Increase b-tagging acceptance for WH search

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- Introduction
- Loose Flavor Separator
- Input Variables
- output: signal & background
- Conclusions

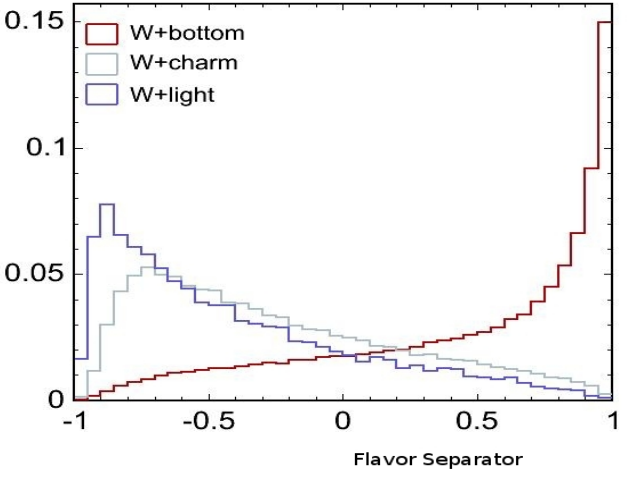
WH Matrix Element Analysis

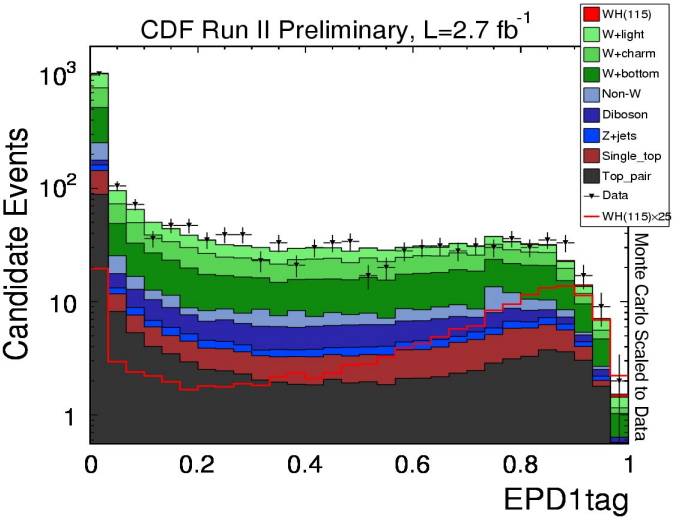
- ME is a technique to separate signal from background exploiting kinematic information
- we apply ME to $WH \rightarrow lvbb$ channel, where one or both b-jets are tagged w/ tight SecVtx
- we define a discriminant (Event Probability Discriminant, EPD):

$$EPD_{1tag} = \frac{b \cdot P_{WH}}{b(P_{WH}+P_{singletop}+P_{Wbb}+P_{tt})+(1-b)(P_{Wcc}+P_{Wcj}+P_{mistags}+P_{diboson})}$$

$$EPD_{2tag} = \frac{b_0 b_1 \cdot P_{WH}}{b_0 b_1 (P_{WH}+P_{schan}+P_{Wbb}+P_{tt})+b_0 \cdot (1-b_1) \cdot P_{tchan}+(1-b_0) \cdot (1-b_1) \cdot (P_{Wcc}+P_{Wcj}+P_{mistags}+P_{diboson})}$$

where P_{proc} is the event prob, and b is a function of KIT





- we want to extend to loose SecVtx $\rightarrow$ a loose KIT is needed

Background Estimation (Method2)

in the following: ST = tight SecVtx, SL = loose SecVtx, JP = JetProb

- there are two different scenarios: use events w/ a LS or with a JP tagged jet
- this table not updated: soon results for 4.3 fb^{-1}

Loose Secondary Vertex (2.7 fb^{-1})			
Process	1 tag (ST)	2 tags (ST-SL)	2 tags (ST-ST)
Total MC	364.2 ± 31.6	28.8 ± 4.0	61.2 ± 7.7
Total HF	993.7 ± 301.8	40.2 ± 13.0	77.9 ± 24.9
Mistags	448.3 ± 55.9	8.9 ± 2.2	2.1 ± 0.6
non-W	130.5 ± 52.2	6.0 ± 2.4	8.9 ± 3.6
Total Prediction	1936.7 ± 313.0	84.0 ± 14.0	150.2 ± 26.3
WH (115 GeV/c^2)	5.5 ± 0.4	0.8 ± 0.1	2.0 ± 0.2
Observed	1919	95	158

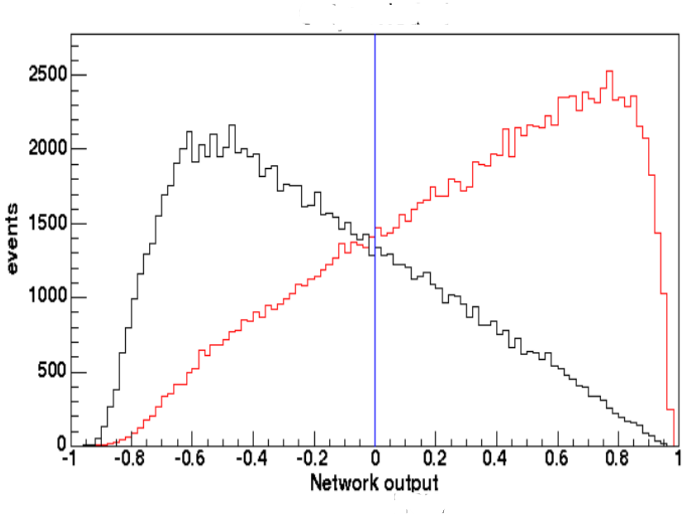
JP<5% (2.7 fb^{-1})			
Process	1 tag (ST)	2 tags (ST-JP)	2 tags (ST-ST)
Total MC	342.6 ± 29.0	51.6 ± 8.9	61.2 ± 7.7
Total HF	944.6 ± 286.8	87.6 ± 29.3	77.8 ± 24.9
Mistags	446.3 ± 54.8	10.7 ± 3.6	2.1 ± 0.6
non-W	129.0 ± 51.6	14.6 ± 5.8	8.9 ± 3.4
Total Prediction	1862.6 ± 297.9	164.5 ± 31.3	150.2 ± 26.3
WH (115 GeV/c^2)	4.9 ± 0.4	1.4 ± 0.2	2.0 ± 0.2
Observed	1855	161	158

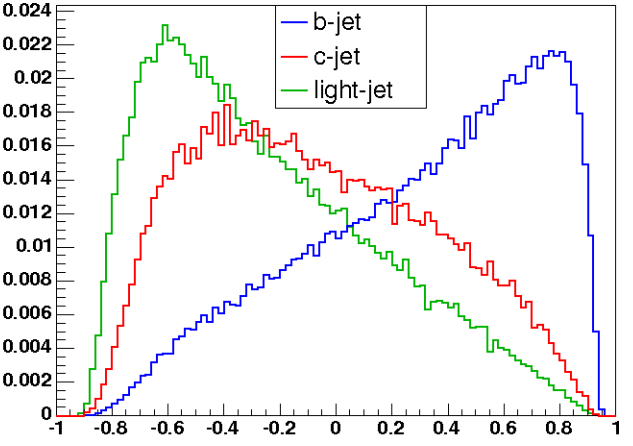
where Total MC includes WW, WZ, ZZ, Top-LJ, Top-Dil, single Top-T, single Top-S, Z+jets processes, and Total HF Wbb and Wcc/cj

- the ST-SL has similar S/B w.r.t. ST-JP but we will apply the flavor separator (for ST this led $\sim 15-20\%$ gain in sensitivity single-top analysis)

NN training

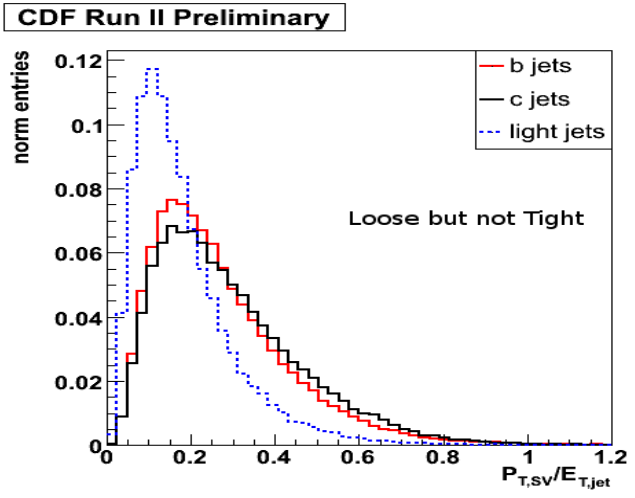
- we want to add the loose but not tight SecVtx events to the analysis and using a flavor separator would increase the sensitivity
- training sample: b-jets for signal (red histo) and c+mistags for background (black histo)
- we trained the NN over several variables related to the reconstructed secondary vertex, tracks associated and leptons inside the jet

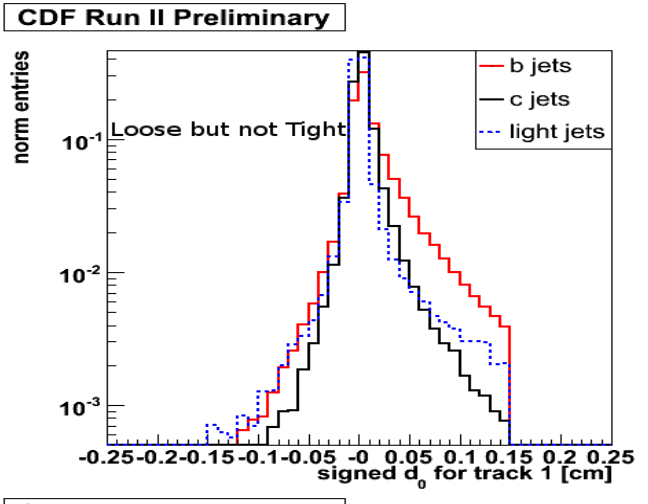


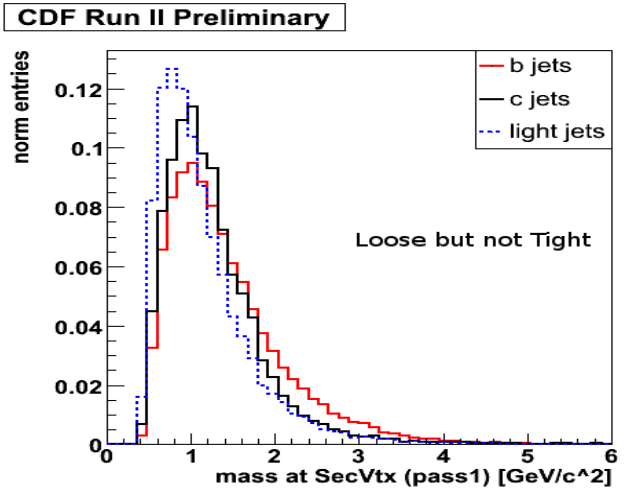


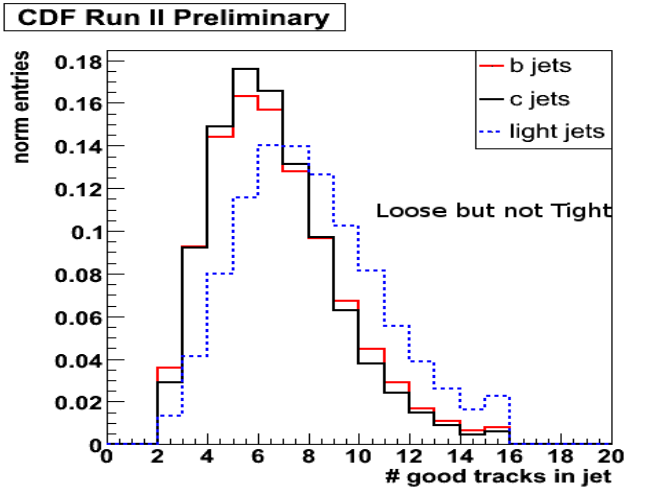
- good separation between b and light jets

Examples of input variables



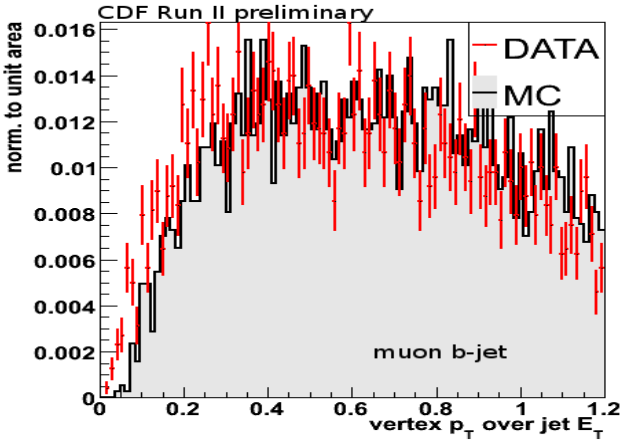


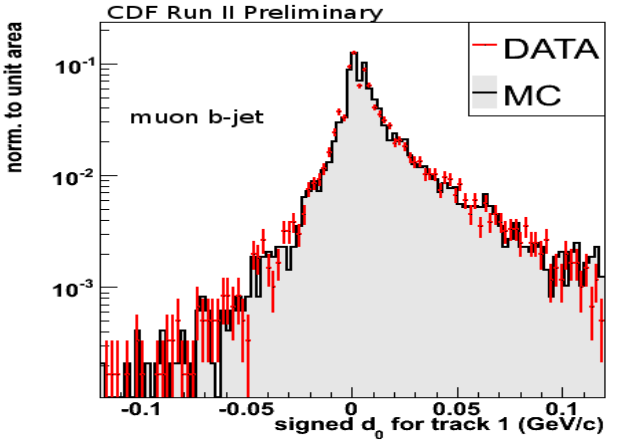


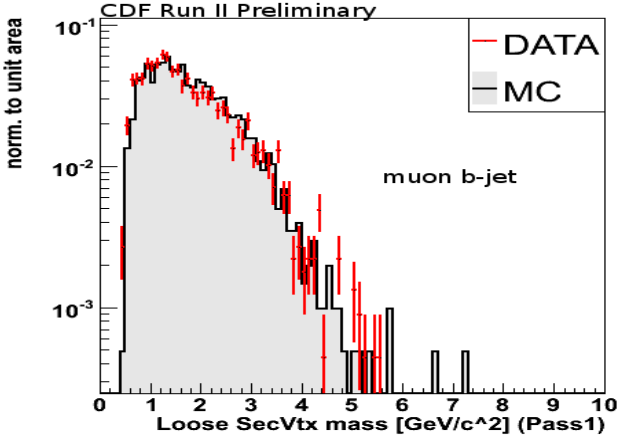


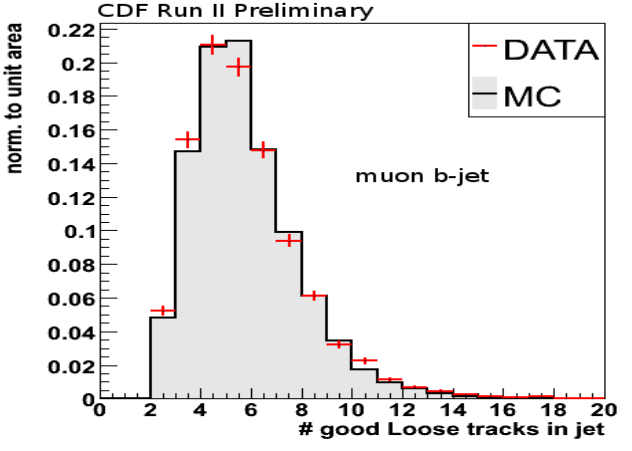
Examples of validation plots (muons)

jet with semi-leptonic b decay which enhances b-fraction in data



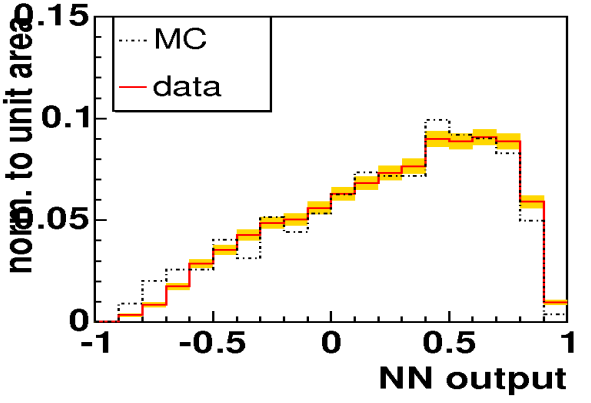


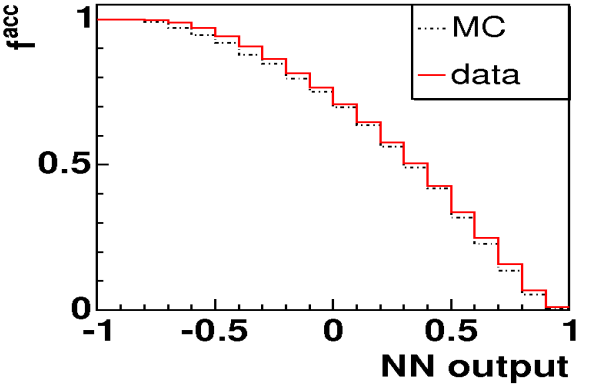


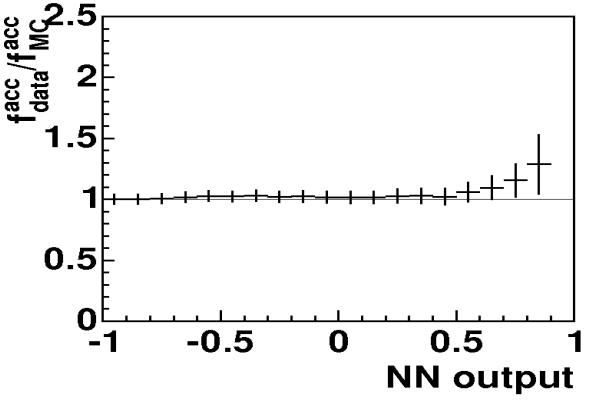


Comparison of signal output

- same selection as for SevVtx scale factor
- 2 jets: lepton jet ST, away jet SL but not ST (b content $\sim 73\%$)



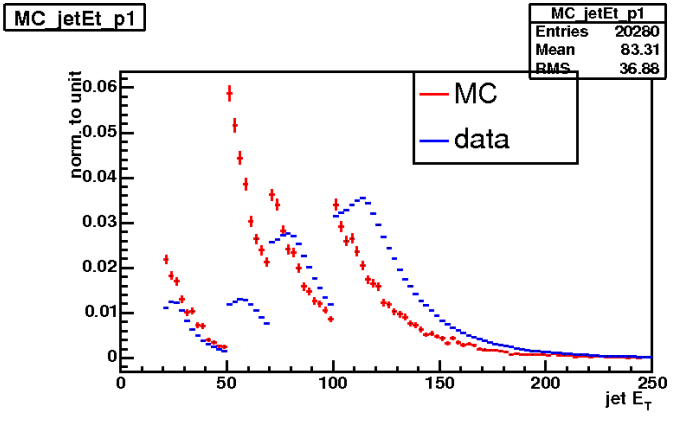




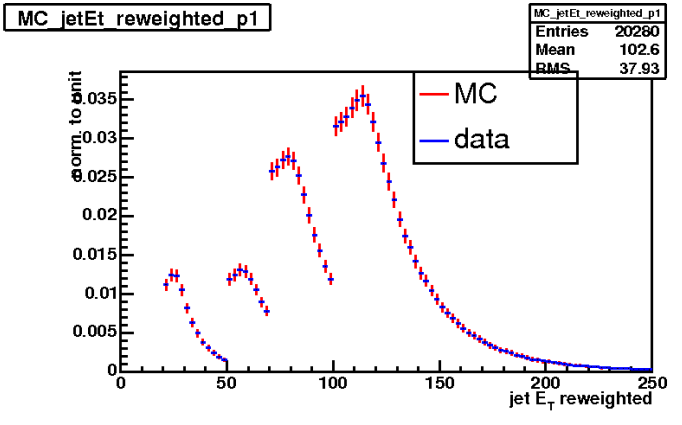
- within the given statistics, looks fine: no correction needed

Mistags

- we use negatively tagged jets to represent light positively tagged jets
- MC samples: btopqb, btoprb, btopsb, btoptb
- Data samples: gjt1XX, gjt2XX, gjet3XX, gje4XX (XX=kd,kh,ki,mi,mj,mk,mm)
- we apply following cuts:
  - btoprb/gjt2XX $\rightarrow E_T \geq 50$ GeV
  - btopsb/gjt3XX $\rightarrow E_T \geq 70$ GeV
  - btoptb/gjt4XX $\rightarrow E_T \geq 100$ GeV
- MC jet E_T distributions reweighted to data



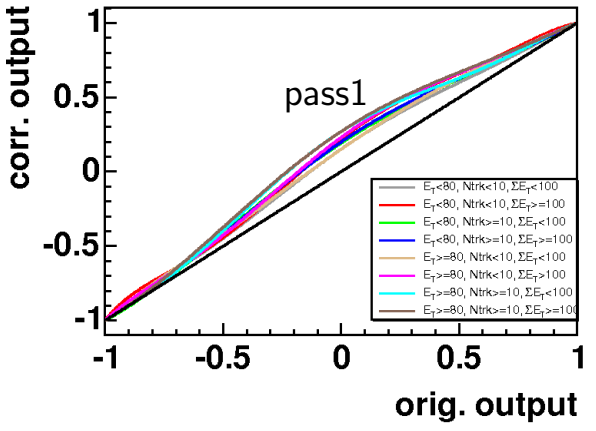
before

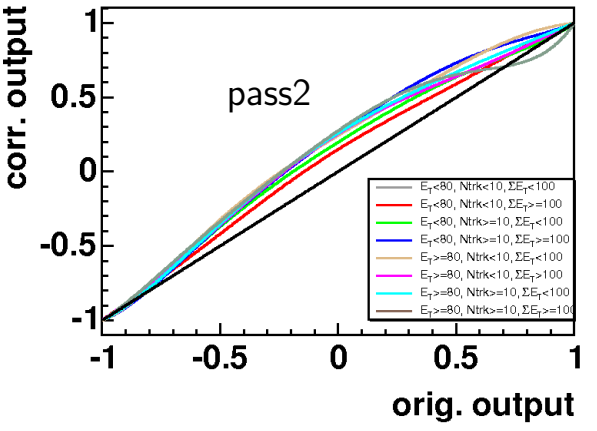


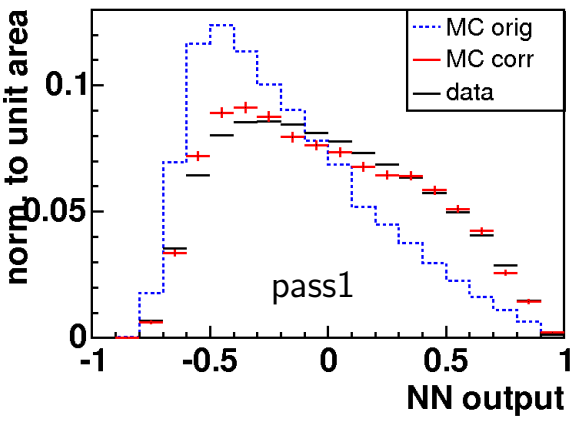
after

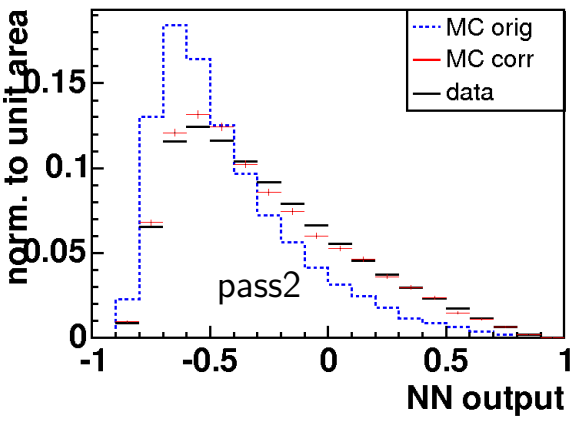
Correction Functions & Corrected Outputs

- small deviations between data & MC in the mistag sample
- better agreement after applying correction functions

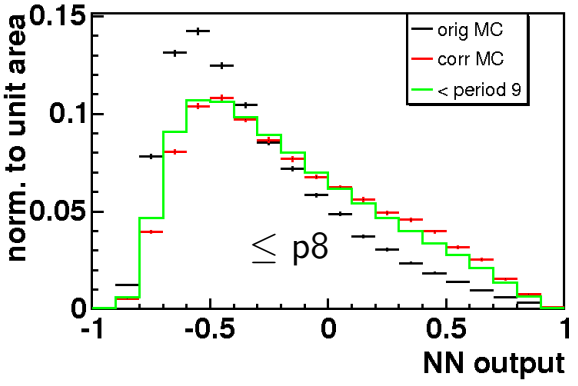


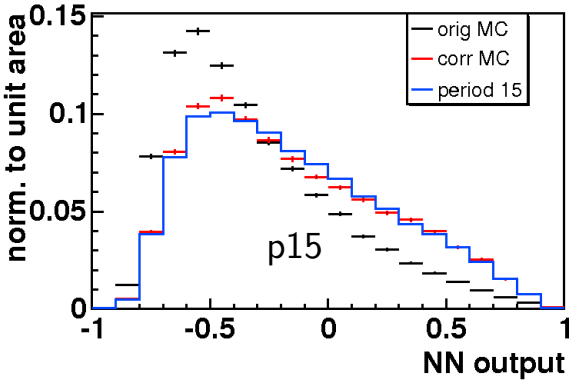


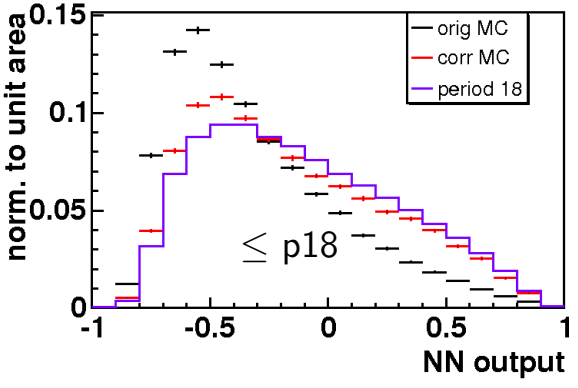


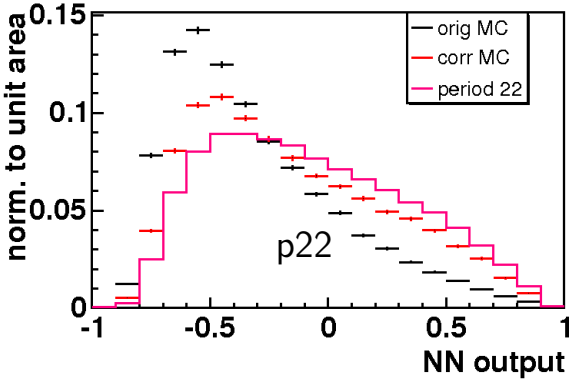


Mistags vs. data period









- good agreement for the first 2.7 fb^{-1}
- more deviations for latest data periods $\rightarrow$ corrrection functions are calculated w/ a low lum MC

Conclusions & Plans

- conclusions:
  - we want to increase b-tagging acceptance my using loose SecVtx tagged jets
  - we develop a loose KIT for loose but not tight jets, in the same way as for the tight
  - we validate input variables and the NN output in a b-enriched sample
  - mistag validation needs some correction functions to be applied
  - residual discrepances in mistags are related to high luminosity data
- plans:
  - calculate Method2 tables for 4.3 fb^{-1}
  - hopefully obtain limits for ST-SL events
  - conclude my thesis for October