FERMILAB-CONF-06-152-CD-T

BARD

See: hep-ph/0602101

Interpreting New Physics at the Energy Frontier

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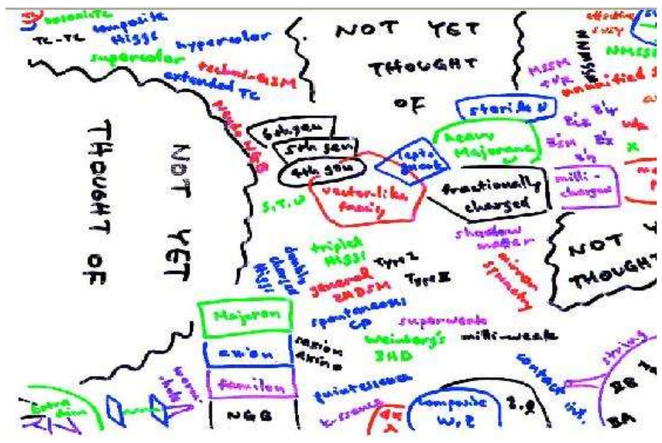
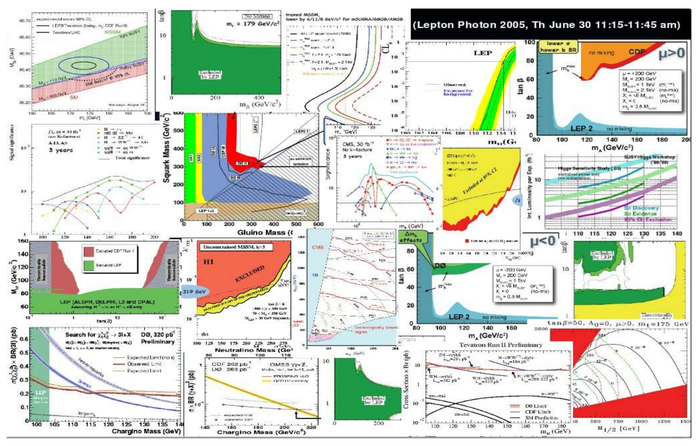
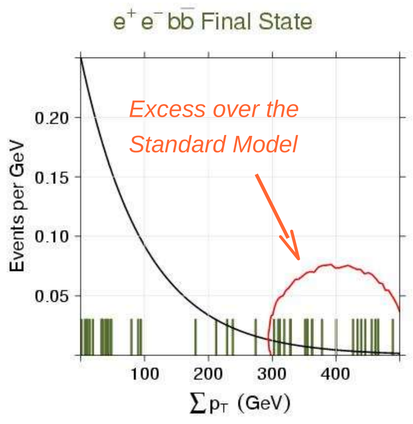
What is the New Physics beyond the Standard Model?



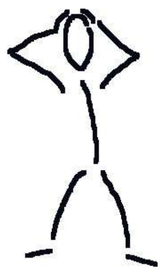


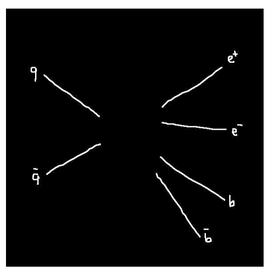


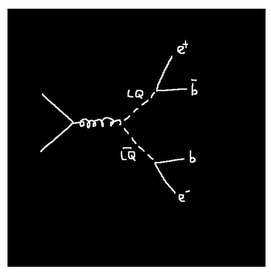
Theorists View — *Experimentalist's View* — *Reality*

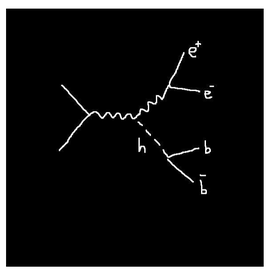
How will we make sense of it?

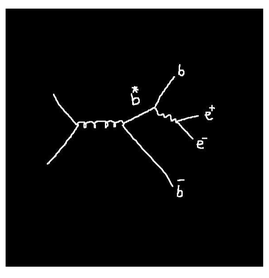
You or Me



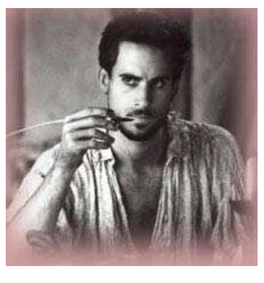




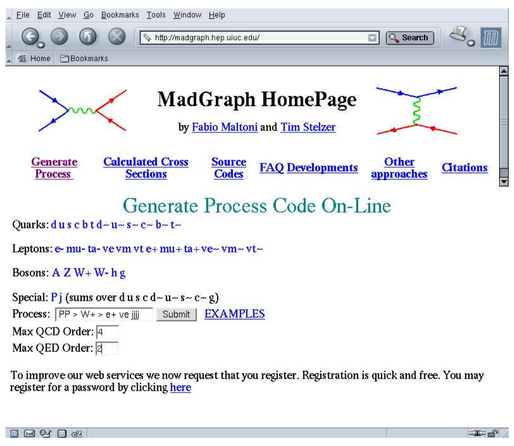




Physics Shakespeare



Automatic way to write stories in the Standard Model



Expand your vocabulary (interaction Lagrangian)

$$\mathcal{L}_{FFV} = \bar{f}'\gamma^\mu \left(G(1)\frac{1-\gamma_5}{2} + G(2)\frac{1+\gamma_5}{2} \right) f V^*_\mu$$

$$\mathcal{L}_{FFS} = \bar{f}' \left(GC(1)\frac{1-\gamma_5}{2} + GC(2)\frac{1+\gamma_5}{2} \right) f S^*$$

$$\mathcal{L}_{VVV} = -iG \; \{ (\partial_\mu V^*_{1\nu})(V^{\mu *}_2 V^{\nu *}_3 - V^{\nu *}_2 V^{\mu *}_3) + (\partial_\mu V^*_{2\nu})(V^{\mu *}_3 V^{\nu *}_1 - V^{\nu *}_3 V^{\mu *}_1) + (\partial_\mu V^*_{3\nu})(V^{\mu *}_1 V^{\nu *}_2 - V^{\nu *}_1 V^{\mu *}_2) \}$$

$$\mathcal{L}_{VVS} = G V^{\mu *}_1 V^*_{2\mu} S^*$$

$$\mathcal{L}_{SSS} = G\, S^*_1 S^*_2 S^*_3 \qquad \mathcal{L}_{VSS} = iG V^*_\mu S^*_2 \overleftrightarrow{\partial}^\mu S^*_1$$

Add interesting characters (new particles)

"Higgs"

"Neutralino"

"Z"

```
sss    sss    s  d  npm(1)   npW  s  Xsss  31
ssf    ssf~   f  s  npm(2)   npW  s  Xssf  32
szs    szs    s  d  npm(3)   npW  s  Xszs  33
szf    szf~   f  s  npm(4)   npW  s  Xszf  34
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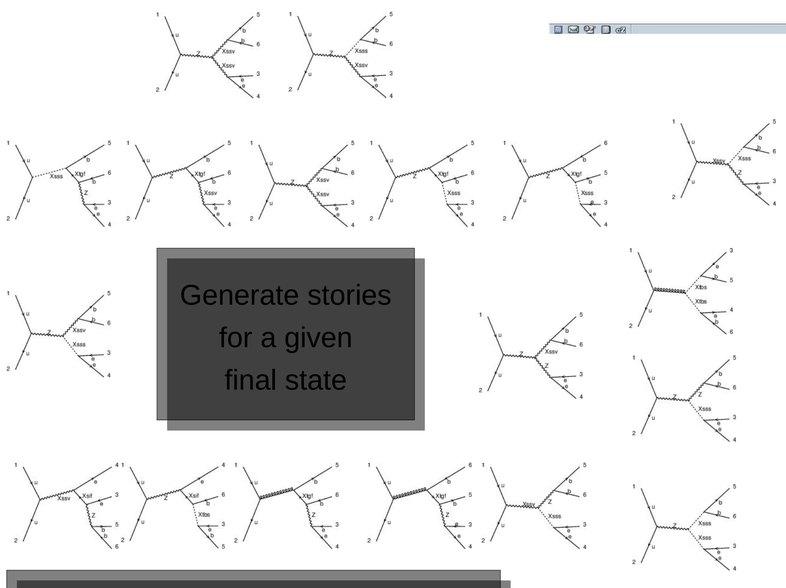
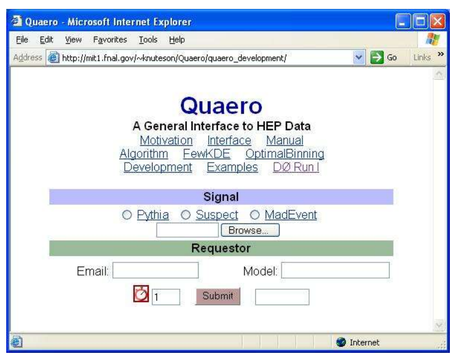


Generate stories for a given final state

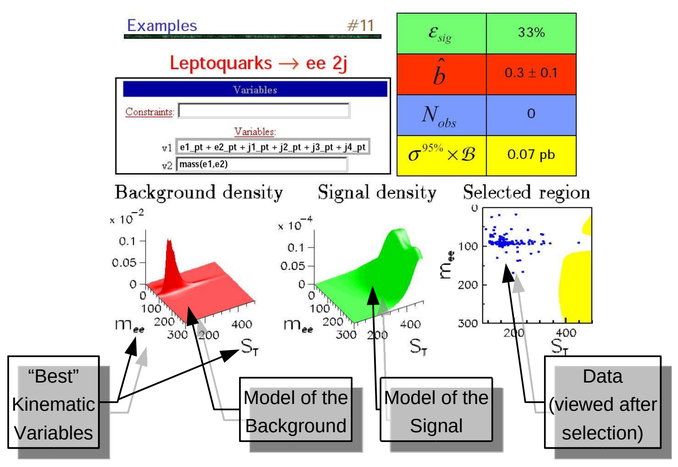
+ ...

Select the Stories that best describe the data

Apply a method to test hypotheses (Signal+Background vs. Background)



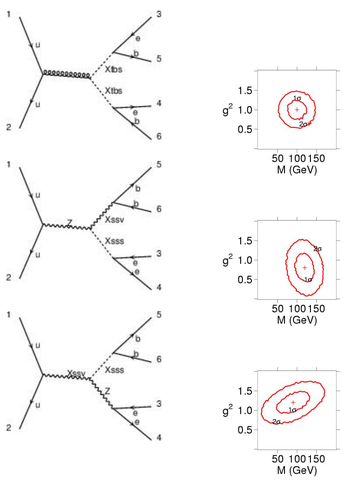
Let the computer choose the best way to discriminate hypotheses



Stories

Parameter Estimates

$$\log_{10} \frac{prob(S+B)}{prob(B)}$$

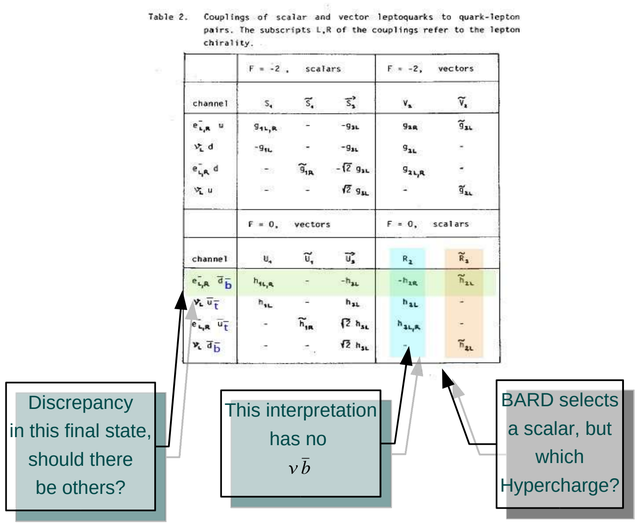


7 — THE WINNER

4

2

Infer other interactions based on quantum numbers of particles



Discrepancy in this final state, should there be others?

This interpretation has no $\nu\bar{b}$

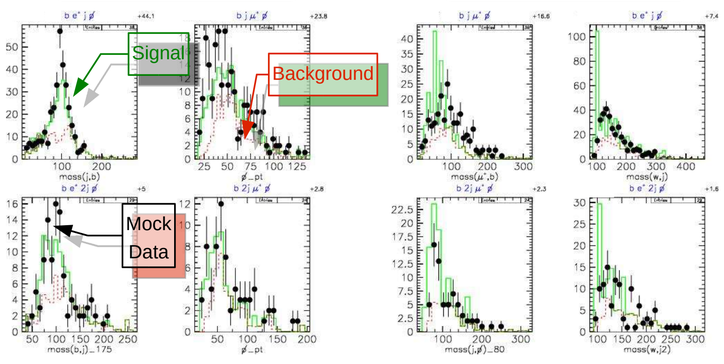
BARD selects a scalar, but which Hypercharge?

Bard at Work:

Find a 100 GeV "Higgs" hidden in the Wbb data

BARD prefers a 100 GeV scalar produced with a W

BARD disfavors "single-top" interpretation



Abstract:

No systematic procedure currently exists for inferring the underlying physics from discrepancies observed in high energy collider data. BARD is an algorithm designed to facilitate the process of *model construction* at the energy frontier. *Top-down* scans of model parameter space are discarded in favor of *bottom-up* diagrammatic explanations of particular discrepancies, an explanation space that can be *exhaustively searched* and *conveniently tested* with existing analysis tools.