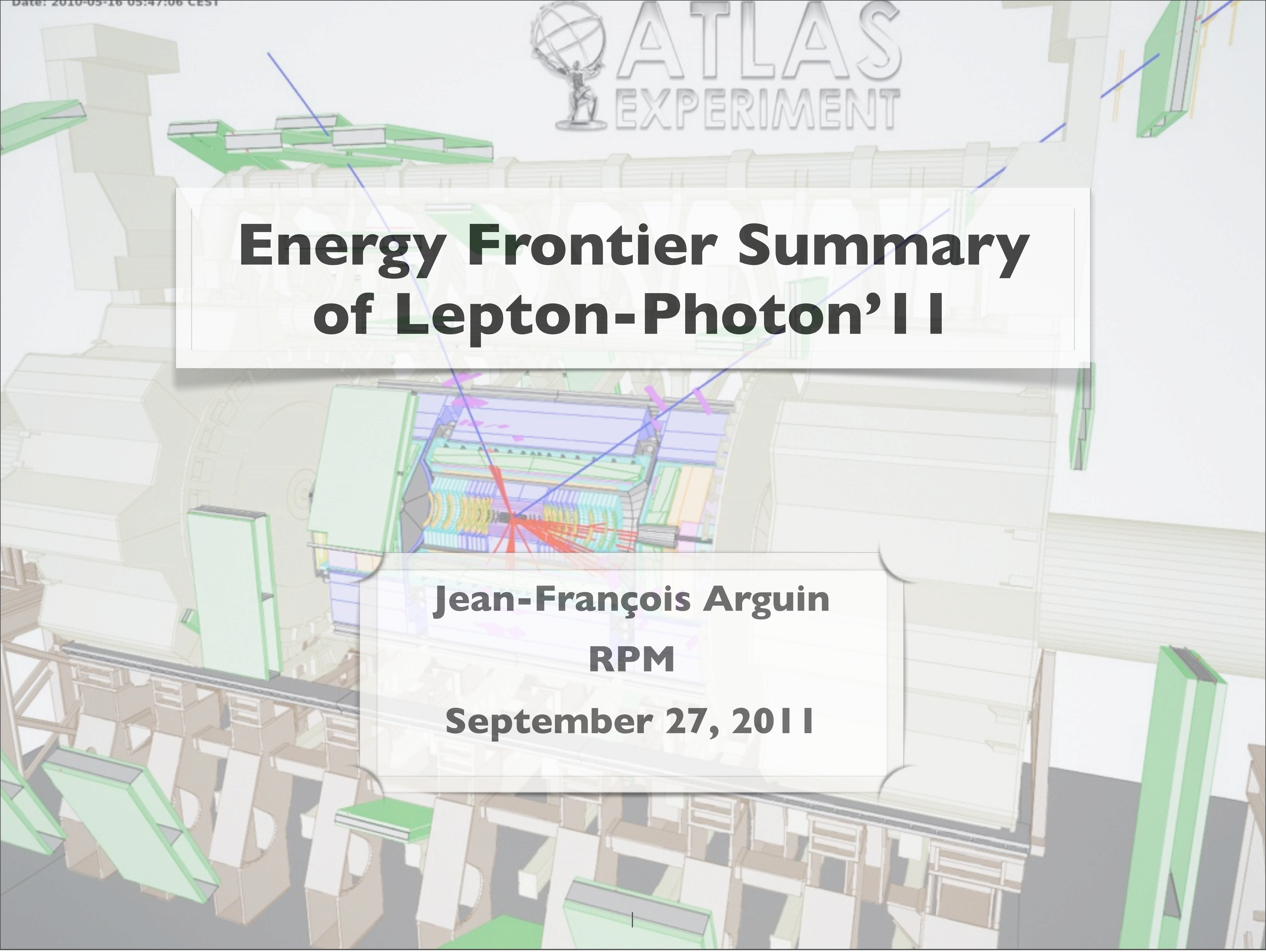


Energy Frontier Summary of Lepton-Photon'11

Jean-François Arguin
RPM

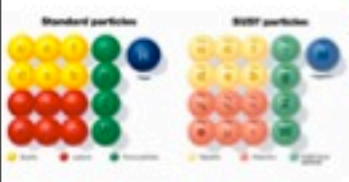
September 27, 2011

DISCLAIMERS

- **I don't try to cover every single talks**, rather I tried to cover the ones I thought were the most interesting/important
- I will **not talk about the Higgs**. There was one CMS RPM recently (and an ATLAS one soon) dedicated to this topic.
    - Short summary: LHC overtakes the Tevatron, provides a large exclusion region for the SM Higgs boson of M~145-460 GeV (95% C.L.)
- Apologies if you have seen my LP'11 summary at the last ATLAS experiment-theory talk, there is a very large overlap!

NEW PHYSICS SEARCHES AT LHC

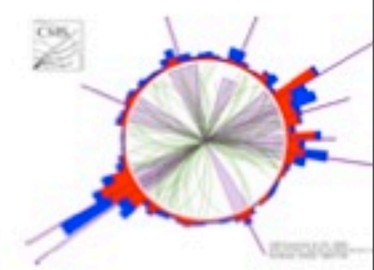
Outline



Supersymmetry (with MET)

- → Jets + MET
- → Lepton(s) + MET
- → 3rd generation + MET
- → Photon(s) + MET

Strong Gravity



- → Monojet
- → Monophoton
- → Dilepton spectrum
- → Black-hole

Heavy Resonances

- → Heavy gauge bosons
- → Diphoton
- → Dijet
- → Doubly-charged Higgs

Long-Lived Particles

- → Displaced vertices
- → Slow particles
- → Out-of-time decays

A very long list of models x signatures

- Many extensions of the SM have been developed over the past decades:
- Supersymmetry
- Extra-Dimensions
- Technicolor(s)
- Little Higgs
- No Higgs
- GUT
- Hidden Valley
- Leptoquarks
- Compositeness
- 4^{th} generation (t', b')
- LRSM, heavy neutrino
- etc...

(for illustration only)

- 1 jet + MET
- jets + MET
- 1 lepton + MET
- Same-sign di-lepton
- Dilepton resonance
- Diphoton resonance
- Diphoton + MET
- Multileptons
- Lepton-jet resonance
- Lepton-photon resonance
- Gamma-jet resonance
- Diboson resonance
- Z+MET
- W/Z+Gamma resonance
- Top-antitop resonance
- Slow-moving particles
- Long-lived particles
- Top-antitop production
- Lepton-Jets
- Microscopic blackholes
- Dijet resonance
- etc...

A complex 2D problem

Experimentally, a **signature standpoint** makes a lot of sense:

→ Practical

→ Less model-dependent

→ Important to cover every possible signature

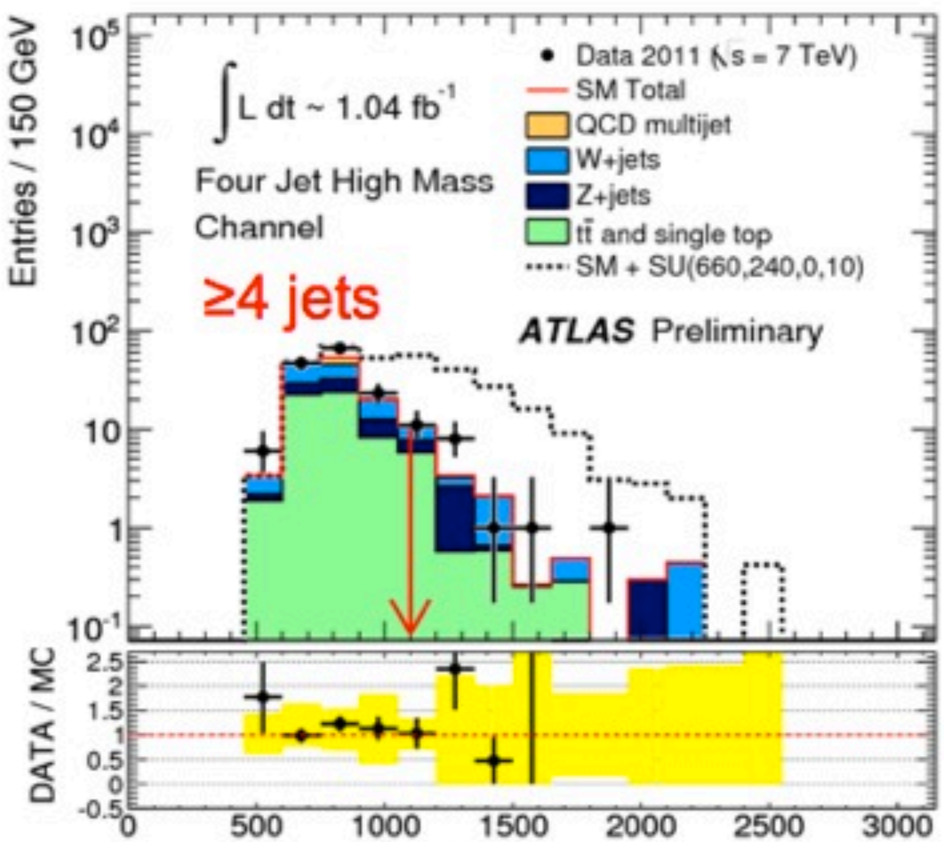
1. SUSY: Jets + Missing E_T

$\tilde{q} \rightarrow q\tilde{\chi}_1^0$

$\tilde{g} \rightarrow qq\tilde{\chi}_1^0$

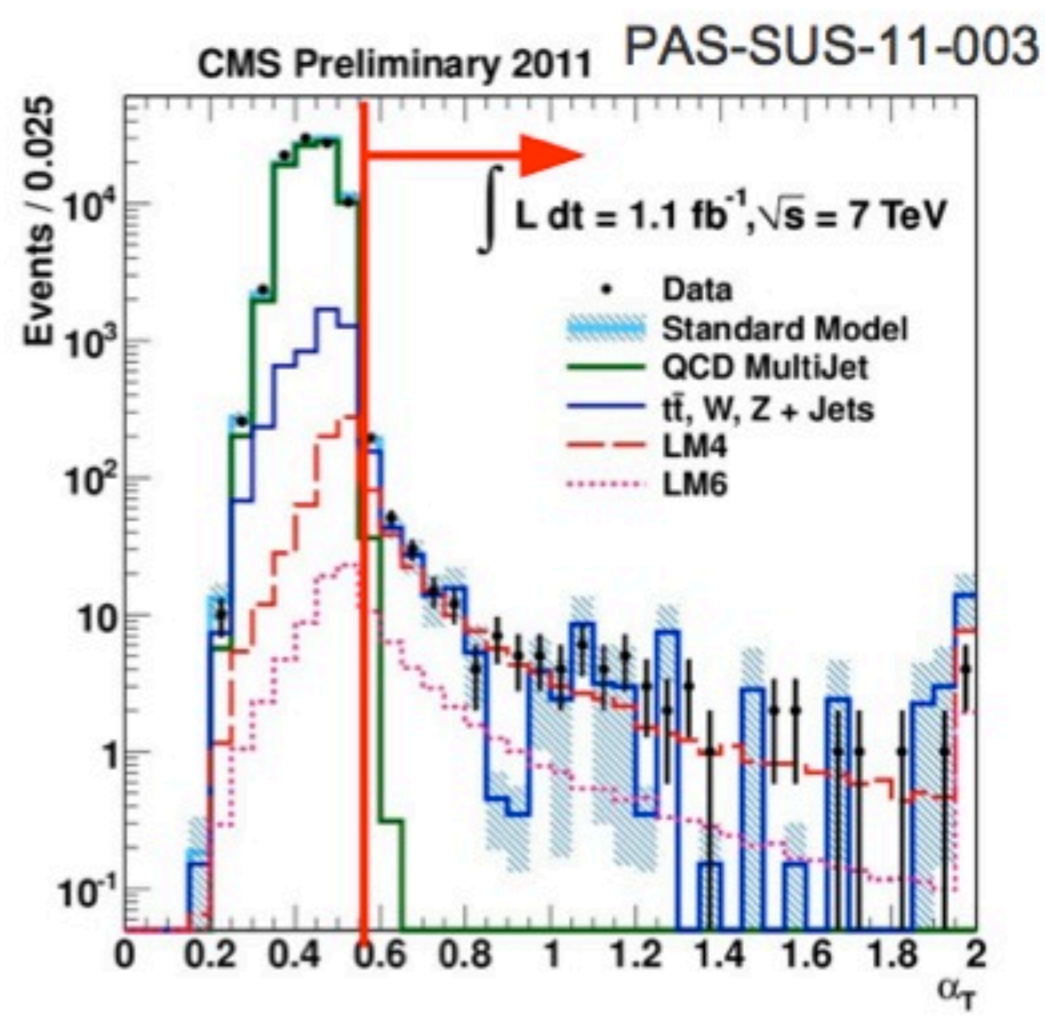
- "Workhorse" of SUSY search
- ATLAS:
  - → Cut on MET and m_{eff}
  - → Combine exclusive channels

H_T = scalar sum of all jet E_T



m_{eff} = H_T + Missing E_T [GeV]

- CMS explores various techniques:
  - → α_T = 2nd jet E_T / Trans. Mass

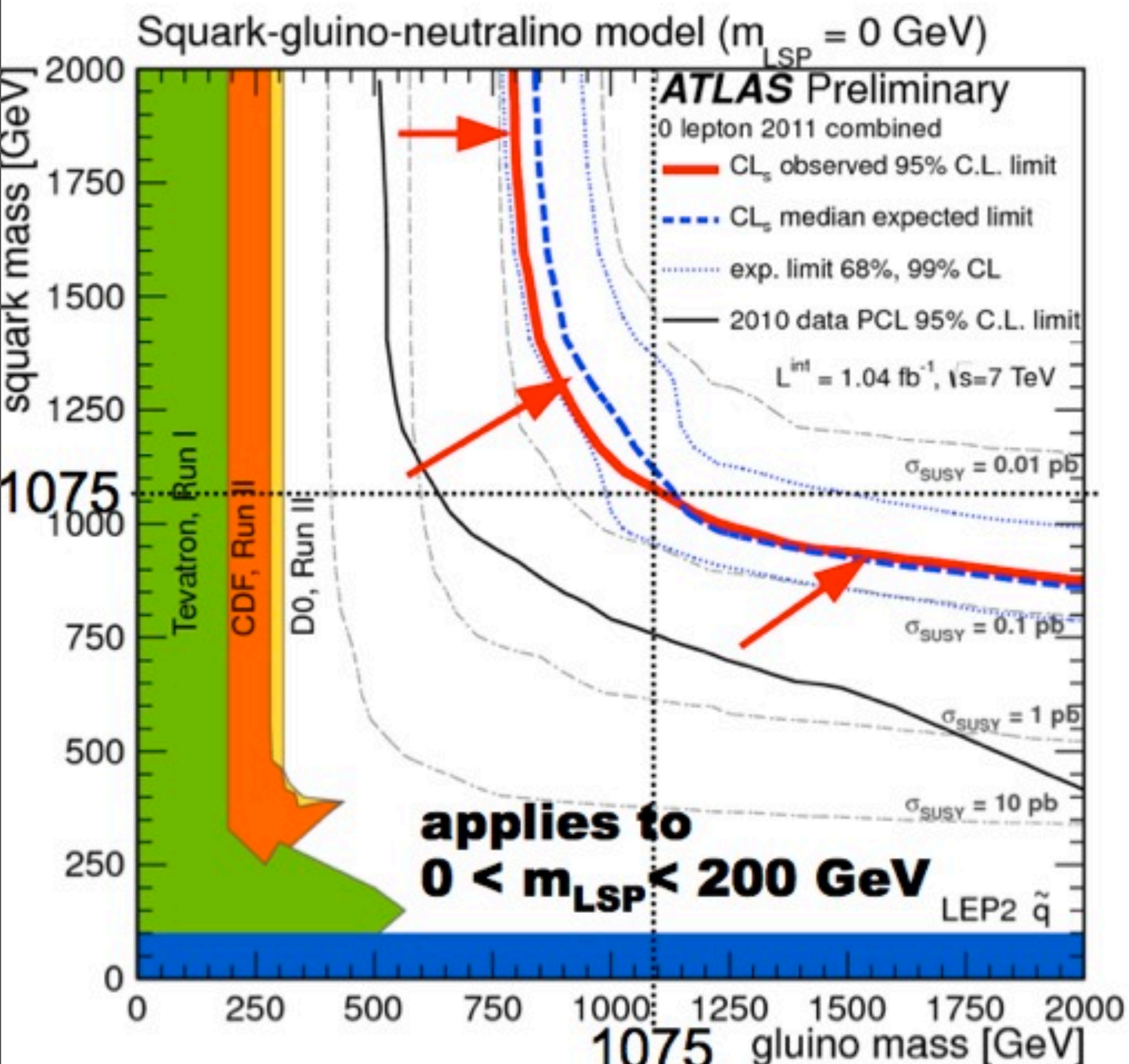


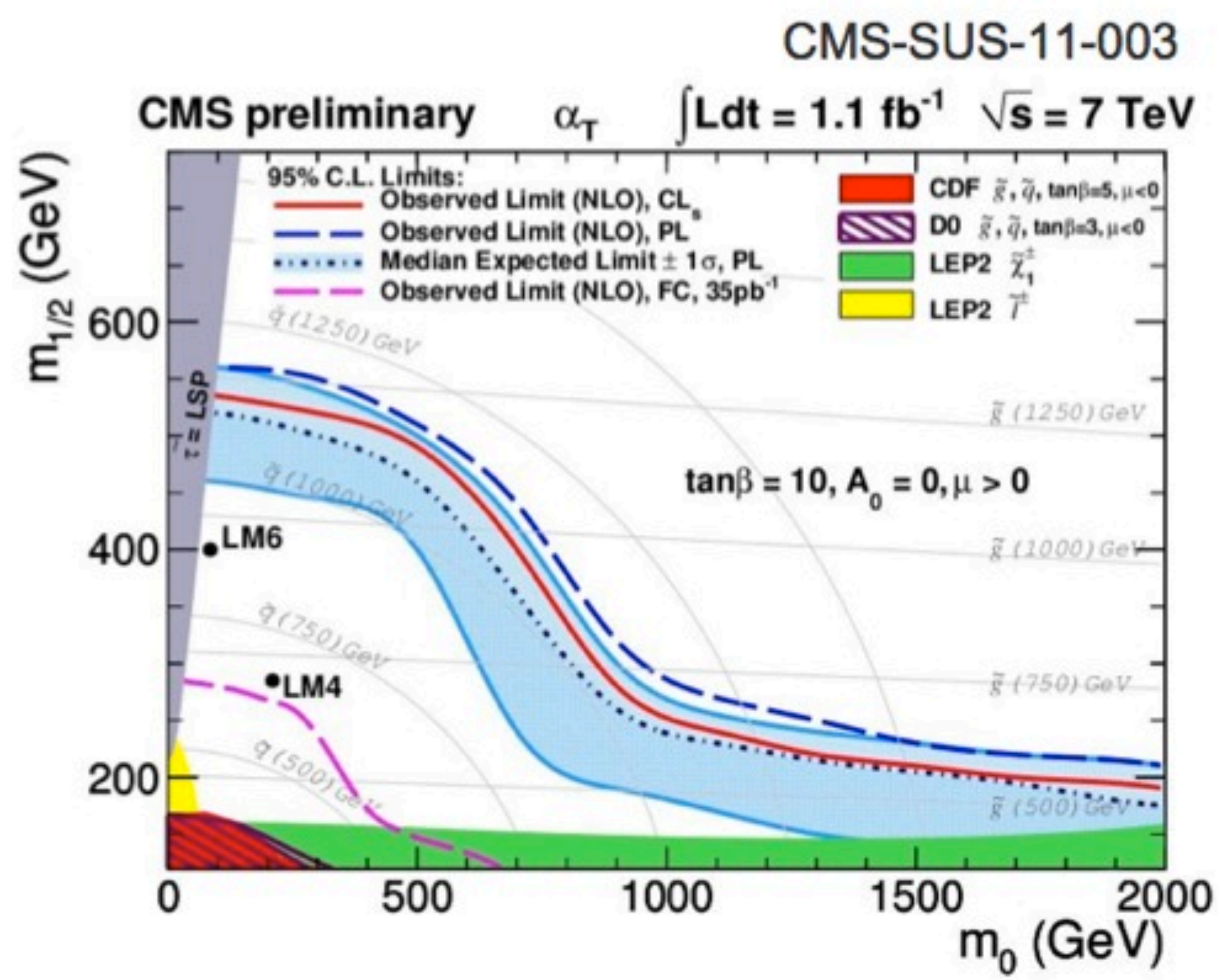
1. SUSY: Jets + Missing E_T

$\tilde{q} \rightarrow q\tilde{\chi}_1^0$

$\tilde{g} \rightarrow qq\tilde{\chi}_1^0$

- Exclude up to ~ 1 TeV for m(squark) = m(gluino)





3. SUSY: b-Jets + lepton + Missing E_T

- What if gluinos decay preferentially to 3rd generation?
- Consider several pheno. scenarii, such as:

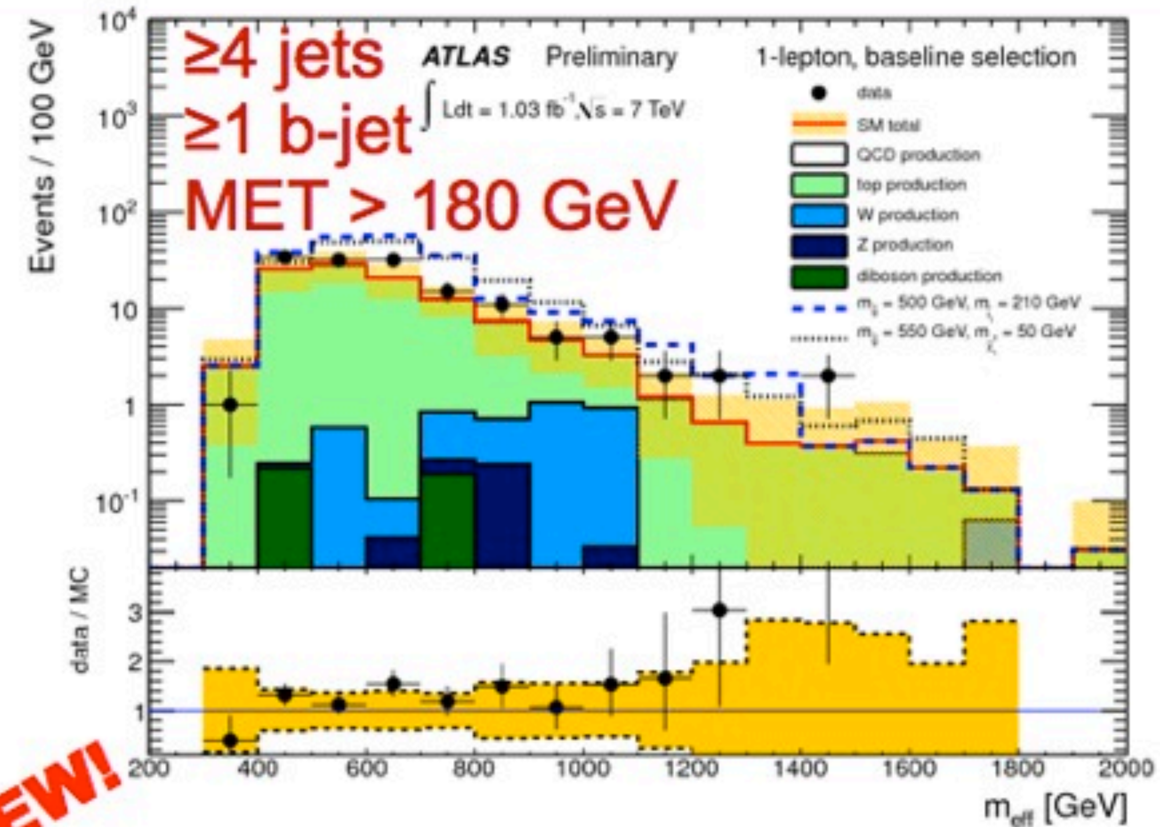
  Assume $m(\tilde{g}) > m(\tilde{t}_1) > m(\tilde{\chi}_1^{\pm}) > m(\tilde{\chi}_1^0)$
  (and everything else heavier)

  Consider only the following decays:

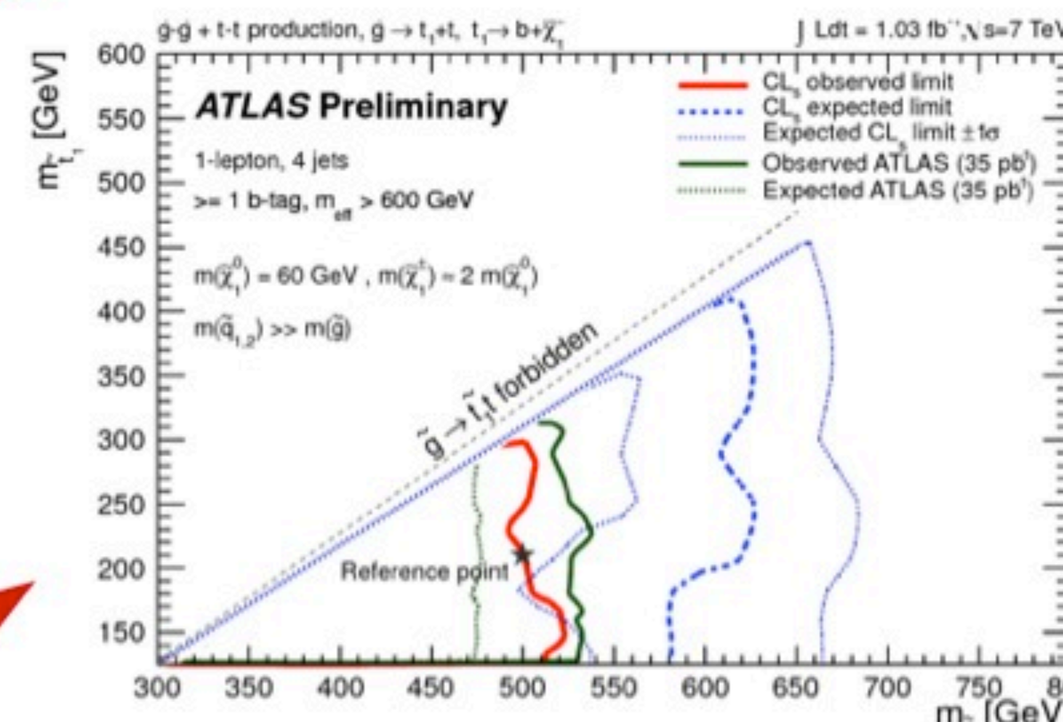
  $\tilde{g} \rightarrow \tilde{t}_1 t$; $\tilde{t}_1 \rightarrow b\tilde{\chi}_1^{\pm}$

  and $\tilde{\chi}_1^{\pm} \rightarrow W^* \tilde{\chi}_1^0$
- Complex final states with lepton(s) and b-jets
- Limit on gluino mass:

  m(gluino) > 500 GeV at 95% C.L.



NEW!



ATL-CONF-2011-098

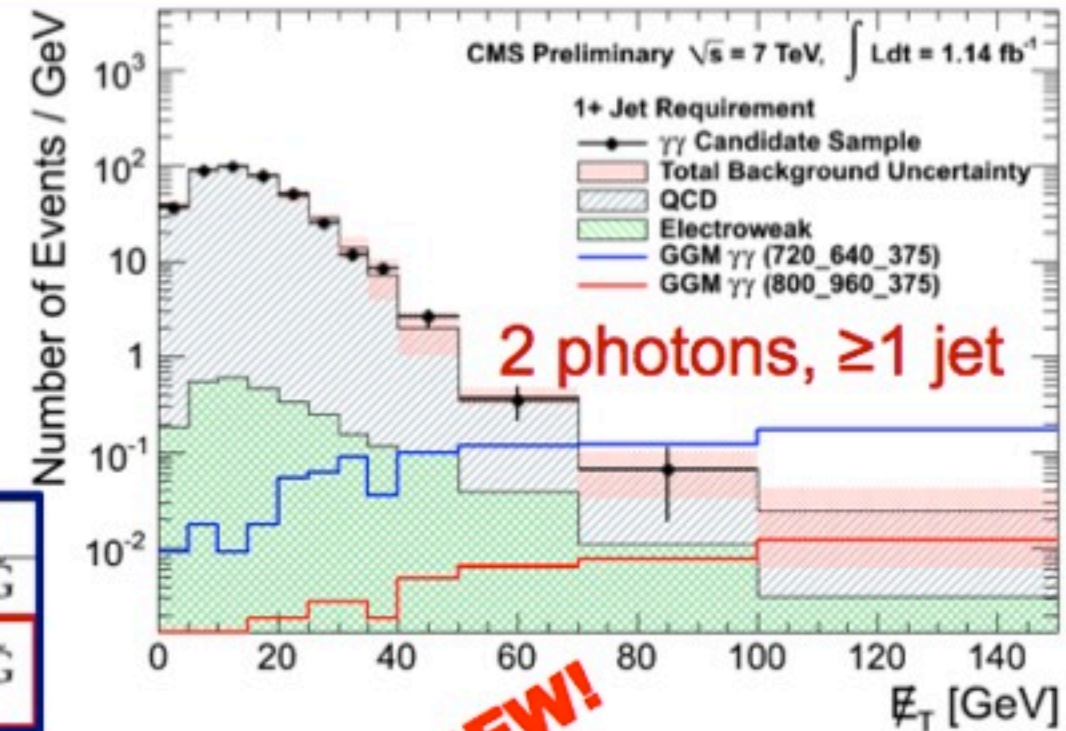
4. SUSY: diphoton + jet + Missing E_T

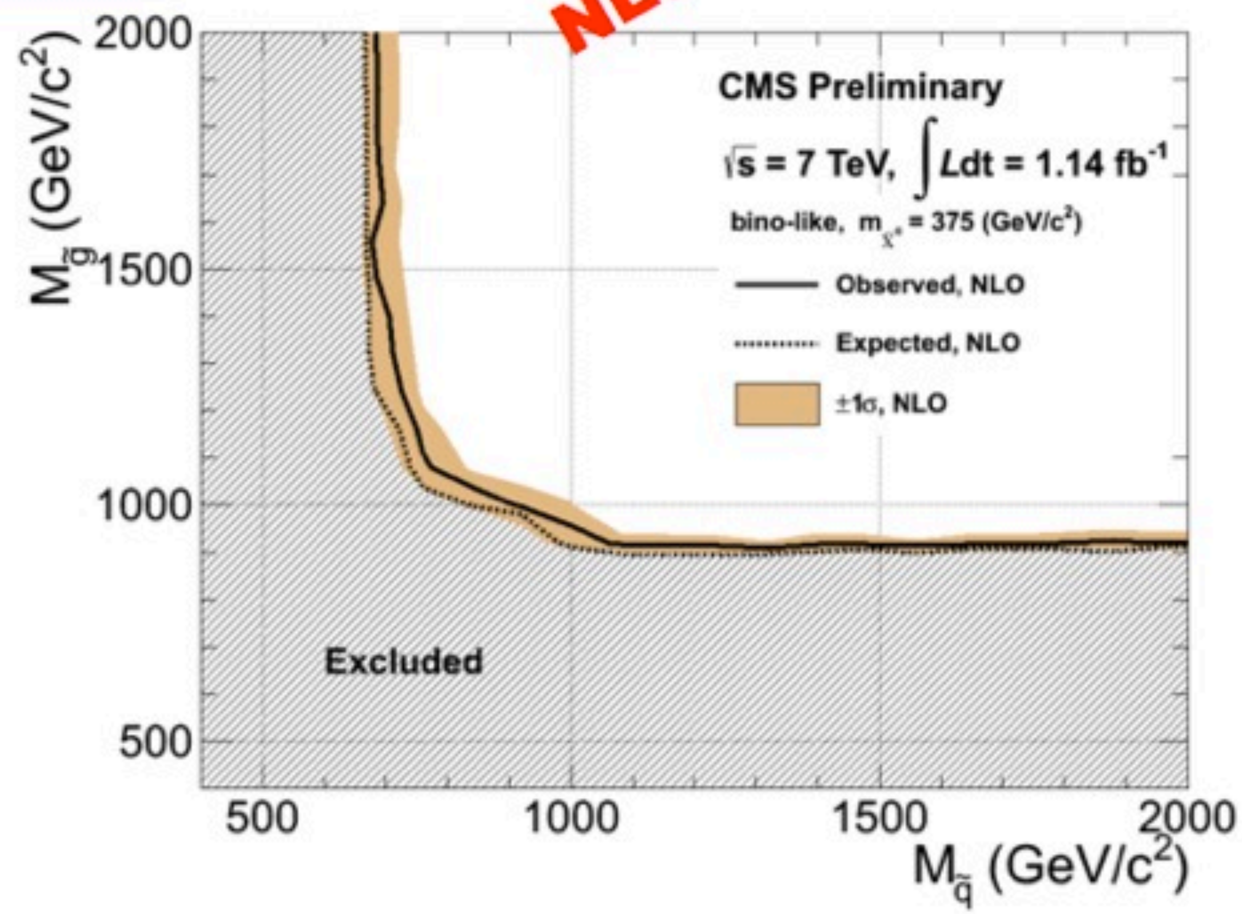
- Gauge-Mediated SUSY Breaking:
  - → LSP = Gravitino
  - → NLSP = Neutralino (and Chargino)
  - → NLSP → LSP + Photon or W or Z

NLSP type	$\gamma + 3\text{ jets} + E_T^{\text{miss}}$	$\gamma\gamma + \text{jet} + E_T^{\text{miss}}$
Bino	$\text{jets} + \tilde{\chi}_1^0\tilde{\chi}_1^0 \to \text{jets} + \gamma + Z + \tilde{G}\tilde{G}$	$\text{jets} + \tilde{\chi}_1^0\tilde{\chi}_1^0 \to \text{jets} + \gamma\gamma + \tilde{G}\tilde{G}$
Wino	$\text{jets} + \tilde{\chi}_1^0\tilde{\chi}_1^0 \to \text{jets} + \gamma + Z + \tilde{G}\tilde{G}$ $\text{jets} + \tilde{\chi}_1^0\tilde{\chi}_1^\pm \to \text{jets} + \gamma + W^\pm + \tilde{G}\tilde{G}$	$\text{jets} + \tilde{\chi}_1^0\tilde{\chi}_1^0 \to \text{jets} + \gamma\gamma + \tilde{G}\tilde{G}$

$m(\chi_1^0) \approx m(\chi_1^\pm)$
co- NLSP's

- Consider both final states:
  - → Diphoton
  - → Single photon (next slide)



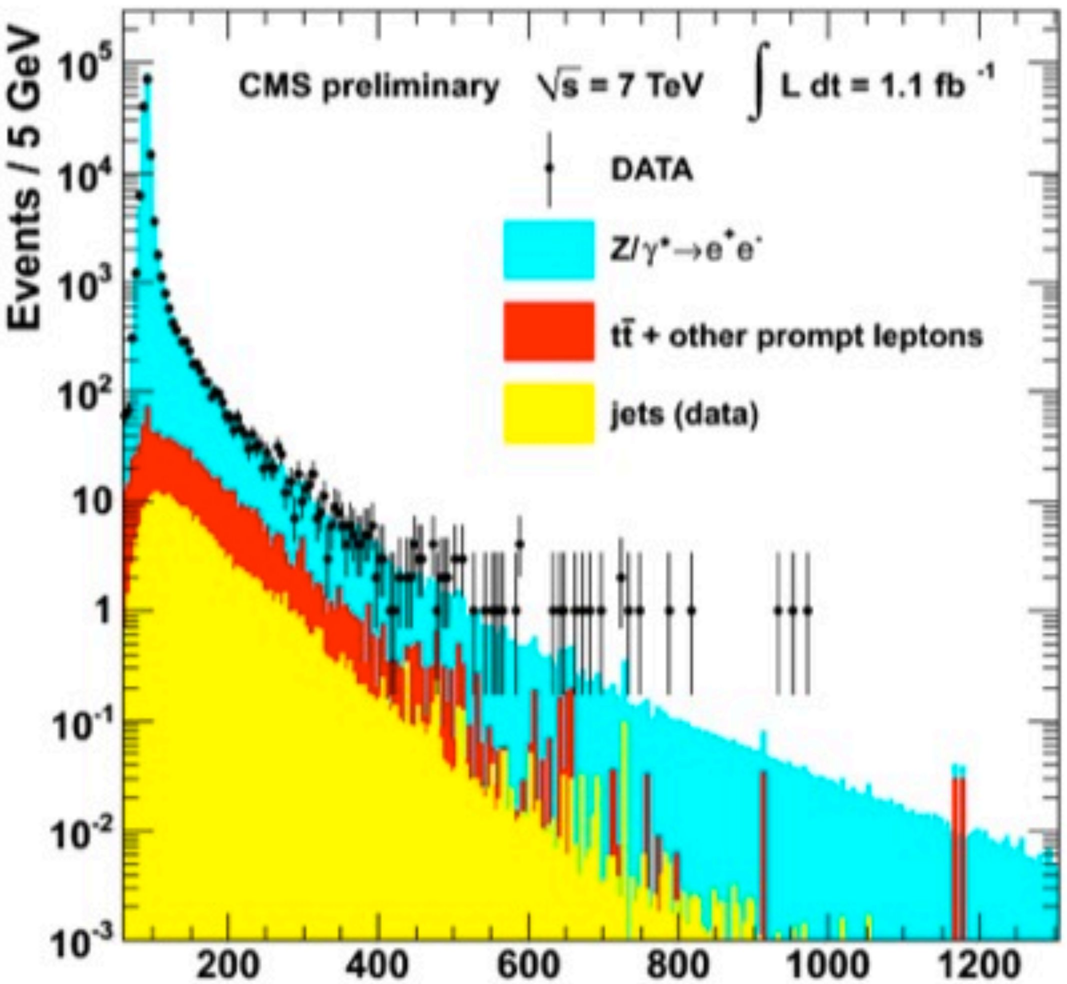


Supersymmetry: Summary

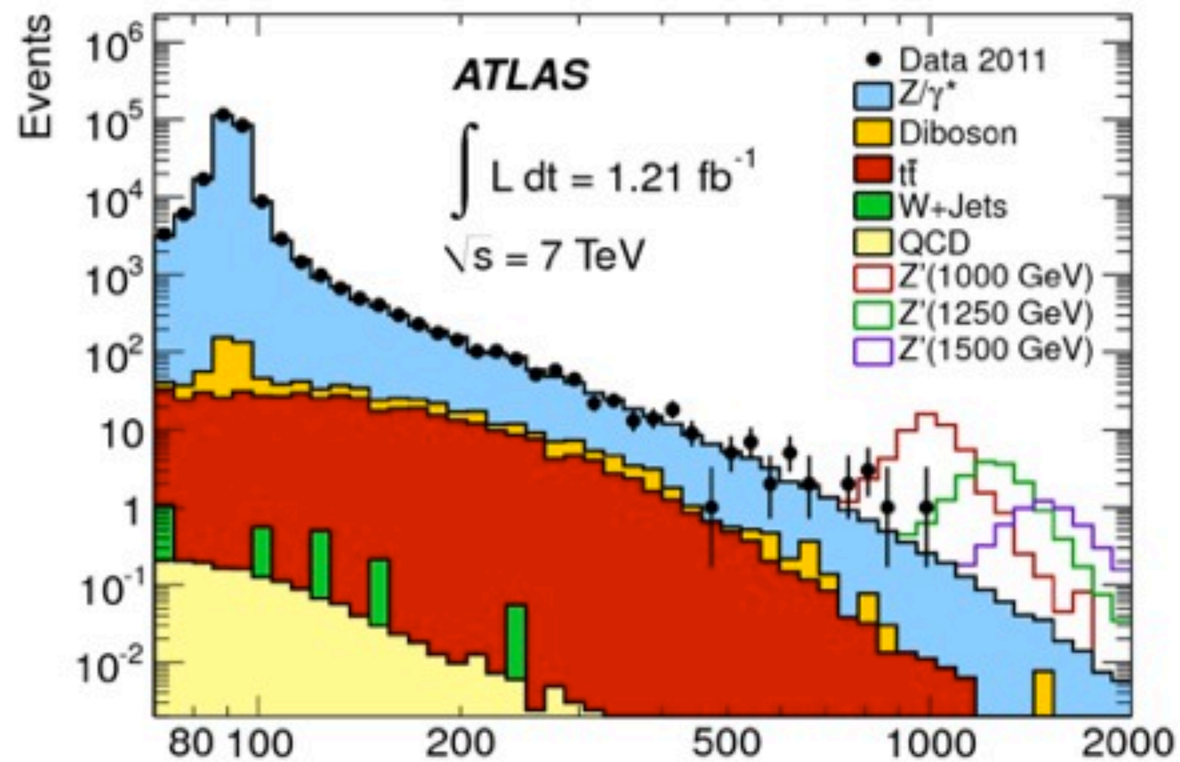
- SUSY in its most hoped for incarnation is starting to be in trouble
  - → Of course we will continue looking and increasing our reach
- What if SUSY were hiding? (e.g. no Missing E_T)
  - → "Split", "low-MET", "squashed", "mashed?"
  - → Even if very soft cascade at tree level, Initial State Radiation still creates MET, but this needs to be studied further
- With >1 fb^{-1}, other SUSY prod. mechanisms open up → exclusive chargino/neutralino and 3rd generation production

Search for Heavy Resonance: dilepton channel

- Randall-Sundrum KK graviton excitation
- Neutral heavy gauge boson
- Technihadron

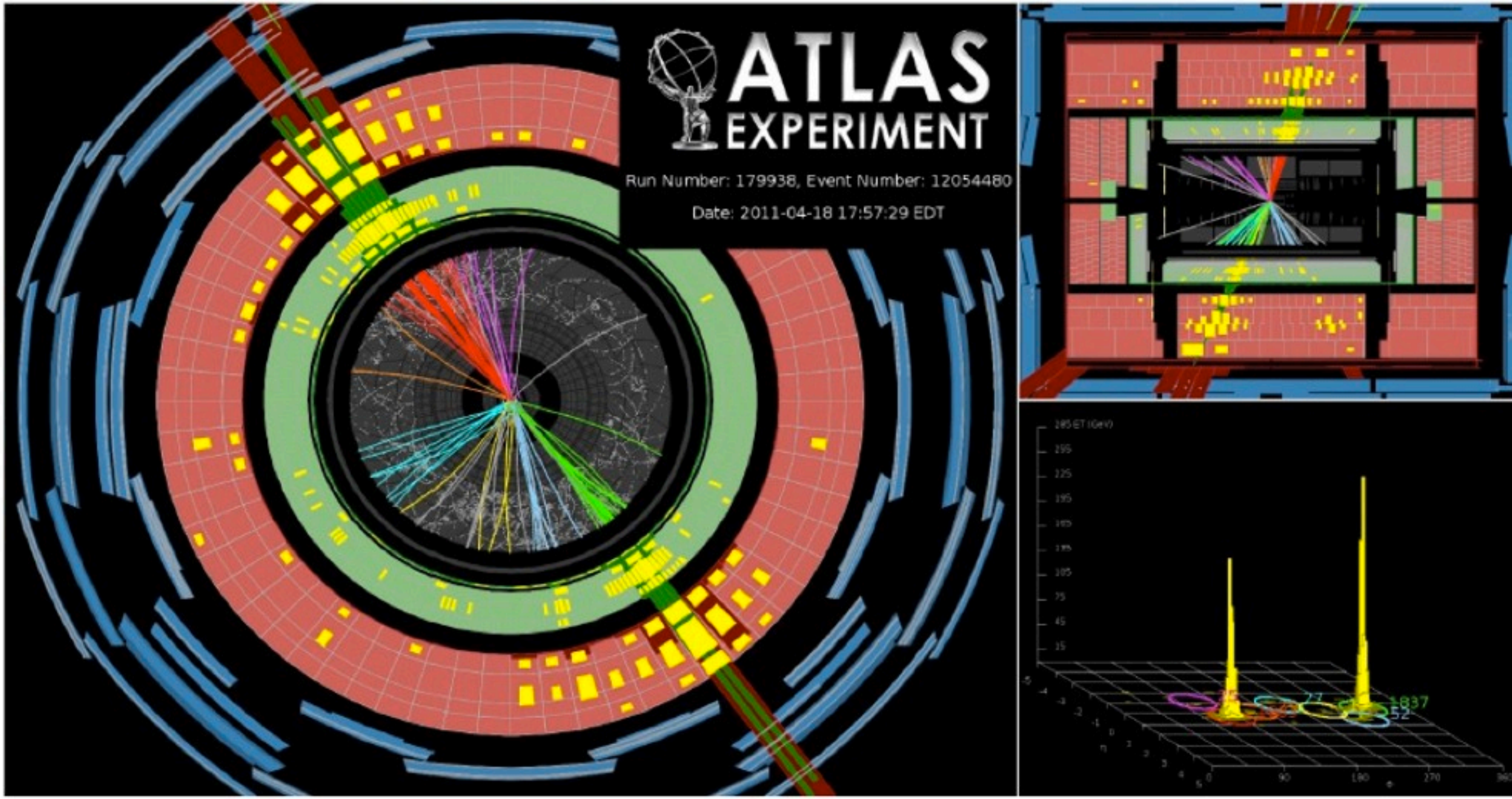


CMS-EXO-11-019 m(ee) [GeV]



arXiv:1108.1582 $m(\mu^+\mu^-)$ [GeV]

Search for Heavy Resonance: Dijet



m(jet-jet) = 4.0 TeV **Missing E_T = 100 GeV**

Search for ~~Heavy Resonance~~ Inclusive search: Same-Sign Dilepton

- Predicted by many models
- Very clean signature
- Inclusive, model-independent search:
  - Fiducial cross-section limit as function of m(μ±μ±)

NEW!

Mass range [GeV]	95% C.L. limit on dimuon pair σ [fb]	
	expected	observed
$m_{\mu\mu} > 15$ GeV	341^{+67}_{-125}	304
$m_{\mu\mu} > 100$ GeV	48^{+20}_{-18}	28
$m_{\mu\mu} > 200$ GeV	$12.6^{+5.3}_{-4.2}$	8.5
$m_{\mu\mu} > 300$ GeV	$7.0^{+2.5}_{-2.0}$	5.0

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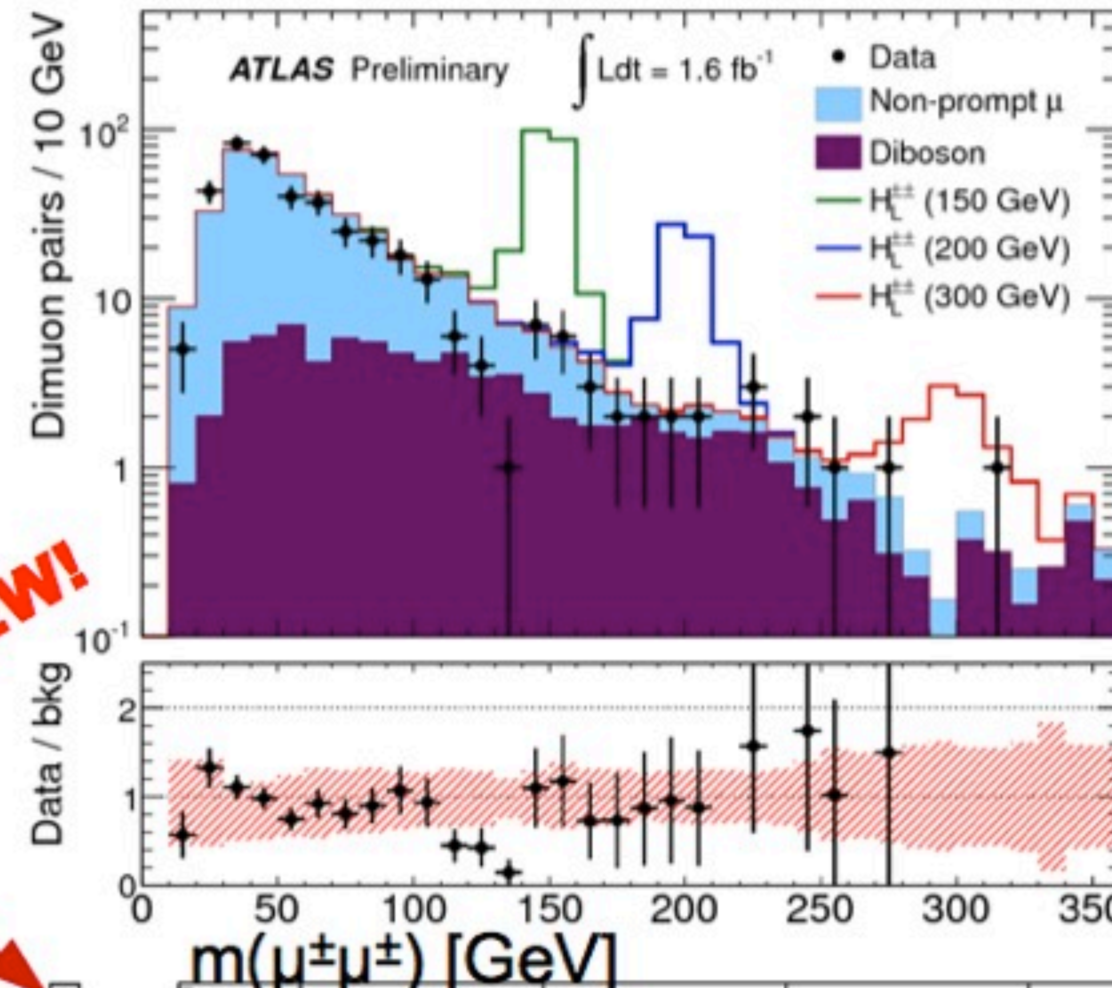
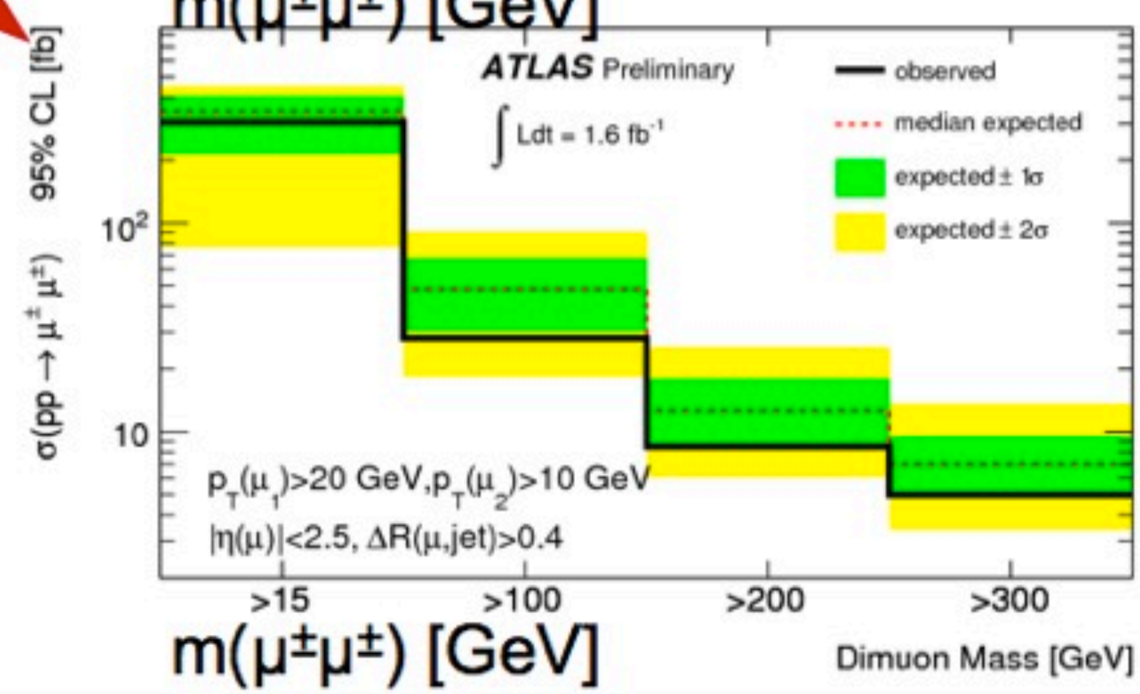
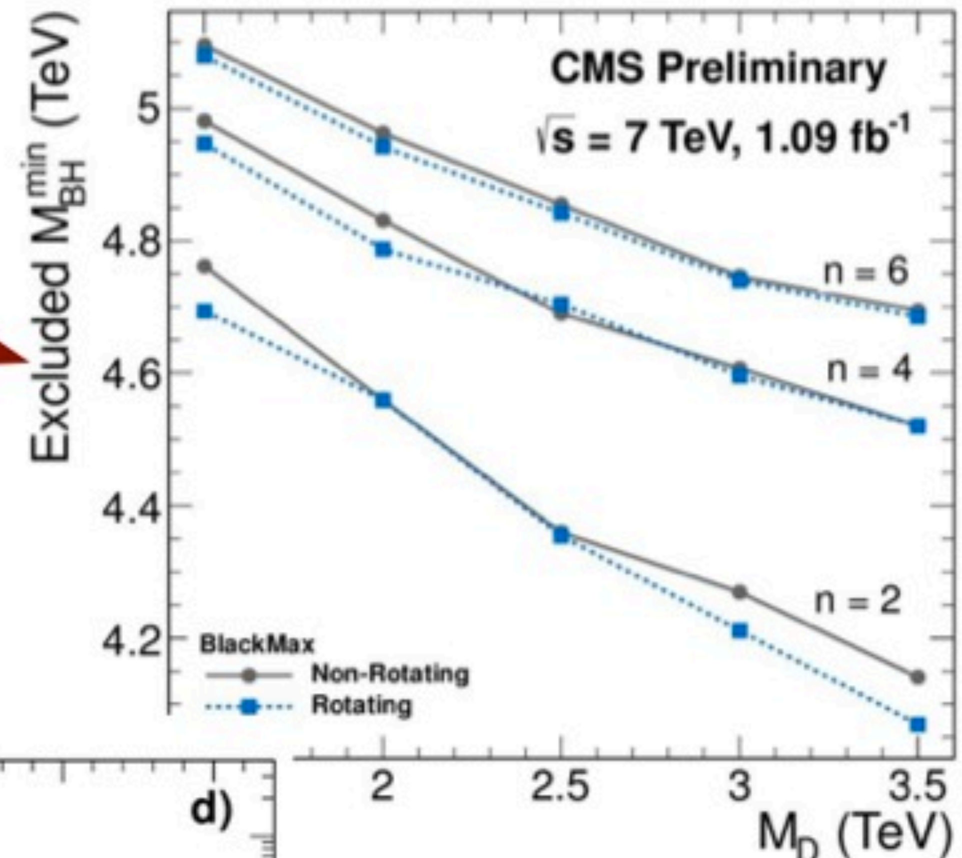




Black Holes: Multi-Object, Multi-Jets, Same-Sign

- Inclusive search: sum energy of all objects (e, μ, jets)
- Can also select peculiar events, e.g. same-sign dilepton with very large track multiplicity



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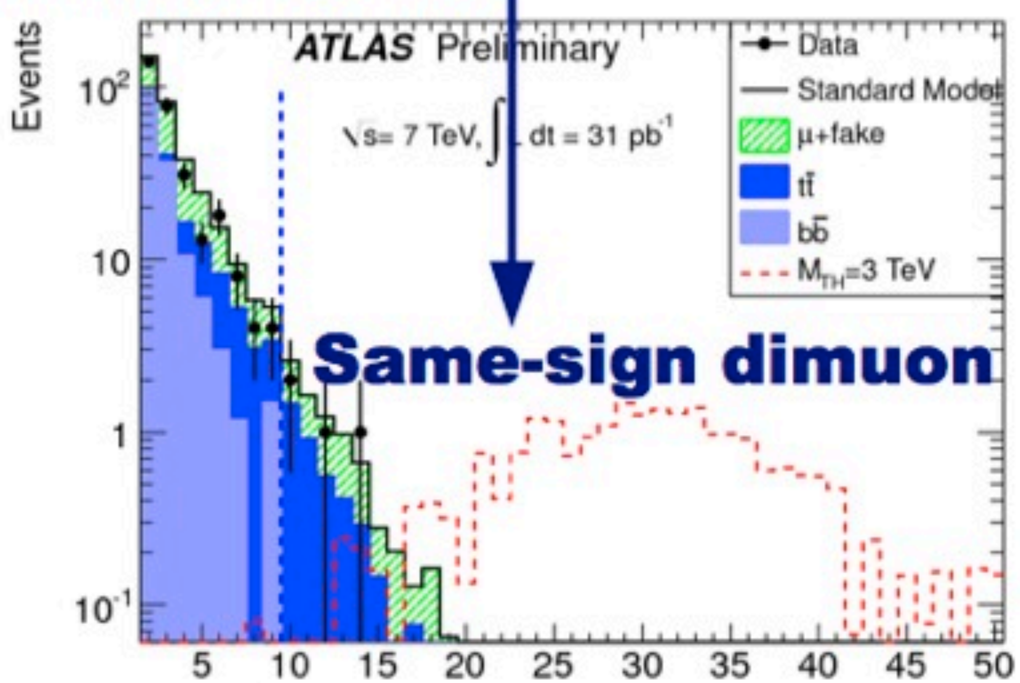
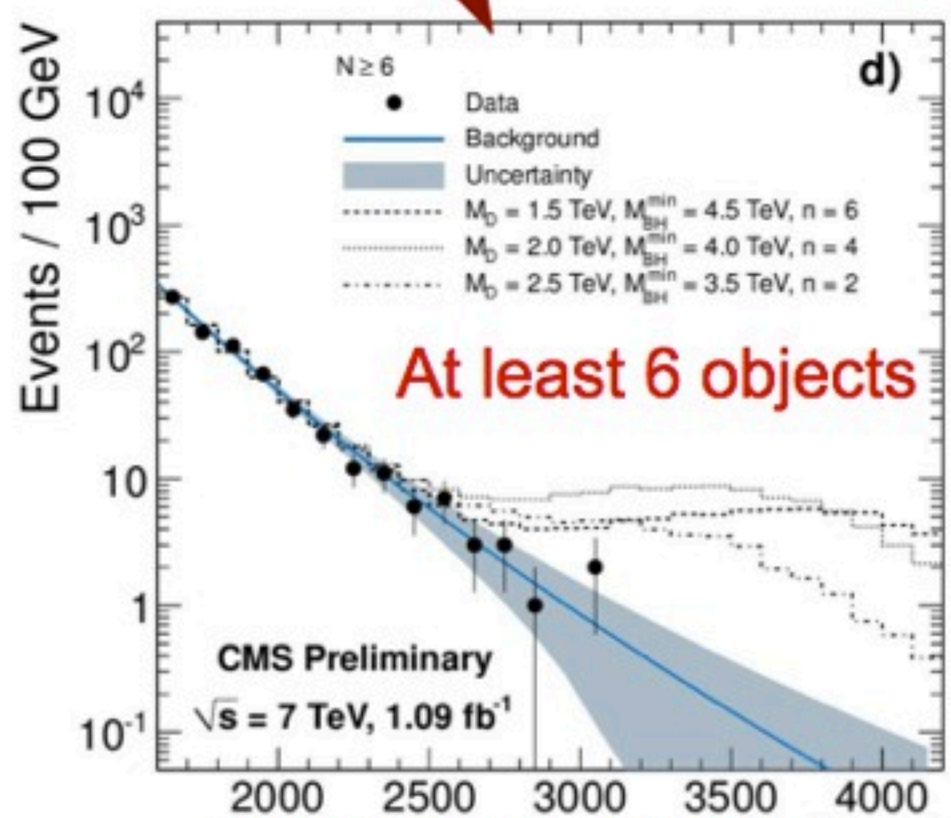


high-pT Tracks



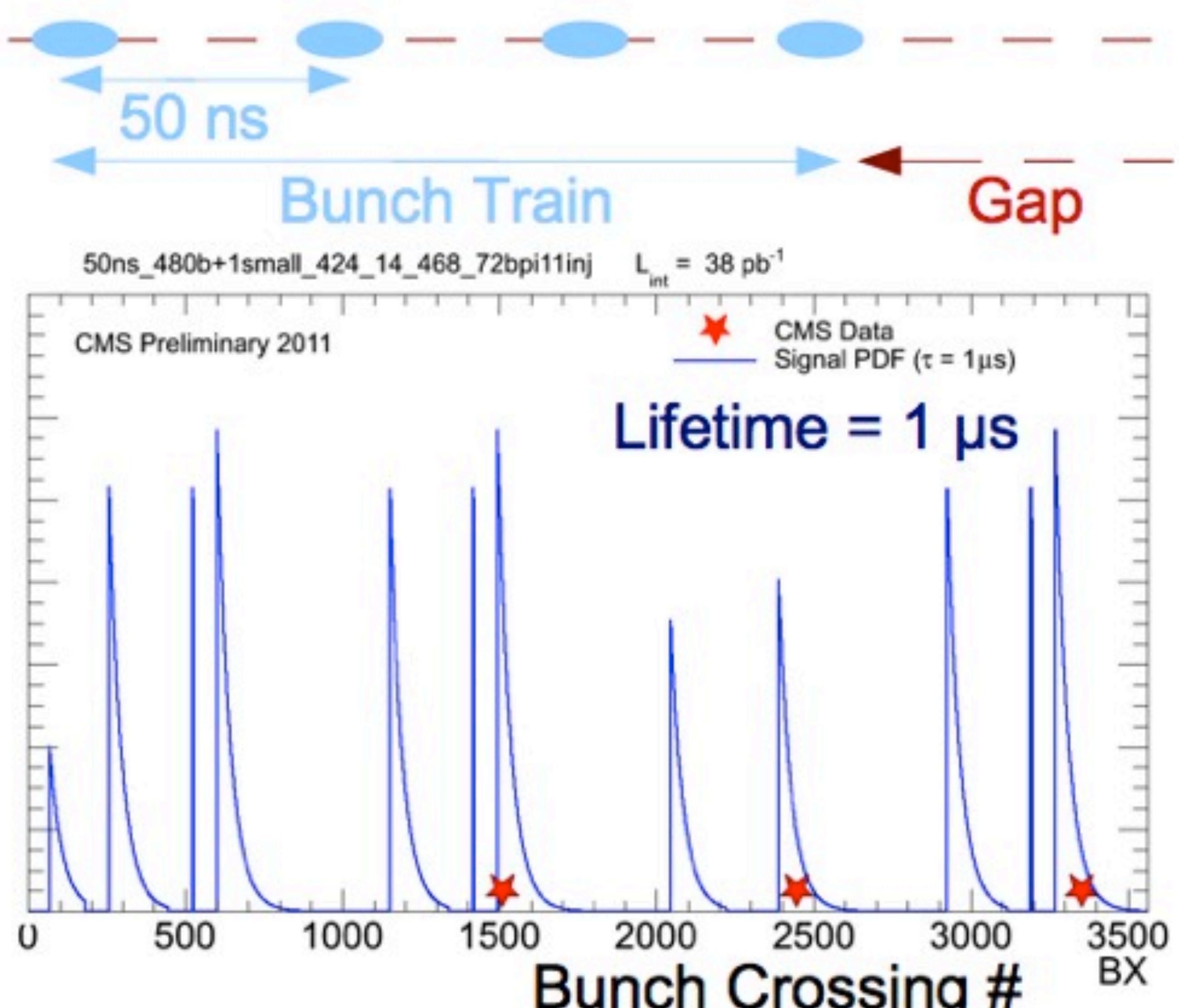
Total Trans. Energy

Multi-object

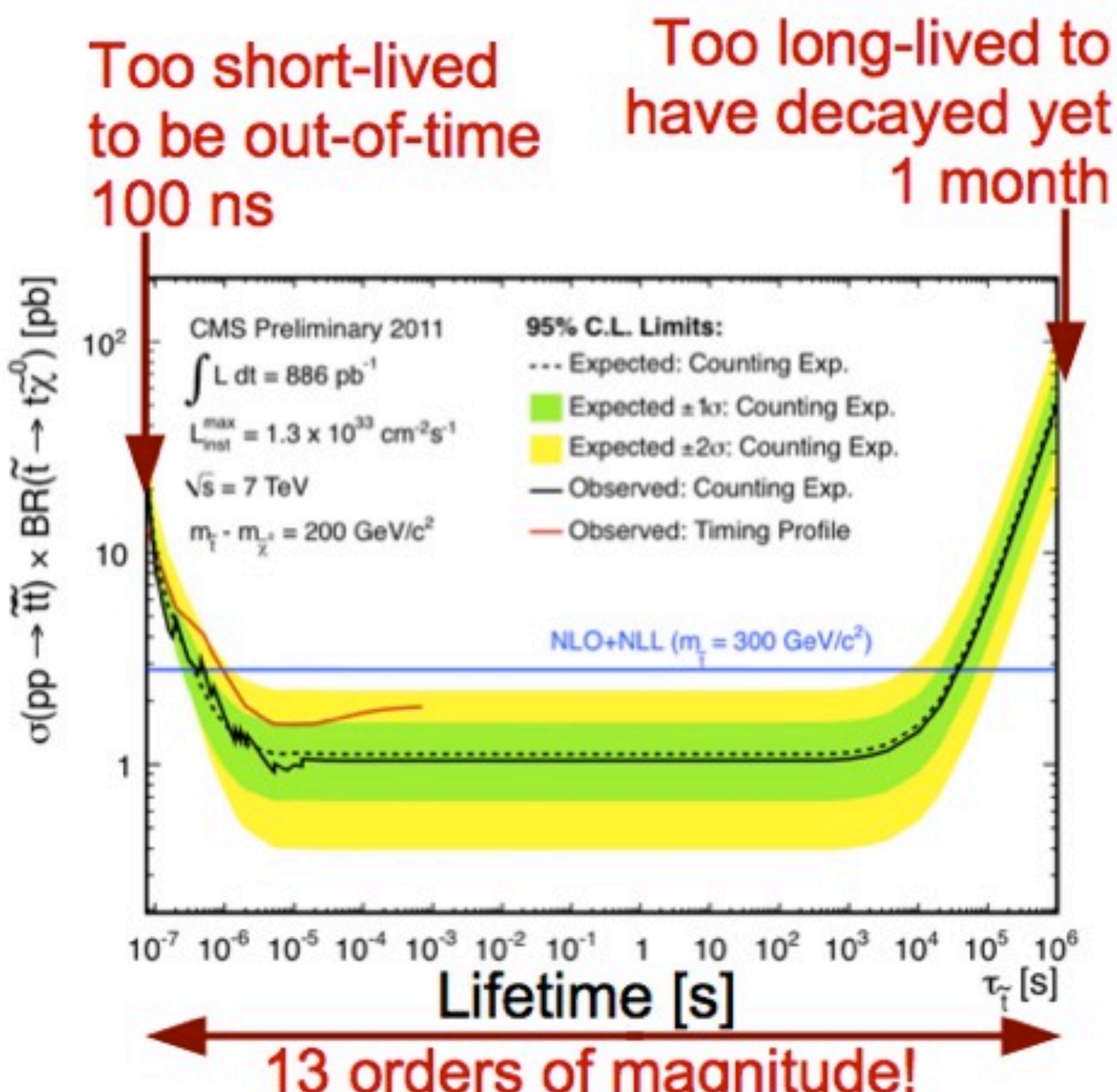
CMS-EXO-11-071

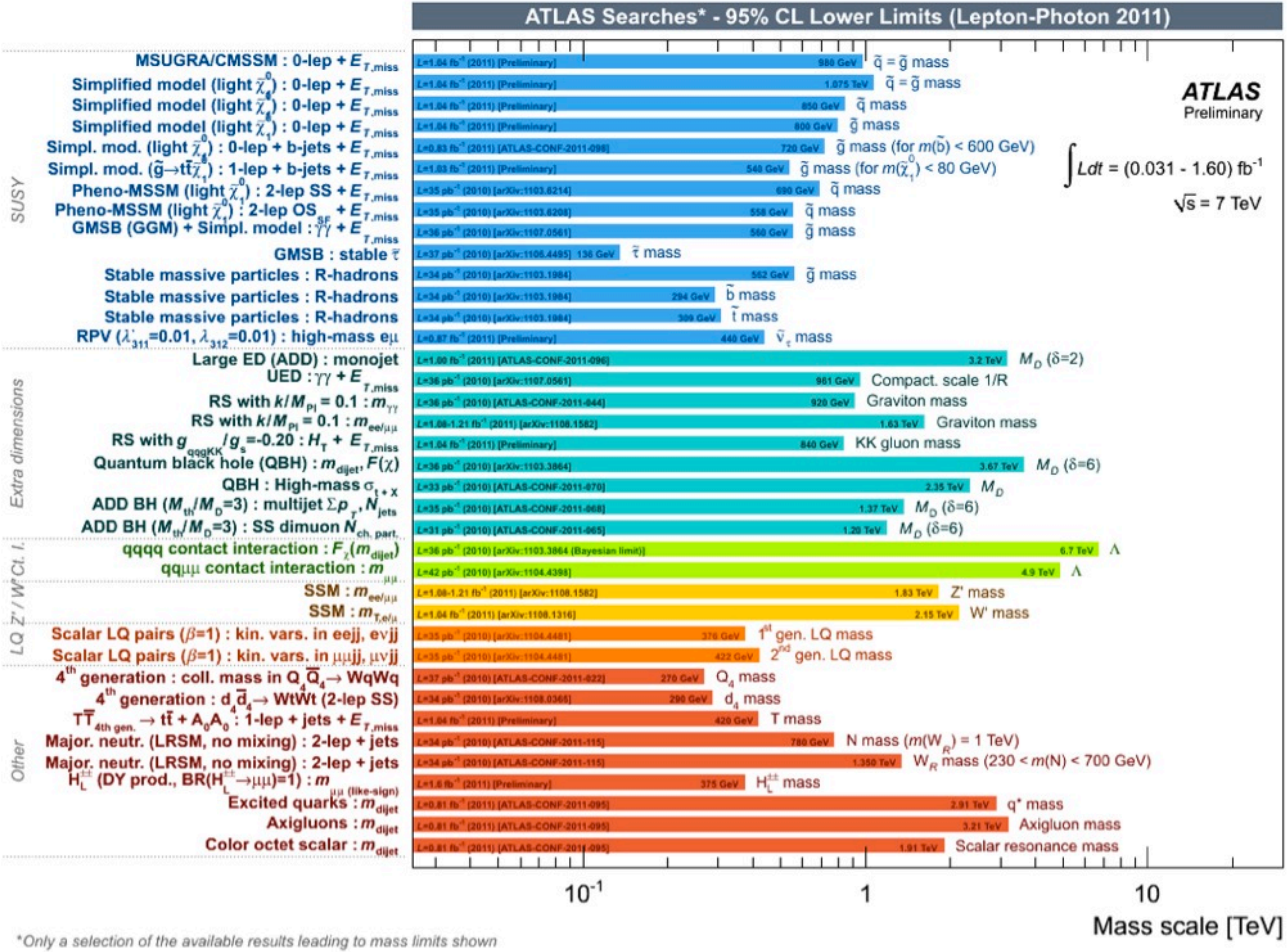
Stopped Gluinos and Stops

- Out-of-time decay of heavy particles stopped in the detector
- Look for signal **without** collisions:
  - → When no beam in the machine
  - → Between bunch trains



CMS-EXO-11-020





ATLAS Searches* - 95% CL Lower Limits (Lepton-Photon 2011)
ATLAS
Preliminary
∫Ldt = (0.031 - 1.60) fb^-1
√s = 7 TeV
SUSY
Extra dimensions
LQ Z' / W' Ct. I.
Other
MSUGRA/CMSSM : 0-lep + E_T,miss
980 GeV q̃ = g̃ mass
Simplified model (light χ̃⁰₁) : 0-lep + E_T,miss
1.075 TeV q̃ = g̃ mass
Simplified model (light χ̃⁰₁) : 0-lep + E_T,miss
850 GeV q̃ mass
Simplified model (light χ̃⁰₁) : 0-lep + E_T,miss
800 GeV g̃ mass
Simpl. mod. (light χ̃⁰₁) : 0-lep + b-jets + E_T,miss
720 GeV g̃ mass (for m(b̃) < 600 GeV)
Simpl. mod. (g̃→tt̄χ̃⁰₁) : 1-lep + b-jets + E_T,miss
540 GeV g̃ mass (for m(χ̃⁰₁) < 80 GeV)
Pheno-MSSM (light χ̃⁰₁) : 2-lep SS + E_T,miss
690 GeV q̃ mass
Pheno-MSSM (light χ̃⁰₁) : 2-lep OS_SF + E_T,miss
558 GeV q̃ mass
GMSB (GGM) + Simpl. model : γγ + E_T,miss
560 GeV g̃ mass
GMSB : stable τ̃
136 GeV τ̃ mass
Stable massive particles : R-hadrons
562 GeV g̃ mass
Stable massive particles : R-hadrons
294 GeV b̃ mass
Stable massive particles : R-hadrons
309 GeV t̃ mass
RPV (λ'311=0.01, λ312=0.01) : high-mass eμ
440 GeV ν̃τ mass
Large ED (ADD) : monojet
3.2 TeV M_D (δ=2)
UED : γγ + E_T,miss
961 GeV Compact. scale 1/R
RS with k/M_Pl = 0.1 : m_γγ
920 GeV Graviton mass
RS with k/M_Pl = 0.1 : m_ee/μμ
1.63 TeV Graviton mass
RS with g_qqgKK/g_s=-0.20 : H_T + E_T,miss
840 GeV KK gluon mass
Quantum black hole (QBH) : m_dijet, F(χ)
3.67 TeV M_D (δ=6)
QBH : High-mass σ_t+X
2.35 TeV M_D
ADD BH (M_th/M_D=3) : multijet Σp_T, N_jets
1.37 TeV M_D (δ=6)
ADD BH (M_th/M_D=3) : SS dimuon N_ch. part.
1.20 TeV M_D (δ=6)
qqqq contact interaction : F_χ(m_dijet)
6.7 TeV Λ
qqμμ contact interaction : m_μμ
4.9 TeV Λ
SSM : m_ee/μμ
1.83 TeV Z' mass
SSM : m_T,e/μ
2.15 TeV W' mass
Scalar LQ pairs (β=1) : kin. vars. in eejj, eνjj
376 GeV 1st gen. LQ mass
Scalar LQ pairs (β=1) : kin. vars. in μμjj, μνjj
422 GeV 2nd gen. LQ mass
4th generation : coll. mass in Q4Q̄4→ WqWq
270 GeV Q4 mass
4th generation : d4d̄4→ WtWt (2-lep SS)
290 GeV d4 mass
TT̄4th gen. → tt̄ + A0A0 : 1-lep + jets + E_T,miss
420 GeV T mass
Major. neutr. (LRSM, no mixing) : 2-lep + jets
780 GeV N mass (m(W_R) = 1 TeV)
Major. neutr. (LRSM, no mixing) : 2-lep + jets
1.350 TeV W_R mass (230 < m(N) < 700 GeV)
H±±L (DY prod., BR(H±±L→μμ)=1) : m_μμ (like-sign)
375 GeV H±±L mass
Excited quarks : m_dijet
2.91 TeV q* mass
Axigluons : m_dijet
3.21 TeV Axigluon mass
Color octet scalar : m_dijet
1.91 TeV Scalar resonance mass
10^-1
1
10
Mass scale [TeV]
*Only a selection of the available results leading to mass limits shown

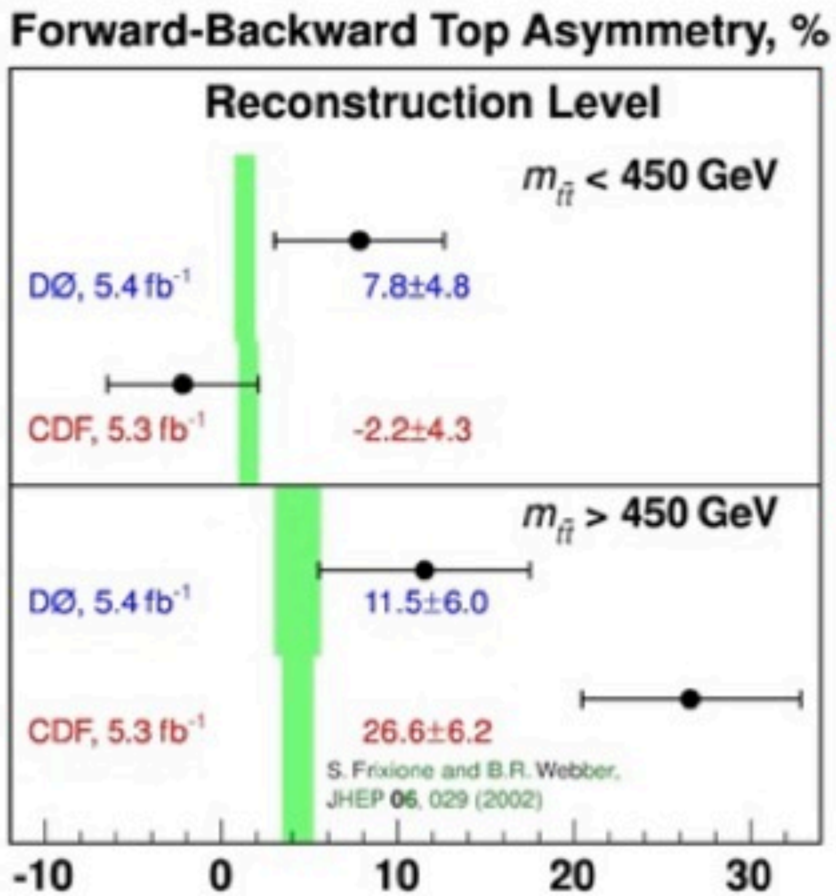
My own over-simplified one-slide summary

Unfortunately, no hint of New Physics in the LHC data (yet)

	Lower Limit (95% C.L.)
SUSY ($m_{\tilde{q}} = m_{\tilde{g}}$)	1 TeV
Gauge bosons (SSM)	2 TeV
Excited quark	3 TeV

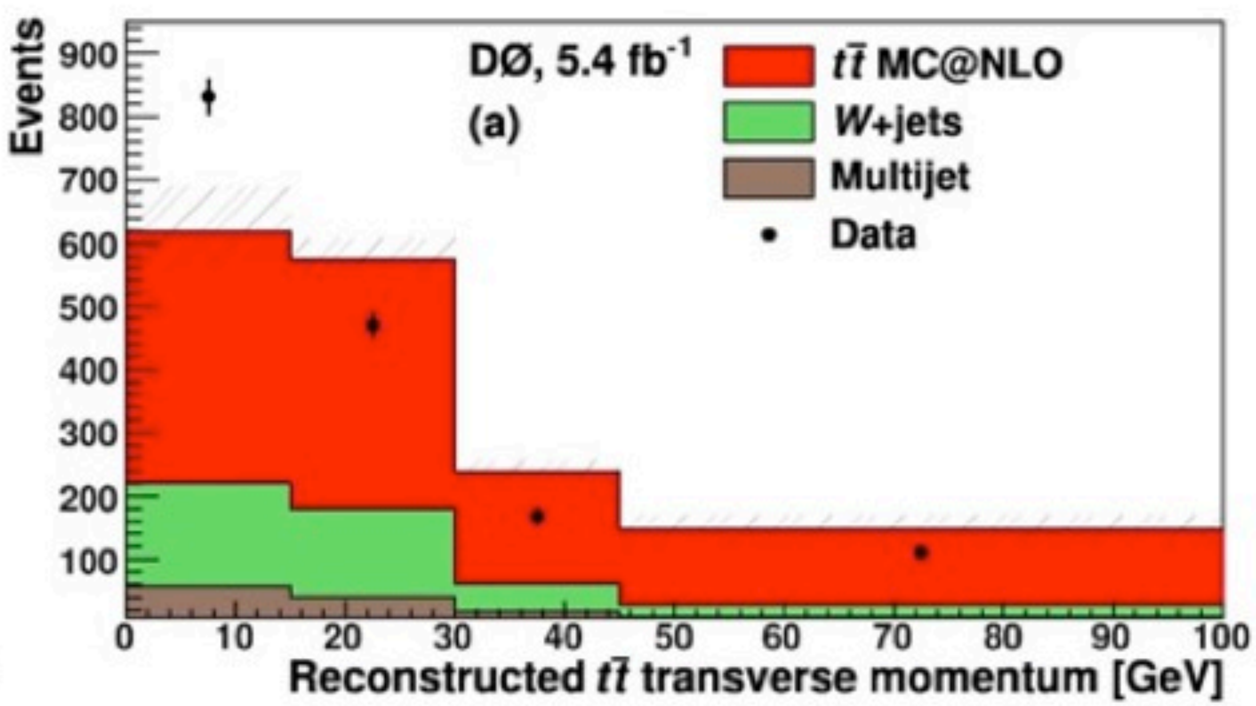
Any Hints of New Physics from Elsewhere?

Top-quark asymmetry



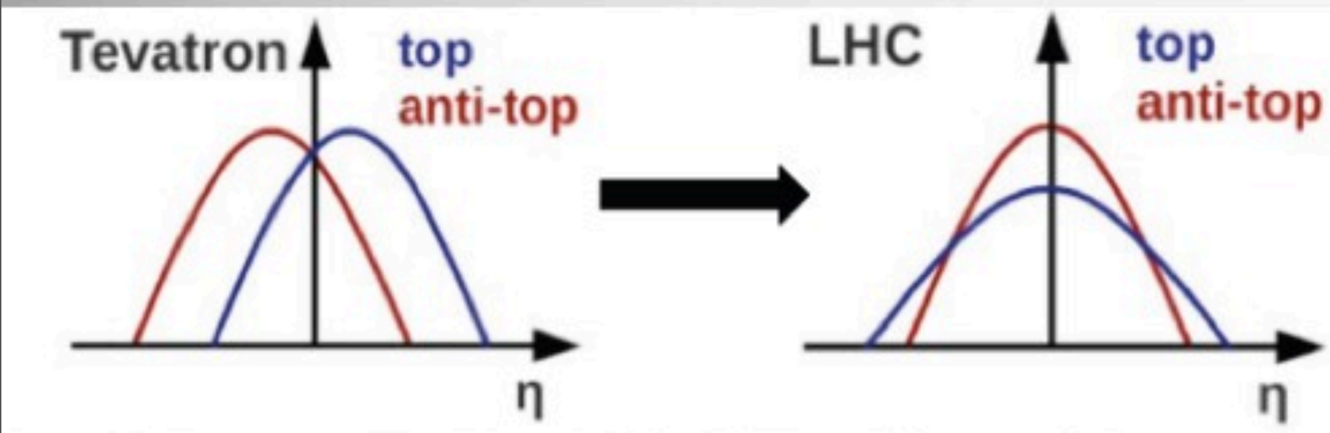
- In tt rest frame: $A^{MC@NLO}$=0.05±0.006
  A^{CDF}=0.15±0.05
  A^{D0}=0.196±0.065
- Theory has drifted; $A^{NLO\ QCD+EW}$=0.089 Hollik, Pagani 2011
- Small conflict in m_{tt} dependence of asymmetry
- Great effort expended in checking QCD stability against higher-order soft gluon corrections, acceptance effects, additional hard radiation; none found (but note that "NLO" here really means "LO", asymmetry only generated with a loop/extra emission!)

Kuhn, Rodrigo; Dittmaier, Uwer, Weinzierl; Almeida, Sterman, Vogelsang; Ahrens, Ferroglia, Neubert, Pecjak, Yang; Melnikov, Schulze; Bernreuther, Si; Bevilacqua, Czakon, van Hammeren, Papadopoulos, Worek; Kidonakis; many others



- Recent D0 results indicate that p_{tt} not well-described by MC@NLO
- Asymmetry depends on p_{tt}
- Stay tuned!

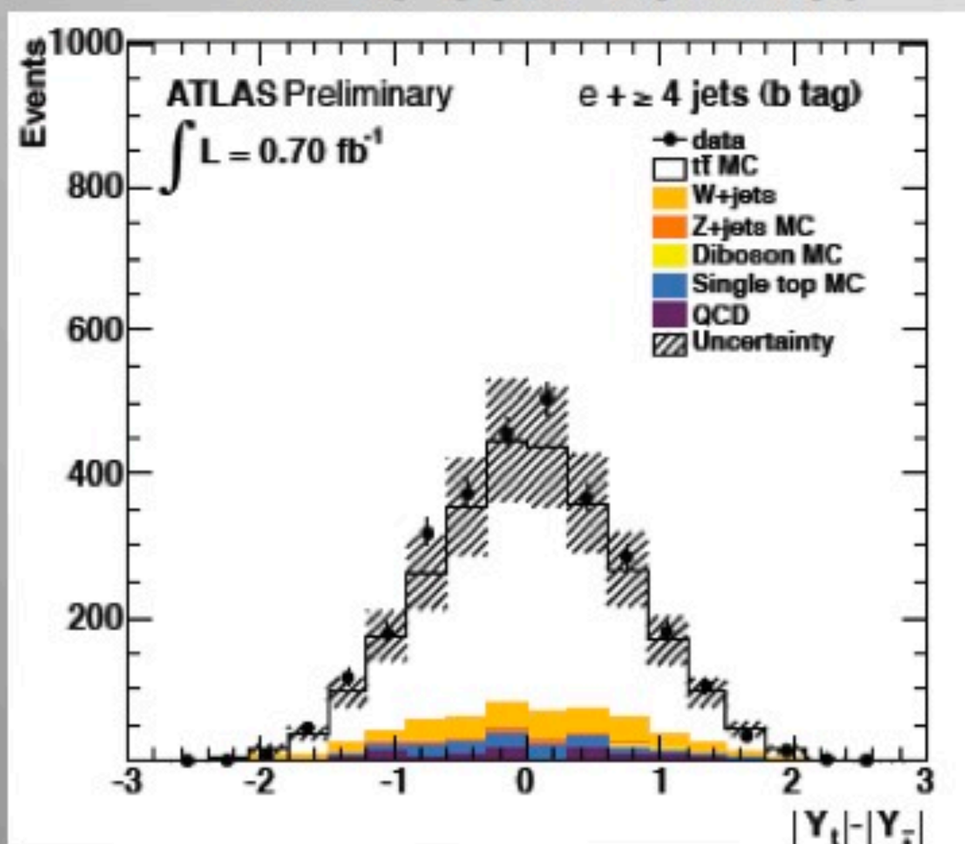
Charge Asymmetry at the LHC



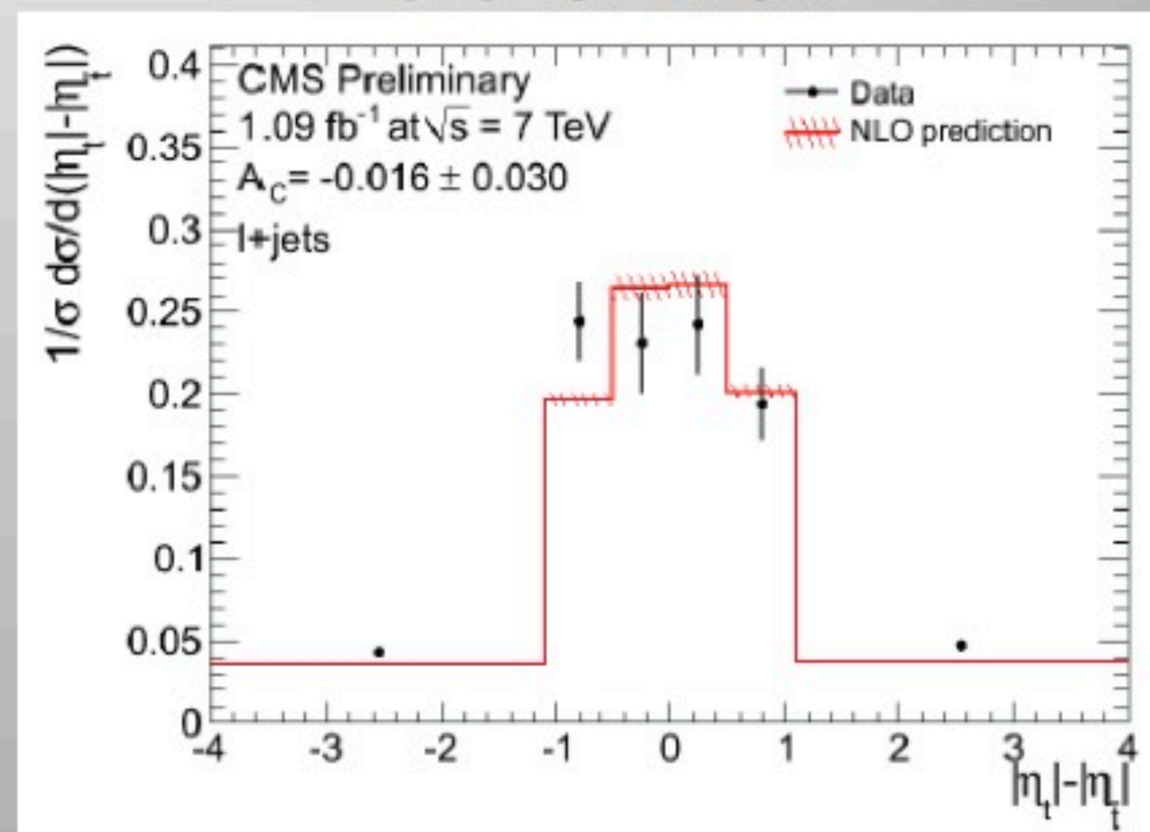
$$A_C = \frac{N(\Delta|y|>0) - N(\Delta|y|<0)}{N(\Delta|y|>0) + N(\Delta|y|<0)}$$

$$\Delta|y| = |y_t| - |y_{\bar{t}}| \qquad \Delta|\eta| = |\eta_t| - |\eta_{\bar{t}}|$$

ATLAS-CONF-2011-106



CMS-TOP-11-014

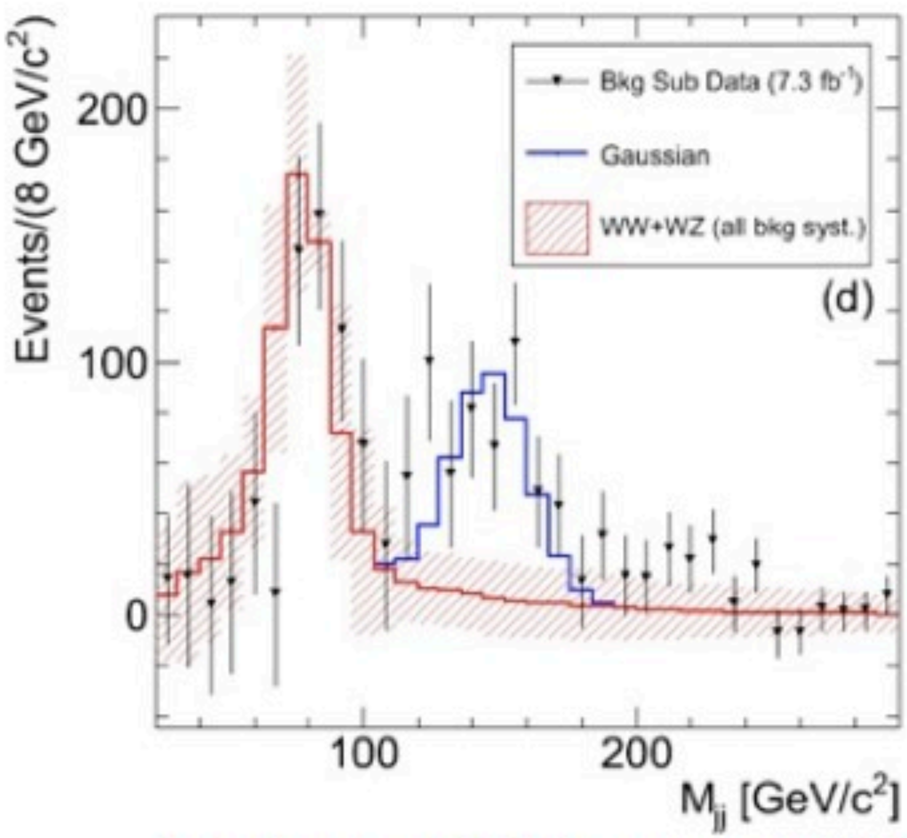


CMS $\quad A_C^{\eta} = -1.6 \pm 3.0(stat)^{+1.0}_{-1.9}(syst)\% \quad A_C^{\eta}(\text{theory}) = 1.3\ \%$

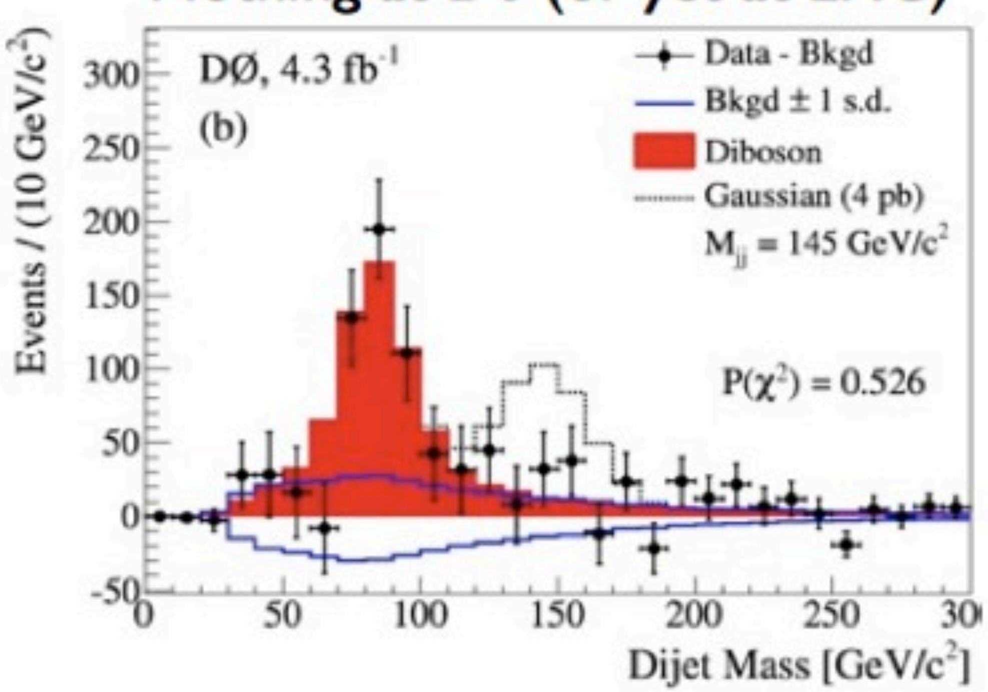
ATLAS $\quad A_C^{y} = -2.4 \pm 1.6(stat) \pm 2.3(syst)\% \quad A_C^{y}(\text{theory}) = 0.6\ \%$

Wjj at CDF

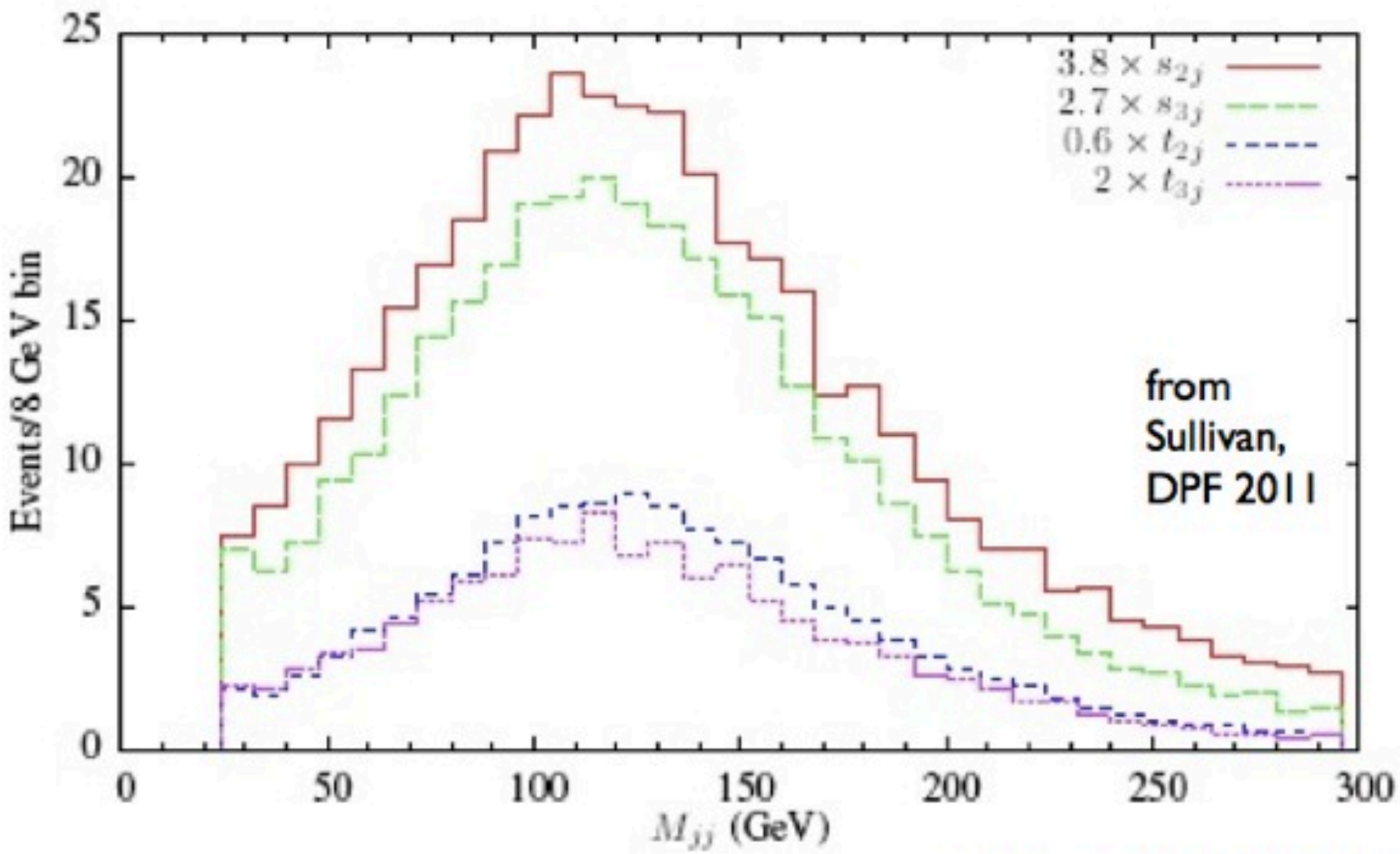
Now a 4.1σ excess!



Nothing at D0 (or yet at LHC)



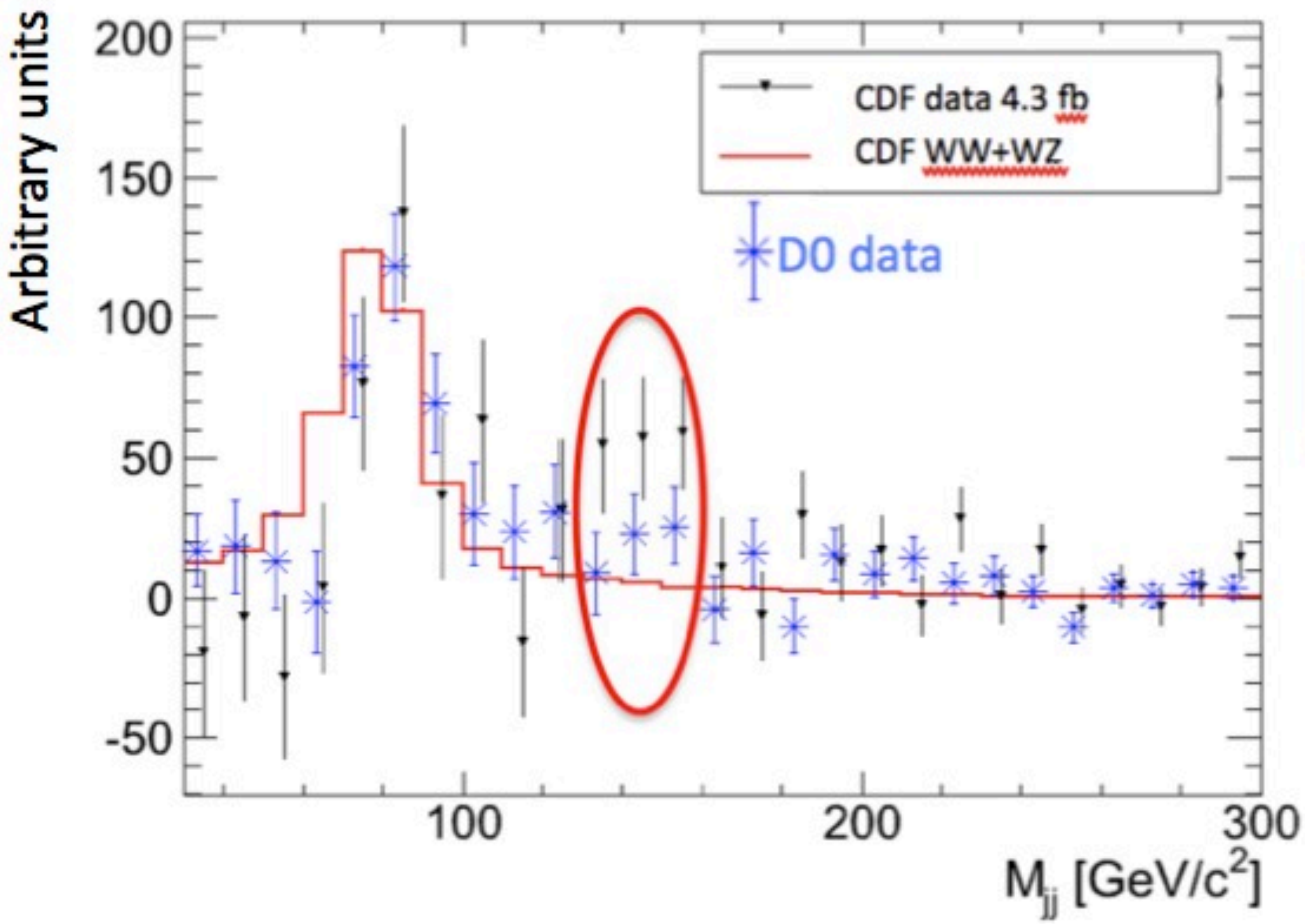
- Possible SM explanation: CDF takes single top from Monte Carlo, which currently doesn't match SM prediction (problems in separate 2 and 3 jet exclusive samples) Menon, Sullivan 2011
- Single top produces kinematic peaks where observed at CDF
- No single-top discrepancy at D0; lack of Wjj excess was *predicted* as a result of this explanation
- Also possible: slight shifts in relative normalizations of WW, top backgrounds Plehn, Takeuchi 2011



from Sullivan, DPF 2011

CDF vs DØ data-data comparison

Scaling subtracted data to same diboson yield.
Rebinned CDF to match DØ.



Consistency between CDF and DZero: ~2.5σ

Subtracted data points compare well,
except in the region of interest.

INTERESTING SM PHYSICS

Inclusive jet cross section

P$_t$ to > 1 TeV, |y| to 4.4
Cross sections vary by 10^{10} over the p$_t$ range measured

Major effort to measure detector calibration lies behind these measurements

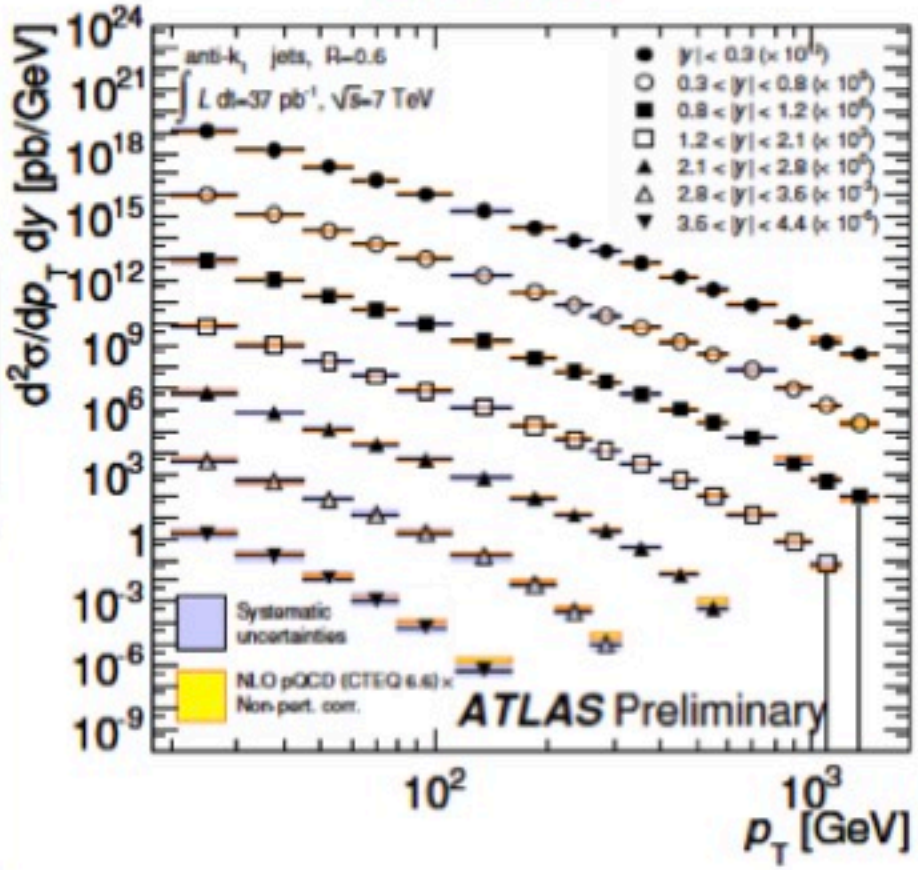
Both expts. compare with NLOJET++ ⊗ NP effects
Pdfs (baseline)
- ATLAS: CTEQ6.6
- CMS: PDF4LHC

Experimental systematic uncertainties ~10-20%

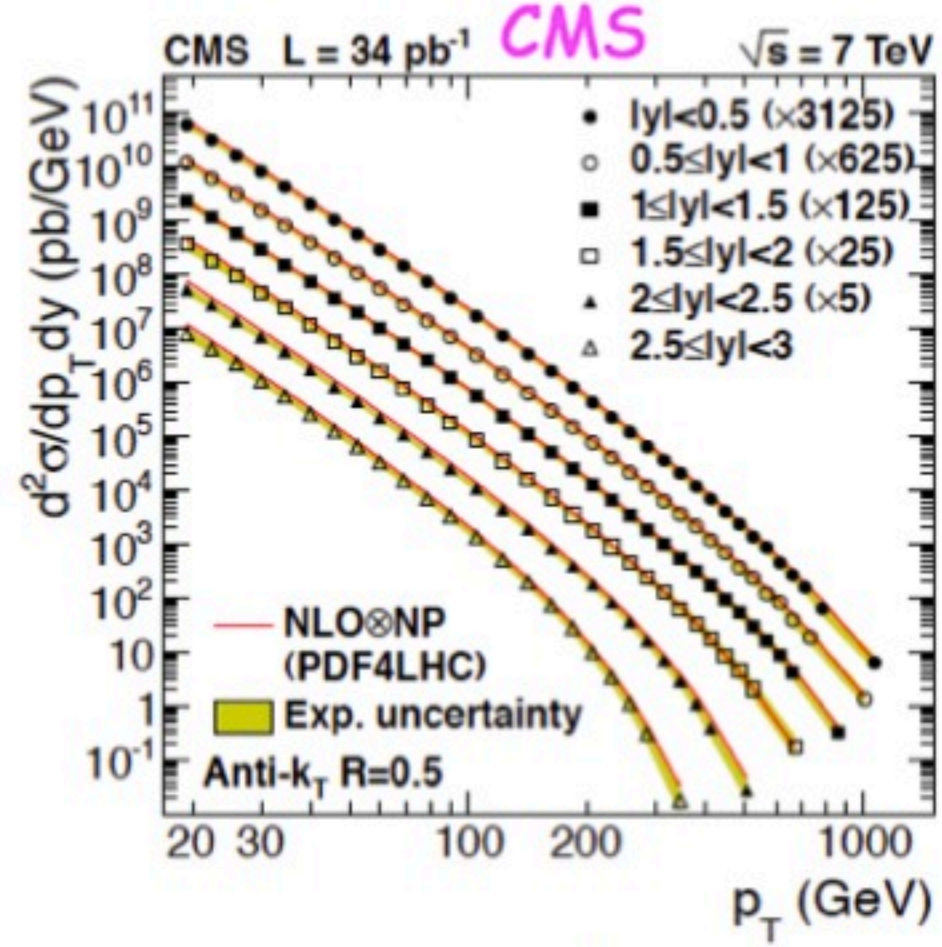
Both experiments agree with predictions within uncertainties

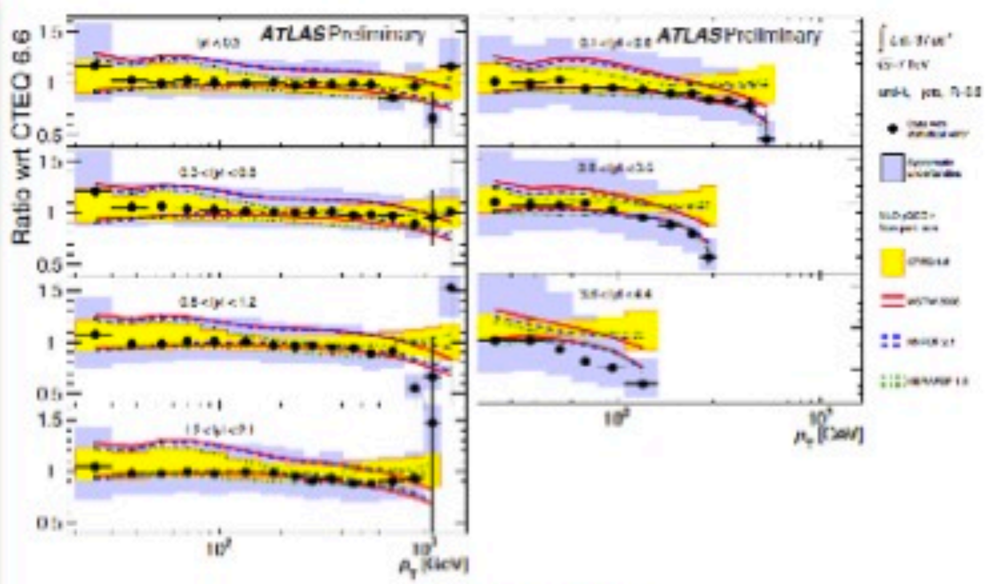
Some trends of central values, relative to predictions

ATLAS

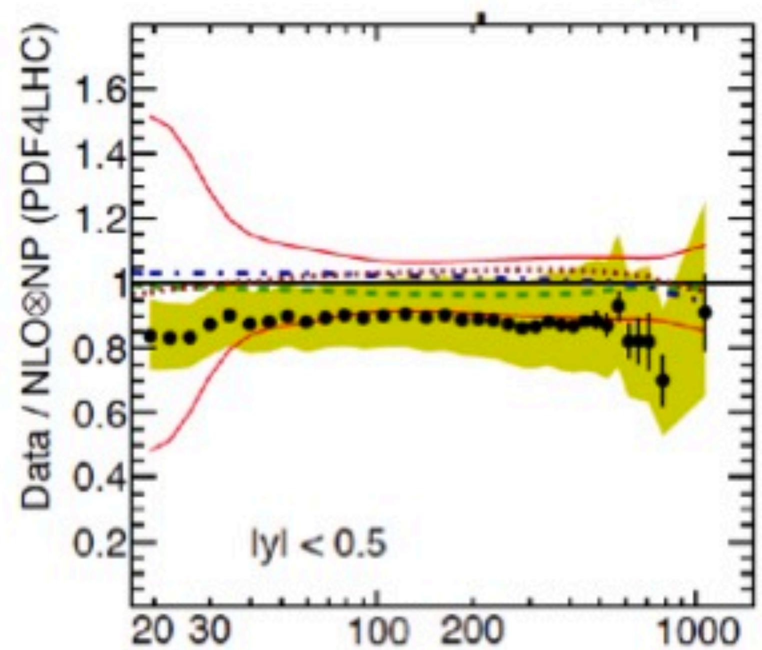


CMS





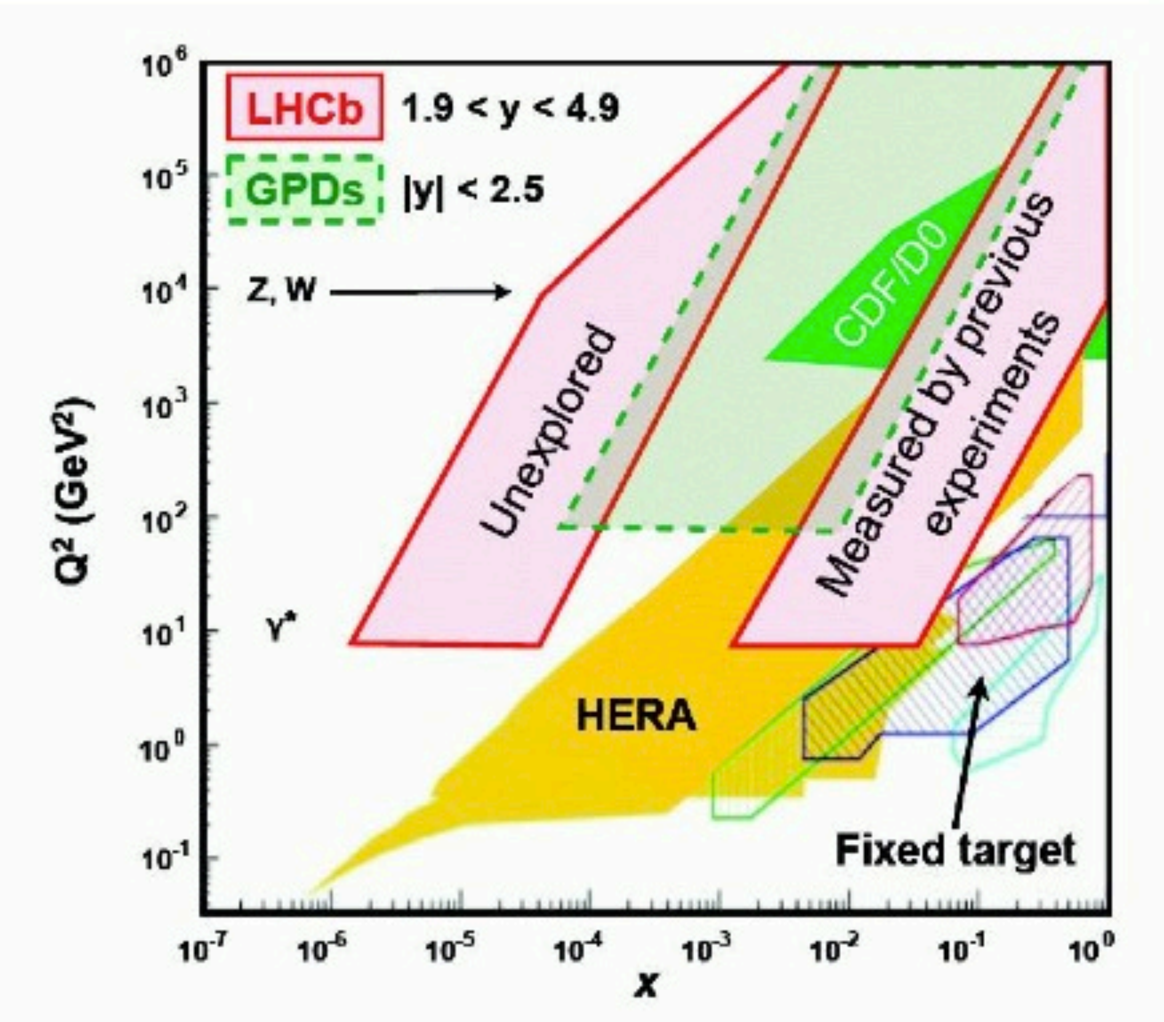
ATLAS

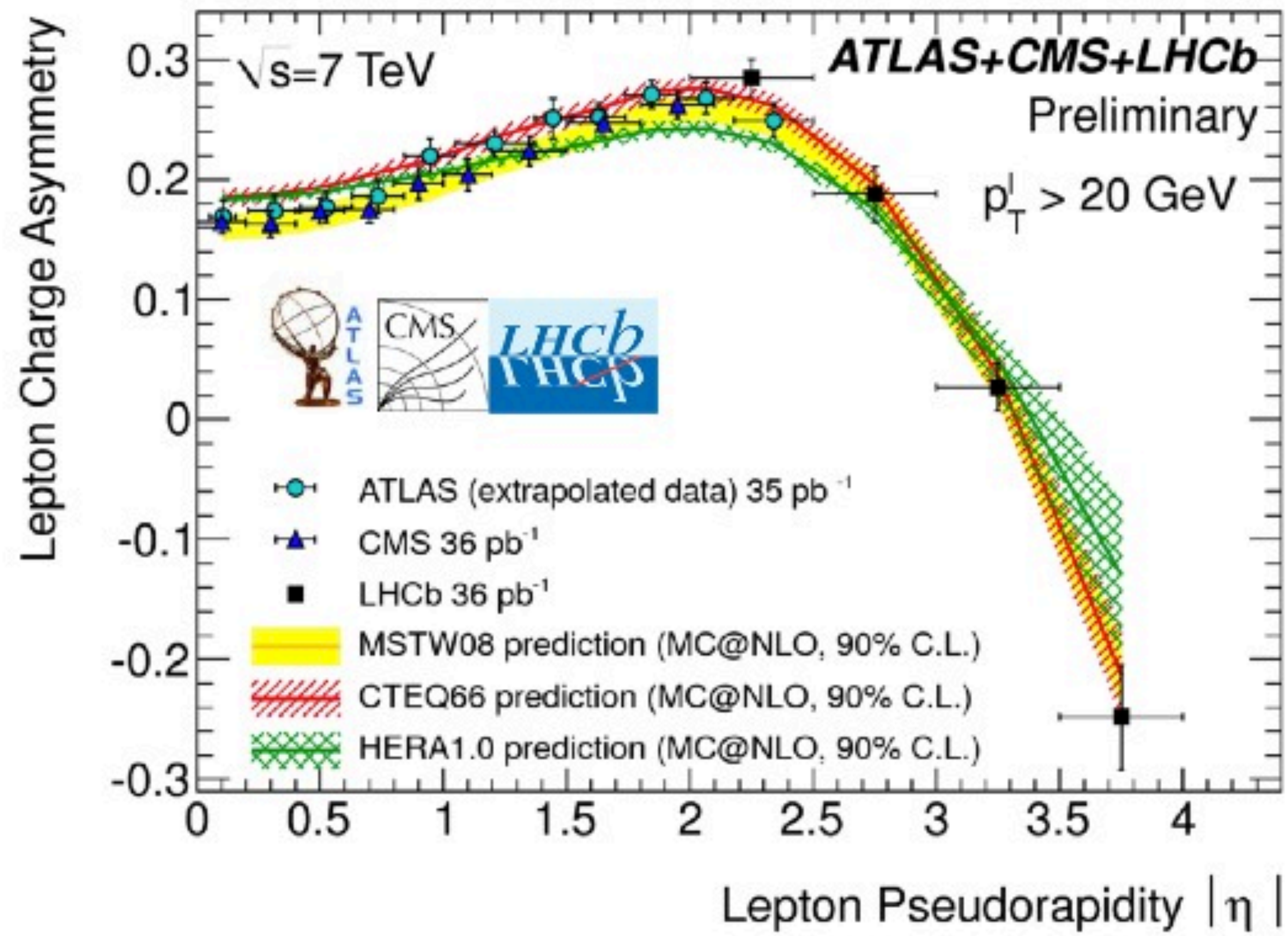


CMS

W Charge Asymmetry

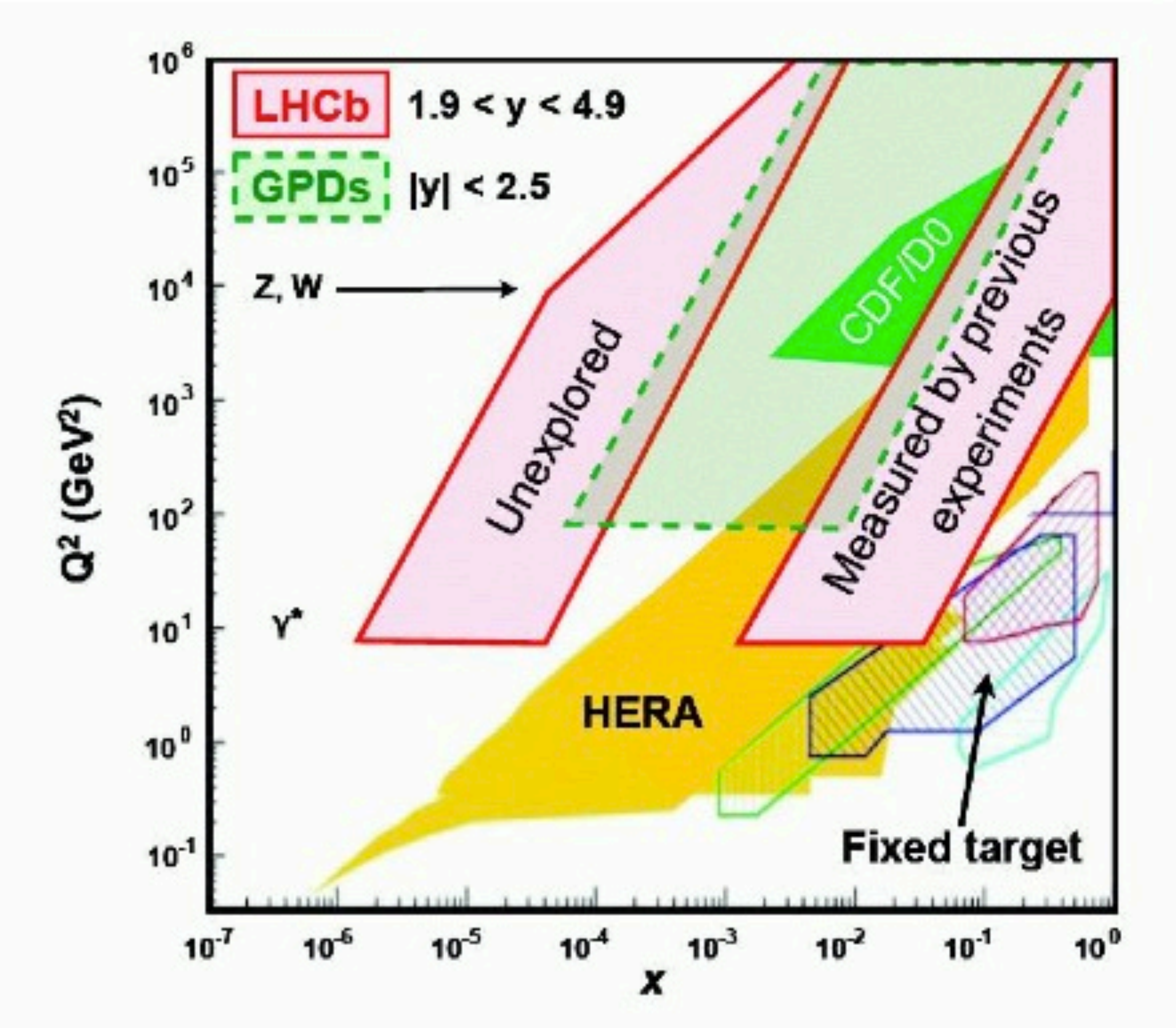
- Combination covers huge kinematic range

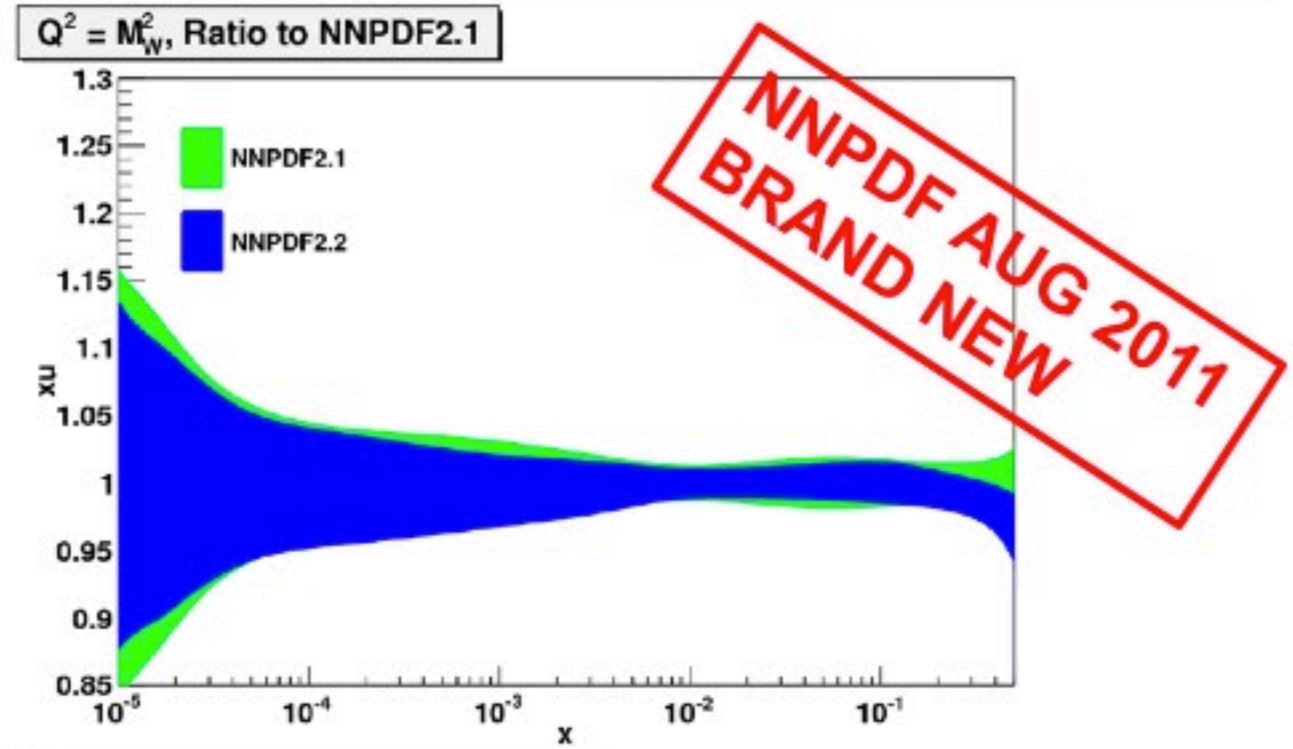


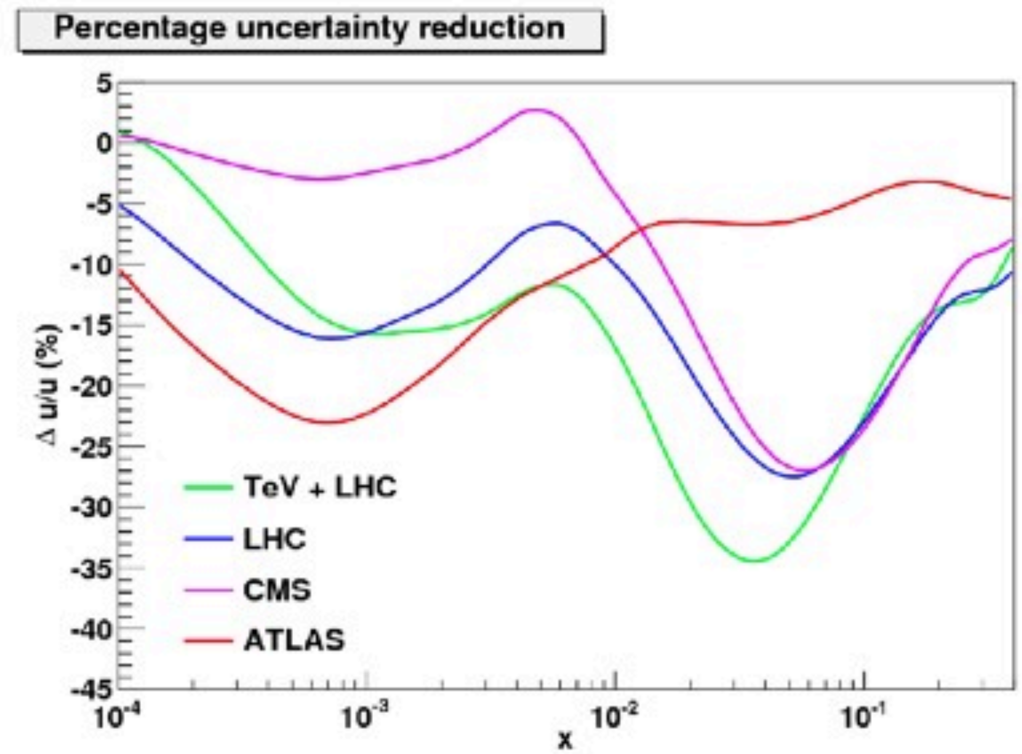


ATLAS-CONF-2011-129
LHCb-CONF-2011-039
CMS-EWK-10-006 (arXiv:1103.3407)

W Charge Asymmetry

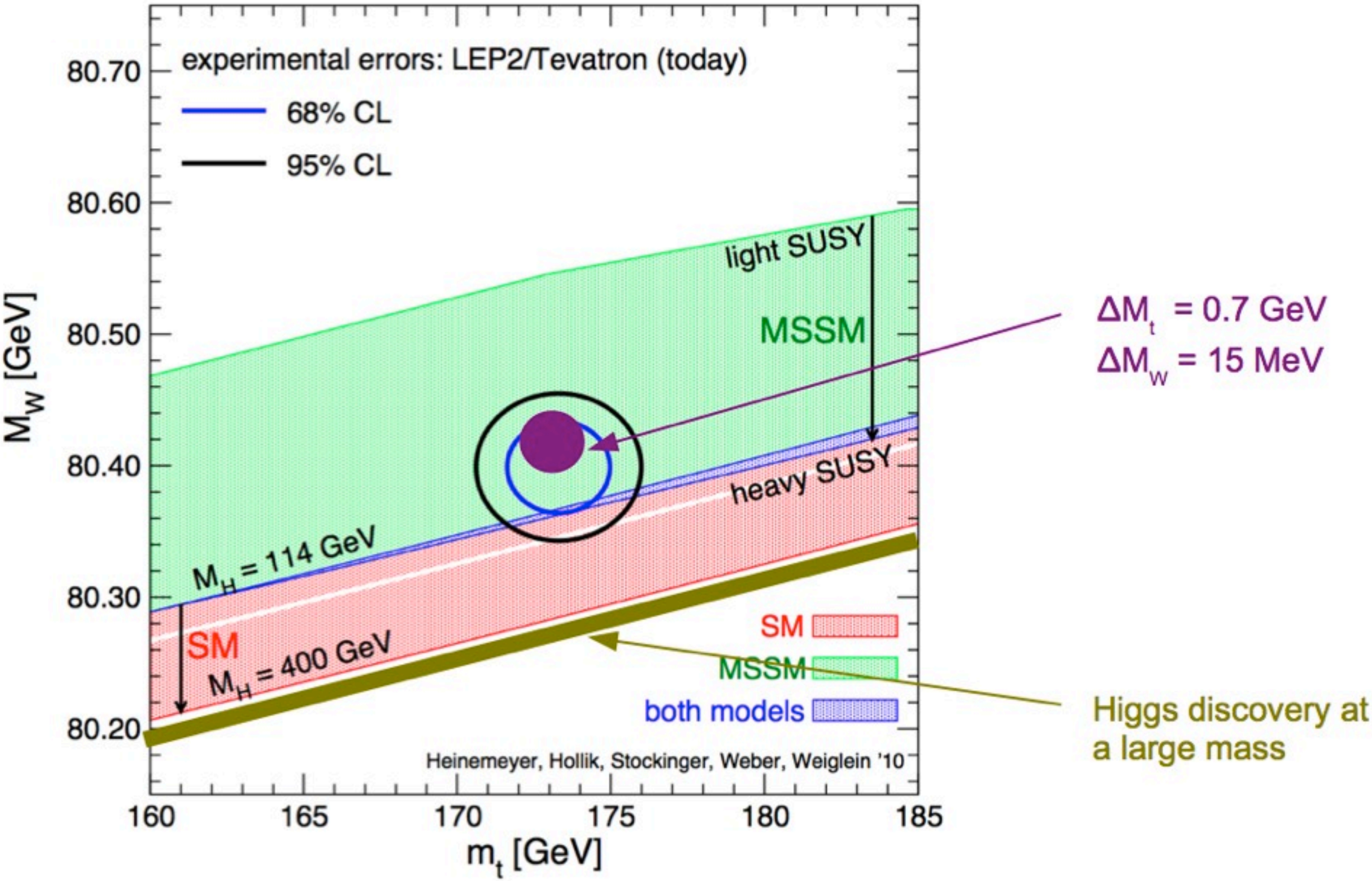






arXiv:1108.1758

A possible scenario for Lepton Photon 2013



Monday, September 26, 2011

W mass: DØ projections

With 1 fb^{-1} uncertainties are mainly statistical (including 'systematics' from limited data control samples). Let's extrapolate:

source of uncertainties	1 fb-1	6 fb-1	10 fb-1
Statistics	23	10	8
Systematics			
Electron energy scale	34	14	11
Electron resolution	2	2	2
Electron energy offset	4	3	2
Electron energy loss	4	3	2
Recoil model	6	3	2
Electron efficiencies	5	3	3
Backgrounds	2	2	2
Total Exp. systematics	35	16	13
Theory			
PDF	9	6	4
QED (ISR-FSR)	7	4	3
Boson Pt	2	2	2
Total Theory	12	8	5
Total syst+theory	37	18	14
(if theory unchanged)		20	17
Grand total	44	21	16

At end of Run II, expect total uncertainty on W mass of 16 MeV from DØ alone.

Expect similar performance from CDF, and combined error of 12 MeV.

This legacy measurement will be in the textbooks for decades to come.

Could be an important contribution to getting the standard model into trouble in the near future:

with δm_W = 15 MeV, δm_t = 1 GeV
and m_W = 80.400 GeV :

$$m_H = 71^{+24}_{-19} \text{ GeV} \quad < 117 \text{ GeV @ 95\% cl}$$

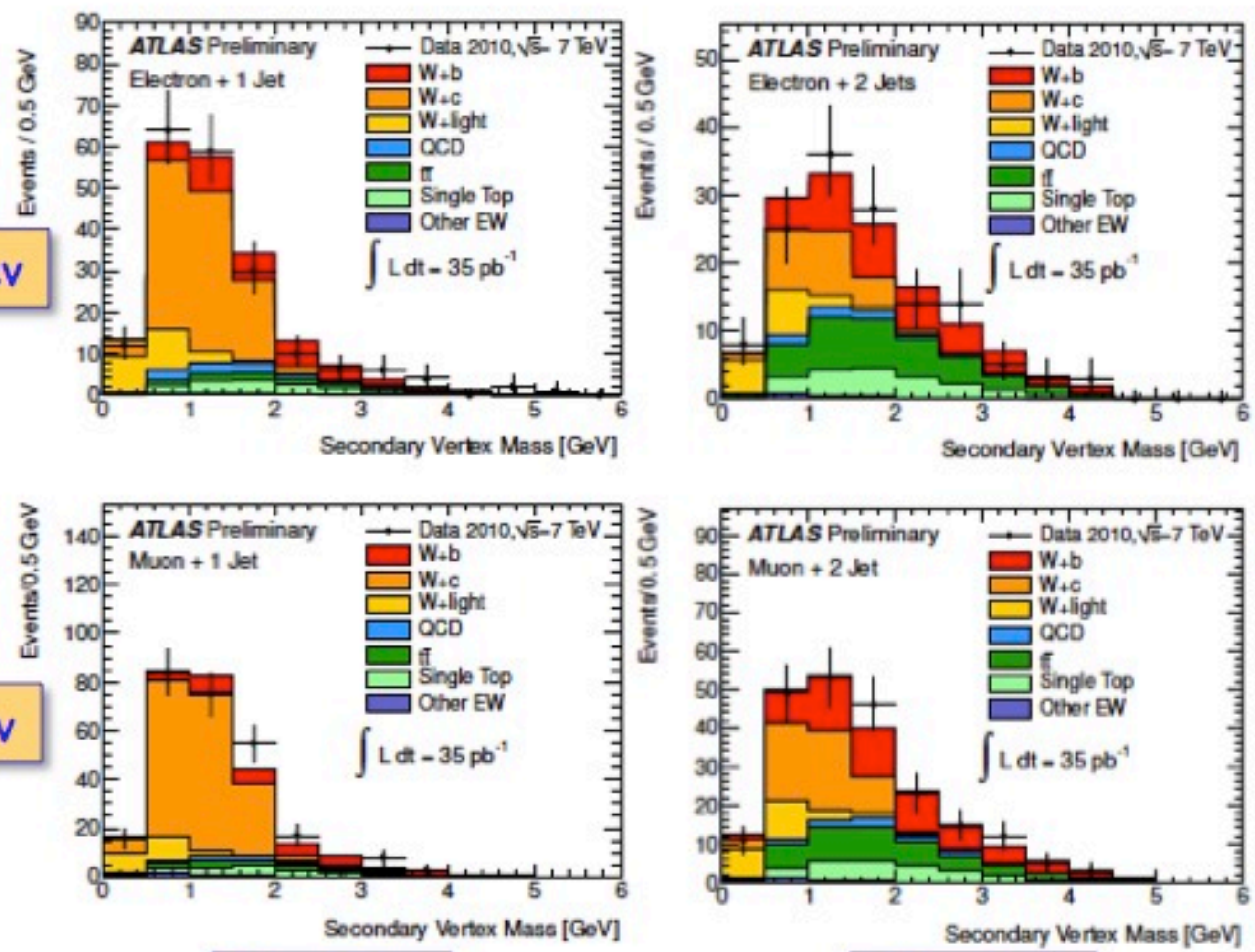
(P. Renton, ICHEP 2008)

W + b

- Important background for many studies (Higgs, SUSY, top)
- Measurements at the Tevatron exceed NLO prediction by 2.9σ
- Measured by ATLAS using 2010 data sample
  - studied W + 1 jet and W + 2 jets
  - b tagging similar to Z + b case

W→eν

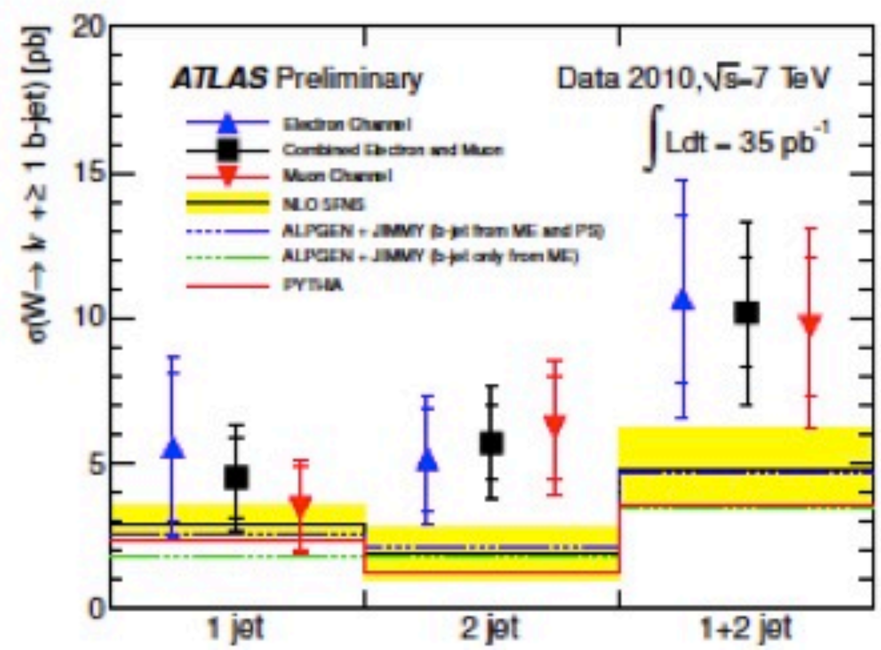
W→μν



W + 1 jet

W + 2 jet

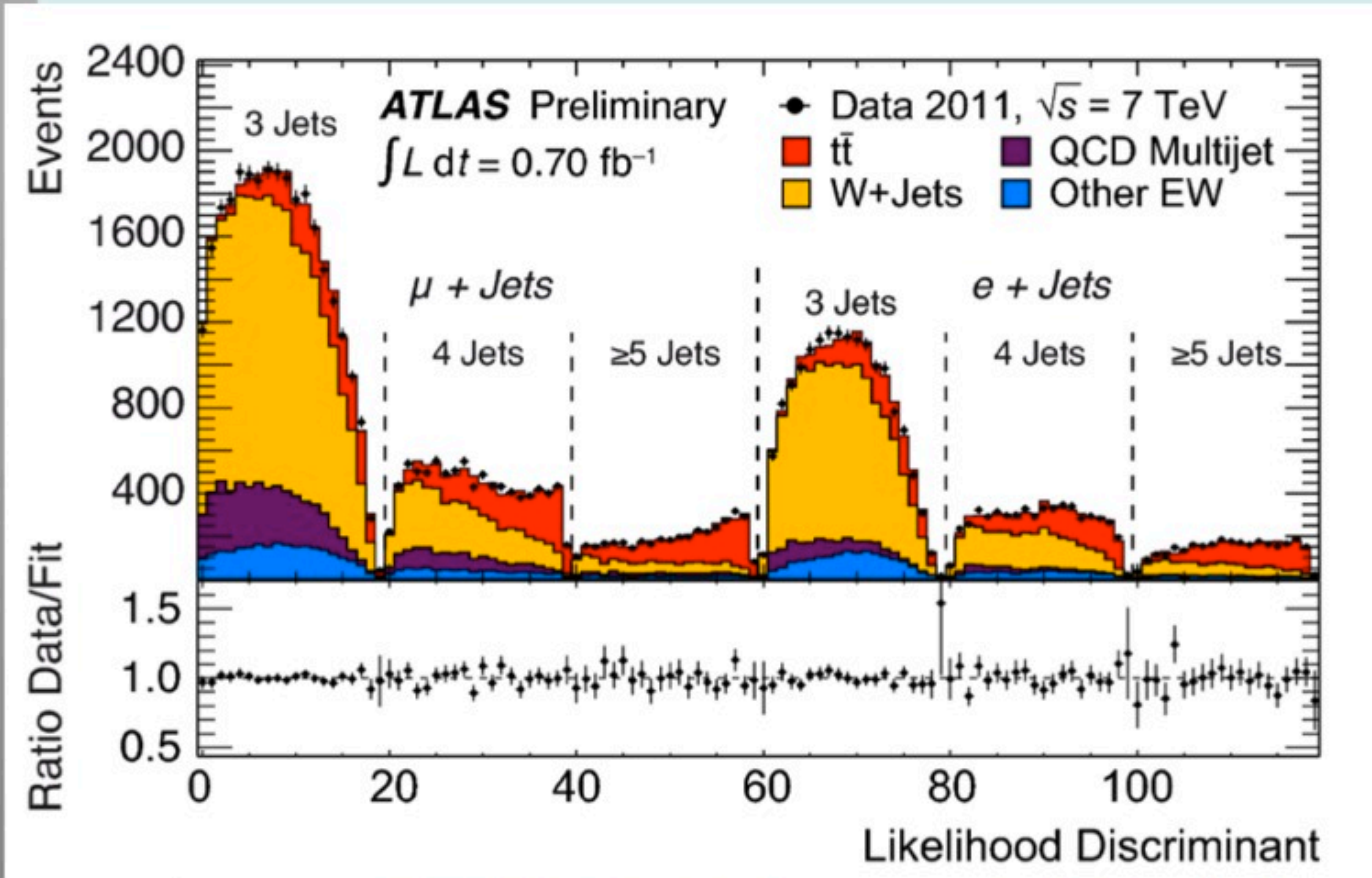
Results from e and μ combined.
Measurements ~1.5σ above NLO prediction.
Largest effect in 2-jet channel.



Monday, September 26, 2011

ATLAS: Leptons + Jets

- Include both muon and electron channels; untagged
- Make use of kinematical differences between ttbar ad W+jets



ATLAS-CONF-2011-121

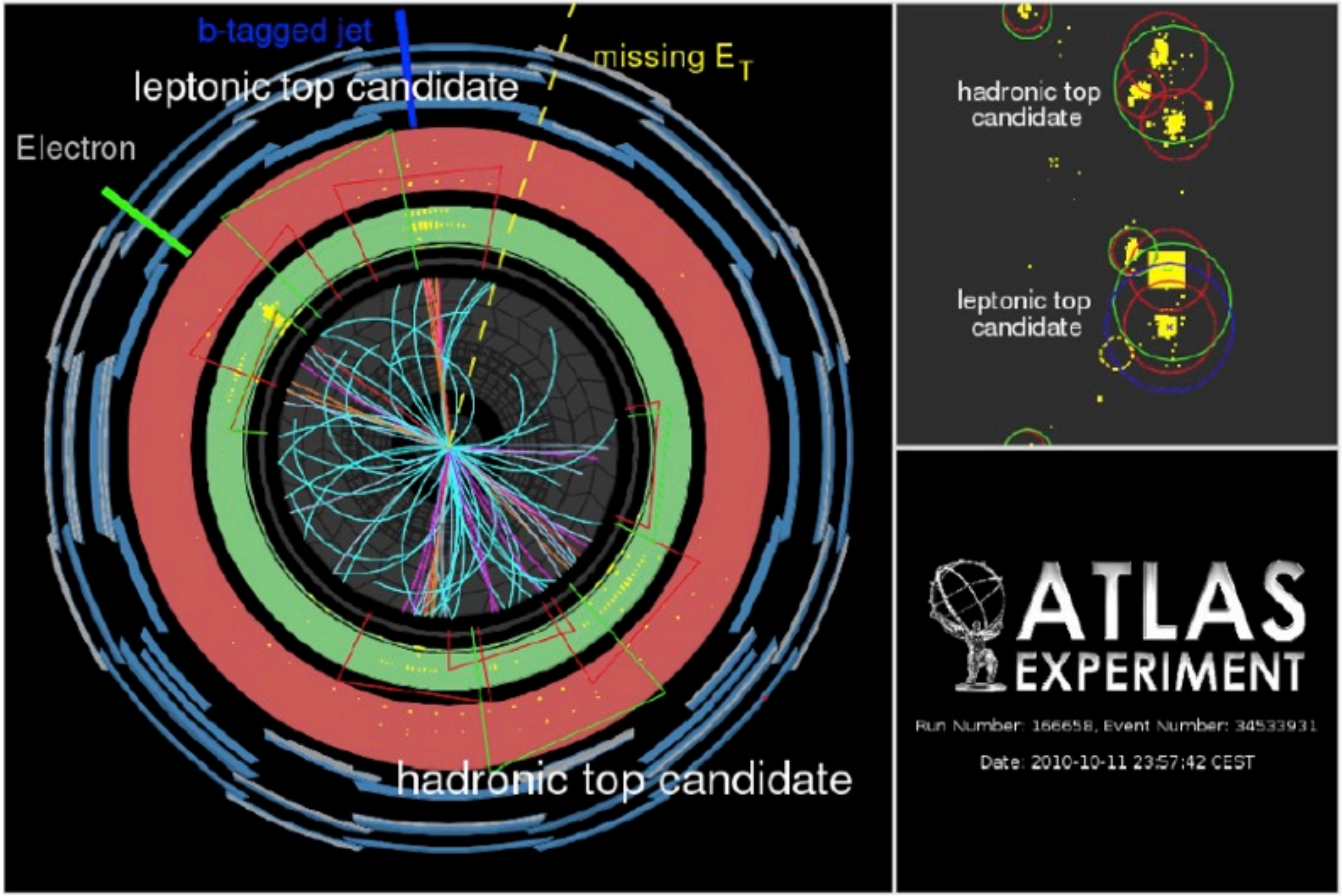
0.70 fb^{-1}

NEW

7% precision!!
August 2011

$$\sigma_{t\bar{t}} = 179.0 \pm 3.9\,(\mathrm{stat}) \pm 9.0\,(\mathrm{syst}) \pm 6.6\,(\mathrm{lumi})\ \mathrm{pb}$$

Jet Mass and Substructure

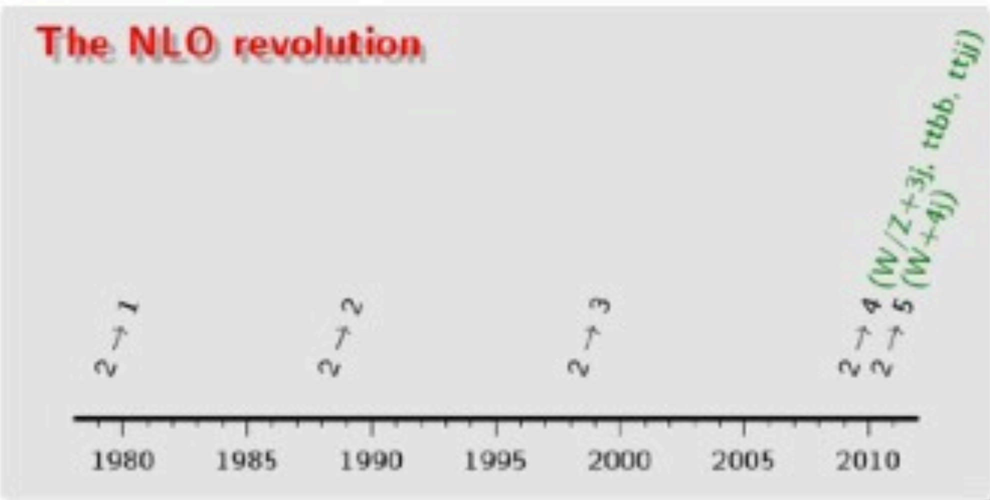


<u>Hadronic top candidate</u>

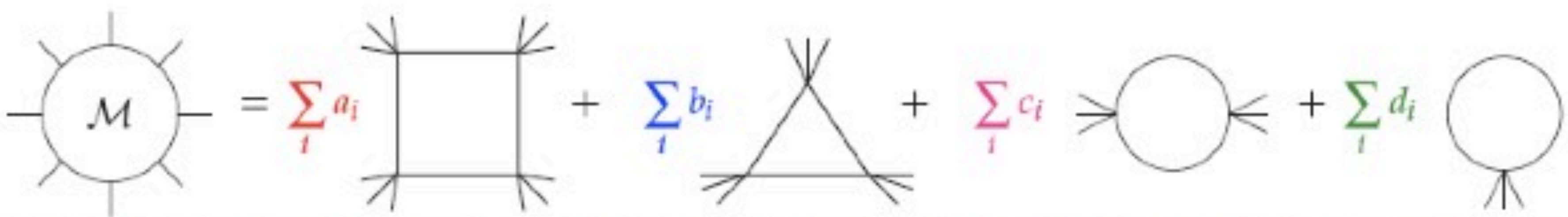
E_T = 356 GeV

Three R=0.4 jets
or
One R=1 jet
M = 197 GeV
$\sqrt{d_{12}}$ = 110 GeV

The NLO revolution



- Incredible recent progress; can now provide NLO for 2→4,5 processes at the LHC



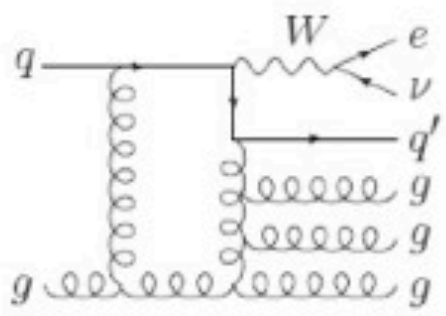
- Extract coefficients of box integrals with quadruple cuts for complex momenta (Britto, Cachazo, Feng 2004; building on Bern, Dixon, Kosower 1990s
- Efficient methods for using triple, double, single cuts to isolate coefficients of lower-point master integrals (Ossola, Papadopoulos, Pittau [OPP] 2006)
- D-dimensional unitarity, bootstrap techniques for obtaining rational parts of amplitudes (Giele, Kunszt, Melnikov 2006; Berger, Bern, Dixon, Forde, Kosower 2005-2007)

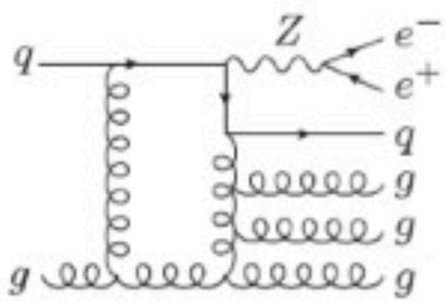
Enormous activity!

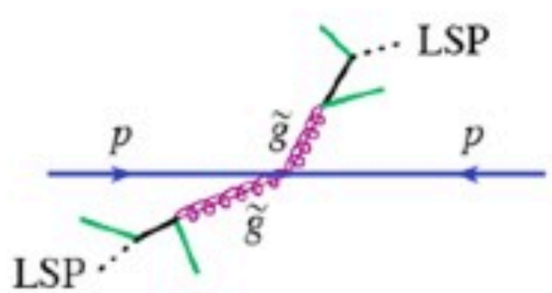
Anastasiou, Andersen, Badger, Becker, Bevilacqua, Bredenstein, Berger, Bern, Binoth, Britto, Cachazo, Campbell, Caola, Cullen, Czakon, Dawson, Denner, Diana, Dittmaier, Dixon, Draggiotis, Ellis, Febres-Cordero, Feng, Forde, Giele, Gleisberg, Greiner, Guffanti, Guillet, van Hameren, Heinrich, Hoeche, Kallweit, Kleinschmidt, Karg, Kauer, Kosower, Kunszt, Ita, Jaeger, Lazopoulos, Maitre, Mastrolia, Melia, Melnikov, Oleari, Ossola, Ozeren, Pilon, Pittau, Papadopoulos, Pozzorini, Reiter, Reuschle, Reuter, Rodgers, Rontsch, Sanguinetti, Schmacher, Schumann, Tramontano, Weinzierl, Winter, Worek, Zanderighi, Zeppenfeld ...

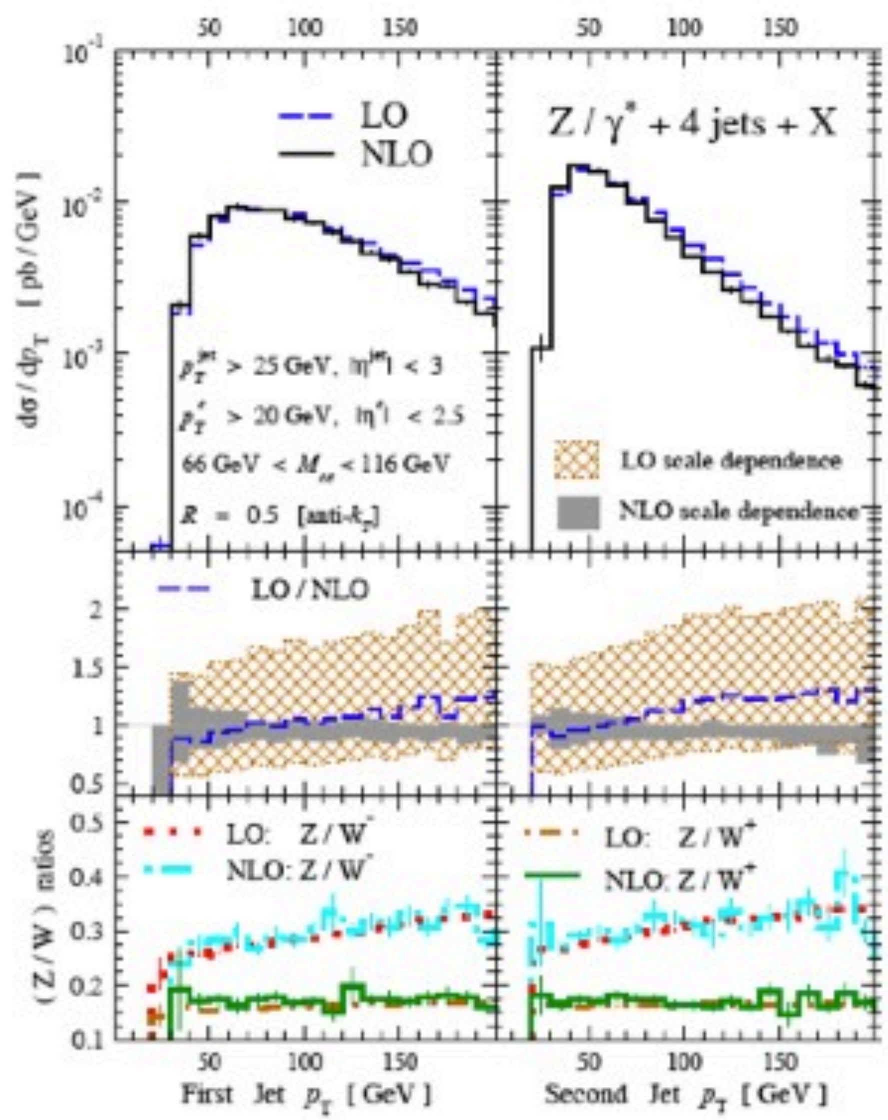
W/Z+4 jets

- Calculations of such complexity, it was unthinkable only a few years ago









- Key background to SUSY searches
- Drastic reduction of scale variation
- Z/W+jets ratios stable under LO→NLO change

BLACKHAT+SHERPA: Berger et al. 2010; Ita, Bern, Dixon, Febres Cordero, Kosower, Maitre 2011

FUTURE PROJECTS

Next decades

Road beyond Standard Model

At the energy frontier through synergy of

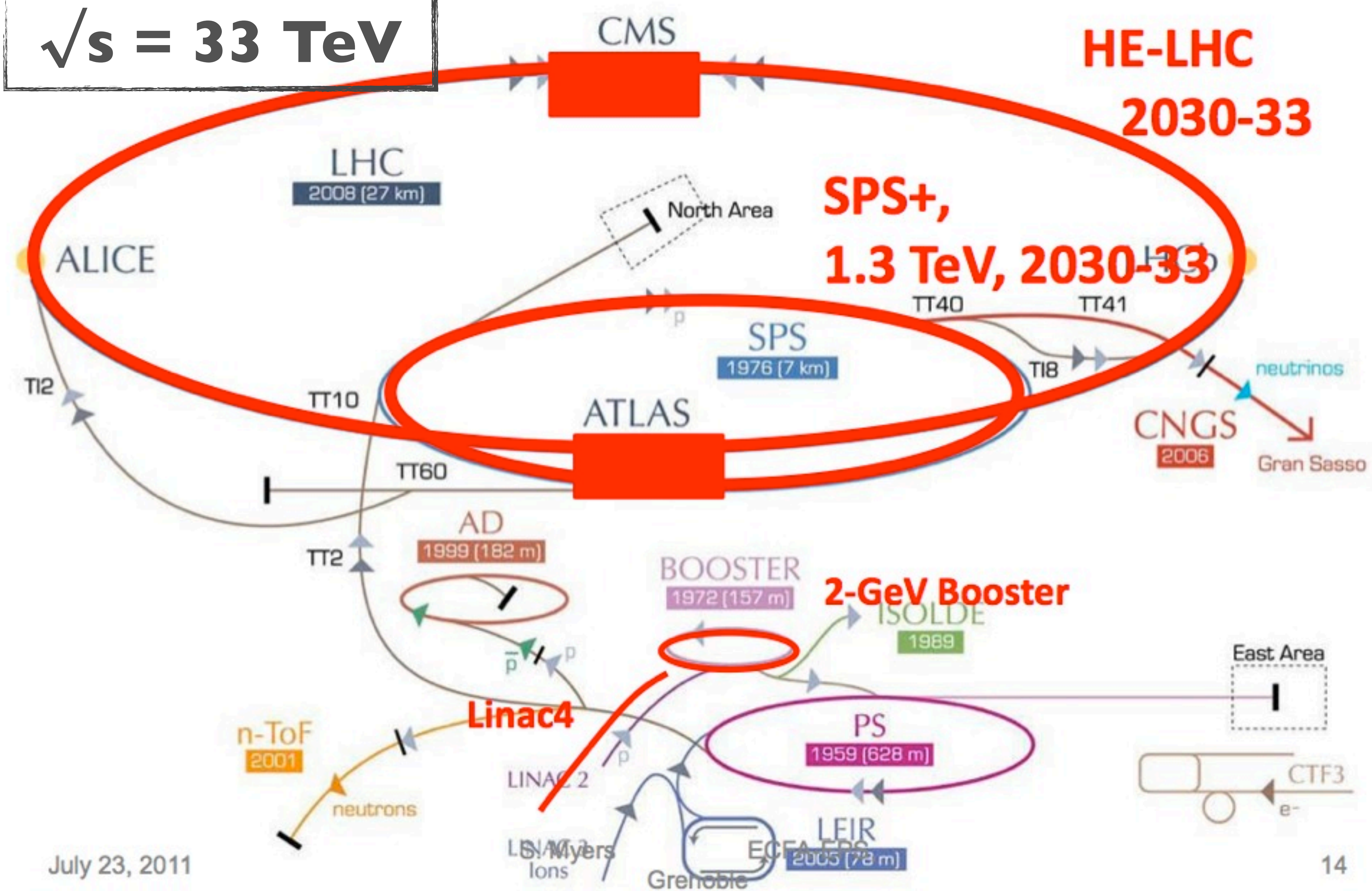
hadron - hadron colliders

lepton - hadron colliders

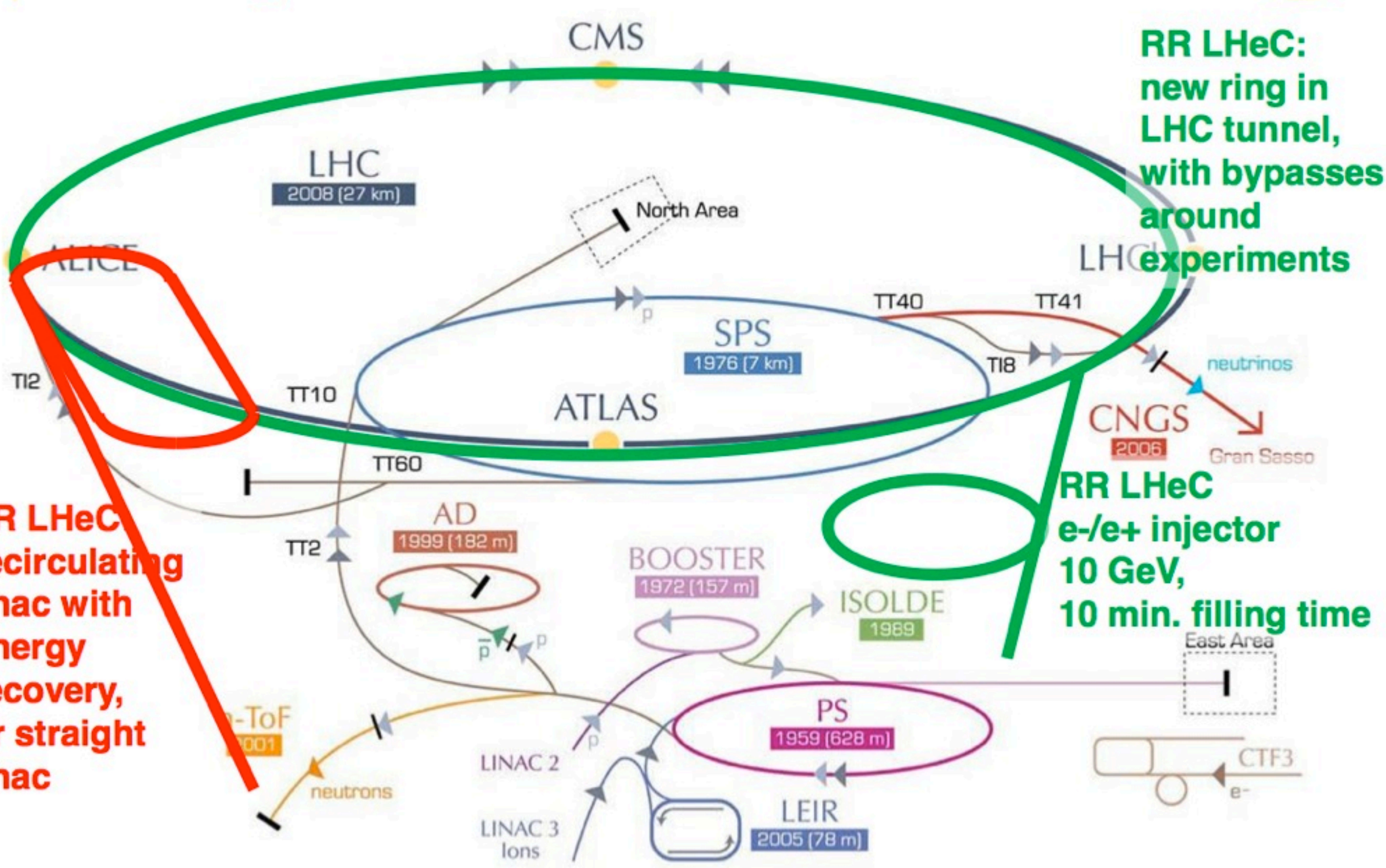
lepton - lepton colliders

HE-LHC – LHC modifications

√s = 33 TeV



LHeC options: RR and LR



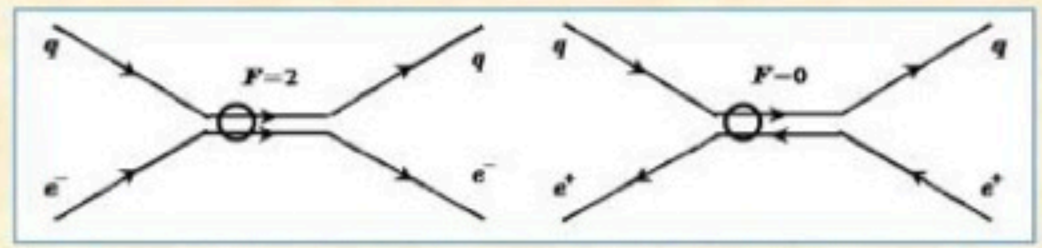
Frank Zimmermann, UPHUK4 Bodrum 2010

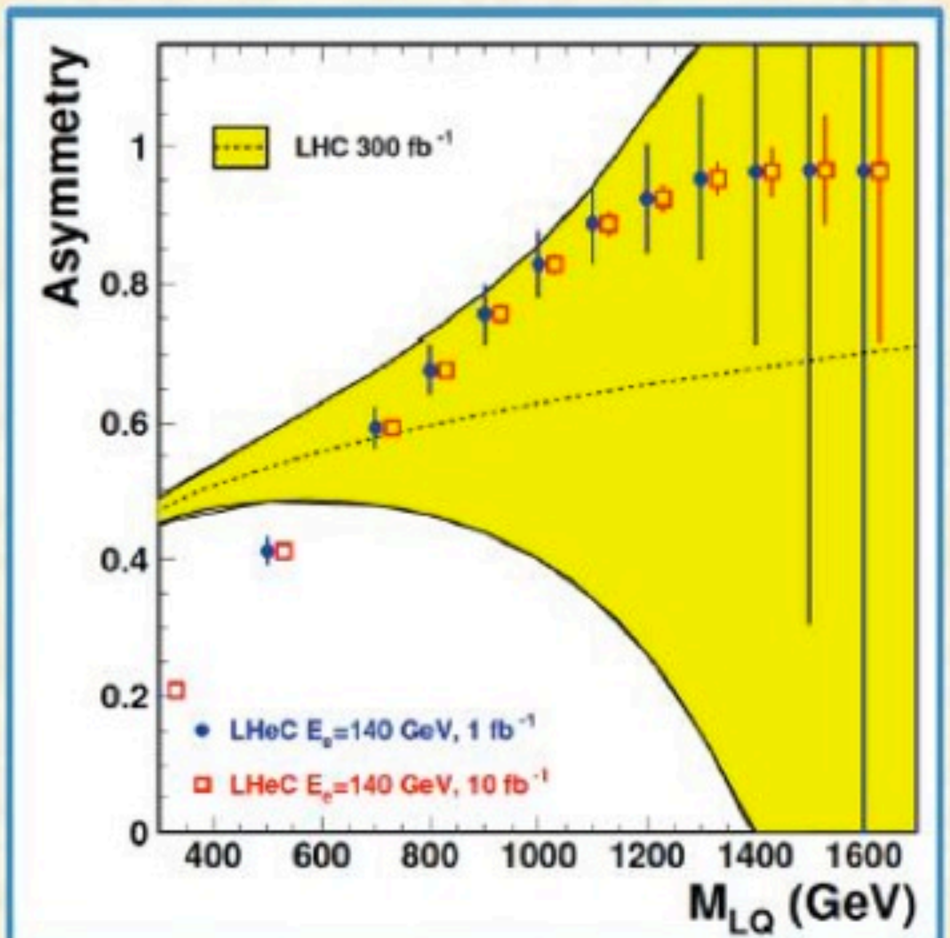
Determining Leptoquark Quantum Numbers

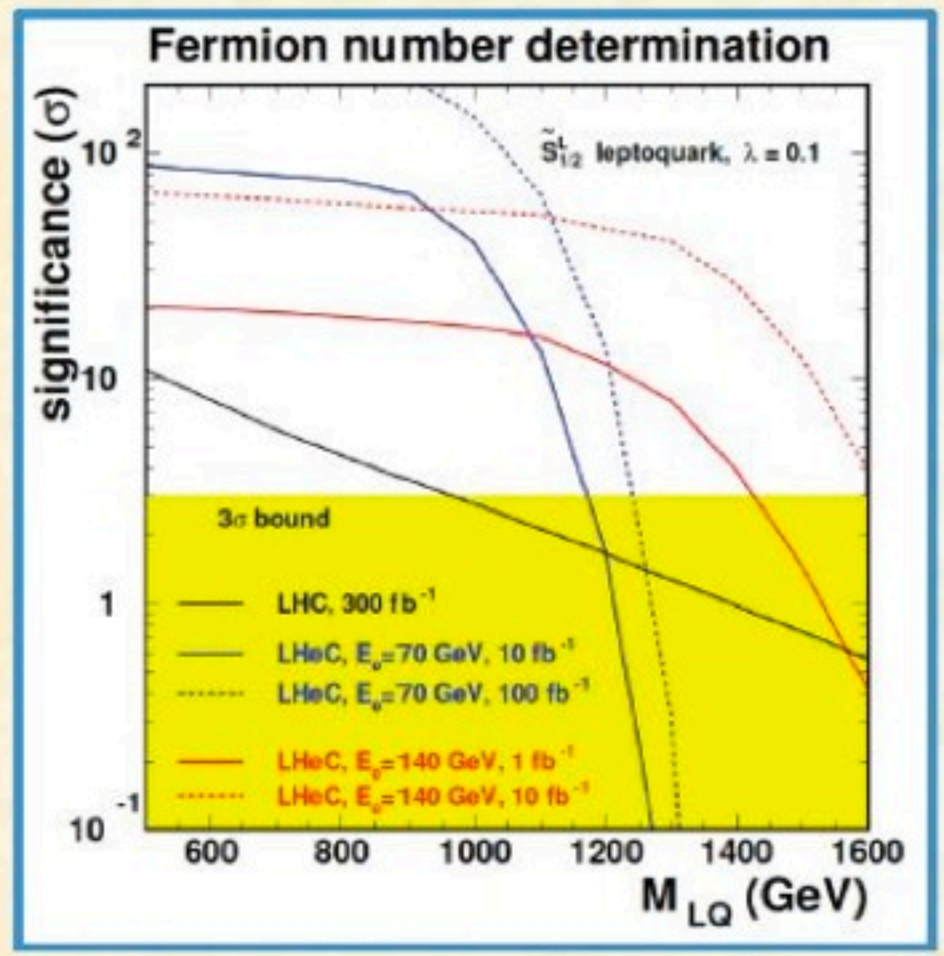
Single production gives access to quantum numbers:
- fermion number (below)
- spin (decay angular distributions)
- chiral couplings (beam lepton polarisation asymmetry)

- Fermion number F from asymmetry in e+/e-p cross sections
- Much cleaner accessible in DIS

$$A = \frac{\sigma_{e^-} - \sigma_{e^+}}{\sigma_{e^-} + \sigma_{e^+}} \begin{cases} > 0 \text{ for } F=2 \\ < 0 \text{ for } F=0 \end{cases}$$







Studies for "low`` lumi assumptions for pp and ep

Status and major issues of Linear Colliders

ILC

- 0.5 TeV upgradable to 1 TeV
- Mature SC-RF technology (TESLA- Flash- XFEL)
- CDR in 2007, TDR in 2012
- Global Intern. collaboration & organisation (GDE)

CLIC

- extension in multi-TeV range
- Novel scheme of Two Beam Acceleration (TBA): CTF1,2,3
- CDR in 2011, TDR in 2016?
- Multi-lateral Int. Collaboration of 41 volunteer Institutes

Extremely fruitful collaboration between CLIC and ILC
Joint working groups on common issues with great synergies

Joint IWLC Workhop (18-22/10/2010 @ CERN)
Next Joint LCWS (26-30/09/2011 @ GRENADA/SPAIN)
http://www.ugr.es/~lcws11/index.php

Towards single Linear Collider community and….

Possibly future joined project based on Physics requests (LHC results) and technology choice as best trade off between performance, maturity, risk, cost, etc….

High Gradient Acceleration

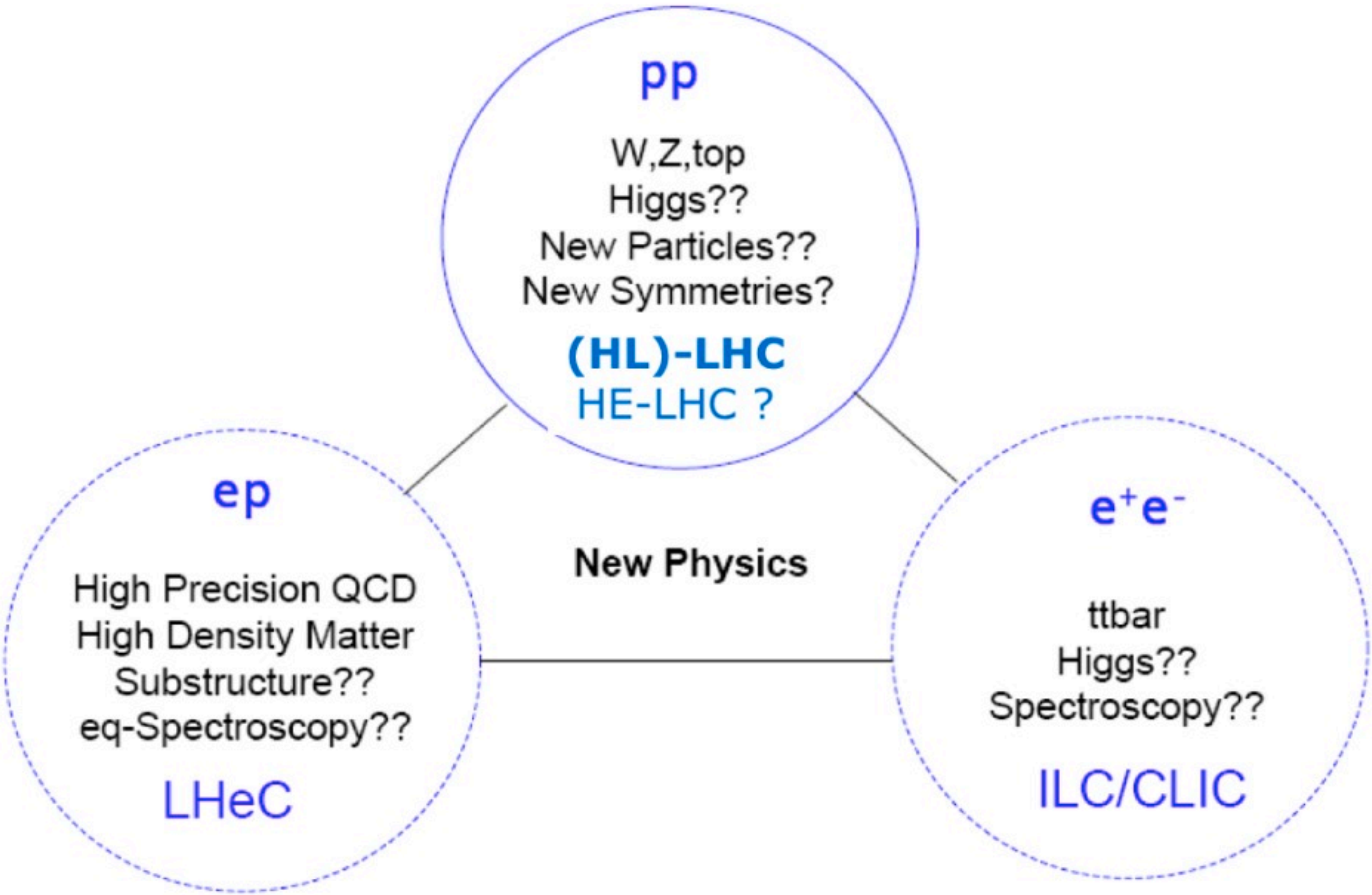
- High gradient acceleration requires high peak power and structures that can sustain high fields
  - Beams and lasers can be generated with high peak power
  - Dielectrics and plasmas can withstand high fields

- Many paths towards high gradient acceleration
  - RF source driven superconducting structur… ~40 MV/m
  - RF source driven metallic structur… MV/m
  - Beam-driven metallic stru…
  - Laser-driven die…ures } ~1 GV/m
  - Beam…ctric structures
  - La…ven plasmas } ~10 GV/m
  - Beam-driven plasmas

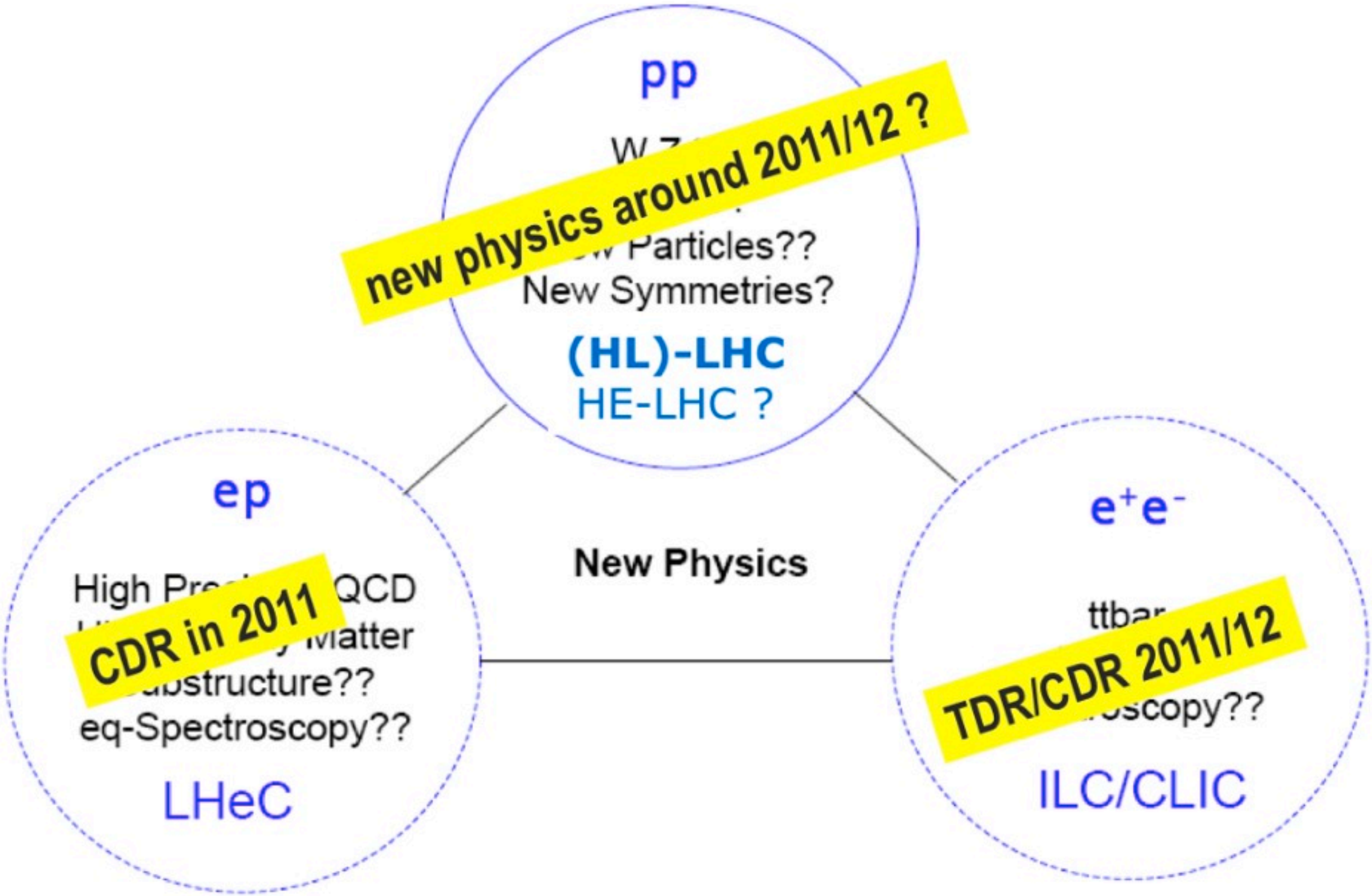
R&D on new technologies mandatory

From: T.Raubenheimer, EPS 2011

The TeV Scale (far) beyond 2010



The TeV Scale (far) beyond 2010



The TeV Scale (far) beyond 2010

pp

W Z

new physics around 2011/12 ?

Particles??

New Symmetries?

(HL)-LHC

HE-LHC ?

ep

e^+e^-

Great opportunities ahead at the TeV scale

first window of opportunity for enabling decision on the way forward around 2012 (?)

Next decades

Road beyond Standard Model

At the energy frontier through synergy of

hadron - hadron colliders (LHC, HE-LHC?)

lepton - hadron colliders (LHeC ??)

lepton - lepton colliders (LC (ILC or CLIC) ?)

(μ-collider ???)

CONCLUSIONS

- **No signs of new physics at the LHC yet**
    - What we'll find will guide the decisions for new projects
- **Several hints at the Tevatron, but none of them are fully convincing**
    - LHC experiments already cross-checking/constraining them
- **Standard Model starting to be well measured at the LHC**
    - In some cases better than ever
- **Lots of improvements in recent years to improve the theoretical tools for the LHC**