Aspects of the search for stable new generation particles in LHC

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Beyond the 3SM generation at the LHC era Workshop

CERN, 4.09.2008

Prediction of (meta)stable quarks and leptons

4th generation

Glashow's model of terafermions

m~50 GeV

See report of **M.Vysotsky**

$$\begin{pmatrix} N \\ E \end{pmatrix}$$

m~0.5 TeV

Stability is well motivated from cosmology

See report of **M.Khlopov**

~300 GeV<m<~1 TeV

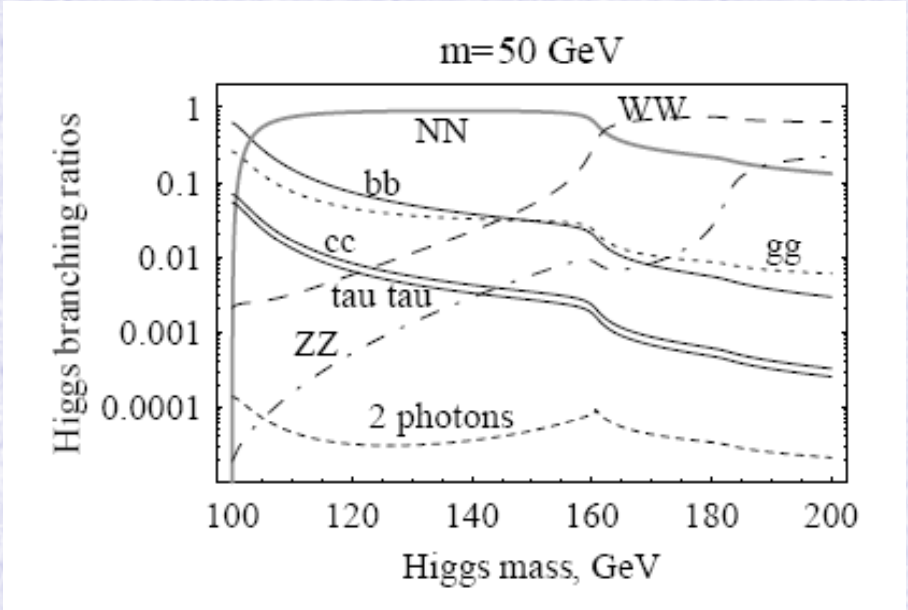
$$\begin{pmatrix} U \\ D \end{pmatrix}$$

m~1-5 TeV

(N,E,U,D) ⇔ W', Z', H', γ and g

Higgs physics in case of 4 generations

See **subsequent reports**

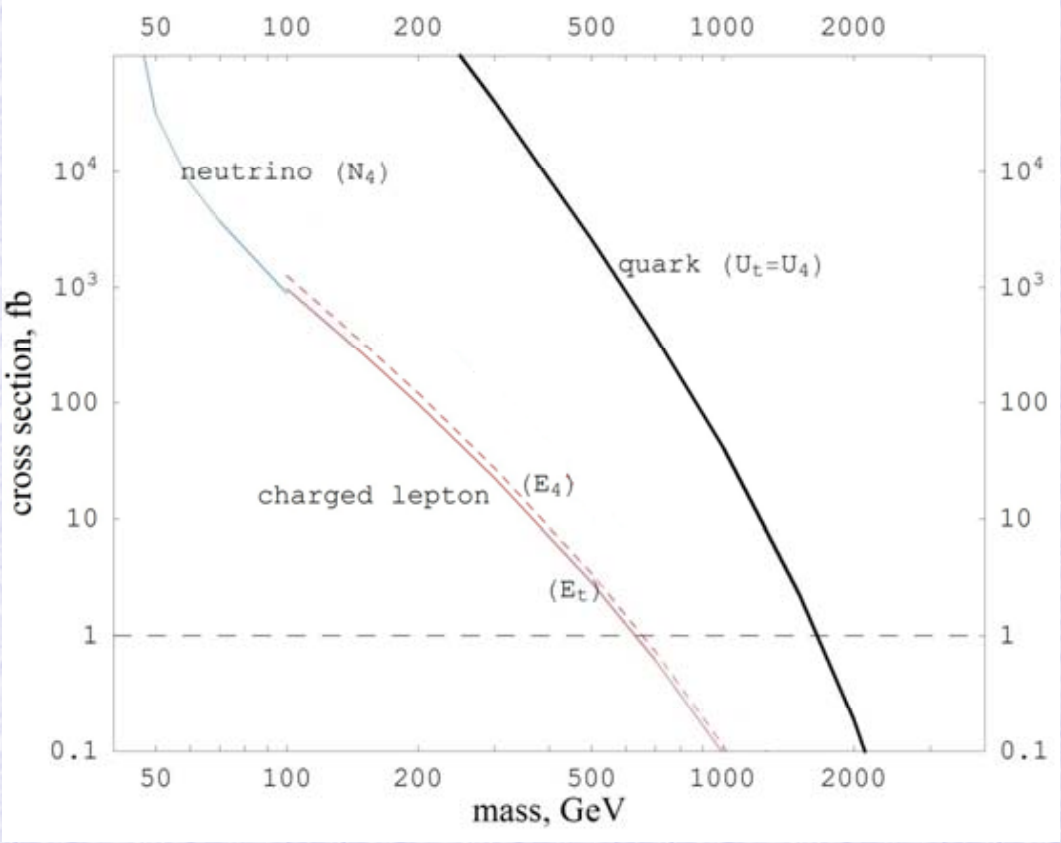


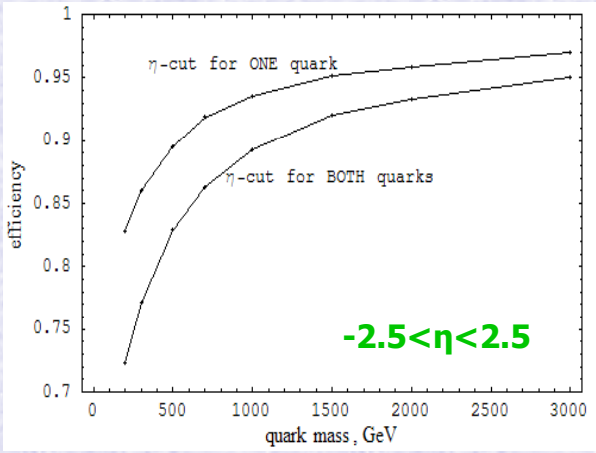
wrt 3 generations case:

- **Higgs is invisible due to H→NN**
- **Γ(H→gg) increases**
- **Γ(H→γγ) decreases**
- **all Γ(H→ff) do not change, so Br(H→ff) are suppressed**

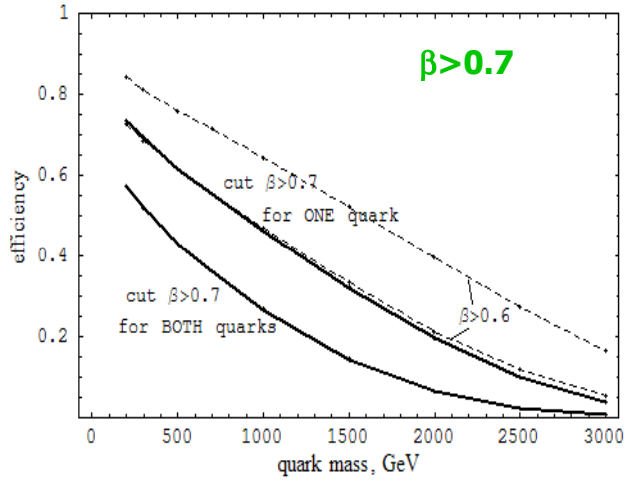
- **in pp→p(H→bb)p, the changes in Γ(H→gg) and Br(H→bb) are almost compensated.**

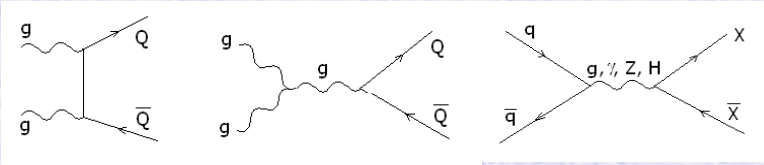
Cross section of pair production in ATLAS



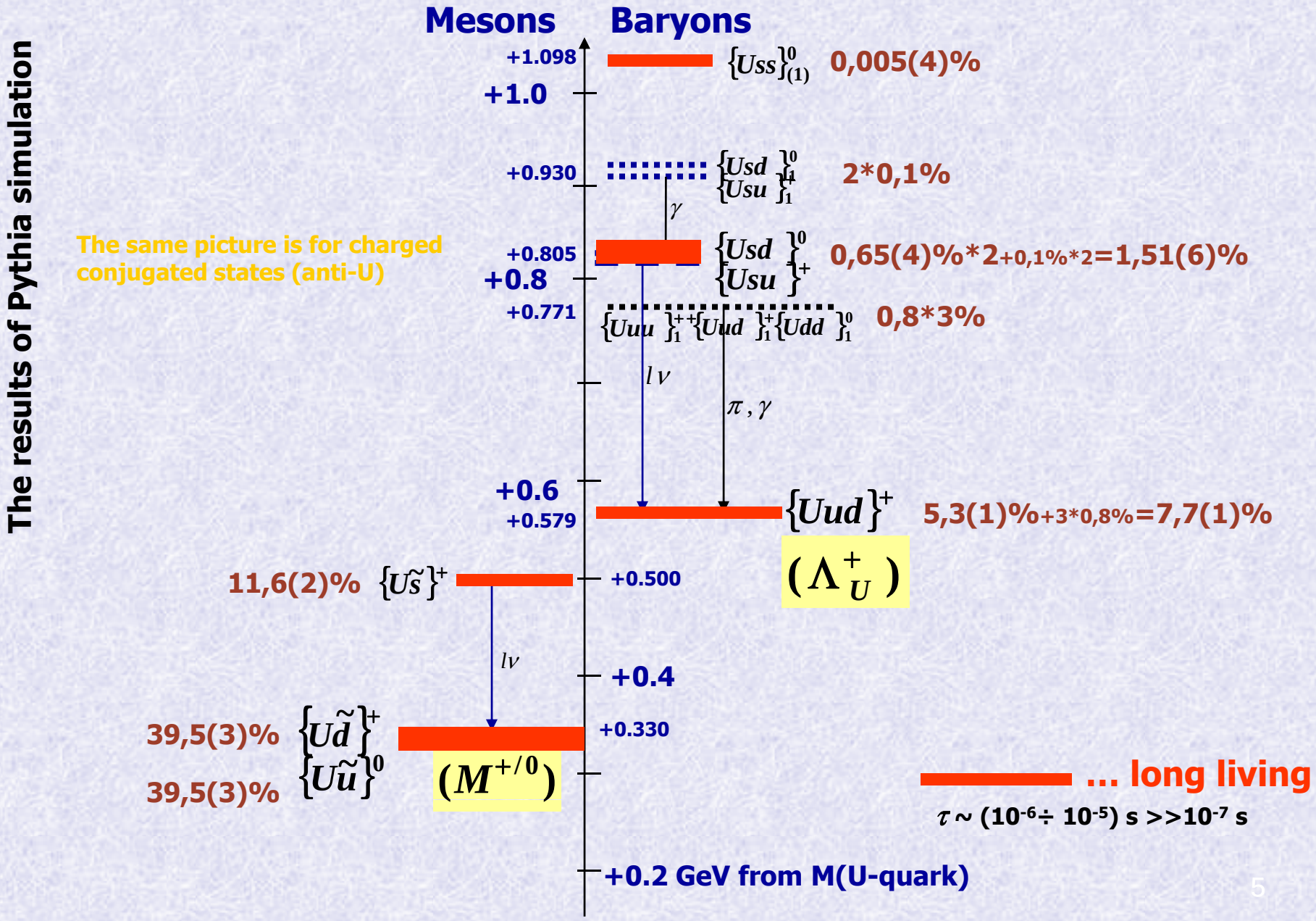


Efficiency suppression due to muon trigger condition

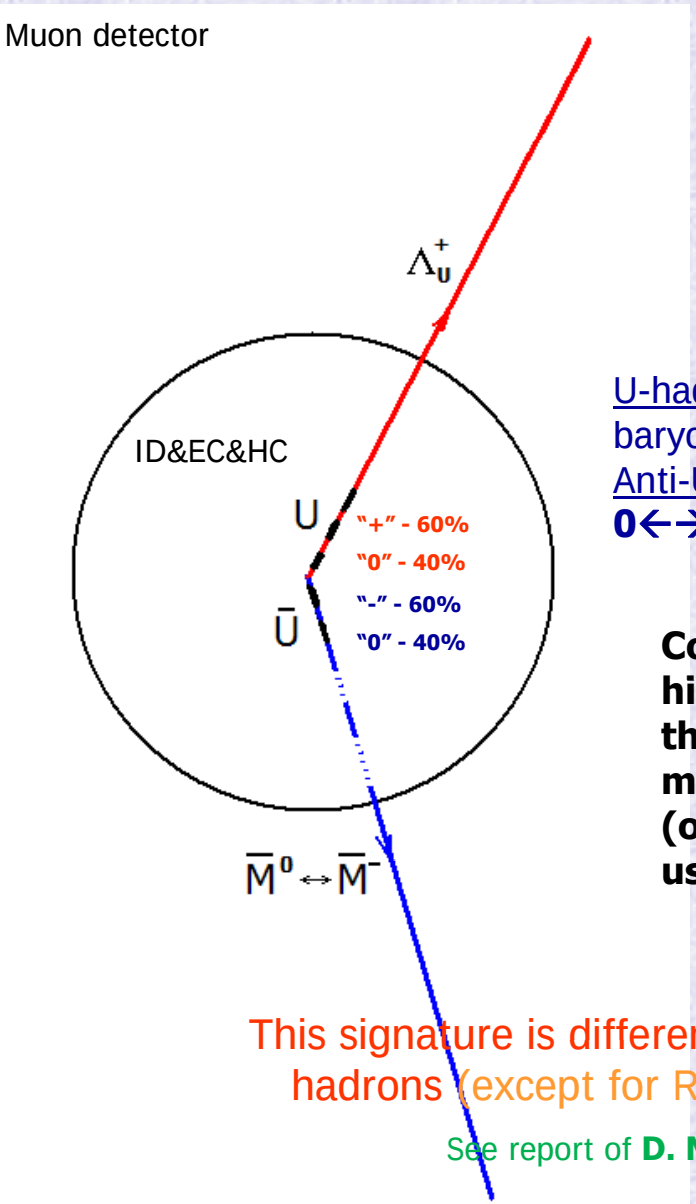




Expected properties of U(stop)-hadrons: mass spectrum, relative yields



Signature of U(stop)-hadrons in experiment



Conversions of U-hadrons during their propagation through the matter of detectors

$$\Lambda_U^+ \to \Lambda_U^+ \qquad \tilde{\Lambda}_U^- \to \tilde{M}^{0/-}$$
$$M^{0/+} \to \Lambda_U^+ \qquad \tilde{M}^{0/-} \leftrightarrow \tilde{M}^{0/-}$$

U-hadrons transform within a few nuclear lengths into U-baryons with the charge **+**.
Anti-U-hadrons transform into mesons, alternating the charge **0←→-**.

Common main features: high pt, low velocity (less than speed of light). The measurement of the latter (over time of flight) gives us a mass.

Transitions with reduction of baryon number of U-hadron are suppressed.

For anti-U-hadrons:

$$\tilde{\Lambda}_U^- + N \to \tilde{M}^{0/-} + \pi,\ldots$$
$$\tilde{M}^{0/-} + N \leftrightarrow \tilde{M}^{0/-} + N,\ldots$$
$$\to \tilde{\Lambda}_U^- + N + N,\ldots \text{ suppressed}$$

For U-hadrons:

$$\Lambda_U^+ + N \to M^{0/+} + N + N,\ldots \text{ suppressed}$$
$$M^{0/+} + N \leftrightarrow M^{0/+} + N,\ldots$$
$$\to \Lambda_U^+ + \pi,\ldots$$

For strange U/anti-U-hadrons:

$$\{\tilde{U}s\tilde{q}\}^{+/0} \to \tilde{M}^{0/-} \qquad \{Us\}^+ \to \Lambda_U^+$$
$$\{Usq\}^{+/0} \to\to \Lambda_U^+ \qquad \{\tilde{U}s\}^+ \to\to \tilde{M}^{0/-}$$

This signature is different from that of R-hadrons (except for R-stop-hadrons)

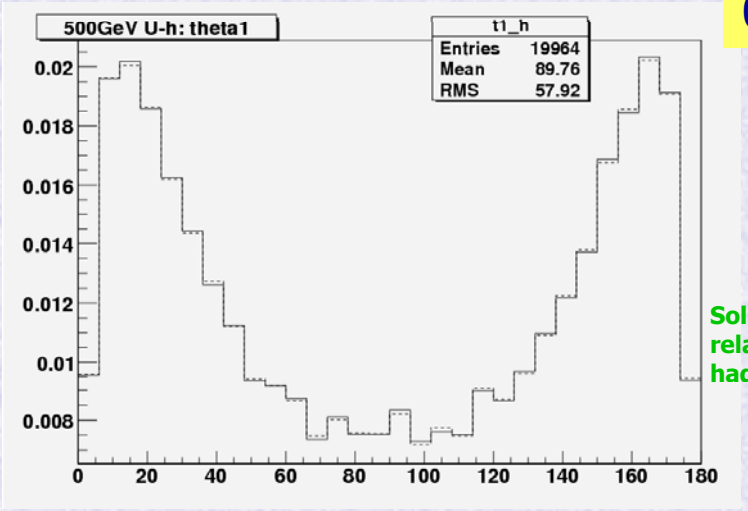
See report of **D. Milstead**

U-hadrons vs stop-hadrons

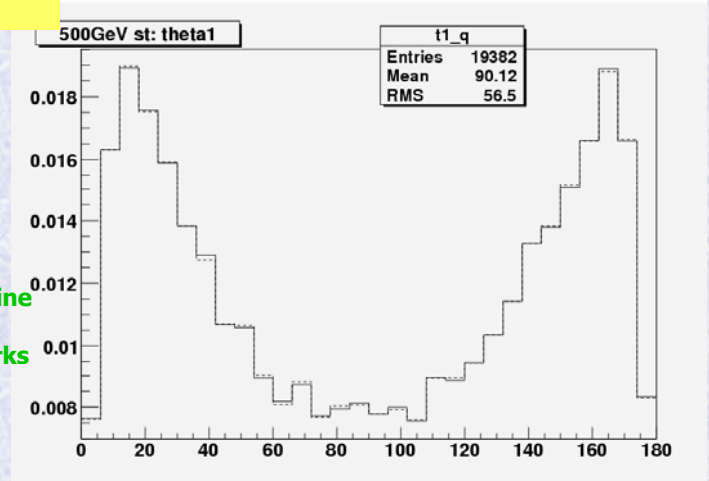
U-quarks/hadrons

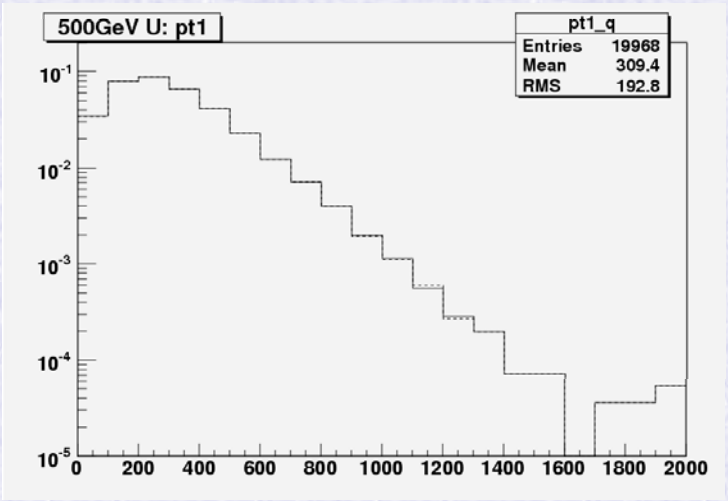
0,5 TeV

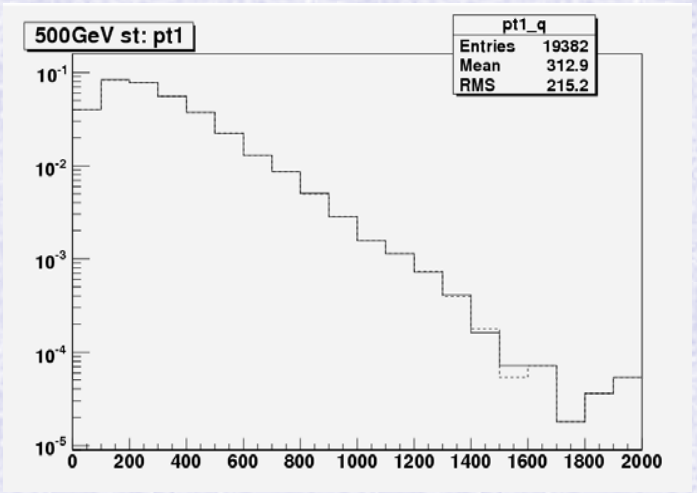
stop-quarks/hadrons



Solid (dashed) line relates to (not) hadronized quarks

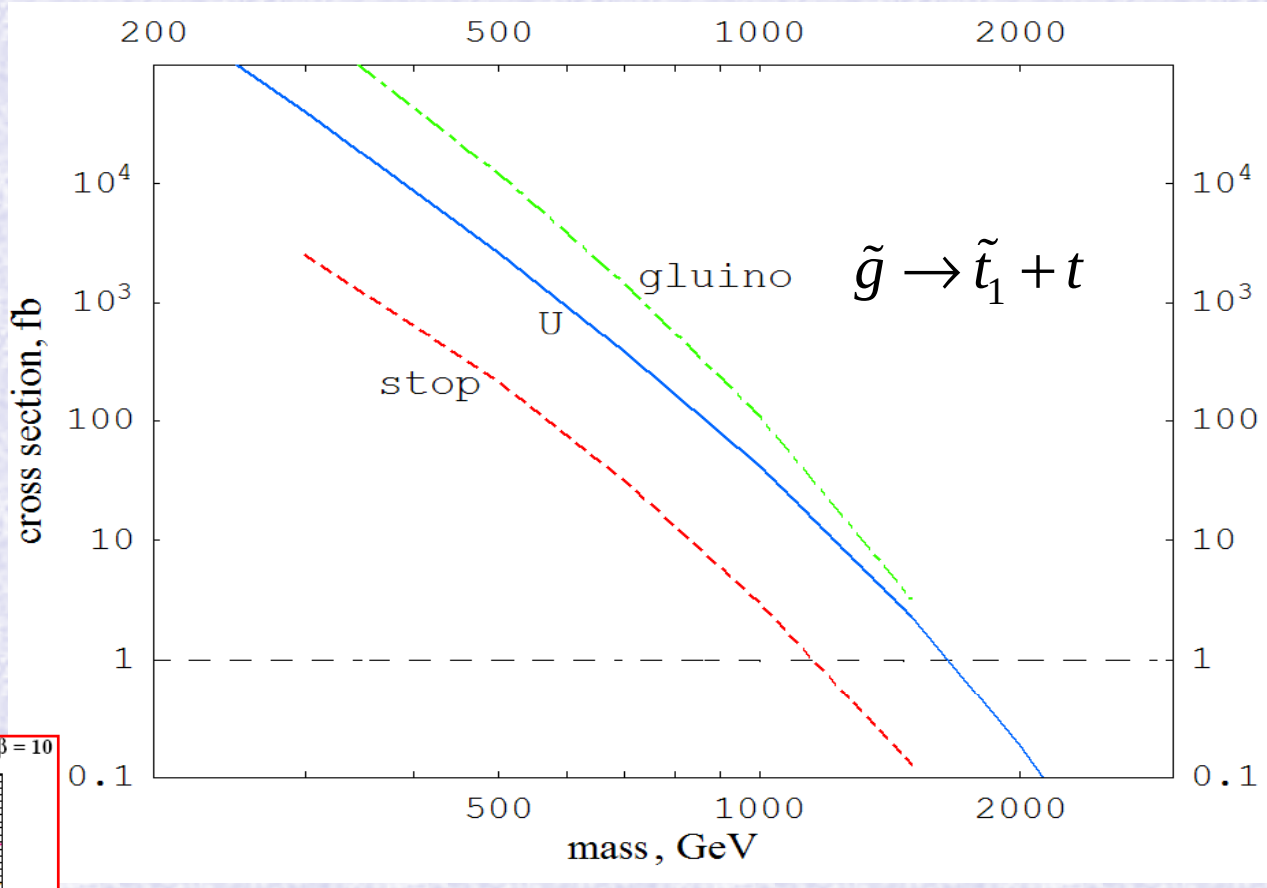


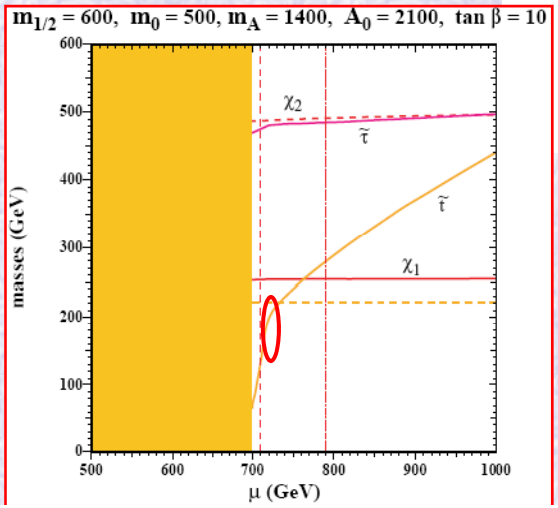




Kinematic distributions of U- and stop-quarks have subtle differences, showing themselves at large statistics. E.g., two hypotheses can be discriminated over a width of pseudorapidity distribution at integral intensity >~100 fb^{-1}.

U-hadrons vs stop-hadrons



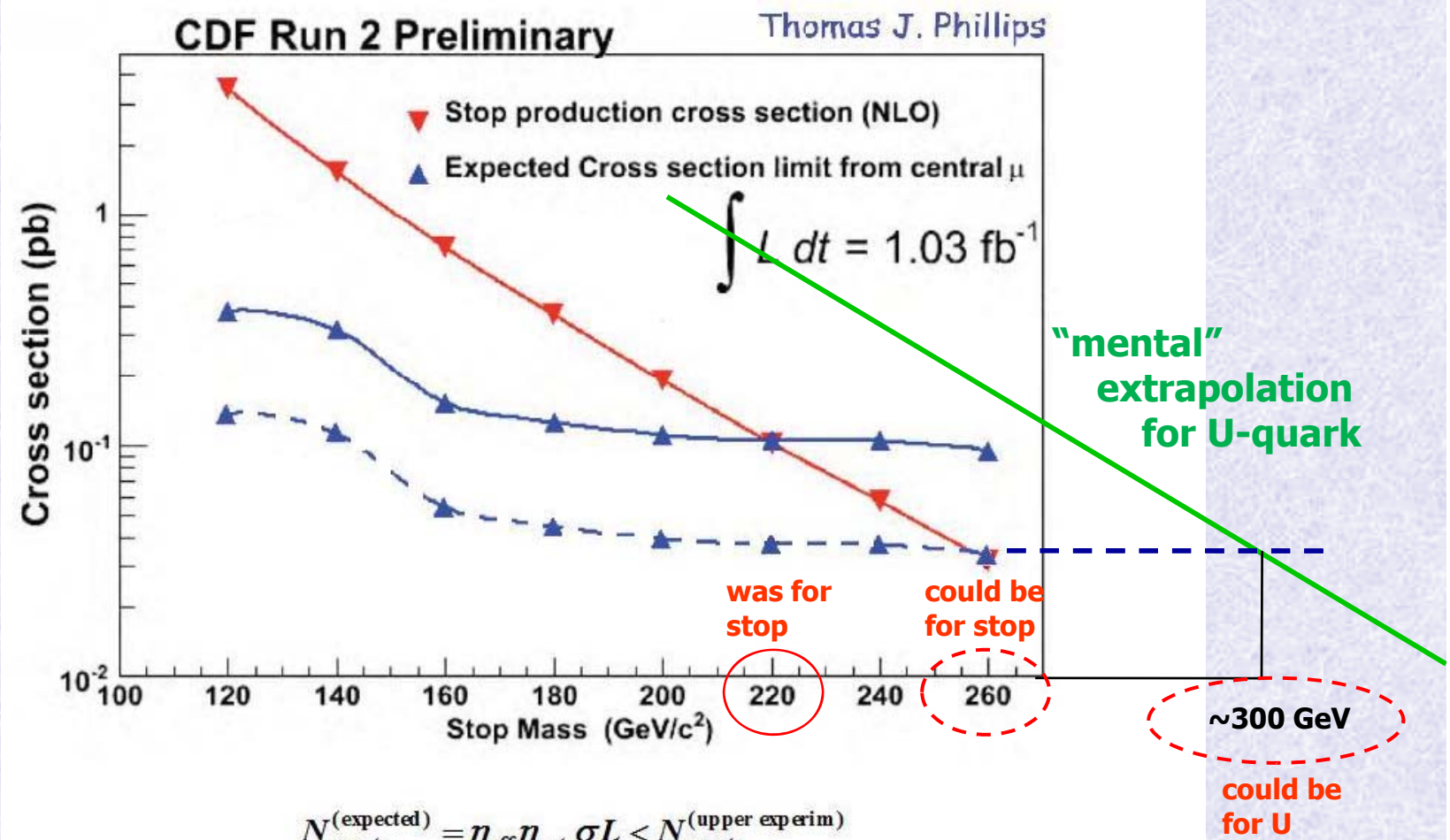


Conclusion

- Model of stable new generation particles may have distinct experimental features (i) connected with Higgs physics, (ii) accounted for by specifics of new hadron family.
- Discrimination of competing hypotheses of U- and stop-quarks existence over kinematic distributions requires a refined analysis and, likely, large statistic taking. Accompanying SUSY effects (such as gluino production) may be of crucial importance.

Back up

Comments about Tevatron constraint on mass of stop and U



$$N_{events}^{(\text{expected})} = \eta_{eff}\eta_{cuts}\sigma L < N_{events}^{(\text{upper experim})}$$

$$\sigma < \sigma^{(\text{upper experim})} = \frac{N_{events}^{(\text{upper experim})}}{\eta_{eff}\eta_{cuts}L}$$

$$was: \ \eta_{eff} = 0.5\cdot 0.5\cdot 0.5\cdot 0.5 = 16^{-1}$$

$$maybe: \ \eta_{eff} = 0.6\cdot 0.6\cdot 1\cdot 0.5 = 5.6^{-1}$$