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Closed-Orbit Statistics from MAD

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1. Introduction

A small program has been written which operates on results from MAD Version 6 for samples of mis-aligned machines and computes means and standard deviations for many optical parameters. It is invoked on the VM/CMS system at CERN by executing the file MISLEP EXEC on the LEPH disk.

2. Input from Terminal

MISLEP starts by asking the user whether he wants to use a NAMELIST or a dialog by questions and answers in order to communicate his wishes to MISLEP. In both cases, the same six variables are involved. Their meanings and default values are shown below:

DEBUG: LOGICAL variable, DEBUG=.TRUE. causes more output from MISLEP (default DEBUG=.FALSE.)

FILNAM: CHARACTER*8 variable, containing the filename of the MAD results (no default)

FILTYP: CHARACTER*8 variable, containing the filetype of the MAD results (no default)

HALT: LOGICAL variable, HALT=.TRUE. stops the execution of MISLEP after the current file with MAD results (default HALT=.TRUE.)

LORIPS: LOGICAL variable, when LORIPS=.TRUE. then MISLEP expects MAD results for the orbit function at the experimental interaction points, and later calculates the corresponding means and standard deviations (default LORIPS=.TRUE.)

STRING: CHARACTER*8 variable, containing the first 8 characters of the title, excluding the carriage control character, as defined in the MAD run by the command TITLE (default STRING='LEP13 - ')

Usually only FILNAM and FILTYP have to be entered when MISLEP is executed. Note that CHARACTER variables must be enclosed in quotes. The console log of a typical MISLEP session is shown in Table 1.

Table 1: Console Log of MISLEP Session

```

R; T=0.01/0.01 14:26:50
mislep
KEI191 ( 1A4 M ) RR
ENTER NAMELIST $DATA WITH DEBUG, FILNAM, FILTYP, HALT, LORIPS, STRING
$data filnam='150c2i',filtyp='summary' $end
ENTER NAMELIST $DATA WITH DEBUG, FILNAM, FILTYP, HALT, LORIPS, STRING
$data halt=t $end
DISK KEI191 (Your 1A4 Mode M ) released/detached.
R; T=0.19/0.28 14:28:07
cp spool console close stop

```

3. Input from MAD File

MISLEP expects the file defined by FILNAM and FILTYP to be on the user's A disk, and to start with MAD results from the TWISS command for the perfect machine, followed by as many batches of MAD results as there are machines with errors in the sample. One batch of MAD results is shown in Figure 1. In this context "MAD results" means the contents of a file which is identified as OUTPUT FILE NAME in the MAD6 EXEC file, not the contents of a file called TWISS VERnn. The dimensions in the program allow for up to 20 machines. Each batch consists of three parts:

1. MAD output for the uncorrected machine, as obtained by the MAD commands

```

PRINT,LORIPS
TWISS

```

2. The minimum MICADO results, i.e. without any of the detailed lists of correctors and/or monitors, obtained by the command:

```

MICADÔ, NCORR = value, ERROR = value, ITERATE = value

```

3. MAD results for the corrected machine, as obtained by the same string of MAD commands as for the uncorrected machine.

MISLEP expects the TWISS results from MAD to contain either zero (for LORIPS = .FALSE) or exactly four lines (for LORIPS = .TRUE.) between the beginning and end of the beam line LEP, giving the orbit parameters at the experimental interaction points. This number of interaction points is set inside the program. MISLEP "knows" the layout of these results and picks up the relevant quantities. It continues reading until it hits an end of file.

4. Calculations and Output

MISLEP then computes the means and standard deviations of all quantities involved, and prepares two files on the user's A disk, which contain the same information but in different formats:

1. The file MISLEP LISTING can be listed on a line printer and is readable. The notation for Greek letters and subscripts follows the conventions of SCRIPT.
2. The file MISLEP TABLE is in a form which can be inserted into an SGML input file.

An example of the results as printed by SGML is shown in Table 2. The first column of the table contains the parameters of the perfect machine, the second column contains the averages and standard deviations of the machines with errors before orbit correction, the third column contains the averages and standard deviations after orbit correction. The first 6 lines show the tunes Q , the chromaticities Q' , momentum compaction α , and transition energy γ_t . The next 4 lines show the maxima of the amplitude functions β and of the dispersions D . The next 4 lines show the maximum and rms orbit distortions taken at the entrances of all elements. The next 6 lines give the number of position monitors used, and the maximum and rms orbit distortions at those monitors. The next 12 lines give parameters at the experimental interaction points: the amplitude functions α and β , the dispersions D , the phase advances μ between neighbouring interaction points, and the orbit positions and slopes. The last six lines show the number of correctors used, and their maximum and rms deflection angles. All horizontal (vertical) quantities carry the symbol x (y).

If `HALT=.FALSE.`, and after the calculations and output, MISLEP returns to reading more instructions from the user, either as another `NAMELIST $DATA` or in the form of a dialog, depending on the user's choice at the beginning. Hence it is possible to process any number of files with MAD results in a single MISLEP execution. The execution of MISLEP is terminated by explicitly entering `HALT=.TRUE.` together with the filename and filetype of the last MAD results file to be processed.

Table 2: Closed Orbit Summary for 10 Machines

FILNAM=L50C2I3 FILTYP=SUMMARY Date=03/06/87 Hour=14.12.20

	Perfect	Before Correction		After Correction		
Q_x	70.350	70.331 ±	0.014	70.357 ±	0.004	
Q_y	78.200	78.192 ±	0.008	78.214 ±	0.012	
$Q_{x'}$	0.066	-0.782 ±	2.160	0.046 ±	0.047	
$Q_{y'}$	-0.255	-0.083 ±	0.433	-0.297 ±	0.104	
$10^4 \alpha$	3.865	3.727 ±	0.007	3.720 ±	0.000	
τ_t	50.867	51.799 ±	0.047	51.848 ±	0.003	
$\beta_{x\max}$	312.776	336.137 ±	11.161	327.821 ±	6.573	m
$\beta_{y\max}$	268.415	285.033 ±	19.176	271.421 ±	11.069	m
$D_{x\max}$	2.222	3.070 ±	0.369	2.277 ±	0.011	m
$D_{y\max}$		2.270 ±	1.091	0.119 ±	0.040	m
x_{\max}		22.491 ±	7.682	2.795 ±	0.380	mm
y_{\max}		30.828 ±	9.720	1.378 ±	0.196	mm
$\langle x \rangle$		6.886 ±	1.984	0.572 ±	0.055	mm
$\langle y \rangle$		11.366 ±	3.561	0.350 ±	0.021	mm
M_x		504.000 ±	0.000	504.000 ±	0.000	
M_y		504.000 ±	0.000	504.000 ±	0.000	
$x_{m\max}$		19.322 ±	5.825	1.370 ±	0.269	mm
$y_{m\max}$		29.843 ±	8.888	1.380 ±	0.182	mm
$\langle x_m \rangle$		5.837 ±	1.750	0.426 ±	0.035	mm
$\langle y_m \rangle$		12.622 ±	3.987	0.420 ±	0.023	mm
β_x^*	1.750	1.730 ±	0.076	1.748 ±	0.058	m
β_y^*	0.070	0.071 ±	0.006	0.072 ±	0.004	m
α_x^*		-0.001 ±	0.038	0.010 ±	0.029	
α_y^*		-0.024 ±	0.080	-0.003 ±	0.047	
D_x^*		0.010 ±	0.030	0.000 ±	0.003	m
D_y^*		0.001 ±	0.021	0.000 ±	0.001	m
$\mu_x^*/2\pi$	17.588	17.583 ±	0.006	17.589 ±	0.005	
$\mu_y^*/2\pi$	19.550	19.548 ±	0.016	19.554 ±	0.009	
$\langle x^* \rangle$		0.174 ±	0.991	-0.017 ±	0.111	mm
$\langle y^* \rangle$		-0.022 ±	0.325	-0.041 ±	0.163	mm
$\langle x^{*'} \rangle$		-0.010 ±	0.600	0.000 ±	0.016	mrاد
$\langle y^{*'} \rangle$		-0.171 ±	5.168	-0.006 ±	0.074	mrاد
C_x		0.000 ±	0.000	92.400 ±	2.458	
C_y		0.000 ±	0.000	93.000 ±	2.569	
$\theta_{x\max}$		0.000 ±	0.000	0.050 ±	0.006	mrاد
$\theta_{y\max}$		0.000 ±	0.000	0.150 ±	0.070	mrاد
$\langle \theta_x \rangle$		0.000 ±	0.000	0.021 ±	0.002	mrاد
$\langle \theta_y \rangle$		0.000 ±	0.000	0.025 ±	0.007	mrاد

POS. NO.	ELEMENT NAME	SEQUENCE NO.	DIST (M)	H O R I Z O N T A L								V E R T I C A L					
				BETAX (M)	ALFAX (1)	MUX (2P1)	X(CO) (MM)	PX(CO) [001] (M)	DX (M)	DPX (1)	BETAY (M)	ALFAY (1)	MUY (2P1)	Y(CO) (MM)	PY(CO) [001] (M)	DY (M)	DPY (1)
BEGIN	LEP	1	0.000	20.946	-0.009	0.000	-0.475	0.086	-0.002	-0.001	0.778	-0.005	0.000	-1.447	0.232	-0.095	0.078
1150	LORIPS	1	3332.359	1.621	-0.038	8.796	-0.245	-0.862	0.043	-0.005	0.068	0.049	9.763	0.152	-6.789	-0.016	-0.353
3261	LORIPS	2	9997.077	1.685	-0.009	26.372	1.161	0.662	0.012	0.010	0.070	-0.123	29.337	-0.039	7.801	0.028	0.242
5395	LORIPS	3	16661.795	1.654	-0.009	43.949	-1.701	0.241	0.002	-0.024	0.074	-0.201	48.887	0.111	-7.319	-0.032	-0.219
7544	LORIPS	4	23326.513	1.824	-0.037	61.529	1.628	-0.430	-0.013	0.017	0.081	-0.114	68.418	-0.019	7.047	0.034	0.058
END	LEP	1	26658.872	18.575	-0.002	70.318	-0.475	0.086	-0.007	0.001	0.706	0.109	78.175	-1.447	0.232	-0.001	0.147
TOTAL LENGTH =				26658.872082		QX =	70.317629		QY =	78.174982							
ALFA =				0.373088E-03		QX' =	-2.309340		QY' =	0.149145							
GAMMA (TR) =				51.771897		BETAX (MAX) =	348.866375		BETAY (MAX) =	277.889148							
						DX (MAX) =	3.076048		DY (MAX) =	3.311195							
						XCO (MAX) =	26.340946		YCO (MAX) =	33.836445							
						XCO (R.M.S.) =	8.367926		YCO (R.M.S.) =	12.657332							

** WARNING ** TWISS1: TWISS PARAMETERS FOR DELTA(P)/P = 0.00000000 MAY BE WRONG DUE TO COUPLING.

SUMMARY:	HORIZONTAL	VERTICAL
TOTAL CORRECTORS:	264	280
MAXIMUM STRENGTHS:	0.000000 MRAD	0.000000 MRAD
MAXIMUM POSITIONS:	0	0
R.M.S. STRENGTHS:	0.000000 MRAD	0.000000 MRAD
USED CORRECTORS:	0	0

SUMMARY:	HORIZONTAL	VERTICAL
TOTAL MONITORS:	504	504
MINIMUM READINGS:	-20.445046 MM	-32.053622 MM
MINIMUM POSITIONS:	65	189
MAXIMUM READINGS:	21.018126 MM	32.103650 MM
MAXIMUM POSITIONS:	125	190
R.M.S. READINGS:	7.062208 MM	14.196362 MM
USED MONITORS:	504	504

SUMMARY:	HORIZONTAL	VERTICAL
TOTAL CORRECTORS:	264	280
MAXIMUM STRENGTHS:	0.043916 MRAD	0.228391 MRAD
MAXIMUM POSITIONS:	237	70
R.M.S. STRENGTHS:	0.022301 MRAD	0.029993 MRAD
USED CORRECTORS:	89	94

SUMMARY:	HORIZONTAL	VERTICAL
TOTAL MONITORS:	504	504
MINIMUM READINGS:	-1.908041 MM	-1.736441 MM
MINIMUM POSITIONS:	354	309
MAXIMUM READINGS:	2.015955 MM	1.506234 MM
MAXIMUM POSITIONS:	158	192
R.M.S. READINGS:	0.580115 MM	0.595080 MM
USED MONITORS:	504	504

POS. NO.	ELEMENT NAME	SEQUENCE NO.	DIST (M)	H O R I Z O N T A L								V E R T I C A L					
				BETAX (M)	ALFAX (1)	MUX (2P1)	X(CO) (MM)	PX(CO) [001] (M)	DX (M)	DPX (1)	BETAY (M)	ALFAY (1)	MUY (2P1)	Y(CO) (MM)	PY(CO) [001] (M)	DY (M)	DPY (1)
BEGIN	LEP	1	0.000	19.818	0.041	0.000	0.011	0.005	0.005	-0.001	0.763	0.033	0.000	-0.007	0.002	0.005	0.001
1150	LORIPS	1	3332.359	1.755	-0.027	8.799	0.166	0.000	0.000	0.001	0.071	-0.014	9.776	0.357	0.093	-0.001	0.017
3261	LORIPS	2	9997.077	1.780	-0.005	26.386	0.238	-0.017	-0.006	-0.002	0.073	-0.014	29.331	-0.082	-0.046	0.001	0.017
5395	LORIPS	3	16661.795	1.733	0.040	43.971	0.209	0.004	0.007	-0.003	0.073	-0.055	48.889	0.090	0.053	-0.001	0.016
7544	LORIPS	4	23326.513	1.663	0.001	61.562	-0.017	0.011	-0.003	-0.001	0.074	-0.026	68.440	0.057	0.018	0.001	-0.030
END	LEP	1	26658.872	19.834	0.041	70.356	0.011	0.005	0.005	-0.001	0.763	0.033	78.212	-0.007	0.002	0.005	0.001
TOTAL LENGTH =				26658.872082		QX =	70.356321		QY =	78.212288							
ALFA =				0.372039E-03		QX' =	0.017438		QY' =	-0.145778							
GAMMA (TR) =				51.844885		BETAX (MAX) =	327.305897		BETAY (MAX) =	266.001781							
						DX (MAX) =	2.311456		DY (MAX) =	0.130523							
						XCO (MAX) =	3.582055		YCO (MAX) =	1.664731							
						XCO (R.M.S.) =	0.718018		YCO (R.M.S.) =	0.457266							

** WARNING ** TWISS1: TWISS PARAMETERS FOR DELTA(P)/P = 0.00000000 MAY BE WRONG DUE TO COUPLING.

Fig. 1. One batch of MAD results, corresponding to one misaligned machine.