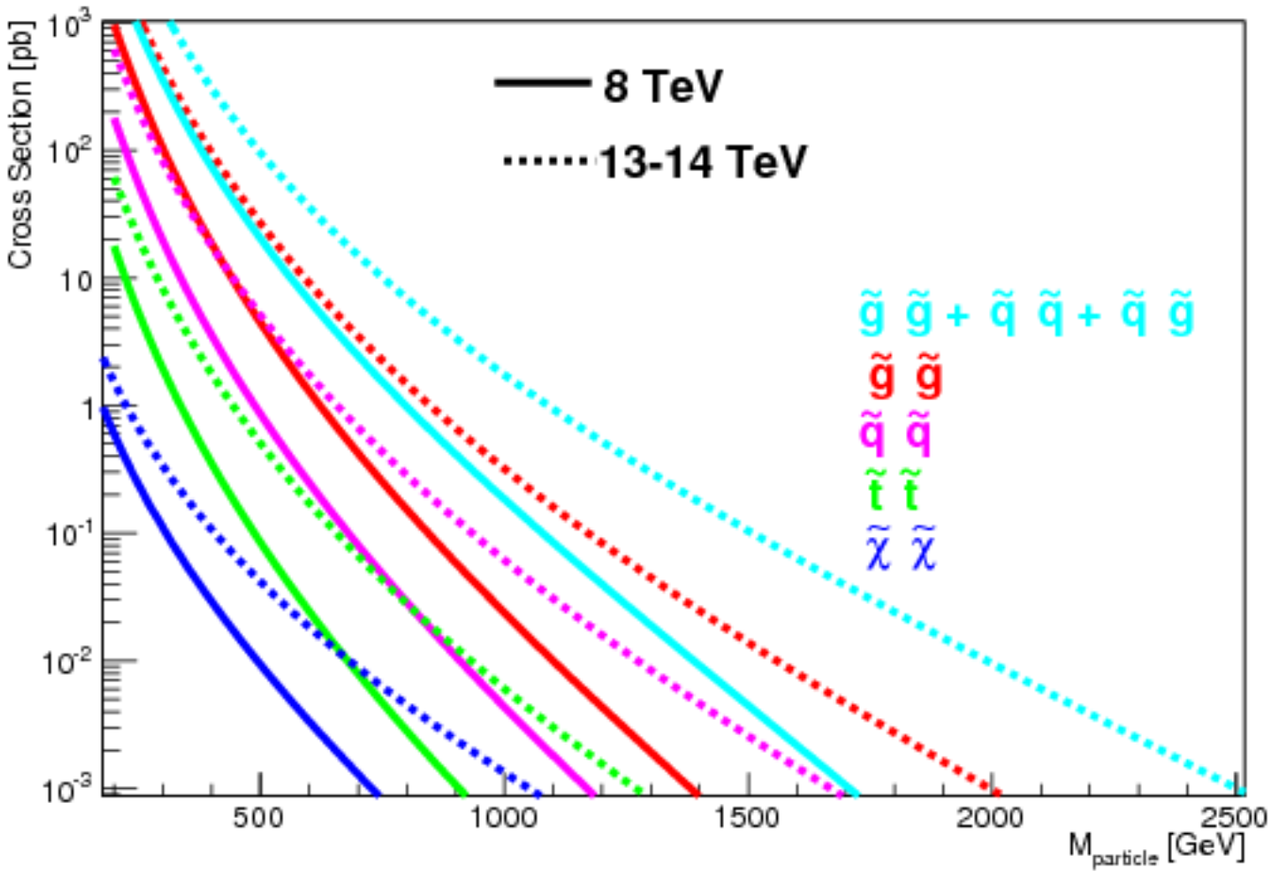
Search for SUSY in the dilepton final state with ATLAS

Partikeldagarna 2017

Giulia Ripellino
KTH Royal Institute of Technology

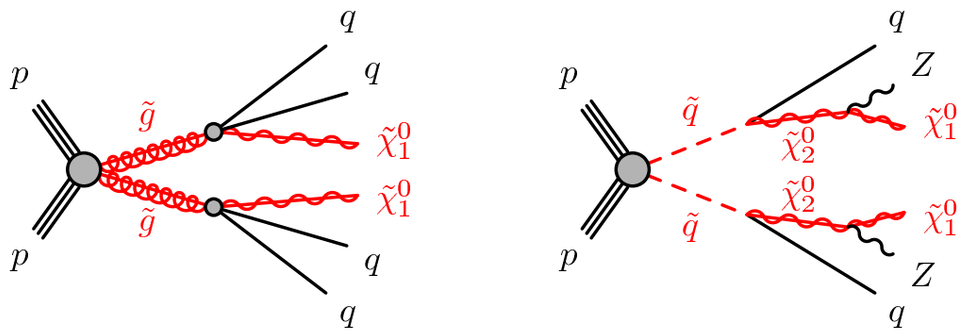
SUSY searches in ATLAS

- Searches are grouped around production channels
- Targeting a wide range of final states
- Each analysis defines a set of selections with high sensitivity for considered models

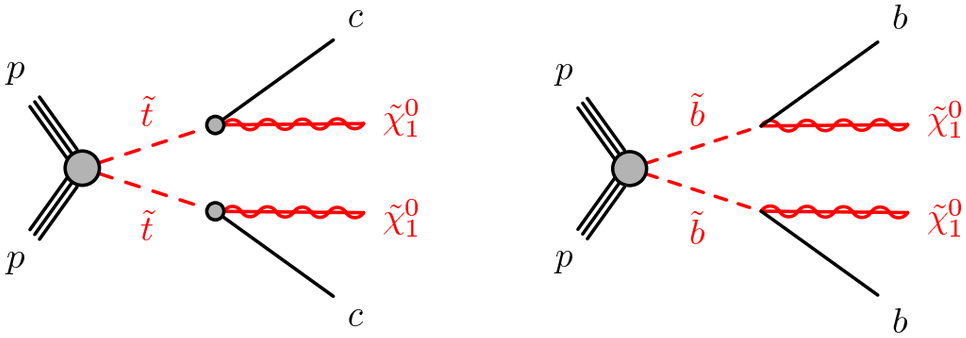


[http://inspirehep.net/record/1326406/]

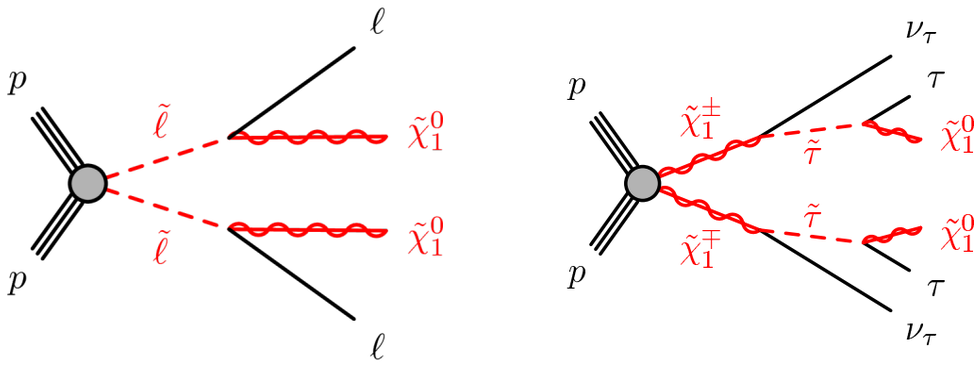
Strong production



3rd generation production



Electroweak production

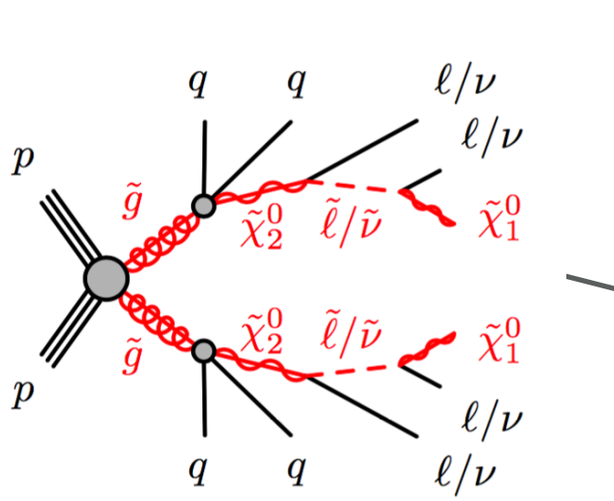


Strong production with a dilepton final state

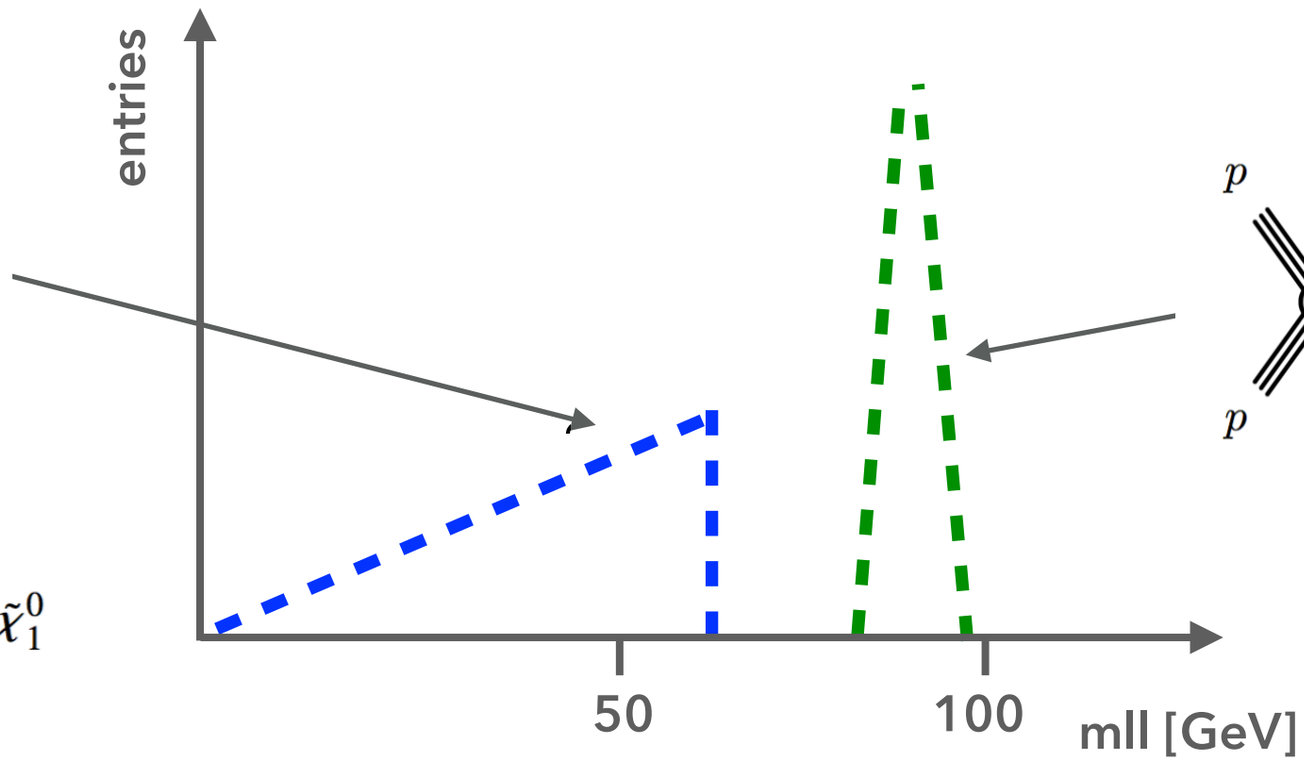
Strong 2L

Edge search

- Two leptons from a cascade decay through sleptons or an off-shell Z boson
- Kinematic edge in the dilepton invariant mass distribution
- Binned search across mll spectrum

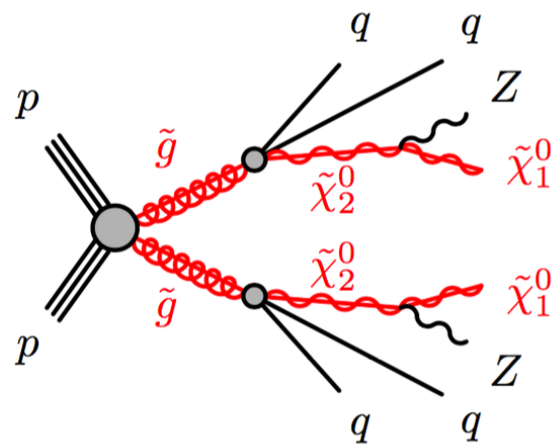


$$m_{\ell\ell}^{\max} \approx m_{\tilde{\chi}_2^0} - m_{\tilde{\chi}_1^0}$$



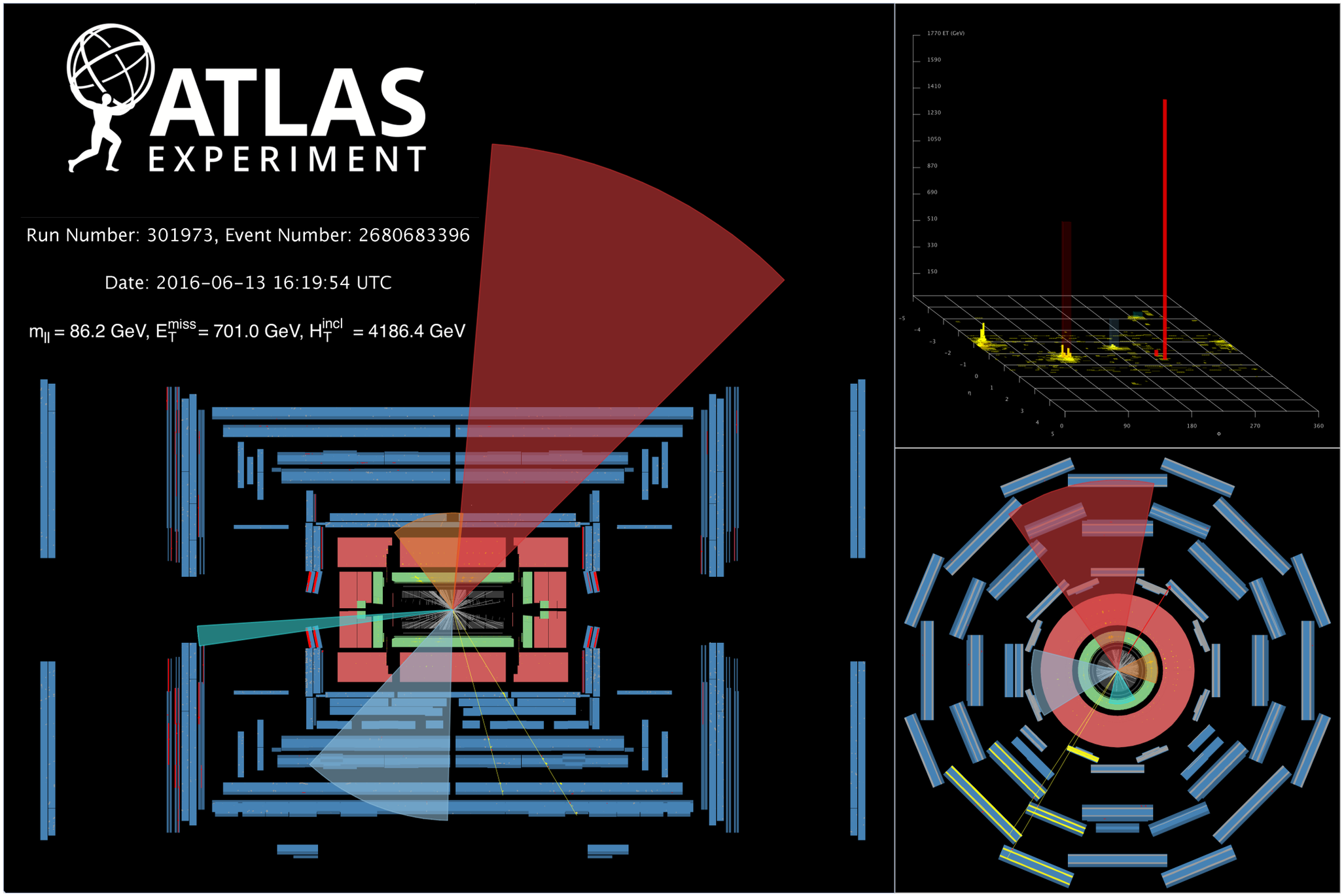
On-shell Z search

- Two leptons from an on-shell Z boson
- Peak in the dilepton invariant mass distribution around the Z boson mass
- Cut-and-count analysis in Z window



2 opposite-sign same-flavour leptons (ee or μμ), jets and missing transverse energy E_T^{miss} in the final state

Candidate dimuon event



[http://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/SUSY-2016-05/]

Analysis history

- First run-2 analysis in the 2 lepton final state published earlier this year
  - Included the first 14.7 fb^{-1} of 2015+2016 13 TeV data
- New paper is now in preparation
  - Reoptimised analysis
  - Including the full 36.1 fb^{-1} of 2015+2016 13 TeV data
  - Similar background estimation techniques

Today's talk presents the reoptimised analysis

Exemplifying with some plots from 14.7 fb^{-1} paper

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THE EUROPEAN PHYSICAL JOURNAL C

Regular Article - Experimental Physics

Search for new phenomena in events containing a same-flavour opposite-sign dilepton pair, jets, and large missing transverse momentum in $\sqrt{s} = 13$ TeV pp collisions with the ATLAS detector

ATLAS Collaboration*

CERN, 1211 Geneva 23, Switzerland

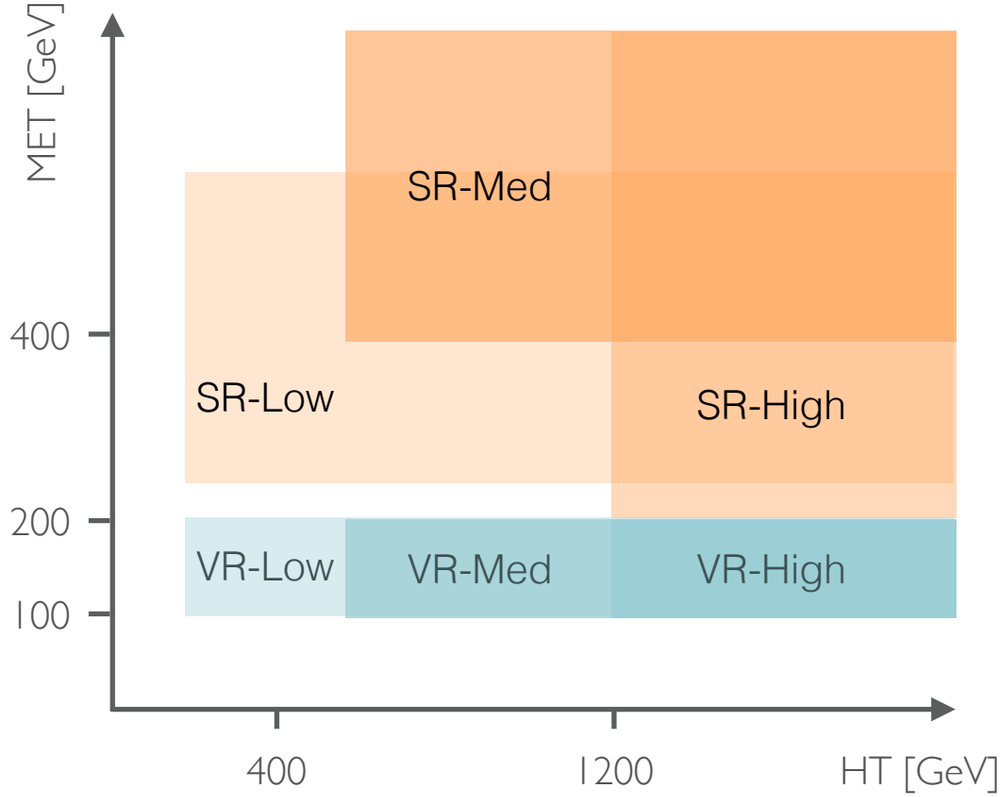
Received: 18 November 2016 / Accepted: 16 February 2017

Signal regions

Signal and validation regions defined with varying E_T^{miss} and H_T requirements

Edge:
Three signal regions binned in m_{ll}

On-shell Z:
Edge result in on-Z bin (81 GeV < m_{ll} < 101 GeV) of edge spectrum interpreted separately in terms of the on-shell Z models

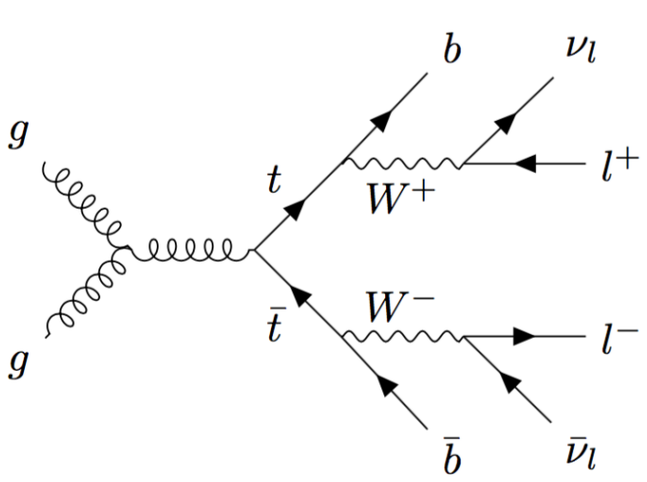


Standard Model backgrounds

Three main Standard Model processes mimic the signal

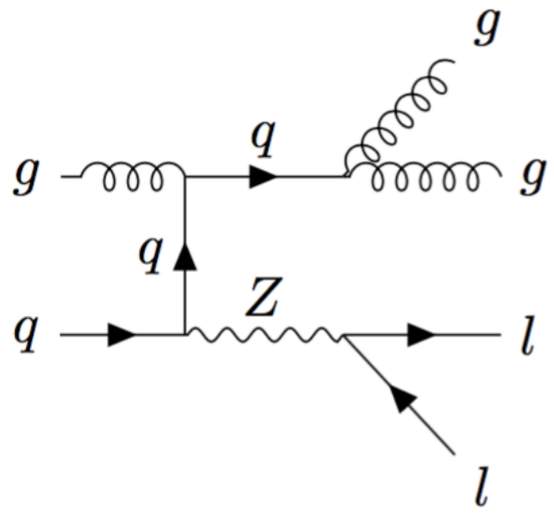
Flavour-symmetric processes

Data-driven estimation method



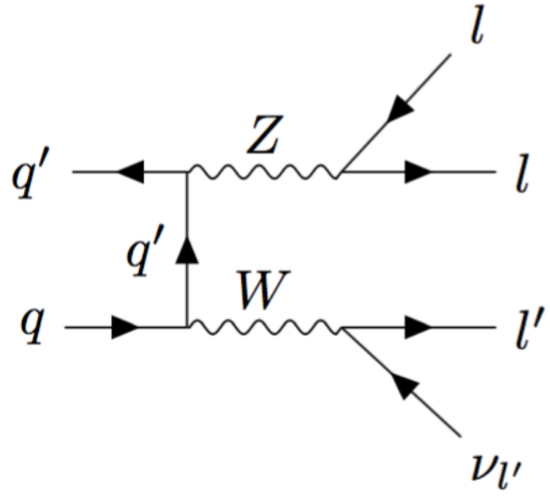
Z+jets

Data-driven estimation method



Dibosons

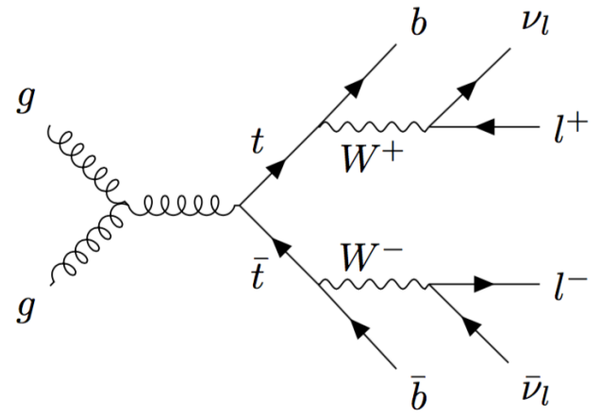
Estimated from MC simulation
Dedicated validation regions



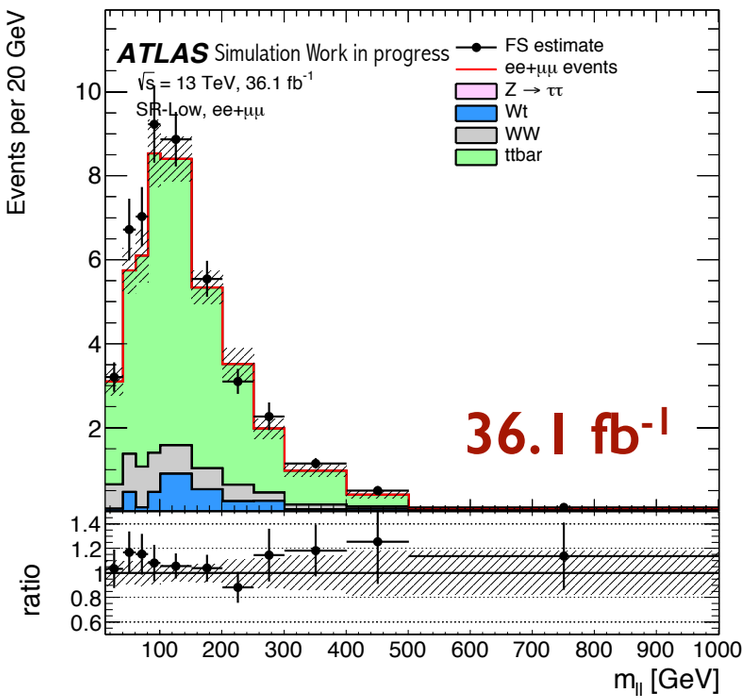
Flavour symmetric backgrounds

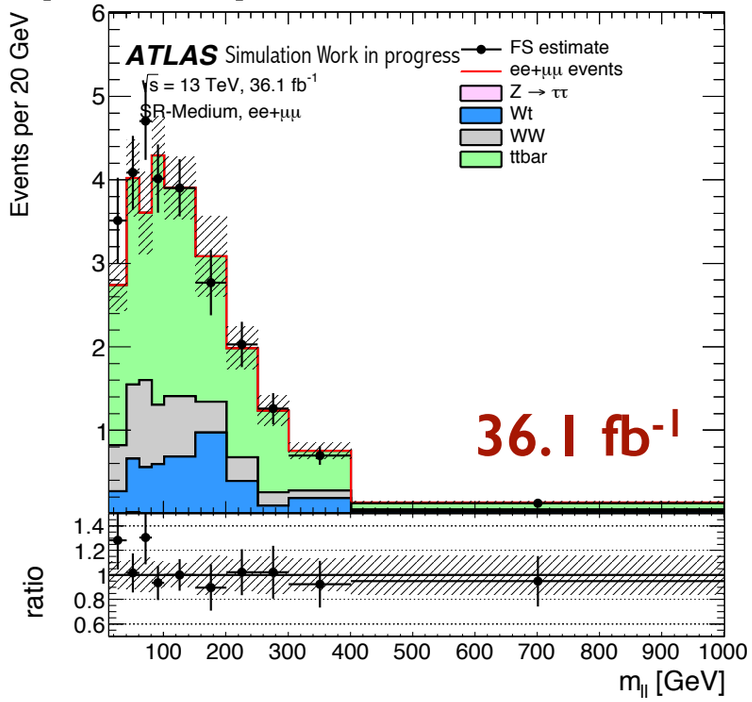
Flavour symmetric processes: **tt, WW, Wt, Z→ττ**

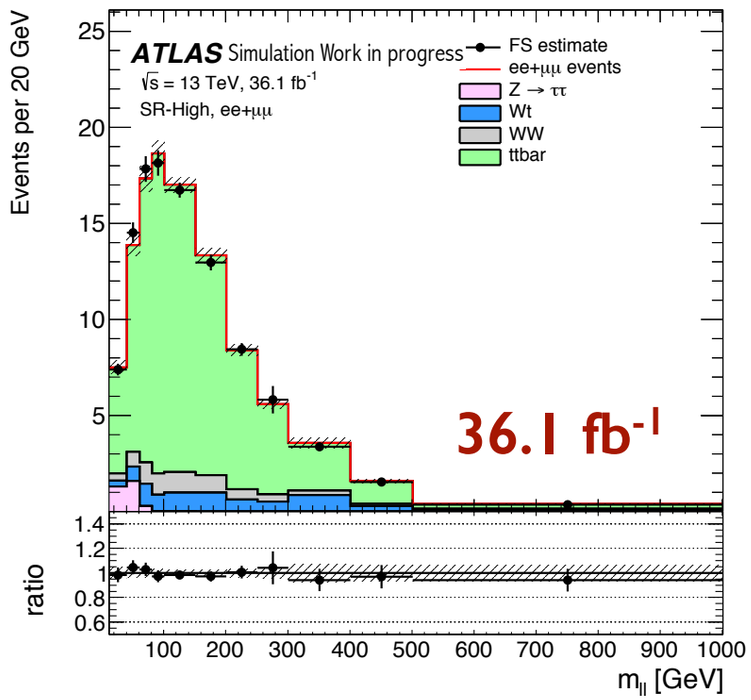
- The two leptons come from independent decays - the lepton flavours are independent
- Assume a **true** ratio of 1:1:2 for ee:μμ:eμ
- Estimate the ee and μμ yields in the signal region from a control region with an eμ selection
- Correct for trigger and identification efficiency differences between e and μ



MC closure test of the flavour symmetry estimate



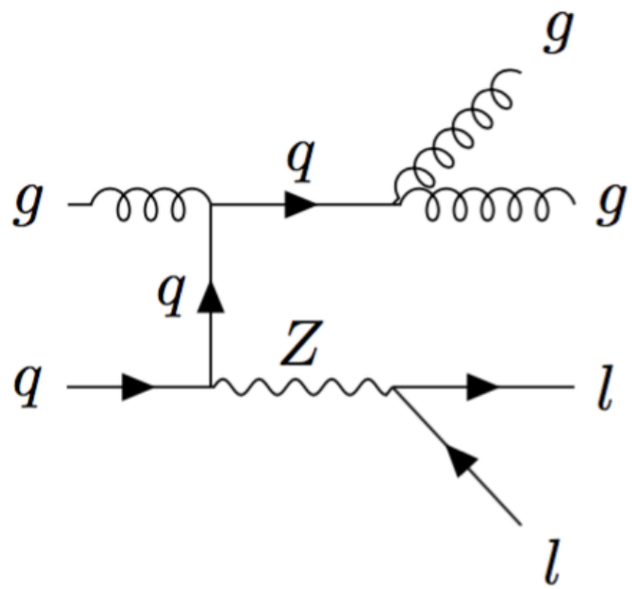


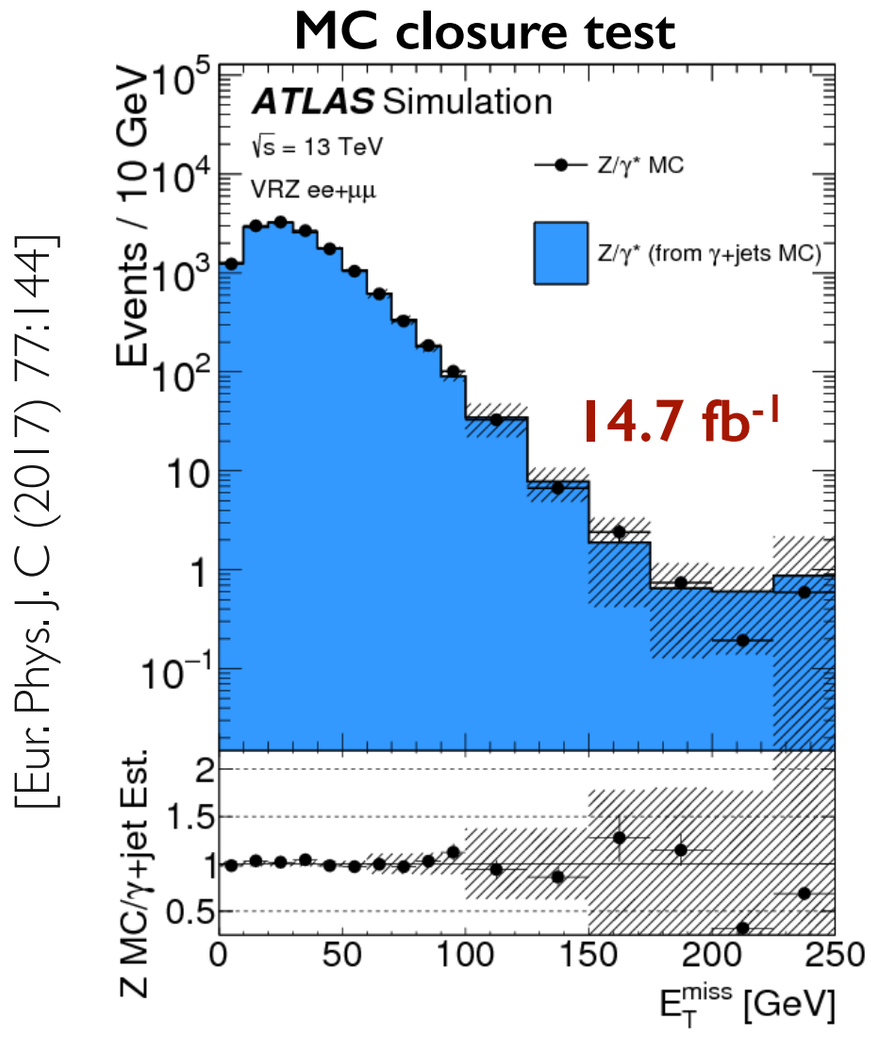


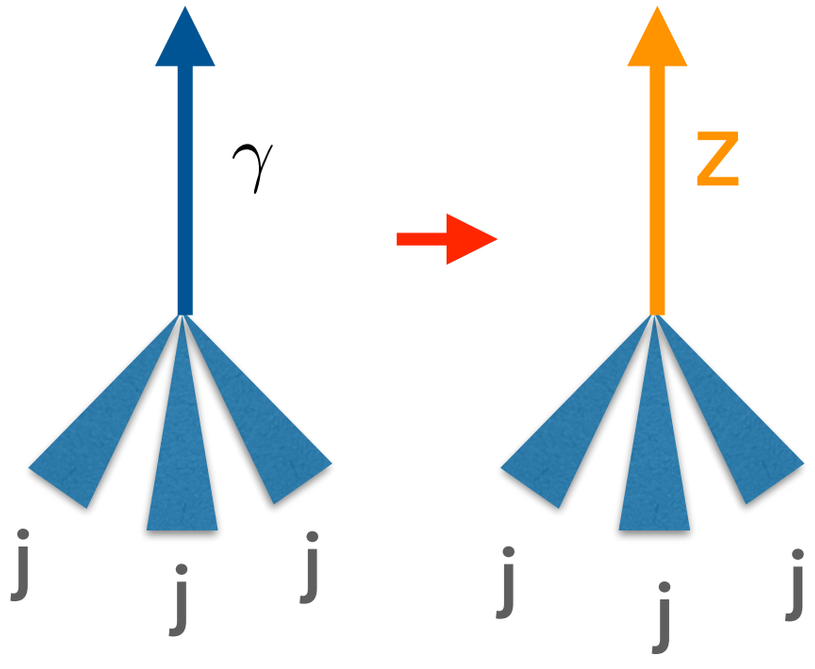
Z+jets background

Z+jets events with large E_T^{miss} from the neutrino, jet mis-reconstruction or lepton mis-measurement

- Use a control sample of γ+jets events
- Reweight γ p_T-spectrum to match Z p_T-spectrum.
- Smear γ resolution to match Z resolution

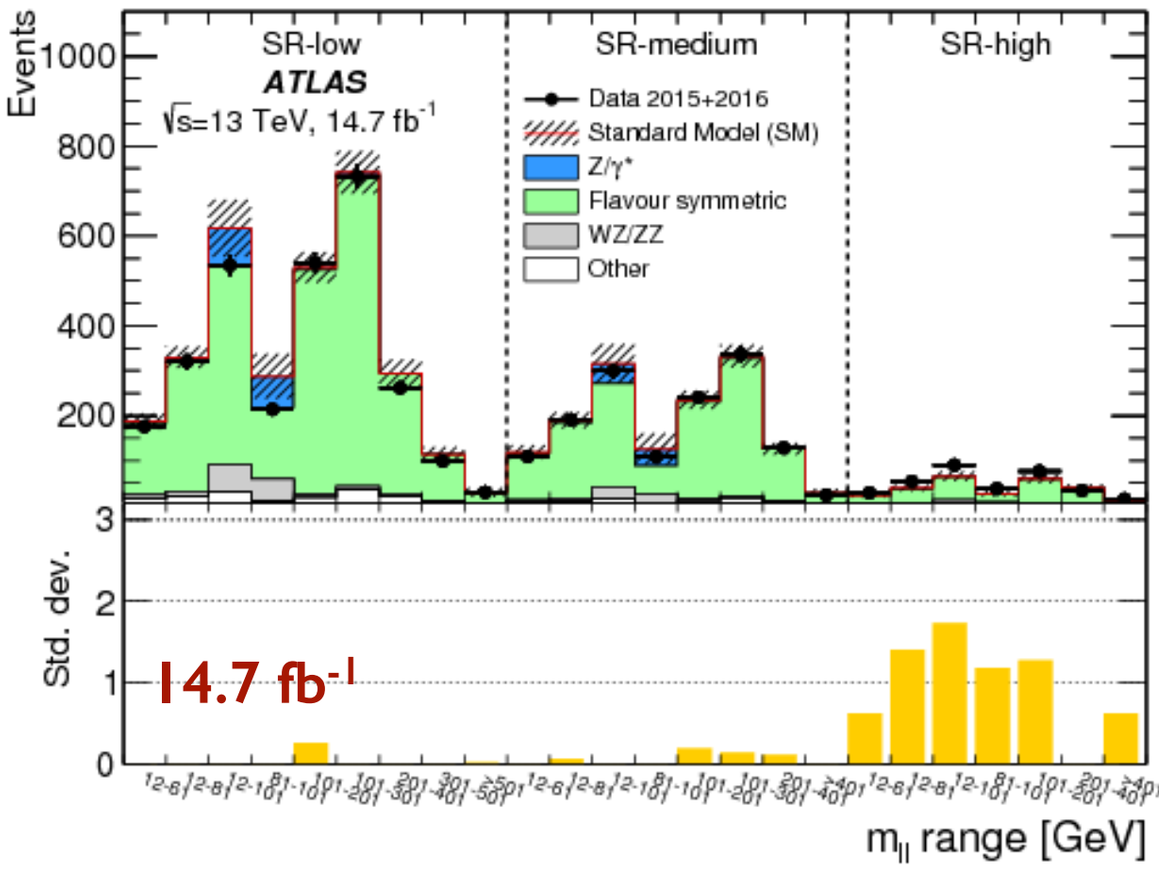


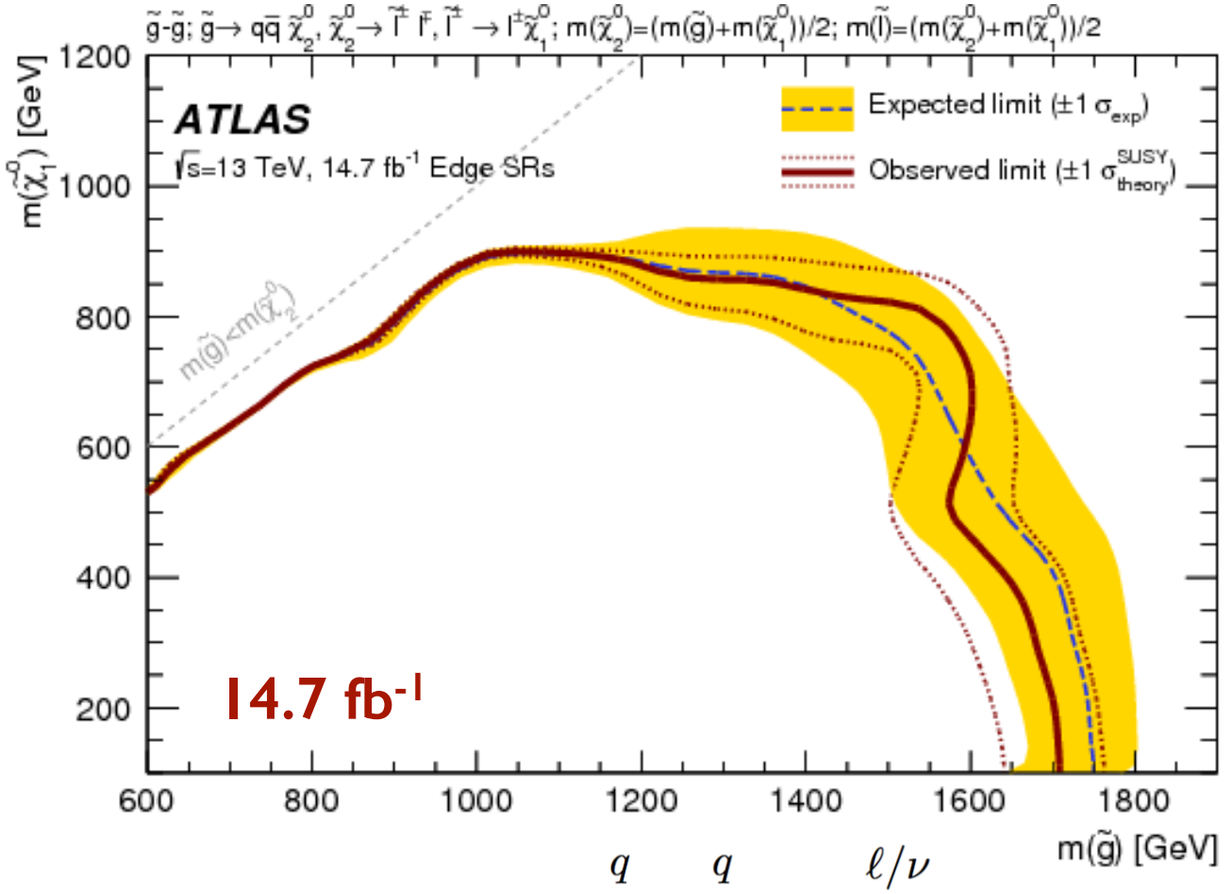




Results from 14.7 fb^{-1} analysis

- The data is compatible with the Standard Model background across the m_{ll} spectrum in all three regions
- Excluding gluino masses up to 1.7 TeV





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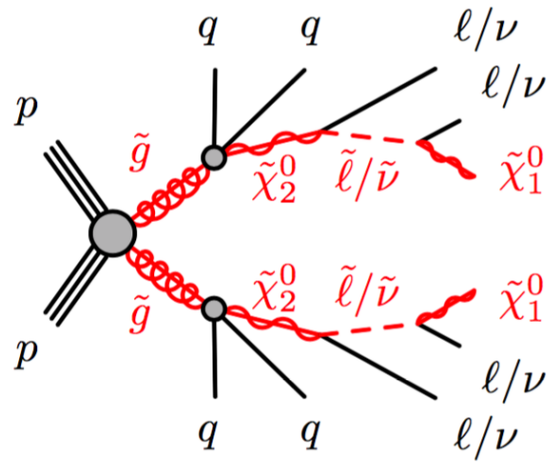


Backup

Signal regions

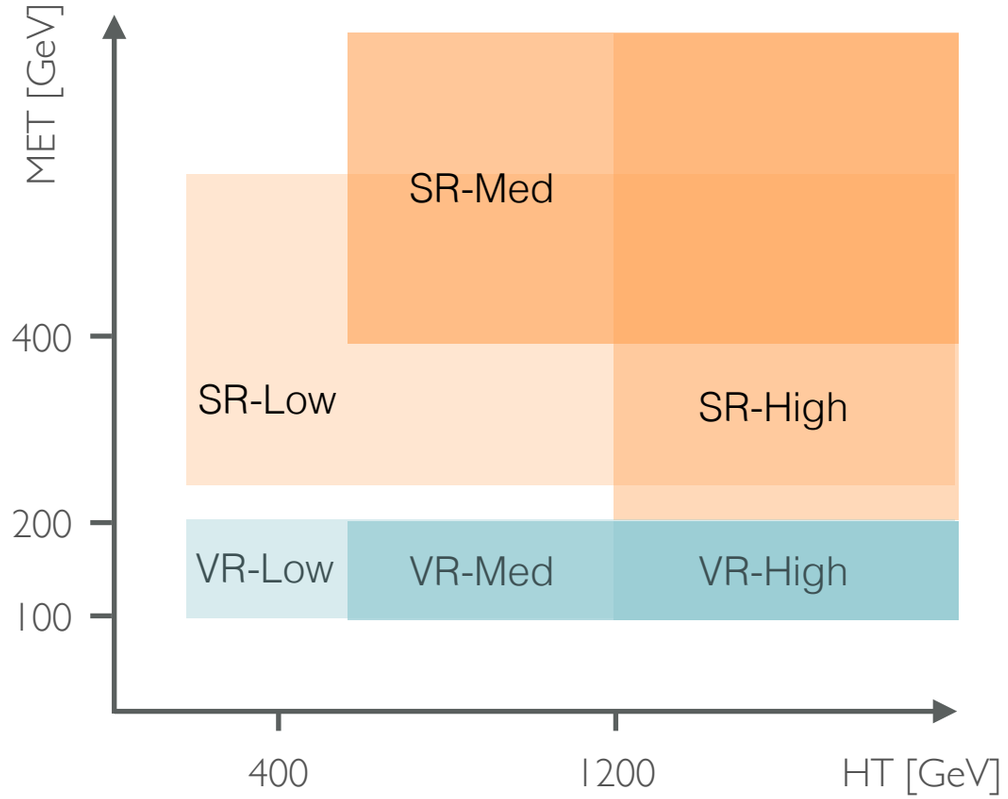
Signal and validation regions defined with varying E_T^{miss} and H_T requirements

Edge:
Three signal regions binned in m_{ll}

On-shell Z:
Edge result in on-Z bin (81 GeV < m_{ll} < 101 GeV) of edge spectrum interpreted separately in terms of the on-shell Z models

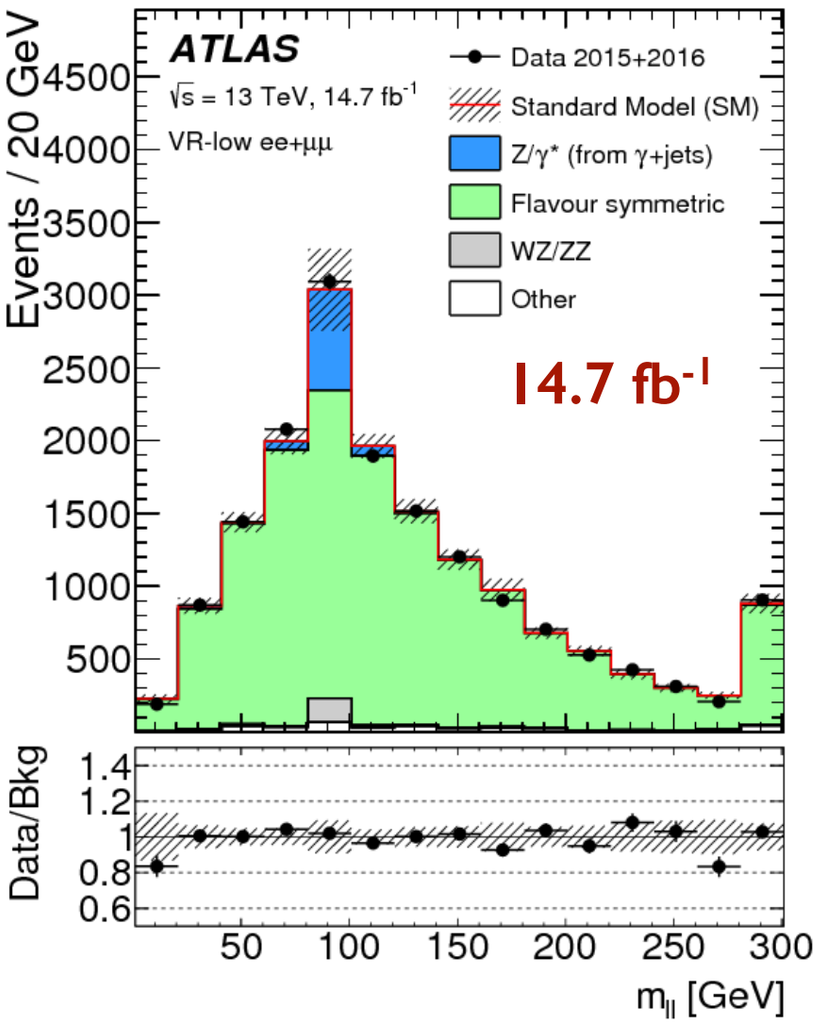
Preselection:

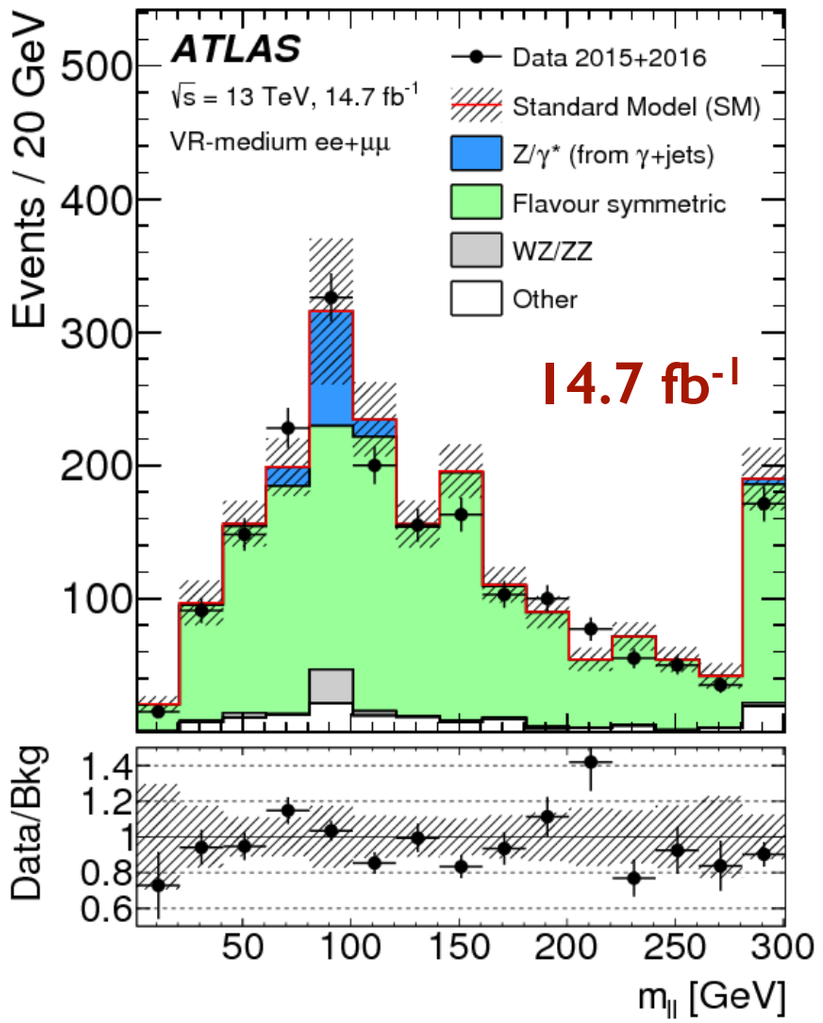
- Two OS-SF leptons
- $N_{jets} > 1$
- $p_T(lep1) > 50$ GeV, $p_T(lep2) > 25$ GeV
- DeltaPhi(E_T^{miss},$jet_{1,2}$) > 0.4

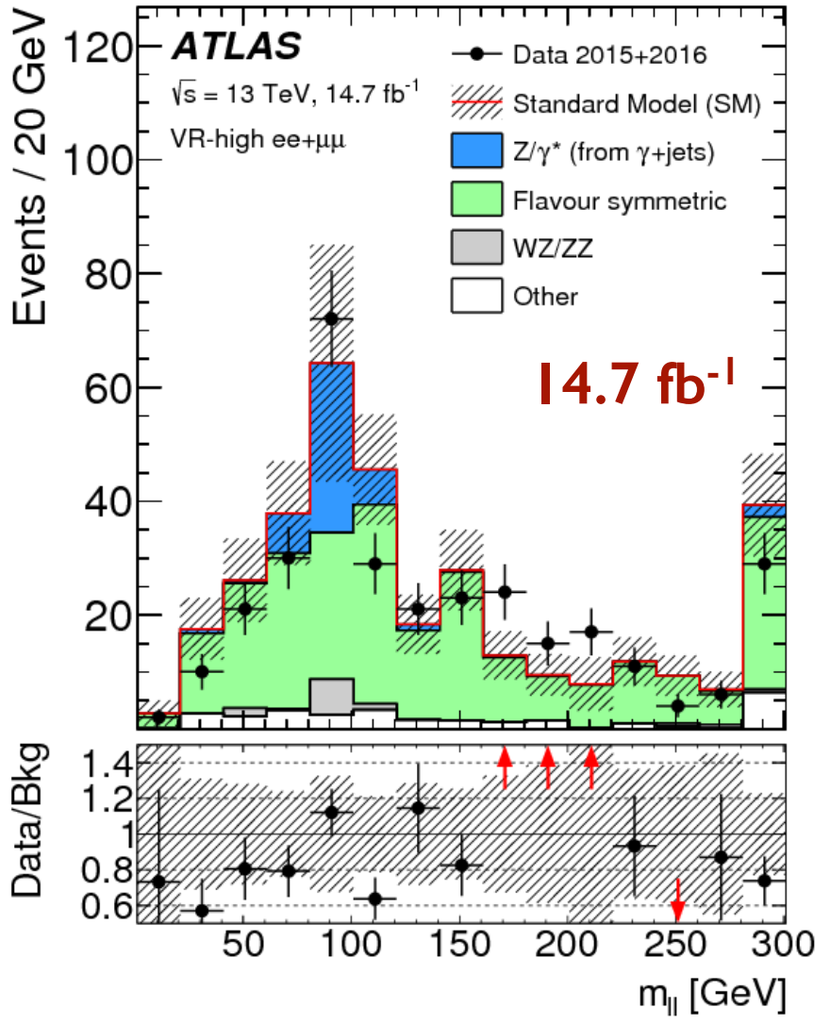


Background estimation validation

Background estimates are validated in dedicated regions at lower E_T^{miss}







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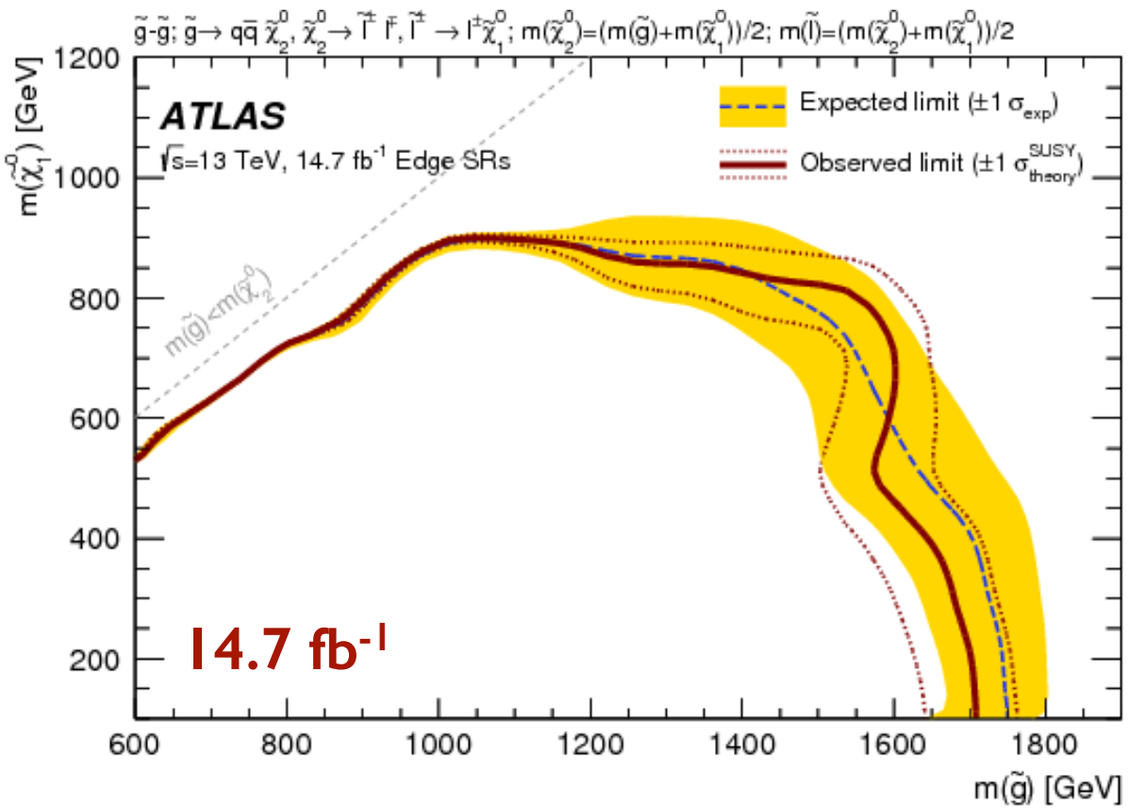
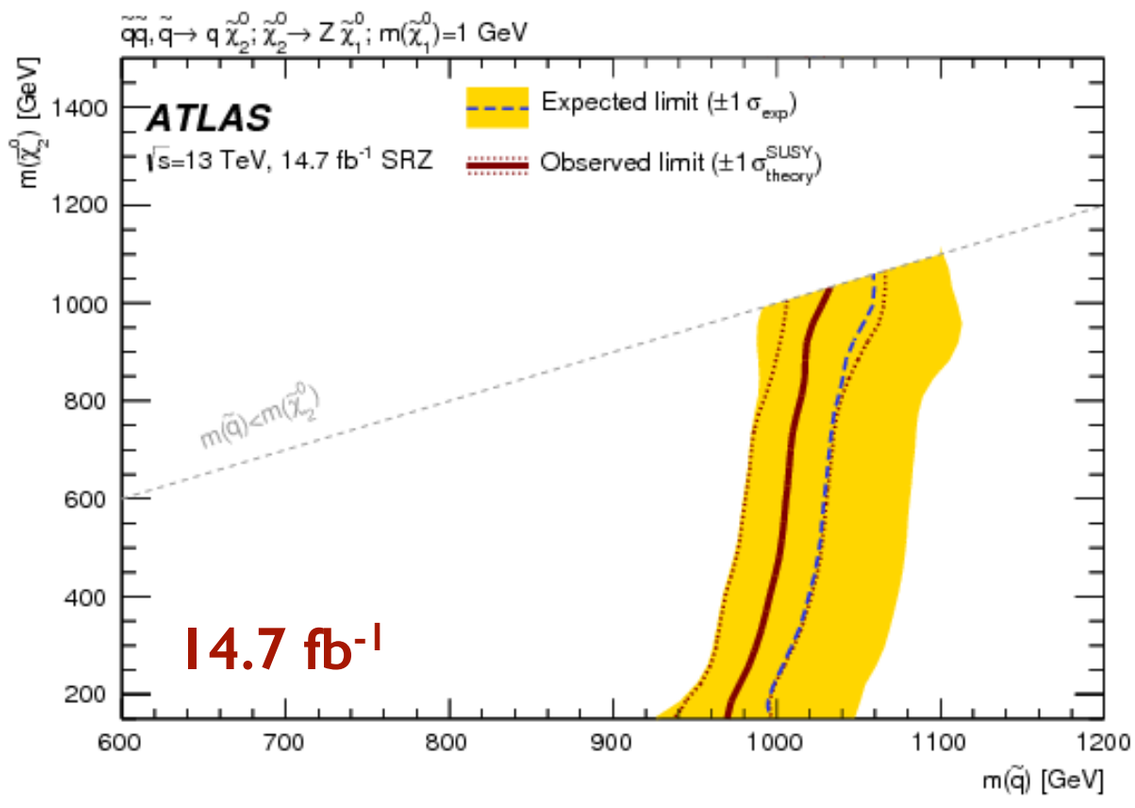
SUSY exclusion limits 14.7 fb^{-1} analysis

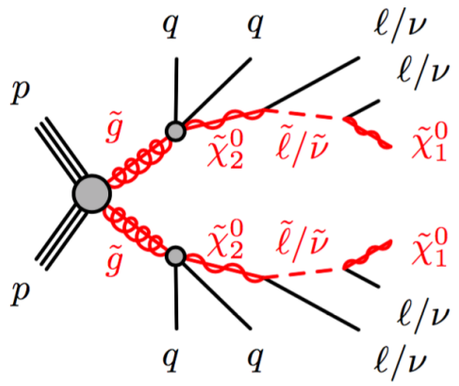
- Excluding gluino masses up to 1.7 TeV
- Excluding squark masses up to 980 GeV

Edge interpretation



On-shell Z interpretation





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