

Higgs Search at CMS

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LINA NECIB

Overview:

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- Theoretical need for the Higgs:
 - The Standard Model Higgs
 - Higgs decay channel
 - CMS detection of Higgs channel
- Analysis at CMS: Example: $H \rightarrow ZZ \rightarrow 2\ell 2b$
 - CMS features for the channel
 - Cuts
 - MC comparison
 - Conclusion
- Alternatives to the Higgs

Theoretical Background

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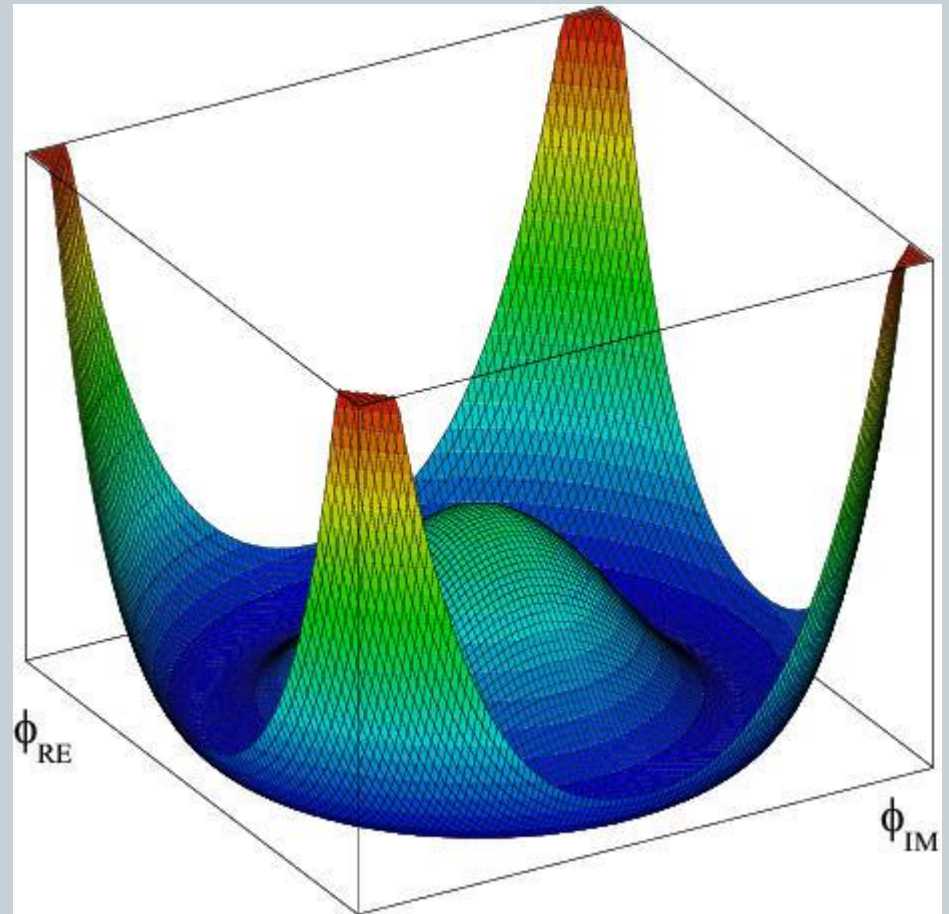
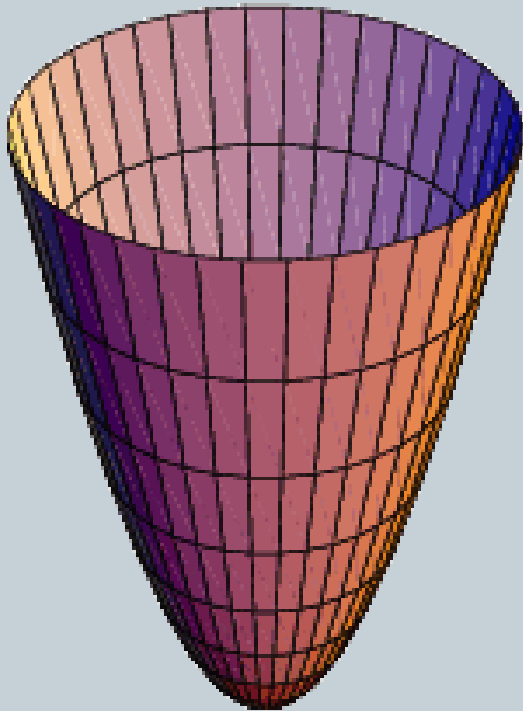


Fig 1: (a) Potential energy with no Higgs field (b) Potential energy with Higgs field

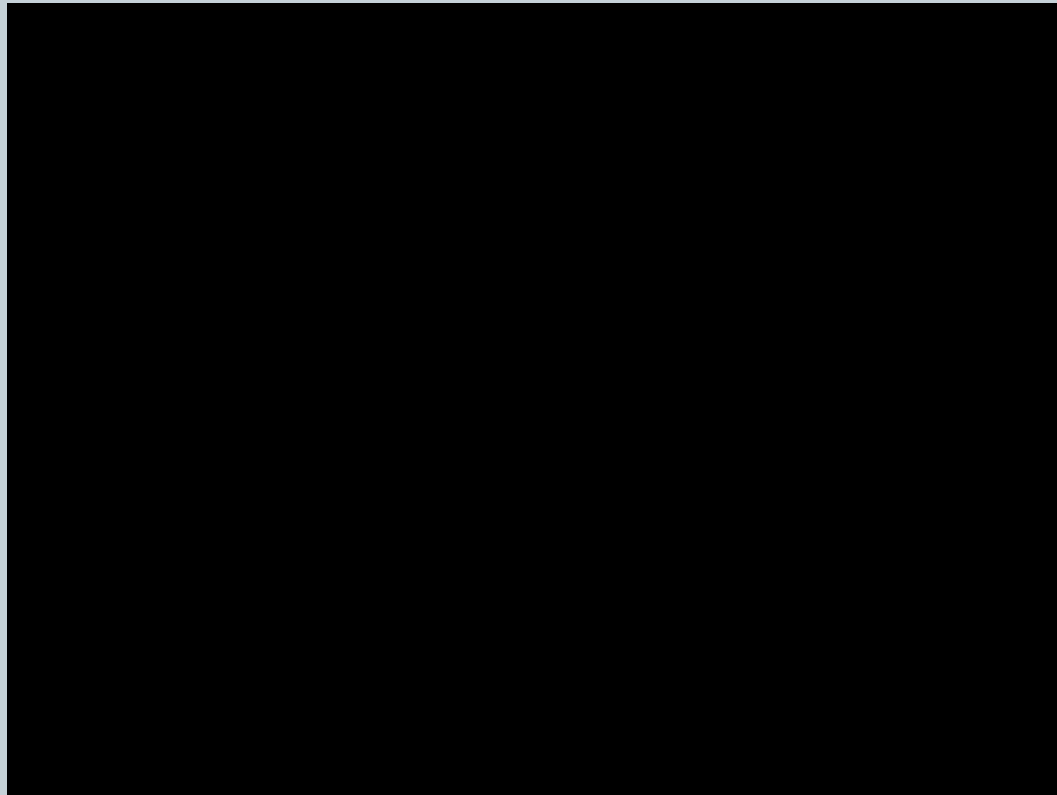
But actually how does the Higgs work?

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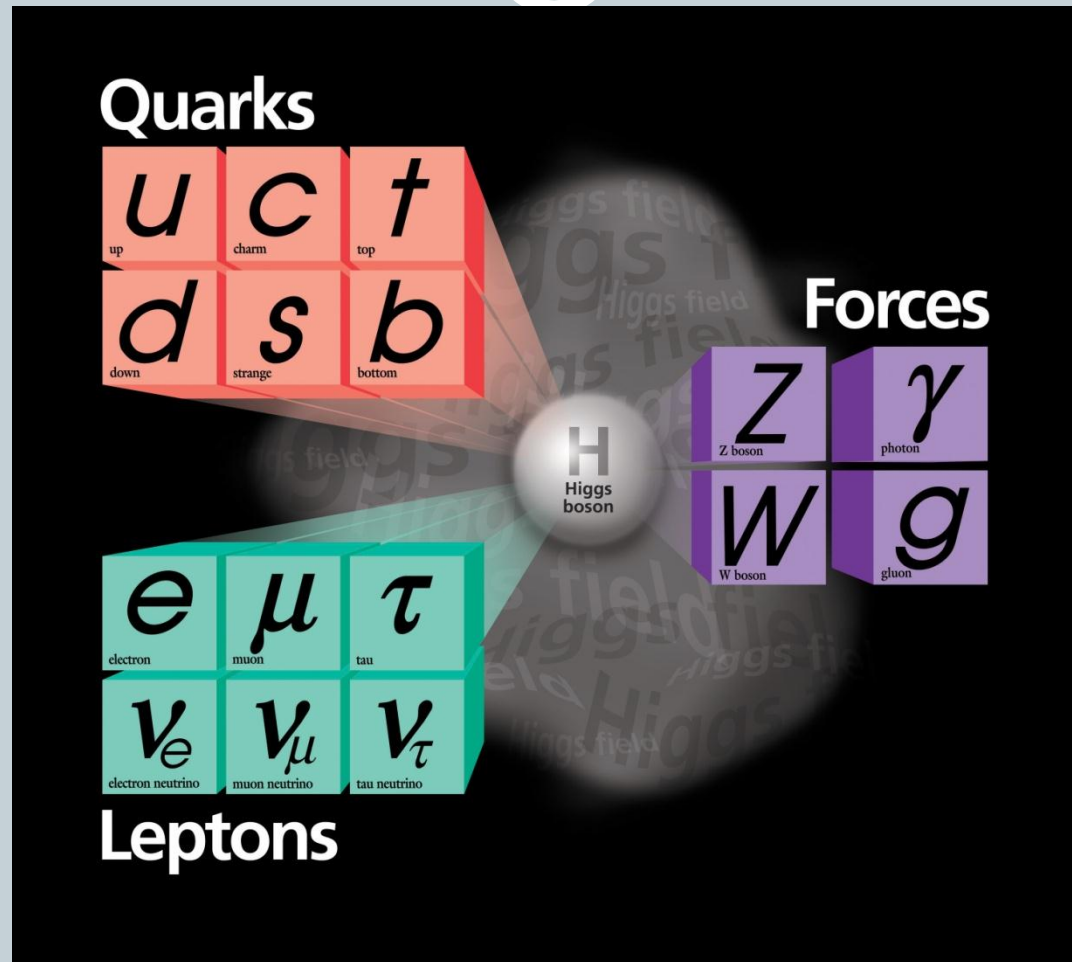
Higgs Field

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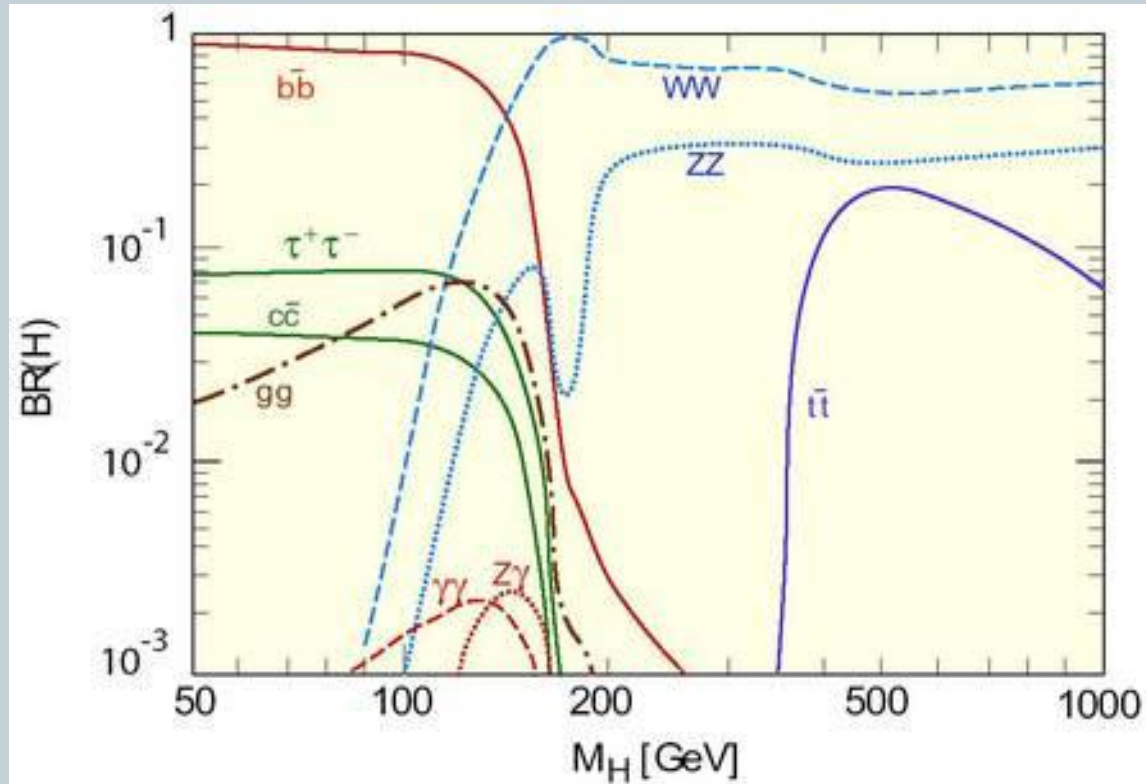
Hmm... Higgs Boson?

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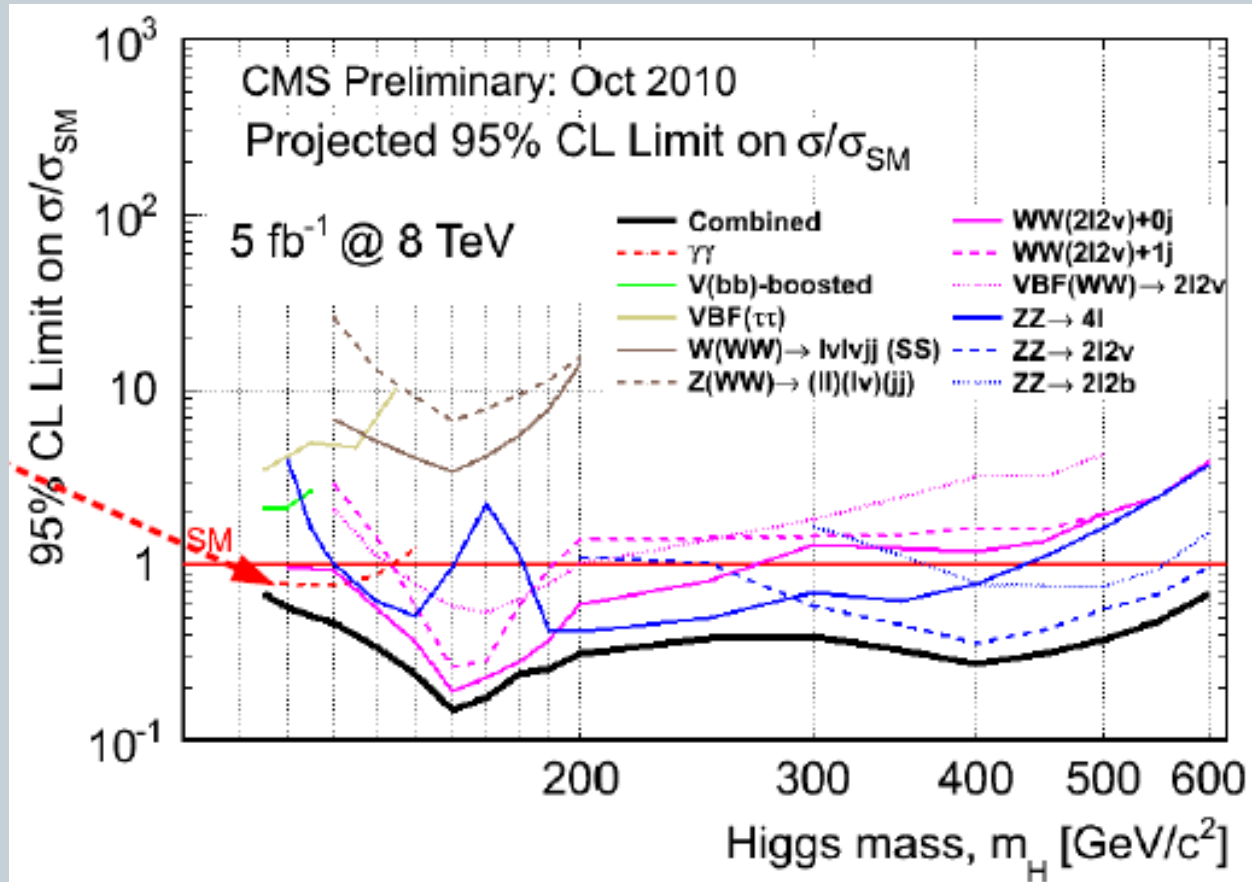
Choose a channel!

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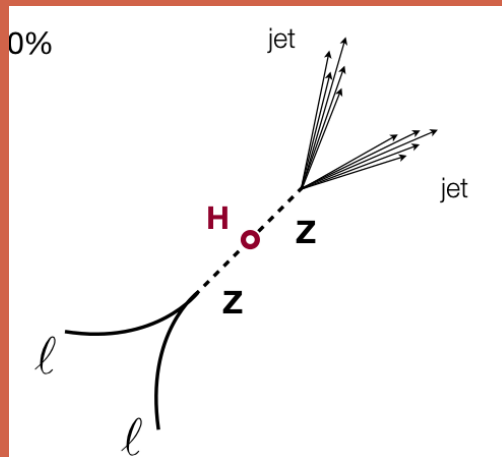


Search for Higgs at CMS

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$H \rightarrow ZZ \rightarrow 2l2q$



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

Background

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- 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 $b \Rightarrow H \rightarrow ZZ \rightarrow 2\ell 2b$

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- Channel features:
 - B- tagging (tracker)
 - High resolution of Ecal
 - High precision measurement of Muon p_T (it is called **C**ompact **M**uon **S**olenoid for a reason...)

CMS Preliminary

Region	pT=[20-100] GeV	
	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

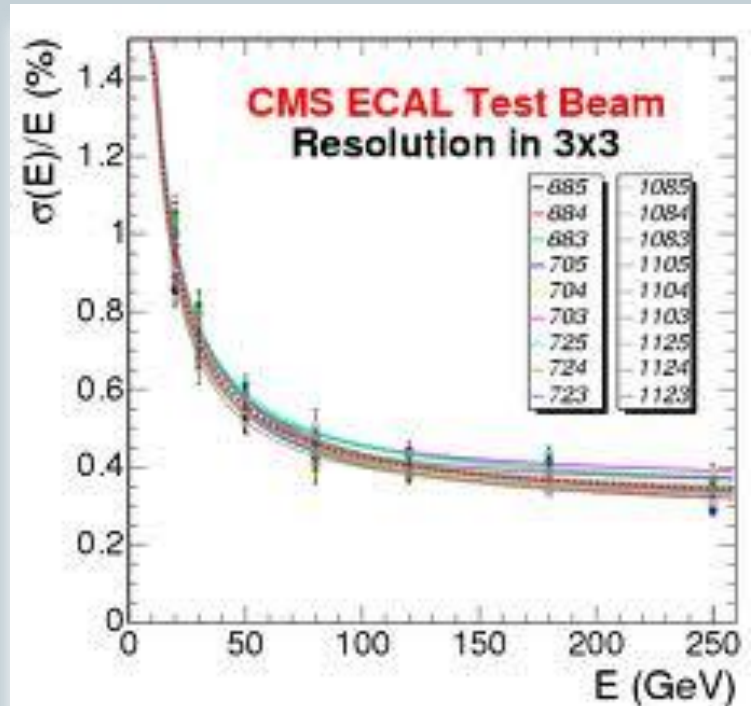
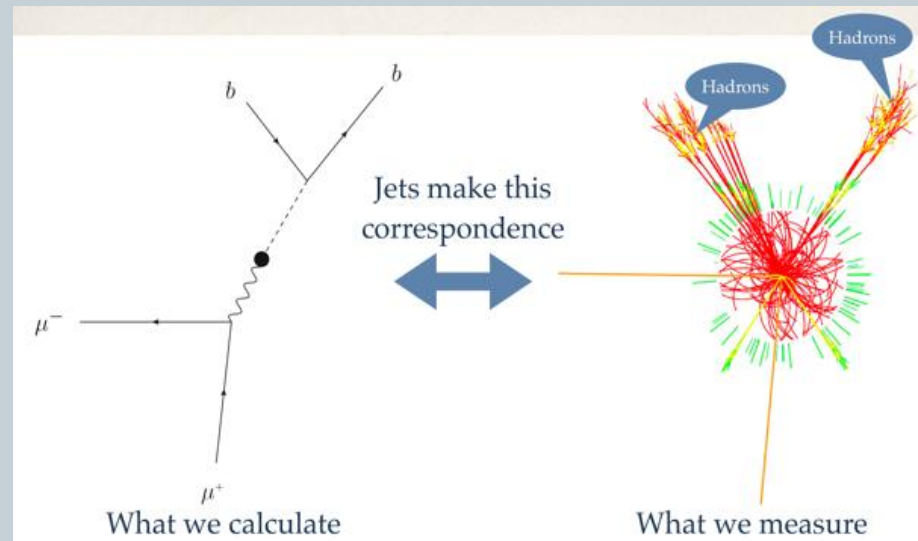
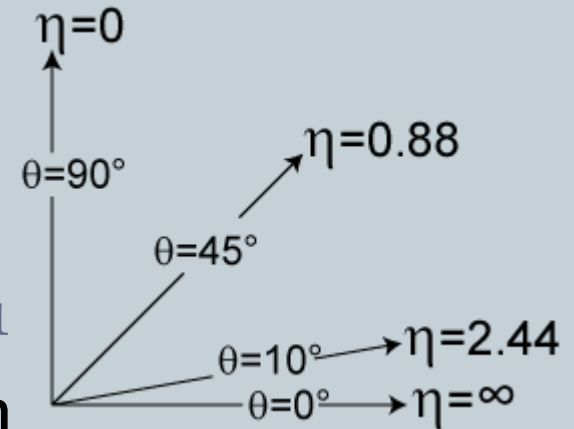


Fig 3: ECAL resolution at different energies

Cuts

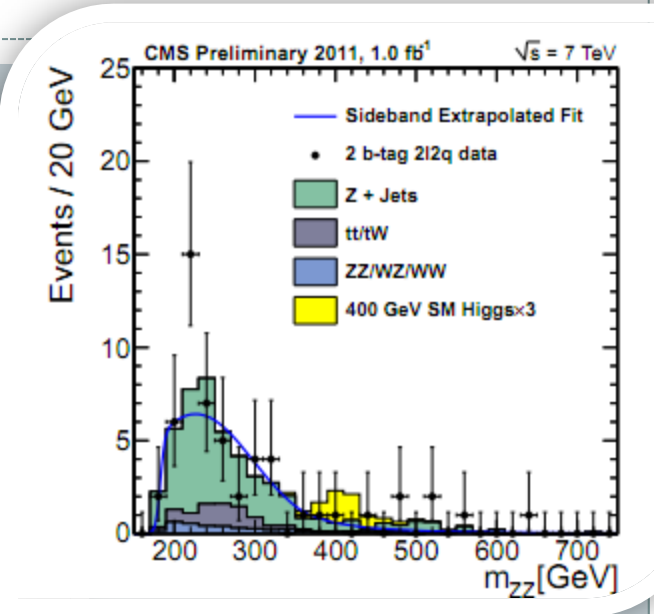
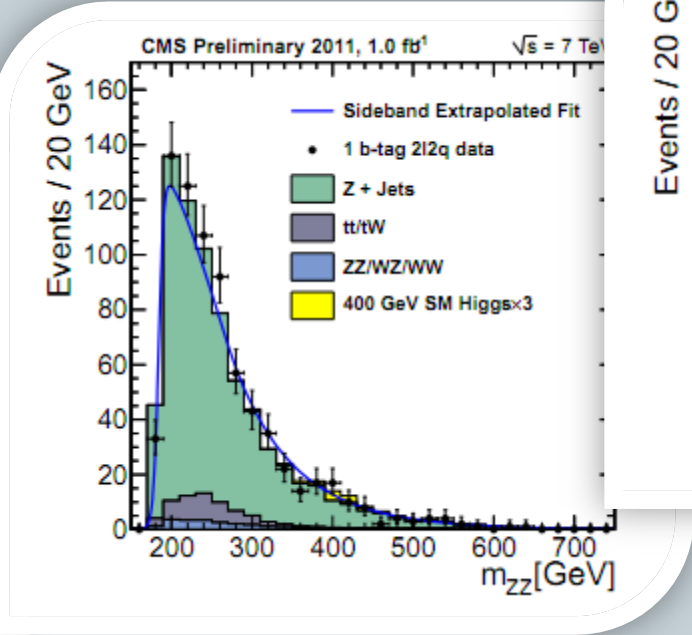
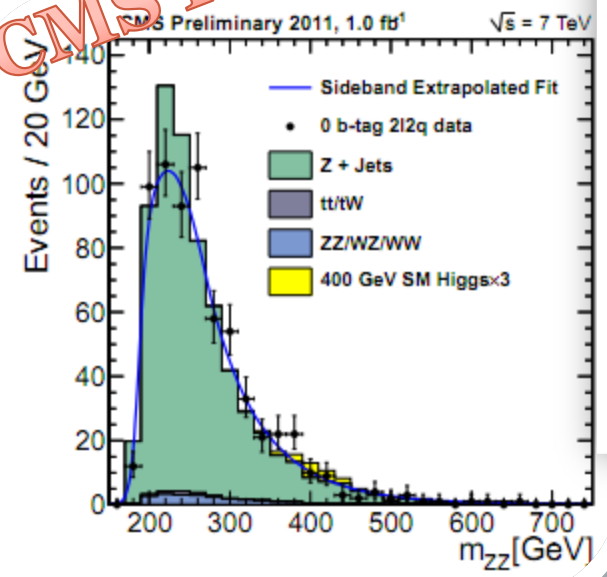
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- **Electron and Muon identification:**
 - $P_t > 20 \text{ GeV}$
 - Electrons: $|\eta| < 2.5$
 - Muons: $|\eta| < 2.4$ and at least one in $|\eta| < 2.1$
- **Reconstructing the Z: Tight selection**
 - $|M(Zll) - 91.19| < 10 \text{ GeV}$
 - $|M(Zjj) - 91.19| < 15 \text{ GeV}$



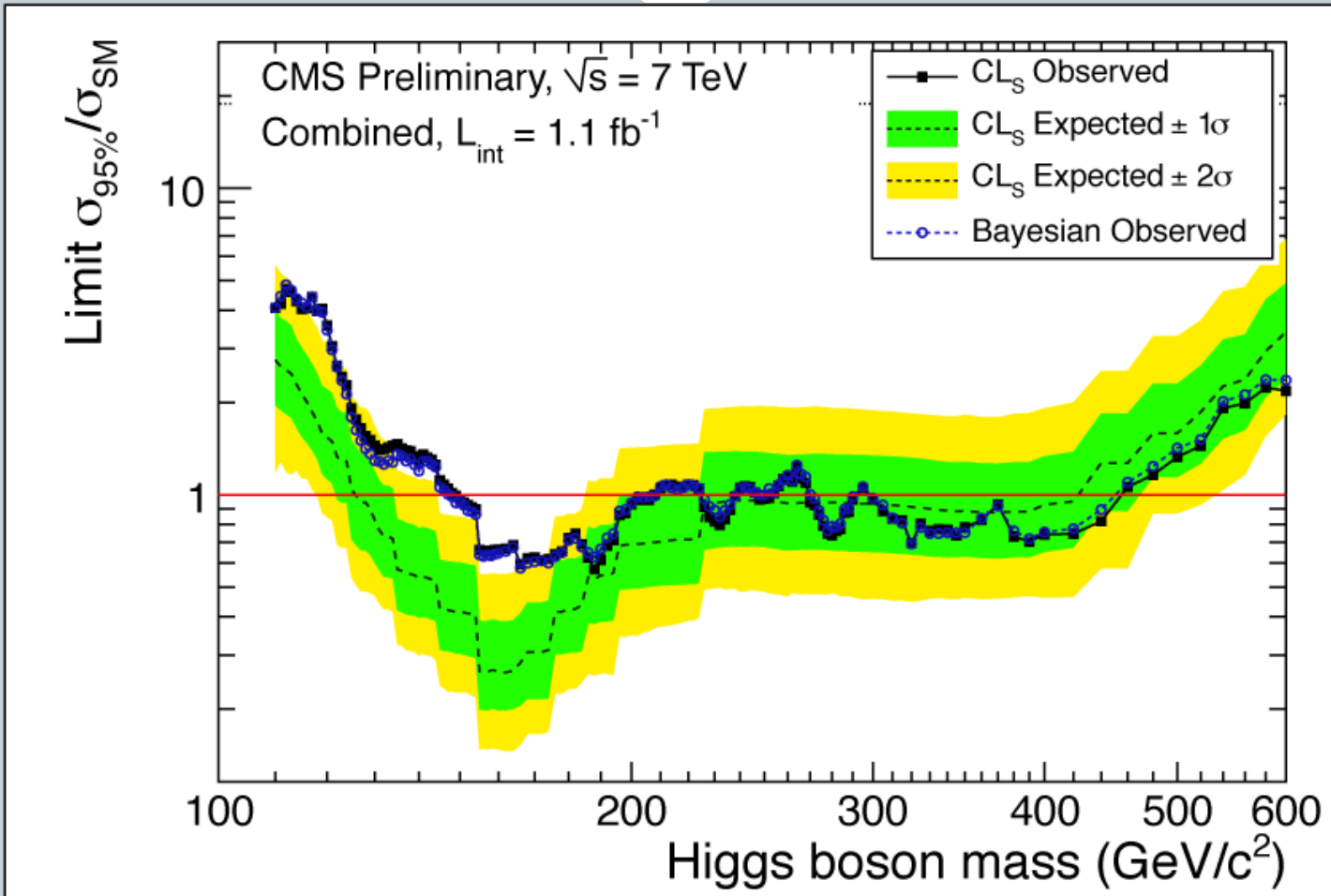
Monte Carlo @1/fb

CMS Preliminary



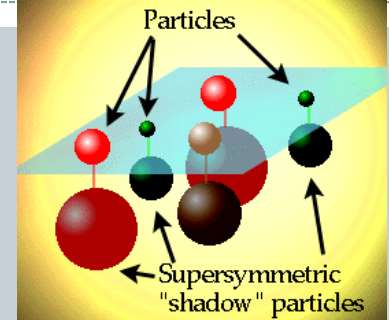
Conclusion plot at CMS

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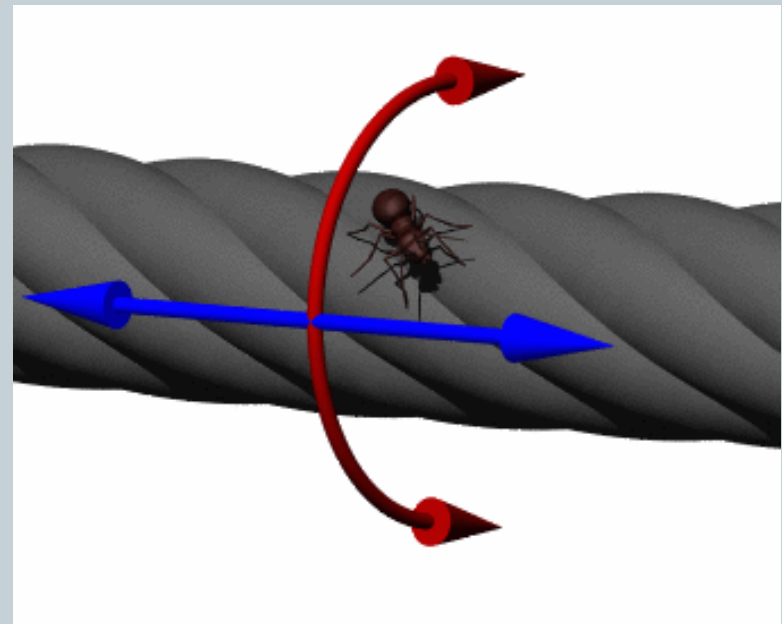


So, is there Higgs??

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- 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...

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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



金吉呀

Sources

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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: $H \rightarrow ZZ \rightarrow 2l2q$:
<http://cdsweb.cern.ch/record/1369551/files/HIG-11-006-pas.pdf>

Picture credits

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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 P H.png](http://en.wikipedia.org/wiki/File:Mecanismo_de_Higgs_P_H.png)
4. <http://fliptomato.wordpress.com/page/8/>
5. http://www-do.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

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Pileup

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