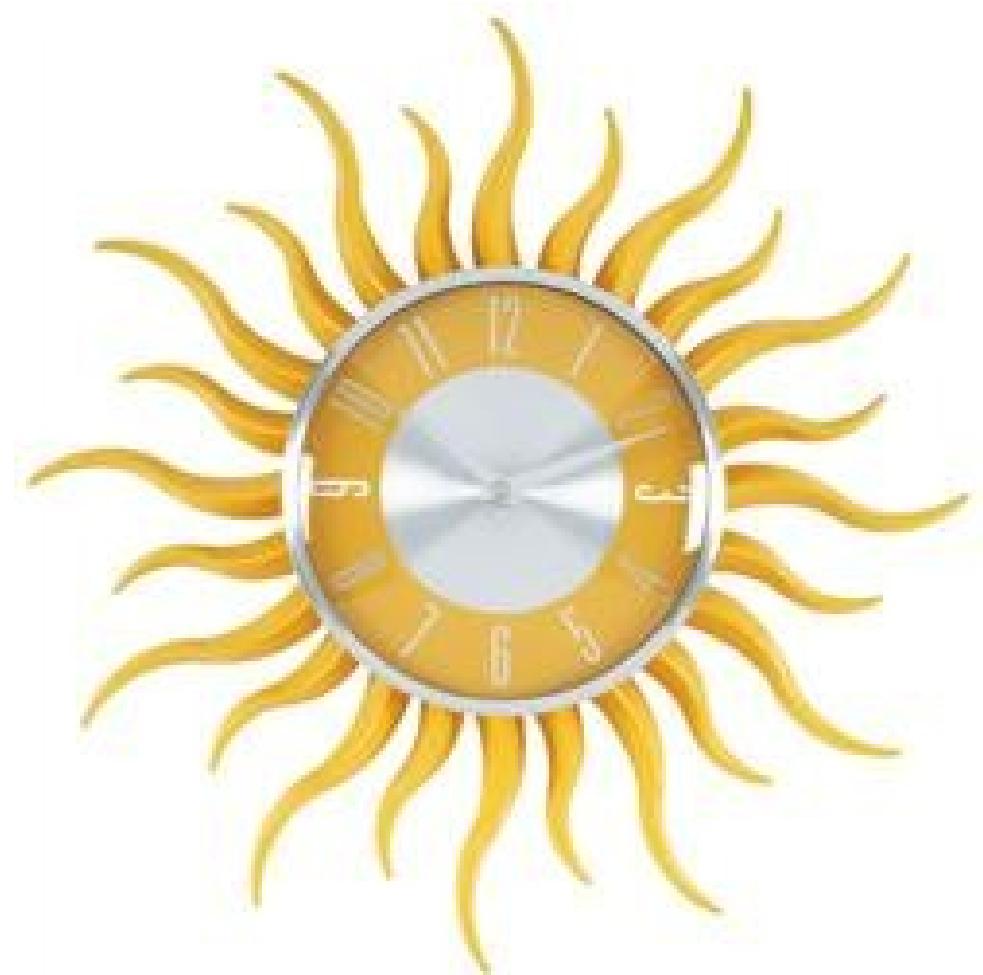


# Requirements for the ECAL/HCAL time alignment

**Yasmine Amhis**  
**(LAL → EPFL )**

**09/09/09**

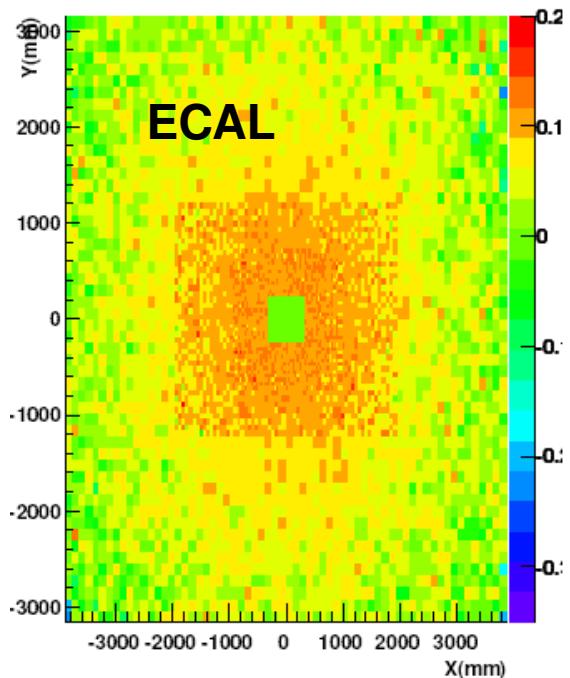


# Using the asymmetry method:

$$R_j = \frac{1}{N} \sum_{i=1}^{i=N} \frac{E_i(\text{Current}) - E_i(\text{Next1})}{E_i(\text{Current}) + E_i(\text{Next1})}$$

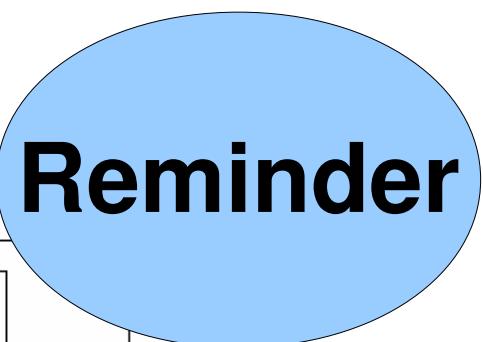
Reminder

**Simulation :** 450 GeV+ B-Off +1 iteration



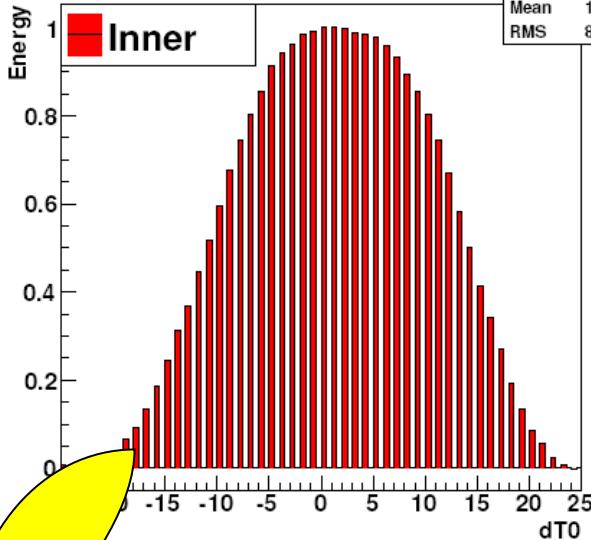
With 55 k minimum bias events we can time align 84 % of the ECAL cells, with a precision better than 0.5 ns.

# Signal shape sensitivity (cosmic events)

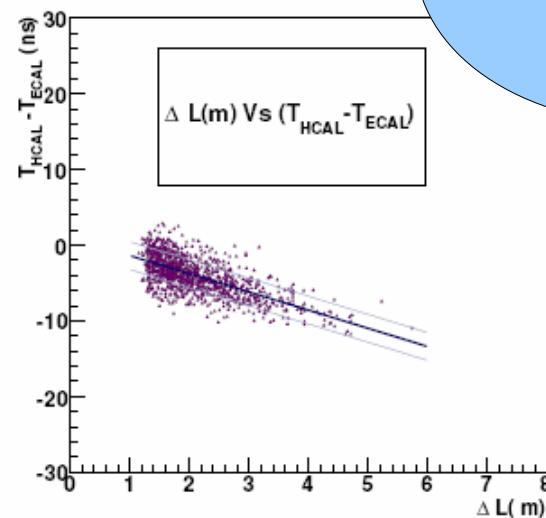
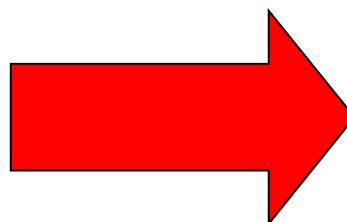


Monte Carlo

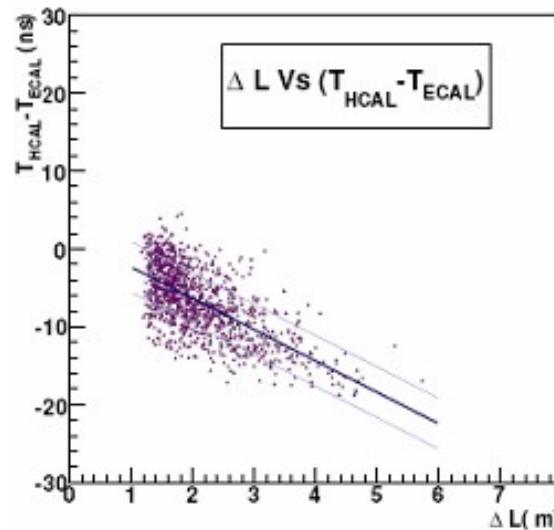
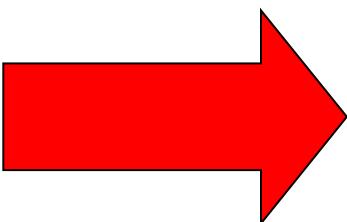
Courbe  
Entries 51  
Mean 1.459  
RMS 8.633



Fake shape



$$SL = (-2.44 \text{ ns} \pm 0.38 \text{ ns}) \text{ ns/m}$$



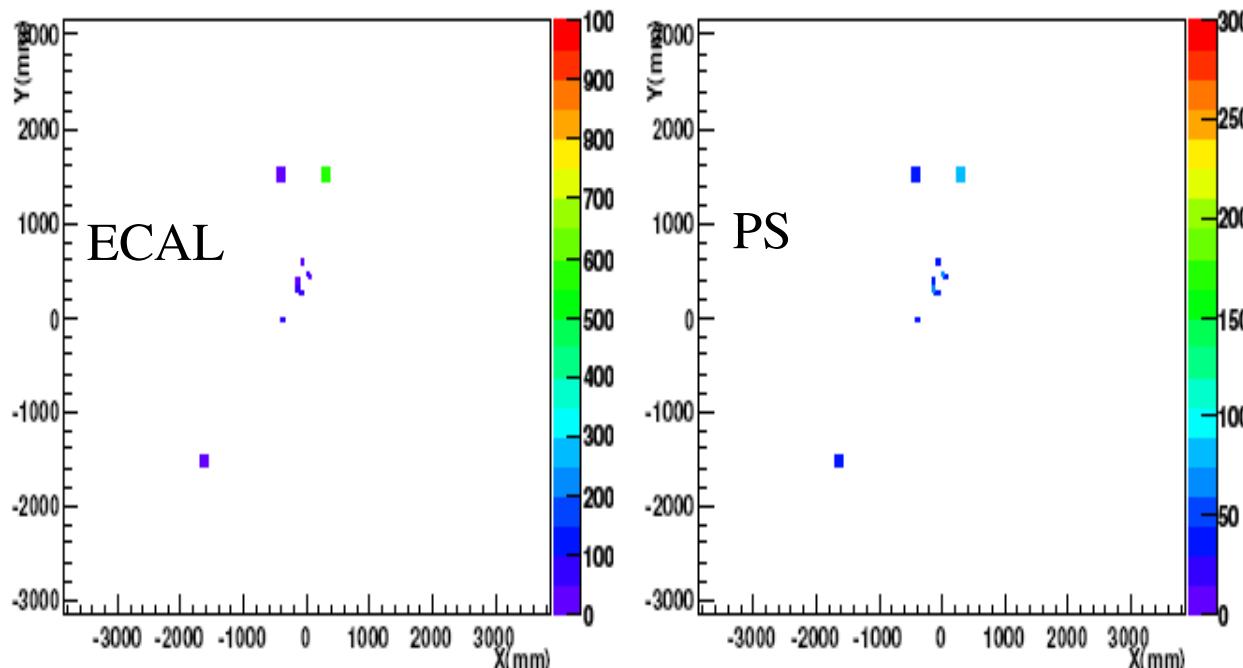
$$SL = (-4.02 \text{ ns} \pm 0.37 \text{ ns}) \text{ ns/m}$$

# Signal shape measurement on data

## Method:

- Scan the ECAL signal with a few steps.
- Apply cuts on the PS cells ( $E(PS) > \text{threshold}$ ) to select ECAL cells.
- Sum ECAL  $\langle Et \rangle$  over the selected cells (N) and determine the precision using:

$$precision = \frac{rms(Et)}{\sqrt(N)}$$

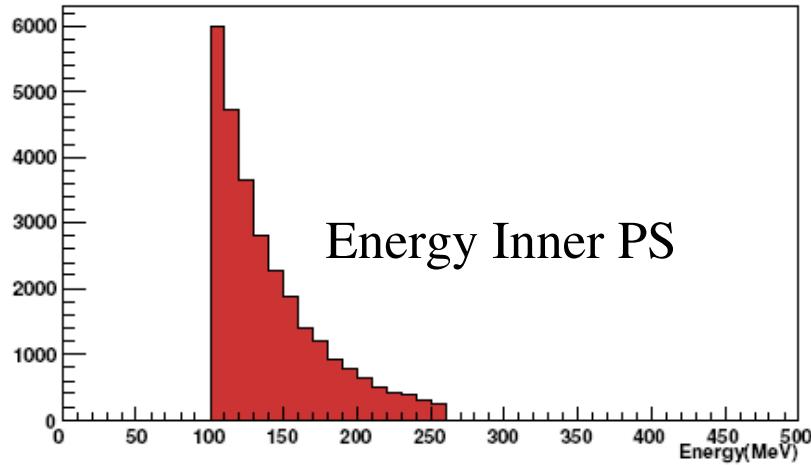


Minimum bias event display

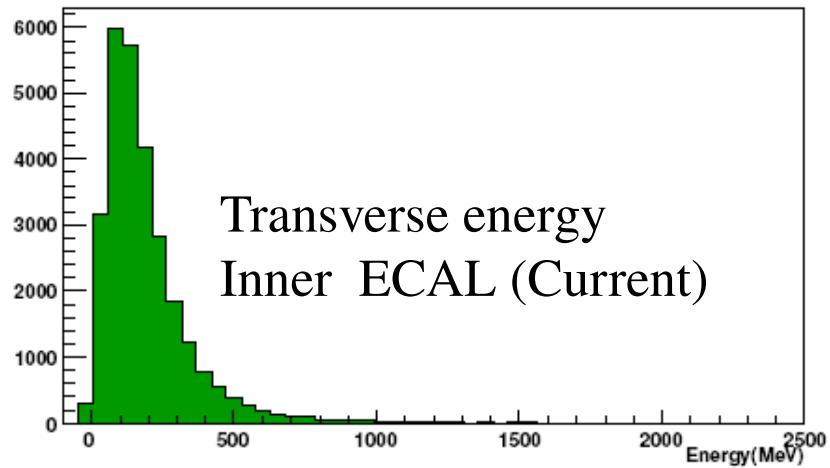
## Simulation:

50k MB + 5TeV + B-Off  
for :  
 $\Delta t = 0, 2, 5, 13, 15$  and  $18$  ns.

# Example of data generated with $\Delta t = 12$ ns in the ECAL



Energy Inner PS



Transverse energy  
Inner ECAL (Current)

## Cuts:

PS energy cut optimised to obtain a precision better than 1%  
on the mean transverse energy in the ECAL for each point:

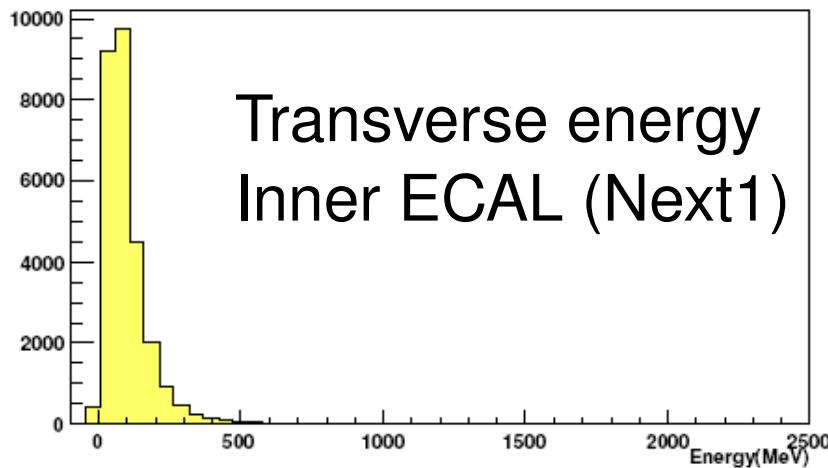
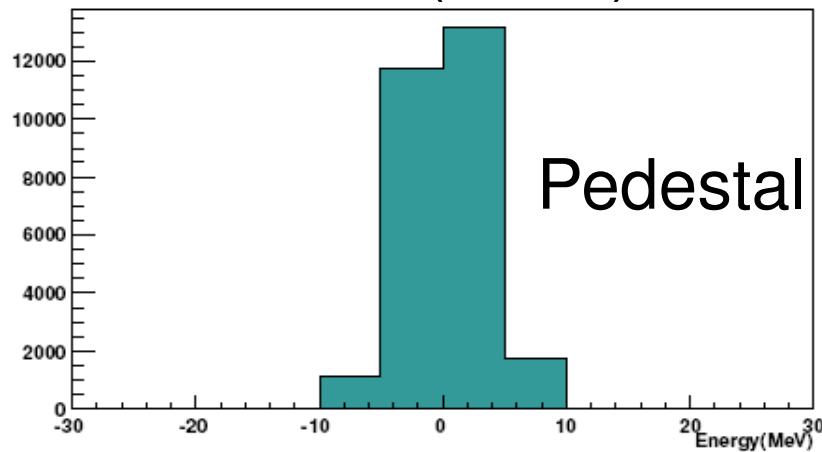
- Inner 100 MeV → precision: 0.51%
- Middle 50 MeV → precision: 0.68%
- Outer 45 MeV → precision: 0.57%

} Using 50 k MB events

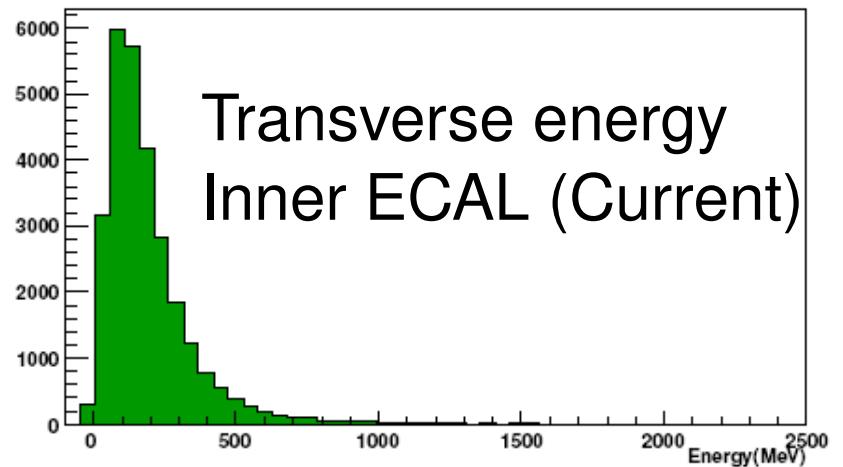
# Example of data generated with $\Delta t = 12$ ns in the ECAL (checks)

Transverse energy

Inner ECAL(Prev1)

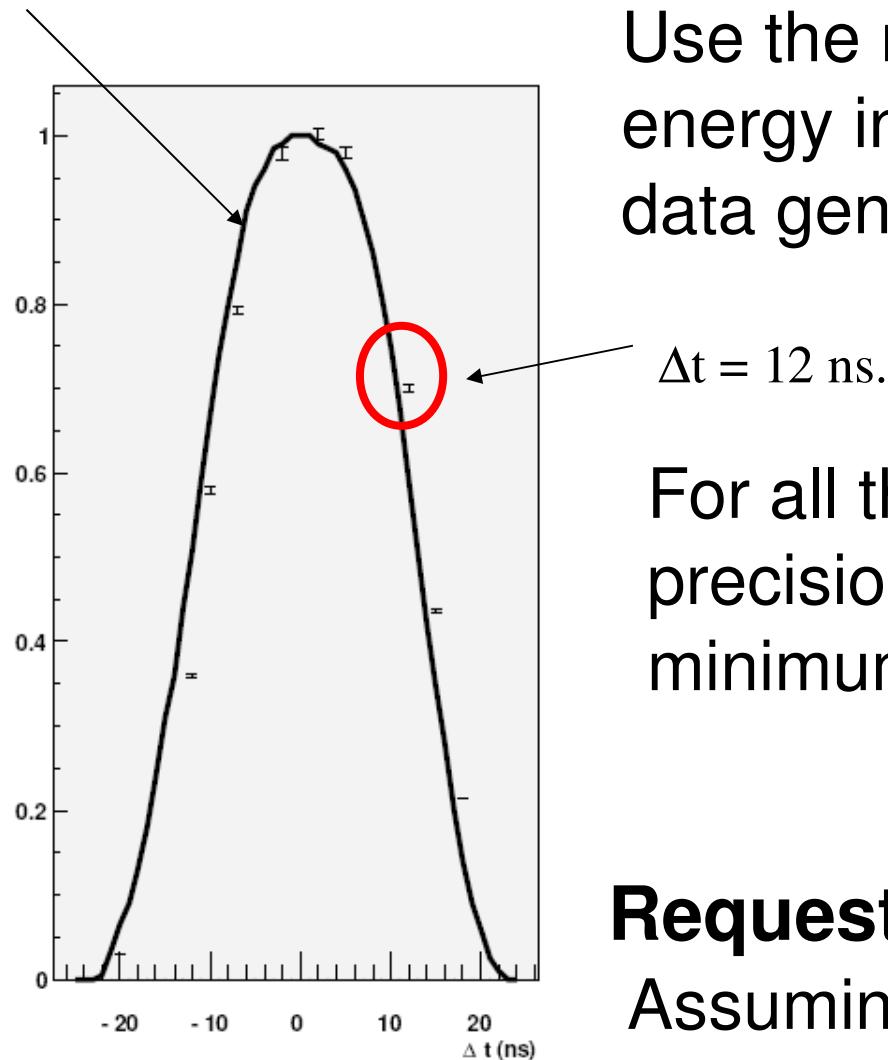


Transverse energy  
Inner ECAL (Current)



# Making the scan

From PG events



## Normalization:

Use the mean transverse energy in the current sample for data generated with  $\Delta t = 0$  ns .

$\Delta t = 12$  ns.

For all the generated points we have a precision better than 1 % with 50 k minimum bias events per point.

## Request data:

Assuming 100 Hz trigger rate:  
50K MB  $\rightarrow$   $\sim$ 10 min of beam.

# Summary Table

Area(i = timing ns )	$\langle E^T( \text{Current}(i) ) \rangle$	$\langle E^T( \text{Next1}(i) ) \rangle$	$\langle E^T( \text{Prev1}(i) ) \rangle$	$\frac{\langle E^T( \text{Current}(i) ) \rangle}{\langle E^T( \text{Current}(i=0) ) \rangle} / F_{\text{Theo}}(i)$	$\frac{\langle E^T( \text{Next1}(\Delta t(i)) ) \rangle}{\langle E^T( \text{Current}(i=0) ) \rangle} / F_{\text{Theo}}(i)$	$\frac{\langle E^T( \text{Prev1}(\Delta t(i)) ) \rangle}{\langle E^T( \text{Current}(i=0) ) \rangle} / F_{\text{Theo}}(i)$	Num.cells
I. ( $\Delta t = -2$ ns)	$267.11 \pm 1.37$	$0.05 \pm 0.01$	$0.06 \pm 0.01$	$(0.979 \pm 0.007)/ 0.980$	0/0	0/0	27888
M. ( $\Delta t = -2$ ns)	$276.04 \pm 1.90$	$0.03 \pm 0.02$	$0.04 \pm 0.01$	$(0.989 \pm 0.009)/ 0.980$	0/0	0/0	20832
O. ( $\Delta t = -2$ ns)	$299.89 \pm 1.74$	$0.12 \pm 0.02$	$0.07 \pm 0.01$	$(0.986 \pm 0.008)/ 0.980$	0/0	0/0	33588
I. ( $\Delta t = 0$ ns)	$272.68 \pm 1.40$	$0 \pm 3.25$	$0 \pm 0.45$	1/1	0/0	0/0	27506
M. ( $\Delta t = 0$ ns)	$279.23 \pm 1.91$	$0 \pm 3.37$	$0 \pm 0.39$	1/1	0/0	0/0	20989
O. ( $\Delta t = 0$ ns)	$303.84 \pm 1.75$	$0 \pm 4.29$	$0 \pm 0.49$	1/1	0/0	0/0	33730
I. ( $\Delta t = 2$ ns)	$273.41 \pm 1.39$	$0.08 \pm 0.01$	$0 \pm 0.01$	$(1.001 \pm 0.007)/ 0.990$	0/0	0/0	27827
M. ( $\Delta t = 2$ ns)	$280.26 \pm 1.93$	$0.05 \pm 0.02$	$0 \pm 0.01$	$(1.001 \pm 0.008)/ 0.990$	0/0	0/0	20930
O. ( $\Delta t = 2$ ns)	$304.34 \pm 1.76$	$0.27 \pm 0.02$	$0 \pm 0.01$	$(1.001 \pm 0.008)/ 0.990$	0/0	0/0	33517
I. ( $\Delta t = 5$ ns)	$267.29 \pm 1.37$	$8.37 \pm 0.05$	$0 \pm 0.01$	$(0.980 \pm 0.007)/ 0.978$	$(0.030 \pm 0.0002)/ 0.039$	0/0	27628
M. ( $\Delta t = 5$ ns)	$275.04 \pm 1.88$	$8.31 \pm 0.07$	$0 \pm 0.01$	$(0.984 \pm 0.009)/ 0.978$	$(0.029 \pm 0.0002)/ 0.039$	0/0	20938
O. ( $\Delta t = 5$ ns)	$298.50 \pm 1.72$	$9.89 \pm 0.07$	$0 \pm 0.01$	$(0.982 \pm 0.008)/ 0.978$	$(0.032 \pm 0.0002)/ 0.039$	0/0	33657
I. ( $\Delta t = 12$ ns)	$191.68 \pm 1.02$	$98.10 \pm 0.54$	$0 \pm 0.01$	$(0.701 \pm 0.005)/ 0.67$	$(0.359 \pm 0.002)/ 0.39$	0/0	28141
M. ( $\Delta t = 12$ ns)	$197.28 \pm 1.43$	$100.56 \pm 0.77$	$0 \pm 0.01$	$(0.706 \pm 0.007)/ 0.67$	$(0.360 \pm 0.003)/ 0.39$	0/0	20913
O. ( $\Delta t = 12$ ns)	$214.14 \pm 1.29$	$111.86 \pm 0.70$	$0 \pm 0.01$	$(0.704 \pm 0.005)/ 0.67$	$(0.368 \pm 0.003)/ 0.39$	0/0	33865
I. ( $\Delta t = 15$ ns)	$119.41 \pm 0.64$	$158.41 \pm 0.85$	$0 \pm 0.01$	$(0.437 \pm 0.003)/ 0.35$	$(0.580 \pm 0.004)/ 0.59$	0/0	27912
M. ( $\Delta t = 15$ ns)	$125.34 \pm 0.91$	$163.67 \pm 1.19$	$0 \pm 0.01$	$(0.448 \pm 0.002)/ 0.35$	$(0.586 \pm 0.004)/ 0.59$	0/0	20964
O. ( $\Delta t = 15$ ns)	$137.31 \pm 0.88$	$182.47 \pm 1.13$	$0 \pm 0.01$	$(0.451 \pm 0.003)/ 0.35$	$(0.600 \pm 0.005)/ 0.59$	0/0	33554
I. ( $\Delta t = 18$ ns)	$58.63 \pm 0.31$	$216.38 \pm 1.13$	$0 \pm 0.01$	$(0.215 \pm 0.001)/ 0.194$	$(0.793 \pm 0.05)/ 0.800$	0/0	27835
M. ( $\Delta t = 18$ ns)	$61.69 \pm 0.45$	$221.98 \pm 1.56$	$0 \pm 0.01$	$(0.220 \pm 0.002)/ 0.194$	$(0.794 \pm 0.07)/ 0.800$	0/0	20835
O. ( $\Delta t = 18$ ns)	$67.32 \pm 0.44$	$245.91 \pm 1.46$	$0 \pm 0.01$	$(0.221 \pm 0.001)/ 0.194$	$(0.809 \pm 0.006)/ 0.800$	0/0	33408

# Conclusion

- With 450 GeV+ B-Off we need :  
55 k events to align 84 % of the cells of the ECAL  
with a precision better than 0.5 ns.
- With 5 TeV + B-Off we need :  
50 k events per point to scan the integrated signal with a precision better than 1%.

This is most probably my last (?) talk for the calorimeter group as a LAL PhD student.



Thank you all

<http://www.youtube.com/watch?v=NoBFhdeR9PE&feature=related>

**Back up  
slides**