

LCLS Machine Protection System High Level Interface Improvements*

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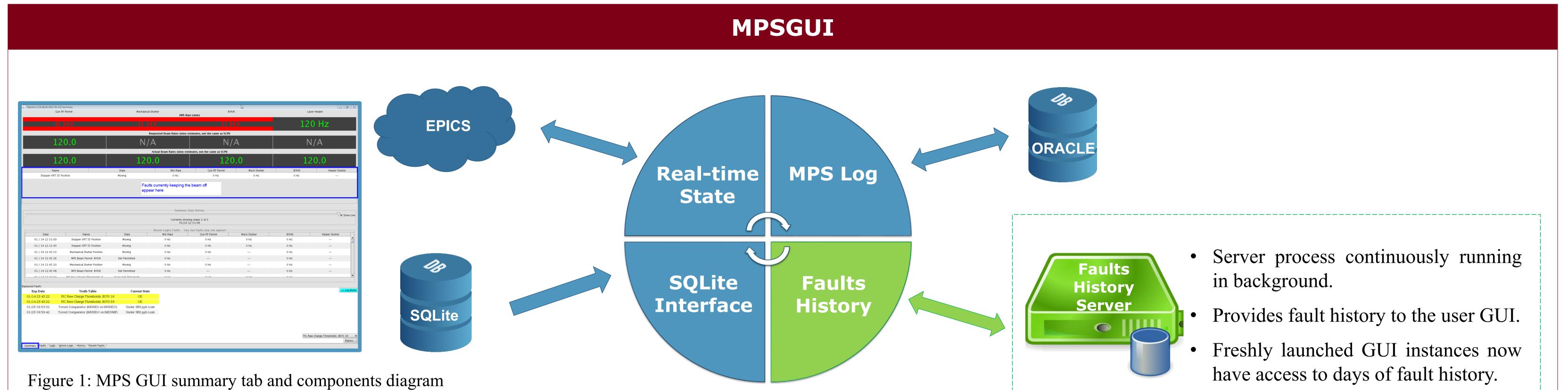
Abstract	Introduction	Project Motivation
The Linac Coherent Light Source (LCLS) is a free electron laser (FEL) facility operating at the SLAC National Accelerator Laboratory (SLAC). The LCLS Machine Protection System (MPS) contains thousands of inputs and hundreds of protection interlocks. Control room operators use a high-level Graphical User Interface (MPSGUI) to view and manage faults.	The purpose of the MPS is to prevent damage to beamline components due to beam. The MPS monitors the states of devices throughout the accelerator. If it detects a condition that may lead to damage, it turns off the beam. MPSGUI, a Java application, is the primary operator interface to the MPS. Operators use it to identify,	 Hard to find inputs associated with a given piece of logic. Missing information in displays. Challenging to identify faults that clear quickly. Difficult to associate a fault to the related logic details. Resolve issues that were discouraging operators from the CUL

using the GUI.

MPSGUI contains a wealth of useful information, from hardware input details to high-level logic flow, but in its first version it was difficult for accelerator operators to take full advantage of this. A recent project has greatly improved the workflow and usability of MPSGUI. This poster describes the enhancements that were made.

diagnose, and manage faults. The MPS defines its static input and logic configuration in SQLite database files. Real-time state information is hosted by EPICS signals. MPSGUI uses this combination of static and dynamic data to provide detailed fault and diagnostic information to operators.

The complete requirements list was defined during a series of meetings with control room operators. A task list was made based on MPSGUI's maintenance tickets, user feedback and feasibility balanced with the limited resources of time and budget.



User Interface Improvements

Figure 2: MPS GUI "Faults History" tab.

Date	Name	State	Min Rate	Gun RF Permit	Mech Shutter	BYKIK	Heater Shutter
/ 14 11:31:34	MPS Beam Permit: BYKIK	Not Permitted	0 Hz	Gun Kr Fermit	mech shutter	0 Hz	Heater Shutter
/ 14 11:31:26	MPS Beam Permit: BYKIK	Not Permitted	0 Hz			0 Hz	
/ 14 11:31:18	MPS Beam Permit: BYKIK	Not Permitted	0 Hz			0 Hz	
/ 14 11:31:10	MPS Beam Permit: BYKIK	Not Permitted	0 Hz			0 Hz	
/ 14 11:31:04	Stopper XRT S5 Position	Moving	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 11:31:04	CXI Configuration 4 Summary	Faulted	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 11:24:18	MPS Beam Permit: BYKIK	Not Permitted	0 Hz			0 Hz	
/ 14 11:23:44	MPS Beam Permit: BYKIK	Not Permitted	0 Hz			0 Hz	
/ 14 11:09:31	PIC Raw Charge Thresholds: Ll	Over High Threshold	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 10:55:20	Stopper XRT S5 Position	Moving	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 10:23:46	Stopper XRT S5 Position	Moving	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 10:18:30	Stopper XRT S5 Position	Moving	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 09:24:08	Mechanical Shutter Position	Moving	0 Hz	0 Hz		0 Hz	
/ 14 09:17:49	CXI:DG2:VGC:01 Gate Valve P	Moving	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 09:14:46	MPS Beam Permit: BYKIK	ByPass	0 Hz			0 Hz	
/ 14 09:11:45	Stopper XRT S5 Position	Open it into LogicTab Moving	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 09:11:27	TD11 Position	Moving	0 Hz	0 Hz	0 Hz		
/ 14 09:10:53	TD11 Position	Moving	0 Hz	0 Hz	0 Hz		
/ 14 09:10:53	Mechanical Shutter Position	Moving	0 Hz	0 Hz		0 Hz	
/ 14 09:09:53	TD11 Position	Moving	0 Hz	0 Hz	0 Hz		
/ 14 09:07:18	Mechanical Shutter Position	Moving	0 Hz	0 Hz		0 Hz	
/ 14 09:05:43	MPS Beam Permit: BYKIK	Not Permitted	0 Hz			0 Hz	
/ 14 09:02:24	MPS Beam Permit: BYKIK	Not Permitted	0 Hz			0 Hz	
/ 14 08:46:19	MPS Beam Permit: BYKIK	Not Permitted	0 Hz			0 Hz	
/ 14 08:46:17	DG2 Diagnostic Stopper Position	Moving	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 08:33:23	TD11 Position	Moving	0 Hz	0 Hz	0 Hz		
/ 14 08:31:44	OTRH2 Position	Moving	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 08:31:40	OTRH2 Position	In	10 Hz	10 Hz	10 Hz	10 Hz	
/ 14 08:31:36	OTRH2 Position	Moving	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 08:31:34	MPS Beam Permit: Mechanical	Not Permitted	0 Hz		0 Hz		
/ 14 08:31:22	OTRH2 Position	Moving	0 Hz	0 Hz	0 Hz	0 Hz	
/ 14 08:31:16	OTRH2 Position	In	10 Hz	10 Hz	10 Hz	10 Hz	
/ 14 08:31:12	OTRH2 Position	Moving	0 Hz	0 Hz	0 Hz	0 Hz	
- 1.4 00:21:00	MDC Deens Deenski Lleeter Chur	Alles, Dennelase al	A.U.=				A 114
	nore Logic / History Recent Faults						

Addition of a new tab displaying MPS Logic

Figure 3: MPS GUI "Logic" tab.

No Magnet P No Magnet P No Magnet P	lame Iower: QUM2				Case-		
No Magnet Po No Magnet Po	ower: QUM2	State	Min Rate 🗸	Gun RF Permit	Mech Shutter	BYKIK	Heater Shutter
No Magnet Pr		On	120 Hz	120 Hz	120 Hz	120 Hz	
	ower: QUM3	On	120 Hz	120 Hz	120 Hz	120 Hz	
No Main Manifold Ga	ower: QUM4	On	120 Hz	120 Hz	120 Hz	120 Hz	
	auge: LI21 Station 5	ОК	120 Hz	120 Hz	120 Hz	120 Hz	
No Main Manifold Ga	auge: LI22 Station 5	ОК	120 Hz	120 Hz	120 Hz	120 Hz	
No Main Manifold Ga	auge: LI23 Station 5	ОК	120 Hz	120 Hz	120 Hz	120 Hz	
No Main Manifold Ga	auge: LI24 Station 5	ок	120 Hz	120 Hz	120 Hz	120 Hz	
No Main Manifold Ga	auge: LI25 Station 5	ОК	120 Hz	120 Hz	120 Hz	120 Hz	
No Main Manifold Ga	auge: LI26 Station 5	ок	120 Hz	120 Hz	120 Hz	120 Hz	
No Main Manifold Ga	auge: LI27 Station 5	ОК	120 Hz	120 Hz	120 Hz	120 Hz	
No Main Manifold Ga	auge: LI28 Station 5	ОК	120 Hz	120 Hz	120 Hz	120 Hz	
No Main Manifold Ga	auge: LI29 Station 5	ОК	120 Hz	120 Hz	120 Hz	120 Hz	
No Main Manifold Ga	auge: LI30 Station 5	ок	120 Hz	120 Hz	120 Hz	120 Hz	
No Main Manifold Ga	auge: LI30 Station 9	ОК	120 Hz	120 Hz	120 Hz	120 Hz	
Misroe Ab	401 Decition	0*	120.05	120.11-	120.11-	120.11-	
Name: Main Manifold Ignored When: YAG01 Is In or	Gauge: LI23 Station 5 B	1 5 PP5.L23.72.58 1 6 SBST.L23.1.585 LCLS	GAUGE STATE OK STATE NOT_SECI T_OK STATE NOT_REA	URE NOT_SECURE Unlatch IDV NOT_READY Unlatch	NOT_SECURE Not Bype	Bypass Bypass Bypass Bypass	
Current State: OK Solution:							
Current State: OK Solution: Contacts:						~~~~	
Solution: Contacts: State	<u> </u>	A Min Rate	Gun RF Perm		Shutter	ВҮКІК	Heater Shutter
Solution: Contacts: <u>State</u> Not OK	-	F 0 Hz	0 Hz	(0 Hz	0 Hz	Heater Shutter
Solution: Contacts: State Not OK OK				(
Solution: Contacts: <u>State</u> Not OK	-	F 0 Hz	0 Hz	12	0 Hz	0 Hz 120 Hz	

• Map hardware inputs to high level logic.

Figure 4: MPS GUI "Input History" tab.

		Freeze
Time	DIM LTUS DIFF OF LOSS 1 L TUDPTUOLD shares of form 0 to 1	Message
14:59:49	BLM_LTU1_BLF545_LOSS_1_L THRESHOLD changed from 0 to 1	
14:59:49	BLM_LTU1_BLF545_LOSS_1_L THRESHOLD changed from 1 to 0	
14:59:49	BLM_LTU1_BLF545_LOSS_1_L THRESHOLD changed from 0 to 1	
14:59:49	BLM_LTU1_BLF545_LOSS_1_L THRESHOLD changed from 1 to 0	
14:59:49	BLM_LTU1_BLF545_LOSS_1_L THRESHOLD changed from 0 to 1	
14:59:49	BLM_LTU1_BLF545_LOSS_1_L THRESHOLD changed from 1 to 0	
14:59:49	BLM_LTU1_BLF545_LOSS_1_L THRESHOLD changed from 0 to 1	
14:59:49	BLM_LTU1_BLF545_LOSS_1_L THRESHOLD changed from 1 to 0	
14:50:43	PICM_BSY0_71_LOSSL THRESHOLD changed from 1 to 0	
14:50:37	BLM_LTU1_762_TEST_1_H THRESHOLD changed from 1 to 0	
14:50:36	PICM_BSY0_75_LOSS60H THRESHOLD changed from 1 to 0	
14:50:36	PICM_BSY0_78A_LOSS60H THRESHOLD changed from 1 to 0	
14:50:36	PICM_BSY0_76_LOSSL THRESHOLD changed from 1 to 0	
1 <mark>4:</mark> 50:36	IMUNDO_COMP_L2 STATE changed from 1 to 0	
1 <mark>4:</mark> 50:36	TC2S1L1 STATE changed from 1 to 0	
1 <mark>4:</mark> 50:36	Beam rate after POCKELS CELL changed from 0 HZ to 120 HZ	
1 <mark>4:</mark> 50:36	MPS_IN20_200_MSHT1_OUT FAULT changed from 0 to 1	
1 <mark>4:</mark> 50:36	Beam rate after BYKIK changed from 120 HZ to 0 HZ	
1 <mark>4:</mark> 50:36	MPS_IN20_200_MSHT1_IN FAULT changed from 1 to 0	
1 <mark>4:</mark> 50:36	PICM_BSY0_16_LOSS60H THRESHOLD changed from 1 to 0	
1 <mark>4:</mark> 50:35	BLM_UND1_1321_LOSS_10_L THRESHOLD changed from 1 to 0	
1 <mark>4:</mark> 50:35	PICM_BSY0_67_LOSS60H THRESHOLD changed from 1 to 0	
1 <mark>4:</mark> 50:35	PICM_BSY0_67_LOSSH THRESHOLD changed from 1 to 0	
1 <mark>4:</mark> 50:35	PICM_BSY0_78B_LOSS60H THRESHOLD changed from 1 to 0	
1 <mark>4:</mark> 50:35	PICM_BSY0_65_LOSS60H THRESHOLD changed from 1 to 0	
14:50:35	Beam rate after BYKJK changed from 0 HZ to 120 HZ	
14:50:35	MPS_IN20_200_MSHT1_IN FAULT changed from 0 to 1	
14:50:35	BLM_UND1_621_LOSS_30_L THRESHOLD changed from 1 to 0	
1 <mark>4:</mark> 50:35	PICS_LTU1_480_LOSS60H THRESHOLD changed from 1 to 0	
14:50:35	BLM_UND1_1221_LOSS_10_L THRESHOLD changed from 1 to 0	
14:50:35	Beam rate after MECHANICAL SHUTTER changed from 0 HZ to 120 HZ	
14:50:35	MPS_IN20_200_MSHT1_IN FAULT changed from 1 to 0	

Added a "freeze" button which allows users

- Faults History. This tab allows users to view recent faults when launching the GUI by reading the information from the Faults History server.
- Map hardware inputs to high level logic, using right click.
- Search for faults.

- Ability to bypass with a right click while selecting a row.
- Hardware inputs display.
- Search for faults.

- to control the GUI and stop receiving updates to the list of input state changes.
- In the past, the list updated at a very fast rate, discouraging the operators from using it.

Summary

The new features now allow operators to quickly identify MPS faults and diagnose problems. The troubleshooting time has been reduced, increasing the uptime for FEL delivery to user experiments. The MPS Logic Faults History server, in particular, has had a strong positive impact, allowing users to access days of recent fault history with freshly launched GUI instances.

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