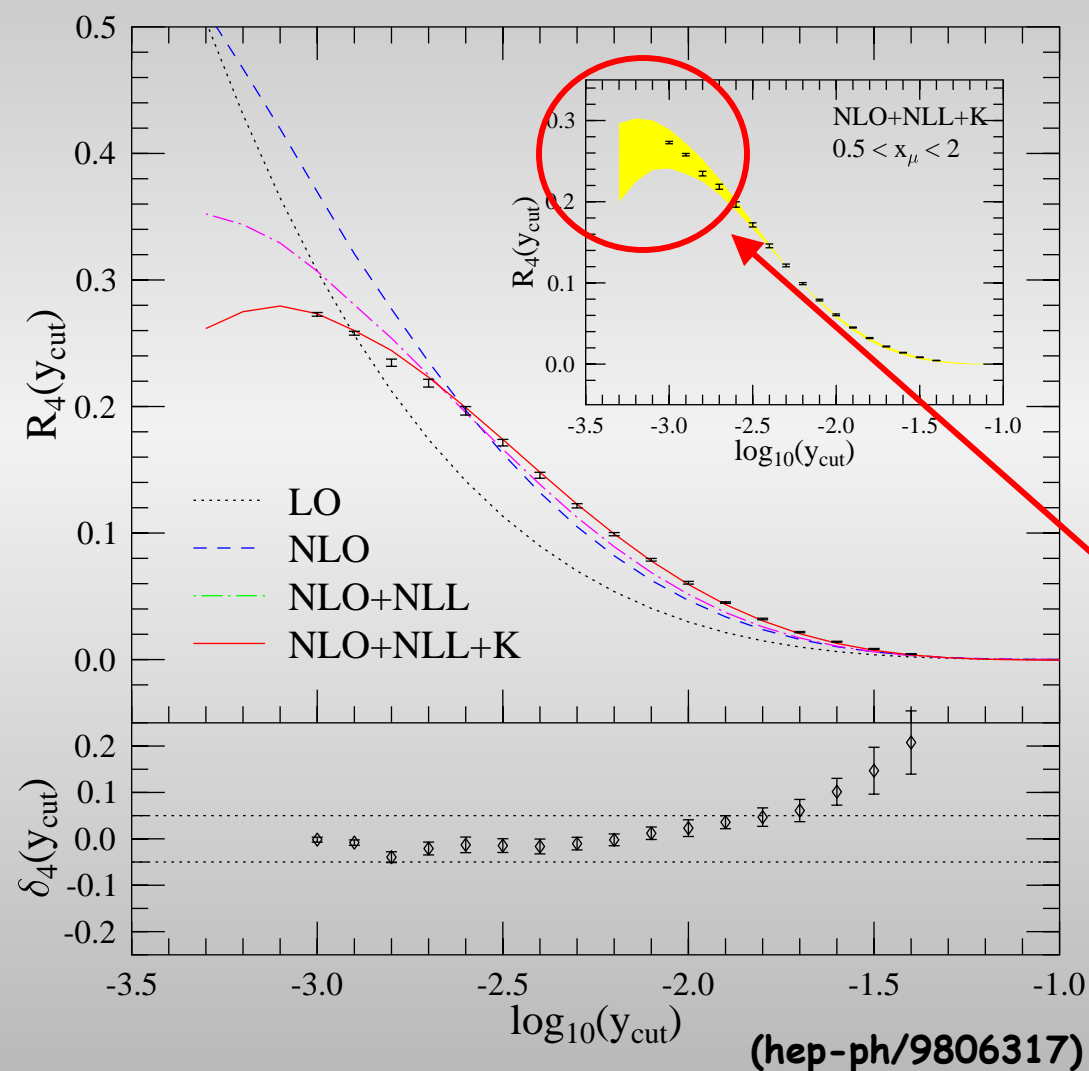# Update on 4-Jet Analysis

- PN527 finished for summer conferences 2004

- remaining open questions:
  - fit range
  - combination of energy points
  - include other 4-Jet sensitive event shapes
    - Thrust-Minor
    - D-Parameter

- prepare paper draft and publish

- investigation of BZ-angle distribution

Fit Range

Durham algorithm

(hep-ph/9806317)

ALEPH has smaller systematic error compared to OPAL
➢ Fit range

reduced fit range, starting at higher y_{cut} values decreases sensitivity to x_μ

Fit Range

- fit range now determined by sensitivity on x_μ and hadronisation correction
- smaller fit range → (slightly) larger statistical error
- looser requirement for size of detector correction
  - at LEP2 WW BG can be large (> factor 2)
  - WW BG evaluated in great detail in systematic error
- additional systematic error by varying fit range by ± 1bin
  - average change using 50 MC sub samples
  - small additional contribution

old fit range: 0.001-0.178 (LEP1) ; 0.0004-0.0072 (LEP2)
new Fitrange: 0.024-0.042(LEP1) ; 0.0013-0.0072(LEP2)
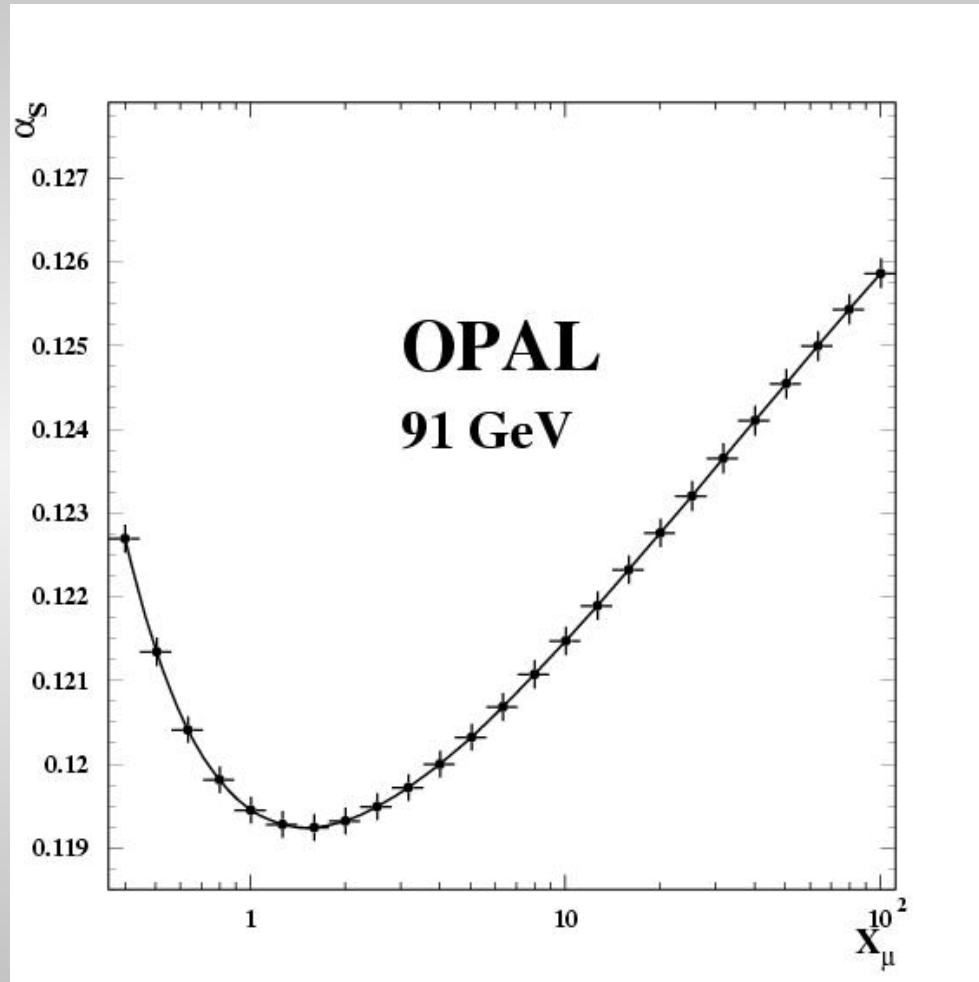
Combination of α_s

in PN527:

- combination of α_s within energy point using luminosity weighted average
- combination to single α_s with LEP QCD WG method
- not really coherent

NOW:

- LEP QCD WG method for all combinations
- minor changes

x_μ dependence on α_s
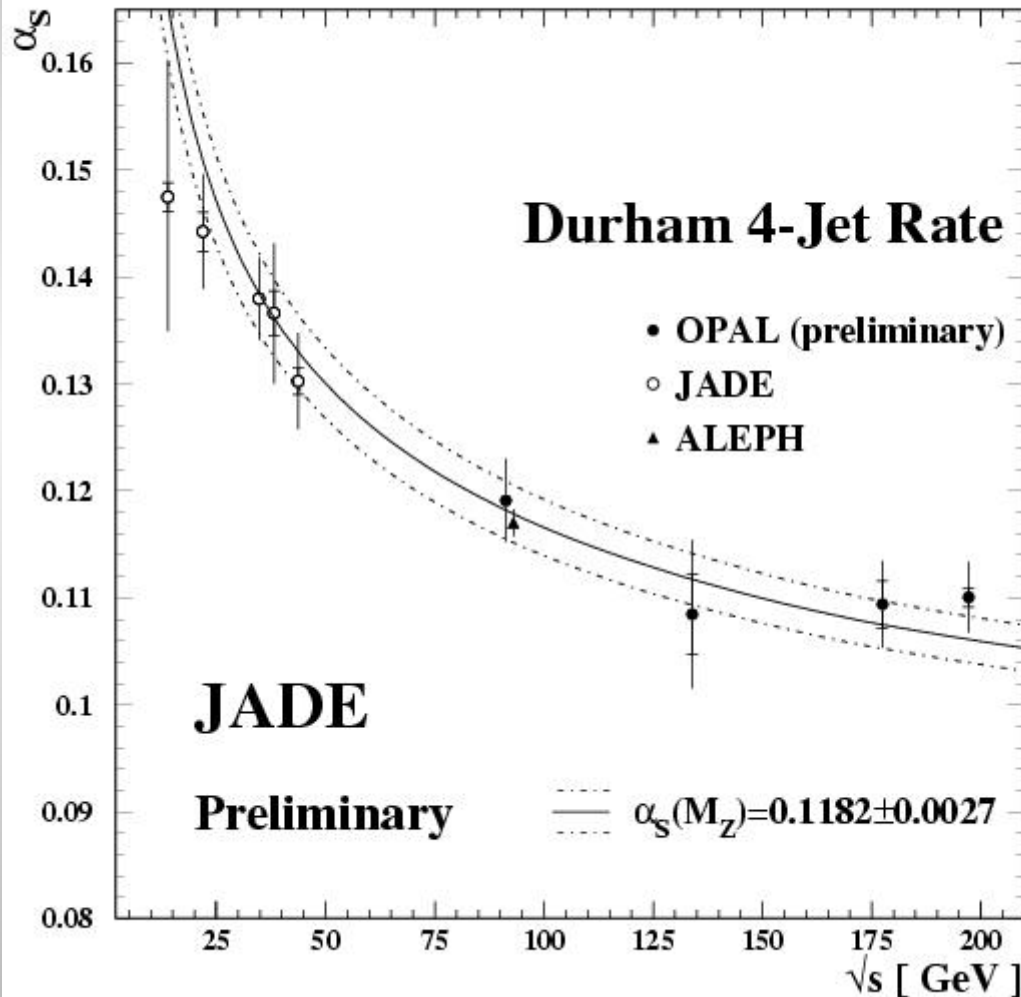

ALEPH determines α_s

with x_μ free

- x_μ around 0.7

  ALEPH, 0.6 OPAL
- determine α_s

  dependence on x_μ
- scale x_μ at minimum

➢**small scale error**

Evolution of α_s

New combined value:
0.1193±0.0021

(dominated by
LEP1 ~90%)

old: 0.1208±0.0038

ALEPH : 0.1170±0.0013
NLO+NLLA, x_μ free
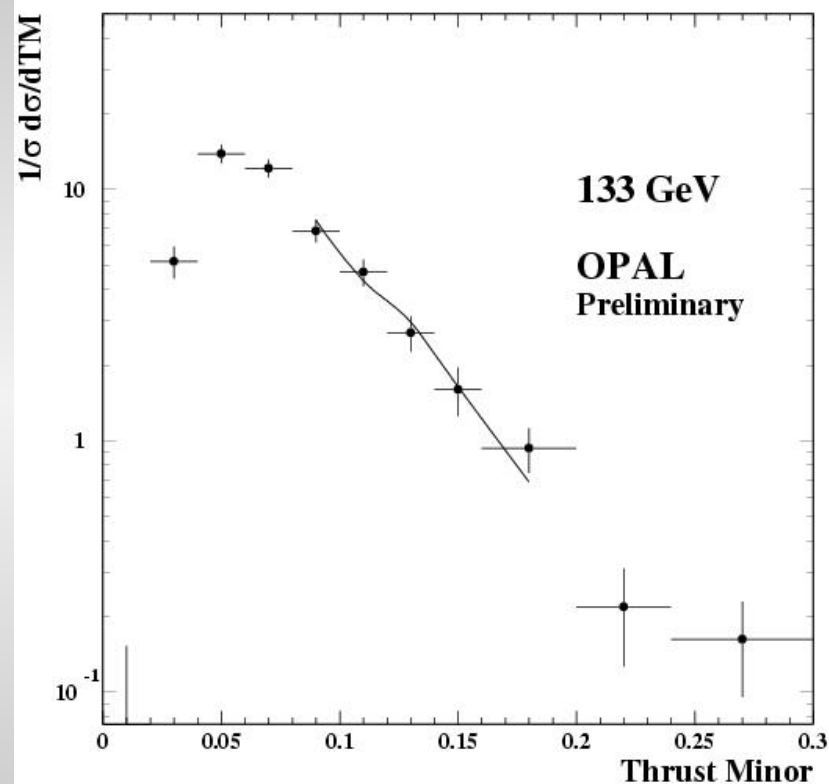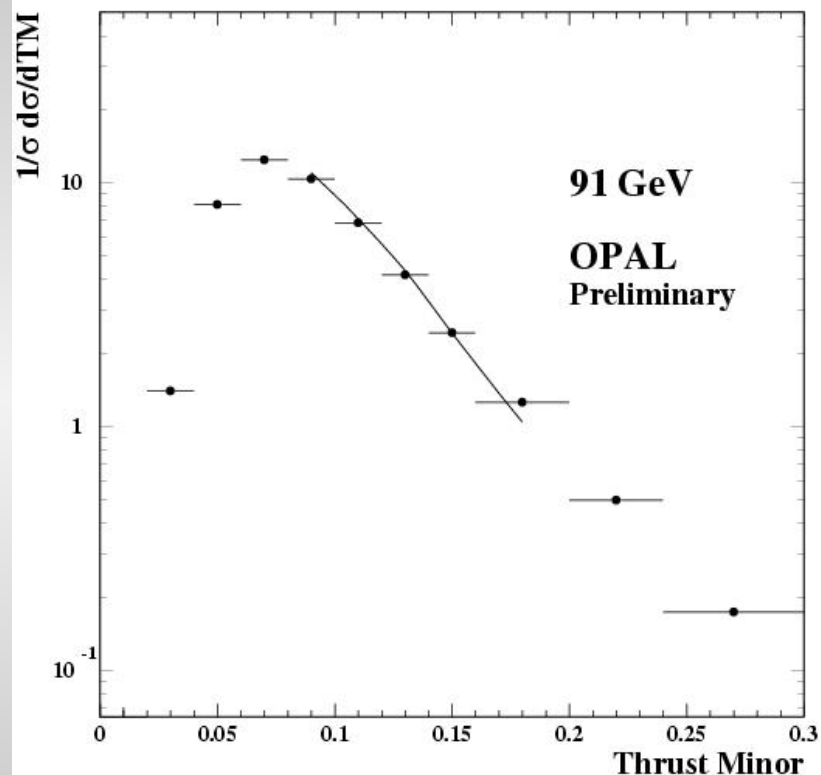DELPHI: 0.1175 ±0.0030
NLO, x_μ free ~0.01
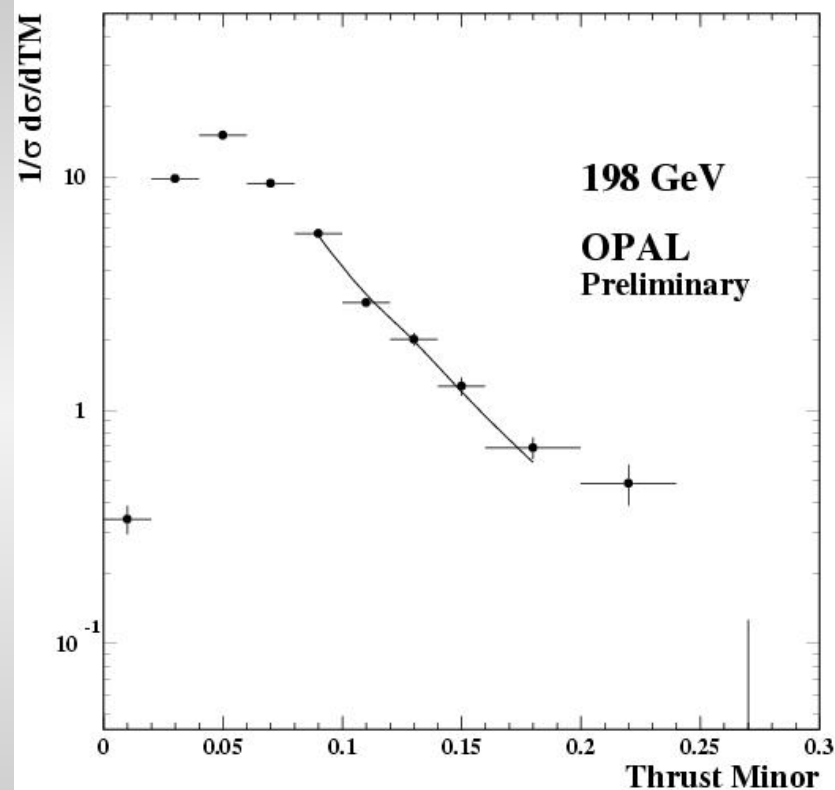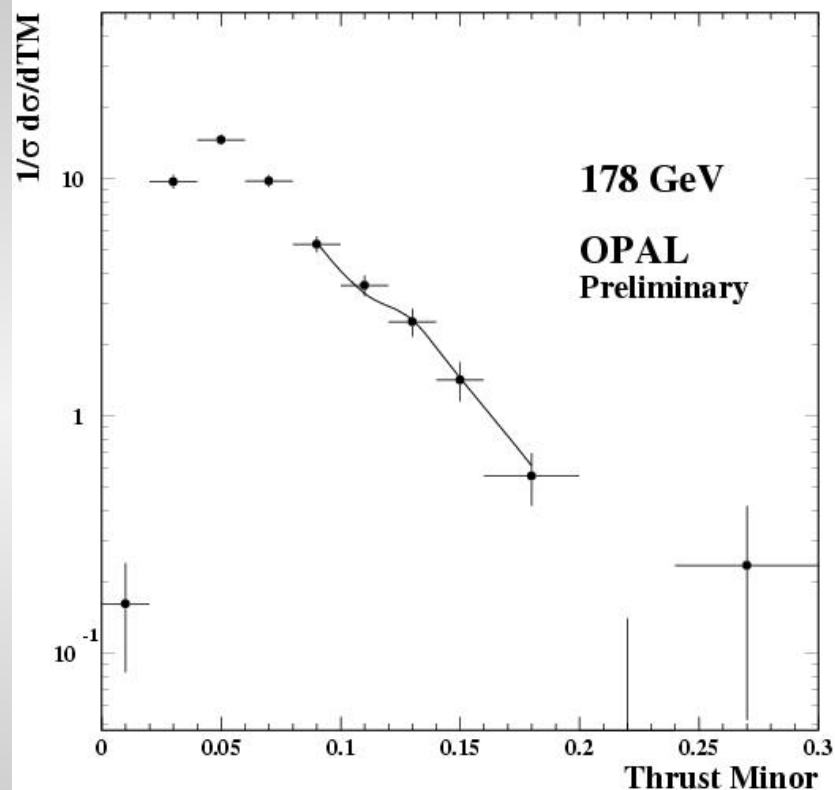
Additional 4-Jet Observables

- investigate further 4-jet observable

  - Thrust-Minor and D-Parameter

- only NLO prediction available, no NLLA

- perform fit with x_μ as free parameter

  - take $0.5 * x_\mu^{min}$ and $2.0 * x_\mu^{min}$ as systematic scale uncertainty

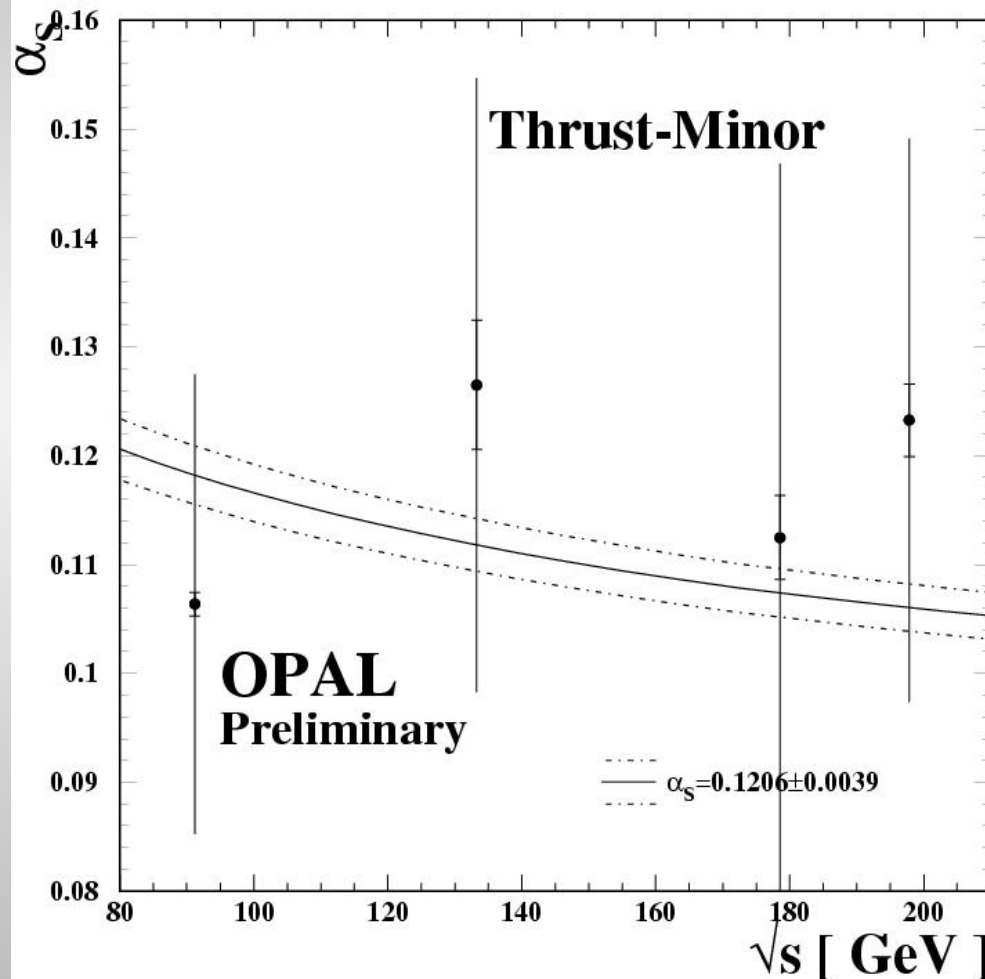- perform fit with x_μ set to 1

Thrust-Minor

Fit looks OK

Thrust-Minor

Fit looks OK

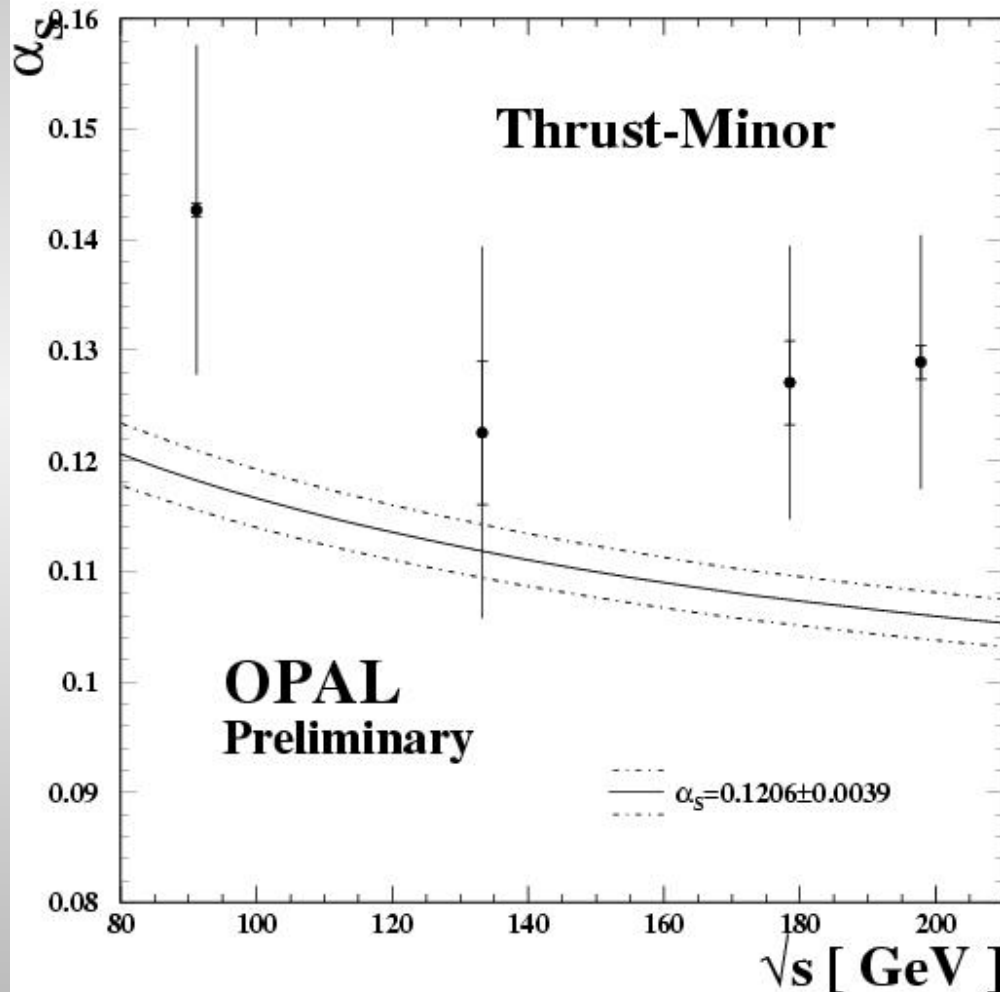large uncertainties from scale dependence

Thrust-Minor

little sensitivity on α_S

combined:
α_S= 0.1129±0.0232

NOTE: large error

Thrust-Minor
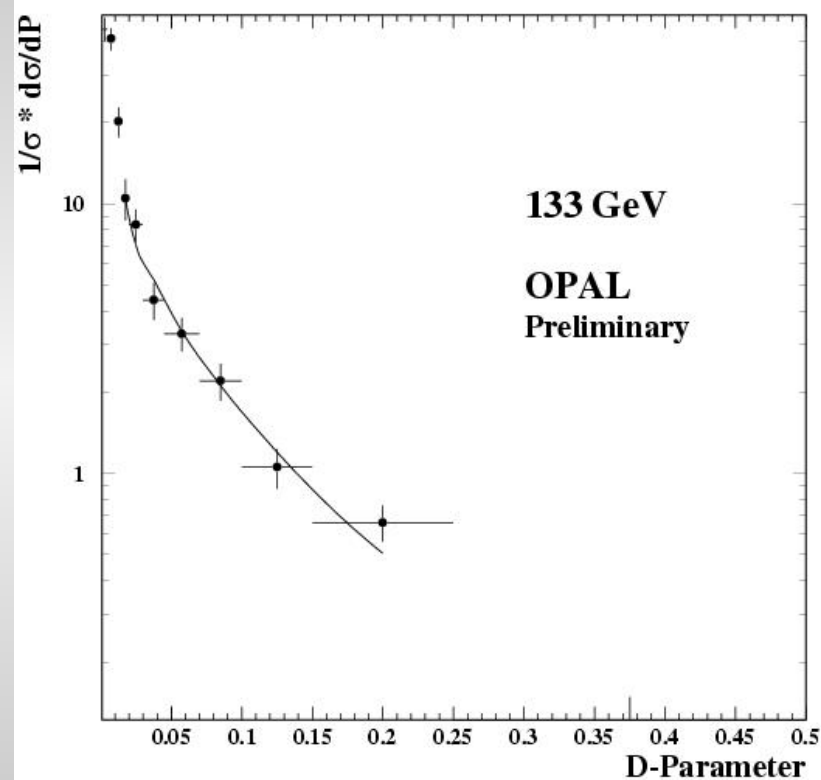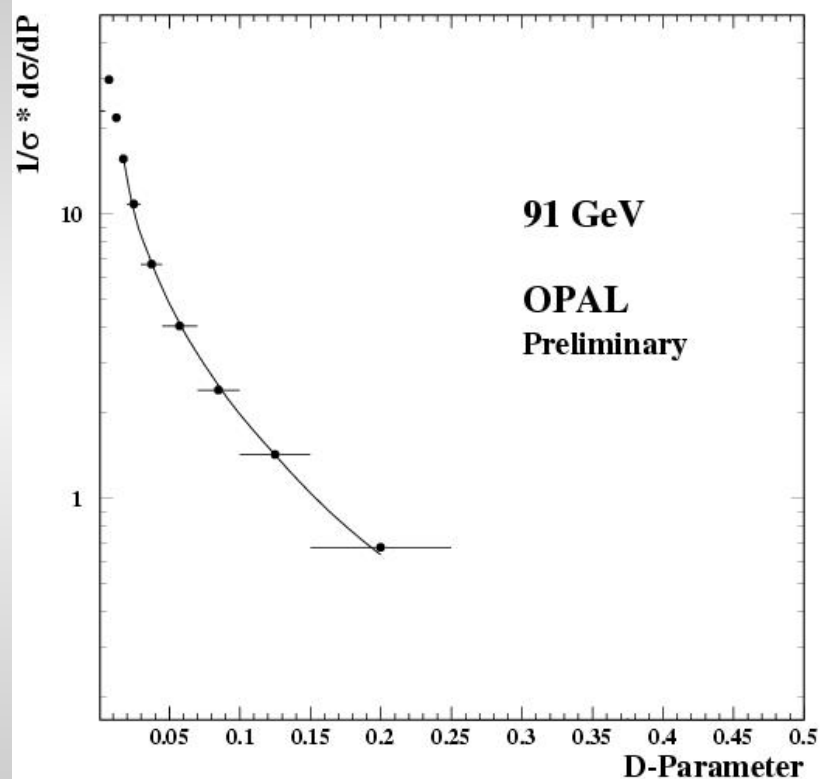

scale set to $x_\mu=1$

combined:
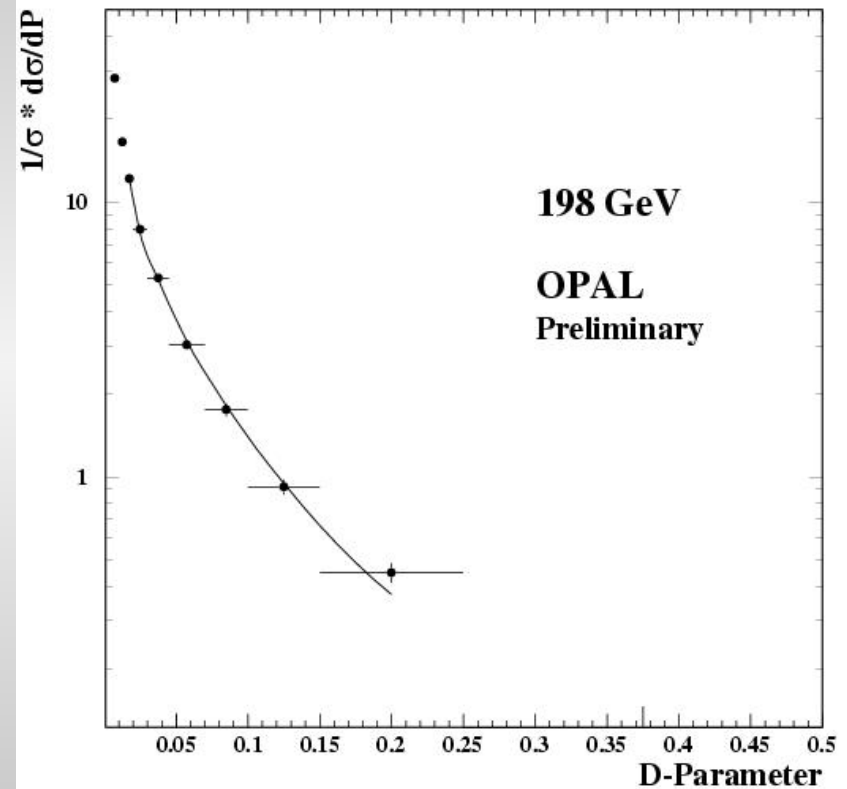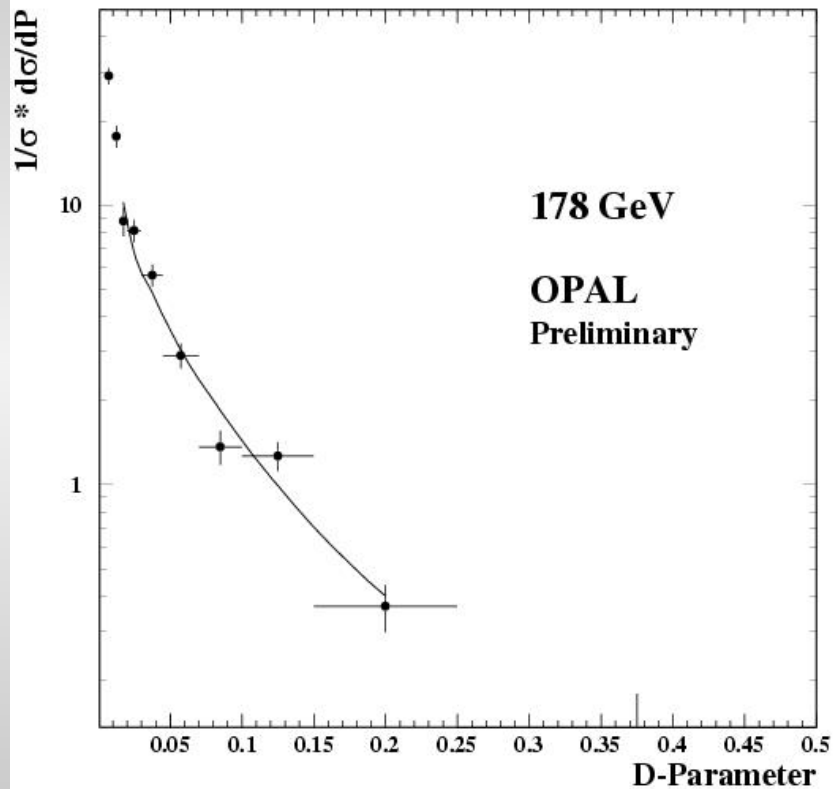$\alpha_S=0.1452 \pm 0.0164$
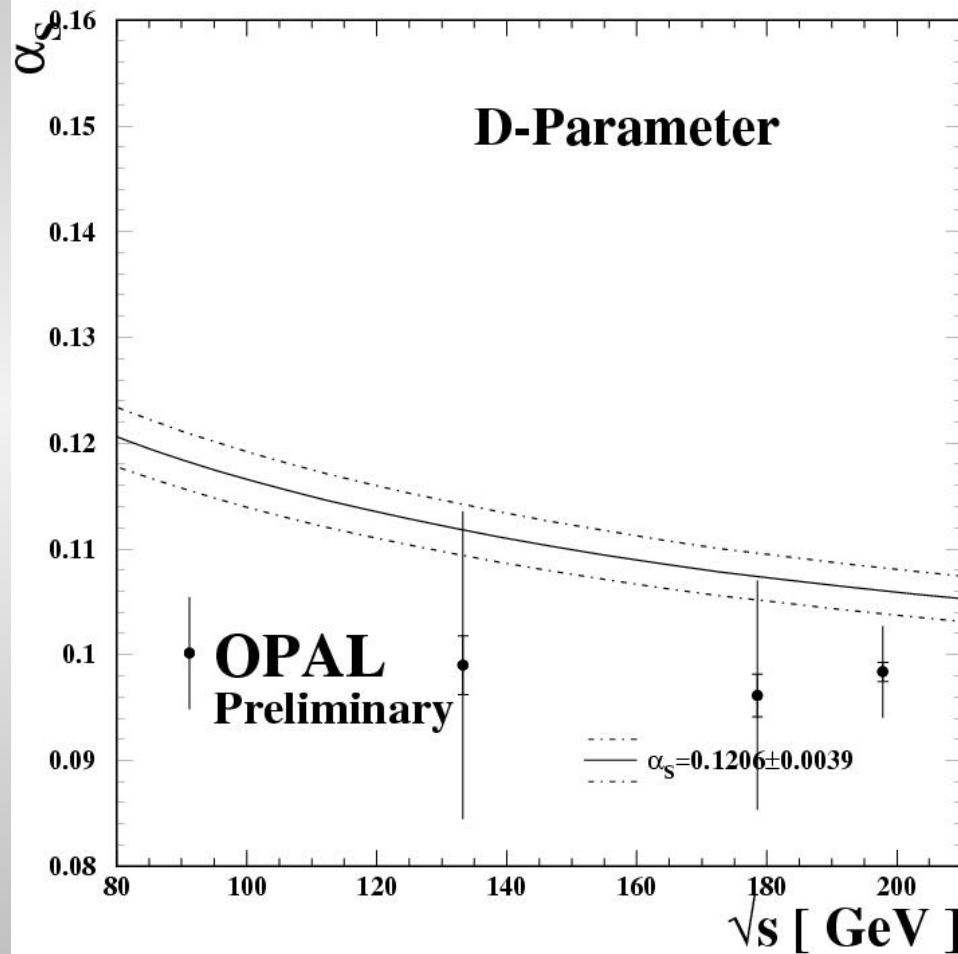(1.6 σ from R_4 value)

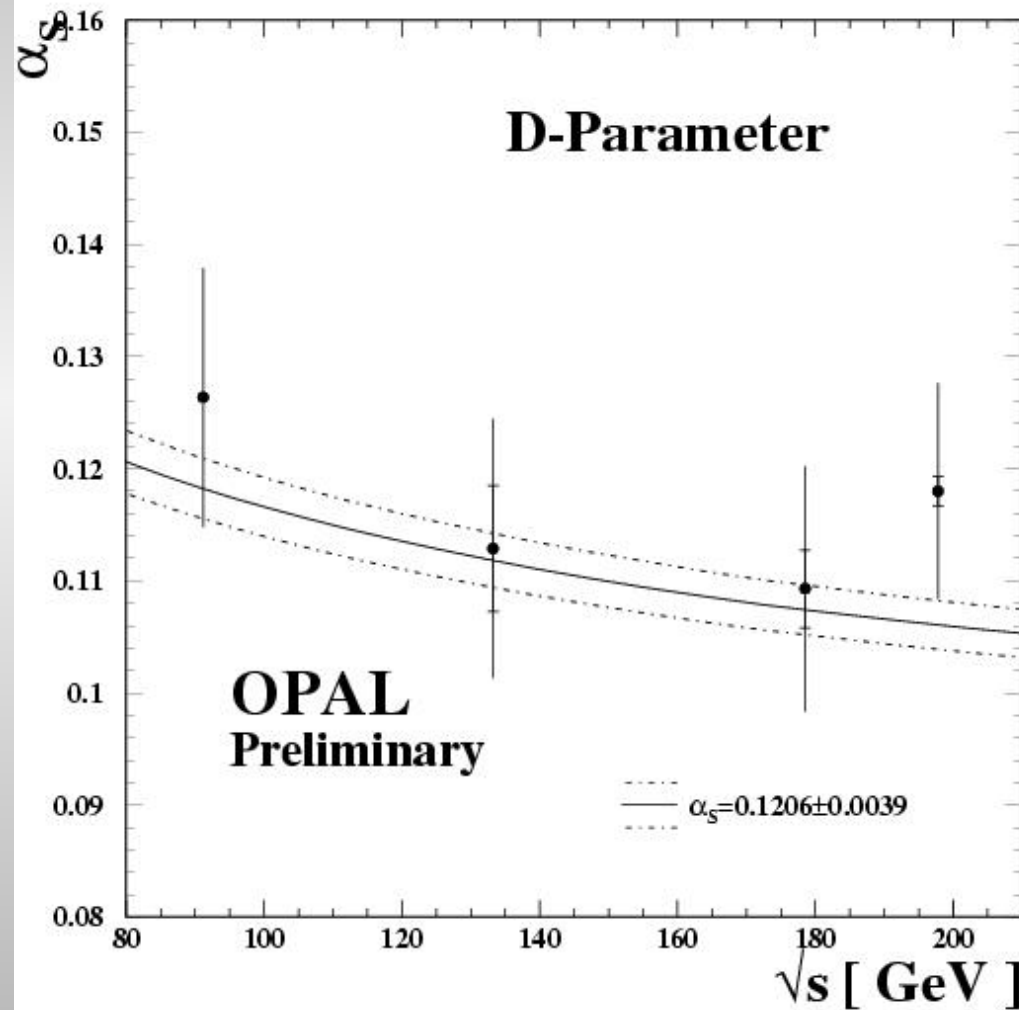# D-Parameter

Fit looks OK

D-Parameter

Fit looks OK

D-Parameter

combined:
α_S = 0.1048±0.0047
(3.1 σ from R_4 value)

syst. error from
scale uncertainty
underestimated

D-Parameter


scale set to $x_\mu=1$

combined:
$\alpha_S = 0.1298 \pm 0.0125$

Investigations of BZ-Angle

- simulate Bengston-Zerwas Angle distribution using debrecen event generator

    following cuts are applied:

    $Y_{34} > 0.012$

    $Y_{45} < 0.006$

    $\cos \theta_{12}$ and $\cos \theta_{34} < 160°$

- cuts also applied on Pythia MC

    at detector, hadron and parton level

    calculate corrections

- cuts also applied on data

    correct for detector and hadronisation

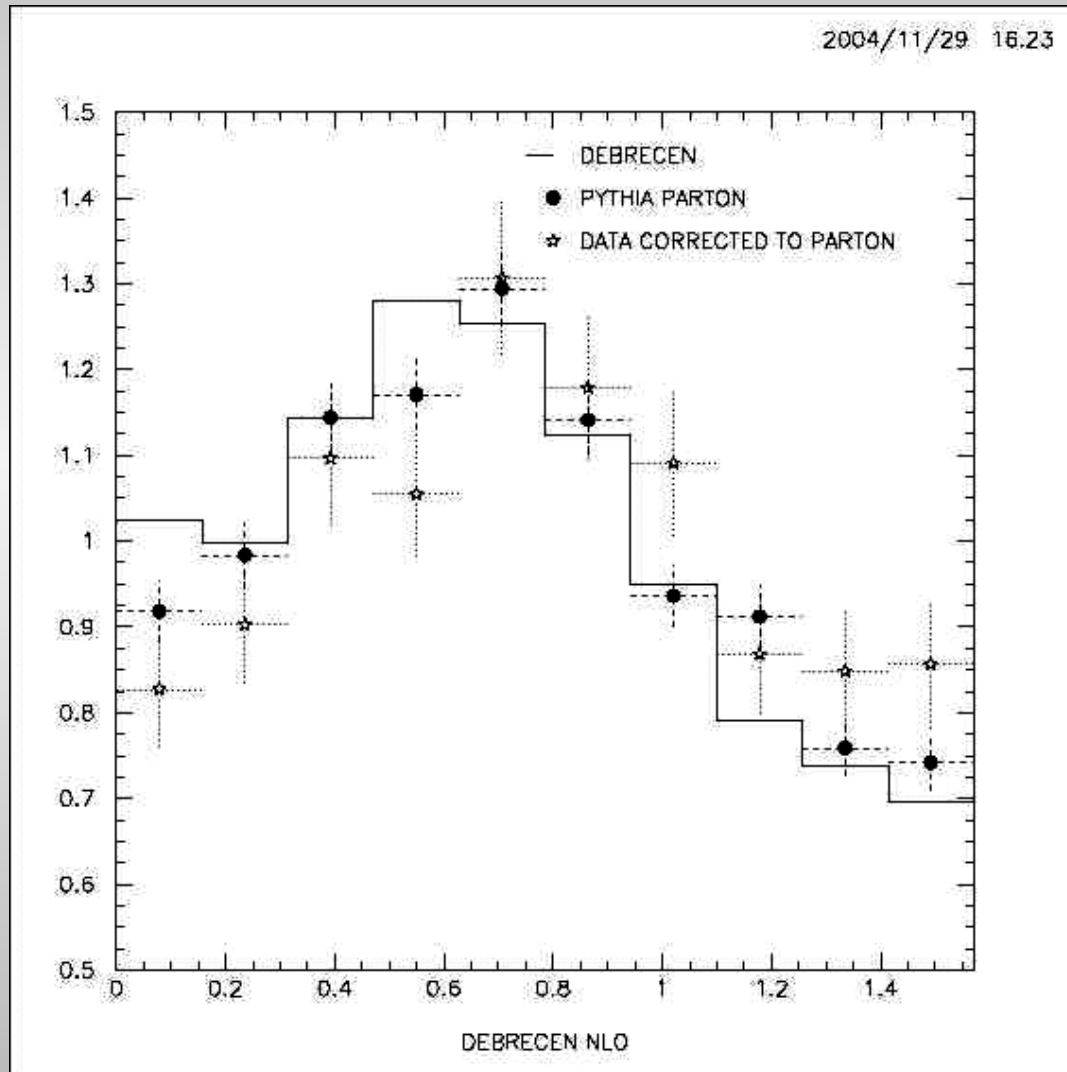   compare with Pythia and debrecen prediction

Investigations of BZ-Angle
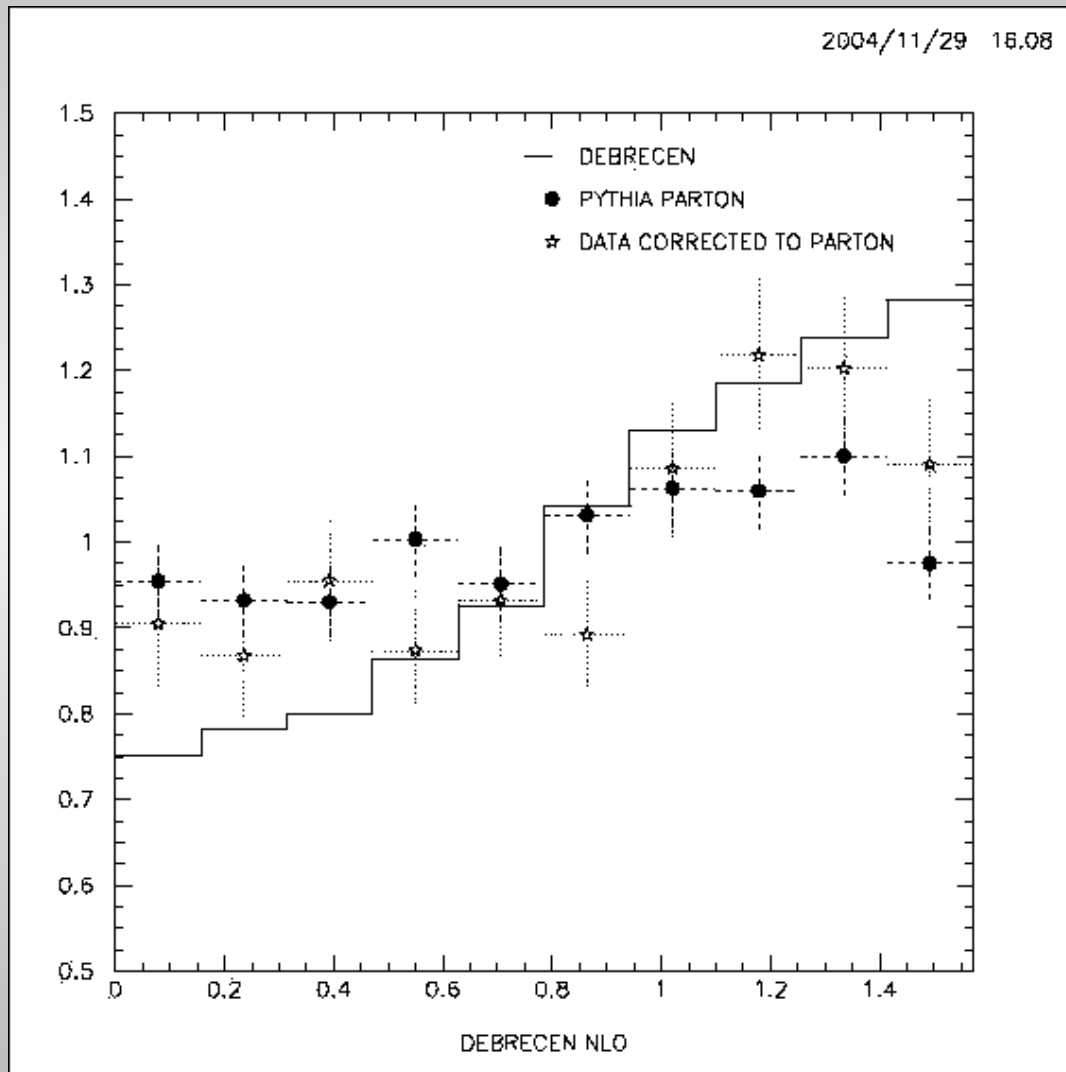
invarinat mass of two least energetic jets < 20 GeV

$$\left(\frac{(\text{debrecen-Pythia})}{\sigma}\right)^2 = 12.3$$

$$\left(\frac{(\text{debrecen-Data})}{\sigma}\right)^2 = 1.99$$

Investigations of BZ-Angle

invarinat mass of two least energetic jets > 20 GeV

$$\left(\frac{\text{(debrecen-Pythia)}}{\sigma}\right)^2 = 1.19$$

$$\left(\frac{\text{(debrecen-Data)}}{\sigma}\right)^2 = 2.42$$

Investigation of BZ-Angle

Comment:

- selection of qqqq and qqgg events in debrecen not possible (color factors? C_A / C_F seperation)
- QCD ntuple from the R_4 analysis used, information on qqqq/qqgg lost
- variable m_3+m_4 not possible in debrecen since particles are massless
- further investigation, in particular to repeat Analysis, would require big effort

Conclusion

- four-jet rate analysis refined

  smaller fit range leading to a smaller error

  final value: **0.1193±0.0021**

  evaluate x_μ dependence

- conversion of the PN in paper soon

- analysis of Thrust-Minor and D-Parameter

  - no coherent picture

  - include in publication

  - take R_4 results with a grain of salt...

- differences between Debrecen and Pythia parton

shower model seen for certain phase space cuts