Si-W ECAL design

- ECAL optimisation , first step
- photon reconstruction as ECAL optimiser
- Is it possible to optimise the ECAL alone ?
- optimisation on performances using "physics" MC event (i.e. tau)

J-C. Brient (LLR-CNRS-IN2P3/ecole polytechnique)

SiW ECAL performance optimization

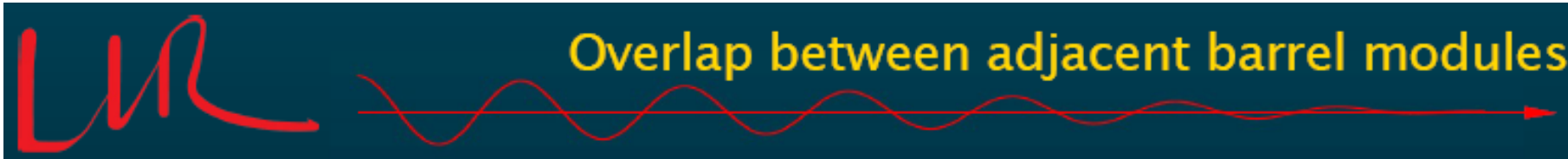
(what affects the performances, optimization issues)

➢To test what is affecting the performances , we need
- high level of realism for the simulation
- test beam with prototype very close to the final detector one

Pixel size,
Layer number
Dead zone
Occupancy
Linearity
etc...

MOKKA
and
TEST BEAM
interaction

Overlap between adjacent barrel modules



By going from 2.8 to 2.1 in the first half
we expect to improve at most by 15%.

we do

From Monte-Carlo (Valencia)

Energies (GeV)	0.2	0.5	2.	5.	10.
ΔE/E 30x2.8 mm	0.365 0.009	0.230 0.004	0.130 0.003	0.084 0.002	0.057 0.002
ΔE/E 20x2.1+10x4.2 mm	0.295 0.008	0.212 0.004	0.112 0.003	0.074 0.002	0.053 0.001
improvement	24 ± 6%	8 ± 4%	16 ± 6%	14 ± 6%	8 ± 6 %

For the same total thickness, the same number of X0
the resolution is systematically better with a finer sampling in front.
The efficiency also!

It is clearly valuable to keep two thicknesses

but the overlap is more awkward

SiW ECAL performance optimization

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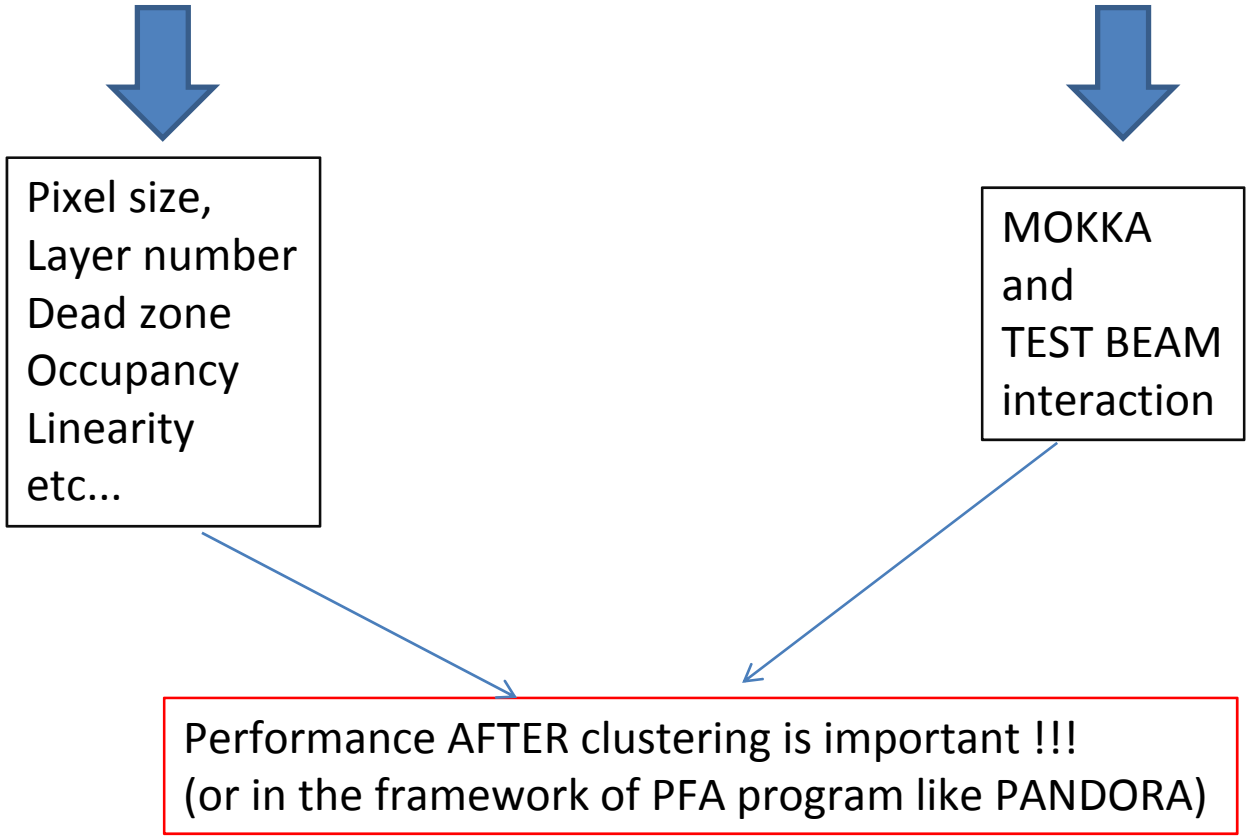


Photon reconstruction using the son of REPLIC : GARLIC (C++ and Marlin acceptable)

Marcel Reinhard, JCB

The algorithm

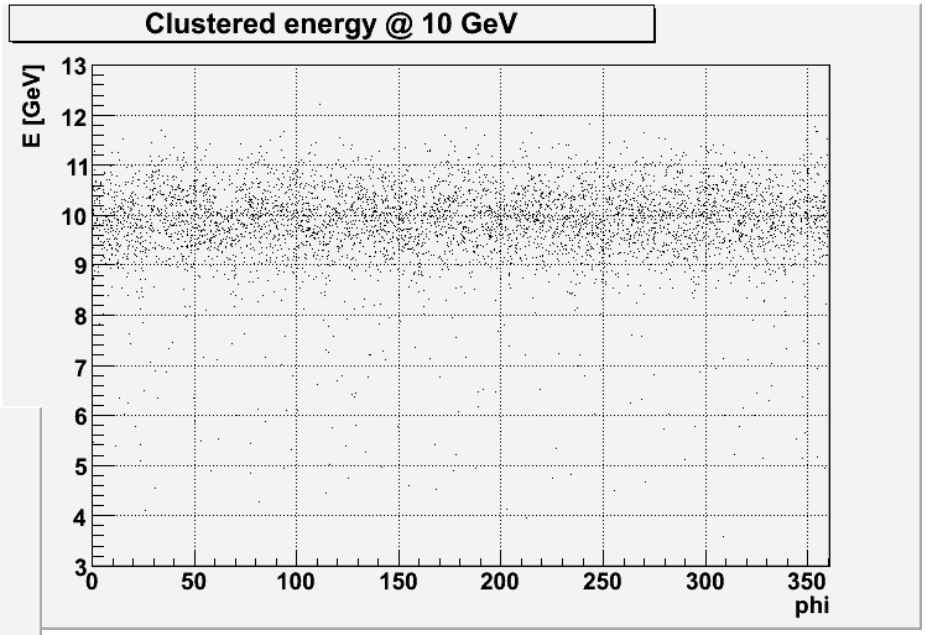
- Based on REPLIC
- Marlin processor
  in: tracks, ECAL hits
  Out: Photon clusters
- Seed search via 2-dim energy projection in first $7X_0$
- Clustering based on neighbour criterion
- Several iterations from front to back
- Originally designed for pointing photons, now works for all angles
- Rejection via simple criteria (#hits, minimum energy, seed criteria,...)

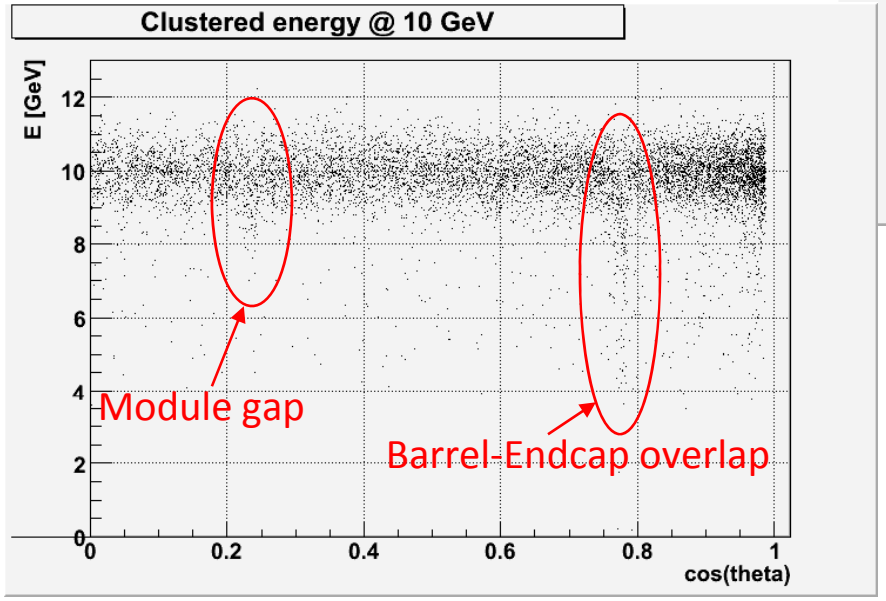
+ Computation of cluster variables (Eccentricity, width, direction, energy deposit in different regions,...)

- Correction for guard ring and module gaps
- Use track extrapolation and cluster criteria to reject pions

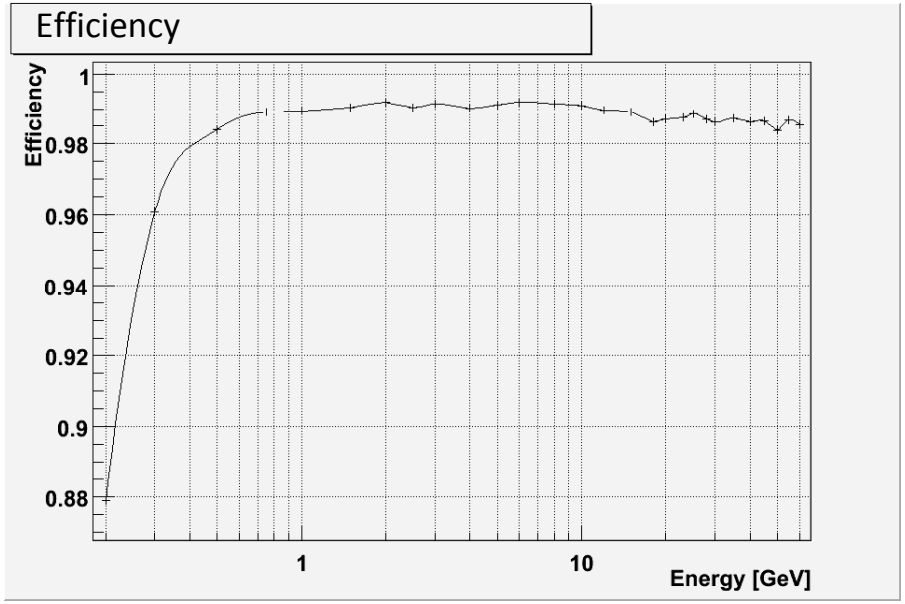
Model : LDC'

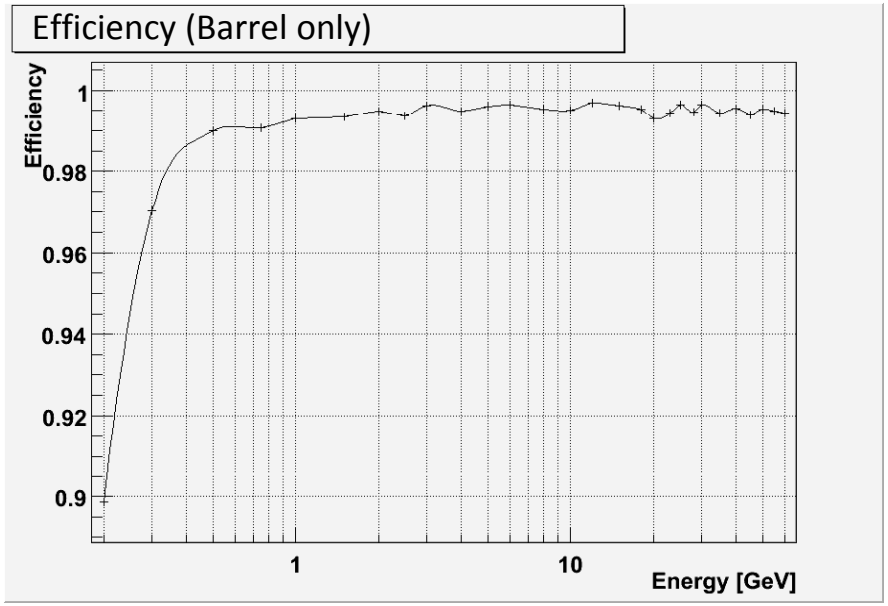
Lost Energy

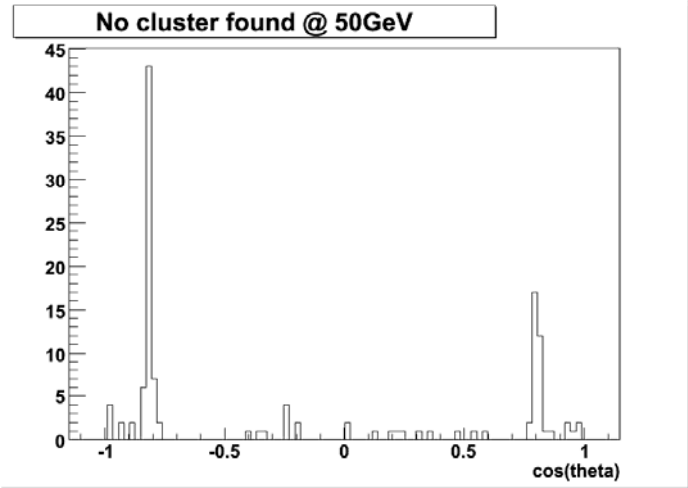




Efficiency





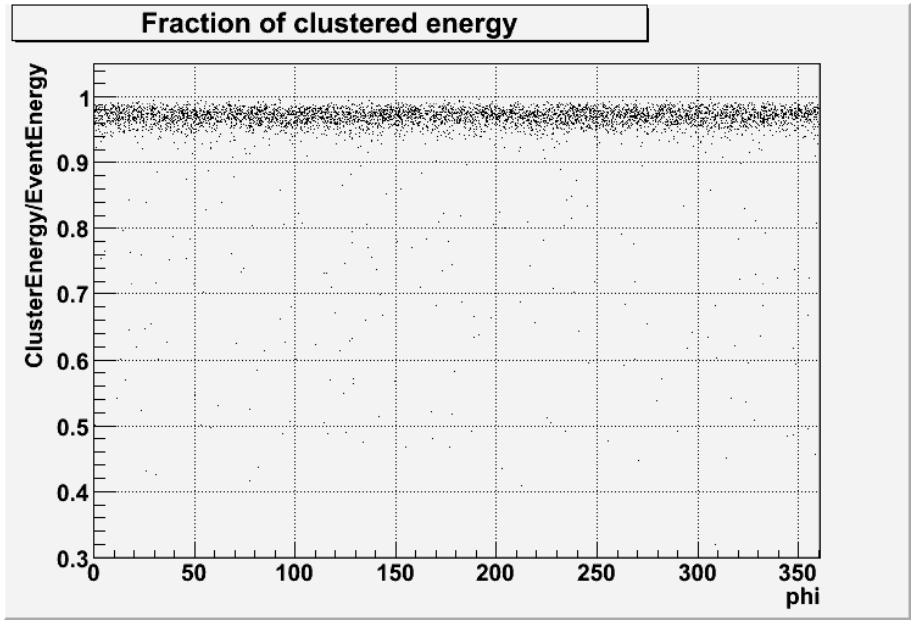


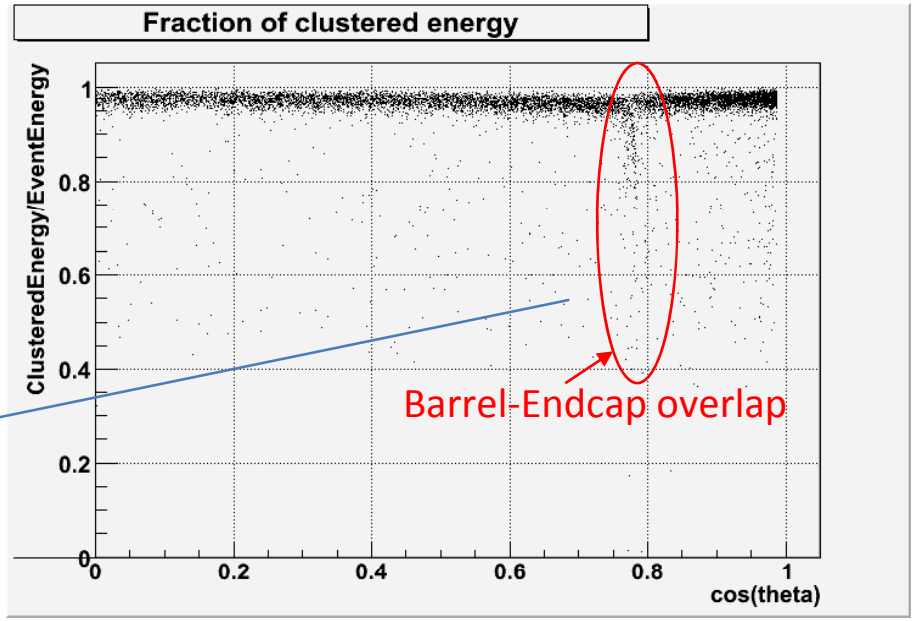
Still problematic:

- Barrel-Endcap overlap region

- Very late interacting photons (layers 11+)

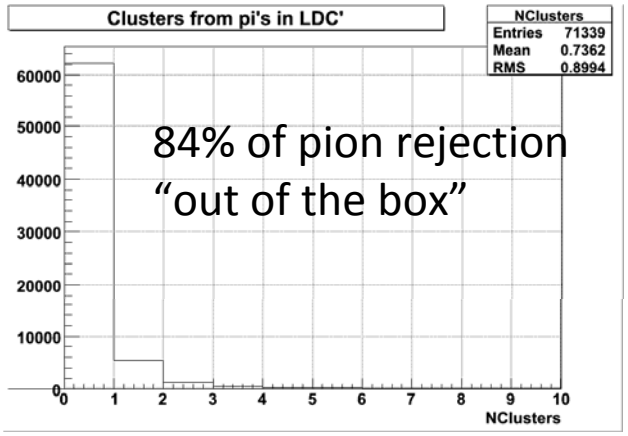
Clustered Energy @ 10 GeV





Minimise the use of the overlap,
For example , we must avoid the
Use of the overlap for electronics
In the ECAL or HCAL

Pion rejection

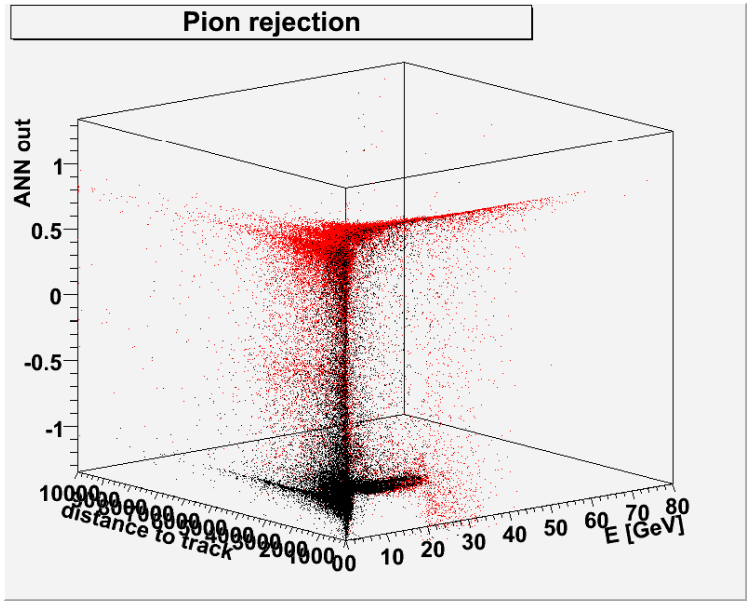


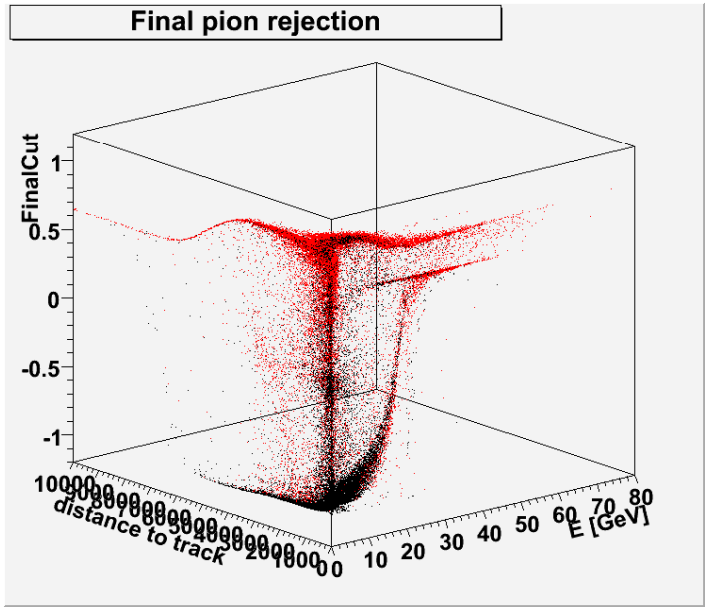
For the rest:

- Feed cluster attributes to an ANN

- re-feed ANN out, distance to track and energy to obtain final “probability”

- different cuts for different energy regions





Is it possible to continue the ECAL optimisation in stand alone ?

The reconstruction of gammas can be used to optimise the other ECAL parameters

But Who test the level of gamma conversion ?

But Who test the level of charged pions interaction which create a lot of Real photon from “fake” energy ?

Lets continue on this direction

What is true for SID has to be true also for ILD
As long as we are speaking of comparable detector

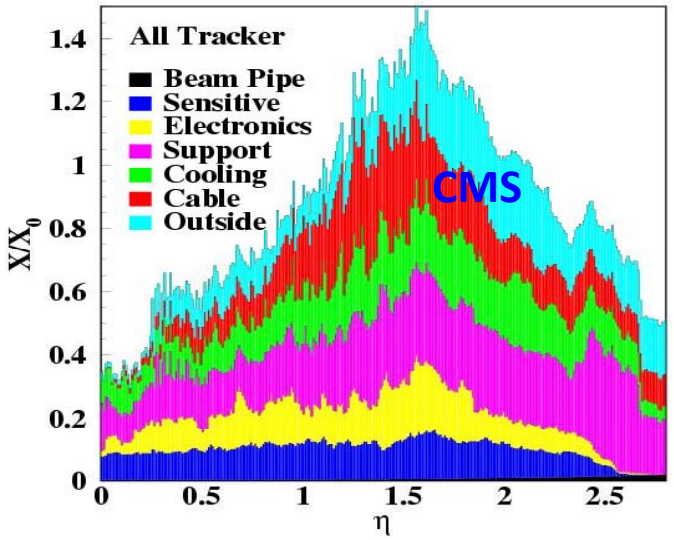
INTERACTIONs of charged hadrons in the numerous layers of silicon (VDET, tracker)
Contribute to about 50% of the jet Energy resolution, comparable to
Sigma confusion from showers mixing !!

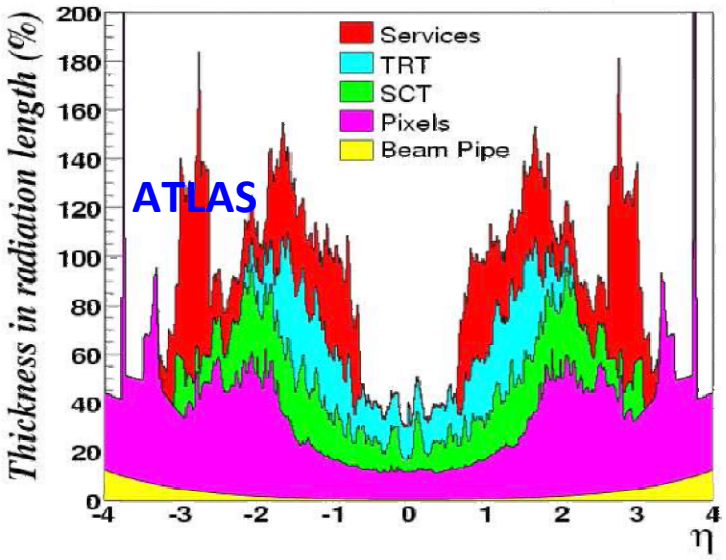
"because of material due to silicon layers, SID is NOT a detector optimised for PFA "
From SID PFA expert (of course not official)

What about the impact of silicon layers in ILD ? **THE SAME**

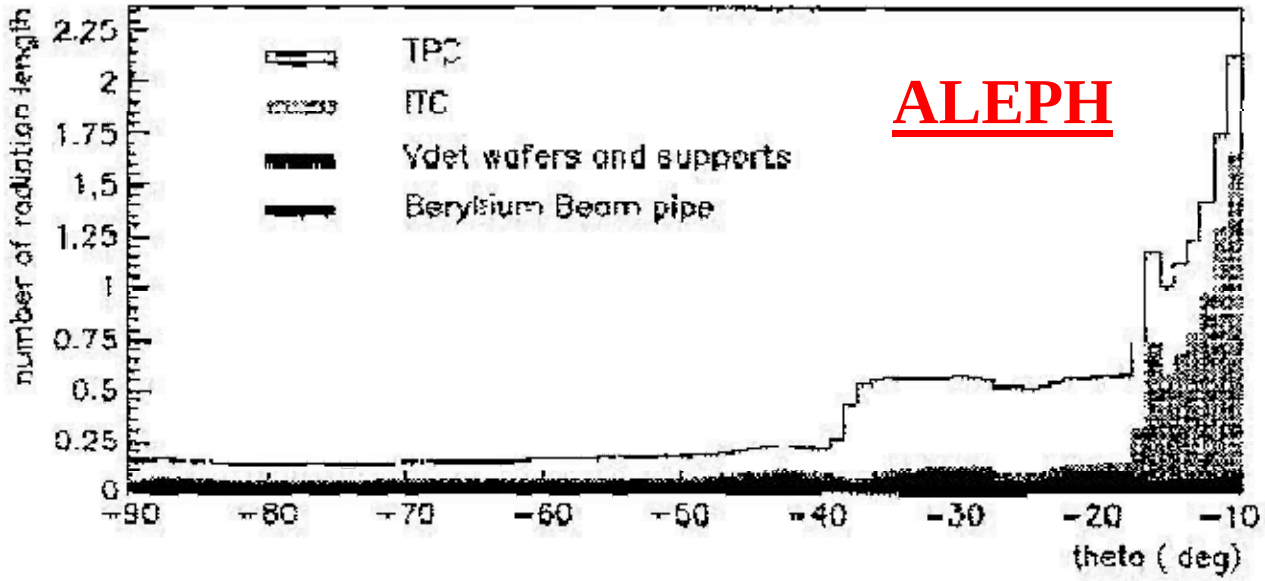
Not sure it is taken into account because of the definition of the "stable particles"
In PANDORA studies !! (Mark could you confirm ?)

PFA at LC is incompatible with this





It is not a dream, ... It is ALEPH



Point 3 :

WARNING on the use of any type of “physics” final state
to optimise the detector can damage the picture
If we don’t do the full study !!

Situation at Z peak

Final state	program	Cross section (mb)	Disentangling with signal
Voie s – τ τ	PYTHIA	$2.0\ 10^{-6}$	**SIGNAL**
Voie s – **e+e-**	PYTHIA	$2.0\ 10^{-6}$	VERT+ em TOTAL ENERGY and ELECTRON ID
Voie s - **μ+ μ-**	PYTHIA	$2.0\ 10^{-6}$	VERT+ Muon ID and total Ch. energy
$\gamma\gamma \rightarrow$ f fbar	PHOJET	**$2.3\ 10^{-6}$** (pre-scaled)	VERT+ Acol, Acop and Pt mis
Bhabha e+e- Angular cut at cos polar <0.99	BHWIDE	**$1.0\ 10^{-5}$**	VERT+ em TOTAL ENERGY and ELECTRON ID
W+W- to τ τ	PYTHIA	**0**	
TOTAL non- exhaustive		**$1.8\ 10^{-5}$**	

S/N about 1/9

- reconstructed vertex for 30% of the sample
- Total ECAL energy
- Total Charged particle energy
- Charged particle ID : e/μ/$h^{\pm}$

Situation at 1 TeV, without beamstralhung

Final state	program	Cross section (mb)	Disentangling with signal
Voie s – τ τ	PYTHIA	$1.2\ 10^{-10}$	**SIGNAL**
Voie s – **e+e-**	PYTHIA	$1.2\ 10^{-10}$	VERT+ em TOTAL ENERGY and ELECTRON ID
Voie s - **μ+ μ-**	PYTHIA	$1.2\ 10^{-10}$	VERT+ Muon ID and total Ch. energy
$\gamma\gamma \rightarrow$ f fbar	PHOJET	**$4.3\ 10^{-6}$** (pre-scaled)	VERT+ Acol, Acop and Pt mis
Bhabha e+e- Angular cut at cos polar <0.99	BHWIDE	**$0.9\ 10^{-8}$**	VERT+ em TOTAL ENERGY and ELECTRON ID
W+W- to τ τ	PYTHIA	**$2.2\ 10^{-9}$**	**20% irreducible and VERY asymmetric**
TOTAL non- exhaustive		**$4.31\ 10^{-6}$**	

S/N about 1/36000

Center of mass Energy	S/N	Selection efficiency
Z peak	1/9	0.85
1 TeV	1/36000	??

If we don't do the **full physics study** ,

Any conclusion on partial study can just be wrong or at least meaningful

My conclusion today

About optimising the ECAL for PFA !!!!

Firtst step : remove a maximum number of silicon layers and X0 of TPC electronics

Second step : count the number of gamma conversion and charged hadrons interaction In the inner layer of the tracker

Third step : Use a dedicated photon reconstruction program (i.e. GARLIC) in jet

But before all of that

My conclusion today

About optimising the ECAL for PFA !!!!

Firtst step : remove a maximum number of silicon layers and X0 of TPC electronics

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But before all of that

Step zero : FIND MANPOWER !!! (first response to Hitoshi , the first consequence of the LOI : Increase the pressure on the manpower)

REAL R&D on Technical for ECAL (at least SiECAL) Take 100% (or so) of the manpower

Contribution to the LOI ??????????????