ATLAS @ Instituto de Física La Plata

Francisco Alonso

(on behalf of the group)

I F L P

CONICET

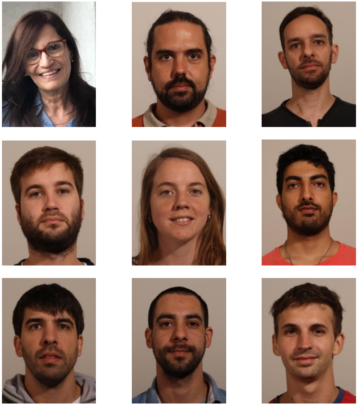
U N L P

PHENOEXP 2018

May 9, 2018

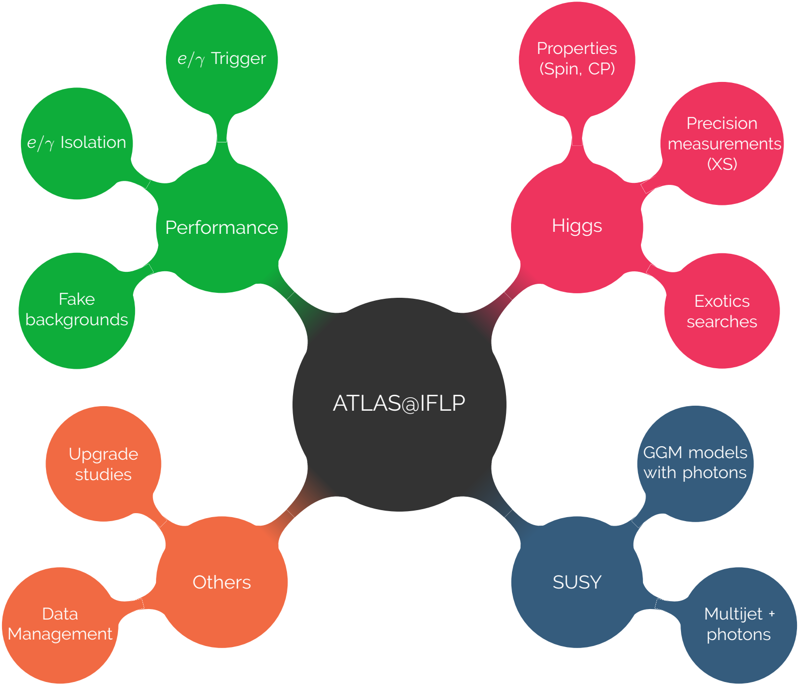
ATLAS@IFLP group

- Researchers
  - Tere Dova
  - Hernan Wahlberg
  - Fernando Monticelli
  - Francisco Alonso
- PostDoc
  - Josefina Alconada
  - Francisco Arduh
- PhD students
  - Joaquin Hoya
  - Joaquin Bogado
  - Gonzalo Orellana



in collaboration with Pheno@IFLP group

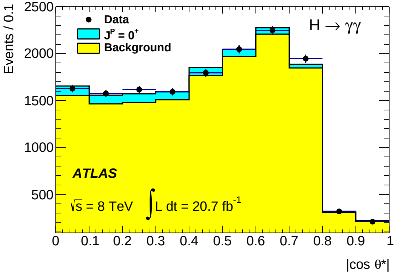
→ see Alejandro Szynkman's talk!



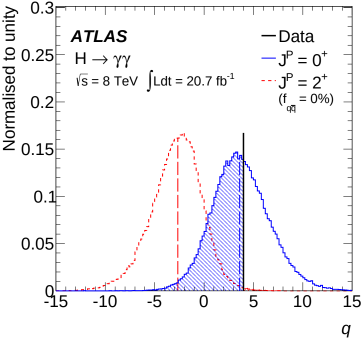
ATLAS@IFLP
Performance
e/γ Trigger
e/γ Isolation
Fake backgrounds
Higgs
Properties (Spin, CP)
Precision measurements (XS)
Exotics searches
Others
Upgrade studies
Data Management
SUSY
GGM models with photons
Multijet + photons

Higgs physics

- After the Higgs discovery, the interest of the group moved towards its characterisation
- Spin, CP properties and cross-section studies in the Higgs decaying into photons analyses were done
- First spin analysis led to Nobel prize
    - $\cos(\theta^*)$ as discriminating variable



Phys.Lett. B726 (2013) 120-144



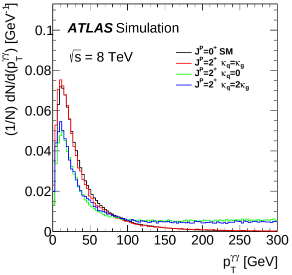
SM Higgs spin

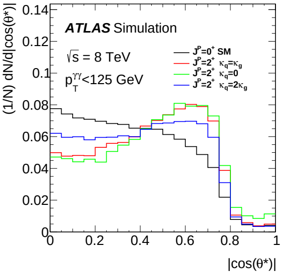
Eur. Phys. J. C75 (2015) 476

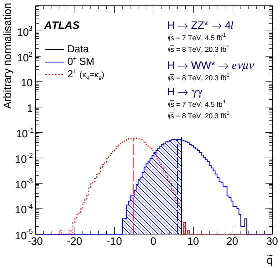
- Second analysis refines phenomenological spin 2 model and improves statistical analysis
- Two hypothesis were tested:
  - Standard Model spin 0
  - EFT spin 2 with different scenarios (κ_g, κ_q):

$$\mathcal{L}_2 = -\frac{1}{\Lambda}\left[\sum_V \kappa_V \mathcal{T}^V_{\mu\nu} X^{\mu\nu} + \sum_f \kappa_f \mathcal{T}^f_{\mu\nu} X^{\mu\nu}\right]$$

- Using $\cos(\theta^*)$, $p_{\mathrm{T}}^{\gamma\gamma}$ and $m_{\gamma\gamma}$ as discriminating variables





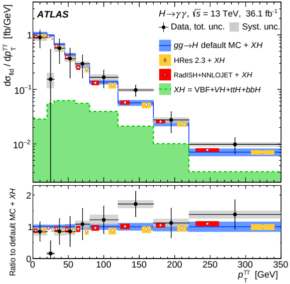


SM Higgs fiducial cross-section

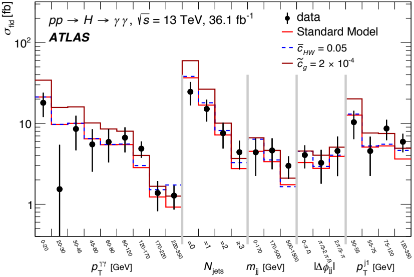
arXiv:1802.04146

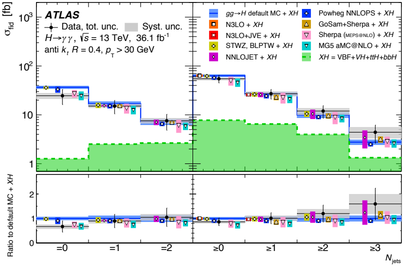
- Cross-section measured in five fiducial regions

Fiducial region	Measured cross section	SM prediction	
Diphoton fiducial	$55 \pm 9\,(\text{stat.}) \pm 4\,(\text{exp.}) \pm 0.1\,(\text{theo.})$ fb	64 ± 2 fb	[N^{3}LO + XH]
VBF-enhanced	$3.7 \pm 0.8\,(\text{stat.}) \pm 0.5\,(\text{exp.}) \pm 0.2\,(\text{theo.})$ fb	2.3 ± 0.1 fb	[default MC + XH]
$N_{\text{lepton}} \geq 1$	≤ 1.39 fb 95% CL	0.57 ± 0.03 fb	[default MC + XH]
High $E_{\text{T}}^{\text{miss}}$	≤ 1.00 fb 95% CL	0.30 ± 0.02 fb	[default MC + XH]
$t\bar{t}H$-enhanced	≤ 1.27 fb 95% CL	0.55 ± 0.06 fb	[default MC + XH]



- Deconvoluted from detector effects using correction factors
- Provided differential XS for 26 variables
- Measurements allow EFT NP studies
  → results compatible with SM





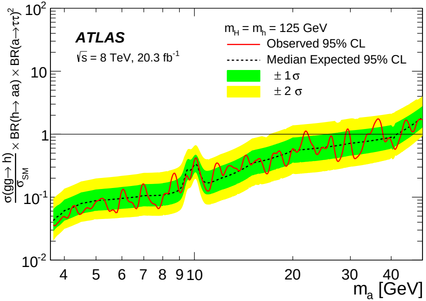
Exotics Higgs decays

- NMSSM predicts an additional light pseudoscalar Higgs boson
- In this model the 125 GeV SM Higgs boson is allowed to decay to a pair of lighter pseudoscalar Higgs bosons "*a*":

$$h \to aa \to \mu\mu\tau\tau$$

- Last ATLAS result in 2015 using 8 TeV data: Phys. Rev. D92 (2015) 052002

  → working in the full Run 2 analysis



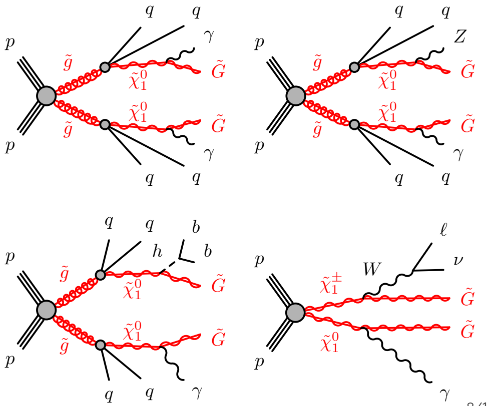
SUSY searches with photons

- Events containing photons and missing energy (plus jets or leptons) are distinctive signatures of SUSY models with gauge-mediated supersymmetry breaking

- In GGM models the LSP is the $\tilde{G}$ and the final states are determined by the NLSP, $\tilde{\chi}_1^0$ for most of the parameter space:
  - $\tilde{\chi}_1^0$ (bino, wino and higgsino mixing) $\rightarrow$ decays into $\tilde{G}$ + γ, Z o h

- Several searches with different final states are considered

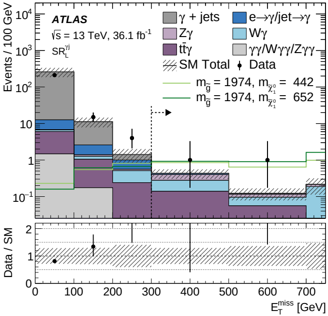
- Bino-like $\tilde{\chi}_1^0$, $\mathrm{BR}(\tilde{\chi}_1^0 \rightarrow \tilde{G}\gamma) \sim 100\%$
  $\rightarrow$ $\gamma\gamma$ + $E_{\mathrm{T}}^{\mathrm{miss}}$
- Bino-higgsino admixture $\tilde{\chi}_1^0$ ($\mu > 0$), $\mathrm{BR}(\tilde{\chi}_1^0 \rightarrow \tilde{G}\gamma) \sim 50\%$
  $\rightarrow$ γ + jets + $E_{\mathrm{T}}^{\mathrm{miss}}$
- Bino-higgsino admixture $\tilde{\chi}_1^0$ ($\mu < 0$), $\mathrm{BR}(\tilde{\chi}_1^0 \rightarrow \tilde{G}\gamma/\tilde{G}h) \sim 50\%$
  $\rightarrow$ γ + b-jets + $E_{\mathrm{T}}^{\mathrm{miss}}$
- Wino-like $\tilde{\chi}_1^0$ (co-NLSP)
  $\rightarrow$ γ + ℓ + $E_{\mathrm{T}}^{\mathrm{miss}}$



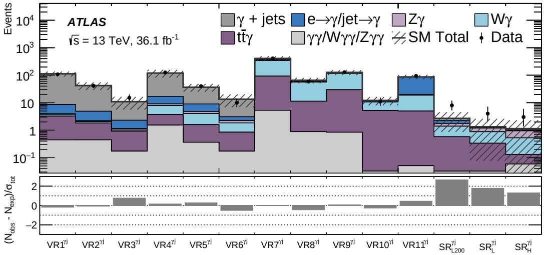
SUSY search with γ + jets + E_T^{miss}

arXiv:1802.03158

- Strong gluino production ($\tilde{g}\tilde{g}$)
- Three SRs to cover different $(m_{\tilde{g}}, m_{\tilde{\chi}_1^0})$
- Background estimation
  - Three CR to "correct" the γ + jets, $W\gamma$ and $t\bar{t}\gamma$ MC
  - Data-driven for fake photon backgrounds (W/Z + jets, multijet, $t\bar{t}$)



- Summary of the observed and expected number of events in all the VRs/SRs



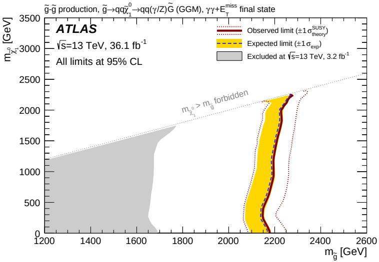
SUSY GGM search results

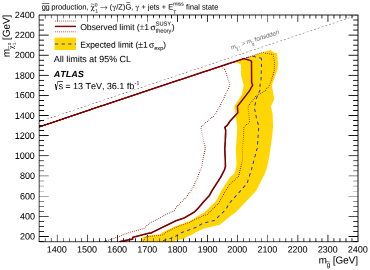
arXiv:1802.03158

- Results compatible with SM expectation
  - → Small excess (about 2.3σ) observed in one of the SR

Signal Region	N_{obs}	N_{exp}	S^{95}_{obs}	S^{95}_{exp}	$\langle A\epsilon\sigma\rangle^{95}_{obs}$[fb]	$\langle A\epsilon\sigma\rangle^{95}_{exp}$[fb]	Z (p)
$SR^{\gamma\gamma}_{S-L}$	0	$0.50^{+0.30}_{-0.26}$	3.0	$3.1^{+1.4}_{-0.2}$	0.083	$0.086^{+0.039}_{-0.003}$	0.00 (0.50)
$SR^{\gamma\gamma}_{S-H}$	0	$0.48^{+0.30}_{-0.25}$	3.0	$3.1^{+1.3}_{-0.1}$	0.083	$0.086^{+0.036}_{-0.003}$	0.00 (0.50)
$SR^{\gamma\gamma}_{W-L}$	6	3.7 ± 1.1	8.6	$5.8^{+2.8}_{-1.6}$	0.238	$0.161^{+0.078}_{-0.044}$	1.06 (0.14)
$SR^{\gamma\gamma}_{W-H}$	1	$2.05^{+0.65}_{-0.63}$	3.7	$4.4^{+1.9}_{-1.0}$	0.103	$0.122^{+0.053}_{-0.028}$	0.00 (0.50)
$SR^{\gamma j}_{L}$	4	$1.33^{+0.54}_{-0.32}$	7.6	$4.7^{+1.6}_{-0.8}$	0.210	$0.130^{+0.044}_{-0.022}$	1.81 (0.035)
$SR^{\gamma j}_{L200}$	8	$2.68^{+0.64}_{-0.63}$	11.5	$5.4^{+2.2}_{-1.2}$	0.318	$0.151^{+0.060}_{-0.033}$	2.36 (0.009)
$SR^{\gamma j}_{H}$	3	$1.14^{+0.61}_{-0.36}$	6.6	$5.9^{+1.8}_{-1.1}$	0.183	$0.162^{+0.050}_{-0.030}$	1.20 (0.116)

- Limits to new physics and to the SUSY particles in the considered GGM models
  - → $m_{\tilde{g}} \sim 2$ TeV, $m_{\tilde{q}} > 1.8$ TeV and $m_{\tilde{\chi}^{\pm}_1, \tilde{\chi}^0_2} > 1$ TeV





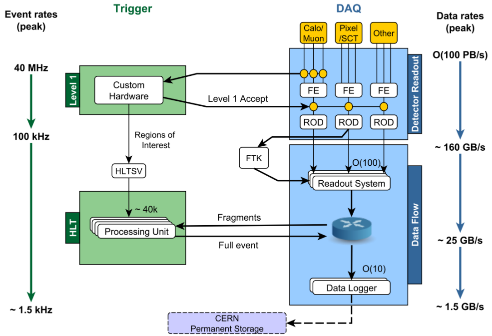
Summary and plans

- Performance, upgrade and computing studies (more in the backup slides)
  - Really important for the collaboration and used in every physics result
  - Plan to provide in kind contribution to TDAQ Phase-II upgrade, in Global Trigger Hardware/Firmware
- Exotics Higgs decays
  - SM Higgs decaying to pseudoscalar Higgs boson analysis in the $h \to aa \to \mu\mu\tau\tau$ channel
- SUSY searches
  - Follow up small excess in photon + jets + $E_{\mathrm{T}}^{\mathrm{miss}}$ analysis
  - Run 2 results with all final states considered for GGM search
  - Currently investigating other models involving photons in the final state (e.g. Stealth SUSY in multijet + photons + low $E_{\mathrm{T}}^{\mathrm{miss}}$)

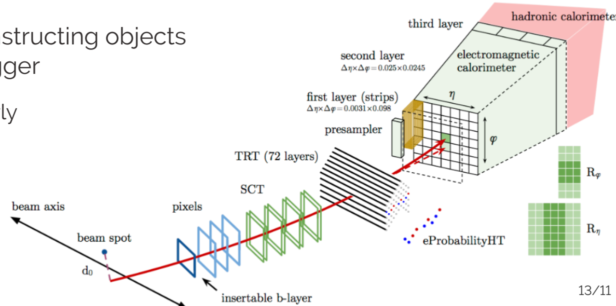
Backup

Trigger

- The trigger is one of the essential pieces of the ATLAS detector.
- Two-level system responsible to reduce event rate recording to ~ 1.5 kHz, from the LHC beam crossing rate of 40 MHz.
- Hardware-based Level 1 trigger (L1)
- Software-based high-level trigger (HLT)



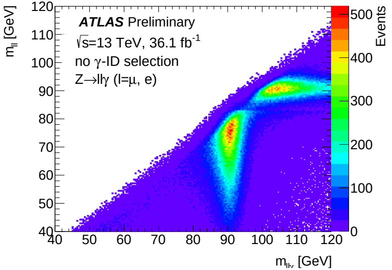
- e/γ trigger is based on reconstructing objects within a RoI seeded by L1 trigger
- Fast algorithms reject events early
- Precise algorithms to efficiently identify e/γ
- Cut-based ID for photons, LH-based ID for electrons



Photon trigger performance

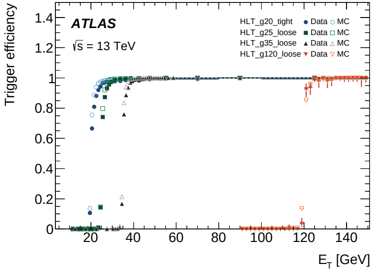
Eur. Phys. J. C 77 (2017) 317

- The e/γ trigger performance studies are important to understand, improve the trigger, and also provide to the trigger efficiency to the precision analyses and searches for new physics

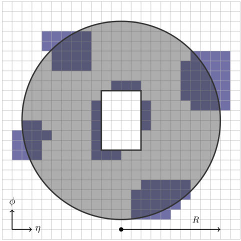


- Efficiency measured with bootstrap method
  - → Events selected from a fully efficient reference trigger
  - Bayesian statistical uncertainty.
  - Plateau efficiency $\sim$ 99%.

- Photons from Z radiative decay $Z \to \ell\ell\gamma$
  - High purity photon sample
  - Low stat. for high p_{T} photons



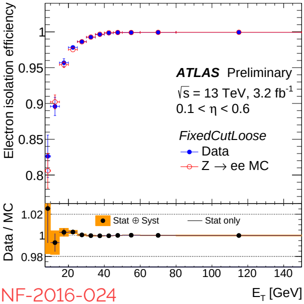
Photon/electron isolation

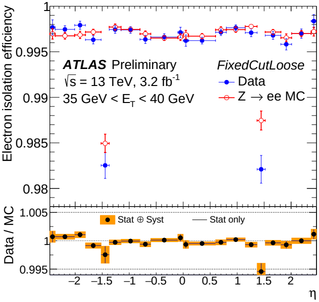


- Most of the interesting physics signatures at the LHC require the identification of prompt non-fake leptons and/or photons
- These leptons/photons are usually isolated, without much activity around them

→ It is important to define a proper isolation energy to reduce contamination from non-prompt and fake objects

- The data-driven efficiencies are measured in $Z \to ee$ for electrons and direct photons for photons, and scale factors are used to correct the MC to match the efficiency in data





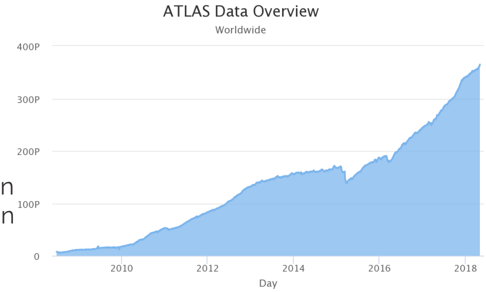
ATLAS-CONF-2016-024

ATLAS Data Management

rucio.cern.ch

- The Worldwide LHC Computing Grid is a global collaboration of computer centres (170 centres in 41 countries). It provides a resource to store, distribute and analyse the 15 PB of data generated every year by the LHC

- Rucio is the Distributed Data Management system in charge of managing all ATLAS data on the grid
  - Migrated from dq2 in 2015 with zero downtime
  - 350 PB of physics data across more than 130 data centers globally, with more than 830 million files
  - More than 3 million file transfers



- We are using Data Analytics to predict the time of the data transfers

  → this will allow a better scheduling and a better resource usage of the GRID