

Fermilab at the Energy Frontier

Rob Roser, Fermilab

Spokesperson of the CDF Experiment

Stefan Soldner-Rembold, University of Manchester (UK)

Spokesperson of the DØ Experiment

The Big Picture!

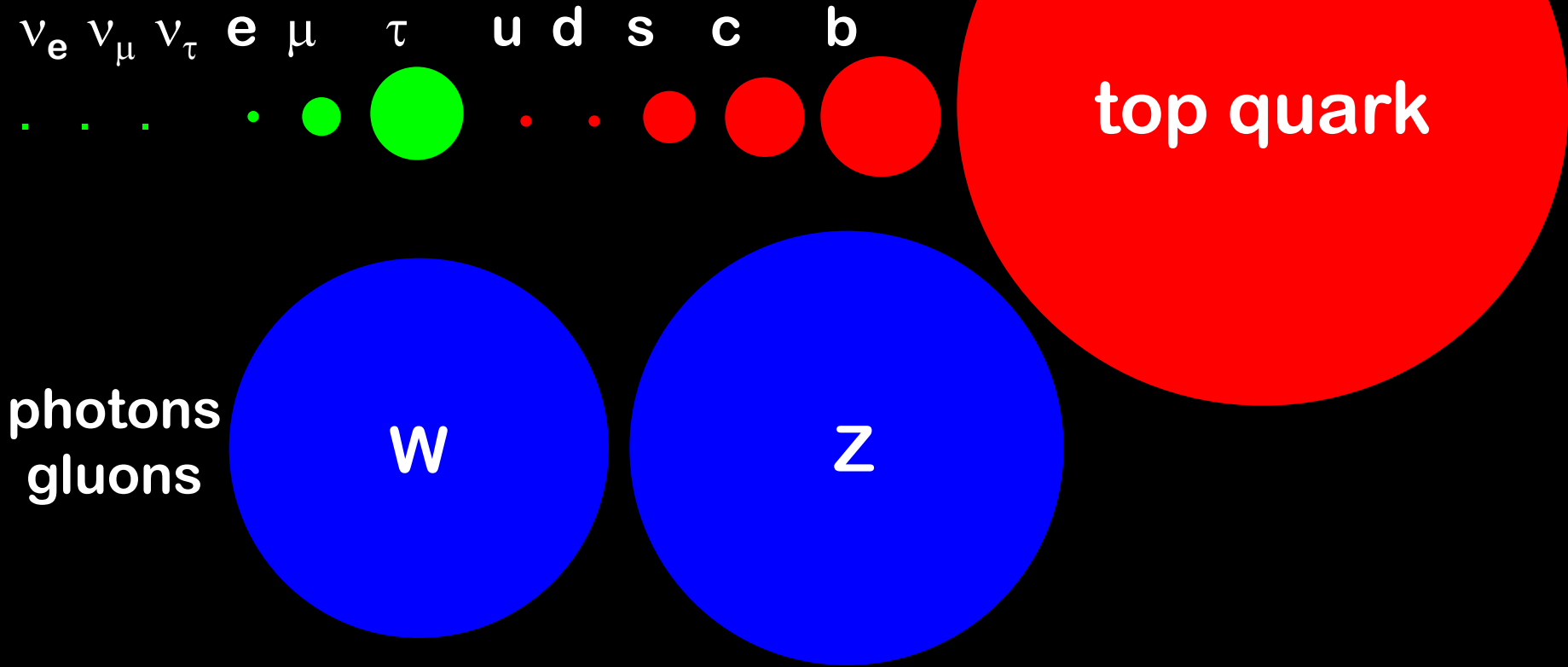
The Standard Model of Particle Physics states:
The world consists of Quarks and Leptons that interact by exchanging Bosons

- Matter is made of quarks and leptons
- Each particle has its own anti-particle
- Quarks and leptons come in 3 generations
- Good description of particles and their interactions
- Extensively tested

Periodic Table of the Particles

	matter: fermions			forces: bosons	
quarks	u	c	t	+2/3	g W Z γ
	d	s	b		
leptons	e	μ	τ	-1	
	ν _e	ν _μ	ν _τ	0	

The \$64,000 Question



Why is top so heavy?

“Why are there three generations?”

“Where does mass come from?”

Enter the Higgs Mechanism



explains mass of elementary particles

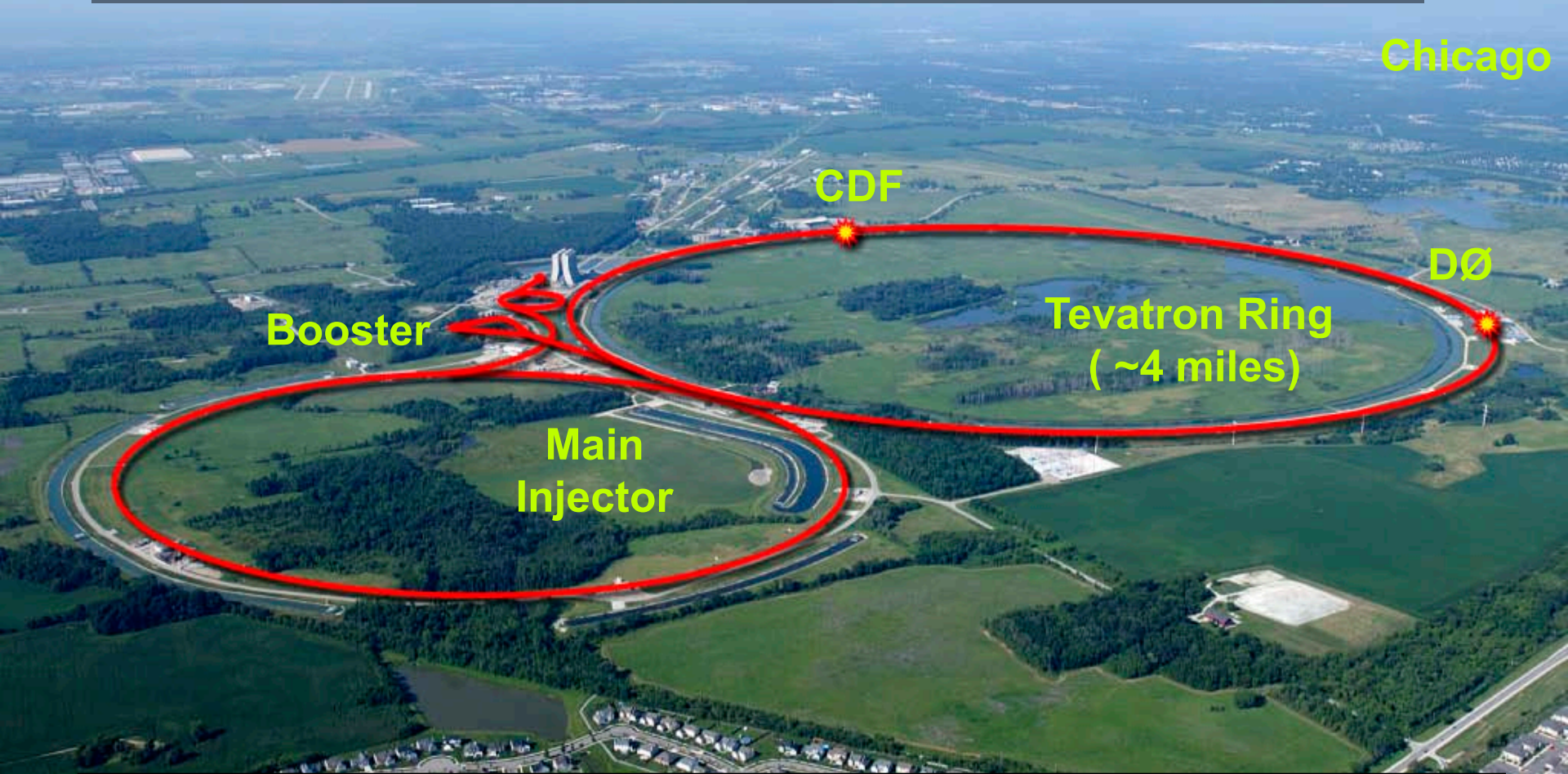


Popularity \propto
Mass



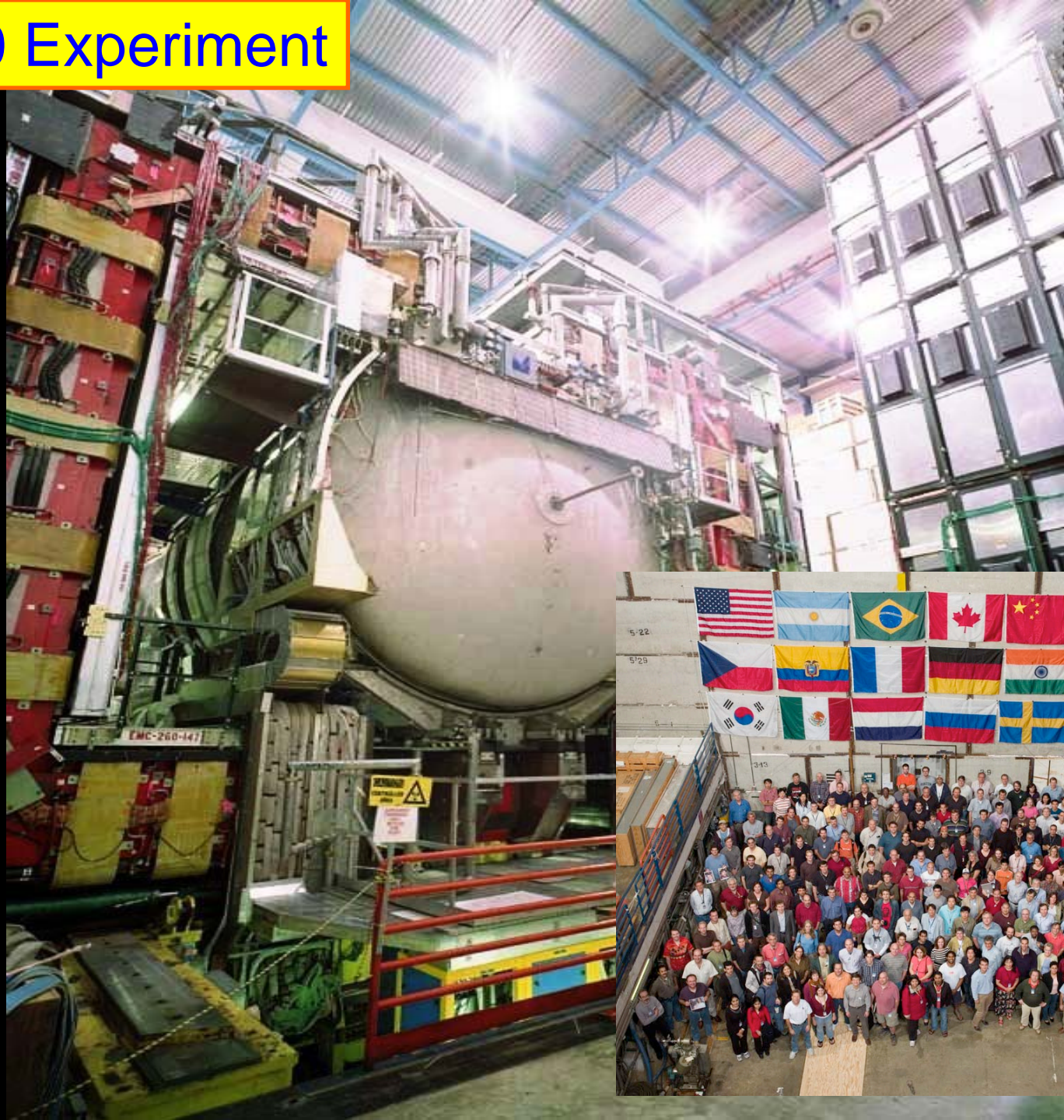
Analogy by Prof. David Miller
University College of
London

America's Most Powerful Accelerator: Fermilab's Tevatron

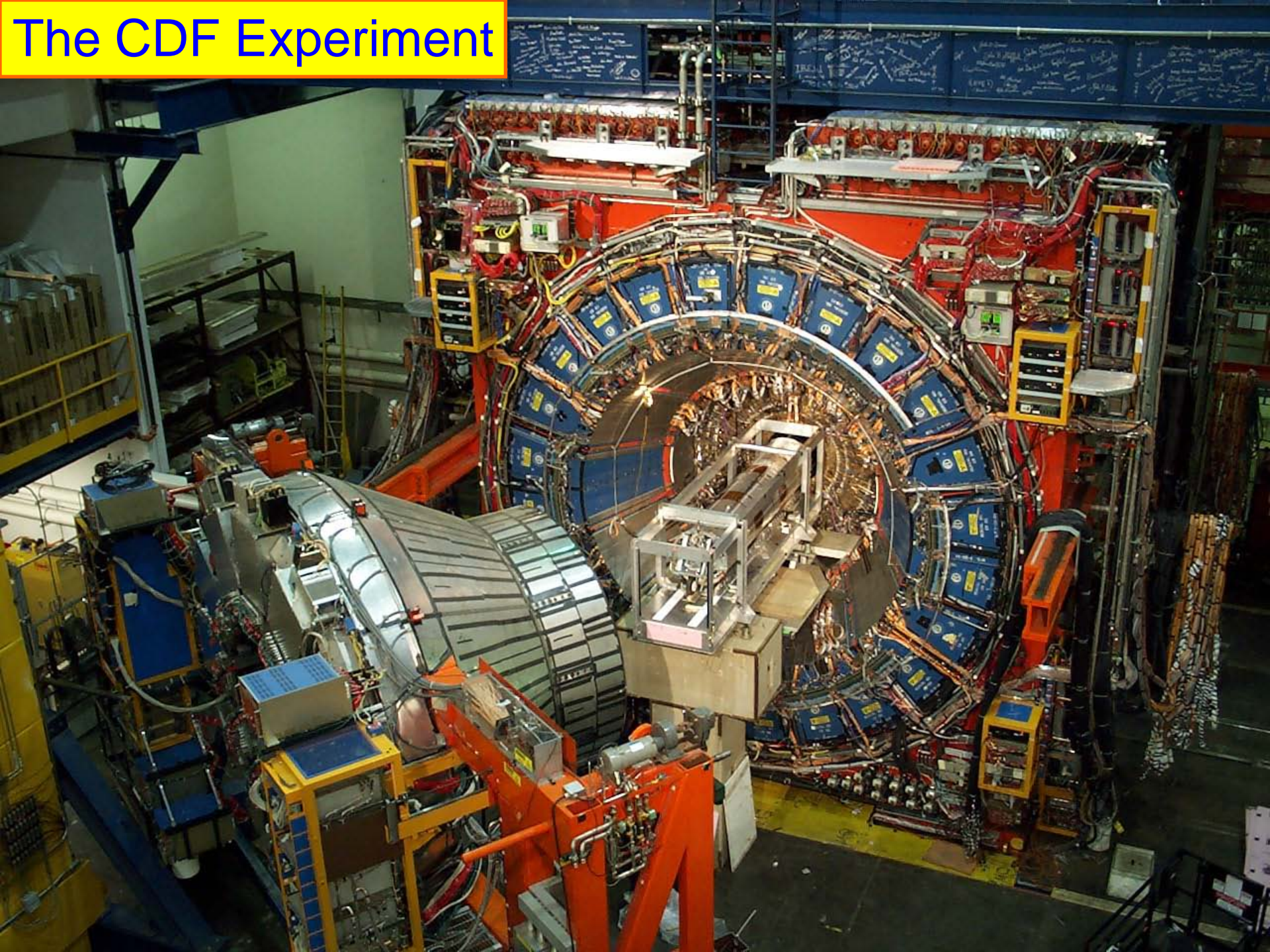


Only accelerator that collides protons and anti-protons

The D0 Experiment



The CDF Experiment





CDF

- ◆ 15 Countries
- ◆ 63 institutions
- ◆ 602 authors

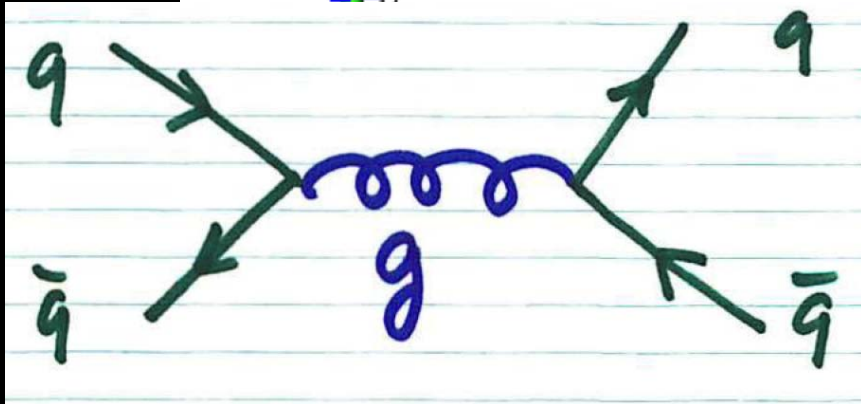
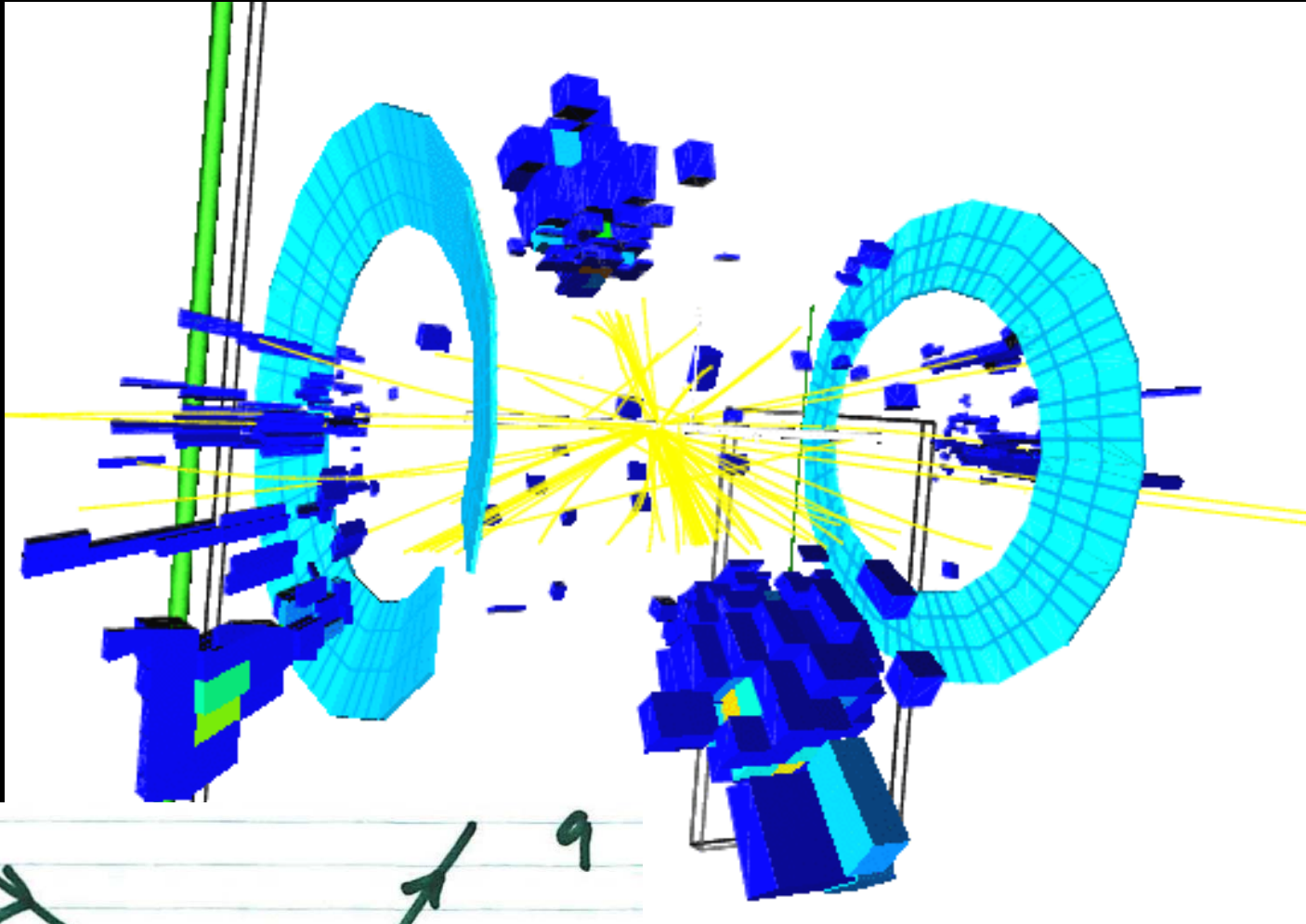
DØ

- ◆ 19 Countries
- ◆ 90 institutions
- ◆ 500 authors

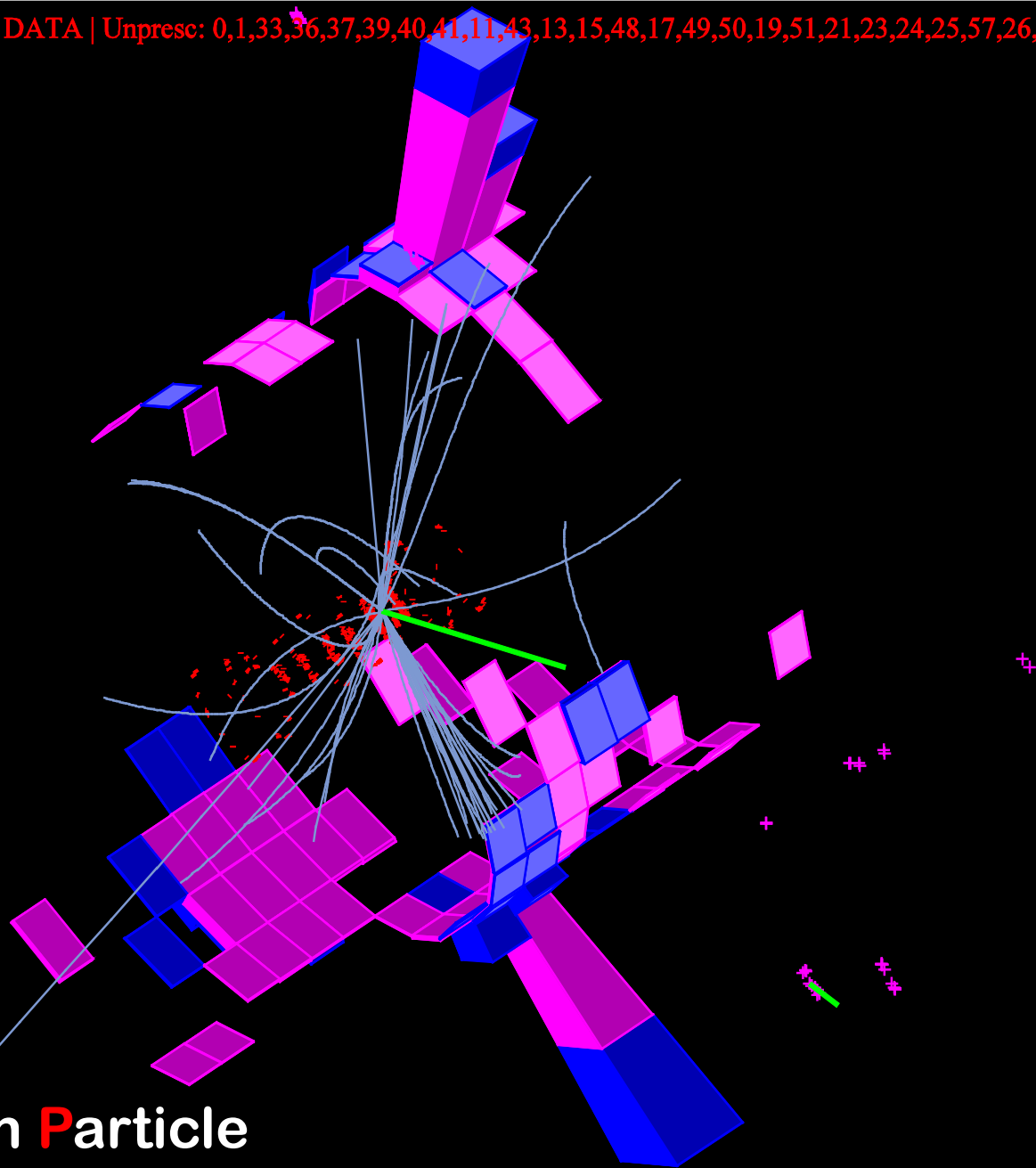
The CDF and DØ Collaborations



Collisions at the high energy frontier:



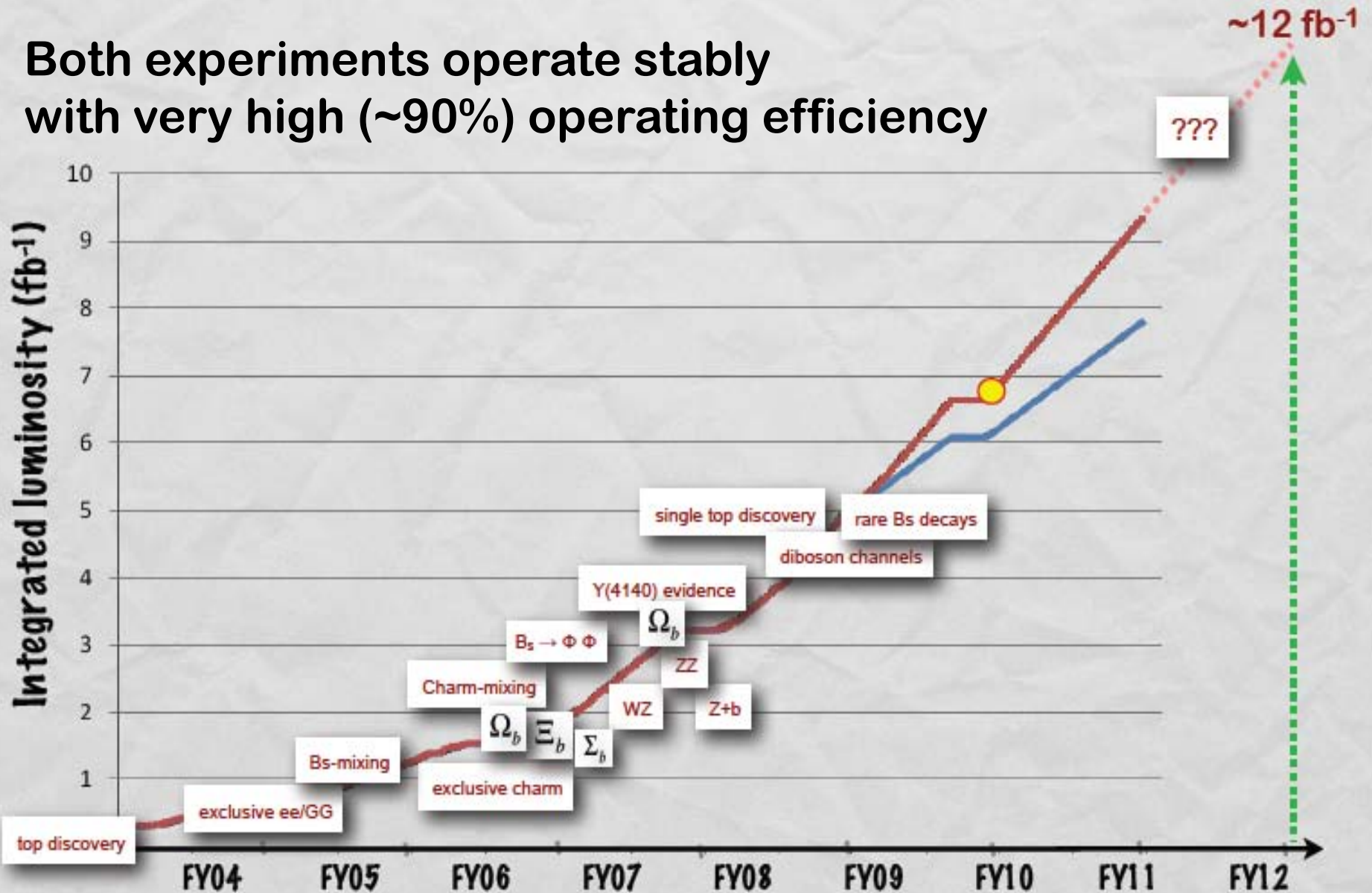
Collision producing a single top quark



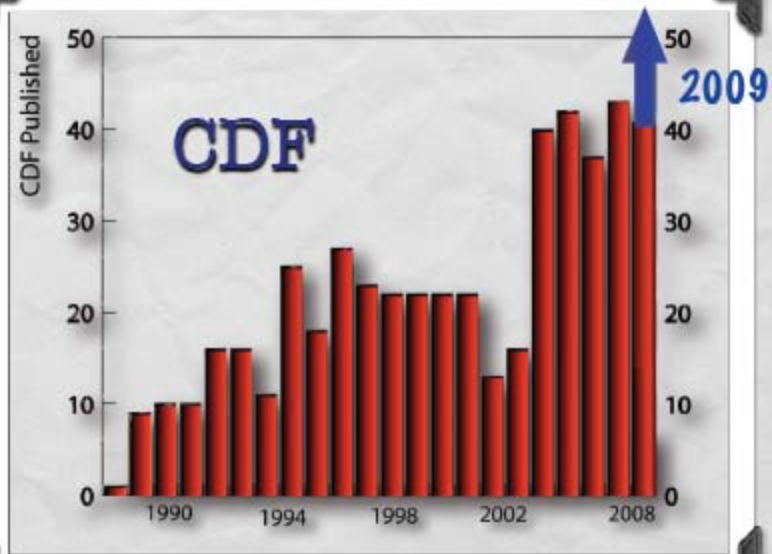
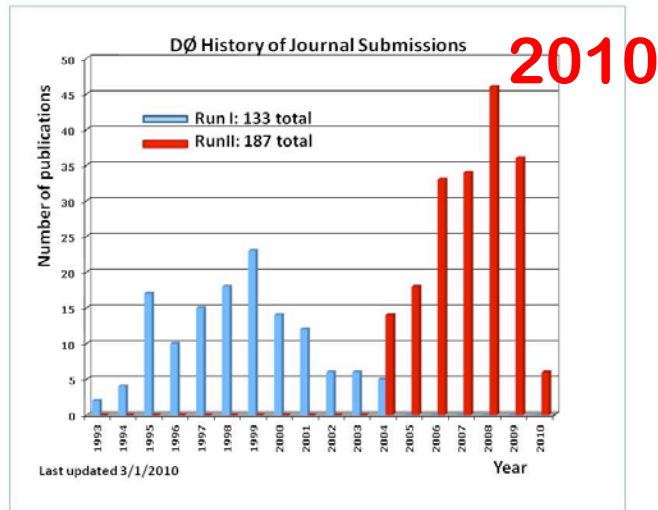
Top = The **TevatrOn Particle** discovered at the Tevatron

New Physics Shows Up Throughout

Both experiments operate stably with very high (~90%) operating efficiency



Tevatron Physics Output



Tevatron Experiments publishing >100 papers/year

Over the last few years, ~60 PhD/year

Present >200 talks at conferences each year

The Tevatron Research Program

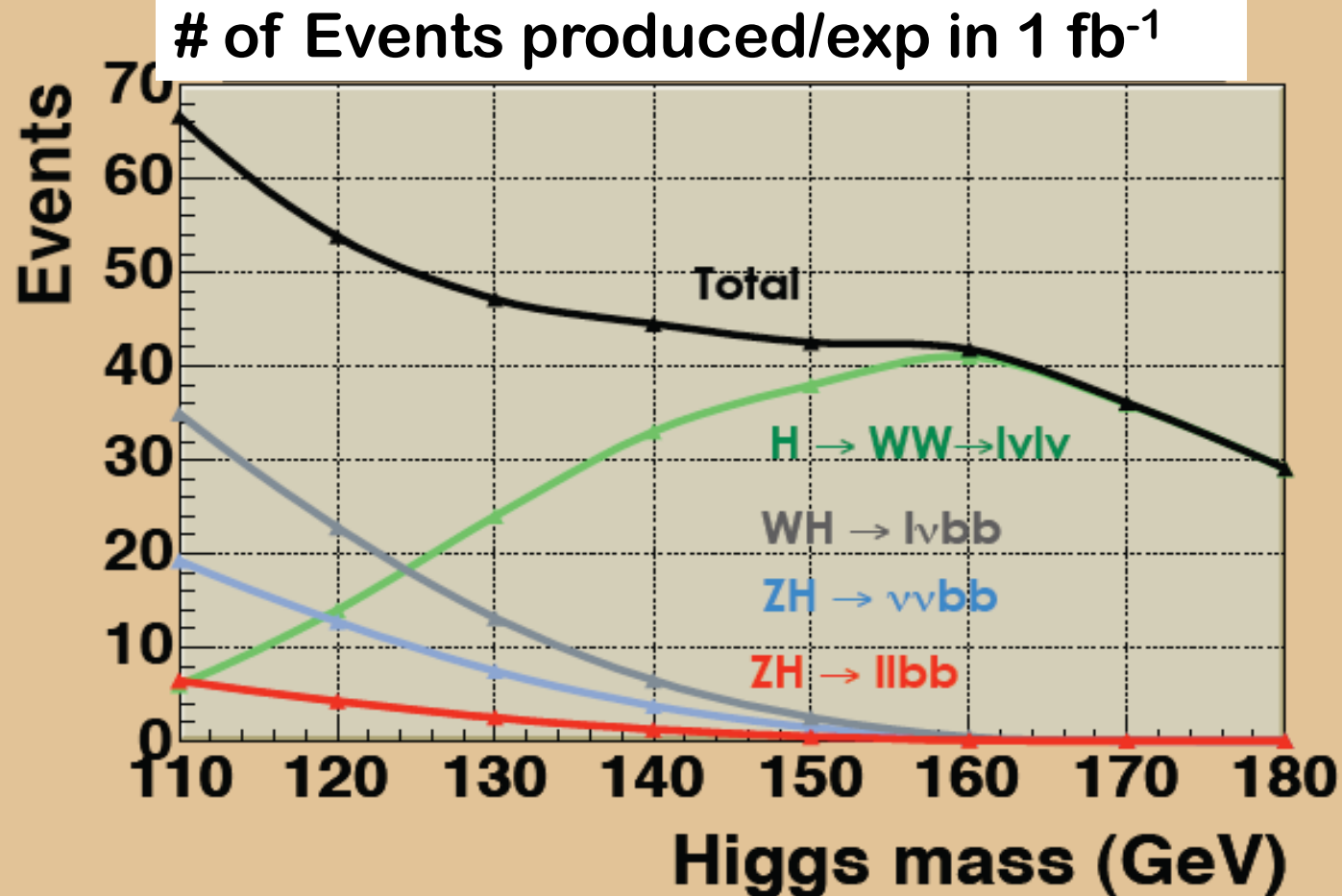
Precision, New Research Discoveries

- Mixing, CKM Constraints and CP Violation
- Heavy Flavor Spectroscopy
- New Heavy Baryon States
- Tests of Quantum Chromodynamics
- Precise measurement of Top-quark and W-boson masses
- Top Quark Properties
- Di-Boson production and SM Gauge Couplings
- New Exclusive/Diffractive Processes

Unique Window into the unknown

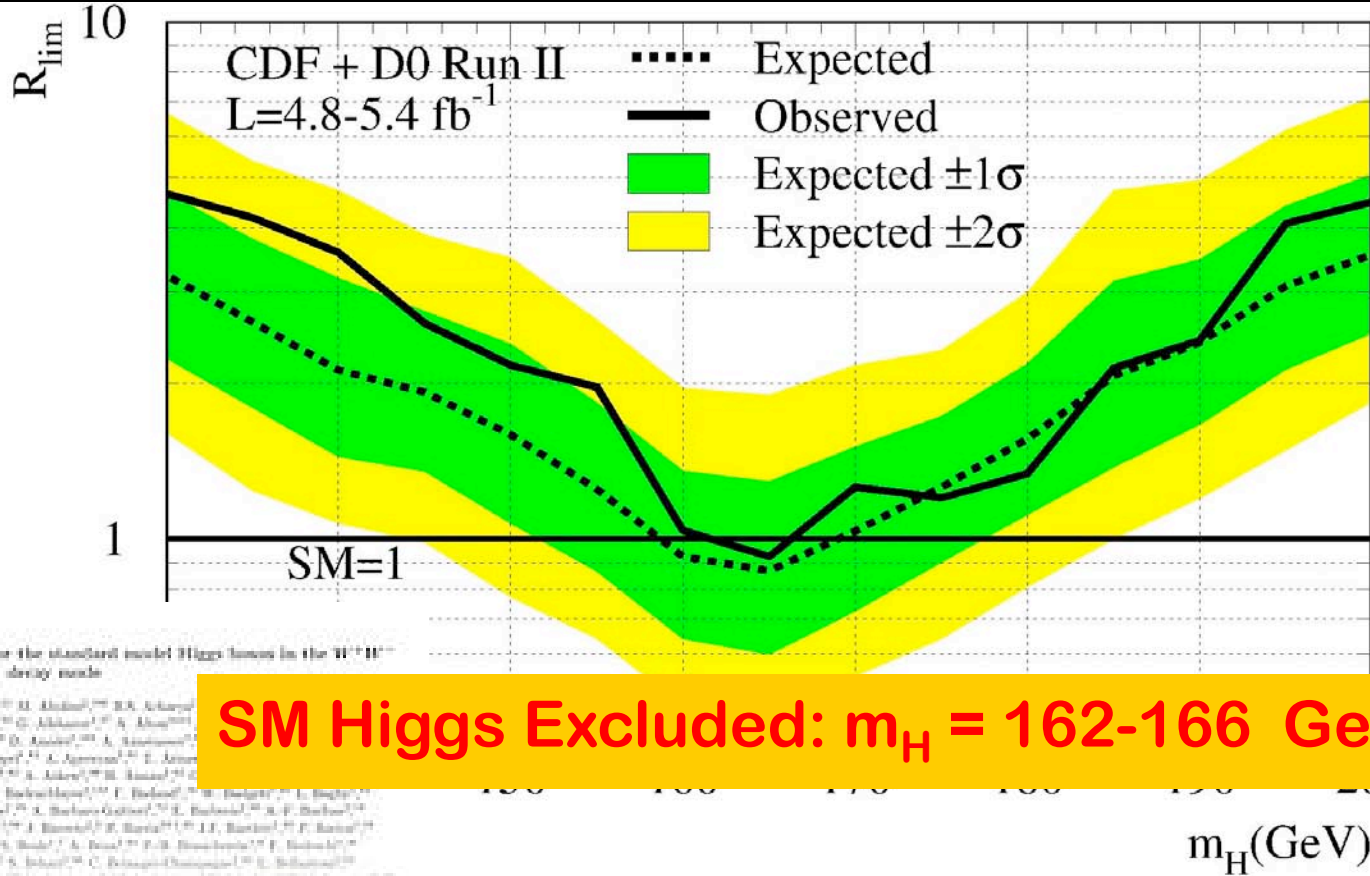
- Searches for Supersymmetry, Extra Dimensions, Exotica
- Still at the Energy Frontier
 - **Probing the Terascale as the luminosity increases**
- The Standard Model BEHGGK (Higgs) Boson is within reach!

The Higgs Challenge



These are production numbers –
trigger, acceptance etc. not yet factored in...

First Joint CDF-DØ Publication in Run II



SM Higgs Excluded: $m_H = 162-166$ GeV

Combination of Tevatron searches for the standard model Higgs boson in the W^+W^- decay mode

E. Abouzaid^{1,2}, M. Abouzaid^{1,2}, B. Adeva³, M. Akhmetov⁴, B.R. Acharya⁵,
F. Adamo⁶, E. Aguilera⁷, G.D. Akhmetov⁴, G. Alkhazov⁸, A. Alton⁹,
G. Alvares¹⁰, G. B. Aleshin¹¹, S. Amato¹², D. Amundson¹³, A. Amundson¹⁴,
J. Antos¹⁵, M. Aoki¹⁶, G. Arabatzis¹⁷, J. Asari¹⁸, A. Aspinwall¹⁹, L. Atanasiu²⁰,
A. Avetisyan²¹, L. Azevedo²², W. Azzam²³, A. Azizov²⁴, B. Baccantini²⁵,
A. Babson²⁶, C. Bacchetta²⁷, E. Bada²⁸, J. Backhaus²⁹, F. Backlund³⁰, W. Backus³¹, L. Bagdasarian³²,
B. Baidya³³, M.V. Baidya³⁴, S. Bagnato³⁵, A. Bahner-Gottschalk³⁶, E. Bahner³⁷, A.P. Bakker³⁸,
P. Bakker³⁹, V.E. Bakker⁴⁰, B.A. Bakker⁴¹, J. Bakker⁴², E. Bana⁴³, J.J. Bakker⁴⁴, P. Bakker⁴⁵,
J. Bannini⁴⁶, D. Baner⁴⁷, G. Baner⁴⁸, A. Bana⁴⁹, A. Bana⁵⁰, F.B. Bannerman⁵¹, F. Bannerman⁵²,
D. Banerjee⁵³, M. Banerjee⁵⁴, M. Banerjee⁵⁵, S. Banerjee⁵⁶, C. Banerjee-Saha⁵⁷, S. Banerjee⁵⁸,
B. Bannister⁵⁹, J. Bannister⁶⁰, B.L. Bannister⁶¹, B. Bannister⁶², J. Bannister⁶³, B.B. Bannister⁶⁴, L. Bannister⁶⁵,
B. Bannister⁶⁶, J. Bannister⁶⁷, H. Bannister⁶⁸, B. Bannister⁶⁹, S. Bannister⁷⁰, S. Bannister⁷¹, S. Bannister⁷²,
S. Bannister⁷³, A. Bannister⁷⁴, M. Bannister⁷⁵, S. Bannister⁷⁶, S. Bannister⁷⁷, S. Bannister⁷⁸, S. Bannister⁷⁹, S. Bannister⁸⁰,
S. Bannister⁸¹, S. Bannister⁸², S. Bannister⁸³, S. Bannister⁸⁴, S. Bannister⁸⁵, S. Bannister⁸⁶, S. Bannister⁸⁷, S. Bannister⁸⁸, S. Bannister⁸⁹, S. Bannister⁹⁰,
S. Bannister⁹¹, S. Bannister⁹², S. Bannister⁹³, S. Bannister⁹⁴, S. Bannister⁹⁵, S. Bannister⁹⁶, S. Bannister⁹⁷, S. Bannister⁹⁸, S. Bannister⁹⁹, S. Bannister¹⁰⁰

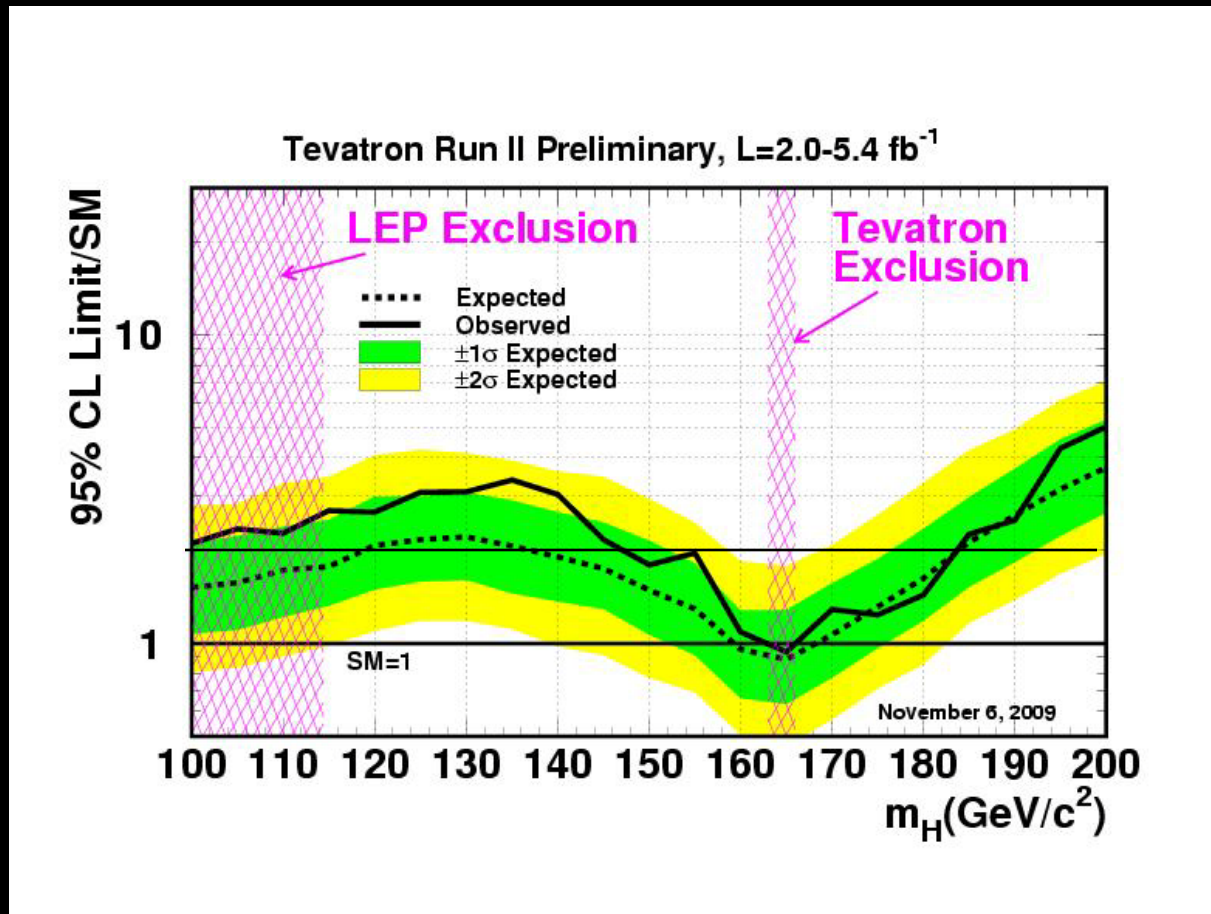


Cover of Physics Review Letters

Tevatron Result on Higgs to Date

Neither experiment has sufficient power to span the entire mass range using the data we expect to acquire in Run II

Factor away in sensitivity
from SM



Find evidence for Higgs OR prove it is not there:
Either outcome would revolutionize particle physics.

A Very Rich Program

CDF Run II Preliminary

