Scheme for Precise Correction of Orbit Variation Caused by Dipole Error-Field of Insertion Device

A. Agui, T. Nakatani, A. Yoshigoe (JAERI/SPring-8),

H. TANAKA, H. Aoyagi, T. Matsushita,
M. Takao, M. Takeuchi (JASRI/SPring-8)
1. Background

• Correction and source suppression, both are crucial towards the ultimate stability

• Presently, the number and variety of IDs are being increased in a SR source

• ID error-field is thus one of the most serious perturbation sources for the orbit stability
2. Motivation

A limiting factor for the precise correction is noise in measured orbit data

A new idea to extract a signal precisely

Can you find out gold dust in the sand of a river bottom?
3. New Approach

The new approach is based on “signal modulation with a mirror symmetric driving pattern”

Signal modulation by periodical “gap” or “phase” change of target ID

S/N improvement by averaging and filtering procedures
3. New Approach (Con’t)

By folding the data against a symmetry point, two effects by static and dynamic error fields are separately extracted.

![Diagram showing going and returning paths with ID parameter changed at point B.](image-url)
3. New Approach (Con’t)

The separation of two effects by static and dynamic error fields

Correction for a certain driving pattern adjustable for any patterns by only scaling a part of correction table, the data for dynamic error correction
4. Experimental set-up

ID specification to be tested

- Type: Apple II type undulator ID23
- Maximum phase driving speed: 0.1 Hz
- Driving pattern: Trapezoidal
- Period length: 120 mm
- Maximum phase driving range: 240 mm
- Minimum ID gap: 25 mm
- Made in JAERI (not Kitamura Gr.)
4. Experimental set-up (Con’t)

Network

WS

ID Control VME

Optical Fiber

BPM

XBPM

BPM

XBPM

BPM

XBPM

BPM

PC Driven Data Acquisition System
5.1. S/N Improvement

Test Data

- Upper cut-off frequency
  - 25Hz
  - 12.5Hz
  - 6.25Hz
  - 3.125Hz

- Cut-off 6.25Hz
  - cycles 1
  - cycles 4
  - cycles 8

- Original vs. Filtered Signal

- r.m.s. deviation (μm)
  - Time (sec)
  - Signal (μm)
  - Number of cycles

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5.2. Correction of Static Error-Field

Horizontal orbit variation at BPM15

- without correction
- with first correction
- with optimized correction

Folding + Averaged Data
5.3. Correction of Dynamic Error-Field

Horizontal orbit variation at BPM15

without correction: going coming
with correction: going coming

Averaged Data

Horizontal orbit variation (\( \mu m \))

Phase position (mm)
5.4. Correction Performance

Horizontal orbit variation at BPM15

Time (sec)

Horizontal orbit variation (µm)

Raw Data
Bef.
Static
Static+Dynam
BG

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5.5. Application to Different Patterns

Horizontal orbit variation at BPM15
with scaling:  
without scaling:

30mm/sec
20mm/sec
10mm/sec

Averaged Data
5.5. Application to Different Patterns (Con’t)

Horizontal orbital variation at BPM15

ID23 phase position

without velocity scaling

with velocity scaling

Raw Data
6. Summary

- The new scheme suppresses the ID inducing COD down to the sub-micron level.

- The correction data once obtained can be applied to the correction for different driving patterns by only scaling the correction data for the dynamic error-field, keeping the correction performance.