Level 1 and 2 triggers

Hank Crawford

Zoran Milosevich

All interested parties -

you test with existing data
you write the algorithm
we integrate and test in trigger

Overview

Only Level 0 can issue triggers

Level 1 and Level 2 give more detailed look at fast detector data and decide whether to abort the event that was selected at Level0, or to accept it and pass it on for further analysis.

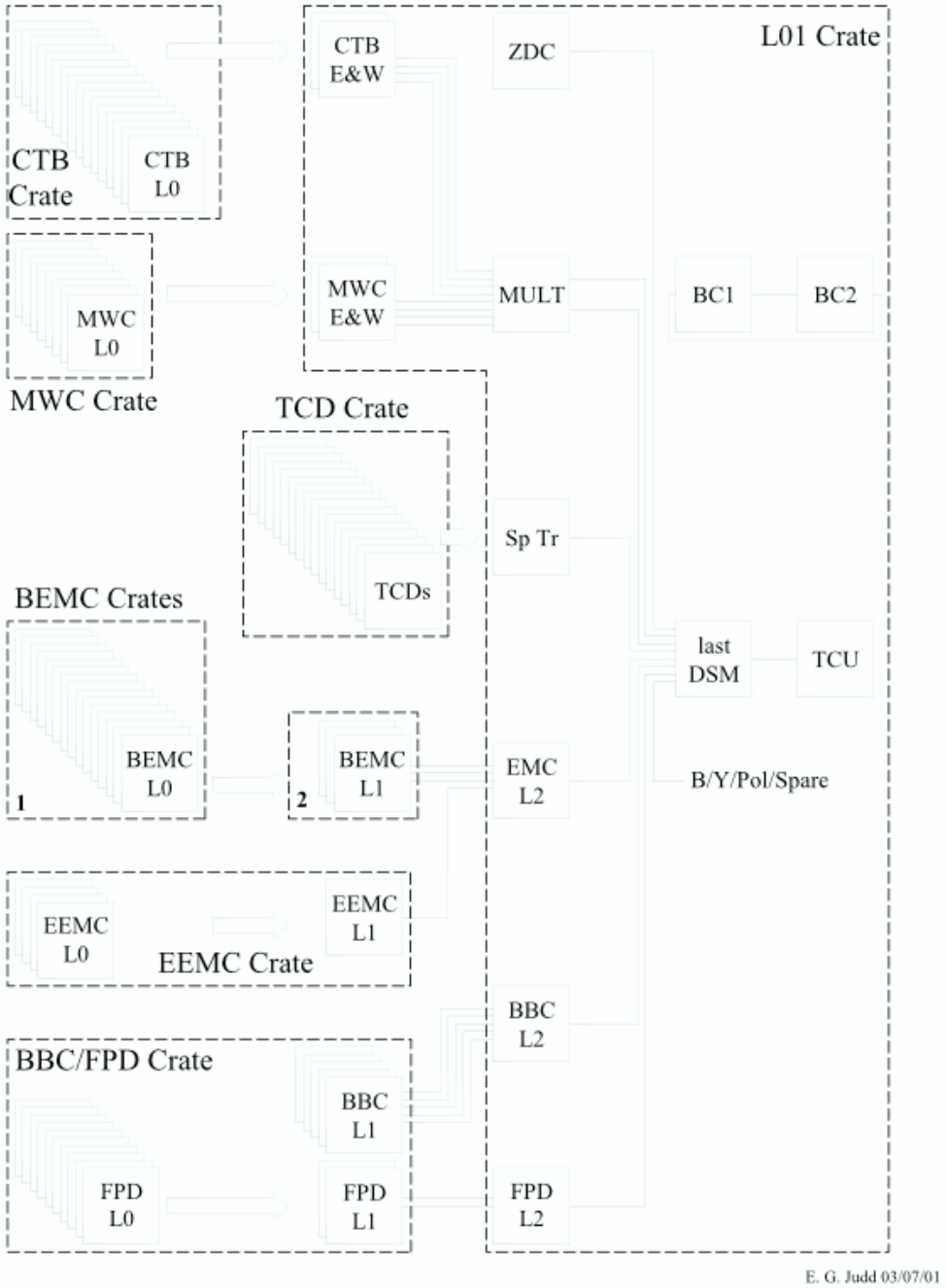
Review data available at Level1
Example algorithms
Review data available at Level2
Example algorithms

Level 1 Data

Level 1	Det	Measures	d□	d□
	CTB	$d^2n/d\square d\square$	0.5	□/2
	MWC	$d^2n/d\square d\square$	0.5	□/2
	BEMC	$d^2E/d\square d\square$	1	2□/3
		>thresholds		
	EEMC	$d^2E/d\square d\square$		
		>thresholds		
	BBC	$d^2n/d\square d\square$	1.6	2π
			1.3	2□
	ZDC	E at 0º all PMT data		
	FPD			

Level1 has
access to
all DSM data
from the L0L1 crate

DSMs in L0L1 Crate



STAR Trigger Level 1 Data Definitions
2003 Run

At Level 1 a subset of the data stored in the DSM boards is available. This includes:

- ZDC raw data
- results of both intermediate stages of DSM processing for the CTB and MWC
- results of just the second intermediate stage of DSM processing for the BEMC and EEMC
- results of the single intermediate stage of DSM processing for the BBC
- 48-bit bunch counter

This list is set by the physical layout of the trigger hardware.

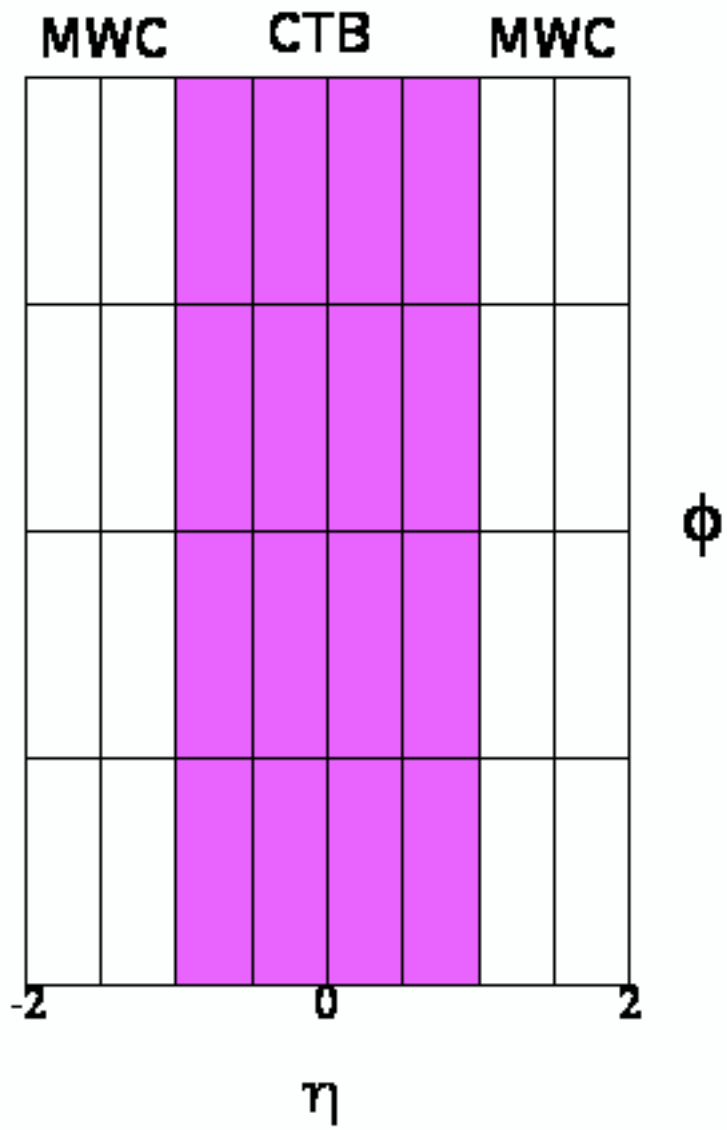
L01 Crate DSMs

DSM Boards	#Bytes	Origin	#Bytes	Data description
Bunch Crossing	32	Internal	6	48-bit bunch crossing number
		Internal	1	0:119 bunch type number
		N/A	25	Unused
ZDC Raw Data	16	ZDC	1	1 byte East PMT1 ADC value
		ZDC	1	1 byte East PMT2 ADC value
		ZDC	1	1 byte East PMT3 ADC value
		ZDC	1	1 byte East analog sum: PMT1 + PMT2 + PMT3
		ZDC	1	1 byte West PMT1 ADC value
		ZDC	1	1 byte West PMT2 ADC value
		ZDC	1	1 byte West PMT3 ADC value
		ZDC	1	1 byte West analog sum: PMT1 + PMT2 + PMT3
		ZDC	1	1 byte East PMT1 attenuated ADC value
		ZDC	1	1 byte East attenuated analog sum: PMT1 + PMT2 + PMT3
		ZDC	1	1 byte West PMT1 attenuated ADC value
		ZDC	1	1 byte West PMT2 attenuated ADC value
		ZDC	1	1 byte West attenuated analog sum: PMT1 + PMT2 + PMT3
		ZDC	1	1 byte East+West attenuated analog sum
		ZDC	1	1 byte East TAC
		ZDC	1	1 byte West TAC
CPA – 1st Intermediate Stage of CTB/MWC processing	64	CTB East	16	8 2-byte multiplicity measurements (ADC or MIP) each covering $\Delta\eta=0.5$, $\Delta\phi=\pi/2$
		CTB West	16	8 2-byte multiplicity measurements (ADC or MIP) each covering $\Delta\eta=0.5$, $\Delta\phi=\pi/2$
		MWC East	16	8 2-byte wire counts each covering $\Delta\eta=0.5$, $\Delta\phi=\pi/2$
		MWC West	16	8 2-byte wire counts each covering $\Delta\eta=0.5$, $\Delta\phi=\pi/2$
Quad DSM – 2nd Intermediate Stage of CTB/MWC processing	16	CTB East	2	2-byte multiplicity measurement (ADC or MIP) covering $\Delta\eta=1$, $\Delta\phi=2\pi$
		CTB East	2	Topology and LED information
		CTB West	2	2-byte multiplicity measurement (ADC or MIP) covering $\Delta\eta=1$, $\Delta\phi=2\pi$
		CTB West	2	Topology and LED information
		MWC East	2	2-byte wire count covering $\Delta\eta=1$, $\Delta\phi=2\pi$

		1-bit West TAC over threshold 1-bit East+West attenuated analog sum over threshold 9-bits TAC difference
Special Trigger	2	5-bit definition of which detector is requesting the special trigger 3-bit definition of which trigger is being requested 8 bits: Unused
BEMC and EEMC	2	Semi-defined 10 bits from BEMC • 2 bits indicating any of the 150 high towers over one of three thresholds • 2 bits indicating any of the 150 trigger towers over one of three thresholds • 2 bits indicating any of the 150 high:trigger tower ratios over one of three thresholds • 2 bits indicating any of the 6 ($\Delta\eta\Delta\phi$) = (1x1) jet patches over one of three thresholds • 2 bits indicating the total energy sum over one of three thresholds 6 bits from BEMC
BBC data	2	Undefined
FPD data	2	Undefined
RHIC	2	2-bits blue and yellow ring strobes 7-bits polarization information 7 bits: Unused

* NOTE: MWC was not used previously but may be included in the coming run.

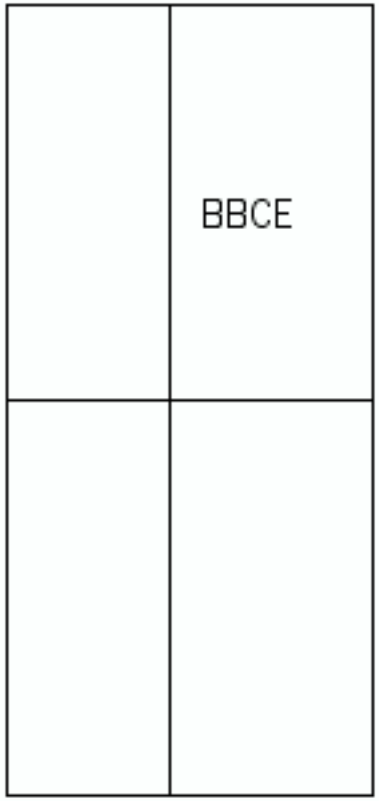
Coarse Pixel Array

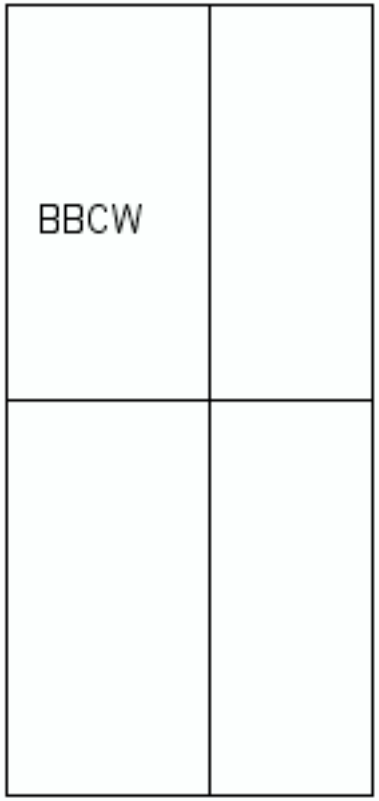


CTB : each pixel is 0.5 in η by $\pi/2$ in ϕ.

MWC : each pixel is 0.5 in η by $\pi/2$ in ϕ.

BBC at Level 1





EMC at level 1

Bits from threshold tests

Level1 Algorithms

Beam-gas event killer
based on asymmetry in CPA

Only action algorithms applied here

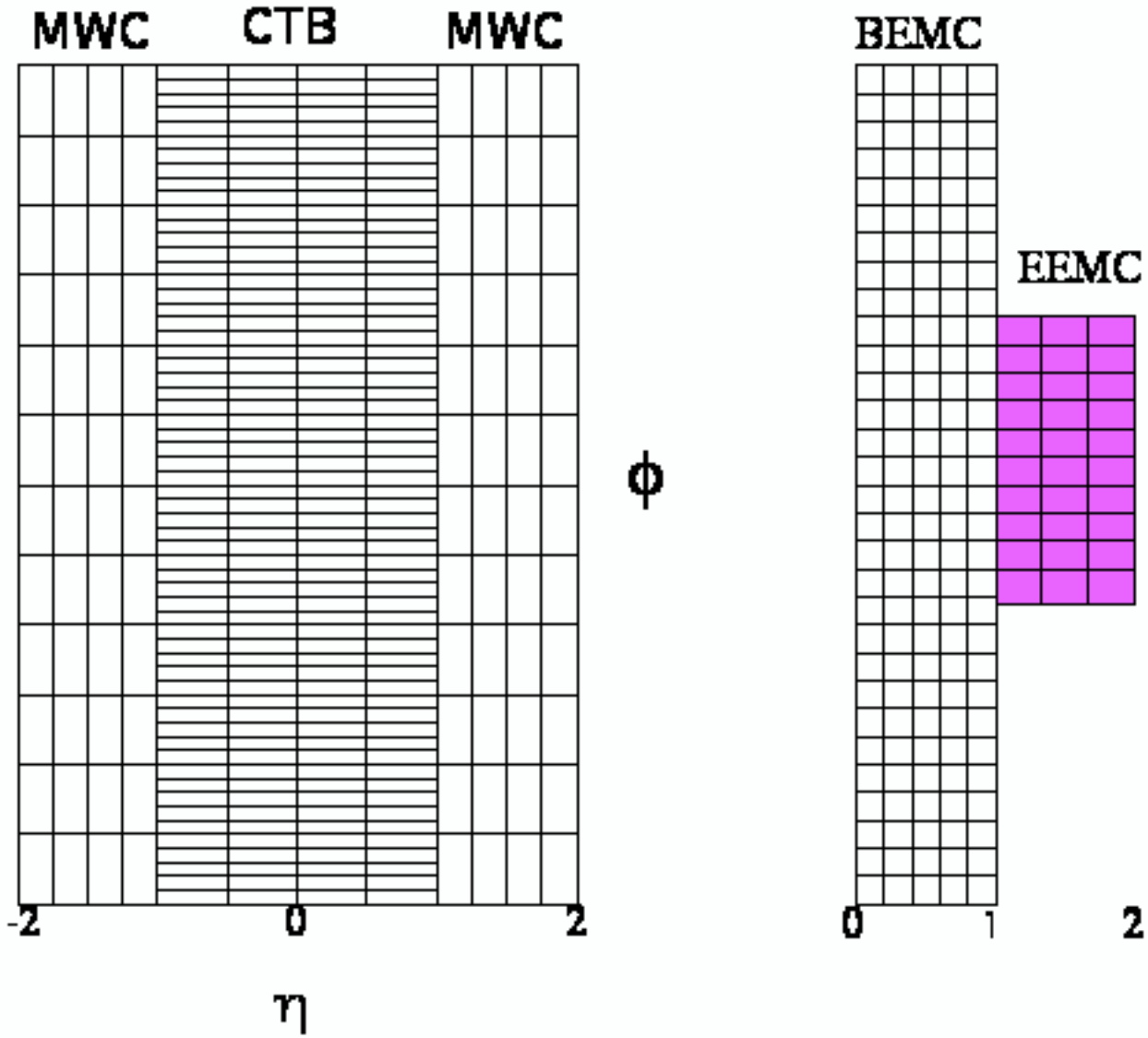
Level 2 Data

Level 2	Det	Measures	$d\eta$	$d\phi$
	CTB	$d^2n/d\eta d\phi$	0.5	$\pi/30$
	MWC	$d^2n/d\eta d\phi$	0.25	$\pi/12$
	BEMC	$d^2E/d\eta d\phi$	0.2	$\pi/15$
	EEMC	$d^2E/d\eta d\phi$	0.2	$\pi/15$
	BBC	$d^2n/d\eta d\phi$	1.6	$\pi/8$
			1.3	$\pi/4$

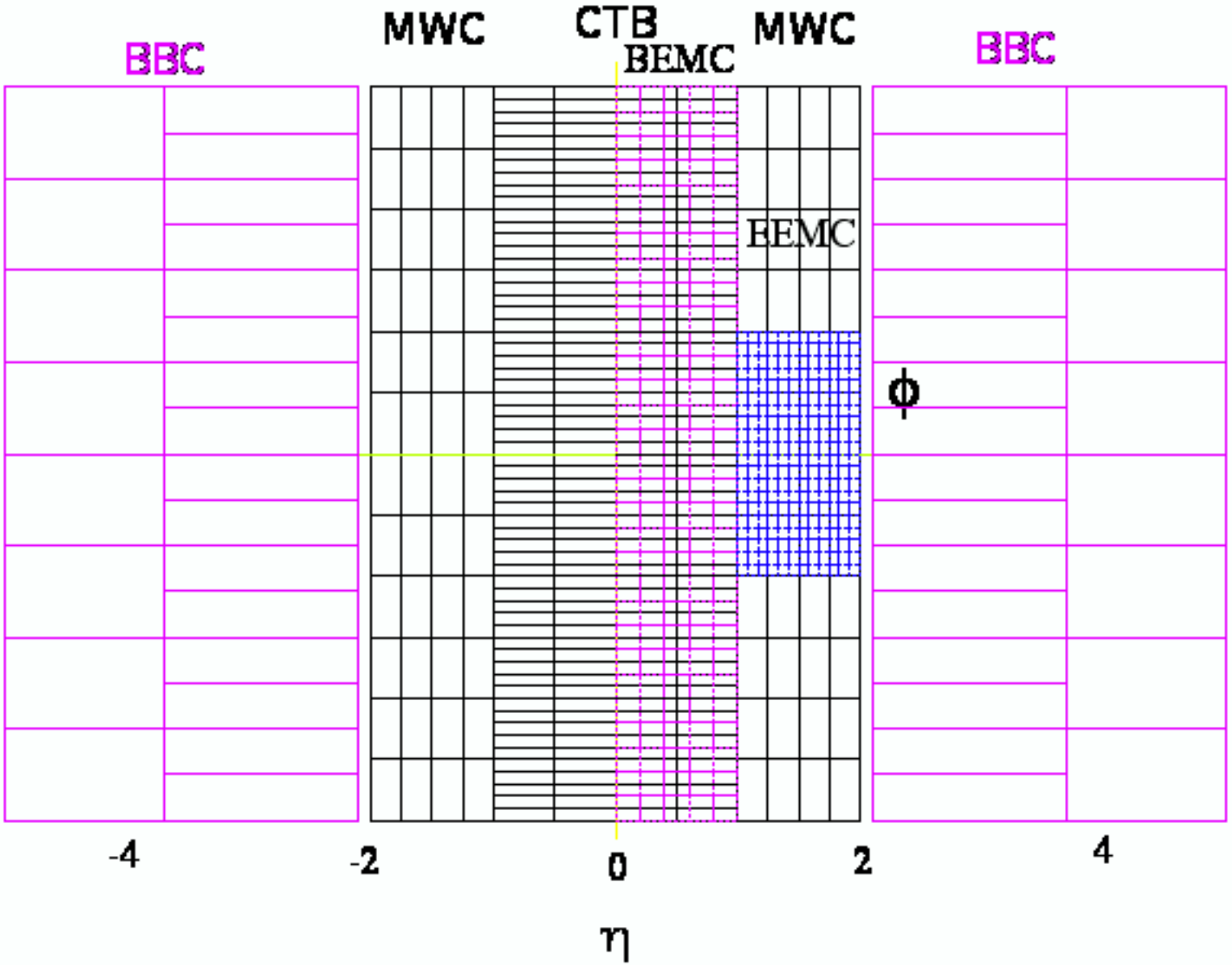
L2Detail

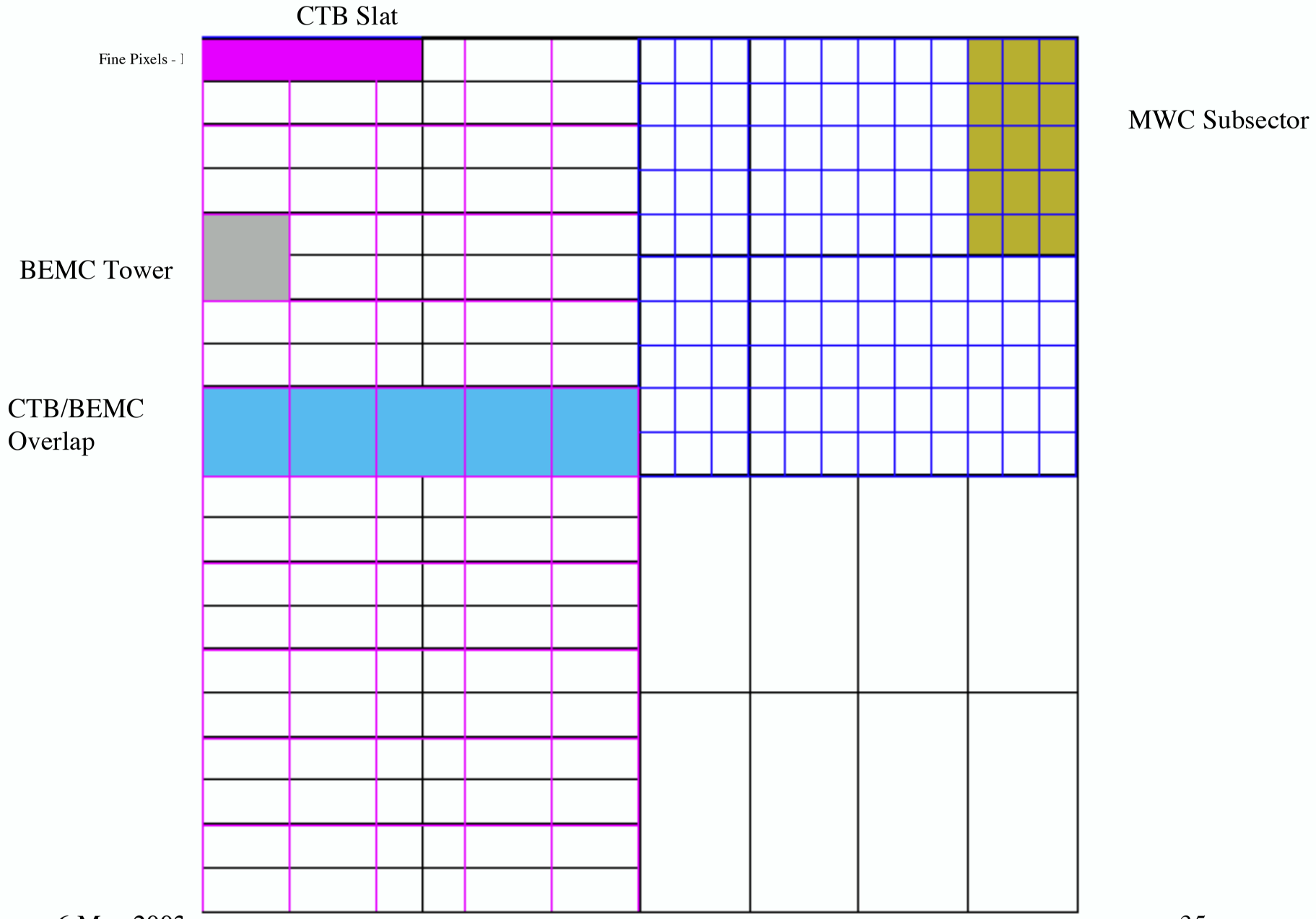
	bytes	150 6-bit trigger tower values 15 bytes - Unused
BEMC – 1st Intermediate Stage	48 bytes	18 2-byte data words from the 15 Layer 0 DSMs. Each of the 18 data words consists of: • 2 bits indicating any high tower over one of three thresholds • 2 bits indicating any trigger tower over one of three thresholds • 2 bits indicating any high:trigger tower ratio over one of three thresholds • 10 bit trigger tower energy sum 12 bytes - Unused
EEMC - Raw Data	80 bytes	40 6-bit high tower values 40 6-bit trigger patch values 4 bytes - Unused
EEMC – 1st Intermediate Stage	80 bytes	16 Undefined bytes from 1 Layer 1 DSM
BBC - Raw Data	80 bytes	16 1-byte BBC East inner annulus ADC values 16 1-byte BBC West inner annulus ADC values 16 1-byte BBC East inner annulus TAC values 16 1-byte BBC West inner annulus TAC values 8 1-byte BBC East outer annulus ADC values 8 1-byte BBC West outer annulus ADC values

Fine Pixel Array

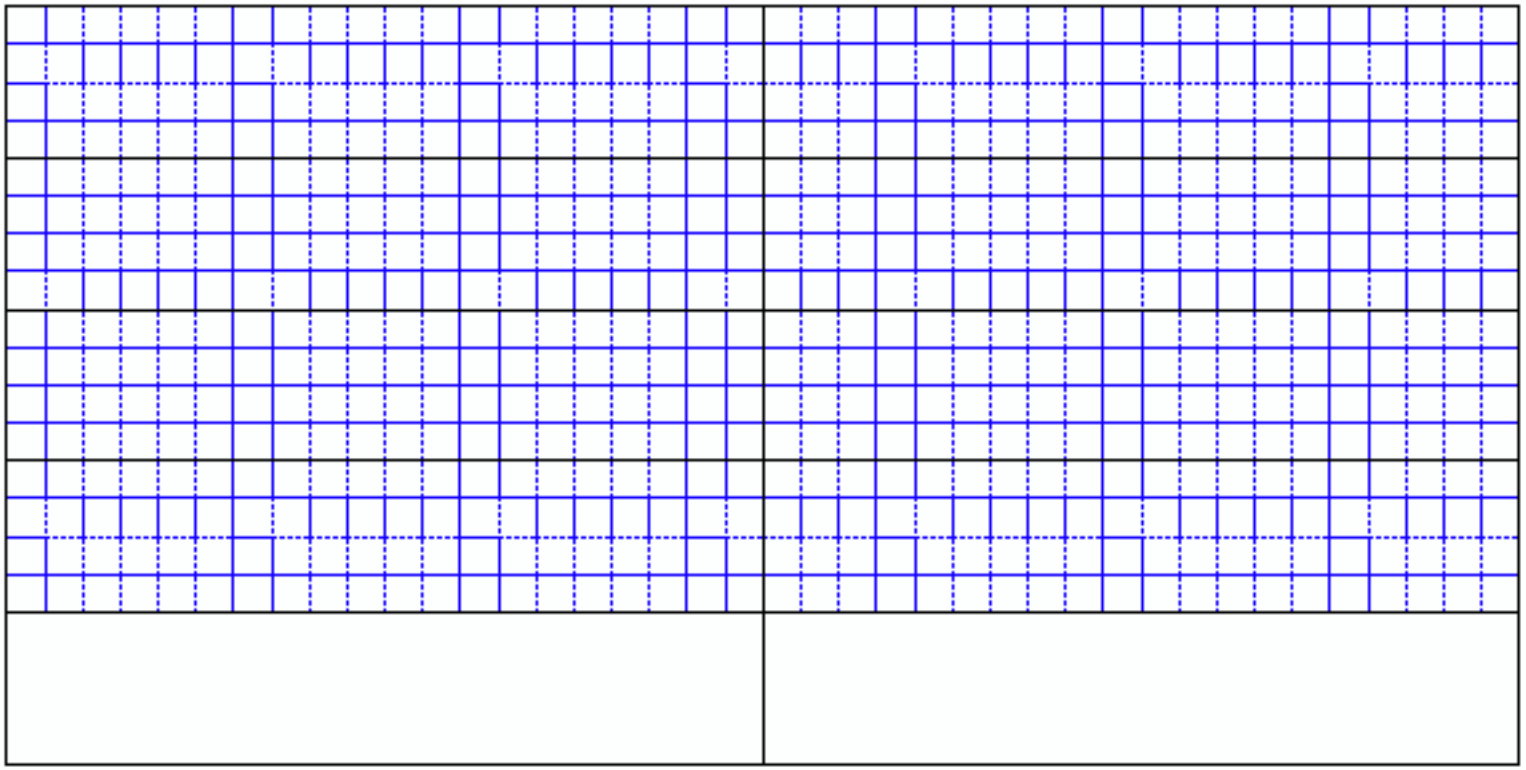


Fine Pixel Array




CTB Slat
Fine Pixels -
MWC Subsector
BEMC Tower
CTB/BEMC
Overlap

Pixels - fine - “raw towers”



Level 2 Bytes

BBC layer 2	16
FPD layer 2	
Special Triggers	16
Total	192

Note: We expect to have full BEMC raw data set available in L2 w/i 400 μs

CTB layer 0	256 bytes
MWC layer 0	128
BEMC layer 0	256
BEMC layer 1	48
EEMC layer 0	64
EEMC layer 1	16
FPD layer 0	
FPD layer 1	
BBC layer 1	80
total	1040

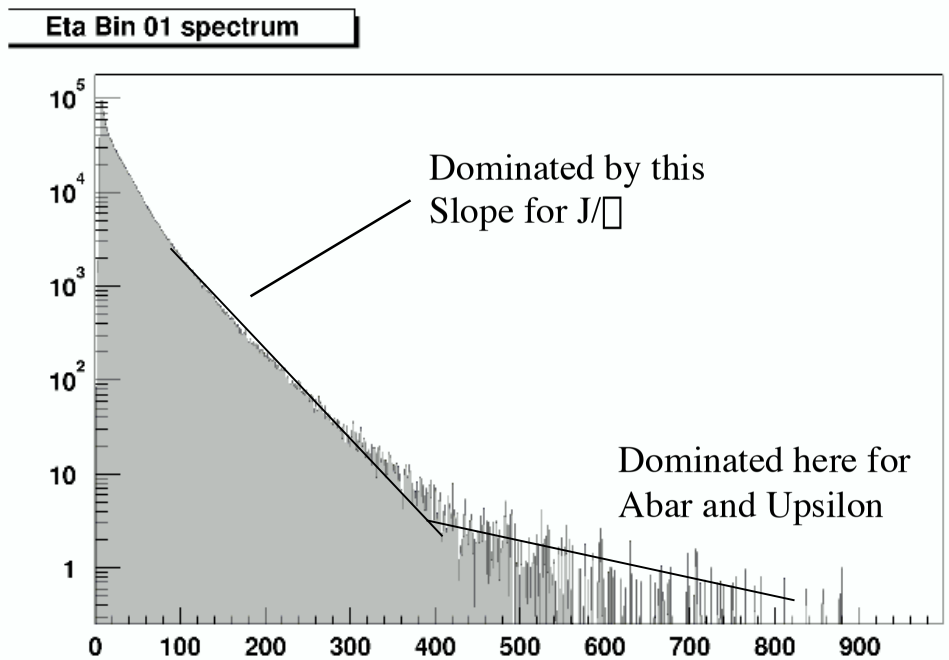
L2 Algorithms

0. Data unpacking (BEMC,EEMC)
1. Jet location using BEMC data
2. Isolated high tower indicating Abar annihilation
3. Back-to-back decay verification for UPC

Fit two slopes, then integrate to get the probability of any tower having an energy greater than some threshold.

P(E>1.5)~0.006
4800 towers (2400 this year)
Implies many events with
>1 tower having >1.5 GeV

Need Level2 to distinguish
correlated back-to-back



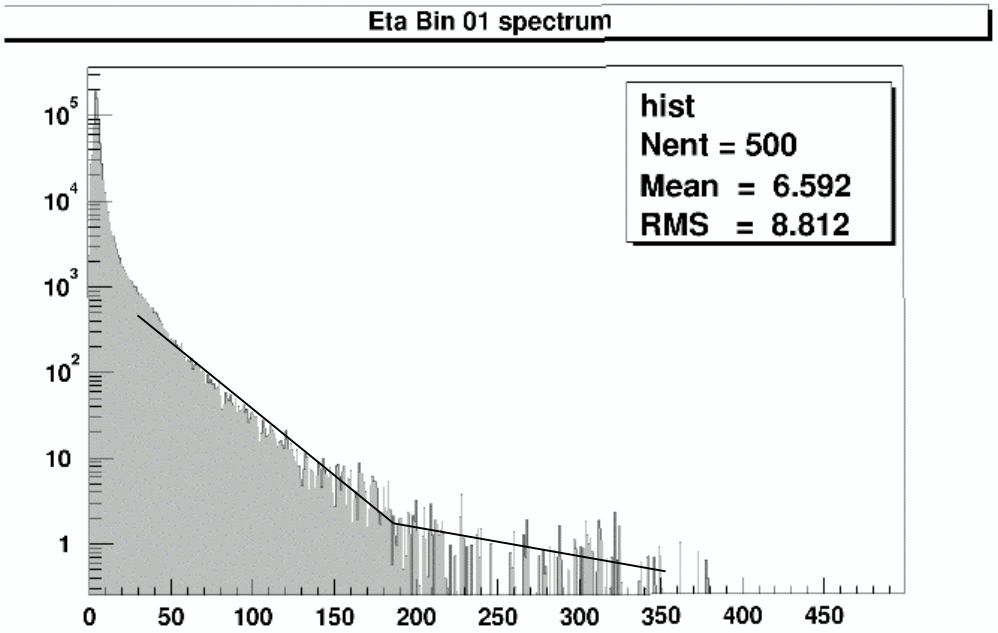
400 = 4 GeV

PP data

P(E>1.5 GeV) = 0.000002

Means Level0 trigger on 2
Towers much more powerful

Use Level2 for cleanup
on back-to-back



A.Suaide

PP Poisson Dist of Number of hits > 1.5 GeV

0	0.00821001	0.99178999	0.001000
1	0.03944748		0.999000
2	0.09474897		4800.000000
3	0.15168687	0.15169070	
4	0.18209258	0.18202884	
5		0.17474768	
6		0.13979815	
7		0.09586159	
8		0.05751695	
9		0.03067571	
10		0.01472434	

Abar Trigger

Assume annihilation of anti He 3 or 4

Means release of 6 or 8 GeV

Thus, set threshold at any tower group having E>6 GeV [P(E>6GeV)~10^{-5}]

UPC Triggers

How can Level2 Clean them up?

Use EMC info to verify CTB hits
Check CTB hit quality
Use MWC to abort

Connection to Off-line

See Herb's talk Tuesday PM

StEventMaker includes:
Trigger data arrays
Unpacker for BEMC and EEMC

Thus same decoded info is available
at Level2 and in offline analysis for testing.

Conclusions

We have a simple structure for calculations
Need tests against existing data
(given small BEMC)

Let us know your ideas - we can help

We will be using the Level2 and Level1 aborts
This year for the first time. These should lead to
A significant increase in the percentage of good
Events that we pass to DAQ.