DOE Review 2010

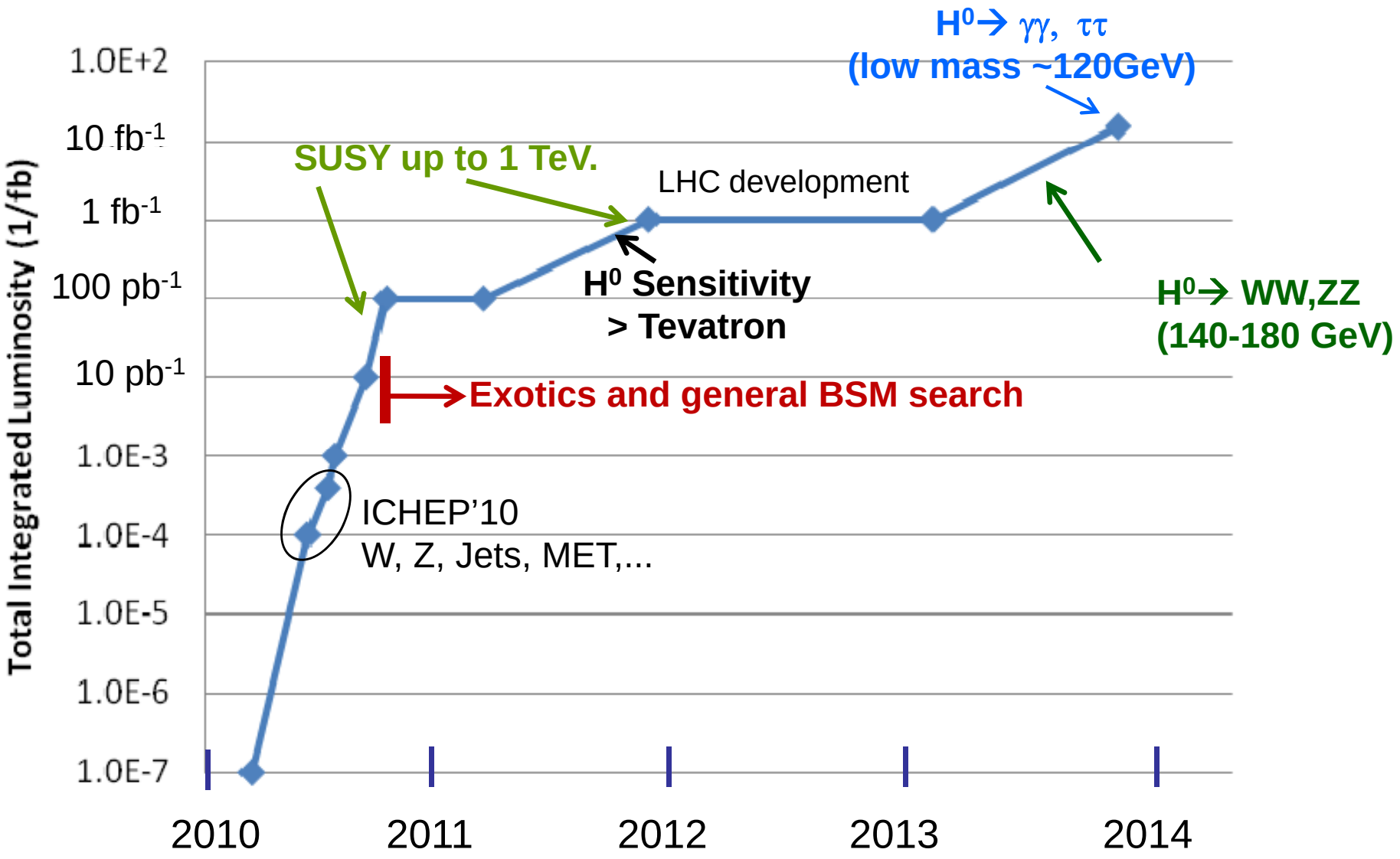
Plans for Physics Analysis

Yibin Pan

For the Wisconsin Task H-2
(B. Mellado and Y. Pan)

Aug 26, 2010

LHC Schedule and Physics (Next 3 Years)



Outline

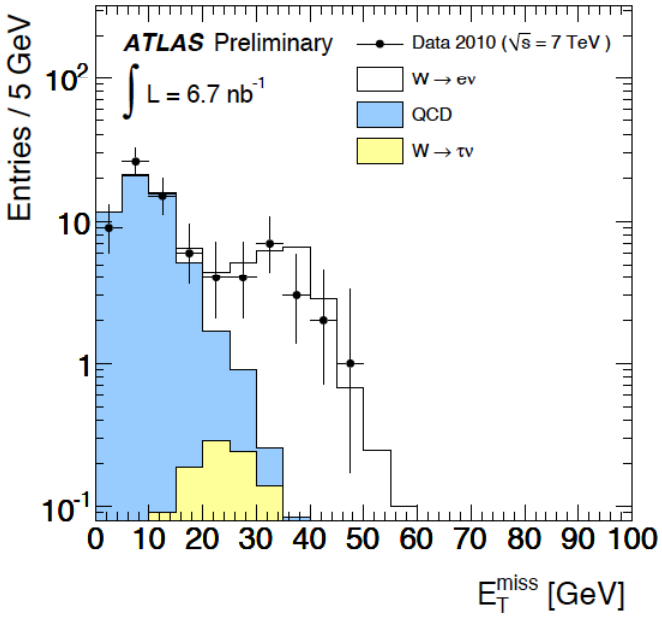
- Roadmap To the Higgs
  - Search for Double Weak Boson Production
  - First Higgs Limits (3σ analyses)
  - Higgs Discovery (5σ analyses)
- Search for Supersymmetry
  - Data Driven Background Estimation
  - Simultaneous Data Fitting for Signal and Background
- Beyond Standard model (BSM) Searches
  - Guided Topological Search
  - Low Background Topological Search
- Collaboration With UW Pheno
  - Explore New Idea and Writing Papers
  - Organization of CTEQ Summer School

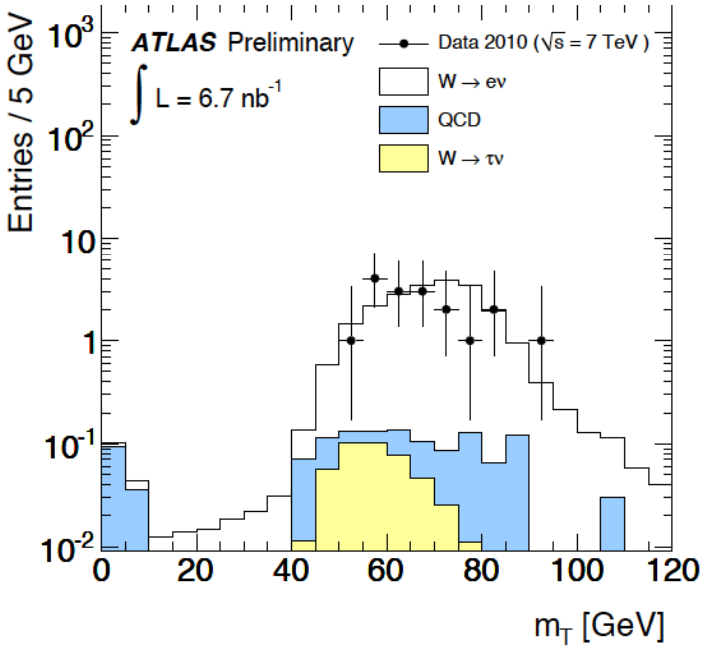
Roadmap To the Higgs

- For ATLAS data up to 1 fb^{-1}, we plan to concentrate on the Higgs search using the WW and ZZ channels
  - Plan to focus on the following areas

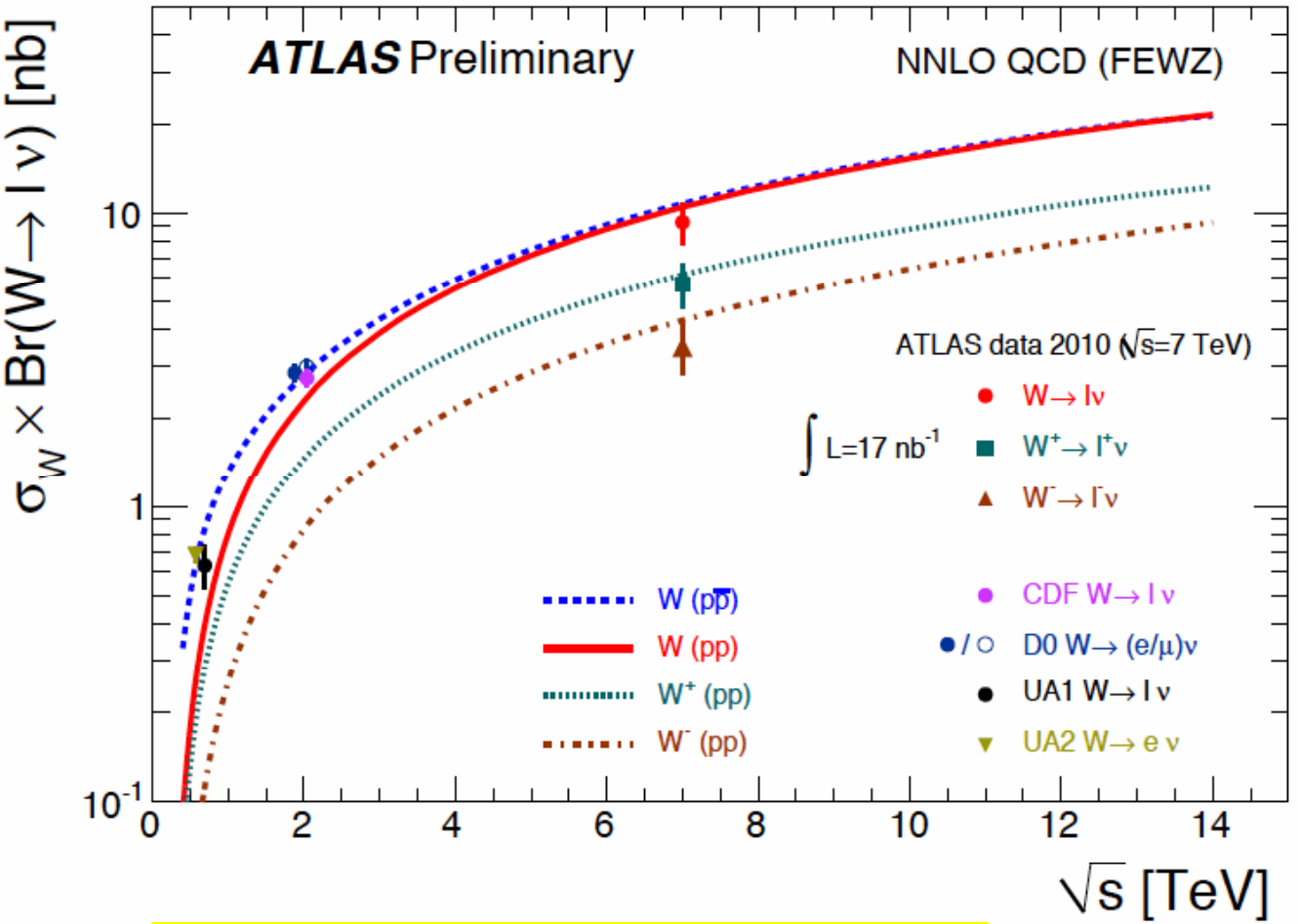
    (Y. Zhu, A. Kruse, B. Mellado)
    - Understanding of QCD and W+jets backgrounds
    - Measurement of WW and ZZ cross-sections
    - Application of data-driven methods for the evaluation of WW/ZZ backgrounds, data-driven extraction of jet veto survival probabilities, normalizations etc…
      - As proposed in Phys Rev D80 054023
    - Analysis and statistical interpretation in terms of exclusion limits
- In the meanwhile, we shall prepare for 10 fb^{-1} scenario (3 years from now), potential discovery within reach for up to 180 GeV
  - Will add $\gamma\gamma$ and $\tau\tau$ channel. (Y. Pan, B. Mellado and students)

Our knowledge was applied for the first observation of the W boson at ATLAS and the first cross-section. Made sure that the MET reconstruction was robust, get full confidence in the MET reconstruction at this early stage, define MET reconstruction, evaluate contribution from fake MET, MET systematics for x-sec





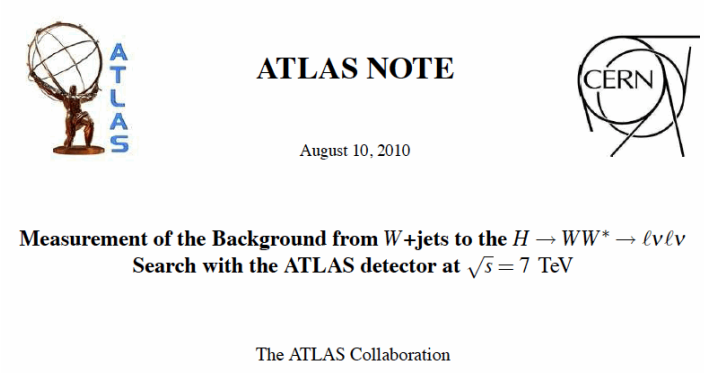
First observation of W and first cross-section



Systematic error due to MET 2%

The Roadmap to the Higgs

B. Mellado is the editor



ATLAS NOTE

August 10, 2010

Measurement of the Background from W+jets to the $H \to WW^* \to \ell\nu\ell\nu$ Search with the ATLAS detector at $\sqrt{s} = 7$ TeV

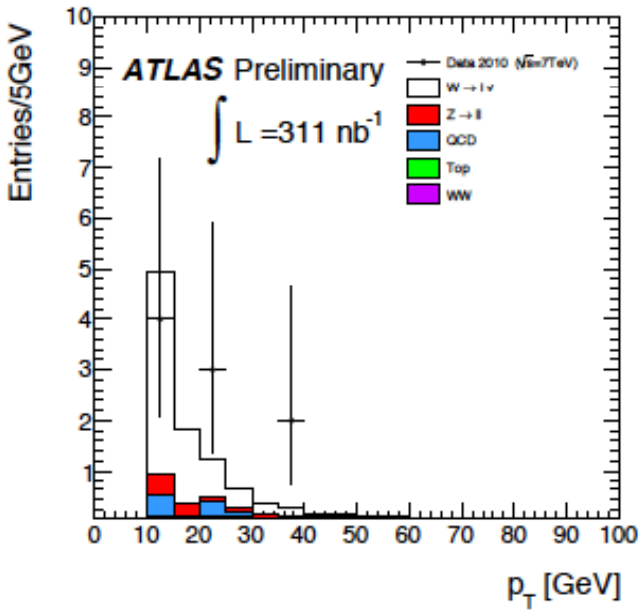
The ATLAS Collaboration

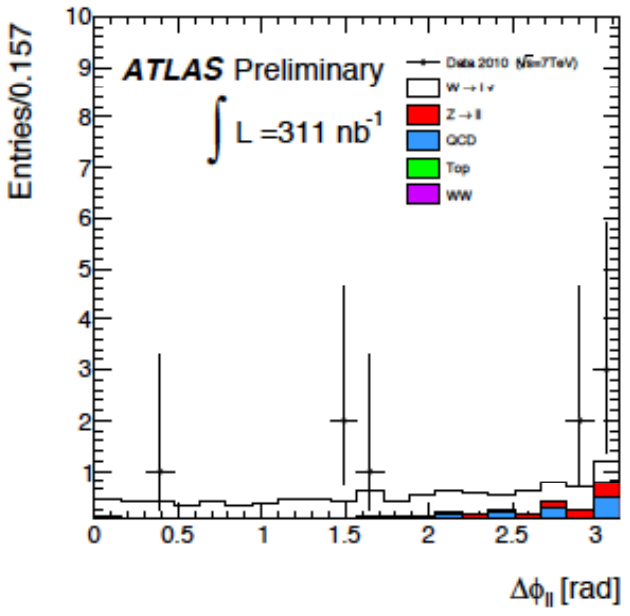
Following the success in the observation of the W the Higgs WG is preparing for the first Higgs related paper with data: first observation of one good lepton fake lepton

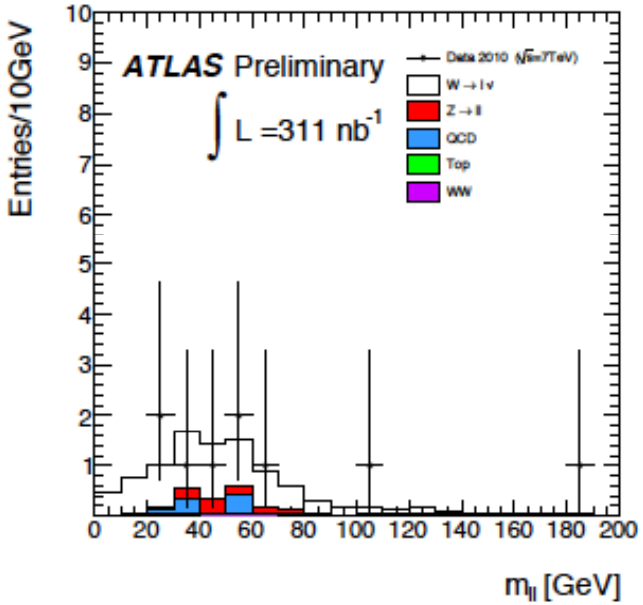
MC agrees well with data.

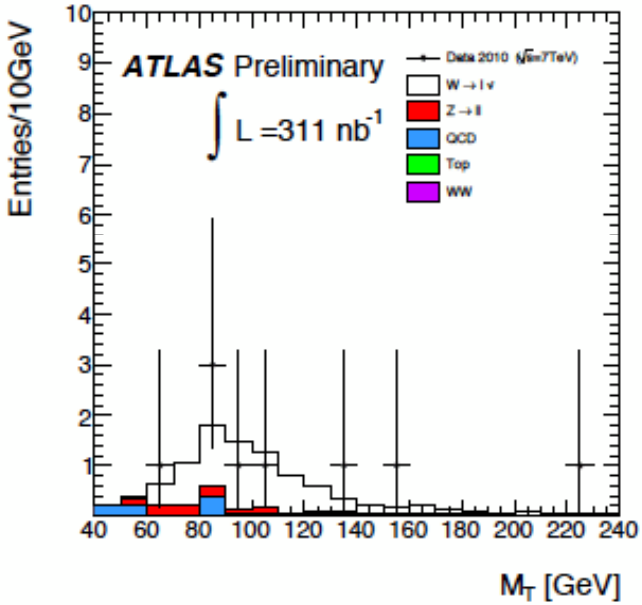
Gives is a lot of confidence that we will be able to search for a low mass Higgs with the WW decay mode!

One good lepton + one fake lepton from W+jets









Normalizing Weak Boson Pair Production at the Large Hadron Collider

J. M. Campbell, E. Castaneda-Miranda, Y. Fang, N. Kauer, B. Mellado, Sau Lan Wu

(Submitted on 13 Jun 2009 (v1), last revised 15 Sep 2009 (this version, v2))

The production of two weak bosons at the Large Hadron Collider will be one of the most important sources of SM backgrounds for final states with multiple leptons. In this paper we consider several quantities that can help normalize the production of weak boson pairs. Ratios of inclusive cross-sections for production of two weak bosons and Drell-Yan are investigated and the corresponding theoretical errors are evaluated. The possibility of predicting the jet veto survival probability of VV production from Drell-Yan data is also considered. Overall, the theoretical errors on all quantities remain less than 5-20%. The dependence of these quantities on the center of mass energy of the proton-proton collision is also studied.

Comments: 11 pages; added references, minor text revisions, version to appear in Phys. Rev. D
Subjects: **High Energy Physics - Phenomenology (hep-ph)**
Journal reference: Phys.Rev.D80:054023,2009
DOI: 10.1103/PhysRevD.80.054023
Cite as: **arXiv:0906.2500v2 [hep-ph]**

Phys Rev D80 054023

Submission history

From: Bruce Mellado [view email]
[v1] Sat, 13 Jun 2009 20:17:03 GMT (204kb)
[v2] Tue, 15 Sep 2009 01:49:32 GMT (869kb)

Method supported by ATLAS and CMS

Excerpt from the talk of A. Korytov, Higgs convenor of CMS at Higgs cross-section meeting, CERN, July 6th 2010.

Two choices:

- **$M_{ll} = m_Z$ (independent of m_{4l})** **CMS NOTE 2006/068 (2006)**
  - plenty of statistics and very clean
  - but we will be losing the correlation between ZZ and Z as m_{4l} slides away from m_Z
- **$M_{ll} = m_{4l}$ (follow m_{4l})** **Phys. Rev. D80, 054023 (2009)**
  - penalty in the statistics in the control sample
  - keep much tighter correlation between ZZ and Z at large m_{4l}

Search for Super Symmetry

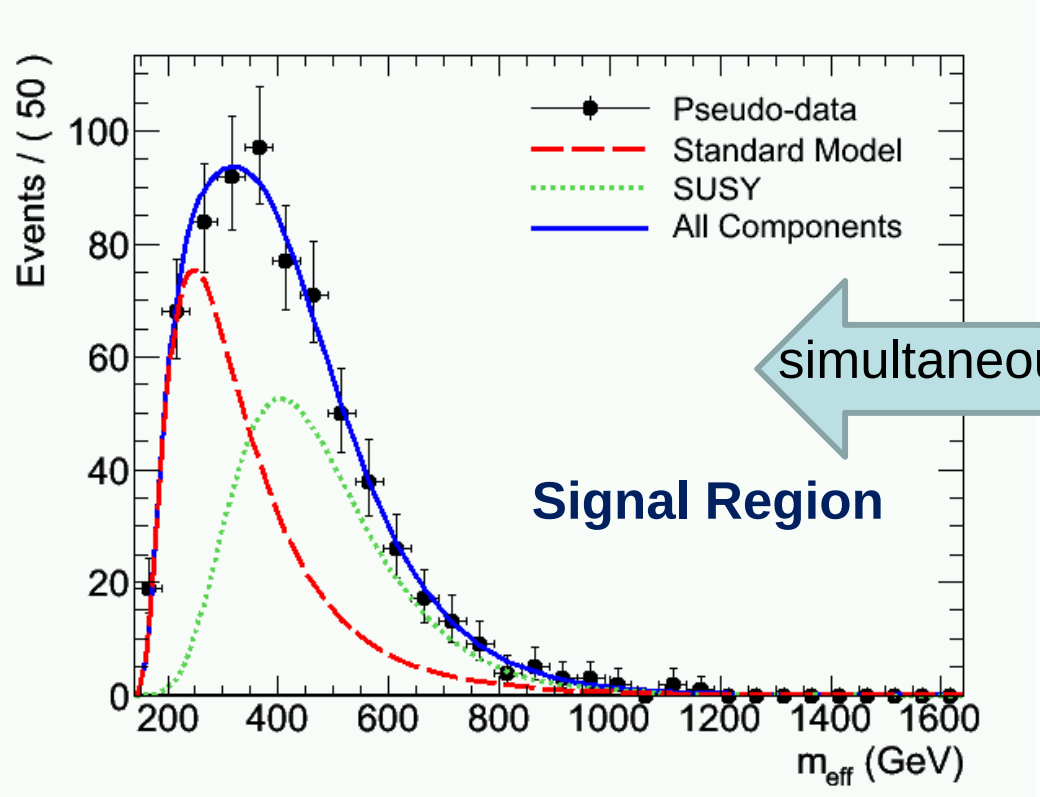
- Since 2007, Y. Pan, through his own work and the work of postdocs he directly supervise, has been making active contributions to the ATLAS SUSY working group. Efforts are in three main directions:
  - Define and optimize selection criteria
  - Data driven background estimation with control samples
  - Simultaneous fitting for signal and backgrounds from data.

  → Our work has resulted in a number of ATLAS approved notes.

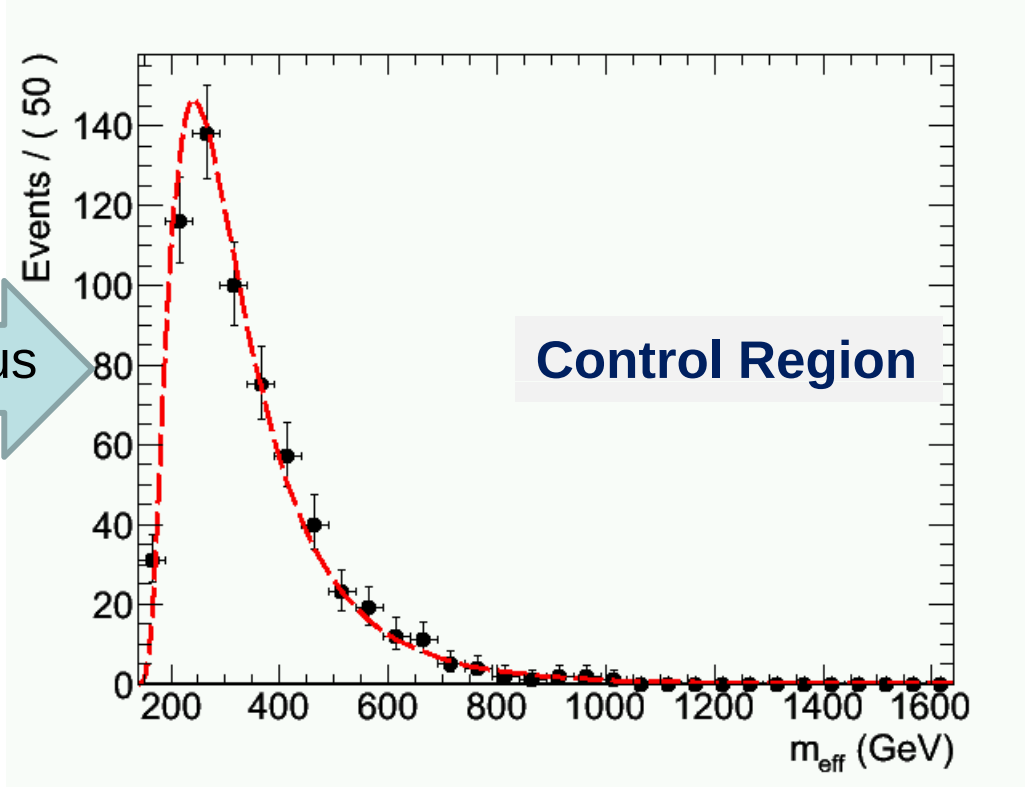
  → We (Y. Pan, X. Chen and students) will continue the efforts.

- In addition, our expertise on MET will be very useful to study/control SUSY backgrounds. (B. Mellado and Y. Pan will continue in this direction.)

Fitting Signal and Background Simultaneously from Data

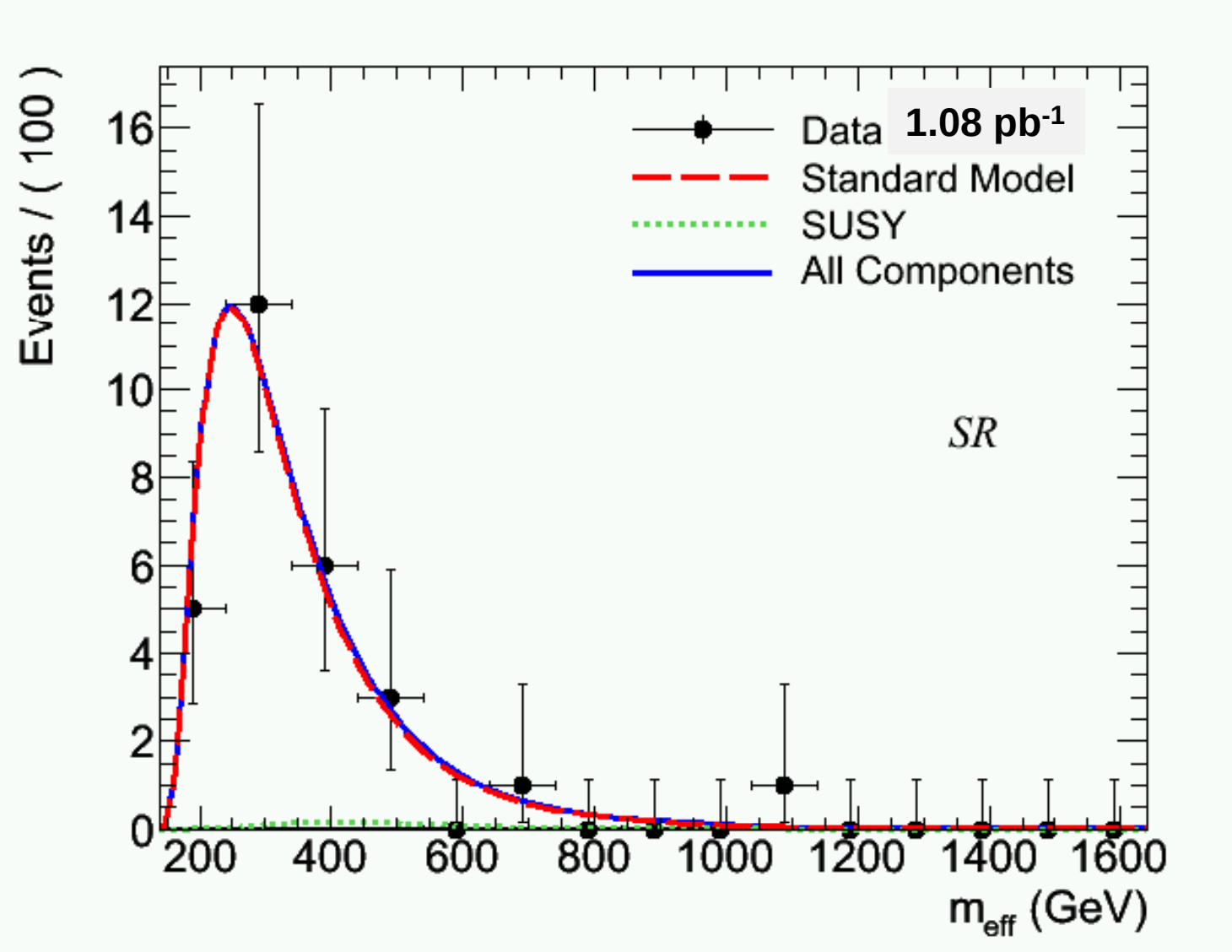


simultaneous



- After fitting projection plots shown for m_{eff}. Actual fitting done in multiple-dimensionally.
- In the fitting, both signal and background yields are let float. The shape of the fitting variables are semi-float: shapes are treated with fixed parameterization but the actual parameters are float.
- The method was used extensively and successfully at BaBar. (and other experiments).

Unofficial Fitting to ATLAS Data



Plot made privately and shown for demonstration purpose only. !

Model Independent Search for BSM

- Model independent searches for Beyond Standard Model (BSM) Physics have always been a hot topic for front line colliders.
  - Y. Pan once initiated some topologic search approaches at LEP/ALEPH in which events are categorized into “boxes” defined by leptons(flavor & charge) , jets/b-jet, photons, missing energy, etc...; New physics is hinted by excesses above SM expectations in certain boxes.
  - This approach was also used by many at Tevatron.

- However, in practice, the method has not been successful.
  - Too many “boxes”. (hundreds in some cases)
  - Lacking reliable statistical means to quantify potential excesses.
  - More importantly, lacking means to reliably estimate the SM contribution to each box, especially with Hadron collisions.

New Approaches to General BSM Search

- **Guided Topological Search**
  - Efforts initiated by a number of theorists who later formed "New Physics Working Group" (NPWG).
  - First Joint ATLAS, CMS and Theory Meeting was held at CERN on June 4th 2010. The meeting defined initial goals and actions
    - Y. Pan actively participated the June 4th discussion.
  - New Approach:
    - Theorists define certain high priority "Topology Sets" to be searched for. These theoretical topologies are constrained by kinematics/phase-space only. (Still largely model independent)
    - Experimentists map those Topology Set to experimental signatures, and study their efficiency and backgrounds.
- **Low Background Topologies**
  - Concentrating only on those topologies with very low SM contributions. → Background uncertainty is of less a problem.
  - Y. Pan initiated this idea in ATLAS in 2008. A few presentations are given and the work is still on going

Collaboration with Pheno (UW)

- *We collaborate closely with various members of the Pheno group in Madison*
  - *Discussions of physics*
  - *Writing papers*
  - *Organization of CTEQ summer school*

T.Han and B.Mellado have been invited to contribute to report to ECFA on the potential of Higgs physics at a future LHeC (electron-proton machine at CERN)

Higgs Boson Searches and the $Hb\bar{b}$ Coupling at the LHeC

Tao Han[1,*] and Bruce Mellado[1,†]

[1] *Department of Physics, University of Wisconsin, Madison, WI 53706, USA*

Once the existence of the Higgs boson is established at the CERN Large Hadron Collider (LHC), the focus will be shifted toward understanding its couplings to other particles. A crucial aspect is the measurement of the bottom Yukawa coupling, which is challenging at the LHC. In this paper we study the use of forward jet tagging as a means to secure the observation and to significantly improve the purity of the Higgs boson signal in the $H \to b\bar{b}$ decay mode from deep inelastic electron-proton scattering at the LHC. We demonstrate that the requirement of forward jet tagging in charged current events strongly enhances the signal-to-background ratio. The impact of a veto on additional partons is also discussed. Excellent response to hadronic shower and b-tagging capabilities are pivotal detector performance aspects.

PACS numbers: 11.15.Ex,14.80.Bn

Phys Rev D82, 016009 (2010)

2011 CTEQ Summer School

The Coordinated Theoretical-Experimental Project on QCD

(CTEQ)

will organize and conduct the sixteenth
CTEQ Summer School on QCD Analysis and Phenomenology
at

Madison, Wisconsin USA

The spokespeople of the CTEQ collaboration have asked **B.Mellado (member of CTEQ) to be the lead organizer** of the 2011 CTEQ Summer School

In collaboration with T.Han and Y.Pan