Higgs Search at CMS

LINA NECIB

Aknowledgement: this presentation uses as resources the H → ZZ → 2ℓ 2q group presentation to the Higgs search presented on 03.06.11 with updates from the latest plots and data, as well as the two updated CMS notes (H → ZZ → 2ℓ2q group) and (H → ZZ → 2ℓ2b group)
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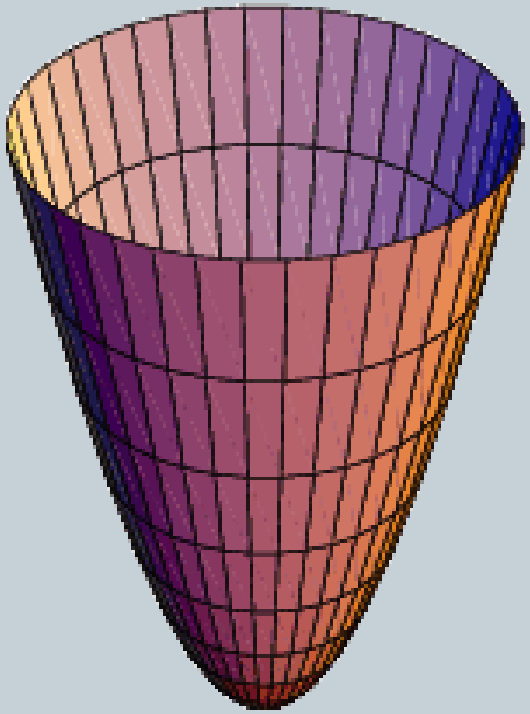
Overview:

- Theoretical need for the Higgs:
  - The Standard Model Higgs
  - Higgs decay channel
  - CMS detection of Higgs channel
- Analysis at CMS: Example: *H->ZZ->2ℓ2b*
  - CMS features for the channel
  - Cuts
  - MC comparison
  - Conclusion
- Alternatives to the Higgs

Theoretical Background



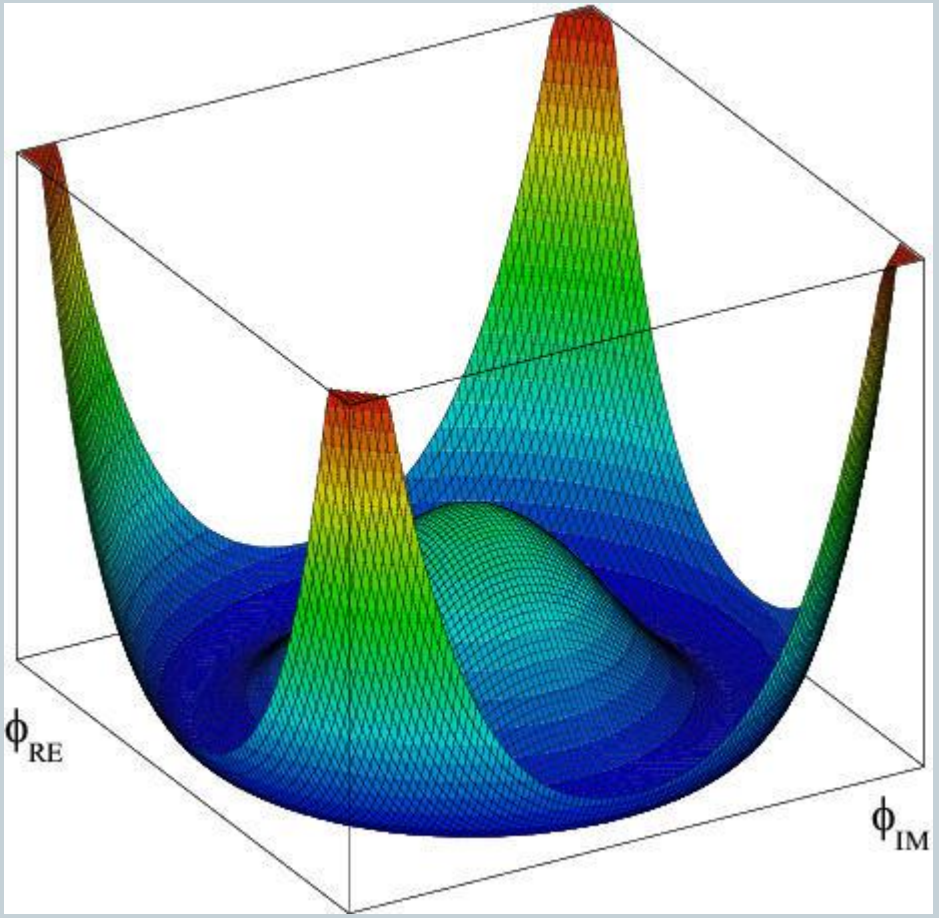
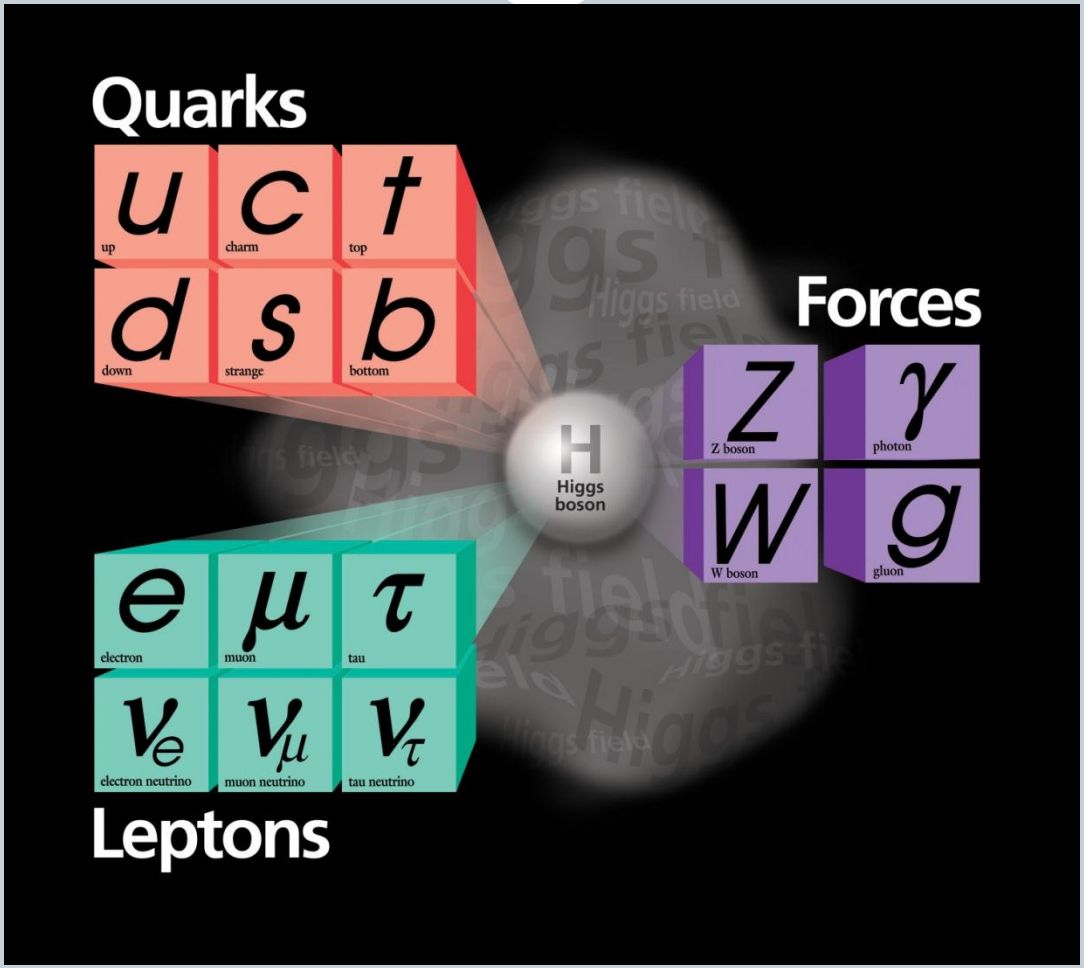


Fig 1: (a) Potential energy with no Higgs field (b) Potential energy with Higgs field

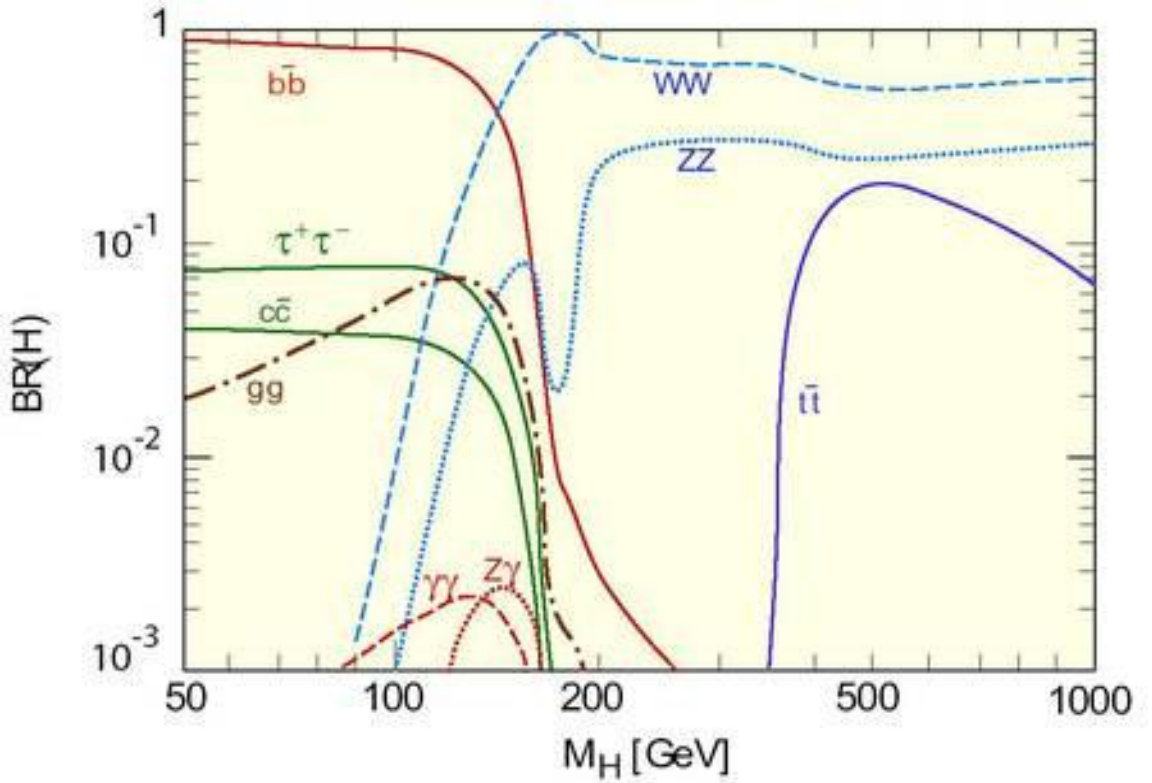
But actually how does the Higgs work?

Higgs Field

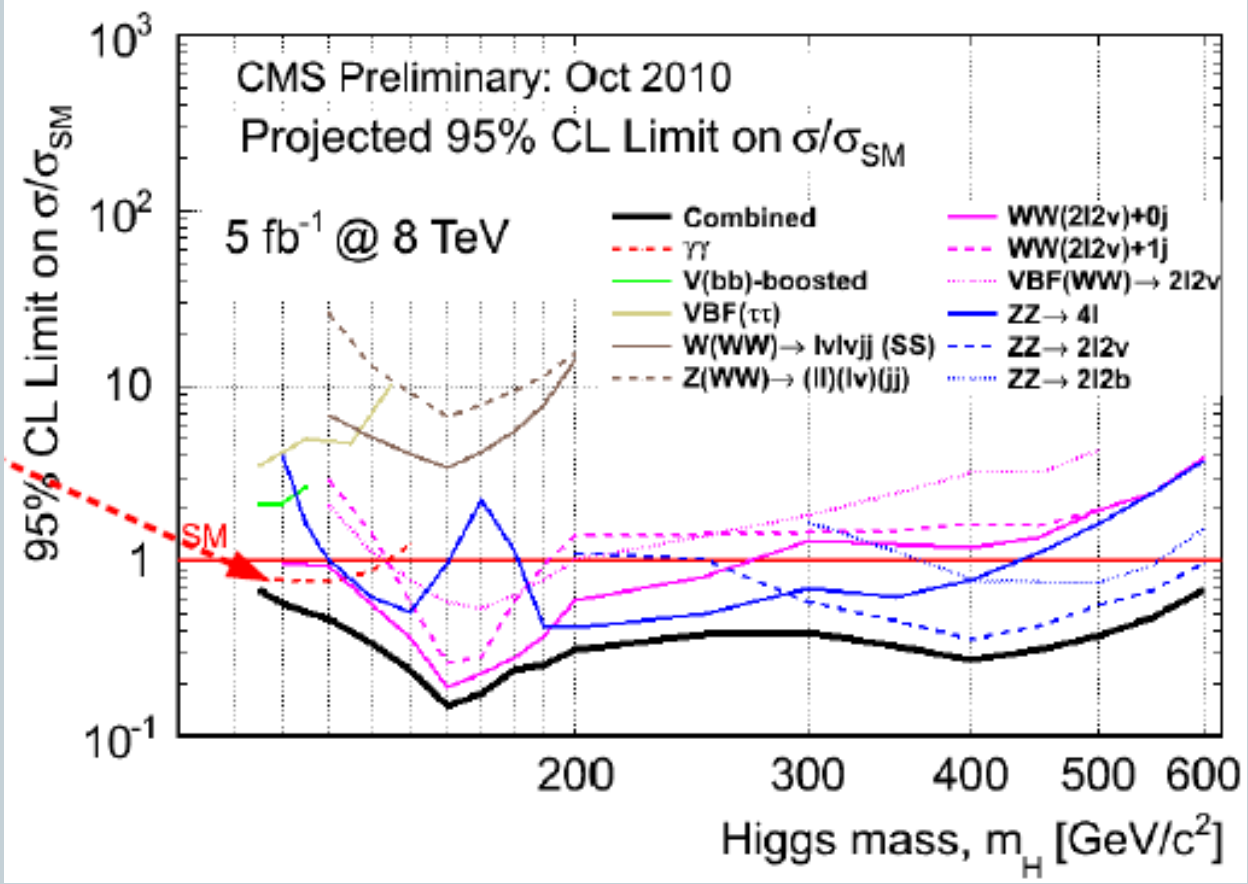
Hmm… Higgs Boson?



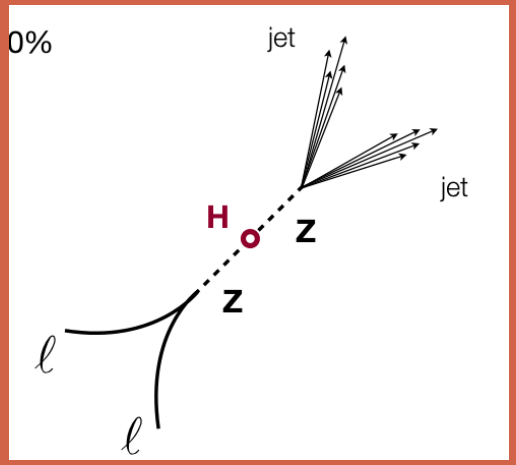
Choose a channel!



Search for Higgs at CMS



H -> ZZ -> 2l2q



- Taking advantage of the large BR to hardrons BR(Z->qq)=70%
  - BR(ZZ → 2l2q)= 20 * BR(ZZ → 4l)
  - BR(ZZ → 2l2q)= 3.5 * BR (ZZ → 2l2 nu)
- Drawbacks:
  - Low jet resolution
  - Large background from Z+jets
- Decay is well reconstructed, closed kinematics (no Missing ET)
  - Good for exclusion and discovery

Background

- Z+Jets (including Drell Yan)
- Ttbar
- Z->BB + n partons
- Decays of WW,ZZ,WZ

Affects the accuracy of b-tagging

And swap a *q* for a *b* => *H->ZZ->2ℓ2b*

- Channel features:
  - B- tagging (tracker)
  - High resolution of Ecal
  - High precision measurement of Muon pT (it is called Compact Muon Solenoid for a reason…)

CMS Preliminary

Mu…	pT=[20-100] GeV	
…egion	data	data/mc ratio
abs(η)<1.2	96.0 -0.1/+0.1	0.996 -0.001/+0.001
1.2<abs(η)<2.4	96.0 -0.1/+0.1	0.986 -0.001/+0.001

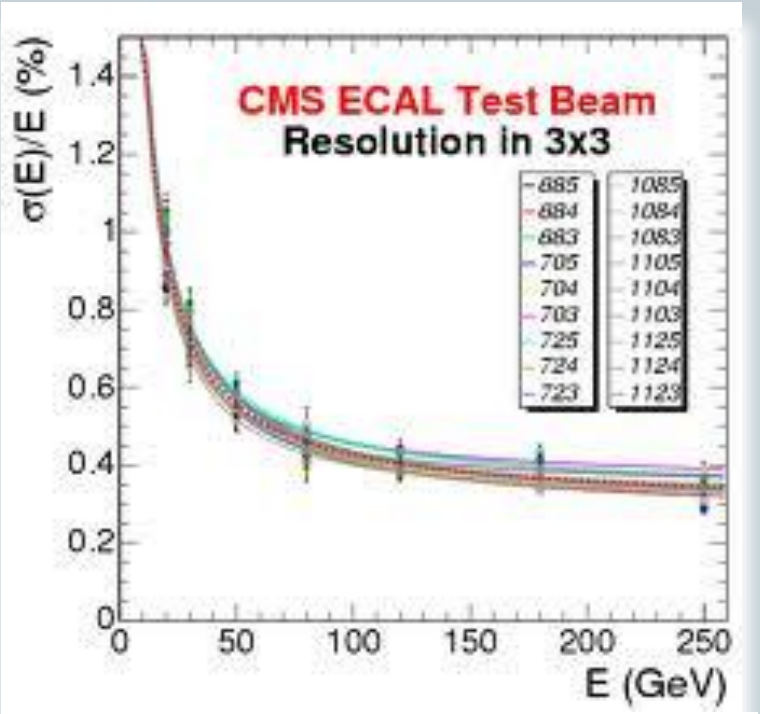
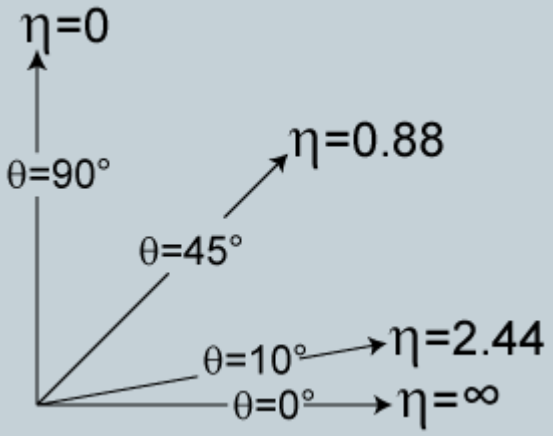
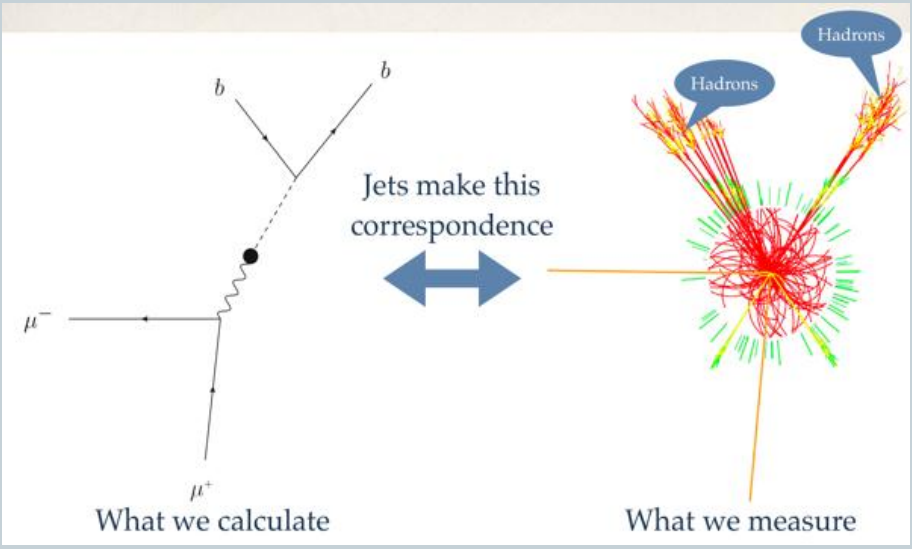


Fig 3: ECAL resolution at different energies

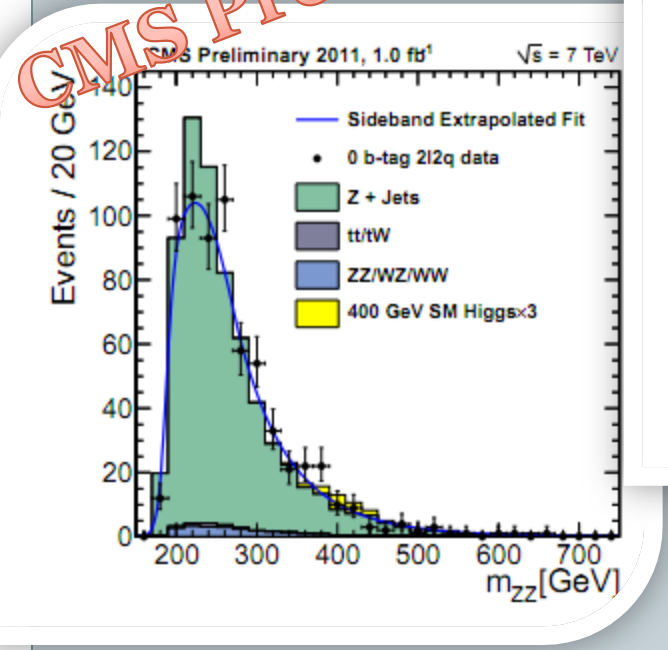
Cuts

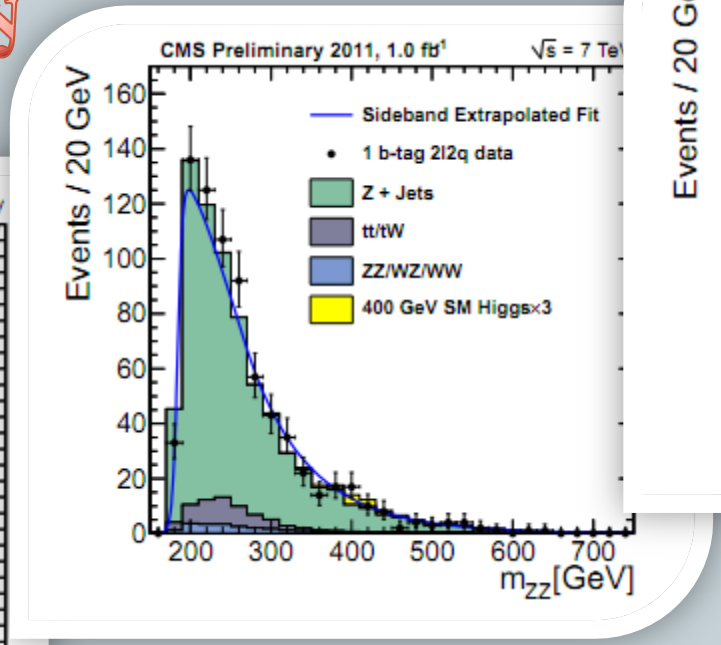
- Electron and Muon identification:
  - Pt>20 GeV
  - Electrons: |η|<2.5
  - Muons: |η|<2.4 and at least one in |η|<2.1
- Reconstructing the Z: Tight selection
  - | M(Zll) - 91.19 | < 10 GeV
  - | M(Zjj) - 91.19 | < 15 GeV

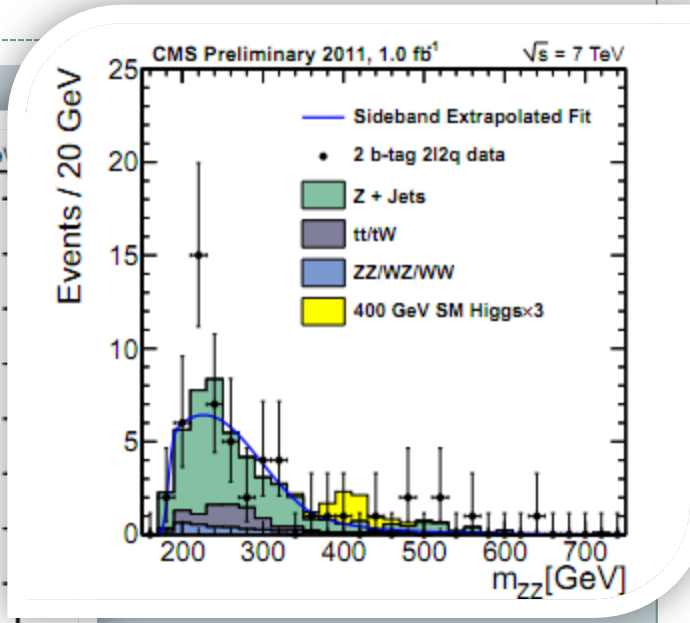




Monte Carlo @1/fb

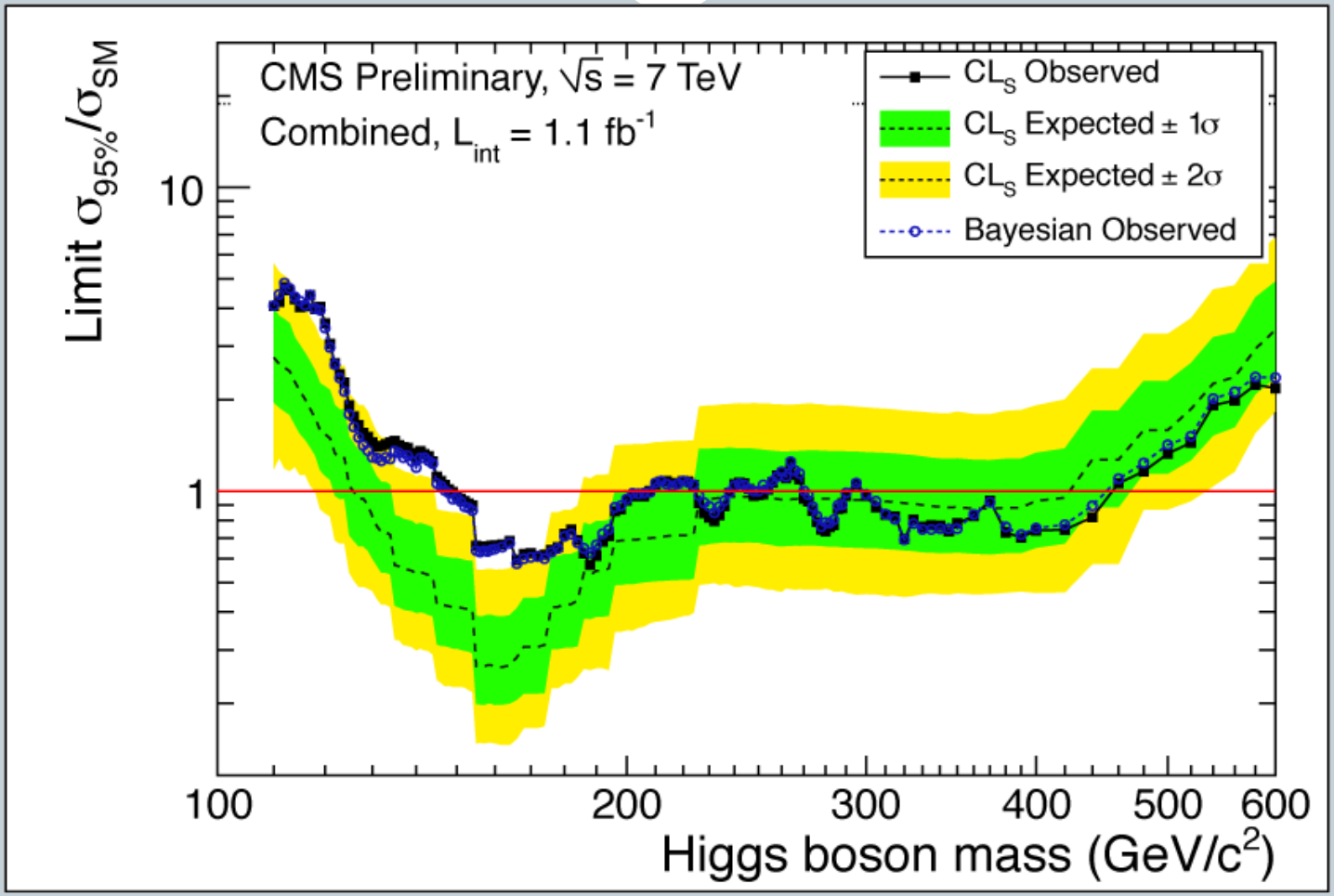




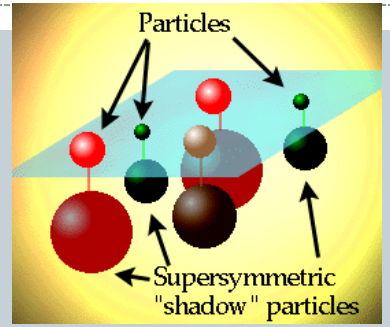


CMS Preliminary

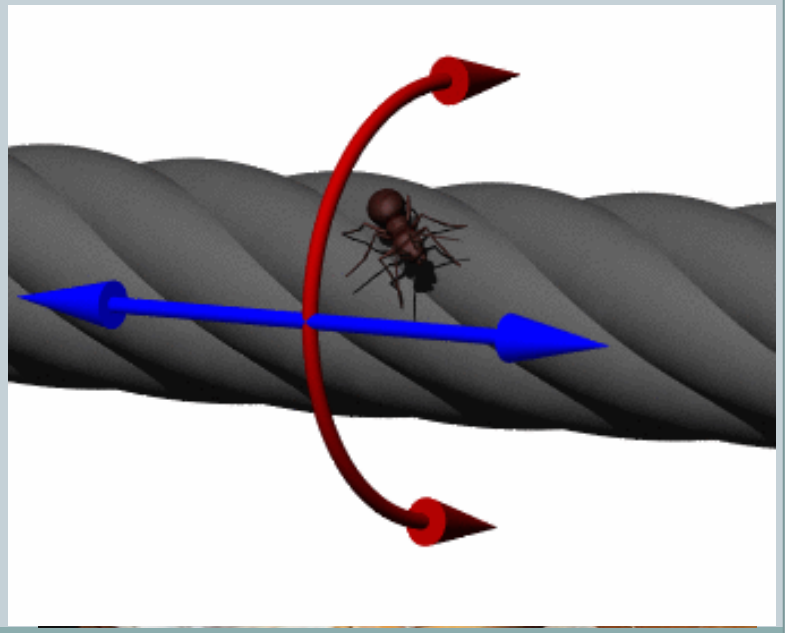
Conclusion plot at CMS



So, is there Higgs??



- So far, no!
- Improvements:
  - More data!
  - Better understanding of CMS => Reduce systematic errors.
  - Pile up: needs investigation!
- Else: Exotica:
  - Technicolor
  - SUSY
  - Extra dimensions
  - Anything else, depending on your creativity



On a Final note…

Dear Higgs Boson,

We know you're out there. We can feel you now. We know that you're afraid. You're afraid of us; you're afraid of change. We don't know the future. We didn't write this to tell you how this is going to end. We wrote this to tell you how it's going to begin.

As you know, our Large Hadron Collider has had some setbacks due to a.... uh... "transformer malfunction" but we know it was you. You sabotaged our machine. We hope you've been enjoying your vacation because we're scheduled to restart in September 2009 and we're pissed.

....so run and hide, asshole. Run and hide. If you should get careless and allow yourself to get detected by the Tevatron, we are going to be supremely disappointed; because we want to find you first, and when we do, rest assured we are not going to publish right away. We're going to teach you some manners first.

Love,

CERN

Sources

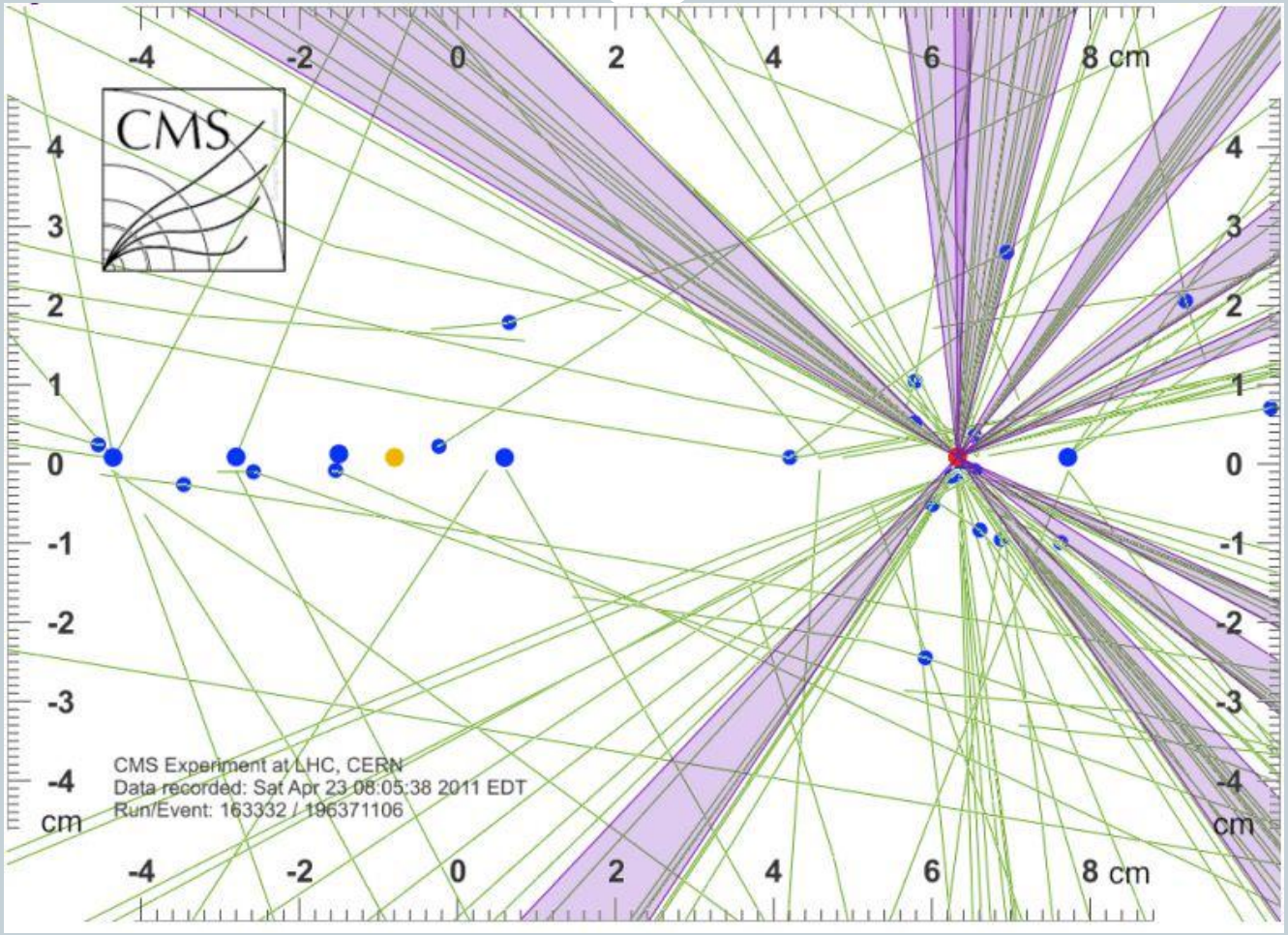
1. http://cms.web.cern.ch/cms/Physics/HuntingHiggs/CMS.html
2. G. Daskalakis, C. Markou: Monte Carlo studies on Position Resolution for the CMS ECAL calorimeter CMS Note 1998/053
3. https://twiki.cern.ch/twiki/bin/viewauth/CMS/HiggsZZlLbB
4. CMS note: H->ZZ->2l2q: http://cdsweb.cern.ch/record/1369551/files/HIG-11-006-pas.pdf

Picture credits

1. http://mathworld.wolfram.com/Paraboloid.html
2. http://www.youtube.com/watch?v=AC1RUufi2XA
3. http://en.wikipedia.org/wiki/File:Mecanismo_de_Higgs_PH.png
4. http://fliptomato.wordpress.com/page/8/
5. http://www-d0.fnal.gov/Run2Physics/top/singletop_observation/
6. http://abstrusegoose.com/118
7. http://www.scottrhardy.com/eng316/activity.php?page=winter_snowshoeing&activity=snowshoeing
8. http://www.jeffgothelf.com/blog/users-are-not-snowflakes/
9. EPS conference: CMS Higgs exclusion plot

Backup

Pileup


CMS
CMS Experiment at LHC, CERN
Data recorded: Sat Apr 23 08:05:38 2011 EDT
Run/Event: 163332 / 196371106
-4
-2
0
2
4
6
8 cm
cm