Sharing NLC/JLC Lattice Description Files

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The NLC lattice description consists of “extended” Standard Input Format (XSIF) files which serve as input to locally modified versions of MAD and DIMAD (and, presumably, TRANSPORT). I assume that the JLC lattice description will be made up mostly of SAD decks. Given the differences between these input languages, how might collaboration members share decks?

Standardized input files for NLC optics programs

In the CD1-level release of the NLC optics, each NLC area will be represented by a single lattice description file containing only element and beam line definitions. Program-specific commands (for MAD, DIMAD, etc.) will be contained in separate files for each area which will reference the corresponding lattice description file.

Element and beam line definitions in the lattice description files will be extended Standard Input Format (XSIF), which is simply Standard Input Format (originally defined at Snowmass in 1984 by Carey and Iselin[†]), as implemented in the MAD, DIMAD, and TRANSPORT (3rd order) optics programs, with some extensions for NLC.

The NLC extensions to SIF include:

- the APERTURE attribute is added to the QUADRUPOLE, SEXTUPOLE, OCTUPOLE, MULTIPOLE, SOLENOID, and RFCAVITY element definitions; this attribute represents the full bore (diameter) of the device

- a new element type, LCAVITY, is defined to represent accelerator structures

- the TYPE attribute of element definitions will be (up to) 16 characters in length; this attribute will contain the *engineering name* of the device, and will provide the primary cross-reference link in the NLC database to the engineering, costing, and reliability data for specific types of components

See Peter Tenenbaum's "deck master's guide", *NLC Beamline Decks Coding Standards*, for the complete set of deck standards.

[†] *A Standard Input Language For Particle Beam And Accelerator Computer Programs*, by D.C. Carey (Fermilab), F.C. Iselin (CERN); CERN LEP-TH/84-10, Jun 1984.

Next Linear Collider Beamline Decks Coding Standards

PETER TENENBAUM

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1 Introduction

The top-level description of every beam line in the Next Linear Collider is, or will be, a "master optics deck" in some dialect of the Standard Input Format [1]. This master deck will ultimately be used for beam dynamics simulations, mechanical layout of the NLC, generation of the master hardware database, accelerator control system functions, and other functions we cannot as yet foresee.

In order to simplify the life of the various end-users, it is helpful to keep certain features of the decks consistent from region to region. These Standards are an attempt to distill the features which are of greatest importance to end-users other than the Deck-Masters of each region. In addition, this Standard is a guide to resolving conflicts between the versions of Standard Input Format in use today, and sets minimum requirements on the input parsers of all "NLC Versions" of programs using the Standard Input Format.

2 Language

The language which describes each beamline shall be the Standard Input Format, as is variously (and somewhat contradictorily) described in [1, 2, 3].

2.1 Units

The units keywords used by DIMAD (ie, **USTANDARD, UMAD, UTRANSPORT**) are forbidden; consequently all decks must use the Standard units set. See Appendix A for enumeration of the Standard units set.

2.2 Elements and Element Names

Each element's deck name (henceforth called its *optics name*) shall be from 1 to 8 characters in length, where character 1 must be a letter, and characters 2 through 8 may be:

- a letter
- a digit
- a period ("."), an underscore ("_"), or a dollar sign ("$").

Names must not be case-sensitive (ie. a given beamline may not contain two different devices whose names are the same other than different capitalization.

Elements may be re-used an arbitrary number of times in a deck.

2.3 Engineering Type Specification

The engineering specification of a device's properties (henceforth called its *engineering type*) is a string of up to 16 characters specified by the **TYPE** keyword. The first character must be either a letter or a digit: subsequent characters may be letters, digits, periods, underscores, dollar signs, or colons (":"). Case-sensitive engineering names are prohibited.

NLC Formal Device Names (FDNs)

FDNs make references to individual NLC devices unambiguous. The unique name for each device will provide a first level key into the databases that will be used for cost estimation and scheduling, as well as providing the essential tag needed during production and installation. Finally, the future NLC control system will require unique names for control points. Because the name includes information on what a device is and where it is located, lists sorted by device type or geographical region can be constructed by keying off portions of the name.

A global device name consists of three fields as follows:

- *area field:* a beam line area designation (*e.g.* EDR or PFF1)
- *function field:* a generic functional device descriptor (*e.g.* QUAD)
- *location field:* a number related to location along the beam line.

An example of a name:

EDR:QUAD:234

Ideally, the location field is related to the longitudinal position of the device along the beam line, referenced to the start of the appropriate area. In the linac and beam delivery areas the location value represents distance along the beam line in meters; in the injector areas the location value represents beam line distance in decimeters.

Each device will have one or more additional names associated with it, both in the primary database and in the optics decks. These secondary names will include (where appropriate):

- an *engineering name* which cross references lists of physical attributes, cost information, etc. for the device type (as in Dieter Walz's magnet catalog)
- a common name (something easier to look at than the formal device name, *e.g.* QD1 rather than EFF1:QUAD:1723 for the final doublet)

See the *NLC Device Naming Convention* document for details.

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NLC Device Naming Convention

M. Woodley, T. Raubenheimer, R. Sass
October 27, 1998

The purpose of this note is to describe the formal global naming scheme for NLC devices. To begin with, the proposed scheme is intended for use in naming NLC beam line components (magnets, accelerators, diagnostics, etc.), however the scheme should be flexible enough to be extended to other NLC components.

The global naming scheme makes references to individual NLC devices unambiguous, and allow us to enumerate global device lists for engineering and cost estimates. The unique name of each device will provide a first level key into the databases that will be used for cost estimation and scheduling, as well as providing the essential tag needed during production and installation, and by the future NLC control system. Because the name includes information on what a device is and where it is located, lists sorted by device type or geographical region can be constructed by keying off portions of the name.

A global device name consists of three fields as follows:

- *area field:* a beam line area designation (*e.g.* EDR or PFF1)
- *function field:* a generic functional device descriptor (*e.g.* QUAD or HCOR)
- *location field:* a number related to a device's location along the beam line.

To improve the readability of the names a colon (:) is used to separate the fields. At this time there is no limit on the number of character positions assigned to each field, although brevity is desirable. For consistency, all device names are upper case, although we should avoid making the names case sensitive. Each field consists of alphanumeric characters (A-Z, 0-9); the special characters "." (period) and "_" (underscore) will also be allowed. An example of a name:

EDR:QUAD:234

Ideally, the location field is related to the longitudinal position of the device along the beam line, referenced to the start of the appropriate area. In the linac and beam delivery

Standardized output files from NLC optics programs

Output files from various optics programs are being used as inputs for automated CAD element layout, parts counting, and database generation programs. In order to minimize the number of special programs needed to convert the outputs of optics programs into a form suitable for these other tasks, we define a standard format for some forms of the output of the optics programs we will use.

We have chosen the MAD "tape file format", used for SURVEY and TWISS output‡, as the basis of our standard, and have added some extensions to create what we call extended tape file format (XTFF).

MAD outputs SURVEY and TWISS data to "tape files" as follows:

- the "tape files" are ASCII (*i.e.* readable by humans)
- the data for each element is output as a block of 80-column lines
- the first two lines contain element definition data, and the remaining lines (2 for SURVEY and 3 for TWISS) contain coordinate or twiss parameter data

XTFF **does not** change the format of columns 1-80, but adds additional data to the first two lines (the element definition data lines) in columns 81-132, as follows:

- APERTURE, TYPE (the element's *engineering name*), and beam energy are added to line 1
- the Formal Device Name (FDN) is added to line 2

Finally, a third type of XTFF file, containing beam σ–matrix data, is envisioned. At present, only the MAD and DIMAD programs have been modified to output XTFF files.

‡ See Appendix A of *The MAD Program User's Reference Manual*, CERN/SL/90-13 (AP) Rev. 4, for details.

D. R. Walz
2-22-96
Rev. 8-5-98

NLC Master Dipole List
Magnet & Power Supply Summary

Magnet Type	Location WBS	Location Section	Quantity	Max B kG	Full Aperture cm	L_{eff} m	Total Magnet Turns	Conductor Size	Max Voltage V	Max Current A	Flow Rate gpm	P.S. V/A/kW	P.S. Quantity
4D22.6	1.1.3.2.1	e^+/e^- Compr Inj	16	15.874	2.54	0.60	64	0.340"×0.340"	20	480	3.7	250/600/150	2
4D22.6	1.1.3.2.1	e^+/e^- RTL	28	15.874	2.54	0.60	64	0.500"×0.500"	9	500	1.7	0	0
4D30.5(sep)	1.1.3.2.1	e^+/e^- Compr Inj	2	9.110		0.80							2
4D30.5-I	1.1.3.2.1	e^+/e^- RTL	12	5.23	2.54	0.80	64	0.340"×0.340"	8.4	170	0.5	60/200/12	2
4D30.5-II	1.1.3.2.1	e^+/e^- RTL	20	14.204	2.54	0.80	64	0.500"×0.500"	11	500	2.1	250/600/150	2
4D38C	1.1.7.2.1	FFIR&Dumps	32	8.339	3.18	1.00	128	0.340"×0.340"	19	170	1.3	100/250/25	8
4D98	1.1.4.2.1	BNCH-Compr	32	1.096	2.54	2.50	8	0.255"×0.255"	7.5	285	0.8	150/300/45	2
4D48.2	1.1.4.2.1	e^+/e^- Compr Arc	278	6.075	1.27	1.25	64	0.340"×0.340"	7	100	0.3	200/150/30	14
5D14.5	1.1.3.2.1	EDR&PDR	8	14.409	3.2	0.3970	34	0.500"×0.500"	12.5	1275	6.0	800/1500/1200	0
5D14.9	1.1.3.2.1	PPDR	4	17.5	2.2	0.40	40	0.500"×0.500"	9	810	2.8	500/1000/500	0
5D25.7	1.1.3.2.1	EDR&PDR	76	16.843	3.2	0.6844	40	0.500"×0.500"	16.5	1275	7.0	800/1500/1200	4
5D30.6	1.1.3.2.1	PPDR	28	17.5	2.2	0.80	40	0.500"×0.500"	13	810	4.0	500/1000/500	1
10D6	1.1.1.2.1	e^--Injector	1	0.0075	7.0	0.22	40	AWG#14	0.7	1	Air-Cooled	12/6/0.07	1
10D6	1.1.1.2.1	e^+-Drive	1	0.0075	7.0	0.22	40	AWG#14	0.7	1	Air-cooled	12/6/0.07	1
12D18.1	1.1.1.2.1	e^--Injector	2	2.7944	4.0	0.50	76	0.250"×0.250"	20	120	1.0	60/200/12	1
12D18.1	1.1.1.2.1	e^+-Drive	2	2.7944	4.0	0.50	76	0.250"×0.250"	20	120	1.0	60/200/12	1
16D8.8	1.1.2.2.1	e^+-Injector	3	6.500	13.6	0.36	80	0.500"×0.500"	15	910	5.2	60/1000/60	1
20D96	1.1.1.2.1	e^+-Drive	3	14.485	6.0	2.50	80	0.500"×0.500"	65	900	22.2	250/1000/250	1

ENGINEERING NAMES

Optics modeling and simulation programs for NLC

The original NLC lattice was developed by many people, using a broad selection of optics and simulation programs, on a variety of computer platforms. We are now moving toward using MAD as the primary optics modeling program for the entire NLC, running mainly on PCs (Windows NT) and unix workstations.

Along with MAD, we are in the process of collecting a set of optics and simulation programs which will run in the Windows NT and unix environments and which will be modified for NLC use. These modifications will include:

- large array sizes for modeling big hunks of NLC
- full XSIF input compatibility
- XTFF output file creation capability

At present, only MAD and DIMAD have been modified in this way. A list of the programs collected so far, along with a description of their status, can be found on the NLC *Simulation Codes* web page.

Some examples of SAD/XSIF incompatibilities†

- Syntactic differences

  - Element (and beamline) definition blocks:

SAD :
```
BEND  BH1R =( ... )  BH2R =( ... )
      BH3R =( ... )  BH4R =( ... )
      BH5R =( ... )  BH6R =( ... )
;
```

XSIF :
```
BH1R : SBEN ... ; BH2R : SBEN ...
BH3R : SBEN ... ; BH4R : SBEN ...
BH5R : SBEN ... ; BH6R : SBEN ...
```

  - Element definition syntax:

SAD :
```
QUAD  QF2R =( L =.1986  K1 =1.6439780463978 ... )
```

XSIF :
```
QF2R : QUAD  L =.1986  K1 =1.6439780463978 ...
```

  - Beamline definition syntax:

SAD :
```
LINE LQF1R =(SQF1R QF1R SQF1R)
     LQM3R =(SQM3R QM3R SQM3R)
```

XSIF :
```
LQF1R : LINE=(SQF1R QF1R SQF1R)
LQM3R : LINE=(SQM3R QM3R SQM3R)
```

- Definition of multipole strength

SAD : $K_n = \frac{L}{B\rho}\frac{\partial^n B_y}{\partial x^n}$

XSIF : $K_n = \frac{1}{B\rho}\frac{\partial^n B_y}{\partial x^n} = \frac{K_{n_{SAD}}}{L}$

- Element attributes

SAD :
```
QUAD: L, K1, ROTATE, DISFRIN, DISRAD, DX, DY, F1, F2, FRINGE,
      transformation
```

XSIF :
```
QUAD: L, K1, TILT, APERTURE, TYPE
```

† Here I'm only discussing differences in the way elements and beamlines are *defined* …

A SAD ⇔ XSIF translator program

Because of these fundamental differences between SAD input language and XSIF, I believe a SAD ⇔ XSIF *translator* program would need to be created to facilitate sharing of lattice description files among members of the collaboration.

Some of the issues which would need to be addressed are:

- an input file for the translator would consist of element and beamline definitions only … commands (to compute Twiss, do matching, *etc.*) would be contained in a true SAD or MAD or DIMAD input file which loads (READs, CALLs, *etc.*) the translatable SAD or XSIF file

- a common subset of allowed element attributes would have to agreed on … the translator program would only translate these attributes, since obviously all attributes cannot be used by all optics programs

- keyword mappings need to be established … should a BLMON element (bunch length monitor) from an XSIF deck be translated into a MARKer or a zero-length drift, or what?

- the mapping of attribute values between SAD and XSIF needs to be specified (units, sign conventions, fringe field parameters, default phase of cavities, *etc.*)

- some information needed for actually generating the optics for a given lattice (such as beam energy, input beam emittances, Twiss parameters, *etc.*) might be included in a translatable file as specially named parameters, or even as specifically formatted comments

- all optics programs involved should be available at both SLAC and KEK … the SLAC programs are running on Windows NT, while SAD runs on unix

- can the SAD "input parser" be separated from the rest of the program, as the XSIF parser can?

- … ?

SAD / TRANSPORT decks[†]

In order to allow collaboration members to study various parts of the ATF lattice in a consistent manner, we suggest that a standard "format" be adopted for the SAD decks which define the design lattice. The primary motivation for standardization is twofold: (1) given standardized decks, anyone who has a complete set of decks can model any part (or all) of the ATF machine using only the information in the decks themselves ... the need for additional sources of information is greatly reduced and hence the chance for confusion is also reduced, and (2) some of us use programs other than SAD (i.e. TRANSPORT, TURTLE, MAD, DIMAD, COMFORT) to do lattice modeling; a properly standardized deck will contain all of the information necessary to translate the SAD deck into an input deck for one or more of these other programs, allowing people who don't use SAD to contribute to the study as well as providing a greater ability to cross-check each other's results.

Some general things which should be included in standardized ATF SAD decks are as follows:

- Since comments are allowed in SAD decks, we suggest that "official" changes to the decks be logged with comments appearing at the tops of the files; include name, date, and nature of changes.

- Changes made to any deck which affect other decks should be propagated to the affected decks; for instance, if a change is made to the nominal tunes of the DR, the matched Twiss parameters at the end of the BT and at the beginning of the EXT might change, in which case appropriate changes should be made to these decks to maintain a properly matched system and consistency among decks.

- Input phase space should be specified (as comments or whatever) in each deck. Include betas, alphas, dispersion, emittances, bunch length, and energy spread. Also, distributions should be specified as Gaussian, uniform, or whatever, as appropriate.

- A global floor coordinate system for the layout (geometry) of ATF (X, Y, Z, yaw, pitch, roll) would be useful; the coordinates of the beginning and end points (in this global coordinate system) of each deck could be specified in this deck, as comments or whatever.

- Some description of matching strategies should be included in each deck, as comments or whatever. We all need to know what to fit, where to fit, what values to fit to, and which magnet(s) to use to accomplish the fit.

- Include in each beam line definition the locations of diagnostic/correction devices such as BPMs, horizontal and vertical correctors, wire scanners, profile monitors, etc.; also include the locations and apertures of collimators and slits.

- Element names (except for families of identical magnets which have identical strengths) should be unique among all decks, so that when decks are combined there is no confusion about which magnet you're talking about. An exception would be magnets which are in one or more decks, such as DR quad QM8R, which is in both the DR and BT decks; these magnets should have the same name in all decks.

- In the BT and EXT decks, the off-axis quadrupoles which form part of the injection/extraction schemes should be modeled as combined function bends ... the nominal beam offsets in these quads should also be specified, as comments or whatever.

Finally, as a necessary tool for lattice studies, we will need a rather complete table of magnet parameters. This table should have one line per magnet (or per family of identical magnets) which specifies the magnet's name (as it appears in the SAD deck(s)), effective length, bore diameter or gap height/width, and maximum achievable pole-tip field. This table should also detail which magnets are to be powered in series and which are individually controllable.

[†] From the *ATF Review Summary*, T. Raubenheimer, S. Ecklund, P. Emma, and M. Woodley, December 22, 1992.