Status of W+jets analysis

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- Acceptance/Background
- Parton-jet matching
- Comparison with data

Data set

Luminosity : ~ 72 pb^{-1} (Mar.2002 – Jan.2003)
Trigger path : High Pt Electron 18 GeV

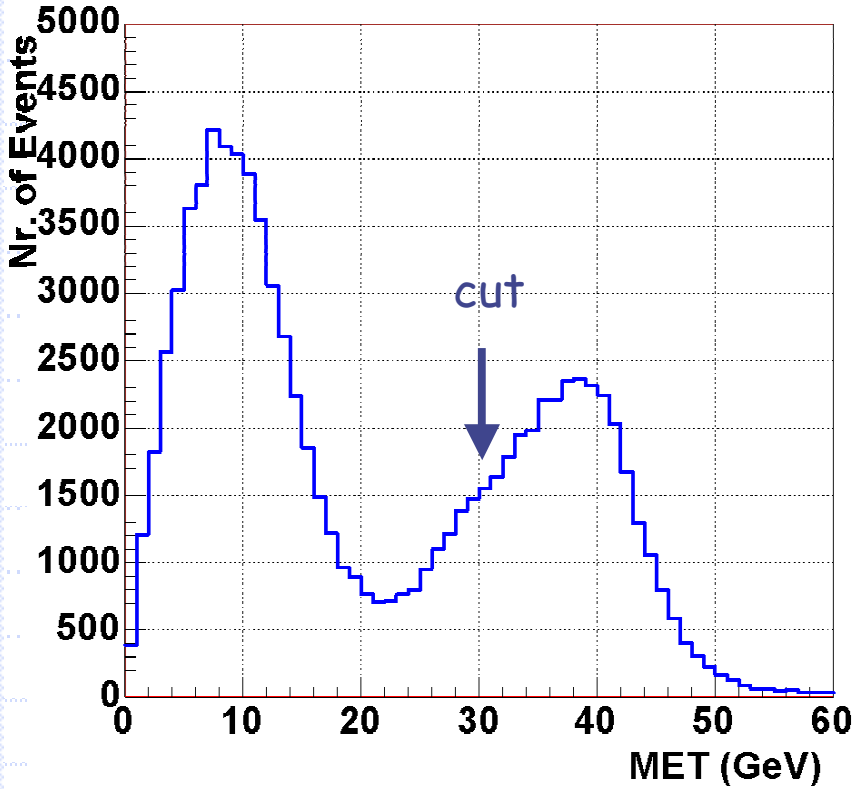
Electron Cuts :	Events	%
Central Region ($|\eta| < 1.1$)	352,420	1.00
$|Z_o| < 60$ cm	336,250	0.95
Fiducial Region	309,376	0.88
$E_t > 25$ GeV	144,015	0.41
$P_t > 10$ GeV	143,364	0.41
Had/EM < 0.055 + 0.00045 x E	143,100	0.41
E/P < 2.0 or $E_t > 50$ GeV	142,085	0.40
-3 cm < Q Dx < 1.5 cm	142,067	0.40
$|Dz| < 3.0$ cm	142,055	0.40
Strip $\chi 2 < 10$	142,009	0.40
Lshr < 0.2	141,988	0.40
Track segment	134,449	0.38
Isolation(0.4) < 0.1	92,444	0.26

Selection of W→ eν sample

MET > 30 GeV

Final number of W sample:

31,945 events



Jet Definition

Parton-jet profile:

Big discrepancy in low Pt region.

2 sets of Jet sample:

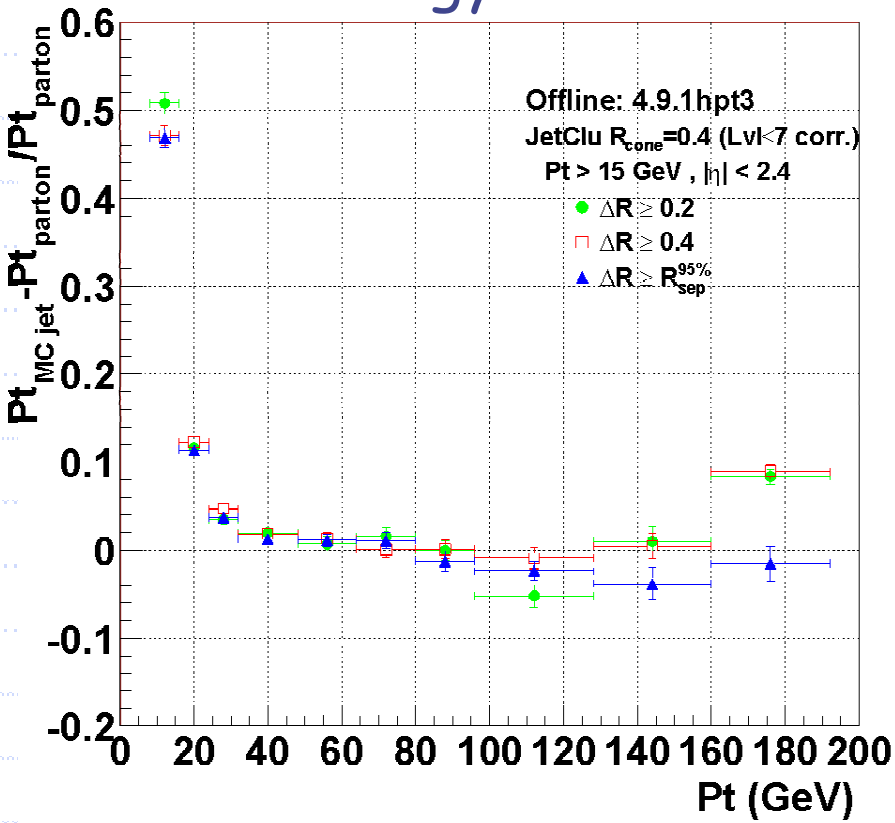
a) Pt > 15 GeV
b) Pt > 25 GeV

Merging/splitting:

$R_{sep}^{95\%}$ -basis

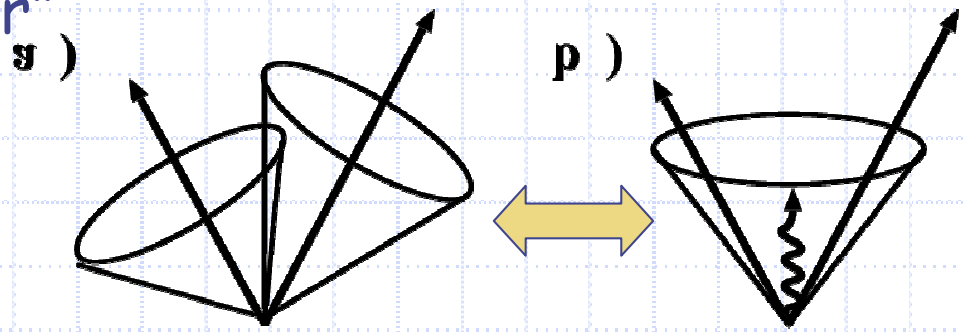
(backup solution, R=0.52)

Jet Energy Correction



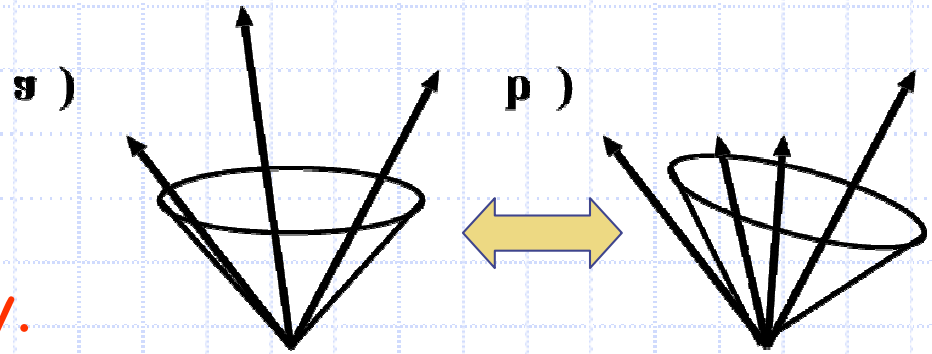
Problems of cone algorithms

Example of the "collinear" problem in cone jet clustering.



Collinear problem 1

Other problem is "infrared" problem.



Collinear problem 2

Algorithm should be collinear/infrared safety.

Separation phase space (NOTE 6442)

Result:

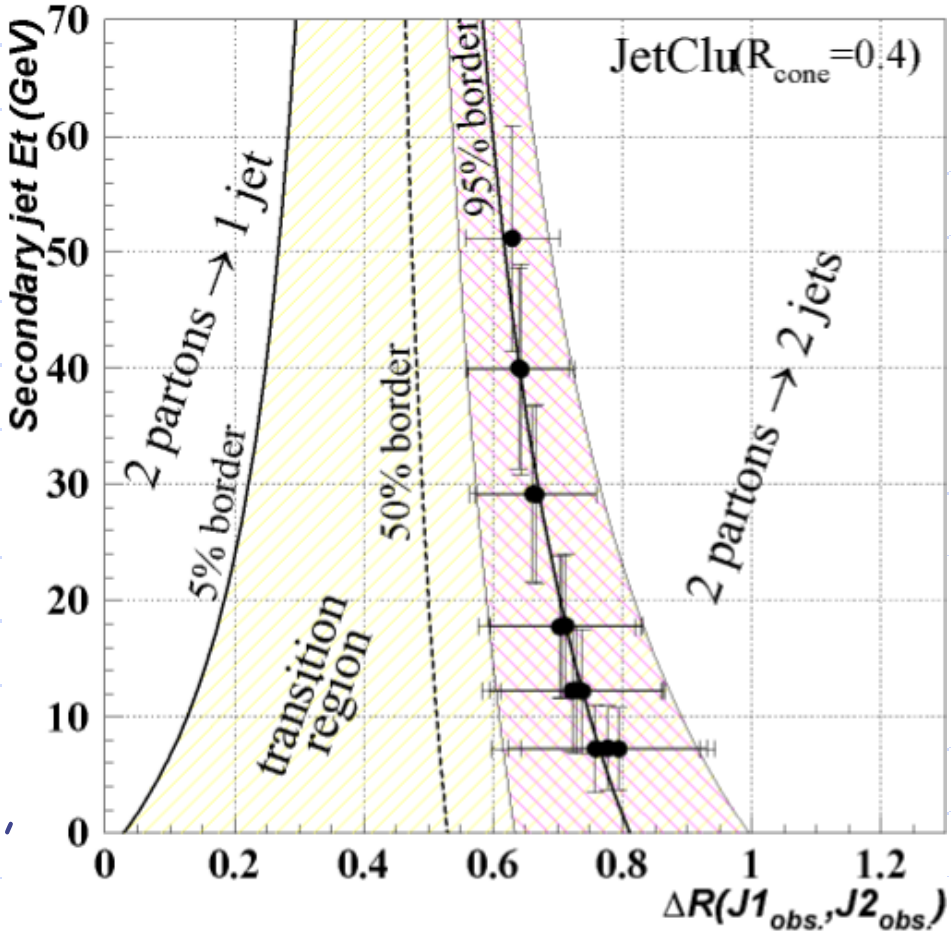
$$R^{95\%}_{sep} = \frac{23.2(1)}{\min(Et1,Et2)+56.5(6)} + R_{cone}$$

with the 95% separation probability for the cone size of 0.4.

Merging/splitting:

if $\Delta R(j,j) < R^{95\%}_{sep}$,merge,

else, split.



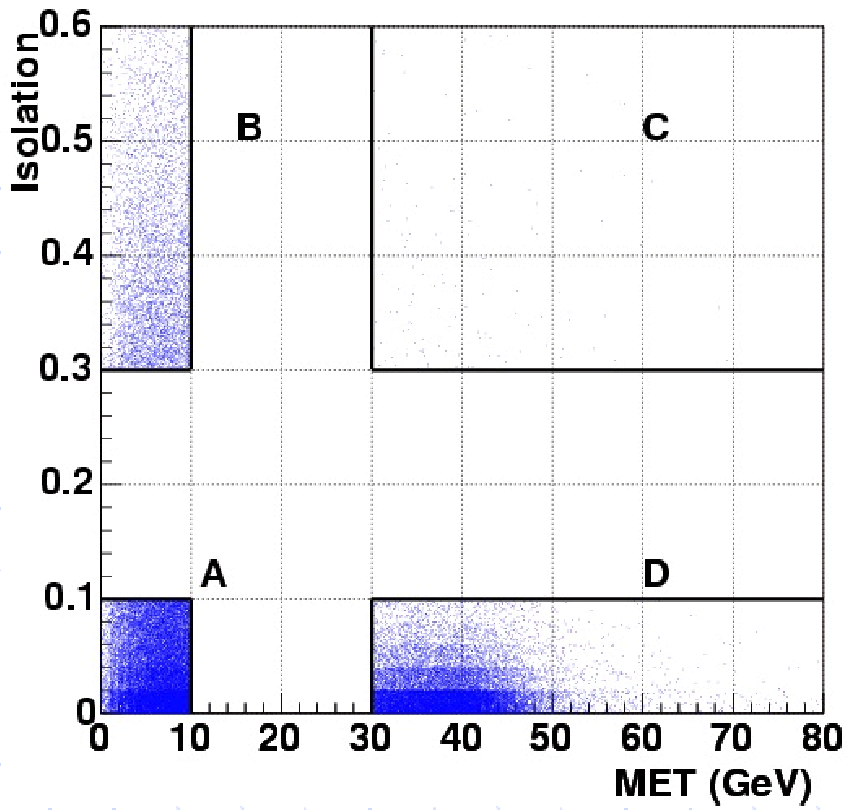
QCD Background

QCD background :

$$N_D^{QCD} = \frac{N_A}{N_B} N_C$$

(assumption of linear relation)

Region A: MET < 10 GeV, Iso < 0.1
B: MET < 10 GeV, Iso > 0.3
C: MET > 30 GeV, Iso > 0.3
D: MET > 30 GeV, Iso < 0.1



Test of the QCD bkg. calculation

	Low MET sample MET < 10 GeV				Anti-isolation sample Isolation > 0.3			
	Pt > 15 GeV		Pt > 25 GeV		Pt > 15 GeV		Pt > 25 GeV	
	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.
≥0 jets	14,810	18,503	14,810	18,503	159	108	159	108
≥1 jets	3,434	3,767	1,636	1,777	30	21	14	9
≥2 jets	807	859	273	332	6.8	5	7.5	1
≥3 jets	124	193	45	61	3.9	2	2.5	1
≥4 jets	40	44	---	8	10	0	---	0

Results of QCD bkg. (systematics will be assigned as 30%.)

	Pt > 15 GeV		Pt > 25 GeV	
	W candidates	QCD bkg.	W candidates	QCD bkg.
≥0 jets	31,950	766	31,950	766
≥1 jets	6,613	138	3,277	62
≥2 jets	1,522	32	579	15.7
≥3 jets	347	12.3	106	13.1
≥4 jets	64	5.4	14	0.0

Physics Background

Background	≥ 0 jets	≥ 1 jets		≥ 2 jets		≥ 3 jets		≥ 4 jets	
$W \to \tau\nu$	372.2(*)	77	47	19.3	9.1	6.6	2.1	0.9	0.1
$Z \to e^+ e^-$	762.4(*)	158	83	39	18	8.2	2.4	1.1	0.1
Top	32.4	32	32	32	30	26	22	17	11

Pt > 15 GeV

Pt > 25 GeV

Too large??

top bkg. : from MC and theoretical xsec.

$$\sigma_{top}(175) = 6.70^{+0.71}_{-0.88} \text{ (pb)} \quad \text{(hep-ph/0303085)}$$

Single Boson : from Ratio to Data.

$$R_{W\to\tau\nu} = \frac{\sigma(W\to\tau\nu)\,\varepsilon(W\to\tau\nu)}{\sigma(W\to e\nu)\,\varepsilon(W\to e\nu)} \qquad R_{Z\to ee} = \frac{\sigma(Z\to ee)\,\varepsilon(Z\to ee)}{\sigma(W\to e\nu)\,\varepsilon(W\to e\nu)}$$

Acceptance

$$\varepsilon_{tot} = \varepsilon_{geo}\,\varepsilon_{kin}\,\varepsilon_{ID}\,\varepsilon_{trig}\,\varepsilon_{vtx}$$

$\varepsilon_{ID} = 84.2$ +- 0.7(stat) +- 0.2(syst) %

$\varepsilon_{vtx} = 95.1$ +- 0.1(stat) +- 0.5(syst) %

$\varepsilon_{trig} = 96.6$ +- 0.1 %

$\varepsilon_{geo} \sim 42$ % $\varepsilon_{kin} \sim 55$ %

Systematics

Jet Energy Correction ~ +- 5 %
Merging/splitting ~ $\sigma(R_{sep}^{95\%})$

	Pt correction (5%)		Merging/splitting(Rsep95%)	
	Pt > 15 GeV	Pt > 25 GeV	Pt > 15 GeV	Pt > 25 GeV
≥1 jets	+6.7, -7.9 %	+7.3, -8.2 %	-0.15, +0.15 %	-2.1, +1.0 %
≥2 jets	+9.9, -12.2 %	+10.1, -10.5 %	+3.1, -1.9 %	-0.9, -0.5 %
≥3 jets	+16.6, -14.1 %	+11.7, -11.6 %	+8.0, -7.1 %	+2.8, -8.2 %
≥4 jets	+17.9, -18.8 %	+22.2, -40.0 %	+16.9, -17.2 %	+6.7, -27.2 %

Rsep = 0.52	-0.2 %	-3.2 %
	+4.2 %	-0.2 %
	+9.6 %	+3.6 %
	+32.8 %	+7.1 %

Parton-Jet Matching

In the LO perturbative calculation, the parton-jet matching is defined as "one parton in one cone".

Once we agree with the above, we will have some benefits:

1) No collinear/infrared singularity.
Suppression of kinematical cut dependence at generator level.

2) Partly avoid "double counting".
Showering partons are absorbed into the jet cone.(jet merging)

3) Treatment of "invisible parton" at NLO.
(In NLO, two partons in single cone.)

Comparison with Data will arise a sensitivity toward to the higher order calculation.

Procedure of the Jet Sep. Method.

Cut at generator level:

$$\Delta R(p,p) > R_{sep}^{95\%}$$

Matching condition:

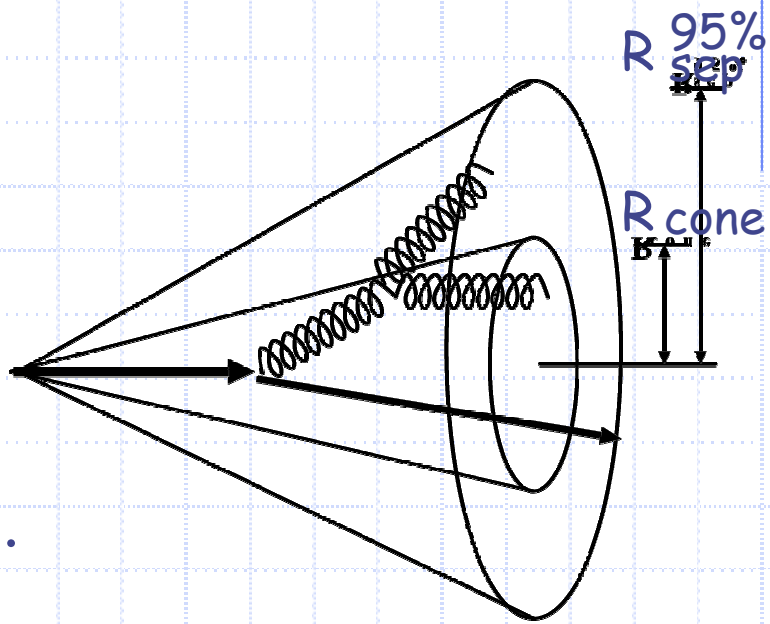
if $\Delta R(p,j) < R_{sep}^{95\%}$, match,

else, not match.

Merging/splitting:

if $\Delta R(j,j) < R_{sep}^{95\%}$, merge,

else, split.



Only described one parameter, $R_{sep}^{95\%}$

Matching efficiency

JetClu (R=.4)

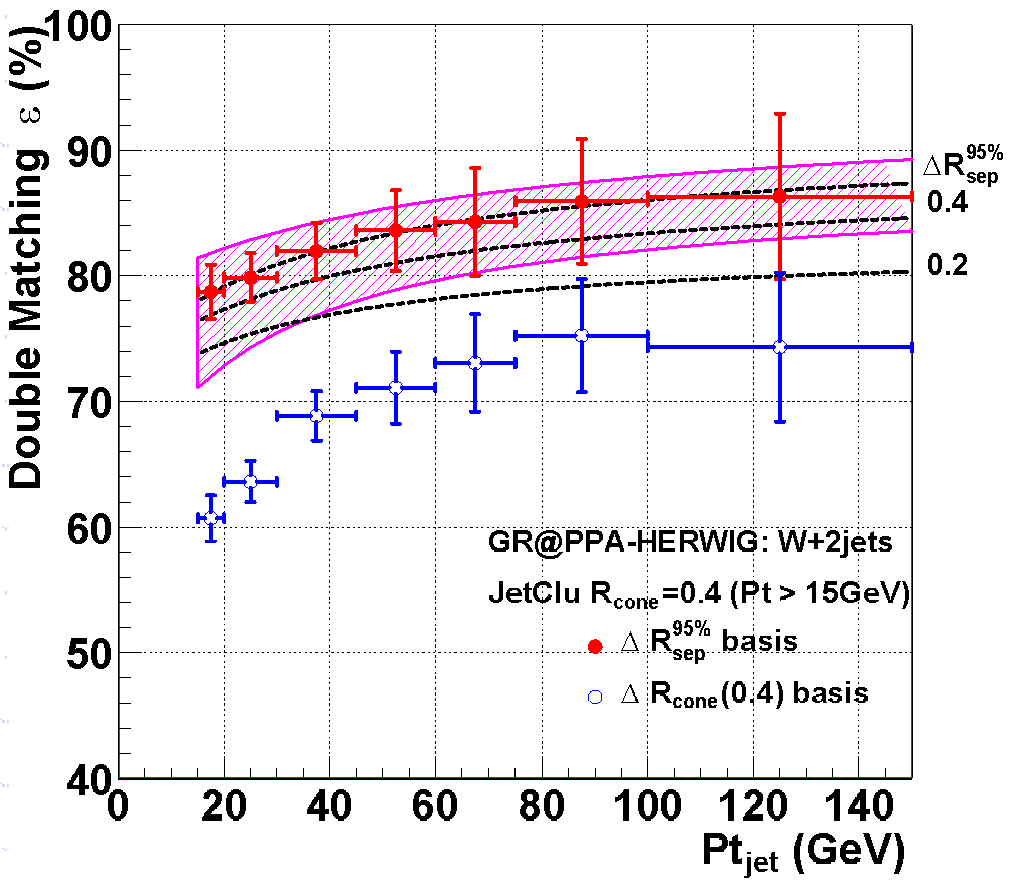
Pt > 15 GeV

Definition:

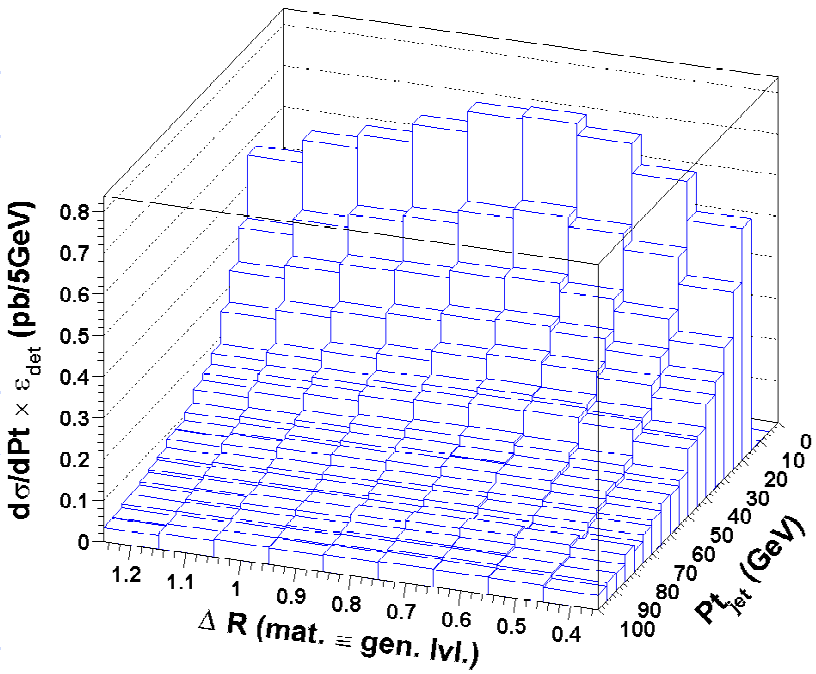
$$\varepsilon = \frac{N(Pt; \Delta R(p,j) < Rc)}{N(Pt; \min\{\Delta R(p,j)\})}$$

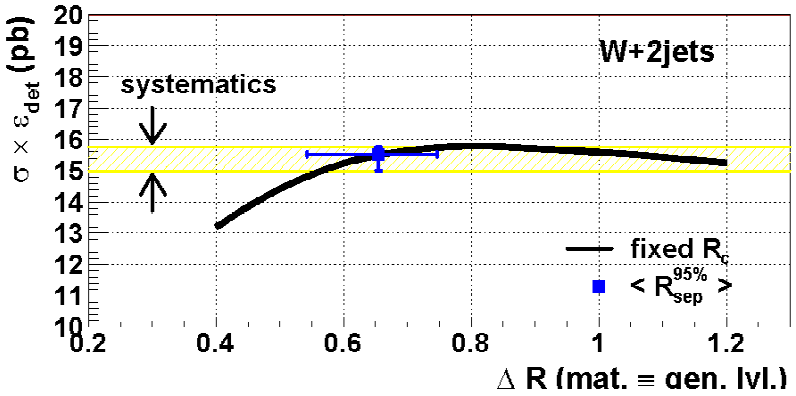
,where Rc = 0.4, $R_{sep}^{95\%}$

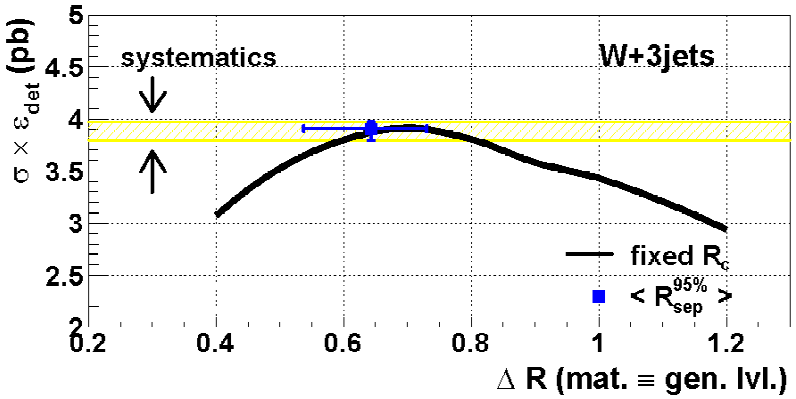
A new systematics in the matching, $\Delta R(p,j)$.



Optimization







$R_{sep}^{95\%}$ maximizes the matching efficiency.

Kinematical cut dependence

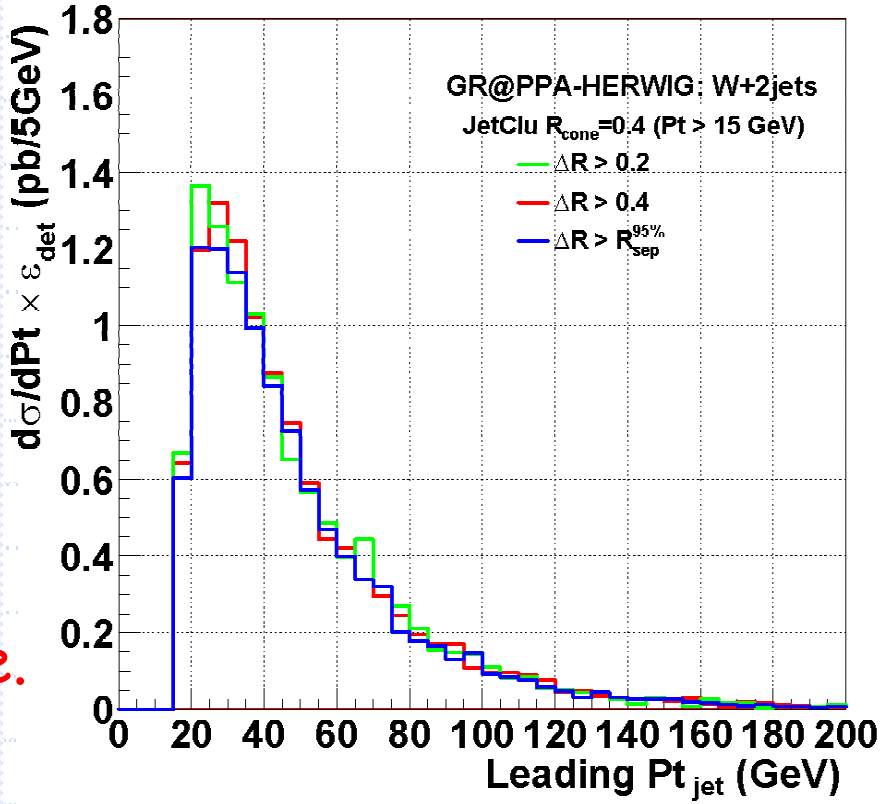
Matching condition:

$$R_c = R_{sep}^{95\%}$$

Separation cut
at generator level:

$$0.2,\ 0.4,\ R_{sep}^{95\%}$$

No kinematical dependence.



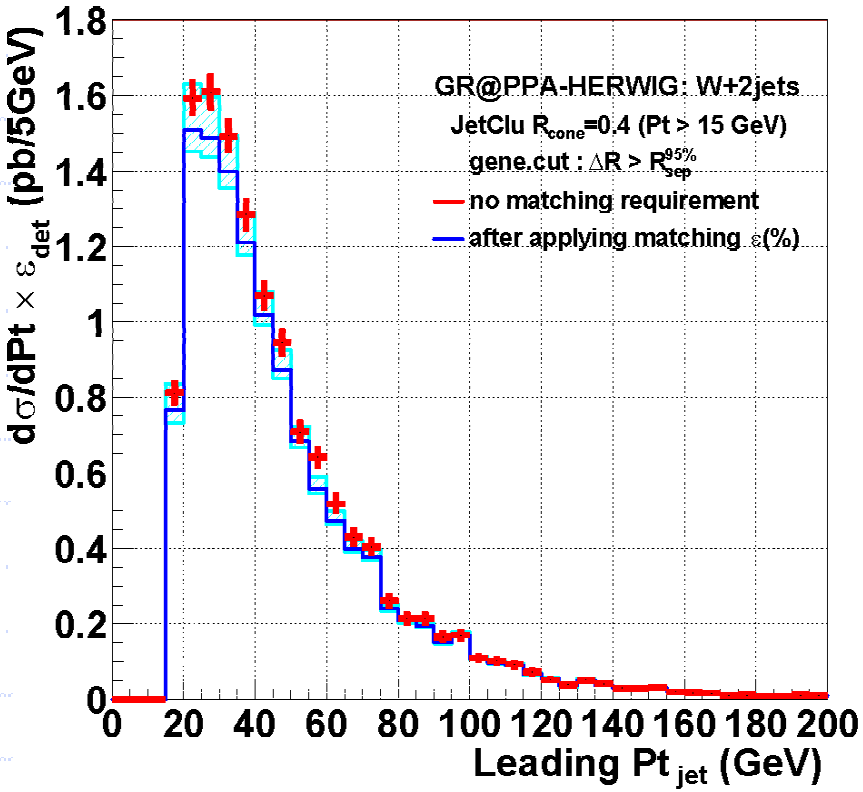
Apply matching efficiency

Distribution is biased by the matching effic..

We can also apply the matching effic..

Almost same distribution with the case of no-matching requirement.

But we have new systematics by the matching effic. in the kinematical distribution.

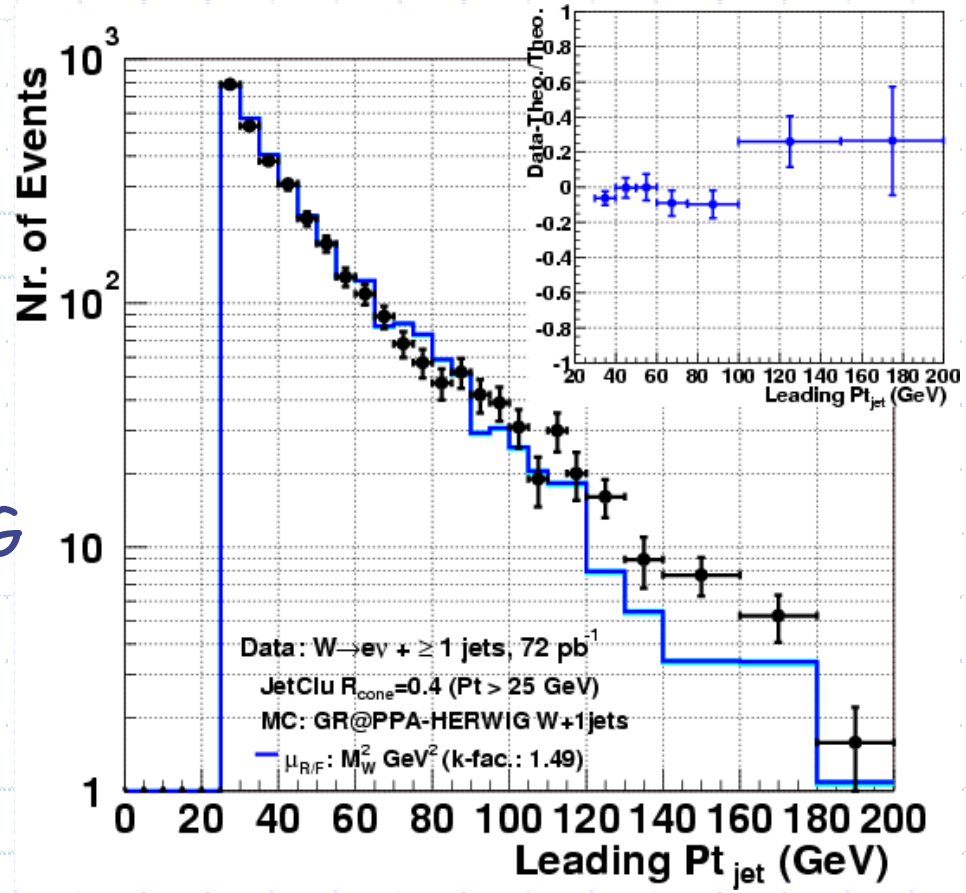


Shape analysis 1.

Leading jet Pt
in W ≥ 1 jets sample.

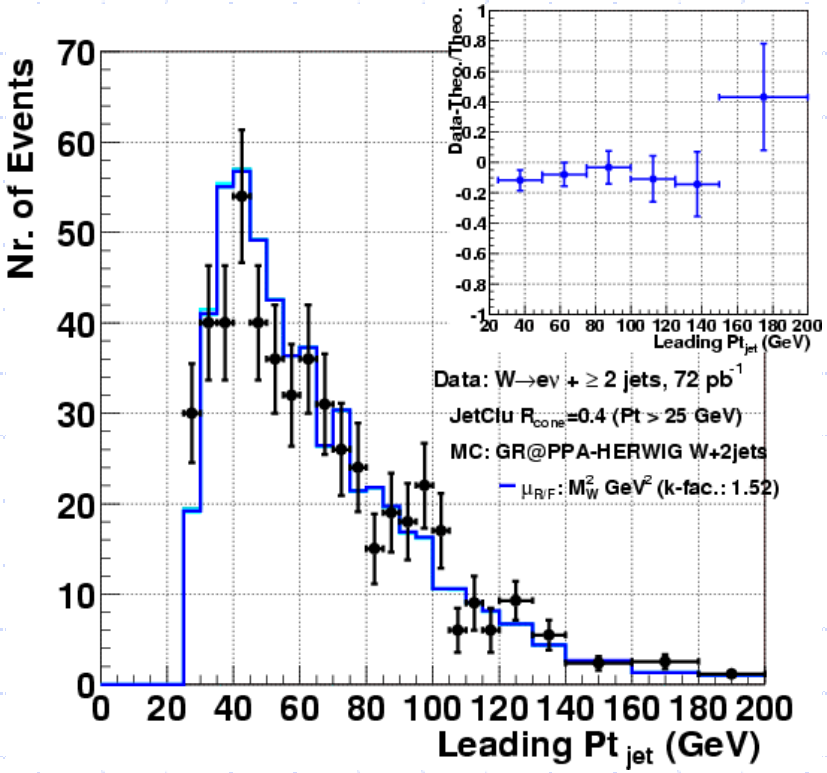
MC: GR@PPA-HERWIG

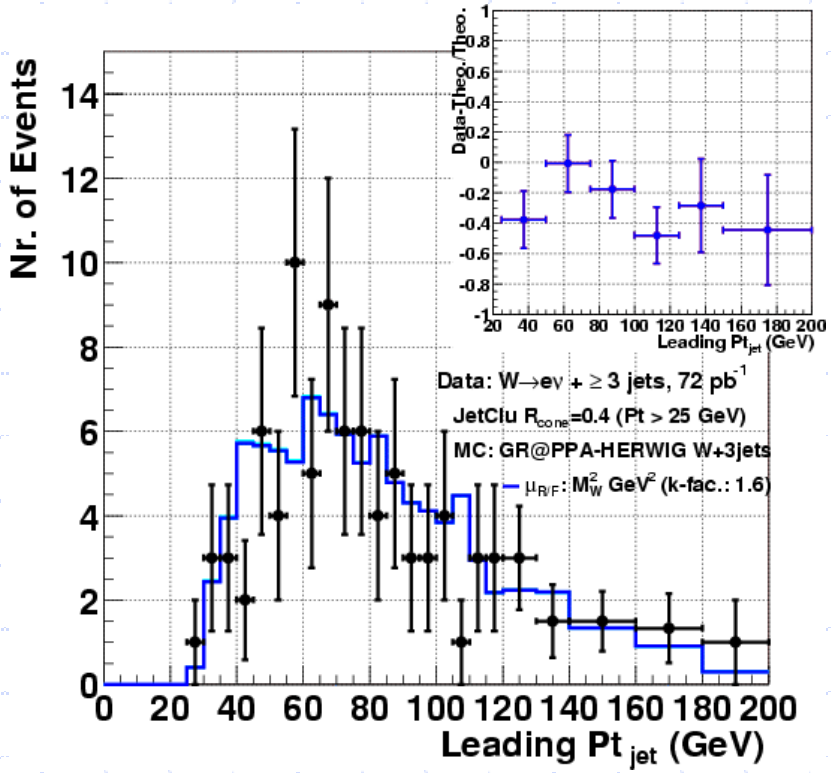
MC is normalized
by data.



Shape analysis 2.

Leading jet Pt distribution of W ≥ 2 jets and ≥ 3jets.





Jet multiplicity

Energy scale: M_W^2 GeV^2

Deviation:

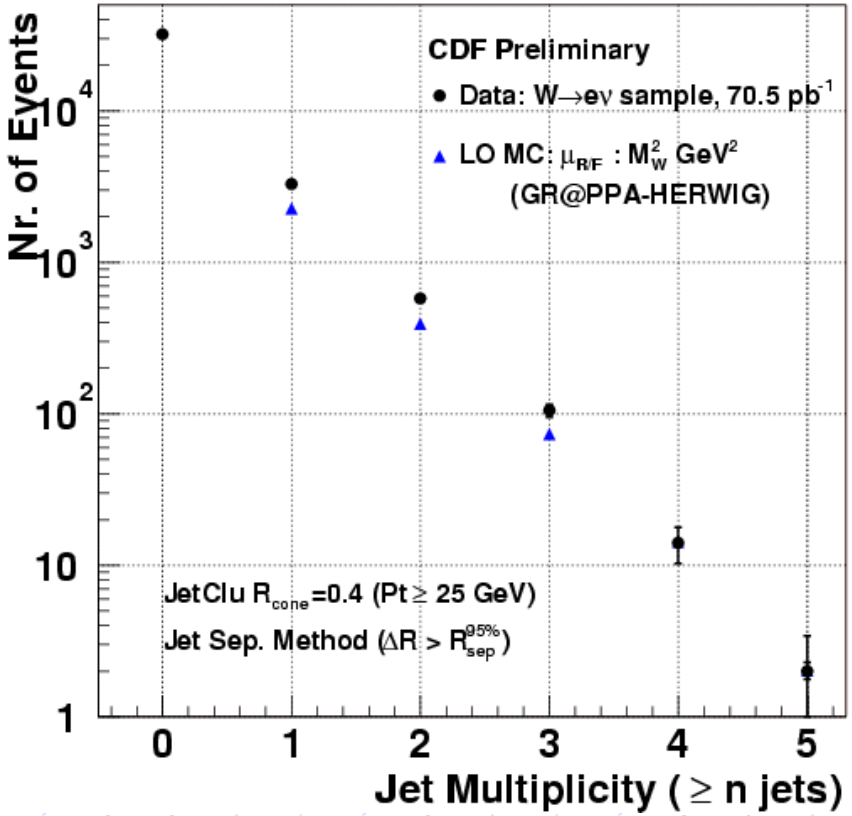
W ≥ 1 jet : 1.5

≥ 2jets: 1.5

≥ 3jets: 1.6

Constant behavior.

No bkg. subtraction in data



Summary

Physical quantities :

xsec: $\sigma(W \geq n \text{ jets})$

ratio: $\dfrac{N(W \geq (n+1) \text{ jets})}{N(W \geq n \text{ jets})}$, $\dfrac{N_{Data}(W \geq n \text{ jets})}{N_{MC}(W \geq n \text{ jets})}$

dream: strong coupling constant!!

Plan : I like to show some results at MC4LHC WC at CERN on July 7th.

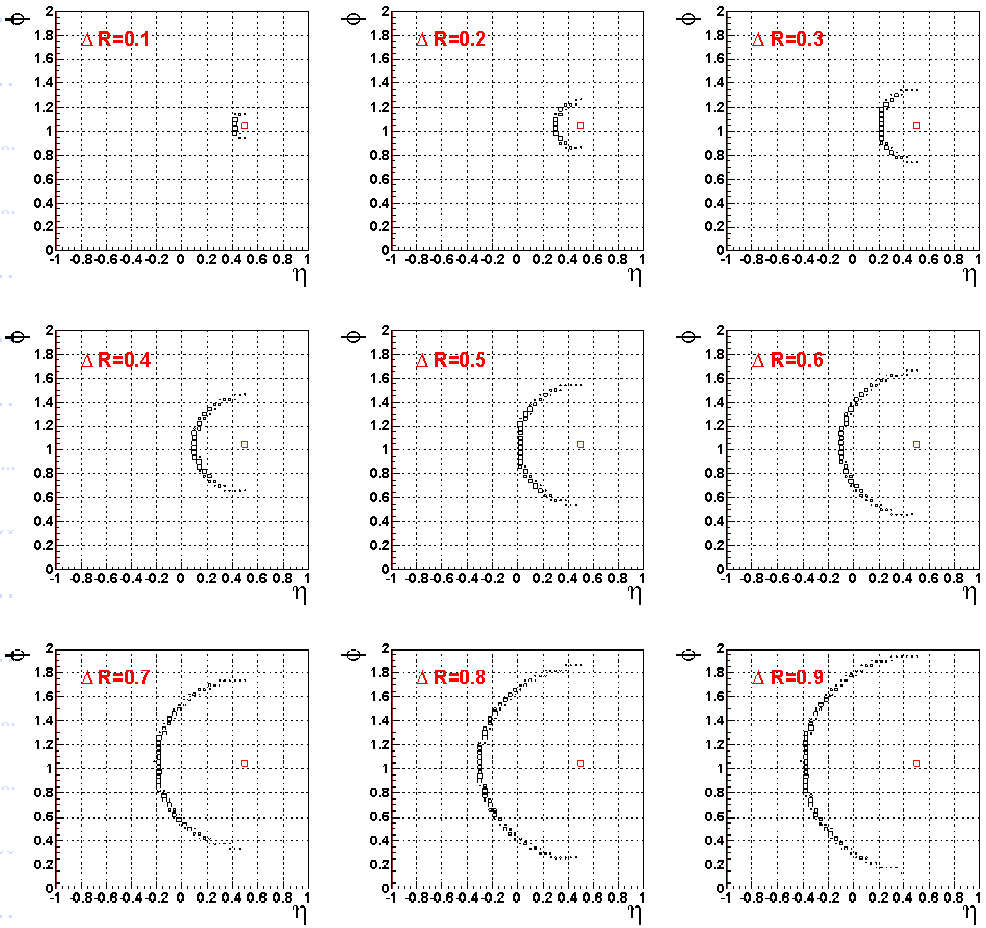
EPS, too…

Long term : Lots of things!!!

Many of detailed studies (jet, bkg, jet sep., etc),
Jet shape, Algorithm dep., Jet ene. Correction,
Of cource, GR@PPA in NLO, …

Toy Monte Carlo

Makes two parton in the particular direction.



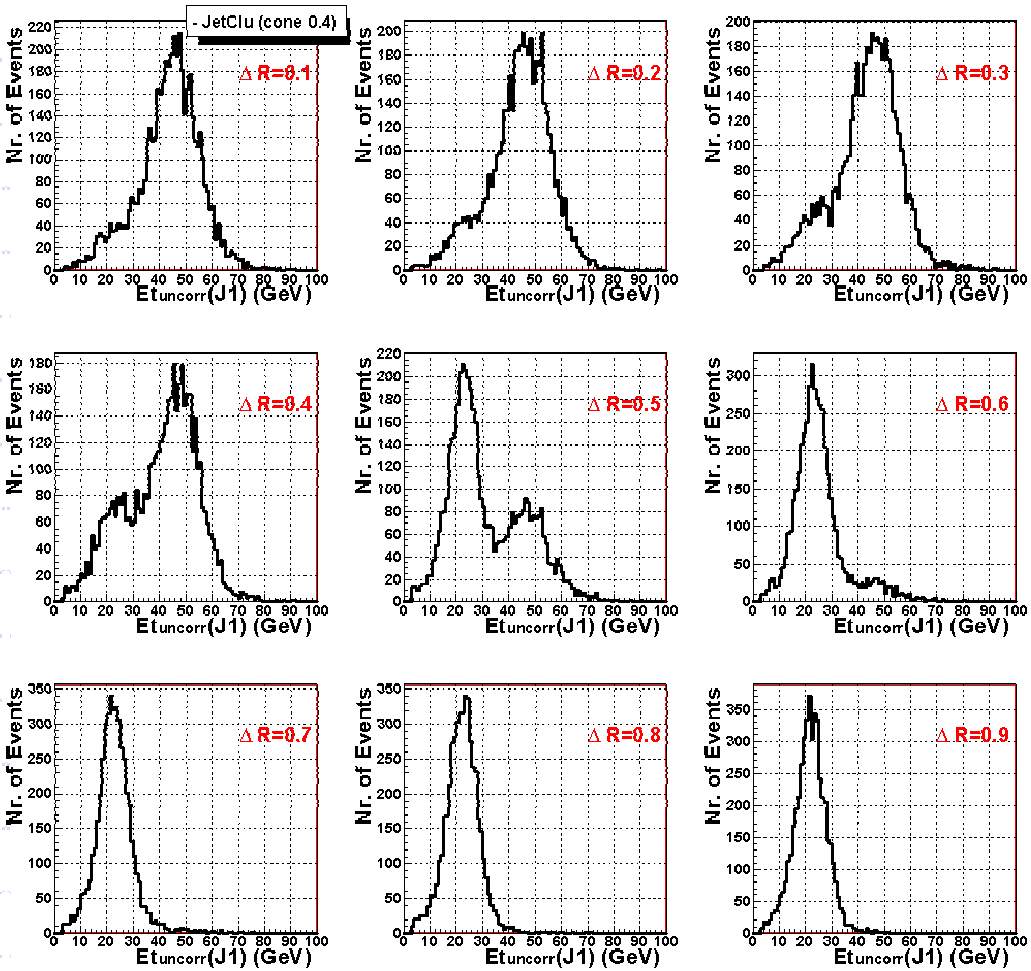
By changing the separation angle, soft/collinear situation is reproduced.

Transition behavior 1.

Leading jet distribution.

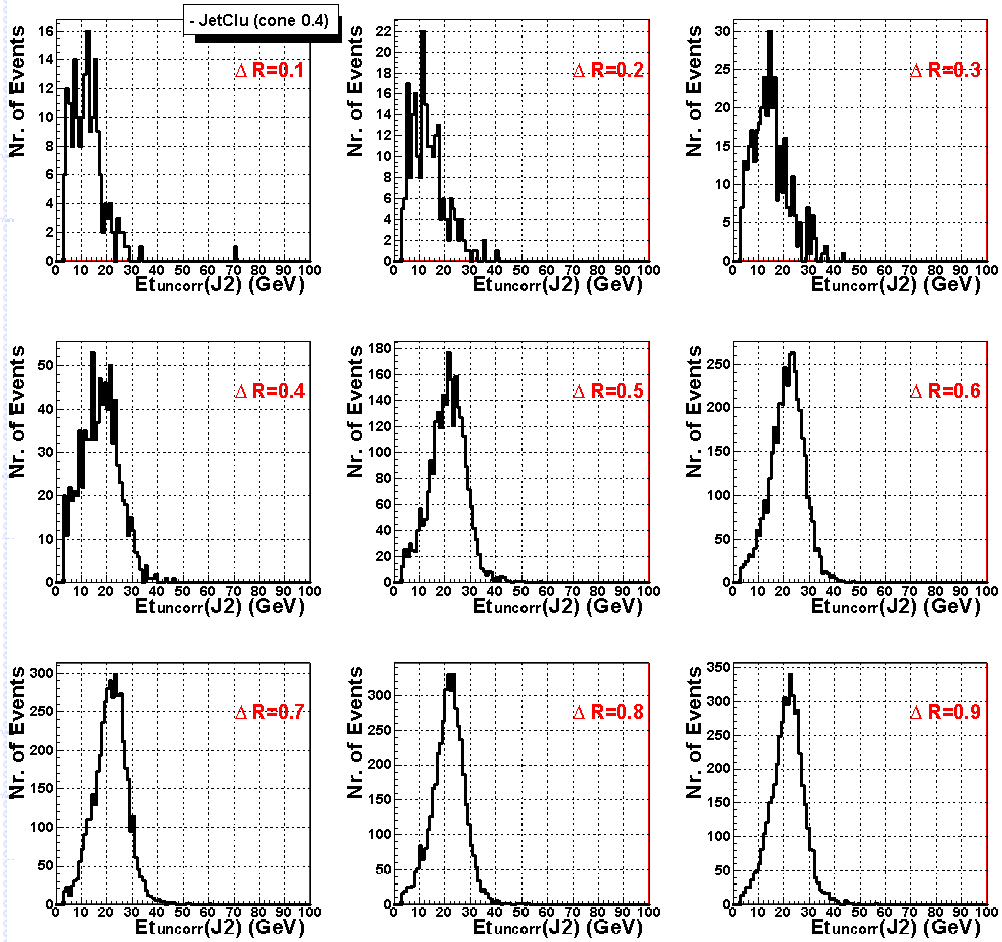
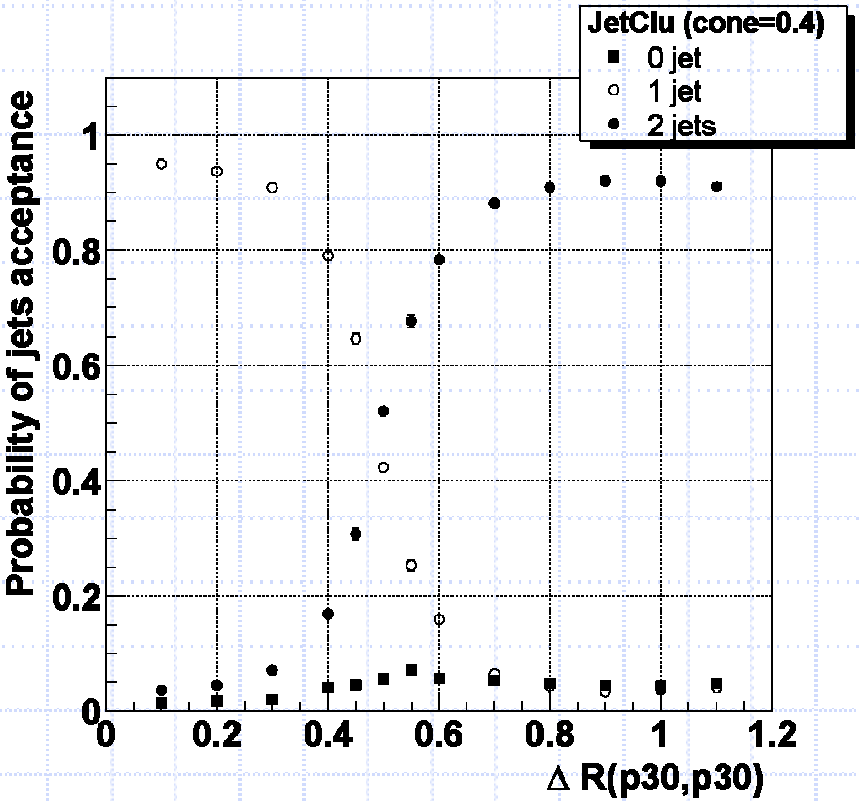
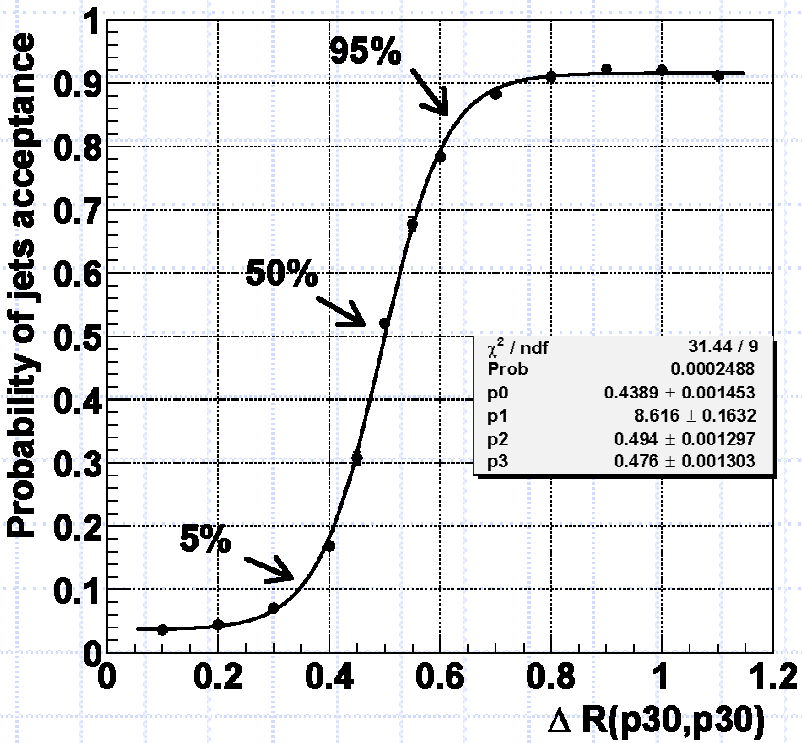
Pt1 : 30 GeV

Pt2 : 30 GeV



Transition behavior 2.

Secondary jet.



Transition behavior 3.