La fisica ad LHC

… e oltre!

Attilio Santocchia

Workshop sulle Prospettive future della ricerca INFN

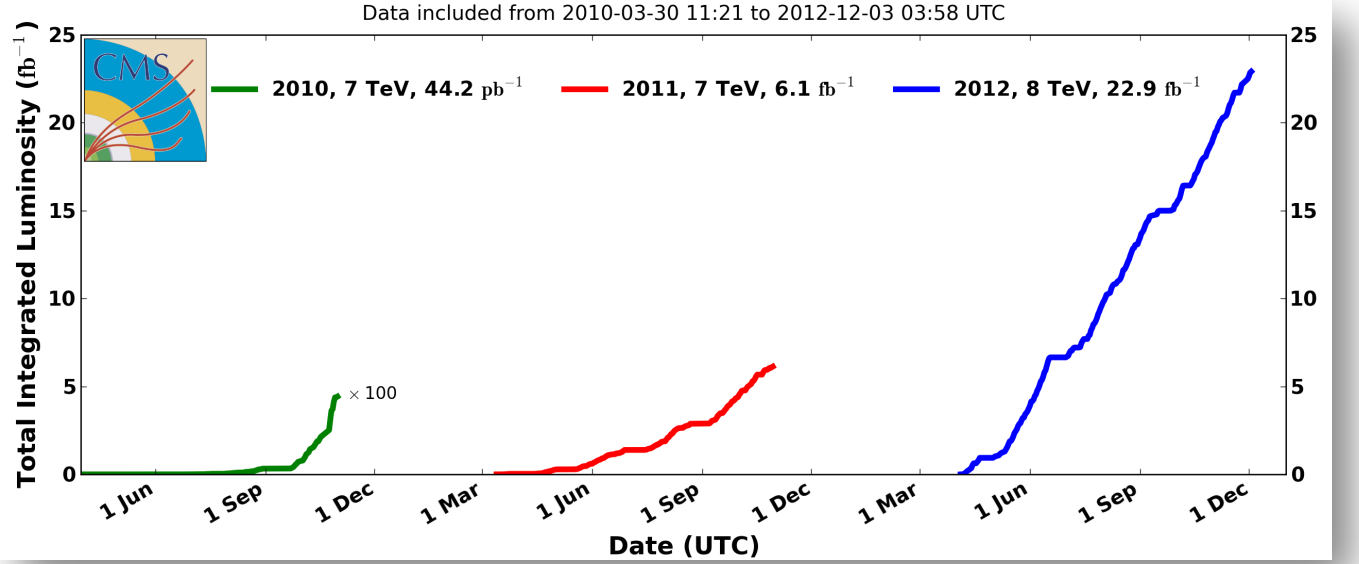
Perugia 15.01.2013

INFN Istituto Nazionale di Fisica Nucleare
Sezione di Perugia

Inquadriamo il talk…

- Una rapida carrellata dei principali risultati prodotti a LHC nel primo periodo di run
- Cosa succede dopo il primo stop della macchina a partire dal 2015 (nel 2013 e 2014 non ci sono run di fisica)
- Cosa succede dopo il secondo stop della macchina (e siamo già vicini al 2020)
- Quali sono le linee di pensiero sul prossimo decennio e la fisica post-LHC

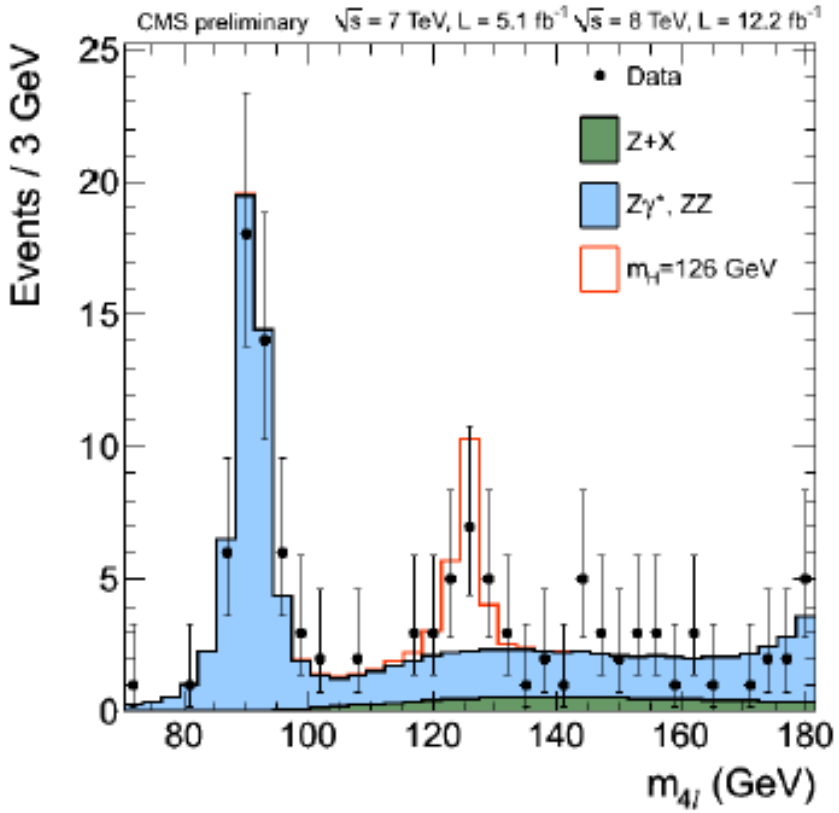
It has been a long run…

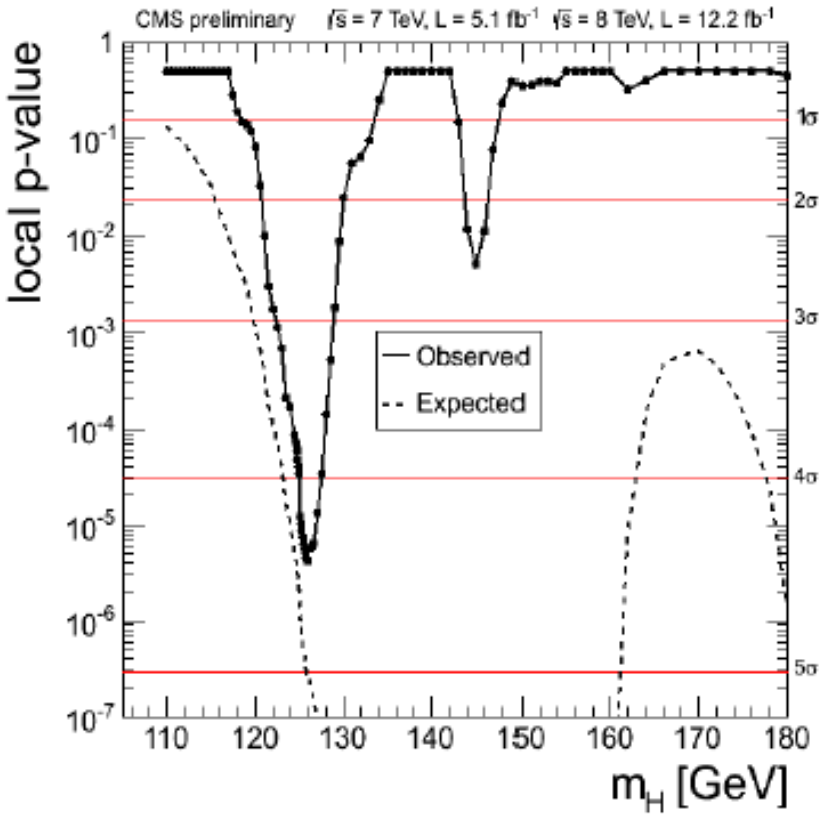


- CMS has been improving steadily
  - Typical operations report
    - Fill 3363: (1374 bunches)
    - peak lumi: 7.0×10^{33}
    - Delivered: 162.1 pb^{-1}
    - Recorded: 157.2 pb^{-1}
    - efficiency by lumi: 96.93%
    - efficiency by time: 98.46%

Higgs Highlights: ZZ

- 4.5σ (5.0σ) observed (expected) significance in the ZZ(4l) channel alone
- Mass in the ZZ(4l) channel alone: 126.2 ± 0.6 ± 0.2 GeV (helped by in situ Z(4l) measurement)



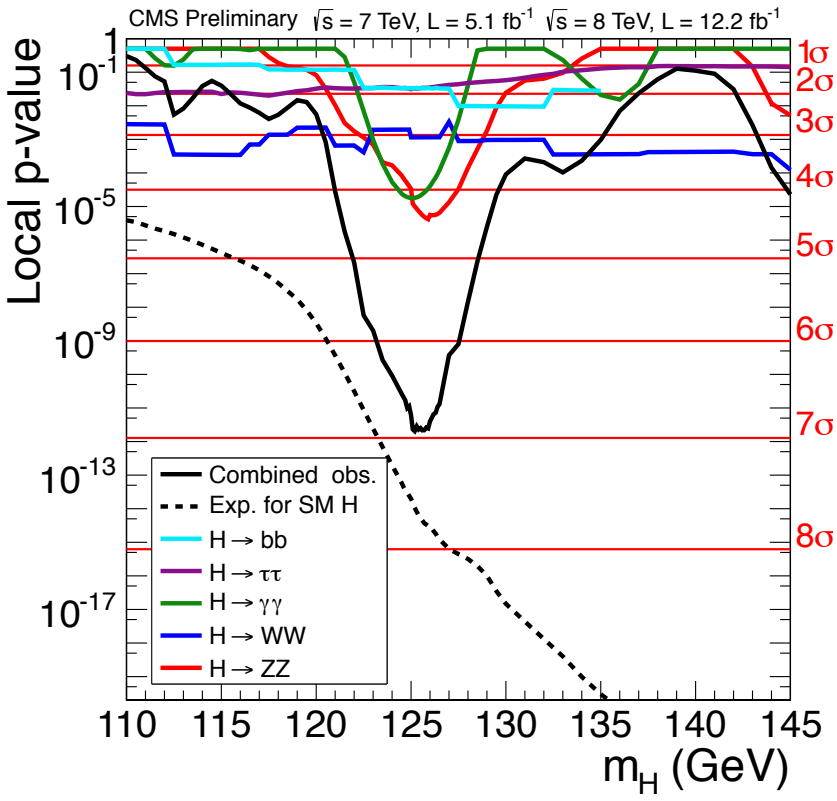


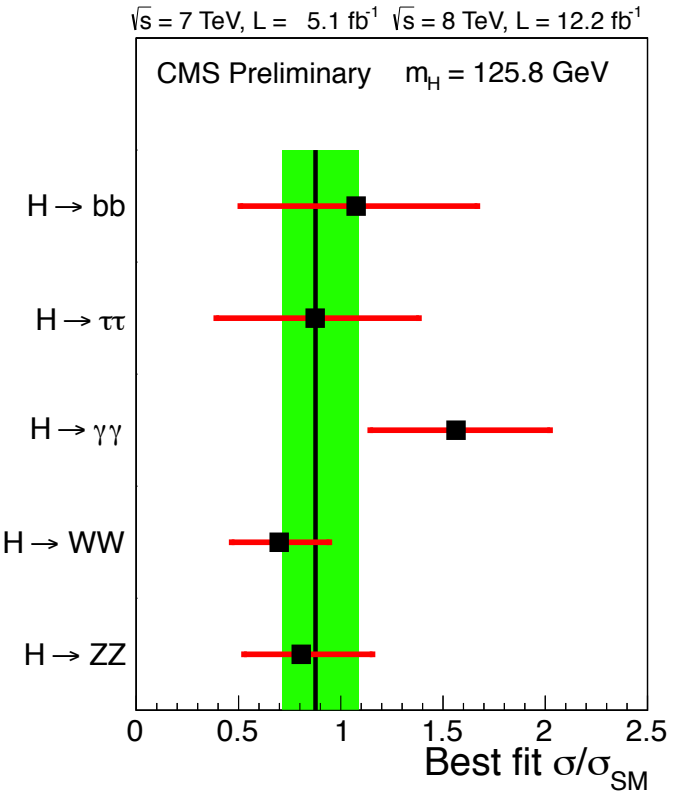
Higgs Highlights: Combination

Significance: 6.9σ (7.8σ) observed (expected)

Mass: 125.8 ± 0.4 ± 0.4 GeV

So far, it all looks pretty consistent with the SM Higgs

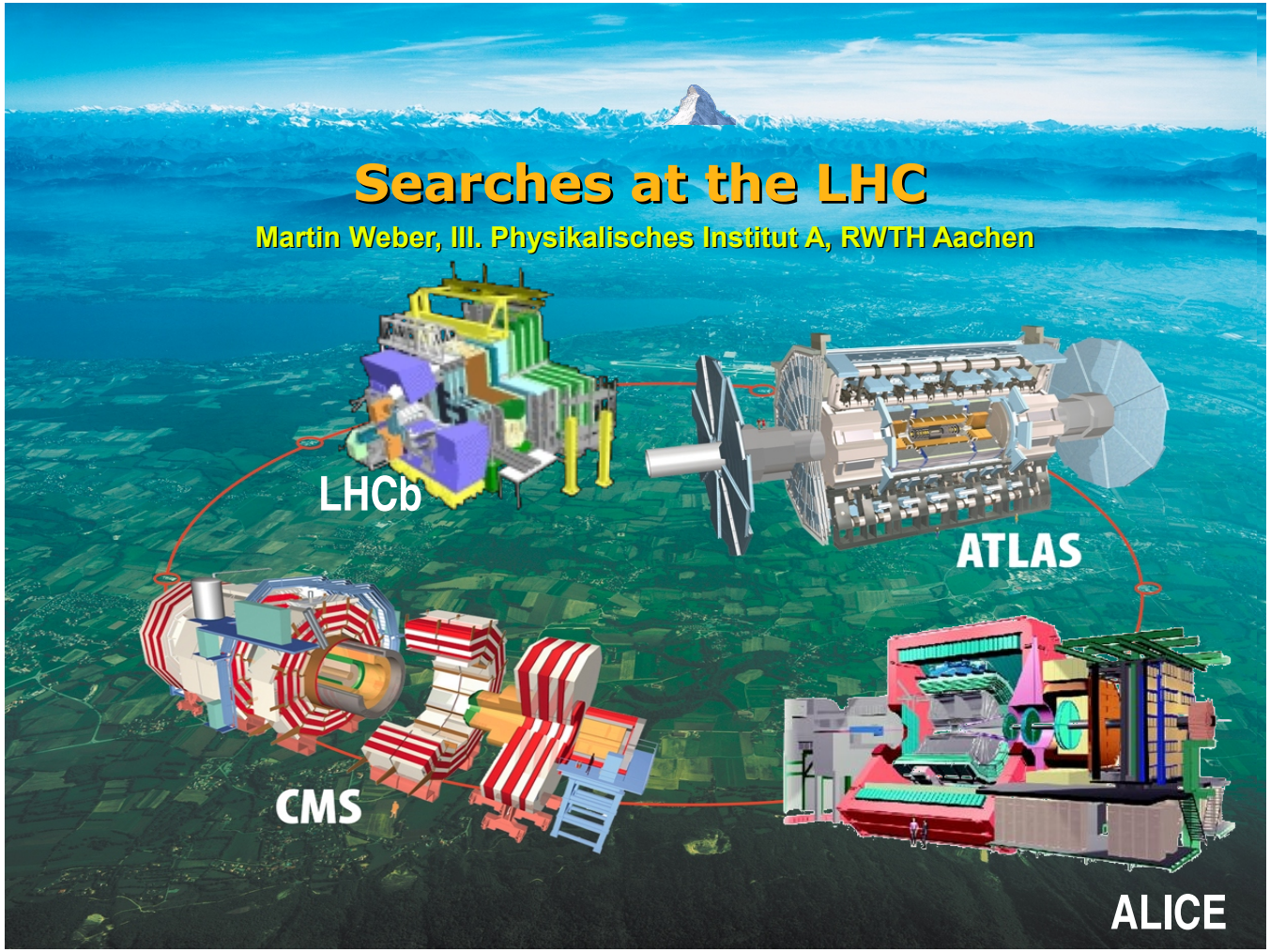




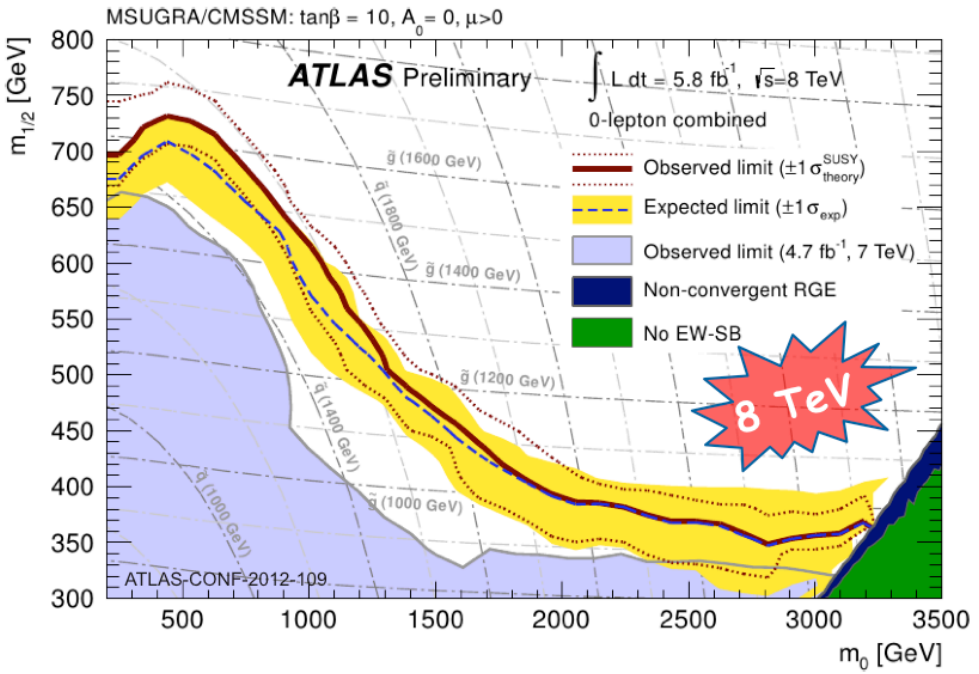
What is it ?

J. ELLIS in Dine-Haber Fest, 2013

- Does it have spin 0 or 2?
  - **Spin 2 seems unlikely, but needs experimental checks**
- Is it scalar or pseudoscalar?
  - **Pseudoscalar disfavoured by experiment**
- Is it elementary or composite?
  - **No significant deviations from Standard Model**
- Does it couple to particle masses?
  - **Some *prima facie* evidence that it does**
- Quantum (loop) corrections?
  - **$\gamma\gamma$ coupling > Standard Model?**
- What are its self-couplings? **Wait for HL-LHC …?**


Searches at the LHC
Martin Weber, III. Physikalisches Institut A, RWTH Aachen
LHCb
ATLAS
CMS
ALICE

Interpretations: CMSSM parameters



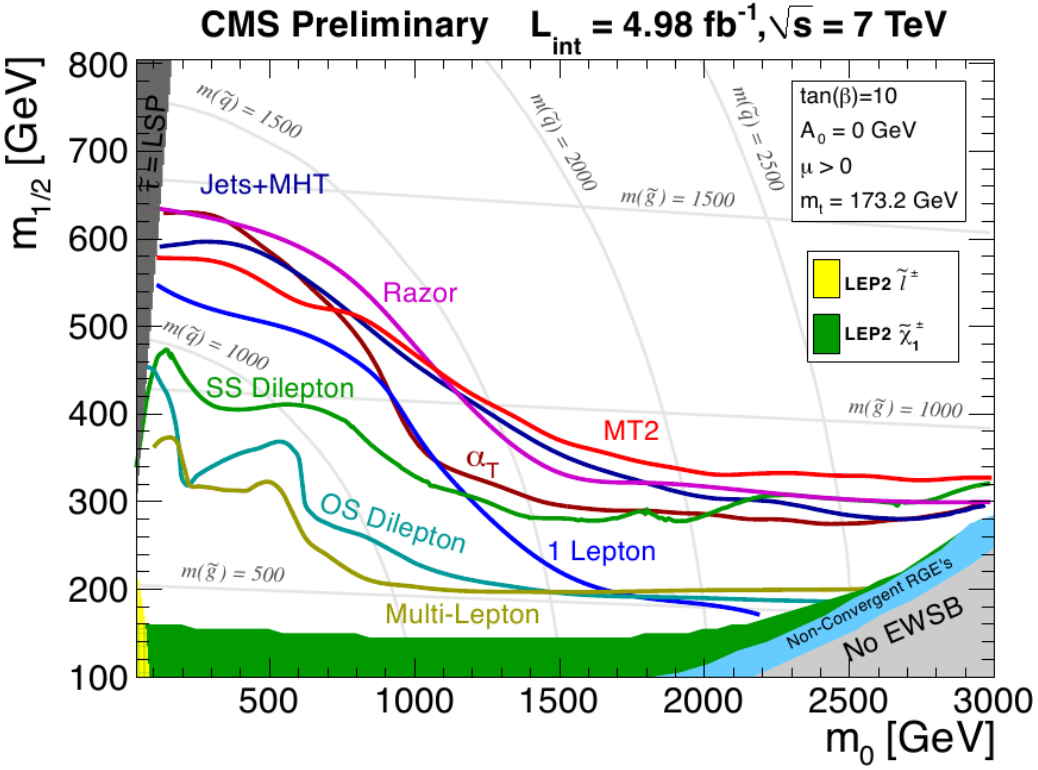
CMSSM / MSUGRA interpretation

- Limits from 2011 extended ~ 50 GeV in $m_{1/2}$

Memo:
CMSSM: constrained Minimal SuperSymmetric Model
mSUGRA: minimal SUper GRAvity

CMS SUSY CMSSM summary

https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsSUS



- CMSSM exclusion limits from CMS, ATLAS limits similar
- No signs for SUSY — Exclusion limits from previous experiments largely improved

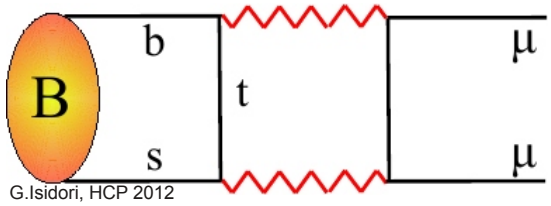
$B_s \to \mu\mu$ theory

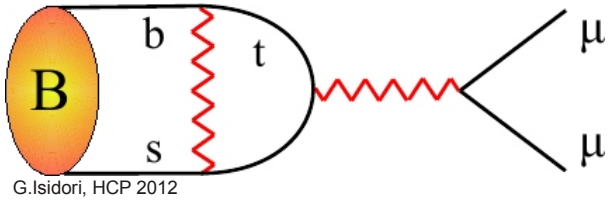
$B_s \to \mu^+\mu^-$ doubly suppressed in Standard Model (FCNC, helicity suppressed)

- SM Prediction: $\mathcal{B}(B_s \to \mu^+\mu^-) = (3.54 \pm 0.30) \times 10^{-9}$

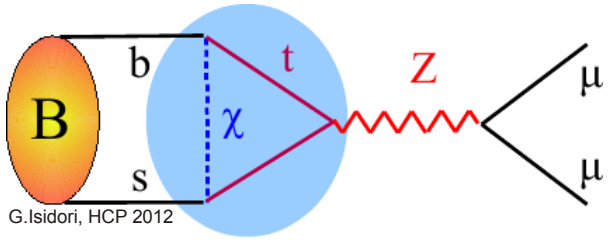
  Buras, Isidori: arXiv:1208.0934; De Bruy et al. arXiv:1204.1737

Standard Model diagrams:

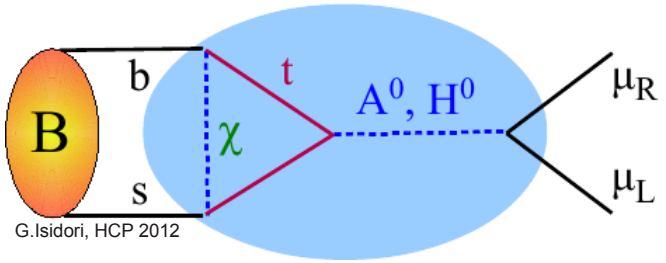




Possible SUSY contributions:



- Important if $\mathcal{B} \sim$ SM



- Large effect at high $\tan\beta$

First evidence for $B_s \rightarrow \mu\mu$ (new physics could show up here)

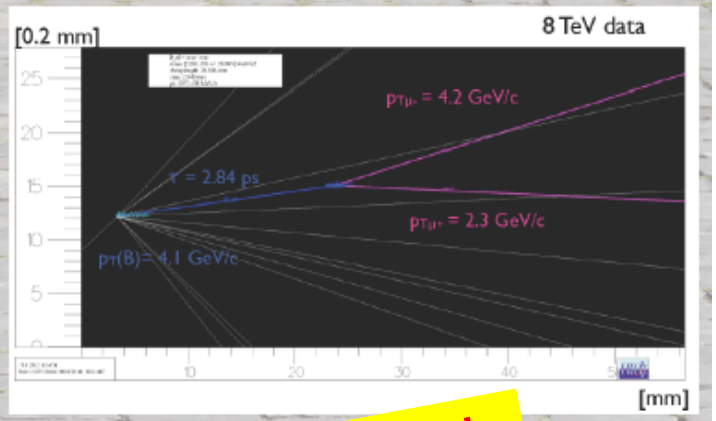
Predicted to be very rare in SM due to GIM & helicity suppression:

Precise predictions in SM:

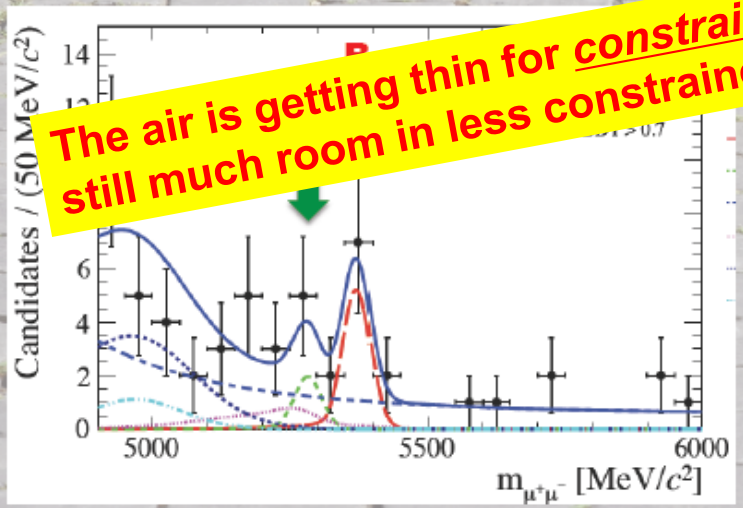
- $BR(B_s \rightarrow \mu\,\mu) = 3.5 \pm 0.2\ 10^{-9}$
- $BR(B_d \rightarrow \mu\,\mu) = 1.1 \pm 0.2\ 10^{-10}$

"Golden channel" for New Physics effects

$$\mathrm{Br}_{\mathrm{MSSM}}(B_q \to \ell^+\ell^-) \propto \frac{M_b^2 M_\ell^2 \tan^6\beta}{M_A^4}$$



The air is getting thin for constrained SUSY. .....but there is still much room in less constrained models



data (2.1/fb) LHCb has got the first evidence of $B_s \rightarrow \mu\,\mu$ decay at ~ 3.5 σ

$\mathcal{B}(B^0_s \to \mu^+\mu^-) = (3.2^{+1.5}_{-1.2}) \times 10^{-9}$

in agreement with SM.

"Background only" p value ~ $5\ 10^{-4}$

Also best limit on $B_d \rightarrow \mu\,\mu$

$\mathcal{B}(B^0 \to \mu^+\mu^-) < 9.4 \times 10^{-10}$ at 95% CL

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A look at the CMSSM with Fittino

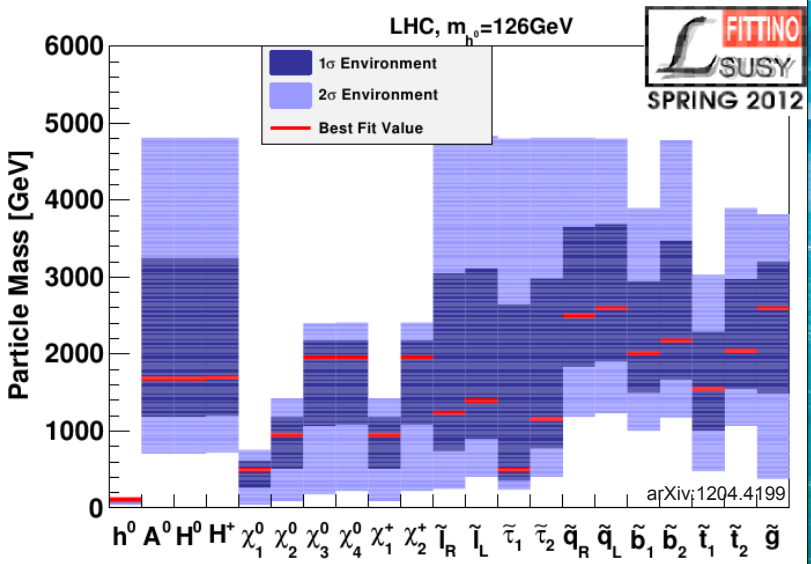
arXiv:1204.4199

Fittino:

- Estimate CMSSM parameters from measurements
- Quantify compatibility with CMSSM

Input sets of observables to CMSSM fits

- Indirect constraints:
  $\mathcal{B}(b \to s\gamma)$, $\mathcal{B}(B \to \mu\mu)$,
  $\mathcal{B}(B \to \tau\nu)$, Δm_{B_s},
  $\Delta a_\mu = a_\mu^{exp} - a_\mu^{SM}$.
- Astrophysical observations:
  $\Omega_{CDM}h^2$, XENON,
  γ-rays from dwarf galaxies
- Collider results:
  LHC SUSY & Higgs & $B_S \to \mu\mu$,
  LEP $m_{\chi^\pm}$



- **Multi-TeV $\tilde{q}, \tilde{g}$, most sparticles $\gtrsim 1\,TeV$**

Input measurements	χ^2/ndf
low energy +astrophysics (LEO)	10.3/8
LEO+SUSY limits	13.1/9
LEO+SUSY+M(Boson)=126	18.4/9

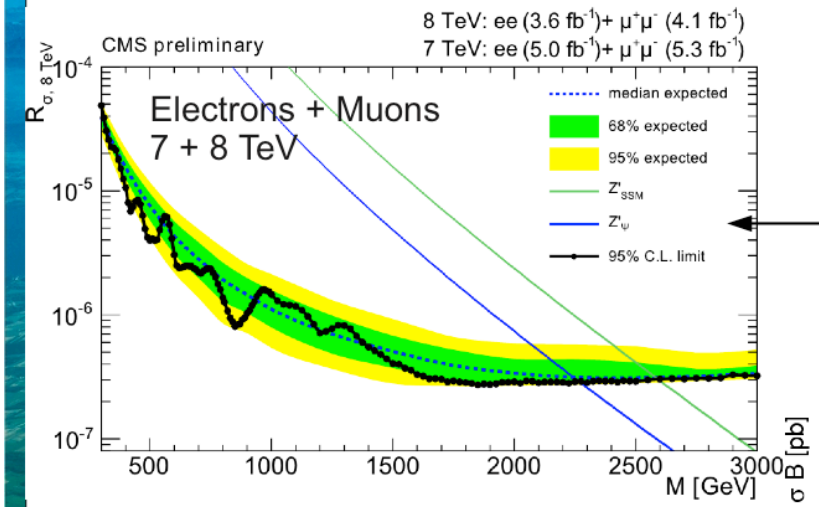
- **Bad overall compatibility when Higgs is included!**

Tue 17:15 X. Prudent

http://cern.ch/Martin.Weber 6th annual Workshop "Physics at the Terascale" 21

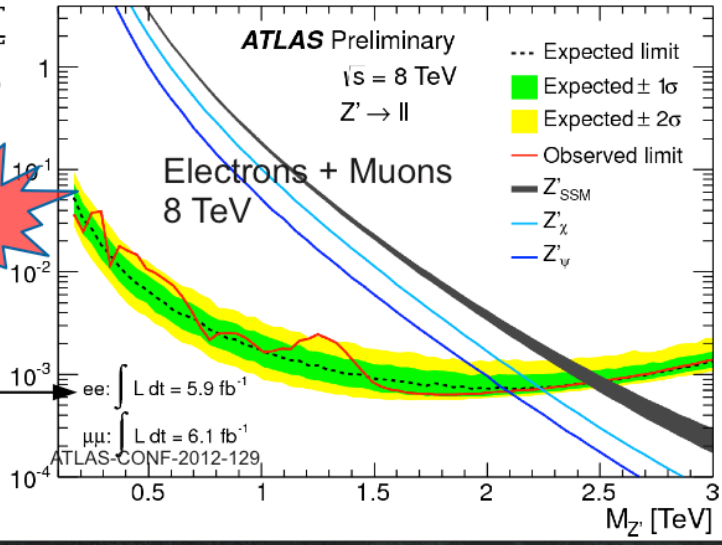
Memo:
LEO: Low Energy Observables

Z': New limits



CMS: Combination of 7 TeV and 8 TeV data

- $M(Z'_{SSM}) > 2590$ GeV
- $M(Z'_\psi) > 2260$ GeV



NEW

ATLAS limits 8 TeV:

- $M(Z'_{SSM}) > 2.49$ TeV
- $M(Z'_\psi) > 2.09$ TeV
- $M(Z'_\chi) > 2.24$ TeV

Mo 16:30 J. Caudron

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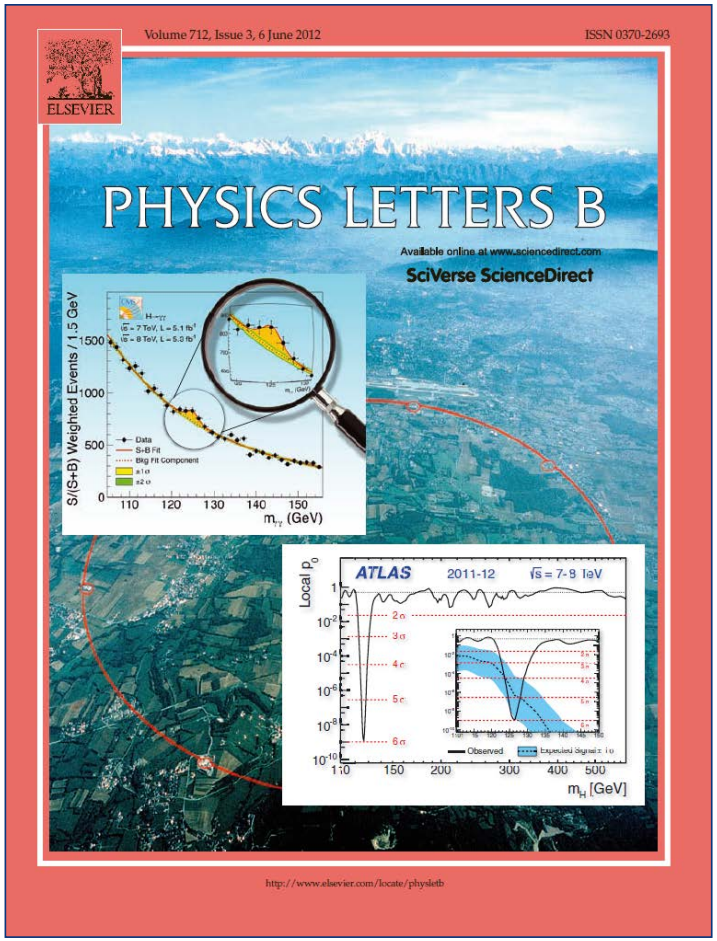
General Meeting January 2013

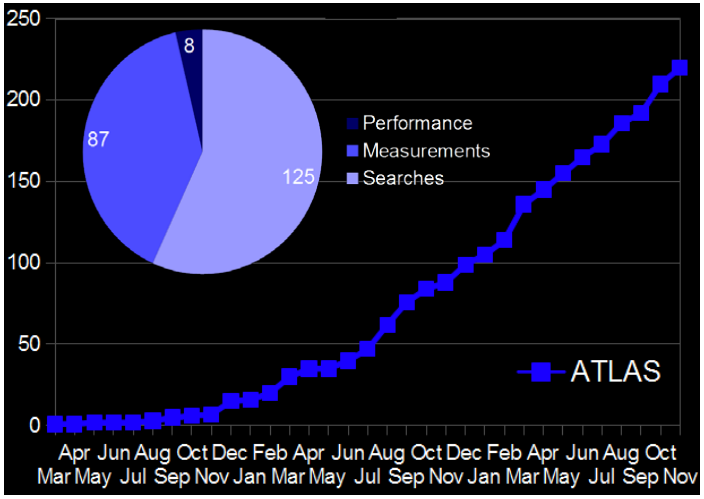
European Organization for Nuclear Research
Organisation européenne pour la recherche nucléaire

R.-D. Heuer

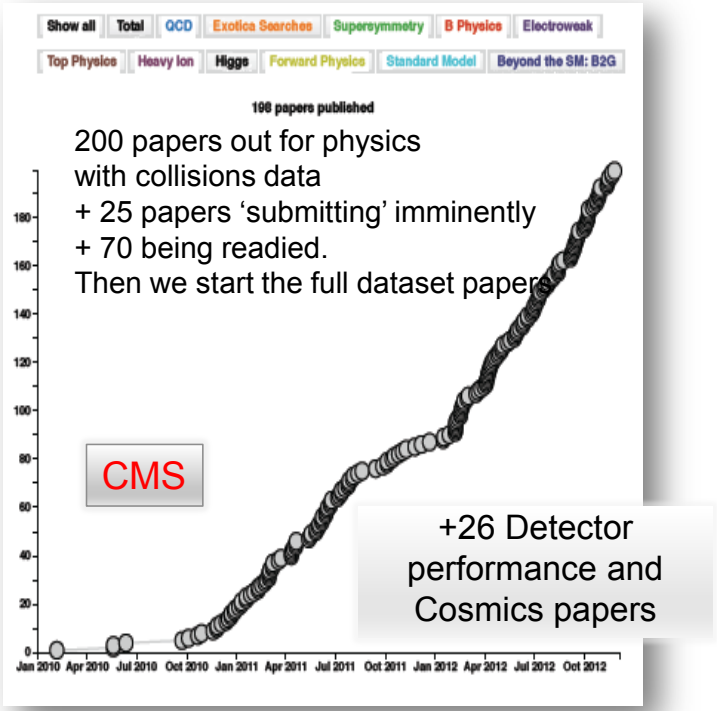
The highlight of a remarkable year 2012



A huge scientific output from LHC



223 articles on collision data (~ 2.5/week recently)
434 Conference notes



Total number of (exp) EP preprints: 375 (LHC 352)

European Organization for Nuclear Research
Organisation européenne pour la recherche nucléaire

The near future

Jan/Feb: LHC run for 4 weeks with p-Pb collisions

Shutdown 2013/14 for the whole accelerator complex (LS1)
LS1 was started as the project for the repair of the magnet interconnects to allow operating LHC at 14 TeV cms.
It has now turned into a programme involving all the groups owning equipment in the accelerator complex, the experiments and the infrastructure systems. The number of people, the volume of the activities involved in the latter is by far higher than for the magnets and circuits project.

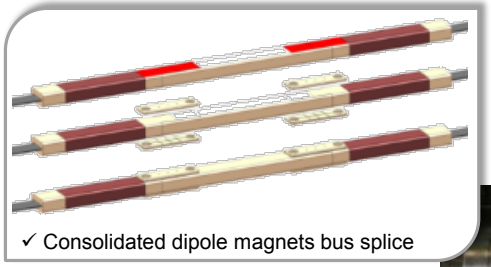
Some examples of the activities during LS1, emphasis on the accelerator complex

Main activities in LHC

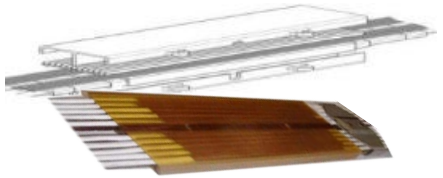
- The main key drivers are:

Superconducting Magnets And Circuits Consolidation *(SMACC)*

- Interconnections consolidation
  - Total magnet to magnet interconnects in the LHC: 1 695 (**10'170 high current splices**)
  - Number of splices to be redone: ~1'000 - 1'500 (~ 10-15%)
  - Number of shunts to be applied: > 27 000 (**100% of interconnections**)

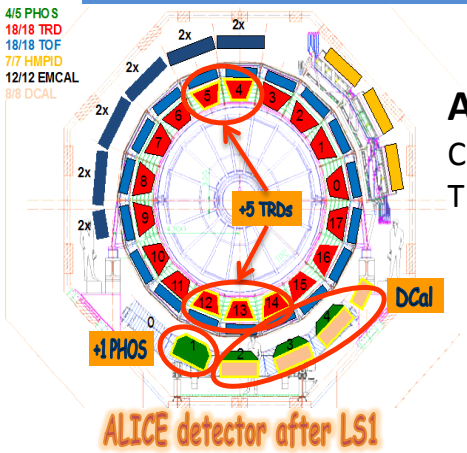


✓ Consolidated dipole magnets bus splice



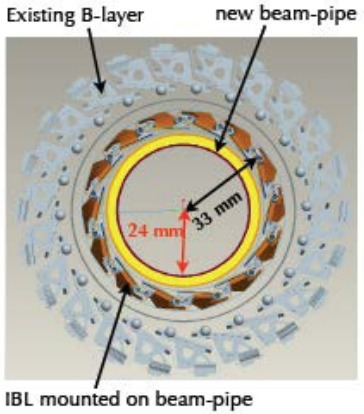
✓Consolidated electrical insulation system

Main activities in Experiments

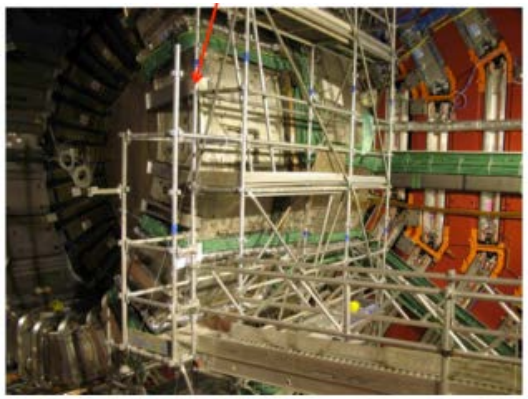


ALICE:
Completion of
TRD,DCAL,PHOS

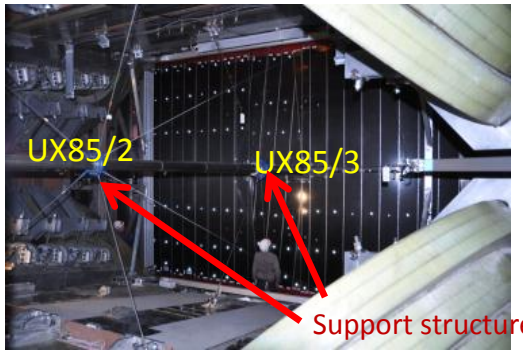
ATLAS:
Smaller beam pipe
New inner pixel layer (IBL)
Additional muon chambers



Infrastructure consolidation for all experiments

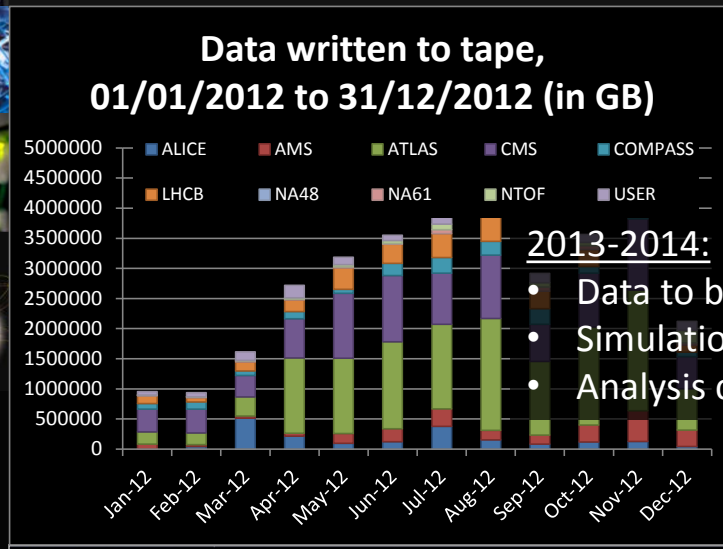


CMS:
Smaller beam pipe
4th Endcap muon station
New HCAL photodetectors
New DAQ



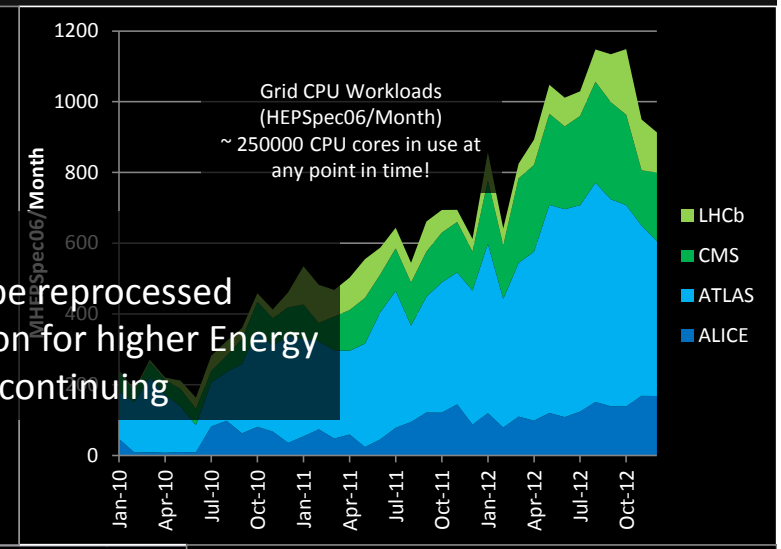
LHCb :
Lighter beam pipe
Dipole Magnet improvement

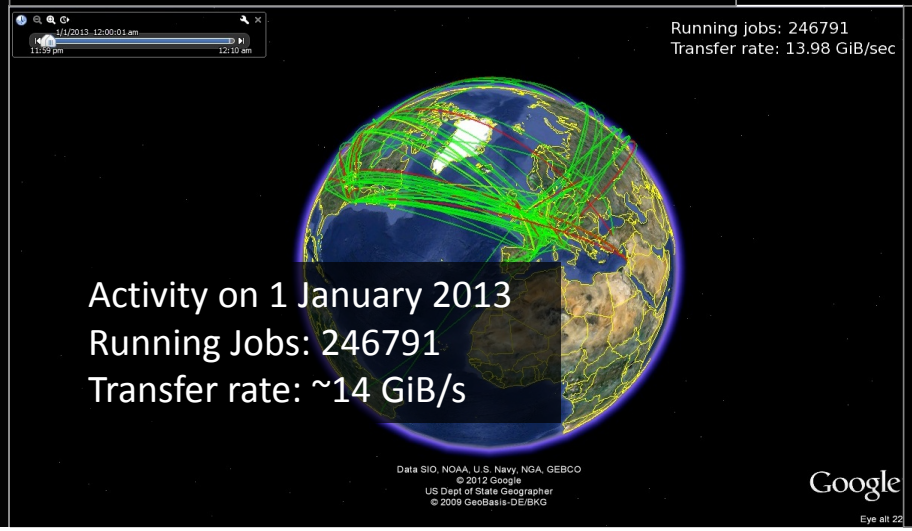
LS1: no stop for the computing !

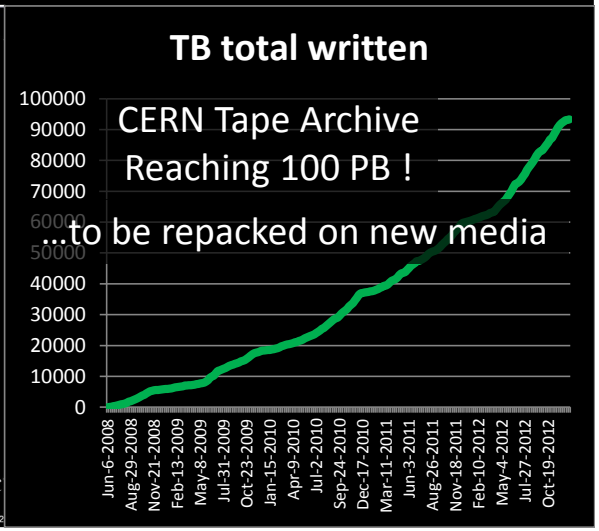


2013-2014:

- Data to be reprocessed
- Simulation for higher Energy
- Analysis continuing







CERN today .into the future (as presented Jan 2012)

- CLIC conceptual design report by 2012
- Participation in all LC activities
- LHeC conceptual design report early 2012
- R&D for high-field magnets (towards HE-LHC)
- Generic R&D (high-power SPL, Plasma Acc)
- Participation in Neutrino-Projects studied

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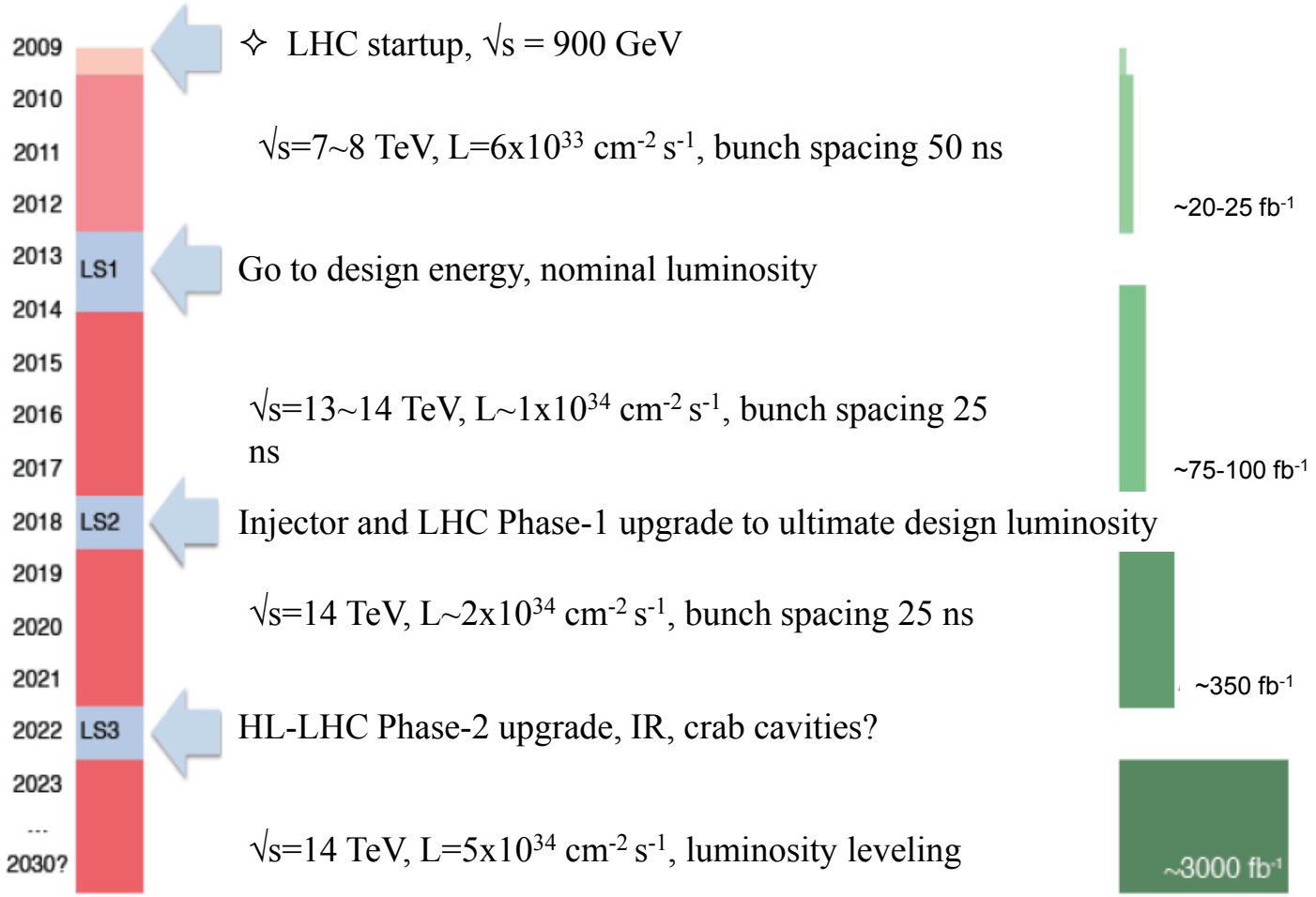
Memo:
SPL: low-power Superconducting Proton Linac
LHeC: Large Hadron-electron Collider
CLIC: Compact Linear Collider
HE-LHC: High Energy LHC (30TeV?)

LHC Upgrade and Outlook

How will the LHC look at 45 years old?

Jordan Nash – Imperial College London

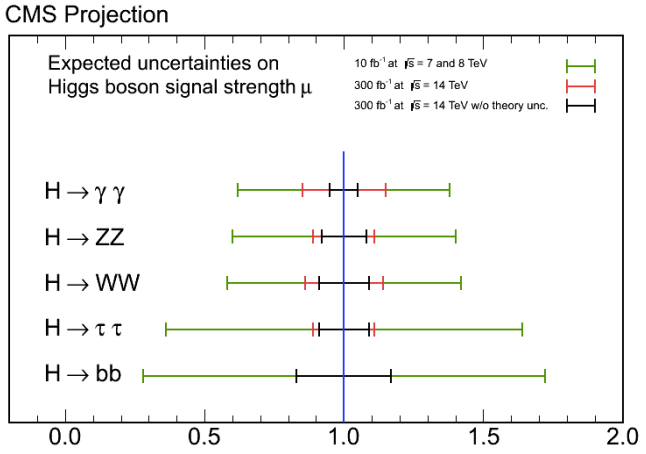
The LHC Timeline



Benchmarks: How well can we measure the properties of this Boson?

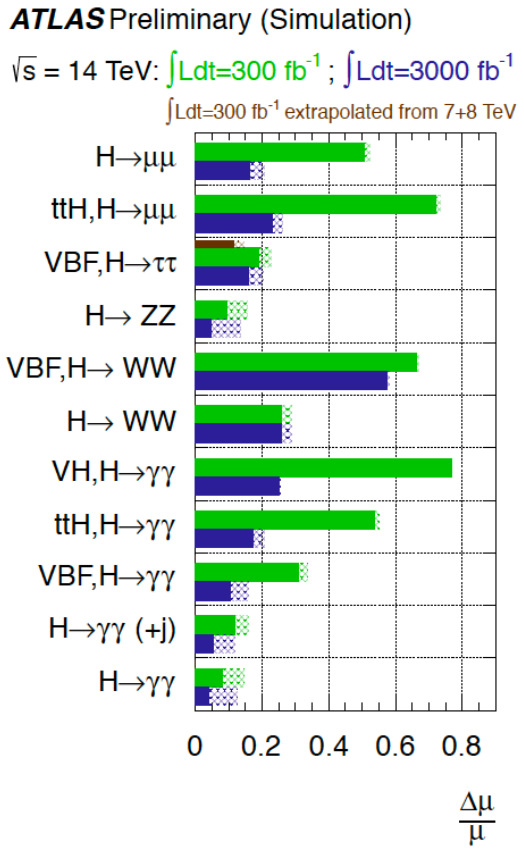
- Some General assumptions in these estimates
  - The systematic errors will scale with (Luminosity)^(-1/2)
    - A challenge to the experimentalists
    - Many of the systematic uncertainties are "data driven" and should improve with more data collected
  - The theoretical errors will reduce by a factor of 2
    - A challenge to the theorists
  - The statistical errors on the measurements will decrease
    - A challenge to the machine
    - A challenge to the experimentalists (high pile up)

First guesses at how well properties can be measured with high luminosity



Some Caveats:

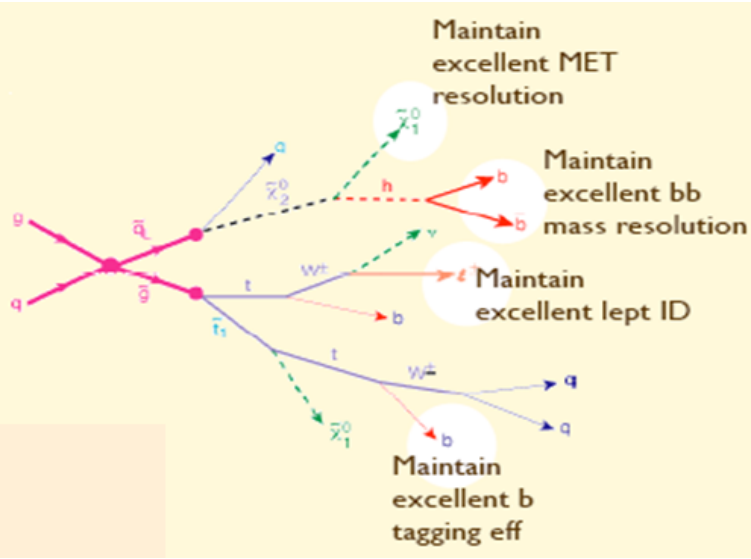
- These are preliminary studies
- Assumptions about scaling …
- These assume we are measuring a SM Higgs

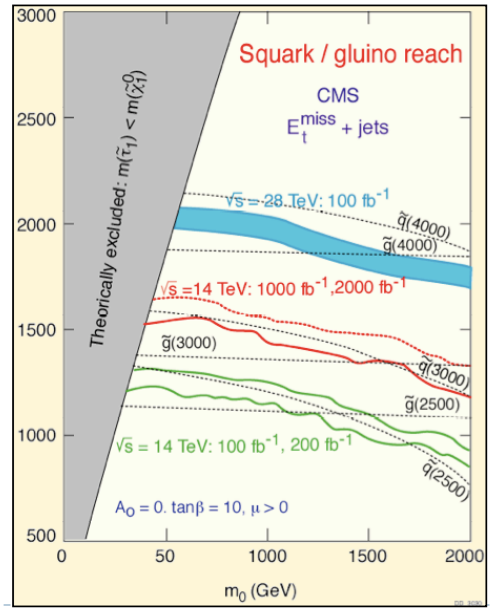


SUSY what if we find it- how well will we explore the spectrum?

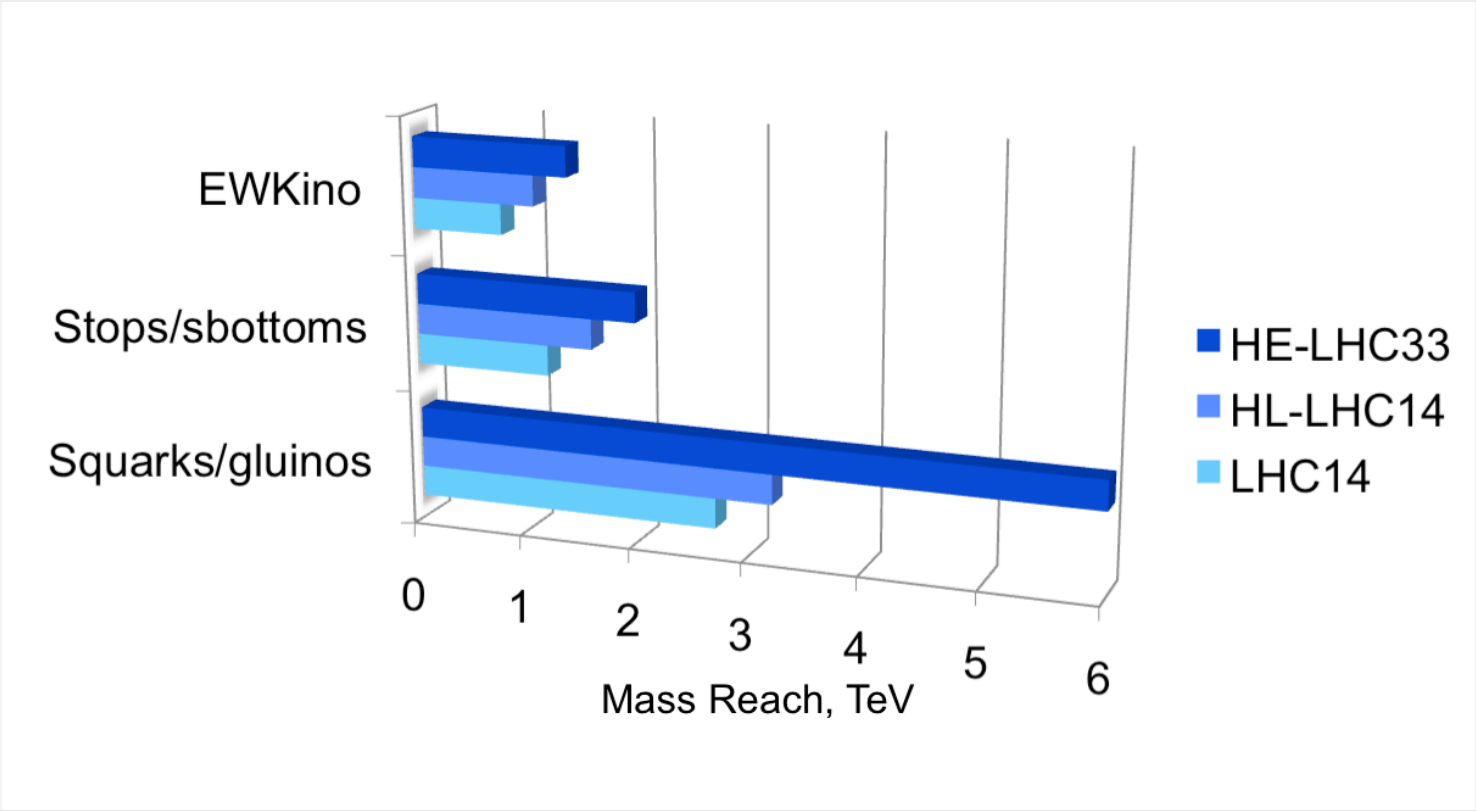
- HL-LHC statistics would be vital in reaching understanding of complicated SUSY channels
- Performance of the detector here is vital
  - B-tagging
  - Lepton id

Here we need a lot of Integrated Luminosity, but it needs to be high quality. Lower pile-up is important.





Examples – expected reach for LHC upgrades



HL-LHC Parameters

Parameters agreed on at the 2nd HL-LHC Coordination Group

-maximum of 140 events per crossing

- ➔ $L = 5\ 10^{34}\ cm^{-2}\ sec^{-1}$ for 25ns
- ➔ $L = 2.5\ 10^{34}\ cm^{-2}\ sec^{-1}$ for 50ns

Pile-up density leveling

- ➔ Leveling options?

-goal for integrated annual luminosity:

- ➔ 250 fb^{-1} per year

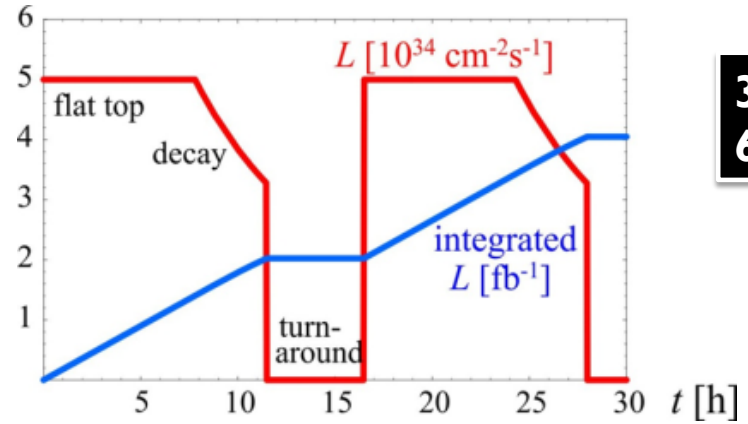
-Total luminosity for HL-LHC project

- ➔ 3000 fb^{-1} total

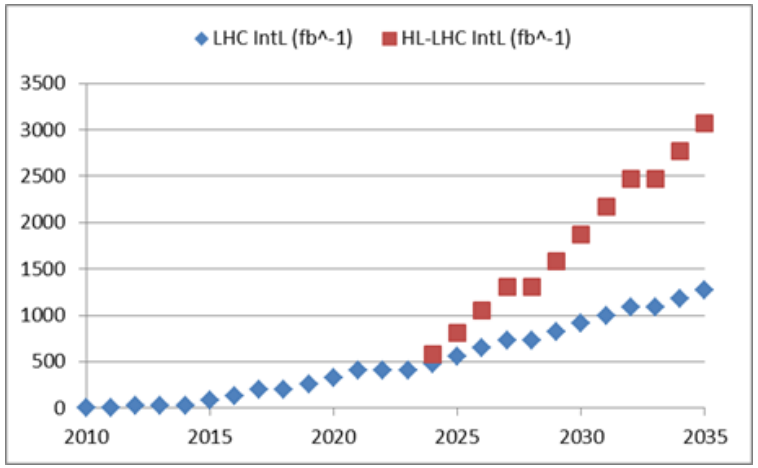
2nd HL-LHC General Meeting 13-14 November 2012 Oliver Brüning BE-ABP CERN

Memo:
LUMI Leveling: is performed by moving the proton beams relative to each other to modify the area available for interactions

Final goal : 3000 fb^{-1} by 2030's…



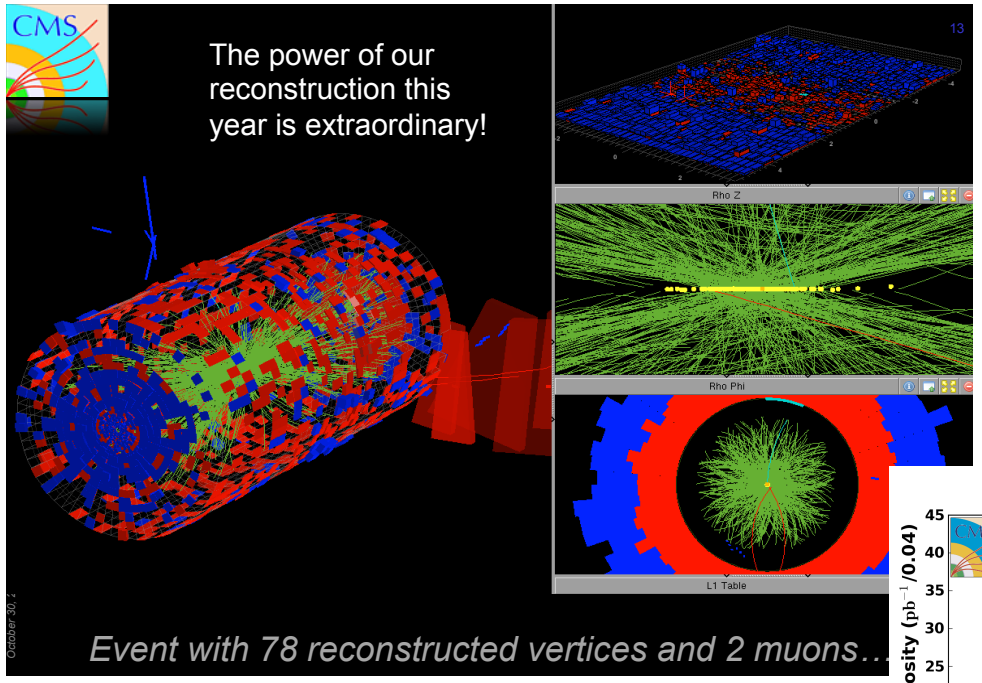
3/fb per day
60% of efficiency



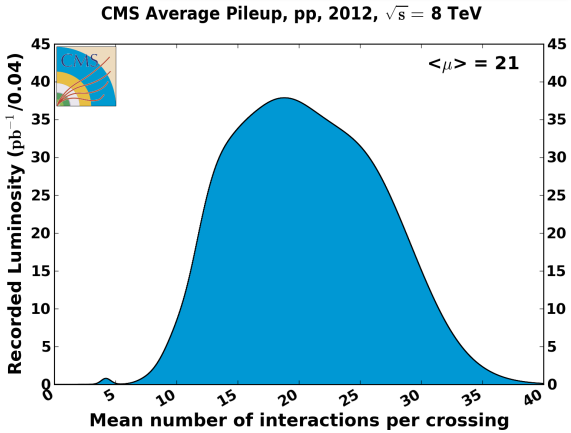
HL-LHC

Consolidation only

More luminosity means more pileup



Because the LHC is running with 50ns bunch spacing, pile-up is already at design levels.



First stage of upgrades must cope with about a factor of two above the design luminosity of the LHC.
The inner tracking layers are crucial

Time needed for Phase II R&D

- There were about 10 years of R&D for the initial build of LHC detectors
- Followed by
  - 2 years proto-typing
  - 5 years production-install-commission
- To get a new big detector ready by 2022 the timescale of 2014 for a Technical Proposal just fits.
  - The detectors for phase II are the same scale as major sub-detectors were for the LHC, and technically more complex
- We will need to ensure we are doing enough focused R&D to be ready to make designs and decisions.


CERN
Accelerating Science and Innovation
The High Energy Frontier :
From Todays Discovery
to the Future
R.-D. Heuer, CERN
Terascale Alliance, Dec 4, 2012

In conclusion….

Approved LHC 300 fb-1 at 14 TeV:

- Higgs mass at 100 MeV
- Disentangle Spin 0 vs Spin 2 and main CP component in ZZ*
- Coupling rel. precision/Exper.
  - Z, W, b, τ 10-15%
  - t, μ 3-2 σ observation
  - $\gamma\gamma$ and gg 5-11%

HL-LHC 3000 fb-1 at 14 TeV:

- Higgs mass at 50 MeV
- More precise studies of Higgs CP sector
- Couplings rel. precision/Exper.
  - Z, W, b, τ, t, μ 2-10%
  - $\gamma\gamma$ and gg 2-5%
  - H□HH >3 σ observation (2 Exper.)

Assuming sizeable reduction of theory errors

F.Cerutti - Higgs Factory


beyond LHC ?

Beyond High Energy LHC

- **First studies on a new 80 km tunnel in the Geneva area**
  - **42 TeV with 8.3 T using present LHC dipoles**
  - **80 TeV with 16 T based on Nb3Sn dipoles**
  - **100 TeV with 20 T based on HTS dipoles**

Figure 9. Two possible location, upon geological study, of the 80 km ring for a Super HE-LHC (option at left is strongly preferred)

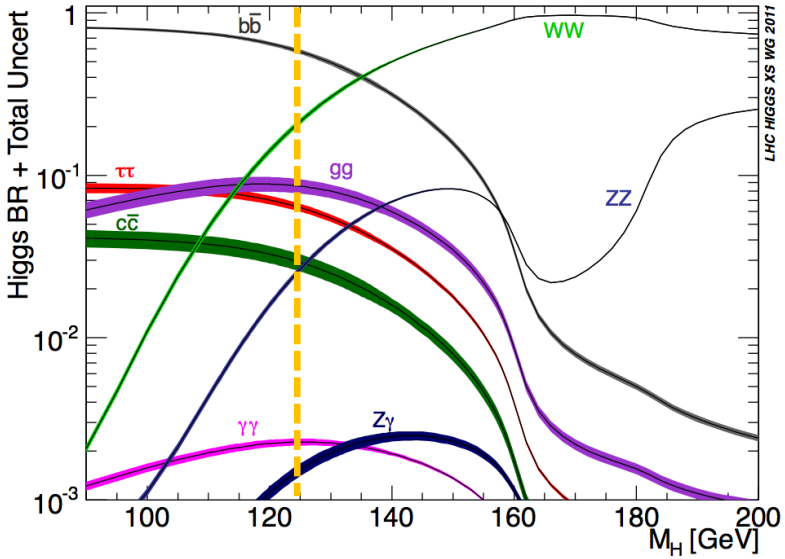
Ma ci sono altre opzioni in vista…

LEP3: a low-cost, high-luminosity Higgs factory

Mike Koratzinos on behalf of the
LEP3 proto-collaboration

Question #1 : Precision Needed

- Couplings: a Higgs with a mass of 125GeV decays in the most diverse fashion
- Many channels are open – most couplings can be measured from decays
- Large theoretical uncertainties (2 - 6%, mostly QCD) that need to be improved



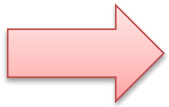
- **Are the effects of new physics measurable ?**

m_H = 125 GeV

Decay	BR [%]	Unc. [%]
bb	57.9	3.
ττ	6.4	6.
cc	2.8	12.
μμ	0.022	6.
WW	21.6	4.
gg	8.2	10.
ZZ	2.6	4.
γγ	0.27	5.
Zγ	0.16	9.
ΓH [MeV]	4.0	4.

Higgs factories

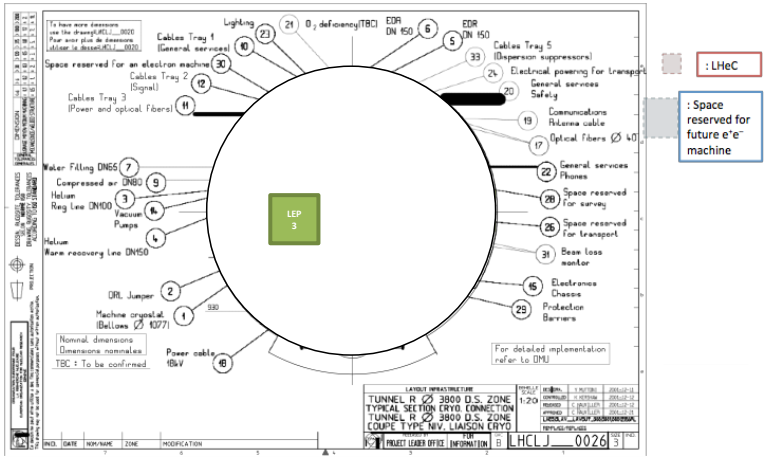
- …so we need another, complementary, machine
- This could be a
  - Muon collider
  - γγ collider
  - e^+e^- collider
- If it is an e^+e^- collider, it can be a linear or circular one
- If it is a circular e^+e^- collider,it can fit in the LHC tunnel (LEP3) or be installed in a new, larger tunnel (TLEP – 80 km)



See prof. Valery Telnov's talk

The LEP3 option : Where ?

- The obvious choice: in the LHC tunnel, too
  - LEP2 parameters were not that far from what we want
  - The cost would be minimized, by re-using
    - The tunnel Save 1 G$
    - The cooling infrastructure Save 1 G$
    - Two multi-purpose detectors (CMS/ATLAS) Save 1 G$
  - Also saves significant amount of time for construction
  - Integration in the tunnel : less difficult than LHeC (no concurrent operation needed)



…alternatively

After the 13 TeV programme
(with or without HL-LHC run,
choice depends on physics in 2022)

Before the 33 TeV programme
(Should HE-LHC be chosen as our LHC upgrade, cannot start before 2035 to have magnets ready)

The bigger picture

- Does it make sense to invest in a machine like LEP3?
  - Depends primarily on the physics outcome of the LHC running at 13TeV (so we will not know before 2017)
  - If at 2017 the priority would be to measure the Higgs properties, then:
    - LEP3 can do it more economically than the ILC
    - LEP3 can do it better than HL-LHC
- LEP3 remains a good idea that should be investigated further

Conclusion

❖ A Higgs factory is needed for precision measurement of the Higgs properties. Most probable candidates:

Linear e+e- Collider (2E=240-350 GeV)
Ring e+e- Collider (2E=240-350 GeV, depending on R)
Muon collider (2E=126 GeV)
$\gamma\gamma$ collider, only as add-on to e+e-.

❖ The choice depends on LHC discoveries:

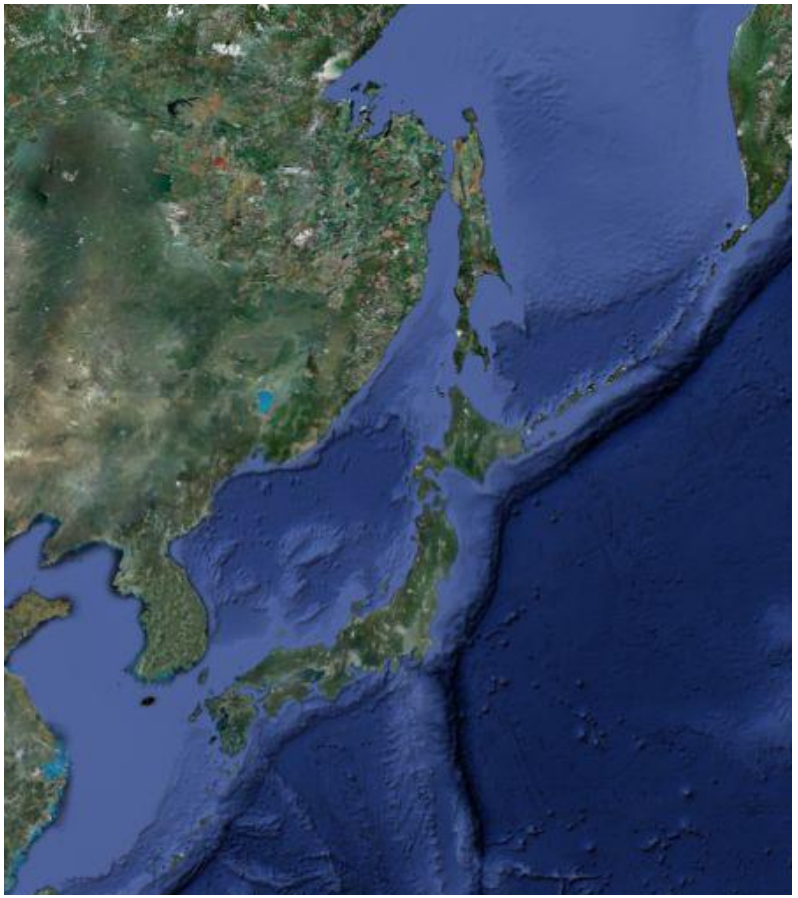
If new physics (like SUSY, etc) exists in 200-1000 GeV region, then ILC or CLIC.

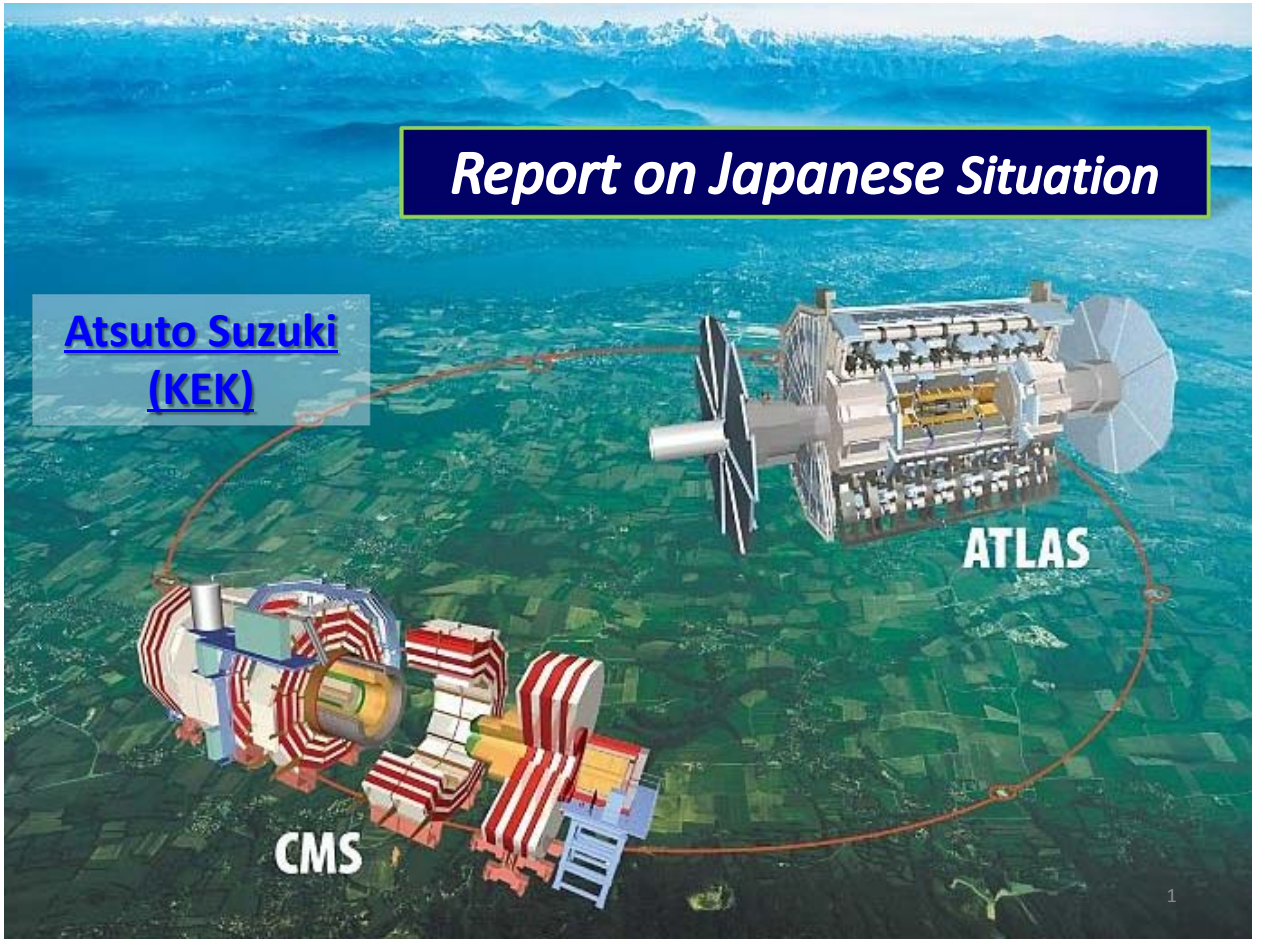
If new physics exist in 1000-3000 GeV region, then CLIC.

If nothing, except H, is found, then a low energy e+e- Higgs factory, ring or LC. Ring Higgs factory with large R looks very attractive.

❖ Muon collider is always welcome (as potentially a highest energy collider)

Cambiamo continente e facciamo un salto in…



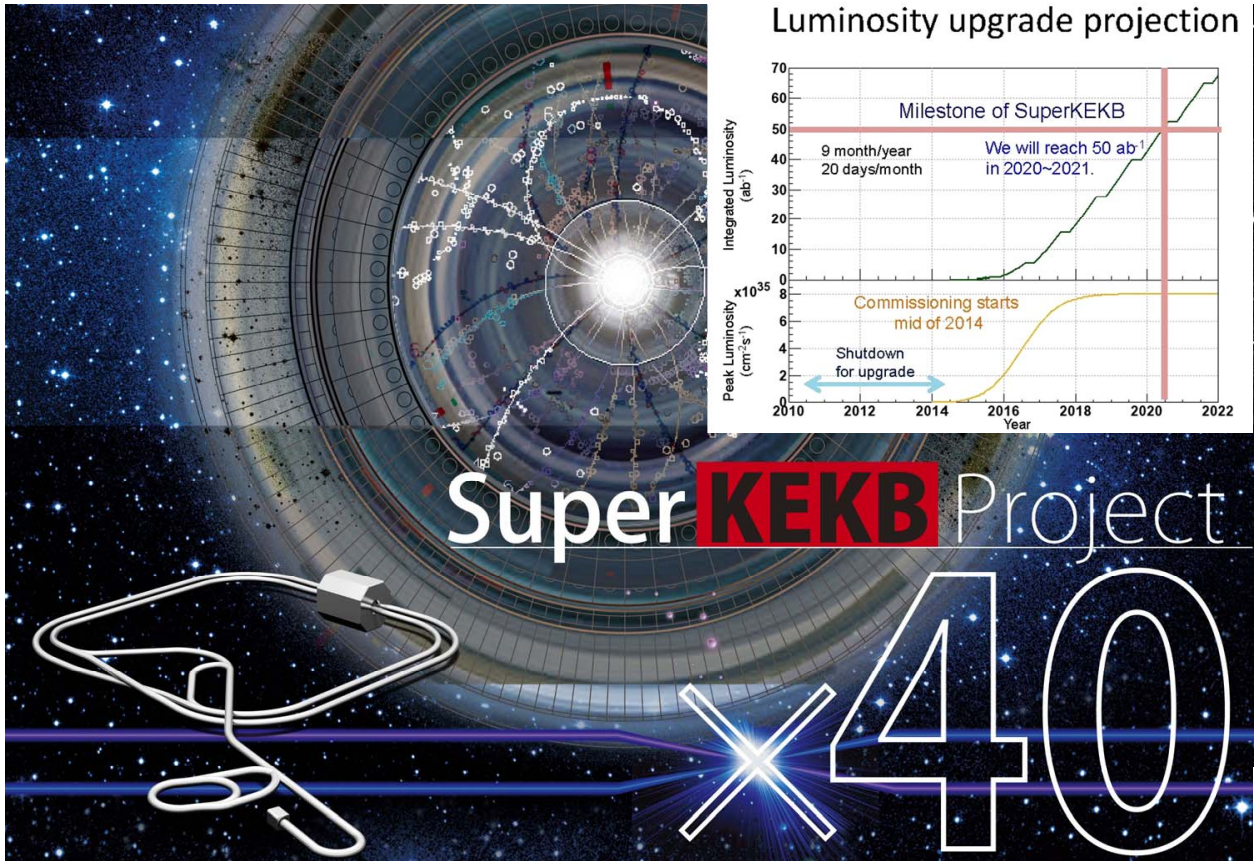

Report on Japanese Situation
Atsuto Suzuki
(KEK)
ATLAS
CMS
1

Large Projects (1)

- If a new particle such as a Higgs boson with a mass below around 1TeV is confirmed at LHC, Japan should take the leadership in early realization of e^+e^- linear collider. In particular if the particle is light, experiments at low collision energy should be started at the earliest possible time. In parallel continuous studies on new physics should be pursued at LHC and upgraded LHC. If the energy scale of new particles/physics is higher, accelerator R&D to realize the necessary collision energy should be reinforced.

1. Quark Flavor Project

KEKB upgrade to SuperKEKB



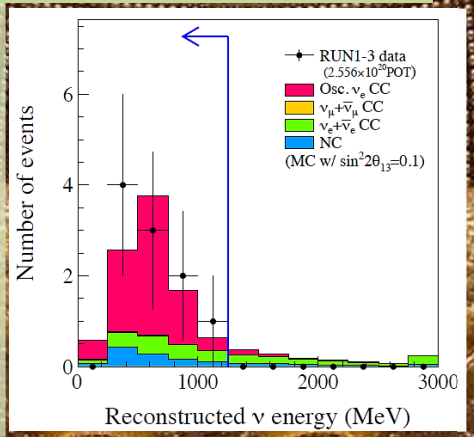
2. Lepton Flavor Project

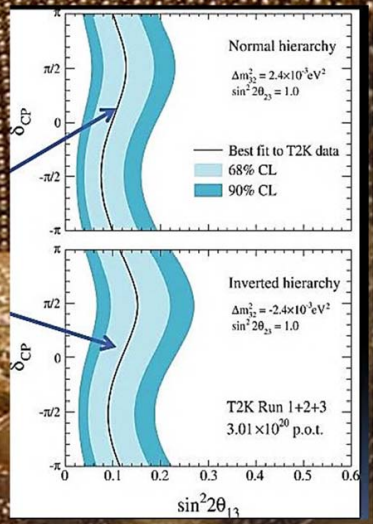
T2K Experiment

Long-Baseline Neutrino Experiment

$\nu_\mu \rightarrow \nu_e$ Result from T2K

- **10 electron neutrino candidates are detected**
- Expected **BG** (θ_{13}=0) is estimated to be **2.73±0.37 evts**
- Probability to observe >=10 evts w/ θ_{13}=0 is **0.08% (3.2σ)**
  - C.f. 0.7% (2.5σ) in 2011



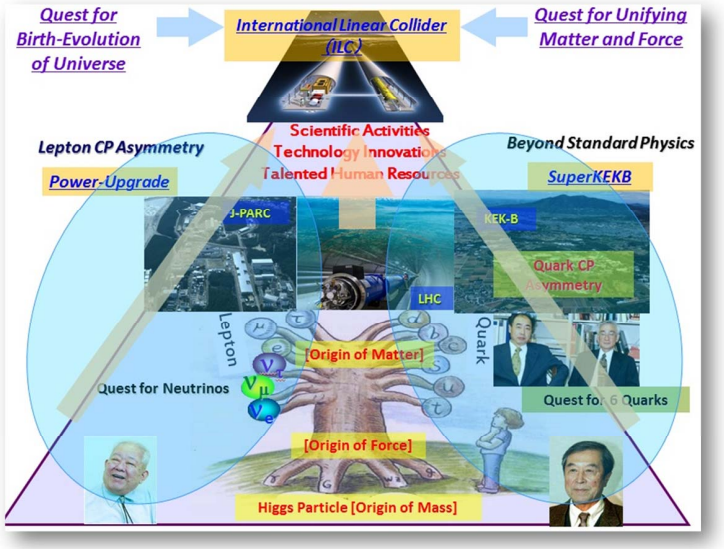


3. Energy Frontier Project

ILC Proposal from Japan

In 2008

1. Why ILC in Japan ? : 1



Why ILC in Japan ? : 2

Japan Policy Council
Second Recommendations:
Regional Development through Creation of Global Country inside Japan

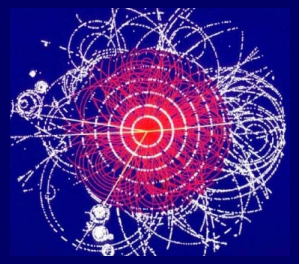
Realizing a global city that can attract human and financial resources from around the world: Regional development triggered by the International Linear Collider (ILC)

Realizing an international organization for the International Linear Collider (ILC), to push towards reforming regional cities as a role model for the creation of a global country.

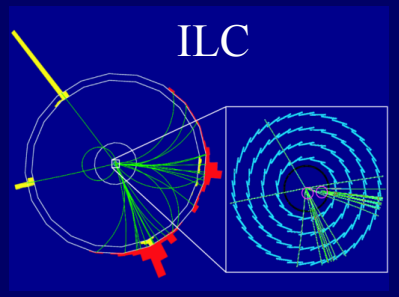
ILC Physics

- LHC discovery of Higgs-like particle :
  - Beginning of new era of particle physics
    - Is it the Standard Model Higgs?
    - Where is the dark matter?
    - Is there really new physics at Terascale?
- ILC Higgs
  - Generate ~10K Higgs (can be tagged!)
    - 5 σ sensitivity in ~ 1 day (LHC : ~1 year)
  - Higgs Brs to a few % (LHC : a few 10s %)
    - e.g. H → cc (LHC : cannot)
  - Γ_{tot} to 5% (challenging at LHC)
  - CP to 3~4% (mix coeff)
- ILC top
  - m_t(msbar) to 100 MeV (LHC: ~ 1 GeV)
  - Anomalous ttZ, tbW, ttg coupl (LHC: hint of ttg only)
- ILC new physics
  - Composite Higgs scale to 45 TeV (LHC: ~7 TeV)
  - Anomalous WWV coupl (x10 better than LHC)

LHC



ILC

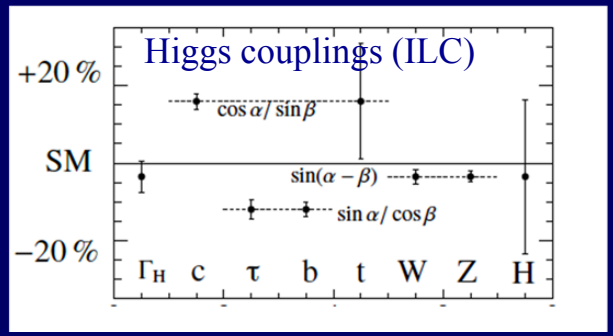


ILC: Simple and clean initial&final states

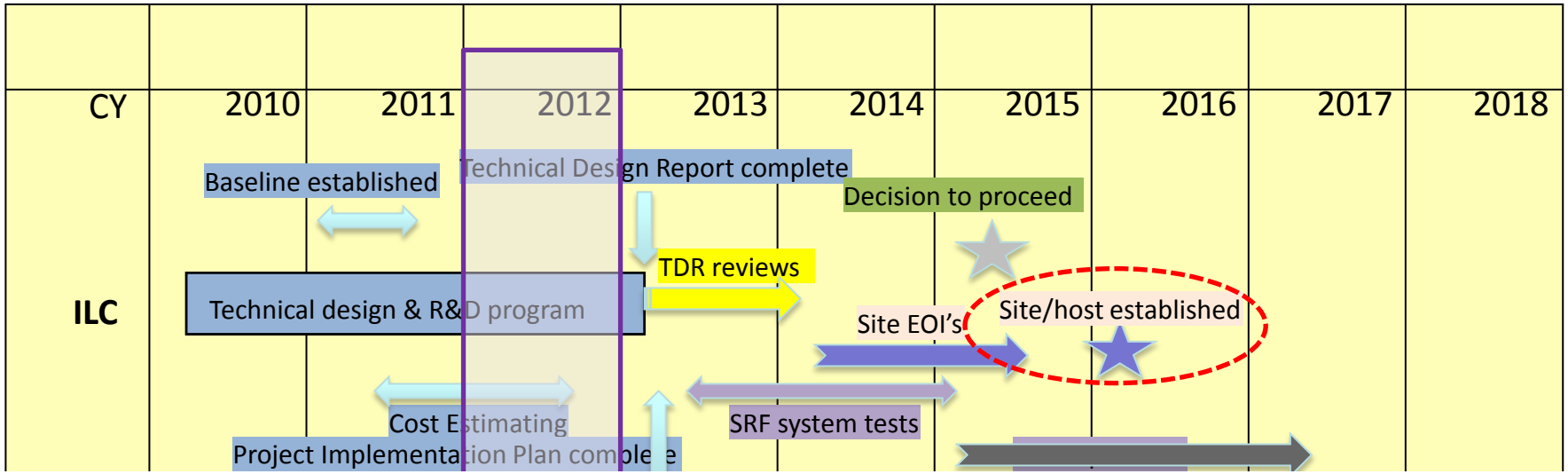
Specify Initial-state 4-momentum

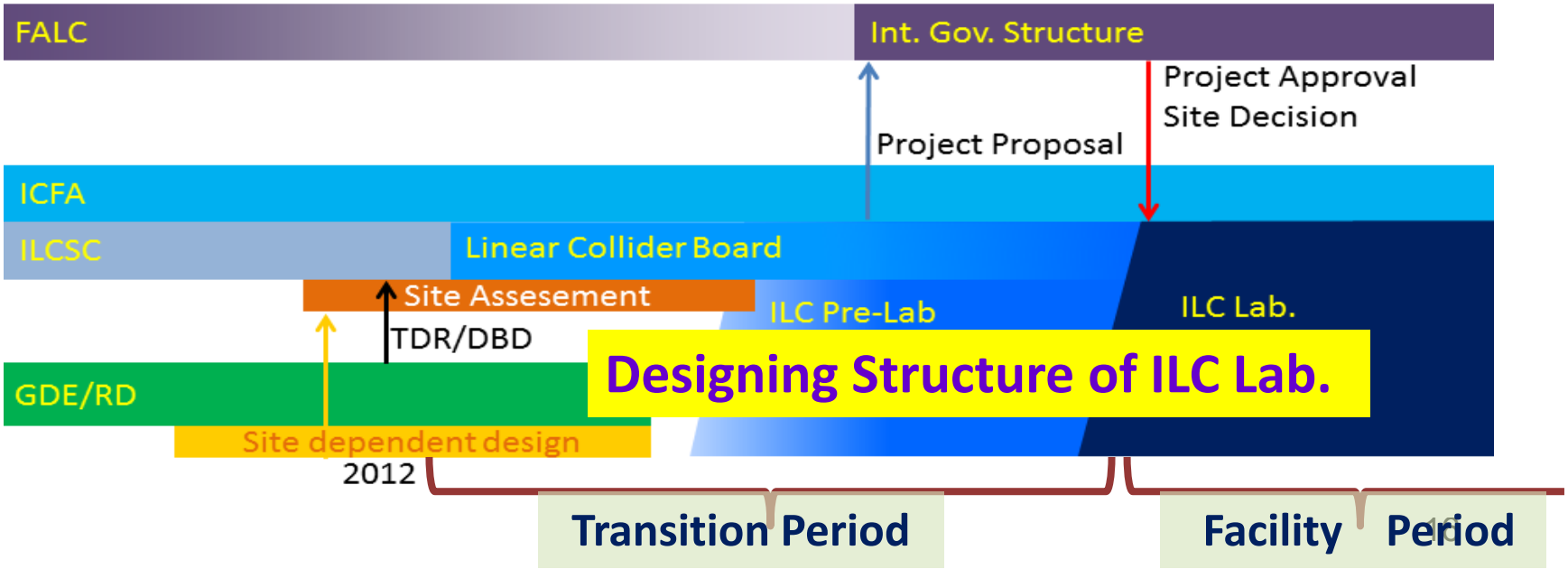
& beam polarization : control intermediate state

(e.g. e_R turns of $W^{\pm}$&A^0)



2. ILC Possible Timeline





Ora però torniamo a…

European Strategy for Particle Physics
Update Process Status

https://europeanstrategygroup.web.cern.ch/EuropeanStrategyGroup/

ESG meeting

CERN, Geneva, 11 December 2012

T. Nakada

EPFL-LPHE

Lausanne, Switzerland

Scientific Secretary for Strategy Session of CERN Council

Chair of Strategy Group and Preparatory Group

Some issues from Briefing Book

- Introduction
  - Major scientific changes since 2006
    - Experience in LHC operation, both by the machine and experiments in p·p, Pb·Pb, p·Pb collisions
    - Discovery of Higgs like particle
    - Compelling sign of physics beyond the Standard Model neither from the direct search at high energy nor precision experiments so far
    - Third angle, θ_{13}, in the neutrino mixing found to be ≠0
  - Major items where decisions are required (in random order)
    - LHC upgrade for 0.3 → 1 or 3 ab^{-1}
    - Short and long baseline neutrino facilities and experiments
    - Toward ILC under discussion in Japan
    - Needs for preparing for the decision process of the next large machine in Europe

Some issues from Briefing Book

- High Energy Frontier (I)
  - ATLAS and CMS achievement
    - Standard Model Physics: QCD, top, W, and Z
    - Higgs studies: production and decays
    - Search for particles beyond the Standard Model
  - ATLAS and CMS prospects for short ($\int L dt = 0.3$ ab^{-1}) and longer term (1 to 3 ab^{-1})
    - Higgs studies and New Physics search
  - Achieving higher energies with 16 to 20 T dipoles
    - with the LHC tunnel: 26 to 33 TeV (HE-LHC)
    - New 80 Km circumference tunnel: 42 to 100 TeV (VHELHC)

Some issues from Briefing Book

- High Energy Frontier (II)
  - e^+e^- colliders
    - Higgs studies at $\sqrt{s} \approx 250$ GeV ($e^+e^- \rightarrow HZ$)
    - Higgs studies at much higher energies ($e^+e^- \rightarrow H\tau\tau$, HHZ, HH$\nu\nu$, …)
    - Trilinear and quartic gauge coupling
    - Top physics (mass in particular)
    - Search for weakly coupling SUSY particles
    - Linear colliders versus circular colliders
      - at lower energies, $L_{\text{circular}} > L_{\text{linear}}$
      - $\sqrt{s}$: circular limited to 350 GeV, linear > 500 GeV
      - many machines built for circular, only one for linear
      - paper/software studies for circular, TDR/CDR stages for linear
      - expandability: circular TLEP→VHELHC, linear 250→500→?
      - $\gamma\gamma$ collider: 2×125 GeV e^- + laser, limited to $\gamma\gamma \rightarrow H$

Some issues from Briefing Book

- High Energy Frontier (IV)
  - CDR for LHeC
    - LHC p/ion, + 60 GeV e from re-circulating lineac, L_{target} (e^-p) = 10^{33} cm^2s^{-1} running together with LHC from > 2025
    - PDF of p for the LHC relevant range
    - search for new particles (e.g. leptoquark)
  - Muon collider
    - multi TeV lepton collider with a "reasonable" size
    - neutrino factory as a possible intermediate stage

Some issues from Briefing Book

- Flavour and Precision Physics (I)
  - Look for Physics Beyond the Standard Model for quark and leptons via
    - Qualitative studies
      - search for forbidden processes in the SM, e.g. lepton number violation decays
      - search for processes at a well above the rate predicted by SM, e.g. neutron dipole moment
    - Quantitative studies
      - measure the SM parameters with an extremely high precision and look for a deviation, e.g. $\mu(g-2)$
    - Global studies
      - to measure same quantities with a good precision but in many different ways and test a consistency, e.g. CKM parameter studies
  - Potentially sensitive to energy scales much higher then direct searches.

Some issues from Briefing Book

- Flavour and Precision Physics (II)
  - Done at different energies with different facilities for
    - With existing facilities, e.g. LHC
    - With dedicated facilities, e.g. (Super) B factories
    - With high intensity beams at high energies, e.g. NA62
    - With high intensity beams at low energies, e.g. MEG
  - Results on B_s and D from LHCb do not show any compelling evidence for new physics.
  - Future requirements are (usually); clean measurements with high intensities→ accelerator and beam lines, detector and clever ideas
  - Interesting measurements can still be done with small to medium size investments → effort at national laboratories are also possible and on going

Strategy Statements

- Scientific Issues
  - The LHC will be the energy frontier machine for the foreseeable future, maintaining European leadership in the field; ***the highest priority is to fully exploit the physics potential of the LHC, resources for completion of the initial programme have to be secured such that machine and experiments can operate optimally at their design performance. A subsequent major luminosity upgrade (SLHC), motivated by physics results and operation experience, will be enabled by focused R&D; to this end, R&D for machine and detectors has to be vigorously pursued now and centrally organized towards a luminosity upgrade by around 2015.***

→LHC is running now and the base programme is up to ~300 fb^{-1}. Do we have scientific justification already now to upgrade machine and experiments for 1 to 3 ab^{-1}?

Strategy Statements

- Scientific Issues (continue)
  - In order to be in the position to push the energy and luminosity frontier even further it is vital to strengthen the advanced accelerator R&D programme; ***a coordinated programme should be intensified, to develop the CLIC technology and high performance magnets for future accelerators, and to play a significant role in the study and development of a high-intensity neutrino facility.***

→LHC results at ~13 TeV needed for the decision on the next large accelerator in Europe.

Strategy Statements

- Scientific Issues (continue)
  - It is fundamental to complement the results of the LHC with measurements at a linear collider. In the energy range of 0.5 to 1 TeV, the ILC, based on superconducting technology, will provide a unique scientific opportunity at the precision frontier; ***there should be a strong well-coordinated European activity, including CERN, through the Global Design Effort, for its design and technical preparation towards the construction decision, to be ready for a new assessment by Council around 2010.***

→Japanese HEP community sees a window of opportunity for the next couple of years to host ILC. What is the European position toward this initiative? Is this an opportunity for a new worldwide facility, complementing a possible future machine at CERN without jeopardizing it?

Strategy Statements

- Scientific Issues (continue)
  - Flavour physics and precision measurements at the high-luminosity frontier at lower energies complement our understanding of particle physics and allow for a more accurate interpretation of the results at the high-energy frontier; ***these should be led by national or regional collaborations, and the participation of European laboratories and institutes should be promoted.***

  →Need to be more explicit? e.g. exploitation of existing facilities, smaller scale experiments in lepton flavour violation, any new facilities required?

Strategy Statements

- Complementary Issues (continue)
  - Technology developed for nuclear and particle physics research has made and is making a lasting impact on society in areas such as material sciences and biology (e.g. synchrotron radiation facilities), communication and information technology (e.g. the web and grid computing), health (e.g. the PET scanner and hadron therapy facilities); ***to further promote the impact of the spin-offs of particle physics research, the relevant technology transfer representatives at CERN and in Member states should create a technology transfer forum to analyse the keys to the success in technology transfer projects in general, make proposals for improving its effectiveness, promoting knowledge transfer through mobility of scientists and engineers between industry and research.***
    →No real change needed.

Conclusioni

Bibliografia

Tutto il materiale presentato è stato preso in prestito dai seguenti talk:

- Sergio Bertolucci – HCP2012 12-16 Novembre 2012
  - **CERN now and in the Future**
  - http://kds.kek.jp/categoryDisplay.py?categId=835
- Martin Weber - Physics at the Terascale, 3-5 Dicembre 2012
  - **Searches**
  - http://indico.desy.de/conferenceDisplay.py?confId=5679
- Jordan Nash - Physics at the Terascale, 3-5 Dicembre 2012
  - **LHC: Upgrade and Outlook**
  - http://indico.desy.de/conferenceDisplay.py?confId=5679
- Rolf Heuer - New Year's presentation, 9 Gennaio 2013
  - **DG's New Year's presentation**
  - https://indico.cern.ch/conferenceDisplay.py?confId=219327
- Rolf Heuer - Physics at the Terascale, 3-5 Dicembre 2012
  - **The High Energy Frontier: From Todays Discovery to the Future**
  - http://indico.desy.de/conferenceDisplay.py?confId=5679

Bibliografia

- Atsuto Suzuki - 4th European Strategy Group Meeting, 11 Dicembre 2012
  - **Report on the Japanese situation**
  - http://indico.cern.ch/conferenceDisplay.py?confId=217861
- Tatsuya Nakada – European Strategy Group Meeting, 11 Dicembre 2012
  - **European Strategy for Particle Physics, Update Process Status**
  - http://indico.cern.ch/conferenceDisplay.py?confId=217861
- Mike Koratzinos - LHC ON THE MARCH 20-22 Novembre 2012
  - **LEP3: a low-cost, high-luminosity Higgs factory**
  - http://indico.cern.ch/conferenceProgram.py?confId=202467
- Valery Telnov - LHC ON THE MARCH 20-22 Novembre 2012
  - **Higgs Factory**
  - http://indico.cern.ch/conferenceProgram.py?confId=202467
- Benno List – Physics at the Terascale, 3-5 Dicembre 2012
  - **ILC: Scenarios for a Higgs Factory**
  - http://indico.desy.de/conferenceDisplay.py?confId=5679