Super-FOFO + Dipole Simulations: Status Report II

Gail G. Hanson
Indiana University
September 29, 2000

Emittanace Exchange with Super FOFO Lattice

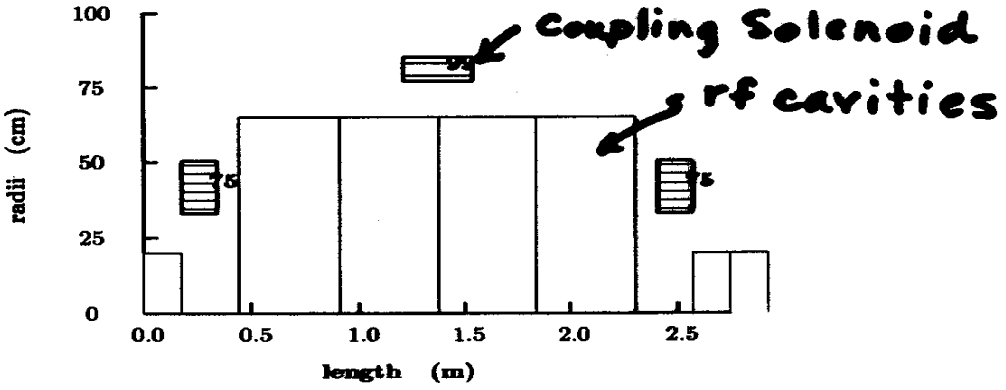
DRAFT

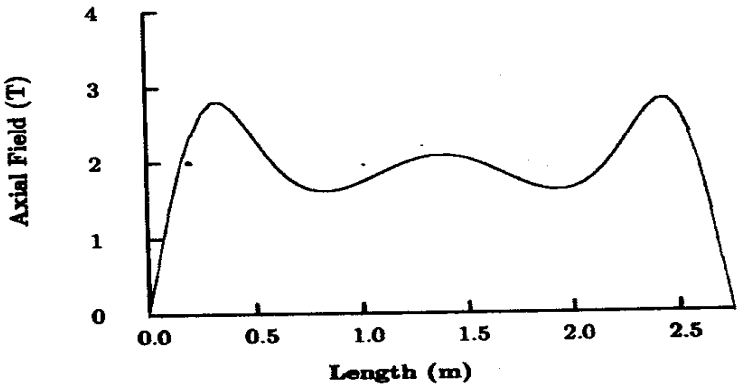
R.B. Palmer 8/17/00

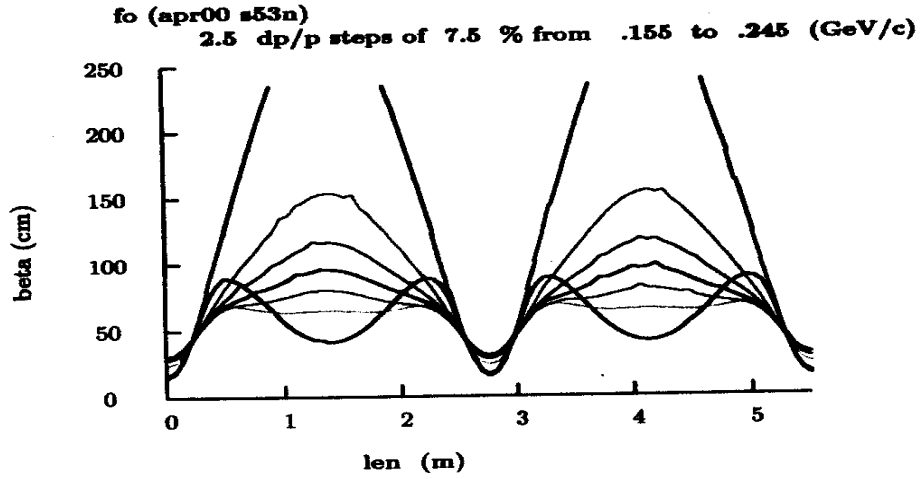
0.1 Super FOFO

Consider modifying the initial super FOFO lattice as used now in the Study 2 simulations. The cell length is 2.75 m, the β at the absorber is $\approx$ .3 m and it accepts an emittance ($\epsilon_n \approx 10$ mm rad), and a momentum spread of +/− 22 %.

Figs (a) and (b) show the coils and axial field. Fig (c) shows the beta functions for a range of momenta, as a function of position down the cell. Fib (d) shows the phase advance per cell vs momentum (it is realtively linear between limits at π and 2 π where there are resonaces), and the maximum and minimum β's. It is seen that the *beta* at the absorber (red) is realtively flat, but the β at the center is strongly mometum dependent, rising from about .4 m at one limit and 3 m at the other (this will turn out ot be important).




Axial Field (T)
4
3
2
1
0
0.0
0.5
1.0
1.5
2.0
2.5
Length (m)


fo (apr00 s53n)
2.5 dp/p steps of 7.5 % from .155 to .245 (GeV/c)
beta (cm)
250
200
150
100
50
0
0
1
2
3
4
5
len (m)

2.11 Cooling Latices

2.11.1 Introduction

The cooling is done in six sections with steadily decreasing β's. This is done to maximize the cooling rate. Too small a β at a given emittance results in too large divergence angles and particle loss. Too large a β gives small divergence angles and a greater relative emittance growth from coulomb scattering. The best β scales down with the emittance and is always such as to give a certain constant divergence angles ($\sigma_{x'} = \sigma_{y'} \approx 0.1$).

The six sections are made from two different physical lattices [(1) and (2)], with three different current setting in each: 1,1 1,2 1,3 in the first lattice, and 2,1 2,2 2,3, in the second. The final cooling section (2,3) is further broken into 2 parts (2,3a) and (2,3b) that differ only in their window sizes and thicknesses.

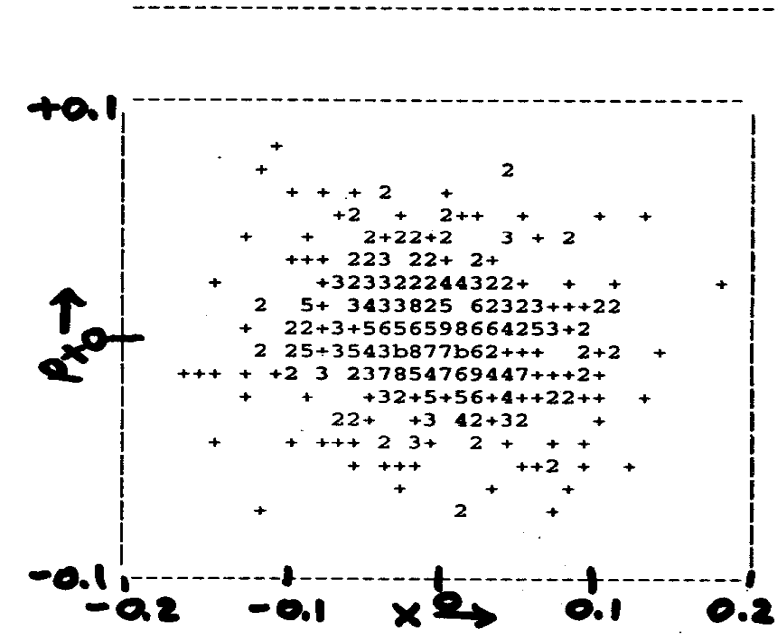
The lengths of the sections are:

	length m	from target m
cool 1,1	$6 \times 2.75 = 16.5$	444.9
cool 1,2	$6 \times 2.75 = 16.5$	461.4
cool 1,3	$6 \times 2.75 = 16.5$	477.9
cool 2,1	$14 \times 1.65 = 23.1$	501
cool 2,2	$10 \times 1.65 = 16.5$	517.5
cool 2,3a	$16 \times 1.65 = 26.4$	543.9
cool 2,3b	$16 \times 1.65 = 26.4$	570.3

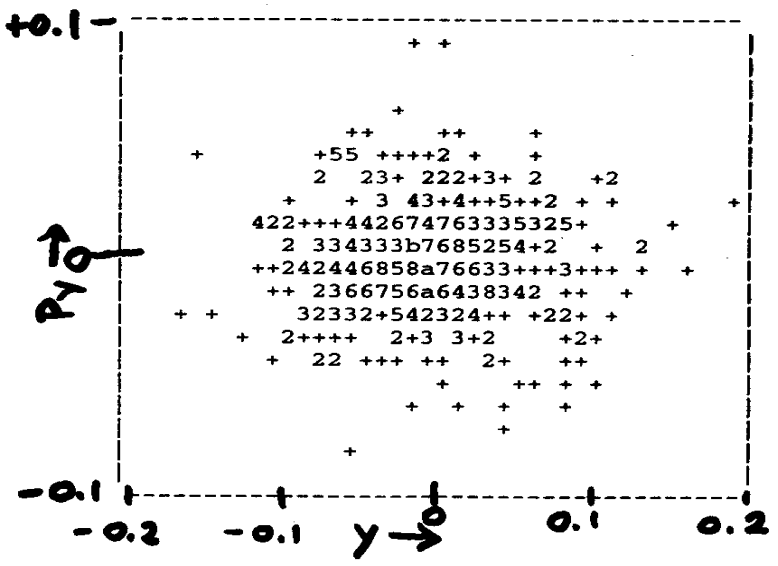
The lattices used have been named "Super FOFO". The "FOFO" refers to the basic sequence of alternating solenoids, that focus the beam and generate β, and thus beam size, minima between the solenoids. The "Super" part, proposed by A. Sessler, is the replacement of the simple alternating solenoids with alternating, but more complex, solenoid systems. In this case the systems consist of strong short "focusing" solenoids at either end, and a weaker "coupling" fields between them.

An example of the fields (for the last part) is given below

BEFORE COOLING

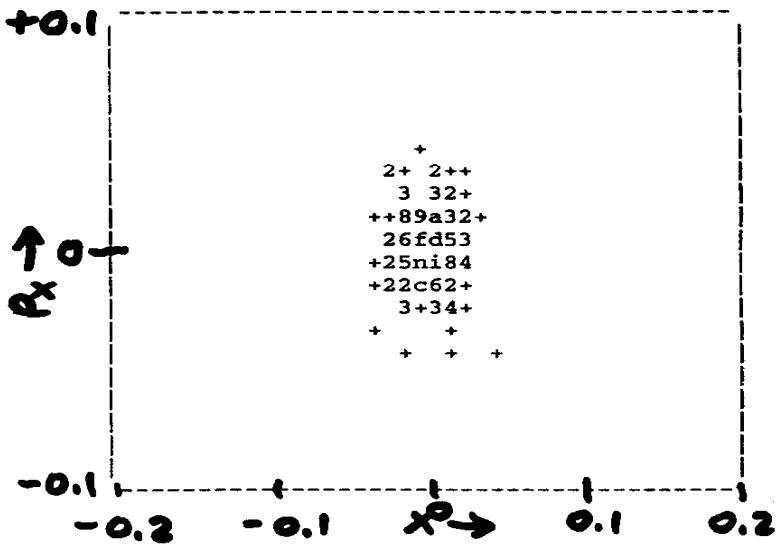


ICOOL	2.11
plot	1
var(x)	X
dest(x)	1
var(y)	Px
dest(y)	1
lo x	=-0.200E+00
hi x	= 0.200E+00
step x	= 0.100E-01
lo y	=-0.100E+00
hi y	= 0.100E+00
step y	= 0.100E-01
contents	= 500
under x	= 0
over x	= 0
under y	= 0
over y	= 0

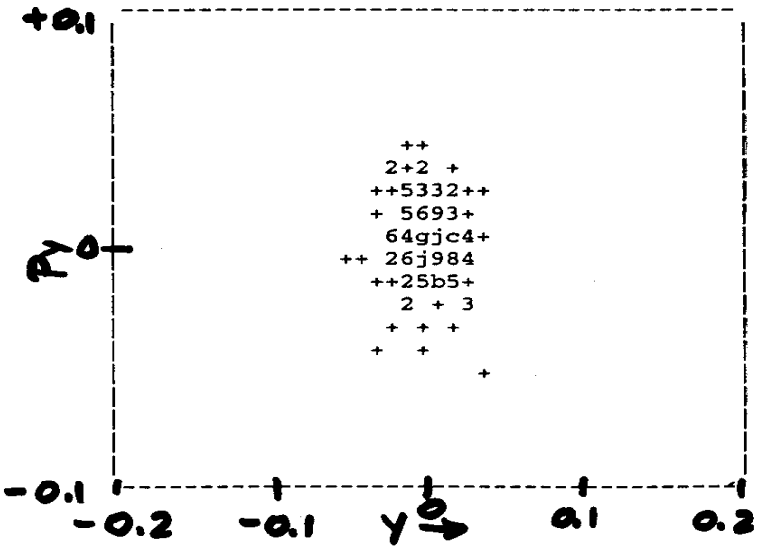


ICOOL	2.11
plot	2
var(x)	Y
dest(x)	1
var(y)	Py
dest(y)	1
lo x	=-0.200E+00
hi x	= 0.200E+00
step x	= 0.100E-01
lo y	=-0.100E+00
hi y	= 0.100E+00
step y	= 0.100E-01
contents	= 500
under x	= 0
over x	= 0
under y	= 0
over y	= 0

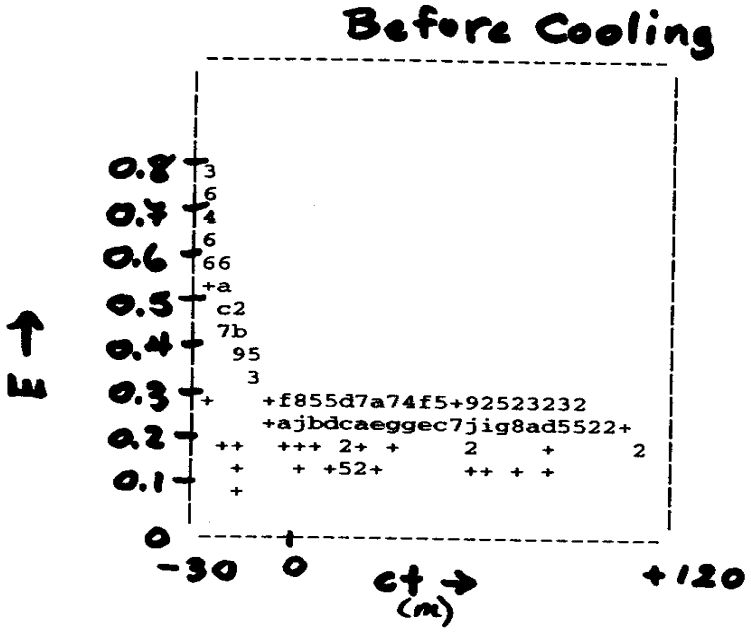
AFTER COOLING



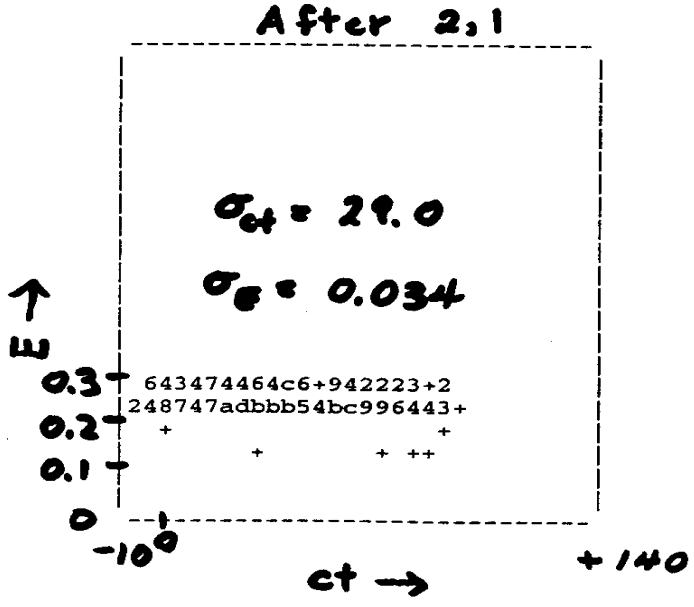
ICOOL	2.11
plot	18
var(x)	X
dest(x)	1042
var(y)	Px
dest(y)	1042
lo x	=-0.200E+00
hi x	= 0.200E+00
step x	= 0.100E-01
lo y	=-0.100E+00
hi y	= 0.100E+00
step y	= 0.100E-01
contents	= 200
under x	= 0
over x	= 0
under y	= 0
over y	= 0



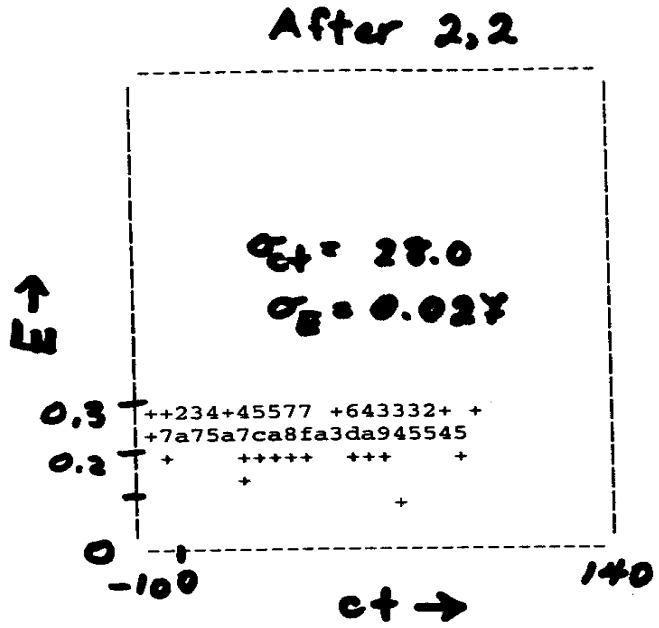
ICOOL	2.11
plot	19
var(x)	Y
dest(x)	1042
var(y)	Py
dest(y)	1042
lo x	=-0.200E+00
hi x	= 0.200E+00
step x	= 0.100E-01
lo y	=-0.100E+00
hi y	= 0.100E+00
step y	= 0.100E-01
contents	= 200
under x	= 0
over x	= 0
under y	= 0
over y	= 0



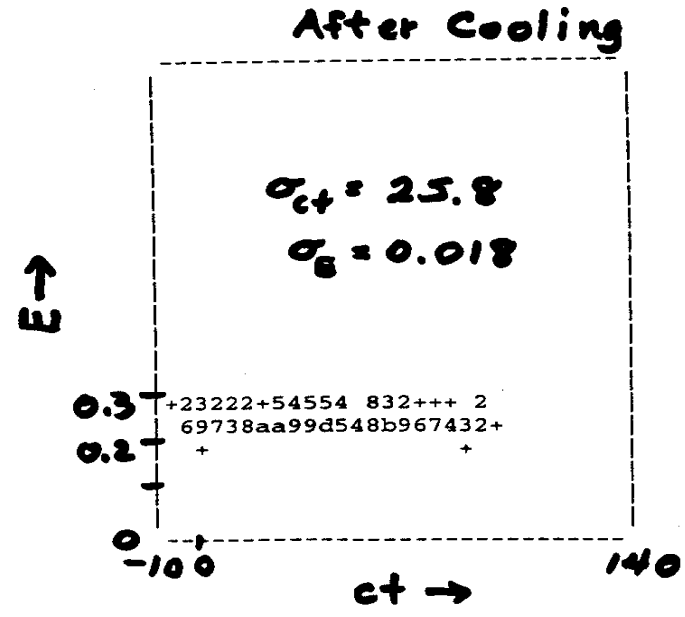
ICOOL	2.11
plot	3
var(x)	ct
dest(x)	1
var(y)	E
dest(y)	1
lo x	=-0.300E+02
hi x	= 0.120E+03
step x	= 0.500E+01
lo y	= 0.000E+00
hi y	= 0.100E+01
step y	= 0.500E-01
contents	= 500
under x	= 0
over x	= 0
under y	= 0
over y	= 0



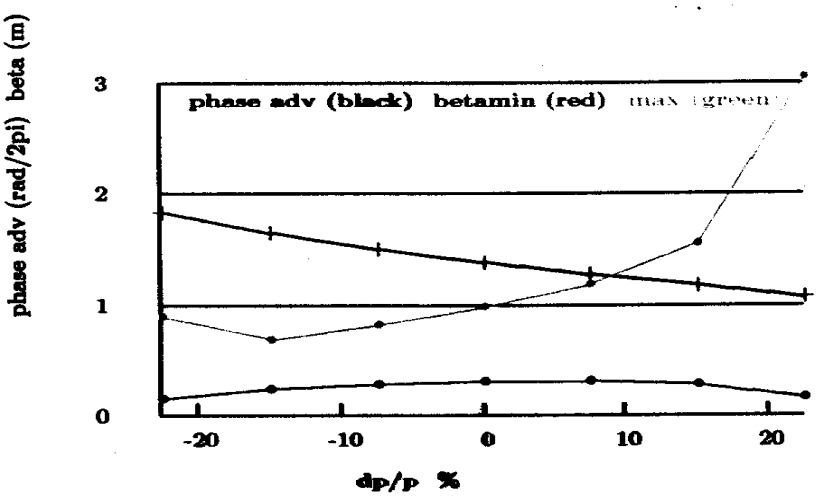
ICOOL	2.11
plot	14
var(x)	ct
dest(x)	496
var(y)	E
dest(y)	496
lo x	=-0.100E+02
hi x	= 0.140E+03
step x	= 0.500E+01
lo y	= 0.000E+00
hi y	= 0.100E+01
step y	= 0.500E-01
contents	= 248
under x	= 9
over x	= 0
under y	= 0
over y	= 0




```
 ICOOL                2.11
--------------------------
 plot          =       17
 var(x)        =       ct
 dest(x)       =      626
 var(y)        =        E
 dest(y)       =      626

 lo x     =-0.100E+02
 hi x     = 0.140E+03
 step x   = 0.500E+01
 lo y     = 0.000E+00
 hi y     = 0.100E+01
 step y   = 0.500E-01

 contents      =      236
 under x       =        6
 over x        =        0
 under y       =        0
 over y        =        0
--------------------------
```

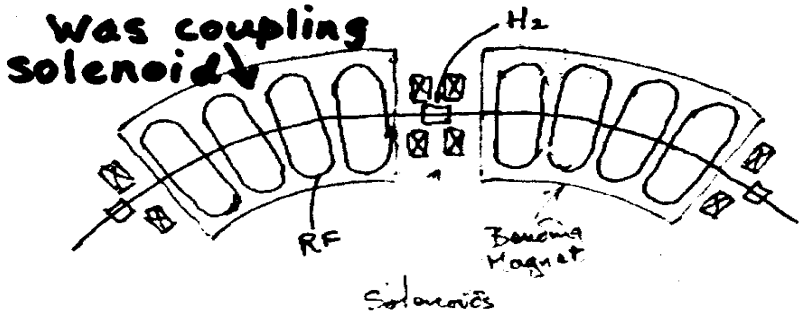



```
 ICOOL                2.11
--------------------------
 plot          =       20
 var(x)        =       ct
 dest(x)       =     1042
 var(y)        =        E
 dest(y)       =     1042

 lo x     =-0.100E+02
 hi x     = 0.140E+03
 step x   = 0.500E+01
 lo y     = 0.000E+00
 hi y     = 0.100E+01
 step y   = 0.500E-01

 contents      =      200
 under x       =        0
 over x        =        0
 under y       =        0
 over y        =        0
--------------------------
```



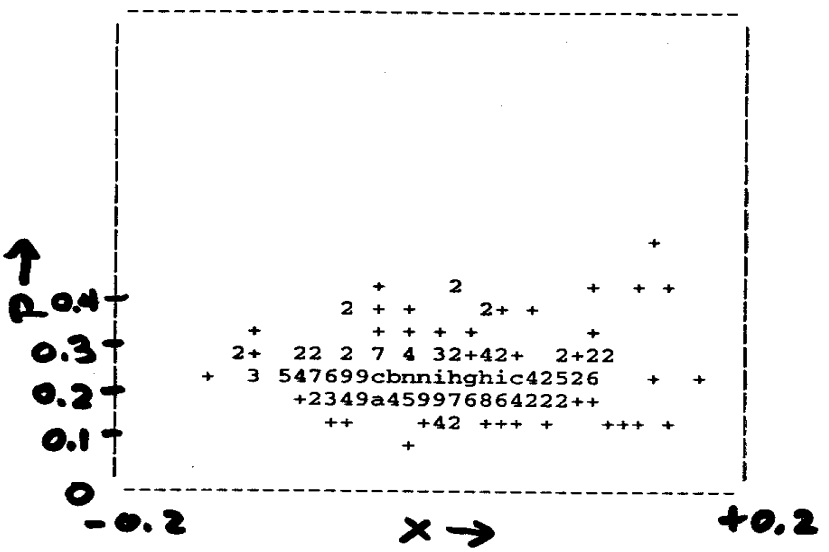
0.2 Add a Bend

In order to use this lattice for emittance exchange we must add some bending to generate dispersion at the absorber. The absorber can then be made wedge like and the required exchange obtained. Consider putting the bend in the center of the cell¿ It now falls on top of the coupling solenoid, which is uncomfortable. But bening magnets have focussing: perhaps it can replace this solenoid.



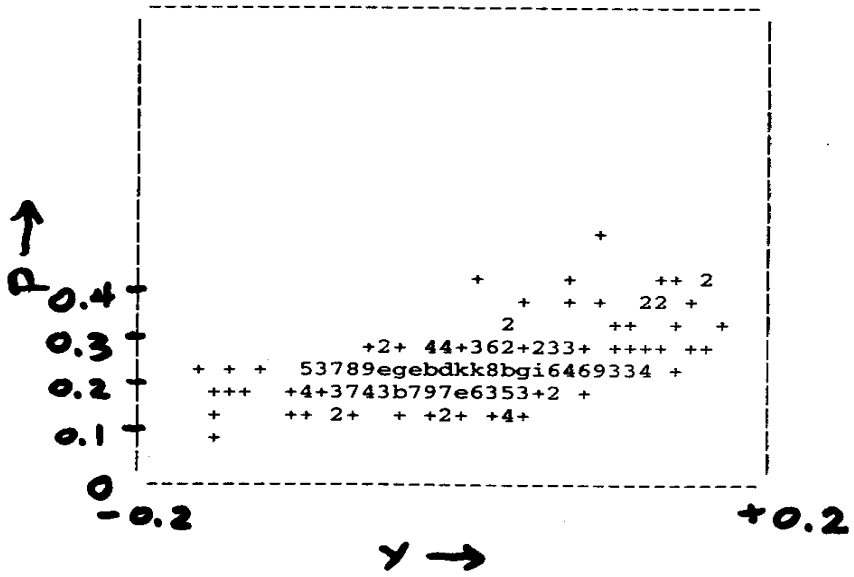
By = 0.12 T Same After 1st Absorber

| ICOOL 2.11



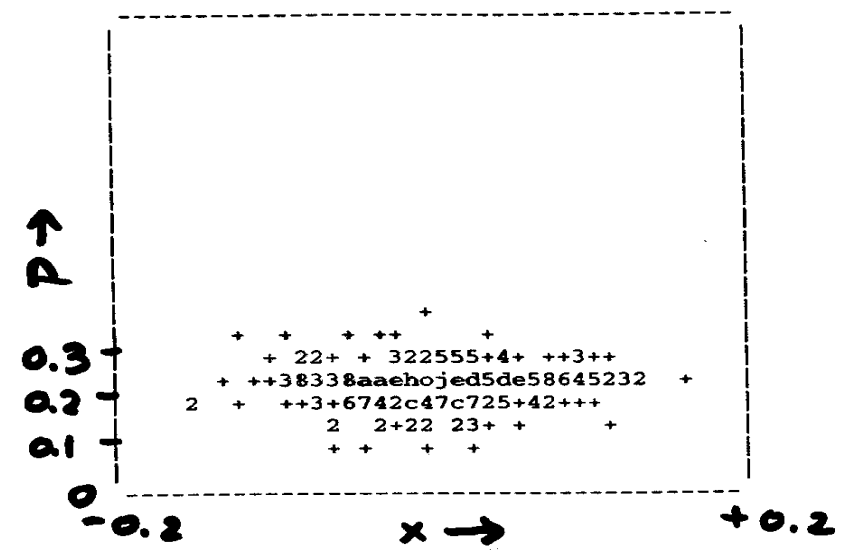
plot	7
var(x)	X
dest(x)	17
var(y)	Pm
dest(y)	17
lo x	=-0.200E+00
hi x	= 0.200E+00
step x	= 0.100E-01
lo y	= 0.000E+00
hi y	= 0.100E+01
step y	= 0.500E-01
contents	= 406
under x	= 0
over x	= 0
under y	= 0
over y	= 0

| ICOOL 2.11

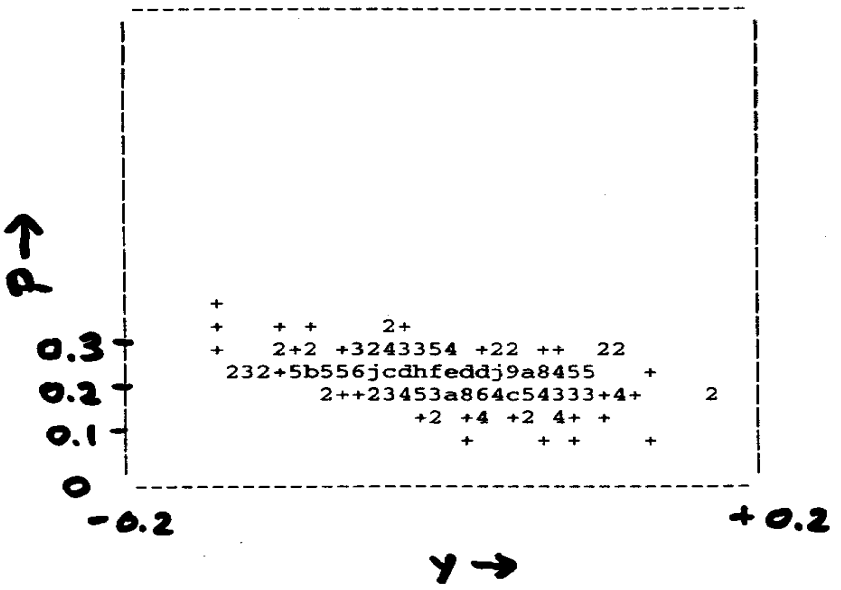


plot	8
var(x)	Y
dest(x)	17
var(y)	Pm
dest(y)	17
lo x	=-0.200E+00
hi x	= 0.200E+00
step x	= 0.100E-01
lo y	= 0.000E+00
hi y	= 0.100E+01
step y	= 0.500E-01
contents	= 406
under x	= 0
over x	= 0
under y	= 0
over y	= 0

By = 0.12 T Same
After 2nd Absorber

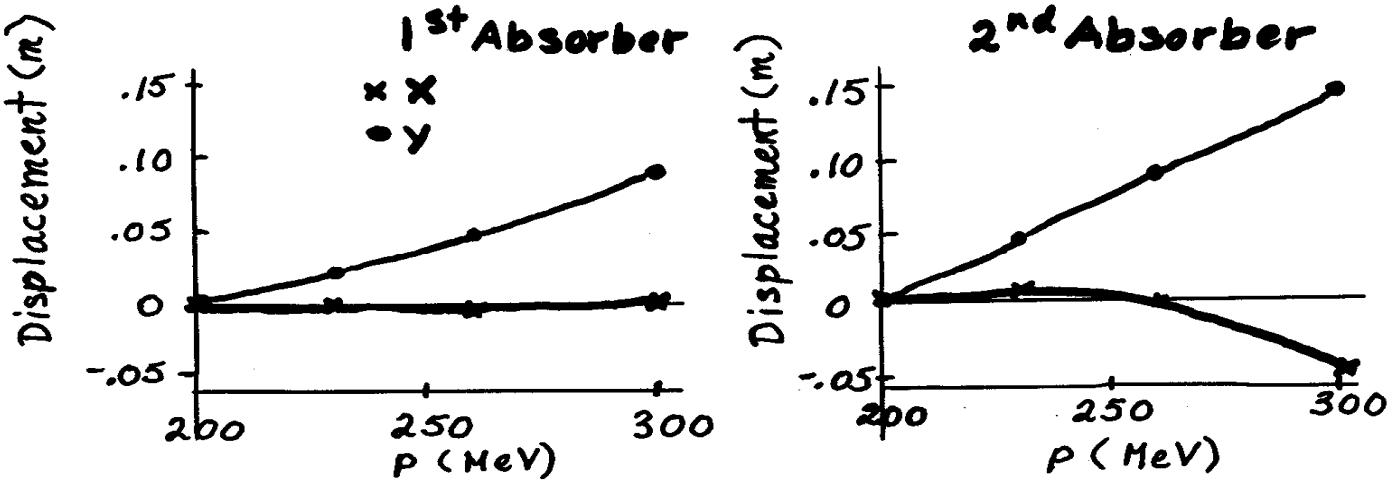


ICOOL	2.11
plot	9
var(x)	X
dest(x)	35
var(y)	Pm
dest(y)	35
lo x	=-0.200E+00
hi x	= 0.200E+00
step x	= 0.100E-01
lo y	= 0.000E+00
hi y	= 0.100E+01
step y	= 0.500E-01
contents	= 374
under x	= 0
over x	= 0
under y	= 0
over y	= 0



ICOOL	2.11
plot	10
var(x)	Y
dest(x)	35
var(y)	Pm
dest(y)	35
lo x	=-0.200E+00
hi x	= 0.200E+00
step x	= 0.100E-01
lo y	= 0.000E+00
hi y	= 0.100E+01
step y	= 0.500E-01
contents	= 374
under x	= 0
over x	= 0
under y	= 0
over y	= 0

CONSTANT $B_y = 0.12$ T FLIPPED



CONSTANT $B_y = 0.12$ T SAME