CDC alignment studies for GCR2 using Millepede-II

Claus Kleinwort - DESY

Belle II tracking F2F meeting, 02.10.18

Introduction (I)

- *Alignment with Millepede-II*
  - Explores the correlations between different detector parts (hits) due to tracks
  - For proper linear equation system (well conditioned matrix) a large variety of correlations is needed
  - This means a large variety of track parameters
    - For tracks from IP longitudinal and transverse track projections are correlated ⇒ bad for alignment
    - Cosmics correlate almost all combinations of detector parts (in acceptance) ⇒ good for alignment

Introduction (II)

- Weak modes
  - Distortions of geometry (almost) completely absorbed into track parameters, $\Delta\chi^2 \approx 0$
  - Need constraints on track parameters to fight them, e.g.
    - Invariant mass for two body decays
    - Data without magnetic field (B=0): straight tracks
- My conclusion
  - Cosmics are backbone of (initial) alignment
    - **Both** with magnetic field on and off

GCR2 alignment @ B=0

- B=0 data samples
  - Not centrally defined/processed/calibrated
  - Found exp 2 run 1572 @ B=0 in run list
- Data processing
  - Extract CDC hit information from raw data
    - Using TFCDC_WireHitCreator
  - Track finding and fitting and calibration and alignment with my python toy code outside basf2

(For alignment studies of GCR2 cosmics with B on see calibration meeting 6.6.18)

Setup (I)

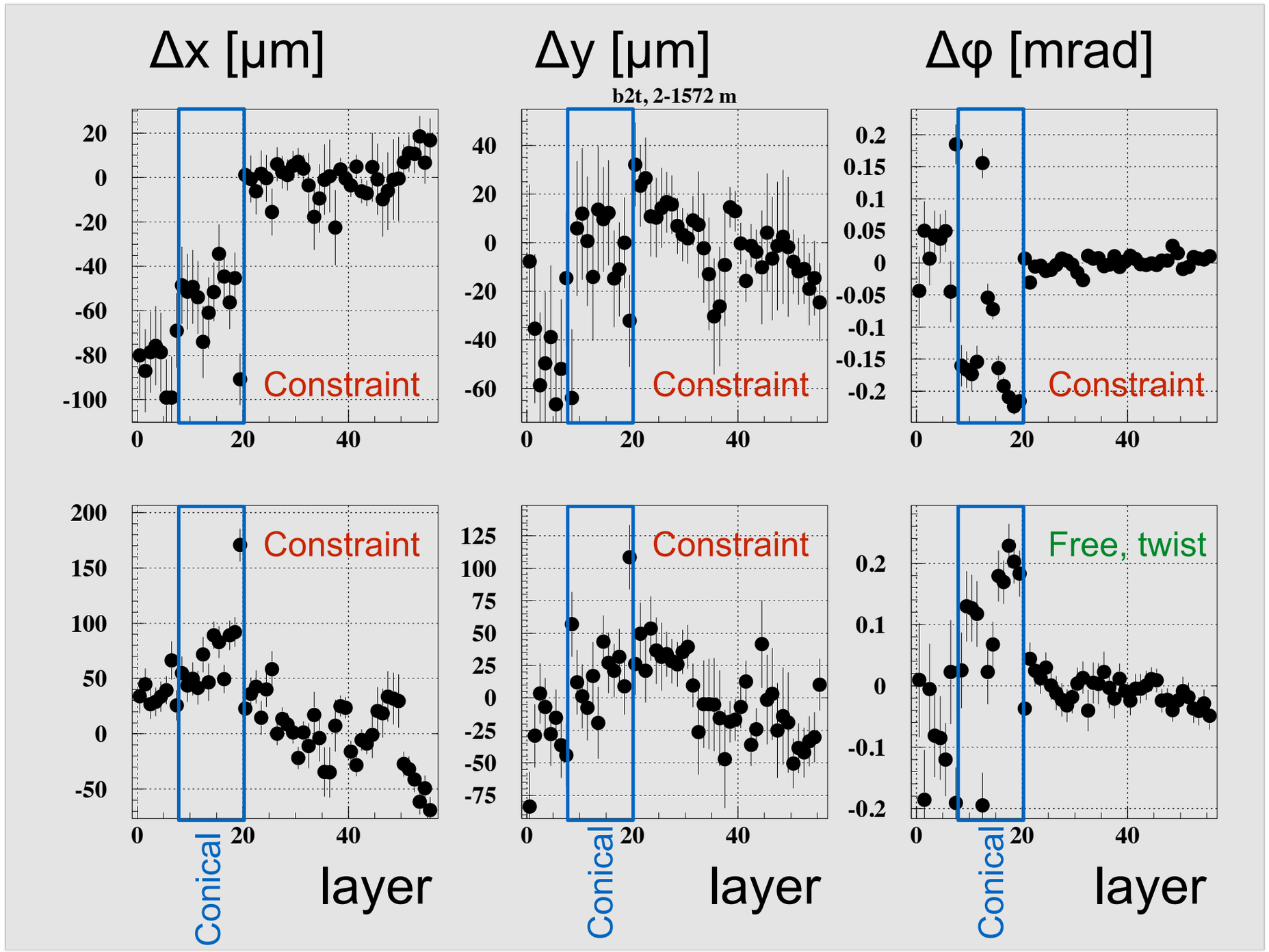
- 12k cosmics @ B=0
  - Exp 2 run 1572
- Layer alignment
  - Determine corrections for displacement and rotation in XY per layer
  - Independently for both end plates (±Z)
  - 2*3*56 = 336 alignment parameters
- Sensitive to twist of end plates (Δφ~Z)
  - Twist introduces curvature into tracks

Setup (II)

- Internal reference, fixed with 7 constraints
  - Account for mechanical substructure of end plates
    - Small cell, conical and main part
    - Apply constraints only on main part
  - Average corrections of displacements for both end plates (4)
  - Average correction of rotations for backward end plate (1)
  - Scale and offset in Z (for stereo layers) (2)

Results

bwd end plate



fwd - bwd end plate

Significant misalignment between mechanical end plate components observed,
no significant twist in main part

Summary

- B=0 cosmics used to check end plate geometry
  - Mechanical substructure, twist
  - Meant as demonstration of the power of this data
  - Results shouldn't be taken at face value as unsure about input geometry
- I strongly recommend to take during the startup for phase 3 some proper cosmics with magnet on **and** off and to process both!
  - Large (trigger) acceptance, all trackers

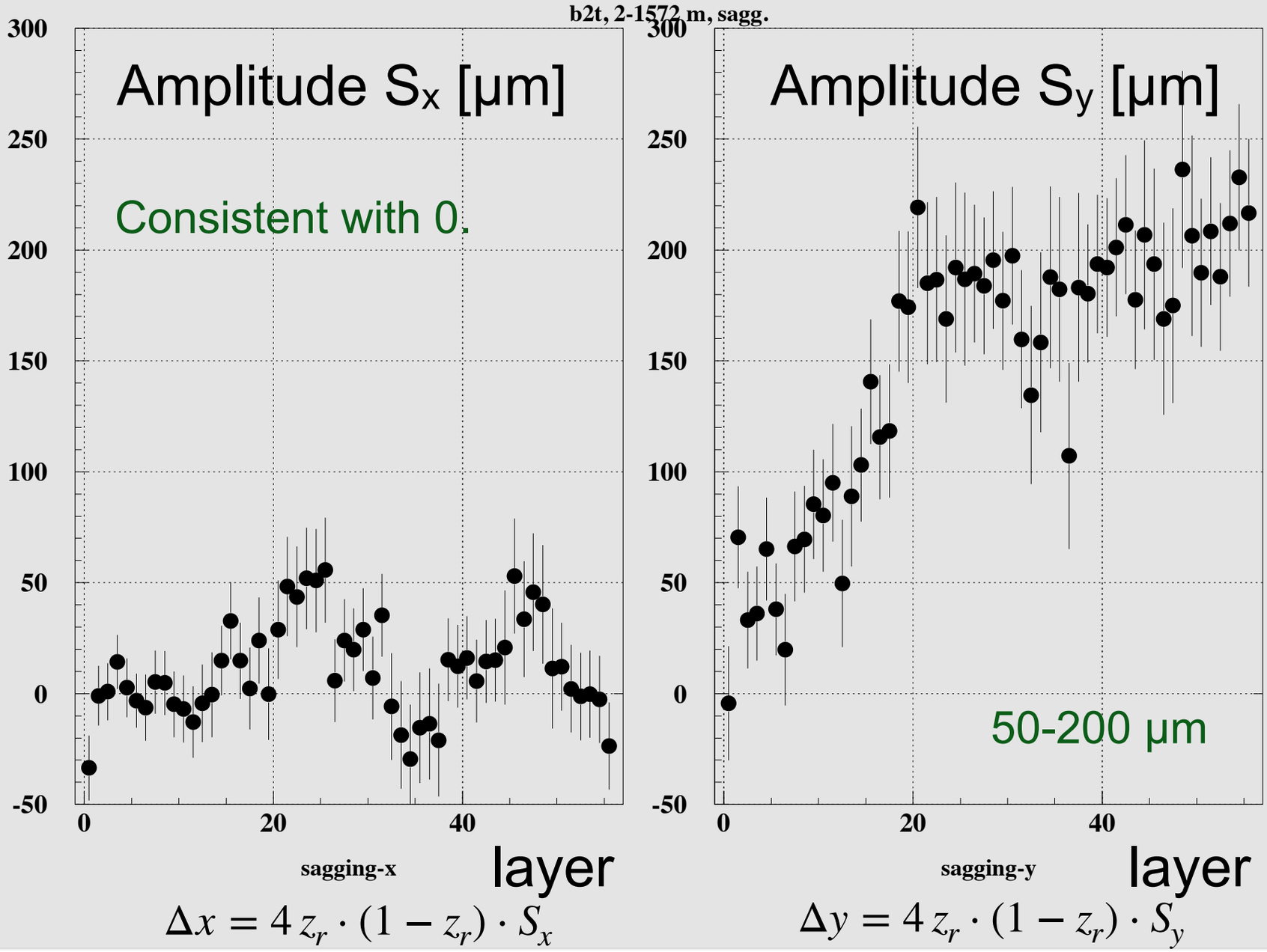
Addendum

Wire sagging with this setup (10.10.18)

Wire sagging

Best done @ B=0, sensitivity to curvature!

As additional alignment parameters for MPII



$$\Delta x = 4\, z_r \cdot (1 - z_r) \cdot S_x \qquad \Delta y = 4\, z_r \cdot (1 - z_r) \cdot S_y$$

relative Z-position $z_r \in [0..1]$