STAR Trigger 2003

Hank Crawford

Les Bland - BBC
Jack Engelage - System Integration
Geary Eppley - CTB
Eleanor Judd - Level 0
Mikhail Kopytine - Simulations
Falk Meissner - UPC
Zoran Milosevich - Level 2
John Nelson - Level 1
Ownedby Nobody - MWC
Skip Vandermolen - EMC
Herb Ward - Offline
Zhangbu Xu - ZDC

Talk overview

Trigger Levels - 0,1,2,3,…

Trigger Detectors -

old (CTB,MWC,ZDC)

new (BBC,BEMC,EEMC,ZDC’ (FPD,VFHC))

Electronics - CDBs,DSMs,TCU,TCDs

Information available - $d^2n/d\square d\square$,$d^2E/d\square d\square$

How to use it

Don’t forget backgrounds

STAR Trigger levels

The trigger levels are designed to match TPC timing

Time 0 = time of interaction

particles propagate to detectors

detector signals digitized and start through decision tree

1.5 μs = Level0 decision issued

TPC gating grid is opened

TPC digitization begins

TPC data begins spooling to receiver cards

100 μs = Level1 decision issued

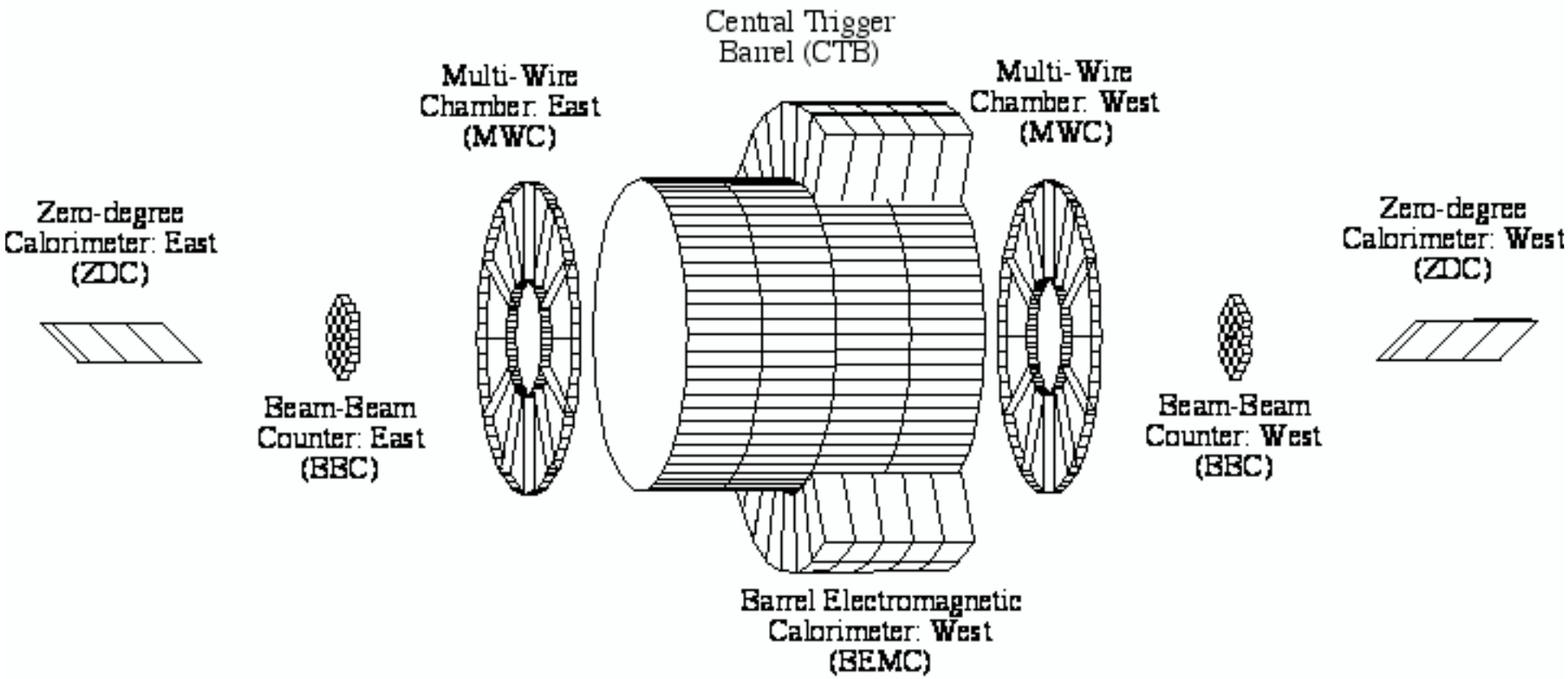
TPC drift complete

<5 ms = Level2 decision issued

10 ms = all TPC data has been collected by DAQ

12-40 ms (depending on occupancy) Level3 begins analysis

STAR Trigger Detectors



EGJ

STAR Trigger η, φ Coverage

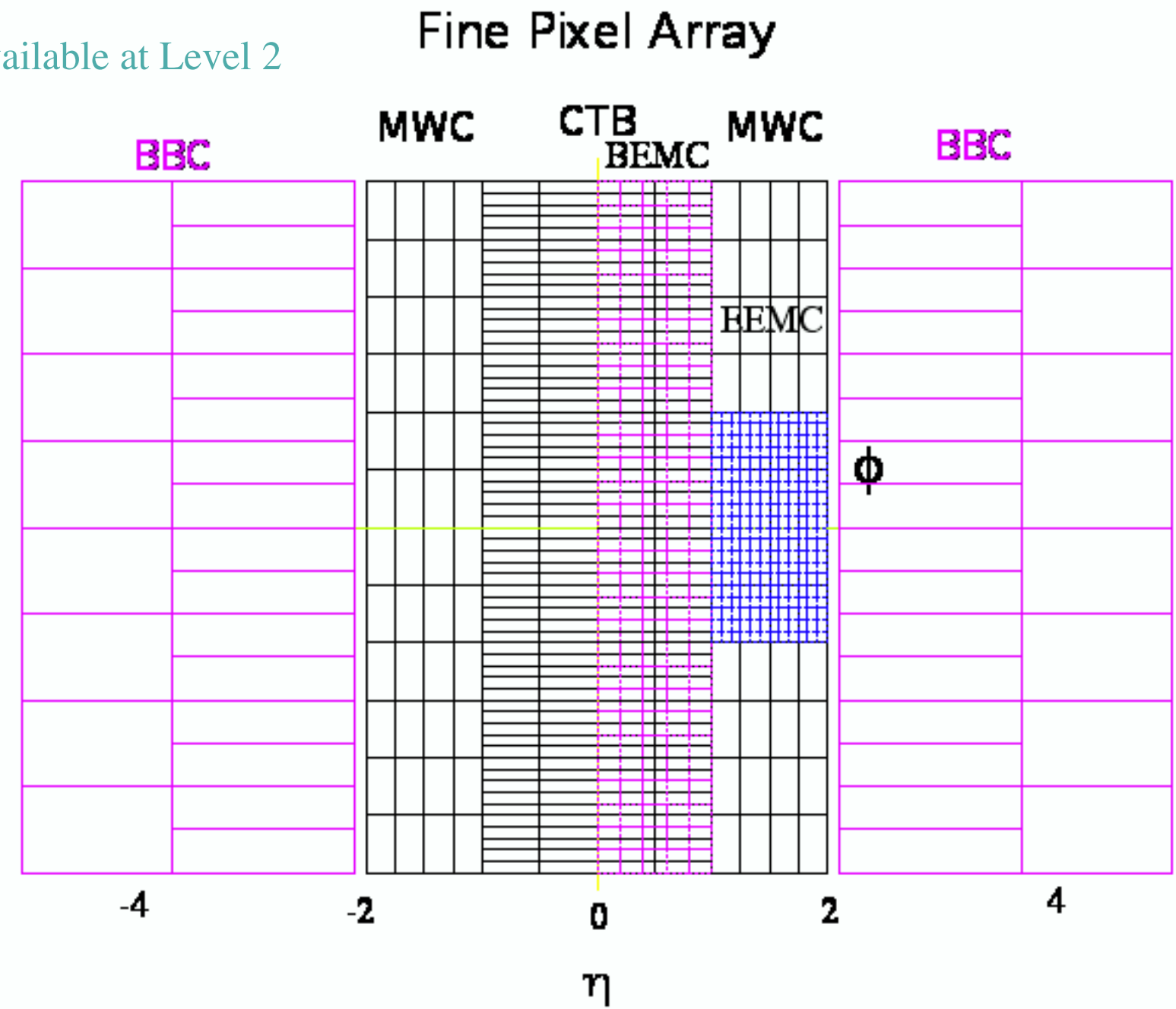
Detector	η				φ	
CTB	-1			1	0	2π
BEMC			0	1	0	2π
(MWC)	-2	-1	1	2	0	2π
EEMC			1	2	2π/3	4π/3
BBC	-5	-2.1	2.1	5	0	2π
ZDC	-5.4	-5.3	5.3	5.4	0	2π
FPD						
VFHC						

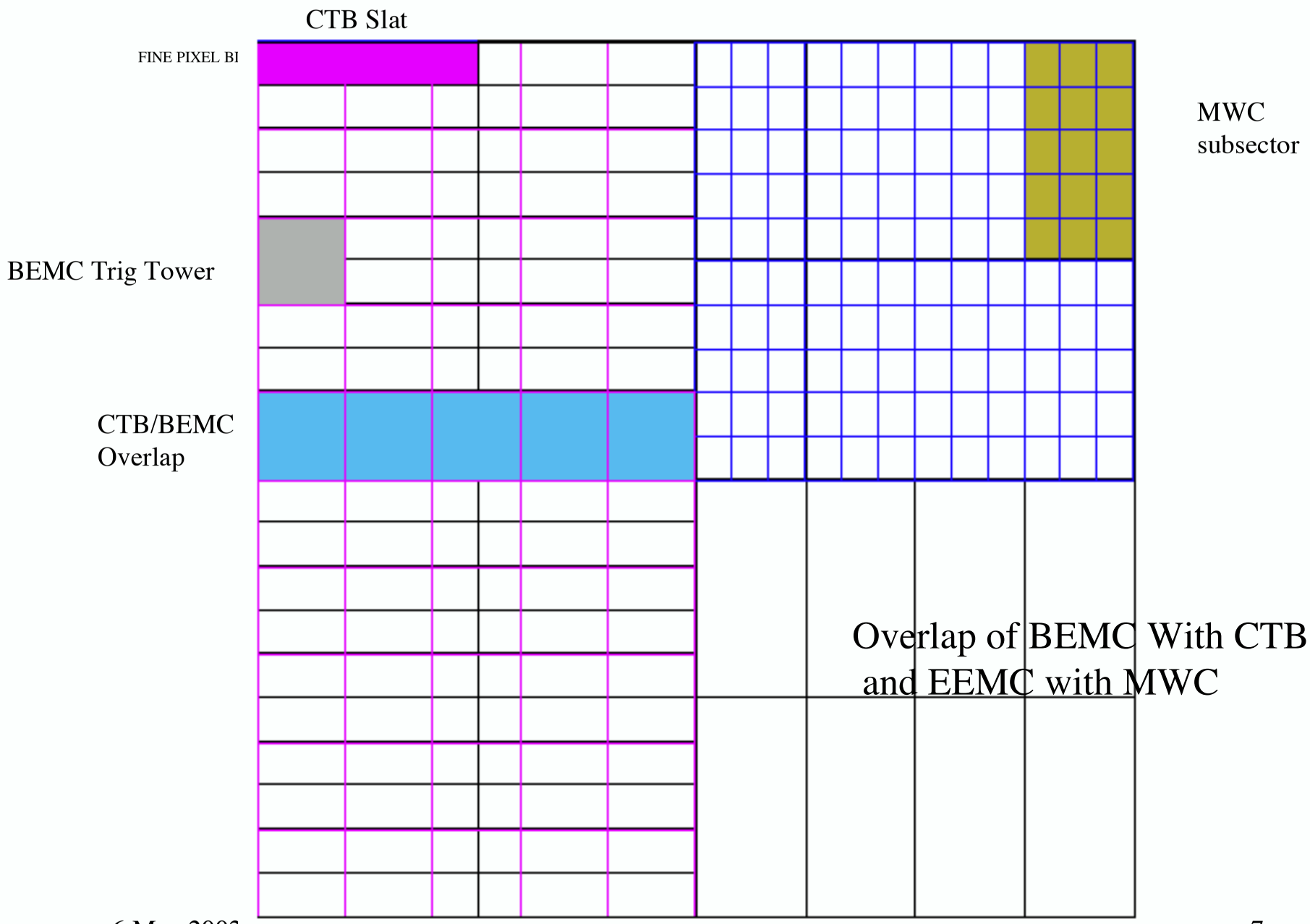
Nearly Hermetic!

Note: Coverage for MWC is problematic because of noise.

Available at Level 2

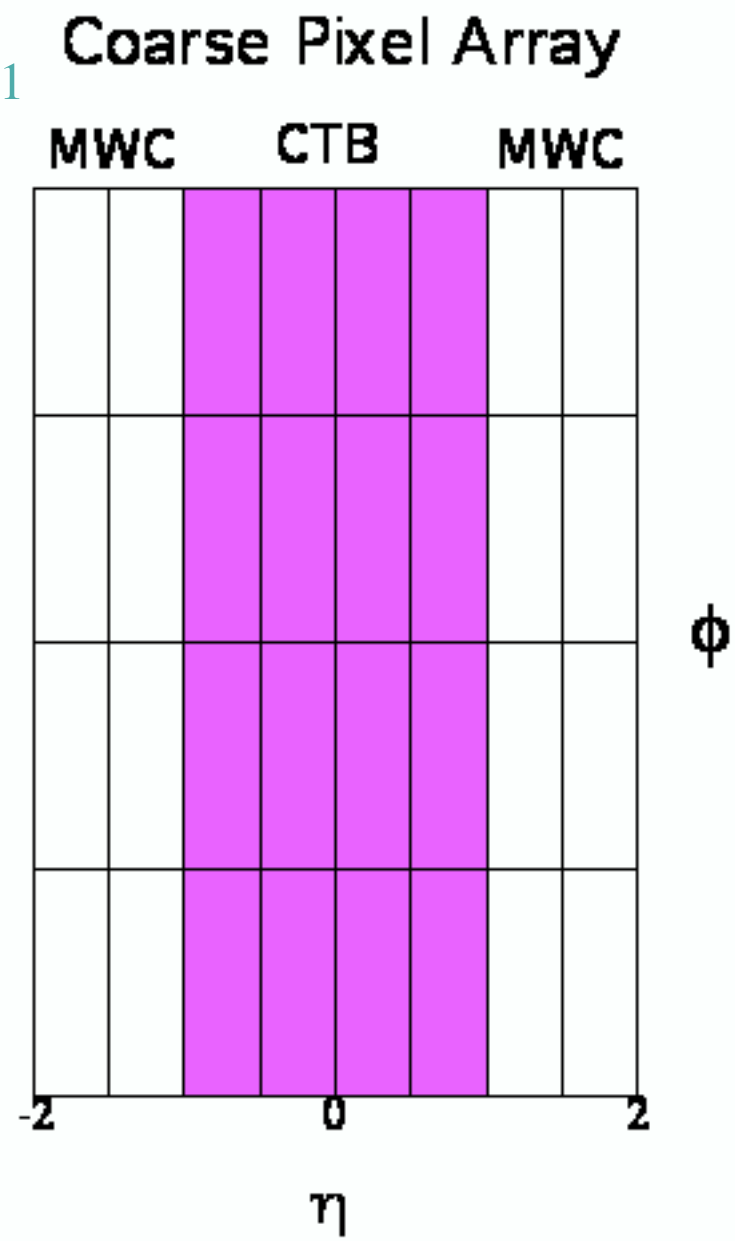
er Data




CTB Slat
FINE PIXEL BI
MWC
subsector
BEMC Trig Tower
CTB/BEMC
Overlap
Overlap of BEMC With CTB
and EEMC with MWC

Available at level 1

Pixels - coarse array



CTB : each pixel is 0.5 in η by π/2 in ϕ.

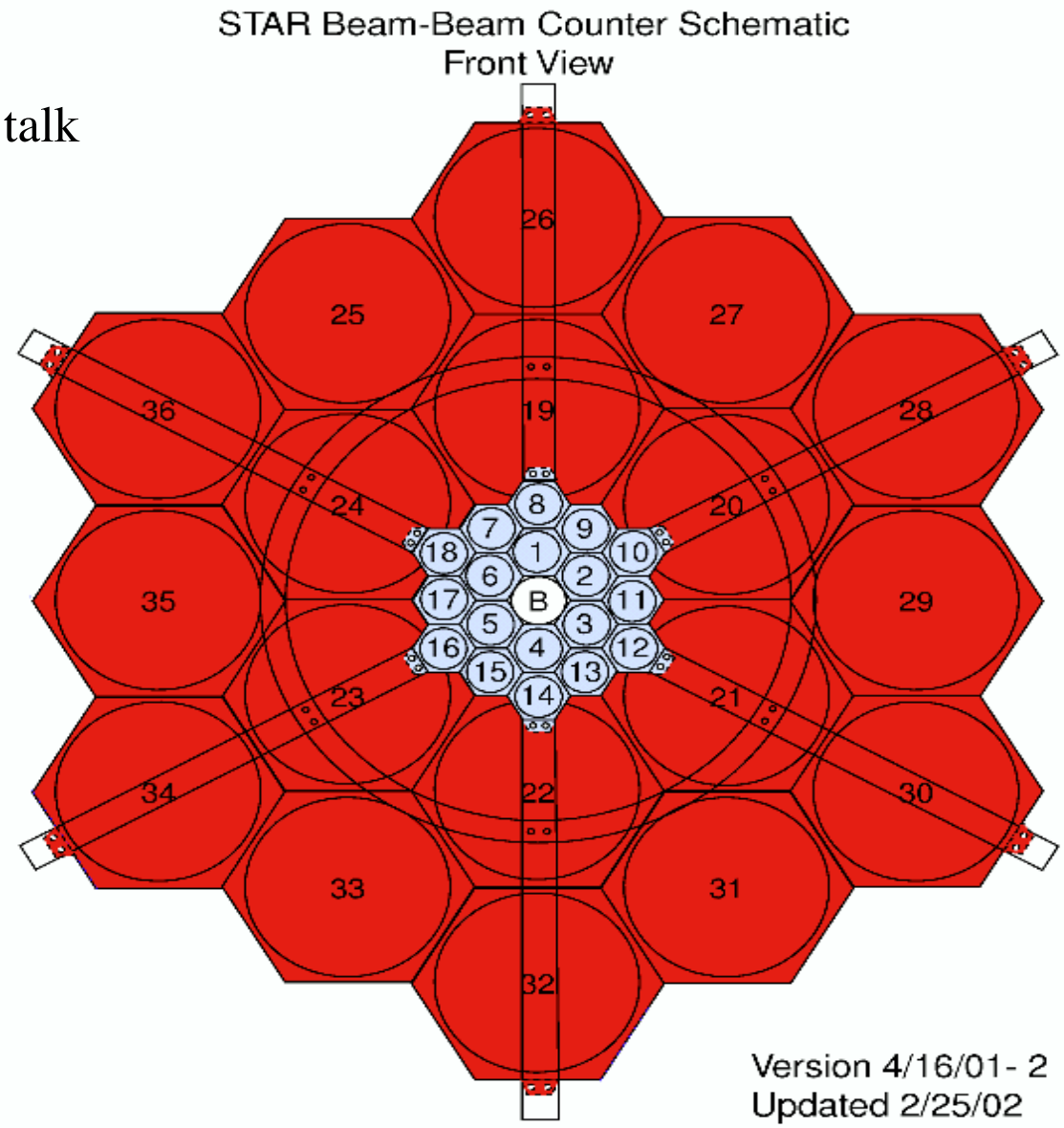
MWC : each pixel is 0.5 in η by π/2 in ϕ.

DSMs in L0L1 crate

New Detectors

- BBC - Beam-Beam Counters
- BEMC - Barrel Electromagnetic Calorimeter
- EEMC - Endcap Electromagnetic Calorimeter
- ZDC - Zero Degree Calorimeter Shower Max
- FPD - Forward π^0 Detector
- VFHC - Very Forward Hadron Calorimeter

See Les' talk


STAR Beam-Beam Counter Schematic
Front View
26
25
27
36
19
28
24
20
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18
1
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6
2
35
17
B
11
29
5
3
16
4
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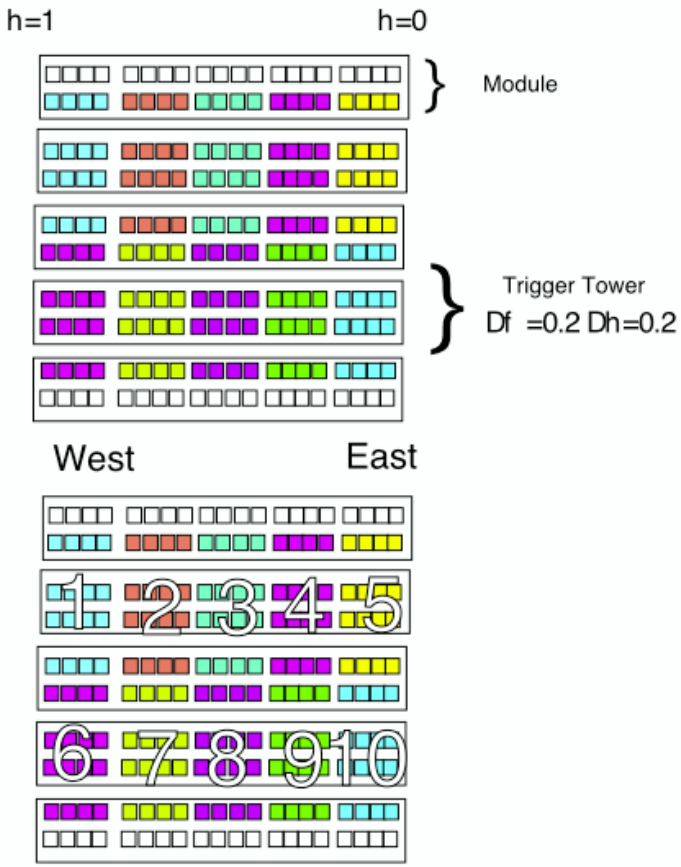
33
31
32
Version 4/16/01- 2
Updated 2/25/02

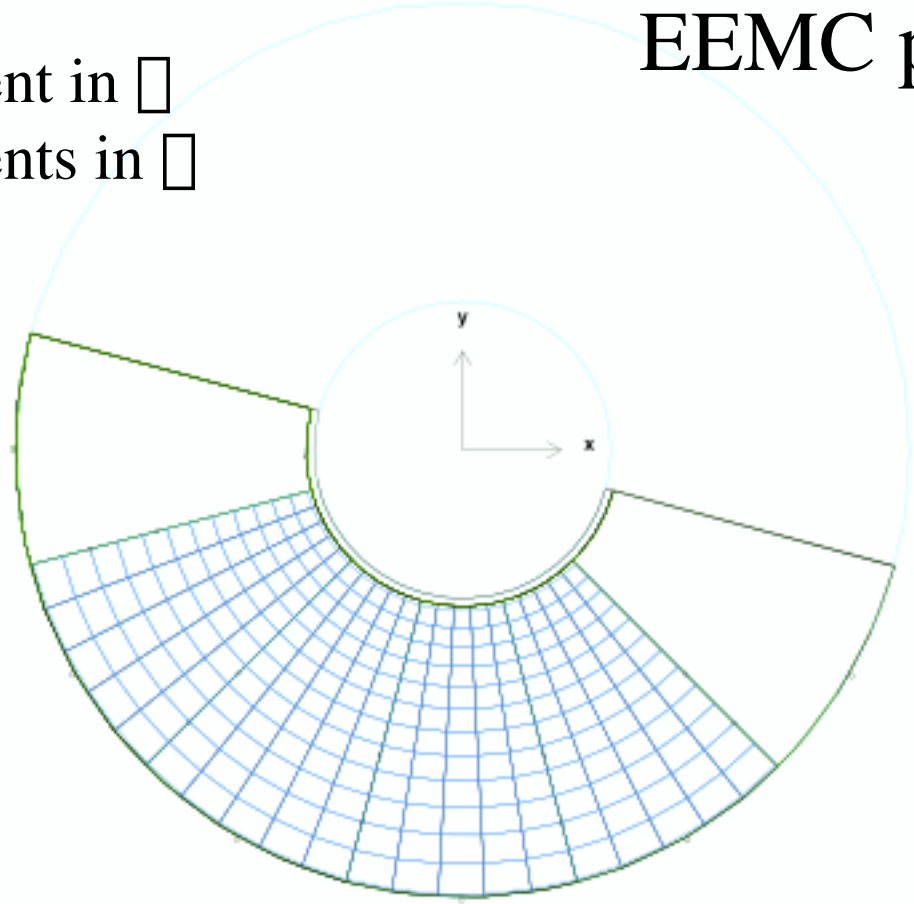
BEMC

See Skip's talk

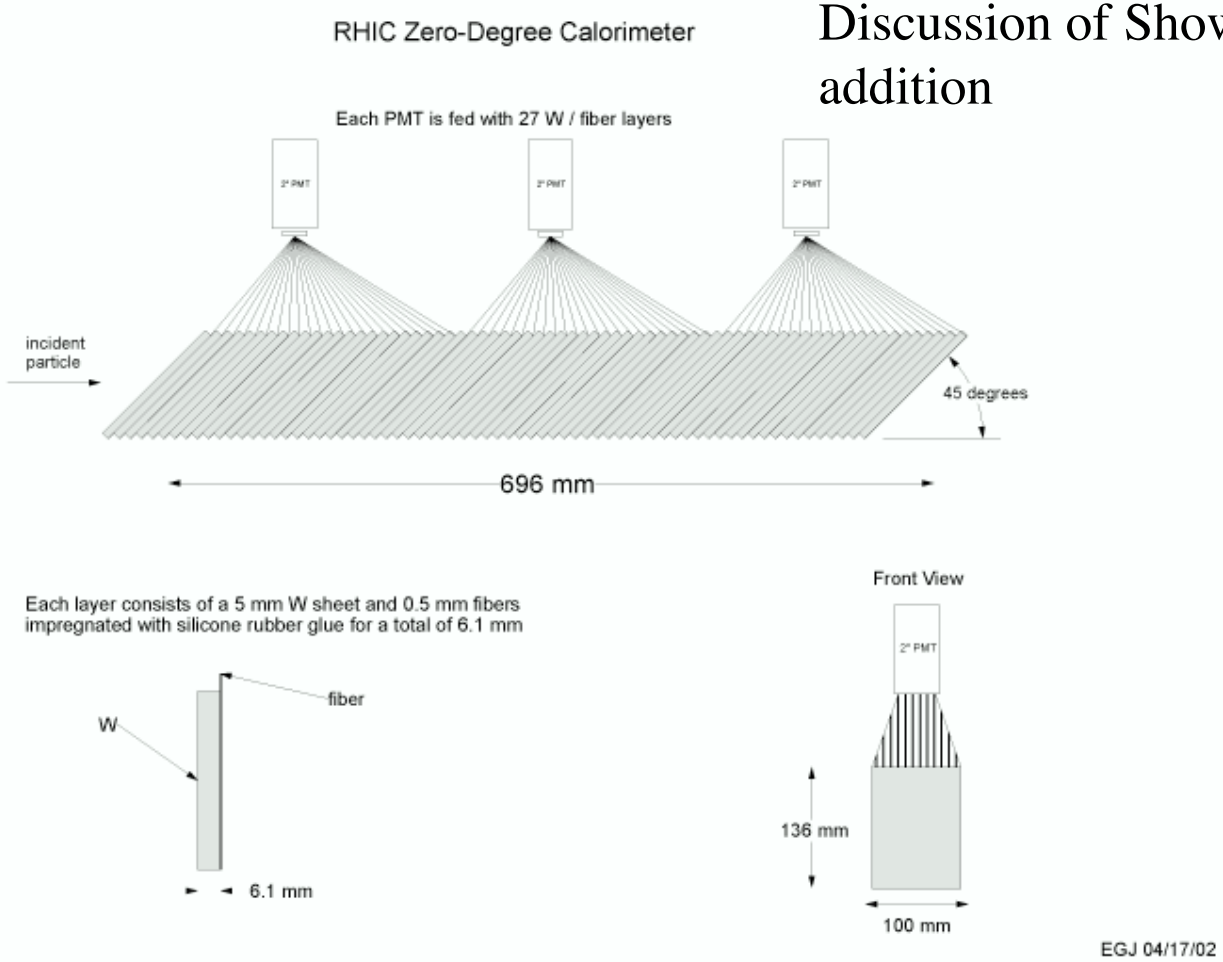


EEMC patch

12 segment in □
20 segments in □



Do we get x,y grid?
Discussion of Shower Max addition



New Electronics

Ken Asselta
Fred Bieser
Eleanor Judd
Jimmie Johnson
Bob Minor
Dan Padrazo
Chris Perkins
Thorsten Stetzelberger
Vanessa Valdez
John Wolf

TCU - Trigger Control Unit
TCD - Trigger Clock Distribution
DSM - Data Storage and Manipulation
CDB - Central Digitizer Board
Scalers

Simple DataFlow Diagram

```
Detector -> Digitizer -> DSM -> TCU -> TCD -> other detectors -> DAQ
                          |  \      |
                          |        L1CPUs
                          |         |
                          ------->  L2CPUs
                                    |
                                   DAQ
```

TCD Description

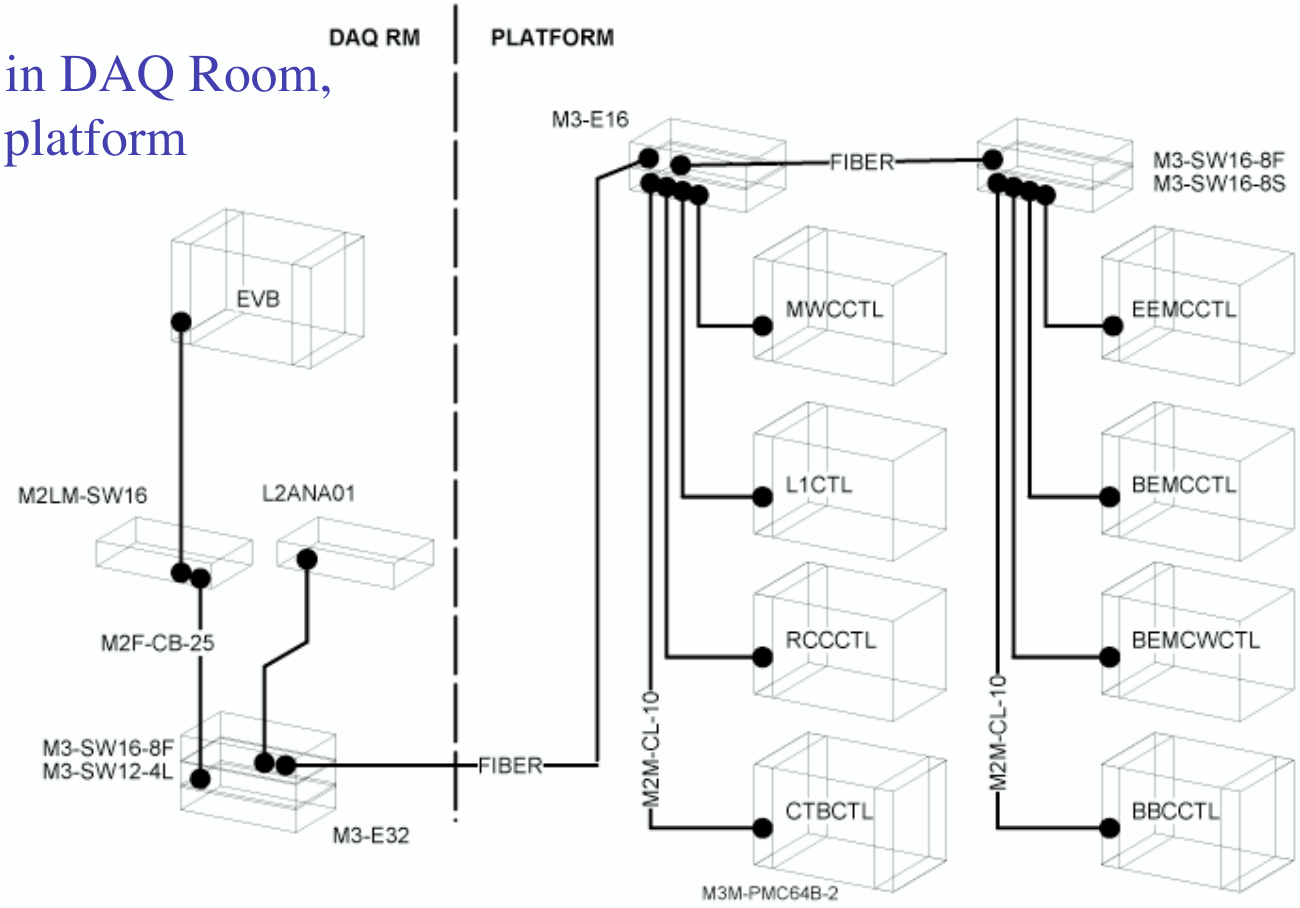
Trigger and Clock Distribution Board

Designed to accommodate increased number of detectors and to make operation simpler.

1. 16 detector bits and live bits
2. VME registers for stand-alone operation
   a. timing delay
   b. live status
   c. token number
   d. trigger word
3. differential outputs for fast detectors (all 20 bits)
4. differential outputs for cable feeds to remote fanout
5. differential outputs for special triggers
6. front-panel in-situ reconfiguration of FPGA

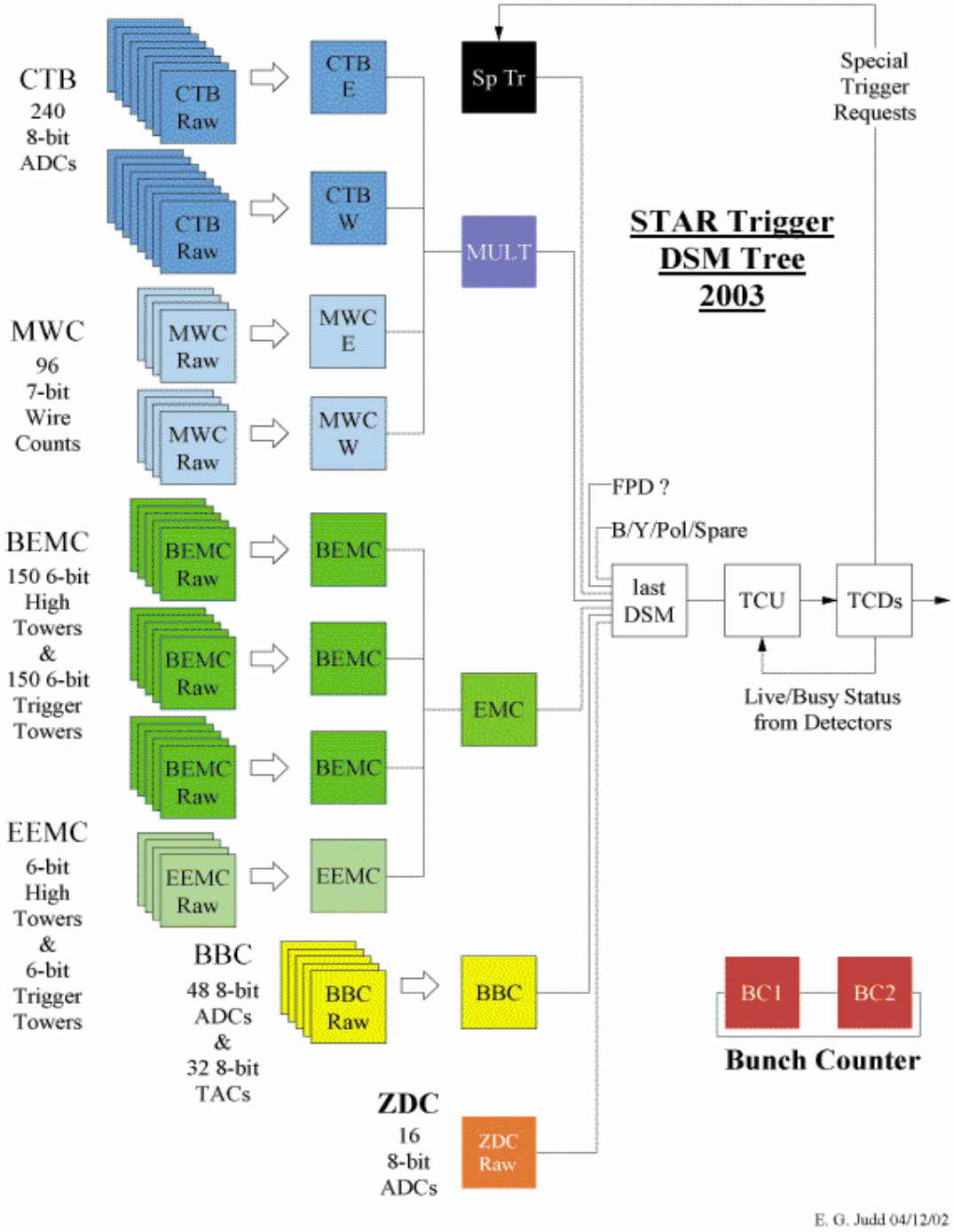
New Trigger Network

Level2 in DAQ Room,
Not on platform



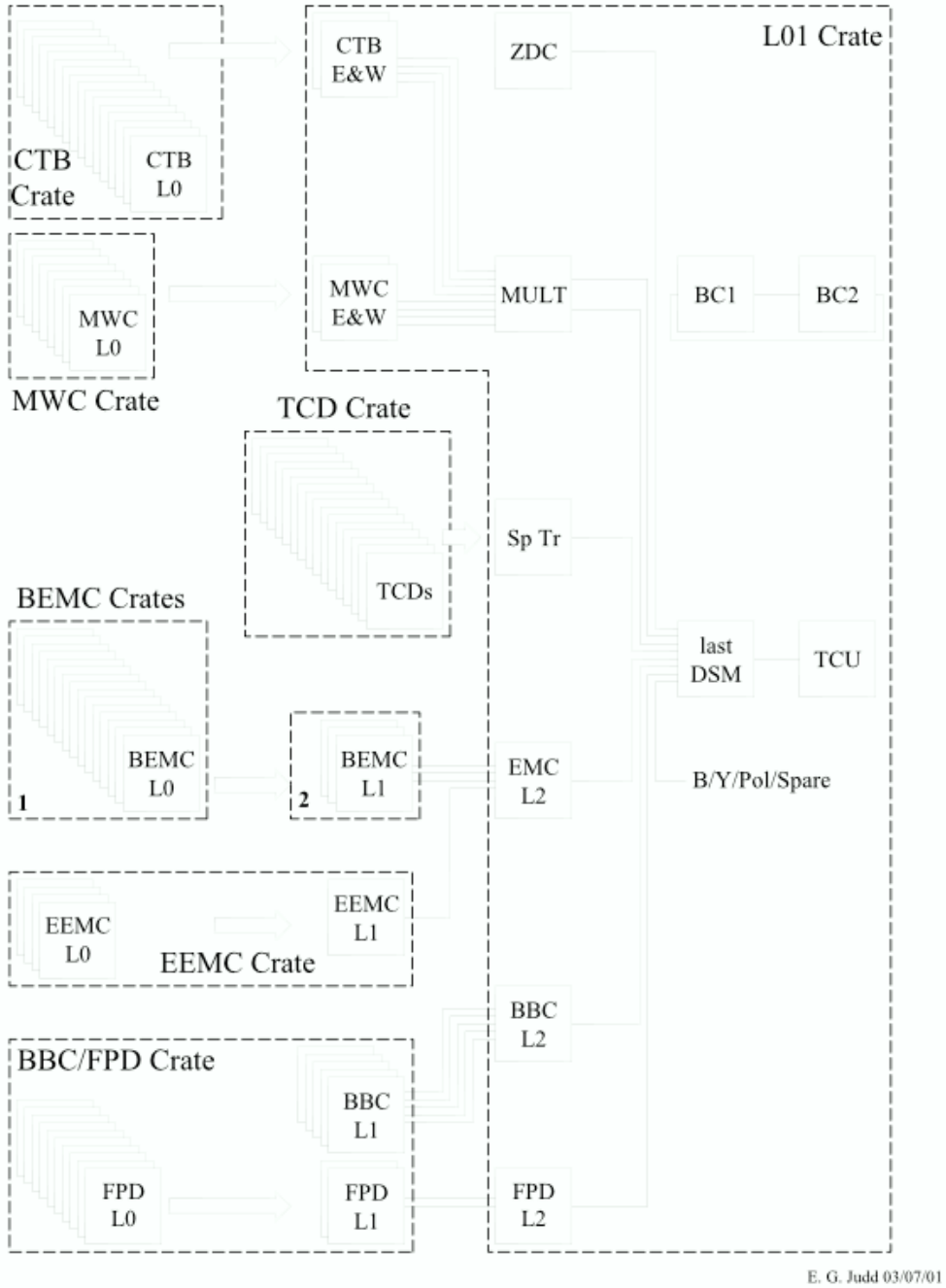
JE

DSM Tree



BITS in GUI are from last DSM to TCU

DSM-tree detail



What information is available? When?

Level 0	Det	Measures	d□	d□
	CTB	$d^2n/d\square d\square$	2	2□
		topology	.5	π/30
	(MWC)	$d^2n/d\square d\square$	1	2□
	BEMC	$d^2E/d\square d\square$	1	2□
		(tower sum)	.2	π/15
		(high tower)	0.05	π/60
		jet patch	1	π/3
	EEMC	$d^2E/d\square d\square$	1	2π/3
		(tower sum)	.2	π/15
		(high tower)	.05	π/60
	BBC	$d^2n/d\square d\square$	1.6	2π
			1.3	2□
		vertex loc.		
	ZDC	0° neutral E	.1	2π
		vertex loc.		
	FPD	$d^2E/d\square d\square$		
	VFHC			
	RHIC	polarization		

Note: The UPC trigger uses individual slats in making its decision.

Note: We can trigger on individual towers, on tower sums, on total energy, or on ratios of these.

Pre-Trigger

Who needs a pre-trigger to arrive before L0 accept?

What should it be?

We need to clarify this issue by 20 May so we can
Include it in our cabling.

Level 1 (100 μs)

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

Level1 operates on all of the DSM Information in the L0/L1 crate.

Note: The BBC has an East and a West detector.
BEMC and EEMC are only on the West end this year.
The CTB and MWC have multiple segments in both East and West available in the CPA.

Level 2 (<5 ms)

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

Level2 operates on all of the raw trigger detector data, which it gathers from the DSM tree, plus the data and results of Level1.
We may also have the full BEMC individual detector data (4800 channels +SMD??)w/i 400 μs next year.

Trigger Detector Coverage – Detail

Coverage detail

Detector		η_{lo}	η_{hi}	ϕ_{lo}	ϕ_{hi}	$d\phi$
CTB	240 slats	-1	1	0	2π	
west outer slat		-1.0	-0.5			$\pi/30$
west inner slat		-0.5	0			$\pi/30$
east inner slat		0	0.5			$\pi/30$
east outer slat		.5	1.0			$\pi/30$
MWC-E	48 subsectors	-2.1	-1.0	0	2π	
subsector 0		-2.08	-1.63			$\pi/6$
subsector 1		-1.63	-1.35			$\pi/6$
subsector 2		-1.29	-1.10			$\pi/6$
subsector 4		-1.10	-0.96			$\pi/6$
MWC-W	48 subsectors	1.0	2.1	0	2π	
subsector 0		2.08	1.63			$\pi/6$
subsector 1		1.63	1.35			$\pi/6$
subsector 2		1.29	1.10			$\pi/6$
subsector 4		1.10	0.96			$\pi/6$
BEMC-W	150 trig towers	0	1.0	0	2π	
tower	*2400 towers*		*0.05*			$\pi/60$
trigger tower	4x4 towers		0.2			$\pi/15$
jet-patch	20x20 towers		1.0			$\pi/3$
EEMC-W	720 towers	1.0	2.0	$2\pi/3$	$4\pi/3$	
tower-inner		1.943	2.0			$\pi/30$
tower-outer		1.0	1.099			$\pi/30$
BBC-E	24 hex dets	-5.0	-2.1	0	2π	
inner ring	16 dets	-5.0	-3.4			$\pi/8$
outer ring	8 dets	-3.4	-2.1			$\pi/4$
BBC-W	24 hex dets	2.1	5.0	0	2π	
inner ring	16 dets	3.4	5.0			$\pi/8$
outer ring	8 dets	2.1	3.4			$\pi/4$

ZDC Data Detail

0	ZDCE PMT1
1	ZDCE PMT2
2	ZDCE PMT3
3	ZDCE PMT sum
4	ZDCW PMT1
5	ZDCW PMT2
6	ZDCW PMT3
7	ZDCW PMT sum
8	ZDCE PMT1 attn.
9	ZDCE PMT3 attn.
10	ZDCE PMT sum attn.
11	ZDCW PMT1 attn.
12	ZDCW PMT3 attn.
13	ZDCW PMT sum attn.
14	ZDCE TAC
15	ZDCW TAC

What can we do with it

At Level 0 -- DSM analysis, crude pixels

min bias, centrality, jets, high-pt, UPC, vertex

At Level 1 - VME CPUs, coarse pixel array

beam-gas rejection, geometry verification

At Level 2 - Linux farm, fine pixel array

jet isolation, 2&4 particle geometry,??

At Level 3 - Linux farm - combined with tracks

At DAQ - global event selection

Level 0 Bit Examples

bit	Run2-AuAu	Run2-pp	Run2003
0	Mult. lo	Mult. lo	M1
1	Mult. mid	Mult. mid	M2
2	Mult. hi	Mult. hi	M3
3	UPC	FPD –no busy	UPC
4	Blue	Blue	Blue
5	Yellow	Yellow	Yellow
6	==0	FPD busy	BBC TAC
7	ZDC TACs	BBC –no vertex	ZDC TAC
8	ZDC sum	BBC -vertex	BBC coinc
9	ZDC coinc	HiTower –lo	ZDC sum
10	BEMC	HiTower –hi	HiTower –lo
11	special	special	HiTower –hi
12	N/A	N/A	FPD
13	N/A	N/A	Jet 1
14	N/A	N/A	
15	N/A	N/A	special

The Run2003 values are a suggested bit list. We will finalize this list in September after discussing conclusions from this meeting and any other issues that arise in the Trigger Board.

Synchronous operation
(input bit pattern recorded
for each RHIC Strobe received)

Expect up to 10 boards
Each having 24 input bits

At least one board will
have 16 bits from last
DSM plus LIVE bits as input

STAR Scaler Boards

bit	scaler 1	scaler 2	scaler 3	scaler 4
0	M1	M1	BBC1	
1	M2	M2	BBC2	
2	M3	M3	BBC3	
3	UPC	UPC	BBC4	
4	Blue	Blue	BBC5	
5	Yellow	Yellow	BBC6	
6	ZDC Time	ZDC Time	BBC7	
7	ZDC Analog	ZDC Analog	BBC8	
8	ZDC Coinc	ZDC Coinc	BBC9	
9	EMC Esum 1	EMC Esum 1	BBC10	
10	EMC Esum 2	EMC Esum 2	BBC11	
11	EMC Tower 1	EMC Tower 1	BBC12	
12	EMC Tower 2	EMC Tower 2	BBC13	
13	BBC Time	BBC Time	BBC14	
14	BBC Coinc	BBC Coinc	BBC15	
15	Trigger live	Trigger live	BBC16	
16	SSD live	SSD live	RHIC0	
17	PMD live	PMD live	RHIC1	
18	TOFp live	TOFp live	RHIC2	
19	RICH live	RICH live	RHIC3	
20	FTPC live	FTPC live	RHIC4	
21	EMC live	EMC live	RHIC5	
22	SVT live	SVT live	RHIC6	
23	TPC live	TPC live		

Installation Schedule

Need Level0 trigger ideas in place by 1 Sept

We need this formation to program the DSM tree, a process which takes many weeks. Once we have programmed the DSMs, we develop a set of up to 16 bits that are then available for the user to select the particular trigger desired at run time, using the much-loved GUI.

We need Level2 simulations and data analysis before implementing triggers

Background Issues

We need to develop good background rejection algorithms based on the data we took in FY02.

Can use the EEMC and MWC for charged particle vetoing at Level 0 for UPC and low-M studies

Conclusions

Expect to use min bias, central, UPC, high-pt and jet triggers for heavy ion running

Expect to use min bias, high-pt, jet and π^o triggers for proton running.

Need interested parties to develop and test trigger ideas