Caratteristiche analisi

- DNN: train e test su eventi di segnale con un’unica massa
- Collezione jet: TCC
- Analisi: merged
- Canale: ggF
- Segnale: Radion (125395 eventi)
- Training fraction: 0.8

Casi studiati

Addestramento della rete confrontato in 4 diversi casi:

1) sull'intero campione di train

2) sull'intero campione di train ma con pesi per compensare il diverso numero di eventi di segnale e di background

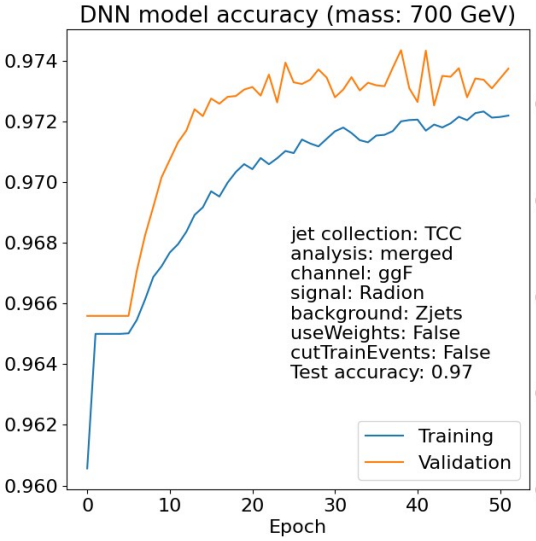
3) su un sottoinsieme del campione di train con uguale numero di eventi di segnale e di background

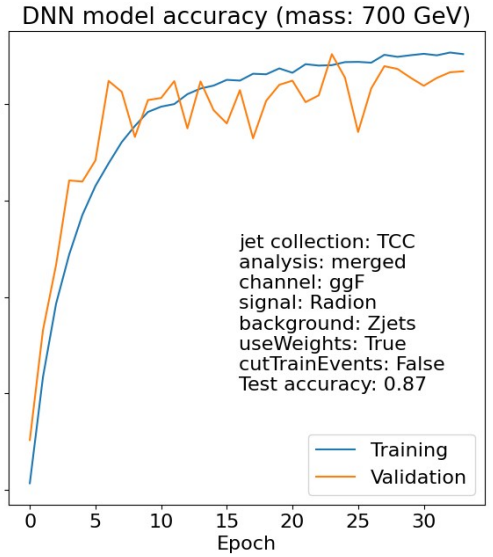
4) su un sottoinsieme del campione di train con $N \cdot sig = bkg$ (N fissato a priori)

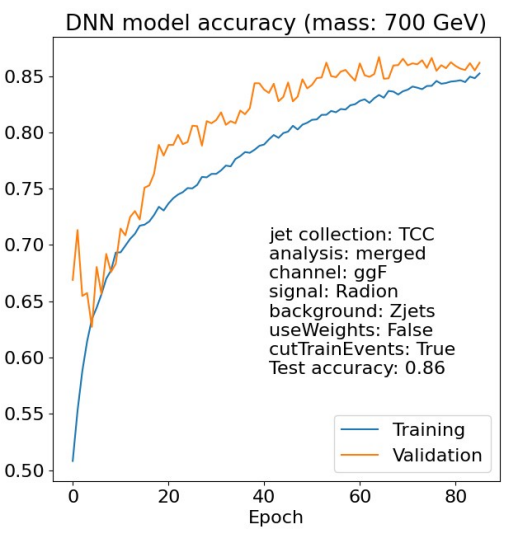
Ogni caso è stato studiato per 3 valori di massa del segnale (700 GeV, 3000 GeV, 6000 GeV) e due diversi background (Zjets o Diboson)

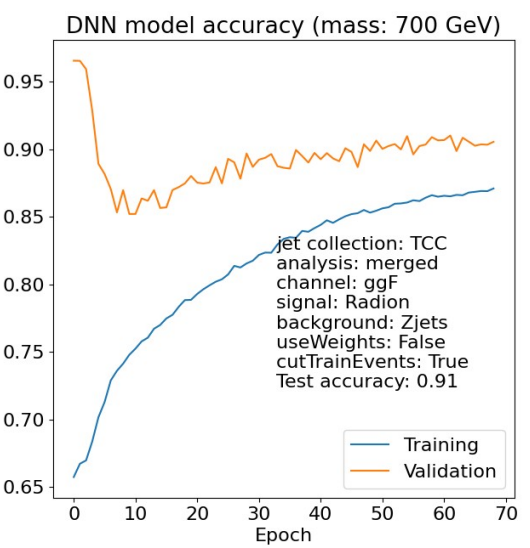
Massa 700 GeV, Zjets

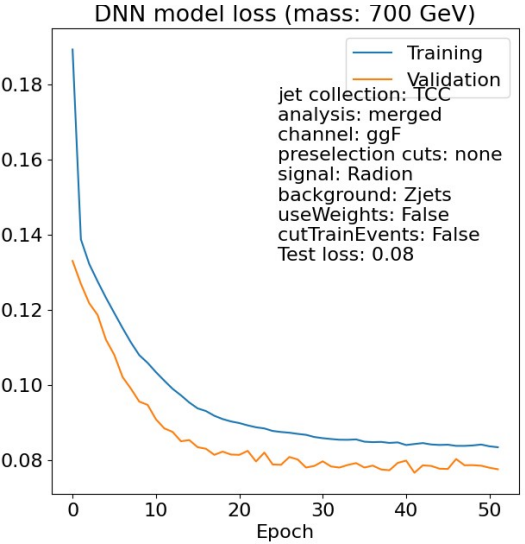
	Intero campione	Intero campione+pesi	sig=bkg	2sig=bkg
Segnale train	9924 (3.6% bkg)	9924	9924	9924
Bkg train	273622	273622	9924	19848
Segnale test	3169	3169	3169	3169
Bkg test	86032	86032	86032	86032
Loss su train	0.0818	0.0224	0.3415	0.3169
Accuracy su train	0.9726	0.8753	0.8557	0.8749
Loss su validazione	0.0775	0.3389	0.3439	0.2540
Accuracy su validazione	0.9737	0.8670	0.8618	0.9056
Loss su test	0.0779	0.3370	0.3412	0.2529
Accuracy su test	0.9735	0.8672	0.8633	0.9063
Area ROC	0.95	0.95	0.94	0.945
Reiezione bkg @ 0.90 WP	7.4	7.4	6.3	6.0
Reiezione bkg @ 0.99 WP	1.9	2.0	2.0	1.8

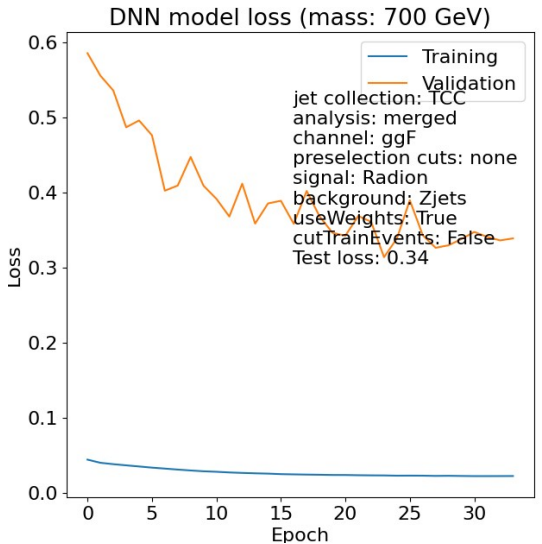

DNN model accuracy (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
Test accuracy: 0.97
Training
Validation
Epoch

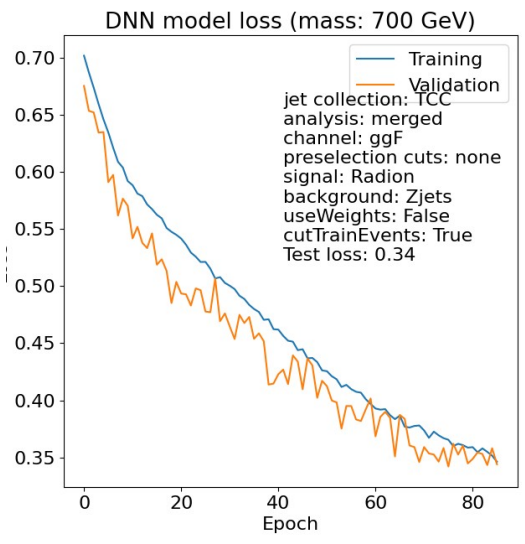

DNN model accuracy (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
Test accuracy: 0.87
Training
Validation
Epoch

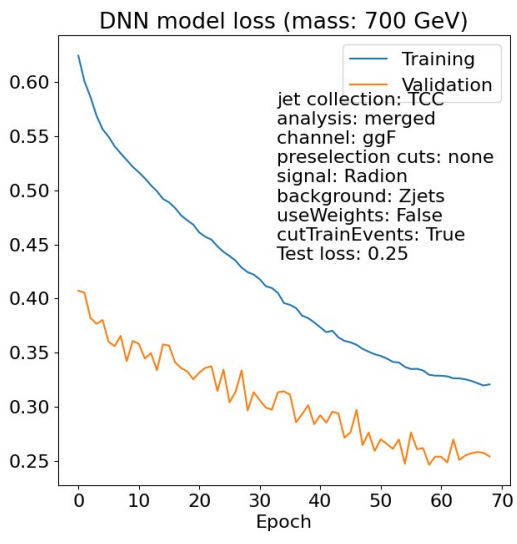

DNN model accuracy (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test accuracy: 0.86
Training
Validation
Epoch

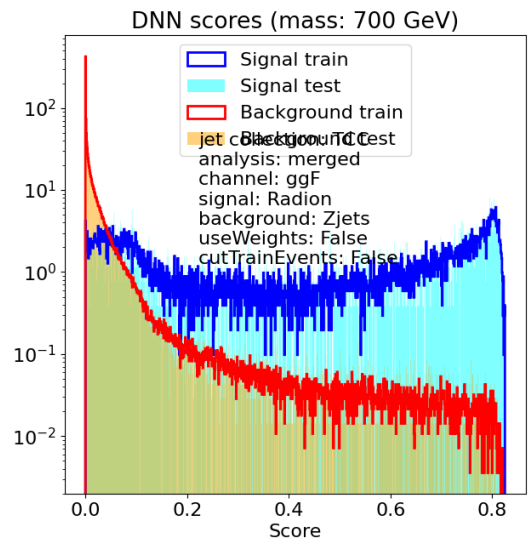

DNN model accuracy (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test accuracy: 0.91
Training
Validation
Epoch

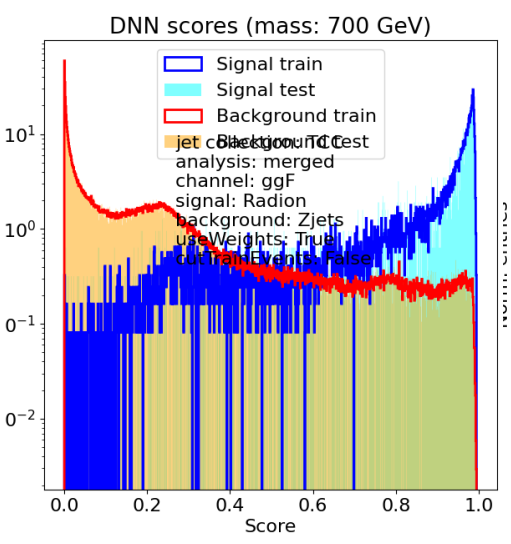

DNN model loss (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
Test loss: 0.08
Training
Validation
Epoch

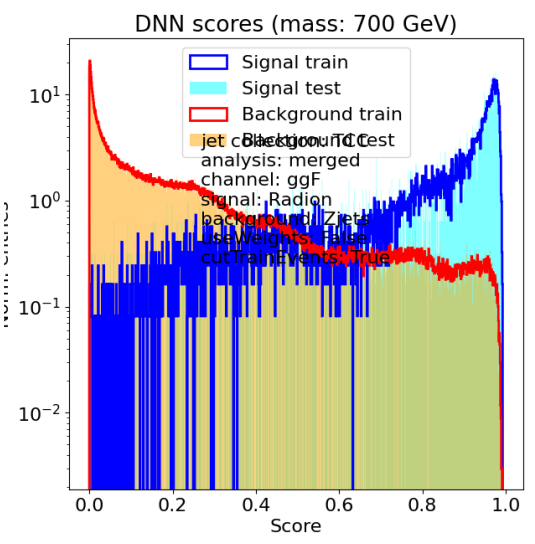

DNN model loss (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
Test loss: 0.34
Training
Validation
Loss
Epoch

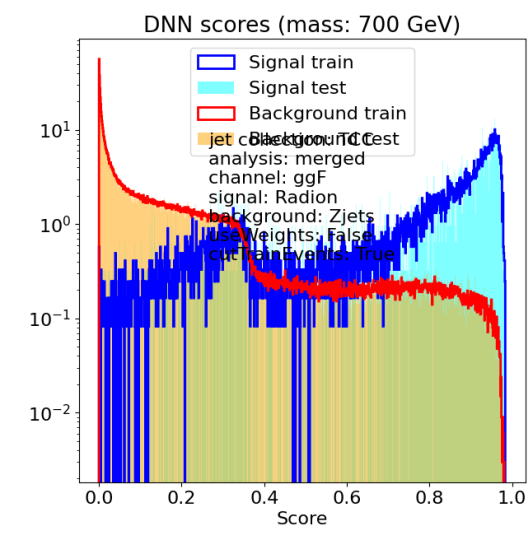

DNN model loss (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test loss: 0.34
Training
Validation
Epoch

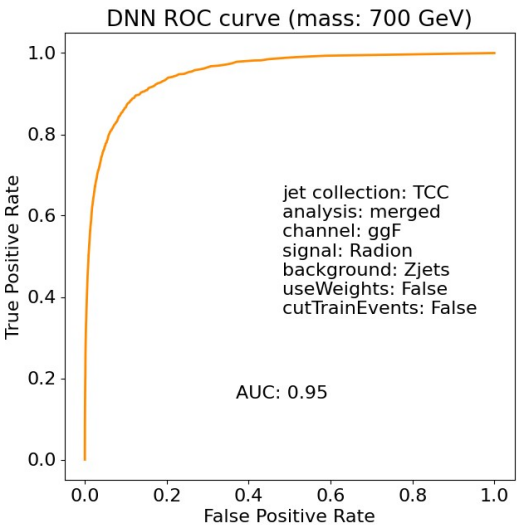

DNN model loss (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test loss: 0.25
Training
Validation
Epoch

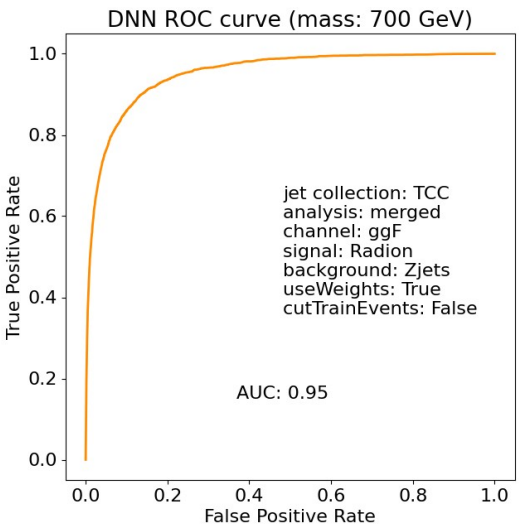

DNN scores (mass: 700 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
Score

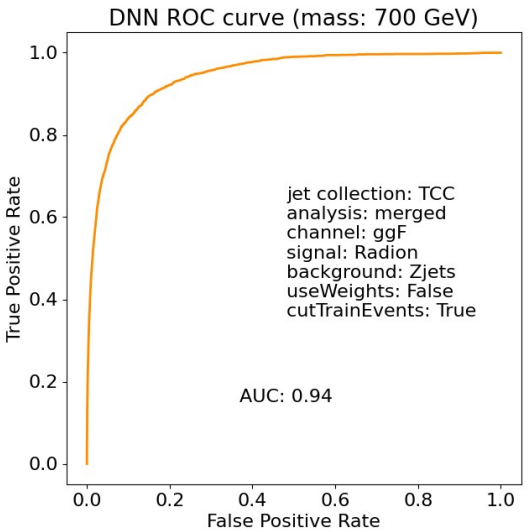

DNN scores (mass: 700 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
Score

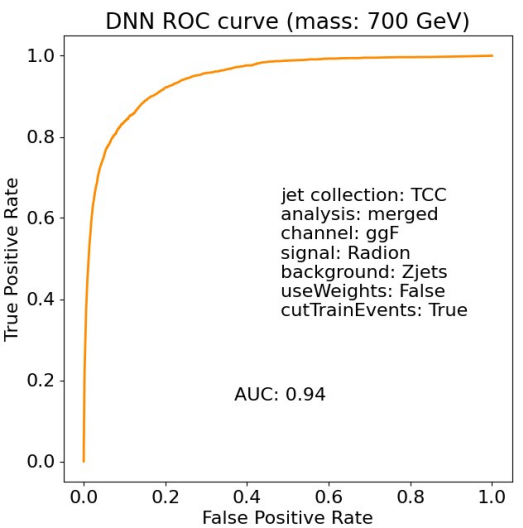

DNN scores (mass: 700 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Score

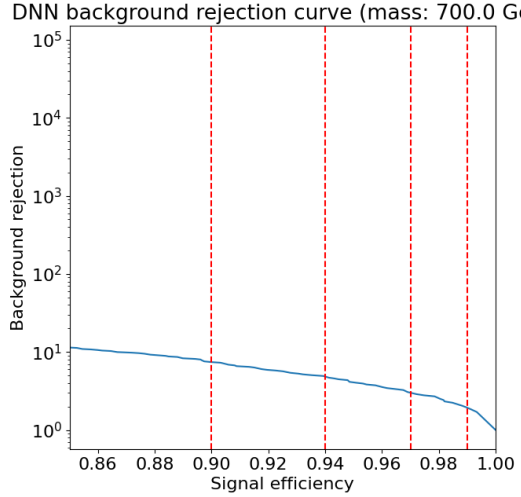

DNN scores (mass: 700 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Score

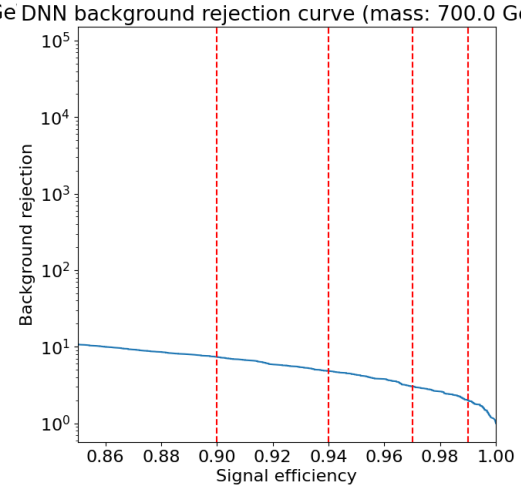

DNN ROC curve (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
AUC: 0.95
True Positive Rate
False Positive Rate

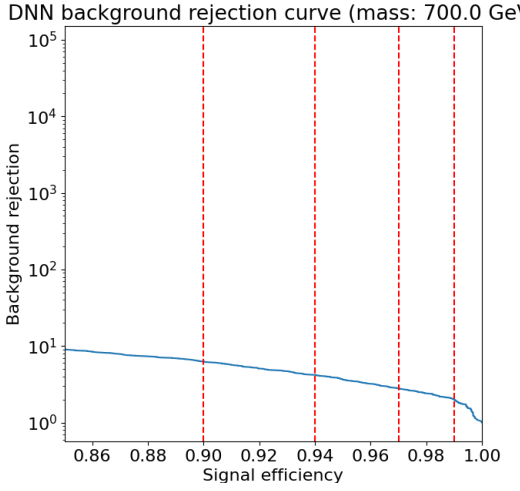

DNN ROC curve (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
AUC: 0.95
True Positive Rate
False Positive Rate

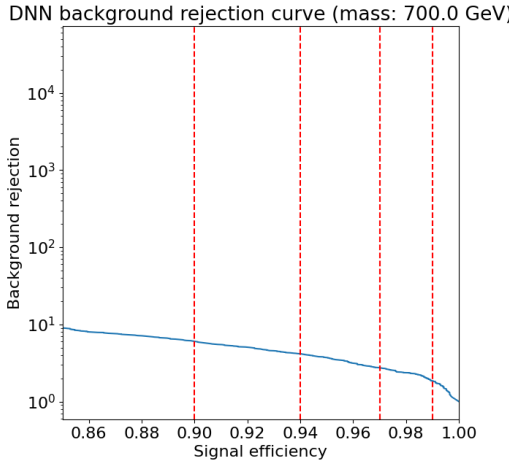

DNN ROC curve (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
AUC: 0.94
True Positive Rate
False Positive Rate

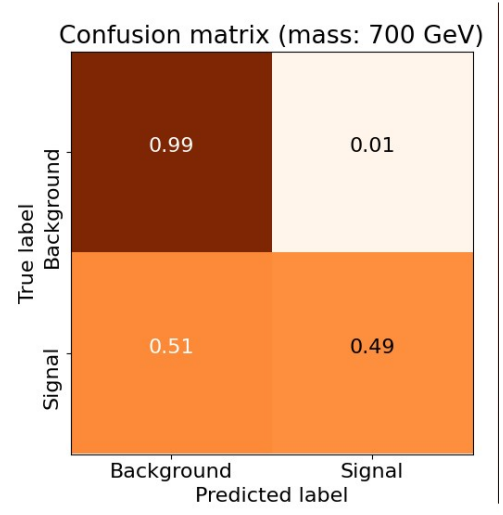

DNN ROC curve (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
AUC: 0.94
True Positive Rate
False Positive Rate

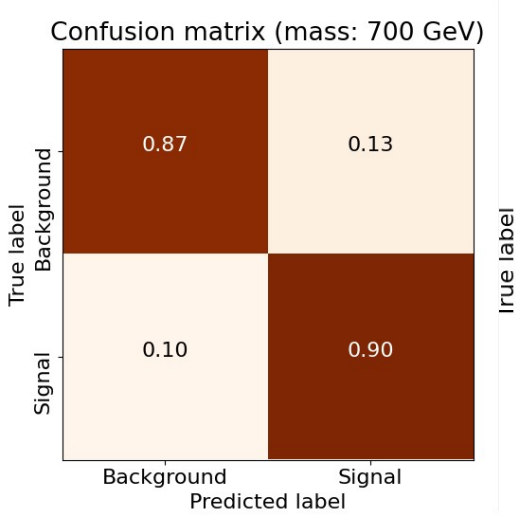

DNN background rejection curve (mass: 700.0 Ge
Background rejection
Signal efficiency

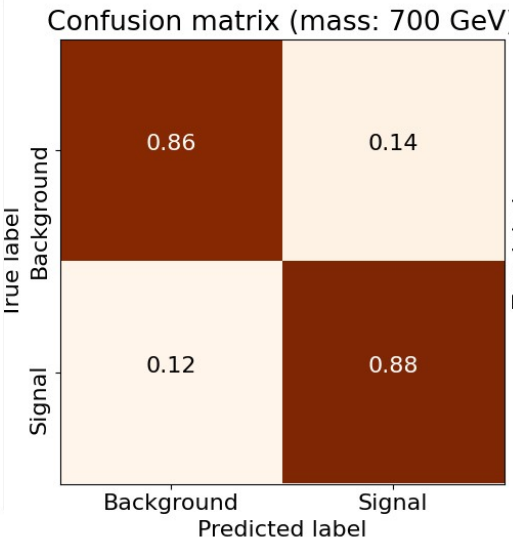

DNN background rejection curve (mass: 700.0 GeV)
Background rejection
Signal efficiency

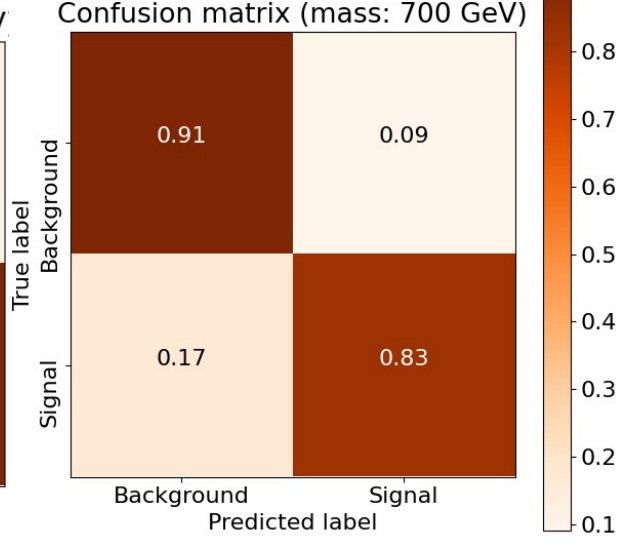

DNN background rejection curve (mass: 700.0 GeV)
Background rejection
Signal efficiency


DNN background rejection curve (mass: 700.0 GeV)
Background rejection
Signal efficiency


Confusion matrix (mass: 700 GeV)
0.99
0.01
0.51
0.49
True label
Background
Signal
Background
Signal
Predicted label

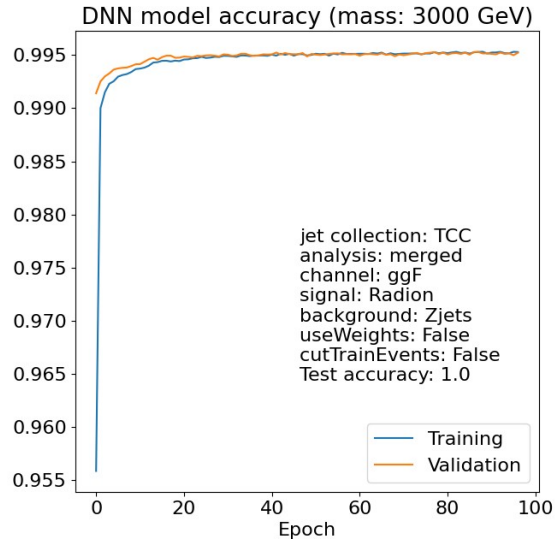

Confusion matrix (mass: 700 GeV)
0.87
0.13
0.10
0.90
True label
Background
Signal
Background
Signal
Predicted label

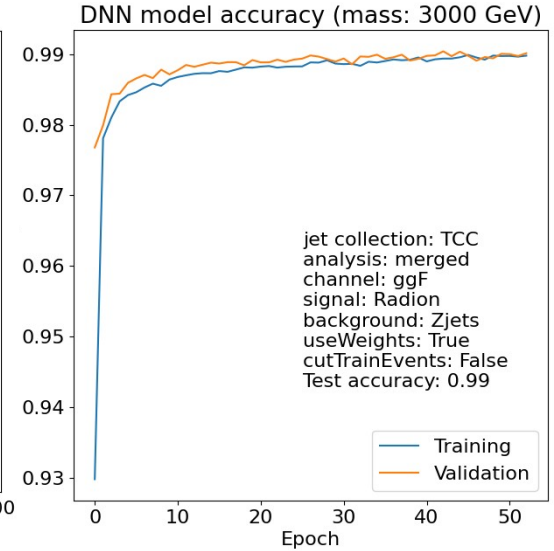

Confusion matrix (mass: 700 GeV)
0.86
0.14
0.12
0.88
True label
Background
Signal
Background
Signal
Predicted label

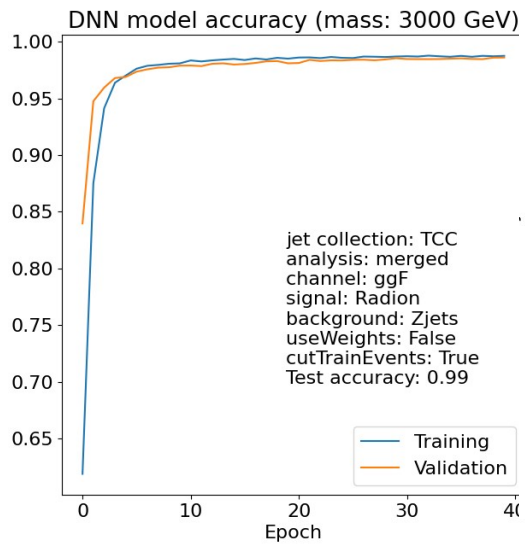

Confusion matrix (mass: 700 GeV)
0.91
0.09
0.17
0.83
True label
Background
Signal
Background
Signal
Predicted label

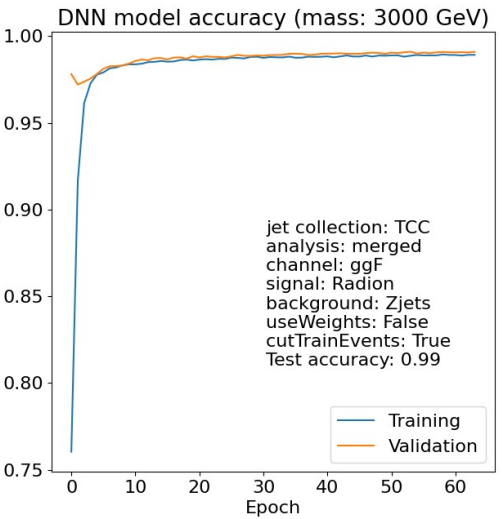
Massa 3000 GeV, Zjets

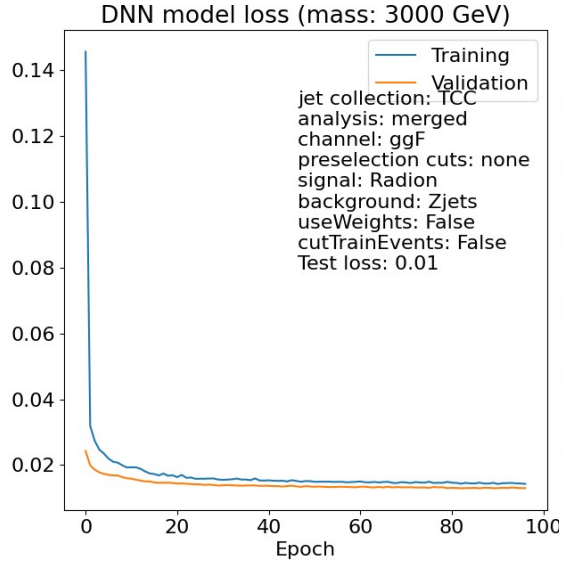
	Intero campione	Intero campione + pesi	sig=bkg	2sig=bkg
Segnale train	13581 (5% bkg)	13581	13581	13581
Bkg train	273615	273615	13581	27162
Segnale test	4143	4143	4143	4143
Bkg test	86032	86032	86032	86032
Loss su train	0.0142	0.0036	0.0433	0.0366
Accuracy su train	0.9954	0.9898	0.9873	0.9896
Loss su validazione	0.013	0.0319	0.0435	0.0285
Accuracy su validazione	0.995	0.9901	0.9860	0.9909
Loss su test	0.0124	0.0303	0.0412	0.0272
Accuracy su test	0.996	0.9907	0.9869	0.9913
Area ROC	0.998	0.999	0.999	0.999
Reiezione bkg @ 0.90 WP	1024.2	666.9	402	521.4
Reiezione bkg @ 0.99 WP	101.8	97.4	86	95.7

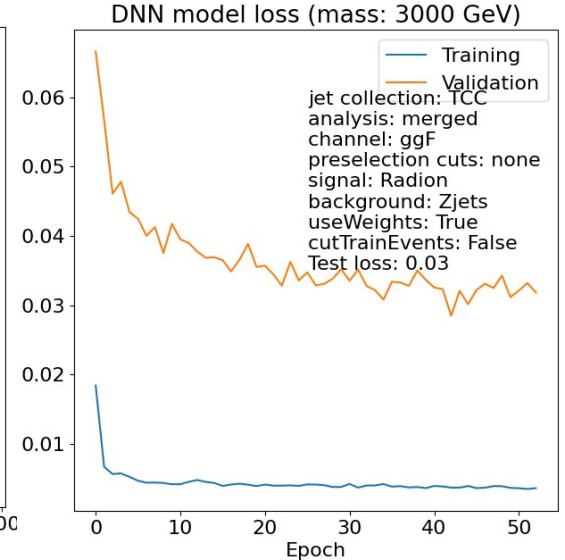

DNN model accuracy (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
Test accuracy: 1.0
Training
Validation
Epoch

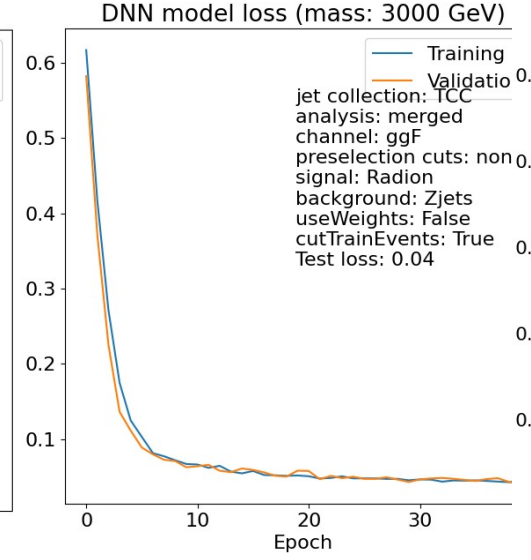

DNN model accuracy (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
Test accuracy: 0.99
Training
Validation
Epoch

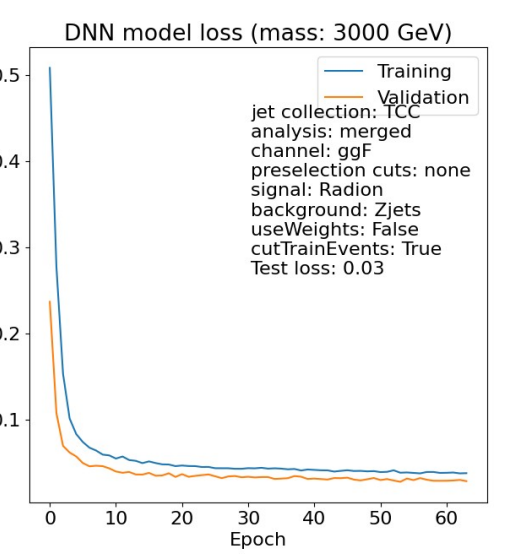

DNN model accuracy (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test accuracy: 0.99
Training
Validation
Epoch

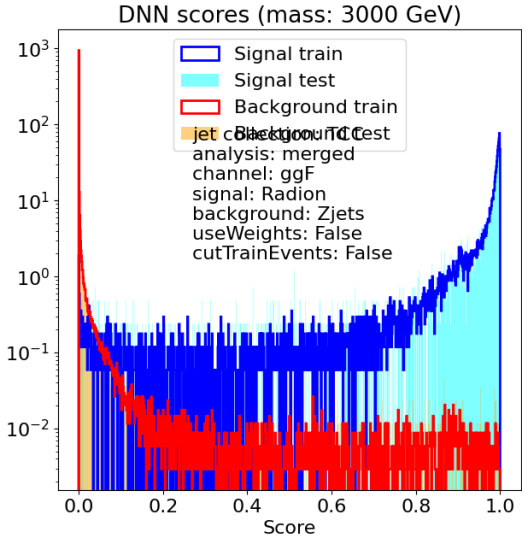

DNN model accuracy (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test accuracy: 0.99
Training
Validation
Epoch

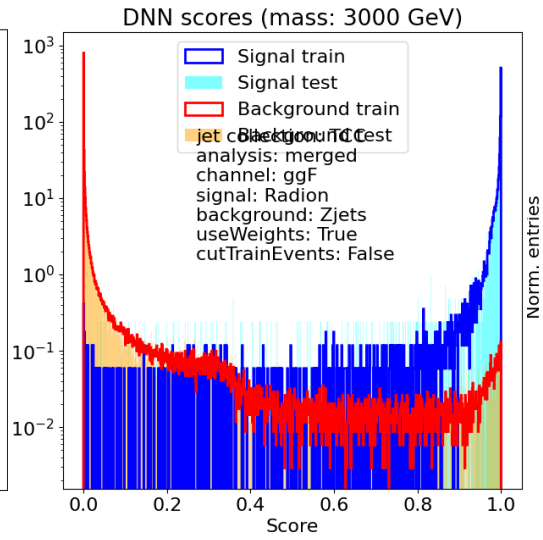

DNN model loss (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
Test loss: 0.01
Training
Validation
Epoch

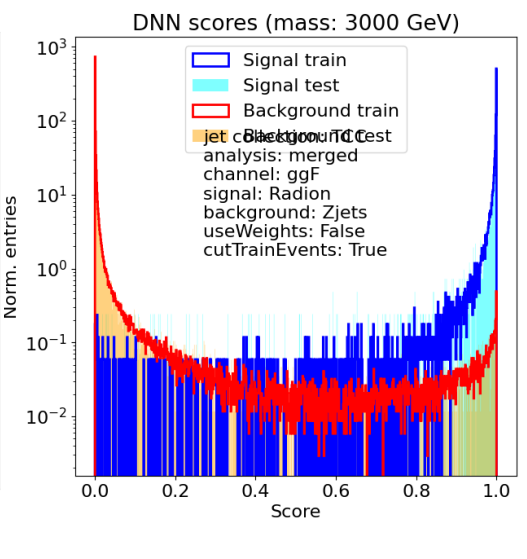

DNN model loss (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
Test loss: 0.03
Training
Validation
Epoch

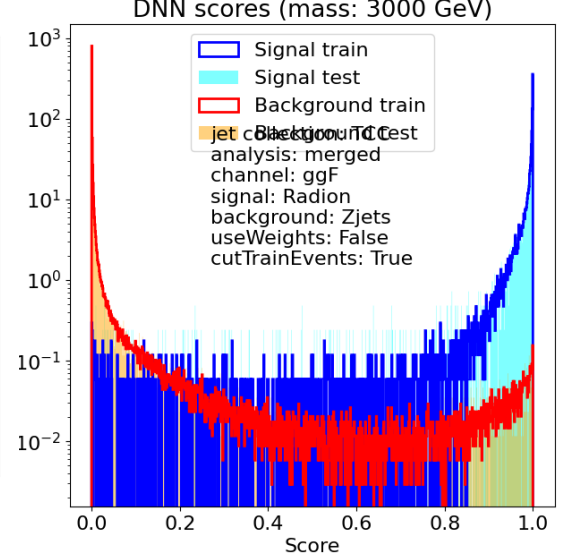

DNN model loss (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: non
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test loss: 0.04
Training
Validatio
Epoch

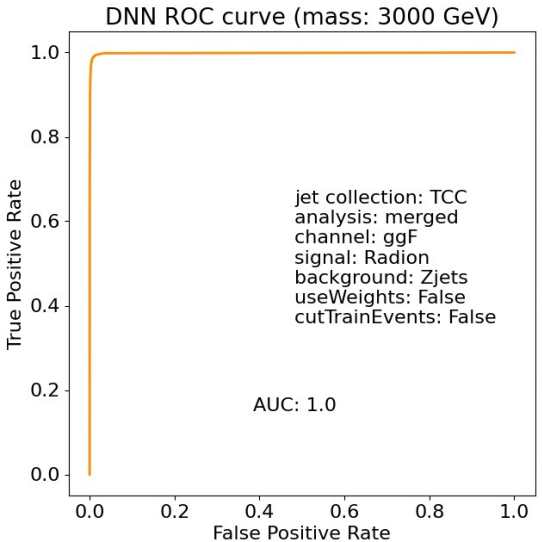

DNN model loss (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test loss: 0.03
Training
Validation
Epoch

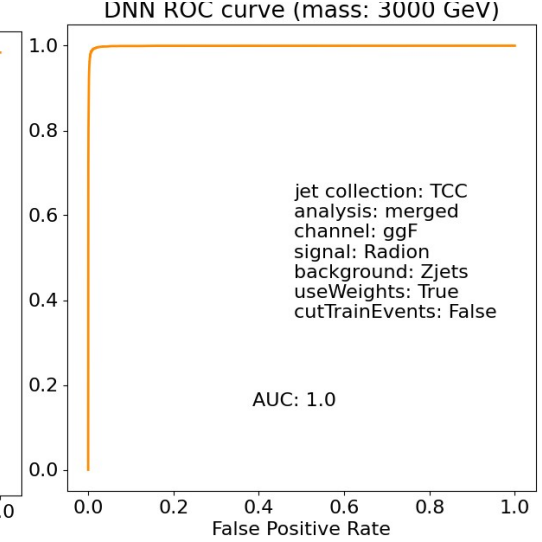

DNN scores (mass: 3000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
Score

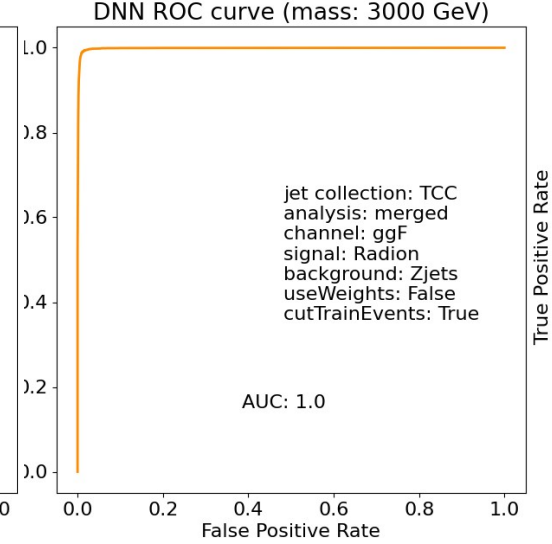

DNN scores (mass: 3000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
Score

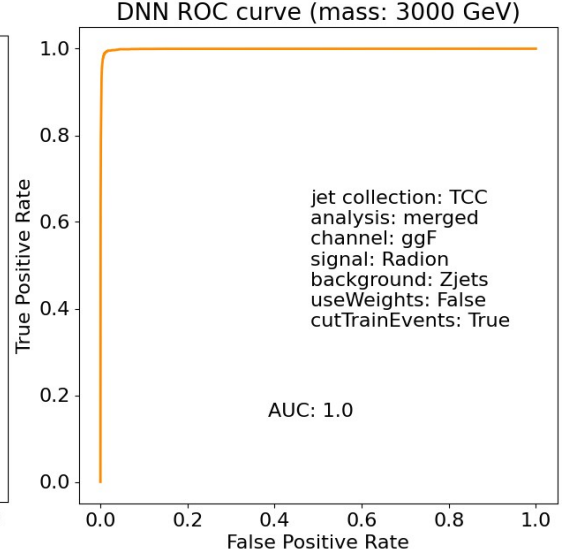

DNN scores (mass: 3000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Norm. entries
Score

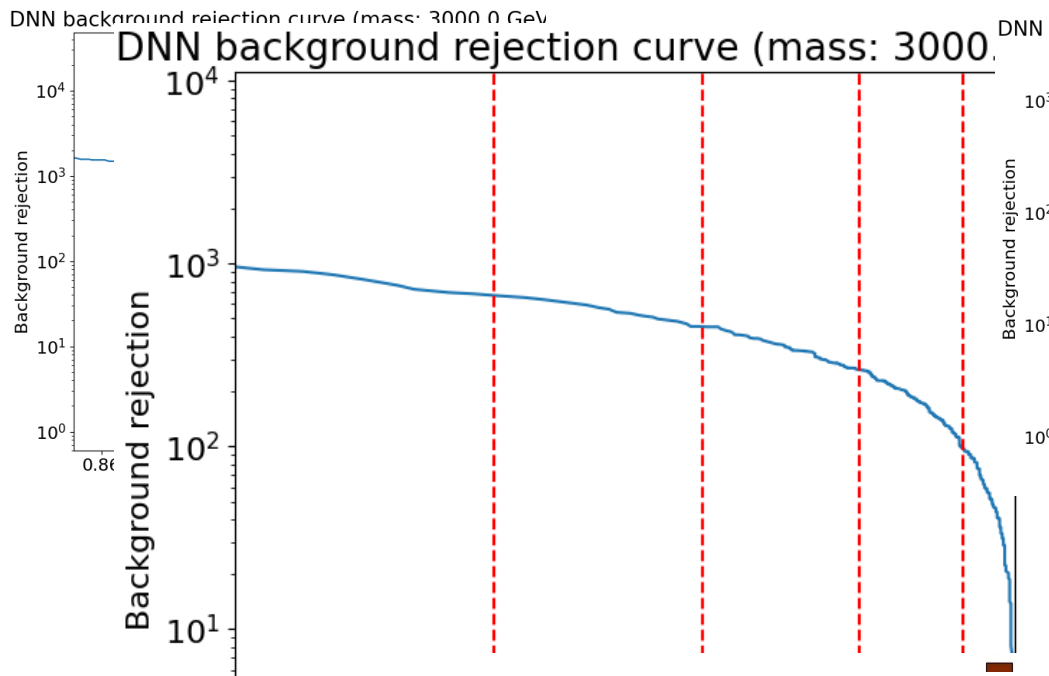

DNN scores (mass: 3000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Score

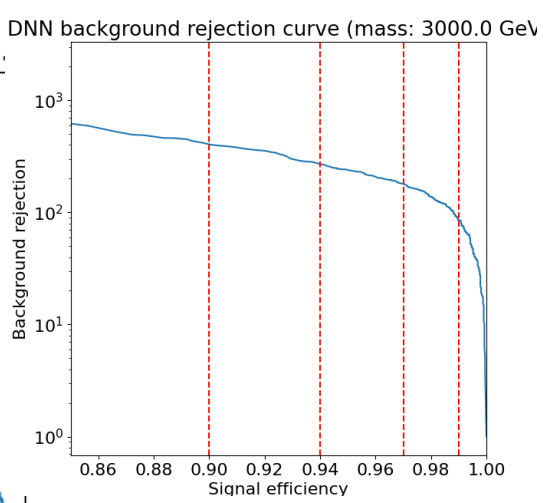

DNN ROC curve (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
AUC: 1.0
True Positive Rate
False Positive Rate

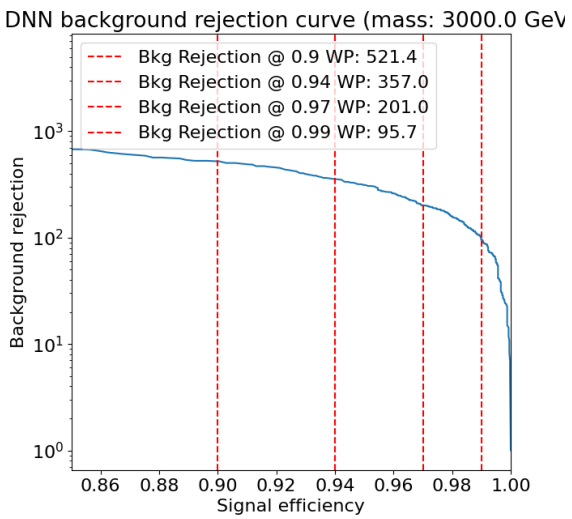

DNN ROC curve (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
AUC: 1.0
False Positive Rate

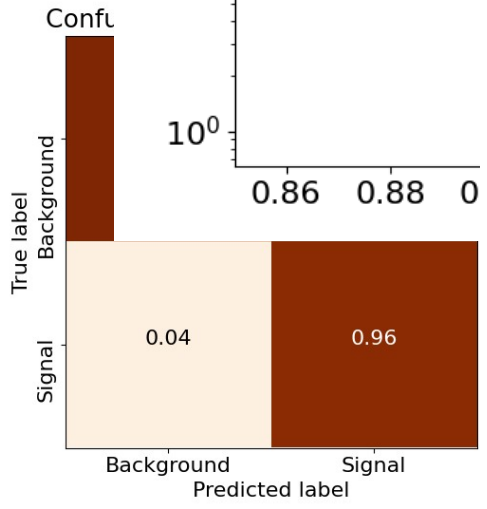

DNN ROC curve (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
AUC: 1.0
False Positive Rate

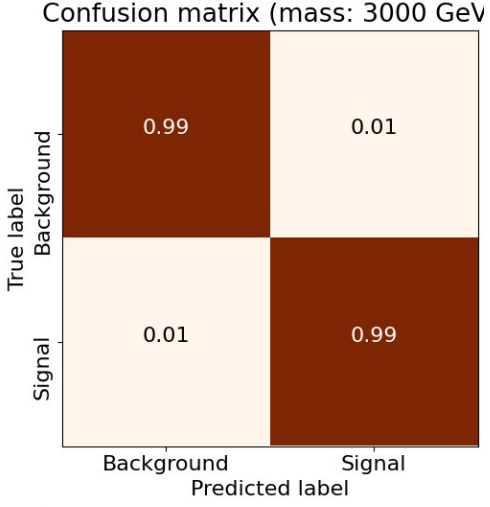

DNN ROC curve (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
AUC: 1.0
True Positive Rate
False Positive Rate

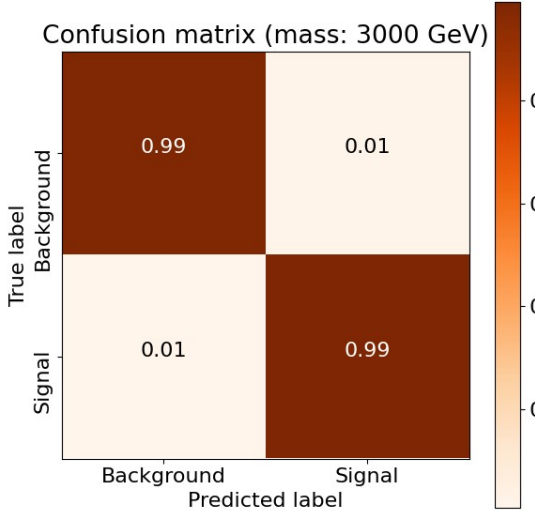

DNN background rejection curve (mass: 3000
Background rejection
0.86
0.88

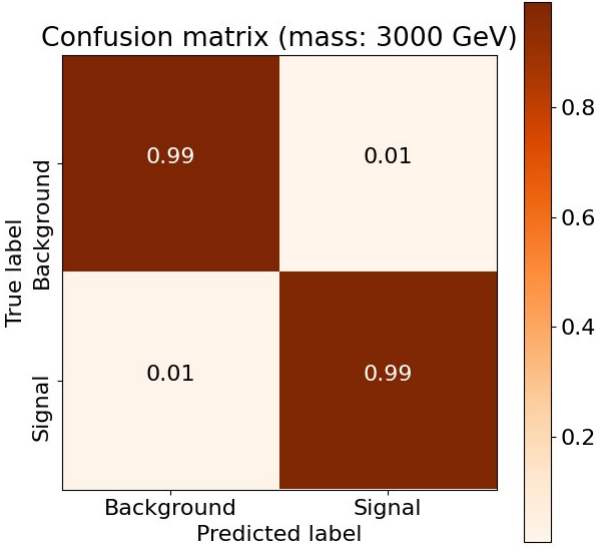

DNN background rejection curve (mass: 3000.0 GeV
Background rejection
Signal efficiency


DNN background rejection curve (mass: 3000.0 GeV
Bkg Rejection @ 0.9 WP: 521.4
Bkg Rejection @ 0.94 WP: 357.0
Bkg Rejection @ 0.97 WP: 201.0
Bkg Rejection @ 0.99 WP: 95.7
Background rejection
Signal efficiency


Confu
True label
Background
Signal
0.04
0.96
Background
Signal
Predicted label

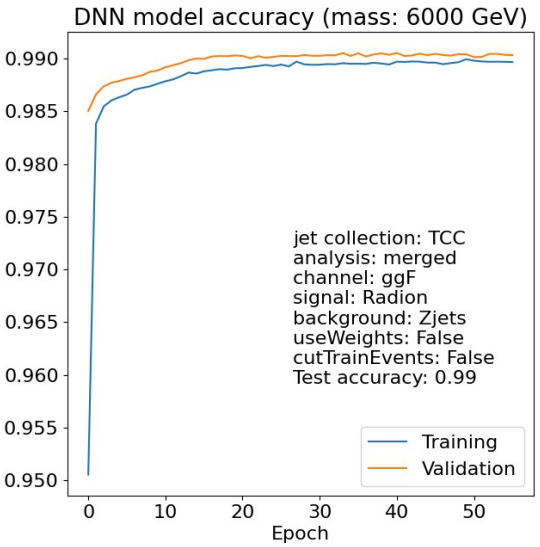

Confusion matrix (mass: 3000 GeV
True label
Background
Signal
0.99
0.01
0.01
0.99
Background
Signal
Predicted label

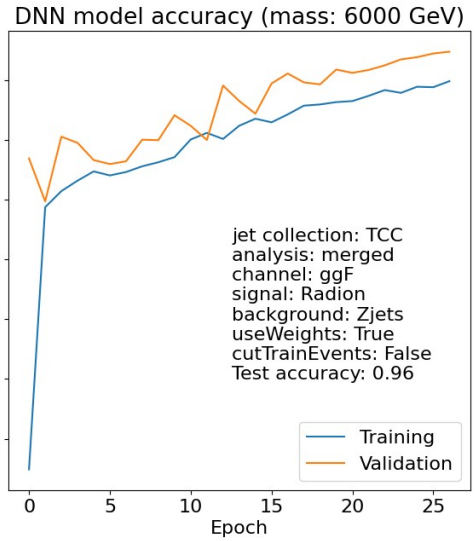

Confusion matrix (mass: 3000 GeV)
True label
Background
Signal
0.99
0.01
0.01
0.99
Background
Signal
Predicted label

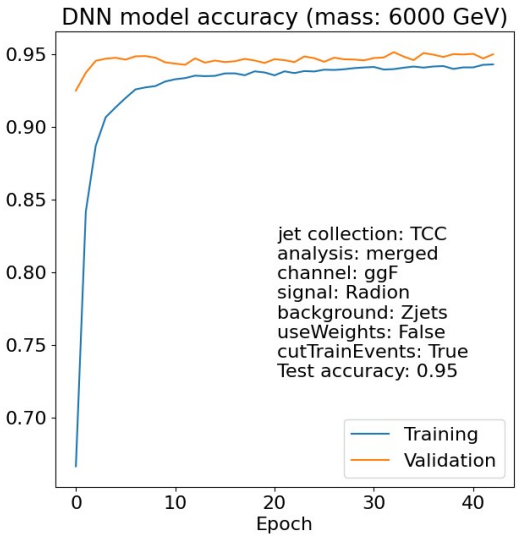

Confusion matrix (mass: 3000 GeV)
True label
Background
Signal
0.99
0.01
0.01
0.99
Background
Signal
Predicted label
0.8
0.6
0.4
0.2

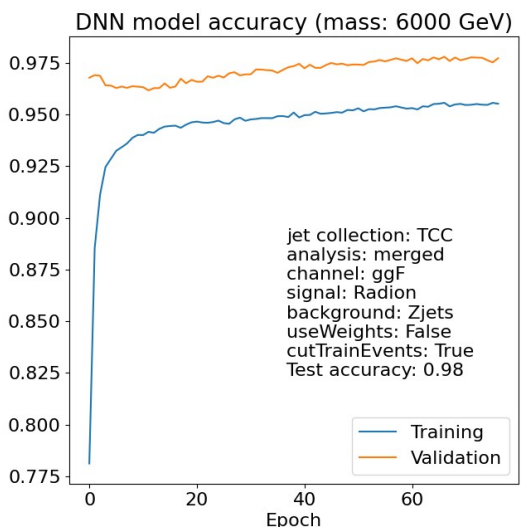
Massa 6000 GeV, Zjets

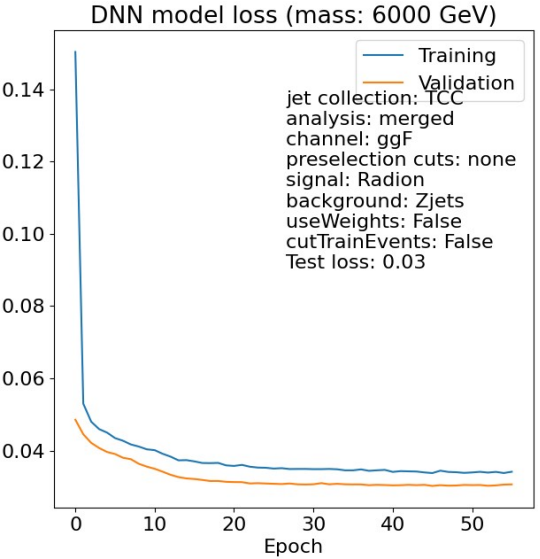
	Intero campione	Intero campione+pesi	sig=bkg	2Sig=bkg
Segnale train	10473 (3.8% bkg)	10437	10437	10437
Bkg train	273614	273614	10437	20874
Segnale test	3169	3169	3169	3169
Bkg test	86032	86032	86032	86032
Loss su train	0.0339	0.0098	0.1567	0.1216
Accuracy su train	0.9898	0.9603	0.9420	0.9564
Loss su validazione	0.0307	0.1097	0.1353	0.0728
Accuracy su validazione	0.9901	0.9647	0.9499	0.9773
Loss su test	0.0311	0.1109	0.137	0.0748
Accuracy su test	0.9903	0.9633	0.949	0.9763
Area ROC	0.987	0.99	0.986	0.99
Reiezione bkg @ 0.90 WP	73.1	65.9	41.4	66
Reiezione bkg @ 0.99 WP	5.4	4.5	3.9	4.5

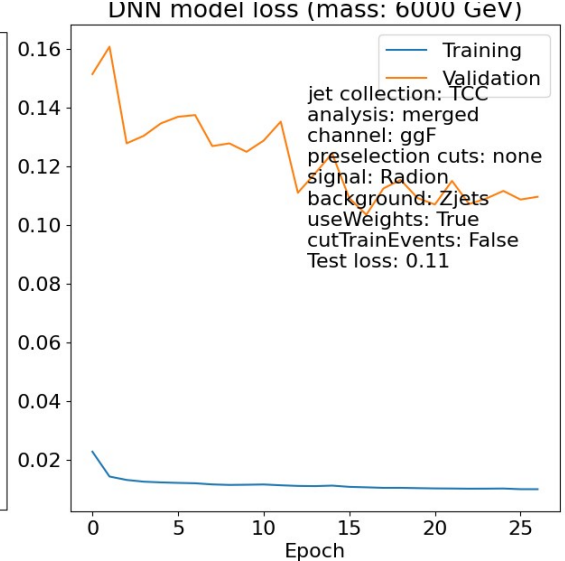

DNN model accuracy (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
Test accuracy: 0.99
Training
Validation
Epoch

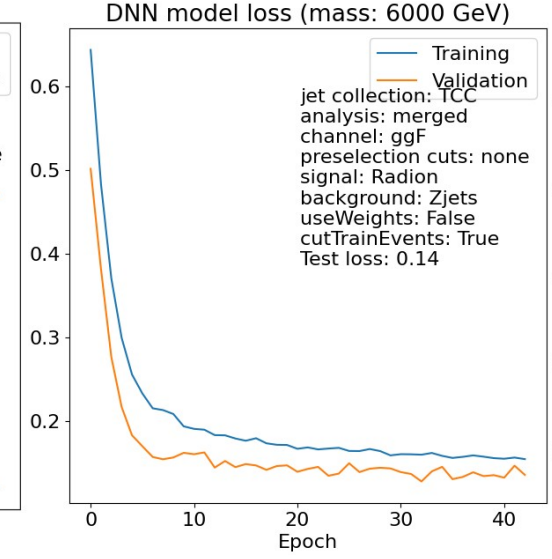

DNN model accuracy (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
Test accuracy: 0.96
Training
Validation
Epoch

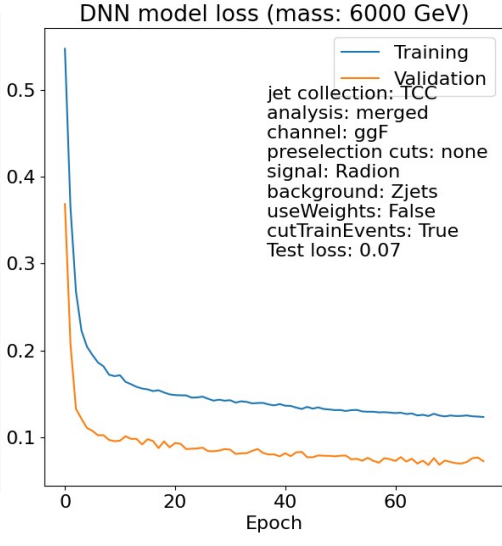

DNN model accuracy (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test accuracy: 0.95
Training
Validation
Epoch

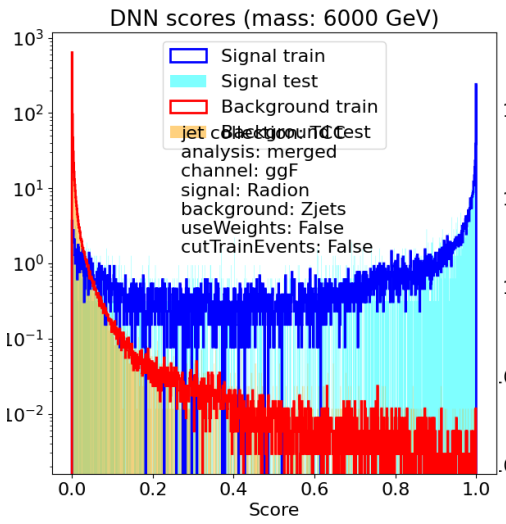

DNN model accuracy (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test accuracy: 0.98
Training
Validation
Epoch

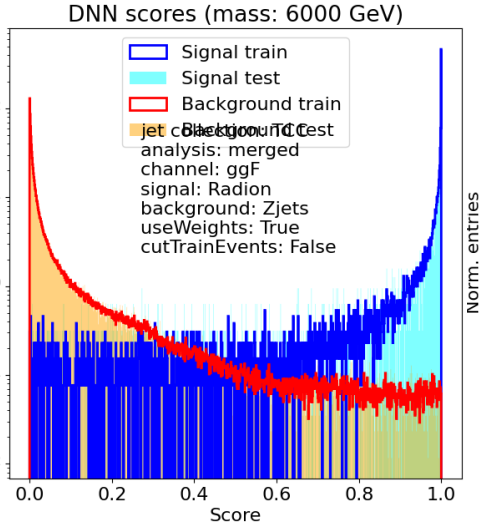

DNN model loss (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
Test loss: 0.03
Training
Validation
Epoch

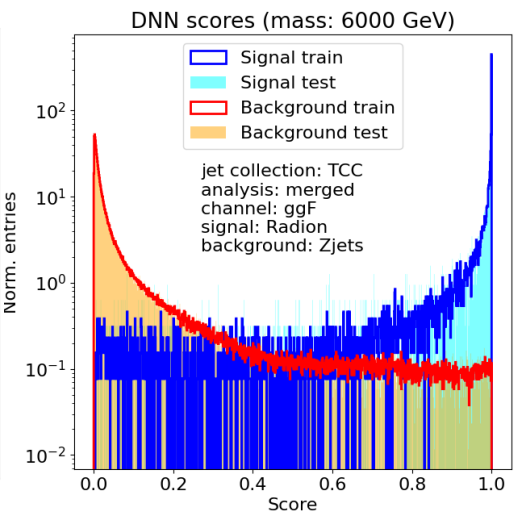

DNN model loss (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
Test loss: 0.11
Training
Validation
Epoch

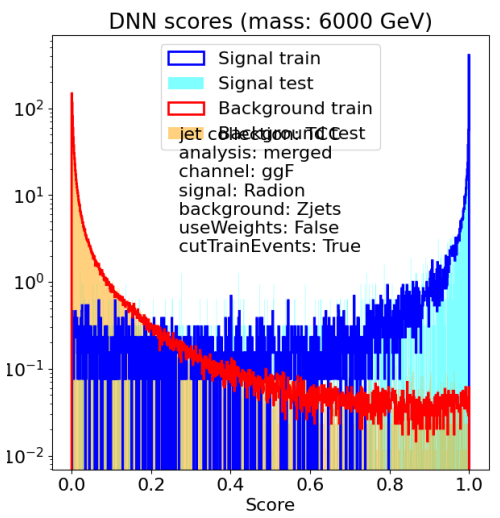

DNN model loss (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test loss: 0.14
Training
Validation
Epoch

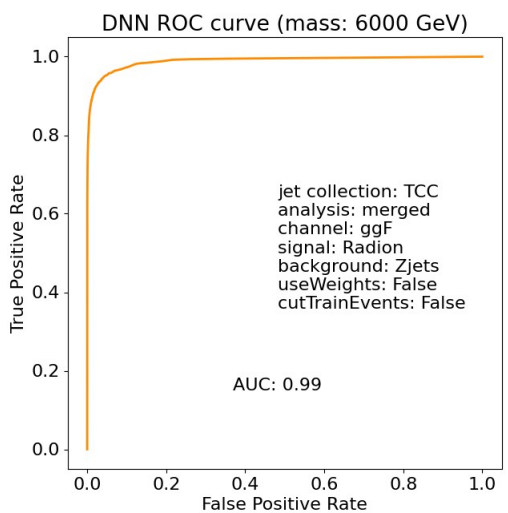

DNN model loss (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Test loss: 0.07
Training
Validation
Epoch

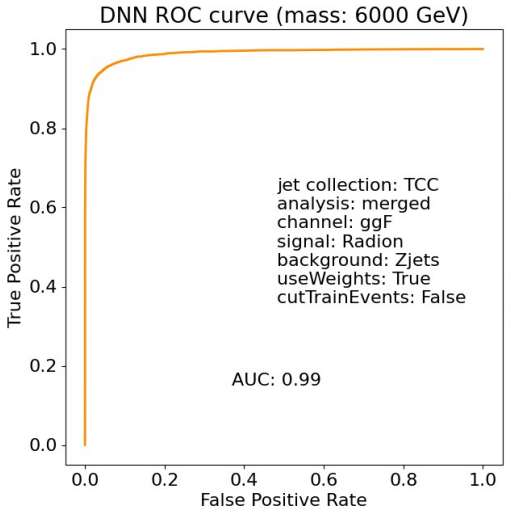

DNN scores (mass: 6000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
Score

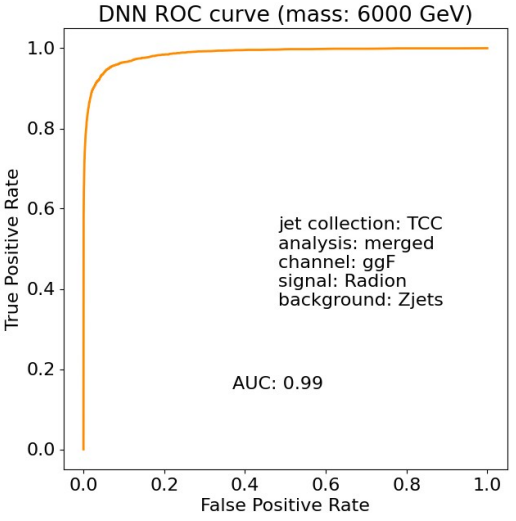

DNN scores (mass: 6000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
Score

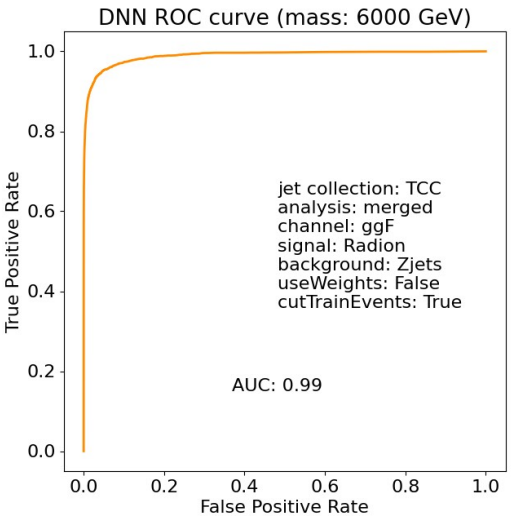

DNN scores (mass: 6000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
Norm. entries
Score

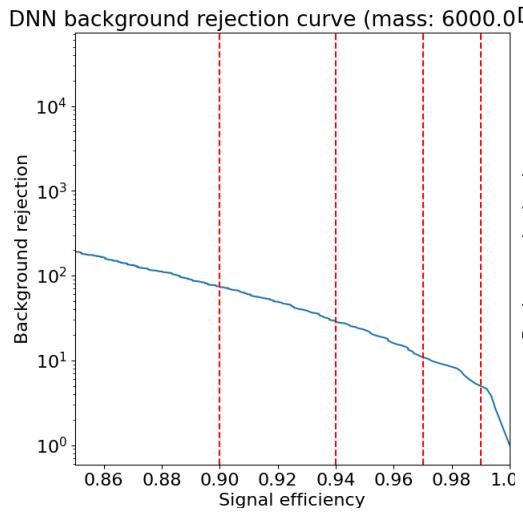

DNN scores (mass: 6000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
Score

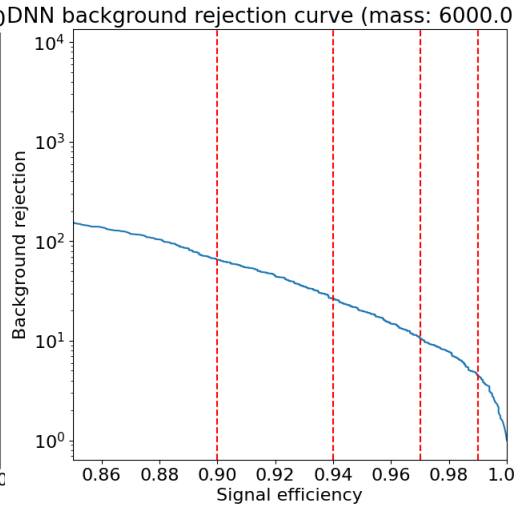

DNN ROC curve (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: False
AUC: 0.99
True Positive Rate
False Positive Rate

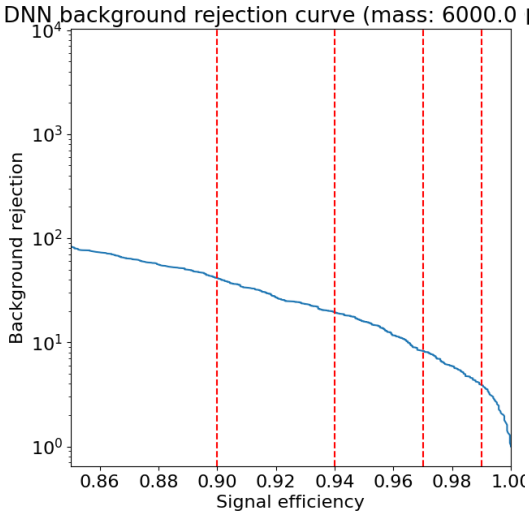

DNN ROC curve (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: True
cutTrainEvents: False
AUC: 0.99
True Positive Rate
False Positive Rate

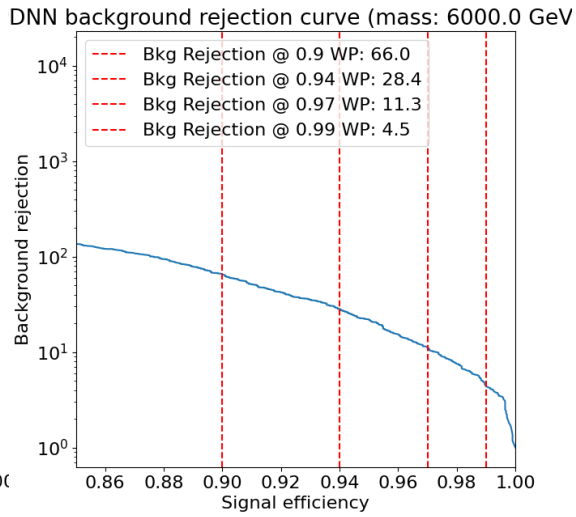

DNN ROC curve (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
AUC: 0.99
True Positive Rate
False Positive Rate

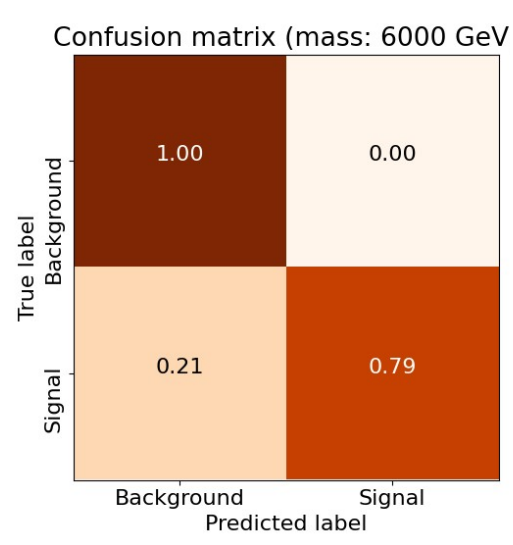

DNN ROC curve (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
cutTrainEvents: True
AUC: 0.99
True Positive Rate
False Positive Rate

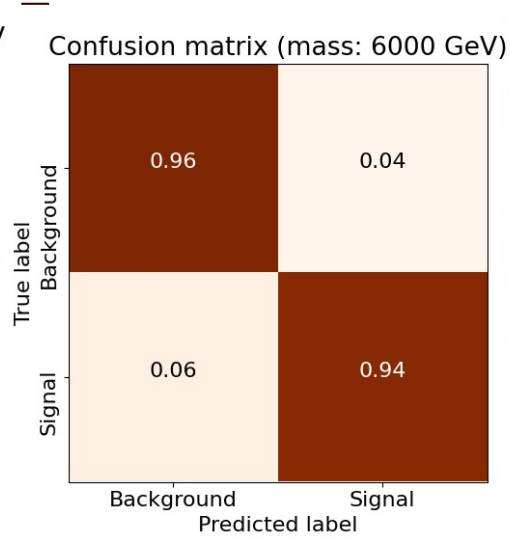

DNN background rejection curve (mass: 6000.0
Background rejection
Signal efficiency

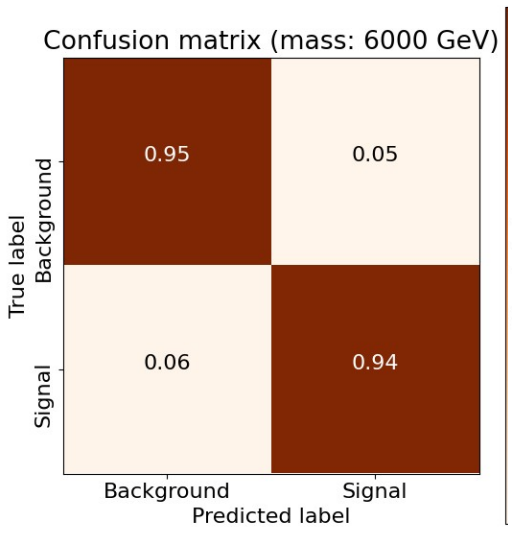

DNN background rejection curve (mass: 6000.0
Background rejection
Signal efficiency

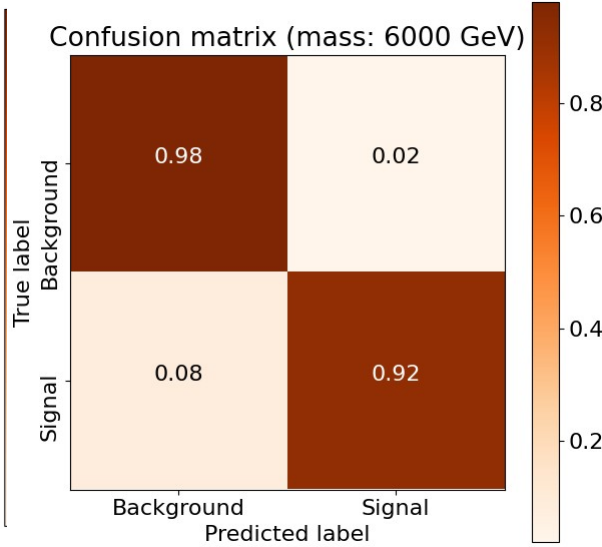

DNN background rejection curve (mass: 6000.0
Background rejection
Signal efficiency


DNN background rejection curve (mass: 6000.0 GeV
Bkg Rejection @ 0.9 WP: 66.0
Bkg Rejection @ 0.94 WP: 28.4
Bkg Rejection @ 0.97 WP: 11.3
Bkg Rejection @ 0.99 WP: 4.5
Background rejection
Signal efficiency


Confusion matrix (mass: 6000 GeV
1.00
0.00
0.21
0.79
True label
Background
Signal
Predicted label

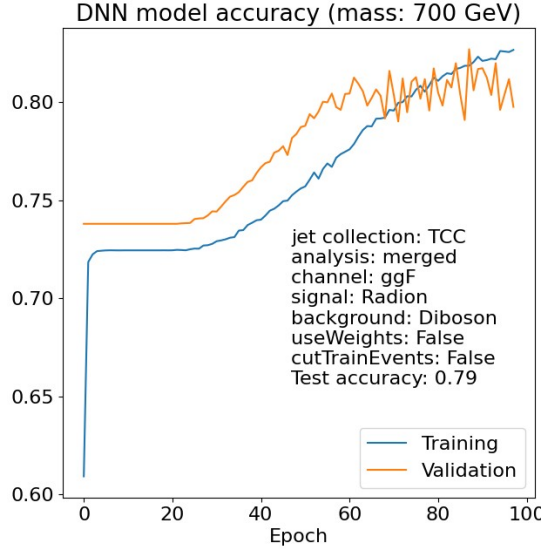

Confusion matrix (mass: 6000 GeV)
0.96
0.04
0.06
0.94
True label
Background
Signal
Predicted label

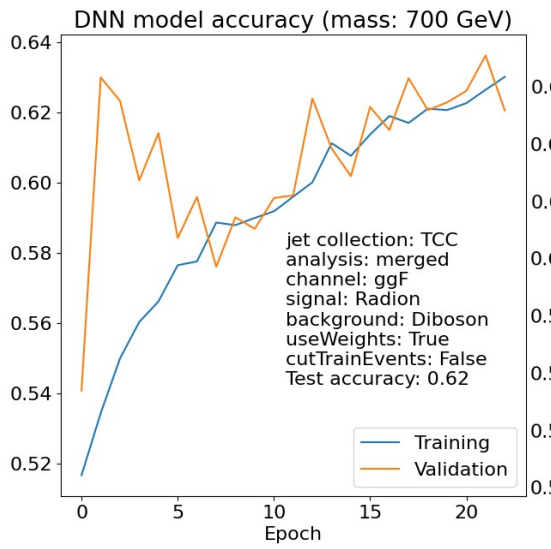

Confusion matrix (mass: 6000 GeV)
0.95
0.05
0.06
0.94
True label
Background
Signal
Predicted label

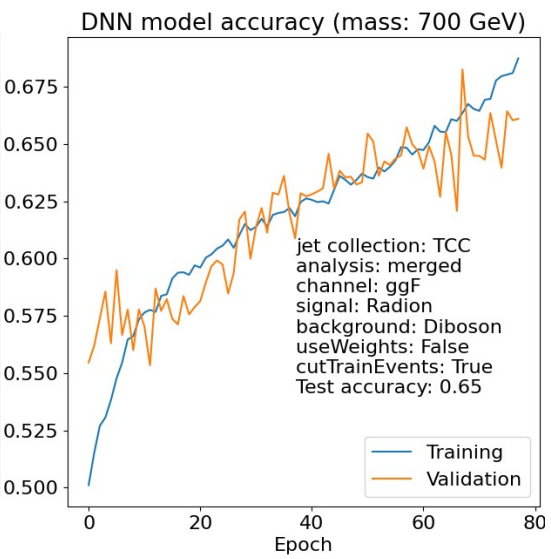

Confusion matrix (mass: 6000 GeV)
0.98
0.02
0.08
0.92
True label
Background
Signal
Predicted label

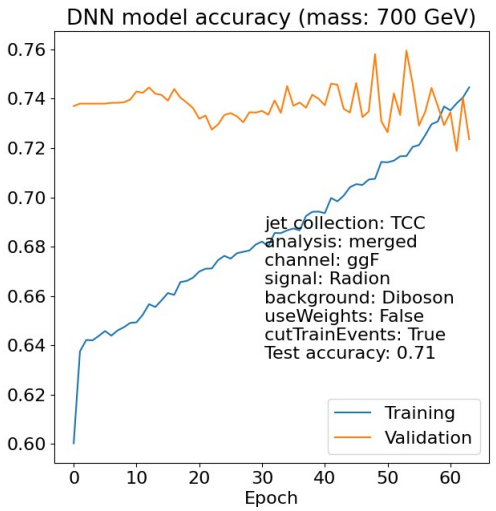
Massa 700 GeV, Diboson

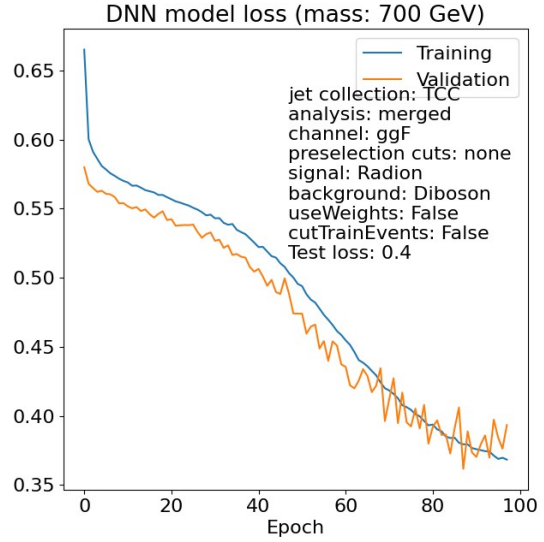
	Intero campione	Intero campione+pesi	sig=bkg	2sig=bkg
Segnale train	10062 (38% bkg)	10062	10062	10062
Bkg train	26455	26455	10062	18258
Segnale test	3078	3078	3078	3078
Bkg test	8180	8180	8180	8108
Loss su train	0.3677	0.3557	0.5870	0.5064
Accuracy su train	0.8286	0.6304	0.6862	0.7448
Loss su validazione	0.3934	0.6636	0.6236	0.5361
Accuracy su validazione	0.7976	0.6207	0.6611	0.7235
Loss su test	0.4024	0.6680	0.6289	0.5472
Accuracy su test	0.7894	0.6174	0.6530	0.7063
Area ROC	0.881	0.682	0.788	0.819
Reiezione bkg @ 0.90 WP	3.3	1.3	1.8	2.1
Reiezione bkg @ 0.99 WP	1.8	1.0	1.2	1.2

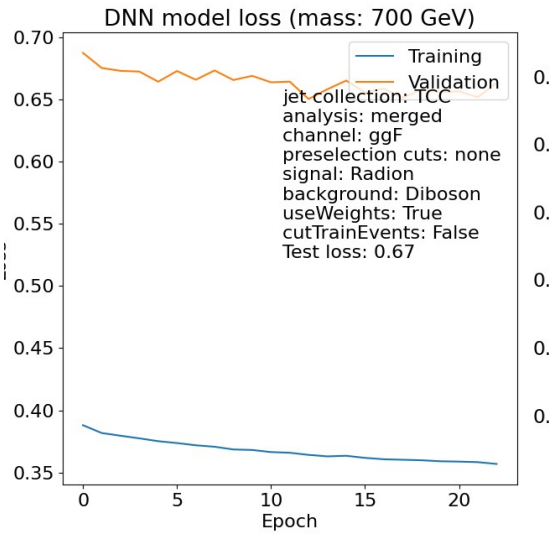

DNN model accuracy (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
Test accuracy: 0.79
Training
Validation
Epoch

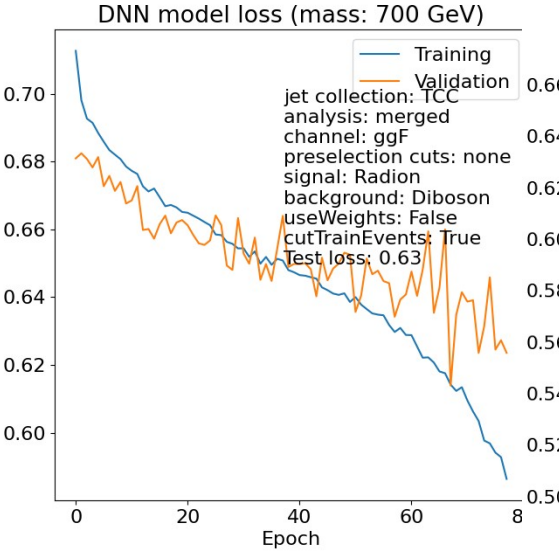

DNN model accuracy (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
Test accuracy: 0.62
Training
Validation
Epoch

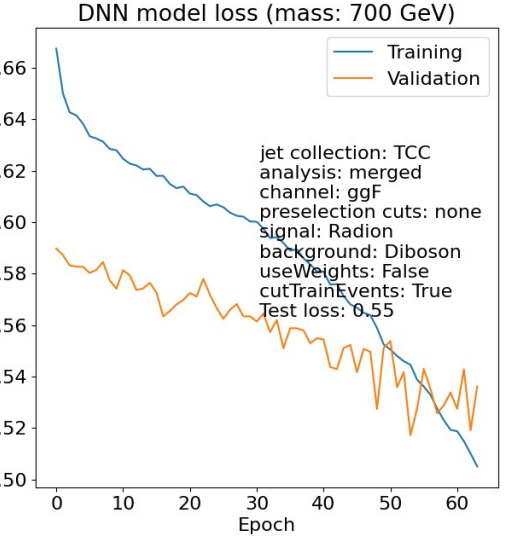

DNN model accuracy (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test accuracy: 0.65
Training
Validation
Epoch

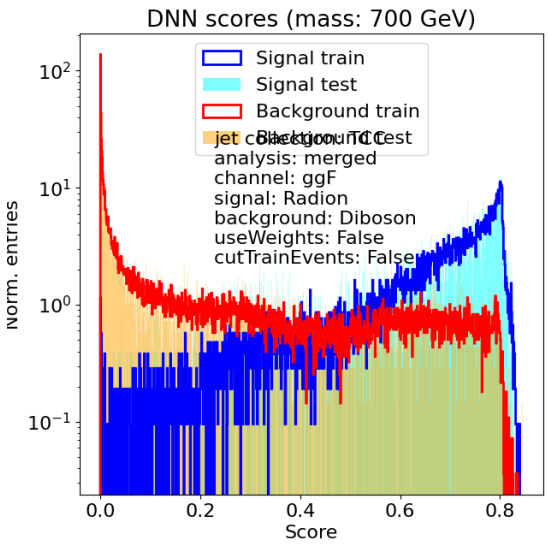

DNN model accuracy (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test accuracy: 0.71
Training
Validation
Epoch

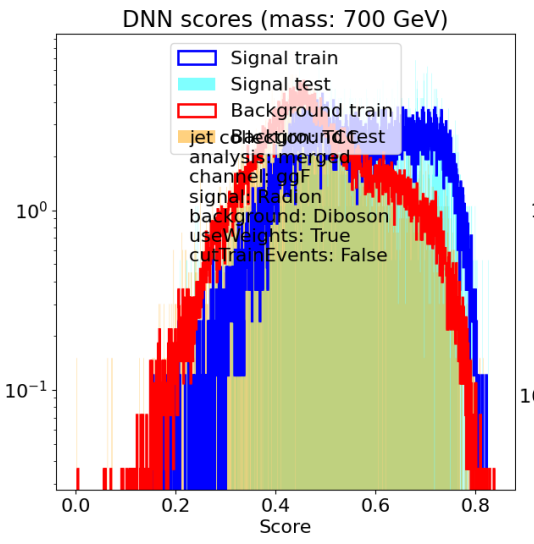

DNN model loss (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
Test loss: 0.4
Training
Validation
Epoch

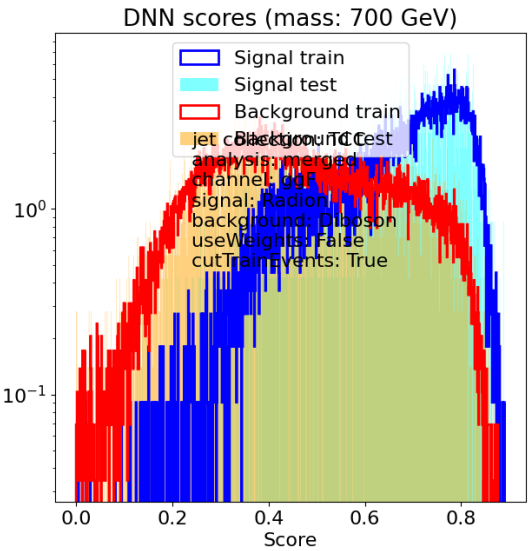

DNN model loss (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
Test loss: 0.67
Training
Validation
Epoch

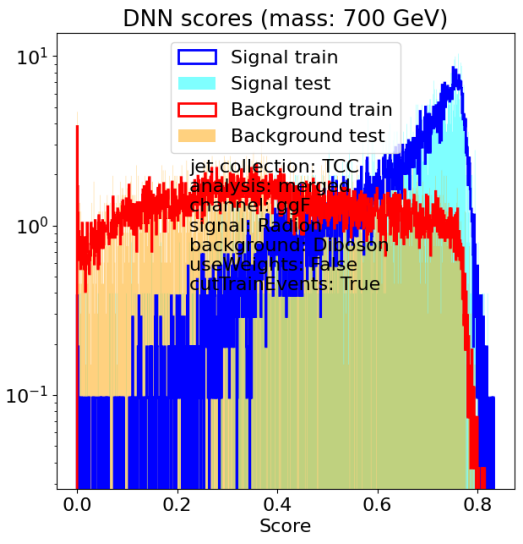

DNN model loss (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test loss: 0.63
Training
Validation
Epoch

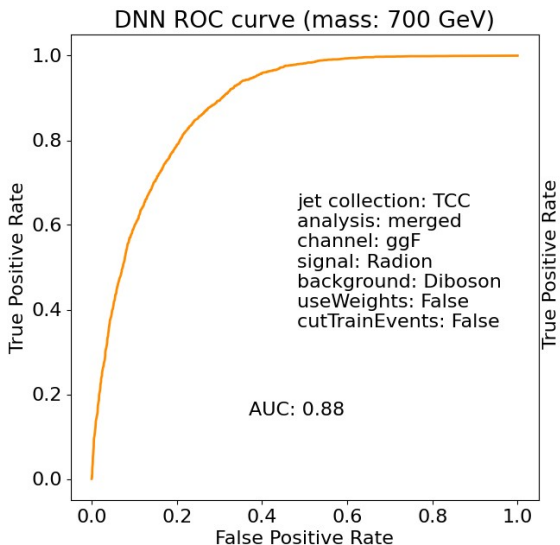

DNN model loss (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test loss: 0.55
Training
Validation
Epoch

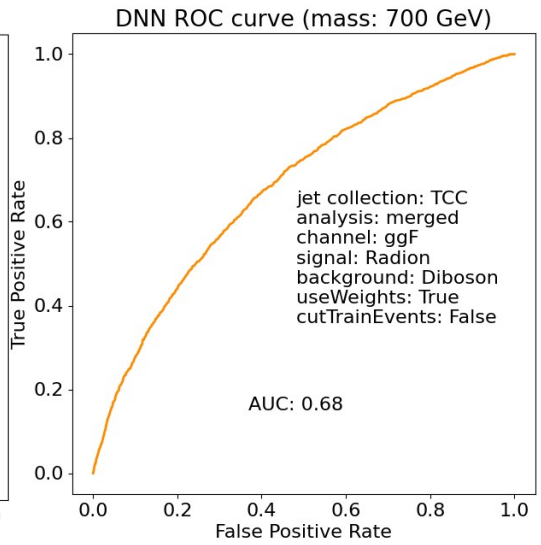

DNN scores (mass: 700 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
norm. entries
Score

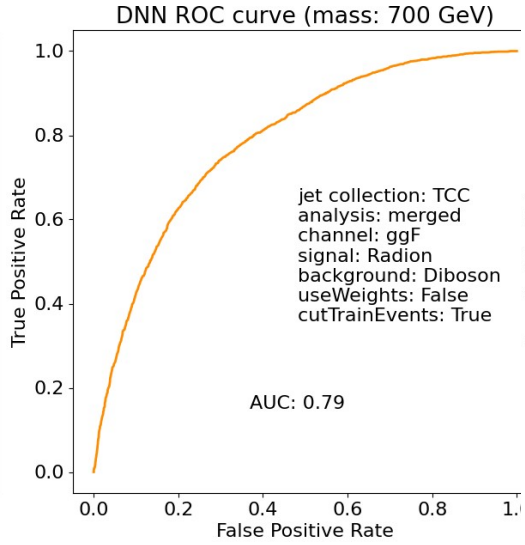

DNN scores (mass: 700 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
Score

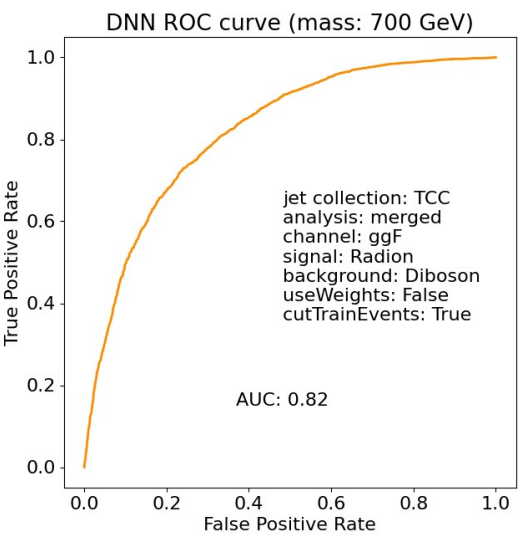

DNN scores (mass: 700 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Score

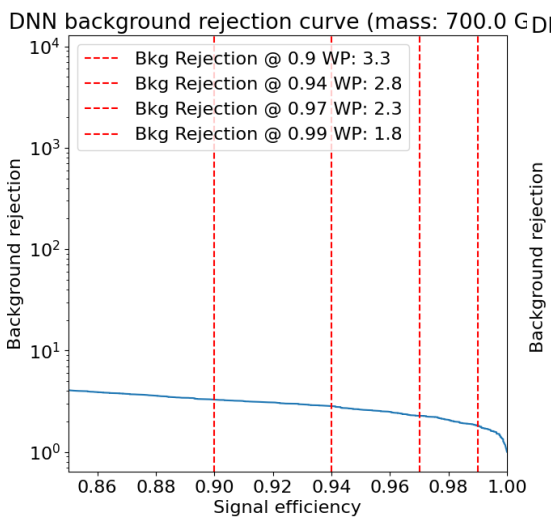

DNN scores (mass: 700 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Score

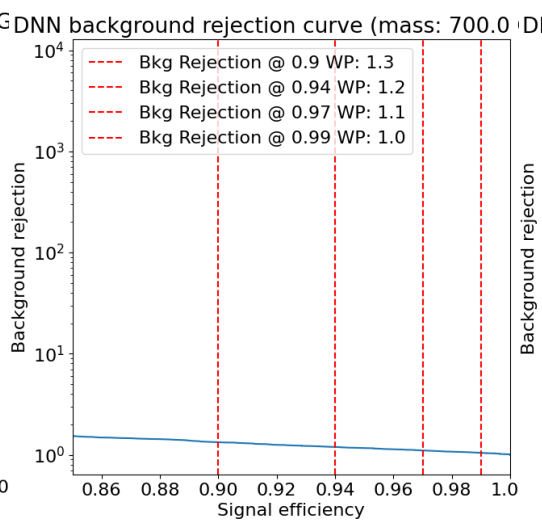

DNN ROC curve (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
AUC: 0.88
True Positive Rate
False Positive Rate

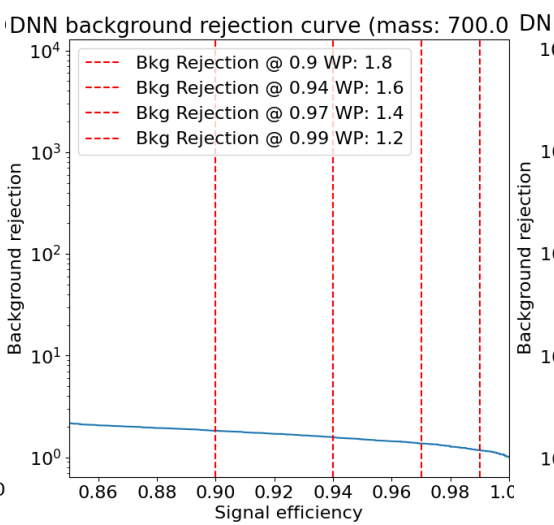

DNN ROC curve (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
AUC: 0.68
True Positive Rate
False Positive Rate

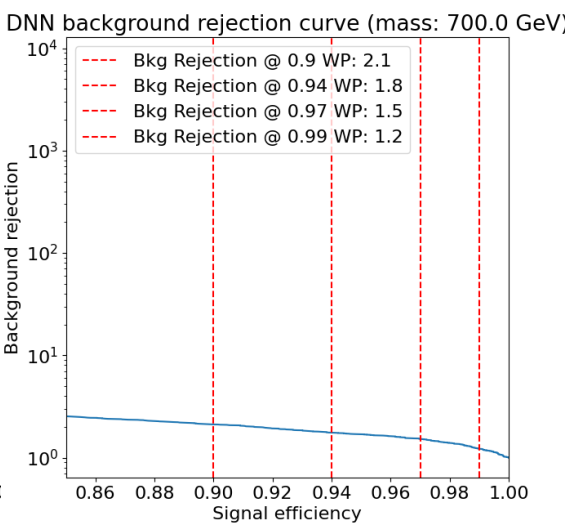

DNN ROC curve (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
AUC: 0.79
True Positive Rate
False Positive Rate

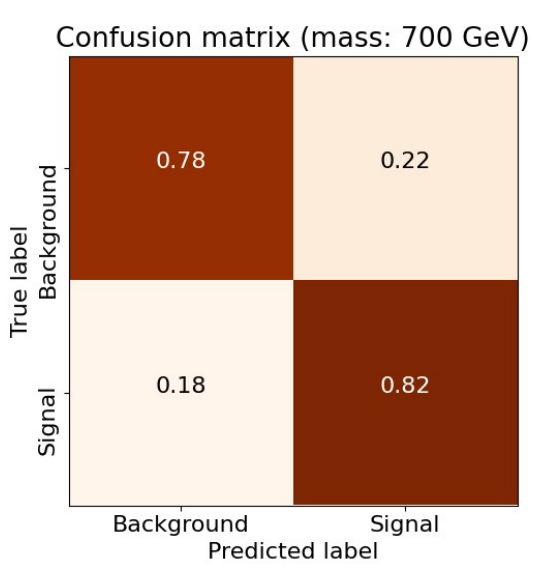

DNN ROC curve (mass: 700 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
AUC: 0.82
True Positive Rate
False Positive Rate

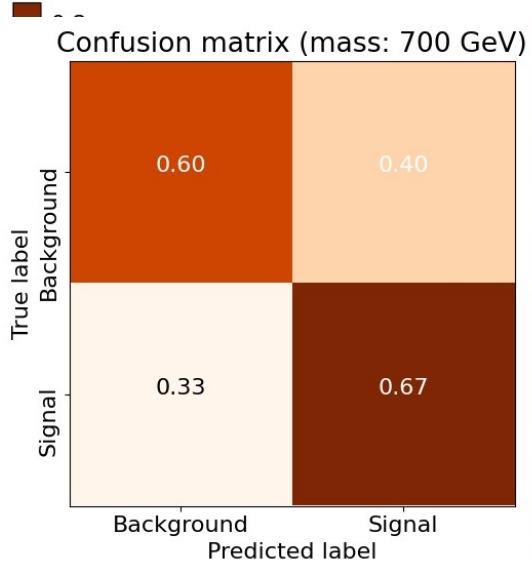

DNN background rejection curve (mass: 700.0 G
Bkg Rejection @ 0.9 WP: 3.3
Bkg Rejection @ 0.94 WP: 2.8
Bkg Rejection @ 0.97 WP: 2.3
Bkg Rejection @ 0.99 WP: 1.8
Background rejection
Signal efficiency

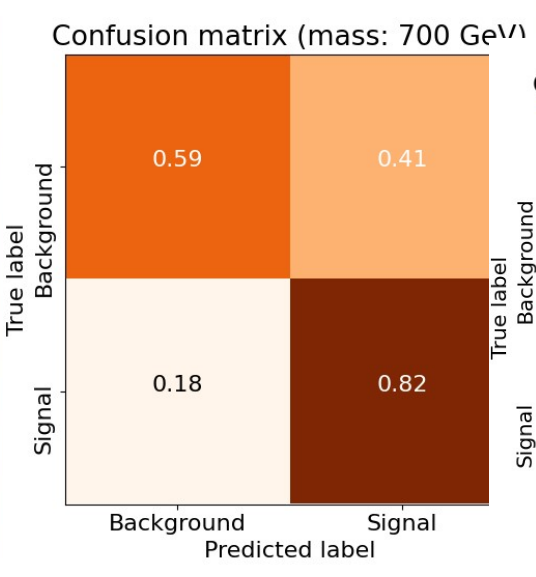

DNN background rejection curve (mass: 700.0
Bkg Rejection @ 0.9 WP: 1.3
Bkg Rejection @ 0.94 WP: 1.2
Bkg Rejection @ 0.97 WP: 1.1
Bkg Rejection @ 0.99 WP: 1.0
Background rejection
Signal efficiency

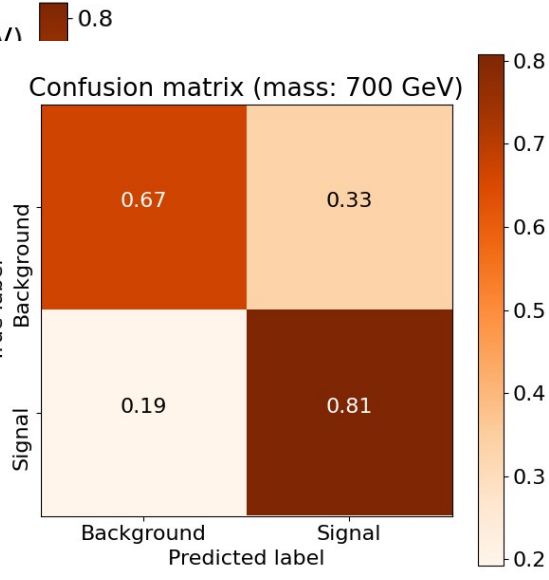

DNN background rejection curve (mass: 700.0
Bkg Rejection @ 0.9 WP: 1.8
Bkg Rejection @ 0.94 WP: 1.6
Bkg Rejection @ 0.97 WP: 1.4
Bkg Rejection @ 0.99 WP: 1.2
Background rejection
Signal efficiency


DNN background rejection curve (mass: 700.0 GeV)
Bkg Rejection @ 0.9 WP: 2.1
Bkg Rejection @ 0.94 WP: 1.8
Bkg Rejection @ 0.97 WP: 1.5
Bkg Rejection @ 0.99 WP: 1.2
Background rejection
Signal efficiency


Confusion matrix (mass: 700 GeV)
0.78
0.22
0.18
0.82
True label
Background
Signal
Predicted label

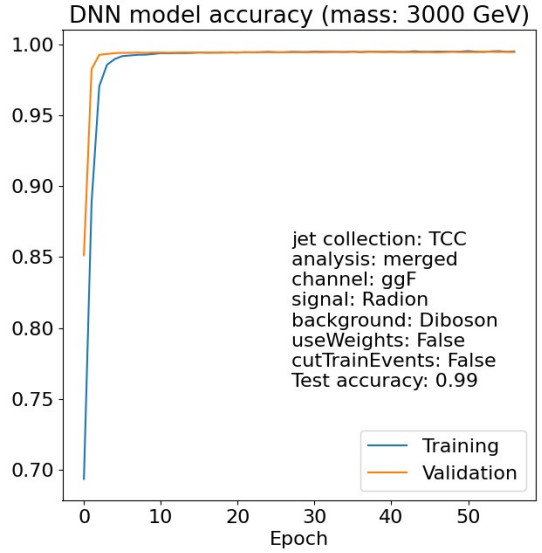

Confusion matrix (mass: 700 GeV)
0.60
0.40
0.33
0.67
True label
Background
Signal
Predicted label

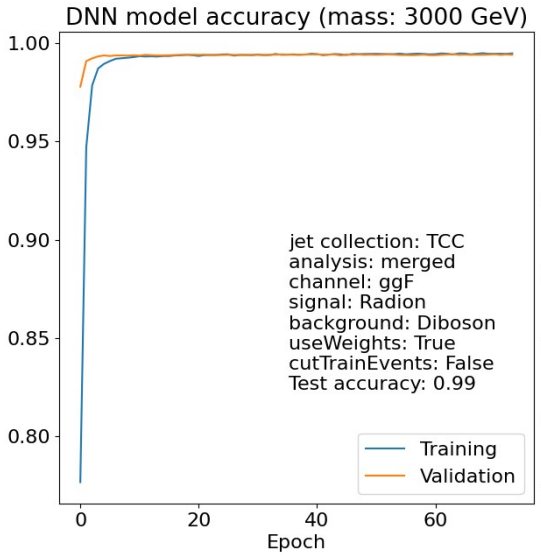

Confusion matrix (mass: 700 GeV)
0.59
0.41
0.18
0.82
True label
Background
Signal
Predicted label

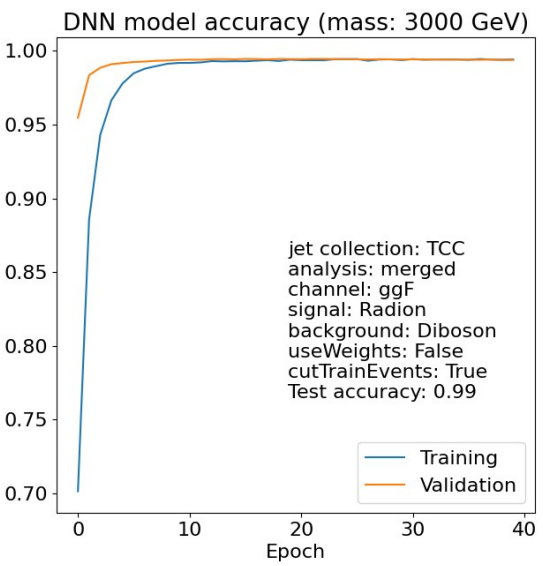

Confusion matrix (mass: 700 GeV)
0.67
0.33
0.19
0.81
True label
Background
Signal
Predicted label
0.8
0.7
0.6
0.5
0.4
0.3
0.2

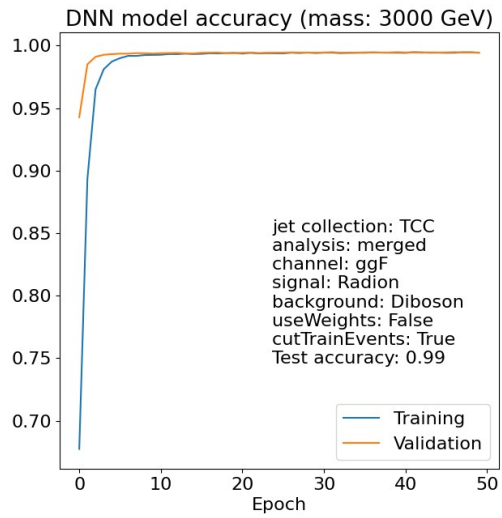
Massa 3000 GeV, Diboson

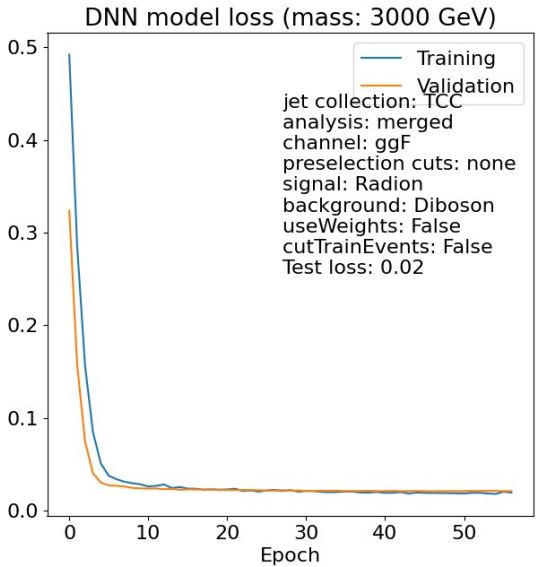
	Intero campione	Intero campione+pesi	sig=bkg	1.5sig=bkg
Segnale train	13614 (51% bkg)	13614	13614	13614
Bkg train	26462	26462	13614	20038
Segnale test	4165	4165	4165	4165
Bkg test	8180	8180	8180	8180
Loss su train	0.0189	0.0125	0.0189	0.0212
Accuracy su train	0.9949	0.9949	0.9946	0.9938
Loss su validazione	0.0209	0.0206	0.0226	0.0207
Accuracy su validazione	0.9949	0.9940	0.9939	0.9944
Loss su test	0.0224	0.0238	0.0247	0.0228
Accuracy su test	0.9937	0.9934	0.9936	0.9934
Area ROC	0.998	0.999	0.999	0.999
Reiezione bkg @ 0.90 WP	1363.3	1168.6	1363.3	1363.6
Reiezione bkg @ 0.99 WP	209.7	227.2	204.5	221.1

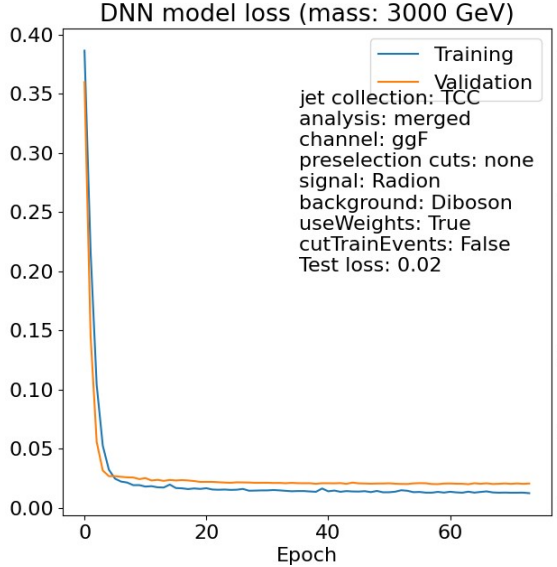

DNN model accuracy (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
Test accuracy: 0.99
Training
Validation
Epoch

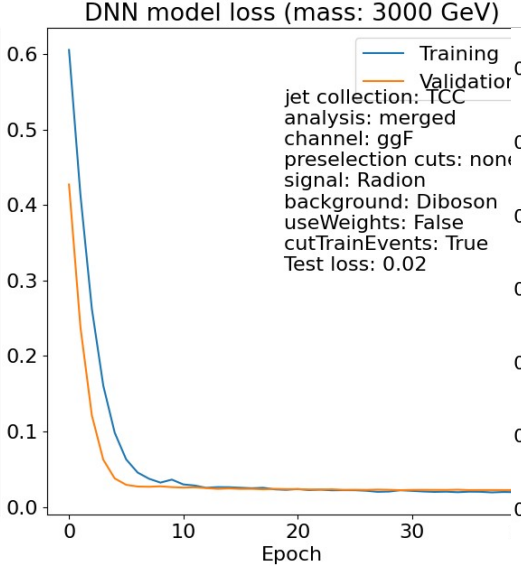

DNN model accuracy (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
Test accuracy: 0.99
Training
Validation
Epoch

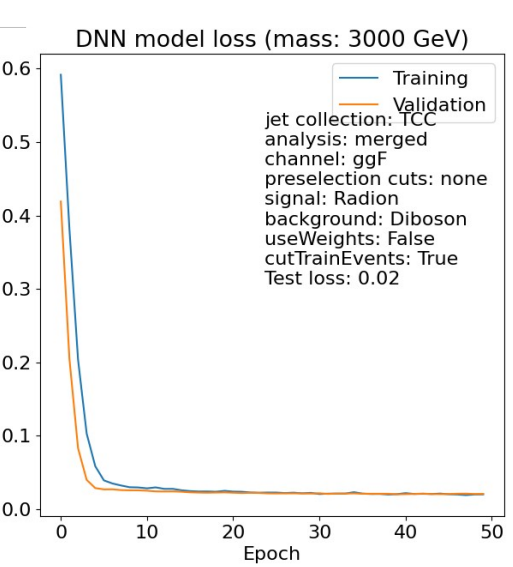

DNN model accuracy (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test accuracy: 0.99
Training
Validation
Epoch

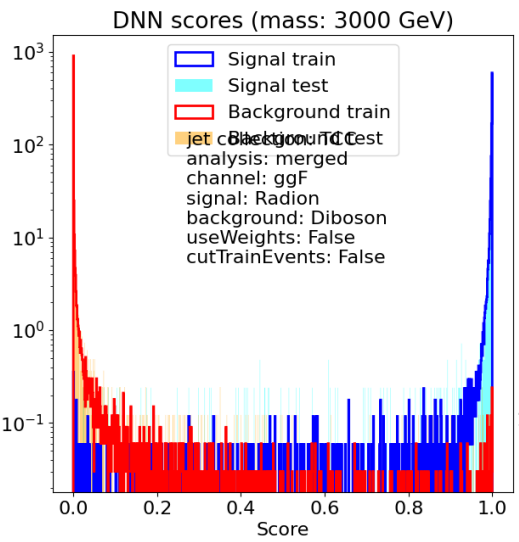

DNN model accuracy (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test accuracy: 0.99
Training
Validation
Epoch

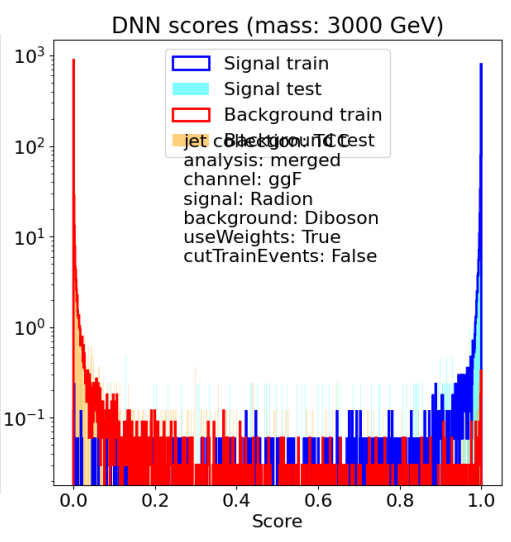

DNN model loss (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
Test loss: 0.02
Training
Validation
Epoch

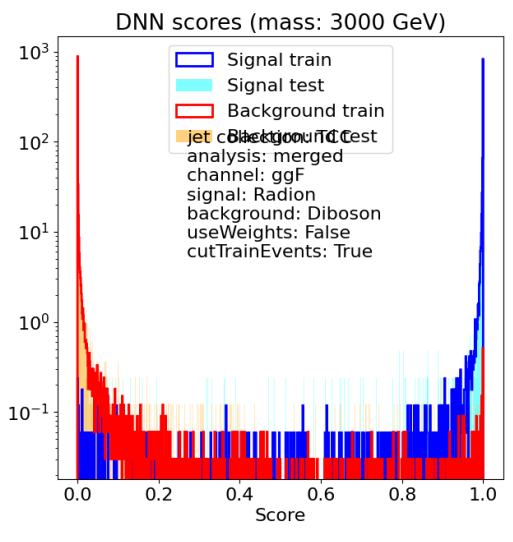

DNN model loss (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
Test loss: 0.02
Training
Validation
Epoch

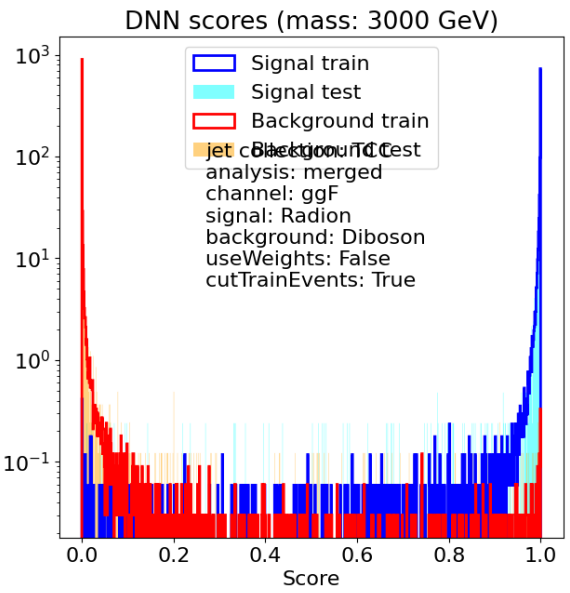

DNN model loss (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test loss: 0.02
Training
Epoch

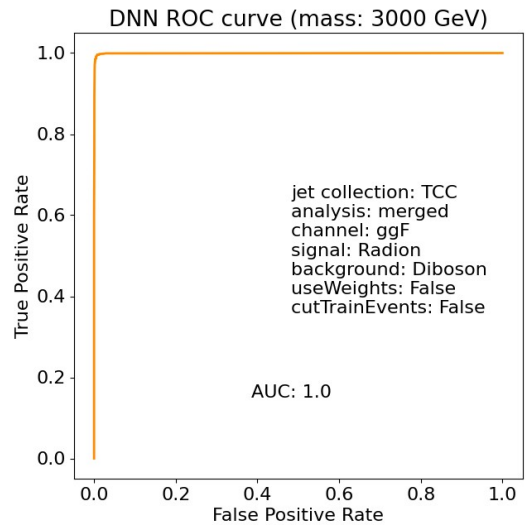

DNN model loss (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test loss: 0.02
Training
Validation
Epoch

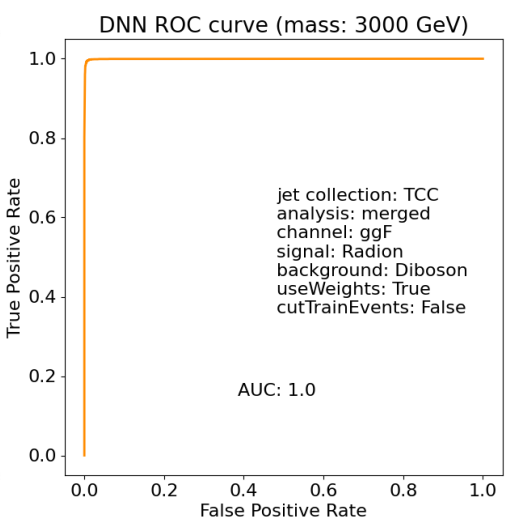

DNN scores (mass: 3000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
Score

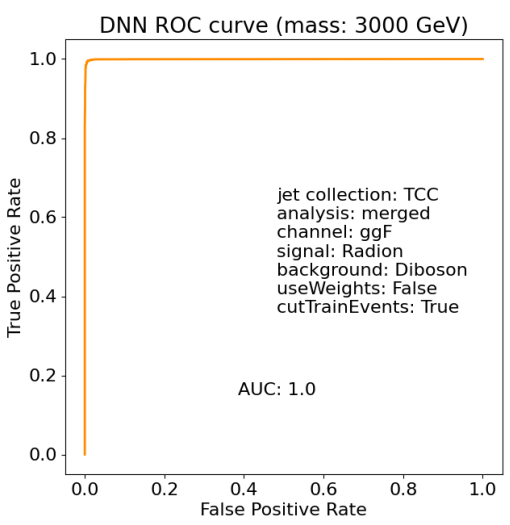

DNN scores (mass: 3000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
Score

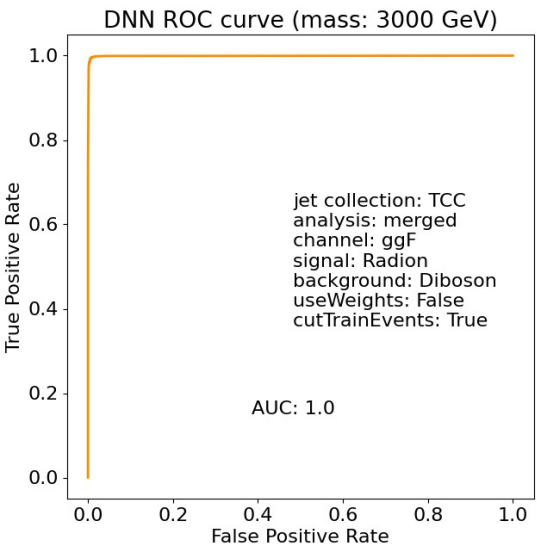

DNN scores (mass: 3000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Score

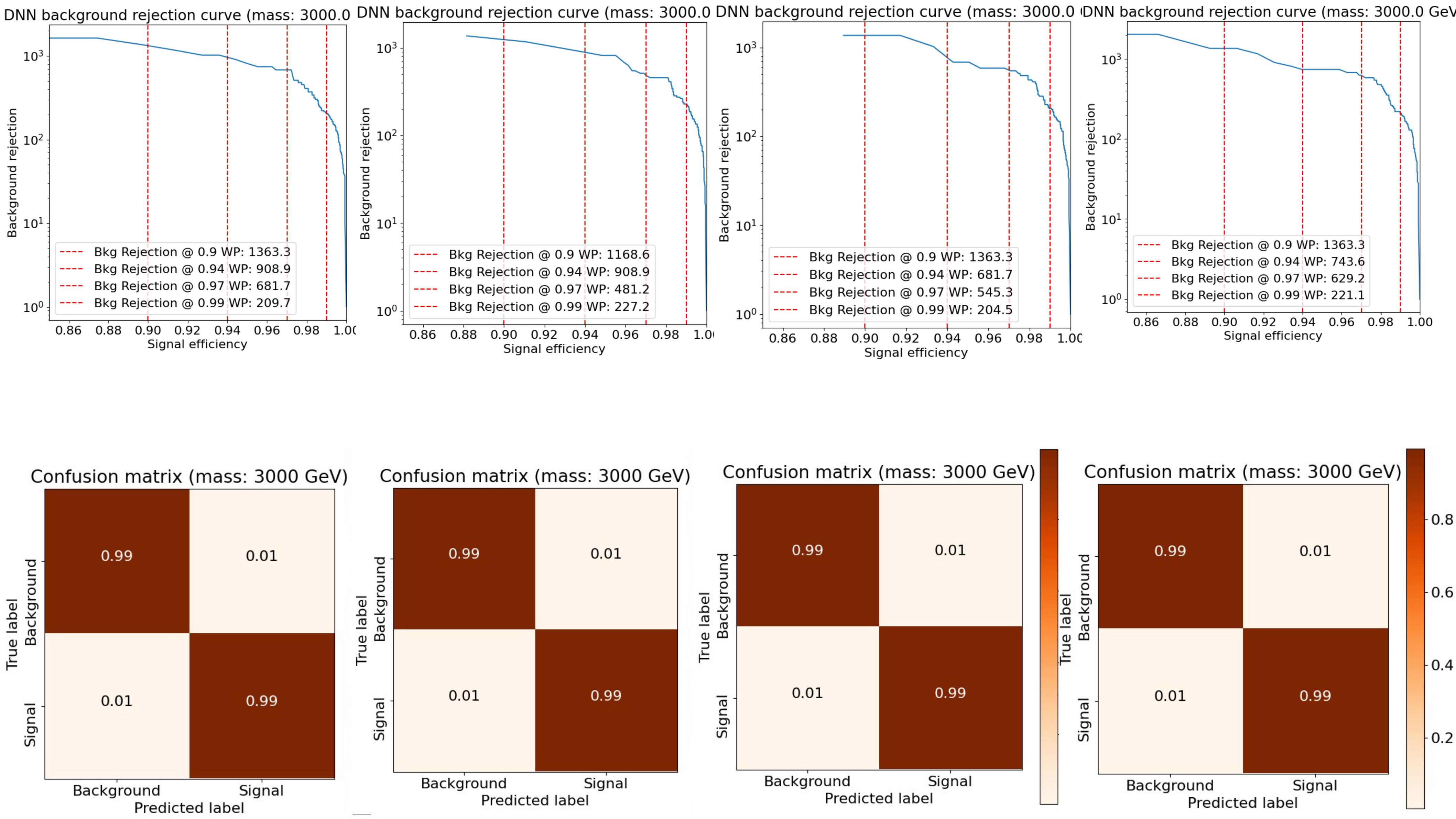

DNN scores (mass: 3000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Score


DNN ROC curve (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
AUC: 1.0
True Positive Rate
False Positive Rate


DNN ROC curve (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
AUC: 1.0
True Positive Rate
False Positive Rate

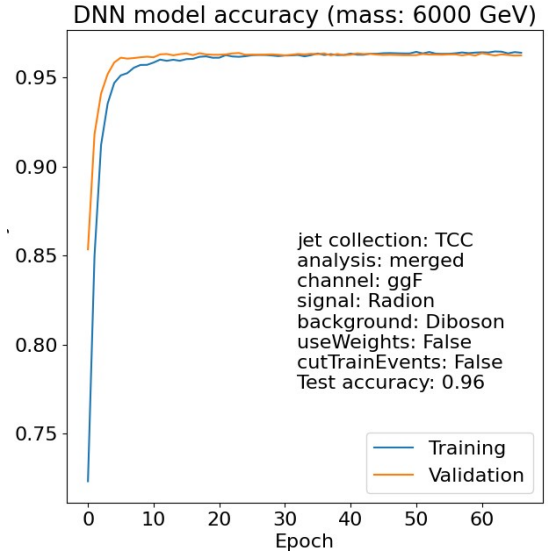

DNN ROC curve (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
AUC: 1.0
True Positive Rate
False Positive Rate

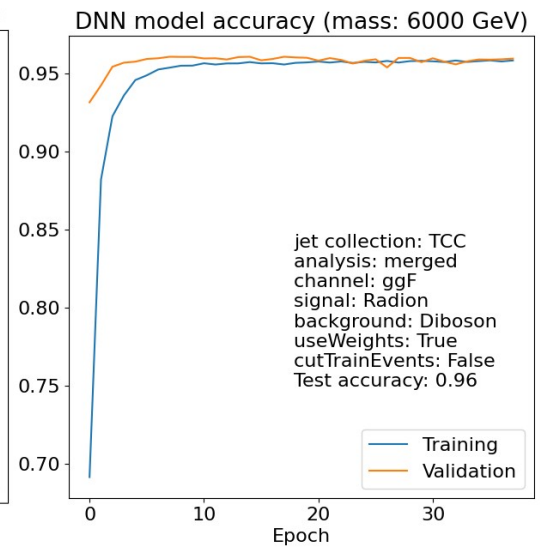

DNN ROC curve (mass: 3000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
AUC: 1.0
True Positive Rate
False Positive Rate

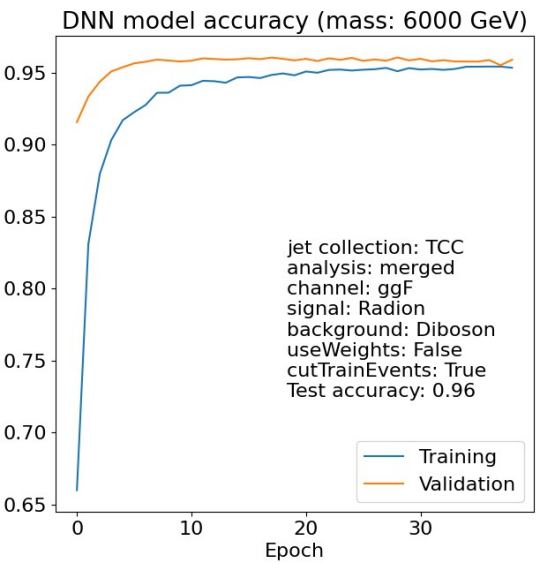

DNN background rejection curve (mass: 3000.0
Background rejection
Signal efficiency
Bkg Rejection @ 0.9 WP: 1363.3
Bkg Rejection @ 0.94 WP: 908.9
Bkg Rejection @ 0.97 WP: 681.7
Bkg Rejection @ 0.99 WP: 209.7
DNN background rejection curve (mass: 3000.0
Background rejection
Signal efficiency
Bkg Rejection @ 0.9 WP: 1168.6
Bkg Rejection @ 0.94 WP: 908.9
Bkg Rejection @ 0.97 WP: 481.2
Bkg Rejection @ 0.99 WP: 227.2
DNN background rejection curve (mass: 3000.0
Background rejection
Signal efficiency
Bkg Rejection @ 0.9 WP: 1363.3
Bkg Rejection @ 0.94 WP: 681.7
Bkg Rejection @ 0.97 WP: 545.3
Bkg Rejection @ 0.99 WP: 204.5
DNN background rejection curve (mass: 3000.0 GeV
Background rejection
Signal efficiency
Bkg Rejection @ 0.9 WP: 1363.3
Bkg Rejection @ 0.94 WP: 743.6
Bkg Rejection @ 0.97 WP: 629.2
Bkg Rejection @ 0.99 WP: 221.1
Confusion matrix (mass: 3000 GeV)
True label
Background
Signal
0.99
0.01
0.01
0.99
Predicted label
Confusion matrix (mass: 3000 GeV)
True label
Background
Signal
0.99
0.01
0.01
0.99
Predicted label
Confusion matrix (mass: 3000 GeV)
True label
Background
Signal
0.99
0.01
0.01
0.99
Predicted label
Confusion matrix (mass: 3000 GeV)
True label
Background
Signal
0.99
0.01
0.01
0.99
Predicted label

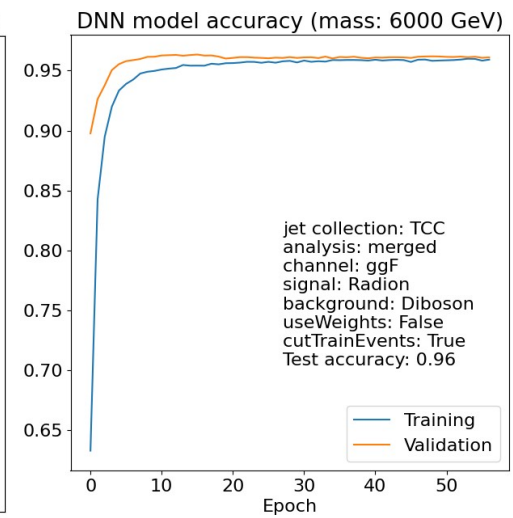
Massa 6000 GeV, Diboson

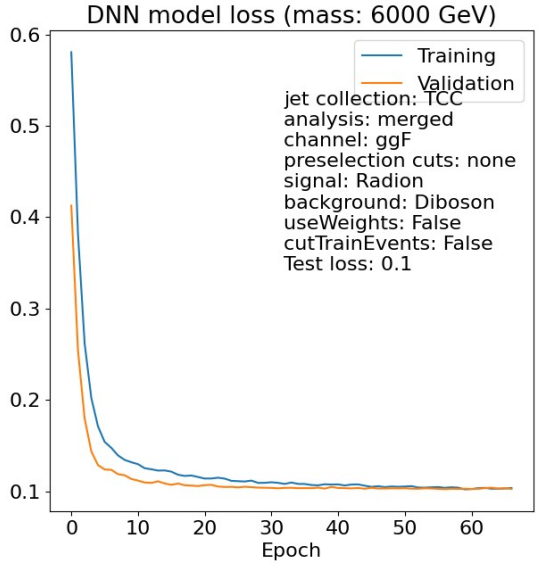
	Intero campione	Intero campione+pesi	sig=bkg	1.5sig=bkg
Segnale train	10448	10448	10448	10448
Bkg train	26473	26473	10448	18460
Segnale test	3269	3269	3249	3249
Bkg test	8180	8180	8180	8180
Loss su train	0.0999	0.073	0.1280	0.1114
Accuracy su train	0.9643	0.958	0.9520	0.9581
Loss su validazione	0.1027	0.1113	0.1157	0.1065
Accuracy su validazione	0.9623	0.9593	0.9592	0.9611
Loss su test	0.1015	0.1113	0.1152	0.1068
Accuracy su test	0.9645	0.9598	0.9593	0.9620
Area ROC	0.99	0.99	0.99	0.99
Reiezione bkg @ 0.90 WP	82.6	75.7	72.4	75.7
Reiezione bkg @ 0.99 WP	4.8	3.9	4.8	4.7

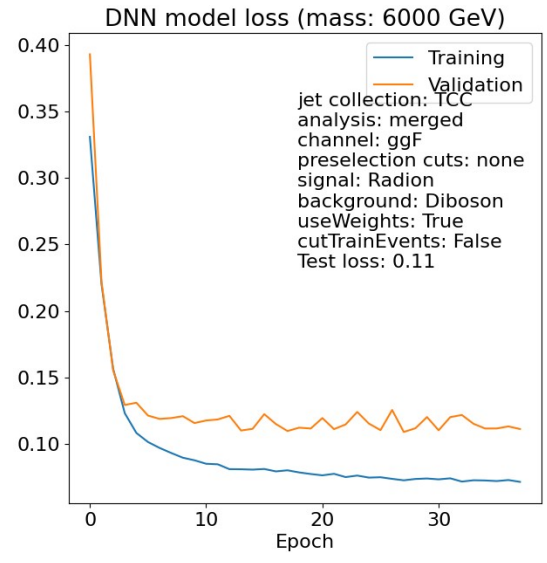

DNN model accuracy (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
Test accuracy: 0.96
Training
Validation
Epoch

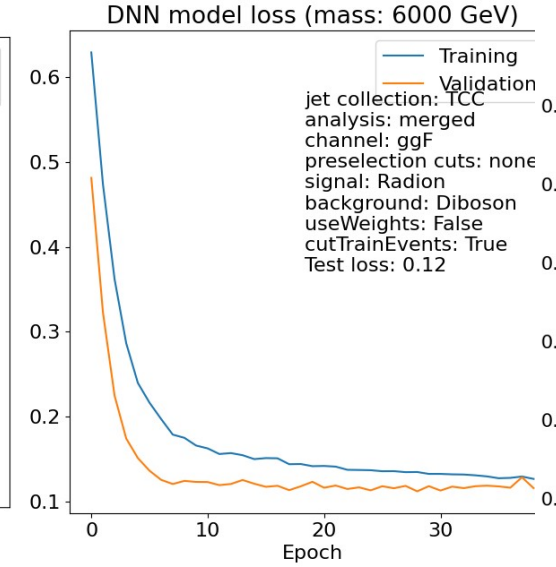

DNN model accuracy (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
Test accuracy: 0.96
Training
Validation
Epoch

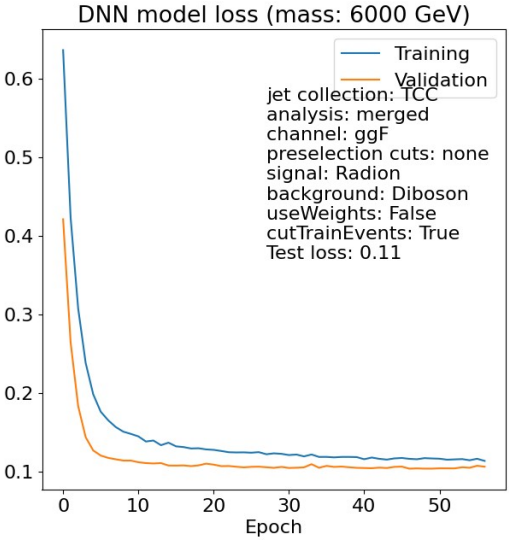

DNN model accuracy (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test accuracy: 0.96
Training
Validation
Epoch

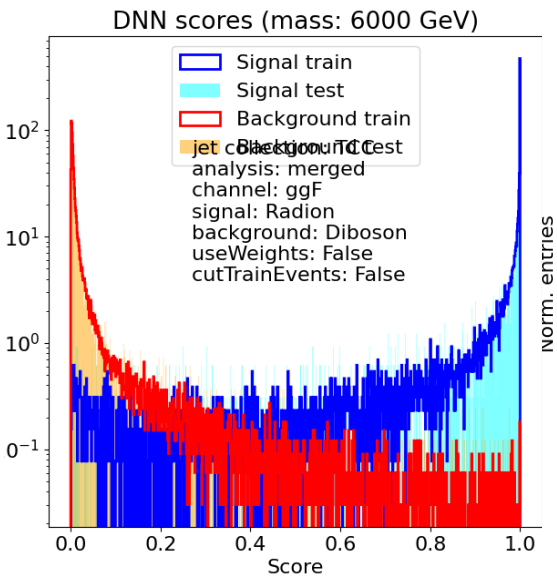

DNN model accuracy (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test accuracy: 0.96
Training
Validation
Epoch

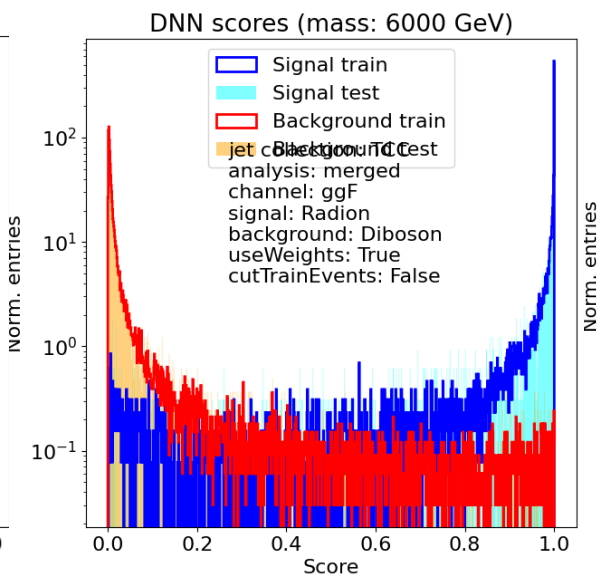

DNN model loss (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
Test loss: 0.1
Training
Validation
Epoch

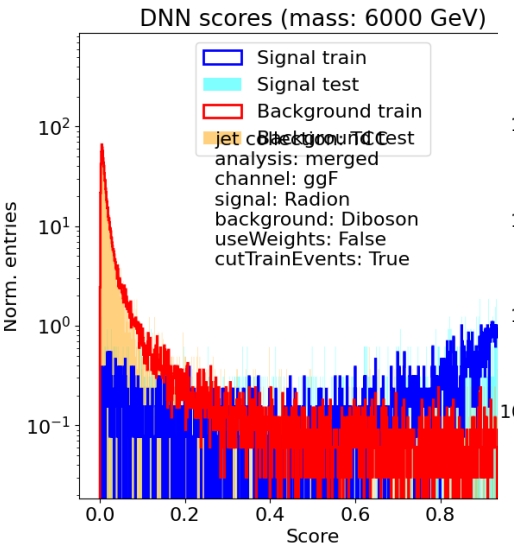

DNN model loss (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
Test loss: 0.11
Training
Validation
Epoch

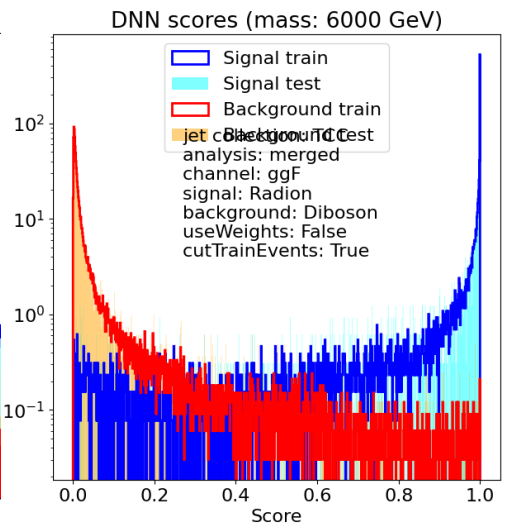

DNN model loss (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test loss: 0.12
Training
Validation
Epoch

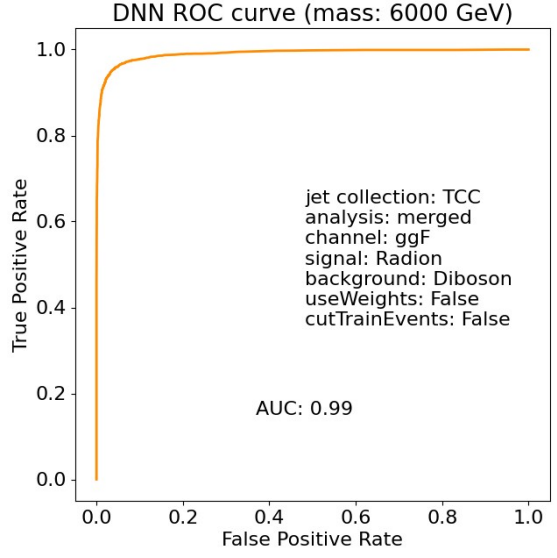

DNN model loss (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Test loss: 0.11
Training
Validation
Epoch

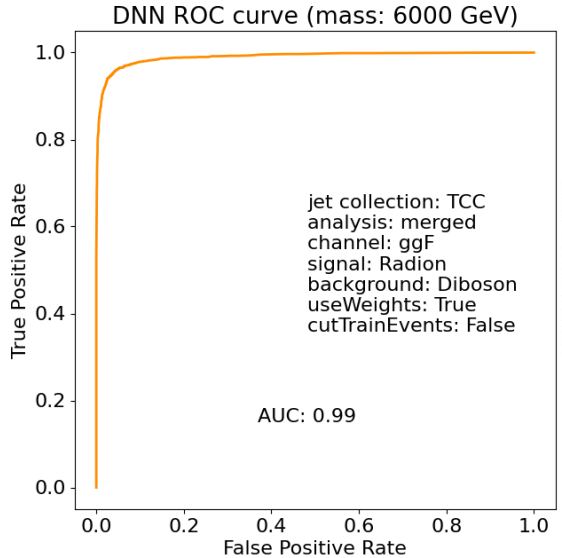

DNN scores (mass: 6000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
Score

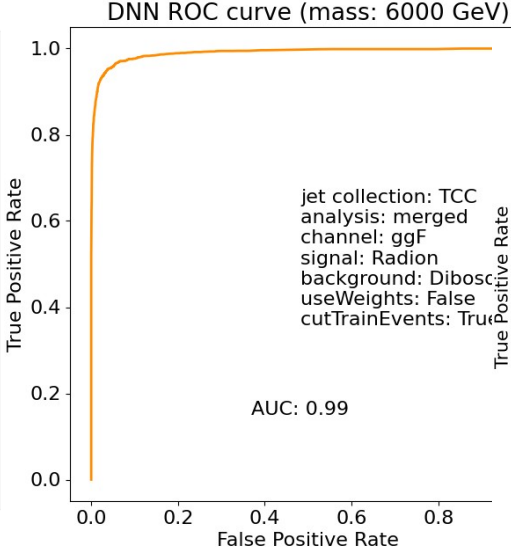

DNN scores (mass: 6000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
Norm. entries
Score

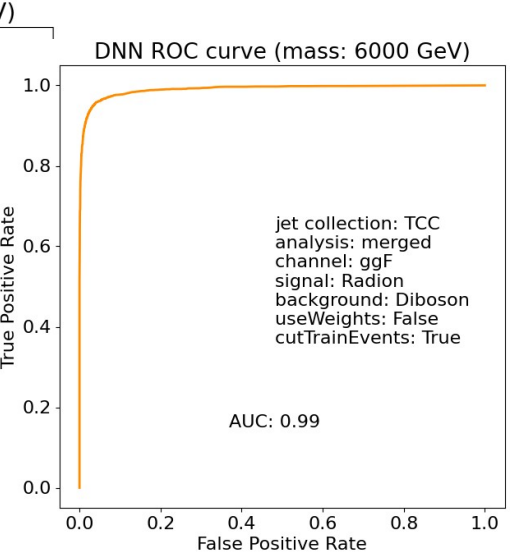

DNN scores (mass: 6000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Norm. entries
Score

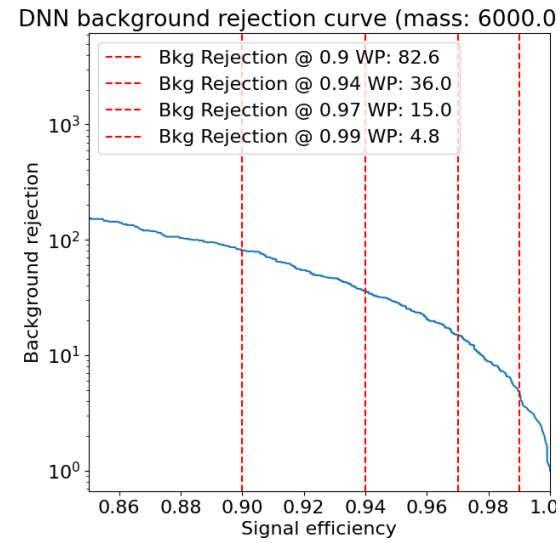

DNN scores (mass: 6000 GeV)
Signal train
Signal test
Background train
Background test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
Score

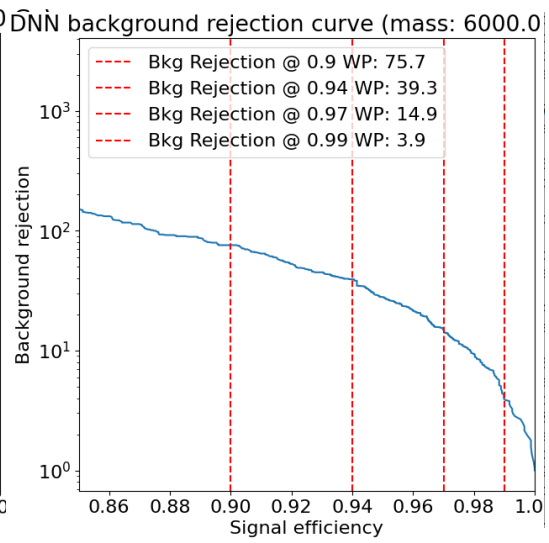

DNN ROC curve (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: False
AUC: 0.99
True Positive Rate
False Positive Rate

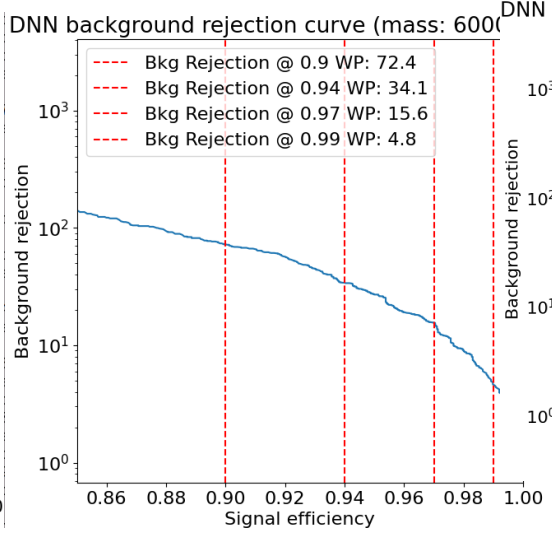

DNN ROC curve (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: True
cutTrainEvents: False
AUC: 0.99
True Positive Rate
False Positive Rate

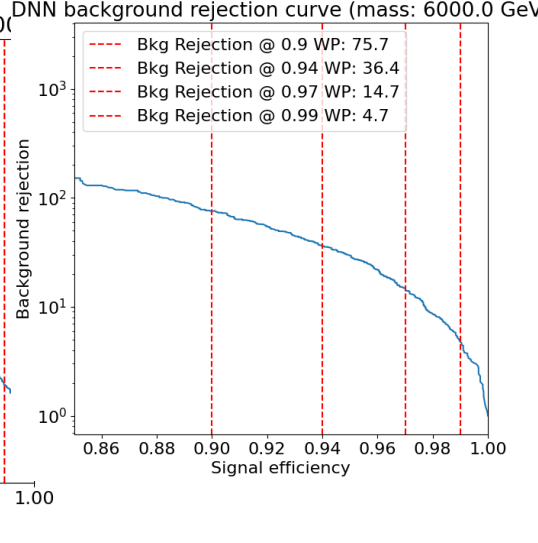

DNN ROC curve (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
AUC: 0.99
True Positive Rate
False Positive Rate

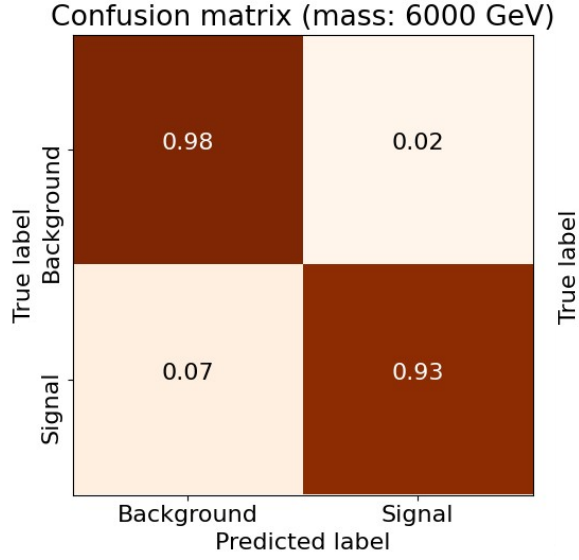

DNN ROC curve (mass: 6000 GeV)
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
cutTrainEvents: True
AUC: 0.99
True Positive Rate
False Positive Rate

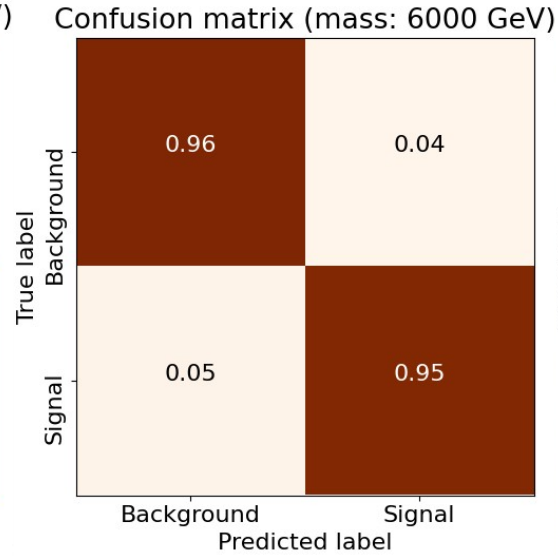

DNN background rejection curve (mass: 6000.0
Bkg Rejection @ 0.9 WP: 82.6
Bkg Rejection @ 0.94 WP: 36.0
Bkg Rejection @ 0.97 WP: 15.0
Bkg Rejection @ 0.99 WP: 4.8
Background rejection
Signal efficiency

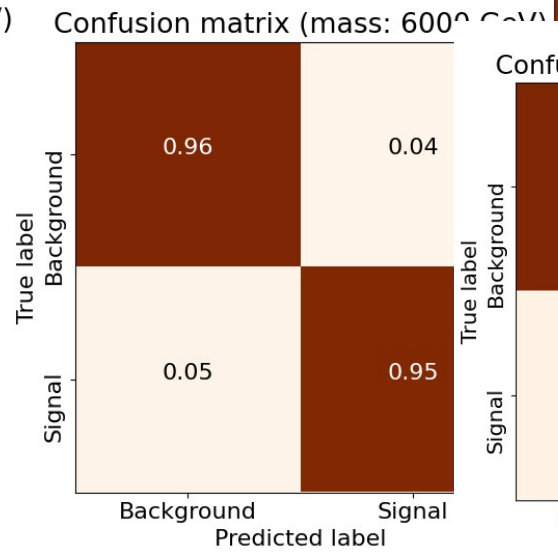

DNN background rejection curve (mass: 6000.0
Bkg Rejection @ 0.9 WP: 75.7
Bkg Rejection @ 0.94 WP: 39.3
Bkg Rejection @ 0.97 WP: 14.9
Bkg Rejection @ 0.99 WP: 3.9
Background rejection
Signal efficiency

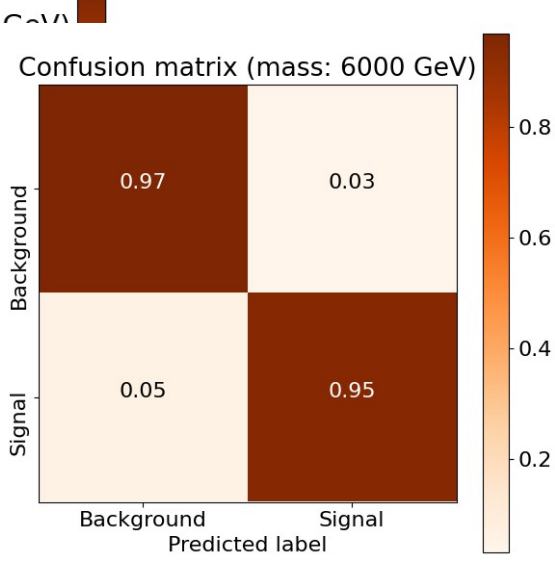

DNN background rejection curve (mass: 600
Bkg Rejection @ 0.9 WP: 72.4
Bkg Rejection @ 0.94 WP: 34.1
Bkg Rejection @ 0.97 WP: 15.6
Bkg Rejection @ 0.99 WP: 4.8
Background rejection
Signal efficiency


DNN background rejection curve (mass: 6000.0 GeV
Bkg Rejection @ 0.9 WP: 75.7
Bkg Rejection @ 0.94 WP: 36.4
Bkg Rejection @ 0.97 WP: 14.7
Bkg Rejection @ 0.99 WP: 4.7
Background rejection
Signal efficiency


Confusion matrix (mass: 6000 GeV)
0.98
0.02
0.07
0.93
True label
Background
Signal
Predicted label


Confusion matrix (mass: 6000 GeV)
0.96
0.04
0.05
0.95
True label
Background
Signal
Predicted label


Confusion matrix (mass: 600
0.96
0.04
0.05
0.95
True label
Background
Signal
Predicted label


Confusion matrix (mass: 6000 GeV)
0.97
0.03
0.05
0.95
True label
Background
Signal
Predicted label

Mixing backgrounds

- Training with Radion, Zjets and Diboson (mass = 3 TeV)
- Test with Zjets only, Diboson only, Zjets + Diboson (mass = 3 TeV)
- 4 different cases:

  - case 0: all background events (no cut nor weights)

  - case 1: all background events (not cut) but Zjets and Diboson weighted to the signal statistics

  - case 2: all background events (not cut) but Zjets and Diboson weighted to half of the signal statistics

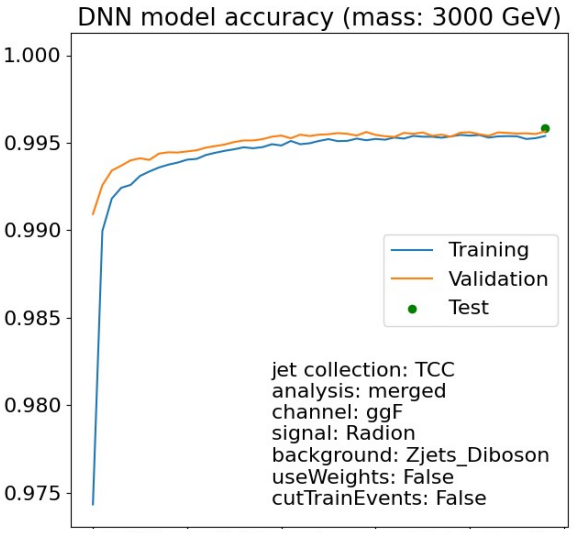
  - case 3: N(Zjets) = N(Diboson) = N(Signal)

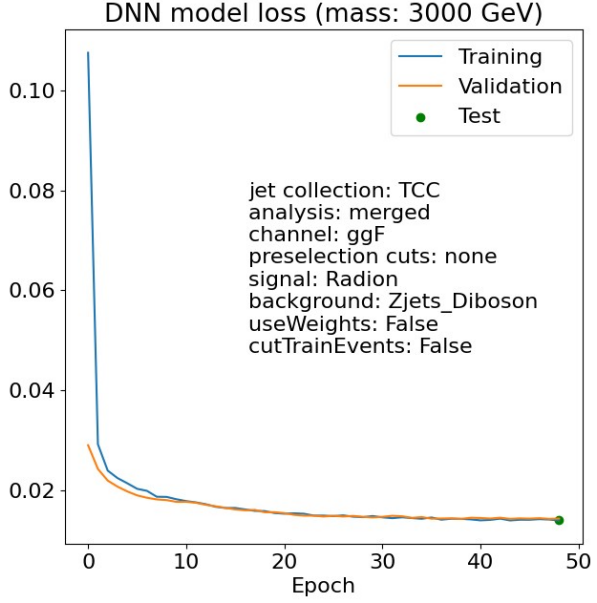
  - case 4: N(Zjets) = N(Diboson) = N(Signal) / 2

Massa 3000 GeV, Zjets + Diboson

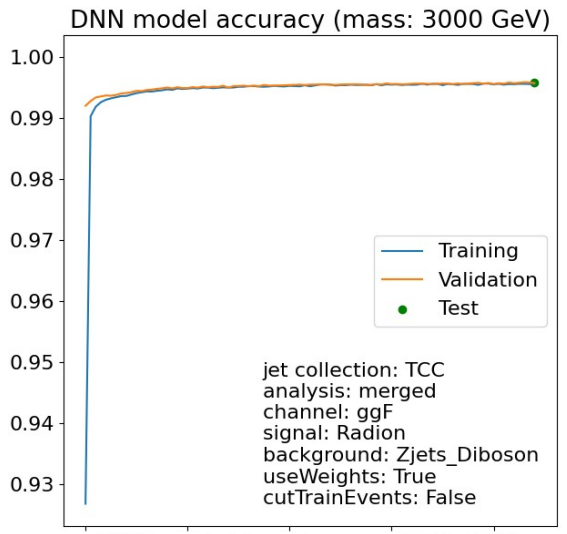
	Case 0	Case 1	Case 2	Case 3	Case 4
# sig in train	13431 (4% bkg)			13431	13431
# bkg in train	300381 (91% Zjet)			26862	13430
# sig in test	4271 (4% bkg)				
# bkg in test	94006 (91% Zjets)				
# sig in val	3366 (4% bkg)				
# bkg in val	75086 (91% Zjets)				
Val loss	0.0143	0.0133	0.0133	0.0370	0.0556
Val acc	0.9957	0.9961	0.9958	0.9883	0.9832
Test loss	0.0141	0.0126	0.0123	0.0344	0.0527
Test acc	0.9958	0.9958	0.9959	0.9887	0.9837
Train loss	0.0148	0.0128	0.0131	0.032	0.0329
Train acc	0.9953	0.9952	0.9957	0.9906	0.9912

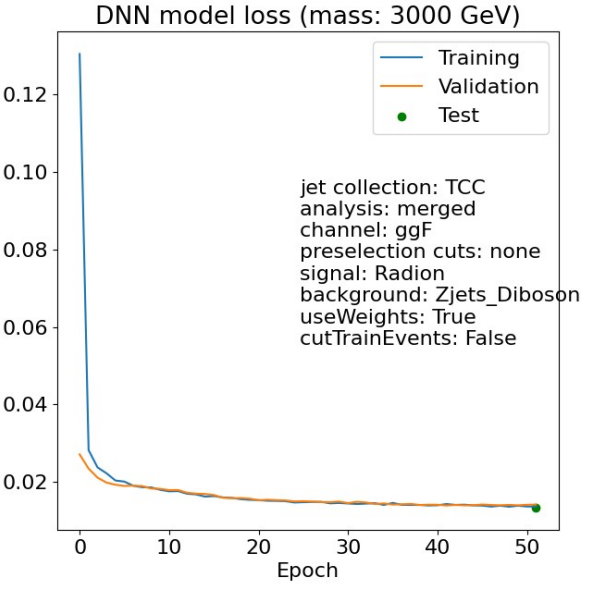
Case 0



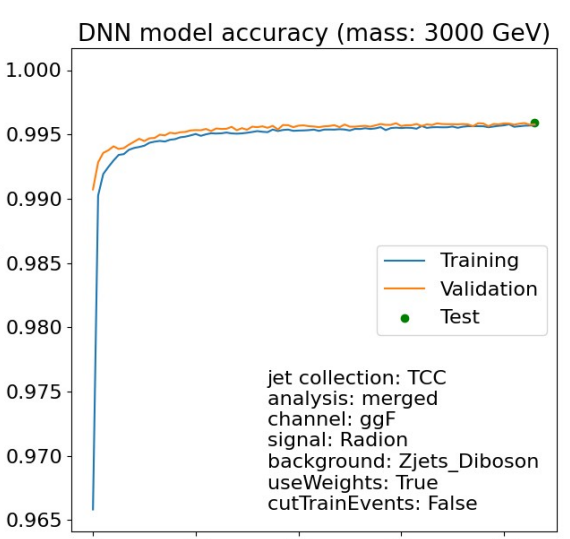


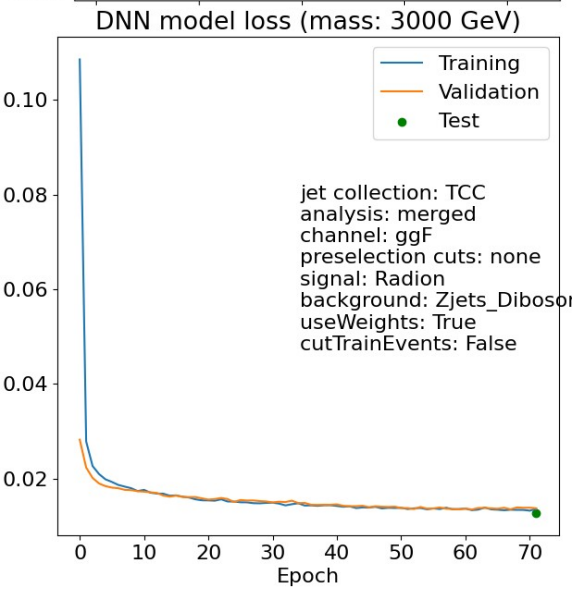
Case 1



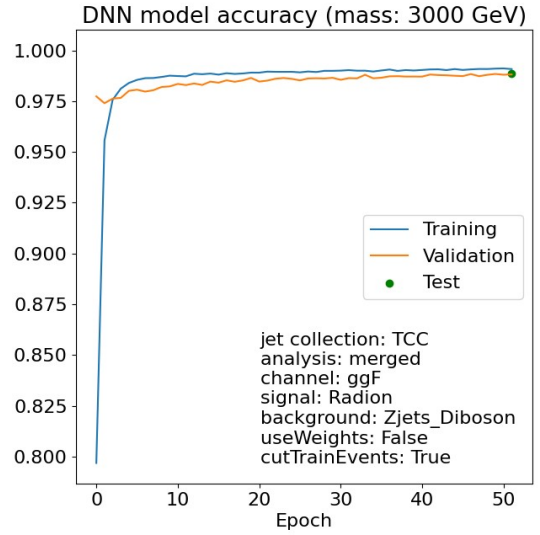


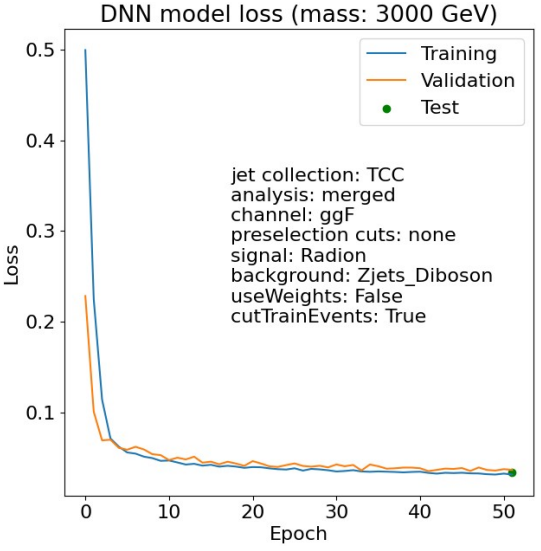
Case 2



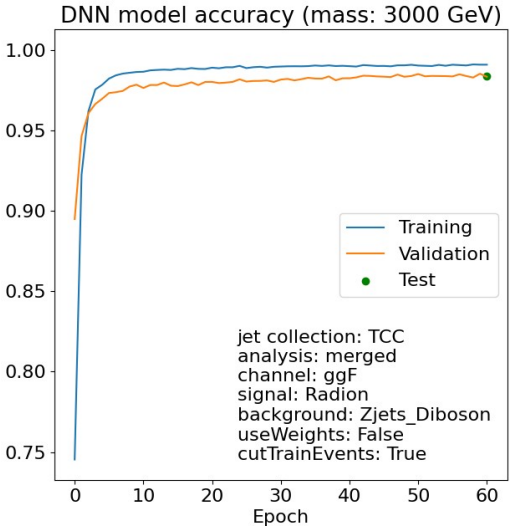


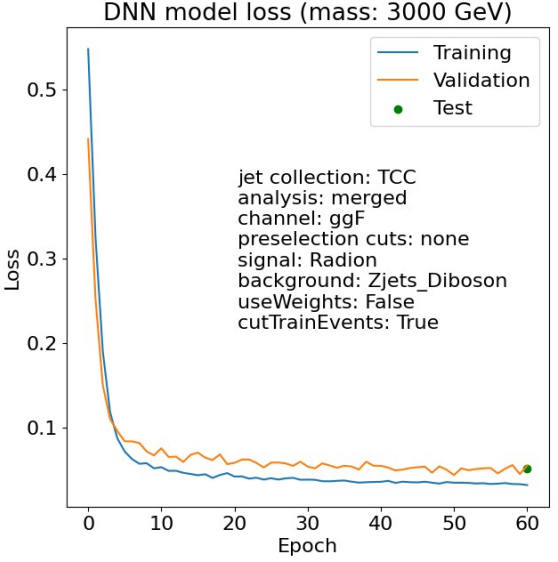
Case 3


DNN model accuracy (mass: 3000 GeV)
Training
Validation
Test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets_Diboson
useWeights: False
cutTrainEvents: True
Epoch

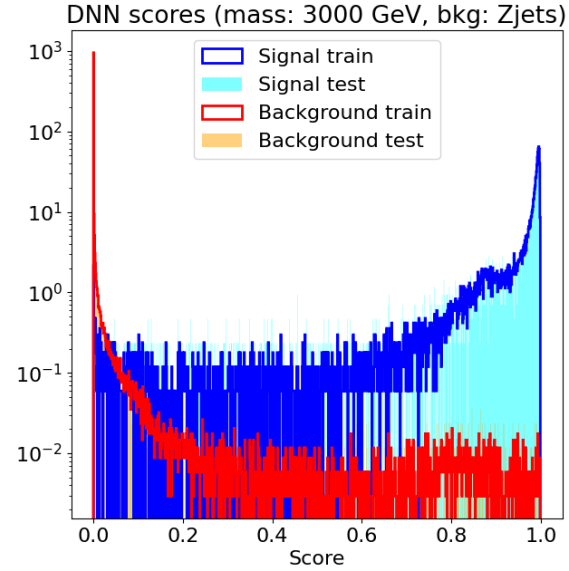

DNN model loss (mass: 3000 GeV)
Training
Validation
Test
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets_Diboson
useWeights: False
cutTrainEvents: True
Loss
Epoch

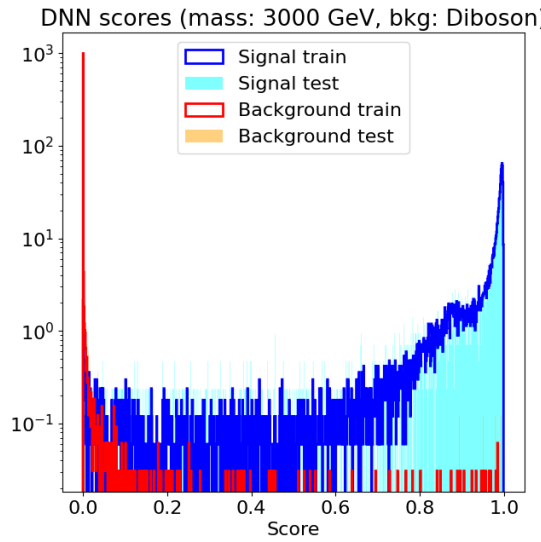
Case 4


DNN model accuracy (mass: 3000 GeV)
Training
Validation
Test
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets_Diboson
useWeights: False
cutTrainEvents: True
Epoch

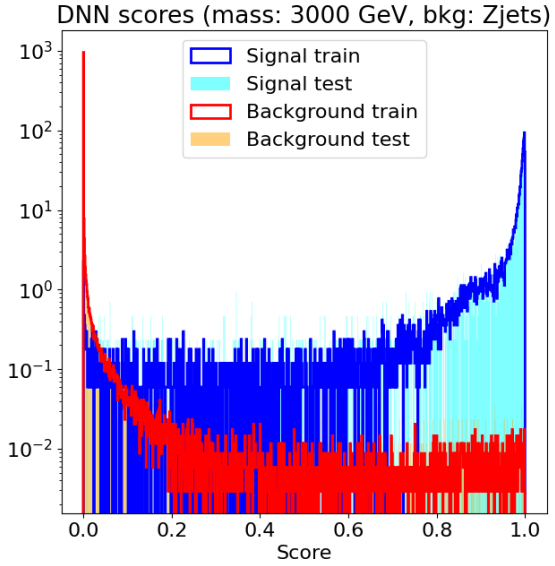

DNN model loss (mass: 3000 GeV)
Training
Validation
Test
jet collection: TCC
analysis: merged
channel: ggF
preselection cuts: none
signal: Radion
background: Zjets_Diboson
useWeights: False
cutTrainEvents: True
Loss
Epoch

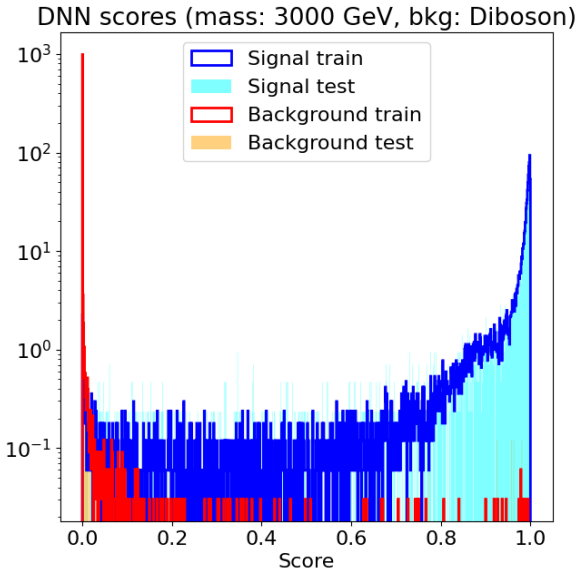
Case 0



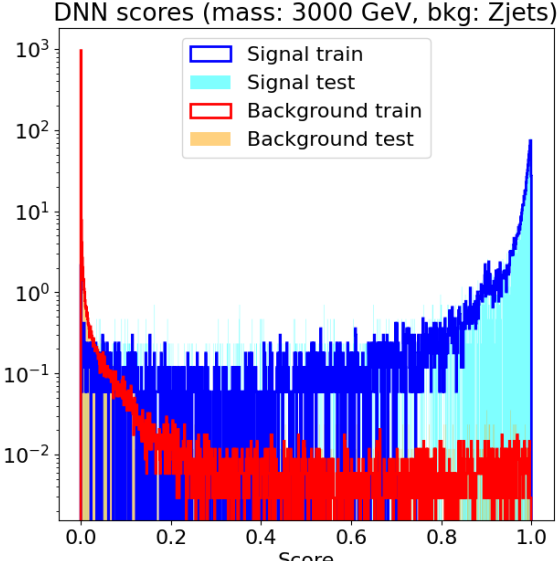


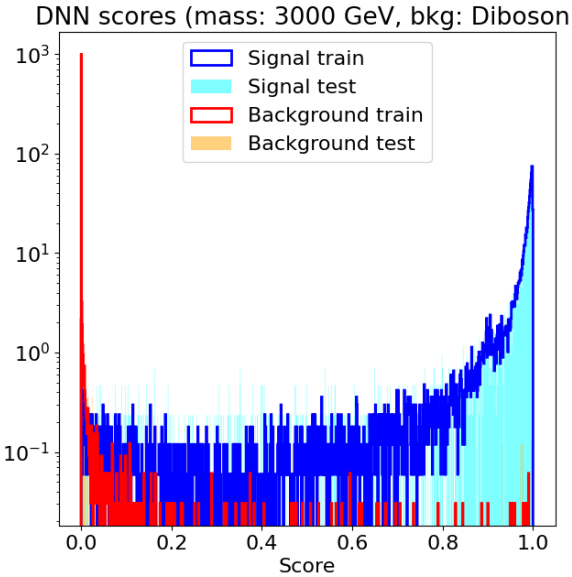
Case 1



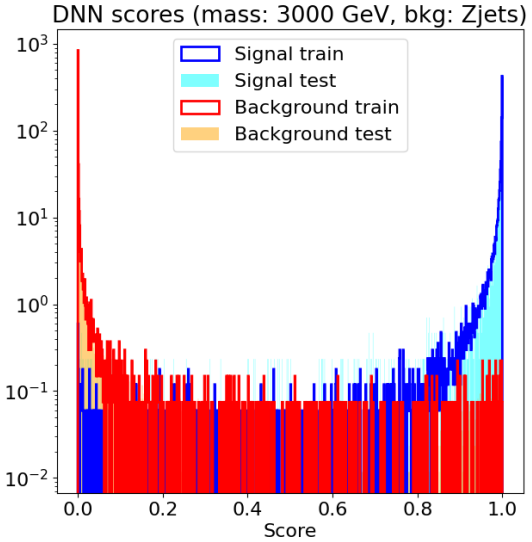


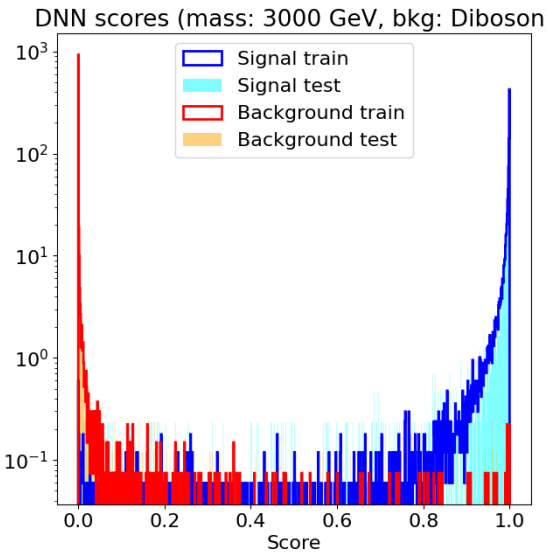
Case 2



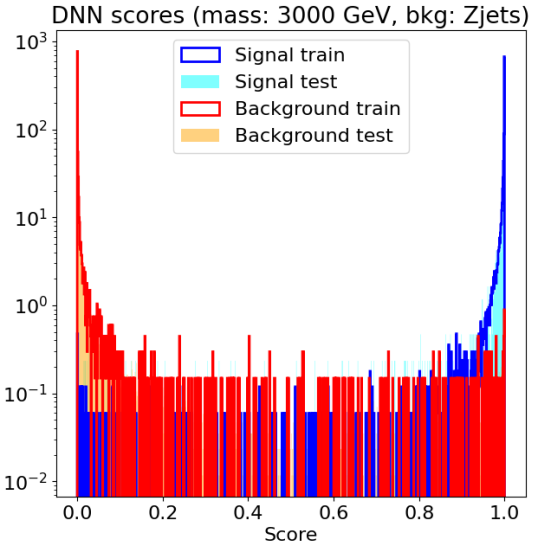


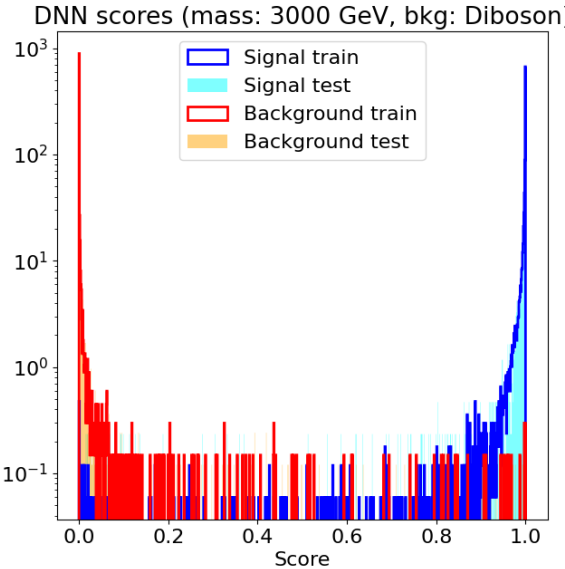
Case 3


DNN scores (mass: 3000 GeV, bkg: Zjets)
Signal train
Signal test
Background train
Background test
Score

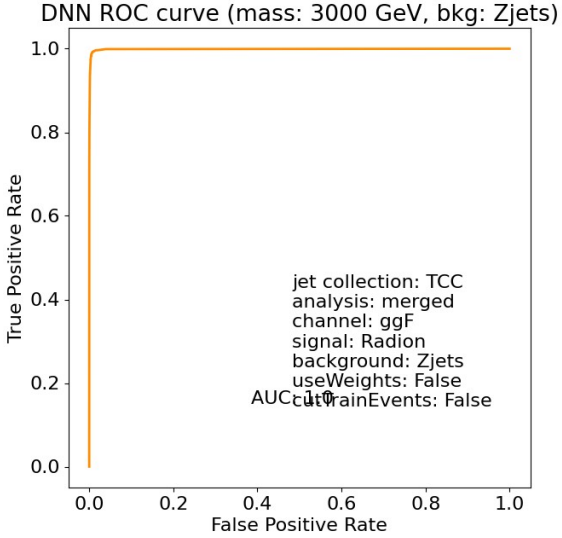

DNN scores (mass: 3000 GeV, bkg: Diboson)
Signal train
Signal test
Background train
Background test
Score

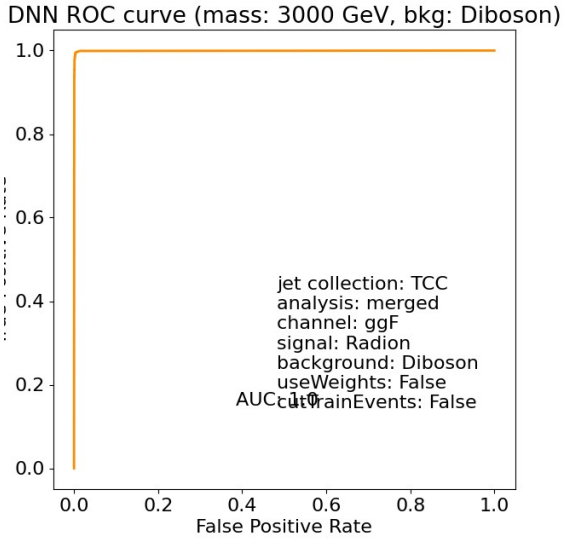
Case 4


DNN scores (mass: 3000 GeV, bkg: Zjets)
Signal train
Signal test
Background train
Background test
Score

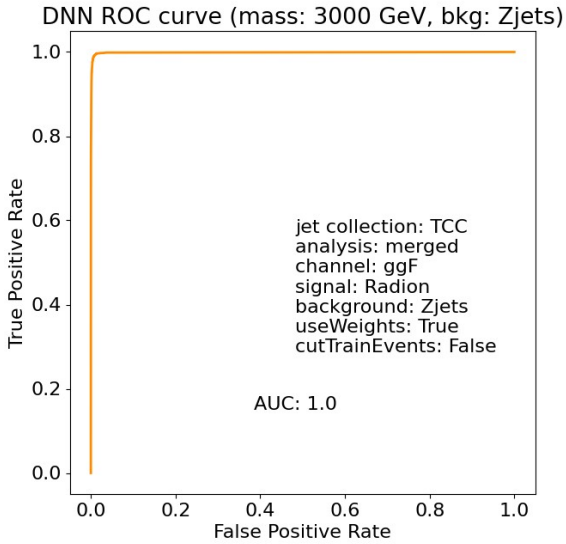

DNN scores (mass: 3000 GeV, bkg: Diboson)
Signal train
Signal test
Background train
Background test
Score

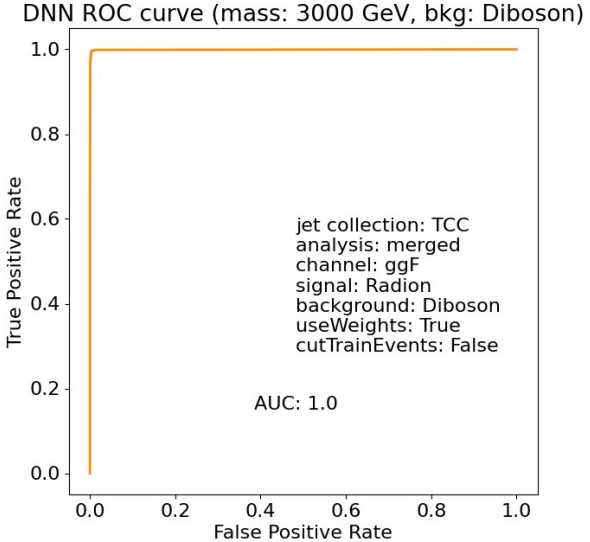
Case 0



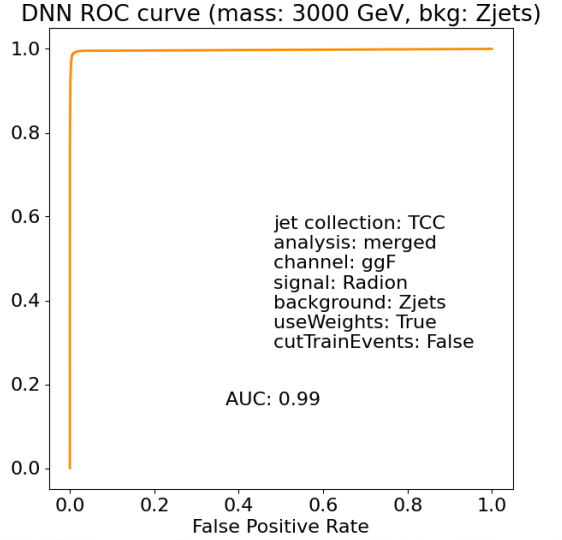


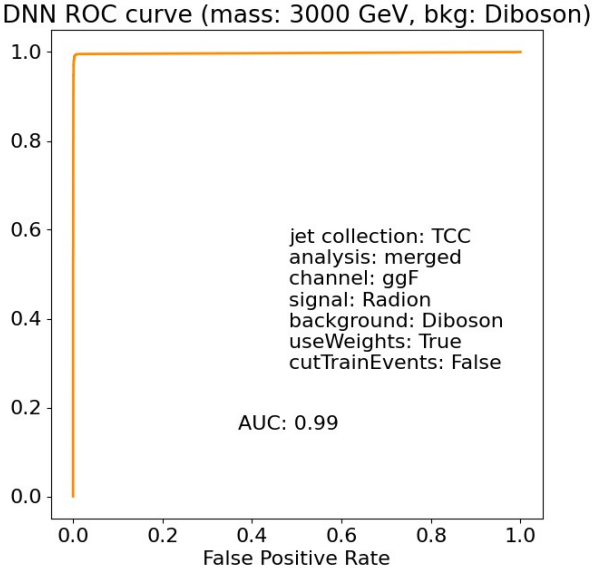
Case 1



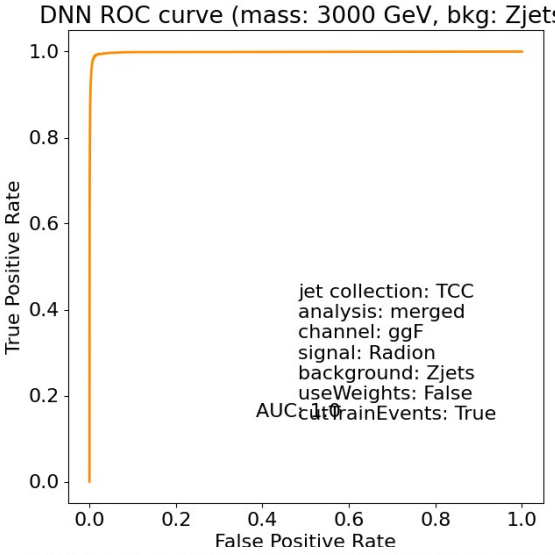


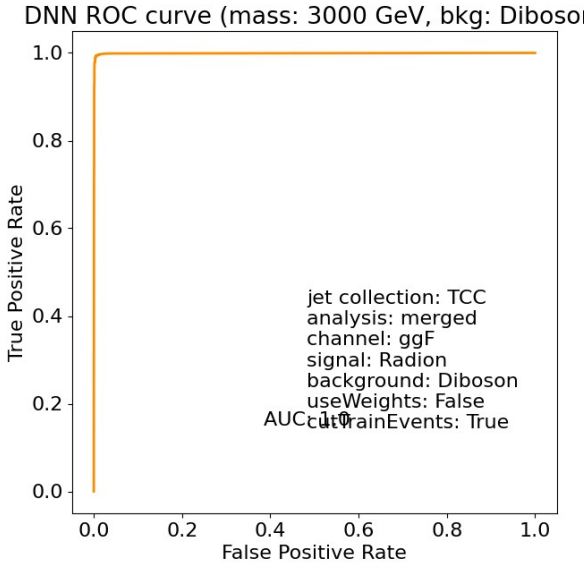
Case 2



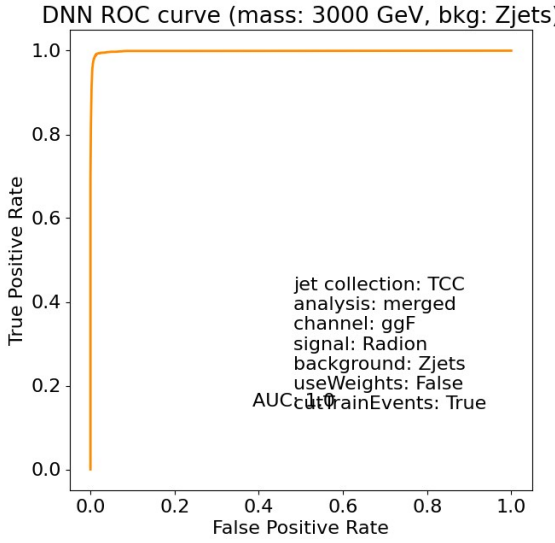


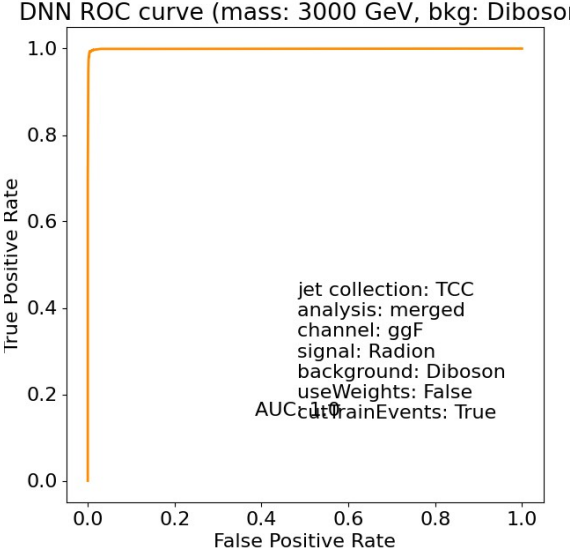
Case 3


DNN ROC curve (mass: 3000 GeV, bkg: Zjets)
True Positive Rate
False Positive Rate
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
AUC: 1.0
cutTrainEvents: True

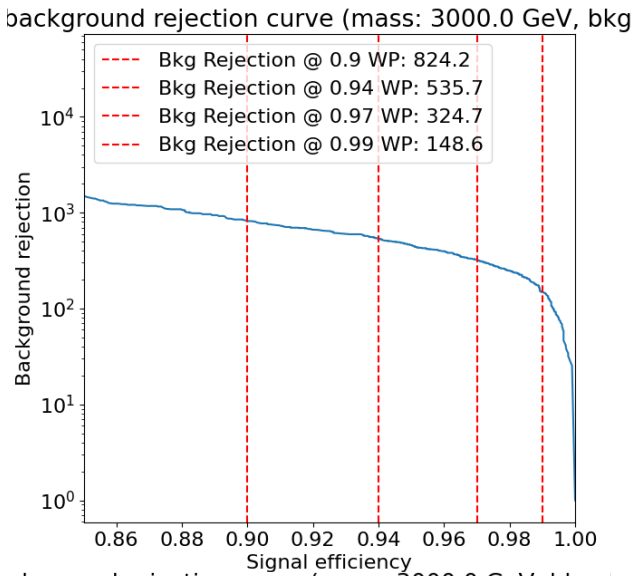

DNN ROC curve (mass: 3000 GeV, bkg: Diboson)
True Positive Rate
False Positive Rate
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
AUC: 1.0
cutTrainEvents: True

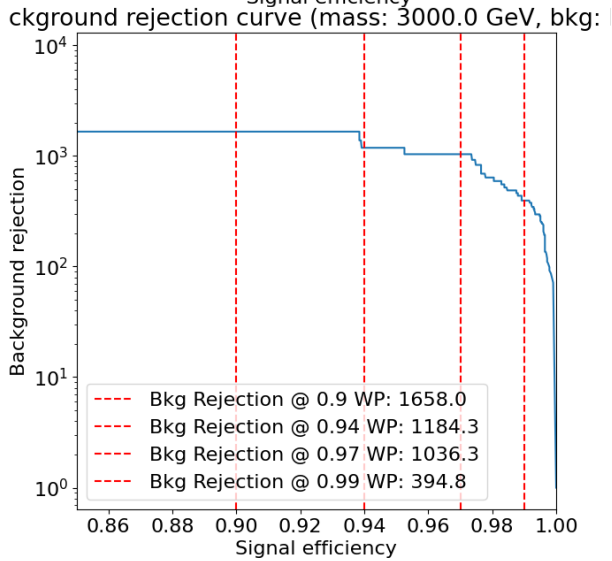
Case 4


DNN ROC curve (mass: 3000 GeV, bkg: Zjets)
True Positive Rate
False Positive Rate
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Zjets
useWeights: False
AUC: 1.0
cutTrainEvents: True

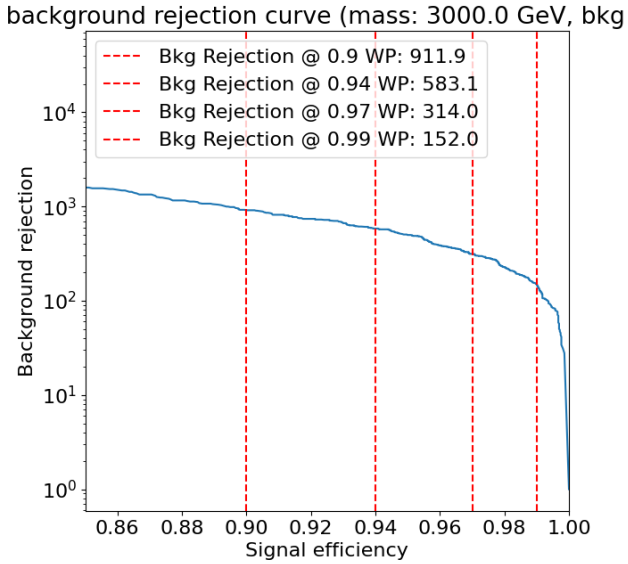

DNN ROC curve (mass: 3000 GeV, bkg: Diboson)
True Positive Rate
False Positive Rate
jet collection: TCC
analysis: merged
channel: ggF
signal: Radion
background: Diboson
useWeights: False
AUC: 1.0
cutTrainEvents: True

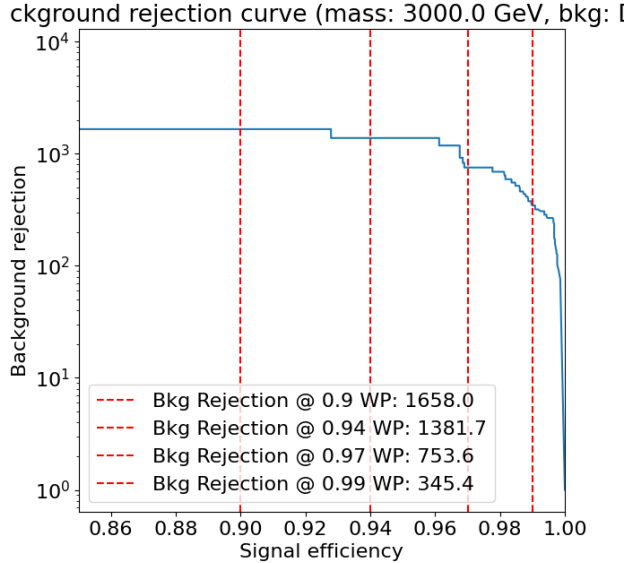
Case 0



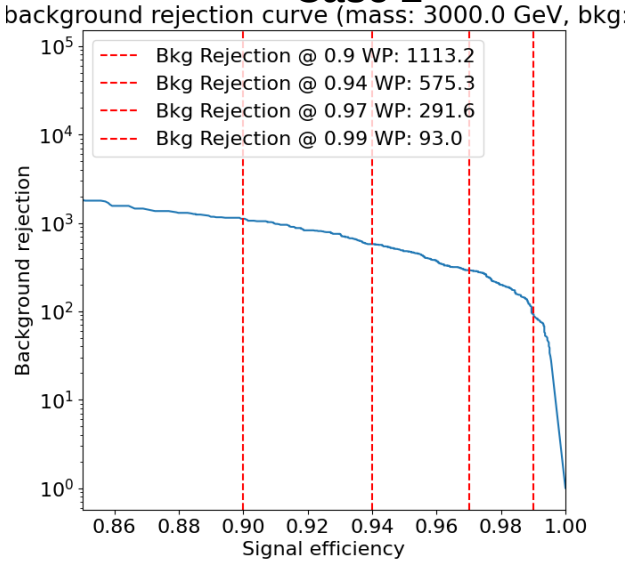


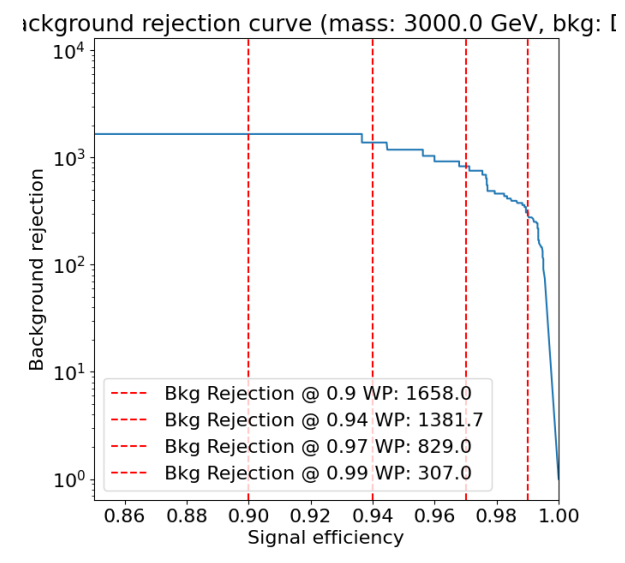
Case 1



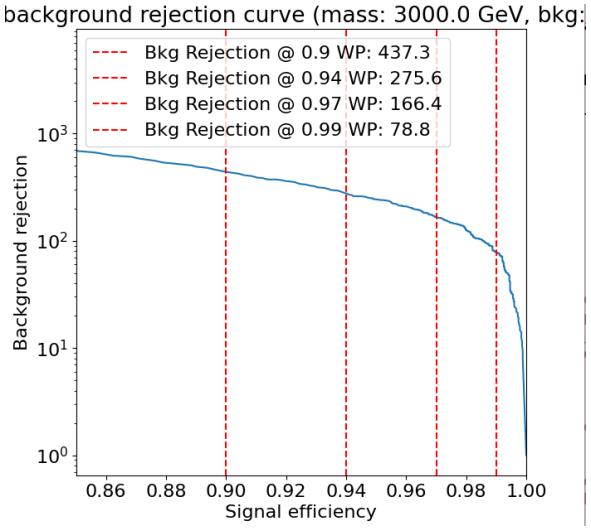


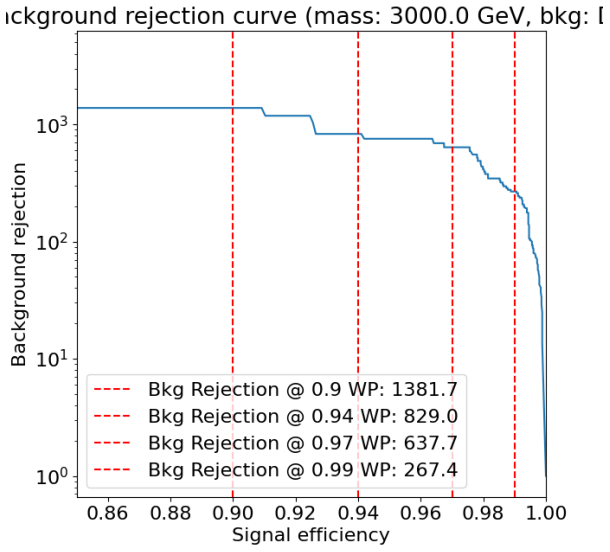
Case 2



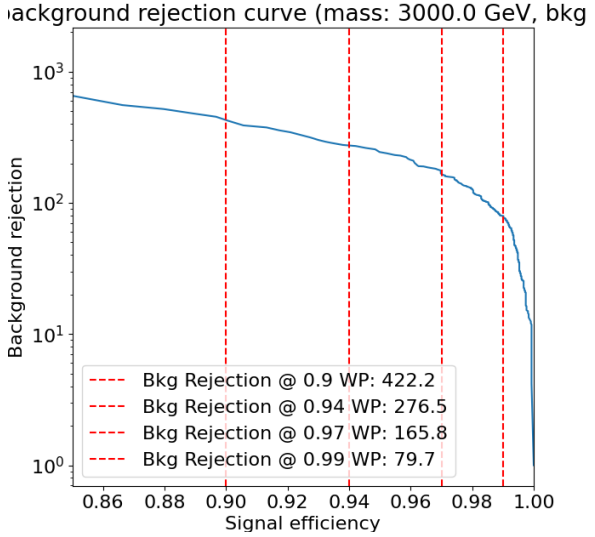


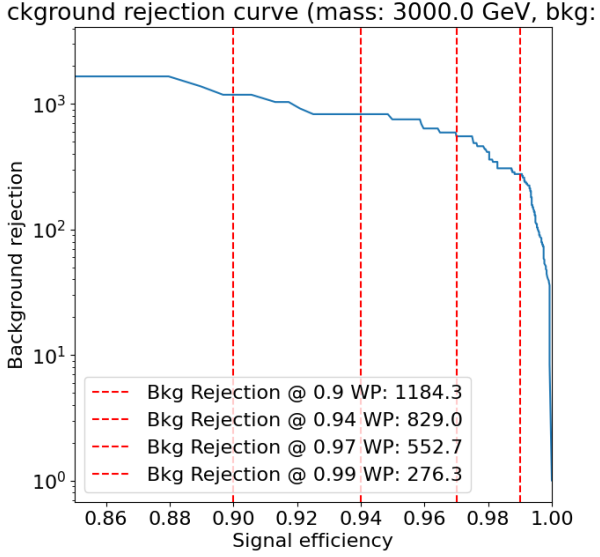
Case 3


background rejection curve (mass: 3000.0 GeV, bkg:
Bkg Rejection @ 0.9 WP: 437.3
Bkg Rejection @ 0.94 WP: 275.6
Bkg Rejection @ 0.97 WP: 166.4
Bkg Rejection @ 0.99 WP: 78.8
Background rejection
Signal efficiency

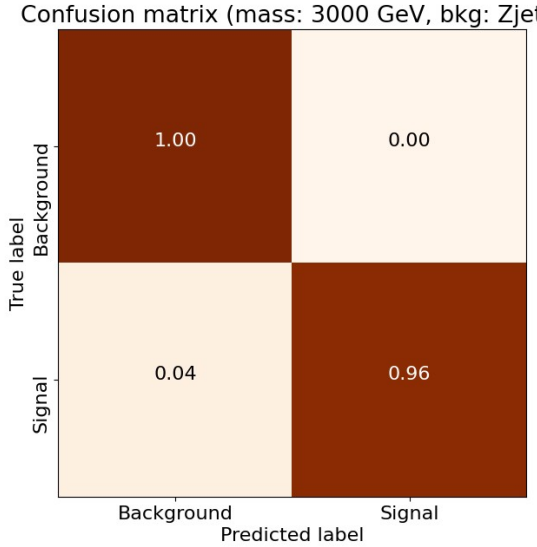

ckground rejection curve (mass: 3000.0 GeV, bkg: I
Bkg Rejection @ 0.9 WP: 1381.7
Bkg Rejection @ 0.94 WP: 829.0
Bkg Rejection @ 0.97 WP: 637.7
Bkg Rejection @ 0.99 WP: 267.4
Background rejection
Signal efficiency

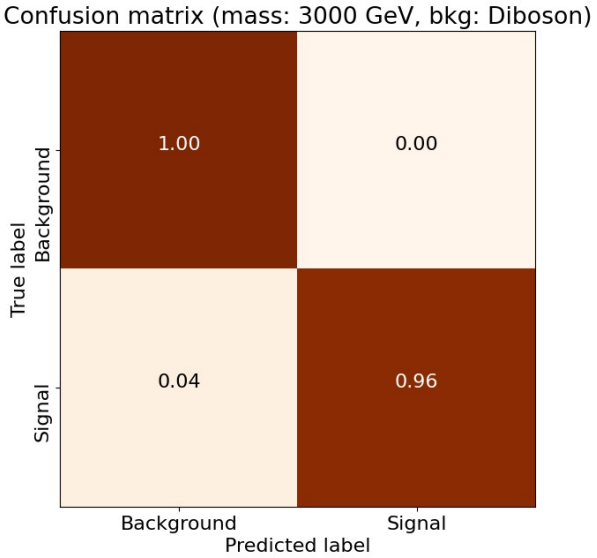
Case 4


ackground rejection curve (mass: 3000.0 GeV, bkg
Bkg Rejection @ 0.9 WP: 422.2
Bkg Rejection @ 0.94 WP: 276.5
Bkg Rejection @ 0.97 WP: 165.8
Bkg Rejection @ 0.99 WP: 79.7
Background rejection
Signal efficiency

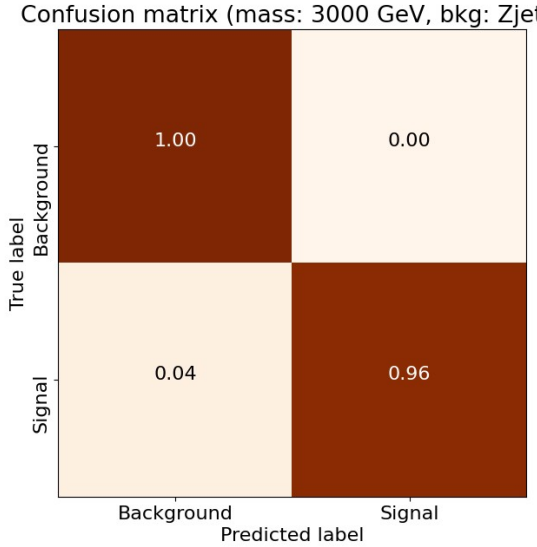

ckground rejection curve (mass: 3000.0 GeV, bkg:
Bkg Rejection @ 0.9 WP: 1184.3
Bkg Rejection @ 0.94 WP: 829.0
Bkg Rejection @ 0.97 WP: 552.7
Bkg Rejection @ 0.99 WP: 276.3
Background rejection
Signal efficiency

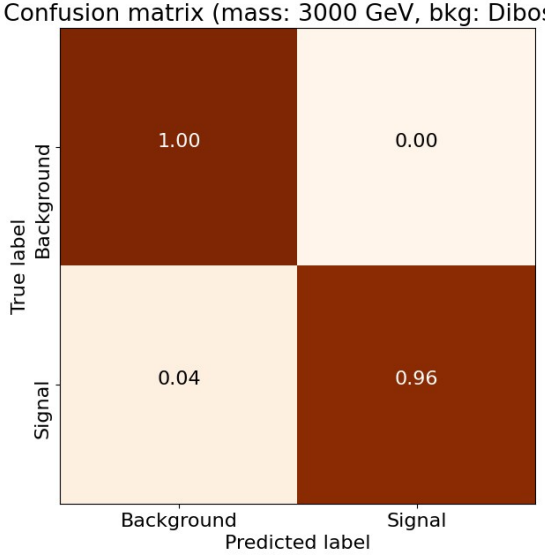
Case 0



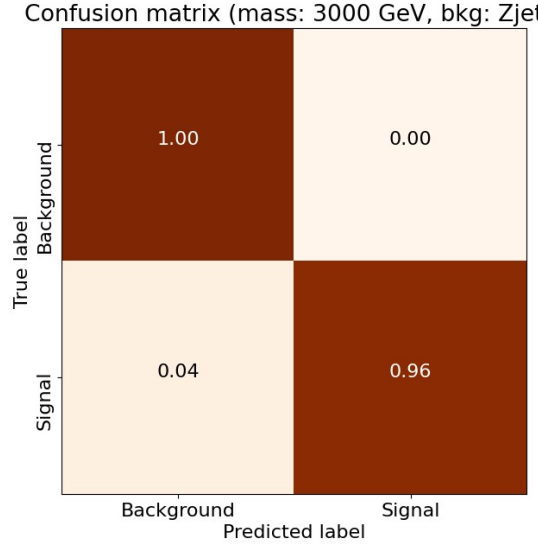


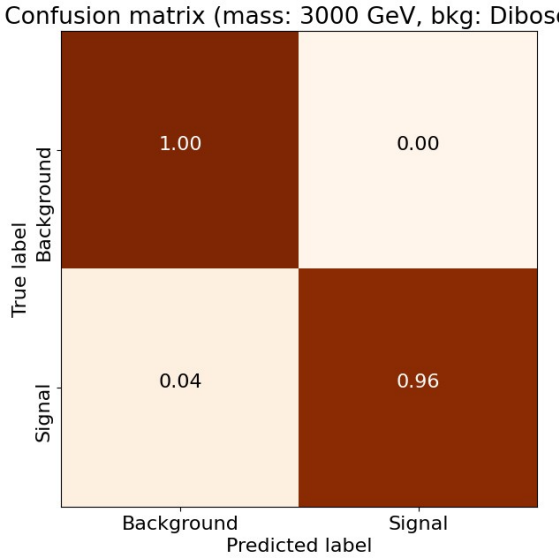
Case 1



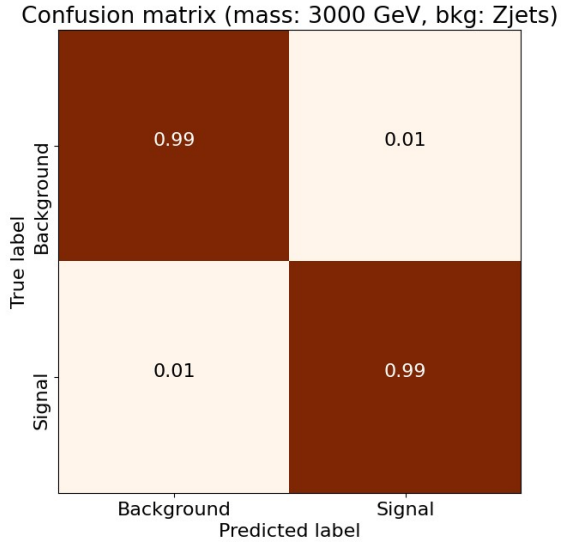


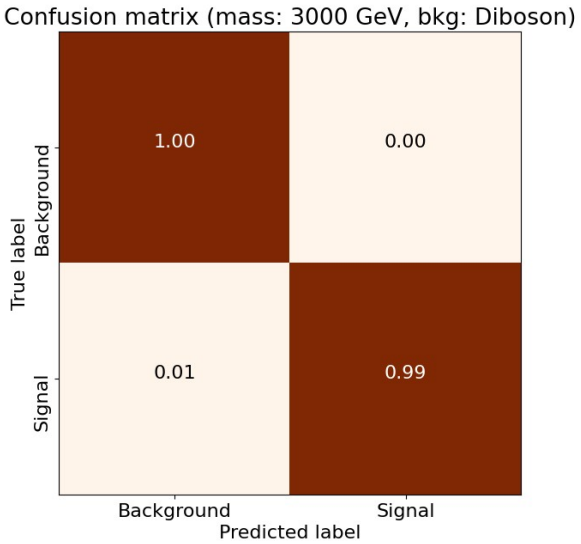
Case 2



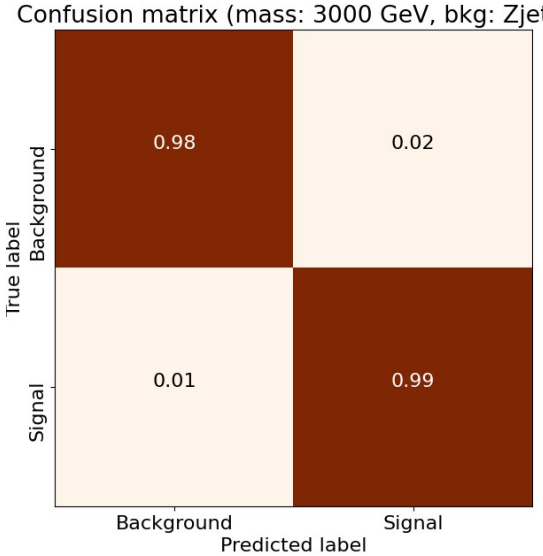


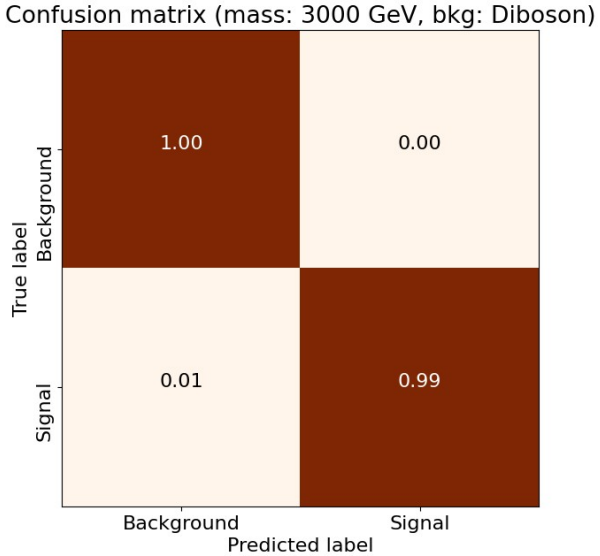
Case 3


Confusion matrix (mass: 3000 GeV, bkg: Zjets)
0.99
0.01
0.01
0.99
True label
Background
Signal
Background
Signal
Predicted label

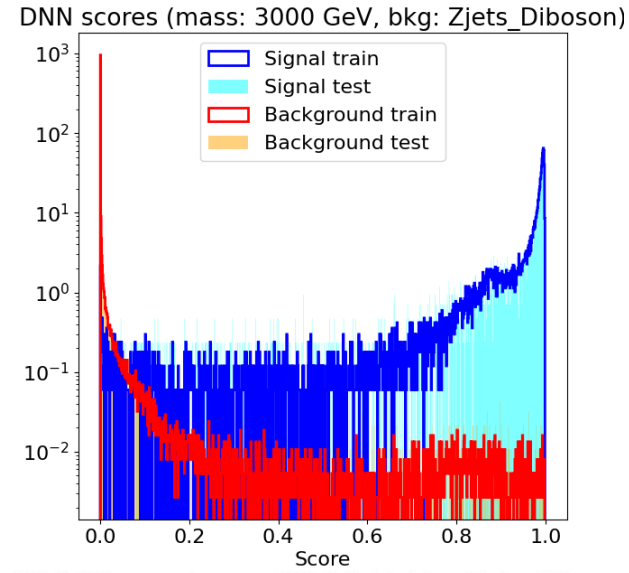

Confusion matrix (mass: 3000 GeV, bkg: Diboson)
1.00
0.00
0.01
0.99
True label
Background
Signal
Background
Signal
Predicted label

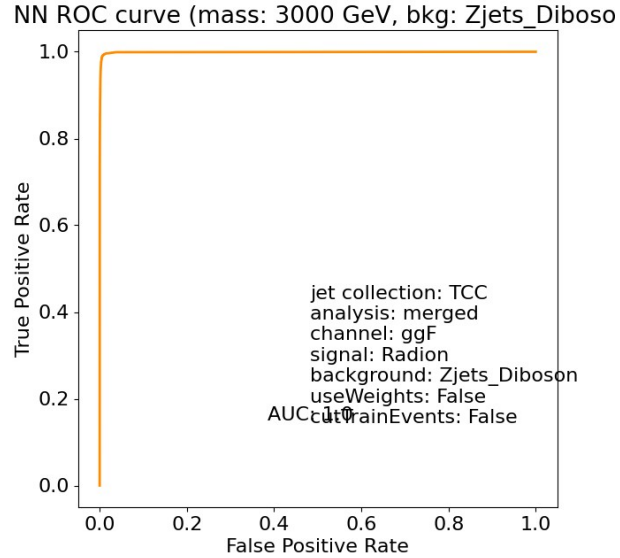
Case 4


Confusion matrix (mass: 3000 GeV, bkg: Zjets)
0.98
0.02
0.01
0.99
True label
Background
Signal
Background
Signal
Predicted label

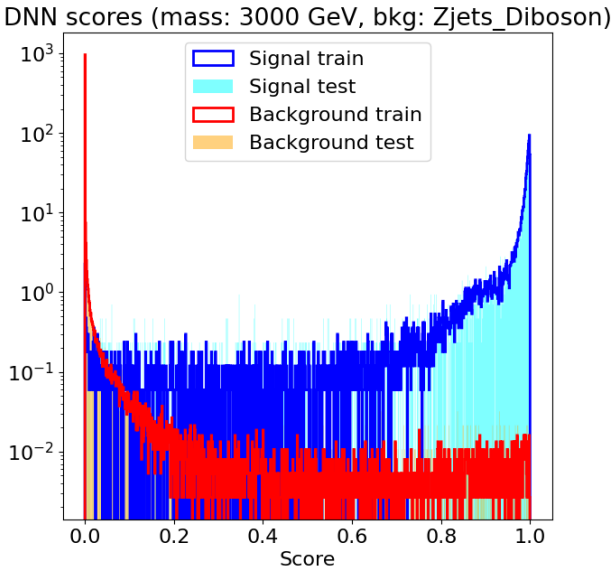

Confusion matrix (mass: 3000 GeV, bkg: Diboson)
1.00
0.00
0.01
0.99
True label
Background
Signal
Background
Signal
Predicted label

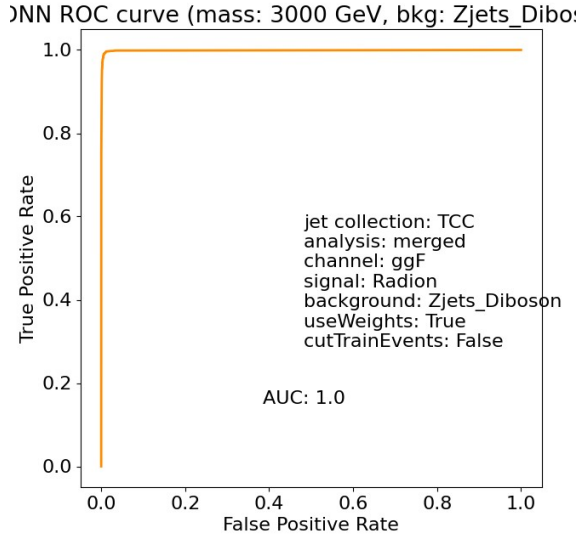
Case 0 (all bkg types)



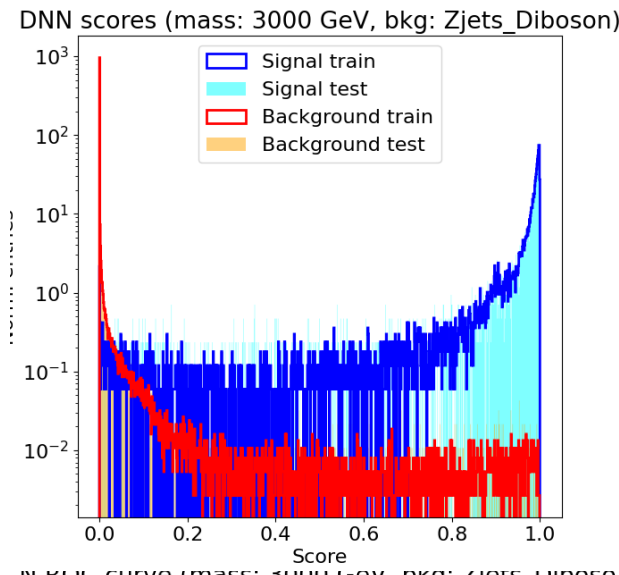


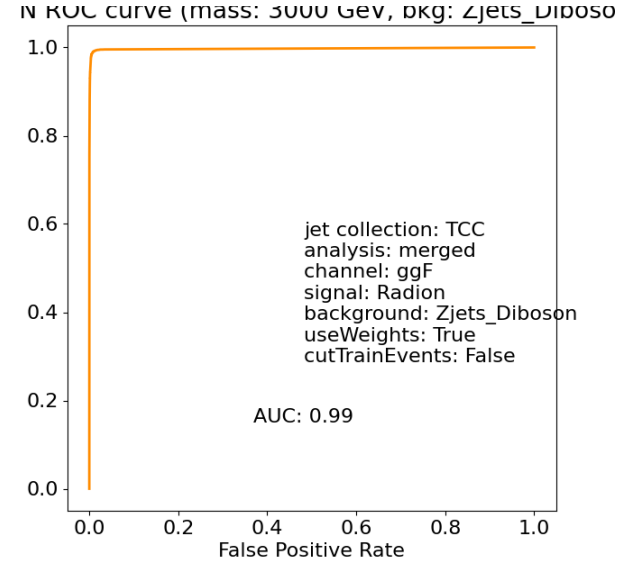
Case 1 (all bkg types)



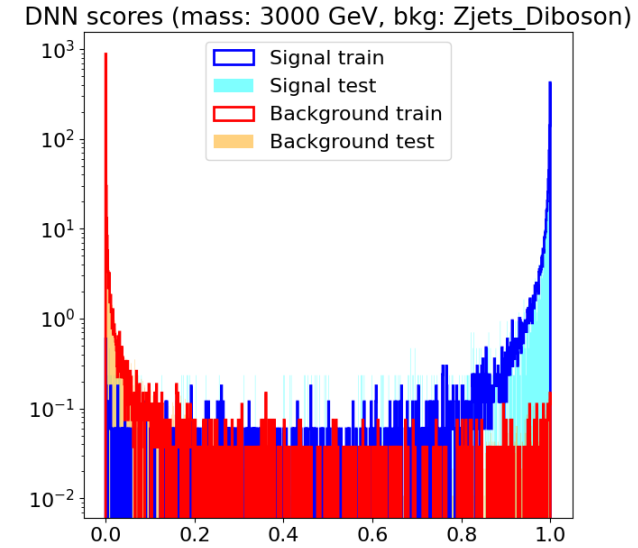


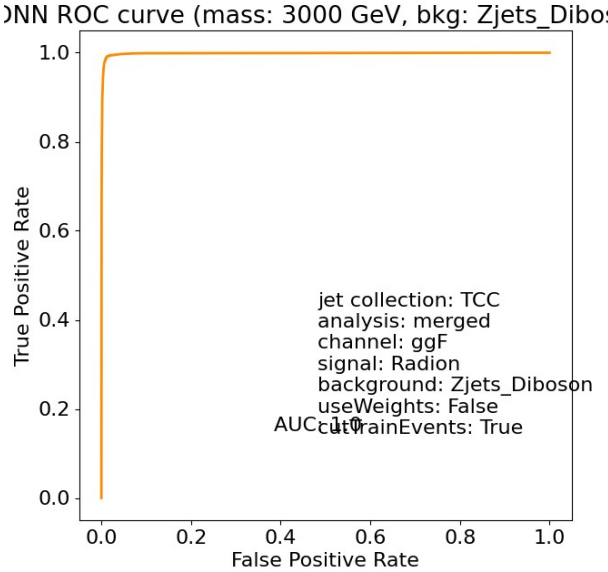
Case 2 (all bkg types)



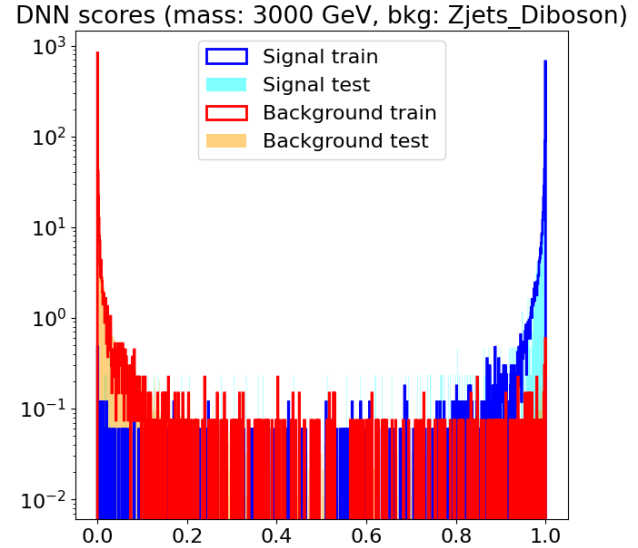


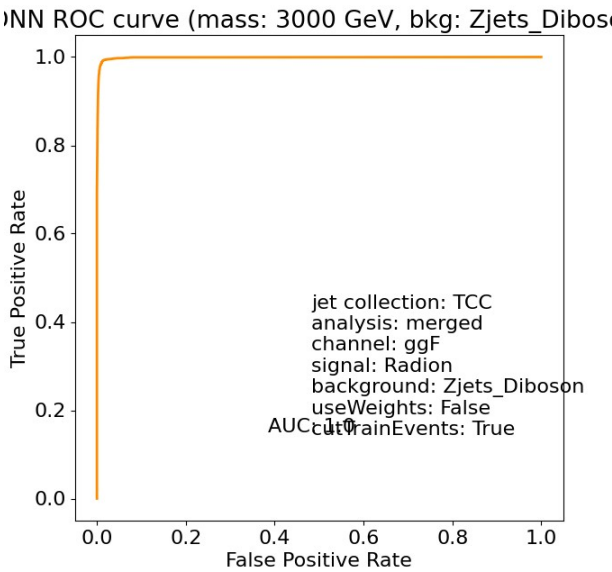
Case 3 (all bkg types)



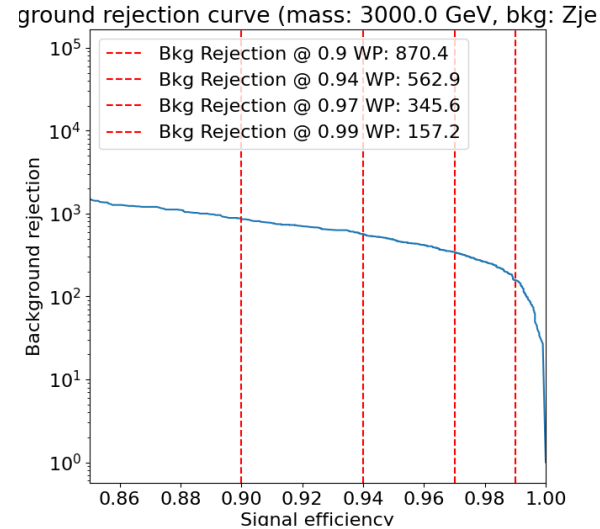


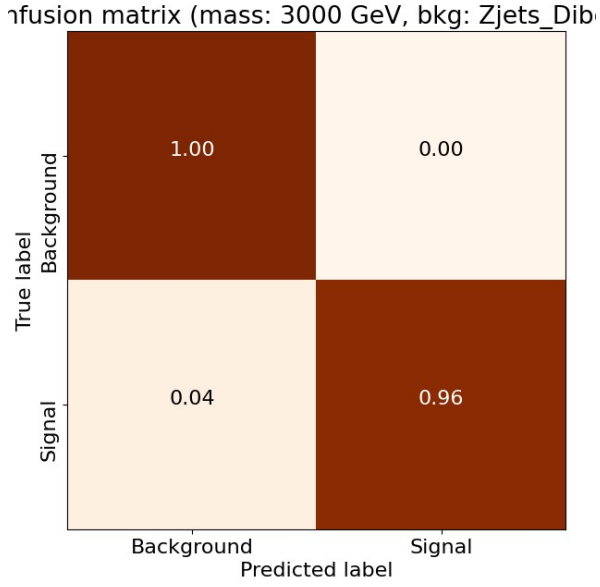
Case 4 (all bkg types)



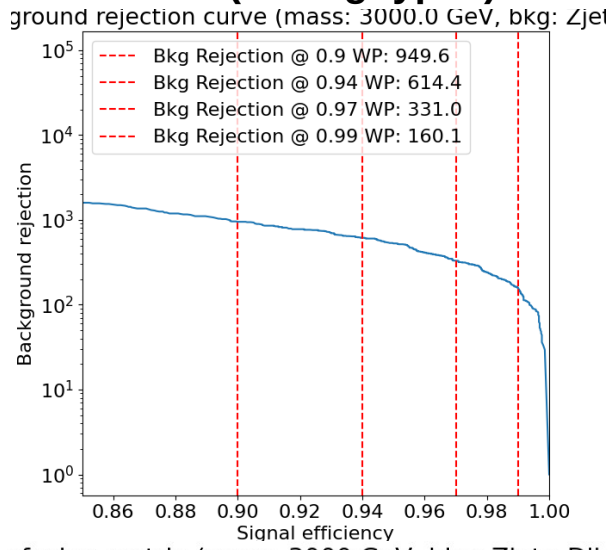


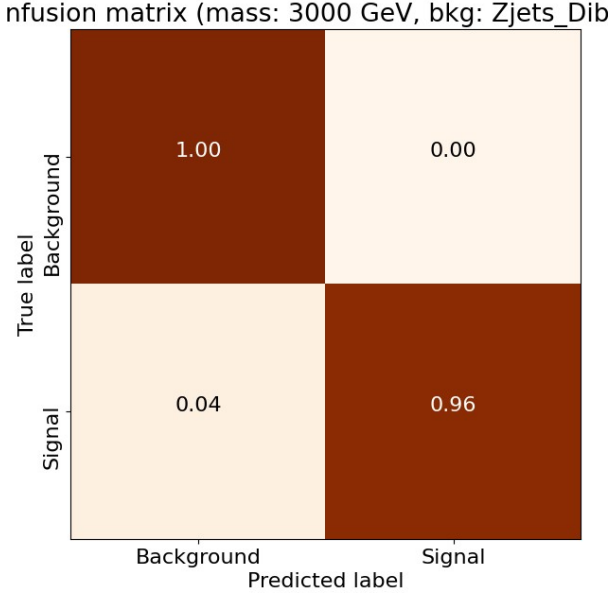
Case 0 (all bkg types)



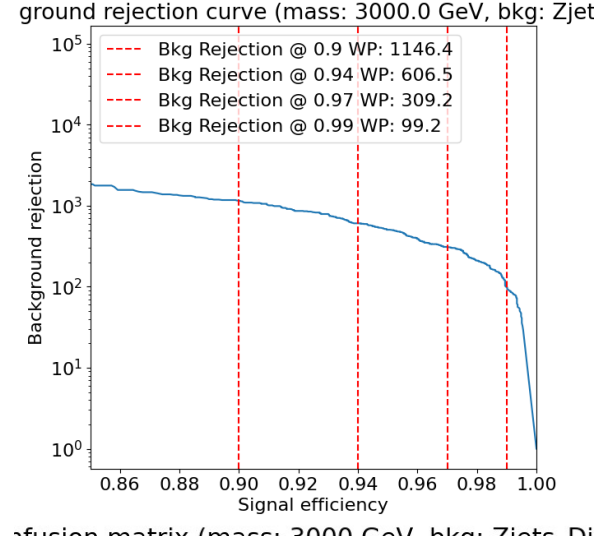


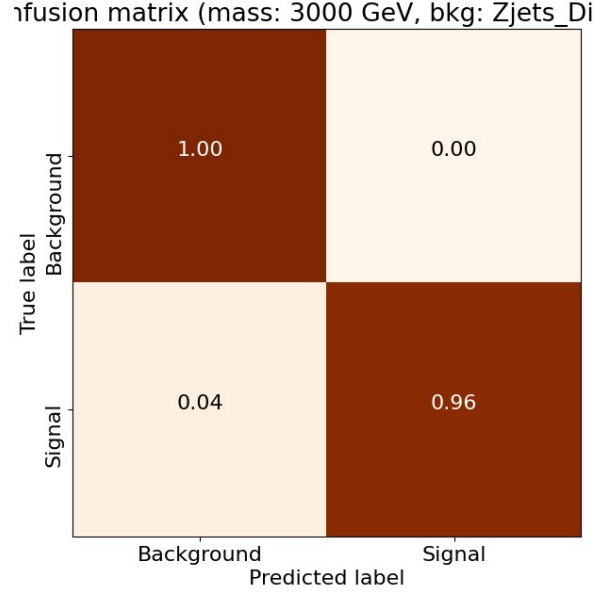
Case 1 (all bkg types)



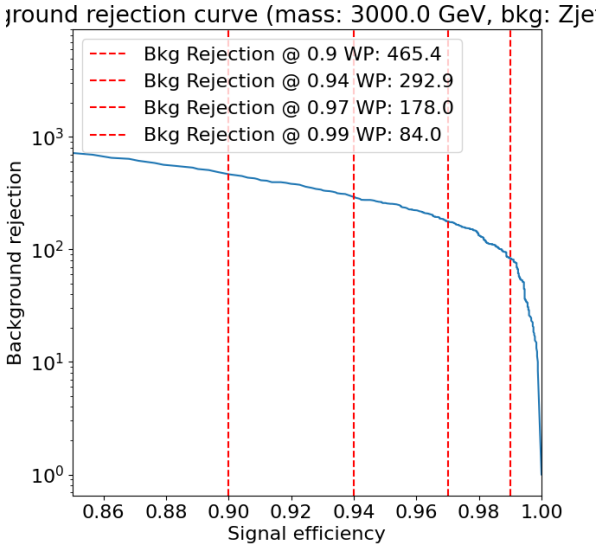


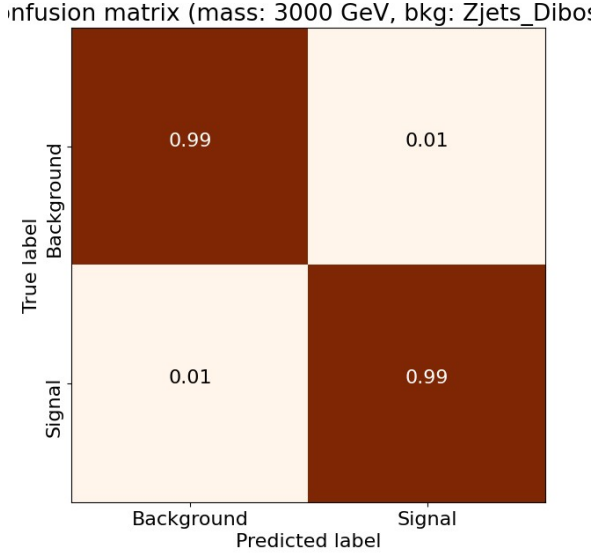
Case 2 (all bkg types)



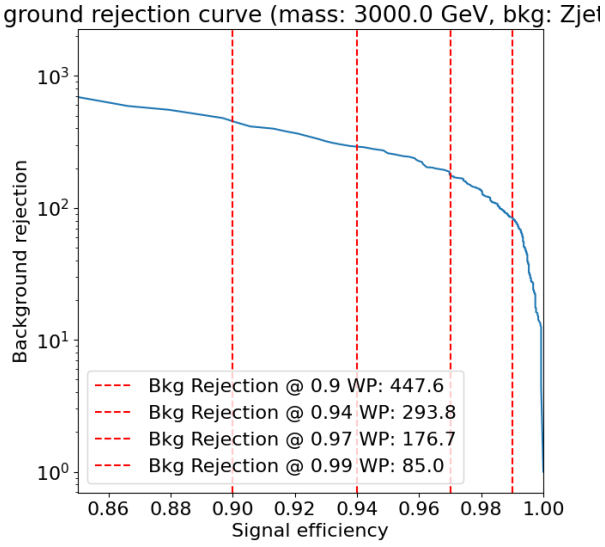


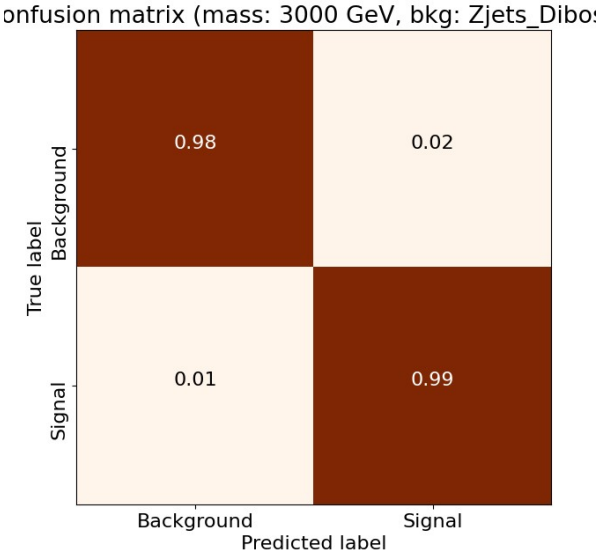
Case 3 (all bkg types)





Case 4 (all bkg types)





Conclusions

- Weighting events seems to give the best performances
- Using weights, signal efficiency is higher when the training is performed using only one background (confusion matrices) but the background rejection is worse

Next steps

- Test on each different background after training on Zjets