OCHEP Physics Interests

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Oklahoma Center for High Energy Physics

- *Introduction*
- *Physics interests*
- *Research in ATLAS*
- *Conclusions*

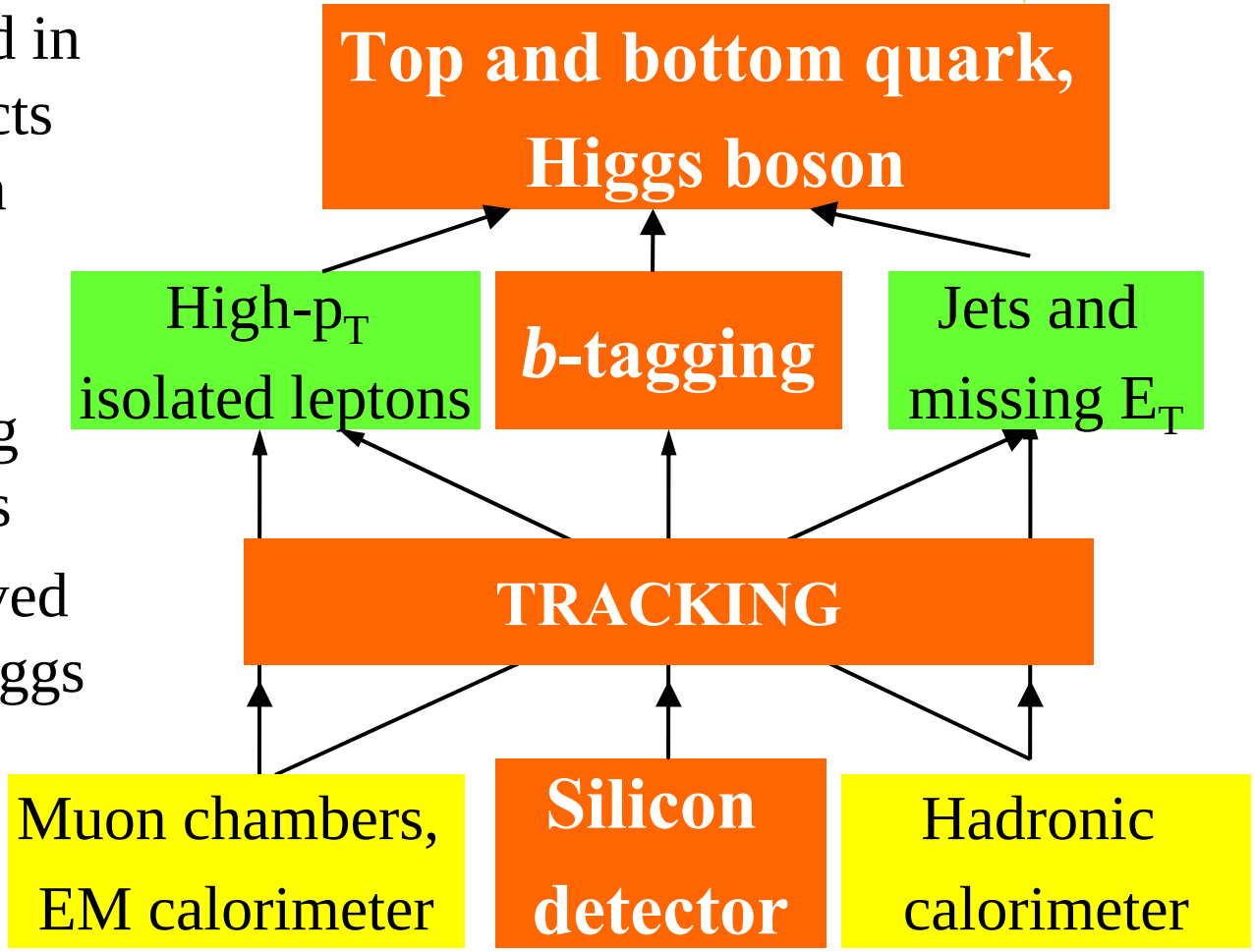
Introduction

- OCHEP is a consortium of three universities: Langston University (LU), Oklahoma State University (OSU), and the University of Oklahoma (OU)
- Involved in the same experiments, DØ and ATLAS;
- Have common projects in these experiments;
- Have regular bi-weekly video conferences between OSU, LU and OU experimental groups with connection to CERN (OU person participating on commissioning)
- Have common seminars

We benefit a lot from working together !

Research Experiences of OCHEP

- Traditionally involved in silicon detector projects (SMT in D0, pixels in ATLAS)
- Research utilizes our knowledge of tracking and vertexing systems
- We are heavily involved in t-,b-physics and Higgs boson searches;
- Also involved in computing in D0 and ATLAS



OCHEP Physics Interests

- Search for a Higgs boson in the SM and beyond;
- Indirect searches for new physics in b-meson decays and in top quark decays;
- Discovery of Higgs or other particle(s) will imply further deep studies of their properties.
- That requires creation of a long-term physics program that will cover running and future HEP experiments.
- The facilities that can address these problems are the Tevatron at present and the LHC in the near future.

Present Activities in DØ

- High p_T Physics:
  - Top physics – OSU/OU;
  - Higgs searches – OSU/OU;
- Low p_T Physics:
  - B-physics – OU;
- Software/Computing:
  - Responsible for track reconstruction – OSU/OU;
  - Reprocessing of the DO data – LU/OU;
  - B-tagging – OSU;

Top and b Quark Physics at DØ

- Search for the single top quark production
  - OU: Gutierrez + S. Jain;
- t-tbar production
  - OSU: Rizatdinova
- Search for new physics in top quark decays
  - OSU: Rizatdinova
- B-physics (B_s oscillations and B-lifetimes)
  - OU: Abbot, Gutierrez, Strauss + graduate students

Higgs Physics at DØ

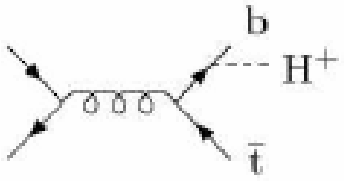
- OSU: strong position in Higgs physics group
  - A. Khanov is convener of the joint Higgs/New phenomena multilepton physics group with 5 analyses under his supervision:
  - OSU analysis on direct search for the SM Higgs in the $WH \rightarrow WWW$ channel – work on publication. **Best limit on σ_H in the intermediate mass range.**
- OU: search for a charged Higgs boson in top quark decays (P. Gutierrez + A. Pompos + grad. student)

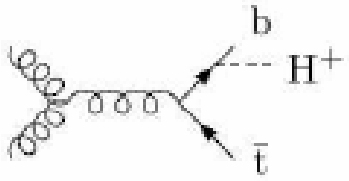
OU Contributions to D0

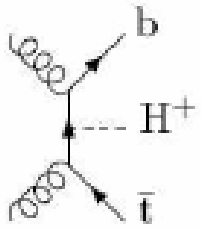
- Single top search *S. Jain*
  - Limits on FCNC in single top
- Charged Higgs search *A. Pompoš*, S. Hossain, P. Gutierrez
- B-Physics *B. Abbott, P. Gutierrez, M. Strauss, M. Kopál, I. Hall, M Rominsky, R. Lebbai*
  - $B^0 \rightarrow J/\psi K^{*-}\pi^+$
  - B_s *mixing using* $D_s^- \rightarrow K^*K^-$
  - B_s *lifetime using* $D_s^- \rightarrow K^*K^-$
  - $K_s \rightarrow \mu^+\mu^-$

Charged Higgs

- Primary people A. Pompoš, S. Hossain, P. Gutierrez
- Motivation: $H^{\pm}$ arises in two Higgs doublet models (for example supersymmetry)
- $H^{\pm}$ produced at DØ via gg-fusion or via $q\bar{q}$ annihilation

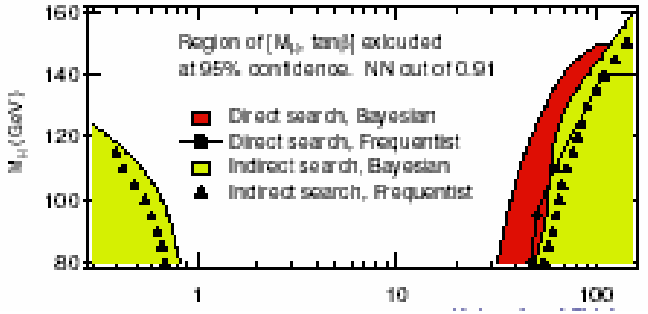






Current LEP limit $m_H = 80$ GeV

DØ Run I Limit



Activities in ATLAS

- Physics: plan to continue with high-p_T physics
  - i.e., Higgs searches in the tH, ttH channels
- Software:
  - Implementation of the CSIP algorithm (developed by the OSU members for DØ) in the ATLAS analysis framework – ***OSU/OU project***
  - Development of the b-tagging/mistagging efficiency measurement techniques based on our current experience with top quark physics – ***OSU project***
- ATLAS GRID Computing: ***OU/LU project***

OCHEP Physics Interests at the LHC

- Top physics is a great topic to start with at the LHC

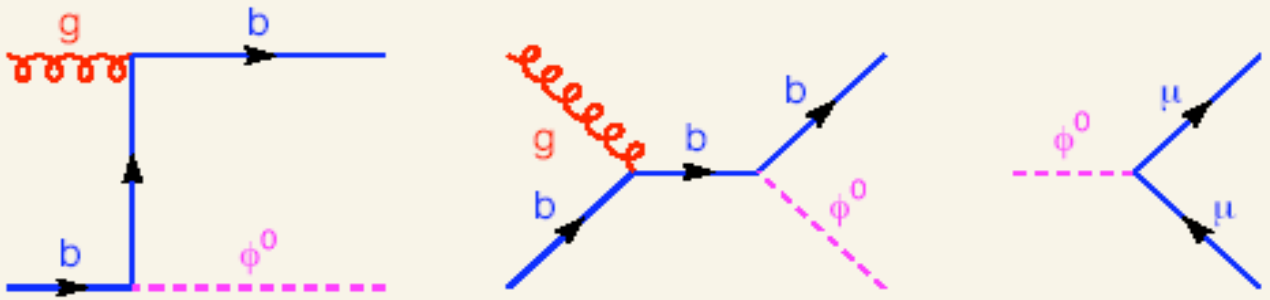
ATLAS TDR

- SM Higgs with m_H<130 GeV (if exists) will be discovered in ~ 3 years by combination of two channels, *ttH* and $H \rightarrow \gamma\gamma$;
- MSSM Higgs $H^+ \rightarrow tb$ also need 3 years
- LHC – top factory: 8000 *tt* events expected every 10 pb^{-1}
- In one year, results obtained at the LHC will be much better than those from the Run II Tevatron
- Need a good b-tagging calibration sample – *tt* is certainly the best one: allows to measure b-tagging efficiency at high p_T of jets, in realistic multijet environment

Discovering Higgs Bosons with Muons and a Bottom Quark

Direct search for Higgs bosons at the LHC

$$pp \to b\phi^0 \to b\mu^+\mu^- + X, \phi^0 = H^0, h^0, A^0$$



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C. Kao and N. Stepanov, Phys. Rev. D **52,** 5025 (1995).

Higgs Decay into Muons

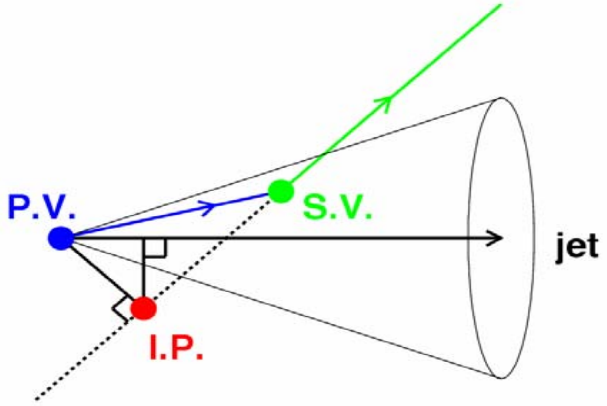
- The discovery channel of $b\phi^0 \rightarrow b\mu^+\mu^-$ offers great promise to discover the A^0 and the H^0 at the LHC for $\tan\beta > 10$, $m_A < 650$ GeV with $L = 30$ fb^{-1}.
- A higher luminosity of 300 fb^{-1} can improve the discovery reach in m_A up to $m_A = 800$ GeV.
- The $b\phi^0$ channel greatly improves the discovery potential beyond the reach of the inclusive channel $pp \rightarrow \phi^0 \rightarrow \mu^+\mu^- + X$.
- This discovery channel might provide good opportunities to measure important parameters such as the Higgs masses, $\tan\beta$, and Higgs couplings with bottom quarks and leptons.

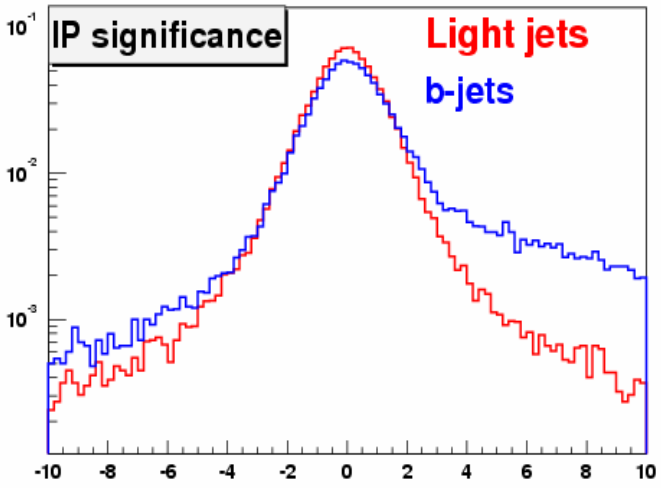
B-tagging in ATLAS

- Optimization of CSIP algorithm for ATLAS:
  - Useful at early stages of an experiment – might be the only well understood b-tagging algorithm because of its simplicity;
- Selection of the *tt* events for estimation of the b-tagging efficiency:
  - Need to find unbiased ways to select tt events
  - Want to use kinematical approach used for tt cross section measurement in DØ;
- Next step will be development of methods to select as pure sample of light jets as possible.

CSIP Tagger

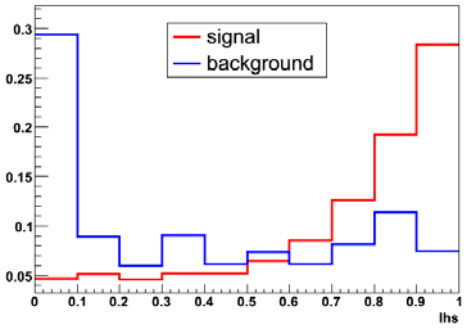
- Approach: count tracks inside a jet that are displaced with respect to the event primary vertex
- The method is robust, does not require detailed understanding of tracker performance nor careful tuning, very useful for initial studies as soon as first data arrives
- Competitive with more sophisticated methods like secondary vertex tagger

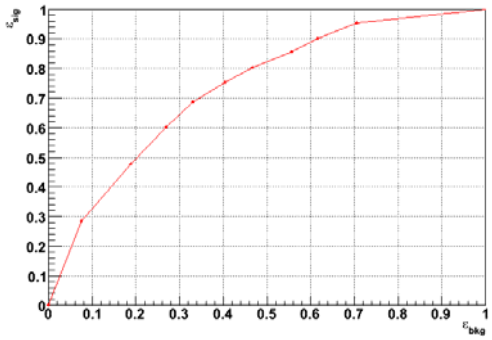




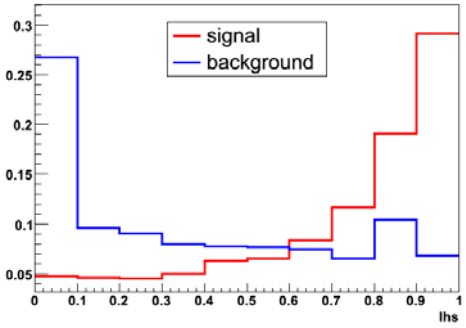
Selection of a Clean b-jet Sample

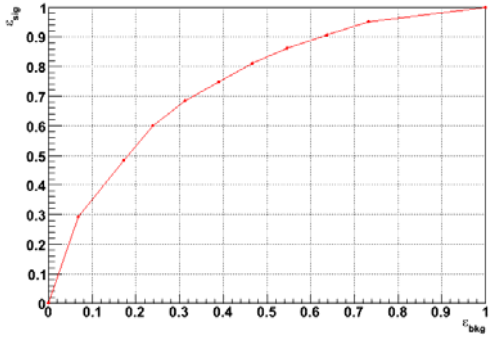
- From our Tevatron experience, we believe that an optimal approach is to select a tt→l+jets sample using topological information
- Plots on the right show separation between signal (ttbar→l+jets) and main background (W+jets) achieved with a topological likelihood discriminant





Topological likelihood for tt→e+jets

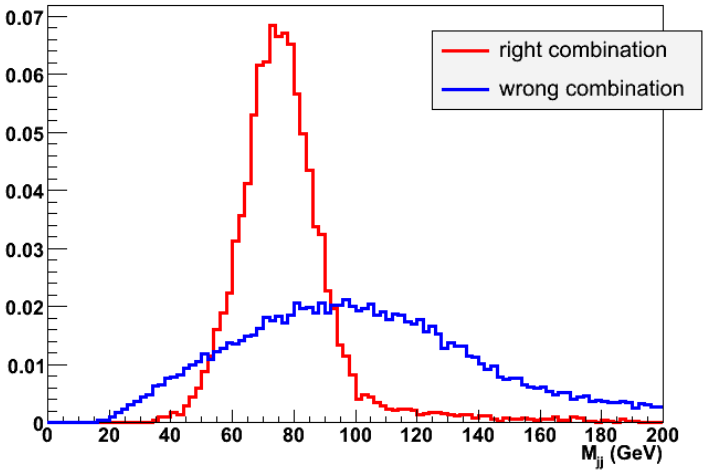


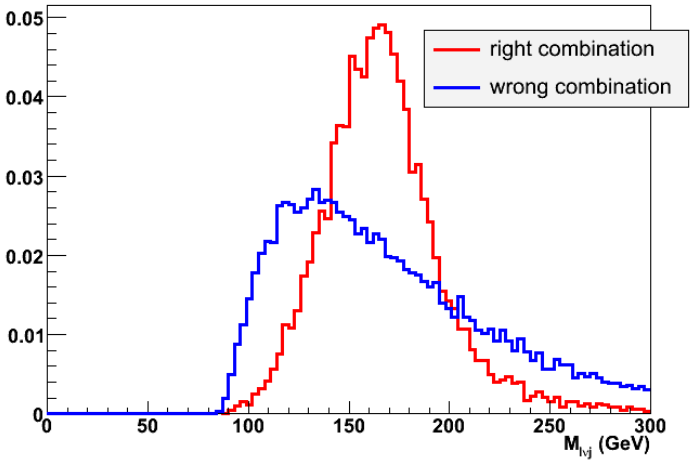


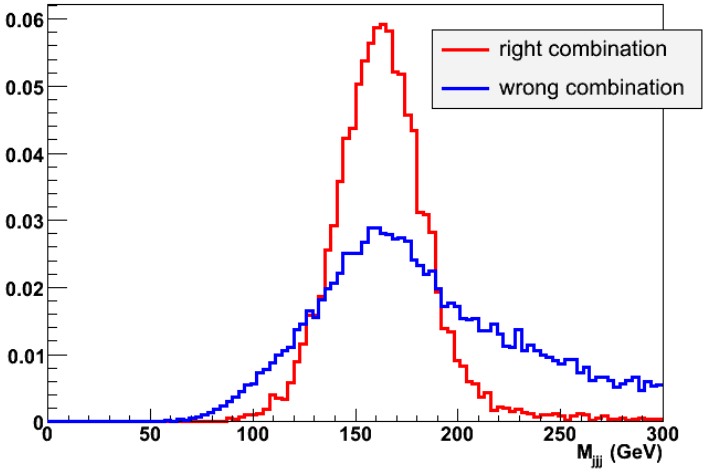
Topological likelihood for tt→μ+jets

Selection of b-jets

- tt→l+jets has four jets, only two of them being b-jets
- Task: statistically separate b-jets from non-b-jets







Conclusions

OCHEP groups have

- common interests in physics analyses which are based on our experience in top and Higgs physics;
- common projects in software which will be b-tagging and related issues – hope to benefit from b-physics experience of OU;

Collaboration between the Oklahoma Universities makes our physics potential stronger. We hope that DOSAR and the SW Tier 2 Center will help us to make a sizeable contribution to ATLAS