Calorimetry at ILC

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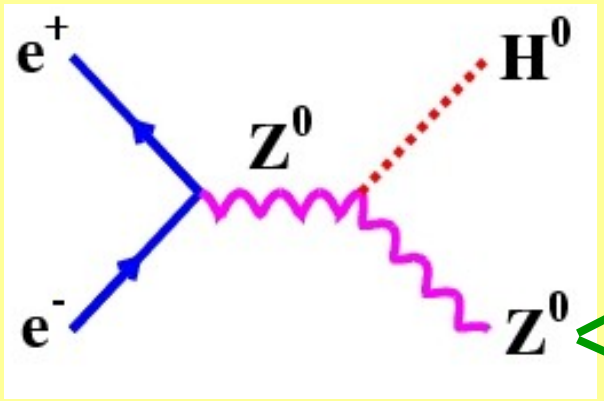
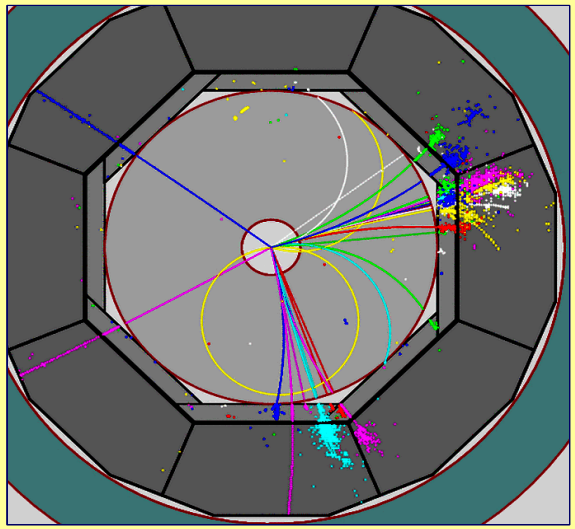
CIEMAT

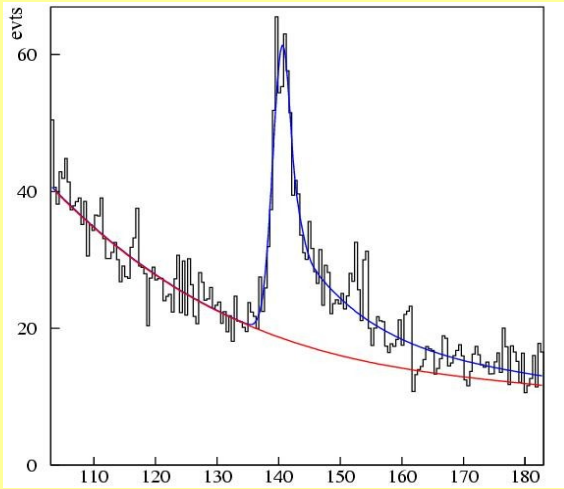
Why?

First Goal of ILC: Study of EW symmetry breaking

Golden Channel







BUT ....

Why?

processes at ILC

Multi bosons	Multifermions + Boson(s)
ZH	e^+e^- H , e+e− Z
WW	ννH ,ννZ
ZZ	ttH
ZHH	eνW
ZZZ	ννWW, ννZZ
ZWW	ttbar

Etc …

Z to	BR
$\ell^+\ell^-$	10 %
Qq (jets)	70 %

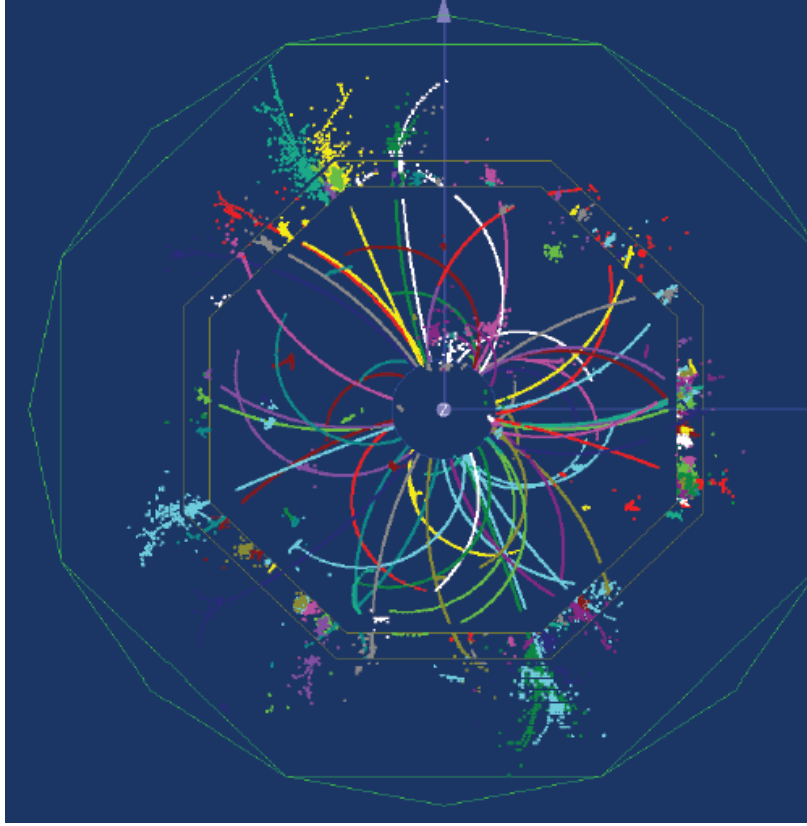
W to	BR
$\ell^\pm\nu$	32 %
qq' (jets)	68 %

H(120,SM) to	BR
$\ell^+\ell^-$	<15 %
qq(jets),WW,ZZ	>85 %

In order to **use** all the produced events (the luminosity of the machine)
It is needed to tag the bosons **W,Z,H in their decays to jets**

How? .... Particle Flow

- Particle Flow needs
  1) Reconstruction of ALL final state particles
  2) Find charged particles in the tracker system
  3) Find photons in the ECAL
  4) Find neutral hadrons in ECAL and HCAL
     - 3) and 4) are only possible if there is no mixing between deposited energy from different particles
- Calorimeters should then
  - far away from IP
  - dense (small lateral spread of showers)
  - High granularity
    - Detector readout in 3D
    - Small pixel size (< Moliere radius)
    - ECAL and HCAL inside the coil



E_{jet} =	$E_{charged\ tracks}$	+ E_{γ}	+ E_{h^0}
fraction	65%	26%	9%

Charged track(s)	$\Delta p/p$	~ qq 10^{-5}
Photon(s)	$\Delta E/E$	~ 12%
Neutral hadrons	$\Delta E/E$	~ 45%

Perfect Algorithm →

$$\sigma^2_{jet} = \sigma^2_{ch} + \sigma^2_{\gamma} + \sigma^2_{h^0} \approx (0.14)^2\ E_{jet}$$

Real Life: Efficiency
Confusion →
Recons. Thres.

$$\sigma^2_{jet} = (0.30)^2\ E_{jet} + (0.50)^2$$

How much should Calorimeters Improve?

$$\Delta E_J = a \times \sqrt{E_J} \oplus b \times E_J \oplus c$$

	a	b	c
ALEPH	0.59	0	0.6
ATLAS	0.6	0.03	0
H1	0.5	0.05	0
ILC	0.3	0	0.5

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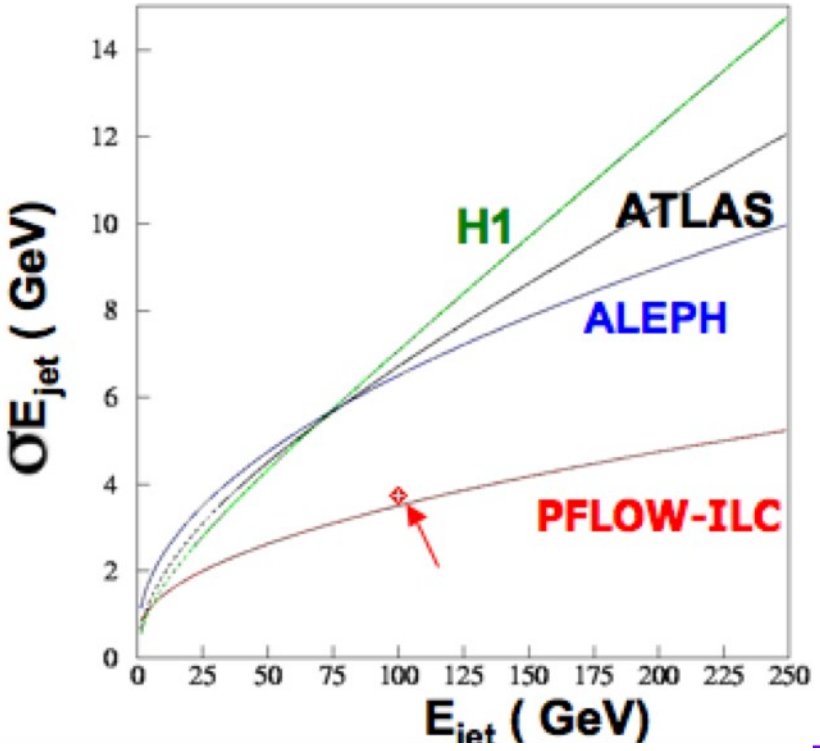
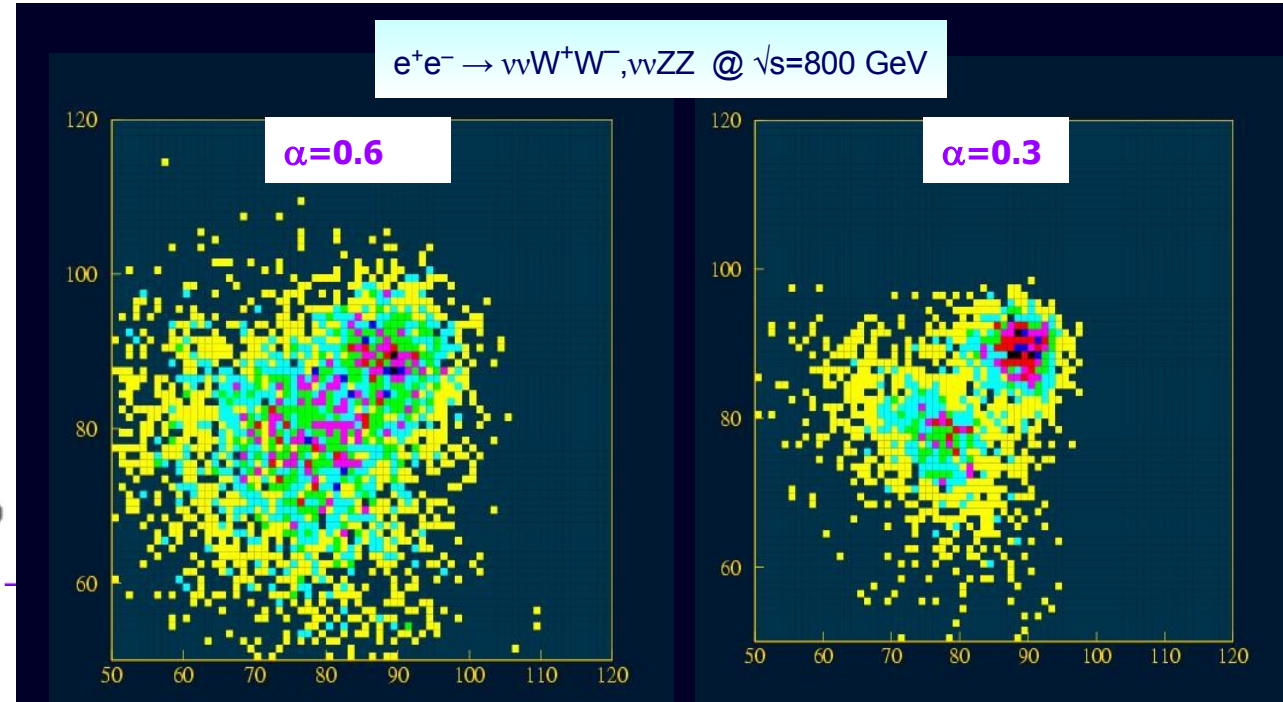
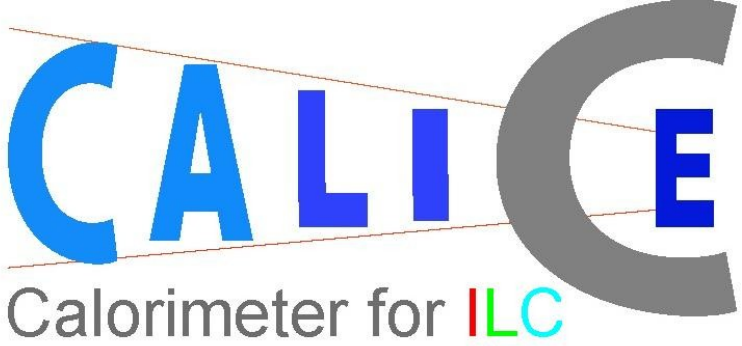




E. Cortina

CALICE



http://polywww.in2p3.fr/flc/calice.html

A high granularity calorimeter optimised for the Particle Flow measurement of multi-jets final state at the International Linear Collider running at a center-of-mass between 90 GeV and 1 TeV

- 200 physicist/engineers
- 38 institutes
- 11 countries

	Material	Pixel Size	RO layers	Readout
ECAL	W+Si	1X1 cm^2	20-30	Si Pad
ECAL	W+Scin	3x3 cm^2	20-30	Si Pms
AHCAL	Stell+Scin	4x4 cm^2	~50	Si Pms
DHCAL	Steel+Gas	1X1 cm^2	~50	RPC/GEM/uMega

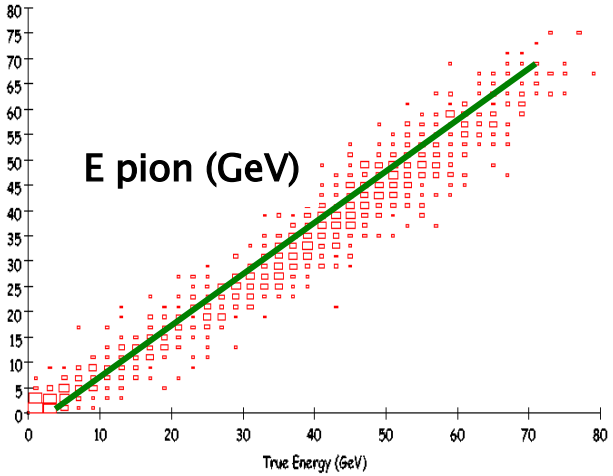
15-250 Millions channels for ECAL
~50 Millions channels for HCAL

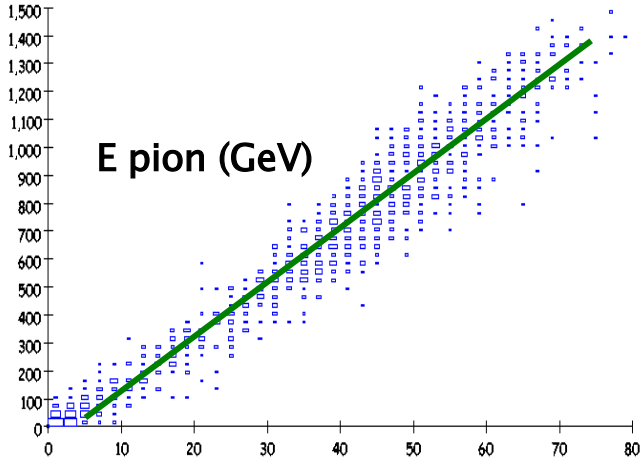
CALICE collaboration

- Share major efforts
  - Front-End Chips (HARDROC)
  - Common DAQ
  - Common Framework Analysis (Grid,Data Format...)
  - Coordinate Test Beams
- MC Validation
  - Now data and MC compatible but with error >20%
- No “loosers” politics
  - Goal is to build the best calorimeter
- R&D motivated by physics analysis
  - Working groups in each channel
- Easy to join
  - Still lot of work needed to be done

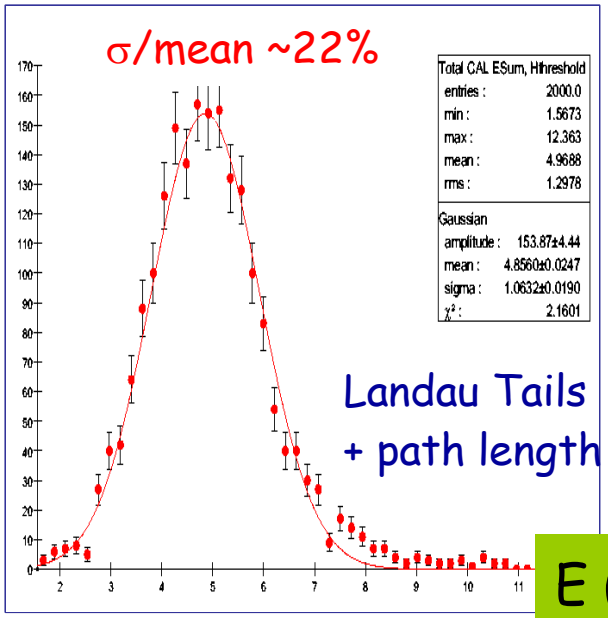
CIEMAT participation

Feasibility study and contruction of a Digital Hadronic Calorimeter

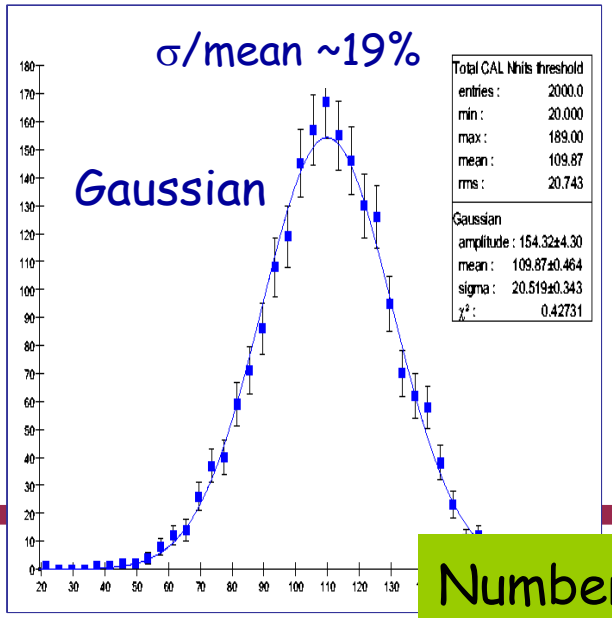




Analog



Digital



CIEMAT participation

Feasibility study and construction of a Digital Hadronic Calorimeter

- We will join CALICE coll before the end of the year
  - 2 or 3 physicist
  - 1 mechanical Engineer
  - 1 electronic Engineer
- Main activities to be done:
  1) Participation in CALICE Test-Beams
  2) Montecarlo and Analysis activities
  3) Sensor Characterization
  4) Detector Plane Design
  5) 1 m^3 prototype construction