LHC Collimator Alignment Operational Tool*

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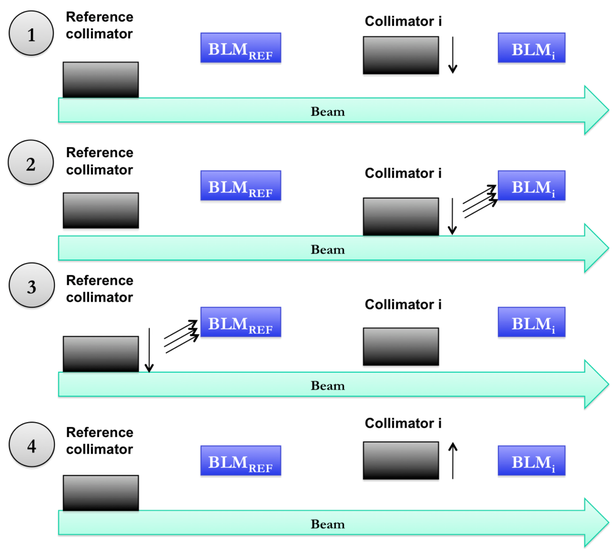
Abstract

Beam-based LHC collimator alignment is necessary to determine the beam centers and beam sizes at the collimator locations for various machine configurations. The cleaning efficiency of the system is dependent on the accurate positioning of the jaws with respect to the beam [1]. Fast and automatic alignment [2] is provided through an operational tool that has been developed for use in the CERN Control Center, which is described in this paper. The tool is implemented as a Java application, and acquires beam loss and collimator position data from the hardware through a middleware layer. The user interface is designed to allow for a quick transition from application start up, to selecting the required collimators for alignment and configuring the alignment parameters. The measured beam centers and sizes are then logged and displayed in different forms to help the user set up the system.

LHC Collimator Alignment Procedure



1. Define beam edge by horizontal, vertical or skew primary collimator in IR7.
2. Align jaw of collimator *i*.
3. Re-align primary collimator.
4. Open collimator *i* to the required settings in terms of the measured beam size and beam center.

Aligned left jaw position / Aligned right jaw position

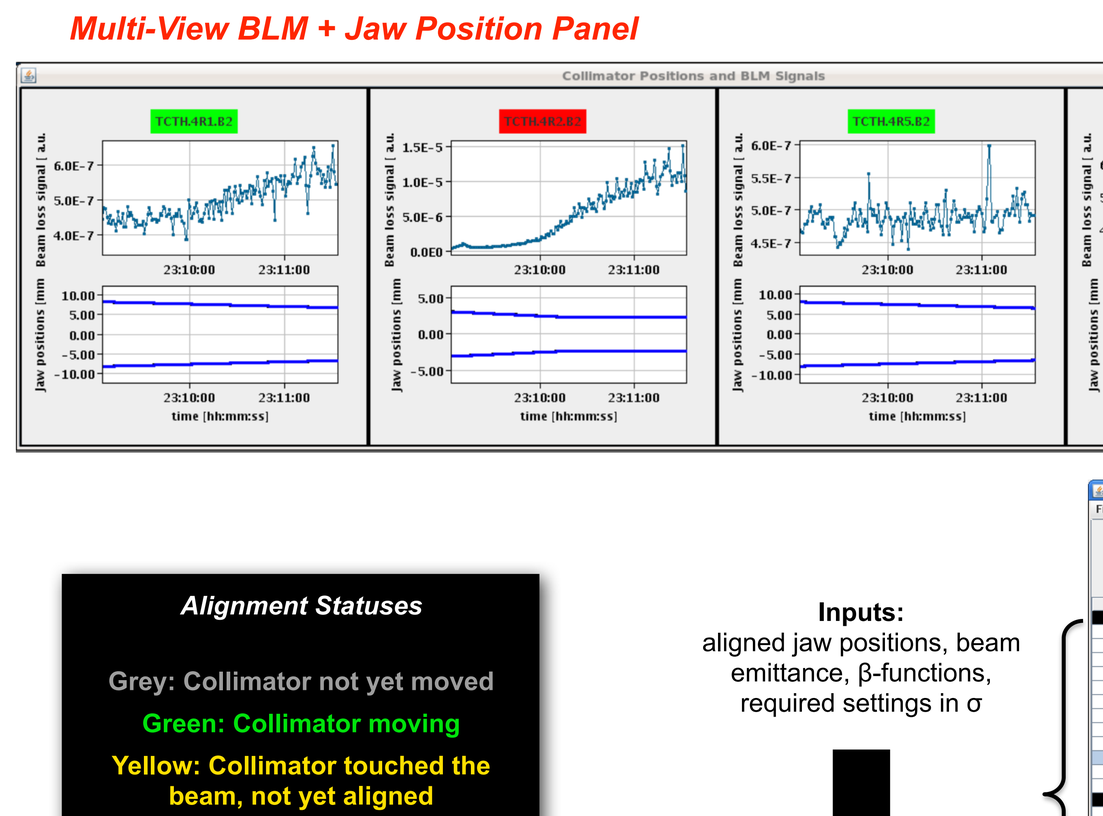
Beam Center: $\Delta x_i = \frac{x_i^{L,m} + x_i^{R,m}}{2}$

Beam Size: $\sigma_i = \frac{x_i^{L,m} - x_i^{R,m}}{(N_0^{k-1} + N_0^{k+1})/2}$

TCP cut in beam σ

Alignment Tool

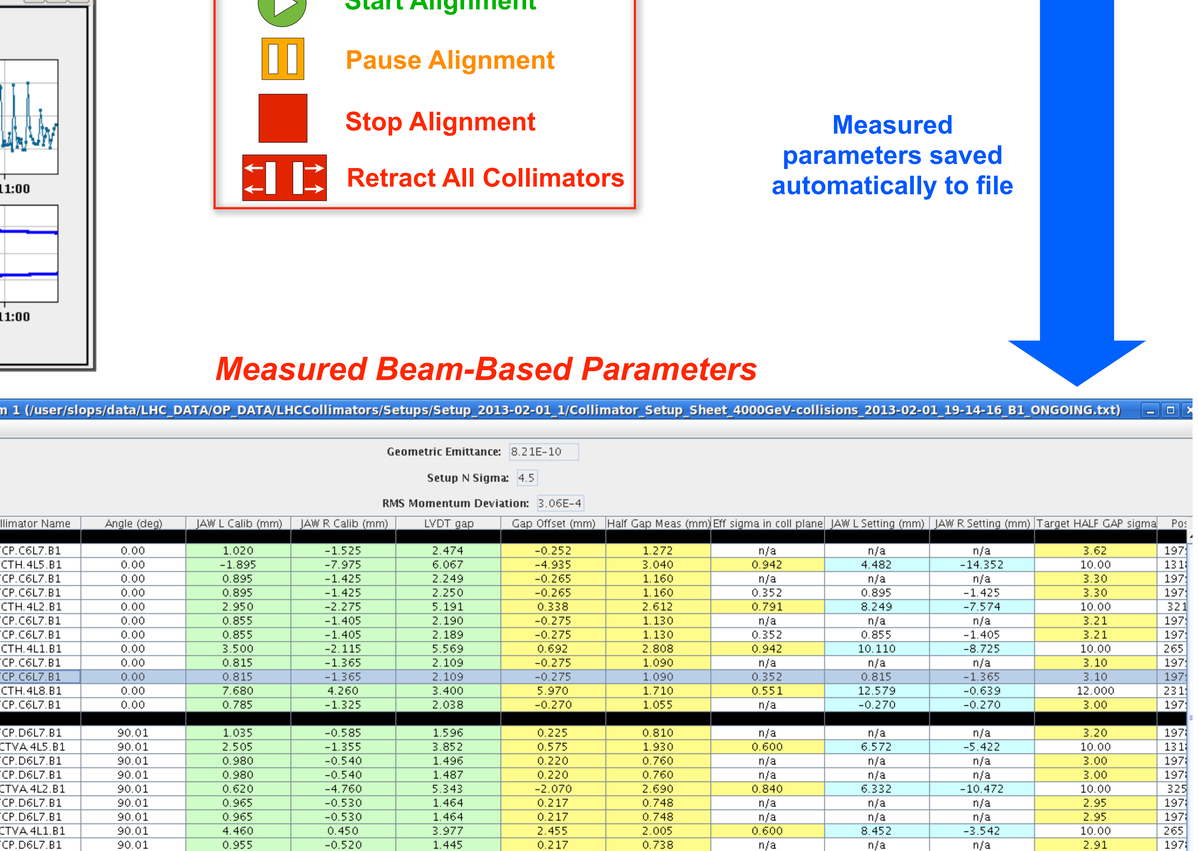
Main Collimator Status Display



Jaw step size, stopping BLM threshold can be input manually in case needed

Collimator Alignment Application

Selected collimators for alignment



Launch Alignment Application

View multiple BLM-jaw position plots

Multi-View BLM + Jaw Position Panel

- Start Alignment
- Pause Alignment
- Stop Alignment
- Retract All Collimators

Measured parameters saved automatically to file

Measured Beam-Based Parameters

Collimator Setup Sheet - Beam 1 (/user/slops/data/LHC_DATA/OP_DATA/LHCCollimators/Setups/Setup_2013-02-01_1/Collimator_Setup_Sheet_4000GeV-collisions_2013-02-01_19-14-16_B1_ONGOING.txt)

File Edit Options

Geometric Emittance: 8.21E-10
Setup N Sigma: 4.5
RMS Momentum Deviation: 3.06E-4

Number	Status	Collimator Name	Angle (deg)	JAW L Calib (mm)	JAW R Calib (mm)	LVDT gap	Gap Offset (mm)	Half Gap Meas (mm)	Eff sigma in coll plane	JAW L Setting (mm)	JAW R Setting (mm)	Target HALF GAP sigma	Pos
Horizontal													
9	True	TCP.C6L7.B1	0.00	1.020	-1.525	2.474	-0.252	1.272	n/a	n/a	n/a	3.62	197
10	True	TCTH.4L5.B1	0.00	-1.895	-7.975	6.067	-4.935	3.040	0.942	4.482	-14.352	10.00	131
11	True	TCP.C6L7.B1	0.00	0.895	-1.425	2.249	-0.265	1.160	n/a	n/a	n/a	3.30	197
36	True	TCP.C6L7.B1	0.00	0.895	-1.425	2.250	-0.265	1.160	0.352	0.895	-1.425	3.30	197
37	True	TCTH.4L2.B1	0.00	2.950	-2.275	5.191	0.338	2.612	0.791	8.249	-7.574	10.00	321
38	True	TCP.C6L7.B1	0.00	0.855	-1.405	2.190	-0.275	1.130	n/a	n/a	n/a	3.21	197
42	True	TCP.C6L7.B1	0.00	0.855	-1.405	2.189	-0.275	1.130	0.352	0.855	-1.405	3.21	197
43	True	TCTH.4L1.B1	0.00	3.500	-2.115	5.569	0.692	2.808	0.942	10.110	-8.725	10.00	265
44	True	TCP.C6L7.B1	0.00	0.815	-1.365	2.109	-0.275	1.090	n/a	n/a	n/a	3.10	197
45	True	TCP.C6L7.B1	0.00	0.815	-1.365	2.109	-0.275	1.090	0.352	0.815	-1.365	3.10	197
46	True	TCTH.4L8.B1	0.00	7.680	4.260	3.400	5.970	1.710	0.551	12.579	-0.639	12.000	231
47	True	TCP.C6L7.B1	0.00	0.785	-1.325	2.038	-0.270	1.055	n/a	-0.270	-0.270	3.00	197
Vertical													
0	True	TCP.D6L7.B1	90.01	1.035	-0.585	1.596	0.225	0.810	n/a	n/a	n/a	3.20	197
1	True	TCTVA.4L5.B1	90.01	2.505	-1.355	3.852	0.575	1.930	0.600	6.572	-5.422	10.00	131
2	True	TCP.D6L7.B1	90.01	0.980	-0.540	1.496	0.220	0.760	n/a	n/a	n/a	3.00	197
12	True	TCP.D6L7.B1	90.01	0.980	-0.540	1.487	0.220	0.760	n/a	n/a	n/a	3.00	197
13	True	TCTVA.4L2.B1	90.01	0.620	-4.760	5.343	-2.070	2.690	0.840	6.332	-10.472	10.00	325
14	True	TCP.D6L7.B1	90.01	0.965	-0.530	1.464	0.217	0.748	n/a	n/a	n/a	2.95	197
18	True	TCP.D6L7.B1	90.01	0.965	-0.530	1.464	0.217	0.748	n/a	n/a	n/a	2.95	197
19	True	TCTVA.4L1.B1	90.01	4.460	0.450	3.977	2.455	2.005	0.600	8.452	-3.542	10.00	265
20	True	TCP.D6L7.B1	90.01	0.955	-0.520	1.445	0.217	0.738	n/a	n/a	n/a	2.91	197
21	True	TCP.D6L7.B1	90.01	0.955	-0.520	1.445	0.217	0.738	n/a	n/a	n/a	2.91	197
22	True	TCTVB.4L8	90.01	2.025	-1.895	3.883	0.065	1.960	0.650	7.862	-7.732	12.000	232
23	True	TCP.D6L7.B1	90.01	0.940	-0.500	1.405	0.220	0.720	n/a	0.220	0.220	2.84	197
Skew													

Alignment Statuses

Grey: Collimator not yet moved
Green: Collimator moving
Yellow: Collimator touched the beam, not yet aligned
Red: Collimator stopped moving
Turquoise: Collimator aligned

Inputs:
aligned jaw positions, beam emittance, β-functions, required settings in σ

Outputs:
jaw settings in mm for LHC operation

Paper Download

References

[1] R. W. Assmann *et al.*, "Requirements for the LHC collimation system", in Proceedings of EPAC'02, Paris, France, pp. 197-199, 2002.

[2] G. Valentino, R. W. Assmann, R. Bruce, S. Jackson, S. Redaelli, B. Salvachua, N. Sammut, D. Wollmann, C. Zamantzas, "Fast Automatic Beam-Based Alignment of the LHC Collimation System", these proceedings, THCOCB03.

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