

Search for BSM phenomena in top events: Heavy charged Higgs



Top physics @ LPSC

- Motivation : single-top production @ LHC
- Present activities in single-top measurements

Top physics beyond Standard Model

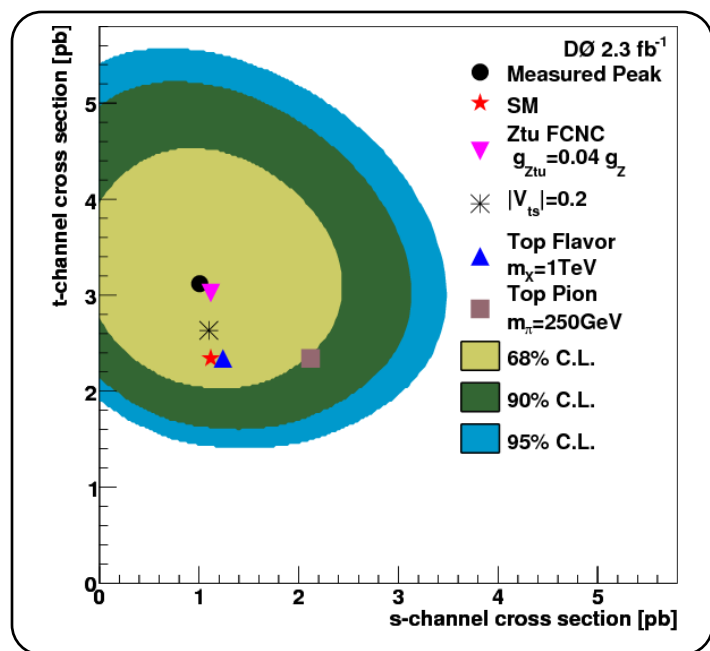
- Search for FCNC, polarisation measurement
- Direct search for a heavy charged Higgs
- Indirect search for extra bosons

A. Lleres, A. Lucotte, J. Collot
G. Belanger, S. Kraml
A. Ferrari (Uppsala)

Motivation for single-top measurement

Specific Constraint on the Standard Model

- Establish electro-weak top production mechanisms
- Offers a direct measurement of W - t - b vertex:
with complementary measurements
- Constrain production mechanisms of top quark
fully polarized production
- Single-top production : defined at LO
Care must be used at NLO (specifically for tW)



Probe for new phenomena BSM

3 channels are sensitive to different types of new physics

— Cross-section and polarization measurements:

[t-channel] sensitivity to FCNC,
anomalous couplings,
 $|V_{tb}|$, 4th generation quark

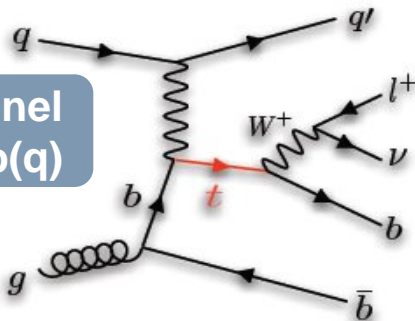
[s-channel] sensitivity to extra charged ($W^\pm / \phi^\pm / \pi^\pm$)
anomalous couplings,
 $|V_{tb}|$, 4th generation quark

[tW-channel] sensitivity to $|V_{tb}|$

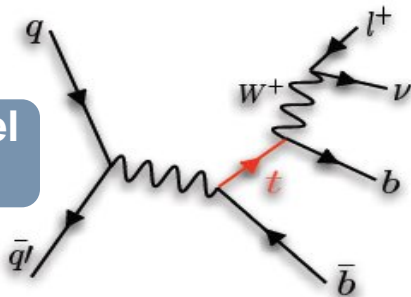
→ tW sensitive mostly to modified $|V_{tb}|$. Allows to disentangle effects of distinct sources of BSM !

What do we know about single-top ?

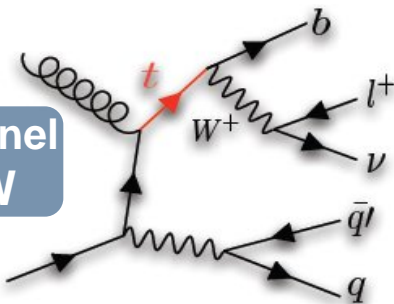
t-channel
 $gq \rightarrow tb(q)$



s-channel
 $q\bar{q} \rightarrow tb$



W+t channel
 $b\bar{g} \rightarrow tW$



Results from the TeVatron

Production established in 2009

- $\sigma(s+t)$ measured with 21% precision
- *t-channel* production established at 5σ
- *s-channel* production at 3σ with 10 fb^{-1}
- *tW-mode* production not accessible !
- $|V_{tb}|$ determined to $\sim 8\%$
- Tests of anomal. couplings (vector, tensor, L/R)
 $|V_{tb}| \times f_{LV}$, $|V_{tb}| \times f_{LT}$, $|V_{tb}| \times f_{RV}$, $|V_{tb}| \times f_{RT}$

ATLAS strategy at 7/8 TeV

t-channel: rediscover and do precise measurement

s-channel: to establish

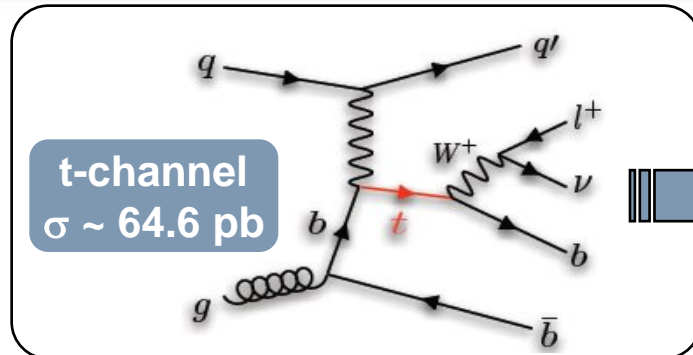
Wt production: establish and measure

Large program of searches in single-top :

- anomal. couplings, FCNC (TOPQ-2011-18)
- new extra bosons W' (TOPQ-2011-20)
- new 4th generation quarks (TOPQ-2012-09)
- etc...

The LPSC is involved
In all 3 channels

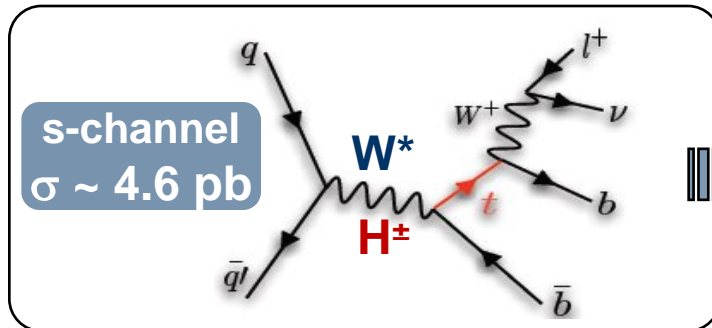
Single-top : present involvements @ LPSC



t-channel cross-section measurement

Annick (+Julien) + 2 PhD (Jin Wang , Xiaohu Sun)

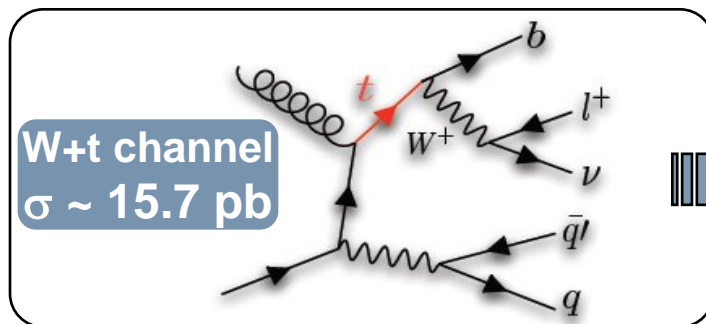
- Cross-section (published, PhD defense / End june)
- FCNC (participation to paper published)
- Polarisation (in progress)



S-channel cross-section measurement

Arnaud, Annick + 1 PhD (Caterina Monini)

- Discovery at 7+8 TeV (in progress)
- Mesure de déviations et interprétations en termes de bosons supplémentaires (W' , H^\pm)

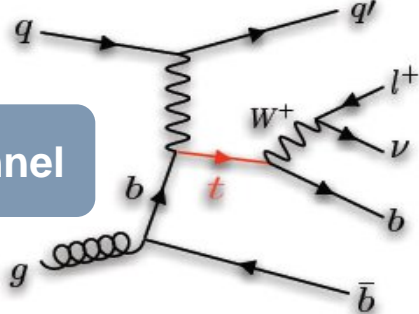


Measurement of tW production

Benoit, Arnaud + 1 PhD (Thomas Delemontex)

- 3-sigma evidence (published last Monday!) in dilepton channel
- Limits at 95% CL in lepton+jets channel

t-channel

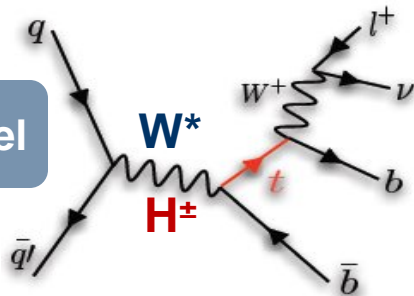


BSM phenomena in t-channel

Annick, Genevieve ? + 1 PhD ?

- Polarisation and anomalous coupling
- Phenomenology/interpretation (effective Lagr.)

s-channel

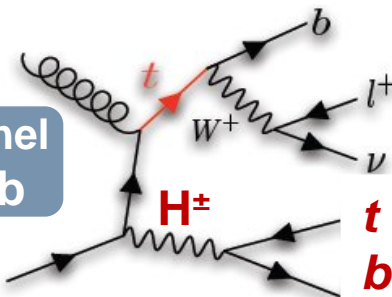


BSM phenomena in s-channel @ 13 TeV

Arnaud, Annick + 1 PhD ?

- Measurement at 13 TeV and high lumi
- Measurement of cross-section deviations and interpretation in terms of extra bosons (W' , H^\pm)
- Direct search for heavy charged Higgs
 $cs \rightarrow H^\pm \rightarrow tb$ (scalar vs vector)

tH $^\pm$ channel
 $\sigma=4-1$ pb



BSM in associated production: charged Higgs

**Johann, Arnaud, Genevieve,
+ Uppsala (A.Ferrari) and 1 PhD (Alexander)
+ 1 postdoc ?**

- Search for a heavy charged Higgs
 $m_{H^\pm} > m_{\text{top}}$ avec $H^\pm \rightarrow tb$

Past and present activities

Strong involvements of the LPSC group in EW top production since 2005

- 4 seniors (will turn to 3 from September on)
 - 4 PhDs (1 has defended her PhD, 2 will be defending their PhD this year)
- Linked to Phenomenology : major achievement
- Carole 's PhD with M. Klasen \rightarrow NLO (QCD) computation of tH^\pm , now in POWHEG
- Major experimental achievements:
- Rediscovery of t-channel, first evidence for tW , FCNC (all 3 published)

Projection for the 13 TeV run

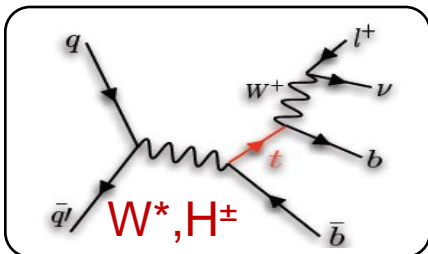
Once EW top production is established, turn to BSM Top physics with LAPTH

- Indirect search for extra heavy bosons (W' , H^\pm) in s-channel, tW channel
- Search for deviation in polarisation, anomalous couplings measurement
- Direct search for heavy charged Higgs : high mass \rightarrow search in tb final state
 - \rightarrow in s-channel
 - \rightarrow in the golden channel $pp \rightarrow tH^\pm \rightarrow t(tb)$
- Need collaboration from phenomenologists
 - \rightarrow NLO s-chan (via H^\pm), new decays for H^\pm

**Would need a post-doc position dedicated to charged Higgs search
In 2012/2013 and 1 PhD starting in 2013/2014**

Extra material

s-channel and H^\pm with 30 fb^{-1} at 14 TeV ?



Disclaimer

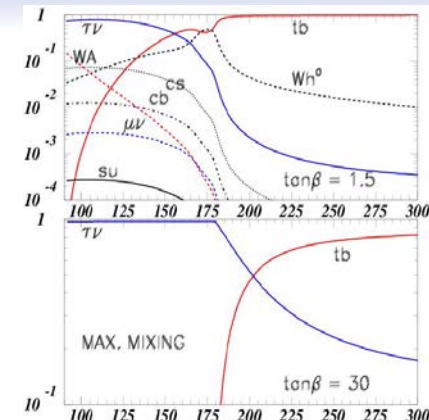
This analysis has been performed during CSC

- Optimistic in certain aspects (systematics)

MC generator

- TopRex 4.1 used (LO) with MSSM type-II models

These numbers should thus be taken with care !



Analysis (CSC-like)

- 1) measure s-channel in e, μ and look for deviations

- interpret in terms of charge Higgs boson

Analysis based on a likelihood:

- $H_T(j1, j2)$, $m_{\text{top}, b1}$, $m_{\text{top}, b2}$

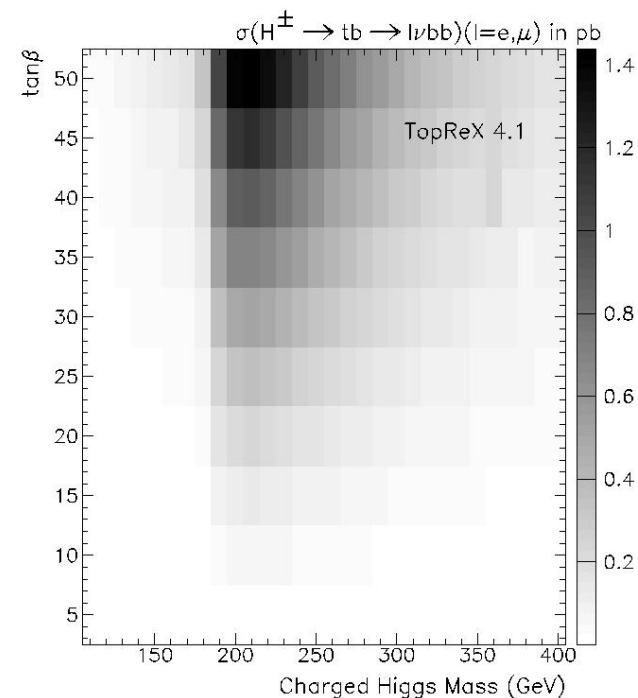
Cut on likelihood:

- Optimized by minimizing systematic uncertainties
JES, btagging, ISR/FSR, tt/W+jets bkgd etc...

- 2) Differentiate s-channel from H^\pm decay

- Use of angular correlation in decay products

- Train MVA s-chan vs H^\pm



s-channel and H^\pm with 30 fb^{-1} at 14 TeV ?

Signal Selection : likelihood

Three discriminating variables:

— $H_T(j1,j2)$, $m_{\text{top},b1}$, $m_{\text{top},b2}$

Cut on likelihood

— Optimized by minimizing systematic uncertainties
JES, btagging, ISR/FSR, tt/W+jets bkgd etc...

