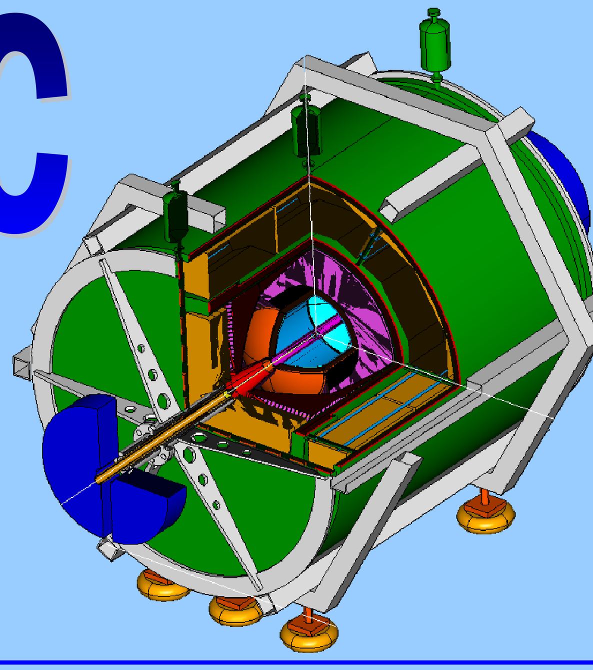
The 4th Concept Detector at ILC



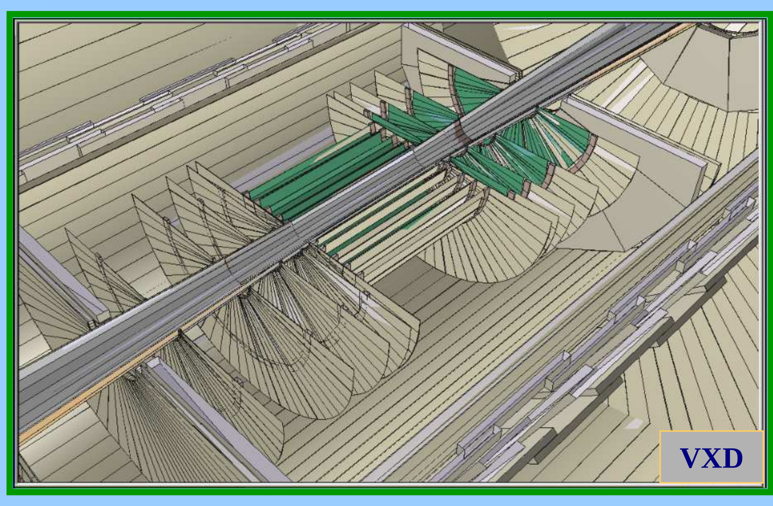
A. Mazzacane

Dipartimento di Fisica dell'Universita' di Lecce, Italy

INFN Sezione di Lecce, Italy

ABSTRACT

The 4th Concept Detector is designed for high precision measurements of Physics processes accessible at ILC.
It consists of four basic subsystems: a pixel vertex detector for high precision vertex definitions, impact parameter for flavour tagging and near-beam occupancy reduction; a cluster-counting low-mass drift chamber for robust pattern recognition with over one hundred three-dimensional space-points each with about 55 μm resolution, 3.5% specific ionization measurement; a high precision dual-readout fiber calorimeter, complemented with a dual-readout crystal calorimeter, both with time-history readout, for the energy measurement of hadrons, jets, electrons, photons, and the tagging of muons; an iron-free dual-solenoid to return the flux and provide a second field region for the inverse direction bending of muons in a gas volume to achieve high acceptance and good muon momentum resolution. All four subsystems separately achieve the important scientific goal to be 2-to-10 times better than the already excellent LEP detectors, Aleph, Delphi, L3 and Opal.



Vertex Detector (VXD)

5 barrel layers (96 ladders) , total 1.2% X/X_0

4 endcaps (96 sectors)

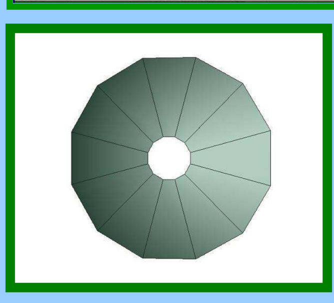
20 μm x 20 μm pixel size

Total 4.3×10^9 pixels

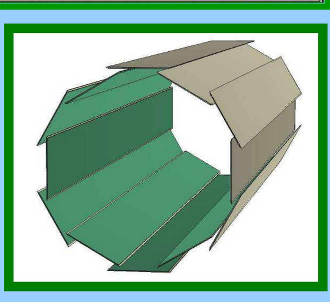
Detector support: 100 mm CarbonFiber

Basic barrel building block: rectangular ladder

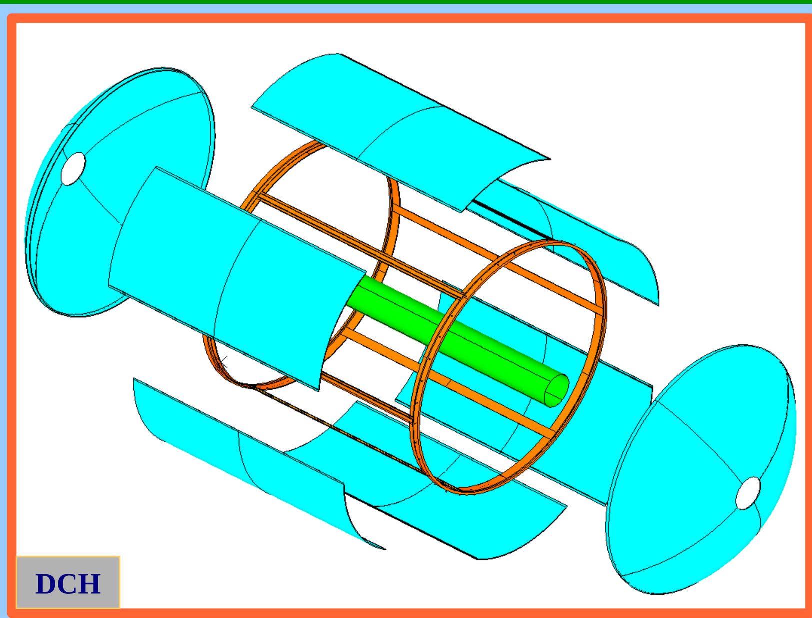
Basic endcap building block: trapezoidal sector



one layer of the VXD endcaps



one layer of the VXD barrel



Drift Chamber (DCH)

All stereo, cluster timing drift chamber

150000 field wires (80 μm Al)

66000 sense wires (20 μm W)

Light He based gas mixture (90% He – 10% iC_4H_{10})

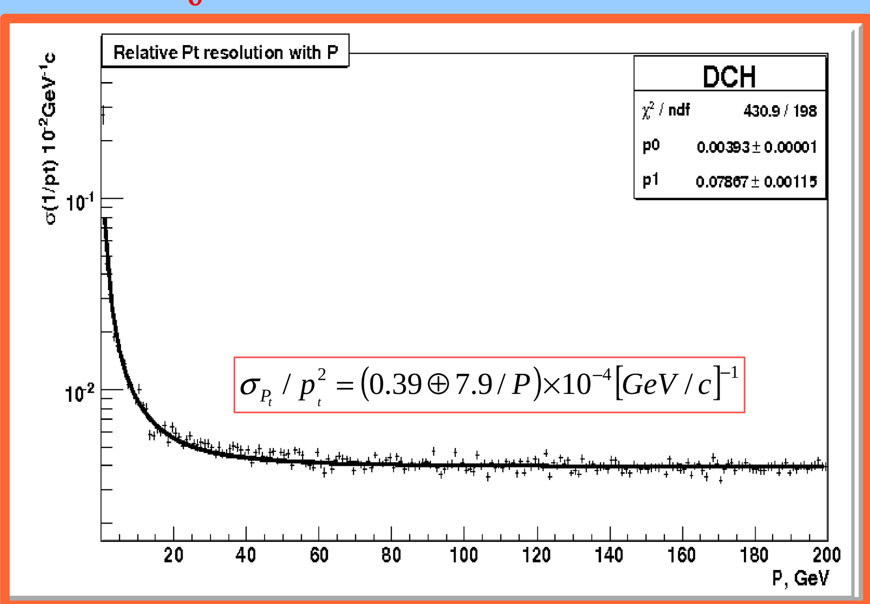
Mechanical structure entirely C-fiber

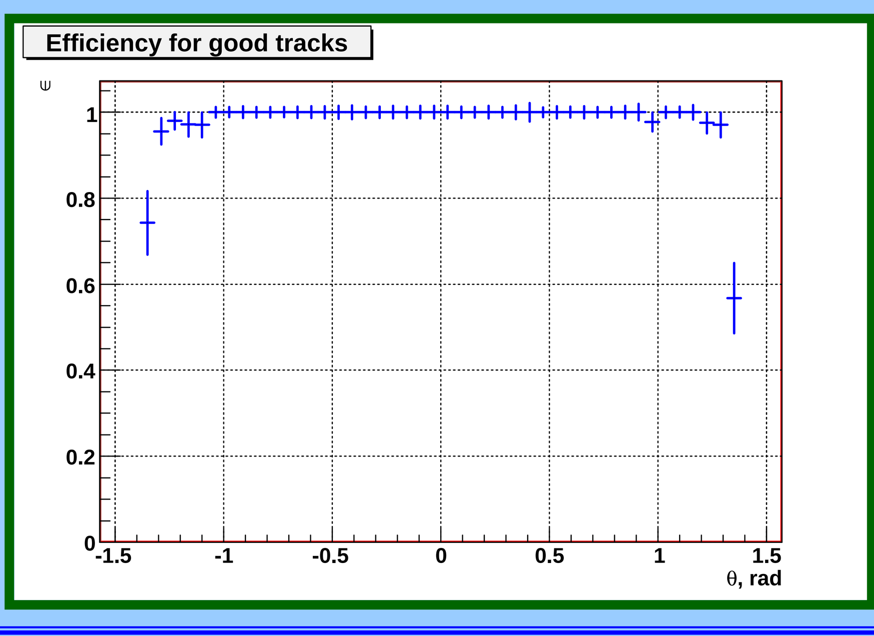
Max drift time contained in one BX

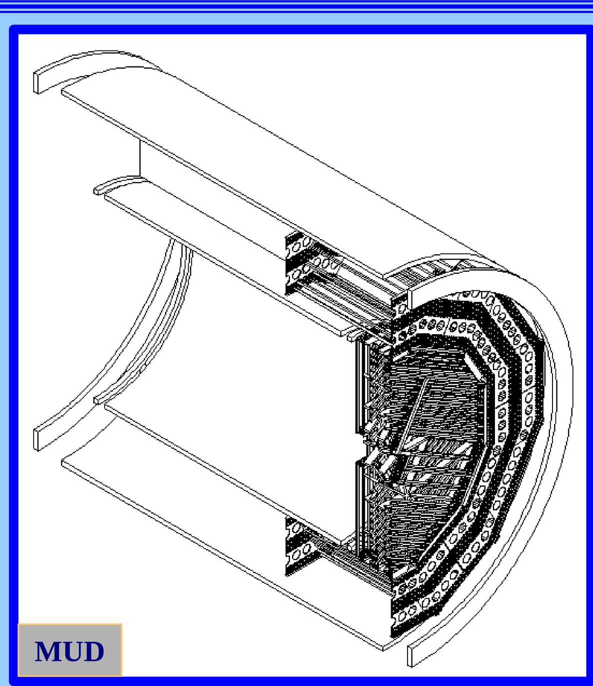
Total tracking volume (inner wall, gas and wires) < 0.5% X_0

Basic building block: exagonal cell

See G. Tassielli's poster







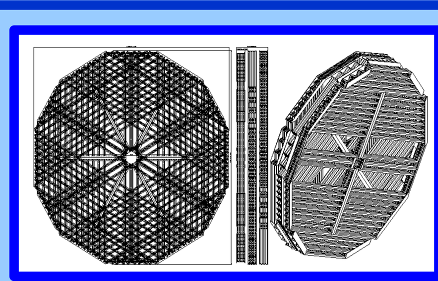
Muon Spectrometer (MUD)

Barrel: 31500 tubes 21000 channels

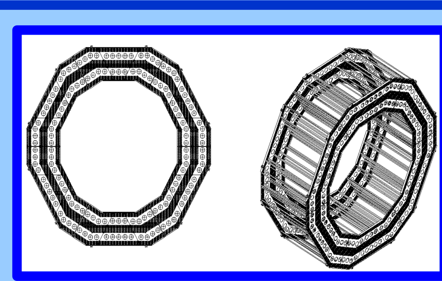
Endcaps: 8640 tubes 9762 channels

Total: 40140 tubes 30792 channels

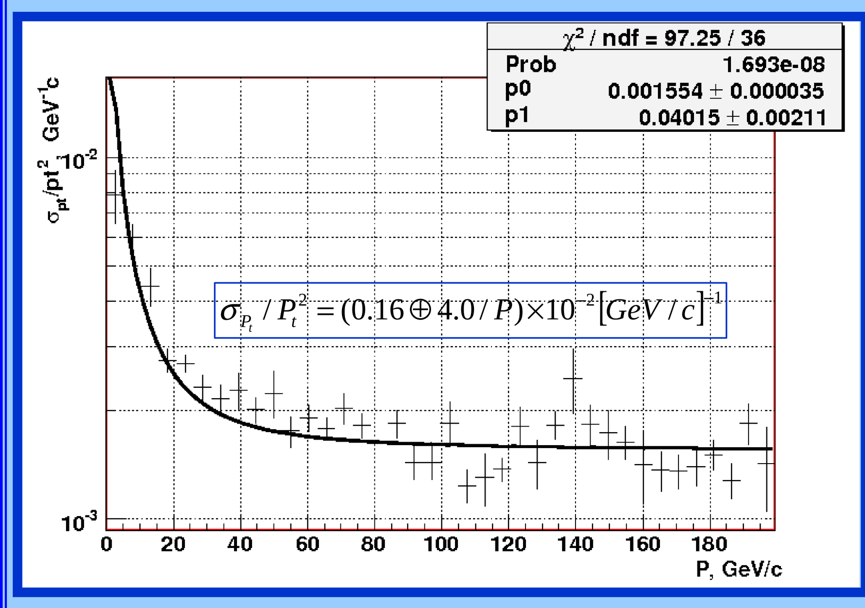
Basic building block: 4.6 cm drift Al tube filled with gas mixture 90% He – 10% iC_4H_{10}

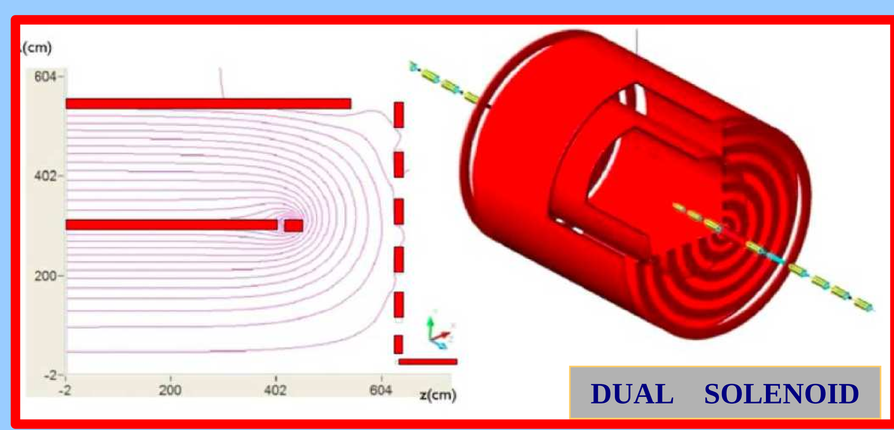


one MUD endcap



one stave of MUD barrel





Inner B_z-field 3.5 T

Outer B_z-field -1.5 T

Advantages of a dual magnetic system:

avoids 14 kTons of flux return iron

avoids huge forces on iron at switch on/off (support)

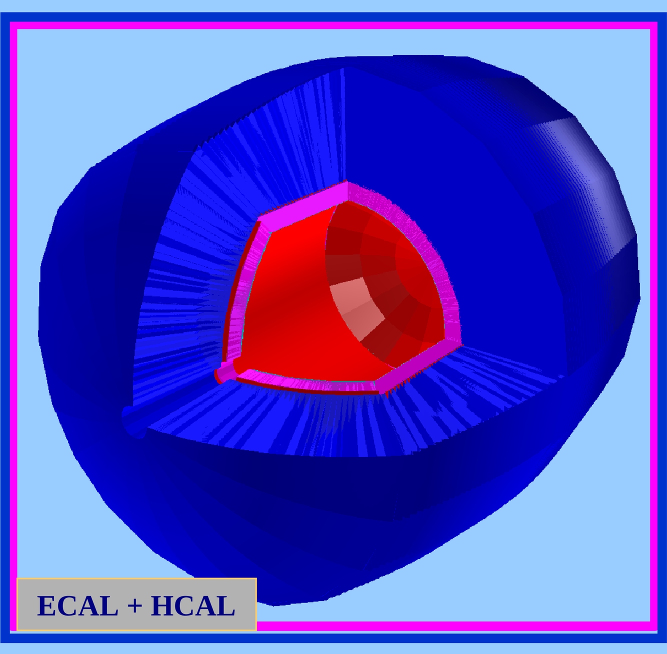
allows for a muon spectrometer in air (better momentum resolution)

allows for a ZERO fringe field outside of the magnet volume

allows for the FF optics to be placed inside the detector on the same support structure (stability against ground motion)

allows for an easier survey and alignment of internal subsystems

allows to run at any value of B, from B= –3.5T to B= +3.5T, including 0T (studies of asymmetry)



Dual Readout Electromagnetic Calorimeter (ECAL)

Barrel: 262144 BGO crystals

Endcaps: 119200 BGO crystals

4X4 crystals for each HCAL tower

~ 22.7 X_0 depth and ~ 1 λ_{int}

Azimuth coverage down to ~ 2.8°

Fully projective geometry

Basic building block: 25 cm BGO crystal

Outer tower size: ~ 8.1 × 8.1 cm²

Inner tower size: ~ 4.4 × 4.4 cm²

Triple Readout Hadronic Calorimeter (HCAL)

Cu + scintillating fibers + Čerencov fibers

Barrel: 16384 towers

Endcaps: 7450 towers

~ 7.3 λ_{int} depth

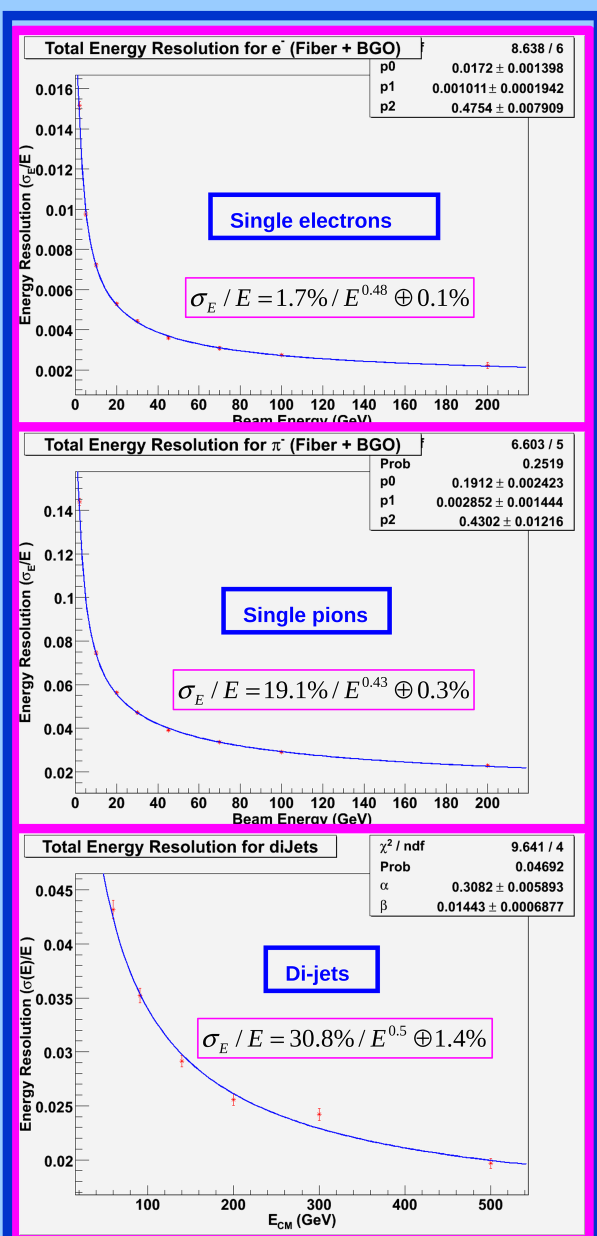
Azimuth coverage down to ~ 2.8°

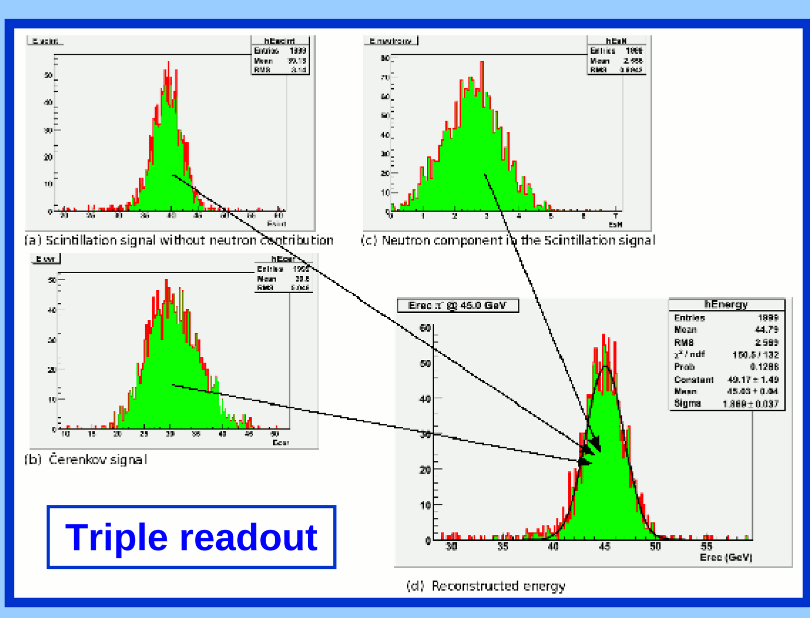
Fully projective geometry

Outer cell size: ~ 4.3 × 4.3 cm²

Inner cell size: ~ 3.7 × 3.7 cm²

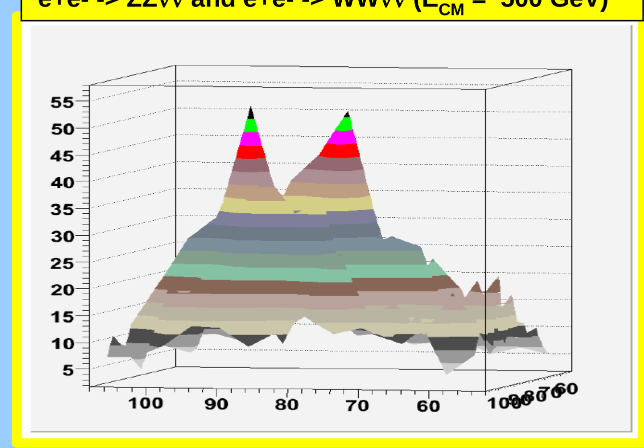
Basic building block: 150 cm tower





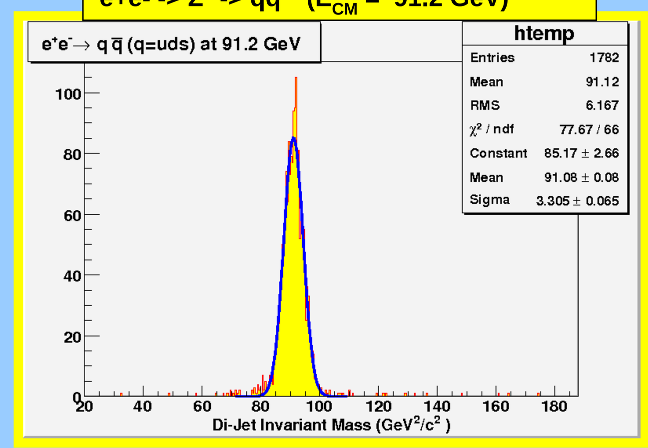
Physics Performance

e+e- -> ZZνν and e+e- -> WWνν (E_{CM} = 500 GeV)



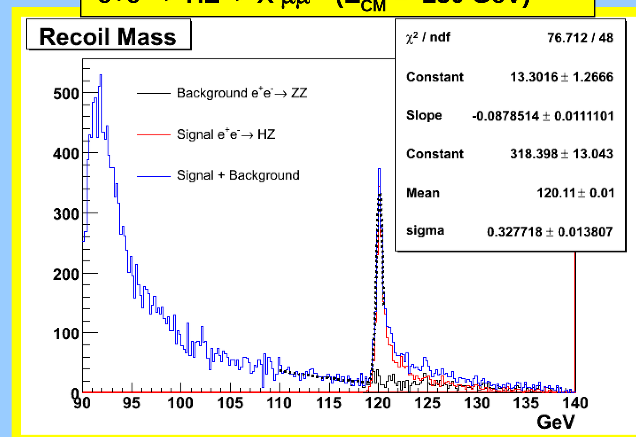
W-Z mass separation Analysis
Clear separation of Z and W mass from di-jets

e+e- -> Z^0 -> qq (E_{CM} = 91.2 GeV)



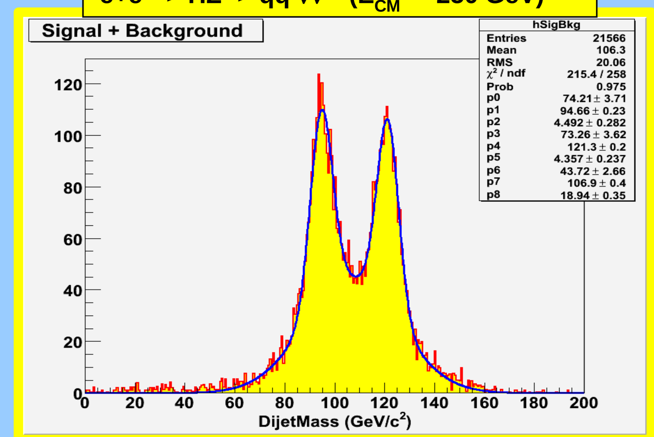
Z-Pole Analysis
Excellent Z^0 mass resolution

e+e- -> HZ -> X μμ (E_{CM} = 230 GeV)



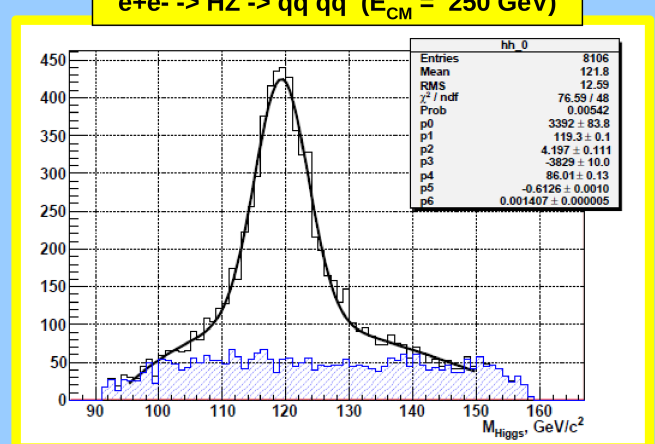
Recoil Mass Analysis
Excellent recoil mass against two muons from Z^0

e+e- -> HZ -> qq νν (E_{CM} = 250 GeV)



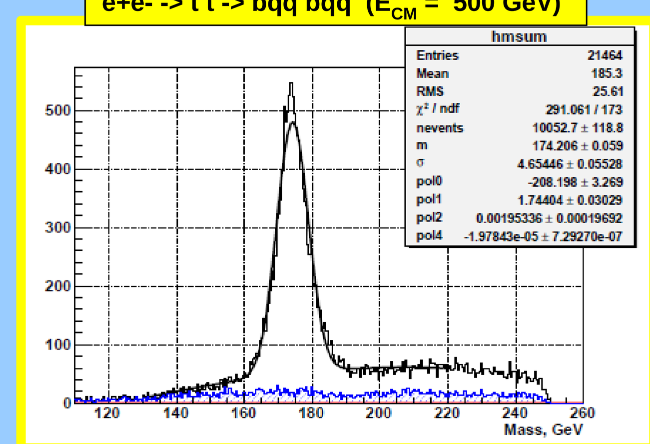
Two-jet Analysis
Clear separation of Higgs from Z^0 mass

e+e- -> HZ -> qq qq (E_{CM} = 250 GeV)



Four-jet Analysis
Very clean analysis of Higgs in four jets

e+e- -> t t -> bqq bqq (E_{CM} = 500 GeV)



Six-jet Analysis
Excellent resolution for top mass

Contact anna.mazzacane@le.infn.it