The Importance of W→jj and Z→jj

A few obvious comments on why
the detector is critical

John Hauptman, Iowa State University

DREAM group & CMS & D0

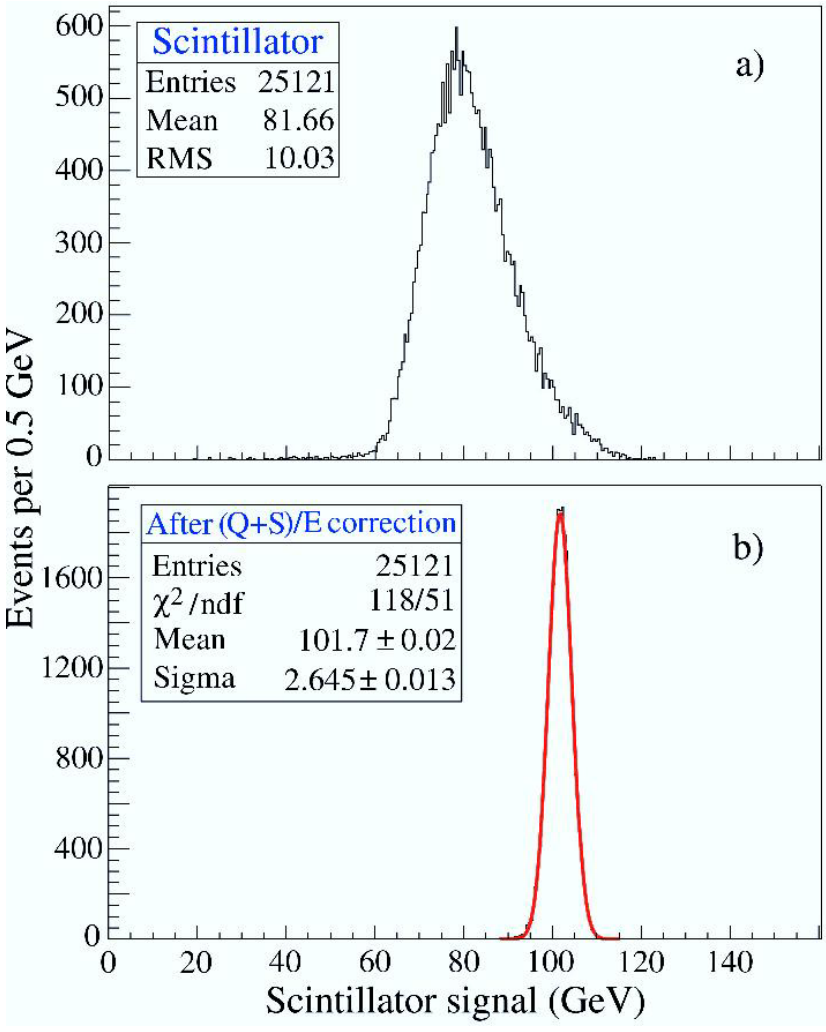
This is not a new idea …

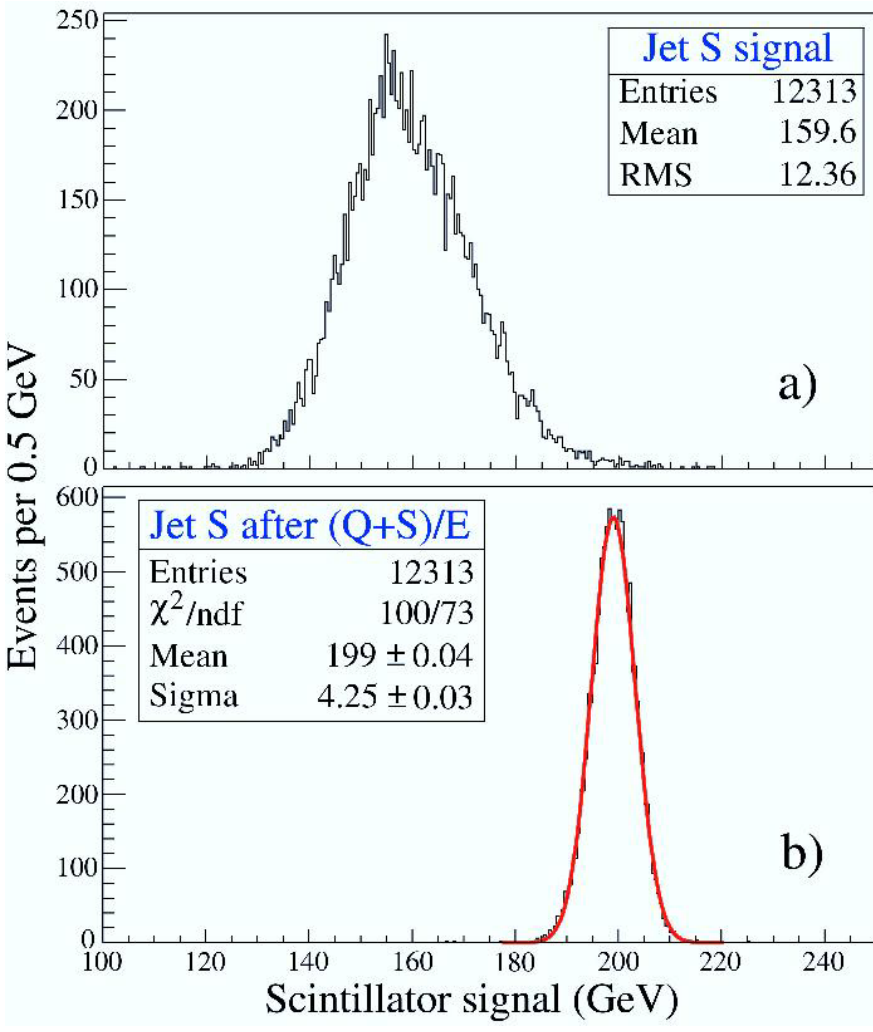
- Many years ago, Henri Videau (the same!) showed a plot of W→jj and Z→jj mass distributions in which W and Z peaks were distinct, and he argued for excellent jet energy resolution to achieve this.

- This is now possible. A "dual-readout" calorimeter has been built, tested at CERN, and analyzed with a jet energy resolution of about 2% at 200 GeV.

- DREAM – R. Wigmans, N. Akchurin, H. Kim, K. Carrell, and R. Thomas at Texas Tech University; H. Parr at UC San Diego; J. Hauptman at Iowa State University; Aldo Penzo at INFN, Trieste.

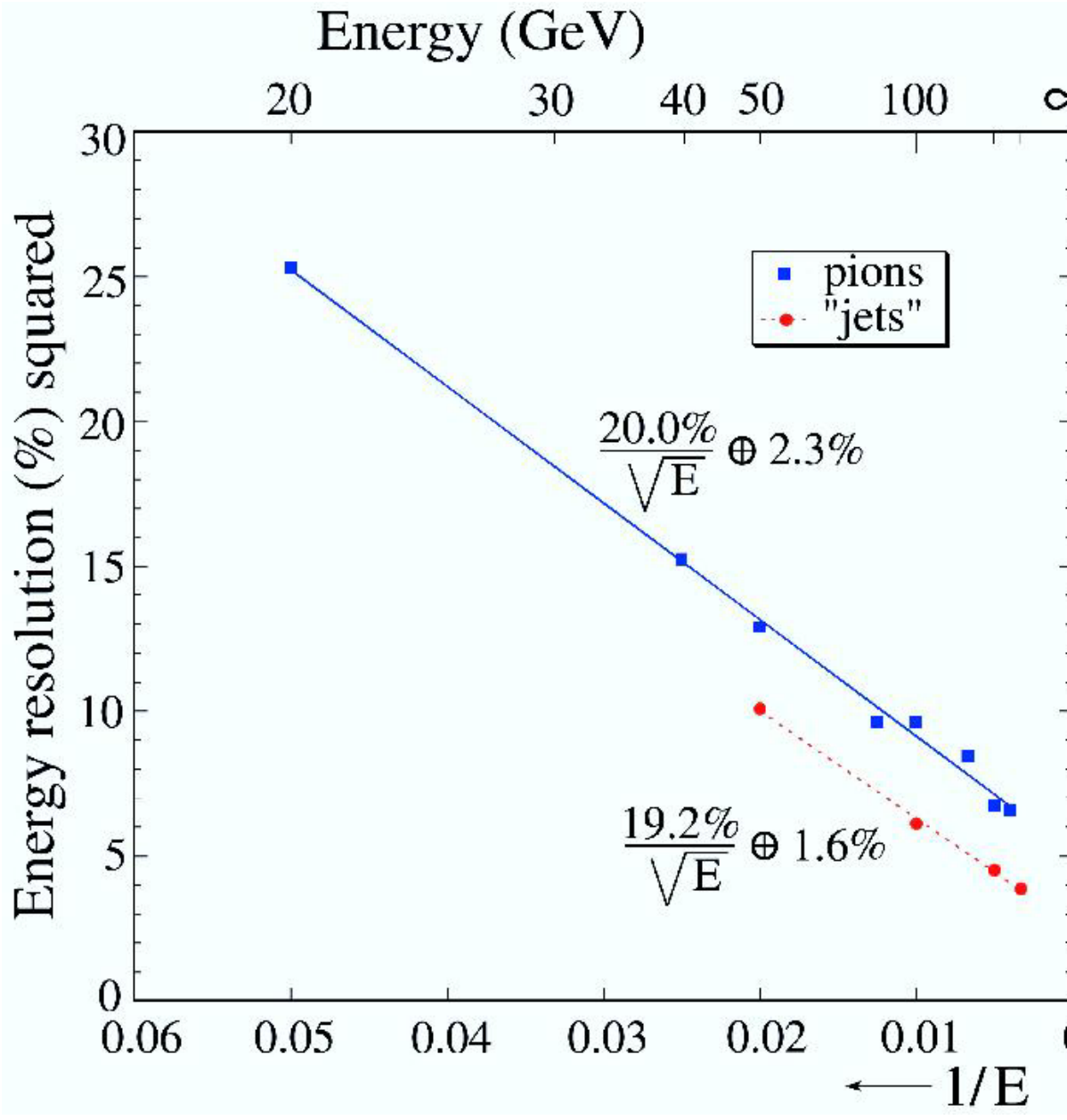
Data: 100 GeV π and 200 GeV "jets"



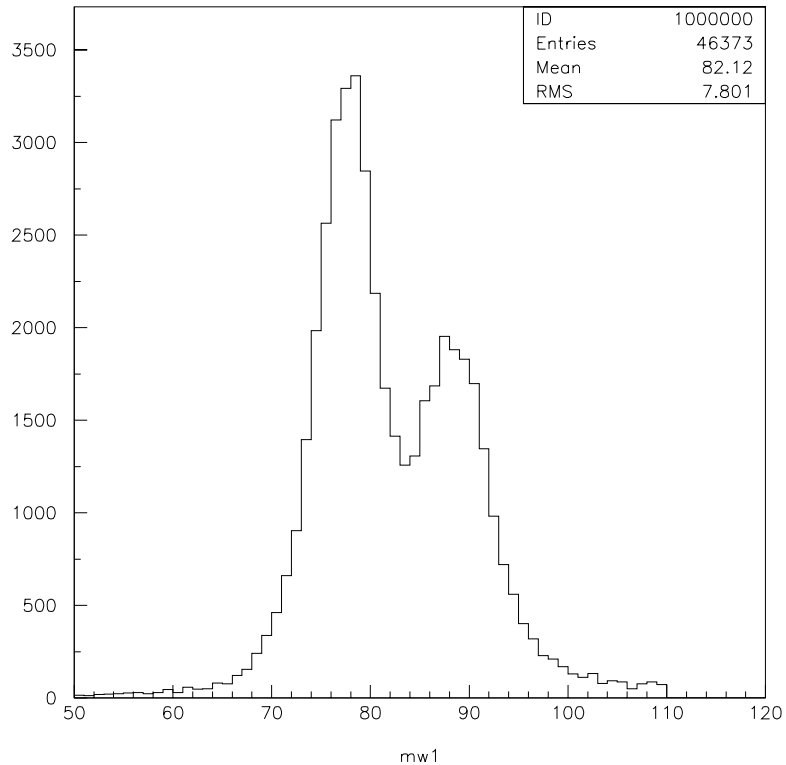


Measured energy resolution of pions and “jets” from 20 to 300 GeV

DREAM



e+e- → WW and ZZ (Pythia 22,25)



Mjj (GeV) →

Pythia events

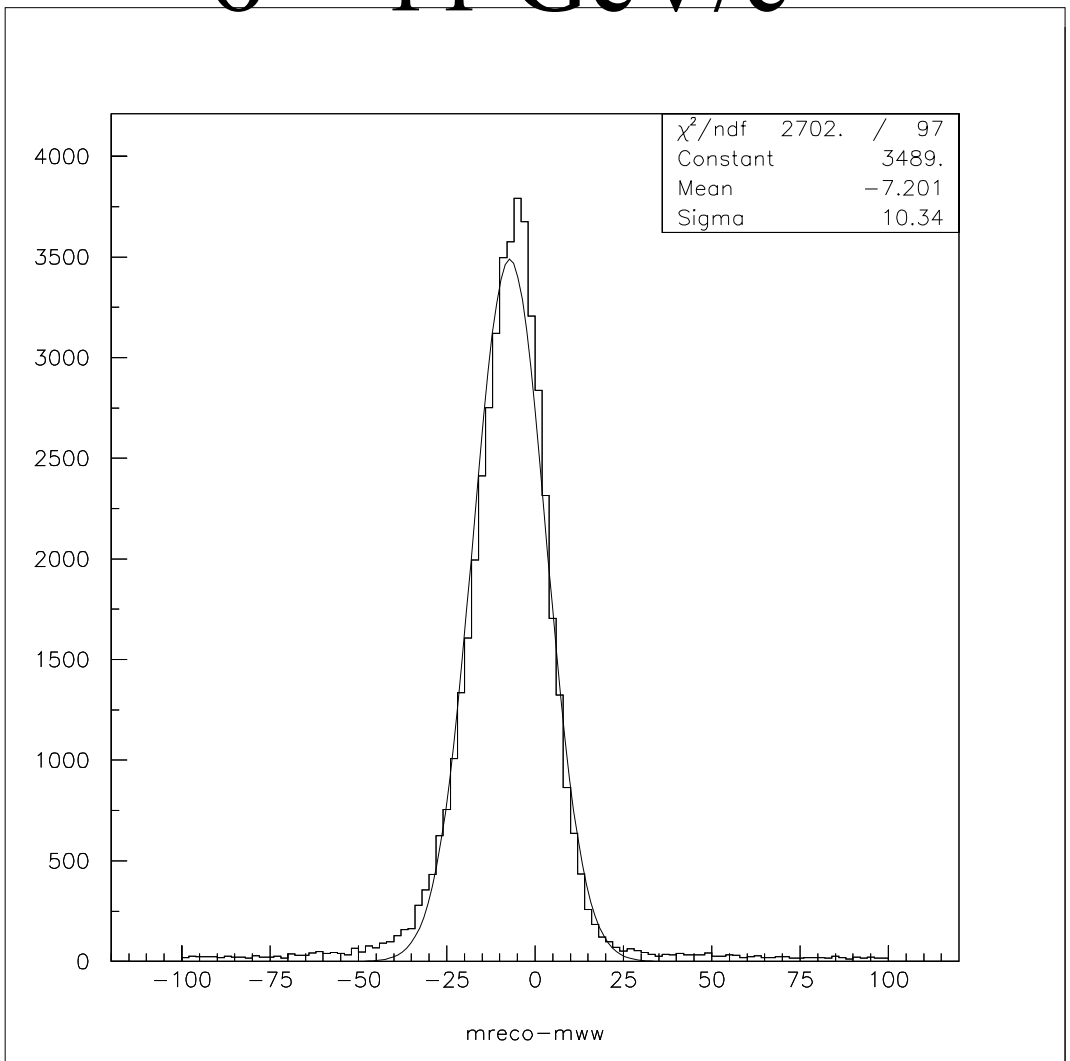
$\Delta\eta = \Delta\varphi = 0.16$

LUCELL jet algorithm

Calorimeter resolution of the DREAM module

$\sigma/E = 19.2\%/\sqrt{E} + 1.6\%$

WW mass resolution: $\sigma \sim 11$ GeV/c^2



“quark-lepton-photon universality”

- Finally, all of the fundamental particles of the SM can be measured with comparable precision, including the photon.
- This allows $W \rightarrow jj$ and $Z \rightarrow jj$ to be resolved experimentally, and their four-vectors measured with some precision.
- Single neutrinos “measured” by missing momentum vector in the event.
- $B(W \rightarrow jj) / B(W \rightarrow e\nu) = 3.5$
- $B(Z \rightarrow jj) / B(Z \rightarrow ee/\mu\mu) = 10$.
- For WW, ZZ and WZ final states, the “physics luminosity” gain is the square of these numbers.

u	-	-
d	-	-
e	μ	-
ν	ν	ν

W	Z	γ

Dynamics of collaborations

The building of big detectors is very complex – technology, engineering, new ideas, funds, schedules, egos, surprises, etc. In the beginning, sometimes there is an incomplete understanding of technical issues.

Beware only that the technology choices are often "locked in" very early in the life of a collaboration, and are unchangeable after than, no matter what the scientific consequences may be.

Neither of the big LHC detectors can separate W→jj from Z→jj, and while this is a different machine, *the LC must at least be able to do so.*