



# On $\mu\mu H$ Cut Flow

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# $\mu\mu H$ cut flow

|              | Expected | Cut 1: reco muon |           | Cut 2: InvM/recoilM |            | Cut 3: Trk/Photon number |           | MVA  |           |
|--------------|----------|------------------|-----------|---------------------|------------|--------------------------|-----------|------|-----------|
| e2e2h_sig    | 2258     | 2167             | 0.960135  | 2096                | 0.928468   | 2070                     | 0.917055  | 1512 | 0.669667  |
| e2e2h_bkg    | 33591    | 32181            | 0.958038  | 29966               | 0.892085   | 1408                     | 0.0419296 | 499  | 0.0148699 |
| qqh          | 724097   | 127387           | 0.175926  | 913                 | 0.00126134 | 14                       | 2.00E-05  | 0    | 0         |
| zz_l04tau    | 22119    | 1915             | 0.0865832 | 334                 | 0.0151102  | 315                      | 0.0142786 | 1    | 5.01E-05  |
| zz_l04mu     | 73578    | 55478            | 0.75401   | 15620               | 0.2123     | 15616                    | 0.21224   | 38   | 0.00052   |
| zz_l0taumu   | 88577    | 41369            | 0.46705   | 8286                | 0.09355    | 8065                     | 0.09106   | 121  | 0.00137   |
| zz_l0mumu    | 91758    | 40678            | 0.44332   | 3041                | 0.03315    | 3041                     | 0.03315   | 0    | 1.00E-05  |
| zz_l0tautau  | 46460    | 1211             | 0.02607   | 79                  | 0.00172    | 79                       | 0.00172   | 0    | 0         |
| zz_h0utut    | 419604   | 40387            | 0.0962525 | 0                   | 0          | 0                        | 0         | 0    | 0         |
| zz_h0dtdt    | 1142310  | 141618           | 0.123975  | 23                  | 2.07E-05   | 0                        | 0         | 0    | 0         |
| zz_h0uu_nodt | 483032   | 50286            | 0.104106  | 10                  | 2.08E-05   | 0                        | 0         | 0    | 0         |
| zz_h0cc_nots | 485002   | 69353            | 0.142996  | 4                   | 1.02E-05   | 0                        | 0         | 0    | 0         |



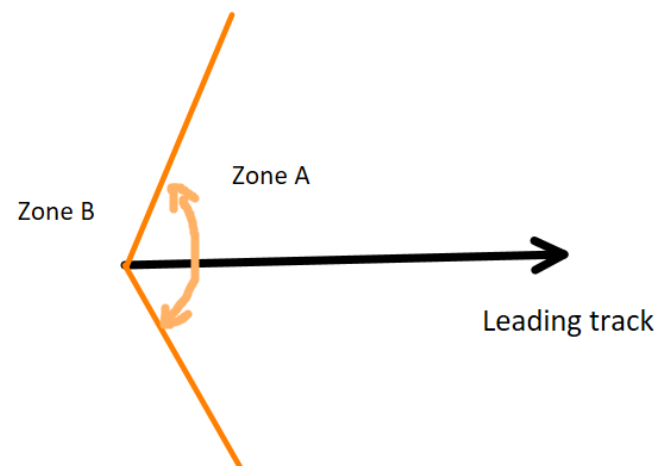
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- All applied on reco data
- Cut 1:  $N\mu^+ \geq 1 \ \&\& \ N\mu^- \geq 1$
- Cut 2:
  - find  $M(\mu^+, \mu^-)$  most close to  $M_Z$ ,
  - Apply cut:  $60 \leq M(\mu^+, \mu^-) \leq 120, 120 \leq RecoilM \leq 220$
- Cut 3: define A/B zone
  - $NTrk(A/B) \leq 10, NPhoton(A/B) \leq 6$

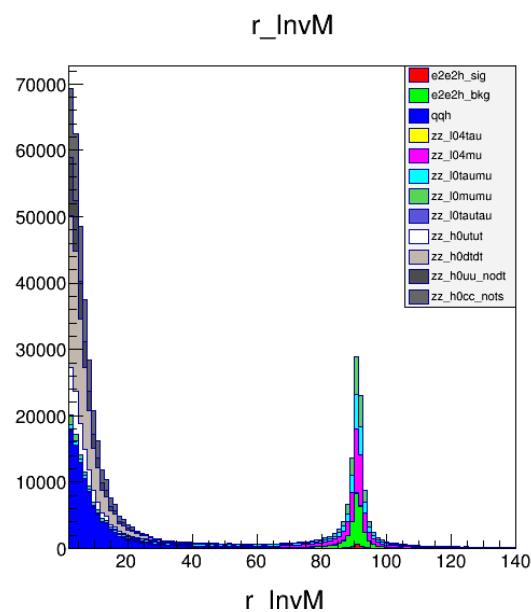
# $\mu\mu H$ cut flow

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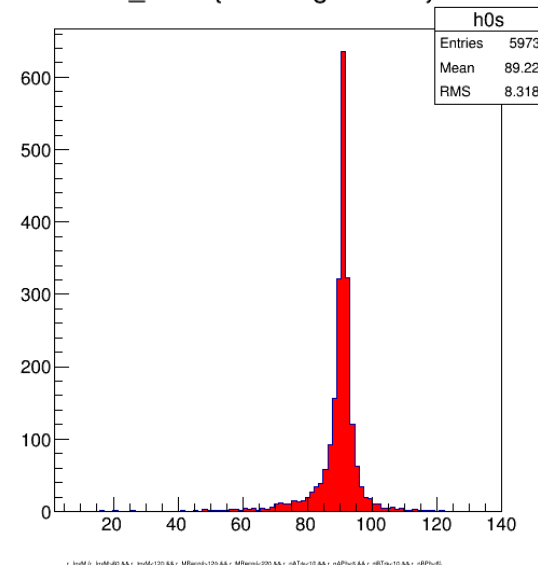


# Some intriguing figures

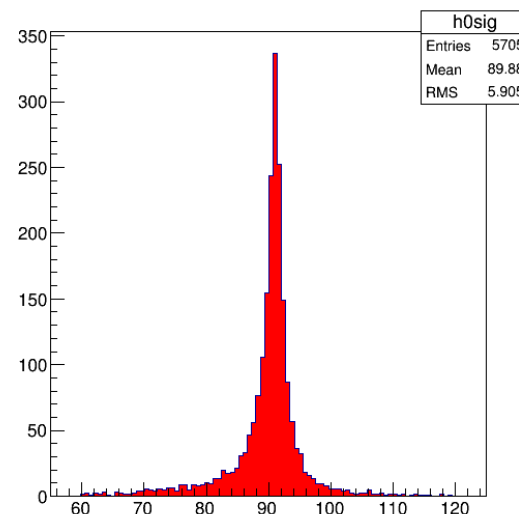
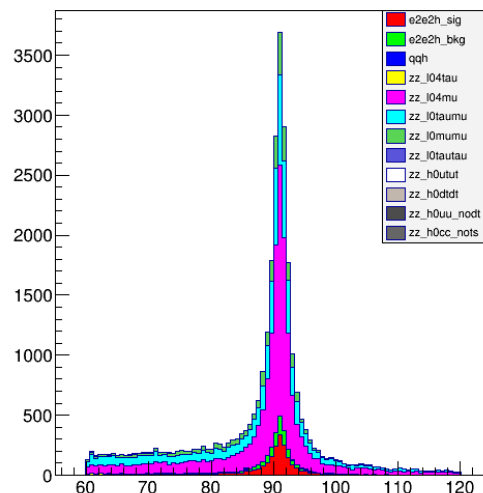
• After cut 1



r\_InvM {1 && flagTau==1}

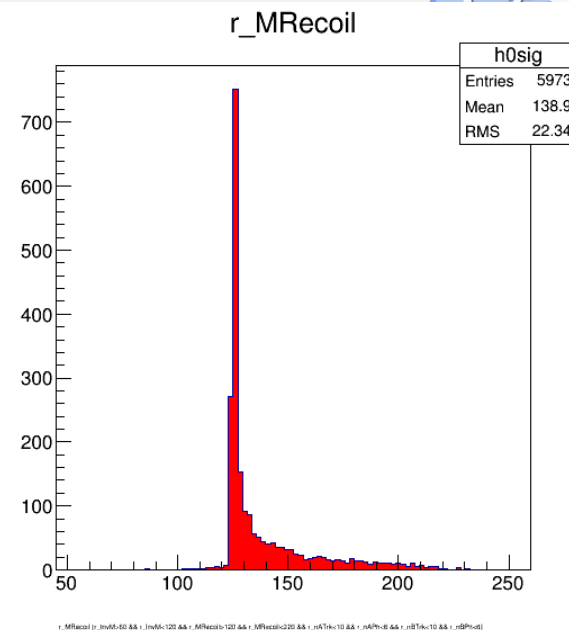
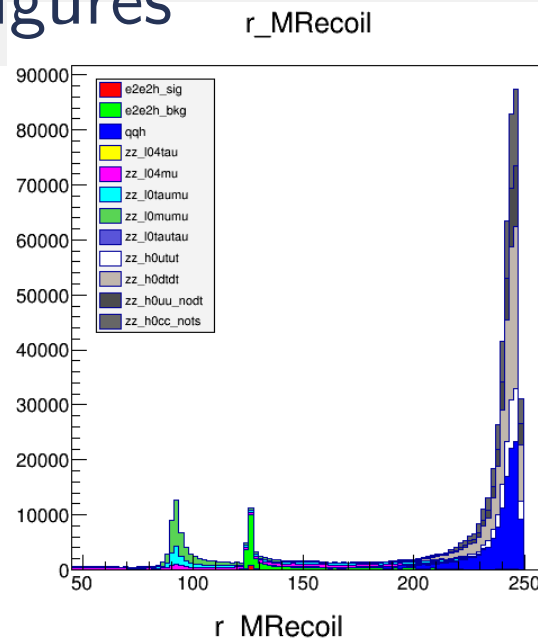


• After cut 1-3

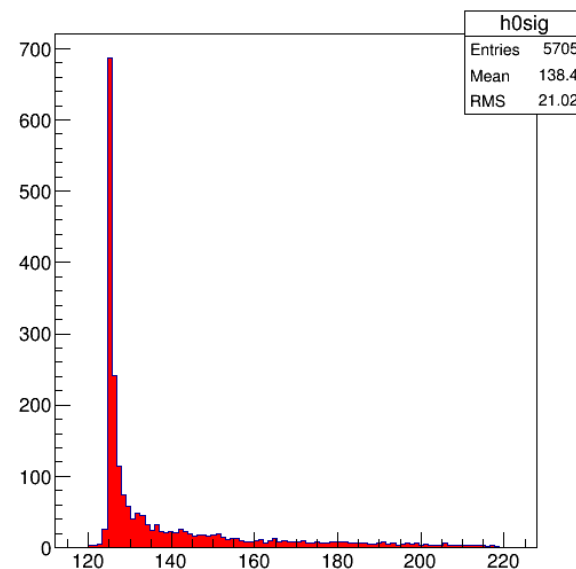
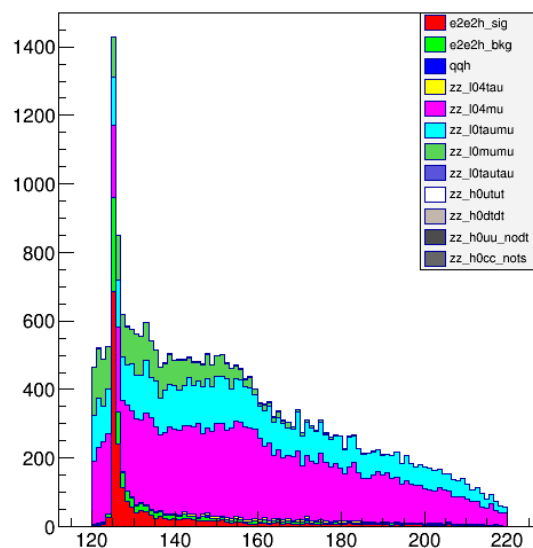


# Some intriguing figures

• After cut 1

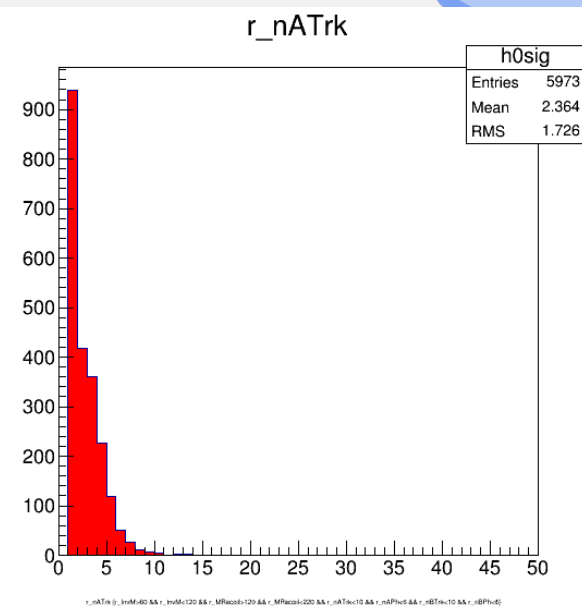
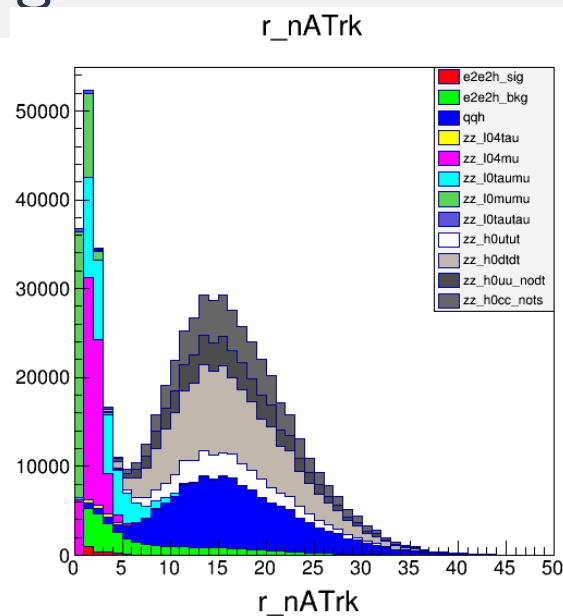


• After cut 1-3

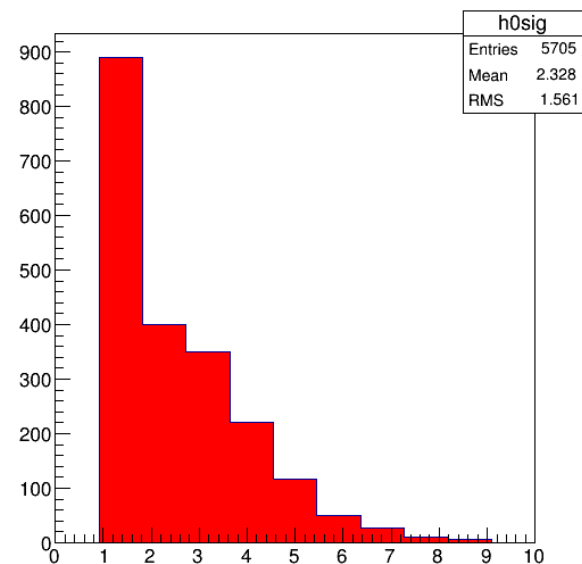
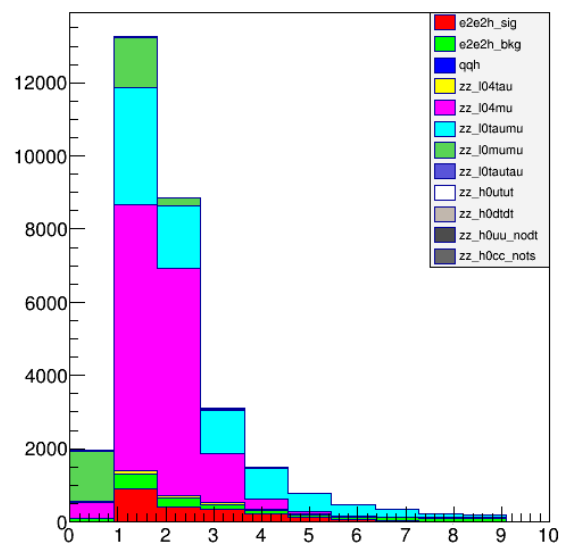


# Some intriguing figures

• After cut 1

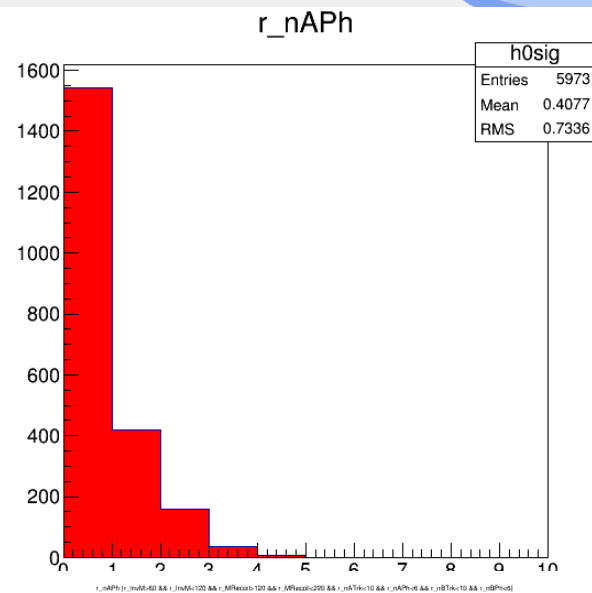
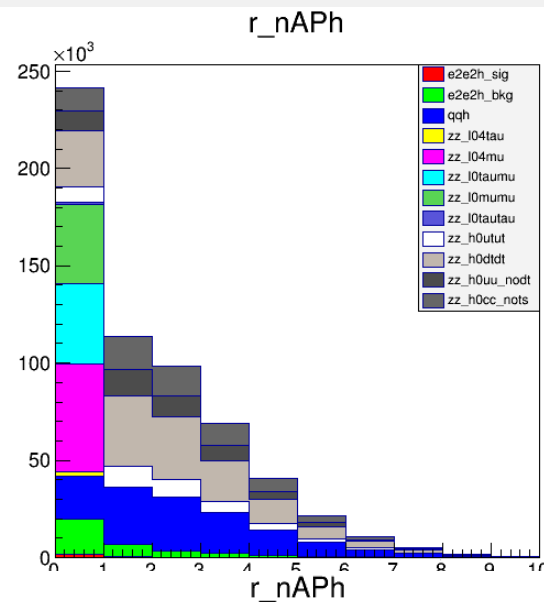


• After cut 1-3

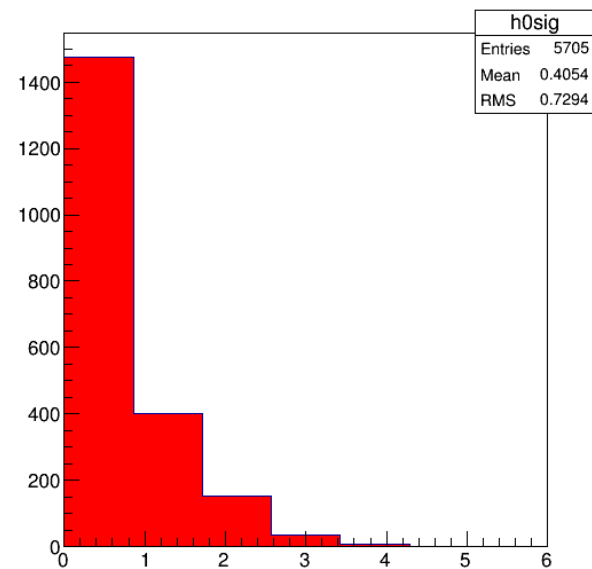
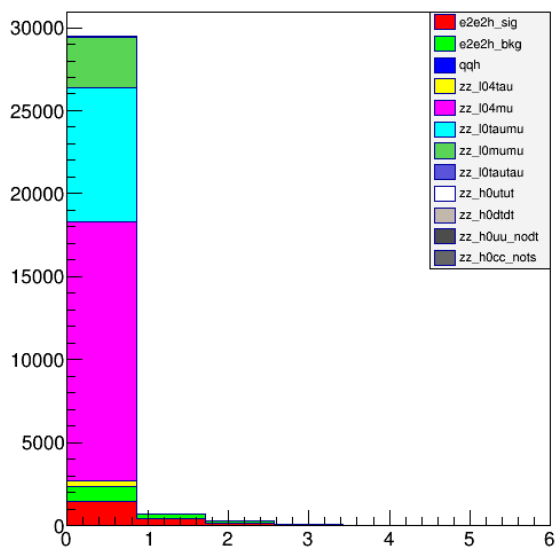


# Some intriguing figures

• After cut 1



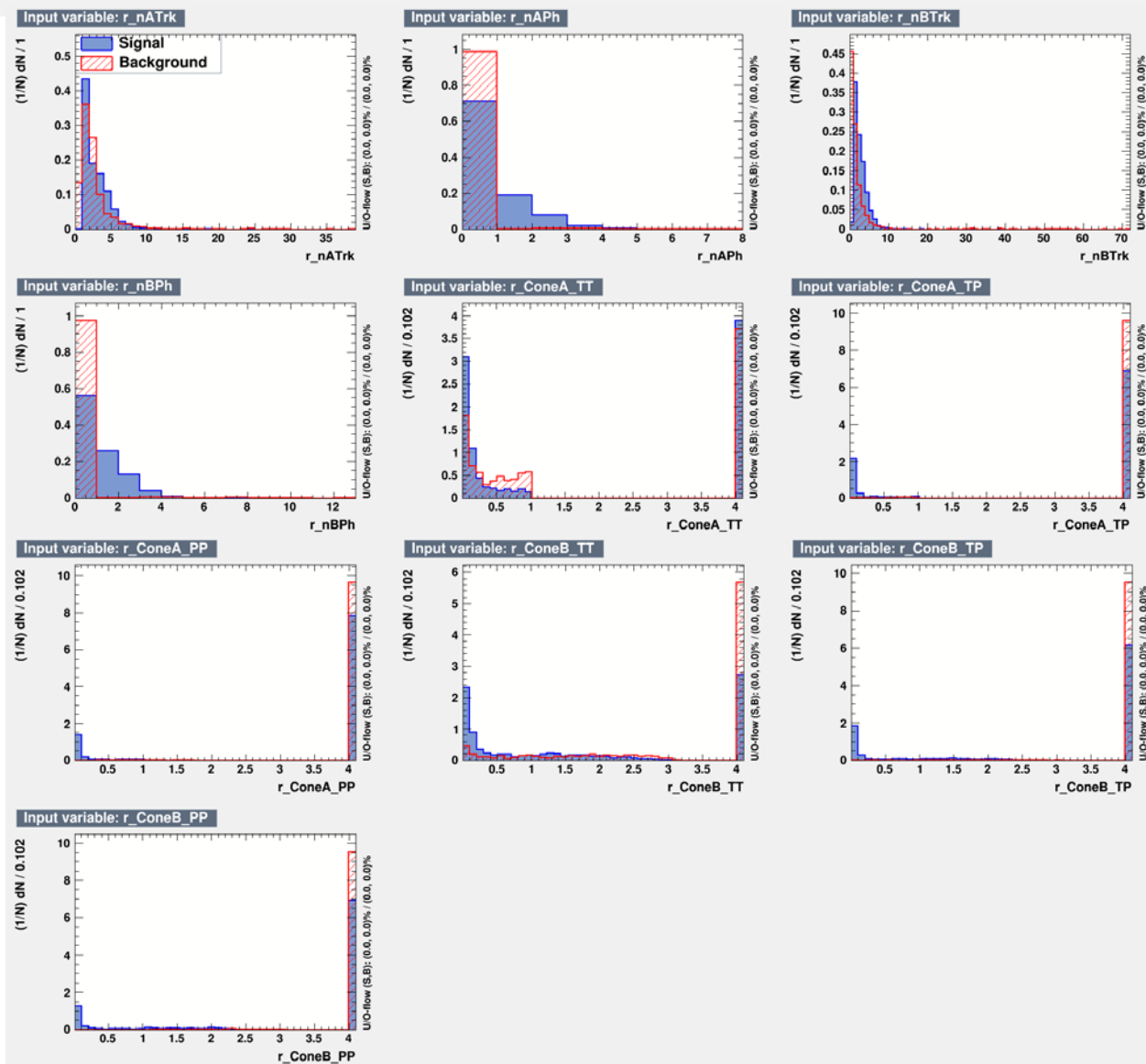
• After cut 1-3



# TMVA

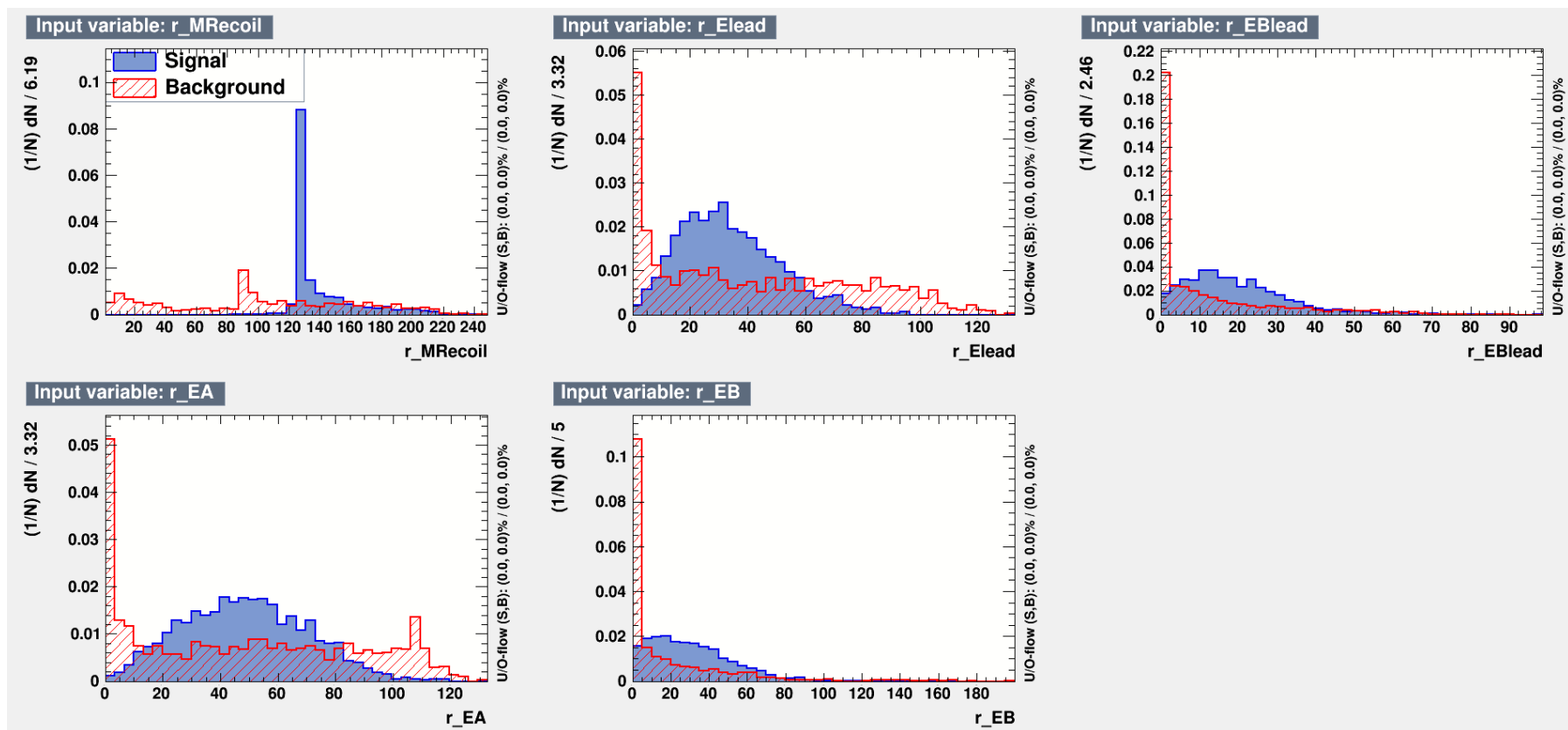
- NTrk(A/B), NPh(A/B)
- Additional parameters 6 angles:
  - $Cone_{T-T}(A/B)$ ,  $Cone_{T-P}(A/B)$ ,  $Cone_{P-P}(A/B)$
- Get the angle between the leading tracks in region A or B and the furthest track in this region, noted as  $Cone_{T-T}(A/B)$ .
- $Cone_{T-P}(A/B)$  is the angle between the leading tracks in region A or B and the furthest photon in this region.
- $Cone_{P-P}(A/B)$ , the angle between the leading photon in a region and the furthest photon in this region.
- (Optional) Add 5 other parameters
  - Mrecoil, EAlead, Eblead, EA, EB

# TMVA

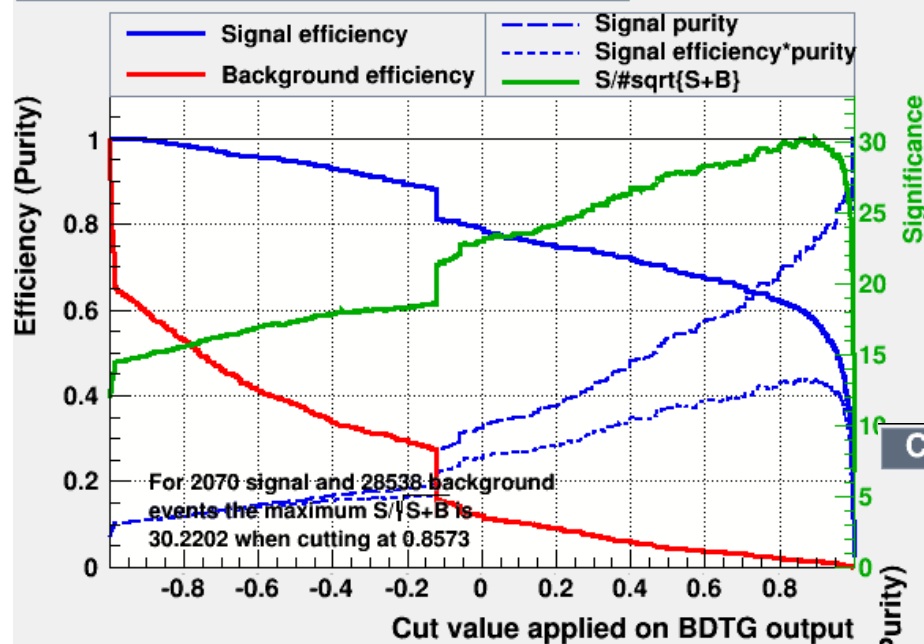


# TMVA

## Additional 5 parameters

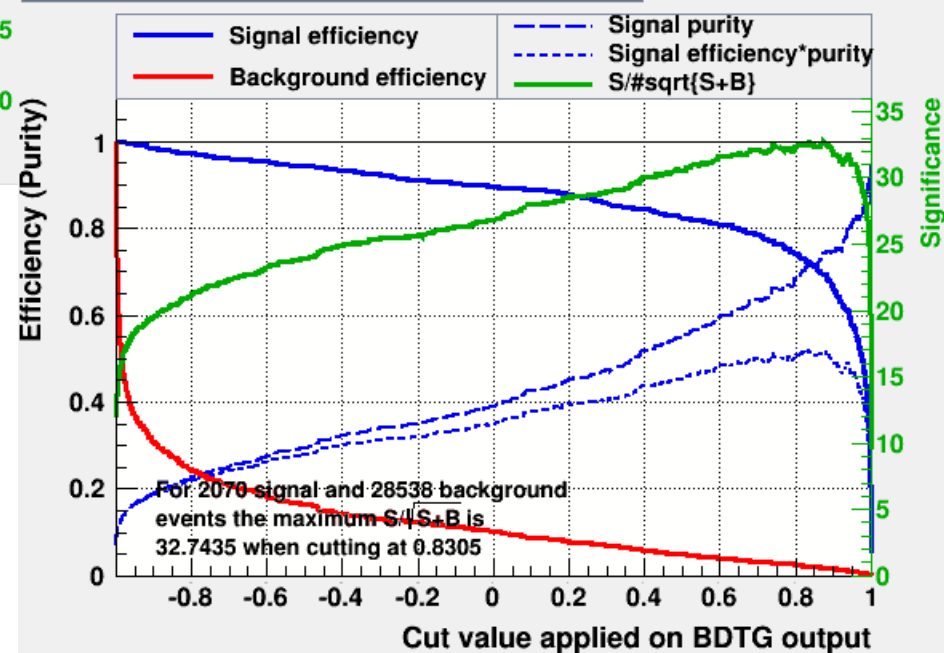


## Cut efficiencies and optimal cut value



● 10-parameter sets

## Cut efficiencies and optimal cut value



● 15-parameter sets



# TMVA training result

10 parameters

| Classifier | ( #signal, #backgr.) | Optimal-cut | S/sqrt(S+B) | NSig    | NBkg     | EffSig | EffBkg  |
|------------|----------------------|-------------|-------------|---------|----------|--------|---------|
| BDTG:      | ( 2070, 28538)       | 0.8573      | 30.2202     | 1237.86 | 439.9692 | 0.598  | 0.01542 |

15 parameters

| Classifier | ( #signal, #backgr.) | Optimal-cut | S/sqrt(S+B) | NSig    | NBkg    | EffSig | EffBkg  |
|------------|----------------------|-------------|-------------|---------|---------|--------|---------|
| BDTG:      | ( 2070, 28538)       | 0.8305      | 32.7435     | 1500.75 | 599.958 | 0.725  | 0.02102 |

# TMVA test

|              | Expected | Cut 1: reco muon |           | Cut 2: InvM/recoilM |            | Cut 3: Trk/Photon number |           | MVA  |           |
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$$S:B = 1:0.439$$

$$Eff(S) = 0.670$$

## ● Dan's result

Table 1.  $\mu\mu H$  cut flow

|                                           | $\mu\mu H\tau\tau$ | $\mu\mu H$<br>inclusive bkg | $ZZ$    | $WW$     | singleW  | singleZ | 2f        |
|-------------------------------------------|--------------------|-----------------------------|---------|----------|----------|---------|-----------|
| total generated                           | 2292               | 33557                       | 5711445 | 44180832 | 15361538 | 7809747 | 418595861 |
| after preselection                        | 2246               | 32894                       | 122674  | 223691   | 0        | 86568   | 1075886   |
| $N_{Trk}(A/B) < 6$<br>& $N_{Ph}(A/B) < 7$ | 2219               | 1039                        | 2559    | 352      | 0        | 9397    | 25583     |
| BDT>0.78                                  | 2135               | 885                         | 484     | 24       | 0        | 157     | 161       |
| efficiency                                | 93.15%             | 2.63%                       | <0.01%  | <0.01%   | <0.01%   | <0.01%  | <0.01%    |

$$S:B = 1:0.641$$

$$Eff(S) = 0.932$$