

# Application of BNN for prompt/ non prompt separation in ALICE @5TeV in Pb-Pb

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# Data set

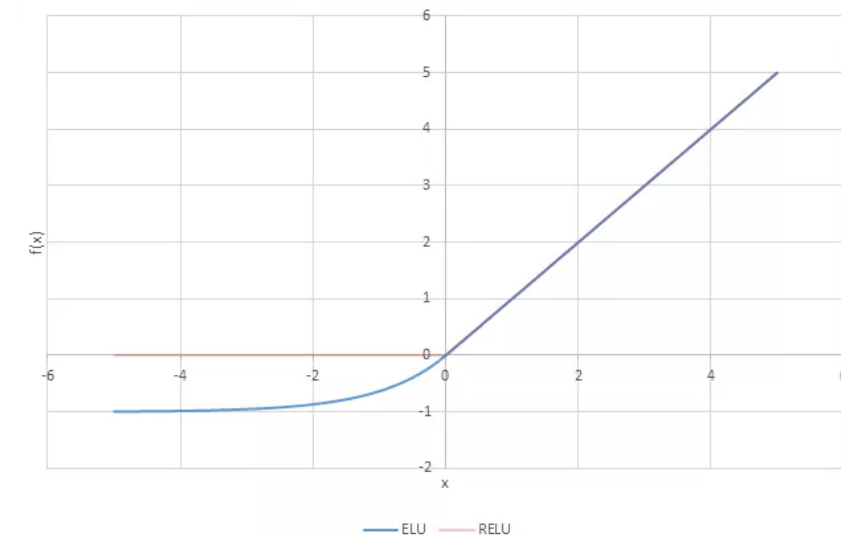
- 2 M events
- **Number of Candidates 2.5 M (RAW), 10 candidates per event on average**
- 70% prompt events generate by HIJING
- 30% B decays by EvtGen
- Only  $e^+ e^-$  final state (by particle ID)

# The Network

- TensorFlow 1.15
- PCA (decorrelation)
- NumPy for data storage
- 50/50 Signal background mixing
- 85 element input vector
- 4 hidden layers
  - 100 neurons
  - 165 neurons (3x)
  - Activation function “Elu[**Exponential Linear Unit**]”
  - 70/30 prompt /non prompt mixing for test validation

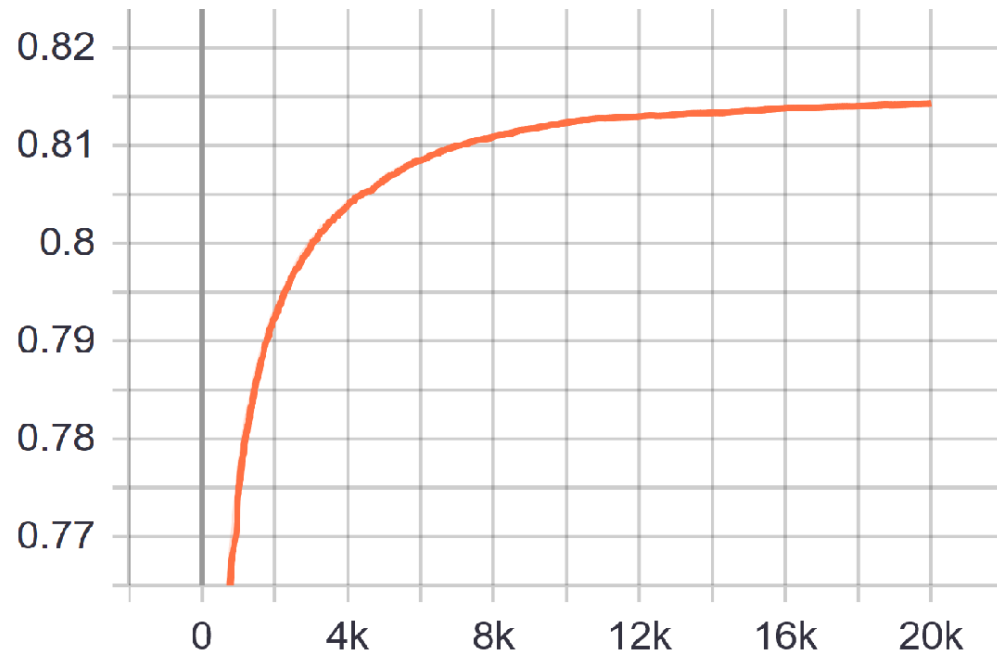
## NN properties:

- 15 min for data loading to NumPy
- 1 min training for 20k iterations
- 10 min for weight application
- Ram usage 32 Gb + 50 Gb swap
- 6 Gb ddr6 GPU (RTX 2060)



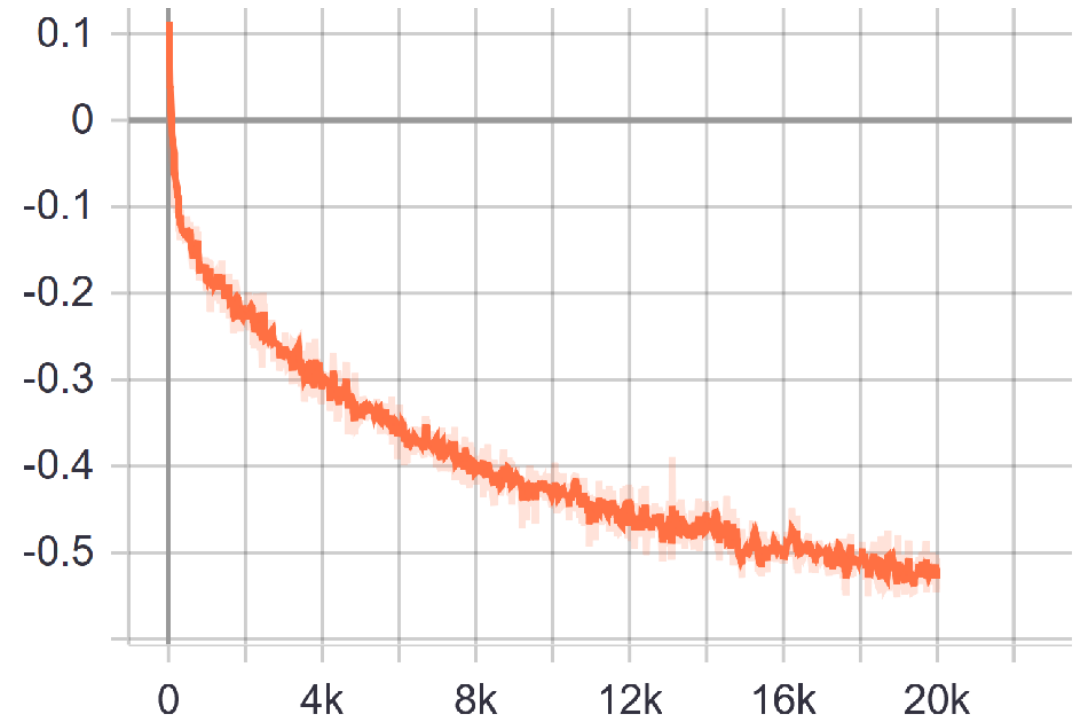
# Training on GPU

- 20 000 training iterations



- More training iterations
- Unstable system (look loss function)

Los function



## Dominating Processes :

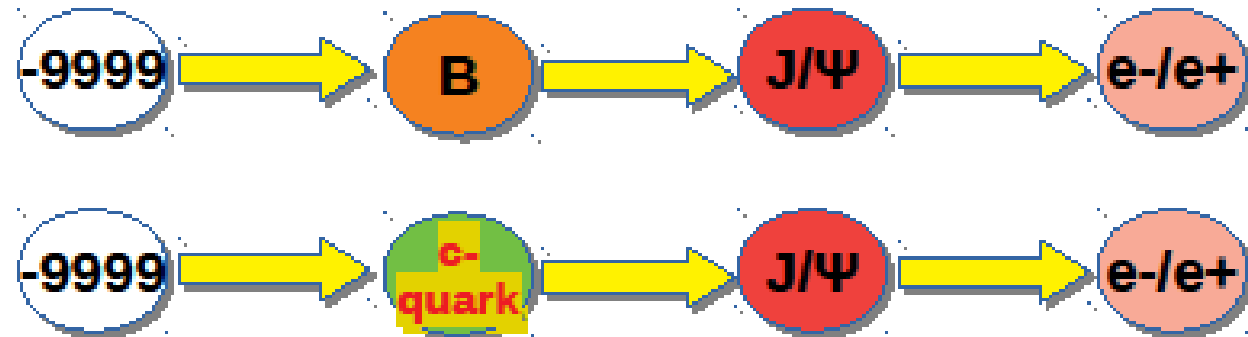


### # Number of Processes

→ # 5,040,030

→ # 8,245,574

## Rare Processes :



→ # 15,304

→ # 846

# Model nr 1

- Signal =  $\text{Ele\_fGrandGrandMother} > -9999 \ \&\& \ \text{abs}(\text{Ele\_fGrandGrandMother}) \neq 5$
- $\text{bg\_sel} = \text{'Ele\_fGrandGrandMother} == -9999\text{'}$

=====  
 All numbers come from Invariant mass integral from 2.9 to 3.2 GeV  
=====

===== BEFORE the NN =====

- All reconstructed J/psi 474321
- Number of non prompt J/psi 136619
- Number of Prompt J/psi 337452

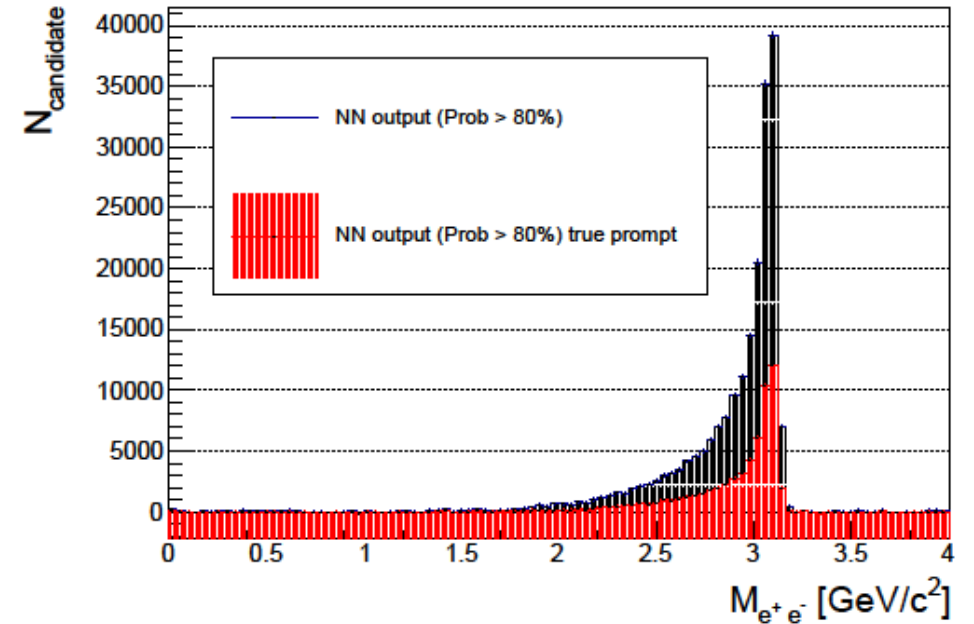
===== After NN (Prob > 80%) =====

- Number of non prompt J/psi 102547 (true)
- Number of Prompt J/psi 42909 (true)
- Total number of J/psi after NN 145456 marked as Non prompt
- Contamination is 29%

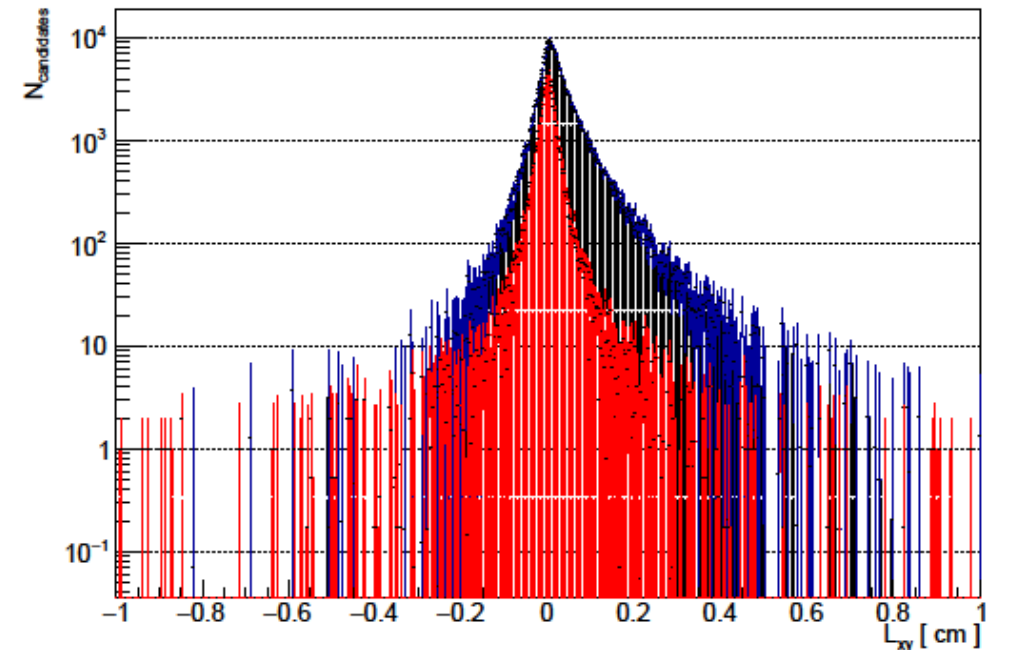
==== Reduction rate of NN =====

- For Prompt the sample is reduced **7.9** times
- For non prompt the sample is reduced **1.3** times

*All plots after combinatorial background subtraction!*



**Binning set to 1000 for higher precision**



# Model nr 2

- `s_sel = 'Ele_fGrandGrandMother > -9999 && abs(Ele_fGrandGrandMother) != 5 && Ele_fMother == 443'`

- `bg_sel = 'Ele_fGrandGrandMother == -9999 && Ele_fGrandMother == -9999'`

=====  
☐ All numbers come from Invariant mass integral from 2.9 to 3.2 GeV  
=====

===== BEFORE the NN=====

- **All reconstructed J/psi 474321**
- **Number of non prompt J/psi 136619**
- **Number of Prompt J/psi 337452**

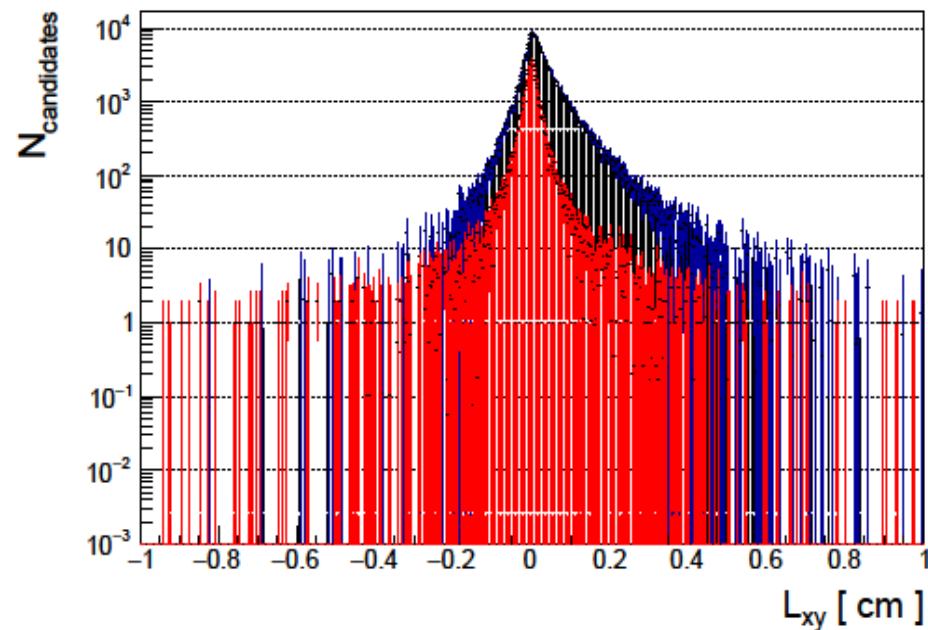
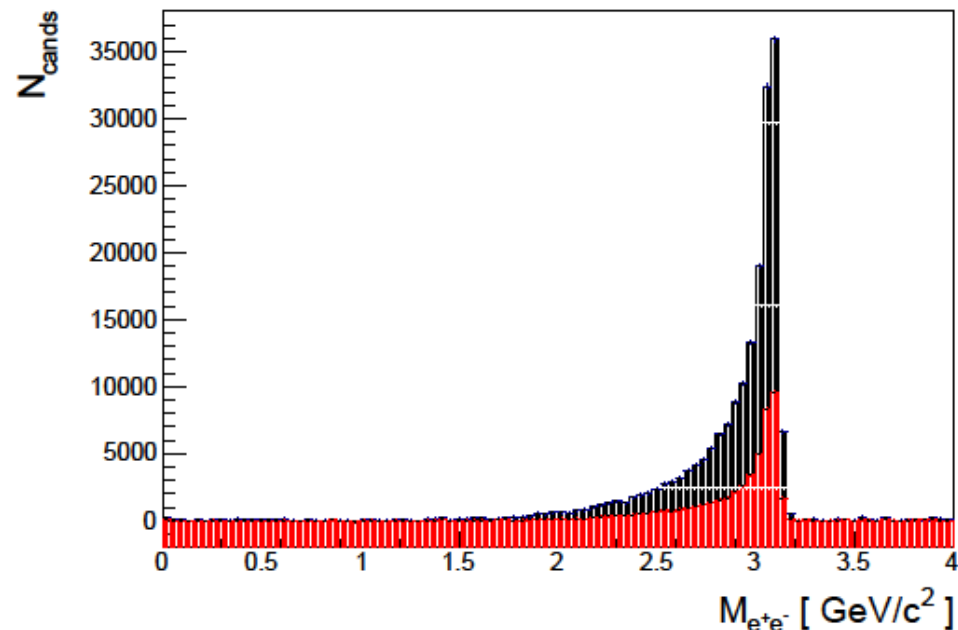
*Bug! Selections only on electron*

=====After NN (Prob > 80%)=====

- Number of non prompt J/psi 99793 (true)
- Number of Prompt J/psi 34350 (true)
- Total number of J/psi after NN 134119 marked as Non prompt
- Contamination is 25.6 %

==== Reduction rate of NN=====

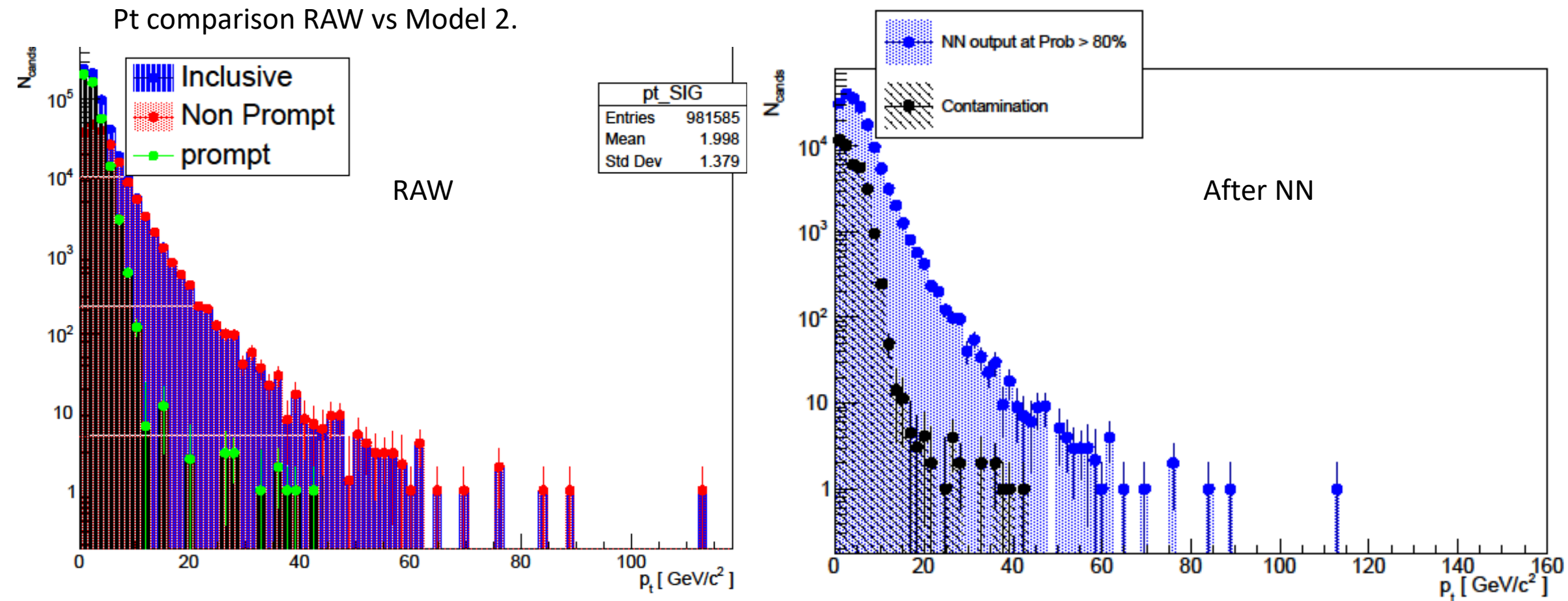
- For Prompt the sample is reduced **9.8** times
- For non prompt the sample is reduced **1.37** times



# Comparison

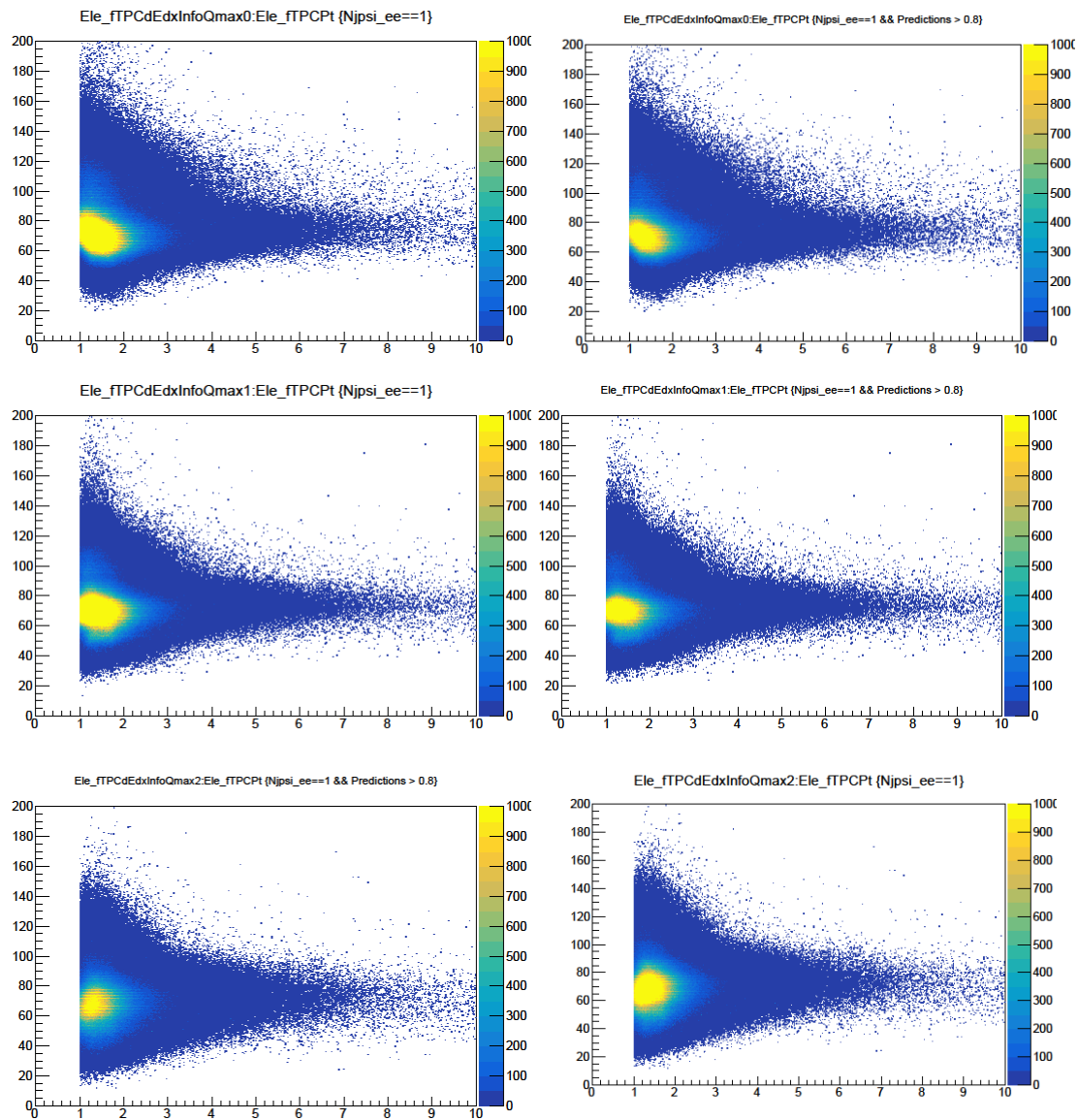
Model	Contamination	Prompt reduction rate	Non prompt reduction rate	True prompt	True non prompt	All after NN
1.	29% ( $\pm 2\%$ )	7.9	1.3	42909	102547	145456
2.	25.6% ( $\pm 2\%$ )	9.8	1.37	34350	99793	134119

Pt comparison RAW vs Model 2.





# Experimental results QA plots



Additional cuts:

- $p_T$  [1,30] for tracks
- $TPCnSharedclusters < 0.3$
- [2.0,4.0]

NN specs:

- 100 neurons
- 165 neurons
- 165 neurons
- 165 neurons

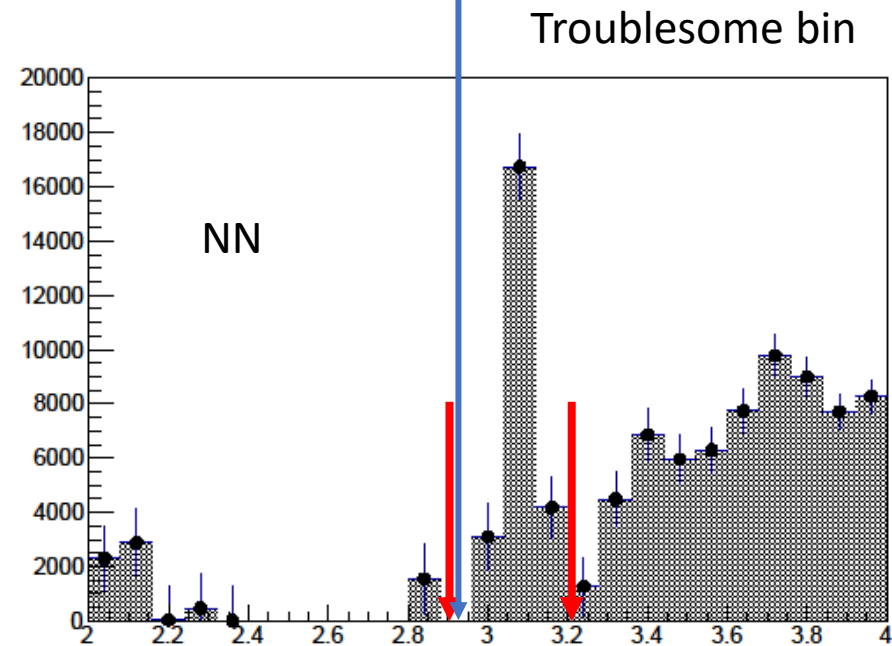
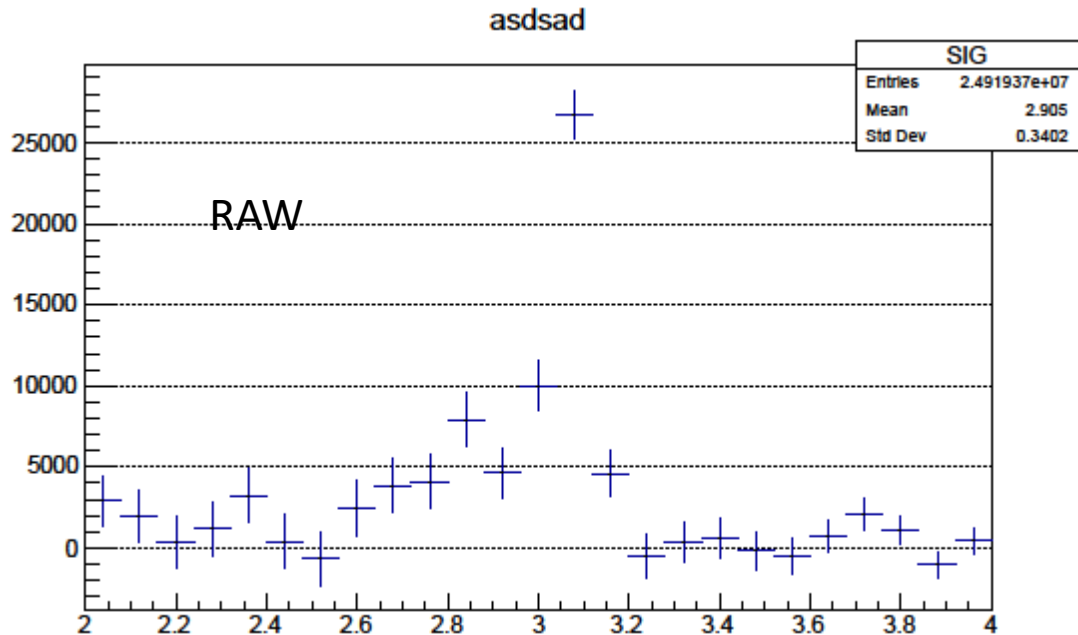
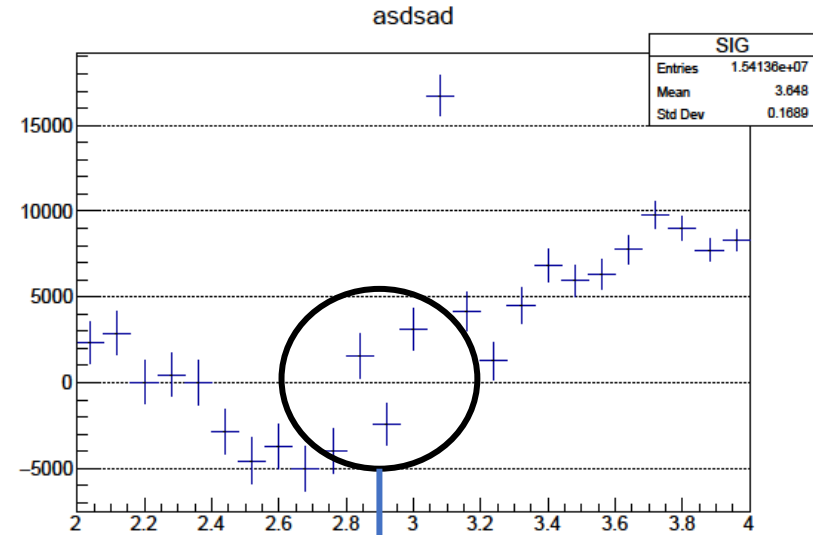
Feed Forward ?

- 166 neurons (2x 83 inputs)
- Similar results on MC testing on data

# J/psi reconstruction

Information:

- LHC18 q+r
- Number of J/psi (RAW) **45901**
- After NN **21613** (actually there is more 23k) 😊



# PID cuts

- ```
AliReducedTrackCut* standardCut = new AliReducedTrackCut("standard","");
standardCut->AddCut(AliReducedVarManager::kP, 1.0,30.);
standardCut->AddCut(AliReducedVarManager::kEta, -0.9,0.9);
standardCut->AddCut(AliReducedVarManager::kDcaXY, -1.0,1.0);
standardCut->AddCut(AliReducedVarManager::kDcaZ, -3.0,3.0);
standardCut->AddCut(AliReducedVarManager::kTPCncls, 70.,160.0);
standardCut->AddCut(AliReducedVarManager::kTPCnSig+AliReducedVarManager::kElectron, -3.0, 3.0);
standardCut->AddCut(AliReducedVarManager::kTPCnSig+AliReducedVarManager::kProton, 3.5, 30000.0);
standardCut->AddCut(AliReducedVarManager::kTPCnSig+AliReducedVarManager::kPion, 3.5, 30000.0);
standardCut->AddCut(AliReducedVarManager::kTPCnclsSharedRatio, 0.3, 2., kTRUE);
standardCut->AddCut(AliReducedVarManager::kTPCchi2, 0.1, 4.0);
standardCut->AddCut(AliReducedVarManager::kITSchi2, 0., 36.);
standardCut->SetRequestITSrefit();
standardCut->SetRequestTPCrefit();
standardCut->SetRequestSPDany();
standardCut->SetRejectKinks();
processor->AddTrackCut(standardCut);
```

# Model 3.

- `s_sel = 'Ele_fGrandGrandMother > -9999 && abs(Ele_fGrandGrandMother) != 5 && Ele_fMother == 443'`

- `bg_sel = 'Ele_fGrandGrandMother == -9999 && Ele_fGrandMother == -9999'`

=====

☐ All numbers come from Invariant mass integral from 2.9 to 3.2 GeV

=====

===== BEFORE the NN=====

- **All reconstructed J/psi 237278**
- **Number of non prompt J/psi 63112**
- **Number of Prompt J/psi 173319**

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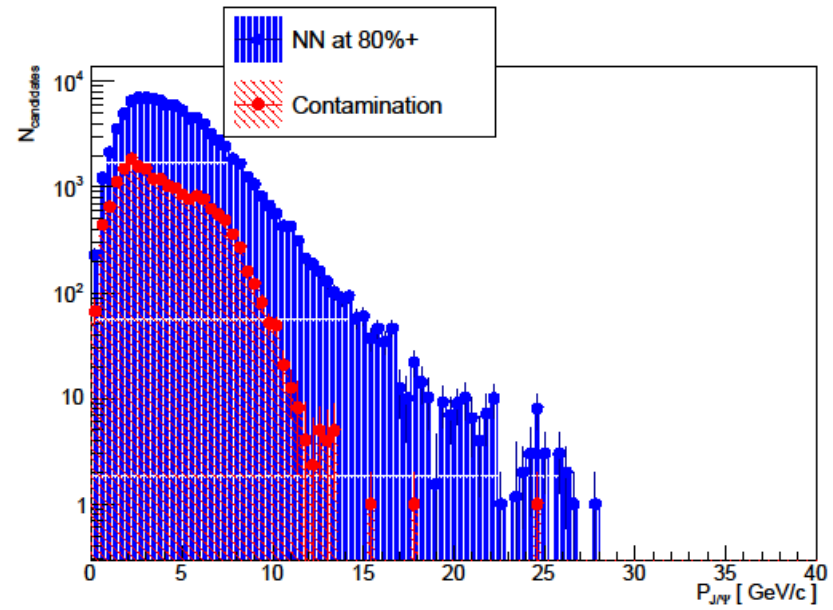
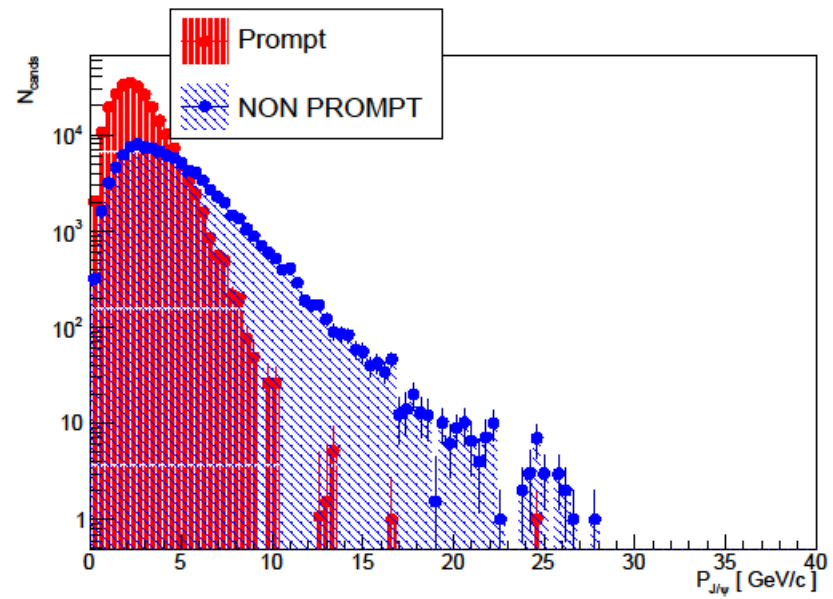
=====After NN (Prob > 80%)=====

- Number of non prompt J/psi 42384 (true)
- Number of Prompt J/psi 14327 (true)
- Total number of J/psi after NN 57047 marked as Non prompt
- Contamination is 25 %

==== Reduction rate of NN=====

- For Prompt the sample is reduced **12** times
- For non prompt the sample is reduced **1.49** times

# Momenta



# Correlations

