Inclusive Dijet Mass Spectrum

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Inclusive dijet mass spectrum

- cross section - counting measurement
- take the two leading jets
  - both of them should be in the central region of calorimeter $|\eta| < 0.5$

$$M_{JJ}^2 = (P_{jet1} + P_{jet2})^2 = (E_{jet1} + E_{jet2})^2 - (\vec{p}_{jet1} + \vec{p}_{jet2})^2$$

- **Master formula**

$$\left\langle \frac{\mathrm{d}\sigma}{\mathrm{d}M_{JJ}} \right\rangle = \frac{N_{evt}}{\mathcal{L}} \frac{1}{\varepsilon_{eff}} C_{unsmear} \frac{1}{\Delta M_{JJ}}$$

Data sample

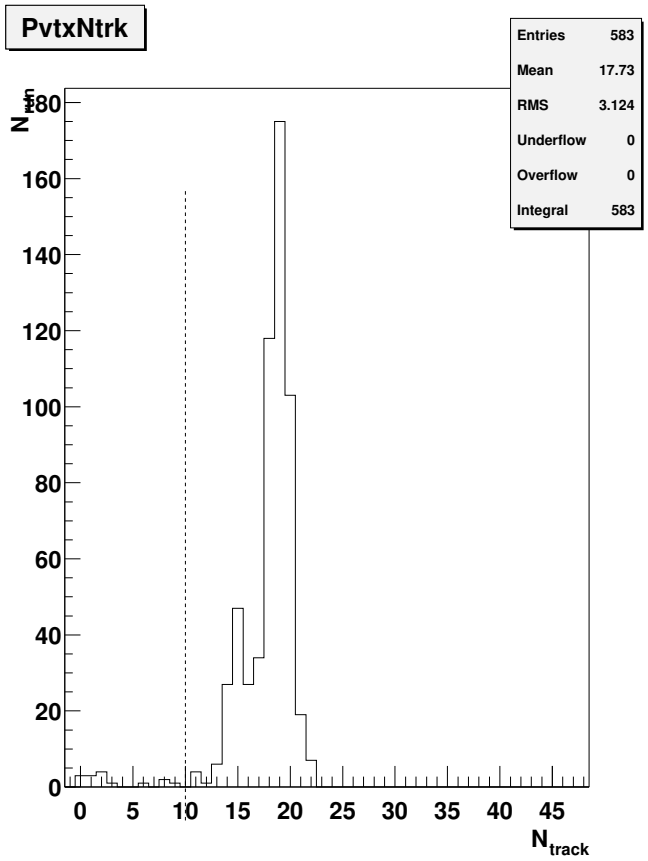
- stripped p13.04, p13.05 and p13.06 thumbnails (single jet triggers)
- stripping done by QcdSkim code (`qcd_tools` package)
- trigger versions 8, 9, and 10
- integrated luminosity is $\mathcal{L} = 55.9\,\text{pb}^{-1}$

	p13.04	p13.05	p13.06
$\mathcal{L}$ [pb^{-1}]	12.0	38.8	5.1

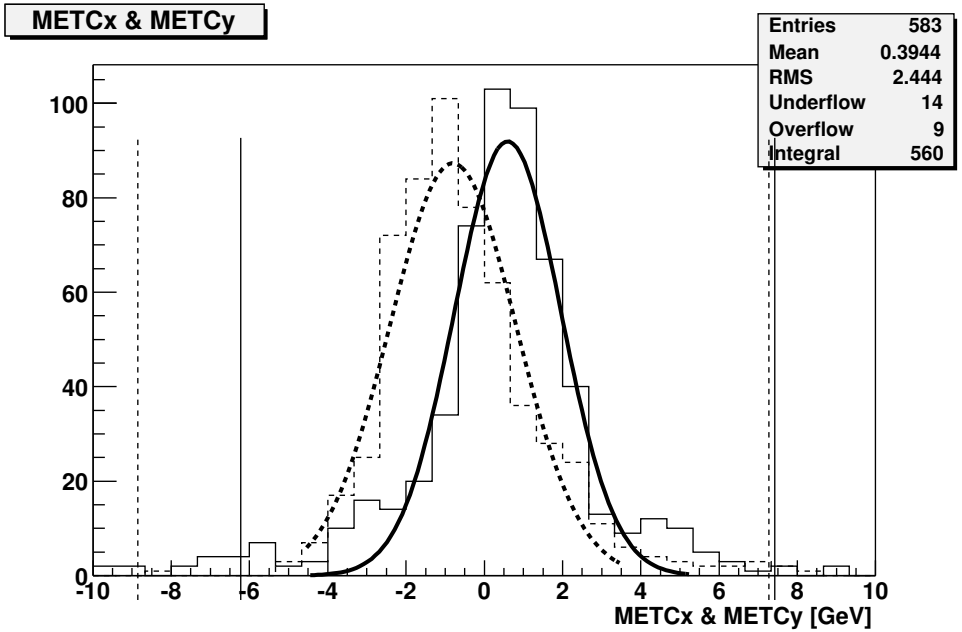
Run selection

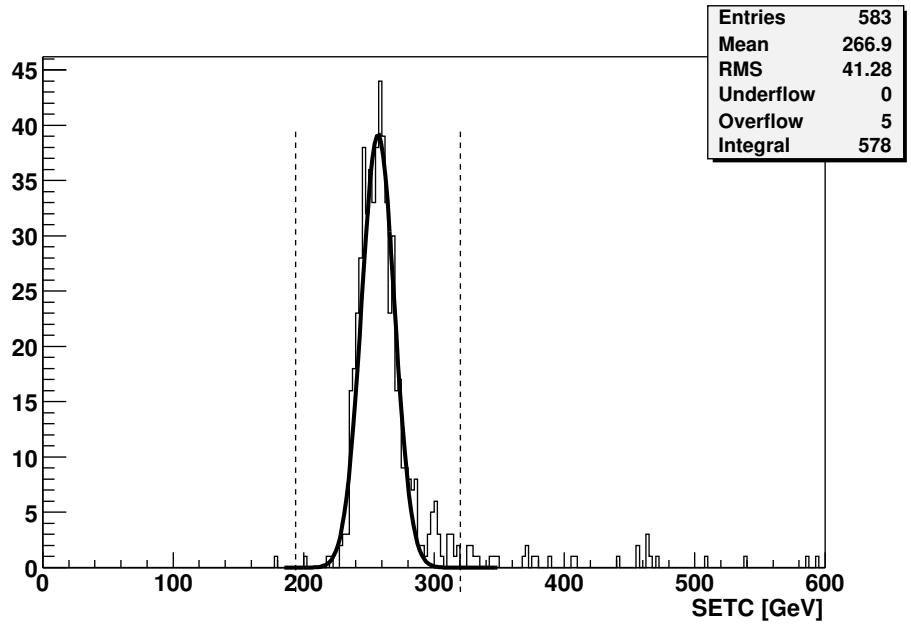
- run selection based on MET, METx, METy, SET

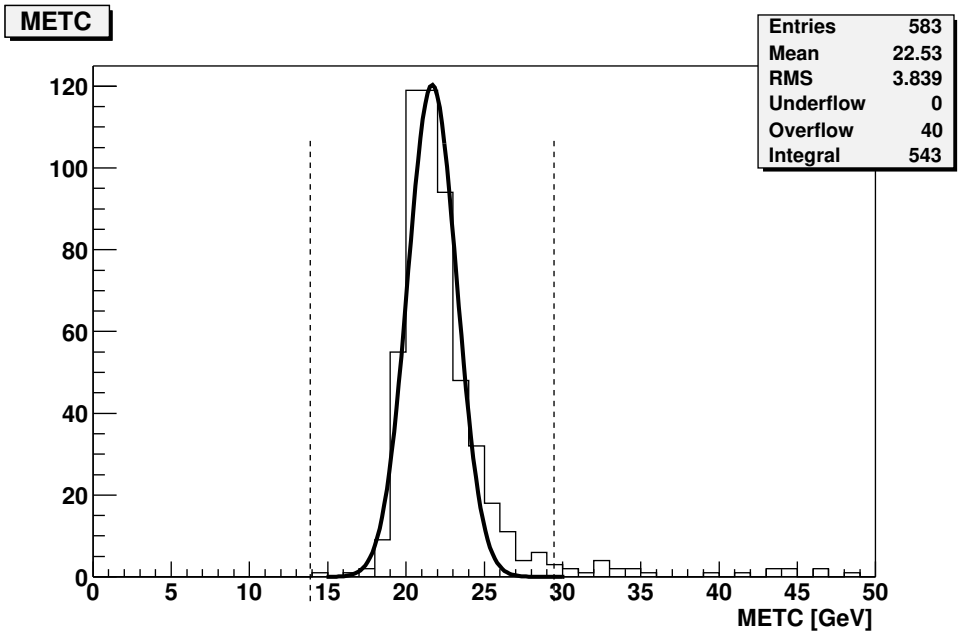
  $+$ runs with spikes in jet φ distribution were removed
- slightly loose the selection criteria - 5σ condition
- at least 50 events in trigger JT_65TT
  - check on number of tracks associated to the vertex
  - $43.0\,\mathrm{pb}^{-1}$ survives

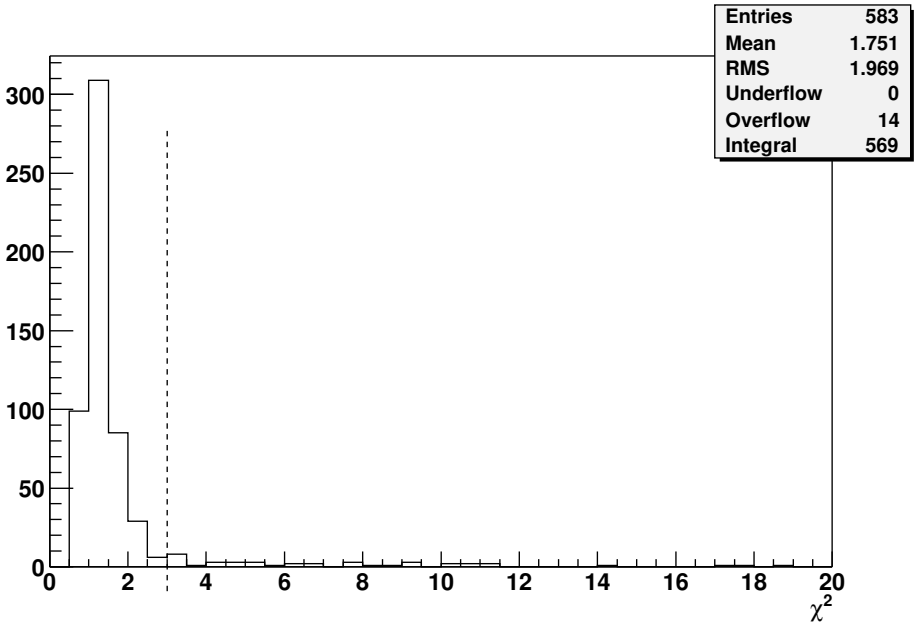


Run selection variables



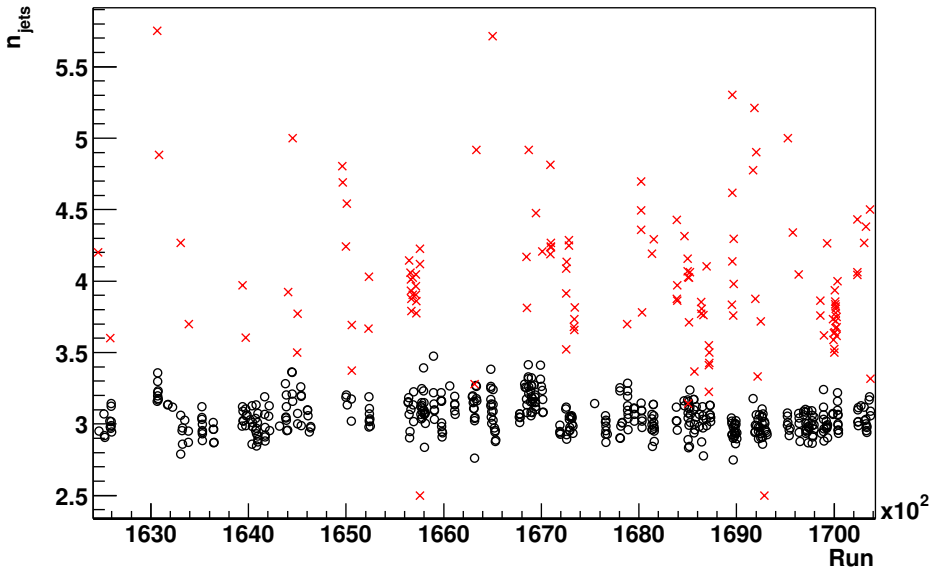




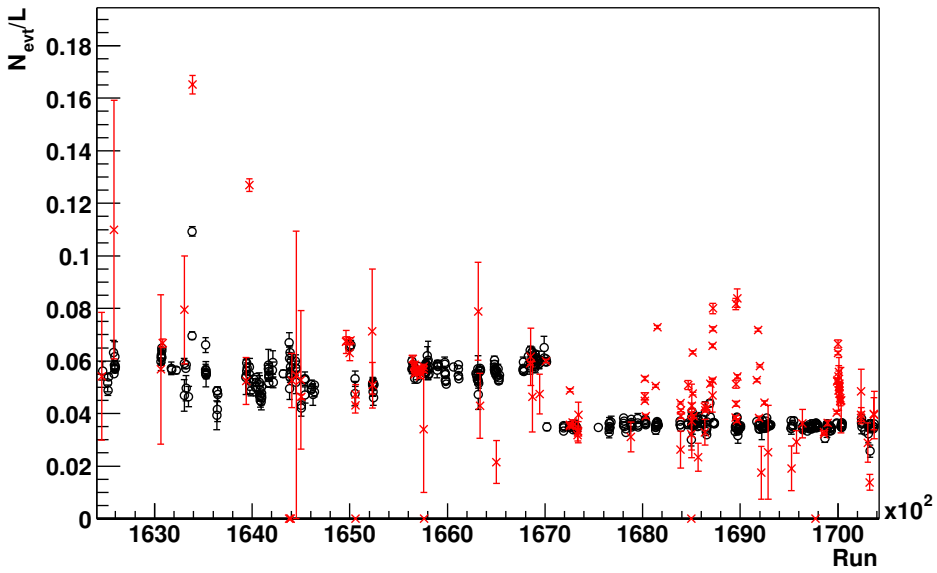


Run selection check

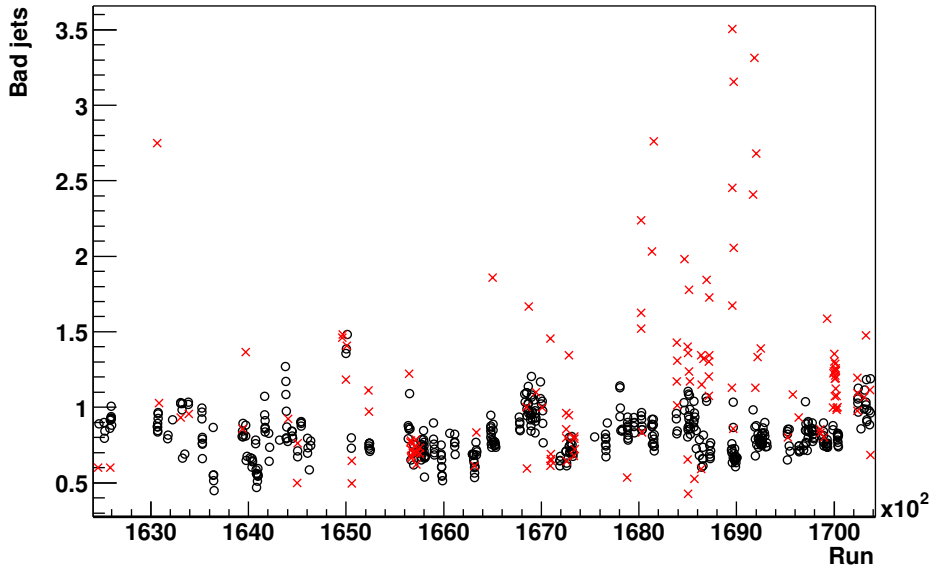
number of good jets



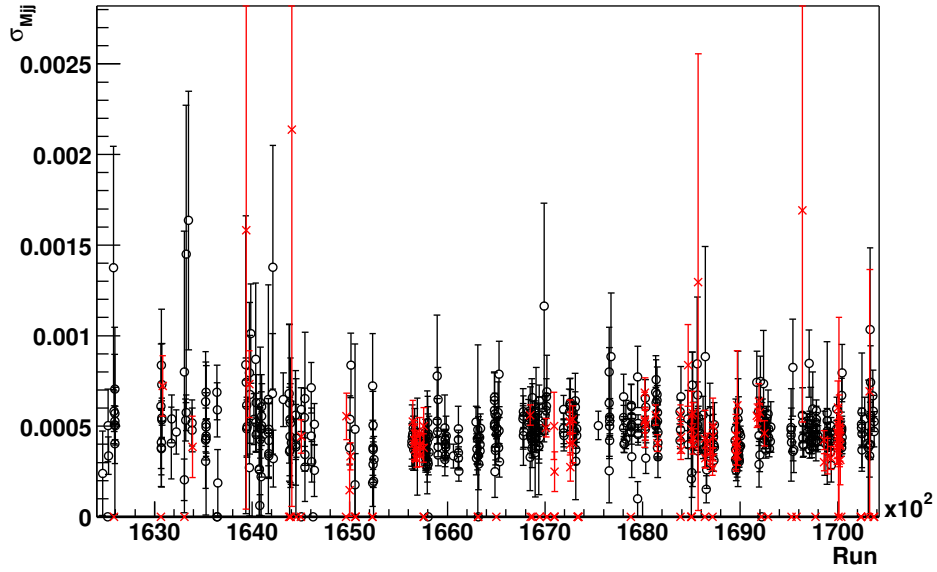
N_evt/L



number of bad jets



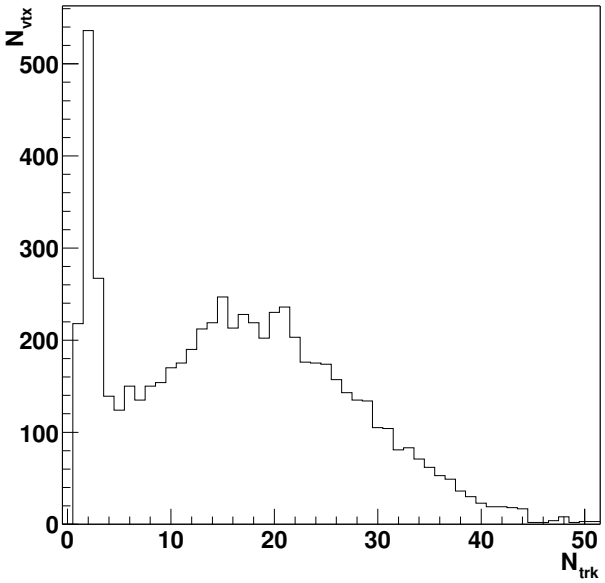
raw σ M_{jj}, M_{jj} > 250 GeV

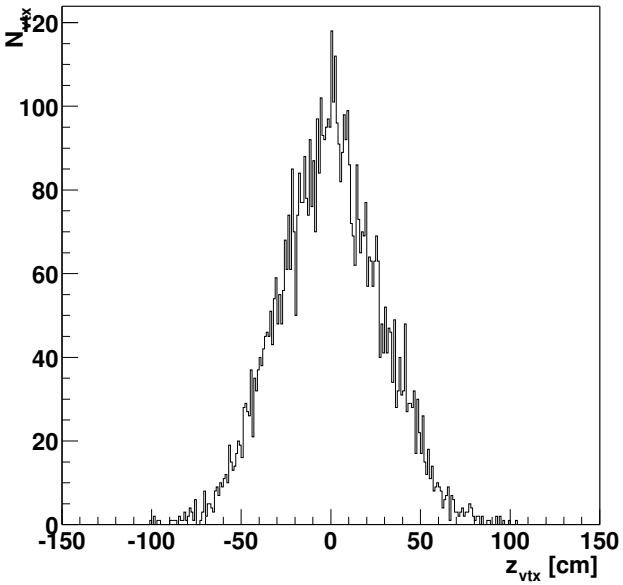


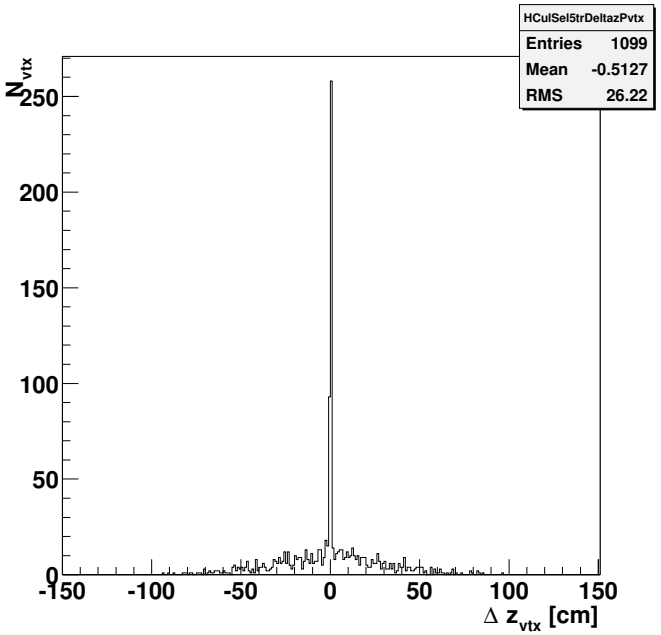
Event Selection

- event contains at least 2 jets (RunII cone R=0.7)
- both the two leading jets are within $|\eta| < 0.5$ region
- MET $< 0.7 p_T^{1st\ jet}$
- at least 5 tracks pointing to the primary vertex and $|z_{vtx}| < 50$ cm
- both the two leading jets satisfy p13 jetID criteria
  - $0.05 <$ EMF < 0.95, CHF < 0.4, HotF < 10, n90 > 1
  - if $(\text{CHF} > 0.1)$ then f90ch $=$ n90/nItem $+ 0.5$ CHF > 0.8
- dijet sample is very clean
  - no peculiar behaviour observed in jet ID variables distributions
  - efficiencies for jet ID cuts are close to one

Vertex cut

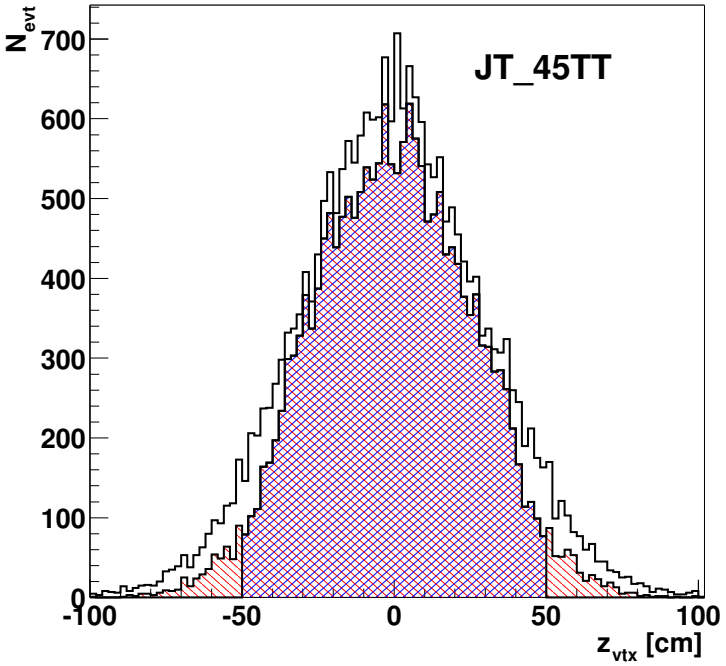






- 15% percent of events show another primary vertex
- 59% of them show $|\Delta z| > 5\,\text{cm}$
- 20% events with more than one primary vertex has probably misidentified vertex associated with the hard interaction

Vertex cut efficiency

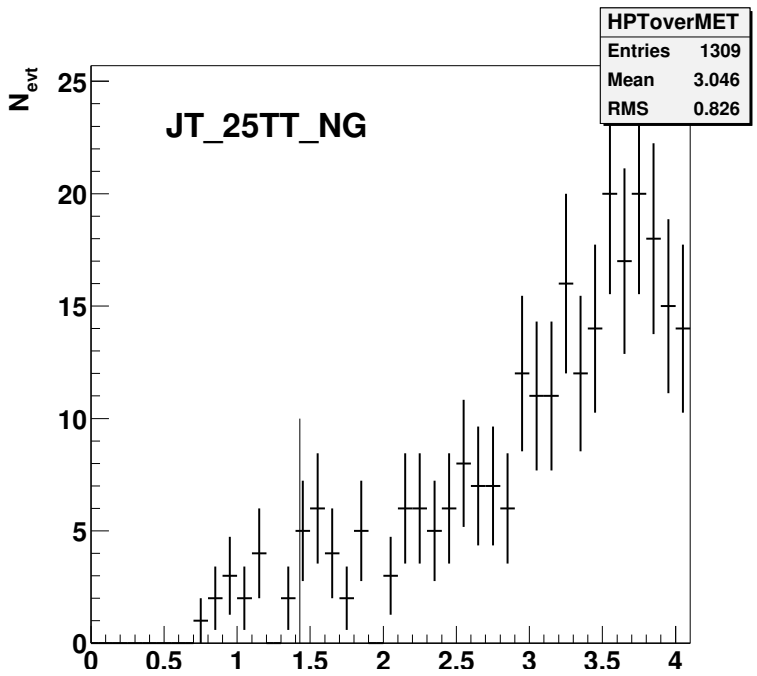


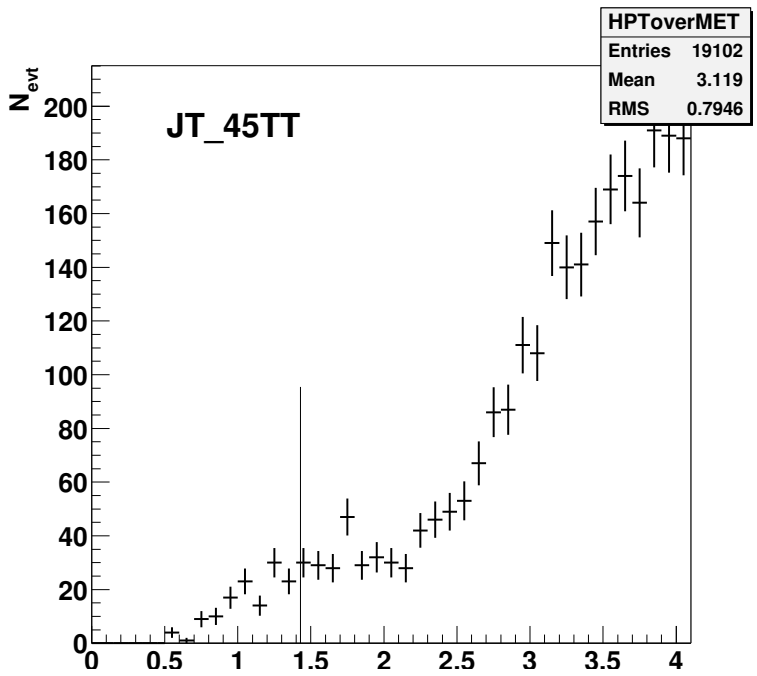
$$\varepsilon = \frac{N_{good}}{N_{all}}, \quad \Delta\varepsilon = \sqrt{\frac{\varepsilon\,(1-\varepsilon)}{N_{all}}}$$

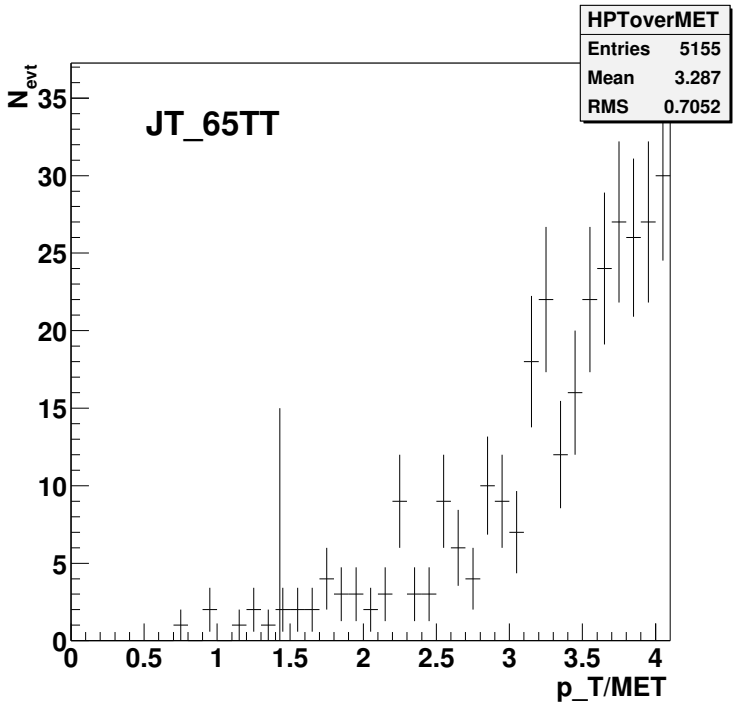
- ε_1 - cut on $|z_{vtx}| < 50\,\text{cm}$
- ε_2 - cut on number of tracks

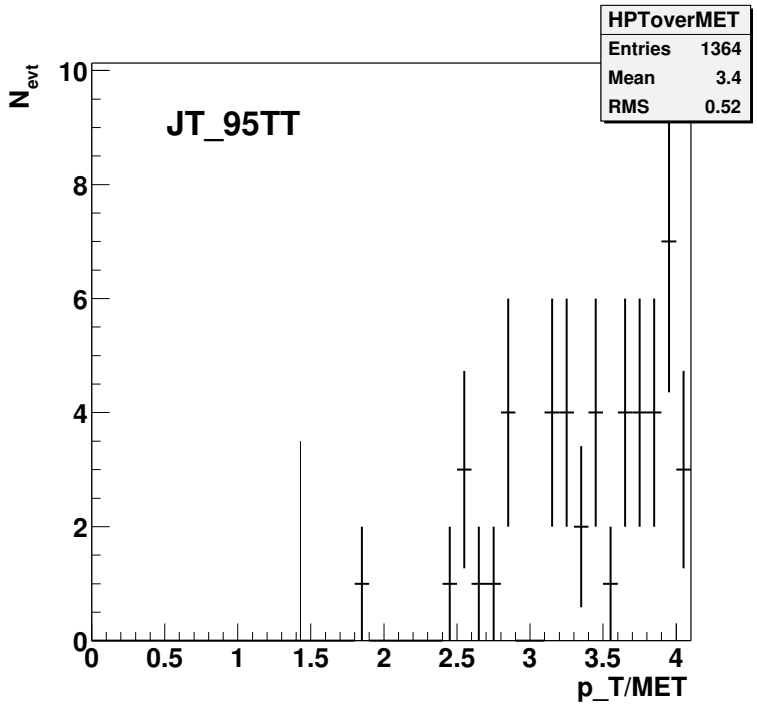
trigger	M_{jj}^{cut}	ε_1	ε_2	ε_3
JT_25TT_NG	150 GeV	0.959	0.815	0.782
JT_45TT	180 GeV	0.949	0.823	0.781
JT_65TT	300 GeV	0.963	0.819	0.788
JT_95TT	390 GeV	0.965	0.796	0.768

MET cut

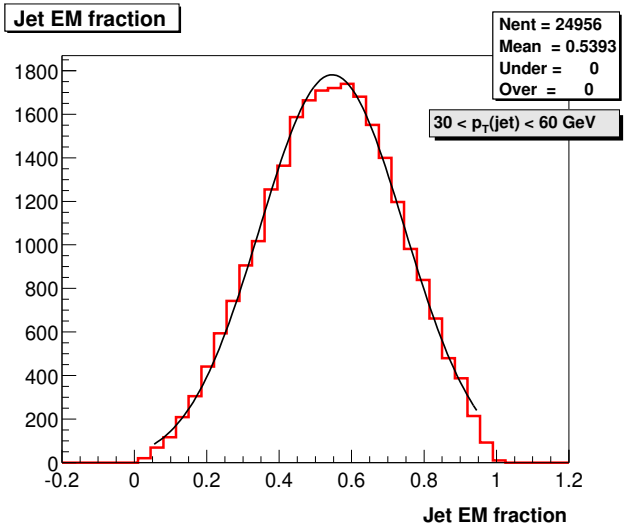

HPToverMET
Entries 1309
Mean 3.046
RMS 0.826
JT_25TT_NG
N_evt

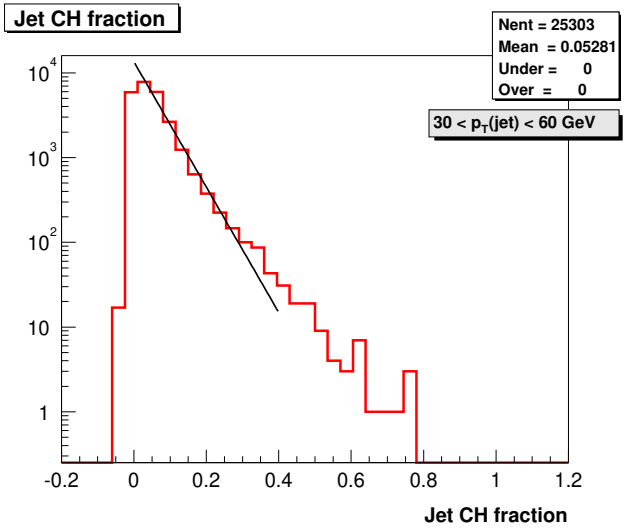

HPToverMET
Entries 19102
Mean 3.119
RMS 0.7946
JT_45TT
N_evt

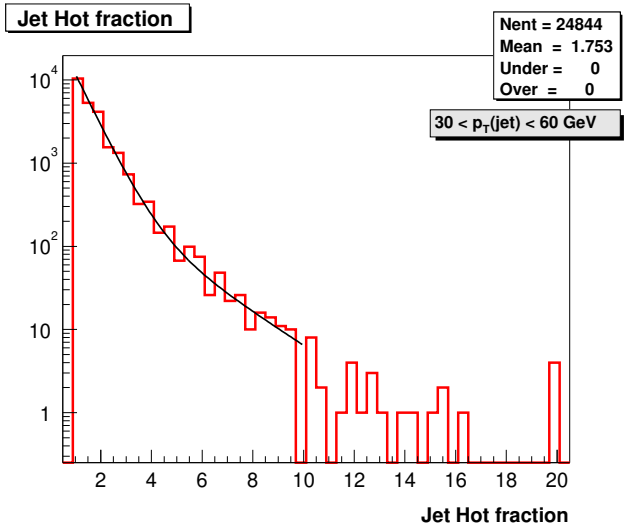

HPToverMET
Entries 5155
Mean 3.287
RMS 0.7052
JT_65TT
N_evt
p_T/MET

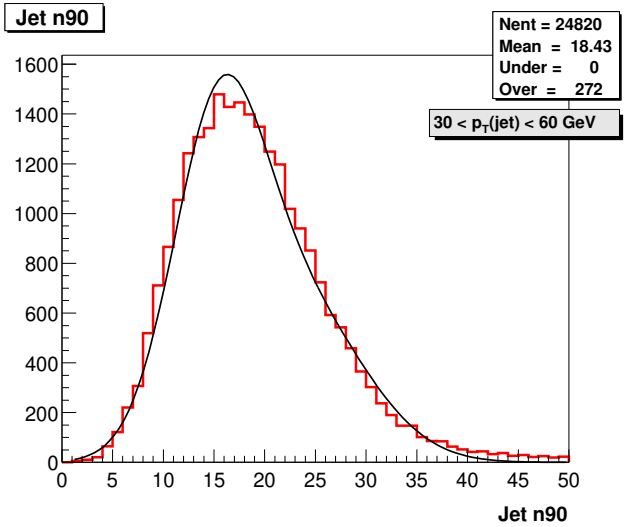

HPToverMET
Entries 1364
Mean 3.4
RMS 0.52
JT_95TT
N_evt
p_T/MET

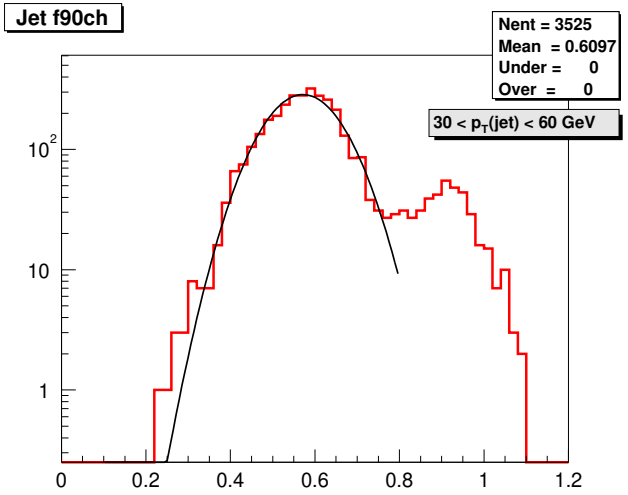
jetID cuts efficiencies (Pavel Demine)









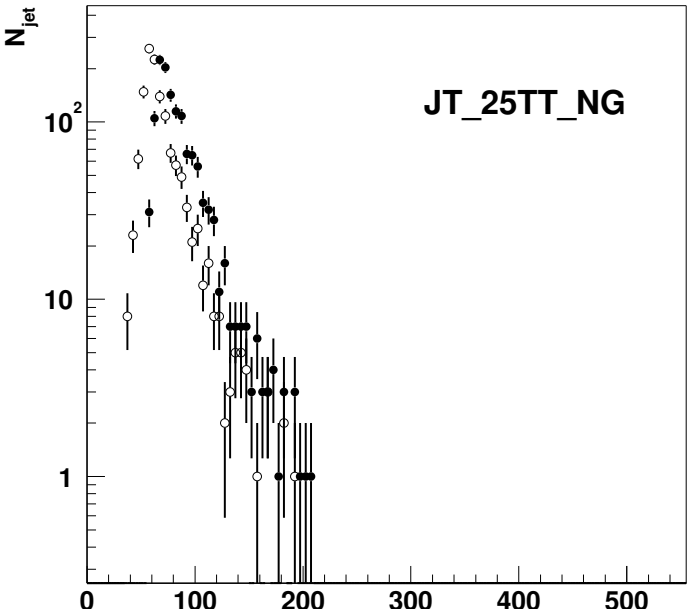


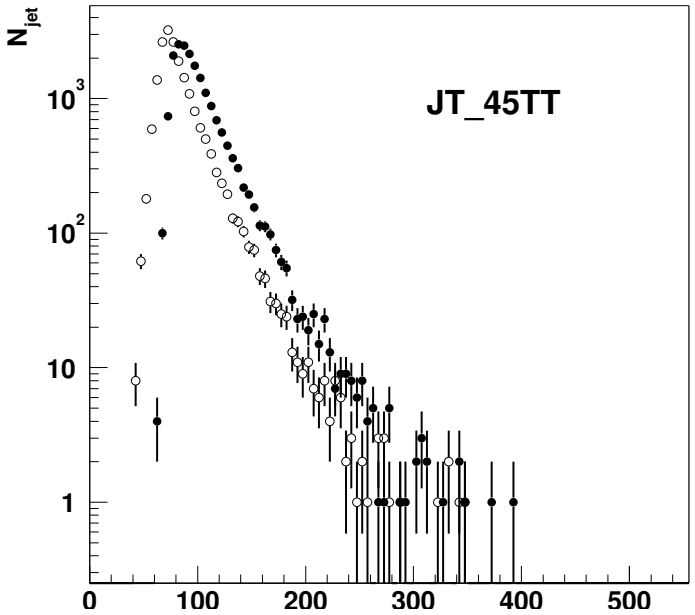
- dijet event sample
- efficiencies measured in different p_T bins

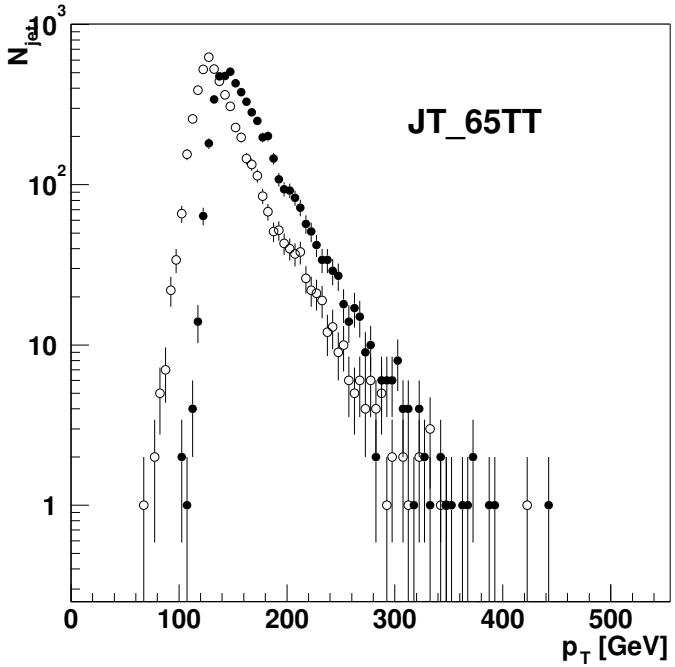
jetID cuts efficiencies (Pavel Demine)

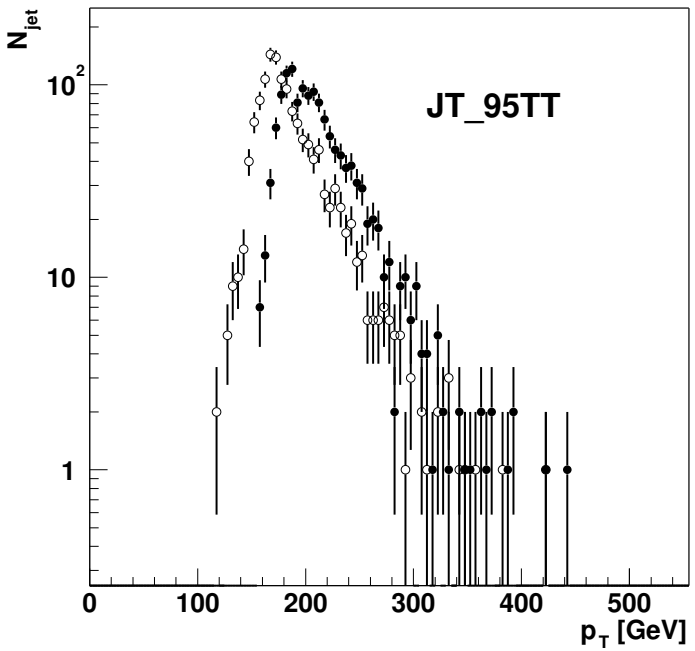
	30 – 60	60 – 90	90 – 125	125 – 160	160 – 250	250 –
EMF	0.993 ± 0.006 ± 0.0	0.993 ± 0.003 ± 0.001	0.993 ± 0.003 ± 0.002	0.993 ± 0.005 ± 0.002	0.993 ± 0.008 ± 0.001	0.993 ± 0.03 ± 0.001
CHF	0.999 ± 0.001 ± 0.0	1.000 ± 0.0 ± 0.0	1.000 ± 0.0 ± 0.0	0.999 ± 0.001 ± 0.0	0.999 ± 0.002 ± 0.0	0.998 ± 0.012 ± 0.0
HotF	0.999 ± 0.0 ± 0.001	0.999 ± 0.0 ± 0.0	0.999 ± 0.0 ± 0.0	0.999 ± 0.0 ± 0.0	1.000 ± 0.0 ± 0.0	0.999 ± 0.002 ± 0.0
n90	1.000 ± 0.0 ± 0.0	1.000 ± 0.0 ± 0.001	1.000 ± 0.0 ± 0.001	0.999 ± 0.0 ± 0.0	0.999 ± 0.0 ± 0.0	0.998 ± 0.003 ± 0.005
f90ch	0.97 ± 0.001 ± 0.03	0.98 ± 0.0 ± 0.02	0.98 ± 0.0 ± 0.02	0.98 ± 0.001 ± 0.02	0.99 ± 0.002 ± 0.01	0.99 ± 0.014 ± 0.01
Total	0.96 ± 0.006 ± 0.03	0.97 ± 0.003 ± 0.02	0.97 ± 0.003 ± 0.02	0.97 ± 0.005 ± 0.02	0.98 ± 0.01 ± 0.01	0.98 ± 0.03 ± 0.01

jet p_T

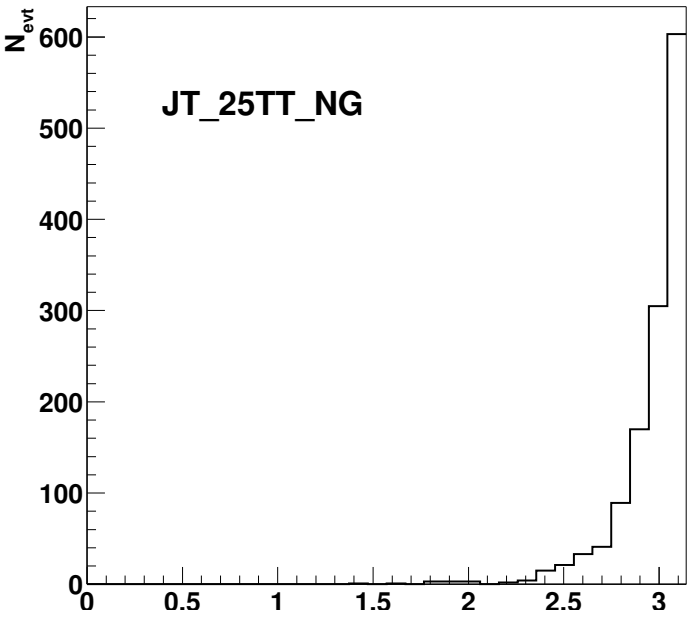

JT_25TT_NG
N_jet
10^2
10
1
0
100
200
300
400
500

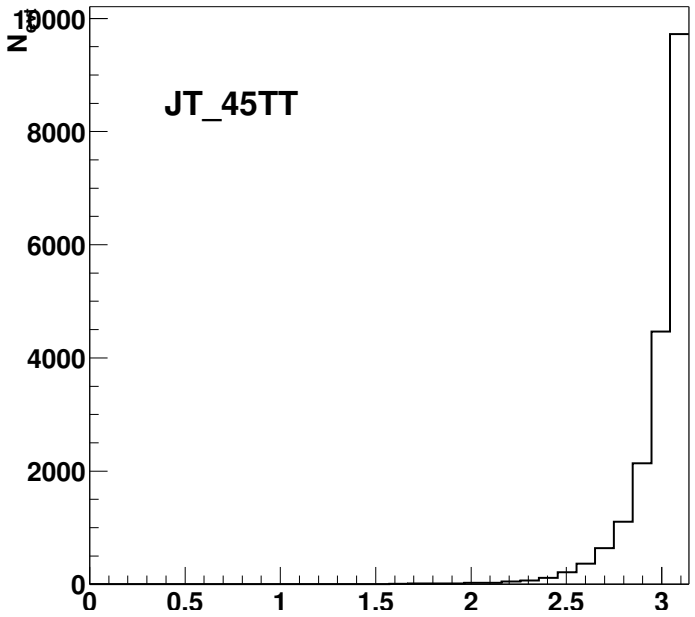

JT_45TT
N_jet
10^3
10^2
10
1
0
100
200
300
400
500

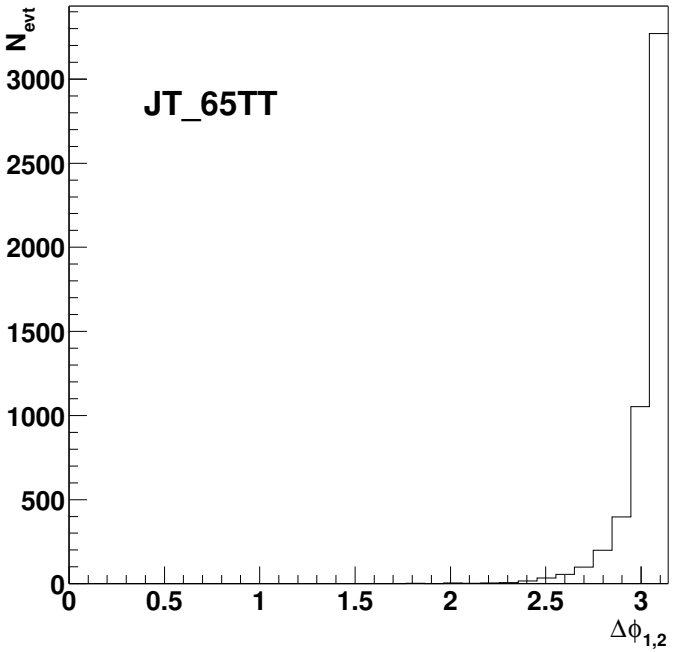

JT_65TT
N_jet
10^3
10^2
10
1
0
100
200
300
400
500
p_T [GeV]

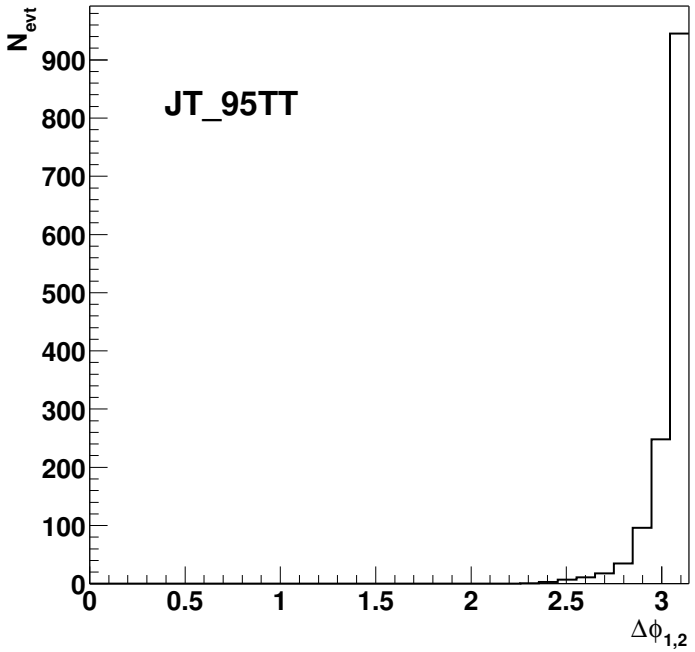

JT_95TT
N_jet
10^2
10
1
0
100
200
300
400
500
p_T [GeV]

$|\varphi_1 - \varphi_2|$ distribution

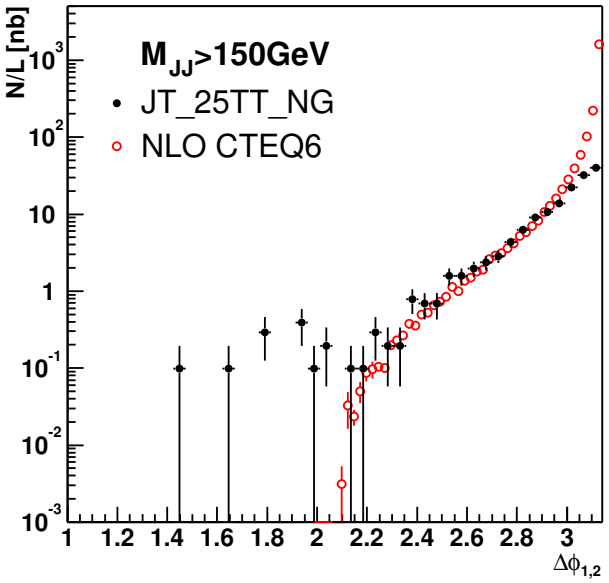


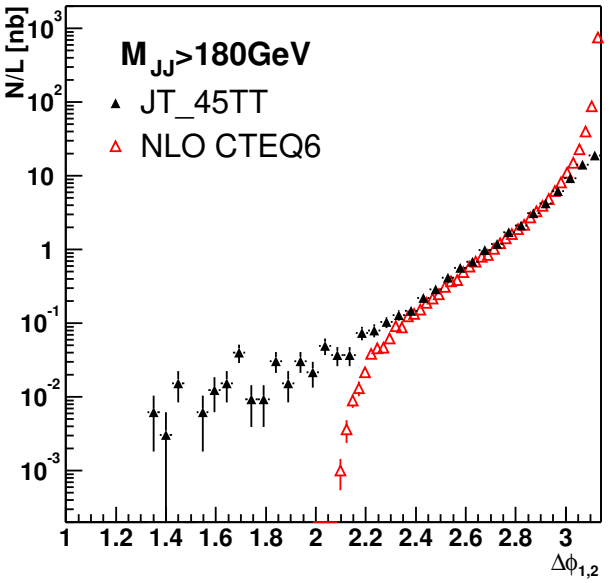


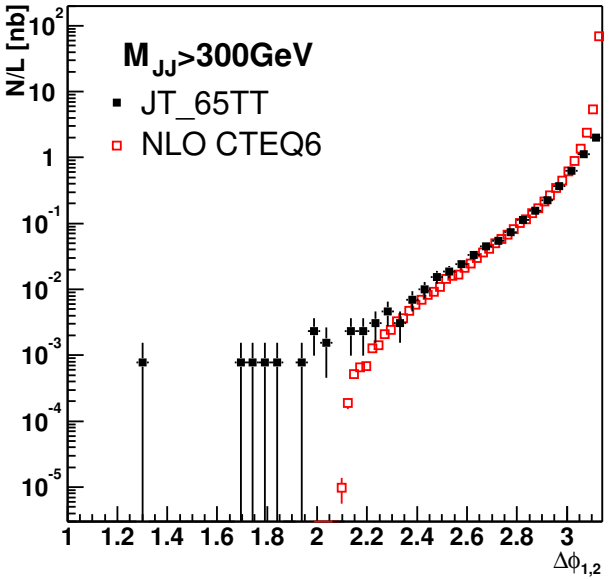


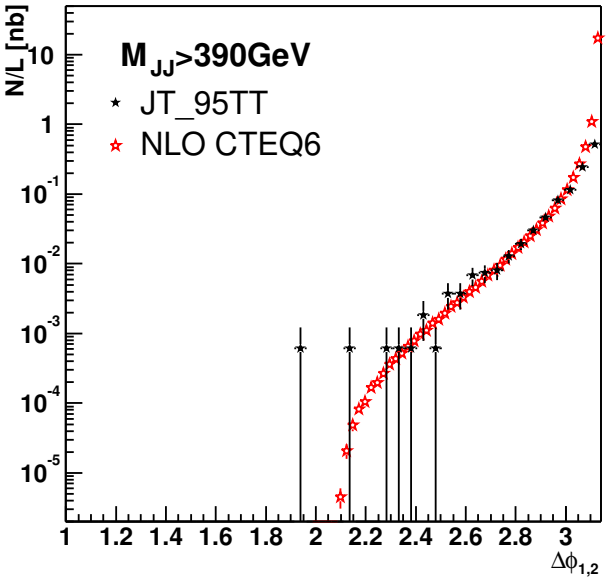


$\Delta\phi_{1,2}$ distribution



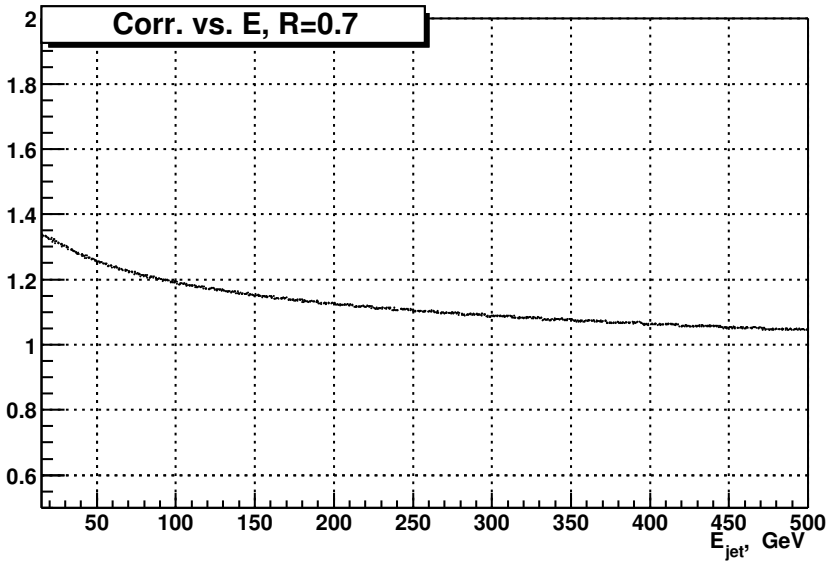


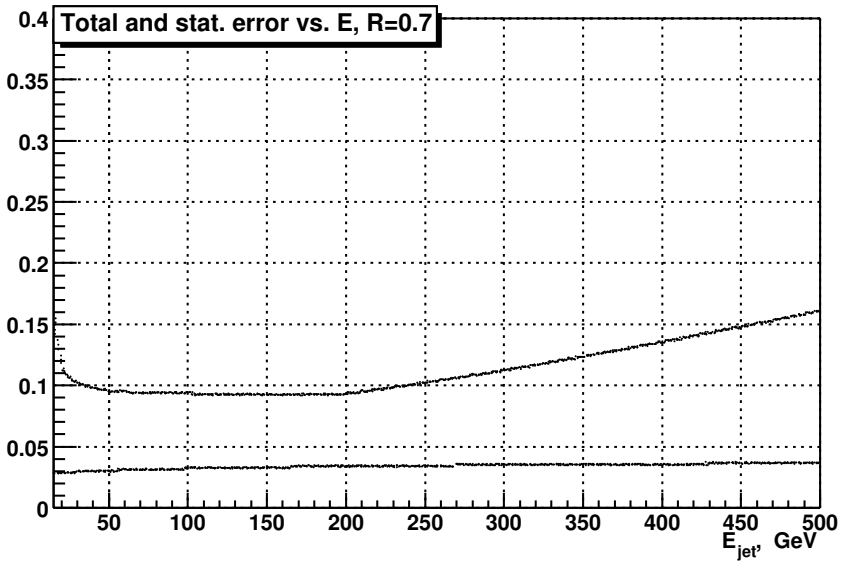


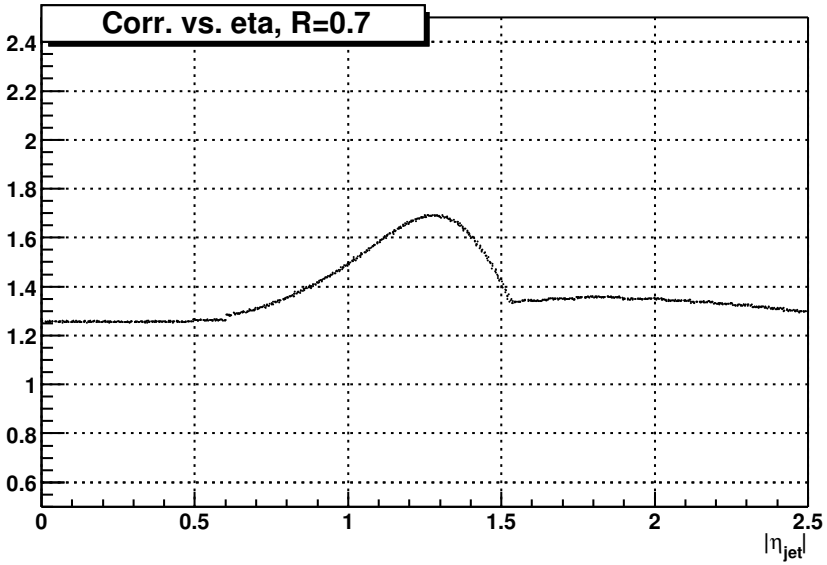


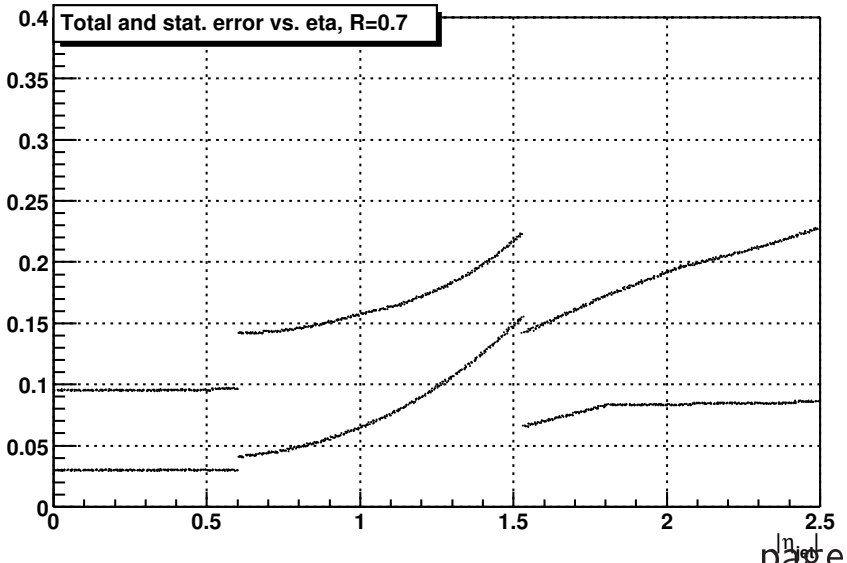
- normalized by luminosity
- vertex cut efficiency applied
- distribution is not sensitive to JES
- ϕ smearing is probably small
- JETRAD fails to discribe all the regions of $\Delta\phi$

Jet energy scale

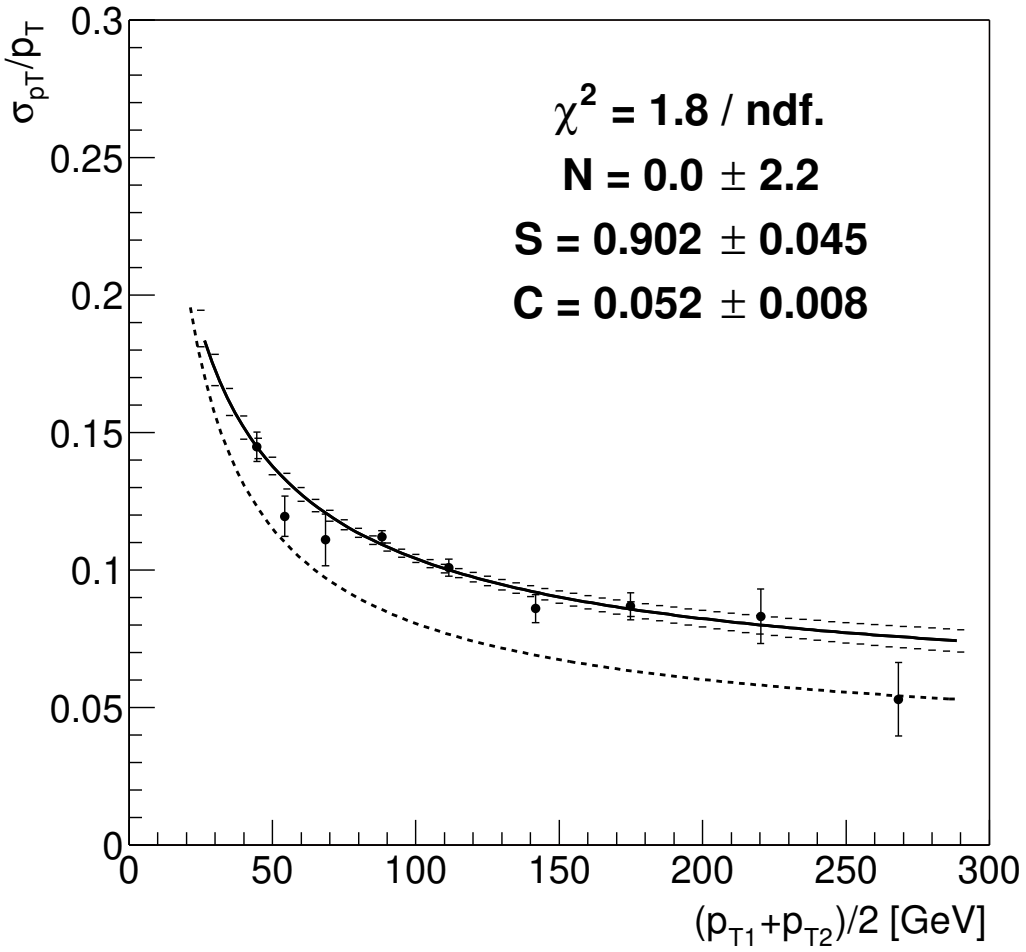








Jet p_T resolution - final result



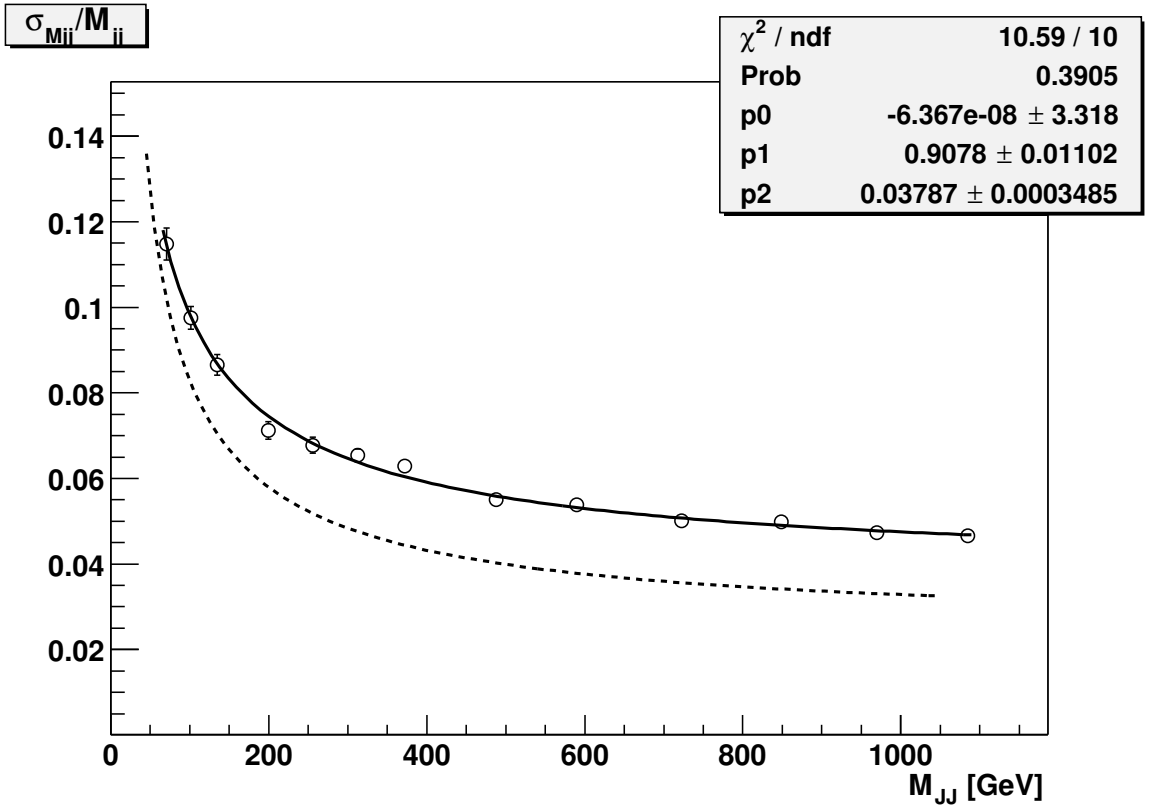
Correlation matrix

	N	S	C
N	1.000	-0.002	0.001
S	-0.002	1.000	-0.936
C	0.001	-0.936	1.000

- JES correction
- soft radiation correction
- particle jet imbalance correction

- central region of calorimeter, $|\eta| < 0.5$
- event selection cuts constistent with those used in dijet mass analysis
- for more detailed information see my talk on next JES group meeting

Dijet mass resolution - final result

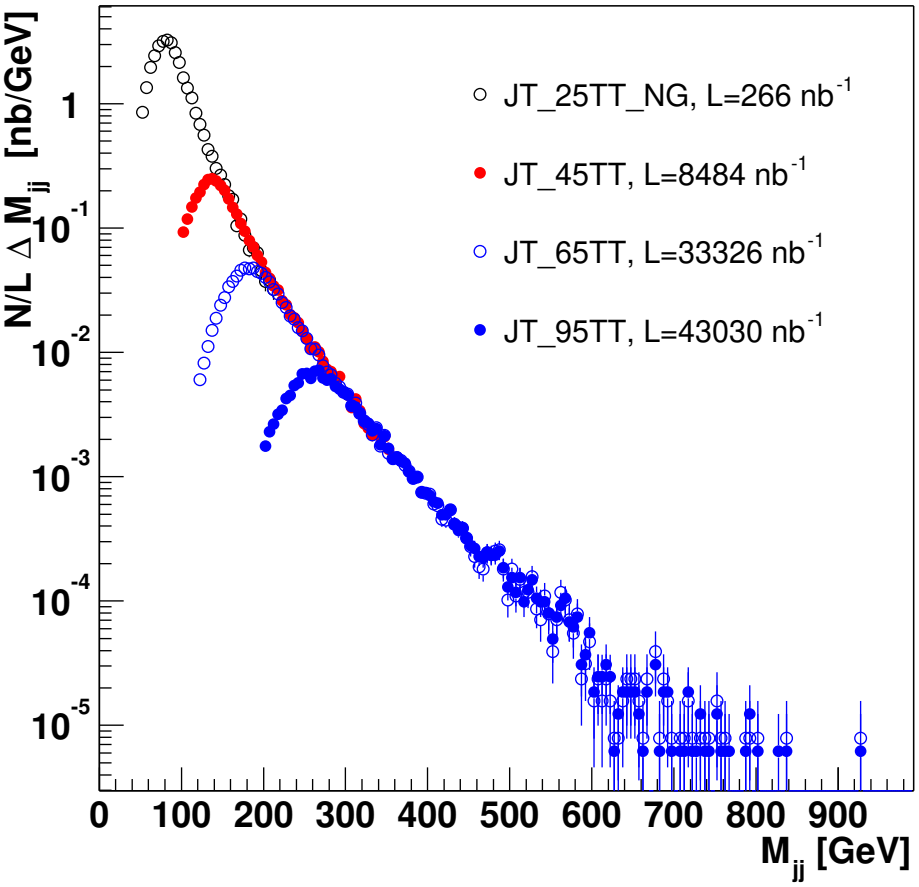


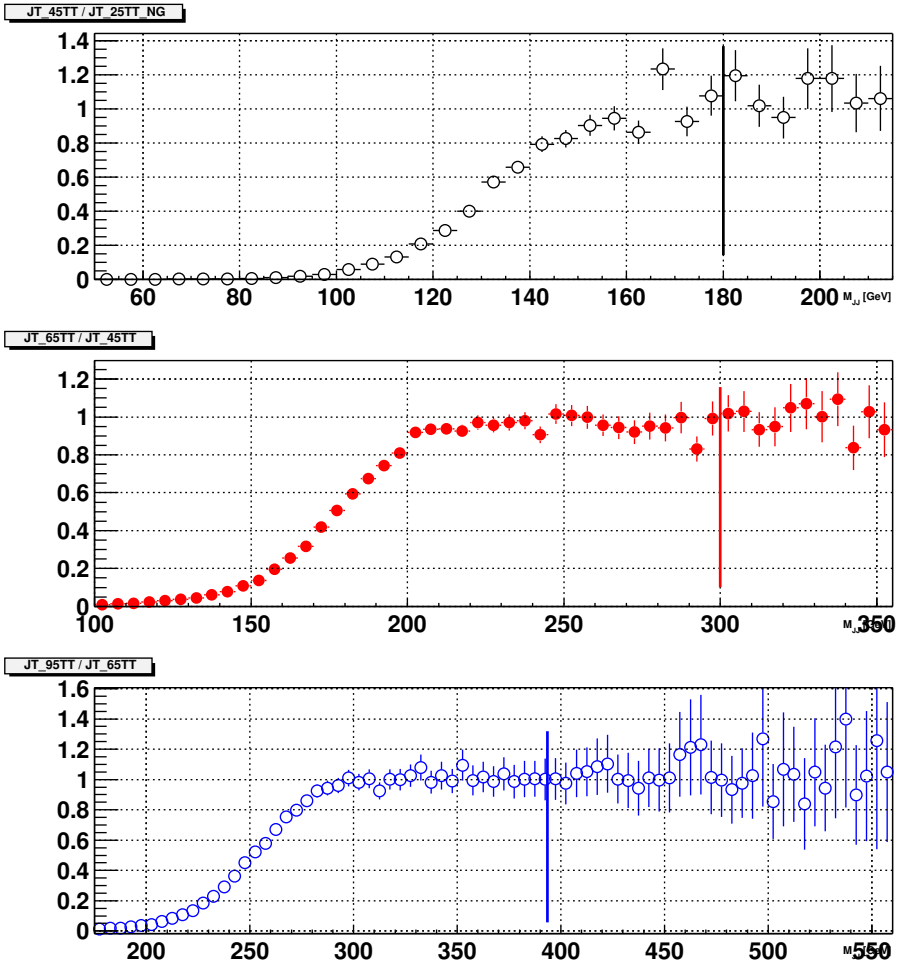
Fitted function

$$\frac{\sigma_{p_T}}{p_T} = \sqrt{\frac{N^2}{p_T^2} + \frac{S^2}{p_T} + C^2}$$

- from the QCD MC sample - the particle jet energies were smeared using measured jet p_T resolution
- dashed line is for corresponding RunI curve

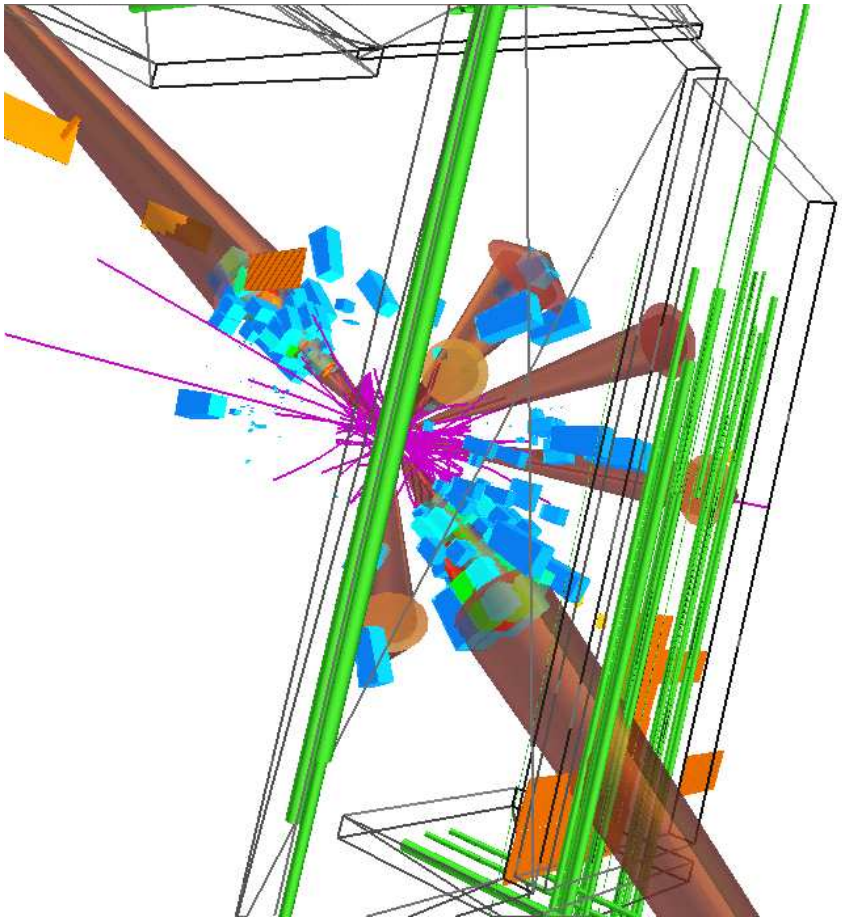
Raw dijet mass spectrum

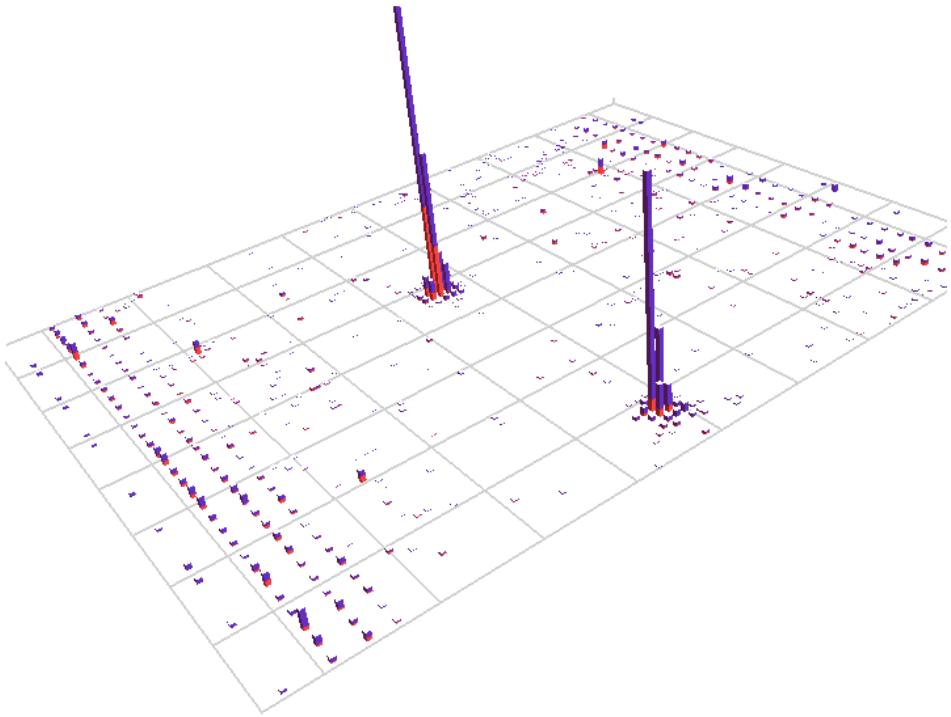




- JES correction v04-01-00
- vertex cut efficiency correction

Event display (Laurent Duflot)





- jet1 : $p_T = 475\,\text{GeV}$, EMF $= 0.42$, CHF $= 0.05$, n90 $= 10$
- jet2 : $p_T = 442\,\text{GeV}$, EMF $= 0.11$, CHF $= 0.17$, n90 $= 12$
- $M_{JJ} = 926\,\text{GeV}$
- missing E_T is $28\,\text{GeV}$

Unsmearing - method

- ansatz function

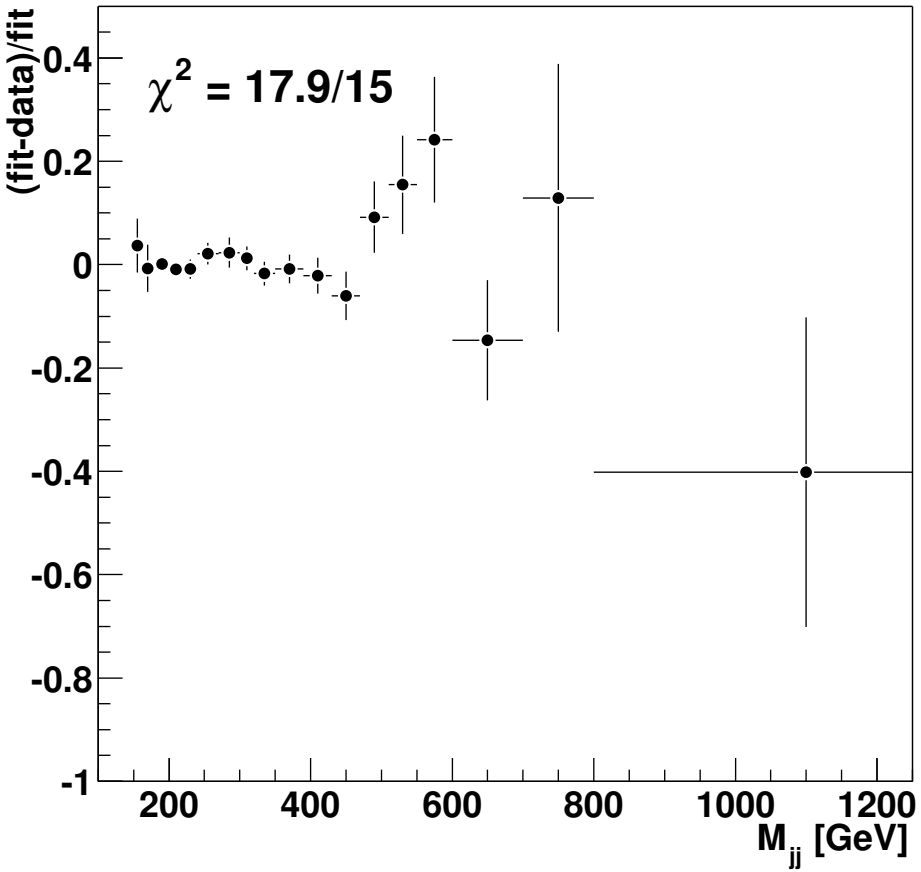
$$f = N M_{jj}^{-\alpha} \left(1 - \frac{M_{jj}}{\sqrt{s}}\right)^{-\beta}$$

- for a given set of parameters
  - convolute function f with the dijet mass resolution

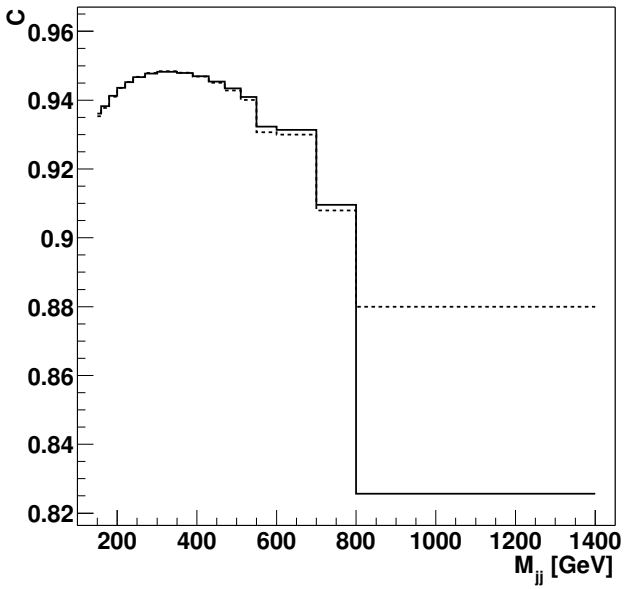
$$F(M) = \int \mathrm{d}M' f(M') G(M - M')$$

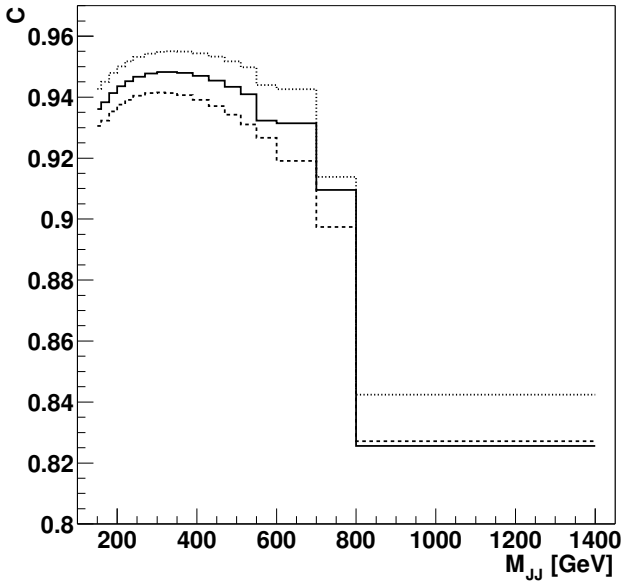
  - make prediction on dijet mass cross section for all bins
  - calculate χ^2 for the prediction
- use Minuit to find the best fit
- unsmearing correction

$$C_{bin} = \frac{\int_{bin} \mathrm{d}M \; f(M)}{\int_{bin} \mathrm{d}M \; F(M)}$$



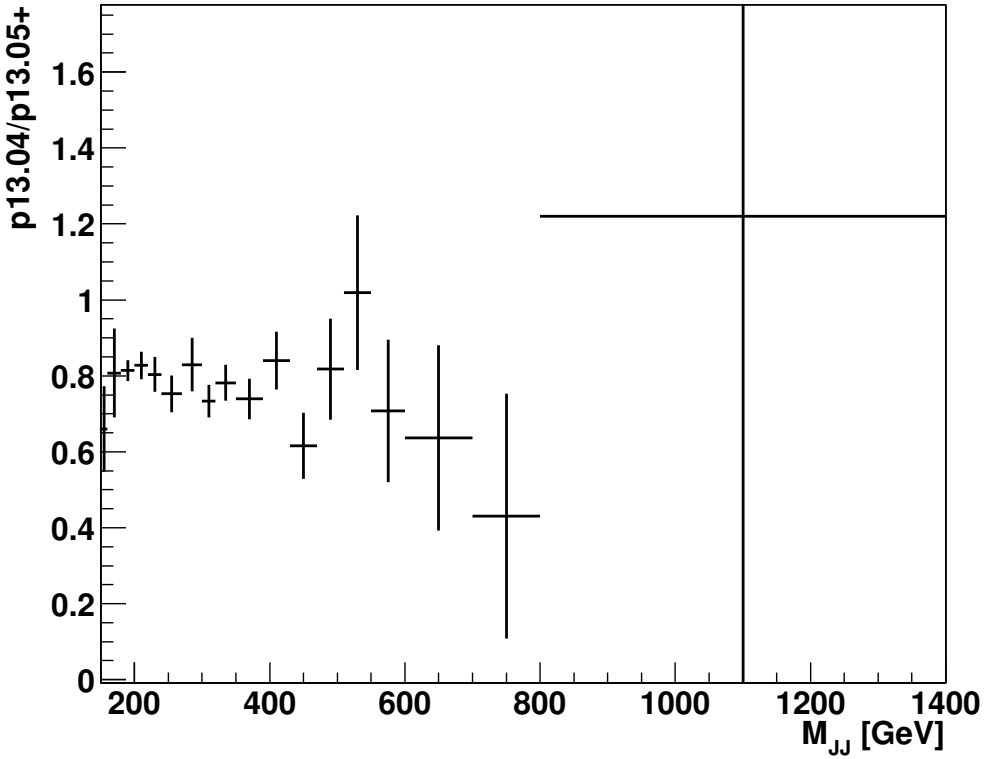
Unsmearing correction





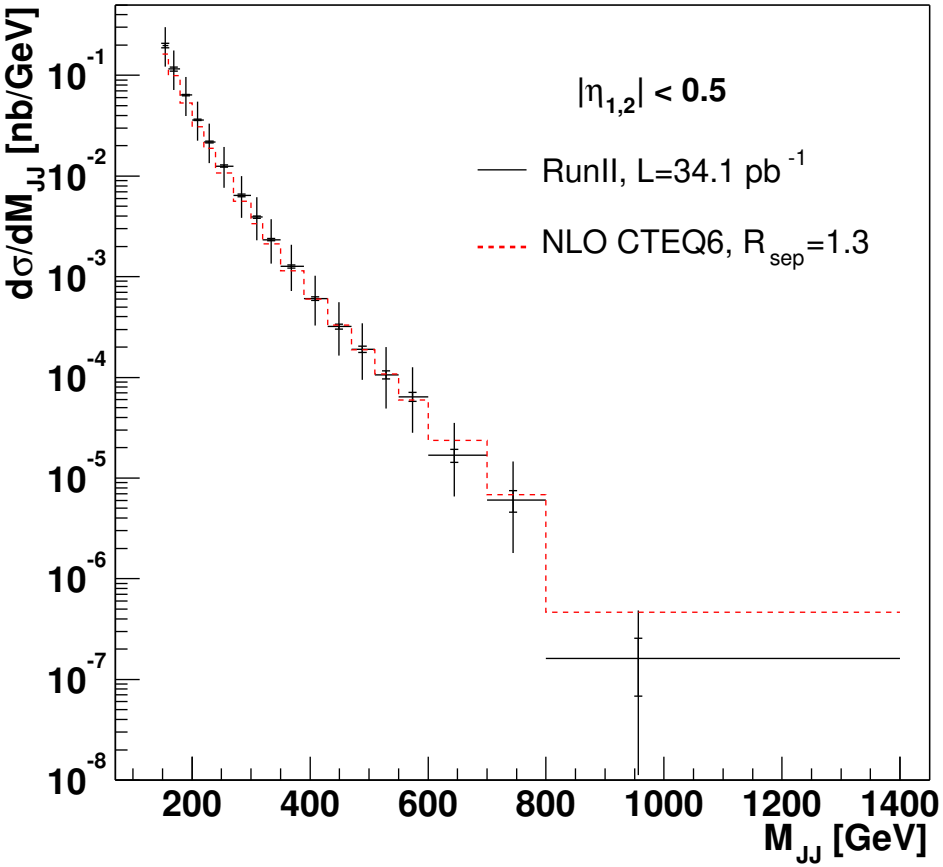
- same binning as in RunI
- slightly higher than in RunI
- the same shape
- systematic error
  - different ansatz functions
  - error from jet resolution

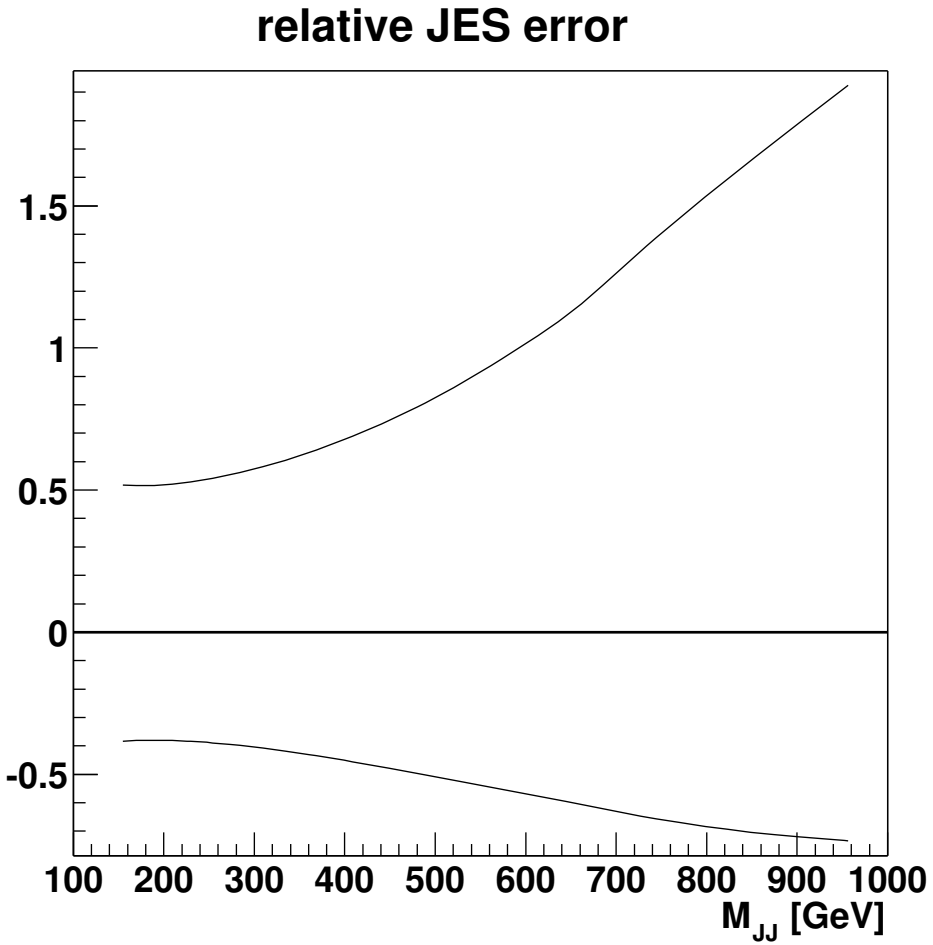
p13.04.00 versus p13.05.00



- the difference in cross section is 20% arround $200\,\text{GeV}$
- corresponds to $3-4\%$ difference in JES
- reprocess p13.04 data with the latest version of p13

Inclusive dijet mass cross section

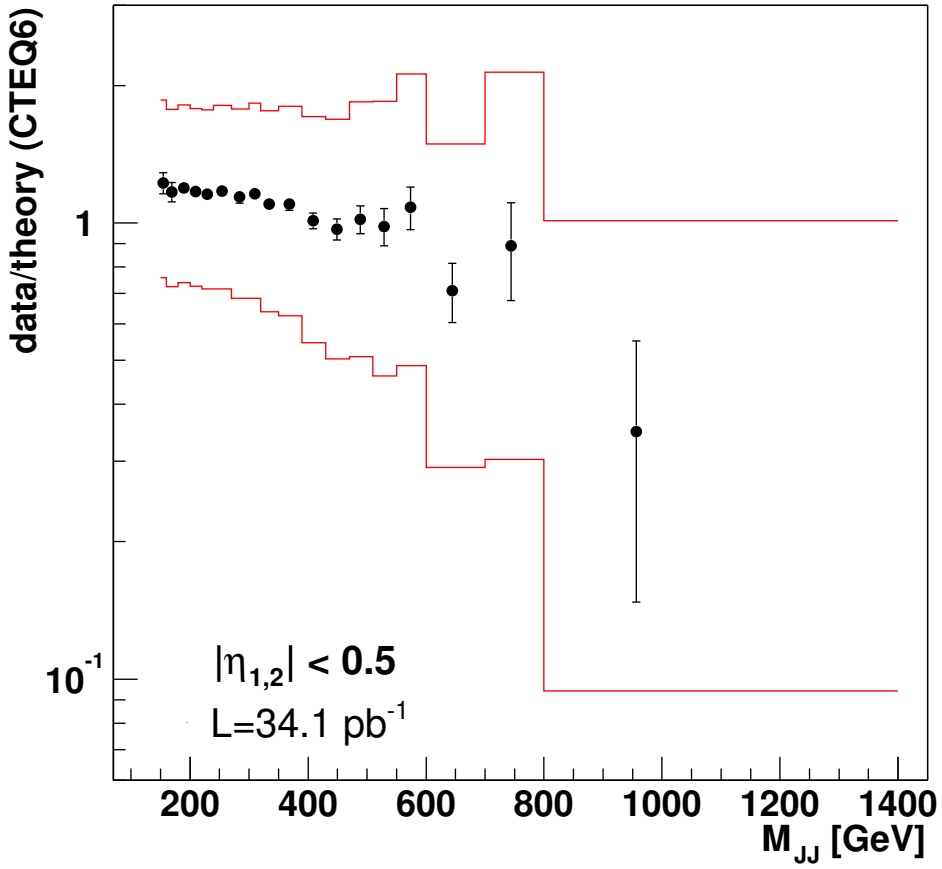




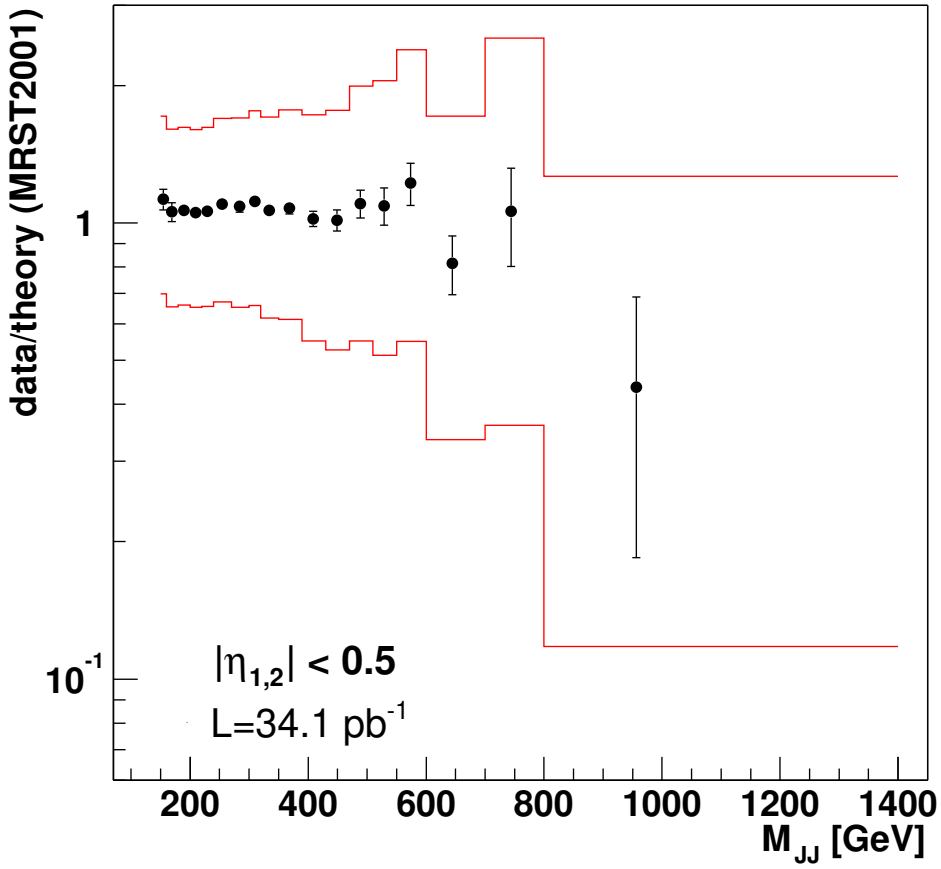
- only p13.05 and p13.06 data
- overall 10% uncertainty on luminosity
- an agreement with the QCD prediction
- dominant source of systematic error comes from JES

CTEQ6 versus MRST2001

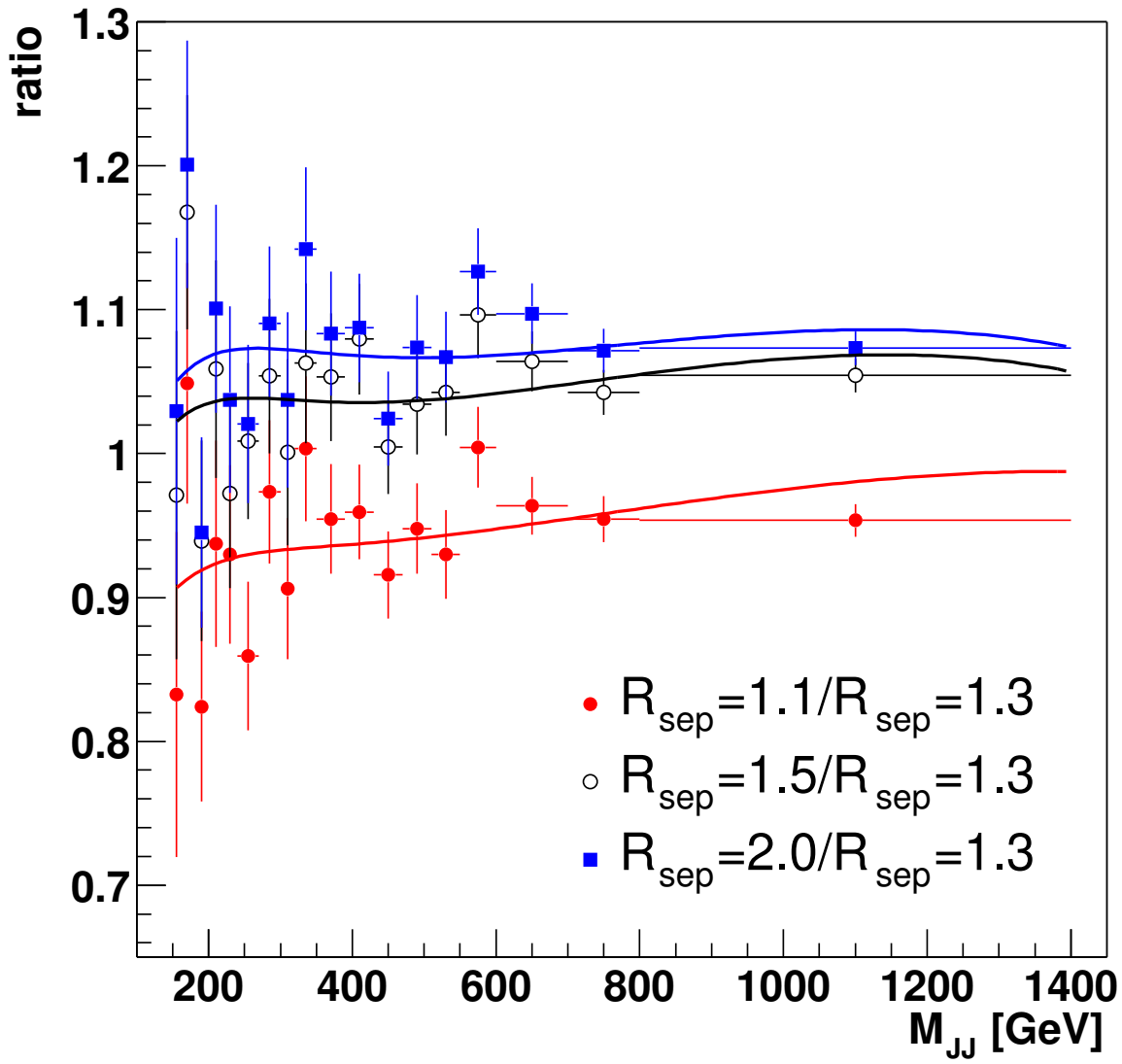
CTEQ6



MRST2001

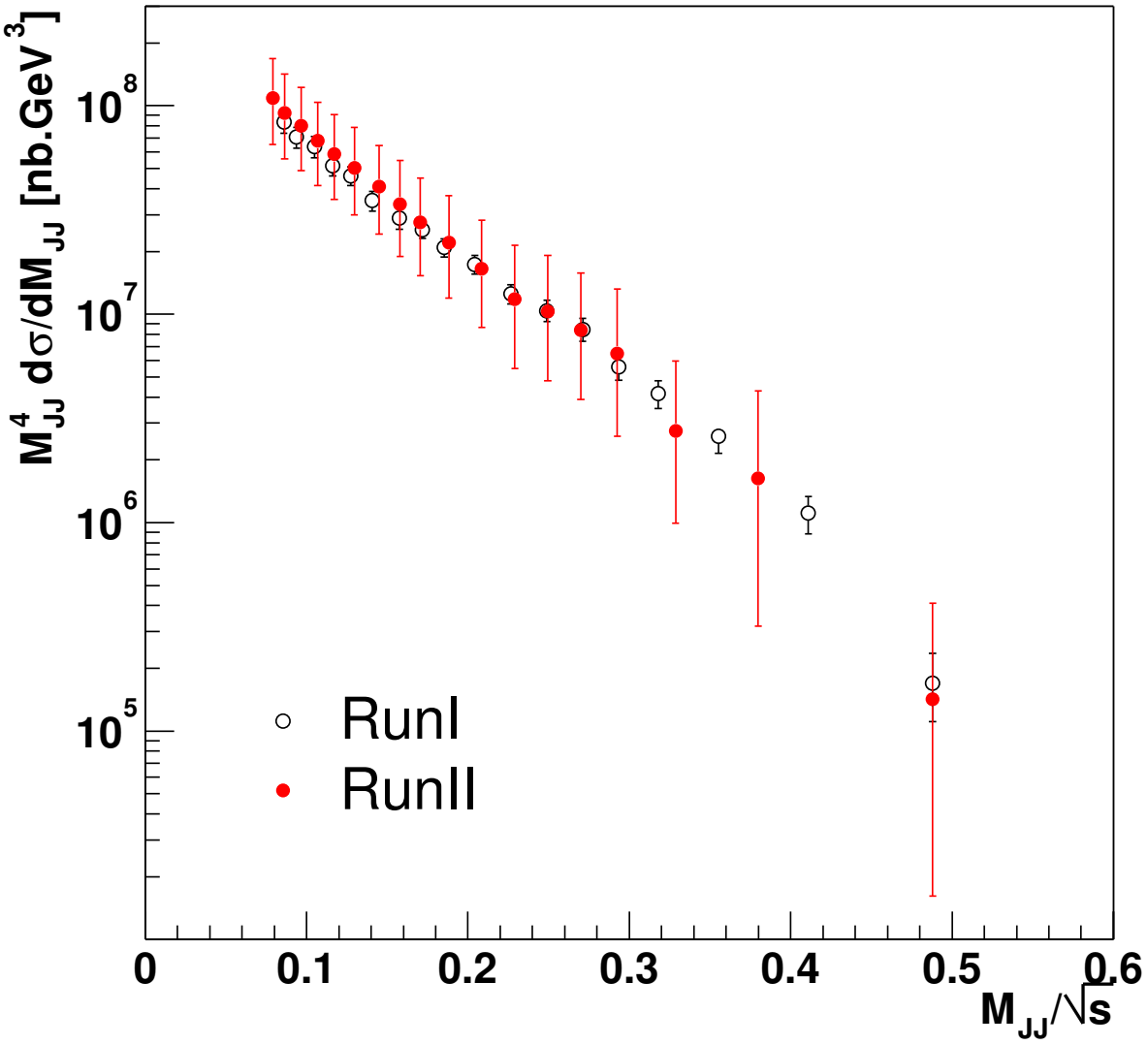


Various R_{sep} predictions



10% change in theoretical prediction

RunI and RunII comparison



$$\frac{\mathrm{d}\sigma}{\mathrm{d}M} \propto \frac{1}{M^4} f(M/\sqrt{s})$$

Summary

- the measurement of inclusive dijet mass cross section on data sample with $\mathcal{L} = 34\,\mathrm{pb}^{-1}$ was presented
- note in preparation

  http://www-d0.fnal.gov/Run2Physics/qcd/d0_private/agendas/
  /2003_talk_slides/kupco/dijetmass.ps
- consistent with RunI results
- agreement with the NLO QCD prediction