

# Status report

Mar 11, 2021

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HYU / IP2I

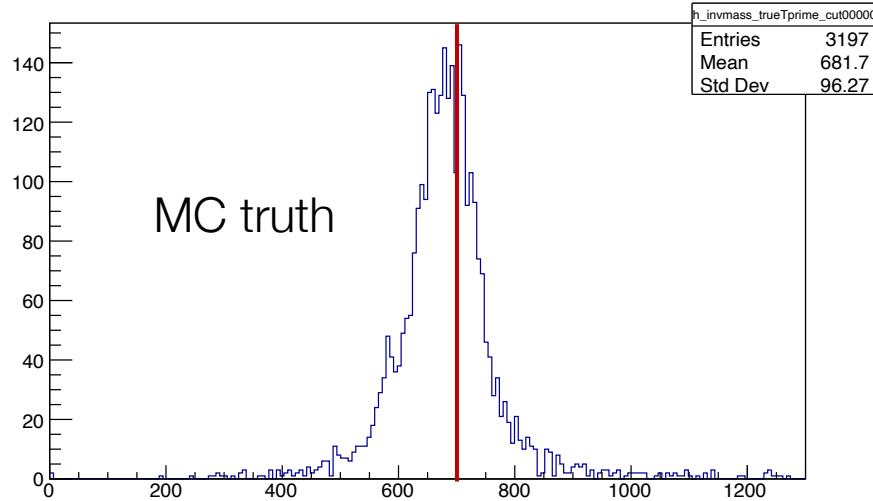
# Invariant mass distribution of 5 jets

T' mass is modeled – 700 GeV

invariant mass of 5 jets from trueTprime\_cut00000

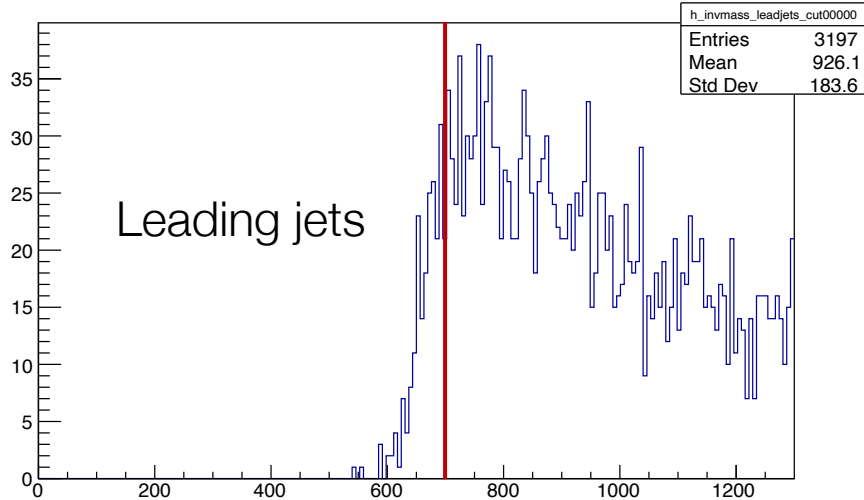
Bins 100

MC truth



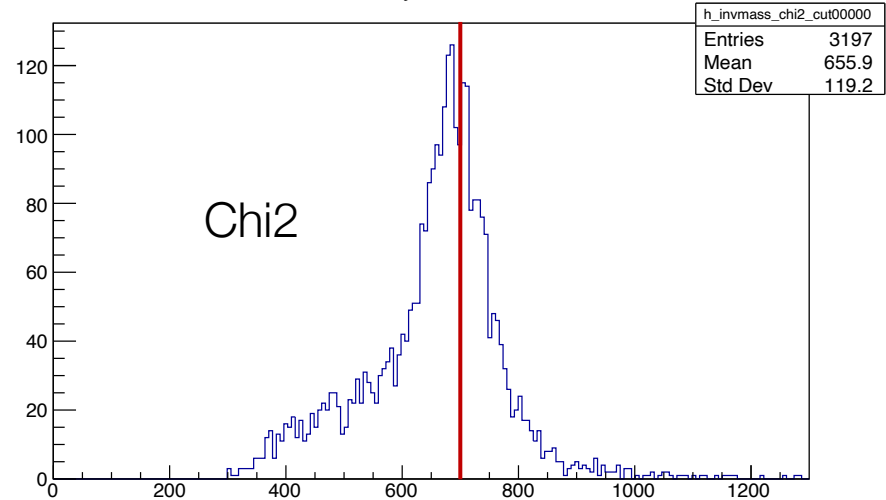
invariant mass of 5 leading jets\_cut00000

Leading jets



invariant mass of 5 jets from chi2\_cut00000

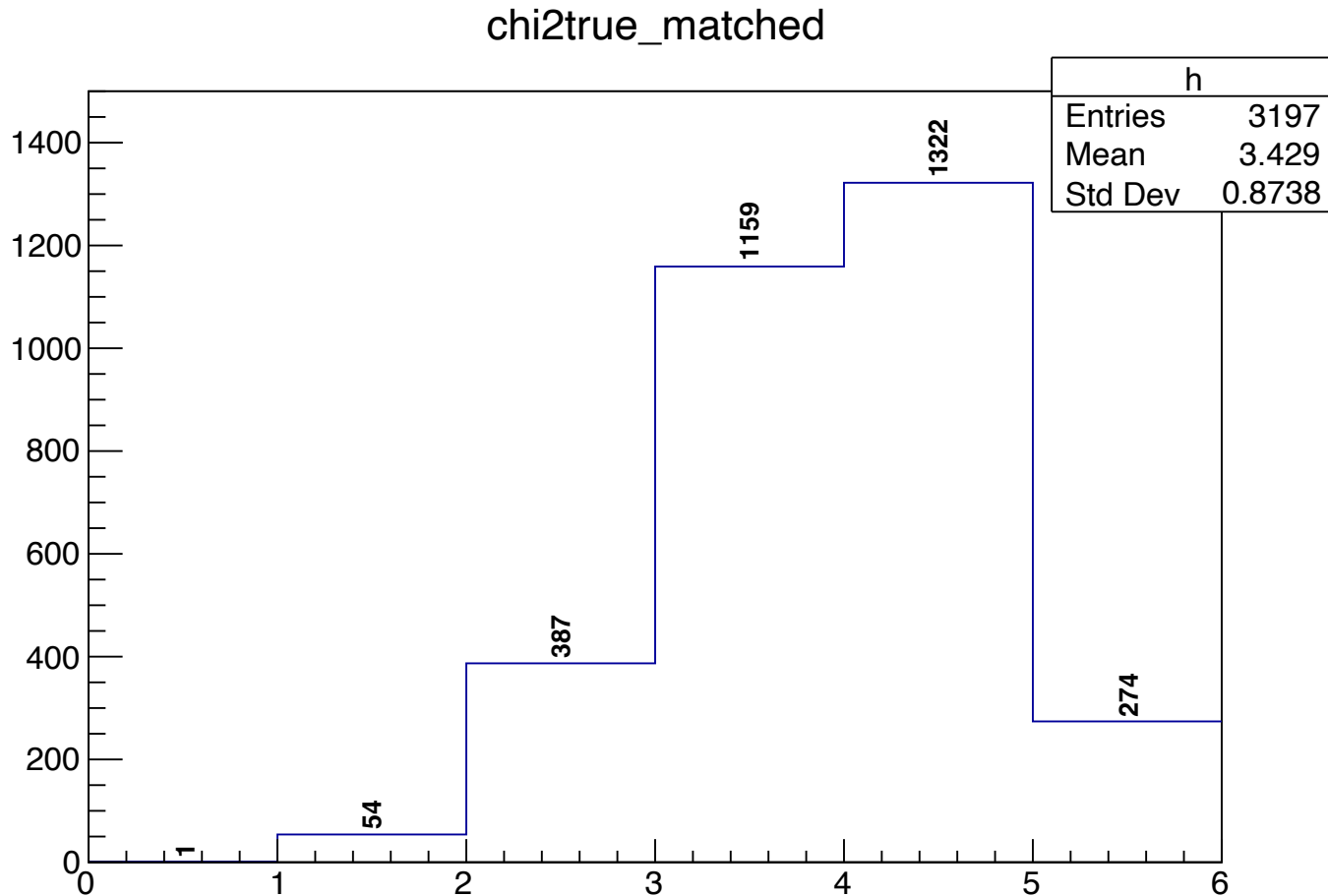
Chi2



# Matching jets between MC truth - Chi2

Matching trueTprime jets (MC) with chi2 jets

- After Cut 0
- Number of chi2 jets matched with true jets
- Avg ~ 70% of jets coming from Tprime are matched with chi2 jets



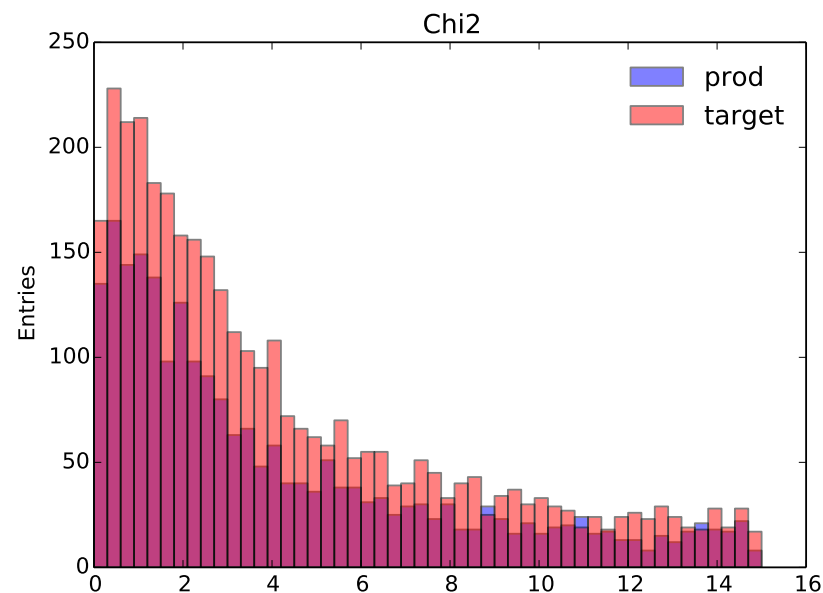
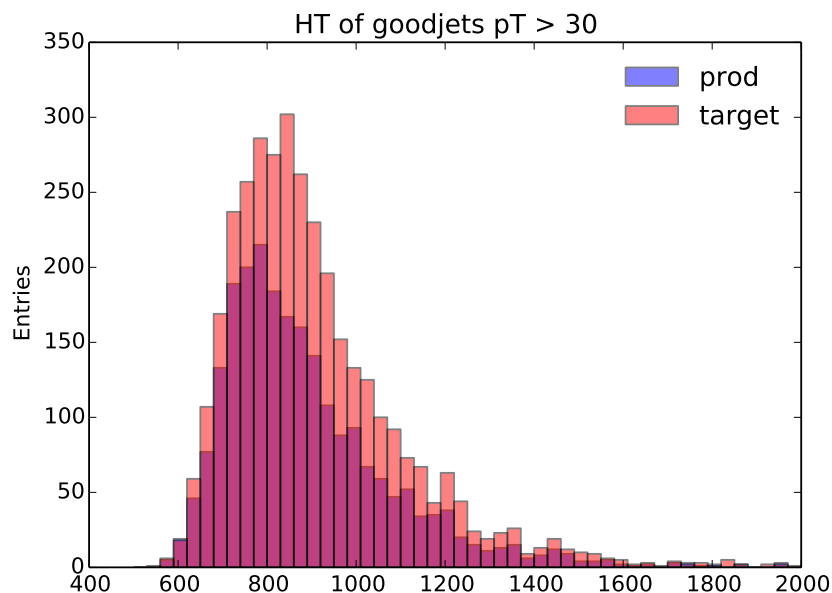
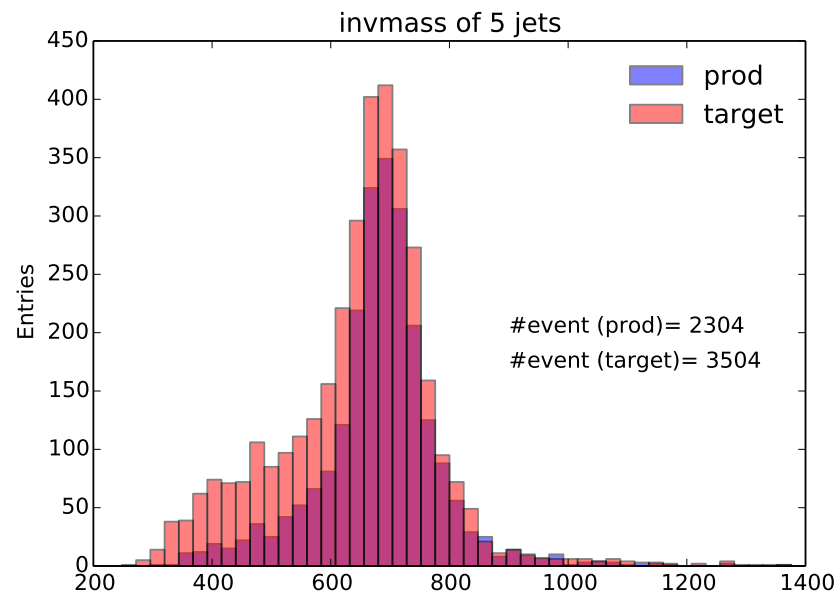
# Synchronization: previous status

Digging into more detail...

- Prod: nanoAOD + RDframework (Jieun)
- Target: miniAOD + previous result (Stephanie)

After Cut0:

- 1) HLT && nJets  $\geq 6$  && nb(DeepCSV)Jets  $\geq 3$
- 2) jet1pt  $> 170$  && jet2pt  $> 130$  && jet3pt  $> 80$   
&& HT (jets pT  $> 30$ )  $> 500$
- 3) minimum Chi2  $< 15$
- 4) 2nd Top mass  $> 250$
- 5) Higgs mass  $> 100$



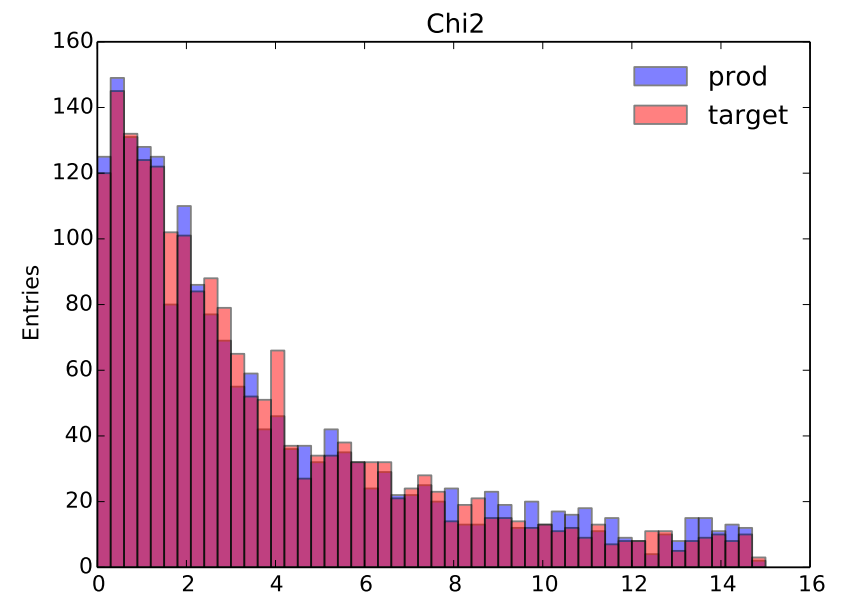
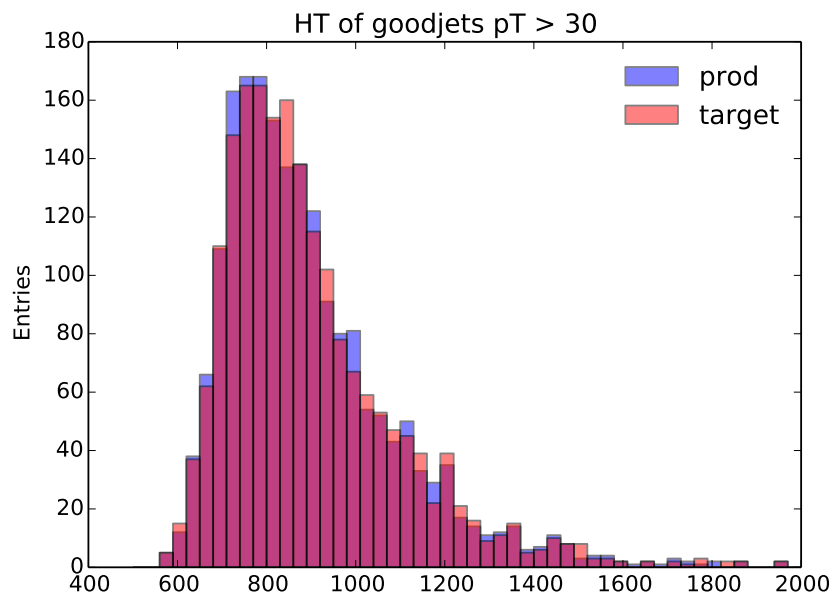
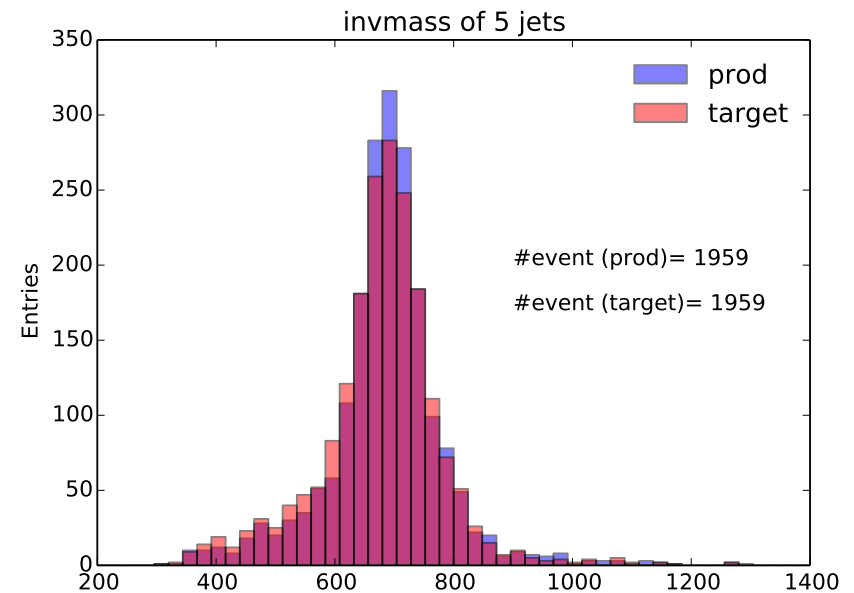
# Synchronization: events in common

Digging into more detail...

- Prod: nanoAOD + RDframework
- Target: miniAOD + previous result
- Number of events in common: 1959

After Cut0:

- 1) HLT && nJets  $\geq 6$  && nb(DeepCSV)Jets  $\geq 3$
- 2) jet1pt  $> 170$  && jet2pt  $> 130$  && jet3pt  $> 80$   
&& HT (jets pT  $> 30$ )  $> 500$
- 3) minimum Chi2  $< 15$
- 4) 2nd Top mass  $> 250$
- 5) Higgs mass  $> 100$



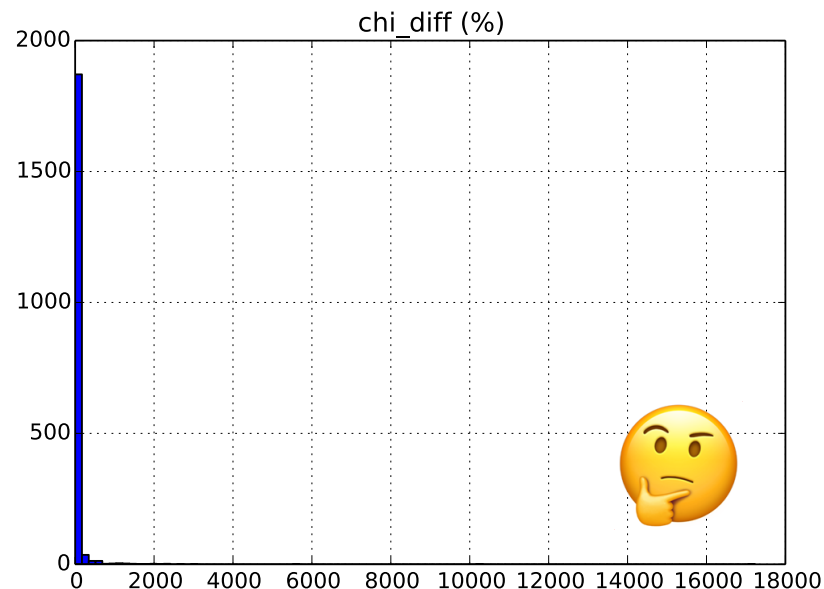
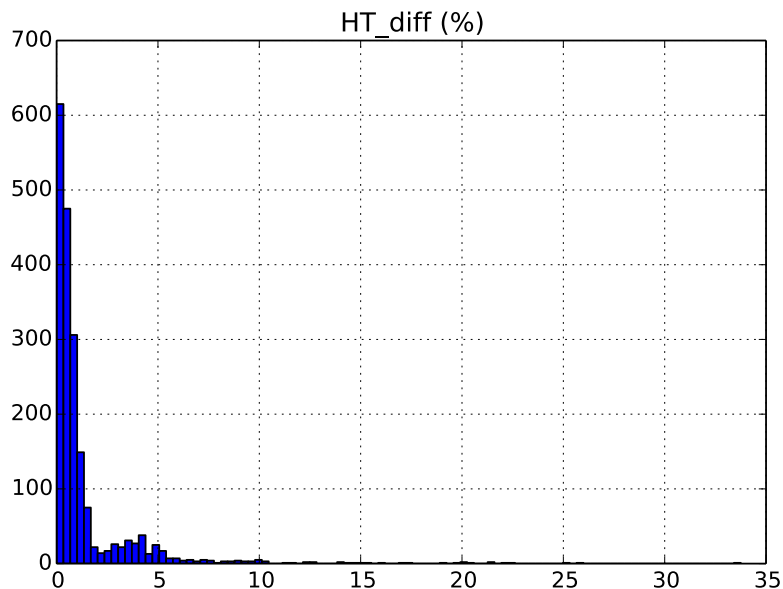
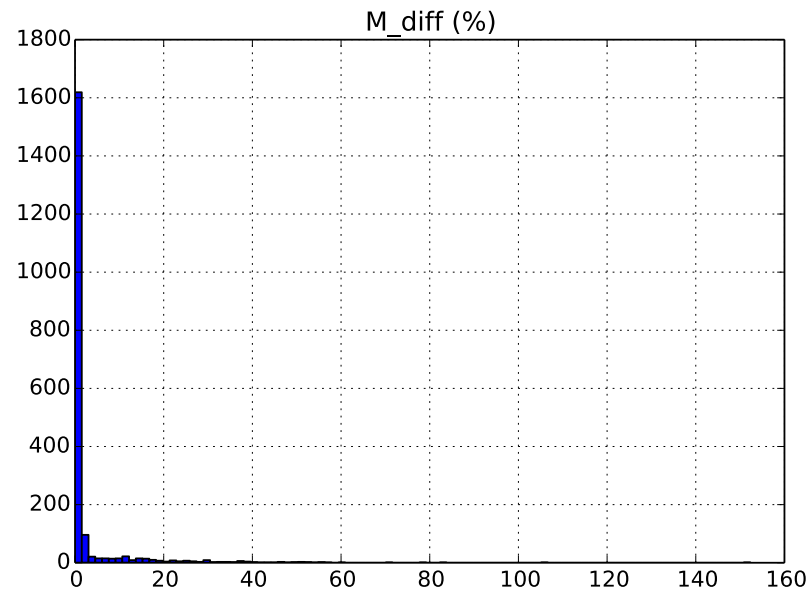
# Synchronization: Differences %

Digging into more detail...

- Prod: nanoAOD + RDframework
- Target: miniAOD + previous result
- Diff:  $|(\text{Prod} - \text{Target}) / \text{Target}| * 100$

After Cut0:

- 1) HLT && nJets  $\geq 6$  && nb(DeepCSV)Jets  $\geq 3$
- 2) jet1pt  $> 170$  && jet2pt  $> 130$  && jet3pt  $> 80$   
&& HT (jets pT  $> 30$ )  $> 500$
- 3) minimum Chi2  $< 15$
- 4) 2nd Top mass  $> 250$
- 5) Higgs mass  $> 100$



# Synchronization: Detail

How Chi2 assign jets (Hb1 / Hb2 / Tbj / Wj1 / Wj2)

- **Target:** Jet 1 / 5 / 6 / 9 / **10**

```
root [33] stp3T->Scan("JET1.Pt():JET5.Pt():JET6.Pt():JET9.Pt():JET10.Pt():First_Higgs_Jet.Pt():Second_Higgs_Jet.Pt():Top_Jet.Pt():First_W_Jet.Pt():Second_W_Jet.Pt()")
*****
* Row * JET1.Pt() * JET5.Pt() * JET6.Pt() * JET9.Pt() * JET10.Pt() * First_Hig * Second_Hi * Top_Jet.P * First_W_J * Second_W_ *
*****
* 5393 * 141.38462 * 79.473307 * 47.704546 * 0 * 0 * 79.473307 * 47.704546 * 141.38462 * 118.51109 * 31.930513 *
* 5394 * 230.92999 * 57.747705 * 46.379394 * 0 * 0 * 108.22266 * 70.279961 * 230.92999 * 57.747705 * 46.379394 *
* 5395 * 311.28976 * 92.027987 * 79.999940 * 44.803405 * 35.833683 * 311.28976 * 92.027987 * 79.999940 * 44.803405 * 35.833683 *
* 5396 * 120.99519 * 66.279098 * 46.304932 * 30.876617 * 0 * 70.561128 * 32.429876 * 68.112560 * 46.304932 * 43.635535 *
* 5397 * 159.13090 * 37.126114 * 33.228612 * 0 * 0 * 159.13090 * 37.126114 * 86.194038 * 132.49441 * 33.228612 *
* 5398 * 174.12877 * 90.409684 * 0 * 0 * 0 * 174.12877 * 92.015031 * 90.409684 * 116.15148 * 82.012558 *
* 5399 * 585.55774 * 67.190923 * 56.426296 * 0 * 0 * 346.64269 * 56.426296 * 193.07432 * 265.44921 * 166.31410 *
* 5400 * 203.46343 * 38.826460 * 35.290304 * 0 * 0 * 203.46343 * 124.57150 * 79.400401 * 127.14701 * 123.08629 *
* 5401 * 605.97053 * 132.52099 * 43.325725 * 0 * 0 * 312.40138 * 227.03398 * 35.360452 * 132.52099 * 43.325725 *
```

- **Prod:** Jet 1 / 5 / 6 / **4** / 9

```
root [1] outTree->Scan("nSelJets:selJet1_pt:selJet5_pt:selJet6_pt:selJet9_pt:selJet10_pt:Hb1_pt:Hb2_pt:Tbj_pt:Wj1_pt:Wj2_pt","event ==397420")
*****
* Row * nSelJets * selJet1_p * selJet5_p * selJet6_p * selJet9_p * selJet10_ * Hb1_pt * Hb2_pt * Tbj_pt * Wj1_pt * Wj2_pt *
*****
* 1302 * 9 * 311.25 * 92.875 * 79.125 * 44.03125 * 35.5625 * 311.25 * 92.875 * 79.125 * 114.3125 * 44.03125 *
```

- There is no 10<sup>th</sup> jets from Prod 🤔
- As the Jet does not pass the condition
- ! WRONG Object selection

## ! Jet Selection:

- $p_T > 30 \text{ GeV}$ ,  $|\eta| < 4.5$ , TightID
- 6 of them  $p_T > 40 \text{ GeV}$
- 3 of 6 jets  $p_T > 80 \text{ GeV}$
- b-tagged : DeepCSV,  $|\eta| < 2.4$

```
root [11] Events->Scan("Jet_pt:Jet_eta:Jet_jetId","event==397420")
*****
* Row * Instance * Jet_pt * Jet_eta * Jet_jetId *
*****
* 191326 * 0 * 311.25 * -0.663452 * 6 *
* 191326 * 1 * 274 * 1.5478515 * 6 *
* 191326 * 2 * 209.25 * 1.3068847 * 6 *
* 191326 * 3 * 114.3125 * -0.172454 * 6 *
* 191326 * 4 * 92.875 * -1.125732 * 6 *
* 191326 * 5 * 79.125 * 0.0317611 * 6 *
* 191326 * 6 * 69.25 * -1.716308 * 6 *
* 191326 * 7 * 45.09375 * 2.3798828 * 6 *
* 191326 * 8 * 44.03125 * -0.289001 * 6 *
* 191326 * 9 * 35.5625 * 1.0764160 * 6 *
* 191326 * 10 * 25.9375 * -3.3125 * 6 *
* 191326 * 11 * 24.5625 * -0.726440 * 6 *
* 191326 * 12 * 21.609375 * 2.5688476 * 6 *
* 191326 * 13 * 18.3125 * 1.5722656 * 6 *
* 191326 * 14 * 15.6875 * -0.189208 * 6 *
```

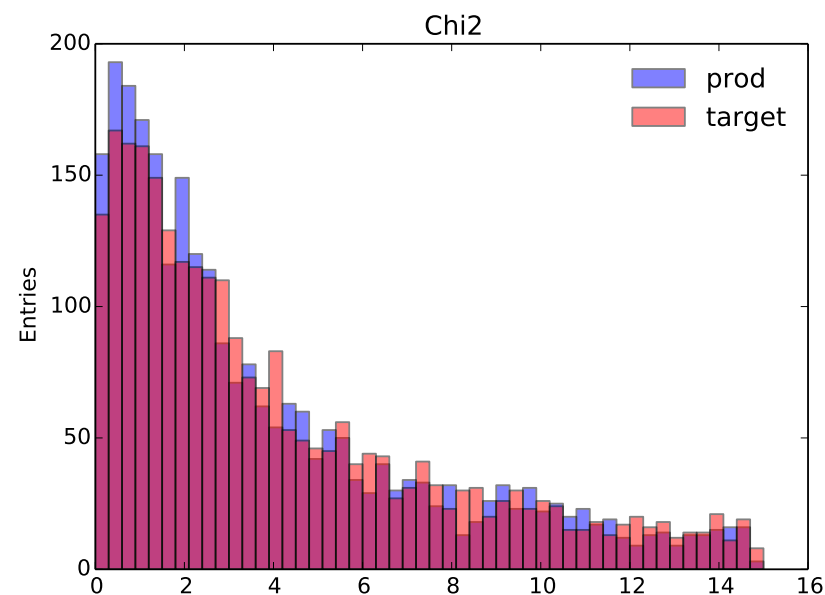
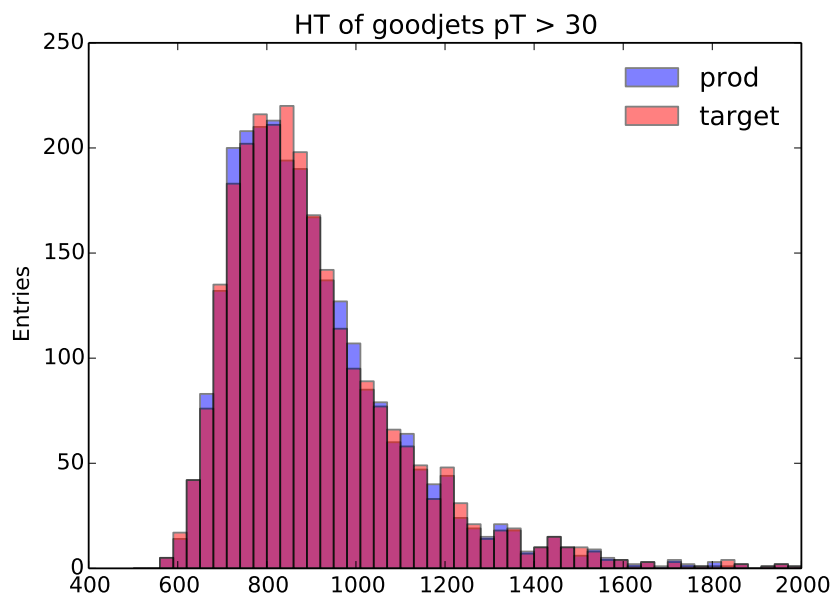
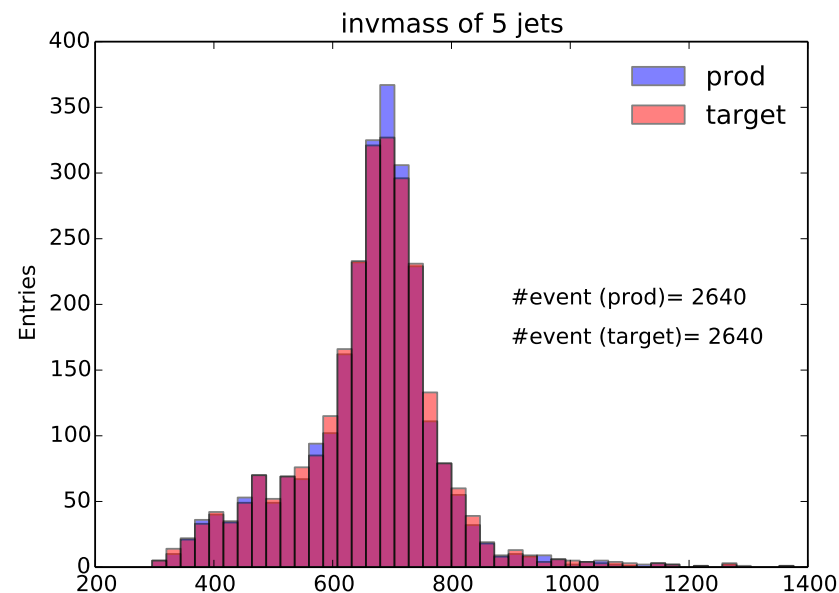
# Synchronization: Recap

Adding more detail...

- Prod: nanoAOD + RDframework
- Target: miniAOD + previous result
- Number of events in common: 1959 → 2640

After Cut0:

- 1) HLT && nJets >= 6 && nb(DeepCSV)Jets >= 3
- 2) jet1pt > 170 && jet2pt > 130 && jet3pt > 80  
&& HT (jets pT > 30) > 500
- 3) minimum Chi2 < 15
- 4) 2nd Top mass > 250
- 5) Higgs mass > 100



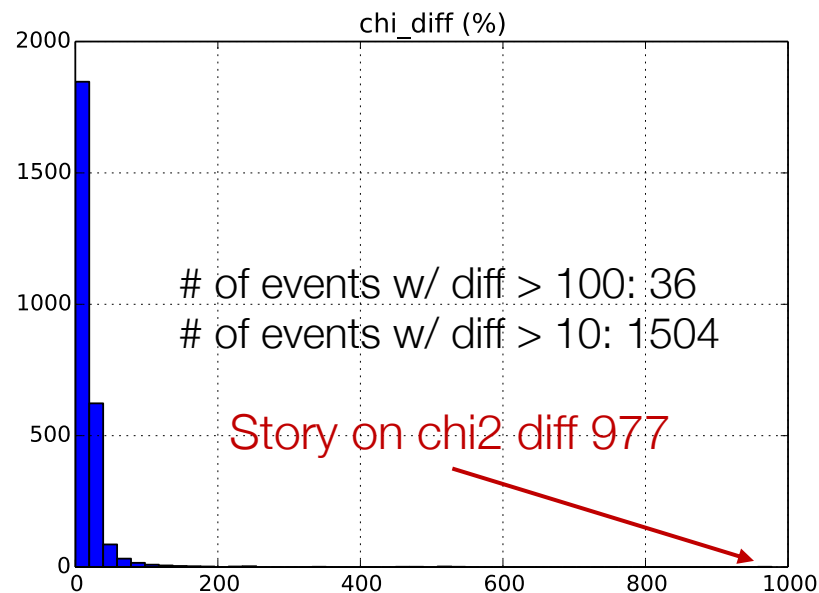
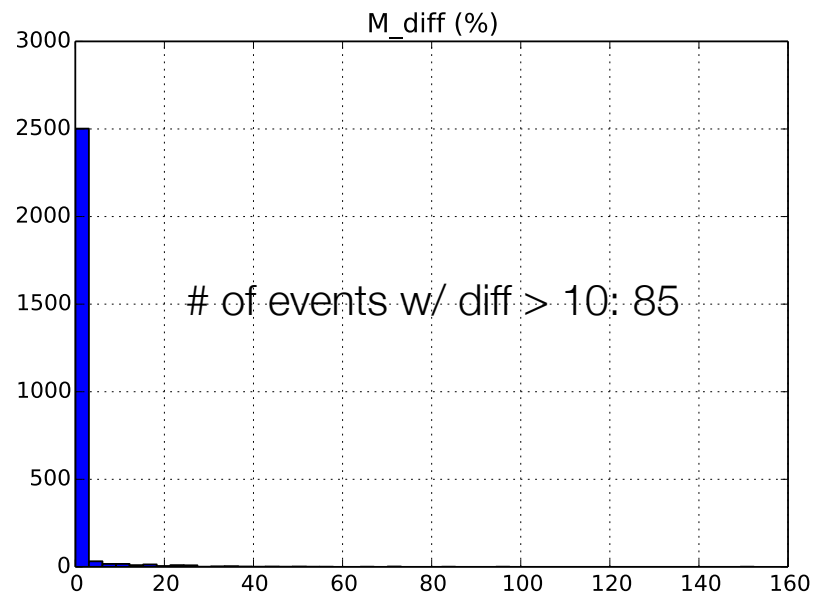
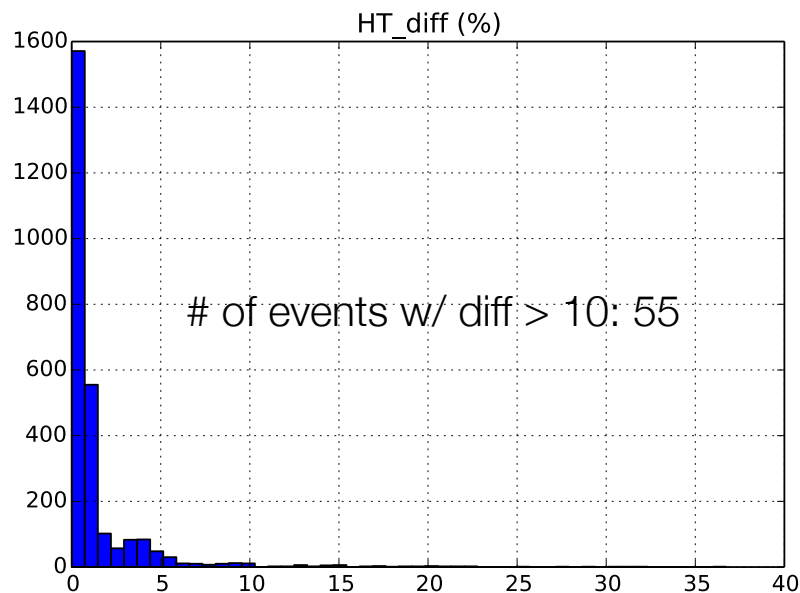
# Synchronization: Recap

## Adding more detail...

- Prod: nanoAOD + RDframework
- Target: miniAOD + previous result
- Diff:  $|(\text{Prod} - \text{Target}) / \text{Target}| * 100$

## After Cut0:

- 1) HLT && nJets  $\geq 6$  && nb(DeepCSV)Jets  $\geq 3$
- 2) jet1pt  $> 170$  && jet2pt  $> 130$  && jet3pt  $> 80$   
&& HT (jets pT  $> 30$ )  $> 500$
- 3) minimum Chi2  $< 15$
- 4) 2nd Top mass  $> 250$
- 5) Higgs mass  $> 100$



# Synchronization: Remaining problems

How Chi2 assign jets (Hb1 / Hb2 / Tbj / Wj1 / Wj2)

- Target: Jet 1 / 5 / 3 / 4 / 9

```
root [11] stp3T->Scan("JET1.Pt():JET5.Pt():JET3.Pt():JET4.Pt():JET9.Pt():First_Higgs_Jet.Pt():Second_Higgs_Jet.Pt():Top_Jet.Pt():First_W_Jet.Pt():Second_W_Jet.Pt()", "LumiID == 2791")
*****
* Row * JET1.Pt() * JET5.Pt() * JET3.Pt() * JET4.Pt() * JET9.Pt() * First_Hig * Second_Hi * Top_Jet.P * First_W_J * Second_W_ *
*****
* 5180 * 189.17269 * 30.506232 * 108.54622 * 52.824132 * 0 * 166.53026 * 52.824132 * 189.17269 * 93.833457 * 50.164760 *
* 5181 * 150.80897 * 66.354617 * 105.14507 * 86.829559 * 0 * 150.80897 * 149.34562 * 65.605556 * 59.181711 * 44.570914 *
* 5182 * 145.31801 * 33.752425 * 70.238448 * 61.273300 * 0 * 123.90385 * 33.752425 * 145.31801 * 61.273300 * 32.610350 *
* 5183 * 284.40164 * 62.082531 * 175.27551 * 120.98501 * 43.684806 * 62.082531 * 61.769416 * 259.84318 * 60.031752 * 56.045583 *
* 5184 * 179.92394 * 65.443730 * 74.655292 * 68.208879 * 0 * 65.443730 * 56.403884 * 138.45223 * 74.655292 * 68.208879 *
* 5185 * 109.66693 * 58.429027 * 90.463087 * 73.535083 * 0 * 109.66693 * 73.535083 * 90.463087 * 58.384930 * 39.215617 *
* 5186 * 161.28766 * 46.379473 * 104.80123 * 59.190241 * 0 * 108.48522 * 34.633523 * 161.28766 * 104.80123 * 46.379473 *
* 5187 * 196.26988 * 111.05948 * 128.22359 * 124.97882 * 0 * 185.44269 * 124.97882 * 111.05948 * 35.446900 * 30.250591 *
* 5188 * 221.08436 * 61.817414 * 91.165708 * 61.971657 * 30.652414 * 221.08436 * 61.817414 * 91.165708 * 61.971657 * 30.652414 *
```

- Prod: Jet 1 / 4 / 3 / 5 / 6

```
root [5] outTree->Scan("nSelJets:selJet1_pt:selJet4_pt:selJet3_pt:selJet5_pt:selJet6_pt:Hb1_pt:Hb2_pt:Tbj_pt:Wj1_pt:Wj2_pt", "event == 279098")
*****
* Row * nSelJets * selJet1_p * selJet4_p * selJet3_p * selJet5_p * selJet6_p * Hb1_pt * Hb2_pt * Tbj_pt * Wj1_pt * Wj2_pt *
*****
* 1591 * 7 * 220 * 62.90625 * 91.5 * 62.34375 * 41.625 * 220 * 62.90625 * 91.5 * 62.34375 * 41.625 *
*****
```

```
root [14] Events->Scan("Jet_pt:Jet_eta:Jet_jetId:Jet_btagDeepB", "event==279098")
*****
* Row * Instance * Jet_pt * Jet_eta * Jet_jetId * Jet_btagD *
*****
* 196896 * 0 * 220 * -1.623046 * 6 * 0.9091796 *
* 196896 * 1 * 183.625 * -1.53125 * 6 * 0.0291137 *
* 196896 * 2 * 91.5 * 0.1602783 * 6 * 0.9921875 *
* 196896 * 3 * 62.90625 * -1.293701 * 6 * 0.9990234 *
* 196896 * 4 * 62.34375 * -0.557617 * 6 * 0.0776977 *
* 196896 * 5 * 41.625 * -0.119766 * 6 * 0.1634521 *
* 196896 * 6 * 30.28125 * -2.129394 * 6 * -1 *
* 196896 * 7 * 29.890625 * 0.3150024 * 6 * 0.0697021 *
* 196896 * 8 * 29.578125 * -0.945434 * 6 * 0.0606689 *
* 196896 * 9 * 28.40625 * -0.007567 * 6 * 0.0325317 *
* 196896 * 10 * 26.359375 * 0.4195556 * 6 * 0.0280609 *
* 196896 * 11 * 22.25 * -0.261962 * 6 * -1 *
```

Cannot avoid touching JER

- 4<sup>th</sup>, 5<sup>th</sup> Jets: The same jets but flipped
- 9<sup>th</sup> Jet: Below the condition ( $p_T > 30$  GeV)
- Most of the cases which have difference in Chi2 are having similar issue
- There is nothing I can do anymore for the moment
- Would be better to go further with JER..

# Synchronization: Remaining problems

How Chi2 assign jets (Hb1 / Hb2 / Tbj / Wj1 / Wj2)

- Target: Jet 3 / 9 / 5 / 4 / 7

```
root [18] stp3T->Scan("JET3.Pt():JET9.Pt():JET5.Pt():JET4.Pt():JET7.Pt():First_Higgs_Jet.Pt():Second_Higgs_Jet.Pt():Top_Jet.Pt():First_W_Jet.Pt():Second_W_Jet.Pt()", "LumiID == 1575")
*****
*   Row   * JET3.Pt() * JET9.Pt() * JET5.Pt() * JET4.Pt() * JET7.Pt() * First_Hig * Second_Hi * Top_Jet.P * First_W_J * Second_W_ *
*****
*   6744 * 67.239391 *      0 * 47.893694 * 56.423624 * 40.666986 * 83.786442 * 40.666986 * 236.74892 * 56.423624 * 33.401185 *
*   6745 * 92.723191 * 35.027386 * 64.392105 * 86.757221 * 53.353029 * 92.723191 * 35.027386 * 64.392105 * 86.757221 * 53.353029 *
*****
```

- Prod: Jet 5 / 8 / 3 / 7 / 9

```
root [9] outTree->Scan("nseJets:selJet_pt[4]:selJet_pt[7]:selJet_pt[2]:selJet_pt[6]:selJet_pt[8]:Hb1_pt:Hb2_pt:Tbj_pt:Wj1_pt:Wj2_pt", "event == 157458")
*****
*   Row   * nseJets * selJet_pt * selJet_pt * selJet_pt * selJet_pt * selJet_pt *   Hb1_pt *   Hb2_pt *   Tbj_pt *   Wj1_pt *   Wj2_pt *
*****
*   1241 *      9 *   66.875 * 33.90625 * 91.4375 *      50 * 30.640625 *   66.875 * 33.90625 * 91.4375 *      50 * 30.640625 *
*****
```

```
root [7] Events->Scan("Jet_pt:Jet_eta:Jet_jetId:Jet_btagDeepB", "event==157458")
*****
*   Row   * Instance *   Jet_pt *   Jet_eta * Jet_jetId * Jet_btagD *
*****
* 155079 *      0 *   226.75 * 0.3342285 *      6 * 0.0684204 *
* 155079 *      1 *    186 * 1.2355957 *      6 * 0.2083740 *
* 155079 *      2 *   91.4375 * 0.1833496 *      6 * 0.9965820 *
* 155079 *      3 *   84.6875 * 0.4556884 *      6 * 0.0195465 *
* 155079 *      4 *   66.875 * 1.0263671 *      6 * 0.7924804 *
* 155079 *      5 *   57.8125 * 4.0693359 *      6 *      -1 *
* 155079 *      6 *     50 * 1.3486328 *      6 * 0.0534057 *
* 155079 *      7 *  33.90625 * -0.610473 *      6 * 0.9541015 *
* 155079 *      8 *  30.640625 * 2.3325195 *      6 *      -1 *
* 155079 *      9 *  29.171875 * 2.9389648 *      6 *      -1 *
* 155079 *     10 *  27.890625 * 0.0736846 *      6 * 0.1380615 *
* 155079 *     11 *  25.84375 * 1.3491210 *      6 * 0.0881958 *
*****
```

## DeepCSV ?

- Event: 157458 (LS1575)
- Chi2 diff: 475
- Jet\_btagDeepB: DeepCSV b+bb tag disc.
- 9<sup>th</sup> Jet: Does not pass the DeepCSV
- But it is assigned as First Higgs Jet
- ?

# JER implementation

## Current example for JME application for nanoAOD

- Bamboo:: CMSJMECalculators ([gitlab](#))
- RDataFrame-friendly implementation of jet and MET for CMS NanoAOD
- Python based
  
- nanoAOD-tools:: jme module ([github](#))
- Mostly activated in JetMET mattormost channel
- Python based