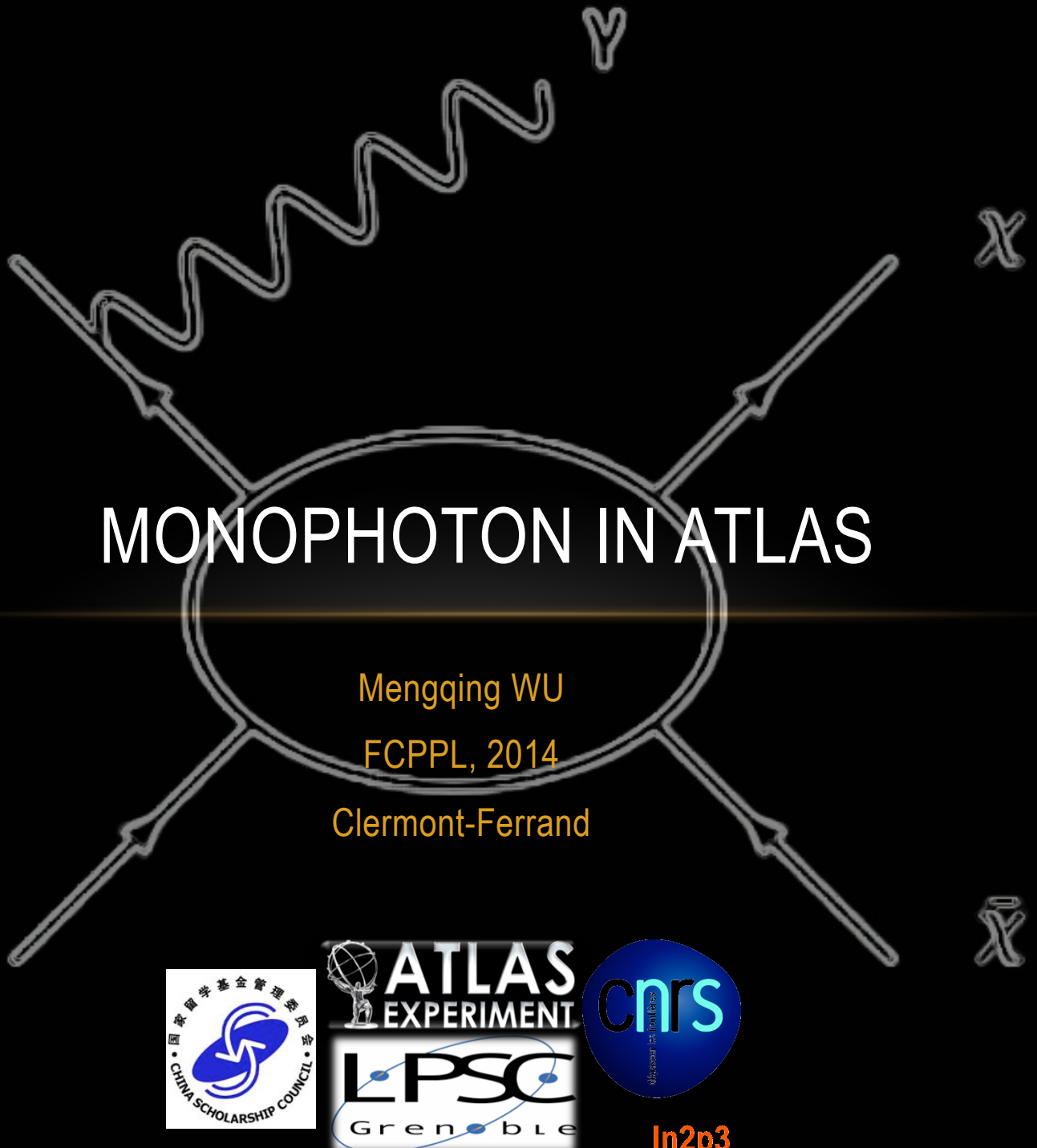


MONOPHOTON IN ATLAS

Mengqing WU

FCPPL, 2014

Clermont-Ferrand

CHINA SCHOLARSHIP COUNCIL

ATLAS EXPERIMENT

LPSC Grenoble

cnrs

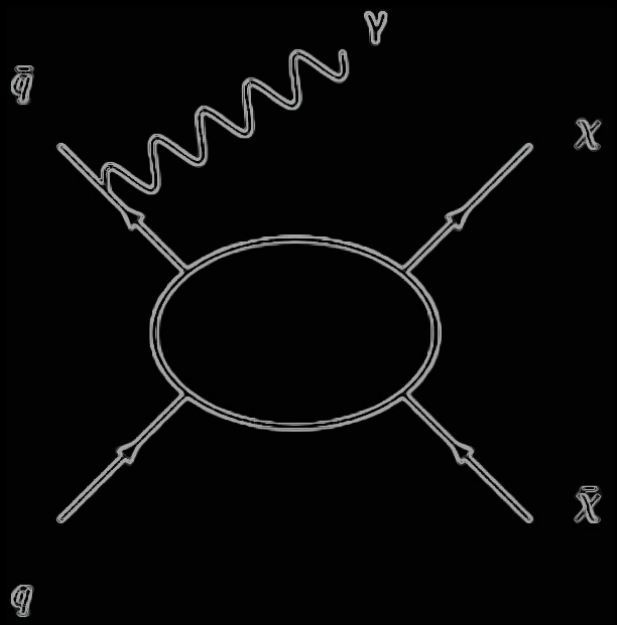
In2p3

CONTENTS

- Motivation
  - what is monophoton; models of new physics; 7TeV: data/ result
- The ongoing 8TeV
  - Event Selection
  - Standard Model Backgrounds
  - Compressed Squark Grid
  - Uncertainties
- Conclusion

what is the monophoton analysis?

MOTIVATION



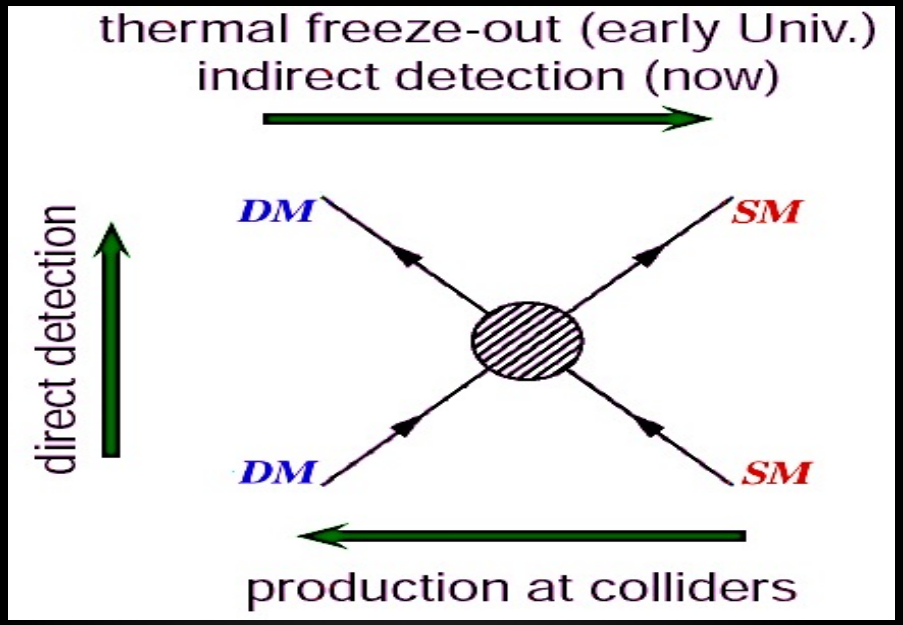
PROBE NEW PHYSICS – DARK MATTER

NOTE: Dark Matter as an Example

Indirect:
Particles coming from WIMP annihilation

Picasso

Direct:
Detectors in deep underground



CERN

LHC:
Creating WIMP pairs in the p-p interacting

WIMP: Weakly Interaction Massive Particles

WHY MONOPHOTON?

Clean, but rare signal

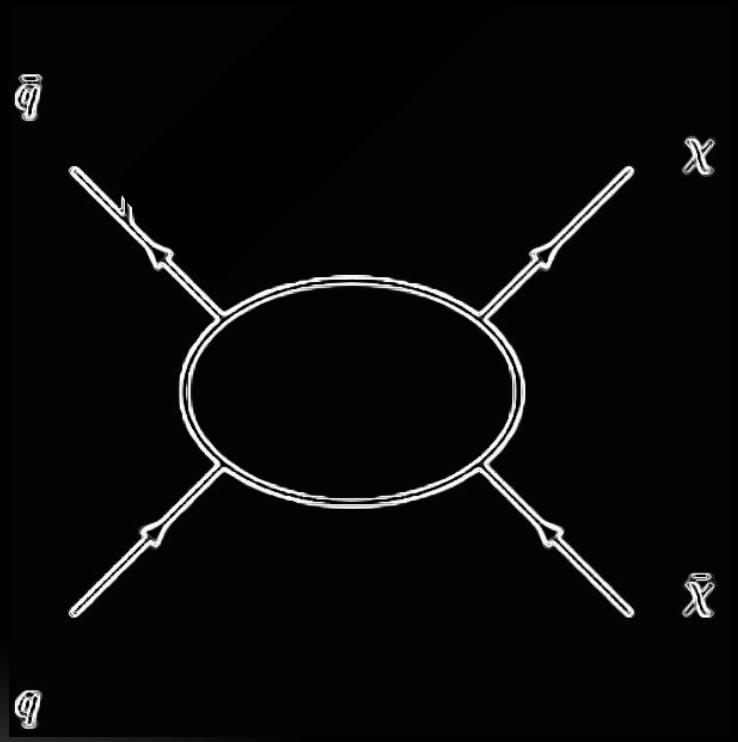
visible signature: single photon

- Sensitive to New Physics

  WIMP models

  Large Extra dimensions models

  Compressed Squark scenario *(New!!)*
- Photon is well measured
- Principal BGs are EWK



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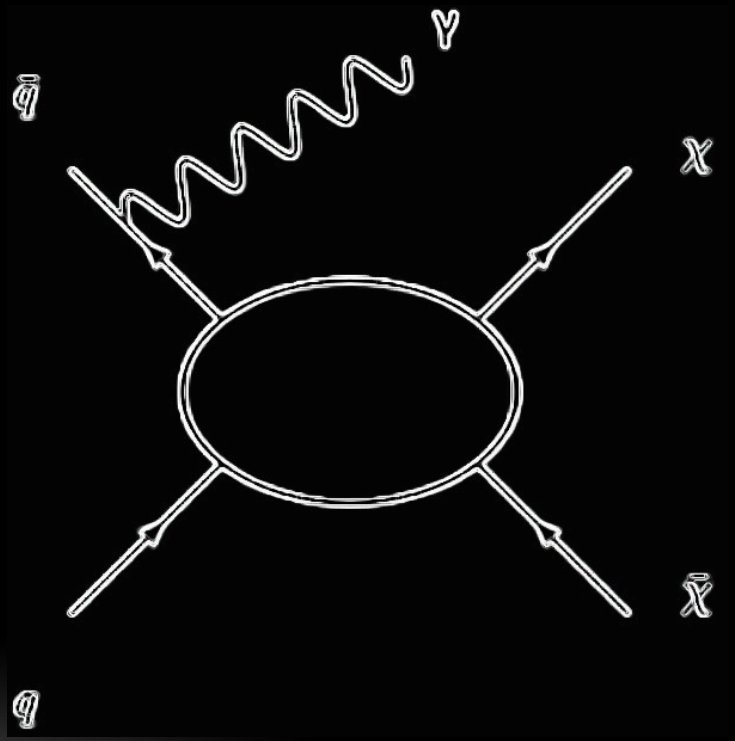


RESULTS ON 7TEV

HOW WE PRESENT RESULTS?

PRL 110, 011802 (2013) PHYSICAL REVIEW LETTERS week ending 4 JANUARY 2013

Search for Dark Matter Candidates and Large Extra Dimensions in Events with a Photon and Missing Transverse Momentum in pp Collision Data at $\sqrt{s} = 7$ TeV with the ATLAS Detector

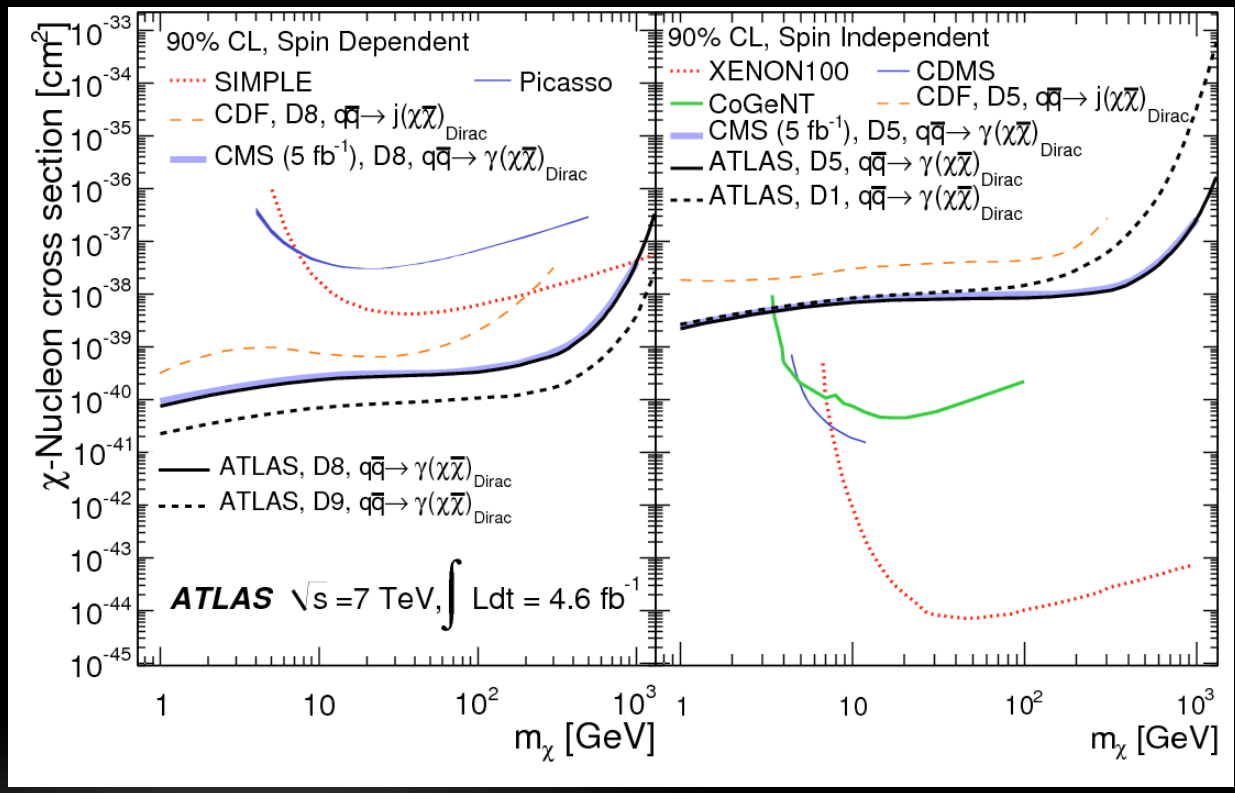
7TeV Published!!

Model Independent CLs limits

observed	σ×A×ε limit [fb]
95%CL	6.8
90%CL	5.6

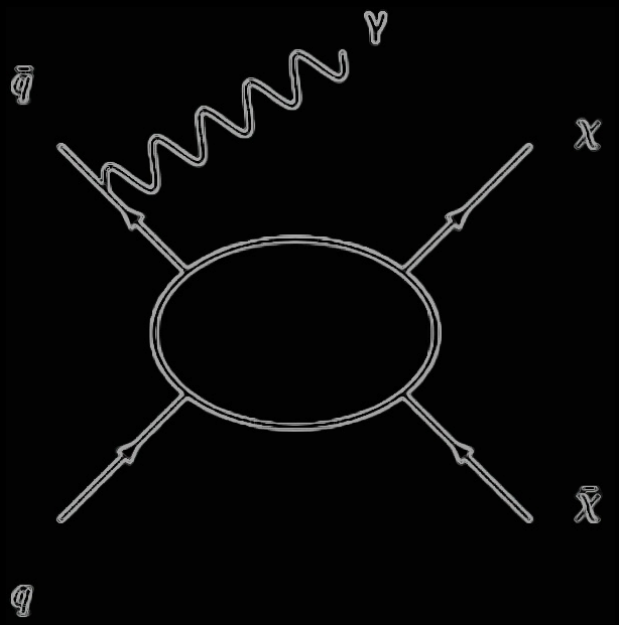
Mediator	vertex operator	
D1	scalar	WIMPs assumed to be Dirac Fermions
D5	vector	
D8	axial-vector	
D9	tensor	

WIMPs Interpretation



What is going on for 2012 data

8TeV ANALYSIS



BACKGROUND SOURCES

Irreducible

γ+Z(νν)

γ+W(τν): hadronic decay of τ

Jet/electron faked photon

jet+W(lν)

jet+Z(ll)

Misidentified Lepton

γ+Z(ll)

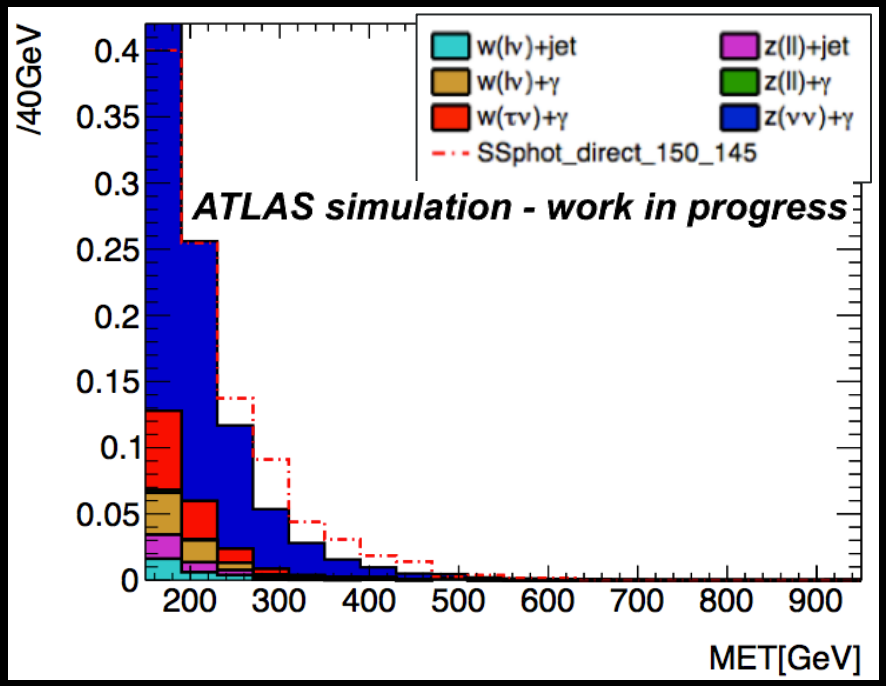
γ+W(lν)

Other Minor ones

ttbar, single top: similar to W+jet

multi-jet, γ+jet

di-boson:γγ, WZ, WW, ZZ



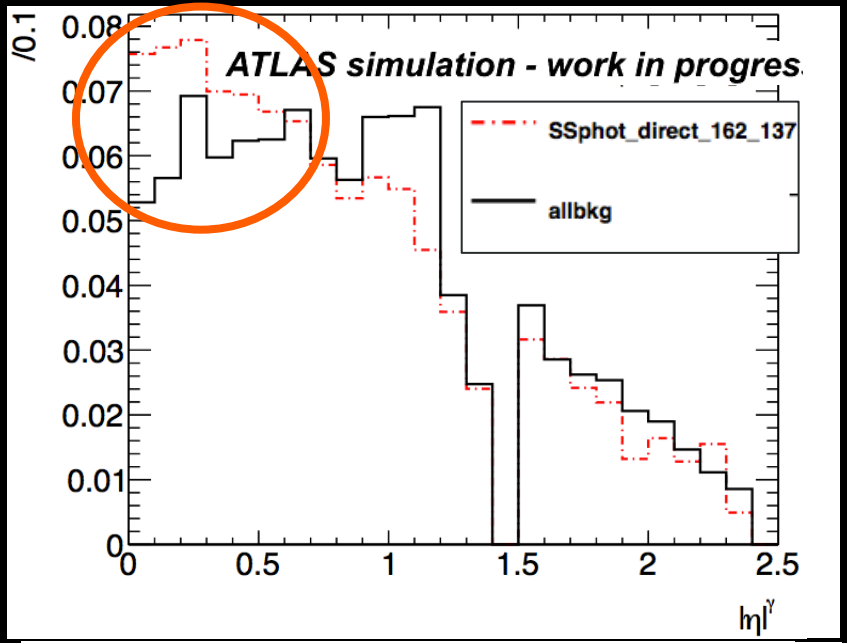
BG Channel	Proportions	
	8 TeV	7 TeV
W/Z+γ	~88%	~86%
W/Z+jet	~11%	~13%
Other minor	~1%	~1%

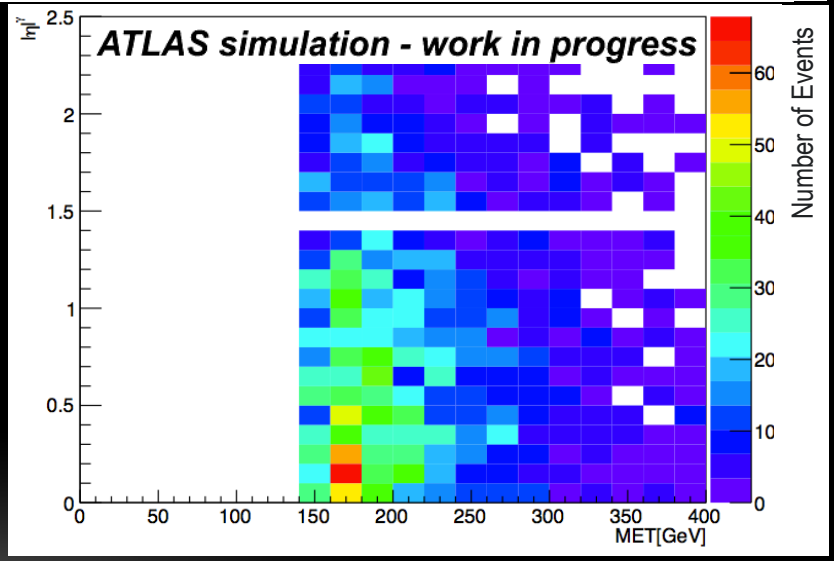
EVENT SELECTION

Step	Z/W+γ/jet	Squark m=100GeV, Δm=5GeV
E_T^{miss}>150GeV, P_T^{γ}>150GeV	Preselection	Preselection
good isolated photon $\|\eta^{\gamma}\|$<1.37	~17%	~72%
Jet cuts: no more than 1 good jet (PT>30 GeV, $\|\eta\|$<4.5) $\Delta\varphi(\gamma,jet)$>0.4, $\Delta\varphi(jet, E_T^{miss})$>0.4	~10%	~46%
lepton veto	~5%	~45%

CUTFLOW OPTIMIZATION

- at SR and preselection level
- Variables Distribution / Correlation
- Significance Signal Grid
- Tighter Cuts SR-> BG estimation more difficult
- Status:
  - *New* SR: with $|\eta^{\gamma}|<1.37$
  - Study ongoing on Etmiss cut

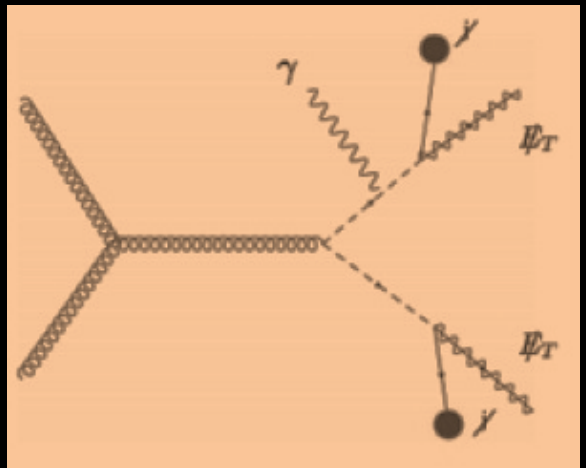


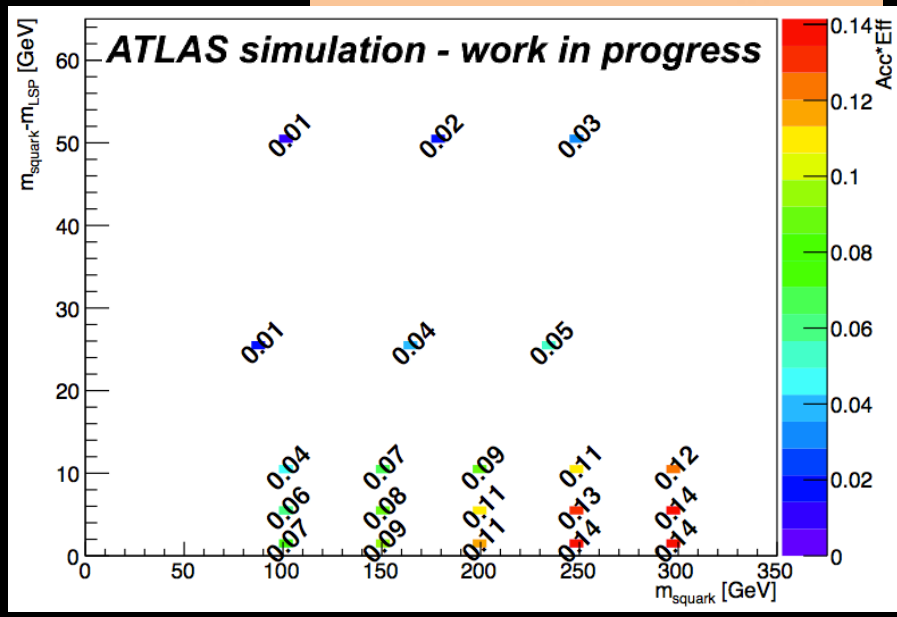


COMPRESSED SQUARK GRID

SQUARK: SUSY PARTNERS OF QUARKS

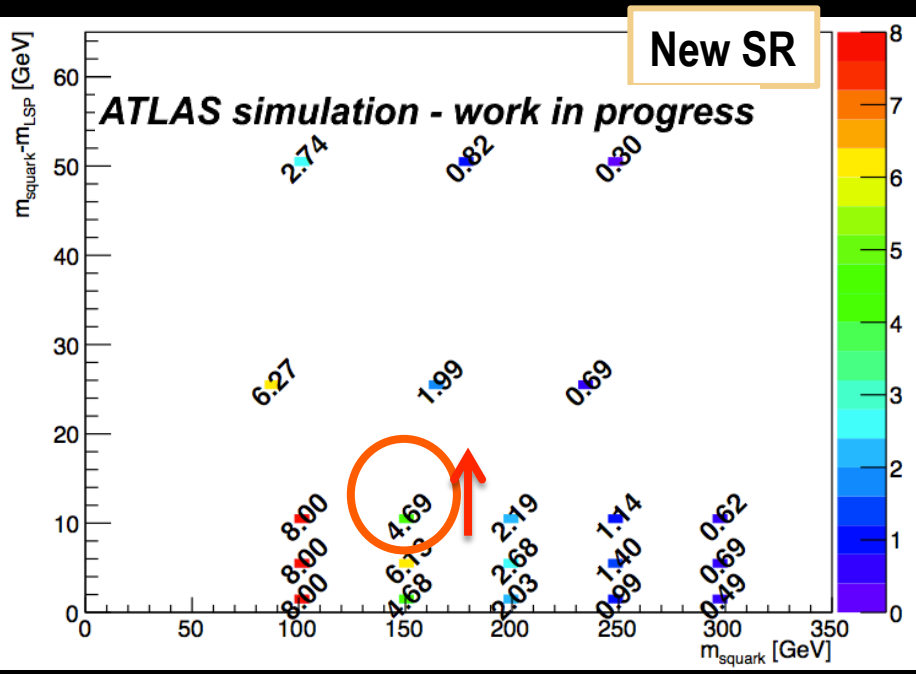
- **Squark with direct decay:**
  - Pair production of first/second generation squarks with direct decay to a quark and a neutralino
- **Compressed:**
  - Low mass difference between the Squark and the Neutralino
- **monophoton:**
  - photon radiated by initial quark or squark

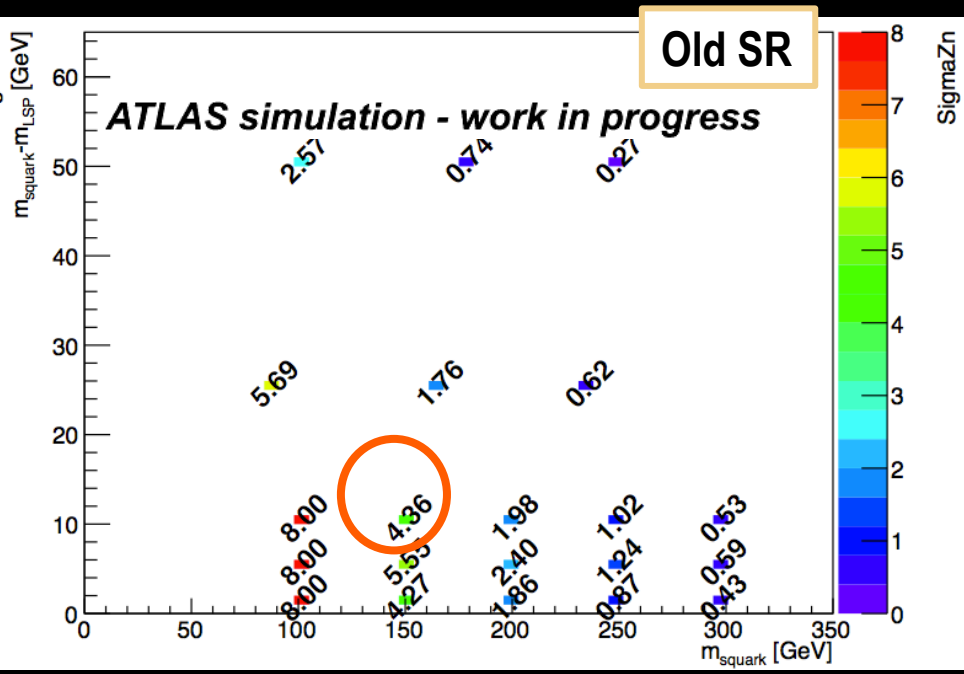




NEW SR

SIGNIFICANCE SQUARK GRID





Increased by 7% on significance

CROSS SECTION & UNCERTAINTY:
COMPRESSED SQUARK GRID

For Compressed Squark Grid interpretation

NLO σ k-factor

- **Using: prospino** - NLO calculation tool for SUSY
  - version: Prospino2.1, of 20-11-2011.
- **With: PDF** - average of CTEQ6 and MSTW

σ uncertainty

- vary PDFs
- vary Renormalization / Factorization scale with Central value of PDF
- vary strong coupling alphaS

BACKGROUND UNCERTAINTY

source of systematics	relative uncert.
Photon Energy Scale	0.9%
simulated **Photon** energy resolution, isolation & identification eff	1.1%
lepton: identification eff	0.3%
Jet Energy Scale	0.9%
Jet Energy Resolution	1.2%
Soft terms in **MET** + pile-up effect on calo energy	0.8%+0,3%
Pile-up reweighting uncertainty	0.5%
PDF and scale uncertainty	1.0%
Parton shower model	6.9%
others	~
Total MC	7.3%

PRL 110, 011802 (2013)

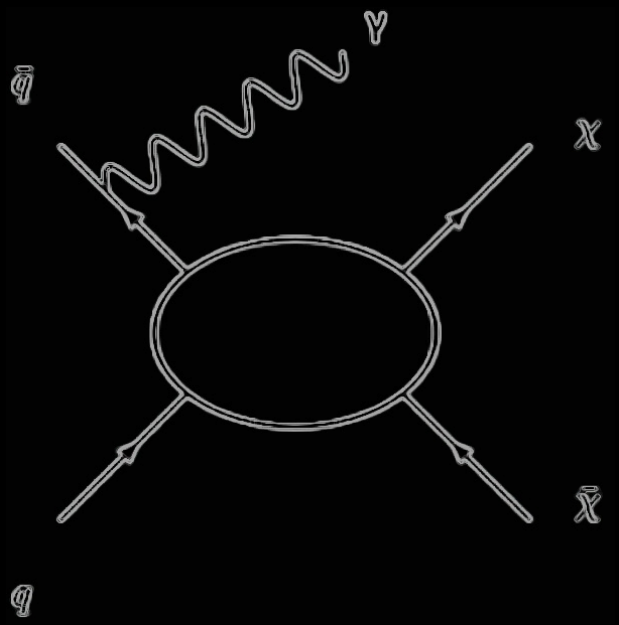
Syst. Uncert.

- 7TeV numbers
- 8TeV:
  - slightly smaller
  - work ongoing

Stat. Uncert.

- Low statistics for BG estimation
- optimisation ongoing

CONCLUSION

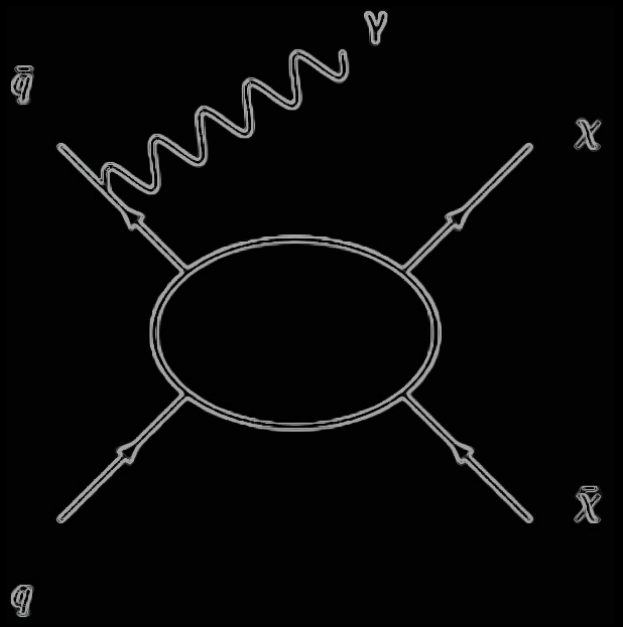


CONCLUSION

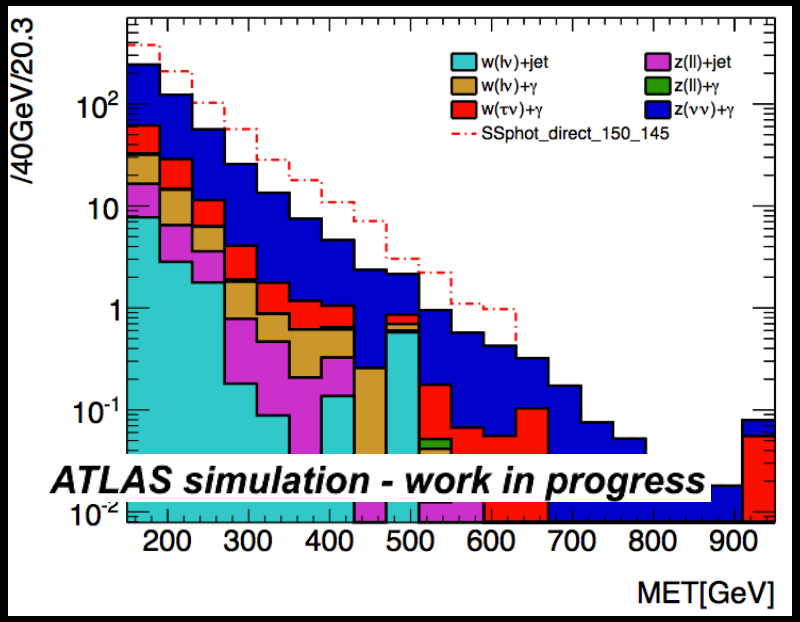
- Monophoton is an interesting channel for new physics analysis
- 7 TeV results have been published
  (Phys. Rev. Lett. 110, 011802(2013))
- 8 TeV analysis work in progress
  - New Signal Region Defined
  - Background estimation
  - Compute Limits – if nothing is found
  - Adding New Compressed Squark Scenario

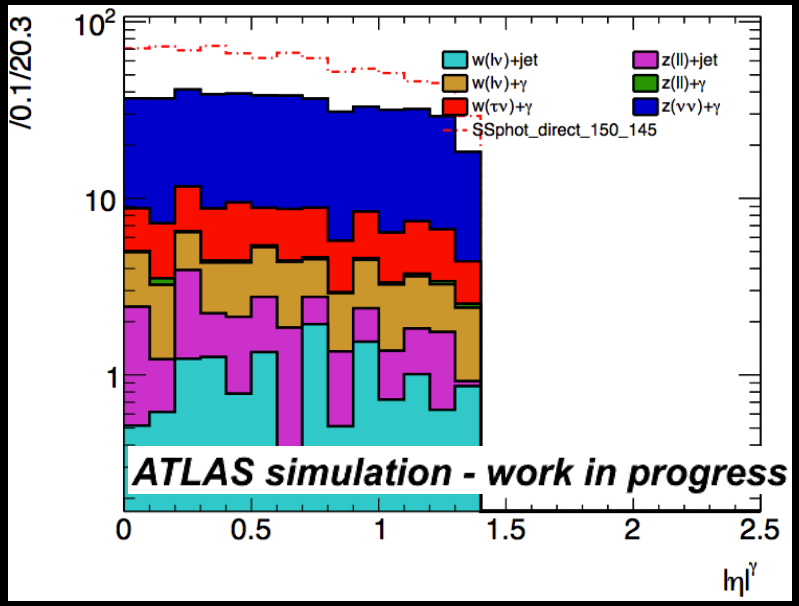
THANK YOU! MERCI! 谢谢！

BACK-UPS



KINEMATICS DISTRIBUTION IN NEW SR 8TEV

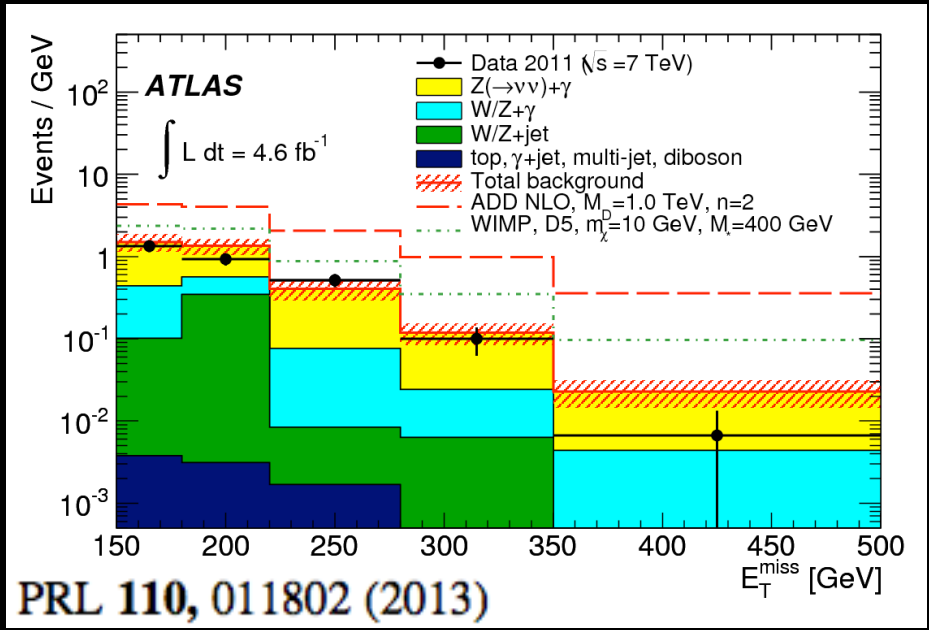




BACKGROUND ESTIMATION

BASED ON 7TEV

- W/Z+γ: Data Driven method, μ+γ+MET CR
- W/Z+jet: Data Driven method, faked electron, faked jet(fake to be a photon)
  - faked electron: Zee peak
  - faked jet: matrix method based on isolation and photon definition

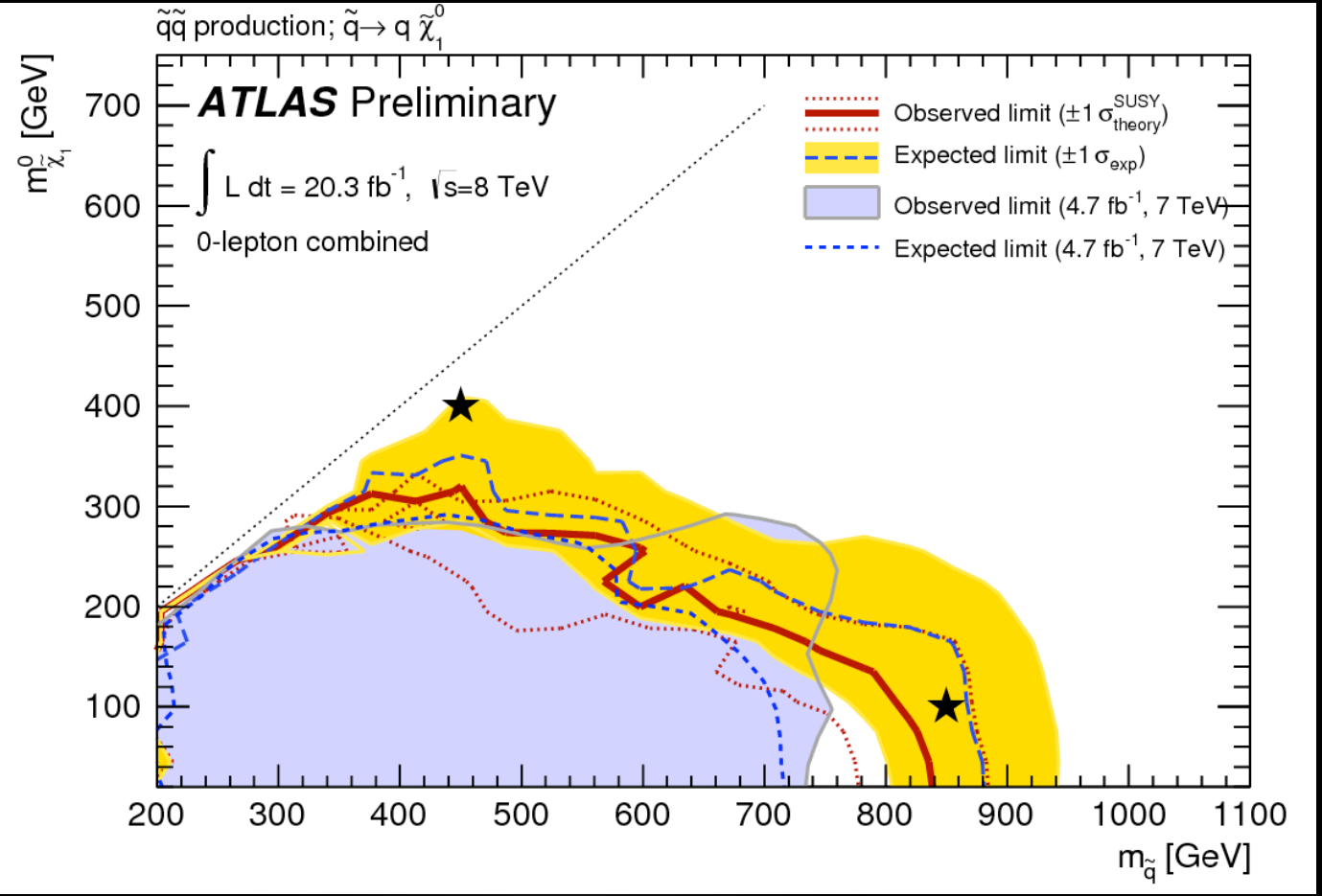


BACKGROUND ESTIMATION

BASED ON 7TEV: Control Region

- For: W/Z+γ BGs
- Due to the low statistics expected, this CR is only used to constrain the total number of events passing the selection cuts. No bin-by-bin correction is applied to cure the shape of the *Emiss* and *p*γ spectra in MC
- inverted the muon veto(*pT* >10 GeV and |η| < 2.4)

0L ANALYSIS ON SQUARK LIMITS



SIGNIFICANCE CALCULATING

sigmaZn

The significance is computed from the p-value:

*sigmaZn=ierf(1-2*p)*sqrt(2)*

where ierf is the inverse error function

SIGNIFICANCE CALCULATING

P value

- refer to the probability that the SM expectation fluctuates upwards to the number of data events observed
- defined by the convolution of a Poisson probability density function (to account for statistical uncertainties) with a gaussian probability density function G (which represents the effects of non-negligible systematic uncertainties) with mean N_SM and width deltaN_SM.

$$p = A \int_0^{\infty} \mathrm{d}b \, G(b; N_{SM}, \delta N_{SM}) \sum_{i=N_{obs}}^{\infty} \frac{e^{-b} b^i}{i!}$$

- - N_SM is the Standard Model background expectation
  - N_obs is the number of data events (in this case, we assume N_obs = N_SM + N_signal, where N_signal is the number of signal events)
  - deltaN_SM is the total systematic uncertainty on the background N_SM