Determine the Efficiencies for $J/\psi \rightarrow \mu^+\mu^-$

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1. Introduction

- **To get total number of J/ψ by the $J/\psi \to \mu^+\mu^-$,**

$$N_{J/\psi} = \frac{N_{\mu\mu} - N_{ee\to\mu\mu}}{\varepsilon_{trg} \times \varepsilon_{\mu\mu} \times BR} \quad (1)$$

$$N_{ee\to\mu\mu} = \frac{N^{3.0}_{ee\to\mu\mu} \times L \times \sigma}{L^{3.0} \times \sigma^{3.0}} \quad (2)$$

  ε_{trg}**: eff. of trigger**
  $\varepsilon_{\mu\mu}$**: eff. of detection and rec.**

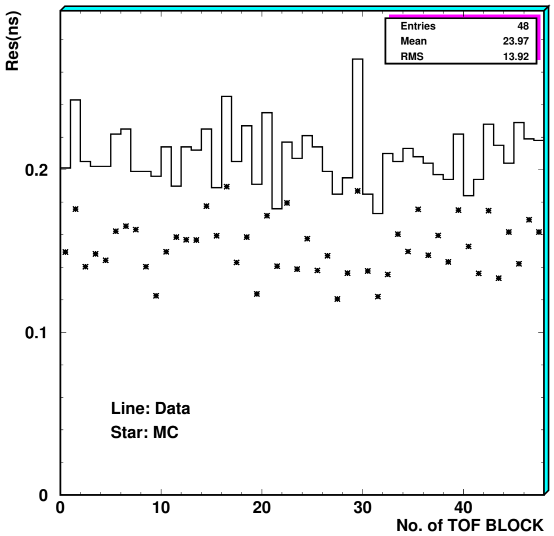
- **Result in BES annual meeting:**
  $N_{J/\psi} = (23.8 \pm 1.4) \times 10^6$

- **Diff. of data and MC:** $\varepsilon_{\mu\mu}$ **??**

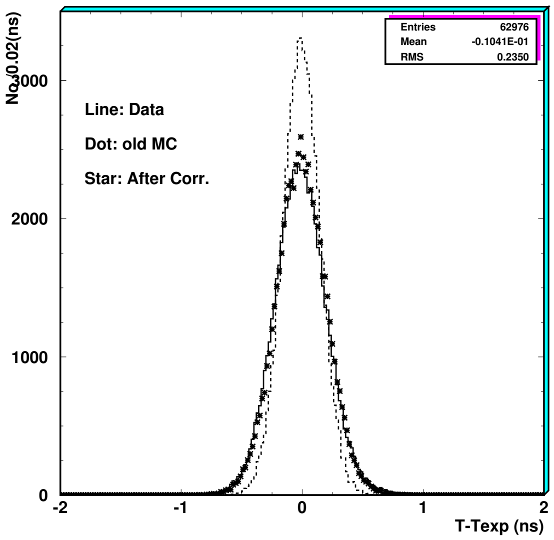
- **Needing double check:** ε_{trg}

2. Resolution of TOF

- **Res. of TOF for 48 pieces**

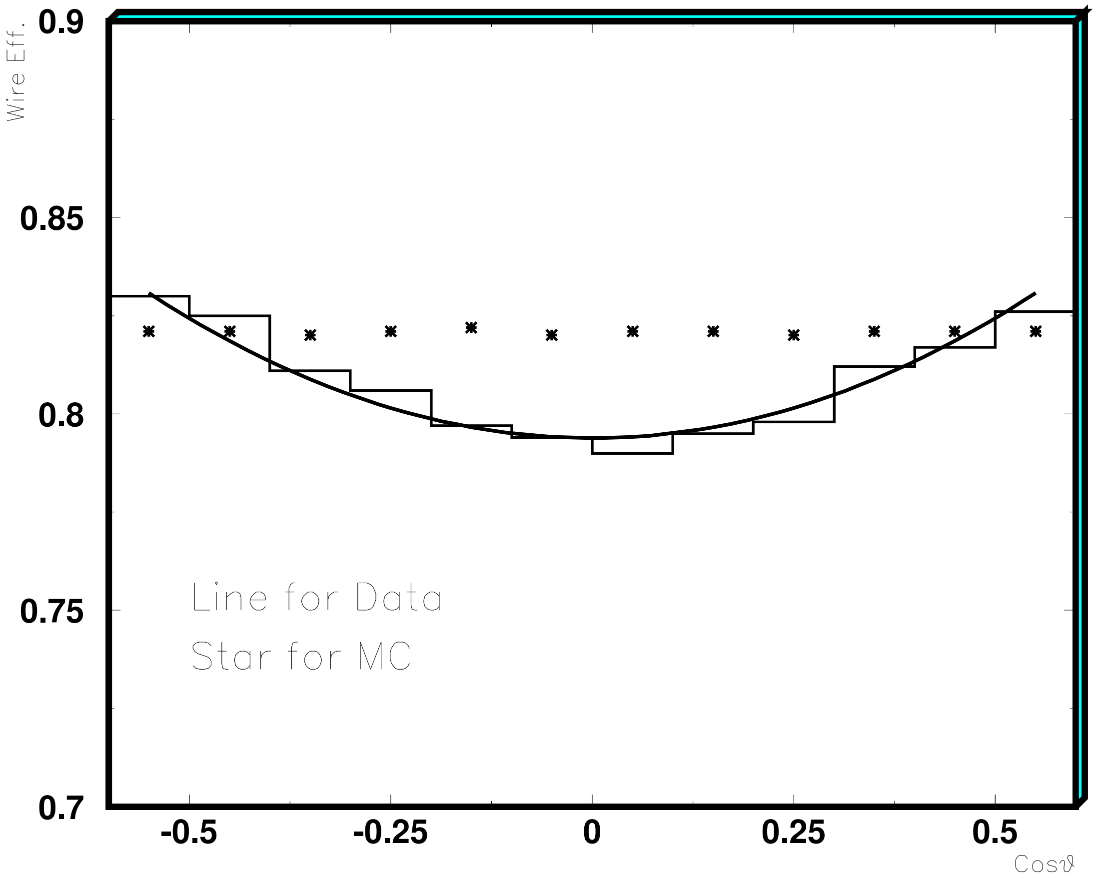


- **Res. of TOF**



3. Eff. of MDC

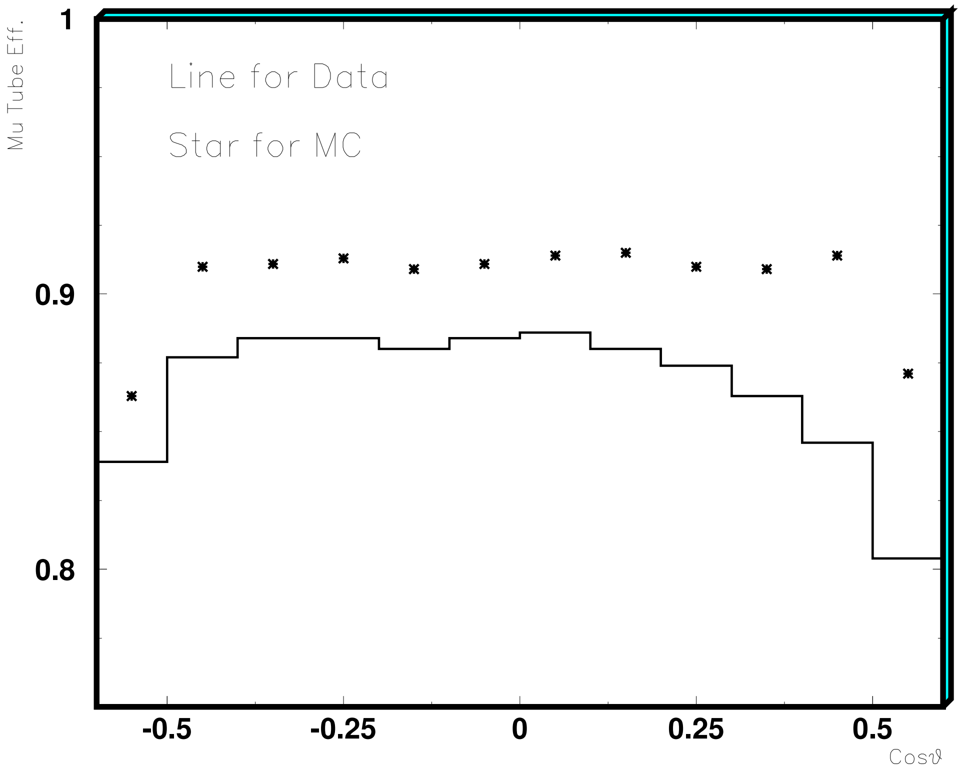
- **Define Wire Eff.** $= \frac{\textbf{Hitted lays' No. used after fit}}{\textbf{Total lays' No. 40}}$



Fitted by $1+\alpha \mathrm{x} \cos\vartheta^2$
α=0.15

4. Tube eff. of Muon Detector

- **Define Tube Eff.** $= \frac{\textbf{Hitted and rec. tubes' No.}}{\textbf{Total tubes' No. 6}}$
- **Mu sample Selection**
  - **- Only two b-to-b tracks, pass P and TOF cuts for muon.**
  - **- One Track pass muid, the other is as sample.**
- **Dist. of Tube Eff.**



5. Trigger Eff.

- **Three trigger channels:**
  - **charged:** $N_{tof} \geq 1$, $N_{vc} \geq 1$, $N_{trk} \geq 1$ **and** E_{totl}
  - **charged-2:** $N_{tof} \geq 2$, $N_{vc} \geq 1$ **and** $N_{trk} \geq 2$
  - **neutral:** $Radial$ **and** E_{toth}
- **Trigger eff. formular:**
  - $\varepsilon = \varepsilon_0 + \varepsilon_1 + \varepsilon_2$
  - $\varepsilon_0 = \varepsilon_{N_{tof}\geq 1}\varepsilon_{N_{vc}\geq 1}\varepsilon_{N_{trk}\geq 1}\varepsilon_{E_{totl}}$
  - $\varepsilon_1 = (1 - \varepsilon_{E_{totl}}) \times \varepsilon_{N_{trk}\geq 2}\varepsilon_{N_{vc}\geq 1}\varepsilon_{N_{tof}\geq 2}$
  - $\varepsilon_2 = (1 - \varepsilon_{N_{tof}\geq 1}\varepsilon_{N_{vc}\geq 1}\varepsilon_{N_{trk}\geq 1}) \times \varepsilon_{Radial}\varepsilon_{E_{toth}} \sim 0$
- **Principles of muon samples to get** ε_{con}**:**
  - **Event trigger: independent to the detector**
  - **Sel. cuts: not use info. from the detector**
- **Trigger data: run13931-run13939(**E_{totl} **is 20)**

5. Trigger Eff.(cont.)

- **Sel. criteria of muon sample:**
  - **Muon detector:**
    - **two tracks hit it, both hit three lays**
    - **position in MU, $\Delta\phi_{mu}$ and $|Z1_{mu} + Z2_{mu}|$**
  - **MDC and VC:**
    - **two tracks with opposite charge**
    - **Vertex cut**
    - $|\Delta\phi_{DC}| < 2^o$**,** $|cos\theta| < 0.6$
    - **momentum: in $[1.0, 2.1]$GeV**
  - **TOF:**
    - **two hits, in [3,6] ns**
    - **position in TOF, $|Z1_{TOF} + Z2_{TOF}| < 0.25$m**
  - **BSC:**
    - **Two tracks, deposited energy < 0.6 GeV**
    - **position in BSC, $|\Delta\phi_{sc}|$ in $[4.5^o, 8.0^o]$**

5. Trigger Eff.(cont.)

- **Double check of trigger eff.: run13931-13939**

	Y.K. Heng (%)	D. Li (%)
$\varepsilon_{N_{vc}\geq 1}$	**100.00**	**99.77**
$\varepsilon_{N_{trk}\geq 1}$	**100.00**	**100.00**
$\varepsilon_{N_{trk}\geq 2}$	**97.96**	**97.97**
$\varepsilon_{N_{tof}\geq 1}$	**99.88**	**100.00**
$\varepsilon_{N_{tof}\geq 2}$	**96.50**	**97.25**
$\varepsilon_{E_{totl}}$	**96.38**	**97.27**
$\varepsilon_{E_{toth}}$	**0.00**	**1.53**
ε_{Radial}	**16.77**	**23.96**
ε_{trg}	**99.69**	**99.64**

- **Effects of variation of E_{totl} during acquring data:**

Data	$\varepsilon_{E_{totl}}$ (%)	ε_{trg}
run13931-13939	**96.38**	**99.69**
run14140-14149	**99.90**	**99.87**
run15580-15589	**99.93**	**99.88**

6. Results

- $\varepsilon_{\mu\mu} = \mathbf{44.86}\%$
  Lower 1.4 % after corr. real. para. of MC.
- $\varepsilon_{\mathbf{trg}} = \mathbf{99.77}\%$
  Stable and almost 1.
- **New total No. of J/ψ:**
  $\mathbf{N_{J/\psi}} = (\mathbf{24.0} \pm \mathbf{1.4}) \times \mathbf{10^6}$