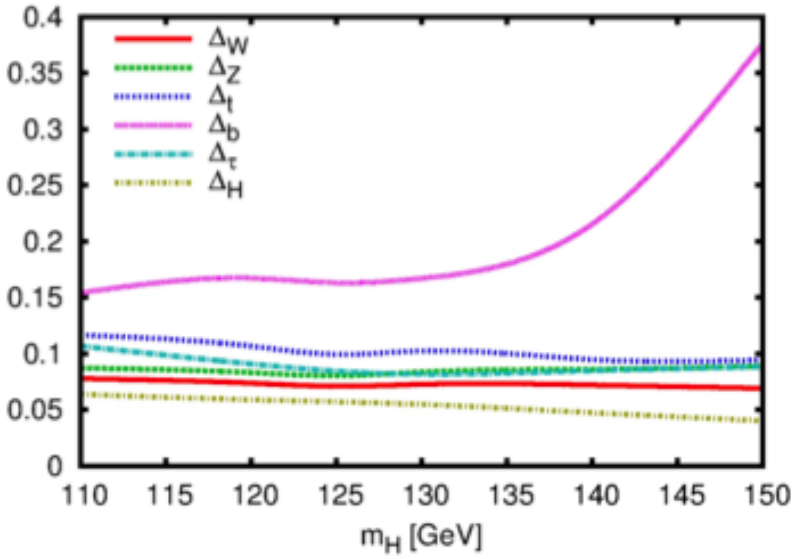
Expected Breakdown

- in the few years to come:
  - Discovery or exclusion of the Standard Model Higgs boson
  - Measurement of the Higgs boson decay rates if it exists
  - Improvement of the study of CP violation in the quark sector
  - Measure CP symmetry violation in the neutrino sector
  - Measure the gravity force on antihydrogen atom

LHC 14 TeV, 30 fb^{-1}



LHC 14 TeV, 3 ab^{-1}



P2IO
Physique des 2 Infinis et des Origines

Main projects where P2IO labs are involved

- Main projects presently in operation
  - Missing piece: the Higgs particle (LHC: ATLAS, CMS)
  - Explanation of the observed matter/anti-matter asymmetry (B-factories: Babar, Belle, LHC: LHCb)
  - No dark matter candidate: cf. P2
  - Description of neutrino masses: T2K, Double-Chooz

- P2IO teams have many leading roles in these experiments
  - Coordinators of physics groups at LHC
  - Coordinators of projects (Double-Chooz, SuperB, GBAR, …)
  - …

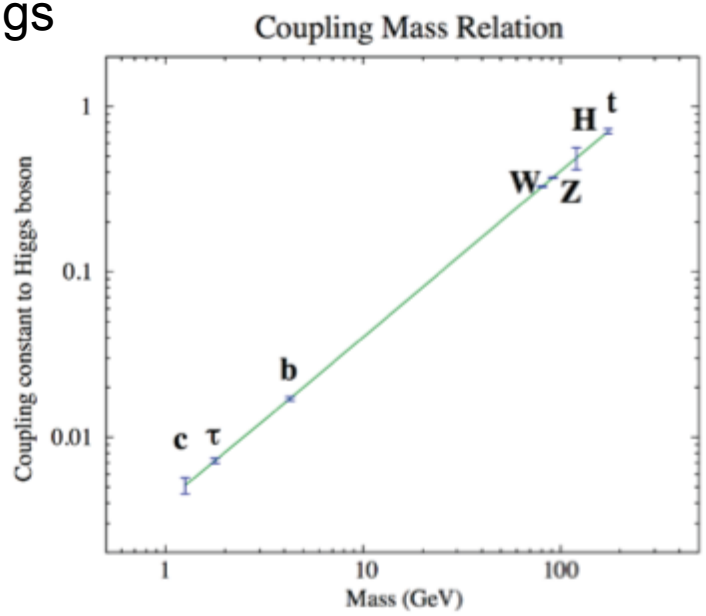
P2IO
Physique des 2 Infinis et des Origines

Main projects where P2IO labs are involved

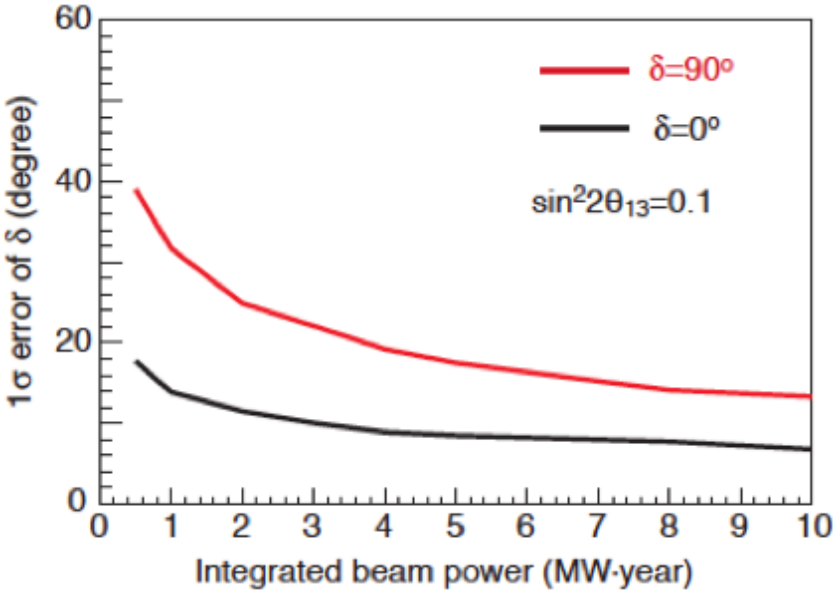
- Main projects in the future
  - LHC upgrades, Linear collider
  - SuperB factories, rare K decays experiments
  - Accelerator based neutrino experiments, double beta decays, rare muon decays
  - Antihydrogen gravity experiments

Error on H couplings

	250	500
g_{HWW}	?	1.2 %
g_{HZZ}	1.5 %	
g_{Hbb}	1.3 %	
g_{Hcc}	4.5 %	
$g_{H\tau\tau}$	~3 %	
g_{Htt}	-	10 %
$g_{H\mu\mu}$	-	
$\lambda_{(HHH)}$	-	<50 %



Error on CP violation neutrino parameter as a function of the beam power



P2IO strengths in the domain

- Large amount of manpower (242) involved in:
  - LAL (66), IRFU (49), LPT (45), IPhT (31), LLR (30), CPhT (12), IPN (7), CSNSM (2)
- Expertise at the highest international level
- Synergy between P2IO labs
  - Between experimentalists/theorists: IPhT-LPT-CPhT
  - Between domains (particle/nuclear/universe)
- Strong involvement in teaching

P2IO actions (ongoing and future)

- Actions benefiting from explicit P2IO fundings
  - Post-docs (2y)

    2012: Pattern recognition and machine learning for imaging calorimeters (R. Poeschl. LAL)

    2012: Bosons de Higgs au-delà du modèle standard (G. Moreau, LPT)

    2012: Trou noir : aspects microscopiques et holographiques (M. Petropoulos, CPHT) linked to possible observations at the LHC

    2011: Top quark measurements as a probe to new physics (F. Déliot, Irfu)

    2011: Lattice QCD computing (G. Grosdider, LAL) linked with R3

  - Supported conferences and schools

    QCD school

    Higgs hunting 2012

    Rencontres de physique de l'infiniment grand à l'infiniment petit

P2IO actions (ongoing and future)

- Visitor supports
  - Dr. H. Hyun (Univ. Korea N. U.) @LAL
  - Pr. A. Mueller (Univ. Columbia) @CPHT
  - Pr. G. Cowan (Royal Holloway, Univ. of London) @LAL

- R&D projects linked to P1
  - Anti-proton decelerator (D. Lunney)
  - 1 ps electronics (E. Delagnes)
  - Grid computing with GPU processors (D. Chamont)

- Support of existing platforms linked to P1
  - Cavity test halls
  - GRIF

Conclusion

- This year will be a key one for our field
- P2IO labs are in very good position in our research domain
- P2IO has strengthened the relation between our labs and created new interactions
- Involvement in developments of future projects