ENIGMASS : Réunion Plénière
14 / déc / 2015, LPSC, Grenoble

LHC results and their interpretation

B. Zaldivar, LAPTh
on behalf of
Collider Working Group

Motivation

** make the most of Run#1 to*

-Better determine the properties of the Higgs

** Prepare for Run#2 to discover/ better constrain the physics Beyond SM:*

-Higgs BSM, Z', SUSY, ...

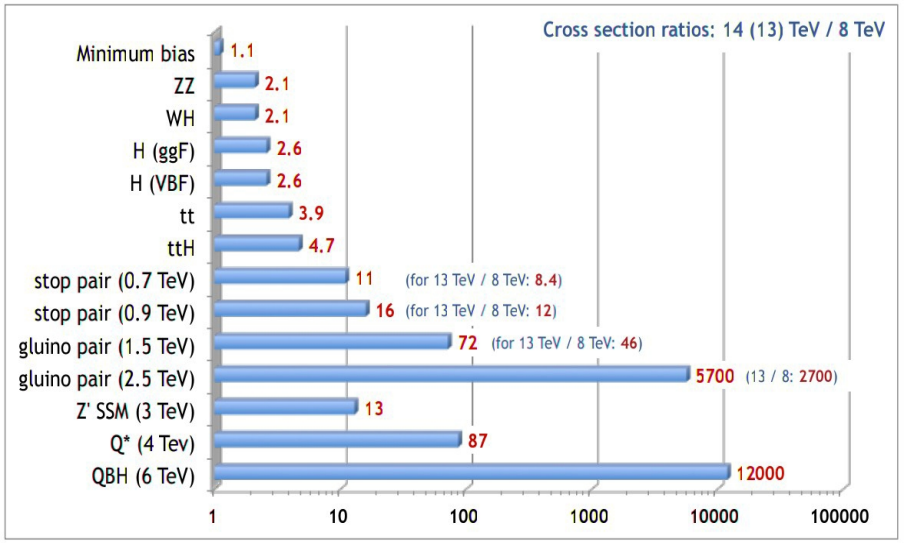
-Recasting results

-Dark Matter searches

****Close collaboration between theorists and experimentalists****

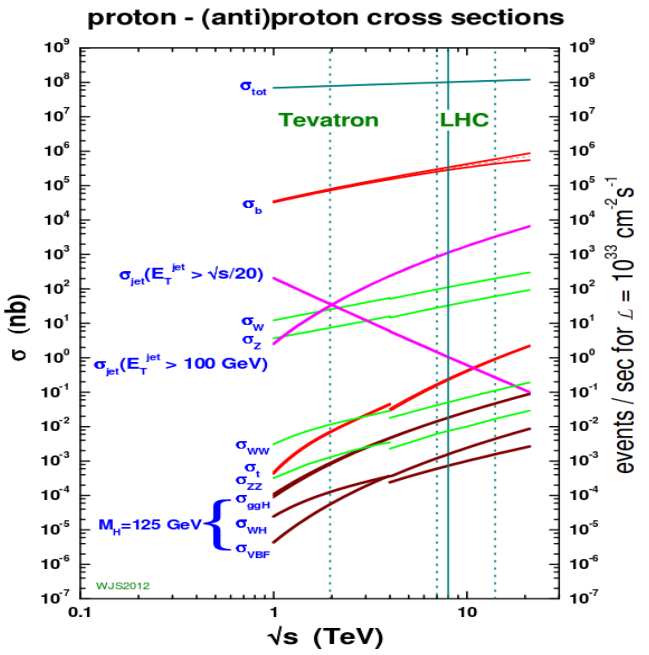
LHC
From Run#1 to Run#2

- LHC improvements for Run2
  - √s : 8 (Run1) → 13 TeV (Run2)
  - Bunch space reduced to 25 ns
  - Higher luminosity expected (25 → 75 fb^{-1})
- Detector improvements



Andreas Hoecker - Physics prospects with the first few 1/fb of Run 2
ATLAS week at Marrakech, Morocco, Oct 7, 2013

- Increase direct discovery potential
  - **Z', other Higgs BSM**, SUSY, black hole
- Improve precision measurements (indirect search)
  - **Higgs, 2-boson**, top
- Rare processes (indirect search)
  - ttH, Vector Boson Scattering, 3-boson



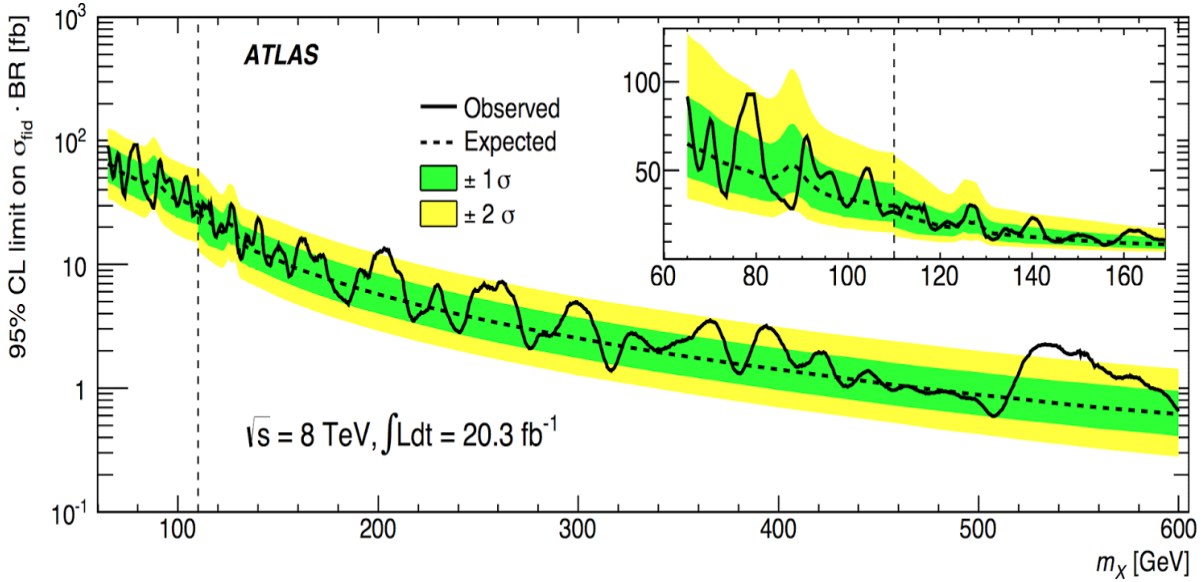
Many first Run2 results to be presented at CERN on 15th December (EoYE)

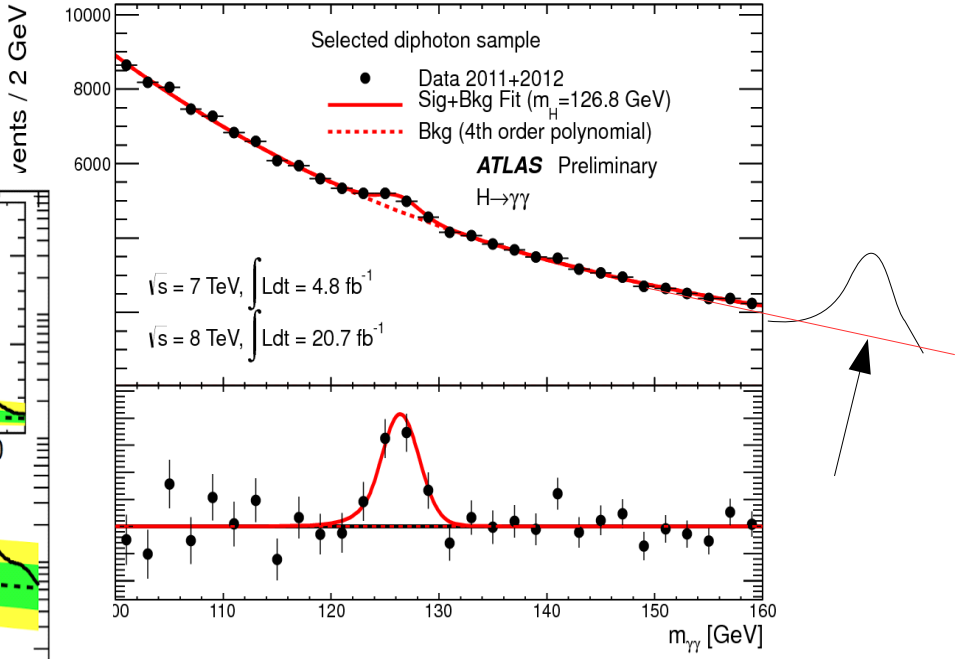
Higgs Beyond SM

Exp: $\gamma\gamma$ Channel

TH: Many theories BSM predict a richer Higgs sector (2HDM, SUSY, Composite, ….)

- $\gamma\gamma$ decay channel : One of most sensitive
- End of Run 2 : Systematic uncertainty





Phys. Rev. Lett. 113, 171801

Limits set for Run 1 (no excess found)

K. Grevtsov, PhD, LAPP

Strong involvement of ENIGMASS:

- Results presented at EoYE
- Analysis with Run2 data

Higgs Beyond SM

Tools: "Lilith"

ENIGMASS: J. Bernon, PhD, LPSC

...a new public tool for constraining new physics from Higgs measurements

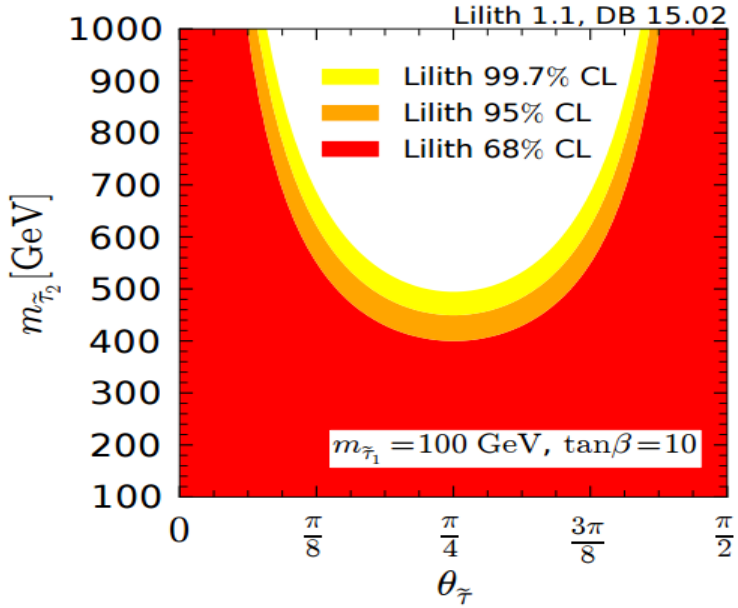
$$\mu(X,Y) \equiv \frac{\sigma(X)\,\mathcal{B}(H\to Y)}{\sigma^{\rm SM}(X)\,\mathcal{B}^{\rm SM}(H\to Y)}$$

-Python!

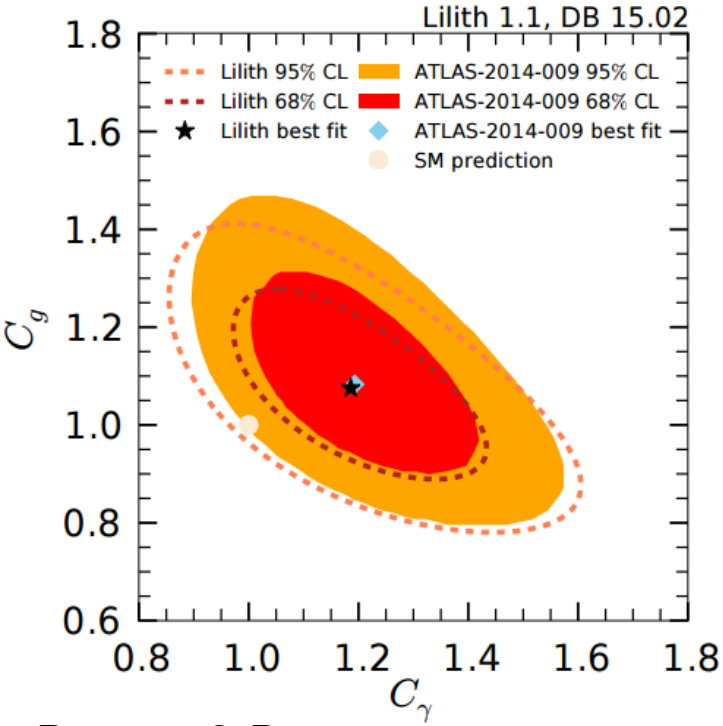
- Command-line interface

e.g. application to a SUSY scenario:

```
1 python examples/python/stau_gammagamma.py
```



validated



Bernon & Dumont,
Eur.Phys.J. C75 (2015) 9, 440

Higgs Beyond SM

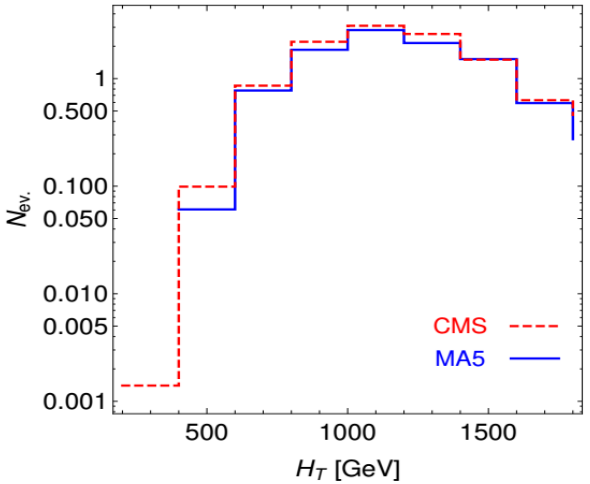
Th: Composite

ENIGMASS: C. Delaunay, PD, LAPTh

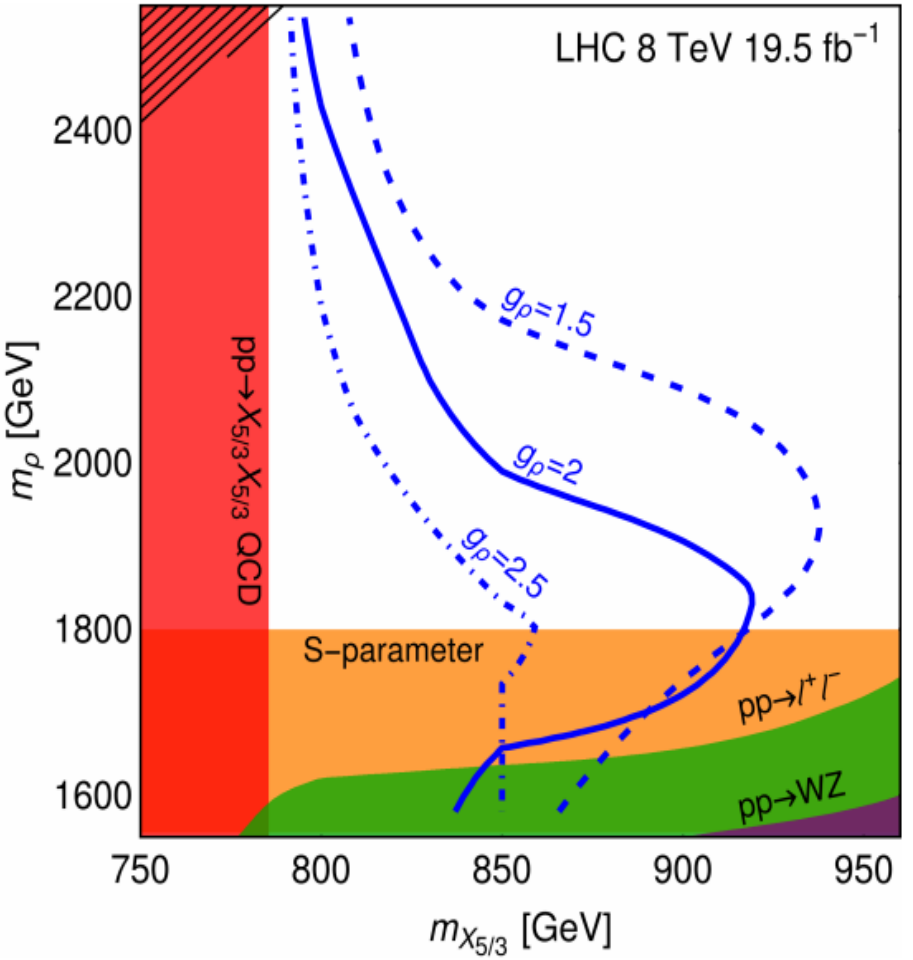
- **Higgs** as pNGB bound-state of a new strongly interacting sector at ~ TeV scale:
  - fermionic top partners "*X*"
    & colorless spin-1 resonances "ρ"

- **Rich pheno actively searched for at the LHC!**

e.g. SS2ℓ from $X^{+5/3} \to W^+ t$, $t \to W^+ b$



Validated **MA5** study



Barducci & Delaunay, 1511.01101

Beyond SM
Recasting Tools

MadAnalysis 5 [Comput.Phys.Commun. 184 (2013) 222]

Approach:

-Implement analysis selections in a computer code that allows to test MC events for any given model

-For the same models interpreted by ATLAS&CMS, such code should give consistent results

Very active LAPTh/LPSC collaboration!!

SModelS [Eur.Phys.J. C74 (2014) 2868]

Approach:

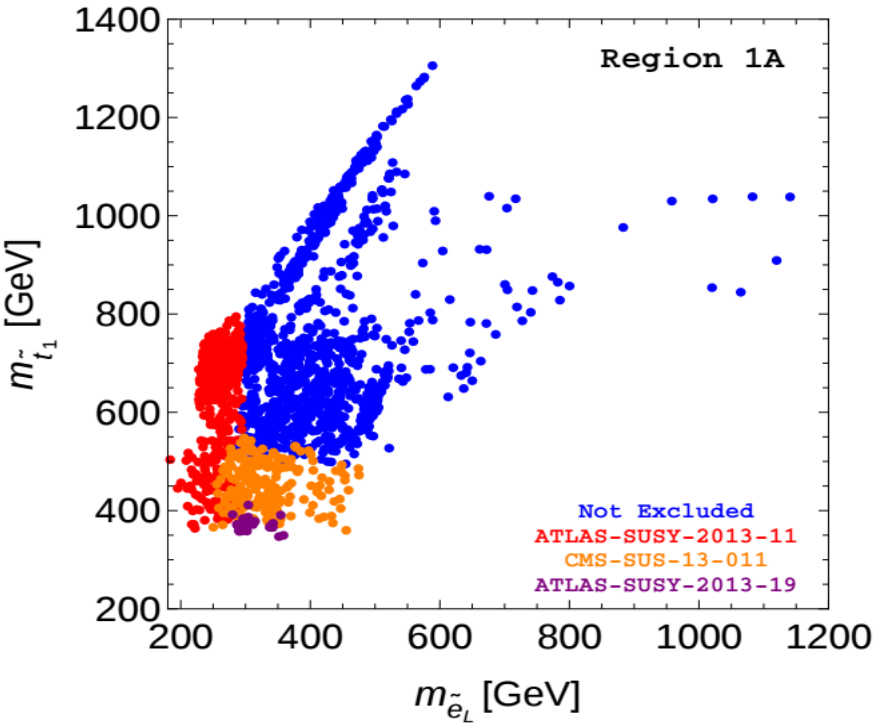
-Decompose a model signal in terms of simplified models topologies

-Through efficiency maps or comparing with xsection upper limits,

Determine if a given model is allowed or excluded

ENIGMASS: U. Laa, PhD, LPSC

Application to SUSY model:



Barducci, Bélanger, Hugonie, Pukhov, 1510.00246

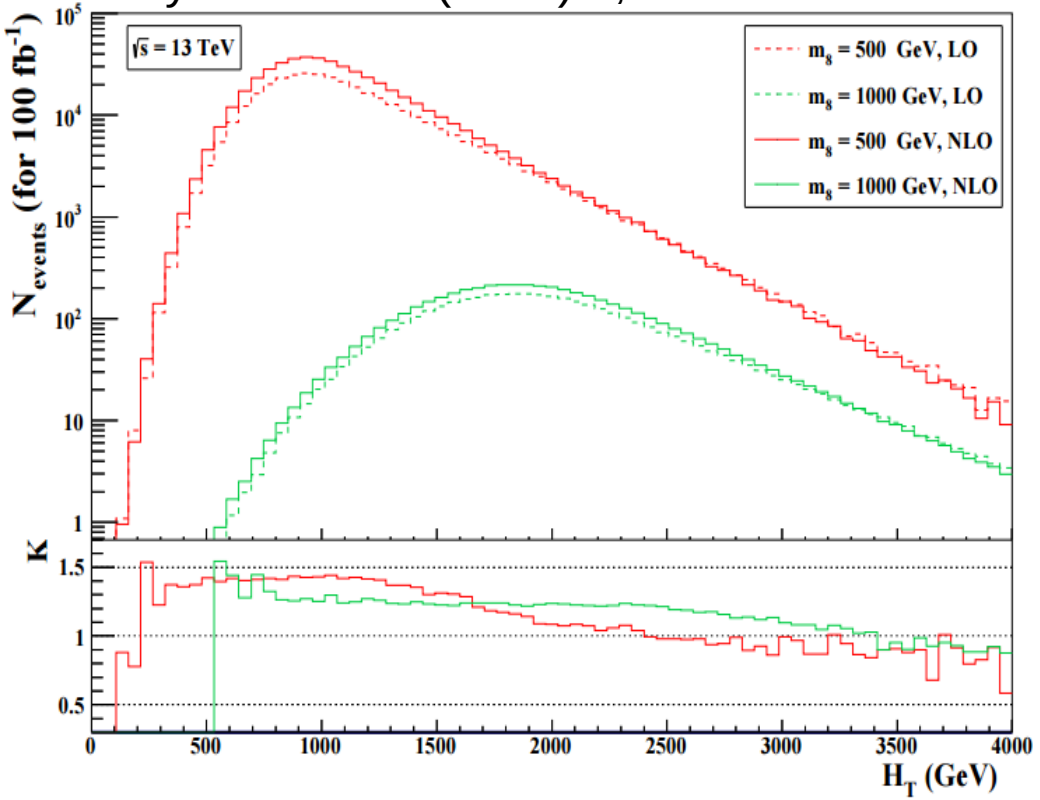
Supersymmetry
NLO computations

Now 1-loop corrections fully accessible via
`NLOCT` and `MadGraph_aMC@NLO` !

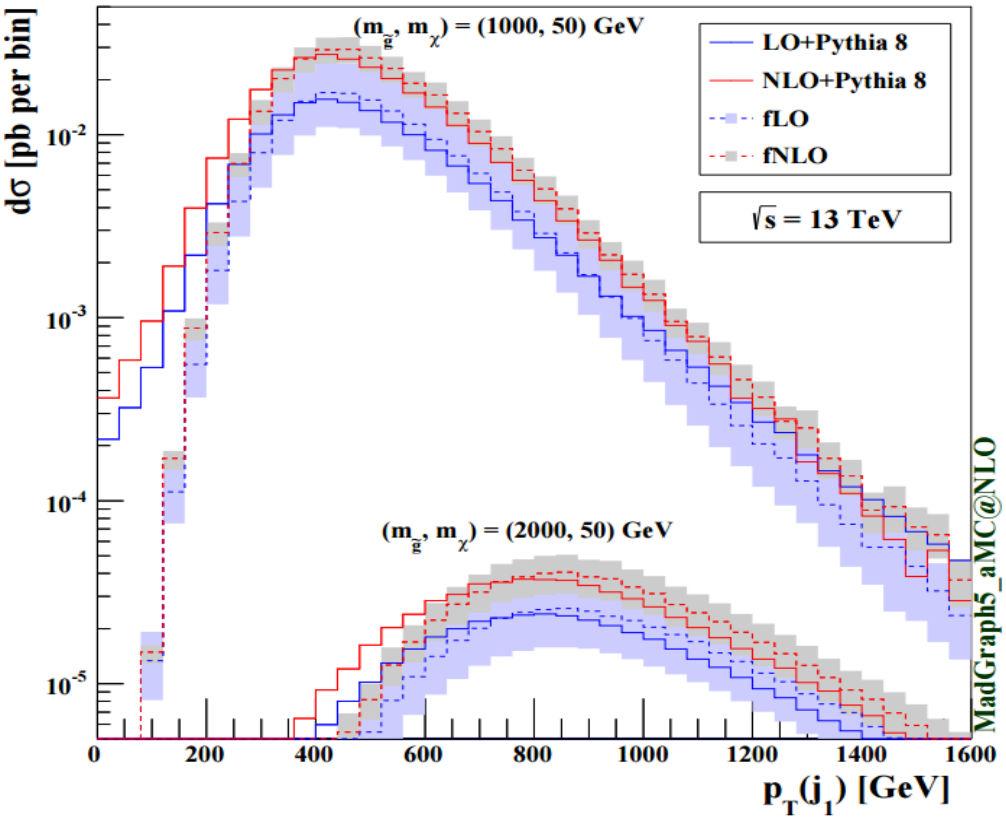
ENIGMASS: J. Proudom, PhD, LPSC

App: Sgluon production at LHC 13

Phys.Rev. D91 (2015) 9, 094005



App: gluino-pair production at LHC 13

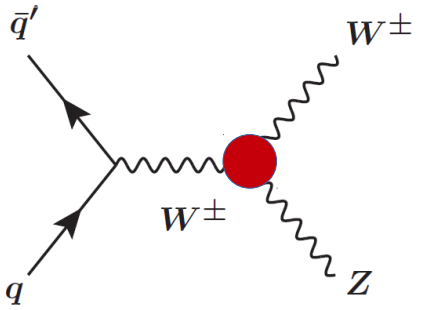


Degrande, Fuks, Hirschi, Proudom, Shao, 1510.00391

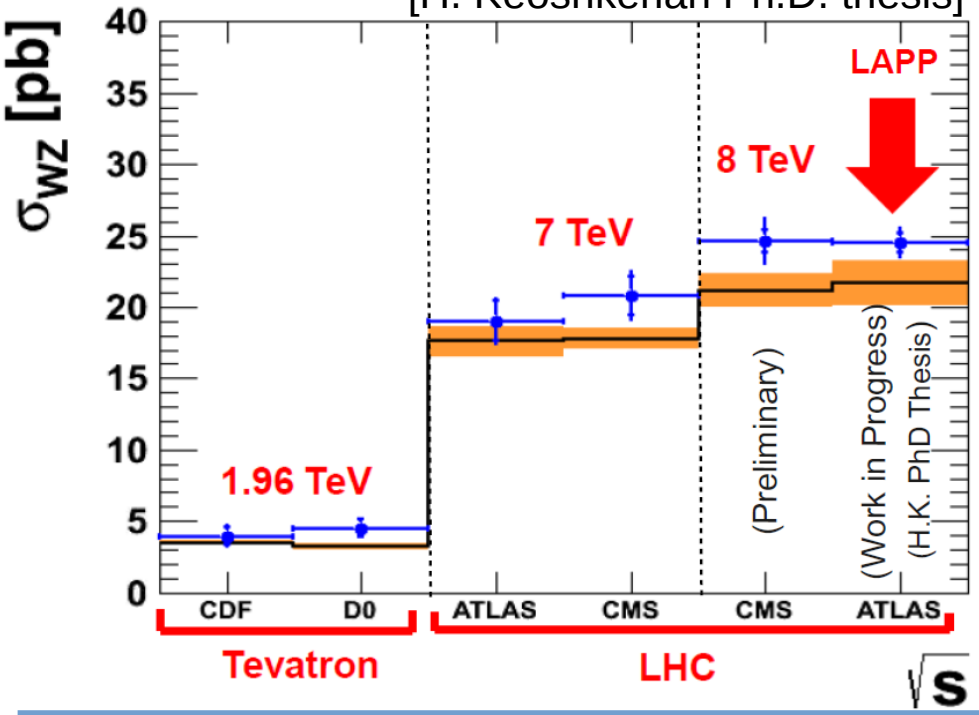
Extra gauge bosons

WZ channel from...

- Experimental precision now better than theory accuracy (NLO only)



[H. Keoshkerian Ph.D. thesis]

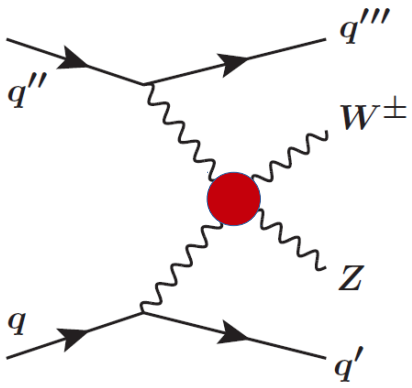


WZ at 13 TeV:

- Increase by ~2 of the WZ production Xsection

- Potential new WZ resonance ?

-Sensitivity for a first evidence for VBS in WZ at LHC Run 2



ENIGMASS:

-Involvement of in the completion of ATLAS paper (publication in Jan 2016)
-Start cooperation with theorists for the estimation of EW NLO corrections
-A first 13 TeV measurement planned for Moriond '16
-Polarisation of W and Z bosons
- Search for hints of NP

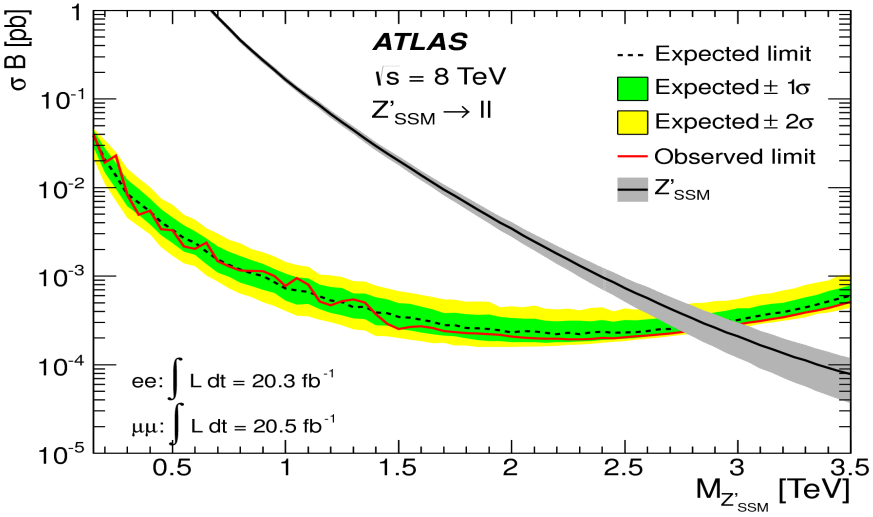
A. Burger (PhD)
E. Yatsenko (postdoc)

Extra gauge bosons

Dilepton channel from Z'

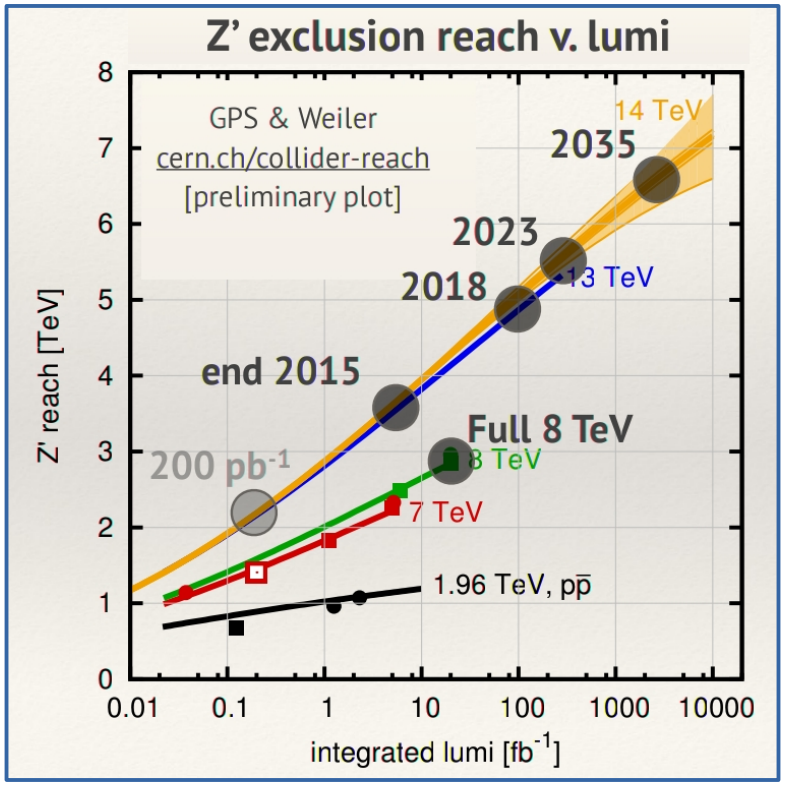
TH: Extra U(1), Dark Matter-related, ...

- Z'→ ee or μμ
- e+e- channel more performant (high pT)
- A narrow resonance within SSM excluded at 95% C.L for masses up to 2.90 TeV



➔ To keep sensitivity at higher mass and Run2 conditions, focus on:

- ➔ Optimize electron identification at high energy
- ➔ Ensure good trigger performances



➔ Strong **ENIGMASS** contribution

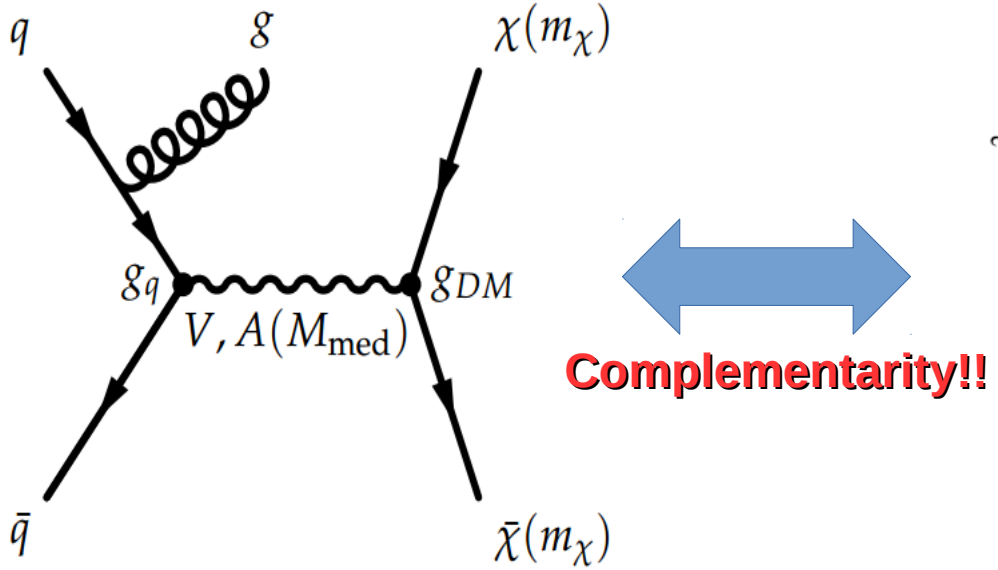
- ➔ First results for EoYE
- ➔ Analysis of Run2 sample

(P. Mastrandrea,PD, LAPP)

Dark Matter
from colliders to the sky...

ENIGMASS: B. Zaldivar, PD, LAPTh

New DM Working Group at the LHC

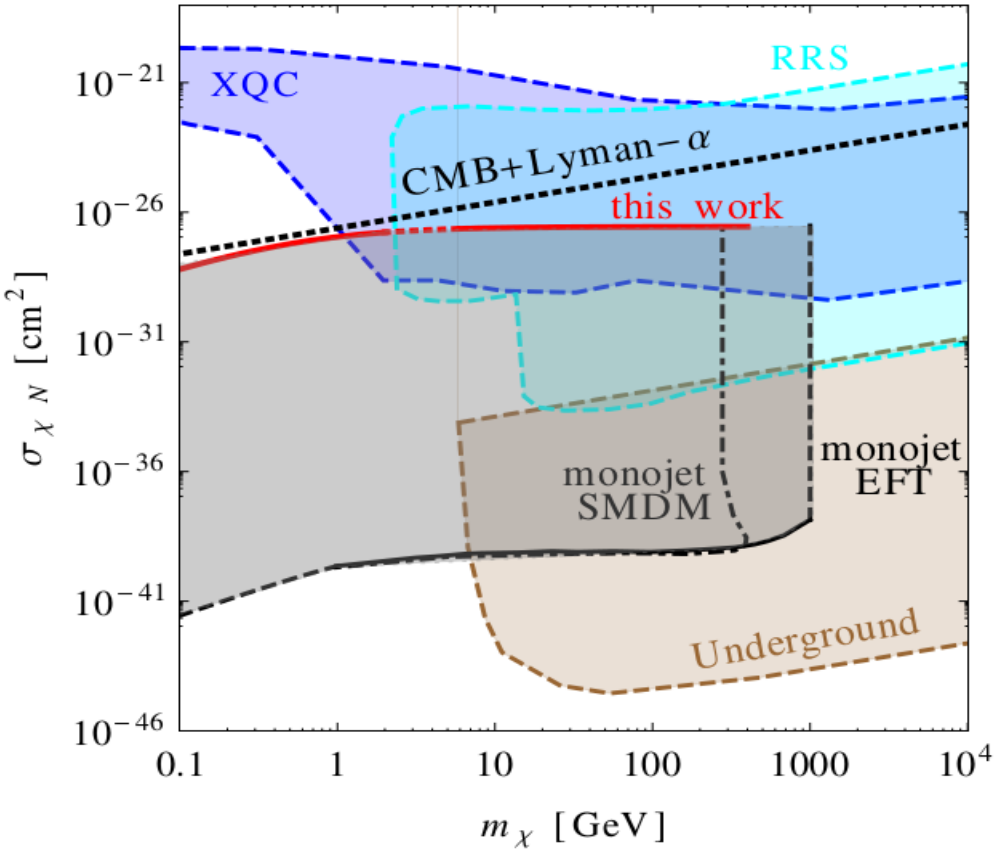


Complementarity!!

First meeting, Dec/2015 !

-Theorists & experimentalists together define benchmark models and characterisation of DM interpretation at LHC searches

Colliders vs. Direct Detection, CMB, ...



Daci, De Bruyn, Lowette, Tytgat, BZ, 1503.05505

ENIGMASS:

LPSC
A
LAPTh
P

- **Experiment**:

  H-to-gg, Z', WZ signatures

- **Tools:**

  Lilith, MadAnalysis5, Smodels

- **BSM pheno**:

  SUSY@NLO, Composite H, Dark Matter