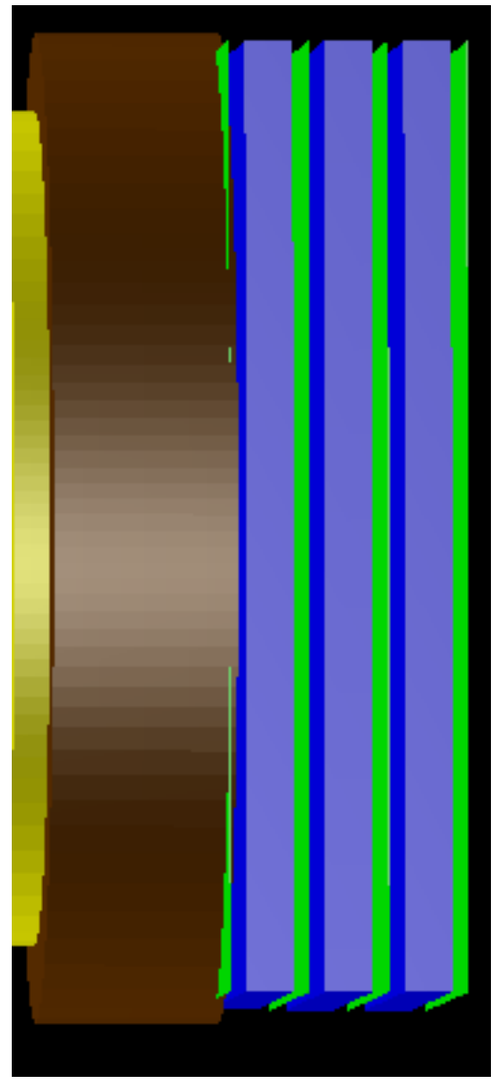
PID studies plans



Here I talk about the general structure

The detailed sub-detector plans are presented by the speakers after me

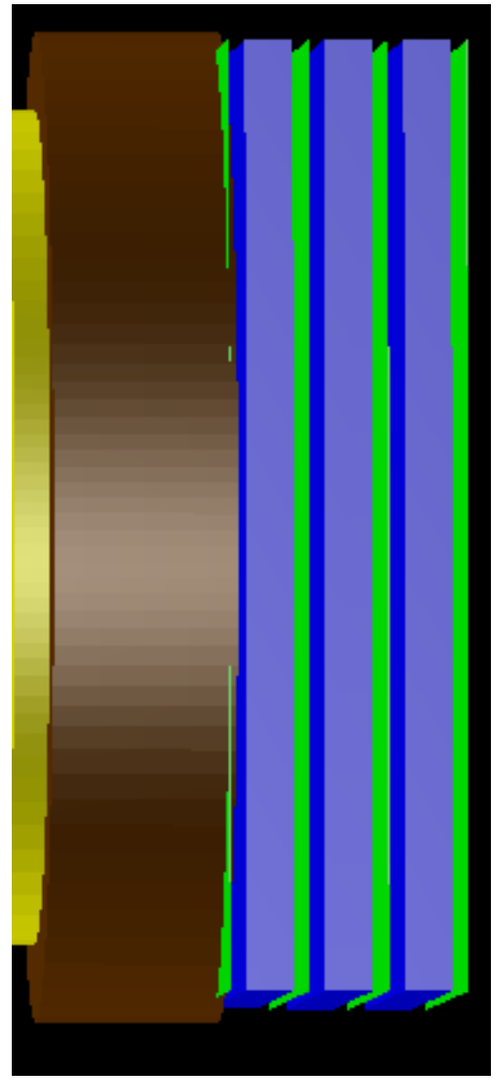
Detector: so far

In the TP we have included:

1. **ECAL: Shashlik; 25X0; 12x12cm2 modules —> 6x6cm2 readout cells**

2. **HCAL: Shashlik; 2 segments 24x24cm2 modules; with ECAL it makes 6.7λ_I**

3. **muon detector with 4 absorbers (3.7λ_I each)and 4 active layers —> detection planes as extruded plastic scintillator bars with long WLS fibres read out on both sides**



Now it is time to start to optimise the system and move to a Technical Design (if possible) and improve the realism of simulations.

New ideas also emerged recently adding more requirements to ECAL.

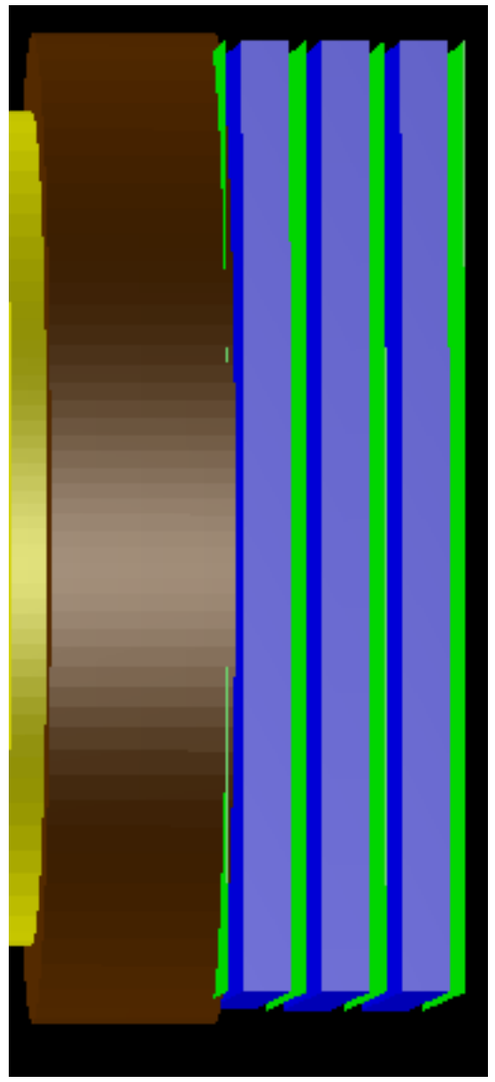
Simulation: so far

We have a FairSHiP implementation of

1. **ECAL with clustering**

2. **HCAL no clustering so far**

3. **muon detector—> the detection planes as one scintillator —>division in pads done at analysis level**



For the TP performance:

PID with ECAL (e/π) and MUON(π/μ) tested with FairSHiP without B field (no track extrapolation in B field)

ECAL/HCAL performance for (π/μ) tested with stand-alone MC

PID TOOL IN FairSHiP

Behzad

So far no PID tool in FairSHiP

Now this is implemented: for each track the end user would know, at state of the art knowledge of the PID team, if it is identified as muon, electron or hadron

This is indeed very important to optimise the PID system with physics channels based on performance

main new ingredient: track extrapolation in B field; now working

PID TOOL IN FairSHiP

Behzad

The implementation is only a skeleton.

CALO and MUON teams are invited to provide Behzad, who is responsible for this tool, with the "official" recipes of cuts and variables to be implemented in FairSHiP

1. **for MUON very flexible setup with selectable FOI**

2. **what do we implement for CALO? likelihoods? so far only E/P for ECAL and Δx; other variables needed to improve ID; need some PID for HCAL as well —> to be done**

Need to develop inside FairSHiP tools (histogramming) for calibration (e..g #hits/layer, Δx of hits ecc.) when changing layers, ECAL structure ecc. —> Behzad UNDERWAY

Photon direction

with Daniel Treille and J. Chauveau

First, who could be the clients?

1) ALP—>γγ

2) HNL,HP,DP—> X+n(γ) : Jacques is studying this

—> either to suppress backgrounds or simply to convince people that signal is really signal

Need information about longitudinal AND transverse shape of showers

Present ECAL is blind to the photon direction

Is it possible to have some ECAL (++ features) allowing for determining the shower direction ?

Photon reconstruction and Shower pointing

The subject apparently has never been studied in detail (interesting): no ECAL was ever optimised for this goal

For space experiments such as MAGIC and FERMI a technique was implemented with detecting the first conversion in thin absorber layer —>low efficiency

For SHiP we need some detector efficient (say >90%) and with best-of-all good angular resolution (say few mrad or better)

Moderate Energy resolution

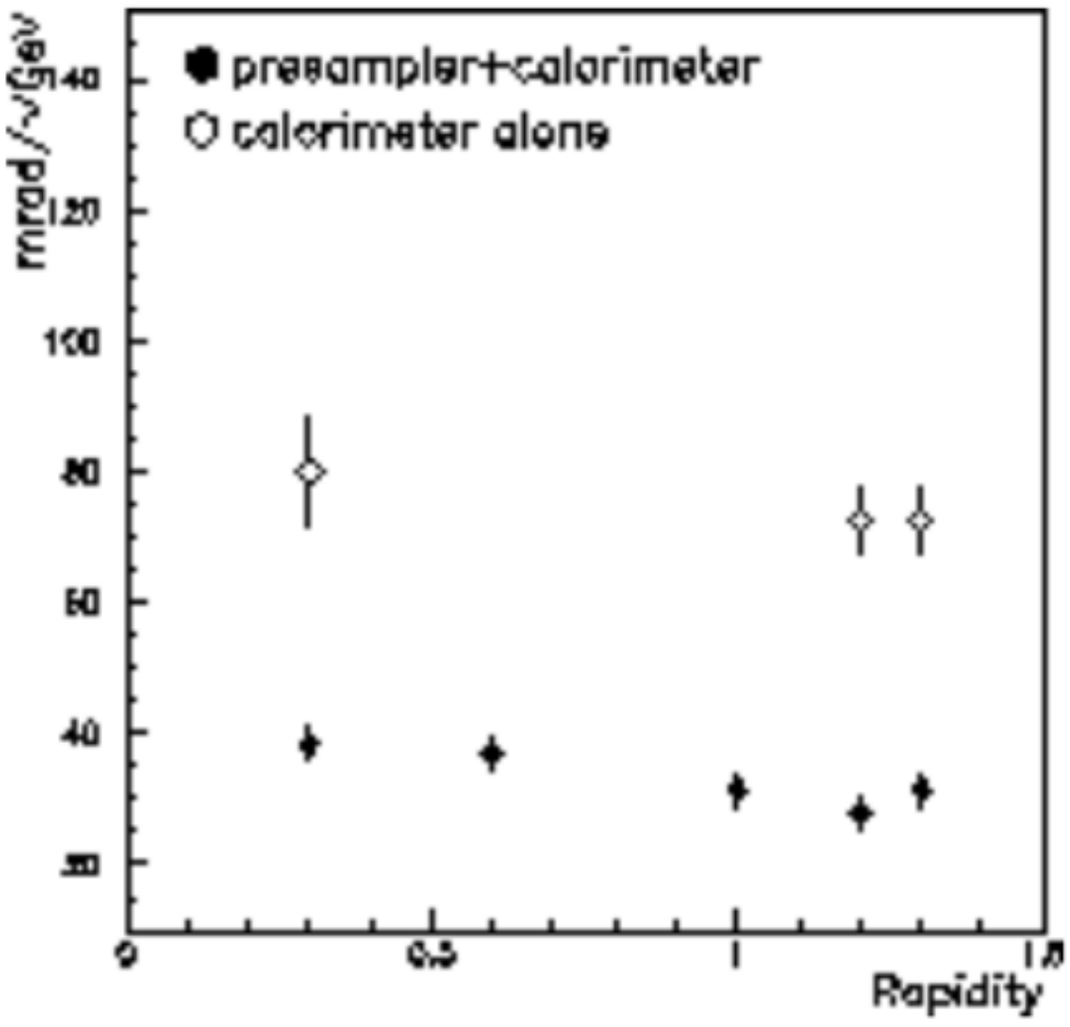
Some past experience

ATLAS $\sigma(\theta)$

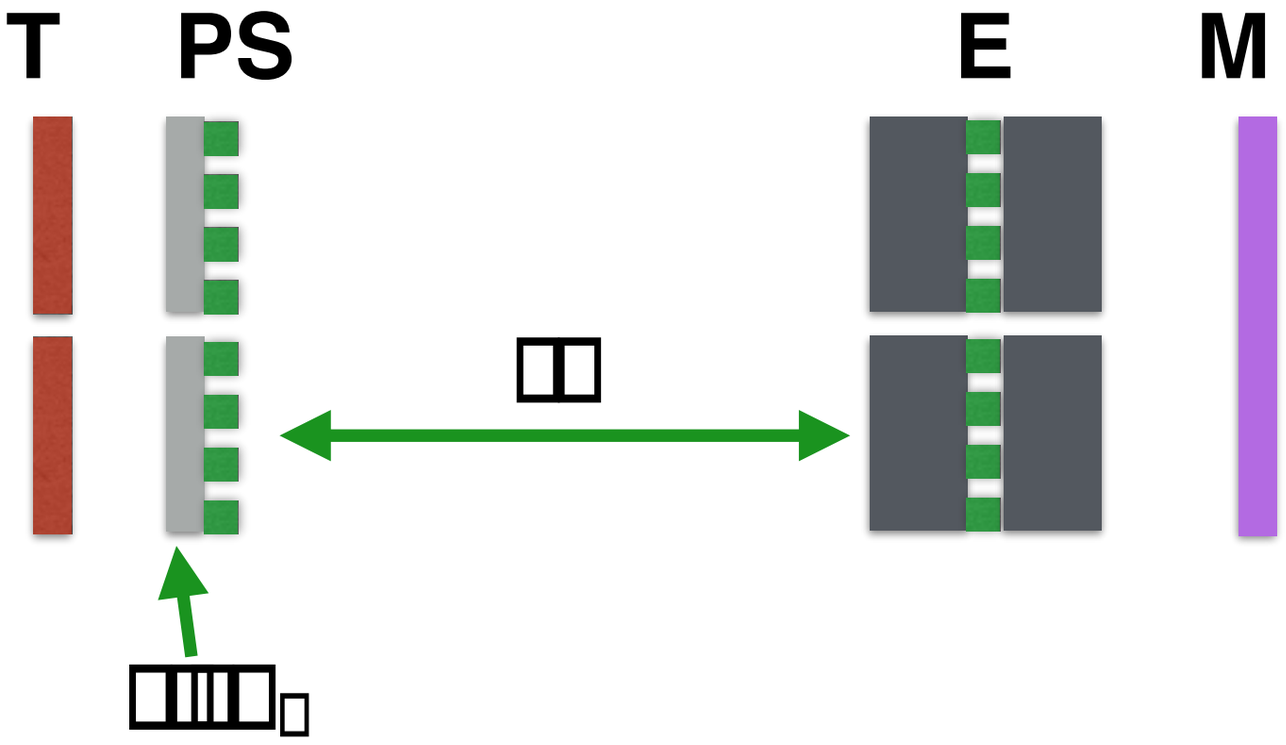
so 20GeV->8mrad

10GeV —> 11mrad

5GeV —> 15mrad



can we do better?



One very first idea.

PS: mm precision; E shower maximum: 1mm precision —> this to reach 1mrad

how precise can one go ? B fringe field? technologies?

possible integration with the timing detector

D.Treille version

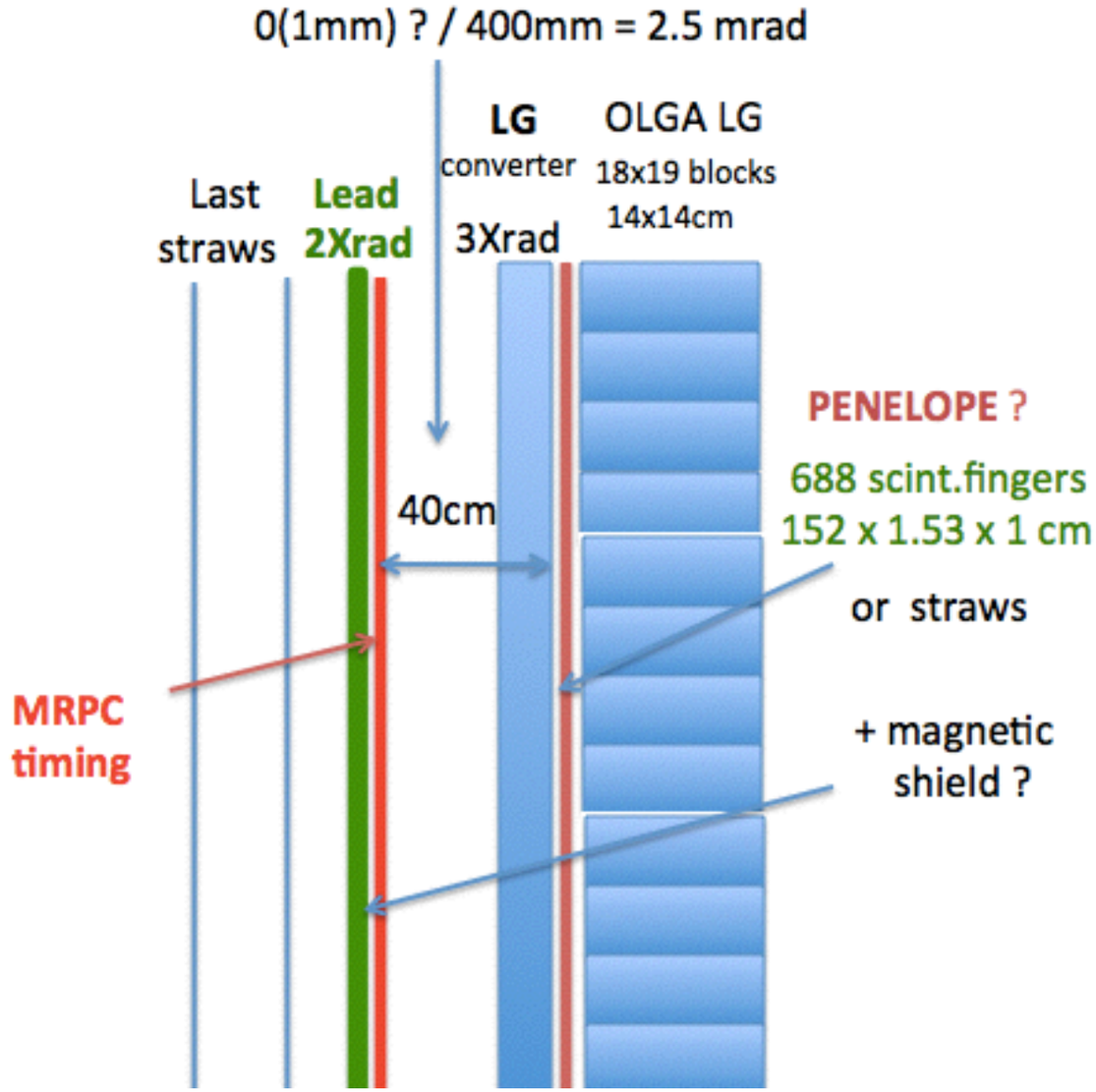
Dans ma jeunesse (OMEGA, NA14) j'utilisais l'ensemble

CONVERTER Lead glass 3 X0 (barres transverses) -- PENELOPE scint.fingers 1 cm width -- OLGA lead glass blocs 18.5 X0, 14 x 14 cm

qui doit encore exister (COMPASS ?). B. d'Almagne était un de ses constructeurs.

On pourrait songer à mettre devant un tel ensemble un premier convertisseur de 2-2.5 X0 de Pb suivi du MRPC timer/tracker. On ferait le tracking entre MRPC et PENELOPE, qui serait alors non loin du max. de gerbe, comme le souhaite Walter. Sauf le Pb tout est "actif" et la résolution en énergie devrait être presque sauvegardée. On compte sur PENELOPE pour identifier les PI0.

Les technologies ont évolué. Mais le verre au plomb doit garder ses mérites. Et nous devons profiter du faible taux et de la simplicité des événements pour essayer de faire pas trop cher.

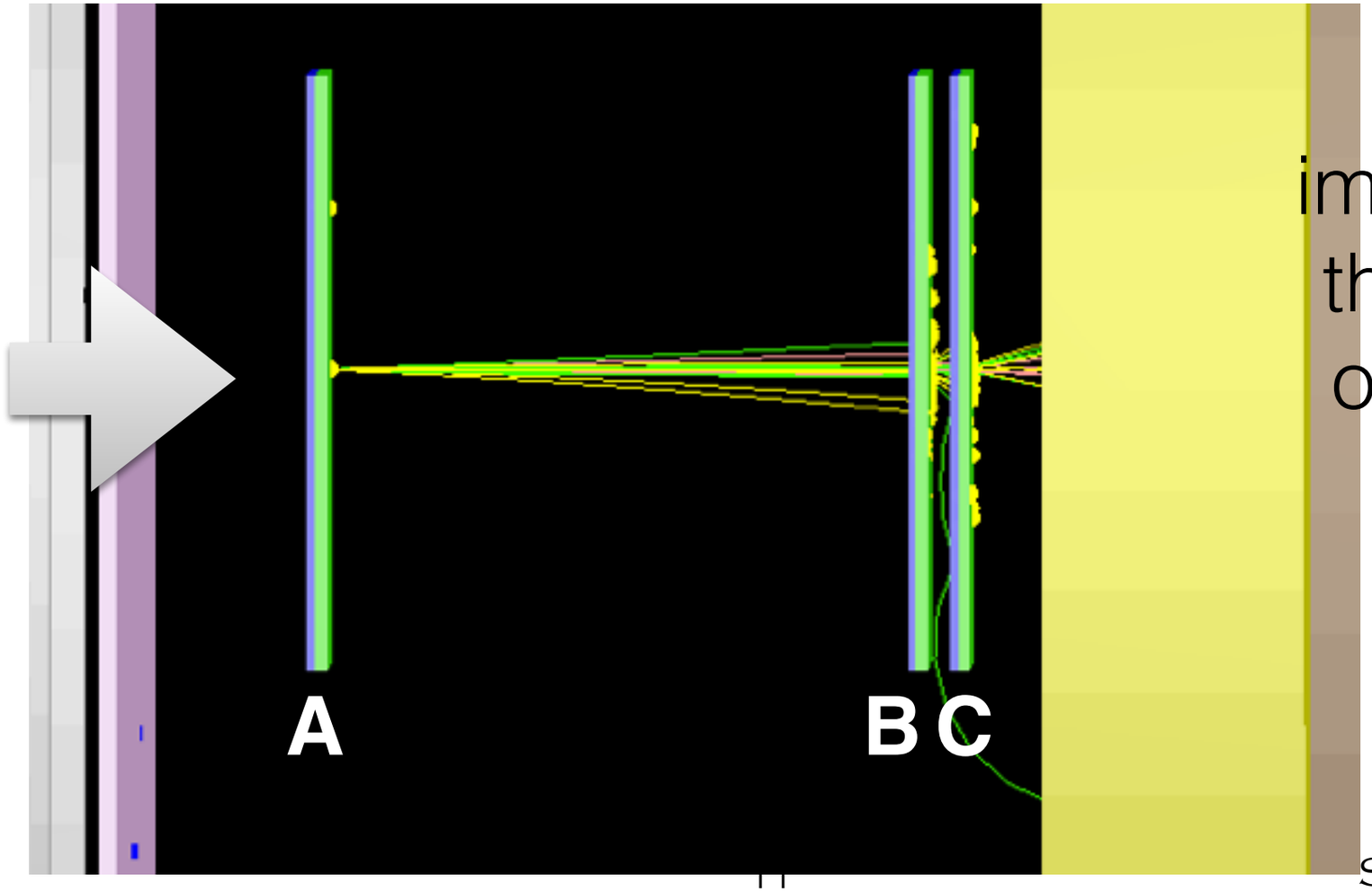


Some trials

With FairSHiP:

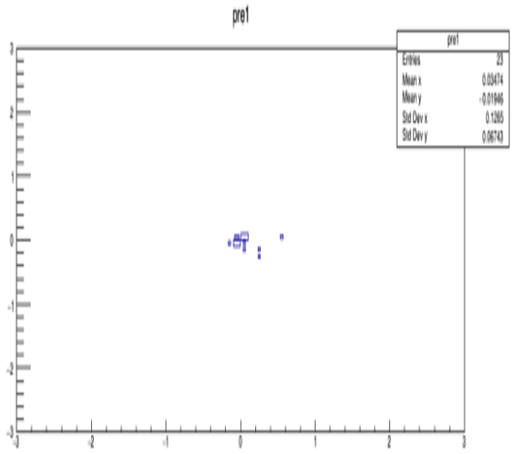
3 layers of scintillator : one sampling the shower at the beginning (2.5X0) and two after another 1.5X0 (as if they were sampling INSIDE the ECAL); 1m lever arm

20GeV γ
θ=0

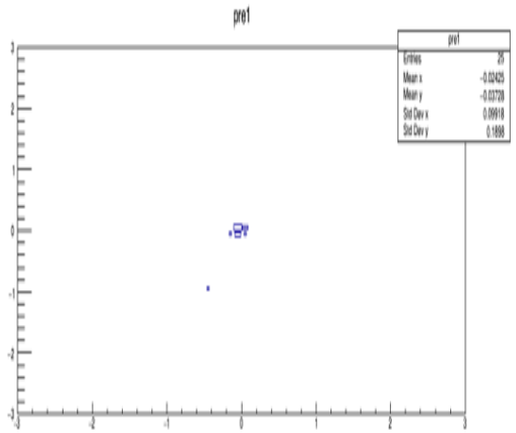


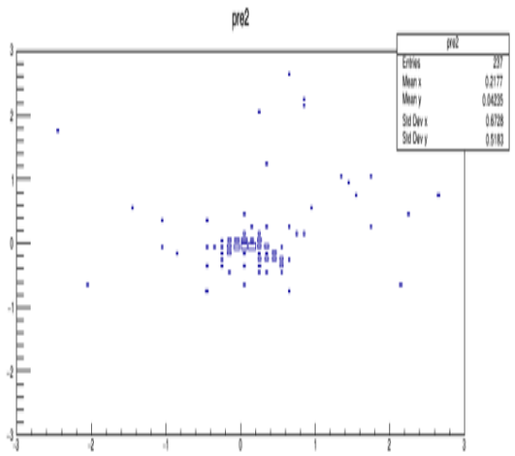
important to have thin exit window of VV like NA62 (He..)

Some events



A





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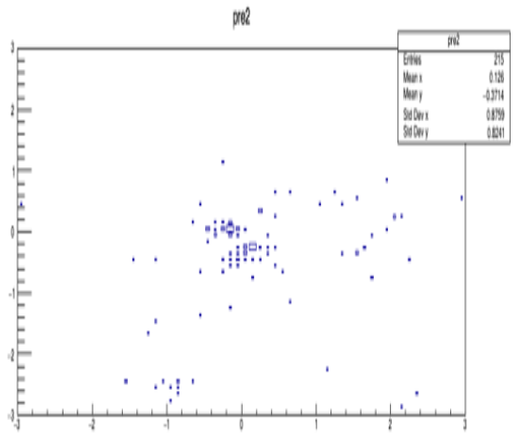
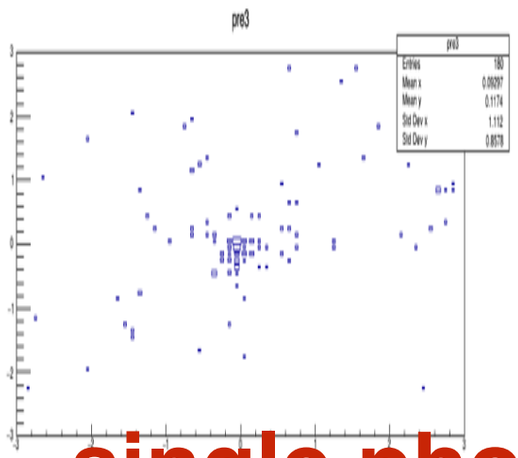
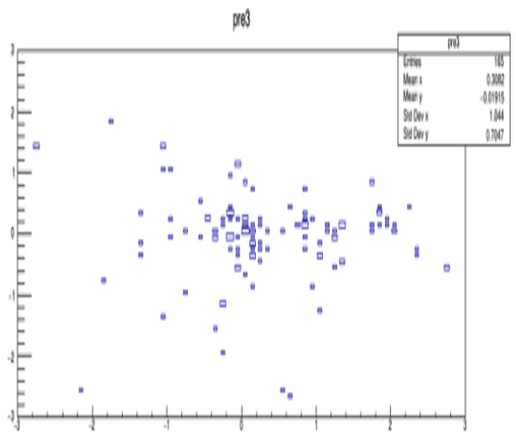


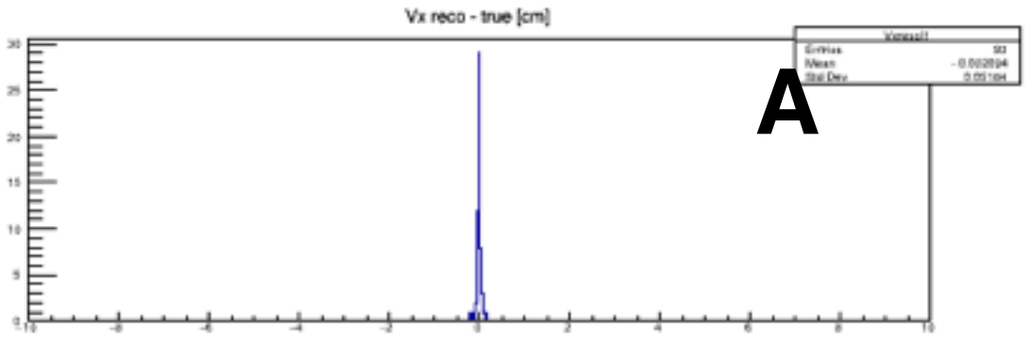


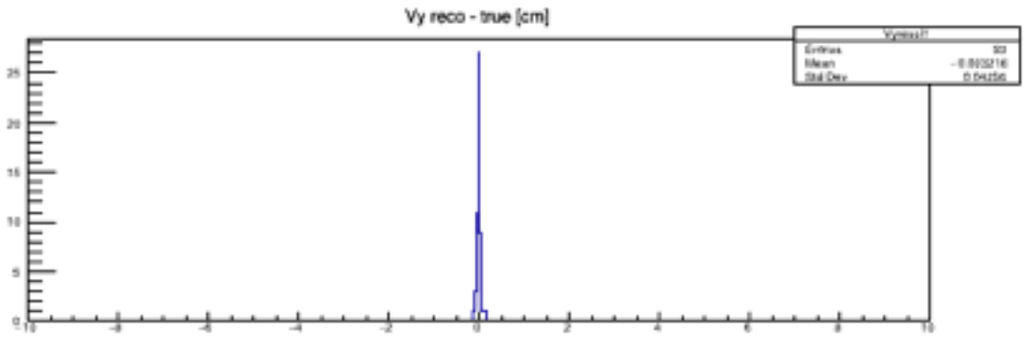
C

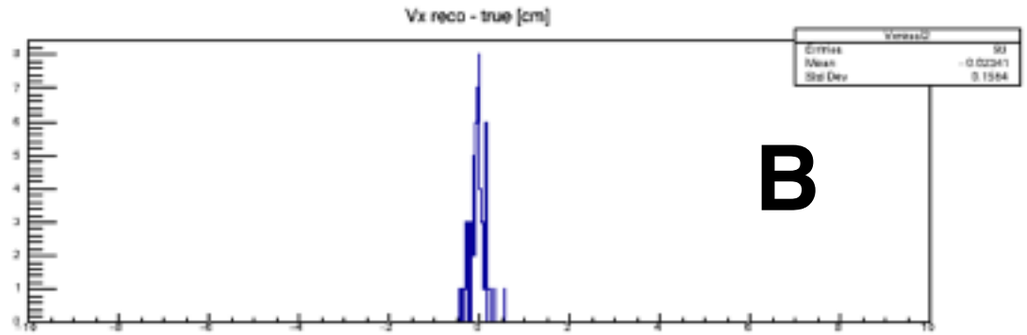


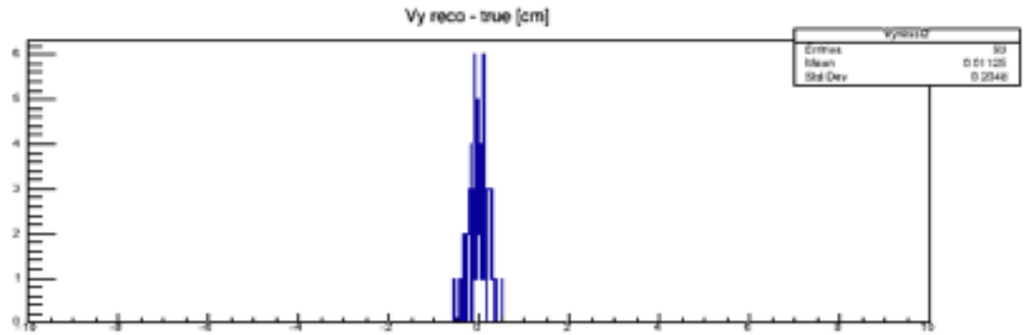
single photons at 0angle; 20GeV; 1mm pixels
—> some clustering is possible

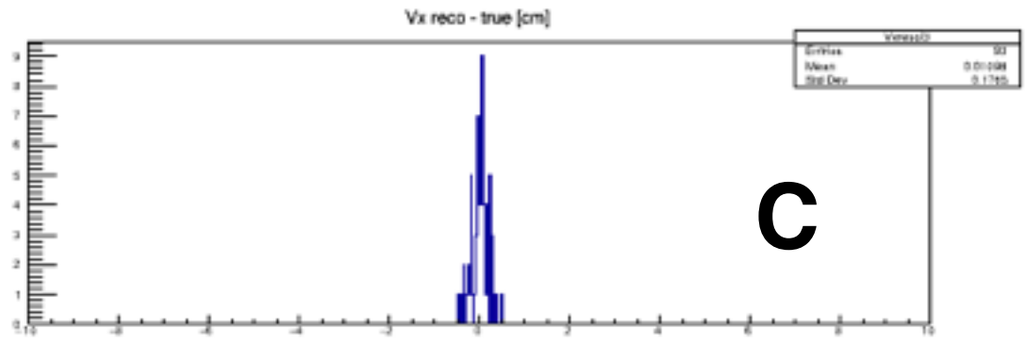
Distributions

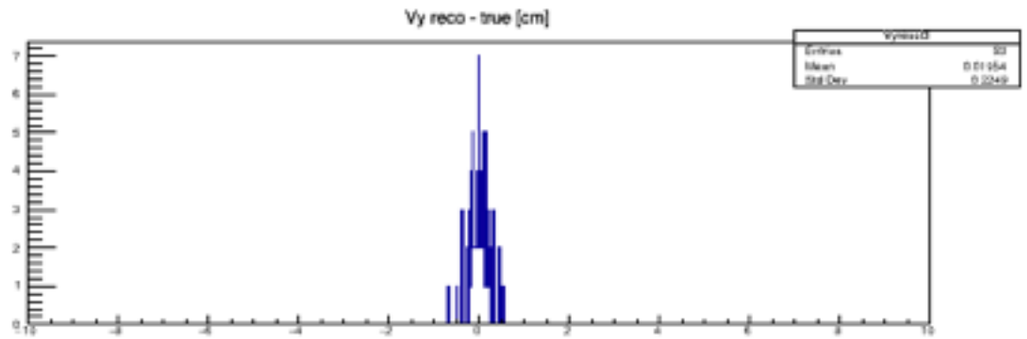












barycentre of positions of energy depositions
for <2cm from 0; 100 ev
for 20GeV —> rms in 2nd and 3rd layer 2mm

Next steps shower pointing

1) try to understand the problem from first principles (it seems it was never done in the past)

2) understand if the present ECAL + pre shower + sampling layer in the middle can do the job

3) investigate another more appropriate ECAL, possibly consider also readout from the sides (es TileCal, also for HCAL)

muon/pion ID and e/pion ID

Need to revisit requirements of the TP—> Thomas/Nico/all ?

1. **needed rejection**

2. **momentum spectrum we need to cover**

It seems from the present studies that we don't need much PID to suppress V0's as we thought beforehand.

Still we need to understand before concluding:

what does it change with Helium instead vacuum? what about cascade production, increase of running time ecc.? maybe with 10x the background this conclusion can change

HCAL vs MUON

Need then to see if only HCAL or only MUON are enough (cost saving): now for PID they are redundant!

However remember HCAL also used as background veto for ALP —>γγ and need to detect also low energy hadronic deposits

HCAL was introduced to cover low momentum PID(π/μ) for p<3GeV; however it works also above and very well!

—> MUON with the HCAL in front is blind for p<3GeV; without HCAL it could detect muon with lower threshold

—> options: no HCAL, no HCAL and smaller thickness of absorber for muon; only HCAL; HCAL + one MUON layer…

Conclusion

For the technical implementation of the PID Tool in FairSHiP we are going fine with the ongoing work (Behzad)

—> I expect CALO and MUON group will also start to contribute to the algorithms from now on

For the issue of photon direction it is difficult now to tell how things will evolve

—>but manpower (and brainpower) would be needed: 1-2FTE

—> it is difficult to quote a pre-shower cost now since we don't even know what system to use and if the ECAL has to be changed and how

For the optimisation of HCAL vs MUON structure for π vs μ separation 2016 will be probably enough to clarify the situation but one more FTE would be welcome.