JADE Computer Note 67

THE JADE MUON MONTE CARLO

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Contents:

Introduction

This describes the routines used to describe nuclear interactions and other processes in the "Muon Monte Carlo".

The routines are in F22RJB.RLMC.S/L at DESY
JADE.LIBRARYS.CASCADE at Manchester (Source)
ULIB.JADEGL at RAL (Load)

At DESY, to use the program you have to put the load library F22RJB.RLMC.L in the SYSLIB DD cards before the standard F22ELS.JMC.L. At RAL this version is the default. In both cases, calibration data files must be given in the standard way.

The original code was taken from Grant [N.I.M. 131 p 167 (1975)], but has been much altered since. The note is for the benefit of (1) people who want to do muon physics and (2) people who might like to use the routines for other purposes (beam pipe, lead glass, etcetera). I have tried to describe in full detail both the program mechanism and also the underlying physics. There are several major areas where both can be improved, especially in the different units used by different routines (GeV-MeV; cm-mm). However, if one waited till the program were perfect before documenting it one would wait forever. Later improvements will be described in addenda to this note, and the existence of these will be advertised by a message in the printout from the program.

OVERVIEW

```
          MUCONM--------------MUFIX
         / get KALIBR consts     fix parameters
         |
         |
         |                 MUDKBG ---- MUROT
         |                / pi, K decay   rotate   ENDCLG
         |                |                      / from lead glass lib
         |                | MUFIND ----------------+-MUZAP
         |                |/ where am I ?          |  hit in muon chambers
         |                |                        \
         |                | MUMAT                   MUSTOR
         |                |/ get material props.       save mu hit
         |                |
         |                | MUPAIR   ----- MUTRAK
         |                |/ gamma -> e+e-
         |                |
         |                | MUBREM   ----- MUTRAK,MUSCAT
         |                |/ e -> e gamma
         |                |
         |                | MUINTA ---------  MUSIGM
         |                |/ did it interact?     get cross section
MCJADE---|-MURTNE --------|
         | steers muon    |\
         |  part of MC    | MUTRAK ---------MUDEDX,    MUMAGF
         |                |   move particle   energy loss    mag field
         |                |\
         |                | MUSCAT
         |                |   coulomb scattering
         |                |\
         |     these      | MUEXNU
         |     only       |   energy to nuclear excitation?
         |     called     |\
         |     if it      | MUNUCL
         |     interacts  |   Produce evaporation nucleons
         |                |\
          \               | MUCAS ------------ MUPCN
          MUORDR-MUSTOR   |  generate        |     Charge exchange
           create MUEV    |   interaction    |\
                          |                  | MUTRYN - Multiplicity
                          |                  |\
                          \                  | MUSGIL - Sage initialise
                           MUPI0 --MUROT     |\
                             pizero decay    | MUSGNS - Sage generator
                                             \
                                              MUSGWT - Sage weight
```

Note: MUCONM is called only once, at the start of the job.
MURTNE is called for every track (that gets as far as the filter).
MUORDR is called once per event, at the end

ROUTINES

DATEMC(H)

Called by: MUCONM
Calls: none
Arguments/value: H is an array of 6 halfwords set to time and date
Input Common(s): TODAY
Output Common(s): none

Moves the Time and date on which this run is supposed to have happened from the common TODAY where it has been set up by the user, to an array for BOS purposes.
This is separate from the date set up for RDMTCO etc. in the analysis step, as described in JADE Computer note 66. It is up to the user to make sure that the two dates are the same.

MUBREM

Called by: MURTNE
Calls: MUTRAK,MUSCAT
Arguments/value: None
Input Common(s): RESULT,SUN,MAT
Output Common(s): RESULT,SUN,EVENT

Called only if this is an electron. For a particle of momentum P generates a photon of energy uniformly distributed between P/10 and P. Probability of radiating this photon is then taken as 10/9 * P/P(photon) * (step size/radn length). Electron is taken a random distance through the step size before radiating.

Status: OK. Formula is a good approximation above a few hundred Mev - see Perkins section 2.5.2. The low energy cutoff at P/10 is not true, of course, and is only there to avoid generating many time-consuming low energy photons. Anyone interested in electromagnetic showers should move it to a lower value.

MUCAS

Called by: MURTNE
Calls: MUPCN,MUTRYN,MUSGIL,MUSGNS,MUSGWT
Arguments/value: None
Input Common(s): RESULT
Output Common(s): EVENT

Generates a multiparticle event.

First decides on the probability of charge exchange (MUPCN) for the target. (p -> n or n -> p)

If the beam momentum is low (<400 Mev/c) then the multiparticle collision is not generated, instead the beam particle loses 10% of its energy, and that's it.

It decides randomly on proton or neutron as target particle.

For a nucleon-nucleon collision, if the target charge exchanges and if the energy is reasonably high, then there is a 50:50 chance of beam charge exchange too. This is a bit of a kludge.

It then decides on the number of charged and neutral pions produced. by calling MUTRYN. If there is not enough cms energy to create all these particles, it drops pi zeros until there is. If there still isn't enough after all the pi zeros have been dropped, then the low energy (<400 Mev/c) procedure is followed.

The SAGE routines are called to generate the event. SAGE produces weighted events, and these have to be selected by comparing the weight with the "maximum weight". This last is very time consuming to calculate. I have set the standard value to 2.0, from looking at actual values of the weight generated. If it takes more than 10 shots at the generation then it decides that 2.0 is far too high, and uses 3 times the average weight (from the >=10 tries it's just made) instead.
At the end, energy, momentum, and charge balance is checked.

Status: Fairly satisfactory. Main defect is the lack of any Kaon production - everything is a pion or a nucleon (though the target mass is correct). If anyone had some numbers for kaon production fractions (which are probably easy - it's reactions like K p -> pi Lambda that will make life difficult) then it would be relatively easy to put them in - SAGE could handle them.

MUCONM

Called by: MCJADE
Calls: DATEMC,KALIBR,MUFIX
Arguments/value: None
Input Common(s): CIOUNI
Output Common(s): Bos Common

Initial stage for calibration data etc. It creates a HEAD bank with date given by DATEMC and run number -1 (!), and calls KALIBR which then gets the calibration data for the requested date, including the muon calibration (as the run number is not 0) but does not re-evaluate the Lorentz angle corrections (as the run number is less than 1). The mendacious HEAD bank is then deleted. MUFIX is called to set up muon chamber parameters.

MUDEDX(BETA)

Called by: MUTRAK
Calls: none
Arguments/value: Beta is particle velocity.
Function returns real value of dE/dx
Input Common(s): MAT,RESULT

Computes dE/dx according to Bethe-Bloch formula.
Status: OK
Output Common(s): none

MUDKBG

Called by: MURTNE
Calls: MUROT
Arguments/value: None
Input Common(s): RESULT,SUN
Output Common(s): RESULT,DISPL

Particle decays. Charged pions decay to muons. Charged Kaons decay to muons or to pi pi0.

Status: OK, except that the pi0 is dropped and not tracked.

MUEXNU(EN,AMAS)

Called by: MURTNE
Calls: none
Arguments/value: EN and AMAS are the energy and mass of the incident particle
Real value returned is the energy to go to nuclear excitation
Input Common(s): MAT

Decides on energy to evaporation nucleons. Gives 10 Mev/nucleon for collisions below 3 Gev, above 3 Gev multiplies this by E/3

Status: very suspicious. Grant's paper and program say different things here. Both are probably wrong. This is first on my list for improvements.
Output Common(s): None

MUFIND(IND)

Called by: MURTNE
Calls: ENDCLG,MUZAP
Arguments/value: Ind is material index: 0 = air (=vacuum)
-1 = left apparatus
1 - 92 are elements
100+ are composites
Input Common(s): RESULT,CGEO1,CMUREG
Output Common(s): MUTYPE

From the position it works out what material it is in (aluminium, lead-glass, iron, iron-loaded concrete, air...) It does this by looking at the geometry common values (for radius of coil, etc), by the lead glass routine ENDCLG which knows where the lead glass blocks are in the end cap, and by looking at the muon region list. If it discovers it is in a chamber, it calls MUZAP to score the hit.

MUFIX(REST,RESL,EFF,RNOISE,DEBUG,RESEND,PPULSE)

Called by: MUCONM
Calls: none
Arguments/value: See below
Input Common(s): none
Output Common(s): MUPARS

Called by MUCONM at the start of the event. It sets values in MUPARS control common:

REST and RESEND are the transverse resolutions in the barrel and endwall chambers - standard values 5.0 and 10.0 mm
RESL is the longitudinal resolution - standard value 500mm
EFF is the chamber efficiency - standard value 95%
RNOISE is the probability of a random hit in each chamber - standard value 1%
DEBUG is a debug flag (logical) usually set to FALSE unless you want piles of paper.
PPULSE is the probability that a chamber will multi-pulse - standard value 0.75 .

Many people find it useful to have their own version of this routine. If you want to change the calibration data - e.g. to switch chambers on or off - then this is the place to do it.

MUINTA(IND)

Called by: MURTNE
Calls: MUSIGM
Arguments/value: IND is the material index - checked for zero
value returned is 1 if the particle interacted, else 0
Input Common(s): RESULT,MAT,SUN,MUABSL
Output Common(s): none

Decides whether a hadron interacted in this step.
For each element in the material, it finds the absorption length from the density and the cross section. Adds these reciprocally, then compares the absorption length with the step size and decides randomly whether or not an interaction occured. If it did, it then decides what element the struck nucleus was by comparing the absorption lengths.

MUMAGF(FIELD)

Called by: MUTRAK
Calls: none
Arguments/value: FIELD(3) is the direction of the field
value returned is the magnitude
Input Common(s): RESULT,MUTYPE
Output Common(s): none

Works out where it is in the return yoke or end walls and evaluates the magnetic field magnitude and direction. This is normalised to 1, the multiplication by 4.8 kG (or whatever) is done in MUTRAK

MUMAT(INDEED)

Called by: MURTNE
Calls: none
Arguments/value: INDEED is index to this material
Input Common(s): None
Output Common(s): MAT,MUABSL

This routine extracts the properties of the current material (density, radiation length, dE/dx parameters etc) from tables and puts them into MAT; MUABSL is also filled.

It looks very complicated, because it is a multi-purpose routine which can also be used to produce the tables for new materials. This part does not happen in normal use.

MUNUCL(TKIN)

Called by: MURTNE
Calls: None
Arguments/value: TKIN is energy to be used in creating fragments
Input Common(s): RESULT,KUT
Output Common(s): EVENT

Produces nuclear fragments. Distribution for KE is T exp-(100 T**2) Goes on producing fragments until all the available energy TKIN is used up.

Status: Uncertain. See MUEXNU.

MUORDR

Called by: MCJADE
Calls: MUSTOR
Arguments/value: None
Input Common(s): CJTCDC,CMUREG,CMUCALIB,CMUSIG,MUPARS
Output Common(s): Bos Common
Input Bank(s): MUX1:1, MUX1:2, MUX1:9
Output bank(s): MUEV:0, MUHC:1

Called at the end of the event to unpack the muon hits and form the MUEV bank for output. First it adds any desired random hits, then sorts the hits into order, then makes MUEV. Hit 4 overwriting hit 1 is done here. Also makes the MUHC bank. Uses MUX1:3,4, and 5 as temporary work space.

MUPAIR

Called by: MURTNE
Calls: MUTRAK
Arguments/value: None
Input Common(s): RESULT,SUN,MAT
Output Common(s): EVENT,SUN,RESULT

For photons, converts to an e+ e- pair with probability exp -(7/9 *step/Rad length). Moves the photon an arbitrary distance along the step before conversion.

Status: OK for photons above 1 Gev. Again, anyone doing EM shower studies should improve it. They should be using EGS anyway.

MUPCN(P)

Called by: MUCAS
Calls: None
Arguments/value: P is momentum of incident particle
Real value returned is probability of charge exchange
Input Common(s): None
Output Common(s): None

This interpolates from a table the probability of charge exchange. This falls from 32% to 1%.

Status: Very insecure. I don't know where these numbers came from or how good they are.

MUPIO

Called by: MURTNE
Calls: MUROT
Arguments/value: None
Input Common(s): RESULT
Output Common(s): EVENT,RESULT

Goes right through the EVENT common looking for neutral pions. When it finds one, two gammas are produced, isotropically about the pi0 direction

MUROT(XP,YP,ZP)

Called by: MUPIO,MUDKBG
Calls: None
Arguments/value: Xp,etc
Input Common(s): RESULT
Output Common(s): RESULT

A rotation routine. A particle produced with components XP,YP,ZP and momentum P (in RESULT) in the frame of a particle with direction SINL,COSL,SINP,COSP (in RESULT) has its direction worked out. This new direction then overwrites the SINL etc values in RESULT.

MURTNE(PV,R,IDUM,*)

Called by: MCJADE
Calls: MUDKBG,MUFIND,MUMAT,MUPAIR,MUBREM,MUINTA,MUTRAK
MUSCAT,MUEXNU,MUNUCL,MUCAS,MUPIO
Arguments/value: PV is momentum vector
R is position
IDUM and * are not used
Input Common(s): DISPL,CJTCDC,CPROD,KUT,JEVENT
Output Common(s): EVENT,CMURJB,CMUSIG,RESULT,SUN,Bos Common
Output Bank(s): MUX1:1, MUX1:2, MUX1:9, MUCH

This is the general steering routine, called for each event.

First time through, it sets up some parameters (NSIZE,STEP,PCUT) and seeds the random number generator.

If this is the first track of an event, then the MUX1:1,2,9 banks are created.

The tracks parameters are then copied from PV and R to RESULT.
Dimensions are converted from mm & GeV to cm & MeV.
K zeros are reassigned as K+-. This is OK for aborption but incorrect as far as energy loss goes.

The MUCH bank is created, and the information about the particle is stored there. The routine has to spot the first decay/interaction/rangeout/escape of this particle.
"Rangeout" happens when the particle momentum falls below PCUT.

The routine steps the particle through the detector, at each step offering the possibilty of decay, interaction, etc, and losing energy. When the tracking of this particle stops (for one of the 4 above reasons) then the next particle is taken from EVE and tracked (n.b. this will have been created in the cascade; the next particle from MCJADE doesn't appear till the next MURTNE call). This continues until there are no particles left.

There is an entry MUSEED(ISEED) which can be used to set the seed used for the random number generator.

MUSCAT

Called by:	MURTNE
Calls:	None
Arguments/value:	None
Input Common(s):	RESULT,SUN,MAT,KUT
Output Common(s):	RESULT

Coulomb scattering a la Particle data book.
theta rms = 15 sqrt(x/X) (1+1/9 log(x/X)) / p beta

status: OK

MUSEED(ISEED)

Called by:	The user, if desired.
Calls:	None
Arguments/value:	ISEED is the seed to be used
Input Common(s):	None
Output Common(s):	None

This is an entry in MURTNE. It sets the value of the seed for the Random Number generator.

MUSIGM(P,AMASS,Q,A)

Called by: MUINTA
Calls: None
Arguments/value: P is momentum of incident particle
AMASS is its mass
Q is the charge
A is the atomic weight of the nucleus
Real value returned is the X-section in millibarns
Input Common(s): ABUL,MUSIGA
Output Common(s): None

Computes the absorption cross section.
Decides on the particle type by looking at AMASS and Q.
AMASS is restricted to certain non-obvious values: see the comments in the listing for complete details.
Then finds the cross section for Nucleon Targets for this momentum by interpolating in the MUSIGA common, obtained from the data compilations.
Then finds C and alpha for the formula C*A**alpha for nuclear targets. (Full details of this method will appear at some point).

Status: Good. I believe these numbers. Results agree with experimentals values of absorption cross sections within 3% - though it may be worse for e.g. low energy antiprotons

MUSTOR(I,X,Z)

Called by: MUZAP,MUORDR
Calls: none
Arguments/value: Chamber Number, transverse and longitudinal values
Input Common(s): CJTCDC,MUPARS,CMUSIG
Output Common(s): CMUSIG
Uses bank(s): MUX1:1, MUX1:2, MUX1:9

Stores a hit in the banks MUX1:1 (x) MUX1:2 (z) and particle info in MUX1:9. Multipulsing, smearing, and inefficiency are all applied here

MUTRAK

Called by: MURTNE,MUPAIR,MUBREM
Calls: MUDEDX,MUMAGF
Arguments/value: None
Input Common(s): RESULT,SUN,CGEO1
Output Common(s): RESULT

Moves particle a step through the detector; energy loss and magnetic field bending are applied

MUTRYN(N,NZ,INSIST)

Called by: MUCAS
Calls: None
Arguments/value: N is the number of charged particles
NZ is the number of pi zeros
INSIST is the minimum no of particles needed
Input Common(s): RESULT
Output Common(s): None

Decides on the Multiplicity of a generated event if the beam energy is below 1 Gev, essentially nothing happens. Otherwise the mean and dispersion of the charged multiplicity distribution are given by a linear dependance on log s

For pi+ and proton beams
<N> = 1.04 + 0.91 log s <D> = -0.405 + 0.497 log s
For pi- and neutron beams
<N> = -0.81 + 1.474 log s <D> =0.07 + 0.493 log s

If the energy is between 1 and 4 Gev, then the prong number is given by a gaussian using the values of <N> and <D>
Above 4 Gev, the (well known) Czyzewski-Rybicki formula is used [Nuclear Physics B 47 p 633 (1972)]

The expected number of pi zeros is taken as <N>/3
the actual number is then given by a poisson distribution.

Status: I have not checked the behaviour of <N> and <D>. The C-R formula is fine. The pi zero assumptions are unchecked but seem not wildly unreasonable.

MUSGIL(BEAM,TARGET,ECM,PLAB,P4TOT)

```
Called by:          MUCAS
Calls:              None
Arguments/value:    BEAM and TARGET are beam and target masses
                     ECM  is the energy in the CMS (returned)
                     PLAB is the lab momentum
                     P4TOT(4) is the Lorentz frame for the event
Input Common(s):    SYMB2,INIT
Output Common(s):   SAGELL,SAGEWT
```

Does some initialisation for the SAGE package, before the call to MUSGNS which does the actual event generation. All energies etc in GeV. See SAGE manual for further details

MUSGNS(TECM,PP,NP,AMASS,PCM,RMAX,IENT)

```
Called by:          MUCAS
Calls:              MUSGRD
Arguments/value:     TECM is the cms energy
                     PP(4) is the Lorentz frame in which the event occurs
                     NP is the number of particles to be generated
                        according to longitudinal phase space
                     AMASS(NP)  are the particle masses
                     PCM(4,NP)  are the 4-momenta generated
                     RMAX is a control parameter for LPS.
                          Set to the recommended value of 0.4
                     IENT is the number of attempts at this event
Input Common(s):    SYMB2,COUNT,SAGEWT
Output Common(s):   COUNT,SAGEWT
```

Generates an NP particle event acording to LPS. For further details consult the SAGE manual (under routine GENIS).

This seems to give sensible results. I havn't done a detailed study - somebody probably should some time - but there's nothing really sticky here.

MUSGRD(A1,A2)

Called by: MUSGNS
Calls: MUSGRN
Arguments/value: A1,A2 are momenta generated
Input Common(s): COUNT
Output Common(s): NONE

Generates an exponential Pt and a uniform azimuth, transforms to x and y, and returns the values.

MUSGRN(R,N)

Called by: MUSGRD
Calls: None
Arguments/value: R contains N random numbers
Input Common(s): PSRAND
Output Common(s): None

Gemerates random numbers - uniformly between 0 and 1

MUSGWT(W)

Called by: MUCAS
Calls: None
Arguments/value: W(2) is a real array
Input Common(s): SAGELL,SAGEWT
Output Common(s): SAGEWT

Sage routine. Fills W from commons produced by the last event generated by MUSGNS. W(2) is the weight

MUZAP(JREG)

Called by: MUFIND
Calls: MUSTOR
Arguments/value: JREG is the region in the filter
Input Common(s): RESULT,CMURJB
Output Common(s): CMURJB

Called when the particle is in a muon chamber region. Checks that it hasn't already just hit this chamber, then works out the number of the chamber it would hit, the transverse and longitudinal coordinates, and calls MUSTOR to register the hit.

COMMON BLOCKS

```
COMMON/ABUL/SIGB(100),ALPHA(100)
                    Cross section interpolation
                    For nucleon target X-section I mb
                    SIGB(I)   is the constant
                    ALPHA(I)  is the exponent

                        Used by MUSIGM


COMMON/CJTCDC/IBANK,IPART
                    Common created by main Monte Carlo
                    IPART = particle number

                        Used by:  MUORDR,MURTNE,MUSTOR

COMMON/CMURJB/LASTR
                     LASTR is the last region number visited

                          used by:  MURTNE,MUZAP

COMMON/CMUSIG/LMUX1,NH,IMUX1,IMUX2,IMUX9
                     Keeps track of hit lists
                     LMUX1    length of MUX1 banks (1 and 2)
                     NH       Number of hits.  -1, 0 are special
                     IMUX1    Index for MUX1:1
                     IMUX2    Index for MUX1:2
                     IMUX9    Index for MUX1:9

                          Used by:  MUORDR,MURTNE,MUSTOR

COMMON/DISPL/IDBUG,DECAY
          LOGICAL IDBUG,DECAY
                    IDBUG    debug printing flag
                    DECAY    flag set for decays

                     used by:  MUDKBG,MURTNE

COMMON/EVENT/NSIZE,NCUR,NEXT,NTOT,EVE(10000)
                   Stores all the particles yet to be tracked
                     NSIZE   Dimension of EVE
                     NCUR    Always 1
                     NEXT    Next empty word in EVE
                     NTOT    Total number of particles in EVE
                     EVE     Particle data. 10 words each.
                                      Correspond to RESULT values

                        Used by:  MUBREM,MUCAS,MUNUCL,MUPAIR,MURTNE
```

COMMON/JEVENT/JEVT

Event number. Set in the standard part of the MC

Used by: MURTNE

COMMON/XUT/ PCUT

PCUT Low momentum cutoff.

Used by: MUNUCL,MURTNE,MUSCAT

COMMON/MAT/DEN,RADLTH,ATWT,ABSL,DDXA,DDXB

Information on material properties

DEN	Density (units Nuclei/gram times 10**-20)
RADLTH	Rad length (cm)
ATWT	Average atomic wt for this material
ABSL	Not used.
DDXA	Energy loss parameters
DDXB	used by MUDEDX

Filled by MUMAT

Used by: MUBREM,MUDEDX,MUEXNU,MUINTA,MUPAIR,MUSCAT

COMMON/MUABSL/NMUABS,ATWTS(20),DENUCS(20),RLENGT(20)

Info about the materials in this composite

NMUABS	Number of elements
ATWTS	their Atomic weights
DENUCS	their densities (Units N/g *1.0E-20)
RLENGT	The reciprocal absorption length of each

Filled by: MUMAT

Used by: MUINTA

COMMON/MUSIGA/ SIG(162,5)

Nucleon target cross sections

See listing of MUSIGM for exact details

used by: MUSIGM

COMMON/MUTYPE/ITYPE,IREGIO

ITYPE	Region type a la MUREG
IREGIO	Muon region number

Filled by MUFIND

Used by MUMAGF

```
COMMON/MUPARS/MUDBUG,SIGT,SIGL,EFFCY,RANDOM,SIGTEW,PULSES
            REAL*8 RANDOM
            LOGICAL MUDBUG
                     MC parameter control common
                      MUDBUG   Debug flag
                      SIGT     Transverse Resolution (mm) of yoke
                                               and sidewall chambers
                      SIGL     Longitudinal Resolution (mm)
                      EFFCY    Chamber efficiency
                      RANDOM   Random noise in chambers
                      SIGTEW   End wall transverse resolution
                      PULSES   Multi-pulsing probability

                           Set by:  MUFIX
                           Used by: MUORDR,MUSTOR


COMMON/RESULT/XEND,YEND,ZEND,P,AMAS,SINL,COSL,SINP,COSP,NCH,EN,RS
      REAL NCH
                  Contains the current data for the current particle
                        XEND
                        YEND    position of this particle (cm)
                        ZEND
                        P       Momentum (Mev/c)
                        AMAS    mass     (Mev/c**2)
                        SINL    sin of dip angle
                        COSL    cos      "    "
                        SINP    sin of azimuthal angle
                        COSP    cos      "         "
                        NCH     Charge   (REAL*4 - don't ask me why!)
                        EN      Energy
                        RS      Available CMS energy

                              Used by:  everybody

COMMON/SUN/DELTN
                 DELTN   is the size of the current step (cm)

              Used by:  MUBREM,MUDKBG,MUINTA,MUPAIR,MURTNE,MUSCA,MUTRAK

COMMON/TODAY/HS,HMIN,HH,HD,HMO,HY
              Time of run - secs, mins, hour, day, month, year
                  all integer*2

                  Set up by BLOCK DATA (after MUCONM) or by the user

                    Read by MCDATE
```

BANKS

MUCH:n Information on track n.
5 words long

WORD 1 MASS
2 FATE
1=INTERACTED
2=DECAYED
3=RANGEOUT
4=LEFT
3 }
4 } x,y,z of position where fate struck
5 }
6 Number of muon chamber hits made by this track

Made by: MURTNE
Output

MUEV:0 Standard MUEV bank.
Made by: MUORDR
Output

MUHC:1 3 integer*4 words/hit: chamber number
transverse co-ordinate
track number

Made by: MUORDR
Output

MUX1:1 Contains transverse values of hits
Made by MUSTOR, read by MUORDR
Temporary

MUX1:2 Contains Longitudinal values of hits
Made by MUSTOR, read by MUORDR
Temporary

MUX1:3 Temporary work bank used by MUORDR

MUX1:4 Temporary work bank used by MUORDR

MUX1:9 Contains track info.
Made by MUSTOR, read by MUORDR
Temporary

Addendum to JADE Computer Note 67

Hugh McCann

October 1983

Since the Muon Tracking Monte Carlo uses the actual calibration which was valid on the date set by the user, it is necessary for the user to supply a date which complies with his requirements. In general, the user requires a calibration version which reasonably represents the conditions under which his real data were recorded. To that end, the following dates can be recommended (the time is always to be taken as 00 : 00 : 00):

Date	$\sqrt{s}$ (GeV) at that Date	# inoperative μ chambers / # installed
20.8.1980	> 30 (scan)	$\sim$ 30/622
25.3.1981	$\sim$ 34	$\sim$ 20/622
21.7.1981	14 (22)	$\sim$130/622
		Use this date also for 22 GeV simulation.
1.11.1981	$\sim$ 35	$\sim$ 70/622
1. 7.1982	34.6	53/618
1.11.1982	$\sim$ 39 (scan)	86/618
		Of these, 74 were in the layer inside the magnet return yoke.
1. 6.1983	> 40 (scan)	8/618

On these dates, the situation represents a reasonable average for the given run period. For an average over our entire data sample at present, 1.7.1982 is a reasonable choice. The user should also take careful note of the comments in J.C.N. 67 page 3 regarding RDMTCO.