Joint meeting of the LHC Collimation Study Group and Machine Protection Panel

Geneva, 27th April 2009

Status of CCC applications for the Roman pot controls

S. Redaelli, AB-OP

with M. Dutour, S. Ravat, I. Atanassov

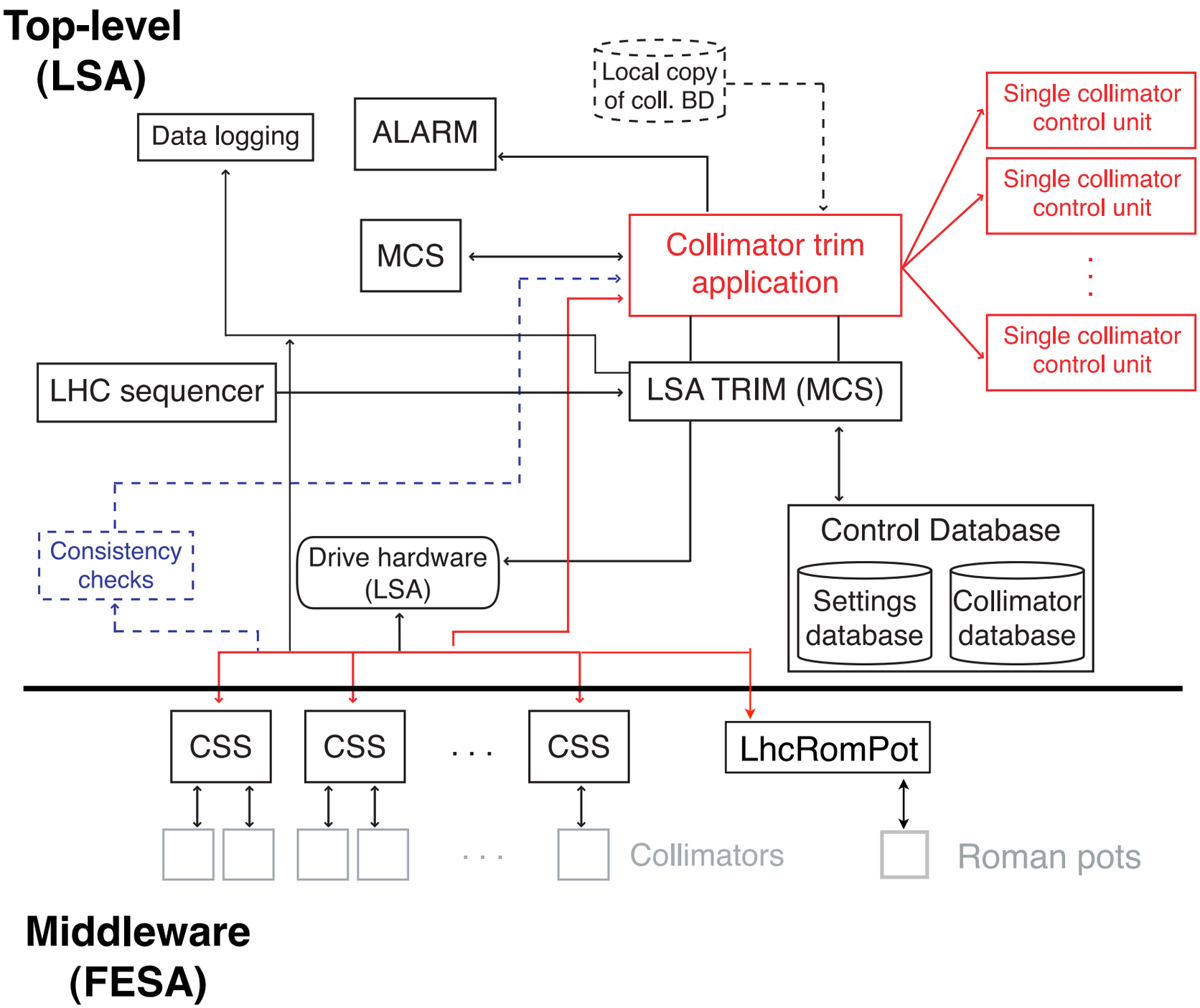
Acknowledgments: M. Lamont, P. Palazzi + TOTEM controls teams

Outline

- ☑ Introduction
- ☑ Results of integration tests
- ☑ Status of CCC applications
- ☑ Conclusions

Introduction

Collimator top-level controls architecture



OP provides the **top-level applications** for the Roman pot controls from the CCC.

In particular:

- Movements performed by the OP crew from the CCC following TOTEM requests
- Definition of **operational windows** for RP movements
- Application for RP alignment based on BLM reading, to have procedure comparable to collimators
- Handling of settings

We agreed on the FESA interface to control the **Roman pots** with the applications developed for the **LHC collimators**.

Specs of FESA interface

LHC Project Document No.
LHC-TC-ES-0002 rev 2.0

CERN Div./Group or Supplier/Contractor Document No.
AB-OP

EDMS Document No.
934341

the Large Hadron Collider project

Date: 2008-07-25

Engineering Specification

MIDDLE-LEVEL INTERFACE TO CONTROL MOVABLE DEVICES LIKE LHC COLLIMATORS

Abstract

This document describes the interface between the collimator middleware controls and the application for the collimator control from the control room. This interface is proposed as an easy way to extend the applications developed within the LHC Application Software (LSA) for the LHC collimator control to other movable devices. In particular, the cases of the beam dump diluter (TCDQ) and of the TOTEM Roman pots are considered in some details.

Prepared by:	*Checked by:*	*Approved by:*
S. Redaelli, A. Masi	**R. Bailey, C. Boucly, E. Carlier, M. Deile, M. Donze, M.P. Dutour, B. Goddard, M. Jonker, E. Radermacher, F. Lucas Rodriguez, J. Wenninger**	**R. Assmann, P. Collier, M. Lamont, R. Losito**

Definition of a minimum set of properties (summer 2008) that allow **plugging-in** the existing collimator applications onto the Roman pot middle-ware:
(1) requested positions; (2) limit functions; (3) measured positions; (4) machine states, error, warnings; (5) stop bottom.

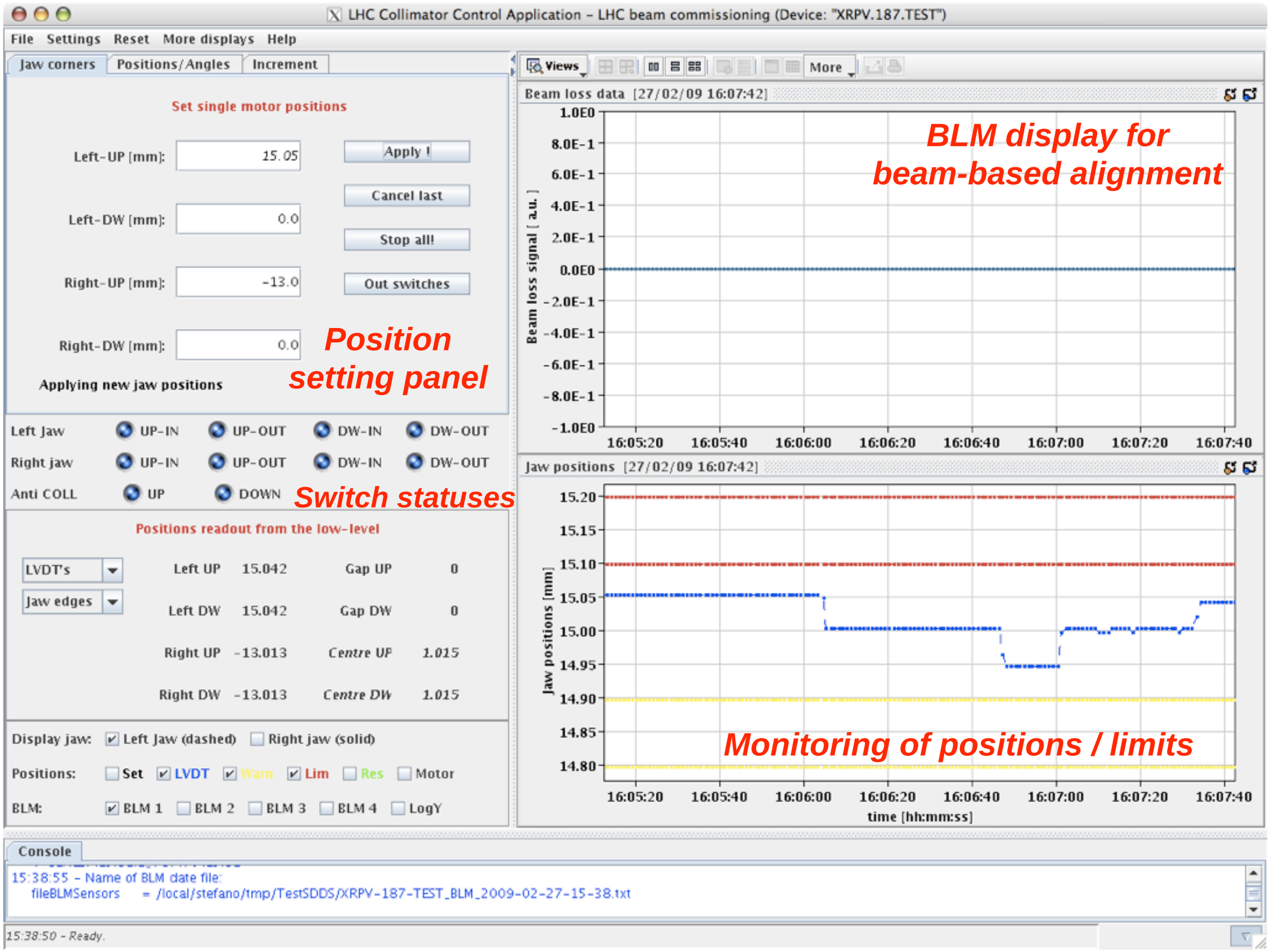
Development by M. Dutour, who translates the commands for the Roman pot low-level controls. *Details in the next talk...*

One **main difference** w.r. to collimators: Roman pots accept **discrete settings only**. No functions of time!

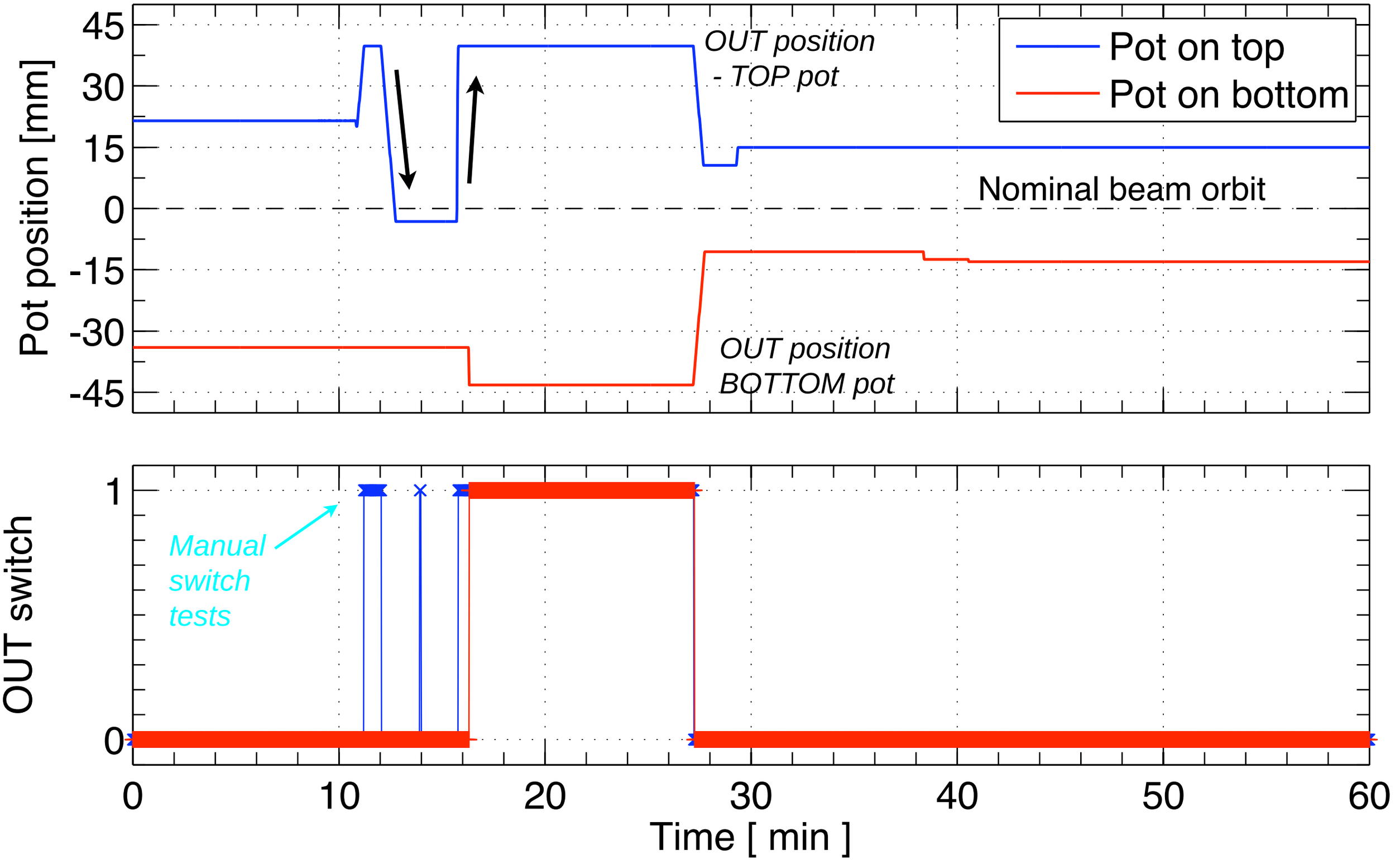
Meetings started at the end of last year to follow up these aspects.
Integration tests done at the Roman pot control test stand in bld. 187
(Mathias, Sylvain, Ivan and mytself)

Results on integration tests, Feb. 09

Two V pots moved for the first time with the CCC application!

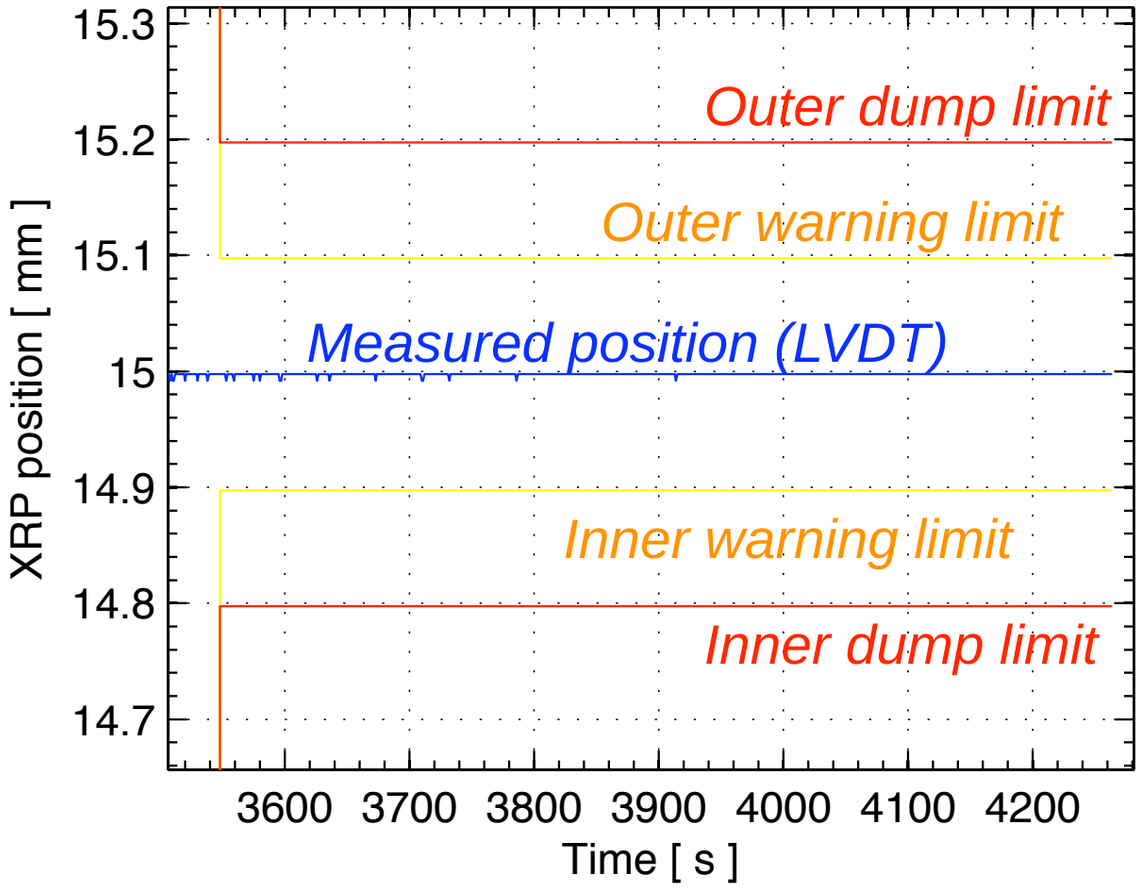


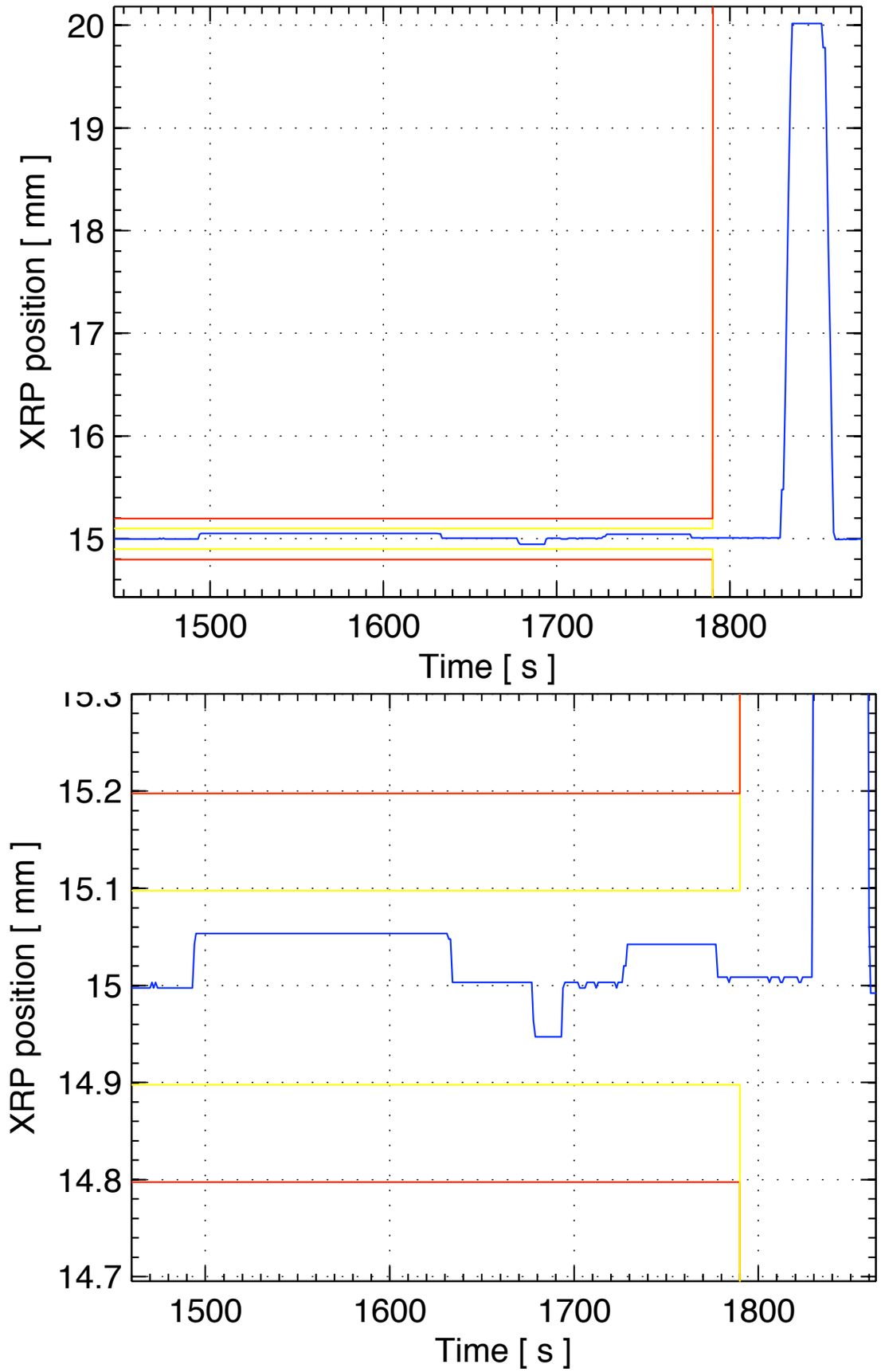
Basic positioning tests



Private logging of position variables also available...

Tests of interlock limits





Set tight tolerance thresholds of 200 microns (warning levels at 100 µm).

Small movements within OP limits.

Checked that settings outside thresholds are REJECTED.

Feedback from first integration test

For a vertical unit with two pots, we could test successfully:

- *Definition of position settings by the top level. Transmission to the PXI through the FESA layer.* ***Movements of the Roman pots*** *as specified!*
- *Response of switches for the OUT positions (monitoring other switches not yet operational)*
- *Verification of the ARMING/DISARMING mechanisms (operator requests + monitoring)*
- *Trigger of movements via software trigger.*
- *STOP functionality.*
- *Precise movements below 50 microns, within OP defined thresholds.*
- *Definition of discrete interlock limits by the top level. Transmission to the PXI through FESA.*
- *Zero-th order* ***check of machine protection tests****: rejection of position settings outside limits.*

List of follow-ups:

- *Implementation of monitoring of all switch statuses* → *Done: ready for tests*
- *Updated GUI's for Roman pots specific features* → *First prototype ready*
- *Implements appropriate FESA exceptions* → *Done: ready for tests*
- *Optimize reaction time of software trigger* → *Done: ready for tests*
- *Minor mistakes of variable assignments for limits (readout only)* → *Ongoing.*

Not addressed yet:

- *Protection of settings from unauthorized changes (Role-based access, RBAC, aspects)*
- *Full integration into the LSA TRIM application (Done: ready for tests)*
- *Finalize list of hardware alarms, warning and errors*
- *Trigger by hardware timing (not yet decided)*

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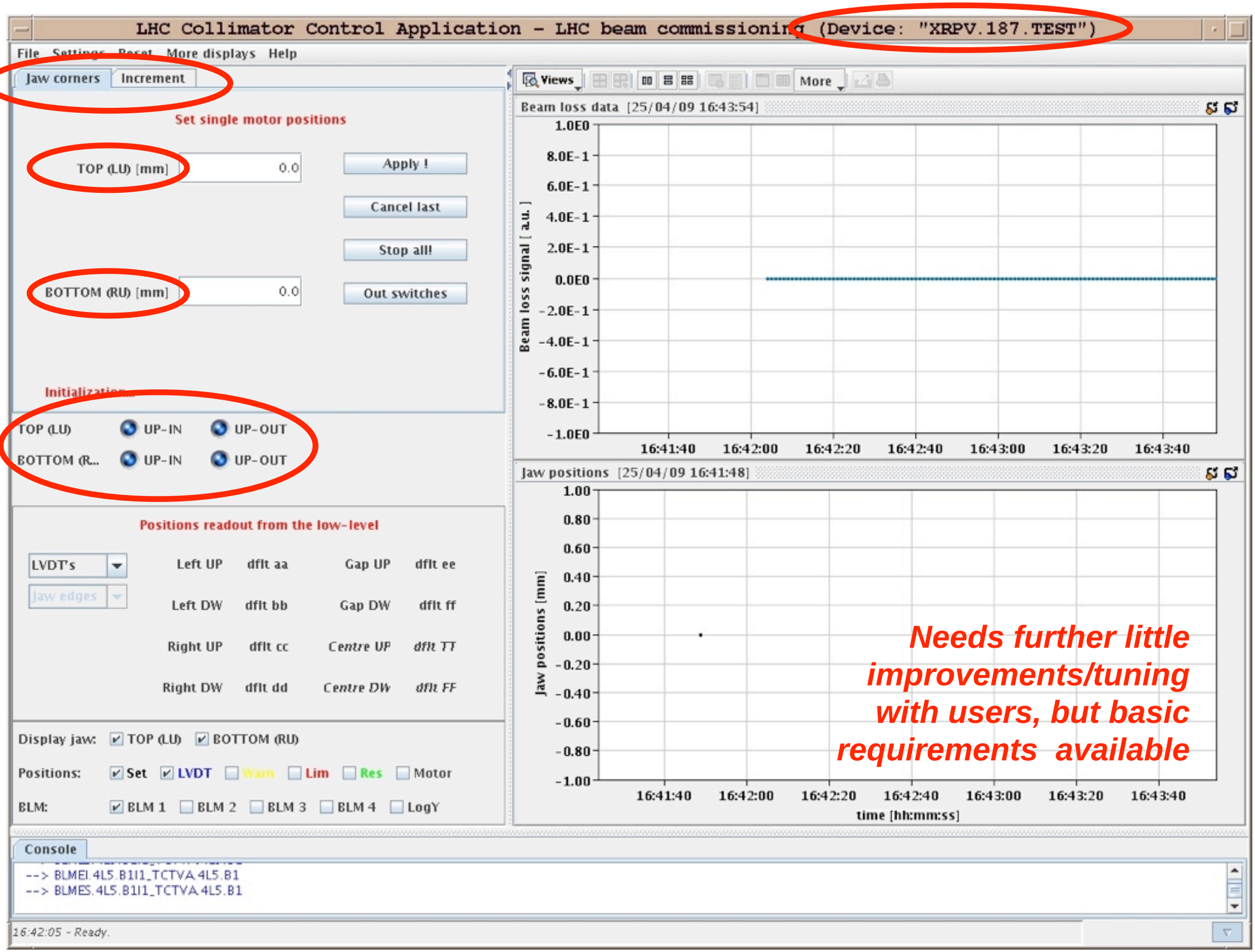
Updated RP application



LSA-TRIM implementation

Setting generation and storage in OP database

Definition of settings in beam size units w.r. to local beam orbit, like the other collimators

Configuration / RP names

TOTEM names | *Official LHC Layout names* | *"display" name for communication*

CMS relative	Roman Pot Product Breakdown Structure	Roman Pot order	RP mechanical design name	LHC layout name	Collimator application name	Roman Pot position	Left up	Right up	Collimator ID (index)	CCC name	CCC "expert" name
	EDMS 906715	EDMS 901060			EDMS 934341		EDMS 934341	EDMS 934341	EDMS 934341		
Left	tot.Rp.45.220.fr.hr	3	Station 3	XRPT1.6L5.B2	XRPTOT04	Horizontal			0	**XRPH.B6L5.B2**	**XRPT1.6L5.B2-XRPTOT04**
	tot.Rp.45.220.fr.tp	1			XRPTOT05	Vertical up			1	**XRPV.B6L5.B2**	**XRPT1.6L5.B2-XRPTOT05/06**
	tot.Rp.45.220.fr.bt	2			XRPTOT06	Vertical down					
	tot.Rp.45.220.nr.hr	4	Station 3	XRPT2.6L5.B2	XRPTOT10	Horizontal			2	**XRPH.A6L5.B2**	**XRPT2.6L5.B2-XRPTOT10**
	tot.Rp.45.220.nr.tp	5			XRPTOT07	Vertical up			3	**XRPV.A6L5.B2**	**XRPT2.6L5.B2-XRPTOT07/11**
	tot.Rp.45.220.nr.bt	6			XRPTOT11	Vertical down					
	tot.Rp.45.147.fr.hr	9	Station 1	XRPT1.4L5.B2	XRPTOT12	Horizontal			4	**XRPH.B4L5.B2**	**XRPT1.4L5.B2-XRPTOT12**
	tot.Rp.45.147.fr.tp	7			XRPTOT14	Vertical up			5	**XRPV.B4L5.B2**	**XRPT1.4L5.B2-XRPTOT14/13**
	tot.Rp.45.147.fr.bt	8			XRPTOT13	Vertical down					
	tot.Rp.45.147.nr.hr	10	Station 1	XRPT2.4L5.B2	XRPTOT15	Horizontal			6	**XRPH.A4L5.B2**	**XRPT2.4L5.B2-XRPTOT15**
	tot.Rp.45.147.nr.tp	11			XRPTOT09	Vertical up			7	**XRPV.A4L5.B2**	**XRPT2.4L5.B2-XRPTOT09/08**
	tot.Rp.45.147.nr.bt	12			XRPTOT08	Vertical down					
Right	tot.Rp.56.147.nr.hr	15	Station 1	XRPT1.4R5.B1	XRPTOT25	Horizontal			8	**XRPH.A4R5.B1**	**XRPT1.4R5.B1-XRPTOT25**
	tot.Rp.56.147.nr.tp	13			XRPTOT27	Vertical up			9	**XRPV.A4R5.B1**	**XRPT1.4R5.B1-XRPTOT27/26**
	tot.Rp.56.147.nr.bt	14			XRPTOT26	Vertical down					
	tot.Rp.56.147.fr.hr	16	Station 1	XRPT2.4R5.B1	XRPTOT23	Horizontal			10	**XRPH.B4R5.B1**	**XRPT2.4R5.B1-XRPTOT23**
	tot.Rp.56.147.fr.tp	17			XRPTOT28	Vertical up			11	**XRPV.B4R5.B1**	**XRPT2.4R5.B1-XRPTOT28/22**
	tot.Rp.56.147.fr.bt	18			XRPTOT22	Vertical down					
	tot.Rp.56.220.nr.hr	21	Station 3	XRPT1.6R5.B1	XRPTOT24	Horizontal			12	**XRPH.A6R5.B1**	**XRPT1.6R5.B1-XRPTOT24**
	tot.Rp.56.220.nr.tp	19			XRPTOT17	Vertical up			13	**XRPV.A6R5.B1**	**XRPT1.6R5.B1-XRPTOT17/20**
	tot.Rp.56.220.nr.bt	20			XRPTOT20	Vertical down					
	tot.Rp.56.220.fr.hr	22	Station 3	XRPT2.6R5.B1	XRPTOT16	Horizontal			14	**XRPH.B6R5.B1**	**XRPT2.6R5.B1-XRPTOT16**
	tot.Rp.56.220.fr.tp	23			XRPTOT19	Vertical up			15	**XRPV.B6R5.B1**	**XRPT2.6R5.B1-XRPTOT19/18**
	tot.Rp.56.220.fr.bt	24			XRPTOT18	Vertical down					

Detailed mapping of device names worked out.

Will provide both names every time to be sure that there are no communication errors...

Need to be EXTREMELY careful!!!

OP database for HW parameters

http://lhc-operation.web.cern.ch/lhc-operation/collimator/LHCCollimatorOPdatabase.asp

LHC Collimation Project

Home of the Project for the LHC Collimation System

Top	Project Team	Notes	Collimator List	Sounds/Movies	Meetings
Links	Papers	Talks (WG)	Layout IR3/7	AB Departm.	Pictures

Collimator operational information

Select by IP		
IP/BEAM	B1	B2
1	X	X
2	X	X
3	X	X
5	X	X
6	X	X
7	X	X
8	X	X
TI	X	X
ALL	X	X

Select collimators Family	
FAMILY	
TCP	TCLP
TCSG	INJP
TCLA	TCDI
TCT	TCDQ
OTHERS	
XRP	

ELEMENT_NAME	MTF links	FAMILY	IP	BEAM	ANGLE	Jaw Orientation	Summary	Photo 252	Photo LHC
TCLA.7L3.B2	+HCTCT__001-CQ000315 +Acceptance +ProDB	TCLA	IP3	B2	0.0	B/D/A/C	xls/pdf		
TCLA.6L3.B2	+HCTCT__001-CQ000313 +Acceptance +ProDB	TCLA	IP3	B2	0.0	B/D/A/C	xls/pdf		
TCLA.B5L3.B2	+HCTCT__001-CQ000318 +Acceptance +ProDB	TCLA	IP3	B2	0.0	B/D/A/C	xls/pdf		

Template for collimator HW parameters

CERN name (MTF) HCTCT__001-CQ000316
CERCA name TCT_065
MADX name TCLA.7R3.B1

ID	1013894
Angle	0.0
Material	W
Length	1.0
Beam	B1
Family	TCLA
IP	3
BLMI	BLMEI.7R3.B1I1_TCLA.7R3.B1
BLMS	BLMES.7R3.B1I1_TCLA.7R3.B1

Jaw corner notation

LEFT UP	B
LEFT DOWN	D
RIGHT UP	A
RIGHT DOWN	C

AXIS LEFT UP	1
AXIS LEFT DOWN	1
AXIS RIGHT UP	1
AXIS RIGHT DOWN	1
AXIS TANK	0

AXIS_A	1
AXIS_B	1
AXIS_C	1
AXIS_D	1
AXIS_E	0

Mechanical STOPS

	OUT	IN
LEFT UP	29.9806	-6.0609
LEFT DOWN	29.9867	-6.0624
RIGHT UP	-30.0021	6.0435
RIGHT DOWN	-29.9979	6.0441
ANTI - UP	0.6339	
ANTI - DOWN	0.6293	

Measurements in the metrology frame:

Mechanical STOPS

	OUT	IN
A	-30.0021	6.0435
B	29.9806	-6.0609
C	-29.9979	6.0441
D	29.9867	-6.0624

Mechanical stops

Max gap	AB	59.9827
	CD	59.9845
Min gap	AB	0.6339
	CD	0.6293

Switches

	OUT	IN
LEFT UP	29.3256	-5.3839
LEFT DOWN	29.3327	-5.3984
RIGHT UP	-29.3541	5.3875
RIGHT DOWN	-29.3359	5.3841
ANTI - UP	0.7469	
ANTI - DOWN	0.7393	

Switches

	OUT	IN
A	-29.3541	5.3875
B	29.3256	-5.3839
C	-29.3359	5.3841
D	29.3327	-5.3984

Switches

Max gap	AB	58.6797
	CD	58.6685
Min gap	AB	0.7469
	CD	0.7393

Maximum flatness error

Left	-0.0334
Right	0.0412

Maximum flatness error (mm)

AC	0.0412
BD	0.0334

Mechanical plays

Left UP	0.0180
Left DOWN	0.0150
Right UP	0.0080
Right Down	0.0070

Mechanical plays

A	0.0080
B	0.0180
C	0.0070
D	0.0150

Auto-retraction

Left UP	0.0070
Left DOWN	0.0030
Right UP	0.0040
Right Down	0.0050

Auto-retraction

A	0.0040
B	0.0070
C	0.0050
D	0.0030

Maximum tilt angle

Left Plus	3.00
Left Minus	-3.00
Right Plus	3.00

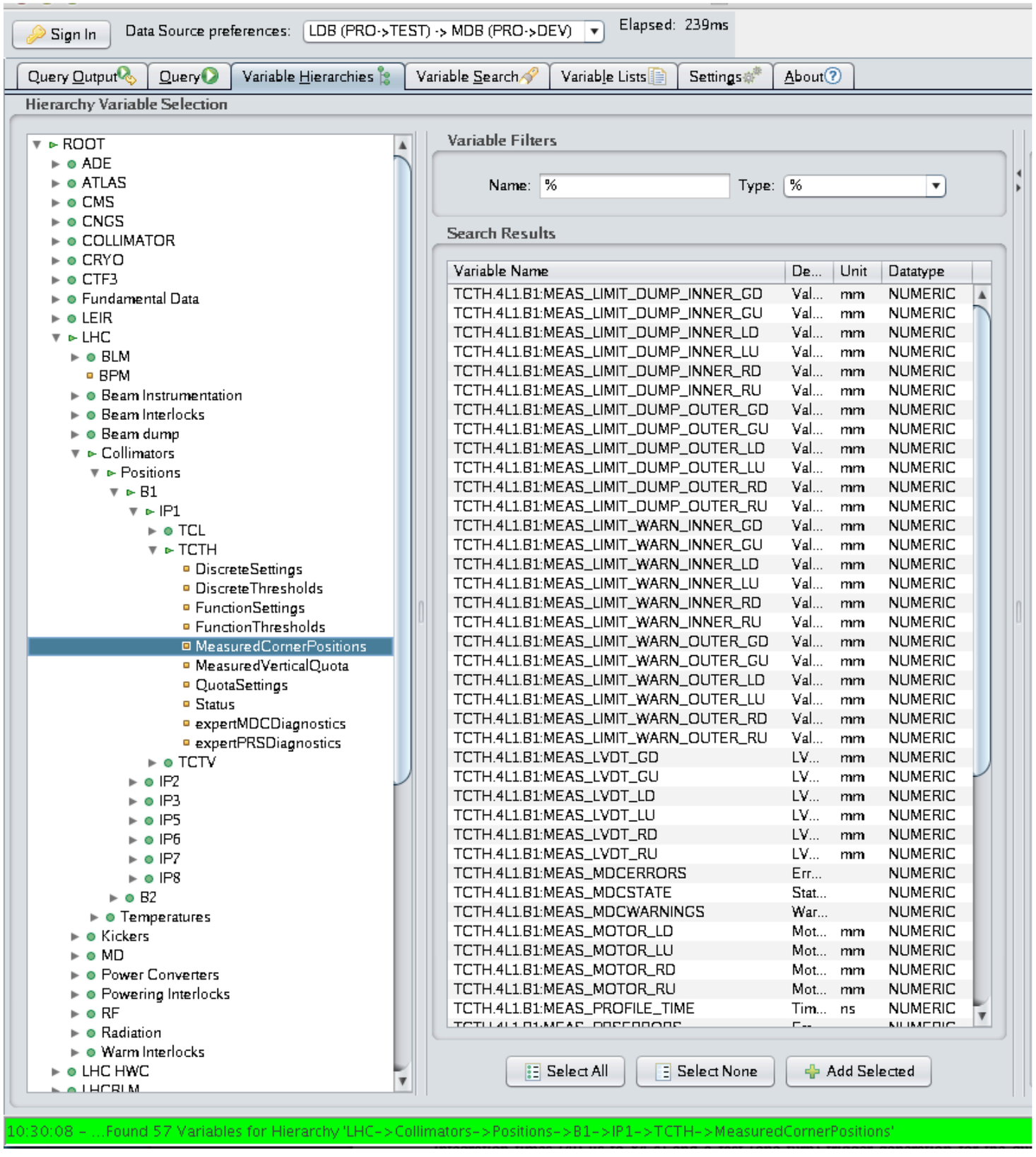
Maximum tilt angle

AC Plus	3.0000
AC Minus	-3.0000
BD Plus	3.0000

ELEMENT_NAME	MTF links	FAMILY	IP	BEAM	ANGLE	Jaw Orientation	Summary	Photo 252	Photo LHC	3D Layout
XRPV.B6L5.B2	+Unknown-Roman-Pot19 +Acceptance +ProDB	XRPV	IP5	B2	90.0	///	xls/pdf			
XRPH.B6L5.B2	+Unknown-Roman-Pot20 +Acceptance +ProDB	XRPH	IP5	B2	0.0	///	xls/pdf			
XRPH.A6L5.B2	+Unknown-Roman-Pot21 +Acceptance +ProDB	XRPH	IP5	B2	0.0	///	xls/pdf			
XRPV.A6L5.B2	+Unknown-Roman-Pot22 +Acceptance +ProDB	XRPV	IP5	B2	90.0	///	xls/pdf			
XRPV.B4L5.B2	+Unknown-Roman-Pot23 +Acceptance +ProDB	XRPV	IP5	B2	90.0	///	xls/pdf			
XRPH.B4L5.B2	+Unknown-Roman-Pot24 +Acceptance +ProDB	XRPH	IP5	B2	0.0	///	xls/pdf			
XRPH.A4L5.B2	+Unknown-Roman-Pot25 +Acceptance +ProDB	XRPH	IP5	B2	0.0	///	xls/pdf			

Input expected from TOTEM: provide the **mechanical references** for the OP database (switch positions, mechanical references, mechanical plays, ...)
BD tables ready to be filled!

Logging of Roman pot positions



Ready to define the same logging structure for the Roman pots.

Implementation by R. Billen, C. Roderick

Will save:

- Requested settings for positions
- Requested settings for interlocks
- Statuses

Additional requirements?

E.g.: for the collimators we also save expert properties for diagnostics purposes...

Post-mortem requirements?

http://cern.ch/timber

Conclusions

- **We have set-up a nice working environment for testing the various aspects related to the Roman pot controls**
- **First controls integration tests were very successful:**
  - *Profited from the availability of the controls test stand on surface.*
  - *3-tier controls architecture deployed and fully tested: saw the first RP movements!*
  - *Could set thresholds with the CCC application. Preliminary checks done.*
- **What comes next:**
  - *Follow-up open issues. Configure the 2009 system (24 pots).*
  - *More integration tests on surface - ToDo's being followed-up:*
    Web-based tracing of issues at **https://savannah.cern.ch/projects/rpcs**
  - *Remote commissioning of the system and machine protection tests*
    (will take inspiration from the validation tests developed for collimators).
- **What we expect from TOTEM:**
  - *Provide HW parameters for OP database for all the pots of the 2009 system*
  - *Handle the critical calibration data (discussed in the next talk)*
  - *HW commissioning in the tunnel, in particular machine protection functionality*
  - *Provide OP with the final set of "as-installed" operational parameters*
  - *Clarify procedures for the communication with the CCC...*
- ***Still a lot of work ahead...***