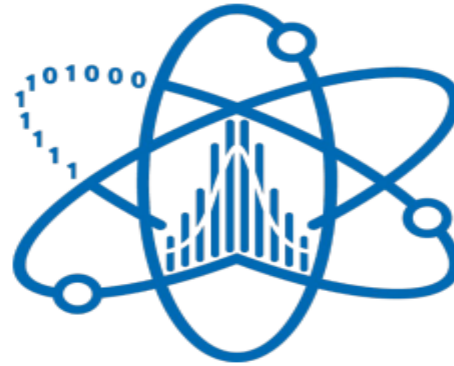




National Research
**Tomsk
State
University**



**Лаборатория
анализа данных
физики высоких энергий**

Томского
государственного
университета

**Measurement of differential cross-sections of a single top quark
produced in association with a W boson with ATLAS at
 $\sqrt{s} = 13$ TeV**

Progress Report

Neda Firoz

Goal: separate tW (top+anti-top) from $t\bar{t}$ in the 1j1b dilepton region

- **Inputs (9 variables used):**

bdt_centralty_ll_recalc_NOSYS,
bdt_delta_pT_ll_MET_recalc_NOSYS,
bdt_delta_pT_llb_MET_recalc_NOSYS,
bdt_eta_llMetB_recalc_NOSYS,
bdt_m_l1b_recalc_NOSYS,
bdt_m_l2b_recalc_NOSYS,
bdt_pT_llMetB_recalc_NOSYS,
bdt_pT_llb_recalc_NOSYS,
bdt_sum_ET_recalc_NOSYS.

- **Samples / tree:** all files' tree name is analysis

Signal: tW (top) + $t\bar{W}$ (anti-top)

Background: $t\bar{t}$ (non-all-had)

- **Event weights:** auto-resolved to
 $\text{weight_mc_NOSYS} * \text{weight_pileup_NOSYS}$
 $* \text{globalTriggerEffSF_NOSYS}.$

- **Bad values:** any variable ≤ -990 or non-finite is masked per event.

Article's Report on BDT

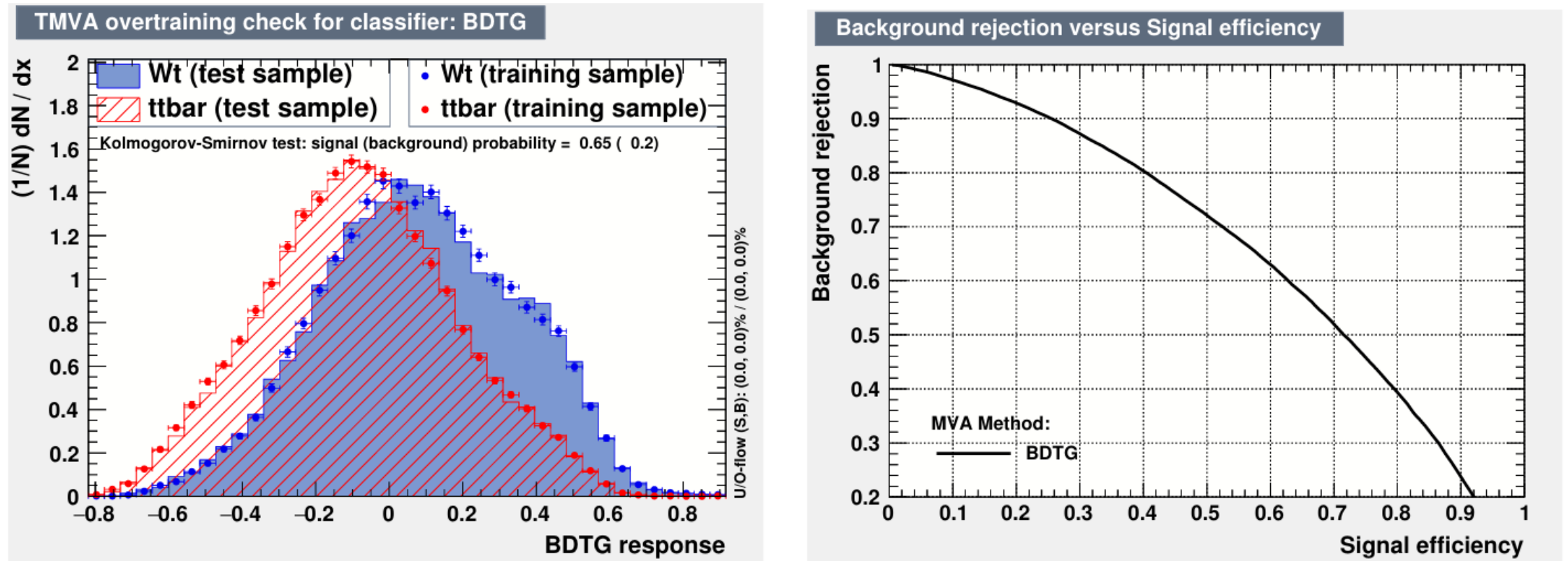


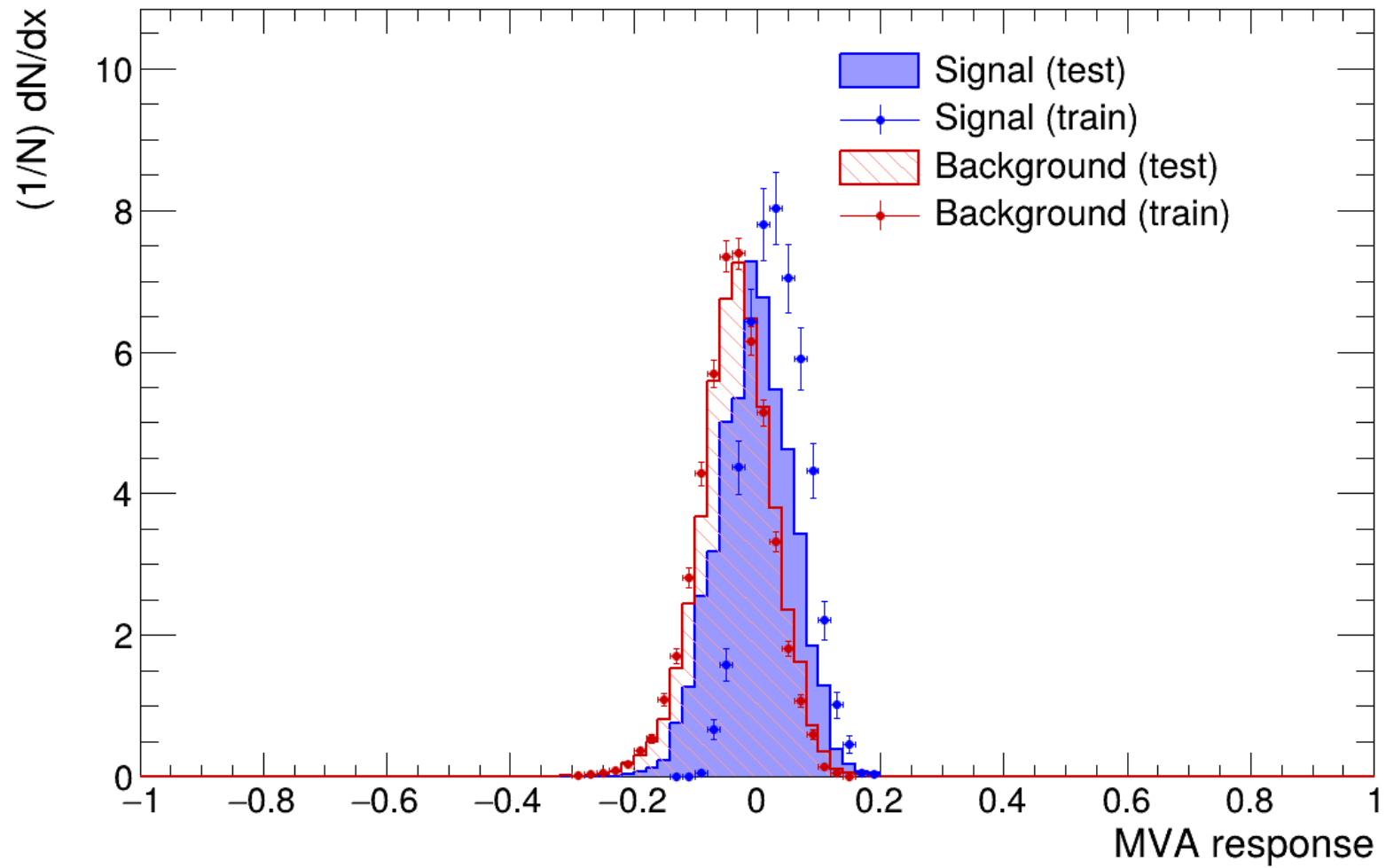
Figure 9: Comparison of test/training sample distributions and background rejection factor versus signal efficiency.

Results of TMVA on new data

16.12.2025

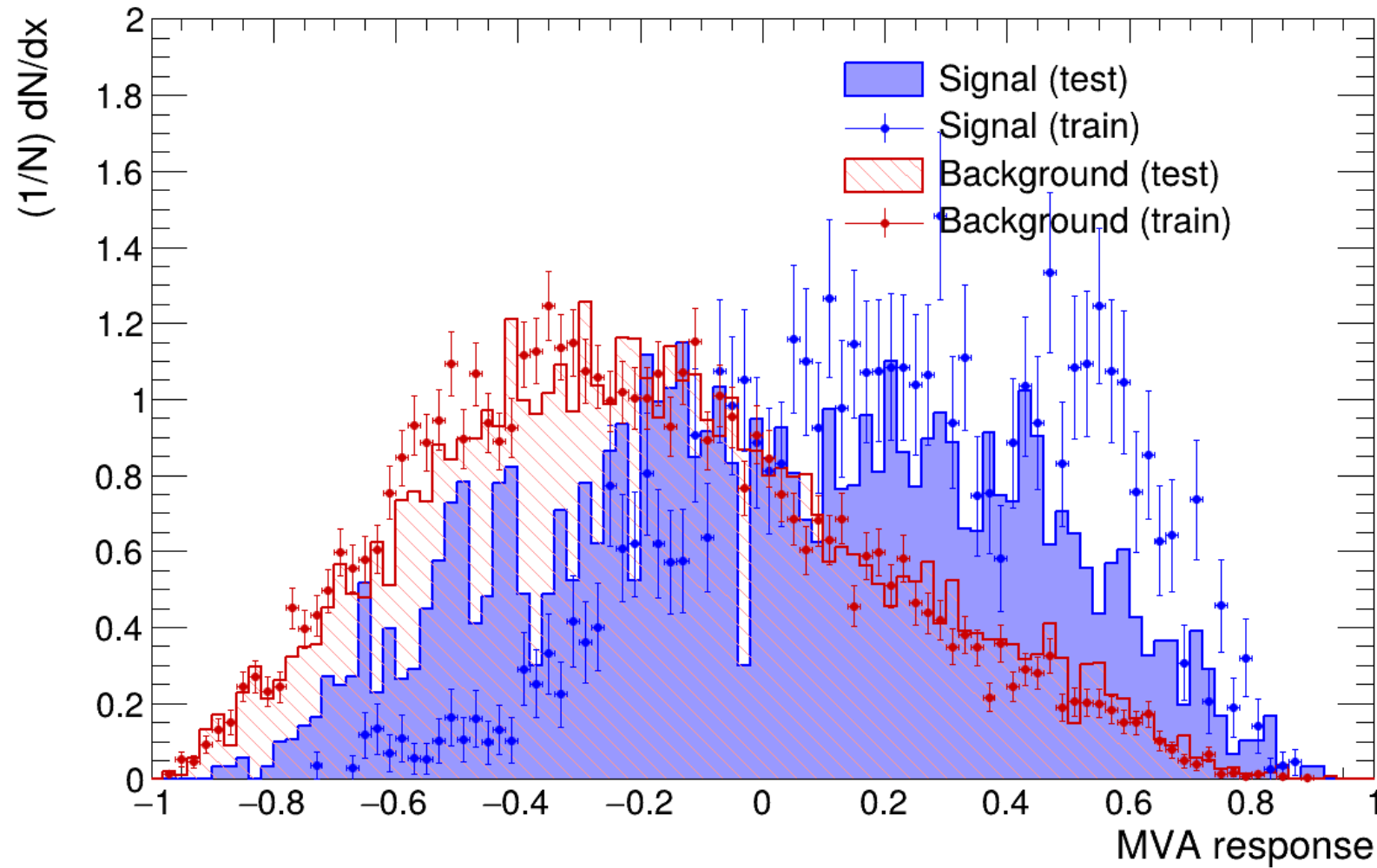
BDT

TMVA overtraining check for classifier: BDT



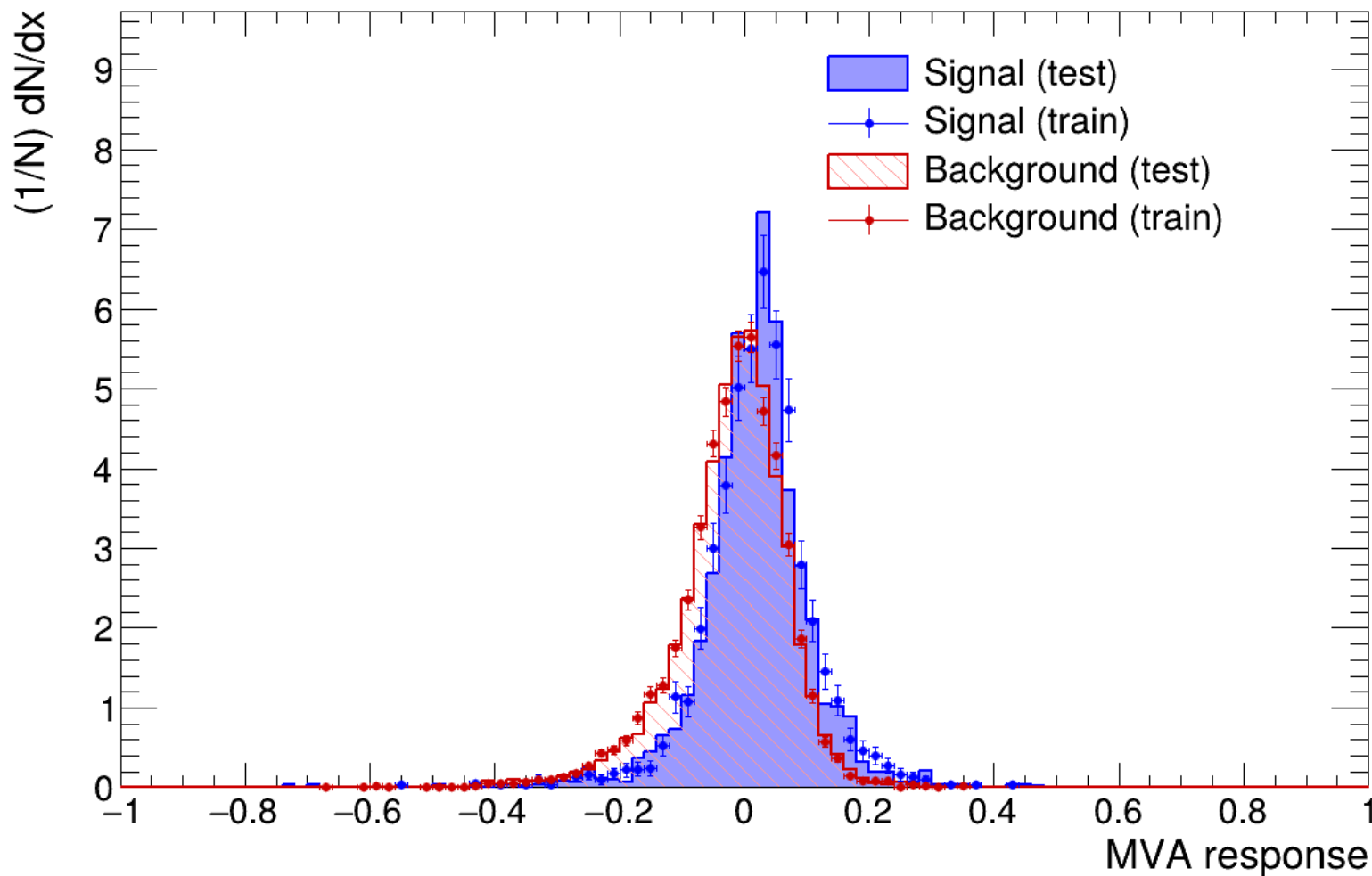
BDTG

TMVA overtraining check for classifier: BDTG



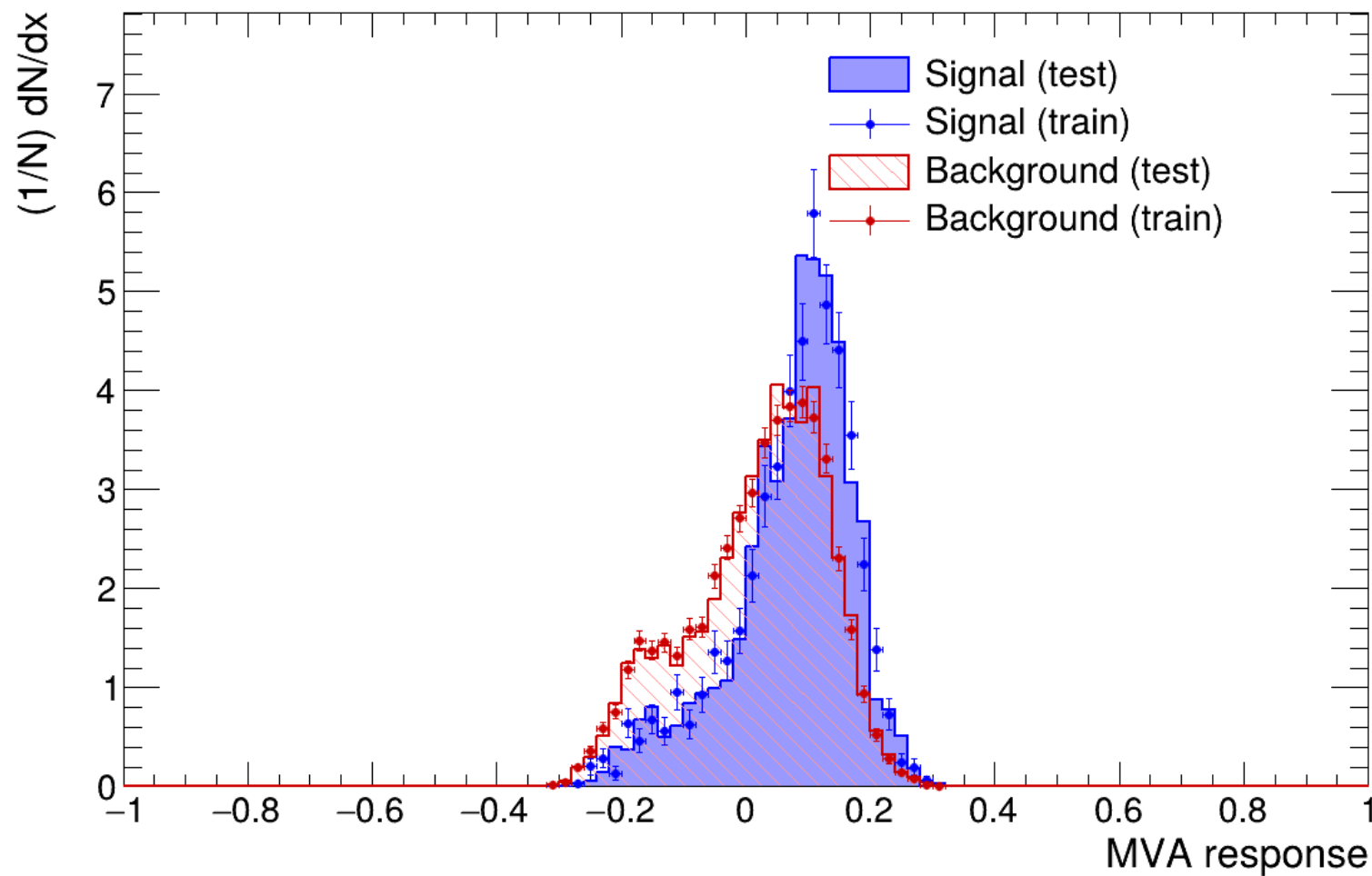
Fisher discriminant TMVA

TMVA overtraining check for classifier: Fisher



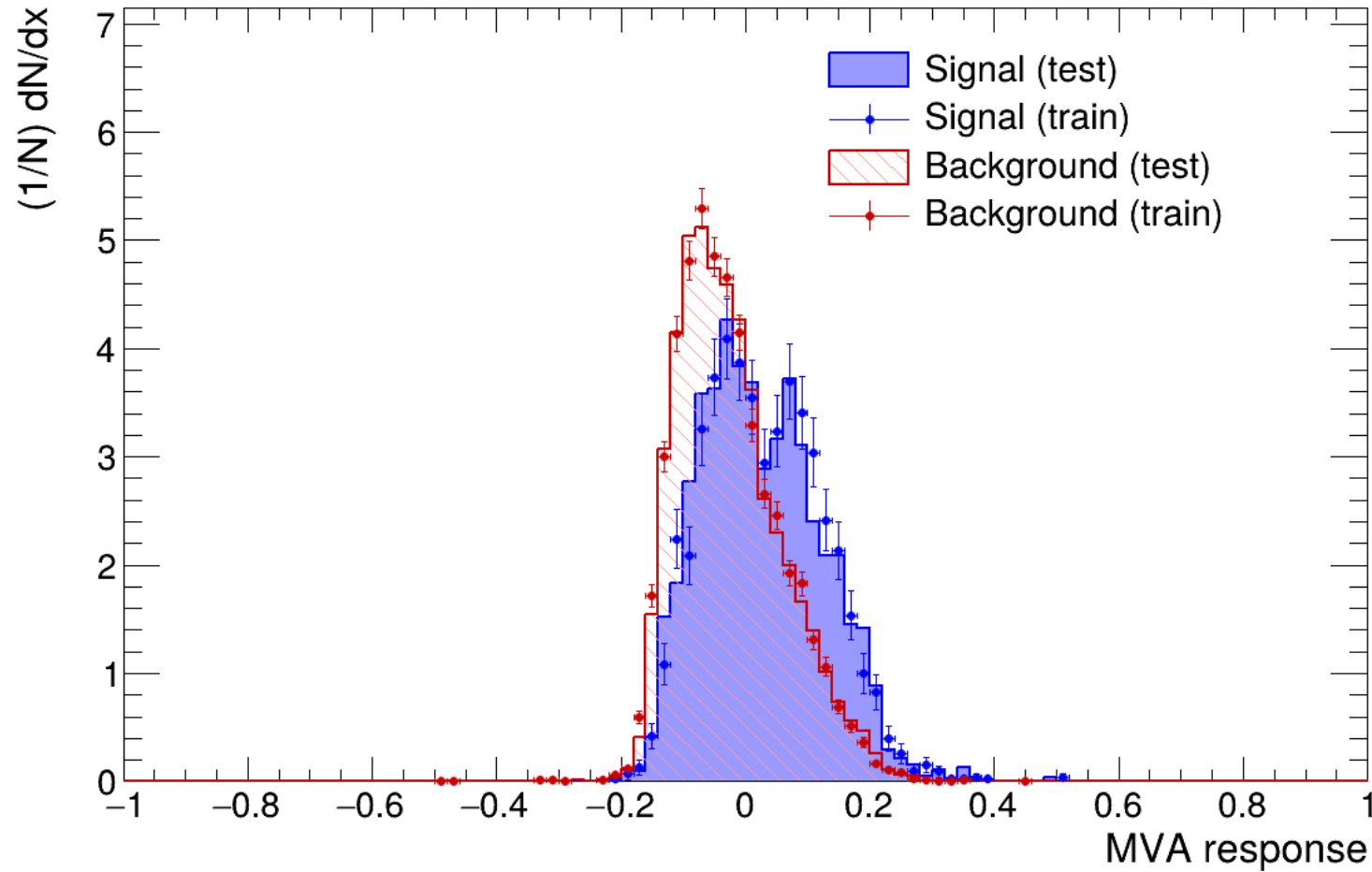
H-Matrix

TMVA overtraining check for classifier: HMatrix



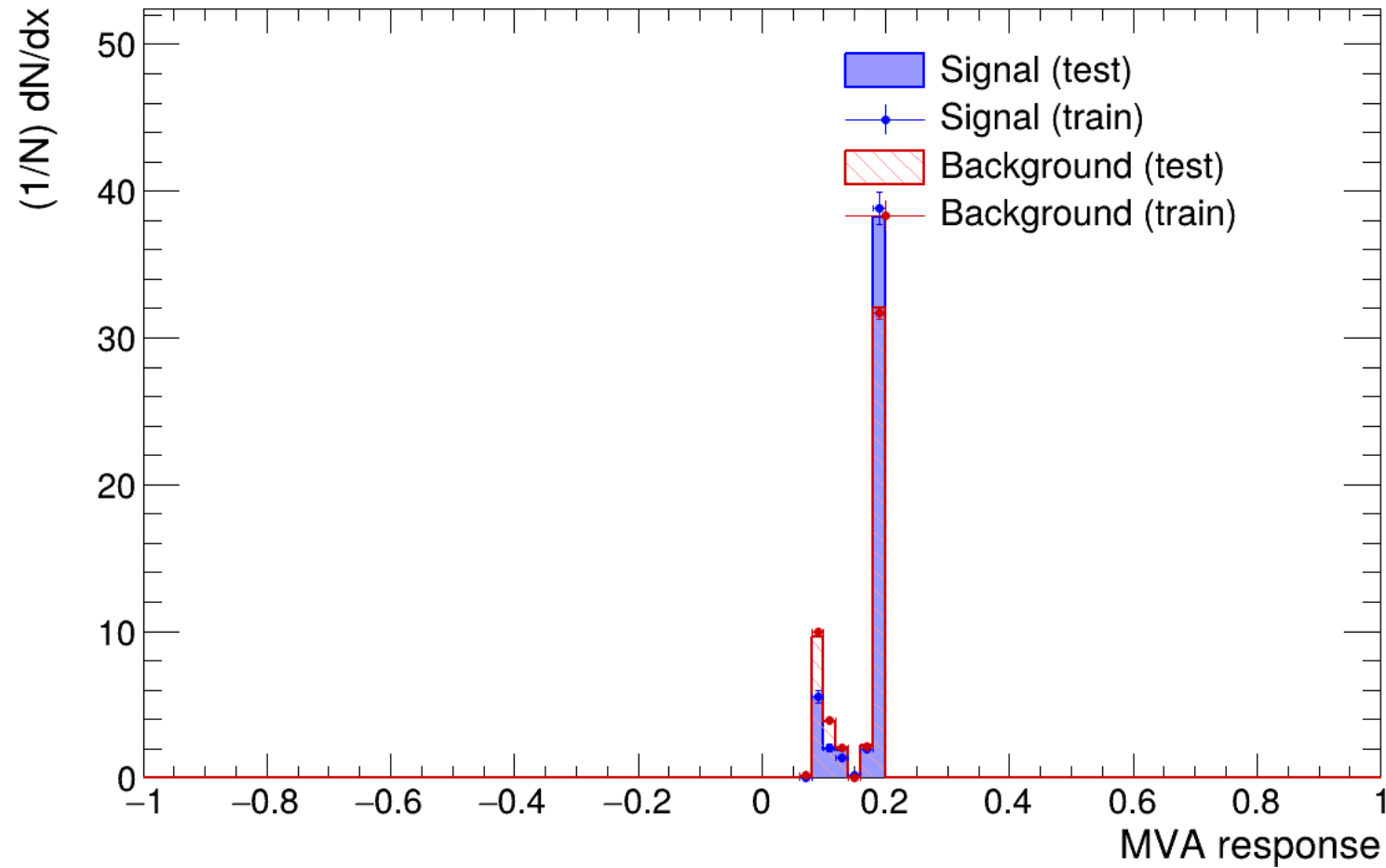
Likelihood Estimate TMVA

TMVA overtraining check for classifier: Likelihood



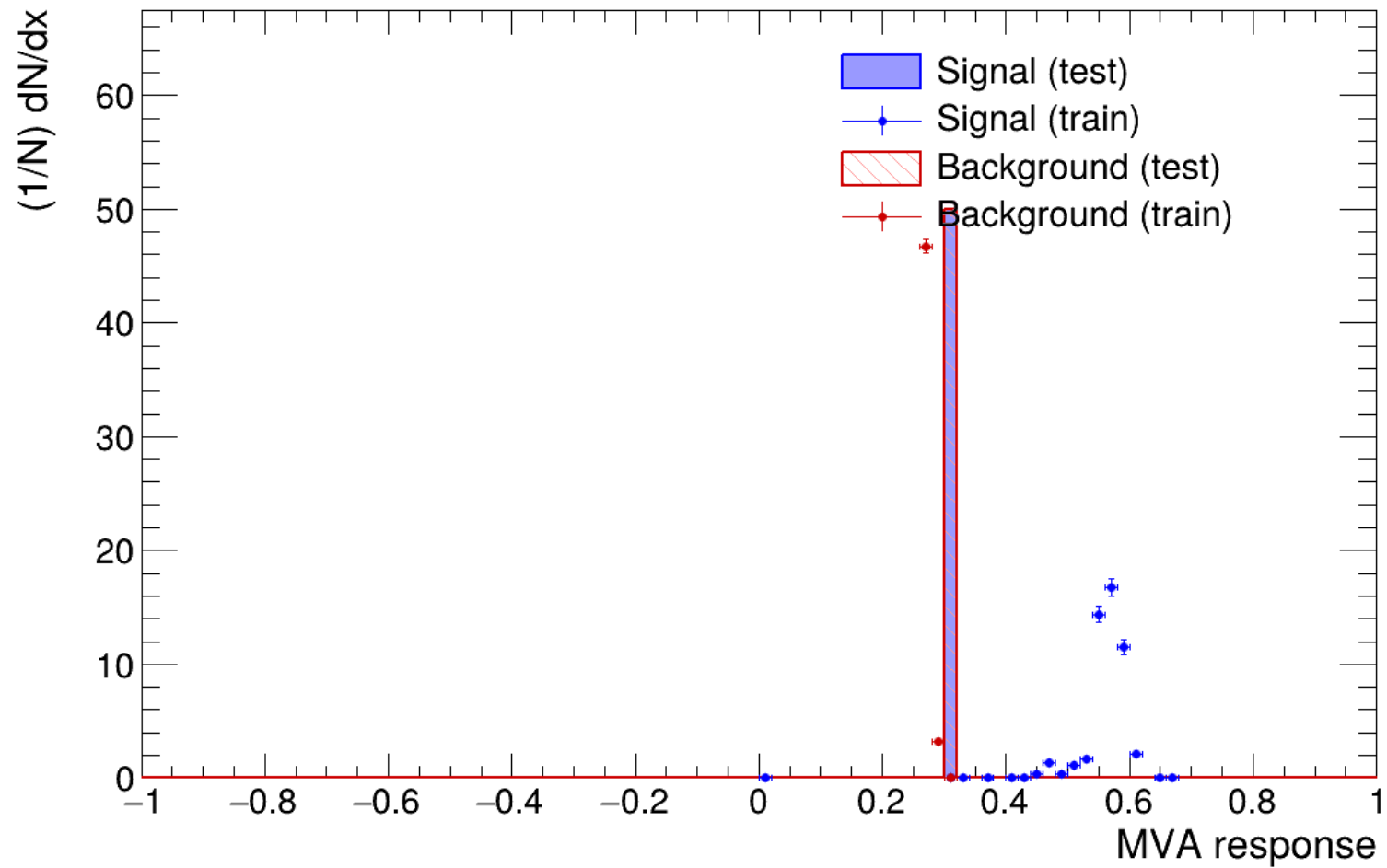
MLP

TMVA overtraining check for classifier: MLP



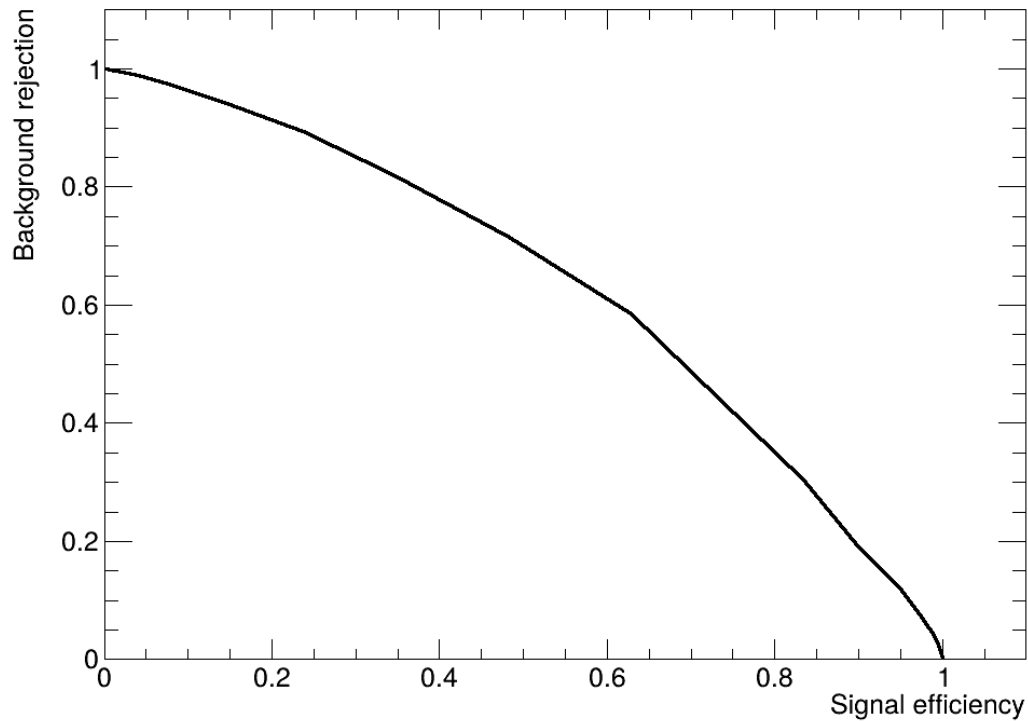
SVM

TMVA overtraining check for classifier: SVM

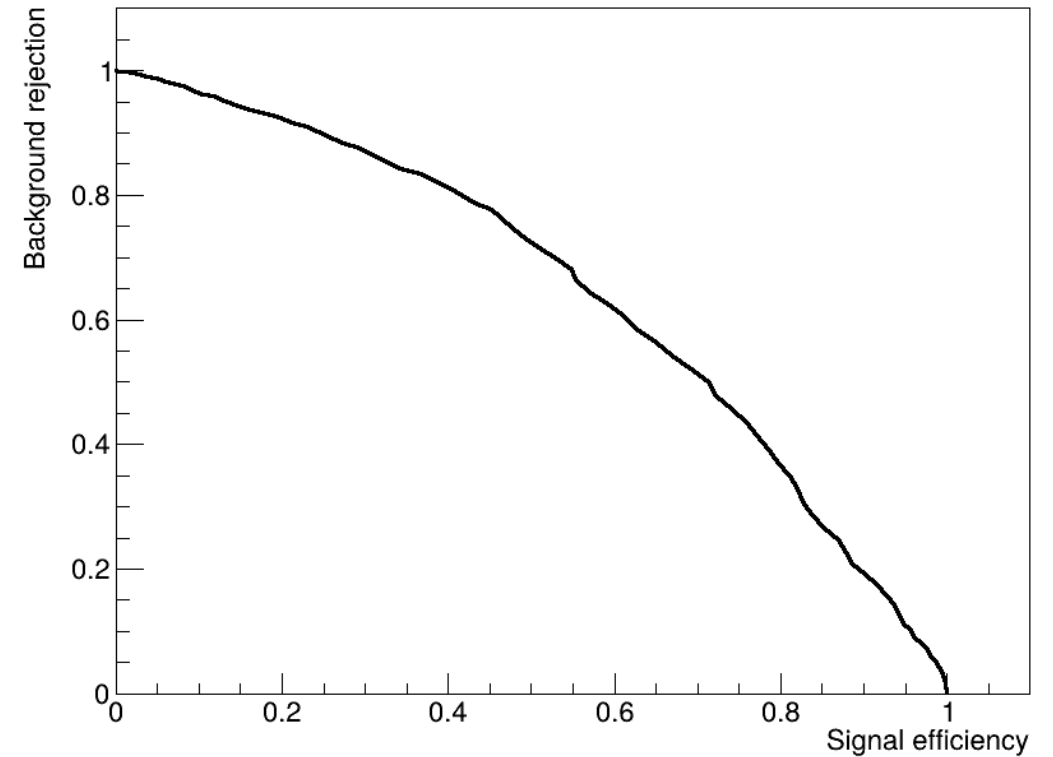


Background vs Signal efficiency BDT and BDTG

Background rejection vs Signal efficiency: BDT

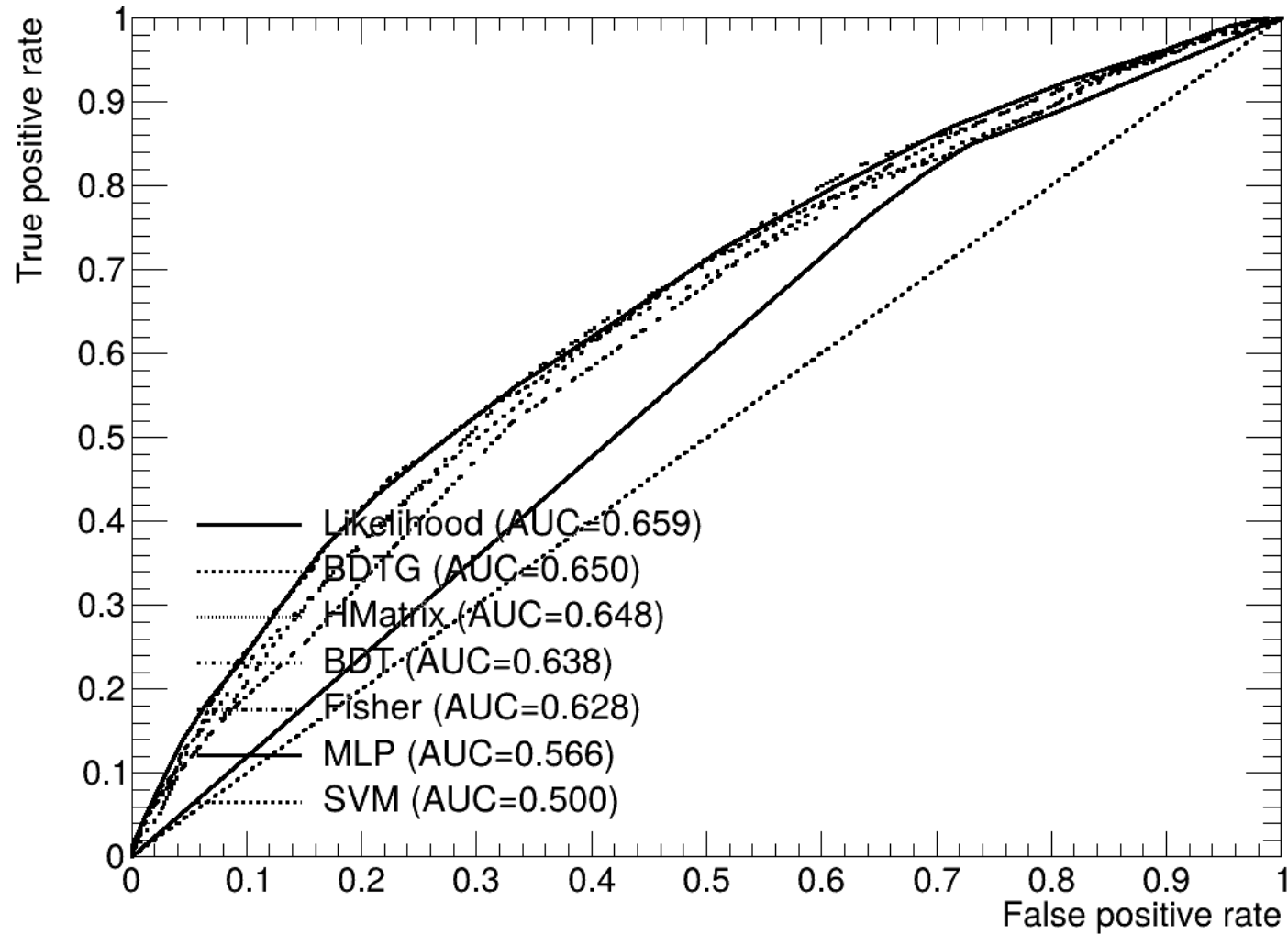


Background rejection vs Signal efficiency: BDTG



All_ROC_TMVA

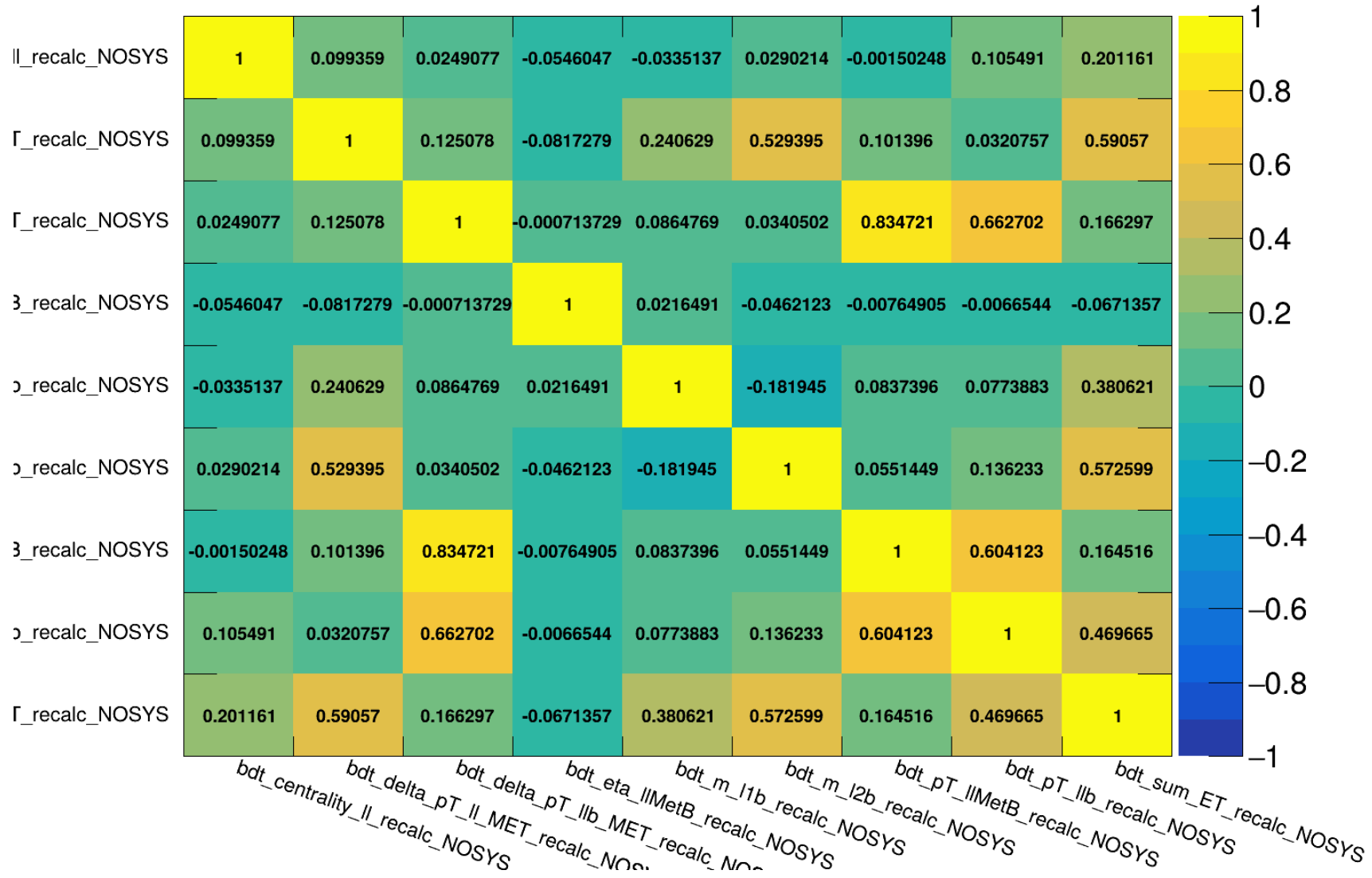
ROC overlay



Comparison of performance of algorithms

Algorithm	AUC
BDTG	0.650342
BDT	0.637717
Fisher	0.627763
HMatrix	0.648258
Likelihood	0.658574
MLP	0.566076
SVM	0.5

Correlation (Signal) à original inputs



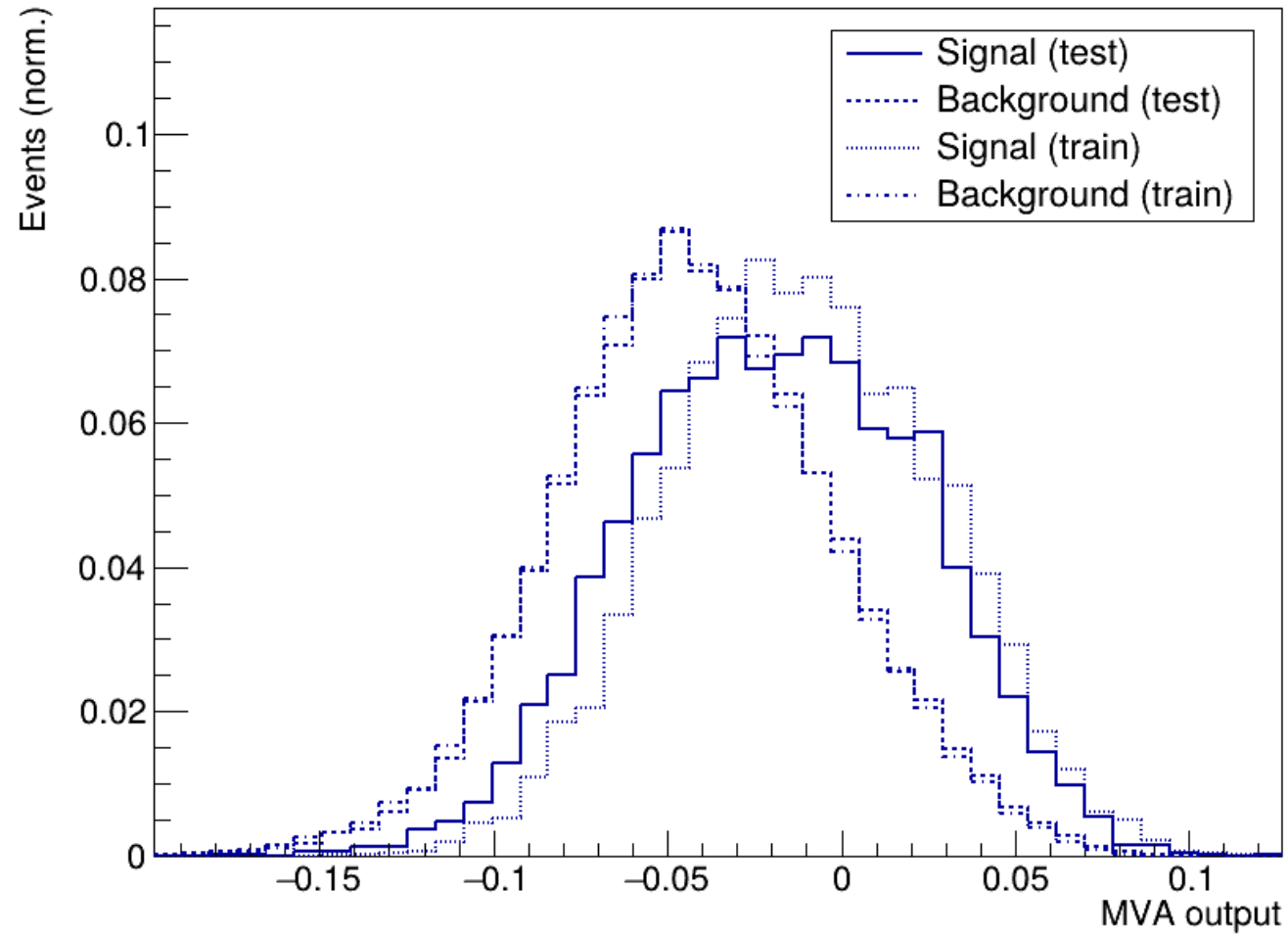
**RESULTS on NEW DATA after some
hyperparameters optimization
30.12.2025**

- TMVA does not provide automatic hyperparameter tuning. Therefore, an external search was performed.
- For each method a limited hyperparameter space (e.g., number of trees, depth, learning rate for BDTG) were defined.
- Training and evaluation of multiple configurations was done using a fixed dataset, fixed event selection, and consistent event weights.
- Each trial was scored using AUC (and cross-checked with background rejection at fixed signal efficiency),
- and the best configuration was retrained to produce the final ROC and overtraining diagnostics.

- Input files (tW signal, ttbar background)
- Tree (analysis)
- Variables (the 9 bdt_*_recalc_NOSYS variables)
- Weights (a product of event weights after dropping constants), and usually balancing S/B in training.

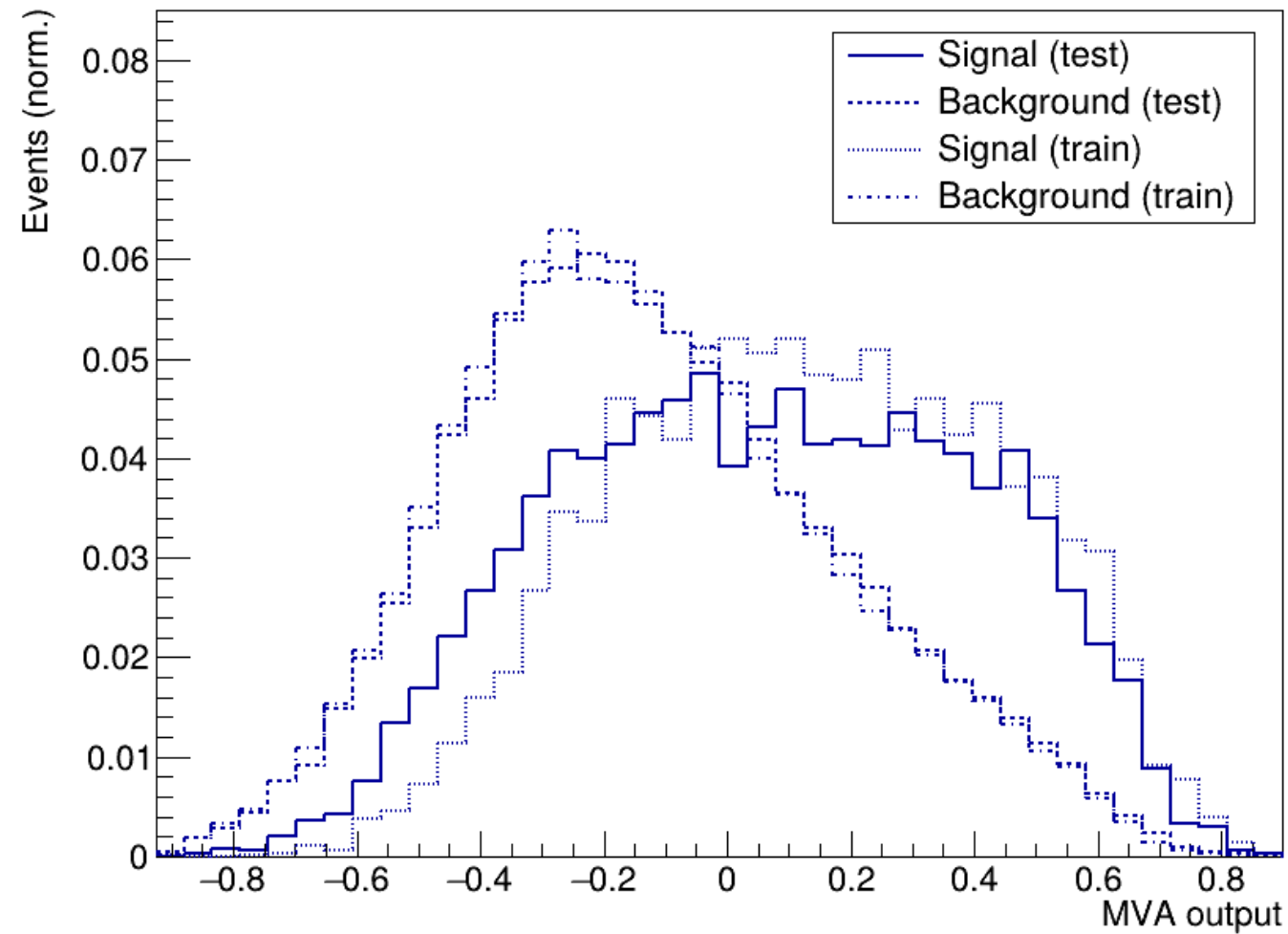
Response Test on BDT from TMVA

Overtraining check - BDT



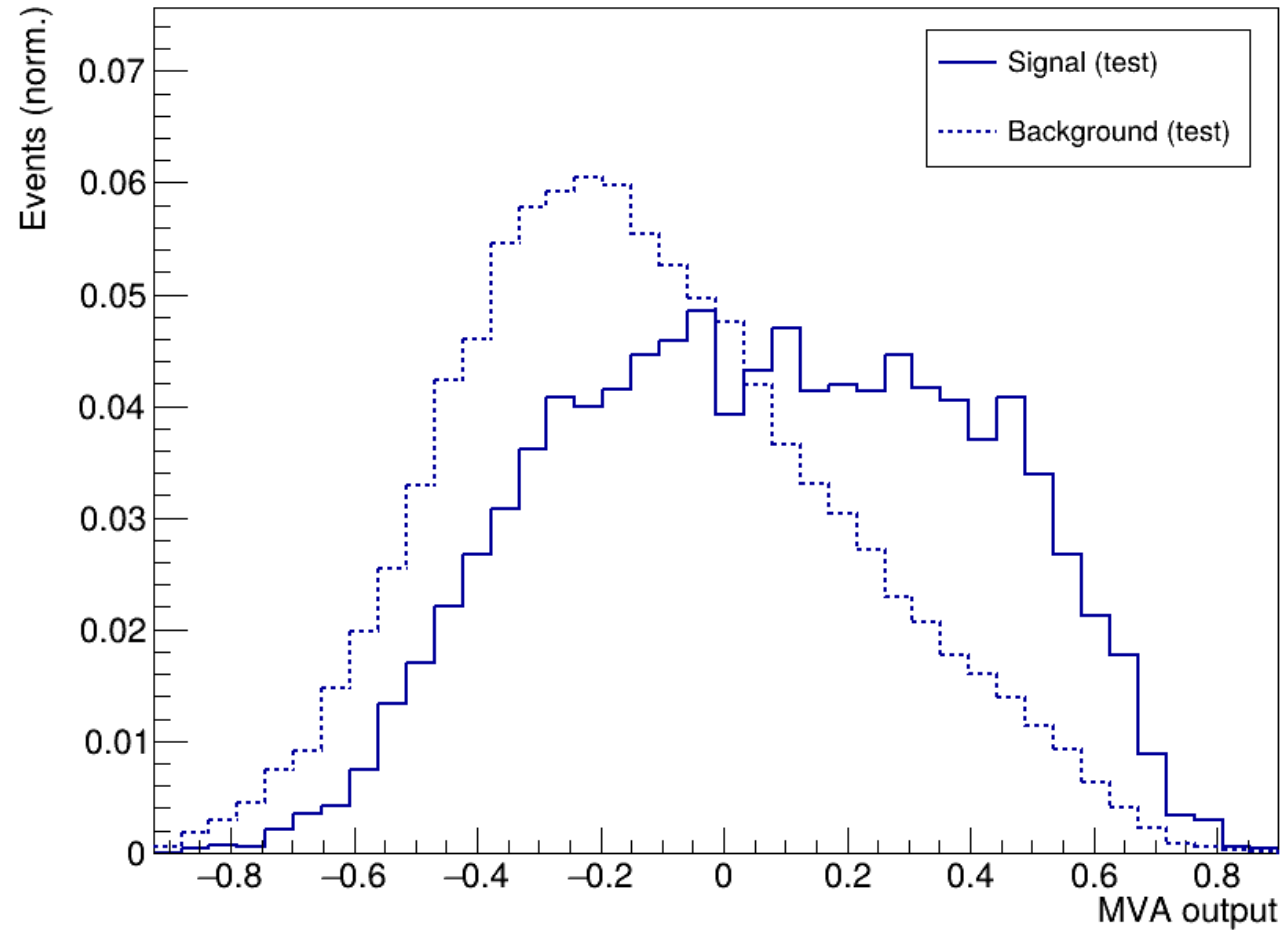
Response Test on BDTG from TMVA

Overtraining check - BDTG



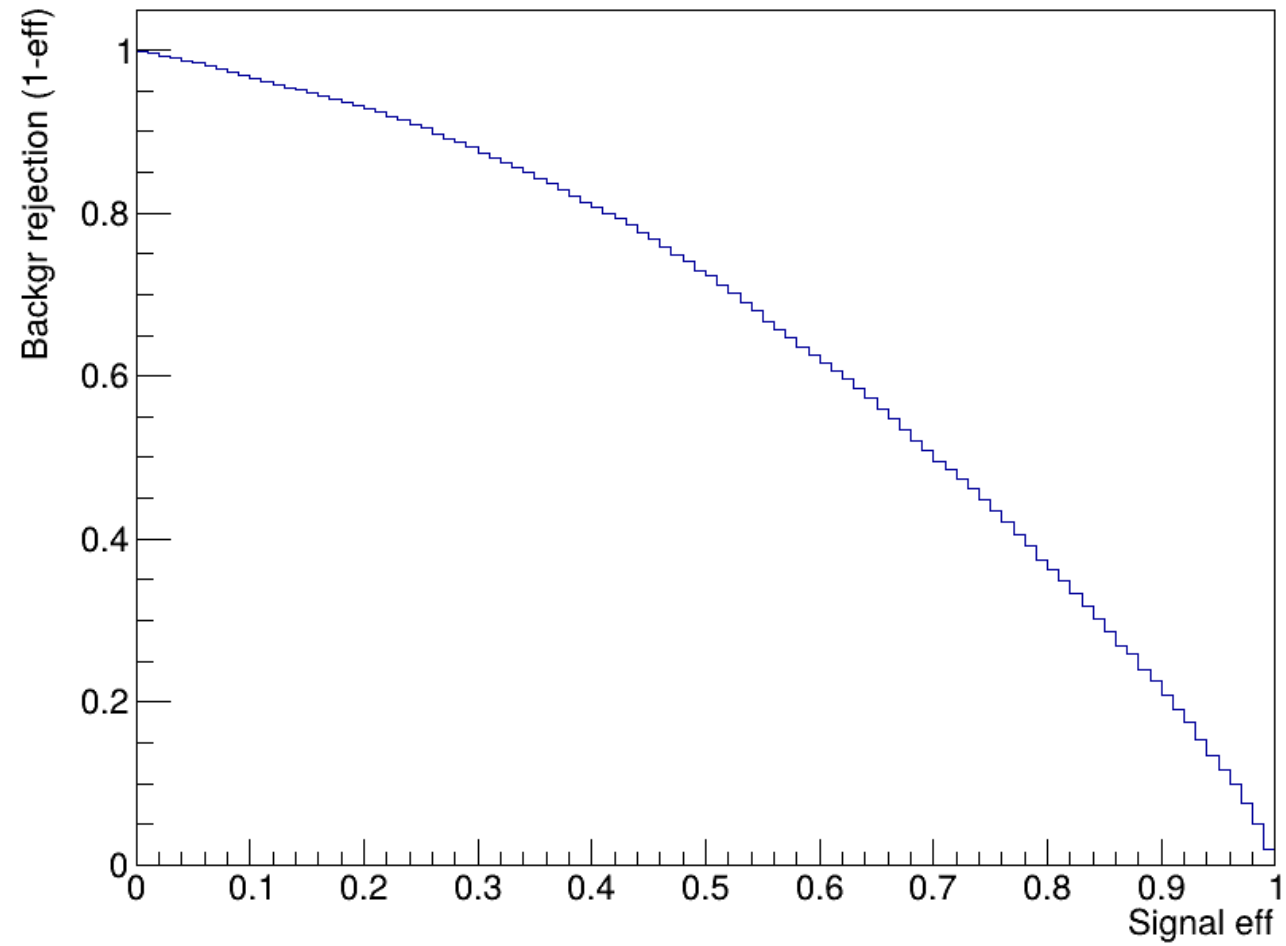
Response Test on BDTG from TMVA

MVA response (test) - BDTG



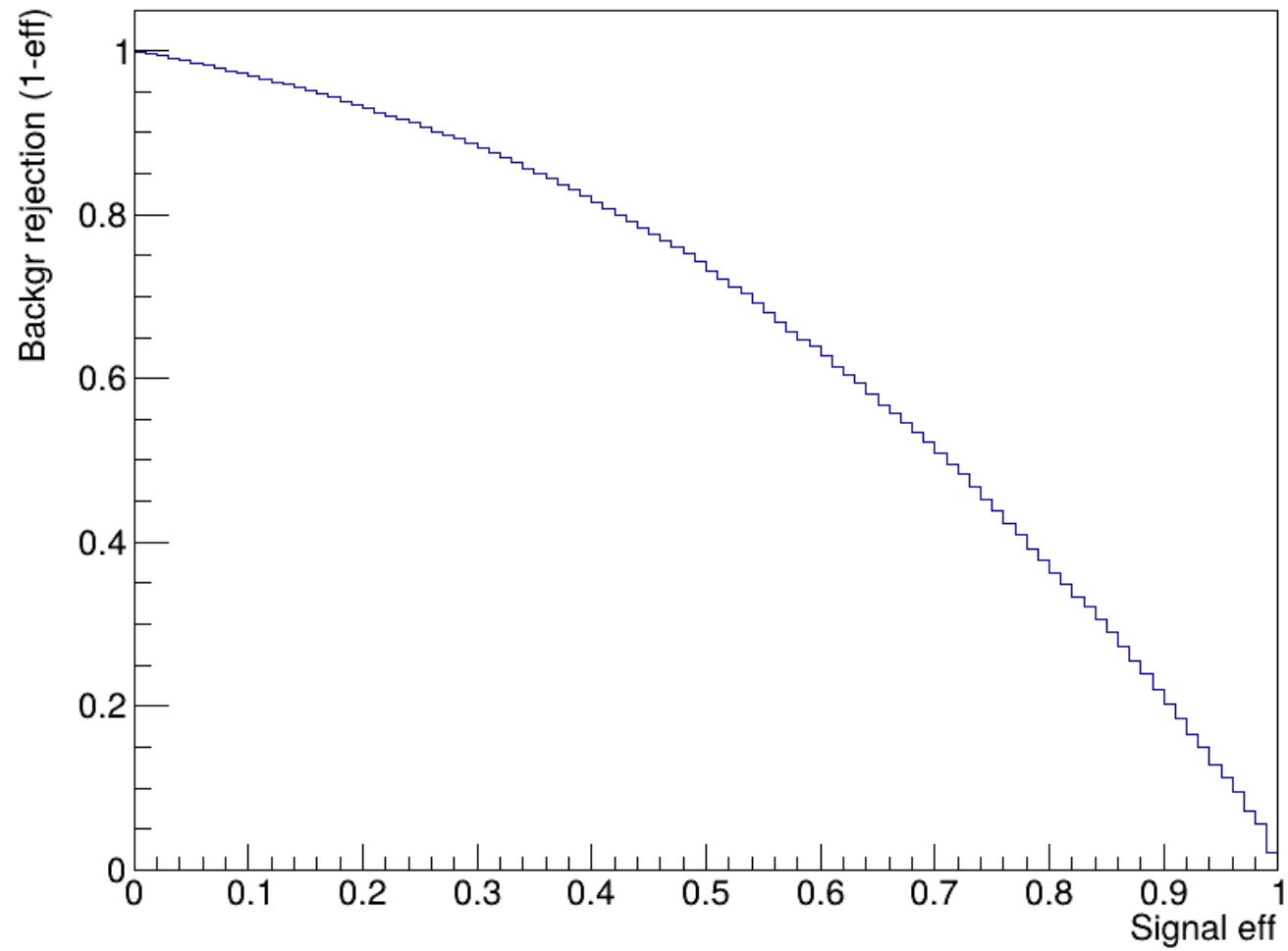
ROC of BDT

MVA_BDT



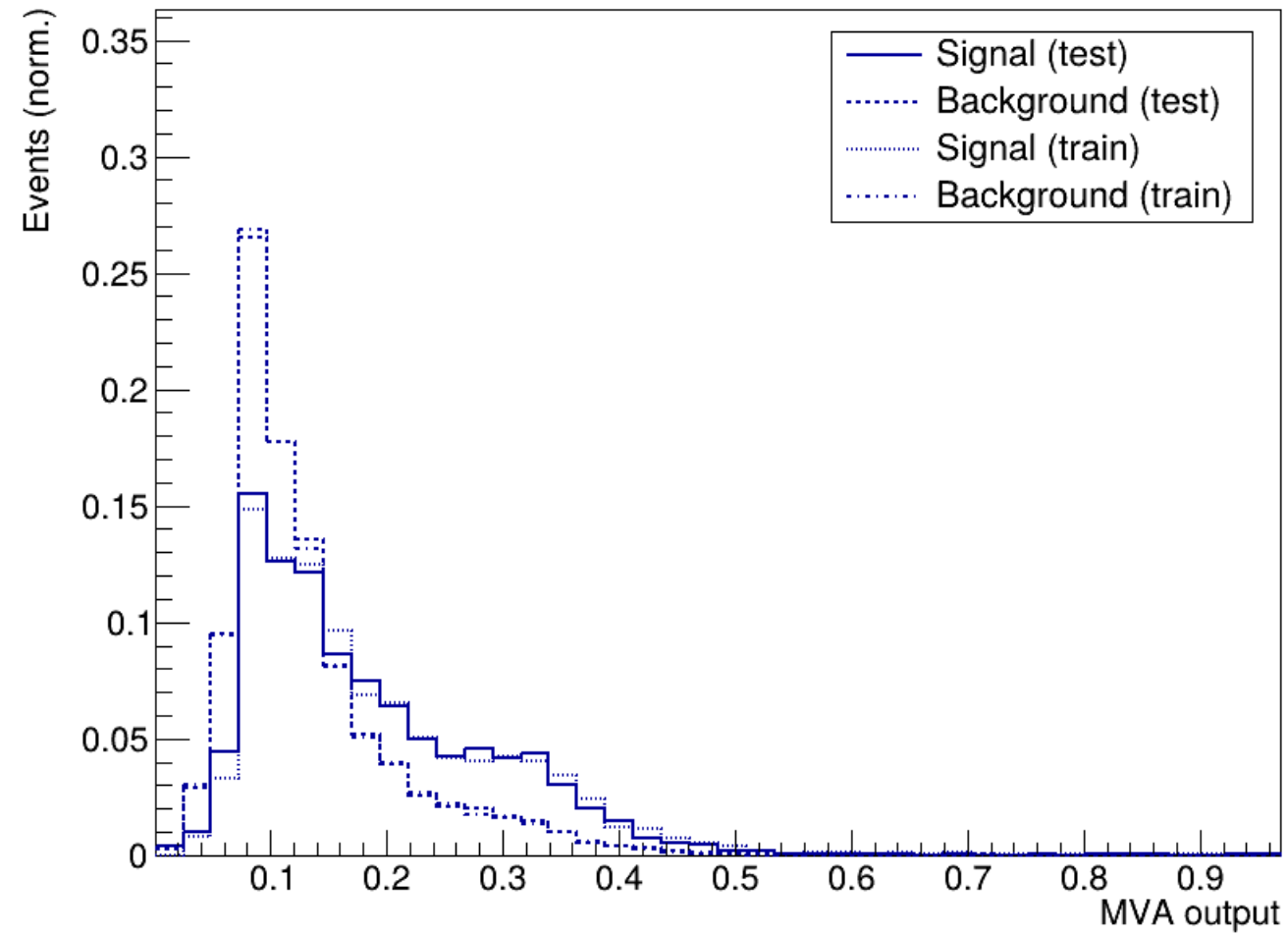
ROC of BDTG

MVA_BDTG

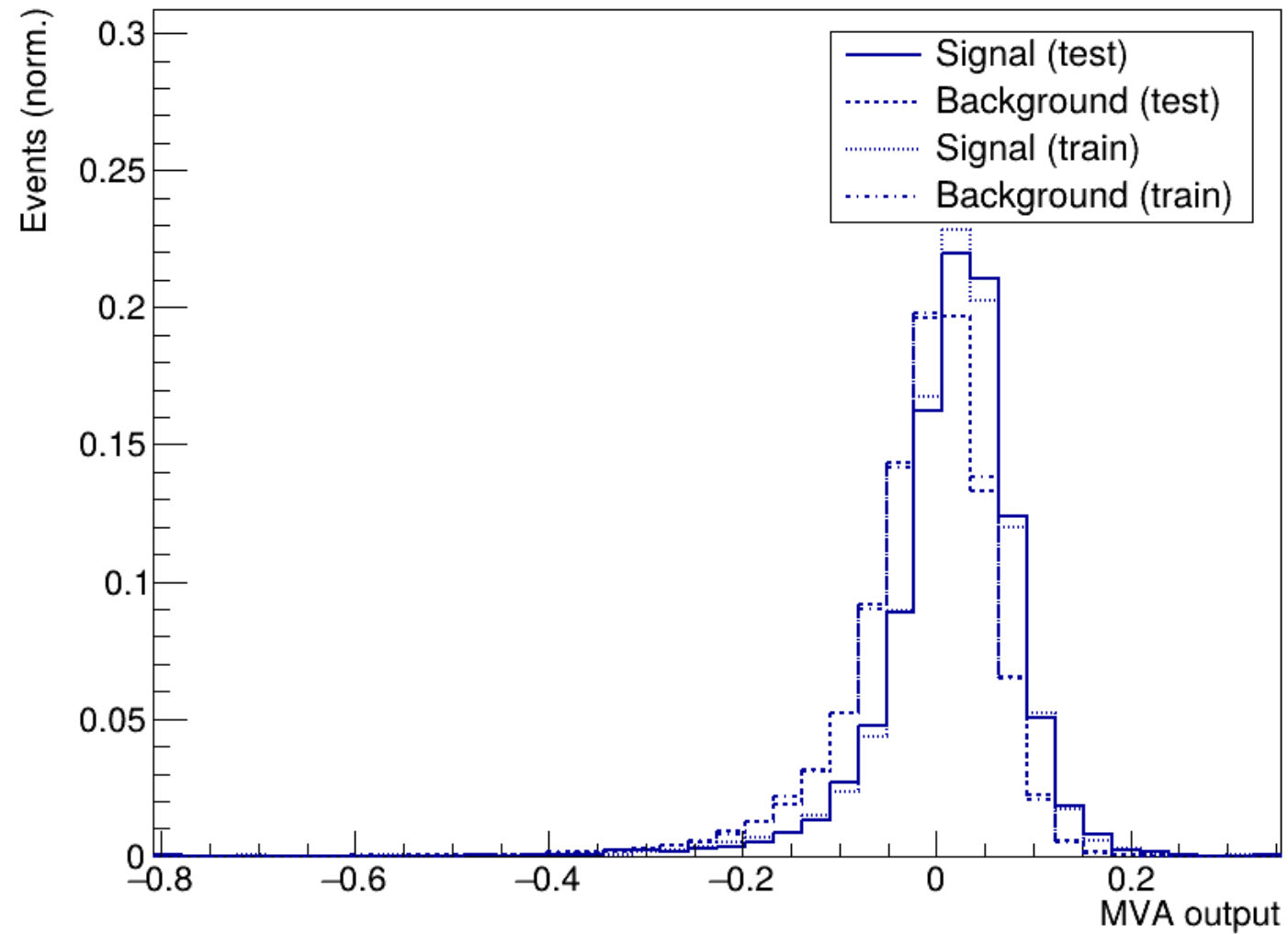


Method	Auc_test	Best_balanced_acc	Best_fpr	Best_tpr	Rejb@effs=0.5	Ks_sig(test-vs-train)	Ks_bkg(test-vs-train)
MLP	0.655274	0.623852	0.277297	0.525	0.743824	0.074855	0.616657
Likelihood	0.643988	0.61763	0.35974	0.595	0.72806	1	0.99803
BDTG	0.639764	0.619807	0.295386	0.535	0.736573	3.30E-20	0.000252
HMatrix	0.637081	0.617358	0.360285	0.595	0.72197	0.232496	0.814639
BDT	0.635302	0.613723	0.277555	0.505	0.725977	2.53E-20	0.001526
KNN	0.63272	0.610293	0.334414	0.555	0.717576	8.93E-08	0.046508
Fisher	0.631464	0.605605	0.34379	0.555	0.703661	0.698448	0.992567
PDERS	0.629422	0.608107	0.378786	0.595	0.712034	0.041206	0.09604
LD	0.627842	0.602462	0.360076	0.565	0.695053	0.608545	0.931392
CutsGA	0.614133	0.606092	0.342816	0.555	0.620033		
RuleFit	0.531323	0.53141	0.43218	0.495	0.562337	0.96558	0.999997

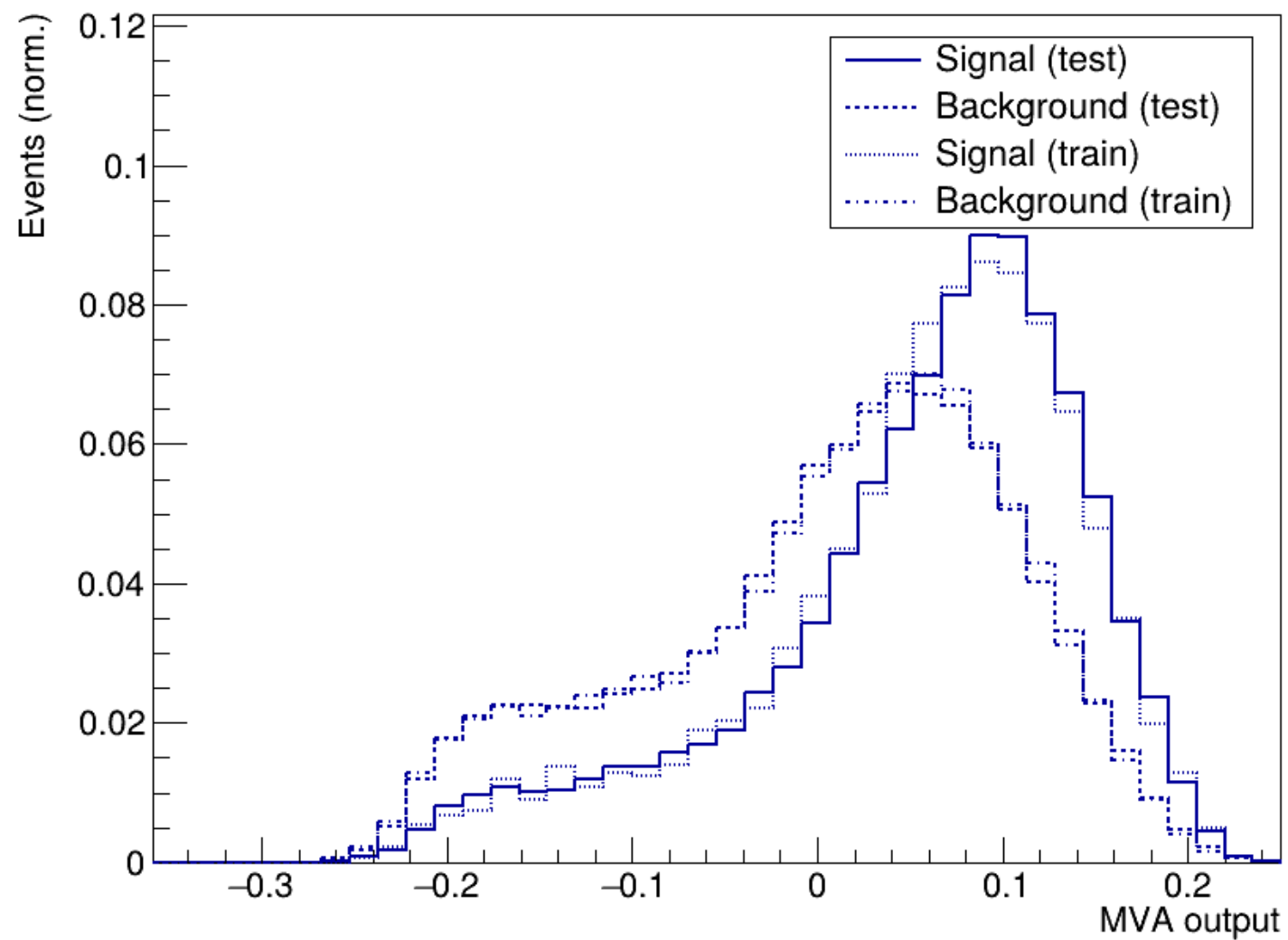
Overtraining check - MLP



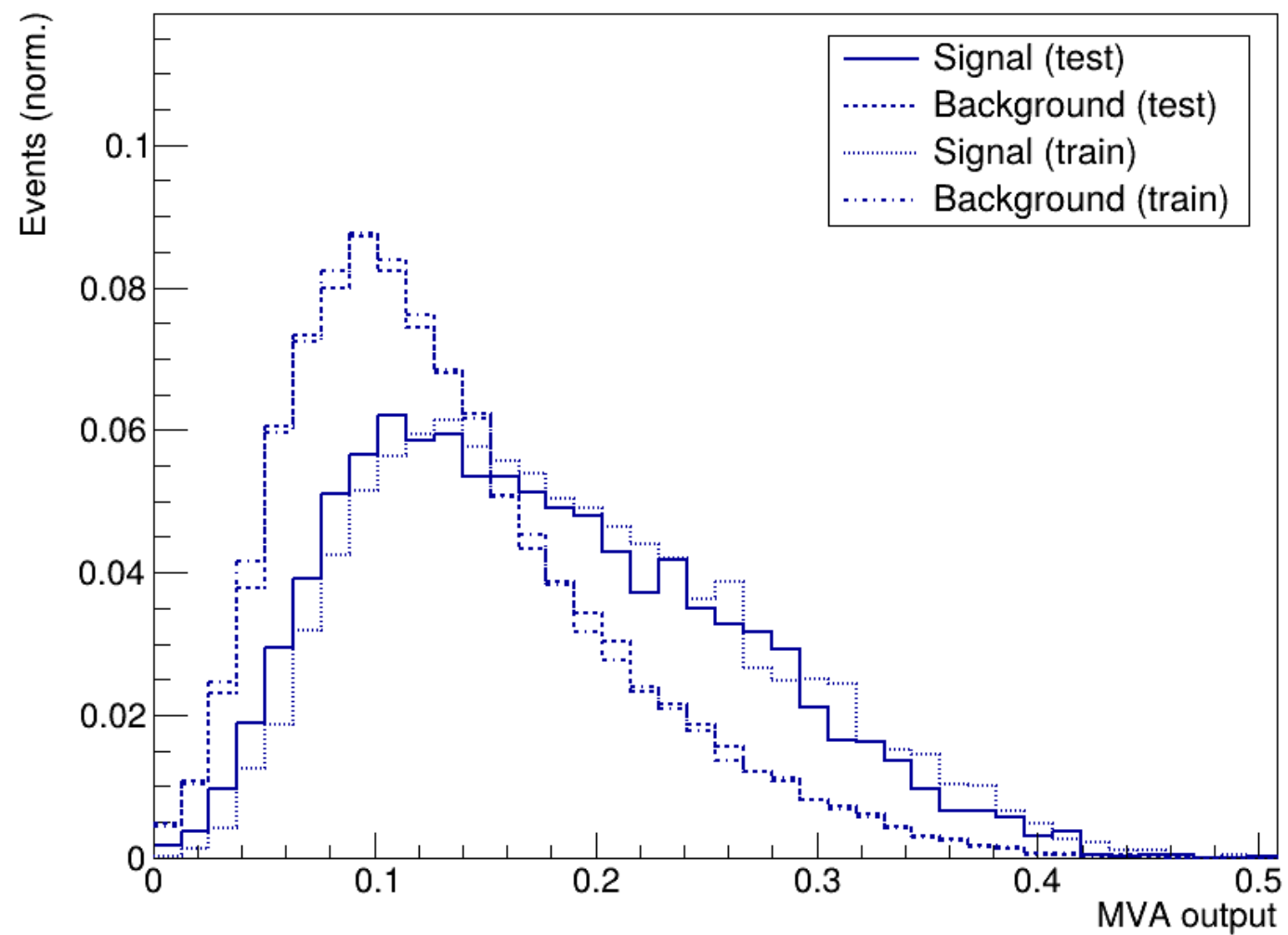
Overtraining check - Fisher



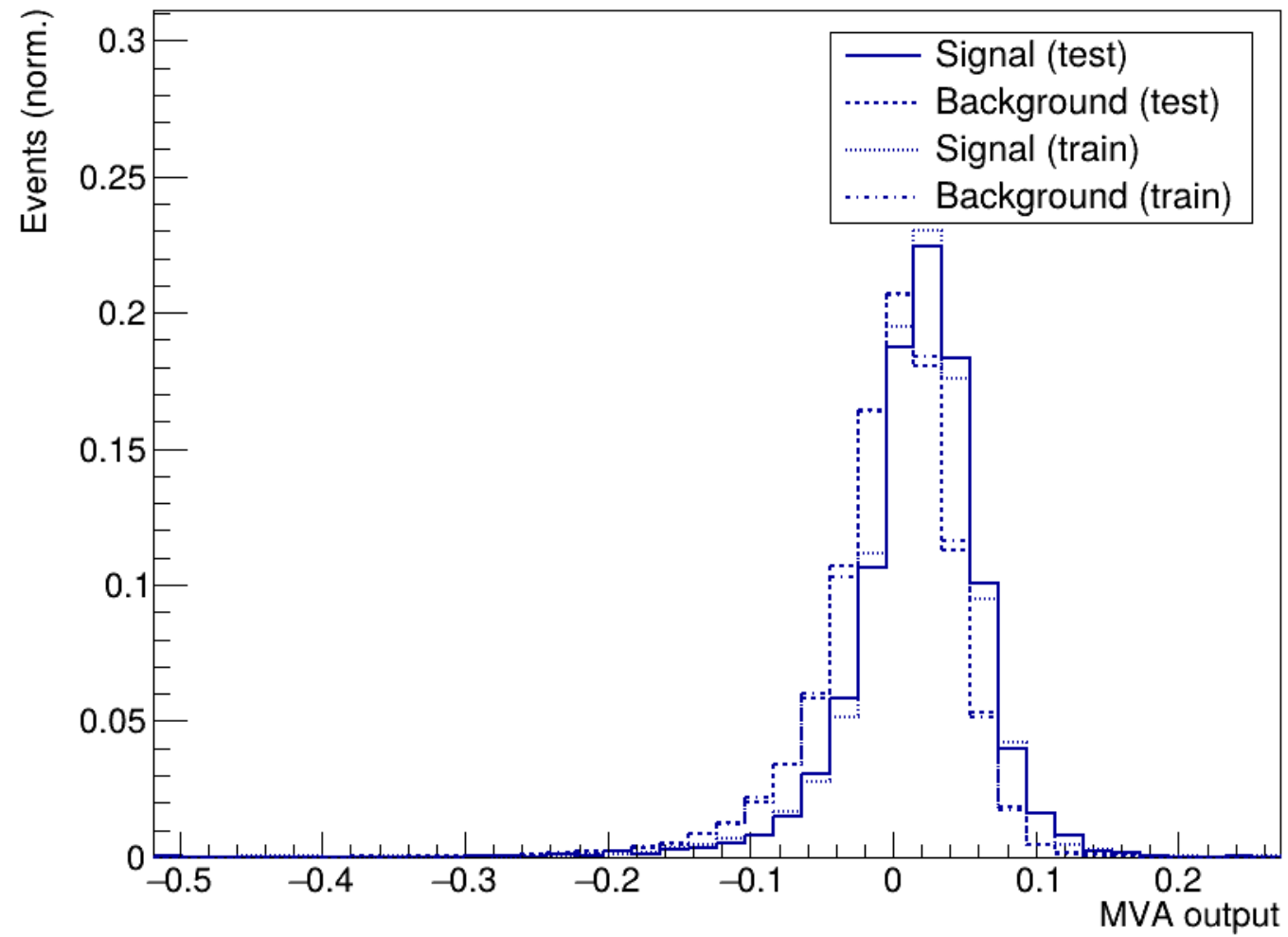
Overtraining check - HMatrix



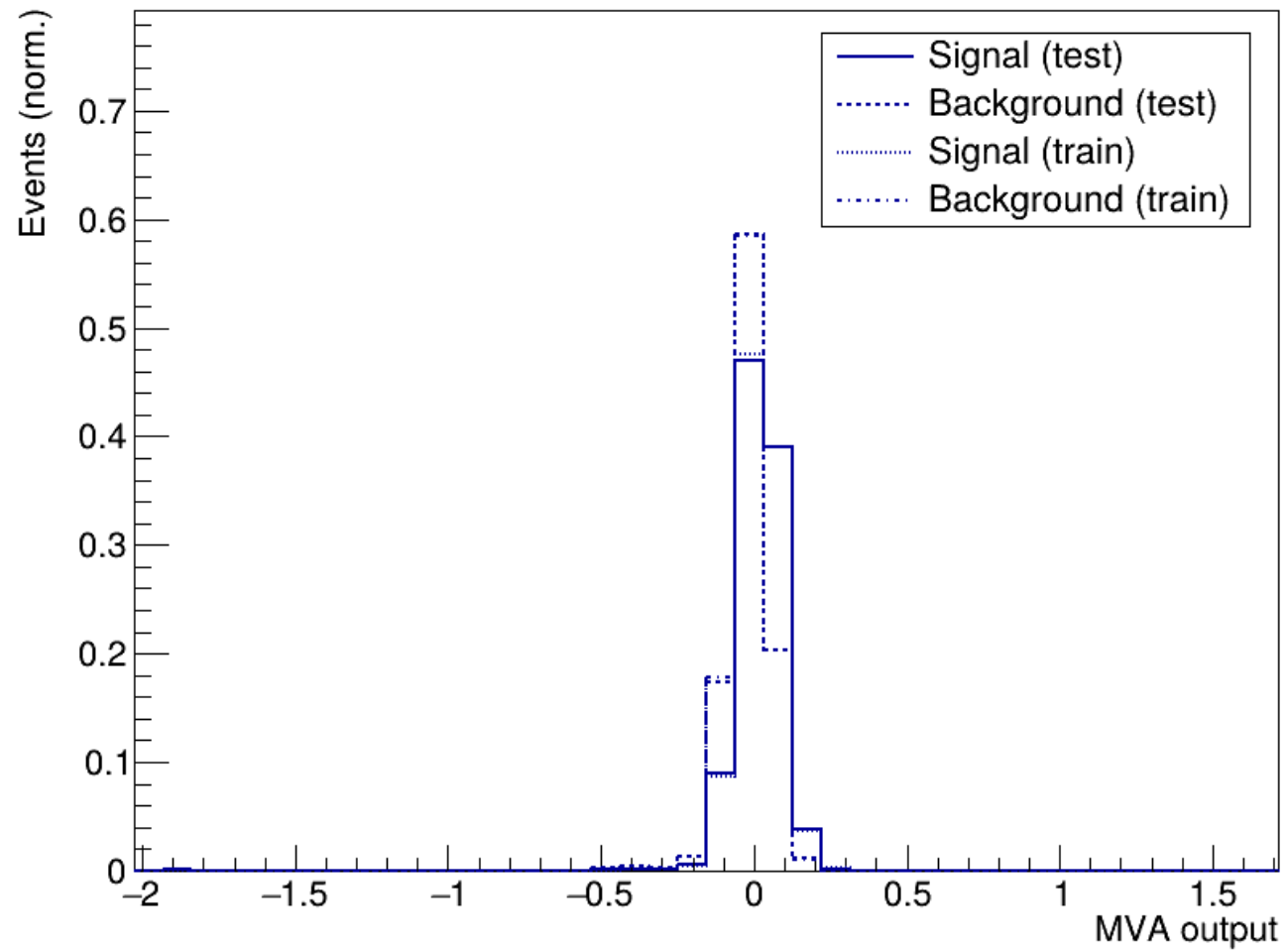
Overtraining check - KNN



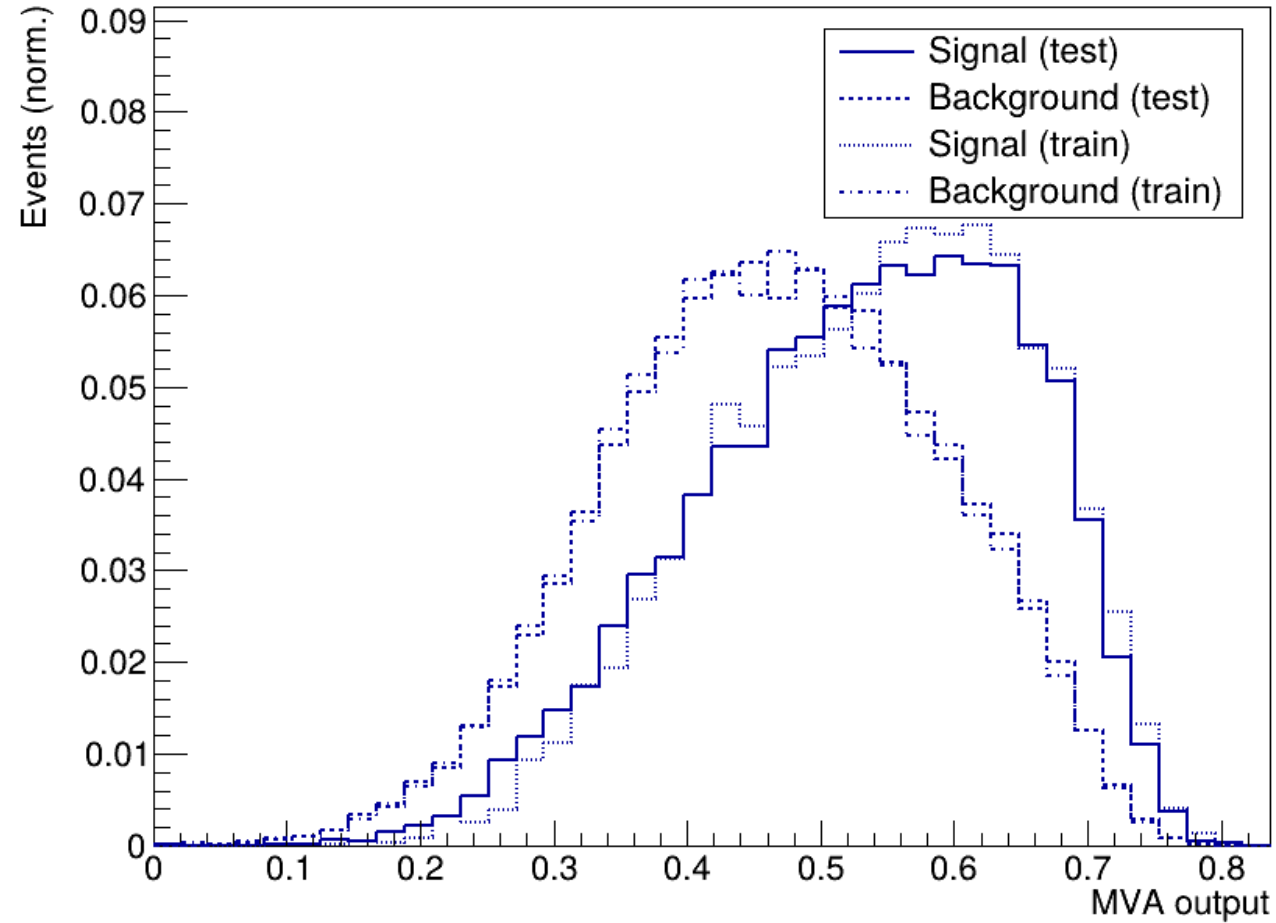
Overtraining check - LD



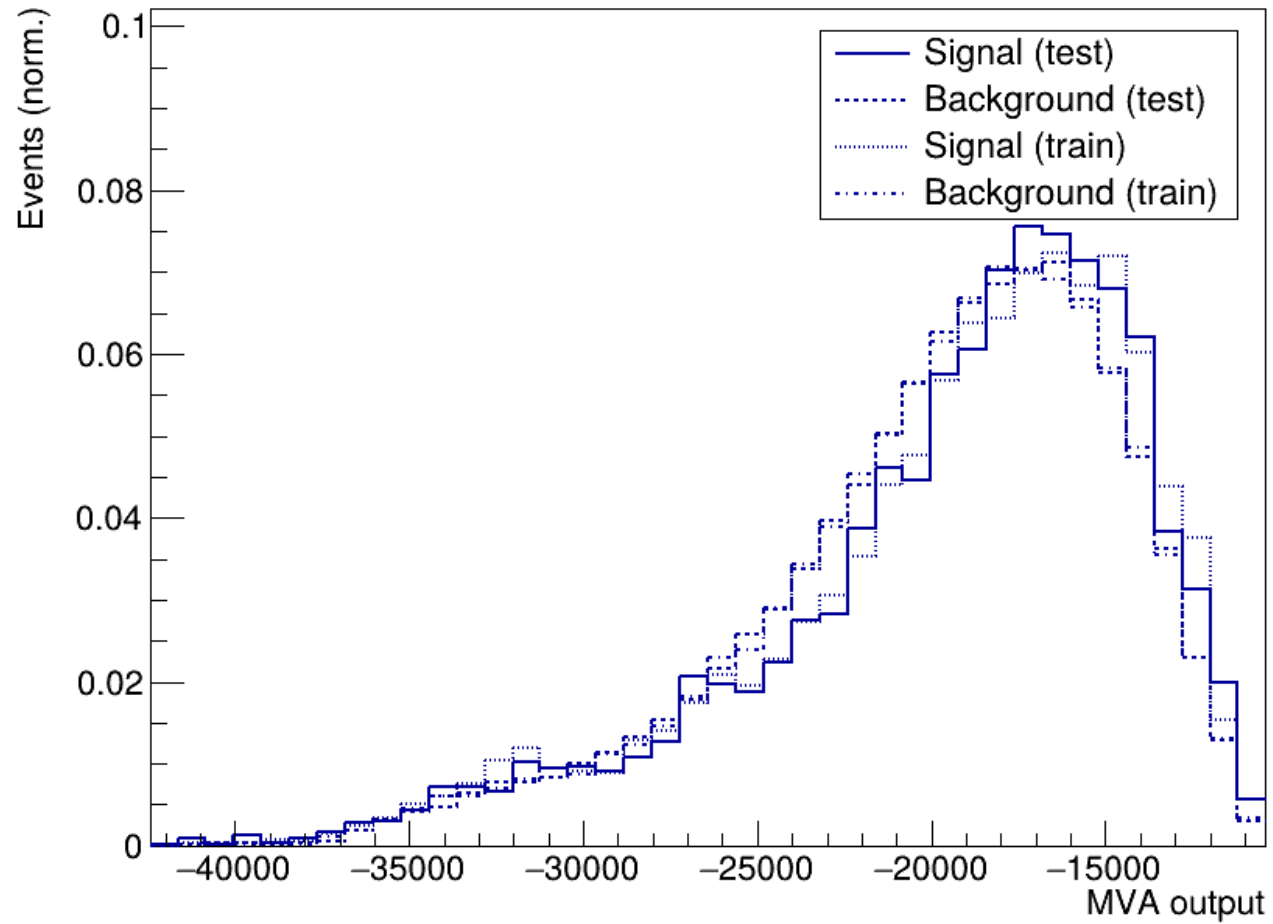
Overtraining check - Likelihood



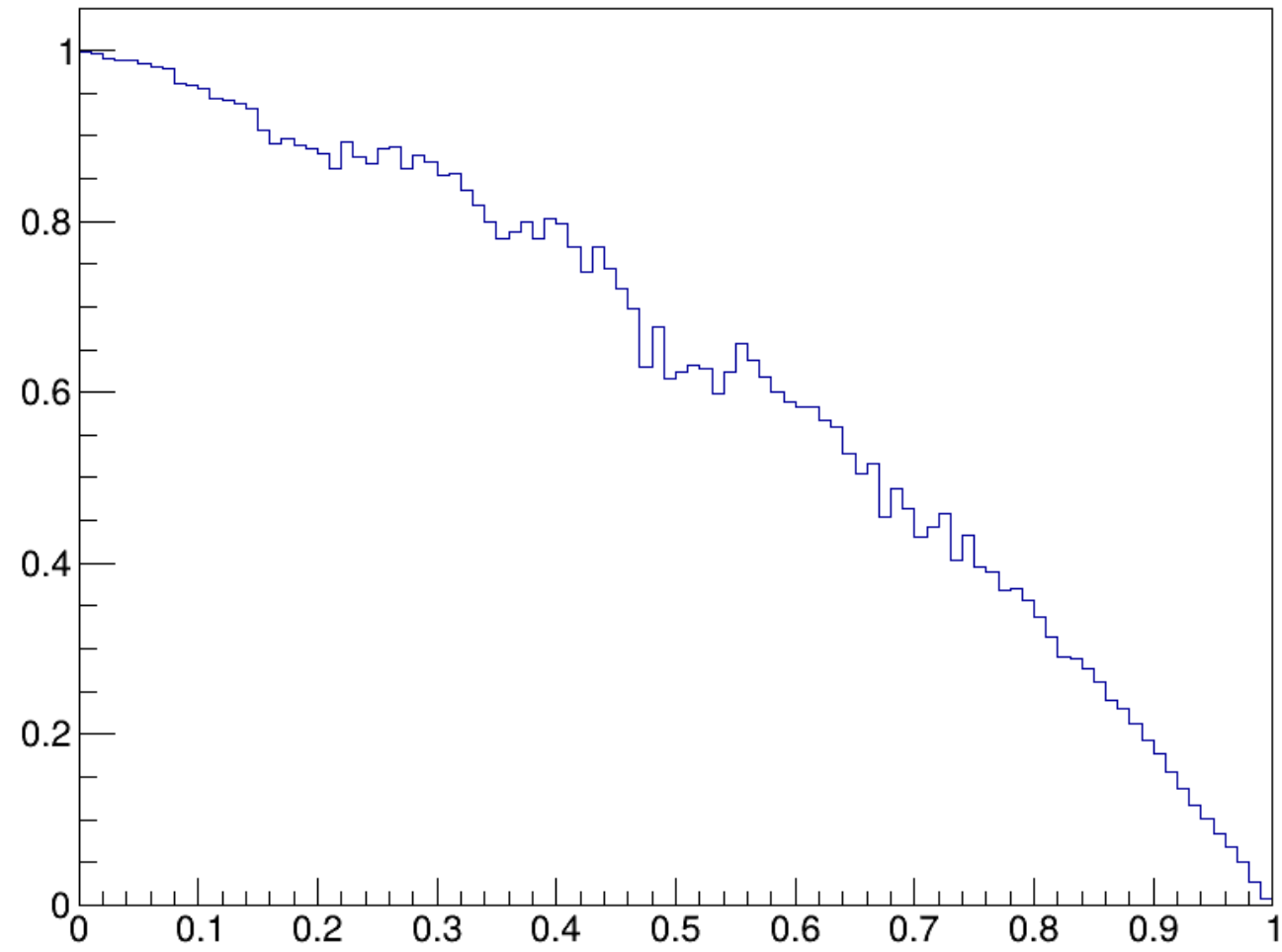
Overtraining check - PDERS



Overtraining check - RuleFit

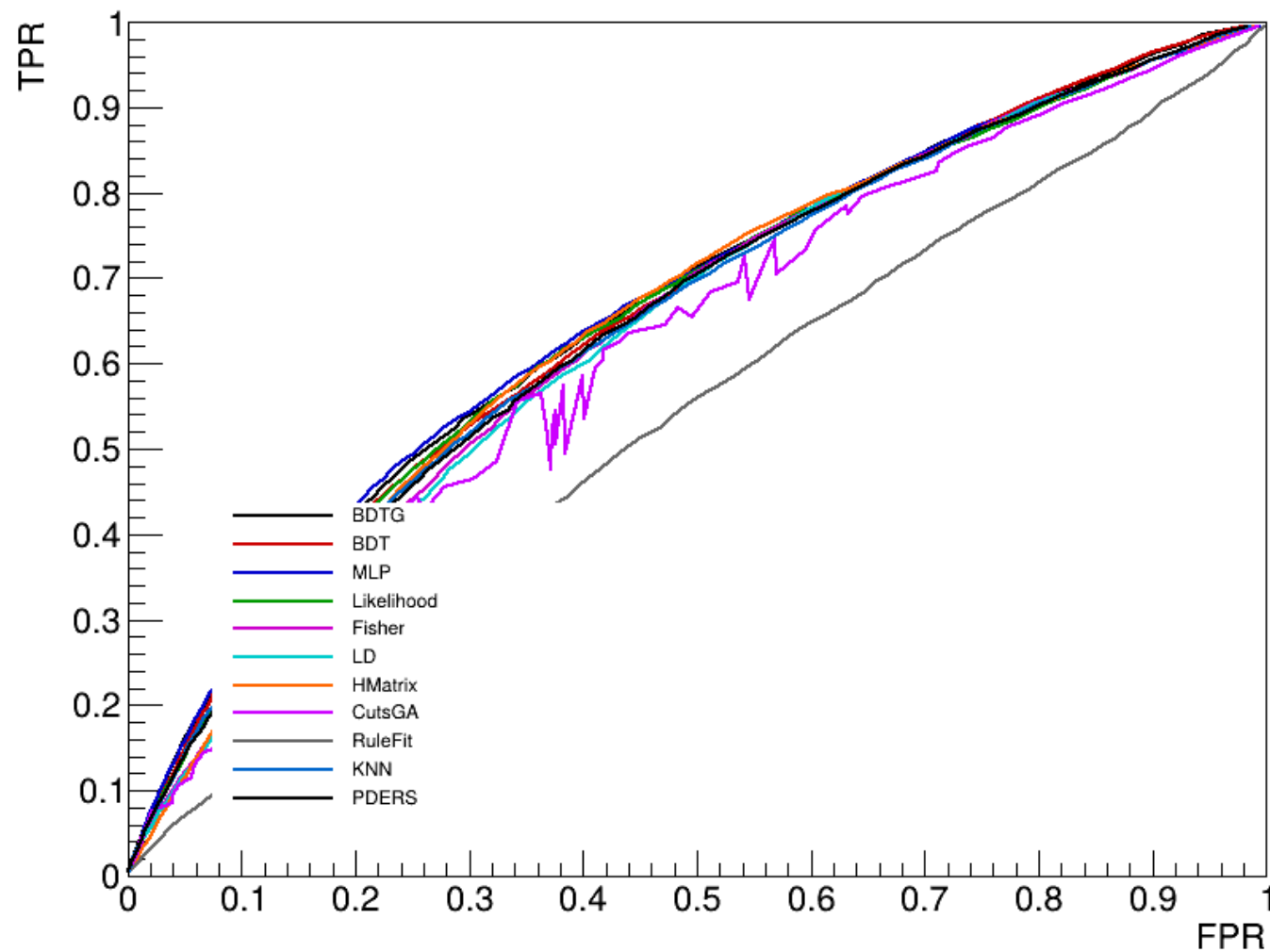


MVA_CutsGA

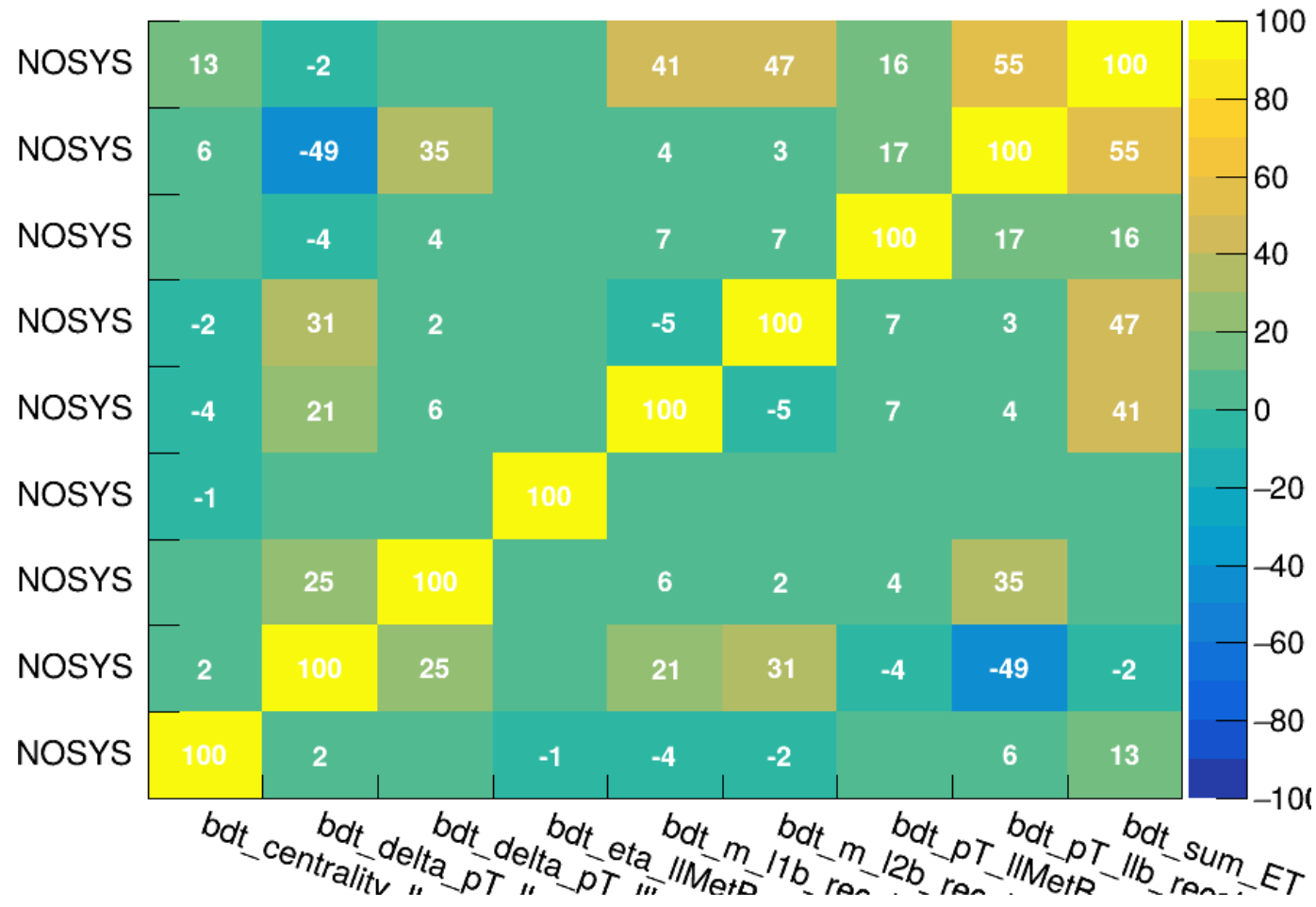


ROC AII

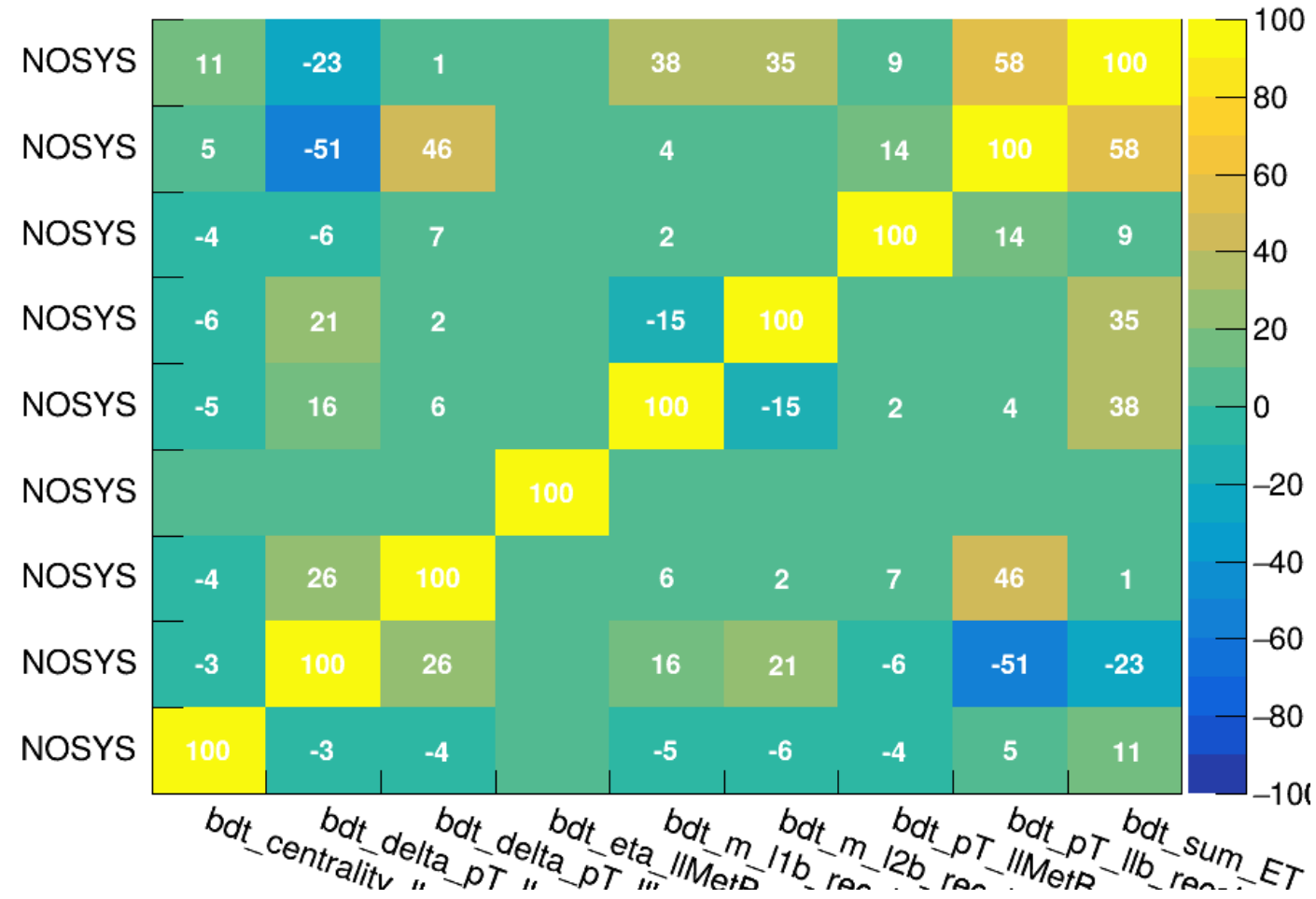
ROC overlay (test)



Correlation Matrix (signal)



Correlation Matrix (background)





National Research
**Tomsk
State
University**



**Лаборатория
анализа данных
физики высоких энергий**

Томского
государственного
университета

Thank you for your attention!!!