Importance of Tracking Calibration

Defined Kinematics Space w/ fixed E and scattering angles

A mass w/ perfect optics
Correlation between $P_{e'}$ and $P_k$

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Defined Kinematics Space w/ fixed E and scattering angles

Detector segmentation effectively divides the space into many mini spaces i.e. localized coordinate system

$P_e'$ (E' Momentum) vs $P_k$ (Kaon momentum)
Importance of Tracking Calibration

Defined Kinematics Space w/ fixed E and scattering angles

- Shift due to HKS side
- Shift due to HES side
- Scale enlarge on HKS side
- Scale enlarge on HES side
- Both kinematics and optics are not uniquely defined

\[ P_{e'} (E' \text{ Momentum}) \]

\[ P_k (\text{Kaon momentum}) \]
Importance of Tracking Calibration

Defined Kinematics Space w/ fixed E and scattering angles

Tracking precision is the most important part which defines the outcome
Origin of Problem

- HKS is the only experiment trying to reach high precision with extremely high particle rate
- High segmentation
- High multiplicity (existing tracking code cannot ensure satisfied precision under high Multiplicity)
Source of Problems

• Alignment of start time – $T_o$ for each chamber
  – Its resolution is not as crucial as that for KID and coin_t gate
  – It unifies the localized coordinate systems
  – It ensures the validity of one common Drift time vs Drift Distance calibration per plane. Otherwise, we may have to have one calibration for each group of channels defined by Amp-Disc. card.

• Error in start time for events with multiplicity larger than 1, i.e. multiple tracks and multiple hits on the TOF counters

• Events which have irresolvable timing (either start or stop)

• Alignment of stop time – TDC for each group defined by Amp-Disc. card
Goal of Tracking Calibration

Before we start full replay, kinematics calibration and optics optimization we must:

- Align each focal plane (HKS and HES) into one single unified coordinate system within our needed precision
- Ensure scale uniformity of entire focal plane

Problem may not be resolved in 100% but the goal is to keep it as small as possible, such as < few %
Kinematics Alignment

There are two important alignments:

- Relative beam energy alignment
  - Apply beam energy shift correction

- Target straggling corrections to $\Delta E$, $\Delta P_{e'}$, $\Delta P_k$
  - Obtain (by simulation) and apply corrections for targets with well known thickness, i.e. $^{12}C$, $^{7}Li$, $^{9}Be$, $^{10}B$, and $^{52}Cr$
  - Try to find $^{12}_{\Lambda}B_{g.s.}$ from $CH_2$ data and align it with that from $C$ data by finding the corresponding target straggling for $CH_2$ target.
  - Find corresponding target straggling for $H_2O$ data by aligning $\Lambda$ and $\Sigma^o$ with those from $CH_2$ target.
Optical Alignment

Effect to optics: symmetry and description of higher orders

What we must do before optics optimization:

Simulation  Matching  Real Data

First Default Optical Matrices for $P$ and $M_1(angular)$
Optical Matrices

Target Plane: $(x'_t, y'_t, \delta)$
S.S. Plane: $(x_s, y_s)$
Focal Plane: $(x_f, x'_f, y_f, y'_f)$

- **Angular matrices – two steps**
  - $(x_s, y_s) = M_2 (x_f, x'_f, y_f, y'_f)$  \textit{Precise and one step extraction from s.s. data}
  - $(x'_t, y'_t) = M_1 (x_s, y_s, \delta)$  \textit{Need to be optimized w/ multiple iterations}

- **Momentum matrix**
  - $\delta = M_{\delta} (x_f, x'_f, y_f, y'_f)$  \textit{Need to be optimized w/ multiple iterations}