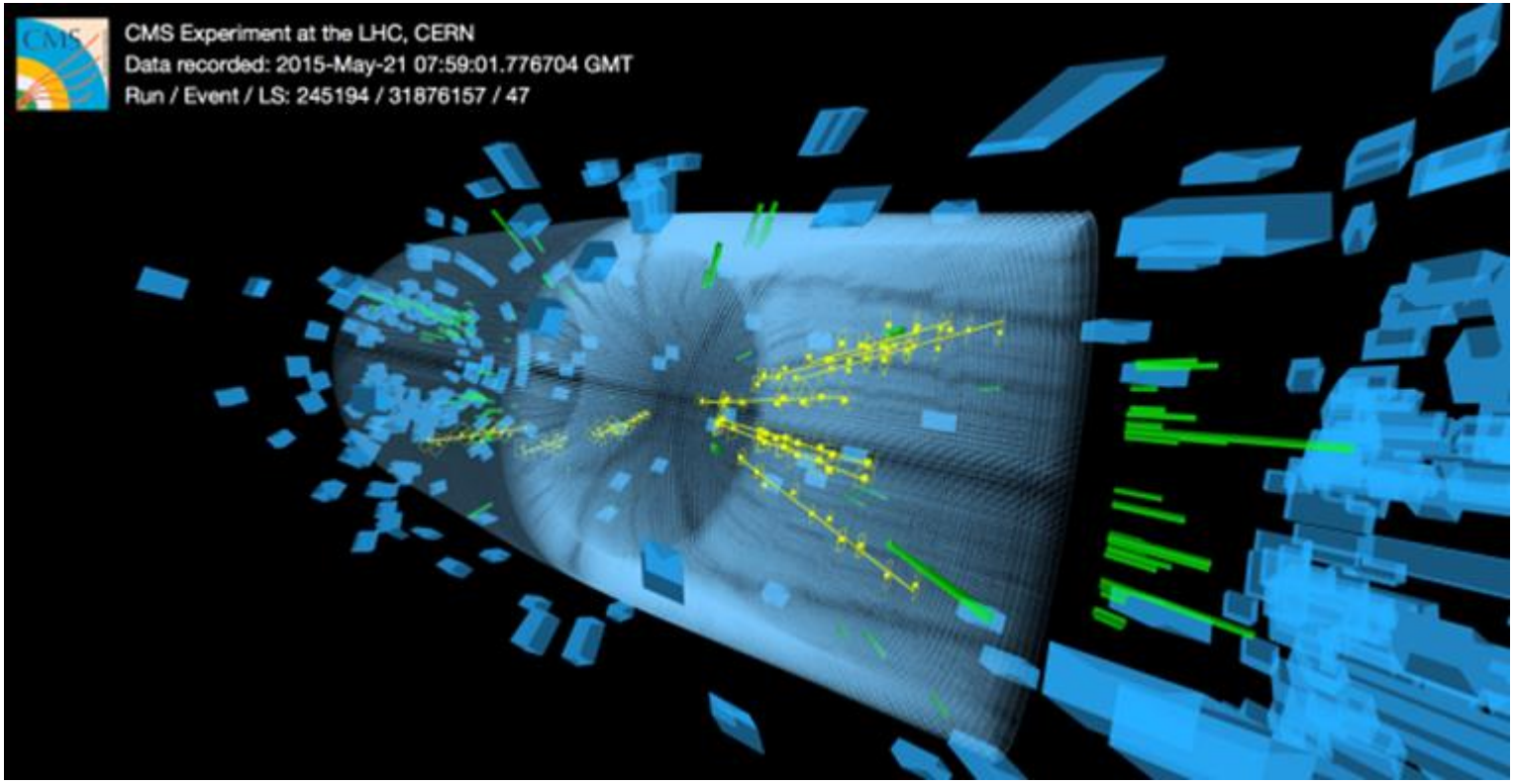
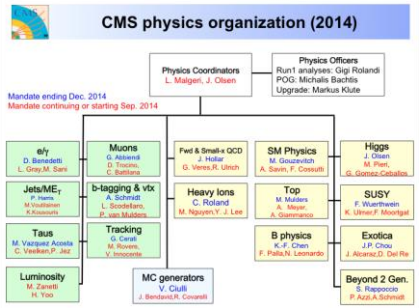
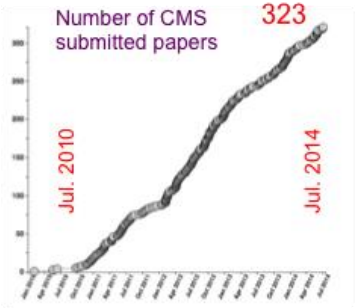
Induction Session:
Physics Coordination Overview

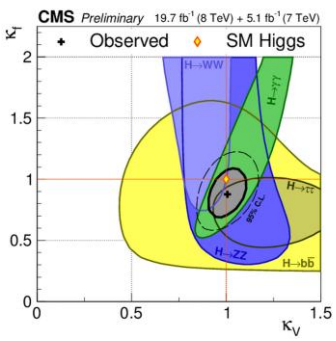
2nd CMS Induction Session - 10/7/2014



Outline

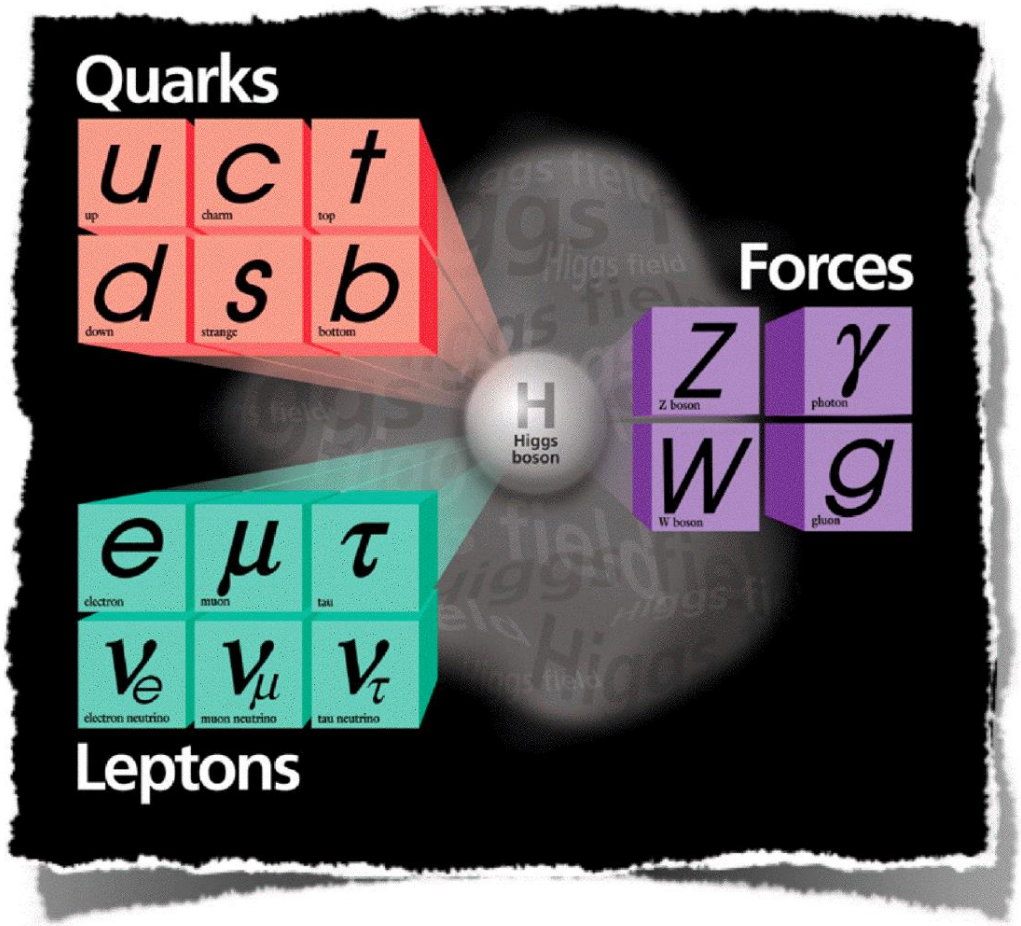






- A brief introduction:
  - Status of the Standard Model
  - Open questions (for YOU to answer!)
- Organization
  - POGs, PAGs, and Workflows, oh my!
- CMS Publications: A to Z
  - Story of a physics analysis
  - Publication Committee details
- Getting started with physics analysis
  - A few “first steps” to a final result
- Overview of Run 2
  - Physics strategies and targets @ 13 TeV
  - LHC schedule and CMS physics timeline

A Brief Introduction: Where do we stand?



Fundamental matter:

quarks and leptons

Symmetries:

$U(1)_Y$, $SU(2)_L$, $SU(3)_C$

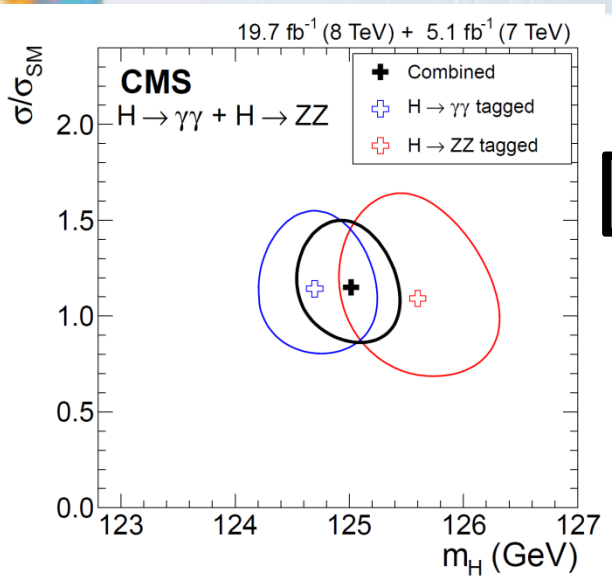
Local gauge invariance:

gauge bosons (force carriers)

Higgs field:

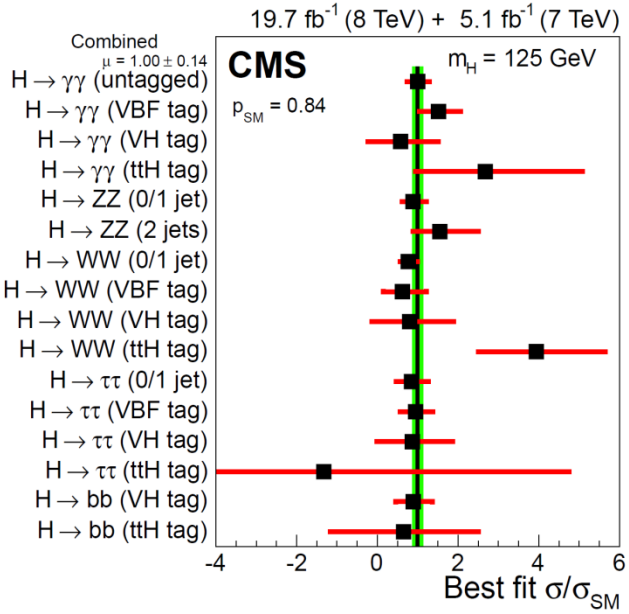
spontaneous EWK symmetry breaking and the Higgs boson

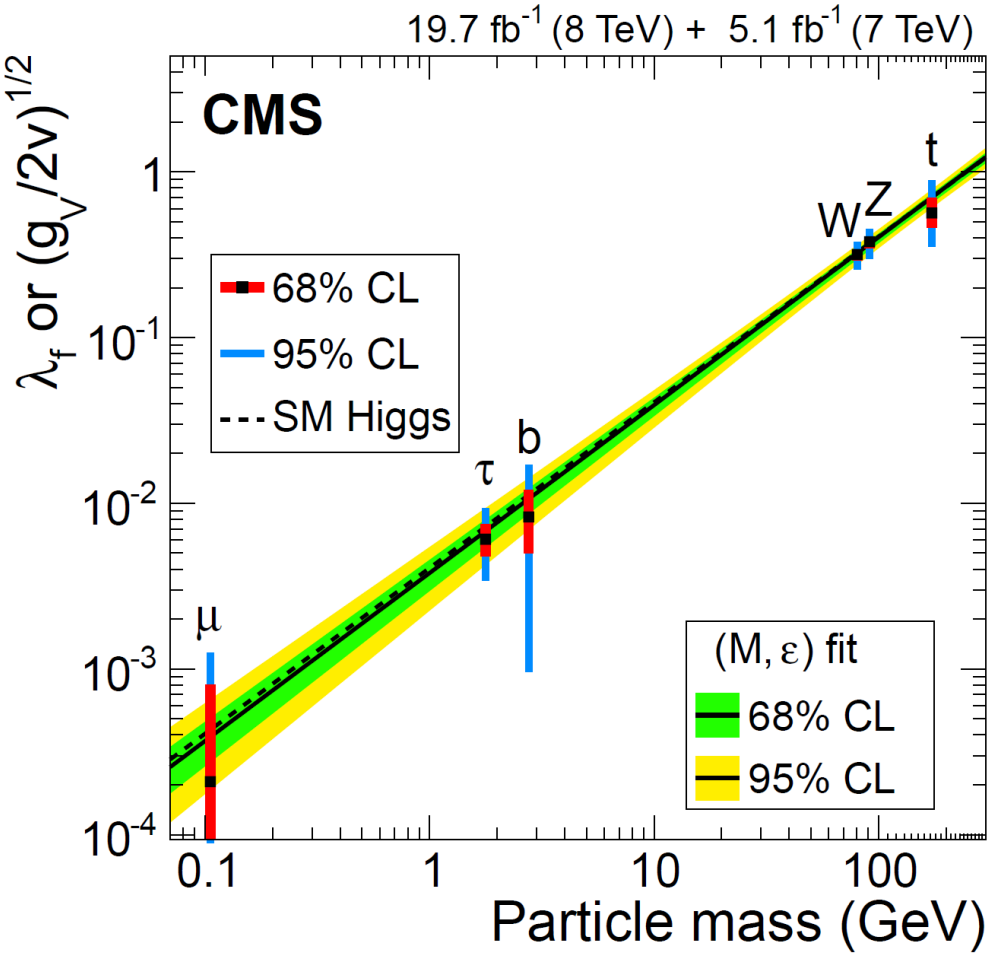
The last piece, the Higgs Boson, was discovered in 2012 at the LHC



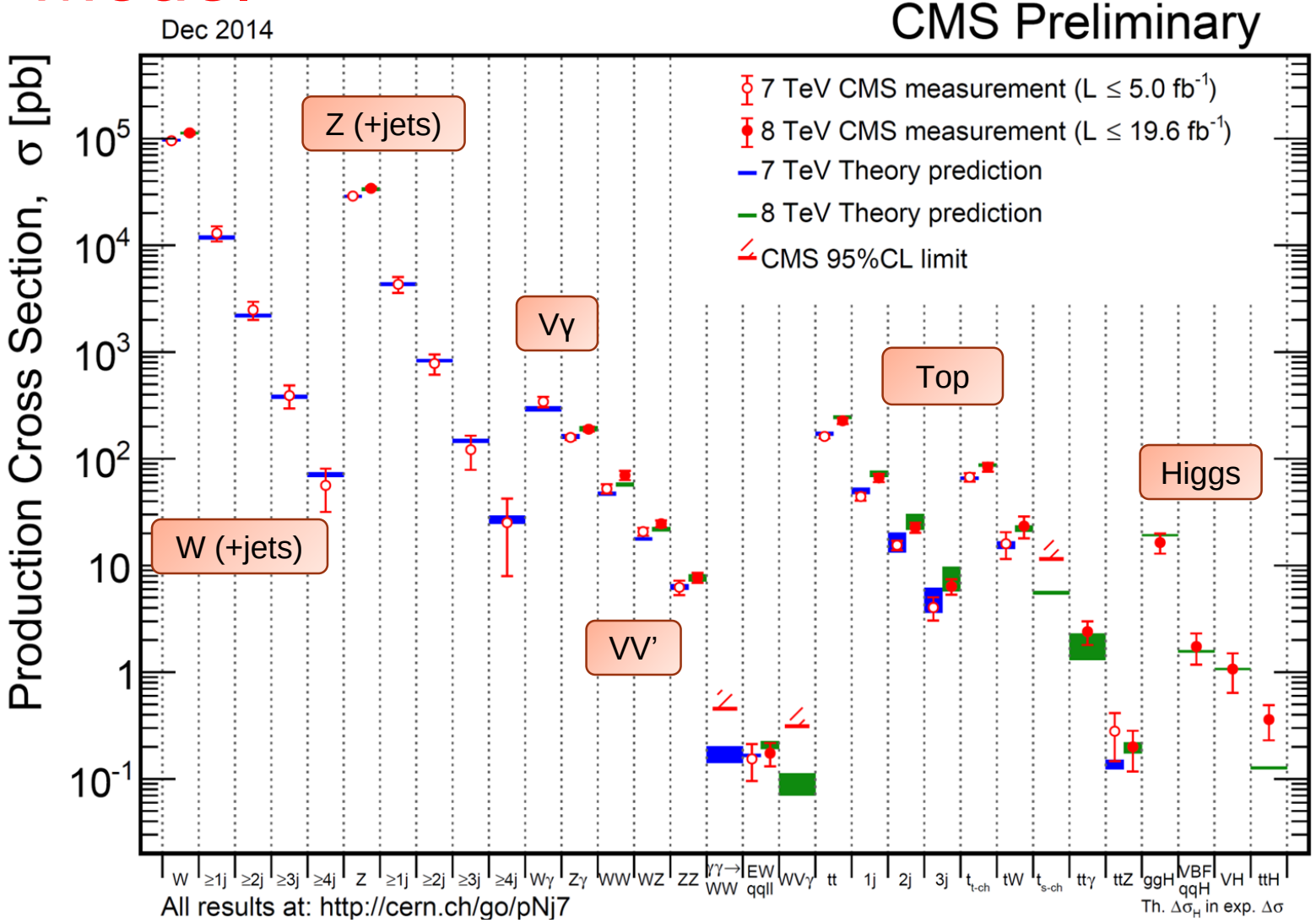
$m_H = 125.02\ ^{+0.26}_{-0.27}\ (\text{stat.})\ ^{+0.14}_{-0.15}\ (\text{syst.})$ GeV

$\mu = 1.00\ ^{+0.14}_{-0.13}\ [\pm 0.09\ (\text{stat.})\ ^{+0.08}_{-0.07}\ (\text{theo.}) \pm 0.07\ (\text{syst.})]$



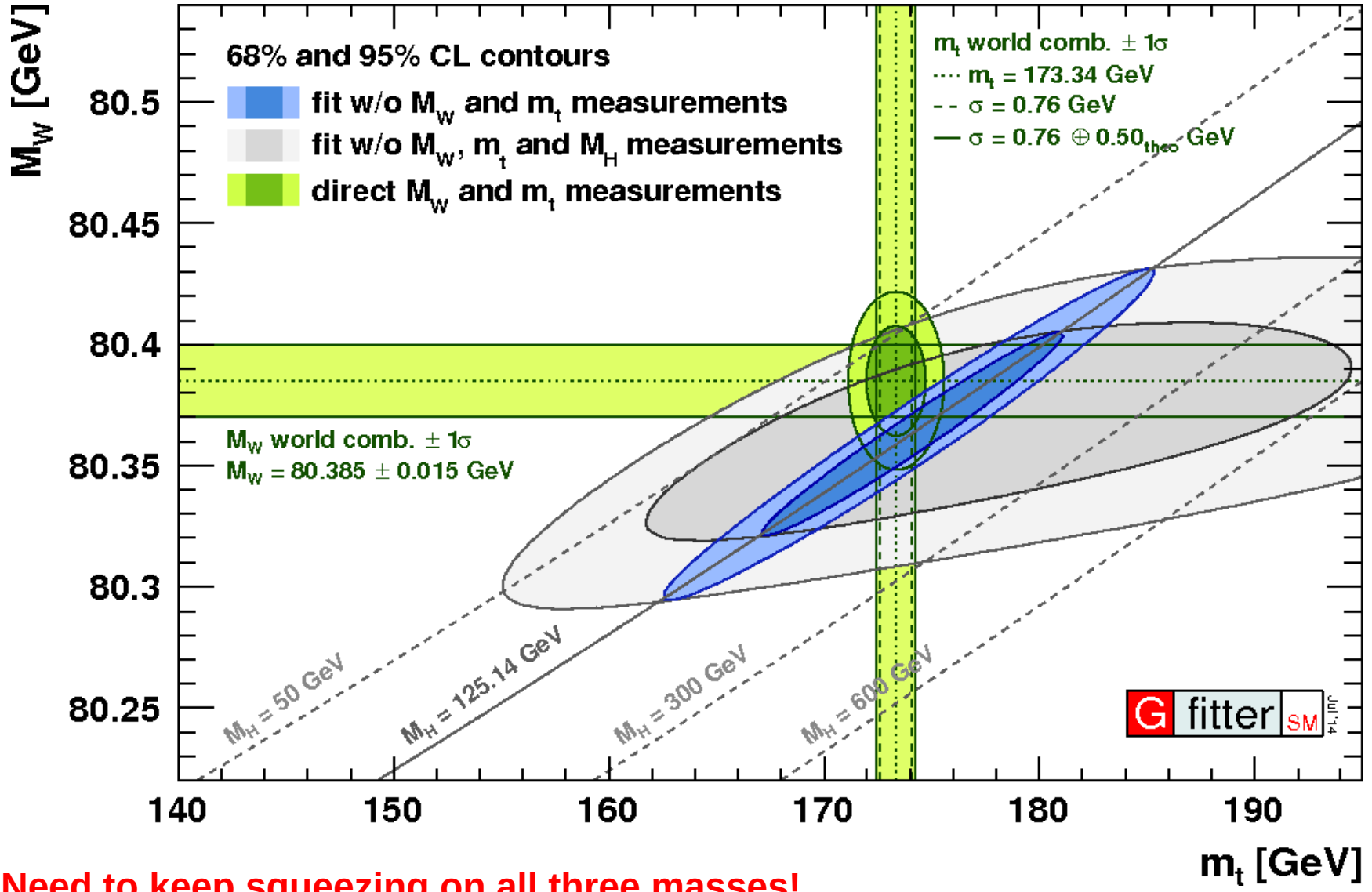


Precision Standard Model



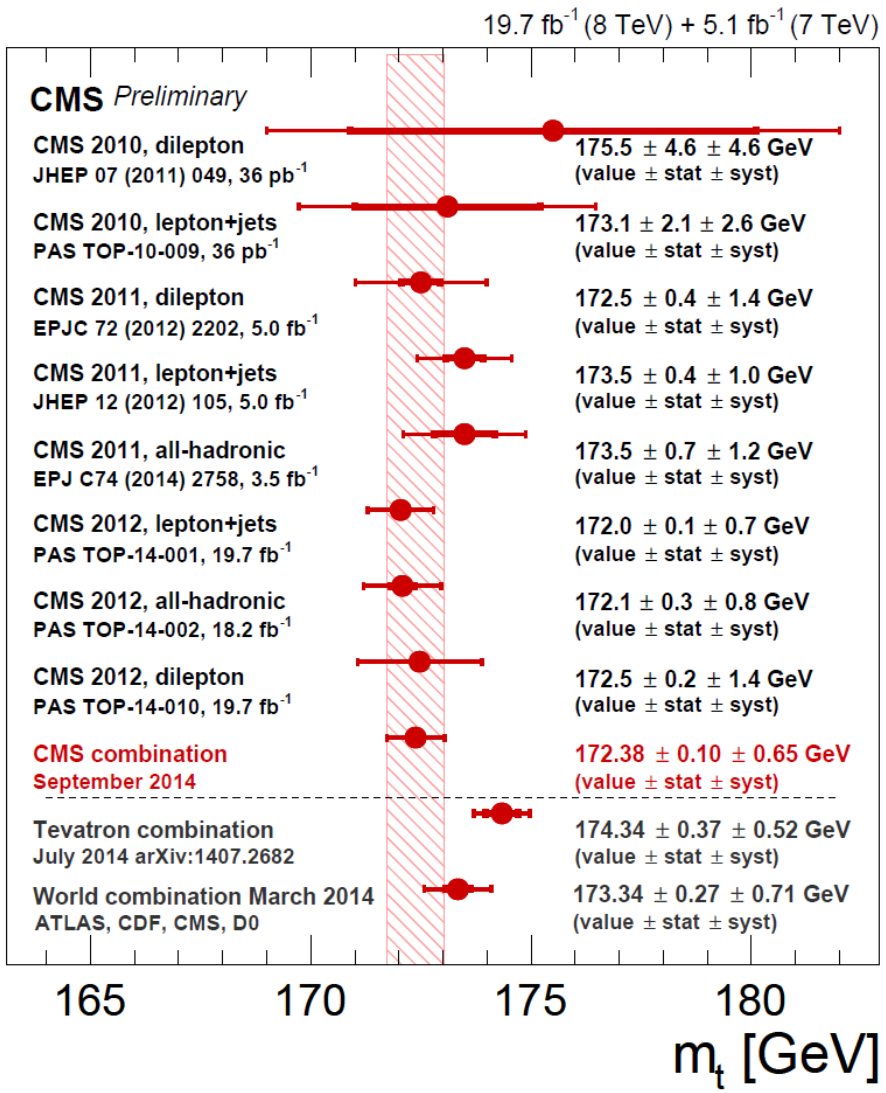
Exquisite agreement over 6 orders of magnitude, precision SM measurements are critical in the search for New Physics!

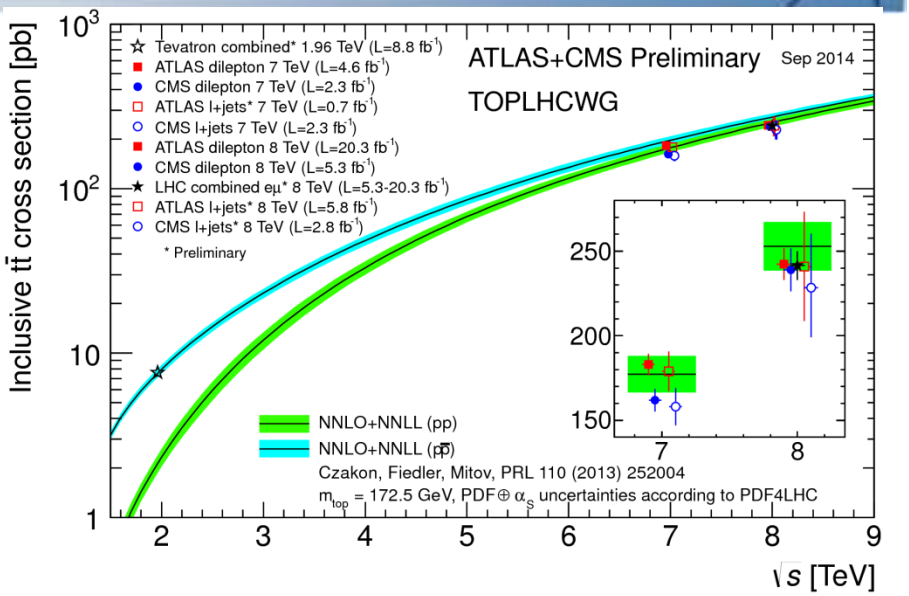
Mission Accomplished?

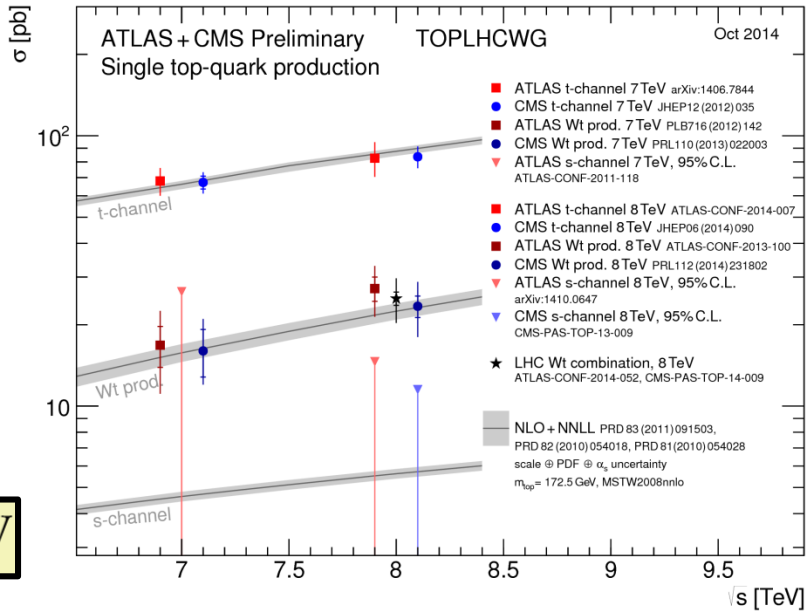


Need to keep squeezing on all three masses!

Top Quark Measurements





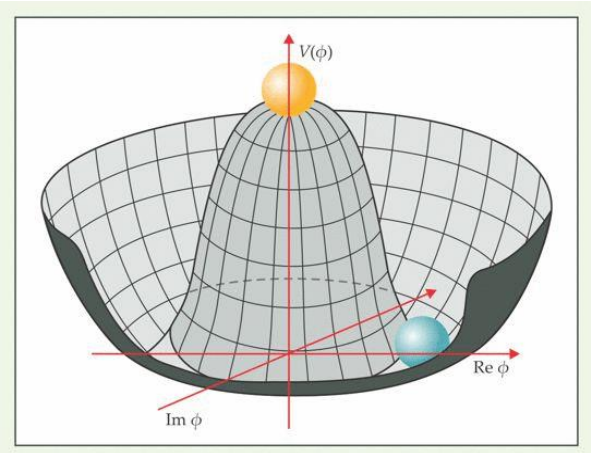


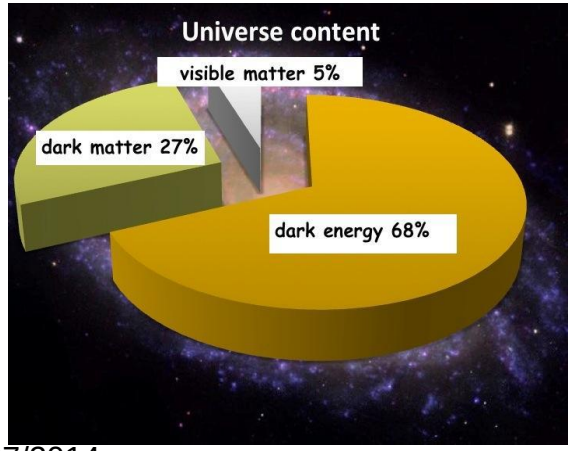
$$m_t = 172.38 \pm 0.10\,(\text{stat.}) \pm 0.65\,(\text{syst.})\,\text{GeV}$$

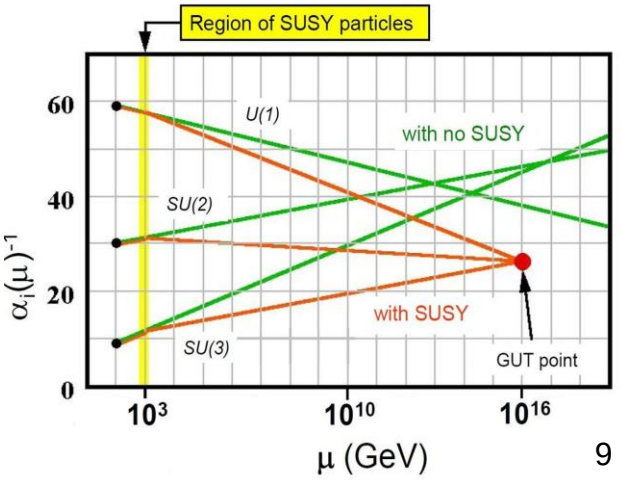
No cracks yet in the SM, but lots of gaps

- Is there is an extended Higgs sector beyond the standard model?
- What mechanism stabilizes the Higgs mass?
  - SUSY?
  - Are we fine-tuned?
- Why is gravity so weak? Hiding in extra dimensions?
- What is Dark Matter?? Not to mention Dark Energy!
- The motivation for "something else" has never been higher!

Using the CMS detector, you will attempt to answer some of these questions. We hope that what follows will serve as a 0th-order guide for CMS physics analysis







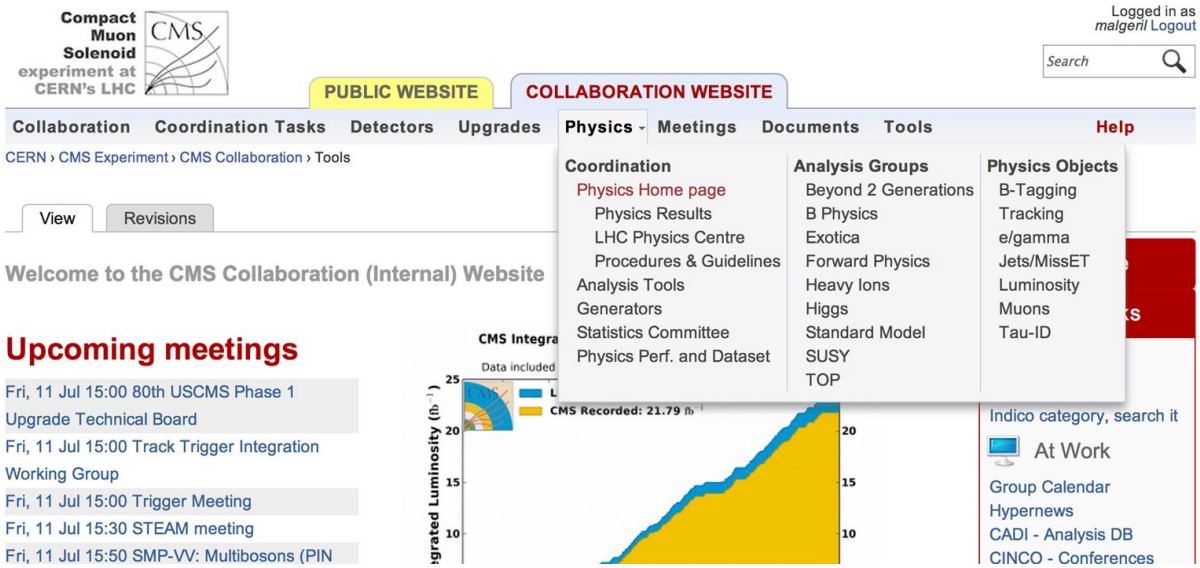
Physics Coordination Organization

What is Physics Coordination in CMS

- Just a clarification on what what we mean by Physics Coordination:
  - It is not the only place where we do physics, indeed everything you have seen in this Induction, from detector construction up to analysis, IS experimental particle "Physics"!
- For a lack of better name in CMS (and in this talk) we call "Physics" (or better Physics Coordination) what is left at the end of the data food chain:
  - Physics Object performance Groups (POGs) and Physics Analysis Groups (PAGs).

What is Physics Coordination in CMS

First stop for documentation:
https://cms.web.cern.ch/org/cms-collaboration



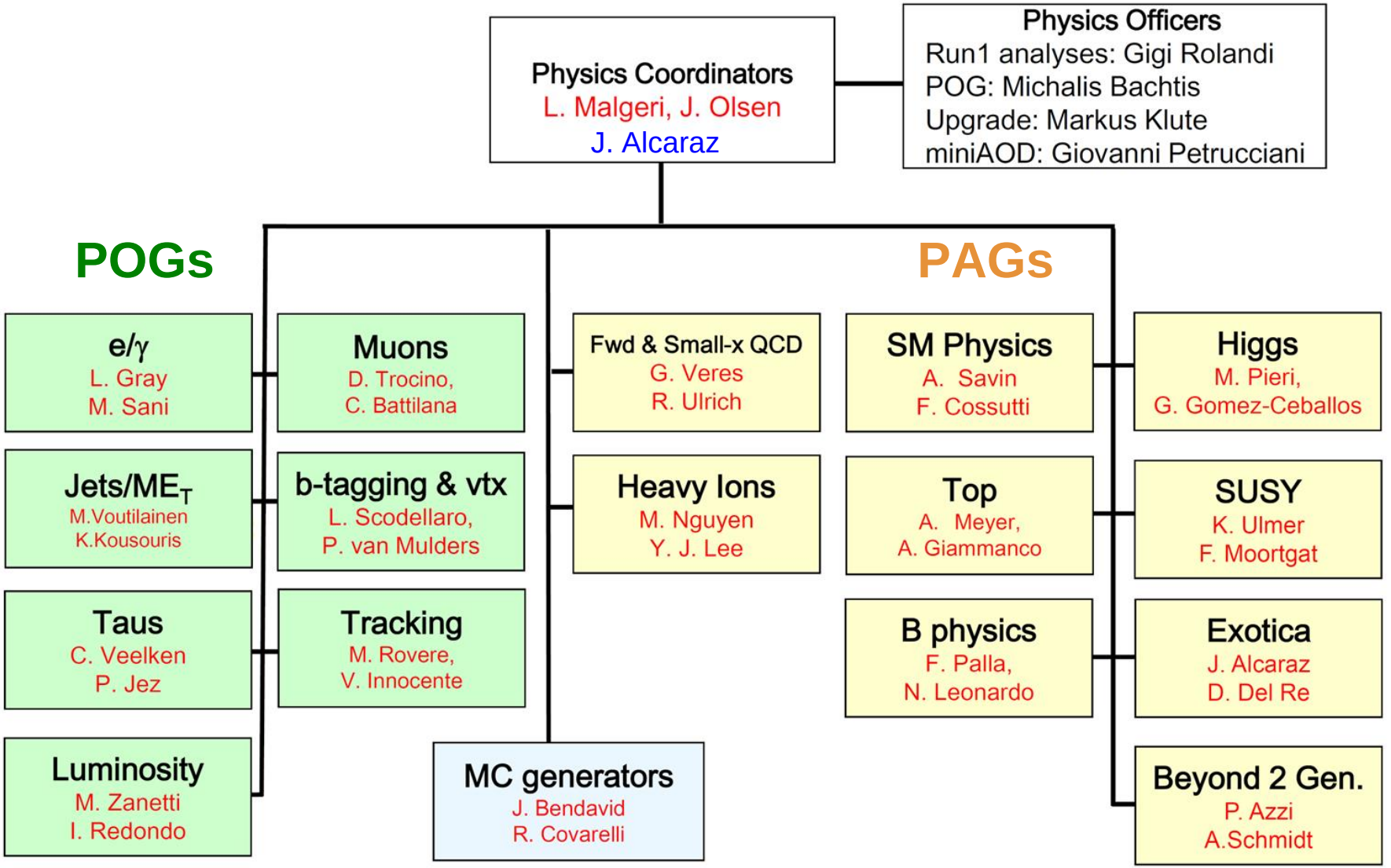
Direct link: https://twiki.cern.ch/twiki/bin/view/CMS/DrupalPhysicsCoordination

Main channel for general communication (> 1200 subscribers):
hn-cms-physics-announcements@cern.ch

➞all "central" news, approval calls, rehearsals are announced there, please subscribe!

All sub-groups have their own HN that you are also invited to join

Physics Coordination Structure (2015)



Physics Coordination Structure

Physics Office

Starting from Jan 2014 we have established the figures of "Physics Officers". Three (now four) high profile colleagues helping Physics Coordination to overview three major areas:

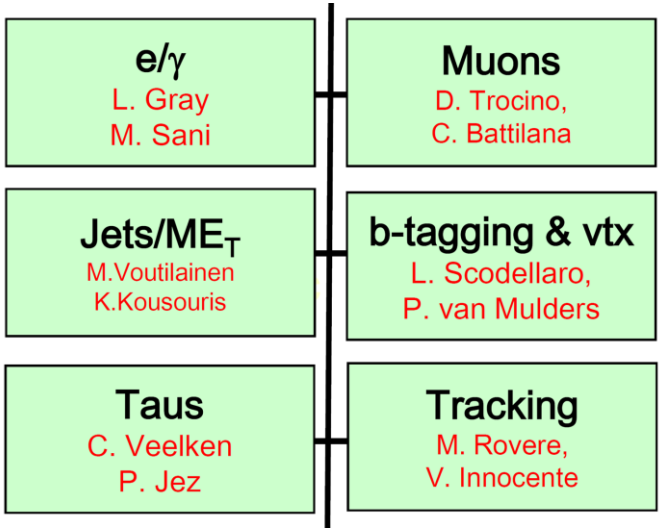
Physics Officers
Run1 analyses: Gigi Rolandi
POG: Michalis Bachtis
Upgrade: Markus Klute
miniAOD: Giovanni Petrucciani

- Exploitation of the full Run I potential (aka "Legacy Papers"): Gigi Rolandi
- Upgrade Physics Studies: simulations, performance studies, preparation of TP: Markus Klute
- Cross-POG issues: GED(PFlow) development (run2 and beyond), improvements in physics objects; HLT: Michalis Bachtis
- Mini-AOD coordination: Giovanni Petrucciani

Physics Coordination Structure

POGs= Physics Object Groups

- Define the single "objects" reconstruction and ID.
- Work closely in synch with Trigger coordination, Offline, PPD and related Detector Performance Groups.
- Validate and certify object's working points for physics analyses.
  - Provide official recipes and recommendations on how to optimally use our objects.
  - Twikis for all groups accessible from main page



Egamma: identification of electron and photons

JetMET: Jet and missing ET performance

Taus: the name says it all

Muons: the name says it all

B-tagging & Vtx: deals with secondary vertexing (and b-tag in general)

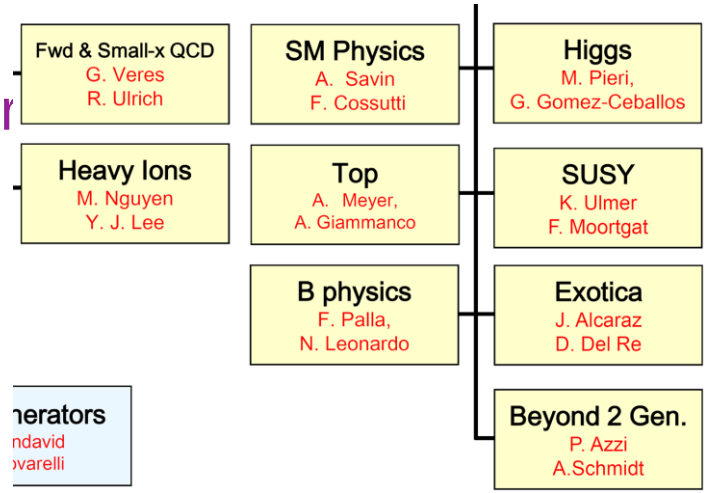
Tracking: deals with tracking and primary vertex

Luminosity: special POG. Delivers luminosity values for Physics analyses (several methods, tools). Work in close contact with BRIL project.

Physics Coordination Structure

PAGs= Physics Analysis Groups

- Coordinate the physics analysis plan
- Follow single analyses associated to their group up to the approvals
- Make sure that all recommendations are applied and participate in forming them (through object experts)
- Help defining Trigger strategies
- Deal with anything going public from our analyses: conference reports, PAS, twiki pages



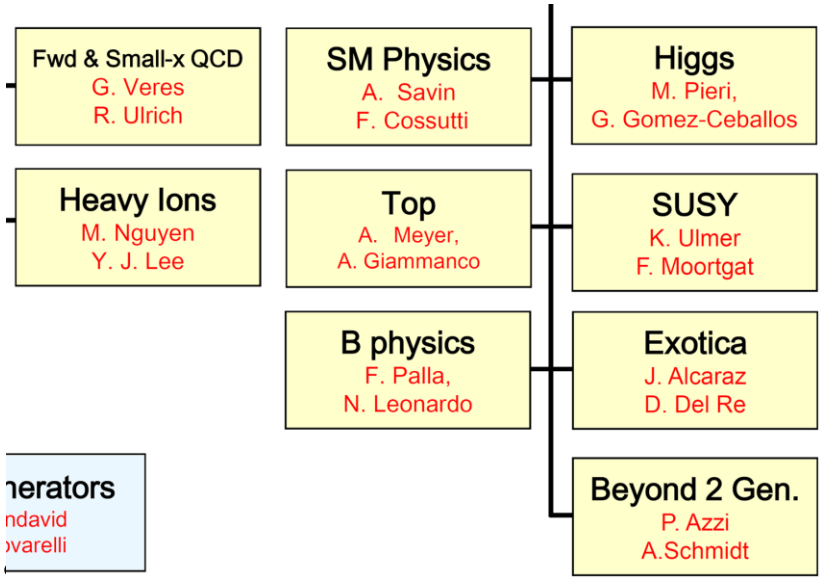
All twiki pages accessible from main page, including links to latest greatest results to prepare your conference report

Physics Coordination Structure

PAGs= Physics Analysis Groups

Common results in: https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResults

- FSQ: Forward and small-x QCD analyses (interacts also with TOTEM)
- SMP: Standard Model Physics (apart from FSQ, TOP, Higgs and BPH)
- HIG: everything “Higgs” (up to a certain mass, after which it becomes EXO/SuSy)
- HIN: Heavy Ion analyses, including pp reference samples
- TOP: name says it all
- SUS: searches for SuperSymmetry
- EXO: searches for exotic phenomenologies
- BPH: B physics and quarkonia in general
- B2G: Searches based on Beyond 2nd Generation (usually top, boosted objects)
- GEN: in between Physics and Offline, deal with generators in general and their validation (includes UE tuning, PDF, etc.)



Physics Coordination Structure

How the work is organized in POGs and PAGs

- Most groups have internal working groups (a.k.a. L3 groups).
- In POG's they mostly address specific areas: Identification, Reconstruction, HLT, etc.
- In PAG's they mostly address specific signatures common to many analyses or needs: leptonic, photonic, MC production, Trigger, etc.
  - they are also the first entry for analysis proposals and follow analyses up to pre-approval stage (see later for more details).

Meeting structure:

- fortnightly POG general meetings on Monday
- fortnightly PAG general meeting on Tuesday
- weekly plenary PPD and WGM on Wednesday
- parallel working group meetings saturating all afternoons on Thursday and Fridays

Please have a look at the calendar in
https://www.dropbox.com/s/xcheni5kzee33wa/PhysRooms2015_pub.xlsx
and pay attention to the groups HN announcements/twikis.

CMS Publications: A to Z

What kind of documents we produce

We have 5 types of *public* documents:

1)Journal Publications: they appear on refereed journals and are signed by the whole CMS Collaboration
2)Physics Analysis Summaries (PAS): summary documents usually in preparation for a paper or a conference contribution. Many PAS can be "concentrated" in a single paper.
3)Detector Performance Summaries (DPS): equivalent of PAS for performance plots and detector related analyses. They are managed jointly by Physics Coordination, Run Coordination and PPD.
4)Conference Reports (CR): proceedings to be submitted to conference.
5)CMS Notes: it is now obsolete (absorbed by PAS), so please forget about it. ;-)

Please note:

1)All documents, apart CR, are signed by the whole CMS Collaboration
2)All public documents must pass an internal review.

What kind of documents we produce

We have 4 types of *private* documents:

1)Analysis notes (AN): they are usually in support of a PAS with detailed documentation on analysis single step. They are used in the internal review of analyses and should be kept up-to-date.
2)Detector Performance Notes (DP): it is the private version of a DPS. Usually contains more material and explanation w.r.t. a DPS to help CMS speakers in conferences.
3)Internal Notes (IN): they were used as internal backup material of CMS Notes. They are now much less, if at all, used.
4)Detector Notes (DN): focussed on technical aspects of the detectors and managed usually internally in every single project.

Please note:

1)All private documents have explicit reference to the authors
2)No real wide review, but only a check that the material is not inappropriate.

The story of a physics analysis in CMS

Step 1: Think and Act

- You have an idea
- You don't have an idea but you would like to contribute
  - Select a group and talk directly to group/sub-group conveners

Step2: Attend the PAG meetings and become active in the group

- Do you need a particular sample? -> Help becoming a MC production expert
- Do you need a particular object? -> Work in the POG in order to get it as performant as you need it (and for the whole CMS)
- Do you need a particular workflow? -> Develop it and propose it to PPD.
- Do you need a special trigger? -> Work in L1 and HLT in order to set it up (in a way that is useful to the whole CMS)
- How can YOU help the group? -> ask the conveners and volunteer!

Step 3: Present your work

- Start presenting your analysis (or your team's analysis) in the pertinent working group meetings until you reach a state that is judged sufficient for pre-approval (the sub-group conveners decide in consultation with the conveners)

The story of a physics analysis in CMS

Step 4: Pre-approval

- It is usually held inside a working group meeting and called by the sub-group conveners. This is also the time when an Analysis Review Committee (ARC) is appointed and starts to follow your analysis.

Step 5: Approval

- It is usually held inside a general group meeting and called by the POG/PAG convener. The ARC should give a green light for the approval.
  - For at the least the first batch of Run 2 results, they will be approved in the Wednesday General Meetings (WGMs)
- After approval the analysis is ready to be shown in public as preliminary result unless it was agreed to go directly to a paper (it is usually the case when there is already a first preliminary result).

Step 6: Collaboration Wide Review (CWR)

- Everybody in the collaboration is asked to comment on the paper
- This step is coordinated by the Publication Committee

Step 7: Final Reading (FR) and submission to a journal

- The ARC and the Publication Committee evaluate the comments from CWR and the FR is scheduled to wrap it up before submission

The story of a physics analysis in CMS

A few important things to keep in mind:

- Despite the minimal required time between the steps, in general you should foresee (by experience):
  - at least 1 month between pre-approval and a public Physics Analysis Summary
  - at least 2 months between start of CWR and submission to a journal

- The documentation freezing time is to allow the full collaboration to get involved and give comments, not to punish the analyzers :-)

- We have two basic ways to exchange information about an analysis:
  - the dedicated HN forum (created automatically using the CADI interface, see later)
  - the dedicated twiki pages (private and public versions) that will stay forever also as additional material, if agreed upon.

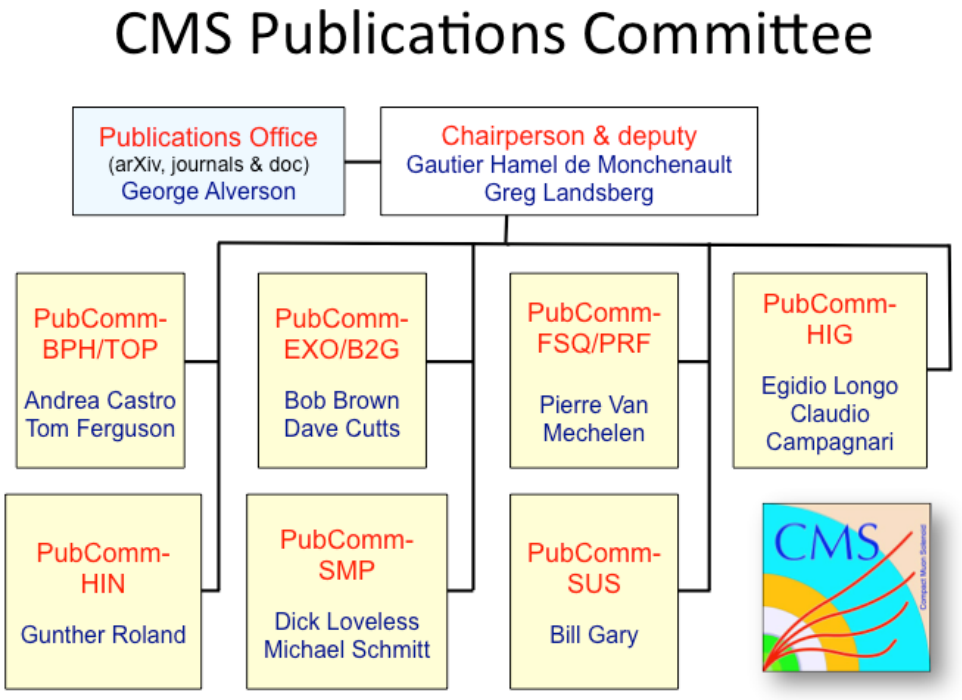
What next after approval? Publication

Slides from Gautier Hamel de Monchenault

Role of the Publication Committee

https://twiki.cern.ch/twiki/bin/viewauth/CMS/CMSPubComm

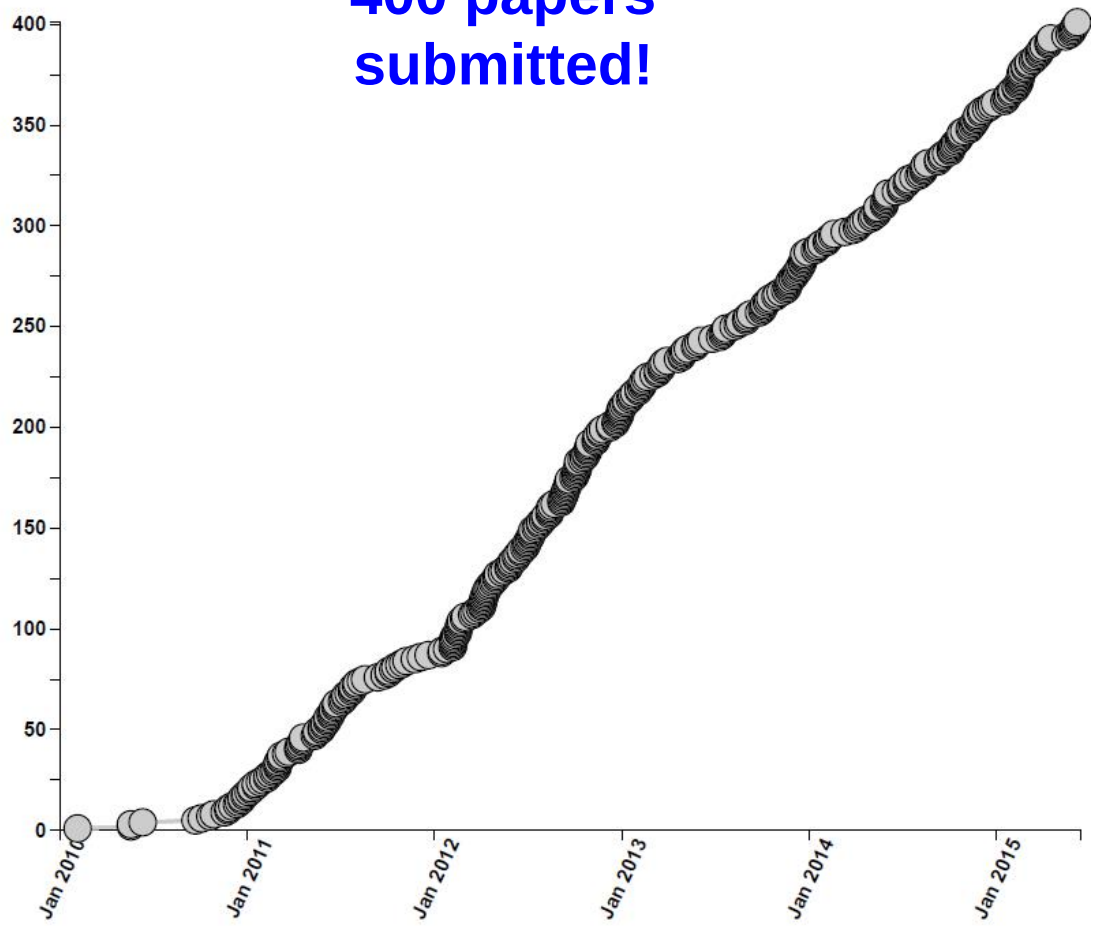
- The CMS Publications Committee (PubComm) is responsible for the high editorial quality of all CMS publications and public documents
- The PubComm defines the CMS standards for detector descriptions, figures, formats, styles, symbols, etc.
- The PubComm is organized in seven Editorial Boards (EB)
- The EB chairs form the PubComm Steering Board



Run 1 Publications: 400!

Show all | Total | QCD | Exotica Searches | Supersymmetry | B Physics | Electroweak
Top Physics | Heavy Ion | Higgs | Forward Physics | Standard Model | Beyond the SM: B2G

400 papers submitted!



Pub rate steady, ~2.5/week

400 papers submitted:
+23 CRAFT based
+32 ready for CWR or later
+17 PubDraft

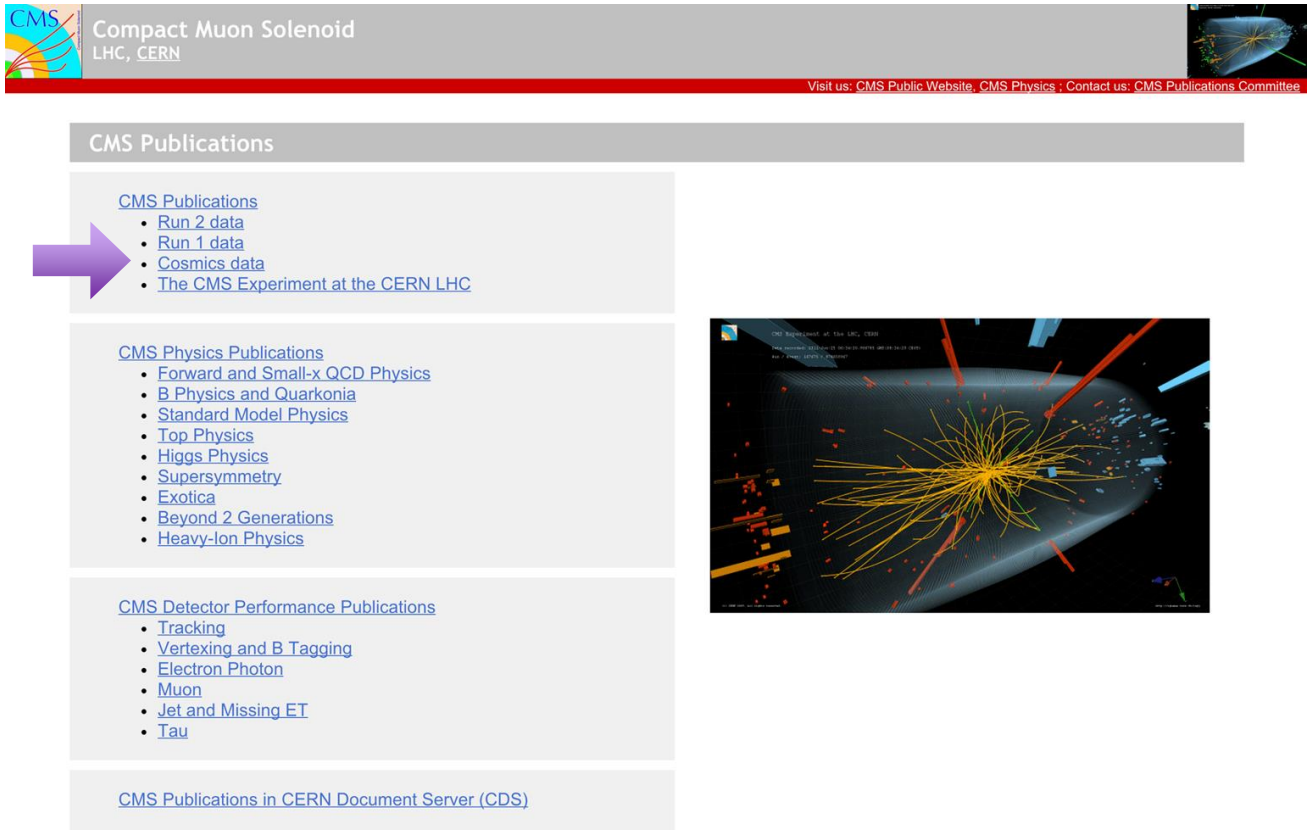
In review process (128):

84 GoingToPreApp or higher
44 in PAG review (= in state “AWG”)

All CMS papers are published Open Access in:
JHEP, PLB, EPJC, JINST, PRL, PRD, PRC,
Nature, Nature Physics, Science
(red=SCOAP3, blue=APS, green=other)

New CMS results public page!

- Thanks to Gautier we have now a new, and much nicer, public entry point for our publications
- It also includes public PAS



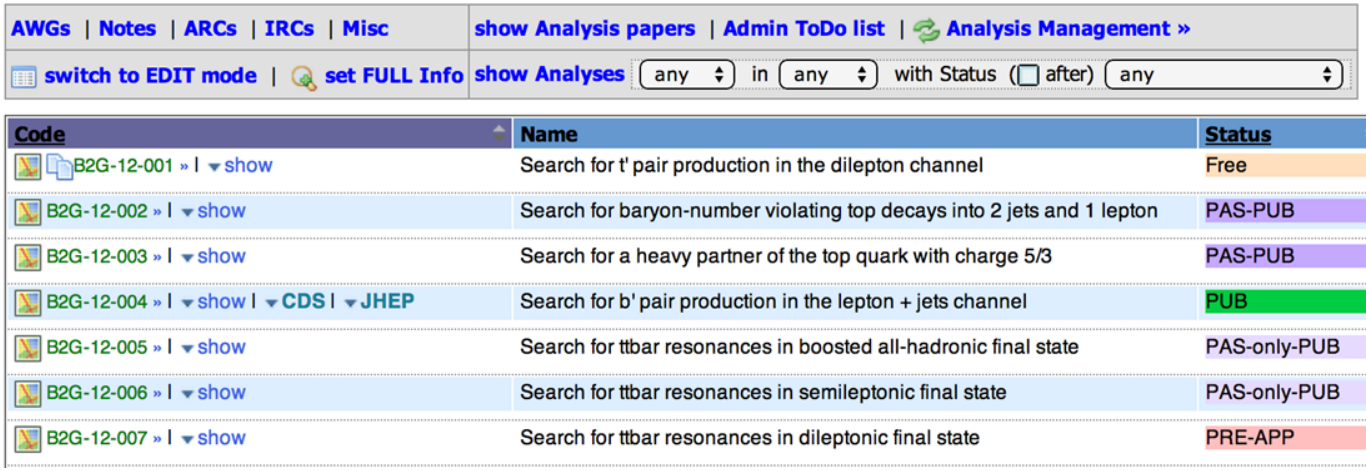
http://cms-results.web.cern.ch/cms-results/public-results/publications/

Where to find information on analyses

We have a single database that stores all info.
CADI (CMS Analysis Database Interface).

Important note:
use this new link: http://cms.cern.ch/iCMS/analysisadmin/cadilines
and NOT the old link: http://cms.cern.ch/iCMS/jsp/analysis/admin/analysismanagement.jsp

unless you want to wait for ages before getting a page
(unfortunately the new link is not yet propagated everywhere)



First steps in a physics analysis

Getting started: a few “first steps”

You now know:

- how we took our data
- how they are separated in datasets (trigger paths, skims,etc.)
- where to look for them (DAS and alike)
- what are the steps in order to get an analysis approved and published

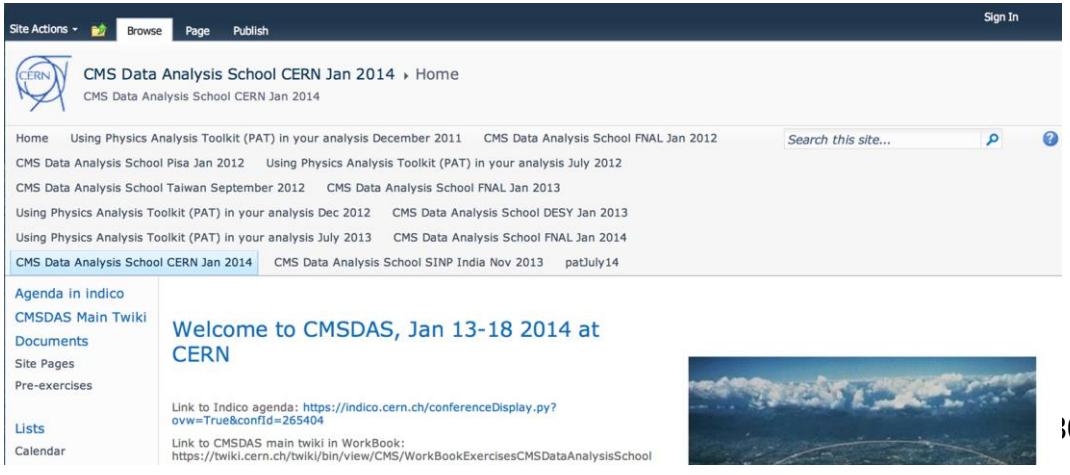
In the next few slides you will have some practical hooks on how to produce your first plots

- how to get a quick look at the data (with examples)
- how to access data on the grid
- how to deal with complex statistical procedure

CAVEAT: this is far from being a tutorial!

For a real tutorial please have a look at (and/or join!) a CMS Data Analysis School (CMSDAS):

https://espace.cern.ch/learncms/AnalysisSchoolCERNJan14/SitePages/Home.aspx



Getting started: a few "first steps"

Slides from Tae Jeong Kim

For your first interaction with CMSSW and data analysis, PAT (Physics Analysis Toolkit) should be the way to go.

- PAT is a toolkit, part of the CMSSW framework, aimed at performing analysis.

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

Interface
- Between RECO expertise and analysis contacts
- Simplifies access via dataformats
- Canalizes expertise of Physics Object Group (POG) and Physics Analysis Group (PAG)

Common Tool
- approved algorithms & sensible defaults
- synergy (everybody can profit from recent developments)
- quick start into analysis for the beginners

Common Format
- facilitates transfer & comparisons
- PAG common configurations
- sustained provenance

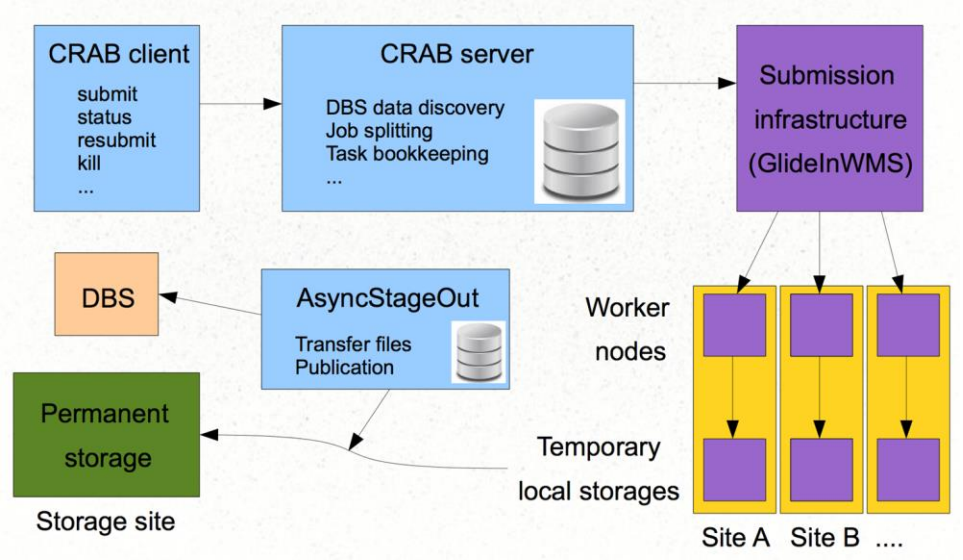
Getting started: a few “first steps”

How do you access full datasets on the GRID?

CRAB !

CRAB (CMS Remote Analysis Builder) is software & hardware infrastructure used by CMS to submit analysis jobs to the LHC Computing Grid.

We are now in its third major release (CRAB3) and this is the ONLY one supported for Run2.



Tutorial: https://indico.cern.ch/event/320672

Twiki page: https://twiki.cern.ch/twiki/bin/view/CMSPublic/WorkBookCRAB3Tutorial

Getting started: a few “first steps”

Where to get help and find info

First stop, the WorkBook!
https://twiki.cern.ch/twiki/bin/view/CMSPublic/WorkBook

Physics Analysis Tool group twiki page:
https://twiki.cern.ch/twiki/bin/view/CMSPublic/SWGuidePhysicsTools

Tutorials

PAT tutorial:
https://twiki.cern.ch/twiki/bin/view/CMSPublic/WorkBookPATTutorial
MiniAOD tutorial:
https://twiki.cern.ch/twiki/bin/view/CMSPublic/WorkBookMiniAOD
PAT release recipe for each CMSSW release:
https://twiki.cern.ch/twiki/bin/view/CMSPublic/SWGuidePATReleaseNotes70X

Questions about Physics Analysis Tools should be sent to
hn-cms-physTools@cern.ch (please register)

Another source of information is the weekly RECO/AT meeting every Thursday at 5 pm, CERN time.

Interpreting and presenting our data

Statistics tools

With the complexity of analyses, the statistical interpretation of the results has reached a totally new level at the LHC.

The help of experts in statistics is needed:

- How to evaluate errors and correlations when I use an MVA of an MVA of an MVA? (we have analyses needing this approach)
- What should I use for settings limits?
- Is CLs ok? Should I use frequentist or Bayesian approaches?
- How I can be sure my limits cover? (i.e. 95% CL is really 95%?)
- What kind of error should I use when no event is surviving?
- ……

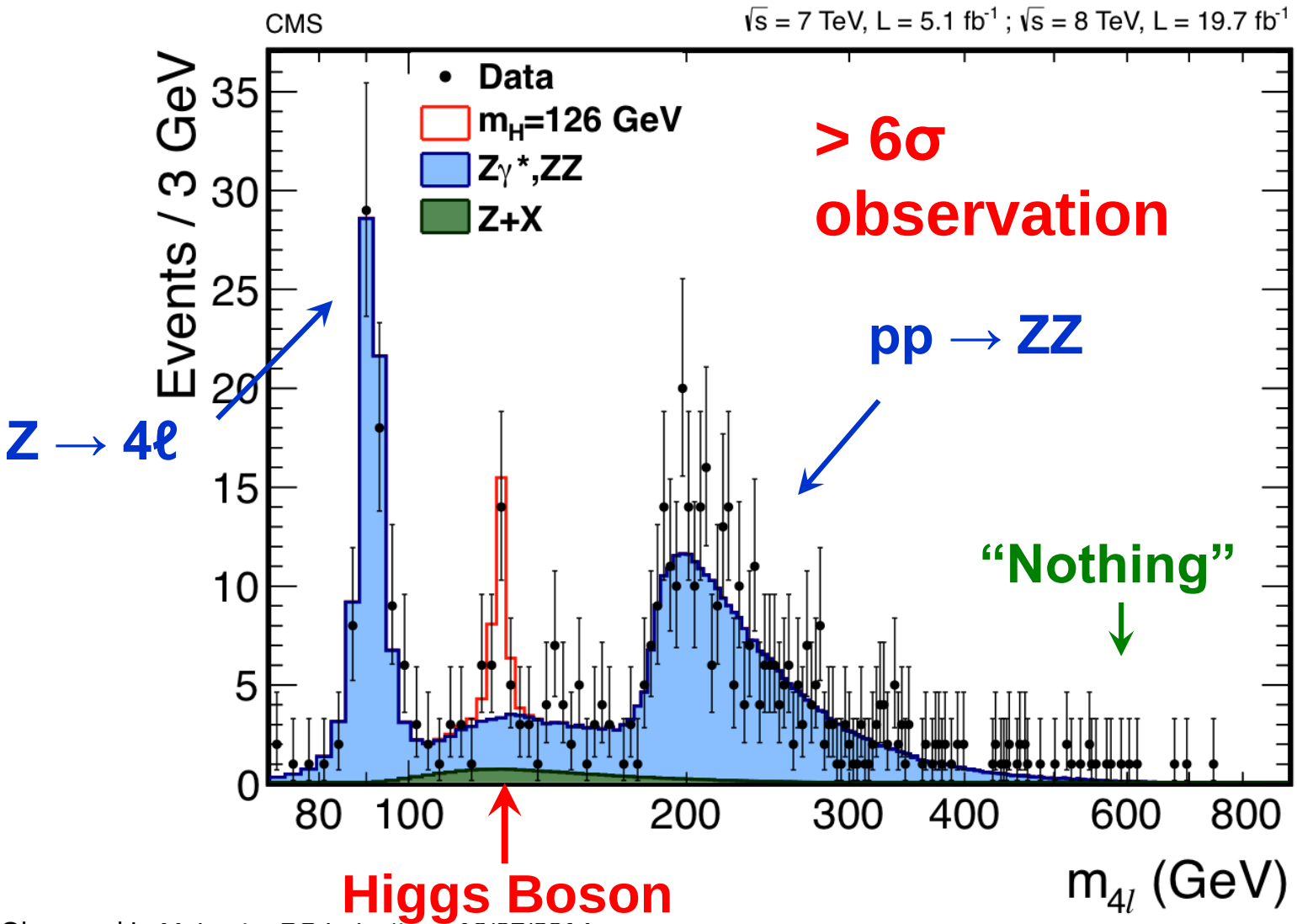
These are just some of the common issues that are continuously popping up.

If you are not sure about them, don't embark on a DIY statistics project!

Rather, contact our Statistics Committee!

Example: H → ZZ* → 4ℓ

HIG uses the 'combine" statistics tool in all measurements of Higgs boson properties



Interpreting and presenting our data

The CMS Statistics Committee

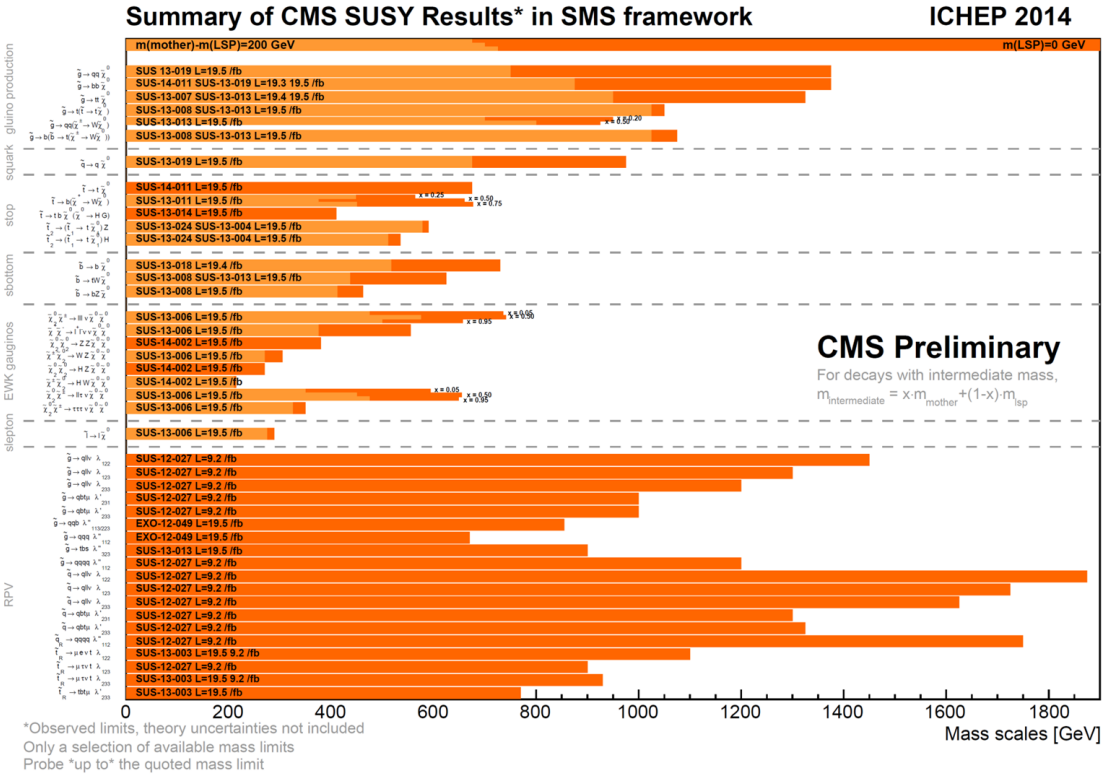
SC members:
Tommaso Dorigo (Chair)
Olaf Behnke (Co-Chair)
Sudeshna Banerjee
Emilien Chapon
Mingshui Chen
John Conway
Bob Cousins
Louis Lyons
Francisco Matorras
Pietro Vischia
Igor Volobouev

PCs are ex-officio

- 11-12 CMS members with interest in statistics who work to help collaborators produce results using recommendable statistics procedures
- The CMS Statistics Committee forms recommendations on statistical issues relevant to CMS physics analyses
  The members of the committee also act as consultants to CMS collaborators seeking input on specialized statistics issues.
- The committee has a useful twiki page which can be found at
https://twiki.cern.ch/twiki/bin/view/CMS/StatisticsCommittee
- It is also a good idea to subscribe to the "Statistics Discussions" Hypernews: low-rate, high S/N threads

Where are we going? Overview of Run 2

Run 1 Limits


Summary of CMS SUSY Results* in SMS framework
ICHEP 2014
m(mother)-m(LSP)=200 GeV
m(LSP)=0 GeV
gluino production
squark
stop
sbottom
EWK gauginos
slepton
RPV
SUS 13-019 L=19.5 /fb
SUS-14-011 SUS-13-019 L=19.3 19.5 /fb
SUS-13-007 SUS-13-013 L=19.4 19.5 /fb
SUS-13-008 SUS-13-013 L=19.5 /fb
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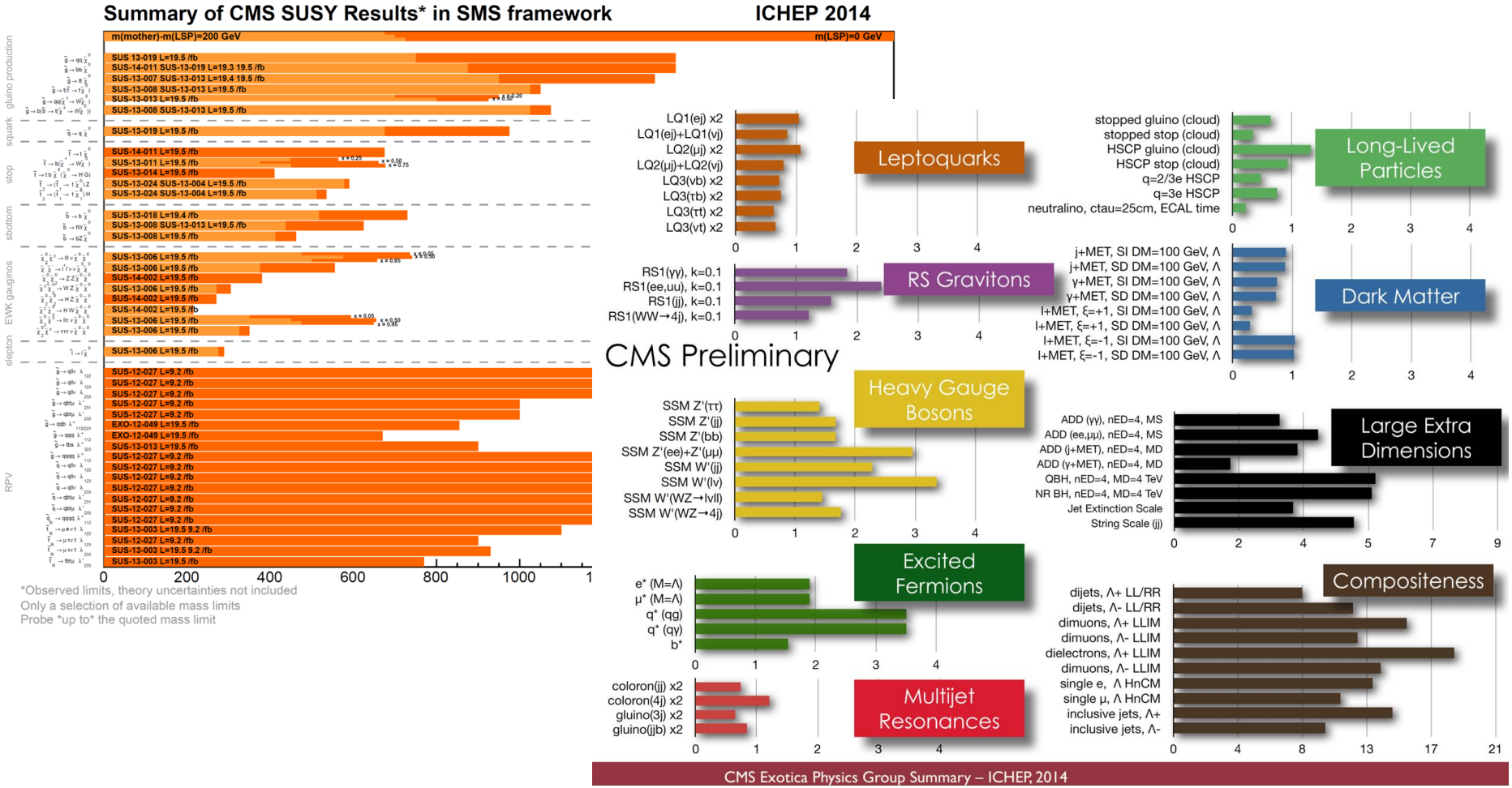
SUS-12-027 L=9.2 /fb
SUS-13-003 L=19.5 9.2 /fb
SUS-13-003 L=19.5 /fb
CMS Preliminary
For decays with intermediate mass,
m_intermediate = x·m_mother +(1-x)·m_lsp
0
200
400
600
800
1000
1200
1400
1600
1800
Mass scales [GeV]
*Observed limits, theory uncertainties not included
Only a selection of available mass limits
Probe *up to* the quoted mass limit

Run 1 Limits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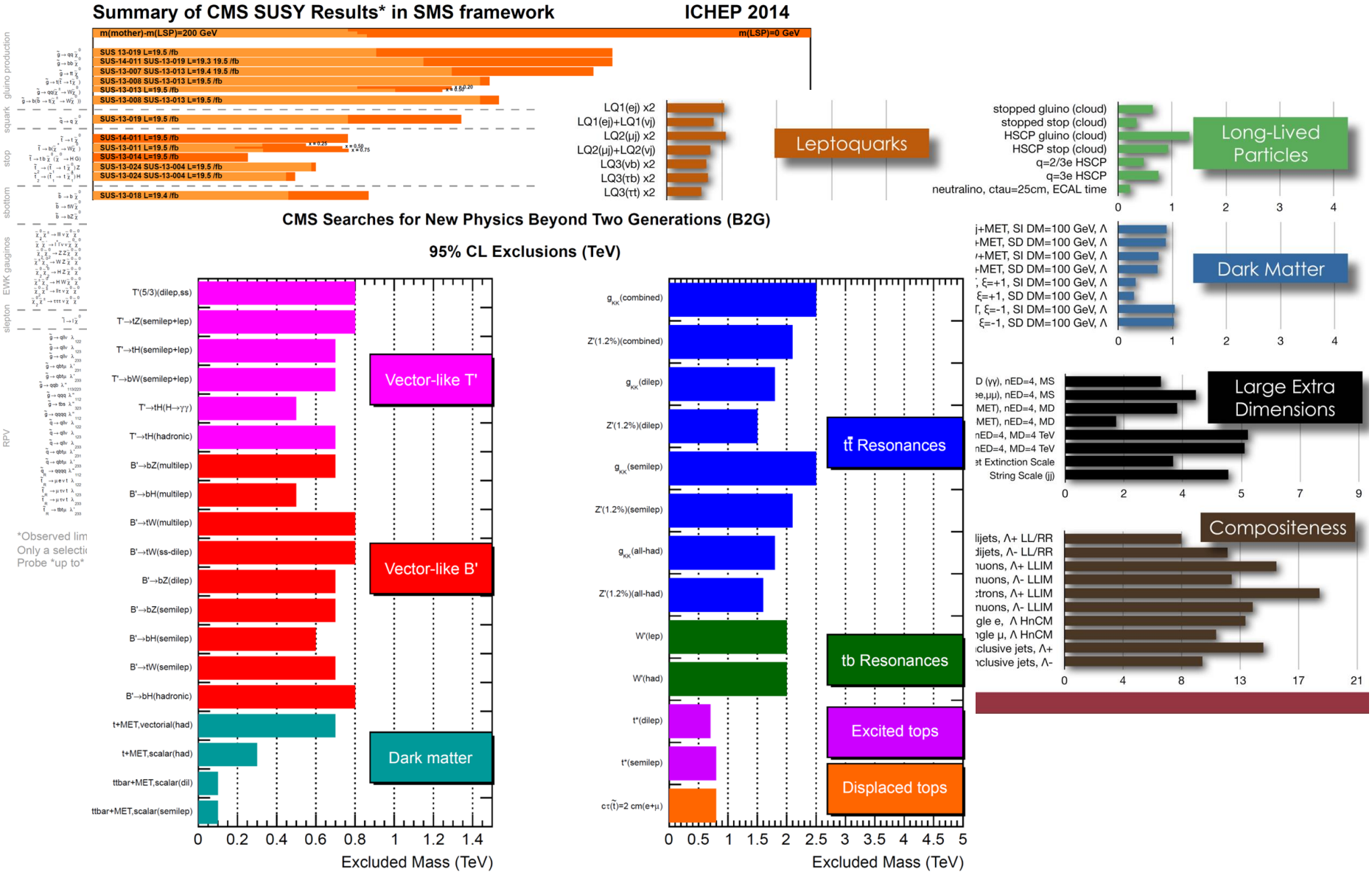
SUS-13-003 L=19.5 9.2 /fb
SUS-12-027 L=9.2 /fb
SUS-13-003 L=19.5 9.2 /fb
SUS-13-003 L=19.5 /fb
0 200 400 600 800 1000 1
*Observed limits, theory uncertainties not included
Only a selection of available mass limits
Probe *up to* the quoted mass limit
LQ1(ej) x2
LQ1(ej)+LQ1(vj)
LQ2(μj) x2
LQ2(μj)+LQ2(vj)
LQ3(vb) x2
LQ3(τb) x2
LQ3(ττ) x2
LQ3(vt) x2
Leptoquarks
RS1(γγ), k=0.1
RS1(ee,uu), k=0.1
RS1(jj), k=0.1
RS1(WW→4j), k=0.1
RS Gravitons
CMS Preliminary
SSM Z'(ττ)
SSM Z'(jj)
SSM Z'(bb)
SSM Z'(ee)+Z'(μμ)
SSM W'(jj)
SSM W'(lv)
SSM W'(WZ→lvll)
SSM W'(WZ→4j)
Heavy Gauge Bosons
e* (M=Λ)
μ* (M=Λ)
q* (qg)
q* (qγ)
b*
Excited Fermions
coloron(jj) x2
coloron(4j) x2
gluino(3j) x2
gluino(jjb) x2
Multijet Resonances
stopped gluino (cloud)
stopped stop (cloud)
HSCP gluino (cloud)
HSCP stop (cloud)
q=2/3e HSCP
q=3e HSCP
neutralino, ctau=25cm, ECAL time
Long-Lived Particles
j+MET, SI DM=100 GeV, Λ
j+MET, SD DM=100 GeV, Λ
γ+MET, SI DM=100 GeV, Λ
γ+MET, SD DM=100 GeV, Λ
l+MET, ξ=+1, SI DM=100 GeV, Λ
l+MET, ξ=+1, SD DM=100 GeV, Λ
l+MET, ξ=-1, SI DM=100 GeV, Λ
l+MET, ξ=-1, SD DM=100 GeV, Λ
Dark Matter
ADD (γγ), nED=4, MS
ADD (ee,μμ), nED=4, MS
ADD (j+MET), nED=4, MD
ADD (γ+MET), nED=4, MD
QBH, nED=4, MD=4 TeV
NR BH, nED=4, MD=4 TeV
Jet Extinction Scale
String Scale (jj)
Large Extra Dimensions
dijets, Λ+ LL/RR
dijets, Λ- LL/RR
dimuons, Λ+ LLIM
dimuons, Λ- LLIM
dielectrons, Λ+ LLIM
dimuons, Λ- LLIM
single e, Λ HnCM
single μ, Λ HnCM
inclusive jets, Λ+
inclusive jets, Λ-
Compositeness
CMS Exotica Physics Group Summary – ICHEP 2014

Run 1 Limits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LQ3(τb) x2
LQ3(τt) x2
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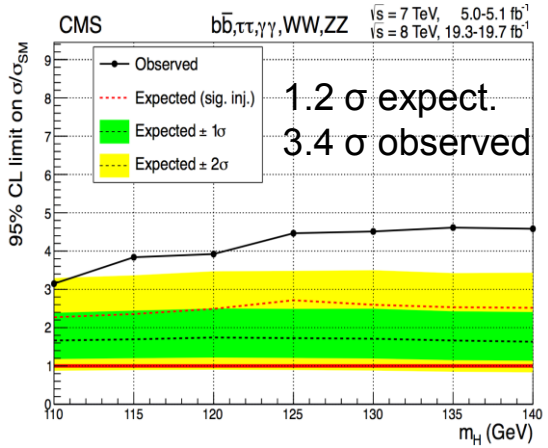
stopped stop (cloud)
HSCP gluino (cloud)
HSCP stop (cloud)
q=2/3e HSCP
q=3e HSCP
neutralino, ctau=25cm, ECAL time
Long-Lived Particles
0 1 2 3 4
CMS Searches for New Physics Beyond Two Generations (B2G)
95% CL Exclusions (TeV)
T'(5/3)(dilep,ss)
T'→tZ(semilep+lep)
T'→tH(semilep+lep)
T'→bW(semilep+lep)
T'→tH(H→γγ)
T'→tH(hadronic)
B'→bZ(multilep)
B'→bH(multilep)
B'→tW(multilep)
B'→tW(ss-dilep)
B'→bZ(dilep)
B'→bZ(semilep)
B'→bH(semilep)
B'→tW(semilep)
B'→bH(hadronic)
t+MET,vectorial(had)
t+MET,scalar(had)
ttbar+MET,scalar(dil)
ttbar+MET,scalar(semilep)
Vector-like T'
Vector-like B'
Dark matter
0 0.2 0.4 0.6 0.8 1 1.2 1.4
Excited Mass (TeV)
g_KK(combined)
Z'(1.2%)(combined)
g_KK(dilep)
Z'(1.2%)(dilep)
g_KK(semilep)
Z'(1.2%)(semilep)
g_KK(all-had)
Z'(1.2%)(all-had)
W'(lep)
W'(had)
t*(dilep)
t*(semilep)
cτ(t̃)=2 cm(e+μ)
tt̄ Resonances
tb Resonances
Excited tops
Displaced tops
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
Excited Mass (TeV)
j+MET, SI DM=100 GeV, Λ
-MET, SD DM=100 GeV, Λ
/+MET, SI DM=100 GeV, Λ
-MET, SD DM=100 GeV, Λ
, ξ=+1, SI DM=100 GeV, Λ
ξ=+1, SD DM=100 GeV, Λ
Γ, ξ=-1, SI DM=100 GeV, Λ
ξ=-1, SD DM=100 GeV, Λ
Dark Matter
0 1 2 3 4
D (γγ), nED=4, MS
e,μμ), nED=4, MS
MET), nED=4, MD
MET), nED=4, MD
nED=4, MD=4 TeV
nED=4, MD=4 TeV
t Extinction Scale
String Scale (jj)
Large Extra Dimensions
0 2 4 5 7 9
lijets, Λ+ LL/RR
ijets, Λ- LL/RR
nuons, Λ+ LLIM
nuons, Λ- LLIM
trons, Λ+ LLIM
nuons, Λ- LLIM
gle e, Λ HnCM
ngle μ, Λ HnCM
nclusive jets, Λ+
nclusive jets, Λ-
Compositeness
0 4 8 13 17 21
*Observed lim
Only a selecti
Probe *up to*

Examples of Hot Spots: Higgs

In the Higgs arena we have a couple of effects to monitor:

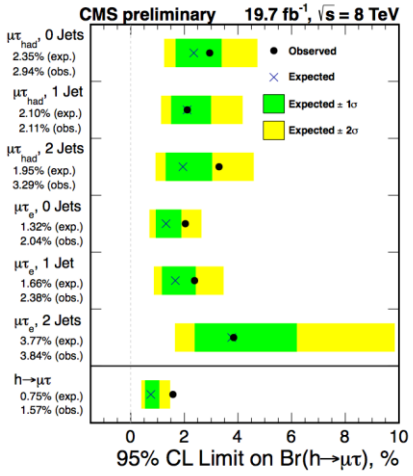
ttH:

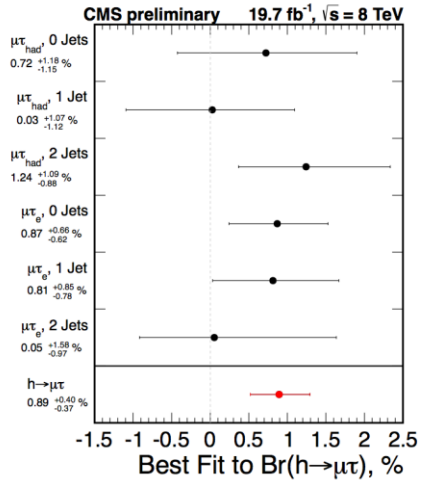
- we see more than what we expect
- excess is located in multilepton final state



Higgs lepton flavor violating decays:

- in the search for H→$\mu\tau$ we see an excess of ~2.5σ
- both hadronic and leptonic taus are affected

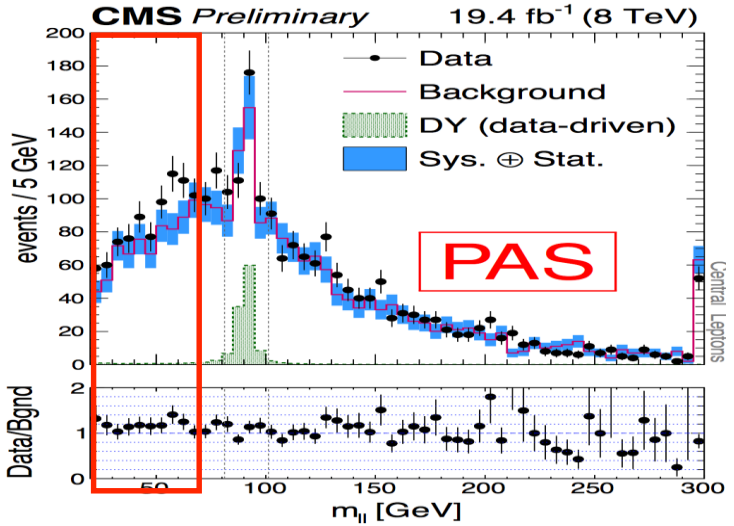


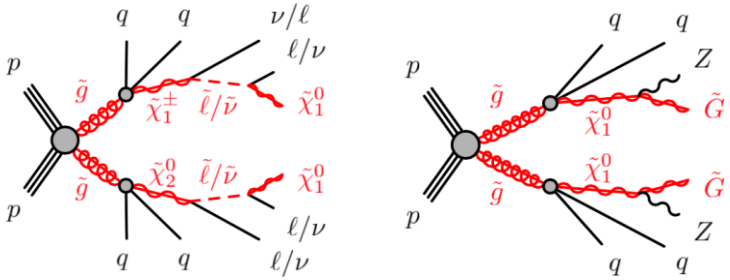


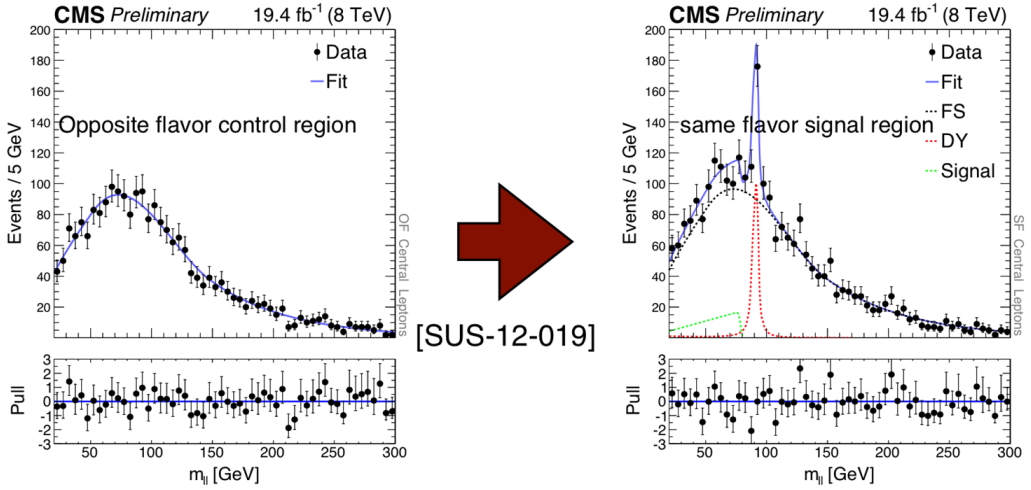
Examples of Hot Spots: SUSY

The di-lepton edge analysis (SUS-12-019)

- There is an excess (2.6 σ)visible on the low di-lepton invariant mass that was first shown during Lisbon is CMS Week 2012.
- Any plausible hypothesis of new physics is not corroborated by evidence in other channels.







Examples of Hot Spots: SUSY

The di-lepton edge analysis (SUS-12-019)

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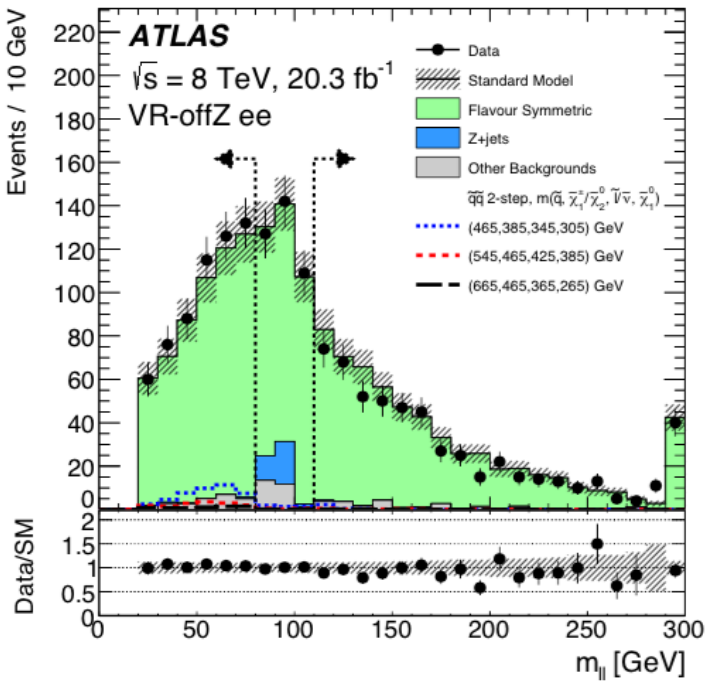
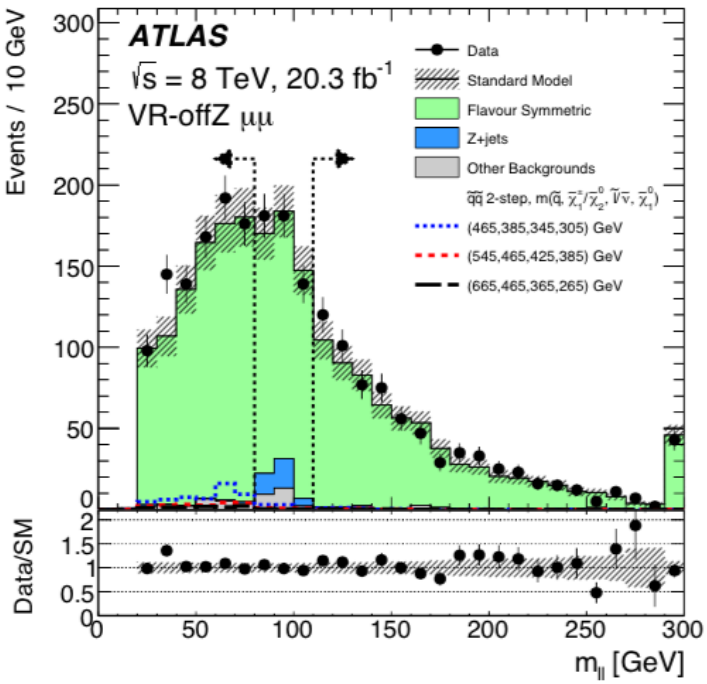
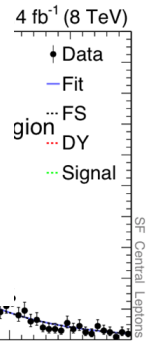
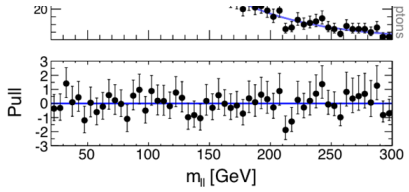
- duri
- Any
- not
- chan

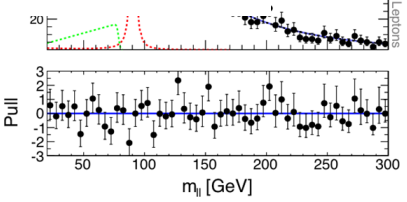








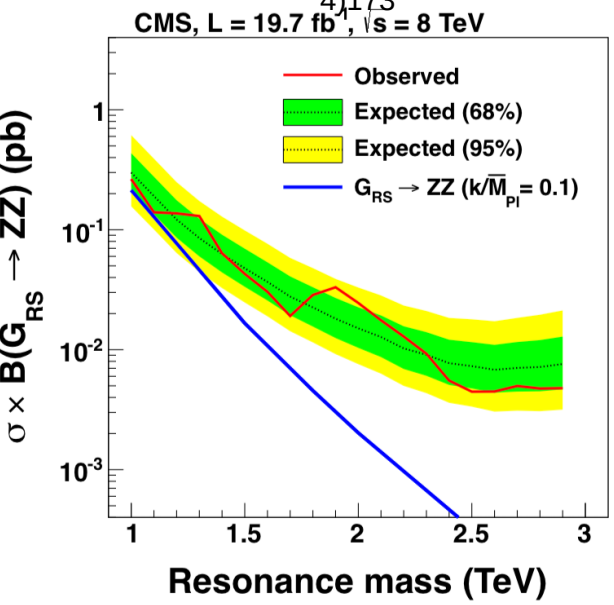
[SUS-12-019]



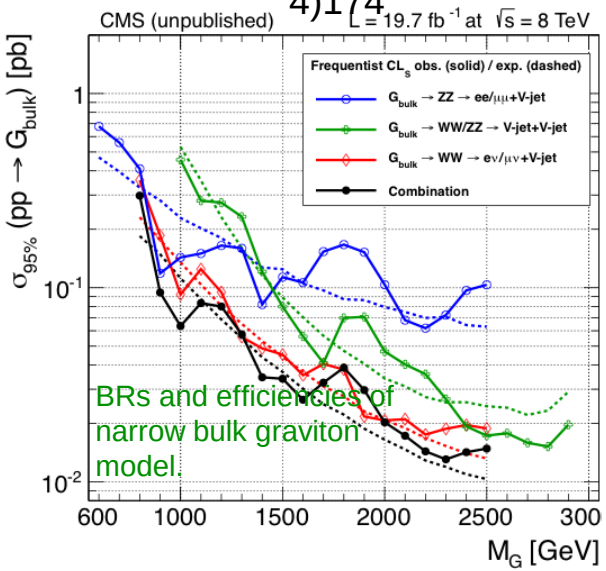
Examples of Hot Spots: Exotica

Non exhaustive!) List of effect to keep under strict surveillanc

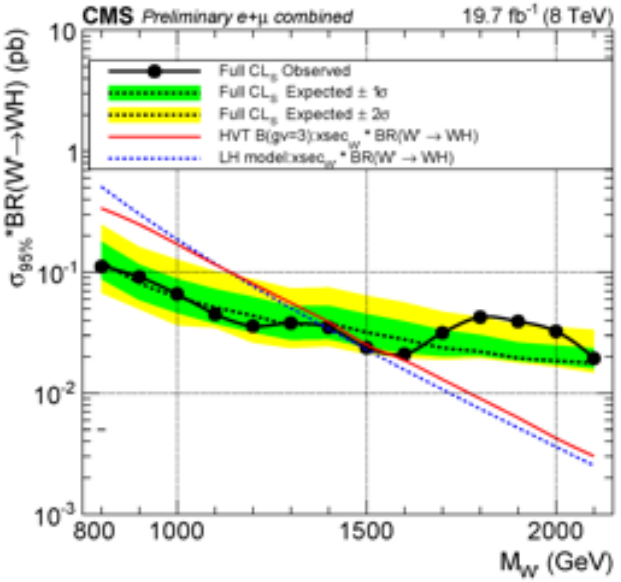
EXO-12-024
http://dx.doi.org/10.1007/JHEP08(2014)173



Combination: EXO-13-009
(includes EXO-12-024)
http://dx.doi.org/10.1007/JHEP08(2014)174



EXO-14-010



Excess around 1.8 TeV, (1.5σ in VV, ~2.0σ in VH)

Enhanced in exclusive decay modes.

Examples of Hot Spots: Exotica

And in this case ATLAS has also an excess (but only hadronic).

BTW, the started looking when we published first signs…

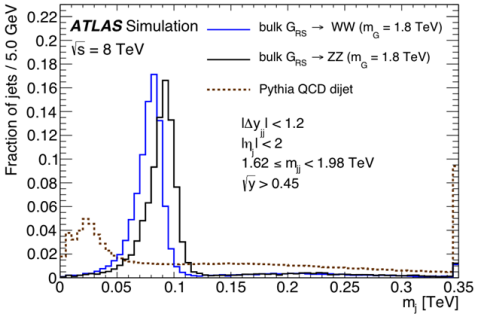
Search for X' -> VV' -> JJ

submitted to JHEP (arXiv: 1506.00962)

Search for narrow diboson resonances (WW, WZ, ZZ) in all-hadronic channel.

based on boosted and boson tagged groomed jets.

Jet mass

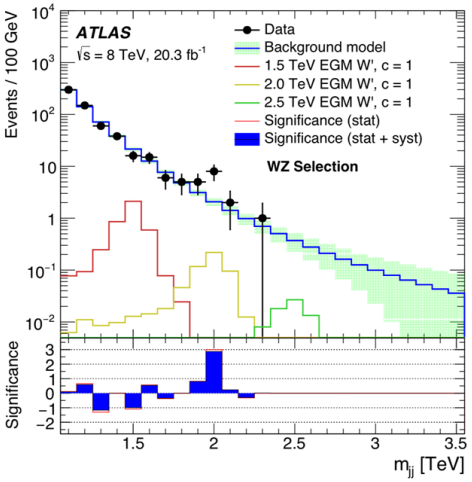


Background due to dijet events from QCD processes: smoothly falling, fitted with empirical function.

Data well described by background model except for a few bins near m_{jj} = 2 TeV. Local p_0 = 3.4σ (WZ channel at m_{jj} ~ 2 TeV), global significance 2.5σ (full mass range, all channels)

→ check in Run2

Signal region



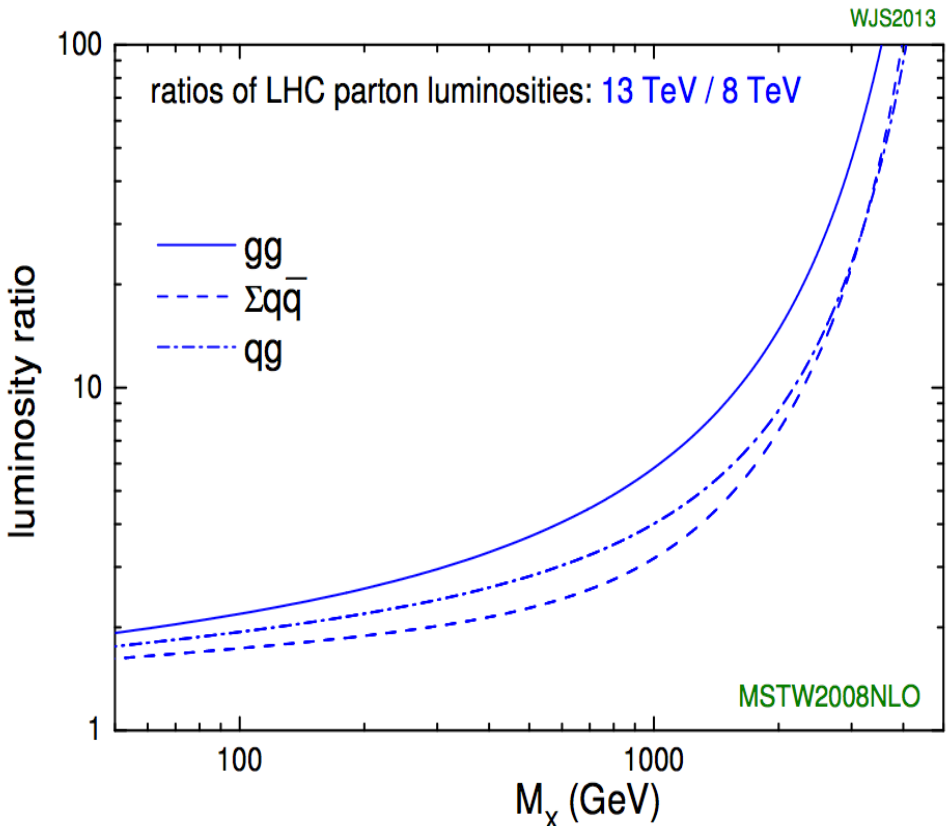
T. Eifert - ATLAS Status Report - 122nd LHCC meeting - 3rd June 2015 24

For more details about this please see Maurizio's summary in:

https://indico.fnal.gov/getFile.py/access?contribId=82&sessionId=29&resId=0&materialId=slides&confId=8982

Run2 Strategies

The road is already well paved (after our 8 TeV data):

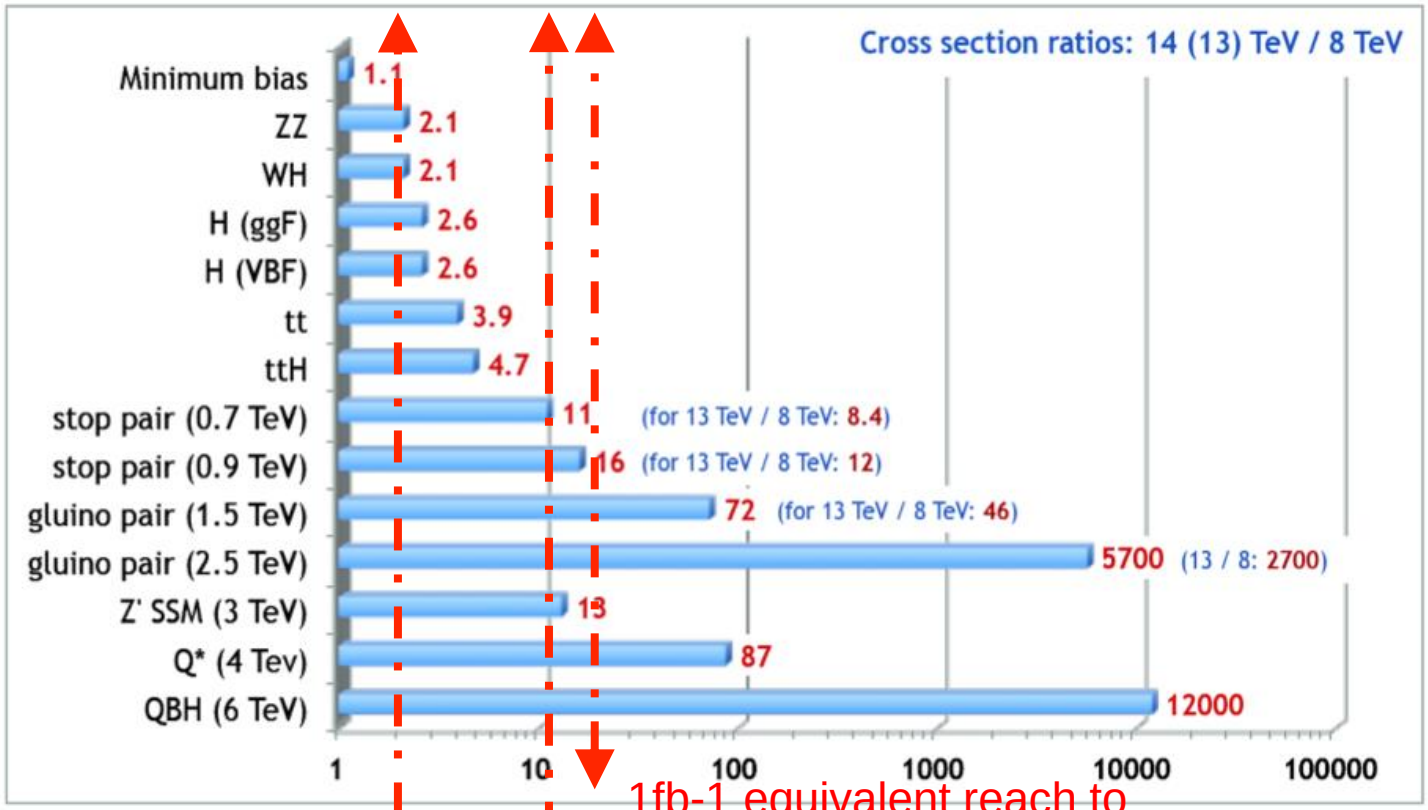


- Direct extrapolation from Stirling plot (i.e. when will we exceed the 8 TeV discovery potential?): repeat Run 1 analyses and wait for discovery
- Explore corners of phase space left hidden in our 8 TeV data (low missing Et, low pt leptons, long-lived, etc.)
  - but for this we need a lot of ingenuity and flexibility at trigger and data processing level
- Precision physics:
  - test that bkgs for searches are well modelled (including our MC tuning)
  - Indirect searches.

Run2 Discovery Potential

A different way to look at the Stirling plot:

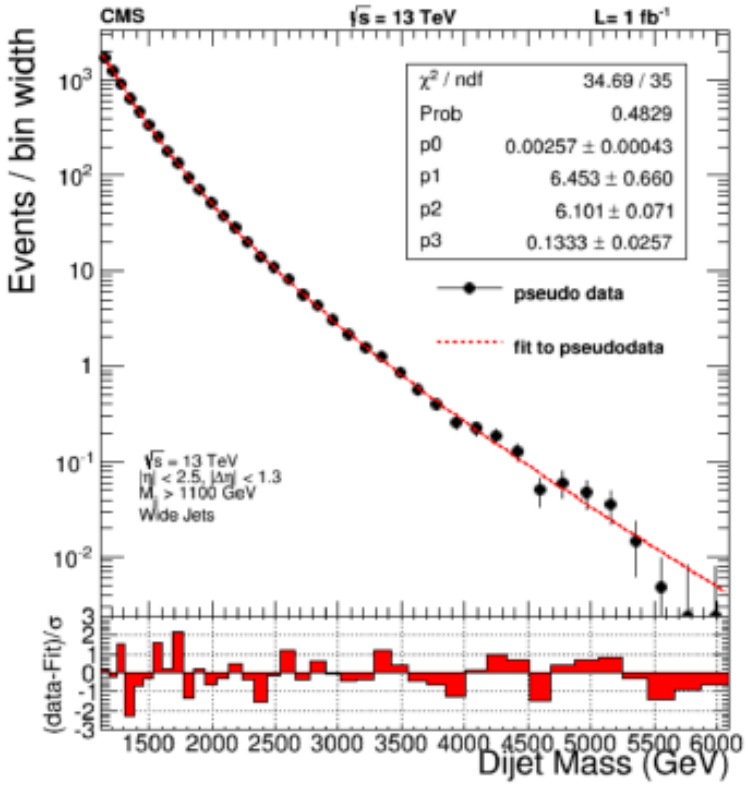
how much luminosity @13TeV is needed to equal the 8 TeV discovery potential (a really approximate view!)

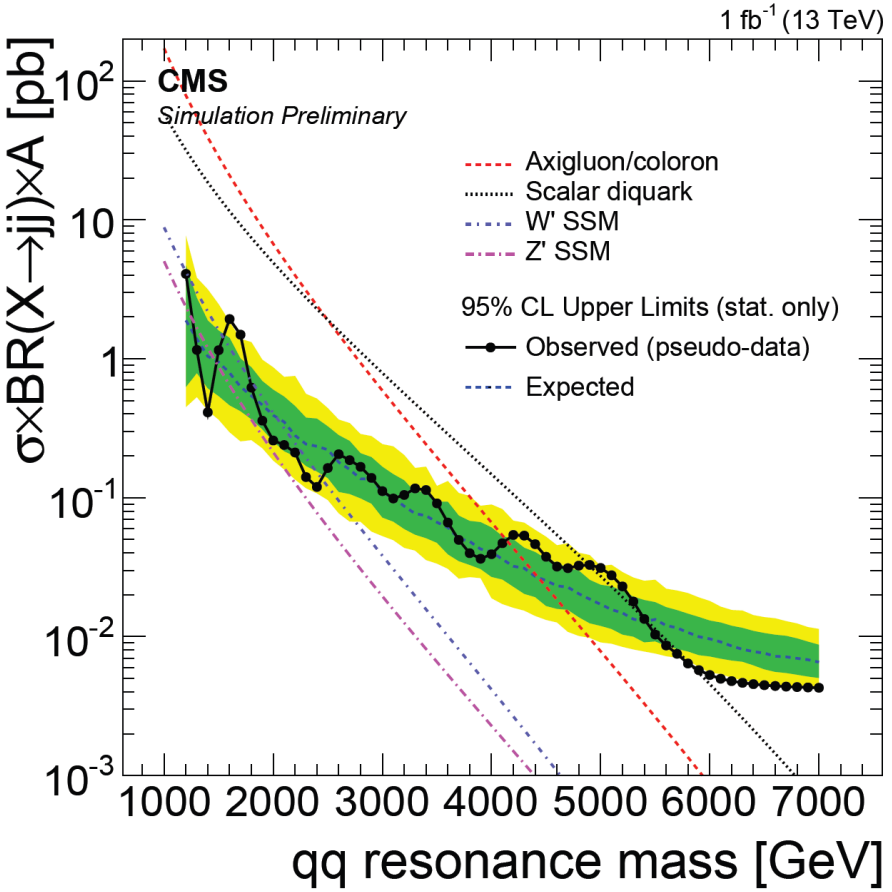


Example Early Target: dijet resonance

Dijet: background and shape fit

- Variable mass binning that corresponds to the estimated dijet mass resolution
- Pseudo dataset corresponding to 1/fb
- Pythia8 QCD MC PHYS14
- Likelihood fit, range 1.1 to 6 TeV





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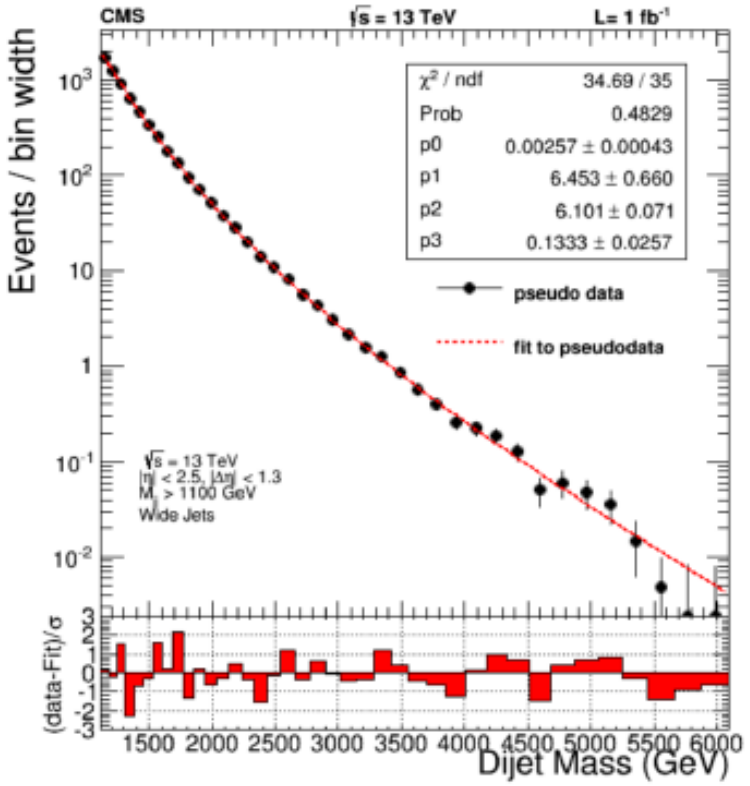
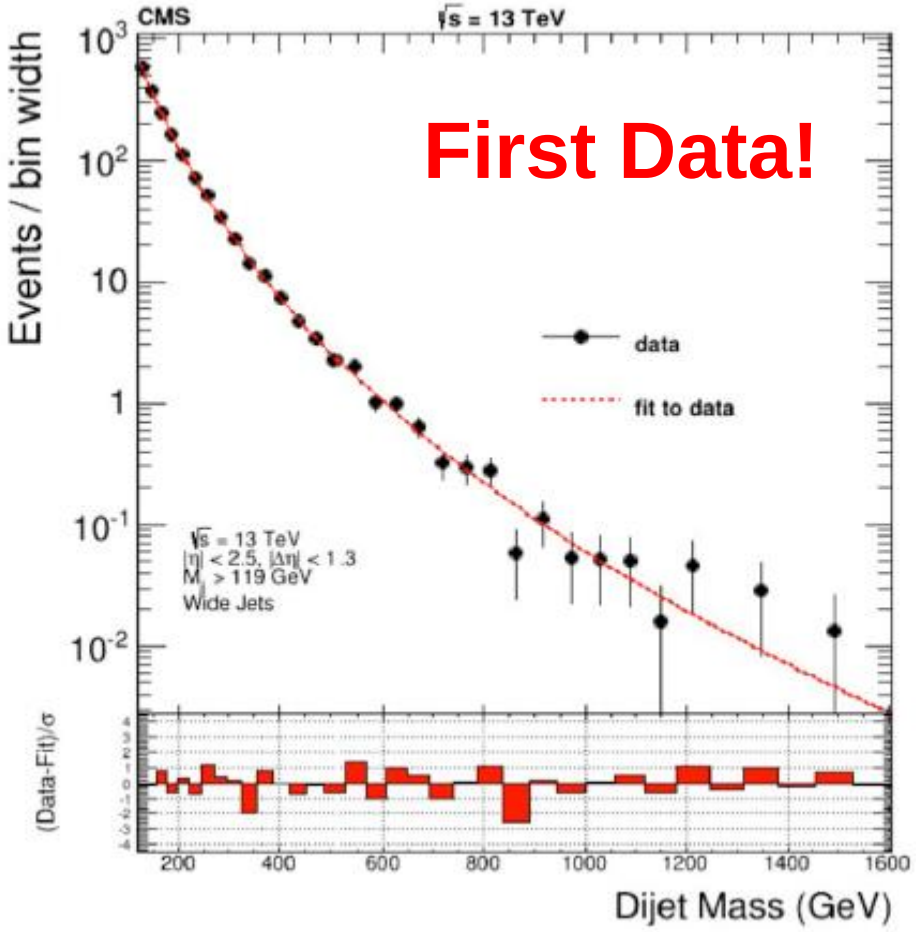
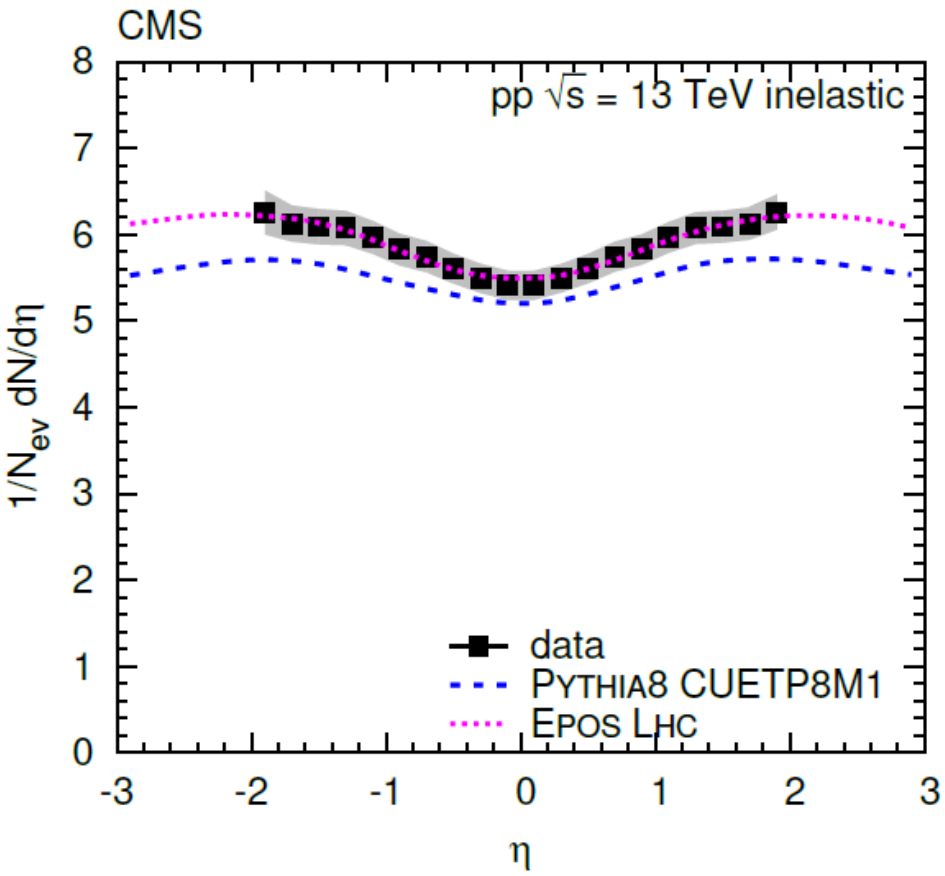
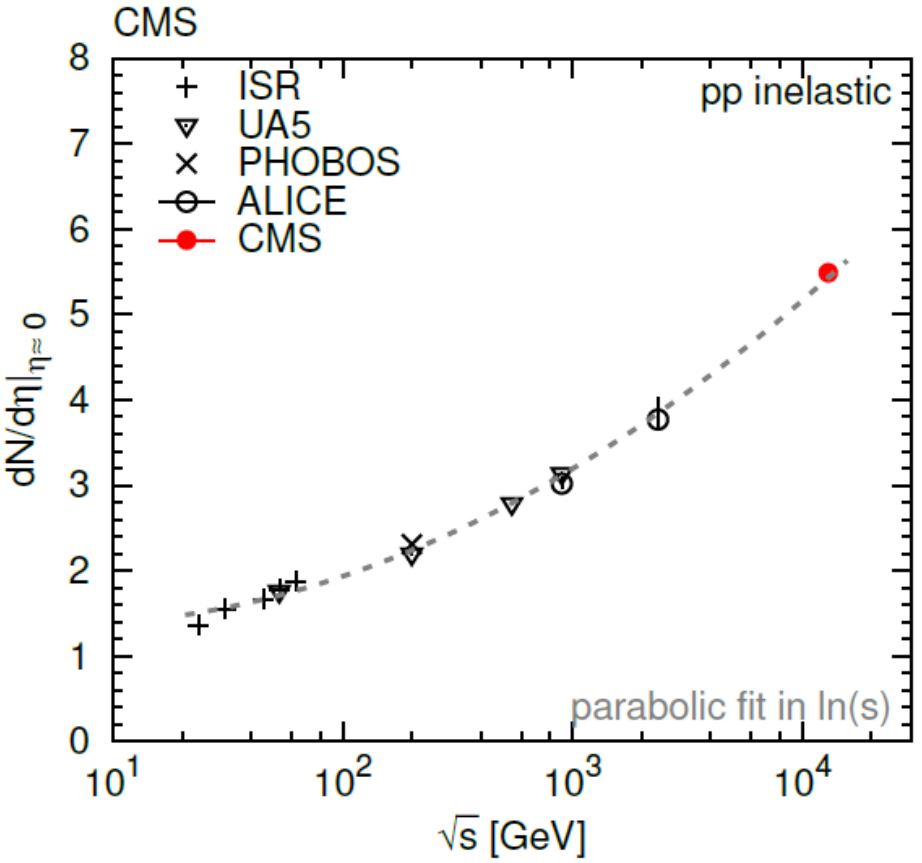




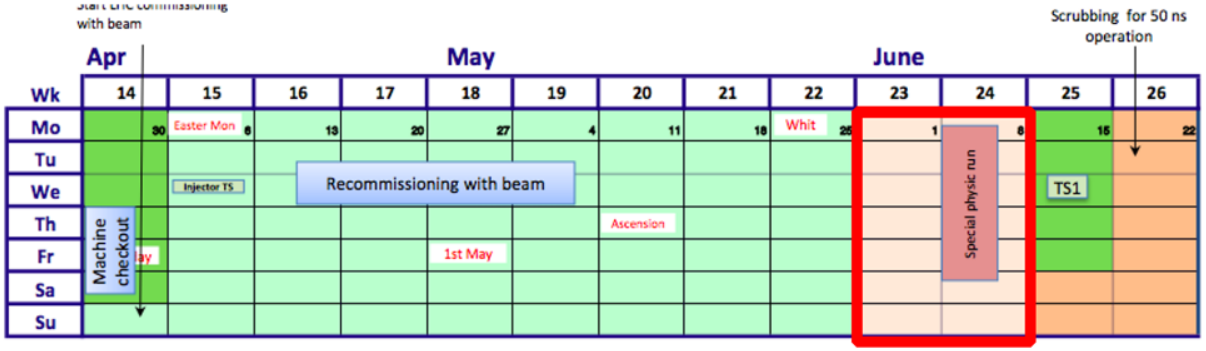
First 13 TeV Paper: dN/dη

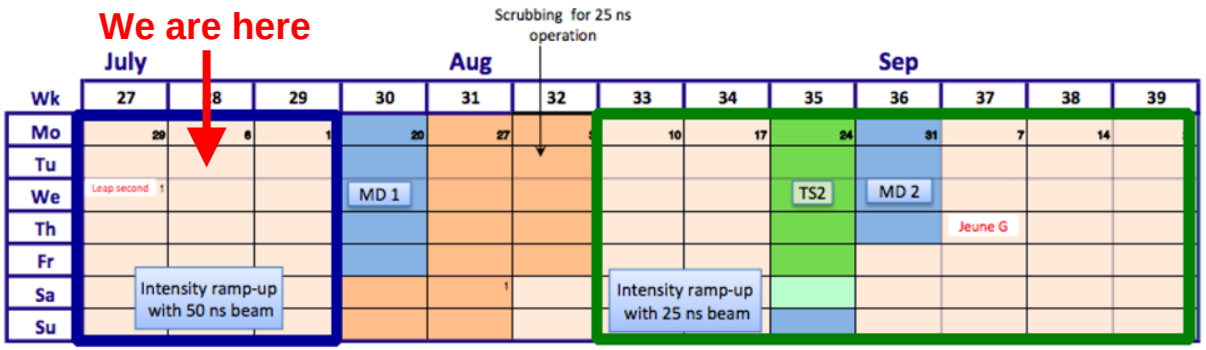
FSQ-15-001
In CWR since yesterday
Approval at the WGM next Wednesday

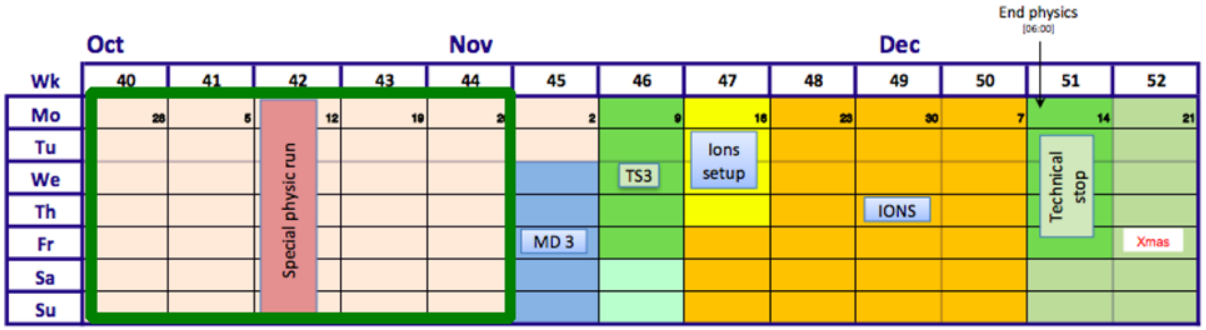




Early Physics Timeline







June 1: LHCf + VdM

- Very low luminosity
- POG performance studies begin (mostly LUM, TRK, MUO)
- **First luminosity measurements**
- **dN/dη (FSQ-15-001)**

  Task force in CMS Centre

July 1: 50ns run (~1 fb^{-1})

- Luminosity up to 0.5 x 10^{34} Hz/cm^2
- POG studies (JME, EGM, TAU, BTV)
- **Physics analyses:**

  dijet resonance search (EXO-15-001)
  ttbar cross section (TOP-15-003)
  single top (TOP-15-004)
  W/Z inclusive cross section
  inclusive b and quarkonia

Aug-Oct: 25ns run (<~10 fb^{-1})

- Luminosity up to 1.4 x 10^{34} Hz/cm^2
- POG studies at 25ns, OOTPU
- **Physics Analyses:**

  More SM: SMP, TOP, BPH, FSQ
  More EXO searches
  First SUSY searches
  First B2G searches
  First look at Higgs

Conclusions

- This is just a really limited overview of the activities in the Physics Coordination areas
- Hopefully you can find here at least a hook from where you can find your way through the maze.
- Please feel free to contact anybody you have seen named in these slides for any doubt or question you might have!
- And remember, the best source of info are:
  - ➞hyper news
  - ➞twiki pages (especially the WorkBook)
  - ➞tutorials and CMSDAS schools

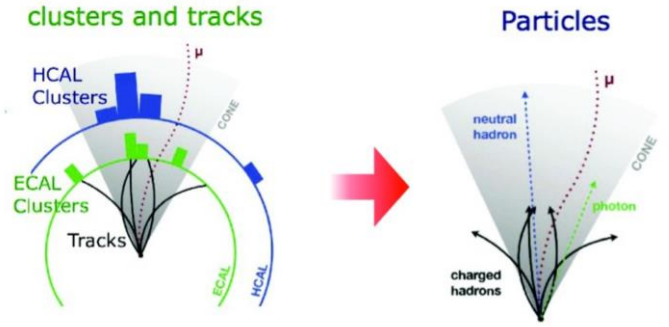
BACKUP

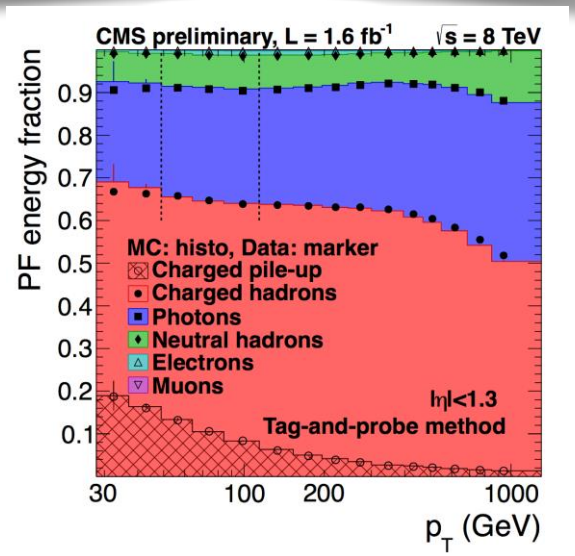
Physics Coordination Structure

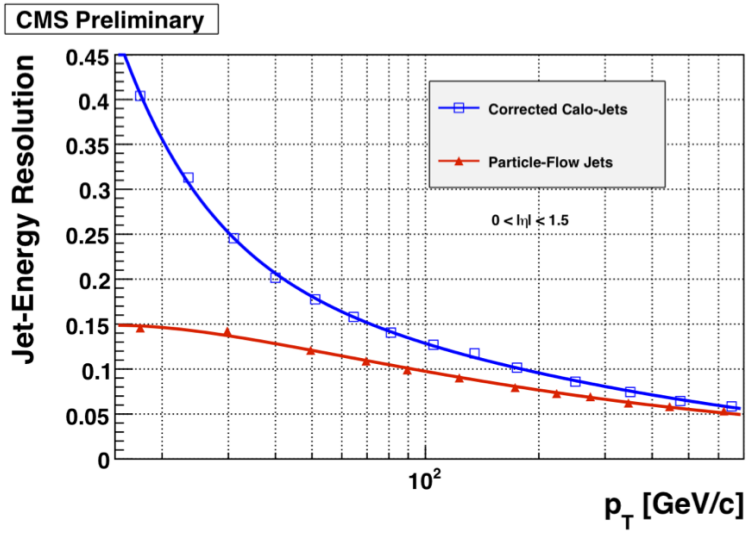
CrossPOG forum: a new addition since Jan 2014

Forum to discuss issues common to all POGs and develop in a consistent way the future Global Event Description tools.
It oversees all Particle Flow developments (basis of our high-level reconstruction)

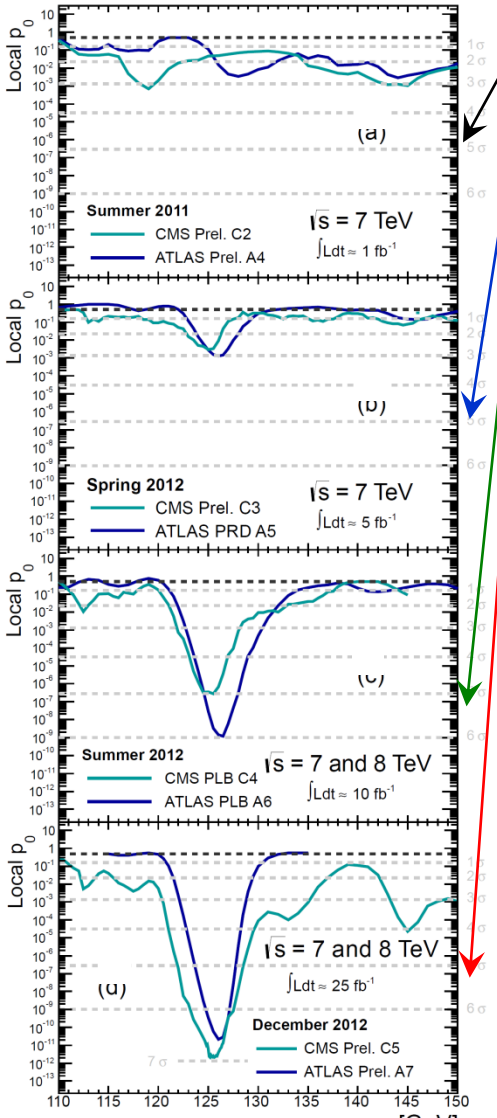
Particle Flow in a nutshell:
combine information from all subdetectors to define particles.
Deal with particles, not hits.







From the PDG:
http://pdg.lbl.gov/2013/reviews/rpp2013-rev-higgs-boson.pdf



Summer 2011: drops in the bucket

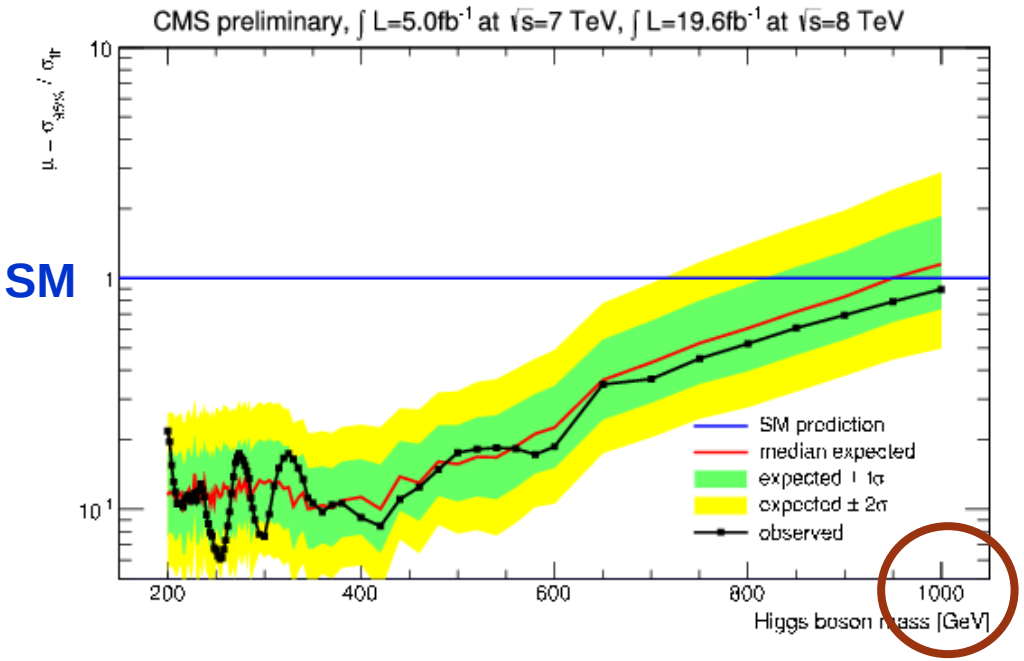
Dec, 2011: tantalizing hint, the trail begins

Summer 2012: discovery! 5σ @ CMS & ATLAS

Dec, 2012: confirmation! Measurement era begins

…and we did not find a SM-like Higgs boson anywhere else:

SM



Physics Coordination Structure

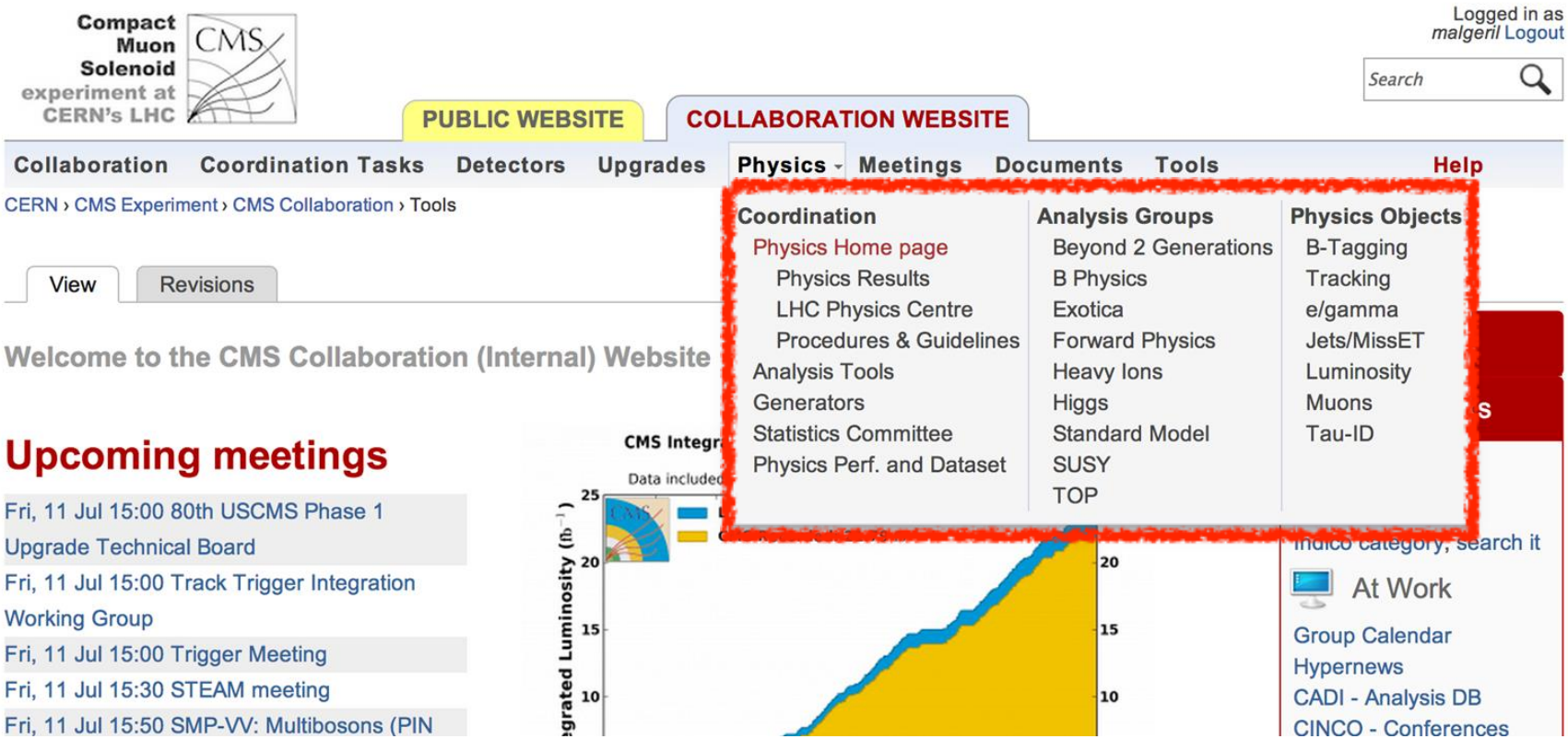
CrossPOG forum: a new addition since Jan 2014

Forum to discuss issues common to all POGs and develop in a consistent way the future Global Event Description tools.
It oversees all Particle Flow developments (basis of our high-level reconstruction)

- Coordinate the improvements to the Particle Flow algorithms for the high-luminosity pile-up conditions expected in 2015.
- Guide the studies and the developments needed for the new Particle Flow reconstruction to take full advantage of the Phase I detector (Pixel, segmented HCAL).
- Develop and demonstrate GED performance for Phase I and Phase II detector concepts, as well as possibly propose new PFlow oriented detector geometries. The development may be similar to the original development of Particle Flow and involvement of the existing experts will be essential, both technically and in training new experts.
- Overview the recommendations of object ID to be used in the analysis and works together with PAGs to coordinate the choice of their working points. In particular avoid duplicated work in different POGs and PAGs and ensure a complete coverage of physics analyses needs.

Physics Coordination Structure

All info seen so far (and more) can be obtained from POG and PAG twikis:

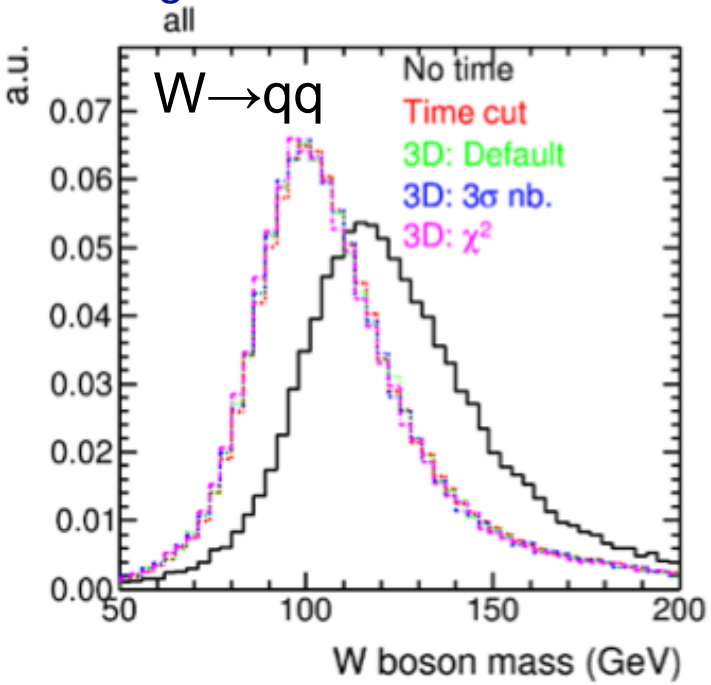


Physics Coordination Structure

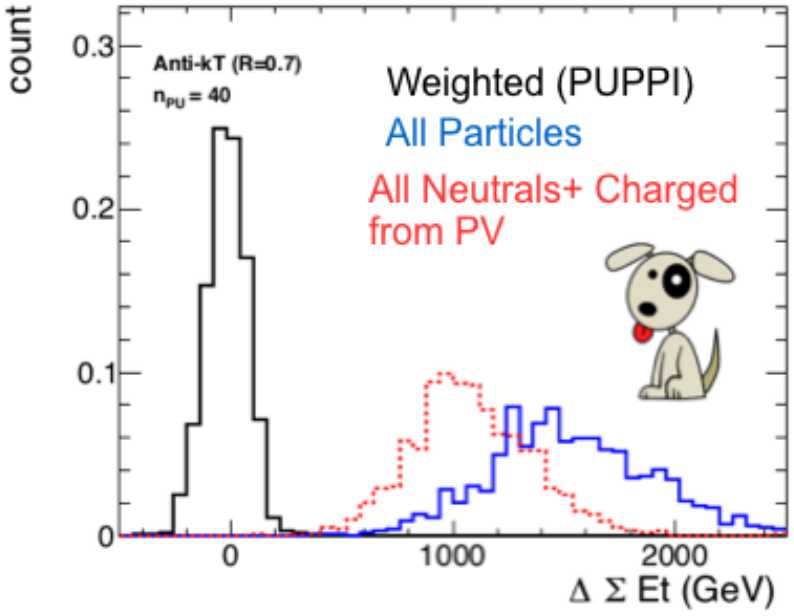
CrossPOG forum: a new addition since Jan 2014

Current activities focussing on PU mitigation (both in time and out of time→crucial for 25ns running!)

Adding time information to hits to distinguish out of time contribution



PU per Particle Identification (PUPPI) to improve in time PU mitigation



Meets (bi)-weekly on Tue: hn-cms-eflow@cern.ch

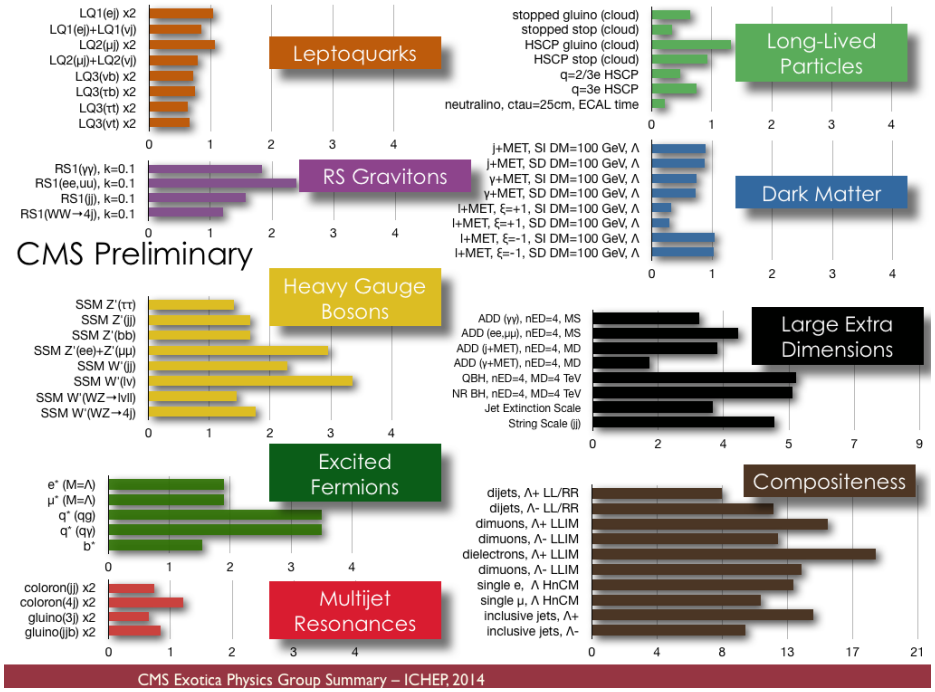
Physics Coordination Structure

PAGs= Physics Analysis Groups

Common results in: https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResults

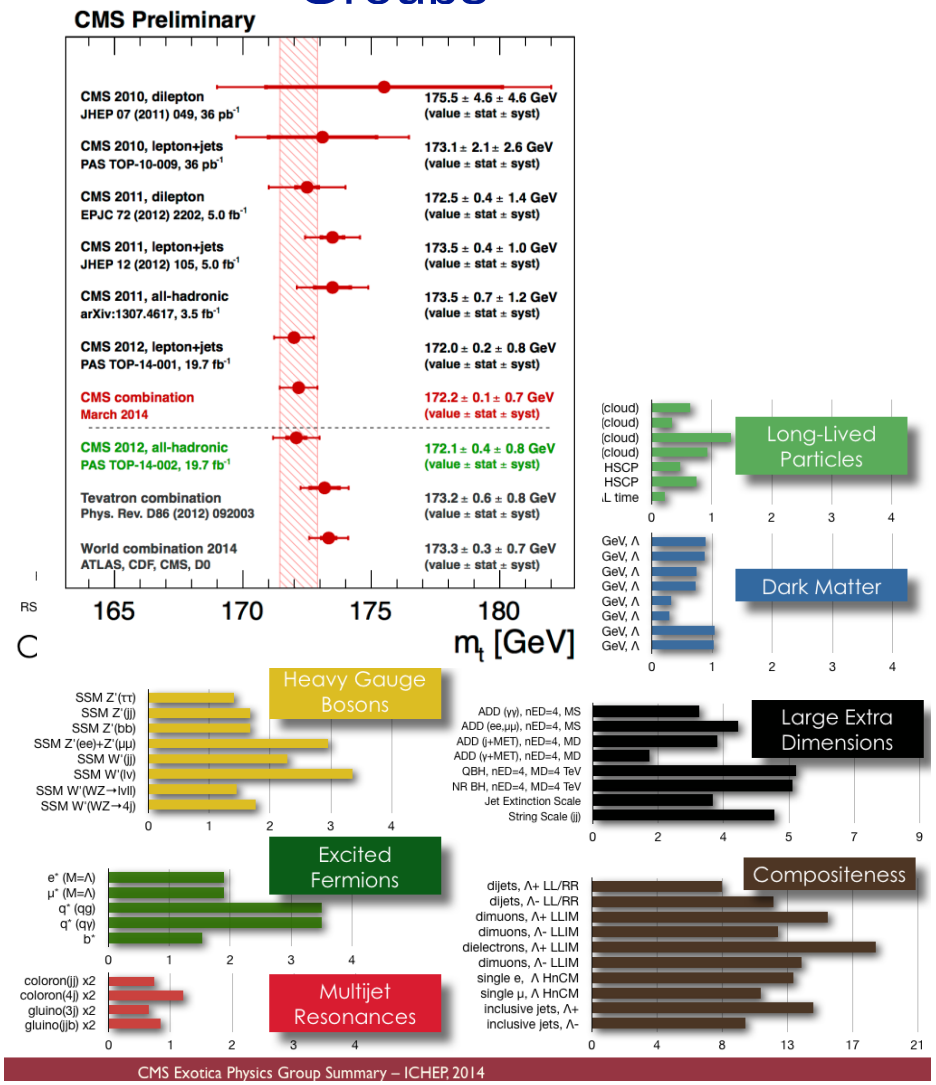
Physics Coordination Structure

PAGs= Physics Analysis Groups



Physics Coordination Structure

PAGs= Physics Analysis Groups



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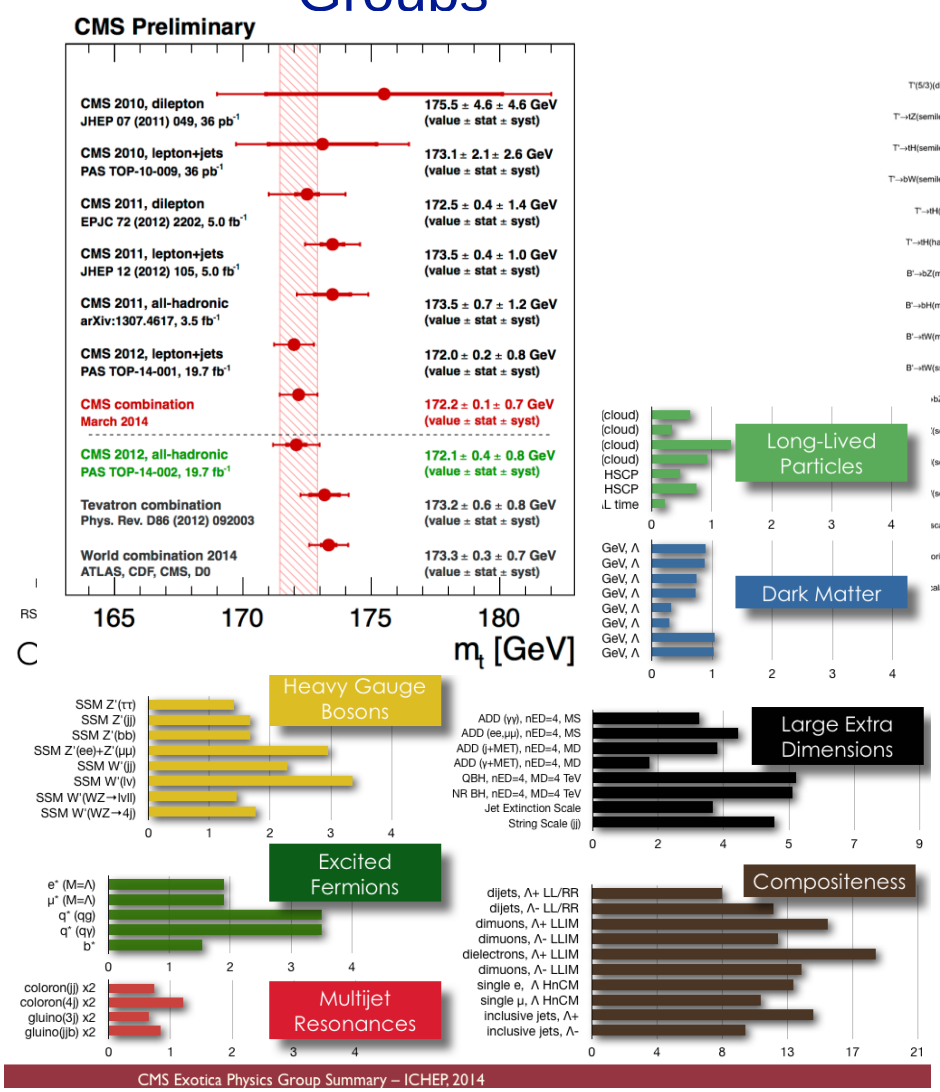

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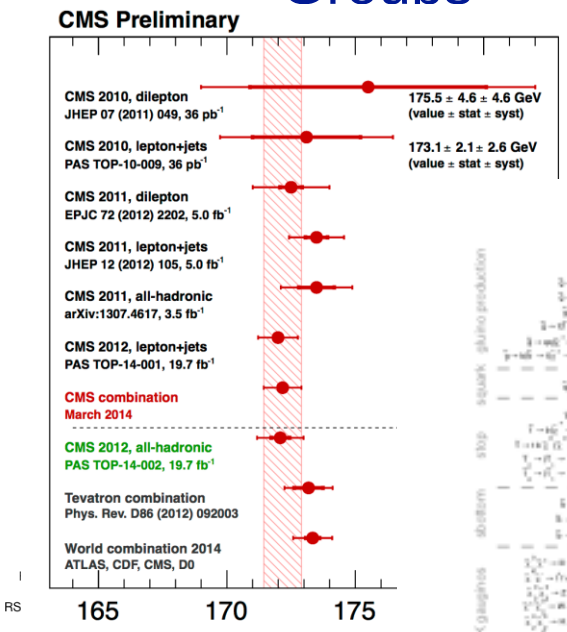
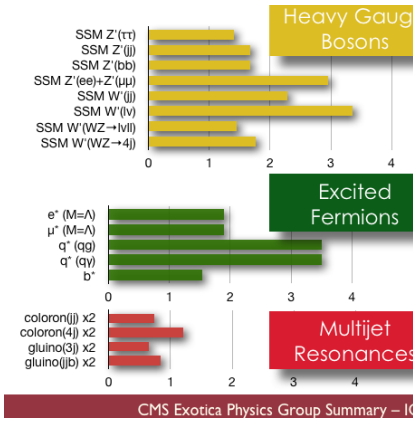
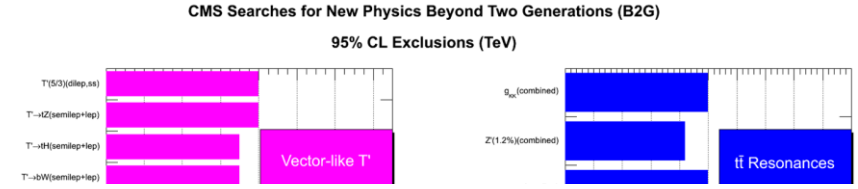
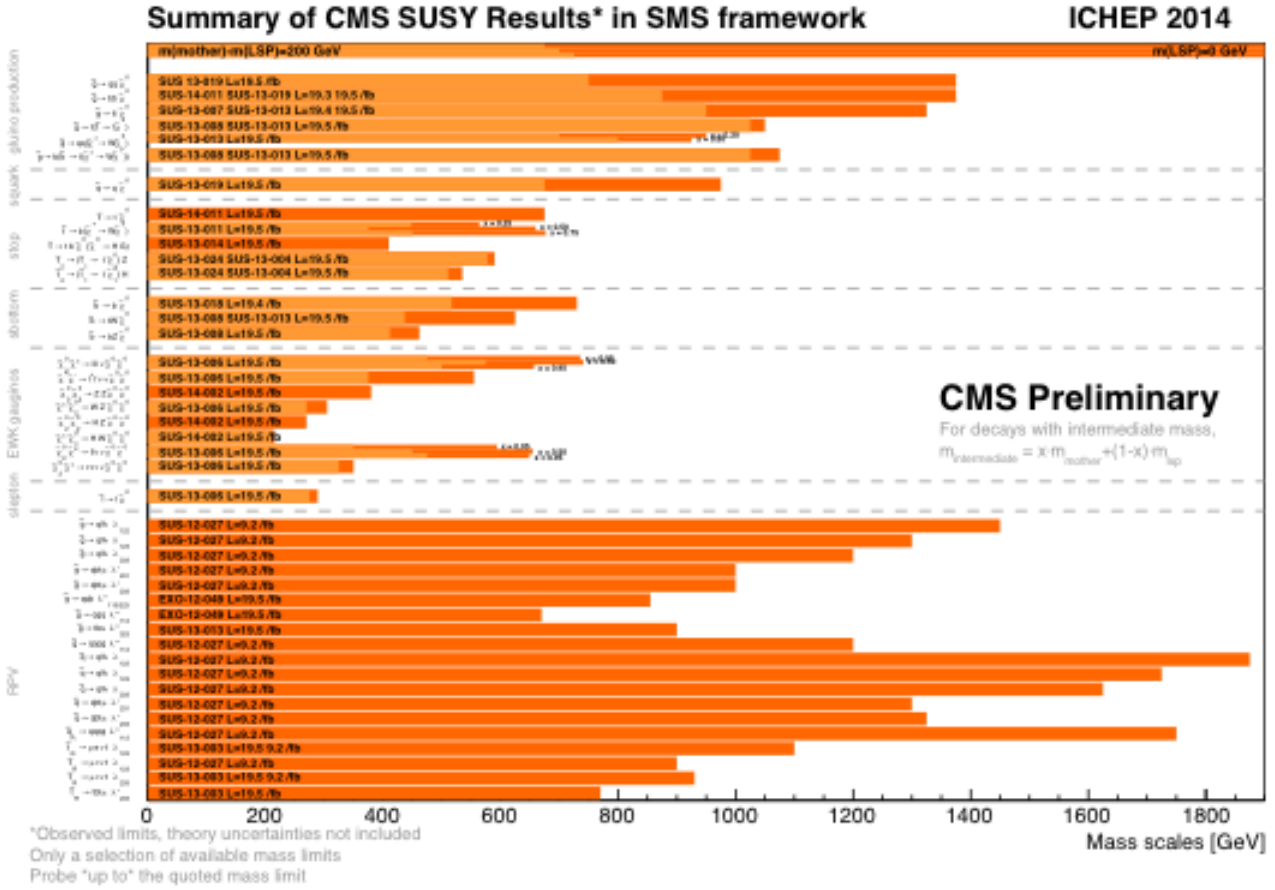


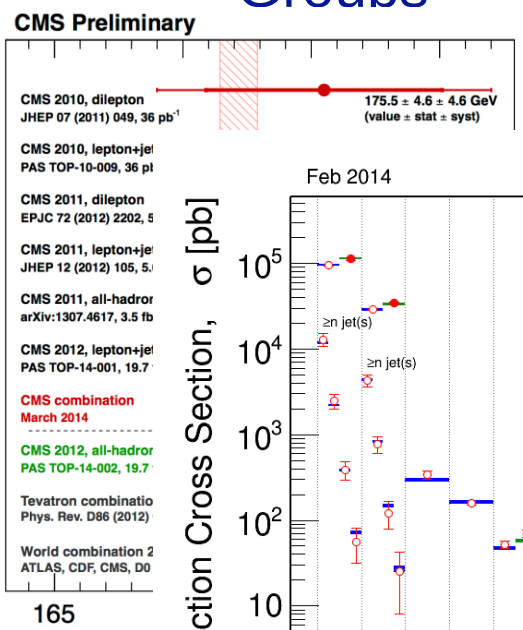


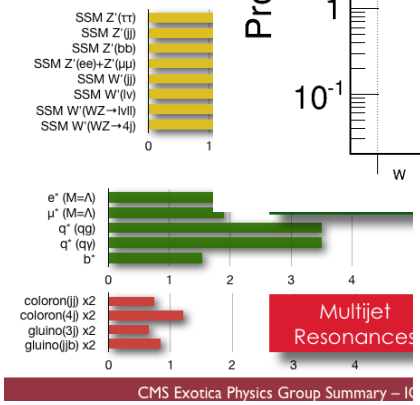


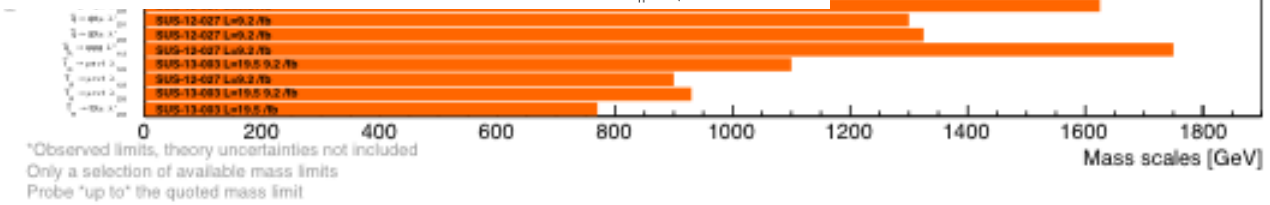


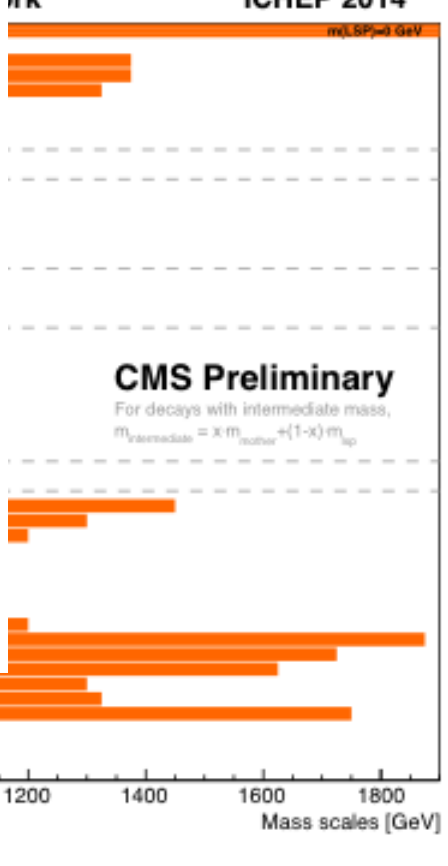
Physics Coordination Structure

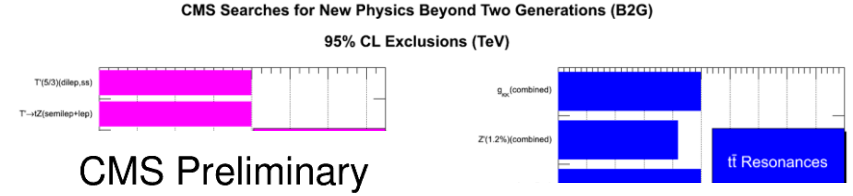
PAGs= Physics Analysis Groups











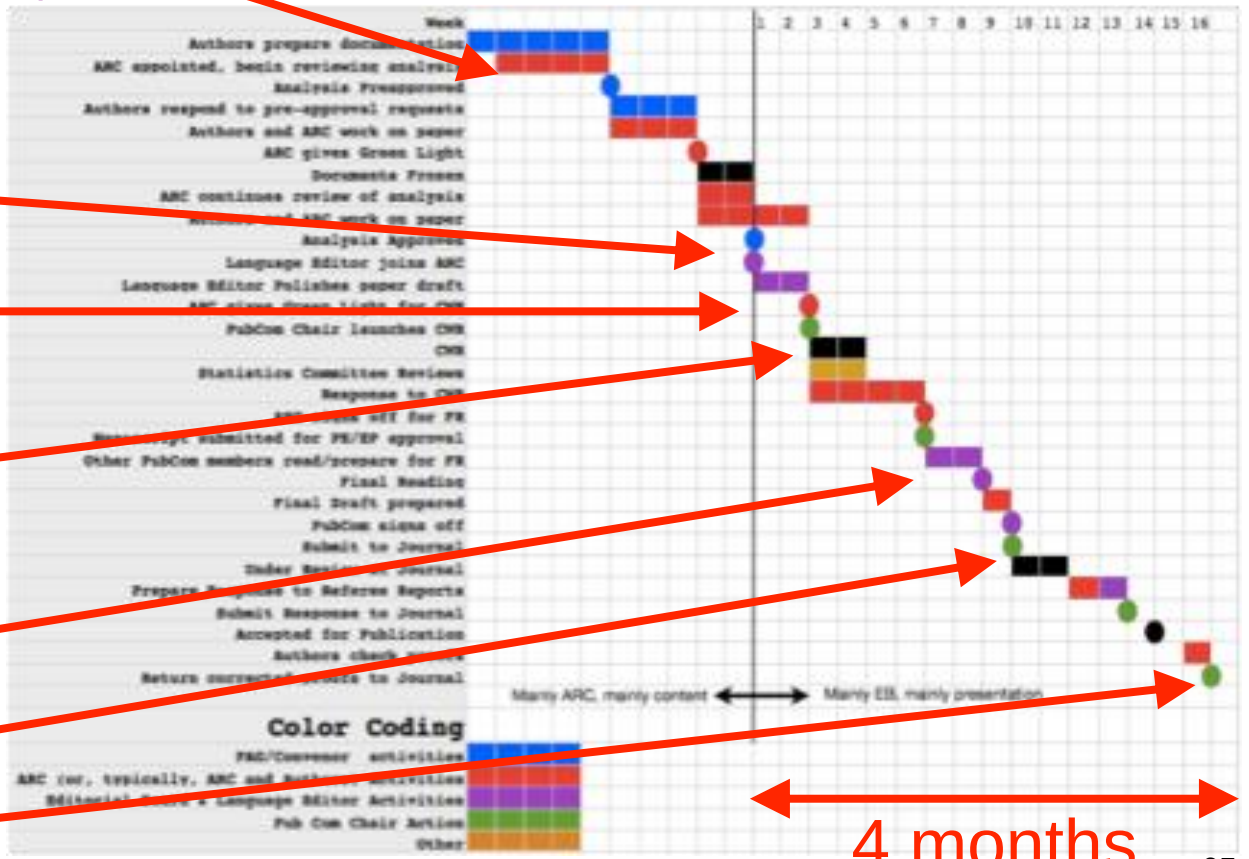
What next after approval? Publication

Slides from Gautier Hamel de Monchenault

Milestones of a physics publication in CMS

https://twiki.cern.ch/twiki/bin/view/CMS/ArcCollaborationWideReview

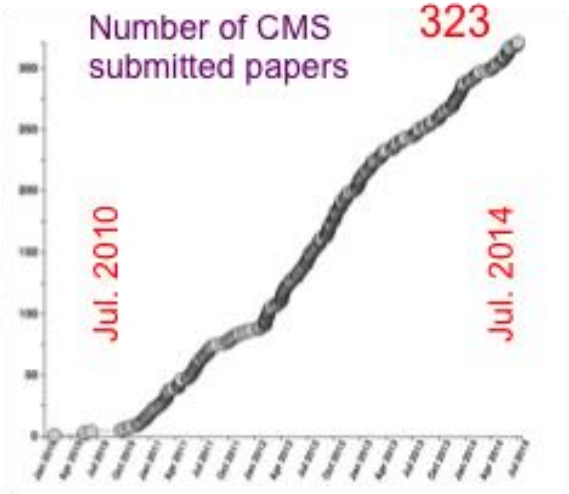
- The PubComm chair and the Physics Coordinator appoint the Analysis Review Committee (ARC: 4 members)
- The work of the Editorial Board starts when the analysis is approved
- A language editor (LE) is appointed
- The draft paper is circulated in the Collaboration (CWR)
- All comments are included for the Final Reading (FR)
- The paper is submitted to the journal
- The paper is published



What next after approval? Publication

Slides from Gautier Hamel de Monchenault

CMS publications so far



All CMS papers are published Open Access in:
JHEP, PLB, EPJC, JINST, PRL, PRD, PRC,
Nature Physics and Science
(red=SCOAP3, blue=APS, green=other)

Submitted by CMS:
- 323 papers (collision data)
- 1 paper (cosmic ray data)
- 10 detector papers
- 1 tau performance paper
- 1 paper in Science
- 23 CRAFT papers

	JHEP	PLB	PRL	EPJC	PRD	PRC	NatPh	SUB	PUB
EWK	6	5	2	1	3	0	0	17	17
QCD	11	3	5	3	3	0	0	25	25
FWD	5	1	0	2	1	0	0	9	9
SMP	8	5	3	5	3	0	0	24	13
FSQ	3	0	0	3	1	0	0	7	5
BPH	9	6	6	2	2	0	0	25	24
TOP	12	7	6	8	3	0	0	35	30
HIG	10	10	4	4	2	0	1	31	27
SUS	15	7	7	5	8	0	0	42	37
EXO	21	28	15	1	8	0	0	73	67
B2G	3	2	2	0	0	0	0	7	7
HIN	6	7	7	4	0	3	0	28	25
	108	**81**	**57**	**38**	**34**	**3**	**1**	**323**	**286**

Grand total = 359 CMS papers submitted

Where to find information on analyses

We have a single database that stores all info.

CADI (CMS Analysis Database Interface).

What you can do with CADI (just a short list):

- define a new analysis (for the conveners)
- change its status (defined, pre-approval, approved, published, etc.)
- ask for dedicated HN
- define tentative targets (dates, conference)
- link documents
- define ARCs (for PC and Pub.Comm)
- dig out history of analyses and ARCs
- upload additional material (still under work)
- contact authors and other interested people in a single analyses
- ……..

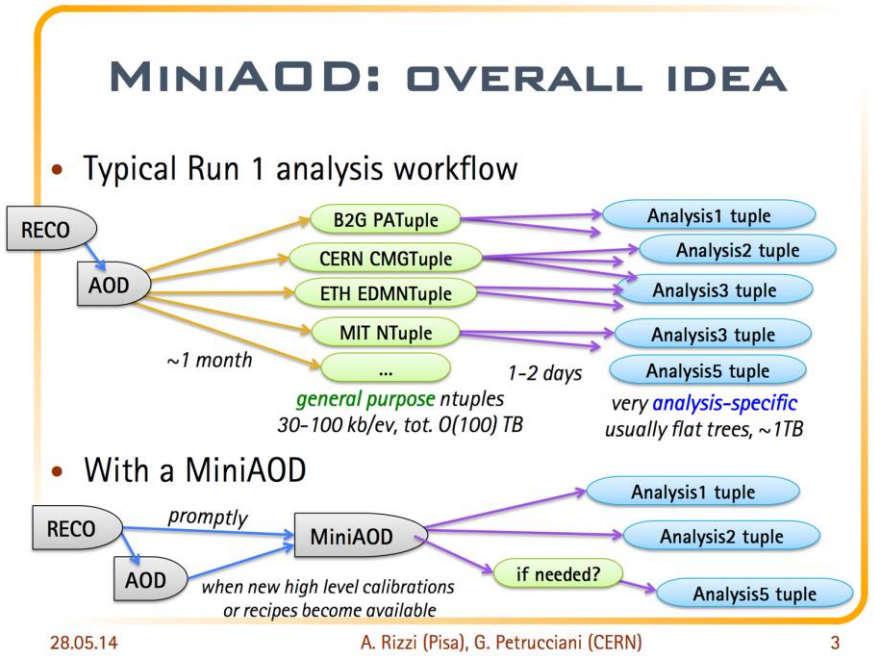
In short: it is your single stop to get info on what is going on

Few practical hooks for the "first steps"

Slides from Tae Jeong Kim

How to organize your analysis?

- Producing and using PAT objects
  - All up-to-date features collected from all POGs
  - Get latest algorithms always from the same interface: the PAT objects
- Can use centralized PAT production → miniAOD (this is new!!)



Dataset	PU	kb/evt
SingleMu-Run2012D-15Apr2014	2012D	18
DoubleElectron-Run2012D-15Apr2014	2012D	26
DYJetsToLL_M-50_13TeV-madgraph-pythia8	20 (25ns)	29
DYJetsToLL_M-50_13TeV-madgraph-pythia8	20-50 (50ns)	40
TT_Tune4C_13TeV-pythia8-tauola	20 (25ns)	40
TT_Tune4C_13TeV-pythia8-tauola	S14* (50ns)	46
VBF_HToZZTo4L_M-125_13TeV-powheg-pythia6	S14* (50ns)	40
TTbarH_HToWWTo2LAndTauNu_M-125_13TeV_pythia6	20 (25ns)	46
RSGluonToTT_M-4000_Tune4C_13TeV-pythia8	20 (25ns)	44
RSGluonToTT_M-4000_Tune4C_13TeV-pythia8	S14* (50ns)	49

(*) CSA14 50ns scenario: 50% flat 20-50 PU plus 50% fixed 40 PU

Few practical hooks for the “first steps”

The CMS Statistics Committee

SC members take 3-week shifts to be “on call”, answering statistics questions (sent through “Statistics discussions” Hypernews or the cms-statistics-committee@cern.ch mailing list) or directing collaborators to relevant resources

The shifter guarantees a quick initial response and interfaces the committee in the solution of the problem

Rapid Response Shifts

The CMS Statistics Committee attempts to answer statistic
shortest possible time. To speed up the process, members
rapid interaction with the person asking the question.

The table below allows Statistics Committee members to v
information is mainly for internal use of the committee
should submit it through the Hypernews forum or the mail
committee@cernSPAMNOT.ch. However, please note that when
recommendable) to get in touch in person, to save time e

Begin date	End date	Member in charge	At CERN ?
Jul 28th 2014	Aug 17th 2014	Sudeshna Banerjee	
Jul 7th 2014	Jul 27th 2014	John Conway	
Jun 16th 2014	Jul 6th 2014	Mingshui Chen	yes
May 26th 2014	Jun 15th 2014	Louis Lyons	No
May 5th 2014	May 25th 2014	Bob Cousins	

- The SC reviews every CMS paper draft to check the exposition of the statistical treatment of the data and the reporting of results.
- The SC also created a questionnaire that analysts need to fill before approving a physics result. This aims at steering analyzers away from fautly techniques or ad-hockery which would otherwise result in large losses of time during later analysis review stages.
- The CMS Statistics Committee meets via vidyo every 2 weeks to discuss questions by collaborators , papers, questionnaires, and to form recommendations on statistics issue. Meetings are open to all.

Physics Coordination Structure

All info seen so far (and more) can be obtained from POG and PAG twikis: TOP example

CMS Top Quark Physics Group

CMS Physics

Group conveners: Andreas Meyer (DESY), Martijn Mulders (CERN)

Previous conveners: Roberto Tenchini (Pisa), Roberto Chierici (Lyon), Frank-Peter Schilling (Karlsruhe), Tim Christiansen (CERN), Claudio Campagnari (UCSB), Jorgen D'Hondt (Brussels), Joachim Mnich (DESY)

- Public Results
- Internal Links
- Meetings & Hypernews
- Subgroups
- Contact persons
- Useful Links
- Some historical Top PAG documents and links

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CMS To

CMS Physics

Group conve

Previous conve

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- Public Re
- Internal L
- Meetings
- Subgroup
- Contact p
- Useful Li
- Some his

Subgroups

Group	Conveners	Twiki page	Hypernews	Meeting
Cross sections	Akram Khan, Mara Senghi Soares	TopCrossSections	Cross section HN	indico
Mass	Sebastian Naumann-Emme, Pedro Silva	TopMass	top-mass HN	indico
Properties	Jacob, Linacre, Efe Yazgan	TopProperties	top-properties HN	indico
Single top	Rebeca Gonzalez Suarez, Orso Iorio	SingleTop	Single Top HN	indico

Twikis, meetings, HN

Contact persons

rlsruhe), Tim

(DESY)

Task / Liaison	contact persons	additional info/links
Software and Documentation	Volker Adler	TWikiTopRefEventSel , SWGuideTQAF
Datasets / T2 space managers	Annik Olbrechts, Lukasz Kreczko, Thorsten Chwalek	TopSamplesT2Locations
Trigger, TSG, SDs, Skims	Javier Fernandez, Stephanie Beauceron	TOP Trigger Analysis - TopTriggerPlanning - indico - Top Trigger HN
GEN group, MC production	Jan Kieseler, Markus Seidel, Benedikt Maier, Javier Fernandez, James Keaveney	TopMonteCarlo
DQM, PVT	Abideh Jafari, Enrique Palencia	TOP DQM main Twiki
JME	Henning Kirschenmann, Nathan Mirman	TOP JetMET Analysis
EGM	Kelly Beernaert, Nik Berry	TOP EGM Analysis
MUO	Carlo Battilana, Carmen Diez Pardos	TOP MUO Analysis - TOP-MUO Coordination
TAU	Federico Nguyen	TOP TAU Analysis
BTV	James Keaveney, Luca Scodellaro (interim)	TOP BTV Analysis
Fast Sim	Andrea Giammanco	
Conference Support	Andrea Giammanco, Efe Yazgan	

Additional info

The story of a physics analysis in CMS

A more formal timeline from main PC twiki page:

Procedure and Guidelines: https://twiki.cern.ch/twiki/bin/viewauth/CMS/Drupal-CMSRules

Stage/event	Responsibility	Actions	Comments
Early stages of an analysis	PAG conveners	Analysis record is created on CADI web page (i).	
	Authors + WG conveners	Analysis is discussed regularly in the working group	
	Authors + POG conveners	If analysis uses non-standard tools, these must be reviewed & approved by the relevant POG	The procedure to be followed for formal pre-approval in a POG is identical to that for formal pre-approval in a PAG
Prior to scheduling pre-approval	PAG conveners	Target dates for pre-approval updated in CADI	
	PAG conveners	Request formation of ARC	Preferably at least 2 weeks before pre-approval meeting
	WG conveners	Read preliminary version of PAS & supporting AN-NOTE approximately 1 week prior to preapproval announcement. Thus decide if pre-approval can go ahead.	
Announcement of pre-approval meeting	Authors	PAS (iv) & supporting AN-NOTE(s) submitted & frozen in CADI until pre-approval	Authors can continue to edit latex in response to comments, but not submit new drafts to CADI.
	PAG conveners	Announce pre-approval meeting on Hypernews(ii)	May happen only hours after PAS put into CADI.
		AT LEAST ONE WEEK	**Conveners**, **ARC** and general members of CMS to read documents .
Pre-Approval meeting	WG/PAG Conveners	Decide if analysis is (conditionally) pre-approved.	ARC should ideally attend (as observers).
After pre-approval meeting	Authors	Post new version of PAS (iv) & AN-NOTE(s) to CADI, taking into account comments made during pre-approval. Document all questions/answers on twiki.	
	PAG conveners	If analysis was pre-approved (or conditionally pre-approved & conditions have been met by revised documentation), set flag in CADI and announce on Hypernews (ii)	CADI status flag ♦ Pre-App
	Authors	Discuss analysis schedule with ARC chairperson	Helps minimize time between pre-approval and approval
		N WEEKS	**ARC Review** of analysis (Usually takes at least 2 weeks). If major changes to the analysis are needed, the ARC may recommend that it be sent back to PAG for re-preapproval.
Prior to scheduling approval	Authors	Post new version of PAS (iv) & AN-NOTE(s) to CADI, taking into account comments made by ARC. Document all questions/answers on twiki.	
	ARC	Decide whether analysis is ready for approval meeting, announce this on Hypernews (iii) & set flag in CADI.	CADI status flag ♦ ARC-GreenLight

The story of a physics analysis in CMS

A more formal timeline from main PC twiki page:

Procedure and Guidelines: https://twiki.cern.ch/twiki/bin/viewauth/CMS/Drupal-CMSRules

Stage/event	Responsibility	Actions	Comments
Announcement of Approval meeting	Authors	All documentation is frozen in CADI until the approval meeting. Any plots to be made public (especially those not in PAS) should be posted to twiki.	Authors can continue to edit latex in response to comments, but not submit new drafts to CADI.
	Phys. Coor.	Announces approval meeting is on Hypernews (ii)	
	Language Editor	In exceptional circumstances only, Language Editor improves English in PAS or draft PAPER (iv). This only happens if the PAS is very badly written or if the PAS/PAPER is very important. (e.g. Discovery).	Can work on latex whilst PAS (iv) is frozen, uploading new draft to CADI only after approval meeting.
	AT LEAST ONE WEEK		Members of CMS read the documentation.
Approval meeting	ARC	Makes statements about the analysis	Changes made to the analysis, after documentation was frozen, must be highlighted. Major changes require a return to pre-approval.
	PAG conveners/P.C.	Decide if the analysis is (conditionally) approved & announce it on Hypernews(ii)	
After approval meeting	Authors	Post new version of PAS (iv) & AN-NOTE(s) to CADI, taking into account comments made during approval. Document all questions/answers on twiki.	
	ARC	Check that authors have implemented all comments and announce this in Hypernews (iii)	
	PAG conveners	If analysis was approved (or conditionally approved & conditions have been met by revised documentation), set flag in CADI.	CADI status flag ♦ Phys-App
	ARC	Check quality of plots on twiki that authors wish to publish. If good enough for publication, set CADI flag.	CADI status flag ♦ PAS-readyForPub
	PAG conveners	Make plots on twiki public (v).	
	Physics Coord.	Make PAS public (v).	CADI status flag ♦ PAS-readyForPub Phys. Coor. may decide not to make the PAS itself public if the intention is to publish almost immediately in a journal.

The story of a physics analysis in CMS

Additional steps for a publication in a journal

Starting Point	Analysis assumed to have already been formally "approved" & documented in PAS + AN-NOTE(s)		
	Authors	Write PAPER, if not already done.	This may be very similar to the PAS.
	ARC	Once decent draft paper exists, ask Pub. Comm. Board chair to assign a Language Editor to the PAPER.	CADI status flag ♦ Pub-Draft
	Language Editor	Improve English in paper.	
Prior to Collaboration Wide Review	**ARC**	Check that comments made during approval meeting have been implemented & language editor has finished. Then indicate that it is ready for CWR in hypernews (i) and by changing CADI flag.	CADI status flag ♦ ReadyForCWR
	Pub. Comm. Chair	Copy PAPER from CADI (ii) to CDS web page (iii). .	CADI status flag ♦ CWR
Announcement of Collaboration Wide Review	**Pub. Comm. Chair**	Assign ~4 institutes to review it.	
	Pub. Comm. Chair	Ask Stat. Comm. to review it.	
	Pub. Comm. Chair	Announce start of CWR (iv).	
	2 WEEKS		Members of CMS submit physics/clarity comments on PAPER via CDS web page. **Authors** reply to them & update PAPER in CADI.
After Collaboration Wide Review	**Authors**	Post new version of PAPER to CADI, taking into account comments made during pre-approval. Document all questions/answers on twiki.	
	Language Editor	Improve English in paper.	Arbitrate on English comments made during CWR & check that authors do not introduce any new English errors.
	ARC	Check that comments made during CWR have been implemented & language editor has finished. Then indicate that it is ready for FR in hypernews (i) and by changing CADI flag.	CADI status flag ♦ ReadyForFR
Before Final Reading	**Pub. Comm. Chair**	Arrange Final Reading	
	A FEW DAYS AT LEAST		**Pub. Comm. members** submit physics/clarity comments on PAPER via hypernews (i). **Authors** reply to them on twiki & update PAPER in CADI.
Final Reading	**Pub. Comm.**	Discuss paper, in particular any unresolved comments from Pub. Comm. Members.	**ARC Chair** & **Analysis Contact Person** (author) to attend. Both to note any action items from the meeting.
After Final Reading	**Authors**	Post new version of PAPER to CADI, taking into account comments made during the FR.	Should only take a few days ...
	Language Editor	Improve English in paper.	Check that no new English errors added in these final steps.
	ARC	Check that all comments have been implemented & Language Editor has finished. Then announce in Hypernews (i).	
	Pub. Comm Chair	Submit to journal.	

Getting started: a few “first steps”

Slides from David Lange

To simplify the analysis tasks (and also to make them uniform) we are moving towards using Analysis certified CMSSW Releases.

Concept:

Releases created specifically for analysis code integration such as:

- PAT developments (e.g., new version of miniAOD)
- POG object ID recipes (goal to stay up to date with Twiki page recipes)
- Broadly use ntuple making codes
- Other developments that naturally lag behind release cycle that focuses on simulation and reconstruction timelines.

Planned implementation:

- Analysis releases would start once CMSSW release has stabilized and is in use for reconstruction
- Clear deadlines: approximately monthly, adjusted to match “object reviews” or other deadlines as needed

Implementation starting with the release cycle for CSA14 (Computing, Software and Analysis challenge starting now) – watch the release announcements forum for more news:
hn-cms-relAnnounce@cern.ch

What next after approval? Conference

Slides from Arnd Meyer

Everything that has to do with conferences in CMS is managed by the CMS Conference Committee (CCC)

CCC MEMBERS:
Arnd Meyer (AACHEN-3A) (chair)
Nicolo Cartiglia (TORINO)
Monika Grothe (WISCONSIN)
Vivian O'Dell (FERMILAB)
Borislav Pavlov (SOFIA-UNIV)
Gavin Davies (LONDON-IC)
Kajari Mazumdar (TIFR-EHEP)
Sergey Petrushanko (MOSCOW-MSU)
Sung Won Lee (TEXAS-TECH)
Vincenzo Chiochia (ZURICH-UNIV)
Ulrich Goerlach (STRASBOURG)
Jorge Rodriguez (FLORIDA-FIU)

All available talks are advertised on the "Conference announcements" hypernews (hn-cms-confAnnounce@cern.ch)

➞ Everybody interested in conference talks should read / subscribe to this

(Only) urgent requests are in addition communicated at the weekly general meeting

General questions / requests: cms-conf@cern.ch, but also no problem with approaching us individually

We strive for a transparent and fair distribution of all talks – you can help us in achieving this goal

➞ Tell us what you like / don't like

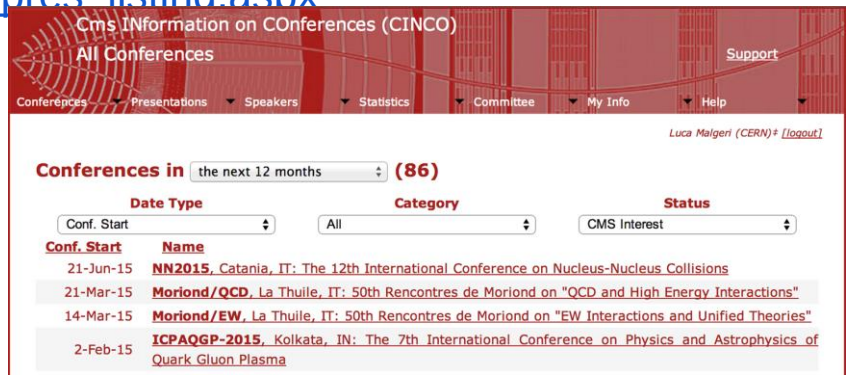
➞ Nominate for talks! Your colleagues, any deserving CMS member, yourself

What next after approval? Conference

Slides from Arnd Meyer

The main gateway to conference presentations is CINCO (CMS INformation on COnferences):

https://cms-mgt-conferences.web.cern.ch/cms-mgt-conferences/conferences/conf_listing.aspx
https://cms-mgt-conferences.web.cern.ch/cms-mgt-conferences/conferences/pres_listing.aspx



Any CMS member has a "profile" in CINCO:
https://cms-mgt-conferences.web.cern.ch/cms-mgt-conferences/user_info.aspx

➞Please add information (→ biography, contributions, …), and keep it up to date

Your conference of interest may not (yet) be in CINCO

➞Enter it yourself, and/or send an email to cms-conf@cern.ch

Don't always wait for "looking for speakers..." announcements

➞Consider submitting an abstract in CINCO, tailored to your own interests

➞For some conferences (DIS, Lake Louise, ...), if nobody thought of the topic you might want to talk about, there will be no abstract, and thus no talk, and a missed opportunity…

What next after approval? Conference

Slides from Arnd Meyer

Few things to keep in mind:

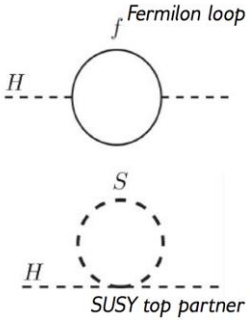
- To be selected for a presentation, speaker candidates need to be “nominated” in CINCO
  - Nomination is by anyone for anyone
- Self-nomination is perfectly fine (and common), additional nomination (convener, supervisor, etc.) particularly useful for younger colleagues
  - Can be deciding factor for otherwise equally deserving candidates
- It does not hurt to have many nominations
- Selection among nominated candidates based on
  - History of (analysis) talks and their importance (e.g. schools/national meetings do not count)
  - Contributions (on analysis, detector, data taking, etc.)
  - Other information in profile (non-tenured, student, job needs,author, ...)
  - Nominations and recommendations

Searches in Run2: SuSy

Theorists have suggested what is the “minimal” effort approach assuming what we observe is the “Higgs”, SuSy is there and it is the solution to the Hierarchy problem:

- the mass of the Higgs gets quadratically divergent loop corrections:

$$\delta m^2{}_H = \delta m_H^2{}^{top} + \delta m_H^2{}^{W,Z} + \delta m_H^2{}^{self}$$



- we need a “natural” cancelling term with negative contribution:

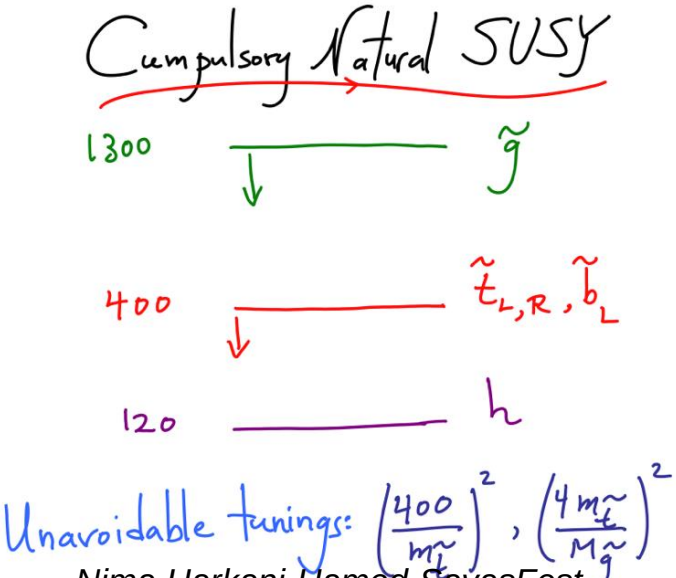
arXiv:1110.6926, J. Ruderman et al.

$$\delta m_{H_u}^2 = -\frac{3y_t^2}{8\pi^2}\left(m_{Q_3}^2 + m_{u_3}^2 + |A_t|^2\right)\ln\left(\frac{\Lambda}{m_{\tilde{t}}}\right)$$

- but in turns, a light stop requires a not too heavy gluino (two loop corrections):

$$\delta m_{H_u}^2|_{gluino} = -\frac{2}{\pi^2}y_t^2\left(\frac{\alpha_s}{\pi}\right)|M_3|^2\log^2\left(\frac{\Lambda}{\mathrm{TeV}}\right)$$

- + additional constraints on Higgsinos.....

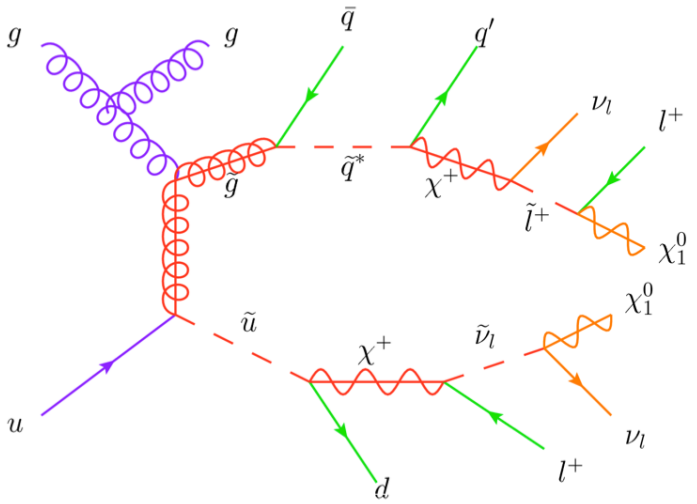


Nima Harkani-Hamed SavasFest 2012

Searches in Run2: SuSy

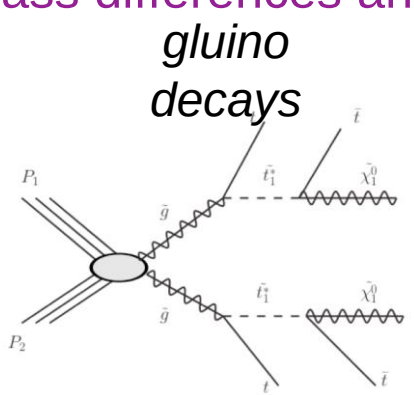
Standard SuSy searches are based on characteristic signatures: large missing energy (stable LSP), b-tag and multiple leptons, multi-jet (...) appearing from decay cascades.

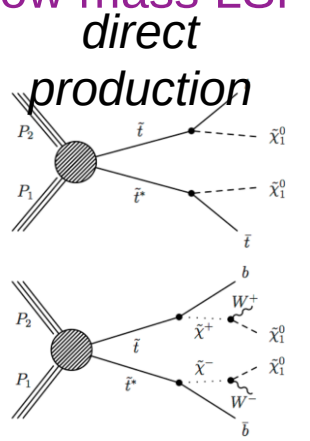
Broad/generic searches in CMS have not given positive results so far.



Dedicated search for stop and sbottom after the “Higgs” discover (in gluino decays and direct production) are based on low mass differences and low mass LSP:

- low missing energy
- soft leptons
- boosted top (jet substructure)
- long-lived particles, stopping tracks



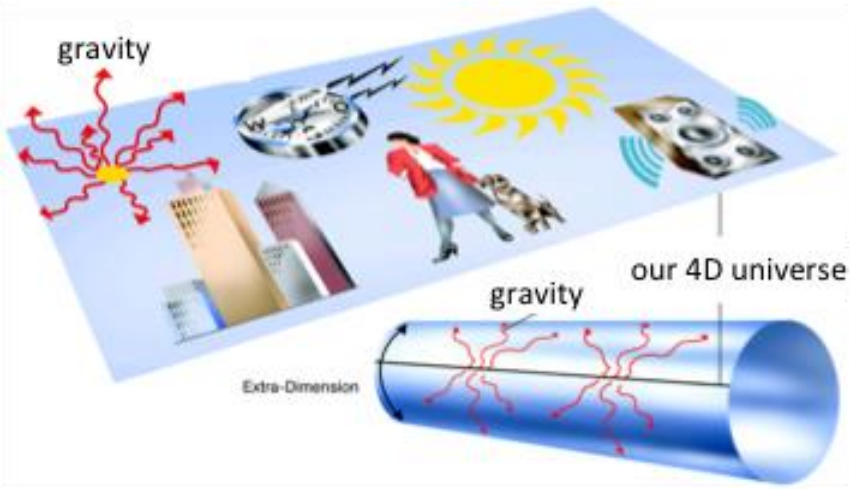


Beyond natural SuSy (and beyond SM)

While a “natural” solution to the hierarchy problem looks elegant and appealing, there is absolutely no other fundamental reason to believe it is the only possible solution (if a solution is really needed).

- Nature might be extremely fine tuned (actually many think there is no absolute scale to define a fine tuning...)
- There is no need to be R parity conserving. We would miss a good candidate for dark matter but nobody ordered that SuSy solves both the hierarchy and the dark matter problems.

- More exotic BSM models (extra dimensions, new gauge forces (Z’,W’), Hidden sectors, unparticles) might completely change the picture

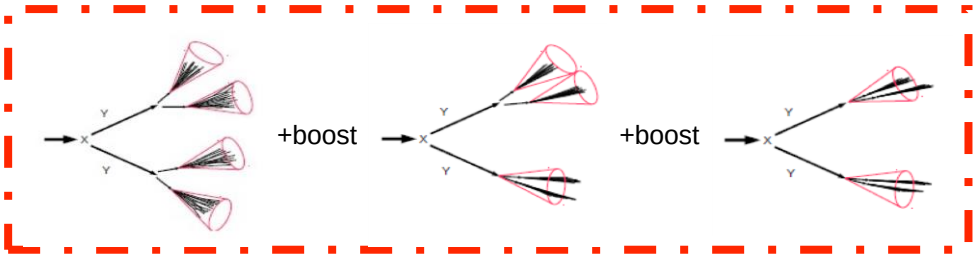


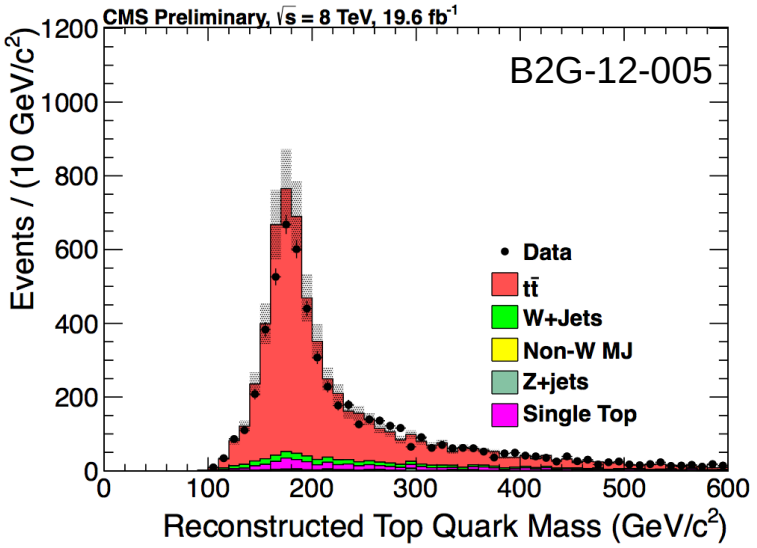
Exotica searches in CMS

CMS has a very large program in EXOTICA searches (this includes B2G analyses).

In general these use the most demanding “object” id/reco, particularly important for Run2:

- TeV range muons and electrons for W’, Z’ searches
- abnormal timing/tracking (long-lived particles, displaced vertices)
- highly boosted jets (monojet, etc.)

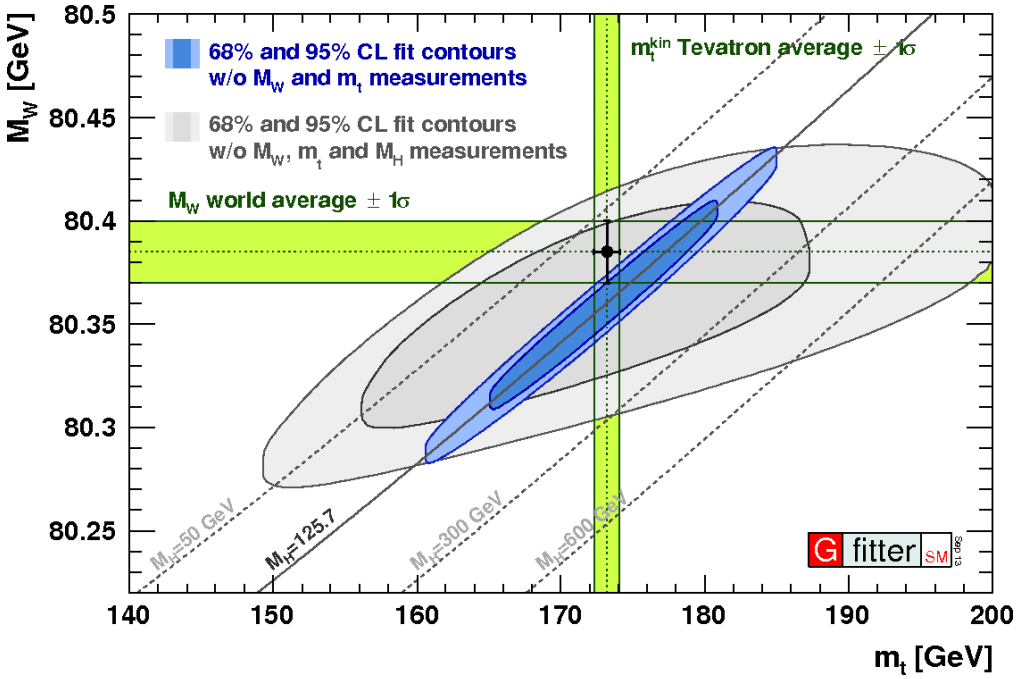




Other searches in CMS: Standard Model !

We should not forget that Standard Model precision physics IS a discovery tool:

- history has shown us that indirect searches via SM tests are a powerful way to get hints on new physics
- with the discovery of the Higgs (assuming it is the SM Higgs) we have closed the parameter space of the SM and precision measurements become even more powerful
- in addition, the represent an intrinsic "calibration/validation" tool for all our analyses.



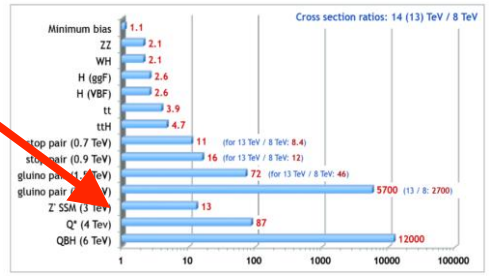
- We (LHC/CMS) are already doing pretty well in M_{top}.
- M_W might be the next (big) challenge. Tevatron did great and much better than expected.
- Need to keep an eye on it and prepare for Run2!

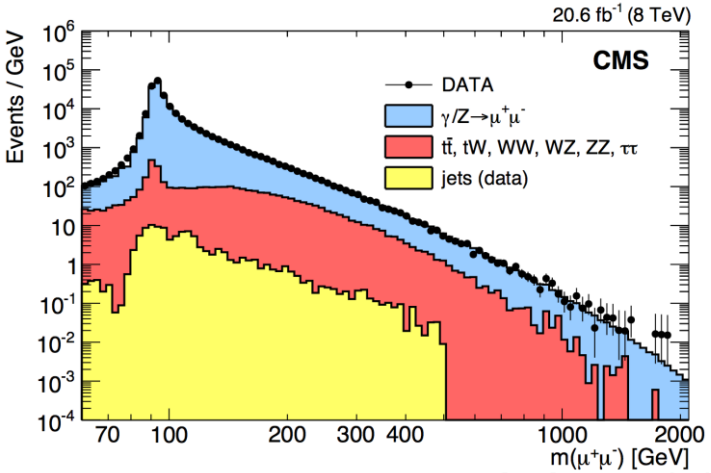
Some suggestions for Run2

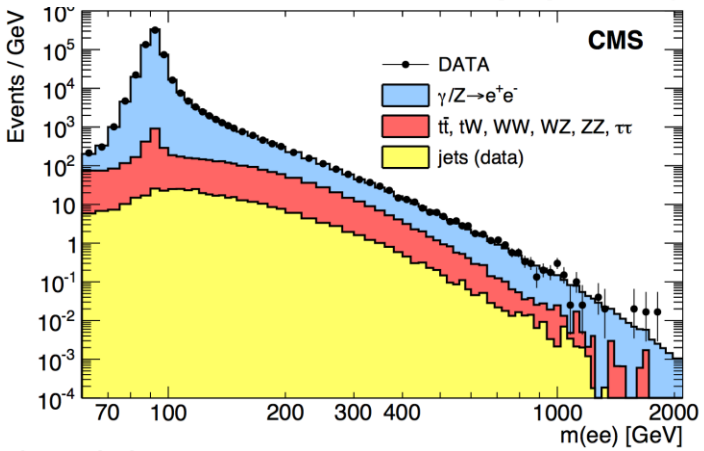
Going backward along the line of big cross section multipliers

Z'→ x13 (M= 3 TeV)

we will be in an unexplored region with 1-2 fb^{-1} !

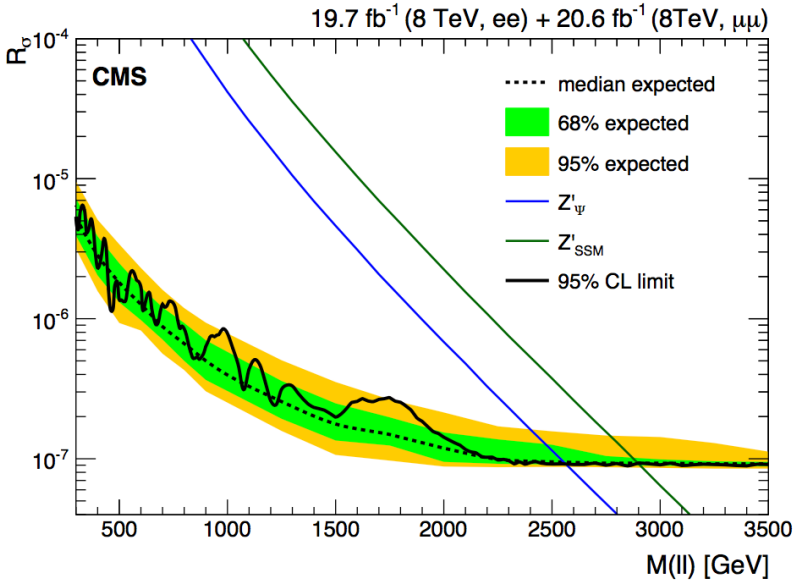






Needs:

- high energy lepton id and reco
- boosted topologies (for other channels)

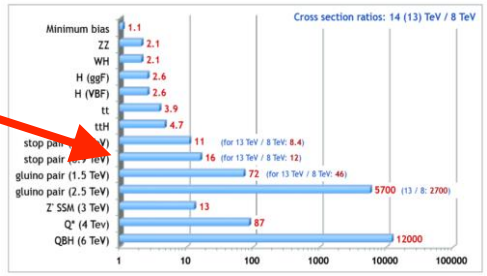


Some suggestions for Run2

Going backward along the line of big cross section multipliers

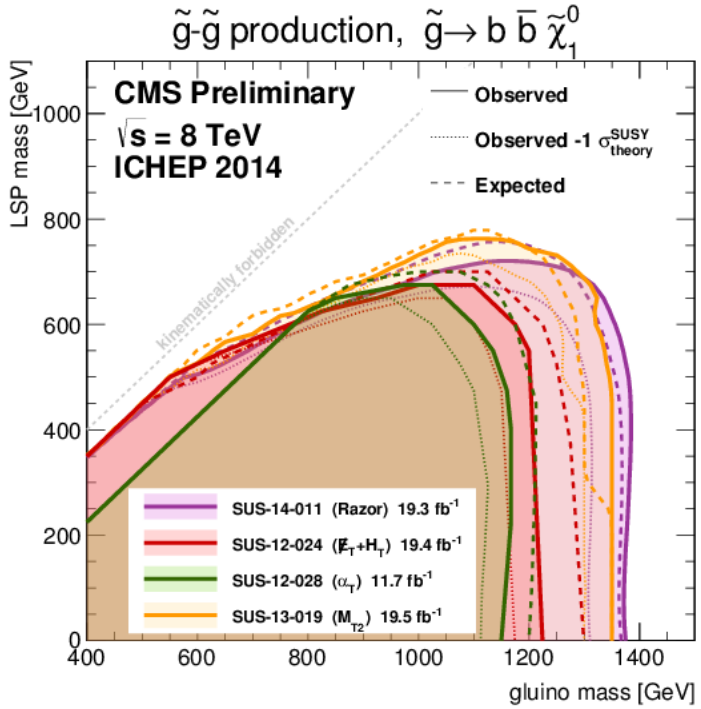
gluino pair→ x46 (M = 1.5 TeV)

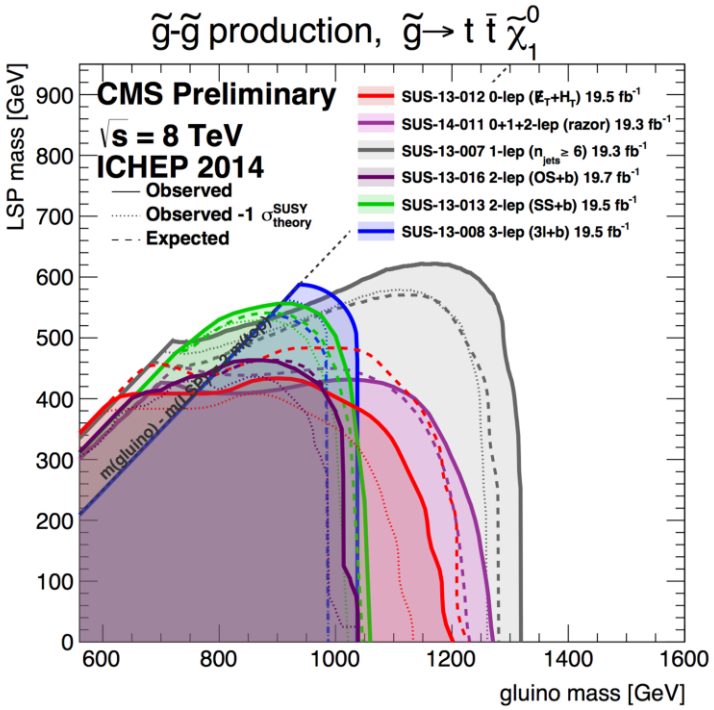
we will be in an unexplored region with 0.5 fb^{-1} !



Need to understand (very early in the run):

- missing Et, lepton efficiencies
- btag, ttbar background



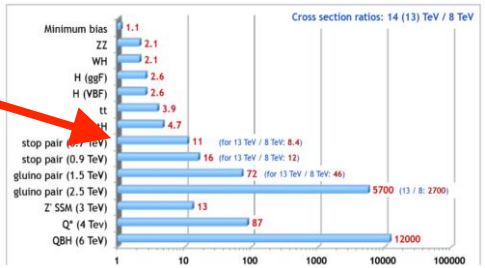


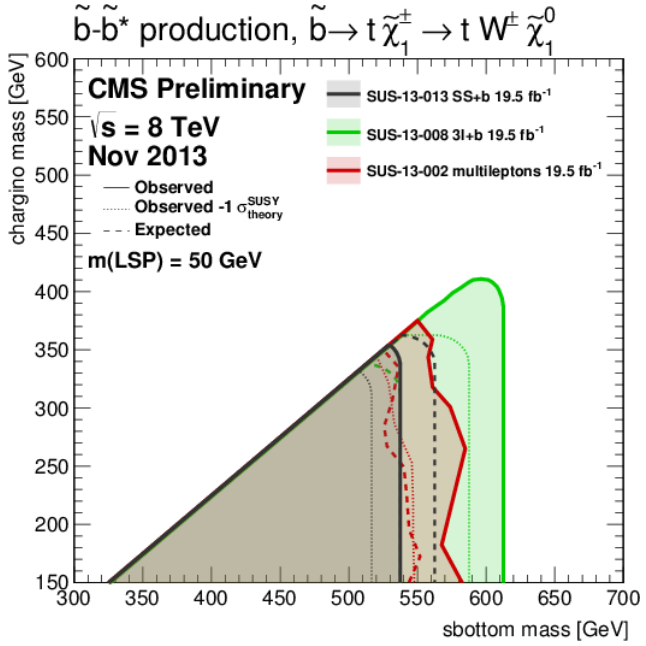
Some suggestions for Run2

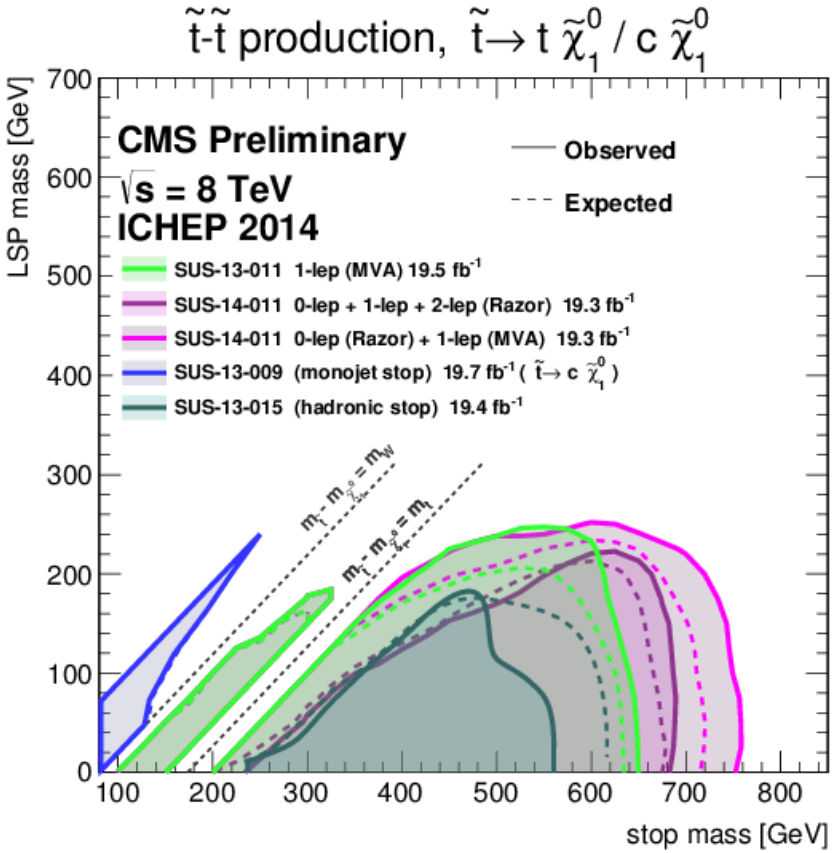
Going backward along the line of big cross section multipliers

stop/sbottom pair → x6 (M = 0.7 TeV)

we will be in an unexplored region with 4 fb^{-1} !



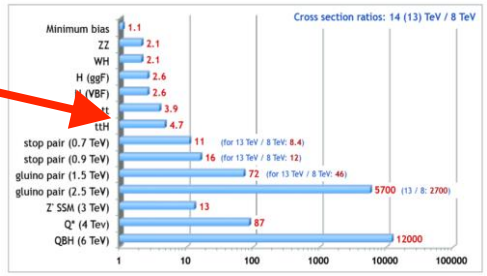




Some suggestions for Run2

Going backward along the line of big cross section multipliers

ttH → x4

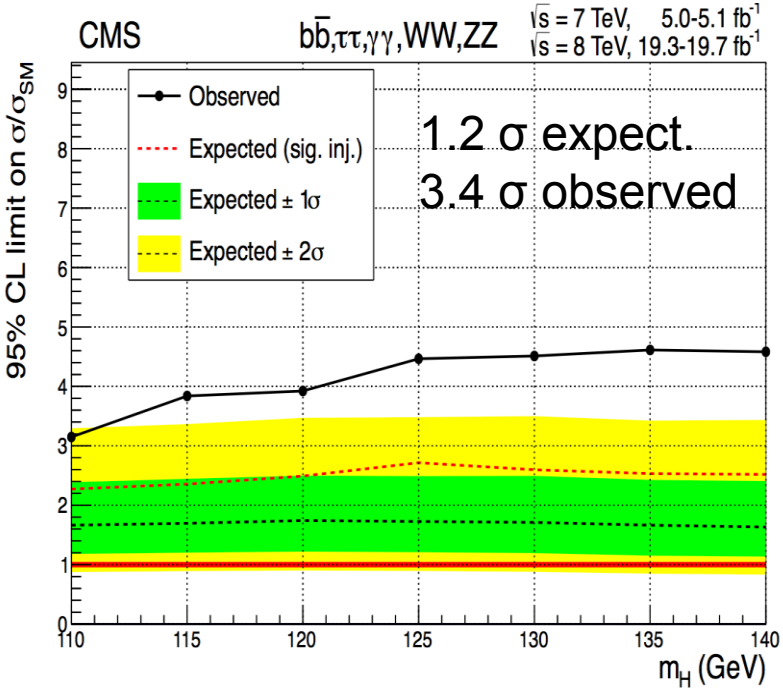


ttH can probably pass the "observation" threshold already with ~10fb-1 @13TeV

The other Higgs process will get a boost around 2x (i.e. need to wait ~40fb-1 to equal our current knowledge)

Experimentally extremely challenging (all possible final states considered including multileptons!

$t\bar{t}H$ Channel	Measured μ	95% CL upper limits on $\mu = \sigma/\sigma_{SM}$ ($m_H = 125.6$ GeV)				
			Expected			
	Observed	Observed	Median Signal-injected	Median	68% CL range	95% CL range
$\gamma\gamma$	$+2.7^{+2.6}_{-1.8}$	7.4	5.7	4.7	[3.1, 7.6]	[2.2, 11.7]
$b\bar{b}$	$+0.7^{+1.9}_{-1.9}$	4.1	5.0	3.5	[2.5, 5.0]	[1.9, 6.7]
$\tau_h\tau_h$	$-1.3^{+6.3}_{-5.5}$	13.0	16.2	14.2	[9.5, 21.7]	[6.9, 32.5]
4l	$-4.7^{+5.0}_{-1.3}$	6.8	11.9	8.8	[5.7, 14.3]	[4.0, 22.5]
3l	$+3.1^{+2.4}_{-2.0}$	7.5	5.0	4.1	[2.8, 6.3]	[2.0, 9.5]
Same-sign 2l	$+5.3^{+2.1}_{-1.8}$	9.0	3.6	3.4	[2.3, 5.0]	[1.7, 7.2]
Combined	$+2.8^{+1.0}_{-0.9}$	4.5	2.7	1.7	[1.2, 2.5]	[0.9, 3.5]



Hot spots for physics analyses in Run2

SM/Precision Physics High Priority Analysis

SMP+FSQ+BPH:

- integrated lumi is not an issue here, cross section will be high enough.
- Essential is a low PU run early both for physics analyses (inclusive X-sec, etc.) and for MC tuning as we have done in 2009/2010. Only a (very) low int. lumi is needed!
- inclusive Xsec (W, Z, VV) accessible with 0.1-1.0fb^{-1}
- aQGC limits, VV scattering need > 5 fb^{-1}

TOP

- first ttbar X-sec can be obtained with few pb^{-1}.
- important to develop a dynamical trigger strategy: simple paths up to the 1st fb^{-1}, more complex (b-tag, MET, combined, etc.) for later on.

HIG

- "re-discovery" with first 5-10 fb^{-1} (but BSM heavy Higgs searches probably earlier).
- maintaining trigger performance is a must

Hot spots for physics analyses in Run2

Searches High Priority Analyses

B2G:

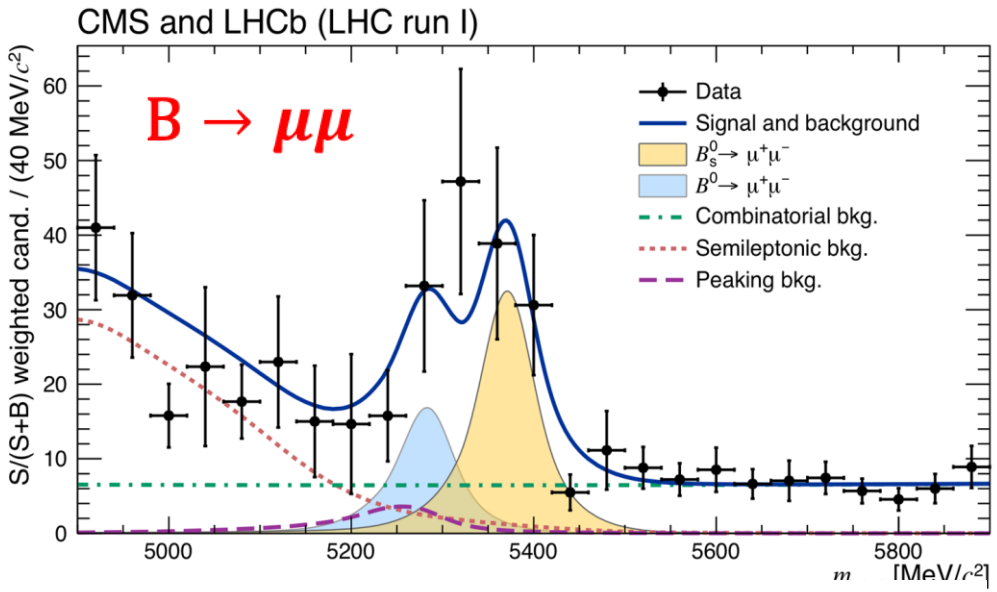
- Crucial for B2G to develop non-isolated lepton trigger and merged hadronic tops (boosted top)
- priority analyses:
  - l+j and dilepton, single lepton
  - Z'->ttbar, W'->tb

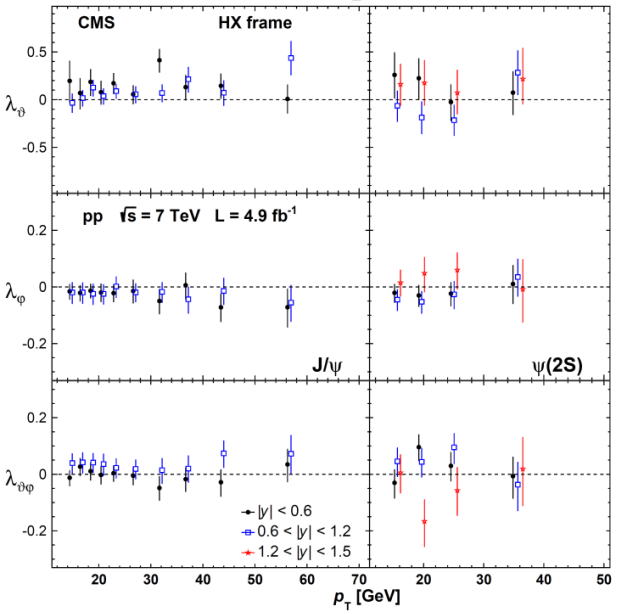
EXO:

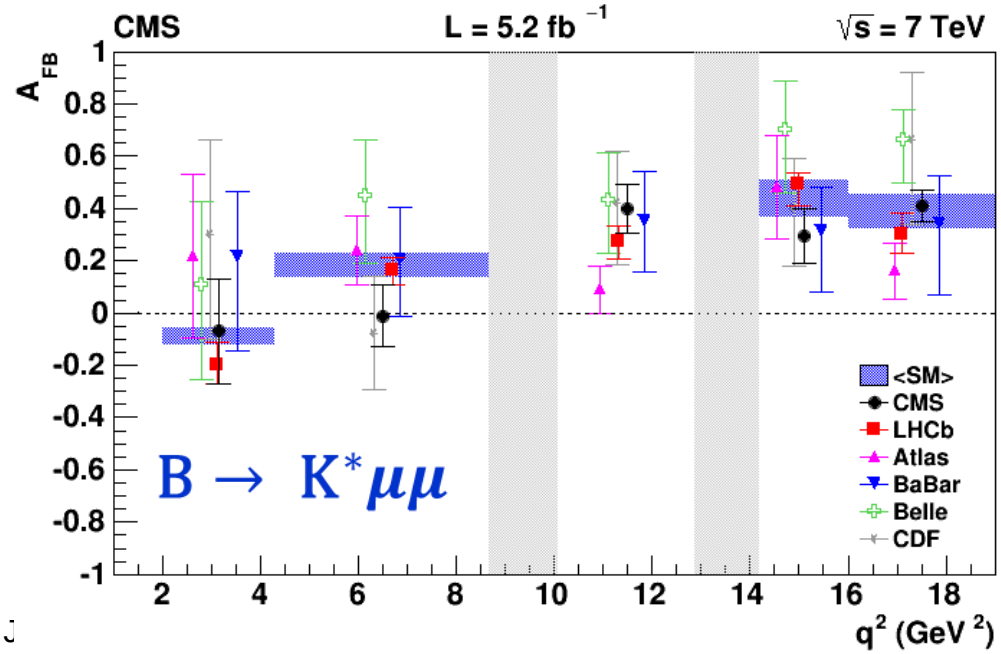
- Natural high priority analysis:
  - Z',W'
  - di-jet, di-photon
  - VV resonance
- On the trigger side, the long-lived paths should be rethought

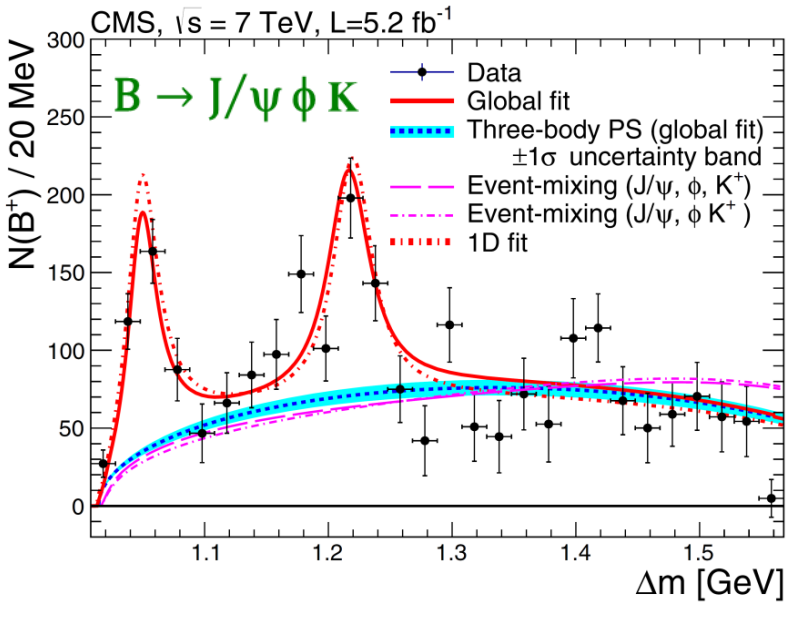
SuSy:

- exceeding 8 TeV reach after 2-5 fb^{-1} of 13TeV data
- natural SuSy will still be under the spot (Mgluino <1.5 TeV, Mstop<800 GeV) but if nothing pops up, next frontier is small mass splitting, long-lived, stealth (a nightmare for trigger)

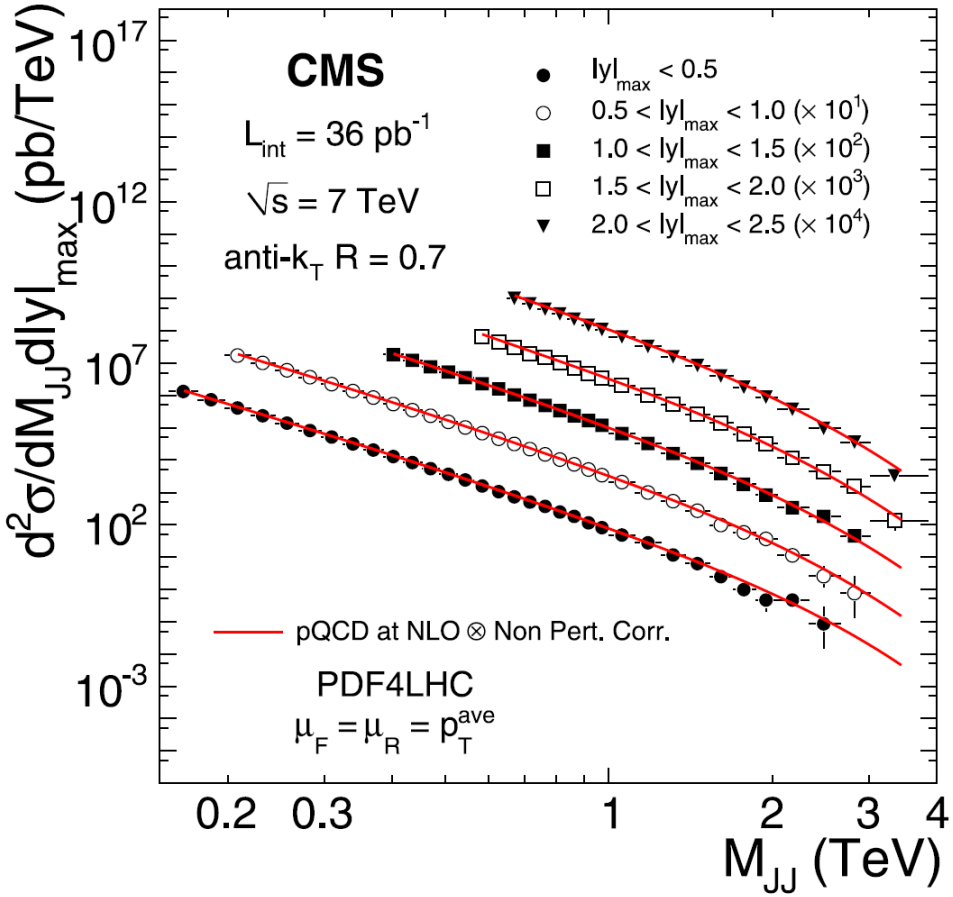

CMS and LHCb (LHC run I)
B → μμ
Data
Signal and background
$B_s^0 \to \mu^+\mu^-$
$B^0 \to \mu^+\mu^-$
Combinatorial bkg.
Semileptonic bkg.
Peaking bkg.
S/(S+B) weighted cand. / (40 MeV/c²)
m [MeV/c²]

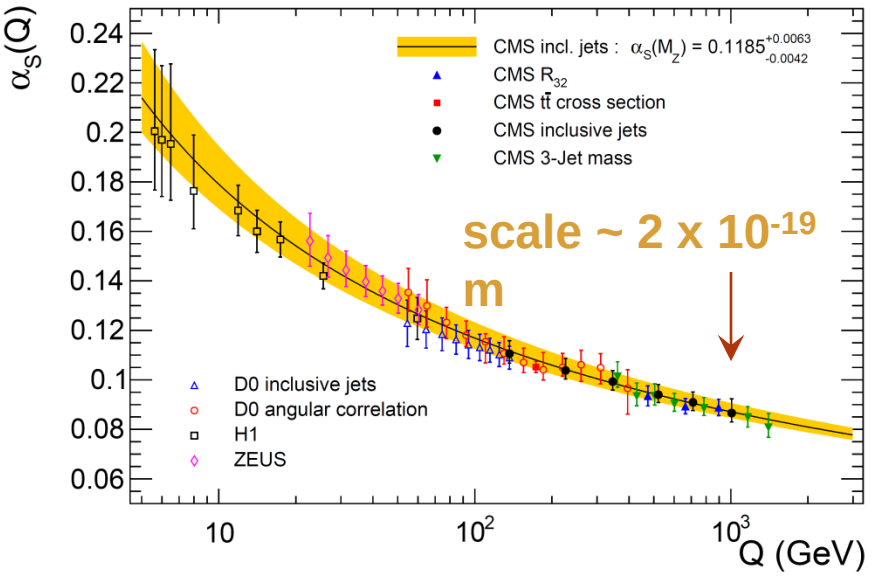

J/ψ and ψ(2s) polarization
CMS
HX frame
pp √s = 7 TeV L = 4.9 fb⁻¹
J/ψ
ψ(2S)
|y| < 0.6
0.6 < |y| < 1.2
1.2 < |y| < 1.5
p_T [GeV]


CMS
L = 5.2 fb⁻¹
√s = 7 TeV
A_FB
B → K*μμ
<SM>
CMS
LHCb
Atlas
BaBar
Belle
CDF
q² (GeV²)

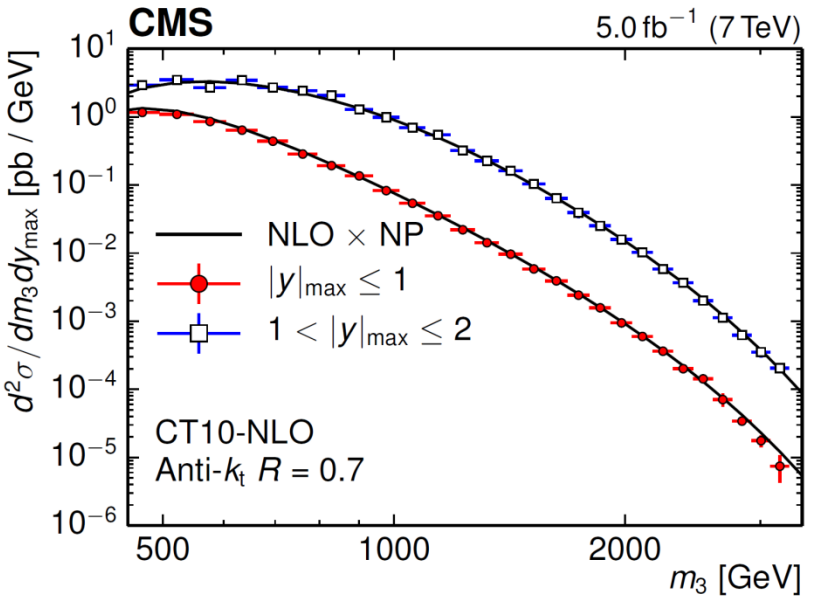

CMS, √s = 7 TeV, L=5.2 fb⁻¹
B → J/ψ φ K
Data
Global fit
Three-body PS (global fit)
±1σ uncertainty band
Event-mixing (J/ψ, φ, K⁺)
Event-mixing (J/ψ, φ K⁺)
1D fit
N(B⁺) / 20 MeV
Δm [GeV]

We are in the precision multijet era! Differential xsecs in 2- and 3-jet mass

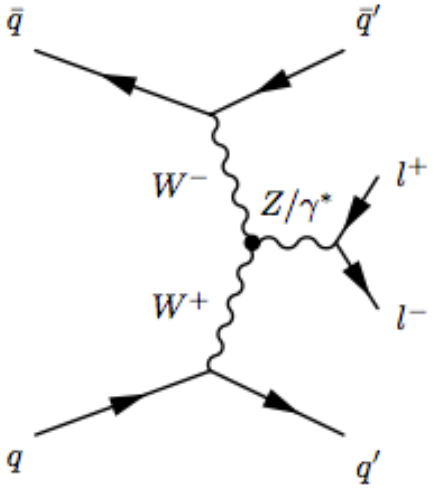


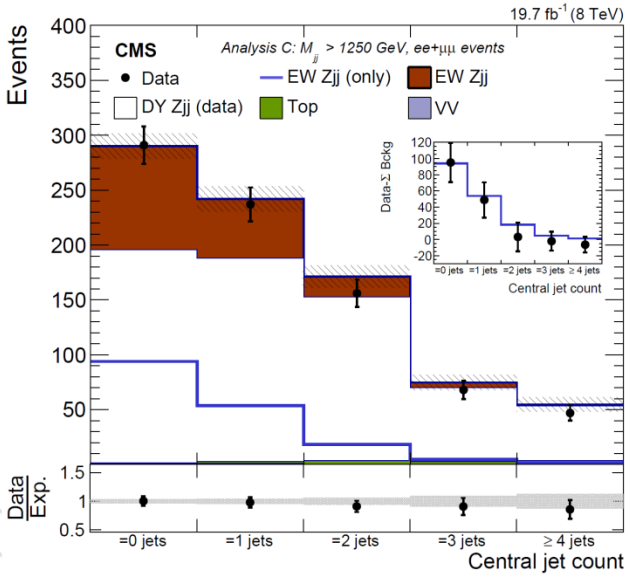


scale ~ 2 x 10^{-19} m

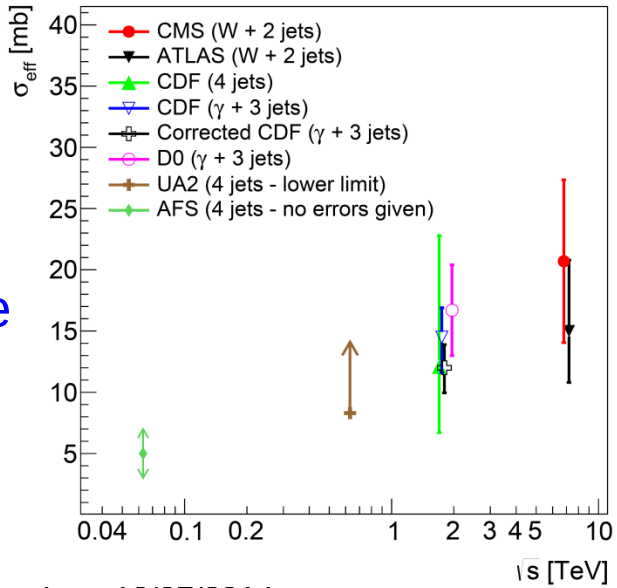


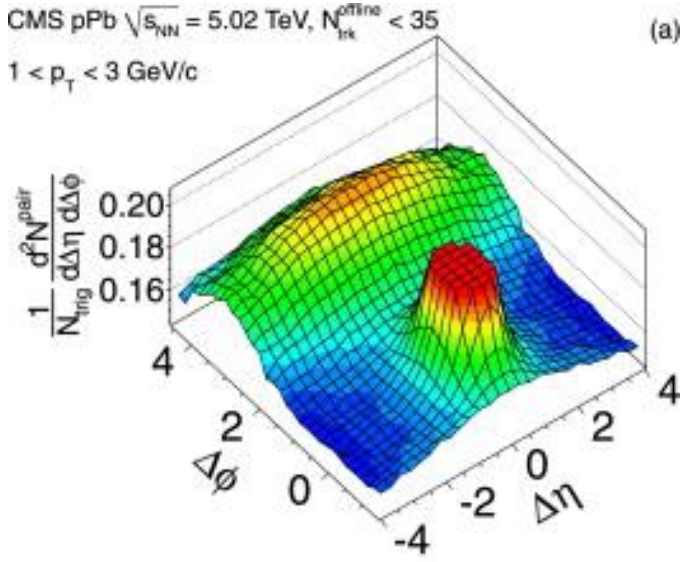
Z production in VBF



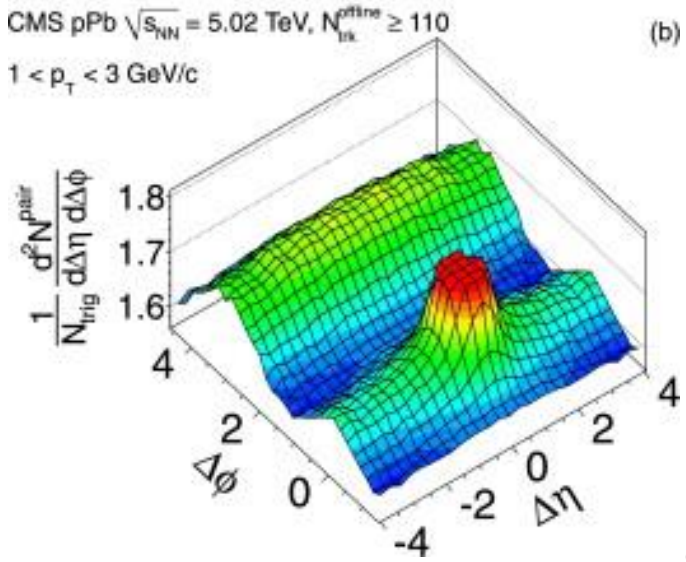


Exploring multiparton interactions (more than one hard scatter in the same pp collision, in this case W + jj)

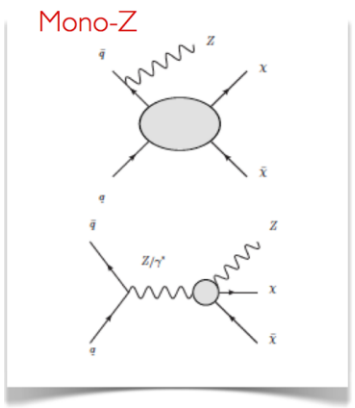


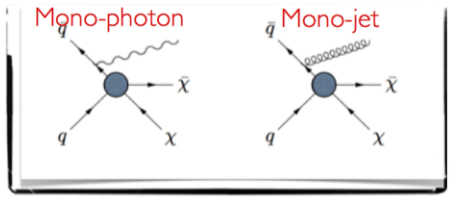


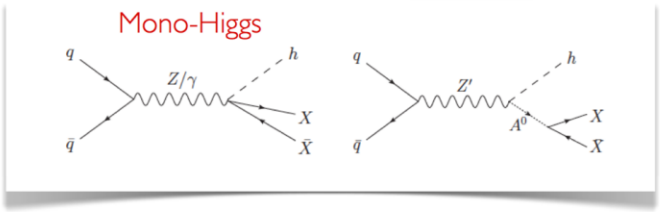
Ridge physics in pPb

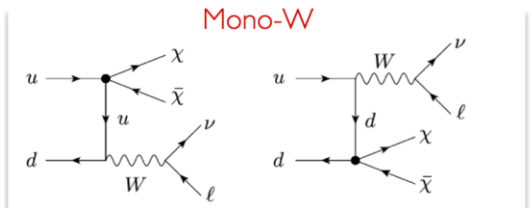


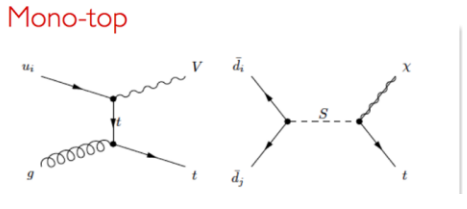
Dark Matter?

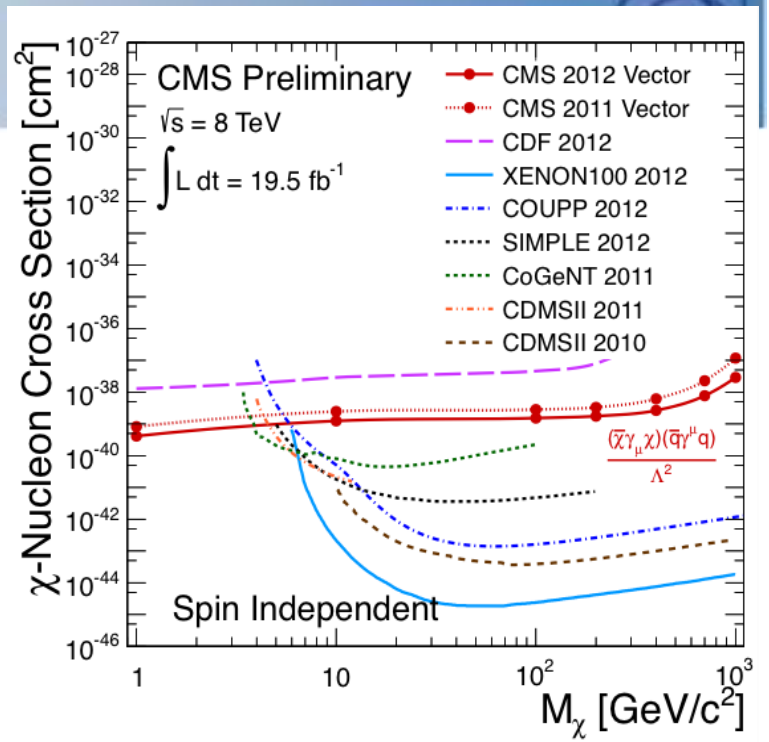












- **Many possible paths to search for Dark Matter in CMS data**
  - Emerging as most promising are searches for “Mono-X”; e.g, mono-jet, mono-photon, etc