

Muon Front End Studies At RAL

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1. Decay channel, chicane and 88 MHz linac [NuFact02]

2. Decay channel, of optimised solenoid magnets.

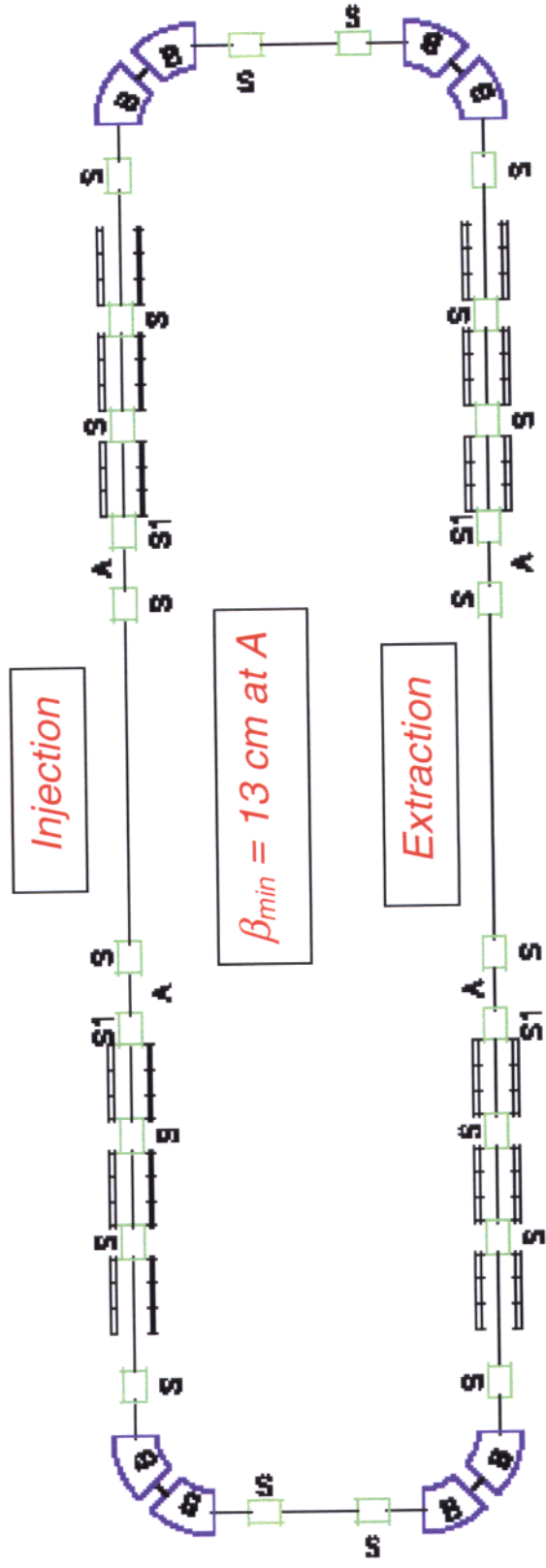
31.4 MHz Φ -rotation of 180 ($\pm 70 \rightarrow \pm 23$) MeV muons.

201 MHz racetrack cooling ring (bunch splitting).

Problem Areas for a Muon Cooling Ring

1. Non linear fields for the large acceptances.
2. Momentum acceptance of the 180° arcs.
3. $\Delta p/p$ for large energy loss (gain) per turn.
4. Injection and extraction induction kickers.

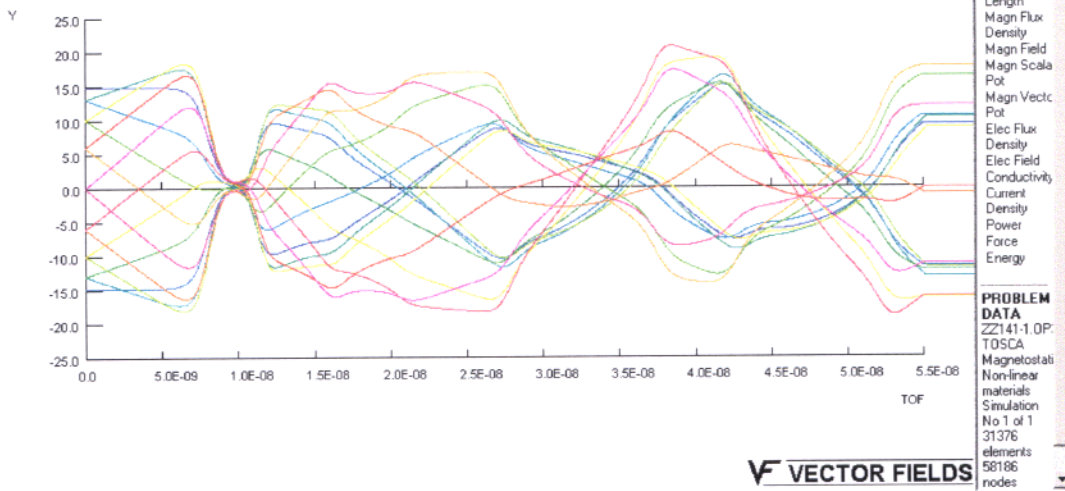
S = solenoid, A = absorber, 36 cavities in blocks of 3



Muon Race Track Cooling Ring

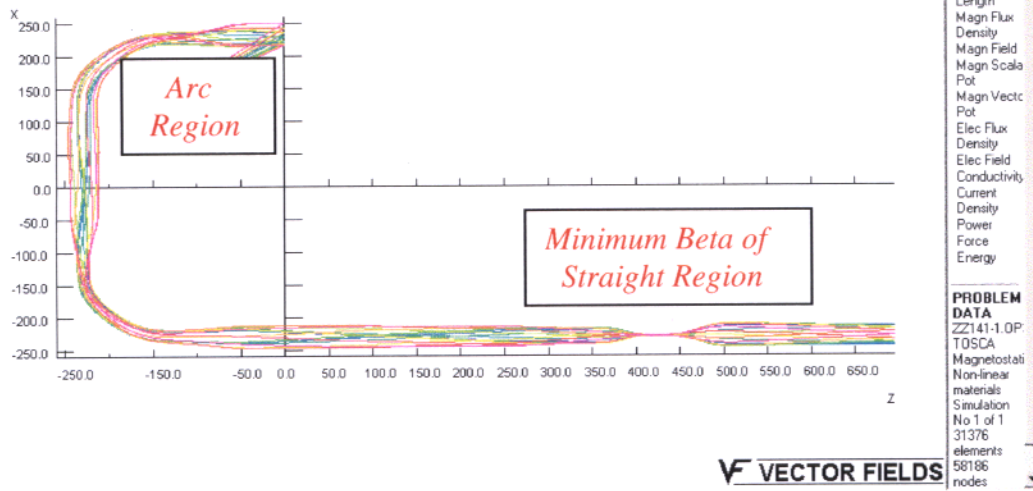
180 MeV Vertical Muon Beam Behaviour

14/May/2003 07:35:35



180 MeV Horizontal Muon Beam Behaviour

14/May/2003 09:20:06



130 MeV (pink) to 240 MeV (green) Muon Beam Dispersion

14/May/2003 09:32:56

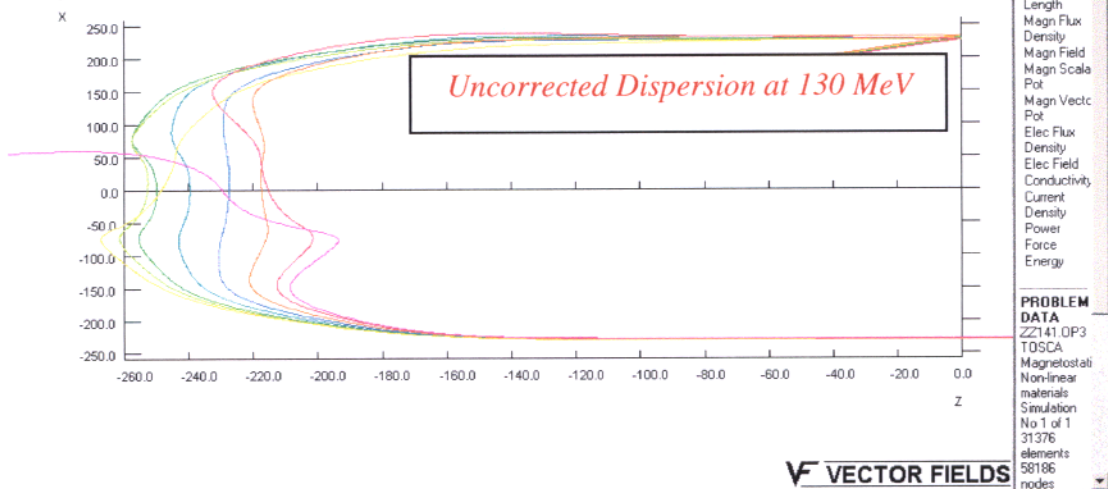
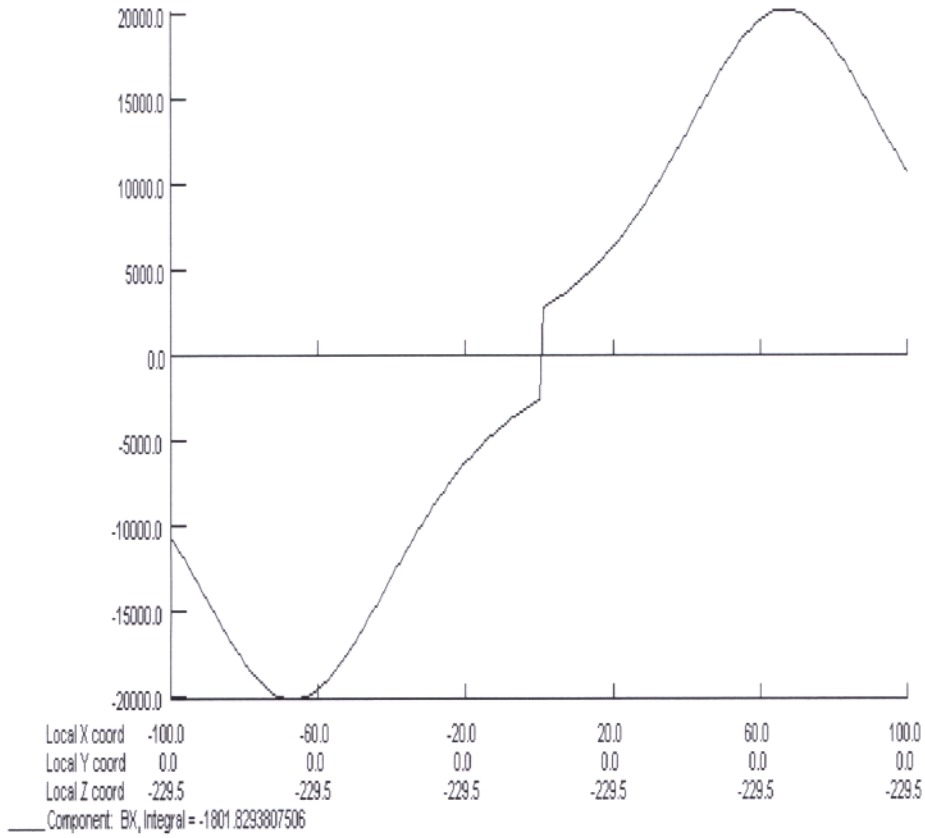


Figure 9: Tracking of Single Muons with Opera3D

14/May/2003 07:01:12



Add
iron
over
centre

V VECTOR FIELDS

Field Discontinuity at the Arc Centre due to Mesh

Non Linear Magnet End Fields

Solenoids (with iron): Opera3D field simulations.

Solenoids (no iron): Opera3D or series expansions.

Quadrupole longitudinal end fields: Opera3D

octupole type effects: $\Delta x' \approx \pm (eG / p) xy'$

Bending unit longitudinal end fields: Opera3D

sextupole type effects: $\Delta y' \approx \pm (eB / p) yx'$

Opposite signs of kicks at the input and output

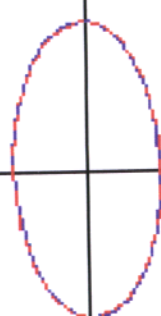
Design for 180° betatron phase shifts between arc dipoles.

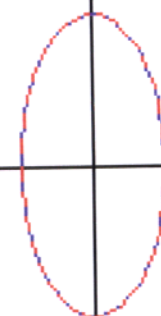
(Design for 96° / cell for a FFAG ring of $5n$ cells.)

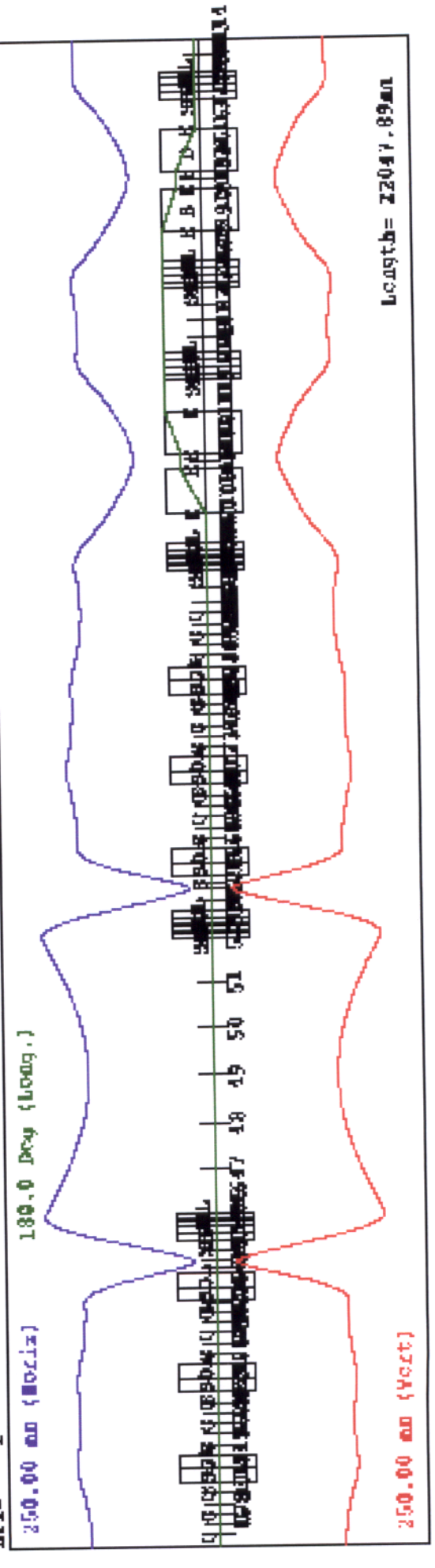
L= 0.0mA
 M= 100.0000 100.0000 MeV
 FREQ= 201.14MHz ML=1490.45mm
 EMIT1=*****1000.000 0.10
 EMIT2=*****10001.035 152.51
 MI= 1 M2= 114
 PRINTOUT VALUES
 PP FE VALUE
 1 1A 14640.10000
 1 25 13310.10000
 SANCHING TYPE = 5
 DESIRED VALUES (BEAM)
 alpha beta
 2 0.0000 2.2000
 MATCH VARIABLES (MC=0)
 MPE MPE VALUE

CODE: TRACE3D v67LY
 FILE: Pollack.005
 DATE: 03/17/2003
 TIME: 11:53:16

Muon Cooling Ring Betatron Envelopes

H A= -5.15035E-02	D= 2.1911
V A= -2.91773E-02	D= 2.1016
	
225.000 mm	X 200.000 mrad
Z A= -1.60716E-02	D= 9.99488E-
100.000 Deg	X 1000.00 MeV

H A= 0.0000	D= 2.3000
V A= 0.0000	D= 2.3000
	
225.000 mm	X 200.000 mrad
Z A= 0.0000	D= 0.30000
100.000 Deg	X 1000.00 MeV



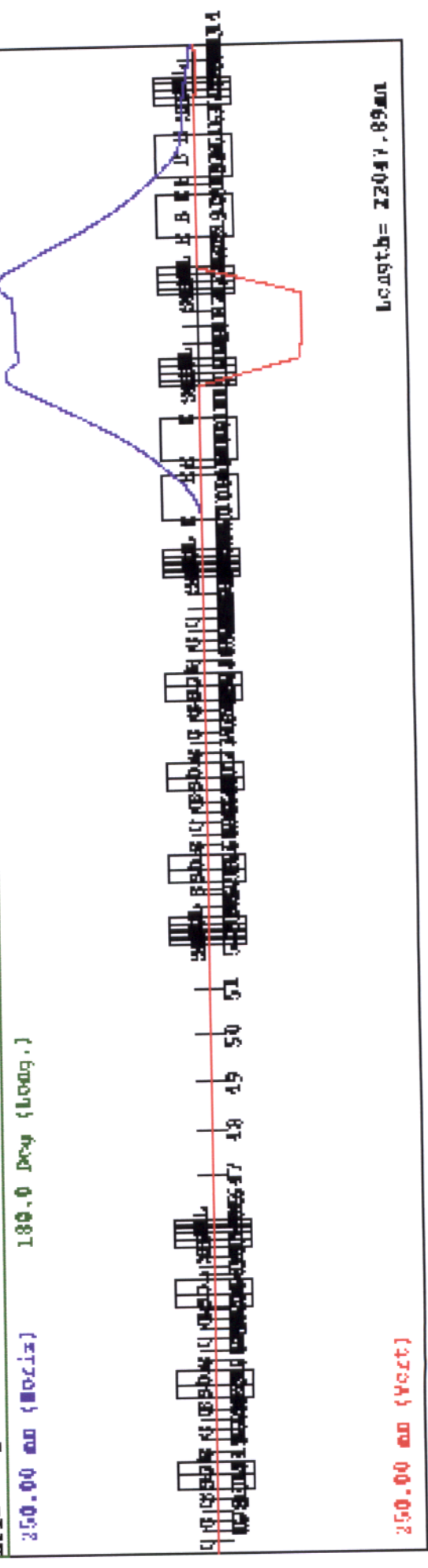
L= 0.0mA
 M= 180.0000 180.0000 MeV
 PBEQ= 201.148Hz WL=1490.45um
 EMIT1= 0.010 0.010180000.00
 EMIT0= 1.682 0.956*****
 NI= 1 NI2= 114
 PRELIMOUT VALUES
 PP FE VALUE
 1 14 14680.10000
 1 25 13318.10000
 MATCHING TYPE = 5
 DESIRED VALUES (DEARF)
 alpha beta
 0.0000 2.2000
 MATCH VARIABLES (MC=0)
 NI*P ME VALUE

CODE: TRACE3D v671LY
 FILE: POLLOCK.005
 DATE: 03/17/2003
 TIME: 11:42:04

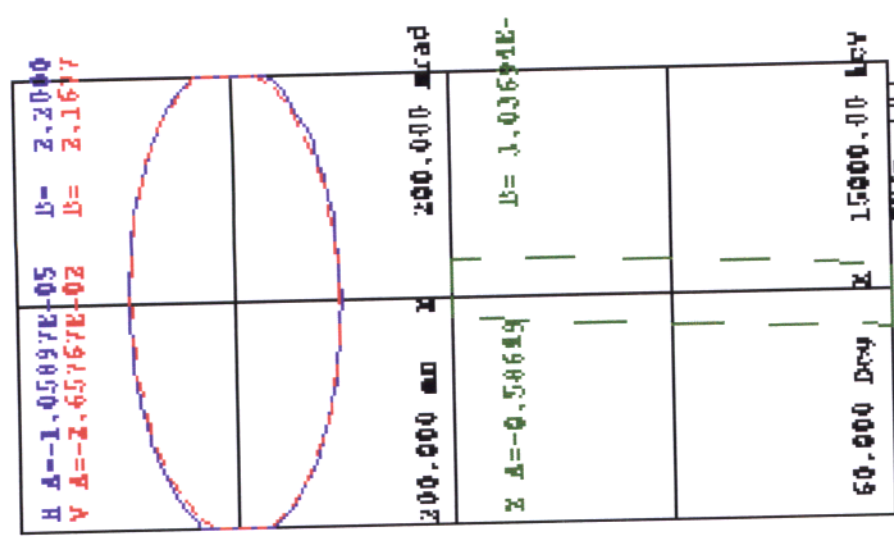
Muon Cooling Ring H and V Dispersion

H A= 20.374 V A= 11.659	B= 5.5198 B= 3.1741
225.000 mm	200.000 mrad
X A= 2.0310	B= 2.31213E-
180.000 Deg	1800.00 MeV

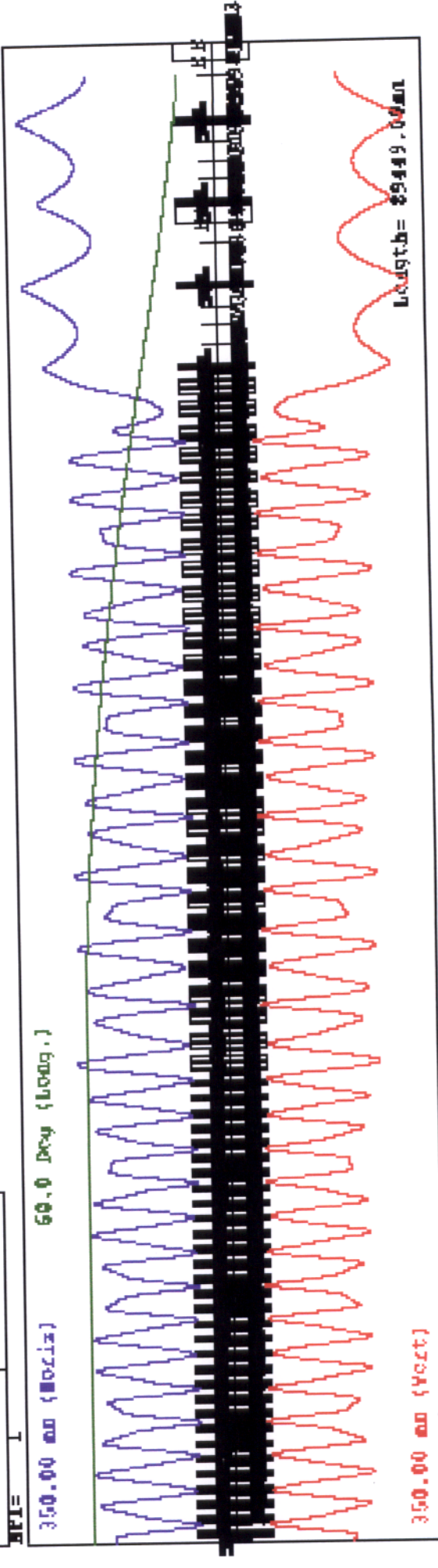
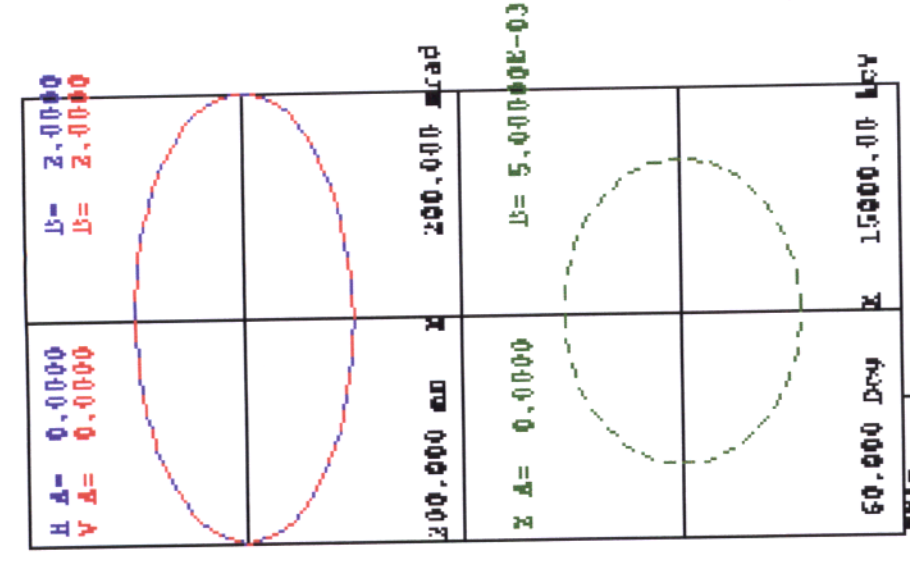
H A= 0.0000 V A= 0.0000	B= 2.3000 B= 2.3000
225.000 mm	200.000 mrad
X A= 0.0000	B= 0.30000
180.000 Deg	1800.00 MeV



I= 0.0mA
 M= 100.0000 100.0000 MeV
 PREQ= 31.43MHz WL=9538.87mm
 EMIT1=*****20000.000330000.00
 EMIT0=*****20000.000330000.00
 MI= 1 M2= 158
 PRINTOUT VALUES
 PP FE VALUE
 1 411 35910.50000
 1 452 31060.00000
 MATCHING TYPE = 5
 DESIRED VALUES (DEARE)
 alpha beta
 Z 0.0000 2.2000
 MATCH VARIABLES (MC=0)
 MIP MEV VALUE



Front End and Cooling Ring Input Match

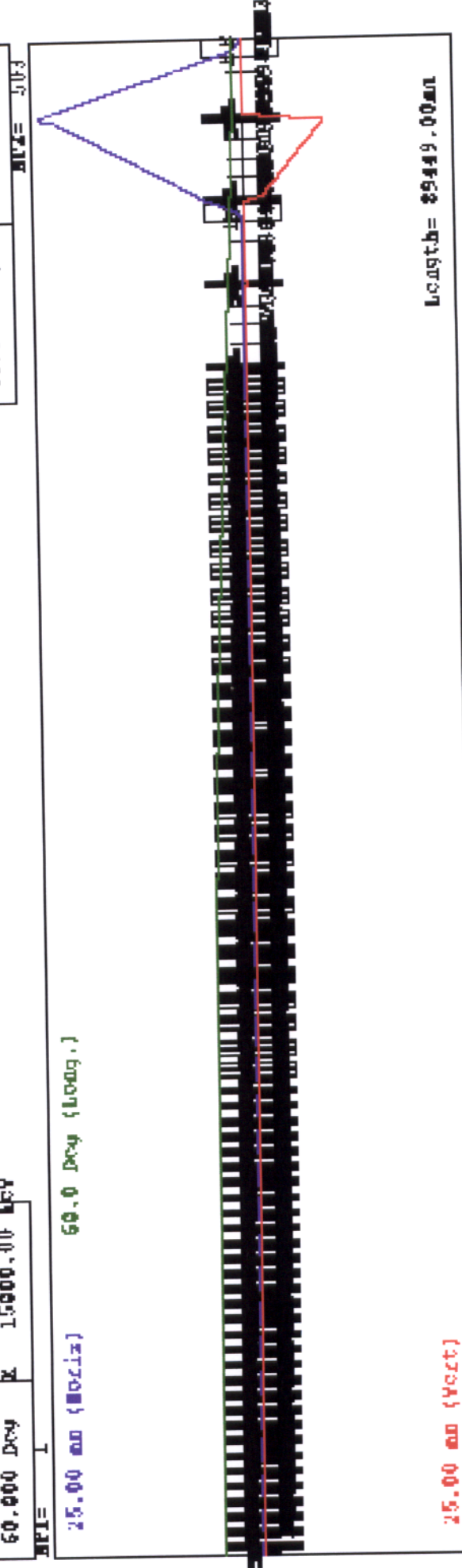


L= 0.000
 M= 100.0000 100.0000 MeV
 PBEQ= 31.438z WL=9538.87mm
 EMIT= 0.010 0.010 25000.00
 EMIT0= 0.011 0.010 25000.02
 NI= 1 NI= 503
 PRINTOUT VALUES
 PP PE VALUE
 1 444 35918.50000
 1 452 31068.00000
 MATCHING TYPE = 5
 DESIRED VALUES (REAR)
 alpha beta
 1 0.0000 2.2000
 MATCH VARIABLES (MC=0)
 NIP NFE VALUE

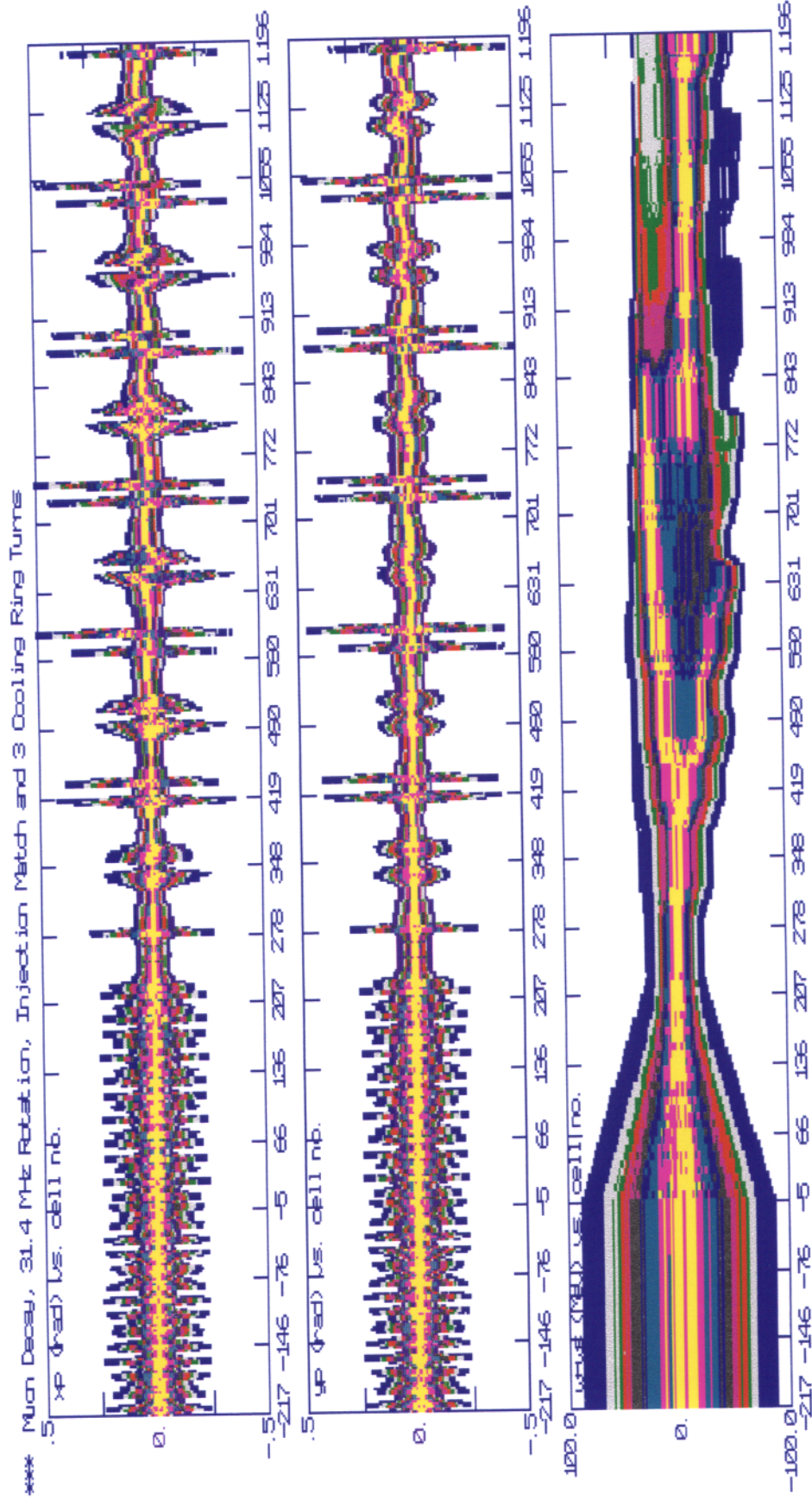
CODE: TRACE3D v67LY
 FILE: f01fact.004
 DATE: 03/17/2003
 TIME: 12:38:24

Muon Cooling Ring Dispersion Matching

H A= 0.85155 V A= -0.93086		B= 3.7350 B= 4.0749
200.000 mm	Z	200.000 micrad
Z A= -0.20139		B= 2.29258E-
60.000 Deg	X	15000.00 MeV

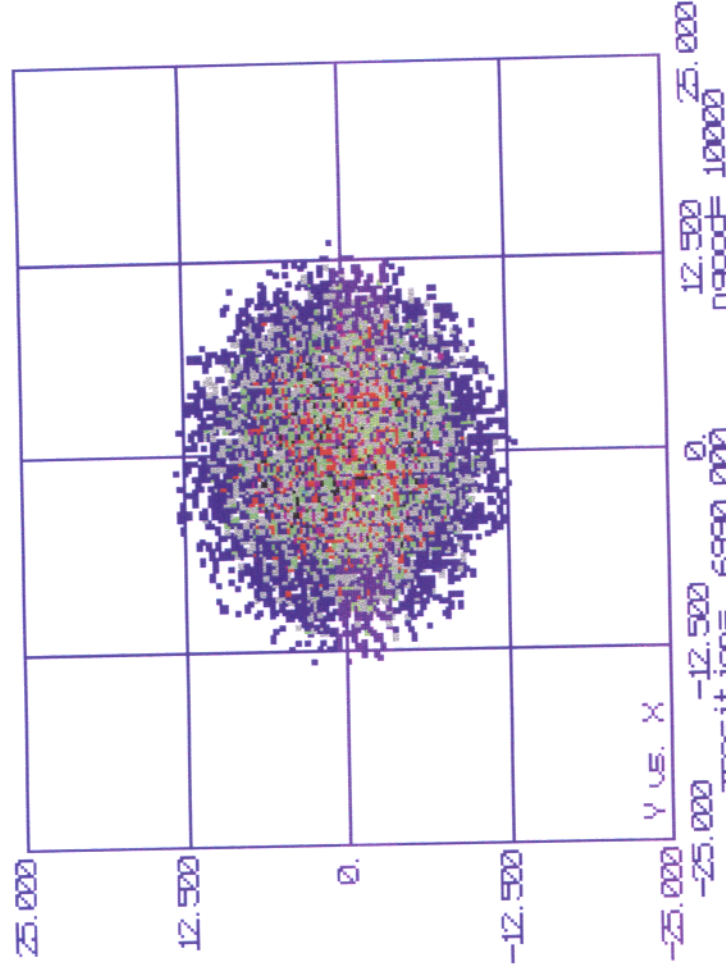
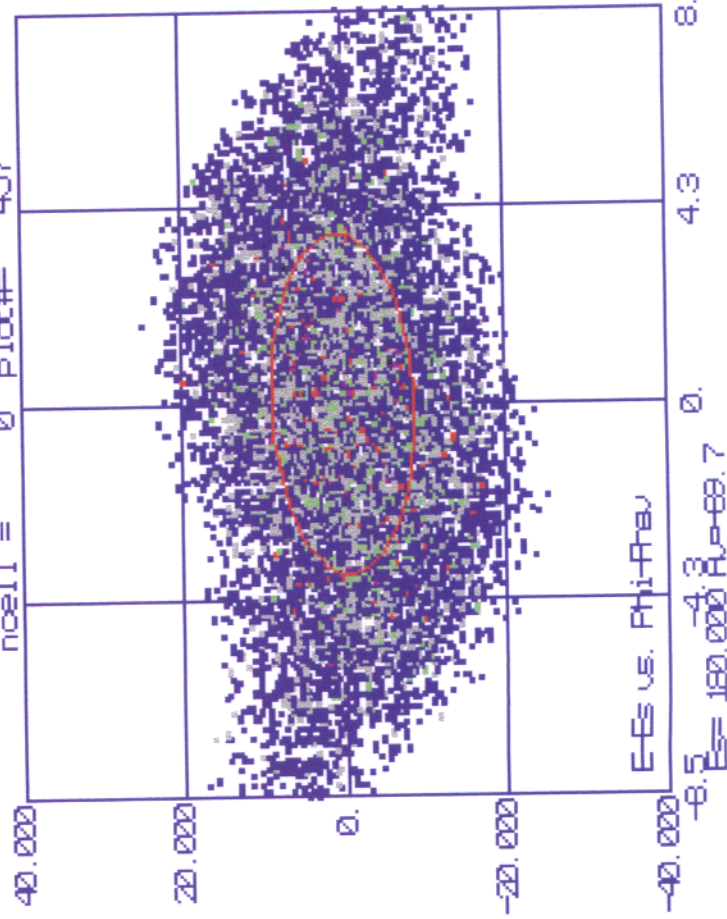
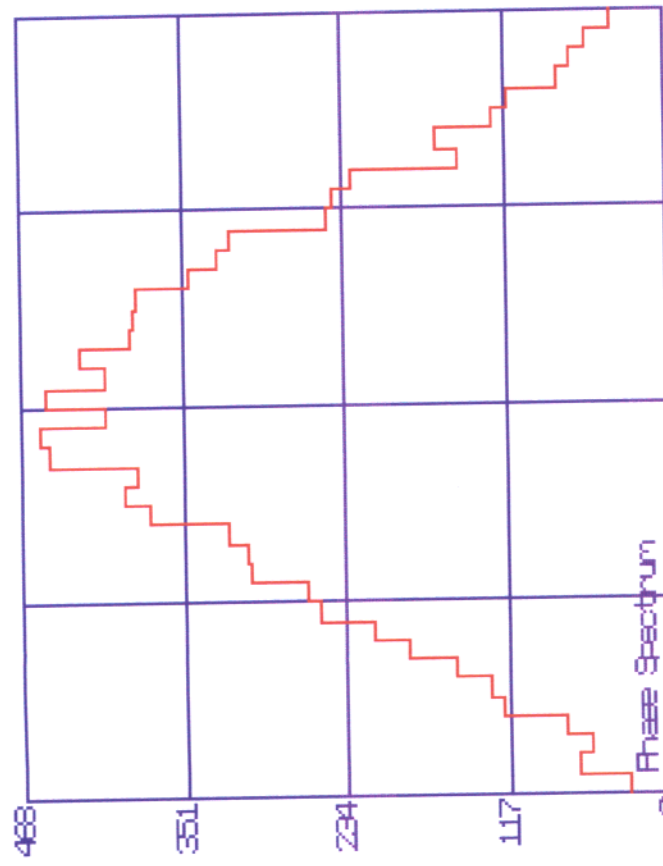


H A= 0.0000 V A= 0.0000		B= 2.0000 B= 2.0000
200.000 mm	Z	200.000 micrad
Z A= 0.0000		B= 5.0000E-03
60.000 Deg	X	15000.00 MeV

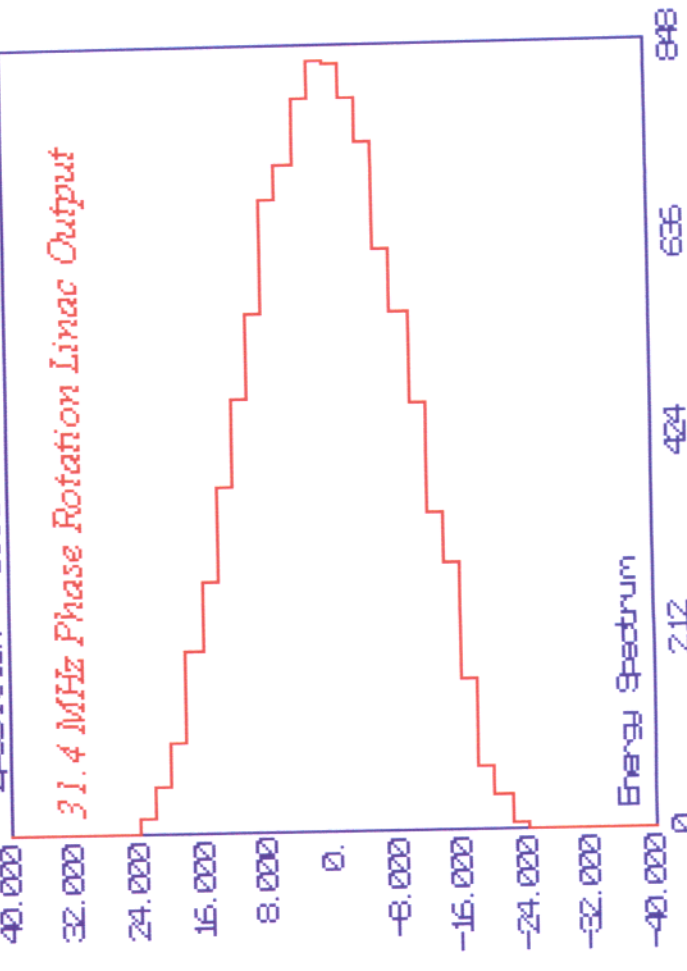


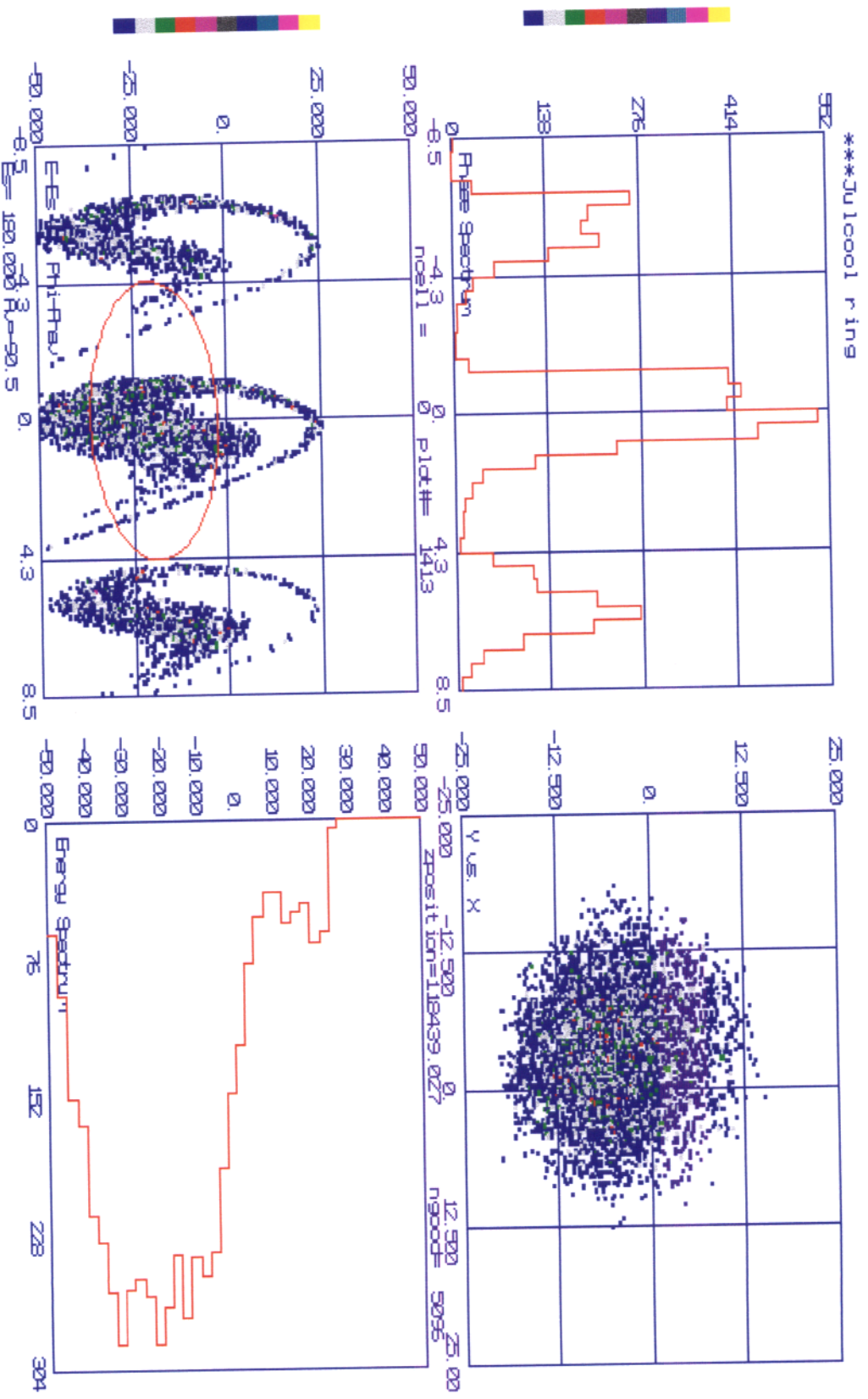
Muon Front End Betatron and Energy Spread Envelopes

***Julcool ring



31.4 MHz Phase Rotation Linac Output





Muon Cooling Ring Phase Space Plots after Three Turns

Future Plans

1. New code for 31 MHz muon bunch rotation (SJB).
2. Completion of Opera3D simulations (MRH and SJB).
3. New ring code, including RF, absorbers and 2. (SJB).
4. Study the effect of longitudinal & transverse dampers.
5. Evaluate experimental possibilities (MICE solenoids?).