

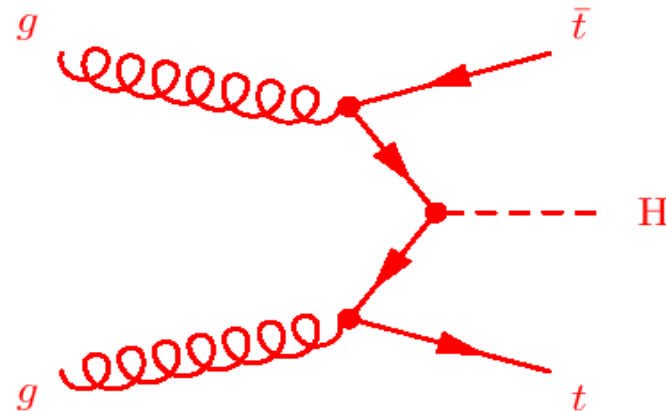
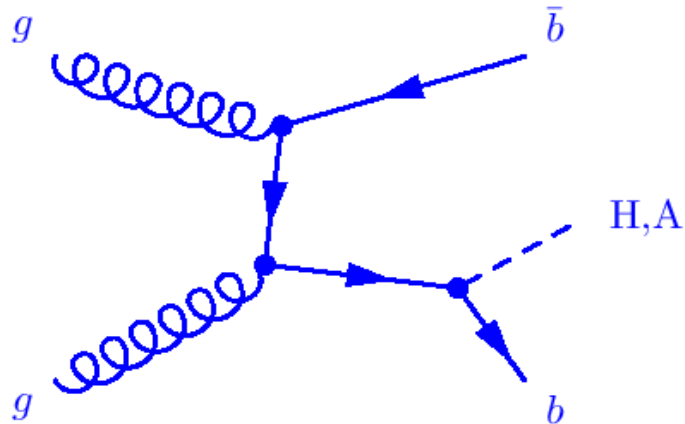
Young Investigator Group VH-NG-503

Status and Plans

Alexei Raspereza,
CMS-DESY Meeting 21/10/2009

Project, Partner and Physics Goals of the Group

- Project title : “Probing Electroweak Symmetry Breaking: Higgs Physics with the CMS Detector”
- Collaborator : Karlsruhe Institute of Technology (KIT)
- Physics goals
 - study of Higgs boson associated production with heavy quarks



- measurements of Higgs couplings to bottom and top quarks. Interpretation within the context of MSSM

Accompanying Tasks

- Hardware related activities
 - Operations of beam condition monitor
 - R&D of radiation hard sensors for luminosity upgrade of LHC to super-LHC
- Software projects
 - Development of software for online monitoring of beam condition (DIP publishing of the BCM status)
- Physics related tasks
 - Study of b fragmentation and B-hadron decay related systematic effects on b-tagging, development of corresponding software tools
 - Jet energy scale calibration with emphasis on low p_T region.
Refinement of jet energy calibration in the whole kinematic range exploiting Z boson production in association with one or more jets

Group Structure

- Group leader (Alexei Raspereza)
 - administration, supervision of PhD students (Higgs analyses)
- Postdoc : Roberval Walsh
 - development of software for DIP publishing of BCM status, maintenance of b-Tagging code, supervision of PhD students
- PhD student @ Karlsruhe (not filled yet) :
 - study of top-pair production employing b-tagging, study of Htt production (close collaboration with Karlsruhe to group)
- Two PhD positions @ DESY with affiliation to the University of Karlsruhe (not filled yet)
 - PhD topics : study of MSSM Higgs production $Hbb \rightarrow \tau\tau bb$ and $\mu\mu bb$ channels, Hbb coupling measurements, interpretation within context of MSSM
 - service tasks : jet energy calibration of low p_T jets (Hbb analysis specific), study of systematic effects on b-tagging

Current Activities

Tools for b fragmentation systematic studies

- Main idea : introduce weight for each b-jet :

$$w = f(z)_{\text{probed}} / f(z)_{\text{gen}}$$

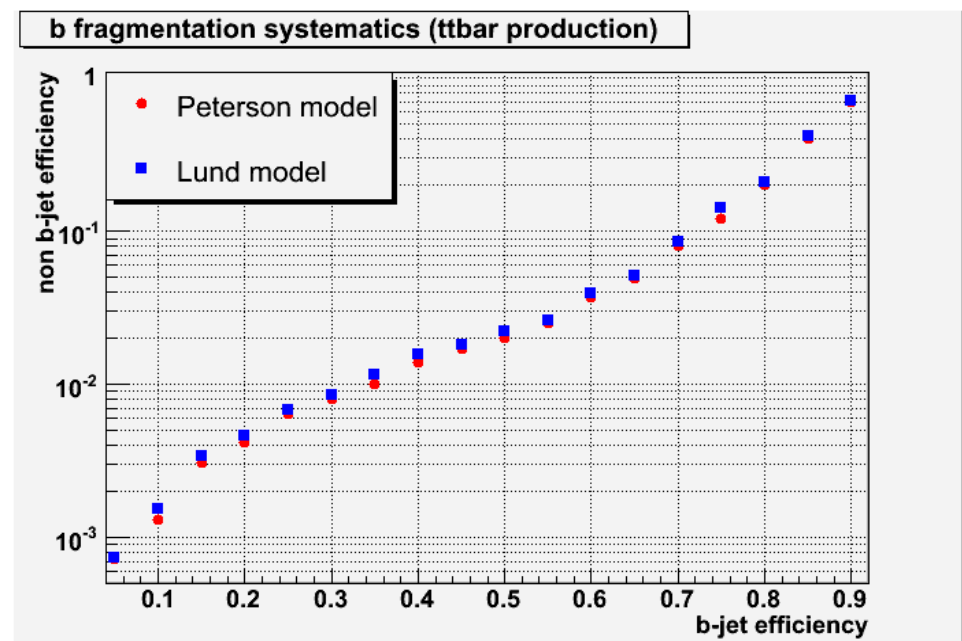
$f(z)_{\text{probed}}$ – probed fragmentation function

$f(z)_{\text{gen}}$ – fragmentation function used in event generation

- Corresponding software tools for re-weighting procedure & study of b fragmentation systematic effect are developed and delivered to P-Tag POG

First look at b-tagging performance in dependence of fragmentation model (privately generated MC TTBar samples used)

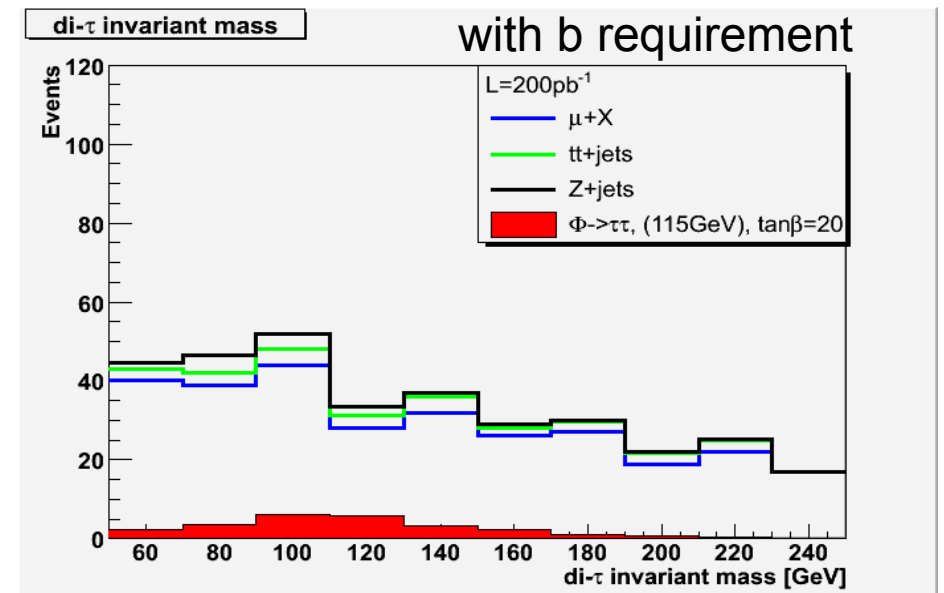
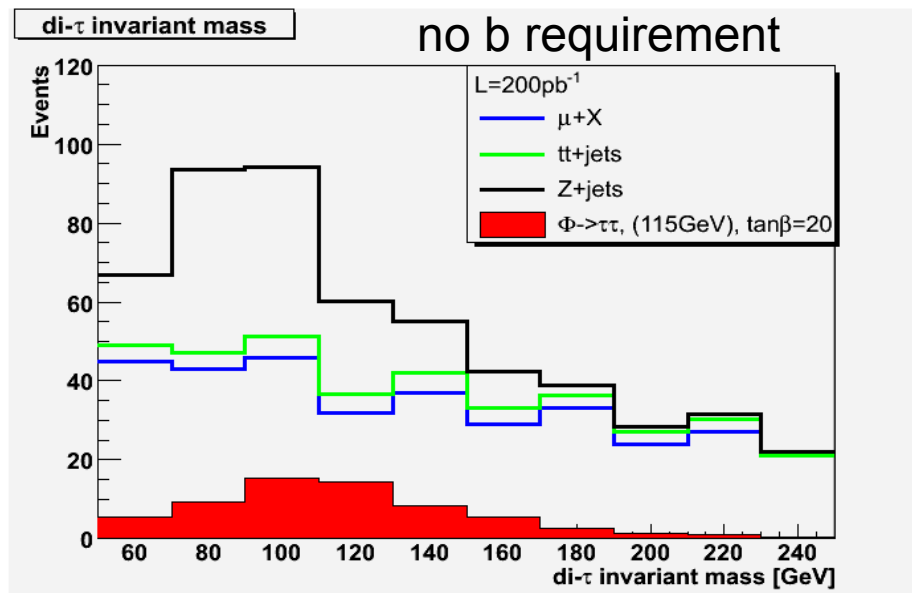
Peterson model used in simulation vs Lund model favoured by LEP experiments and SLD



Current Activities

$Hb\bar{b}\rightarrow\tau\tau b\bar{b}$ Analysis

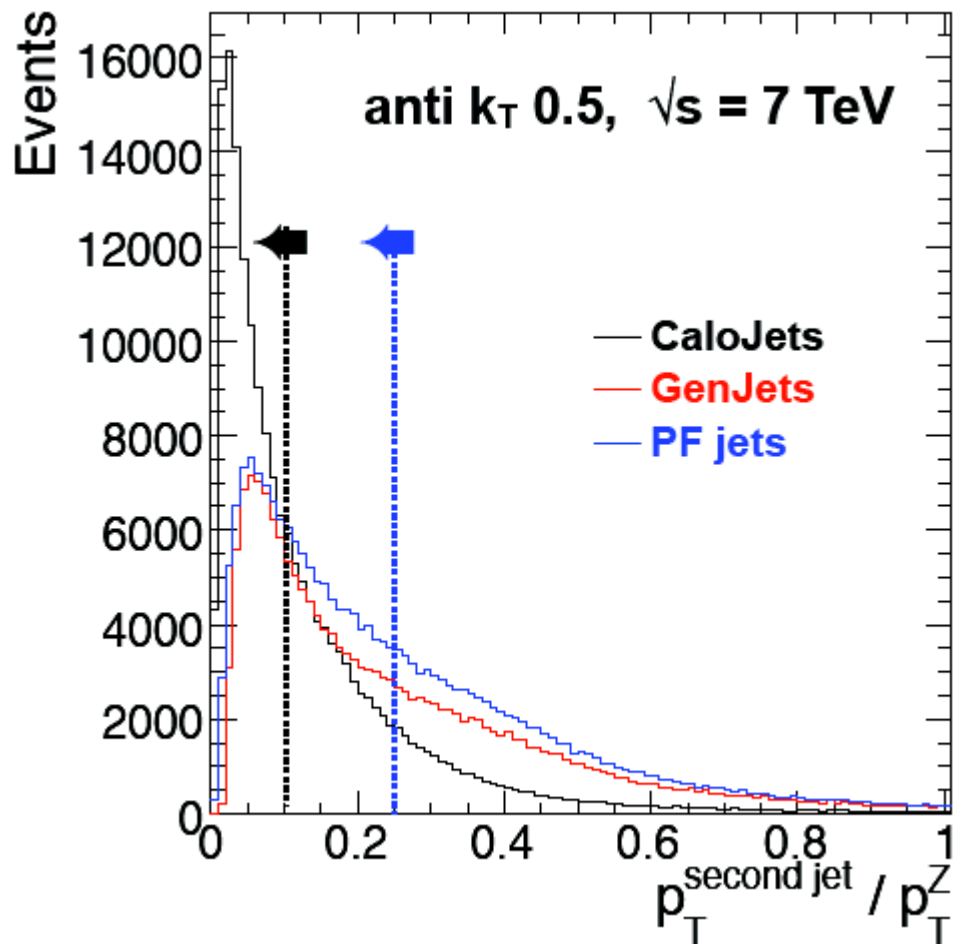
- Official inclusive MSSM $H\rightarrow\tau\tau\rightarrow\mu\tau_{\text{jet}}$ analysis @ 10TeV as a starting point (CMS AN 2009/143)
- Adding b-tag requirement – at least one jet is tagged as b-jet using track counting algorithm
- Construction of $\tau\tau$ invariant mass using “collinear” approximation



- Analysis at the early stage of development and needs further optimization
 - × Usage of more performant b-tagging algorithm (CSV)
 - × Additional discriminating variables
 - × Multi-variate approach

Refinement of Jet Energy Calibration (Idea to use Z+jet(s) events)

Plot by K. Mishra



- PF jet : p_T of second leading jet is peaked at larger values and has longer tail
- To derive CaloJet response from Z+jet sample the cut on p_T of second leading jet is applied : $p_T^{\text{second jet}} / p_T^Z < 0.1$
=> reduced statistics for PF jets
- Looser cut on p_T of second leading jet will lead to larger systematic error (events where two jets come from the same hard process are interpreted as Z+1jet events)
- Why not use Z+jets events to refine calibration constants

Refinement of Jet Energy Calibration Using Z+jets Events. Method

- One needs initial set of calibration constants as seeds
- For each selected event define χ^2_{event}
- $\chi^2_{\text{event}} = (p_x^Z - \sum p_x^{\text{jets}})^2 / \sigma^2(\Delta p_x) + (p_y^Z - \sum p_y^{\text{jets}})^2 / \sigma^2(\Delta p_y)$
- Chose jet configuration (Z + 1 or 2 jets) which minimizes χ^2_{event}
- Define global χ^2 : $\chi^2_{\text{global}} = \sum \chi^2_{\text{events}}$
- Calibration constants are determined in bins of p_T and η : C_{ij}
- Find calibration constants from the system of linear equations :
 - $\partial \chi^2_{\text{global}} / \partial C_{ij} = 0$
(χ^2_{global} quadratically dependent on C_{ij})
- Method is currently being implemented as a CMSSW package

Summary

- Young Investigator Group is being gradually involved in CMS activities
- Main achievement over the past two months : development of the tools for evaluation of systematic effects on b-tagging, code delivered to B-Tag POG
- Participation in Beam Condition Monitor commissioning (November 2009)
- $Hbb \rightarrow \tau\tau bb$ analysis has started
 - first rough estimate of signal significance with 200 pb^{-1} is encouraging
 - analysis is being optimized
- A method to refine jet calibration using Z+jets (one or more jets) events is proposed and being tested
- New members (PhD students) will join group in the fall of this year or beginning of the next year => group activities will intensify
- Hope to be prepared for the first LHC data