16/12/97

DIRC OEP monitoring model (preliminary)

L. Del Buono, L. Roos, M. Zito

In order to minimize the DIRC OEP monitoring impact on the farm, no data is produced for storage on an event per event basis.
Taking into account this constraint, histograms (2D or 1D) are first filled with the event level data ("1st level" histograms). Then, other quantities are computed from these primary histograms through usually simple algorithms; these new data are stored in ntuple-like objects and can be used to produce other histograms ("2nd level" histograms) which allow, for example, to check time drifts or to compare these quantities to the corresponding ones originating from the DIRC calibration. Both types of histograms should be available to the OEP user, for visualization or other purposes. We don't discuss in detail here the way OEP users interact with the data.

The following tables present the various quantities and histograms which the OEP DIRC team foresees to exist during **physics runs**. This list will certainly evolve with time and should not be considered final (in particular, the *minimum* set of histograms to be produced has still to be precised, for the moment the priority of the various histograms corresponds grossly to the ordering in the tables).

There are two sets of complementary tables. The first one describes the tests to be performed within the monitoring and the related histograms (1st and 2nd level), along with the data to be stored and the databases which need to be accessed.
The second set of tables gives a more accurate idea about the load the DIRC monitoring process generates on the farm processors, through a few informations: the histogram structure (dimension, binning), number of histograms, the amount of data to store, the frequency of data or histogram storing.

Different tables are comprised in every set:

- the DIRC calibration specific quantities which one can expect to monitor with physics events (table 1)
- the tests which allow to ascertain that the front end electronics is working normally (table 2)
- the quantities which can be used to check the DIRC global performances (table 3)

- more speculative tests which need further investigation to be considered for the DIRC monitoring (table 4)

Some of these tests need other subdetectors data in addition of DIRC data, they correspond to shaded areas in the tables.

Current useful parameters for the DIRC are listed in the following table.

Parameter	Quantity	Value
N_{ch}	Number of channels	10752
N_{analog}	Number of analog chips	1344
N_{TDC}	Number of digital chips	672
N_{DFB}	Number of front end boards	168
N_{DCC}	Number of crate controllers	12
N_{HV}	Number of HV lines	672
N_{bar}	Number of quartz bars	144
N_{mass}	Number of mass hypothesis	5
N_{hit}	Number of event hits	~300

It should be clear that these tables do not present an exhaustive view of the monitoring studies possible in the DIRC. As instance, many of the quantities mentioned in this document can be extracted using L1 or L3 events (depending, for example, on the needed statistics), and useful comparisons can be made between the two trigger levels. Also, cross checks between subdetectors are not fully addressed here.
The warnings or alarms generated by the monitoring tests will be specified later.

Tests and histograms for the DIRC monitoring

Table 1: Calib Test specific quantities (physics data taking)

Test	cpu	priority	Quantity used for test	1^{st} level histograms	Computations on histograms	Stored data	DB access	Computations on stored data or 2^{nd} level information
Channel Gains	FM	1	ADC data	1 ADC spectra (1/ch, probably long accumulation time)	Fit ADC spectra shape	single photoelectron peak position	calib DB	Check time drifts Check calib DB reference
Channel ADC response	FM	1				2 (3?) ADC spectra shape parameters (pedestal, σ,threshold, peak/valley, ...)		
Channel efficiency	FM	1	TDC data	1 hit map (all ch)		raw occupancy in channel	OEP DB	Check time drifts
	PR FM	2	TDC data + tracker data	Simulated photon density along the track cerenkov image PMTs	compare with hit map	efficiency in channel	OEP DB calib DB	Check time drifts Check calib DB reference
Channel t_0	FM	1	TDC data	TDC time - trigger time (1/ch)	mean, sigma (see table 2)	mean, sigma	OEP DB	Check time drifts
	FM PR	1	TDC data + tracker data	reconstructed photon travel time - uncorrected (calib) TDC time (1/ch)	mean, sigma	mean, sigma	OEP DB calib DB	Check time drifts Check calib DB reference

Nota: shaded areas correspond to histograms which need other detectors data to be filled...
"priority" tries to account for the histogram/test degree of necessity
"OEP DB" is the place where histograms and data produced by the OEP are to be stored

Table 2: Electronics Test specific quantities (physics data taking)

Test		cpu	prio rity	Quantity used for test	1^{st} level histograms	Computations on histograms	Stored data	DB access	Computations on stored data or 2^{nd} level information
Electronic occupancies	TDC chip	FM	1	TDC data	TDC chip hit map		histogram	conditions DB OEP DB	check time drifts
	Analog chip	FM	1		Analog chip hit map				
	DFB	FM	1		DFB hit map				
	DCC	FM	1		DCC hit map				
	HV line	FM	1		HV line hit map				
DFB error flags	TDC fifo full/ event damage	FM	1	DFB data	occurrences/TDC		histogram	OEP DB	
Data coherence	word counts	FM	1	DFB/ROM data	occurrences				
	trigger time/tag	FM	1	DFB data	Nb of different trigger times/ event				
ADC readout	global	FM	1	ADC data	nb of readout ADC/evt full DIRC	mean, sigma	mean, sigma	OEP DB	check time drifts
	sector	FM	1		nb of readout ADC/evt each sector			conditions DB OEP DB	
ADC priority method (geographic priority)		FM	3	ADC data	ADC hit vs ADC board channel numbering	Simple peak search compare with first board channel/check ordering	histogram	conditions DB	

Table 2: Electronics Test specific quantities (physics data taking)

Test		cpu	prio rity	Quantity used for test	1^{st} level histograms	Computations on histograms	Stored data	DB access	Computations on stored data or 2^{nd} level information
TDC selective R/O	All channels	FM	1	TDC data	(hit time - L1 trigger time) distribution	Count hits outside trigger resolution window (see also table 1)		conditions DB	
	single TDC	FM	2						
TDC multiplicity		FM	1	TDC data	Nb of hits/evt (1/ch)	mean, sigma	mean, sigma	OEP DB	check time drifts
TDC low resolution bit test (?)		FM	3	TDC data	5 lowest TDC bits (1/ch)	check uniformity			

Nota: additional data could come from 24 scalers connected to selected DFBs. These data could be used to monitor (without any filtering) the noise in the DIRC. It's not clear yet whether it will be available at the OEP level.

Table 3: DIRC global performance test quantities (physics data taking)

Test		cpu	priority	Quantity used for test	1st level histograms		Computations on histograms	Stored data	DB access	Computations on stored data or 2nd level information
Nb of TDC hits	Global	FM	1	TDC data	hits/event full DIRC		mean, sigma	mean, sigma		check time drifts
	sector	FM	1		hits/event each sector				conditions DB	
Spatial occupancy	Global	FM	1	TDC data	hit map (2D: ϕ,θ)		check non uniformity compare reference	histogram	OEP DB	
	Sector	FM	1		hit map per sector (12 bins)			histogram	conditions DB OEP DB	
Noise conditions	electronics + machine noise	FM PR	1	TDC data + tracker data + low multiplicity events	hit map in areas grossly away from tracks or near below threshold tracks	Global	compare reference	histogram	OEP DB	
						Sector		histogram		
		PR FM	1		Timing of bkg channels	out of track TDCs	compare reference	histogram	OEP DB	
						out of time TDCs				
	full noise	PR FM	2	TDC data + tracker data	hit map outside “track/ring” areas	Global	compare reference	histogram	OEP DB	
						Sector		histogram		

Table 3: DIRC global performance test quantities (physics data taking)

Test	cpu	prio rity	Quantity used for test	1^{st} level histograms	Computations on histograms	Stored data	DB access	Computations on stored data or 2nd level information
N_γ/bar	FM PR	1	TDC data + tracker data (+ low multiplicity events ?)	Event N_γ frequency in each bar	mean, sigma	mean, sigma	OEP DB	check time drifts
N_γ/track	PR FM	1	TDC data + tracker data	N_γ/track vs $\theta_{tracker}$ at different Z_{bar} (1/bar)		N_γ/track at 3 $\theta_{tracker}$ at 4 Z_{bar}	OEP DB	check time drifts
Bar check	PR FM	1	TDC data + tracker data (+ low multiplicity events ?)	N_γ vs Z_{bar} at different incidence angles (1/bar)	fit attenuation (per bar section)	"attenuation"	OEP DB calib DB (bars)	check time drifts

Table 3: DIRC global performance test quantities (physics data taking)

Test	cpu	priority	Quantity used for test	1^{st} level histograms	Computations on histograms	Stored data	DB access	Computations on stored data or 2nd level information
θ_c reconstruction	PR FM	1	TDC data + tracker data	θ_c vs $P_{tracker}$ (all masses)		histogram	OEP DB	
	PR FM	1		θ_c vs $P_{tracker}$ (each mass) for selected P	Fit DIRC Cerenkov thresholds	Thresholds		check time drifts
					Fit means and resolutions at fixed $P_{tracker}$	Means/resolutions at fixed $P_{tracker}$		check time drifts
	PR FM	1		Mass hypothesis frequencies (for each mass)		Frequencies		check time drifts
	PR	2		θ_c vs $P_{tracker}$ (each mass, each bar)	Fit Cerenkov thresholds	Thresholds		check thresholds uniformity check time drifts
					θ_c mean and resolution at fixed $P_{tracker}$	mean/resolutions at fixed $P_{tracker}$		check time drifts
	PR FM	1		θ_c measured $-\theta_c$ expected each mass — vs P		histogram		
	PR FM	1		θ_c measured $-\theta_c$ expected each mass — vs dip				

Table 3: DIRC global performance test quantities (physics data taking)

Test		cpu	prio rity	Quantity used for test	1^{st} level histograms	Computations on histograms	Stored data	DB access	Computations on stored data or 2nd level information
DIRC accept-ance	$P_{tracker}$	PR	1	TDC data + tracker data	DIRC efficiency vs $P_{tracker}$	compare refer-ence	histogram	OEP DB	
	$\theta_{tracker}$	PR	1		DIRC efficiency vs $\theta_{tracker}$				
	$\phi_{tracker}$	PR	1		DIRC efficiency vs $\phi_{tracker}$				

Table 4: more "speculative" histograms for physics run data (to be studied by simulation)

Test	cpu	prio rity	Quantity used for test	1^{st} level histograms	Computations on histograms	Stored data	DB access	Computations on stored data or 2nd level information
DIRC "multiplicity"	FM PR	3	TDC data	hit time distribution for 1 evt (all channels)	search and count peaks			
Z reconstruction	FM PR	3	TDC data + tracker data	$Z_{tracker}$-Z_{DIRC}	mean			check bias
Timing	PR	1	TDC data + tracker data + 0° incidence tracks	direct photons - reflected photons flight time difference (for several near 0° track incidence angle, one mass hypothesis, Z_{bar} fixed) (1/ch)	mean, sigma			check σ_{t0} for each channel or relative t_0 between channels
alignment ?	PR FM	2	TDC data + tracker data + 0° incidence tracks	Study photon time peaks around 0° track incidence angle	estimate "dirc" track angle wrt bar			cross check with tracker info

Additional information on DIRC monitoring

Table 1': Calib Test specific quantities (physics data taking) additional information

Test	Quantity used for test	1st level histograms	1st level histogram structure	Nb of histos	Stored data (produced from 1st level histos)	Data volume stored	Data fill/ refresh	fill time	2nd level histogram (example)
Channel Gains	ADC data	1 ADC spectra (1/ch, probably long accumulation time)	1D,50 bins	N_{ch}	single photoelectron peak position	N_{ch} floats	10^3 hits in channel	5 mn	peak pos. vs time calibration shifts
Channel ADC response					2 (3?) ADC spectra shape parameters (pedestal,σ,peak/val-ley,...)	2 (3?)x N_{ch} floats	10^3 hits in channel		parameter vs time
Channel effi-ciency	TDC data	1 hit map (all ch)	1D,N_{ch} bins or DIRC display	1	raw occupancy in channel	N_{ch} floats	10^4 evt	10 s	occupancy vs time
	TDC data + tracker data	Simulated photon den-sity along the track cer-enkov image PMTs	1D,N_{ch} bins or DIRC display	N_{ch}	efficiency in channel	Nch floats	10^3 hits in channel	5 mn	efficiency vs time calibration shifts
Channel t_0	TDC data	TDC time - trigger time (1/ch)	1D,50 bins	N_{ch}	mean, sigma	(2?x) N_{ch} floats	10^3 hits in channel	5 mn	mean vs time
	TDC data + tracker data	reconstructed photon travel time - uncorrected (calib) TDC time (1/ch)	1D,50 bins	N_{ch}	mean, sigma	2 x N_{ch} floats	10^3 hits in channel	5 mn	mean vs time calibration shifts

NB: 'fill times' are given for a 100 % efficiency of the OEP monitoring event access (i.e monitoring sees ALL L3 level events)

Table 2’: Electronics Test specific quantities (physics data taking) additional information

Test		Quantity used for test	1^{st} level histograms	1^{st} level histogram structure	Nb of histos	Stored data (produced from 1st level histos)	Data volume stored	Data fill/ refresh	fill time	2^{nd} level histogram (example)
Electronic occupancies	TDC chip	TDC data	TDC chip hit map	1D,N_{TDC} bins	1	histogram	histogram	10^4 events	10 s	
	Analog chip		Analog chip hit map	1D,N_{analog} bins	1					
	DFB		DFB hit map	1D,N_{DFB} bins	1					
	DCC		DCC hit map	1D,N_{DCC} bins	1					
	HV line		HV line hit map	1D,N_{HV} bins	1					
DFB error flags	TDC fifo full	DFB data	occurrences/TDC	1D, N_{TDC} bins	1	histogram	histogram	full run	?	
Data coherence	word counts/ event damage	DFB/ ROM data	occurrences of incorrect word counts	1D, N_{DFB} bins	1					
	trigger time/ tag	DFB data	Nb of different trigger times/event	1D, 10 bins	1					
ADC readout	global	ADC data	nb of readout ADC/ evt full DIRC	1D, 50 bins	1	mean, sigma	2 floats	10^4 events	10 s	mean vs time
	sector		nb of readout ADC/ evt each sector		12		2x12 floats			
ADC priority method (geographic priority)		ADC data	ADC hit vs ADC board channel numbering	1D, 50 bins	1	histogram	histogram	10^4 evt (peak) full run (hist)	?	

Table 2': Electronics Test specific quantities (physics data taking) additional information

Test		Quantity used for test	1^{st} level histograms	1^{st} level histogram structure	Nb of histos	Stored data (produced from 1st level histos)	Data volume stored	Data fill/ refresh	fill time	2^{nd} level histogram (example)
TDC selective R/O	All channels	TDC data	(hit time - L1 trigger time) distribution	1D, 50 bins	1			10^4 events	10 s	
	single TDC				N_{TDC}			10^3 hits in channel	5 mn	
TDC multiplicity		TDC data	Nb of hits/evt (1/ch)	1D, 10 bins	N_{ch}	mean, sigma	$2xN_{ch}$ floats	10^4 events	10 s	mean vs time
TDC low resolution bit test (?)		TDC data	5 lowest TDC bits (1/ch)	1D, 32 bins	N_{ch}			10^5 events	2 mn	

Table 3’: DIRC global performance test quantities (physics data taking) additional information

Test		Quantity used for test	1^{st} level histograms		1^{st} level histogram structure	Nb of histos	Stored data (produced from 1st level histos)	Data volume stored	Data fill/ refresh	fill time	2^{nd} level histogram (example)
Nb of TDC hits	Global	TDC data	hits/event full DIRC		1D, 50 bins	1	mean, sigma	2 floats	full run	?	
	sector		hits/event each sector			12		2x12 floats		?	
Spatial occu-pancy	Global	TDC data	hit map (2D: ϕ,θ)		DIRC display N_{ch} bins	1	histogram	histogram	full run	?	
	Sector		hit map per sector (12 bins)		1D, 12 bins	1		histogram			
Noise conditions	electronics + machine noise	TDC data + tracker data + low multiplicity events	hit map in areas grossly away from tracks or near below threshold tracks	Global	DIRC display N_{ch} bins	1	histogram	histogram	full run	?	
				Sector	1D, 12 bins	1		histogram			
			Timing of bkg channels	out of track TDCs	1D, 50 bins	1	histogram	histogram			
				out of time TDCs	DIRC display N_{ch} bins	1		histogram			
	full noise	TDC data + tracker data	hit map outside “track/ring” areas	Global	DIRC display N_{ch} bins	1	histogram	histogram			
				Sector	1D, 12 bins	1		histogram			

Table 3': DIRC global performance test quantities (physics data taking) additional information

Test	Quantity used for test	1^{st} level histograms	1^{st} level histogram structure	Nb of histos	Stored data (produced from 1st level histos)	Data volume stored	Data fill/ refresh	fill time	2^{nd} level histogram (example)
N_γ/bar	TDC data + tracker data (+ low multiplicity events ?)	Event N_γ frequency in each bar	1D, 50 bins	N_{bar}	mean, sigma	2xN_{bar} floats	10^4 events	10 s	mean vs time
N_γ/track	TDC data + tracker data	N_γ/track vs $\theta_{tracker}$ at different Z_{bar} (1/bar)	2D, 50x50 bins	N_{bar} x 4 Z_{bar}	N_γ/track at 3 $\theta_{tracker}$ and 4 Z_{bar}	3x4xN_{bar} floats	full run	?	N_γ/track vs time
Bar check	TDC data + tracker data (+ low multiplicity events ?)	N_γ vs Z_{bar} at different incidence angles (1/bar)	2D, 50x50 bins	N_{bar} x 3 angles	"attenuation" in bars	3xN_{bar} floats	full run		"attenuation" vs time

Table 3': DIRC global performance test quantities (physics data taking) additional information

Test	Quantity used for test	1^{st} level histograms	1^{st} level histogram structure	Nb of histos	Stored data (produced from 1st level histos)	Data volume stored	Data fill/ refresh	fill time	2^{nd} level histogram (example)
θ_c reconstruction	TDC data + tracker data	θ_c vs $P_{tracker}$ (all masses)	2D, 50x50 bins	1	histogram	histogram	full run	?	
		θ_c vs $P_{tracker}$ (each mass) for selected P	2D, 50x50 bins	N_{mass}	thresholds	N_{mass} floats	full run		thresh-olds vs time
					mean/resolu-tions at fixed $P_{tracker}$	$2xN_{mass}$ floats	10^4 -10^5 events	1 mn	Resolu-tions vs time
		Mass hypothesis frequen-cies (for each mass)	1D, N_{mass} bins	1	histogram	histogram	10^5 events	2 mn	Frequen-cies vs time
		θ_c vs $P_{tracker}$ (each mass, each bar)	2D, 50x50 bins	N_{mass}x N_{bar}	thresholds	N_{mass} x N_{bar}- floats	full run	?	thresh-olds vs time, vs bar number
					mean/resolu-tions at fixed $P_{tracker}$	$2xN_{mass}$ x N_{bar}floats			Resolu-tions vs time
		θ_c measured - θ_c expected each mass — vs P	2D, 50x50 bins	N_{mass}	histogram	histogram	full run	?	
		vs dip		N_{mass}					

Table 3': DIRC global performance test quantities (physics data taking) additional information

Test		Quantity used for test	1^{st} level histograms	1^{st} level histogram structure	Nb of histos	Stored data (produced from 1st level histos)	Data volume stored	Data fill/ refresh	fill time	2^{nd} level histogram (example)
DIRC accept-ance	$P_{tracker}$	TDC data + tracker data	DIRC efficiency vs $P_{tracker}$	2D, 50x50 bins	1	histogram	histogram	full run	?	
	$\theta_{tracker}$		DIRC efficiency vs $\theta_{tracker}$		1					
	$\phi_{tracker}$		DIRC efficiency vs $\phi_{tracker}$		1					

Table 4': more "speculative" histograms for physics run data additional information

Test	Quantity used for test	1^{st} level histograms	1^{st} level histogram structure	Nb of histos	Stored data (produced from 1st level histos)	Data volume stored	Data fill/ refresh	fill time	2^{nd} level histogram (example)
DIRC "multiplicity"	TDC data	hit time distribution for 1 evt (all channels)	1D, 50 bins	1			1 evt		
		histogram nb of peaks	1D, 10 bins	1	nb of peaks histogram	histogram	10^4 evt	10 s	
Z reconstruction	TDC data + tracker data	$Z_{tracker}$-Z_{DIRC}	1D, 50 bins	1	mean	1 float	10^5 evt	2 mn	
Timing	TDC data + tracker data + 0° incidence tracks	direct photons - reflected photons flight time difference (for several near 0° track incidence angle, one mass hypothesis, Z_{bar} fixed) (1/ch)	1D, 50 bins	N_{ch}	mean, sigma	2 x N_{ch}	10^5 evt	2 mn	
alignment ?	TDC data + tracker data + 0° incidence tracks	Study photon time peaks around 0° track incidence angle	1D, 50 bins	a few angles			10^6 evt	20 mn	