

Collaboration SDU(ACC)-LPSC
Single Top Analysis

LPSC Grenoble & Shandong University
(Since 2008)

April 7, 2011

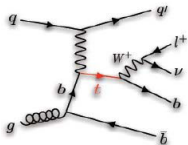
General Introduction

Manpower in Collaboration and Students Exchange in 2010

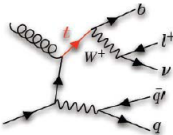
- 4 PhD/Master students
 - Thomas Delemontex (PhD in LPSC)
 - Jin Wang (Co-PhD SDU-LPSC)
 - Xiaohu Sun (SDU Master → LPSC PhD)
 - Peng Ge (Master in SDU)
- 5 senior researchers
 - Benoit Clement, Cunfeng Feng, Julien Donini, Annick Lleres, Arnaud Lucotte
- Students Exchange in Collaboration in 2010
 - 2010-06: 1 month at cern for Jin
 - 2010-09: Xiaohu became a PhD in LPSC funding by China.
 - 2010-10: 2 months for Peng and 3 months for Jin in LPSC

Introduction of Single Top Studies

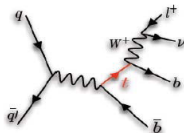
Single Top Production in LHC



t-channel



Wt channel



s-channel

Features of Single Top Production in LHC

- 1 high p_T lepton (electron/muon)
- Large missing E_T (E_T^{miss})
- 2-4 high p_T jets
- Presence of the b-jets

Introduction of Single Top Studies

Motivation of Single Top Studies

- Precision measurement on the Standard Model
 - Establish electroweak production mechanisms of top quark
 - Direction measurement of $|V_{tb}|$, couplings
- Probe of new physics
 - Sensitive to anomalous couplings: t-channel
 - Sensitive to extra charged boson: Wt , s-channel
-

A Little History

- Single top studies at the TeVatron (2009)
 - $\sigma(s + t)$ measured with 21% precision
 - $|V_{tb}|$ measured to $\sim 8\%$
- Some challenge:
 - Evidence for t-channel alone still to be shown
 - $W+t$ is kinematically inaccessible

ATLAS Single Top Group Activities in LHC

10TeV Notes Before Data Taking

- Public note: ATL-PHYS-PUB-2010-003
- Establish strategy of single top events searching with early data (10TeV)
 - Devised data-driven techniques to estimate main backgrounds
 - Likelihood method to optimize single top event selection
- Results shown cross section measurement limited by systematic uncertainties:
 - Need better understanding of the backgrounds
 - Significant improvement with advanced b-tagging algorithm

ATLAS Single Top Group Activities in LHC

First Single Top Results form LHC with 7TeV Data

- Conference note: ATLAS-CONF-2011-027
- Using 35pb^{-1} collected data in the 2010 LHC run
- Obtained single top t-channel results:
 - Cut based selection and likelihood approach
 - $\sigma_t = 53_{-36}^{+46}$ pb (standard model expectation: 66 pb)
 - Upper limit of 162 pb at 95% confidence level
- Wt channel cross section measurement results:
 - Selection: one or two leptons, jets and missing transverse energy
 - A 95% confidence level limit: $\sigma_{Wt} < 158\text{pb}$ (SM: 15pb)

Collaboration SDU-LPSC

Important contributions from SDU-LPSC collaboration for both notes

Collaboration Activities

- Monte Carlo Generation and Validation
- Single top event selection evaluation and data challenge
- Multijet backgrounds estimation for single top cross section measurement
- Other collaboration work.

Collaboration SDU-LPSC: Monte Carlo Generation

Monte Carlo Generation and Validation

- Single top and top pair Monte Carlo events generation:
 - Generator: MC@NLO 3.41, PDF set version: CTEQ6.6
 - Assumed top quark mass: 172.5 GeV
- Understanding issues with generators:
 - Tuning of Hadronization/showering, pile-up
 - Dependence in PDF set
 - Validation of NLO generators

Collaboration contribution to common single-top group tasks

Collaboration SDU-LPSC: Single Top Event Selections

Cuts Evaluation and Data Challenge

- Single top event pre-tag and tag selection:
 - General purpose events selections
 - Trigger requirement and trigger matching
 - $M_T^W + E_T^{miss} > 60\text{GeV}$ (M_T^W : W transverse mass)
 - One and only one tight lepton
 - 2-4 selected jets
 - $E_T^{miss} > 25\text{GeV}$
 - Exactly one selected b-jet.
- Evaluate performance of these cuts with different limits.
- Define standard cut flow for everyone to cross check.

Collaboration contribution to common single-top group tasks

Collaboration SDU-LPSC: Multijet Estimation

Multijet Backgrounds Estimation for Single Top Analysis

- Matrix method for multijet backgrounds estimation:

$$N^{loose} = N_{real}^{loose} + N_{fake}^{loose}$$

$$N^{tight} = N_{real}^{tight} + N_{fake}^{tight} = \epsilon_{real} N_{real}^{loose} + \epsilon_{fake} N_{fake}^{loose}$$

$$N_{fake}^{tight} = \frac{\epsilon_{fake}}{\epsilon_{real} - \epsilon_{fake}} (N^{loose} \epsilon_{real} - N^{tight})$$

- N^{loose} : Number of events with one loose lepton
- N^{tight} : Number of events with one tight lepton
- Using data to obtain $\epsilon_{real} = \frac{N_{real}^{tight}}{N_{real}^{loose}}$ and $\epsilon_{fake} = \frac{N_{fake}^{tight}}{N_{fake}^{loose}}$.
- N_{fake}^{tight} : Estimated multijet events after tight selection

Collaboration SDU-LPSC: Multijet Estimation

ϵ_{real} from ZDiLeptons Control Sample

- Select control sample: $z \rightarrow ll$
- Tag and probe method:
 - Two loose leptons with one tight.
 - Ask the other to pass the tight criteria, obtain ϵ_{real}

Iteration Method for ϵ_{fake}

- Use multijet enriched control sample ($E_T^{miss} < 10\text{GeV}$)
- Iteratively reduce contributions from $w/z+\text{jets}$ events.
- Finally $\epsilon_{fake} = \frac{N_i^{tight}}{N_i^{loose}}$, i means i_{th} iteration.

Collaboration SDU-LPSC: Multijet Estimation

Estimated Multijet Events in Data after Selections

- Results are parameterized and finally separated into jet bins.
 - integral luminosity 35pb^{-1}
 - Results for moriond conference.

Electron Channel	2 jets	3jets	≥ 4 jets
$N_{data}^{selected}$	163 ± 13	141 ± 12	179 ± 13
$N_{QCD}^{estimated}$	8 ± 8	11 ± 11	6 ± 6

Muon Channel	2 jets	3jets	≥ 4 jets
$N_{data}^{selected}$	265 ± 16	170 ± 13	203 ± 15
$N_{QCD}^{estimated}$	42 ± 21	22 ± 11	13 ± 7

Collaboration contribution to background estimation in single top
7TeV Note

Collaboration SDU-LPSC: Other Activities

Other SDU-LPSC Collaboration Work

- Object calibration : B-tagging for single-top selection:
 - Calibration of the b-tagging efficiency using $p_T^r e/$ and System8
 - Calibration of rejection rate using negative weight method
- Contributions in single top analysis with 7TeV Data
 - Cut based analysis for the Wt -channel
- The validation/development of common tools
 - Single top ntuple maker (created, developed, maintained by LPSC)
 - Common analysis framework initially developed in LPSC

Collaboration contribution of calibration, analysis cross check and software service

Summary

Collaboration SDU-LPSC

- Active collaboration work and intense communications between SDU and LPSC
- Help both group to balance manpower and to finish common tasks.
- Provide important contributions in single top group at ATLAS in LHC.

Future Plans

- Collaborate on multi variable techniques (BDT) for single top t-channel cross section measurement
- Further studies on Wt channel measurement
- Plan to develop data-driven method for $t\bar{t}$ background estimation in single top analysis.

THANK YOU