Appendices
A.1 Relativistic kinematics

In high energy nuclear collisions, the nucleons travel nearly with the speed of light ($c$). Hence, it is convenient to use the kinematics in relativistic limits. In this field, the special theory of relativity is used for describing the events and results. Here some of the important and widely used mathematical relations and parameters are discussed:

- In Special theory of relativity, any event in an interial reference frame can be described in 4-D as: $x^\mu = (t, x, y, z) \equiv (x^0, x^1, x^2, x^3)$, known as 4-vector. Covariant vectors are denoted as $x^\mu$ and Contravariant vectors are denoted as $x_\mu$. These two are related as: $x_\mu = g_{\mu\nu} x^\nu$, $g_{\mu\nu}$ is known as metric tensor. It has only diagonal elements, the off-diagonal elements are zero, $g_{\mu\nu} = \text{diag}(1, -1, -1, -1)$. Also, $x^\mu$ is denoted by $(t, \vec{x})$ and $x_\mu$ is denoted by $(t, -\vec{x})$. The scalar product of two 4-vectors is given as,

$$x^\mu x_\nu = x^0 x_0 - x^1 x_1 - x^2 x_2 - x^3 x_3 = x^2$$  \hspace{1cm} (A.1)

$$x^\mu y_\nu = x^0 y_0 - x^1 y_1 - x^2 y_2 - x^3 y_3 = x.y$$  \hspace{1cm} (A.2)

These scalar products are invariant quantities and often referred as Lorentz invariant.

- Lorentz transformation: Let an event in an interial reference frame is at $x = (t, x, y, z) \equiv (x^0, x^1, x^2, x^3)$. Let $x'$ be a 4-vector in another frame, which is moving with a velocity $v$ along the X direction with respect to the initial frame. Let $x' = (t', x', y', z') \equiv (x'^0, x'^1, x'^2, x'^3)$ be the co-ordinates in the other interial frame. In that case, these two frames are related as,

$$x'^0 = \gamma(x^0 - \beta x^1)$$  \hspace{1cm} (A.3)

$$x'^1 = \gamma(x^1 - \beta x^0)$$  \hspace{1cm} (A.4)

$$x'^2 = x^2$$  \hspace{1cm} (A.5)

$$x'^3 = x^3$$  \hspace{1cm} (A.6)
where, $\beta = v/c$ and $\gamma = 1/\sqrt{1-\beta^2}$, known as Lorentz factor.

- **4-velocity and 4-momentum**: To obtain the 4-velocity and hence 4-momentum, proper time, which is a Lorentz invariant quantity, is defined as,

$$\tau^2 = t^2 - x^2 \quad (A.7)$$

The 4-velocity is given as,

$$u^\mu = \frac{dx^\mu}{d\tau} = \frac{dx^\mu}{dt} \frac{dt}{d\tau} = \gamma(1, \vec{v}) \quad (A.8)$$

The 4-momentum is defined as,

$$p^\mu = mu^\mu = m\gamma(1, \vec{v}) \quad (A.9)$$

Energy-Momentum four vector is also represented as: $p^\mu = (E, p_x, p_y, p_z) \equiv (p^0, p^1, p^2, p^3) \equiv (p^0, \vec{p})$. The invariant mass formula:

$$|p^2| = p^\mu p_\mu = E^2 - \vec{p}^2 = m^2. \quad (A.10)$$

In high energy nuclear collisions, the beams collide with each other along the beam direction. Generally, the beam direction is taken along Z direction of cartesian co-ordinates. The particles in beam travel with relativistic speed. Hence, the boost will be along Z direction with respect to the observers from rest frame. To make life simpler, some quantities are defined which are boost invariant or they transform in a simple manner with the boosted frame.

- **Transverse momentum and mass**: The components of energy-momentum four vector in a boosted frame (along Z axis) takes the form,

$$E'^0 = \gamma(E^0 - \beta p_z) \quad (A.11)$$

$$p'_x = p_x \quad (A.12)$$

$$p'_y = p_y \quad (A.13)$$

$$p'_z = \gamma(p_z - \beta E) \quad (A.14)$$

It is seen that, the transverse component of momentum $p_T = p_x^2 + p_y^2$, has not changed due to the Lorentz boost. Same is the case with transverse mass $m_T^2 = p_T^2 + m_0^2$, where $m_0$ is the rest mass. Hence, these two variables have utmost importance in relativistic high energy collision.

- **Rapidity**: This variable is defined as,

$$y = \frac{1}{2} \ln \left( \frac{E + p_z}{E - p_z} \right) = \ln \left( \frac{E + p_z}{m_T} \right) \quad (A.15)$$

This can be understood as a logarithmic measure of longitudinal momentum and total

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energy of particle. Using the relation $\beta_z = p_z/E$, $y$ takes the form,

$$y = \frac{1}{2} \ln \left( \frac{1 + \beta_z}{1 - \beta_z} \right)$$  \hspace{1cm} (A.16)

For low energy limit, it can be shown that $y \simeq \beta_z$. Under Lorentz boost, with a velocity $\beta$ along $Z$ direction, this variable transforms as,

$$y' = y + \ln \sqrt{\frac{1 - \beta}{1 + \beta}}$$  \hspace{1cm} (A.17)

$$\implies y' = y - \tanh^{-1} \beta$$  \hspace{1cm} (A.18)

The main advantage of using this variable is its additive property under boost along the beam direction. This variable is useful when comparing the rapidity distributions of particles in fixed target experiment and collider experiments (discussed later). The total energy $E$ and momentum component $p_z$ can be expressed in terms of $y$, as,

$$E = m_T \cosh y, p_z = m_T \sinh y$$  \hspace{1cm} (A.19)

This leads to the relation, $\tanh y = p_z/E$.

- **Pseudo-Rapidity**: Other than rapidity, another important variable in relativistic collision is pseudo-rapidity, denoted by $\eta$ and defined as,

$$\eta = - \ln \left( \tan \frac{\theta}{2} \right)$$  \hspace{1cm} (A.20)

where, $\theta$ is the angle between the beam axis and the direction of emitted particle. For high energy limit $y \to \eta$. This variable is important as it involves single information. Further, in high energy collisions, it is difficult to obtain the information of total energy $E$ and longitudinal momentum $p_z$. Hence, in those places, this variables become quite handy. It is seen that, for $\theta > 0$, $\eta$ is also greater than zero. For $\theta = \pi/2$, $\eta = 0$. For $\theta > \pi/2$, $\eta$ has negative values.

The particle multiplicity is expressed as a function of rapidity or pseudo-rapidity, $dN/dy$ or $dN/d\eta$.

- **Center of mass energy**: The center of mass energy is defined as the energy in the center of momentum frame. The center of momentum frame of a system is the unique inertial frame, in which the total momentum of the system vanishes. Classically, the
position ($\vec{r}_{CM}$), velocity ($\vec{v}_{CM}$) and acceleration ($\vec{a}_{CM}$) of center of mass is given as,

\[
\vec{r}_{CM} = \frac{\sum_i m_i \vec{r}_i}{\sum_i m_i} \tag{A.21}
\]

\[
\vec{v}_{CM} = \frac{\sum_i m_i \vec{v}_i}{\sum_i m_i} \tag{A.22}
\]

\[
\vec{a}_{CM} = \frac{\sum_i m_i \vec{a}_i}{\sum_i m_i} \tag{A.23}
\]

In case of center of momentum frame,

\[
\vec{p}_{CM} = \sum_i \vec{p}_i = 0 \tag{A.24}
\]

When an inelastic collision takes place in a small region and for a small duration of time, the energy dumped can be used in production of new particles. While working in high energy regime, it is important to estimate the amount of energy used and wasted in collision. This can be estimated by working in ‘center of mass’ frame. Let us consider inelastic collision of two particles A and B, giving rise to two particles C and D in final state.

\[
A + B \rightarrow C + D
\]

Let $p_A = (E_A, \vec{p}_A)$, $p_B = (E_B, \vec{p}_B)$ be the four-momentum of A and B, then, in center of mass frame, $\vec{p}_A + \vec{p}_B = 0$. From Mandelstam variable $s$, one can find the energy in center of mass frame for both fixed target experiment and collider experiments.

\[
s^2 = (p_A + p_B)^2 = p_A^2 + p_B^2 + 2p_A.p_B
\]

\[
= (E_A^2 - \vec{p}_A^2) + (E_B^2 - \vec{p}_B^2) + 2(E_A.E_B - \vec{p}_A.\vec{p}_B)
\]

\[
= m_A^2 + m_B^2 + 2(E_A.E_B - \vec{p}_A.\vec{p}_B) \tag{A.25}
\]

- For fixed target experiment let $B$ is at rest and $\vec{p}_B = 0$. Hence, $p_B = (m_B, 0)$,

\[
s^2 = m_A^2 + m_B^2 + 2(E_A.m_B) \tag{A.26}
\]

- For collider experiments, none of $\vec{p}_A$ or $\vec{p}_B$ is zero. Hence,

\[
s^2 = m_A^2 + m_B^2 + 2(E_A.E_B - \vec{p}_A.\vec{p}_B)
\]

\[
= m_A^2 + m_B^2 + 2(E_A.E_B - |\vec{p}_A||\vec{p}_B|) \tag{A.27}
\]
if $m_A << E_A$ and $m_B << E_B$, then,

$$s^2 \sim 2(E_A E_B + E_A E_B)$$
$$\sim 4E_A E_B \quad (A.28)$$

If the both the particles participating in the collisions are same i.e. $m_A = m_B = m_0$, $E_A = E_B = E$ and the rest masses are very small in comparison to the kinetic energy, then,

for fixed target, $\sqrt{s} = \sqrt{2mE}$

for collider, $\sqrt{s} = 2E$

- **Luminosity**: The rate of interaction $R$ is proportional to the cross-section ($\sigma$). The constant of proportionality is known as Luminosity ($L$), which is defined as the number of particles in beam crossing in unit time through an unit area and has the unit of $\text{cm}^{-2} \text{s}^{-1}$.

  - **Fixed target**: In case of Fixed target, the reaction rate will depend on both the beam flux and the target centers. Let $\varphi$ is the flux of the incoming beam i.e. number of particles ($N_{\text{beam}}$) per second. Now, let $\rho$ be the density of the target and $l$ be the target length. The density $\rho$ can be perceived as, $\rho = N_{\text{target}}/V$, $V$ is the volume. Then the reaction rate becomes,

  $$R = \varphi \rho l \sigma$$
  $$= N_{\text{beam}} \frac{N_{\text{target}}}{V} l \sigma$$
  $$= \frac{N_{\text{beam}} N_{\text{target}}}{\text{area}} \quad (A.29)$$

  Hence, the expression for $L$ becomes, $L = \varphi \rho l = N_{\text{beam}} N_{\text{target}}/\text{area}$

  - **Collider**: In case of colliding beams, the reaction depends on the bunches in the beam, beam cross-sectional area, number of particles in a bunch and number of bunch crossings per second. For Gaussian beam profile, reaction rate $R$ is given by,

  $$R = \frac{N_1 N_2 N_b f}{4\pi \sigma_x \sigma_y} \sigma \quad (A.30)$$

  where $N_1$, $N_2$ are the number of particles in bunches in 1 and 2 respectively, $f$ is the RF frequency which is the bunch crossings per second and $N_b$ is the number of bunches. The transverse cross-sectional area of beam is given by $4\pi \sigma_x \sigma_y$. Hence, luminosity,

  $$L = \frac{N_1 N_2 N_b f}{4\pi \sigma_x \sigma_y} \quad (A.31)$$

- **Integrated luminosity**: Integrated Luminosity ($L_{\text{int}}$) is obtained by integrating the
Luminosity \((L)\) over a certain time: \(L_{\text{int}} = \int_0^T L(t)dt\) This parameter relates the number of observed events as: \(L_{\text{int}} = \sigma N_{\text{events}}\)

### A.2 Thermodynamics

The basic thermodynamical relations are:

- **Density operator.**
  \[
  \dot{\rho} = \frac{1}{Z}e^{-(\hat{H} - \mu\hat{N})/T}
  \]
  \((A.32)\)

- **Partition function.**
  \[
  Z(T, V, \mu) = T e^{-(\hat{H} - \mu\hat{N})/T}
  \]
  \((A.33)\)

- **Grand Potential**
  \[
  \Omega(T, V, \mu) = -T \ln Z(T, V, \mu) = E - TS - \mu N = -pV
  \]
  \((A.34)\)

- **Energy Density**
  \[
  \epsilon = \frac{E}{V} = -\frac{T^2}{V} \frac{\partial \Omega}{\partial T} - \frac{\mu}{T} \frac{\partial \Omega}{\partial \mu}
  \]
  \[
  = \frac{1}{V} \frac{T \partial (T \ln Z)}{\partial T} + \mu n
  \]
  \((A.35)-(A.36)\)

- **Particle Density**
  \[
  n = \frac{1}{V} \frac{\partial (T \ln Z)}{\partial \mu}
  \]
  \((A.37)\)

- **Pressure**
  \[
  P = \frac{\partial (T \ln Z)}{\partial V}
  \]
  \((A.38)\)

- **Entropy density**
  \[
  s = \frac{1}{V} \frac{\partial (T \ln Z)}{\partial T}
  \]
  \((A.39)\)

- **Pressure, energy density and number density for non-interacting relativistic bosonic**

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gases

\[ P_b = g \frac{4\pi}{3(2\pi)^3} \int_0^\infty \frac{p^3 dp}{e^{p/T} - 1} = g \frac{\pi^2}{90} T^4 \]  \hspace{1cm} (A.40)

\[ \epsilon_b = g \frac{4\pi}{(2\pi)^3} \int_0^\infty \frac{p^3 dp}{e^{p/T} - 1} = g \frac{\pi^2}{30} T^4 = 3P \]  \hspace{1cm} (A.41)

\[ n_b = g \int \frac{d^3 p}{\hbar^3} \frac{1}{e^{p/T} - 1} = g \frac{1}{(2\pi)^3} \int_0^\infty \frac{p^2 dp}{e^{p/T} - 1} = g \frac{\zeta(3)}{\pi^2} T^3, \zeta(3) = 1.202 \]  \hspace{1cm} (A.42)

- Pressure, energy density and number density for non-interacting relativistic fermionic gases

\[ P_f = g \frac{4\pi}{3(2\pi)^3} \int_0^\infty \frac{p^3 dp}{e^{p/T} + 1} = \frac{7}{8} P_b \]  \hspace{1cm} (A.43)

\[ \epsilon_f = \frac{7}{8} \epsilon_b \]  \hspace{1cm} (A.44)

\[ n_f = \frac{3}{4} n_b \]  \hspace{1cm} (A.45)

This can be found in details in
http://web-docs.gsi.de/~andronic/intro_rhic2012/2012_04_phase_AA.pdf
In Botzmann-Gibbs statistics, the particle spectrum is given as,

$$E \frac{d^3N}{dp^3} = C_B e^{-E/T}, \quad (B.1)$$

where $C_B$ is the normalization constant, $E$ is the particle energy and $T$ is the temperature of the system.

In non-extensive statistics (Tsallis), the Boltzmann-Gibbs distribution takes the form

$$E \frac{d^3N}{dp^3} = C_q \left(1 + (q-1) \frac{E}{T}\right)^{\frac{1}{q-1}}, \quad (B.2)$$

where $C_q$ is the normalization factor. One can use the relation $E = m_T$ at mid-rapidity and $n = 1/(q-1)$ in Eq. B.2 to obtain:

$$E \frac{d^3N}{dp^3} = C_n \left(1 + \frac{m_T}{nT}\right)^{-n}, \quad (B.3)$$

where, $C_n$ is the normalization factor. Eq. B.3 can be re-written as:

$$\frac{1}{2\pi p_T} \frac{d^2 N}{dp_T dy} = C_n \left(1 + \frac{m_T}{nT}\right)^{-n}, \quad (B.4)$$

The value of $C_n$ can be obtained by integrating Eq. B.4 over momentum space:

$$C_n = \frac{dN/dy}{\int_0^\infty \frac{1}{(1 + \frac{m_T}{nT})^{-n}} \frac{2\pi p_T dp_T}{2\pi p_T dp_T}}, \quad (B.5)$$

The denominator of Eq.B.5 can be integrated by,

$$I = \int_0^\infty \left(1 + \frac{m_T}{nT}\right)^{-n} 2\pi p_T dp_T, \quad (B.6)$$

X
putting

\[ m^2_T = p^2_T + m^2 \]

\[ 2 \ m_T \ dm_T = 2 \ p_T \ dp_T \]

Hence Eq. B.6 becomes,

\[ I = \int_{\infty}^{\infty} \left( 1 + \frac{m_T}{nT} \right)^{-n} 2\pi m_T dm_T, \quad (B.7) \]

Substituting \( 1 + \frac{m_T}{nT} = x \implies dm_T = dx \ nT \)

\[ I = 2\pi n^2 T^2 \int_{1+m_T/nT}^{\infty} x^{-n} (x - 1) \ dx \quad (B.8) \]

Now,

\[ \int_{1+m_T/nT}^{\infty} x^{-n} (x - 1) \ dx = \left. \frac{x^{2-n}}{2-n} \right|_{1+m_T/nT}^{\infty} - \left. \frac{x(1-n)}{(1-n)} \right|_{1+m_T/nT}^{\infty} \quad (B.9) \]

Putting the limits and doing some algebra,

\[ I = 2\pi n T \frac{(1+m_T/nT)^{-n+1}}{(n-1)(n-2)} \cdot \left[ (n-1)(m+nT) - nT(n-2) \right] \quad (B.10) \]

Hence,

\[ C_n = \frac{dN/dy}{I} \quad (B.11) \]

\[ = \frac{dN}{dy} \ \frac{1}{2\pi} \ \frac{(n-1)(n-2)}{[nT+m(n-1)]} \left( \frac{nT}{nT+m} \right)^{-n} \quad (B.12) \]

Then,

\[ E \frac{d^3N}{dp^3} = C_n \left( 1 + \frac{E}{nT} \right)^{-n} \]

\[ = \frac{dN}{dy} \ \frac{1}{2\pi} \ \frac{(n-1)(n-2)}{[nT+m(n-1)]} \left( \frac{nT+m_T}{nT+m} \right)^{-n} \quad (B.13) \]
C.1 Calibration plots for “++” field configuration

C.1.1 Recalibration plots for $emcsdz$

The mean and sigma of the uncalibrated distributions of $emcsdz$ as a function of $p_T$ are shown in Fig. C.1 for “++” field configuration. The calibrated distributions of the same are shown in Fig. C.2.

C.1.2 Recalibration plots for $pc3sd\phi$

The mean and sigma of the uncalibrated distributions of $pc3sd\phi$ as a function of $p_T$ are shown in Fig. C.3 for “++” field configuration. The calibrated distributions of the same are shown in Fig. C.4.

C.1.3 Recalibration plots for $pc3sdz$

The mean and sigma of the uncalibrated distributions of $pc3sdz$ as a function of $p_T$ are shown in Fig. C.5 for “++” field configuration. The calibrated distributions of the same are shown in Fig. C.6.

C.1.4 Recalibration plots for $tofsd\phi$

The mean and sigma of the uncalibrated distributions of $tofsd\phi$ as a function of $p_T$ are shown in Fig. C.7 for “++” field configuration. The calibrated distributions of the same are shown in Fig. C.8.

C.1.5 Recalibration plots for $tofsdz$

The mean and sigma of the uncalibrated distributions of $tofsdz$ as a function of $p_T$ are shown in Fig. C.9 for “++” field configuration. The calibrated distributions of the same
Figure C.1: The $emcsdz$ distributions for “++” field as a function of $p_T$ without any calibration. The upper 8 plots are for the mean of $emcsdz$ and the lower 8 plots are the $\sigma$ of $emcsdz$. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.2: The $emcsdz$ distributions for "++" field as a function of $p_T$ after calibration. The upper 8 plots are for the mean of $emcsdz$ and the lower 8 plots are the $\sigma$ of $emcsdz$. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.3: The $pc3sd\phi$ distributions for “++” field as a function of $p_T$ without any calibration. The upper 8 plots are for the mean of $pc3sd\phi$ and the lower 8 plots are the $\sigma$ of $pc3sd\phi$. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.4: The $pc3sd\phi$ distributions for “++” field as a function of $p_T$ after calibration. The upper 8 plots are for the mean of $pc3sd\phi$ and the lower 8 plots are the $\sigma$ of $pc3sd\phi$. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.5: The \( p_{c3sdz} \) distributions for the \(++\) field as a function of \( p_T \) without any calibration. The upper 8 plots are for the mean of \( p_{c3sdz} \) and the lower 8 plots are for the \( \sigma \) of \( p_{c3sdz} \). The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.6: The $pc3sdz$ distributions for “++” field as a function of $p_T$ after calibration. The upper 8 plots are for the mean of $pc3sdz$ and the lower 8 plots are the $\sigma$ of $pc3sdz$. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.7: The $\text{tof} \phi$ distributions for “++” field as a function of $p_T$ without any calibration. The left and right plots correspond to the mean and $\sigma$ of $\text{tof} \phi$ distribution, respectively. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.

Figure C.8: The $\text{tof} \phi$ distributions for “++” field as a function of $p_T$ after calibration. The left and right plots correspond to the mean and $\sigma$ of $\text{tof} \phi$ distribution, respectively. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.9: The tofsdz distributions for "++" field as a function of $p_T$ without any calibration. The left and right plots correspond to the mean and $\sigma$ of tofsdz distribution, respectively. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.

are shown in Fig. C.10.

C.1.6 Recalibration plots for isK

The mean and sigma of the uncalibrated distributions of isK as a function of $p_T$ are shown in Fig. C.11 for "++" field configuration. The calibrated distributions of the same are shown in Fig. C.12.

C.2 Calibration plots for "--" field configuration

C.2.1 Recalibration plots for emcsd$\phi$

The mean and sigma of the uncalibrated distributions of emcsd$\phi$ as a function of $p_T$ are shown in Fig. C.13 for "--" field configuration. The calibrated distributions of the same are shown in Fig. C.14.

C.2.2 Recalibration plots for emcsdz

The mean and sigma of the uncalibrated distributions of emcsdz as a function of $p_T$ are shown in Fig. C.15 for "--" field configuration. The calibrated distributions of the same are shown in Fig. C.16.
Figure C.10: The $tof_{sdz}$ distributions for “++” field as a function of $p_T$ after calibration. The left and right plots correspond to the mean and $\sigma$ of $tof_{sdz}$ distribution, respectively. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.

Figure C.11: The isK distributions for “++” field as a function of $p_T$ without any calibration. The left and right plots correspond to the mean and $\sigma$ of isK distribution, respectively. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.12: The isK distributions for “++” field as a function of $p_T$ after calibration. The left and right plots correspond to the mean and σ of isK distribution, respectively. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.

C.2.3 Recalibration plots for $pc3sd\phi$

The mean and sigma of the uncalibrated distributions of $pc3sd\phi$ as a function of $p_T$ are shown in Fig. C.17 for “--” field configuration. The calibrated distributions of the same are shown in Fig. C.18.

C.2.4 Recalibration plots for $pc3sdz$

The mean and sigma of the uncalibrated distributions of $pc3sdz$ as a function of $p_T$ are shown in Fig. C.19 for “--” field configuration. The calibrated distributions of the same are shown in Fig. C.20.

C.2.5 Recalibration plots for $tofsd\phi$

The mean and sigma of the uncalibrated distributions of $tofsd\phi$ as a function of $p_T$ are shown in Fig. C.21 for “--” field configuration. The calibrated distributions of the same are shown in Fig. C.22.

C.2.6 Recalibration plots for $tofsdz$

The mean and sigma of the uncalibrated distributions of $tofsdz$ as a function of $p_T$ are shown in Fig. C.23 for “--” field configuration. The calibrated distributions of the same are shown in Fig. C.24.
Figure C.13: The emcsdz distributions for “-” field as a function of $p_T$ without any calibration. The upper 8 plots are for the mean of emcsdz and the lower 8 plots are the $\sigma$ of emcsdz. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.14: The $emcsdz$ distributions for “- -” field as a function of $p_T$ after calibration. The upper 8 plots are for the mean of $emcsdz$ and the lower 8 plots are the $\sigma$ of $emcsdz$. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
The emcsdz distributions for "-" field as a function of $p_T$ without any calibration. The upper 8 plots are for the mean of emcsdz and the lower 8 plots are the $\sigma$ of emcsdz. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.16: The $emcsdz$ distributions for “...” field as a function of $p_T$ after calibration. The upper 8 plots are for the mean of $emcsdz$ and the lower 8 plots are the $\sigma$ of $emcsdz$. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.17: The $pc3sd\phi$ distributions for “--” field as a function of $p_T$ without any calibration. The upper 8 plots are for the mean of $pc3sd\phi$ and the lower 8 plots are the $\sigma$ of $pc3sd\phi$. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.18: The $pc3s\phi$ distributions for “- -” field as a function of $p_T$ after calibration. The upper 8 plots are for the mean of $pc3s\phi$ and the lower 8 plots are the $\sigma$ of $pc3s\phi$. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.19: The $pc3sdz$ distributions for “--” field as a function of $p_T$ without any calibration. The upper 8 plots are for the mean of $pc3sdz$ and the lower 8 plots are the $\sigma$ of $pc3sdz$. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.20: The $pc3sdz$ distributions for “-” field as a function of $p_T$ after calibration. The upper 8 plots are for the mean of $pc3sdz$ and the lower 8 plots are the $\sigma$ of $pc3sdz$. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.21: The $tofsd\phi$ distributions for “-” field as a function of $p_T$ without any calibration. The left and right plots correspond to the mean and $\sigma$ of $tofsd\phi$ distribution, respectively. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.

Figure C.22: The $tofsd\phi$ distributions for “-” field as a function of $p_T$ after calibration. The left and right plots correspond to the mean and $\sigma$ of $tofsd\phi$ distribution, respectively. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.23: The $tofsdz$ distributions for “--” field as a function of $p_T$ without any calibration. The left and right plots correspond to the mean and $\sigma$ of $tofsdz$ distribution, respectively. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.

Figure C.24: The $tofsdz$ distributions for “--” field as a function of $p_T$ after calibration. The left and right plots correspond to the mean and $\sigma$ of $tofsdz$ distribution, respectively. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
C.2.7 Recalibration plots for isK

The mean and sigma of the uncalibrated distributions of isK as a function of $p_T$ are shown in Fig. C.25 for “- -” field configuration. The calibrated distributions of the same are shown in Fig. C.26.

C.3 Invariant mass plots

C.3.1 Invariant mass plots before background subtraction

The $K^{*0}$ meson invariant mass spectra with the correlated ($K^0_S$ meson and $\phi$ meson) and uncorrelated background contributions for “Kaon Identified”, “Unidentified” and “Full Identified” techniques are shown in Fig. C.27, Fig. C.28 and Fig. C.29, respectively.

C.3.2 Invariant mass plots after background subtraction

The $K^{*0}$ meson invariant mass spectra after the removal of uncorrelated background contributions for “Kaon Identified”, “Unidentified” and “Full Identified” techniques are shown in Fig. C.30, Fig. C.31 and Fig. C.32, respectively.
Figure C.26: The isK distributions for “- -” field as a function of $p_T$ after calibration. The left and right plots correspond to the mean and $\sigma$ of isK distribution, respectively. The blue color markers are for the positive particle tracks and the red color markers are for the negative particle tracks.
Figure C.27: Invariant mass plots for “Kaon Identified” technique in Cu+Cu collisions for MB data. Blue symbols are the data points, black line is RBW function plus third order polynomial fitted to the data points, red line is the third order polynomial as residual background, black histogram is the mixed event background. Magenta is the mis-identified pairs from $\phi$ and green one is the mis-identified pairs from $K_S^0$. 
Figure C.28: Invariant mass plots for “Unidentified” technique in Cu+Cu collisions for MB data. Blue symbols are the data points, black line is RBW function plus third order polynomial fitted to the data points, red line is the third order polynomial as residual background, black histogram is the mixed event background. Magenta is the mis-identified pairs from $\phi$ and green one is the mis-identified pairs from $K_S^0$. 
Figure C.29: Invariant mass plots for "Fully Identified" technique in Cu+Cu collisions for MB data. Blue symbols are the data points, black line is RBW function plus third order polynomial fitted to the data points, red line is the third order polynomial as residual background, black histogram is the mixed event background. Magenta is the mis-identified pairs from φ and green one is the mis-identified pairs from $K_S^0$. 
Figure C.30: Invariant mass plots for “Kaon Identified” technique in Cu+Cu collisions for MB data. Blue symbols are the data points, black line is RBW function plus third order polynomial fitted to the data points, red line is the third order polynomial as residual background.
Figure C.31: Invariant mass plots for “Unidentified” technique in Cu+Cu collisions for MB data. Blue symbols are the data points, black line is RBW function plus third order polynomial fitted to the data points, red line is the third order polynomial as residual background.
Figure C.32: Invariant mass plots for “Fully Identified” technique in Cu+Cu collisions for MB data. Blue symbols are the data points, black line is RBW function plus third order polynomial fitted to the data points, red line is the third order polynomial as residual background.