CMS-LHC Signal Exchange

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Presentation to Ad-Hoc Working Group on LHC Machine Parameters and Signal Exchange

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Outline:

Luminous region and CMS tracker - G. Rolandi

Bunch Luminosity Information - J. Varela

"Fine-grain time spectrum"

Absolute Time-Tagging (GPS)

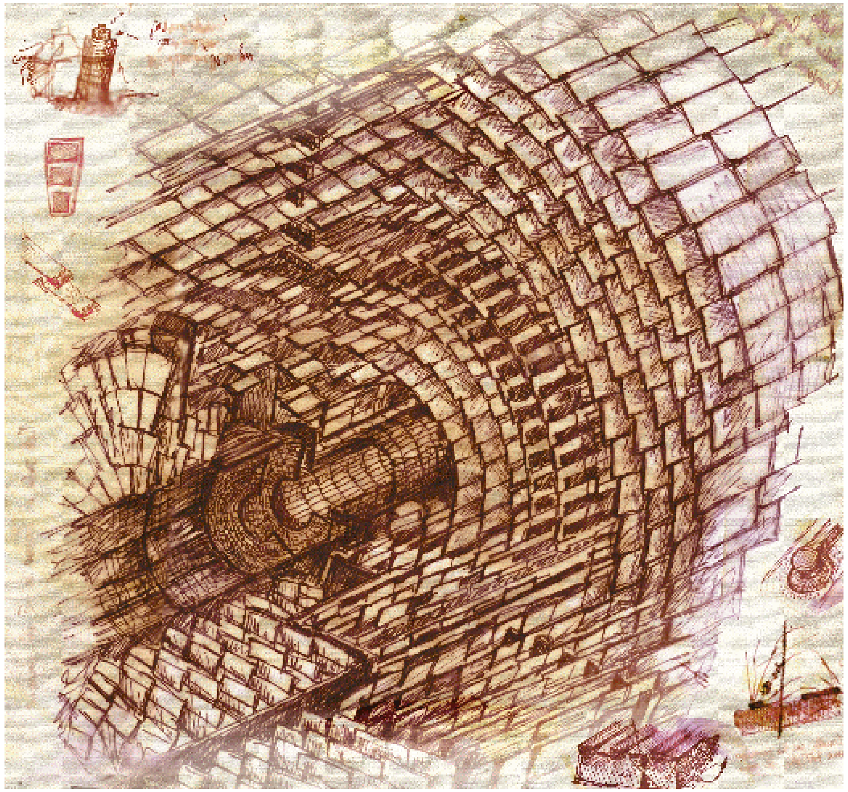
Use of RF-pickups

The pdf file of this talk is available at:

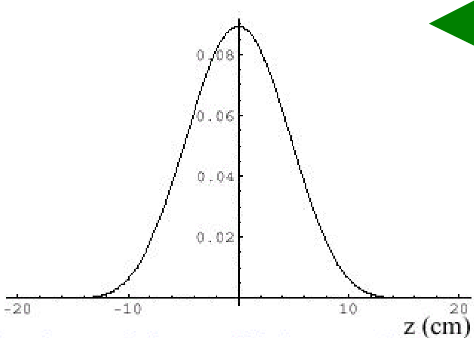
http://cmsdoc.cern.ch/~wsmith/LHCWG_0602.pdf

Tracker Status Report

CMS GENERAL MEETING JUNE 2002



Tracker hermeticity (1)



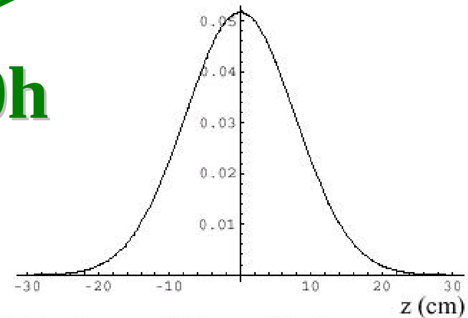
Start of coast

Distribution of the collision point:

$$4[\rho_b(2\cdot z)*\rho_b(2\cdot z)]$$

- 95% of the distribution in a width of 16.8cm

After 10h



Distribution of the collision point:

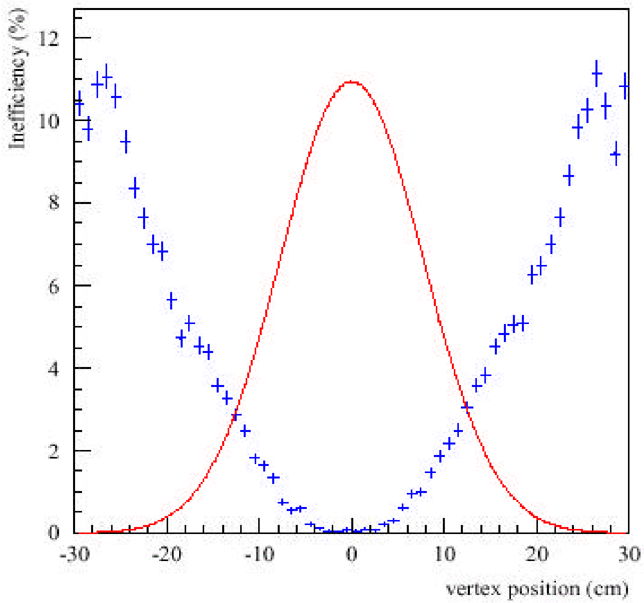
Gaussian with $\sigma = 7.72$ cm

- 95% of the distribution in a width of 30.3cm

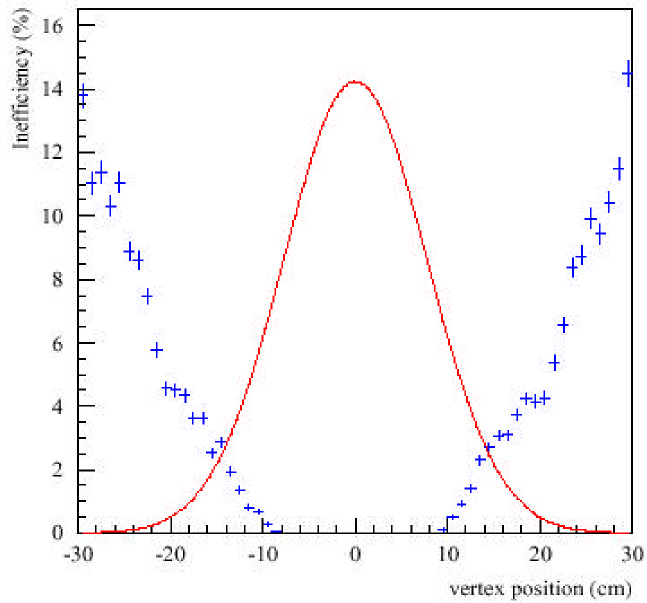
With RF phase jitter: displacement of 140 ps on each side

Tracker hermeticity (2)

Inner Barrel Layers



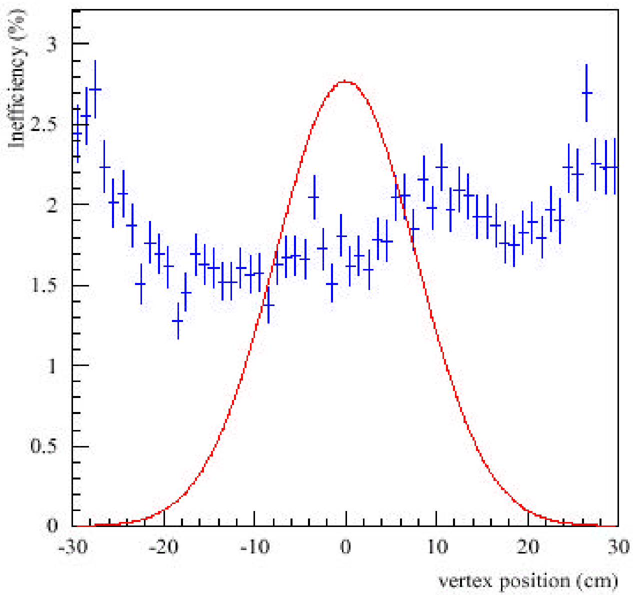
TIB layer 1:
Global inefficiency = 1.05 ± 0.01%



TIB layer 2:
Global inefficiency = 0.41 ± 0.01%

Tracker hermeticity (3)

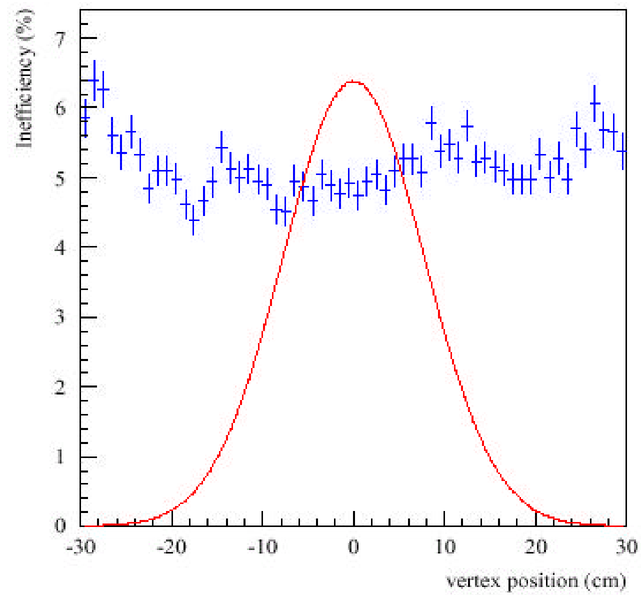
Outer Barrel Layers



TOB layer 1:

Inefficiency of r−φ modules

= 1.76 ± 0.02%



TOB layer 1:

Inefficiency of r−z modules

= 5.00 ± 0.03%

Tracker hermeticity (4)

Barrel Hermeticity

Layer	Inefficiency		
	r−φ modules	*r*−z modules	Global
TIB 1	1.05%	3.41%	1.05%
TIB 2	0.41%	1.61%	0.41%
TIB 3	0.54%	–	0.54%
TIB 4	0.17%	–	0.17%
TOB 1	1.76%	5.00%	1.76%
TOB 2	2.88%	5.91%	2.88%
TOB 3	2.53%	–	2.53%
TOB 4	1.25%	–	1.25%
TOB 5	1.11%	–	1.11%
TOB 6	0.96%	–	0.96%

For a Gaussian collision point distribution with $\sigma = 7.72$ cm

Tracker hermeticity (5)

- Barrel Pixel:
  - Inefficiency ~ 3%, no dependence on the vertex position
- Inner Barrel:
  - Coverage strongly dependent on the vertex position
  - Full Mono coverage for vertex position < 8 cm
- Outer Barrel:
  - Small dependence on the vertex position
  - Degradation for vertex position > 25 cm
- Forward Pixel:
  - Inefficiency ~ 1−2%, dependence on the vertex position (asymmetry)
- Endcap:
  - Very good coverage (inefficiency < 0.1 %)

Requirements on Bunch Structure Data for CMS Synchronization

J. Varela

LIP-Lisbon & CERN

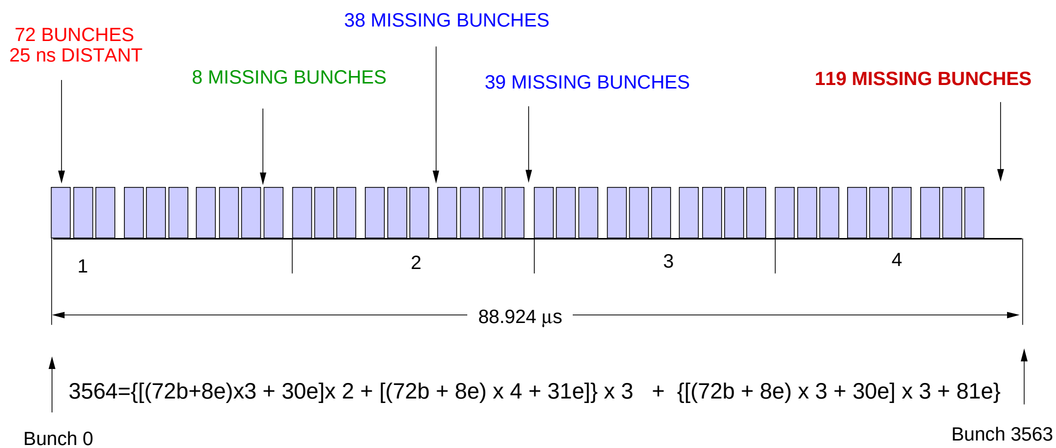
Algorithms for BC identification

The **absolute synchronization** of the data (trigger links and DAQ pipelines) is based on the **identification of the LHC bunch structure**

Histograms of the bunch crossing number for physics events show the gaps of the LHC beam structure

In some cases, the histograms are **incremented at LHC frequency** using **dedicated Synchronization circuits** in the readout and trigger boards

Special beam conditions at start-up (bunches every 75ns) will be very helpful



Bunch Structure Correlation Function

Correlation function between detector data and luminosity data:

$$C(\tau) = \sum_i N_i \bullet L_{i+\tau}$$

where:

N_i – number of events in bunch crossing i

L_i – luminosity in bunch crossing i

Define **D=C(0)-C(1)**, the difference between the correlation function at right synchronization and one bunch crossing off:

$$\mathbf{D \sim N_t * (N_b - N_e) * (L_b - L_e)}$$

where:

L_b – average luminosity of bunches with beam

L_e – average luminosity of empty bunches (ghosts)

N_b – average number of events in bunches with beam

N_e – average number of events in empty bunches

N_t – number of transitions bean/no beam in the LHC structure

Precision Requirements

The precision on the variable D quatifies the precision of the synchronization method

CMS histograming data:

aiming at 1% precision on N_b, in 1 sec aquisition time

Requirements on luminosity data:

1% precision on L_b (bunch crossing luminosity),

in 1 sec (or less) measuring interval (~11k measurements)

Sampling Frequency

One measurement:

16 kBytes (4k bunches x 2 beams x 2 bytes)

Assume sampling frequency 1 Hz:

data rate	16 kBytes/s	OK
data volume in 12h	700 Mbyte	OK

Requirements Summary

Measurement of individual bunch crossing luminosity: L_i

Sampling frequency: 1Hz

Precision of individual bunch luminosity: 1%

"Fine-grain" time spectrum

Request for sub-ns-scale time spectrum of each bunch

- Whatever scale is available with resolution < 1 ns
- Request spectrum delivery once per minute
- Provided in addition to the 1 Hz of integrated bunch luminosity

Uses:

- Identification of Satellite bunches
- Diagnosis of synchronization problems.

Absolute Time Tagging

Request that LHC information have absolute GPS time tag

Request that Experiments have absolute GPS time tag

- Antenna for connection to GPS or a GPS signal feed from a central source
- Problem with access to signals underground

Is there an existing solution?

Use of LHC RF pickups

Separate Quadrant Readout

- **Can they reliably predict position at I.P.?**

Readout Electronics

- **Query to M.G. as to available electronics and applicability for adoption by LHC experiments**
  - What signals are produced with what quality?
- **Request for technical liaison btw. M.G. and LHC experiments concerning use of pickup detectors, amplifiers and signal processing.**