The GX alignment & KF-fitted tracks

$$\mathcal{R} = \sum_{\text{tracks}} A^T V^{-1} R V^{-1} \boldsymbol{\rho}, \quad \mathcal{M} = \sum_{\text{tracks}} A^T V^{-1} R V^{-1} A, \qquad \Delta\alpha = -\overbrace{\left(\mathcal{M}^{-1}\right)}^{Cov(\alpha)} \mathcal{R}.$$

with $R = V - HCH^T$ - the covariance of the residuals of the track fit.

Kalman Filter track model:

- $H \equiv \frac{\partial \boldsymbol{\rho}}{\partial \boldsymbol{\pi}}$ $\quad n_r \times 5n$
  H usually trivial and sparse! ☺
- Track covariance ($Cov(\boldsymbol{\pi})$): $\quad (5n)^2$

$$C = \begin{pmatrix} C_1 & C_{1,2} & \dots & C_{1,n} \\ C_{2,1} & C_2 & \dots & C_{2,n} \\ \dots & \dots & \dots & \dots \\ C_{n,1} & C_{n,2} & \dots & C_n \end{pmatrix}$$

- The off-diagonal elements of C can be obtained recursively using the already known smoother gain matrix: $C_{k,l} = A_k C_{k+1,l}$.
  $A_k = (F_k)^{-1}(C^k_{k+1} - Q_k)(C^k_{k+1})^{-1}$.
- Calculation of $R = V - HCH^T$ is fast for the KF thanks to the sparse nature of H. ☺

- Constarints on track parameters can be introduced as in the LS by adding pseudo-measurements in the filtering (a miningful prior).
- Any other constraints (VTX, invariant mass, etc.) can be equally introduced with full propagation to Kalman states which does not involve large matrix inversions.