DELPHI

DELPHI Status Report

The DELPHI 1997 Data Taking & First Results

Philippe Charpentier
CERN

DELPHI

Modifications during 96-97 shutdown

Detectors

- Completed macro-pixel layers in the Silicon Tracker
- Repaired ID jet chamber
- TPC opened to fix a grid cabling

Online system

- Replacement of all VAX-Stations (VMS) by AXP-Station (VMS)
  - Porting of all online software (Slow-Controls, DAS, Monitoring)
- New control software
  - Full rewriting of the "State Management Interface" (SMI) using OO methodologies
- Replacement of the Fastbus-VMS interface
  - Obsolete CHI-VAX interface (optical fiber) removed
    Use of TCP-IP on Ethernet between a FIP-Booster module and an AXP-Server
- Replacement of the central Timing Controller

1997 running

Data collected

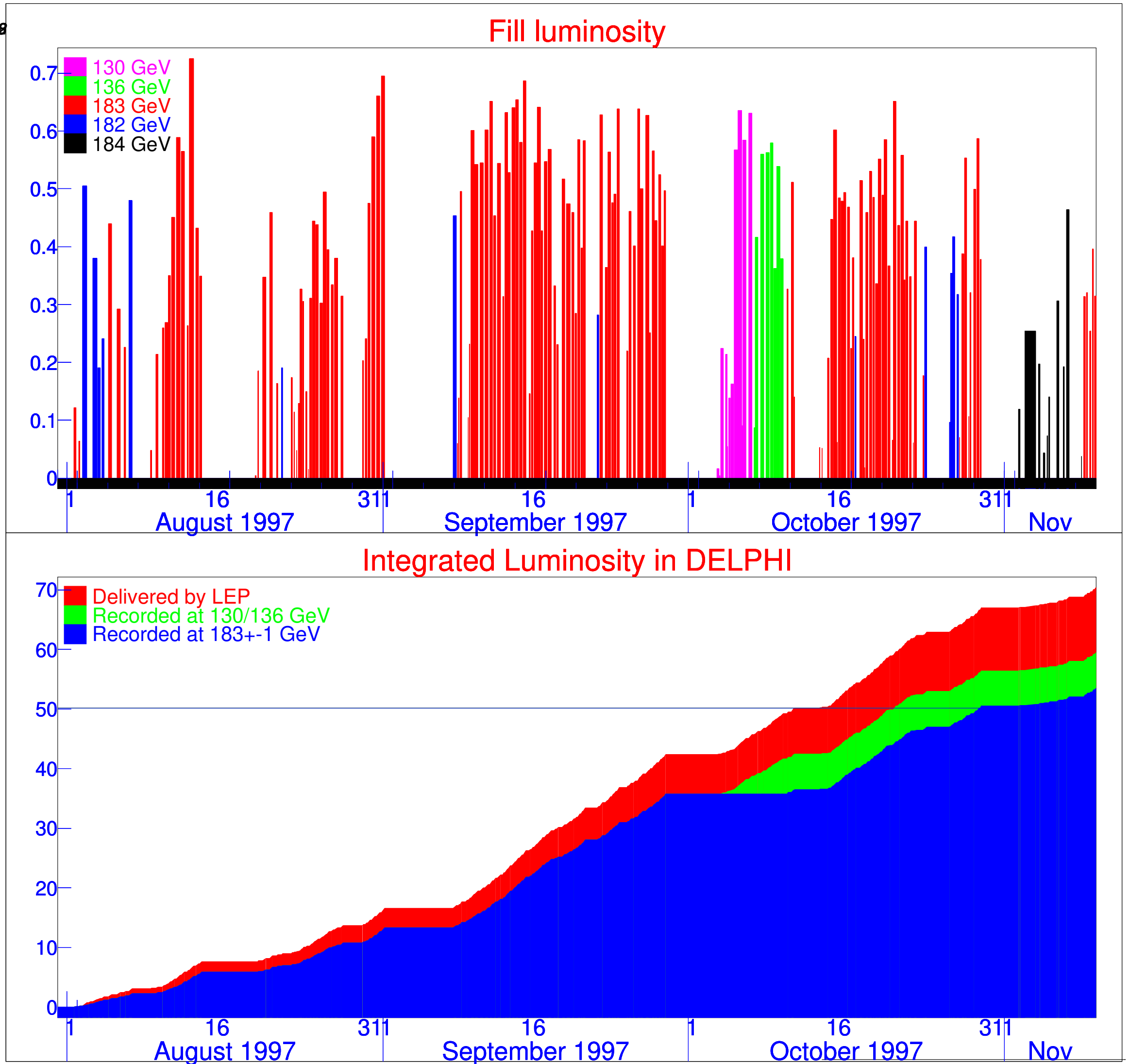
Recorded data :

Z^0 : 1.5 pb^{-1}

183 GeV : 53.5 pb^{-1}

130 GeV : 3.03 pb^{-1}

136 GeV : 2.91 pb^{-1}



1997 Running

Running efficiency

Overall efficiency

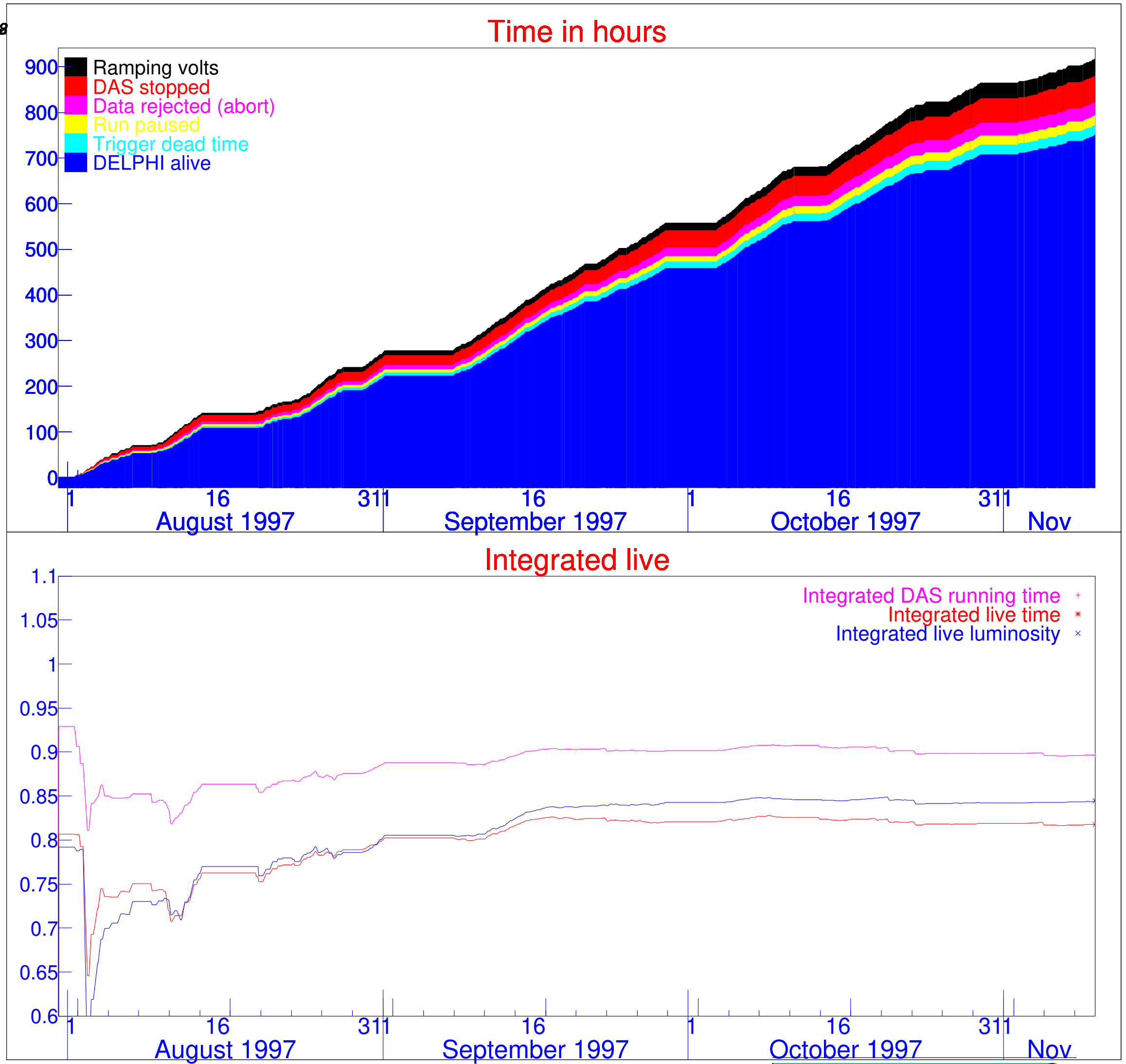
Lumi : 82.6 %

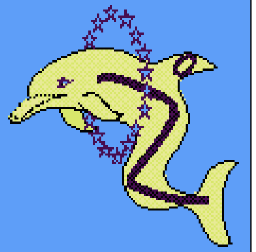
Time : 81.6 %

Losses (in time) :

Start-up fill : 4.3 %
DAS crashed : 6.3 %
Data rejected : 3.2 %
Run paused : 2.3 %

Trigger deadtime : 2.3 %

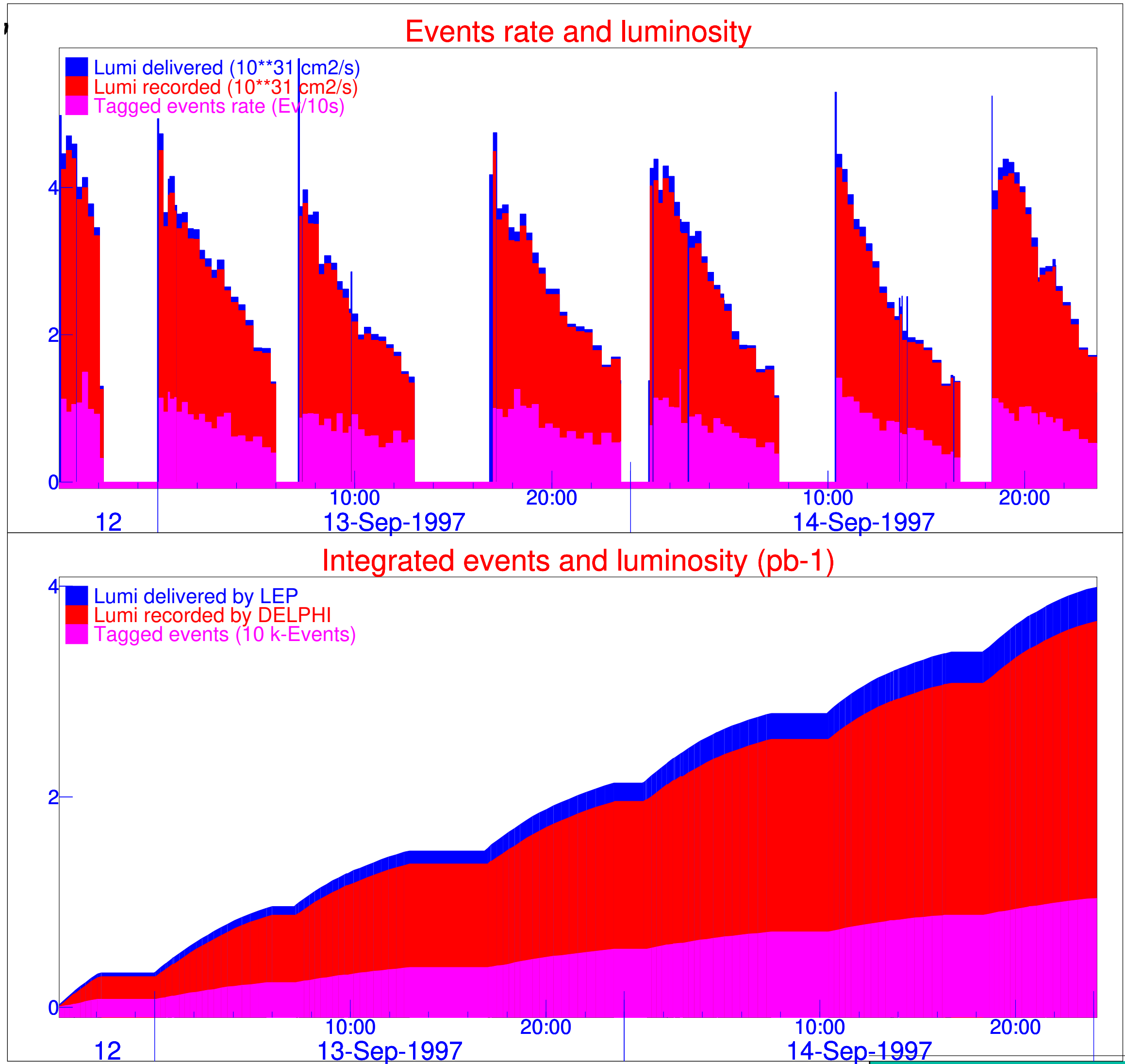




1997 Running

DELPHI running policy

- Ramping volts
  - When LEP declares physics
  - Automated from LEP
- Stopping DAS
  - When detectors trip
  - When too large bckgd
  - Automated from SC
  - When a detector DAS crashes
    Wait for it to recover
- Backspace at error to previous check-point
  - This avoids keeping corrupted data
  - Loss : on average one minute at each crash

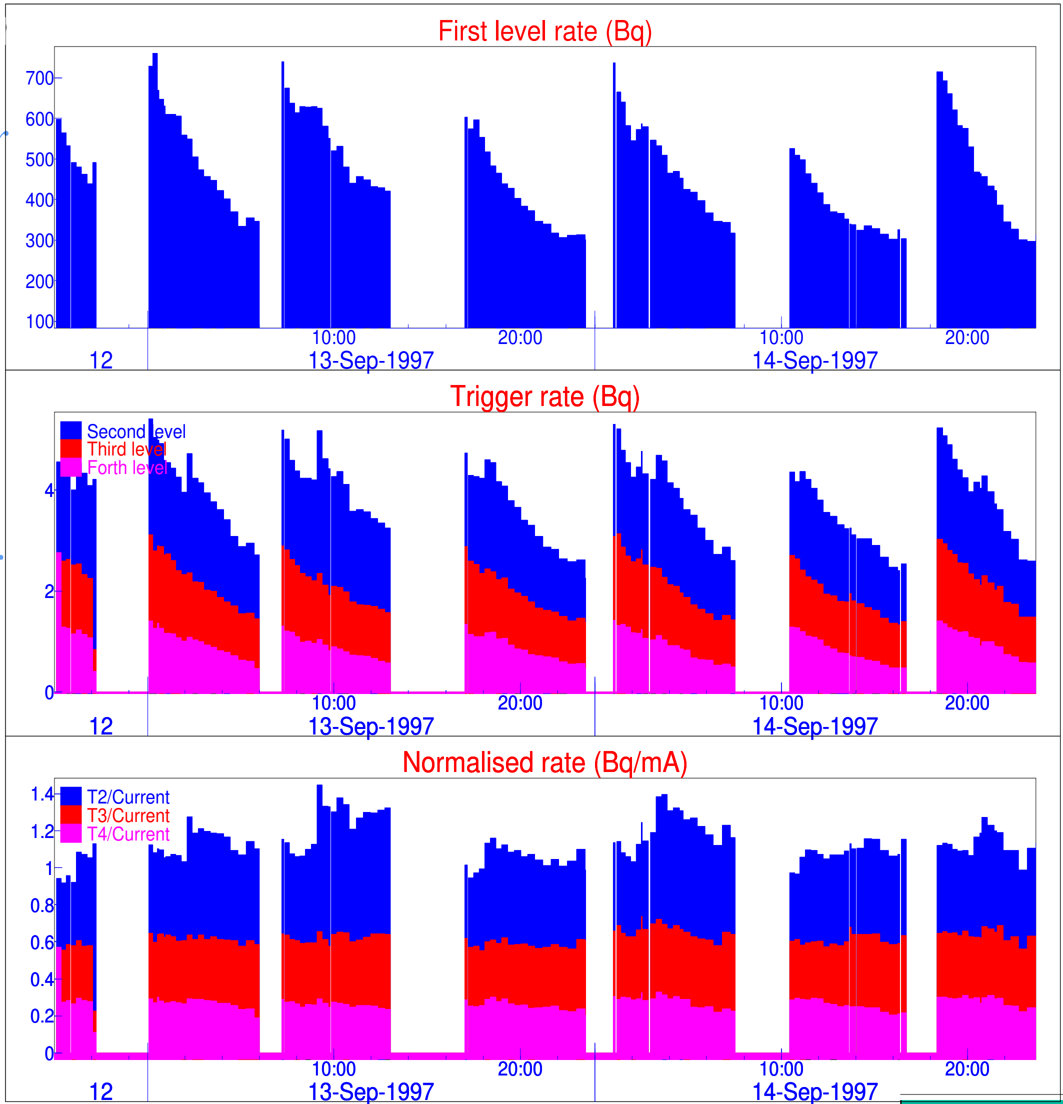


DELPHI

1997 Running

Trigger and deadtime

- *First level trigger*
  - *After 3 μs*
  - *Deadtime : 1 BCO*
- *Second level trigger*
  - *After 38 μs*
  - *Deadtime : 2.5 ms*
- *Third level trigger*
  - *Software algo of T2*
  - *About 50 ms*
  - *No deadtime*
- *Fourth level trigger*
  - *Full DELANA recons.*
  - *Rejecting empty events*
  - *No deadtime*



DELPHI

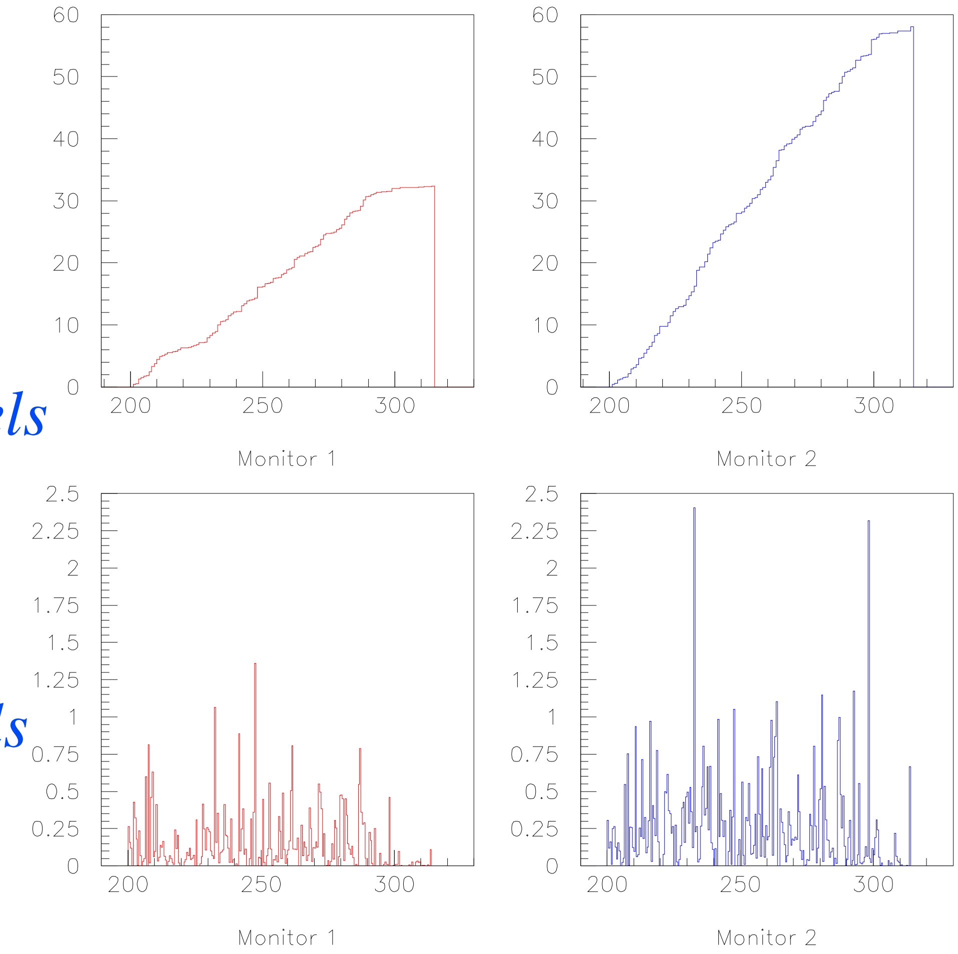
1997 running

Some of the problems...

- FCB : 6 out of 24 half-planes on one side could not stand HV
  - Set a gradient of voltage to recover tracking efficiency
  - Adapt the trigger logic to recover trigger efficiency
- MUF : efficiency drop
  - Since end of august : efficiency drop from 95% to 70% on all chambers
  - Many tests performed, but very difficult problem
    - Presence of an electronegative component in the gas, inducing absorption
    - Not clear yet which primary component, likely to be alcohol
- General failures
  - Front-end electronics (ageing...)
  - Fastbus processors (FIPs)
  - Fastbus power supplies and fan units (no increase w.r.t. 1996)
  - HV power supplies (TPC, TOF...)

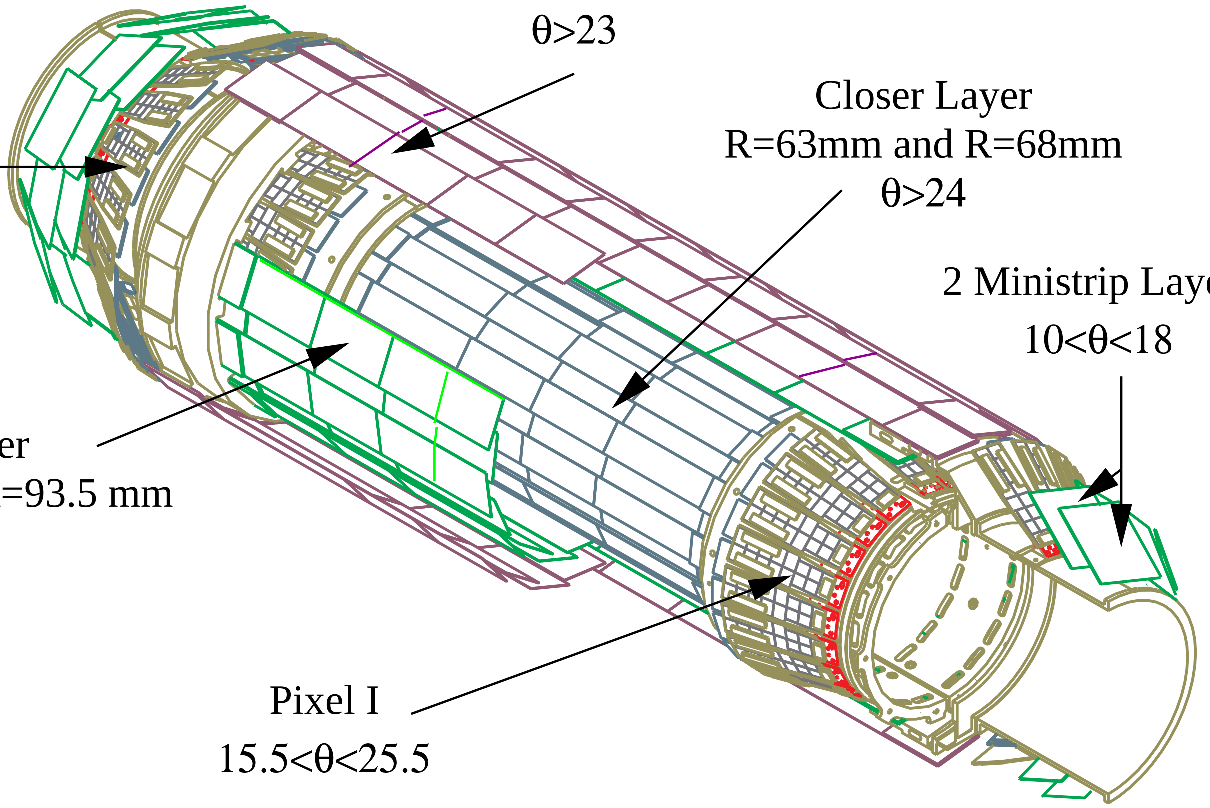
Radiation background

- DELPHI dumped the beam once (25/10 at 5:40)
- Some damage to pixels during fill 4410
- Integrated dose : 60 rad, but... *10 more at the pixels (max. 5 krad)



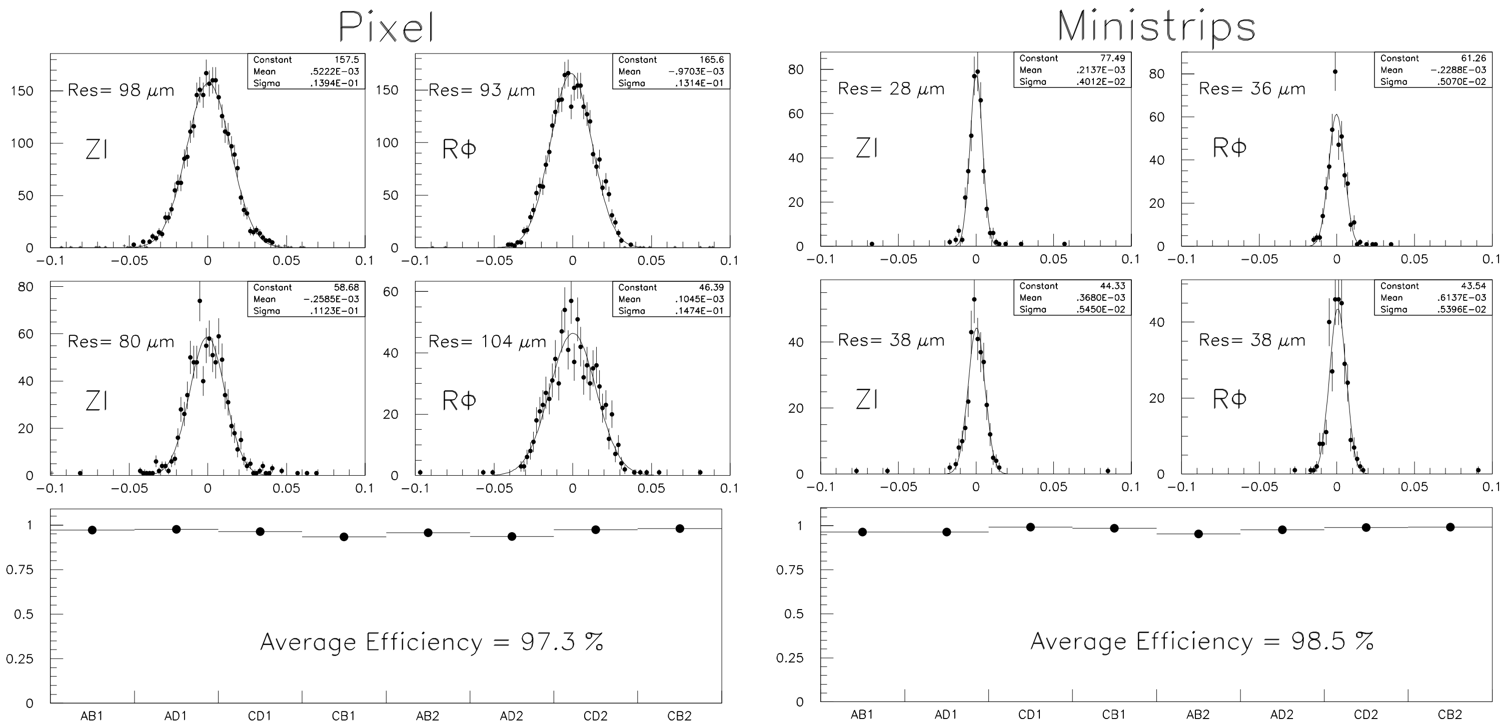
The DELPHI Silicon Tracker

- *Longer barrel (b tagging to 25 deg.)*
  Tracking to 15 deg.
  Hermetic to 10 deg.



VFT resolution

- Computed using overlap regions
- Comparable with test beam results
- Macro-pixels : 80 to 100 µm (expected 70 to 95 µm)
- Mini-Strips : 28 to 38 µm (expected 20 to 30 µm)



DELPHI

DELPHI Physics results in '97

Final results of LEP1, first results of LEP2

- Full reprocessing of LEP1 data
  - New tracking, better calibrations and alignements
  - 1994 and 1995 completed
  - 1992 and 1993 in progress

- Physics papers at Jerusalem

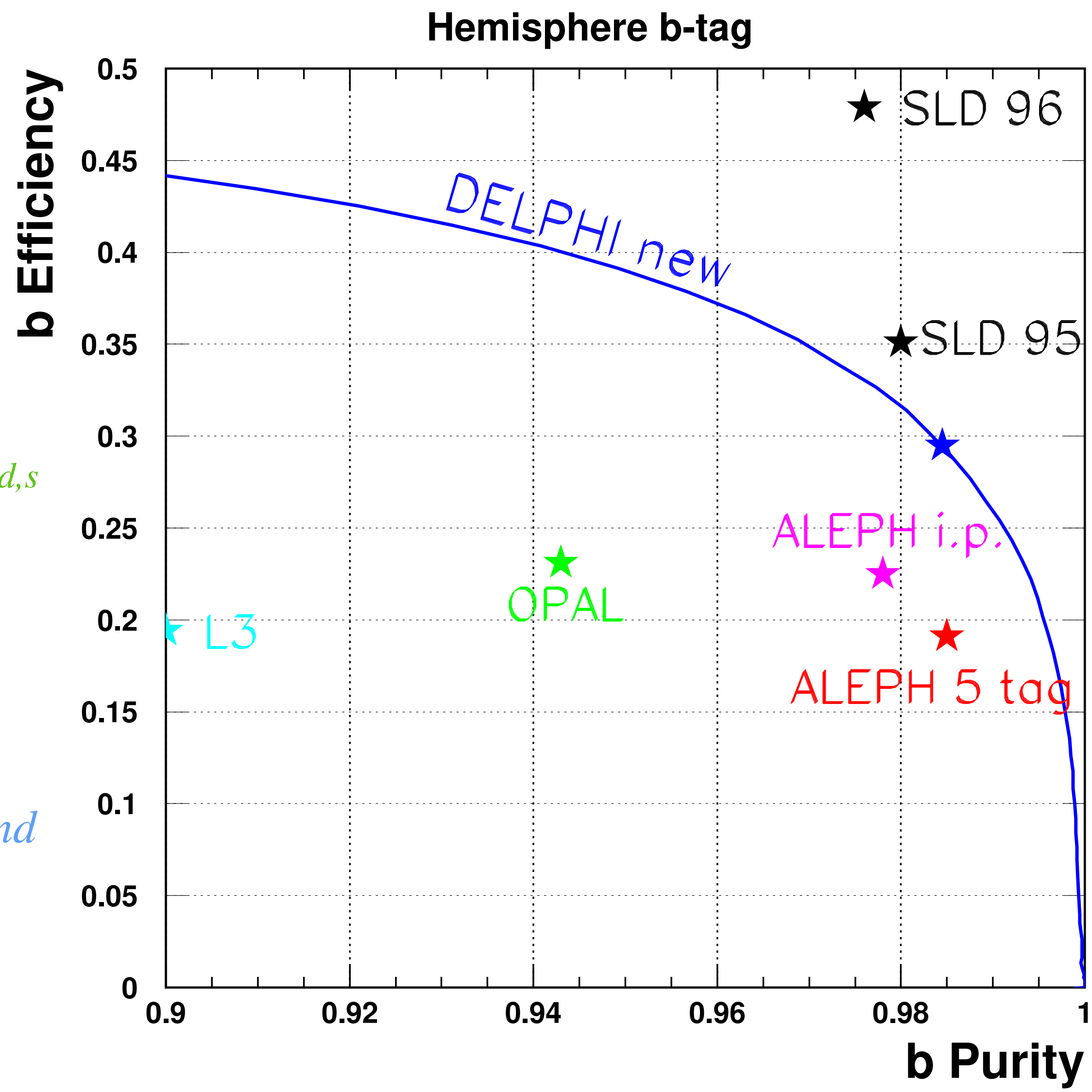
Topic	LEP 1	LEP2
Searches		13
W physics		7
ff production	6	6
$\gamma\gamma$ physics		2
QCD	14	2
b/c physics	13	
τ physics	7	
Silicon Tracker		1
Total	**40**	**31**

DELPHI

b tagging performance

- *Impact parameter + secondary vertices*
  - *Hemisphere probability*
- *Secondary vertex mass*
  - *Higher mass for B*
- *Secondary vertex track rapidity*
  - *Rapidy intermediate between u,d,s and c quarks*
- *Secondary vertex charged energy*
  - *Higher for B's*

- *Best use of our 3 layers, and of RΦ and z informations*



DELPHI

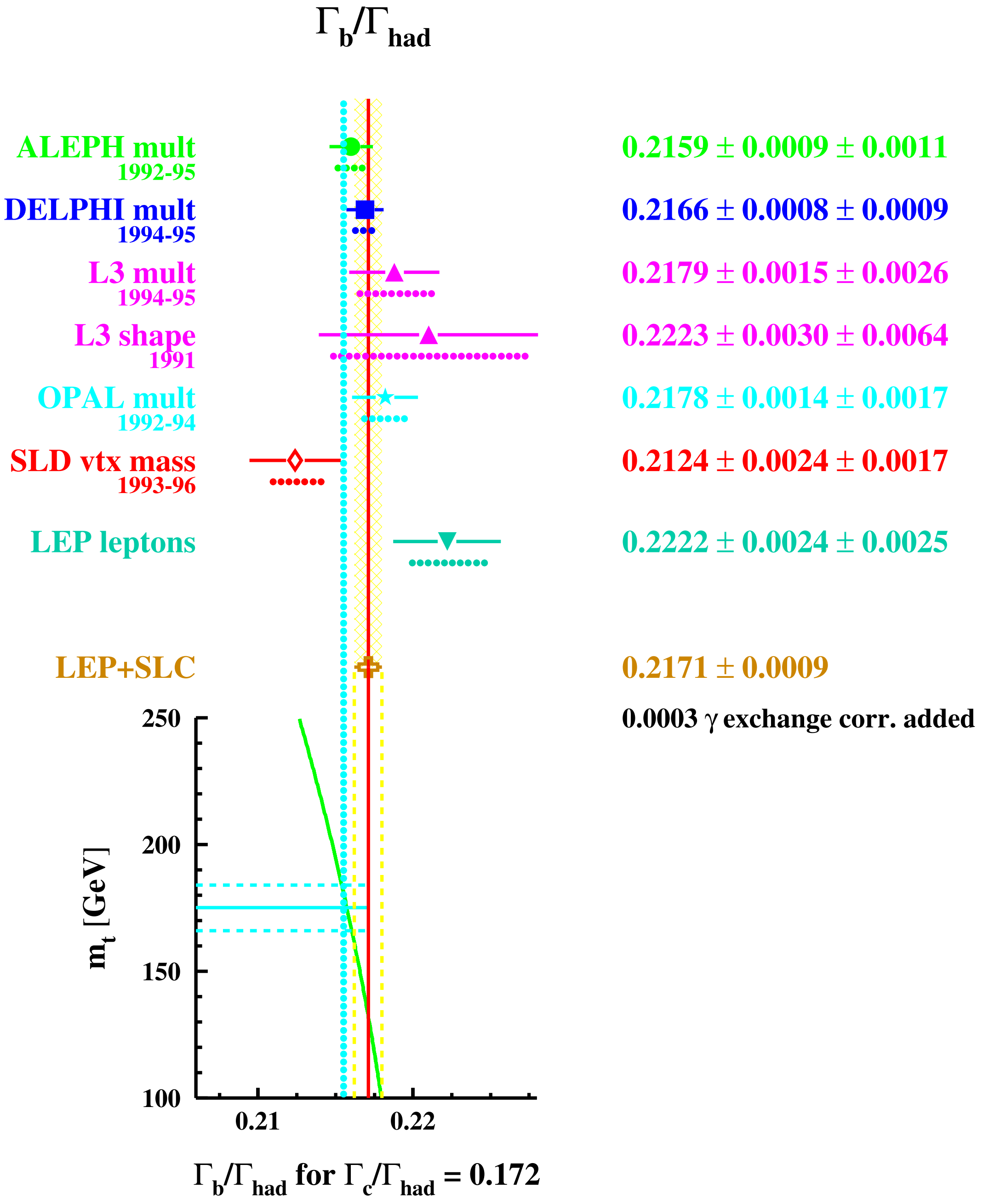
LEP1 Physics result in '97

R_b measurement

- Use multivariate analysis
  - Define 6 categories for each hemisphere (tight b / standard b / loose b / c / u,d,s)
  - 21 categories of events, hence 20 observables
    14 unknowns (R_b and 13 efficiencies)
  - Correlations, efficiencies for c and u,d,s (tight tag) from MC
- Verify stability or R_b vs B-tagging cut
- Chose optimum cut (98% purity, 32% efficiency)
- Using data from 1994-95 :

$$R_b = 0.21660 \pm 0.00082 \pm 0.00088$$

R_b result (data from 1994-95)



DELPHI

183 GeV preliminary results

Cross-sections and asymmetries

- Standard hadronic and leptonic selections
  Two cuts as a function of the reduced energy s' :
  - Total cross-section ($s'/s > 10\%$)
  - Non radiative cross-section ($s'/s > 85\%$)
- Luminosity : 50.5 pb^{-1} analysed

Hadronic cross-section

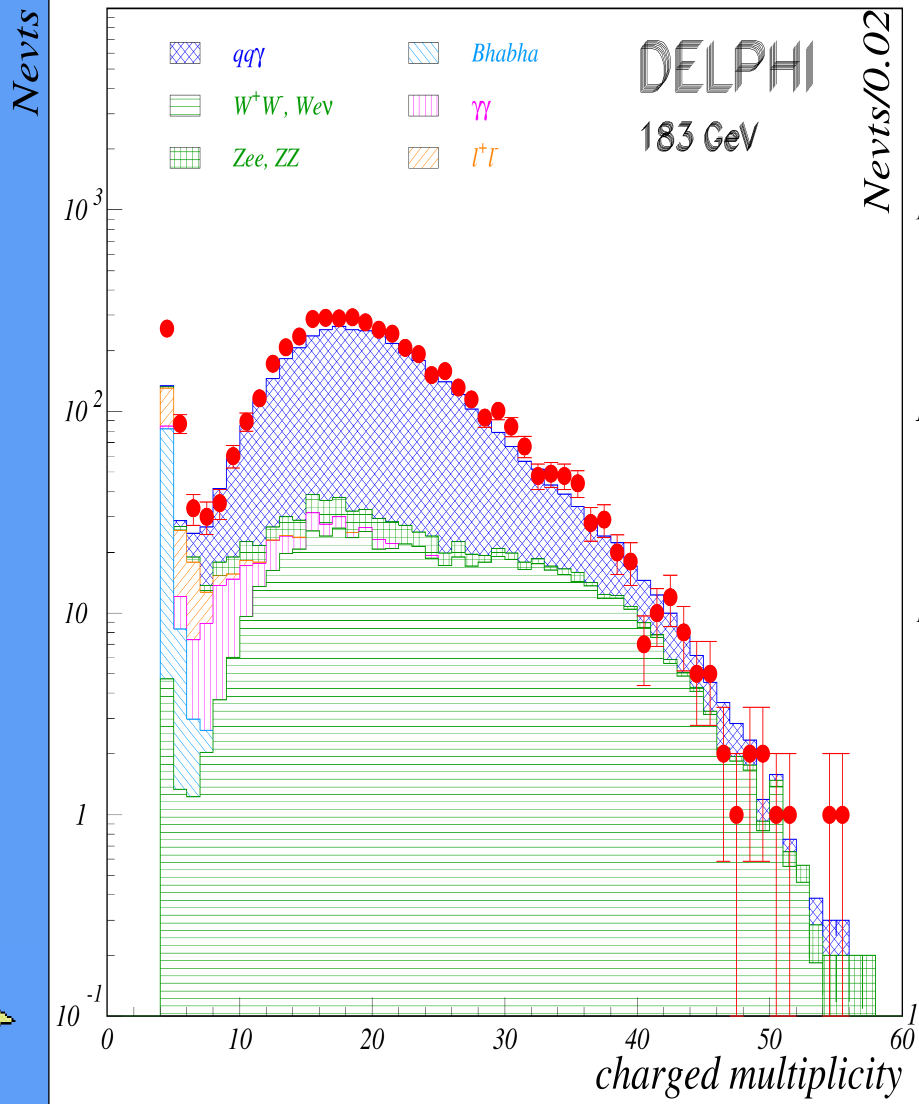
- 78.4 ± 1.2 % signal efficiency from MC (PYTHIA)
- Background :
  - WW pairs : 13.6 ± 0.5 pb
  - $\gamma\gamma$ collisions : 2.5 ± 0.5 pb
  - ZZ pairs and Ze^+e^- : 2.7 ± 0.3 pb
  - Others : 0.5 ± 0.1 pb
- Compare the results with ZFITTER predictions

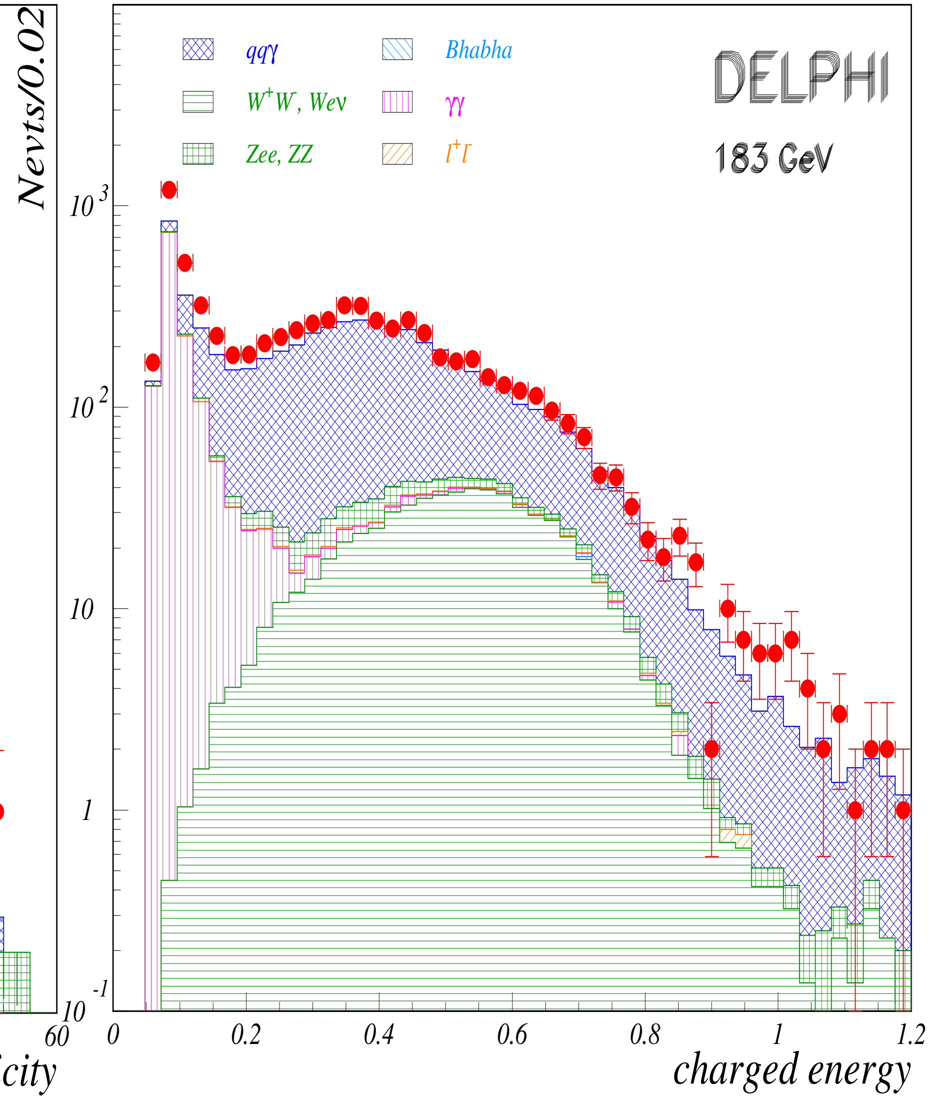
DELPHI

Hadronic cross-section

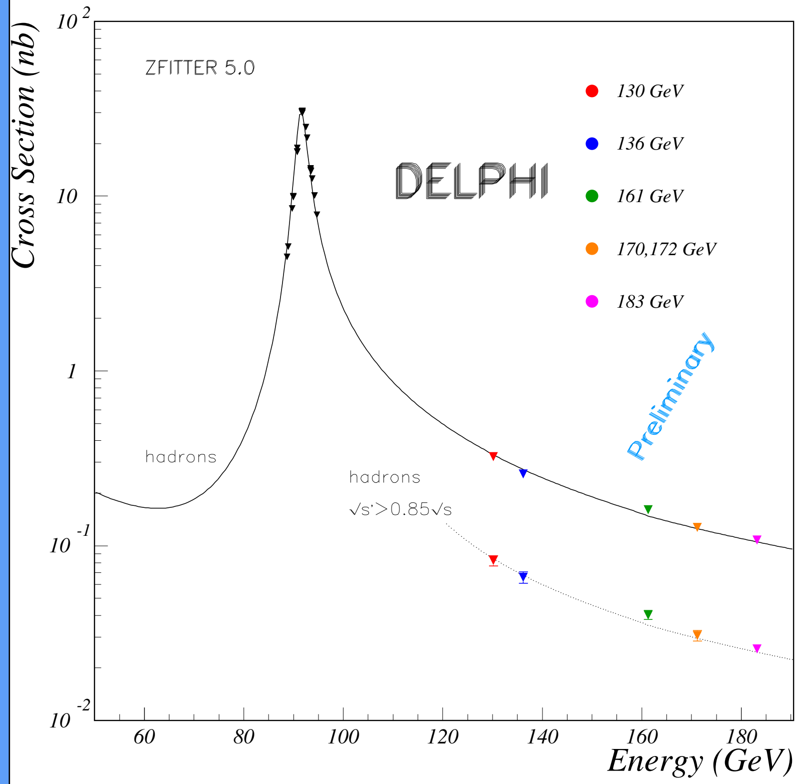
❈ Data-MC comparison

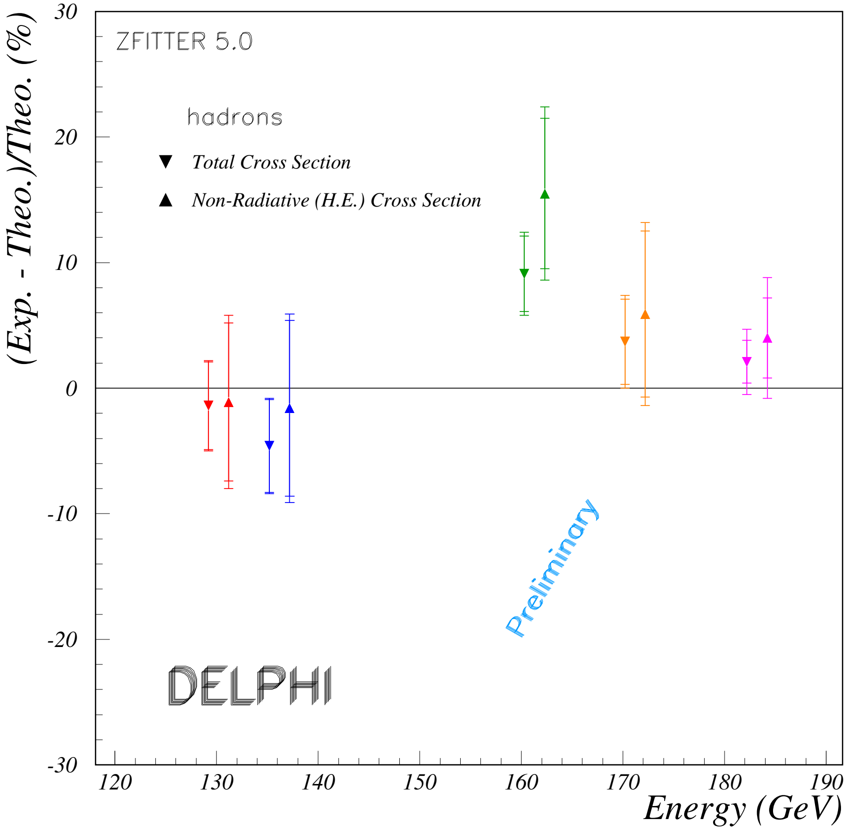
♦ Monte-Carlo : PYTHIA rescaled to the ZFITTER cross-section



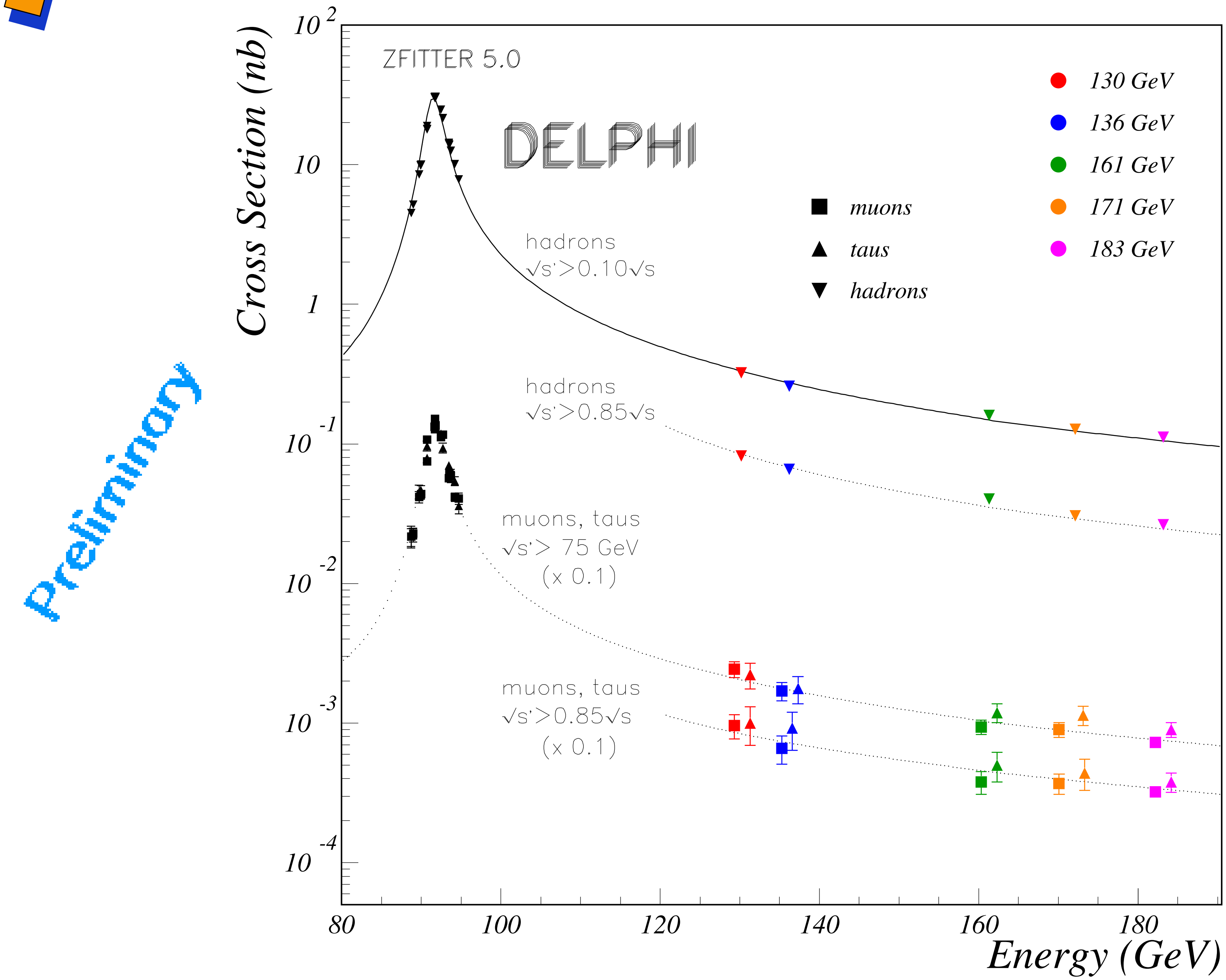


Hadronic cross-section (cont'd)

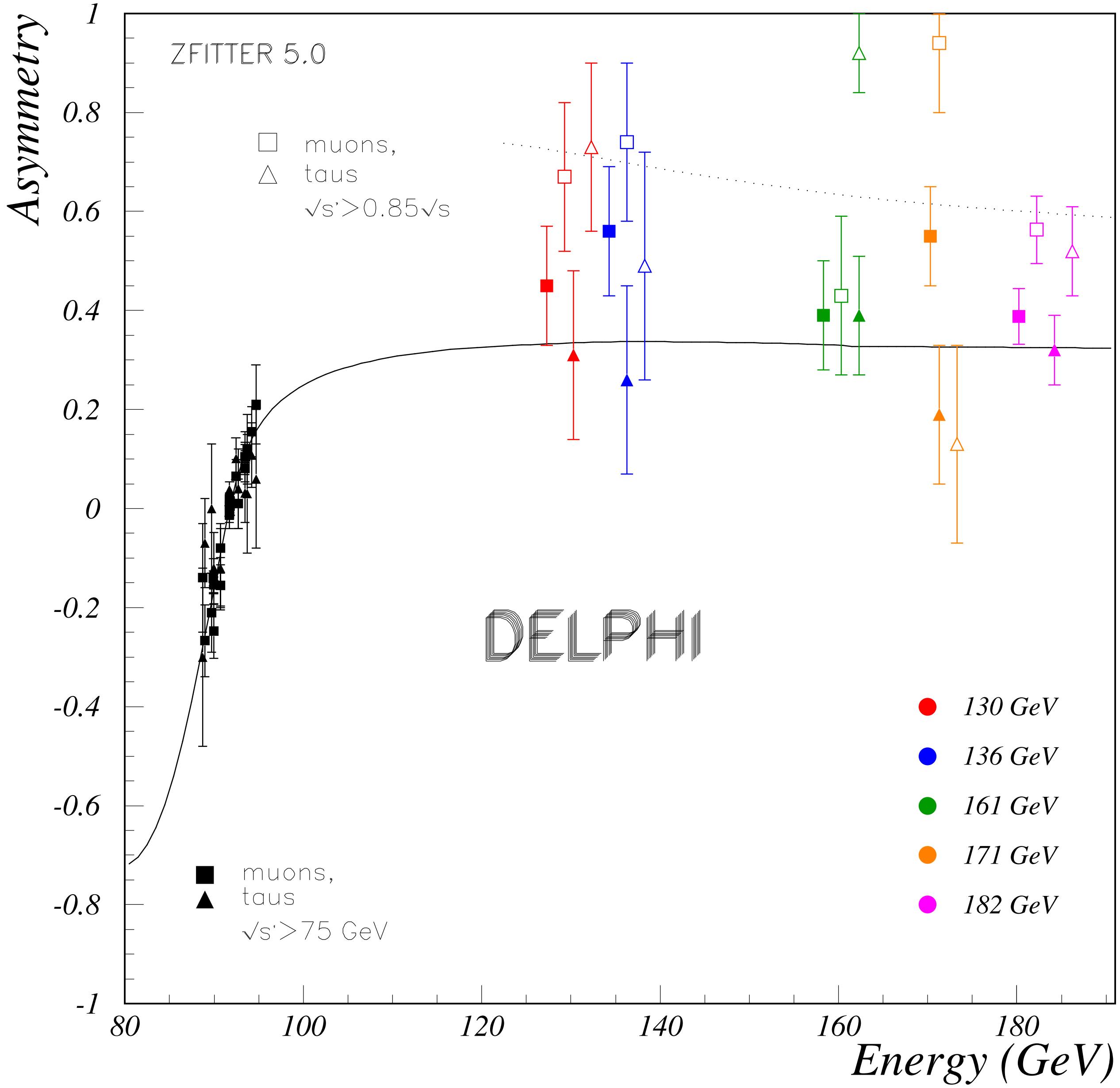




Leptonic cross-section



Leptonic asymmetries



Preliminary

DELPHI

W pair production at 183 GeV

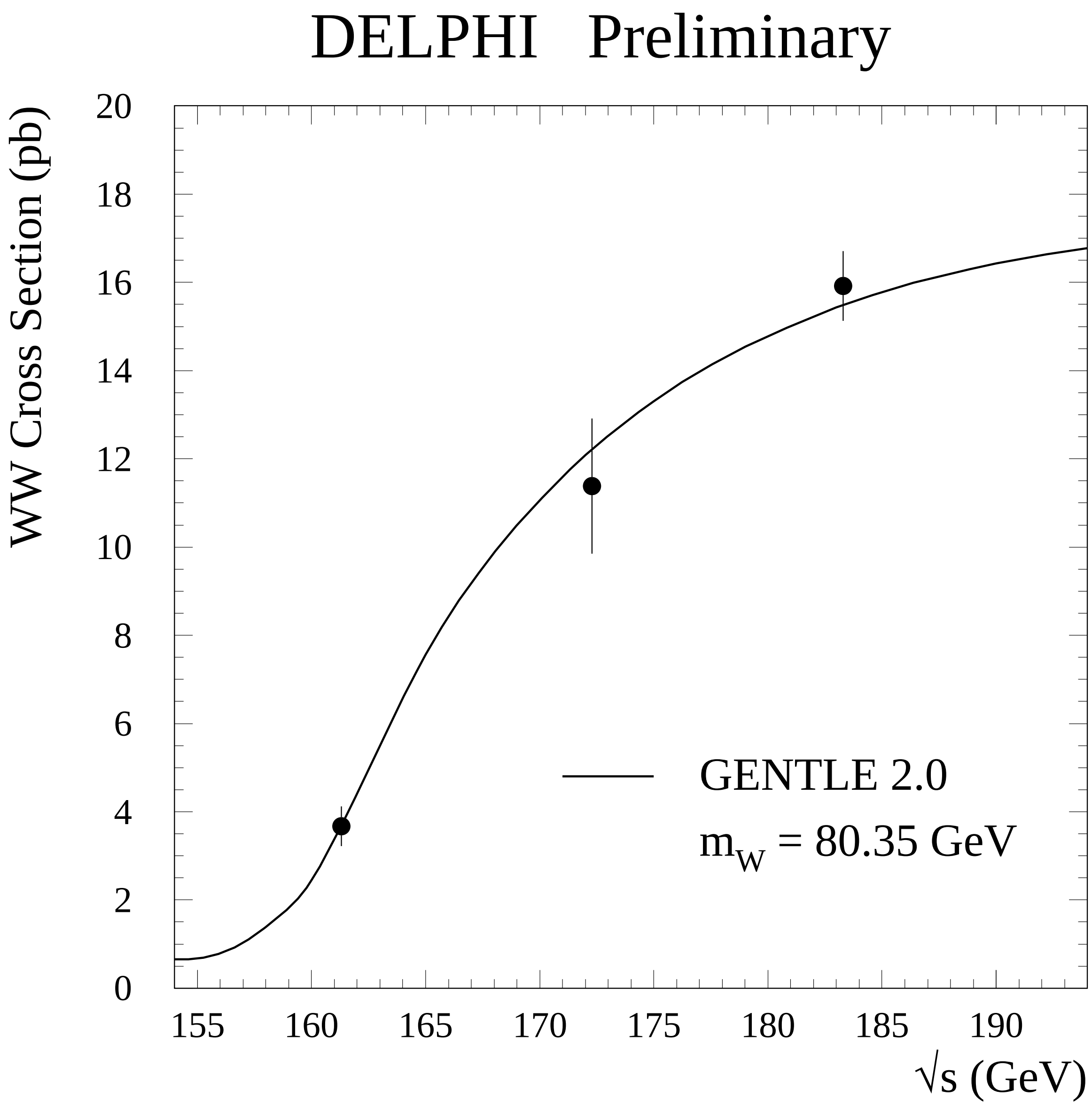
Production cross section

- **Decay modes used :**
  - *Fully hadronic : 4 jets*
  - *One leptonic decay : 2 jets and a lepton (missing energy)*
  - *Fully leptonic : 2 leptons (missing energy)*
- **Luminosity analysed : 50.7 pb^{-1}**

Decay modes	Efficiency (%)	Background (pb)	Number of events
qq qq	80.8 ± 0.3	1.84 ± 0.05	386
qq $l\nu$	70.1 ± 0.4	0.50 ± 0.03	274
$l\nu\ l'\nu$	48.5 ± 1.3	0.21 ± 0.05	54

Preliminary

W pair cross-section (cont'd)

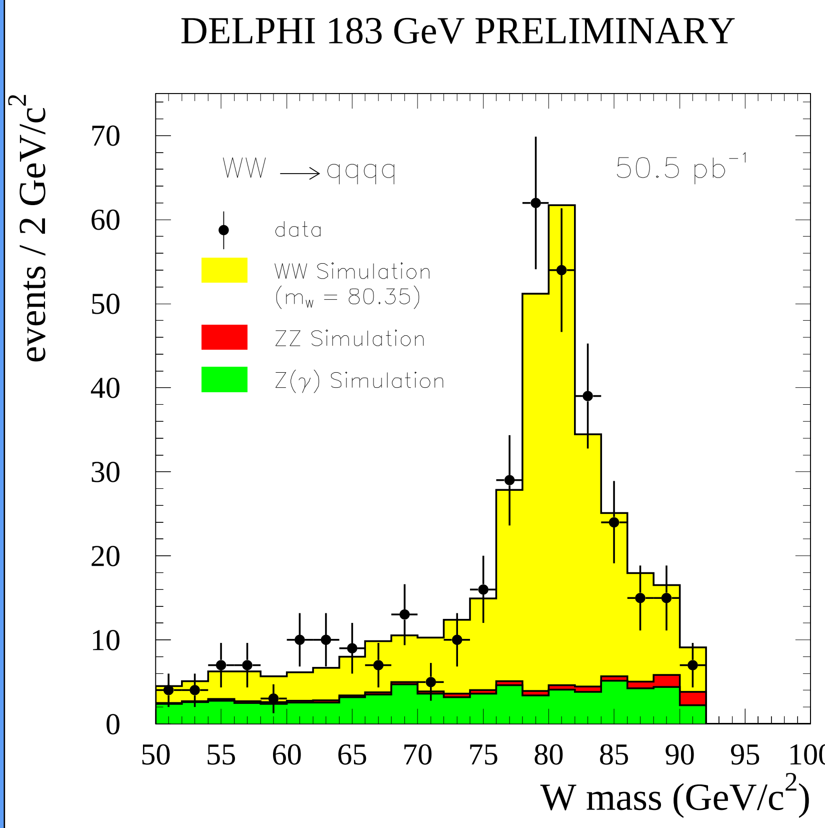


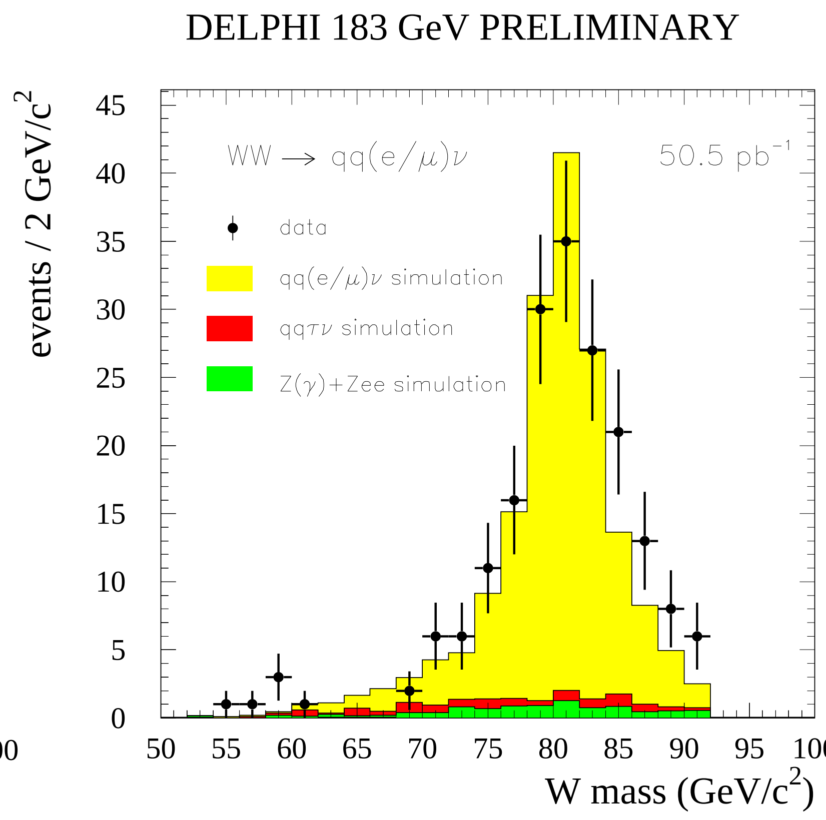
Preliminary

W mass

Kinematical constained fit

- *Impose equal masses for both W's*
- *MC is for a W mass of 80.35 GeV/c^2*





DELPHI

Triple Gauge Couplings

- *Preliminary results with only the semi-leptonic channel*
  - *No estimate of systematic error yet*
  - $\alpha_{W\Phi} = 0.09 \pm 0.13$
  - $\alpha_{W} = -0.07 \pm 0.22$
    - *To be compared with previous values (all high energy, all channels) :*
    - $\alpha_{W\Phi} = 0.24 \pm 0.27$
    - $\alpha_{W} = 0.11 \pm 0.49$

DELPHI

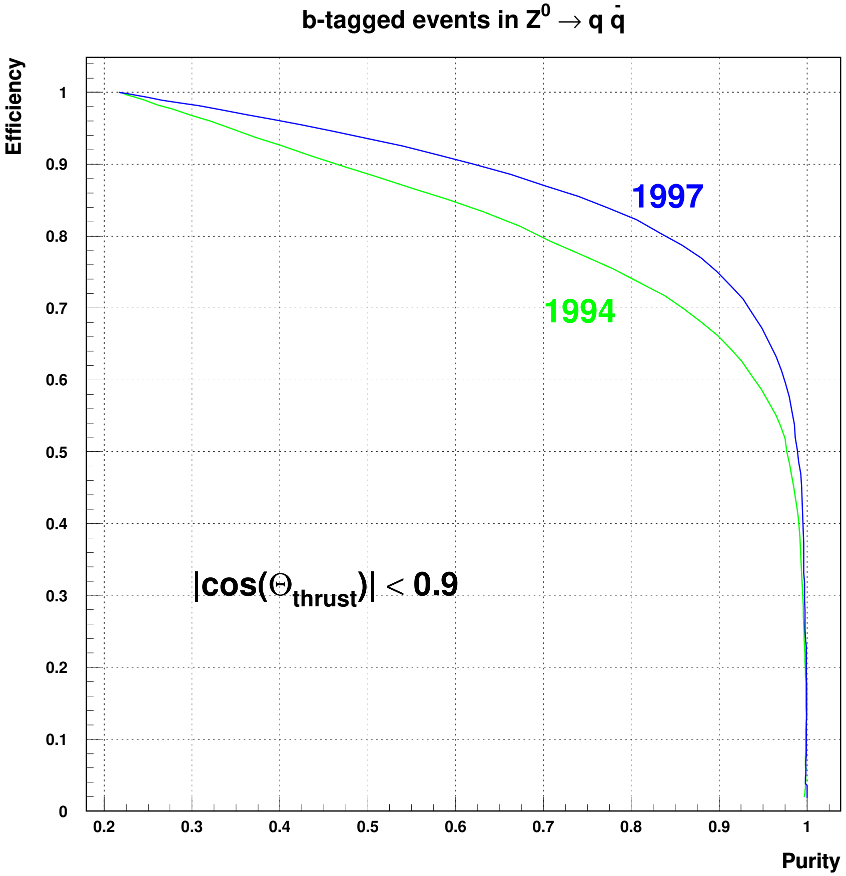
Searches at 183 GeV

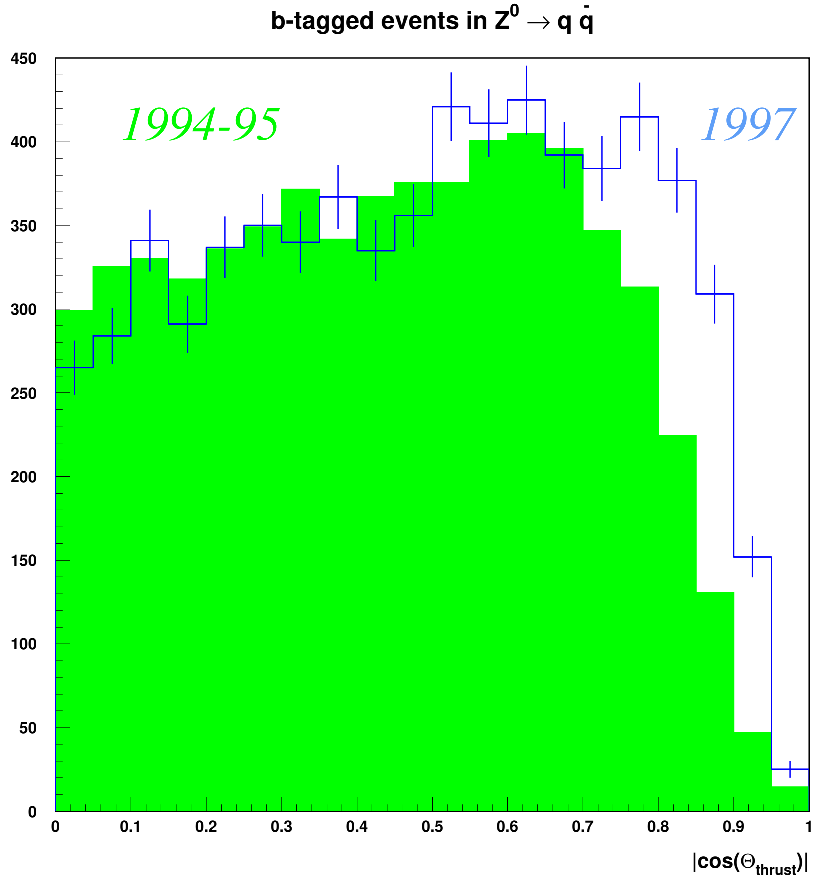
Higgs searches

- **Production mechanisms**
  - $e^+e^- \rightarrow HZ$ $\qquad$ $e^+e^- \rightarrow hA$ $\qquad$ (in MSSM)
- **Decay of the Higgs**
  - $H,h,A \rightarrow b\bar{b}$
    - 2 jets mode
    - b tagging essential to reject background (WW, $Z\gamma^*$)
  - $H,h,A \rightarrow \tau^+\tau^-$
- **Decay of the Z**
  - Hadronic : 4 jets events
  - Charged leptons : 2 jets and 2 identified leptons
  - Neutrinos : 2 jets and missing energy
- **Irreducible background**
  - ZZ for $M_{higgs} \cong M_Z$
  - Only excess of b decays can sign a Higgs boson...

b-tagging in '97

- *Improved compared to '94 (longer VD)*
- *As good as before in the overlap region*





DELPHI

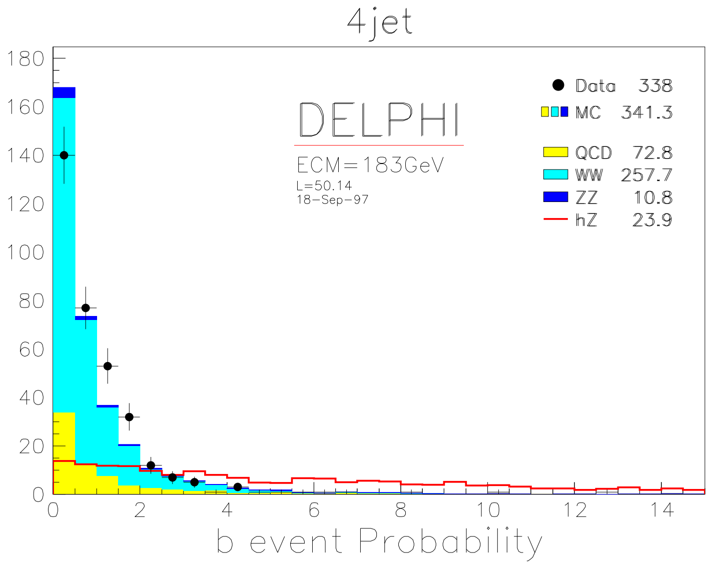
Higgs search selections (HZ channels)

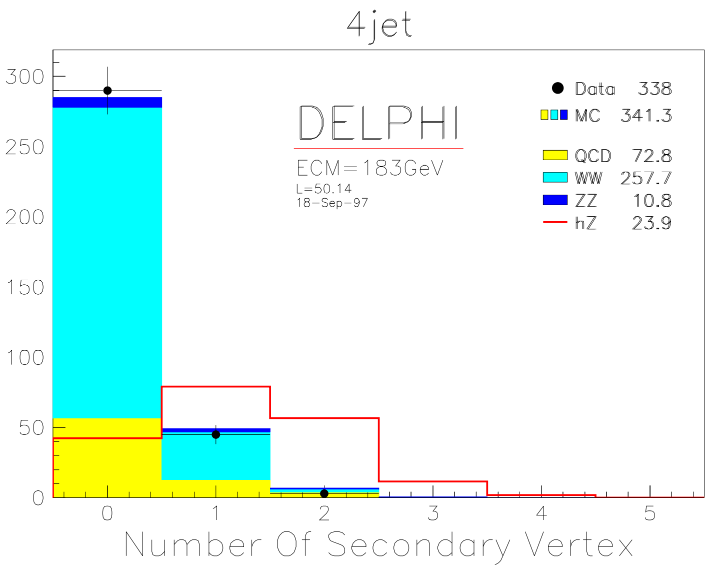
- Main backgrounds : QCD, WW (for 4 jets), $Z\gamma^*$ and ZZ
- Event topology selection
  - jets, lepton identification (with isolation criteria)
- Rejecting QCD
  - Jet energy - angle cuts + dijet mass cuts
- Rejecting WW (4 jets)
  - b-tagging (after jet pairing in the hZ hypothesis)
- Rejecting ZZ, $Z\gamma^*$
  - b-tagging
- Optimizing the cuts
  - Use the N_{95} criterion for this preliminary analysis
  - Use likelihood ratio method for mass limits

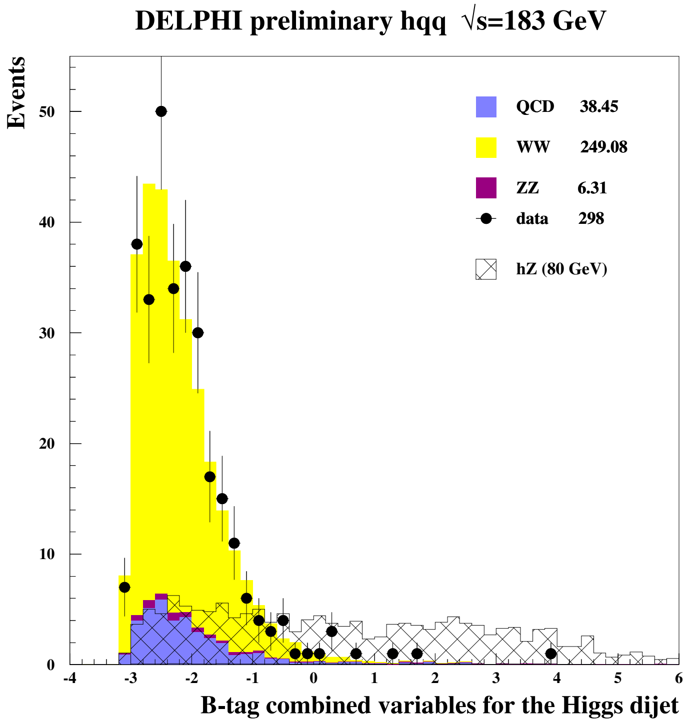
DELPHI

Example of the HZ - 4 jets analysis

❅ Final cut : b-tagging

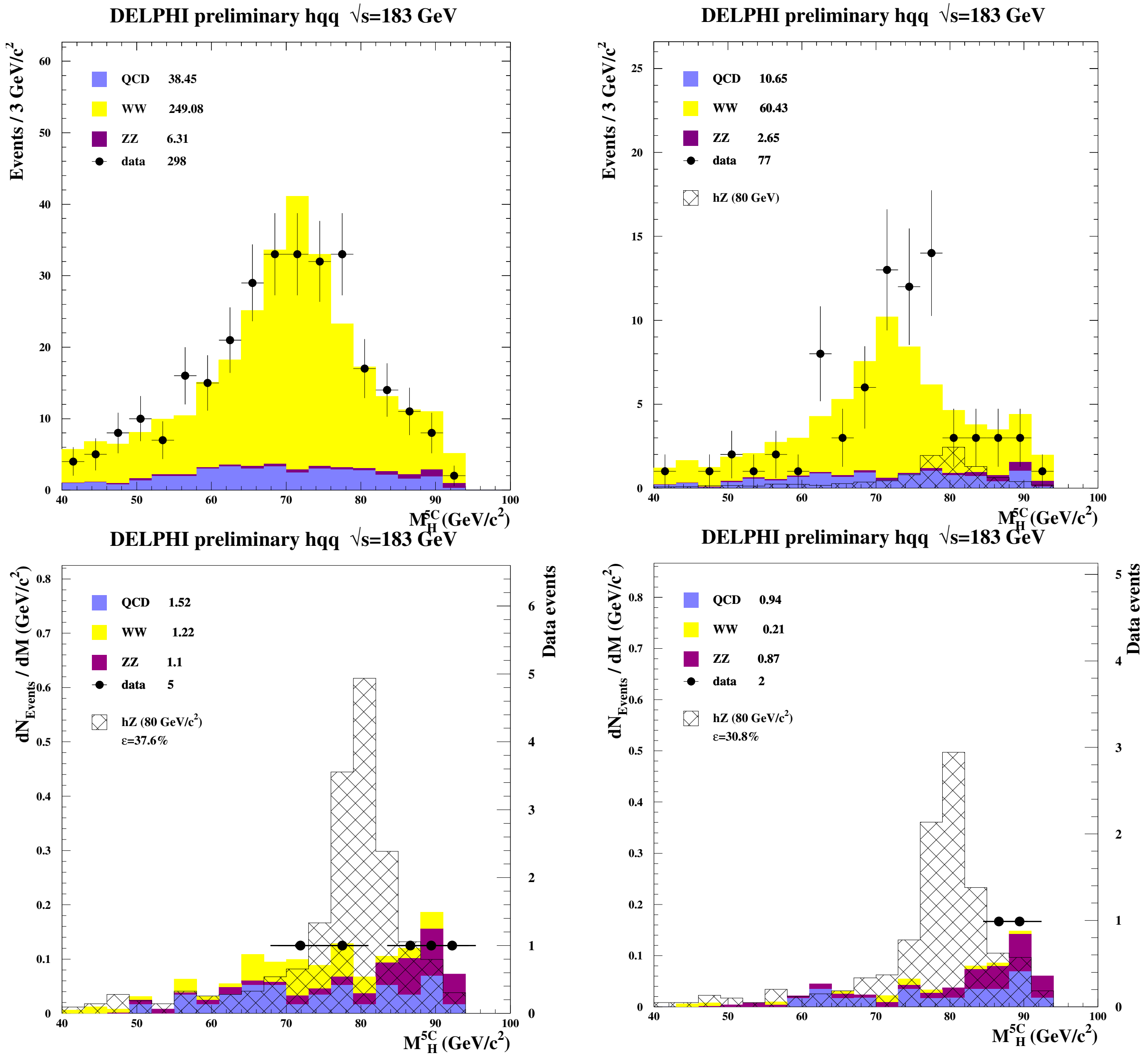






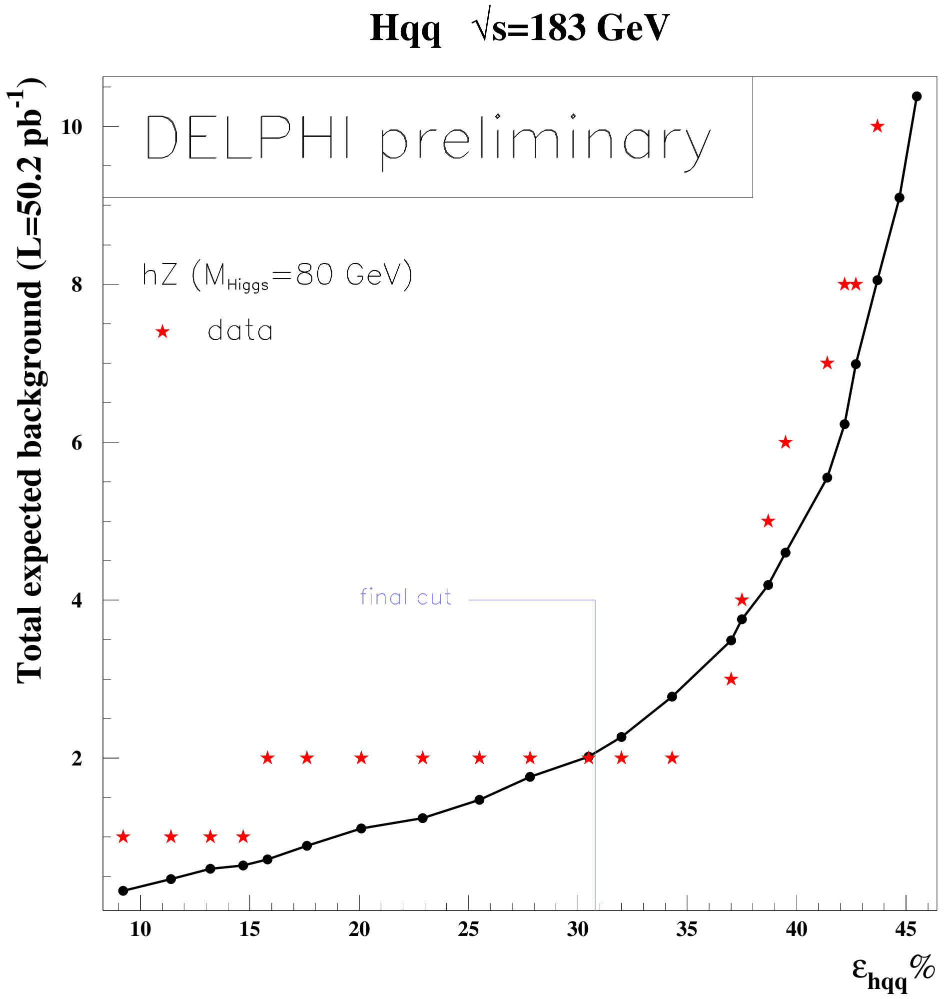
HZ in 4 jets : final cut on b-tagging

- *Check Data-MC agreement varying the cut*



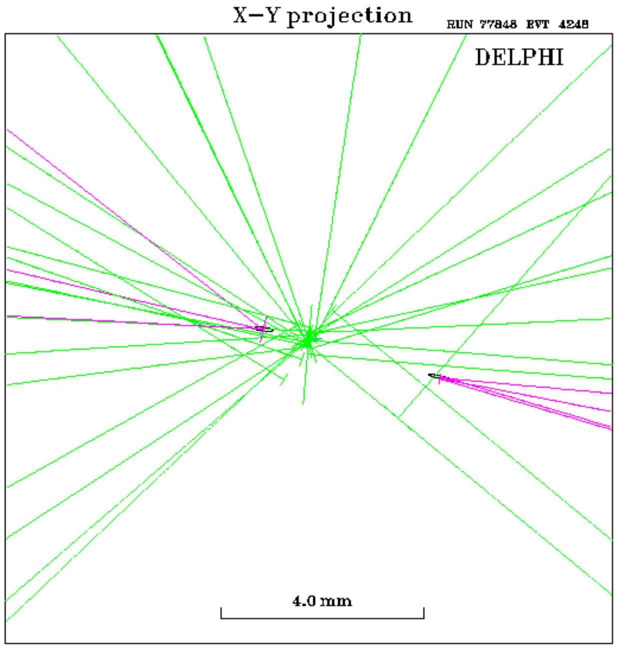
HZ in 4 jets : preliminary results

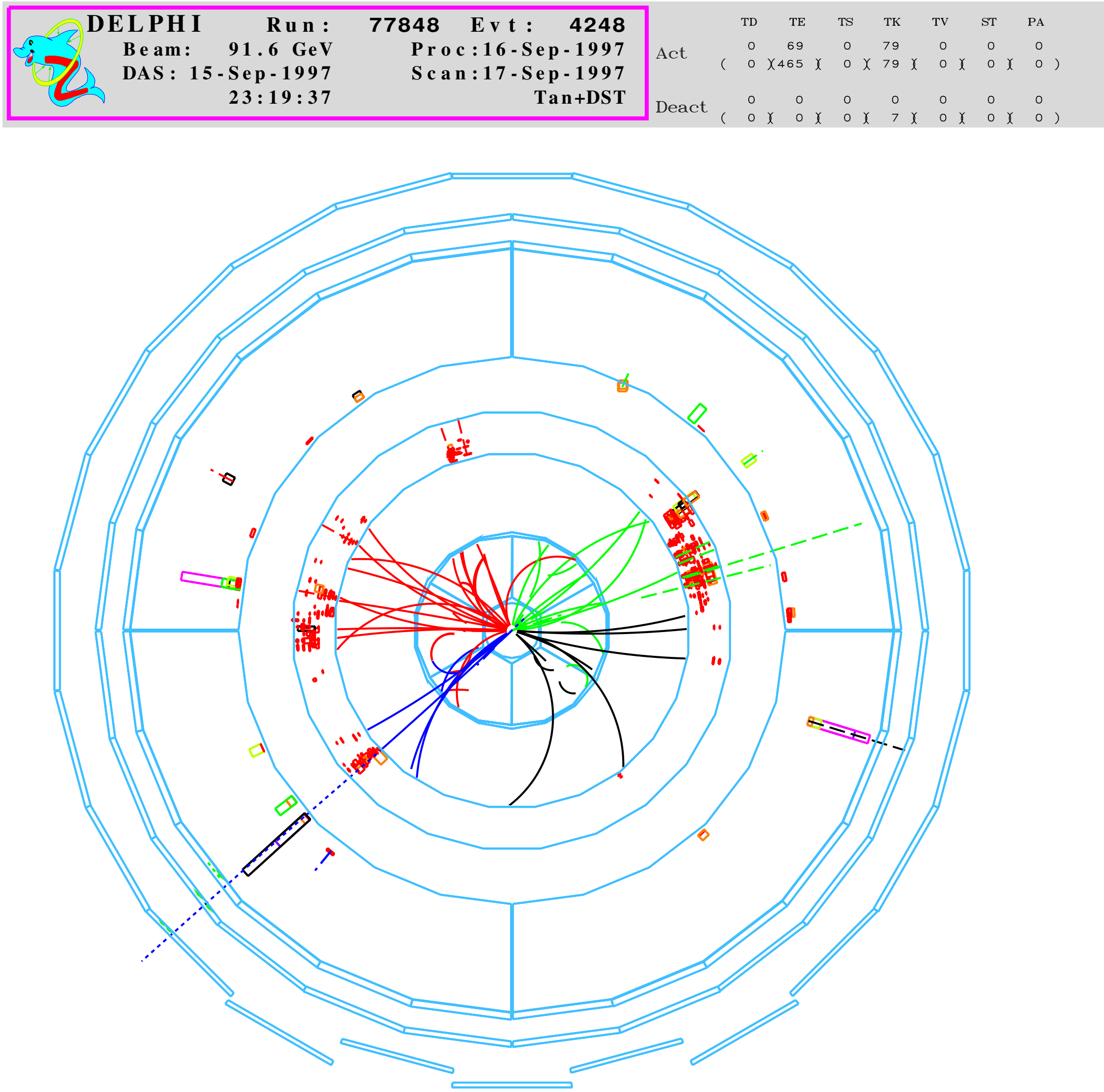
- ***Efficiency :***
  - *30.8 ± 1.2 % at 80 GeV*
- ***Background :***
  - *2.04 ± 0.24 (QCD, ZZ)*
- ***Data :***
  - *2 events selected*



One of the 4-jet selected events

- Very clean event
- 2 jets with secondary vertex
- $M_{sec.vert.} = 4.4$ and 1.5 GeV
- $M_{jj} = 89\ GeV/c^2$





DELPHI

Summary of Higgs search :

- Hqq, $H\mu\mu$, Hee, $qq\tau\tau$: sequential analysis
- $H\nu\nu$: nonlinear discriminant analysis
  - Very preliminary, still tuning the analysis
- Results with optimised cuts (Efficiencies below are for M_h = 80 GeV)
  - The cuts are provisional and subject to changes...

Preliminary

Channel	QCD (qq ng)	WW Wlν	ZZ Zll	Background (total)	Efficiency (%)	Number of events
Hqq	.94 ± .22	.22 ± .07	.87 ± .07	2.04 ± .24	30.8 ± 1.2	2
Hνν	.49 ± .12	.07 ± .02	.30 ± .07	0.86 ± .14	31.2 ± 1.6	2
Hμμ	0	0.16	0.62	0.78	70.3	1
Hee	0.1 ± 0.1	0.37 ± .13	0.82 ± .10	1.29 ± 0.19	46.7	1
Hττ ττZ	-	-	-	0.19 ± 0.05 0.44 ± 0.07	15.2 ± 0.8 15.4 ± 0.8	0 0

- Limit in the Standard Model (95% CL) : 83.6 GeV

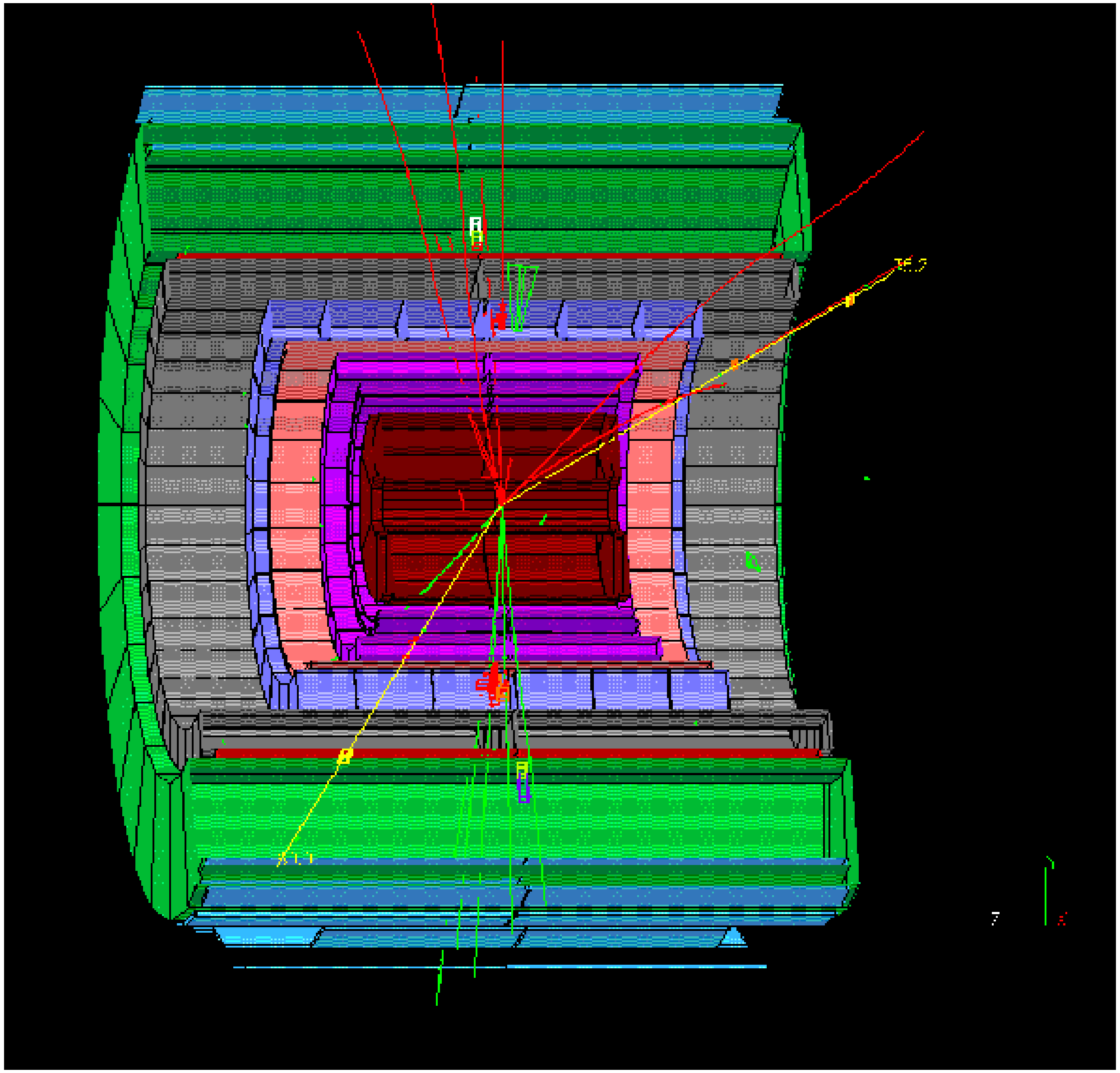
DELPHI

The selected Hμμ event

$M_{\mu\mu} = 89.3$ GeV

$M_{jj} = 83.2$ GeV

No secondary vertices
Tracks with offsets



Higgs search in the hA channel

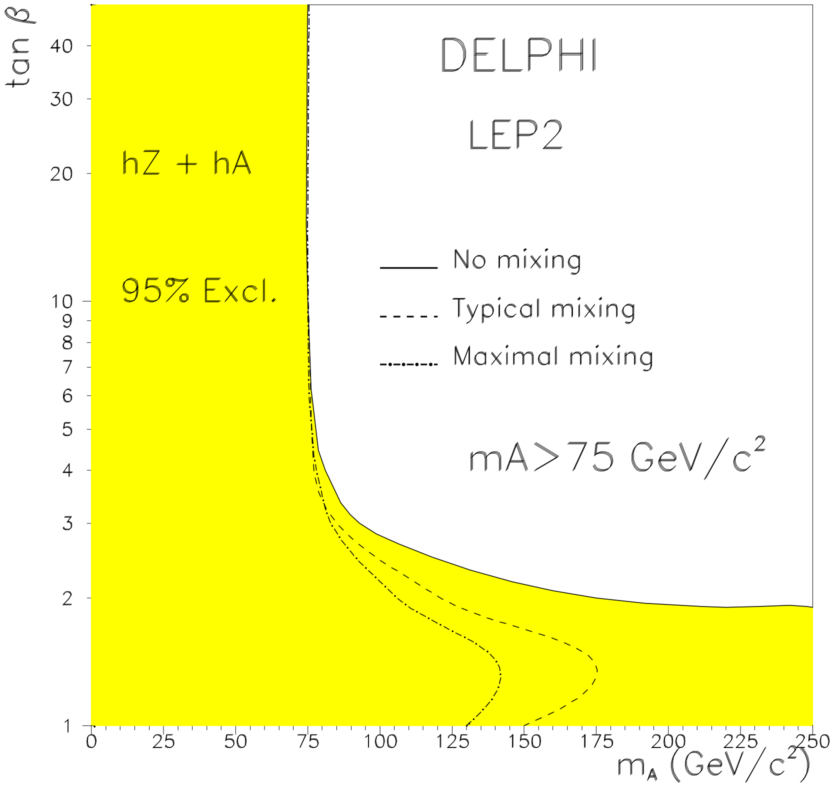
- 4 jets with b-tagging
  - Efficiency : 50 ± 1 % at M_A = 70 GeV
  - Background : 1.4 ± 0.3 (0.95 QCD, 0.07 WW, 0.38 ZZ)
  - Selected events : 1 (not amongst the HZ selected events)
- 2 jets and 2 τ's
  - Efficiency : 18.8 ± 0.9 % at 70 GeV
  - Background : 0.18 ± 0.1
  - Selected events : 0

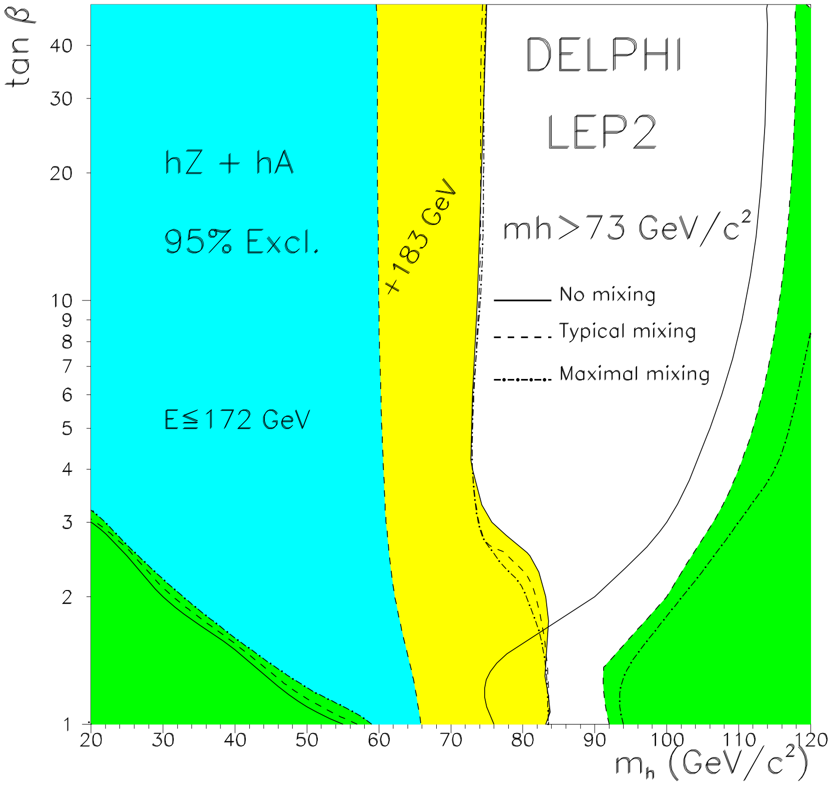
Preliminary

MSSM exclusion

- M_{top} = 175 GeV, M_{susy} = 1 TeV (incl. squarks)
- Limits not using the mass information from the selected ever
- At all values of tan β, M_A > 75 GeV and M_h > 73 GeV

Preliminary



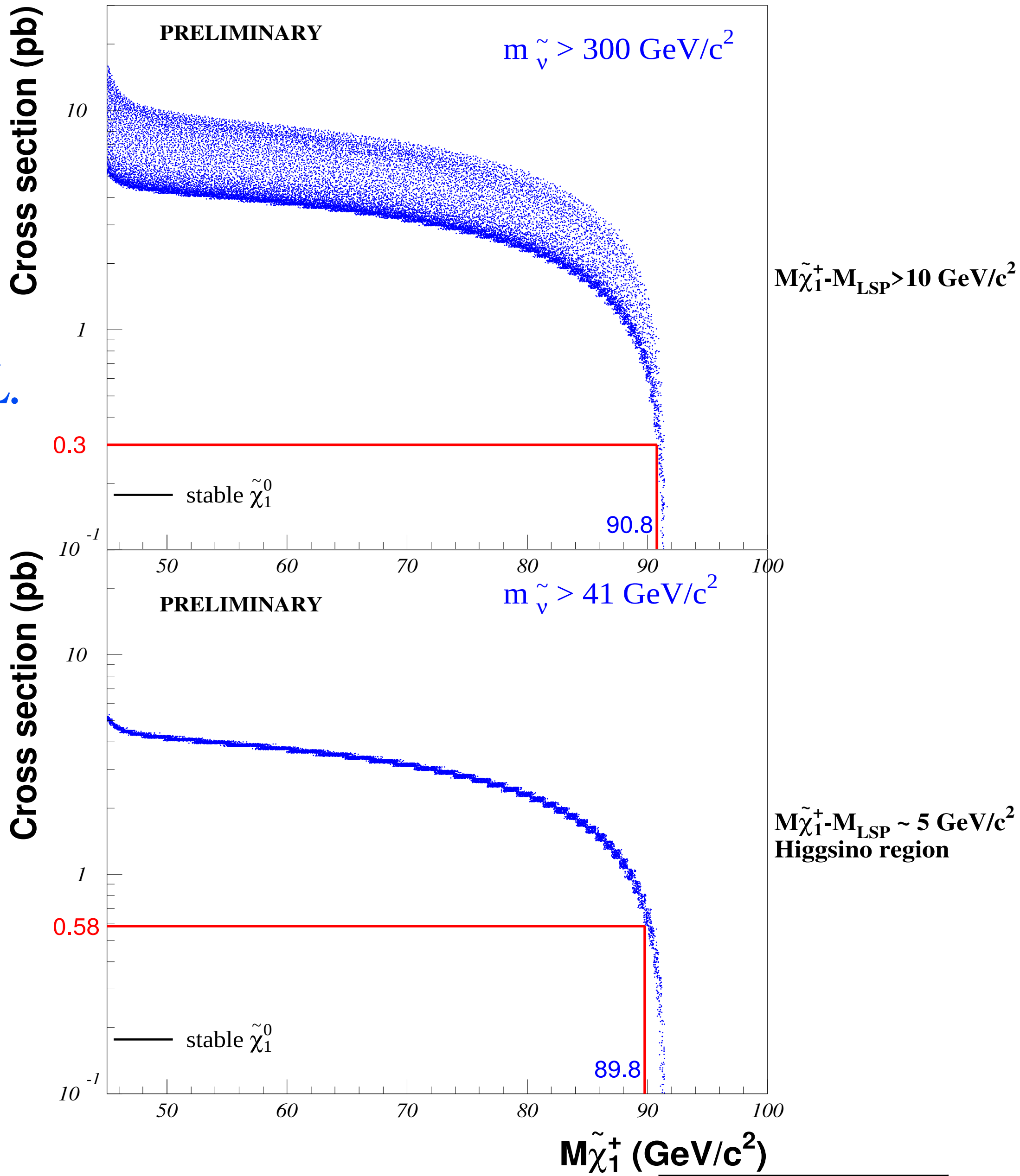


Chargino searches

- $e^+e^- \rightarrow \chi^+\chi^-$

  $\chi^{\pm} \rightarrow \chi^0 f\underline{f}'$
- High expected cross-section
- Limits at 95% C.L.
  - $\Delta_M > 10$ GeV : 90.8 GeV
  - $\Delta_M = 5$ GeV : 89.8 GeV

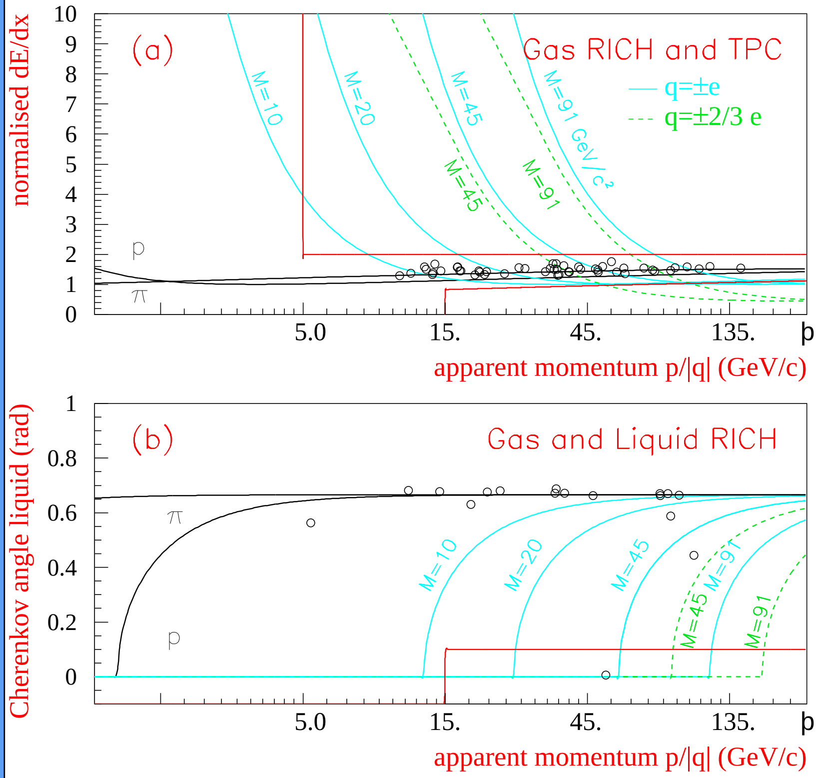
DELPHI $\tilde{\chi}_1^+\tilde{\chi}_1^-$ limits at 183 GeV



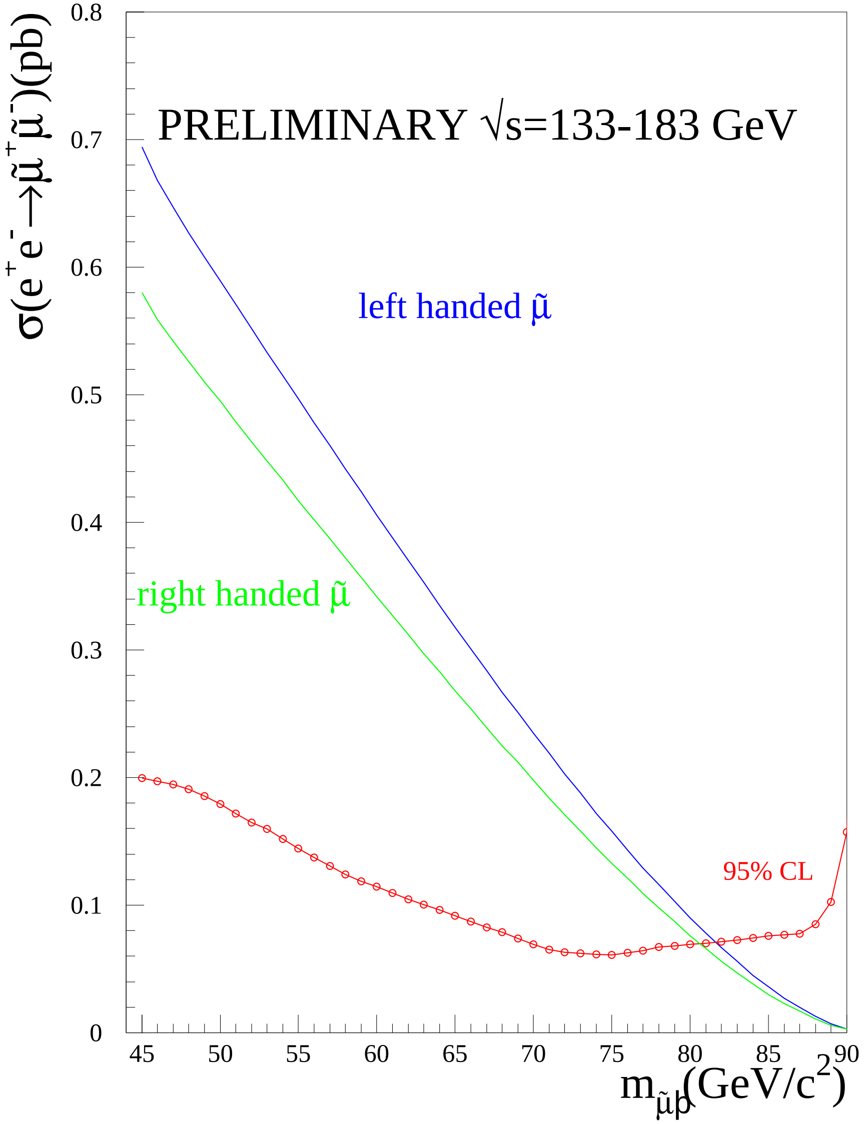
Search for stable supersymmetric particles

Using RICH and dE/dx (TPC)

DELPHI searches at 183 GeV



DELPHI limits stable sleptons

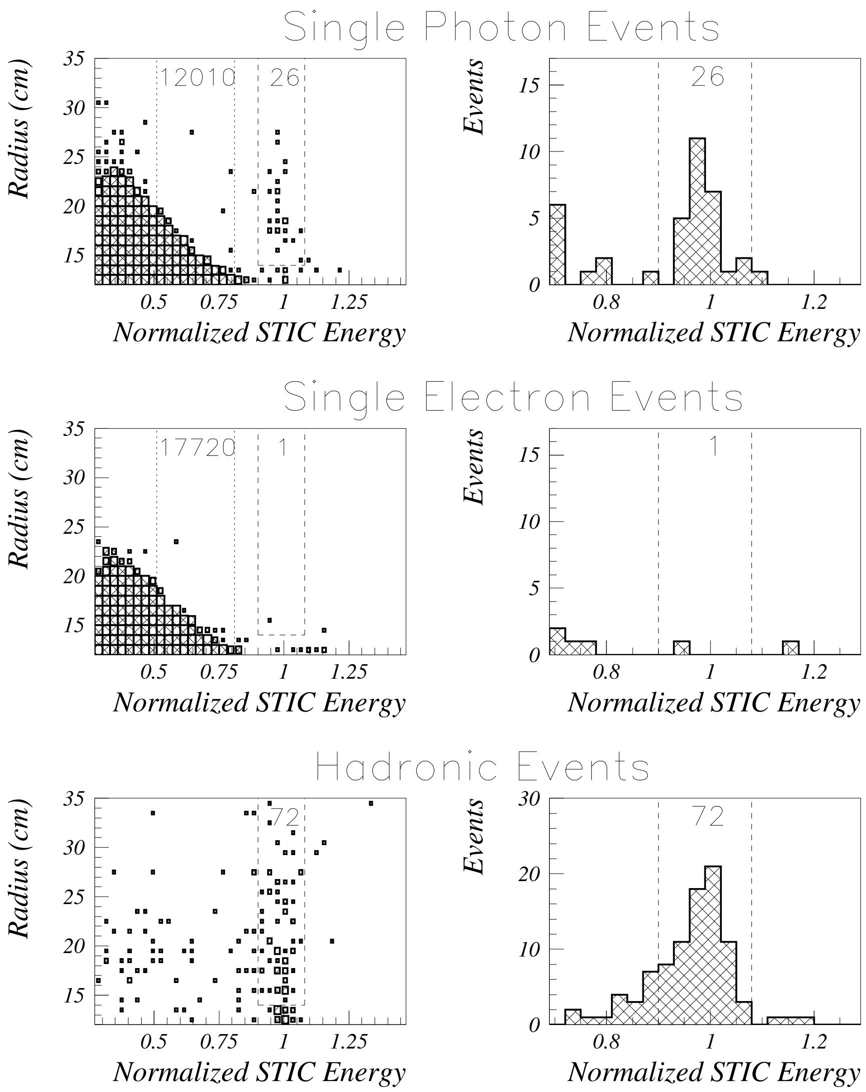


DELPHI

Physics with photons

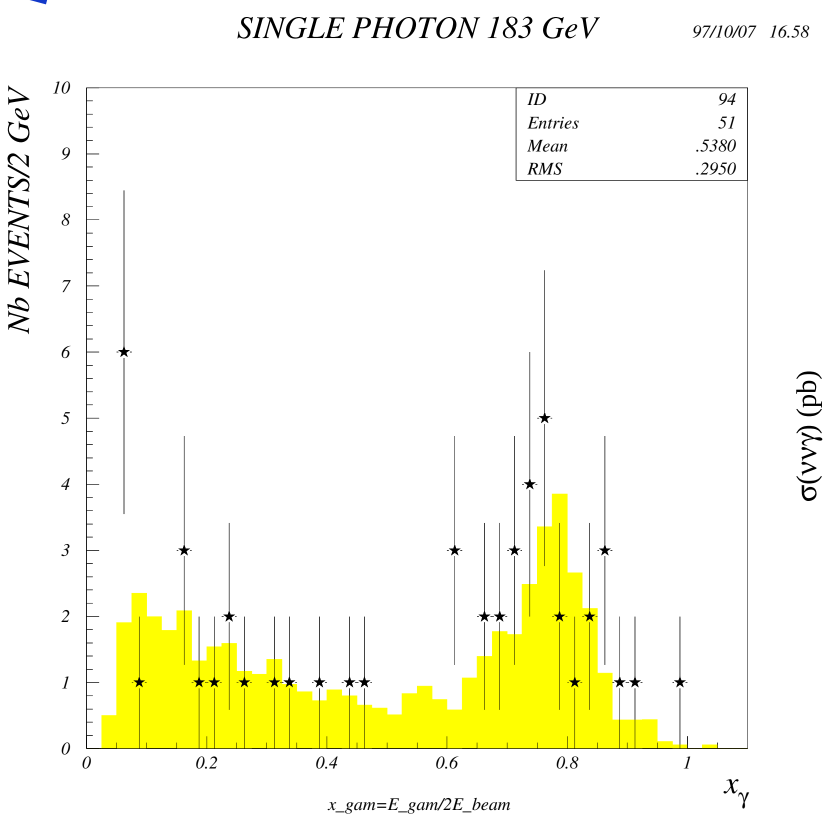
Single photon production int the STIC

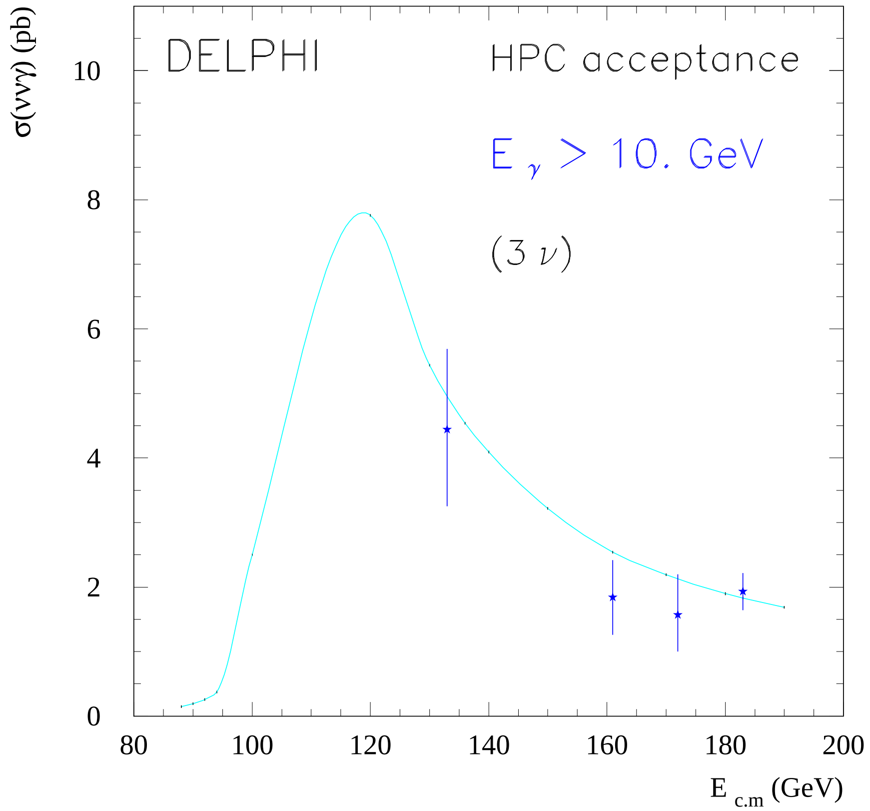
- **ν counting :**
  - $N_\nu = 2.93 \pm 0.57$ with 183 GeV only
  - $N_\nu = 2.98 \pm 0.21$ with all high energy data



Single photons in the HPC

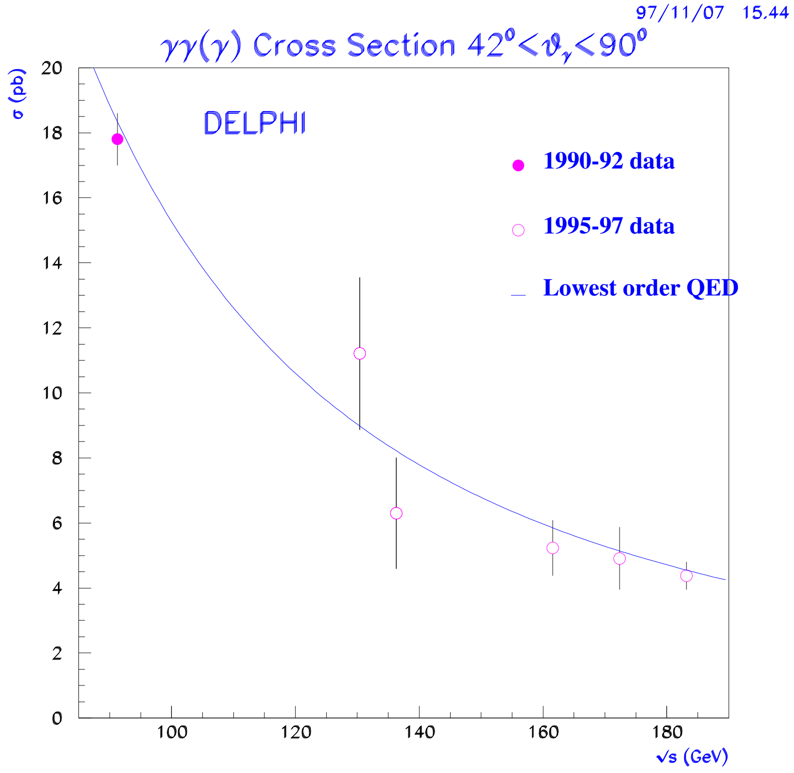
- Preliminary result with 35 pb^{-1}

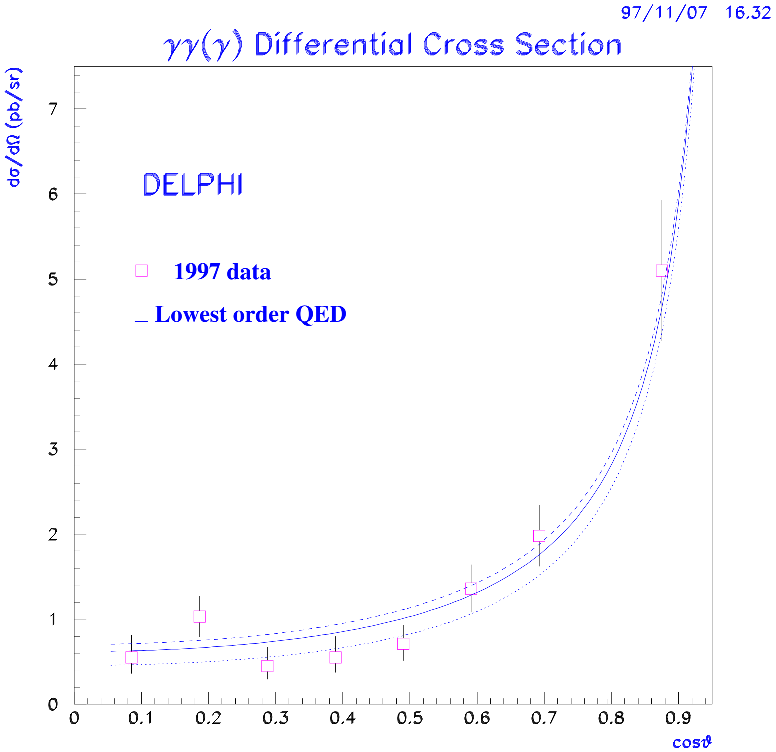




$\gamma\gamma$ production (coplanar)

- *QED cross-section*
- *Sensitive to compositeness*





Limits on compositeness :

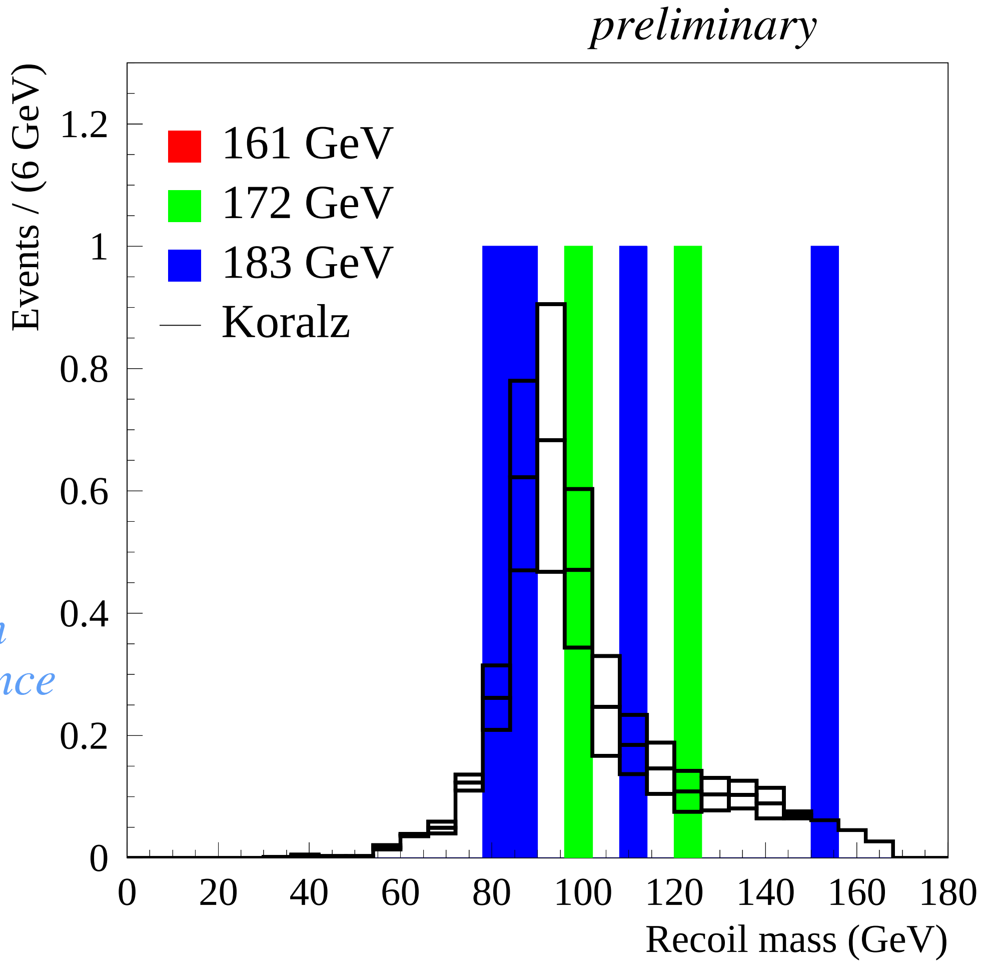
Λ^+ > 254 GeV
Λ^- > 214 GeV

On excited electron :

M_e^* > 228 GeV

$\gamma\gamma$ production (acoplanar)

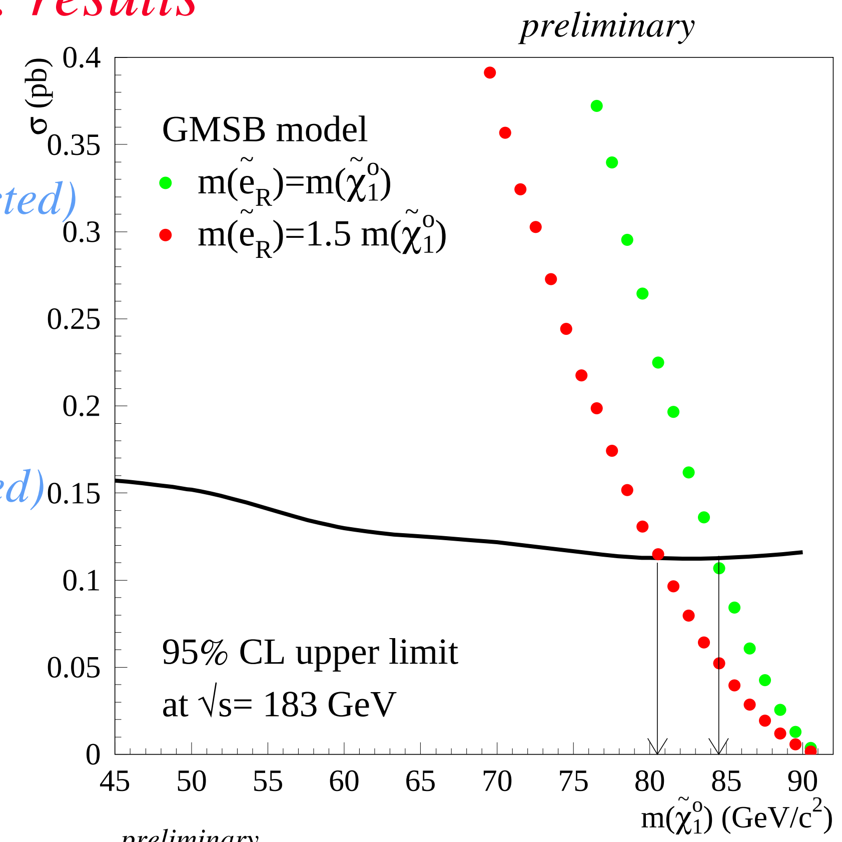
- *Light gravitino*
  - $e^+e^- \rightarrow \chi^0\chi^0$
    $\chi^0 \rightarrow G\,\gamma$
  - *High energy* γ
- *Neutralino cascade*
  - $e^+e^- \rightarrow \chi^0{}_2\chi^0{}_2$
    $\chi^0{}_2 \rightarrow \chi^0{}_1\,\gamma$
  - *Broader energy spectrum*
    Depends on mass difference

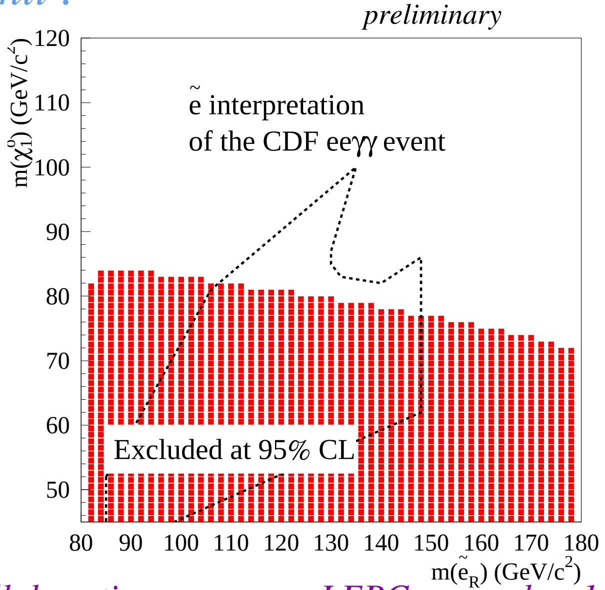


$\gamma\gamma$ production (acoplanar) : results

- **Light gravitino**
  - No events selected (1.2 expected)
  - $M_{\chi^0} > 80.5$ GeV
- **Cascade decay**
  - 2 events selected (0.9 expected)
  - For the following range : $65\ \text{GeV} < M_{\chi^{0,2}} < 85\ \text{GeV}$

    $M_{\chi^{0,2}} - M_{\chi^{0,1}} > 20\ \text{GeV}$
  - We obtain the limit : $\sigma_{\chi\chi} < 0.25$ pb
  - Exclusion in the "CDF event scenario"





DELPHI

Conclusions

1997 : a very good year for physics... and for DELPHI

- LEP has been GREAT! We look forward to 150 pb^{-1}(at least) next year at higher energy...
- DELPHI has been running satisfactorily in 1997
  - Some signs of ageing however...
- Shutdown plans :
  - Minimum interventions (endcaps in place) to fix FCB
  - Should be closed early next year
- We reach a new domain in searches where we have to cope with selected events...
  - Are there some signs that we are not too far?...
- We in DELPHI are very keen at running at the highest possible energy, in the next 3 years (including year 2000)