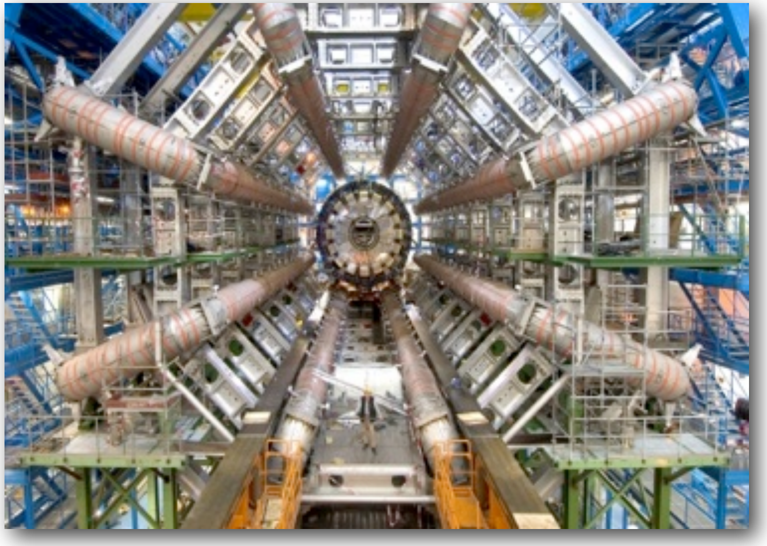
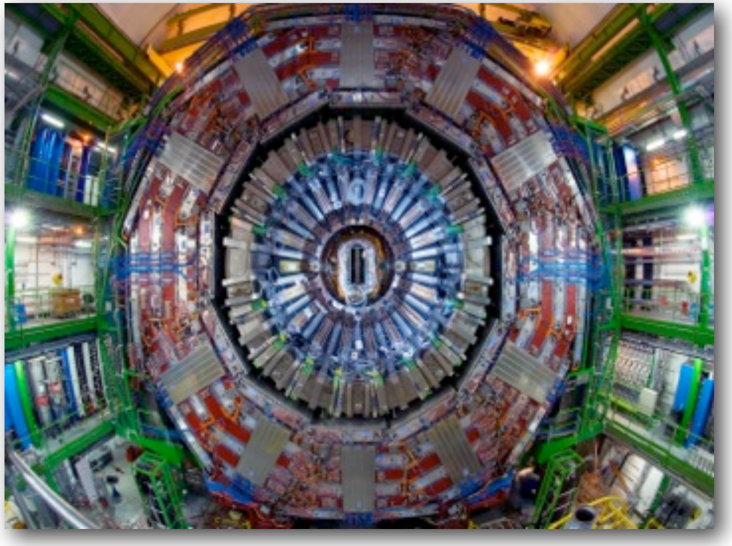
Searches for Exotic Physics





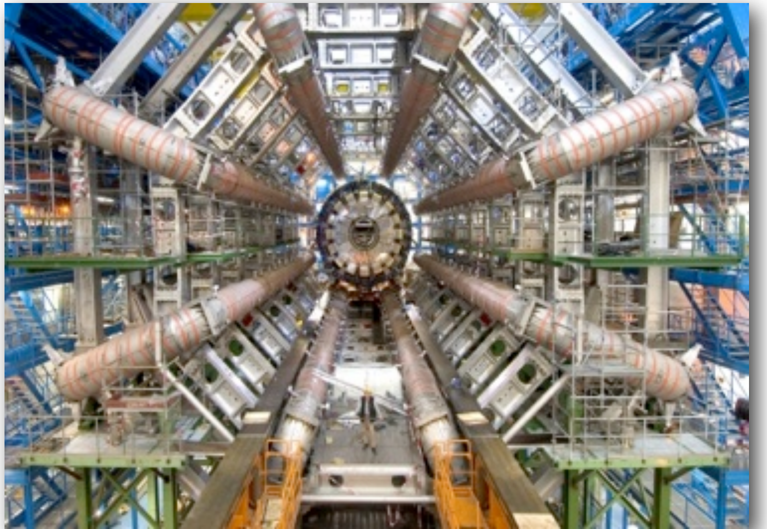
Steve Worm

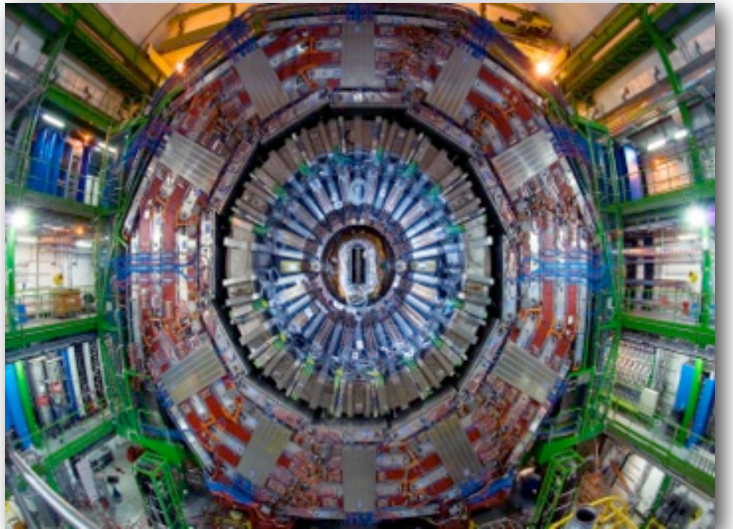
Science & Technology Facilities Council
Rutherford Appleton Laboratory

Taller de Altas Energías

Benasque, 26 September 2013

SEARCHES FOR EXOTIC* PHYSICS





Steve Worm

Science & Technology Facilities Council
Rutherford Appleton Laboratory

Taller de Altas Energías

Benasque, 26 September 2013

*also known as "BSM (non - SUSY) Results I"

Outline

- *What is "Exotic"?*
  - Standard Model, standard problems
  - New energy regime
  - Top example and detectors
- *Resonances and "standard stuff"*
  - Z', ADD
  - W'
  - Dijet, dijet w/ b-tag
  - 3-jet, 3-jet w/ b-tag
  - black holes
- *Top-like BSM*
  - W' $\longrightarrow$ tb
  - vector-like T'
  - Q=5/3 top partners
  - X $\longrightarrow$ tt semi-leptonic, hadronic
- *Di-boson resonance*
  - Boosted techniques
  - $W'/\rho_{TC} \longrightarrow WZ \longrightarrow 3l + MET$
  - $G_{bulk} \longrightarrow WW \longrightarrow l + jet + MET$
  - $G_{bulk} \longrightarrow ZZ \longrightarrow 2l + 2jets$
  - $G_{RS} \longrightarrow WW/ZZ$ and $W' \longrightarrow WZ$
- *Long-lived particles*
  - displaced jets
  - HSCP
- *Dark Matter*
  - monojet
  - monolepton
- *Conclusions*

Disclaimer

- Not an attempt to cover all Exotica results for ATLAS or CMS
  - Each collaboration has 60-70 analyses going at any given moment
  - I selected some highlights and a few to discuss in more detail
- Extra apologies to ATLAS... I probably show more CMS results
- Thanks to H. Bachacou, C. Issever, E. Thompson from which I stole a few ideas (and slides)

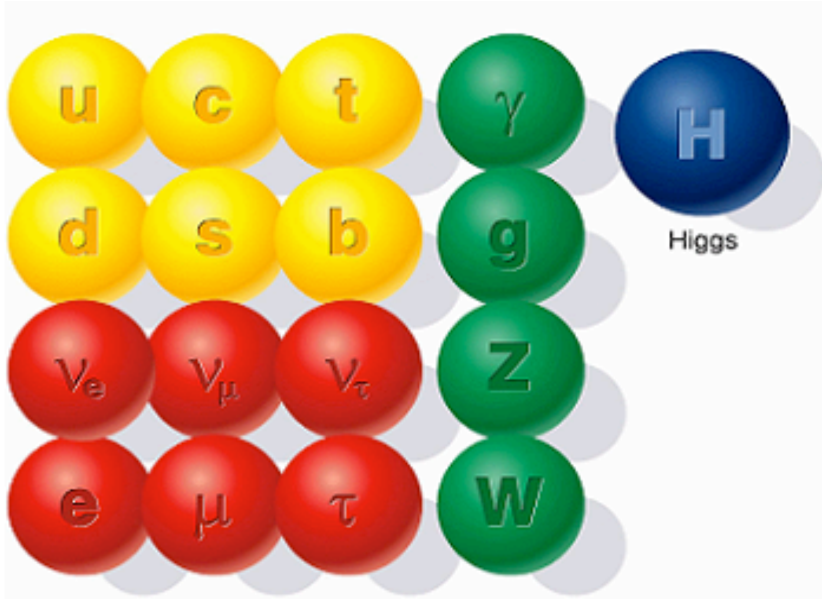
Some Basics…

THE STANDARD MODEL

From experimental evidence and theory insight, a simple picture emerged:

The Standard "Ingredients":

- Handful of fundamental particles
- Particles constructed by 2 or 3 quarks and only a few rules
- A few forces mediated by bosons
- Add one particle, the Higgs give the particles mass



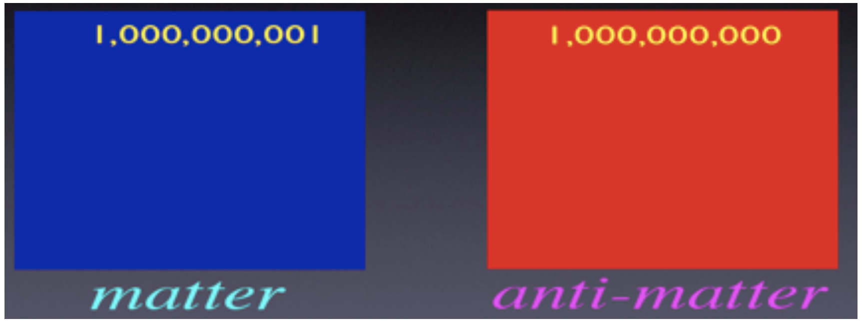
Standard Model Particles

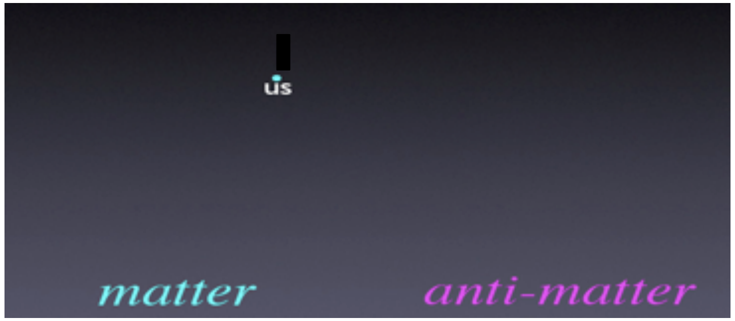
The Standard Model has been incredibly successful in explaining all data...

...but there are problems too

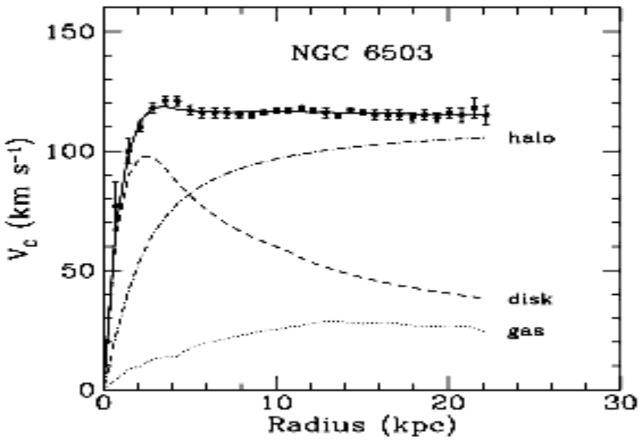
STANDARD MODEL, STANDARD PROBLEMS

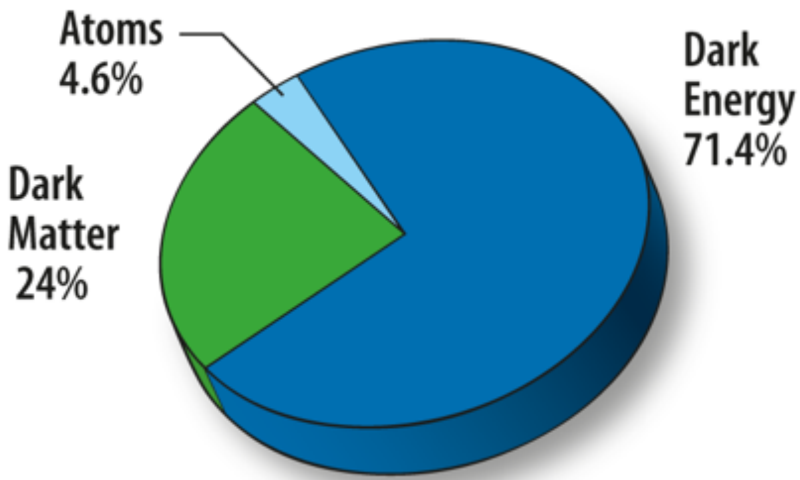
- Antimatter: *What happened to all the antimatter?*





- Dark Matter: *We don't know what most of the matter in our world is made of!*





STANDARD MODEL, STANDARD PROBLEMS

"Cracks" have started to appear in the Standard Model…

Many problems identified over time

- No explanation of masses, coupling constants
- Why three families?
- Gravity not included
- The "hierarchy" problem, fine tuning…
- What is the Dark Energy?

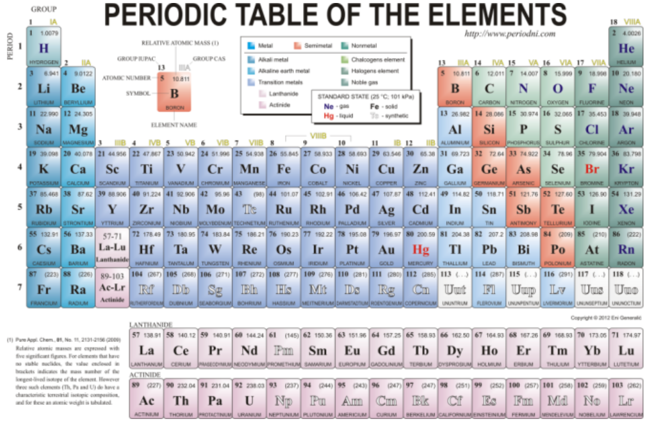
…and yet it explains the data

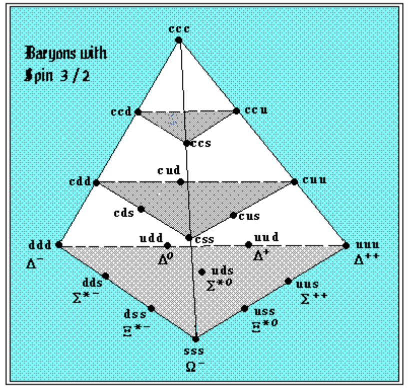
The Standard Model isn't so much wrong as it is incomplete

Effective Theories... and Scale

- Fundamental theory may be hiding at shorter distances (higher energies)
- ~1900 we reached the atomic scale
  - 10^{-8} cm ≈ $\hbar^2/e^2 m_e$
  - Quantum Mechanics
  - Quantum Electrodynamics
- ~1950 we reached strong interaction scale
  - 10^{-13} cm ≈ $M\exp[-8\pi^2 g_s^2(M) b_0]$
  - QCD
  - Quarks, Gluons
- 2010 we reach (and exceeded) the EWK scale
  - 10^{-17} cm, the TeV scale
  - EWK phase transition is happening
  - W, Z, electron…etc. acquire mass
  - $v = (\sqrt{2}G_F)^{-1/2} \approx 246$ GeV ← Higgs VEV

Expect lots of interesting stuff at 14 TeV!

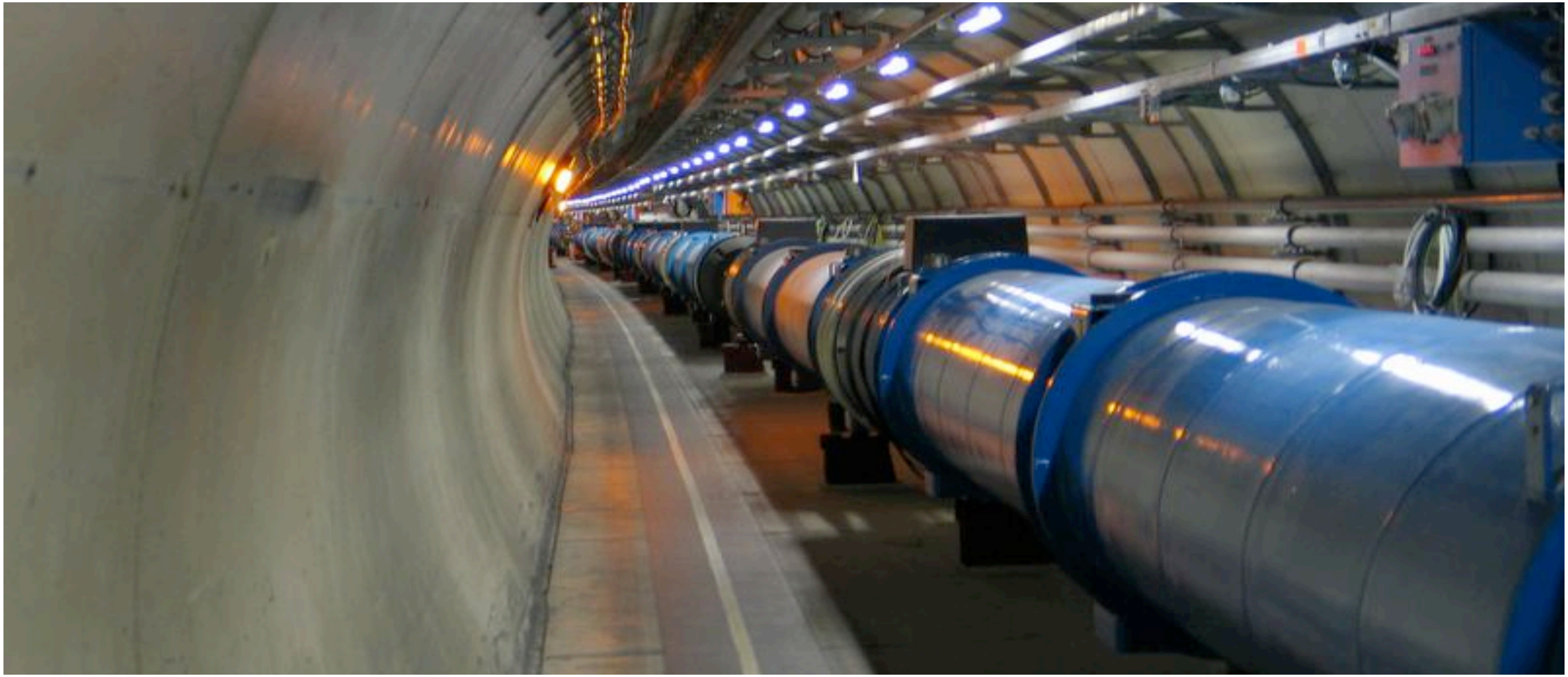




Accelerator Advances

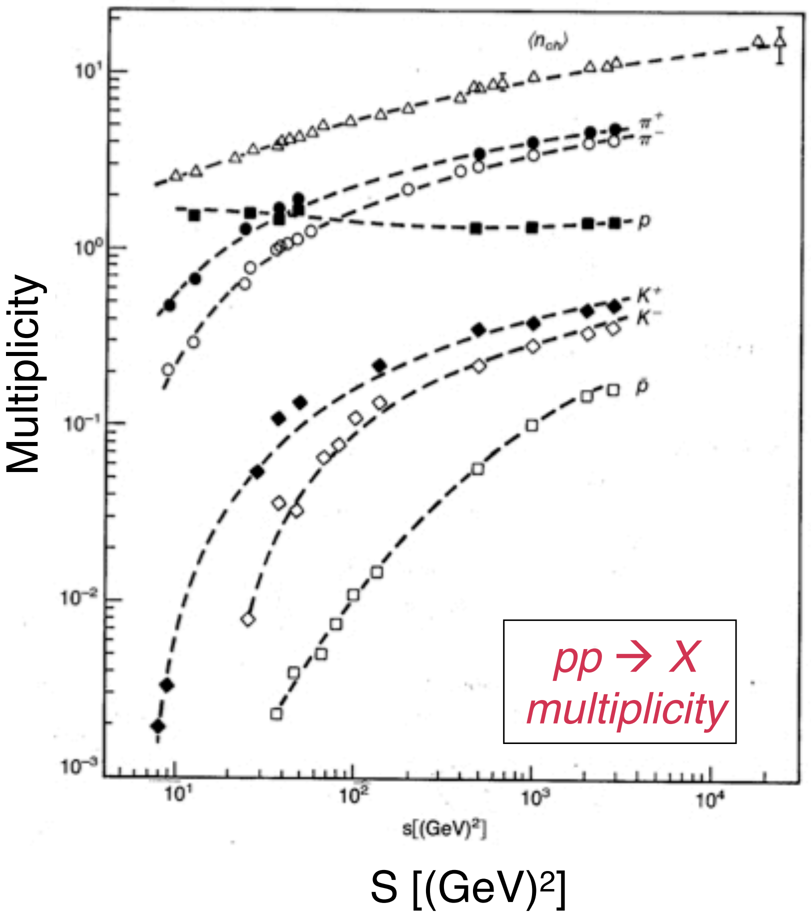
- Each advance is a revolution… but sadly only once or twice per generation
  - Previous energy record-holder (Tevatron) first started in 1983 - 30 years ago
  - LEP at CERN stopped in 2000 - 13 years ago

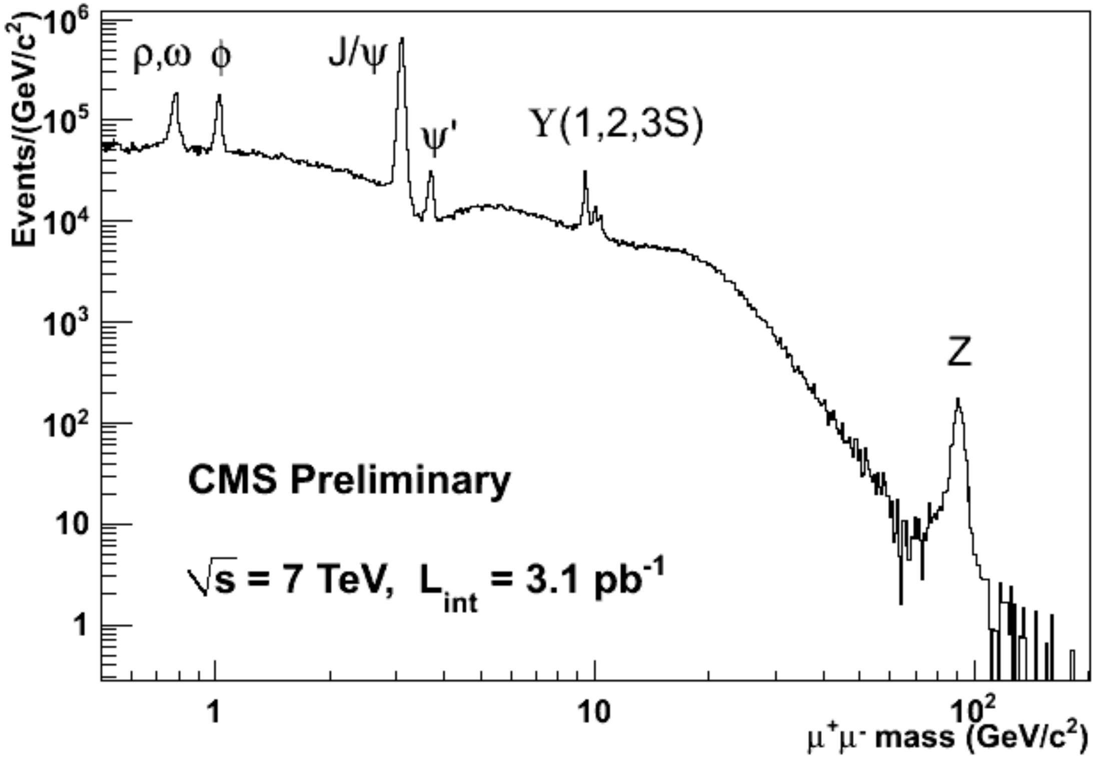
The jump to 14 TeV will be a huge advance for BSM searches



NEW ENERGY REGIMES

- Each advance in territory makes new discovery possible
- Many historic examples…
- Hunting for "bumps" in the mass spectra is the first step





Some Experimental Basics…

Number of events $= \mathcal{L}\ \sigma\ \mathrm{Br}\ A\ \varepsilon$

- Integrated Luminosity – how much beam (protons passing each other)
- Cross section – likelihood of interaction between particles
- Branching ratio – how often we get the interaction/decay we want
- Acceptance – did the event enter the detector?
- Efficiency – was the event detected? (trigger, detector, selection…)

Example: Top Search circa 1993

- Integrated luminosity: 25 pb^{-1}
- Top production cross section: 7 pb
- Branching Fraction (not to taus):
  - Lepton+lepton (plus b jets) = 5%
  - Lepton+jets = 30%
  - Multi-jet = 44%
- Acceptance*: ~30% (varies by decay, m_T)
- Efficiencies*:
  - Trigger efficiency: ~90%
  - Lepton recon. eff.: ~90% (applied twice)
  - Lepton isolation, other cuts: ~30%
  - b-tag efficiency: ~50-60% (applied once)
- Background:
  - "noise" in dilepton channel ~0.5 event

Events = $\mathcal{L}\ \sigma\ Br\ A\ \varepsilon$

= (25)(7)(0.05)(0.3)2(0.9)3(0.6)

= ~2

Did we find it?

What can be done better?

- *(Warning! Numbers are approximate)

EXAMPLE: TOP SEARCH CIRCA 1993

- Did not find the top… can set limits on mass/cross section
- Roughly equivalent to saying "We looked at low mass and didn't find it"

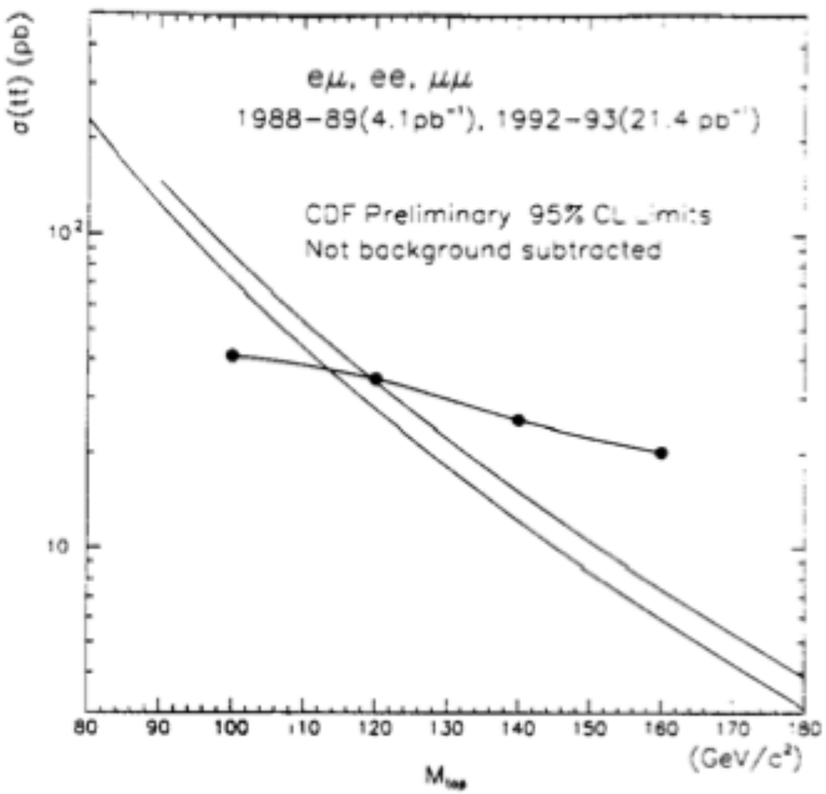
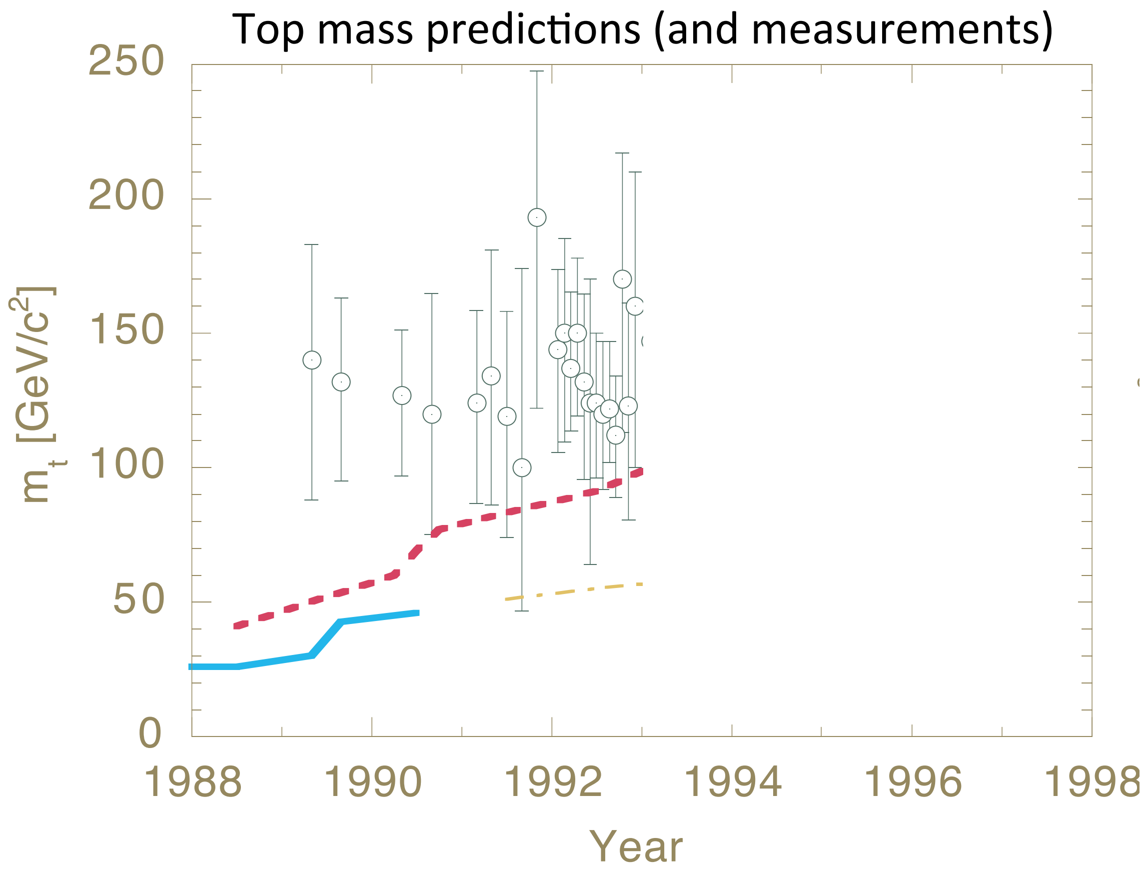


Figure 2: The experimental 95%C.L. limit on $\sigma_{t\bar{t}}$ as measured in the dilepton channel (points) and two theoretical predictions.

- *Knowing where it isn't… is still useful!*

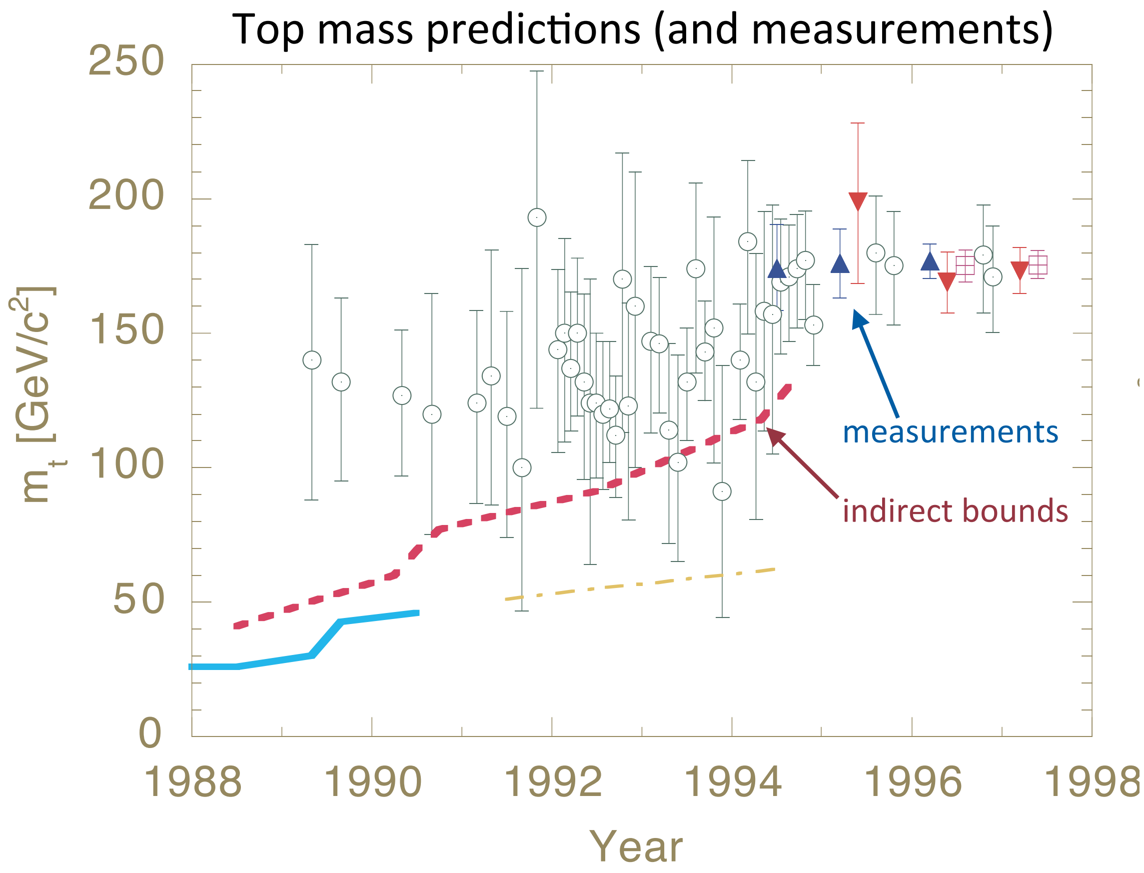
EXAMPLE: TOP SEARCH CIRCA 1993

- What can improve the sensitivity?
  - More data
  - Search more channels
  - Improve b-tagging
  - Improve selection algorithms
  - Combine many experiments
  - Go to more powerful accelerator
  - Ask a different theorist!
    (look in a different place)



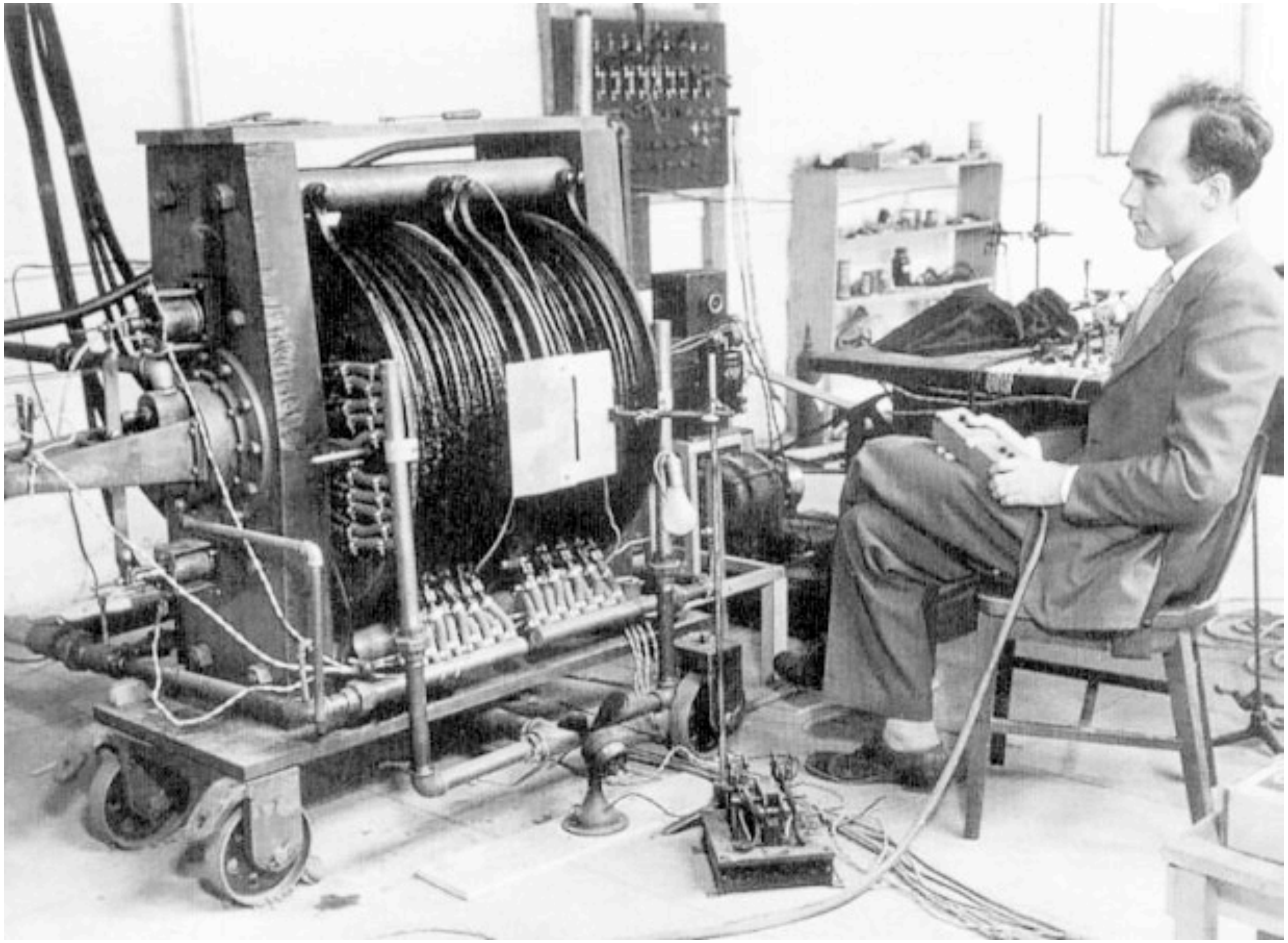
EXAMPLE: TOP SEARCH CIRCA 1993

- What can improve the sensitivity?
  - More data
  - Search more channels
  - Improve b-tagging
  - Improve selection algorithms
  - Combine many experiments
  - Go to more powerful accelerator
  - Ask a different theorist!
    (look in a different place)



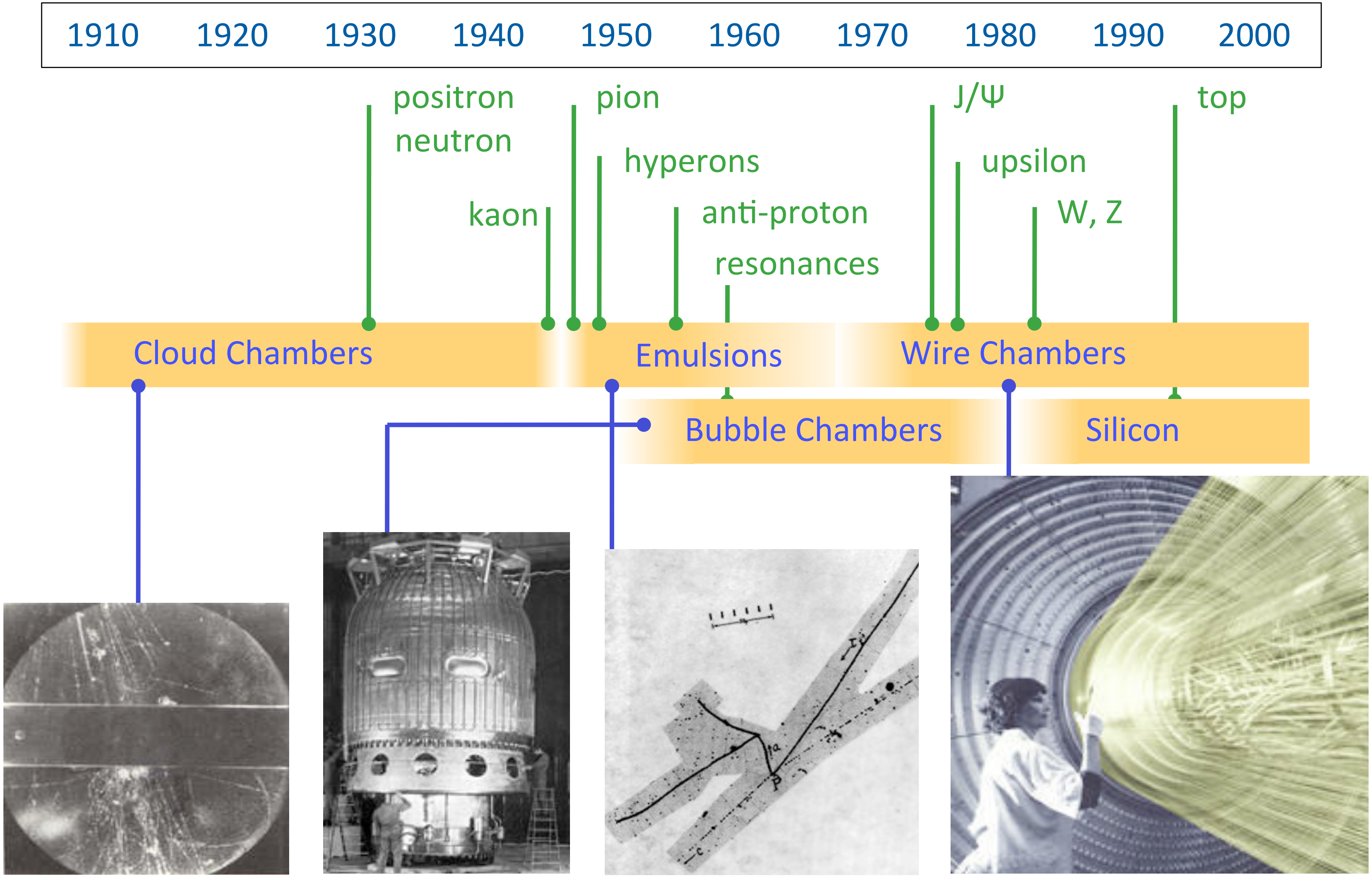
Top found in ~1995 with more data... role of detector was crucial

SEARCHES AND (OLD FASHIONED) DETECTORS



New/better detector → new physics found → Nobel prize (simple, isn't it?)

Interplay of Detectors and Discoveries



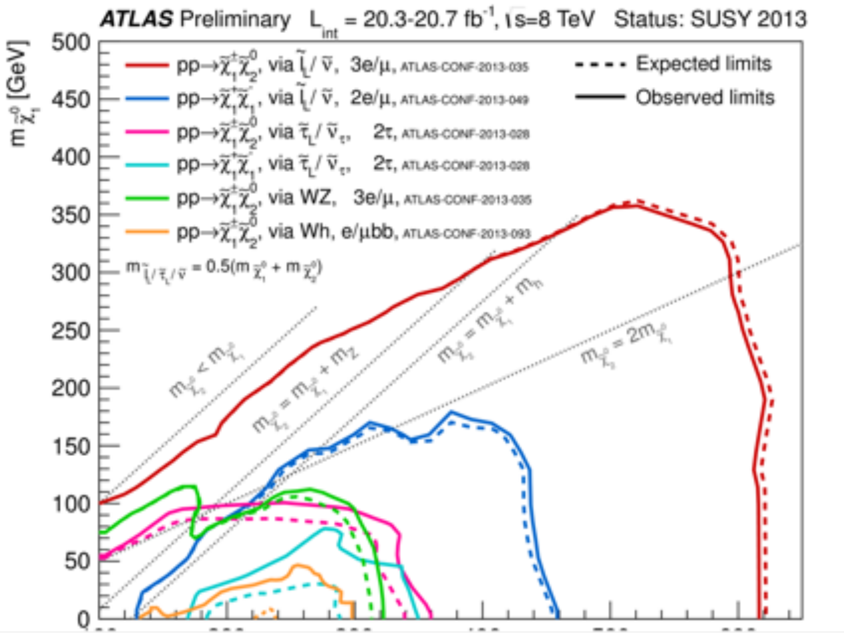
Don't underestimate the role of new technology, techniques, triggers...

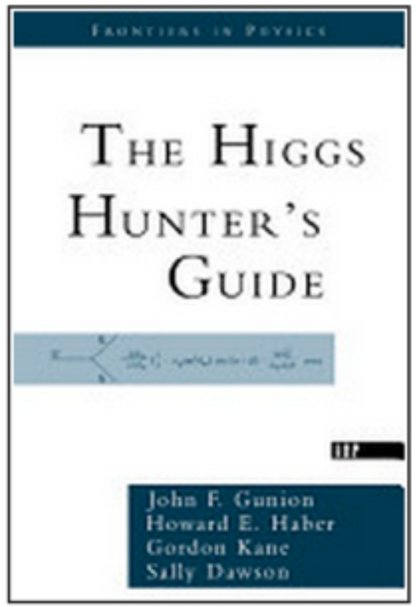
WHAT IS "EXOTIC"?

BSM AND EXOTICA: WHAT IS "EXOTICA"?

Comprehensive search of the landscape of √s = 8 TeV proton collisions

- *SUSY* provides a framework in which to search and compare results: *a map*
- *Higgs* phenomenology fleshed-out many years ago: *a guide book*
- *Exotica* searches have to cover a wide range... no set map or guide
  - with new data, race to cover as much as possible in search for BSM physics
  - now working on depth: more "general" searches, more complete coverage

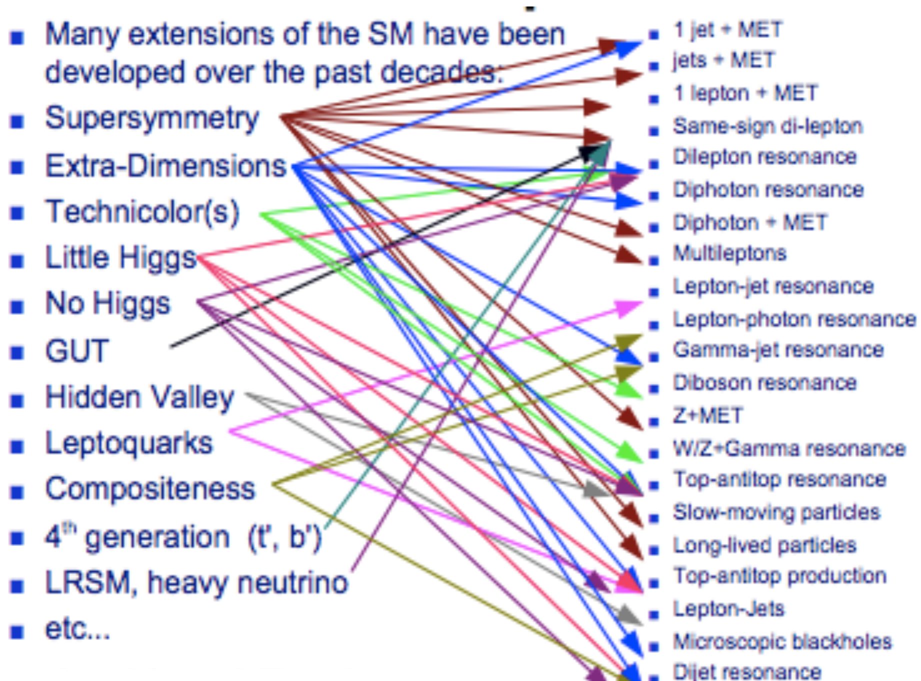




BSM and Exotica: What is "Exotica"?

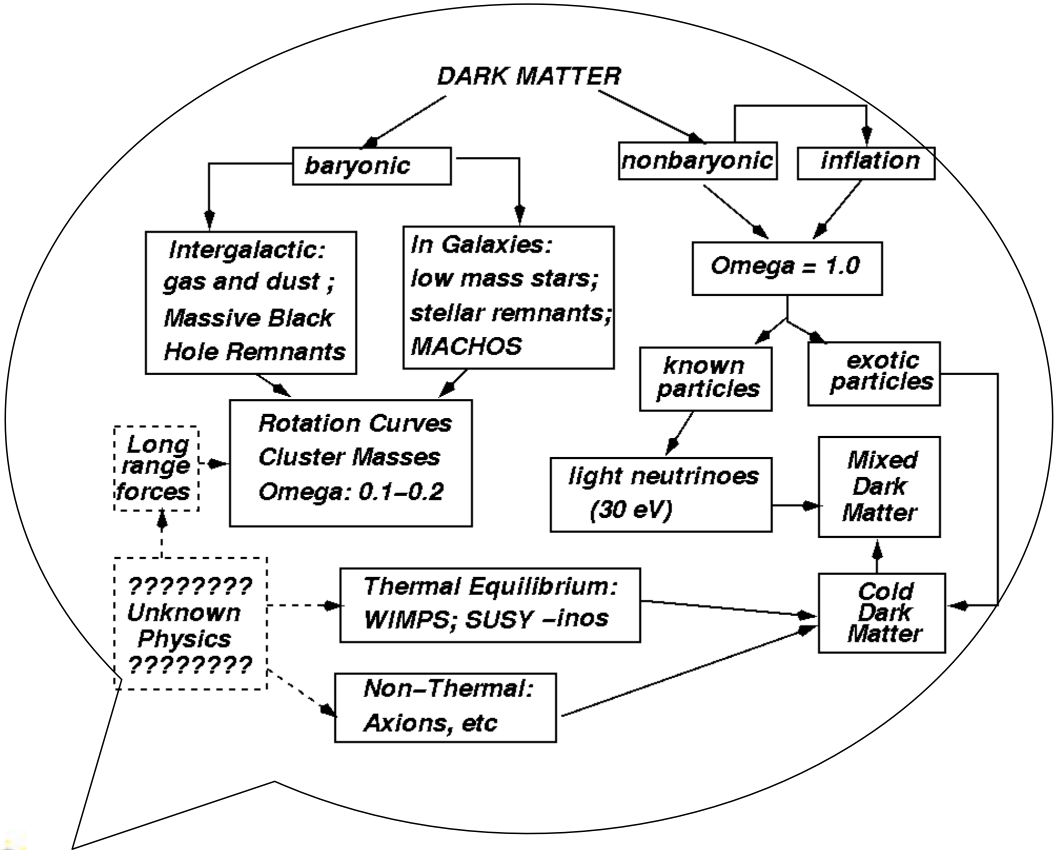
- So how to cover so much parameter space? How to conduct searches, to categorize? How do we plot out progress with few models?
- Wide variety of search strategies used
  - look for interesting features in the data – new resonant states e.g. Z', W'
  - look at all possible channels for disagreements with expectation – leptons, photons, jets
  - follow-up interesting new BSM models

[Murayama]



[Bachacou]

CAN THEORY HELP?



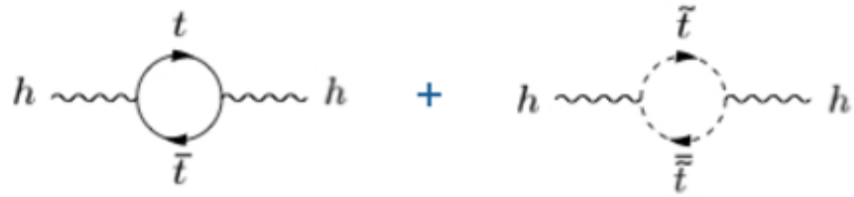
Yes, but they also need to see something new in the data

(no shortage of good ideas)

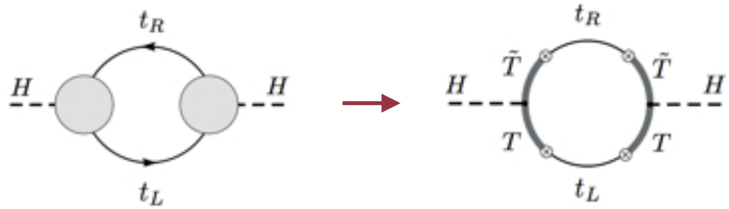
THE HIERARCHY PROBLEM

Low-mass Higgs causes tensions, but also motivates new physics at ~TeV

- Implications of Higgs as a scalar
  - radiative corrections to self-energy are divergent
  - maybe we are missing a new (fermion/scalar/vector) degree of freedom?
- Supersymmetry:
  - sparticles cancel particle contributions
  - well-studied but so far undetected



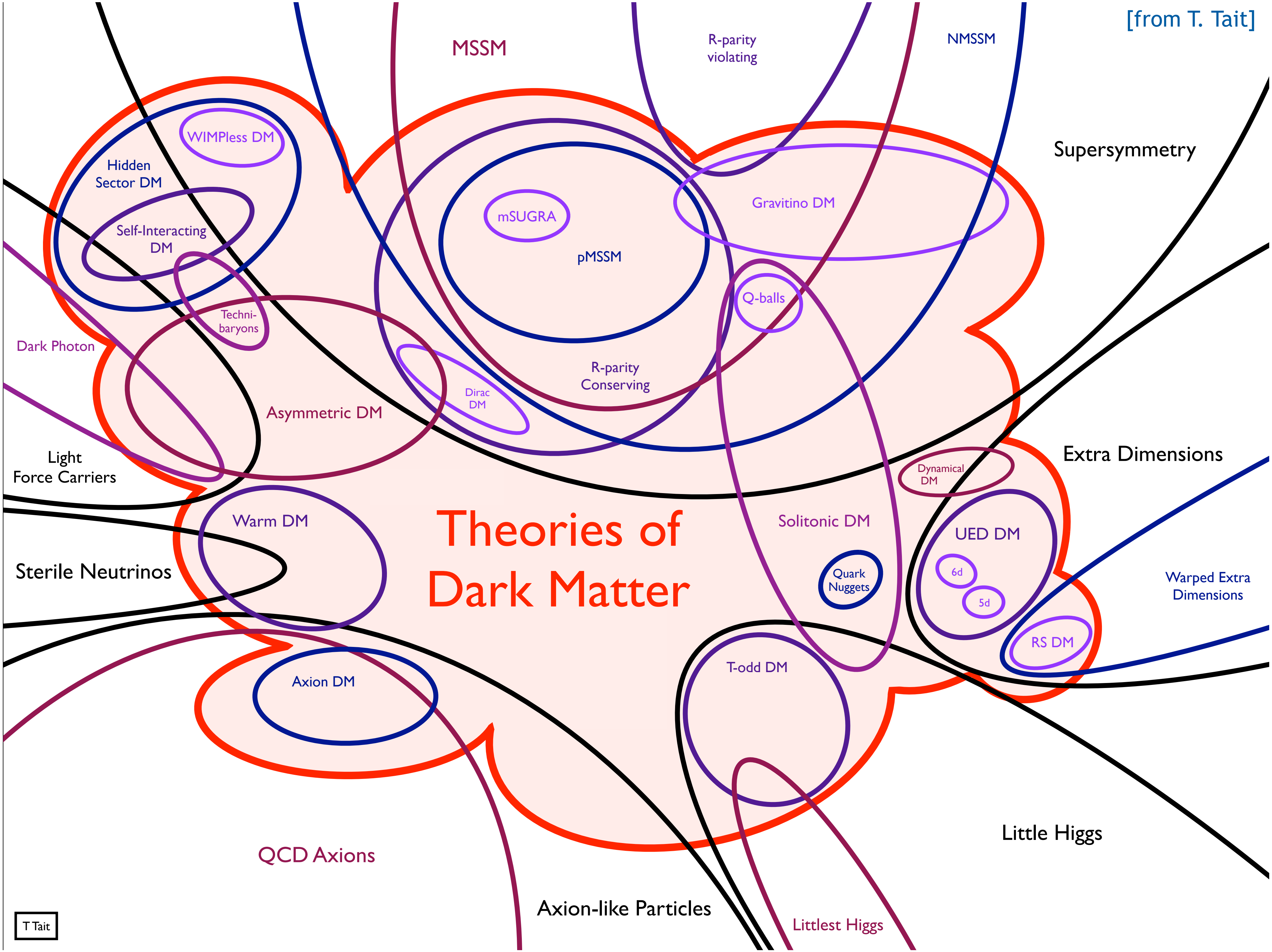
- Higgs is a composite:
  - strongly-coupled BSM, yielding vector-like q
  - multi-jet resonances from heavy gluons



- Extra Dimensions:
  - Higgs is a vector in 5D
  - motivates LED searches, KK excitations

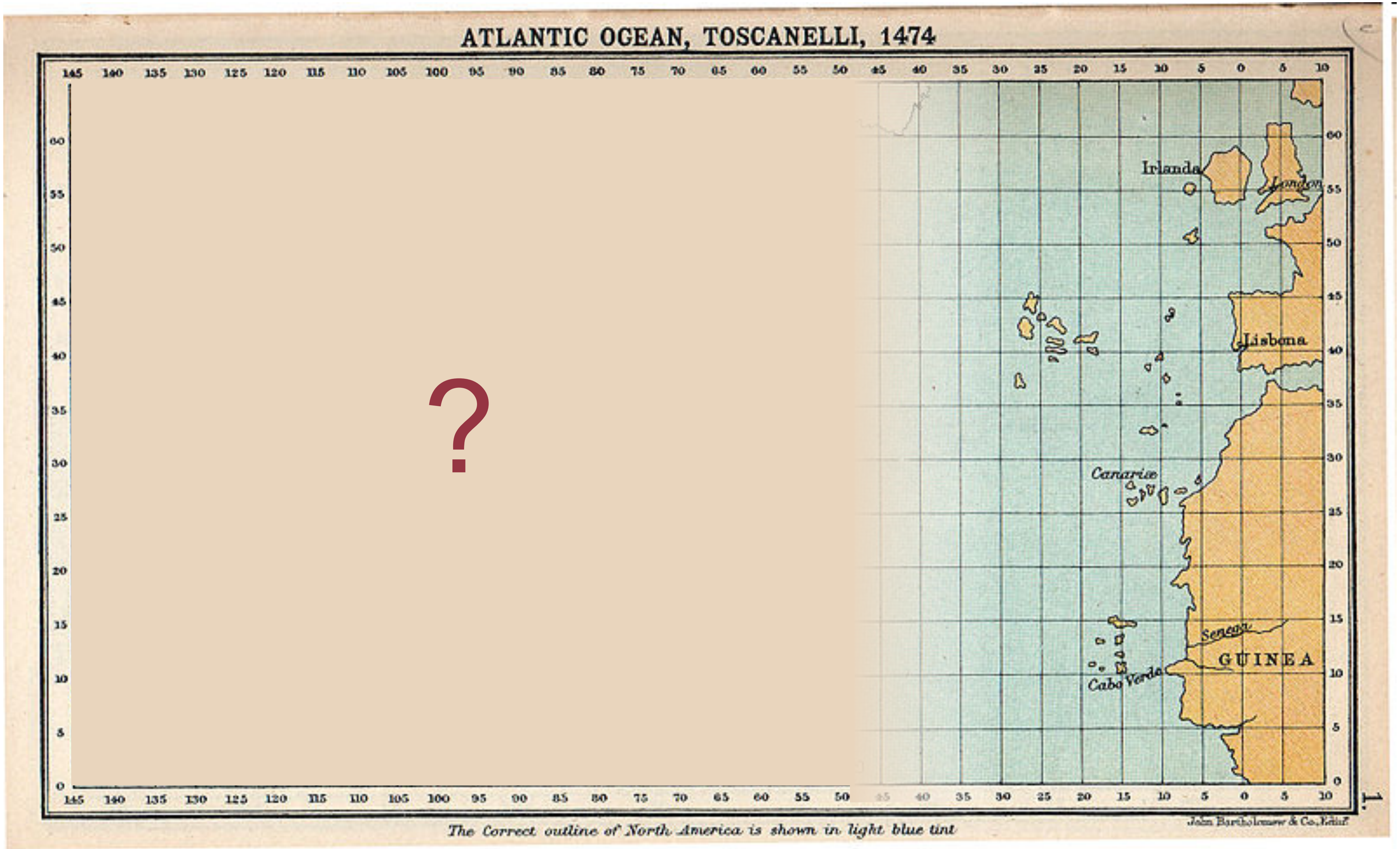
$$M_{Pl}{}^2 \sim M_D{}^{2+n} R^n$$

- Or maybe there is no fine tuning problem!
  - See for example arXiv:1306.5647


[from T. Tait]
MSSM
R-parity violating
NMSSM
Supersymmetry
WIMPless DM
Hidden Sector DM
Self-Interacting DM
Techni-baryons
mSUGRA
pMSSM
Gravitino DM
Q-balls
Dark Photon
R-parity Conserving
Dirac DM
Asymmetric DM
Light Force Carriers
Dynamical DM
Extra Dimensions
Warm DM
Theories of Dark Matter
Solitonic DM
UED DM
Sterile Neutrinos
Quark Nuggets
6d
5d
Warped Extra Dimensions
RS DM
T-odd DM
Axion DM
Little Higgs
QCD Axions
Axion-like Particles
Littlest Higgs
T Tait

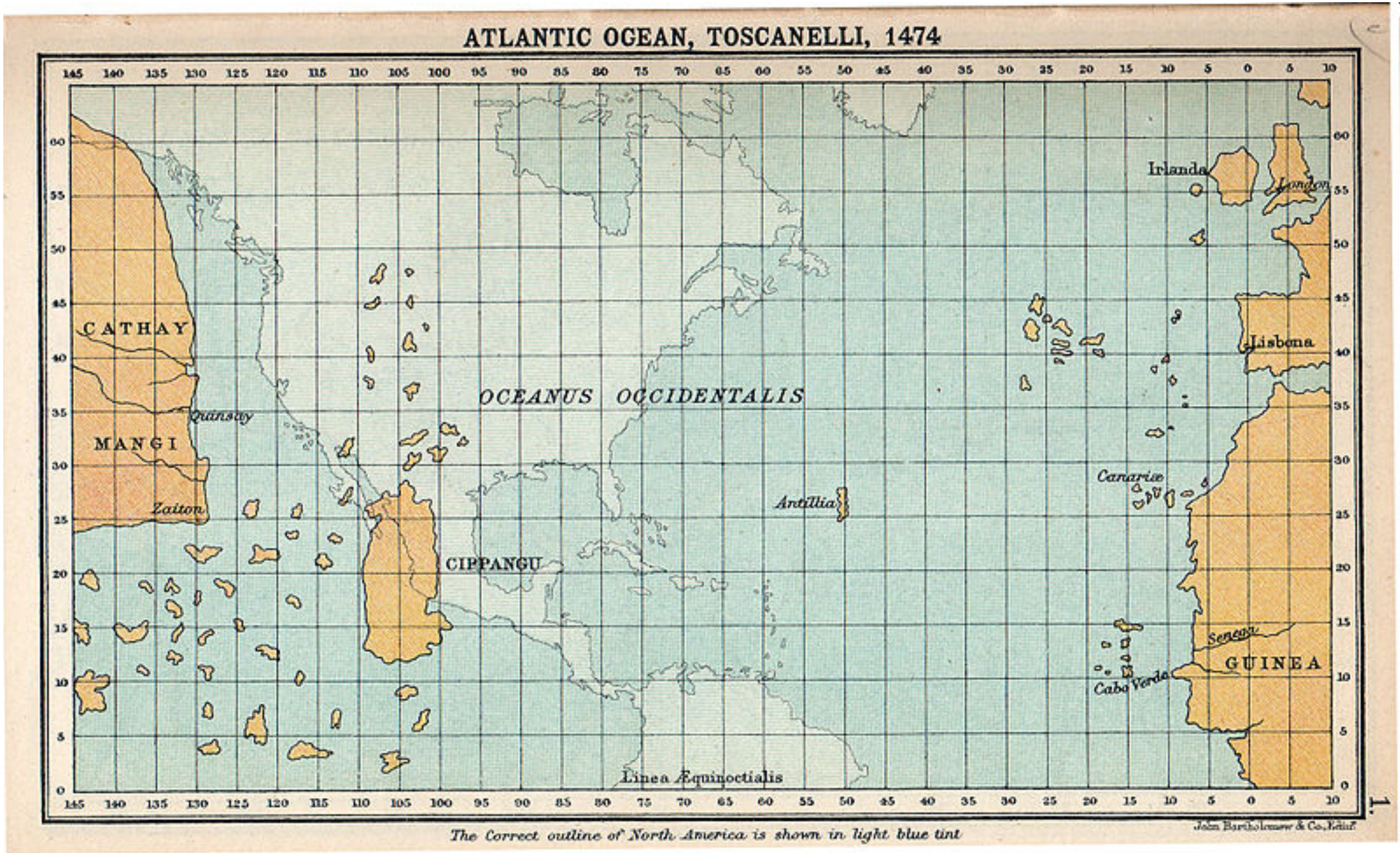
Role of Models in Exotica

[borrowed from C. Issever]



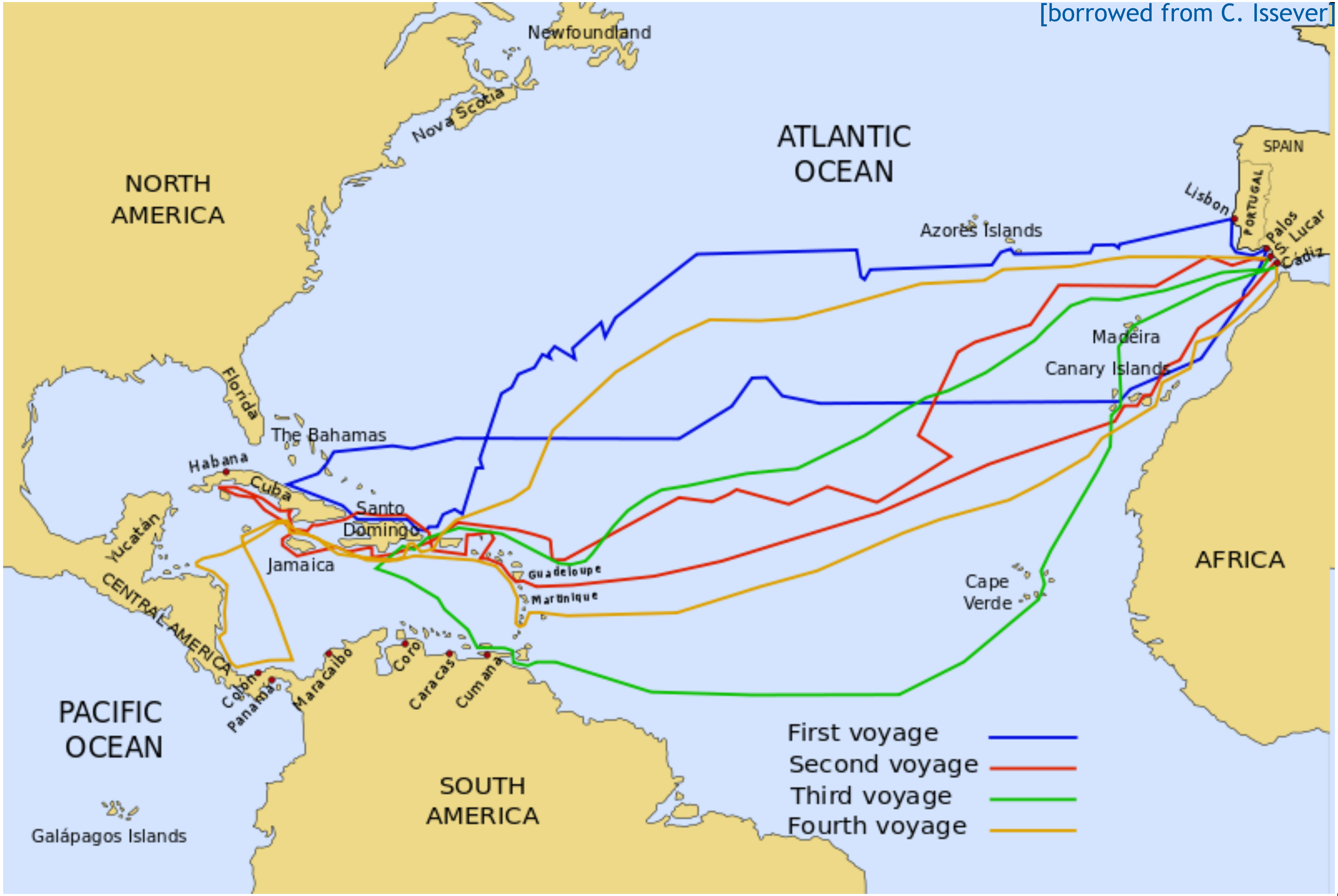
Role of Models in Exotica

[borrowed from C. Issever]

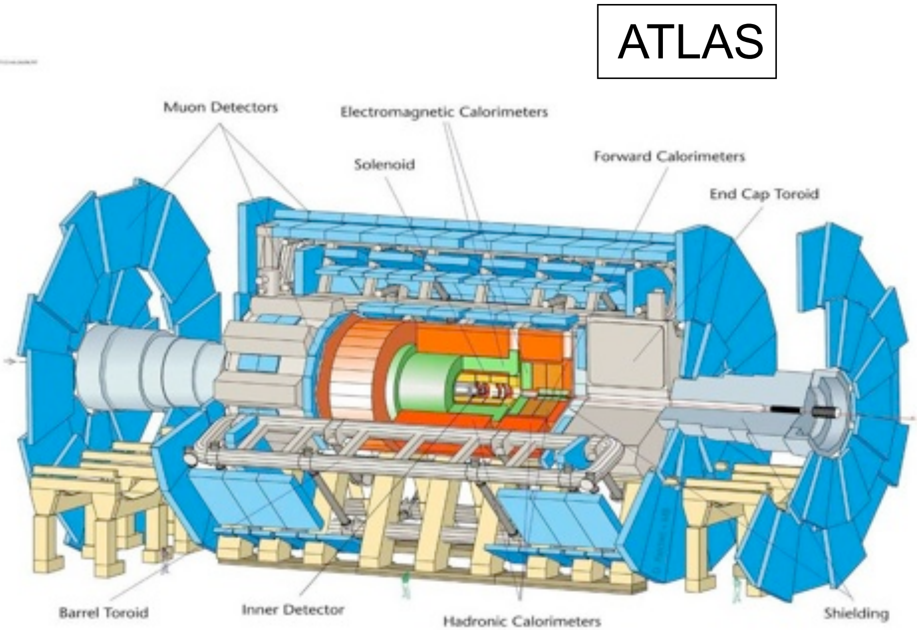


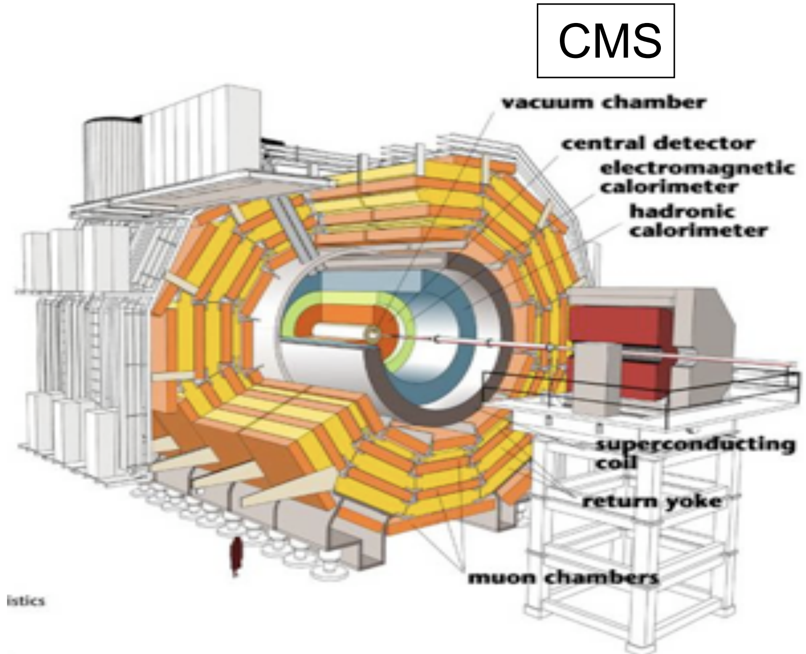
Role of Models in Exotica

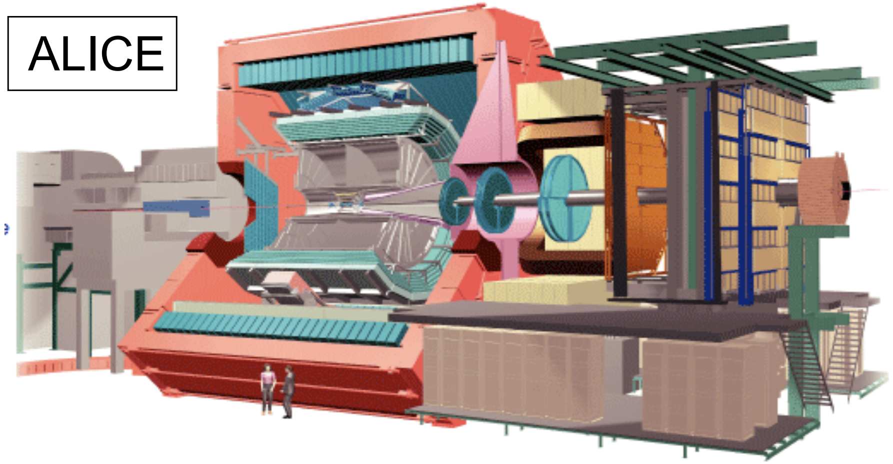
[borrowed from C. Issever]

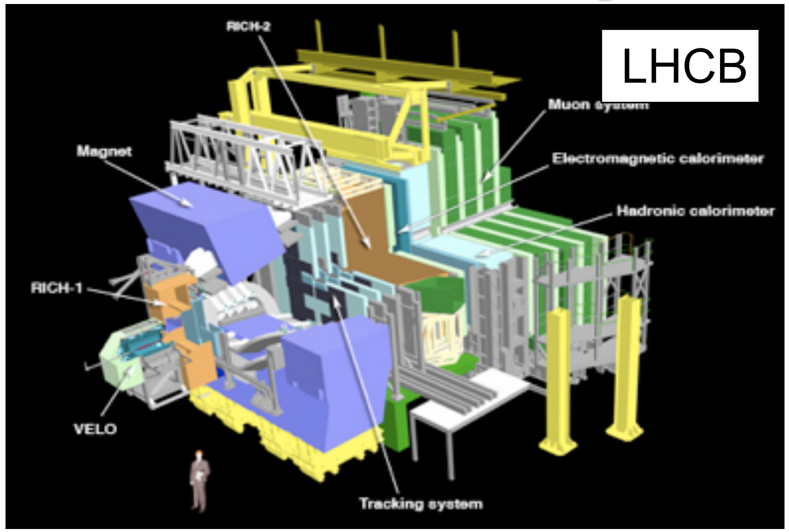


The Four Main LHC Experiments

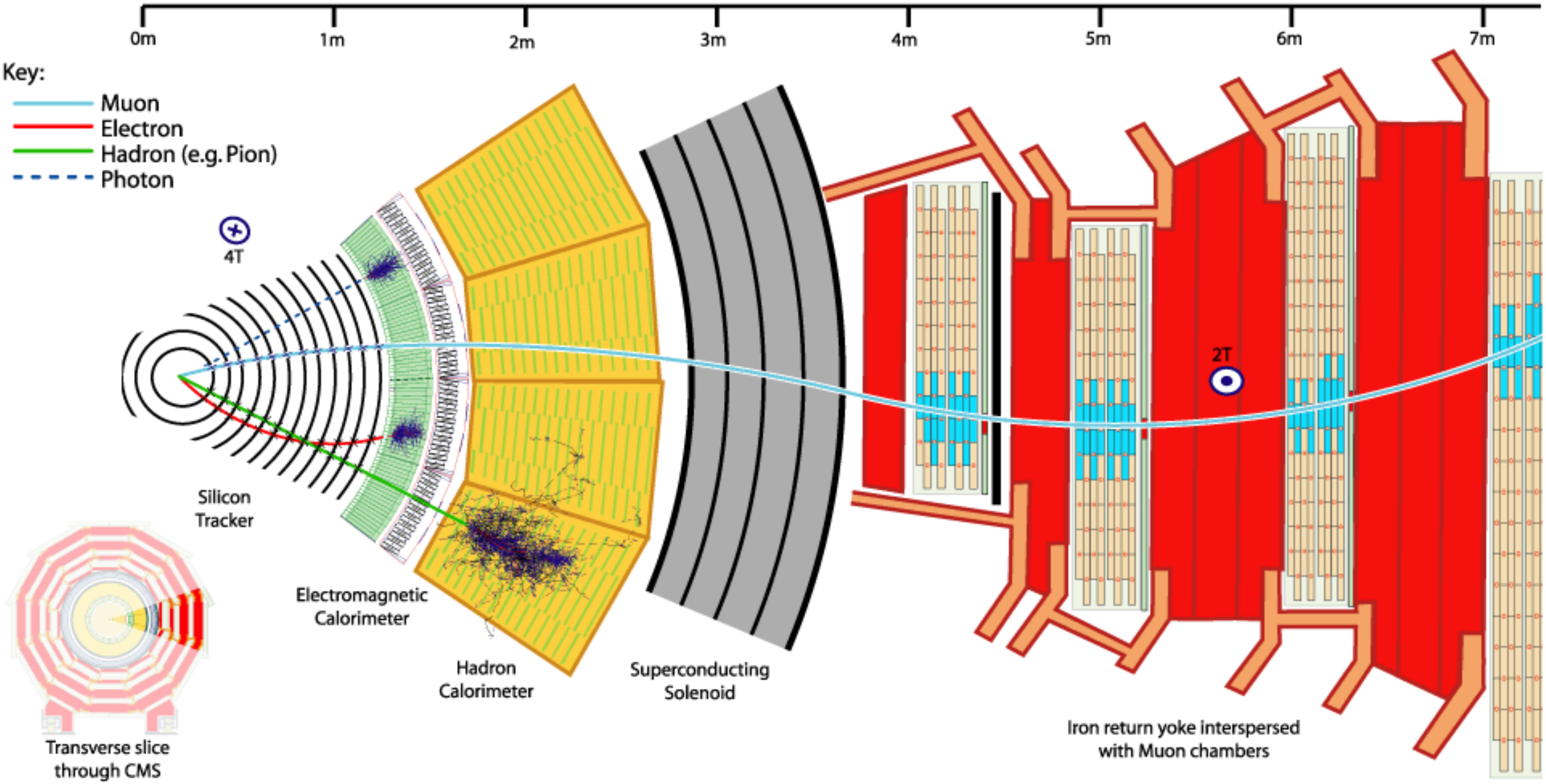






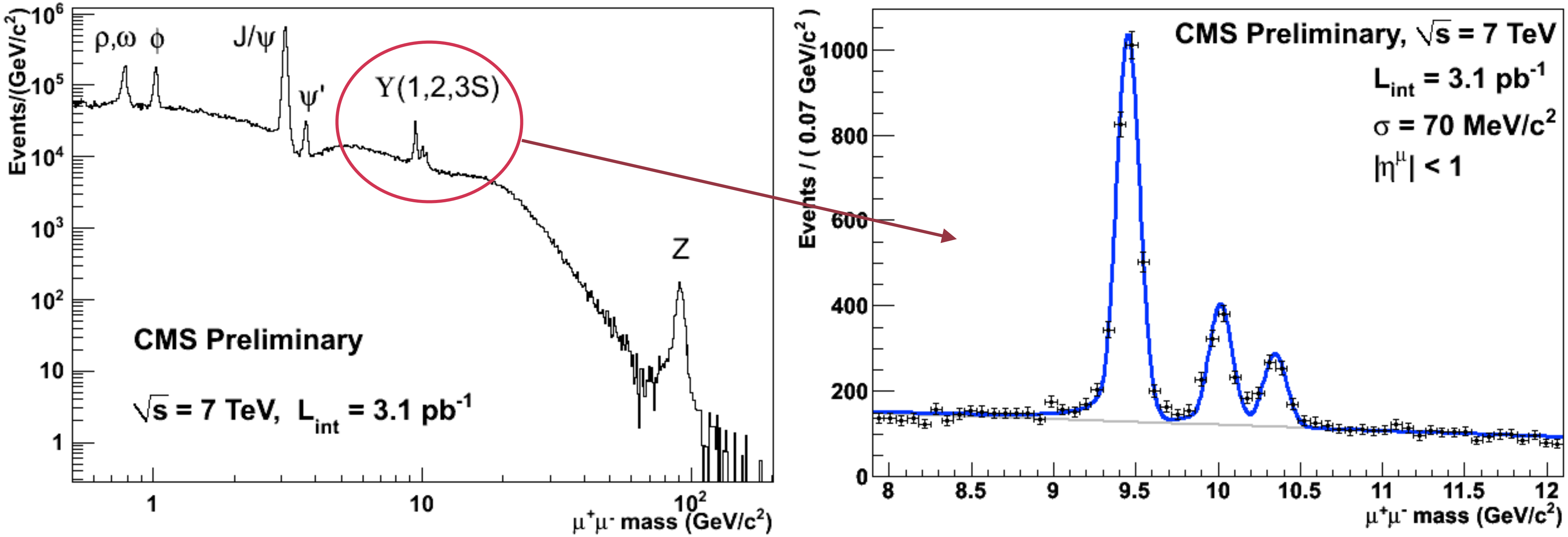


(Normal) Particles in the Detector



UPSILONS

- CMS: clear calibration peaks after only a few weeks
  - Width related to precision with which we can reconstruct the particles
  - Careful alignment will improved things, but only a little: already extremely good at 3 pb^{-1}
- ATLAS, Alice, LHCb similar: no major problems at startup



Now on to searches for higher-mass resonances...

Resonances and other "Usual Suspects": Z', W', Dijets, ...

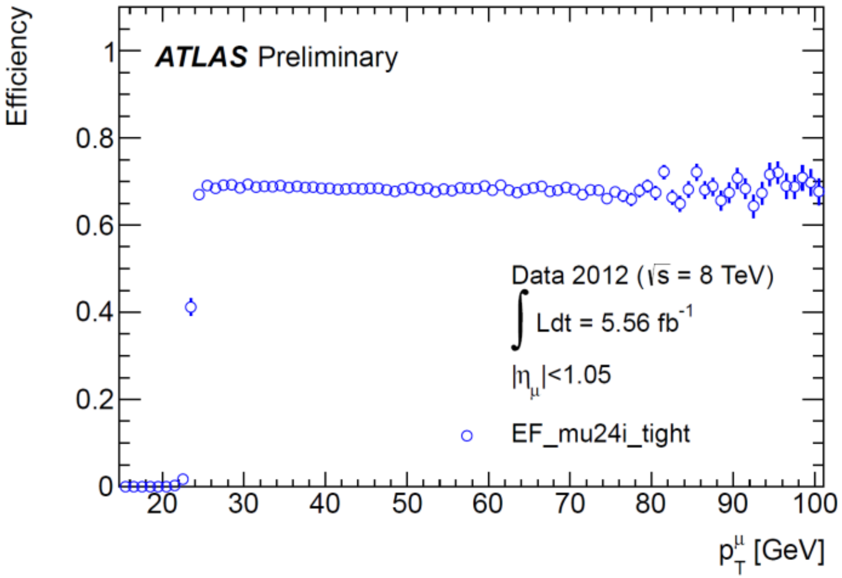
Dilepton Resonance Search: Trigger

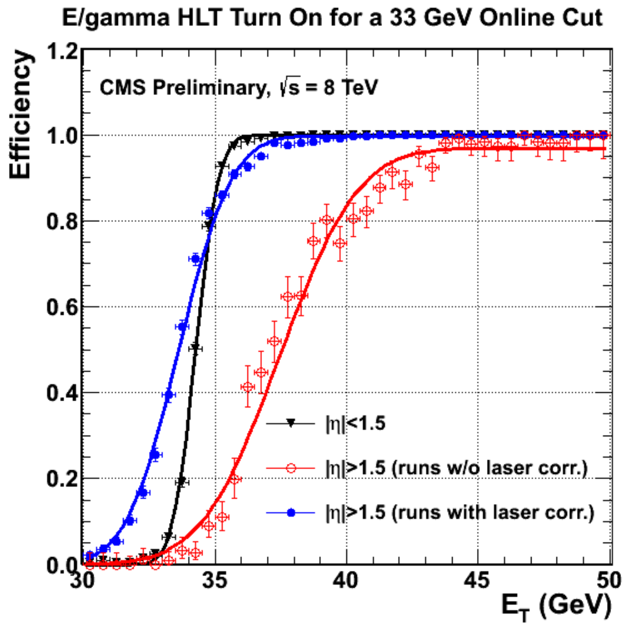
ATLAS

- ee channel
  - Diphoton trigger
  - $E_T > 35$ GeV and $E_T > 25$ GeV
- μμ channel
  - Single muon triggers
  - $E_T > 24$ GeV or $E_T > 36$ GeV

CMS

- ee channel
  - Dielectron trigger
  - Both clusters w $E_T > 33$ GeV
- μμ channel
  - single muon trigger
  - $E_T > 40$ GeV





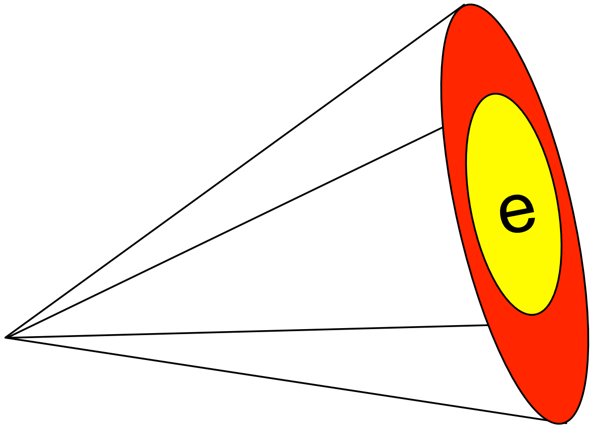
EM CALORIMETRY (ATLAS)

Barrel Liquid Argon Calorimeter

Accordion Sampling Layers

DILEPTON RESONANCE SEARCH: ELECTRONS

- Electron p_T thresholds similar
- Jets fake electrons: use isolation to reduce fakes



ATLAS	CMS
E_T^1>40GeV	E_T^1>35GeV
E_T^2>30GeV	E_T^2>35GeV

	ATLAS	CMS	
leading	$I^{calo}_{0.2}$<0.7%·E_T + 5 GeV	$I^{tracker}_{0.3}$<5 GeV	$I^{Calo}_{0.3}$<3%·E_T
subleading	$I^{calo}_{0.2}$ <2.2%·E_T + 6 GeV		

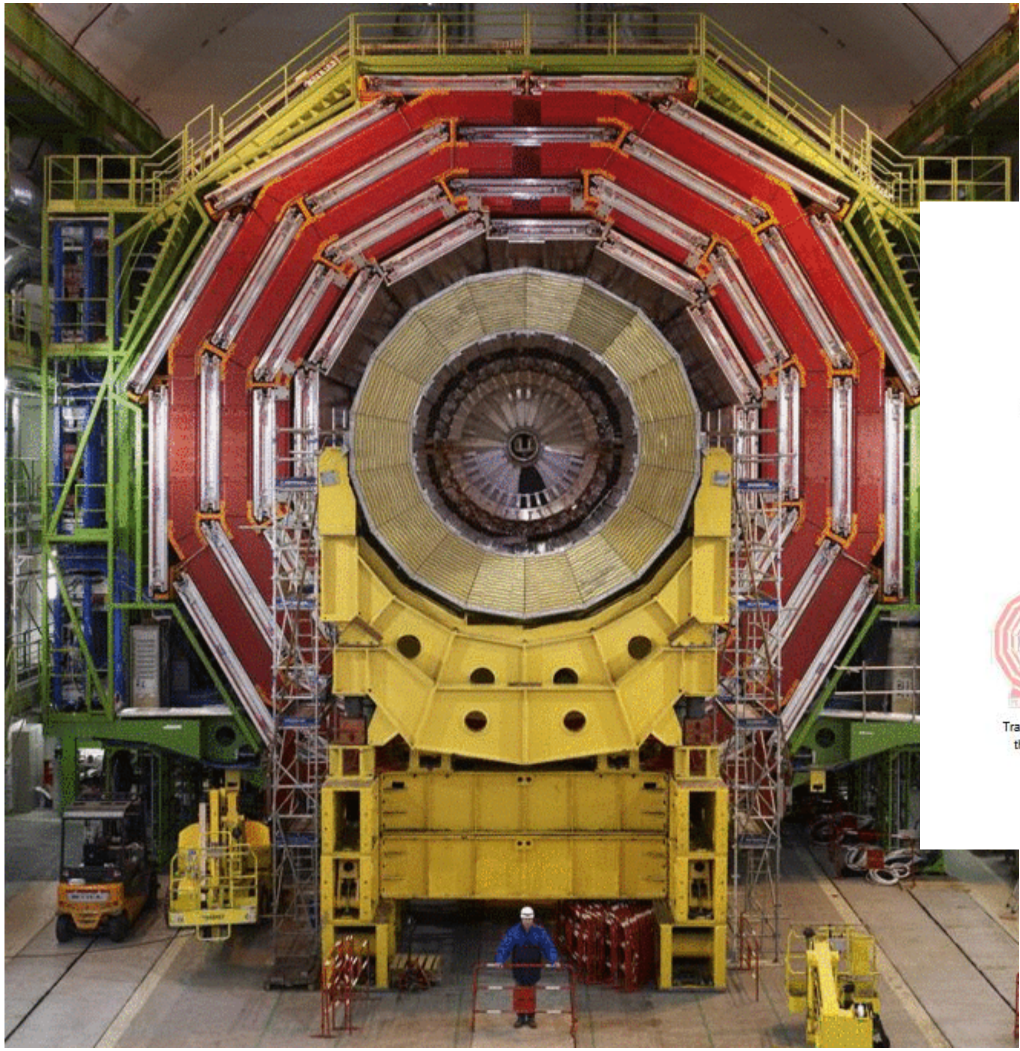
ATLAS

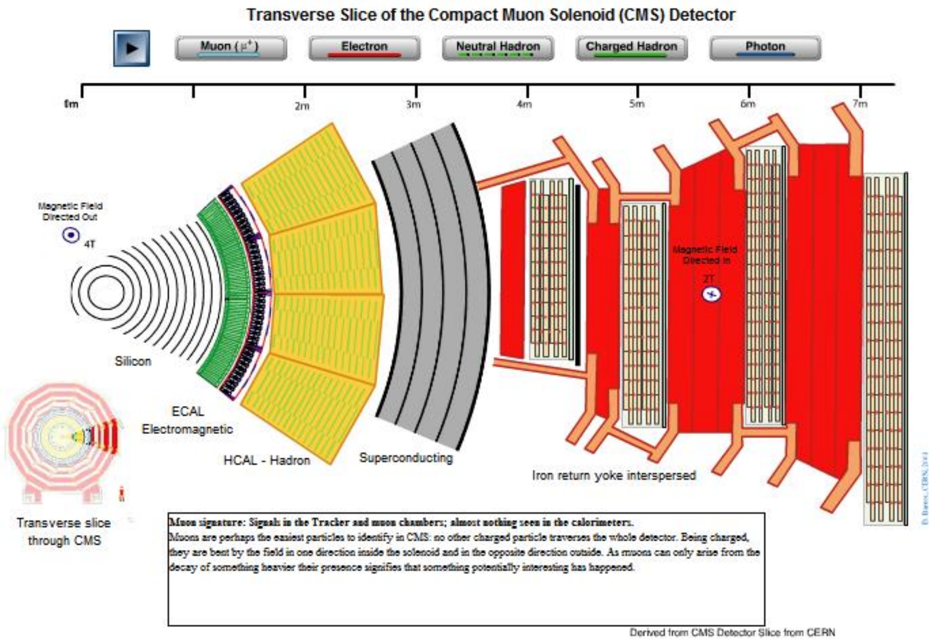
- *A x ε = 73%* (m = 2 TeV)

CMS

- *A x ε = 67%* (m = 2.5 TeV)

MUON DETECTORS (CMS)





Dilepton Resonance Search: Muons

ATLAS

- Single muon triggers
  - $p_T > 25$ GeV
  - $|\eta| < 2.4$
- Suppress cosmic rays
  - $|d_0| < 0.2$ mm
  - $|z_0 - z_{(vertex)}| < 1$ mm
- Suppress jets faking μ's
  - $\sum p_T(\Delta R<0.3) < 5\% \cdot p_T$
- Require opposite charge

- *A x ε = 46%* (m = 2 TeV)

CMS

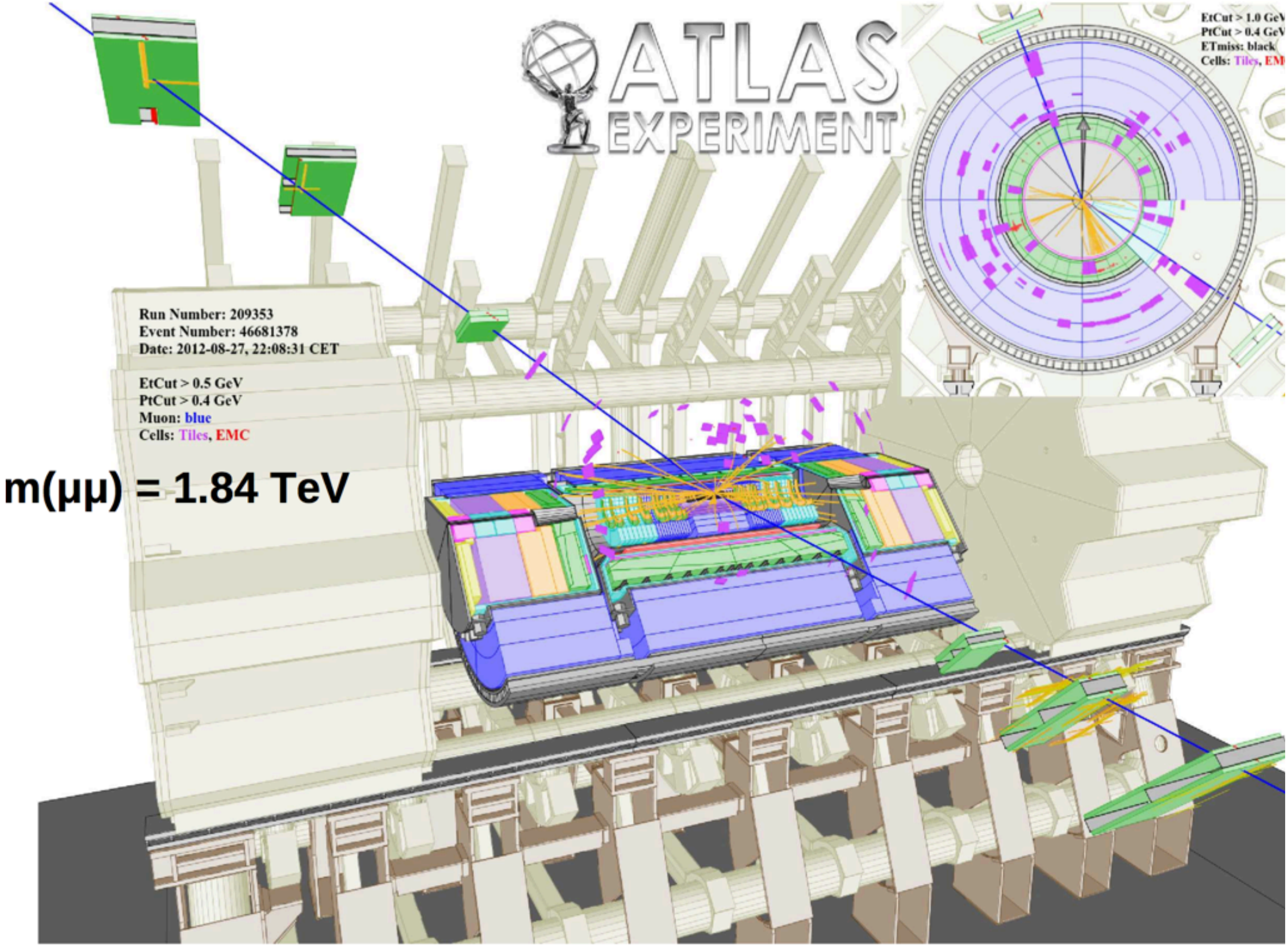
- Single muon trigger
  - $p_T > 45$ GeV
  - $|\eta| < 2.4$
- Suppress cosmic rays
  - $|d_0| < 0.2$ mm
  - $|z_0 - z_{(vertex)}| < 24$ cm
- Suppress jets faking μ's
  - $\sum p_T(\Delta R<0.3) < 10\% \cdot p_T$
  - $|z0 - z(vertex)| < 0.2$mm
- Require opposite charge

- *A x ε = 80%* (m = 2.5 TeV)

Dilepton Resonance Search: Backgrounds

- SM Drell-Yan: $\gamma^*/Z \rightarrow l^+l^-$
  - shape taken from Monte Carlo
  - normalisation taken from Z peak in data
- t-tbar:
  - where tt goes to e+e-, μ+μ-
  - est. from MC, cross-checked in data
  - also includes Z->ττ, WW, WZ
- Jet Background (for ee):
  - di-jet, W+jet events where the jets are misidentified as electrons/muons
- Cosmic Ray Background (for μμ):
  - muons from cosmic rays
  - estimated <0.1 event after vertex and angular difference requirements

...Start taking data and what do we see?

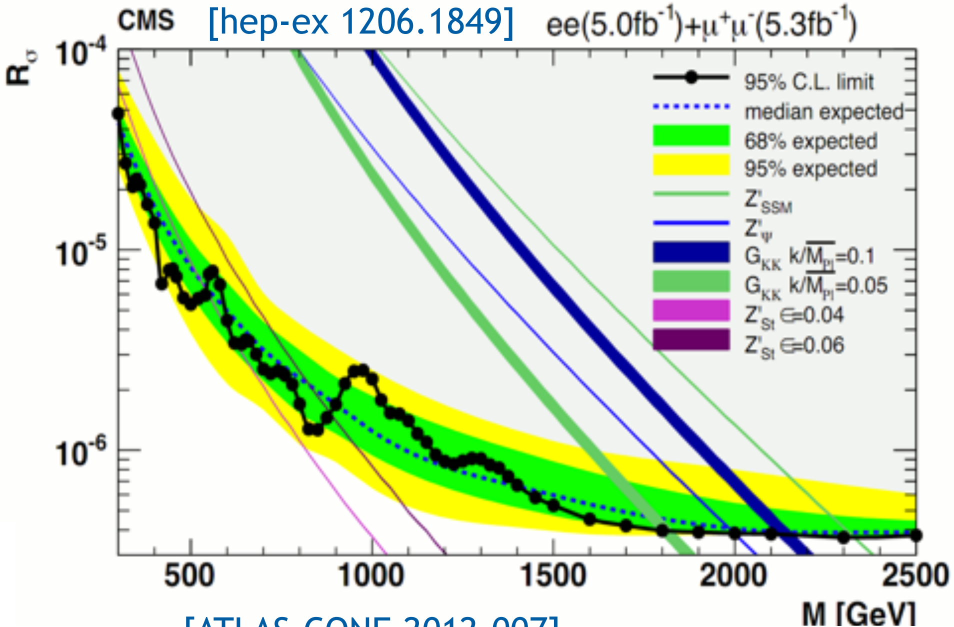

ATLAS
EXPERIMENT
Run Number: 209353
Event Number: 46681378
Date: 2012-08-27, 22:08:31 CET
EtCut > 0.5 GeV
PtCut > 0.4 GeV
Muon: blue
Cells: Tiles, EMC
m(μμ) = 1.84 TeV
EtCut > 1.0 GeV
PtCut > 0.4 GeV
ETmiss: black

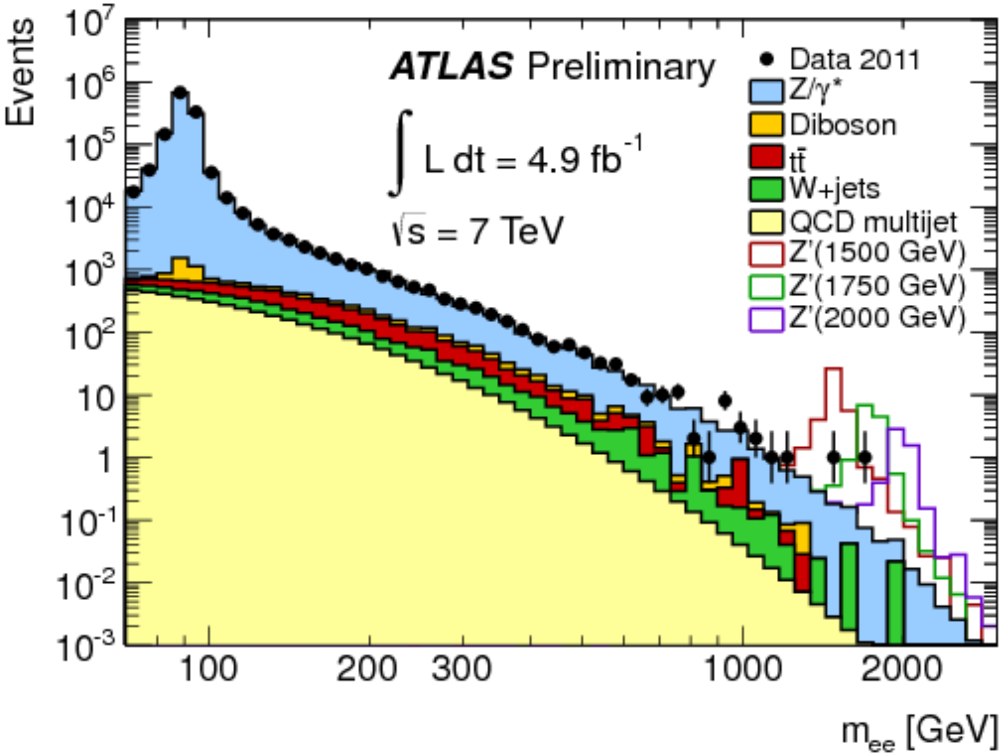
slide circa March 2012

Z' IN 2011 DATA?

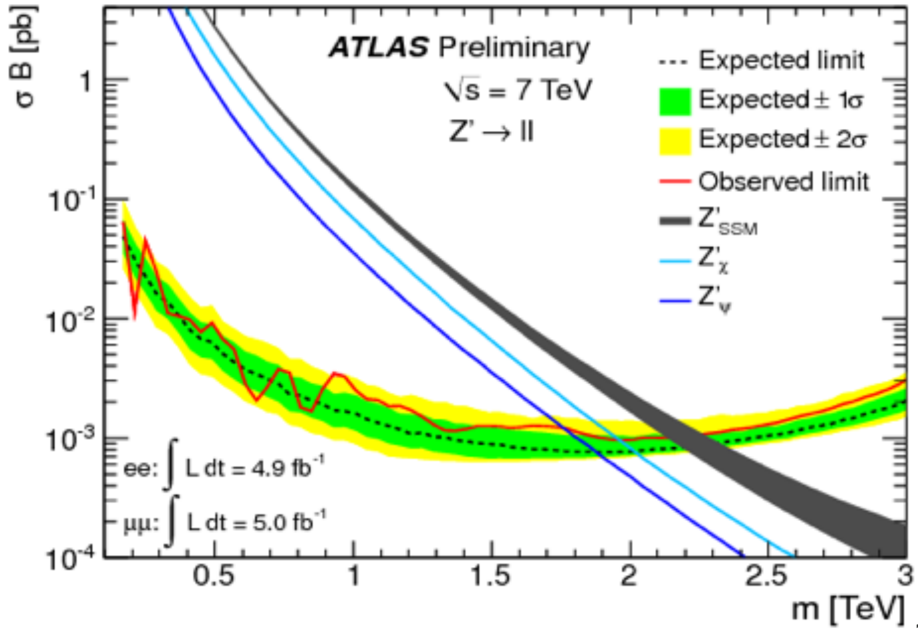
- Many new models have Z-like narrow resonances decaying to dileptons
- Interesting features in dilepton spectra
  - around 2σ each for CMS & ATLAS in e+μ
  - similar in scale to 2011 Higgs excess

Worth watching in 2012's 8 TeV data...





[ATLAS-CONF-2012-007]

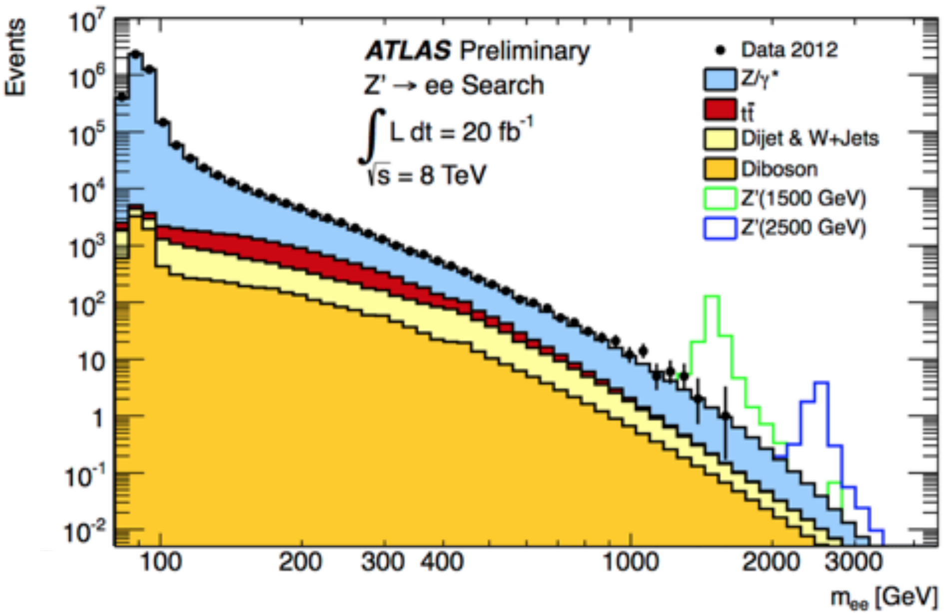


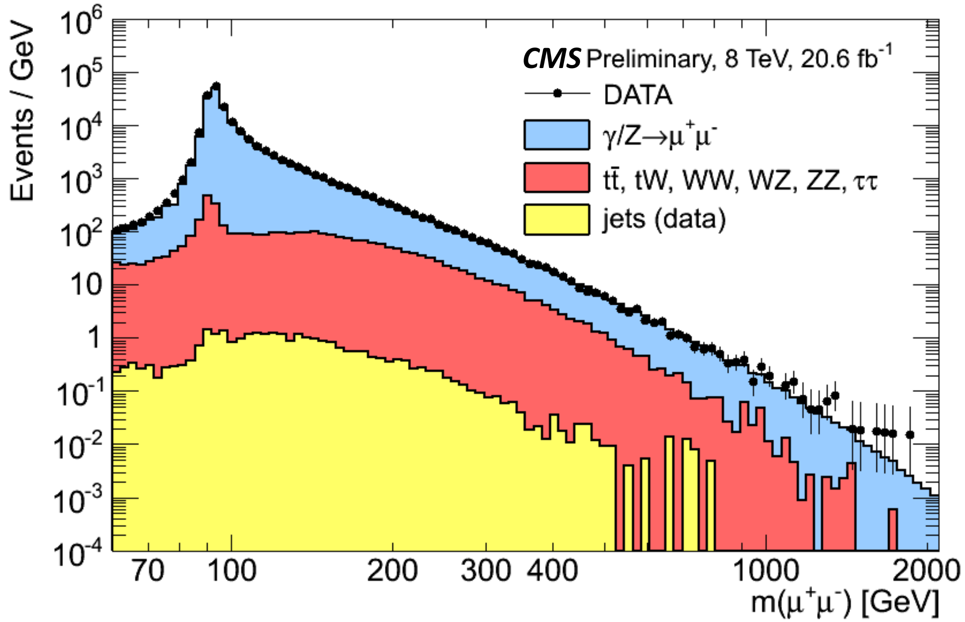
Dilepton Resonance Search

[ATLAS-CONF-2013-017, CMS EXO-12-061]

- Event selection
  - CMS: E_T (e1,e2) > 35 GeV, p_T (μ1,μ2) > 45 GeV, plus isolation criteria
  - ATLAS: E_T (e1,e2) > (40,30) GeV, p_T (μ1,μ2) > 25 GeV, plus isolation criteria
- Backgrounds
  - Z/γ*, tt, tW, VV, Z → ττ, multijets with ≥1 jet reconstructed as lepton
  - estimated by functional fit

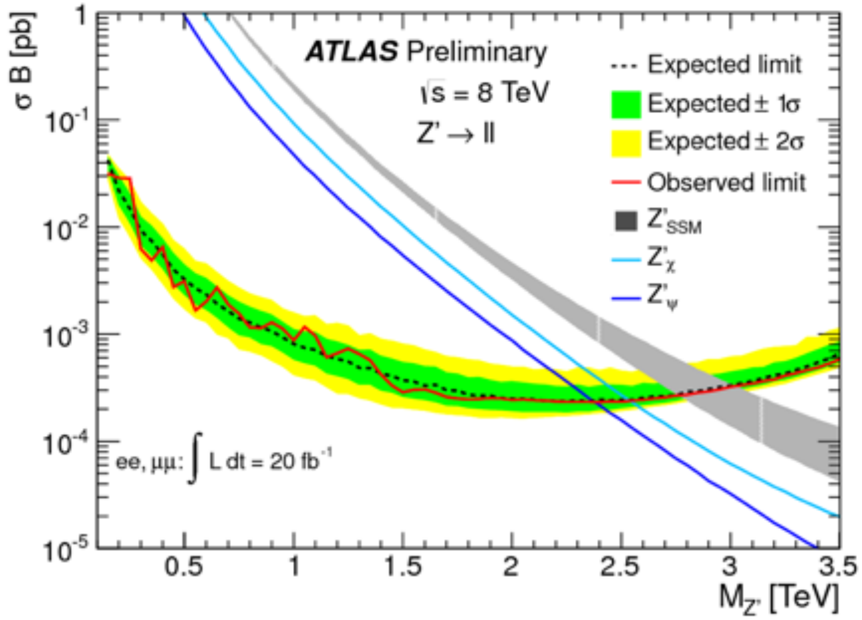
No obvious excess observed in 2012 data

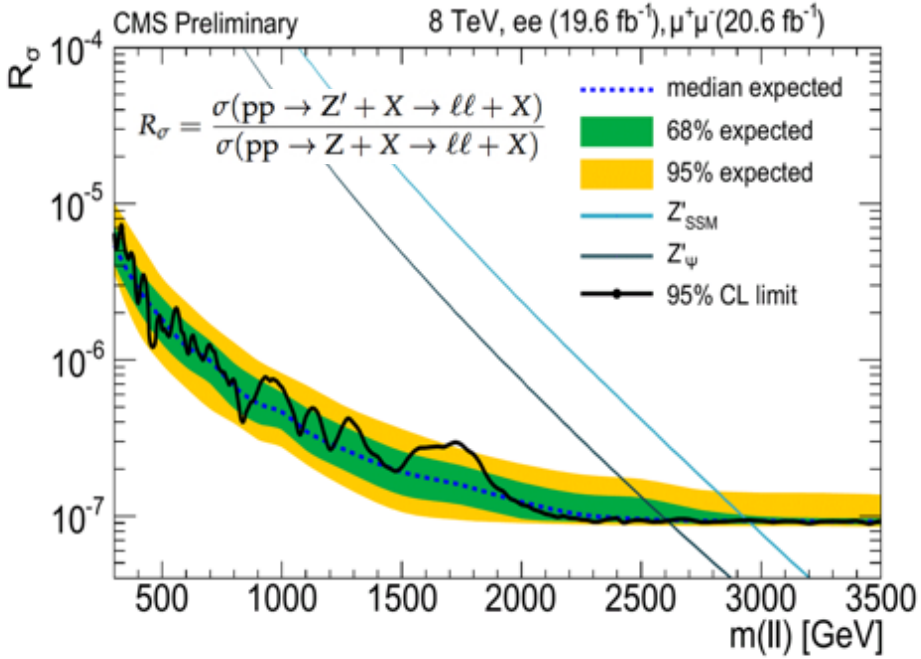




Search for Z' (Dilepton Resonance)

- Both experiments analysed full 8 TeV datasets, combined ee and μμ channels
- No excess; limits set for a variety of narrow resonances (Z'_{SSM}, Z'_{ψ}, etc.)



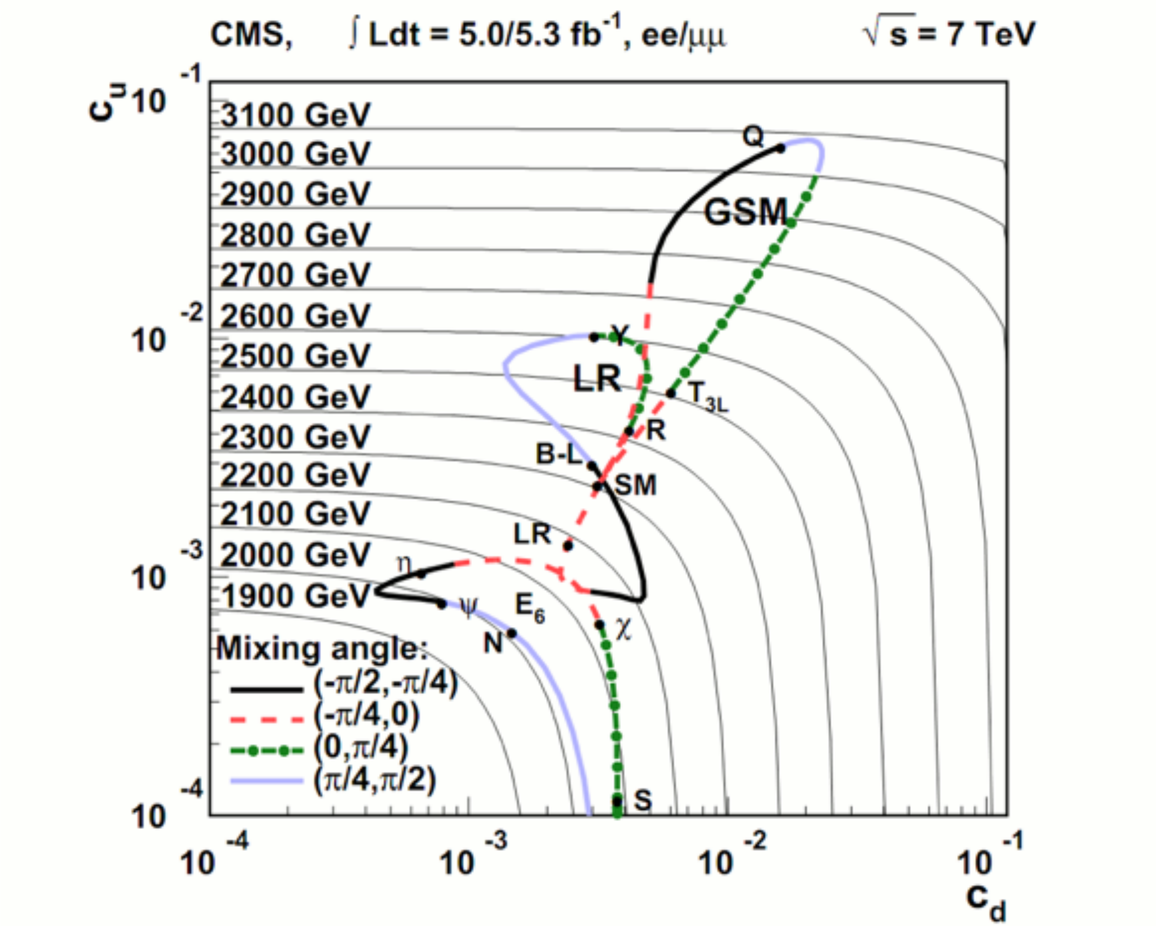


$M(Z'_{SSM})$	expected	observed
CMS	> 2.96 TeV	> 2.96 TeV
ATLAS	> 2.85 TeV	> 2.86 TeV

Excess in 2011 data just below 1 TeV all but gone in 2012

SEARCH FOR Z' (DILEPTON RESONANCE)

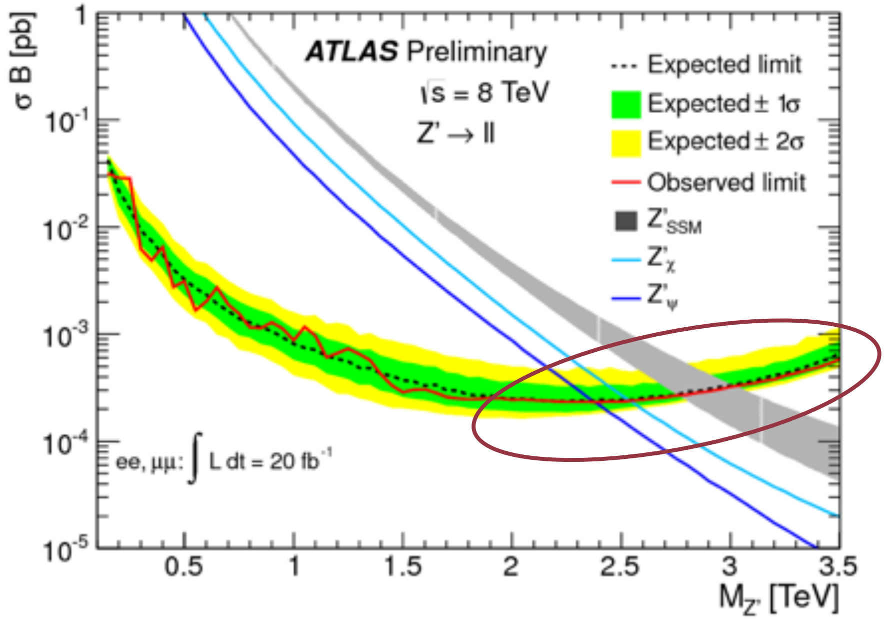
- Working to extend usefulness of search by (for example) plotting vs coupling
- Can plot many Z'-like models in one, unfortunately not a simple mass-vs-coupling

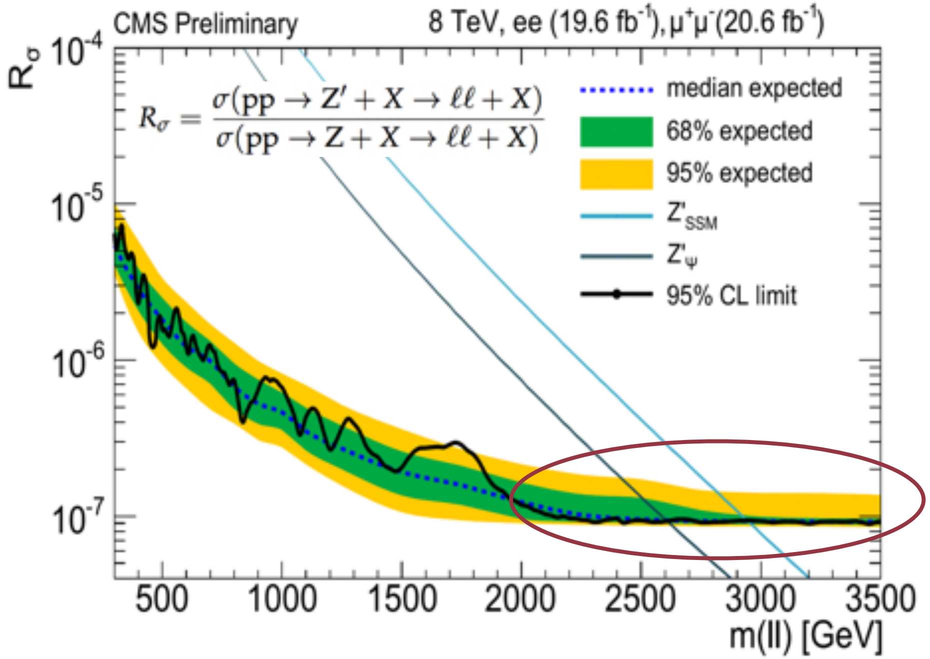


For theorists: if our searches are almost what you want, but not quite, then contact us

Search for Z' (Dilepton Resonance)

- Both experiments analysed full 8 TeV datasets, combined ee and μμ channels
- No excess; limits set for a variety of narrow resonances (Z'_{SSM}, Z'_{ψ}, etc.)



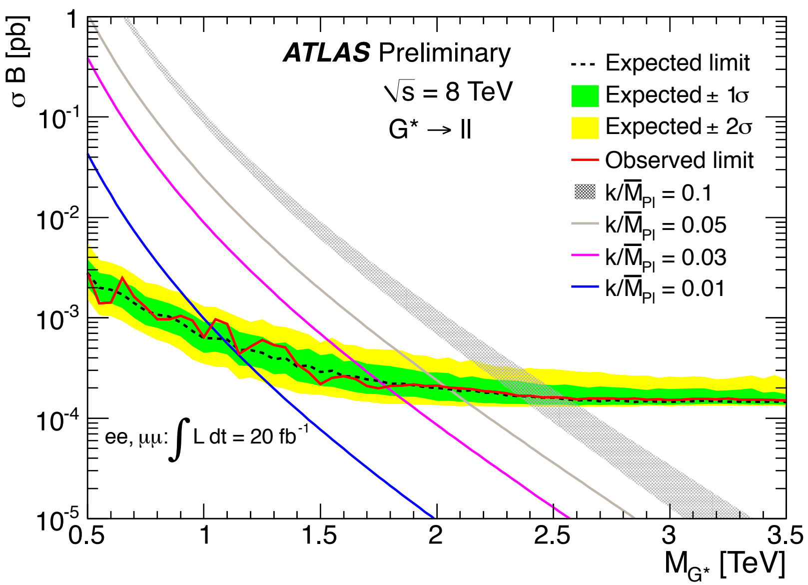


Interesting also to look at the differences in the searches...

ATLAS AND CMS DIFFERENCES?

ATLAS

- Uses signal templates for Z' limits
- Loss of sensitivity at high masses (parton luminosities)
- Cross section limits model-specific
- narrow resonance G* has no rise:



CMS

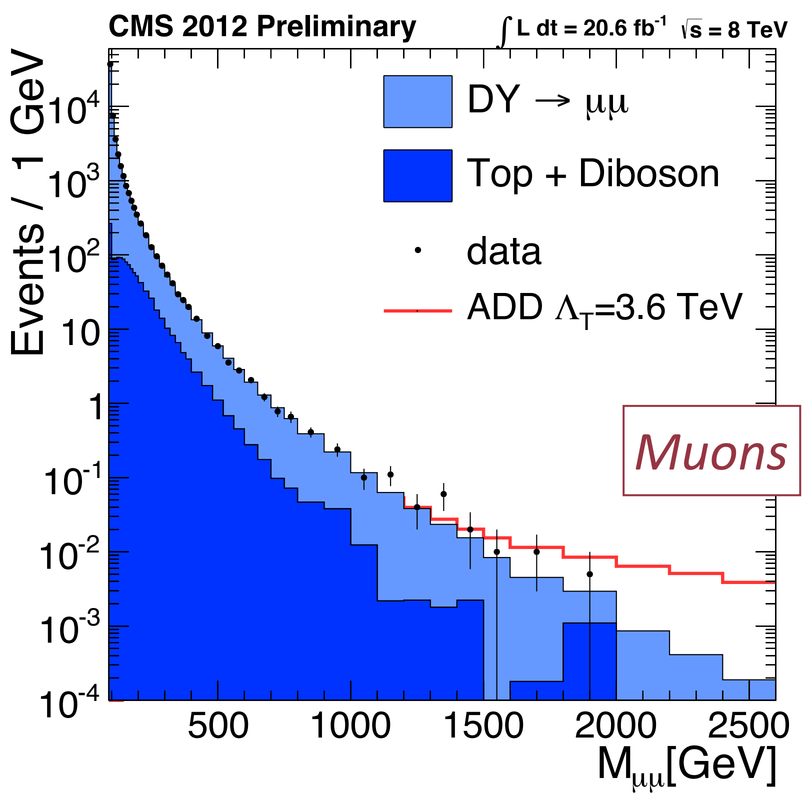
- Use narrow resonance window
  - Cross section upper limits less model dependent
  - Give outside world description of what was done
- Take signal shapes within ±40% of the mass peak into account to compute theory curves
- Not sensitive to parton luminosities
- Generic resonance search

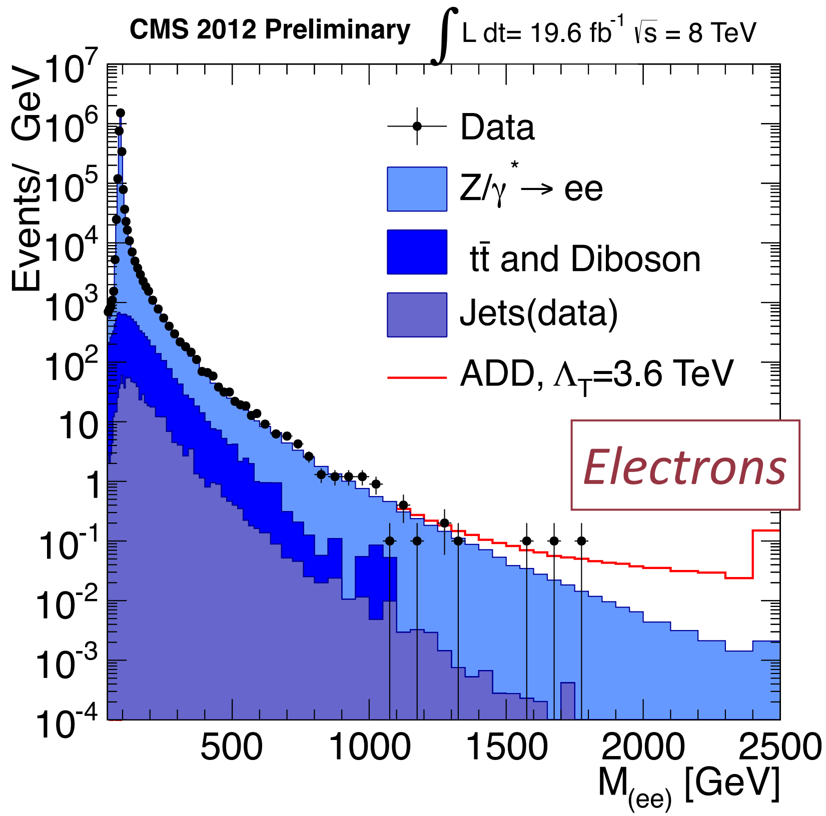
Big difference in efficiency and approach... small difference in limit

SEARCH FOR EXTRA DIMENSIONS IN DILEPTONS

[CMS EXO-12-027, CMS EXO-12-031]

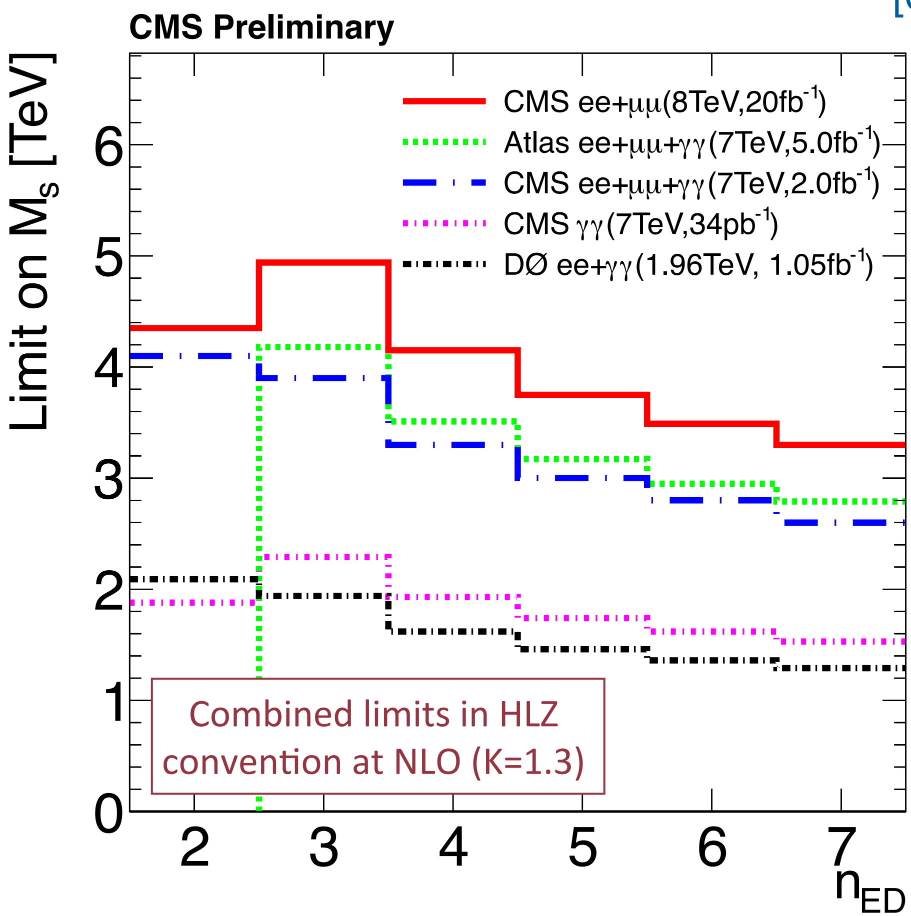
- Extra Dimension search in dilepton invariant mass spectra (same as Z')
- Simple counting experiment on integral above a mass threshold (Bayesian)
- Leading systematics from momentum scale (muons) and PDF (electrons)





Extra Dimensions in Dileptons

[CMS EXO-12-027, CMS EXO-12-031]



M_S (ADD) at LO 95% CL limits	Lumi. [fb^{-1}]	δ=3 Exp.	δ=3 Obs.	δ=6 Exp.	δ=6 Obs.	Λ_T (GRW) [TeV]
CMS dimuon	20.6	4.34	4.33	3.07	3.06	3.64
CMS dielectron	19.6	4.62	4.64	3.27	3.28	3.90
Combined:	20.6+19.6	4.76	4.77	3.37	3.37	4.01

W' → lν in 8 TeV Data

[CMS PAS EXO-12-060]

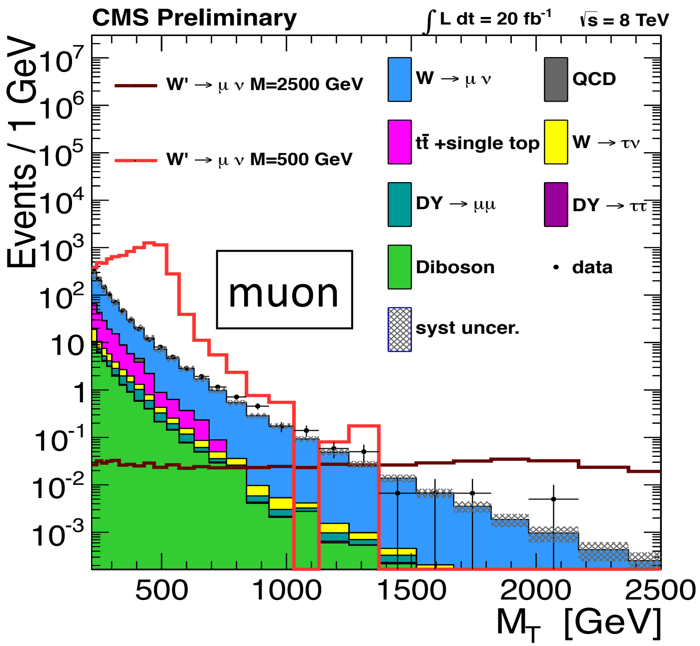
- Search for a new heavy gauge boson W' decaying to a charged lepton (μ or e) and ν

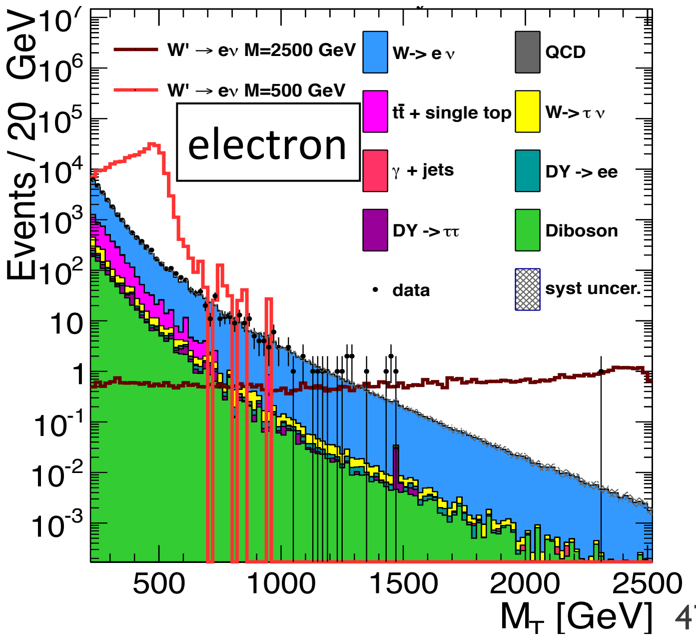
$$M_T = \sqrt{2 \cdot p_T^{\ell} \cdot E_T^{miss} \cdot (1 - \cos \Delta\phi_{\ell,\nu})}$$

- Many models possible
  - right-handed W' bosons with standard-model couplings
  - left-handed W' bosons including interference
  - Kaluza-Klein W'_{KK}-states in split-UED
  - Excited chiral boson (W*)

- Event Selection and Backgrounds
  - back-to-back isolated lepton and E_T^{miss}
  - Plot transverse mass of lν system
  - backgrounds from W, QCD, tt+single t, DY, VV from data

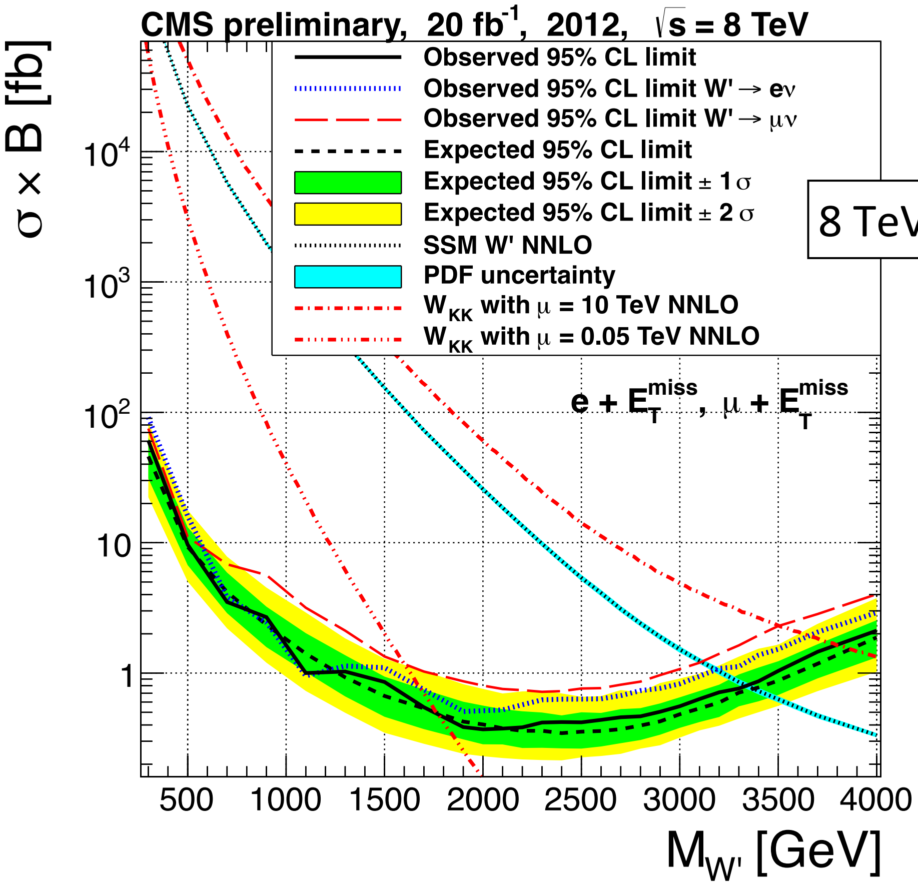
No significant excess observed





W’ → lν IN 7 AND 8 TEV

[CMS PAS EXO-12-060]

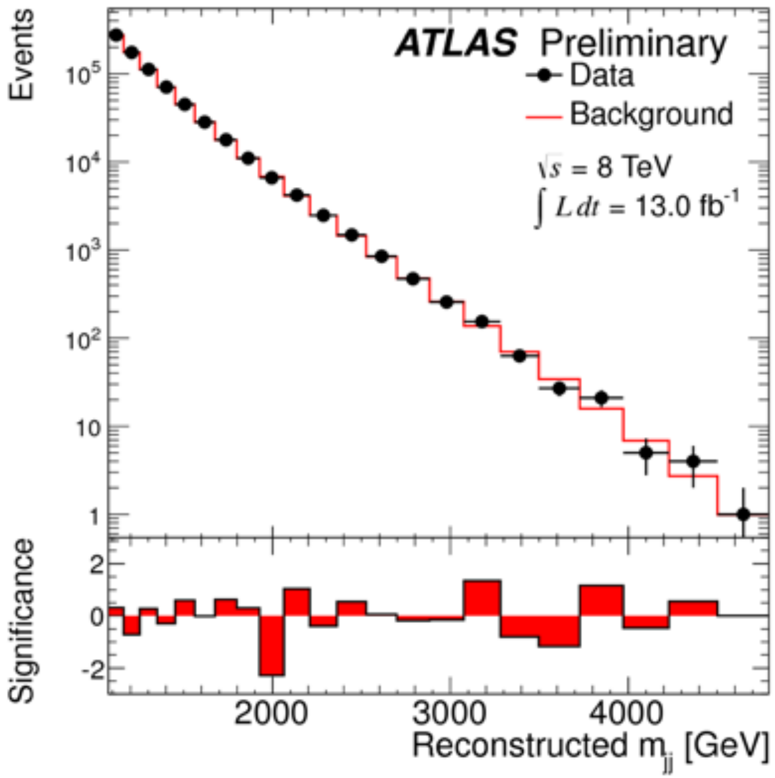


8 TeV 2012

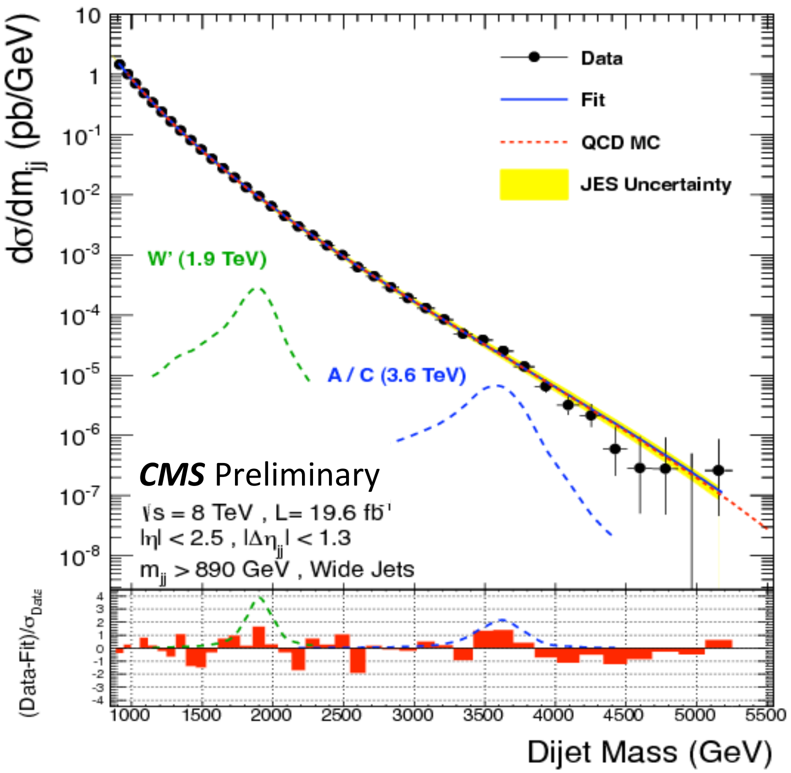
M(W’$_{SSM}$) 95% CL	Luminosity	Expected	Observed
ATLAS e+μ, 2011	4.7	> 2.55 TeV	> 2.55 TeV
CMS e+μ, 2012	3.7	> 2.80 TeV	> 2.85 TeV
CMS e+μ, 2012	20	> 3.37 TeV	> 3.35 TeV

DIJETS IN 8 TEV DATA

[ATLAS-CONF-2012-148]



[CMS PAS EXO-12-059]

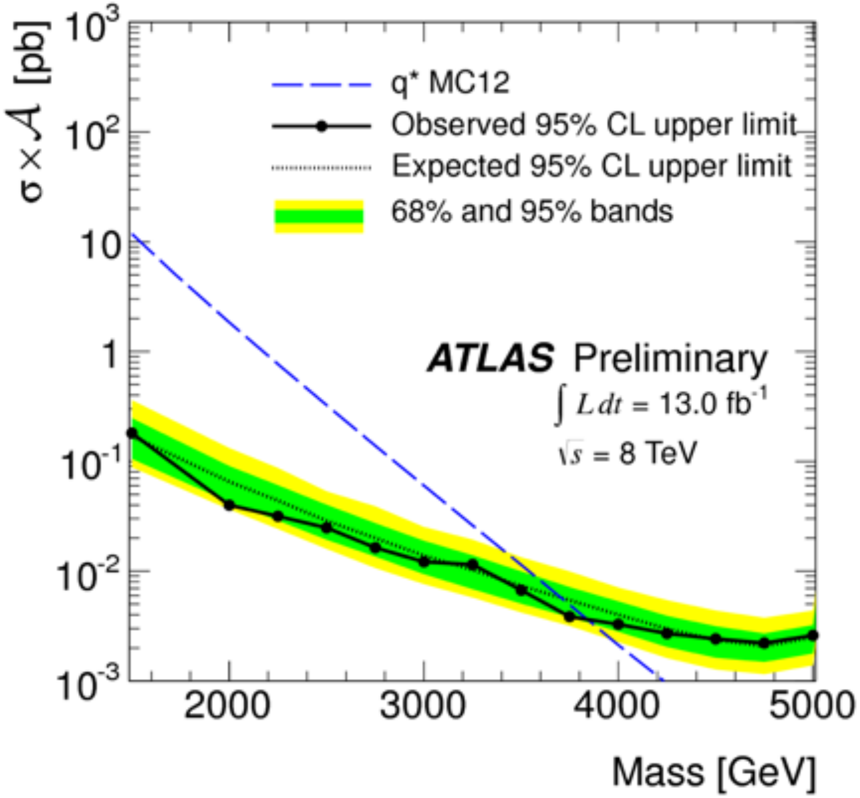


- Search for dijet resonance in smoothly falling mass spectrum
  - leading jet mass m_{jj} > 0.9-1 TeV from trigger and other constraints
  - Background estimated from smooth functional fit

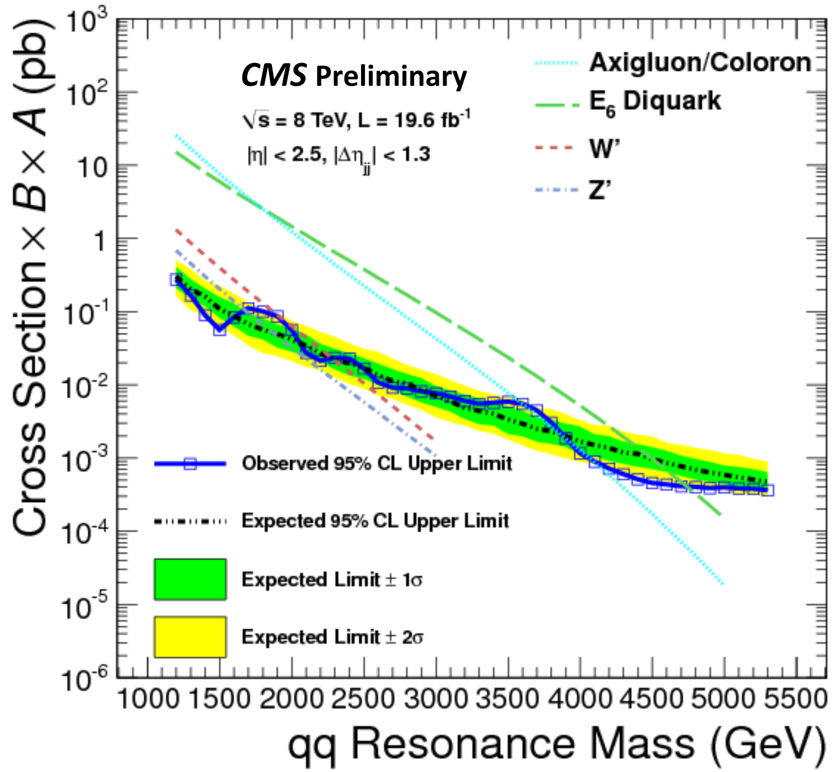
$$\frac{d\sigma}{dm_{jj}} = \frac{P_0(1-x)^{P_1}}{x^{P_2+P_3\ln(x)}}$$

DIJETS IN 8 TEV DATA

[ATLAS-CONF-2012-110]



[CMS PAS EXO-12-016]



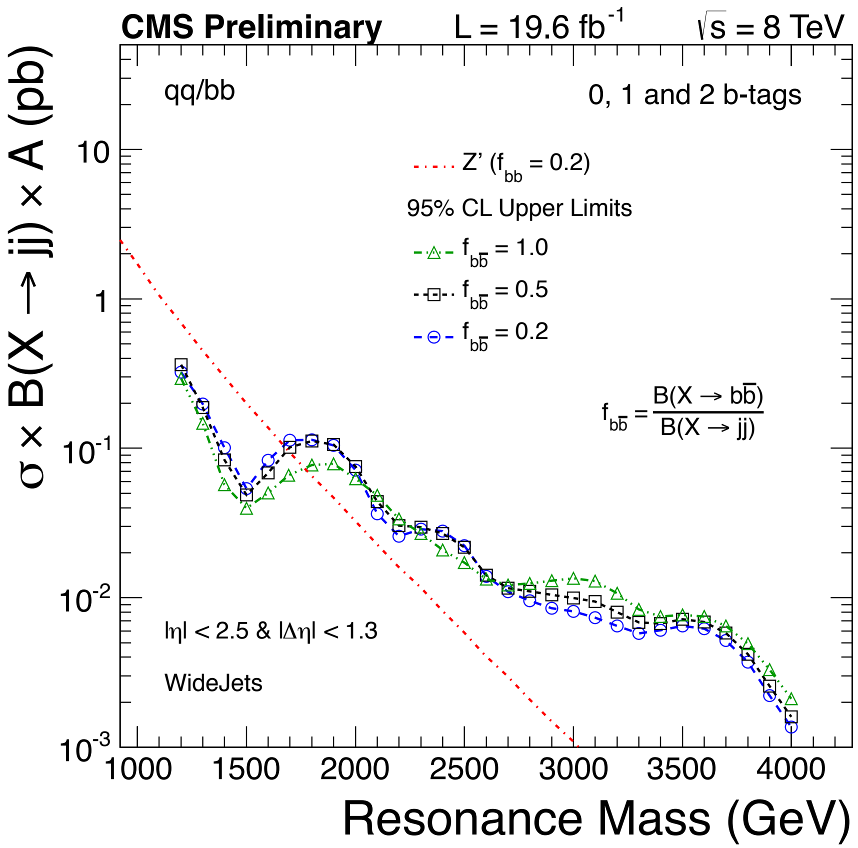
M(q*) 95% CL	Luminosity	Expected	Observed
ATLAS 2011	4.8	> 3.09 TeV	> 3.55 TeV
CMS 2011	5.0	> 3.27 TeV	> 3.05 TeV
ATLAS 2012	13.0	> 3.70 TeV	> 3.84 TeV
CMS 2012	19.6	> 3.75 TeV	> 3.50 TeV

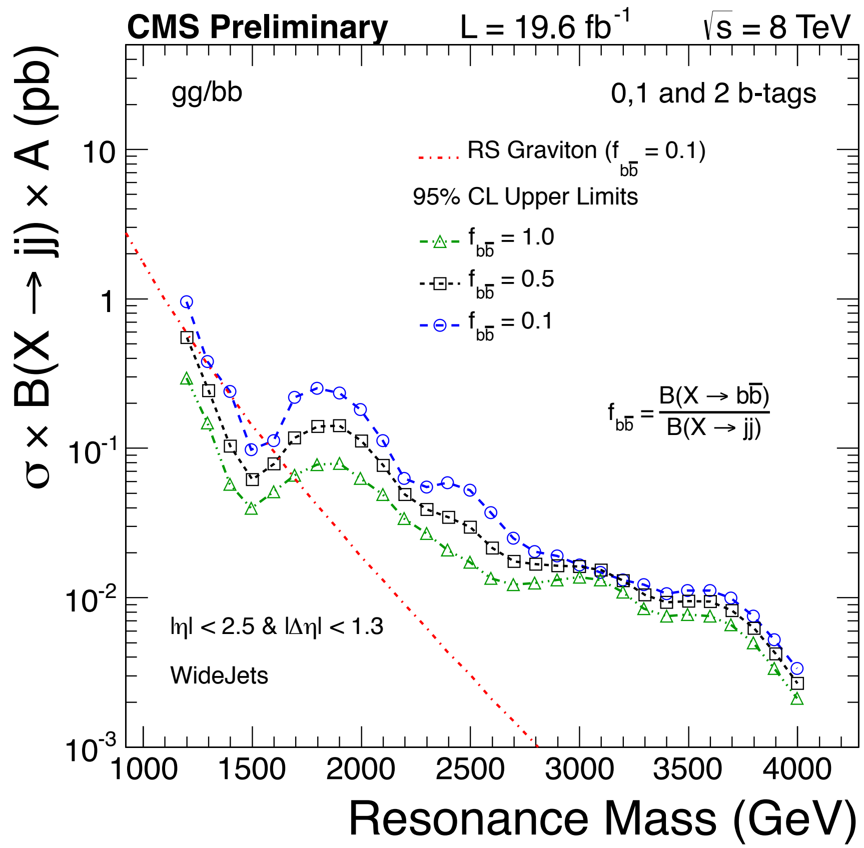
DIJET WITH b-TAG

[CMS EXO-12-023]

- Dijet with 0, 1, 2 b-tags
  - model-independent limits vs. BR
  - Simultaneous search in 0, 1 and 2 b-tags
  - Limits set on qq, gg and bg (Z', G_{RS} and b* models)

$$f_{b\bar{b}} = \frac{BR(X \to b\bar{b})}{BR(X \to jj)}$$



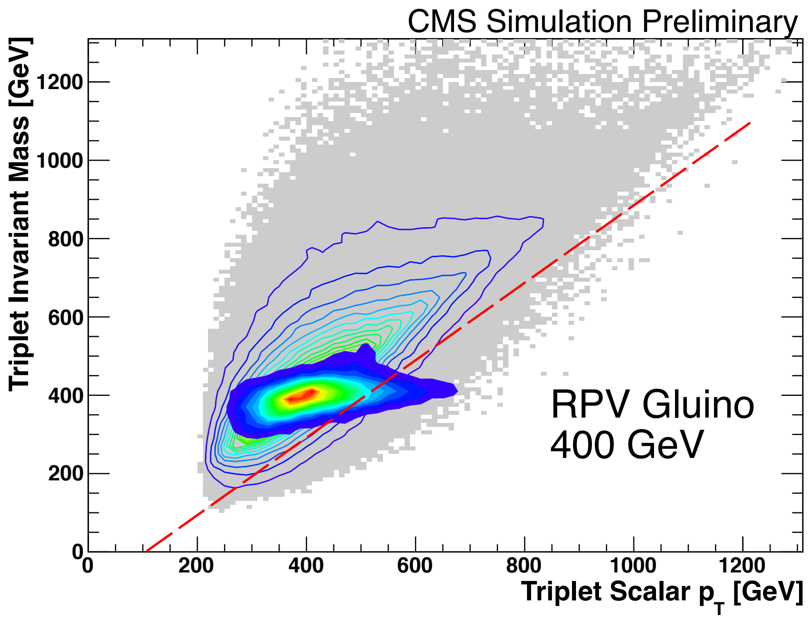


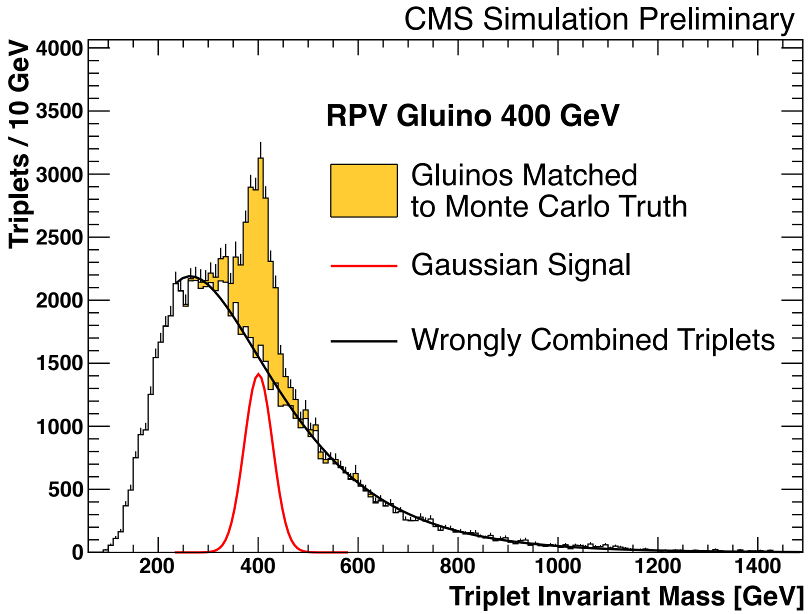
PAIR-PRODUCED THREE JET RESONANCES

[CMS EXO-12-049]

- Search for strongly coupled resonances decaying to three jets
- Benchmark: pair produced gluinos to three jets through UDD RPV coupling
- Event Selection
  - ≥6 jets > 60 GeV (1st–4th jet > 80 GeV)
  - Use sphericity to suppress backgrounds at high mass
  - Apply b-tagging for gluino ⟶ udb/csb scenario
- Combine the six highest p_T jets into 20 unique triplet combinations
- To suppress wrong combinations and QCD, only accept triplets that satisfy

$$M_{jjj} < \sum_{i=1}^{3} |p_T|_i - \Delta$$



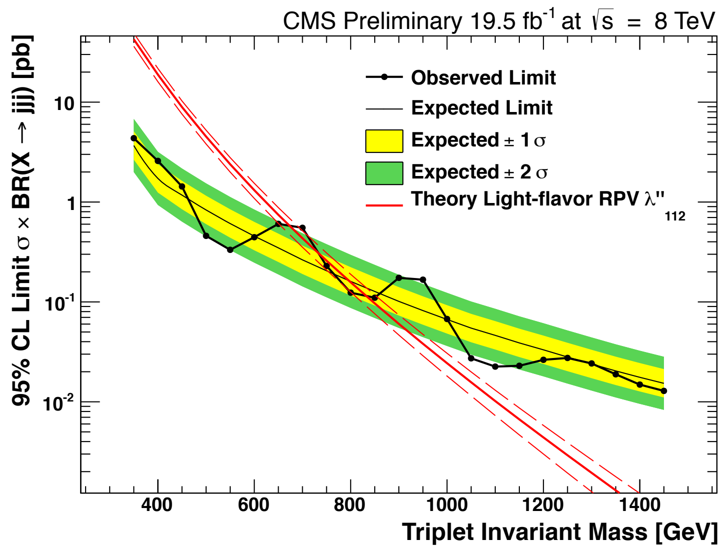


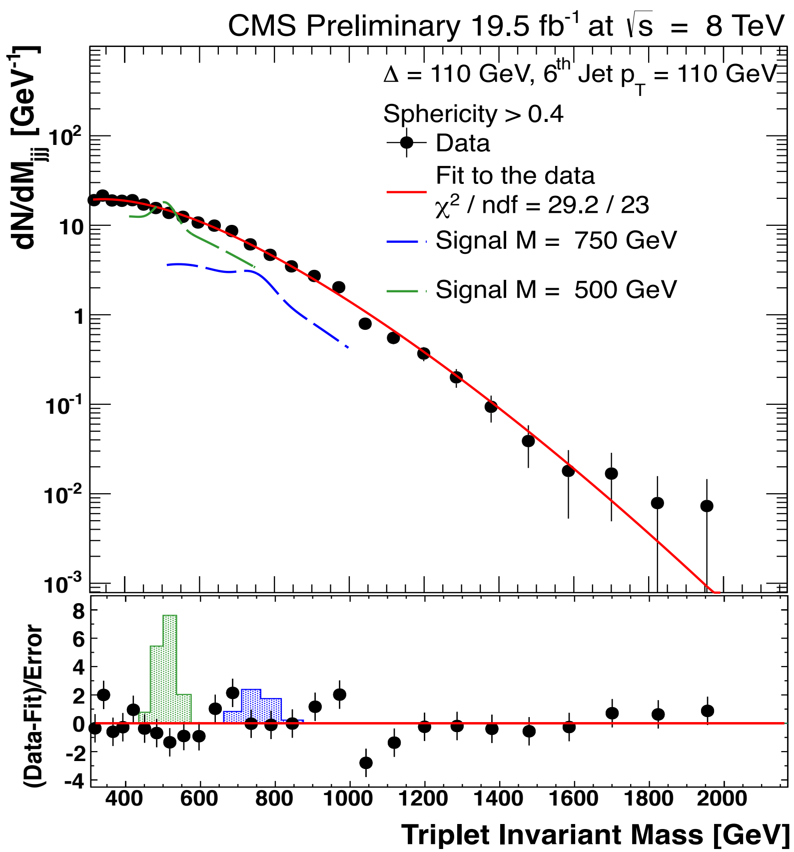
THREE JET RESONANCES

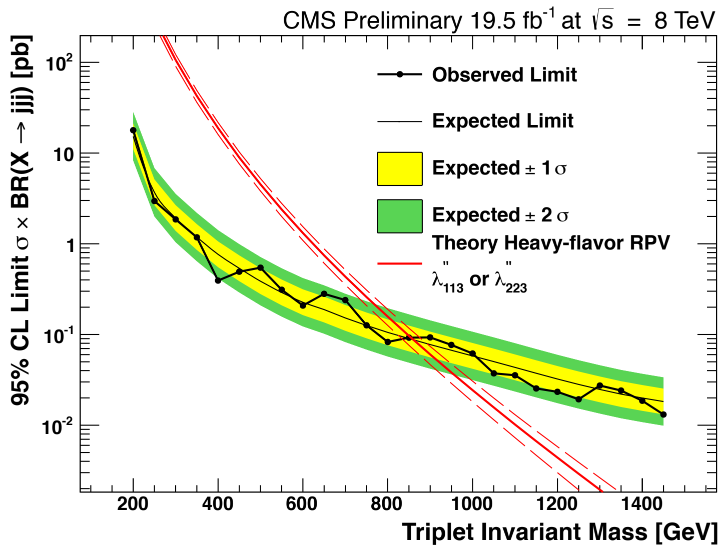
[CMS EXO-12-049]

- Look for bump in falling spectrum
  - For b-tagged result, QCD shape from b-vetoed data
  - All-hadronic top bkgnd consistent w/ SM rate

Limits on RPV gluinos < 650 GeV (light-flavor) and between 200 and 835 GeV (heavy-flavor)







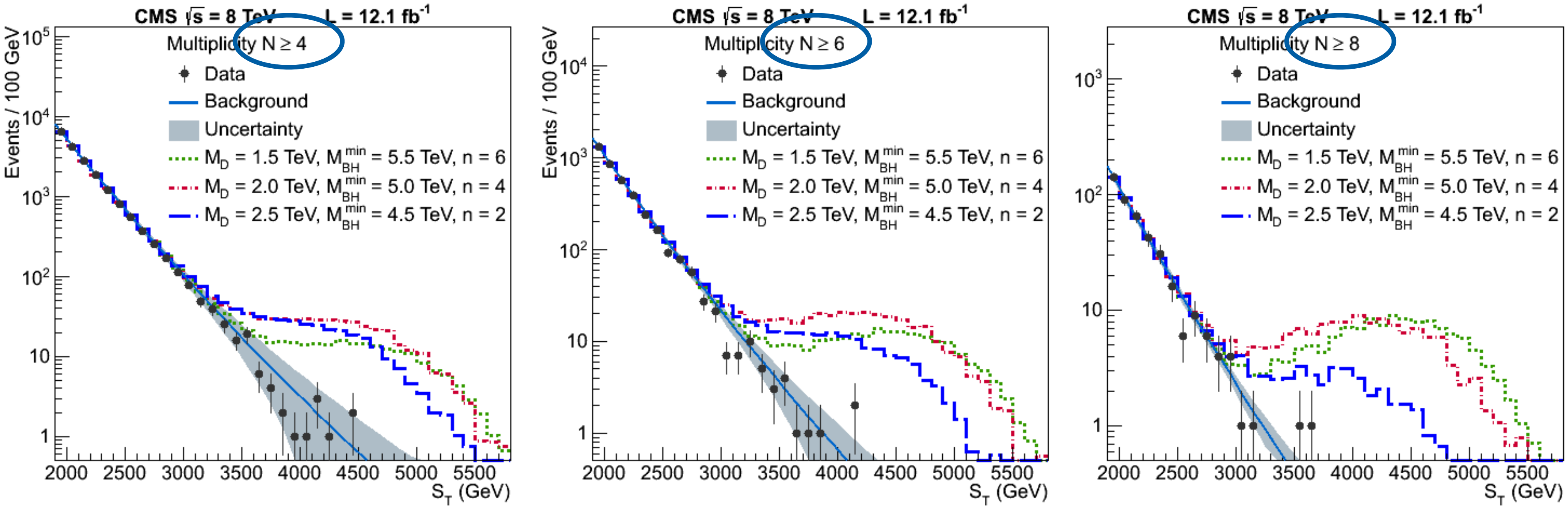
SEARCH FOR BLACK HOLES

[arXiv:1303:5338, EXO-12-009]

- Search for microscopic Black Holes in 12 fb^{-1} of 8 TeV data
  - Hypothetical BH would evaporate into many high-$p_{t.}$ objects
  - Estimate by S_T, the p_T sum of physics objects with p_T > 50 GeV
- Main background of QCD estimated by fit to n=2 distribution
  - Normalised for each multiplicity bin separately at S_T = 1.8–2.2 TeV
  - Model-independent limits vs S_T and multiplicity

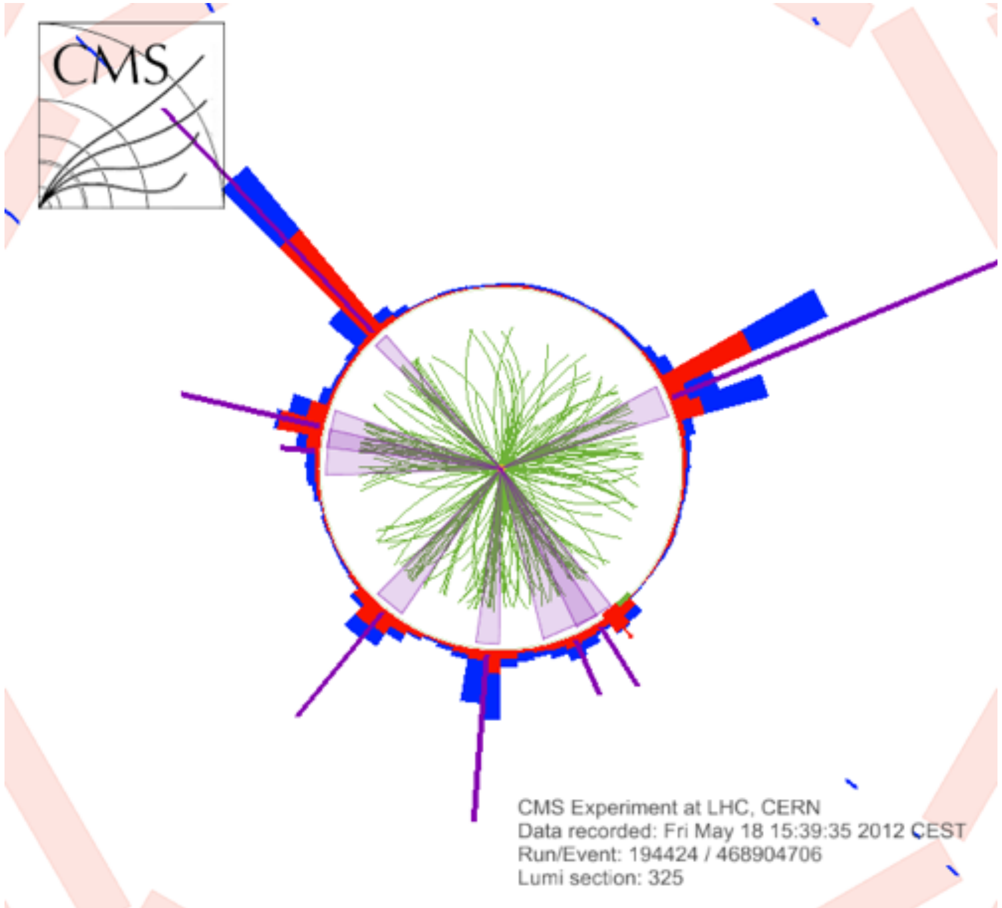
$$S_T = \sum_{j,e,\mu,\gamma,MET}^{N} p_T$$

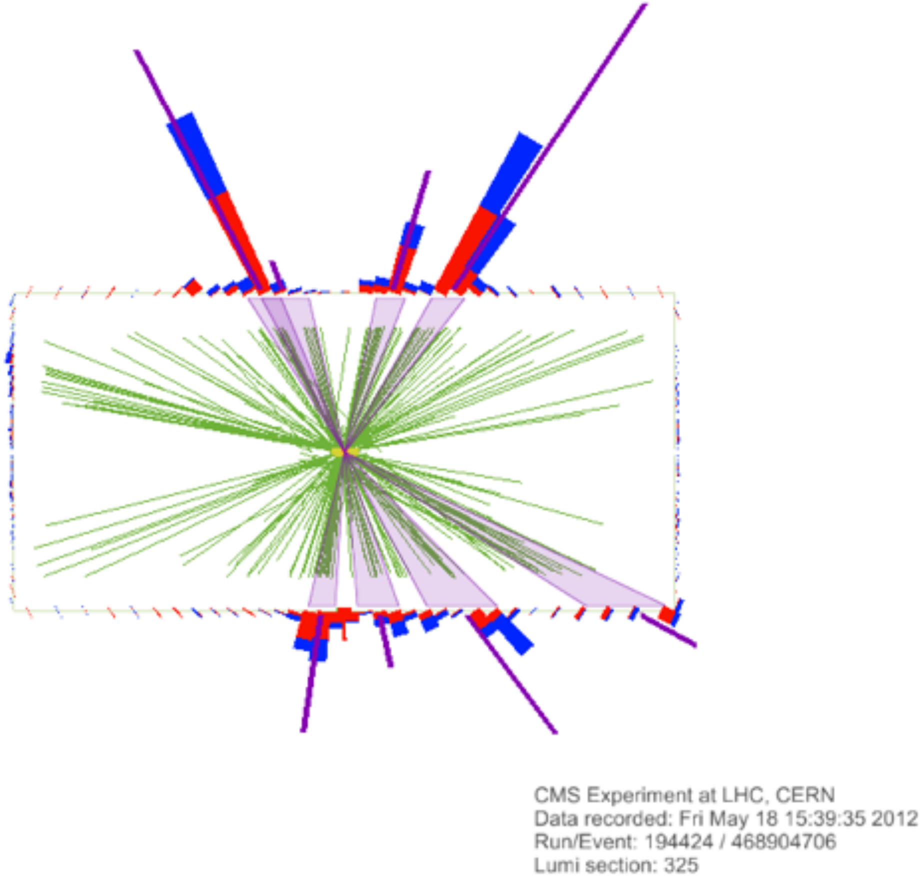
Significant improvement in sensitivity (~15-20%) with respect to 7 TeV data



8-Jet Event, S_T = 3 TeV

[arXiv:1303:5338, EXO-12-009]





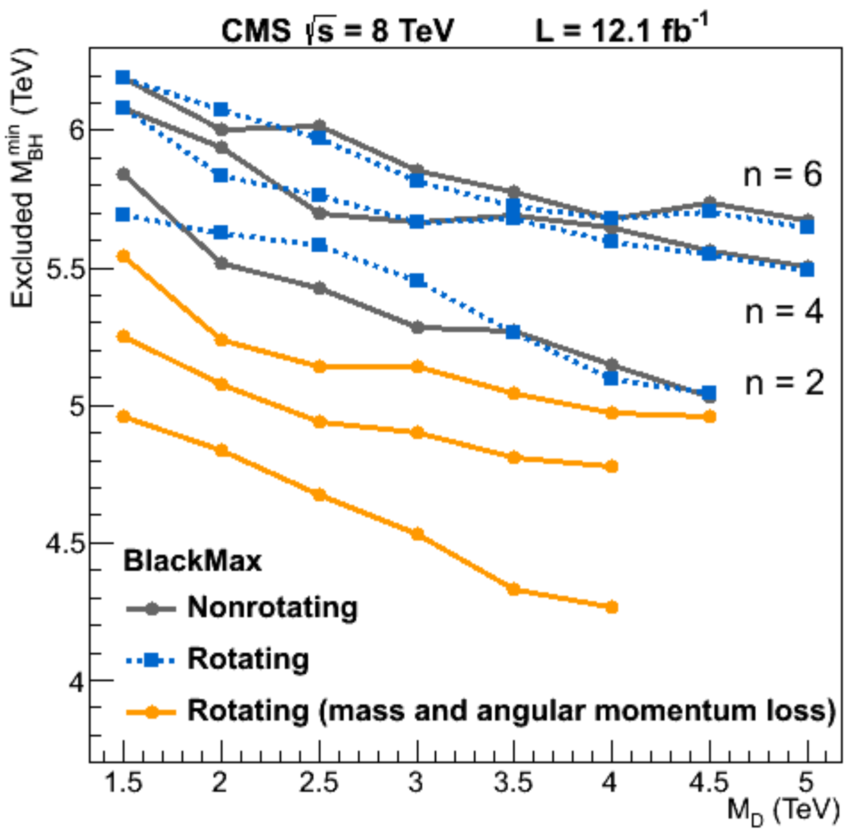
Many interesting events found!

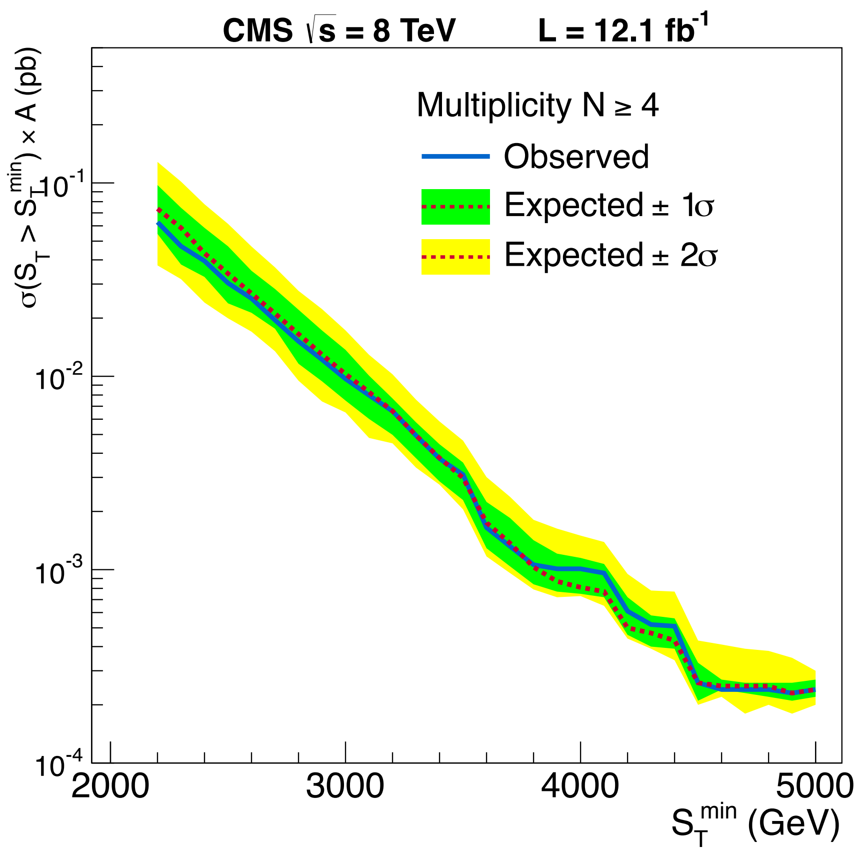
SEARCH FOR BLACK HOLES - HIGH S_T

[arXiv:1303:5338, EXO-12-009]

- No excess of events above expected backgrounds observed
  - Limits on ADD parameter M_D assuming specific BH models (Charybdis, BlackMax, ...)
  - Model-specific limits on semiclassical BH masses in the 4.3 – 6.2 TeV range

Also interesting as a model-independent search vs S_T and multiplicity

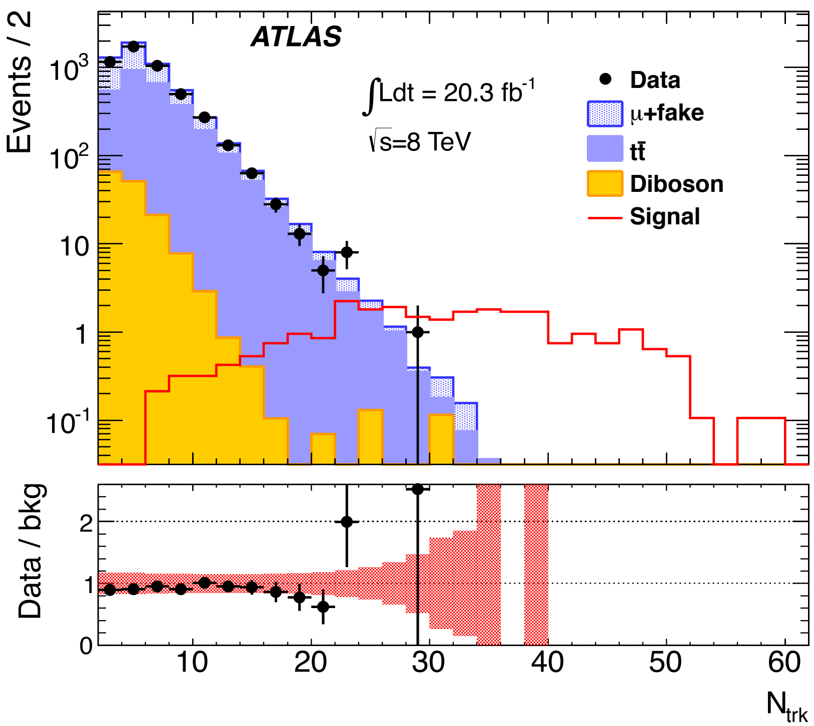


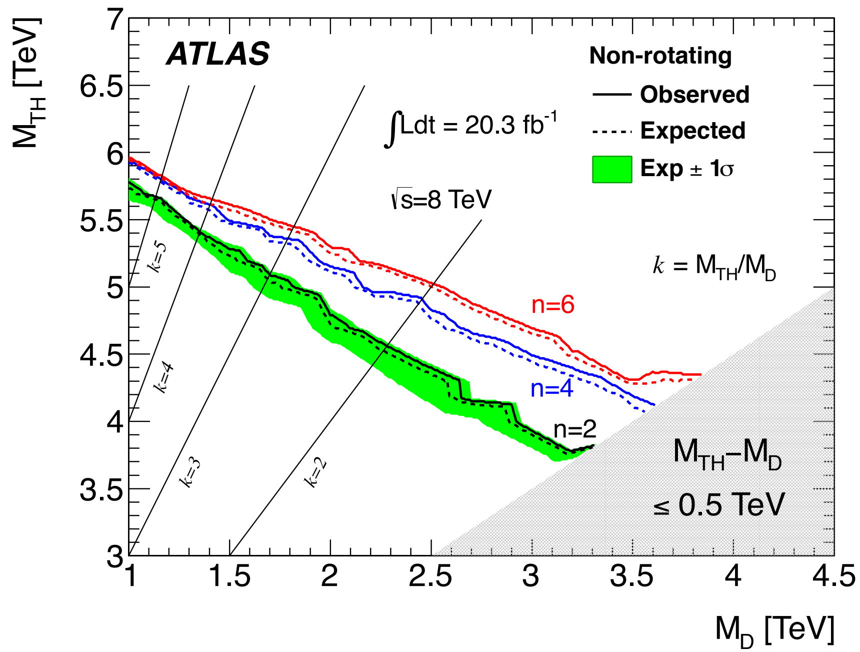


SEARCH FOR BLACK HOLES - SAME-SIGN μμ

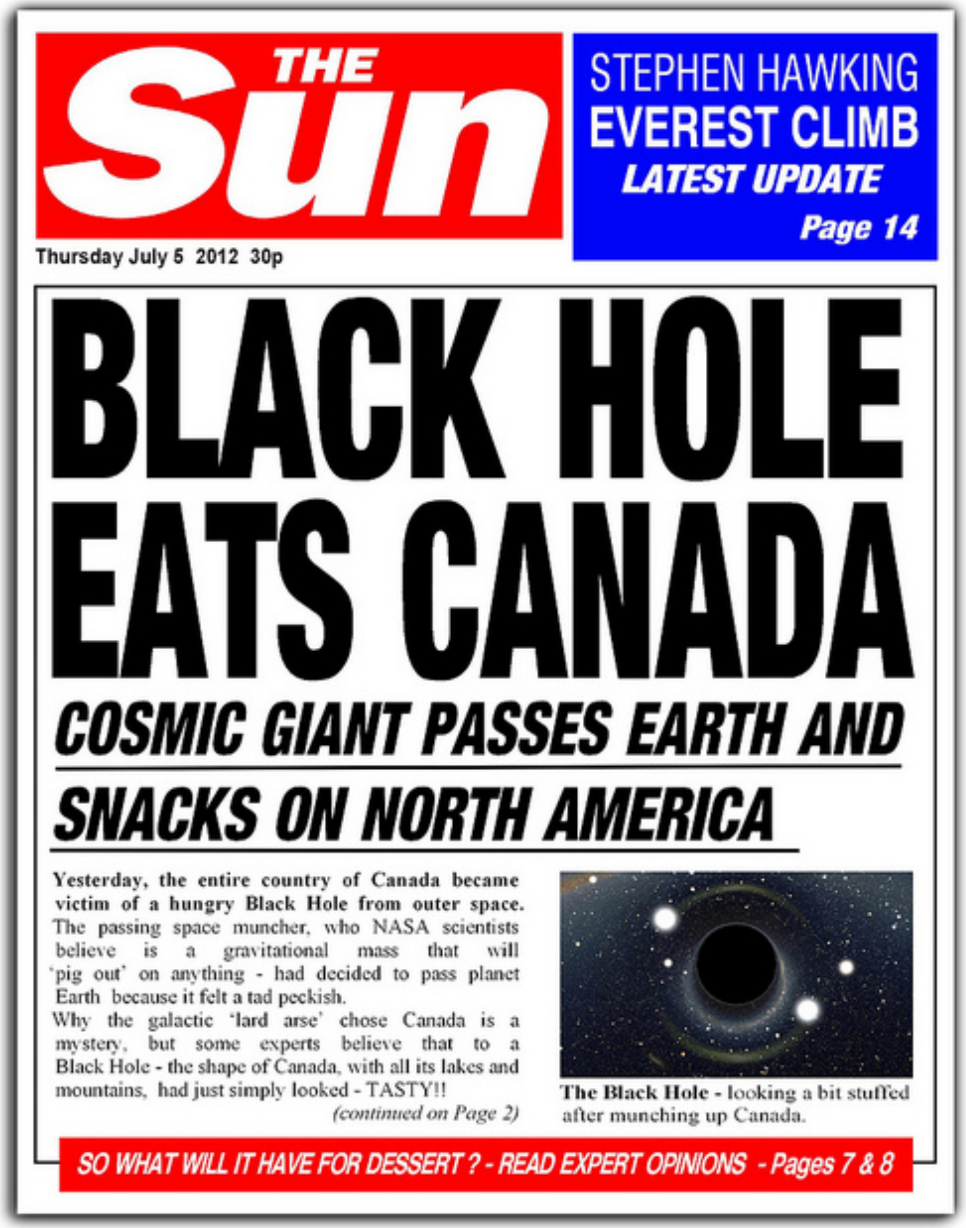
[ATLAS arXiv:1308:4075]

- If black holes lead to high multiplicity, can just count tracks for same-sign μμ
- Use track multiplicity for (p_T{trk} > 10 GeV) for events with p_T(μ) > 100 GeV
- 95% CL exclusion contours for non-rotating BH, rotating BH, and stringball models with n = 2, 4, and 6: up to ~6 TeV for M_D = ~1 TeV





COFFEE BREAK?



THE Sun

STEPHEN HAWKING EVEREST CLIMB LATEST UPDATE Page 14

Thursday July 5 2012 30p

BLACK HOLE EATS CANADA

COSMIC GIANT PASSES EARTH AND SNACKS ON NORTH AMERICA

Yesterday, the entire country of Canada became victim of a hungry Black Hole from outer space. The passing space muncher, who NASA scientists believe is a gravitational mass that will 'pig out' on anything - had decided to pass planet Earth because it felt a tad peckish.

Why the galactic 'lard arse' chose Canada is a mystery, but some experts believe that to a Black Hole - the shape of Canada, with all its lakes and mountains, had just simply looked - TASTY!!

(continued on Page 2)

The Black Hole - looking a bit stuffed after munching up Canada.

SO WHAT WILL IT HAVE FOR DESSERT ? - READ EXPERT OPINIONS - Pages 7 & 8