OU Physics Analysis

Why I'm Here

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Outline

- The OU group
- Current analysis in b-physics
  1. CP-violation and Mixing *Flavor tagging*
  2. B_s mixing
- Top physics
  1. Past analysis
  2. Future prospects
- Summary and conclusions

OU Personnel

- **Faculty**
  - B. Abbott
  - P. Gutierrez
  - P. Skubic
  - M. Strauss
- **Postdocs**
  - S. Jain
  - M. Kopal
  - A. Pompoš
  - H. Severini
- **Students**
  - I. Hall
  - X. Zhang

Overview of Interests

- Electroweak symmetry breaking sector
  - Higgs searches
  - Mass $\neq$ Weak fermion eignstates $\Rightarrow$ CKM matrix
    - Flavor mixing, mixing of CP eignstates, CP-violation
  - Rare decays
- Concentrate on Heavy Flavors (b and t quarks)
  - b-quark $\Rightarrow$ Mixing and CP-violation
  - t-quark $\Rightarrow$ Mass, $\sigma(p\bar{p} \rightarrow t\bar{t})$, rare decays, CKM, ...

b-Physics

- CP-violation
  - Goal: measure angles/sides of unitarity triangle
    - 6 possible triangles from unitarity constraint of CKM matrix
  - Many experiments to contribute
  - Many non-standard model sources
    - Belle & BaBar find indication of this
    - Measurement of $\sin 2\beta$

$$B^0(\bar{B}^0) \to J/\psi K_s \quad \Rightarrow \quad \sin 2\beta = 0.73 \pm 0.06$$

$$B^0(\bar{B}^0) \to \phi K_s \quad \Rightarrow \quad \sin 2\beta = \begin{cases} -0.96 \pm 0.5 \\ 0.45 \pm 0.43 \end{cases}$$

b-Physics OU Analysis

- Plan to make $\sin 2\beta$ measurement
  - Measure asymmetry in $B^0(\bar{B}^0) \to J/\psi K_s$

$$A_{CP} = \sin 2\beta \sin(\Delta m_d\, t)$$

- Need to tag flavor at production
  - 3 common methods
    - Opposite side lepton
    - Same side jet
    - Opposite side jet (OU effort here)
      - Have measured dilution in $B^{\pm} \to J/\psi K^{\pm}$
      - Studying how to translate to B^0 sample
  - Future to consider $B_s^0(\bar{B}_s^0) \to J/\psi\phi$

b-Physics OU Analysis

- Studies underway to measure B_s mixing
  - At present only possible at Tevatron
  - Current limit $x_s > 19$ @ 95% CL ($x_s = \Delta m_s/\Gamma_s$)
    - Global fit of data indicates $x_s \approx 25$
  - Need to measure flavor at production and decay
    - Considering $B_s^0(\bar{B}_s^0) \rightarrow D_s\,\ell\,\nu_\ell$ —*a self tagged mode*
      - Should be able to reach $x_s = 30$

t-Physics

- Least studied quark
  - ≈ 35 times heavier than b-quark
    - Yukawa coupling ≈ 1.4
    - Clearest manifestation of EWSB
  - m_t ($\sigma_{m_t} \approx \pm 3$ GeV) & M_W ($\sigma_{M_W} \approx \pm 40$ MeV) $\Rightarrow \quad \delta M_H \approx 40\% M_H$
  - $\sigma(\bar{p}p \rightarrow t\bar{t} + X)$ expect $\approx \pm 8\%$, theory $\approx \pm 10\%$
    - Deviations could be indication of new physics
  - Single top production $\bar{p}p \rightarrow t + X$ direct measurement of V_{tb}
    - At present limits come from unitarity of CKM assuming 3 generations

t-Physics Past Analysis

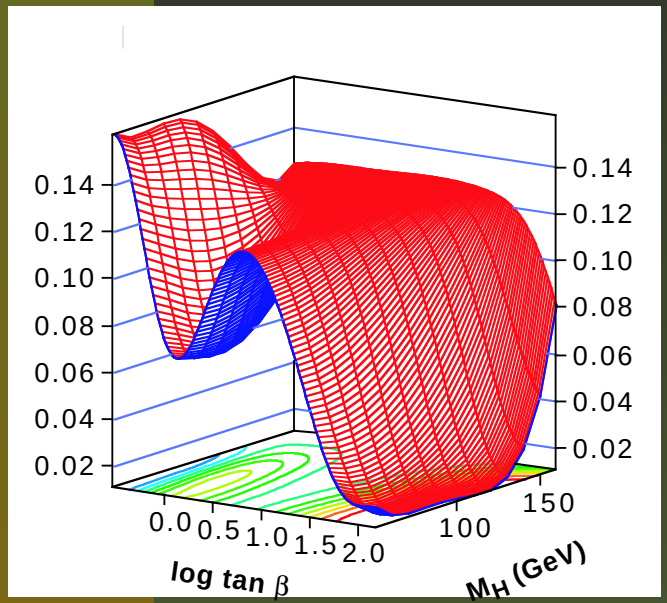
- Members of our group contributed to Run I t analysis
- Search for $t \rightarrow bH^+$
  - Most straight forward extension to SM, add second Higgs doublet
  - Introduces 4 new scalar particles with 2 charged
  - Coupling: one doublet to weak isospin $+\frac{1}{2}$ & one to weak isospin $-\frac{1}{2}$ fermions; MMSM inspired
  - Search in parameter space M_H vs. $\tan\beta$

t-Physics Past Analysis

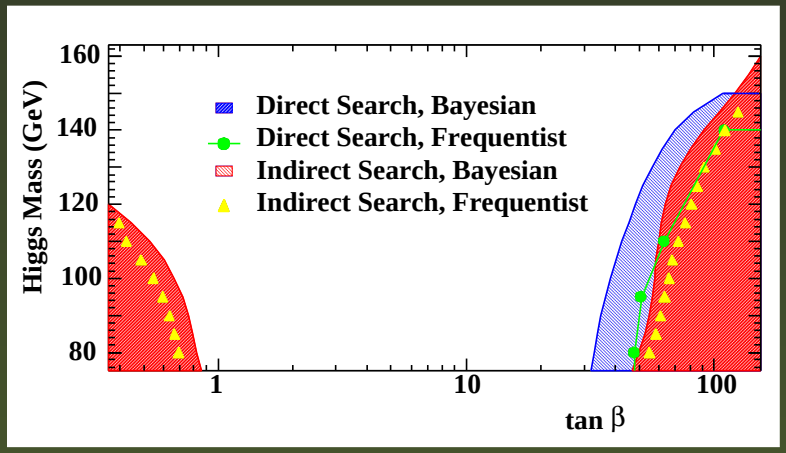
- Carried out search using two methods
  - If $\sigma(\bar{p}p \rightarrow t\bar{t})$ lower than predicted, could be due to non-SM decays
  - Search parameter space for regions where SM and $t \rightarrow H^+$ have high efficiency of being found. Regions can be excluded since SM σ agrees with data
  - Direct search, look for excess of τ's from $H^{\pm}$ decays

t-Physics Past Analysis

Probability Surface



Exclusion Regions



- Search for narrow resonance decay $M_x \longrightarrow t\bar{t}$
  - Expected in extended technicolor models
    - Set limit $M_{t\bar{t}} > 560$ GeV for $\Gamma < 0.012 M_{t\bar{t}}$

t-Physics Run II

- Initiating new effort in single top search
  - Electroweak production
  - s and t channel contributions
  - Run I limits (Neural Net analysis)

$$\sigma(\bar{p}p \rightarrow tb + X) < 17 \text{ pb}$$

$$\sigma(\bar{p}p \rightarrow tqb + X) < 22 \text{ pb}$$

  - Provides a direct measurement of V_{tb}
    - Expect a 12% error on V_{tb} using Run IIa data

Summary & Conclusions

- Our primary interest is studying the EWSB sector of SM
  - Will purse physics through study of t & b quarks
- All these analysis require substantial Monte Carlo samples