Selctive Readout : Data size estimation using CMSIM

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1. Introduction

- **Estimation of data size with recent ECAL configuration**
  - ➔ **EE trigger tower geometry**
  - ➔ **Signal shapin**
  - ➔ **Various S.R. thresholds**
- **Genration of data files to study compression**
  - ➔ **Dynamic Coding**
  - ➔ **Commercial Chips (ALDC, DCLZ)**
    : talk of G.B. KIM
- **Optimization of S.R. thresholds**

2. Simulation with CMSIM

- **PYTHIA : Hard-QCD (P_t > 100 GeV)**

  (gen. by Ch.Tully) Minimum bias events

  H(150 Gev)➔$e^+e^-e^+e^-$

- **CMSIM verson 115**

- **Recent ECAL endcap trigger tower (by G.Heath)**

  W.Badgett, Trigger Tower Definition Issues

  $5 \le I_\eta \le 11$ $1 \le I_\phi \le 72$

  $46 \le I_\eta \le 52$

- **Digitization**

  ➔ **Barrel : LSB(E_t)= 20 MeV**

  ➔ **Endcap : LSB(E)= $\frac{20}{\sin\theta}$ MeV**

- **Electronics Noise**

  ➔ **Barrel : E_t = 30 MeV**

  ➔ **Endcap : E = 150 MeV**

Zero suppression removed (ecal.tz) : default 1σ

Pedestal : 25 ADC counts

We consider Two S.R. types

- **SR1 : Time-domain data** $2.5\ \text{GeV} < E^t_{\text{tower}}$

  Space-domain data $1 < E^t_{\text{tower}} < 2.5\ \text{GeV}$

  Time : 10 samplings
  Space : 1 filter output
  ] all crystals in 3×3 towers

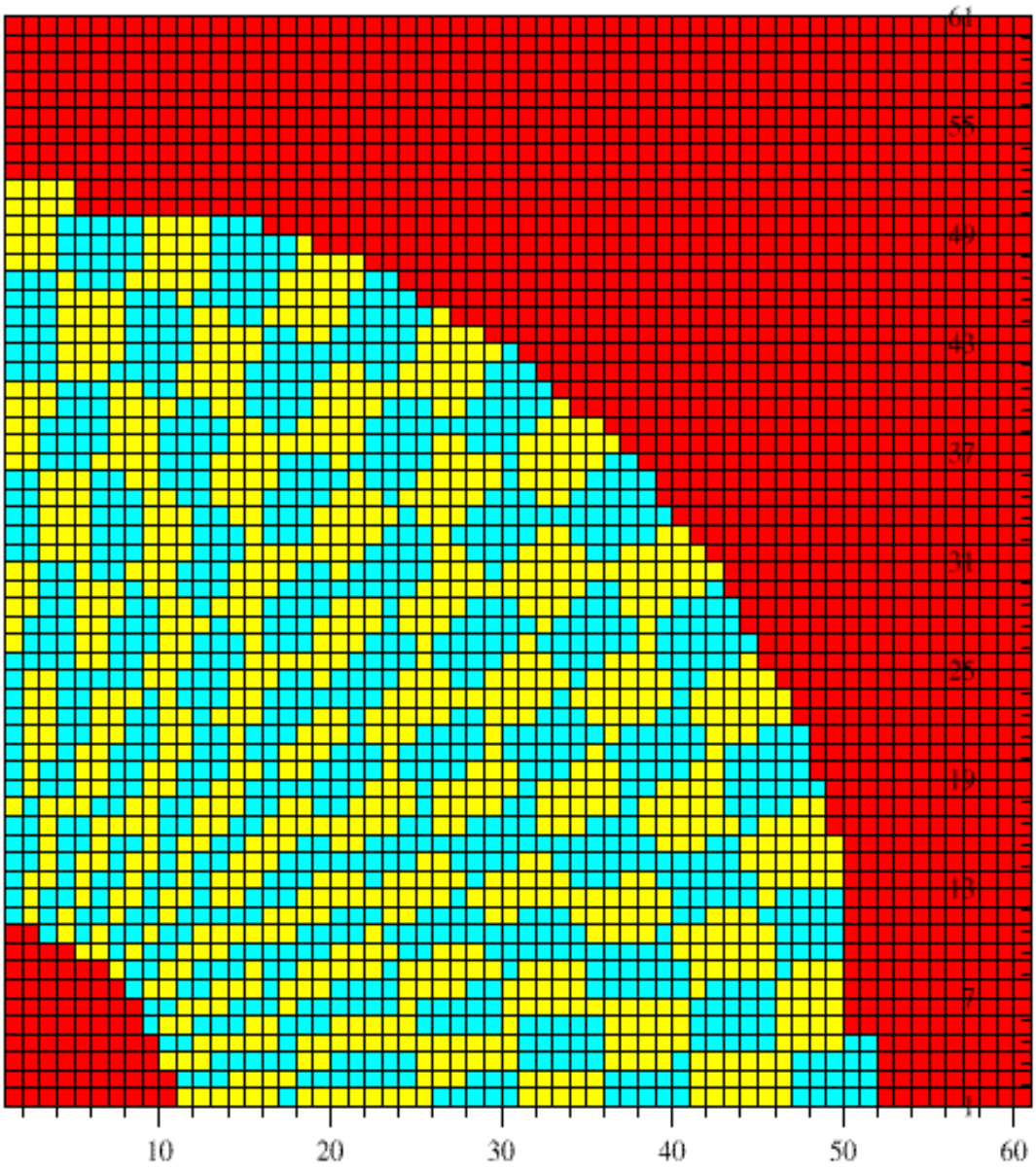
- **SR2: Time-domain data**

$E^t_{\text{tower}} > 2.5\ \text{GeV}$

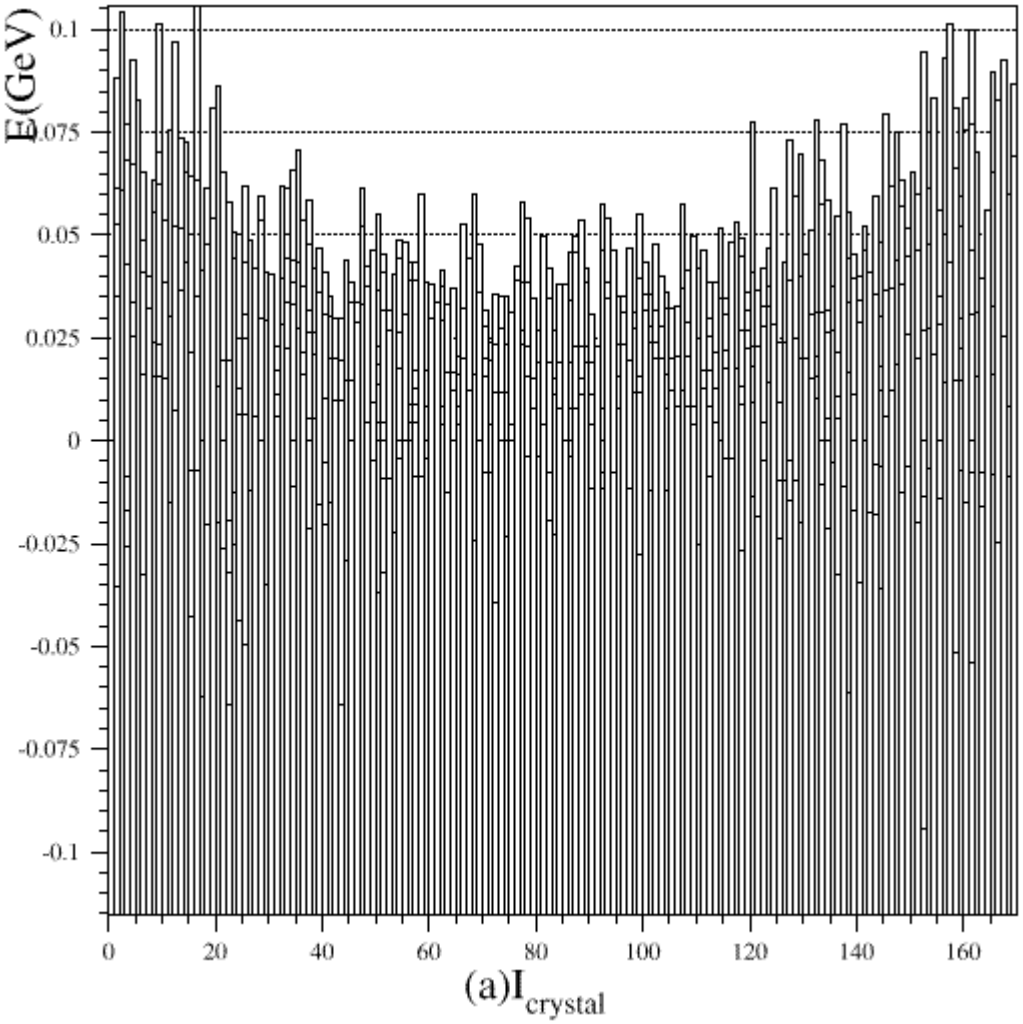
$1.0\ \text{GeV}$

$0.5\ \text{GeV}$

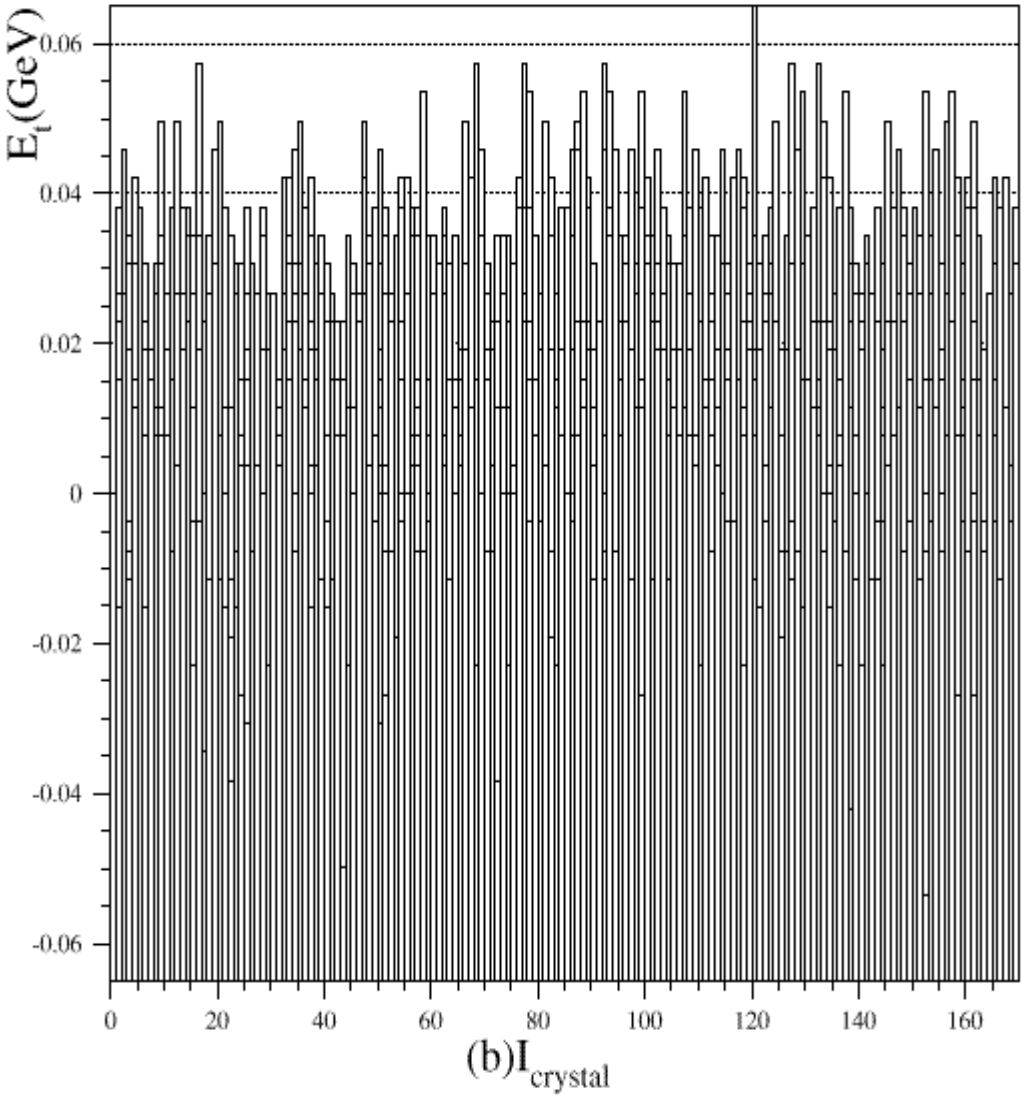
$0.3\ \text{GeV}$



Trigger cell



Noise level in E for barrel ***vs*** η



Noise level in E_t for barrel ***vs*** η

● Signal shape (Ph. Busson)

$$f(t) = \begin{cases} \left(1 + \dfrac{t - tof - \alpha\beta}{\alpha\beta}\right)^{\alpha} e^{-\left(\frac{t - tof - \alpha\beta}{\beta}\right)} & \text{if } t > tof - \alpha\beta \\ 0 & \text{otherwise} \end{cases}$$

$\alpha=1.5$, $\beta^{-1}=0.568$

● Pileup

➔ **Same bunch crossing**

- ❒ **1 QCD + 20 minimum bias**
- ❒ **1 QCD + $N_{poisson}$ (minnimum bias), $L=10^{34}/cm^2/sec$**

➔ **Bunch crossings differing in time not considered assuming that the starting time of a given sample can be determined by the filter**

$H \rightarrow e^+e^-e^+e^-$

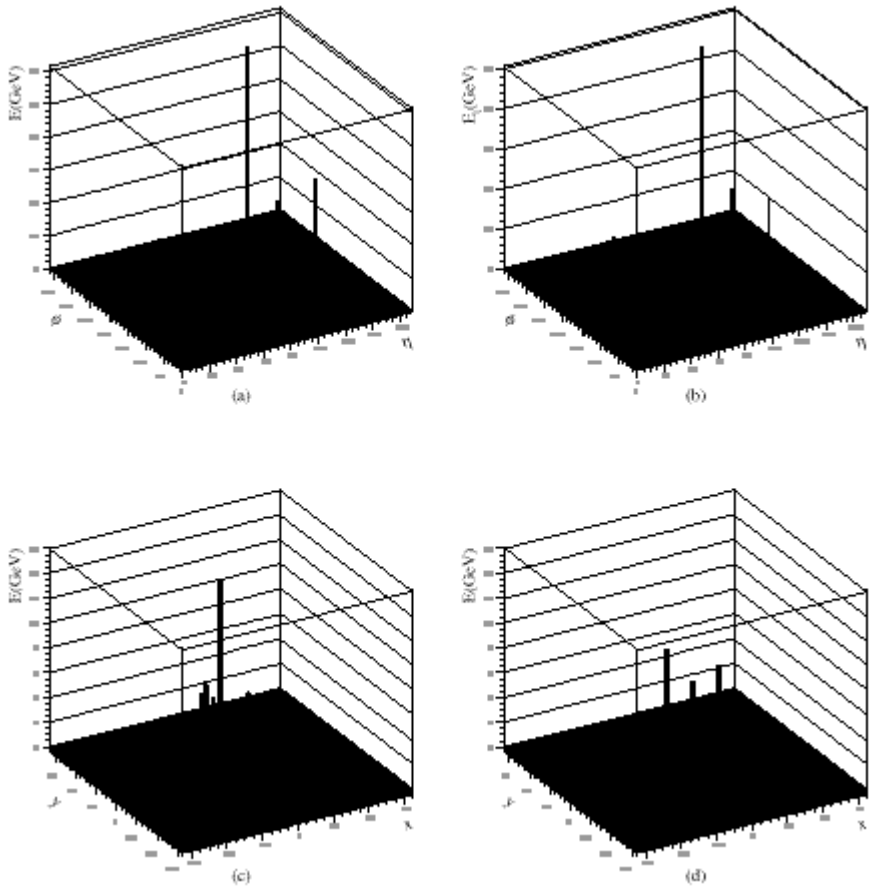


Figure 4 : (a) The crystal energy in the barrel
(b) the crystal Et in the barrel
(c) The crystal energy in the forward endcap
(d) the crystal energy in the backward endcap

A Higgs particule of 150 GeV/c^2 decays into four electrons

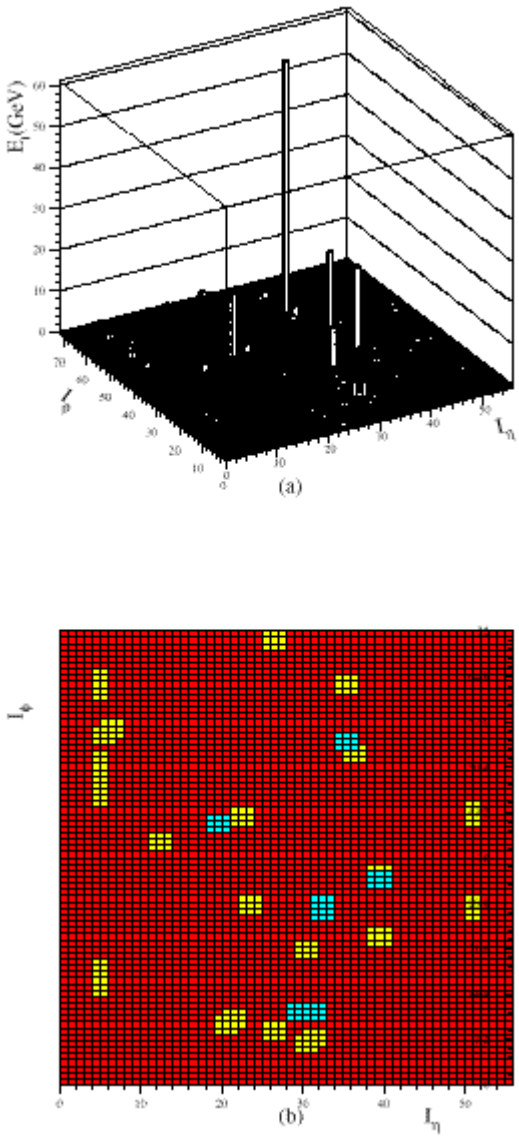
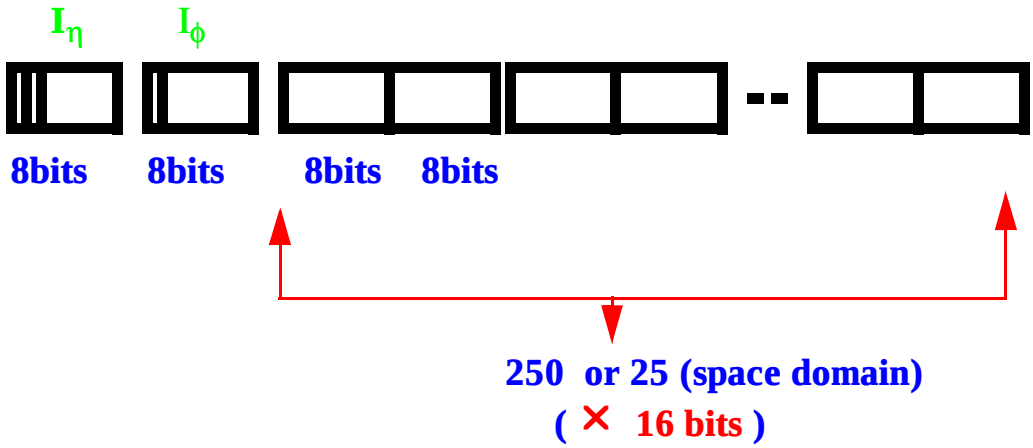


Figure 5: (a)The Et distribution of the trigger towers for the Higgs event, (b)The positions in I_ vs I_ plane of the towers that have recorded more than 1 GeV of transverse energy, as well as the adjacent trigger towers. The gray cells correspon to the time domain, and the brighter cells represent the space domain.

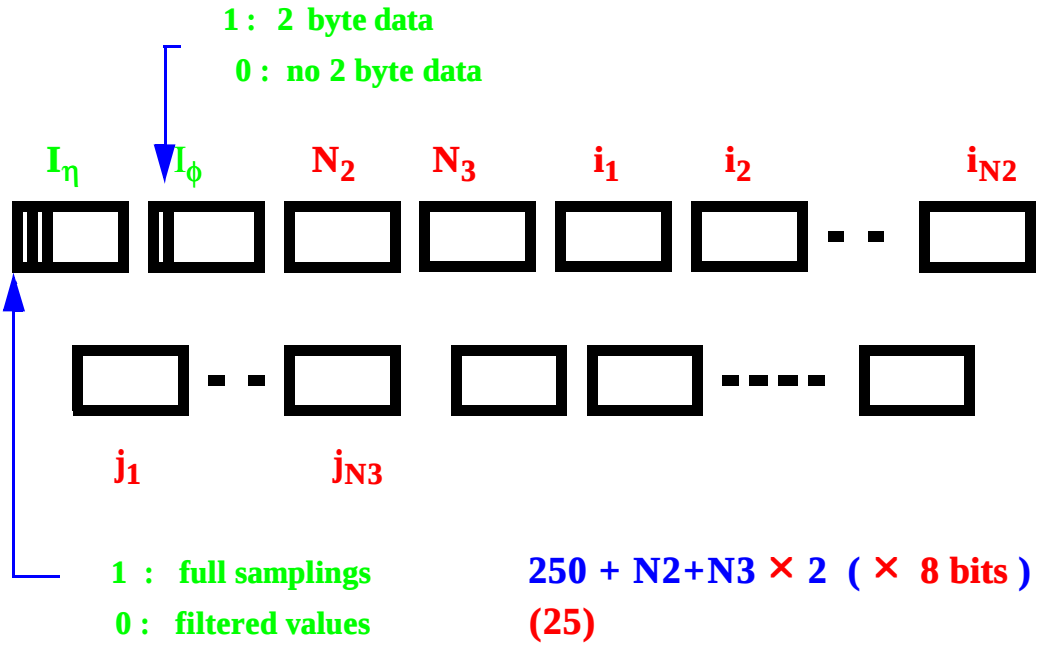
3. Dynamic Coding

●Fixed 16 bit coding

Binary files with 2 byte word / sampling for crystal ADC counts of selected towers



●Dynamic coding : 8bits +16bits+24 bits



Reduction factor $\sim \frac{1}{2}$

4. Event Size

SR type	no. of towers	no. of crystals	event size	dynamic coding
SR1(time + space)	68(252)	1,482(5,416)	41.2 kB	21.0 kB
SR2-1(time, E_t >2.5 GeV)	68	1,482	29.8 kB	15.0 kB
SR2-2(time, E_t >1.0 GeV)	330	6,898	138.9 kB	69.8 kB
SR2-3(time, E_t >0.5 GeV)	908	18,936	381.4 kB	191.7 kB
SR2-4(time, E_t >0.3 GeV)	1,554	32,935	662.8 kB	333.0 kB

Table 1: Occupancies of the towers and crystals. Two types of the selective readout arecompared. In the case of SR1, the values in the parentheses correspond to the space domain data. In the case of SR2, where the space domain is not used, three different cuts on Et are considered. An event is composed of a high-Pt QCD event piled-up with 20 minumum bias events. One hundred of such events have been used. The event sizes with and without dynamic coding are also indicated. The coarse grain data of about 4 kbytes needs to be added to each of them.

SR type	event size	size with ALDC	compression rate
SR1(time + space)	41.2(21.0) kB	15.9(12.4) kB	2.58(1.68)
SR2-2(time only, E_t >1.0 GeV)	138.9(69.8) kB	52.7(40.5) kB	2.63(1.71)
SR2-3(time only, E_t >0.5 GeV)	381.4(191.7) kB	143.0(110.2) kB	2.66(1.73)

Table 2: The data size before and after applying the ALDC algorithm and the compression ratios for two SR types with various Et thresholds. The values in parentheses correspond to the dynamically coded data.

5. Summary

- **ECAL Selective readout data simulation using CMSIM**

- **Event Size with/without dynamic coding**

  E_t > 1.0 GeV full time samplings

  QCD : 139 KB ➔ 70 KB
  Higgs : 122 KB ➔ 62 KB

- **Compression with commercial chips**
  ➔ by G.B. Kim

- **Realistic data flow simulation to be done as suggested by DCC**

  Divide an event into pieces corr. to ULR crates.