



Jets reconstruction in CMS



1) Jets in LHC physics

Jets produced starting in parton-parton scattering starting from LO:



Jets are statistically the most significant observable after the hadrons multiplicity.

- Used in most of the analyses:
 - Searches of new particles (R&S, q* etc...).
 - Standard model measurements: proton PDF, Z/W+jets, quarks t, b....
 - Background for many analyses: $H \rightarrow \gamma y (\tau \tau)$...
 - Tag for back ground reduction: $H \rightarrow \gamma y (\tau \tau)$ in VBF...

2) Jet reconstruction in CMS: 3 types





For 1st tests we use: anti-k_T, R=0.5 (see Matteo Cacciari talk from 07/06/2010)

2) Jet reconstruction in CMS: 3 strategies







For 1^{st} tests we use: anti- k_{T} , R=0.5

2) Jet reconstruction in CMS: 3 strategies





For 1^{st} tests we use: anti- k_{T} , R=0.5

2) Jet reconstruction in CMS: 3 strategies





For 1^{st} tests we use: anti-k₊, R=0.5

Particle Flow jets

Use a coherent combination all detectors to reconstruct and identify particles.

Compute jets out of those particles.

3) Example: 3-Jets event at \sqrt{s} = 2.36 TeV





3) Example: 3-Jets event at \sqrt{s} = 2.36 TeV





4) Jet energy correction

- 2 step calibration procedure: Reco to Gen (stable hadrons).
 - Relative in η to equalize the response wrt the barrel ($|\eta| < 1.3$).
 - Absolute in p_T .

$$P_{\mu}^{cor} = C(p_{\mathrm{T}},\eta) \times P_{\mu}$$





Corr (PF) ~ 1.15 << Corr (Calo) ~ 2. PF jets gain from charged hadrons (~60% of jet p_T in the barrel).







1) Selection of jets for commissioning

- 900 GeV, 2360 GeV:
 - Loose cuts in p_T to enhance statistics: $p_T > 8-15 \text{ GeV}, |\eta| < 2-3 + \text{quality selection}.$
 - Commissioning of low p_T jets.
 - 7 TeV:
 - More restrictive cuts in p_T . $p_T > 25 \text{ GeV}, |\eta| < 3 + \text{quality selection}.$
 - Commissioning of jets for first analyses.
- Quality selection:
 - Remove most of the noise jets passing selection cuts.
 - Depend on the jet type: different detector informations.
 - Reject jets purely HCAL, single tower, no tracks (PF Jets).₁₂
 Gouzevitch PLHC Hamburg 10/06/2010



2.1) Commissioning of low pT jets (900 GeV)



- Done at 900 GeV and 2360 GeV (PAS-JME-10-001).
- Inclusive jets spectrum independent of event structure.
- Good agreement Data/MC.



2.2) Commissioning of low p_T jets (900 GeV)



- Going lower in p_{T} (Particle Flow jets) :
 - No quality cut and $p_T > 5$ GeV (PAS-PFT-10-001).
 - Lowest p_T jets sensitive to the experimental effects (noise...).

Noise peak due to p_{τ} cut

Excellent global agreement.



2.3) Commissioning of low p_T jets (900 GeV)



15

In addition a dedicated study shows a good description of the internal structure of jets. This result is confirmed @ $\sqrt{s} = 7$ TeV:

- Electromagnetic fraction for Calo and JPT jets.
- Different species for PF jets (see below).





3.1) Commissioning of jets for physics: di-jets



- Done (a) $\sqrt{s} = 7 \text{ TeV}$
- Di-jet spectrum provide a clear scale to the event : tree level QCD parton-parton hard scattering.
- High purity selection cuts:

p _⊤ (1 st jet)	>25 GeV
p _T (2 nd jet)	>25 GeV
$\Delta \phi = \phi 1 - \phi 2 $	> 2.1
η	η < 3
Quality selection	Dependent on jet type



The back-to-back topology in the transverse region shows the high purity of the sample for any type of jets.

3.2) Commissioning of jets for physics: 2-jets











Summary and Prospects for di-jet physics in CMS







- The jet commissioning was successfully performed starting from $p_T = 5$ GeV and up to 100 GeV.
- The kinematics and structure of jets is well understood and controlled.
 The presence of 2 jet back-to-back is a benchmark of a hard scattering and provide a hard scale to the event.
- The jet observables are ready for physics analyses. A wealth of results is expected for ICHEP with a full commissioning of jets @ $\sqrt{s} = 7$ TeV: resolution measurement, jet energy scale uncertainty...

PROSPECT FOR DI-JET PHYSICS

CERN

Seek for signatures of new physics in the di-jet mass spectrum: deviation at large mass, resonances...

→ q^* , GUT - Z', R&S, Gluinos etc...



PROSPECT FOR DI-JET PHYSICS

Seek for signatures of new physics in the di-jet mass spectrum: deviation at large mass, resonances...

→ q*, GUT - Z', R&S, Gluinos etc...





BACKUP



variable	$ \eta $	loose
EMF	< 2.6	> 0.01
$n_{ m hits}^{90}$	-	> 1
$f_{ m HPD}$	-	< 0.98

Table: Loose calorimeter jet ID criteria (PAS JME-09-008).

Definition EMF := electromagnetic energy fraction $n_{\text{hits}}^{90} :=$ minimum number of hits to contribute 90% of jet energy $f_{\text{HPD}} :=$ maximum jet energy fraction contributed by a single HPD



variable	$ \eta $	loose
CHF	< 2.4	> 0.0
NHF	-	< 1.0
CEF	-	< 1.0
NEF	-	< 1.0

Table: Loose particle flow jet ID criteria.

