Physics Potential of an Exteded Tevatron Run

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on behalf of the D0 and CDF collaborations

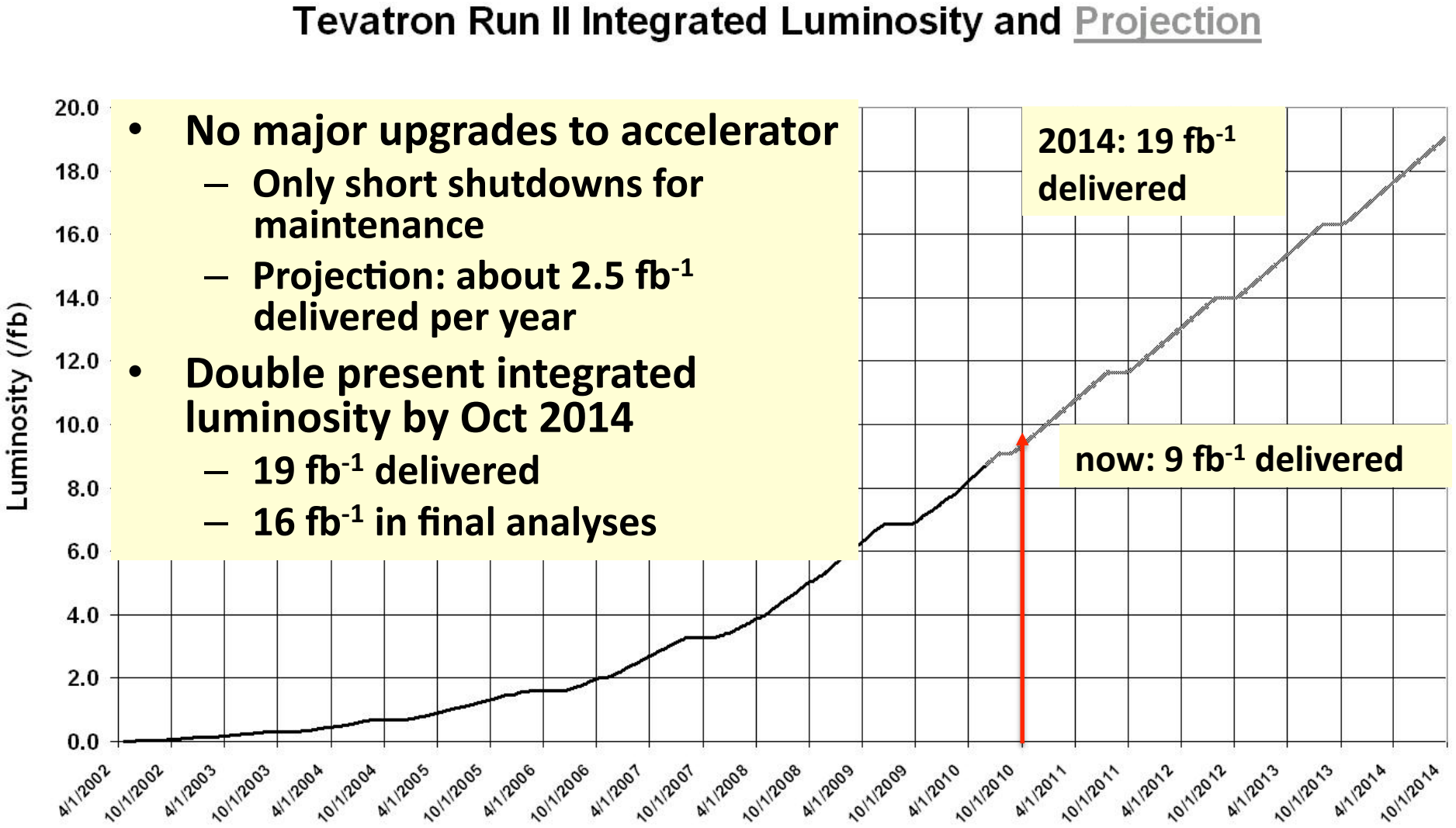
Irfu/SPP CEA-Saclay

Thanks in particular to Darian Wood for his HCP slides!

Overview

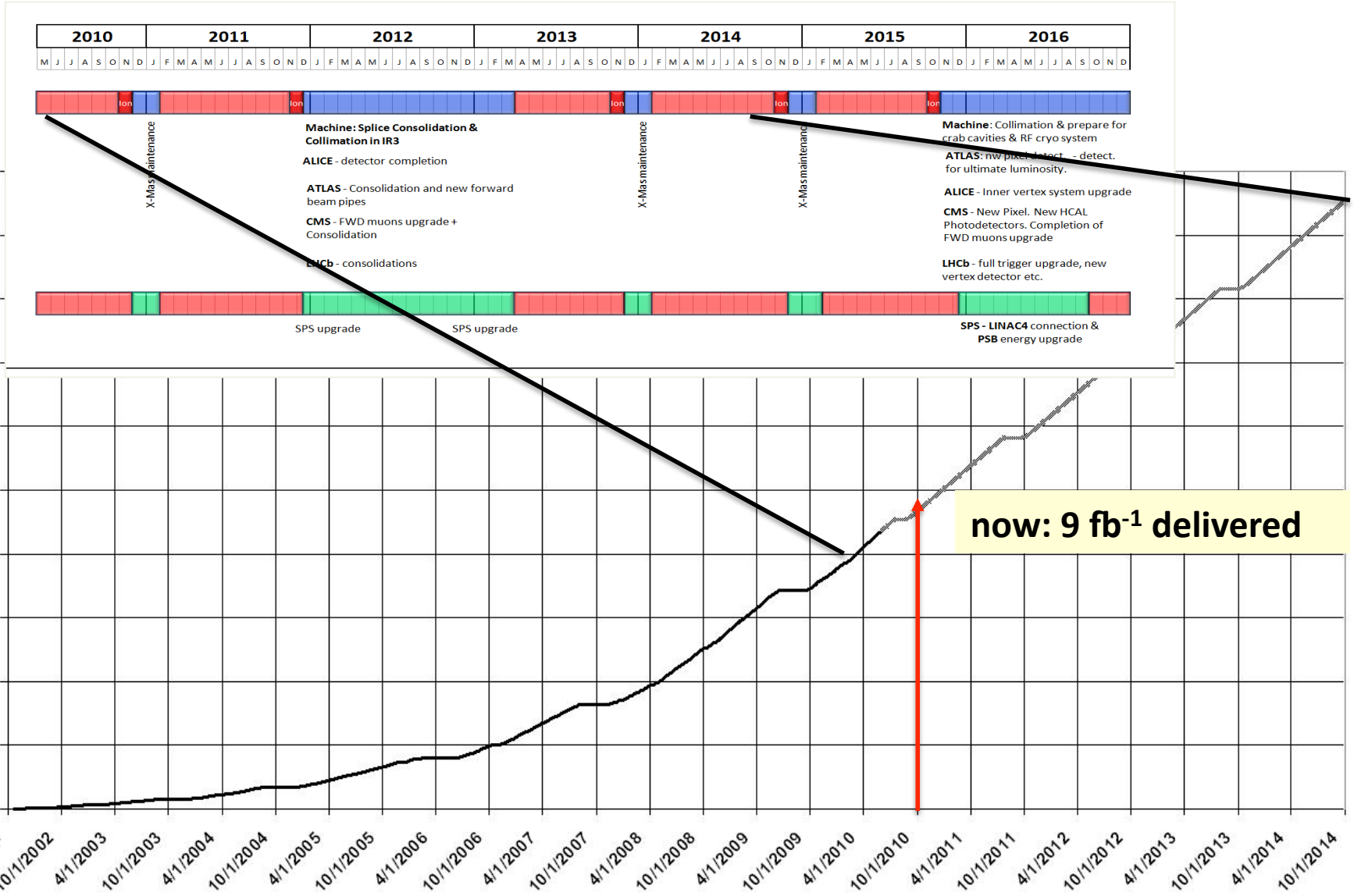
- The Context: Tevatron, CDF & Dzero, LHC
- Physics opportunities
  - Complementary Tevatron/LHC measurements
  - Legacy measurements
  - Higgs and other opportunities for discovery

Integrated Luminosity and Schedule



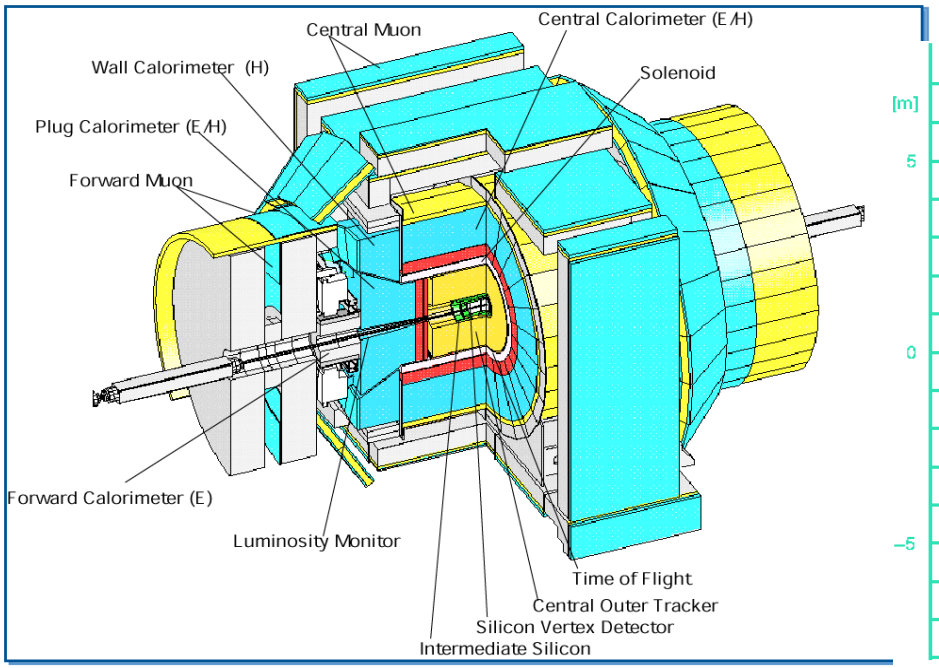
- **No major upgrades to accelerator**
  - **Only short shutdowns for maintenance**
  - **Projection: about 2.5 fb^{-1} delivered per year**
- **Double present integrated luminosity by Oct 2014**
  - **19 fb^{-1} delivered**
  - **16 fb^{-1} in final analyses**

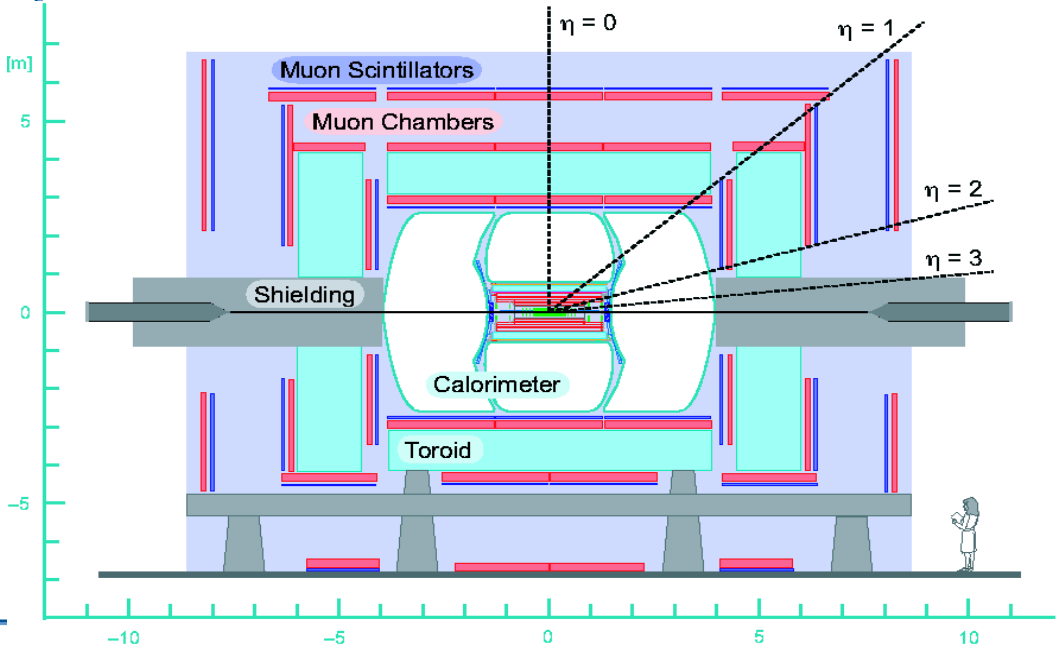
Integrated Luminosity and Schedule



CDF and Dzero Detectors

- Detectors operating stably for many years
  - Existing 9 fb^{-1} of luminosity has been used to track ageing effects
- Main attention is focused on aging of tracking detectors
  - Fermilab review in June 2010





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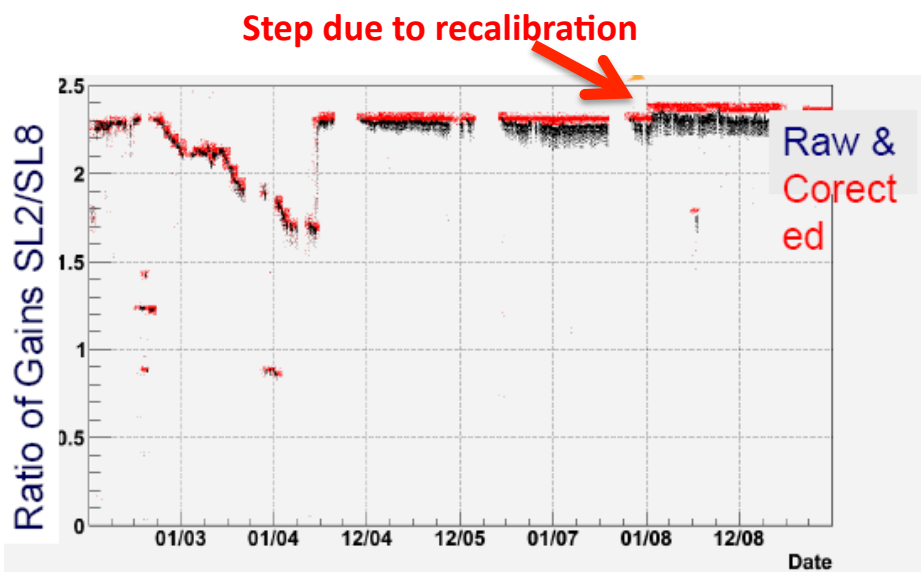
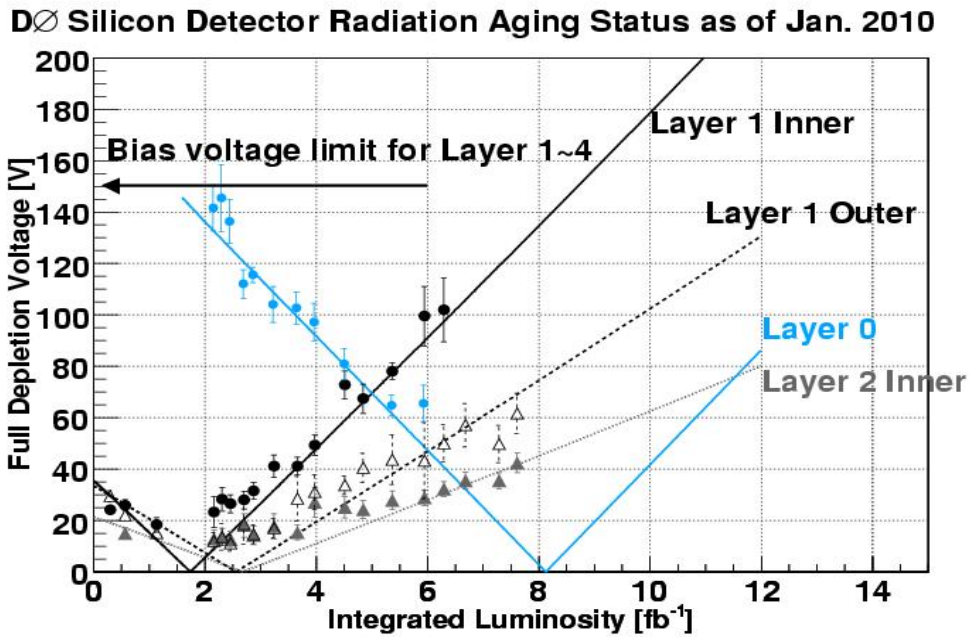
Example: CDF Central Outer Tracker (drift chamber)



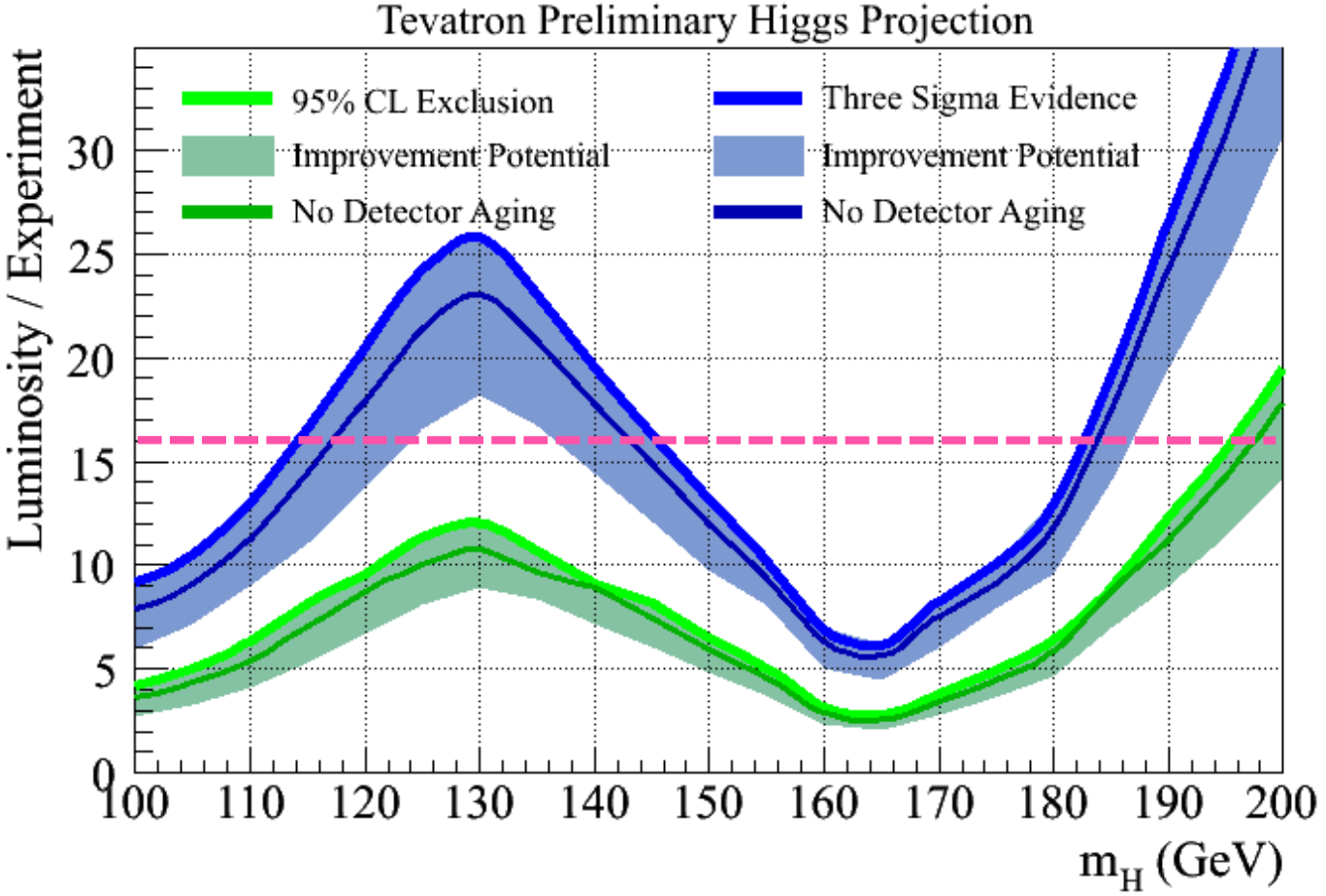
Example: Dzero Silicon Microstrip Detector: Layor 1 will be touched beyong 10fb^{-1}



Higgs projection

D0 only

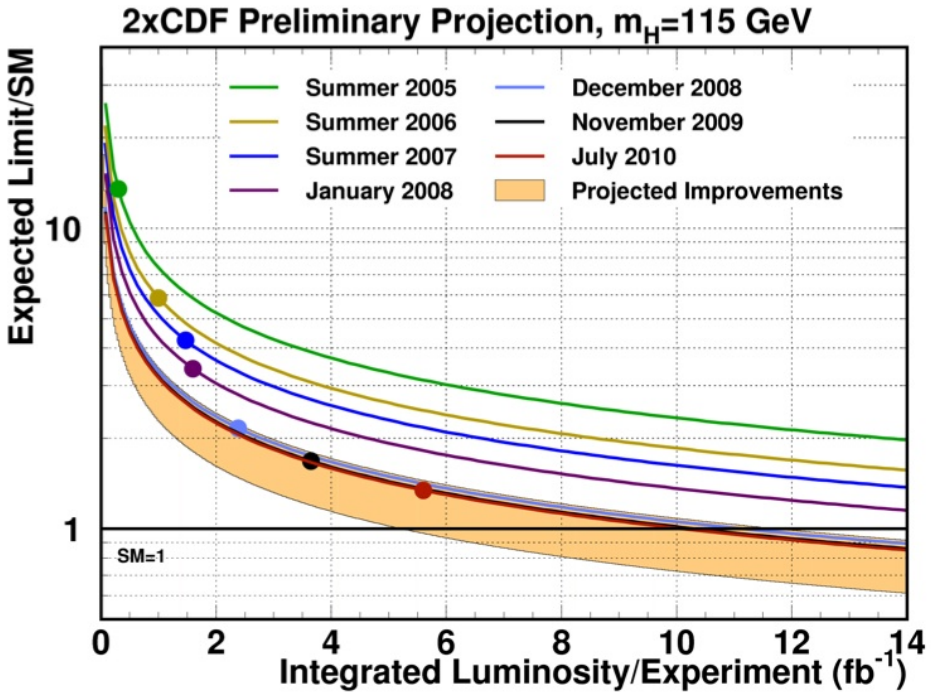
Essentially no Detector aging effects expected for CDF

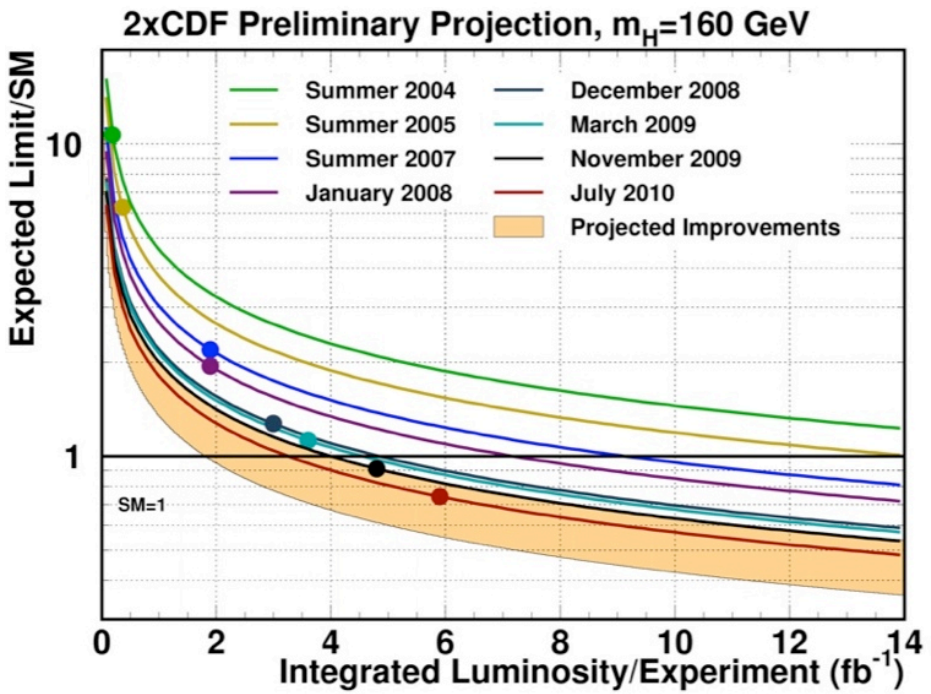


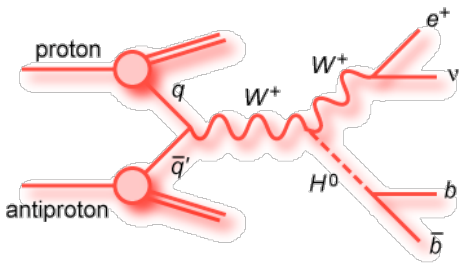
With 16 fb-1 at the Tevatron, expect:

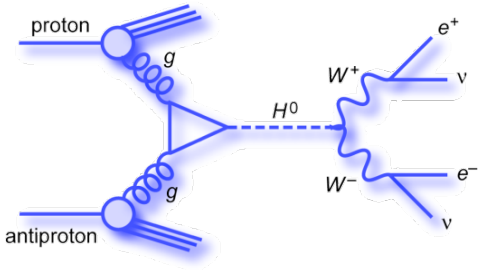
- 95% CL exclusion (and stronger) over whole range m_H<190 GeV
- 3σ evidence, in 100 < m_H < 180 GeV
- 4σ evidence for m_H=115 GeV

Higgs Improvements

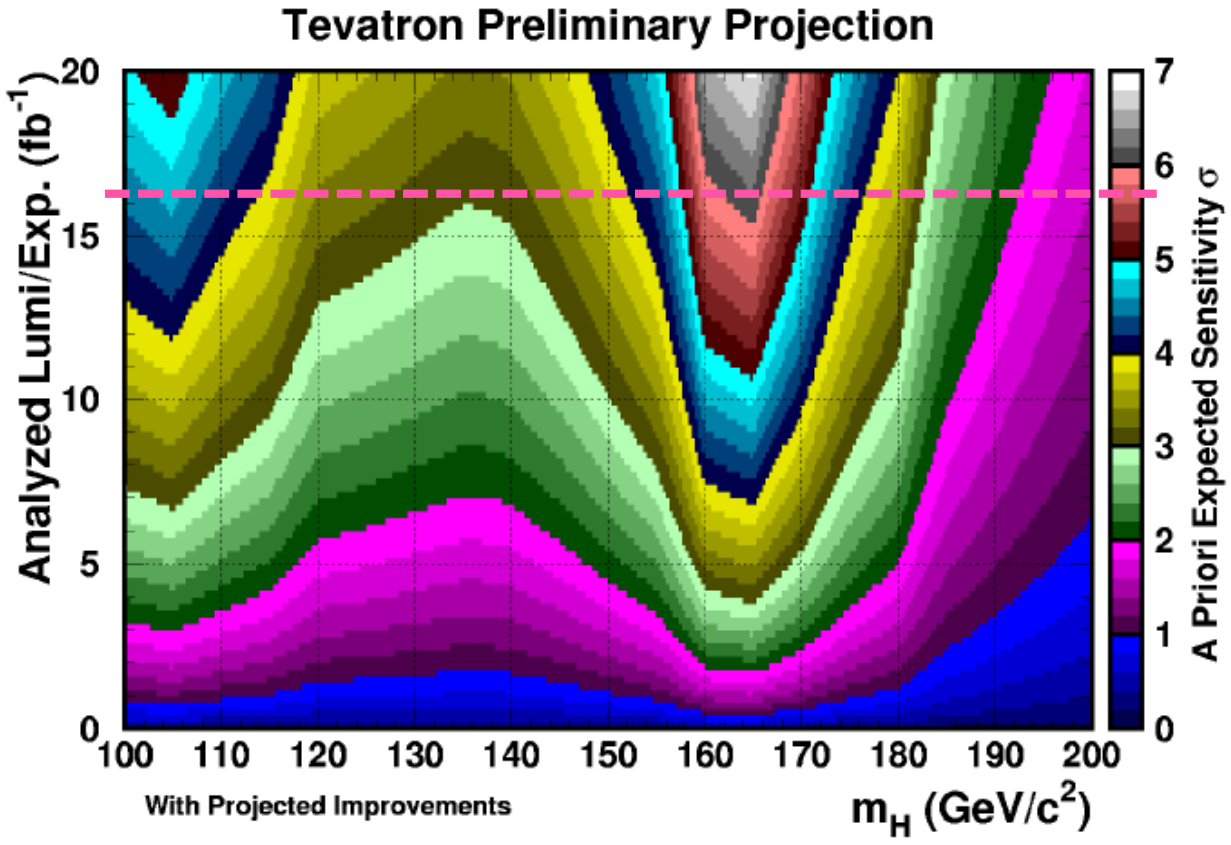








HIGGS PROJECTION



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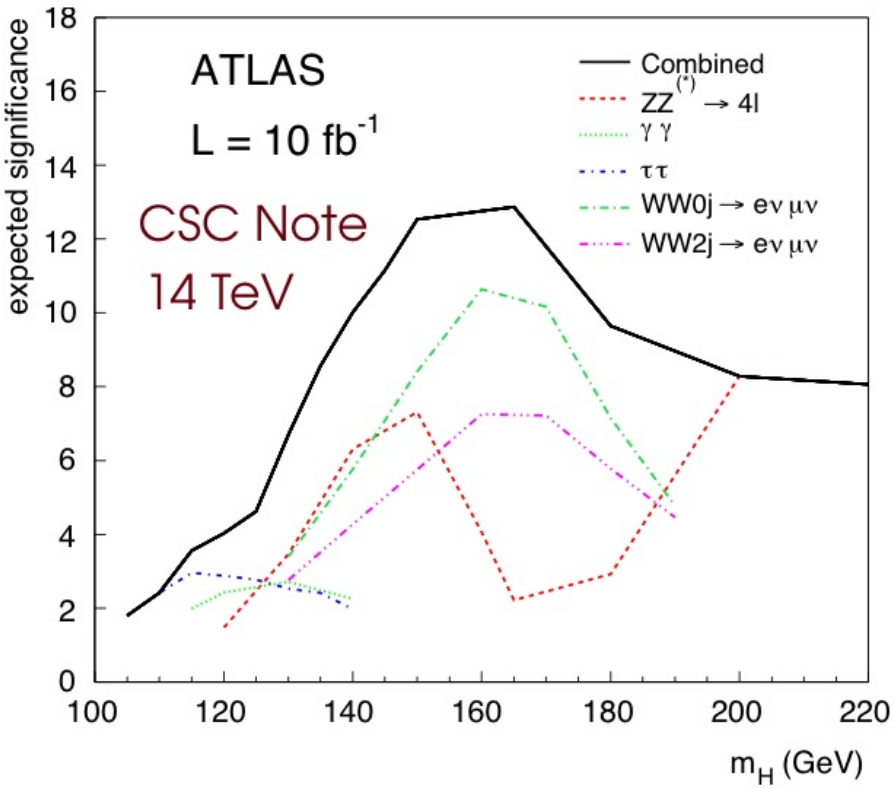
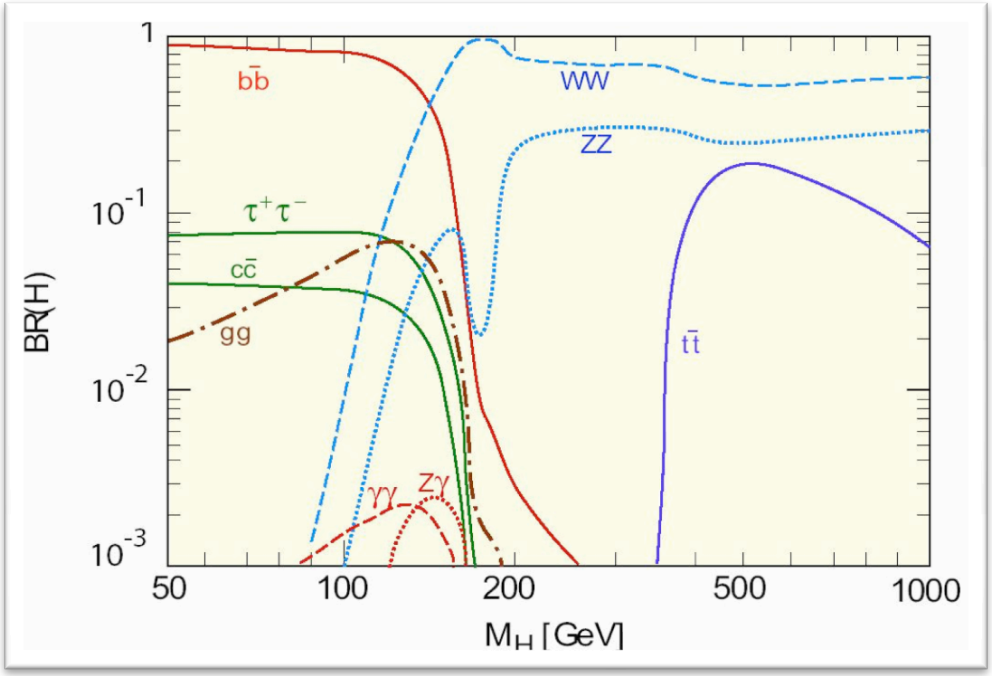
Complementary: Nature of the SM Higgs

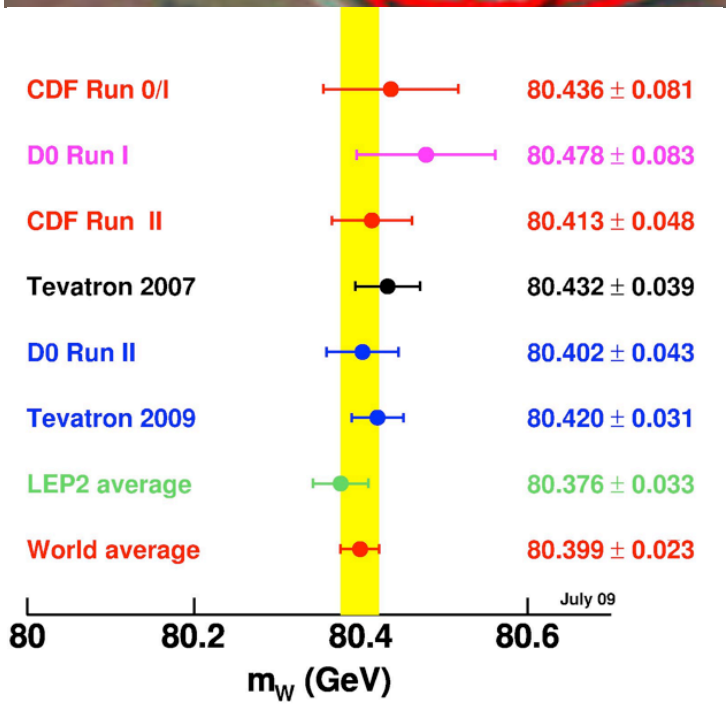
Low mass Higgs search at the LHC relies on $H \to \gamma\gamma$ and $H \to \tau\tau$



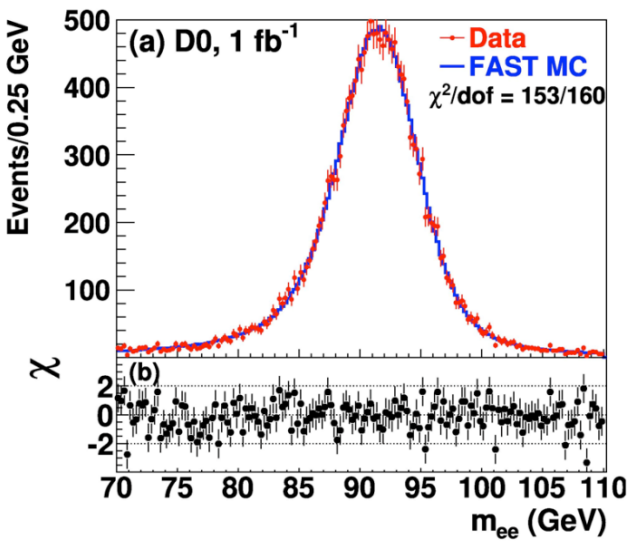


Yet observation of Higgs decays into b-jets is an important signature not to be missed!

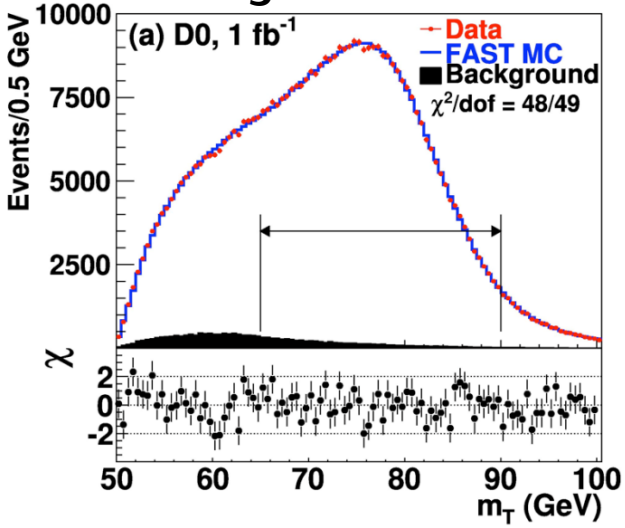
Future Legacy: W mass



calibration



signal



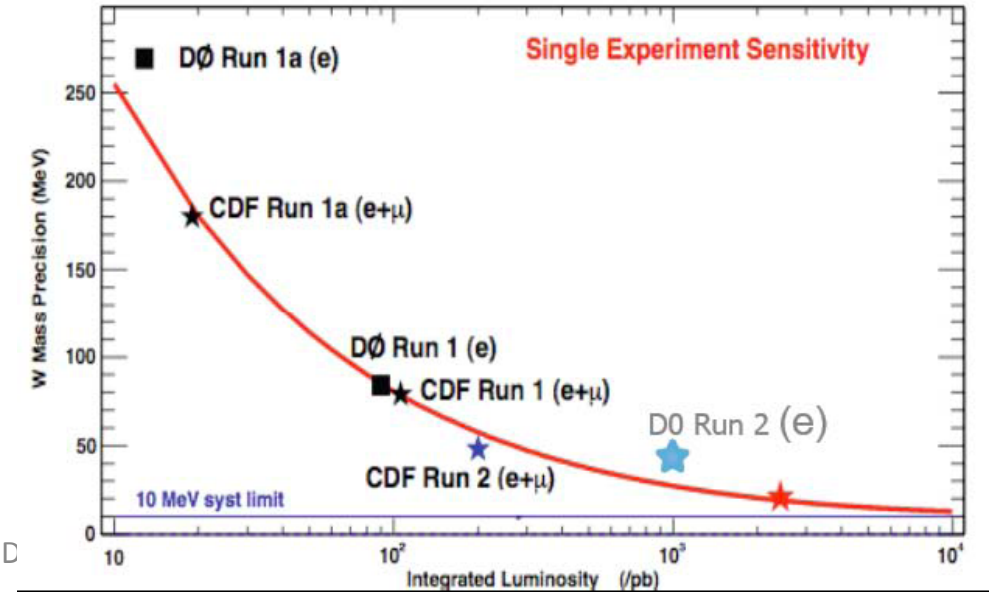
~18k events in 1 fb^{-1}

~485k events in 1 fb^{-1}

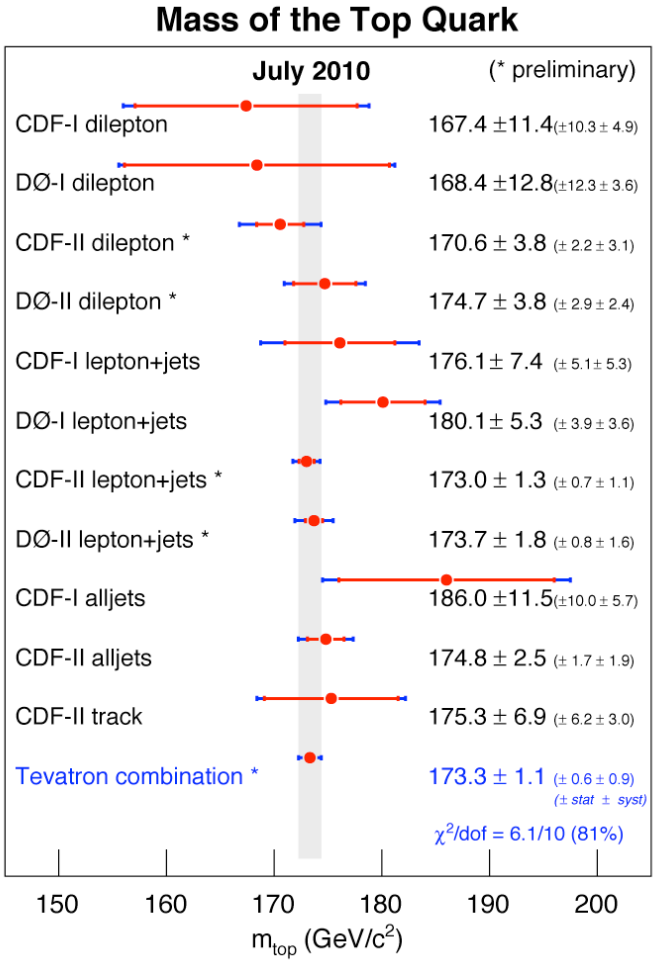
current Tevatron precision: 0.04%

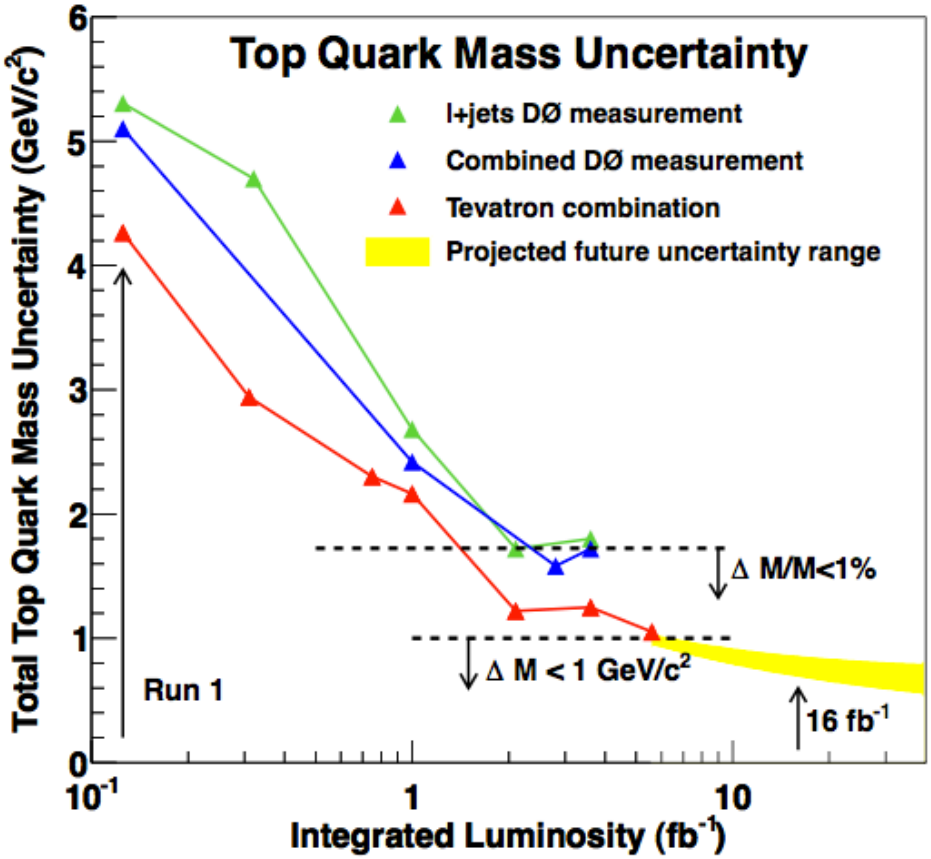
→expect improvements (statistics +systematics) with larger data sets

Aim: 15MeV error



Future Legacy: Top Mass

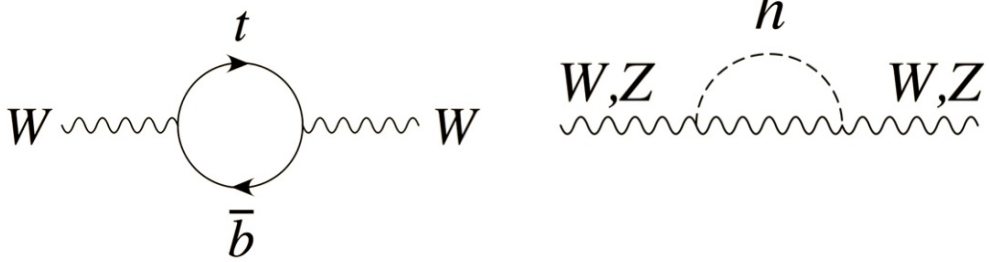




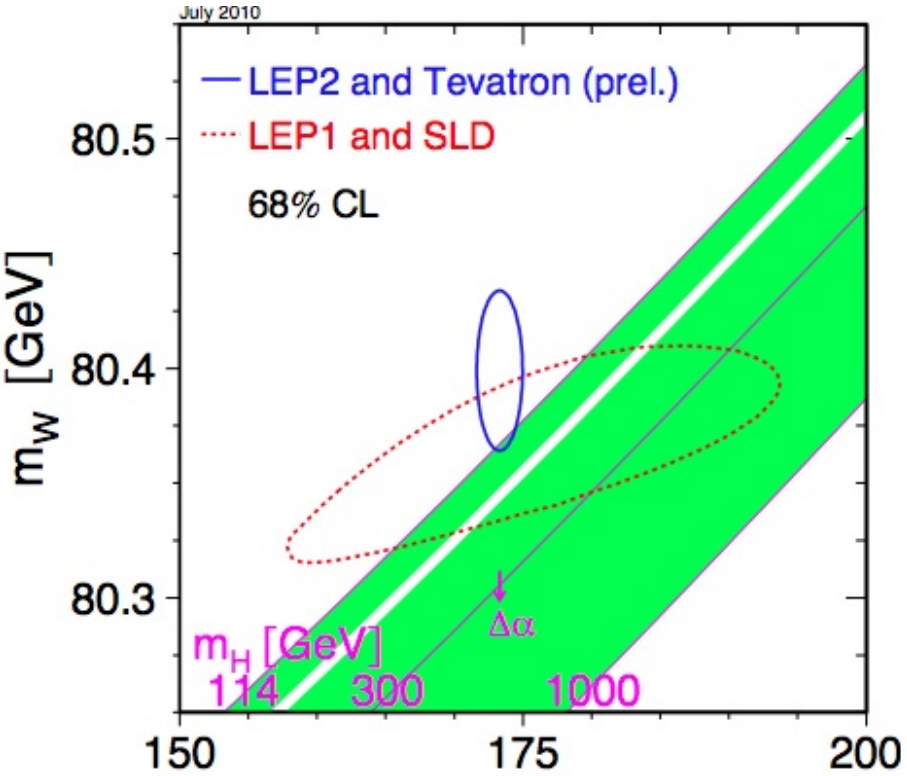
current Tevatron precision: 1.1 GeV ➔0.7%

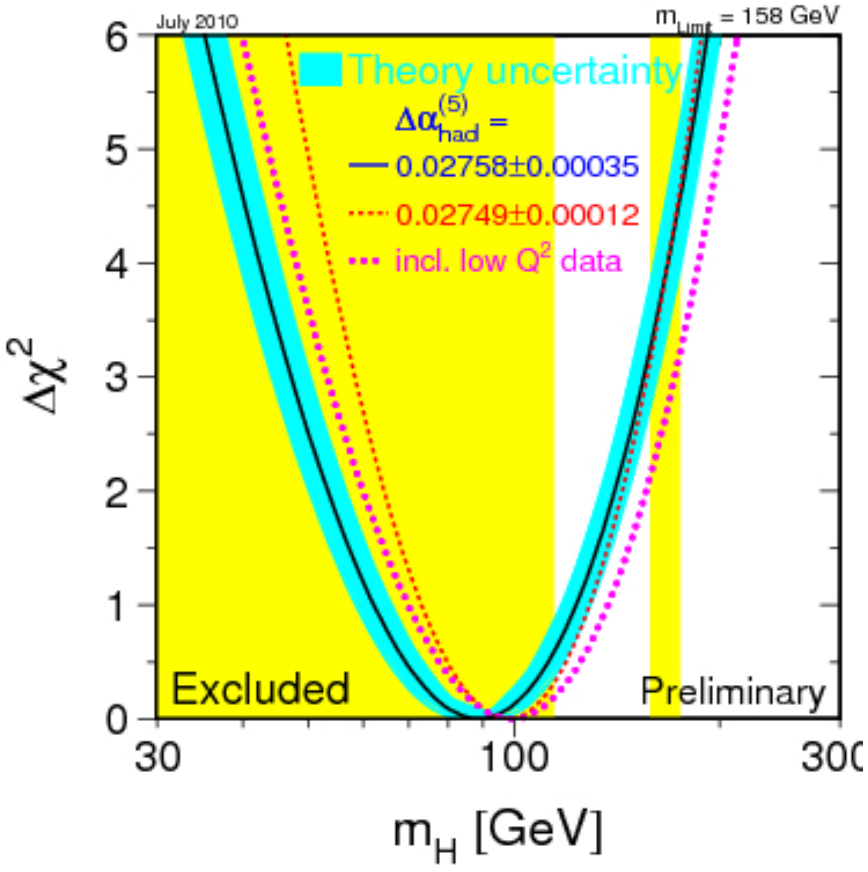
Aim : better than 1 GeV

Self-Consistency of the SM



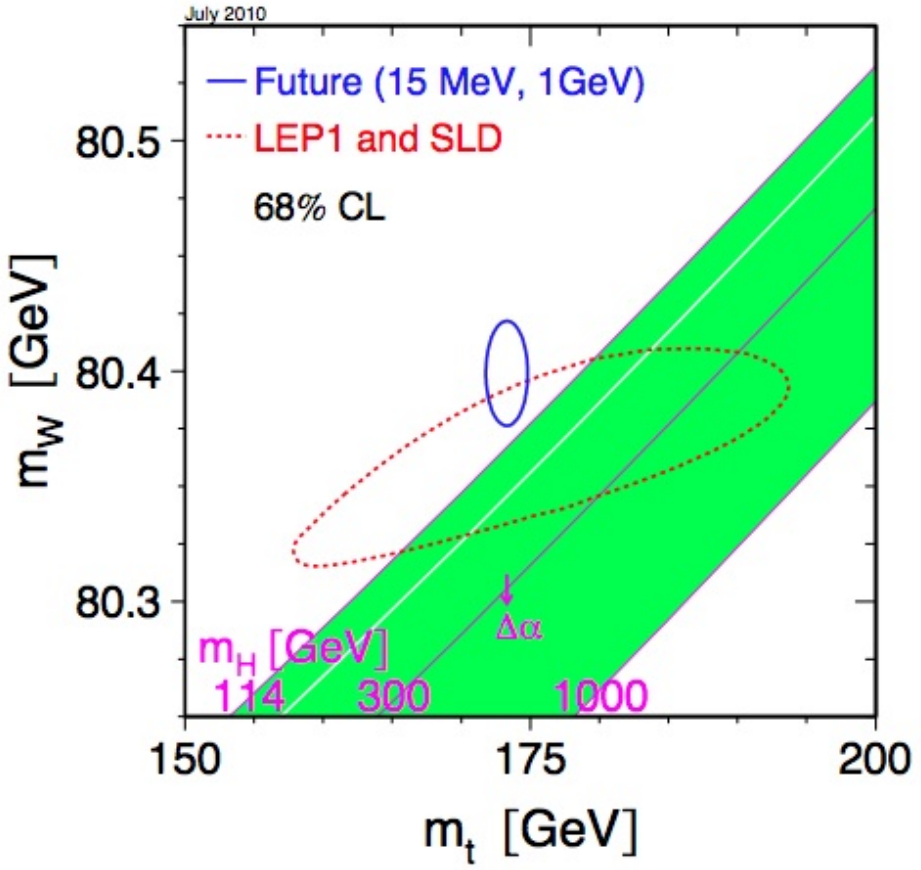
Current





Self-consistency of the SM

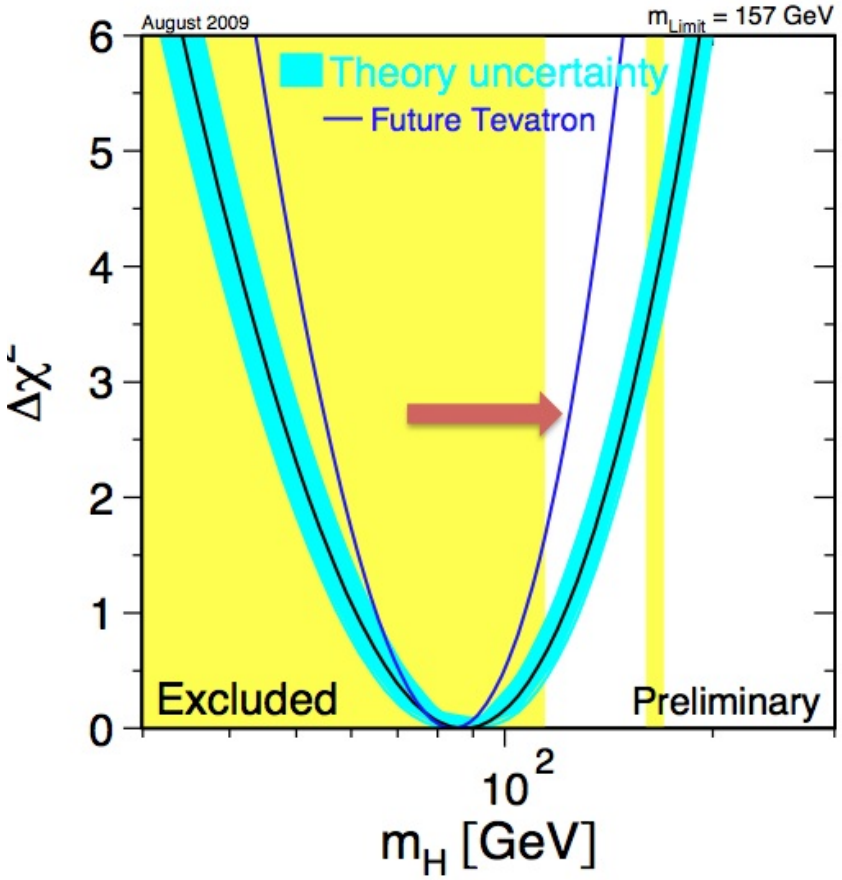
Projections



Improved W mass measurement is critical

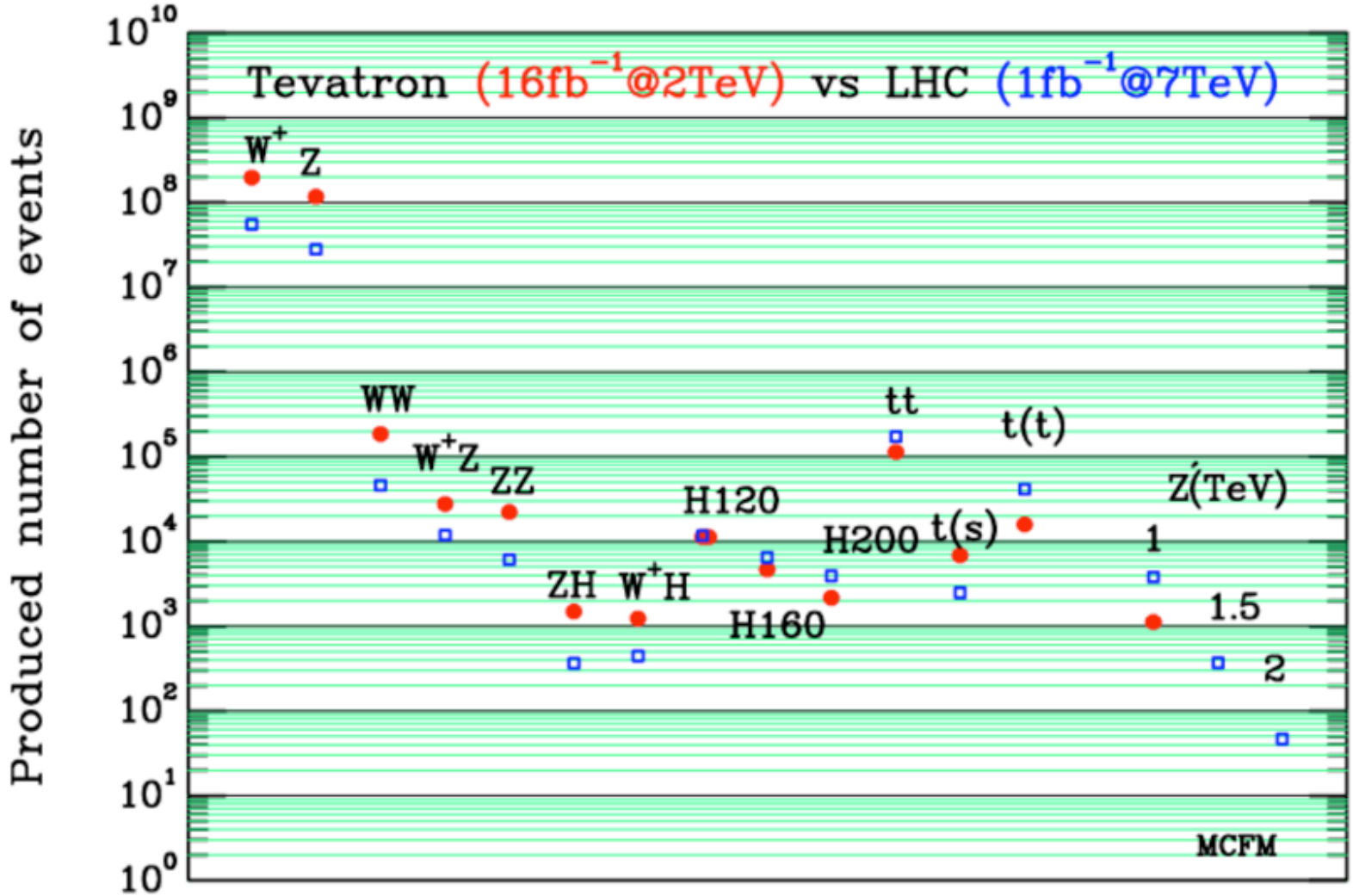
Assume:

top mass uncertainty = 1 GeV
W mass uncertainty = 15 MeV



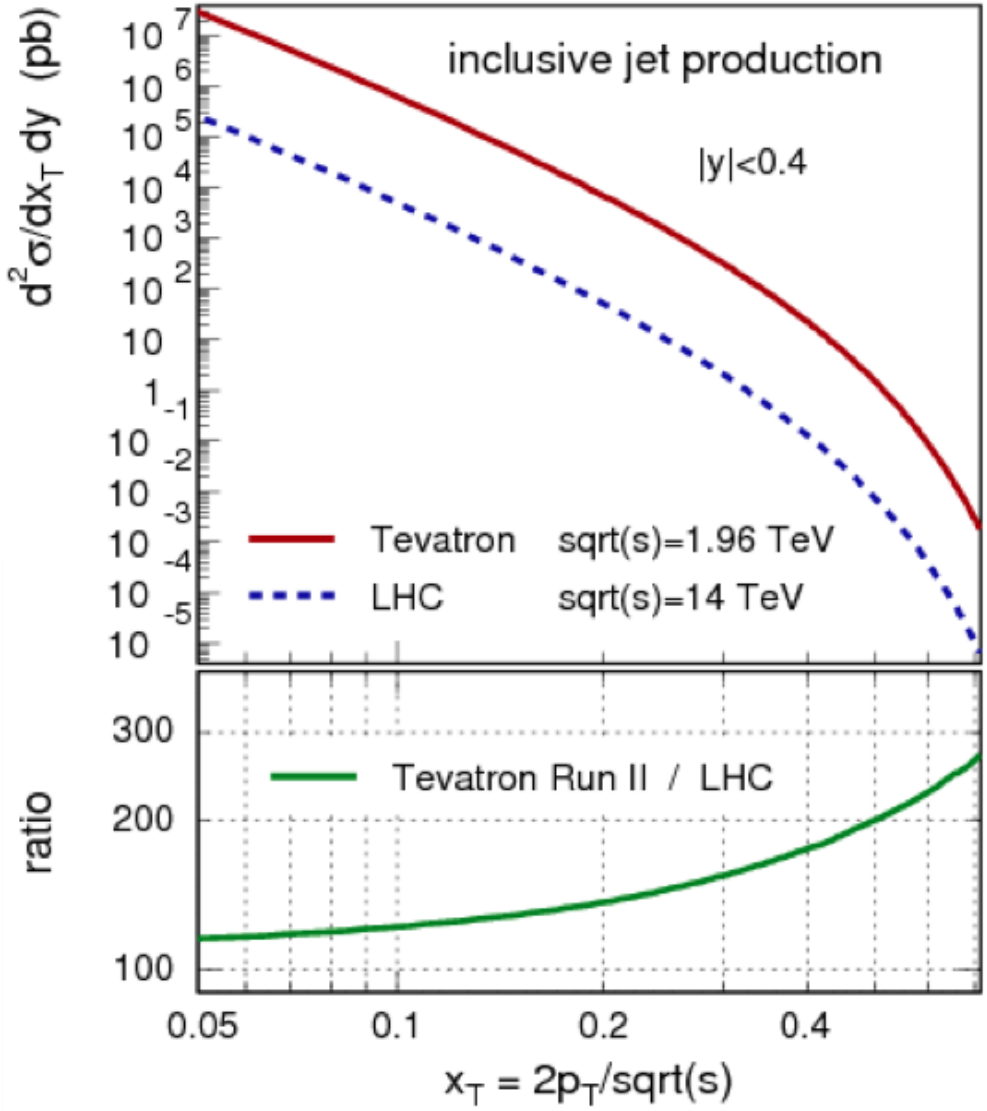
m_H < 117 GeV at 95% CL at current minimum

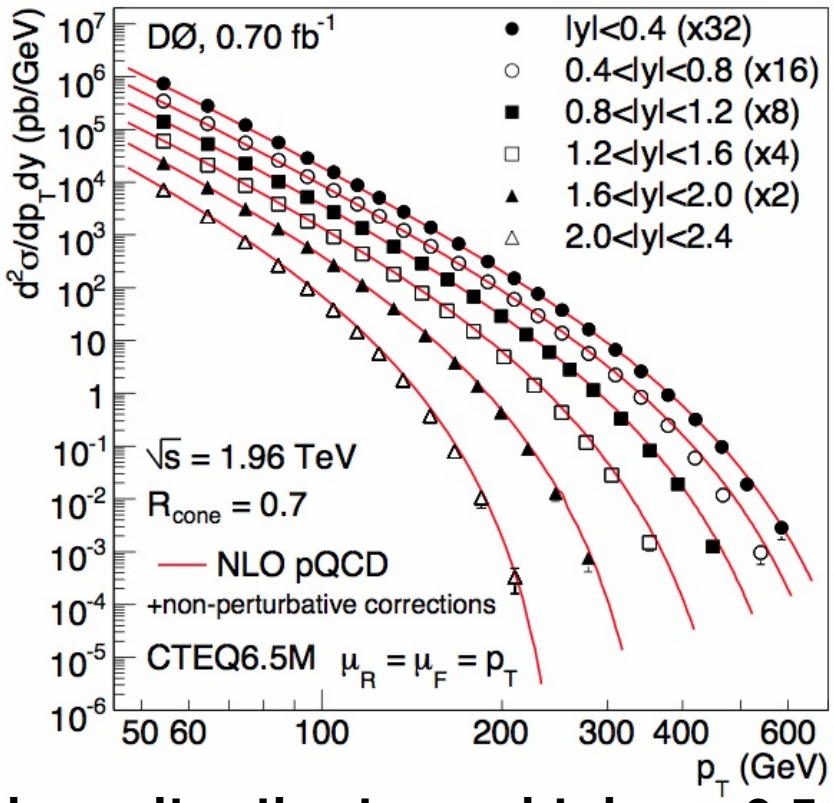
Event Yields: Tevatron and LHC



(Caution: compares 2014 Tevatron data set with 2012 LHC data set)

COMPLEMENTARY: HIGH-X GLUONS

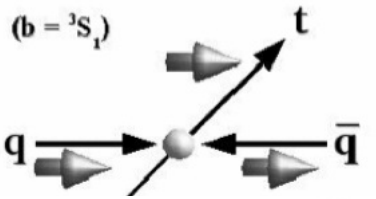




gluon distribution at high x_T>0.5: LHC needs 200 times more luminosity than Tevatron to reach the same sensitivity on PDFs measurement still statistically limited

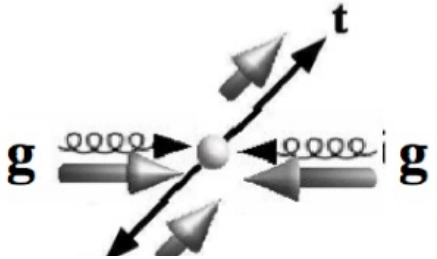
Complementary: P-Anti-P vs PP

Tevatron

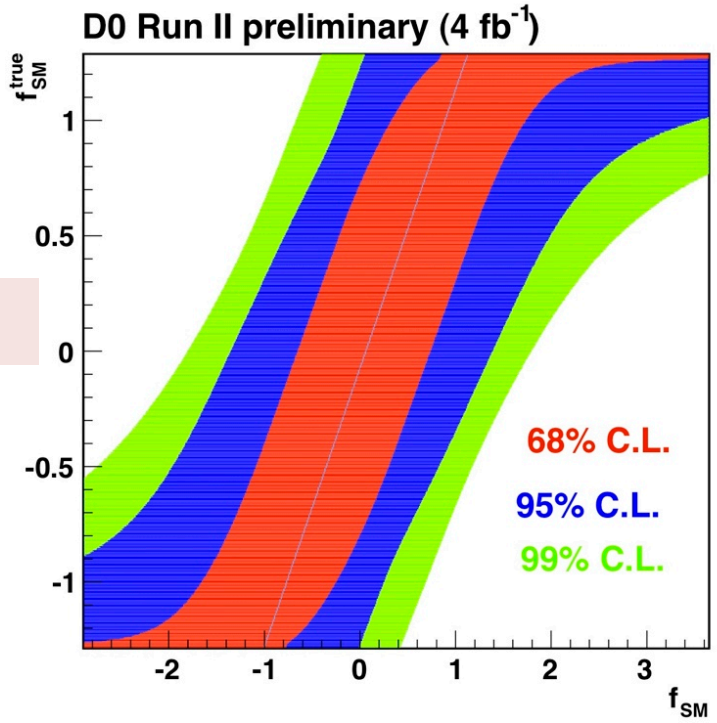


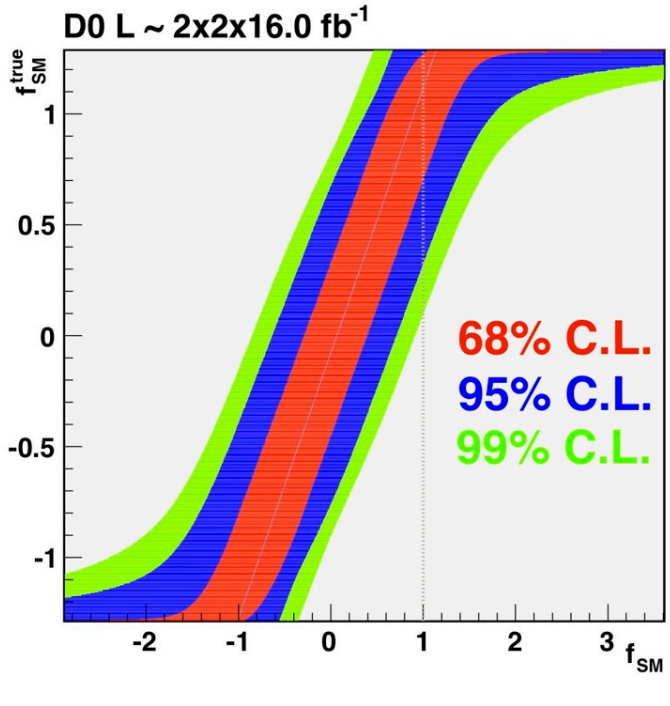
Example: spin correlations in t-tbar production

LHC



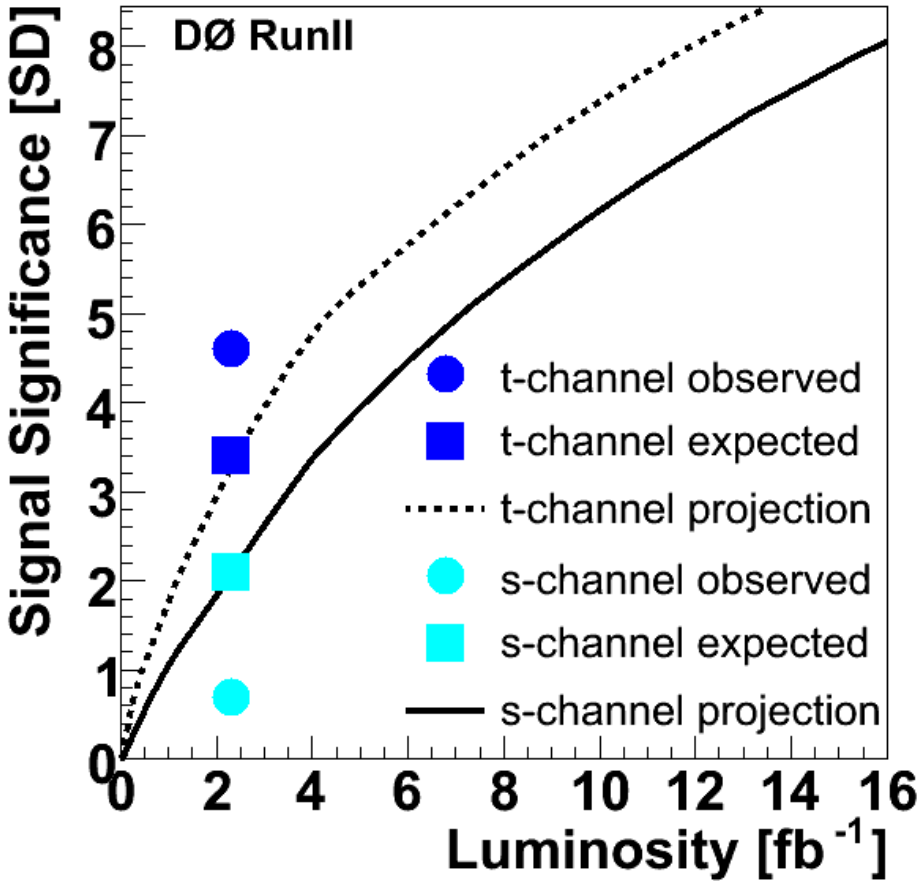
Now

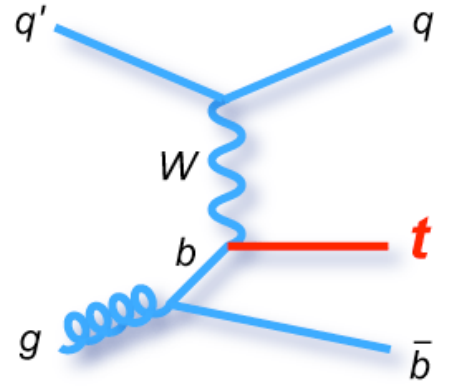




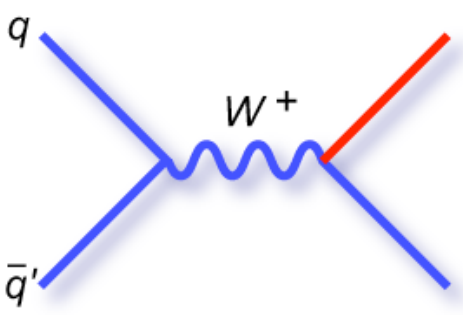
Projected sensitivity

LEGACY: SINGLE TOP (S-CHANNEL)





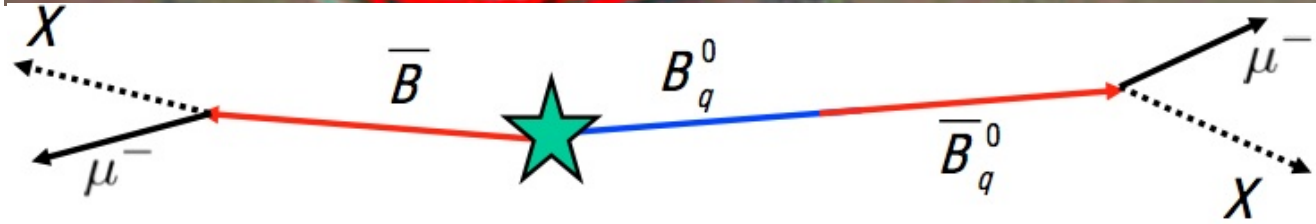
t-channel



s-channel

LHC estimation: 10-30 fb^{-1} at $\sqrt{s}$=14 TeV for 3-sigma excess in s-channel

HINTS AND EXCESSES: DIMUON ASYMMETRY



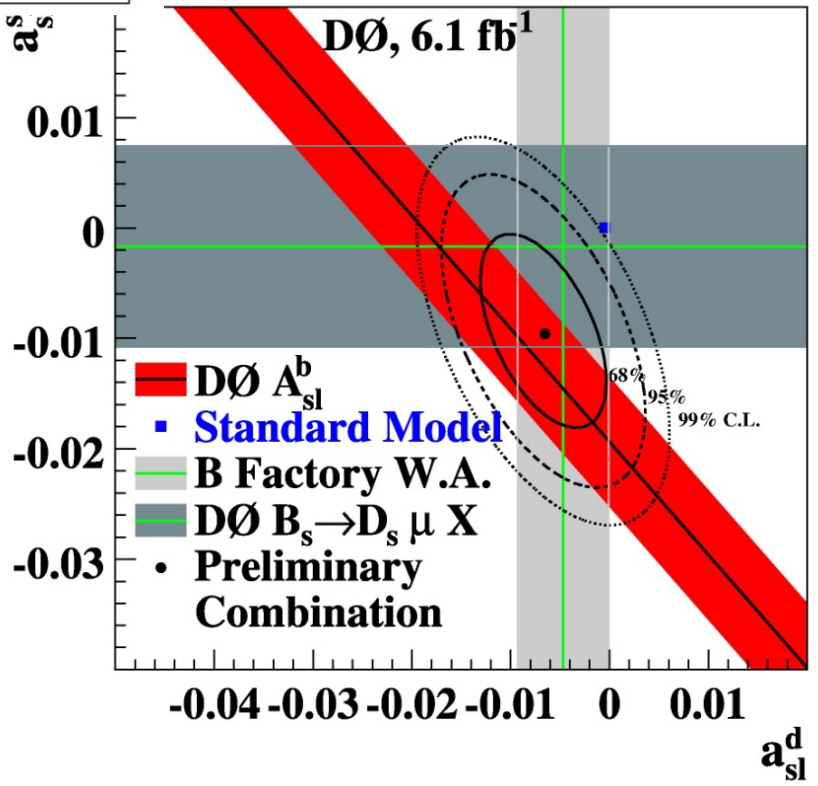
$$A_{sl}^b \equiv \frac{N_b^{++} - N_b^{--}}{N_b^{++} + N_b^{--}}$$

N_b^{++} (N_b^{--}) – number of same-sign $\mu^+\mu^+$ ($\mu^-\mu^-$) events from $B \to \mu X$ decay

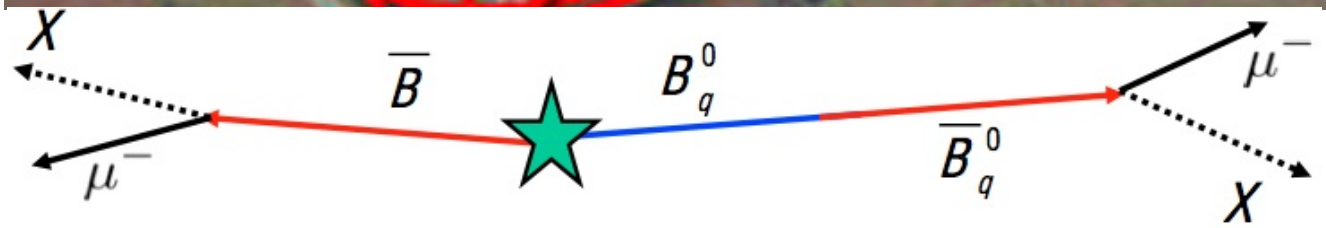
$$a_{sl}^q \equiv \frac{\Gamma(\overline{B}_q^0 \to \mu^+ X) - \Gamma(B_q^0 \to \mu^- X)}{\Gamma(\overline{B}_q^0 \to \mu^+ X) + \Gamma(B_q^0 \to \mu^- X)}; \quad q = d, s$$

Given relative abundances of B_d and B_s, measured asymmetry A^b_{sl} gives linear combination of a^b_{sl} and a^d_{sl}

3.2 σ deviation from SM



COMPLEMENTARITY : DIMUON ASYMMETRY



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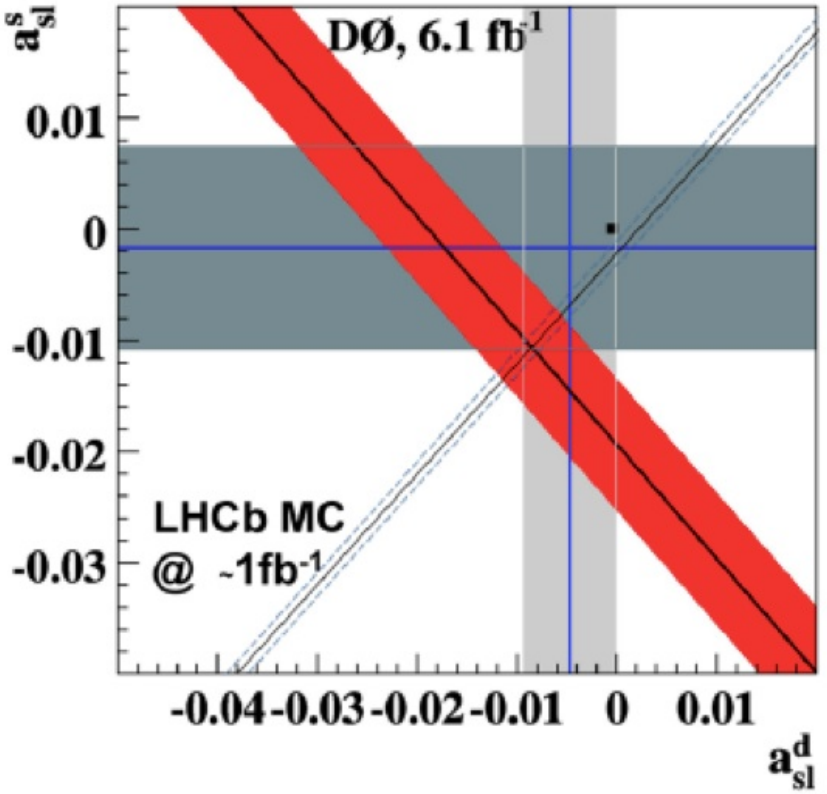
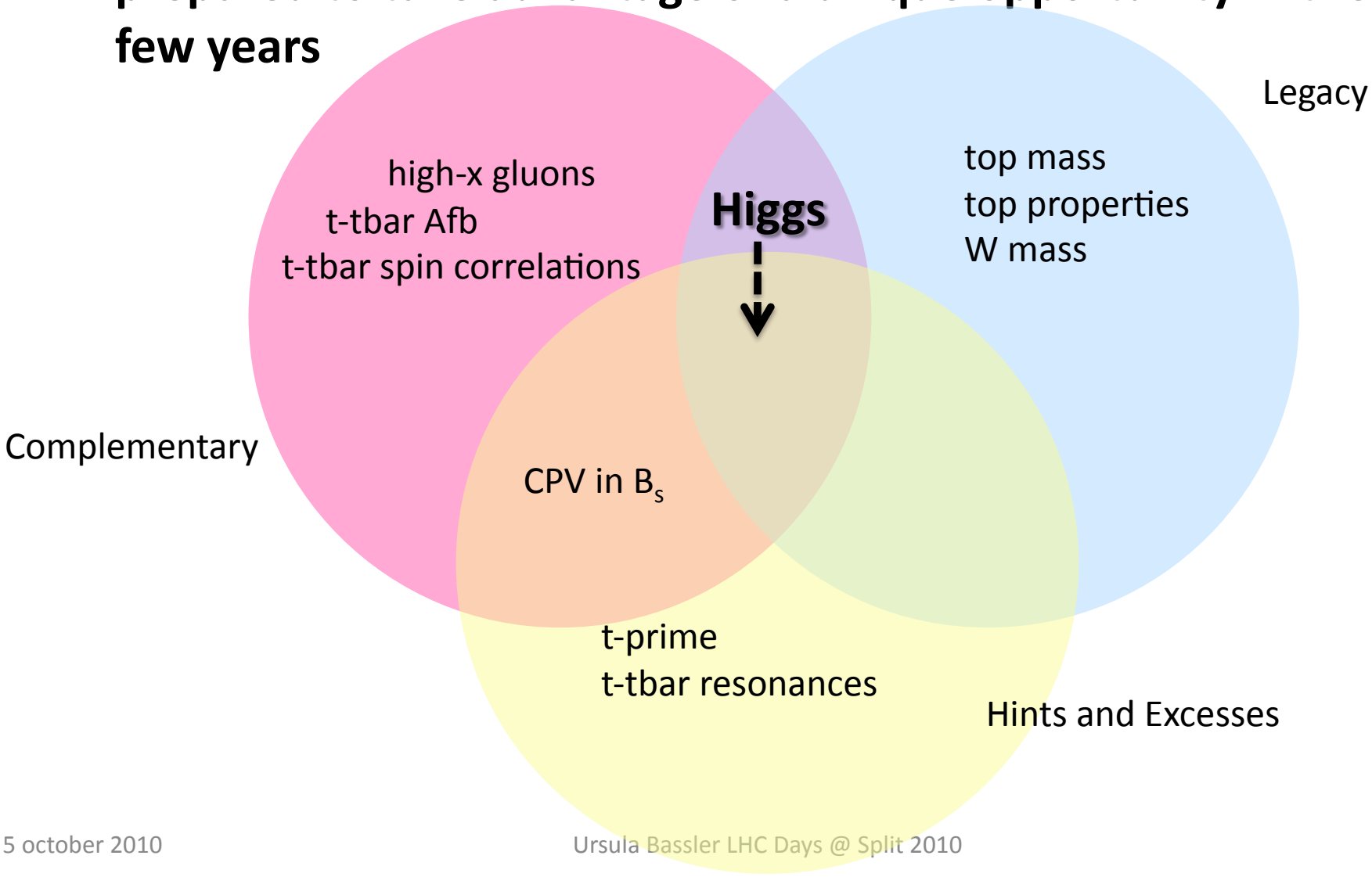


semileptonic decays:

$B_{s,d} \to D\mu\nu$ at the LHCb

SUMMARY

- **Tevatron accelerator and the CDF and Dzero detectors are prepared to take advantage of a unique opportunity in the next few years**



History

- **February 2010 : first thoughts in the experiments for running beyond 2011**
- **June 2010 Fermilab PAC meeting**
  - **- CDF and DZero proposed 3 years Tevatron Run extension**
  - **- Many questions asked to the "Beyond 2011" task force**
- **August 2010 special PAC meeting**
  - **–Answers to all PAC questions provided**
  - **- Excellent progress by "Beyond 2011" task force**
  - **➔ Tevatron experiments should be able to collect and analyze data efficiently!**
  - **–Very strong support of the extension by the PAC**

Recommendation

The Committee strongly endorses the extension of the Tevatron run for three years during 2011–2014 under either funding scenario presented in the charge. The Committee is aware that the development of the future programs might be severely affected and projects delayed by the Collider run. The Committee recommends that efforts be made to mitigate the effects. While the Tevatron run extension would take advantage of a compelling opportunity, the long-term plans of the Laboratory and of the field, as outlined by the P5 report, should be pursued vigorously.

STATUS

- **Extension of the Tevatron run has strong support**
  - **PAC recommendation**
  - **Letters to DOE and Fermilab director**
  - **Support from physicists and funding agencies around the world**
  - **The Fermilab is now actively pursuing this option**
- **There are many steps still ahead before approval**
  - **P5 and HEPAP meetings in october**
  - **Budget decisions for 2012**

We are delighted about the success of the LHC taking over physics at the high energy frontier

We want to achieve the best possible Tevatron legacy !

We are motivated to make progress in the best possible ways for our field!