# Running ILC at 250 GeV .

# What does it change for ECAL design ?

Jean-Claude BRIENT

Laboratoire Leprince-Ringuet
CNRS/IN2P3 – Ecole polytechnique

Physics goals for an ILC at 250 GeV is the precision studies of Higgs boson and at second rank, the precision studies on EW physics (W,etc..)

⇒

Multi-jets production in e+e- collider at 250 GeV centre of mass comes from $e^+e^- \to ZZ, ZH, WW$ or ZH and H to ZZ* or WW* or even $\gamma$ Z …

⇒

Due to branching fraction of Z and W into jets, even at 250 GeV center of mass, the multi-jets events will remains the main final state events.(4 jets, 6 jets, etc..)

Separation of Z, W and H, on the base of di-jet mass

→

PFA apply perfectly for it , in order to improve the multi-jets mass resolution to a level where we can separate Z from W and from H

## Which jets we are talking about

- Energy

- where in the detector

- density of jets

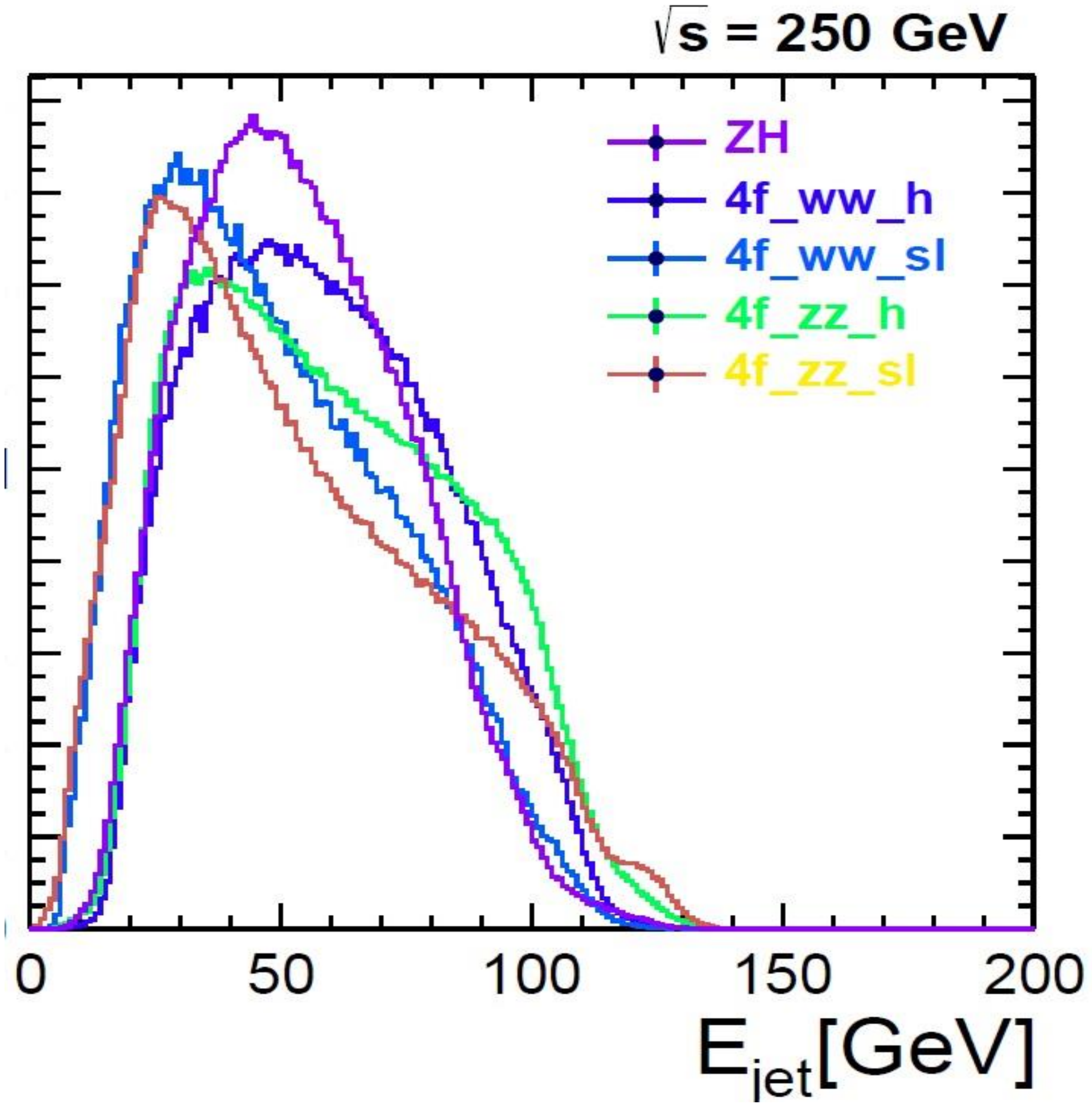
But jets are not the end of the story

Tau as polarimeter for Z decays to tau , polarization and AFB(Pol) , which could be affected by Z' somewhere BUT ALSO for a very important piece of the program at ILC : the CP violation in Higgs decays

The Jacobian peak is at 50 GeV or lower

But need to measure jets up to the maximum energy

and to think about running ILC at 500 GeV

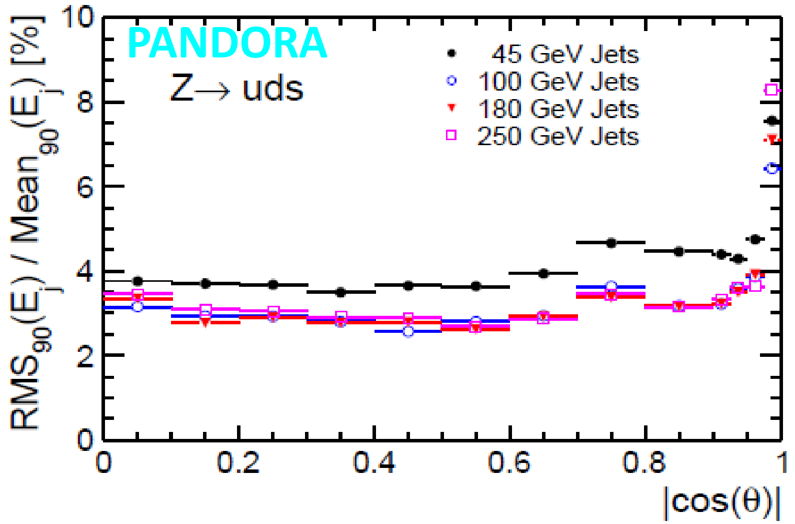


## Where in the detector

For events of interest ,

s-channel di-boson, since t-channel much smaller
Example : ZH instead of ν νbar H (W-fusion)

IMPACT could come from the
Jets angular distribution of the polar angle
(end-cap versus overlap versus barrel)

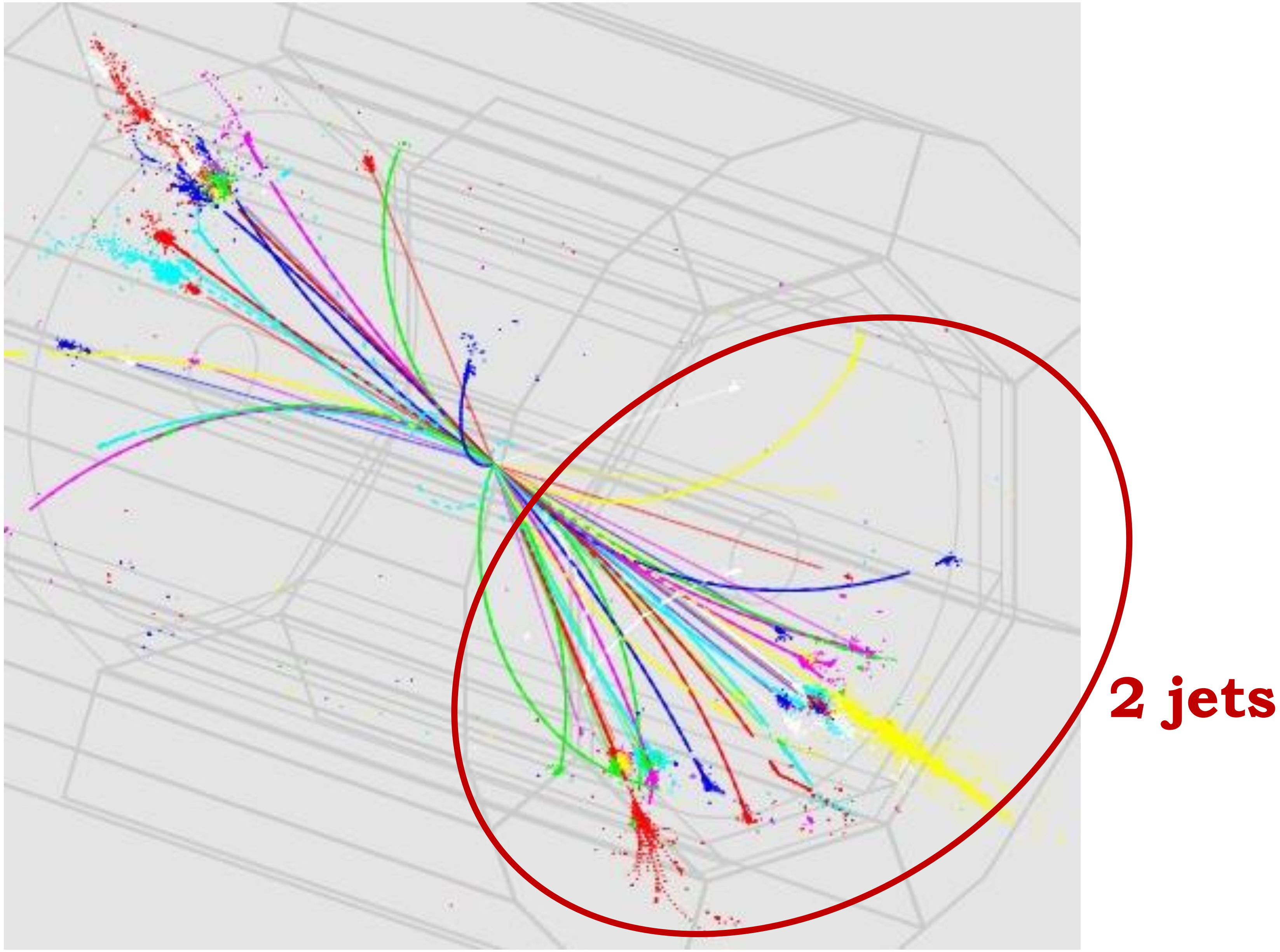



## Jets density

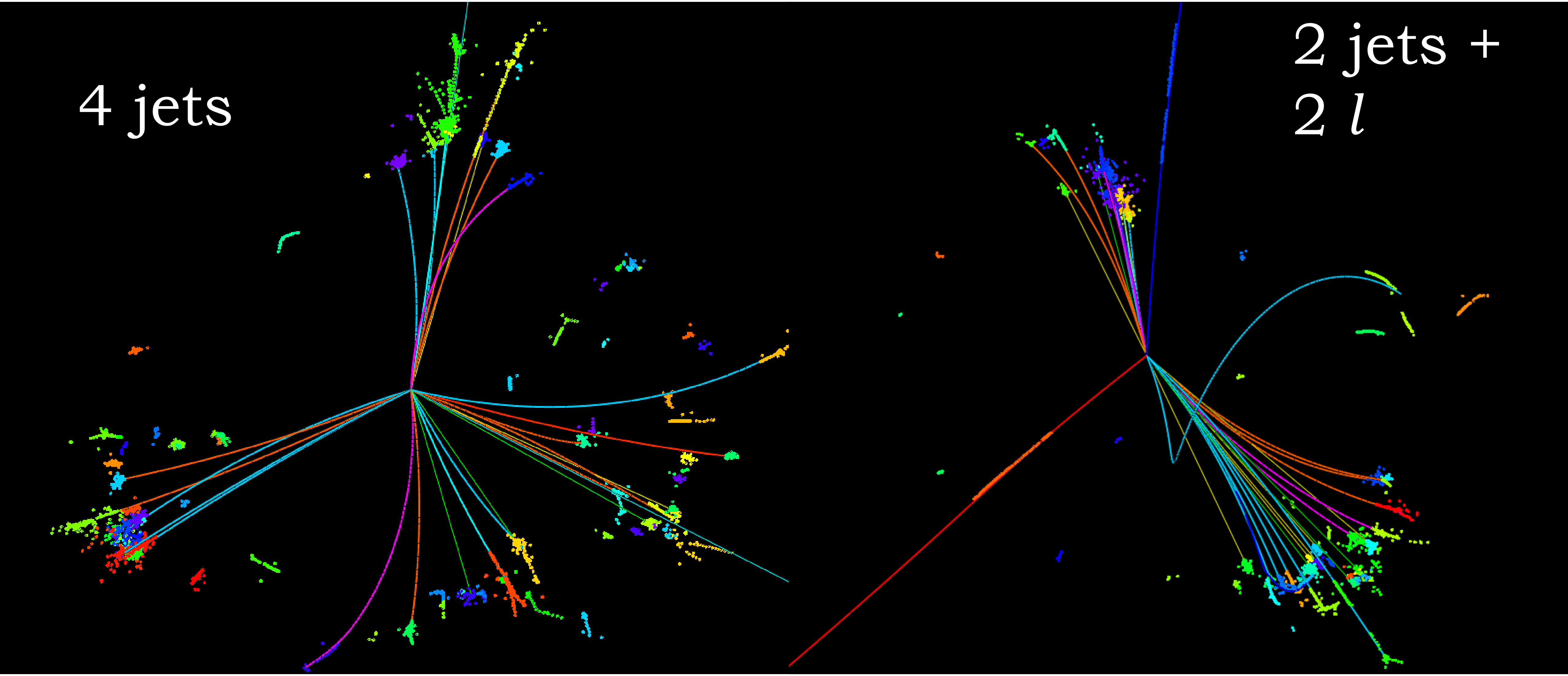
Smaller boosts induce a larger separation between jets , when compare 500 or 800 GeV ECMS

For example WW at 800 GeV , the W decays to jets create a di-jet , large and broad particle structure

WW final state into 4 jets at 800 GeV centre of mass energy



# ZH final state at 250 GeV centre of mass energy



PFA performs better than in higher center of mass energy
Reconstruction is therefore based on

- A full topological separation

- smaller use of recovery iteration (usually based on Energy Flow “a la CMS” (i.e. Pandora))

→ Better performance is expected

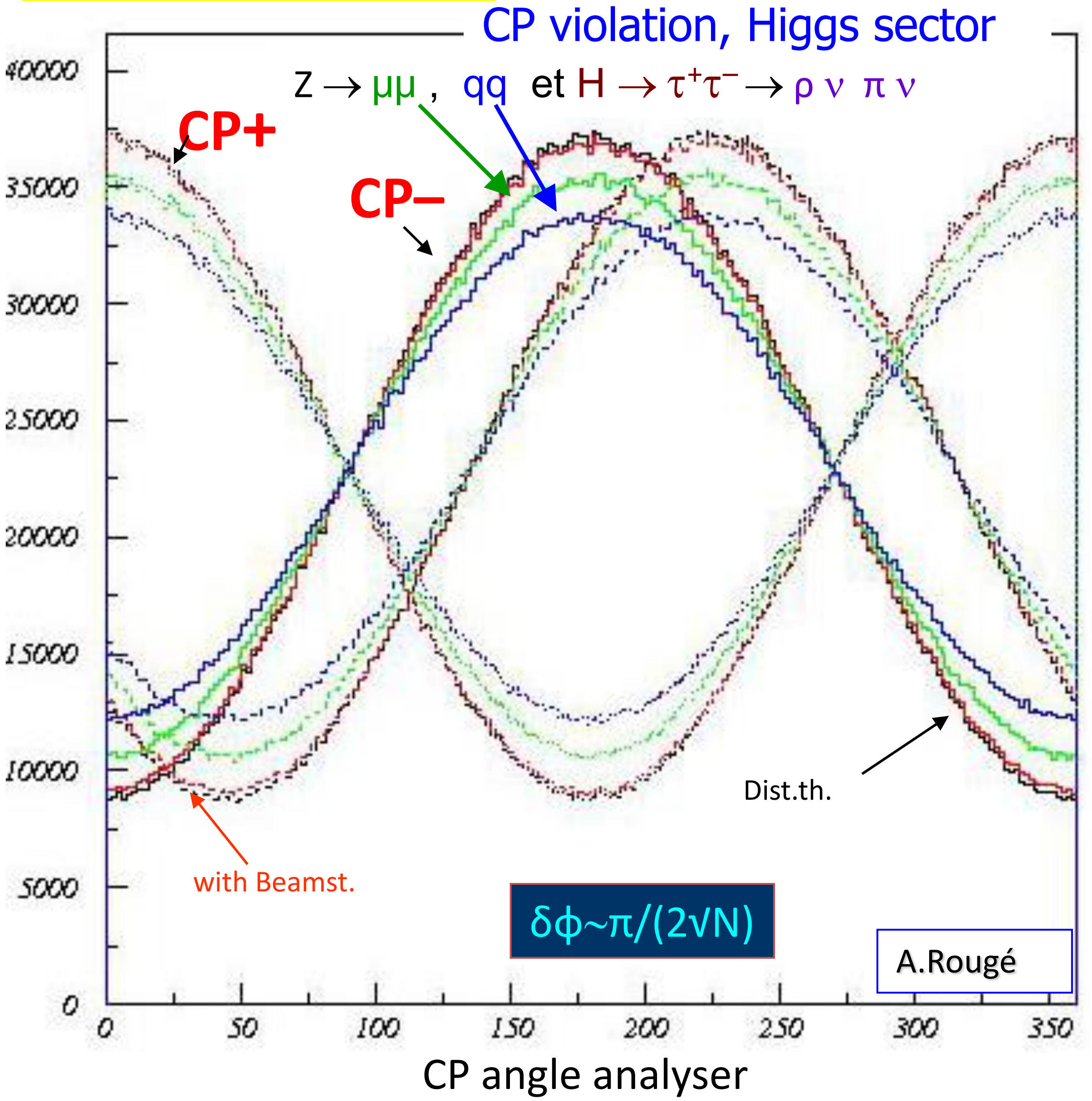
## Which jets we are talking about

- Energy
- where in the detector
- density of jets

## But jets are not the end of the story

Tau as polarimeter for Z decays to τ τ , polarization and AFB(Pol) , which could be affected by *Z'* somewhere , BUT ALSO for a very important piece of the program at ILC : the CP violation in Higgs decays

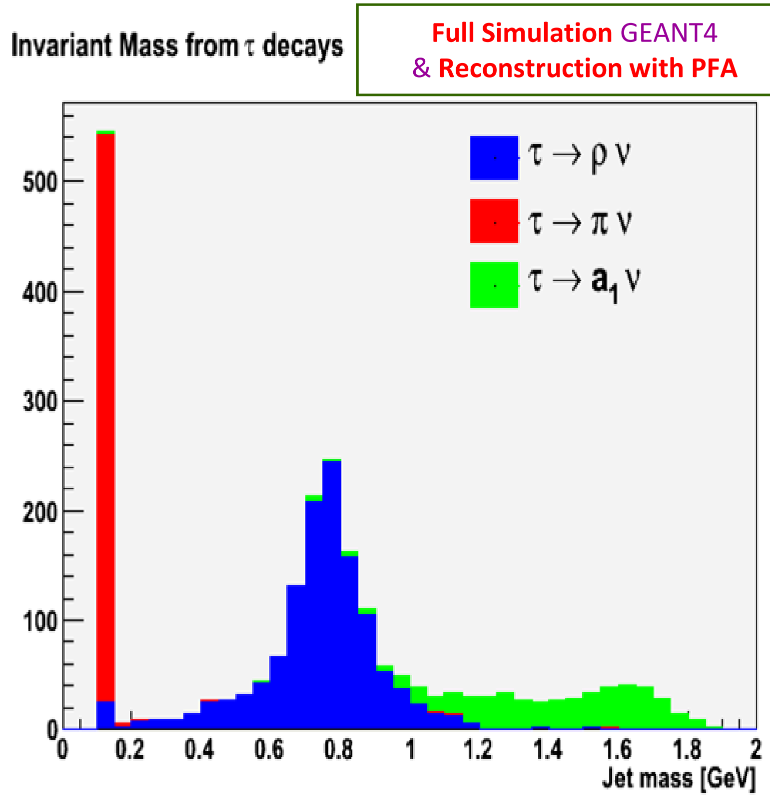
$e^+ e^- \rightarrow ZH \rightarrow Z\,\tau^+\tau^-$

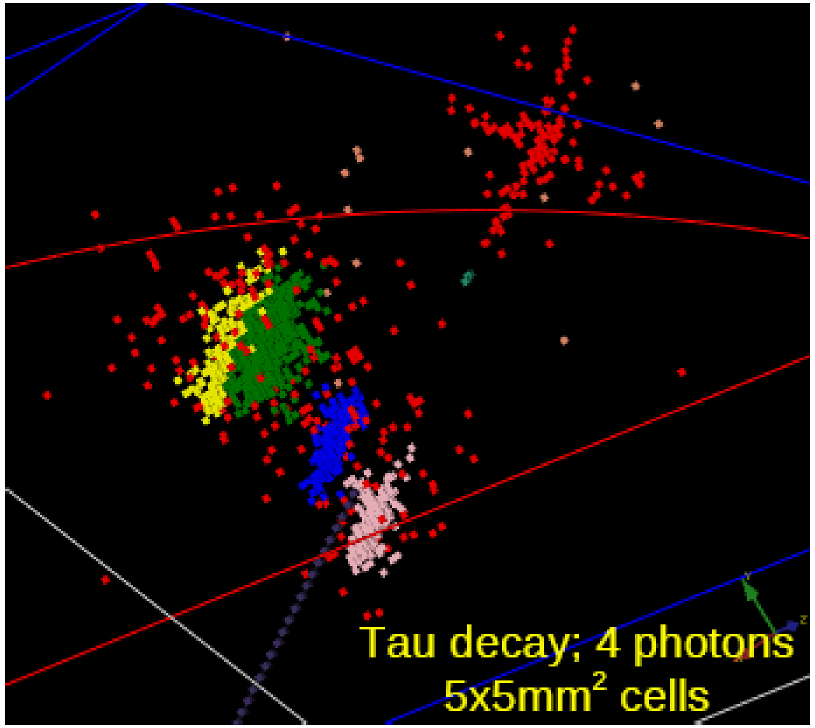


# $\tau^{\pm}$ as a polarisation analyser

→ Need to reconstruct photon(s) in dense environment…. **Even at 250 GeV**

Full Simulation GEANT4
& Reconstruction with PFA



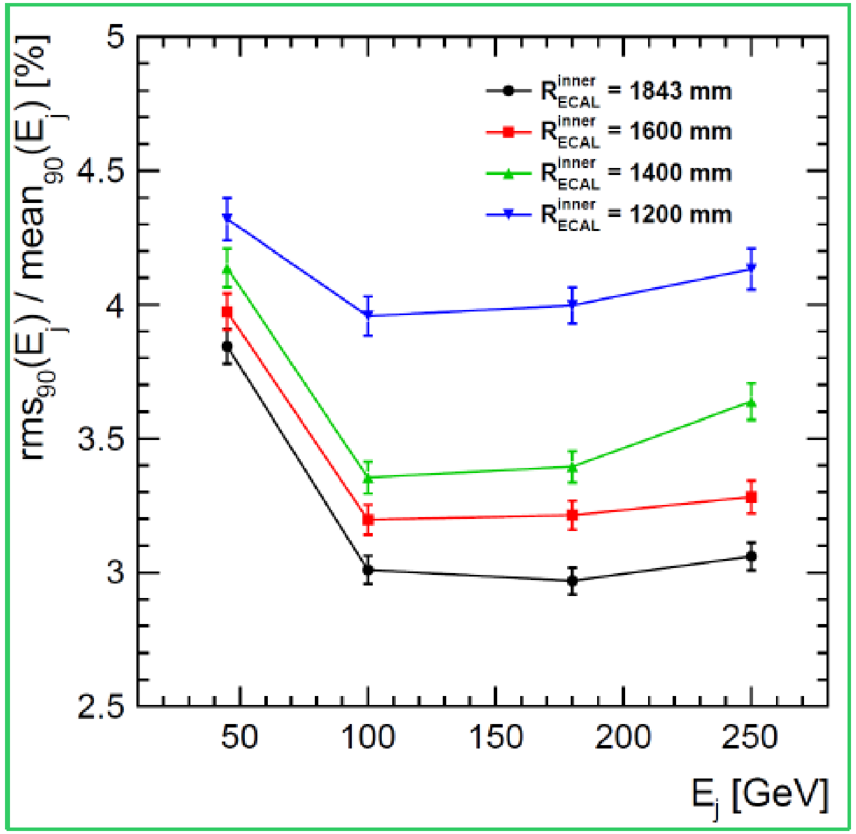

| | Jet mass < 0.2 | Jet mass in 0.2-1.1 | Jet mass >1.1 |
|---|---|---|---|
| $\tau \to \pi\nu$ | 90.2 % | 1.7 % | 8.1 % |
| $\tau \to \rho\nu$ | 1.7 % | 87.3 % | 7.4% |
| $\tau \to a_1\nu$ | 0.6 % | 7.4 % | 92.0 % |

Performances depends strongly on ECAL granularity
Not so much on ECAL radius

# To summarize !!

Impacts on the ECAL design and cost optimization

Changing the geometry
- Reduction of radius
- Reduction of the number of layers
- Optimise the B-Field




Changing the constraints
- Granularity (lateral size)
- S/N at mip MPV
- Compactness
- Dynamic

Changing the technology
- Active device
- Radiator material

# Impacts on the ECAL design and cost optimization

## Changing the geometry

- Reduction of radius → Interesting , since the boost is lower
- Reduction of the number of layers → No, it will play an important role on $(\Delta E/E)\gamma$
- Optimise the B-Field → But, keep in mind the ILC phase-2 , at 500 GeV

## Changing the constraints

- Granularity (lateral size) → to be adapted to 500 GeV !!
- S/N at mip MPV → >10σ seems the minimum . (DAQ)
- Compactness → Overall cost of HCAL, Coil, Return Yoke
- Dynamic → 14 bits (0.1 to 1300 mip) for 1 $cm^2$ cells

## Changing the technology

- Active device → Silicon for S/N at MIP, stability, compactness,
- Radiator material → Tungsten for compactness, Rm, X0,

# Impacts on the ECAL design and cost optimization

**Changing the geometry**

- Reduction of radius → Interesting , since the boost is lower
- Reduction of the number of layers → No, it will play an important role on $(\Delta E/E)\gamma$
- Optimise the B-Field → But, keep in mind the ILC phase-2 , at 500 GeV

**Changing the constraints**

- Granularity (lateral size) → to be adapted to 500 GeV !!
- S/N at mip MPV → >10σ seems the minimum . (DAQ)
- Compactness → Overall cost of HCAL, Coil, Return Yoke
- Dynamic → 14 bits (0.1 to 1300 mip) for 1 $cm^2$ cells

**Changing the technology**

- Active device → Silicon for S/N at MIP, stability, compactness
- Radiator material → Tungsten for compactness, Rm, X0,

# Conclusion

- No need for large B-Field   (3 T could be enough, even at 500 GeV)
- No need for large radius (1.5m seems well adapted)

BUT
- Need good em resolution (prefers to keep as large as possible the number of layers)
- Need good granularity, at least for final state with $\tau$

STILL need

- Good S/N at mip, compactness and stability