

# JADE data analysis today - motivation and results

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Max-Planck-Institute of Physics, Munich 0):now at LMU 1):now at Fermilab 2):DESY

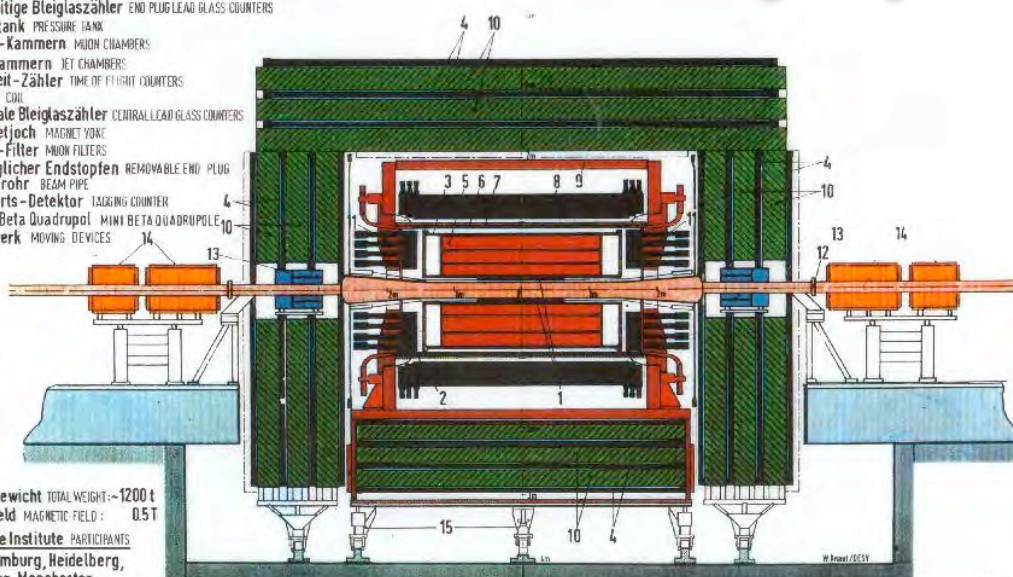
- the JADE experiment
- physics benefits: new results from old data
- JADE data & software formats
- revitalisation of JADE data & software
- some anecdotes along the line...
- future plans

## The JADE Experiment

MAGNETDETEKTOR **JADE**  
MAGNET DETECTOR

at the PETRA  $e^+e^-$  storage ring @ DESY

- 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 FORWARD COUNTER
- 14 Mini-Beta Quadrupol MINI BETA QUADRUPOLE
- 15 Fahrwerk MOVING DEVICES

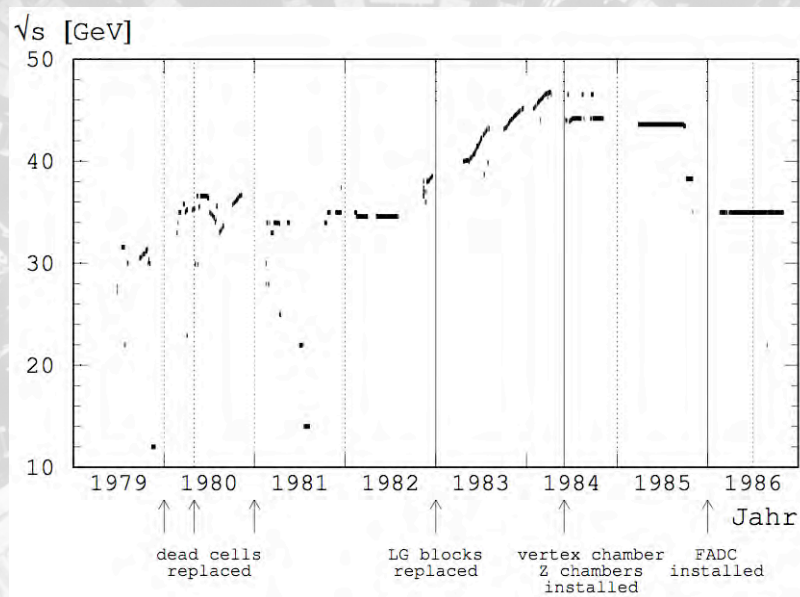


Gesamtgewicht TOTAL WEIGHT: ~1200 t  
Magnetfeld MAGNETIC FIELD: 0.5 T  
Beteiligte Institute PARTICIPANTS  
DESY, Hamburg, Heidelberg,  
Lancaster, Manchester,  
Rutherford Lab., Tokio

operation time: 1978 - 1986

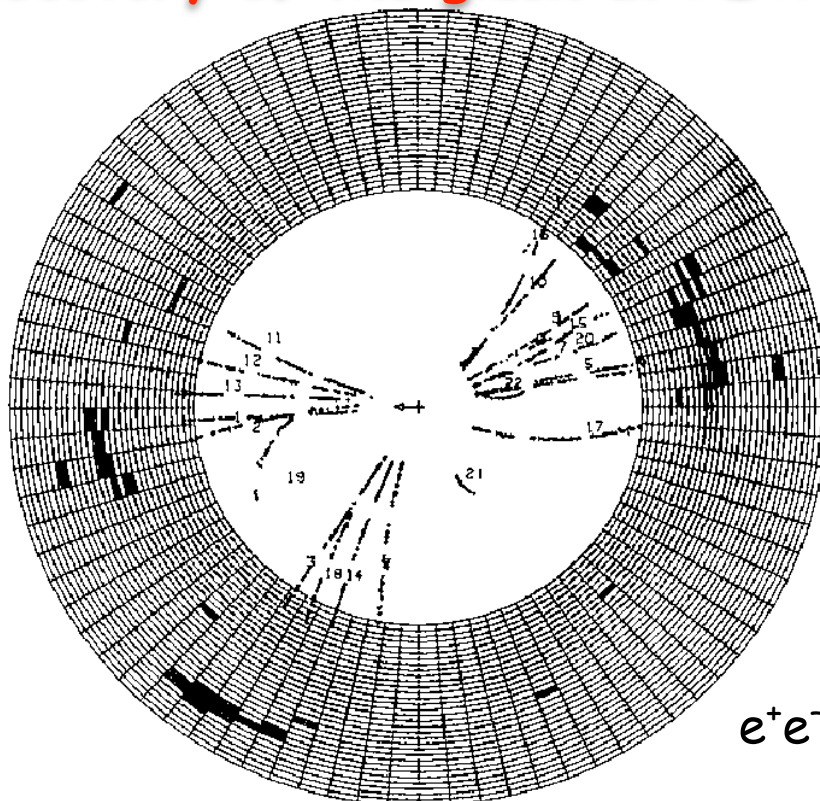
operation mode:  $e^+e^-$  annihilation;  $E_{cm} \sim 14 \dots 46 \text{ GeV}$

# JADE data taking



$\sim 200 \text{ pb}^{-1}$  ;  $\sim 45.000$  „good“ multihadronic events

# discovery of the gluon at PETRA

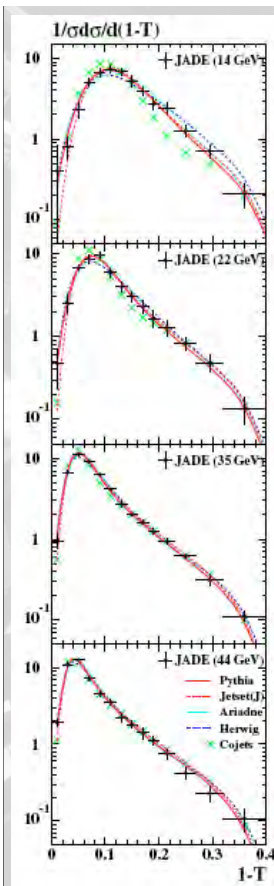


# physics benefits: new results from old data

	now (after LEP)	then (PETRA)
• new and improved theoretical calculations	NNLO QCD	(N)LO QCD
• new and improved MC models	NLLA+NLO shower	(N)LO fixed order
• new and optimised observables	$B_w$ , $B_t$ , $D_3$ , Durham jets	event shapes: T, S, O, ...
• more complete knowledge of Standard Model	top, W, Z	-----

- > re-do previous measurements:
  - increased precision
  - reduced systematics
- > perform new measurements:
  - at Energies and processes where no other data are available today (and in future)
- > if new phenomena found today:
  - go back and check at lower E

## two examples:



## Universality of QCD and Hadronisation

- at Petra times: not possible to describe data at all energies using QCD MC models with one consistent set of parameters

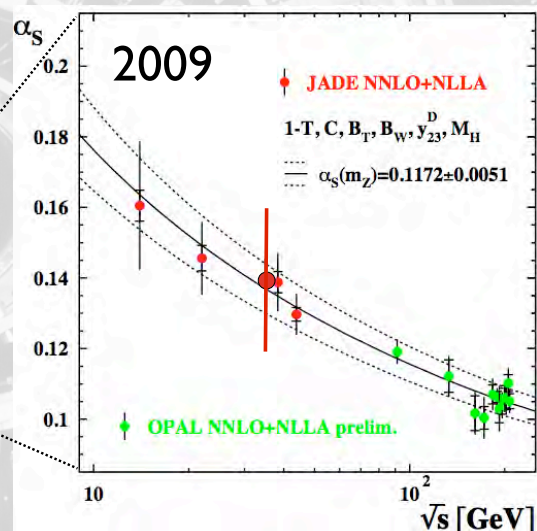
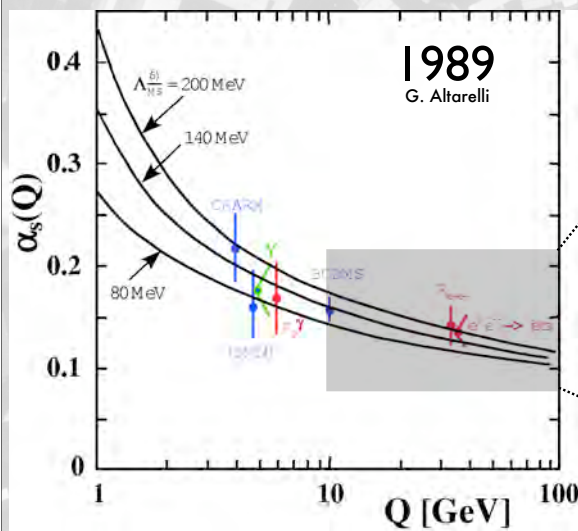
-> lowest energy data (14 GeV, 22 GeV) hardly used

- (new) QCD models with parameters tuned at LEP describe PETRA data down to lowest energies

-> confirms QCD concept of running coupling (Asymptotic Freedom) plus universality of hadronisation process

-> now allows to use lowest energy data for precision measurements, e.g. of  $\alpha_s$ .

# Precision measurements of $\alpha_s$ and proof of Asymptotic Freedom



- in NLO QCD:  $\alpha_s(35 \text{ GeV}) = 0.14 \pm 0.02$
- no running  $\alpha_s$  signature

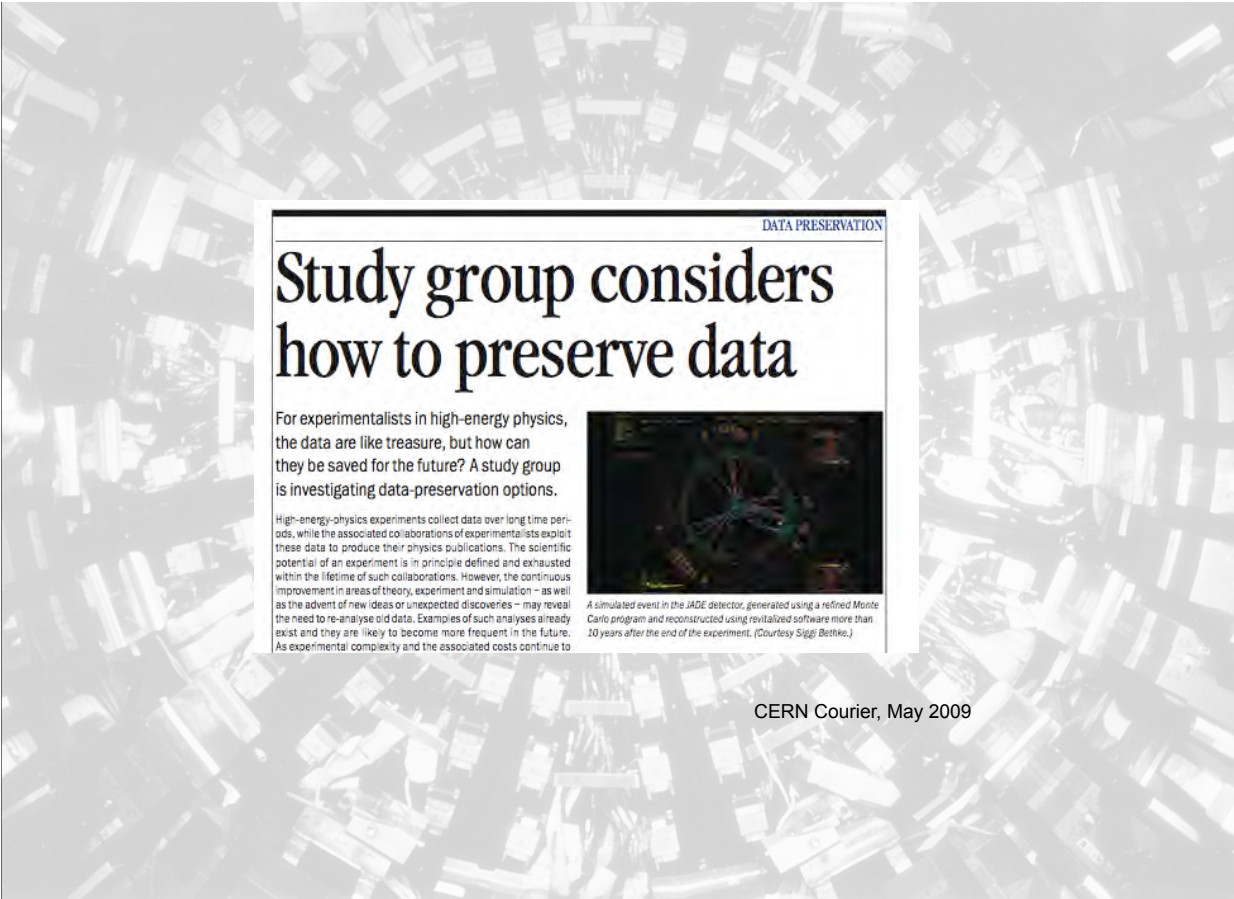
- in resummed NNLO:  $\alpha_s(M_Z) = 0.1172 \pm 0.0051$
- significant proof of running  $\alpha_s$  and asympt. freed.

## JADE data and software

- 1995: „private“ (neither collaboration nor lab) initiatives to :
  - rescue data from original archive tapes and copy them onto more modern media (IBM cartridges & Exabyte) (J. Olsson @ DESY)
  - reanalyse data using modern (LEP-like) methods and observables plus improved theoretical calculations (S. B. and P. Movilla-Fernandez @ RWTH Aachen)
  - revitalise JADE software on modern computer platforms to enable generation of new MC data files (P. Movilla Fernandez, J. Olsson)
- so far, the only example of reviving and still using 25-30 year old data & software in HEP
- since 1996, O(10) publications, O(10) conf. contributions; no competition in  $e^+e^-$  data analysis at  $E_{\text{cm}} \sim 14 \dots 46 \text{ GeV}$

## Publications based on resurrected JADE data (1997-2009)

- 7) Study of moments of event shapes and a determination of  $\alpha(S)$  using  $e^+ e^-$  annihilation data from JADE.  
Christoph Pahl (Munich, Max Planck Inst. & Munich, Tech. U.) , Siegfried Bethke, Stefan Kluth, Jochen Schieck, the JADE collaboration (Munich, Max Planck Inst.) . MPP-2008-135, May 8, 2009. 14pp. Eur.Phys.J.C60:181-196,2009, e-Print: arXiv:0810.2933 [hep-ex]
  - 6) Determination of the Strong Coupling  $\alpha(S)$  from hadronic Event Shapes and NNLO QCD predictions using JADE Data.  
By JADE Collaboration (S. Bethke et al.). MPP-2008-131, Oct 2008. 9pp., Submitted to Eur.Phys.J.C. e-Print: arXiv:0810.1389 [hep-ex]
  - 5) Measurement of the strong coupling  $\alpha(s)$  from the four-jet rate in  $e^+ e^-$  annihilation using JADE data.  
By JADE Collaboration (J. Schieck et al.). MPP-2006-161, 2006. 11 pp. Eur.Phys.J.C48:3-13,2006, Erratum-ibid.C50:769,2007. e-Print: arXiv:0707.0392 [hep-ex]
  - 4) Measurement of the longitudinal and transverse cross-sections in  $e^+ e^-$  annihilation at  $s^{**}(1/2) = 35\text{-GeV} - 44\text{-GeV}$ .  
By JADE Collaboration (M. Blumenstengel et al.). MPI-PHE-2001-11, Jun 2001. 12pp., Phys.Lett.B517:37-46,2001. e-Print: hep-ex/0106066
  - 3) QCD analyses and determinations of  $\alpha(s)$  in  $e^+ e^-$  annihilation at energies between 35-GeV and 189-GeV.  
By JADE collaboration and OPAL Collaboration (P.Pfeifschneider et al.). CERN-EP-99-175, Dec 1999. 49pp. Eur.Phys.J.C17:19-51,2000. e-Print: hep-ex/0001055
  - 2) C parameter and jet broadening at PETRA energies.  
By JADE Collaboration (O. Biebel et al.). PITHA-98-21A, Mar 1999. 14pp. Phys.Lett.B459:326-334,1999., e-Print: hep-ex/9903009
  - 1) A Study of event shapes and determinations of  $\alpha-s$  using data of  $e^+ e^-$  annihilations at  $s^{**}(1/2) = 22\text{-GeV}$  to 44-GeV.  
By JADE Collaboration (P.A. Movilla Fernandez et al.). PITHA-97-27, Aug 1997. 36pp., Eur.Phys.J.C1:461-478,1998. e-Print: hep-ex/9708034
- =====
- 3) Tests of analytical hadronisation models using event shape moments in  $\{lepem\}$  annihilation.  
C. Pahl, S. Bethke, O. Biebel, S. Kluth, J. Schieck . MPP-2009-38, Apr 2009. 17pp. e-Print: arXiv:0904.0786 [hep-ex]
  - 2) Tests of power corrections for event shapes in  $e^+ e^-$  annihilation. P.A. Movilla Fernandez, S. Bethke, O. Biebel, S. Kluth (Munich, Max Planck Inst.) . MPI-PH-2001-005, May 2001. 27pp., Eur.Phys.J.C22:1-15,2001. e-Print: hep-ex/0105059
  - 1) A Measurement of the QCD color factors using event shape distributions at  $s^{**}(1/2) = 14\text{-GeV}$  to 189-GeV.  
S. Kluth, P.A. Movilla Fernandez, S. Bethke, C. Pahl, P. Pfeifschneider (Munich, Max Planck Inst.) . MPI-PHE-2000-19, Dec 2000. 25pp. Eur.Phys.J.C21:199-210,2001. e-Print: hep-ex/0012044




DATA PRESERVATION

## Study group considers how to preserve data

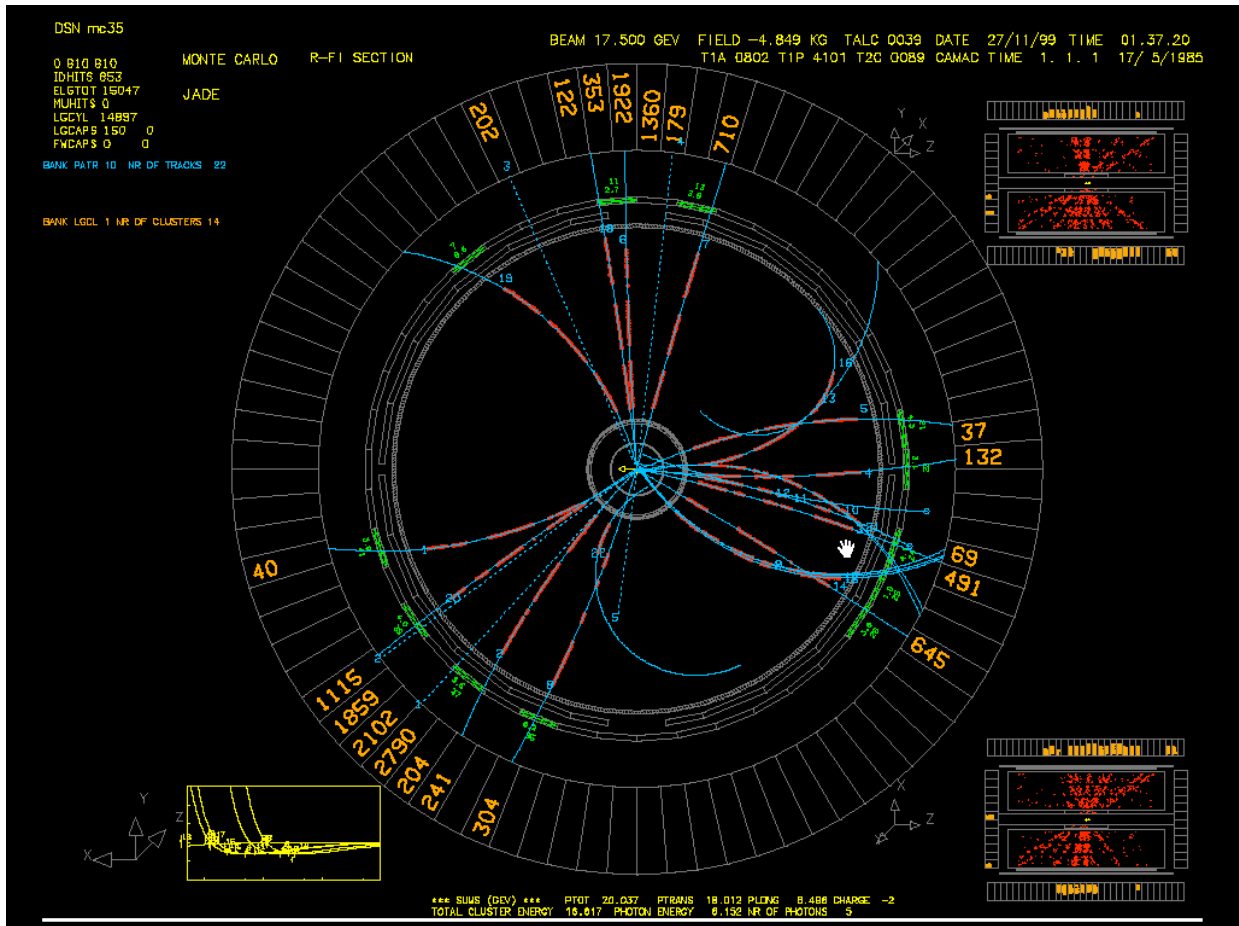
For experimentalists in high-energy physics, the data are like treasure, but how can they be saved for the future? A study group is investigating data-preservation options.

High-energy-physics experiments collect data over long time periods, while the associated collaborations of experimentalists exploit these data to produce their physics publications. The scientific potential of an experiment is in principle defined and exhausted within the lifetime of such collaborations. However, the continuous improvement in areas of theory, experiment and simulation – as well as the advent of new ideas or unexpected discoveries – may reveal the need to re-analyse old data. Examples of such analyses already exist and they are likely to become more frequent in the future. As experimental complexity and the associated costs continue to



A simulated event in the JADE detector, generated using a refined Monte Carlo program and reconstructed using revitalized software more than 10 years after the end of the experiment. (Courtesy Sigi Bethke.)

CERN Courier, May 2009



## Revitalisation of JADE software

- started in 1995 at RWTH Aachen (P. Movilla-Fernandez; Diploma- and PhD thesis), proceeded until ~2003 at MPP.
  - conversion, translation, partly rewriting of Fortran-IV, Mortran, Sheltran, assembler routines
  - complete installation on IBM RS6000 AIX platform using xlf compiler
  - successfully revitalised and validated entire JADE core software:
    - reconstruction software
    - simulation software
    - event display and JADE graphics package (now in colour !)
- generation of full-simulation MC events, using modern MC generators plus the experience from LEP

## Revitalisation of JADE data

- primarily used original ZE4V format data files for new analyses, plus newly generated MC data converted to ZE4V format
- task to convert FPACK generated copies of raw data files back to readable BOS files accomplished in 2005 and 2008 (J. Olsson)
- data (600 GB) now reside on file servers at MPG RZ Garching

## continued analyses of OPAL (LEP) data

- use of NTUPLES (data and MC) generated for QCD studies during running time of OPAL
- JADE data (and new „LEP-like“ MC) converted to same format of NTUPLES → use of identical analysis software for JADE and OPAL data

## Some anecdotes along the line ....

- one important „calibration“ file, containing the recorded luminosities of each run and fill, was stored on a private account and therefore lost when DESY archive was cleaned up.

*Jan Olsson, when cleaning up his office in ~1997, found an old ASCII-printout of the JADE luminosity file.*

*Unfortunately, it was printed on green recycling paper - not suitable for scanning and OCR-ing.*

*A secretary at Aachen re-typed it within 4 weeks. A checksum routine found (and recovered) only 4 typos.*

- an old version of the original BOSlib 1979 version was found, on our request, at the Tokyo computer centre.
- Peter Bock, when cleaning out an old lab at the Physics Institute at Heidelberg University, found a few 9-track tapes containing original JADE MC files which were very valuable for validating results of our first re-analyses in ~1997

## Future prospects

- develop (semi automatic) portability of JADE software to other platforms (Mac OS, Linux/PC)
- studies of topics which involve access to raw data (inclusive lepton production; b-jet and vertex tagging; take advantage of FADC resolution; ....)
- however: question of available manpower (LHC running!)

**exp. HEP data have cost  
a lot of €/\$/£/¥/🍏 !**

**not preserving them for long-time  
and future use  
would be a crime**

**„If the same (loss of data as at PETRA)  
will happen with LEP data,  
I will sue the CERN DG“**

(A well-known theorist after having seen reanalysed JADE results)