Table of Contents

Electron Identification Based on Simple Cuts....1
Electron Identification Based on Simple Cuts (for 2010 data)....1
Introduction....1
Implementing the Simple Cut Based ID in CMSSW....1
How to Calculate the Electron ID variables in CMSSW....1
Isolations Calculation....1
ID and Conversion Rejection....2
Cut values and performance....2
Performance of the Working Points....3
Electron Identification Based on Simple Cuts (for 2011 data)....3
Electron ID Working Points....3
Barrel Cuts (|eta supercluster| <= 1.479)....4
Endcap Cuts (1.479 < |eta supercluster| < 2.5)....4
Glossary of Variables....4
dEtaIn....4
dPhiIn....4
sigmaIEtaIEta....4
H/E....4
fbrem....4
E/P_in....5
|1/E - 1/p_in|....5
Impact Parameters....5
Detector Isolation....5
Particle Flow Isolation....5
Conversion Rejection....5

Electron Identification Based on Simple Cuts

Electron Identification Based on Simple Cuts (for 2010 data)

Introduction

This twiki contains information on electron selection intended to be used with 2010 data. The selection is based on cuts on a small number of variables. Different thresholds are used for electrons found in the ECAL barrel and the ECAL endcap. Electron selection variables may be categorized in 3 groups:

- e-ID variables (shower shape, track cluster matching etc)
- isolation variables
- conversion rejection variables

The sets of cuts given here are obtained by tuning all cuts together, but the sets of cuts on each of the 3 groups of variables may be used alone quite effectively. The fake rate, and fake sources, vary with ET, and for any set of cuts, rejection power and efficiency vary with ET. However, sets of cuts optimized for ET>25 GeV are near optimal for the interval 100>ET>20 GeV, and can usefully be employed down to 15 GeV. Ultimately the most performant selection should be obtained using multi-variate techniques, likelihood fits etc. Prior to that cut-based selections can provide a useful tool to understand the data and make comparison with MC. The advantages of "Simple Cuts" are:

- Cut inversion (used in many data driven signal extraction and background subtraction methodologies) is simple
- Smallest statistics are needed for full understanding and efficiency measurement
- It is simple to cleanly separate the e-ID, isolation and conversion rejection pieces

The selection has been tuned in order to get a set of cuts with maximum background rejection for a given efficiency.

Implementing the Simple Cut Based ID in CMSSW

How to Calculate the Electron ID variables in CMSSW

Most of the variables that are currently used or planned to be used can be accessed from Reco::CMS.GsfElectron or Pat::Electron.

Isolations Calculation

Isolation variables can be accessed directly from the GsfElectron using the methods:

```
trackIso = electron->dr03TkSumPt()
ecalIso = electron->dr03EcalRecHitSumEt()
hcalIso = electron->dr03HcalTowerSumEt()
```

Notice that the cone sizes in use are DR=0.3 for all three isolations. Relative isolations are the absolute isolations, described previously, divided by the electron ET:

```
trackIsoRel = electron->dr03TkSumPt()/electron->p4().Pt()
ecalIsoRel = electron->dr03EcalRecHitSumEt()/electron->p4().Pt()
hcalIsoRel = electron->dr03HcalTowerSumEt()/electron->p4().Pt()
```

Combined Isolation as is defined with the following way:

```
Combined Isolation for Barrel = ( electron->dr03TkSumPt() + max(0., electron->dr03EcalRecHitSumEt
Combined Isolation for Endcaps = ( electron->dr03TkSumPt() + electron->dr03EcalRecHitSumEt() + el
```

where the -1 is the pedestal subtraction and appears only in the barrel.

ID and Conversion Rejection

Shower Shape, track-cluster matching and conversion rejection variables are calculated from the following methods of the GsfElectron:

Shower shape:

```
electron->hadronicOverEm()
electron->sigmaIetaIeta()
```

Track-cluster matching:

```
electron->deltaPhiSuperClusterTrackAtVtx()
electron->deltaEtaSuperClusterTrackAtVtx()
```

Conversion rejection:

```
electron->gsfTrack()->trackerExpectedHitsInner().numberOfHits() (number of missing hits)
electron->convDist() (Minimum distance between conversion tracks)
electron->convDcot() (Dcot(theta) between conversion tracks at conversion vertex)
```

Cut values and performance

The original tuning of electron selections based on simple cuts using the followig MC samples:

- Signal: Wenu and Zee
- Backgrounds: Wtaunu, TTbar, Wmunu, Ztautau, QCD Dijets

The cut values that appear in the following table for the electron ID variables have been tuned separately and then matched to appropriate electron isolation cuts. The user should take the conversion rejection cuts (same for both barrel and endcaps), the electron ID cuts, and then choose the isolation of their preference: either combined or relative. The efficiency number that is quoted here is approximate and refers to electrons in W events passing this selection after demanding a 25 GeV cut in the ET of the electron supercluster.

Efficiencies	95%	90%	85%	80%	70%	60%
Conversion Rejection						
missing hits ≤	1	1	1	0	0	0
Dist	N/A	0.02	0.02	0.02	0.02	0.02
Δcot	N/A	0.02	0.02	0.02	0.02	0.02
BARREL						
Combined Isolation	0.15	0.10	0.09	0.07	0.04	0.03
Relative Isolation						
trackRel03	0.15	0.12	0.09	0.09	0.05	0.04
ecalRel03	2.00	0.09	0.08	0.07	0.06	0.04
hcalRel03	0.12	0.10	0.10	0.10	0.03	0.03
Electron ID						
i i	0.01	0.01	0.01	0.01	0.01	0.01
Δ	0.8	0.8	0.06	0.06	0.03	0.025

Δ	0.007	0.007	0.006	0.004	0.004	0.004
HoE	0.15	0.12	0.04	0.04	0.025	0.025
ENDCAPS						
Combined Isolation	0.1	0.07	0.06	0.06	0.03	0.02
Relative Isolation						
trackRel03	0.08	0.05	0.05	0.04	0.025	0.025
ecalRel03	0.06	0.06	0.05	0.05	0.025	0.02
hcalRel03	0.05	0.03	0.025	0.025	0.02	0.02
Electron ID						
i i	0.03	0.03	0.03	0.03	0.03	0.03
Δ	0.7	0.7	0.04	0.03	0.02	0.02
Δ	0.01	0.009	0.007	0.007	0.005	0.005
HoE	0.07	0.05	0.025	0.025	0.025	0.025

Performance of the Working Points

The comparison of the performance of the working points presented in the table of the previous session are shown here

Electron Identification Based on Simple Cuts (for 2011 data)

- This page documents the EGamma simple cut based electron ID
- It is a robust identification, mostly used in those analyses (eg precision EWK measurements) where it is not needed to have the ultimate electronID performance
- The proposed working points have been described in the following slides
  - https://indico.cern.ch/getFile.py/access?contribId=1&resId=0&materialId=slides&confId=185495

Electron ID Working Points

Four standard working points are provided

- Veto
  - Similar to VBTF 95 working points
  - Use for third lepton veto or counting
- Loose
  - Similar to VBTF 90 working points
- Medium
  - Similar to VBTF 80 working points
- Tight
  - Similar to VBTF 70 working points

On top of these working points two additional selections are provided

- Tight trigger ID
  - To ensure selection used offline is tighter than typical trigger requirements
- E/p_in and fbrem cuts
  - Useful to gain extra suppression of fake electrons at low pT

The cuts used in these working points, and how to access the decisions in CMSSW are now described.

Barrel Cuts (|eta supercluster| <= 1.479)

	Veto	Loose	Medium	Tight
fabs(dEtaIn) <	0.007	0.007	0.004	0.004
fabs(dPhiIn) <	0.8	0.15	0.06	0.03
sigmaIEtaIEta <	0.01	0.01	0.01	0.01
H/E <	0.15	0.12	0.12	0.12
fabs(d0) (vtx) <	0.04	0.02	0.02	0.02
fabs(dZ) (vtx) <	0.2	0.2	0.1	0.1
fabs(1/E - 1/p) <	N/A	0.05	0.05	0.05
PF isolation / pT (cone dR=0.3) <	0.15	0.15	0.15	0.10
Conversion rejection: vertex fit probability	N/A	1e-6	1e-6	1e-6
Conversion rejection: missing hits <=	N/A	1	1	0

Endcap Cuts (1.479 < |eta supercluster| < 2.5)

pT > 20 (pT < 20)	Veto	Loose	Medium	Tight
fabs(dEtaIn) <	0.01	0.009	0.007	0.005
fabs(dPhiIn) <	0.7	0.10	0.03	0.02
sigmaIEtaIEta <	0.03	0.03	0.03	0.03
H/E <	N/A	0.10	0.10	0.10
fabs(d0) (vtx) <	0.04	0.02	0.02	0.02
fabs(dZ) (vtx) <	0.2	0.2	0.1	0.1
fabs(1/E - 1/p) <	N/A	0.05	0.05	0.05
PF isolation / pT (cone dR=0.3) <	0.15	0.15(0.10)	0.15(0.10)	0.10(0.07)
Conversion rejection: vertex fit probability	N/A	1e-6	1e-6	1e-6
Conversion rejection: missing hits <=	N/A	1	1	0

Glossary of Variables

dEtaIn

```
reco::GsfElectron::deltaEtaSuperClusterTrackAtVtx()
```

dPhiIn

```
reco::GsfElectron::deltaPhiSuperClusterTrackAtVtx()
```

sigmaIEtaIEta

```
reco::GsfElectron::sigmaIetaIeta()
```

H/E

```
reco::GsfElectron::hadronicOverEm()
```

fbrem

```
reco::GsfElectron::fbrem()
```

E/P_in

```
reco::GsfElectron::eSuperClusterOverP()
```

|1/E - 1/p_in|

- Use the following definitions for E and p_in

```
reco::GsfElectron::ecalEnergy()
reco::GsfElectron::trackMomentumAtVtx().p()
```

Note that `reco::GsfElectron::trackMomentumAtVtx().p()` is identical to
`reco::GsfElectron::ecalEnergy() / reco::GsfElectron::eSuperClusterOverP()`

Impact Parameters

```
reco::GsfElectron::gsfTrack()->dxy (const Point &vertex)
reco::GsfElectron::gsfTrack()->dz (const Point &vertex)
```

Detector Isolation

```
reco::GsfElectron::dr03TkSumPt()
reco::GsfElectron::dr03EcalRecHitSumEt()
reco::GsfElectron::dr03HcalTowerSumEt()
```

Particle Flow Isolation

See https://twiki.cern.ch/twiki/bin/view/CMS/EgammaPFBasedIsolation

The standard recommended conesize is 0.3, giving minimal pileup dependence and reduced probability of other objects overlapping with the cone. The use of a larger conesize, 0.4, can be used if found to be beneficial (possibly the case for e.g. a zero jet environment).

Note that an "effective area" correction needs to be applied to the isolation sum to remove the effect of pileup - see EgammaEARhoCorrection.

Conversion Rejection

- Use the default parameters in the following to access vertex fit conversion rejection
- For more details see *https://twiki.cern.ch/twiki/bin/view/CMS/ConversionTools

```
RecoEgamma/EgammaTools/interface/ConversionTools.h
static bool hasMatchedConversion(const reco::GsfElectron &ele,
   const edm::Handle<reco::ConversionCollection> &convCol, const math::XYZPoint &beamspot,
   bool allowCkfMatch=true, float lxyMin=2.0, float probMin=1e-6, uint nHitsBeforeVtxMax=0);
```

- To use the number of missing hits conversion rejection

```
reco::GsfElectron::gsfTrack()->trackerExpectedHitsInner().numberOfHits();
```

-- MatteoSani - 20 Oct 2014

This topic: CMSPublic > EgammaPublicData
Topic revision: r5 - 2016-04-22 - KatiLassilaPerini