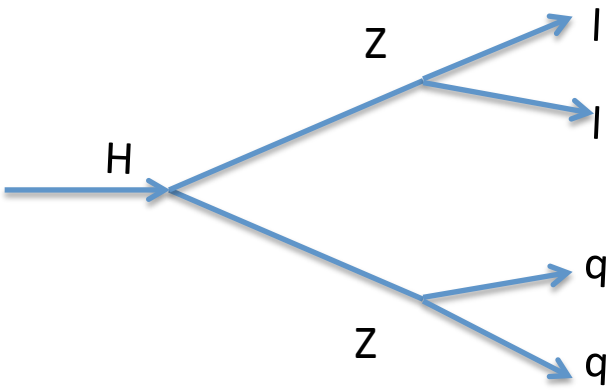
Search of the Higgs **at LHC**
case: ATLAS H➔ZZ*➔qqll analysis

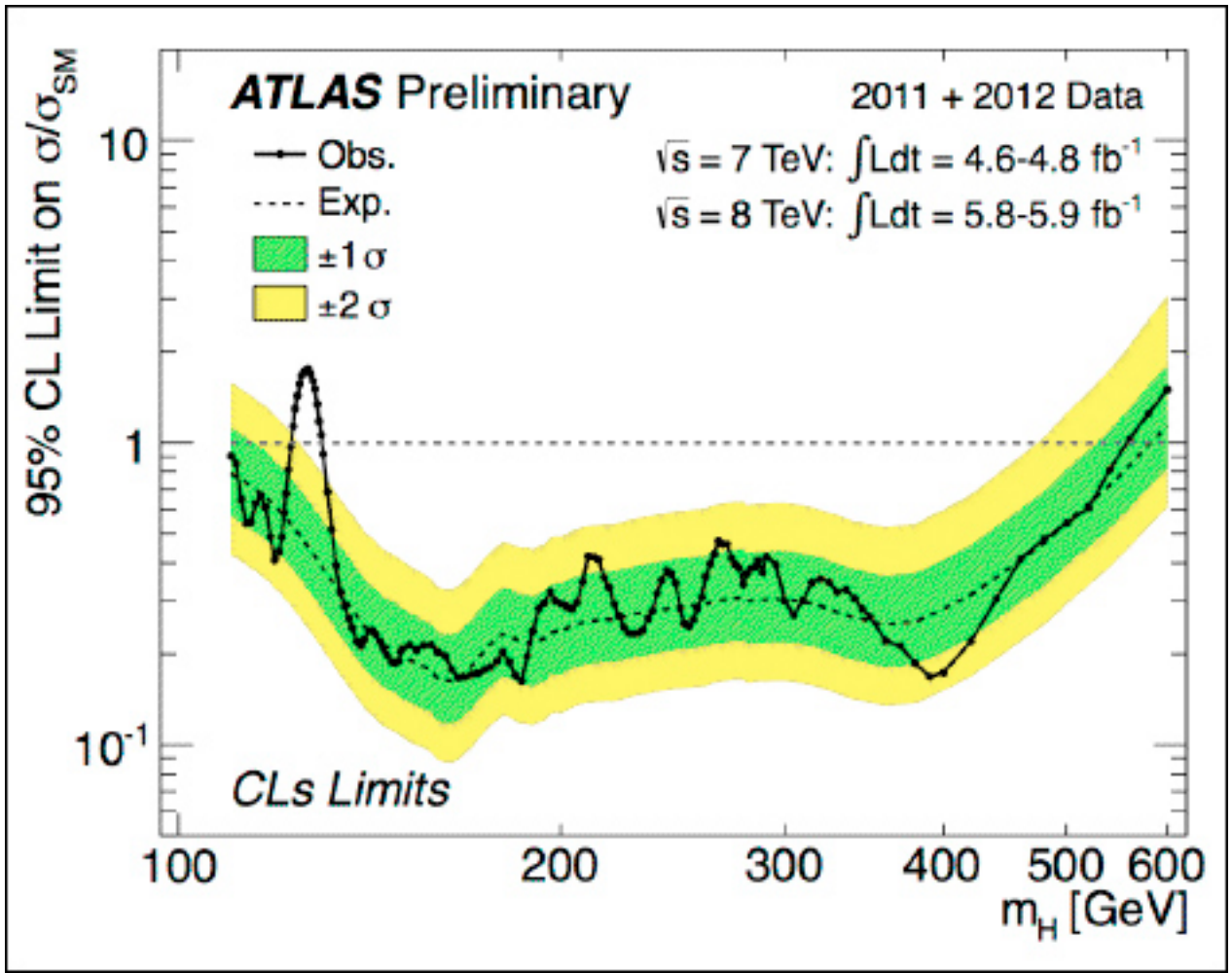


Arturo Sánchez

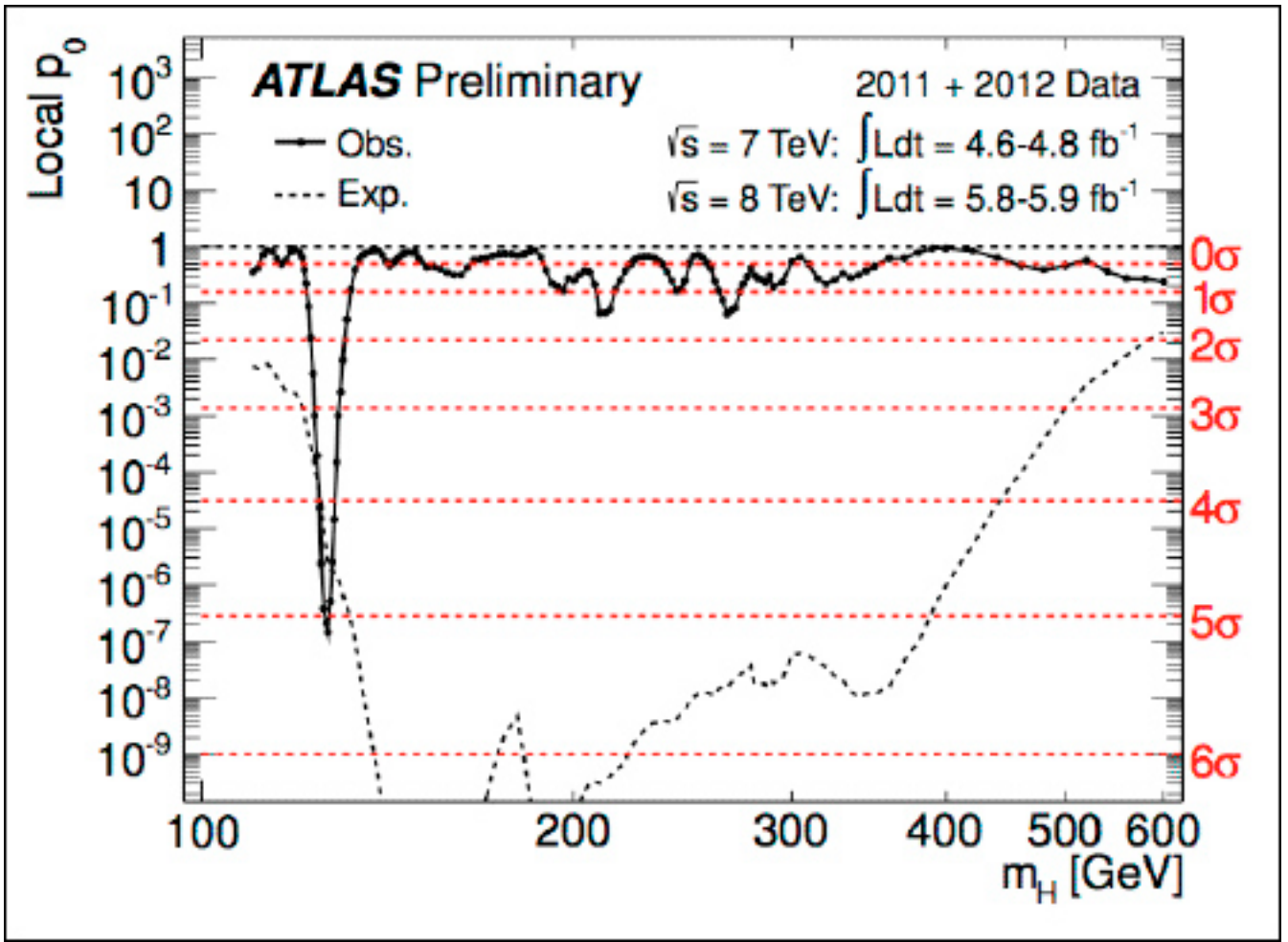
07/12/2012

Just in case that you did not see these plots yet…

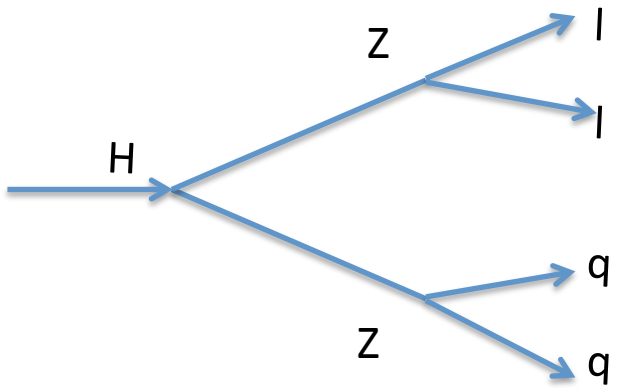
Experimental limits from ATLAS on Standard Model Higgs production in the mass range 110-600 GeV. The solid curve reflects the observed experimental limits for the production of a Higgs of each possible mass value (horizontal axis). The region for which the solid curve dips below the horizontal line at the value of 1 is excluded with a 95% confidence level (CL). The dashed curve shows the expected limit in the absence of the Higgs boson, based on simulations.



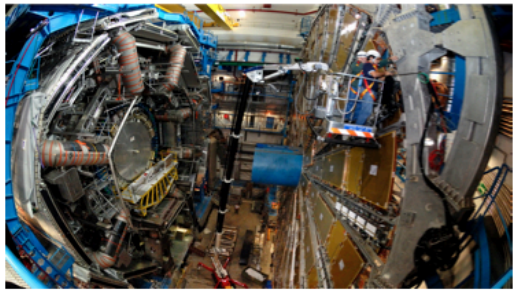
The probability of background to produce a signal-like excess, for all the Higgs boson masses tested. At almost all masses, the probability (solid curve) is at least a few percent; however, at 126.5 GeV it dips to 3x10-7, or one chance in three million, the '5-sigma' gold-standard normally used for the discovery of a new particle. A Standard Model Higgs boson with that mass would produce a dip to 4.6 sigma.



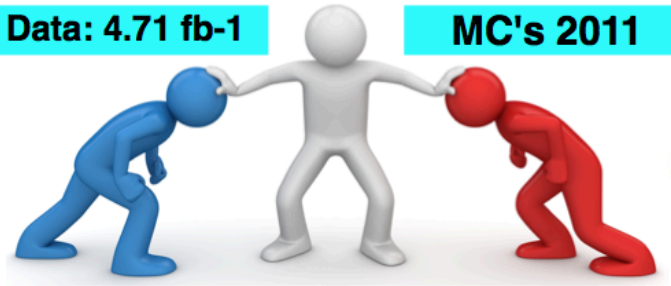
…how do you get this result?
Let me show you a “personal” vision using our analysis…



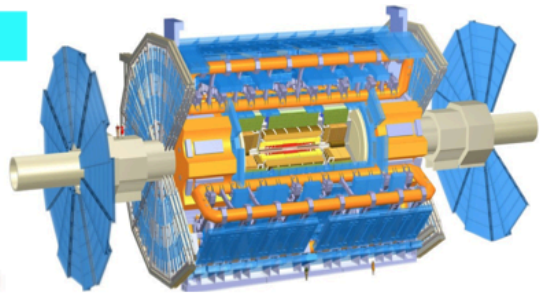
Data 2011



Data: 4.71 fb-1



MC's 2011



MC 2011

ANALYSIS

Luminosity determination

Triggers to use, considering the experimental condition

More that one MC generator (Phytia, MC@NLO,…)

Detector simulation closer and closer to real conditions

Let me try to give you an idea of the "diversification" of the work…

Note: each of the Boxes that we are looking may correspond to a one or more **"Performance Group"…**

ANALYSIS

Combined Performance Groups

- e/gamma WG
- Flavour Tagging WG
- Jet/EtMiss WG
- Tau WG
- Combined Muon WG
- Inner Tracking WG

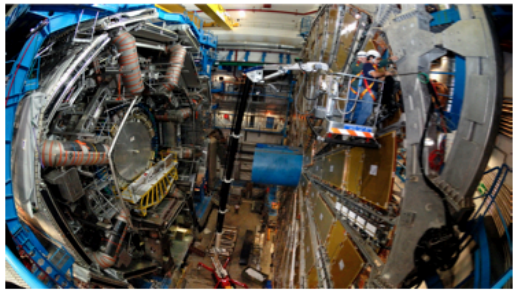
Other

- Trigger
- ATLAS Luminosity WG
- Statistics Forum
- Simulation
- Production Team
- CREM
- CREM Data Distribution

Specific Studies in constant revision

…where a **"Performance Group"** can be integrate for 10, 50 or maybe >100 people

Data 2011



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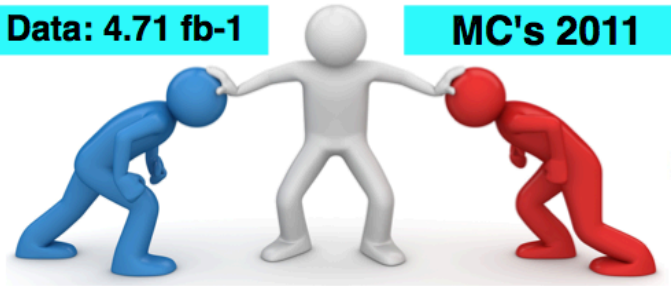
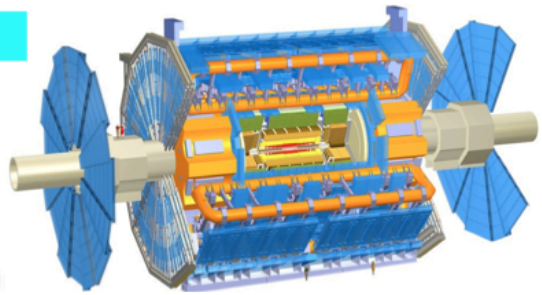


MC's 2011



MC 2011

List of the good data files
Or called : GoodRunList

Calibrations (energy, track position,…) due to real detector conditions

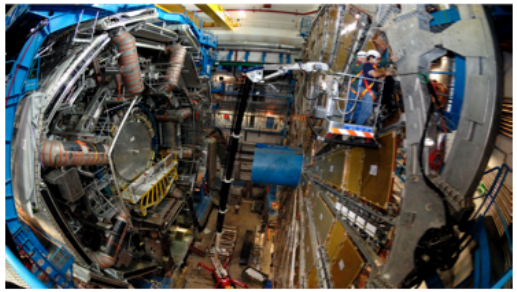
ANALYSIS

MC weights in order to scale factors to experimental conditions

"Adding" Pileup conditions: more than one interaction occurs at the same time

…most of the important aspects is the definition of the good physical objects: electrons, muons, jets, photons,…

Data 2011



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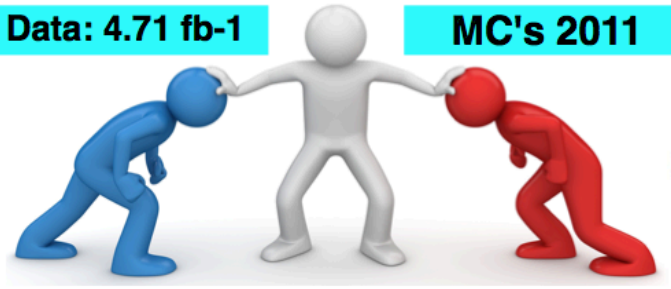
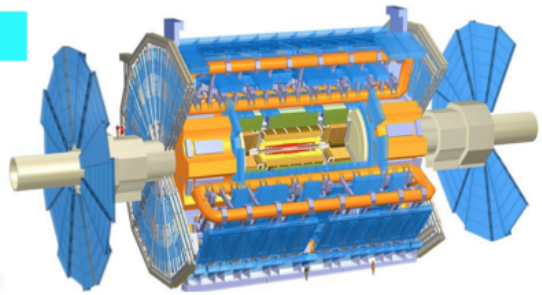


MC's 2011



MC 2011

Reference from previous experiments

MC and data studies

What is a "good electron"?

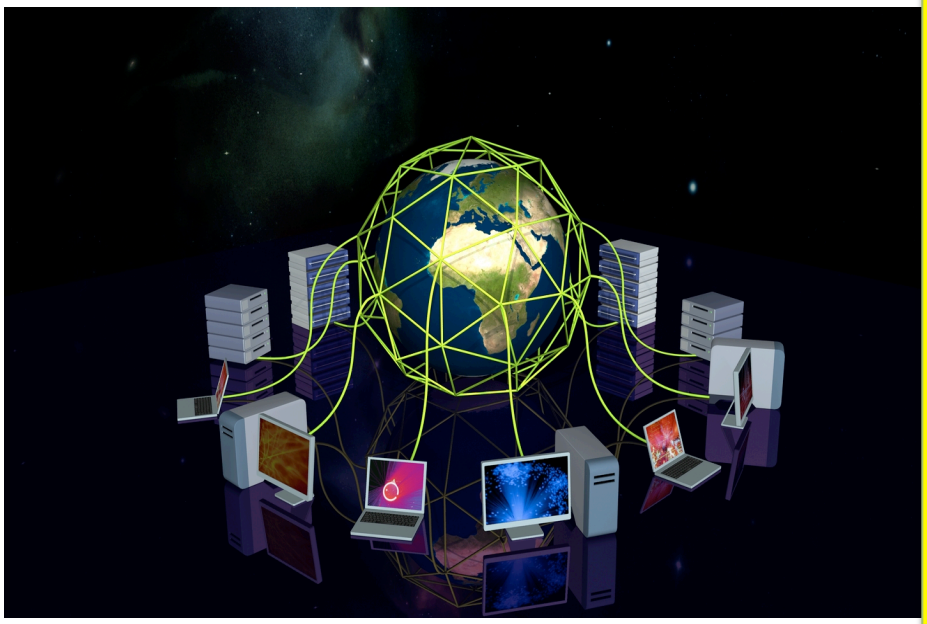
- **Comes from the interaction point?**
- **How clean is the candidate?**
- **Geometrical position?**
- **energy?**
- **…**

ANALYSIS

What is a "good muon"?

- **Number of tracks?**
- **How clean is the candidate?**
- **Geometrical position?**
- **Transverse moment?**
- **…**

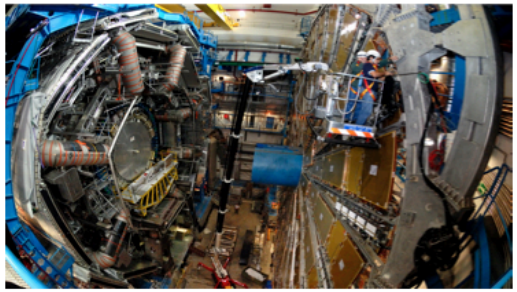
…very important aspect during all this processes: the Computing!



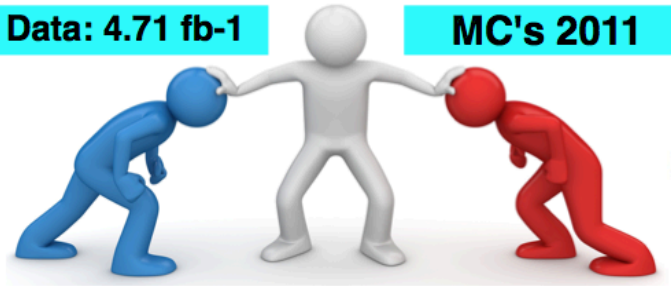
ANALYSIS

…the quantity of real data + simulation + technical files + code + computer power + years of work (*+ PhDs nights!*): Can just be manage using a real global computing infrastructure…

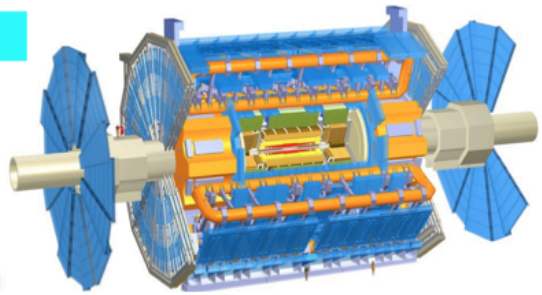
Data 2011



Data: 4.71 fb-1



MC's 2011



MC 2011

ANALYSIS

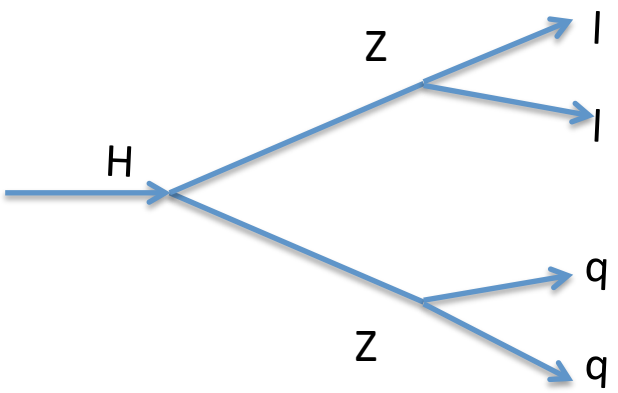
Cross-check with other groups (see later…)

Constant update of the variables inside the data/MC

The best Jet algorithm? The best b-tag discriminant?

New (and faster) technical computing tools

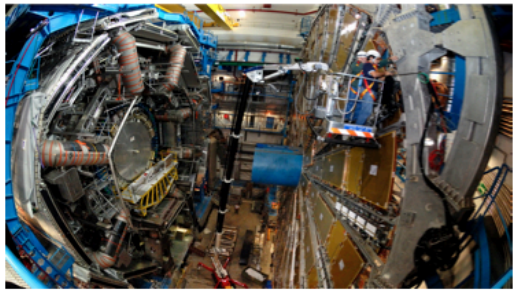
…keep updated inside the collaboration, read the “news”!



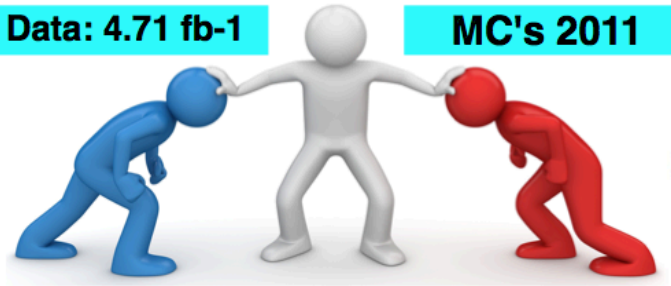
ANALYSIS

…the update of the **recommendations** coming from the **Performance Groups** is constant and to keep in contact is vital…

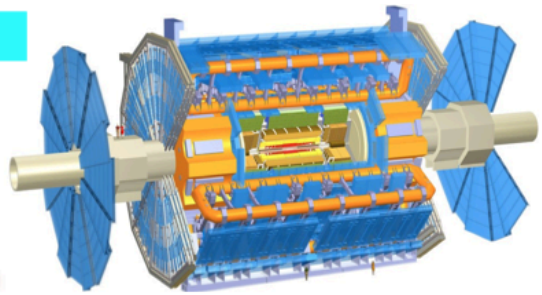
Data 2011



Data: 4.71 fb-1



MC's 2011



MC 2011

ANALYSIS

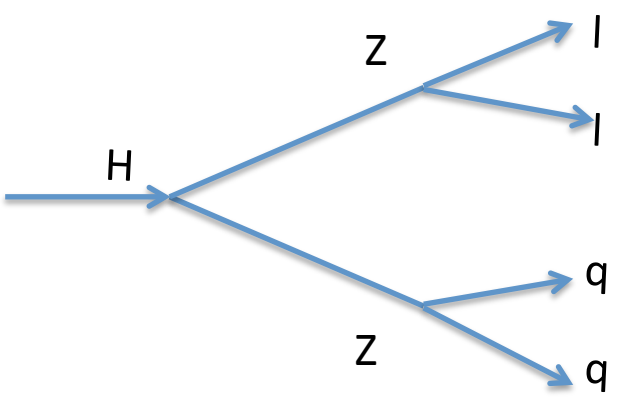
Take your Higgs Analysis i.e. H->ZZ*->qqll

Taking into account the topology of your physical process

Decide the different "cuts" that give you the best signal/bkg relationship

Develop new tools to fight better Vs your principal bkgs.

…let me show you our present analysis status, like an example…



ANALYSIS

Looking for 2 leptons (same flavor) + 2 jets with invariant mass near to a Z. Low missing transverse energy. The invariant mass of the system llqq near to our Higgs signal MC ->

Looking the 2 jets been 2 b-jets or not -> called:
“tag and untag channel”

CutFlow

MC Signal gluon-gluon Higgs at 130GeV

Cross-check with other eternal group

Athens

muon channel	ggH130 No rw no smearing
All	30000
mc event weight	30000
HFOR cut	30000
PowHeg rw	30000
GRL	30000
lar error	30000
trigger	7641
Pileup rw	7641
Vertex	7641
MET cleaning	7641
LAr Hole	7618
Muons	15176
kinematics	13501
tightness/author	13459
ID cuts	13282
cosmic	13278
d0 significance	13048
track isolation	12421
overlap removal	11891
2 leptons + veto	4590
opposite charge	4587
extra kinematics	4297
MET	3684
DIJS	1574
<2 tag	1521
DILM	742
DIJM	540
==2 tag	52
DILM	34
DIJM	30
>2tag	1

ANALYSIS

Roma&Napoli

muon channel	ggH130 No rw no smearing
All	30000
mc event weight	30000
HFOR cut	30000
PowHeg rw	30000
GRL	30000
lar error	30000
trigger	7641
Pileup rw	7641
Vertex	7641
MET cleaning	7641
LAr Hole	7618
Muons	15176
kinematics	13501
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MET	3684
DIJS	1574
<2 tag	1521
DILM	742
DIJM	540
==2 tag	52
DILM	34
DIJM	30
>2tag	1

Muon Channel

CutFlow

MC Signal gluon-gluon Higgs at 130GeV

Cross-check with other eternal group

Athens

electron channel	ggH130 No rw no smearing
All	30000
mc event weight	30000
HFOR cut	30000
PowHeg rw	30000
GRL	30000
lar error	30000
trigger	6779
Pileup rw	6779
Vertex	6779
MET cleaning	6779
LAr Hole	6714
Electrons	46414
goodOQ	36072
author/tightPP	9166
kinematics	8941
track isolation	8781
d0 significance	8541
overlap removal	8541
2 leptons + veto	2546
opposite charge	2536
extra kinematics	2500
MET	2130
DIJS	850
<2 tag	823
DILM	373
DIJM	252
==2 tag	27
DILM	23
DIJM	23
>2tag	0

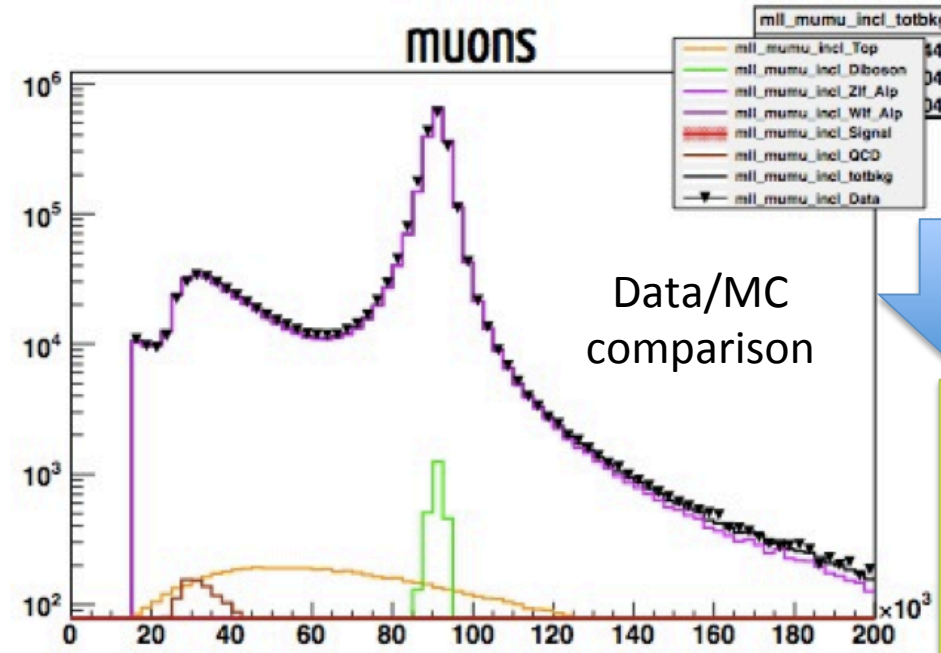
ANALYSIS

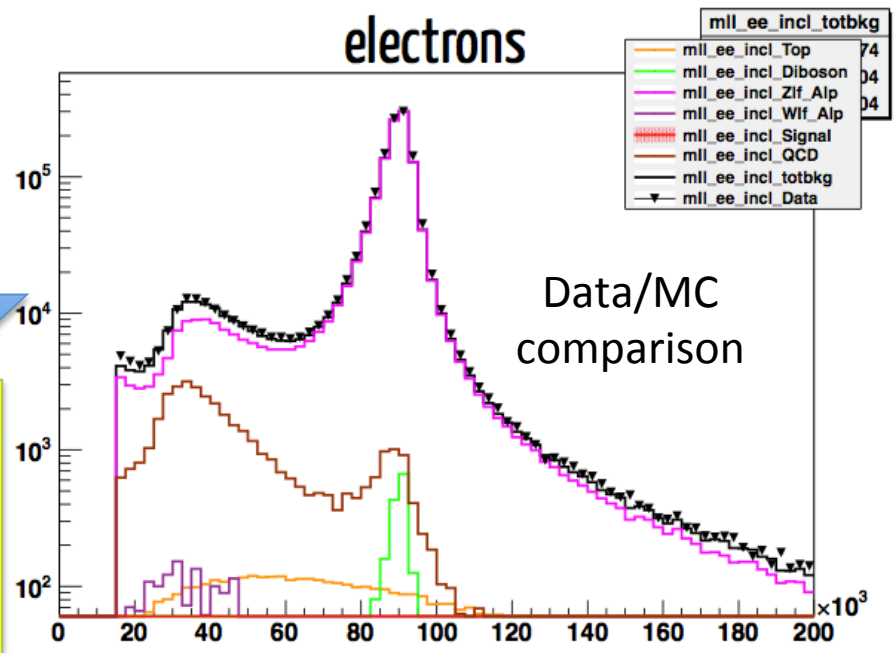
Roma&Napoli

electron channel	ggH130 No rw no smearing
All	30000
mc event weight	30000
HFOR cut	30000
PowHeg rw	30000
GRL	30000
lar error	30000
trigger	6779
Pileup rw	6779
Vertex	6779
MET cleaning	6779
LAr Hole	6714
Electrons	46414
goodOQ	36072
author/tightPP	9166
kinematics	8941
track isolation	8781
d0 significance	8541
overlap removal	8541
2 leptons + veto	2546
opposite charge	2536
extra kinematics	2500
MET	2130
DIJS	850
<2 tag	823
DILM	373
DIJM	252
==2 tag	27
DILM	23
DIJM	23
>2tag	0

Electron Channel

Dilepton inclusive sample



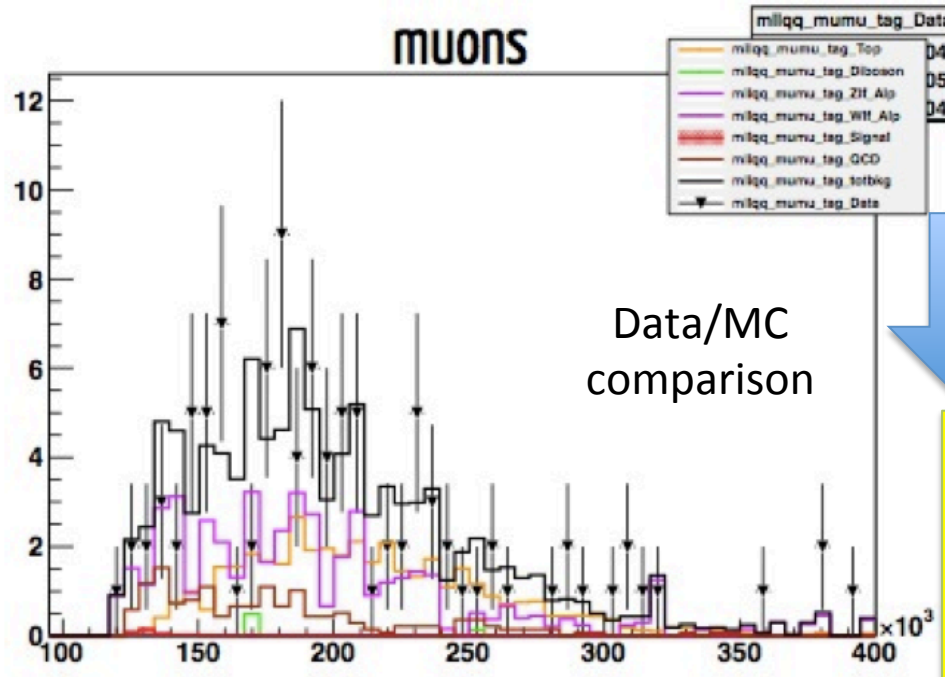


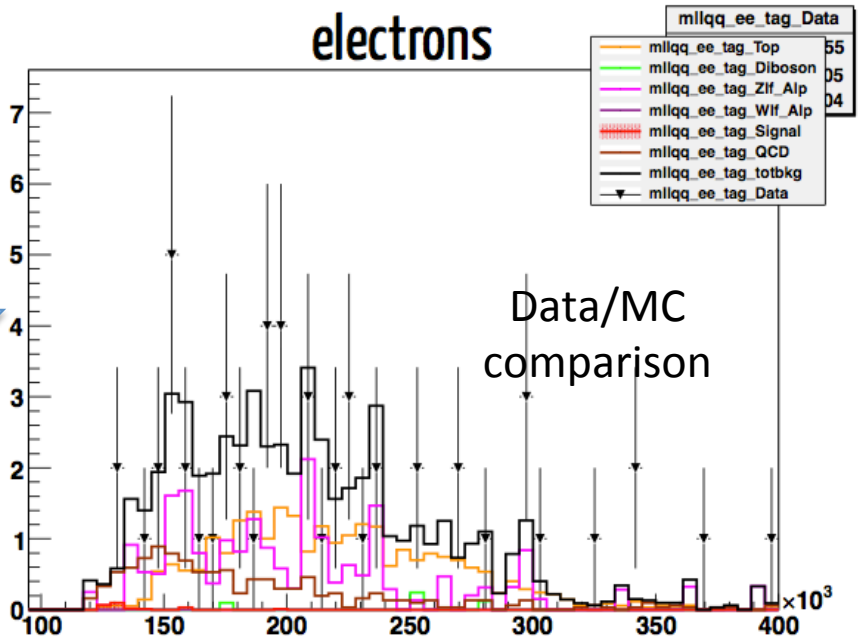
ANALYSIS

Top -- 8277.918128
Diboson -- 4277.465854
Zlf_Alp -- 2357401.593855
Wlf_Alp -- 1264.155640
Signal -- 56.394521
QCD -- 1599.825637
totbkg -- 2372820.959114
Data -- 2385773.000000

Top -- 5270.027953
Diboson -- 2560.925995
Zlf_Alp -- 1227974.412012
Wlf_Alp -- 2119.440184
Signal -- 31.635094
QCD -- 39190.961039
totbkg -- 1277115.767183
Data -- 1332534.000000

Mllqq in the SR -tag



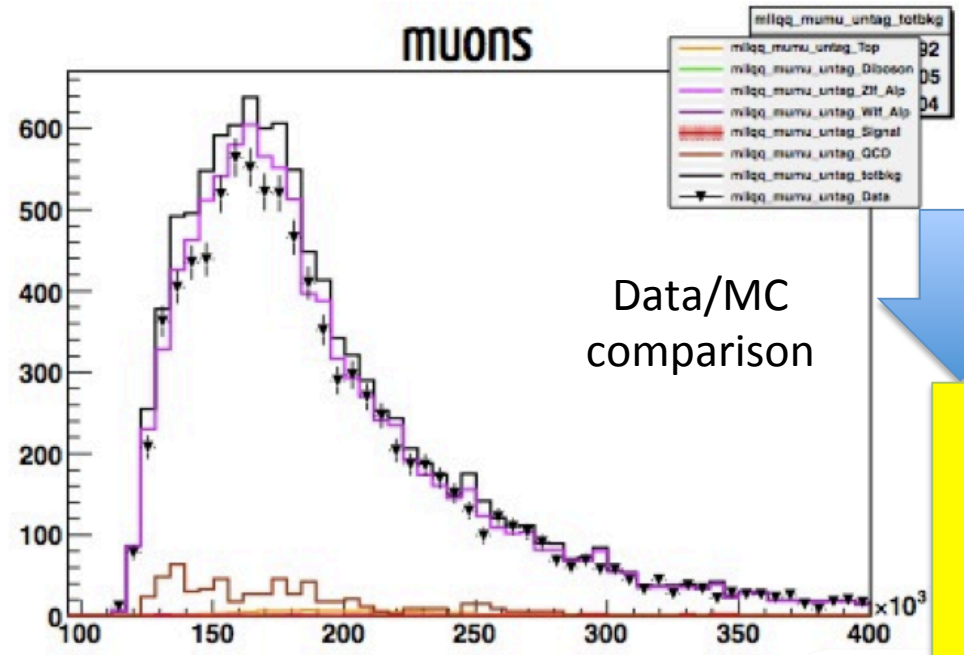


ANALYSIS

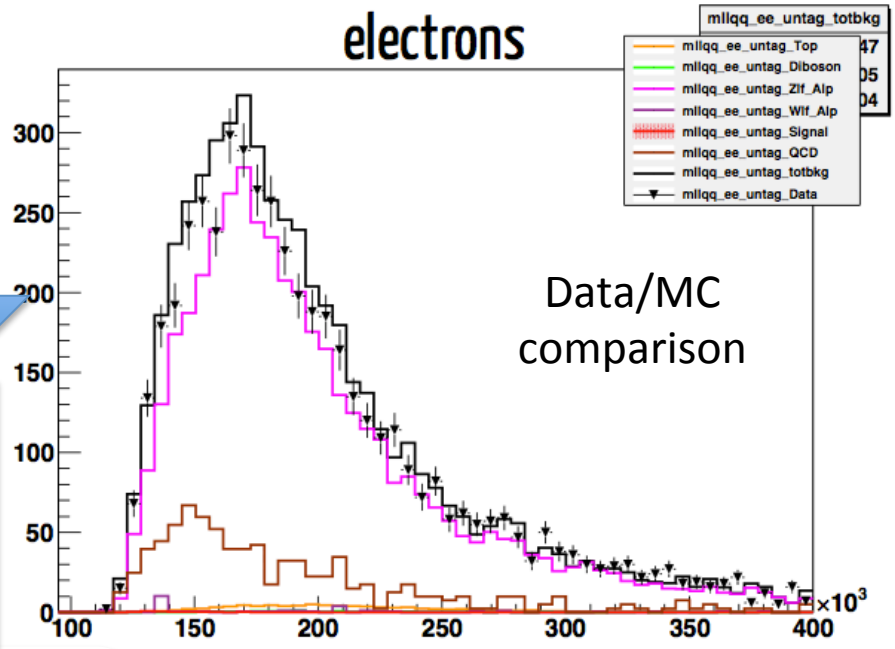
Top -- 40.341852
Diboson -- 0.644354
Zlf_Alp -- 49.353967
Wlf_Alp -- 0.000000
Signal -- 0.378478
QCD -- 14.939779
totbkg -- 105.279952
Data -- 104.000000

Top -- 24.876957
Diboson -- 0.464954
Zlf_Alp -- 23.459702
Wlf_Alp -- 0.000000
Signal -- 0.241970
QCD -- 11.026431
totbkg -- 59.828044
Data -- 55.000000

Mllqq in the SR -untag



Data/MC comparison



Data/MC comparison

ANALYSIS

Top -- 132.095448
Diboson -- 16.819445
Zlf_Alp -- 9989.601205
Wlf_Alp -- 4.008350
Signal -- 7.456661
QCD -- 623.735780
totbkg -- 10766.260228
Data -- 9524.000000

Top -- 87.783799
Diboson -- 12.955403
Zlf_Alp -- 4466.395198
Wlf_Alp -- 25.715972
Signal -- 3.212149
QCD -- 828.678685
totbkg -- 5421.529057
Data -- 5078.000000

Notes

- The only constant, is the change.
- The improvement comes from many different groups and technical/physical aspects.
- The final result is a combination of all this jobs + the very frequently cross-check between the parts.