

# Study on Pythia Events in Different Magnetic Fields Using BDTs

$$\gamma p \rightarrow p \eta \pi^+ \pi^-$$

(08/10/2014)

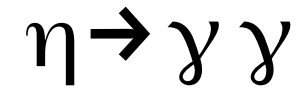
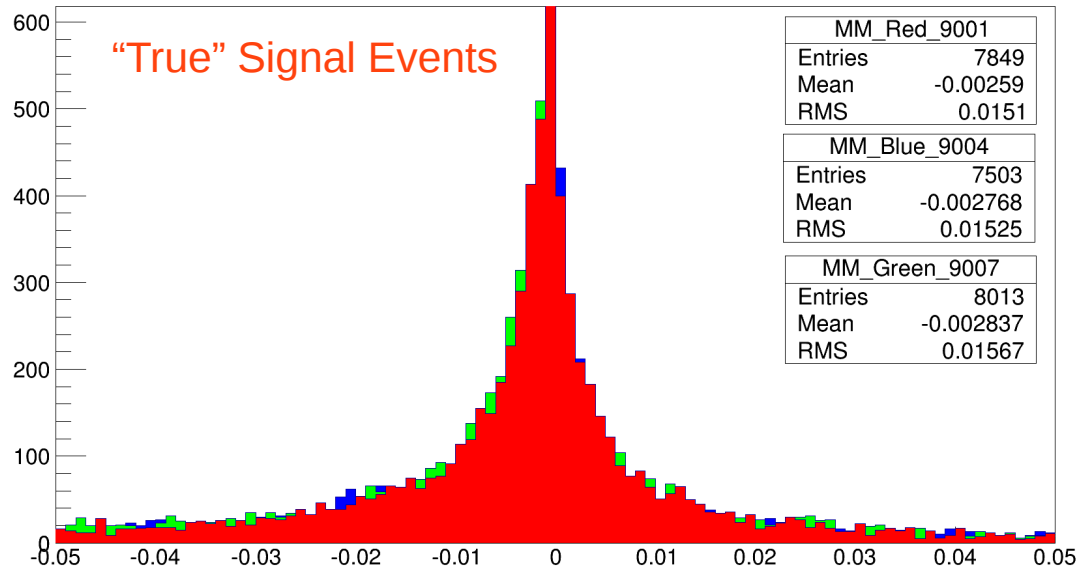
Status report

# Overview

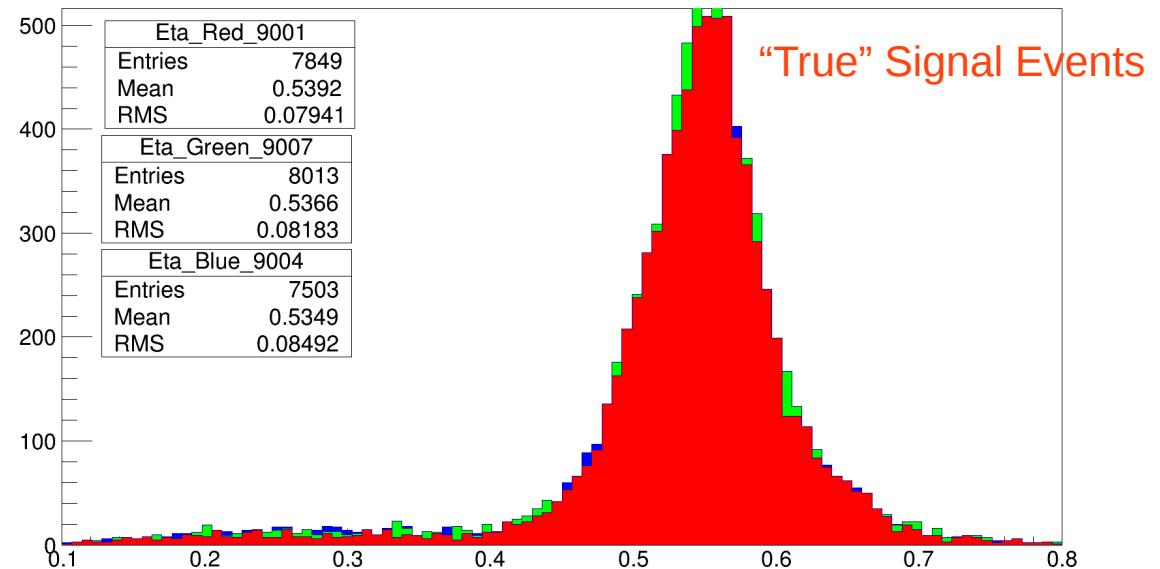
- Selection of  $\gamma p \rightarrow p \eta \pi^+ \pi^-$  over 10M pythia events, with  $\eta \rightarrow \gamma \gamma$ .
- Only the exclusive reaction is presented, with 1.1E7 EM background rate.
- 9001: 1350A
- 9004: 1500A
- 9007: 1200A
- **All preliminary results**; still changing parameters for the BDT and then we need to tune things.

# Mass distribution for the three different currents

Missing Mass Sq (Measured)

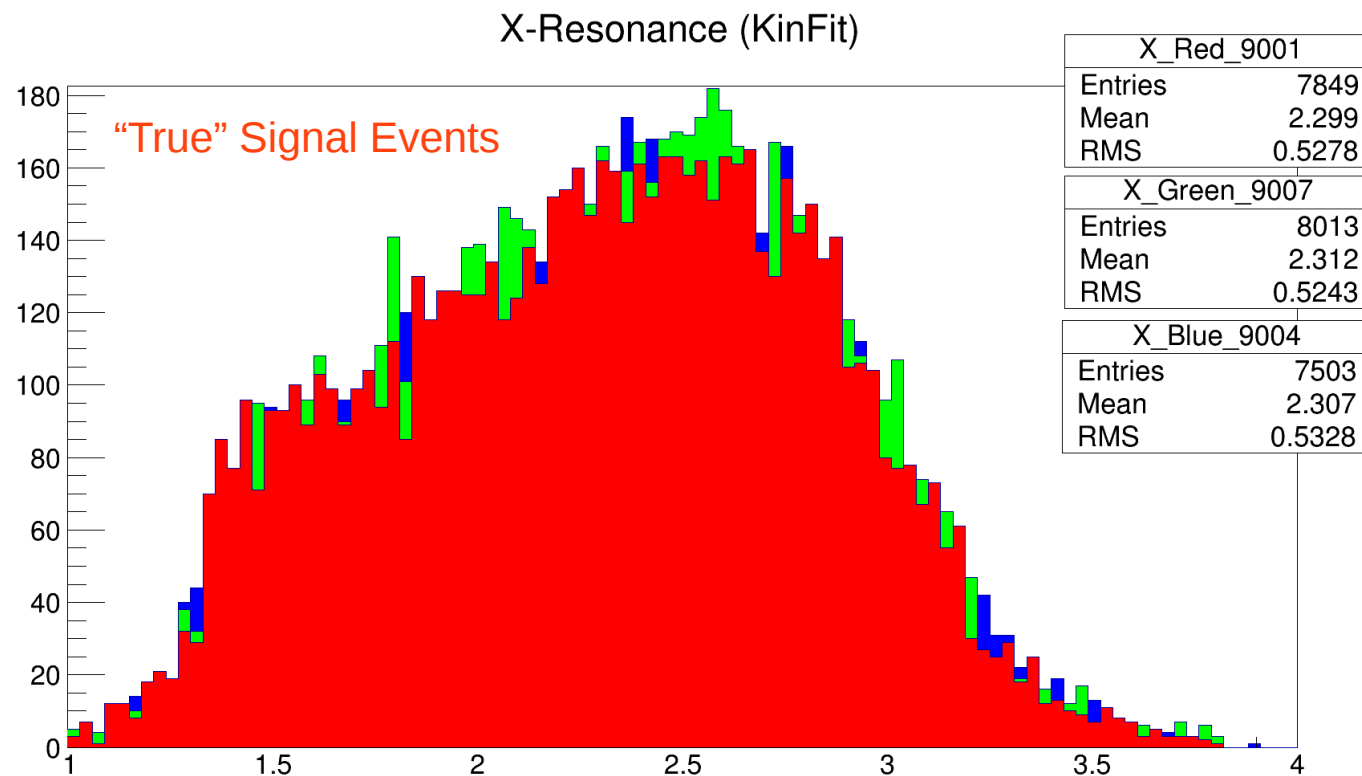


Eta (Measured)



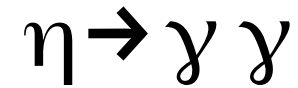
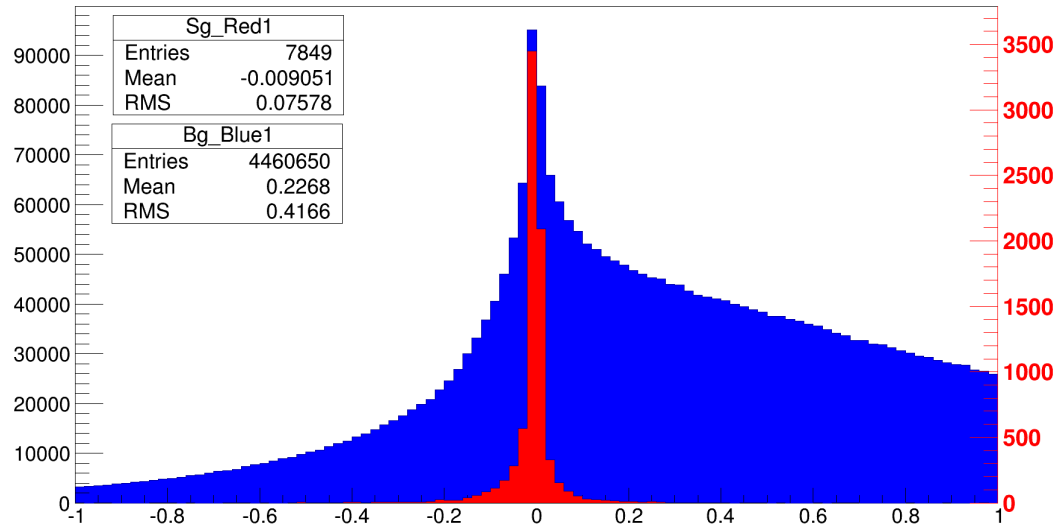
# Mass distribution for the three different currents

$$X \rightarrow \pi^+ \pi^- \eta$$

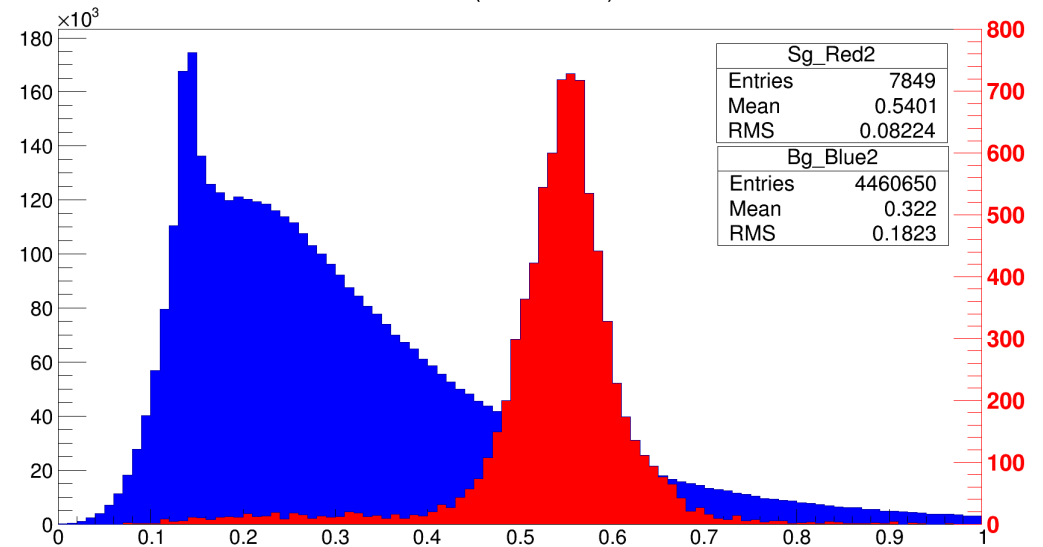


# Signal Vs Background for the BDT for 9001 (1350A)

Missing Mass Sq (Measured)

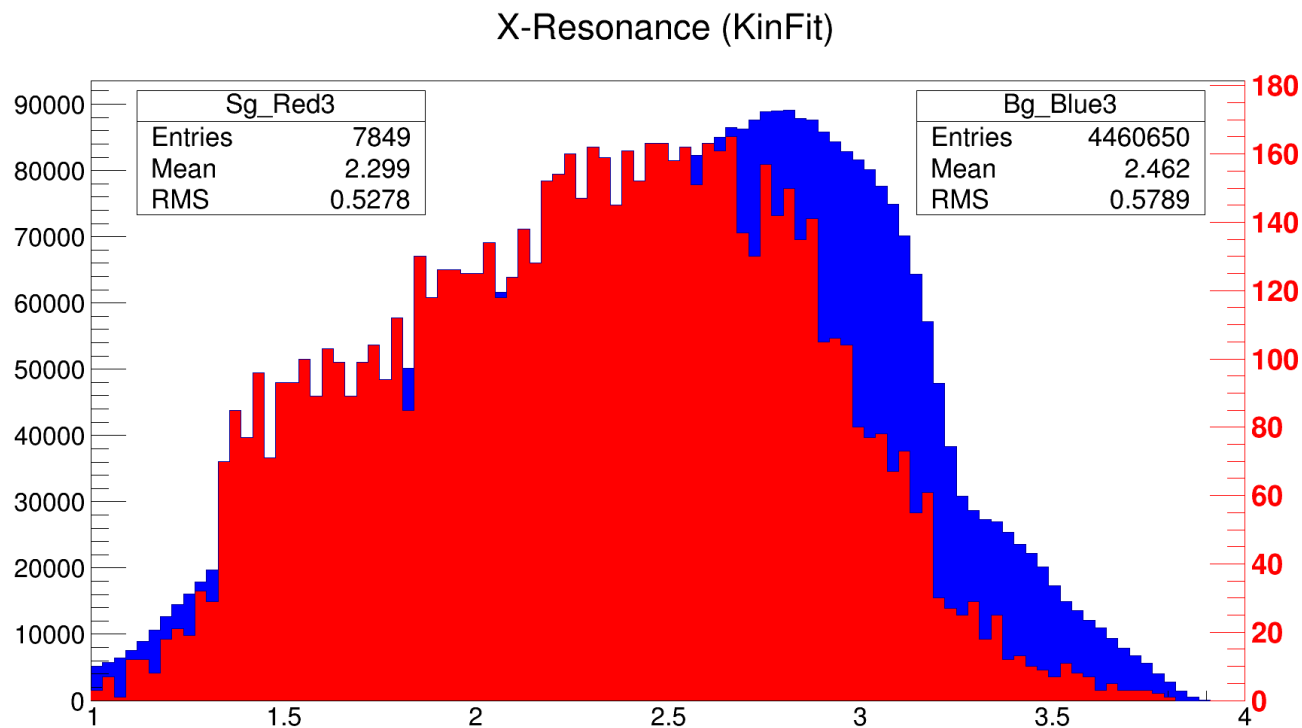


Eta (Measured)



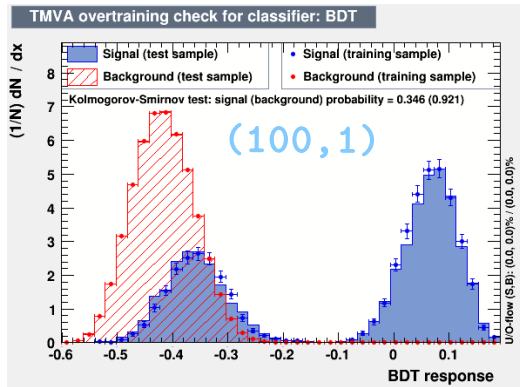
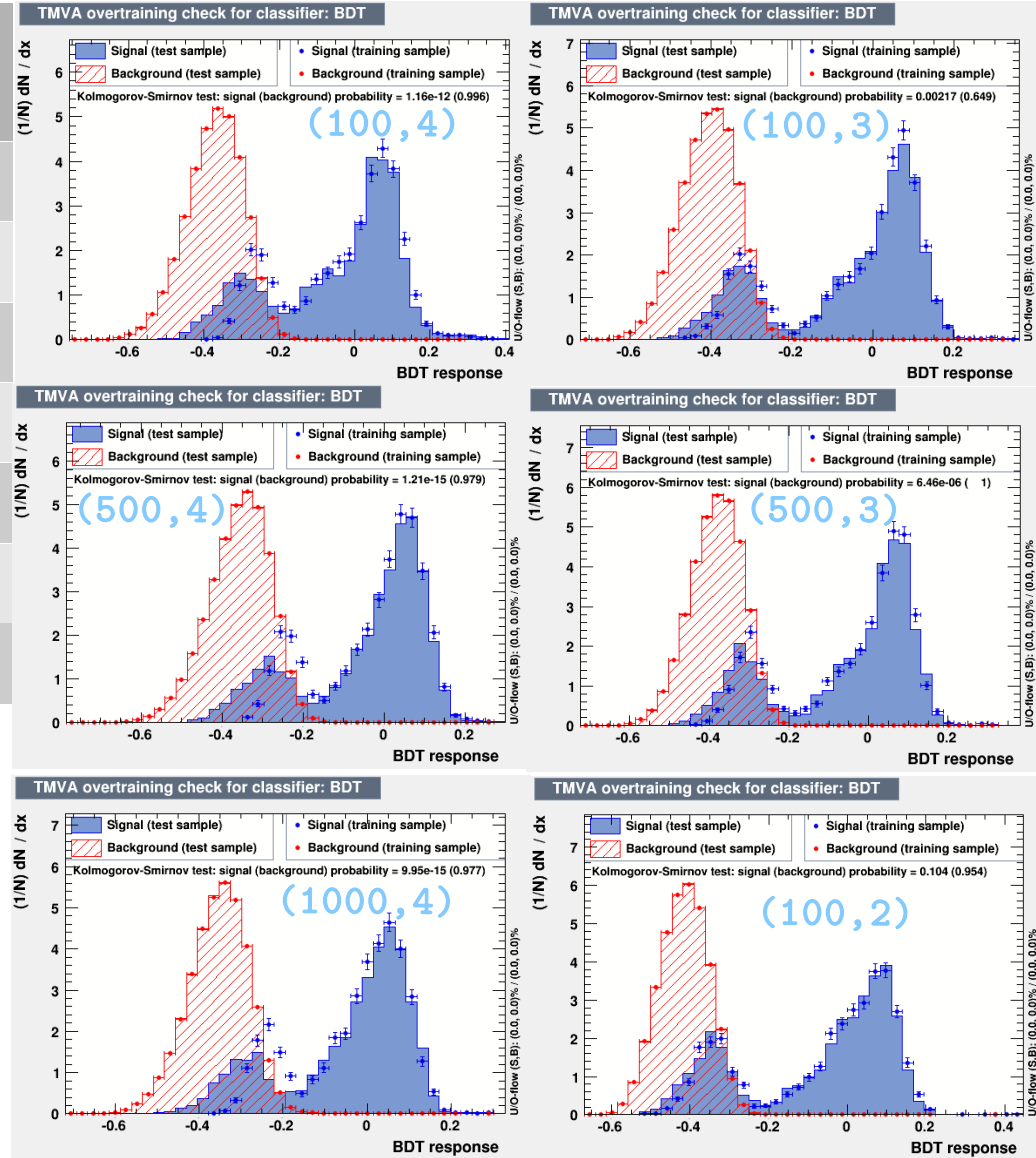
# Signal Vs Background for the BDT for 9001 (1350A)

$$X \rightarrow \pi^+ \pi^- \eta$$



# BDT response variable for 9001 (1350A)

(NeventsMin , MaxDepth)	Kolmogorov-Smirnov test: Signal(Bg)
(100,4)	1.16e-12(0.996)
(100,3)	0.00217(0.649)
(500,4)	1.21e-15(0.979)
(500,3)	6.46e-06(1)
(1000,4)	9.95e-15(0.977)
(100,2)	0.104(0.954)
(100,1)	0.346(0.921)



# Top Ranking Variables & Purity- Efficiency for the three Currents (100,4)

Rank	Variable	Variable Importance
1	FOM_KinFit	1.630e-01
2	Proton_DCdEdx_FOM	8.267e-02
3	Proton_NDF_Tracking	6.871e-02
4	Photon2_Timing_FOM	6.800e-02
5	PiPlus_Timing_FOM	6.557e-02
6	Photon1_Timing_FOM	6.271e-02
7	PiPlus_DCdEdx_FOM	5.931e-02
8	Unused_Max_KPlus_FOM	5.763e-02
9	Unused_Max_Proton_FOM	5.729e-02
10	Proton_Timing_FOM	5.521e-02
11	Unused_Max_KMinus_FOM	5.514e-02
12	PiMinus_NDF_Tracking	5.208e-02
13	PiPlus_NDF_Tracking	5.126e-02
14	PiMinus_Timing_FOM	5.083e-02
15	PiMinus_DCdEdx_FOM	5.060e-02

9001

Rank	Variable	Variable Importance
1	FOM_KinFit	1.769e-01
2	Proton_DCdEdx_FOM	8.959e-02
3	Photon1_Timing_FOM	6.947e-02
4	Proton_NDF_Tracking	6.900e-02
5	PiMinus_Timing_FOM	6.566e-02
6	Proton_Timing_FOM	6.039e-02
7	Unused_Max_KPlus_FOM	5.848e-02
8	PiPlus_Timing_FOM	5.650e-02
9	Unused_Max_Proton_FOM	5.617e-02
10	Photon2_Timing_FOM	5.465e-02
11	PiPlus_DCdEdx_FOM	5.362e-02
12	PiMinus_DCdEdx_FOM	5.068e-02
13	Unused_Max_KMinus_FOM	5.004e-02
14	PiMinus_NDF_Tracking	4.976e-02
15	PiPlus_NDF_Tracking	3.904e-02

9004

Rank	Variable	Variable Importance
1	FOM_KinFit	1.792e-01
2	Proton_DCdEdx_FOM	8.193e-02
3	PiPlus_Timing_FOM	7.306e-02
4	Photon1_Timing_FOM	6.393e-02
5	Photon2_Timing_FOM	6.318e-02
6	Proton_NDF_Tracking	5.985e-02
7	Unused_Max_KPlus_FOM	5.944e-02
8	Proton_Timing_FOM	5.604e-02
9	Unused_Max_Proton_FOM	5.569e-02
10	Unused_Max_KMinus_FOM	5.496e-02
11	PiPlus_DCdEdx_FOM	5.387e-02
12	PiMinus_NDF_Tracking	5.316e-02
13	PiMinus_DCdEdx_FOM	5.277e-02
14	PiMinus_Timing_FOM	5.274e-02
15	PiPlus_NDF_Tracking	4.016e-02

9007



# Top Ranking Variables & Purity- Efficiency for the three Currents (100,4)

Run ## %	Field (A)	Efficiency (error)	Purity			# Correct Thrown*	# Signal events	Background Combos	Accepted* (%)
			0.99	0.9	0.7				
9007	1200	0.781(06)	0.870(05)	0.946(03)	83329	8013(90)	6.5M	24.4(0.3)	
9001	1350	0.772(06)	0.878(05)	0.952(03)	82937	7849(89)	4.5M	24.0(0.3)	
9004	1500	0.765(07)	0.861(05)	0.943(03)	83100	7503(87)	5M	22.9(0.3)	

(\*) The number of correct thrown is for the total  $\gamma p \rightarrow p \eta \pi^+ \pi^-$  reaction where the percent accepted is only for the  $\eta \rightarrow \gamma \gamma$  mode (which is the one that the report refers to).

Run #	Field (A)	% of Thrown events passing BDT cut at given purity		
		0.99	0.9	0.7
9007	1200	19.1	21.2	23.1
9001	1350	18.5	21.1	22.9
9004	1500	17.5	19.7	21.6

# Top Ranking Variables & Purity- Efficiency for the three Currents (100,2)

```

-----
: Rank : Variable                : Variable Importance
-----
: 1 : FOM_KinFit                  : 2.717e-01
: 2 : Unused_Max_Proton_FOM      : 8.974e-02
: 3 : Photon2_Timing_FOM         : 8.472e-02
: 4 : Photon1_Timing_FOM         : 8.337e-02
: 5 : PiPlus_Timing_FOM          : 7.204e-02
: 6 : Unused_Max_KPlus_FOM       : 6.825e-02
: 7 : Unused_Max_KMinus_FOM      : 6.211e-02
: 8 : PiMinus_DCdEdx_FOM         : 6.181e-02
: 9 : PiMinus_Timing_FOM         : 5.854e-02
: 10 : PiPlus_DCdEdx_FOM         : 5.699e-02
: 11 : PiMinus_NDF_Tracking       : 5.143e-02
: 12 : PiPlus_NDF_Tracking        : 3.926e-02
-----

```

9001

```

-----
: Rank : Variable                : Variable Importance
-----
: 1 : FOM_KinFit                  : 3.264e-01
: 2 : Unused_Max_Proton_FOM      : 1.011e-01
: 3 : Photon1_Timing_FOM         : 8.263e-02
: 4 : Unused_Max_KPlus_FOM       : 8.153e-02
: 5 : Photon2_Timing_FOM         : 7.212e-02
: 6 : PiPlus_Timing_FOM          : 6.813e-02
: 7 : PiPlus_DCdEdx_FOM         : 6.747e-02
: 8 : PiMinus_Timing_FOM         : 5.483e-02
: 9 : PiPlus_NDF_Tracking        : 4.324e-02
: 10 : PiMinus_DCdEdx_FOM        : 3.776e-02
: 11 : Unused_Max_KMinus_FOM      : 3.368e-02
: 12 : PiMinus_NDF_Tracking       : 3.106e-02
-----

```

9004

```

-----
: Rank : Variable                : Variable Importance
-----
: 1 : FOM_KinFit                  : 3.047e-01
: 2 : Unused_Max_Proton_FOM      : 9.342e-02
: 3 : Photon1_Timing_FOM         : 8.476e-02
: 4 : PiPlus_DCdEdx_FOM         : 7.755e-02
: 5 : PiPlus_Timing_FOM          : 6.902e-02
: 6 : PiMinus_DCdEdx_FOM         : 6.480e-02
: 7 : Photon2_Timing_FOM         : 6.190e-02
: 8 : Unused_Max_KMinus_FOM      : 5.385e-02
: 9 : PiPlus_NDF_Tracking        : 5.341e-02
: 10 : PiMinus_NDF_Tracking       : 4.940e-02
: 11 : Unused_Max_KPlus_FOM       : 4.784e-02
: 12 : PiMinus_Timing_FOM         : 3.939e-02
-----

```

9007

# Top Ranking Variables & Purity- Efficiency for the three Currents (100,2)

Run #	Field (A)	Efficiency (error)	Purity		
			0.99	0.9	0.7
9007	1200		0.723(07)	0.817(06)	0.911(04)
9001	1350		0.747(07)	0.829(06)	0.916(04)
9004	1500		0.719(07)	0.807(06)	0.901(05)

Run #	Field (A)	% of Thrown events passing BDT cut at given purity		
		0.99	0.9	0.7
9007	1200	17.6	19.9	22.2
9001	1350	17.9	19.9	22.0
9004	1500	16.5	18.5	20.6

# Future Plans

- Find parameters with acceptable BDT response variables.
- Include different variables to the BDT and check the importance and efficiency.
- Expand the analysis to the inclusive reaction and for different EM backgrounds.
- Use the postTrain to evaluate the performance of different BDT cuts using the same sample.
- Do the same analysis for the other two modes of the eta decay.