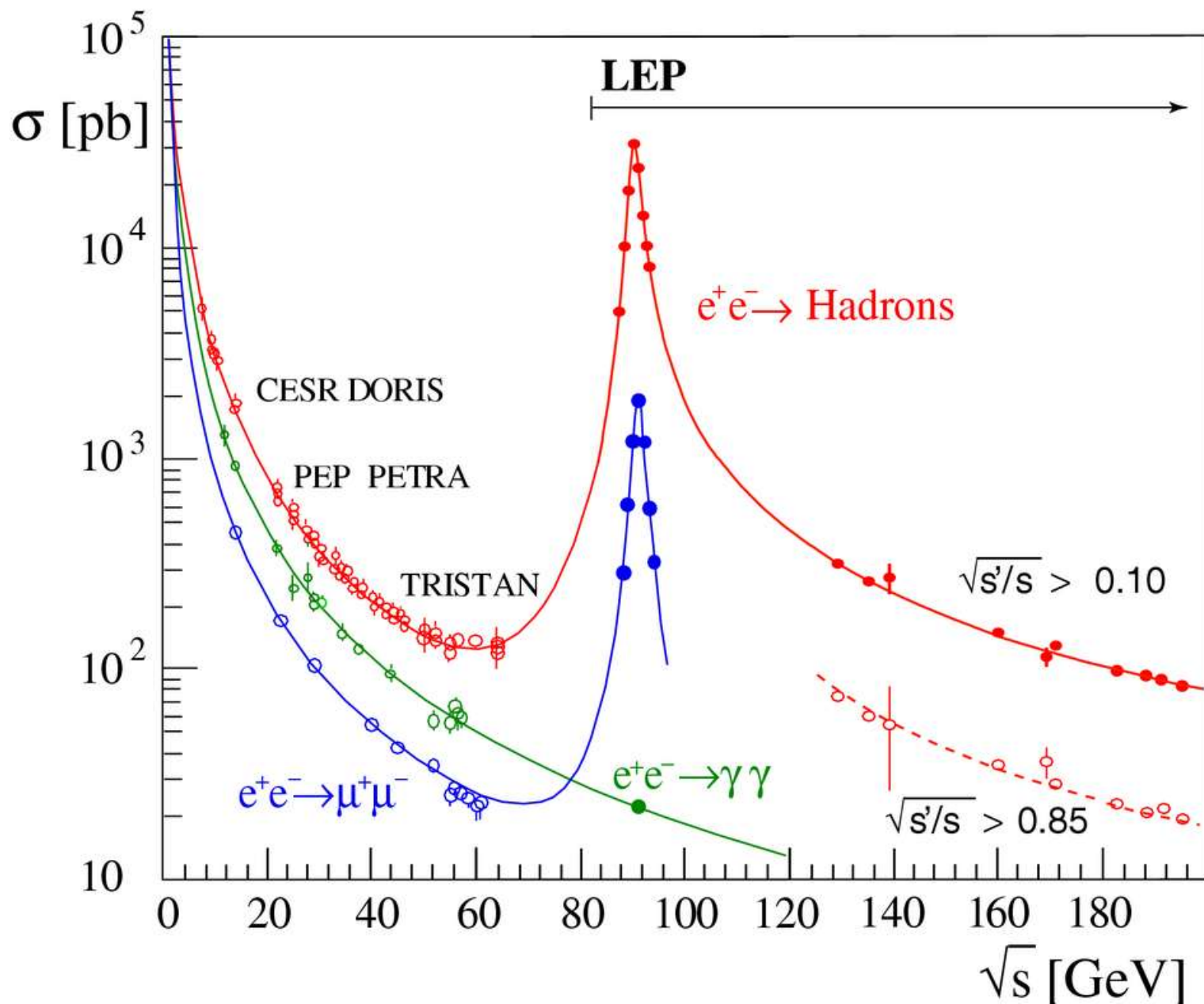


Studies of the 4-jet rate and of moments of event shape observables using JADE data

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ICHEP 2004, Beijing, 16-22 August 2004,
abstracts 5-0498, 5-0502

e^+e^- Annihilation in JADE

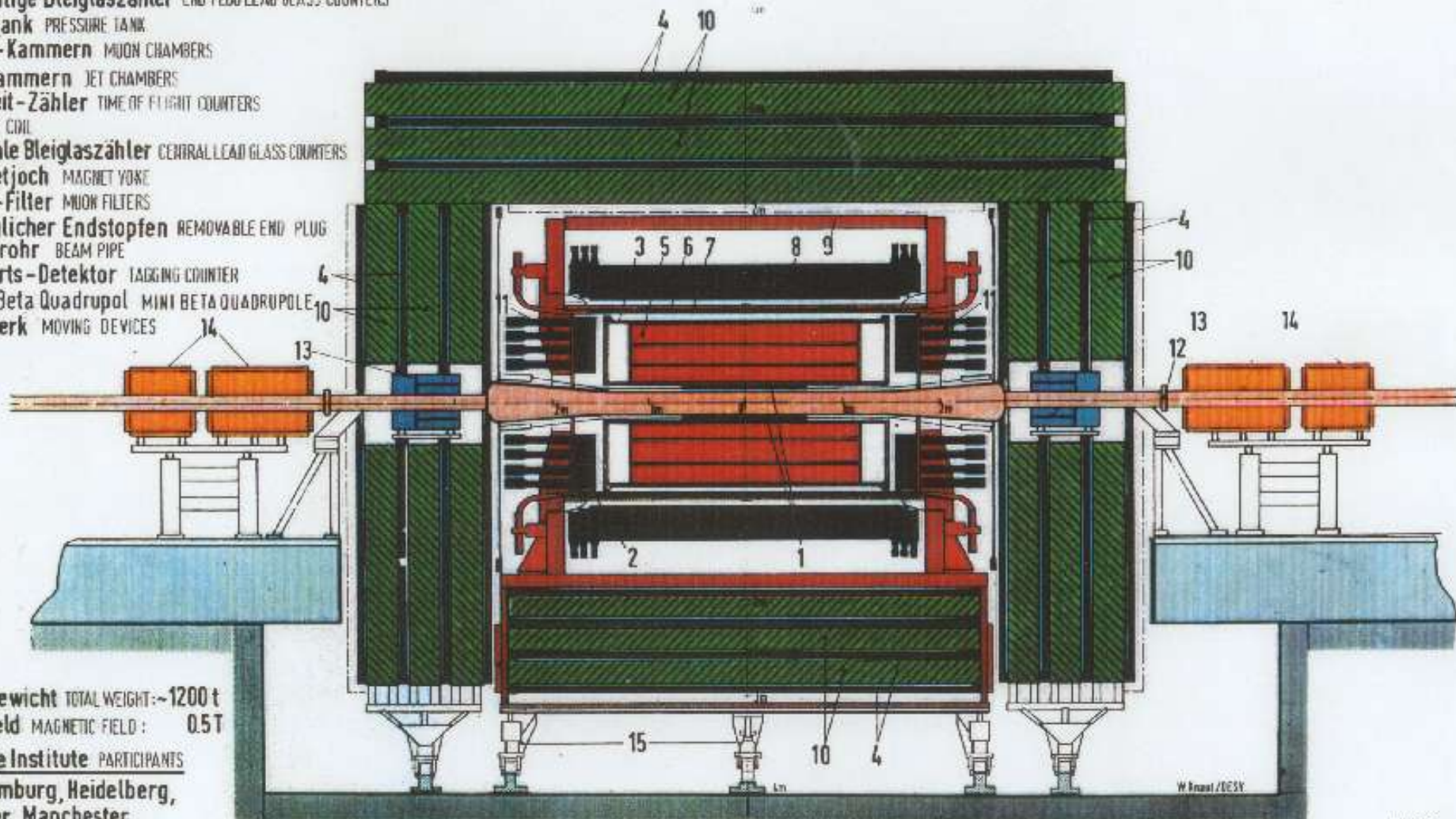


The JADE Experiment

1979 to 1986 at PETRA/DESY

MAGNETDETEKTOR **JADE**
MAGNET DETECTOR

- 1 Strahlrohrzähler BEAM PIPE COUNTERS
- 2 Endseitige Bleiglaszähler END PLUG LEAD GLASS COUNTERS
- 3 Drucktank PRESSURE TANK
- 4 Myon-Kammern MUON CHAMBERS
- 5 Jet-Kammern JET CHAMBERS
- 6 Flugzeit-Zähler TIME OF FLIGHT COUNTERS
- 7 Spule COIL
- 8 Zentrale Bleiglaszähler CENTRAL LEAD GLASS COUNTERS
- 9 Magnetjoch MAGNET YOKE
- 10 Myon-Filter MUON FILTERS
- 11 Beweglicher Endstopfen REMOVABLE END PLUG
- 12 Strahlrohr BEAM PIPE
- 13 Vorwärts-Detektor TAGGING COUNTER
- 14 Mini-Beta Quadrupol MINI BETA QUADRUPOLE
- 15 Fahrwerk MOVING DEVICES



Gesamtgewicht TOTAL WEIGHT: ~1200 t

Magnetfeld MAGNETIC FIELD: 0.5 T

Beteiligte Institute PARTICIPANTS

DESY, Hamburg, Heidelberg,
Lancaster, Manchester,
Rutherford Lab., Tokio

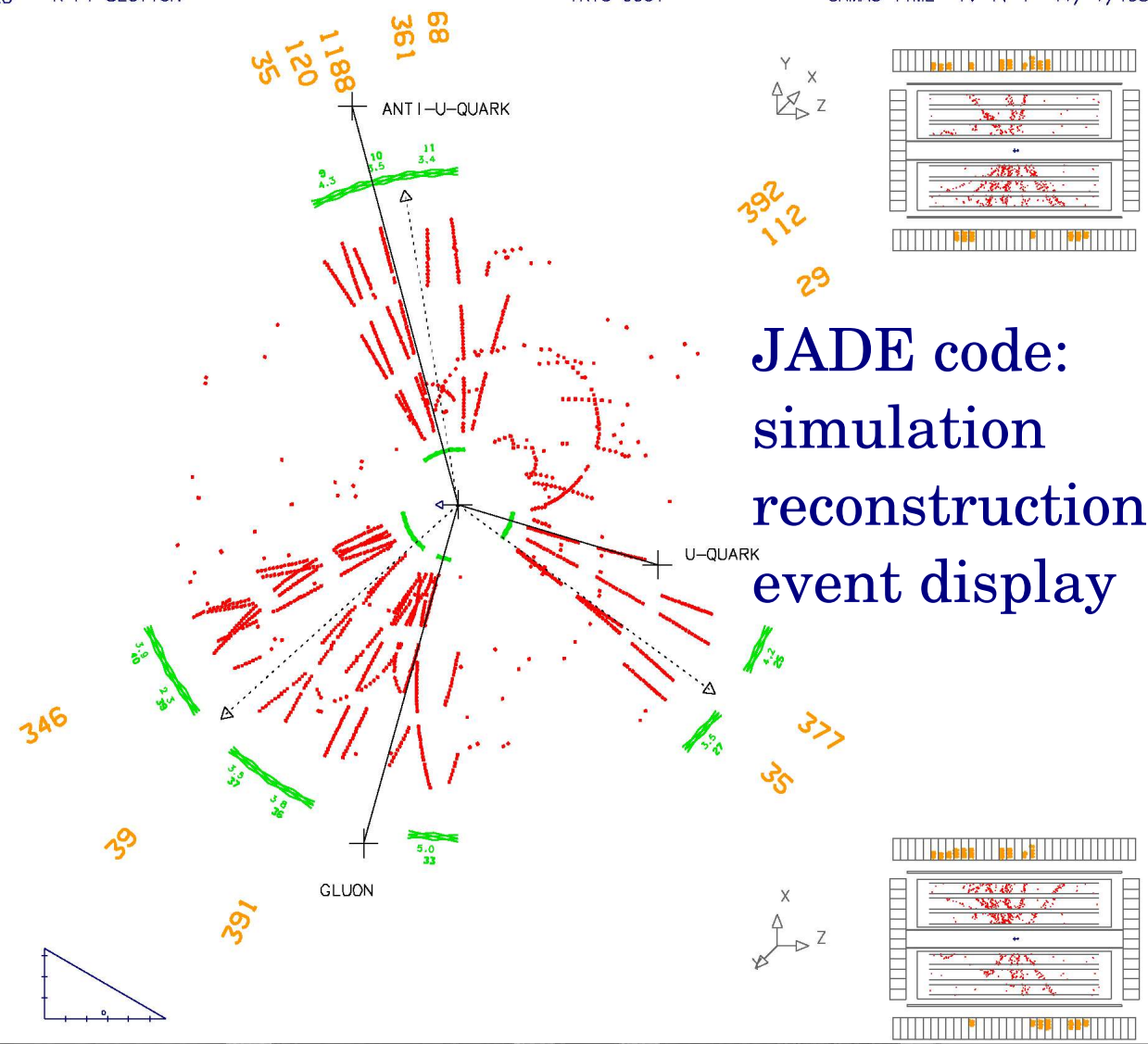
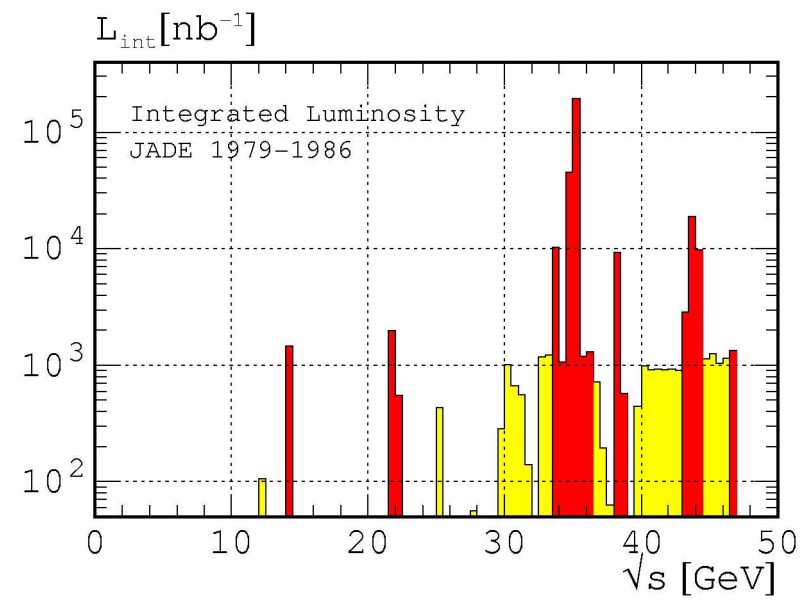
JADE Data and Software

- 1 Strahlrohrzähler STRAW TUBES
- 2 Endseitige Bleiglaszähler END SIDE PILE-UP
- 3 Druckbank PRESSURE BANK
- 4 Nyon-Kammern NYON CHAMBERS
- 5 Tot-Kammern DEAD CHANNELS
- 6 Fluores-Zähler PHOTO MULTIPLIERS
- 7 Spalte COL
- 8 Zentrale Bleiglaszähler CENTRAL PILE-UP
- 9 Magnetfeld Magnet

DSN mc14b
0 120 120
IDHITS 645
ELGTOT 3506
MUHITS 0
LGCYL 3506
LGCAPS 0
FWCAPS 0

MONTE CARLO R-FI SECTION
JADE

BEAM 7,000 GEV FIELD -4,849 KG TALC 0032 DATE 01/11/00 TIME 11,49,22
TRIG 0001 CAMAC TIME 1. 1. 1 17/ 7/1981



JADE code:
simulation
reconstruction
event display

Gesamtgewicht TOTAL WEIGHT = 12001
Magnetfeld MAGNET FIELD = 05T
Beitrag Institute PARTICIPANTS:
DESY, Hamburg, Heidelberg,
Lancaster, Manchester,
Rutherford Lab., Tokio

4-Jet Rate (Durham)

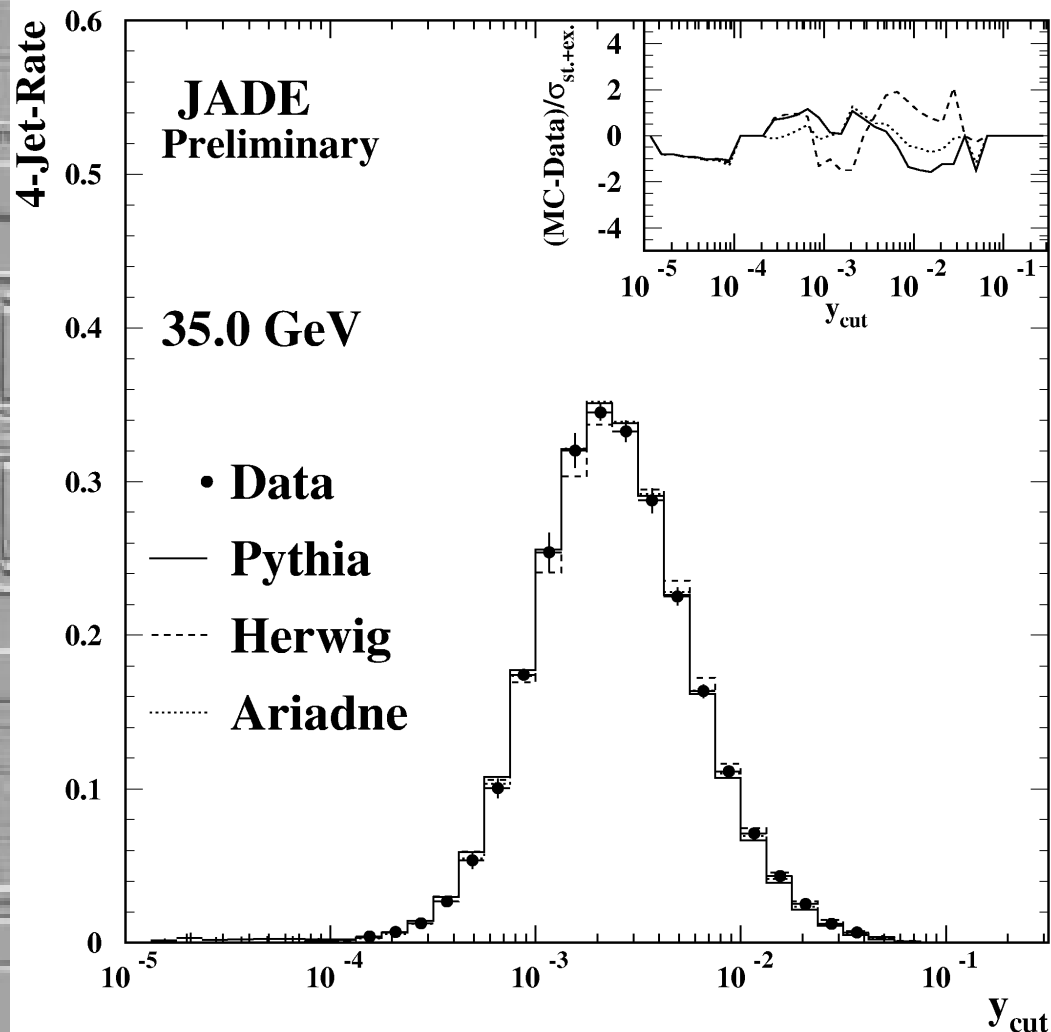
Distance in phase space $\sim k_t$:

$$y_{ij} = 2 \min(E_i^2, E_j^2) / E_{\text{vis}}^2 (1 - \cos\theta_{ij})$$

combine particles with
smallest y_{ij} by adding
4-vectors

stop when $y_{ij} > y_{\text{cut}}$, count jets

Corrected data vs. models

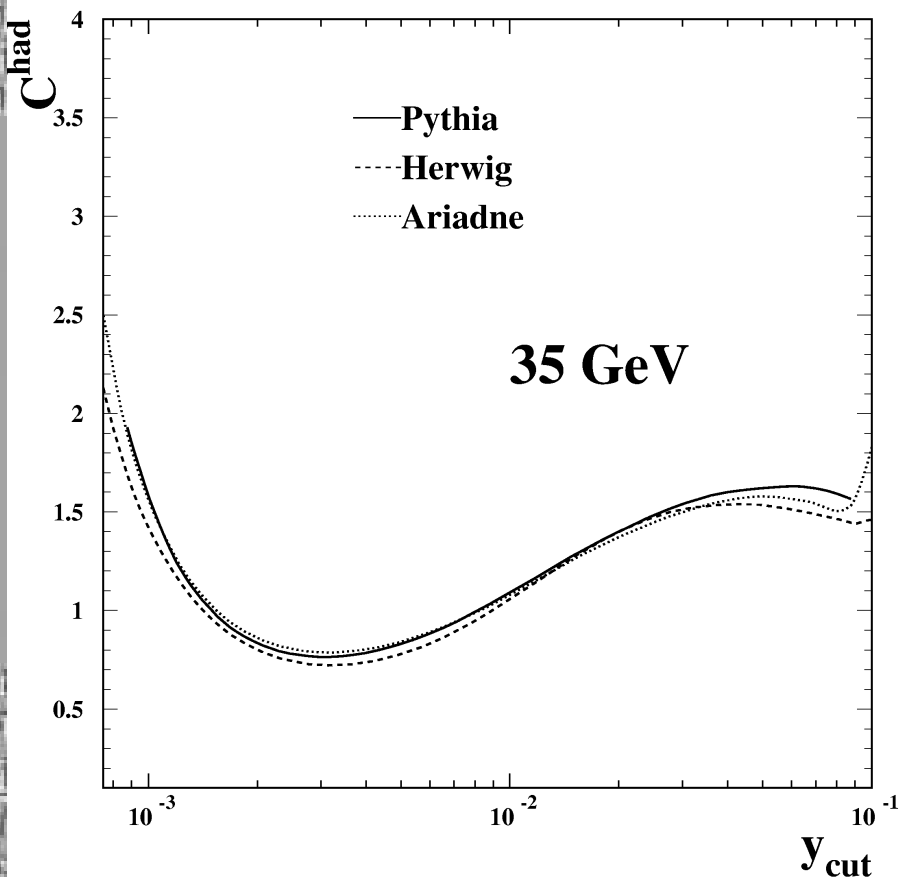


4-Jet Rate Fits

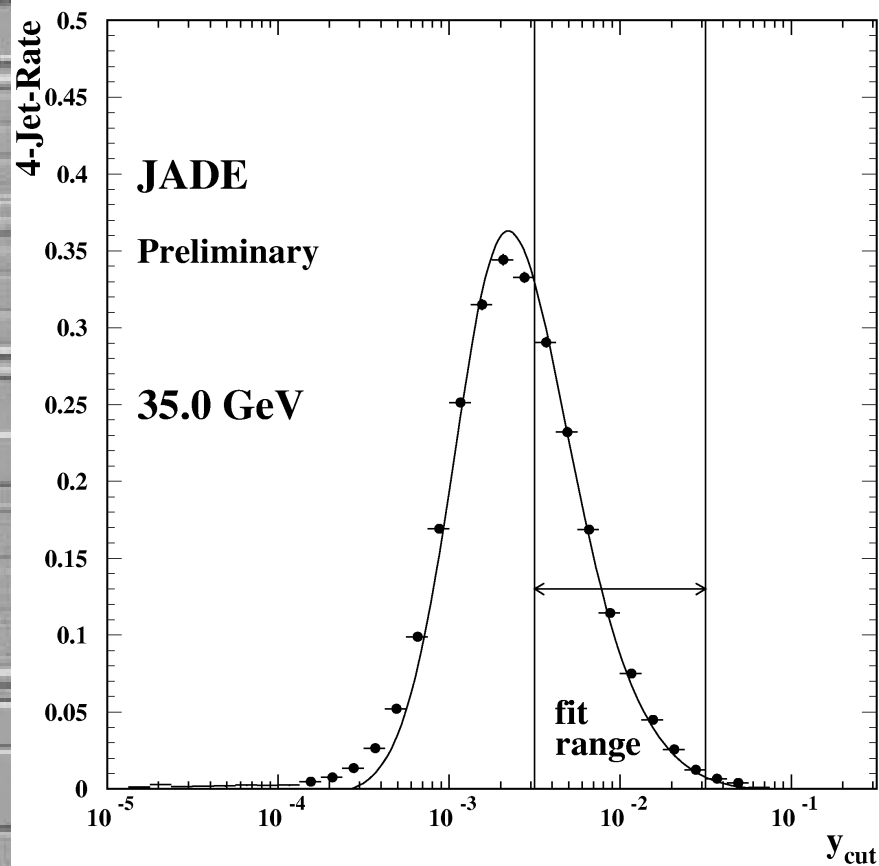
Theory is NLO ($O(\alpha_s^2) + O(\alpha_s^3)$ radiative corrections) combined with resummed NLLA

$$\alpha_s(35 \text{ GeV}) = 0.141 \pm 0.001(\text{stat.}) \pm 0.002(\text{exp.}) \pm 0.003(\text{had.}) \pm 0.001(\text{theo.})$$

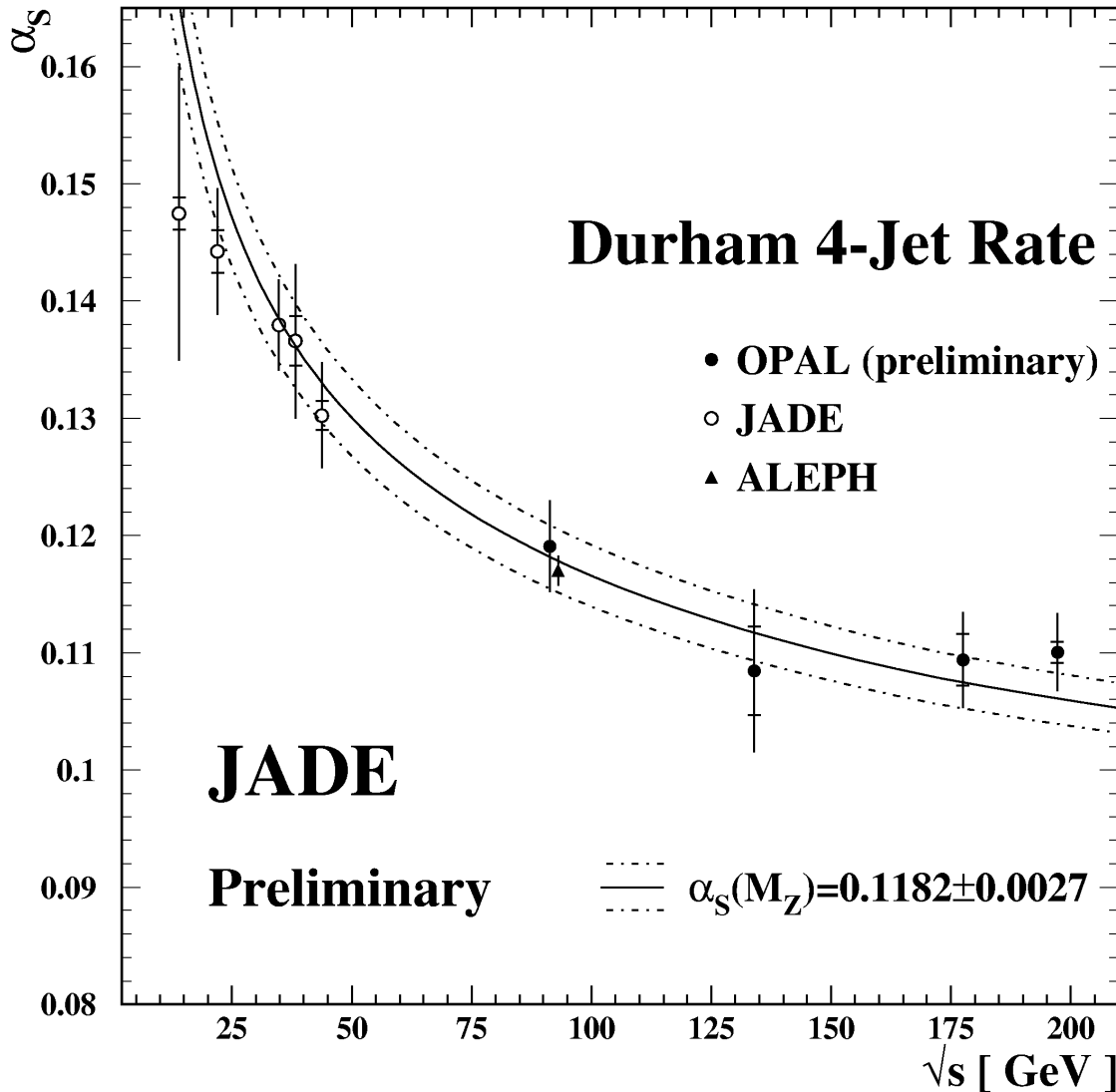
Hadronisation correction



Fit



α_s from Four-Jet Rate: Summary



Combine results from
22 to 43.8 GeV:

$$\alpha_s(M_Z) = 0.1169$$

$$\pm 0.0004(\text{stat.})$$

$$\pm 0.0012(\text{exp.})$$

$$\pm 0.0021(\text{had.})$$

$$\pm 0.0007(\text{theo.})$$

Moments of Event Shapes

Observables:

$1-T, M_H, C, B_T, B_W, y_{23}(D)$

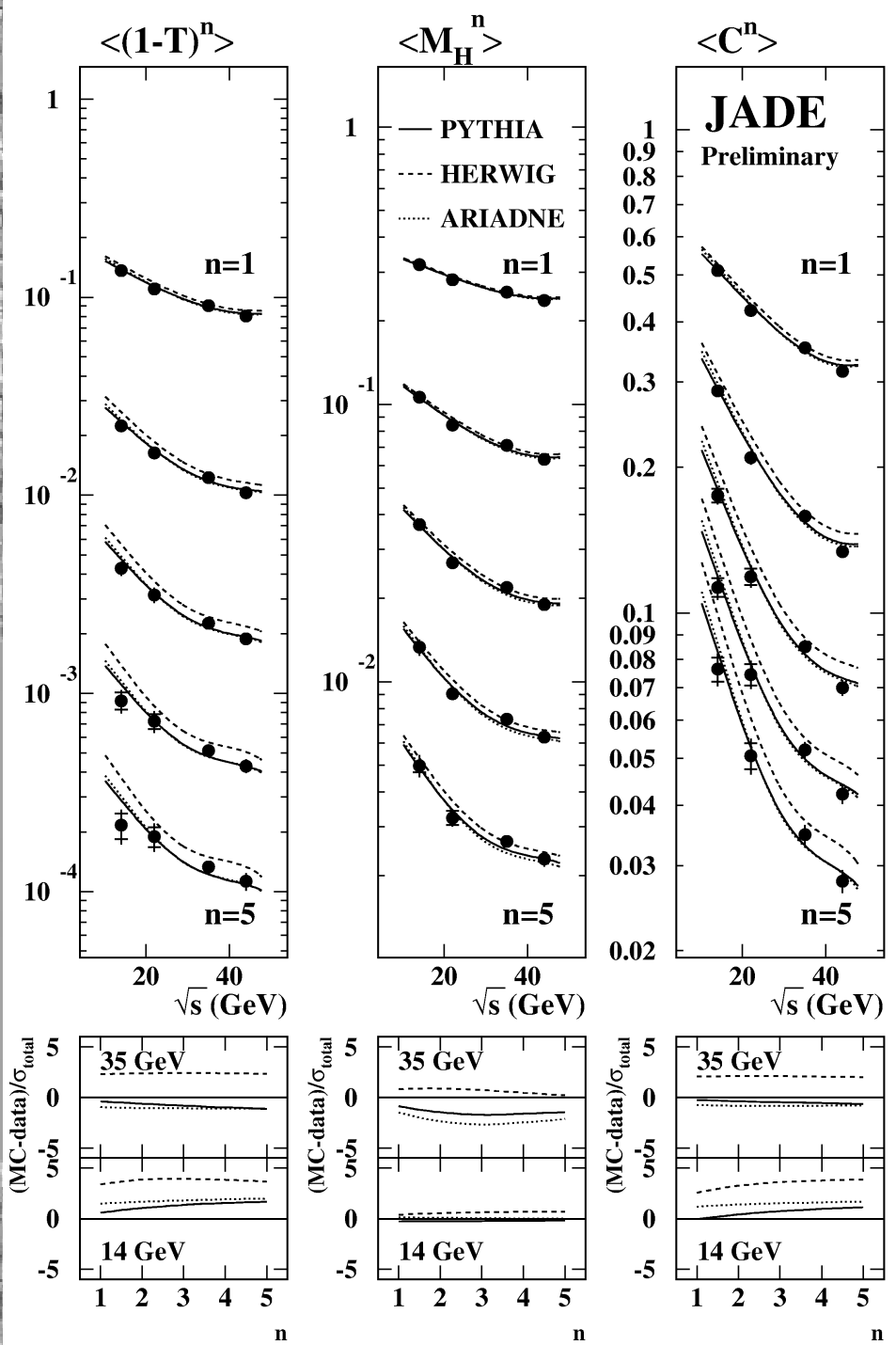
$$\langle y^n \rangle = \int y^n \frac{1}{\sigma} \frac{d\sigma}{dy} dy'$$

$n = 1, \dots, 5$

Theory is NLO QCD:

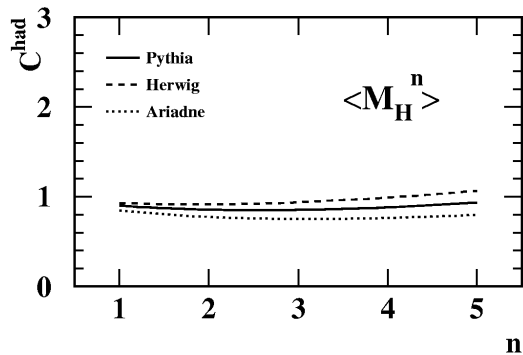
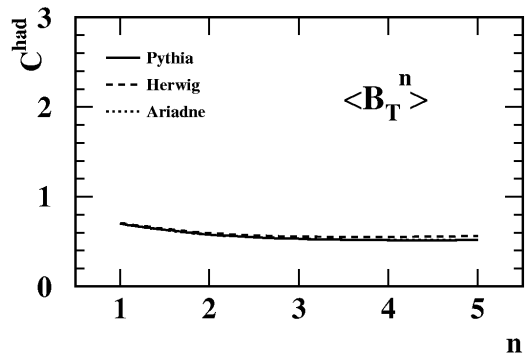
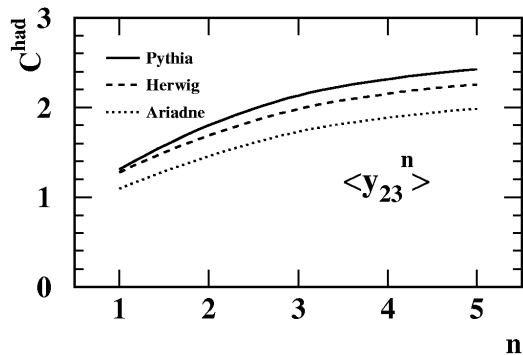
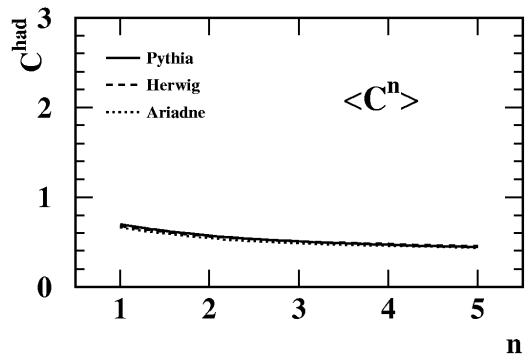
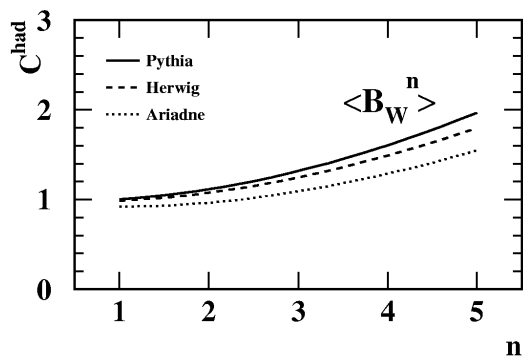
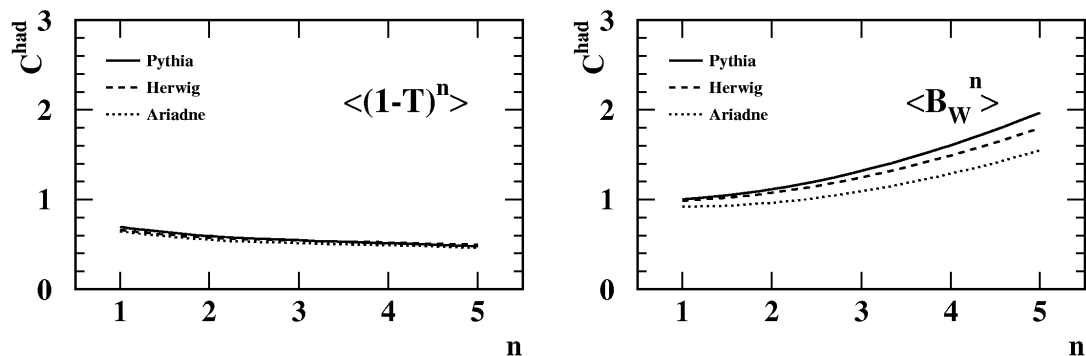
$$\langle y^n \rangle = A_n \alpha_S / (2\pi) + B_n (\alpha_S / (2\pi))^2$$

Complete phase space probed

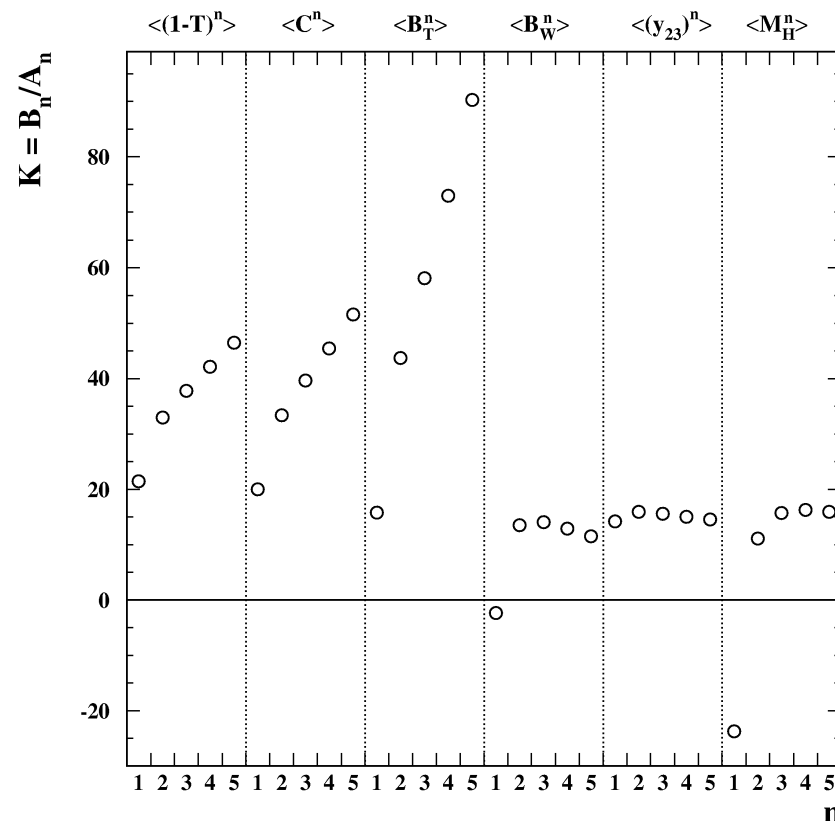


Moments Hadronisation

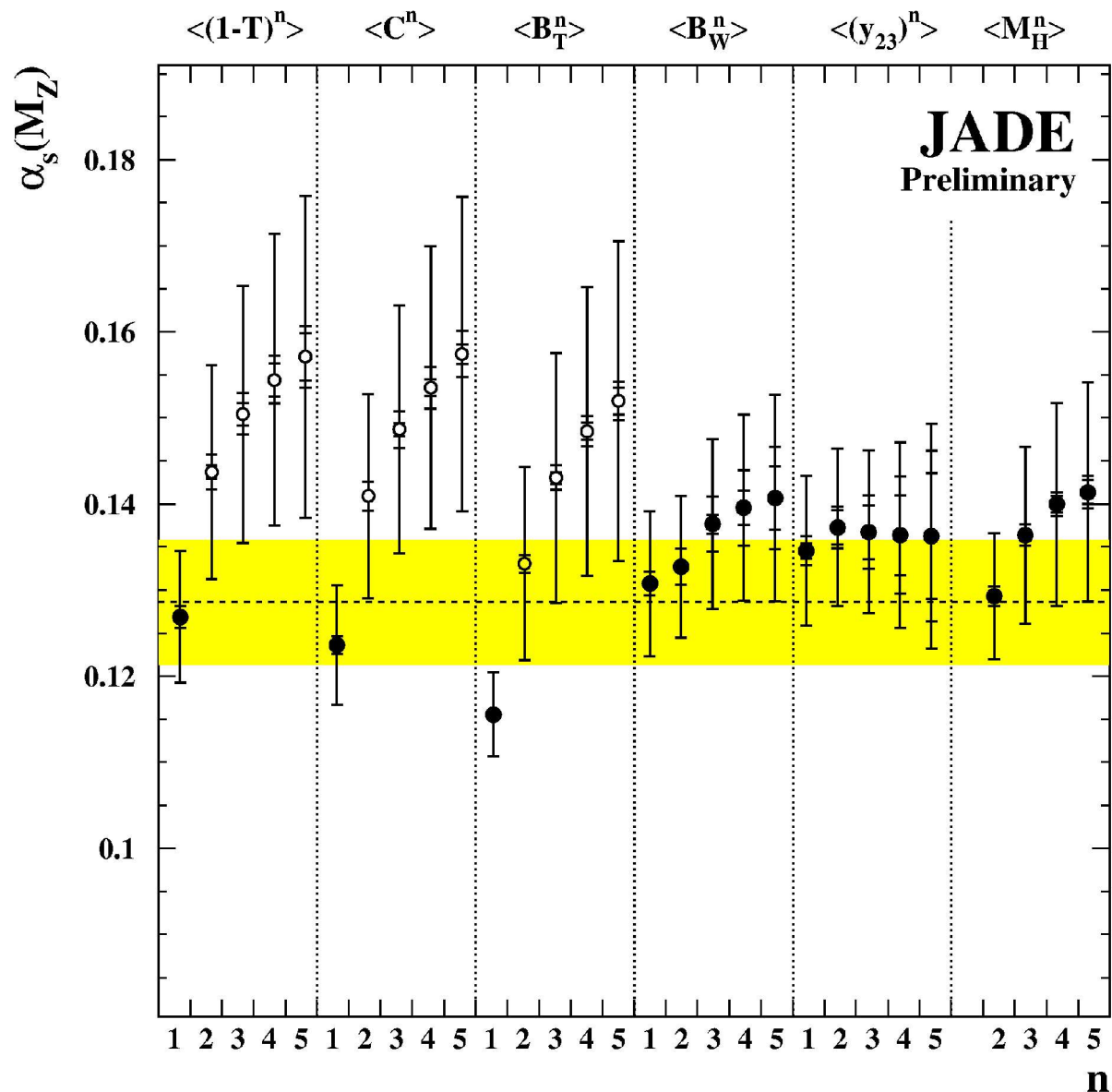
Hadronisation Correction 14 GeV



NLO/LO Ratio



Moments Results



Fit results not stable for
1-T, C, B_T ($n > 1$)

Require $K\alpha_s/(2\pi) < 0.5$ for
final result

$$\alpha_s(M_Z) = 0.1286$$

$$\pm 0.0007(\text{stat.})$$

$$\pm 0.0011(\text{exp.})$$

$$\pm 0.0022(\text{had.})$$

$$\pm 0.0068(\text{theo.})$$

Summary

- JADE data still alive and useful
- Measure 4-jet rate with Durham scheme
 - NLO + NLLA QCD calculation
 - precision measurement of α_s from JADE
 - $\alpha_s(M_Z) = 0.1169 \pm 0.0026$ (preliminary)
- Study 1st 5 moments of event shapes
 - Theory always samples complete phase space
 - Result for α_s consistent for some but not all observables