# High $p_T$ b- and top physics

Marcel Vos – IFIC Valencia
Gustaaf Brooijmans – Columbia University

# High $p_T$ b- and top physics

**A wealth of exotic physics yields final states with boosted b- and/or top quarks:**

(sequential) Z'

EDM, Randall-Sundrum graviton **B. Lillie, hep-ph/0701166,**

6DSM

twin/little Higgs W' $\rightarrow$ tb

little Higgs with T-parity: T $\rightarrow$ tA

topcolor signatures **C. Hill, S. Park, PRD49, 4454, 1994**

# First "exploratory" phone meeting 29th January

## High pT b/top

**Tuesday 29 January 2008**
from **16:00** to **19:05**
at **Phone** ( ***13-2-005*** )
chaired by:
***Gustaaf Brooijmans (Columbia)***,
***Marcel Vos (IFIC Valencia)***

Tuesday 29 January 2008 |

### Tuesday 29 January 2008

top

| | | |
|---|---|---|
| 16:00 | Introduction (20') ( Slides ) | Gustaaf Brooijmans (*Columbia University*) , Marcel Vos (*IFIC Valencia*) |
| 16:20 | Studies on sample 5201 (15') ( Slides ) | Erik van der Kraaij |
| 16:35 | Studies on Z' vs Light Jets: Jet Mass and YSplitter (15') ( Slides ) | Gustaaf Brooijmans (*Columbia University*) |
| 16:50 | Highly boosted top reconstruction (15') ( Slides ) | Akira Shibata (*New York University*) |
| 17:05 | Electron ID (15') ( Slides ) | Denver Whittington |
| 17:20 | Z' -> tt Study (15') ( Slides ) | Ben Smith (*Harvard University*) |
| 17:35 | B-tagging Studies (15') ( Slides ) | Vivek Jain (*Indiana University*) |
| 17:50 | Tops in SUSY (15') ( Slides ) | Christophe Clement (*CERN*) |
| 18:05 | Phase Space Studies in samples 6230-6234 (15') ( Slides ) | Florian Hirsch (*Universitat Dortmund*) |
| 18:20 | W' -> tb in Twin Higgs (15') ( Slides ) | Manouk Rijpstra (*NIKHEF*) |
| 18:35 | Valencia Plans (15') ( Slides ) | Marcel Vos (*IFIC Valencia*) |
| 18:50 | high pt top reconstruction for top antitop resonance search (15') ( Slides ) | Dominique Pallin (*Laboratoire de Physique Corpusculaire (LPC)*) |

# First "exploratory" phone meeting 29th January

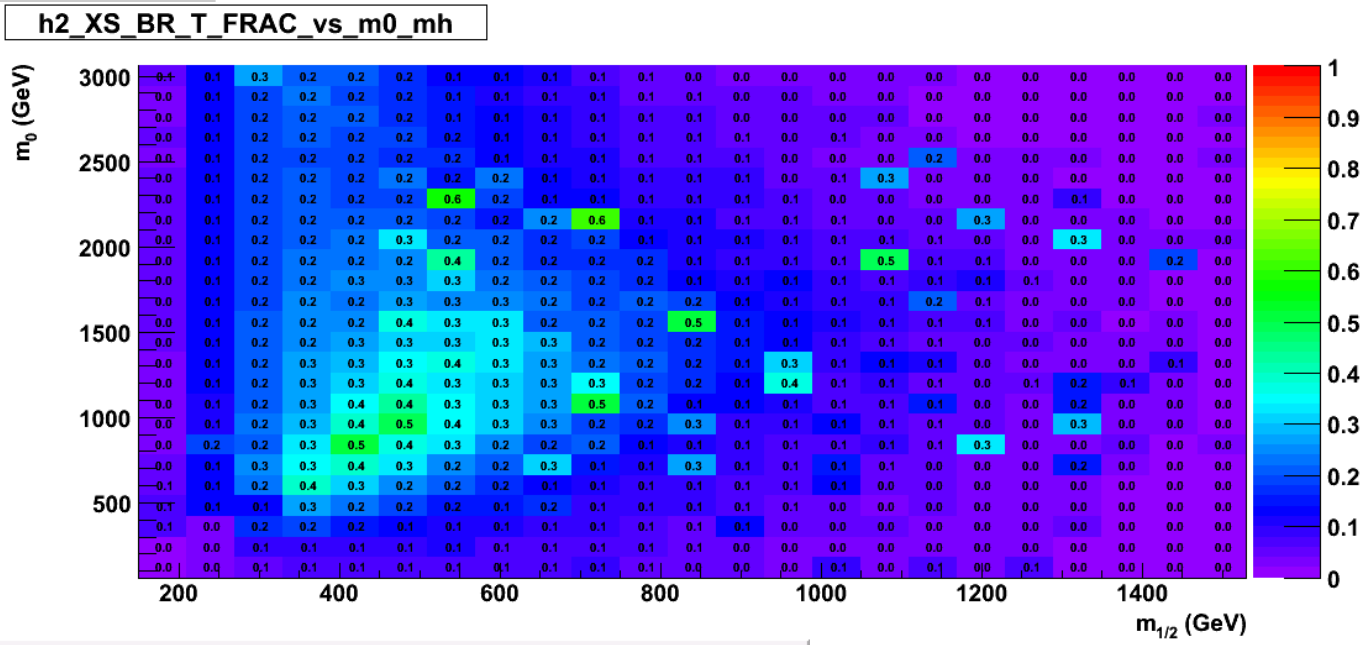
http://indico.cern.ch/conferenceDisplay.py?confId=26662

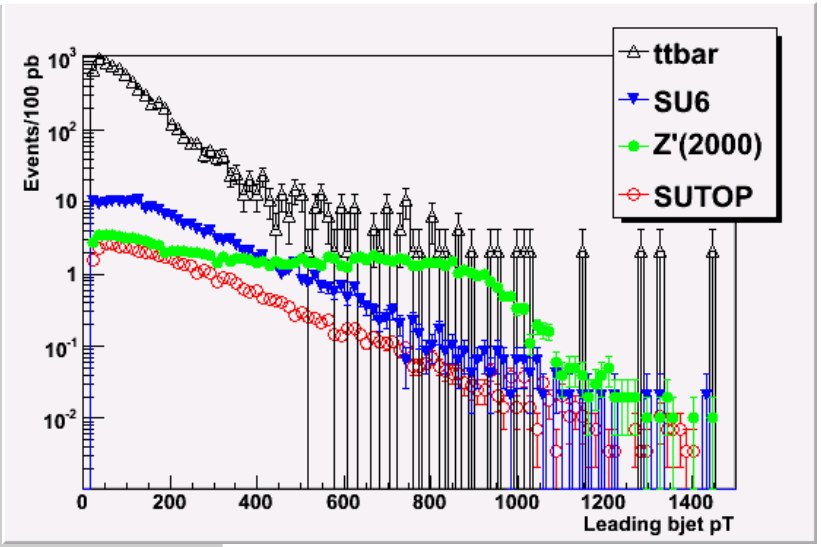
12 high-quality presentations on "studies in progress", many more "expressions of interest"

Interest from top physics WG, SUSY WG

Strong overlap with performance groups (jets, flavour tagging)

# Overlap with SUSY group



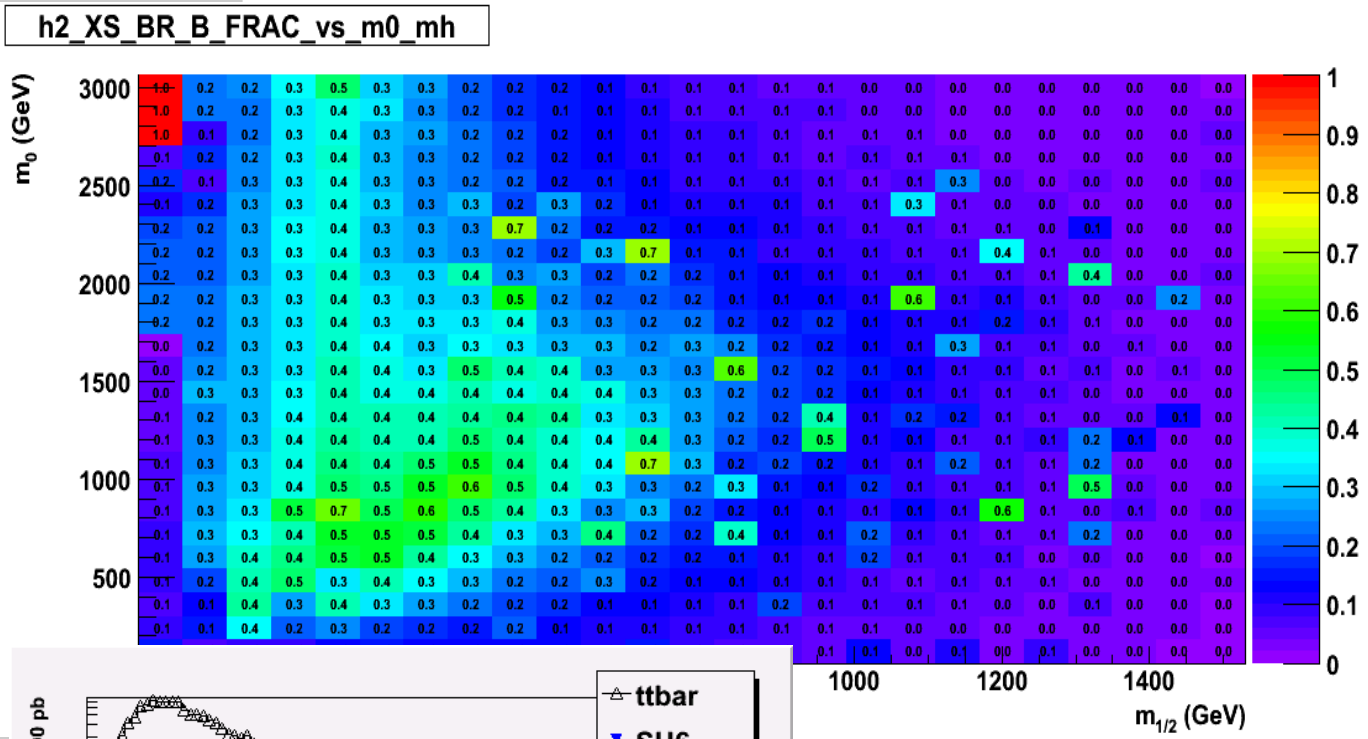

*Abundance of b-jet production in MSUGRA parameter space*

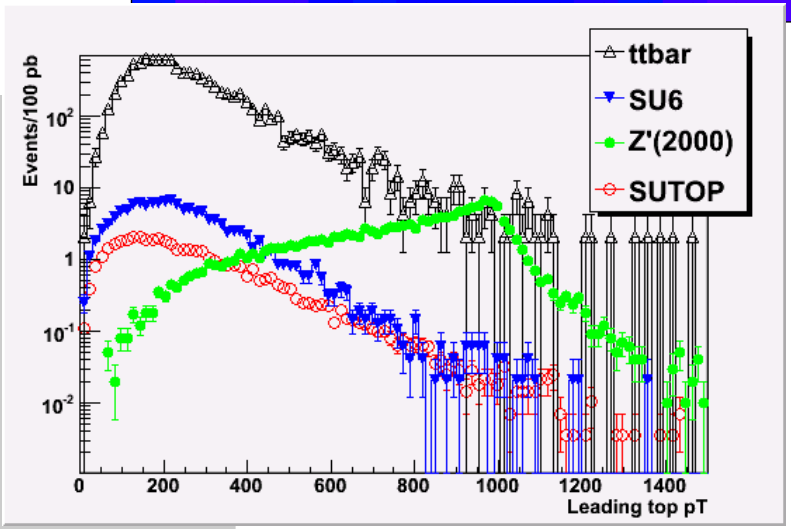
and

**SUSY b-jet spectrum**

C. Clement, Stockholm University

# Overlap with SUSY group



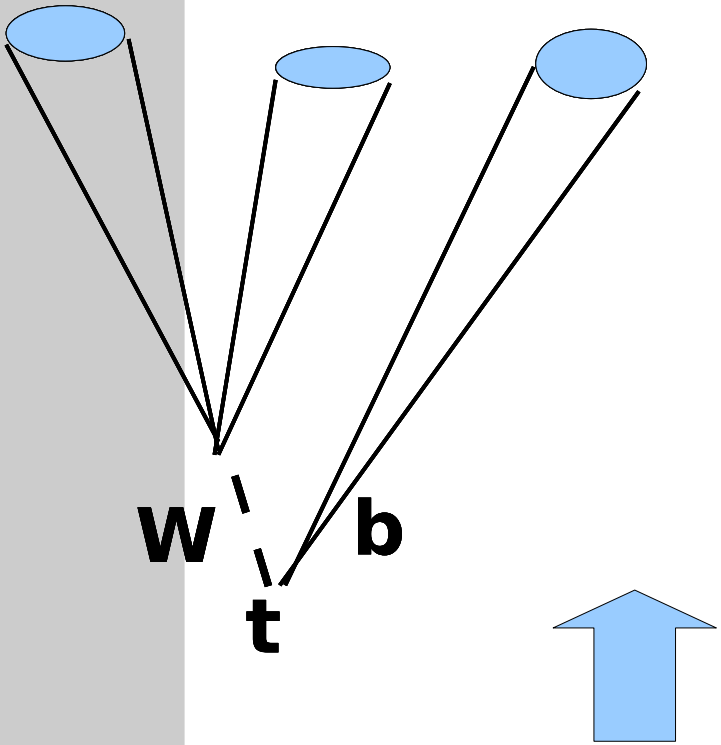

*Abundance of top production in MSUGRA parameter space*

and

**SUSY top spectrum**

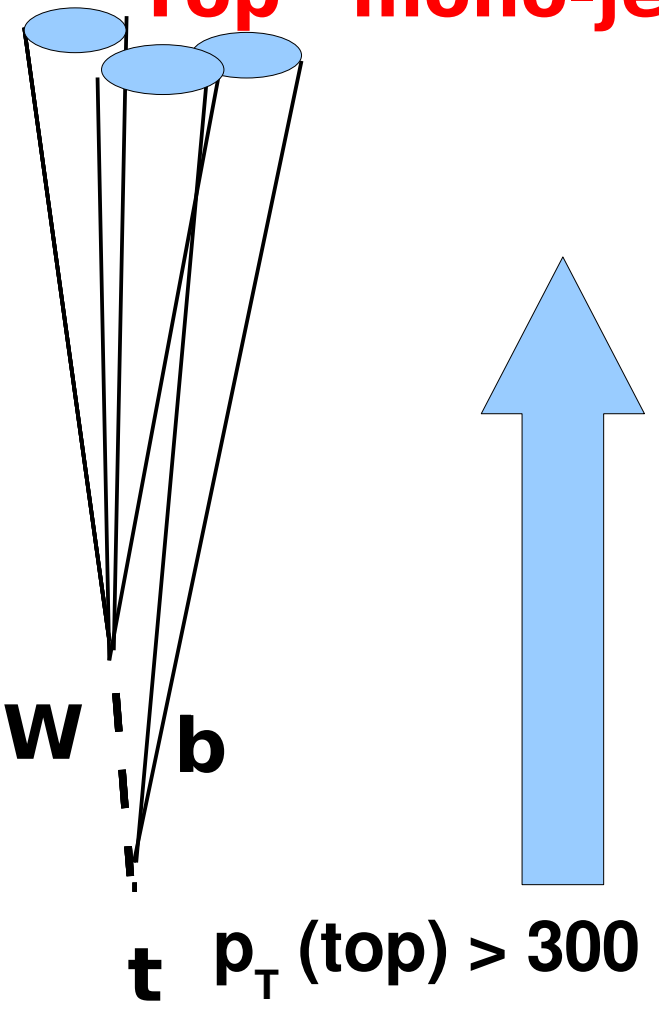
C Clement, Stockholm University

# High $p_T$ top: Reconstruction of boosted tops



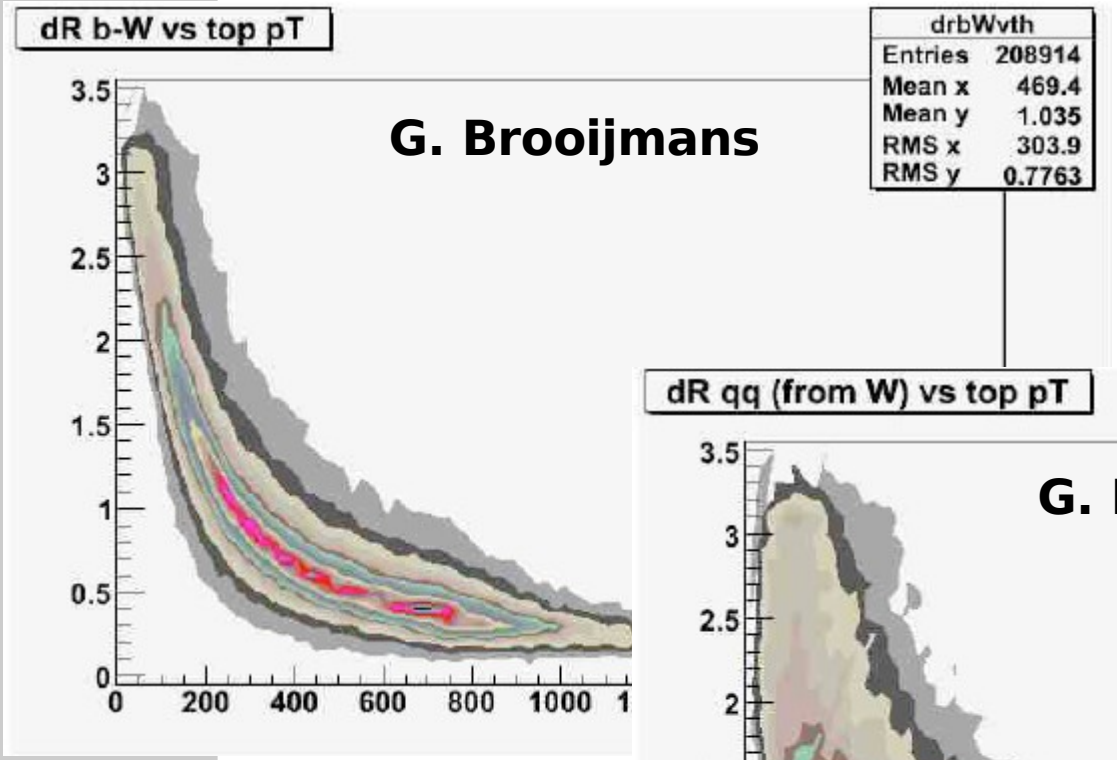

$p_T$ (top) ~ 0 – 100 GeV

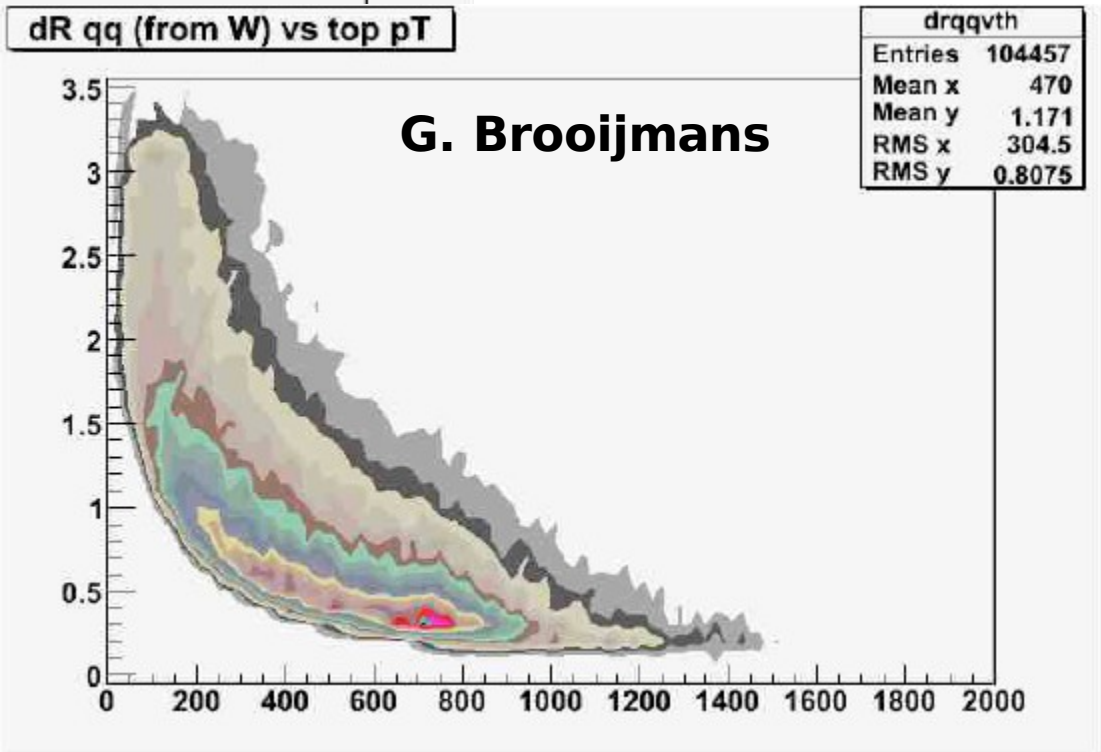
Top "mono-jet"



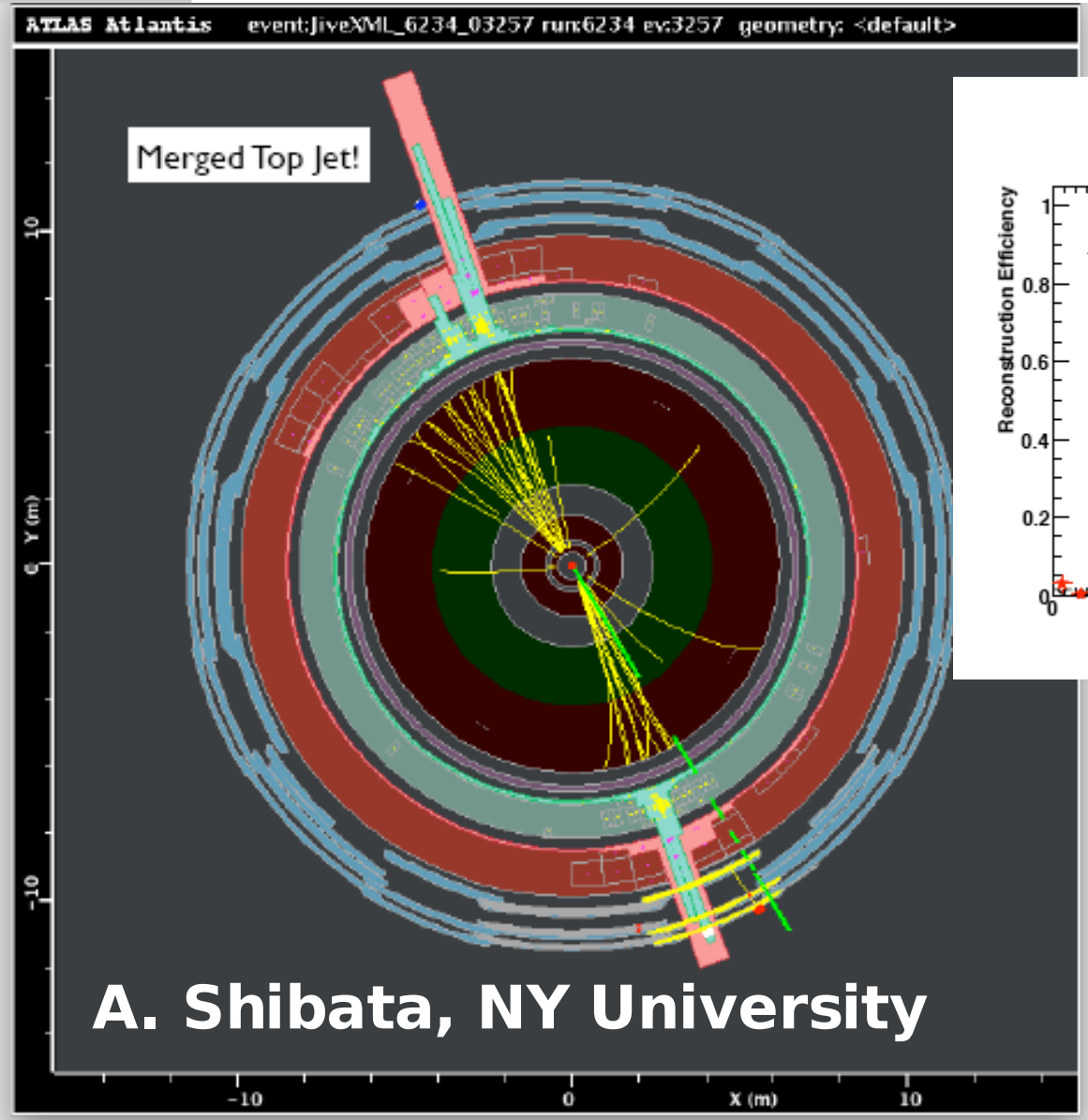

$p_T$ (top) > 300 GeV

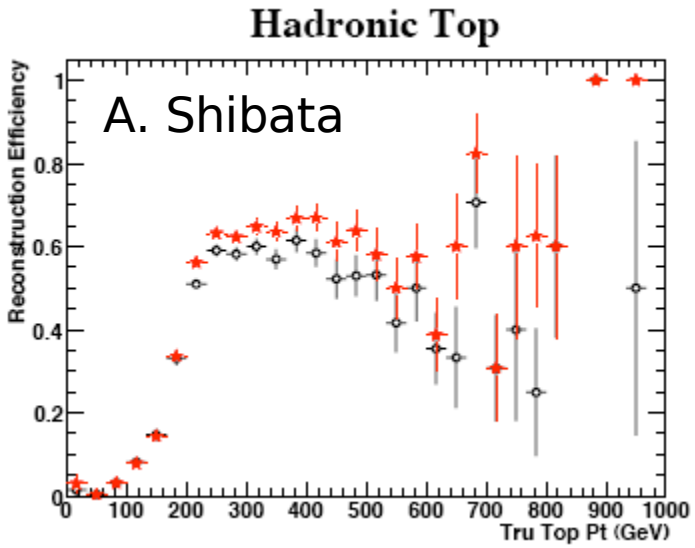
# High $p_T$ top: Reconstruction of boosted tops



# High $p_T$ top: Reconstruction of boosted tops

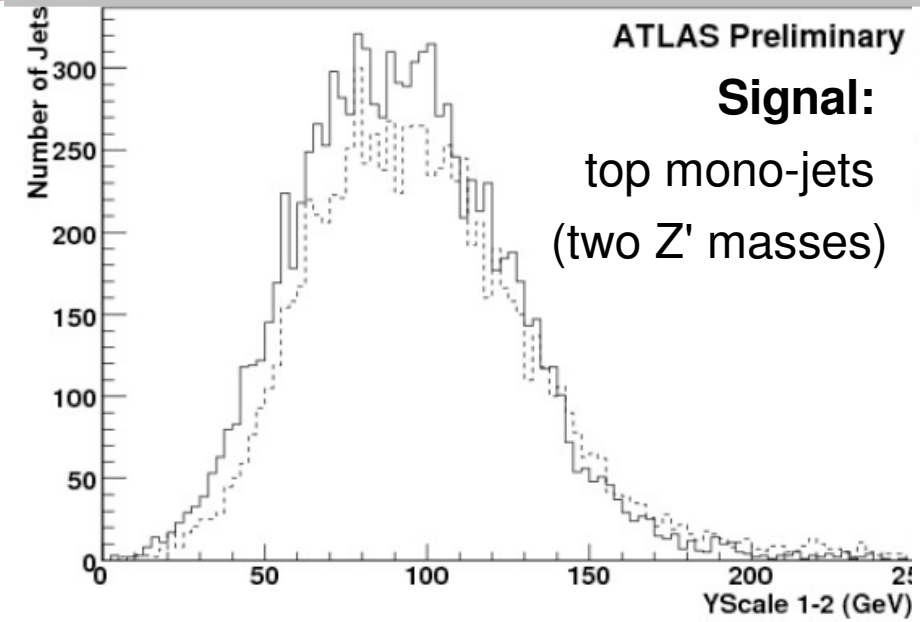


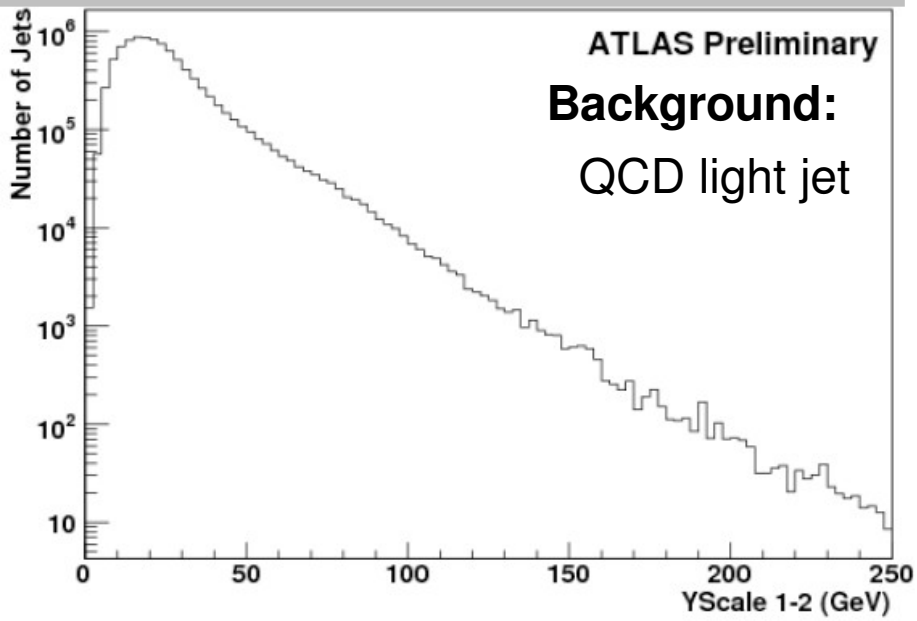




Standard resolved "commissioning style" top reconstruction. Beyond 400 GeV strongly reduced efficiency.

# High $p_T$ top: alternative approach

Distinguish top mono-jets from QCD (light) jet background using the jet structure




G. Brooijmans, High pT Hadronic Top Quark Identification Part 1 : Jet Mass and Ysplitter, ATL-PHYS-CONF-2008-008; ATL-COM-PHYS-2008-001

M. Vos, High pT Hadronic Top Quark Identification Part 2: life-time signature, work in progress

# High $p_T$ top: many more issues

Kinematic fit in the presence of merged jets, Ben Smith

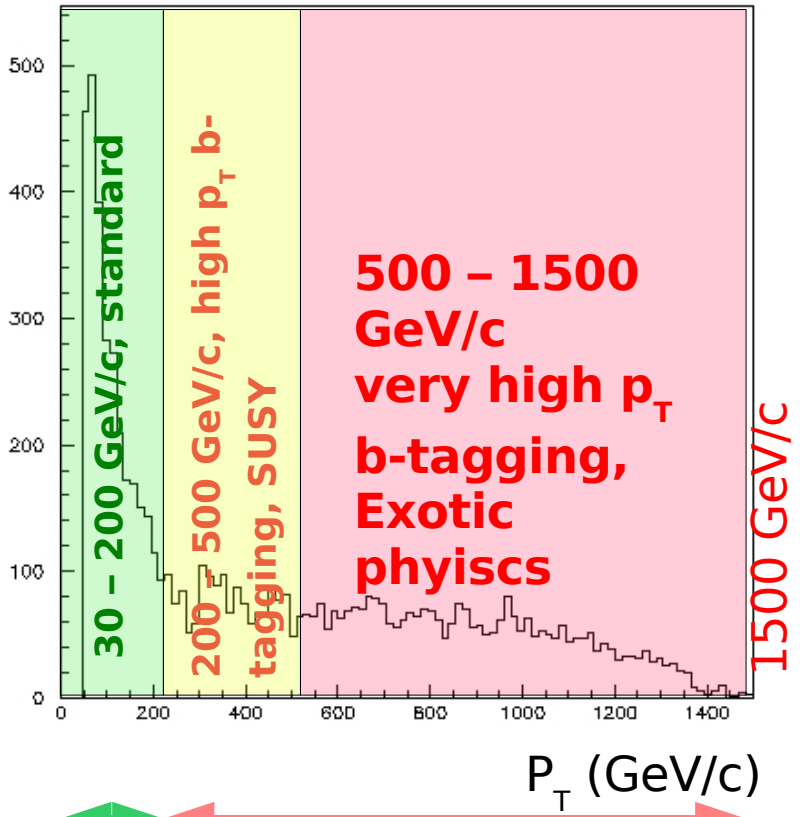
lepton isolation, Denver Whittington

Top polarization

# High $p_T$ bottom

$P_T$ spectrum for b-jets in

$W_H$ (3 TeV/$c^2$) → Tb → 4 b + l + $E_t^{miss}$

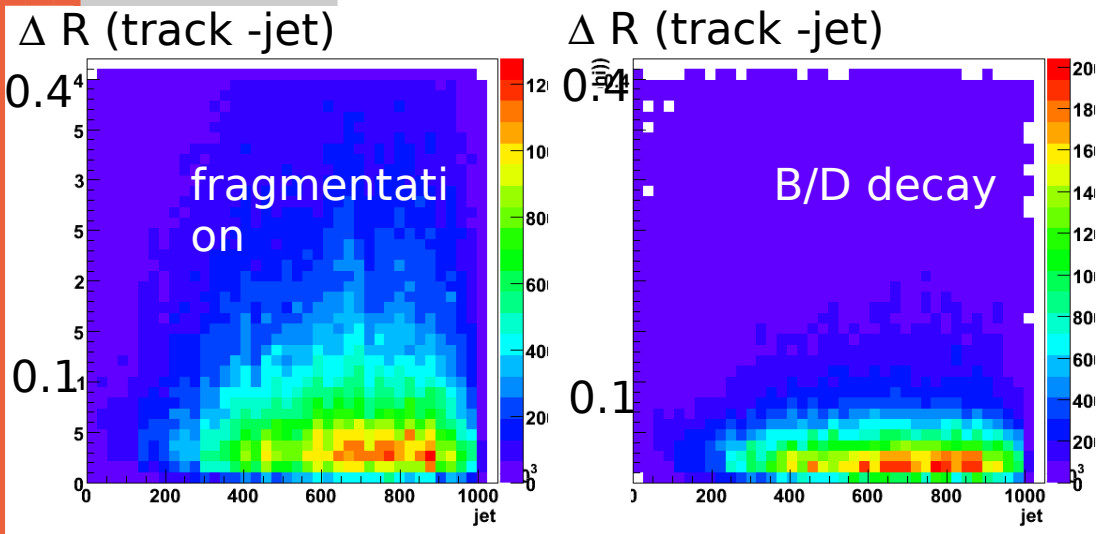


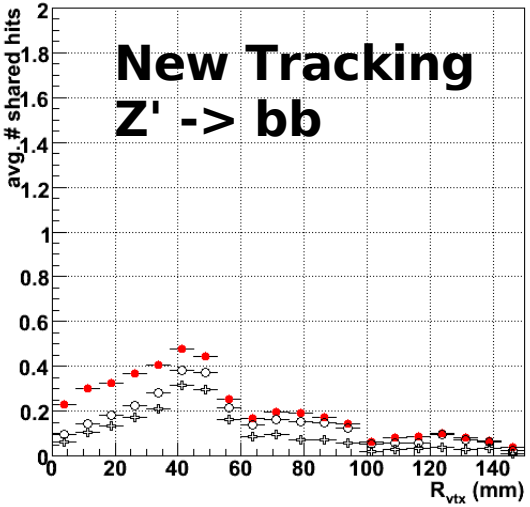
# High $p_T$ bottom

Decay length $L = \gamma c \tau \rightarrow$ strongly enhanced for high $p_T$ b-jets; A significant fraction of B/D hadrons decays close to the B-layer

Track multiplicity from fragmentation increases strongly

Jets collimated into narrow cone.



# high $p_T$ bottom

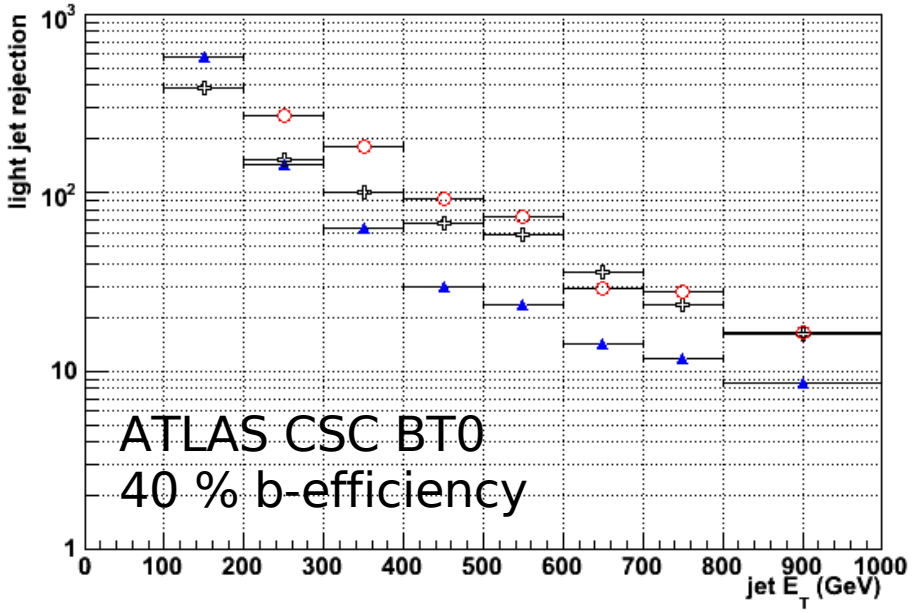
b-tagging in high $p_T$ jets

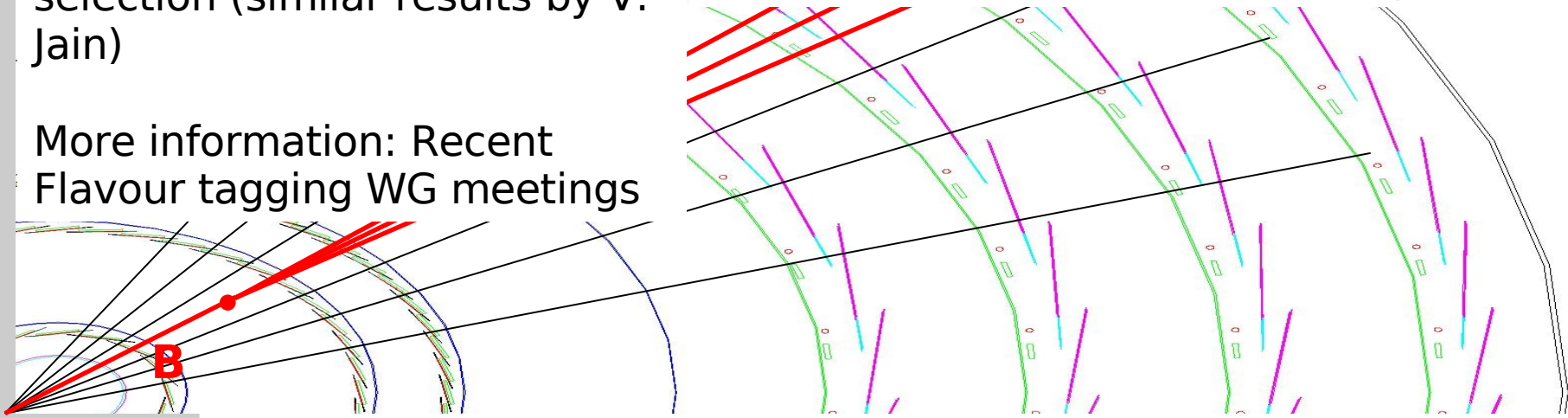
Pattern recognition in high pT jets with displaced vertices highly non-trivial.

performance of the ATLAS algorithms greatly reduced in this corner of phase space.

Includes retuning of track selection (similar results by V. Jain)

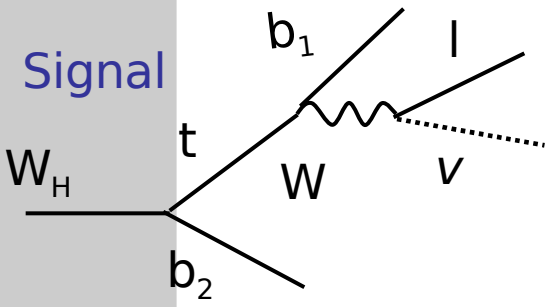
More information: Recent Flavour tagging WG meetings



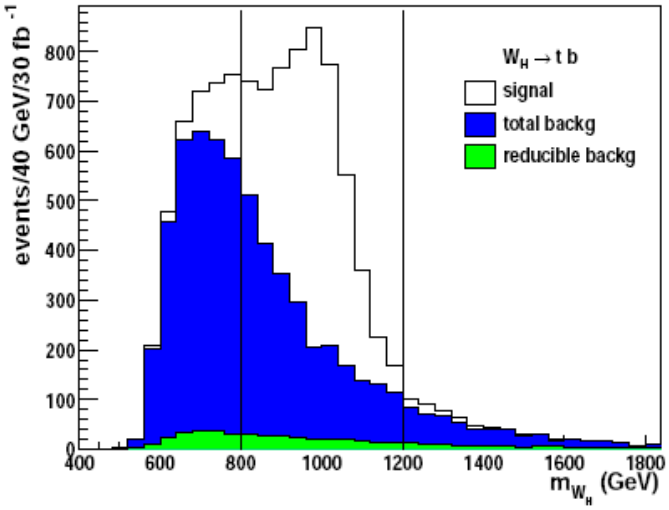
# $W_H \rightarrow tb$, one topology that has it all

Signal




Dominant background: tt

**Littlest Higgs: reconstructed $W_H$ mass (PHYS-PUB-2006-003).**




Study ongoing (M. Rijpstra) within more challenging LR Twin Higgs model

**Top mono-jets are interesting for:**
Signal efficiency
Rejection dominant tt background

# MC samples

identified large body of MC samples:

**Top:**
tt background (MC@NLO, formerly 5200)
preselection on top pT (like 5201, > 500 GeV?)
$Z' \rightarrow tt$ (6230-6234)

**Bottom:**
$Z' \rightarrow uu,cc,bb$ (formerly 6601-6603)

Particular topologies:
$W' \rightarrow tb$

# Conclusions

**First meeting has drawn a large crowd (~ 20 mini-groups)**

and, perhaps even more importantly, revealed **interest from relevant physics and performance groups**

**Proceed as an informal working group, share findings and build on each other's work.**

Pending the discussion in physics coordination on reorganization (tomorrow morning)...

First urgent issue: MC samples...