

Analysis of Single-kick data for Electron BT Line

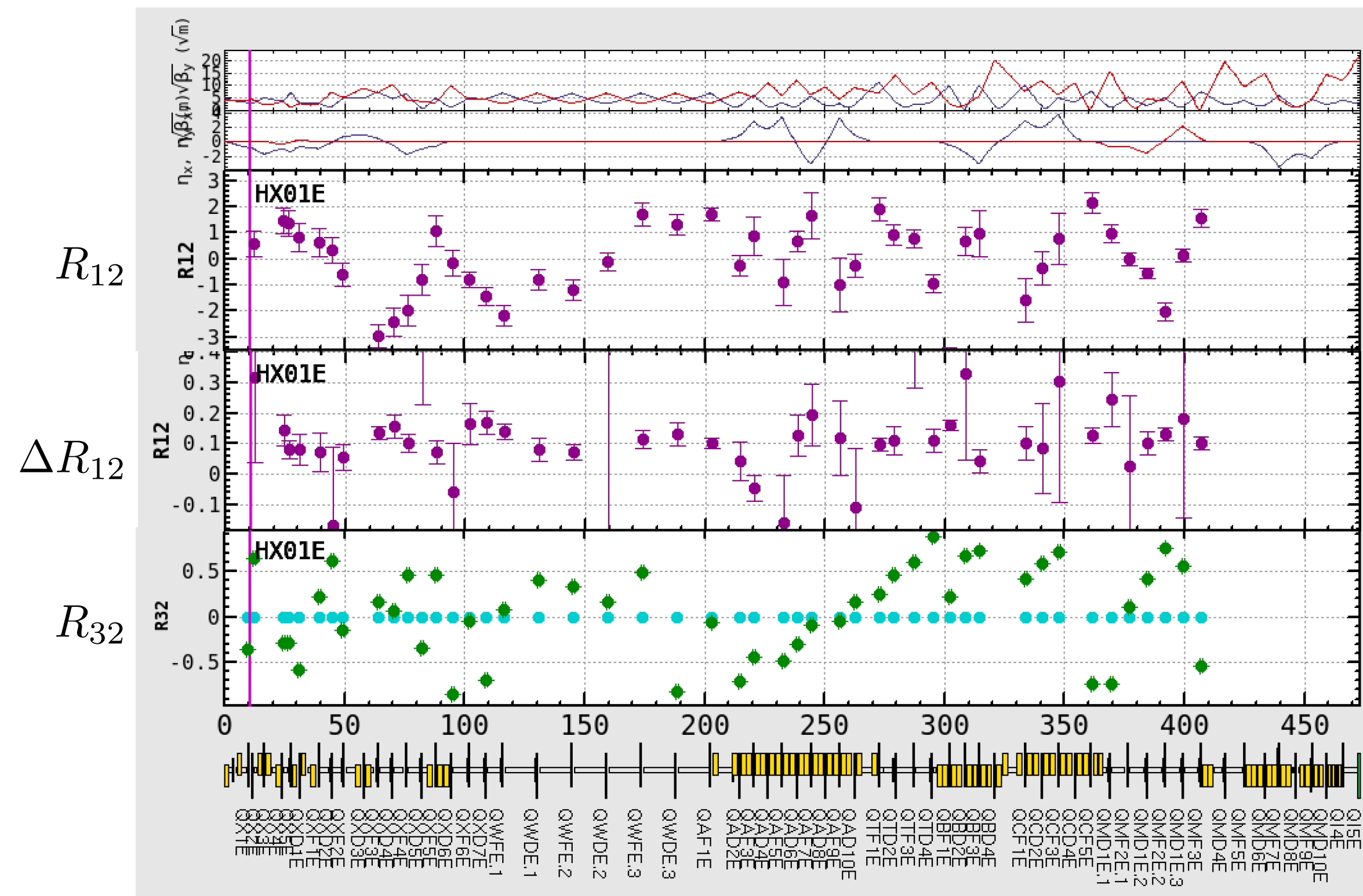
M. Kikuchi, EPTF-meeting, July 17, 2020.

- Single kick response was measured on June 18, 2019.
- The electron beam was not stable, orbit and energy fluctuated.
- BPM mapping was updated AFTER the measurement.
- Data analysis results were reported on the EPTF-meeting, Oct. 25, 2019.
- In this report we revisit the data from a viewpoint of the emittance-explosion issue.

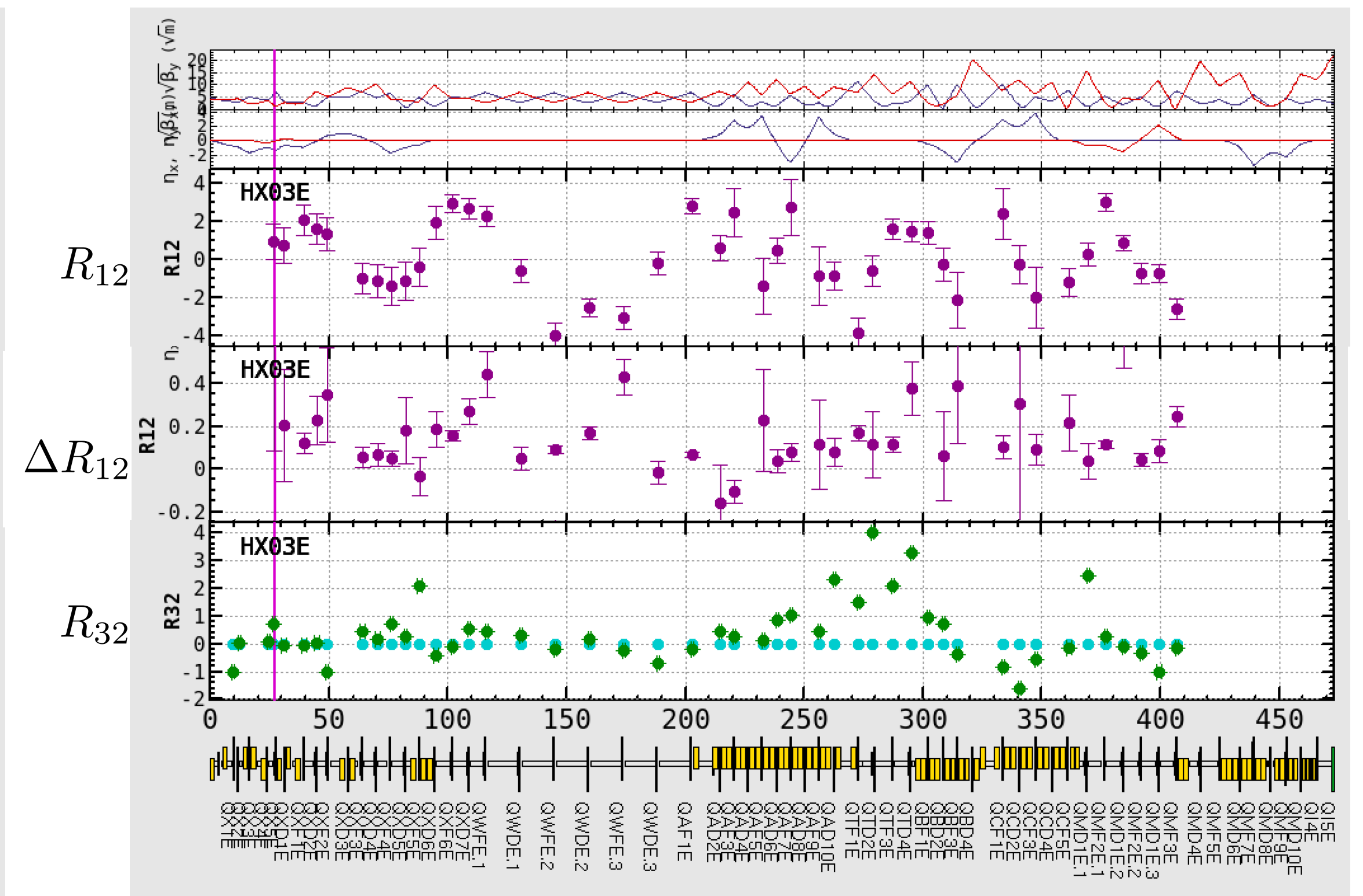
■ Orbit Response (Horizontal kick)

ΔR_{12} : difference from the model calculation

HX01E



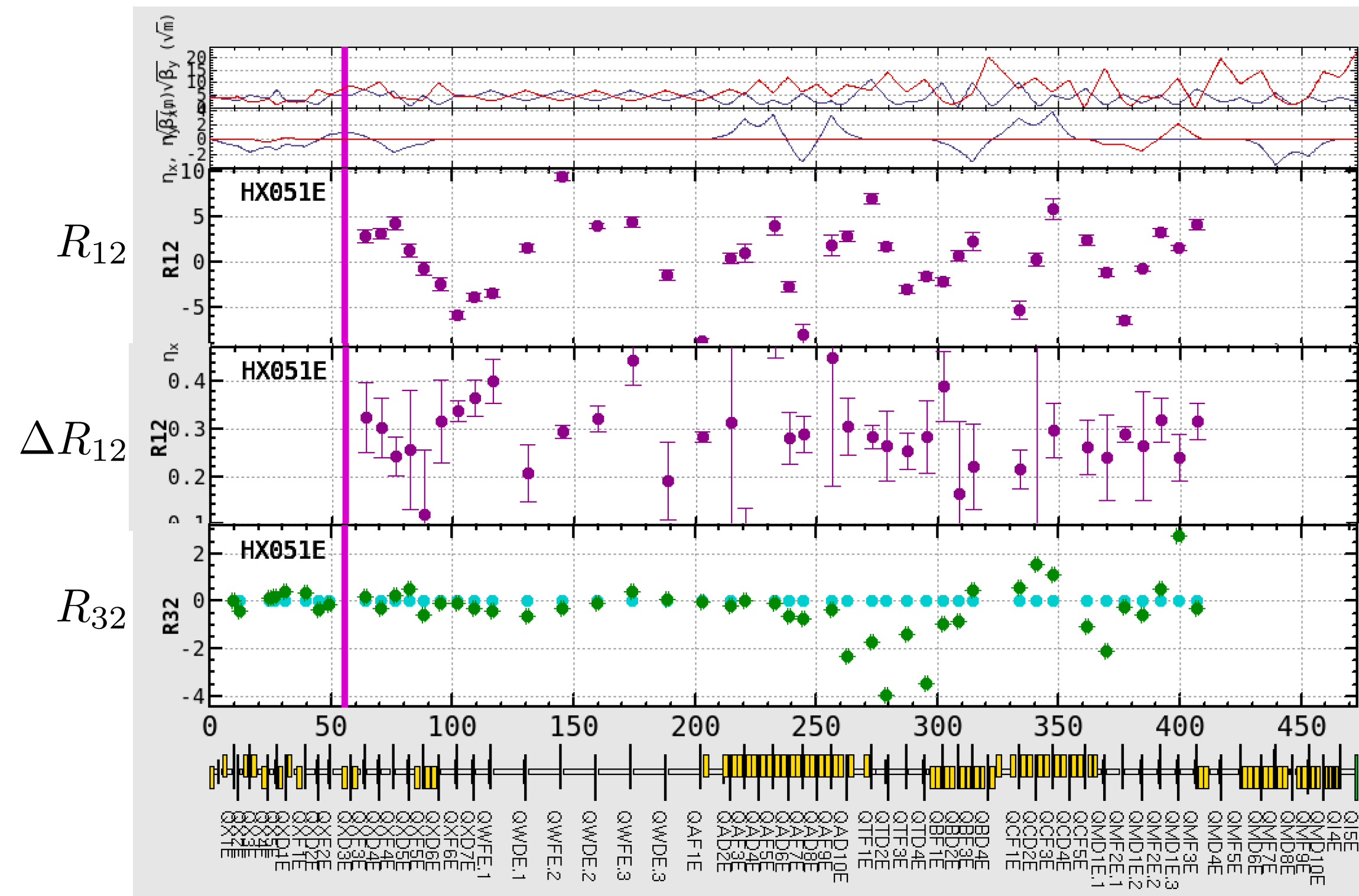
HX03E



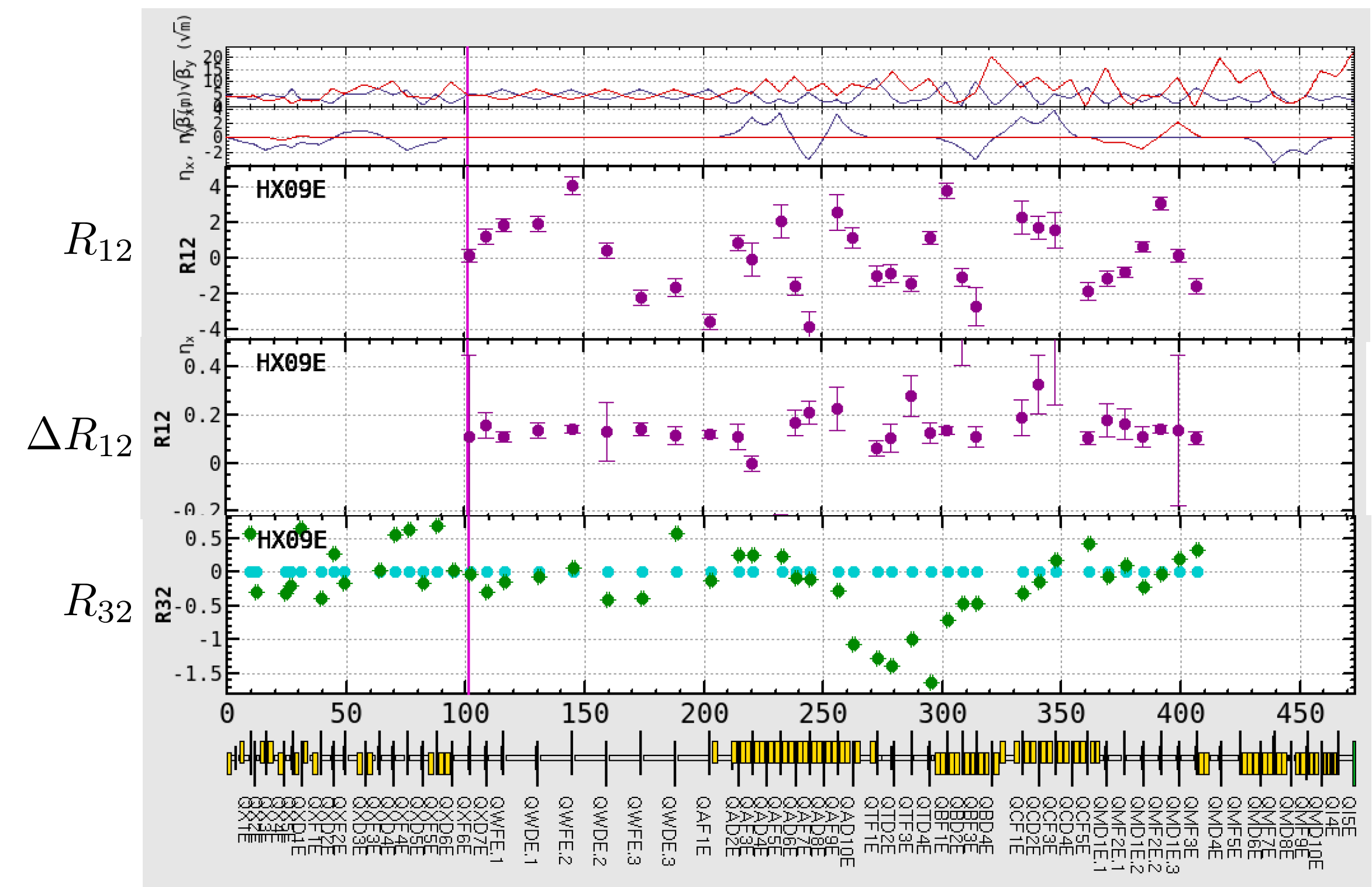
- Orbit Response (Horizontal kick)

- Leakage to vertical plane was observed.

HX051E



HX09E

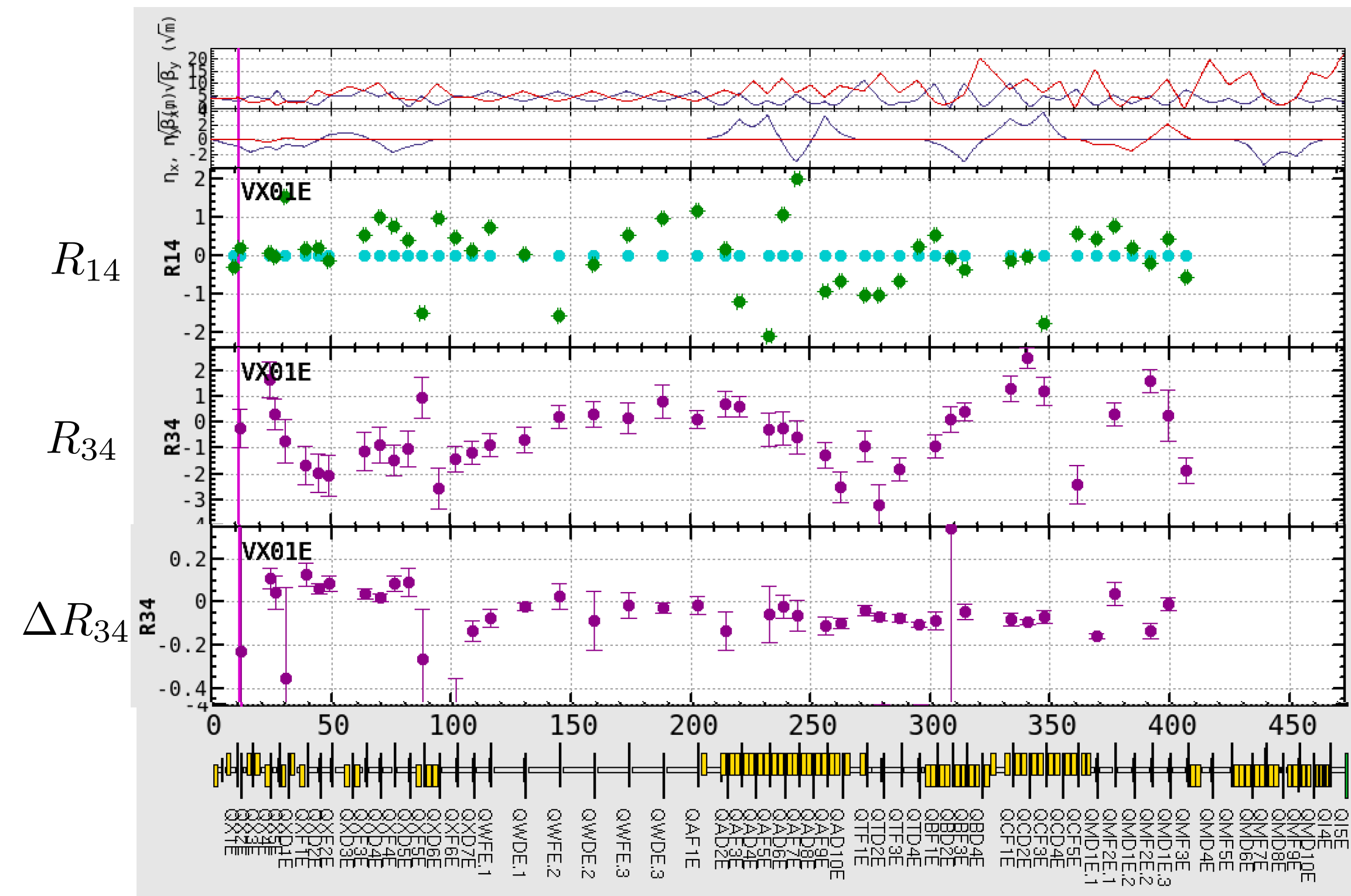


- Orbit Response (Vertical kick)

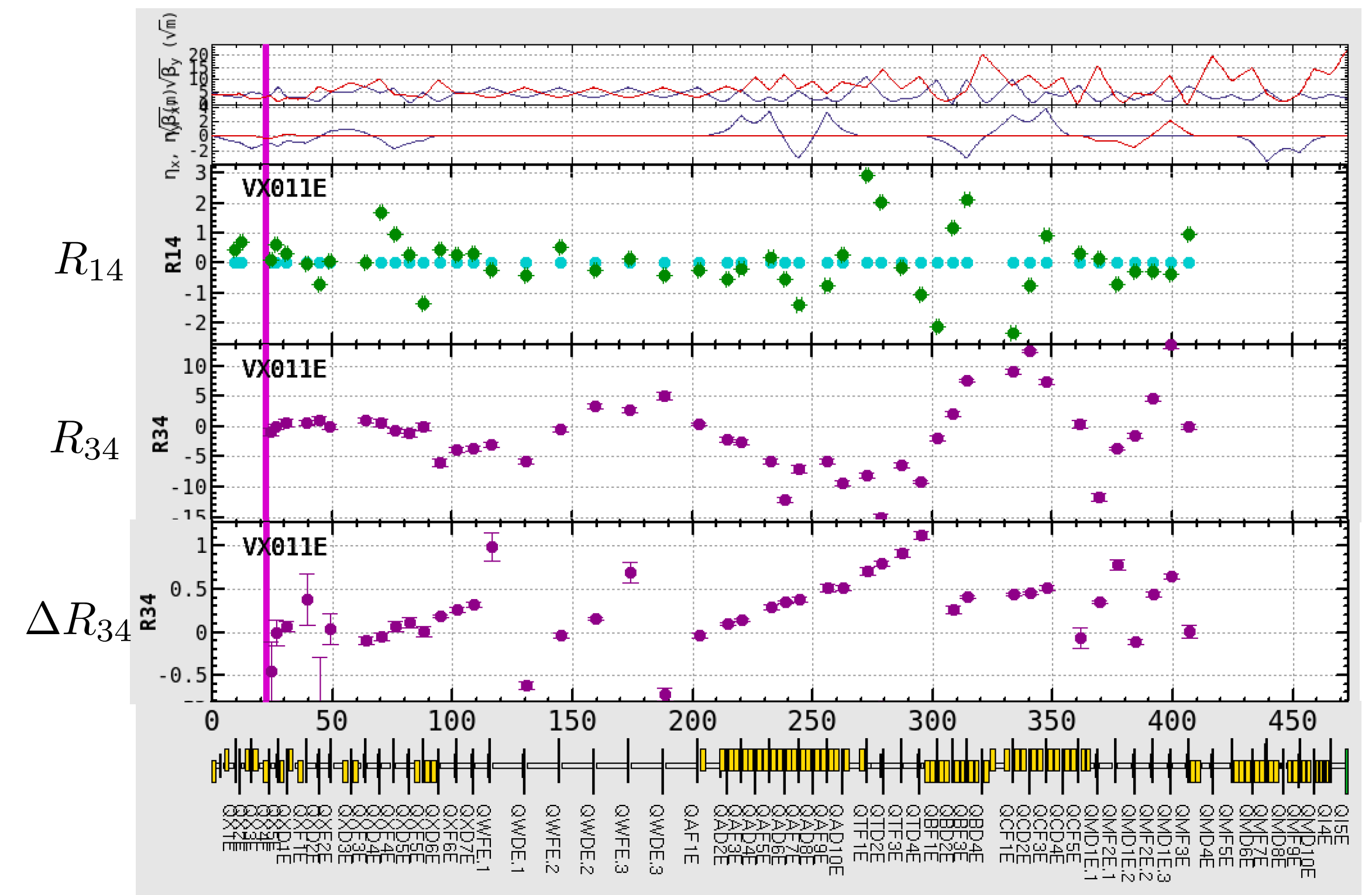
 ΔR_{34} : difference from the model calculation

- Phase advance seems systematically changed in some cases.

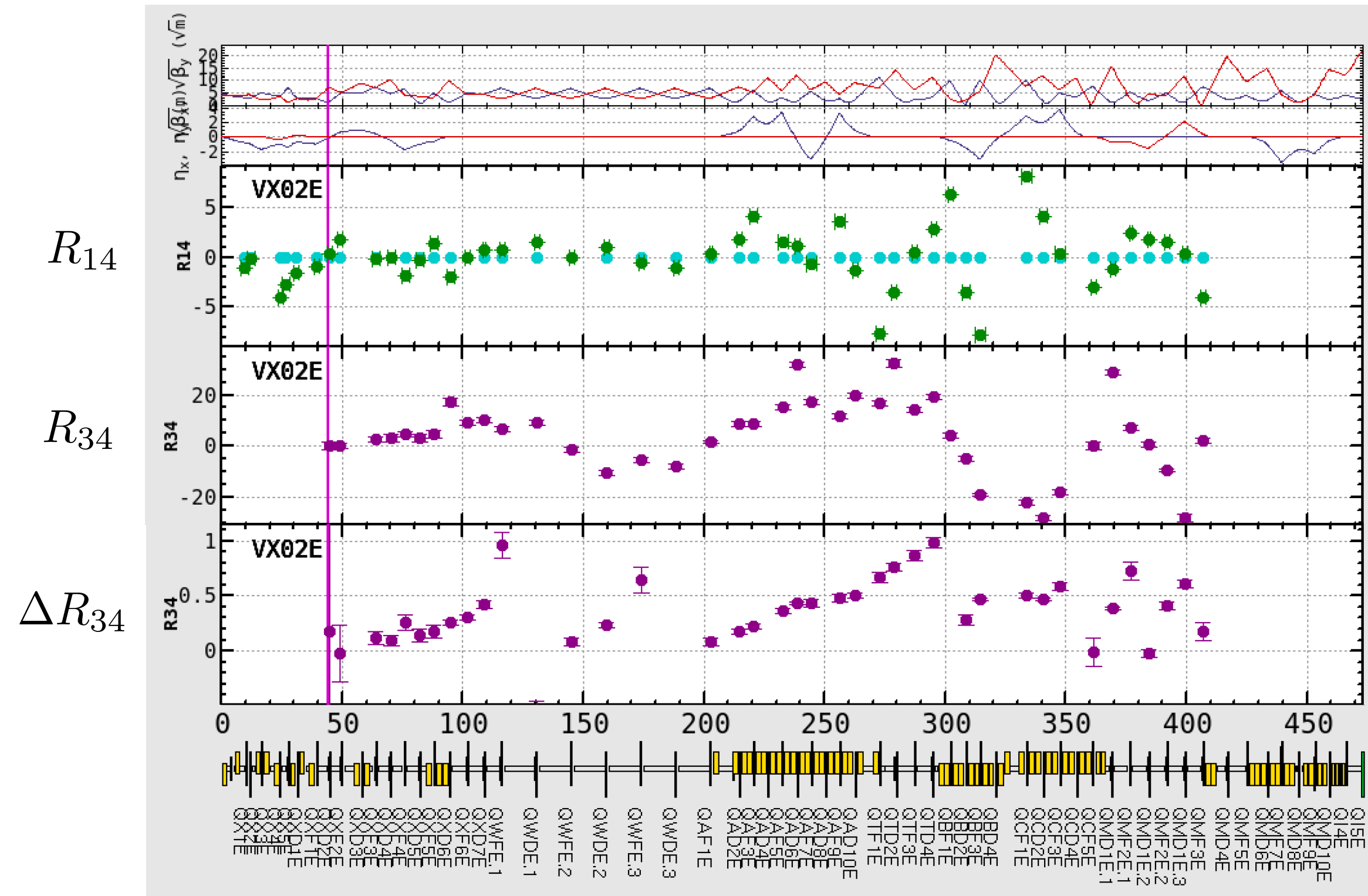
VX051E



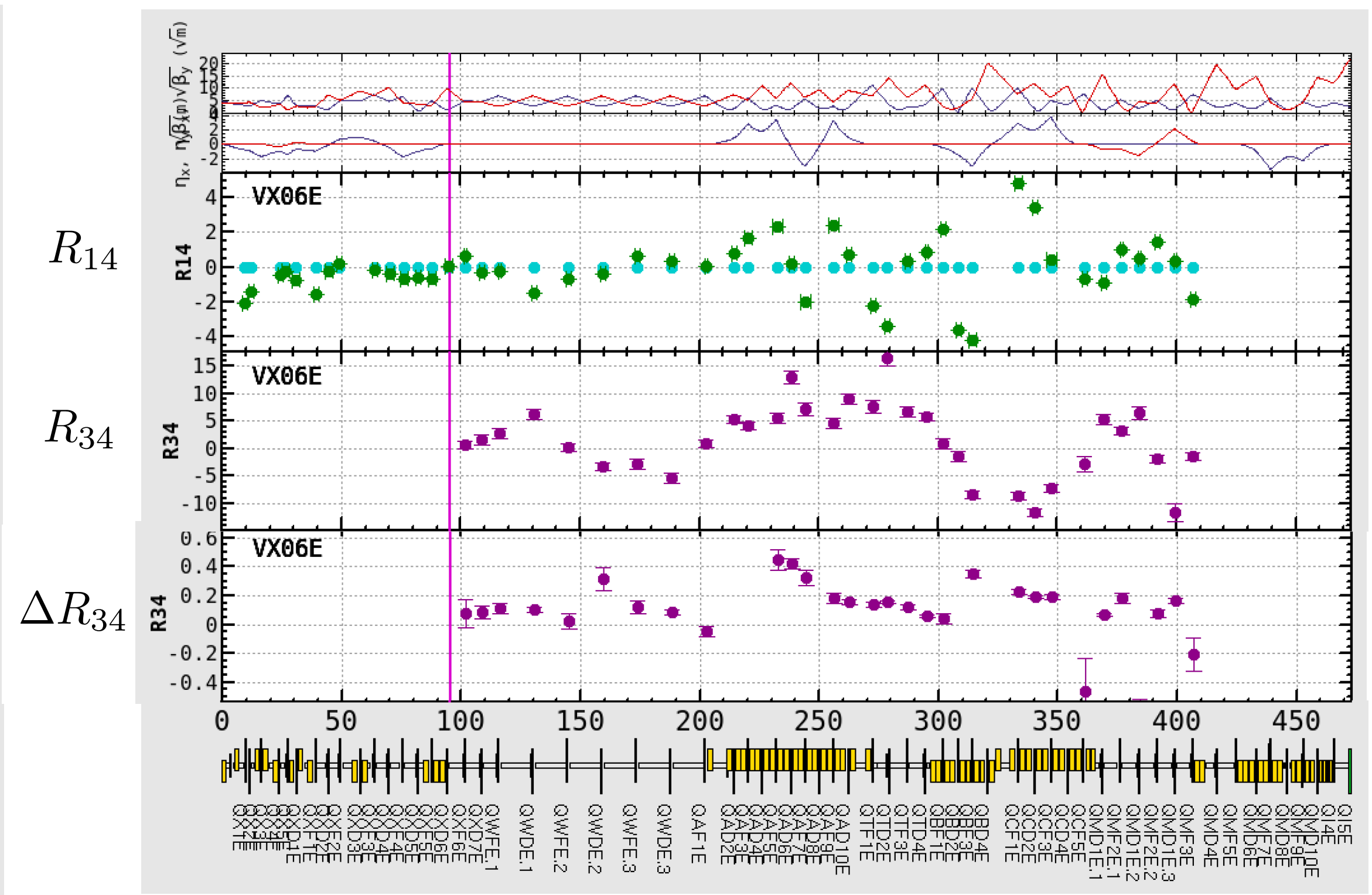
VX011E



VX02E



VX06E



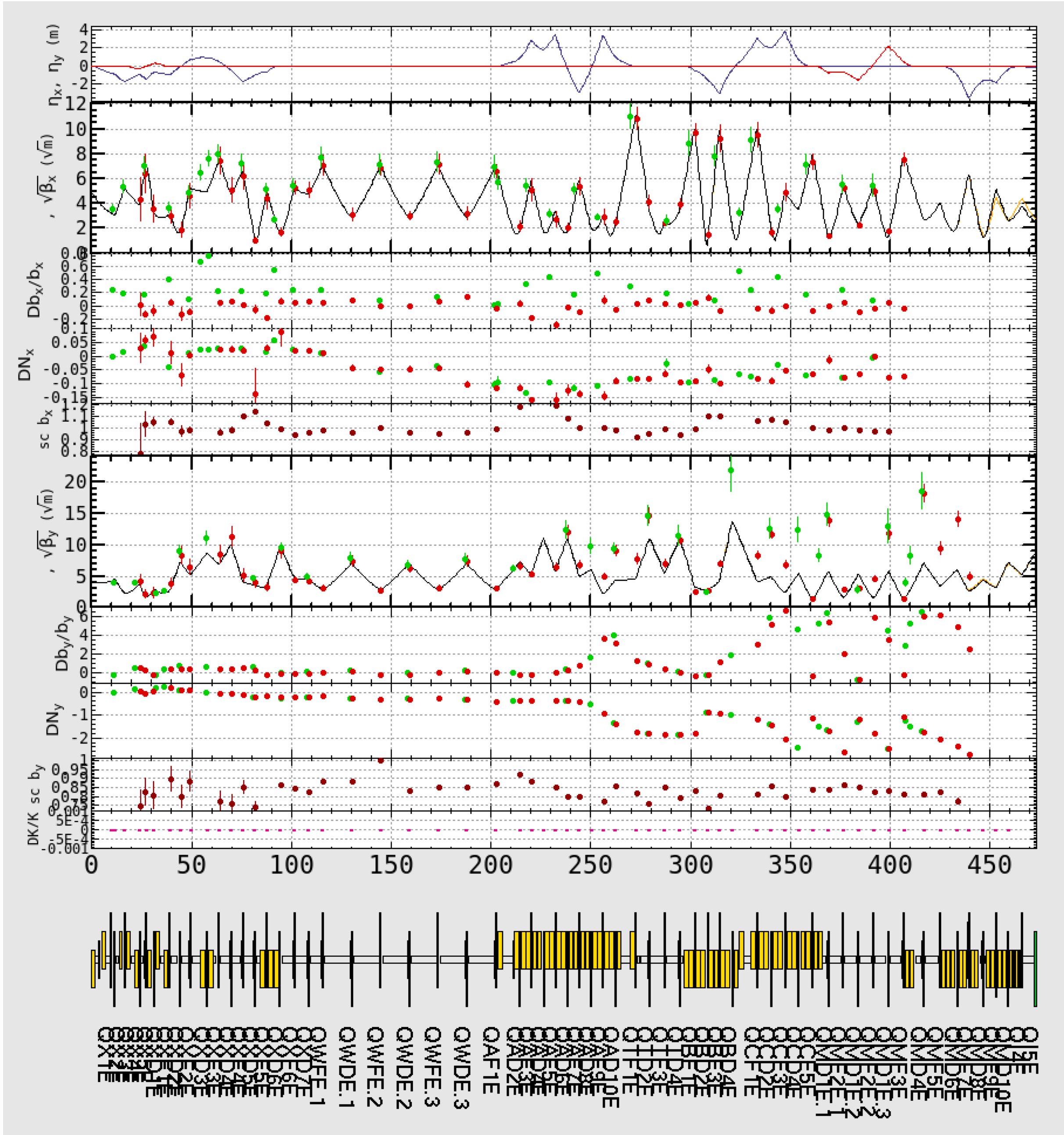
■ Analysis

- Fit the beta function and the phase at the BPM and at the steering to the data R12 and R34, which are measured for all steer elements.
- Algorithm is basically the same as that used in the ring.
- Boundary condition was set such as the beta function of the uppermost element should be identical to the design value.
- The beta-function at the steering includes the scaling error of the steering.
- Overall scaling for the beta-function at the BPM is still uncertain. Using an assumption that the transfer matrix between the two successive BPMs is the same as the model, we can get the scaling factor for the two BPMs. The overall scaling factor could be found from requirement that the average of the scaling factor for entire BPMs has to be unity.
- In the fit a constraint was applied that the beta functions at the long straight section is identical with the design value.

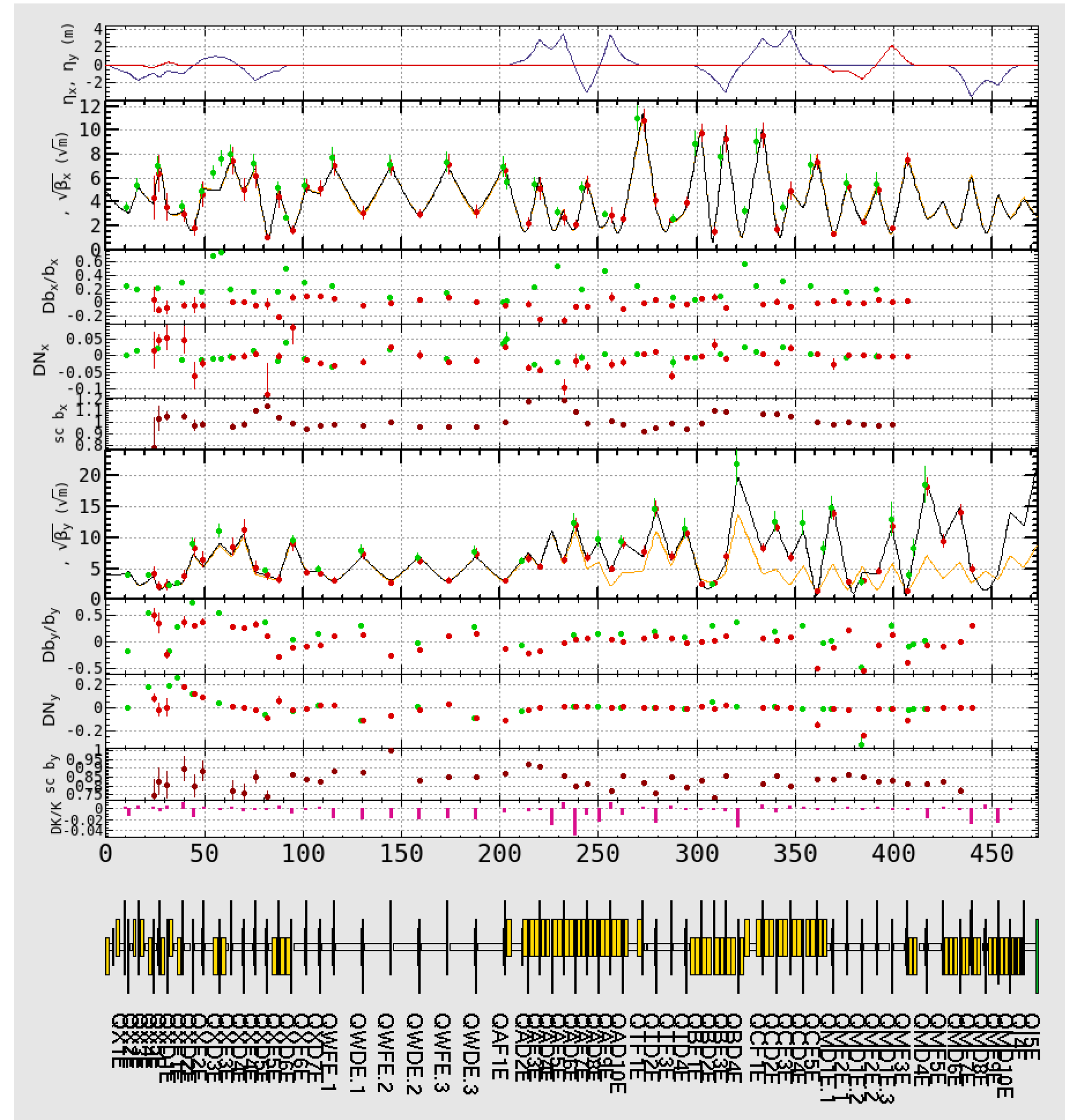
Fit result

● BPM

● Steering



After matching to the observed beta-functions



• Matching variables:

- All quads were set free except those having common power supply.

- Fit condition for the dispersion was set

• Matching results:

- Defocus quads are systematically smaller by -2 to -4 %.
- Vertical beta function seems to start to deviate from QAD6E.
- It amounts to 400 m at QBD4E, where no BPM exists.
- At BT2 wire beta-y is 100 m while the QScan measurement tells beta-y is 242±102 m.
- Unfortunately the horizontal beta at BT2 is not available.

Fit

Beta

Delta-R

Free quads:

☐ QM-type

☐ QF

☐ Q-arc0

☐ QWF

☐ Q-arc1

☐ Q-arc23

☐ Q-sss

☐ QMD1

☒ Q-all

☐ QS-type

☐ QD

☐ Q-iss

☐ QWD

☐ Q-trns

☐ Q-slope

☐ Q-arc4

☐ QMF2

Free steers:

☒ ZE

☒ BL-B1E

☒ BL-BH1E

☒ BL-BH4E

☒ BL-BV2E

☒ MR-ZE

☒ BL-BH1AE

☒ BL-BH3E

☒ BL-BV1E

Coupled variables:

☐ QM-type

☐ QF

☐ Q-arc0

☒ QWF

☐ Q-arc1

☐ Q-arc23

☐ Q-sss

☒ QMD1

☐ Q-all

☐ QS-type

☐ QD

☐ Q-iss

☒ QWD

☐ Q-trns

☐ Q-slope

☐ Q-arc4

☒ QMF2

Free | Variables | Couple | AF-1

<input checked="" type="checkbox"/> QX1E	0	.00186	<input checked="" type="checkbox"/> QXD5E	0	5.7E-4	<input checked="" type="checkbox"/> QAF3E	0	-.0018	<input checked="" type="checkbox"/> QBD2E	0	-2E-4	<input checked="" type="checkbox"/> QMF3E	0	-.001
<input checked="" type="checkbox"/> QX2E	0	-.0132	<input checked="" type="checkbox"/> QXF5E	0	.00341	<input checked="" type="checkbox"/> QAD4E	0	-.0286	<input checked="" type="checkbox"/> QBF3E	0	-.004	<input checked="" type="checkbox"/> QMD4E	0	-.0168
<input checked="" type="checkbox"/> QX3E	0	.00453	<input checked="" type="checkbox"/> QXD6E	0	-.008	<input checked="" type="checkbox"/> QAF5E	0	.00995	<input checked="" type="checkbox"/> QBD4E	0	-.0335	<input checked="" type="checkbox"/> QMF5E	0	.00198
<input checked="" type="checkbox"/> QX4E	0	.00246	<input checked="" type="checkbox"/> QXF6E	0	-2E-4	<input checked="" type="checkbox"/> QAD6E	0	-.0482	<input checked="" type="checkbox"/> QCF1E	0	.00613	<input checked="" type="checkbox"/> QMD6E	0	-.0026
<input checked="" type="checkbox"/> QX5E	0	-.0047	<input checked="" type="checkbox"/> QXD7E	0	.00181	<input checked="" type="checkbox"/> QAF7E	0	-.01	<input checked="" type="checkbox"/> QCD2E	0	-.0069	<input checked="" type="checkbox"/> QMF7E	0	-.0262
<input checked="" type="checkbox"/> QXD1E	0	.00361	<input checked="" type="checkbox"/> QWFE.1	1	-.0173	<input checked="" type="checkbox"/> QAD8E	0	-.0229	<input checked="" type="checkbox"/> QCF3E	0	.00359	<input checked="" type="checkbox"/> QMD8E	0	.00598
<input checked="" type="checkbox"/> QXF1E	0	.00951	<input checked="" type="checkbox"/> QWDE.1	2	-.0182	<input checked="" type="checkbox"/> QAF9E	0	.00991	<input checked="" type="checkbox"/> QCD4E	0	.00151	<input checked="" type="checkbox"/> QMF9E	0	-.0252
<input checked="" type="checkbox"/> QXD2E	0	-.0136	<input checked="" type="checkbox"/> QWFE.2	1	-.0173	<input checked="" type="checkbox"/> QAD10E	0	-.0108	<input checked="" type="checkbox"/> QCF5E	0	-.002	<input checked="" type="checkbox"/> QMD10E	0	-1E-4
<input checked="" type="checkbox"/> QXF2E	0	.00292	<input checked="" type="checkbox"/> QWDE.2	2	-.0182	<input checked="" type="checkbox"/> QTF1E	0	.00249	<input checked="" type="checkbox"/> QMD1E.1	3	-4E-5			
<input checked="" type="checkbox"/> QXD3E	0	-.0031	<input checked="" type="checkbox"/> QWFE.3	1	-.0173	<input checked="" type="checkbox"/> QTD2E	0	-.0245	<input checked="" type="checkbox"/> QMF2E.1	4	.0013			
<input checked="" type="checkbox"/> QXF3E	0	.00113	<input checked="" type="checkbox"/> QWDE.3	2	-.0182	<input checked="" type="checkbox"/> QTF3E	0	.00298	<input checked="" type="checkbox"/> QMD1E.2	3	-4E-5			
<input checked="" type="checkbox"/> QXD4E	0	-.0045	<input checked="" type="checkbox"/> QAF1E	0	-.007	<input checked="" type="checkbox"/> QTD4E	0	-.0018	<input checked="" type="checkbox"/> QMF2E.2	4	.0013			
<input checked="" type="checkbox"/> QXF4E	0	-5E-4	<input checked="" type="checkbox"/> QAD2E	0	-.0044	<input checked="" type="checkbox"/> QBF1E	0	-.0016	<input checked="" type="checkbox"/> QMD1E.3	3	-4E-5			

☒ ZE 1 | 0 | ☒ BL-BH1AE | 4 | 0 | ☒ BL-BH4E | 7 | 0 |

☒ MR-ZE 2 | 0 | ☒ BL-BH1E | 5 | 0 | ☒ BL-BV1E | 8 | 0 |

☒ BL-B1E 3 | 0 | ☒ BL-BH3E | 6 | 0 | ☒ BL-BV2E | 9 | 0 |

Constraints: Position | Variable | Target | Current - Target

<input checked="" type="checkbox"/> QWFE.1 EX	0	-2E-6	<input checked="" type="checkbox"/> QTF3E EX	0	-6E-6	<input checked="" type="checkbox"/> QMD4E EY	0	-4E-8	<input checked="" type="checkbox"/> QI5E EX	0	-7E-6
<input checked="" type="checkbox"/> QWFE.2 EX	0	9.5E-7	<input type="checkbox"/> QTF3E BX	5.3744	.34244	<input checked="" type="checkbox"/> QMD6E EY	0	-3E-7			
<input checked="" type="checkbox"/> QWFE.1 BX	48.429	-.0019	<input type="checkbox"/> QTF3E AX	-1.115	-.1685	<input type="checkbox"/> QMD4E BY	48.541	309.21			
<input checked="" type="checkbox"/> QWFE.2 BX	48.429	-.0122	<input type="checkbox"/> QTD4E BY	120.25	6.9985	<input type="checkbox"/> QMD4E AY	-4.629	-30.4			
<input checked="" type="checkbox"/> QWDE.1 BY	48.428	5.6E-5	<input type="checkbox"/> QTD4E AY	-8.296	.67348	<input type="checkbox"/> QMF5E BX	16.321	.09829			
<input checked="" type="checkbox"/> QWDE.2 BY	48.432	-6E-5	<input checked="" type="checkbox"/> QMF2E.1 EX	0	-2E-5	<input type="checkbox"/> QMF5E AX	-1.135	-.1032			
<input checked="" type="checkbox"/> QTF1E EX	0	2.4E-5	<input checked="" type="checkbox"/> QMF2E.2 EX	0	3.5E-6	<input checked="" type="checkbox"/> QI4E EX	0	-3E-6			

K

B

Estimate beta

Tolerance: 1E-8 Converage(h): 1.7E-8 Residual(h): .8505 Converage(v): 5.6E-4 Residual(v): .6169

Constraint beta at: ☒ SPQWFE_2M ☒ SPQWDE_2M

Go

Reset

Match Optics

Iterate: 10 Threshold: .1 Weight: 10 Residual: 4.824

Match

Recover

Reset

Calc

Plot

- Orbit response difference from the design after matching

