# Search for new physics in multi-body final states at high invariant masses with ATLAS

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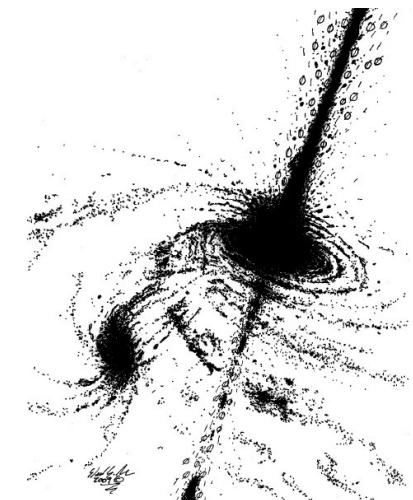
Low-Scale Gravity

Hierarchy problem
open question
in the Standard Model

<u>One solution</u>

Large extra dimensions

Gravity: everywhere
SM: our world
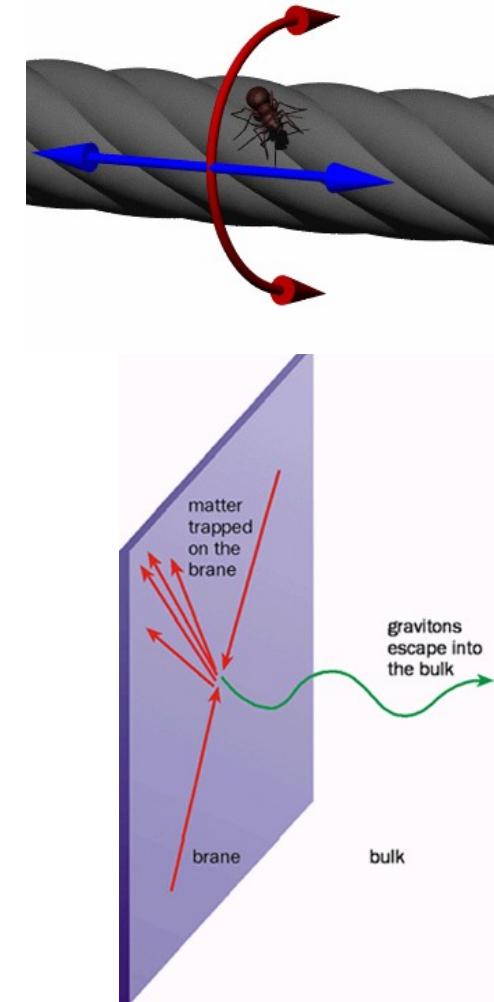
Low-Scale Gravity

Flux through surface area:	Field strength
Number of dimensions:	Surface area
More small dimensions:	Increasing potential at small scales
Planck-scale:	Effective scale in 3d world
Fundamental gravity scale:	M_D
Tevatron lower limit on M_D:	800 GeV (ADD model searches)

Low-Scale Gravity

Near M_D : Gravitational states

Above M_D : Non-perturbative states

$$\sigma_{geom} = \pi\, R_S^2$$

R_S Schwarzschild radius

Estimate for M_D = 800 GeV: 60 nb
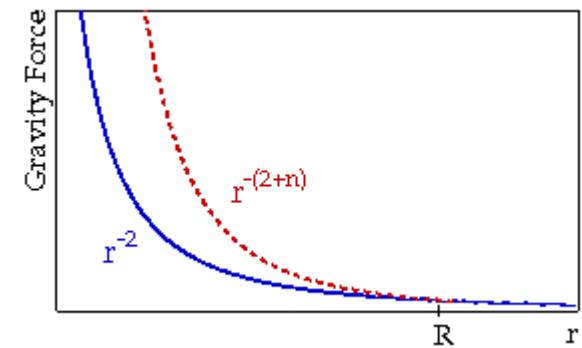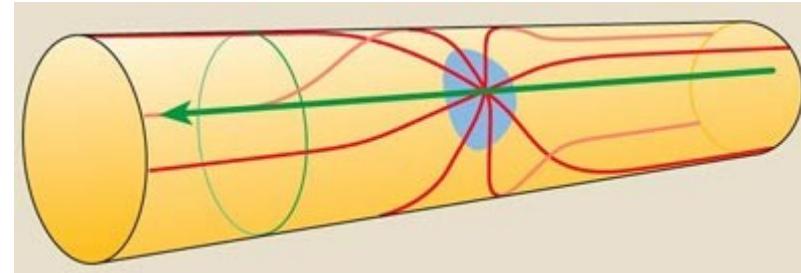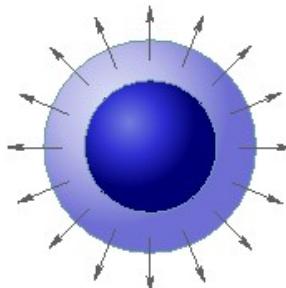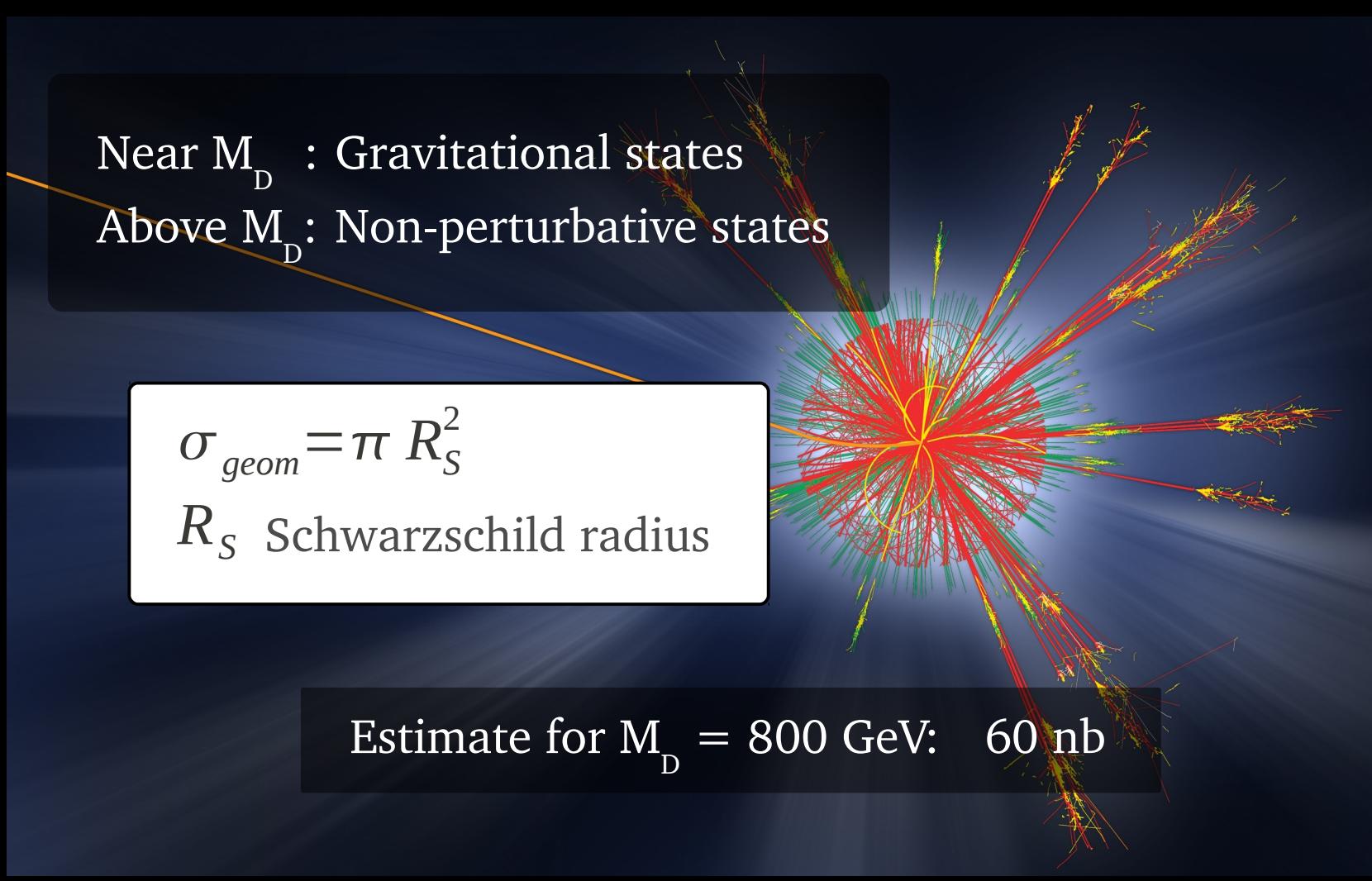
Basic Assumptions and the Search Idea

No valid theory: model-independent search

Energy-coupling of gravity: equal decay probabilities to SM degrees of freedom

Inclusion of electrons, photons, muons, and jets

Non-Standard Model behaviour in final states of **more than two objects** with high **Sum(p_T)** and **high M_{inv}**
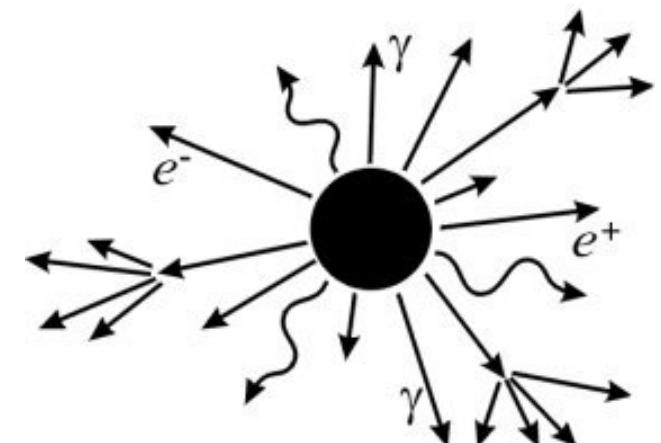
Object Selection

Jets

$p_T > 40$ GeV, $|eta| < 2.80$

Electrons

$p_T > 20$ GeV, $|eta| < 2.47$

Photons

$p_T > 20$ GeV, $|eta| < 2.37$

Muons

$p_T > 20$ GeV, $|eta| < 2.00$
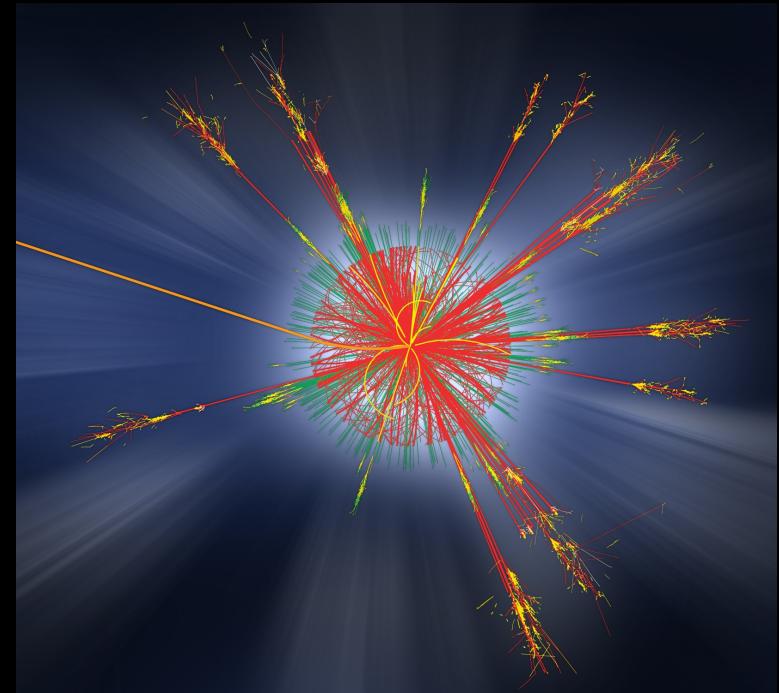
Background Object Multiplicities
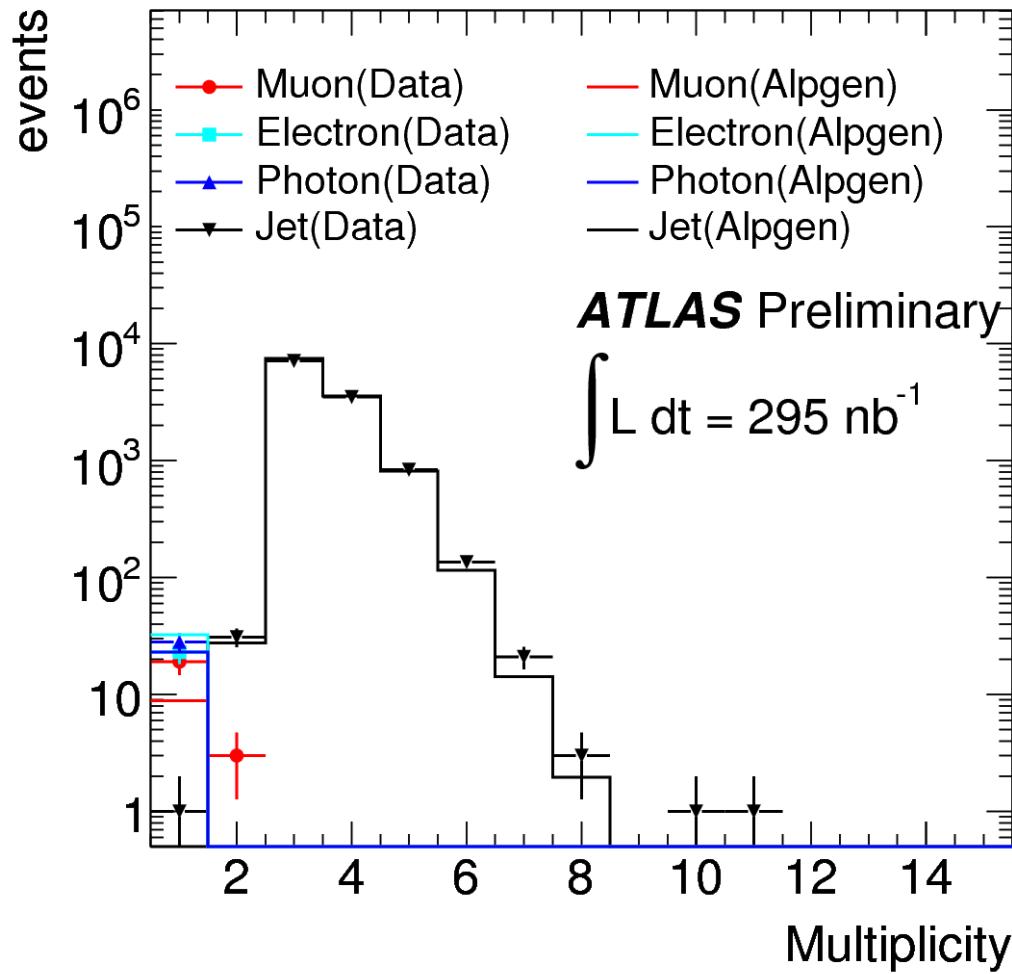
N > 2

$Sum(p_T) > 300$ GeV

Dominant SM
background:
QCD jet production

Good agreement
between Data and
Monte Carlo

# Background Estimation: Control and Signal Regions
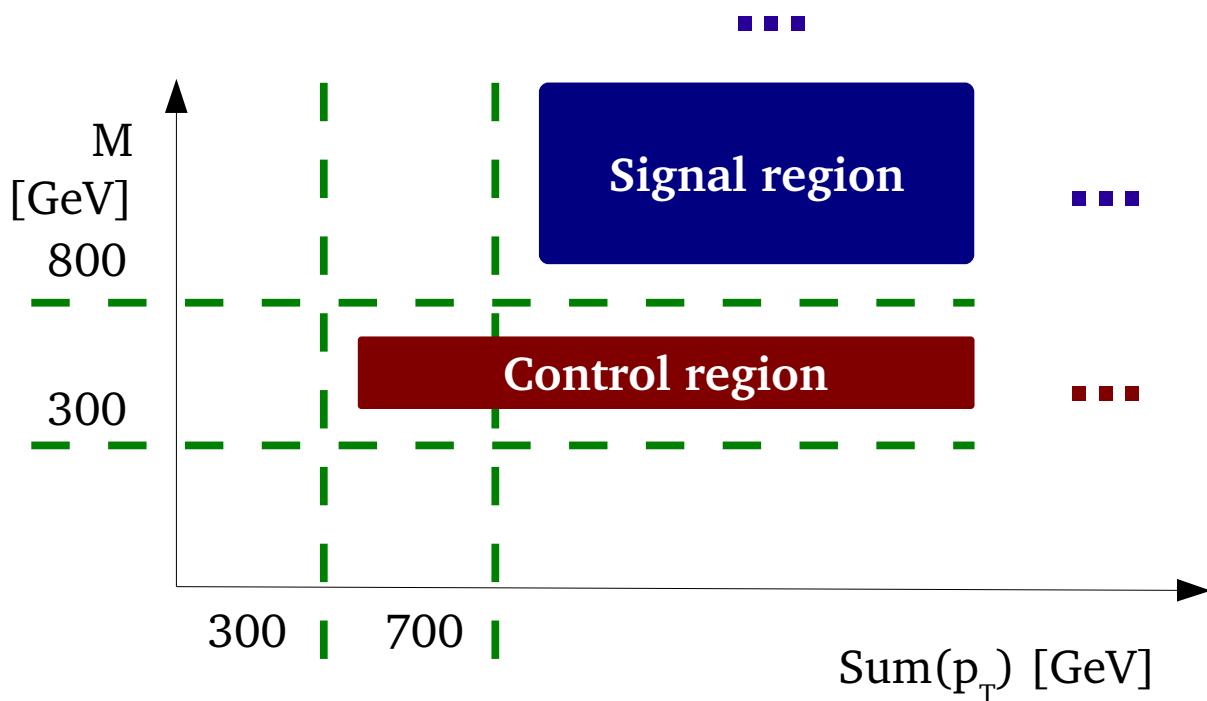
Background estimation MC-driven

Extrapolation from control region into signal region

Choice of control region:
- statistics
- kinematic proximity

Background Extrapolation
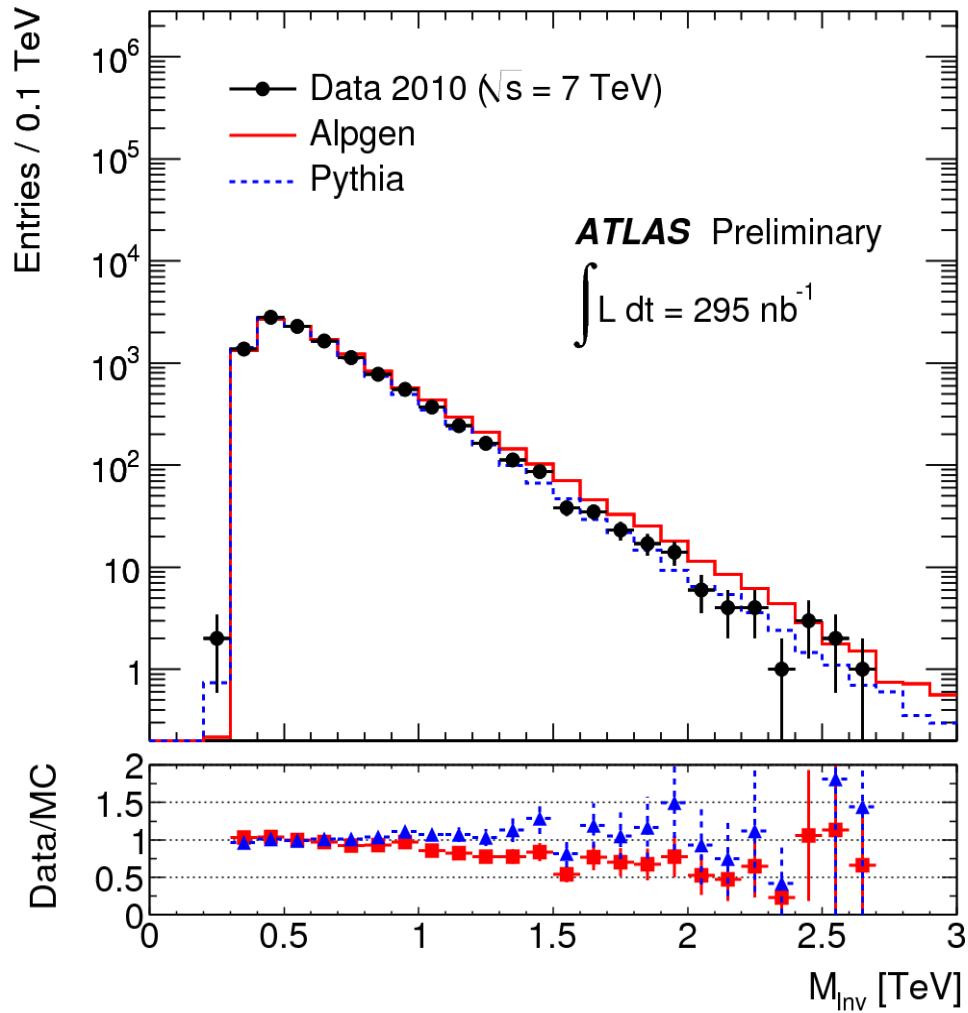
Assumption on shapes

Normalization of MC to data in control region

$(Sum(p_T) > 300 \text{ GeV}, 300 \text{ GeV} < M_{inv} < 800 \text{ GeV})$

Difference between Alpgen and Pythia as systematic uncertainty

Experimental Result
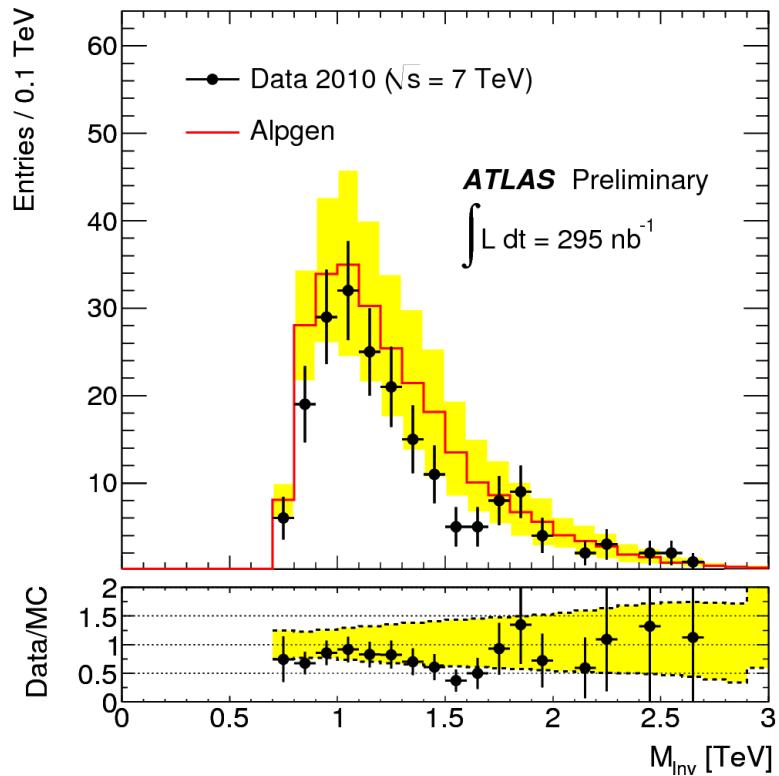
Mass distribution in the signal region:
$\text{Sum}(p_T) > 700$ GeV, $M_{\text{inv}} > 800$ GeV

Quantity	Value	Uncertainty	Uncertainty [%]
		Data	
Observed events	193		
Luminosity [nb^{-1}]	295	±32	±11%
	Estimated Background		
ALPGEN	254	±18	6.9%
PYTHIA	174	±11	6.2%
Background (statistical)	254	±18	6.9%
	Systematic Uncertainties		
Background (QCD)		±66.5	26%
PDF (choice)			±12%
PDF (error set)			+6.8%
PDF (error set)			−5.2%
Control region			±10%
Un-simulated backgrounds			±0.6%
Including e, γ, μ			±0.2%
Missing transverse energy			±0.02%
JES			±11.0%
JES (MET)			±0.5%
JER			±0.6%
Systematic uncertainty		+84	+33%

Observation consistend with SM
Upper limit on cross-section x acceptance:
0.34 nb at 95% CL

Summary

Search for new physics in multi-body final states in pp collisions at sqrt(s) = 7 TeV

Upper limit of 0.34 nb cross-section x acceptance

Simple acceptance estimation:
Production cross section
< 0.6 nb
(Geom. cross section ~ 60 nb)

First search of this type.
More to follow. Stay tuned.
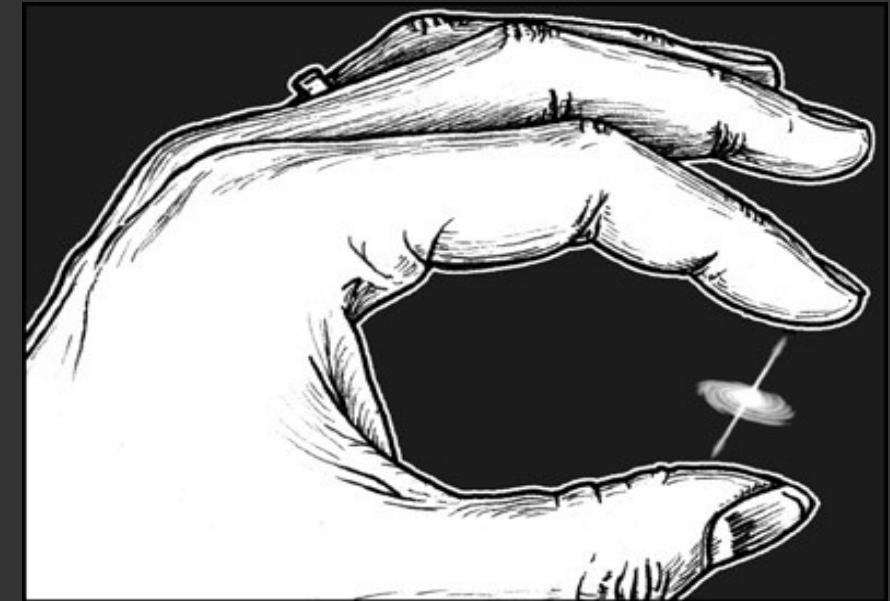
ATLAS-CONF-2010-088

Backup material

Event and Object Selection

Events

Reject cosmics and other non-collision backgrounds via vertex requirements

Single unprescaled jet trigger. Nominal energy threshold: 15 GeV

Jets

Infrared- and collinear safe jet algorithm (AntiKt4)

Input: topological clusters from calorimeter cells

Calibration from electromagnetic to hadronic scale via eta- and pT dependent correction

Reject low pT and forward jets

Muons

Combined reconstruction from Muon System and Inner Detector via Chi² criterion

Reject low pT and forward muons

Electrons and Photons

Reconstructed from cell clusters in the electromagnetic calorimeter

Decision between electrons and photons based on track matching

Reject low pT and forward objects

Missing E_T

Reconstructed from calorimeter cells from clusters

Subtract energy of muon candidates

Overlap removal

Topologically, based on Delta(R)

Muons not included

Transverse Momentum
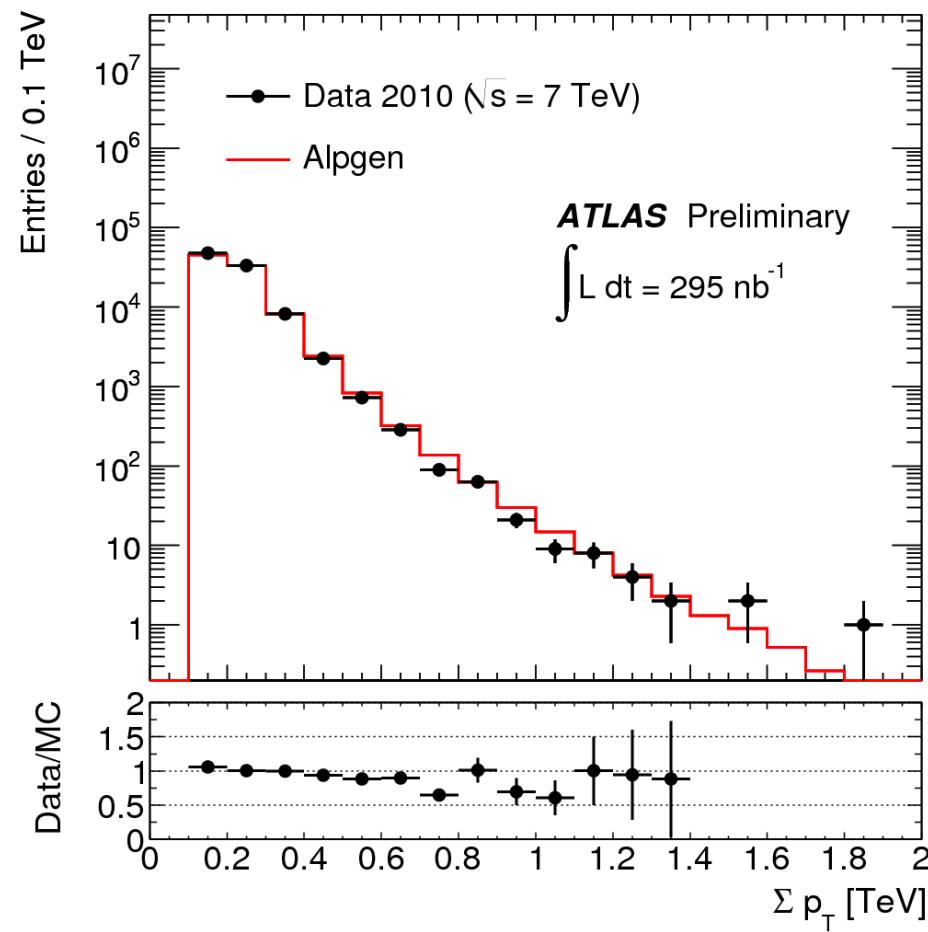
PT and Missing Energy
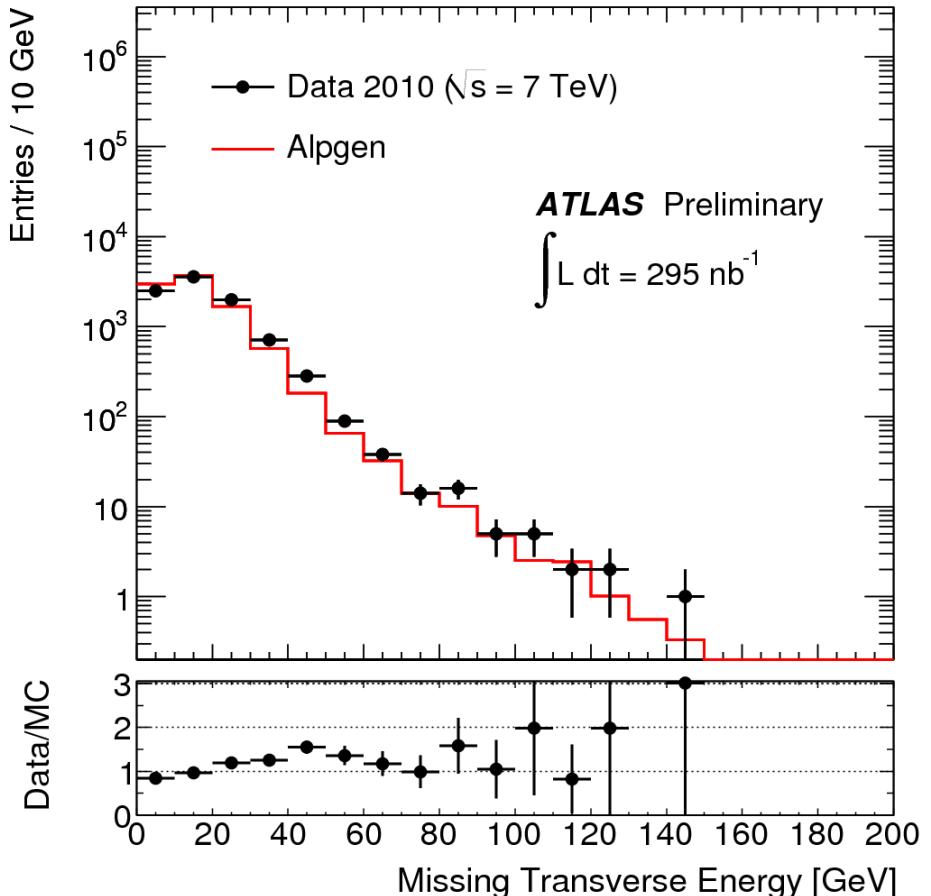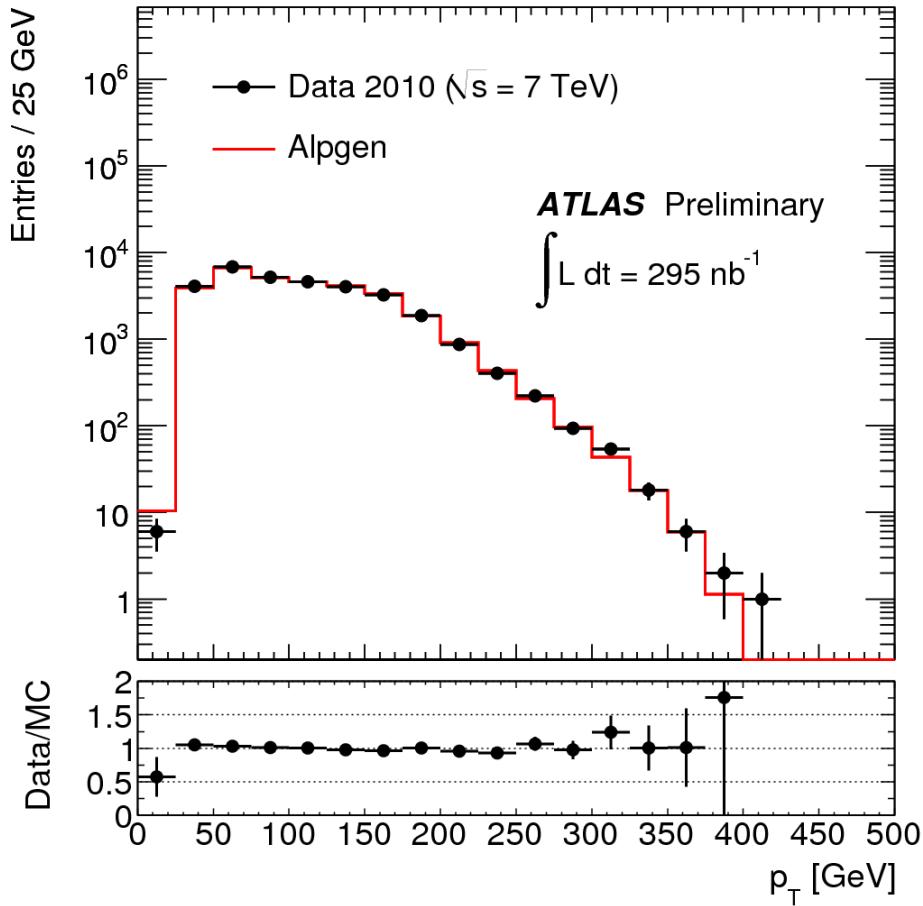
Invariant Mass
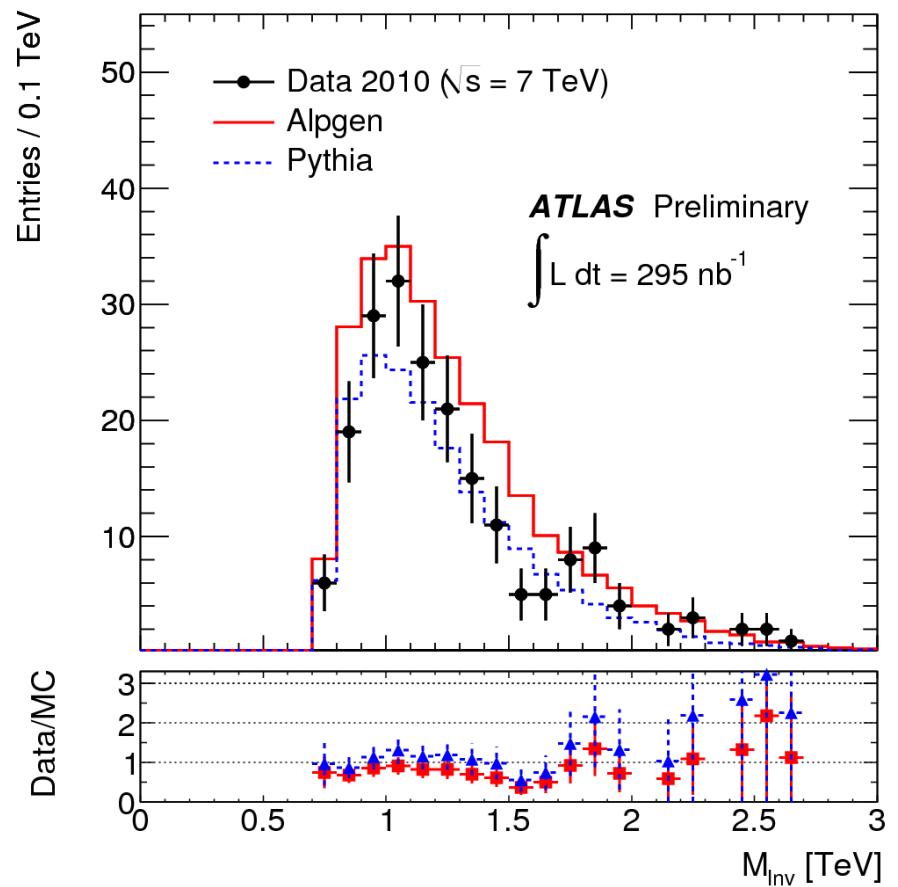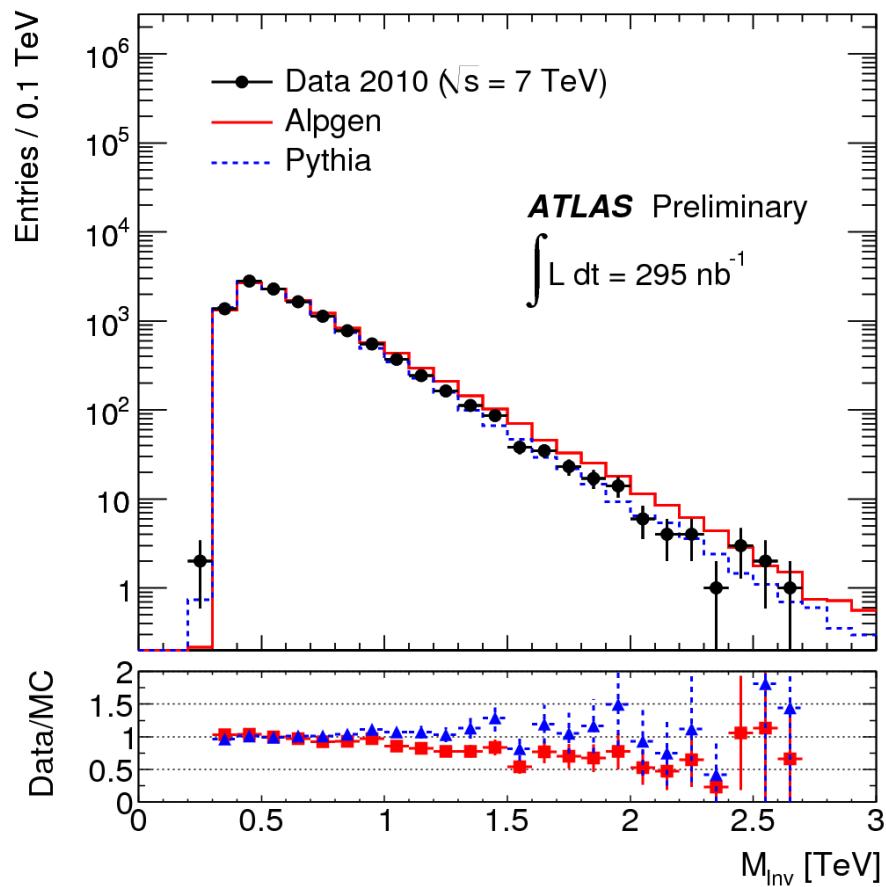
Invariant Mass with Uncertainties