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# MultijetJESUncertaintyProviderSandbox

# Introduction

The MultijetJESUncertaintyProvider is a C++/ROOT compatible class to access the estimate on the JES uncertainty for EM+JES calibrated jets in multi-jet environments. The uncertainty provided via the MultijetJESUncertaintyProvider includes the global JES uncertainty from the JESUncertaintyProvider as well as two additional terms accounting for flavor composition and close-by jets effects.

The current tag is **JetUncertainties-00-03-03**.

This twiki refers to the latest **release 16** MultijetJESUncertaintyProvider. The twiki for release 15 has been moved here.

**Extended pT/eta range:** The JES uncertainty provided via the MultijetJESUncertaintyProvider is now available for jets of  $15 \text{ GeV} < pT < 7000 \text{ GeV}$  and  $\text{le}tal < 4.5$ .

## Close-by jets uncertainty

Based on the studies detailed in these slides [↗](#) and this CONF note [↗](#) the close-by jets uncertainty has been updated w.r.t. release 15. The final numbers have been updated in JetUncertainties-00-03-03.

Please note: The close-by jets uncertainty is now provided as an uncertainty on the data/MC agreement. As such it is applicable to jets after correcting for the response of close-by jets / after unfolding the data to MC prediction.

**Note:** As recommended in slide 15 [↗](#) of this talk each analysis should check whether the provided numbers for the close-by jets uncertainty are applicable to their analysis sample.

To retrieve the close-by jets uncertainty the distance to the closest reconstructed jet with **em scale pT > 7 GeV** (= dR\_min) has to be specified. Jets are considered as isolated if  $dR\_min > 2.5R$  (where  $R=0.4/0.6$  depending on the jet size).

## Flavour composition uncertainty

The basic ideas underlying the estimate on the flavour composition contribution to the JES uncertainty are described in these slides [↗](#), these slides [↗](#) and this CONF note [↗](#). Currently, the flavour composition term only accounts for **gluon** and **light quark** jets - b-jets have not been included so far.

Since the flavour composition uncertainty is an analysis specific term depending on the fraction of gluon initiated jets, the uncertainty assigned to the gluon fraction and the average response of jets in the analysis sample of interest an additional input .root file containing these values has to be provided. For testing purpose you can use one of the example input files located in the analysisPlots/ directory of the package. Further information on the required analysis input plots can be found here (in case you want to use the MultijetJESUncertaintyProvider without the flavour composition contribution as describe below you do not have to provide such an input file, of course).

Note: Due to several changes to the analysis input histograms any release 15 input files are NOT compatible with the latest release 16 MultijetJESUncertaintyProvider.

# Checking out the code and preparing your work area:

Follow the instructions on `JESUncertaintyProvider#CheckingOutCode` for checking out and setting up the package, that includes `MultijetJESUncertaintyProvider`, for both the ROOT standalone version and the ATHENA version. In both cases, include the `MultijetJESUncertaintyProvider` header in your code (that already includes the `JESUncertaintyProvider` header)

The `JESUncertainty.root` located in the `share/` directory of the package needs to be in the same directory where the `MultijetJESUncertaintyProvider` is run. If you want to retrieve the uncertainty **with the flavor composition contribution included** you also need to copy the input file containing the analysis sample specific plots into the directory where the provider is run.

**Note:** The files `JESUncertaintyProvider.h/cxx` are required to run the `MultijetJESUncertaintyProvider`. The uncertainty as given by the `MultijetJESUncertaintyProvider` already includes the global uncertainty from the `JESUncertaintyProvider`. Please do not add the uncertainty from the `JESUncertaintyProvider` on top of the uncertainty provided by the `MultijetJESUncertaintyProvider`!

# Using the MultijetJESUncertaintyProvider

## Retrieving the uncertainty WITH the flavour composition contribution

First of all, follow the instructions on checking out the code and preparing your work area.

- Create an instance of the MultijetJESUncertaintyProvider, ie:

```
MultijetJESUncertaintyProvider myJES("myCollectionName", "mySampleFile.root");
```

- Set "myCollectionName" according to your input collection (currently only **EM+JES**):

```
//AntiKt4 EM+JES calibrated jets:  
"AntiKt4EMJESTopoJets"  
//or  
"AntiKt4H1TopoJets"  
  
//AntiKt6 EM+JES calibrated jets:  
"AntiKt6EMJESTopoJets"  
//or  
"AntiKt6H1TopoJets"
```

- Set "mySampleFile.root" according to the name of the root file with your analysis plots (average response, gluon fraction and gluon fraction uncertainty), see below for further information

- Initialize the instance:

```
myJES.init();
```

- To retrieve the JES uncertainty (by default no pile-up term and no close-by jets systematic) of a jet with  $p_T = \text{myPt}$  and  $\text{Eta} = \text{myEta}$  call one of the functions (with  $p_T$  in **MeV**):

```
myJES.getRelPosUncert(myPt, myEta); // for the relative positive uncertainty  
//or  
myJES.getAbsPosUncert(myPt, myEta); // for the relative positive uncertainty*pT(jet)  
//or  
myJES.getRelNegUncert(myPt, myEta); // for the relative negative uncertainty  
//or  
myJES.getAbsNegUncert(myPt, myEta); // for the relative negative uncertainty*pT(jet)
```

- To include the pile-up term add it to the list of desired uncertainty components (e.g. MultijetJESUncertaintyProvider::ALL to include all uncertainty components - further information on how to access the various uncertainty components separately can be found here) and specify the number of vertices  $n_{Vtx} = \text{myNVtx}$ . The number of vertices should include **all** vertices (primary vertex + pile-up vertices) **with number of tracks  $N > 4$** . To also include the close-by jets uncertainty specify the distance to the closest jet  $dR_{min} = \text{myDR}$  (consider all **reconstructed jets with emscale  $p_T > 7\text{GeV}$**  to calculate  $dR_{min}$ ). Call one of the following functions:

```
myJES.getRelPosUncert(myPt, myEta, MultijetJESUncertaintyProvider::ALL, myNVtx, myDR);  
//or  
myJES.getAbsPosUncert(myPt, myEta, MultijetJESUncertaintyProvider::ALL, myNVtx, myDR);  
//or  
myJES.getRelNegUncert(myPt, myEta, MultijetJESUncertaintyProvider::ALL, myNVtx, myDR);  
//or  
myJES.getAbsNegUncert(myPt, myEta, MultijetJESUncertaintyProvider::ALL, myNVtx, myDR);
```

- According to the procedure described in the JESUncertaintyProvider twiki the user can choose a combination of uncertainty components (as defined in the Components enumerator of the JESUncertaintyProvider base class) to be included into the calculation of the overall JES uncertainty.

## Retrieving the uncertainty WITHOUT the flavour composition contribution

First of all, follow the instructions on checking out the code and preparing your work area.

- Create an instance of the MultijetJESUncertaintyProvider, ie:

```
MultijetJESUncertaintyProvider myJES("myCollectionName");
```

- Set "myCollectionName" according to your input collection (currently only **EM+JES**):

```
//AntiKt4 EM+JES calibrated jets:
"AntiKt4EMJESTopoJets"
//or
"AntiKt4H1TopoJets"

//AntiKt6 EM+JES calibrated jets:
"AntiKt6EMJESTopoJets"
//or
"AntiKt6H1TopoJets"
```

- Exclude the flavour composition uncertainty (**important**: this step needs to be done **before** initializing the provider):

```
myJES.includeFlavorComposition(false);
```

- Initialize the instance:

```
myJES.init();
```

- To retrieve the JES uncertainty call one of the getRelPosUncert(...), getAbsPosUncert(...), getRelNegUncert(...), getAbsNegUncert(...) funtions as described above. Since the flavour composition uncertainty is excluded, getRelPosUncert(...) and getRelNegUncert(...) (getAbsPosUncert(...) and getAbsNegUncert(...)) will give the same result.

# Overview over possible errors and print-outs

## pT/eta outside of covered range

The MultijetJESUncertaintyProvider returns a JES uncertainty of jets within  $15 \text{ GeV} < p_T < 500 \text{ GeV}$  and  $|\eta| < 4.5$ . If the jet pT/eta is outside this range, the following errors will be printed and the relative uncertainty returned will be -1 (the absolute uncertainty will just be the negative pT).

```
pT outside of covered range (15-7000): Returning -1
Eta outside of covered range (0.0<|eta|<4.5): Returning -1
```

## Response of jets in the analysis sample

- If the ratio `response_sample/r_incl` as provided in the analysis input file isn't within a reasonable range, i.e. smaller than `response_gluons/r_incl` or larger than `response_quarks/r_incl` the following warnings will be printed:

```
analysis sample response larger than light quark jet response: setting response(sample)/r_incl = r_incl_gluons
analysis sample response smaller than gluon jet response: setting response(sample)/r_incl = r_incl_gluons
```

The provider will then set `response_sample/r_incl = response_gluons/r_incl / response_sample/r_incl = response_quarks/r_incl` and proceed with the calculation of the JES uncertainty.

- If the response graph isn't available in the input .root file, the MultijetJESUncertaintyProvider will set `response_sample/r_incl = 1` and proceed with the calculation of the uncertainty:

```
Problem finding Required Input Graph responseSample_AntiKt4Topo_EMJES in input file mySampleF
```

## Gluon fraction / gluon fraction uncertainty

Depending on the provided gluon fraction and gluon fraction uncertainty the MultijetJESUncertaintyProvider calculates a prefactor `alphaC` which is required for the calculation of the flavour composition uncertainty (see slides 6-8 [↗](#)).

- The prefactor `alphaC` is calculated according to  $1/(\text{gluon fraction})$  (if positive uncertainty is requested) and  $1/(1-\text{gluon fraction})$  (if negative uncertainty is requested). If the gluon fraction is 0 or 1 the following messages will be printed:

```
gluon fraction = 0/1: setting alphaC = 1 to avoid division by zero!
```

- Both the gluon fraction and gluon fraction uncertainty graph have to be available in the input .root file. If one or both of them is/are missing the provider will set `alphaC = 1`:

```
Problem finding Required Input Graph: gluonFractionError_AntiKt4TopoJetsJES in input file myS
Not enough information to calculate prefactor alphaC: Setting alphaC = 1!
```

# Tag History (only updates in the close-by/flavour uncertainty relevant to the MultijetJESUncertaintyProvider)

For the full tag history, see [JESUncertaintyProvider#TagHistory](#)

**JetUncertainties-00-01-03** - DO NOT USE THIS TAG! - Introduced MultijetJESUncertaintyProvider

**JetUncertainties-00-02-00** - Current tag for release 15 - JESUncertaintyProvider: Updated JES uncertainty for May reprocessed data; MultijetJESUncertaintyProvider: Removed flavour response term

**JetUncertainties-00-03-00** - DO NOT USE THIS TAG! - JESUncertaintyProvider: Updated JES uncertainty for full 2010 ATLAS data; MultijetJESUncertaintyProvider: Updated flavour composition uncertainty for release 16, preliminary numbers for updated close-by jets uncertainty

**JetUncertainties-00-03-03** - MultijetJESUncertaintyProvider: Updated flavour composition uncertainty for release 16, updated numbers for close-by jets uncertainty according to ATLAS-CONF-2011-062

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## Major updates:

-- StefanieAdomeit - 13-Dec-2010

%RESPONSIBLE% CaterinaDoglioni

%REVIEW% **Never reviewed**

-- CaterinaDoglioni - 28-Apr-2011

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