DATABASE APPLICATIONS TO INTEGRATE BEAM LINE OPTICS CHANGES WITH ENGINEERING DATABASES*

A.Chan[#], P.Bellomo, G.R. Crane, P. Emma, E. Grunhaus, K. Luchini, I.A. MacGregor,
D.S. Marsh, R. Pope, P. Prickett, C. Rago, K.Ratcliffe, T. Shab, SLAC, Menlo Park, CA 94025
U.S.A.

Abstract

The LCLS project databases provide key nomenclature information while integrating many engineering and physics processes in the building of an accelerator. Starting with the elements existing in the beam line optics files, the engineers add non-beam-line elements, and controls engineers assign 'Formal Device Names' to these elements. Inventory, power supplies, racks, crates and cable plants are databases that are being integrated into the project database. This approach replaces individual spreadsheets and/or integrates standalone existing institutional databases.

STREAMLINING DATA AND WORK PROCESSES

In the past, data relating to engineering and physics were kept in disparate spreadsheets and files. Although changes to beam line optics elements can affect many engineering processes downstream, such changes had to be incorporated manually into these various spreadsheets and files. Within LCLS, the goal of the project database is to integrate the engineering and physics systems, as well as integrate with legacy SLAC databases already in use. We focused on processes that are commonly needed during the construction as well as the operations phase.

Figure 1 is an overview of the different information systems needed by LCLS.

BEAM LINE OPTICS ELEMENTS

Since the conceptual accelerator model is based on the beam line optics output (MAD output), a database to store the different versions of the MAD deck was an important starting point for the project database.

Additional functions were built into the database to compare older and newer versions of the MAD deck for any of the four LCLS beam lines. Figure 2 shows a report from the database highlighting elements that were added, removed, or changed in the comparison of two versions of the MAD deck.

A DIRECTORY OF ALL DEVICES

The physicists, the engineers, and the controls group often refer to the same accelerator device (or element) by different aliases, different coordinate systems, and different units of measurement. Similar to how a phone directory for people streamlines organization work, we needed a directory of all devices where key attributes are stored and mapped to each other, in order for cross-functional groups to quickly translate aliases and coordinates. With the backbone of elements from the MAD deck in the database, we built an All Devices database where the mechanical and electrical engineers can add their devices and attributes, and where the controls group can add the 'Formal Device Names' (controls names). Database triggers orchestrate how the data are placed in the All Devices database so that the newest version from the MAD deck is used. We used Oracle's Application Express interface (APEX), which works together with the database triggers to provide a uniform view of MAD and non-MAD data in one editable report (see Fig. 3).

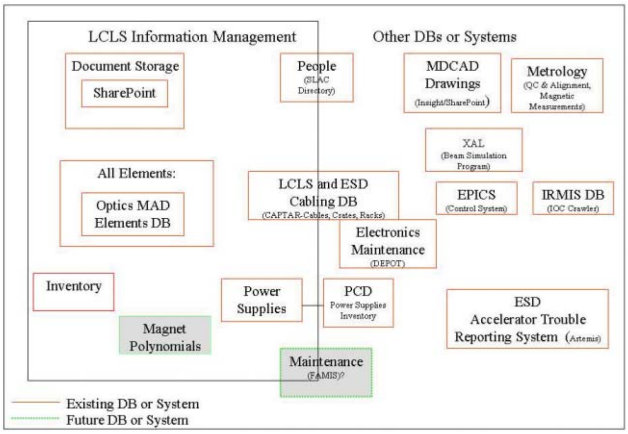

Figure 1: Project-specific and site-wide databases used by LCLS.

From the All Devices database, one is able to select information stored for that element in the cabling database, power supplies database, inventory database, etc.

DATABASE FOR CABLE PLANT, CRATES AND RACK PROFILES

The engineers and controls group invest a lot of time configuring racks, crates and cables. SLAC has a legacy cabling database (CAPTAR) that holds the official cable plant configuration (see Fig. 4 for a rack profile from the CAPTAR database).

However, this database lacks referential integrity support, which opens the door for inconsistent data within the database. Only one legacy Oracle Forms application is able to enforce the needed integrity between the 60+ tables. Therefore, in order to provide

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[#]achan@slac.stanford.edu

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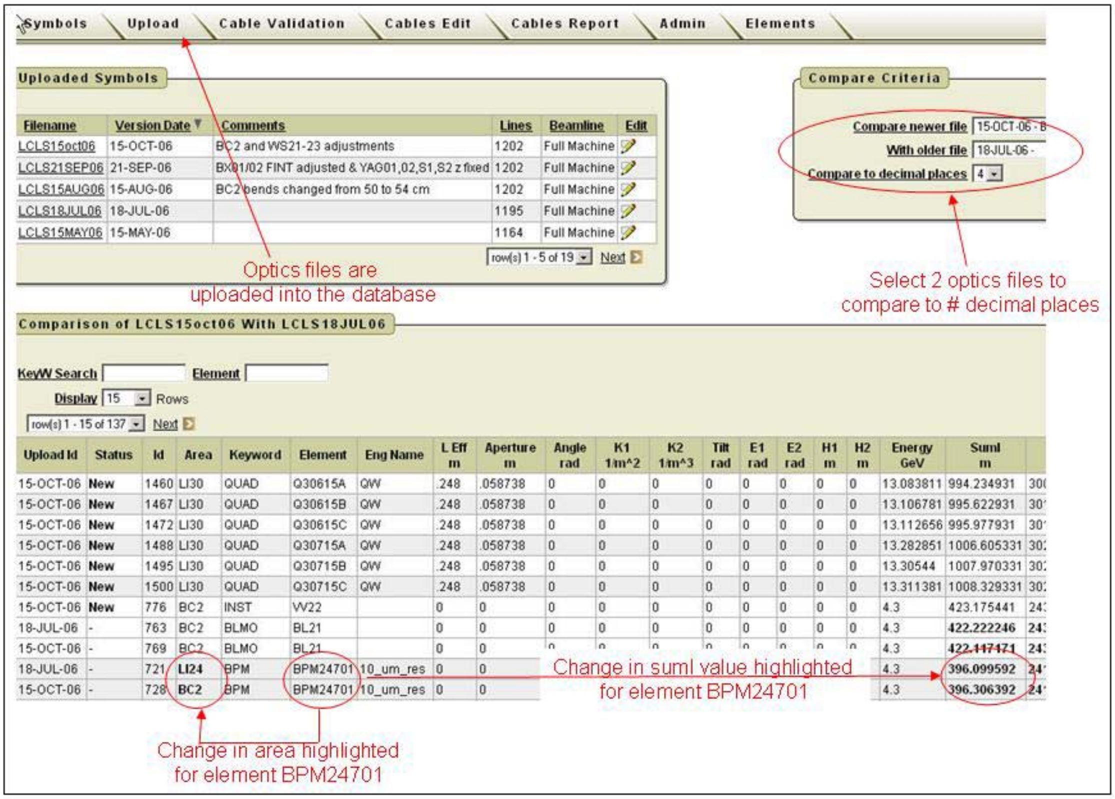


Uploaded Symbols

Filename	Version Date	Comments	Lines	Beamline	Edit
LCLS15oct06	15-OCT-06	BC2 and WS21-23 adjustments	1202	Full Machine	
LCLS21SEP06	21-SEP-06	BX01/02 FINT adjusted & YAG01,02,S1,S2 z fixed	1202	Full Machine	
LCLS15AUG06	15-AUG-06	BC2 bends changed from 50 to 54 cm	1202	Full Machine	
LCLS18JUL06	18-JUL-06		1195	Full Machine	
LCLS15MAY06	15-MAY-06		1164	Full Machine	

row(s) 1 - 5 of 19 Next

Optics files are uploaded into the database

Compare Criteria

Compare newer file: 15-OCT-06 - B
With older file: 18-JUL-06 -
Compare to decimal places: 4

Select 2 optics files to compare to # decimal places

Comparison of LCLS15oct06 With LCLS18JUL06

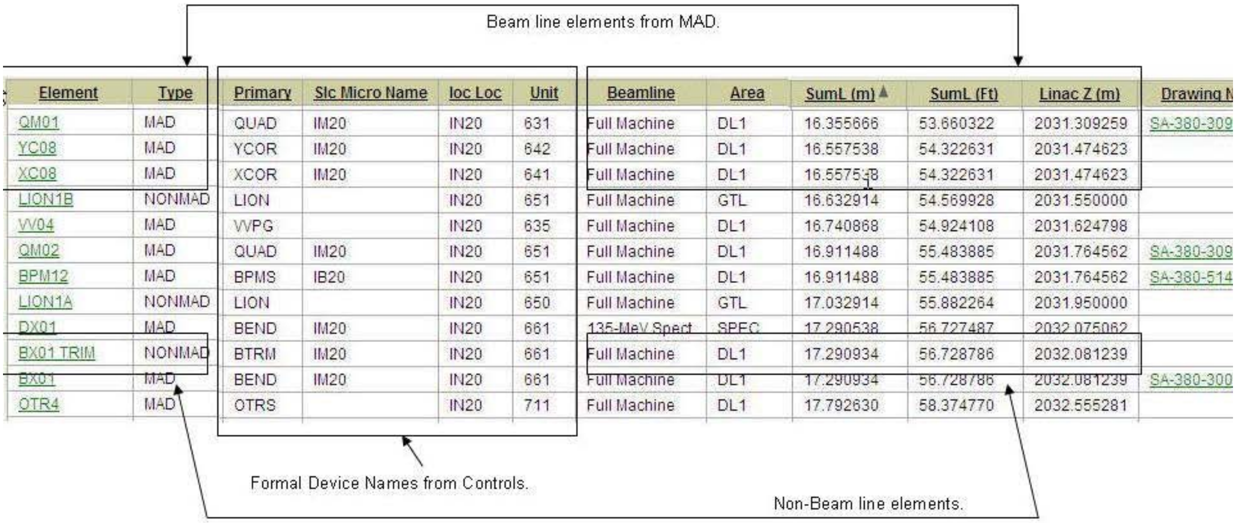
KeyW Search:
Element:
Display 15 Rows
row(s) 1 - 15 of 137 Next

Upload Id	Status	Id	Area	Keyword	Element	Eng Name	L Eff m	Aperture m	Angle rad	K1 1/m^2	K2 1/m^3	Tilt rad	E1 rad	E2 rad	H1 m	H2 m	Energy GeV	Suml m
15-OCT-06	**New**	1460	LI30	QUAD	Q30615A	QW	.248	.058738	0	0	0	0	0	0	0	0	13.083811	994.234931
15-OCT-06	**New**	1467	LI30	QUAD	Q30615B	QW	.248	.058738	0	0	0	0	0	0	0	0	13.106781	995.622931
15-OCT-06	**New**	1472	LI30	QUAD	Q30615C	QW	.248	.058738	0	0	0	0	0	0	0	0	13.112656	995.977931
15-OCT-06	**New**	1488	LI30	QUAD	Q30715A	QW	.248	.058738	0	0	0	0	0	0	0	0	13.282851	1006.605331
15-OCT-06	**New**	1495	LI30	QUAD	Q30715B	QW	.248	.058738	0	0	0	0	0	0	0	0	13.30544	1007.970331
15-OCT-06	**New**	1500	LI30	QUAD	Q30715C	QW	.248	.058738	0	0	0	0	0	0	0	0	13.311381	1008.329331
15-OCT-06	**New**	776	BC2	INST	W22		0	0	0	0	0	0	0	0	0	0	4.3	423.175441
18-JUL-06	-	763	BC2	BLMO	BL21		0	0	0	0	0	0	0	0	0	0	4.3	**422.222246**
15-OCT-06	-	769	BC2	BLMO	BL21		0	0	0	0	0	0	0	0	0	0	4.3	**422.117471**
18-JUL-06	-	721	**LI24**	BPM	BPM24701	10_um_res	0	0									4.3	**396.099592**
15-OCT-06	-	728	**BC2**	BPM	BPM24701	10_um_res	0	0									4.3	**396.306392**

Change in suml value highlighted for element BPM24701

Change in area highlighted for element BPM24701

Figure 2: Comparison program for different MAD deck file versions.


Beam line elements from MAD.

Element	Type	Primary	Slc Micro Name	loc Loc	Unit	Beamline	Area	SumL (m) ▲	SumL (Ft)	Linac Z (m)	Drawing N
QM01	MAD	QUAD	IM20	IN20	631	Full Machine	DL1	16.355666	53.660322	2031.309259	SA-380-309
YC08	MAD	YCOR	IM20	IN20	642	Full Machine	DL1	16.557538	54.322631	2031.474623	
XC08	MAD	XCOR	IM20	IN20	641	Full Machine	DL1	16.557538	54.322631	2031.474623	
LION1B	NONMAD	LION		IN20	651	Full Machine	GTL	16.632914	54.569928	2031.550000	
VV04	MAD	VVPG		IN20	635	Full Machine	DL1	16.740868	54.924108	2031.624798	
QM02	MAD	QUAD	IM20	IN20	651	Full Machine	DL1	16.911488	55.483885	2031.764562	SA-380-309
BPM12	MAD	BPMS	IB20	IN20	651	Full Machine	DL1	16.911488	55.483885	2031.764562	SA-380-514
LION1A	NONMAD	LION		IN20	650	Full Machine	GTL	17.032914	55.882264	2031.950000	
DX01	MAD	BEND	IM20	IN20	661	135-MeV Spect	SPEC	17.290538	56.727487	2032.075062	
BX01 TRIM	NONMAD	BTRM	IM20	IN20	661	Full Machine	DL1	17.290934	56.728786	2032.081239	
BX01	MAD	BEND	IM20	IN20	661	Full Machine	DL1	17.290934	56.728786	2032.081239	SA-380-300
OTR4	MAD	OTRS		IN20	711	Full Machine	DL1	17.792630	58.374770	2032.555281	

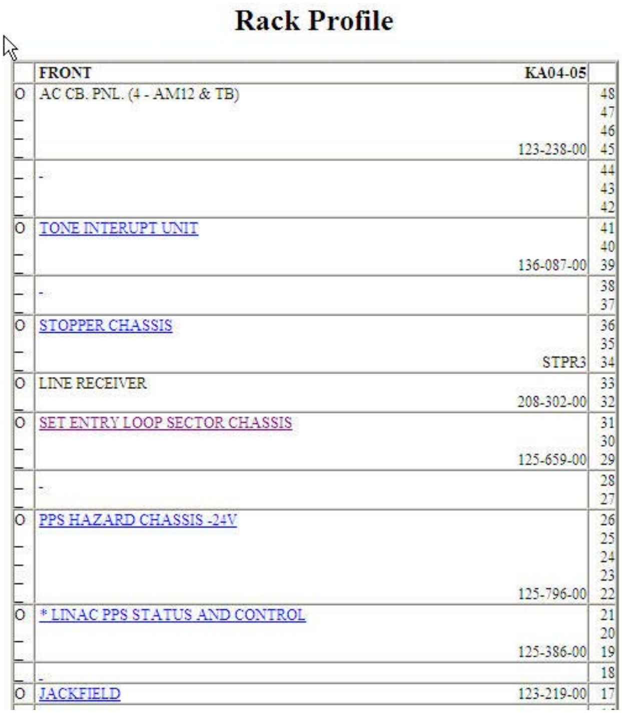
Formal Device Names from Controls.

Non-Beam line elements.

Figure 3: Sources of data for the All-Devices database.

- new functionality for LCLS
- integration of different types of data (LCLS and CAPTAR)
- change history
- workflow for review and approval of changes

we built a staging database to interface with CAPTAR, so that we can add these new functions without having to rebuild CAPTAR. Users will be able to add or edit cable plant data and circulate a version for review before sending the configuration to the CAPTAR administrators for approval and loading into the CAPTAR database (see Fig. 5).



Rack Profile

	FRONT	KA04-05	
O	AC CB. PNL. (4 - AM12 & TB)	123-238-00	48 47 46 45
_	-		44 43 42
O	TONE INTERUPT UNIT	136-087-00	41 40 39
_	-		38 37
O	STOPPER CHASSIS	STPR3	36 35 34
O	LINE RECEIVER	208-302-00	33 32
O	SET ENTRY LOOP SECTOR CHASSIS	125-659-00	31 30 29
_	-		28 27
O	PPS HAZARD CHASSIS -24V	125-796-00	26 25 24 23 22
O	* LINAC PPS STATUS AND CONTROL	125-386-00	21 20 19
_	-		18
O	JACKFIELD	123-219-00	17

Figure 4: Rack profile from CAPTAR database.

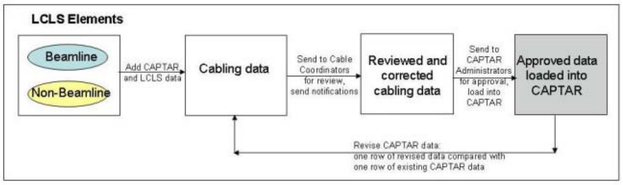
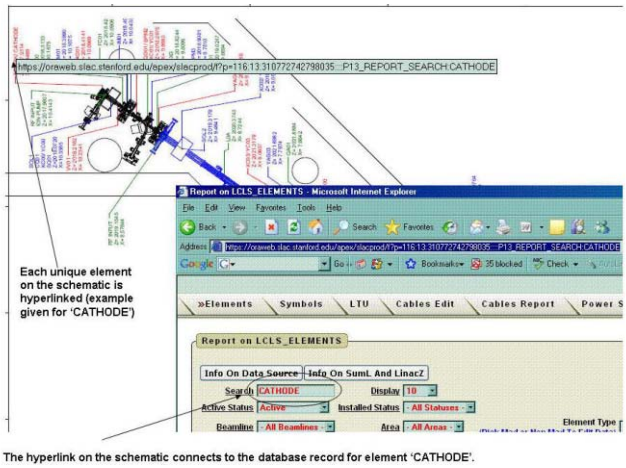

LCLS Elements
Beamline
Non-Beamline
Add CAPTAR and LCLS data
Cabling data
Send to Cable Coordinators for review, send notifications
Reviewed and corrected cabling data
Send to CAPTAR Administrators for approval, load into CAPTAR
Approved data loaded into CAPTAR
Revise CAPTAR data: one row of revised data compared with one row of existing CAPTAR data

Figure 5: Workflow for editing, reviewing and approving cable plant data.

INTEGRATING SCHEMATICS AND DATABASE

It is useful for users to transparently move between a graphical view of the elements and the information stored in the database. A prototype program has been developed that scans the schematics for a match to the unique element names to concatenate a hyperlink to the element's database record (see Fig. 6).



https://oraweb.slac.stanford.edu/apex/slacprod/f?p=116:13:310772742798035::::P13_REPORT_SEARCH:CATHODE

Each unique element on the schematic is hyperlinked (example given for 'CATHODE')

Report on LCLS_ELEMENTS - Microsoft Internet Explorer

Address https://oraweb.slac.stanford.edu/apex/slacprod/f?p=116:13:310772742798035::::P13_REPORT_SEARCH:CATHODE

Report on LCLS_ELEMENTS

Search CATHODE

Display 10

Active Status Active

Installed Status - All Statuses -

Beamline - All Beamlines -

Area - All Areas -

The hyperlink on the schematic connects to the database record for element 'CATHODE'.

Figure 6: Schematic drawing in PDF format, with links to the elements' records in the database.

DEVELOPMENT TOOLS

APEX is a tool that allows those familiar with SQL and Oracle's PL/SQL language to build, test, and deploy database-centric web applications in significantly less time than with other web-based Integration Development Environments.

This tool provides an intuitive interface in which developers "declare" more than "code" an application. Such declarative-type programming makes for quick turn-around times between capturing/documenting user requirements and presenting an application usable with any industry-standard web browser.

APEX automatically takes advantage of Oracle's built-in set of tools and functions such as Single Sign On (SSO), table referential integrity, optimistic locking, and trigger/sequence integration within web screens so as to allow developers to concentrate on the presentation of data, rather than on how that data should be saved or modified within the underlying Oracle tables.

ACKNOWLEDGMENT

We thank the LCLS management and staff, and SLAC's SCCS staff. Without their vision and their many contributions, this work would not have been possible.