

Introducing Direct Steering for Beamline Operations

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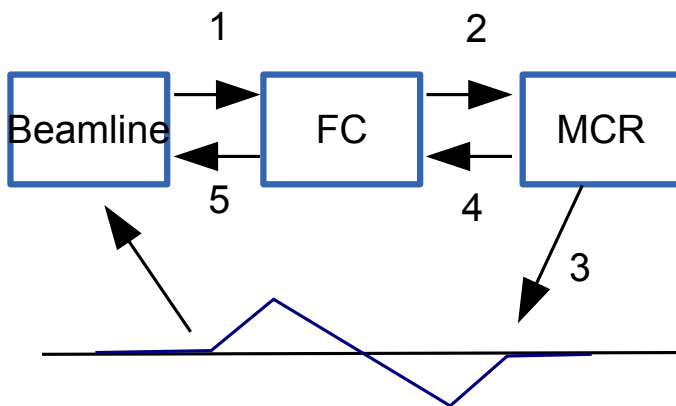
Outline

- What is “beamline steering”
- How to run it
 - What if you don't have EPICS
- How it interacts with other existing steering procedures
- How are MCR operators going to monitor beamline steering
- What is happening in the background
- Future improvements

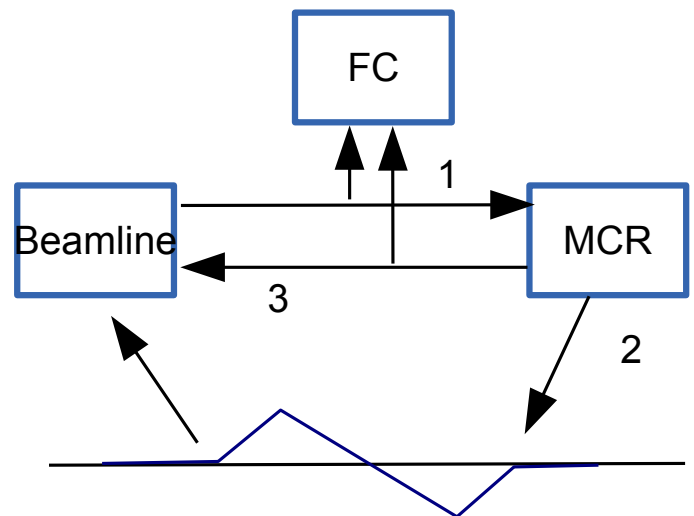


Recent History of Steering Request: Last Run

- From floor coordinators to web-page: reduce wait times and errors in communicating beamline steering requests
- Previous to last run, values were orally passed on twice. Last run they are typed in twice.



Two runs ago

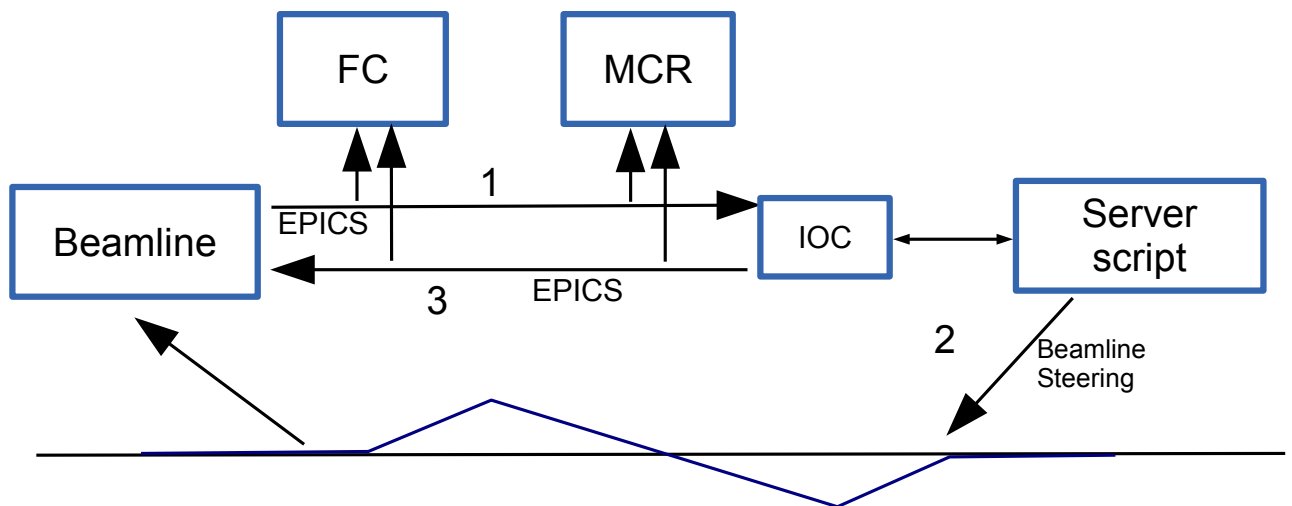


Last run



Steering This Run

- Skip the web page! Beamlines type in their angle requests
- Last run values were typed in twice. Now they will be typed in once.
- Hardly any waiting, 5 to 20 seconds to completion.



Steering Type Allowed for Beamline Steering

- ID and BM steering: angles only (not source positions, as usual)
 - One sector at a time is allowed. Lock-out mechanism enforces this. Hopefully not a problem since steering is of short duration.
- ID Canted Undulator steering: angles only, with usual limits
- Intensity Optimization not available at this time. Must still be requested by web page or through FC
 - Beamline Steering is allowed during a Intensity Optimization running on a different sector
- ID gap scans must still be requested by web page or through FC
- EPCIS access security for steering commands: same as for ID gaps
- Steering may be disabled by MCR operators during operational problems such as interrupted orbit correction or beam instability



Tests of Steering and Communication Mechanism

- Tested during machine studies by AOP/ASD
- Tested during last run by several volunteer beamlines with whole-straight section steering and CU steering



How to Steer Using EPICS windows

- Launch window
 - ADL files location depend on beamline. For example in MCR

```
medm -x -macro "BL=ID,S=01,SEC=1" \  
/usr/local/iocapps/adlsys/sr/id/BLSteering.adl
```

- Enter the xp and yp values
- Press “start”
- Wait a few seconds for background processes to run
- Watch beam move in small steps in 1-second interval
- To undo apply reverse angles
- Monitor the steering accumulators



Launch Window

ID01 Beamline Steering

Steering Enabled

Xp urad Yp urad

Positive Xp number means outboard steering
Negative Xp number means inboard steering

Max Xp Limit urad Min Xp Limit urad
Max Yp Limit urad Min Yp Limit urad

Requested Totals		Actual Totals		Actual Run Totals	
Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad
Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad
<input type="button" value="Reset Accumulator"/>		<input type="button" value="Reset Accumulator"/>			

Request Time

Finish Time

H Angle	<input type="text" value="134.4"/>	V Angle	<input type="text" value="72.8"/>
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Steering Message Enter Steering Amount

Steering Status Other steering

Error Messages



Enter Angles

ID01 Beamline Steering

Steering Enabled

Xp urad Yp urad

Positive Xp number means outboard steering
Negative Xp number means inboard steering

Max Xp Limit urad Min Xp Limit urad
Max Yp Limit urad Min Yp Limit urad

Requested Totals		Actual Totals		Actual Run Totals	
Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad
Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad
<input type="button" value="Reset Accumulator"/>		<input type="button" value="Reset Accumulator"/>			

Request Time

Finish Time

H Angle	<input type="text" value="134.4"/>	V Angle	<input type="text" value="72.8"/>
---------	------------------------------------	---------	-----------------------------------

Steering Message Enter Steering Amount

Steering Status Other steering

Error Messages

Press Green Button

ID01 Beamline Steering

Steering Enabled

Xp urad Yp urad

Positive Xp number means outboard steering
Negative Xp number means inboard steering

Max Xp Limit urad Min Xp Limit urad
Max Yp Limit urad Min Yp Limit urad

Requested Totals		Actual Totals		Actual Run Totals	
Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad
Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad
<input type="button" value="Reset Accumulator"/>		<input type="button" value="Reset Accumulator"/>			

Request Time

Finish Time

H Angle V Angle

Steering Message Enter Steering Amount

Steering Status Other steering

Error Messages

Watch for Feedback Messages

ID01 Beamline Steering

Steering Enabled

Xp urad Yp urad

Positive Xp number means outboard steering
Negative Xp number means inboard steering

Max Xp Limit urad Min Xp Limit urad
Max Yp Limit urad Min Yp Limit urad

Requested Totals		Actual Totals		Actual Run Totals	
Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad
Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad
<input type="button" value="Reset Accumulator"/>		<input type="button" value="Reset Accumulator"/>			

Request Time

Finish Time

H Angle V Angle

Steering Message Enter Steering Amount
Steering Status Other steering
Error Messages

Other Information: Steering Status PV

ID01 Beamline Steering

Steering Enabled

Xp urad Yp urad

Positive Xp number means outboard steering
Negative Xp number means inboard steering

Max Xp Limit urad Min Xp Limit urad
Max Yp Limit urad

Requested Totals		Actual	
Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad
Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad
<input type="button" value="Reset Accumulator"/>		<input type="button" value="Reset"/>	

Request Time
Finish Time

H Angle V Angle

Steering Message Enter Steering Amount
Steering Status
Error Messages

ID01:BLSteerStatus

☐ No Steering Requested ☐ Steering In Progress ☐ Other steering
☐ Steering Requested ☐ Steering Complete ☐ System Unavail

Other Information: Time Stamps and Accumulators

ID01 Beamline Steering

Steering Enabled

Xp urad Yp urad

Positive Xp number means outboard steering
Negative Xp number means inboard steering

Max Xp Limit urad Min Xp Limit urad
Max Yp Limit urad Min Yp Limit urad

Totals are determined by the server on workstations

Requested Totals		Actual Totals		Actual Run Totals	
Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad
Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad
<input type="button" value="Reset Accumulator"/>		<input type="button" value="Reset Accumulator"/>		<input type="button" value="Reset Accumulator"/>	

Steering just requested (not shown here)

Request Time

Finish Time

Will be updated after steering is complete

H Angle		V Angle	
134.4	72.8		

Steering Message Enter Steering Amount

Steering Status Other steering

Error Messages

What if You don't have MEDM windows and EPICS?

- Contact Marty Smith mls@anl.gov, which provide you with list of PVs to work with
- ID24 does not have EPICS and was able to get automatic steering running



What MCR Operators Monitor: Server Log

```
-----
14:34:40: done for sector 1.
14:34:40: Steering lock status: 0 0
-----
14:35:10: Steering lock status: 0 1
14:35:10: Start steering for ID 1 ...
14:35:10: Reading xp yp request of 1 ...
14:35:10: Steering ID 1: 0.001 0.001
14:35:10: compare BPLD limits for sector 1...
14:35:10: The setpoints of 1 bpms are within the BPLD trip limits.
14:35:10: start steering sector 1 ...
14:35:10: Steer 1 xp=0.001 yp=0.001
14:35:10: change corr range for sector 1...
14:35:11: start sector 1 h plane steer...
14:35:11: apply setpoints for sector 1...
14:35:13: steered for h plane.
14:35:13: Restore corr range errors after steering (h plane)...
14:35:14: change corr range for sector 1...
14:35:14: start sector 1 v plane steer...
14:35:14: apply setpoints for sector 1...
14:35:16: steered for v plane.
14:35:16: Restore corr range errors after steering (v plane)...
14:35:17: sector 1 steering done.
14:35:17: updating accumulator for sector 1...
14:35:17: done for sector 1.
14:35:17: Steering lock status: 0 0
```

Previous steering

Last steering

7 seconds elapsed

Print Save As... Email... Expand Dialog...

Start Abort

Direct Steering for Beamlines May 19th 2016



What MCR Operators Monitor: Steering Statuses

During session, all of the colors are green. One blue color would appear during steering



Steering Status

Sector	BM	ID	US	DS
01	■	■		
02	■	■		
03	■	■		
04	■	■		
05	■	■		
06	■	■		
07	■	■		
08	■	■		
09	■	■		
10	■	■		
11	■	■		
12	■	■	■	■
13	■	■	■	■
14	■	■		
15	■	■		
16	■	■	■	■
17	■	■		
18	■	■		
19	■	■		
20	■	■		
21	■	■	■	■
22	■	■		
23	■	■	■	■
24	■	■	■	■
25	■	■		
26	■	■		
27	■	■		
28				
29				
30	■	■		
31	■	■		
32	■	■		
33	■	■		
34	■	■	■	■
35	■	■		

■ No steering requested

■ Steering requested

■ Steering in progress

■ Steering complete

■ System not available

■ Steering Allowed

■ No Steering Allowed

Steering Counts

Sector	BM	ID	US	DS
01	0	0		
02	0	0		
03	0	0		
04	0	0		
05	0	0		
06	0	0		
07	0	0		
08	0	0		
09	0	0		
10	0	0		
11	0	0		
12	0	0	0	0
13	0	0	0	0
14	0	0		
15	0	0		
16	0	0	0	0
17	0	0		
18	0	0		
19	0	0		
20	0	0		
21	0	0	0	0
22	0	0		
23	0	0	0	0
24	0	0	0	0
25				
26	0	0		
27	0	0		
28				
29				
30	0	0		
31	0	0		
32	0	0		
33	0	0		
34	0	0	0	0
35	0	0		

In general successful steerings will not attract the attention of the MCR

However, alarms will be heard when an error message is sent to a beamline. Operator will read the steering status and error message of that beamline

MCR Operators May Disable Steering

ID Beamline Steering									
	Xp	Yp	Steering Status	Steering Status	Run Accumulators		Steering Counts		
					Xp(urad)	Yp(urad)	Sec	US	DS
			Steering Allowed						
			No Steering Allowed						
ID01	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID02	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID03	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID04	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID05	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID06	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID07	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID08	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID09	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID10	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID11	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID12	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	0
ID13	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	0
ID14	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID15	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID16	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	0
ID17	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID18	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID19	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID20	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID21	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	0
ID22	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID23	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	0
ID24	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	0
ID26	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID27	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID30	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID31	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	
ID32	0.000	0.000	Request Steering	Other steering	Reset	0.000	0.000	0	

MCR Operators May Disable Steering

ID01 Beamline Steering

Steering Disabled

Xp urad Yp urad

Positive Xp number means outboard steering
Negative Xp number means inboard steering

Max Xp Limit urad Min Xp Limit urad
Max Yp Limit urad Min Yp Limit urad

Requested Totals		Actual Totals		Actual Run Totals	
Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad
Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad
<input type="button" value="Reset Accumulator"/>		<input type="button" value="Reset Accumulator"/>			

Request Time

Finish Time

H Angle V Angle

Steering Message Enter Steering Amount

Steering Status Other steering

Error Messages

“Request
Steering”
button
disappears

Steering Limits Imposed by IOC and Server

Beamline-settable limit;
self-imposed

EPICS "Limit" on limit is
 ± 50 urad in x, ± 50 urad in y

In addition, server makes
sure that any steering
proposed do not exceed
the steering interlock
minor alarm – a much larger
value.

Message will be given if
that is the case.

ID01 Beamline S

Steering Enabled

Xp urad Yp urad

Positive Xp number means outboard steering
Negative Xp number means inboard steering

Max Xp Limit urad Min Xp Limit urad
Max Yp Limit urad Min Yp Limit urad

Requested Totals		Actual Totals		Actual Run Totals	
Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad	Xp	<input type="text" value="0.000"/> urad
Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad	Yp	<input type="text" value="0.000"/> urad
<input type="button" value="Reset Accumulator"/>		<input type="button" value="Reset Accumulator"/>			

Request Time

Finish Time

H Angle	134.4	V Angle	72.8
---------	-------	---------	------

Steering Message Enter Steering Amount

Steering Status Other steering

Error Messages

Button will not "do" anything
if xp or yp request
exceeds limit



Preparations for Start-up

- Beamlines are invited to run “pretend” steerings during Machine Start-up Week and watch the steering accumulators change and the number of steerings increase
- Again

```
medm -x -macro "BL=ID,S=01,SEC=1" \  
/usr/local/iocapps/adlsys/sr/id/BLSteering.adl
```
- Accumulators will be reset on first day of run
- Request patience on the first day of the run, in case things go awry.
 - Web-based steering will still be available as back-up



What is Happening in Background

- Local IOC decides whether the steering parameters are ok, then changes value of a “start” PV
- Tcl/tk process on a workstation waiting for this “Start” PV to change state
- Conducts further test
 - If fails, then writes and sends message sufficient for beamlines and MCR operators to understand
 - If succeeds, then start a steering by applying a corrector bump and orbit setpoint bump by feedforward.
- Make a new SR operations save (“User-Beam Operator Preferred” i.e. UBOP) after each steering

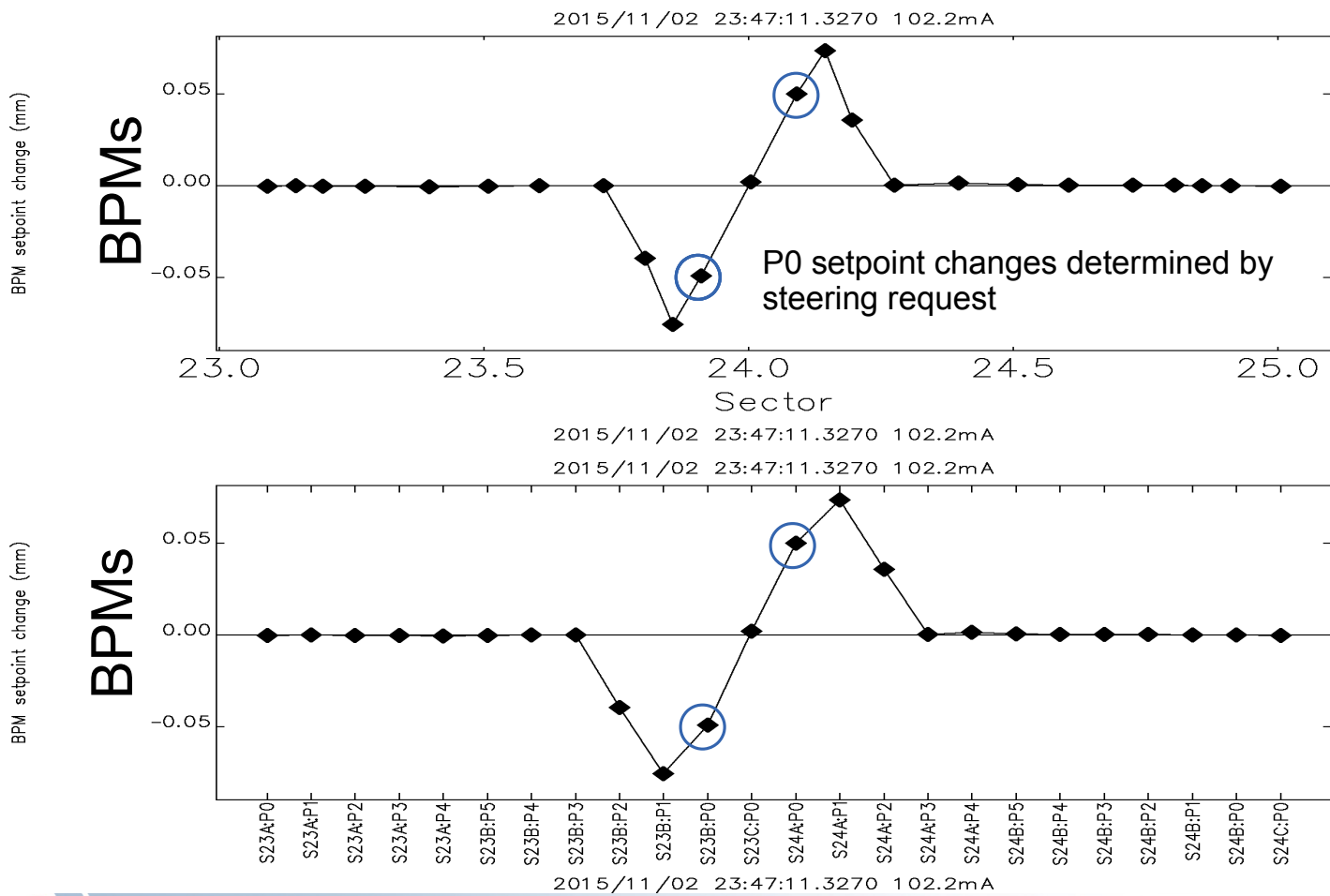


Steering Integrated into Global Orbit Correction by Feedforward

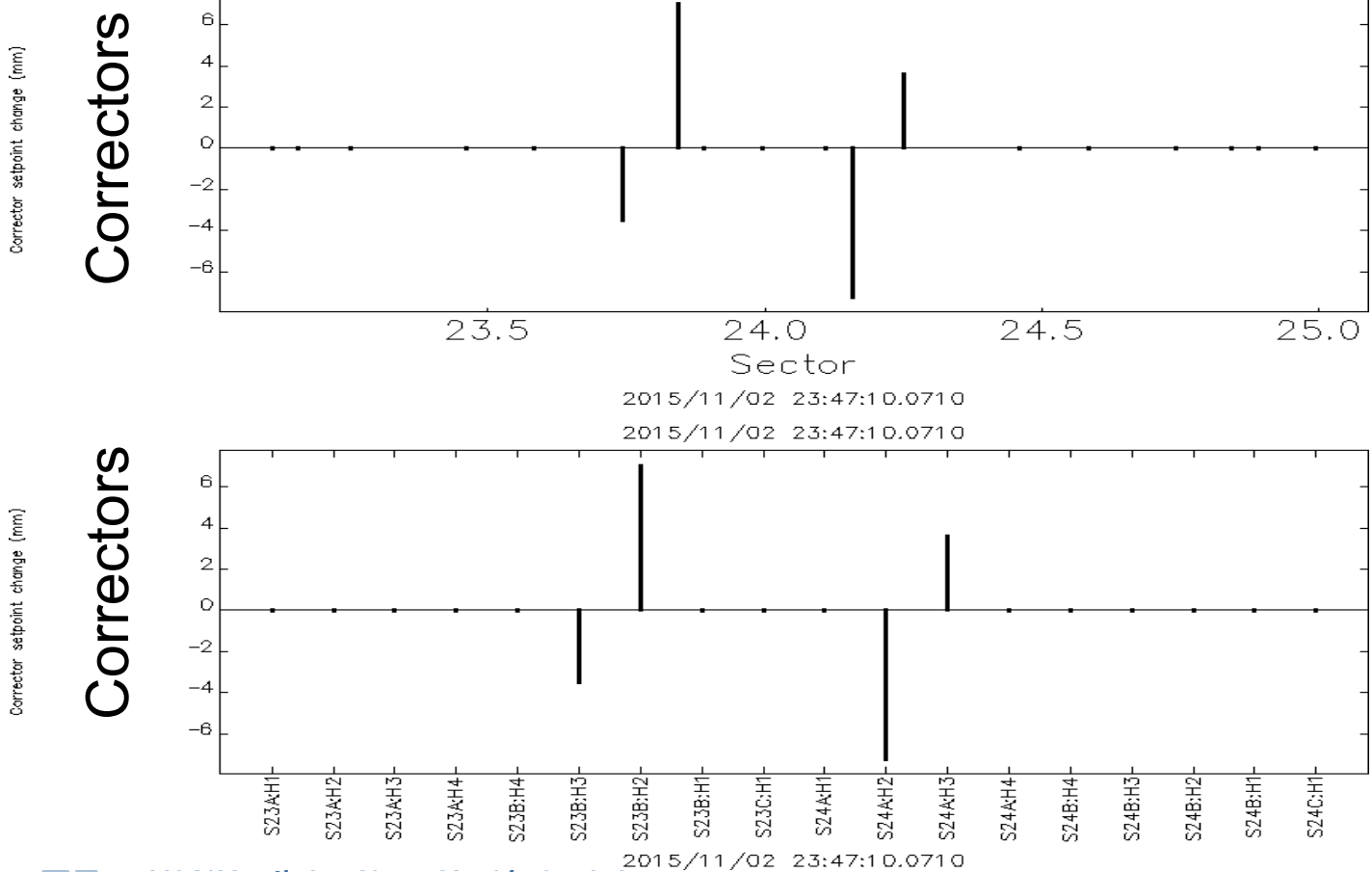
- Introduced in Dec 2015 without telling you. ;)
- Global orbit correction is running at 10 Hz at all times including x-ray bpm
- Removes x-ray bpms from global orbit correction if necessary
- Server calculates “delta waveforms” for bpm and corrector set points and applies these as a feedforward signal
- Maximum orbit change is about 2 μm (see as step locally)
- Repeat feedforward waveform every second a certain number of times
- X-plane goes first, then y-plane. (Can be simultaneous if we really wanted to)
- Data is applied in between datapool 10 Hz updates, which ensures that orbit correction is always running everywhere.



Example of Feedforward Delta Waveforms (Bpms)



Example of Feedforward Delta Waveforms (Correctors)



Future Improvements

- Turn off “lock-out” at some point during the next run. That is, sectors would steer simultaneously and independently.
 - Need to write a multi-threaded server script.
 - Simultaneous steering does not perturb the beam unduly
- Intensity Optimization can also be commanded by the beamline in the future, but we think it is a lower priority for now.
- Presently x-ray bpms for a sector are removed automatically from slow orbit feedback when a steering is requested for that sector. Some of the better x-ray bpms may be allowed to stay in after a steering.

