top quark spin observables

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I would like to discuss two topics

1. Types of top quark spin observables
2. Types of top pair resonances

There are three types of top quark spin observables that should be carefully distinguished.

1. Helicity fractions for W bosons in top quark decay

   3 parameters depends only on decay amplitudes,
   independent of production dynamics
   (w. perfect detector)

2. Average helicity of t or tbar

   function of $\cos\theta_*$ (close to 3 parameters)
   zero in a parity-conserving theory, thus sensitive to new physics

3. Correlation of helicity ($\vec{k}_t \cdot \vec{S}_t$) or $\vec{p} \cdot \vec{S}_t$ between t and tbar

   function of $\cos\theta_*$ (close to a 3x3 density matrix)
   large correlations are predicted in the SM

2. General phenomenological analysis of t tbar resonances

w. Michael Davenport

At a previous HEFTI meeting, Kevin Black suggested that it would be a Good Thing to have an event generator for t tbar resonances which correctly accounted all top spin and interference effects (at the parton level).

Actually, almost everything he wanted was already available in the MADGRAPH model file topBSM, described in

Frederix and Maltoni, arXiv:07122355

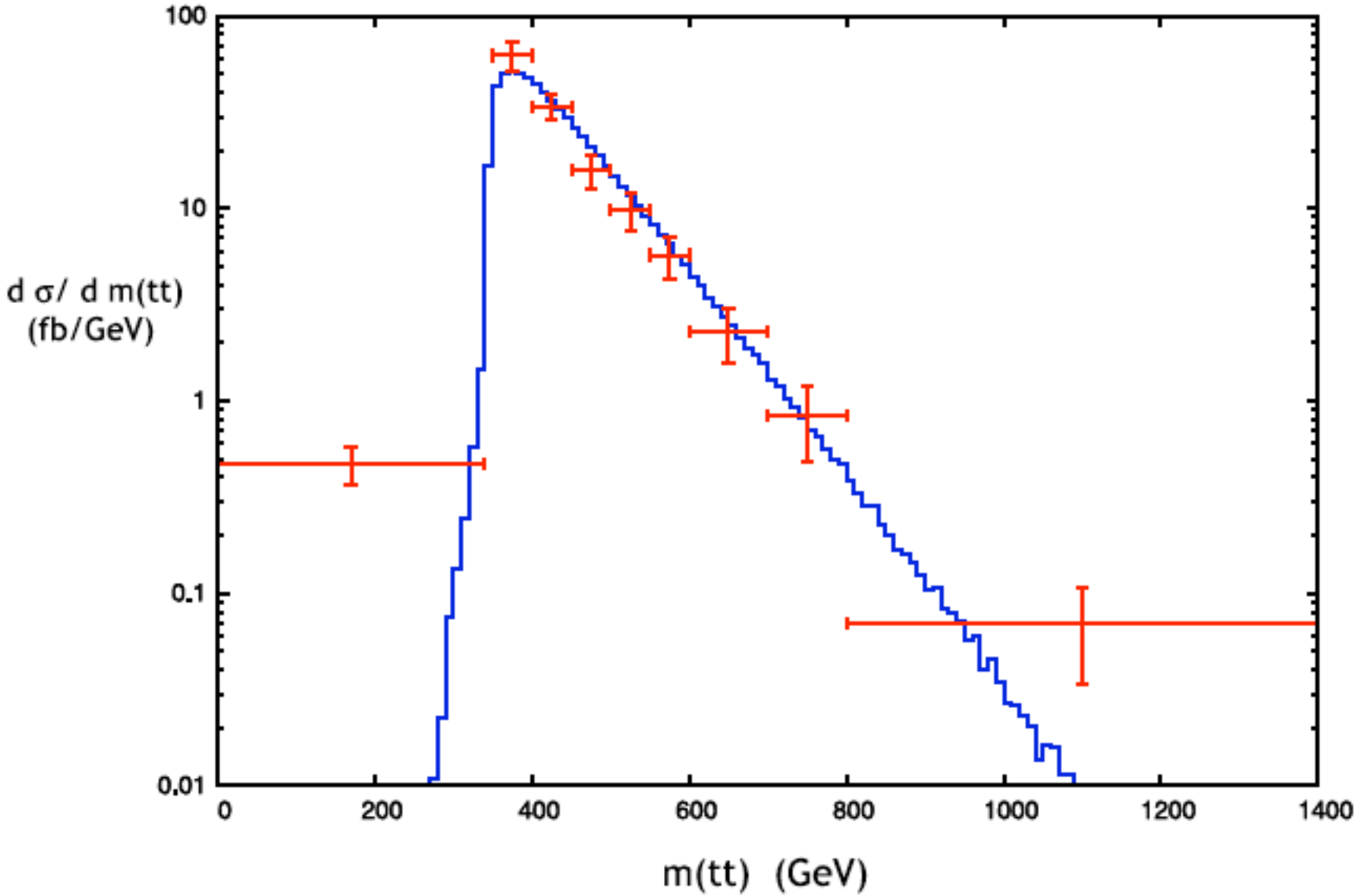
However, sometimes having more than one independently written tool is advantageous, so Davenport and I built another one.

Our program pandora/ttBSM allows the user to include arbitarily many resonances of spin 0, 1, or 2, color 1 or 8, produced from quark or from gluon annihilation.

All calculations are done at the tree level. We include Standard Model t decay to $b\ell\nu, bq\bar{q}$, parton level only. Consistent with this, we include all spin correlations and interference with the Standard Model production. There is allowance for a K-factor, even K(s).

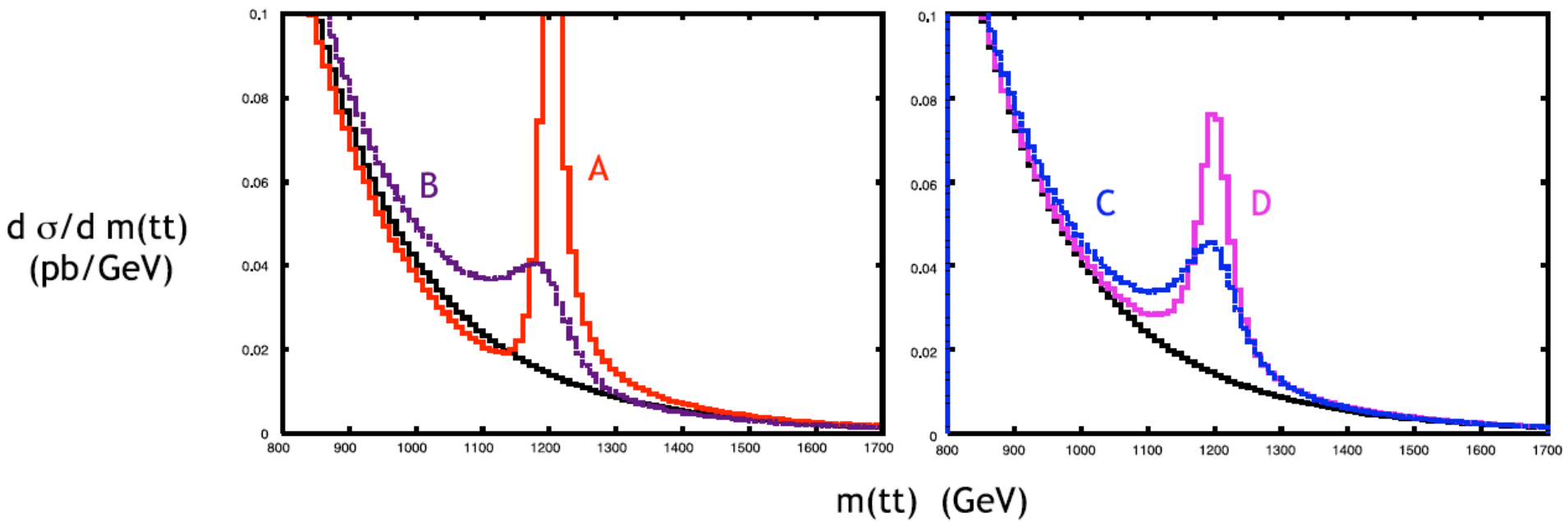
The program writes lhe files that can be input into PYTHIA and HERWIG.

comparison to CDF unfolded m(tt) distribution K = 1.3



5 resonances with m = 1.2 TeV, $\Delta\sigma(\mathrm{LHC},\ 10\ \mathrm{TeV}) = 5\ \mathrm{pb}$

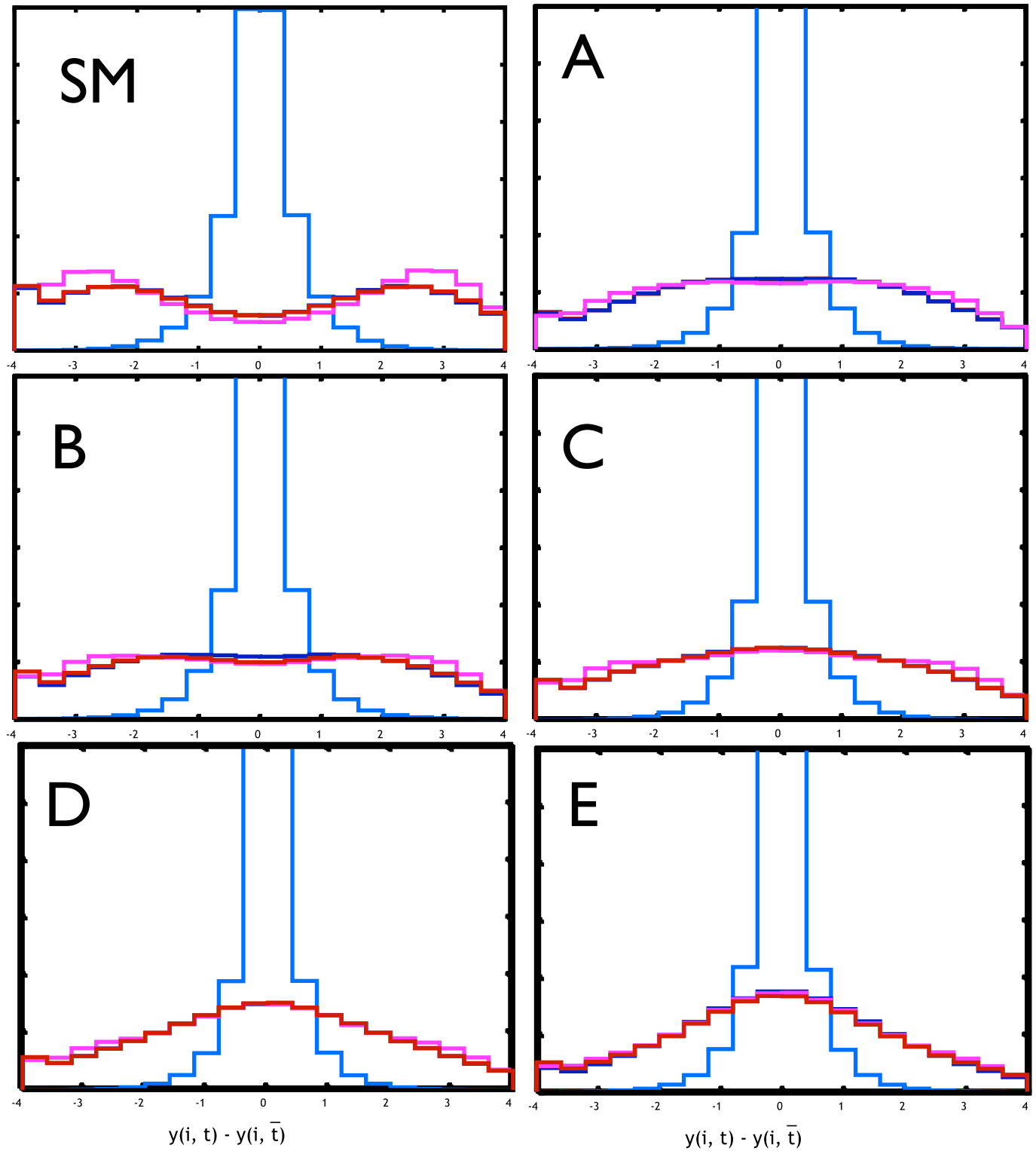
Model	Description	Nonzero couplings	g/g_s	Γ (GeV)
A	vector color 8	$a_{Lf} = a_{Rf} = g$, all f	0.53	29.
B	KK gluon-like	$a_{Lf} = a_{Rf} = -0.2g$, except $a_{Lb} = a_{Lt} = g\ ,\ a_{Rt} = 4g$	0.83	107.
C	color 1 scalar	$a_{St} = 1\ ,\ a_{Sg} = v^2/M_R^2$		99.
D	color 8 tensor	$a_{Lf} = a_{Rf} = a_g = g$	0.13	51.
E	color 6 diquark scalar	$a_{0u} = a_{0t} = g$	0.42	4.4



y differences between t and tbar,

for t, l, W, b

parton level



I apologize that there are still bugs in the code, but it is probably useable by others. If you are interested, please email me at mpeskin@slac.stanford.edu