From RigidBody to CurvedBody ?

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Overview

- Idea
- Method
- Measurement
- Summary
- Outlook

Idea

- ★ Si strip sensor surface w(u,v)
  - Check for curvature with MillePede
  - Deviation Δw from flatness will affect position measurement Δu = Δw tan(track angle)
  - Important for cosmics (large track angles)

Method

- ★ Current alignment: like Taylor expansion
  - In use: $\Delta w(u) = a_0 + a_1\, u$ (offset a_0, slope a_1)
  - Add next term $a_2\, u^2/2$? (curvature a_2)
  - Problem: a_0 and a_2 are correlated → a_0 changes
- ★ Better: use system of orthogonal functions
  - Legendre polynomials: $L_n(x)$, $x = -1 \,..\, +1$
  - $\Delta w(u_r) = c_0\, L_0(u_r) + c_1\, L_1(u_r) + c_2\, L_2'(u_r)$, $u_r = 2u/L_u$, $L_0(x) = 1$, $L_1(x) = x$, $L_2'(x) = x^2 - 1/3$
    (<offset> c_0, step (center to edge) c_1, sagitta c_2)
  - Variance from L_2': $\sigma_w^2 = 4/45\, c_2^2 \approx (0.3\, c_2)^2$

Measurement

- Cosmics, 200k tracks, pixel fixed
- Patched into Mille
  - 3 new alignment parameters (per module)
    $\Delta w \rightarrow \Delta w + S_u L_2'(u_r) + S_{uv} L_1(u_r)L_1(v_r) + S_v L_2'(v_r)$
  - with u_r, v_r in local **sensor** or **module** frame
  - TOB, outer TEC have 2 sensors per module
- Approximations
  - Sensors are **rectangles**
  - Modules consist of 1 or 2 **identical** sensors

Ideal MC sensor sagittas [μm]

	TIB	TID	TOB	TEC ring 1-4	TEC ring 5-7
$\langle S_u \rangle$	0±1	0±1	0±1	0±1	-1±1
$\langle S_{uv} \rangle$	0±1	1±1	0±1	0±1	-2±1
$\langle S_v \rangle$	0±1	0±1	0±1	0±1	2±1

χ^2/ndf = 1.04

‘Default hit error’

CRAFT09 sagittas [μm]

	TIB	TID	TOB	TEC ring 1-4	TEC ring 5-7
<S_u>	-28±1	-40±1	-30±1	-34±1	-29±2
<S_{uv}>	-4±1	-8±2	-5±1	14±1	4±1
<S_v>	-9±1	-6±2	-9±1	-51±1	-13±1
<S_u>	-28±1	-40±1	-30±1	-33±1	-24±2
<S_{uv}>	-4±1	-8±2	-8±1	13±1	16±2
<S_v>	-10±1	-6±2	-68±1	-50±1	-6±2

Sensor

Module

χ^2/ndf = 0.99

χ^2/ndf = 0.88

'Quarter pitch hit error',
no curv.: χ^2/ndf = 1.12

Summary

- Ideal MC
  - Consistent with perfectly flat sensors
- CRAFT09
  - Sagitta in u
    - All modules, about 30 μm
  - Sagitta in v
    - TOB, inner TEC modules, about 60 μm
  - Systematic error in w of 10-20 μm
    - Important contribution to measurement error for cosmics

Outlook

- What to do about module curvature?
  - Check with other sources
  - Ignore as before
  - Use for CPE error angular dependence
  - Implement in tracking
- Complete implementation of CurvedBody as alternative alignable?