

Single Particle Optics Modeling in MCR

P.Spentzouris, CEPA/PSM

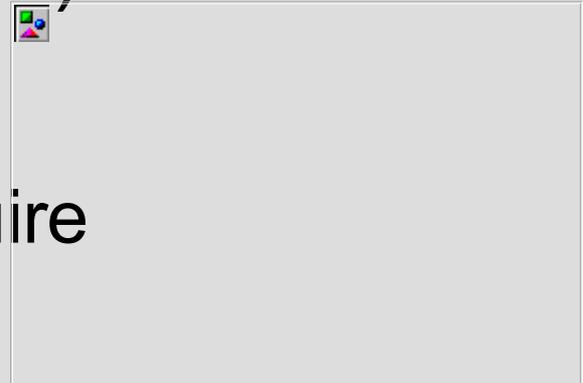
Project description - objectives
What needs to be done/components
Present situation/participants
Where do we fit in and why
Timeline
Time (&resources) management

Overview

- Need for a **unified description of all lattices** in FNAL accelerator complex
 - standard names, alignment info, magnet info
- Need for the ability to provide lattice functions to MCR application programs
 - Together with lattice optimization tools (fitting, matching, etc)
- The tools should have **well defined interfaces**, so they can be extended to new application programs, **run at MCR**

Lattice files and functions

- Lattice files (input to optics programs)
 - Plain text files containing element (i.e., magnet) positions, orientations and settings
 - Basic layout from accelerator design
 - Settings changed via controls in MCR
 - Positions and orientations from surveys
- Lattice functions (first-order optics)
 - Derived from lattice file data
 - Simple enough to be computed quickly, complicated enough to require computer



Tevatron lattice description

constants

```

NBENDS := 774.0
BANGLE := TWOPI / NBENDS ! approx. 8.12 mrad
HANGLE = 3.87625450E-03 ! From N. Gelfand file
LAMBANGLE = 1.83577060E-03 ! From N. Gelfand file
CMAGBANGLE = 1.48790000E-03 ! Changed slightly to make
! 2*HANGLE + 3*LAMBANGLE + 2*CMAGBANGLE = 2*BANGLE = 0.016235621
DOGANGLE = 3.272764E-3

LBFIELD = 6.1214
LHBFIELD = 2.921 ! half dipole length according to Norm G.
LLAMB = 5.521706 ! C0 abort lambertson
LCMAG = 3.73888 ! C0 C-magnet
LDOGBEND = 6.0706 ! 239 inches
LSEPTA = 3.5433

-----
! main dipoles
-----

! Next 4 are defined but never used. They are the magnetic fields in Tesla.
BENDFIELD = BANGLE*BRHO/LBFIELD
HBENDFIELD = HANGLE*BRHO/LHBFIELD
LAMBFIELD = LAMBANGLE*BRHO/LLAMB
CMAGFIELD = CMAGBANGLE*BRHO/LCMAG

BEND: SBEND, L = LBFIELD, ANGLE = BANGLE
BENDQ: MULTIPOLE, K1L = KBENDQ
HBEND: SBEND, L = LHBFIELD, ANGLE = HANGLE
LAMBEND: SBEND, L = LLAMB, ANGLE = LAMBANGLE
CMAGBEND: SBEND, L = LCMAG, ANGLE = CMAGBANGLE

! Next bends are added for fixed target
! They are the dogleg at D0 around the extraction septa and are on
! the Tevatron Main Bus.
! The distance between the upstream DOGPBEND, DOGBBEND is about 4 cm
! different from the distance between the downstream DOGPBEND, DOGBBEND.
! As a result, when these are on, the closure of the Tevatron is
! changed slightly. (This can only be seen in the results of a survey
! command.) The D0BUMPK1 and D0BUMPK2 are probably intended to
! be used as small adjustments to close this bump, but I have not
! ever used them for this. ppb
DOGPBEND: SBEND, L = LDOGBEND, ANGLE = DOGANGLE
DOGBBEND: SBEND, L = LDOGBEND, ANGLE = -DOGANGLE

! E0DOGP and E0DOGM are for the proton removal insert in E0.
! They have their own power supply, the Transrex that used to be used for
! the E0 Lambertsons.
! Most of the time these will be off. When they are turned on, they
! will bend the beams by DOGANGLE (see above)
! E0DOGBEND := 3.272764E-3
! Notice that E0DOGP has a kick of -E0DOGBEND.
! A positive kick is the same sign as the main bends.
! The E0 dogleg should displace the beam to the radial OUTSIDE.
! I've chosen to put them in as closed orbit correctors to make it
! easy to see how much they move the beam. (If I put them in as regular
! bends, I would have to do a survey and figure out how much it moves.)
! ppb 9/12/97
E0DOGBEND := 0.0
E0DOGP: HKICKER, L=LDOGBEND, KICK = -E0DOGBEND
E0DOGM: HKICKER, L=LDOGBEND, KICK = E0DOGBEND
```

```

E0DOGLEGM:LINE = ( DDOGEND1, E0DOGM, DDOGEND1 )
E0DOGLEGP:LINE = ( DDOGEND1, E0DOGP, DDOGEND1 )
E0COLL2: LINE = ( DR2COLLEND, ME02UHCL, ME02UVCL, DR2COLL2, E02HCL, &
E02VCL, DR2COLL2, ME02DHCL, ME02DVCL, DR2COLLEND )
E0COLL3: LINE = ( DR2COLLEND, ME03UHCL, ME03UVCL, DR2COLL2, E03HCL, &
E03VCL, DR2COLL2, ME03DHCL, ME03DVCL, DR2COLLEND )

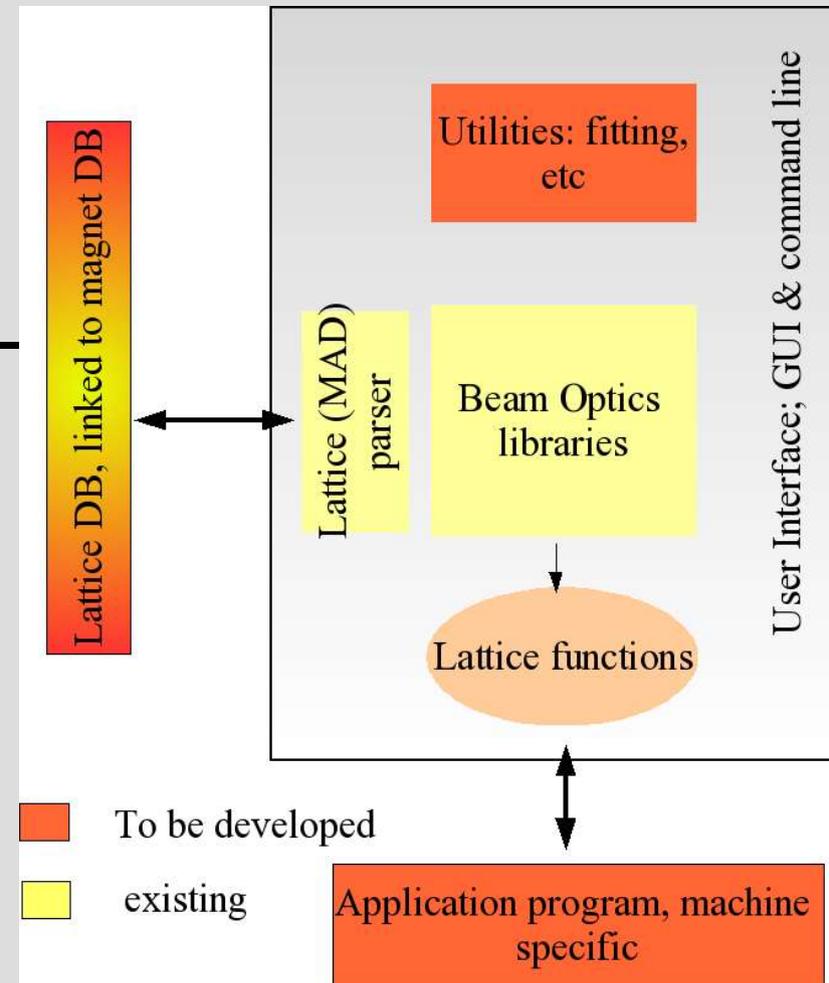
E0DAMPK: LINE = ( DPHDAMPK, D3IN, DPVDAMPK, D3IN, DPBHDAMPK, D3IN,
DPBVDAMPK )
E0DAMPPU: LINE = ( DHDAMPPU, D3IN, DVDAMPPU )
LSTRE0DR2:LINE = ( E0DOGMP2, DDOGEND1, DE0SP6, E0DAMPK, DE0SP7, &
DBELL7A, E0COLL2, DBELL7A, E0COLL3, DBELL7A, &
E0DAMPPU, DE0SP8, DGV4, DE0SP9, DTAB, D3IN )

QUADE0: LINE = ( DQUAD1END, HQUAD1F, DQUAD1END )
COLDBYP1: LINE = ( DCOLD1 )
STRAIGHTE0: LINE = ( DE11END, HFWE11, DE11MID, VFWE11, DE11END )
COLDBYP2: LINE = ( DCOLD2 )
E0DOWN: LINE = ( ME0, LONGSTRE0D, QUADE0D, COLDBYP1, STRAIGHTE0D, COLDBYP2 )
E0DOWNR2: LINE = ( ME0, LSTRE0DR2, QUADE0D, COLDBYP1, STRAIGHTE0D, COLDBYP2 )
QUADE11: LINE = ( DBPMIN, HBPME11, DBPMOUT, HQUAD2D, DQOUT1 )
PACKE11: LINE = (DBPMIN1, VBPME11, DBPMOUT1, DHQUADC, TSQE0, HDE11, VDE11, &
DHQUADC, DPACKOUT1 )
DIPOLE: LINE = ( DBENDEND, BENDQ, BEND, BENDQ, DBENDEND )
E11: LINE = ( ME11, QUADE11, PACKE11, 4*DIPOLE )
QUADE12: LINE = ( DBPMIN, VBPME12, DBPMOUT, HQUAD3D, DQOUT )
PACKE12: LINE = ( DPACKIN, DHQUADC, TSX, TQX, VDE12, DHQUADC, &
DPAKU2D, DPACKOUT )
E12: LINE = ( ME12, QUADE12, PACKE12, 4*DIPOLE )
QUADE13: LINE = ( DBPMIN, HBPME13, DBPMOUT, HQUADF, DQOUT )
PACKE13: LINE = ( DPACKIN, TQFA4, TSF, HDE13, DPAKU2D, TSQ, DPACKOUT )
PACKE13R2:LINE = ( DPACKIN, TQFE1, TSF, HDE13, DPAKU2D, TSQ, DPACKOUT )
```

Full description is 3574 lines

What does it really mean

- **Functionality**
 - Optics libraries
 - Utilities: fitting, matching, plotting,...
 - Communication with applications programs
 - Command line & library
 - User Interface (GUI)
 - Lattice (MAD file) repository interface
- **Packaging**
- **MCR installation**



The Present Situation

- Mandate to AD departments to provide lattice info (MAD files)
 - magnet/alignment info with CEPA participation
- Lattice repository needs to be designed & implemented
- Existing tools:
 - mxyzptlk/beamline (Leo+Francois)
 - Comprehensive optics library, minimal user interface
 - OptiM (V.Lebedev)
 - Minimal optics tools, GUI (but a “frozen windows” one)
 - Variety of application programs

Why us?

- AD/theory no experience with large “user oriented” software projects
- AD participants have conflicting interests
- We have worked well with the AD theory group using and packaging their products
 - Synergia project (Jim A., PGS)
http://cepa.fnal.gov/psm/aas/Advanced_Accelerator_Simulation.html
- *I can't keep my mouth shut*
 - Participated in initial phase of defining the project's scope

Importance

- High profile project
 - Functionality recommended (requested) by two DOE reviews
 - Request to us from AD management
- **It is a useful project!**
 - Compared to our multi-particle effects modeling project, by far less interesting in physics but much more useful for machine operations
- It provides much needed functionality
 - Will be used for all machine studies & **machine tuning**

Timeline

- Full project completion: 2 years
 - Participants Leo, Francois, V. Lebedev, *Jim A., PGS (if we do)*
- First release of libraries with enough of the interface in place for a simple MCR application: 6 months
- Work in progress in optimizing optics libraries, exploring interface options, and lattice repository design
- Current request is to take over project management before Lehman review

Something has to give

- Last year we spent 30% of our time on Booster instrumentation studies and studies
- This can drop to less than 10%
 - Established credibility, can use Booster group connections for data taking
- Our software development (Synergia) plans included extending our framework to include more physics options
 - If no additional CD resources become available, we will complete the framework upgrade but not create any new applications (e.g beam-beam effects)
- *I have not seen the movie...*