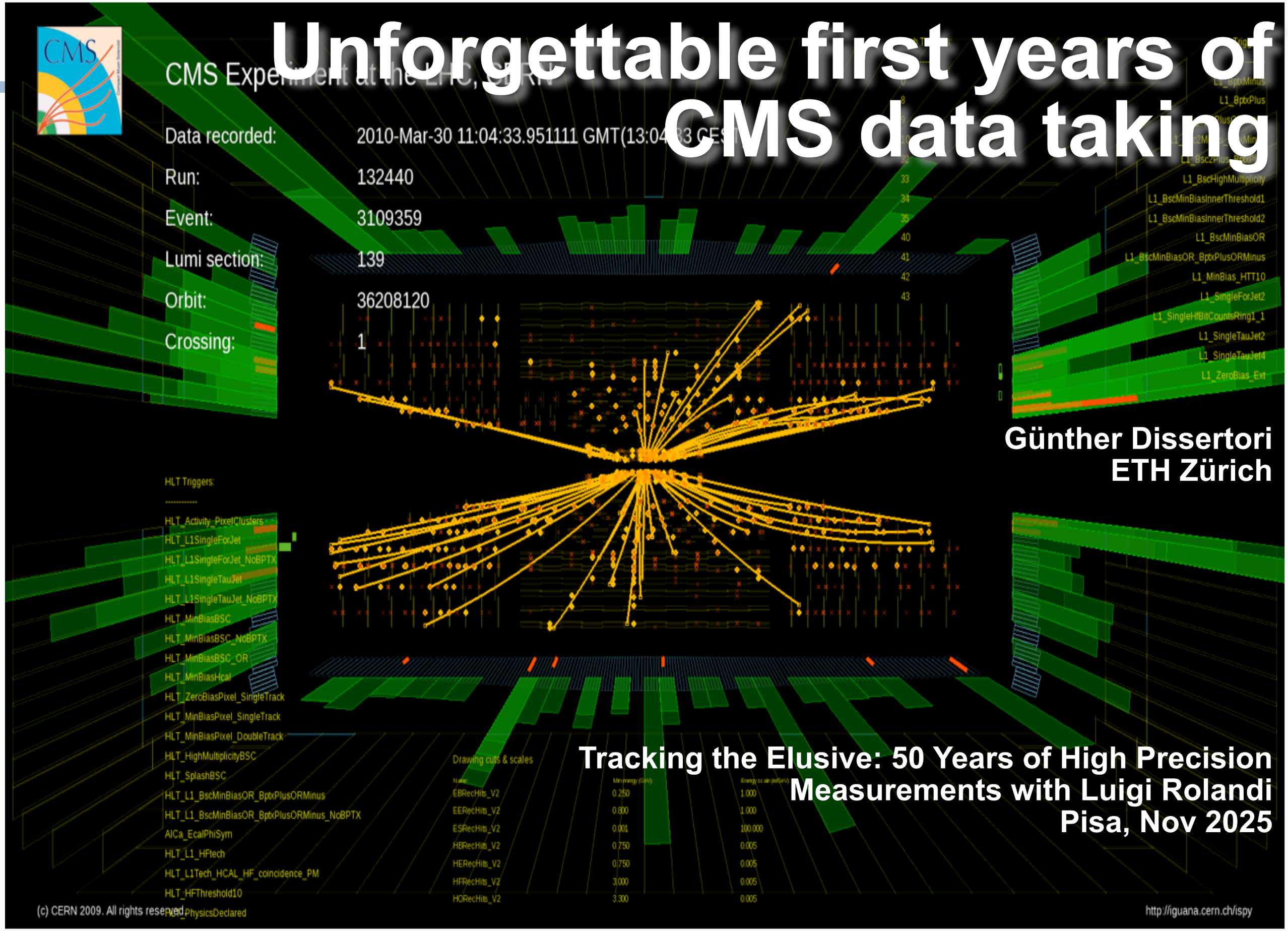
Unforgettable first years of CMS data taking



Günther Dissertori
ETH Zürich

Tracking the Elusive: 50 Years of High Precision Measurements with Luigi Rolandi
Pisa, Nov 2025

Prelude

This is going to be a (not perfectly structured) recollection of one of the (if not THE) most exciting times of my life as a particle physicist, in particular the period 2010-2011 …

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… together with, and also thanks to the wonderful collaboration and friendship with **Gigi**!

… whom I knew already from my times in ALEPH, ie. since ~1994

CMS physics organization (2010)

Physics Coordinator
G. Rolandi
Deputies:
D. Acosta, G. Dissertori

e/γ
P. Meridiani
M. Pieri

Muons
R. Bellan
S. Valuev

Forw. Physics
K. Piotrzkowski
H. Jung

QCD
V. O'Dell
F. Sikler

Higgs
A. Korytov
V. Sharma

Jets/MissET
P. Schleper
R. Harris

b-tagging
W. Adam
A. Rizzi

Heavy Ions
G. Roland
R. G. de Cassagnac

EWK
G. H. de Monchenault
M. H. Schmitt

SUSY
J. Richman
A. Tapper

ParticleFlow/τ
C. Bernet
S. Gennai

Tracking
K. Burkett
A. Venturi

Top
T. Christiansen
F.P. Schilling

Exotica
G. Landsberg
C. Hill

MC generators
F. Stoeckli
F. Cossutti

B physics
P. Eerola
C. Lourenco

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POG PAG SCHEDULE 2010 version 30 November

A	Jan-04	14:30	PFT	GEN
A	Jan-04	16:30	BTV	
A	Jan-05	14:30	EXO	HIG
A	Jan-05	16:30	SUS	FWD
A	Jan-08	10:00	HIN	
B	Jan-11	14:30	JME	MUO
B	Jan-11	16:30	TRK	EGM
B	Jan-12	14:30	BPH	EWK
B	Jan-12	16:30	QCD	TOP
B	Jan-15	16:30	HIN	
A	Jan-18	14:30	PFT	GEN
A	Jan-18	16:30	BTV	
A	Jan-19	14:30	EXO	HIG
A	Jan-19	16:30	SUS	FWD
A	Jan-22	10:00	HIN	
B	Jan-25	14:30	JME	MUO
B	Jan-25	16:30	TRK	EGM
B	Jan-26	14:30	BPH	EWK
B	Jan-26	16:30	QCD	TOP
B	Jan-29	16:30	HIN	
A	Feb-01	14:30	PFT	GEN
A	Feb-01	16:30	BTV	
A	Feb-02	14:30	EXO	HIG
A	Feb-02	16:30	SUS	FWD
A	Feb-05	10:00	HIN	
B	Feb-08	14:30	JME	MUO
B	Feb-08	16:30	TRK	EGM
B	Feb-09	14:30	BPH	EWK
B	Feb-09	16:30	QCD	TOP
B	Feb-12	16:30	HIN	
A	Feb-15	14:30	PFT	GEN
A	Feb-15	16:30	BTV	
A	Feb-16	14:30	EXO	HIG
A	Feb-16	16:30	SUS	FWD
A	Feb-19	10:00	HIN	
22-Feb Physcs Trigger Weel DAYS				
B	Mar-01	14:30	JME	MUO
B	Mar-01	16:30	TRK	EGM
B	Mar-02	14:30	BPH	EWK
B	Mar-02	16:30	QCD	TOP
B	Mar-05	16:30	HIN	

GUDAGI

GUDAGI

GUDAGI

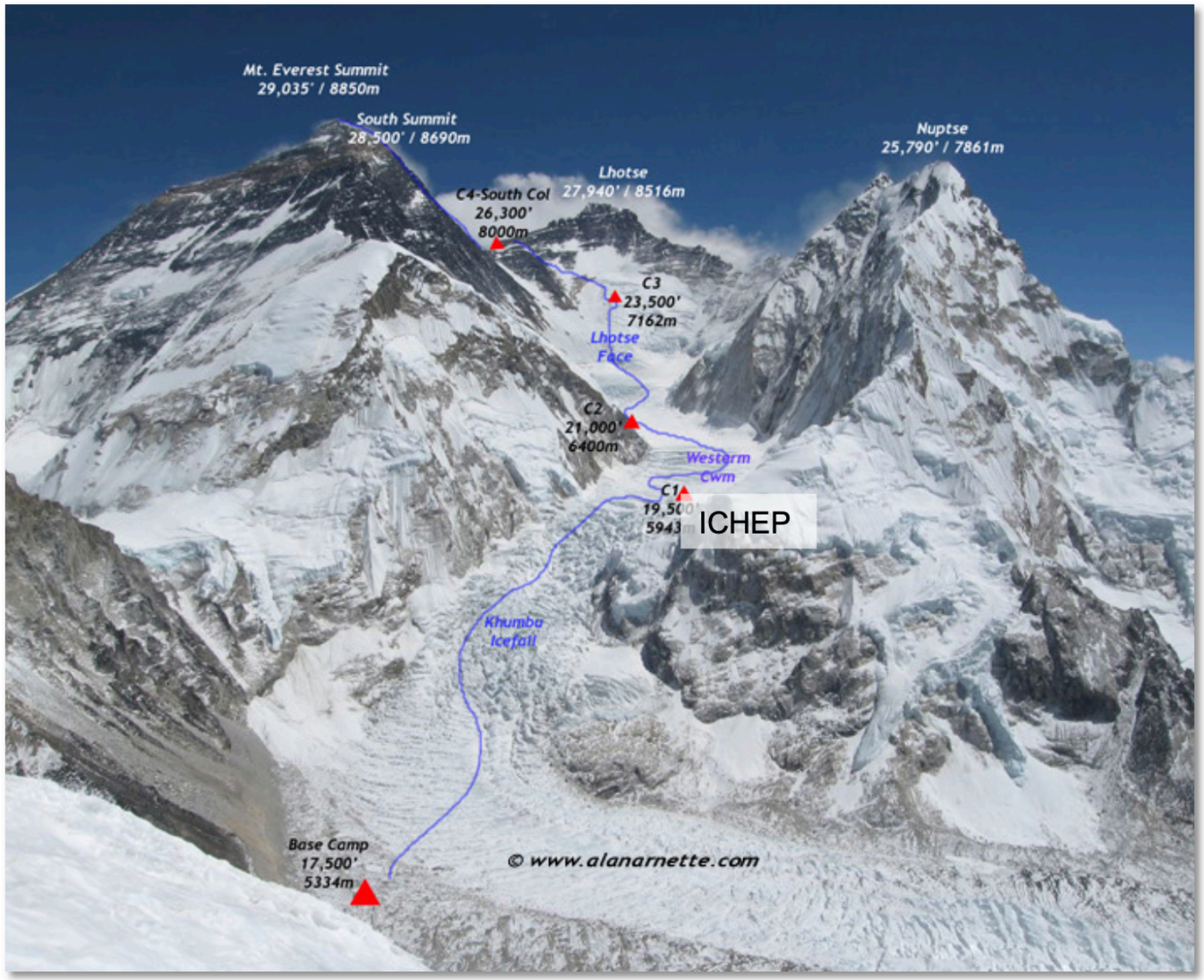
GUDAGI

Preparation for Chamonix: study of different scenarios for the 2010 LHC data taking

Darin Acosta
(on behalf of Gigi, Guenther, and the physics groups)

20 Jan 2010

Presentation of our next Physics Plan:



the 50-100 pb^{-1} era

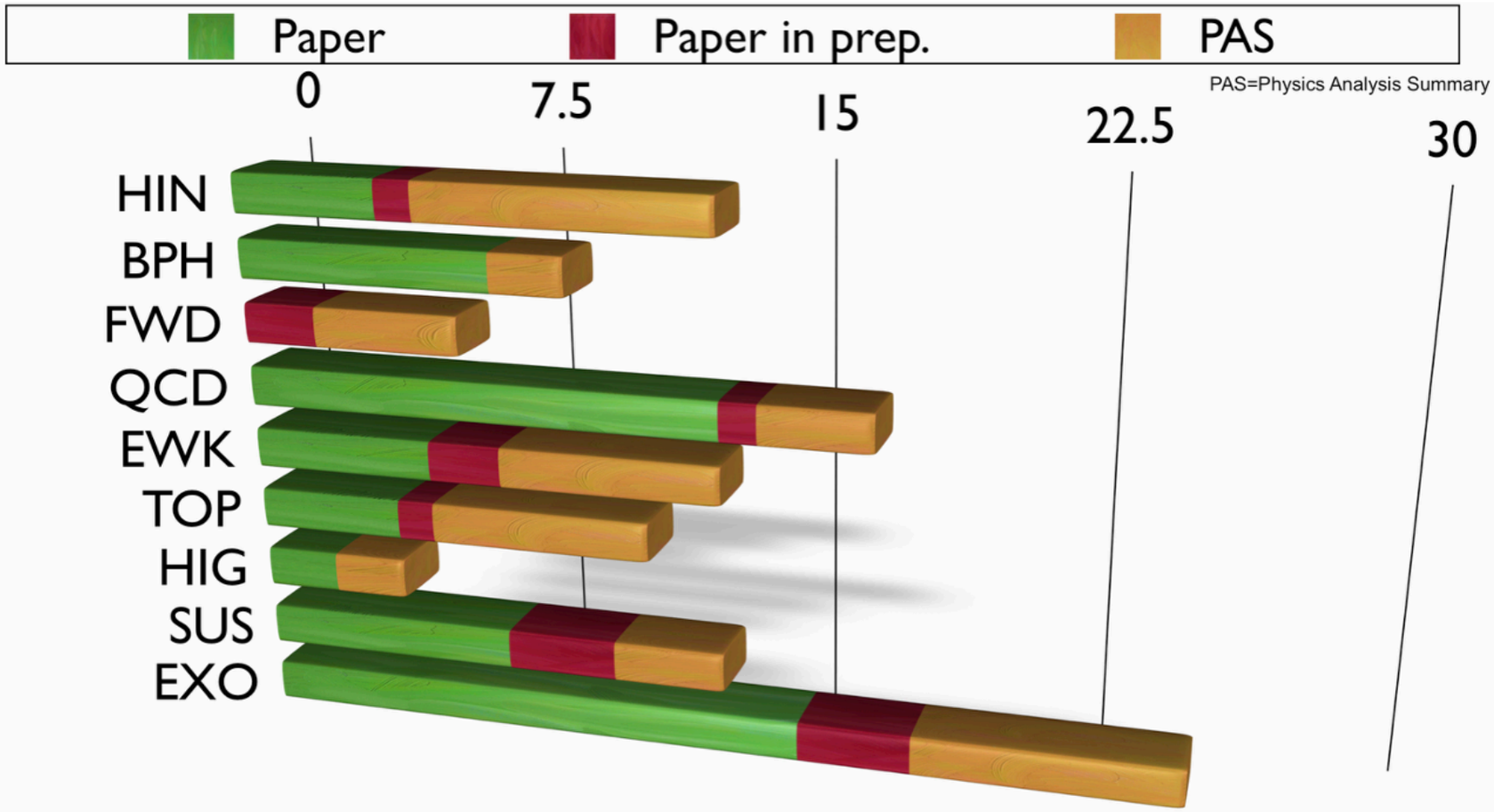
DA, GD, LR

Sep 14, 2010
Bodrum

Proposals for a new POG : The Pflow – Tau case

- In addition to a beautiful and excellently working detector, by now we have another jewel in hand: **PFLOW**
  - The ICHEP results and the recent Jamboree talks have shown: PF will give us an edge on many fronts, and more and more analyses move towards its usage
  - Physics Coordination strongly supports the work towards further improvements and commissioning of PF, as well as its wide and consistent employment in ongoing and upcoming analyses

Our score board, Status June 23

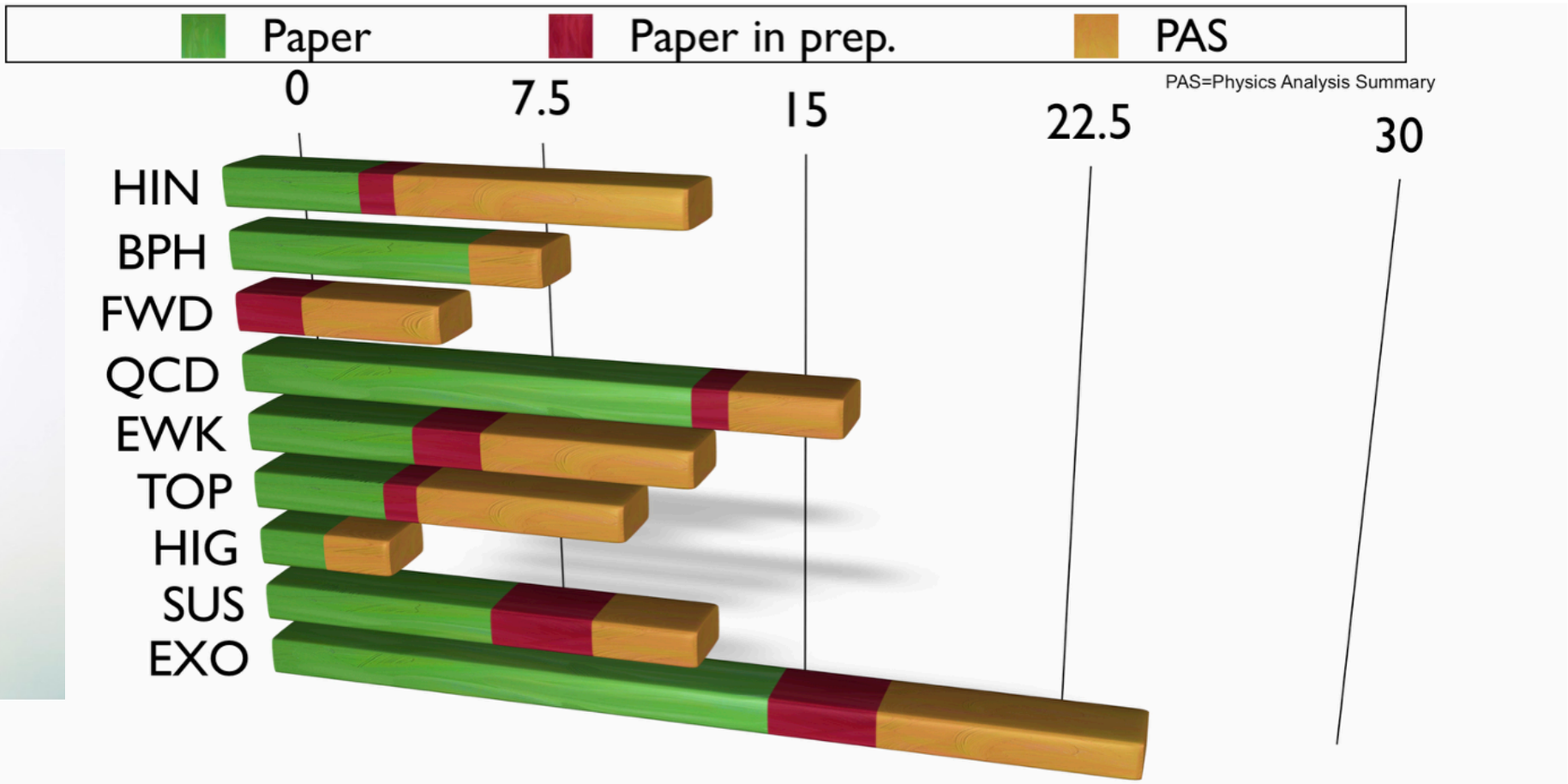


In total : **57** papers on **2010 data**, submitted, accepted or published
15 papers close to submission
57 Physics Analysis Summaries
In addition : **3** papers on **2009 data**, plus 1 TRK and 1 MUO paper,
plus **2 PAS** on **2011 data**

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

1

Our score board, Status June 23



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

1

Priority Analyses (1)

- Here: Focus on Priority Analyses
  - **HIG**

HIG-11-003	Higgs to WW	Pre-approved
HIG-11-010	Higgs to gg	Pre-app during CMS Week
HIG-11-009	Higgs to tau tau	Pre-approved
HIG-11-004	Higgs to 4l	Pre-approved
HIG-11-006	Higgs to 2l 2 nu	Pre-approved
HiG-11-007	Higgs to 2l 2 jets	Pre-approved
HIG-11-011	Higgs Combination	

  - No show-stoppers, on good path to high-qua
  - Note : Hbb analysis aiming for LP

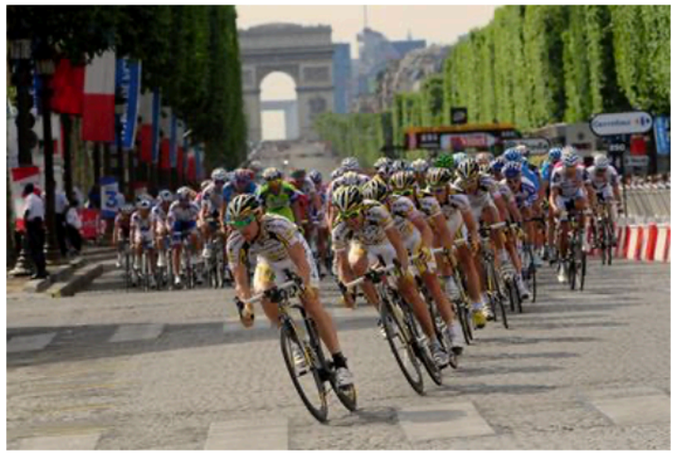
Priority Analyses (2)

- Here: Focus on Priority Analyses
  - **SUS**

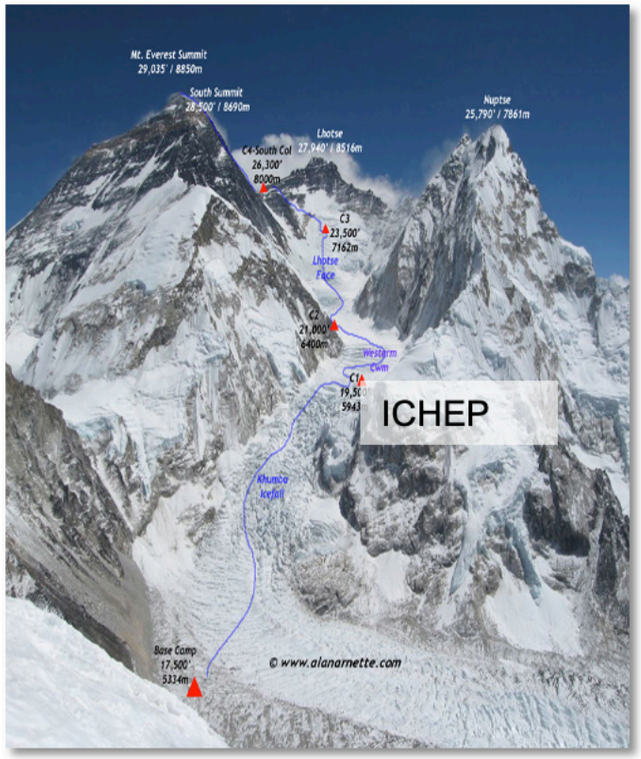
SUS-11-003	RA1	pre-approved
SUS-11-002	RA2	Not for EPS, now aiming for LP
SUS-11-008	Razor	Not for EPS, now aiming for LP
SUS-11-005	MT2	yes
SUS-11-015	One Lepton	??
SUS-11-0XX	Combination PAS	If PAS not achieved, then at least some common plot

Comments:

- Dilepton (OS and SS) analyses on good path
- Also multilepton search possible, but just in time



March 2010



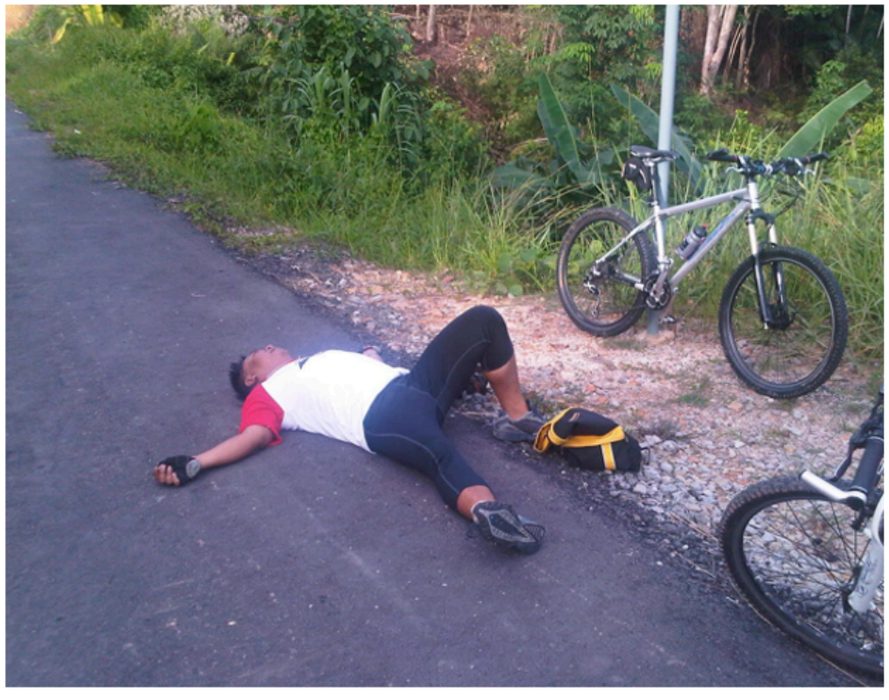
Bodrum 2010

Now (June 2011)

(June 2011)

Soon ?

Avoid this….



… and let’s continue to have fun with this fantastic data !

Many events to be prepared

Many events to be prepared

Moriond 2010, 2011 (2012)

EPS-HEP 2011 (Grenoble)

LP 2011 (Mumbai)

ICHEP 2010 (Paris)

LHCC

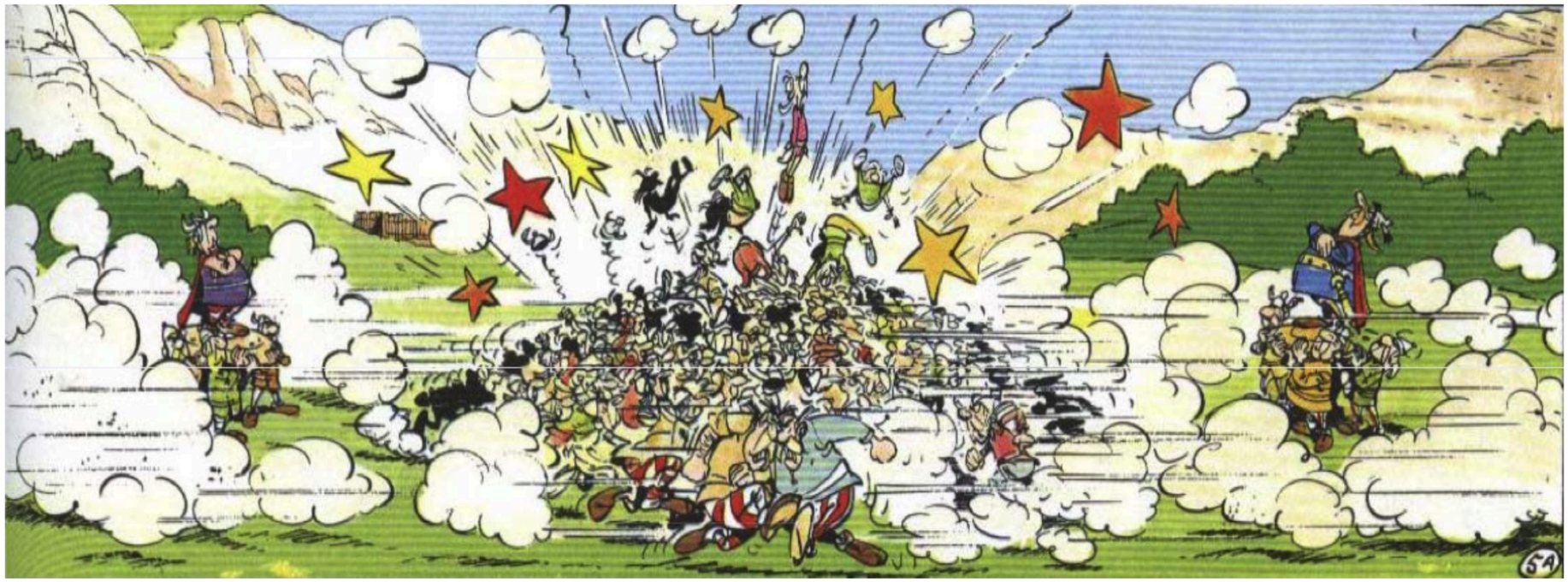
CMS weeks (eg. Physics in Bodrum 2010, Brussels 2011)

How large organizations function…

How large organizations function…

How large organizations function…

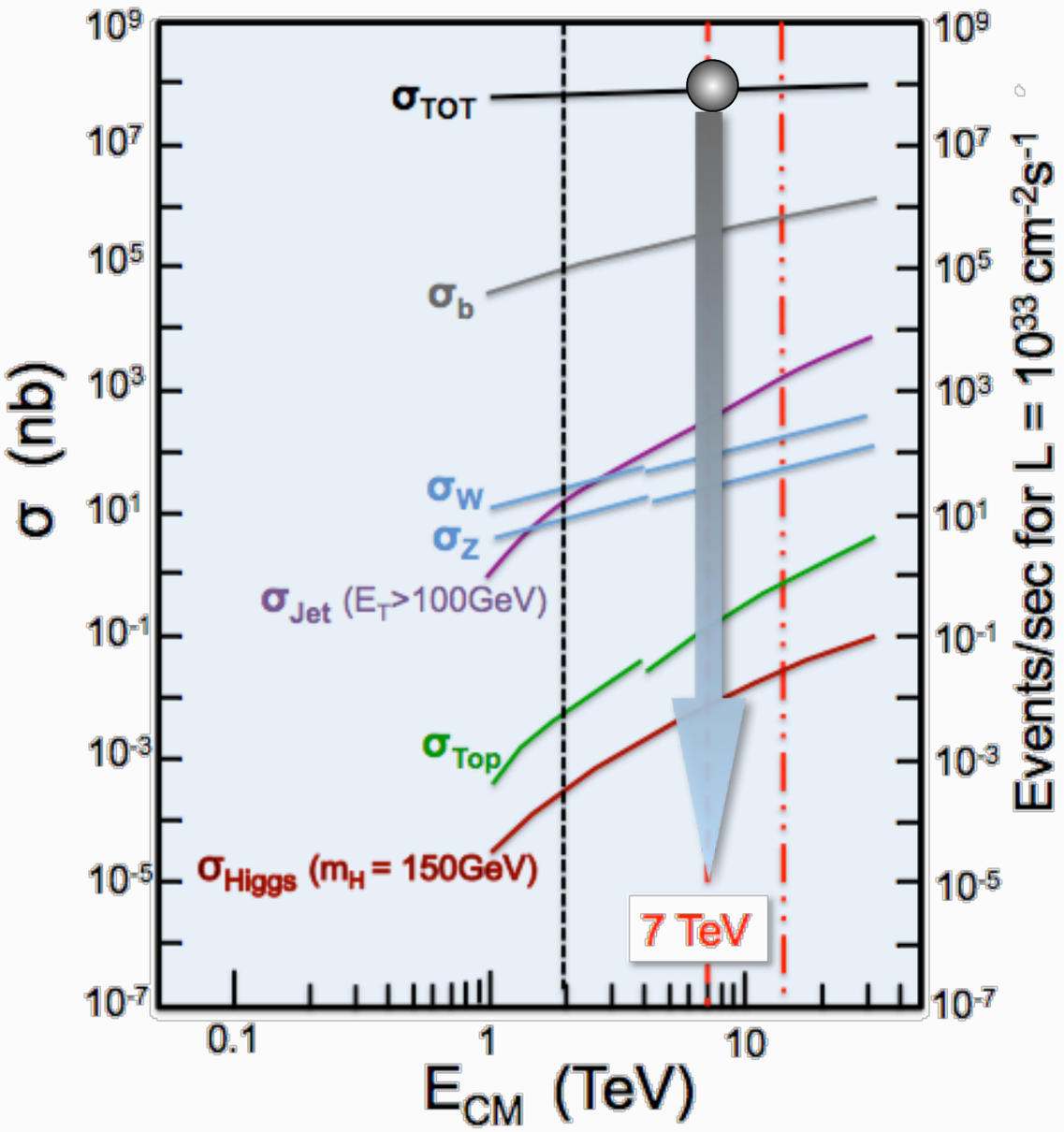
But now in order…

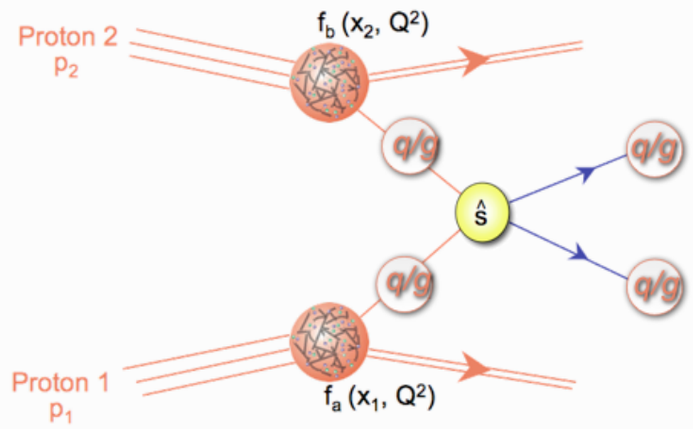


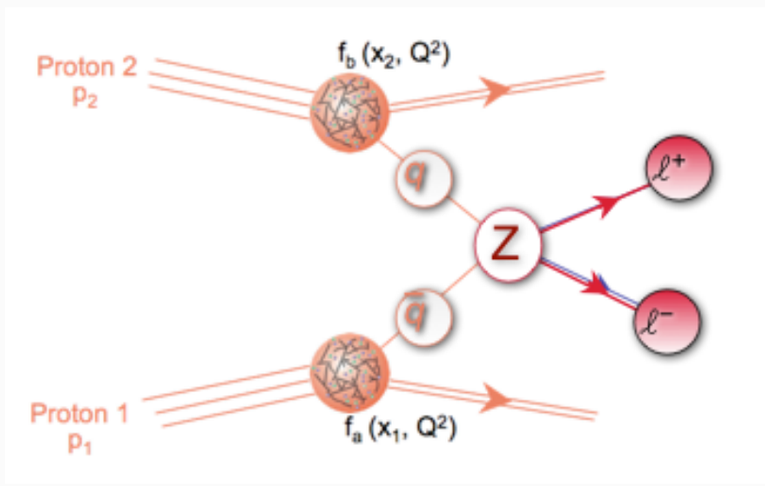
proton - proton collisions are complex….

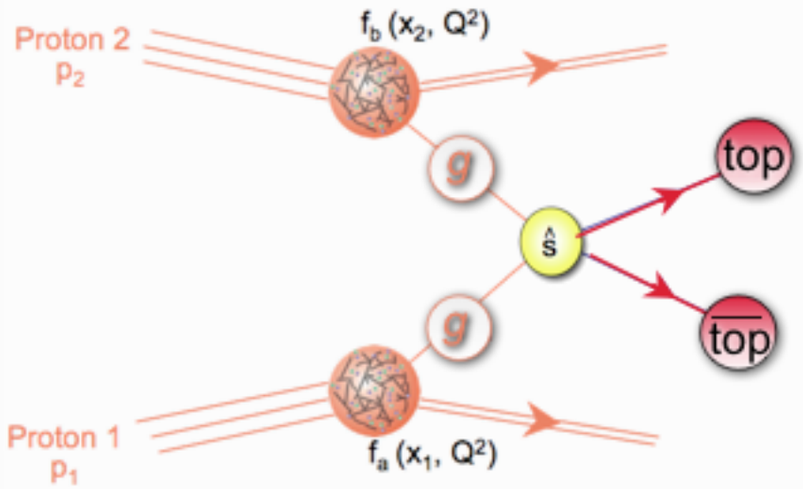
…. but this makes them so interesting…

Proton-Proton Physics









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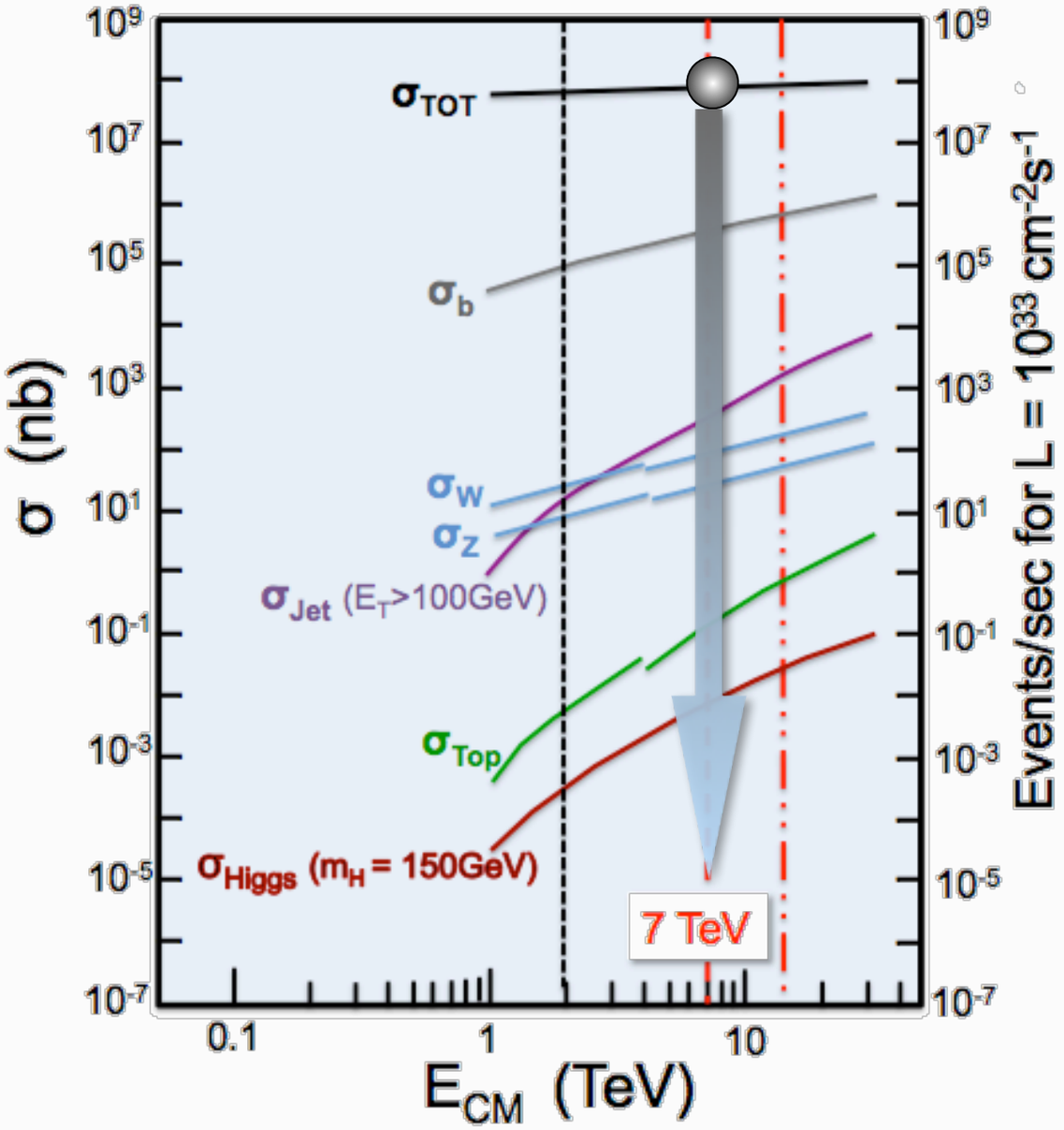
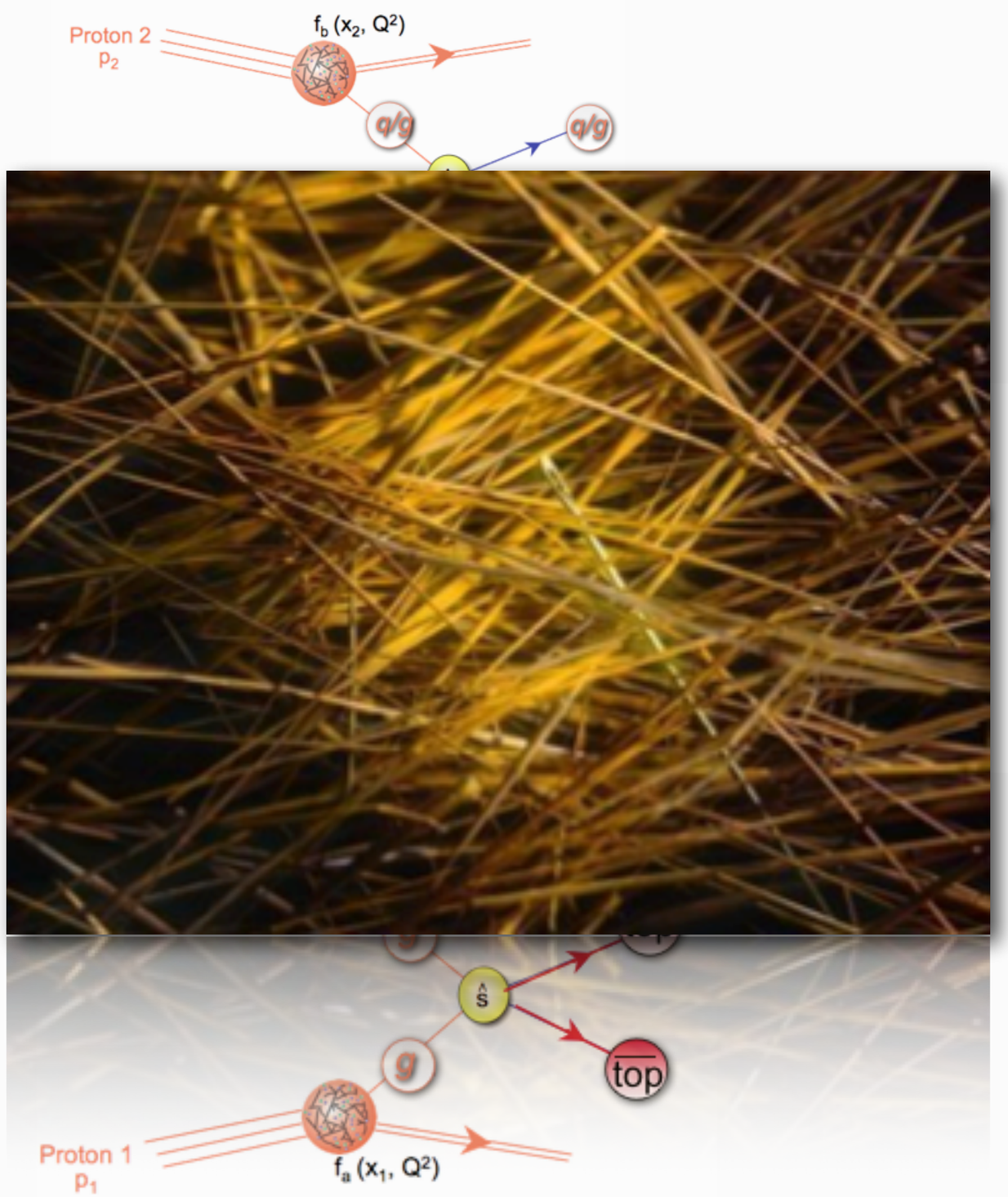
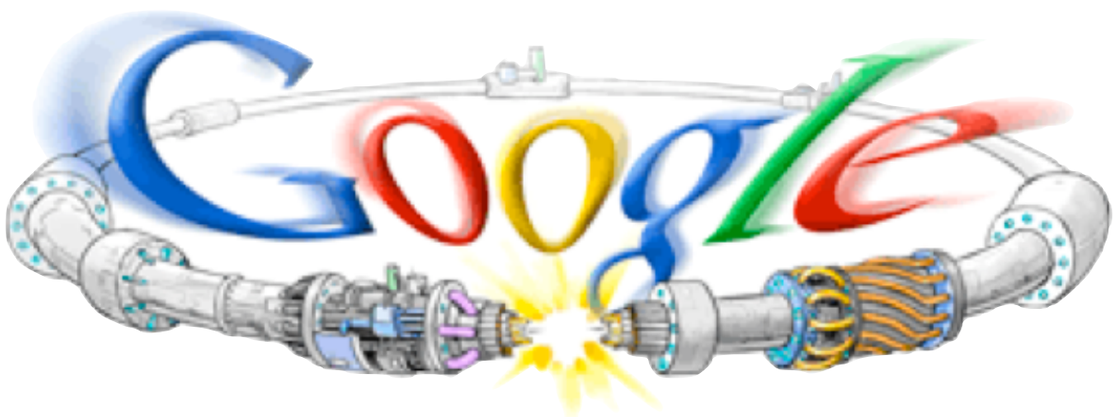




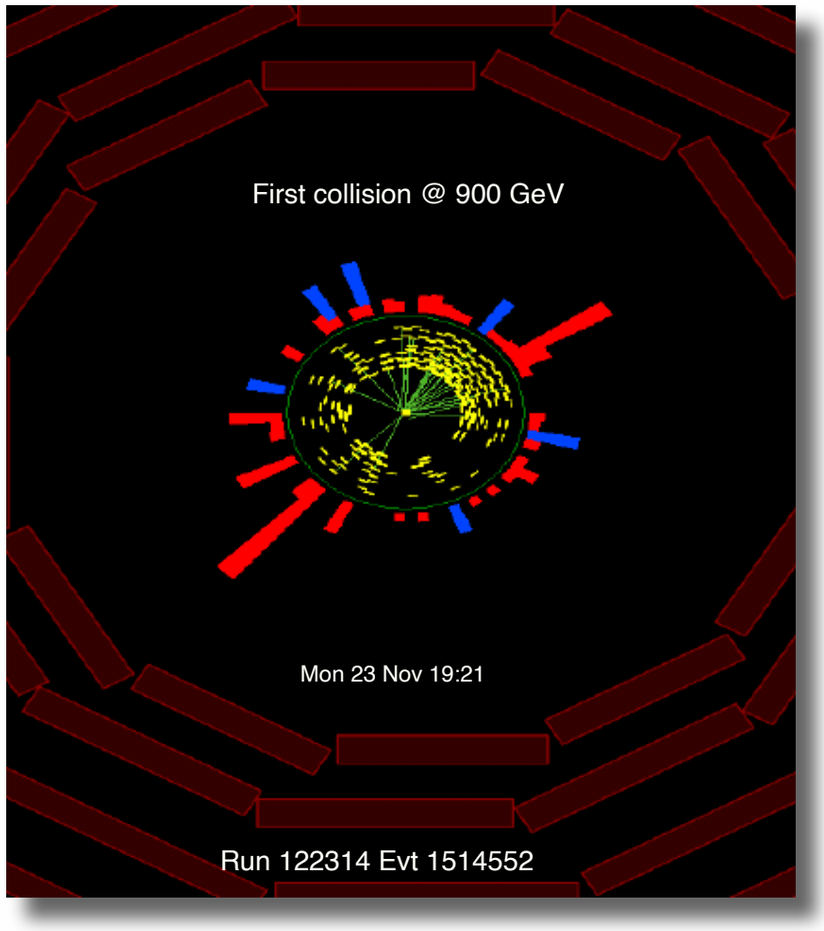
The machine performance

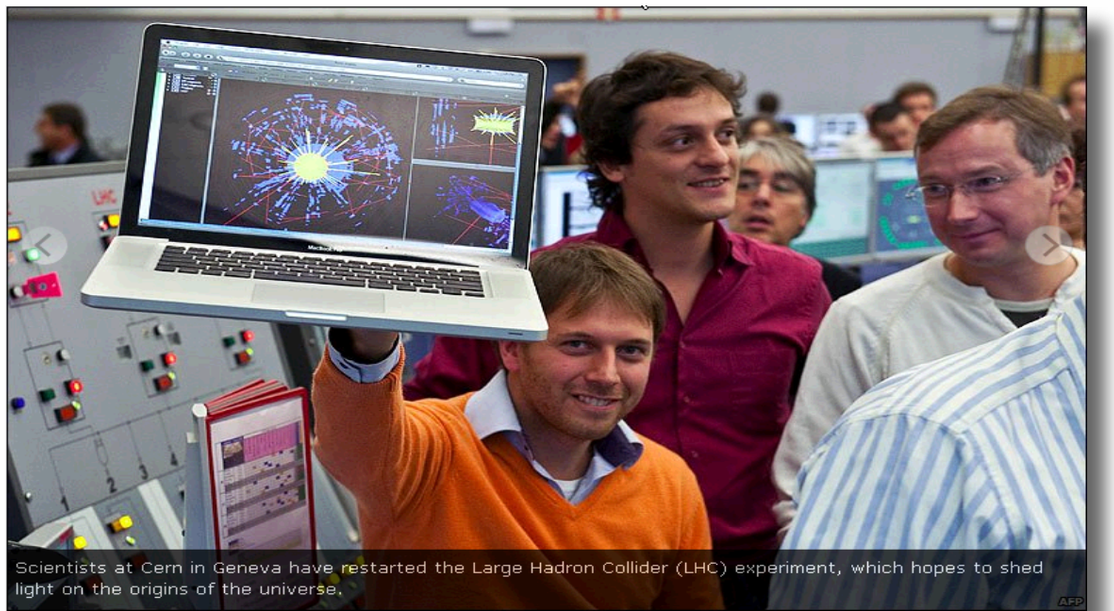


The LHC Start-Up in 2009

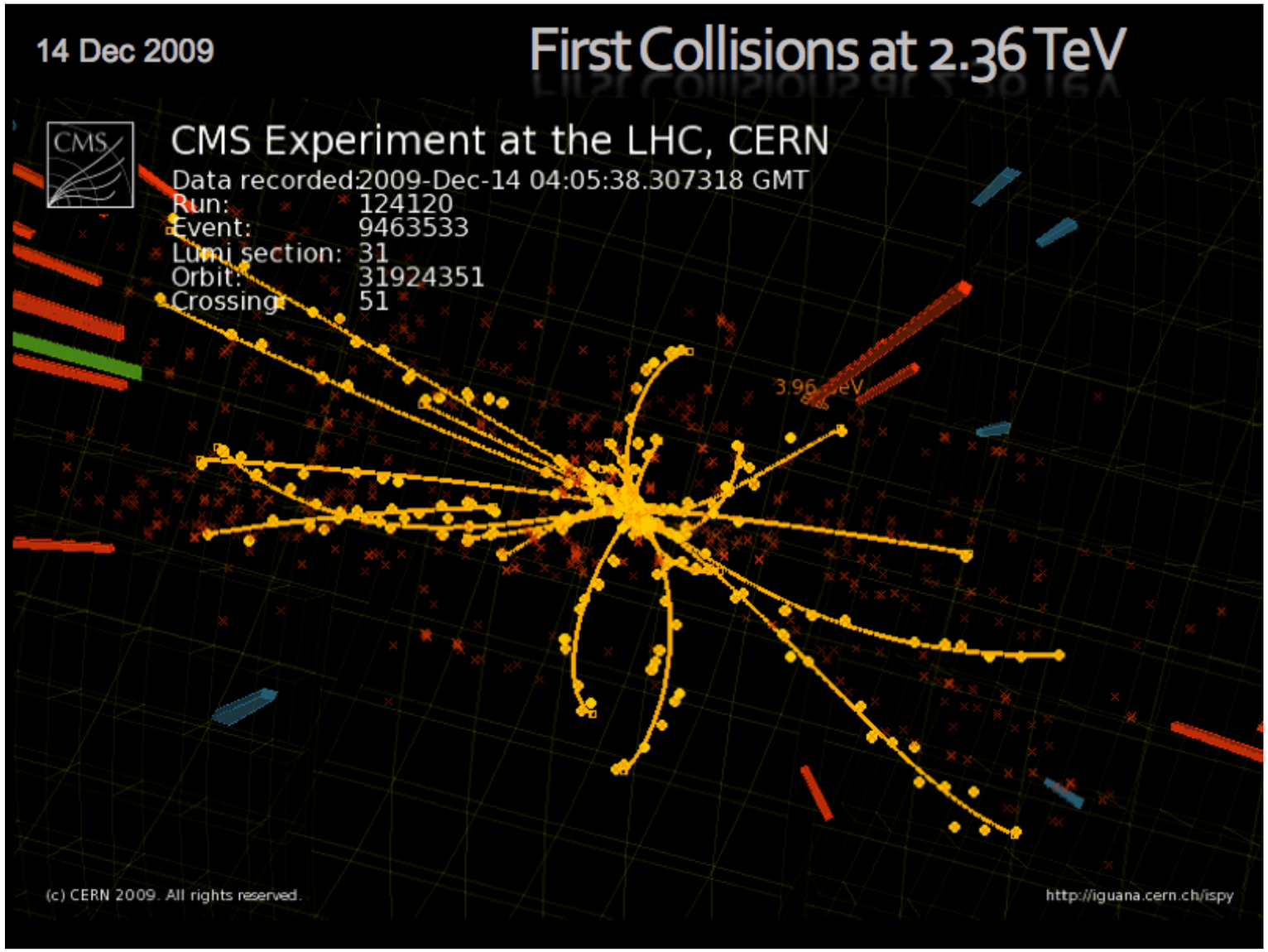
- Nov.20: Start of 2009 beam circulation
- Nov. 23: First collisions at 900 GeV
- Nov. 26: First results shown publicly at CERN!
- Dec.6: First physics fills
- Dec.8: Acceleration
  - both beams ramped to 1.18 TeV each
- Dec.11: Higher proton intensities (7E10)
  - Starting to accumulate luminosity at 900 GeV
- Dec.14, Collisions at 2.36 TeV !

First CMS Collision Event





First results....



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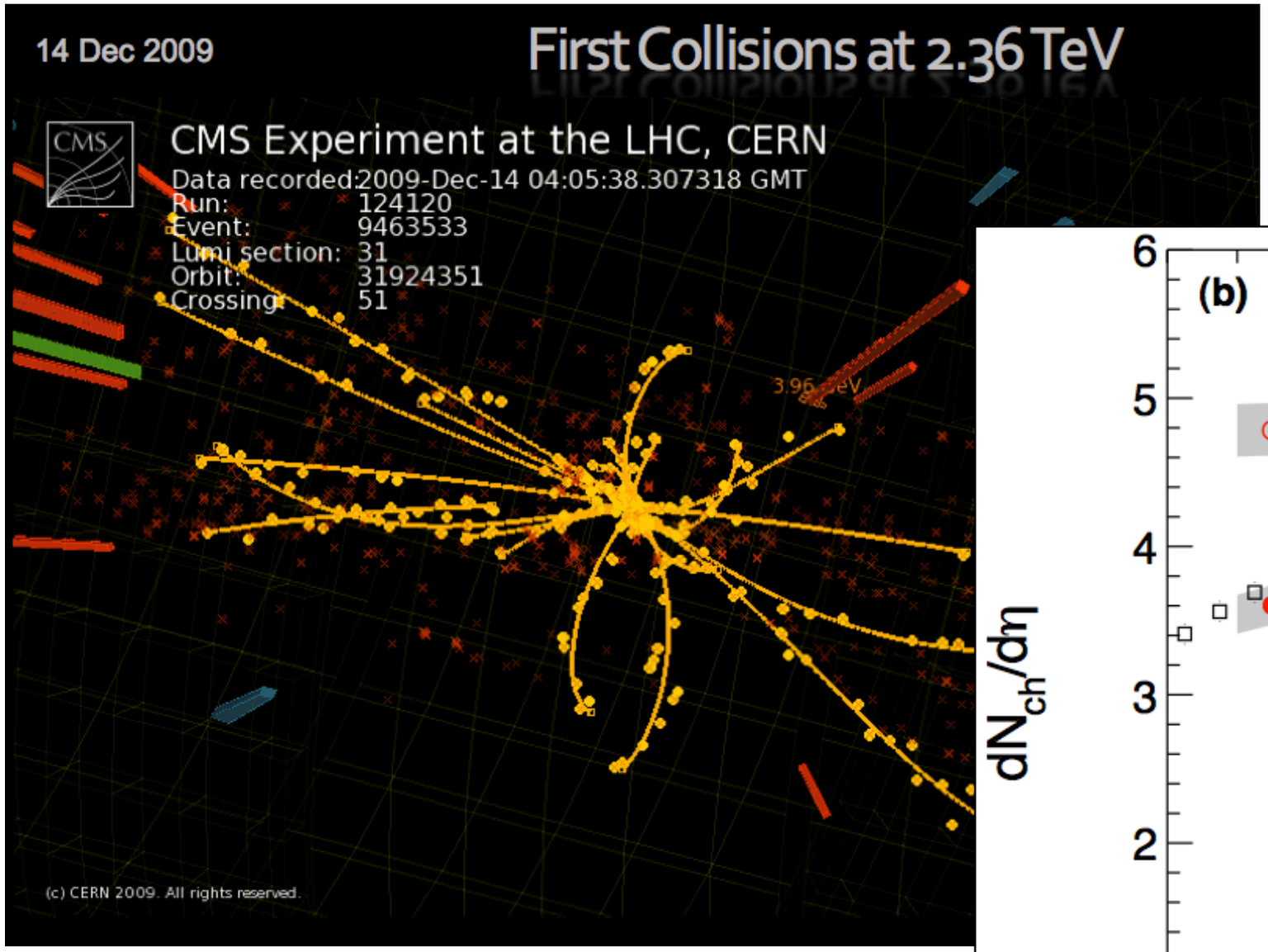

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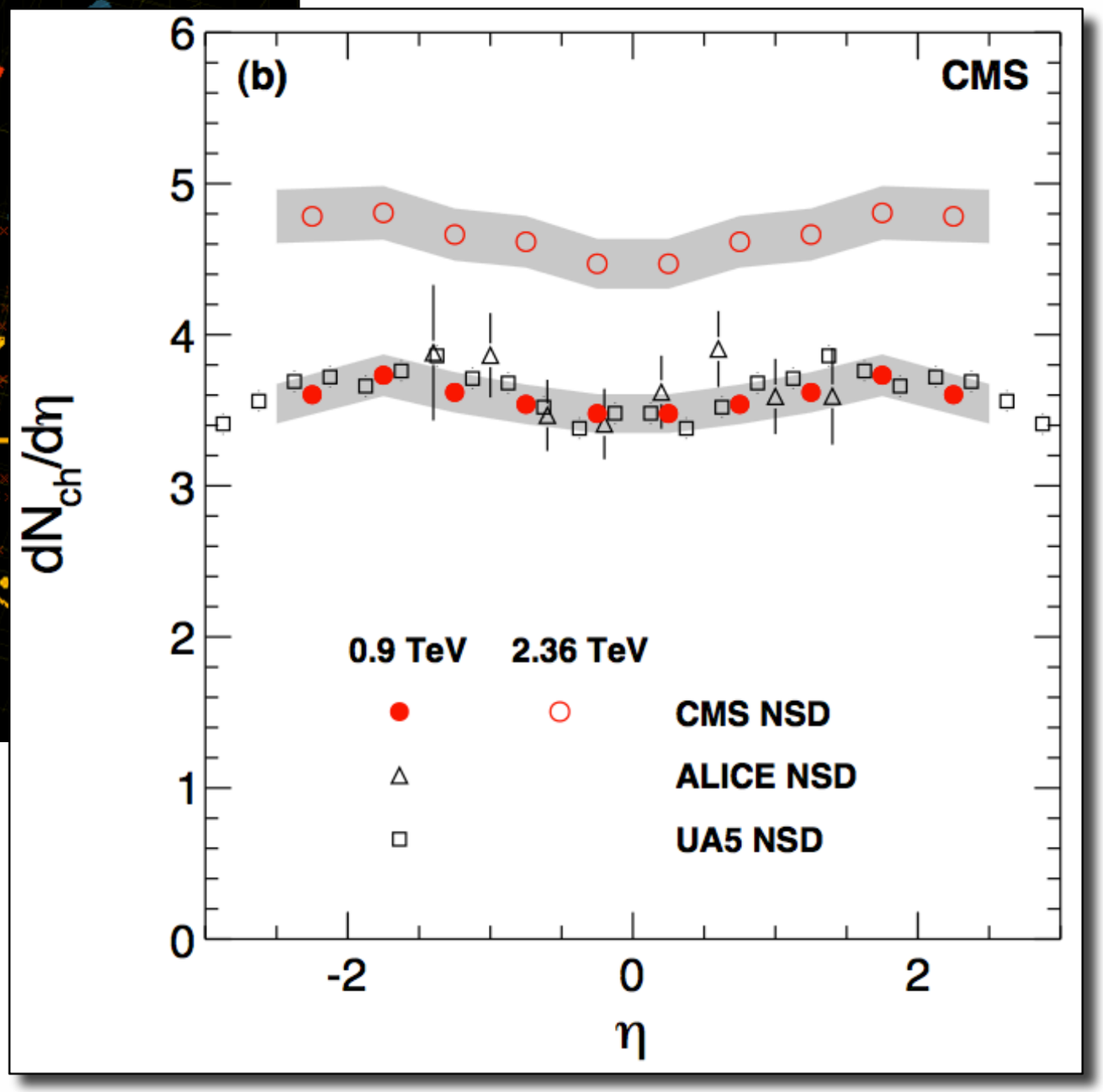

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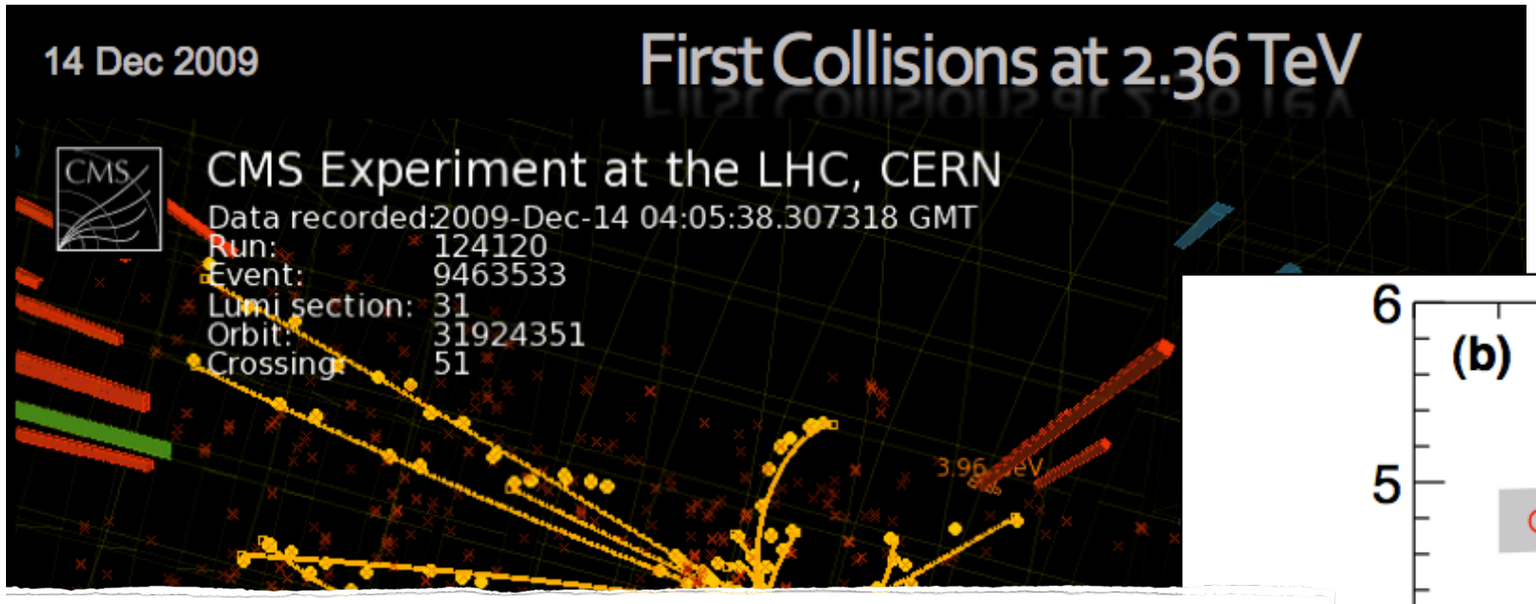

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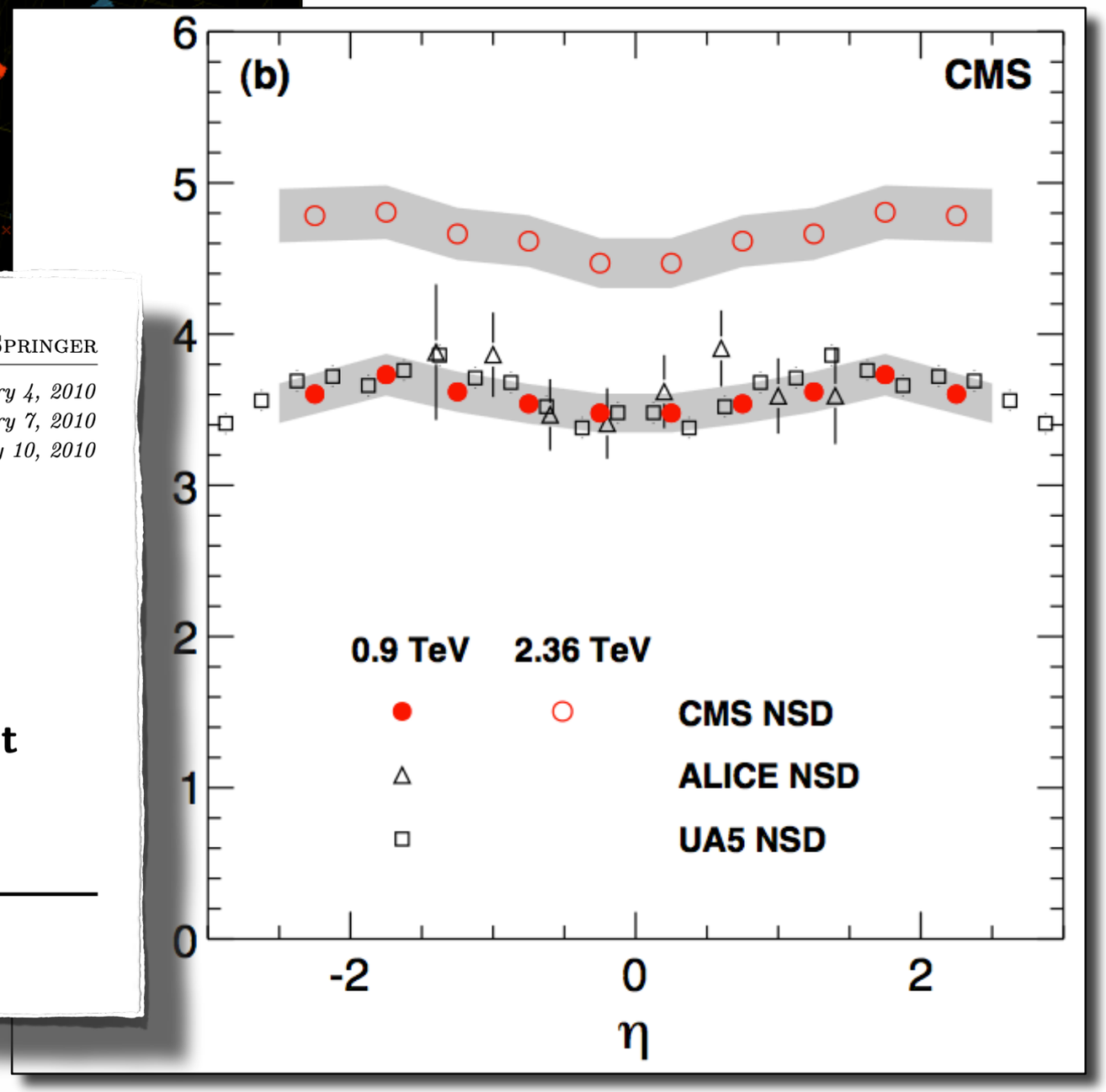


JHEP

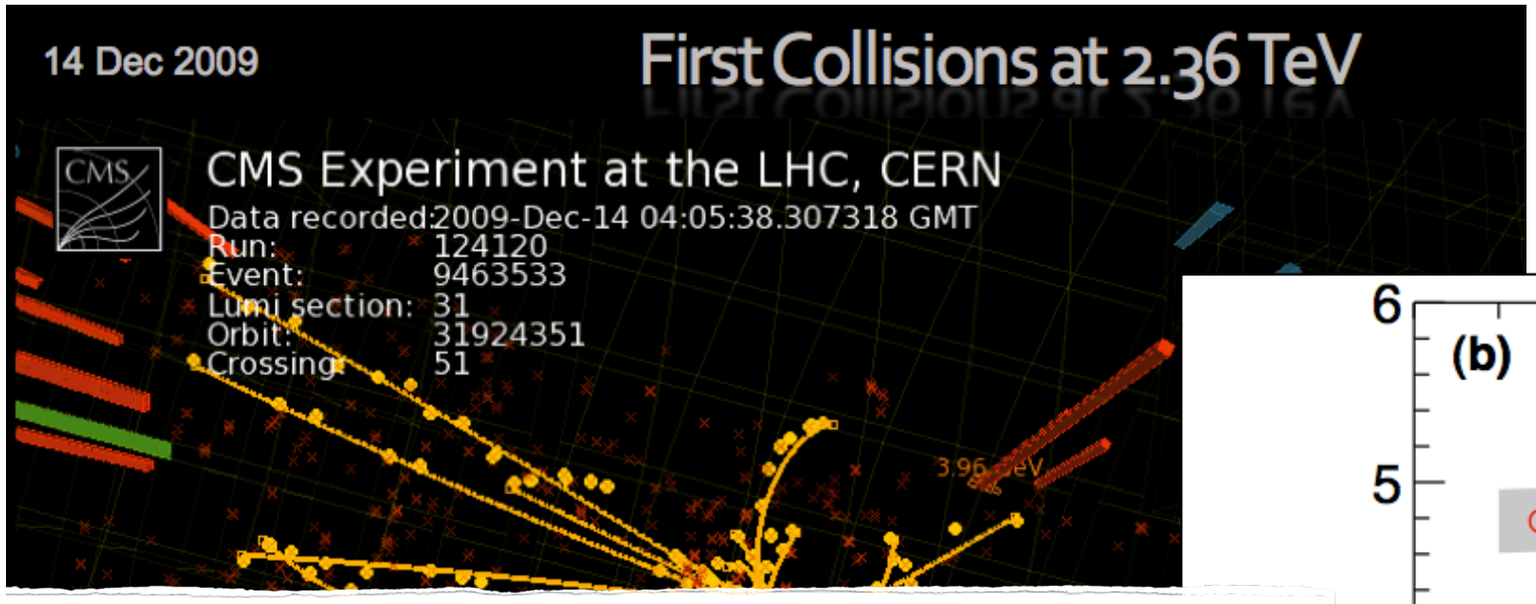
Published for SISSA by Springer

Received: *February 4, 2010*
Accepted: *February 7, 2010*
Published: *February 10, 2010*

Transverse-momentum and pseudorapidity distributions of charged hadrons in pp collisions at $\sqrt{s} = 0.9$ and 2.36 TeV

CMS Collaboration

First results....



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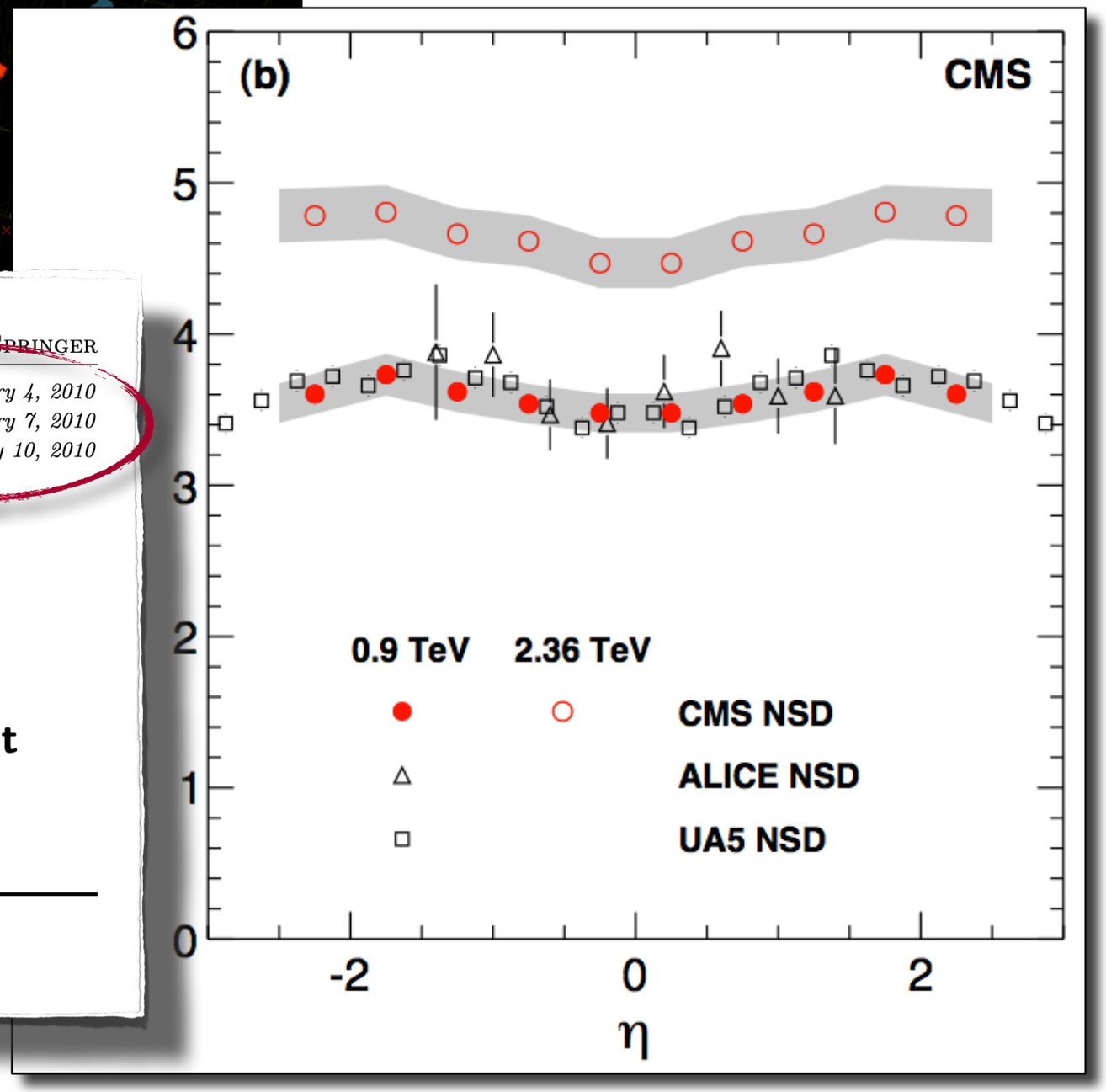
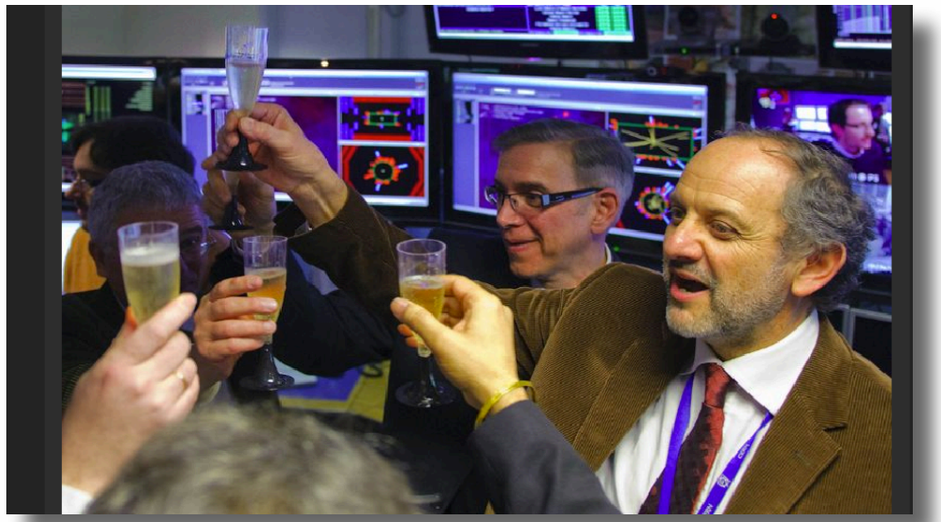


The LHC Start-Up in 2010

- from end of Feb to end of March:
  - commissioning of the machine
  - preparations for the first 7 TeV collisions
- on March 30
  - first attempts for stable beams in the morning
  - **first collisions at 7 TeV achieved at 13:00!**
- under the spot light (again) of the world-wide press



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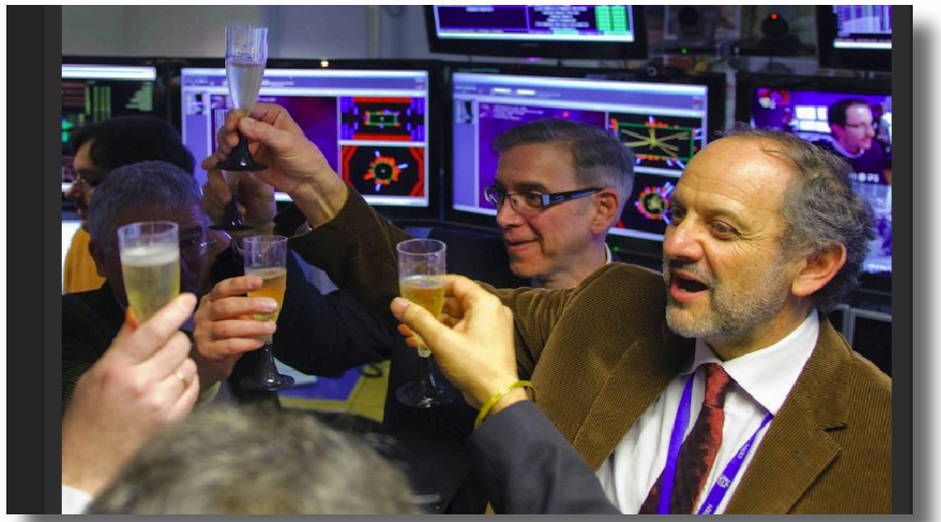

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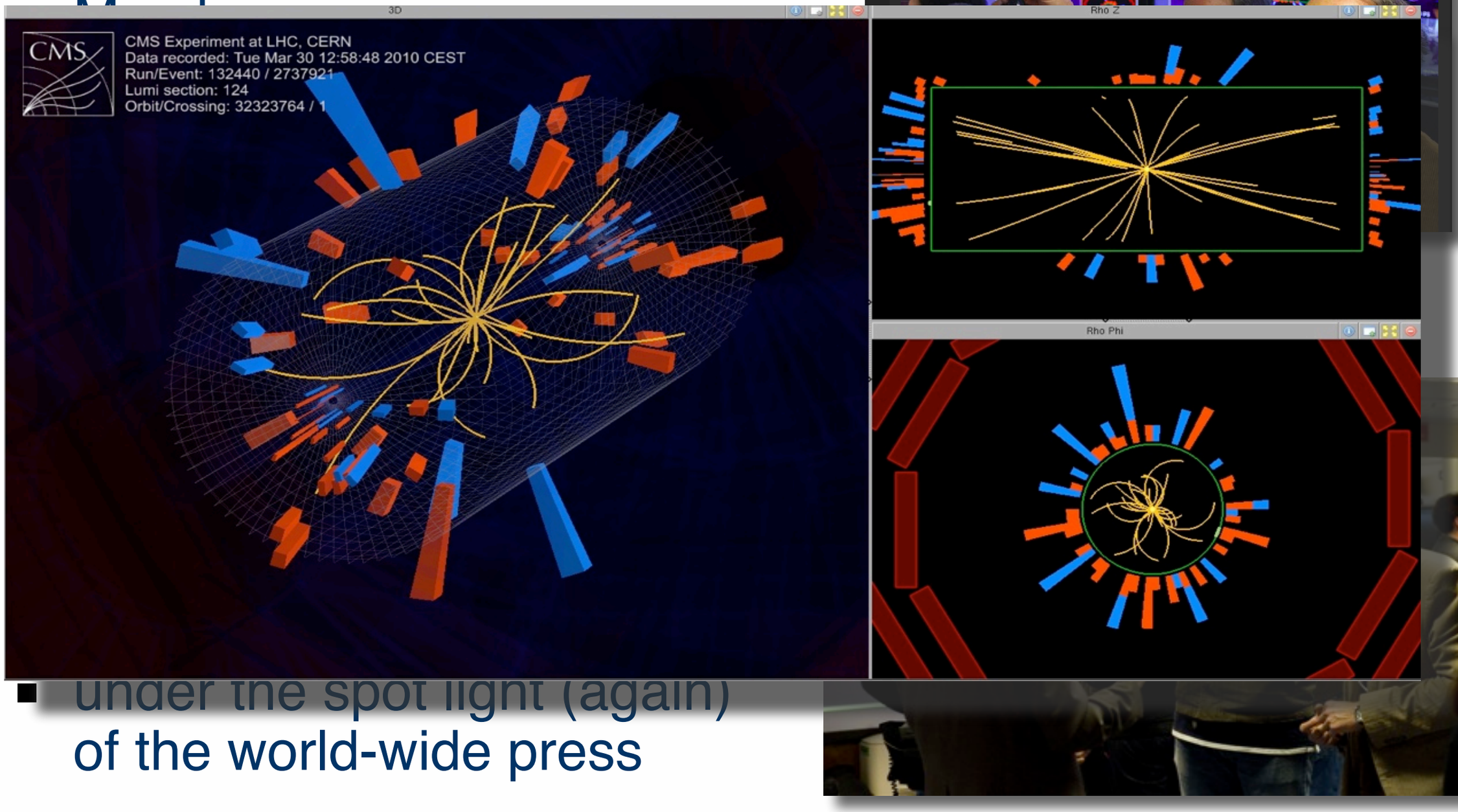
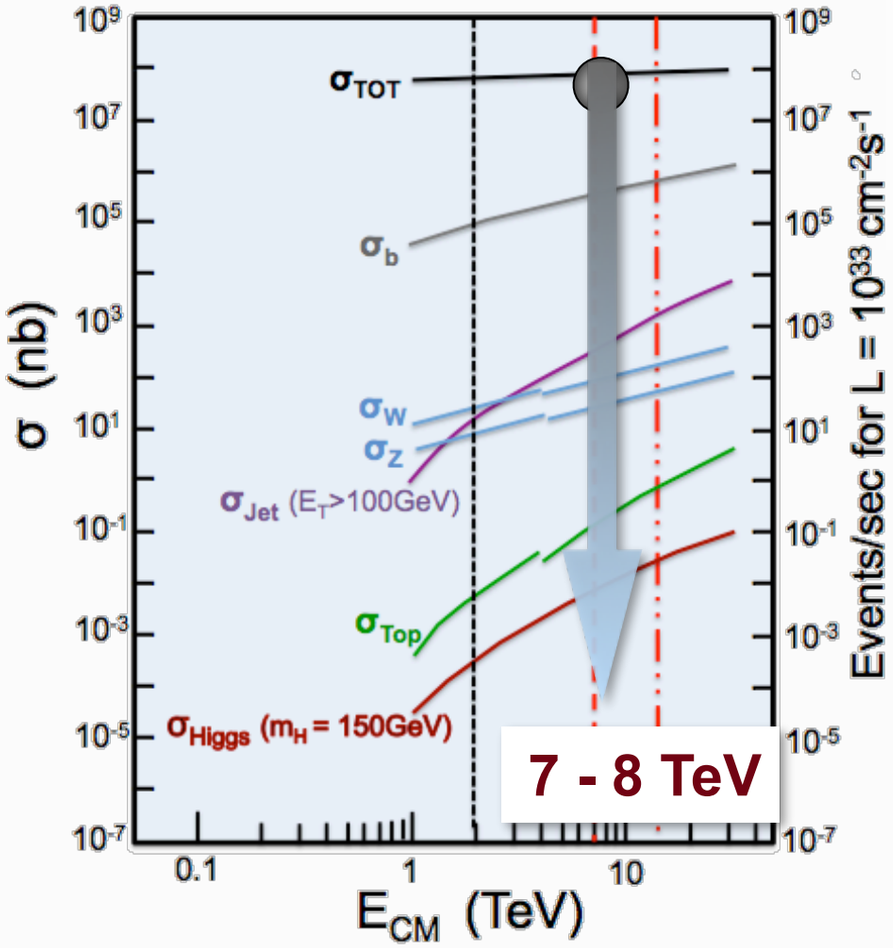
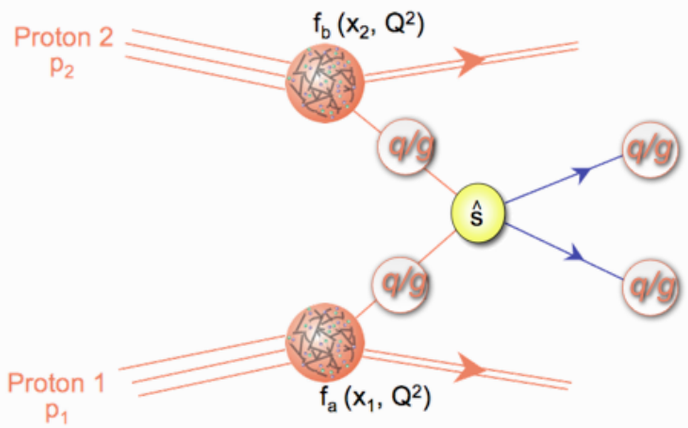
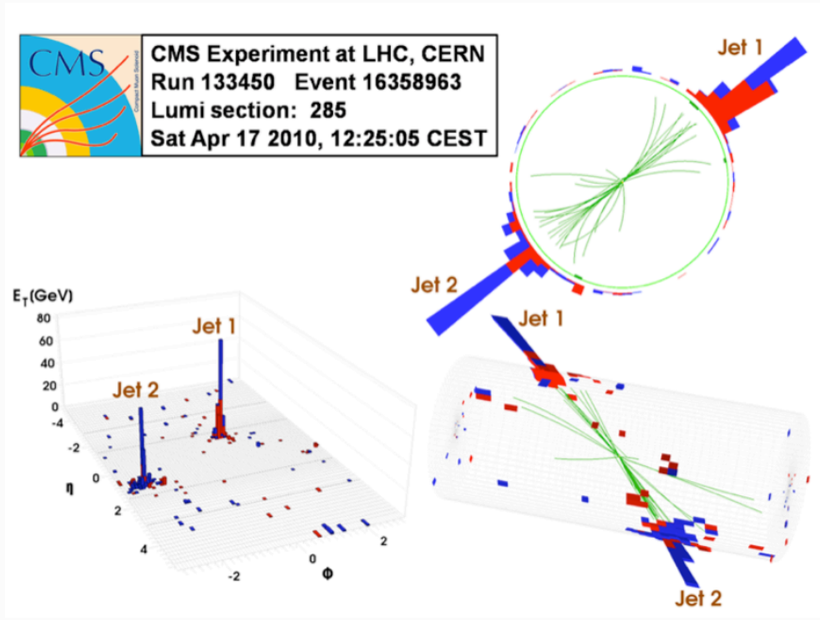


So: the race was on… but first: testing the SM







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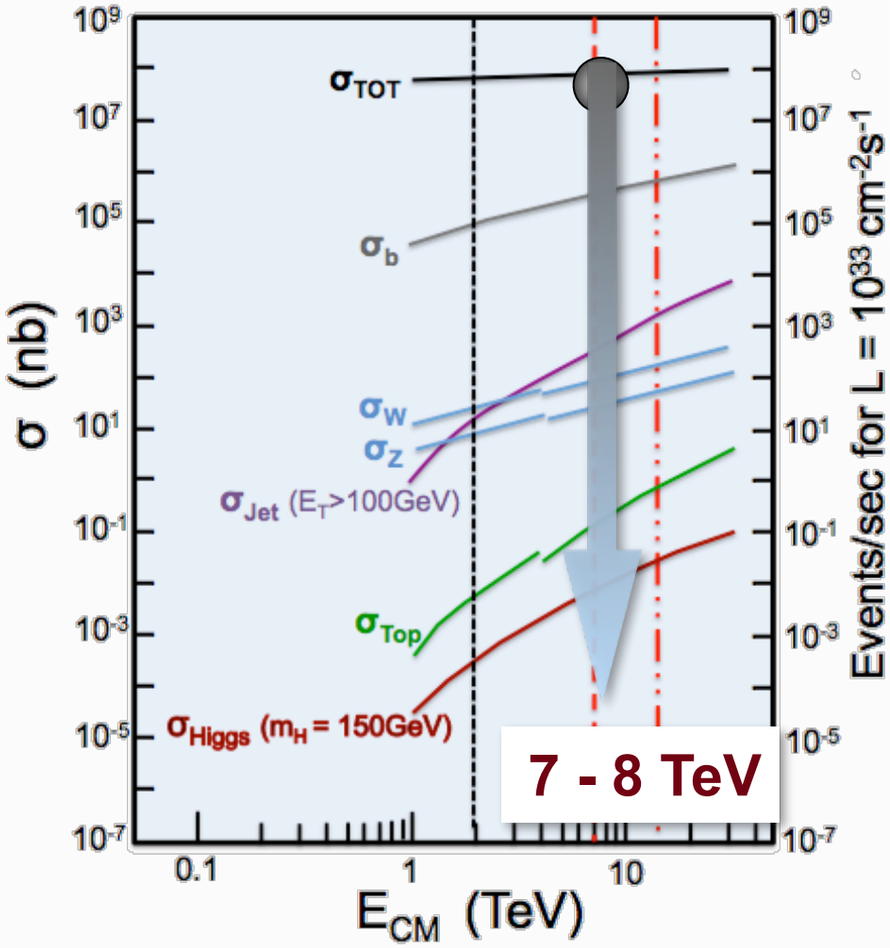

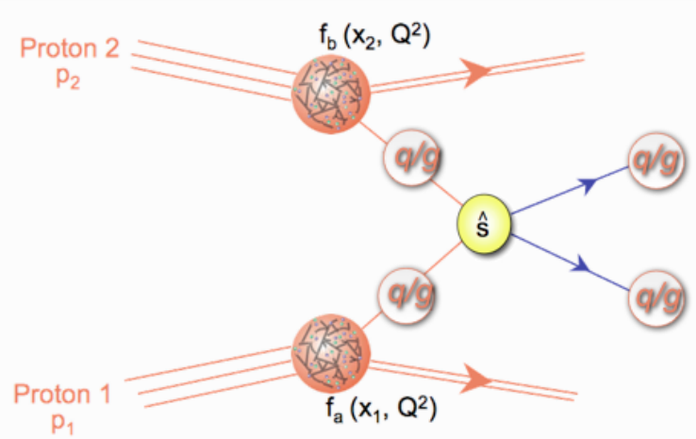

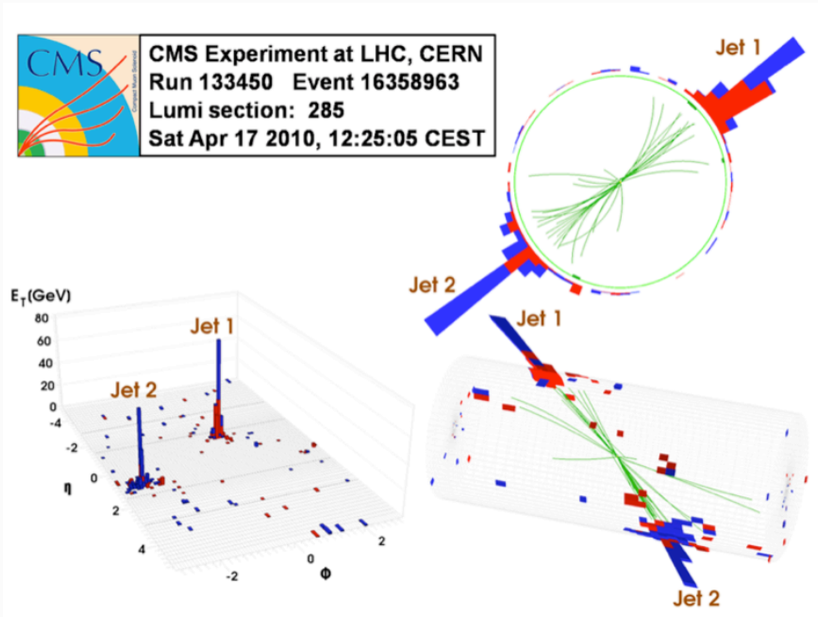

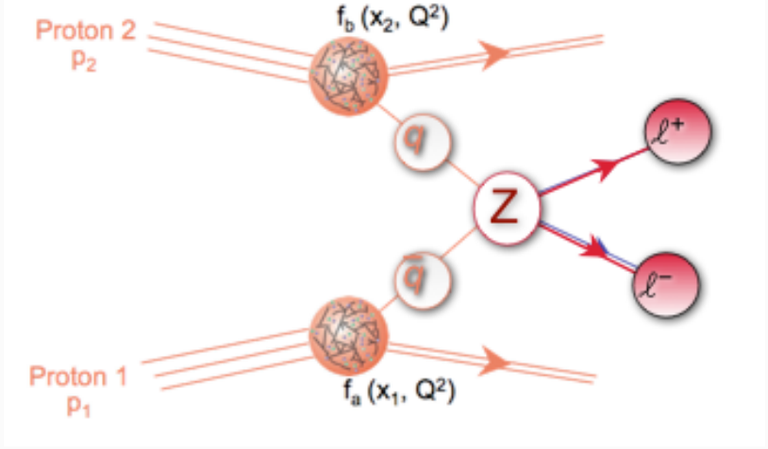

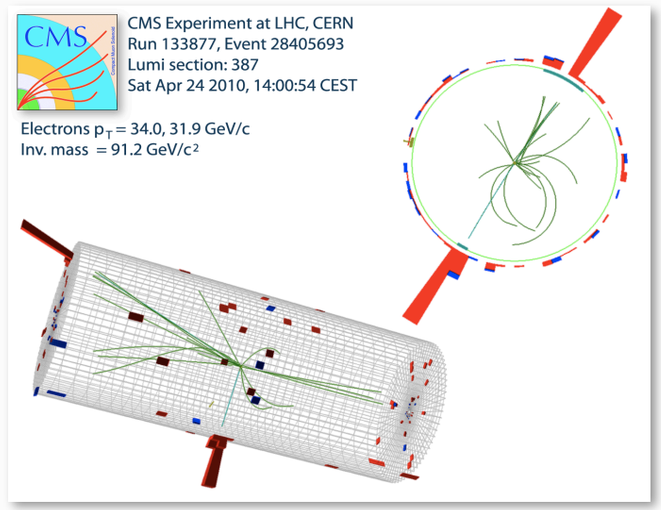

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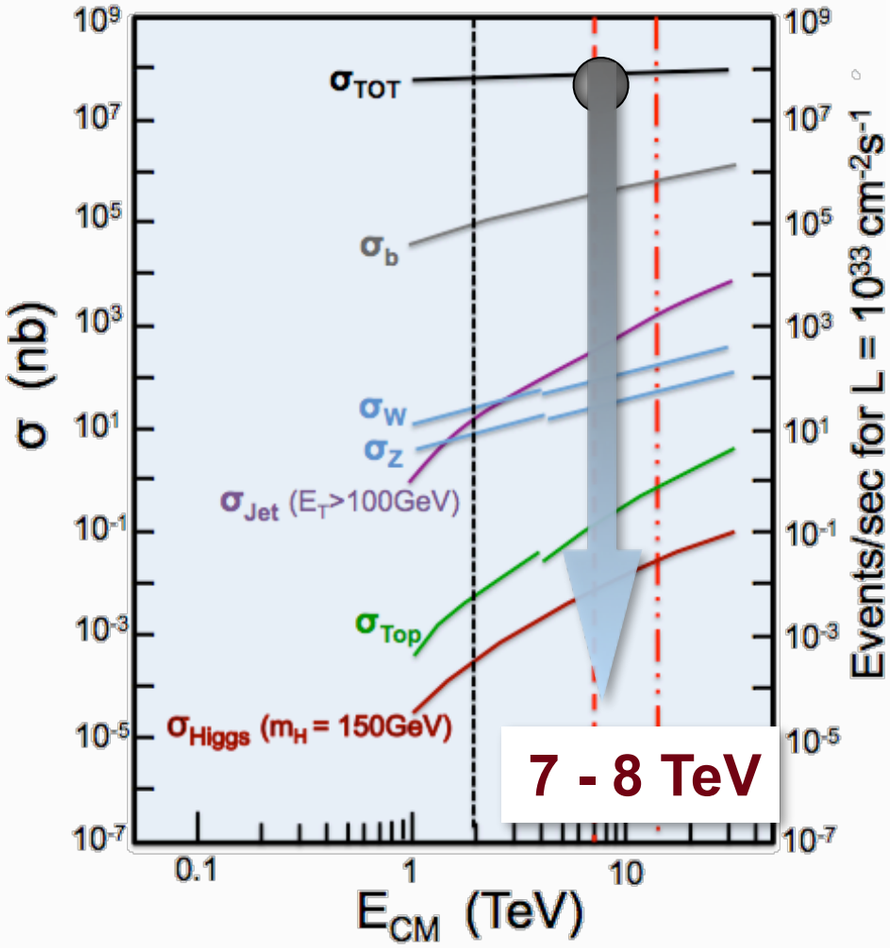

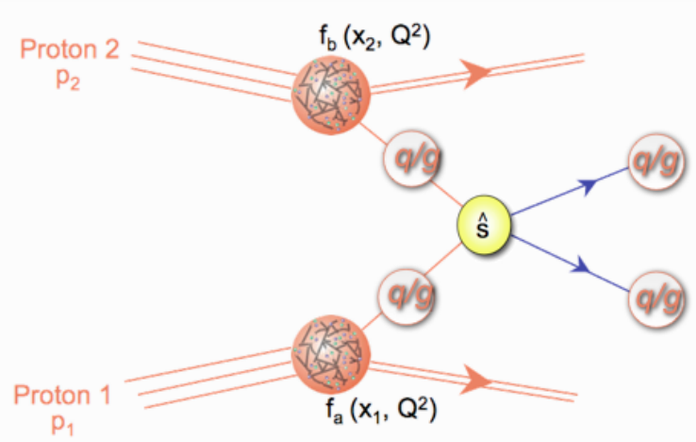

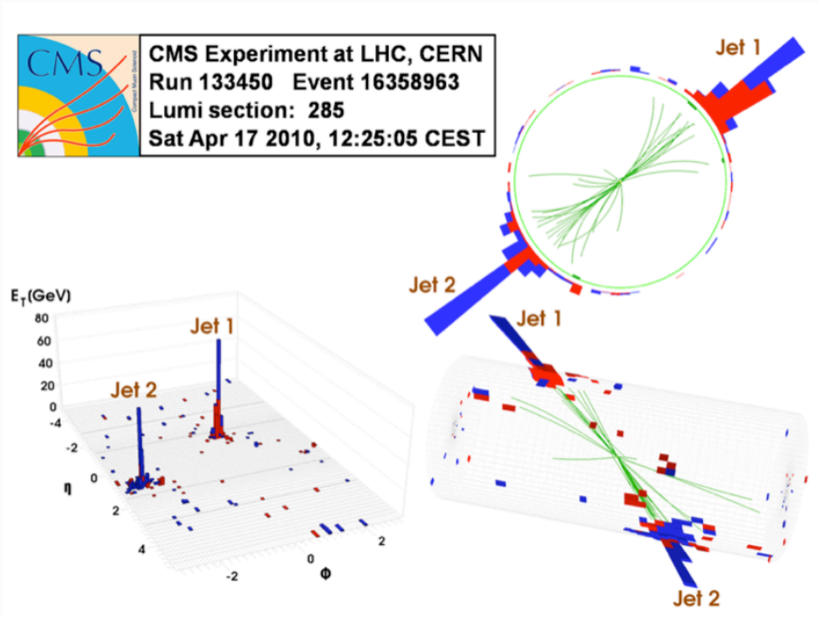

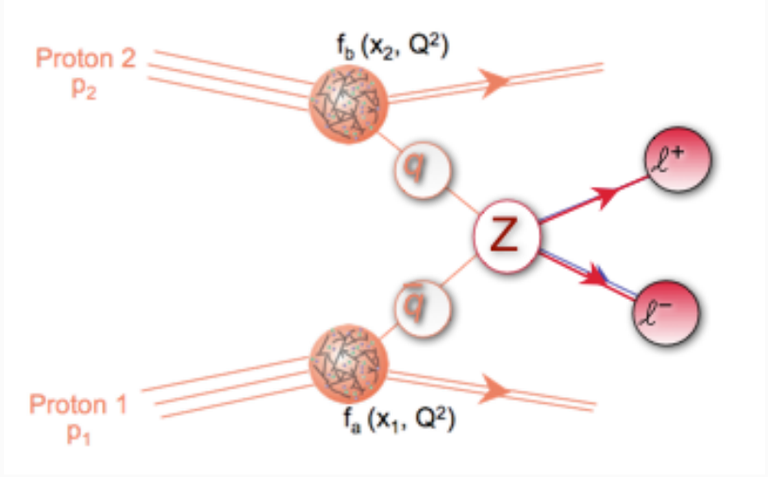

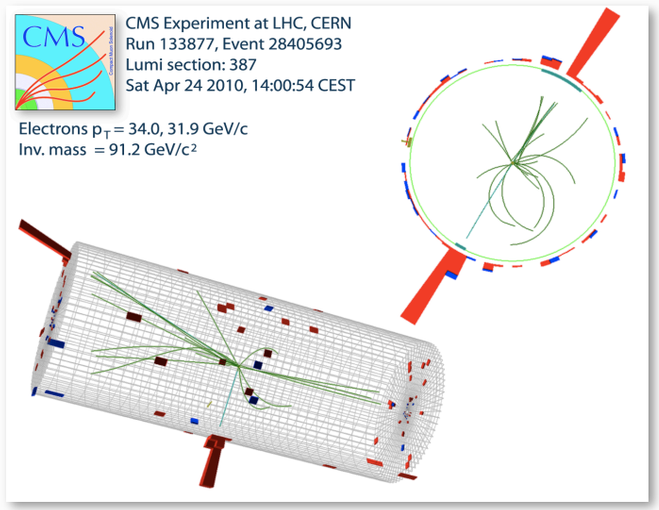

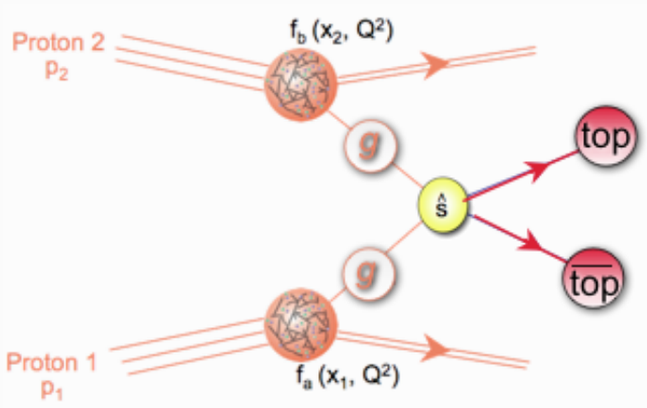

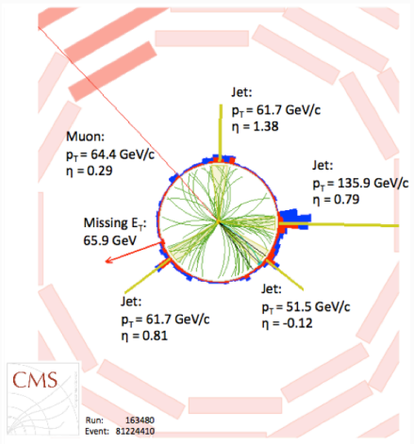

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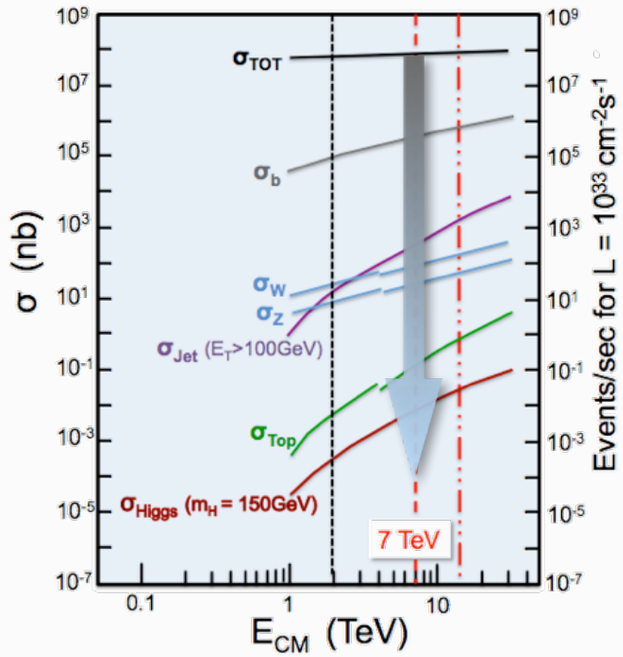

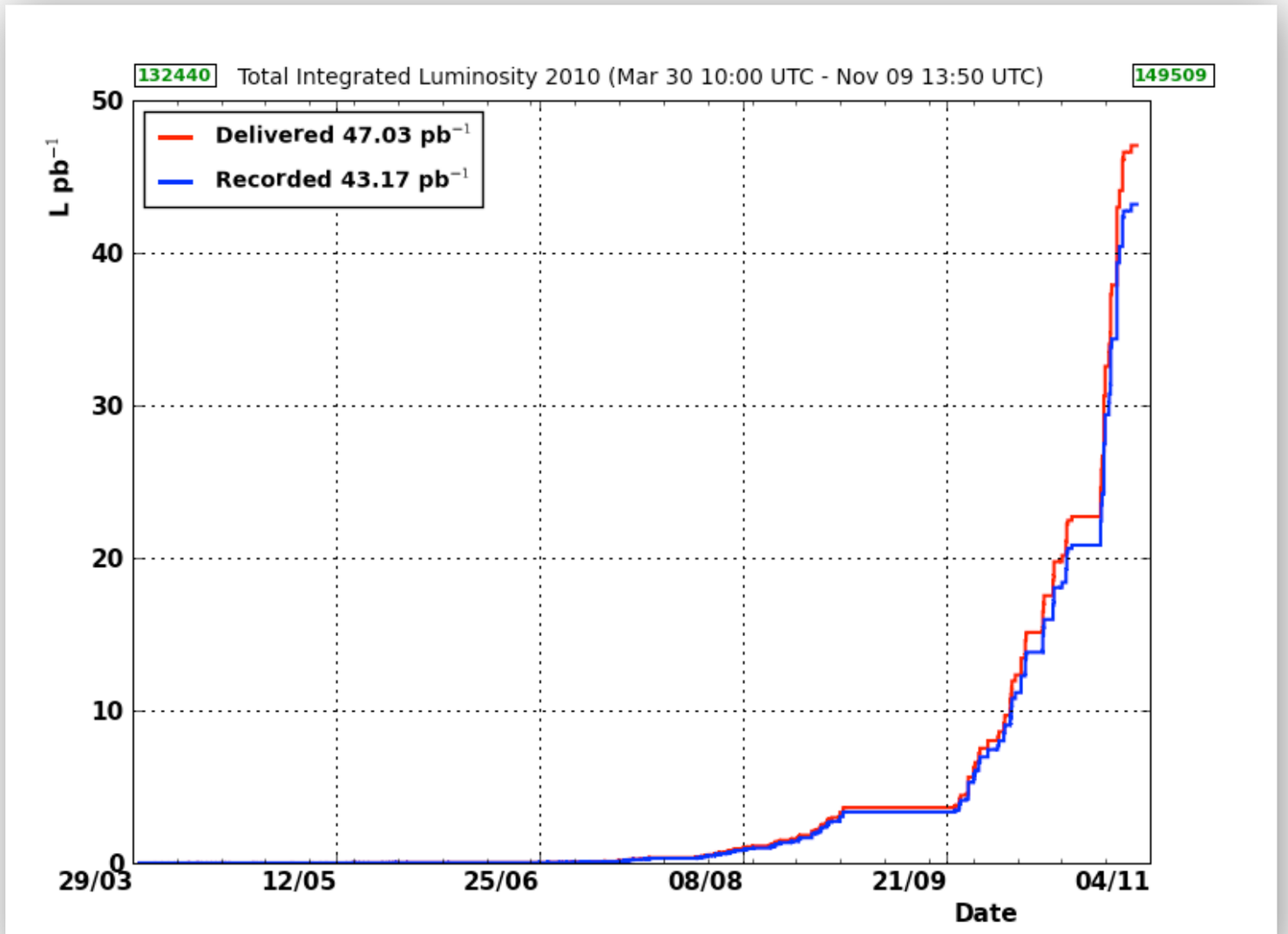

Typical data taking efficiency **> 90 %**
subdetectors with **typically 98% or more** of all channels operational
2010 data ~ O(hundred million) events on tape

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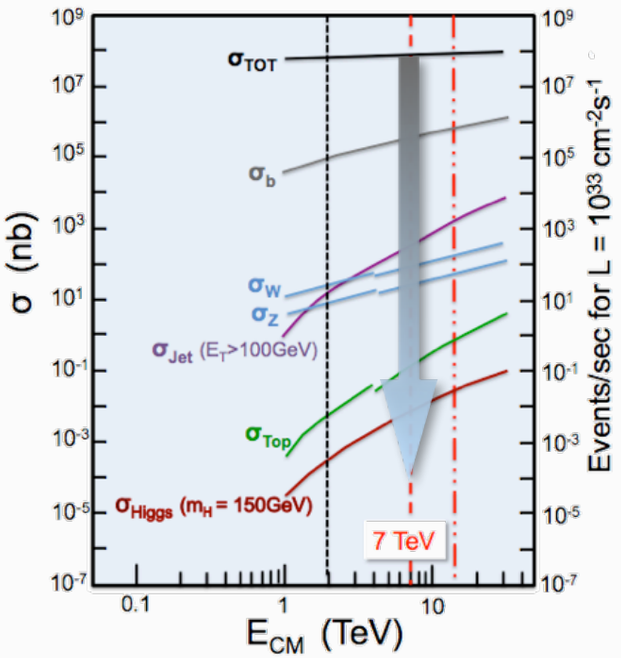

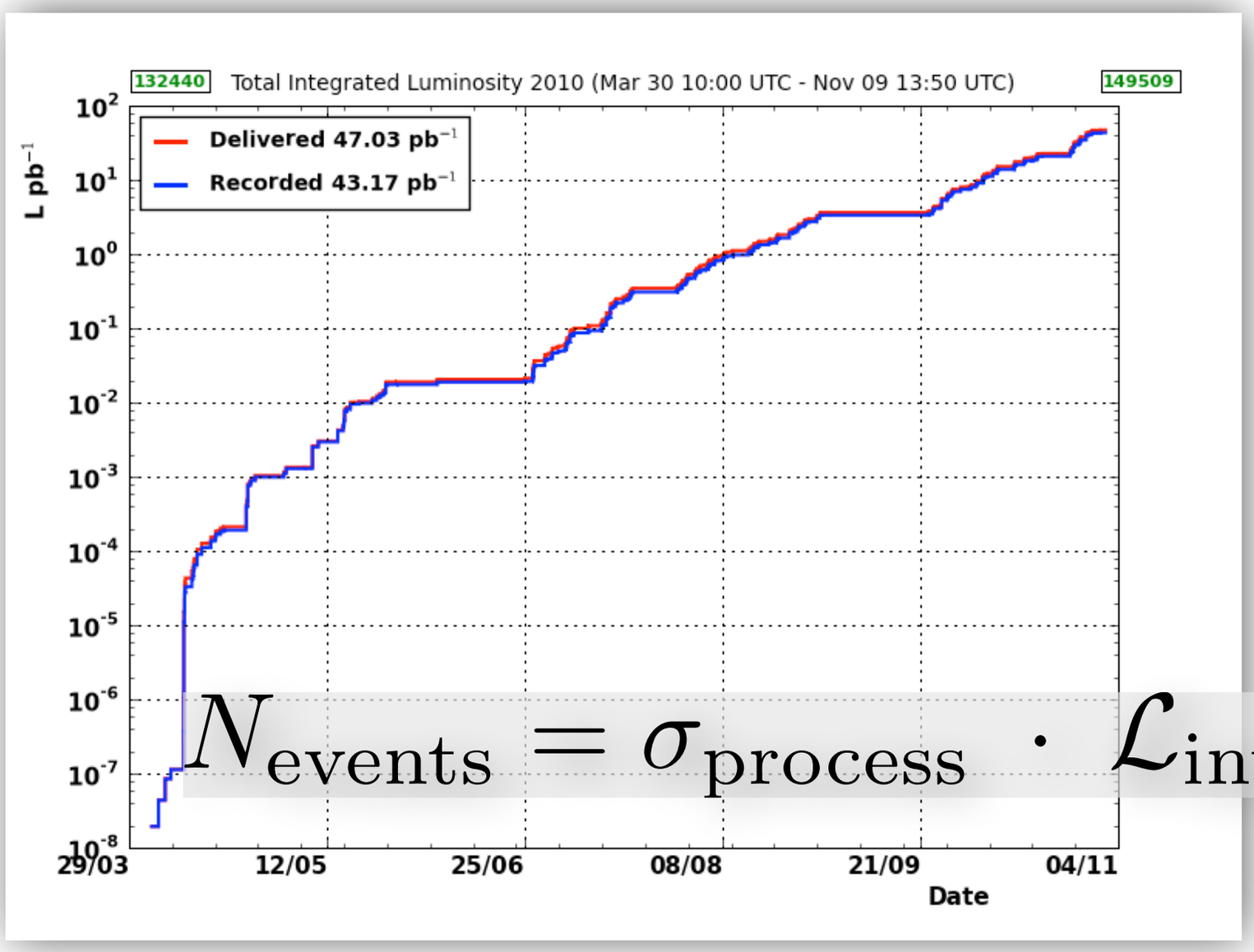

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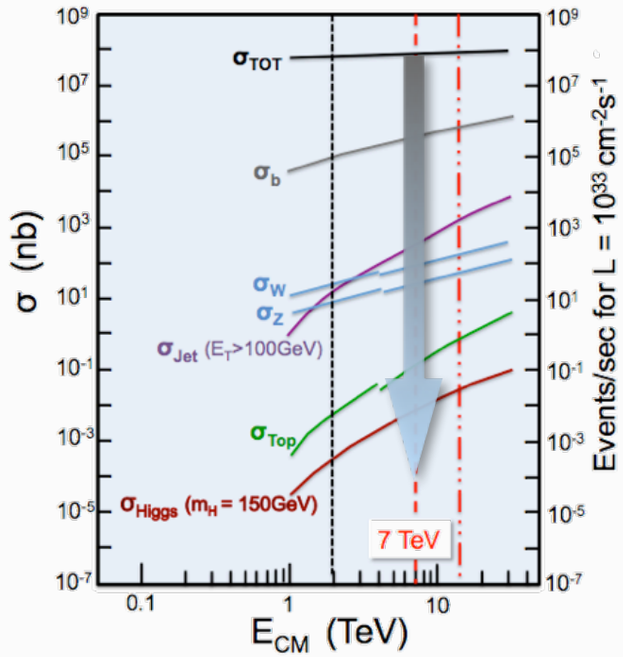

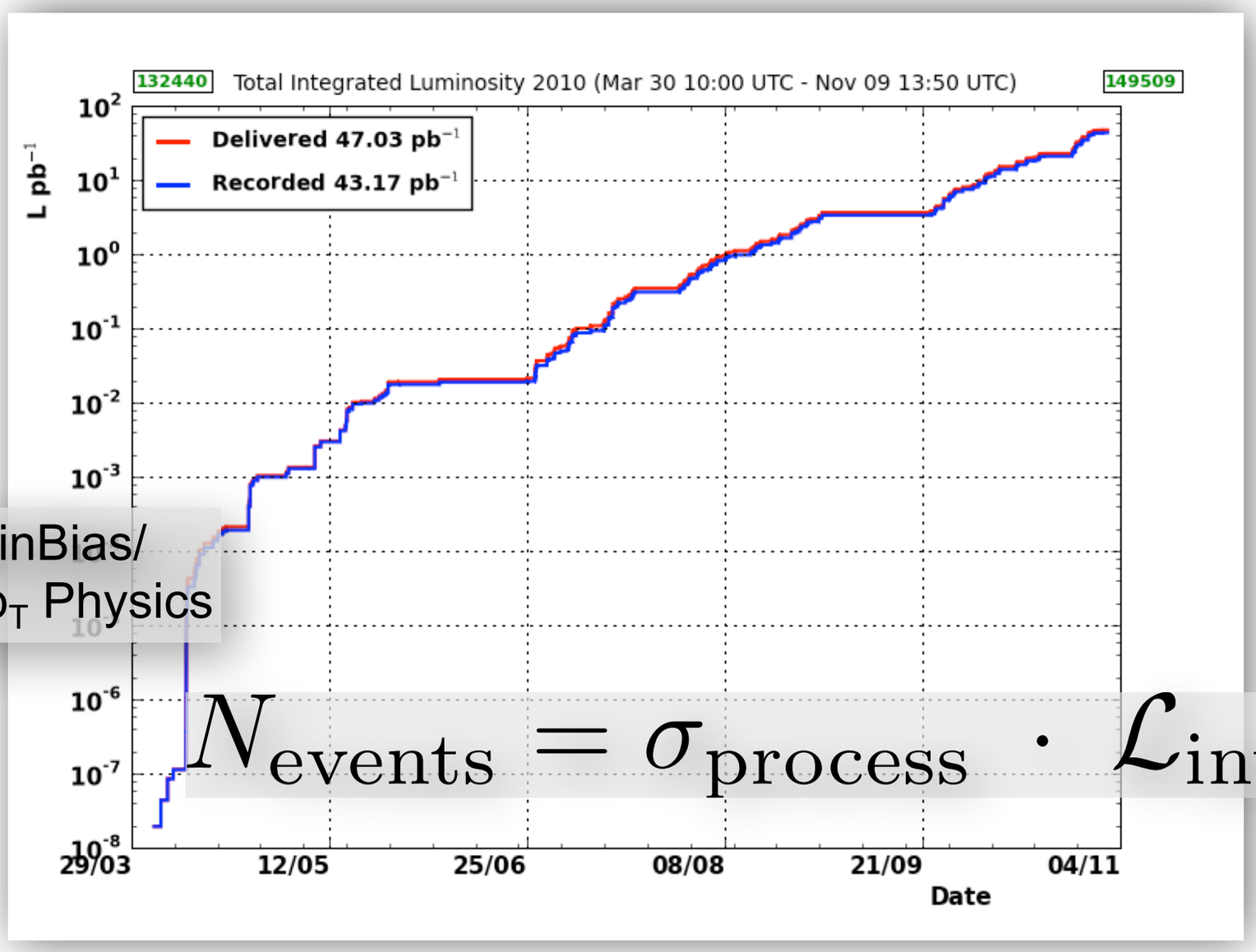

MinBias/
low-p_T Physics

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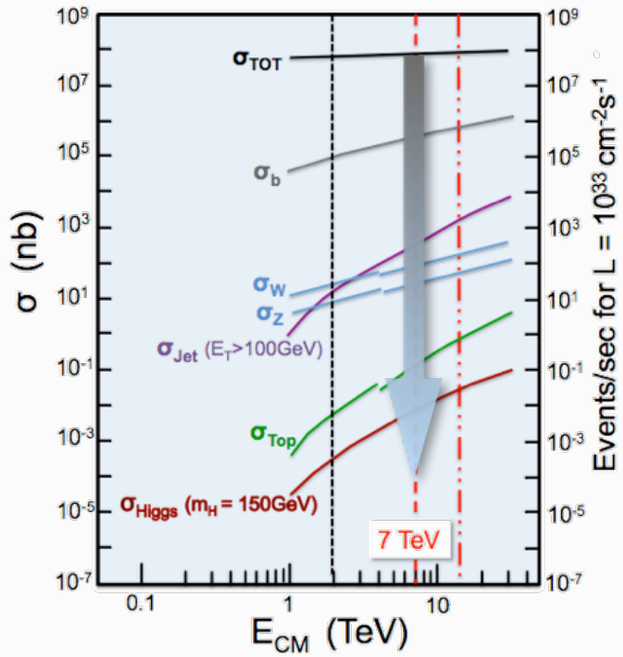

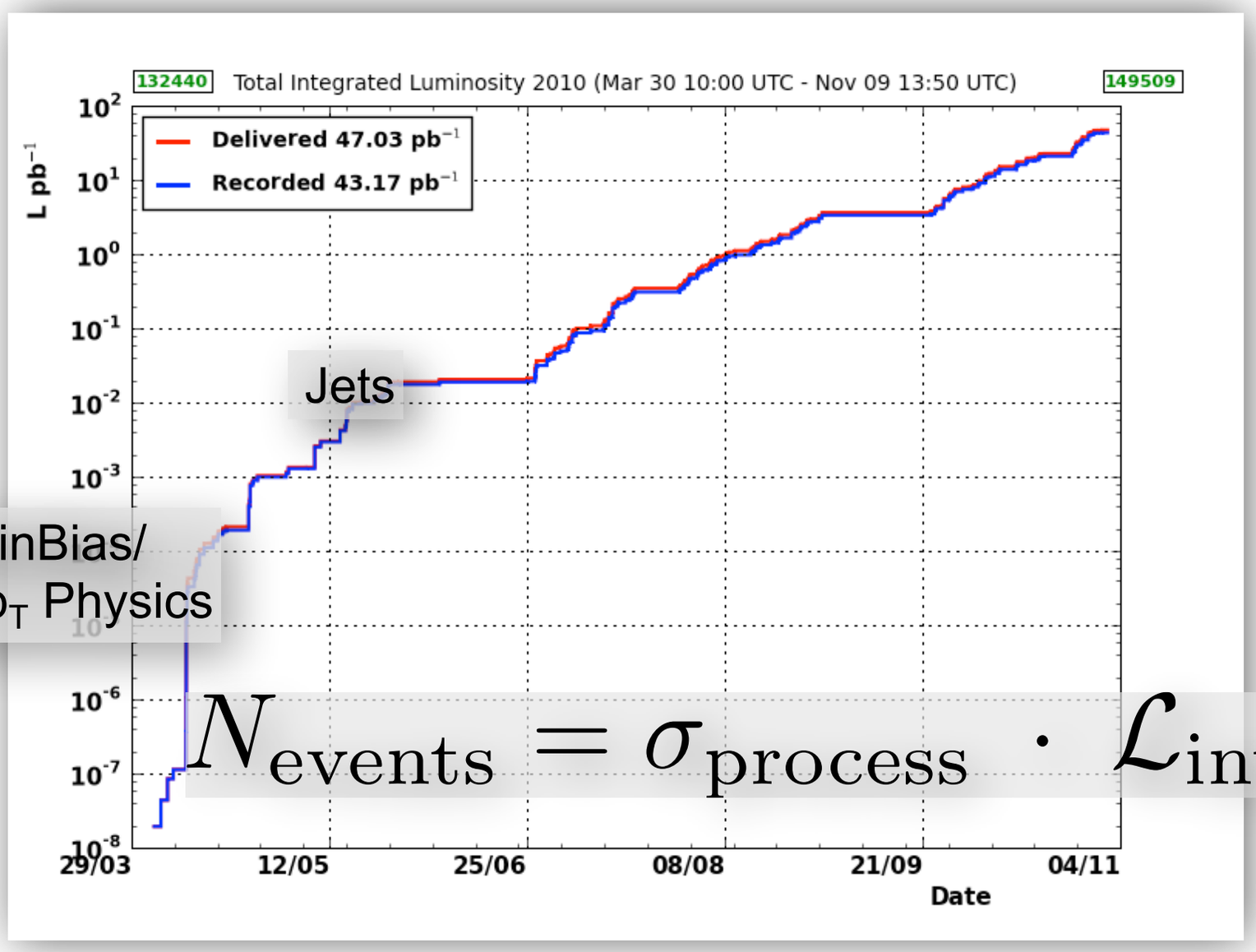

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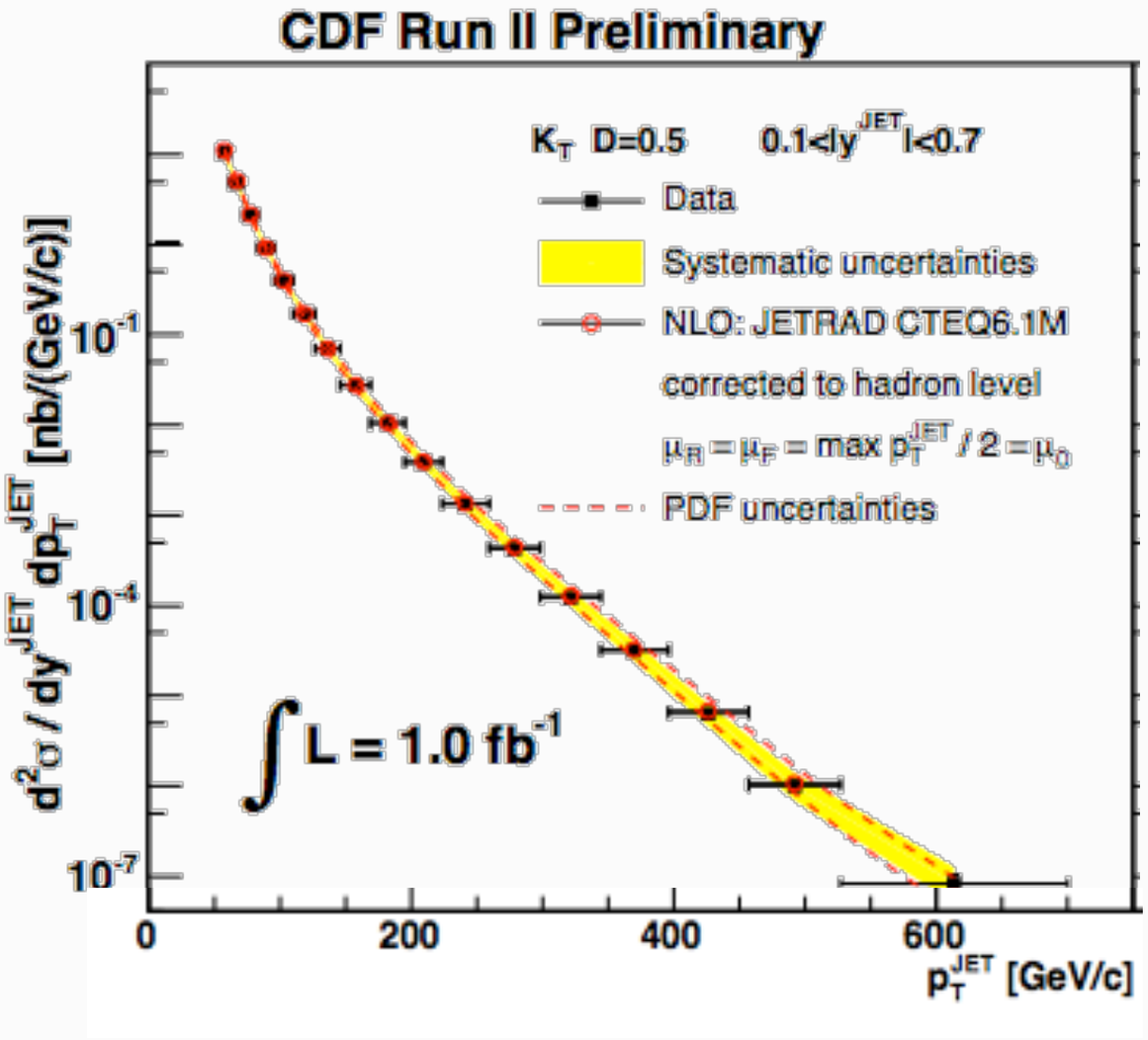
Jet production at 7 TeV – New Territory!

Tevatron
E_{CM}= 2 TeV



Important test of pQCD over many orders of magnitude!
Looking for deviations at highest momentum transfers.

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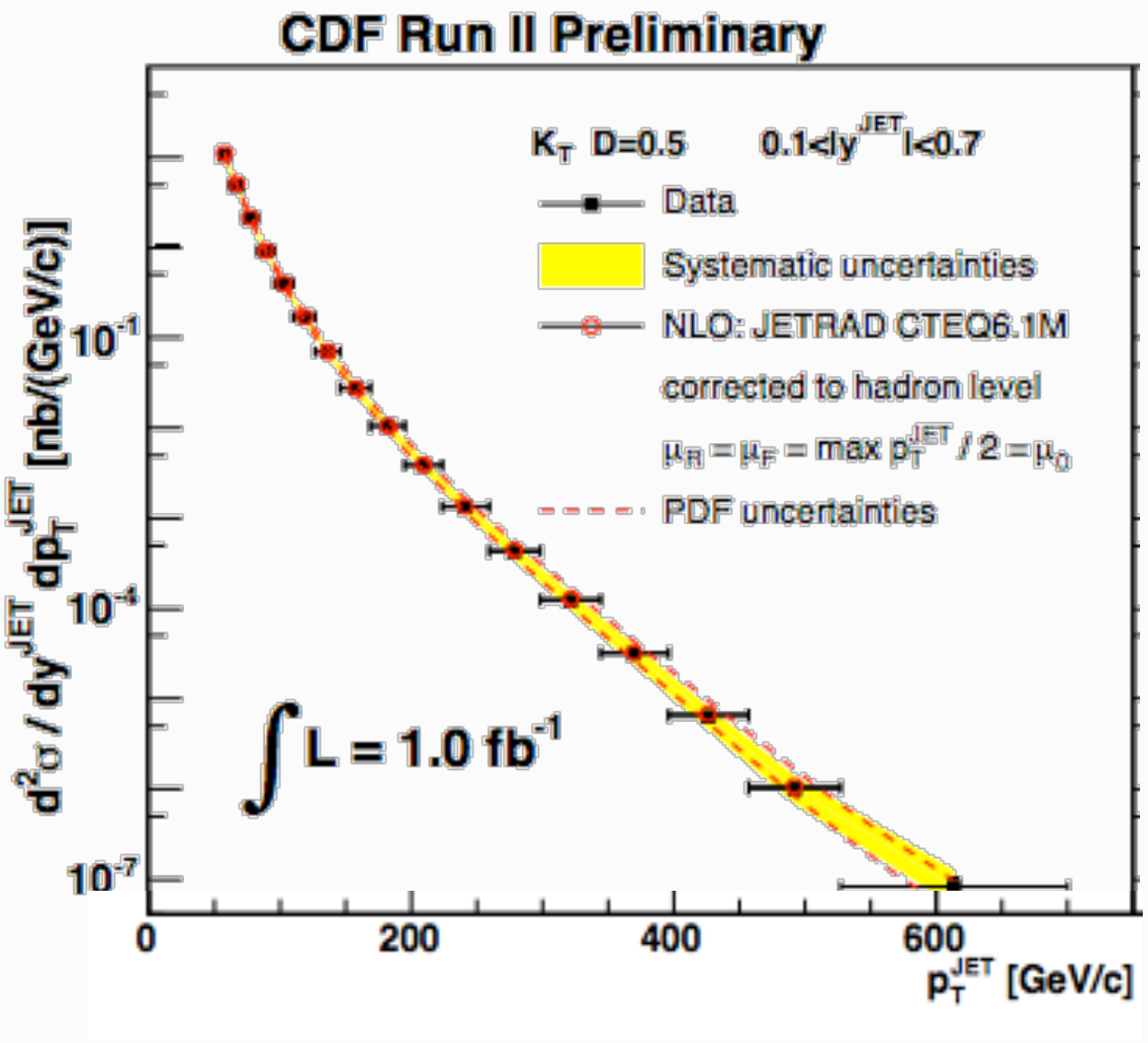

LHC
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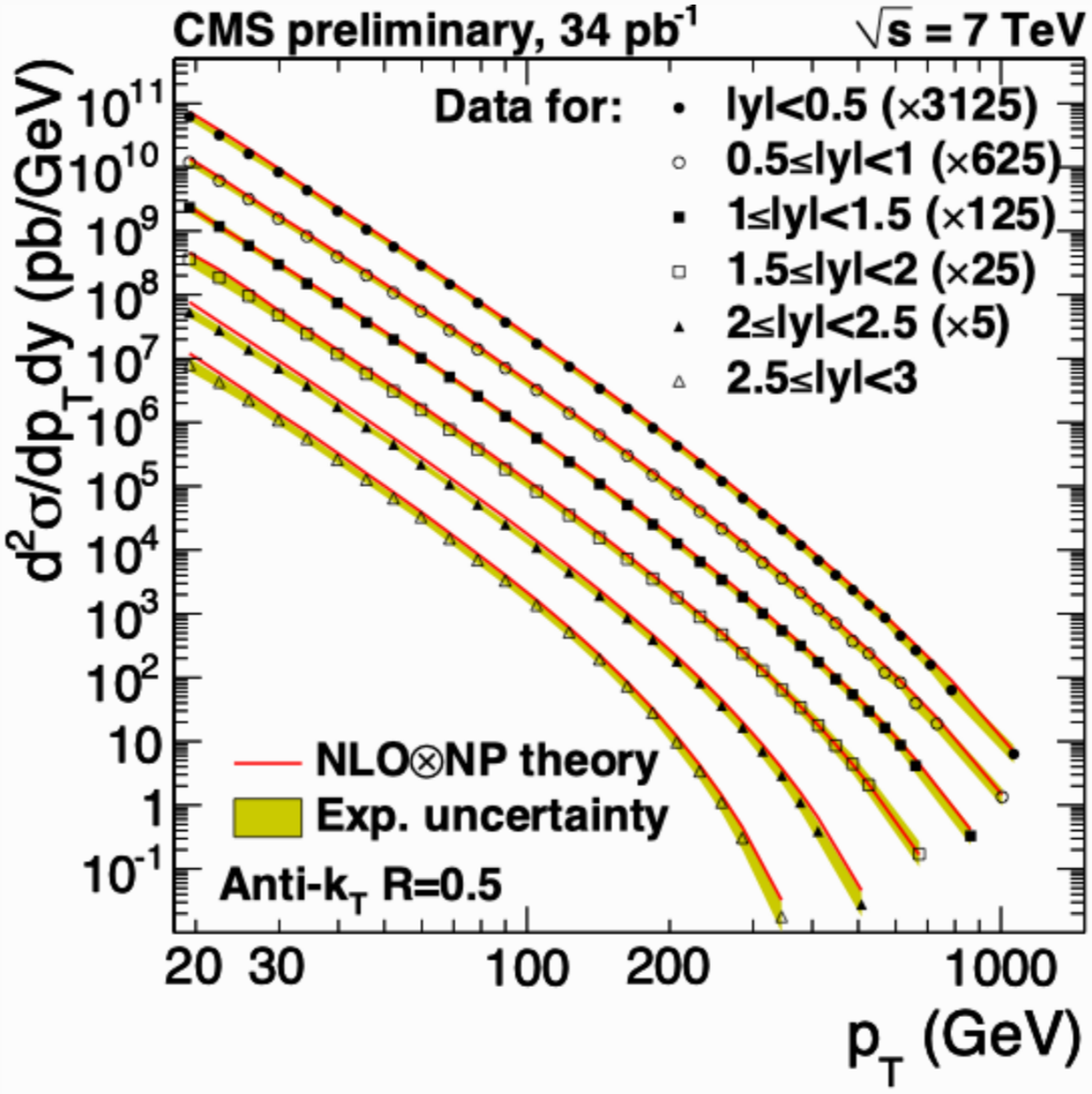

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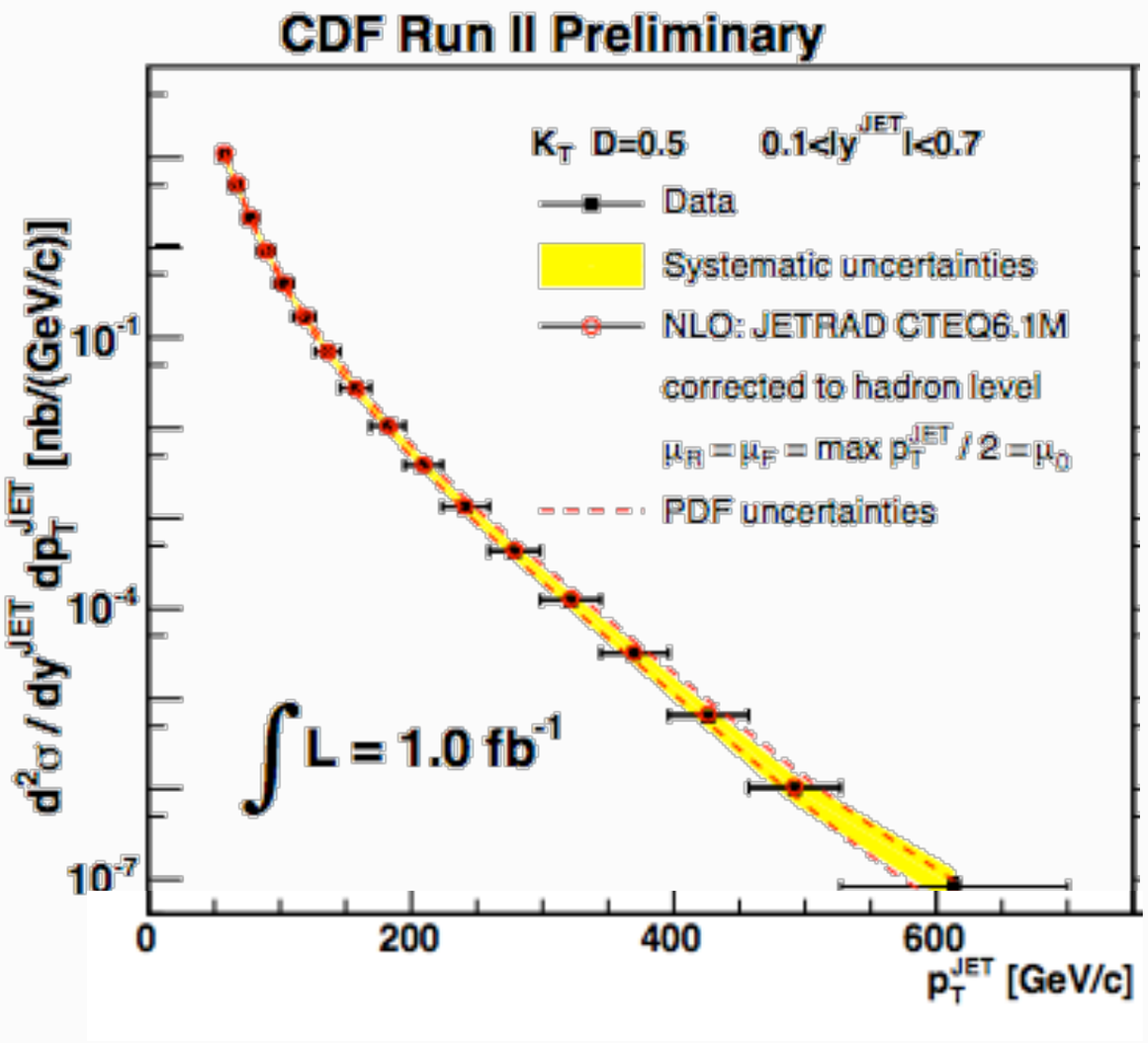

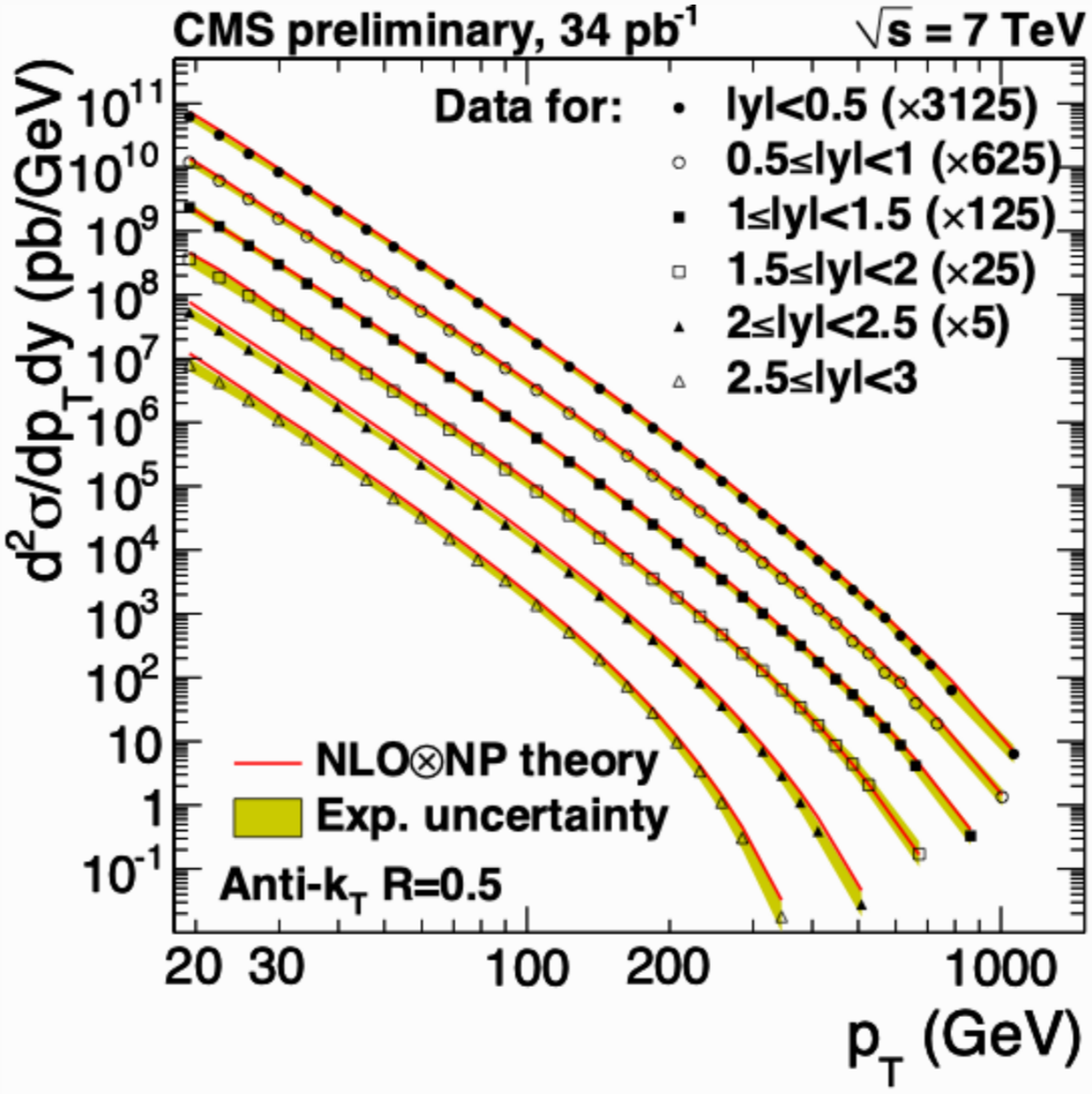

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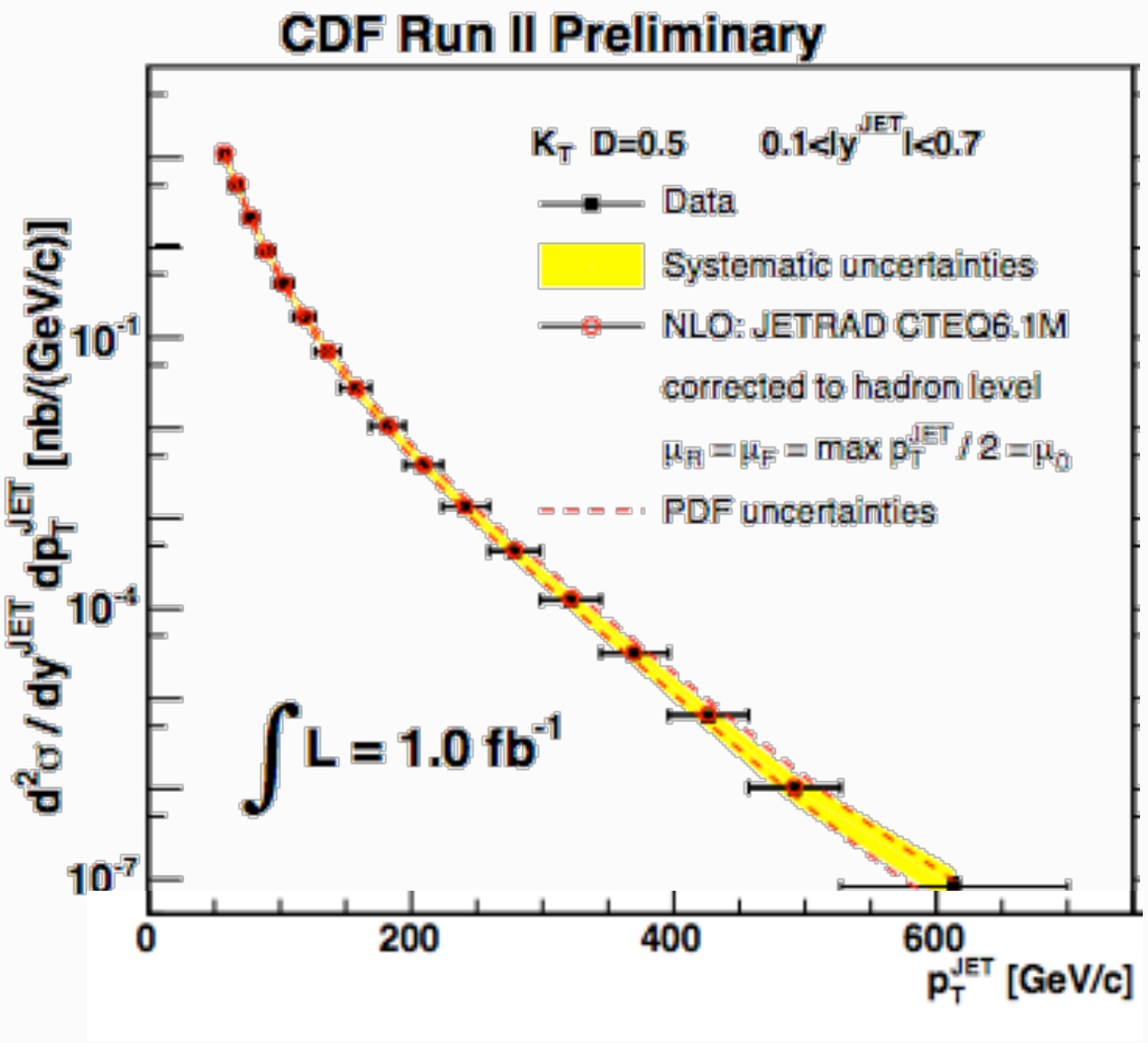

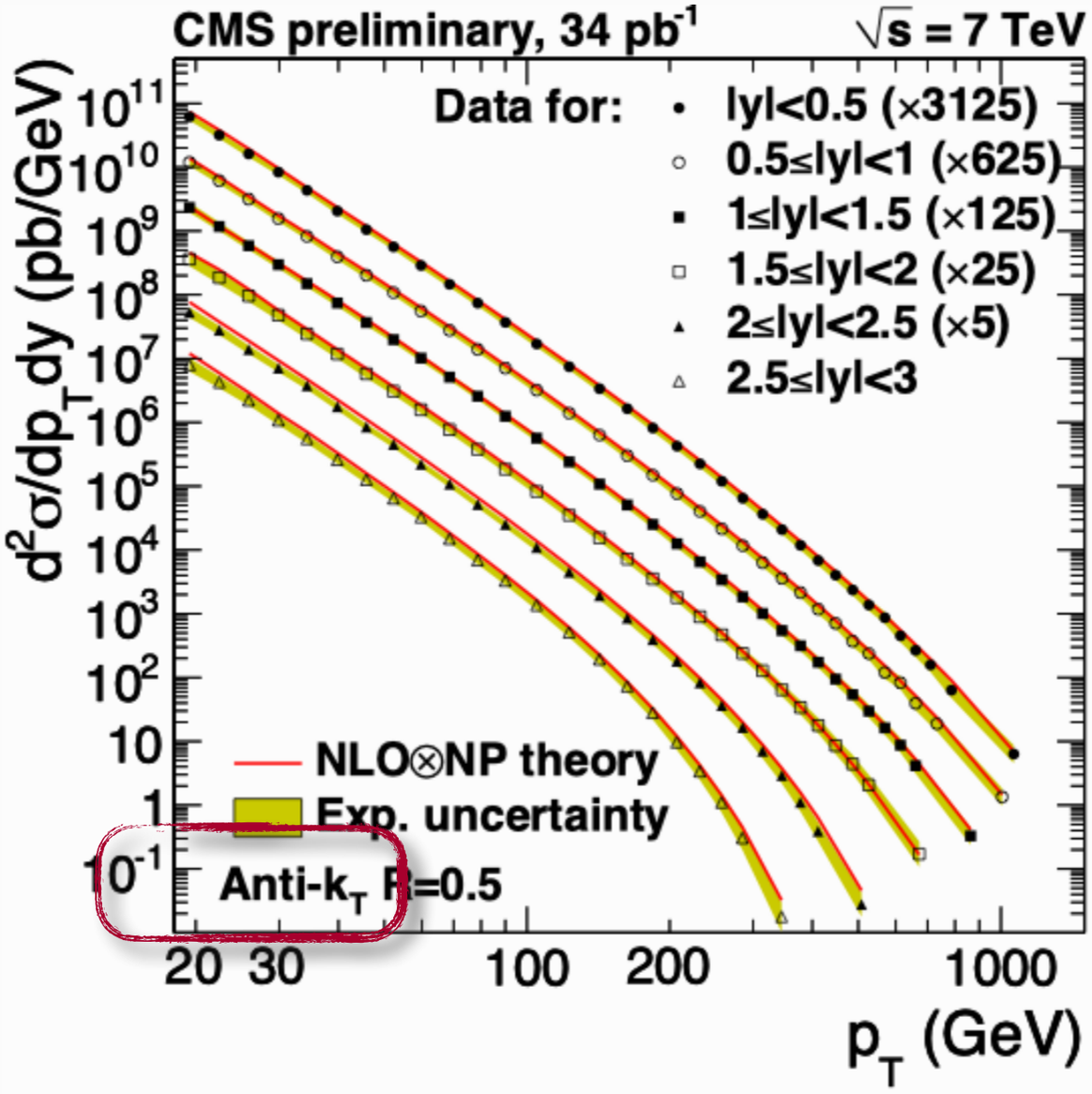

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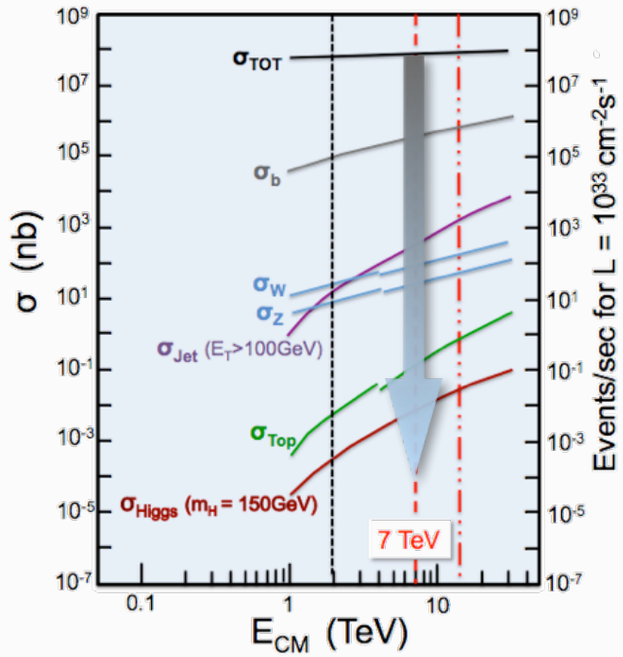

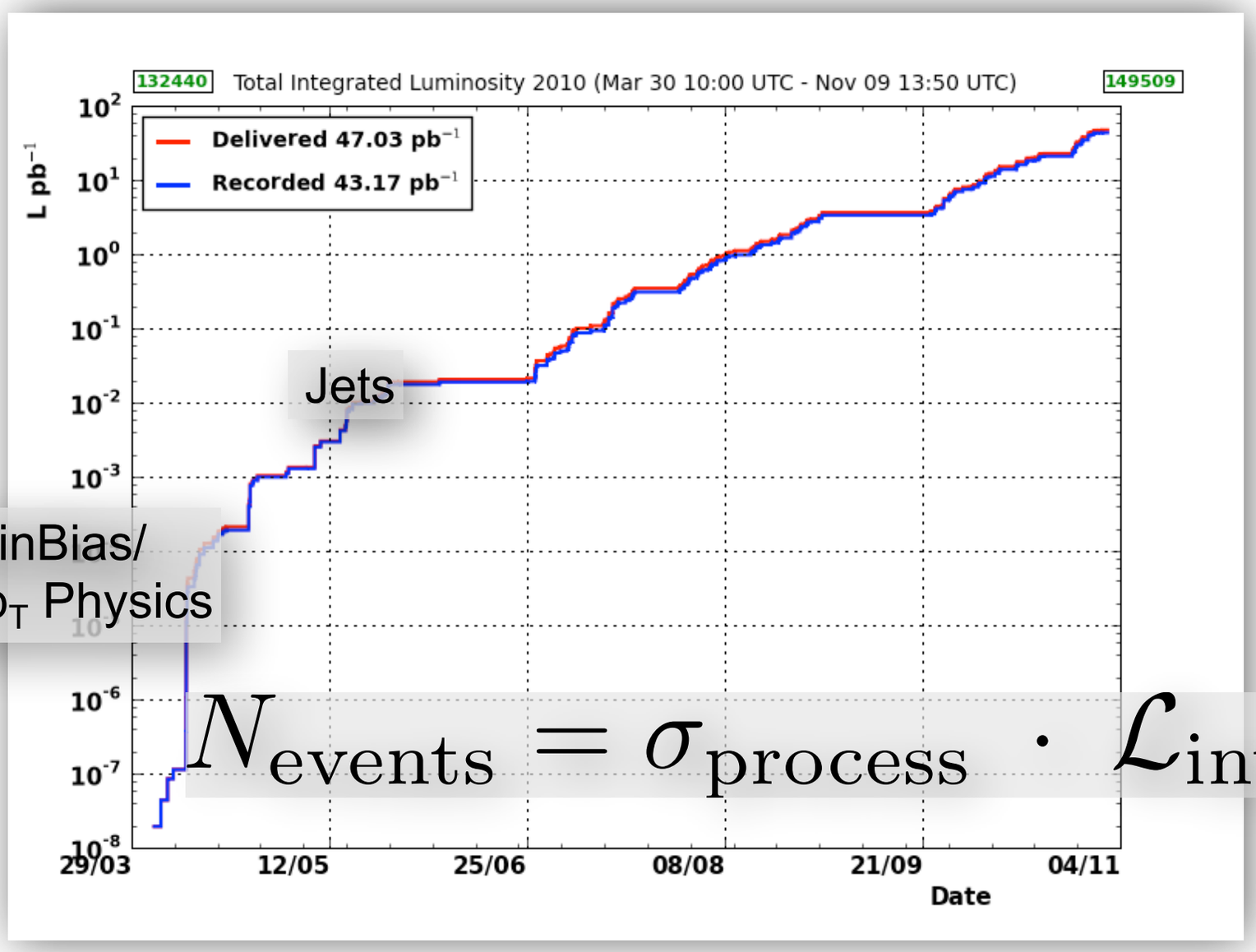

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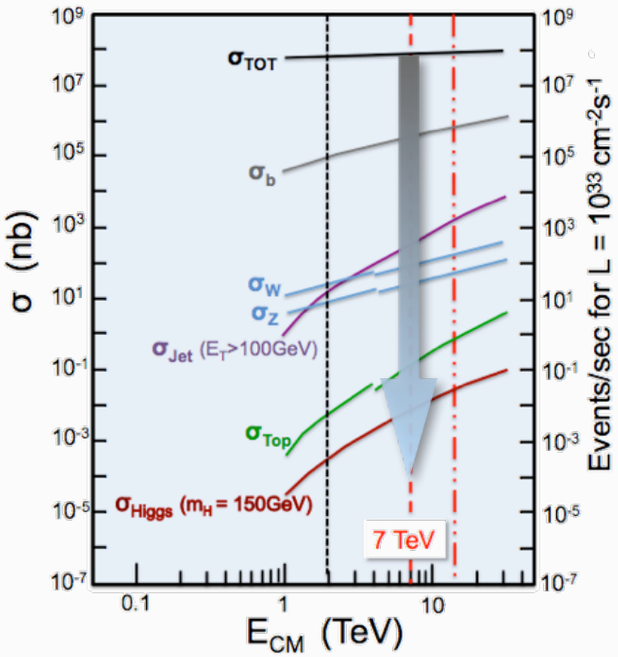

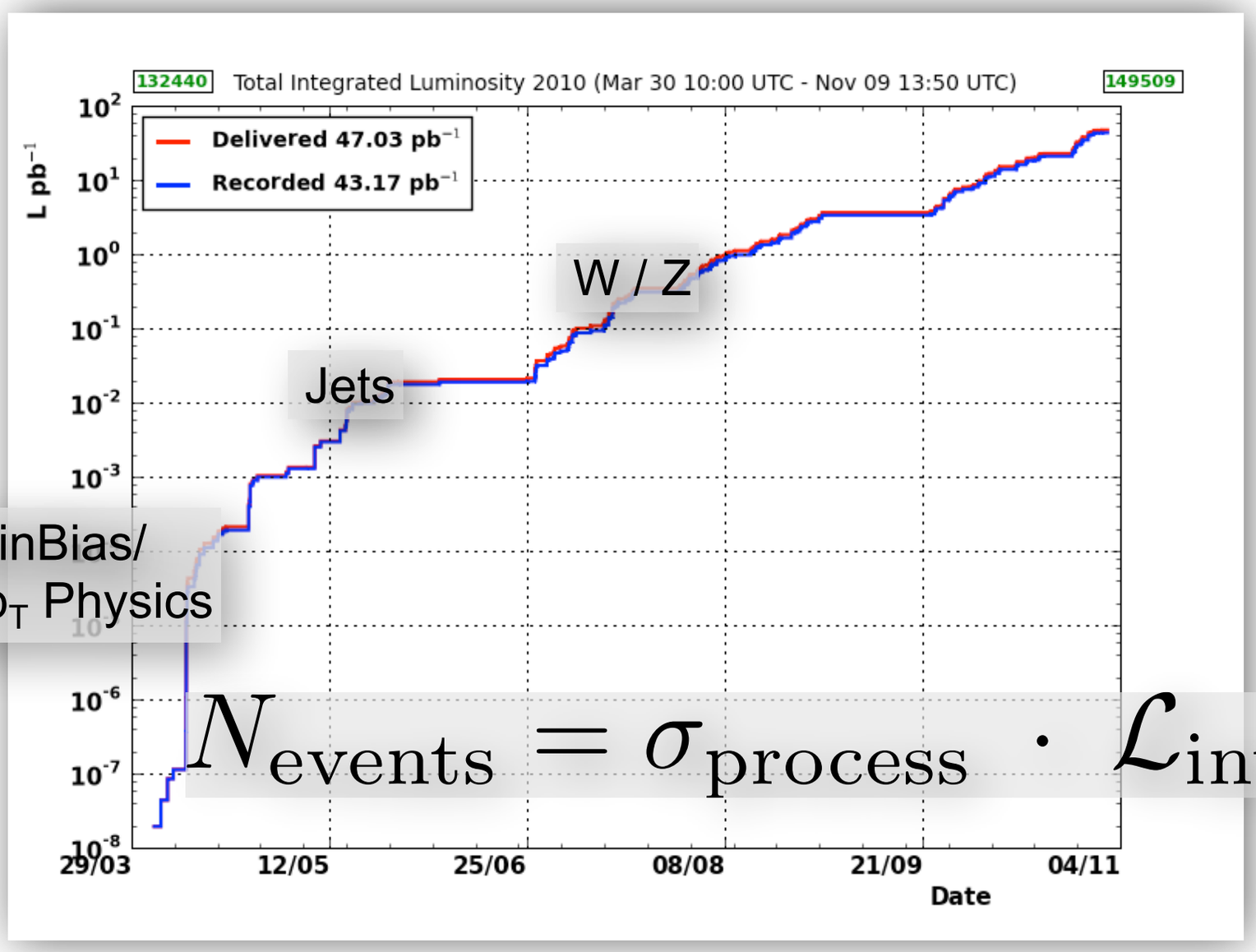

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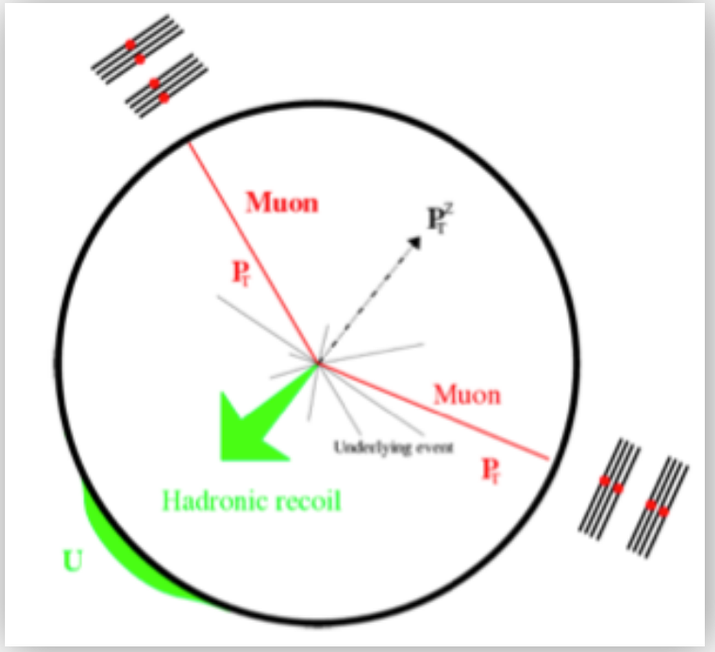
W and Z production at 7 TeV

Z



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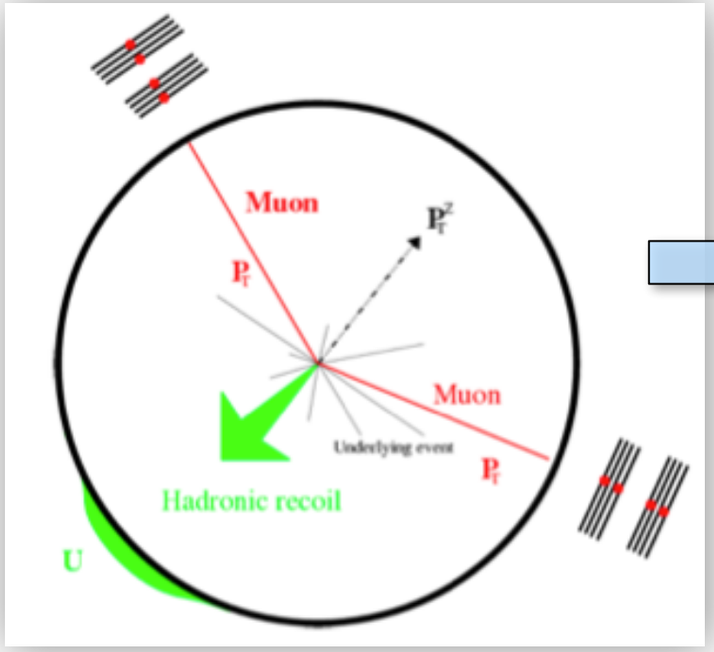

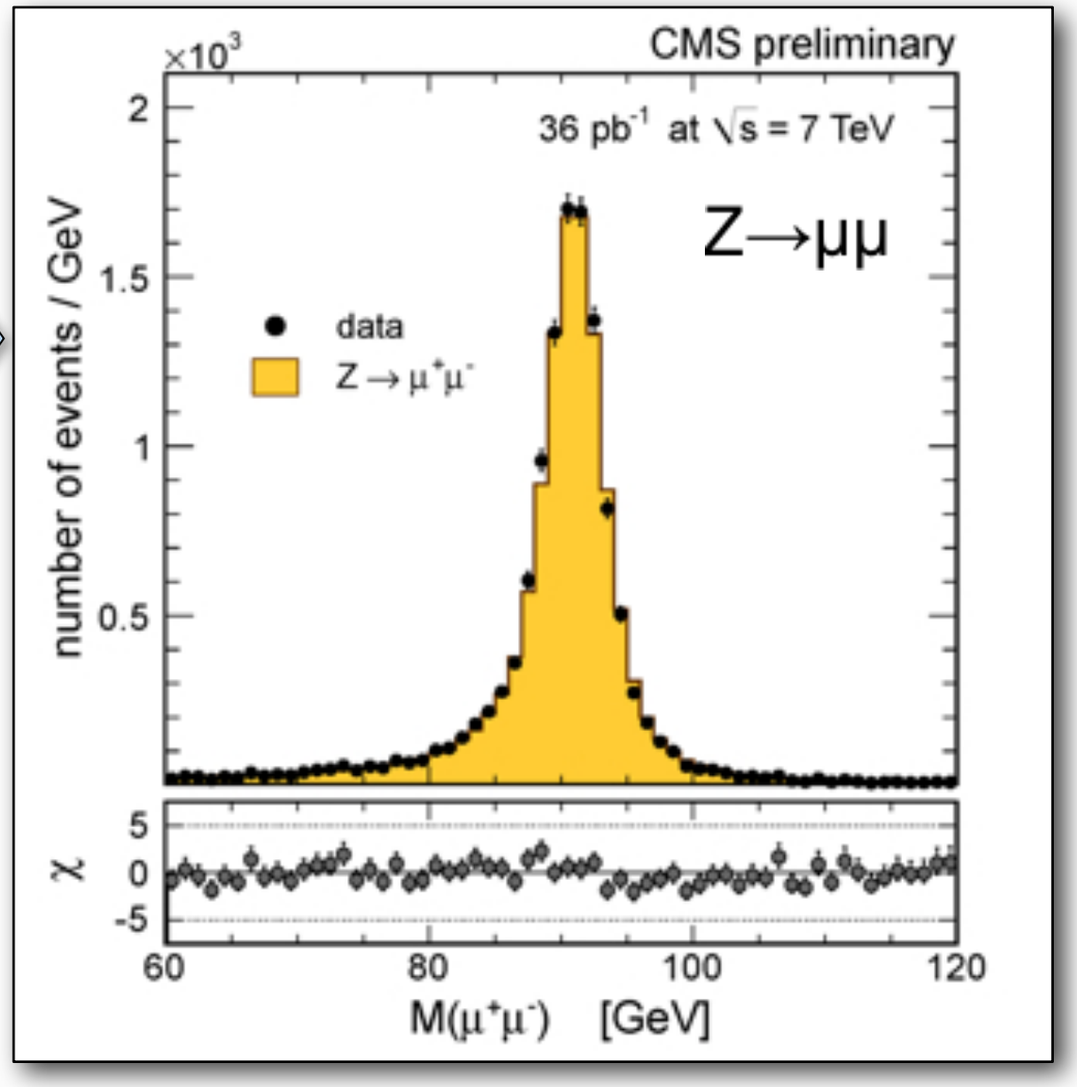

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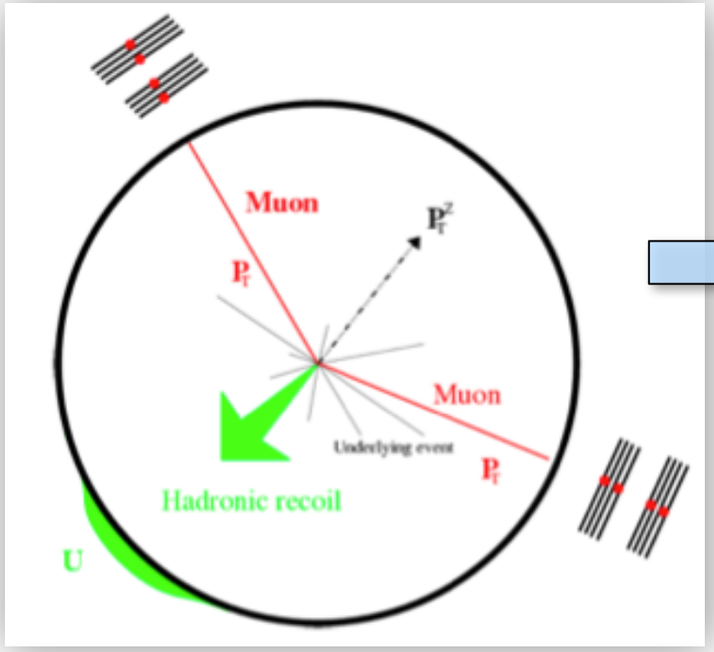
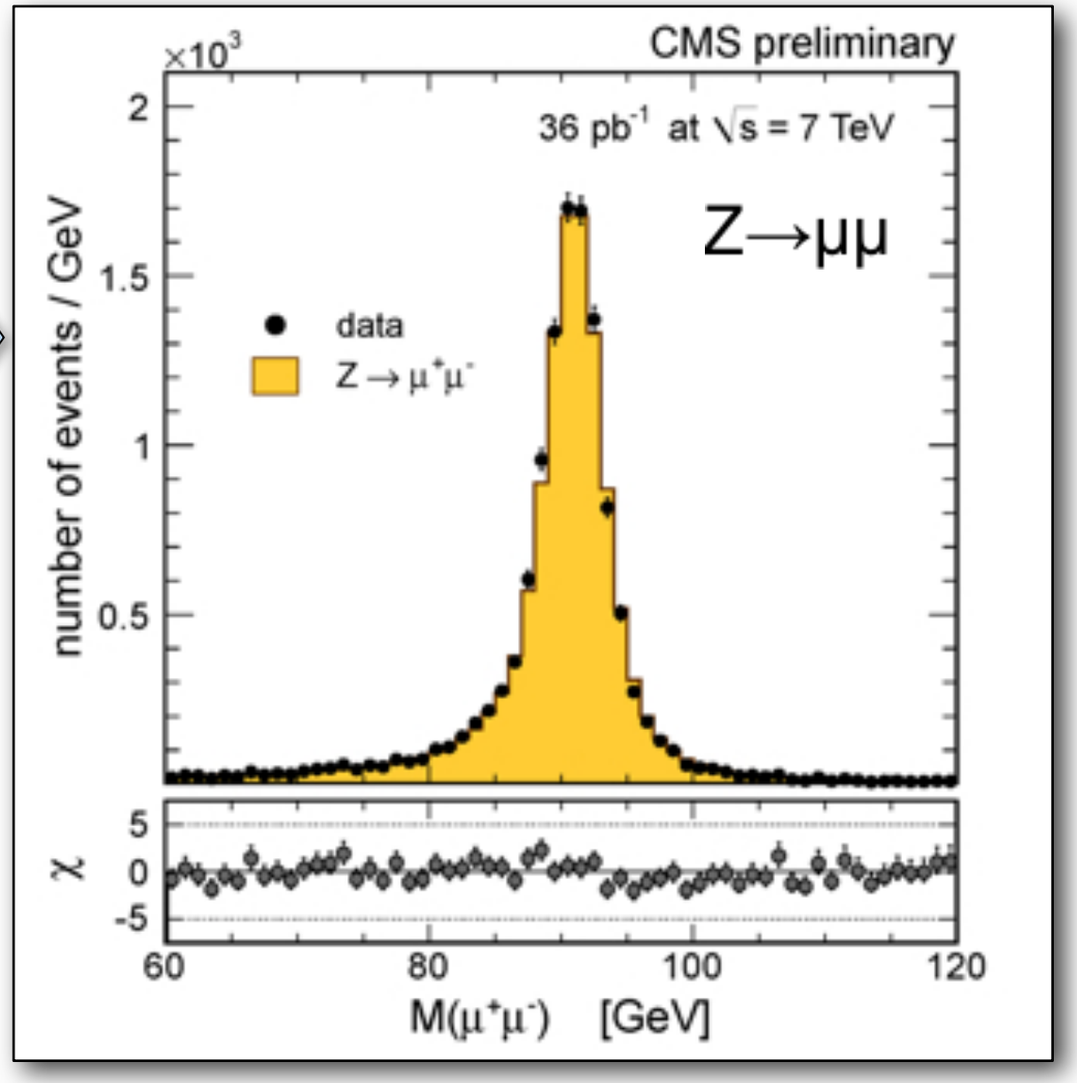
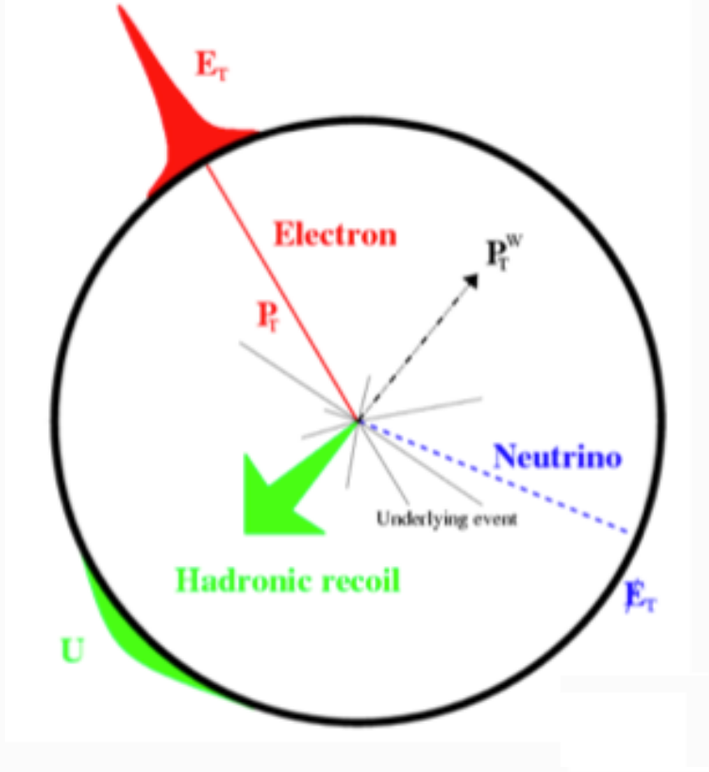




W



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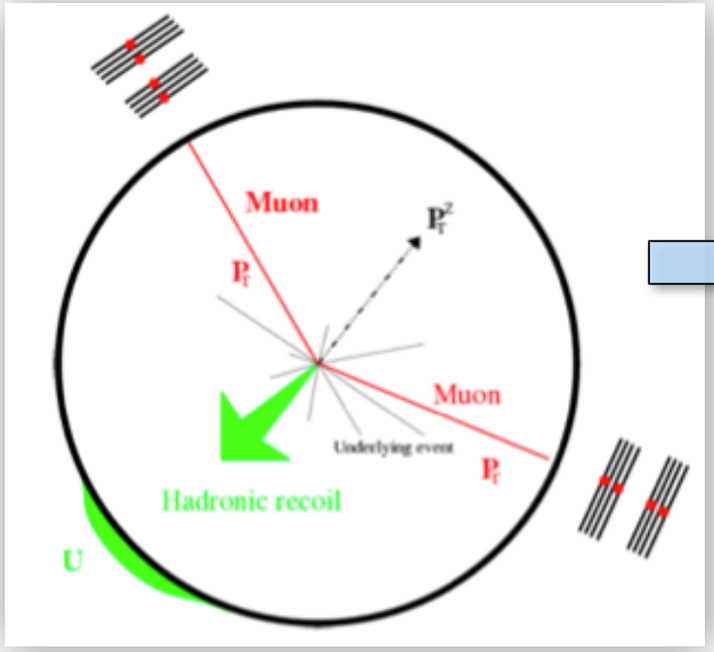
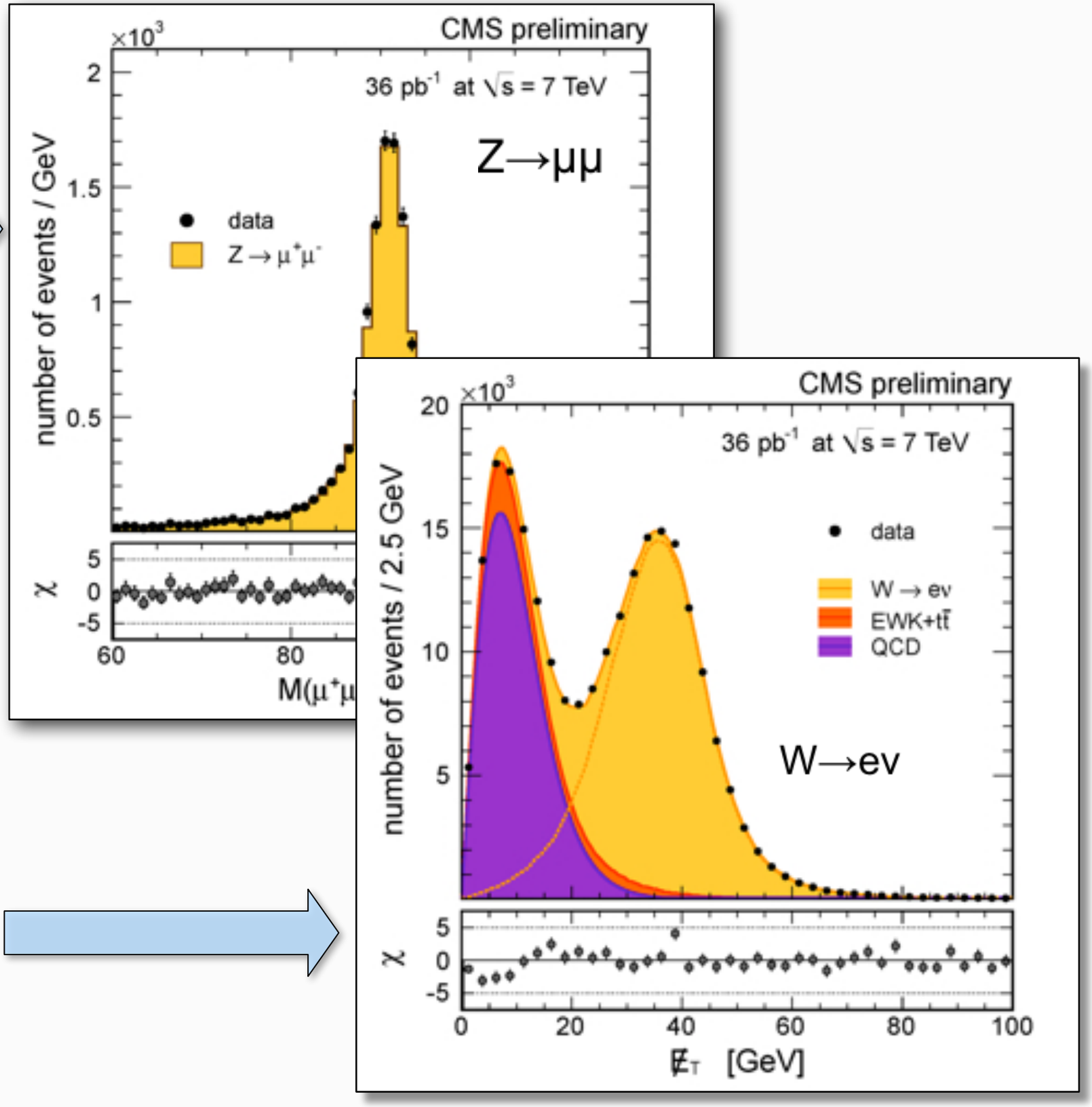
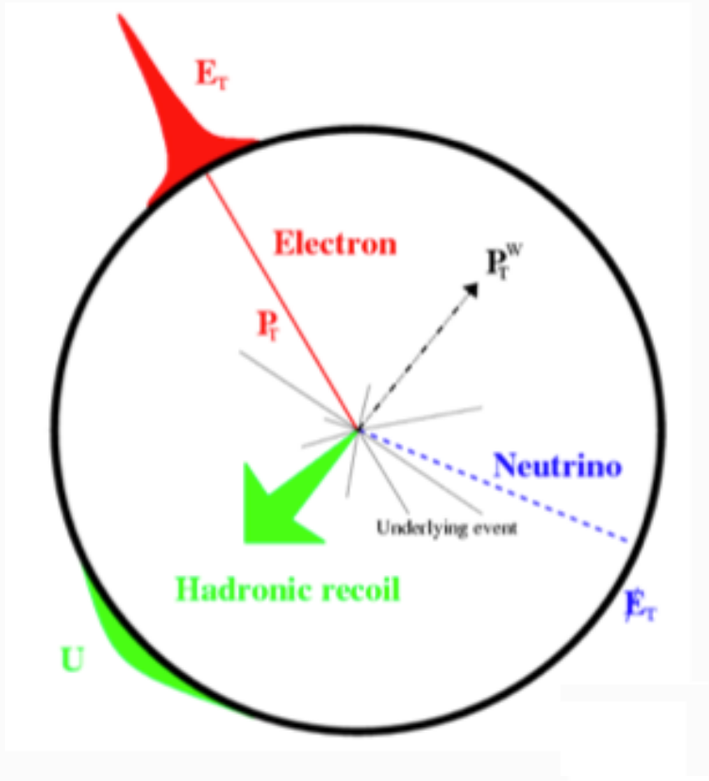




W



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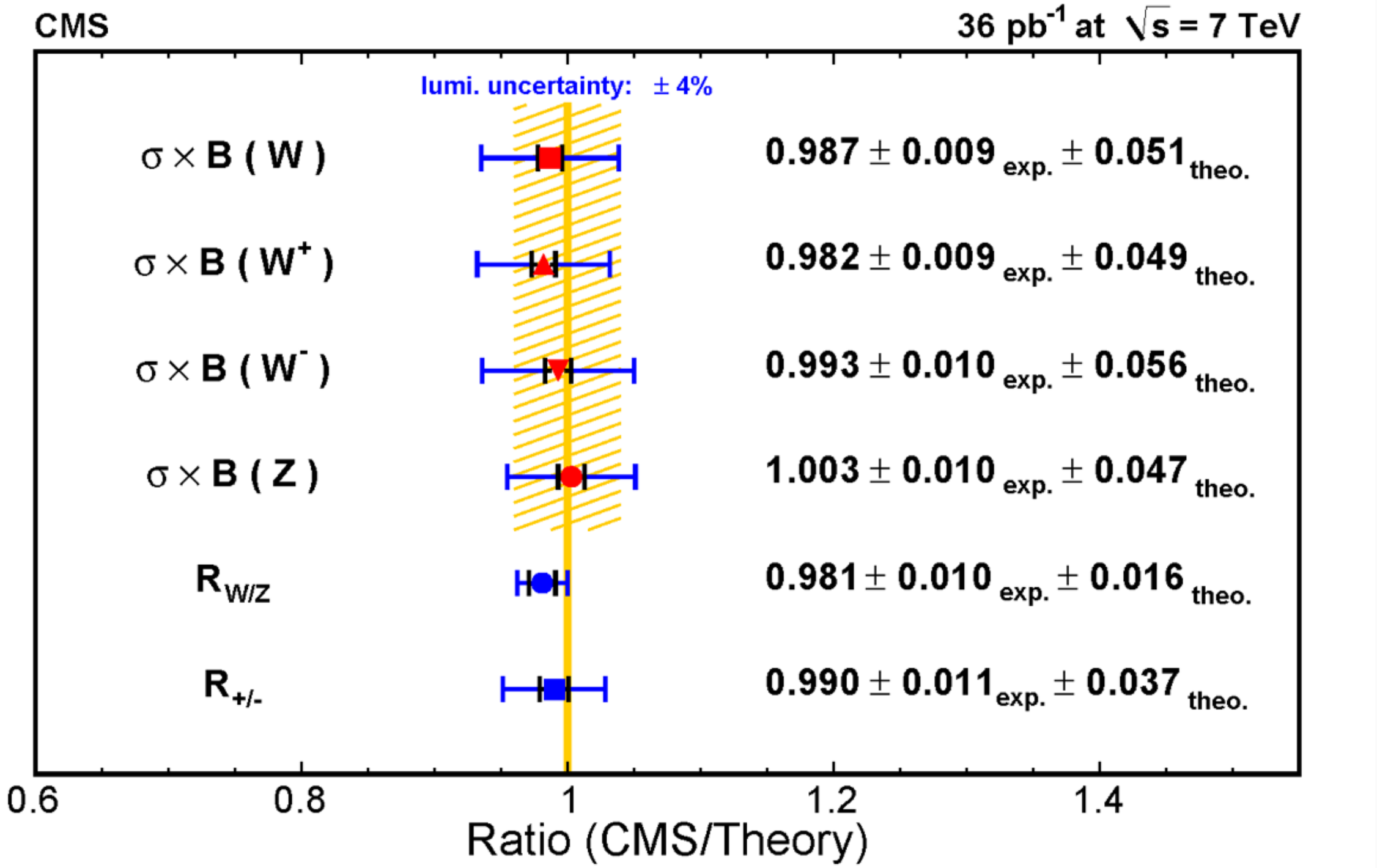
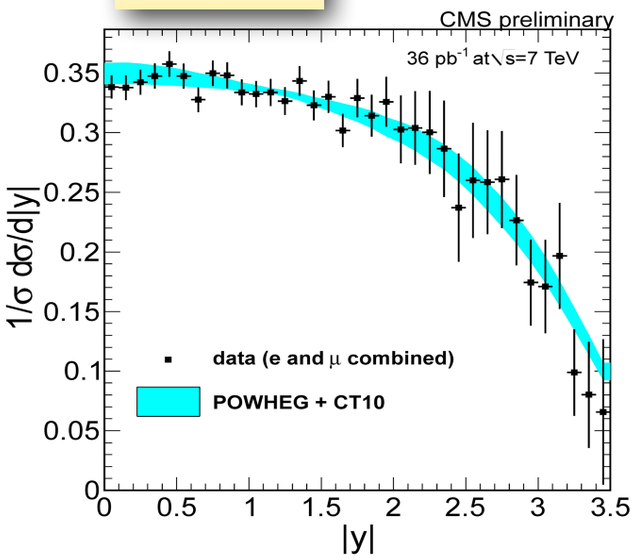
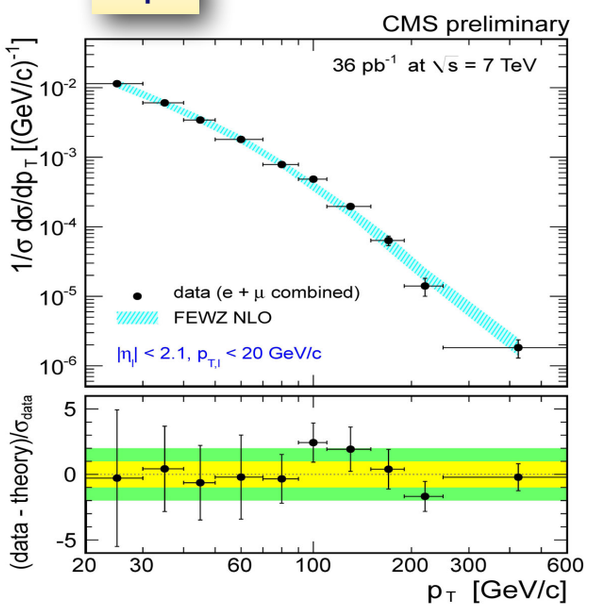


Amazing precision reached (~1% experimental !)
Start to put important constraints on theoretical predictions

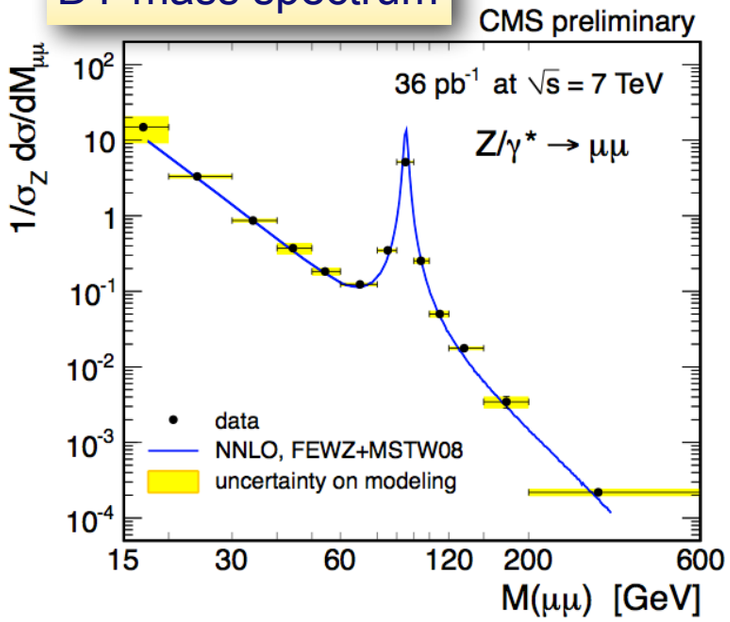
Z rapidity



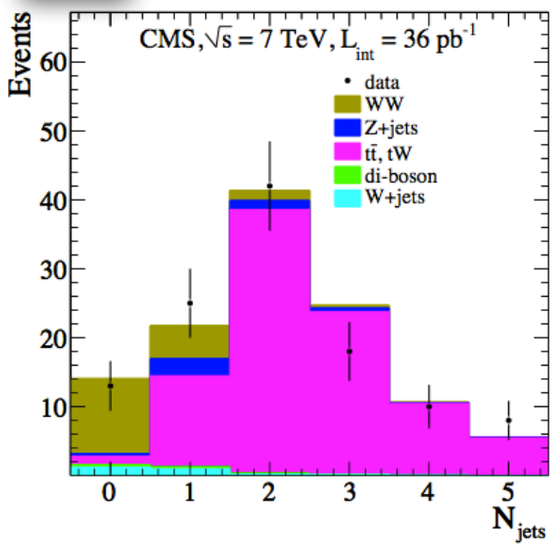
Z p_T



DY mass spectrum

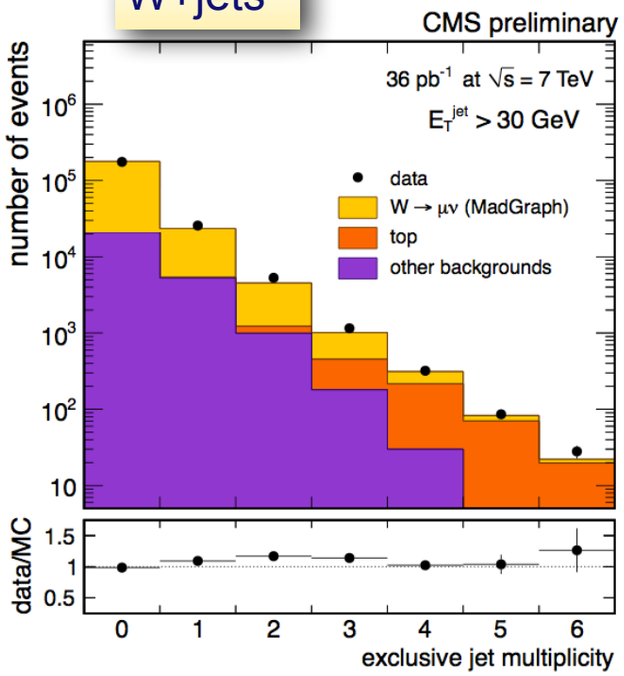


WW

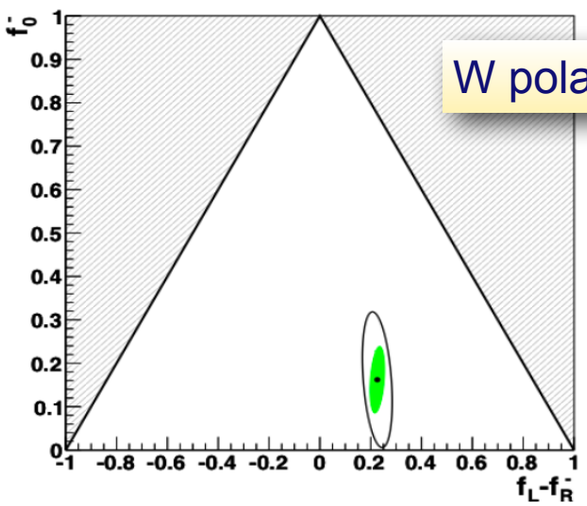


...and many more results...

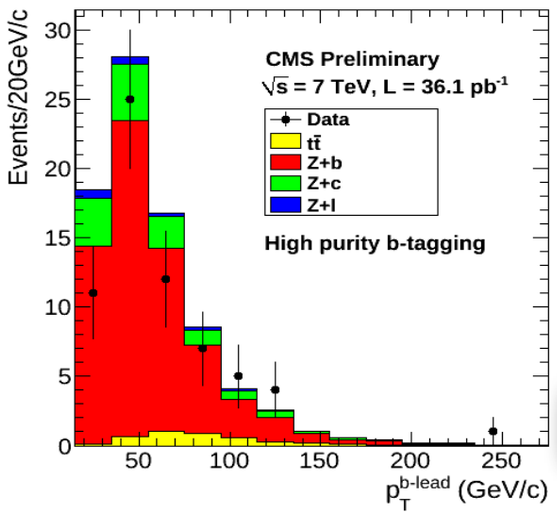
W+jets



W polarization



Zb



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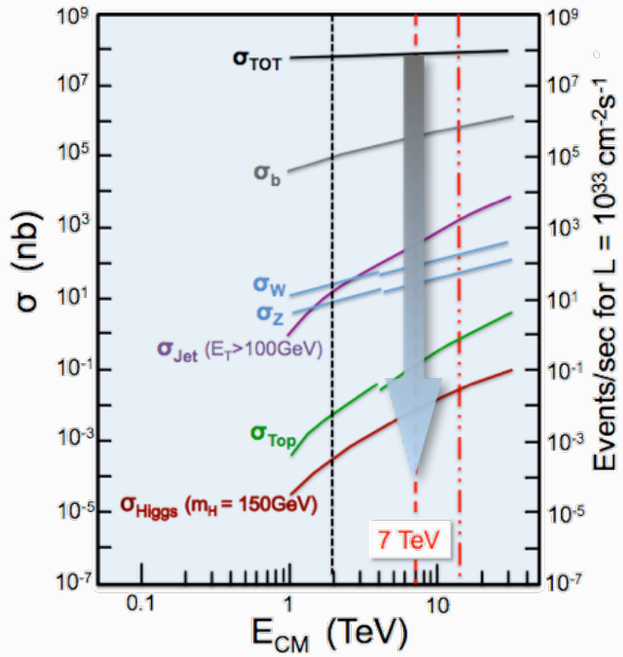

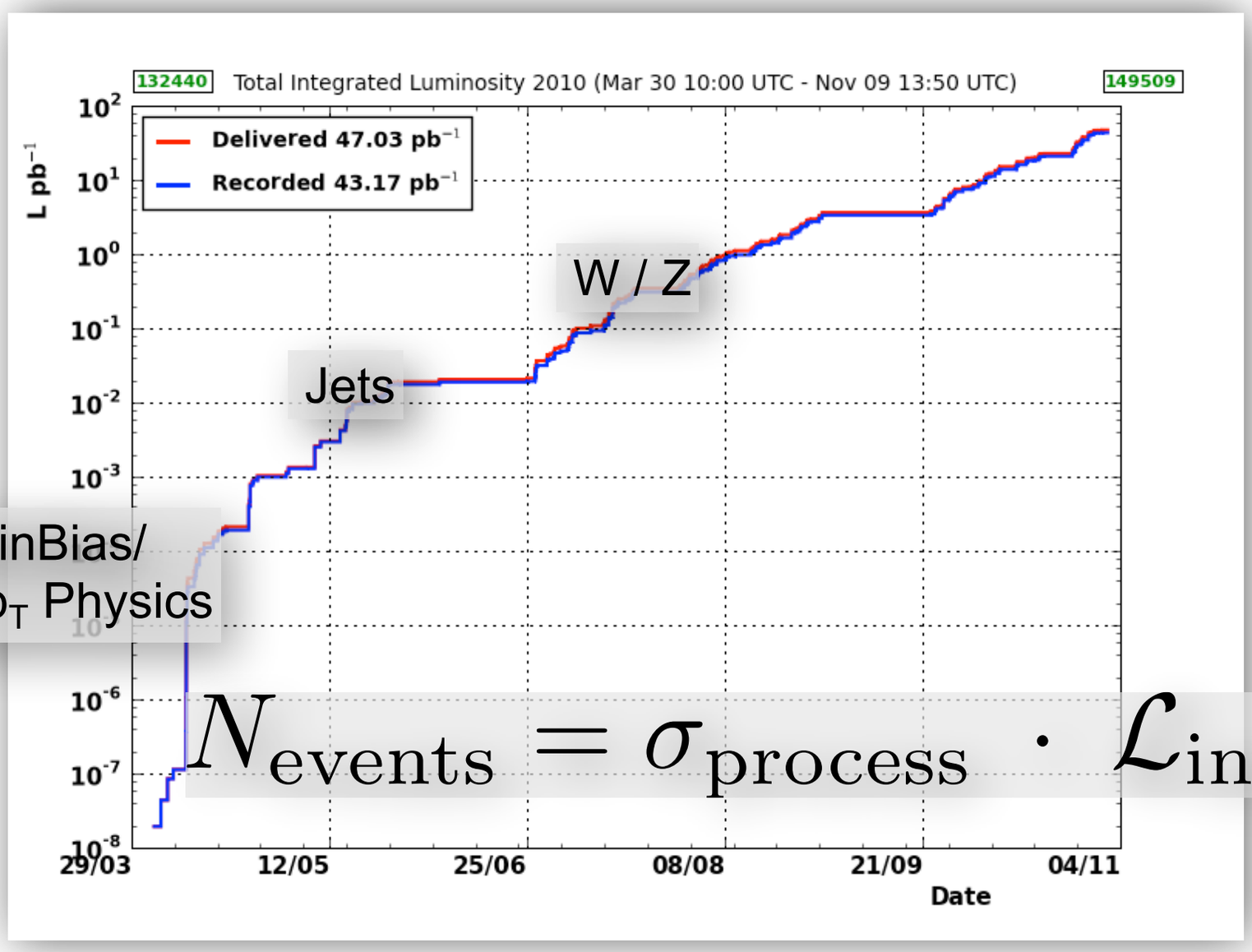

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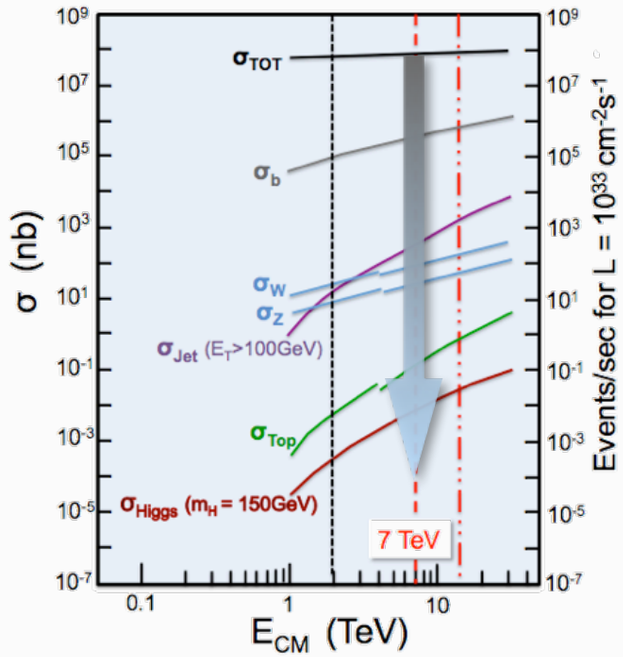

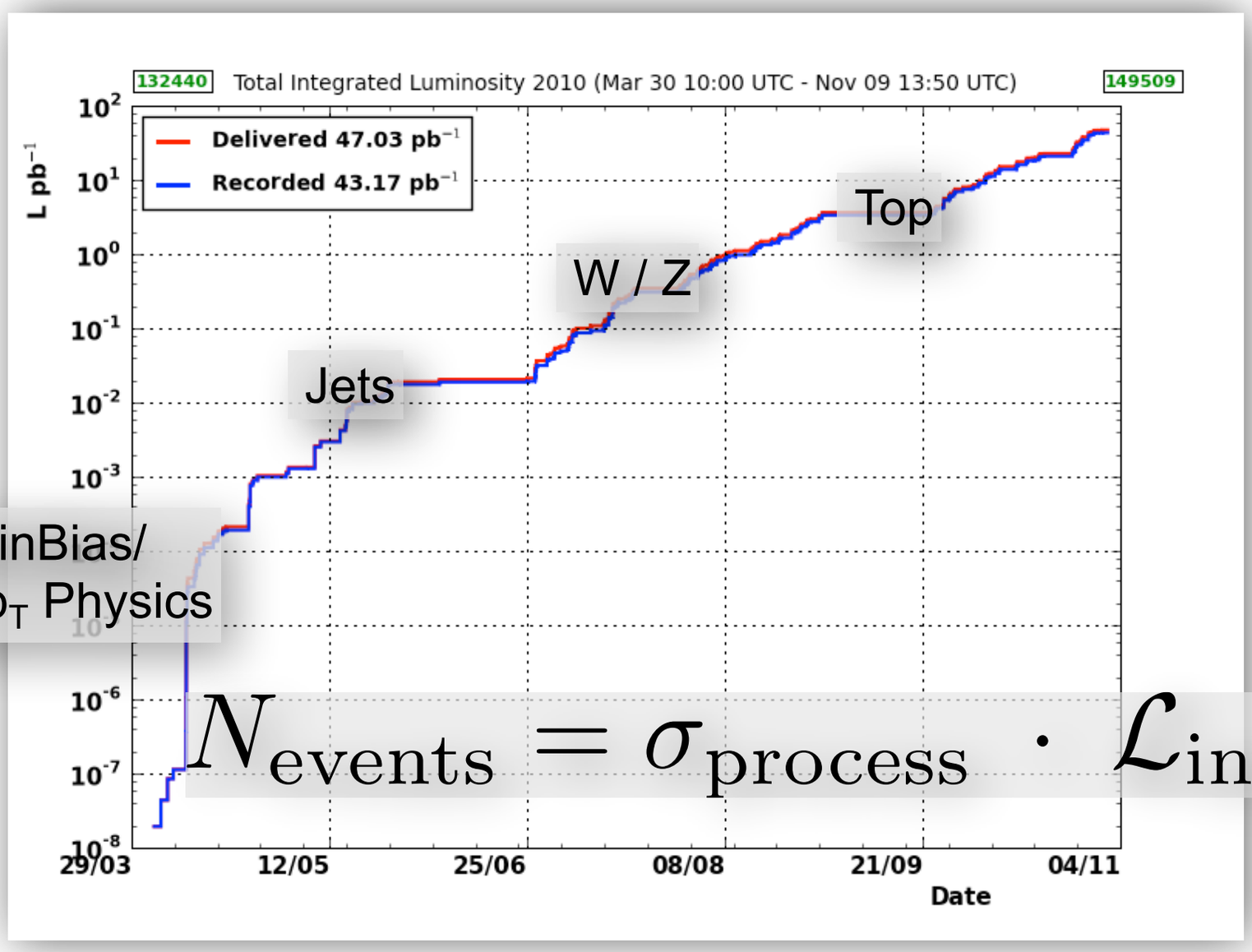

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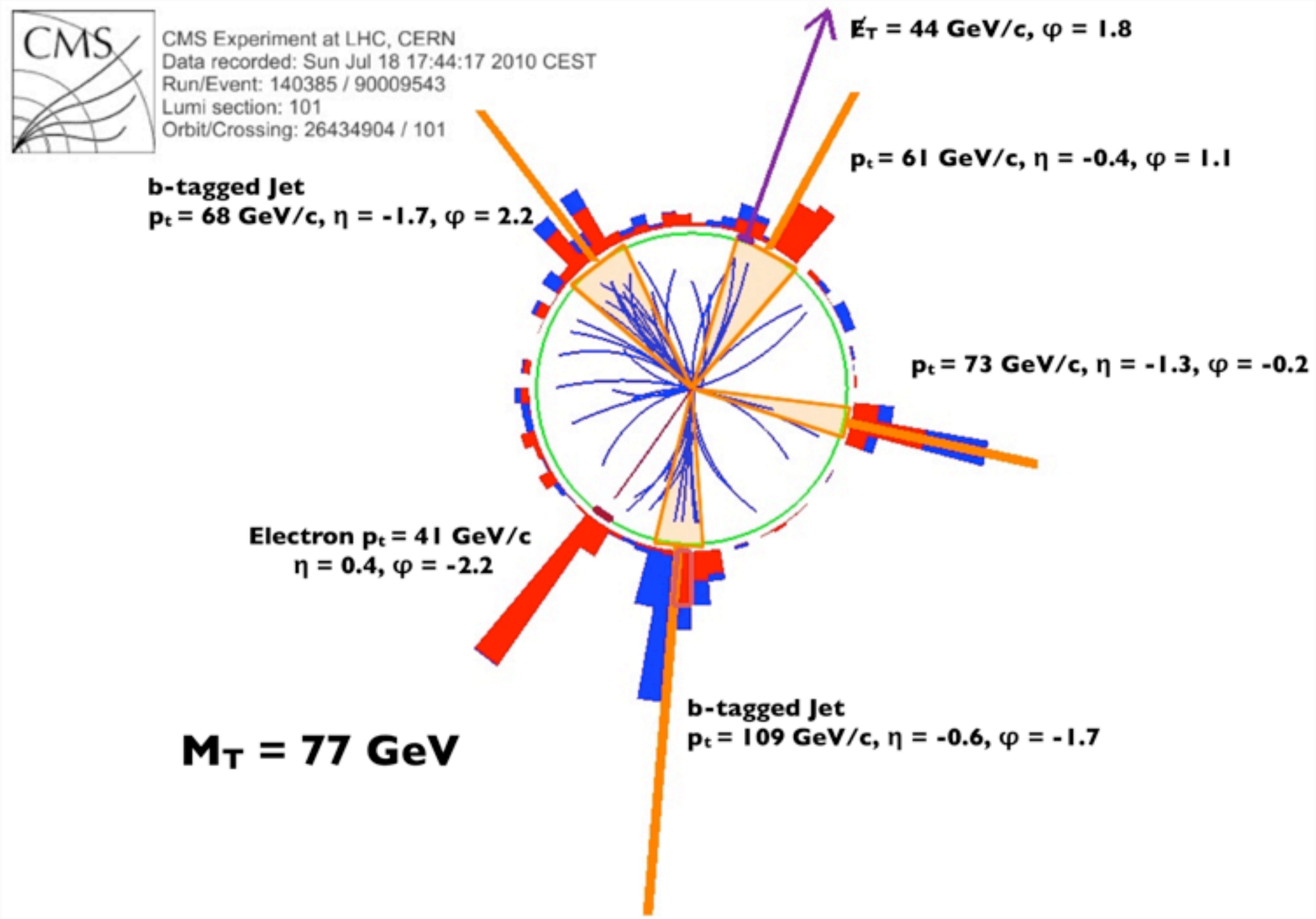
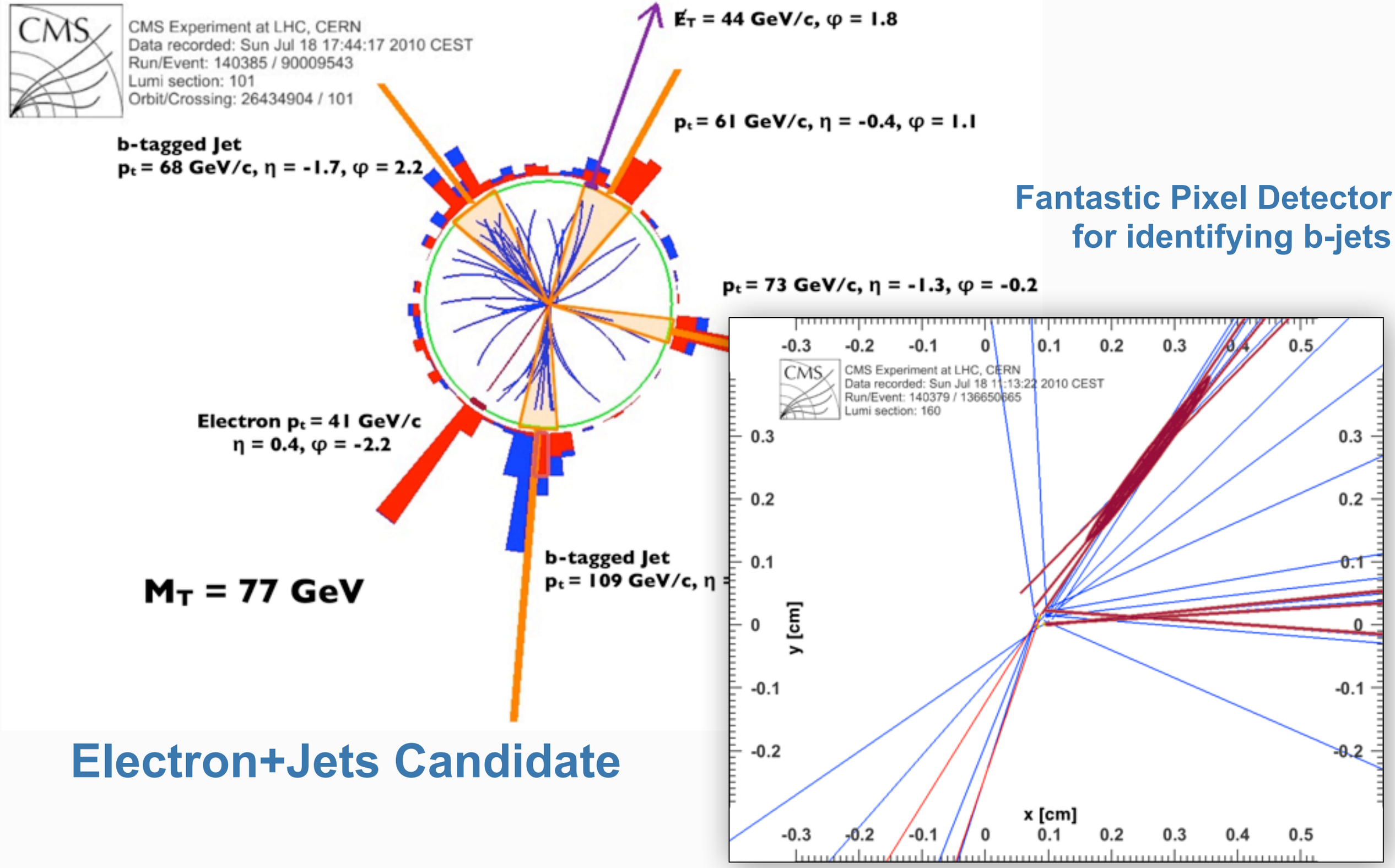
Top production at 7 TeV



Electron+Jets Candidate

Top production at 7 TeV



Fantastic Pixel Detector for identifying b-jets

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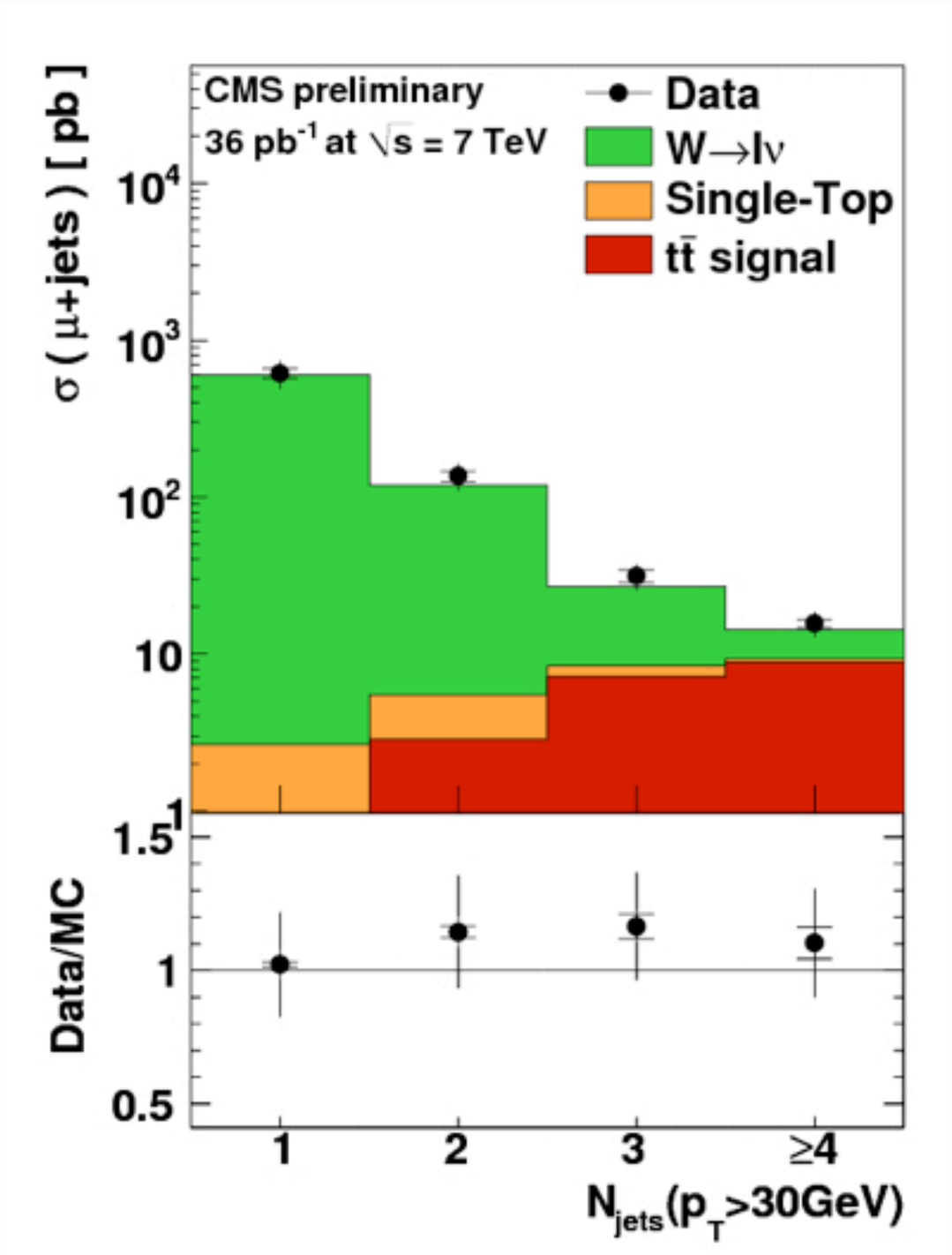

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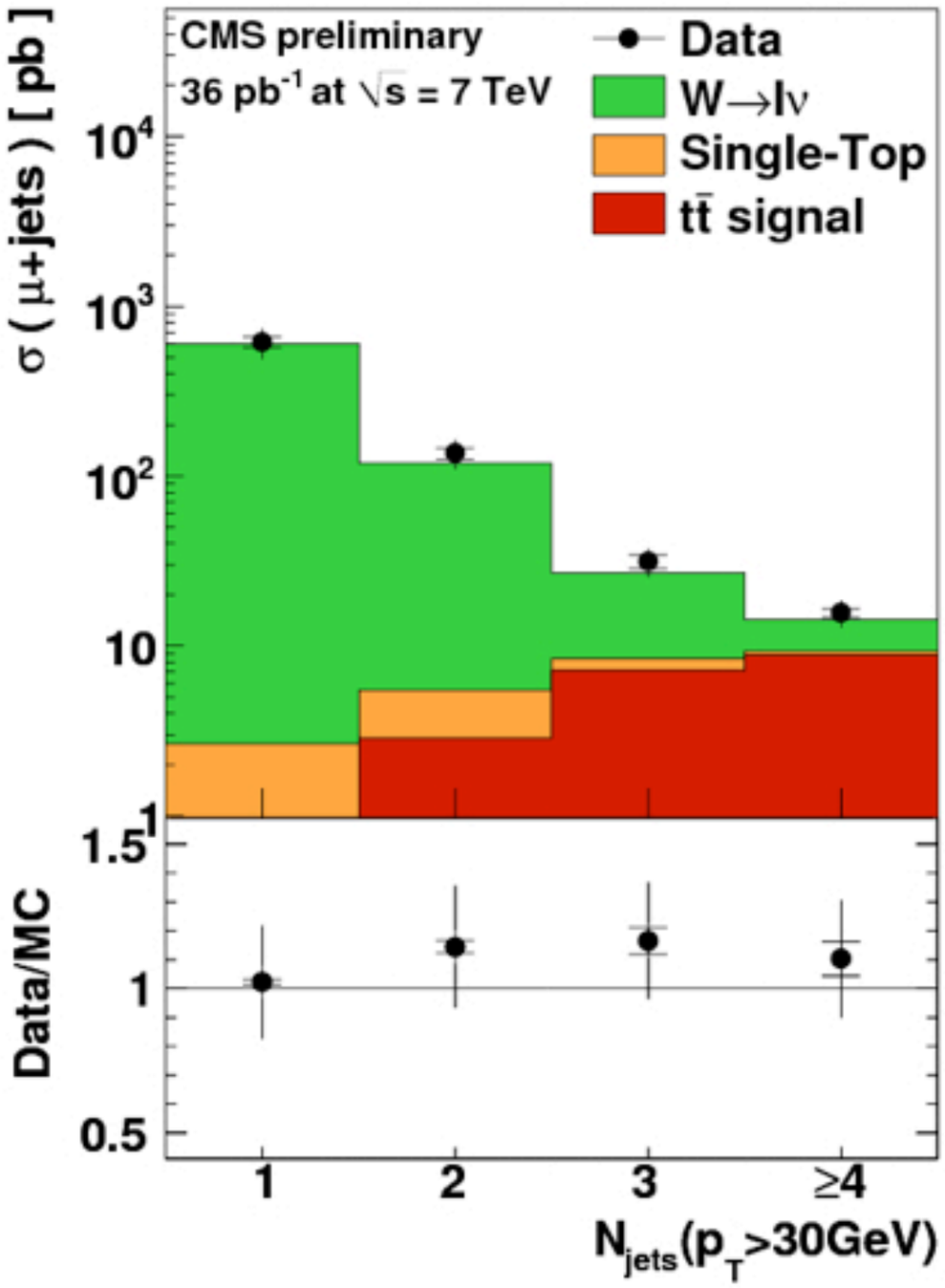

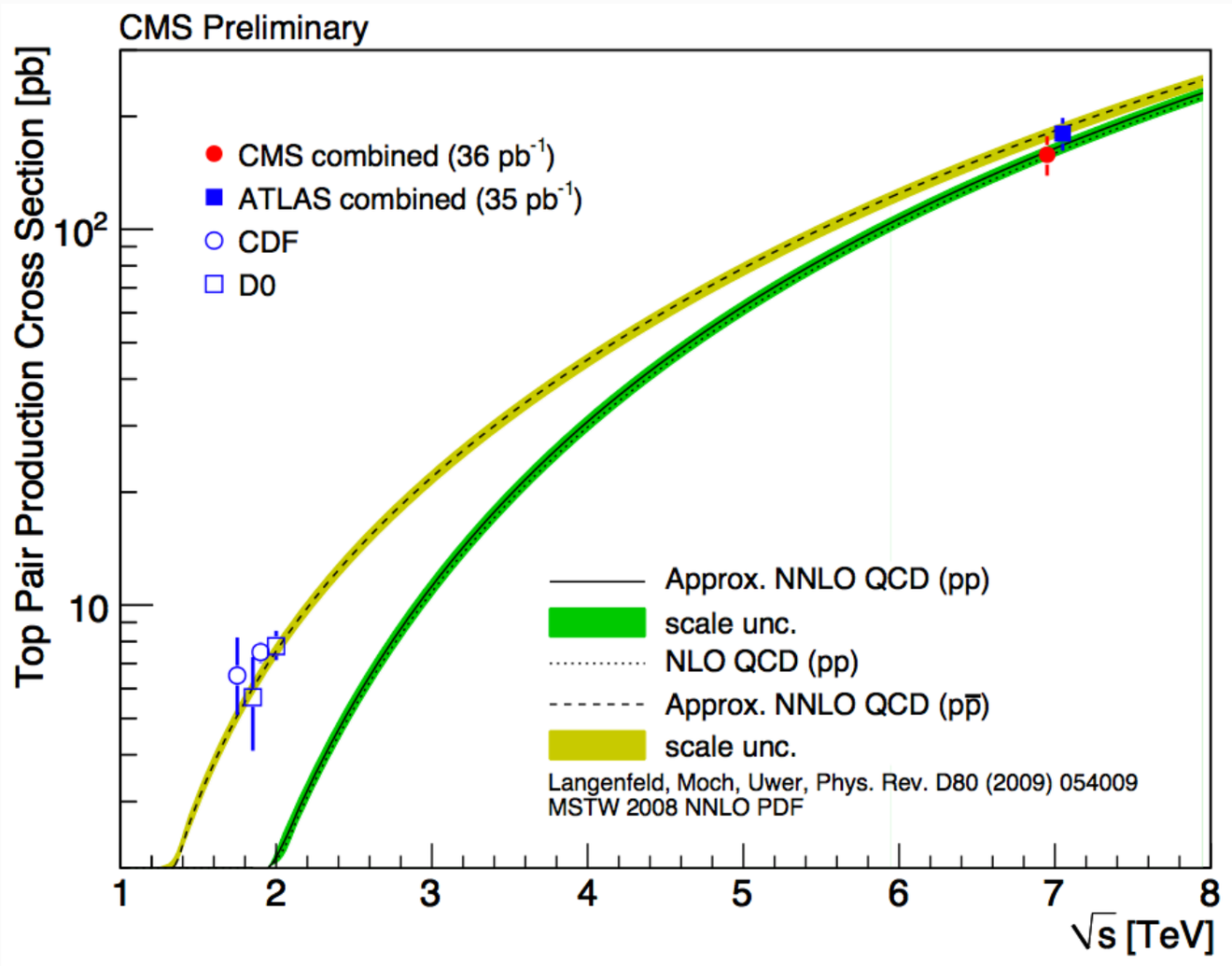

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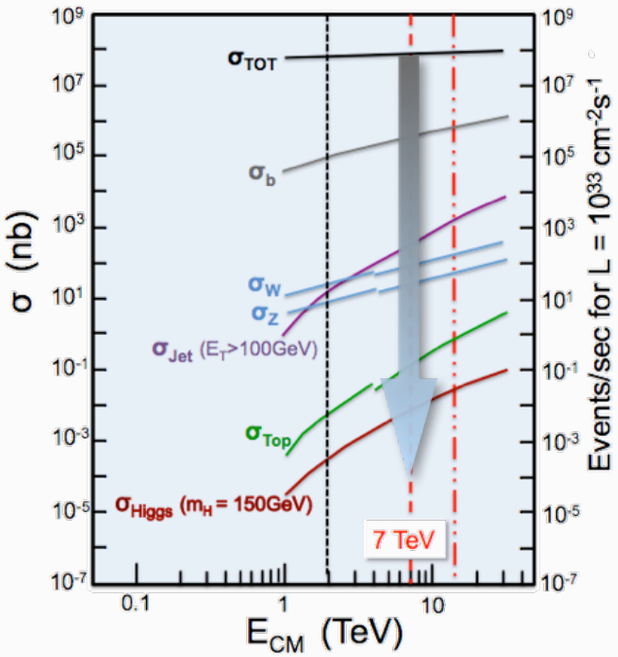

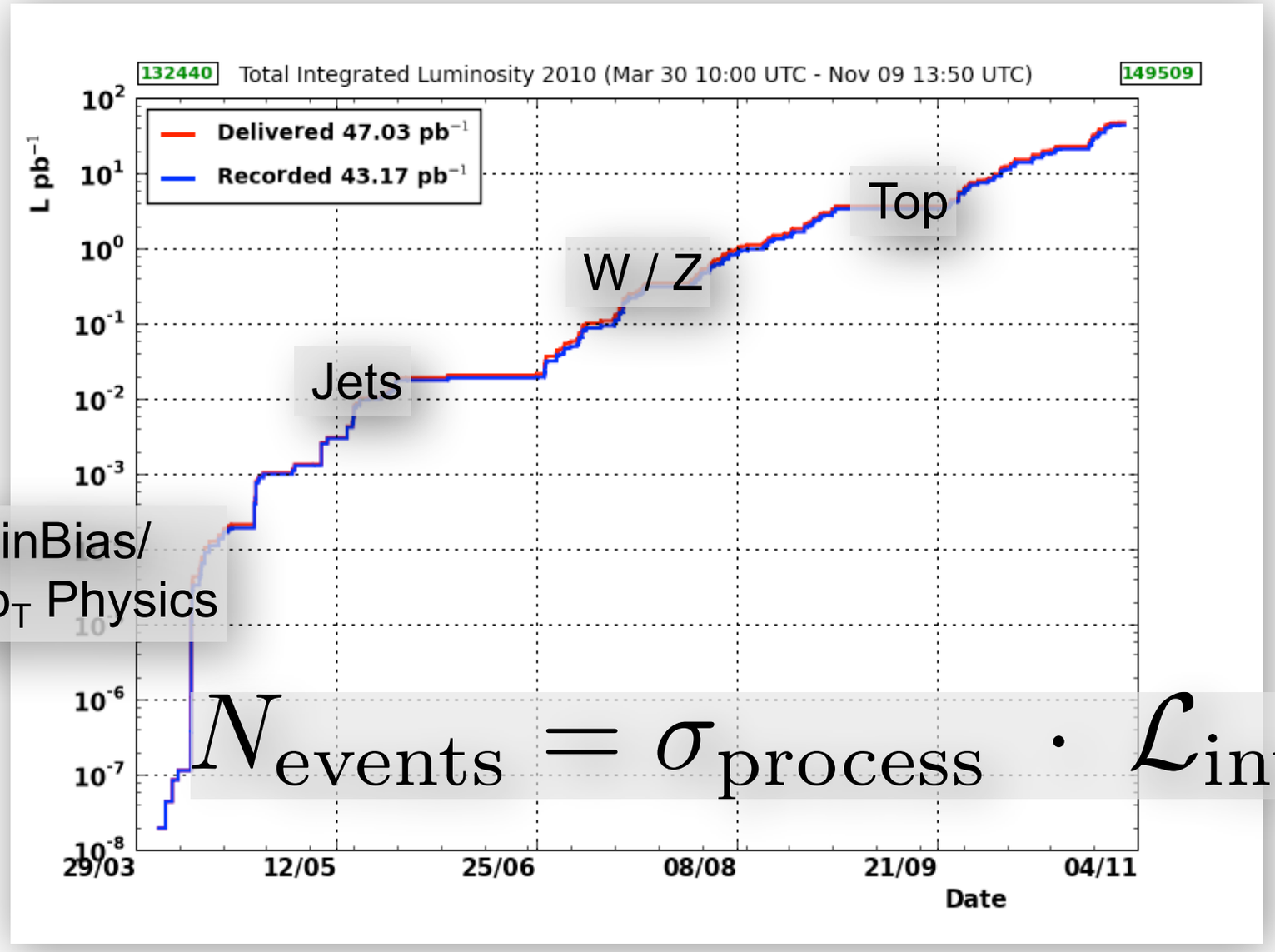

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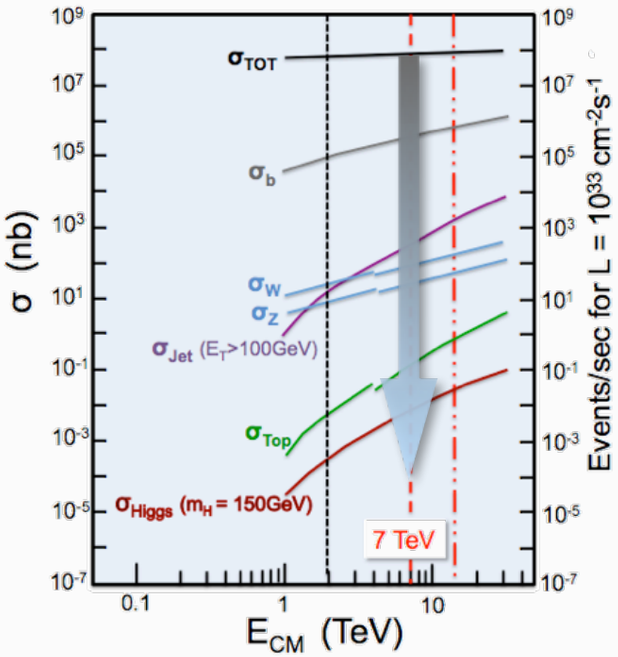
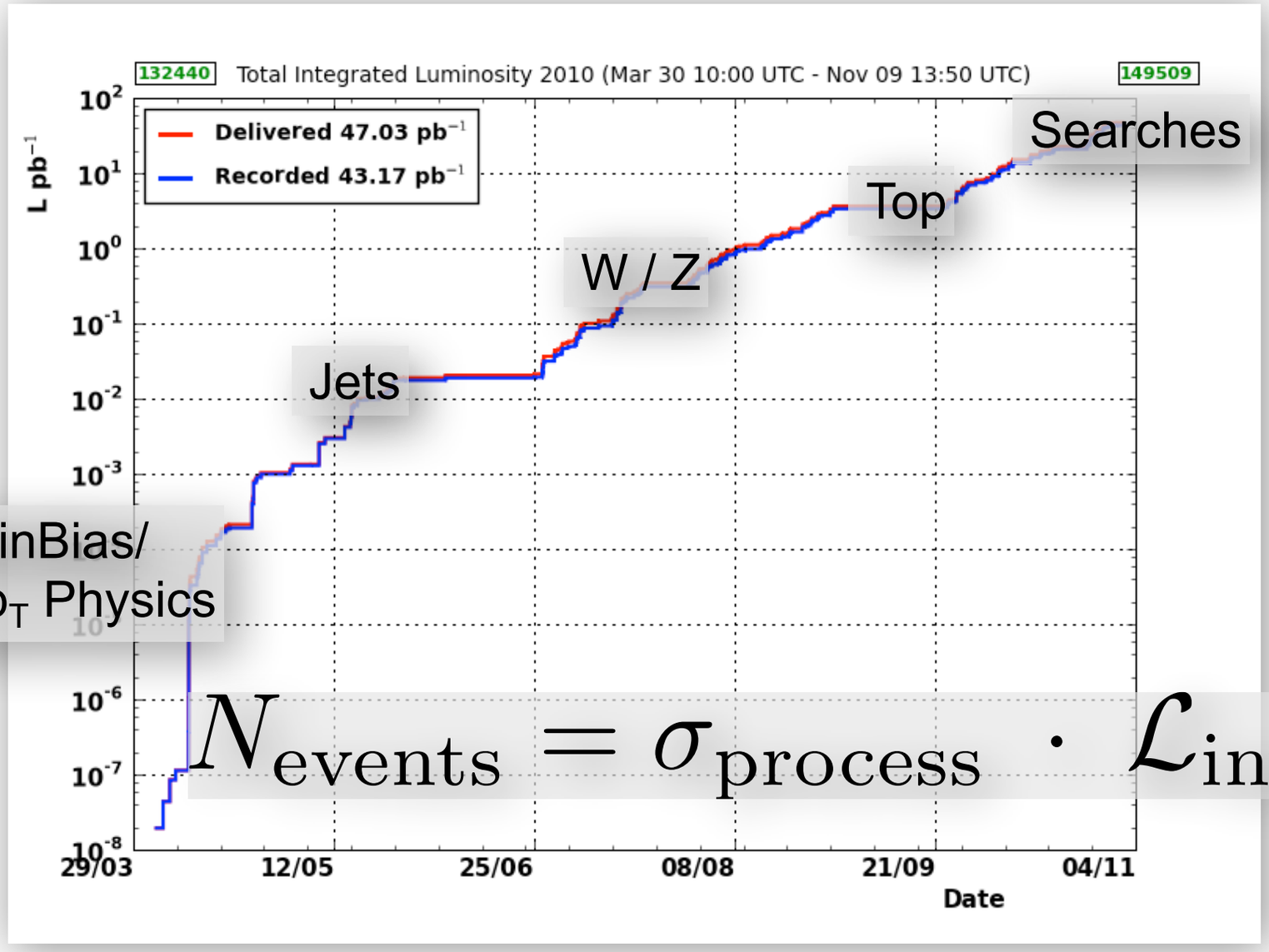
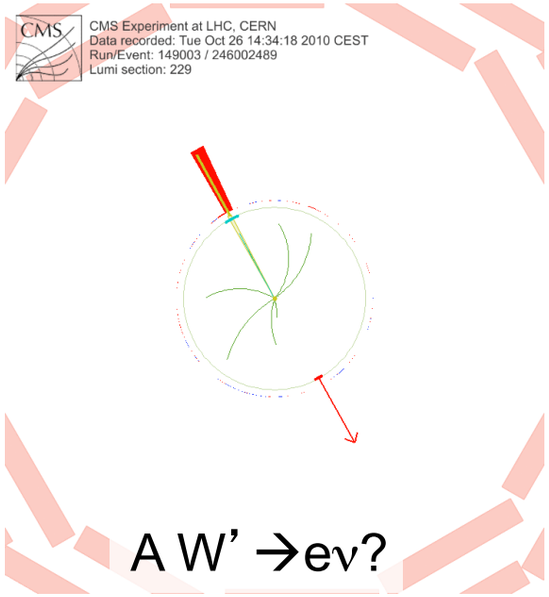
As things appeared with time....

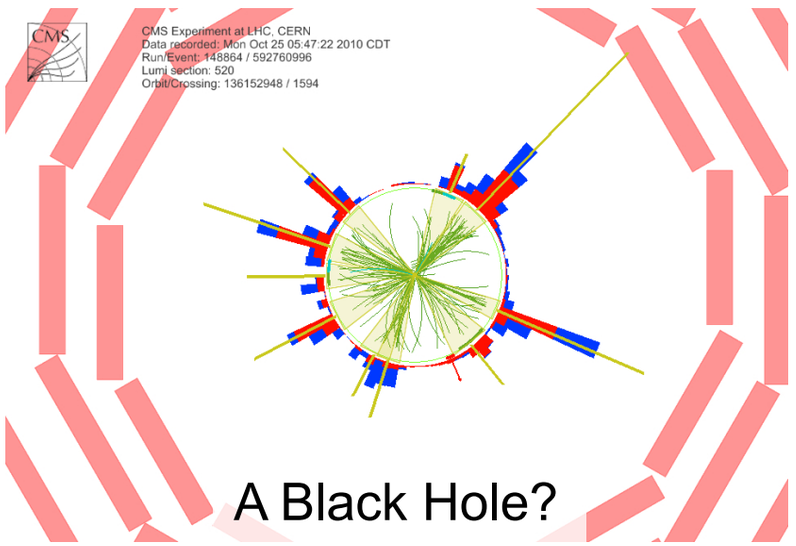




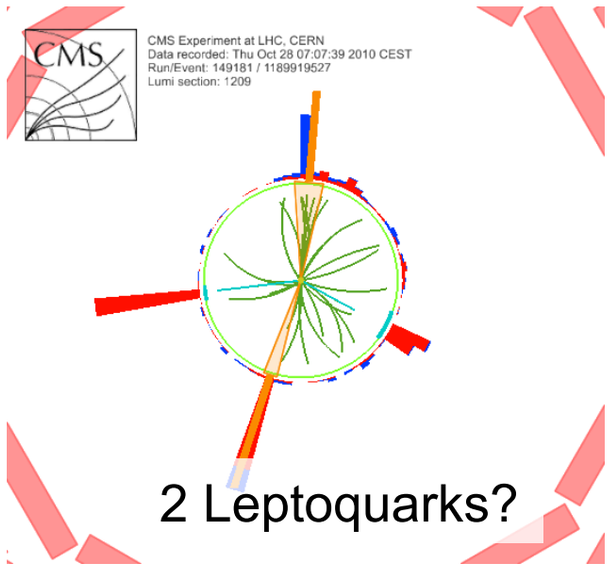
$$N_{\text{events}} = \sigma_{\text{process}} \cdot \mathcal{L}_{\text{int}}$$



A W' →eν?

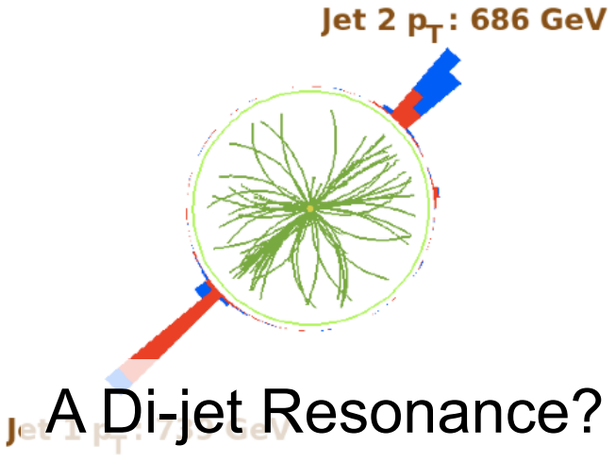


A Black Hole?

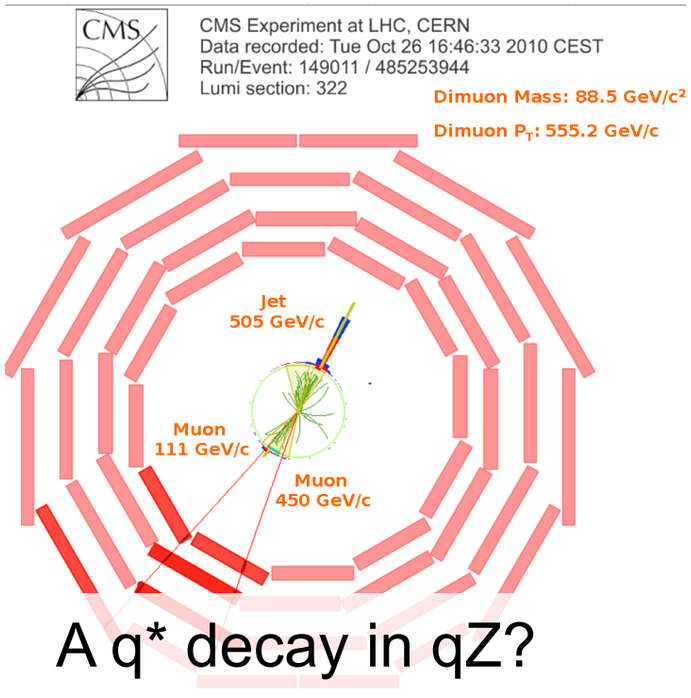


2 Leptoquarks?

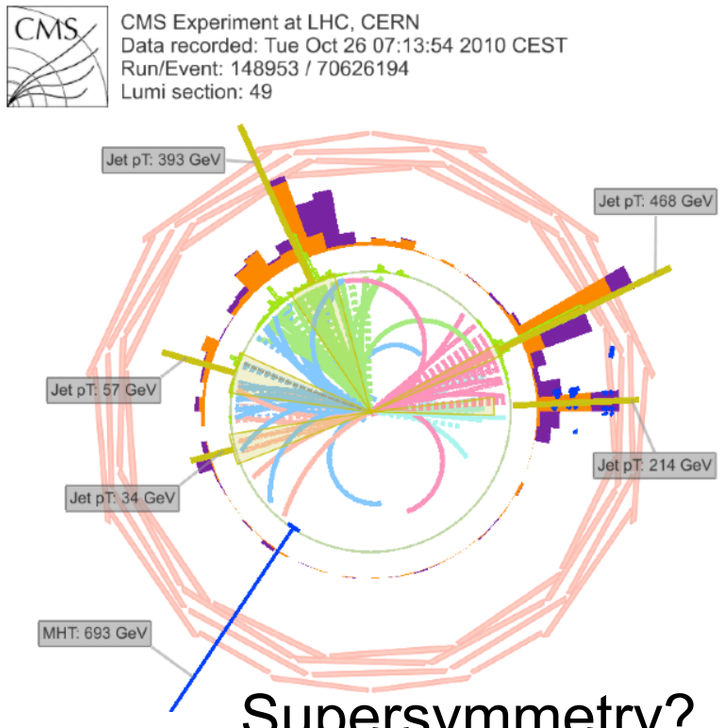
Many signatures looked for ….



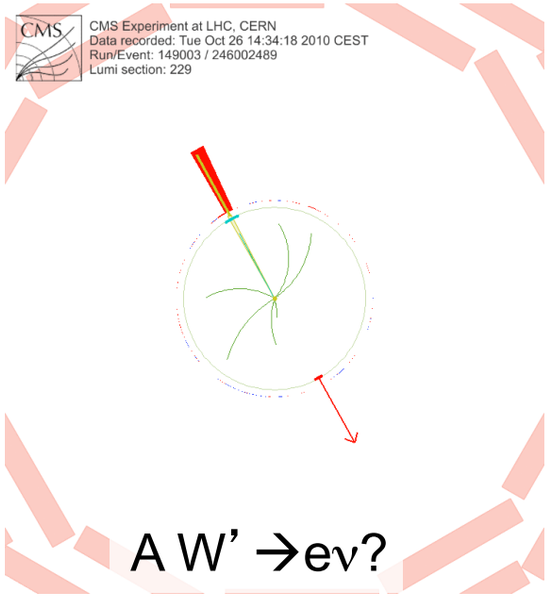
A Di-jet Resonance?



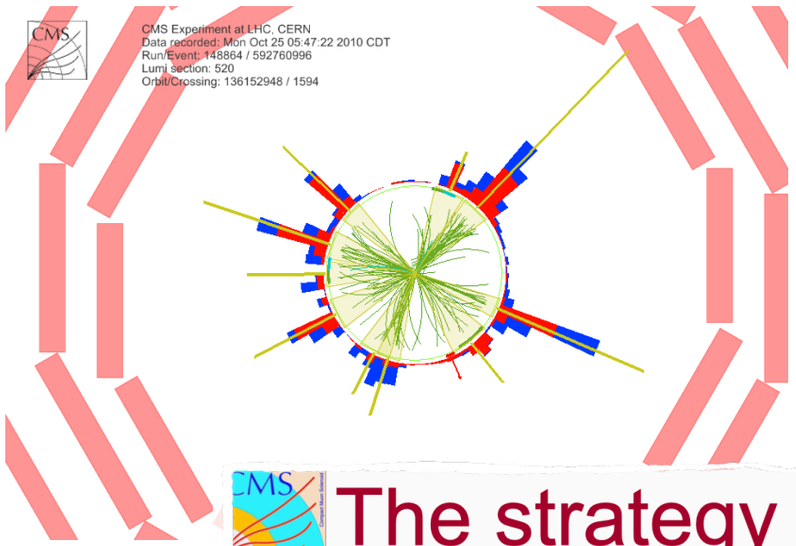
A q* decay in qZ?

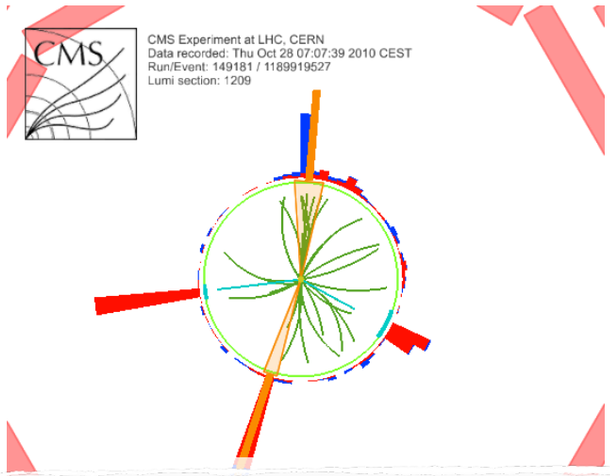


Supersymmetry?

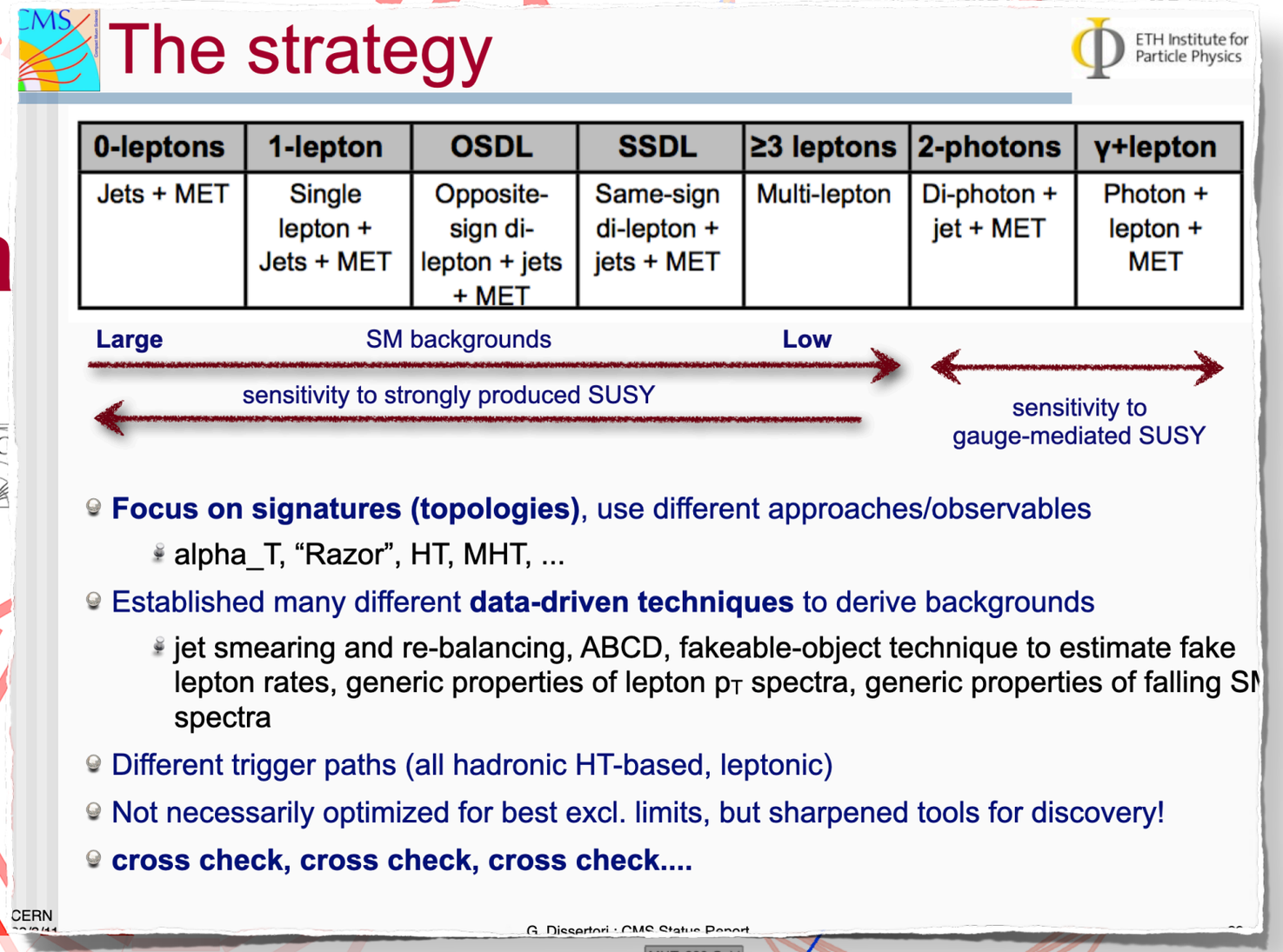


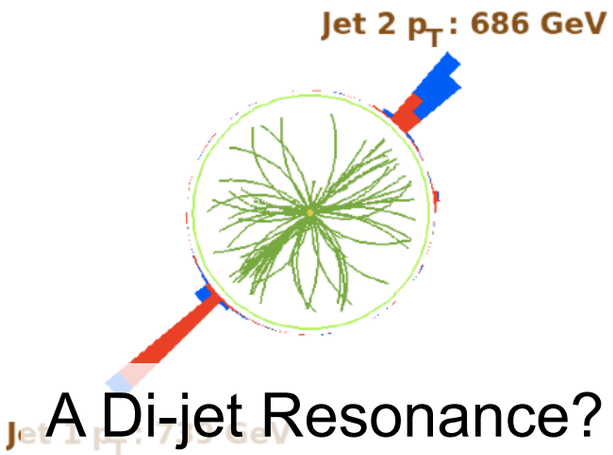
A W' →eν?





Many signa





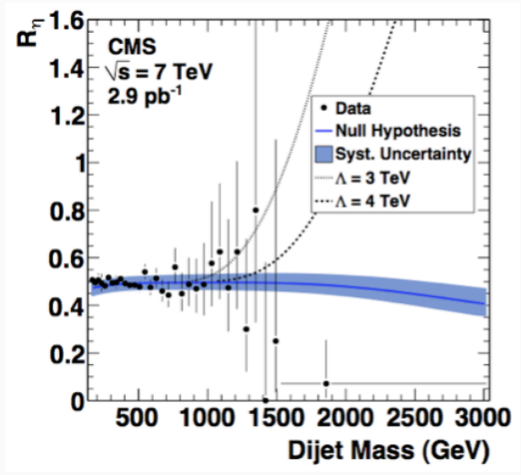
A Di-jet Resonance?

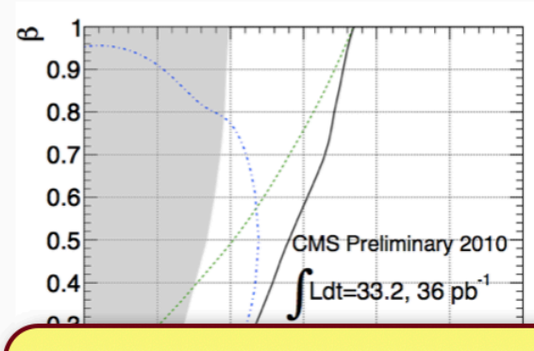
A q* decay in qZ?

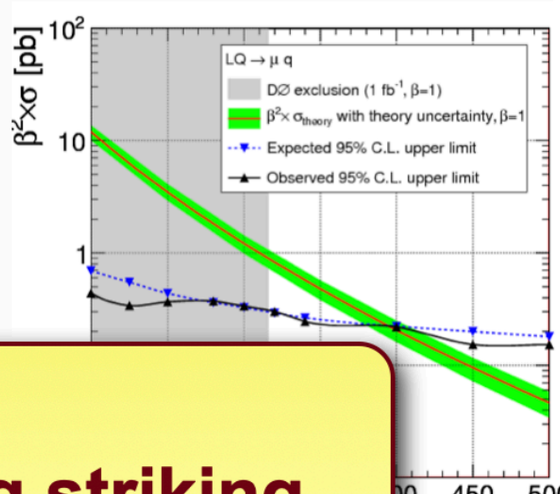
Supersymmetry?

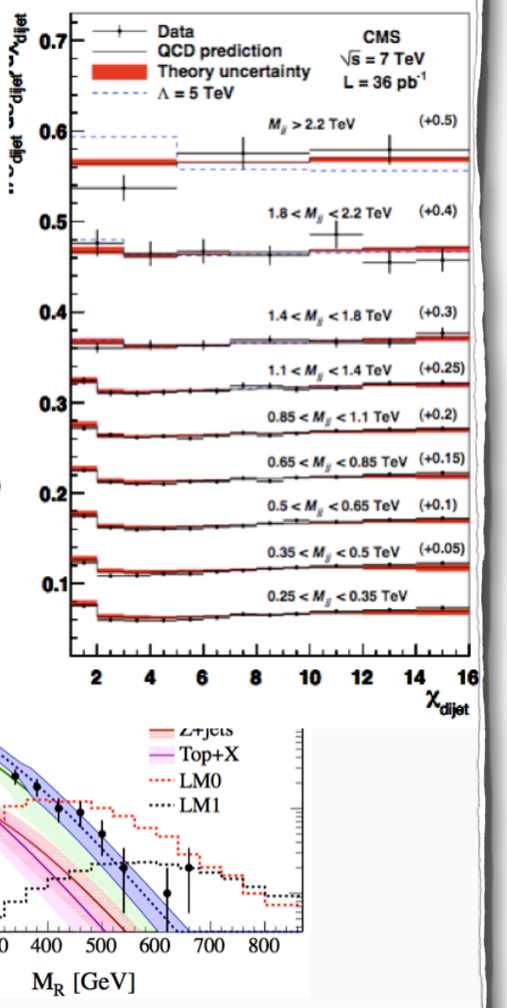
Many, many searches already...

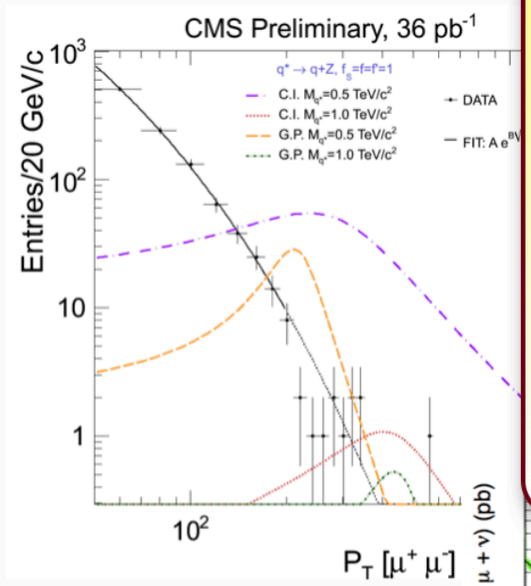
ETH Institute fo
Particle Physics

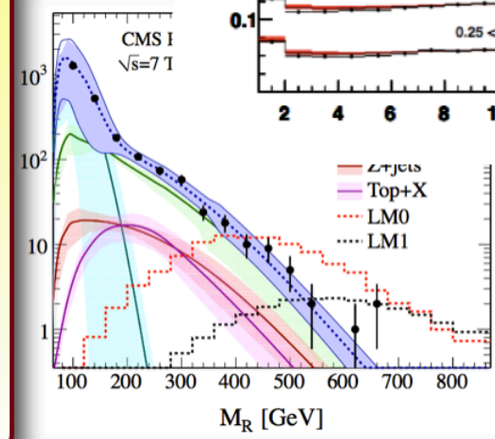






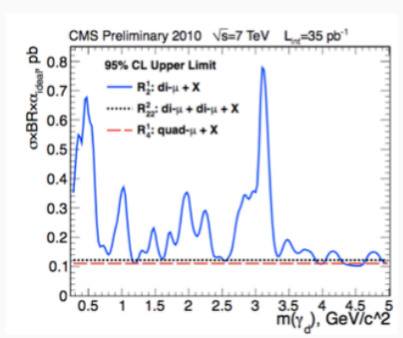


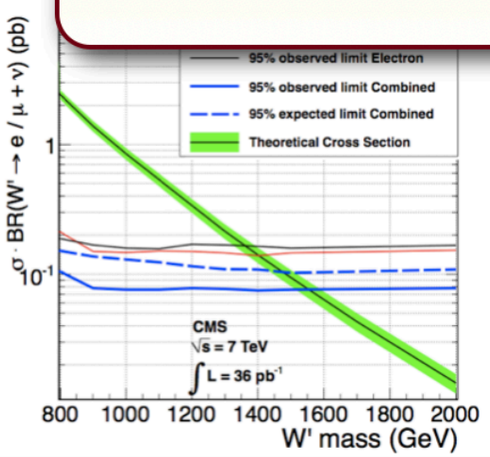


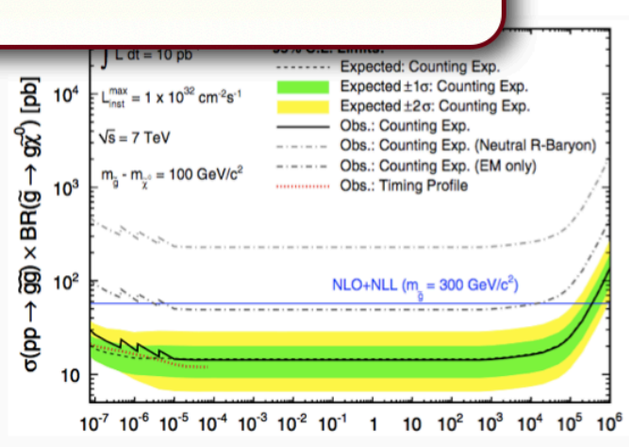


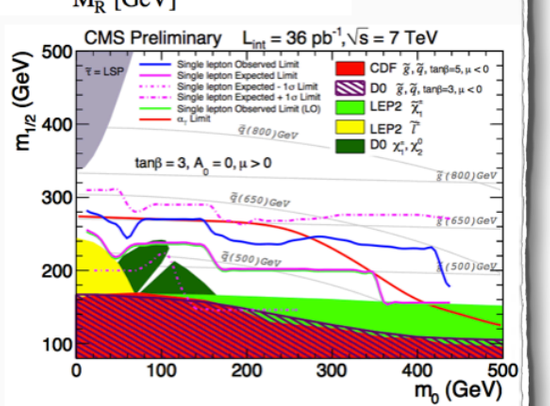
so far, nothing striking found in ATLAS or CMS

but keep looking, and things become really interesting only now...

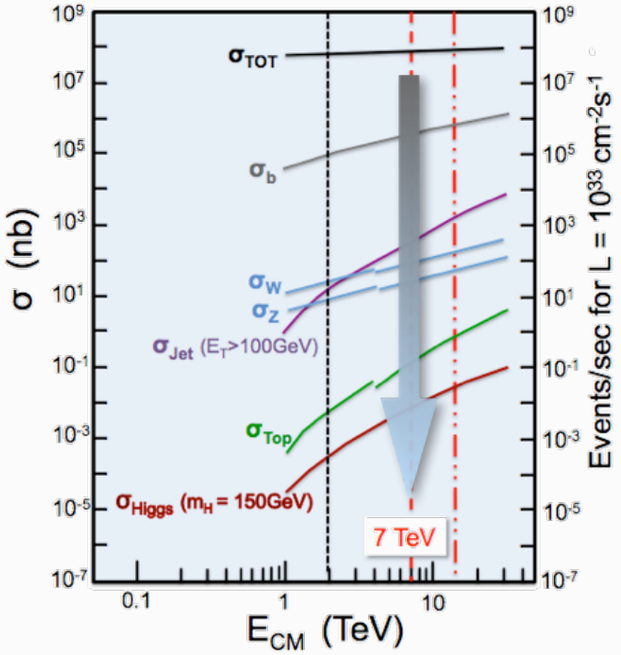




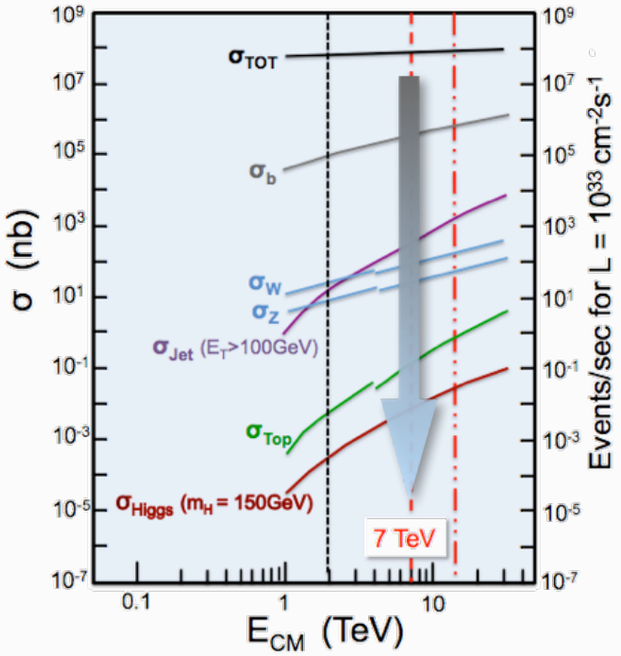


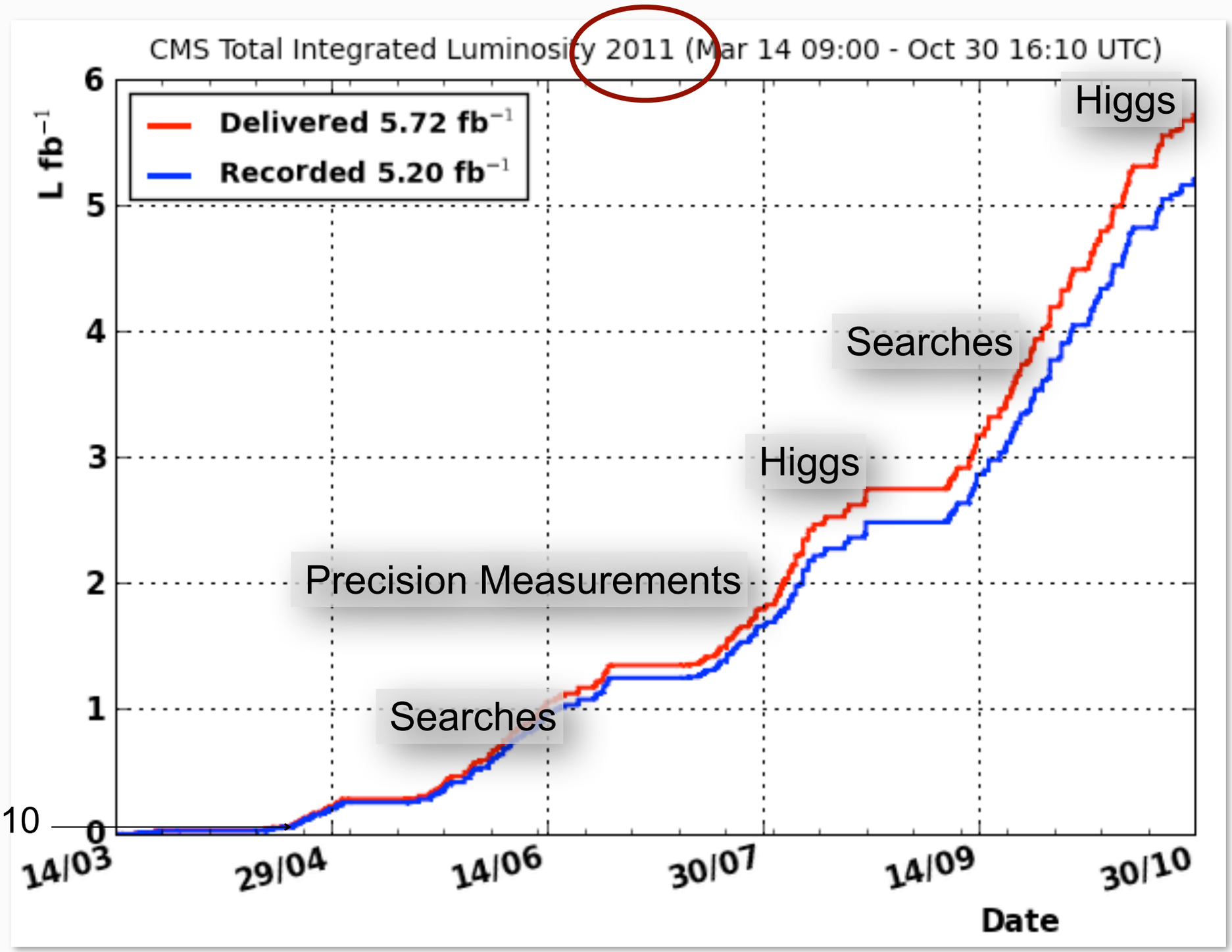


As things appeared with time…. in 2011

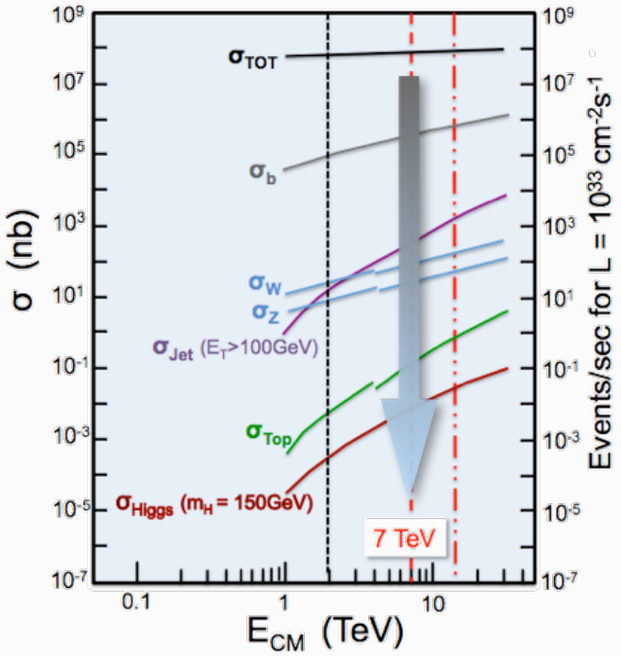


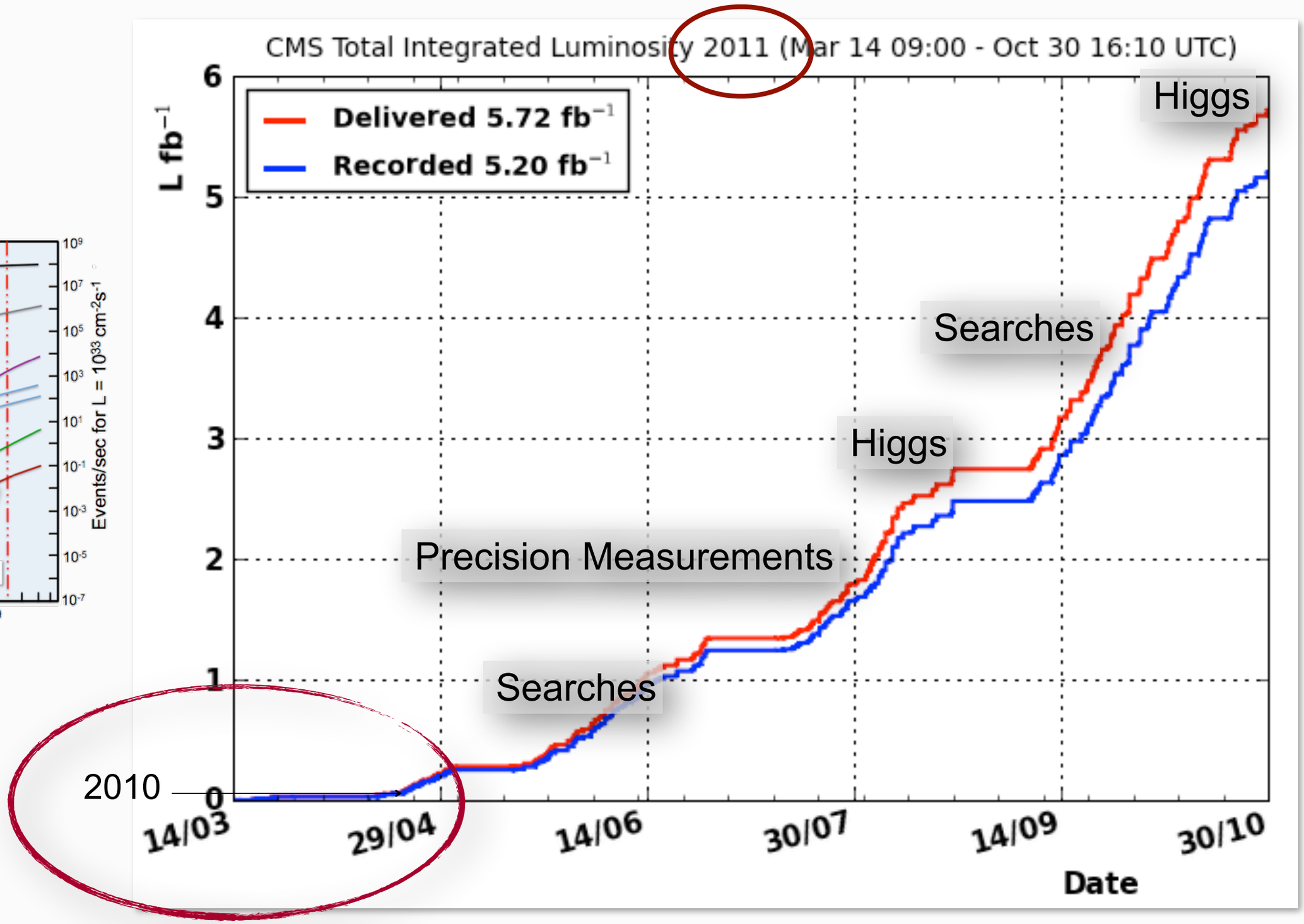
As things appeared with time…. in 2011

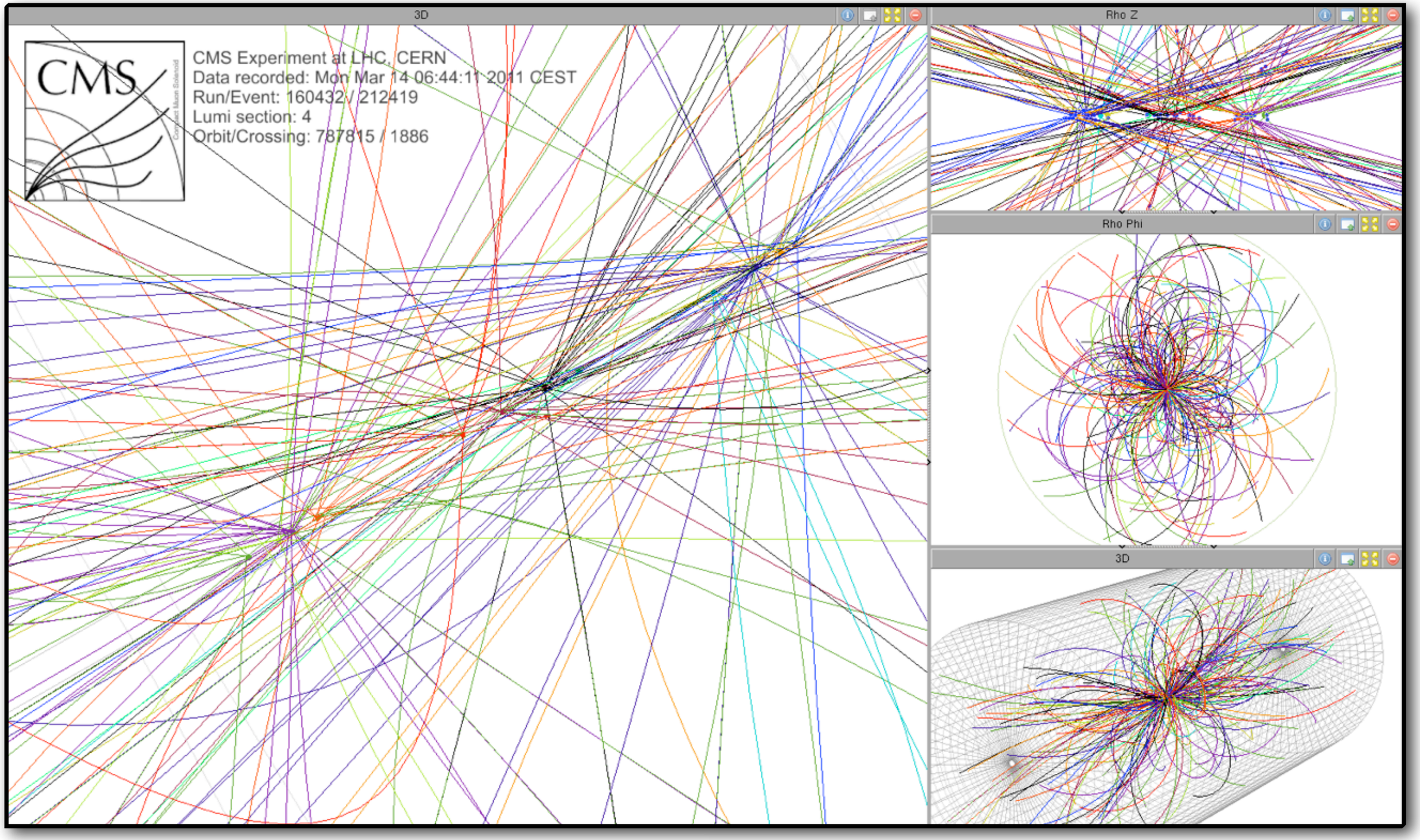




As things appeared with time…. in 2011







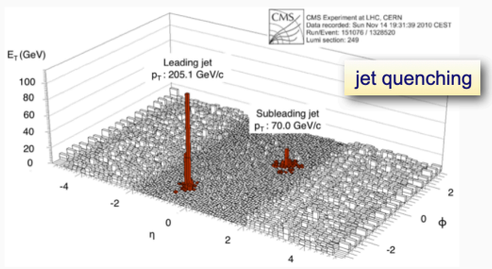
The new challenge: Pile-Up!

CMS was prepared for it on all fronts: Trigger, Reconstruction, Analysis, Computing

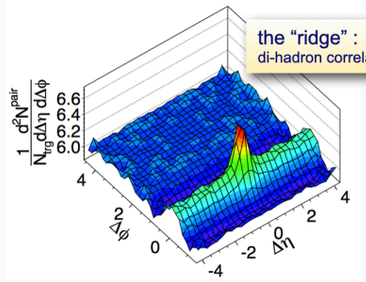
And much more physics…

from my talk at the LHCC, 23/3/2011

ETH Institute fo Particle Physics

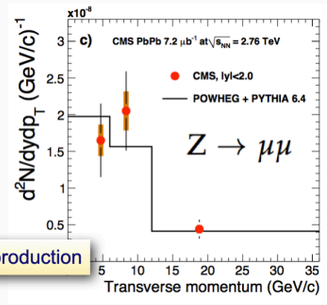


jet quenching

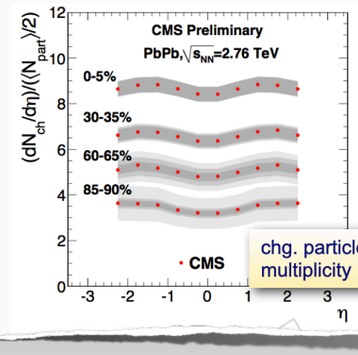


the "ridge" :
di-hadron correlations

Heavy Ion Physics



Z production

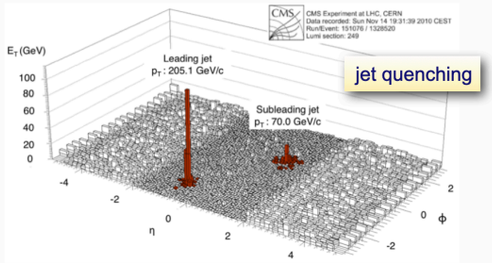


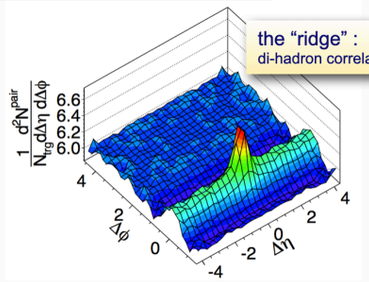
chg. particle multiplicity

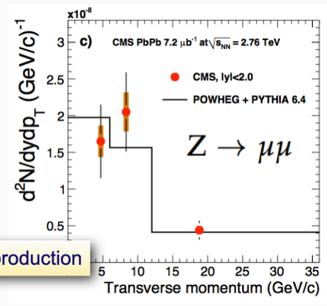
And much more physics…

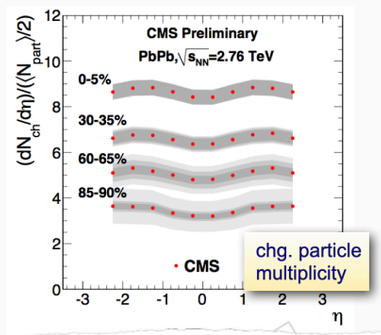
from my talk at the LHCC, 23/3/2011

Heavy Ion Physics





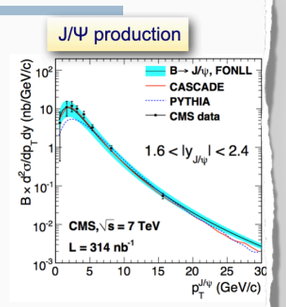


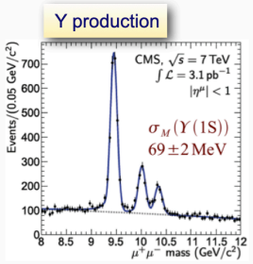


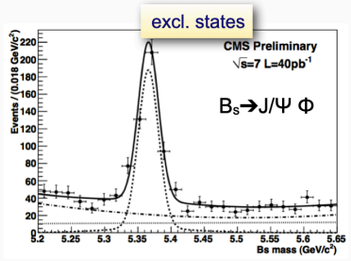
G. Dissertori : CMS Status Report

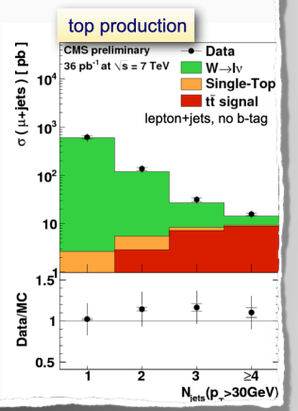
Production of "heavy" quarks:

s → Quarkonia → b → top





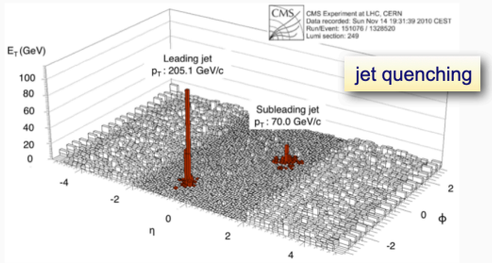


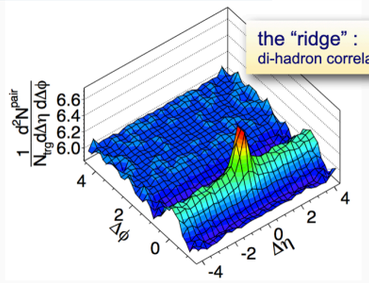


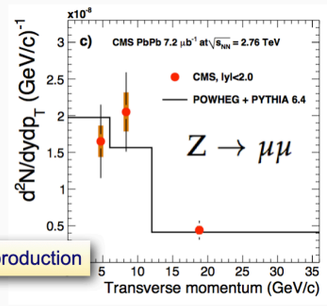
And much more physics…

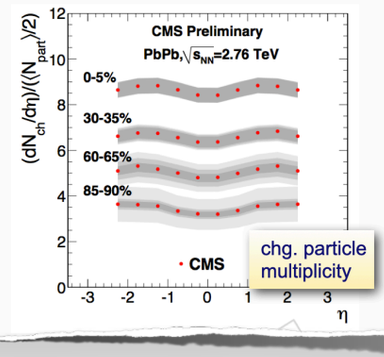
from my talk at the LHCC, 23/3/2011

Heavy Ion Physics

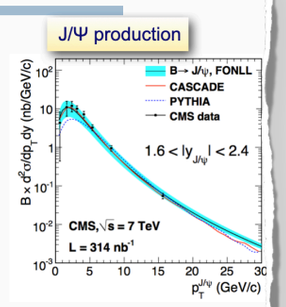




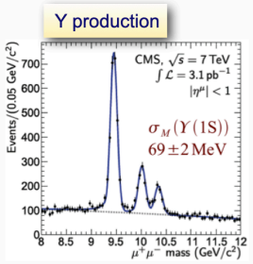


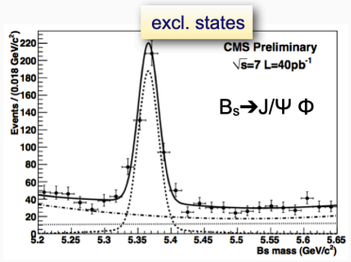


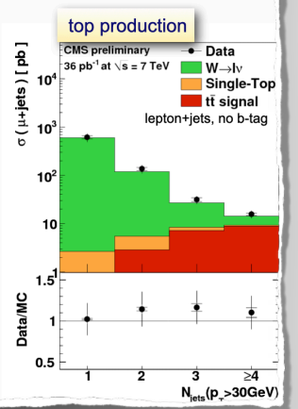
Production of "heavy" quarks:



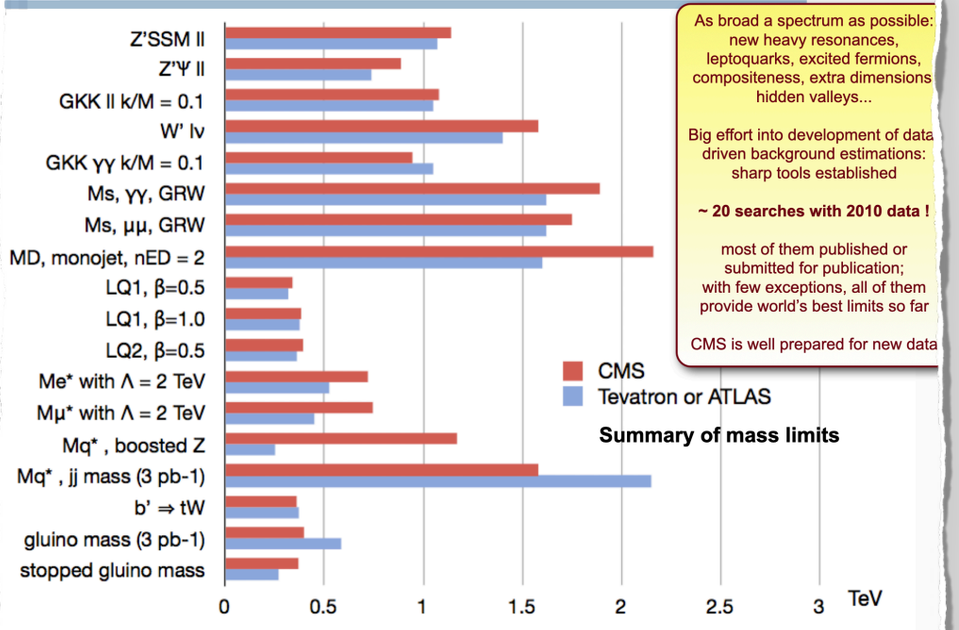
s → Quarkonia → b → top







And many, many more...



As broad a spectrum as possible: new heavy resonances, leptoquarks, excited fermions, compositeness, extra dimensions hidden valleys...

Big effort into development of data driven background estimations: sharp tools established

~ 20 searches with 2010 data !

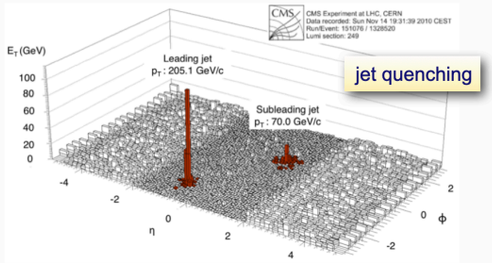
most of them published or submitted for publication; with few exceptions, all of them provide world's best limits so far

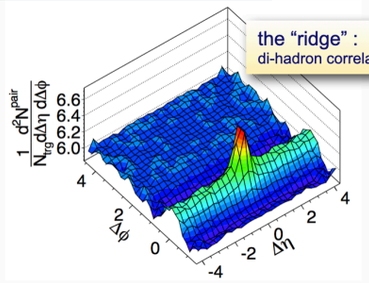
CMS is well prepared for new data

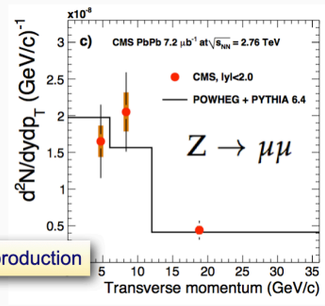
And much more physics…

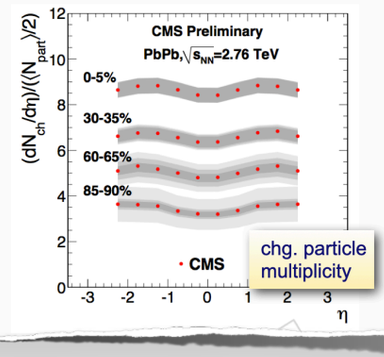
from my talk at the LHCC, 23/3/2011

Heavy Ion Physics



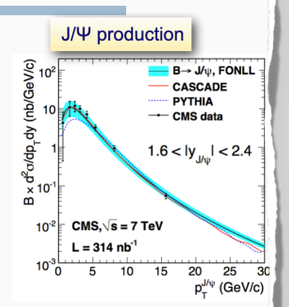


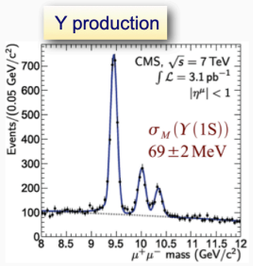


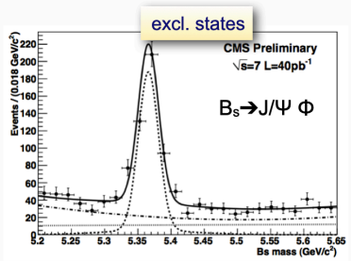


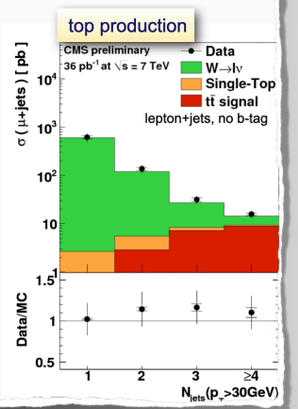
Production of "heavy" quarks:

s → Quarkonia → b → top

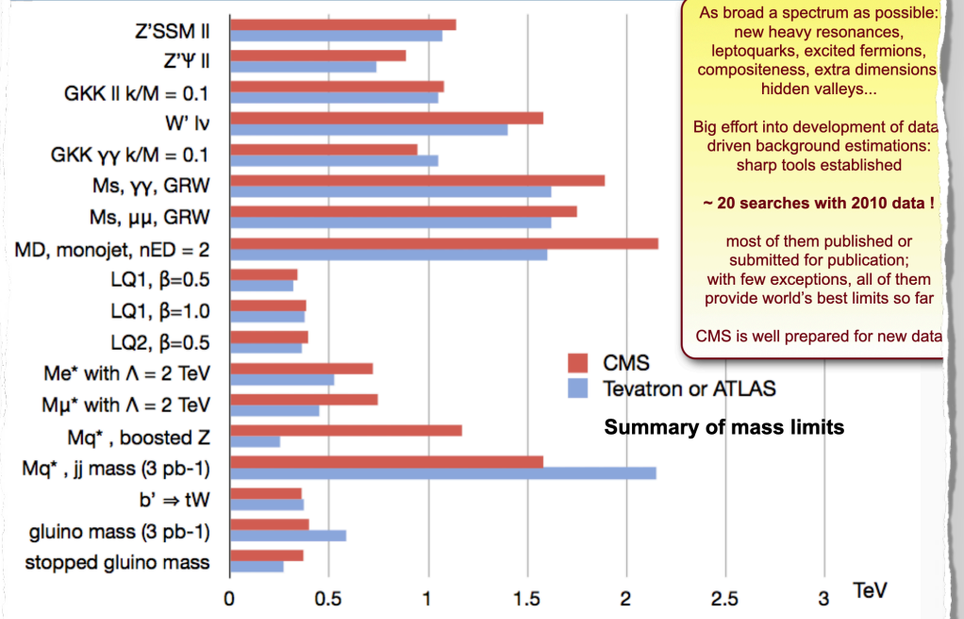








And many, many more...



As broad a spectrum as possible: new heavy resonances, leptoquarks, excited fermions, compositeness, extra dimensions hidden valleys...

Big effort into development of data driven background estimations: sharp tools established

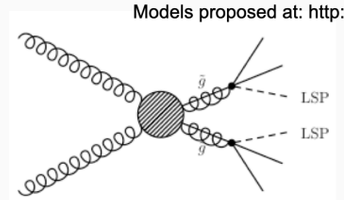
~ 20 searches with 2010 data !

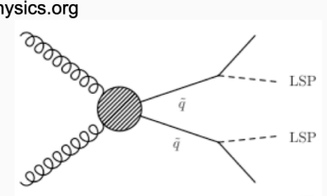
most of them published or submitted for publication; with few exceptions, all of them provide world's best limits so far

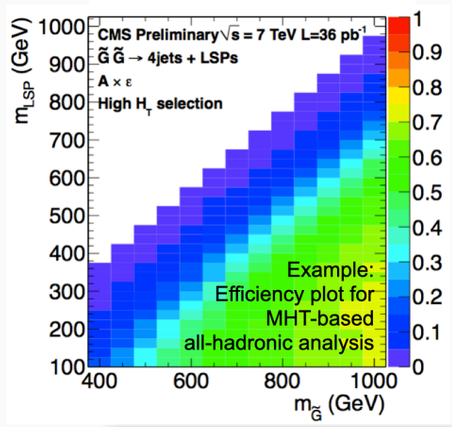
CMS is well prepared for new data

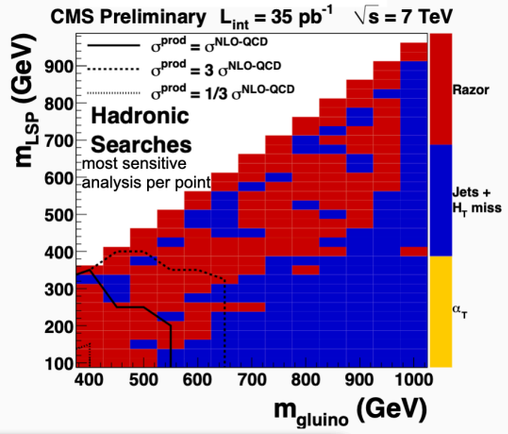
Simplified models

Models proposed at: http://www.lhcnewphysics.org



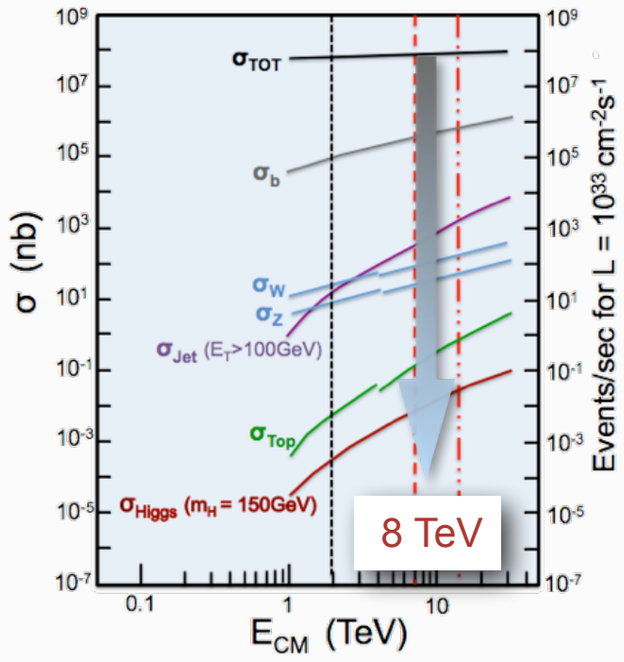


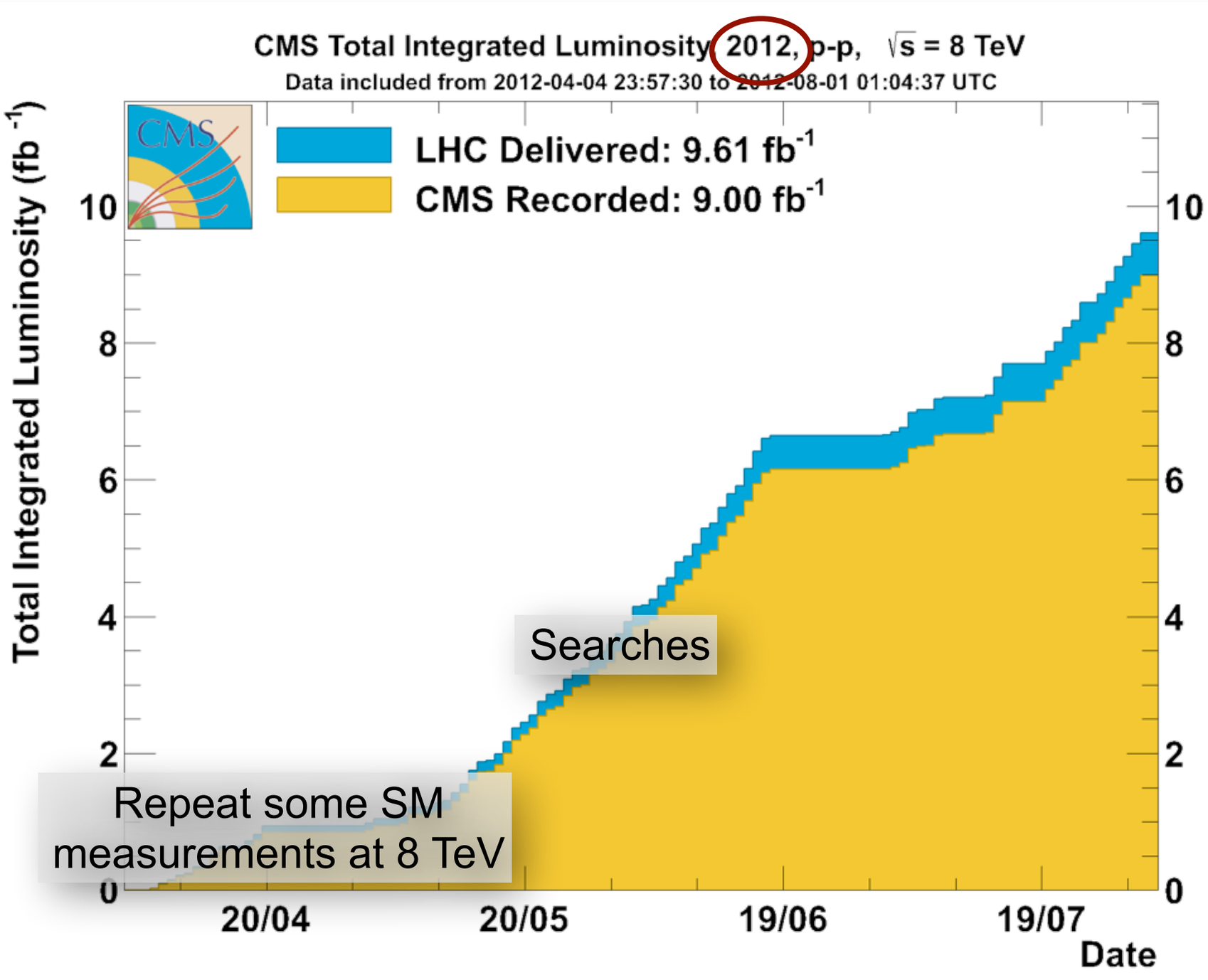




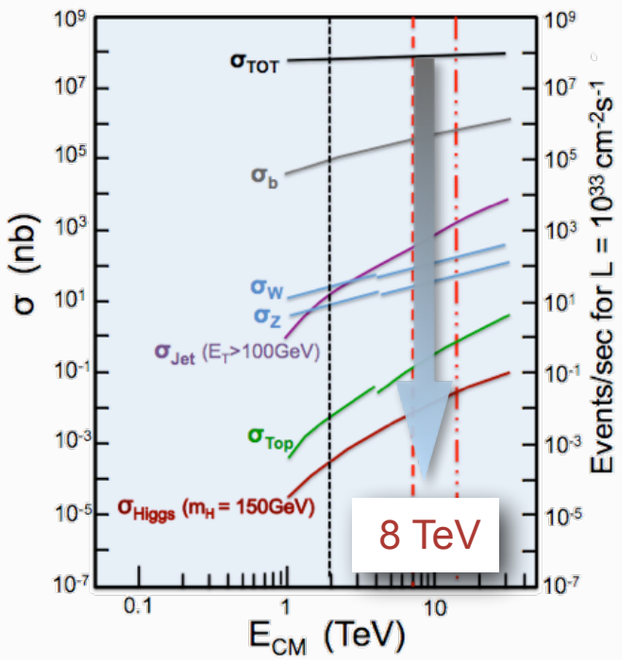
Shows complementarity of hadronic analyses.
CMS will provide these results electronically.
Feedback is welcome.

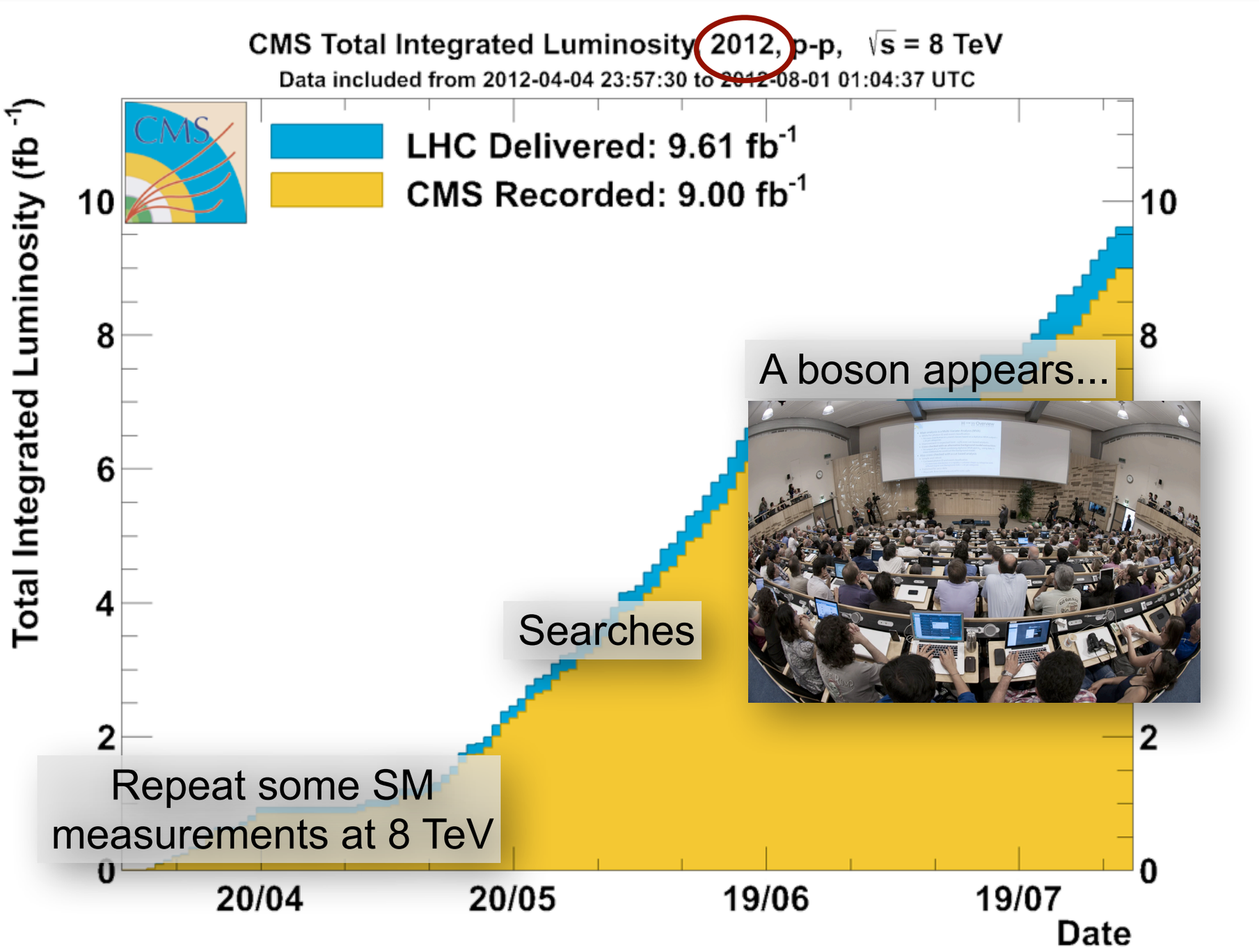
As things appeared with time…. in 2012





As things appeared with time…. in 2012



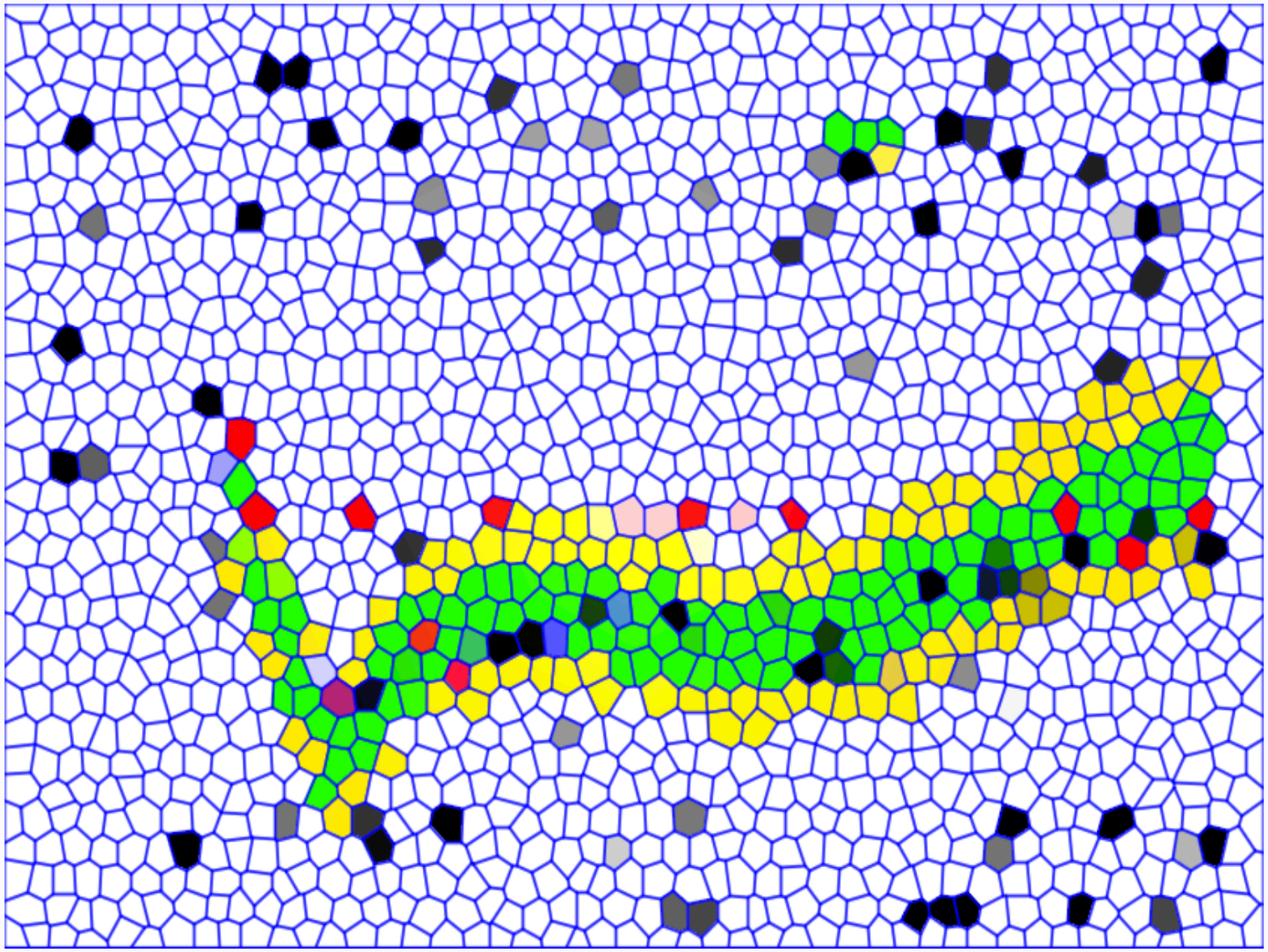


Status of CMS Higgs Search Preparation

Vivek's memorable talk in Bodrum

Analysis Highlights and previews

LHCC Closed session DECEMBER 2011



CERN
6/12/11

GuDaGi

V. Sharma

See https://ep-news-d10.web.cern.ch/content/despair-discovery and **Vivek's talk** in a few mins…

Summary

Summary

Summary

ETH Institute for Particle Physics

- Our sincere thanks go to our colleagues from the machine
  - the excellent LHC performance of last year is extremely promising for the upcoming year(s)
- CMS is in excellent shape
  - the complete chain of operation (from online data taking to final physics plots) has been stress-tested
  - the often better-than-expected performance, and the high motivation of all involved, has allowed for the production of an impressive amount of physics results, on an unseen short time-scale

Summary

Summary

https://www.google.com/url?sa=i&url=https://diyachting.co.uk/%F0%9F%94%B4-special-offer-christmas-discount-on-beautiful-day-%F0%9F%8F%96%EF%B8%8F/&psig=AOvVaw1v-xIT6aSHwNvhQC2XGHr2&ust=1760013108606000&source=images&cd=vfe&opi=89978449&ved=0CBUQjRxqFwoTCIDNjvvNlJADFQAAAAAdAAAAABAE

Summary

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