This $\frac{\partial(\text{residual})}{\partial(\text{new track parameters})}$ is necessary for Millepede.

$\frac{\partial(\text{residual})}{\partial(\text{old track parameters})}$, which we already have.

Derivatives of q (old parameters = state vector (x,y,tx,ty,q/p)) with respect to v (Ks decay vertex) and p (pion 3-momentum).

I'm not confident about this part.
—> It's likely we already have these quantities in KinFit part.

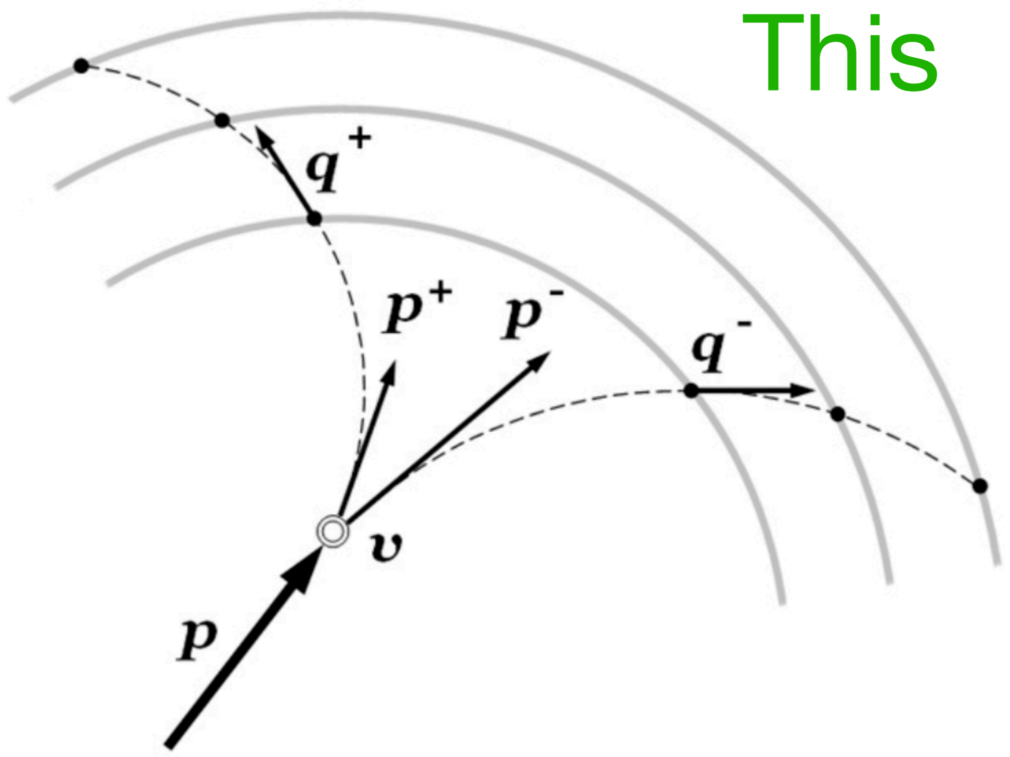

Figure 1: Schematic view of the decay. The dashed lines represent the trajectories, the detector layers are sketched by bold grey lines.

4 Representation

The full set of parameters defining the kinematic properties are from now on denoted with $\boldsymbol{z} = (p_x, p_y, p_z, \theta, \phi, M)$. The information fed for instance to an alignment algorithm then takes the following form:

$$\boldsymbol{m} = \begin{pmatrix} \boldsymbol{m}^+ \\ \boldsymbol{m}^- \end{pmatrix} = \begin{pmatrix} \boldsymbol{f}^+(\boldsymbol{v}, \boldsymbol{z}) + \boldsymbol{\epsilon}_m^+ \\ \boldsymbol{f}^-(\boldsymbol{v}, \boldsymbol{z}) + \boldsymbol{\epsilon}_m^- \end{pmatrix}, \quad \boldsymbol{V}_m = \begin{pmatrix} \boldsymbol{V}_m^+ & \emptyset \\ \emptyset & \boldsymbol{V}_m^- \end{pmatrix},$$

$$\boldsymbol{D} = \frac{\partial \boldsymbol{f}}{\partial(\boldsymbol{v}, \boldsymbol{z})} = \begin{pmatrix} \frac{\partial \boldsymbol{f}^+}{\partial \boldsymbol{q}^+} \cdot \frac{\partial \boldsymbol{q}^+}{\partial \boldsymbol{v}} & \frac{\partial \boldsymbol{f}^+}{\partial \boldsymbol{q}^+} \cdot \frac{\partial \boldsymbol{q}^+}{\partial \boldsymbol{p}^+} \cdot \frac{\partial \boldsymbol{p}^+}{\partial \boldsymbol{z}} \\ \frac{\partial \boldsymbol{f}^-}{\partial \boldsymbol{q}^-} \cdot \frac{\partial \boldsymbol{q}^-}{\partial \boldsymbol{v}} & \frac{\partial \boldsymbol{f}^+}{\partial \boldsymbol{q}^-} \cdot \frac{\partial \boldsymbol{q}^-}{\partial \boldsymbol{p}^-} \cdot \frac{\partial \boldsymbol{p}^-}{\partial \boldsymbol{z}} \end{pmatrix}$$

easy to calculate

Here $\boldsymbol{m}^\pm$ and $\boldsymbol{V}^\pm$ are the measurements and the corresponding covariance matrices of the single trajectories. In the derivative matrix $\boldsymbol{D}$ the chain rule is used, combining the Jacobians $\partial \boldsymbol{f}^\pm / \partial \boldsymbol{q}$ with the Jacobians of the measurement equation $\boldsymbol{q}(\boldsymbol{v}, \boldsymbol{p}_v)$ and the decay model $\boldsymbol{p}^\pm(\boldsymbol{z})$.