Results from analyses of physics and simulated data using different tools

-Brief Summary-

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Experimental issues in Charged Higgs Boson Searches

1. Identification of hadronic tau decays
   - significant branching ratios over large areas of parameter space

2. b-tagging, $E_T^{\text{miss}}$ signatures
   - b-tagging is important, since multi-b final states appear
   - b-tag important for significant background rejections

3. Triggering on hadronic taus
   - in case of no accompanying leptons, dedicated hadronic tau triggers are needed
Identification of hadronic tau decays

Consensus about the general strategy: CDF, D0 → ATLAS, CMS

Standard approach:
Start from the calorimeter cluster information
- exploit shower shape variables
  (reconstruct $\pi^0$ in the calorimeter, depends on longitudinal and lateral calorimeter granularity)
- associate tracks to the calorimeter cluster
- apply calorimeter and track isolation
- additional handles: $\tau$ mass (track + $\pi^0$ mass)
  $\tau$ lifetime (impact parameter)
final step: multivariate analysis (likelihood, NN)
cuts may depend on $P_T$ of the $\tau$

Further discrimination (separate various $\tau$ decay modes)
DØ collaboration

Limitation: efficiency drop for low $p_T$ taus,
→ alternative approaches: track based initialization for low $p_T$ taus
Tau Efficiency & Fake Rate at CDF

- Tau efficiency after tight selection:

- Jet fake rate, using jet triggers:

Similar results from the DØ experiment
Simulation results from ATLAS and CMS

In addition: Methods on how to determine efficiencies from data are being studied
Future steps (work to do for the LHC analyses)

• consolidate $\tau$ ID algorithms
  (profit from the rich experience from the TeVatron, TeV4LHC very useful, …)

• work towards a complementary track-based $\tau$ ID approach to improve the performance at low PT

• discriminate between various decay channels

• refine and consolidate multivariate analyses

• study further ways to measure the $\tau$ tag efficiency from data
The trigger problem

All experiments have multi layer trigger system

- dedicated tau triggers at the Tevatron
  profit from tracking info at L1
  (not possible at the LHC)

  - e/μ + track
  - tau + ETMISS
  - di-tau trigger

LHC tau triggers:

- Single tau triggers have high thresholds
- Hadronic tau decay channels have to rely on
  tau + ETmiss and tau + jet and jet + ETmiss triggers

- Trigger efficiency seems to be adequate, given rather high PT thresholds in
  offline analyses (50-70% trigger eff. even for low H+ masses)
**b-tagging and b-signatures in H+ events**

- Several b-tagging algorithms in place for ATLAS and CMS (good performance expected, with degradation in forward and low-p_T region)

- b-tagging is an important tool in Charged Higgs analyses (in particular in the H+ → tb decay modes)

- b-tagging is essential in any Charged Higgs analyses using tb final states
  - difficult S/B conditions
  - improvements in b-tagging for soft and forward jets would certainly help however, some backgrounds irreducible (b-contents, gluon splitting, …)
  - situation appears to be difficult (tb does not seem to be the “gold plated” charged Higgs boson discovery channel)
ETmiss reconstruction

- ETmiss is an important signature (also for Charged Higgs boson searches)

- resolution is primarily determined by calorimeter resolution and response

- Important issues for future work: calorimeter calibration, response uniformity, ….
  - noise suppression
  - develop methods to determine resolution with data
    (validation, started already)
Conclusions

Search for the Charged Higgs boson at Hadron Colliders is extremely important

The experimental techniques are already well advanced

- ID of hadronic taus: some improvements still desirable
- Hadronic tau triggering seems feasible in combination with ETMISS /jets
- Additional complementary signatures: b-tagging, $E_T^{\text{miss}}$
- Top reconstruction is necessary, but difficult (Ketevi)

New analysis methods have been studied:

- Tau polarisation should be exploited in 1- and 3-prong-decays (improved signal significance)
- IDM method looks promising, however, real confirmation from Tevatron data still needed (+ consideration of all relevant backgrounds)
- And finally: updated LHC discovery contours as usual: increased background is suppressed by smarter ideas / more sophisticated cuts
Discovery potential with 3-prong selection

R. Kinnunen
Conclusions

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M. Flechl

**Discovery Contour by Assamagan/Coadou (Atlfast, 2002)**

- **new Fullsim contour** to be approved by ATLAS:
  - large samples of all relevant backgrounds [estimated bkg: increase by $O(10)$]
  - three new selection cuts
  - new b-/tau-tagging strategies
  - three selection cut value sets

- region $m_{H^\pm} < 165$ GeV covered similar to the contour to the right for $165 < m_{H^\pm} < 200$ GeV, steeper for higher masses
Conclusions (cont.)

Uppsala is a nice place to be, looking forward to forthcoming workshops

Possible Roadmap:

→ 2008: work on tooling (tau, btags, methods to get efficiencies from first data)

→ 2010: first results from data ....

→ 2012: I hope that we know whether a Charged Higgs exists or not

regardless of the outcome: we could continue to get lectures on how to drink the Uppsala Schnaps

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