Trigger Efficiency Determination in the First R Scan

Huang Guangshun
Email:huanggs@pony1.ihep.ac.cn
R Working Group, Div.1,IHEP
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Motivation

$$R = \frac{N_{had}^{obs} - N_{bg} - N_{ll} - N_{\gamma\gamma}}{\sigma_{\mu\mu}^{0} \cdot \varepsilon_{had} \cdot \varepsilon_{trg}^{had} \cdot (1+\delta) \cdot L} \tag{1}$$

$$L_{\mu\mu} = \frac{N_{\mu\mu}^{obs}}{\sigma_{\mu\mu} \cdot \varepsilon_{\mu\mu} \cdot \varepsilon_{trg}^{\mu\mu}} \tag{2}$$

$$L_{\gamma\gamma} = \frac{N_{\gamma\gamma}^{obs}}{\sigma_{\gamma\gamma} \cdot \varepsilon_{\gamma\gamma} \cdot \varepsilon_{trg}^{\gamma\gamma}} \tag{3}$$

$$L_{ee} = \frac{N_{ee}^{obs}}{\sigma_{ee} \cdot \varepsilon_{ee} \cdot \varepsilon_{trg}^{ee}} \tag{4}$$

ε_{trg} to be determined for each event type!

PRINCIPLE

trg. condi. concerning a sub-detector, determing its eff. by a sample from

<u>irrelevant</u> online trigger channel
and
<u>irrelevant</u> offline event selection

sample size: N, events satisfying a certain trg. condi.: $N_{condi.}$, then its eff.,

$$\varepsilon_{condi.} = N_{condi.}/N \tag{5}$$

Table 1: Strategy: a group of samples

trg. condi.	trg. ch.	offline event selection
$N_{vc\geq1}$	VC	MDC, TOF, BSC, Mu
$N_{trk\geq1}$, $N_{trk\geq2}$	MDC	VC, (TOF), BSC, (Mu)
$N_{TOF\geq1}$, TOFBB	TOF	VC, MDC, BSC, Mu
Radial, E_{tot-l}, E_{tot-h}	BSC	VC, MDC, TOF, Mu

Table 2: Trigger Condition Table for Trigger Study

condi. \ type	MDC	VC	BSC	TOF	ESC	ETOF	ENDVC	NML
Active?	Y	Y	Y	Y	Y	Y	Y	Y
TOF BB	-	-	Y	-	-	-	-	-
$N_{TOF\geq1}$	-	-	-	-	-	-	-	Y
$N_{TOF\geq2}$	Y	Y	-	-	-	-	-	-
Radial	-	-	-	-	-	-	-	-
$N_{vc\geq1}$	Y	-	Y	Y	Y	Y	-	Y
$N_{etof\geq1}$	-	-	-	-	-	-	-	-
Etof B-B	-	-	-	-	Y	-	Y	-
$N_{trk\geq1}$	-	-	-	-	-	-	-	Y
$N_{trk\geq2}$	-	Y	Y	Y	-	-	-	-
$N_{trk\geq4}$	-	-	-	-	-	-	-	-
Muon-or	-	-	-	-	-	-	-	-
XXX	-	-	-	-	-	-	-	-
ESC-Etot	-	-	-	-	-	Y	Y	-
E_{tot-l}	Y	Y	-	Y	-	-	-	Y
E_{tot-h}	-	-	-	-	-	-	-	-

Event Selection

trg. eff. study @J/ψ, ψ' due to high S/N
Using trg. data @J/ψ, hadron as example

Standard sample from normal cuts:

track level selection
$|\cos\theta| < 0.84$;
MFIT=2,-19;
for MFIT=2, $V_r < 2.0$cm and $|V_z| < 18$cm;
for MFIT=-19, $N_{dE/dx} > 16$;
$p < p_{beam} + 5 \times \sigma_{p_{beam}}$;
$2 < TOF < t_{proton} + 5 \times \sigma_t$ if good hit;
$E < 0.6E_{beam}$;
$N_{\mu hits} < 5$;
event level selection
$N_{good} \geq 2$ and $N_{MFIT=2} > 1$;
$\Sigma E > 0.28E_{beam}$;
for $N_{good} \geq 3$, $Netchrg \neq N_{good}$
for $N_{good} = 2$,
$|\theta_1 + \theta_2 - 180^\circ| > 10^\circ$, $||\phi_1 - \phi_2| - 180^\circ| > 4^\circ$;
and $N_\gamma > 2$, $E_\gamma > 100$ MeV, $|\phi_\gamma - \phi_c| > 15^\circ$.

Sample without MDC information

Charged track in VC:
- MFITvc=1;
- $V_r < 2.0$cm, $|V_z| < 18$cm;
- $N_{good} \geq 2$;

Neutral track in BSC:
- 0.08GeV< E <0.8GeV;
- $N_{neu} \geq 4$;
- $\Sigma E > 0.28E_{beam}$

Sample without TOF information

almost same as standard cuts, except
$N_{MFIT=2} > 2$;

Sample without BSC information

more cuts concerning MDC added:
- for MFIT=-19,$V_r < 3.0$cm,$|V_z| < 30$cm;
- $p_T \geq 0.08$GeV/c;
- $p_{Tsum} > 0.28p_{beam}$;
- $N_{good} \geq 3$ and $N_{MFIT=2} \geq 2$;
- and, track must have good TOF hit

Comparison between different samples

Table 3: sample size

standard	11783
without MDC	10856
without TOF	11552
without BSC	10838

impression of the samples:
almost same size;
particle bands are clear;
multiplicity and energy are similar;

conclusion:
event selections are reliable.

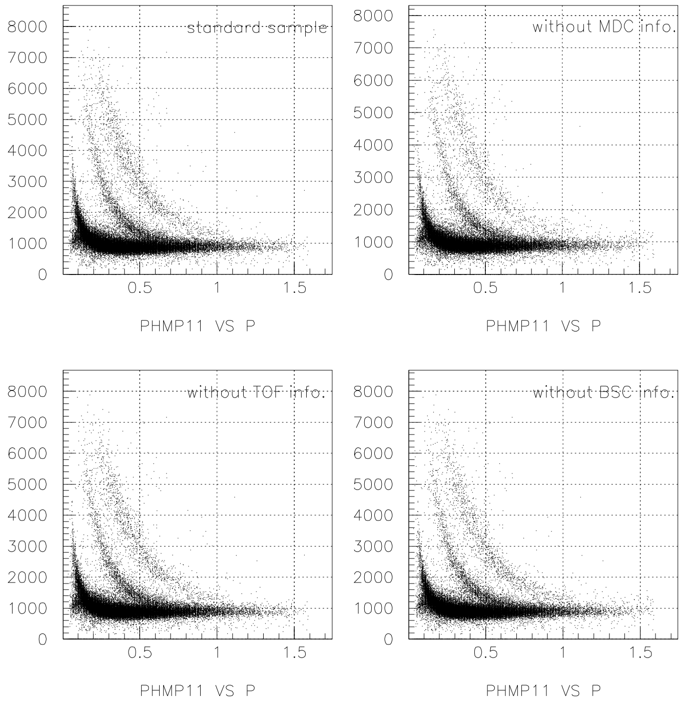

Figure 1: $dE/dx - p$ distribution of 4 samples

Possible in principle to get trg. eff. from R data,
but in fact ...

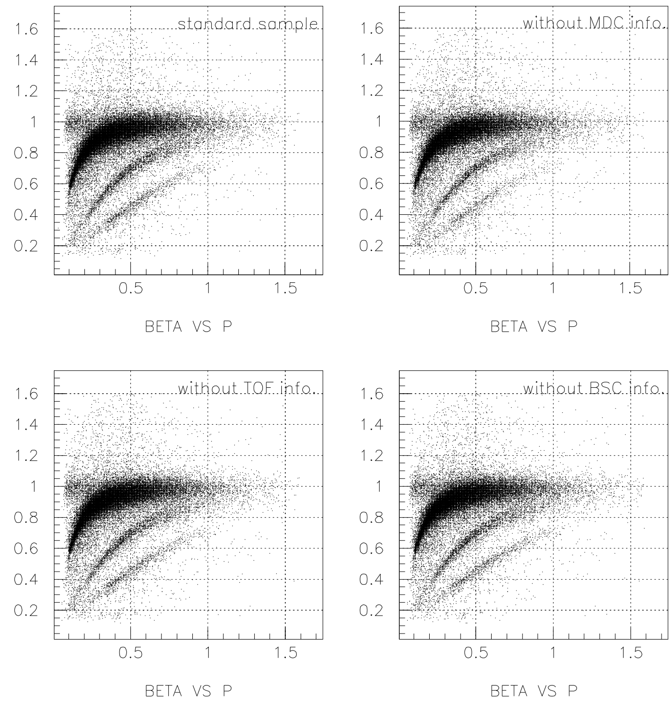

Figure 2: $\beta - p$ distribution of 4 samples

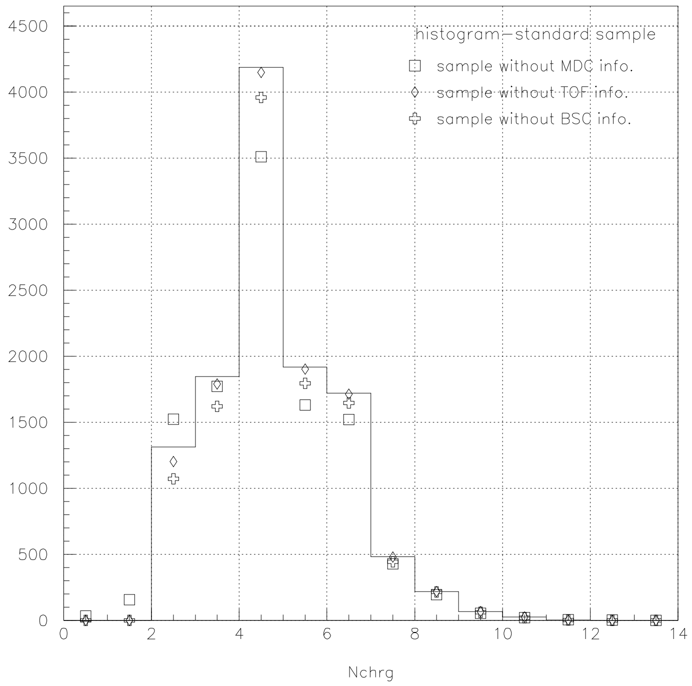

Figure 3: multiplicity distribution of 4 samples

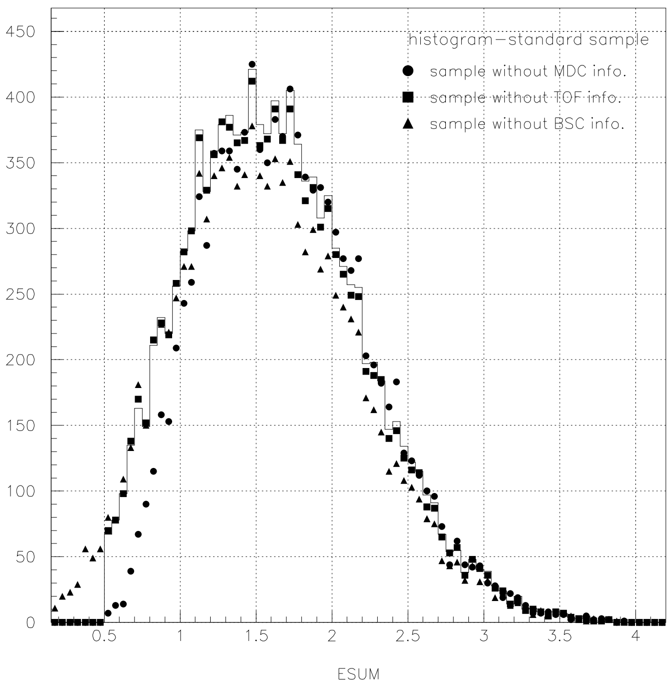

Figure 4: event energy distribution of 4 samples

Table 4: Trigger Condition Table for R Scan

condi. \ type	BB	Charged	2-mu	Char2	Neutral	Cosmic	Esc	BB2
Active?	N	Y	N	Y	Y	N	Y	N
TOF BB	-	-	-	Y	-	-	-	Y
$N_{TOF\geq 1}$	-	Y	Y	-	-	-	-	-
$N_{TOF\geq 2}$	-	-	-	-	-	-	-	Y
Radial	-	-	-	-	Y	-	-	-
$N_{vc\geq 1}$	-	Y	Y	Y	-	Y	Y	-
$N_{etof\geq 1}$	Y	-	-	-	-	-	-	-
Etof B-B	-	-	-	-	-	-	Y	-
$N_{trk\geq 1}$	-	Y	-	-	-	-	-	Y
$N_{trk\geq 2}$	-	-	-	Y	-	Y	-	-
$N_{trk\geq 4}$	-	-	-	-	-	-	-	-
Muon-or	-	-	-	-	-	-	-	-
XXX	-	-	-	-	-	-	-	-
ESC-Etot	-	-	-	-	-	-	Y	-
E_{tot-l}	-	Y	Y	-	-	-	-	Y
E_{tot-h}	-	-	-	-	Y	-	-	-

easy for Bhabha;
two independent selection already

unconvincing for hadron;
difficult to deal with backgrounds
lot of visual scan needed

impractical for dimu
no way to reject cosmic ray events
too few events pass neutral channel

Study to 2.6GeV data (20 runs):

same results for Bhabha;

similar results for hadron;

no results obtained for dimu.

trigger efficiency of each channel:

$$\begin{aligned} \varepsilon_{charged} &= \varepsilon_{N_{tof}\geq 1} \cdot \varepsilon_{N_{vc}\geq 1} \cdot \varepsilon_{N_{trk}\geq 1} \cdot \varepsilon_{E_{tot-l}} && (6) \\ \varepsilon_{char2} &= \varepsilon_{N_{vc}\geq 1} \cdot \varepsilon_{TOFBB} \cdot \varepsilon_{N_{trk}\geq 2} && (7) \\ \varepsilon_{neutral} &= \varepsilon_{Radial} \cdot \varepsilon_{E_{tot-h}} && (8) \end{aligned}$$

trigger efficiency overall:

$$\begin{aligned} \varepsilon &= \varepsilon_{N_{tof}\geq 1} \cdot \varepsilon_{N_{vc}\geq 1} \cdot \varepsilon_{N_{trk}\geq 1} \cdot \varepsilon_{E_{tot-l}} && (9) \\ &+ \left(1 - \varepsilon_{N_{tof}\geq 1} \cdot \varepsilon_{N_{vc}\geq 1} \cdot \varepsilon_{N_{trk}\geq 1}\right) \cdot \varepsilon_{Radial} \cdot \varepsilon_{E_{tot-h}} && (10) \\ &+ \left(1 - \varepsilon_{E_{tot-l}}\right) \cdot \varepsilon_{N_{vc}\geq 1} \cdot \varepsilon_{TOFBB} \cdot \varepsilon_{N_{trk}\geq 2} && (11) \\ &+ \left(1 - \varepsilon_{N_{tof}\geq 1} \cdot \varepsilon_{N_{vc}\geq 1} \cdot \varepsilon_{N_{trk}\geq 1}\right)\left(1 - \varepsilon_{E_{tot-l}}\right) \cdot 0 && (12) \end{aligned}$$

Sample shift will cause lower trg. eff. !

So, trg. eff. obtained is the lower limit.

trg. eff. can be simply regarded as 100%.

Table 5: Trigger Efficiency

	Bhabha		Dimuon		Hardron	
condition	events	efficiency	events	efficiency	events	efficiency
TOFBB	1299/1493	0.87006	499/563	0.886323	5293/11498	0.46034
$N_{TOF\geq 1}$	1491/1493	0.99866	560/563	0.994671	11477/11498	0.99817
$N_{vc\geq 1}$	1380/1382	0.99855	701/701	1.0	11478/11480	0.99983
$N_{trk\geq 1}$	1385/1385	1.0	568/568	1.0	10489/10493	0.99962
$N_{trk\geq 2}$	1380/1385	0.99639	566/568	0.996479	10395/10493	0.99066
Radial	1071/1077	0.99443	177/662	0.267372	2044/5009	0.40807
E_{tot-l}	1081/1081	1.0	653/662	0.986405	5001/5009	0.99840
E_{tot-h}	1075/1076	0.99907	52/662	0.078550	4523/5009	0.90298
$\varepsilon_{charged}$	0.997215		0.981148		0.996027	
ε_{char2}	0.865665		0.883202		0.455962	
$\varepsilon_{neutral}$	0.999071		0.021002		0.368472	
ε	0.999626		0.993267		0.997632	

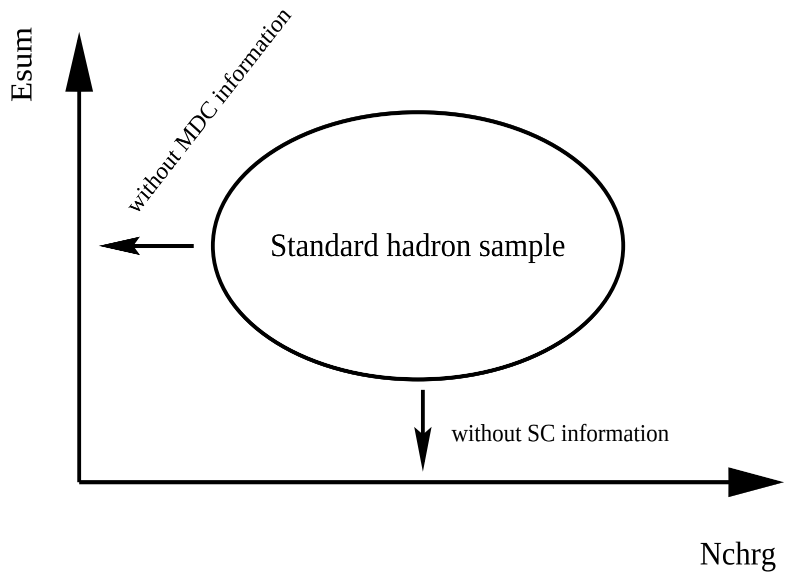

Figure 5: Sample changed due to different information used