

# SIS for Orbit and Correctors

- First implementation of SIS interlocks on beam position and CODs settings commissioned and made operational in STABLE BEAMS (CODs only).
  - Beam position from concentrated data of Orbit Feedback.
  - COD data directly from PCs (~1000 subscriptions).
  - Reference settings and tolerances stored in the LSA DB, controlled through the LHC steering application (YASP).
    - Reference, tolerance, enabled for interlock (per COD/monitor), no. out-of-tolerance elements to trigger dump.
    - Defined as critical settings with limited access.
  - Configured to dump the corresponding beam.
  - One group of settings for injection+ramp+squeeze, one group for stable beams.
    - To be validated by experience.
  - Independent of the interlocks for injection for the experiments (triplet CODs and sep. dipoles).

# Orbit Interlock Settings Control (I)

**SIS Reference Control**

Settings Control | Settings Viewer

**Selection**

Beam: B1 | Plane: Hor.

Type: CODs | Setting: Physics

**Table filter**

Name filter:

Tolerance cut:

Disabled elements:

**Tolerance**

Tolerance:

**Set tolerance**

**Dump Count**

Dump Count:

**Import Data** | Trim & Settings

B1 |  B2 |  Hor. |  Ver.

**Import Active Dataset >> Ref**

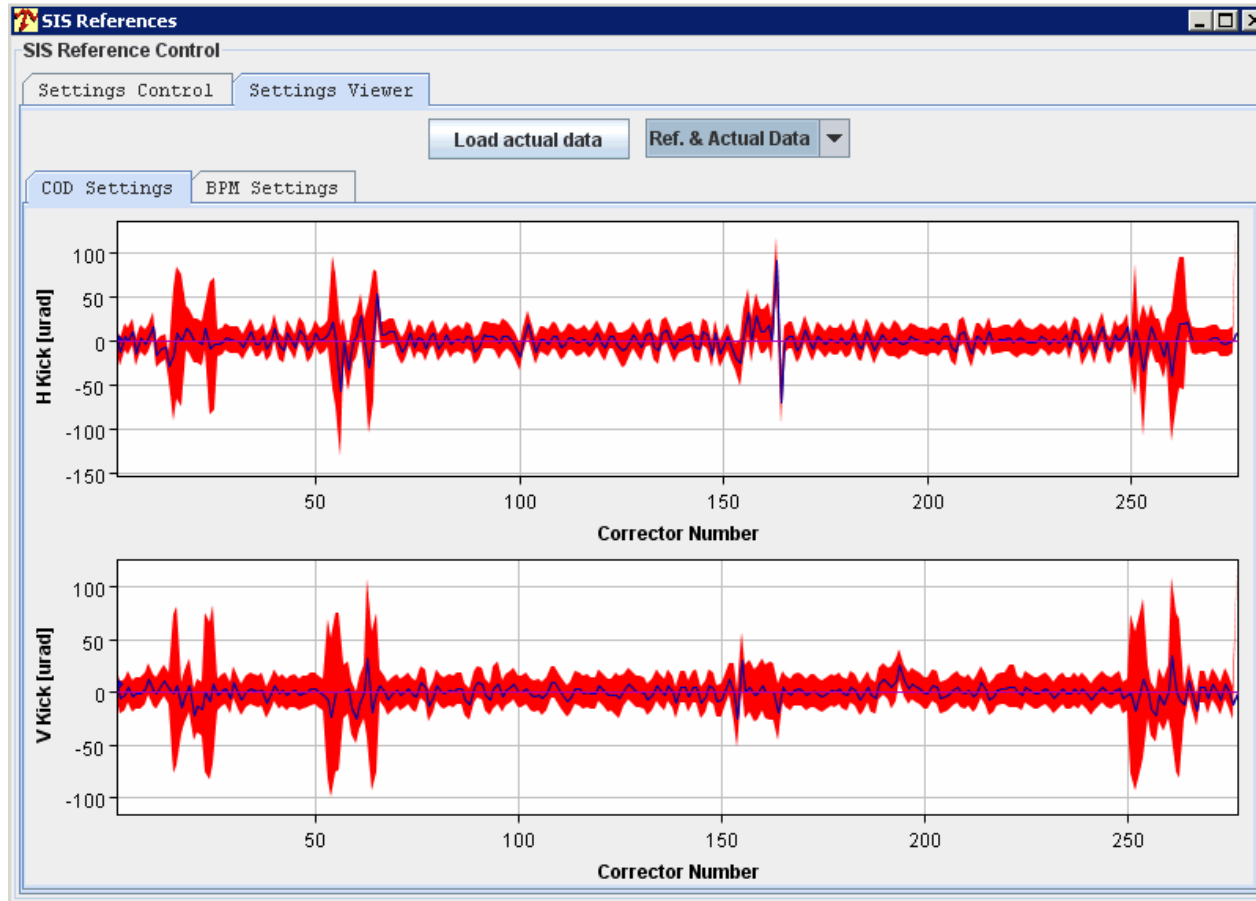
...for the selected type & settings

Name	Ref	Tol	Active
MCBH.34L1.B1	2.2	15	<input checked="" type="checkbox"/>
MCBH.32L1.B1	-13.3	15	<input checked="" type="checkbox"/>
MCBH.30L1.B1	4.8	15	<input checked="" type="checkbox"/>
MCBH.28L1.B1	-0.4	15	<input checked="" type="checkbox"/>
MCBH.26L1.B1	10.3	15	<input checked="" type="checkbox"/>
MCBH.24L1.B1	-13.7	15	<input checked="" type="checkbox"/>
MCBH.22L1.B1	3.2	15	<input checked="" type="checkbox"/>
MCBH.20L1.B1	-3.1	15	<input checked="" type="checkbox"/>
MCBH.18L1.B1	2.8	15	<input checked="" type="checkbox"/>
MCBH.16L1.B1	16.5	15	<input checked="" type="checkbox"/>
MCBH.14L1.B1	-15.7	15	<input checked="" type="checkbox"/>
MCBH.12L1.B1	-9.3	15	<input checked="" type="checkbox"/>
MCBCH.10L1.B1	-7.1	15	<input checked="" type="checkbox"/>
MCBCH.8L1.B1	-29.1	15	<input checked="" type="checkbox"/>
MCBCH.6L1.B1	-16.7	75	<input checked="" type="checkbox"/>
MCBYH.B4L1.B1	8.8	75	<input checked="" type="checkbox"/>
MCBYH.A4L1.B1	0	75	<input checked="" type="checkbox"/>
MCBXH.3L1	14	25	<input checked="" type="checkbox"/>
MCBXH.2L1	10.1	25	<input checked="" type="checkbox"/>
MCBXH.1L1	0	25	<input checked="" type="checkbox"/>
MCBXH.1R1			
MCBXH.2R1			
MCBXH.3R1			
MCBYH.4R1.E			
MCBCH.5R1.E			
MCBCH.7R1.E			
MCBCH.9R1.E			
MCBH.11R1.E			
MCBH.13R1.E			
MCBH.15R1.E			

Interface to edit interlock settings.

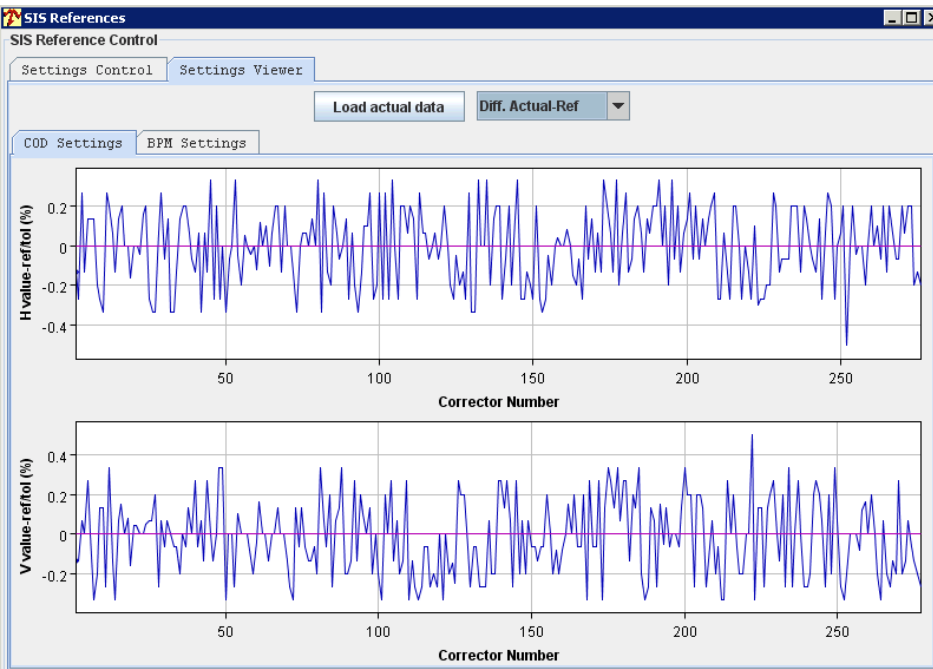
- Manual edition (table)
- Import of actual settings/readings into the interlock settings.
- ...

# Orbit Interlock Settings Control (II)

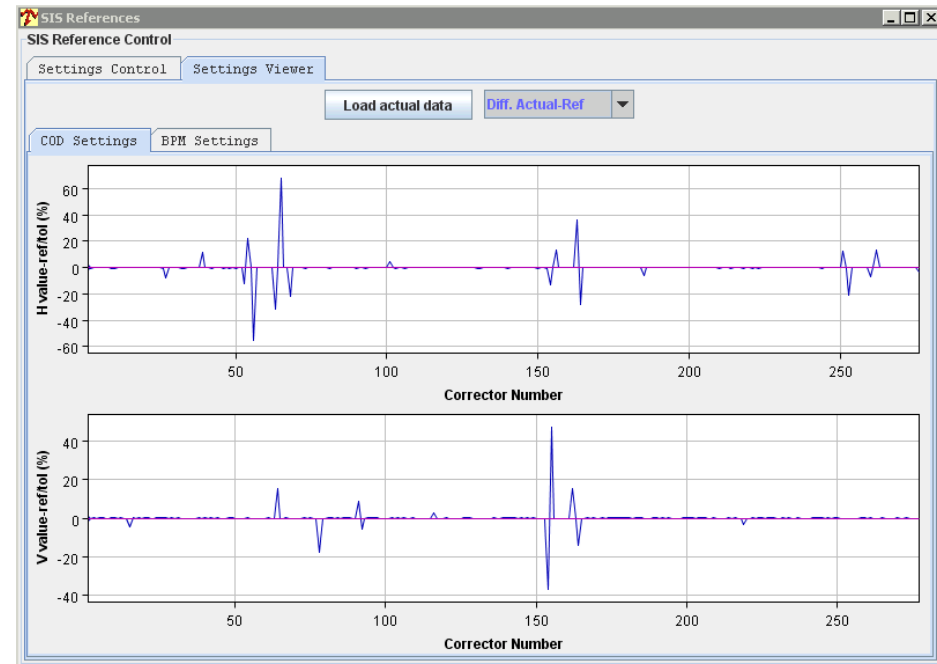


Display of interlock reference (green line), interlock tolerance (green band) and actual orbit/settings (here COD settings).

# Orbit Interlock Settings Control (III)



Good !



**! Critical situation !**

Some CODs close to 70% of tolerance margin.

Display of difference actual-ref normalized to tolerance.

# SIS UI

The screenshot displays the LHC SIS GUI OP interface. The main window is titled "LHC SIS GUI OP" and contains a menu bar with "File", "Operation", "Unlatch all channels", and "Help". Below the menu bar is a toolbar with a power button and a dropdown menu. The main area is divided into two panes. The left pane, titled "Permits Tree", shows a hierarchical tree of permits. The tree is expanded to show the following structure:

- P [AND] INJ\_B1\_PERMIT
- P [AND] INJ\_B2\_PERMIT
- P [AND] INJ\_PERMIT
- P [AND] POWERING\_PERMIT
- P [AND] RING\_ALARM
- P [AND] RING\_B1\_PERMIT
  - L [AND] INTENSITY\_B1
  - L [AND] LBDS\_PC\_SURVEY\_B1
  - L [AND] RING\_ORBIT\_B1
    - COD\_FIELD\_INTEGRAL\_B1
  - L [AND] COD\_SETTINGS\_B1
    - L [OR] COD\_SETTINGS\_PHYS\_B1
      - BEAM\_MODE\_NOT\_STABLE
    - L [AND] COD\_SETTINGS\_PHYS\_HW\_B1
      - ORBIT\_READING\_H\_B1
      - ORBIT\_READING\_V\_B1
- ✗ L [AND] TCDQ\_B1
- P [AND] RING\_B2\_PERMIT
  - L [AND] INTENSITY\_B2
  - L [AND] LBDS\_PC\_SURVEY\_B2
  - L [AND] RING\_ORBIT\_B2
    - COD\_FIELD\_INTEGRAL\_B2
  - L [AND] COD\_SETTINGS\_B2
    - L [OR] COD\_SETTINGS\_PHYS\_B2
      - BEAM\_MODE\_NOT\_STABLE
    - L [AND] COD\_SETTINGS\_PHYS\_HW\_B2
      - COD\_SETTINGS\_PHYS\_H\_B2
      - COD\_SETTINGS\_PHYS\_V\_B2
    - ORBIT\_READING\_H\_B2
    - ORBIT\_READING\_V\_B2
  - L [AND] TCDQ\_B2

The right pane, titled "Operations", contains sub-panes for "Properties" and "Analysis". Below these panes is a text area labeled "Log4j actions for logger [". At the bottom of the main window, there are controls for "Depth: 1", "Show", "Font size: +1 -1 Reset", "Expand All", and "Collapse all".

The bottom status bar shows "Combined \ Running tasks \". Below this, a line of text reads: "TCSG\_R6B1\_ACQ beam : Delta / tol [mm] = 1.099 0.968 @". The system tray at the bottom left shows the time "22:47:56" and the status "All channels unlatched".

## Interlocks implemented in SIS.

- Interlocks by plane and by beam.
- Trigger a dump of corresponding beam.
- Interlocks are latched >> catch 'transients'

interlocks / MPP / JW

# Configuration choices

- ❑ For the orbit correctors, the interlocks are only applied when the PC is ON. Elements that are OFF are ignored.
  - No attempt (for the moment) to protect against failing PCs.
- ❑ For moment correctors that are not delivering data are ignored.
  - Logic to be changed in 2010 – set a limit on number of missing elements.
- ❑ Tolerances were set to 20-25 microrad in December 2009 – corresponds to ~ 2 sigma.
  - To be fine tuned with more experience (margin for correcting the orbit without settings update for 1-2 weeks – if possible).
- ❑ Interlock triggers on correctors if **2 correctors are out of tolerance** (logic applied per beam & plane).
- ❑ For the moment the interlocks are LATCHED.
  - Better diagnostics in case of short transients.

# Operation

- ❑ The corrector interlocks were activated for STABLE BEAMS.
  - No problems, except one fill that was dumped because latched interlock was not reset at appropriate time → dump at the moment STABLE BEAMS was declared.
- ❑ The monitor interlocks were running but remained masked.
  - Need more experience on orbit stability (+ monitor reliability).

# Interlock description

- The logic of all interlocks of SIS will be described in a EDMS document – in preparation.
  - Submitted for comments/approvals after Chamonix.
  - Expect frequent changes for the coming few months !

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the  
Large  
Hadron  
Collider  
project

LHC Project Document No.  
**LHC-OP-MPS-00XX**

CERN Div./Group or Supplier/Contractor Document No.  
**BE/OP**

EDMS Document No.  
**XXXXXX**

Date: 2010-01-10

## MPS Procedure

### THE CONFIGURATION OF THE LHC MACHINE PROTECTION SYSTEM **CONFIGURATION OF THE LHC SOFTWARE INTERLOCK SYSTEM**

#### *Abstract*

This document describes the structure and interlock logic of the LHC Software Interlock System (LHC SIS).

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