First Direct Measurement of the Tracker-Field Alignment

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The Idea

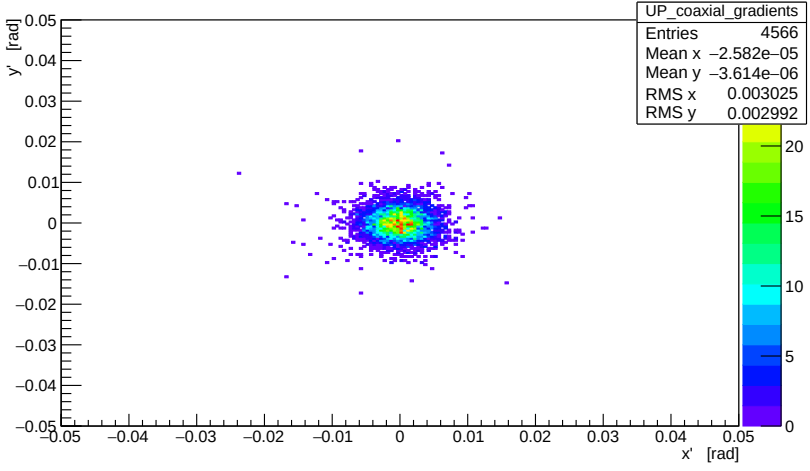
1. Realise that tracks with $p_t = 0$ are *always* coaxial with respect to the magnetic field.
2. Make a TOF Cut. We want high momentum muons.
3. Select events where a given tracker has precisely 5 spacepoints.
4. Perform a simple straight line fit to every event and calculate the Chi-Squared per degree of freedom (χ^2_{NDF}).
5. Select events that have a low χ^2_{NDF} - these will be approximately paraxial.
6. Measure the mean fitted gradient.

Comments

- This will be biased by a distribution that is not small with respect to the parent distribution.
- This will be biased by net angular momentum.
- It seems that as long as the distribution is not biased, large values of χ^2_{NDF} will also work: The whole beam actually travels coaxially - as long as it fits within the tracker!
- A balance is required between sample space volume and systematic bias.
- Understanding the remaining systematic corrections is still quite difficult.

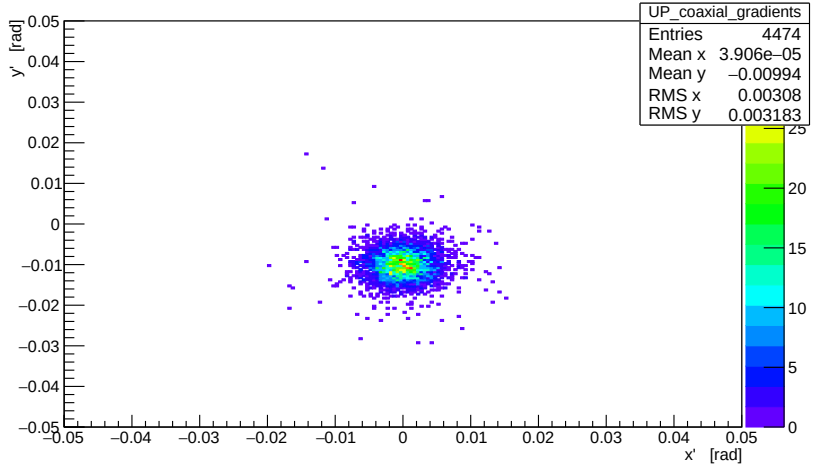
Monte Carlo Model

$\chi^2_{NDF} = 20 \quad \phi = 0$ mrad



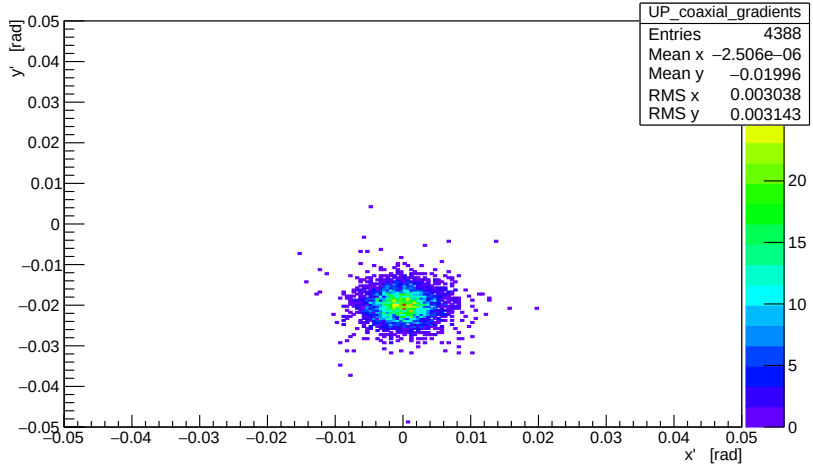
Monte Carlo Model

$\chi^2_{NDF} = 20 \quad \phi = 10$ mrad



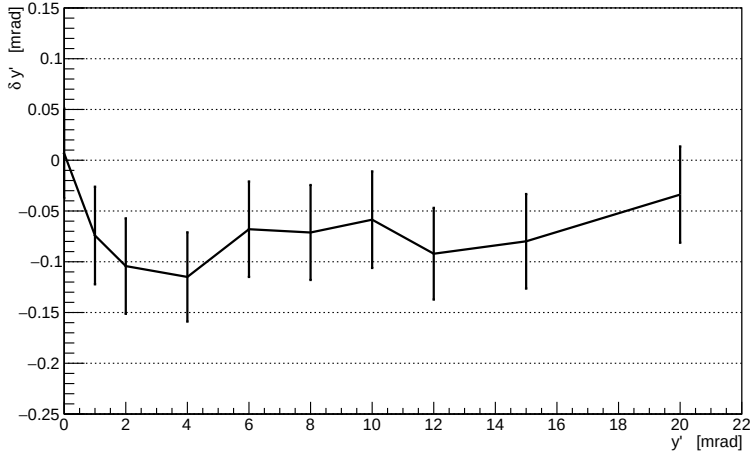
Monte Carlo Model

$\chi^2_{NDF} = 20 \quad \phi = 20$ mrad



Monte Carlo Model

$\chi^2_{NDF} = 20$ Systematic Deviation



Monte Carlo Model

Using the MAUS field map, there appears to be a systematic underestimation of approximately 0.08 mrad, with a deviation on the order of 0.04 mrad.

After looking at different initial beams, the method seems very robust and repeatable.

With this level of selection and specific magnetic field there is a minimal systematic dependency on the beam or the configuration.

So we may currently estimate the systematic correction of 0.08 ± 0.04 mrad.

I then repeating the procedure using dataset from Run 08681.

$$\text{TOF Cut} : 29.0 < T < 32.5 \text{ ns}$$

$$\chi^2_{NDF} < 20.0$$

Magnitude corrections from MC study applied applied the precision they were estimated to.

Data Analysis

Upstream Tracker (No. Muons = 3286)
Correction = 0.08 mrad

$$\phi_x = \quad 0.13 \text{ mrad} \quad \pm 0.07_{\text{stat}} \pm 0.04_{\text{syst}}$$
$$\phi_y = -3.31 \text{ mrad} \quad \pm 0.07_{\text{stat}} \pm 0.04_{\text{syst}}$$

Downstream Tracker (No. Muons = 1980)
Correction = 0.05 mrad

$$\phi_x = -2.51 \text{ mrad} \quad \pm 0.1_{\text{stat}} \pm 0.06_{\text{syst}}$$
$$\phi_y = \quad 0.73 \text{ mrad} \quad \pm 0.1_{\text{stat}} \pm 0.06_{\text{syst}}$$