Optimized Orbit Correction System Configuration for 12 GeV CEBAF

Overview

This note records the concluding effort leading to the proposed modification to the baseline orbit correction configuration of the 12 GeV CEBAF. Motivation and rationale underlying the current note has been documented in an earlier Tech Note [1], wherein examples were given of paths toward eliminating various difficulties presented by the baseline orbit correction configuration. In the current note this path is followed to the full extent of the 5.5 pass design, leading to a complete set of recommendations for upgrades in order to meet the requirement on residual orbit amplitudes at all locations after orbit correction.

Several factors in effect in this updated analysis should be noted. These include:

- Revised error estimates
- Common elements for multi-pass beam, including main dipoles
- Use of per-section peak as well as RMS residual orbit as criterion
- Corrector strength requirement estimates
- Element fine-tuning

These will be elaborated in detail shortly.

Updated Recommendations

Table 1 below summarizes the changes to the baseline configuration in terms of changes to BPM/corrector counts and enhancement to performance parameters. A few points are worth noting:

- Relocation of 5-6 BPM's takes place in each arc. This is reflected in the large number of "deleted" and "added" BPM's leading to a smaller "net gain".
- No relocation is needed in Arc A since it does not yet exist.
- A common horizontal corrector is added to the entrance of each of the two spreaders. Redundancy in total count is corrected by the subtraction by 8 (4 on each side) shown in the bottom rows.
- A common BPM is added to the exit of each of the two recombiners. Redundancy in total count is corrected by the subtraction by 8 (4 on each side) shown in the bottom rows.
- First BCOM in each spreader is used <u>independently</u> for vertical steering analysis.
- Numbers under "Range Change" in corrector table count number of correctors requiring an increase in the maximum BDL in order to handle error distribution at 3σ, based on magnitudes of input errors. Reality check of input errors reflected in existing corrector strength distributions is under way.

BPM

	HORIZONTAL				VERTICAL			
	Deleted	Added	Net Gain	Offset Change	Deleted	Added	Net Gain	Offset Change
ARC 1	5	9	4	0	5	9	4	0
ARC 2	6	9	3	0	6	9	3	0
ARC 3	6	7	1	0	6	7	1	0
ARC 4	6	7	1	0	6	7	1	0
ARC 5	6	7	1	0	6	7	1	0
ARC 6	6	7	1	0	6	7	1	0
ARC 7	6	8	2	0	6	8	2	0
ARC 8	6	8	2	0	6	8	2	0
ARC 9	6	8	2	0	6	8	2	0
ARC A	0	2	2	0	0	2	2	0
TOTAL	59	78-8=70	19-8=11	0	59	78-8=70	19-8=11	0

Corrector

	HORIZONTAL				VERTICAL			
	Deleted	Added	Net Gain	Range Change	Deleted	Added	Net Gain	Range Change
ARC 1	0	3	3	0	0	0	0	0
ARC 2	1	1	0	8	1	1	0	26
ARC 3	0	1	1	0	0	0	0	0
ARC 4	0	1	1	6	0	0	0	0
ARC 5	0	1	1	3	0	0	0	1
ARC 6	0	1	1	5	0	0	0	3
ARC 7	0	1	1	7	2	0	-2	4
ARC 8	0	1	1	8	0	0	0	25
ARC 9	0	1	1	8	0	0	0	18
ARC A	0	1	1	17	2	0	-2	21
TOTAL	1	12-8=4	11-8=3	62	5	1	-4	98

Table 1. Modification to the 12 GeV Orbit Correction Configuration

The independent use of common steering elements in multiple passes at this point is a measure of expediency. The analysis algorithm can rigorously handle such cases in principle, with additional effort. Since conclusions drawn from analyses of different lines sharing common elements lead to consistent implications for the element in question (e.g., similar magnitudes of kick are required for the same corrector on different passes), we choose not to invoke this additional effort at this point.

Relocation of BPM's all occur in arcs proper, following the simple guidelines below:

Arcs 1 & 2:

From:
IPMA13
IPMA19
IPMA23
IPMA29
IPMA33
IPMA39

To:
IPMA15
IPMA17
IPMA25
IPMA27
IPMA35
IPMA37

All other arcs:

From:
IPMA11
IPMA15
IPMA19
IPMA23
IPMA27
IPMA31

To:
IPMA12
IPMA14
IPMA20
IPMA22
IPMA28
IPMA30

Comparison between baseline steering performance and that after optimization, arc by arc, is given in Appendix A. Complete detail of BPM and corrector changes, arc by arc, as summarized in Table 1, can be found in Appendix B.

Revised error estimates

In contrast to [1], the input errors for the analysis are modified. Table 2 shows the comparison between these two studies.

Error Type	Used in X	Used in Y	σ New	σ Old	Comment
Injection Position (mm)	√	√	0.50	0.25	Not used in DIMAD
Injection Angle (mrad)	√	√	0.025	0.025	Not used in DIMAD
Horz. Dipole Field (%)	√		0.02	0.02	
Vert. Dipole Field (%)		√	0.03	0.02	
Horz. Dipole Roll (mrad)		√	1.00	0.267	Not used in DIMAD
Vert. Dipole Roll (mrad)	√		1.00	0.267	Not used in DIMAD
Horz. Quad Offset (mm)	√		0.2	0.2	
Vert. Quad Offset (mm)		√	0.2	0.2	
Horz. Kick from Special Elem. (μrad)	√		5.0	5.0	None identified yet
Vert. Kick from Special Elem. (μrad)		√	5.0	5.0	None identified yet
Horz. BPM Offset (mm)	√		0.25	0.2	
Vert. BPM Offset (mm)		√	0.25	0.2	
Horz. BPM Resolution (mm)	√		0.1	0.1	Not Used
Vert. BPM Resolution (mm)		√	0.1	0.1	Not Used
Horz. Corrector Error (mrad)	√		0.1	0.1	Not Used
Vert. Corrector Error (mrad)		√	0.1	0.1	Not Used
Parameter Type					
Horz. Corrector Range[1] (mrad)	√		0.360	0.360	
Vert. Corrector Range (mrad)		√	0.360	0.360	
End Angle Monitor	√	√			

Table 2. Revised Errors Used for Optimization

The most significant change in the errors is that for the dipole rolls, from 267 μrad to 1 mrad. The impact of this is the considerably increased residual RMS horizontal orbit in the arcs and vertical orbit in spreader/recombiners. Table 3 provides a comparison between the effects of different roll errors in Arc 8. It can be seen that the gain from baseline to optimized configuration is compromised as well with increased roll errors.

Common elements for multi-pass beam, including main dipoles

In the current analysis the issue of excessive residual orbit in the spreaders and recombiners are addressed. These have been exacerbated by the increased dipole roll errors mentioned above. It was realized that, given the assumed injection errors into spreaders and instrumentation after recombiners, the problem had to be solved by additional steering elements at the entry to all spreaders, and monitors at the exit of all recombiners. This led to the inclusion of the first spreader BCOM as vertical steerer, the addition of a horizontal corrector before the first spreader BCOM, and the addition of a BPM after the last recombiner BCOM. The reduction in residual orbit by these changes is easily appreciated by looking at the before/after plots of Appendix A. These changes appear inescapable.

In including these additional elements in the analysis, the steerers were assumed to be independent for each pass. This of course does not correspond to reality. Rigorous treatment is possible and has been done in other cases [2]. However this is not seen as critical here since the common steerers in different lines in the current case are mostly used to counteract the same common error sources, and are seen to display approximately the same effects in the steering action for all passes. If this premise is seen to be contradictory to future observation, more rigorous analysis would need to be invoked.

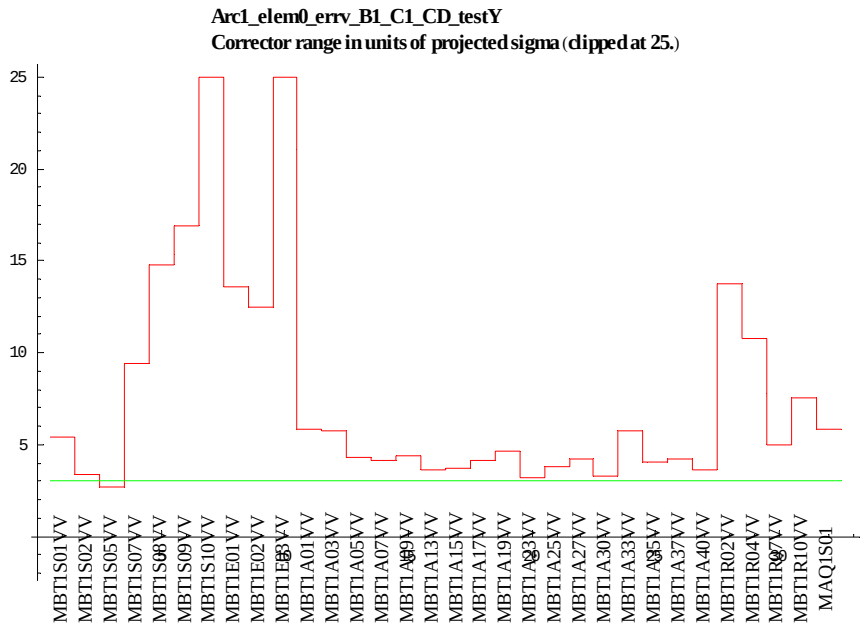


Figure 1. Arc 1 vertical correctors near maxing out at 3σ error due to increased dipole roll errors

Use of per-section peak as well as RMS residual orbit as criterion

It was decided during discussion of the analysis results that each major section needed to be further subdivided, into spreader, arc, and recombiner, with their respective RMS and peak residual orbits presented, in order to accurately gauge the impact of the optimization. These are summarized in Tables 4A/B and 5A/B.

Corrector strength requirement estimates

In this analysis the corrector strength requirement was also rigorously visited. The basic criterion used was the corrector strength required to correct error distribution at the 3σ level such that the final orbit is corrected to the level defined by the fundamentally uncorrectable subspace [1]. Using this criterion a list of recommended corrector range enhancements is given in Appendix B. A large portion of this comes from the large roll in the dipoles in the arcs, causing the vertical correctors to max out or be on the verge of maxing out. This can be seen in the example shown in Figure 1. The situation is similar or worse in all other arcs[1].

Element fine-tuning

The vertical peak sneaking from recombiner into arc, as each main section is divided into spreader, arc and recombiner, causes the BPM moves to appear less effective in the arc. This apparently artificial outcome motivated closer study in this arc-recombiner junction.

Arc 2 and Arc 3 are used as representative cases. It turns out that for Arc 2 (and likely Arc 1) the situation gets slightly & locally better (see below) by not making the last BPM move, whereas in Arc 3 (and up?) it is not an easy fare. The process of orbit correction under different BPM constraints can squeeze the peak up through one gap or the other. If the number of BPM's is to be kept the same but the last bump is to be suppressed, in addition to all the moves already made, one would also need to move the R01 BPM upstream to next to the A32 dipole. This came as a result of trying all other possibilities, as summarized in Figures 2 and 3. Adding IPMA31 back on top (i.e., one extra BPM) will not improve things too much either.

So, if this is the direction to go, it looks like we need 2 less moves total in Arcs 1 & 2, and 8 more moves total in Arcs 3-10.

[1] It can be argued that if one does not require the orbit correction to be carried to the full extent allowed by the fundamentally correctable subspace, then the corrector strength requirements can be relaxed. This is true, although a rigorous analysis based on relaxed residual orbit requirements is not in the scope of this note.

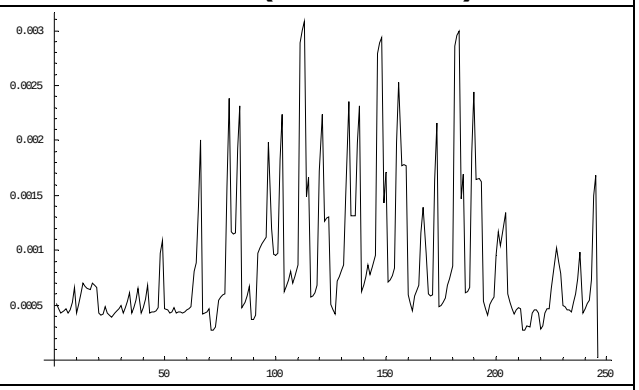
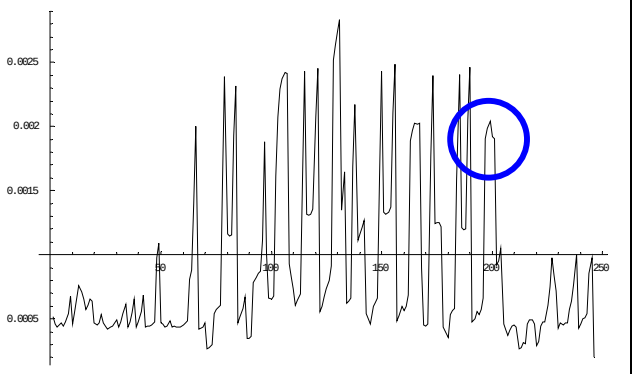
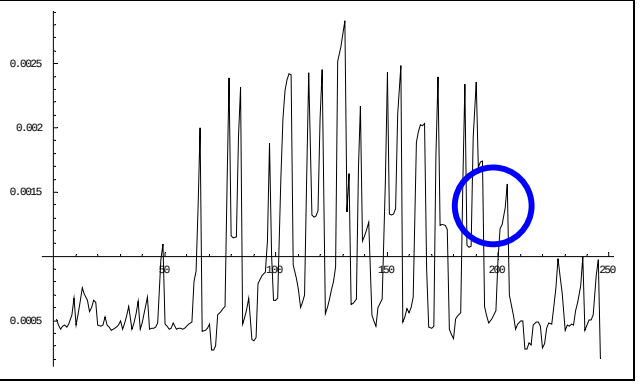
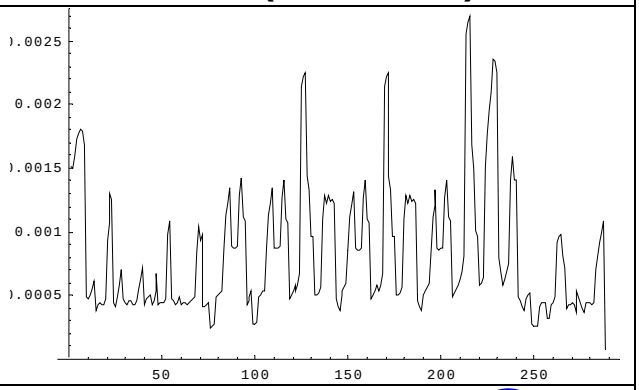
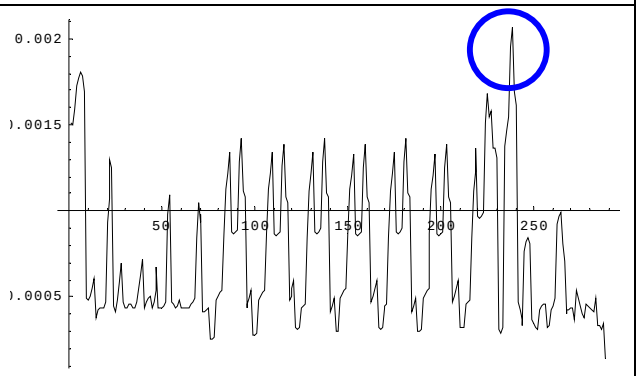
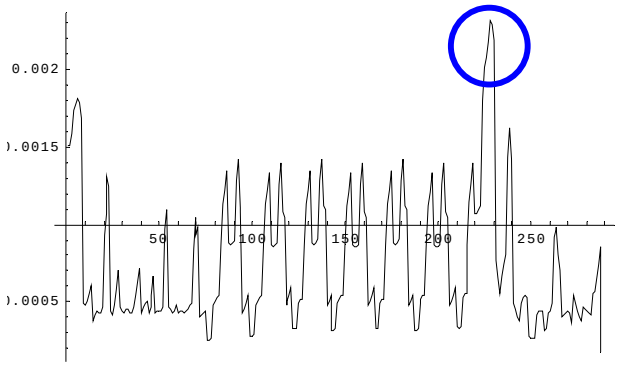
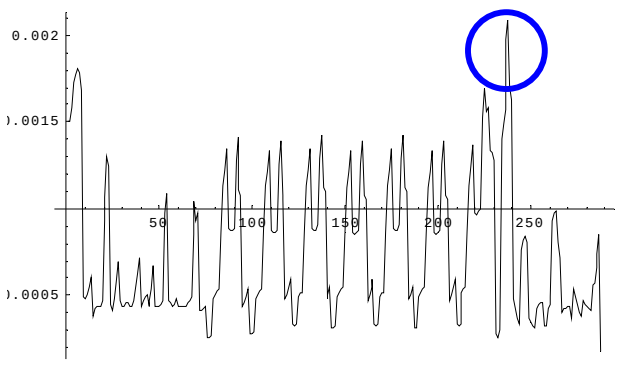
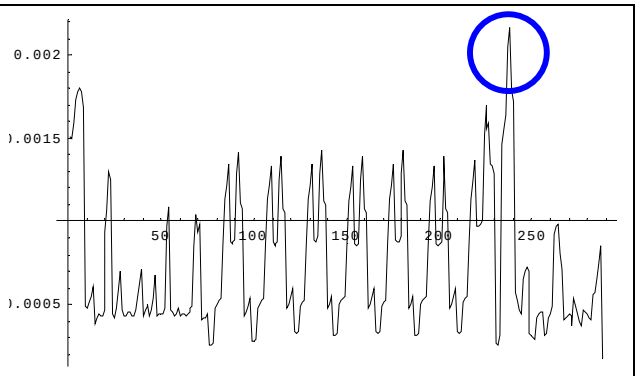
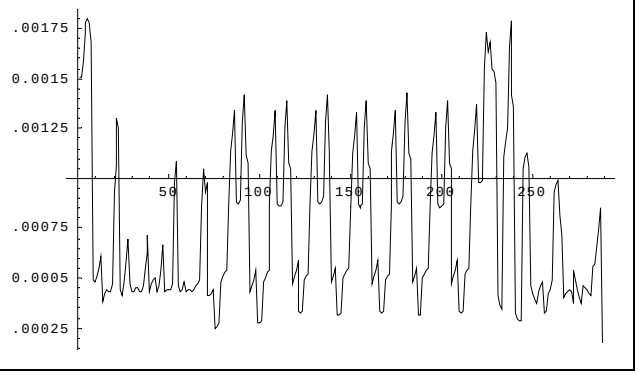
Figure 2. Arc 2 Scenarios	
Scenario	**3σ Underlying Orbit after Correction (Vert. mm)**
Baseline (No BPM moved)	
Previously optimized (IPMA39 moved to IPMA37)	
Move IPMA37 back to IPMA39	

Figure 3. Arc 3 Scenarios	
Scenario	**3σ Underlying Orbit after Correction (Vert. mm)**
Baseline (No BPM moved)	
Previously optimized (IPMA31 moved to IPMA30)	
Move IPMA30 back to IPMA31	
Using both IPMA30 & IPMA31; Strong constraints at these two BPM's forced orbit to go up before IPMR01, where gap caused by roll of dipole A32 can be large.	

Move IPMR01 upstream to dipole A32; Move IPMA30 back to IPMA31.	
Move IPMR01 upstream to dipole A32; Move IPMA31 to IPMA30.	

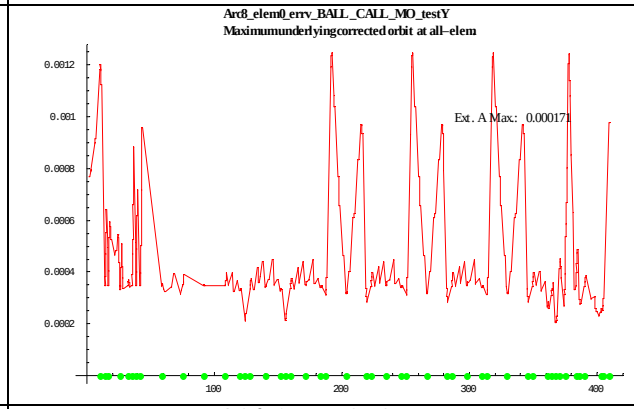
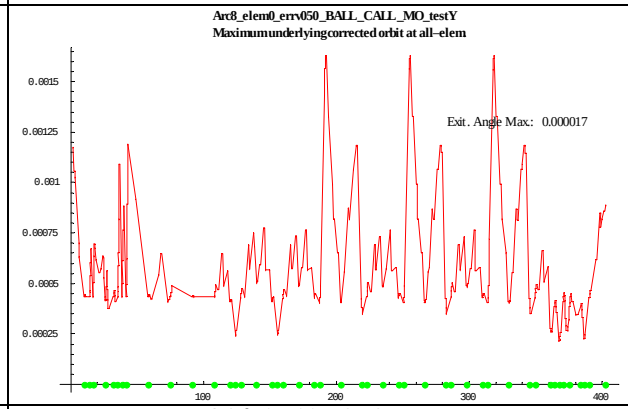
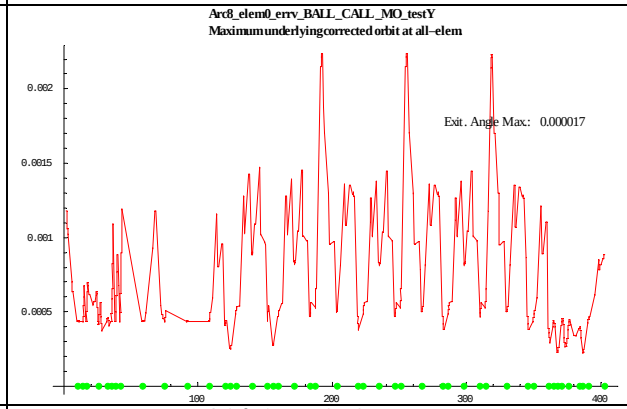
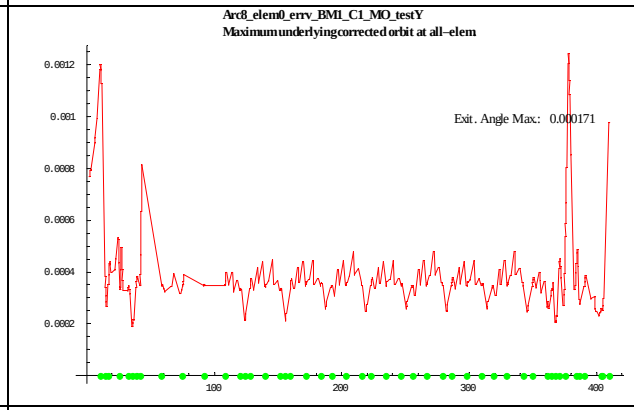
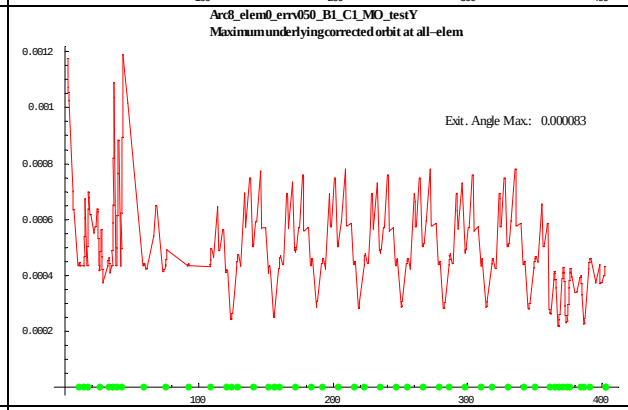
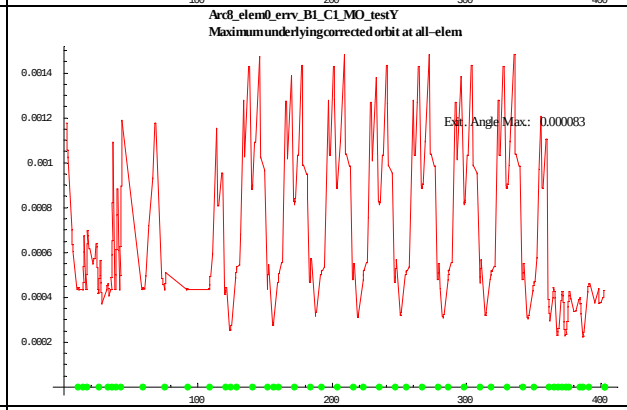
	Roll Error σ = 0.267 mrad	Roll Error σ = 0.5 mrad	Roll Error σ = 1 mrad
BASELINE			
OPTIMIZED			
	Optimization not complete in S/R in this case, only in the arc proper	Optimization done in entire line	Optimization done in entire line

Table 3. Example of ARC 8 Vertical Optimization with Different Roll Errors (note different scales)

		X							Y					
		SPR		ARC		REC			SPR		ARC		REC	
		Before	After	Before	After	Before	After		Before	After	Before	After	Before	After
Arc 1		6.00	1.30	0.50	0.50	10.00	1.40		1.20	1.20	3.50	2.70	2.00	1.10
Arc 2*		5.80	1.10	0.50	0.50	7.00	1.10		1.10	1.10	3.10	2.60	1.50	0.90
Arc 3		3.60	1.30	0.50	0.60	3.70	1.30		1.80	1.80	2.70	1.60	2.50	2.00
Arc 4		3.60	1.20	0.50	0.70	3.60	1.40		1.10	1.10	2.70	1.60	2.40	2.00
Arc 5		2.70	1.30	0.50	0.65	2.50	0.80		1.70	1.70	2.30	1.40	1.70	1.70
Arc 6		2.80	1.20	0.50	0.70	2.60	0.90		1.10	1.10	2.30	1.40	1.10	1.10
Arc 7*		2.40	1.30	0.40	0.65	2.50	1.50		1.30	1.30	2.30	1.40	1.20	0.40
Arc 8		2.00	1.30	0.40	0.70	2.70	1.10		1.20	1.20	2.20	1.40	1.00	0.40
Arc 9		4.00	1.40	0.40	0.60	2.50	0.90		1.40	1.40	2.40	1.40	1.00	0.60
Arc A*		1.80	1.05	0.40	0.70	1.20	1.10		1.20	1.20	2.30	1.40	0.90	0.30
			A		B		C			D		E		F

* Singular corrector combination already eliminated in baseline.

A. "Independent" control of additional horizontal corrector around first BCOM is assumed.

B. No special effort, other than slight degradation due to BPM relocation.

C. End BPM added for all passes. A few horizontal correctors added.

D. "Independent" control of first BCOM is assumed.

E. Major gain through BPM relocation.

F. Gain through addition of end BPM.

Table 4A. 3σ Extent of Real Underlying Orbit Distribution after Correction

		X							Y					
		SPR		ARC		REC			SPR		ARC		REC	
		Before	After	Before	After	Before	After		Before	After	Before	After	Before	After
Arc 1		2.00	0.43	0.17	0.17	3.33	0.47		0.40	0.40	1.17	0.90	0.67	0.37
Arc 2*		1.93	0.37	0.17	0.17	2.33	0.37		0.37	0.37	1.03	0.87	0.50	0.30
Arc 3		1.20	0.43	0.17	0.20	1.23	0.43		0.60	0.60	0.90	0.53	0.83	0.67
Arc 4		1.20	0.40	0.17	0.23	1.20	0.47		0.37	0.37	0.90	0.53	0.80	0.67
Arc 5		0.90	0.43	0.17	0.22	0.83	0.27		0.57	0.57	0.77	0.47	0.57	0.57
Arc 6		0.93	0.40	0.17	0.23	0.87	0.30		0.37	0.37	0.77	0.47	0.37	0.37
Arc 7*		0.80	0.43	0.13	0.22	0.83	0.50		0.43	0.43	0.77	0.47	0.40	0.13
Arc 8		0.67	0.43	0.13	0.23	0.90	0.37		0.40	0.40	0.73	0.47	0.33	0.13
Arc 9		1.33	0.47	0.13	0.20	0.83	0.30		0.47	0.47	0.80	0.47	0.33	0.20
Arc A*		0.60	0.35	0.13	0.23	0.40	0.37		0.40	0.40	0.77	0.47	0.30	0.10
			A		B		C			D		E		F

* Singular corrector combination already eliminated in baseline.

A. "Independent" control of additional horizontal corrector around first BCOM is assumed.

B. No special effort, other than slight degradation due to BPM relocation.

C. End BPM added for all passes. A few horizontal correctors added.

D. "Independent" control of first BCOM is assumed.

E. Major gain through BPM relocation.

F. Gain through addition of end BPM.

Table 4B. 1σ Extent of Real Underlying Orbit Distribution after Correction

X-Plane

	Spreader (Before IPMA01)		Arc (Between IPMA01 and IPMR01)		Recombiner (After IPMR01)	
	Baseline	Optimized	Baseline	Optimized	Baseline	Optimized
ARC 1	1.77083	0.548258	0.388484	0.388633	2.36847	0.635884
ARC 2	1.56827	0.562413	0.382332	0.384051	1.62005	0.635748
ARC 3	1.13416	0.54431	0.350393	0.379566	1.15455	0.53852
ARC 4	1.16337	0.537805	0.350629	0.401143	1.07889	0.560066
ARC 5	0.895921	0.517529	0.350067	0.3955	0.836143	0.49477
ARC 6	0.972252	0.51607	0.348215	0.400219	0.842121	0.508473
ARC 7	0.648751	0.498264	0.348655	0.39571	0.880963	0.512598
ARC 8	0.791949	0.704893	0.351389	0.402902	1.00817	0.546558
ARC 9	1.41774	0.598612	0.350244	0.397194	1.10646	0.498402
ARC A	0.718105	0.50975	0.352055	0.40463	0.641958	0.571386

Y-Plane

	Spreader (Before IPMA01)		Arc (Between IPMA01 and IPMR01)		Recombiner (After IPMR01)	
	Baseline	Optimized	Baseline	Optimized	Baseline	Optimized
ARC 1	0.592739	0.592739	1.4554	1.44453	0.766217	0.548115
ARC 2	0.53762	0.542466	1.33763	1.3494	0.644568	0.558641
ARC 3	0.814196	0.814196	1.08889	0.915906	0.561197	0.526466
ARC 4	0.558384	0.558384	1.07116	0.885093	0.585928	0.59076
ARC 5	0.723477	0.723477	0.989223	0.814719	0.802374	0.731163
ARC 6	0.526562	0.526562	0.965911	0.770819	0.485547	0.44484
ARC 7	0.550209	0.550209	0.998114	0.797916	0.509097	0.369046
ARC 8	0.611453	0.611453	0.985249	0.81119	0.447706	0.362087
ARC 9	0.600357	0.600357	1.00156	0.799731	0.563437	0.467778
ARC A	0.52082	0.52082	1.00212	0.804667	0.453203	0.351663

For explanation of measures taken and effects in each section see http://www.jlab.org/~chao/RMSTable.pdf

Table 5A. Changes in RMS Values by Section (All 3σ in mm)

X-Plane

	Spreader (Before IPMA01)		Arc (Between IPMA01 and IPMR01)		Recombiner (After IPMR01)	
	Baseline	Optimized	Baseline	Optimized	Baseline	Optimized
ARC 1	5.90916	1.26056	0.595383	0.626281	9.32398	1.41368
ARC 2	5.82158	1.10188	0.554738	0.578314	6.81273	1.15144
ARC 3	3.61888	1.30868	0.439989	0.589891	3.74689	1.3491
ARC 4	3.57358	1.20597	0.440071	0.680531	3.46966	1.28875
ARC 5	2.74408	1.32484	0.440003	0.650123	2.41601	0.818827
ARC 6	2.85972	1.17433	0.440088	0.683388	2.51254	0.915064
ARC 7	2.417	1.33852	0.440206	0.653161	2.44622	1.53128
ARC 8	2.00121	1.35035	0.441082	0.684446	2.6973	1.07686
ARC 9	3.9733	1.42115	0.440961	0.654524	2.56855	0.935083
ARC A	1.86328	1.05944	0.441188	0.685844	1.16194	1.14123

Y-Plane

	Spreader (Before IPMA01)		Arc (Between IPMA01 and IPMR01)		Recombiner (After IPMR01)	
	Baseline	Optimized	Baseline	Optimized	Baseline	Optimized
ARC 1	1.13369	1.13369	3.50413	2.70969	2.24481	1.0463
ARC 2	1.09141	1.09141	3.08656	2.83625	1.68783	1.00096
ARC 3	1.80492	1.80492	2.68498	2.06485	1.08453	0.986457
ARC 4	1.09164	1.09164	2.63478	2.0298	1.12223	1.12392
ARC 5	1.66419	1.66419	2.27044	1.44152	1.75019	1.77759
ARC 6	1.17538	1.17538	2.25057	1.36901	0.817276	0.81727
ARC 7	1.29009	1.29009	2.33461	1.47983	1.17086	0.490241
ARC 8	1.18985	1.18985	2.23602	1.48184	0.886711	0.461319
ARC 9	1.36461	1.36461	2.36287	1.47742	0.929593	0.587681
ARC A	1.21224	1.21224	2.28068	1.52556	1.00208	0.473611

For explanation of measures taken and effects in each section see http://www.jlab.org/~chao/RMSTable.pdf

Table 5B. Changes in Peak Values by Section (All 3σ in mm)

References

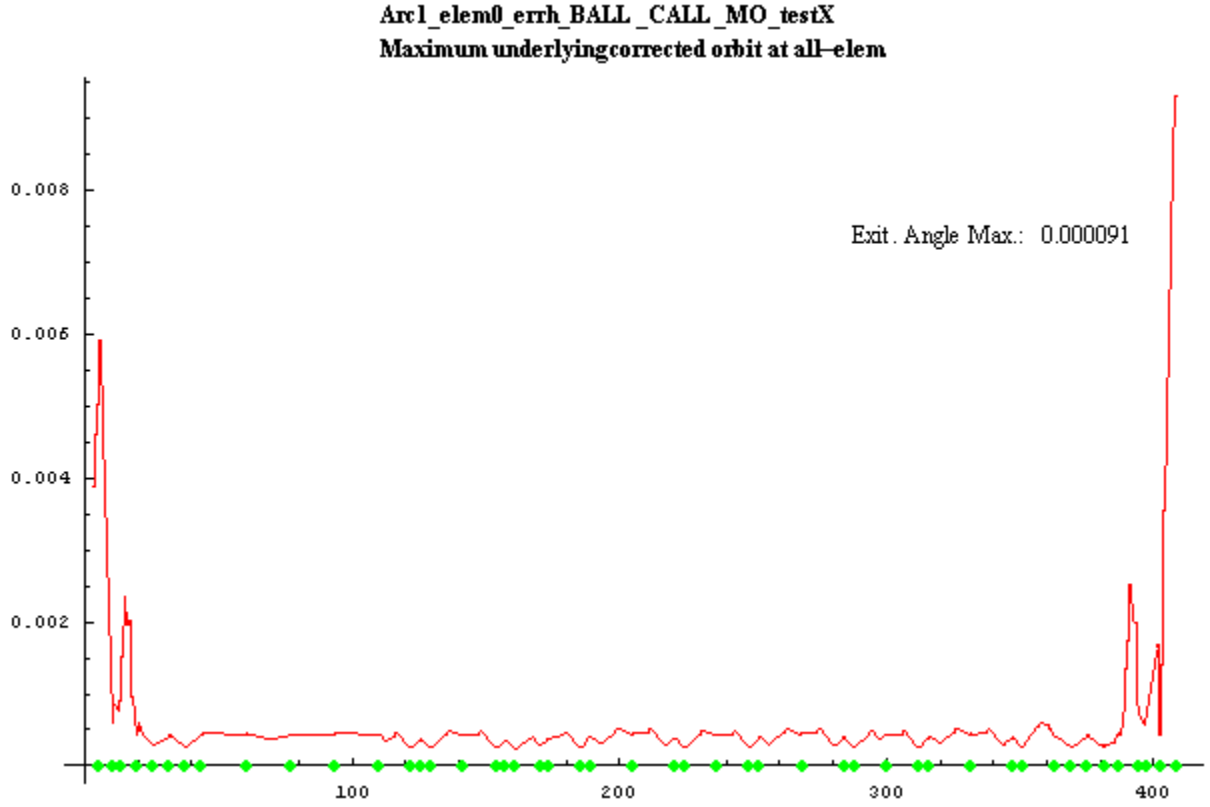
[1]. Y. Chao, “Evaluation and Optimization of Orbit Correction System Configuration of 12 GeV CEBAF”**,** JLAB-TN-06-015.

[2]. See LHC Report 470 for general formulation. Method for treating common elements for multiple lines is described in this Program Manual. Also for actual examples see Extension to Multiple Lines.

Appendix A. Arc by Arc Comparison of 3σ Extent of the Real Underlying Orbit after Orbit Correction – Before (Top) and After (Bottom) Optimization

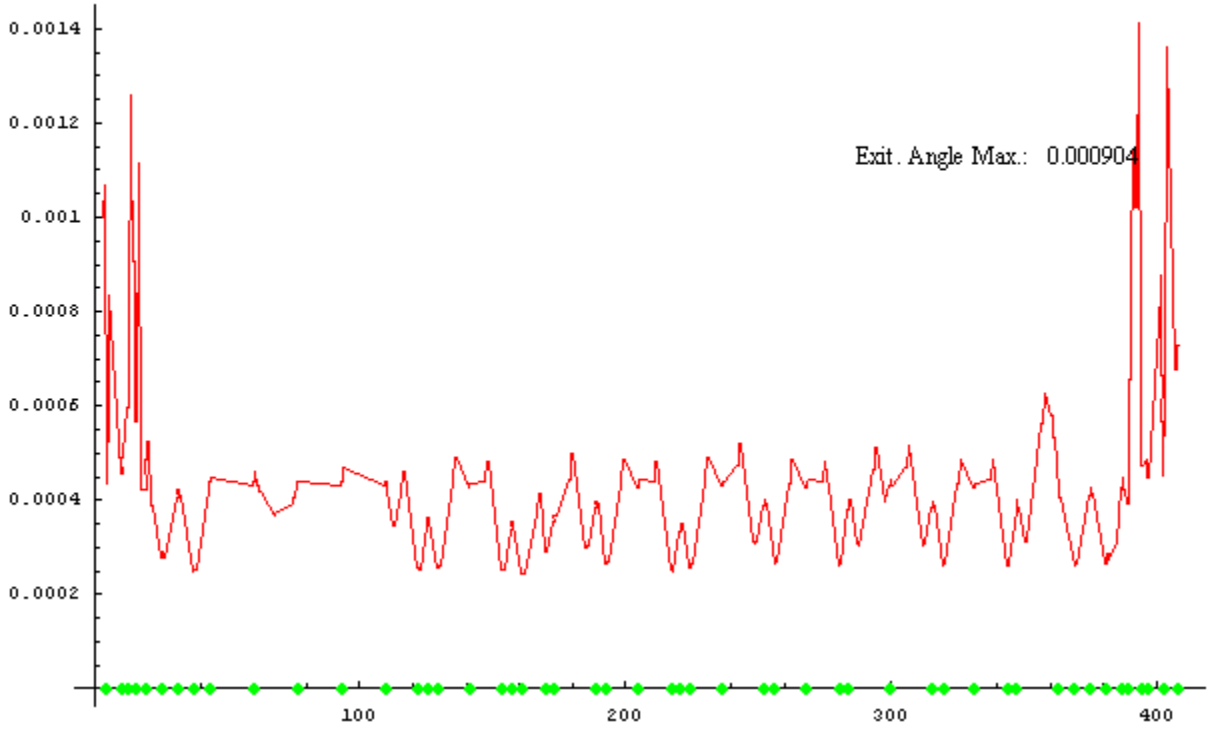
ARC 1

3σ Extent of the Real Underlying Orbit before Orbit Correction in X



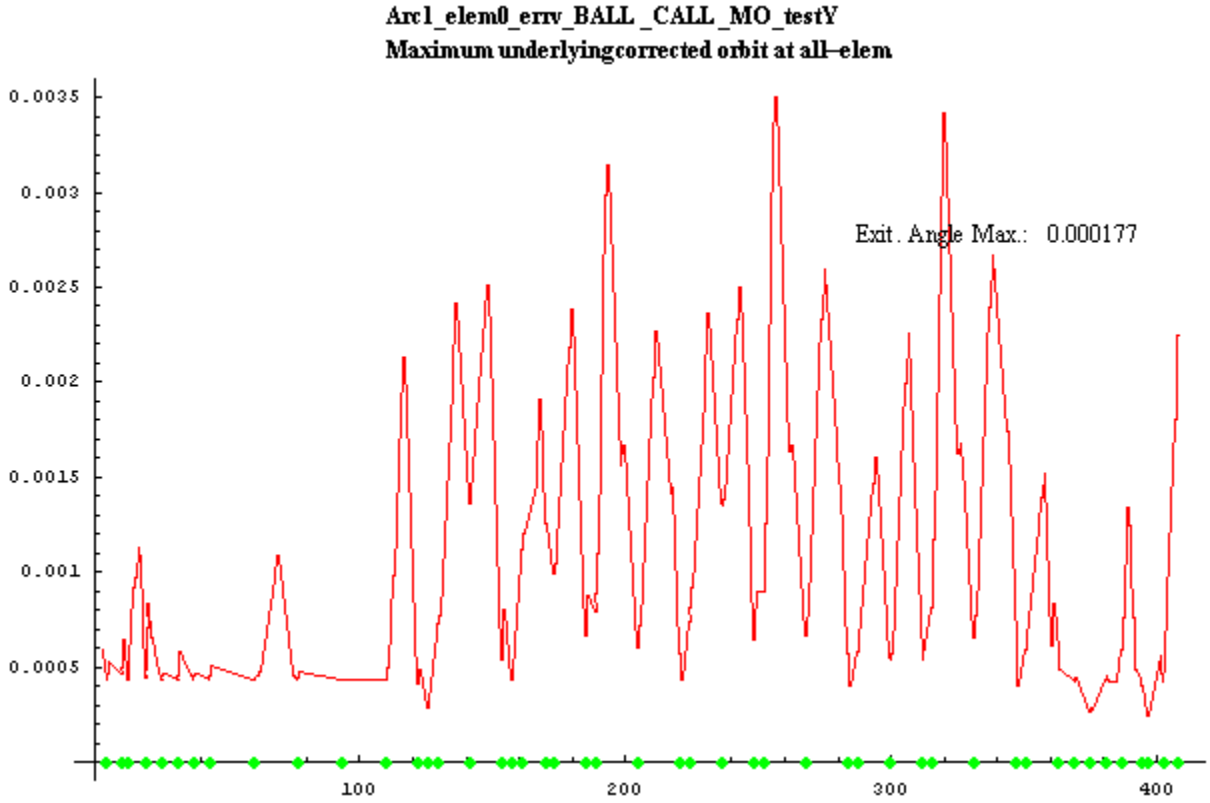
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



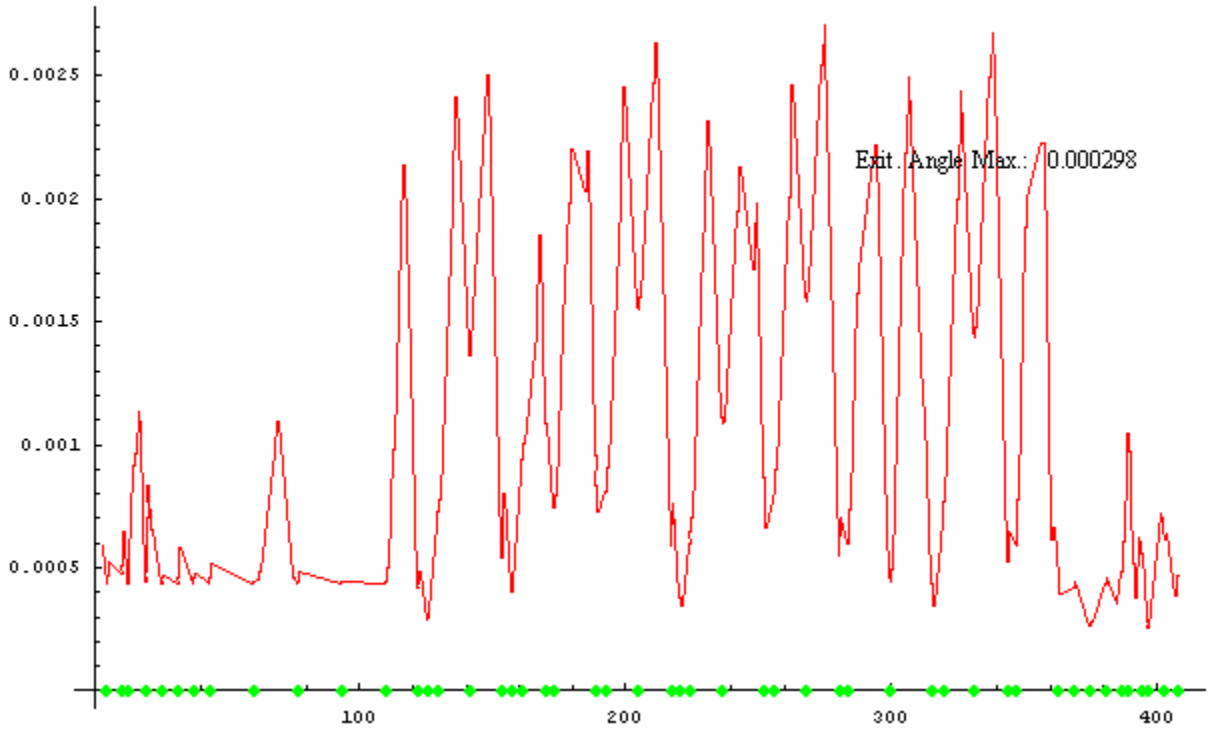
ARC 1

3σ Extent of the Real Underlying Orbit before Orbit Correction in Y



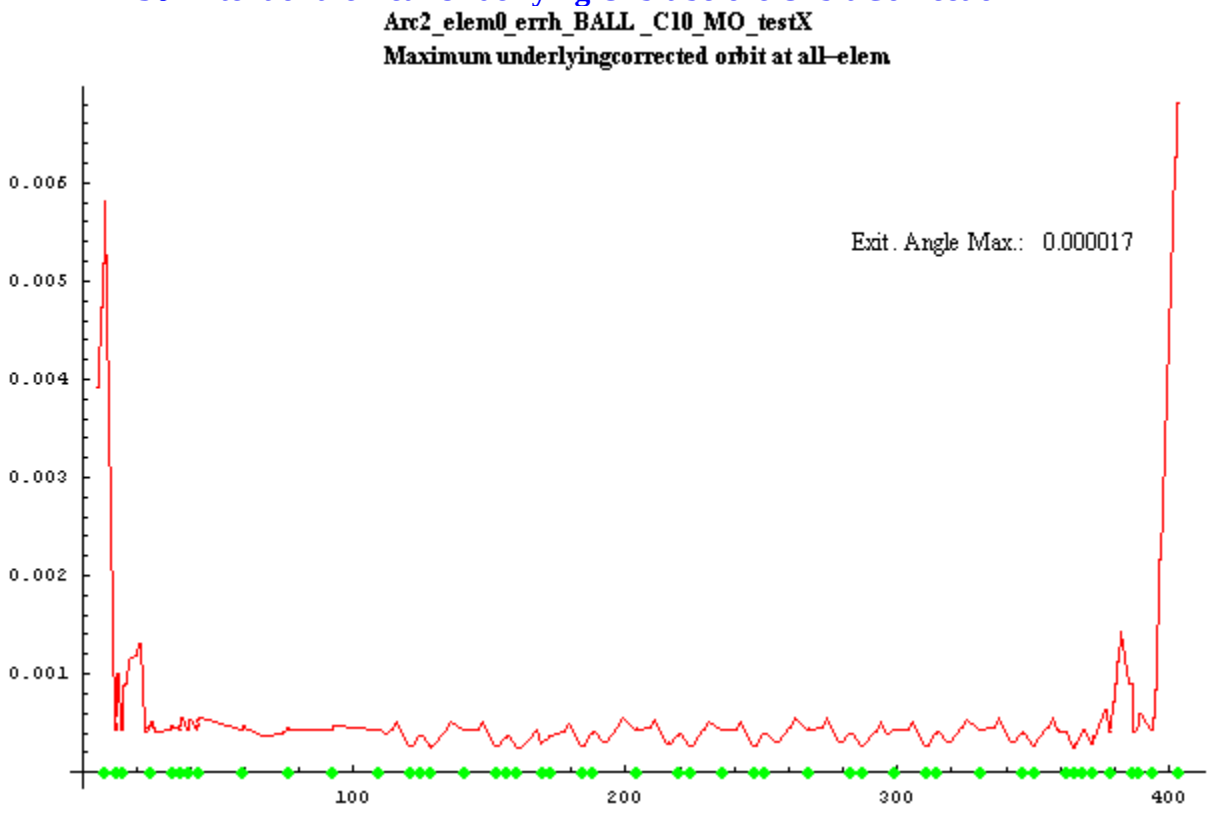
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



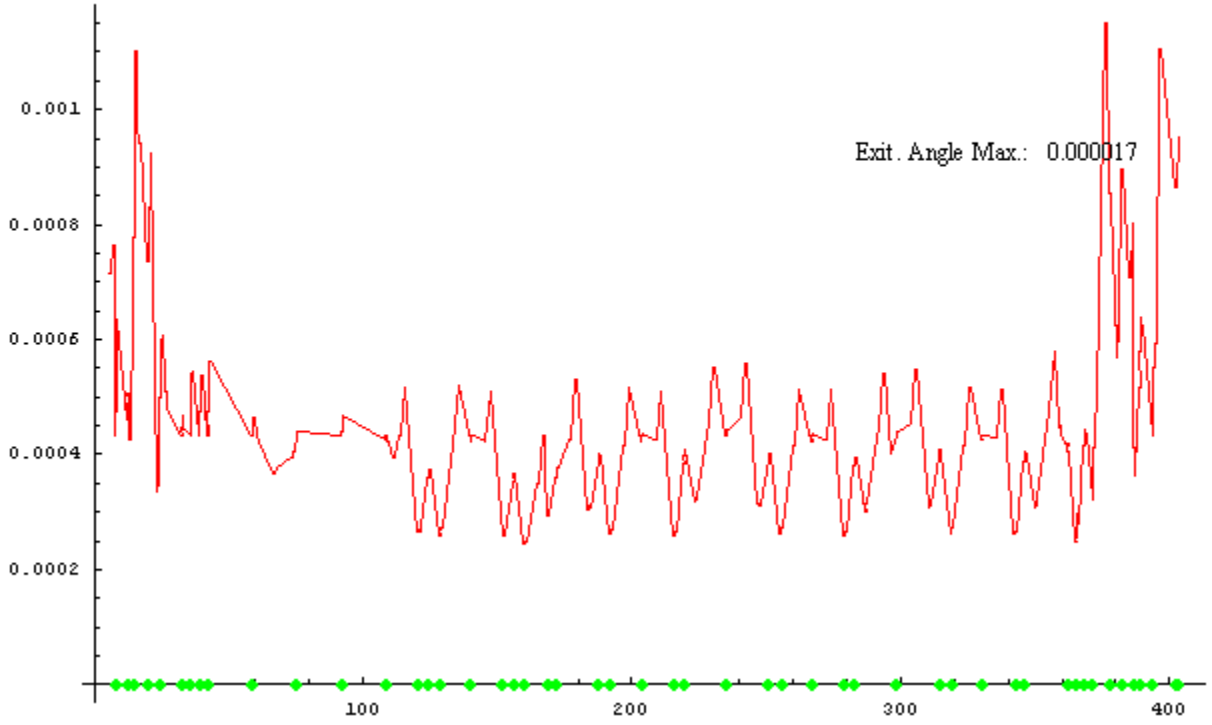
ARC 2

3σ Extent of the Real Underlying Orbit before Orbit Correction in X



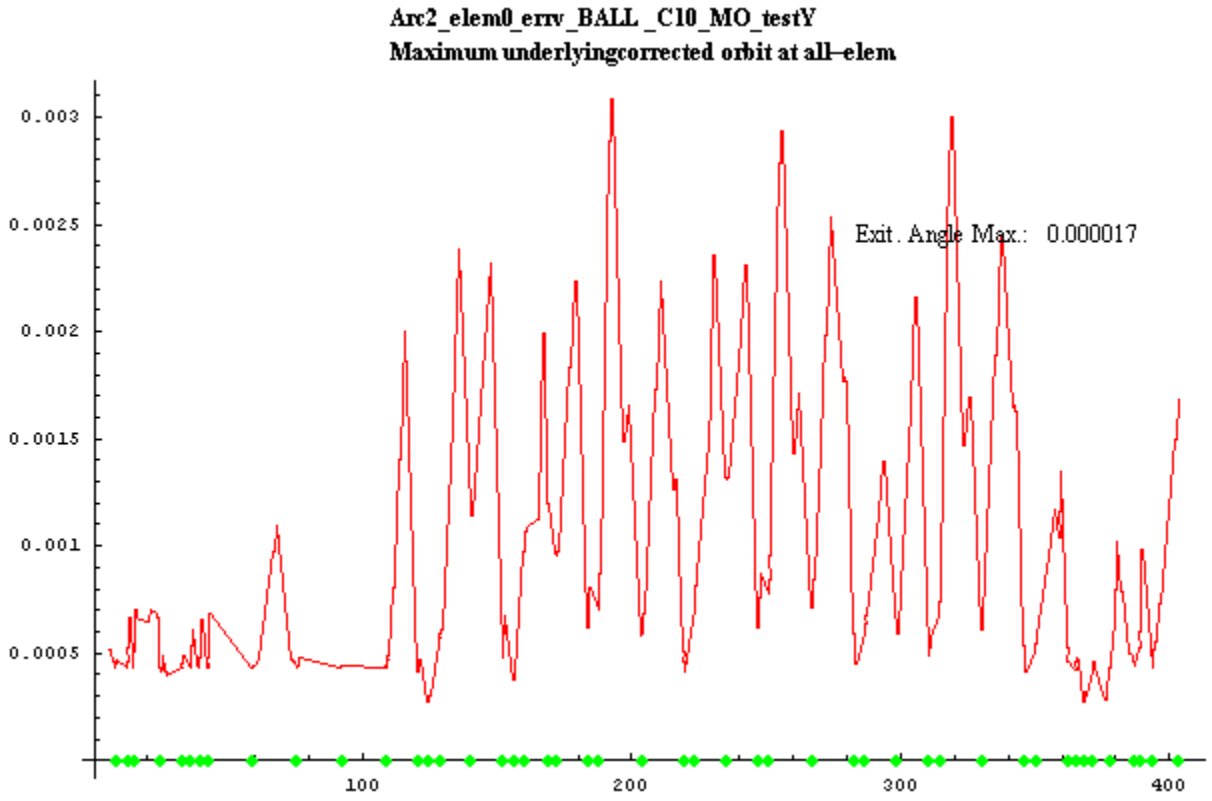
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



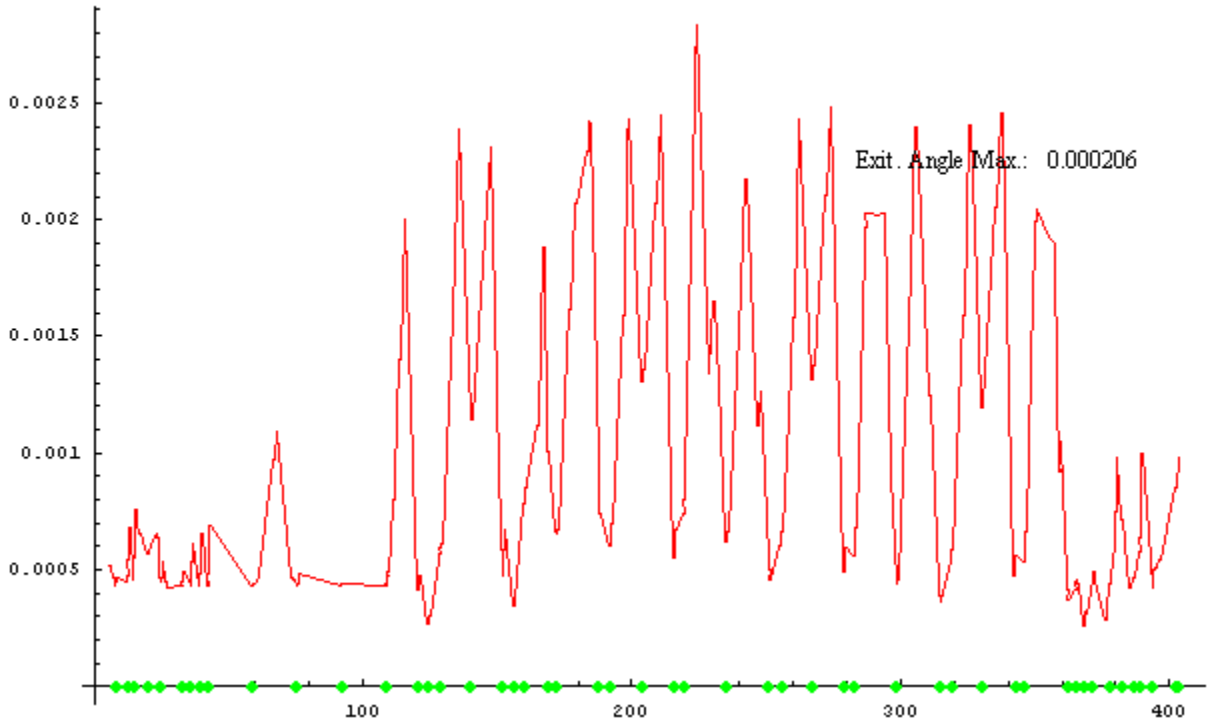
ARC 2

3σ Extent of the Real Underlying Orbit before Orbit Correction in Y



ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in

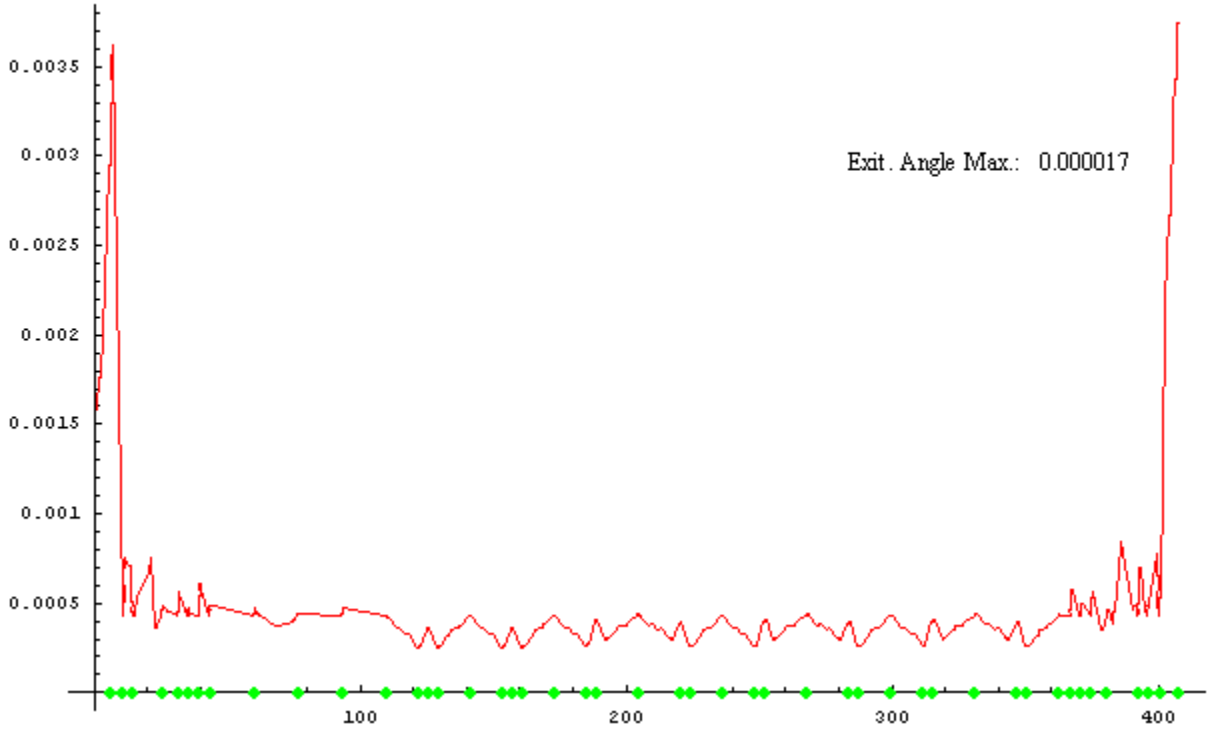


ARC 3

3σ Extent of the Real Underlying Orbit before Orbit Correction in X

Arc3_elem0_errh_BALL_CALL_MO_testX

Maximum underlyingcorrected orbit at all–elem

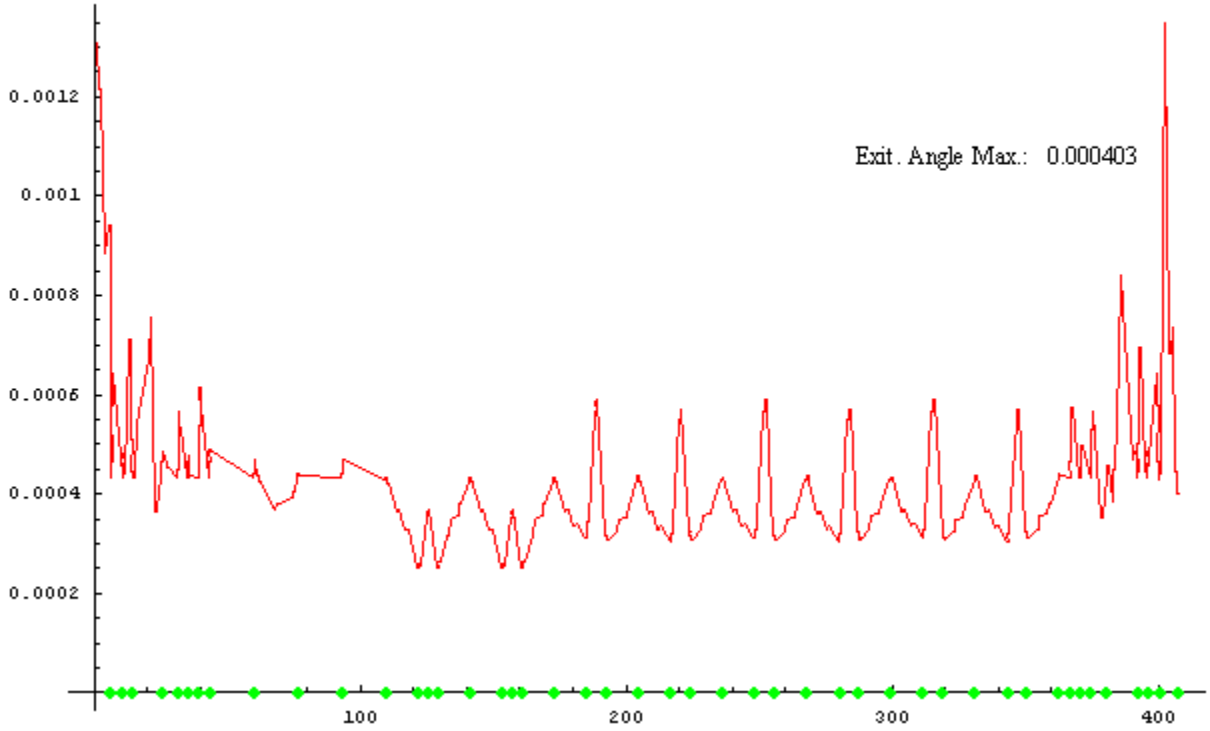


ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in

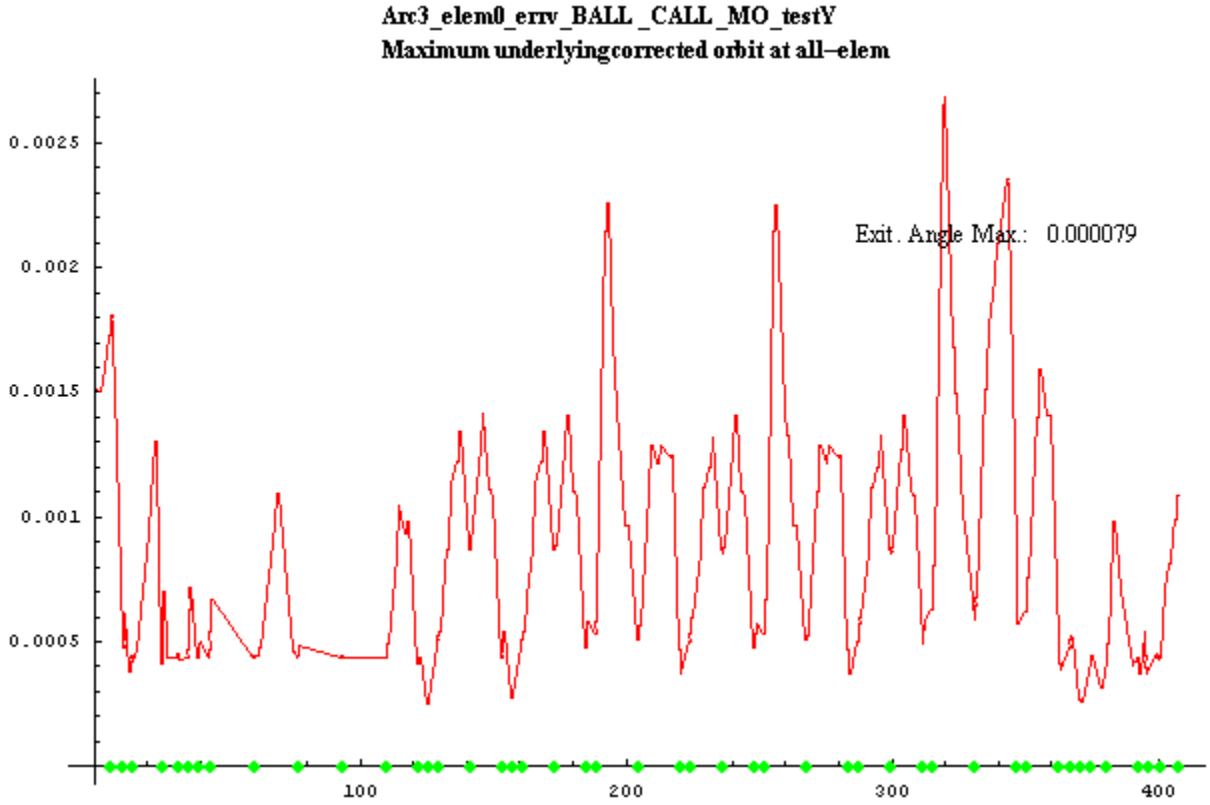
Arc3_elem0_errh_B1_C1_MO_testX

Maximum underlyingcorrected orbit at all–elem



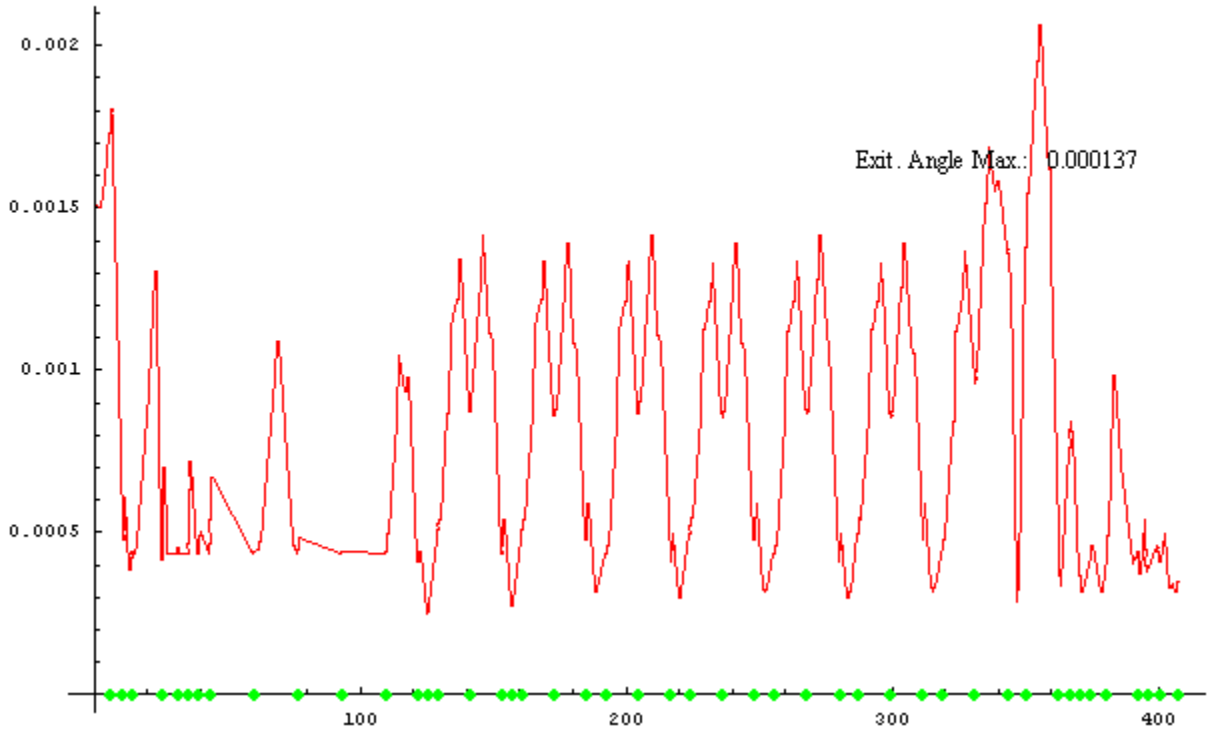
ARC 3

3σ Extent of the Real Underlying Orbit before Orbit Correction in Y



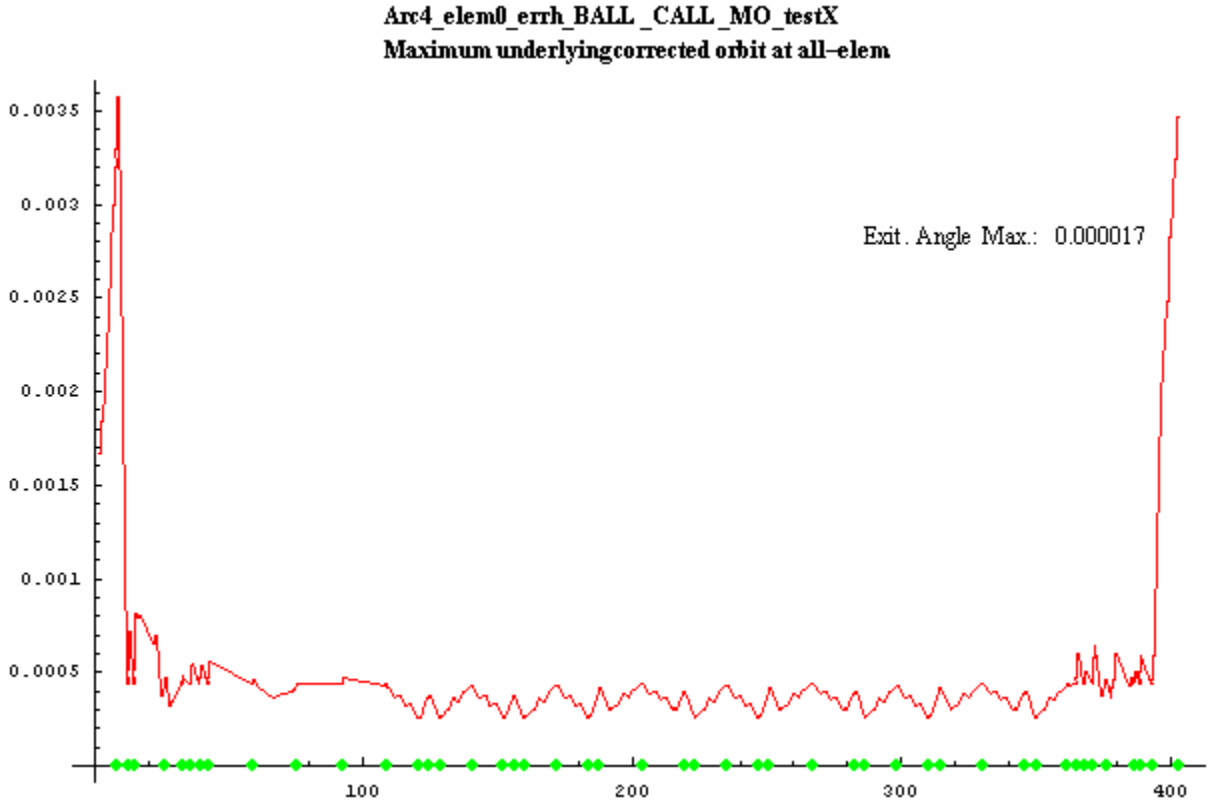
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



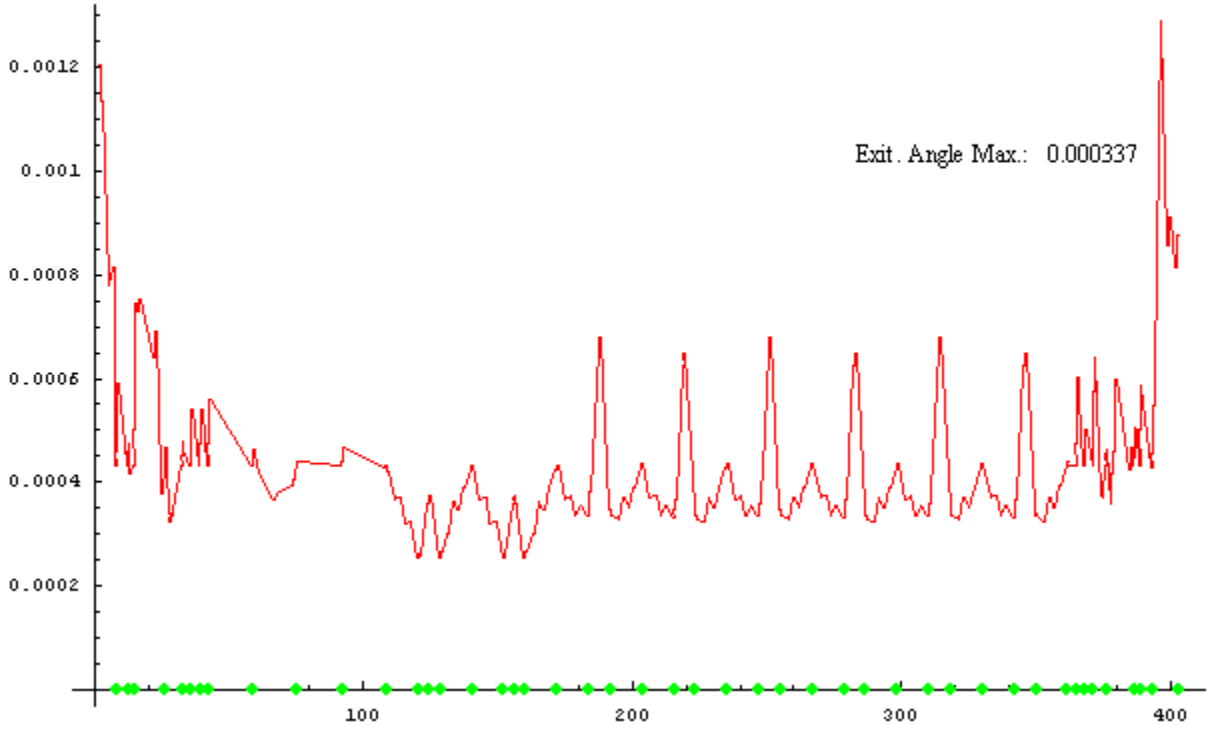
ARC 4

3σ Extent of the Real Underlying Orbit before Orbit Correction in X



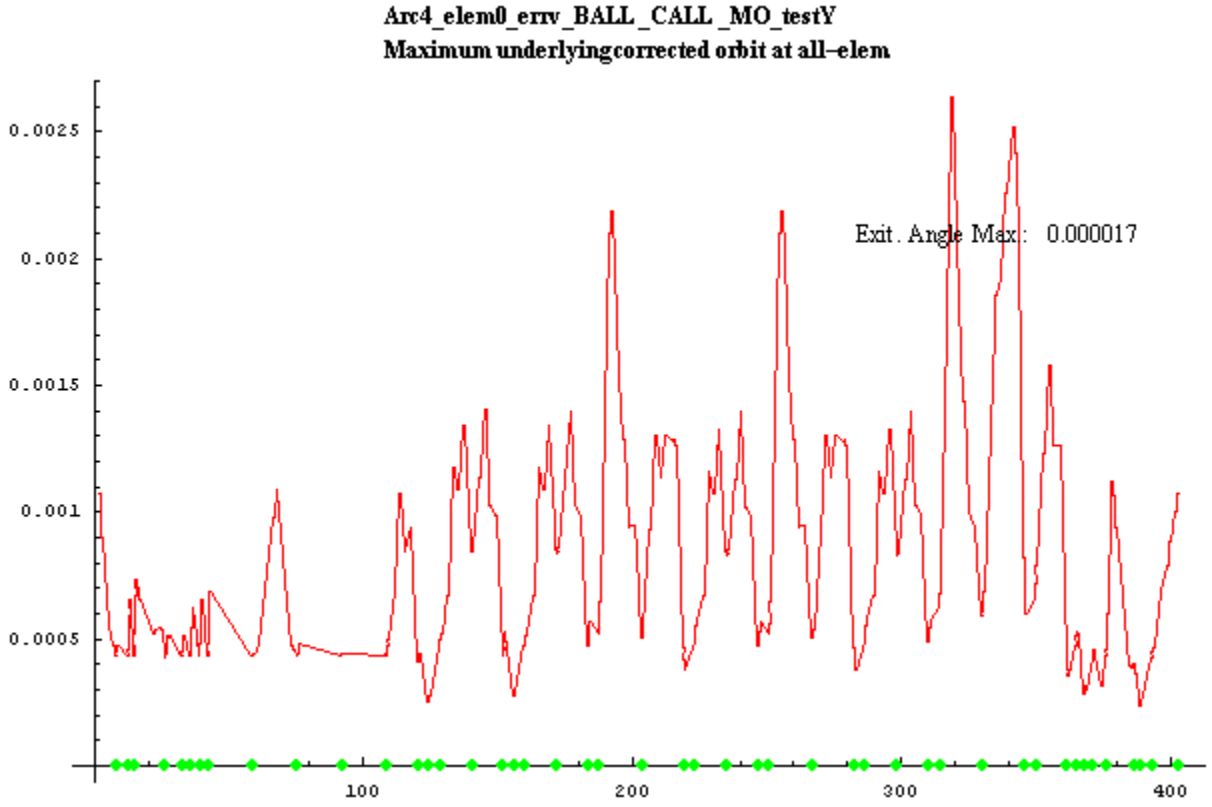
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



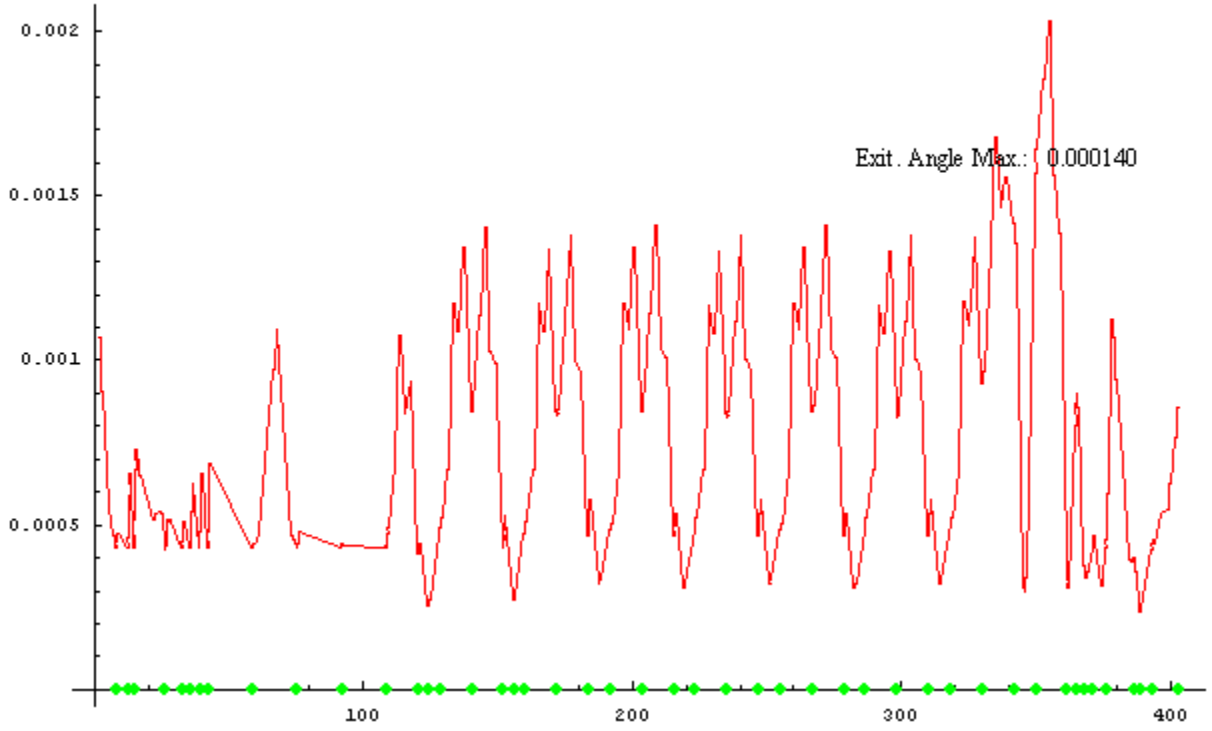
ARC 4

3σ Extent of the Real Underlying Orbit before Orbit Correction in Y



ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



ARC 5

3σ Extent of the Real Underlying Orbit before Orbit Correction in X

Arc5_elem0_errh_BALL_CALL_MO_testX

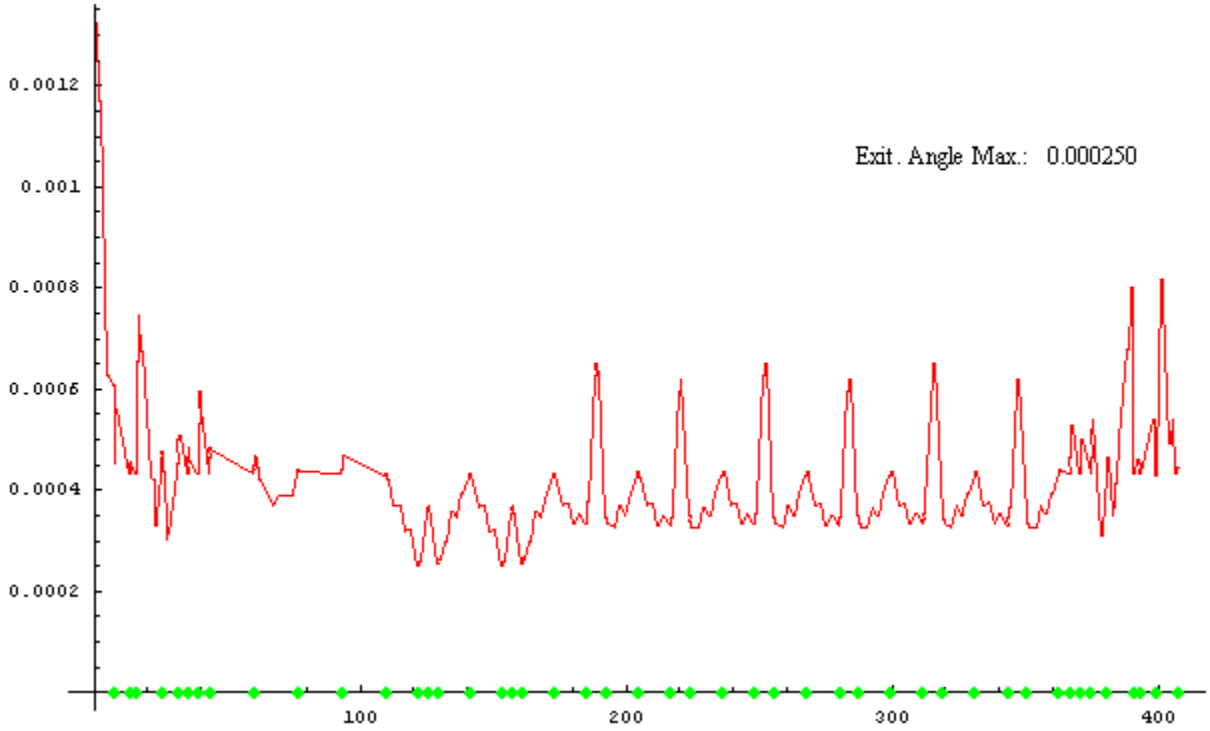
Maximum underlyingcorrected orbit at all–elem

ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in

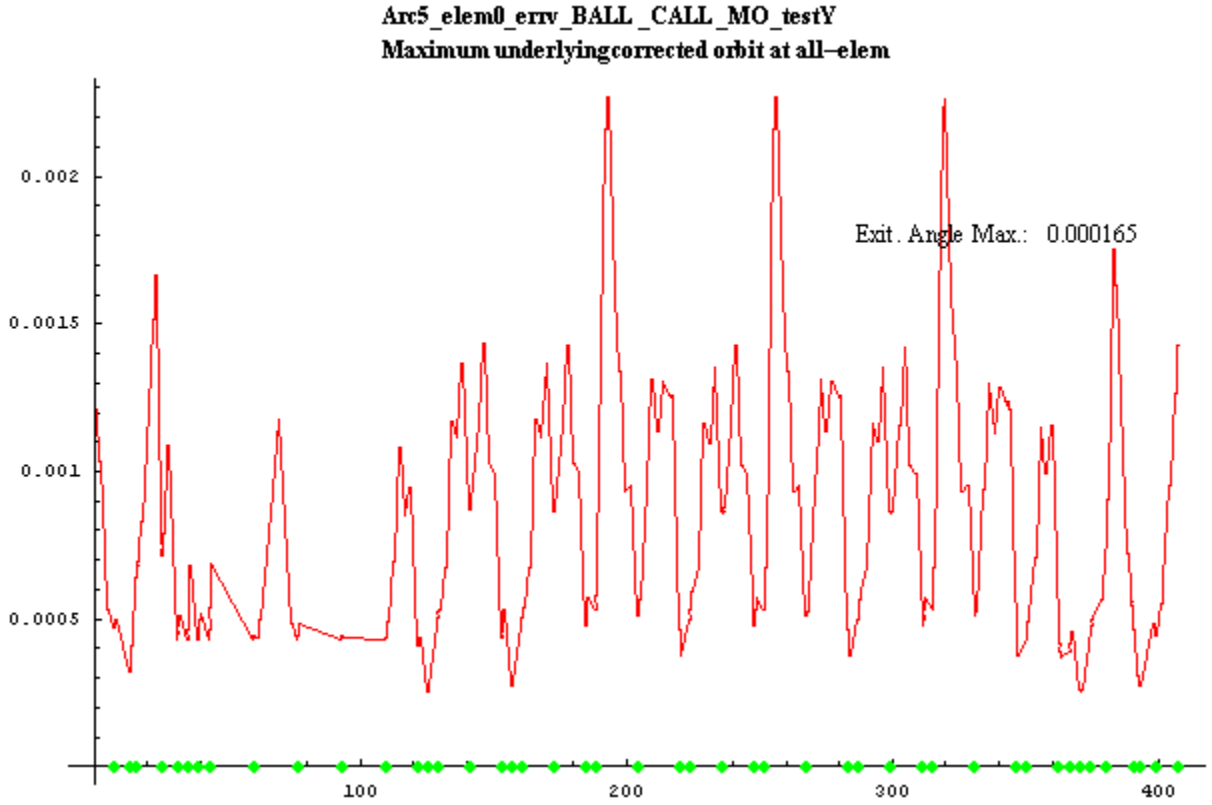
Arc5_elem0_errh_B1_C1_MO_testX

Maximum underlyingcorrected orbit at all–elem



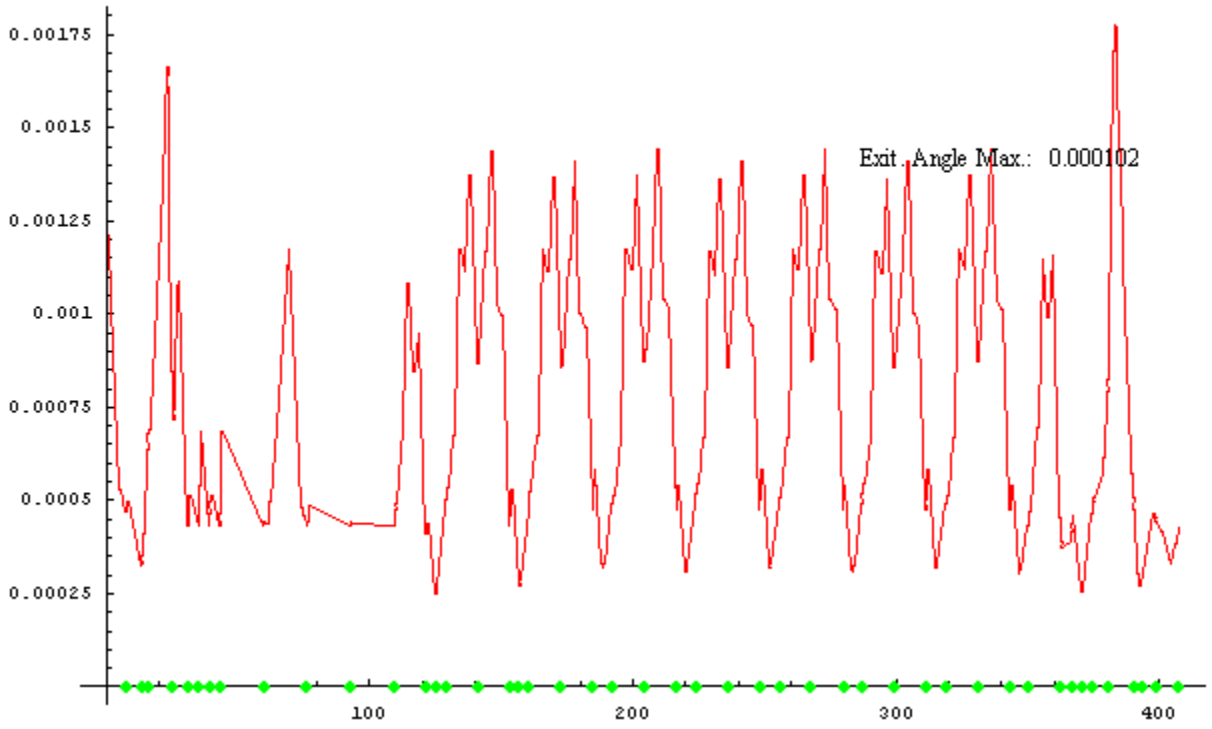
ARC 5

3σ Extent of the Real Underlying Orbit before Orbit Correction in Y



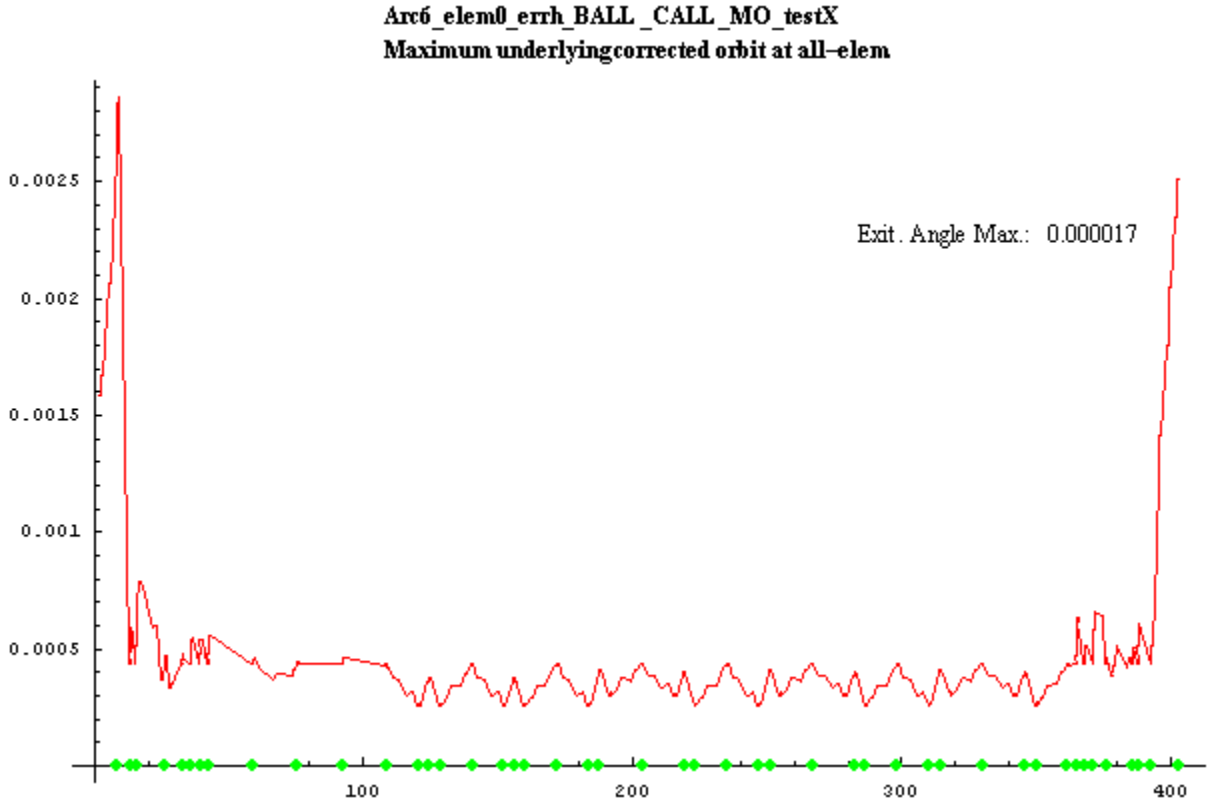
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



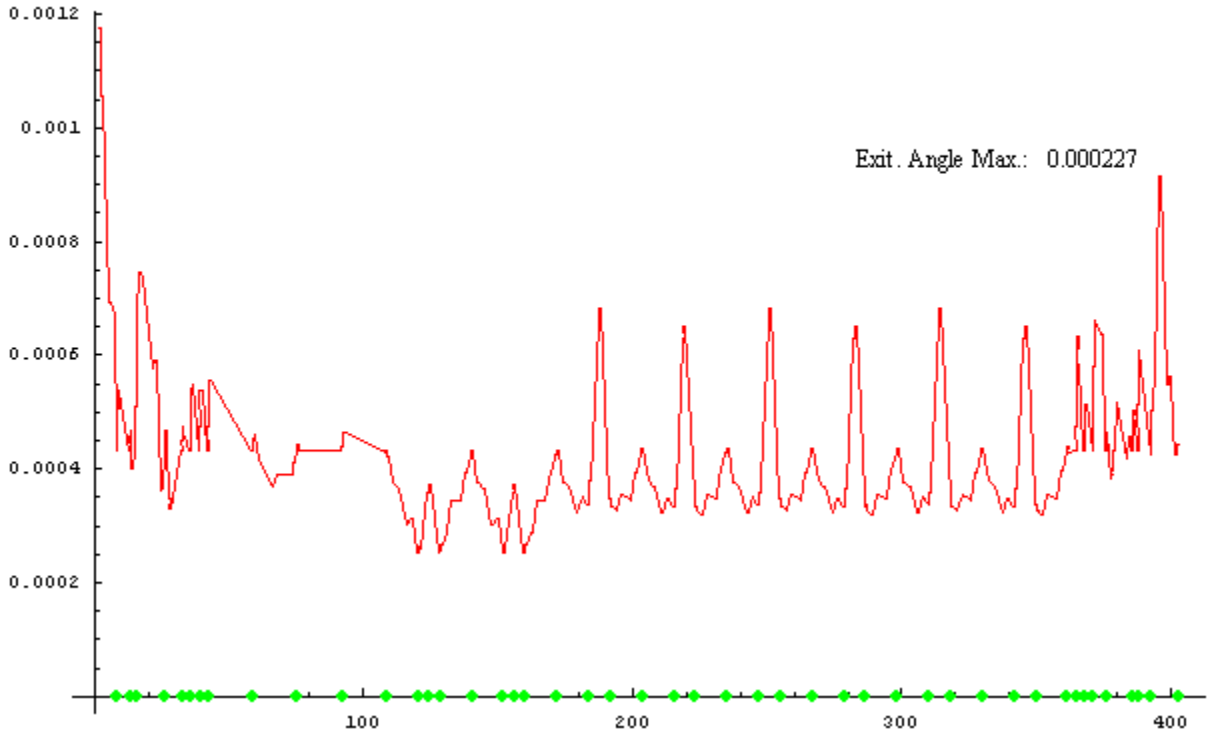
ARC 6

3σ Extent of the Real Underlying Orbit before Orbit Correction in X



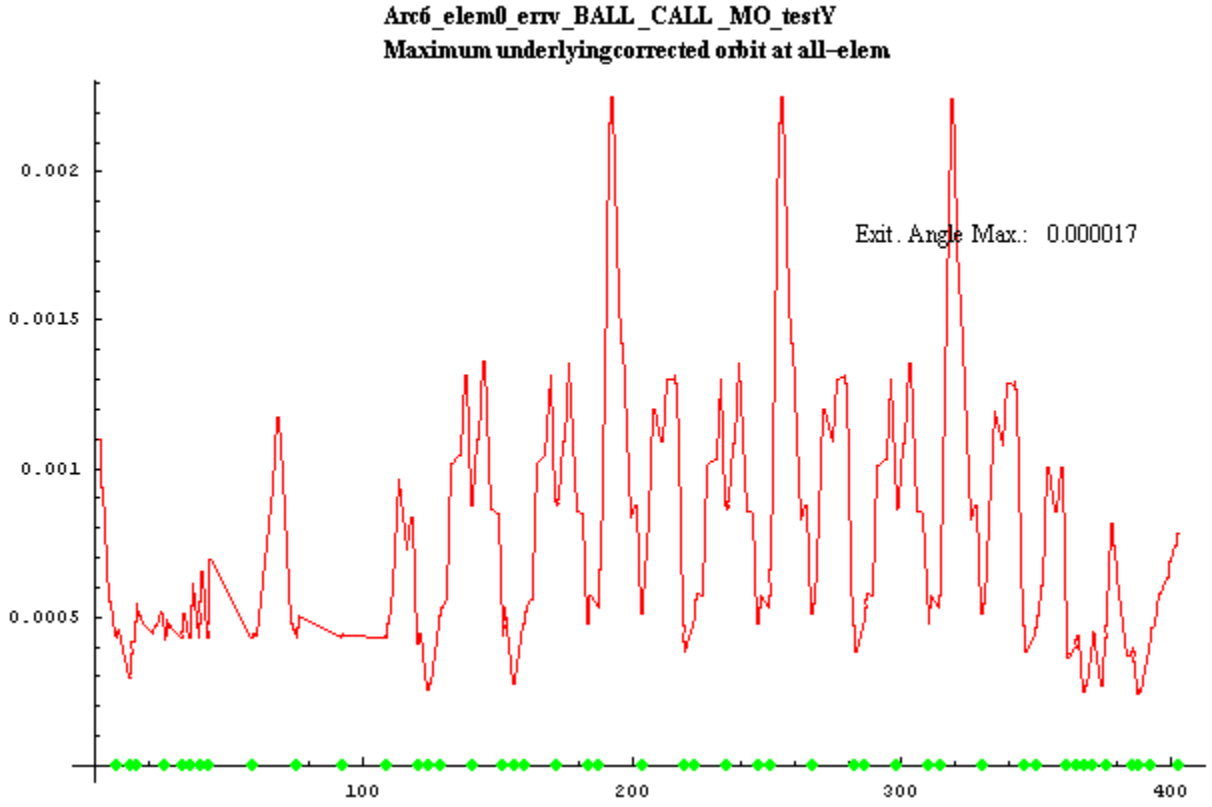
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



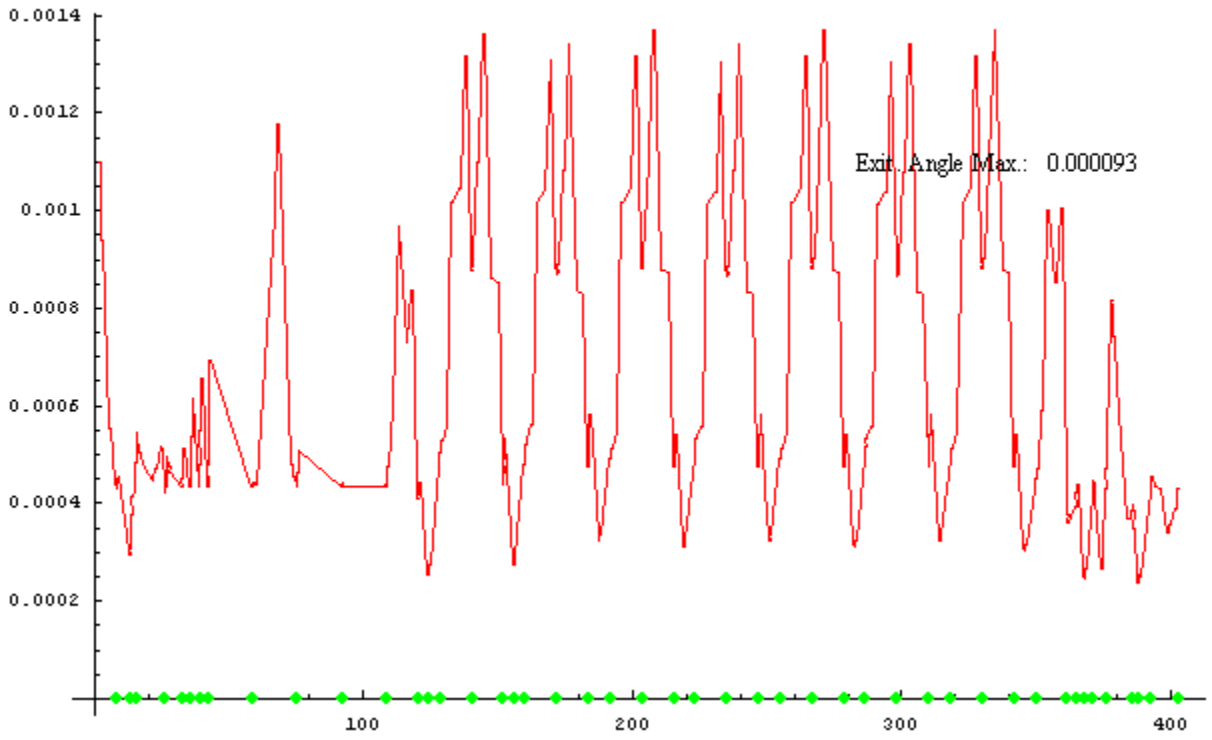
ARC 6

3σ Extent of the Real Underlying Orbit before Orbit Correction in Y



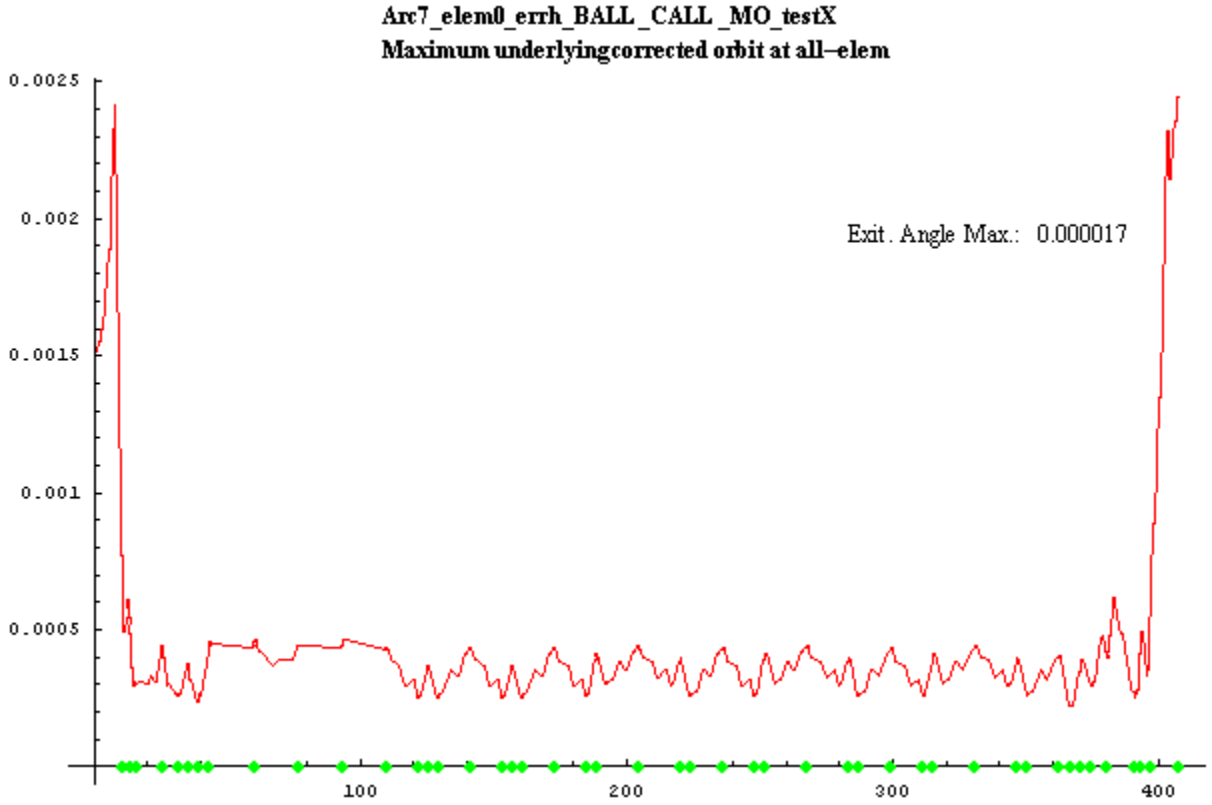
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



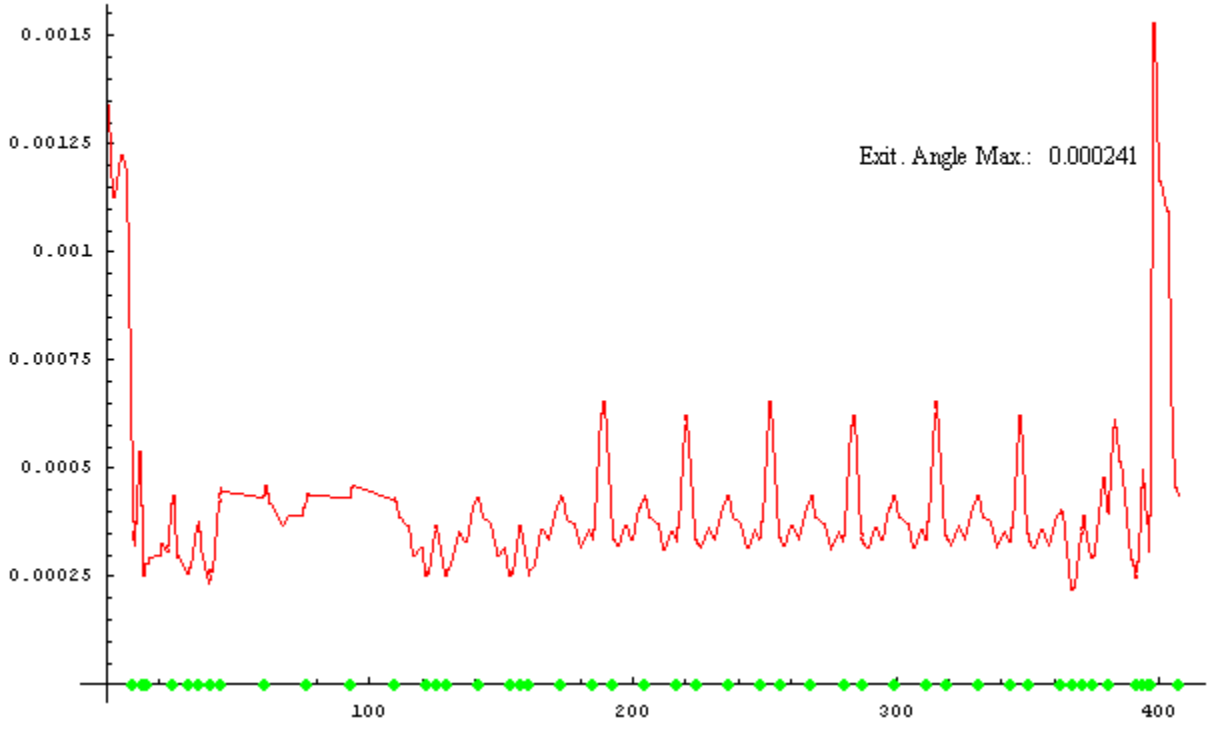
ARC 7

3σ Extent of the Real Underlying Orbit before Orbit Correction in X



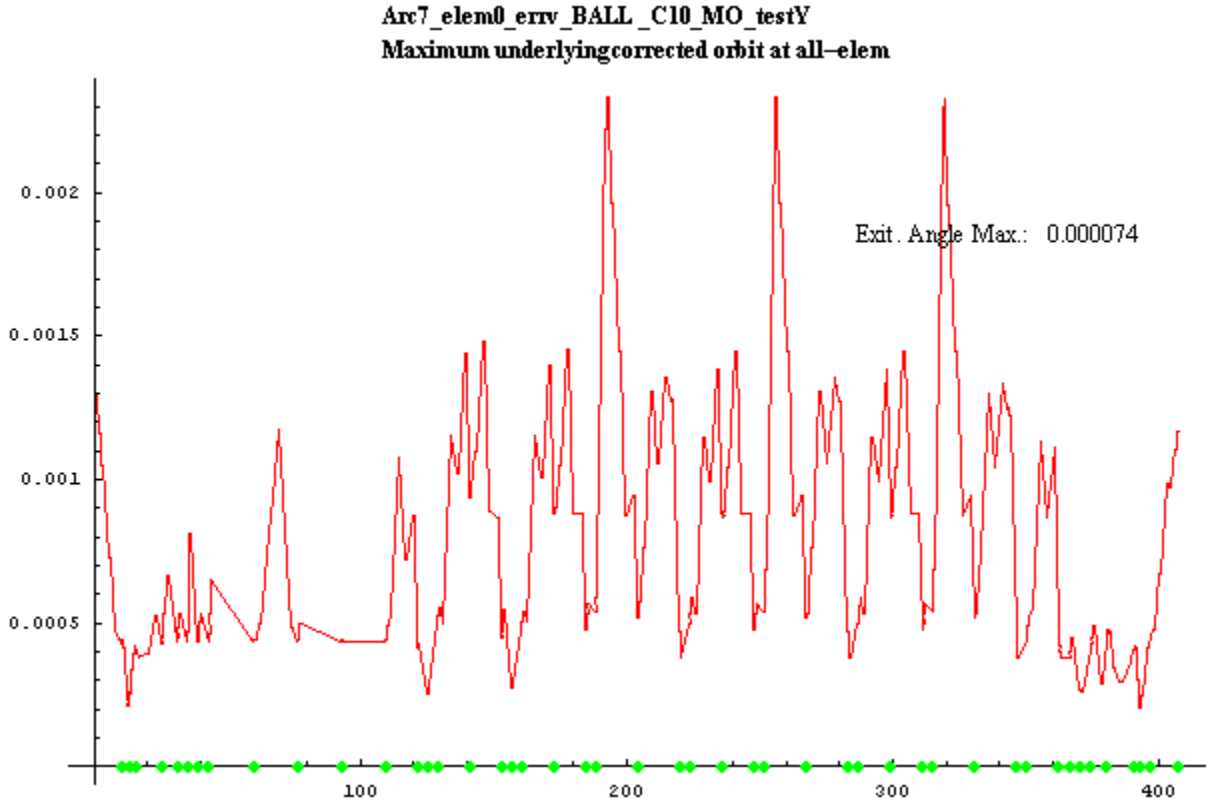
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



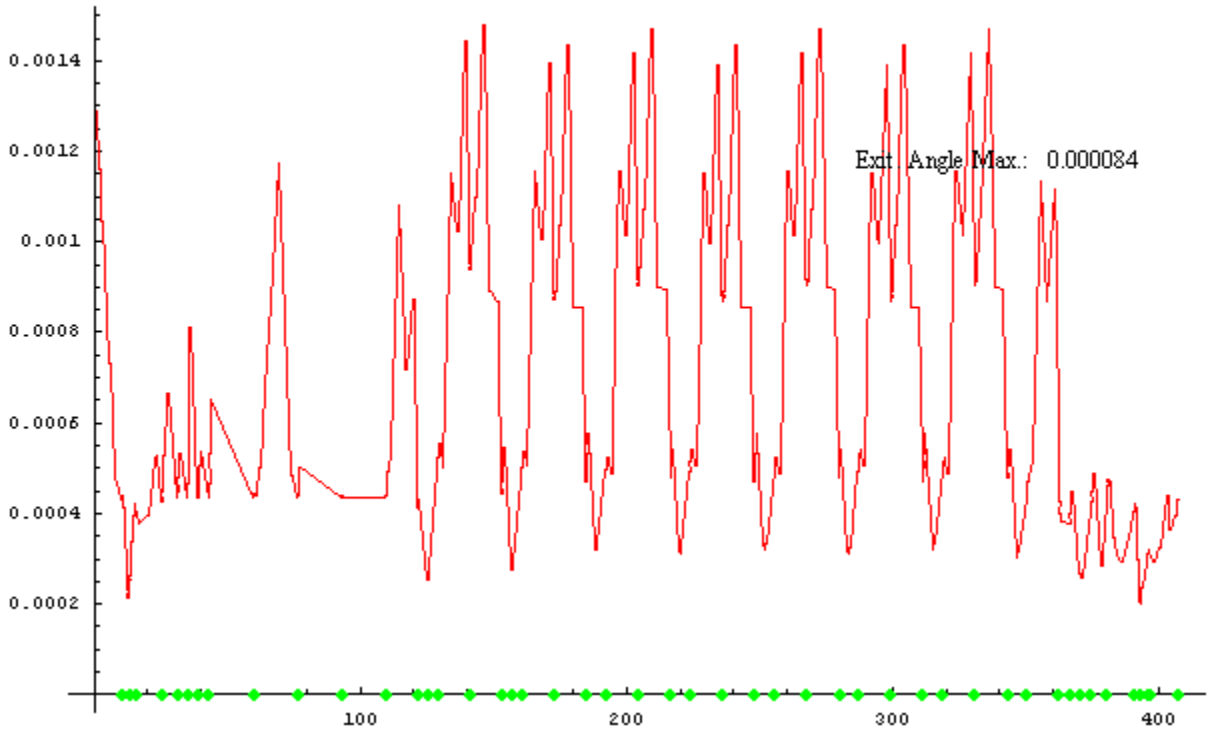
ARC 7

3σ Extent of the Real Underlying Orbit before Orbit Correction in Y



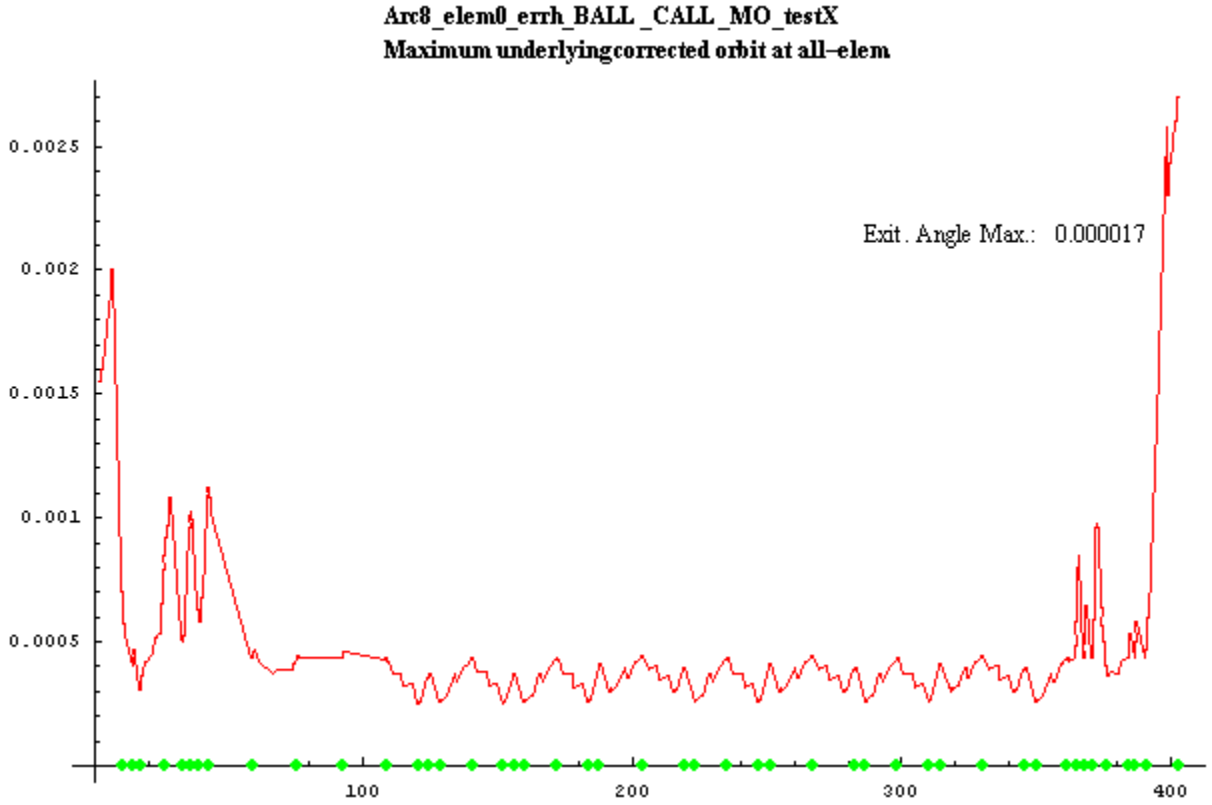
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



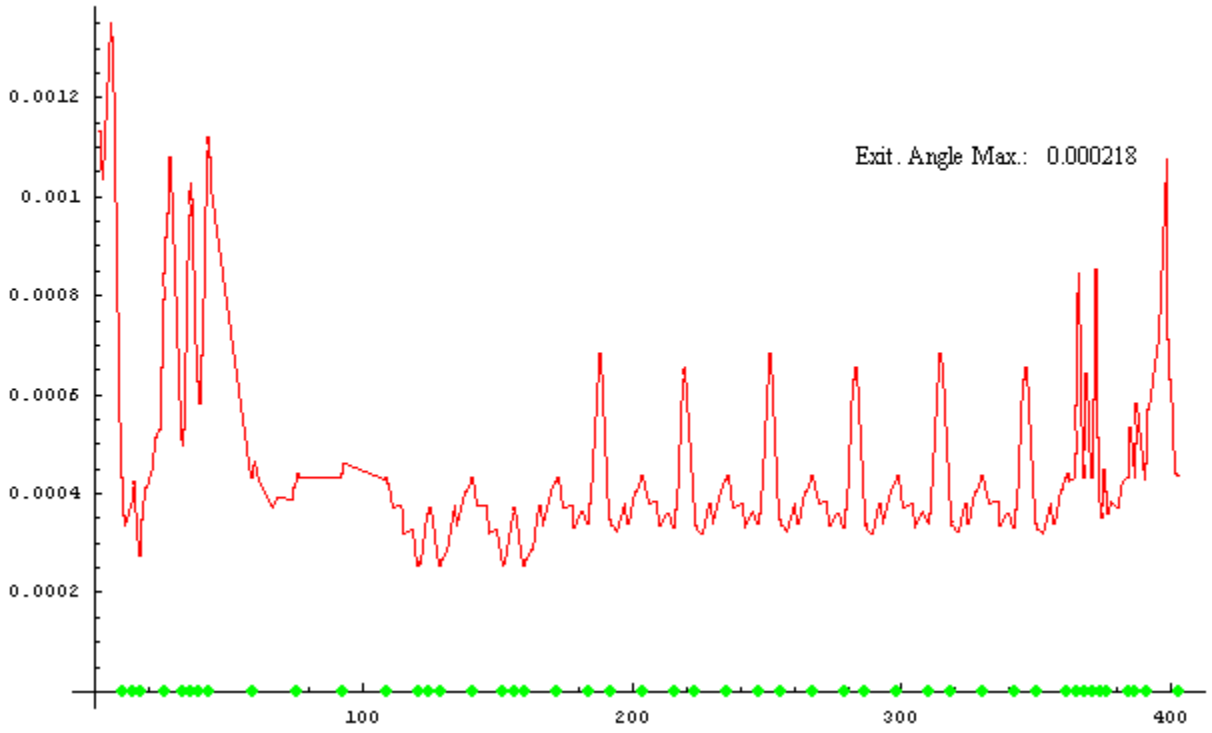
ARC 8

3σ Extent of the Real Underlying Orbit before Orbit Correction in X



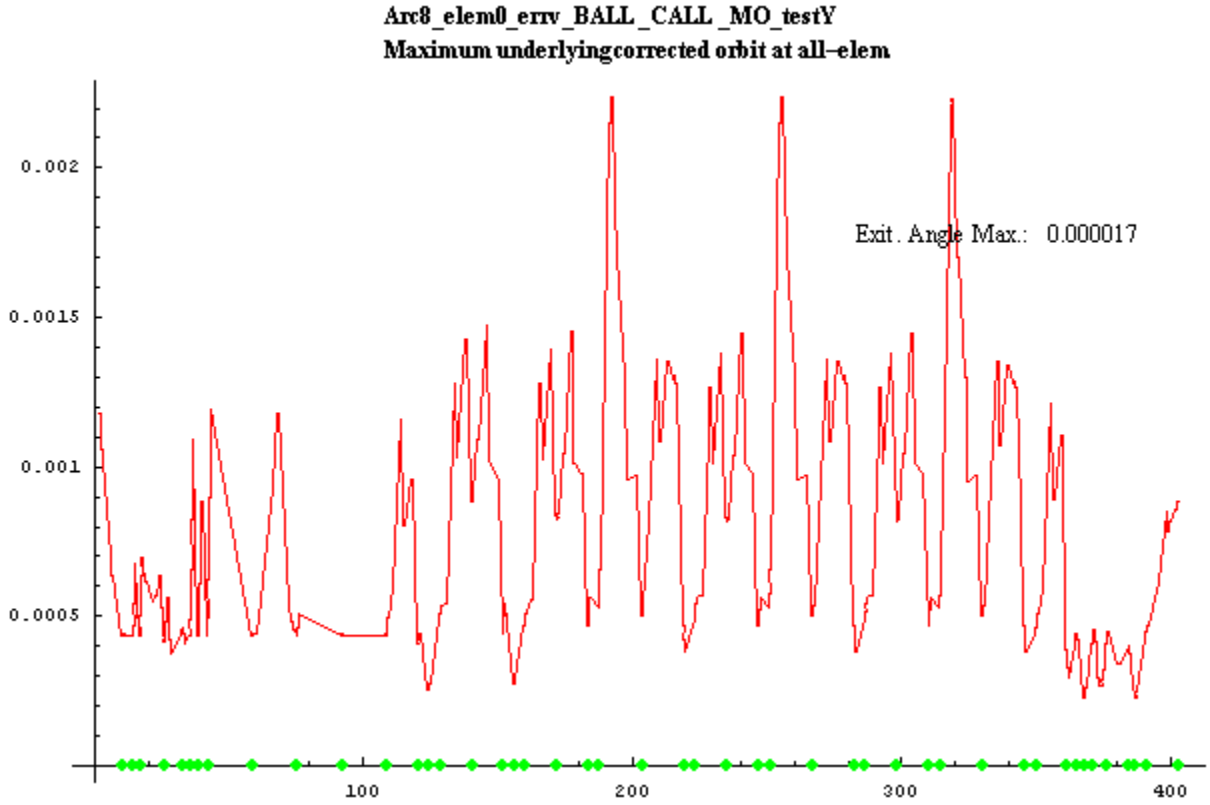
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



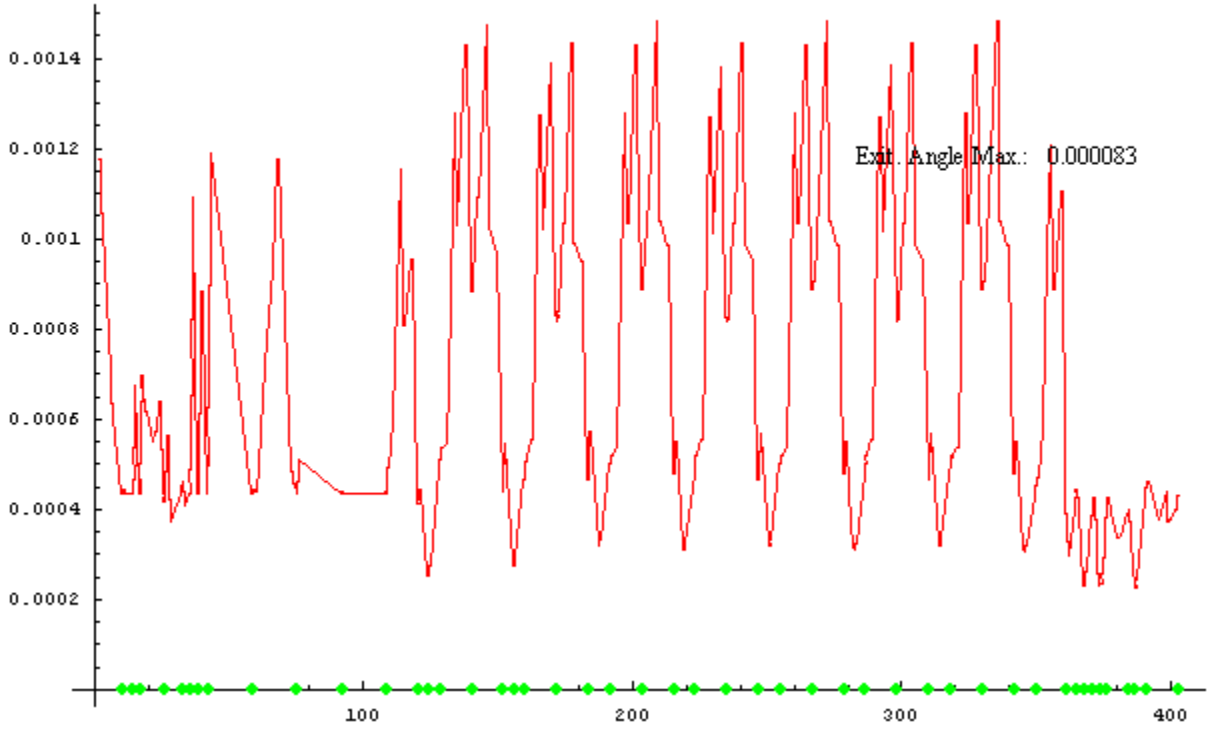
ARC 8

3σ Extent of the Real Underlying Orbit before Orbit Correction in Y



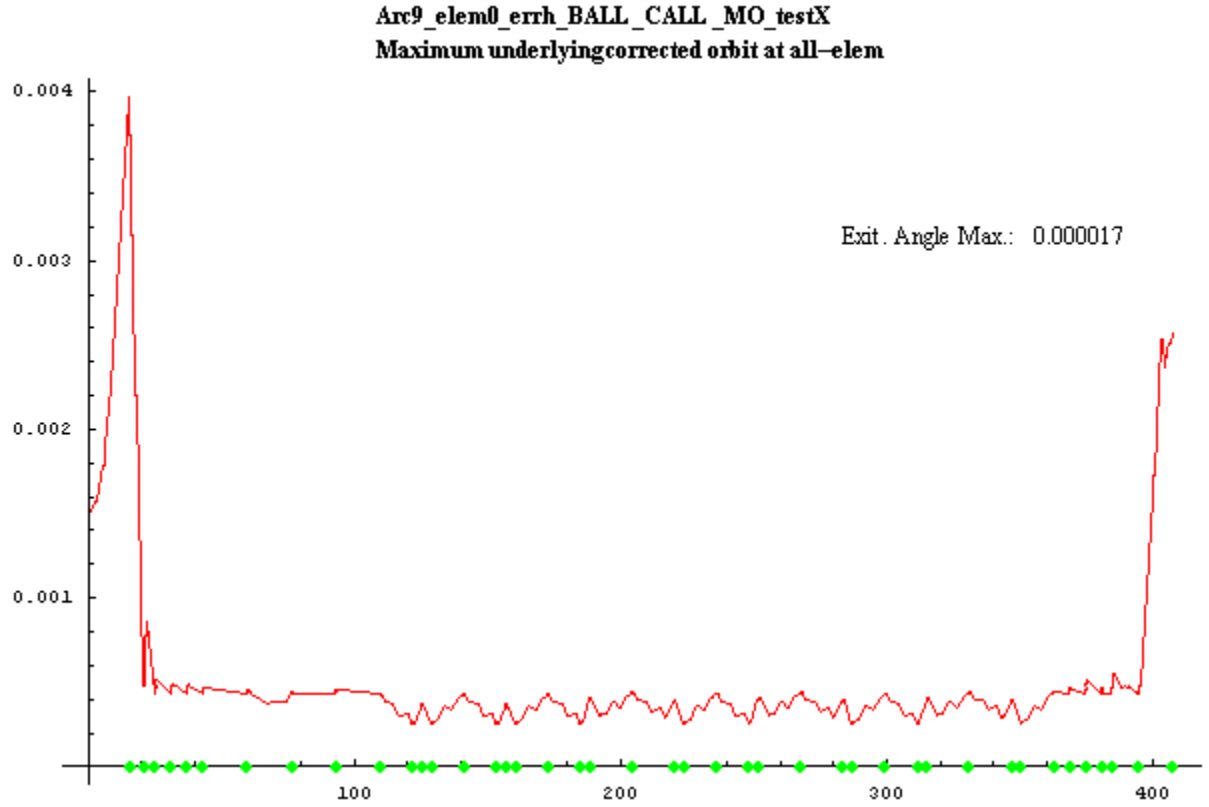
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



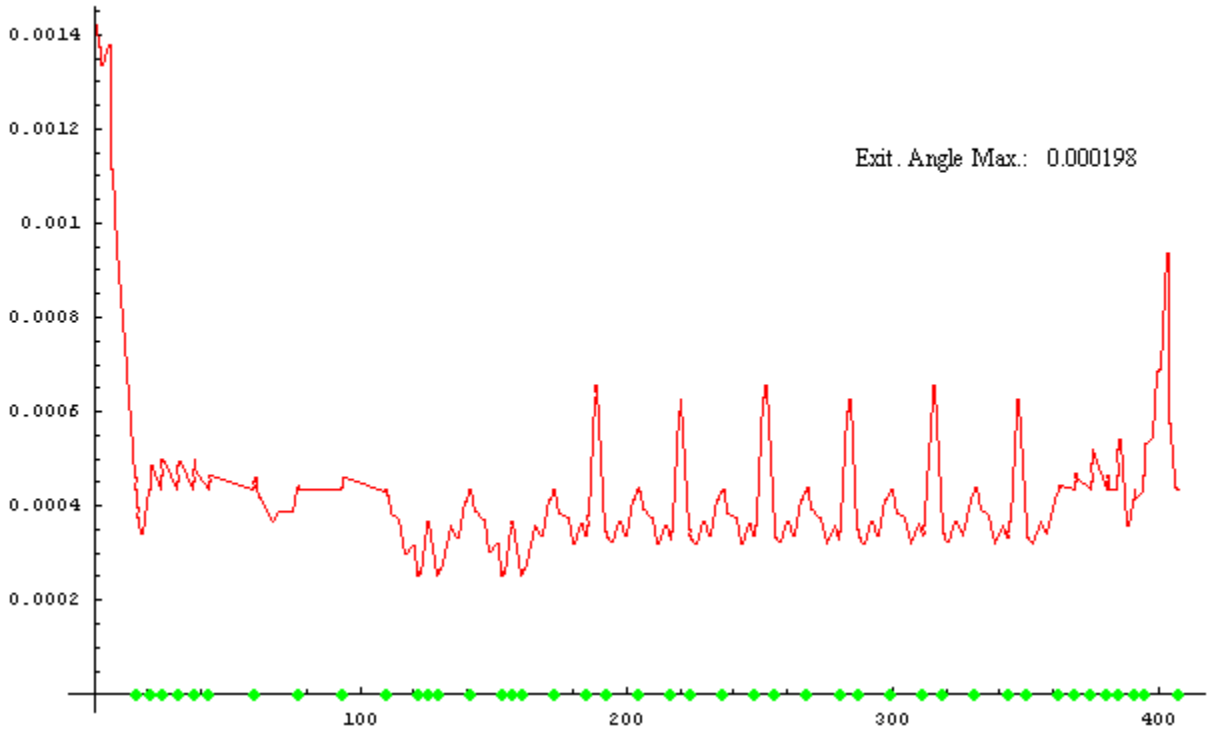
ARC 9

3σ Extent of the Real Underlying Orbit before Orbit Correction in X



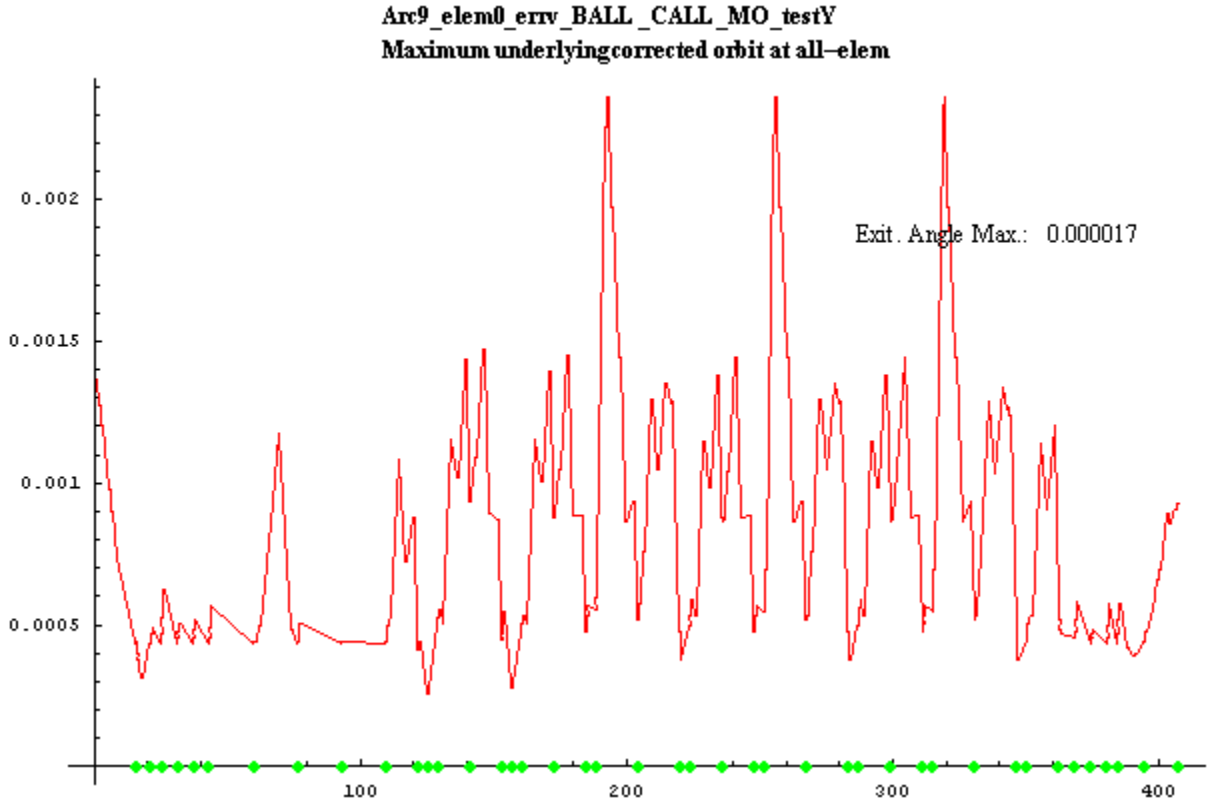
ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



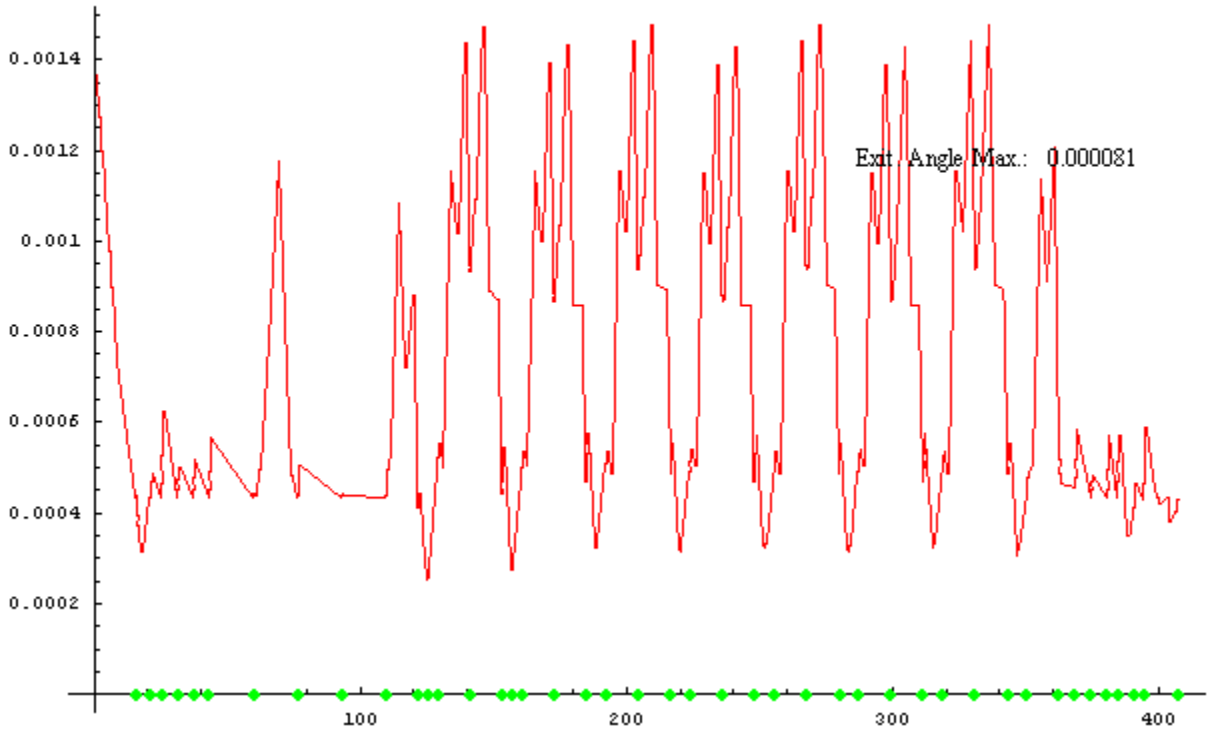
ARC 9

3σ Extent of the Real Underlying Orbit before Orbit Correction in Y



ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in

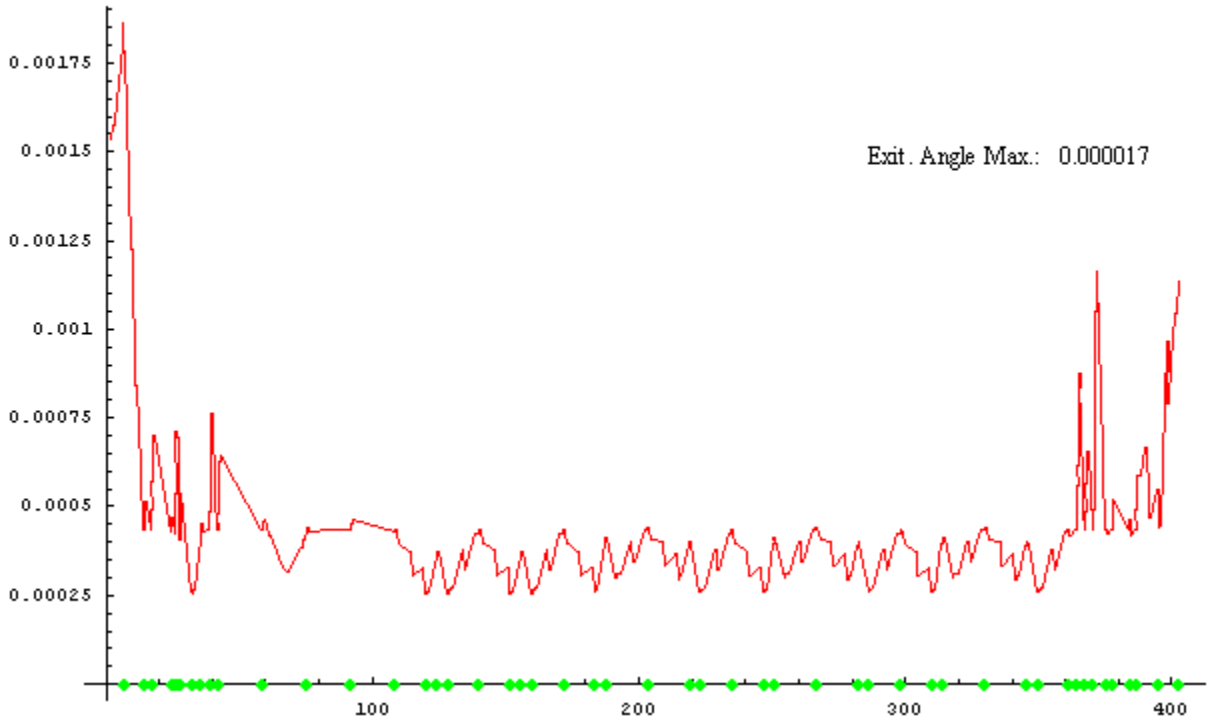


ARC A

3σ Extent of the Real Underlying Orbit before Orbit Correction in X

ArcA_elem0_errh_BALL _CALL _MO_testX

Maximum underlyingcorrected orbit at all-elem

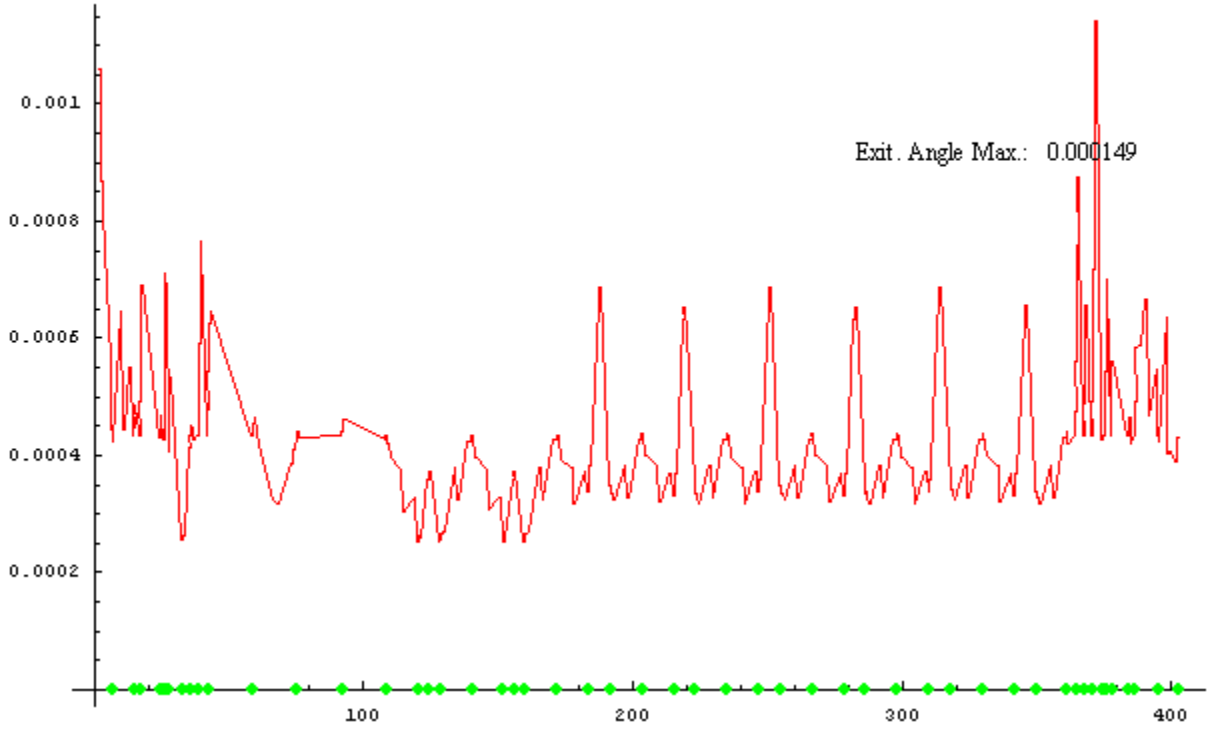


ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in

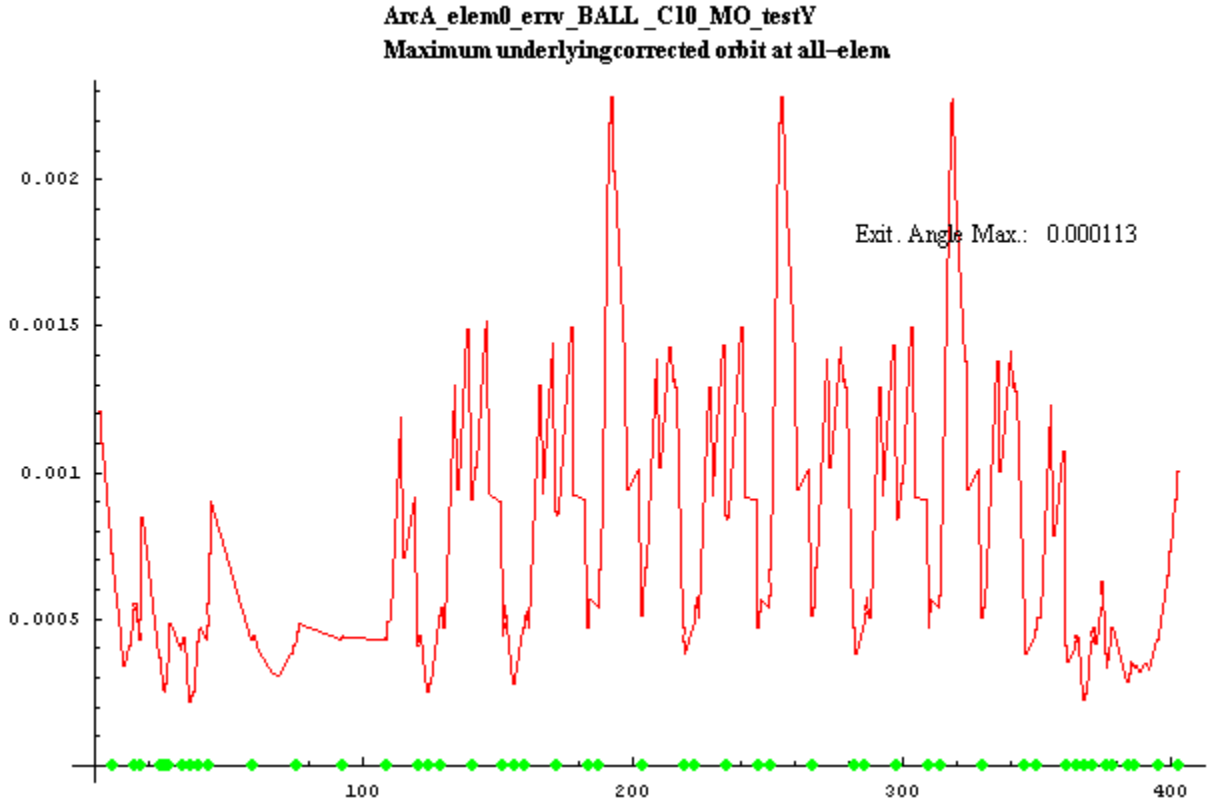
ArcA_elem0_errh_B1_C1_MO_testX

Maximum underlyingcorrected orbit at all-elem



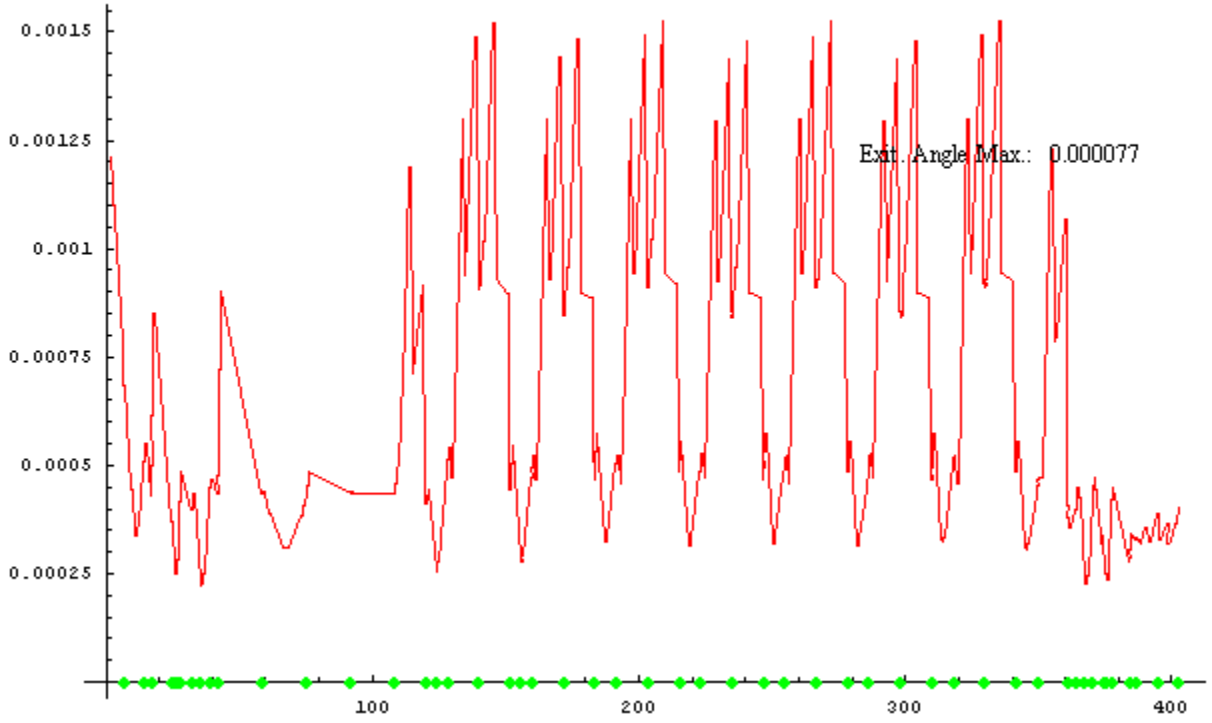
ARC A

3σ Extent of the Real Underlying Orbit before Orbit Correction in Y



ARC

3σ Extent of the Real Underlying Orbit after Orbit Correction in



Appendix B. Details of All Recommended Changes

ARC 1

BPM COUNTS:

HORZ. PLANE:

BPMs deleted from BALL to B1

IPM1A13
IPM1A23
IPM1A29
IPM1A33
IPM1A39

Total BPMs deleted from BALL to B1: 5

BPMs added from BALL to B1

HBPMD13
HBPMMQB1A15
HBPMMQB1A17
HBPMMQB1A25
HBPMMQB1A27
HBPMMQB1A35
HBPMMQB1A37
HBPMMQB1R07
HBPMD190

Total BPMs added from BALL to B1: 9

Net increase in BPMs from BALL to B1: 4

Change in H BPM parameters from BALL to B1:

Element Before After

VERT. PLANE:

BPMs deleted from BALL to B1

IPM1A13
IPM1A23
IPM1A29
IPM1A33
IPM1A39

Total BPMs deleted from BALL to B1: 5

BPMs added from BALL to B1

VBPMD13
VBPMMQB1A15
VBPMMQB1A17
VBPMMQB1A25
VBPMMQB1A27
VBPMMQB1A35
VBPMMQB1A37

VBPMMQB1R07
VBPMD190

Total BPMs added from BALL to B1: 9

Net increase in BPMs from BALL to B1: 4

Change in V BPM parameters from BALL to B1:

Element Before After

CORRECTOR COUNTS:

HORZ. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

HCORMAQ1S01
HCORD12
HCORD177

Total Corrs. added from CALL to C1: 3

Net increase in Corrs. from CALL to C1: 3

Change in H Corr. parameters from CALL to C1:

Element Before After

VERT. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

Total Corrs. added from CALL to C1: 0

Net increase in Corrs. from CALL to C1: 0

Change in H Corr. parameters from CALL to C1:

Element Before After

ARC 2

BPM COUNTS:

HORZ. PLANE:

BPMs deleted from BALL to B1

IPM2A13
IPM2A19
IPM2A23
IPM2A29
IPM2A33
IPM2A39

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

HBPMD15
HBPMMQC2A15
HBPMMQC2A17
HBPMMQC2A25
HBPMMQC2A27
HBPMMQC2A35
HBPMMQC2A37
HBPMMAI2R01
HBPMD196

Total BPMs added from BALL to B1: 9

Net increase in BPMs from BALL to B1: 3

Change in H BPM parameters from BALL to B1:

Element Before After

VERT. PLANE:

BPMs deleted from BALL to B1

IPM2A13
IPM2A19
IPM2A23
IPM2A29
IPM2A33
IPM2A39

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

VBPMD15
VBPMMQC2A15
VBPMMQC2A17
VBPMMQC2A25
VBPMMQC2A27

VBPMMQC2A35
VBPMMQC2A37
VBPMMAI2R01
VBPMD196

Total BPMs added from BALL to B1: 9

Net increase in BPMs from BALL to B1: 3

Change in V BPM parameters from BALL to B1:

Element Before After

CORRECTOR COUNTS:

HORZ. PLANE:

Corrs. deleted from CALL to C1

MBT2S06HH

Total Corrs. deleted from CALL to C1: 1

Corrs. added from CALL to C1

HCORMAW2S01
HCORMAW2R06

Total Corrs. added from CALL to C1: 2

Net increase in Corrs. from CALL to C1: 1

Change in H Corr. parameters from CALL to C1:

Element	Before	After
MBT2S01HH	0.38274893	1.08274893
MBT2S02HH	0.38274893	1.08274893
MBT2S03HH	0.38274893	1.58274893
MBT2S05HH	0.38274893	0.88274893
MBT2R03HH	0.38274893	1.08274893
MBT2R06HH	0.38274893	1.28274893
MBT2R09HH	0.38274893	1.08274893
MBT2R10HH	0.38274893	1.08274893

VERT. PLANE:

Corrs. deleted from CALL to C1

MBT2S06VV

Total Corrs. deleted from CALL to C1: 1

Total Corrs. added from CALL to C1: 0

Net increase in Corrs. from CALL to C1: -1

Change in H Corr. parameters from CALL to C1:

Element Before After

MBT2S01VV	0.38274893	0.88274893
MBT2S02VV	0.38274893	0.88274893
MBT2S03VV	0.38274893	0.88274893
MBT2S05VV	0.38274893	0.88274893
MBT2A01VV	0.38274893	0.68274893
MBT2A03VV	0.38274893	0.68274893
MBT2A05VV	0.38274893	0.68274893
MBT2A07VV	0.38274893	0.68274893
MBT2A09VV	0.38274893	0.68274893
MBT2A13VV	0.38274893	0.88274893
MBT2A15VV	0.38274893	0.88274893
MBT2A17VV	0.38274893	0.88274893
MBT2A19VV	0.38274893	1.08274893
MBT2A23VV	0.38274893	0.88274893
MBT2A25VV	0.38274893	0.88274893
MBT2A27VV	0.38274893	0.88274893
MBT2A30VV	0.38274893	1.08274893
MBT2A33VV	0.38274893	0.68274893
MBT2A35VV	0.38274893	0.88274893
MBT2A37VV	0.38274893	0.88274893
MBT2A40VV	0.38274893	1.08274893
MBT2R02VV	0.38274893	0.68274893
MBT2R04VV	0.38274893	0.68274893
MBT2R07VV	0.38274893	1.28274893
MBT2R09VV	0.38274893	1.28274893
MBT2R10VV	0.38274893	0.68274893

ARC 3

BPM COUNTS:

HORZ. PLANE:

BPMs deleted from BALL to B1

IPM3A11
IPM3A15
IPM3A19
IPM3A23
IPM3A27
IPM3A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

HBPMD97
HBPMD106
HBPMD127
HBPMD136
HBPMD157
HBPMD166
HBPMD211

Total BPMs added from BALL to B1: 7

Net increase in BPMs from BALL to B1: 1

Change in H BPM parameters from BALL to B1:

Element Before After

VERT. PLANE:

BPMs deleted from BALL to B1

IPM3A11
IPM3A15
IPM3A19
IPM3A23
IPM3A27
IPM3A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

VBPMD97
VBPMD106
VBPMD127
VBPMD136
VBPMD157
VBPMD166
VBPMD211

Total BPMs added from BALL to B1: 7

Net increase in BPMs from BALL to B1: 1

Change in V BPM parameters from BALL to B1:

Element Before After

CORRECTOR COUNTS:

HORZ. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

HCORMAQ3S01

Total Corrs. added from CALL to C1: 1

Net increase in Corrs. from CALL to C1: 1

Change in H Corr. parameters from CALL to C1:

Element Before After

VERT. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

Total Corrs. added from CALL to C1: 0

Net increase in Corrs. from CALL to C1: 0

Change in H Corr. parameters from CALL to C1:

Element Before After

ARC 4

BPM COUNTS:

HORZ. PLANE:

BPMs deleted from BALL to B1

IPM4A11
IPM4A15
IPM4A19
IPM4A23
IPM4A27
IPM4A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

HBPMD98
HBPMD107
HBPMD128
HBPMD137
HBPMD158
HBPMD167
HBPMD212

Total BPMs added from BALL to B1: 7

Net increase in BPMs from BALL to B1: 1

Change in H BPM parameters from BALL to B1:

Element Before After

VERT. PLANE:

BPMs deleted from BALL to B1

IPM4A11
IPM4A15
IPM4A19
IPM4A23
IPM4A27
IPM4A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

VBPMD98
VBPMD107
VBPMD128
VBPMD137
VBPMD158
VBPMD167
VBPMD212

Total BPMs added from BALL to B1: 7

Net increase in BPMs from BALL to B1: 1

Change in V BPM parameters from BALL to B1:

Element Before After

CORRECTOR COUNTS:

HORZ. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

HCORMAW4S01

Total Corrs. added from CALL to C1: 1

Net increase in Corrs. from CALL to C1: 1

Change in H Corr. parameters from CALL to C1:

Element	Before	After
MBC4S01HH	0.71194433	3.51194433
MBC4S02HH	0.71194433	1.51194433
MBC4S03HH	0.71194433	1.51194433
MBC4R08HH	0.71194433	1.21194433
MBC4R09HH	0.71194433	1.01194433
MBC4R10HH	0.71194433	1.51194433

VERT. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

Total Corrs. added from CALL to C1: 0

Net increase in Corrs. from CALL to C1: 0

Change in H Corr. parameters from CALL to C1:

Element Before After

ARC 5

BPM COUNTS:

HORZ. PLANE:

BPMs deleted from BALL to B1

IPM5A11
IPM5A15
IPM5A19
IPM5A23
IPM5A27
IPM5A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

HBPMD96
HBPMD105
HBPMD126
HBPMD135
HBPMD156
HBPMD165
HBPMD210

Total BPMs added from BALL to B1: 7

Net increase in BPMs from BALL to B1: 1

Change in H BPM parameters from BALL to B1:

Element Before After

VERT. PLANE:

BPMs deleted from BALL to B1

IPM5A11
IPM5A15
IPM5A19
IPM5A23
IPM5A27
IPM5A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

VBPMD96
VBPMD105
VBPMD126
VBPMD135
VBPMD156
VBPMD165
VBPMD210

Total BPMs added from BALL to B1: 7

Net increase in BPMs from BALL to B1: 1

Change in V BPM parameters from BALL to B1:

Element Before After

CORRECTOR COUNTS:

HORZ. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

HCORMAQ5S01

Total Corrs. added from CALL to C1: 1

Net increase in Corrs. from CALL to C1: 1

Change in H Corr. parameters from CALL to C1:

Element	Before	After
MBC5S01HH	0.57271085	1.07271085
MBC5R08HH	0.57271085	1.07271085
MBC5R10HH	0.57271085	1.07271085

VERT. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

Total Corrs. added from CALL to C1: 0

Net increase in Corrs. from CALL to C1: 0

Change in H Corr. parameters from CALL to C1:

Element	Before	After
MBC5S05VV	0.57271085	1.07271085

ARC 6

BPM COUNTS:

HORZ. PLANE:

BPMs deleted from BALL to B1

IPM6A11
IPM6A15
IPM6A19
IPM6A23
IPM6A27
IPM6A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

HBPMD97
HBPMD106
HBPMD127
HBPMD136
HBPMD157
HBPMD166
HBPMD212

Total BPMs added from BALL to B1: 7

Net increase in BPMs from BALL to B1: 1

Change in H BPM parameters from BALL to B1:

Element Before After

VERT. PLANE:

BPMs deleted from BALL to B1

IPM6A11
IPM6A15
IPM6A19
IPM6A23
IPM6A27
IPM6A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

VBPMD97
VBPMD106
VBPMD127
VBPMD136
VBPMD157
VBPMD166
VBPMD212

Total BPMs added from BALL to B1: 7

Net increase in BPMs from BALL to B1: 1

Change in V BPM parameters from BALL to B1:

Element Before After

CORRECTOR COUNTS:

HORZ. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

HCORMAW6S01

Total Corrs. added from CALL to C1: 1

Net increase in Corrs. from CALL to C1: 1

Change in H Corr. parameters from CALL to C1:

Element	Before	After
MBC6S01HH	0.47902828	1.07902828
MBC6S03HH	0.47902828	0.67902828
MBC6R04HH	0.47902828	0.67902828
MBC6R06HH	0.47902828	0.67902828
MBC6R08HH	0.47902828	0.87902828

VERT. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

Total Corrs. added from CALL to C1: 0

Net increase in Corrs. from CALL to C1: 0

Change in H Corr. parameters from CALL to C1:

Element	Before	After
MBC6S02VV	0.47902828	1.07902828
MBC6R04VV	0.47902828	1.07902828
MBC6R08VV	0.47902828	1.07902828

ARC 7

BPM COUNTS:

HORZ. PLANE:

BPMs deleted from BALL to B1

IPM7A11
IPM7A15
IPM7A19
IPM7A23
IPM7A27
IPM7A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

HBPMD96
HBPMD105
HBPMD126
HBPMD135
HBPMD156
HBPMD165
HBPMD204
HBPMD211

Total BPMs added from BALL to B1: 8

Net increase in BPMs from BALL to B1: 2

Change in H BPM parameters from BALL to B1:

Element Before After

VERT. PLANE:

BPMs deleted from BALL to B1

IPM7A11
IPM7A15
IPM7A19
IPM7A23
IPM7A27
IPM7A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

VBPMD96
VBPMD105
VBPMD126
VBPMD135
VBPMD156
VBPMD165

VBPMD204
VBPMD211

Total BPMs added from BALL to B1: 8

Net increase in BPMs from BALL to B1: 2

Change in V BPM parameters from BALL to B1:

Element Before After

CORRECTOR COUNTS:

HORZ. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

HCORMAQ7S01

Total Corrs. added from CALL to C1: 1

Net increase in Corrs. from CALL to C1: 1

Change in H Corr. parameters from CALL to C1:

Element Before After

MBC7S00HH 0.41168578 0.81168578
MBC7S02HH 0.41168578 0.81168578
MBC7S05HH 0.41168578 0.81168578
MBC7S08HH 0.41168578 0.81168578
MBC7R06HH 0.41168578 0.81168578
MBC7R09HH 0.41168578 0.81168578
MBC7R10AHH 0.41168578 0.81168578

VERT. PLANE:

Corrs. deleted from CALL to C1

MBC7S02VV
MBC7R07VV

Total Corrs. deleted from CALL to C1: 2

Corrs. added from CALL to C1

Total Corrs. added from CALL to C1: 0

Net increase in Corrs. from CALL to C1: -2

Change in H Corr. parameters from CALL to C1:

Element Before After

MBC7S03VV	0.41168578	0.81168578
MBC7S05VV	0.41168578	0.61168578
MBC7S08VV	0.41168578	0.61168578
MBC7R08VV	0.41168578	0.81168578

ARC 8

BPM COUNTS:

HORZ. PLANE:

BPMs deleted from BALL to B1

IPM8A11
IPM8A15
IPM8A19
IPM8A23
IPM8A27
IPM8A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

HBPMD102
HBPMD111
HBPMD132
HBPMD141
HBPMD162
HBPMD171
HBPMD201
HBPMD224

Total BPMs added from BALL to B1: 8

Net increase in BPMs from BALL to B1: 2

Change in H BPM parameters from BALL to B1:

Element Before After

VERT. PLANE:

BPMs deleted from BALL to B1

IPM8A11
IPM8A15
IPM8A19
IPM8A23
IPM8A27
IPM8A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

VBPMD102
VBPMD111
VBPMD132
VBPMD141
VBPMD162
VBPMD171

VBPMD201
VBPMD224

Total BPMs added from BALL to B1: 8

Net increase in BPMs from BALL to B1: 2

Change in V BPM parameters from BALL to B1:

Element Before After

CORRECTOR COUNTS:

HORZ. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

HCORMAW8S01

Total Corrs. added from CALL to C1: 1

Net increase in Corrs. from CALL to C1: 1

Change in H Corr. parameters from CALL to C1:

Element Before After

MBC8S00HH 0.36094377 0.56094377
MBC8S02HH 0.36094377 0.46094377
MBC8S05HH 0.36094377 0.46094377
MBC8S10HH 0.36094377 0.46094377
MBC8R02HH 0.36094377 0.56094377
MBC8R03HH 0.36094377 0.56094377
MBC8R04HH 0.36094377 0.56094377
MBC8R08HH 0.36094377 0.56094377

VERT. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

Total Corrs. added from CALL to C1: 0

Net increase in Corrs. from CALL to C1: 0

Change in H Corr. parameters from CALL to C1:

Element Before After

MBC8S01VV 0.36094377 0.46094377

MBC8S02VV	0.36094377	0.46094377
MBC8S03VV	0.36094377	0.46094377
MBC8S05VV	0.36094377	0.66094377
MBC8S07VV	0.36094377	0.46094377
MBC8S08VV	0.36094377	0.66094377
MBC8S09VV	0.36094377	0.56094377
MBC8A04VV	0.36094377	0.46094377
MBC8A06VV	0.36094377	0.46094377
MBC8A08VV	0.36094377	0.46094377
MBC8A10VV	0.36094377	0.46094377
MBC8A12VV	0.36094377	0.46094377
MBC8A14VV	0.36094377	0.46094377
MBC8A16VV	0.36094377	0.46094377
MBC8A18VV	0.36094377	0.46094377
MBC8A20VV	0.36094377	0.46094377
MBC8A22VV	0.36094377	0.46094377
MBC8A24VV	0.36094377	0.46094377
MBC8A26VV	0.36094377	0.46094377
MBC8A28VV	0.36094377	0.46094377
MBC8A30VV	0.36094377	0.46094377
MBC8A32VV	0.36094377	0.46094377
MBC8R02VV	0.36094377	0.46094377
MBC8R04VV	0.36094377	0.46094377
MBC8R08VV	0.36094377	0.46094377

ARC 9

BPM COUNTS:

HORZ. PLANE:

BPMs deleted from BALL to B1

IPM9A11
IPM9A15
IPM9A19
IPM9A23
IPM9A27
IPM9A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

HBPMD89
HBPMD98
HBPMD119
HBPMD128
HBPMD149
HBPMD158
HBPMMQA9R06
HBPMD199

Total BPMs added from BALL to B1: 8

Net increase in BPMs from BALL to B1: 2

Change in H BPM parameters from BALL to B1:

Element Before After

VERT. PLANE:

BPMs deleted from BALL to B1

IPM9A11
IPM9A15
IPM9A19
IPM9A23
IPM9A27
IPM9A31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

VBPMD89
VBPMD98
VBPMD119
VBPMD128
VBPMD149
VBPMD158

VBPMMQA9R06
VBPMD199

Total BPMs added from BALL to B1: 8

Net increase in BPMs from BALL to B1: 2

Change in V BPM parameters from BALL to B1:

Element Before After

CORRECTOR COUNTS:

HORZ. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

HCORMAQ9S01

Total Corrs. added from CALL to C1: 1

Net increase in Corrs. from CALL to C1: 1

Change in H Corr. parameters from CALL to C1:

Element Before After

MBC9A03HH 0.32133756 0.42133756
MBC9A07HH 0.32133756 0.42133756
MBC9A11HH 0.32133756 0.42133756
MBC9A15HH 0.32133756 0.42133756
MBC9A19HH 0.32133756 0.42133756
MBC9A23HH 0.32133756 0.42133756
MBC9A27HH 0.32133756 0.42133756
MBC9A31HH 0.32133756 0.42133756

VERT. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

Total Corrs. added from CALL to C1: 0

Net increase in Corrs. from CALL to C1: 0

Change in H Corr. parameters from CALL to C1:

Element Before After

MBC9A01VV 0.32133756 0.42133756

MBC9A02VV	0.32133756	0.62133756
MBC9A04VV	0.32133756	0.62133756
MBC9A06VV	0.32133756	0.62133756
MBC9A08VV	0.32133756	0.62133756
MBC9A10VV	0.32133756	0.62133756
MBC9A12VV	0.32133756	0.62133756
MBC9A14VV	0.32133756	0.62133756
MBC9A16VV	0.32133756	0.62133756
MBC9A18VV	0.32133756	0.62133756
MBC9A20VV	0.32133756	0.62133756
MBC9A22VV	0.32133756	0.62133756
MBC9A24VV	0.32133756	0.62133756
MBC9A26VV	0.32133756	0.62133756
MBC9A28VV	0.32133756	0.62133756
MBC9A30VV	0.32133756	0.62133756
MBC9A32VV	0.32133756	0.62133756
MBC9R02VV	0.32133756	0.62133756

ARC A

BPM COUNTS:

HORZ. PLANE:

BPMs deleted from BALL to B1

IPMAA11
IPMAA15
IPMAA19
IPMAA23
IPMAA27
IPMAA31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

HBPMD102
HBPMD111
HBPMD132
HBPMD141
HBPMD162
HBPMD171
HBPMD199
HBPMD223

Total BPMs added from BALL to B1: 8

Net increase in BPMs from BALL to B1: 2

Change in H BPM parameters from BALL to B1:

Element Before After

VERT. PLANE:

BPMs deleted from BALL to B1

IPMAA11
IPMAA15
IPMAA19
IPMAA23
IPMAA27
IPMAA31

Total BPMs deleted from BALL to B1: 6

BPMs added from BALL to B1

VBPMD102
VBPMD111
VBPMD132
VBPMD141
VBPMD162
VBPMD171

VBPMD199
VBPMD223

Total BPMs added from BALL to B1: 8

Net increase in BPMs from BALL to B1: 2

Change in V BPM parameters from BALL to B1:

Element Before After

CORRECTOR COUNTS:

HORZ. PLANE:

Corrs. deleted from CALL to C1

Total Corrs. deleted from CALL to C1: 0

Corrs. added from CALL to C1

HCORMAWAS01

Total Corrs. added from CALL to C1: 1

Net increase in Corrs. from CALL to C1: 1

Change in H Corr. parameters from CALL to C1:

Element	Before	After
MBMAS00HH	0.27988216	0.47988216
MBCAS02HH	0.28956384	0.48956384
MBCAS08HH	0.28956384	0.48956384
MBCAS09HH	0.28956384	0.48956384
MBCAA03HH	0.28956384	0.38956384
MBCAA07HH	0.28956384	0.38956384
MBCAA11HH	0.28956384	0.38956384
MBCAA15HH	0.28956384	0.38956384
MBCAA19HH	0.28956384	0.38956384
MBCAA23HH	0.28956384	0.38956384
MBCAA27HH	0.28956384	0.38956384
MBCAA31HH	0.28956384	0.38956384
MBCAR01HH	0.28956384	0.48956384
MBCAR02HH	0.28956384	0.48956384
MBCAR03HH	0.28956384	0.48956384
MBCAR04HH	0.28956384	0.58956384
MBMAR00HH	0.27988216	0.47988216

VERT. PLANE:

Corrs. deleted from CALL to C1

MBCAS05VV
MBCAR06VV

Total Corrs. deleted from CALL to C1: 2

Corrs. added from CALL to C1

Total Corrs. added from CALL to C1: 0

Net increase in Corrs. from CALL to C1: -2

Change in H Corr. parameters from CALL to C1:

Element	Before	After
MBCAS02VV	0.28956384	0.48956384
MBCAS03VV	0.28956384	0.48956384
MBCAA01VV	0.28956384	0.48956384
MBCAA02VV	0.28956384	0.48956384
MBCAA04VV	0.28956384	0.48956384
MBCAA06VV	0.28956384	0.48956384
MBCAA08VV	0.28956384	0.48956384
MBCAA10VV	0.28956384	0.48956384
MBCAA12VV	0.28956384	0.48956384
MBCAA14VV	0.28956384	0.48956384
MBCAA16VV	0.28956384	0.48956384
MBCAA18VV	0.28956384	0.48956384
MBCAA20VV	0.28956384	0.48956384
MBCAA22VV	0.28956384	0.48956384
MBCAA24VV	0.28956384	0.48956384
MBCAA26VV	0.28956384	0.48956384
MBCAA28VV	0.28956384	0.48956384
MBCAA30VV	0.28956384	0.48956384
MBCAA32VV	0.28956384	0.48956384
MBCAR02VV	0.28956384	0.48956384
MBCAR04VV	0.28956384	0.48956384