Status of anomalous Wtb analysis

$$\mathcal{L} = \frac{g}{\sqrt{2}}\left[W_\nu^- \bar{b}\gamma_\mu(F_1^L P_- + F_1^R P_+)t - \frac{1}{2M_W}W_{\mu\nu}^- \bar{b}\sigma^{\mu\nu}(F_2^L P_- + F_2^R P_+)t\right] + \text{h. c.}$$

The possible result is the first direct limits on the F_{R1}, F_{L2}, F_{R2}

$\sigma \sim c1\ F_{L1}^2 + c2\ F_{R1}^2 + c3\ F_{L2}^2 + c4\ F_{R2}^2 + c5\ F_{L1} \times F_{L2} + c6\ F_{R1} \times F_{R2}$
(production cross section, without top decay)

SM: $F_{L1} = 1$; $F_{R1} = F_{L2} = F_{R2} = 0$ (1000 in our notation)

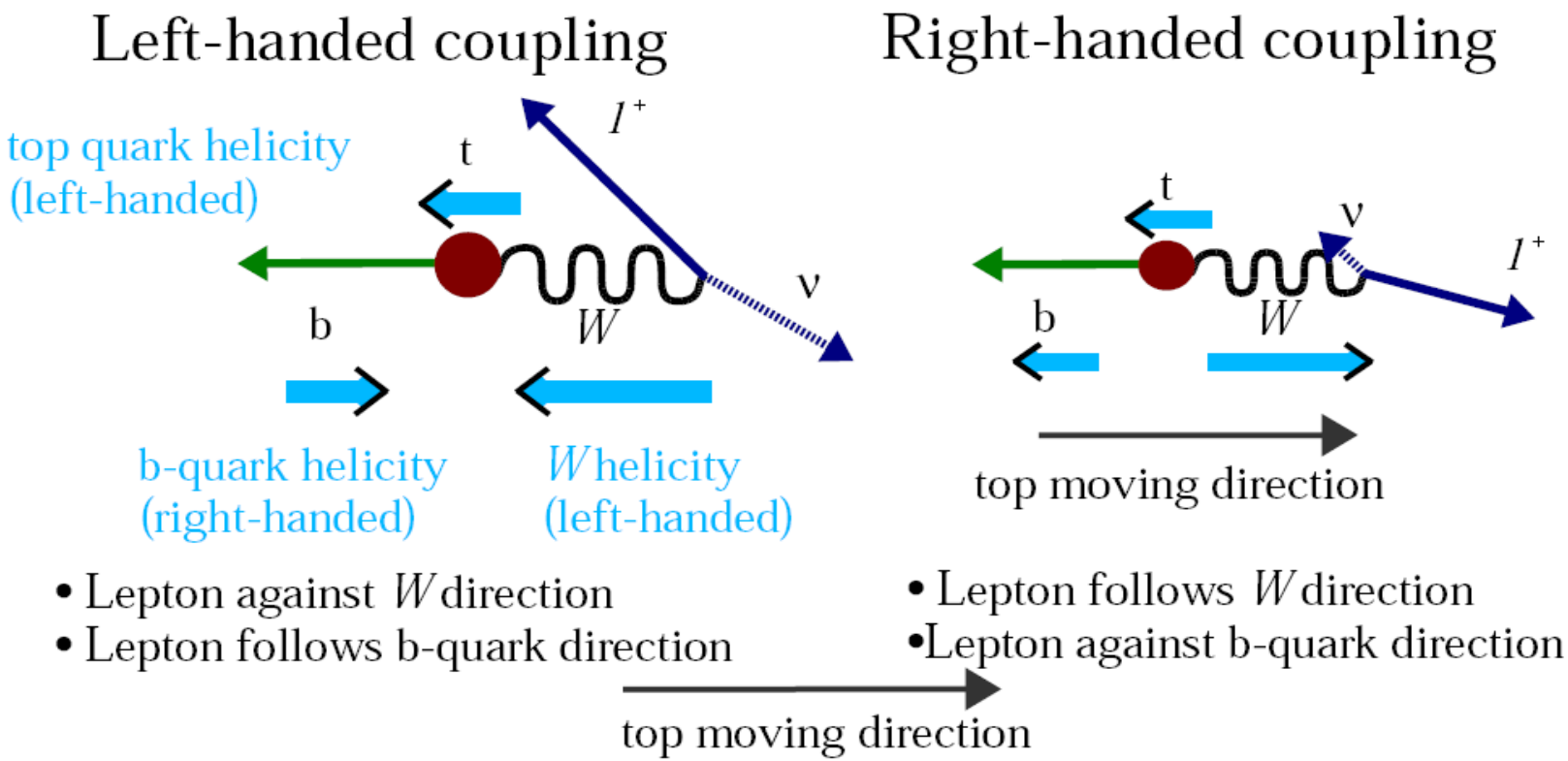
MC samples:
s- and t-channels (e,mu,tau) are ready, 6 points:
1000, 0100, 0010, 0001, 1010, 0101
Anomalous Wtb is in the production and in decay top vertexes
all of the properties are taking into account

The first round: only F_{R1} is non zero

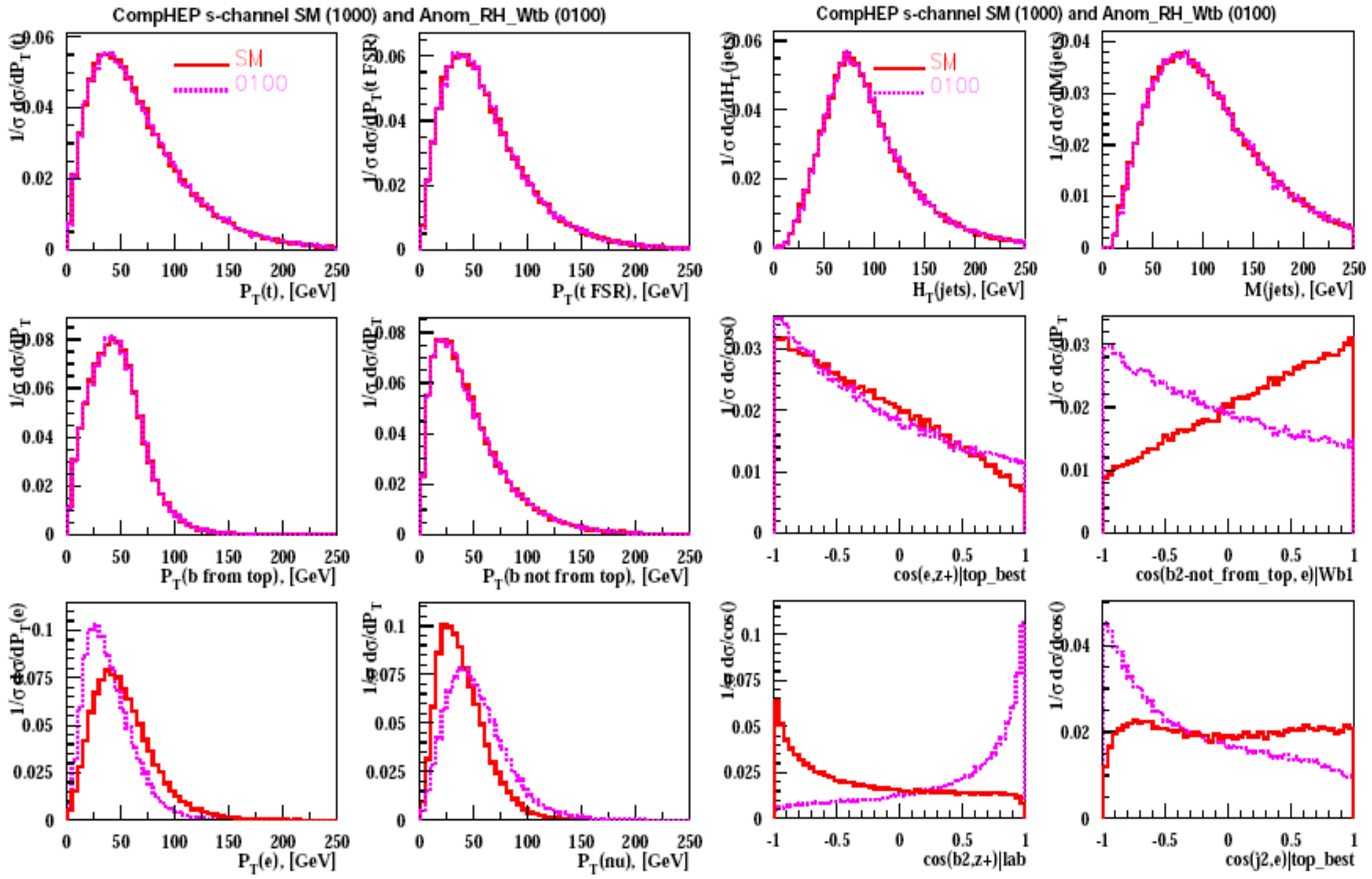
$\sigma \sim c1\ F_{L1}^{2} + c2\ F_{R1}^{2}$

Signal is 0100 sample; Backgrounds are 1000 (SM single top) and SM backgrounds

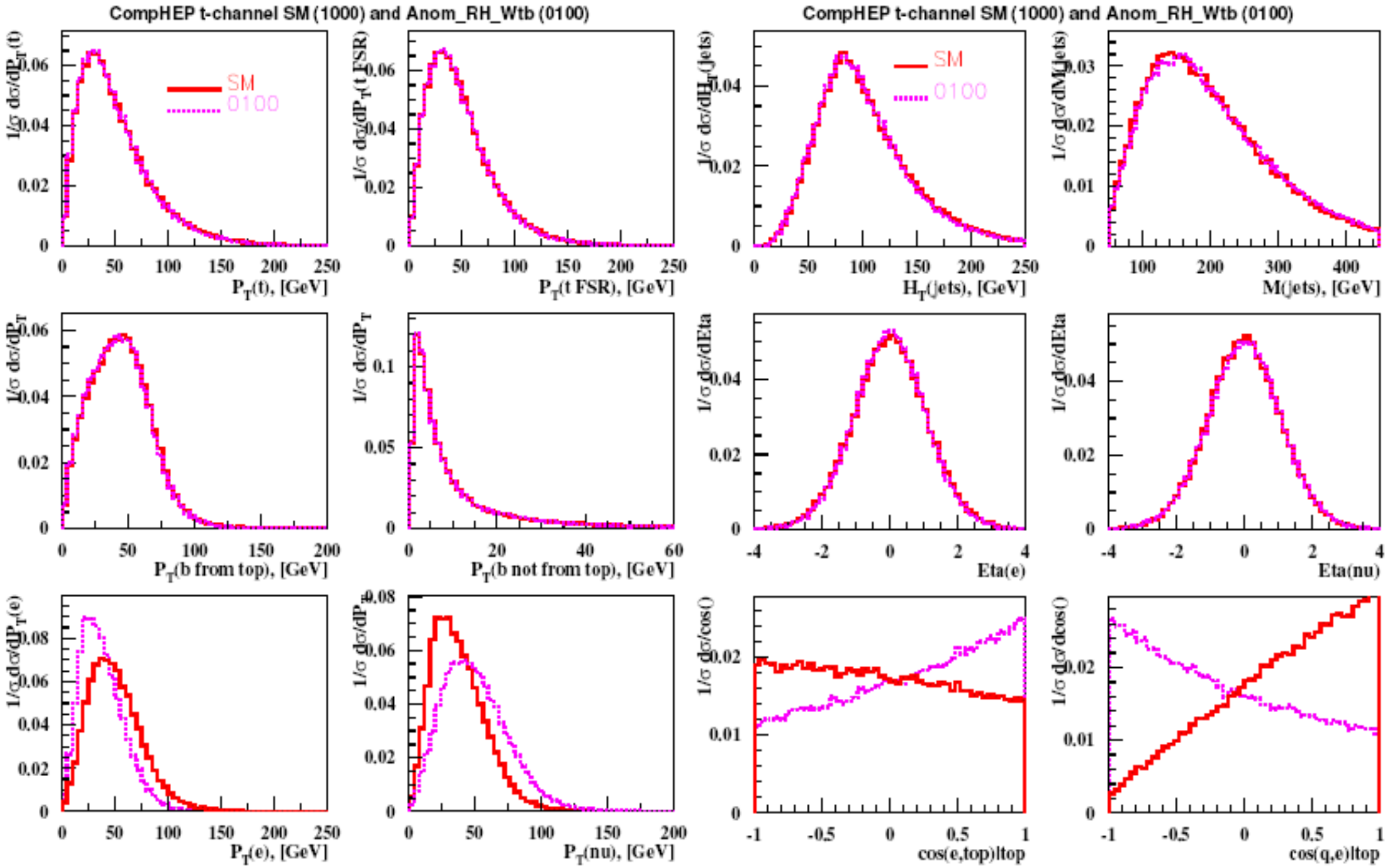
The kinematic properties of 1000 (V-A) and 0100 (V+A) are almost the same, the only difference is in angular correlations due to (V+A) vertex and as the result the differences in Pt of top decay products



S-channel distributions (SM and 0100)



t-channel distributions (SM and 0100)



SM Sensitive Variables

t-channel -- Wjets/QCD or Wbb

Cos_UntaggedJetLepton_BTaggedTop
Cos_NotBestJetAllJets_AllJets
Shat
Jet1Pt
Jet2Pt
Pt_Jet1Jet2
DeltaRJet1Jet2
InvariantMass_AllJets
TransverseMass_Jet1Jet2
HT_AllJets
QTimesEta = 0 for 2jet&&2tag events
BTaggedTopMass
BestJetPt
METPt (not useful for Wbb, only for QCD; can be removed for Wbb NN)

t-channel -- ttbar (l+jets, dilepton)

Cos_UntaggedJetLepton_BTaggedTop
(= Cos_NotBestJetLepton_BestTop for 2jet/2tag events)
Cos_LeptonBestTopFrame_BestTopCMFrame
Jet1Pt_NotBest (= Jet1Pt for 2jet events)
Jet2Pt_NotBest (= Jet2Pt for 2jet events)
BestJetPt
InvariantMass_AllJets_MinusBTaggedJet
(= InvariantMass_AllJets for 2jet events)
InvariantMass_AllJets
HT_AllJets_MinusBestJet (= HT_AllJets for 2jet events)
HT_AllJets
QTimesEta (= 0 for 2jet&&2tag events)
Shat
Pt_Jet1Jet2

s-channel -- Wjets/QCD or Wbb

Cos_LeptonQZ_BestTop
Cos_NotBestJetAllJets_AllJets
Shat
Jet1Pt
Jet2Pt
Pt_Jet1Jet2
DeltaRJet1Jet2
InvariantMass_AllJets
TransverseMass_Jet1Jet2
HT_AllJets
BestTopMass
BestJetPt
METPt (not useful for Wbb, only for QCD; can be removed for Wbb NN)

s-channel -- ttbar (l+jets, dilepton)

Cos_LeptonQZ_BestTop
Cos_LeptonBestTopFrame_BestTopCMFrame
Jet1Pt_NotBest = Jet1Pt for 2jet events
Jet2Pt_NotBest = Jet2Pt for 2jet events
InvariantMass_AllJets_MinusBestJet
(= InvariantMass_AllJets for 2jet events)
InvariantMass_AllJets
Shat
METPt
HT_AllJets
Pt_Jet1Jet2
HT_AllJets_MinusBestJet (= HT_AllJets for 2jet events)
Pt_AllJets_MinusBestJet (= Pt_Jet1Jet2 for 2jet events)

F_{L1} / F_{R1} Sensitive Variables

S-channel SM / 0100 :

Pt(lepton)
Missing Et
cos(l, top)|top
cos(l, Qxz)|top

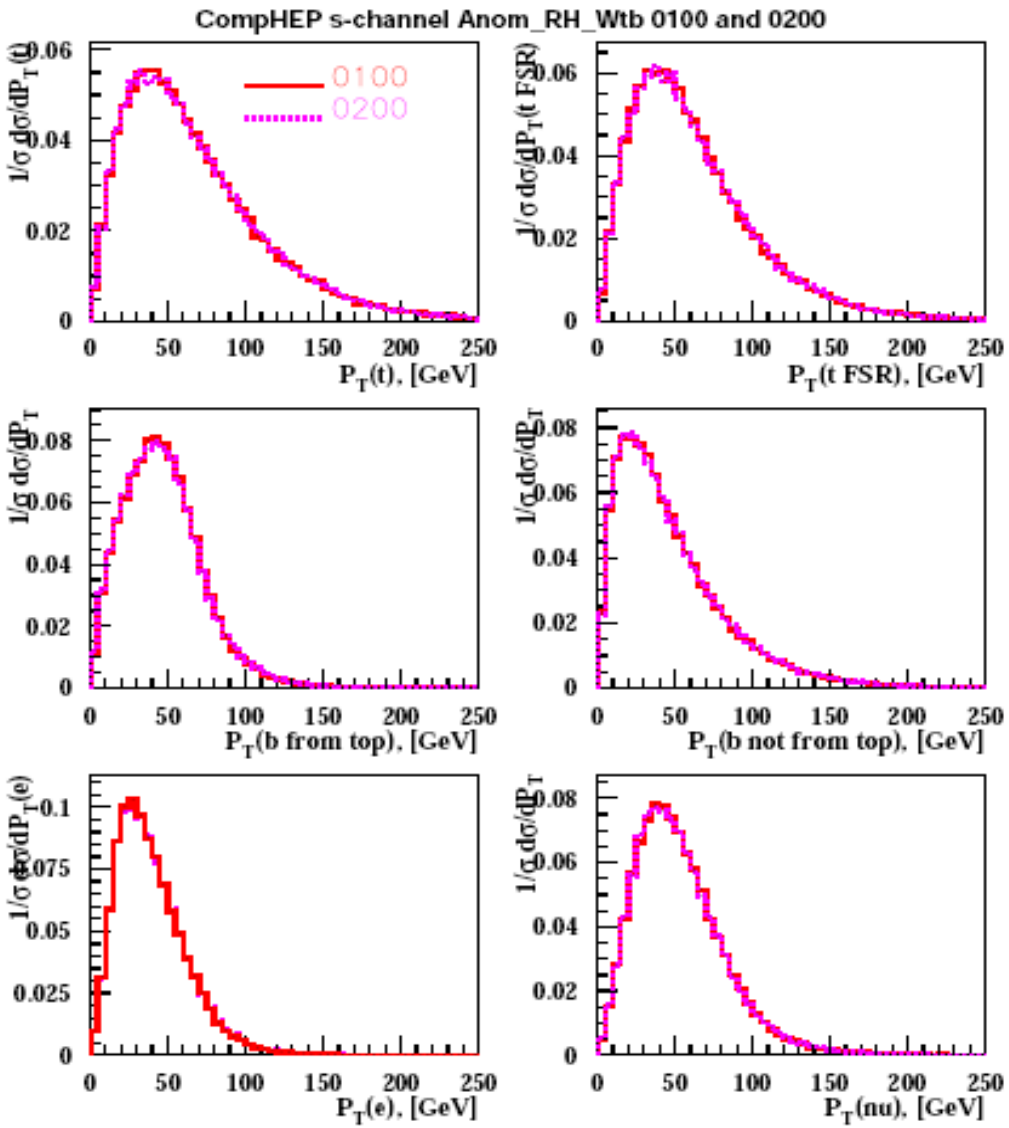
T-channel SM /0100 :

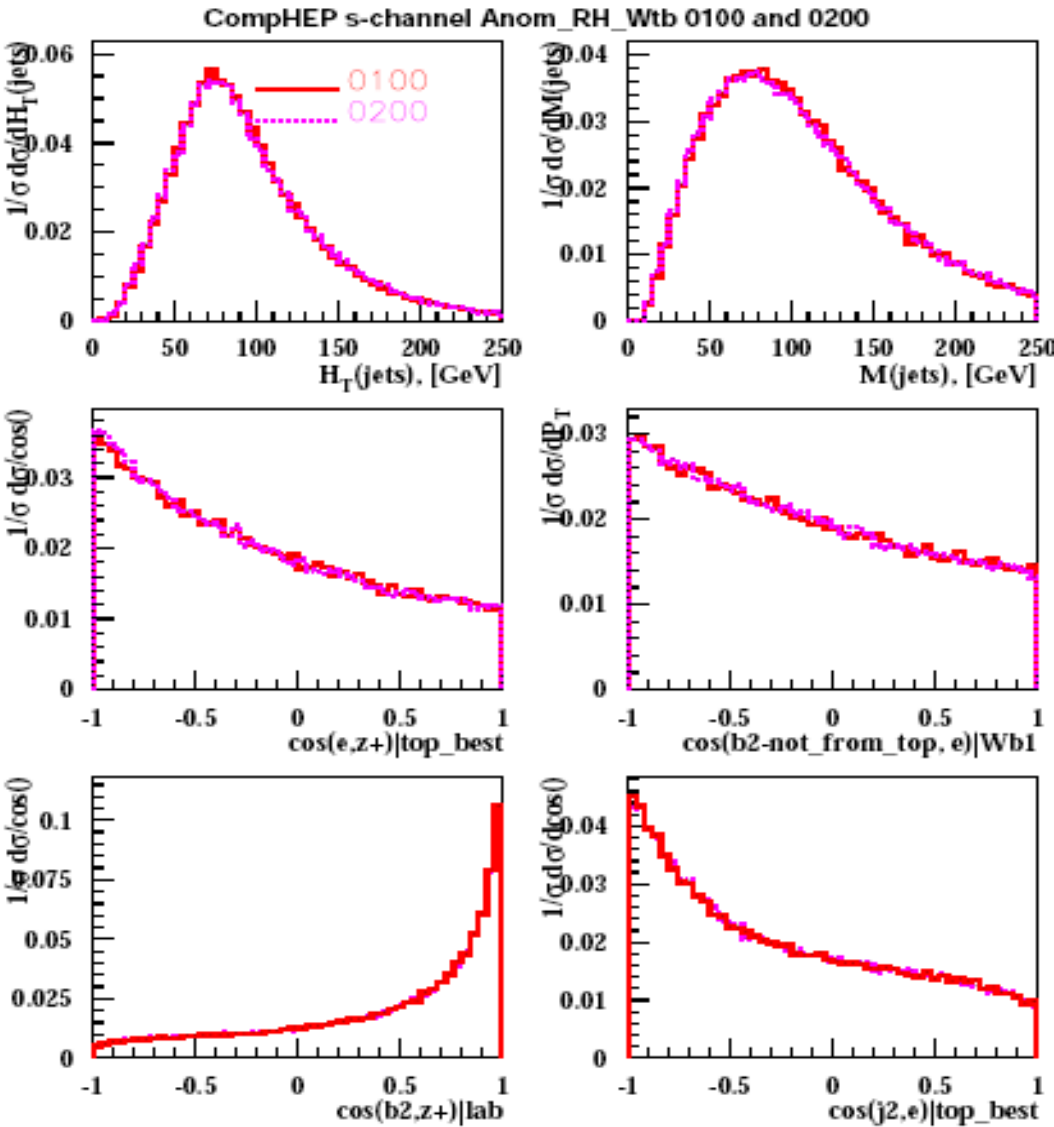
Pt(lepton)
Missing Et
cos(l, top)|top
cos(q, e)|top

cos(l, top)|top - reflects the correlations in decay (helicity bases) (V+A) or (V-A) structure of the Wtb vertex in top decay

cos(l, Qxz)|top and cos(q,e)|top – reflects the correlations between production of top and its decay; Wud-Wtb-Wtb vertexes (V-A)-(V-A)-(V-A) / (V-A)-(V+A)-(V+A)

Can we use only one MC sample for 0100 analysis? Does it reflect all possible properties when the value of F_{R1} changes? We have this coupling not only in the production, but in decay of top as well. Such a difference can brake the correlations in multivariate descriminators.
Let compare 0100 and 0200 distributions to check the difference in shapes.





Analysis strategy for F_{R1} Search

- (0100) t- and s- channels samples are the signal
- SM t-, s-channels and SM Backgrounds are considered as the backgrounds
- Use the standards multivariate techniques to set the limits for (0100) cross sections
- Based on the cross section limits set the limit on F_{R1} coupling (the same method as the limit on V_{tb})

The Second Round of Analysis

$F_{L1} = 1$ and F_{R1}, F_{L2}, F_{R2} are non zero

$$\sigma = A \times \sigma_{LEFT} + B \times \sigma_{RIGHT}$$

$$\sigma_{LEFT} = c1\, F_{L1}^2 + c5\, F_{L1} \times F_{L2} + c3\, F_{L2}^2$$

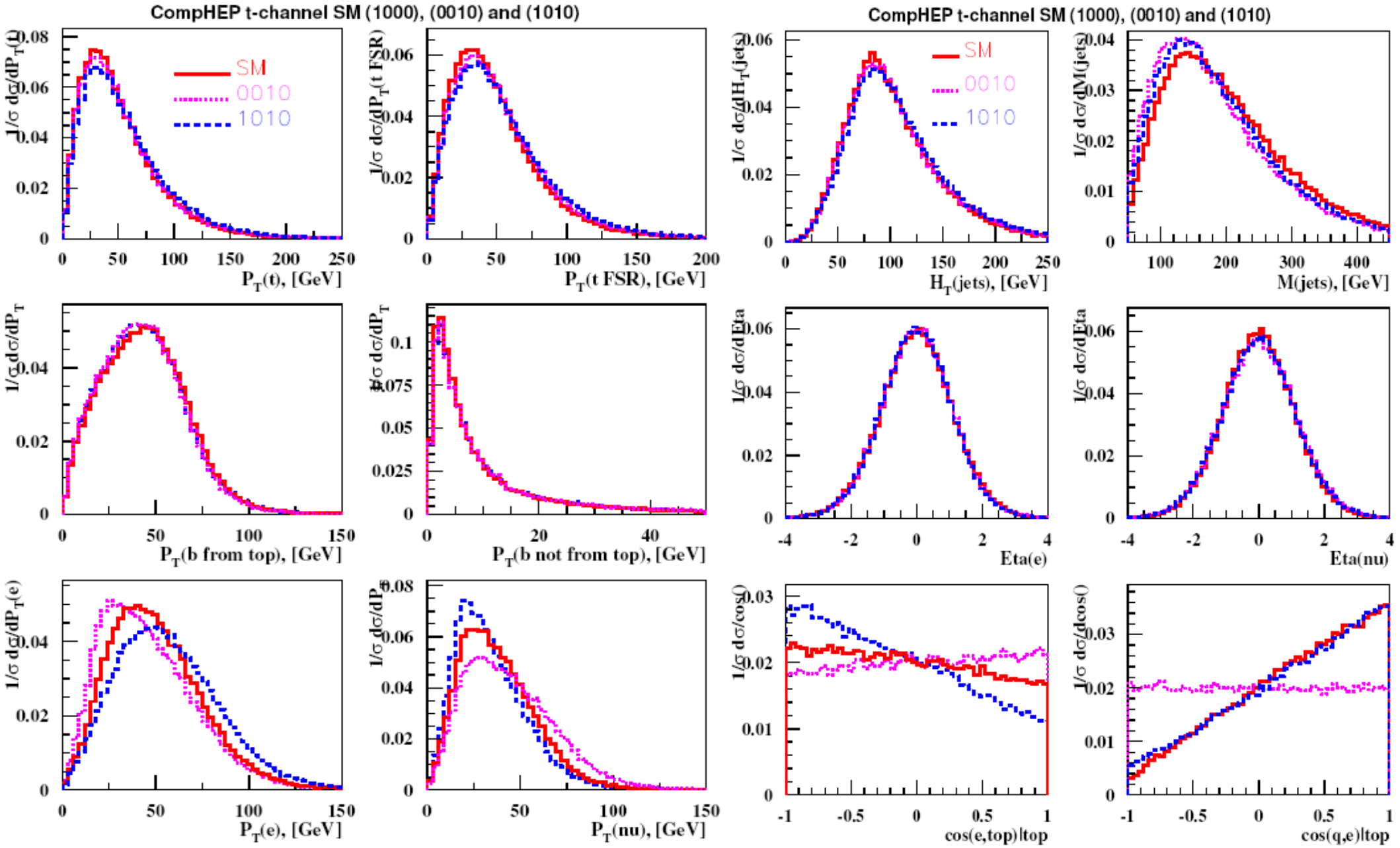
$$\sigma_{RIGHT} = c2\, F_{R1}^2 + c6\, F_{R1} \times F_{R2} + c4\, F_{R2}^2$$

MC signal samples
Left:
1000 - SM signal
0010 - only F_{L2}
1010 - SM + F_{L2} + interference

Right:
0100 - only F_{R1}
0001 - only F_{R2}
0101 - F_{R1} + F_{R2} + interference

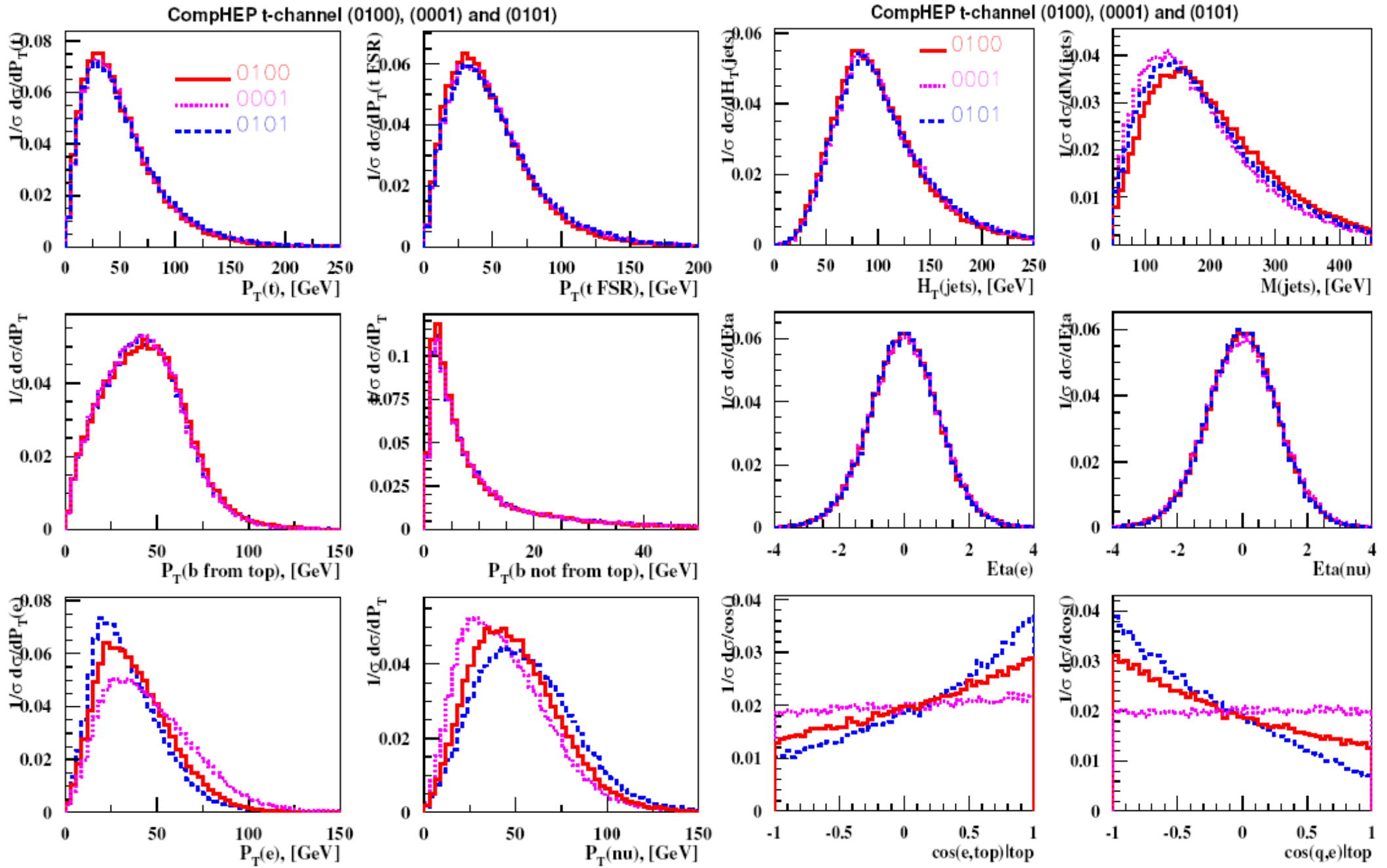
t-channel all possible left couplings

(1000),(0010),(1010)



t-channel all possible right couplings

(0100),(0001),(0101)



Possible analysis strategies

- Consider 3D limits on s + t channels with $F_{L1} = 1$ and F_{R1}, F_{L2}, F_{R2}
  - There are no infrastructure for 3D limits
  - Not obvious how to consider SM signal
  - Possible problems with statistical uncertainty
- Set limits on σ_{LEFT} and σ_{RIGHT} (2D)
  - Not obvious how to set particular limits on F_{R1}, F_{L2}, F_{R2}
  - Not obvious how to consider SM signal

Suggestions and proposals are welcome