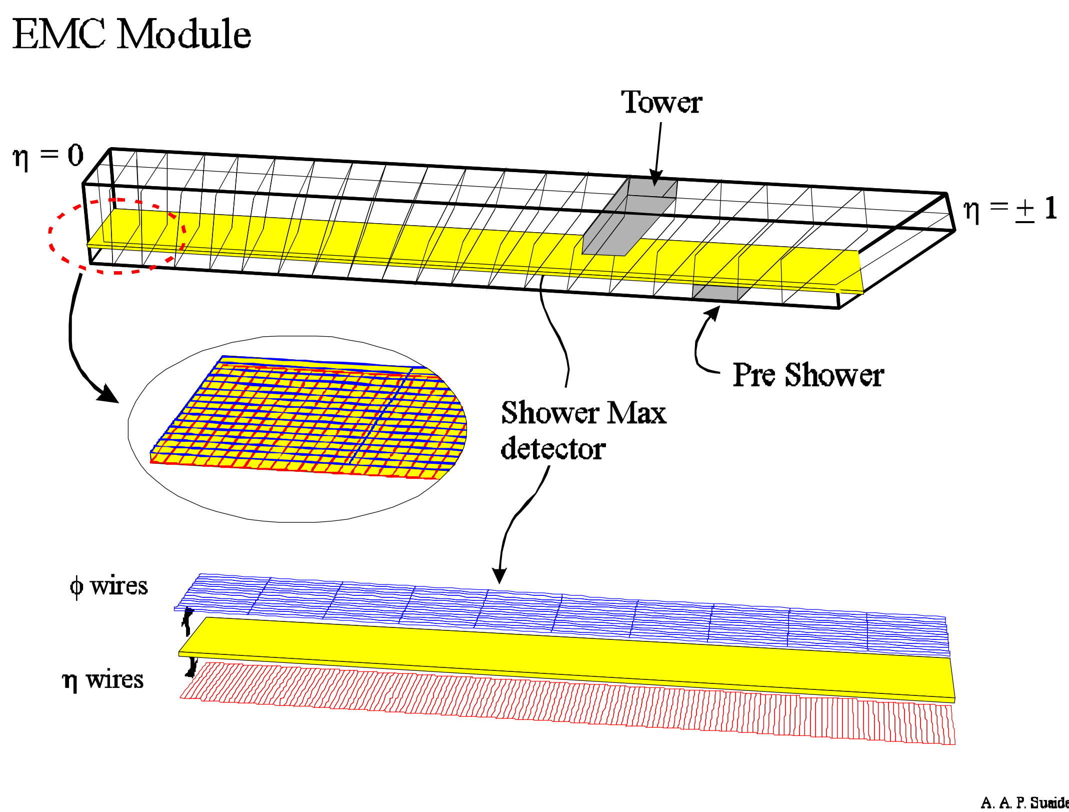
EMC Commissioning for the 2002-2003 run

- Review of last year run
  - Installed system
  - What worked and what didn't work
- EMC for the next run
  - Installed system
  - System modifications
  - Commissioning plan

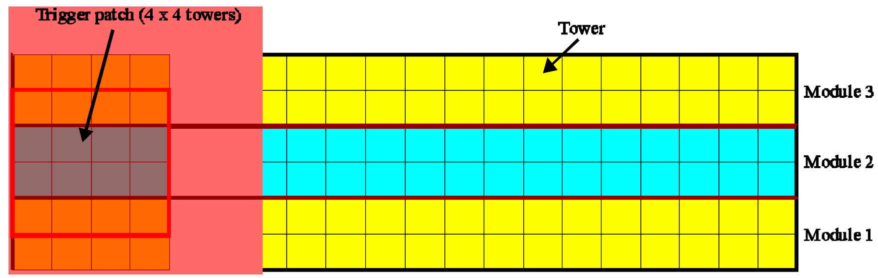
EMC detector overview

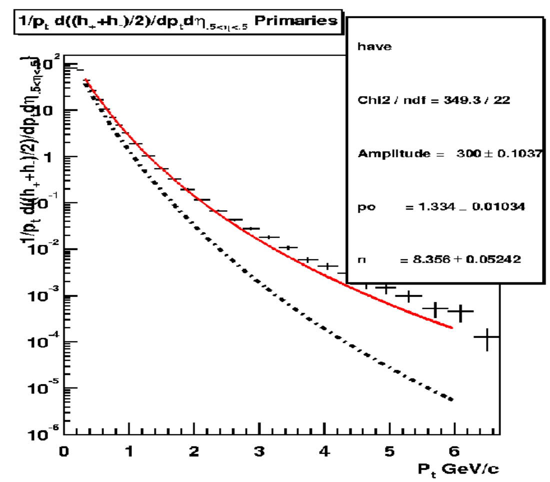
- Full barrel EMC
  - $-1.0 < \eta < 1.0$
  - Full azimutal coverage
  - 120 modules
    - $(\Delta\eta, \Delta\phi)_{module} \sim (1.0, 0.1)$
    - 40 towers/module
      - $21\ X_0$
      - $(\Delta\eta, \Delta\phi)_{tower} \sim (0.05, 0.05)$
      - $dE/E \sim 14\%/\sqrt{E}$
    - Shower max detector
      - Positioned at $\sim 5\ X_0$
      - Larger spatial resolution
      - $(\Delta\eta, \Delta\phi) \sim (0.007, 0.007)$
    - Pre-shower detector
      - $2\ X_0$



EMC trigger overview

- Photons, electrons, π^0, jets, E_t
  - Trigger patches
    - 4 x 4 towers
    - $(\Delta\eta, \Delta\phi) \sim (0.2, 0.2)$
    - Highest tower in patch (HT)
      - 0.5 GeV energy resolution
    - Patch sum
      - Look up table
  - Jet trigger
    - Sum over patches for 10 modules
  - E_t trigger
    - Total Energy on EMC (centrality trigger)

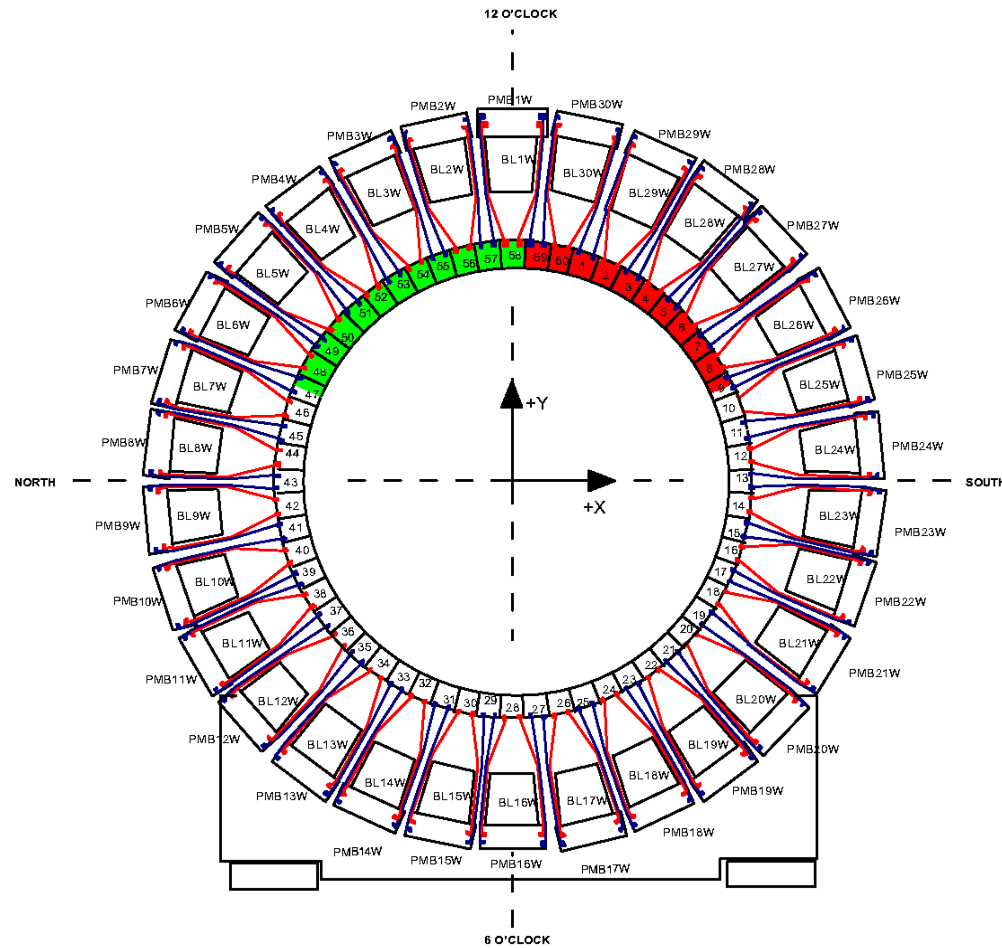




Jon Gans @ 4/22/2002

Review of last year run – Installed patch …

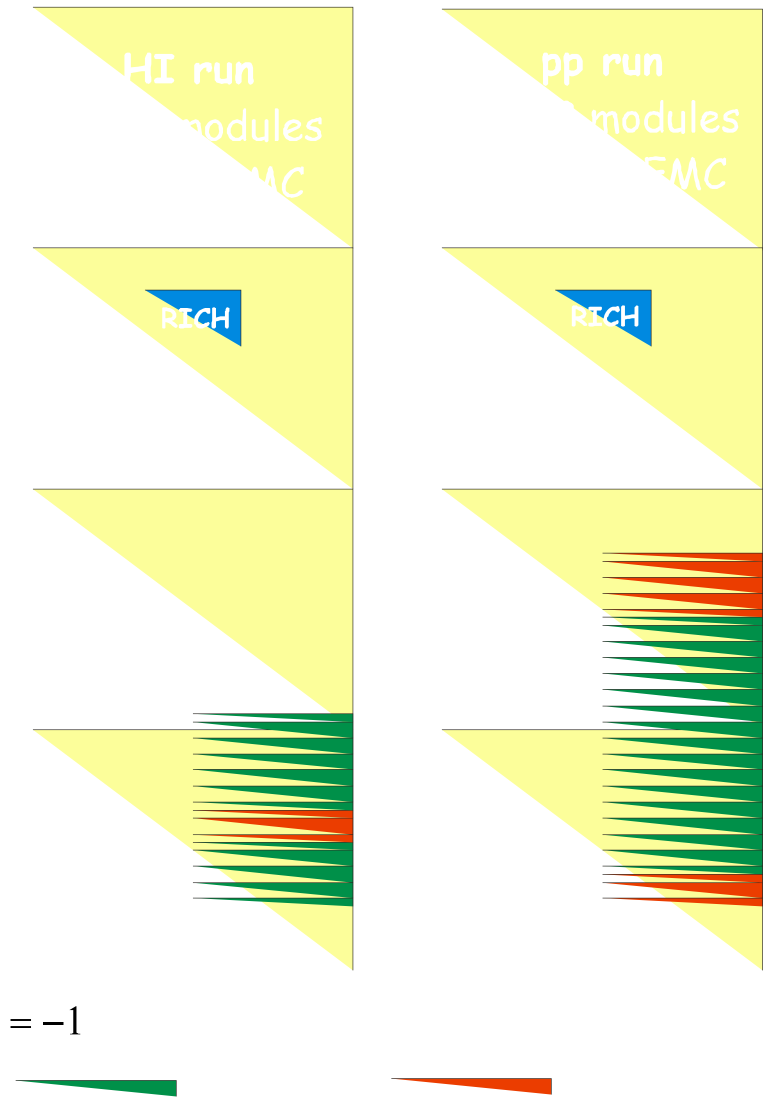
- *Heavy-ion run*
  - *12 modules instrumented*
  - *480 towers*
    - *$(\Delta\eta, \Delta\phi) \sim (1.0, 1.2)$*
  - *No SMD most of time*
    - *Last week of HI only*
- *pp run*
  - *22 modules instrumented*
  - *880 towers*
    - *$(\Delta\eta, \Delta\phi) \sim (1.0, 2.2)$*
  - *SMD*
  - *High-tower trigger*



HI run, + pp run

… and what worked

- Not 100% of instrumented patch took data
  - Digitizer crates problems
    - A few High Towers were turned off
    - Noise on some high towers
    - 12 bits ADC -> 6 bits Trigger ADC problems
  - PMT Boxes problems
    - HV interlock problem on PMT 4 during HI run
    - HV stability problem during pp run
- Heavy-ion run
  - 10/12 modules working
- pp run
  - 16/22 modules working
  - SMD
  - High tower trigger



STAR
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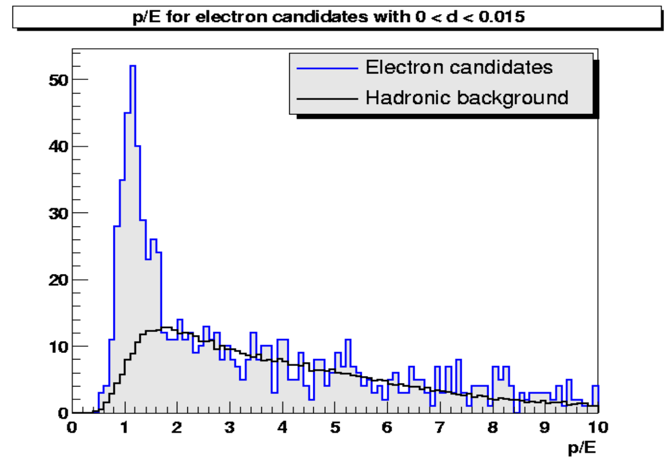
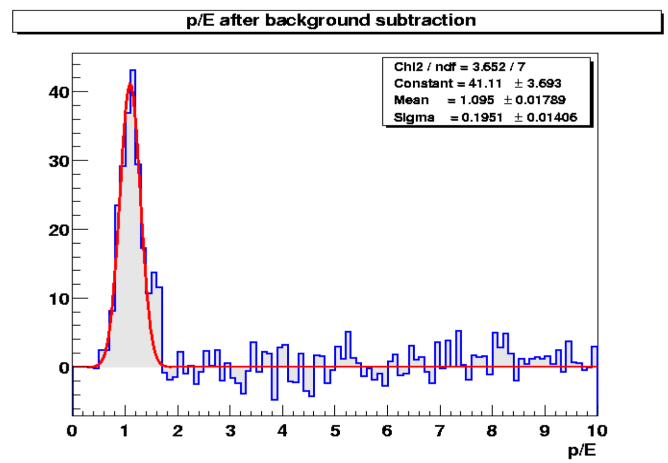
What were the problems (and fixes) ?

- High Voltage system
  - Strong noises and fluctuations on serial line
    - Bad communication, instability
    - FIX: Wrong termination inside PMT boxes
- Electronics
  - Tower crates
    - Power supply failures (2 during the run)
      - FIX: small modification on crates power supply
    - Problem with trigger stability
      - 6 bits conversion and trigger mask
      - FIX: Bug in trigger FPGA code
    - ~0.2% data transfer error to TDC
      - Under investigation (can be easily removed offline)
  - SMD crates and FEES
    - Some FEES didn't work well
      - High noise, instability
      - Thermo switch interlock
      - FIX: we will have spare FEE cards
    - HDLC line problem
      - Under investigation (ultimate solution: put each SMD crate in a different RADSTONE channel)
- DAQ
  - SMD busy (Fixed)
  - TDC Stop bit (understood)
  - Always need a slower detector (not really a problem)
- No automation on start-up and no monitoring
  - FIX: New Slow control software with user friendly interface

But the run wasn't that bad at all…

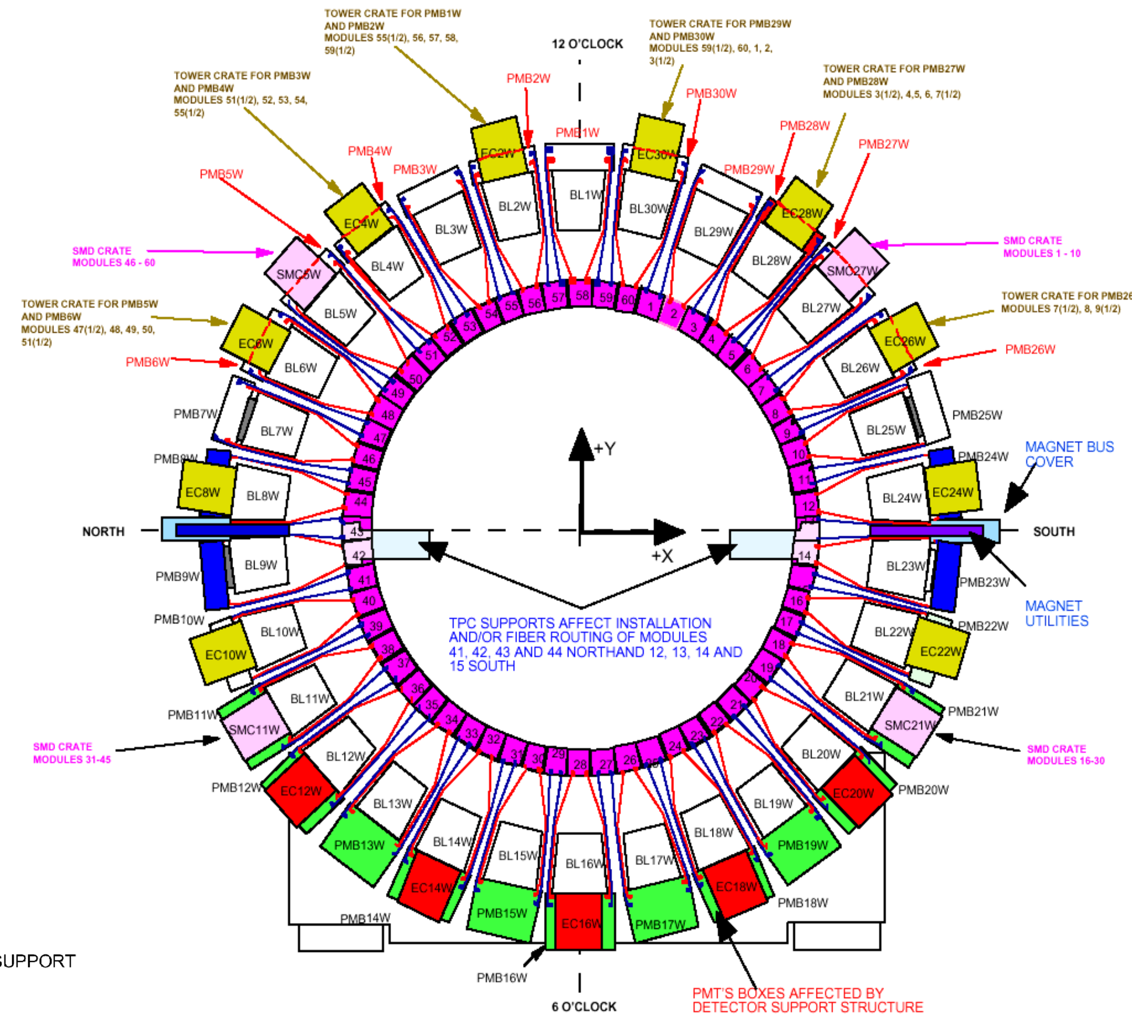
- *EMC took data*
  - *Almost half of minimum bias data for towers*
  - *Almost all central data*
  - *Almost half of pp minimum bias data*
  - *About 800 k high tower triggers*
- *π^0 and electrons can be easily identified.*





EMC for the next run. Installed system

- Full West side installed
  - 60 tower modules
  - 60 SMD modules
  - EMC L0 trigger
  - Pre-shower prototype
- Huge impact on physics
  - High-p_t π^0
  - Jets
  - J/ψ ?

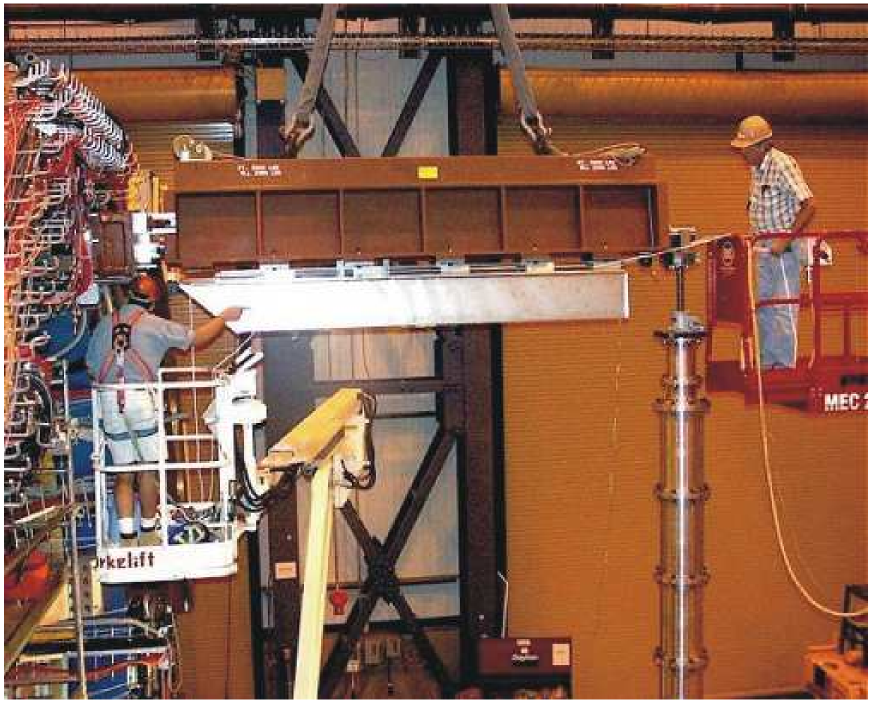


EMC FACE OF THE STAR BARREL AS SEEN FROM +Z (WEST FACE) SHOWING THE CONFIGURATION OF MODULES, PMT'S BOXES AND ELECTRONICS CRATES.

- SPECIAL DESIGN PMT'S BOXES
- INSTALLED MODULES
- ELECTRONICS CRATES AFFECTED BY THE DETECTOR SUPPORT STRUCTURE, POSITION HAS TO BE REASSIGNED.
- BOXES THAT REQUIRE SOME MODIFICATION
- MODULES INSTRUMENTED

Installation schedule

- Modules
  - Full West side
  - Installation done
- PMT boxes
  - Install 18 new PMT boxes
  - Remove and modify 6 old PMT boxes
  - Install fibers and utilities
  - Installation done by october
- Electronics
  - Modify crates power supply – done
  - Some bugs on FPGA codes – Fixed
  - Done before end of october



Commissioning plan: before run starts

- PMT Boxes and High Voltage
  - HV control and stability tests at UCLA (ok)
  - HV control and stability tests at WSU (under way)
  - PMT HV gain curves from LED at WSU (under way)
  - HV control and stability tests on site after boxes are installed
- Tower electronics
  - QA of each digitizer board at LBNL (now -> september)
    - Check pedestals, trigger masks, 6 bits conversion, FIFO latencies, etc…
  - QA of each digitizer board at BNL prior to installation (end of august –> end of september)
  - QA of crates after they are installed (end of august –> first day of run)
- SMD electronics (same schedule as towers)
  - QA of crates at LBNL and BNL prior to installation
  - QA of crates and FEES after installation
    - Pedestals, noise, stability, etc…
- Connection to DAQ and trigger
  - As soon as the first crate is installed (end of august)

QA of HV, electronics and trigger – Detailed plan

Commissioning procedure for each PMT/Crate

	FUNCTION	CRITERIA	METHOD	COMMISSIONING PERIOD AND RELATED PERSONS
PMT'S SYSTEM	pmt's system test before installation	operation of system's HV and LED signal	digital meter/digital scope	9/5/02-10/15/02 VAHE GHAZIKHANIAN OLEG GRACHOV VLADIMIR PETROV
	pmt's system test after installation and connection of clear fiber bundles	operation of system's HV and LED signal, dark current measurement <5nA	digital meter + WSU setup and DAQ	
	Tower High Voltage response			
	measure tower gain as a function of the High Voltage for different HV's in 50-100 V steps		minibias runs with EMC only can take data at about 1 kHz. 100k minibias events for each point	
CANBUS	on/off control		EPICS software - medm...	7/22/02-10/15/02 BOB MINOR
	power supply monitoring	10%	medm -x -displayFont scalable ~/EPICS4/STARvmeApp/op/adl/vme_emc.adl	
	fan speed control	max fan on power up	"	
	fan speed monitoring	10%	"	
	temperature monitoring	10%	"	
HDLC	basic communication to crates via radstone	connect via etd_qa and smdnew	"node info" feedback from etd_qa, smdnew	7/22/02-10/15/02 BOB MINOR
TOWER	PMT to Digitizer			7/22/02-10/15/02 BOB MINOR VAHE GHAZIKHANIAN
	Signal levels	pmt < 1.0 volts for 60gev	integrated signal dynamic range	
	Pulse shape	5nsec rise, 10 nsec fall with tail from cable	scope inspection of cosmic	
	Signal mapping	PMB to Digitizer cabling per table	visual inspection, LED pulser	
	Digitizer operation			
	noise	noise <4 counts rms	etd_qa noise and analysis of DAQ data from pedestal runs	
	gain	mip = 16 counts	physics analysis	
	test pulse injection	dac=1000 yields adc =2000	etd_qa gain plot	
	Digitizer to Crate controller			
	Data integrity	fifo data = crate controller data	etd_qa, load fifo, readout via crate controller	
	Digitizer Crate Controller operation			
	Control and status registers read/write	r/w latency, pulser latency, etc	etd_qa and vme direct via creighton5	
	test data r/w	r/w test data	etd_qa, vxworks r/w	
	Digitizer to Trigger			
	Data integrity	sum and high tower	comparison of data in DAQ vs Trigger	
	Crate controller to Data Collector			
	Data integrity	crate controller data = tdc data	etd_qa data compared to test.tcl data(TDC)	
	Data Collector to DAQ			
	Data integrity	tdc data = DAQ data	test.tcl data compared to DAQ file	
	Trigger to tower			
	Clocks and trigger to crate controller	triggers type 4,7,8,9,abort and L2	exercised from TCD and TCU	
	Trigger timing – latency and delays	smd main delay in TCD up to 128 rhic cycles Tower delay 0-128 nsec	control of TCD delays via trigger vme processor. VxWorks direct control	
	Physics data			
	Tower data		on line and offline analysis software	
SHOWER MAX	FEE			7/8/02-10/15/02 BOB MINOR OLEG TSAI STEPHEN TRENTALANGE
	Signal levels	mip = 16 counts	smdnew and DAQ	
	Noise level	<4 counts rms	sndnew and DAQ	
	Calibration pulser operation	front end pulser and wire pulser	EPICS control code, trigger coordinated pulser events	
	RDO			
	Power distribution	on/off power to FEE	smdnew control and monitoring	
	Clocks and timing	per STAR standard	scope inspection at test card on magnet	
	Multiplexed analog data integrity	SCA clocks and timing	scope inspection at test card on magnet	
	SMD DAQ			
	Data integrity	rdo data = DAQ data packet error rate less than 1%	test data In RDO compared to data in DAQ error rate by DAQ statistics	
	Trigger to SMD RDO			
	Clock distribution	STAR standard clock distribution	RDO adc operation, FEE clocks inspected at test card on magnet	
	L0 trigger distribution	STAR standard trigger distribution	RDO response to trigger	
	Trigger timing – trigger delay	TCD timing set via VxWorks	set during data taking - inspection of total ADC counts to find maximum	
	Physics data			
	SMD data			
SLOW CONTROLS	Slow controls to Tower Crate			7/22/02-10/15/02 BOB MINOR
	Control and status registers	r/w full set	etd_qa, vxworks in creighton5	
	Test data write	write test data to etd card, crate controller and TDC	etd_qa, vxworks in creighton5	
	Test data read	read test data to etd card, crate controller and TDC	etd_qa, vxworks in creighton5	
	Slow controls to SMD RDO			
	Control and status registers	r/w full set	smdnew, vxworks in creighton5	
	Test data write	write test data to RDO crate	smdnew, vxworks in creighton5	
	Test data read	read test datat from RDO crate	smdnew, vxworks in creighton5	
	Power supply control/monitoring	individual and group control of FEE power and monitor	smdnew in creighton5	
	Slow Control Software			
	Tower and SMD monitor			
	Alarms			

Commissioning plan: Online QA, calibrations, etc

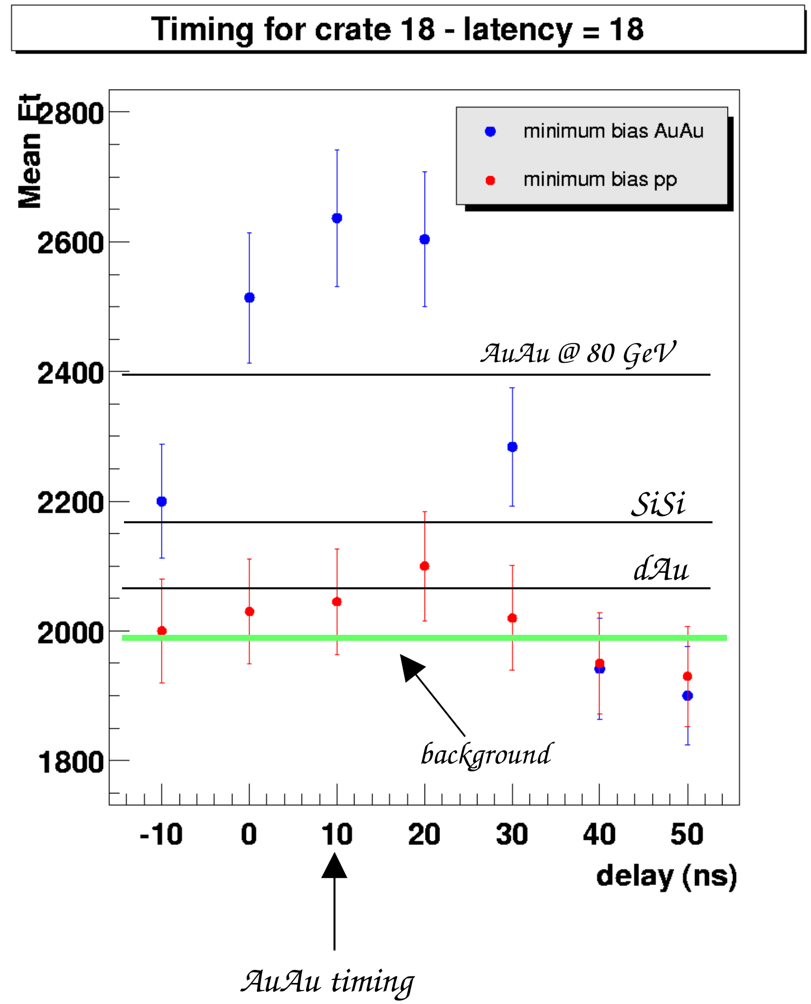
- New slow control software (start testing in august)
  - 1 click to turn on/off EMC
  - Alarms
- New high voltage control software (start testing in august)
  - New monitoring tools
  - Faster communication
  - Easier to use
- New event display
  - Will include trigger data
- Online histograms
  - Better QA histograms (from tower level to EMC level)
- Online pedestals monitoring
- Online gain monitor
- Calibration
  - Pre calibration using L3 tracks
    - Will be done online (not a L3 algorithm) using L3 tracks and events from event pool
    - Will need less events (higher coverage)

Commissioning plan – First day of run

- Timing (towers and SMD)
  - Measure Mean Et x timing for each crate
    - Needs high multiplicity events (AuAu)
    - About 1 day x 2-3 iterations
- PMT HV response (important for trigger calibration)
  - Measure gain x HV for each PMT
    - Needs high multiplicity events (AuAu)
      - 100 k minibias AuAu for each HV point (EMC stand alone runs)
      - About 1 day for take data and 1 day to analyze x 2-3 iterations
- Absolute calibration using MIPS
  - 200 k minibias AuAu with L3 tracks (1-2 days)
- Trigger
  - Check trigger rates for different thresholds
  - Hot towers
- If system is completely debugged before beam -> 1-2 weeks of beam time to finalize EMC commissioning

dAu, SiSi or AuAu @ 80 GeV instead of AuAu @ 200 GeV?

- EMC timing
  - High multiplicity is critical
    - AuAu @ 200 GeV ~ 550; dAu ~50
    - Impossible with pp (no evident signal)
    - dAu signal is higher than pp but the background may be also higher (beam gas, d breakup)
- HV gain curves
  - High occupancy is critical
    - 100k AuAu/HV point vs. 2M pp/HV point
    - if data acquisition is limited to 200 Hz (EMC stand alone runs)
      - 8 min/AuAu and 3 h/pp per HV point
      - Event size is the same if EMC alone
        - » 20 times more time to analyze the data
- EMC is a very important part of next run. AuAu is extremely important to time and to calibrate the system to an uniform trigger response



Detectors experts during commissioning

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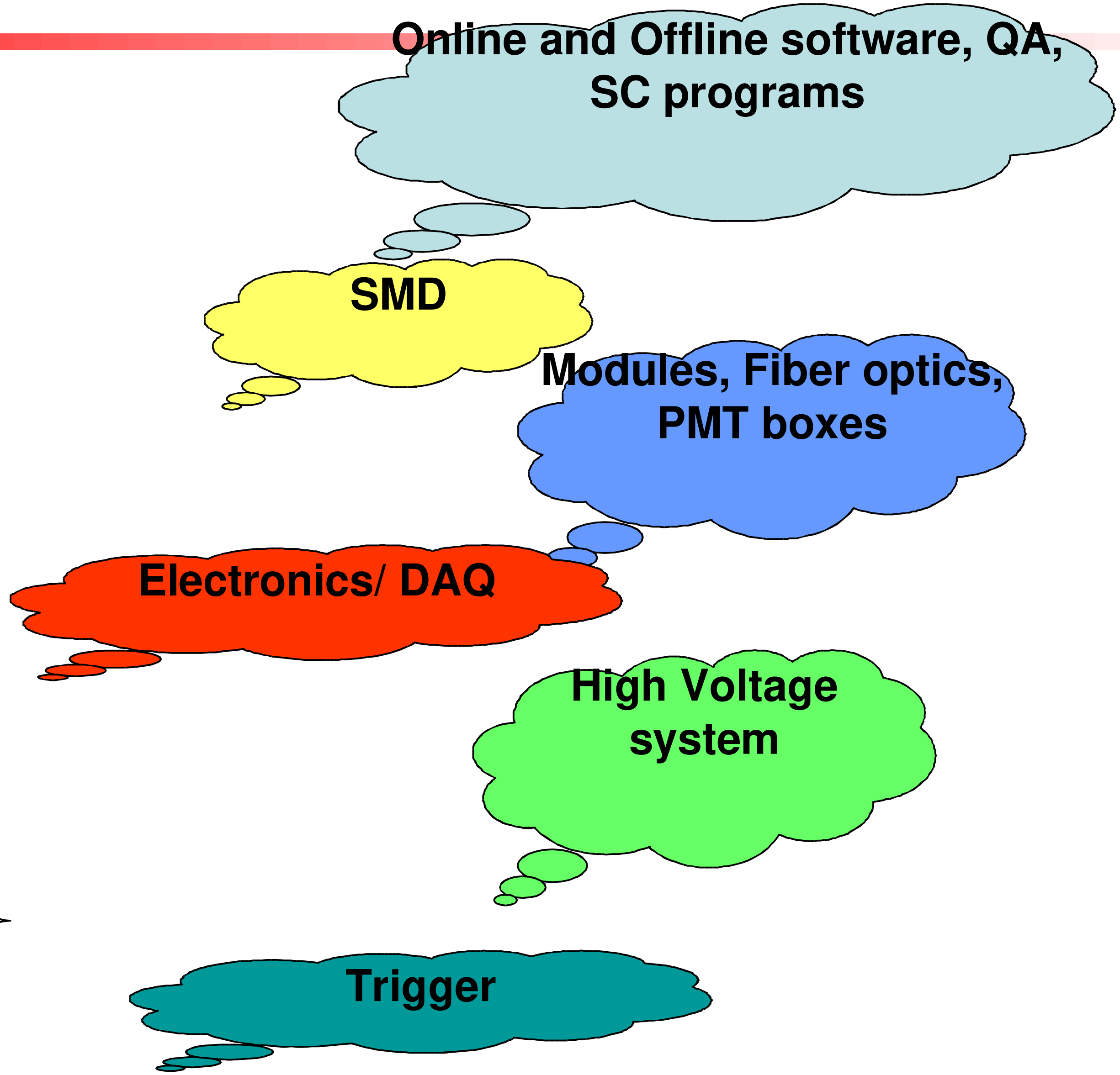
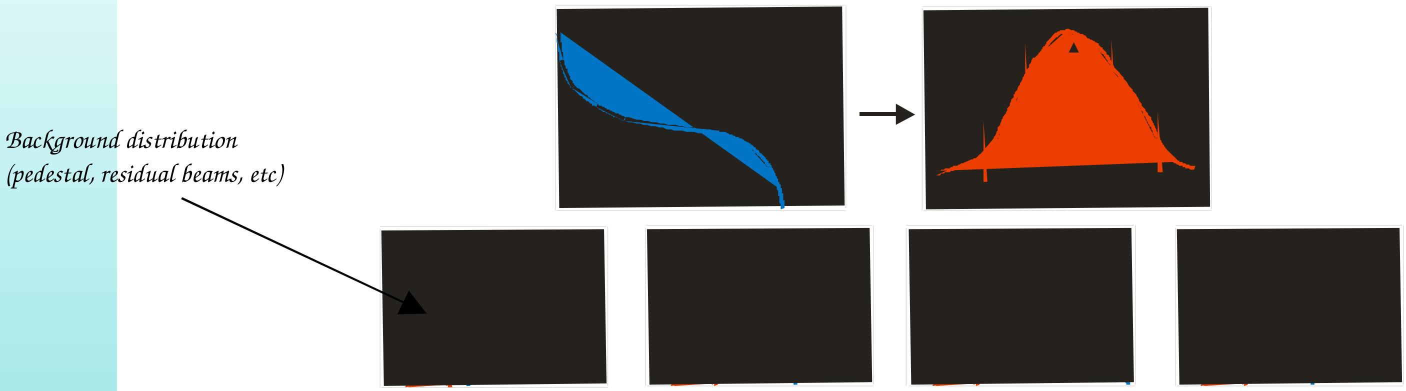


Final comments

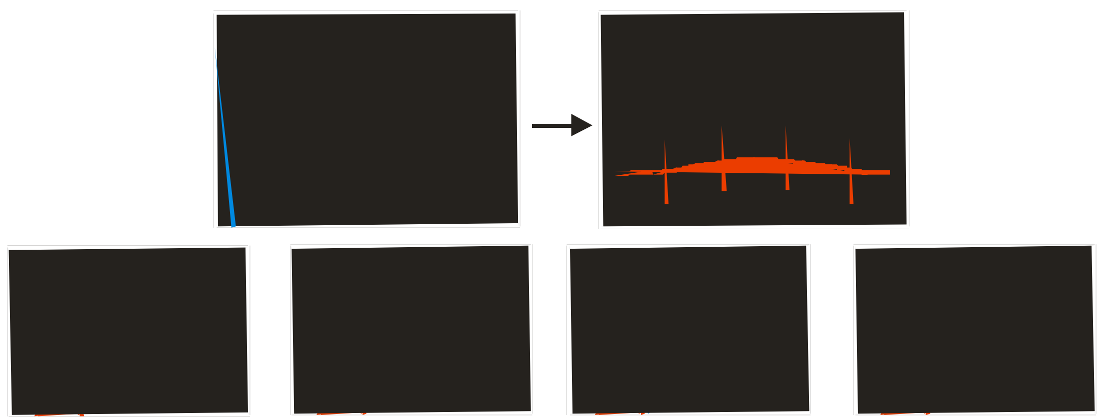
- Last year run was successful
  - EMC electronics debugged
    - Problems were identified and are being fixed
  - EMC took data for the first time
    - Physics are coming out
  - High tower trigger worked
- Next run promises a lot
  - Higher coverage, high tower trigger
- AuAu is extremely important for EMC commissioning
  - 7-14 days of beam time
    - Can not predict well if dAu or pp
  - To commission EMC during dAu or pp can jeopardize the entire EMC run
    - Much lower multiplicity and possible increase in background can make EMC timing impossible
    - EMC hardware calibration with dAu can be more difficult with lower multiplicity -> essential for trigger

Timing procedure

- *High multiplicity events -> high Et on EMC (compared to background)*



- *Low multiplicity events -> low Et on EMC*



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