LBNL-62130 HIFAN 1541

Update on Final Focus

Skunk Meeting

November 29, 2006

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New Beam Parameters

Improved Layout

Chromatic Correction

New Parameters

1.0 MJ Total beam energy

400 beam pulses

80 Linacs

5 pulses per Linac

A_r^{+8} in Linac (mass = 39.963 amu)

A_r^{+16} in Final Focus

Kinetic Energy = { 160 MeV Train Head; 240 MeV Train Tail

→ Velocity Tilt = .20

Pulse length in Linac = 10.0 m
Core Beset length in Linac = 10.0 m

→ Train Length in Linac

= (5 + 4) × 10 = 90 m

Drift Distance = $\frac{90}{.2}$ = 450 m

Parameters Cont.

Charge per pulse in linac = 100 μC

Line charge density = $\frac{100\,\mu C}{10\,m} = 10\,\frac{\mu C}{m}$

Pulse duration at 200 MeV = .32 μs

Train duration at end of linac = 9 × .32 = 2.88 ms

Strip Ions +8 → +16 at end of linac
(only K shell is left)

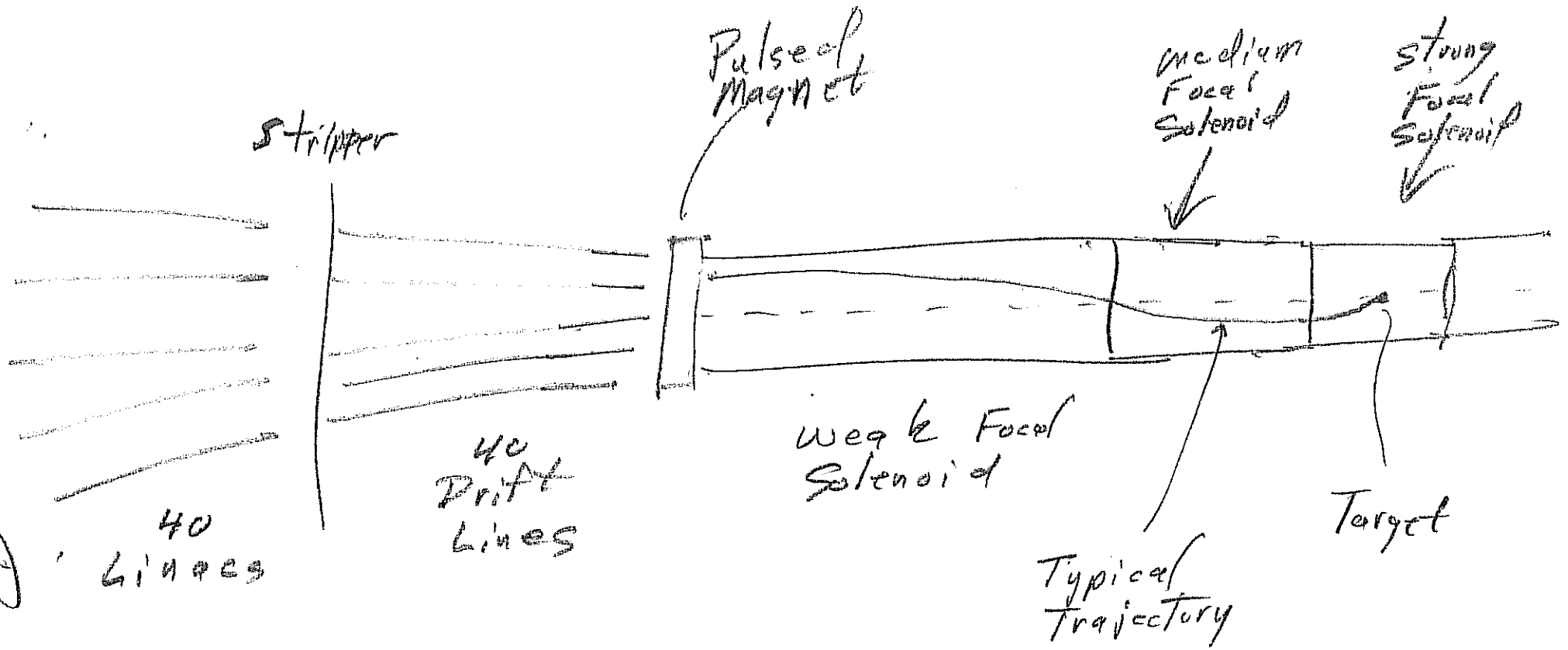
Rigidity is low by HIF standards

160 MeV Ar^{+16} → (BP) = .72 T-m

240 MeV Ar^{+16} → (BP) = .88 T-m

∴ Relatively weak Solenoids may be used

Layout (Larmor Frame for Final Focus)



Parallel to Point Focus 40m

Trajectories cross axis at intermediate point

Pulse Magnet adjusts trajectory to hit target when energy > 160 MeV

Spot radius ≈ 3 mm for $\epsilon_n \approx 2 \times 10^{-6}$ m-r

Angles on target = .7 – 3 radians

Chromatic Study

T	BP	B kick	⊖ target	r_{max}	cross point
160	.721	0	.201	.383	27 m
170	.742	.128	.197	.370 (?)	25.5
180	.764	.181	.198	.41	24
190	.785	.225	.205	.45	23
200	.805	.264	.215	.52	21.5
210	.825	.303	.231	.59	20.0
220	.845	.343	.253	.70	18.0
230	.864	.386	.283	.84	16.5
240	.883	.436	.324	1.02	14.5

↑
Note
Variation

```
In[725]:= A = 39.963;
          q = 16;
          T0 = 160;
          T = 160
          βγ0 = ((T0 / 931.5 / A) ^2 + 2 * (T0 / 931.5 / A)) ^.5;
          βγ = ((T / 931.5 / A) ^2 + 2 * (T / 931.5 / A)) ^.5;
          Brho0 = 3.107 * βγ0 * A / q;
          Brho = 3.107 * βγ * A / q



          z0 = 0;
          z1 = 1;
          z2 = 27;
          z3 = 37;
          z4 = 40;

          B1 = 0.
          B2 = Pi * Brho0 / (z2 - z1)
          B3 = Pi * Brho0 / (z3 - z2)
          B4 = Pi * Brho0 / (z4 - z3)

          B0[z_] = B1 * If[z0 ≤ z ≤ z1, 1, 0] +
             B2 * If[z1 ≤ z ≤ z2, 1, 0] + B3 * If[z2 ≤ z ≤ z3, 1, 0] + B4 * If[z3 ≤ z, 1, 0];

          Plot[B0[z], {z, z0, z4 + 1}, PlotPoints → 300];

          x0 = 1.0
          xp0 = 0.000
          ϕ0 = 0
          zi = z0 - 1
          zf = z4 + 1

          aol = NDSolve[{x'[z] = xp[z],
              xp'[z] = -(B0[z] / 2 / Brho) ^2 * x[z], ϕ'[z] = -B0[z] / 2 / Brho, x[zi] = x0,
              xp[zi] = xp0, ϕ[zi] = ϕ0}, {x, xp, ϕ}, {z, zi, zf}, MaxStepSize → .01,
             MaxSteps → 110000];

          xx[z_] = x[z] /. aol;;
          xxp[z_] = xp[z] /. aol;
          ϕϕ[z_] = ϕ[z] /. aol;
          X[z_] = xx[z] * Cos[ϕϕ[z]];
          Y[z_] = -xx[z] * Sin[ϕϕ[z]];
          Plot[xx[z], {z, zi, zf}];
          Plot[xx[z], {z, z4 - .1, z4 + .1}];
          Plot[ϕϕ[z], {z, zi, zf}];
          Plot[{X[z], Y[z]}, {z, zi, zf}];
          xx[z4]
          xxp[z4 - .01]

Out[728]= 160                KE

Out[732]= 0.720278           BP

Out[738]= 0.                 B kick
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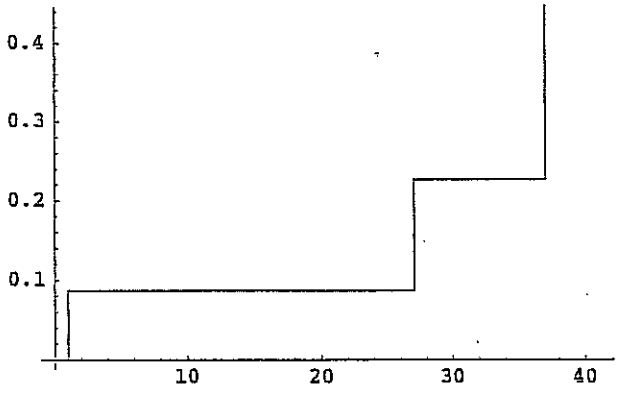
Out[739]= 0.0870315 E weak

Out[740]= 0.226282 E median

Out[741]= 0.754273 E strong



E (z)

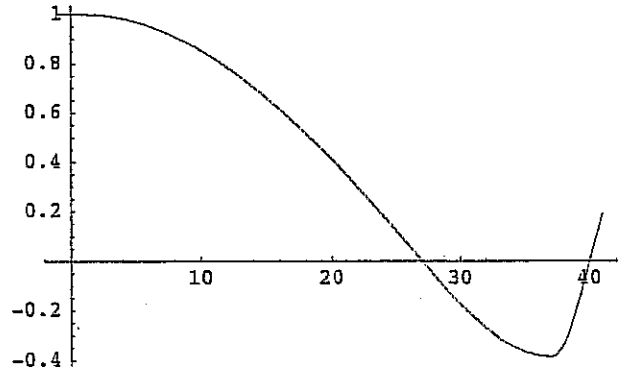
Out[744]= 1.

Out[745]= 0.

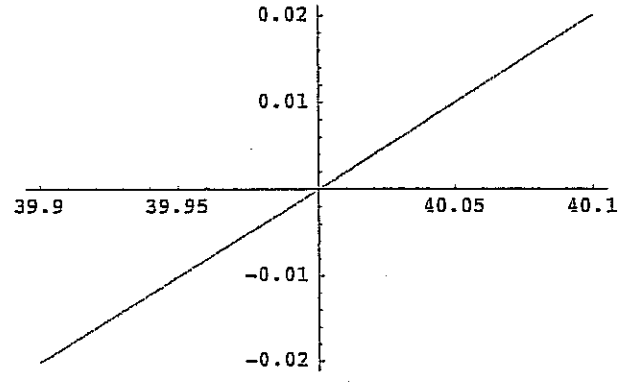
Out[746]= 0

Out[747]= -1

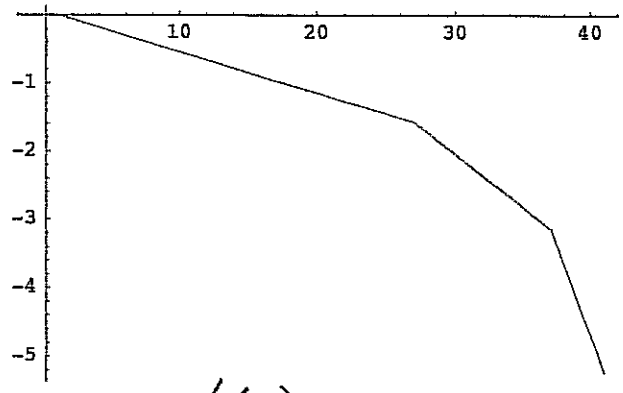
Out[748]= 41



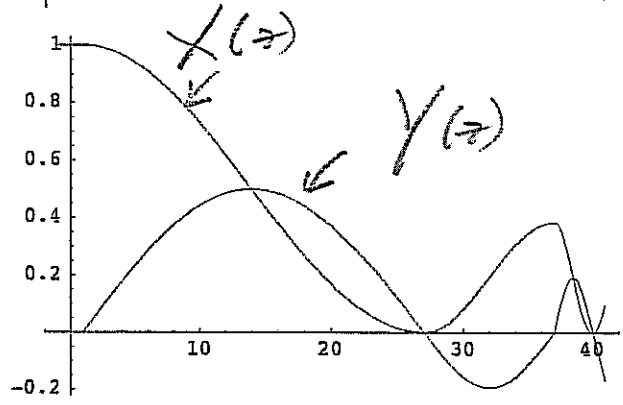
x (z) (Larmor Frame)



x (z) at target (z = 40)



Larmor angle



Lab Frame Coordinates

Out[759]= {-3.86878 × 10^-7}

Out[760]= {0.201381} ← Final Angle

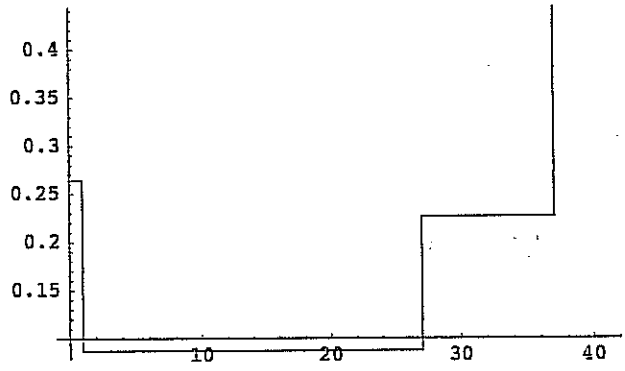
In[724]:= xx[31.]

Out[724]= {-1.02351}

Out[812]= 0.0870315

Out[813]= 0.226282

Out[814]= 0.754273



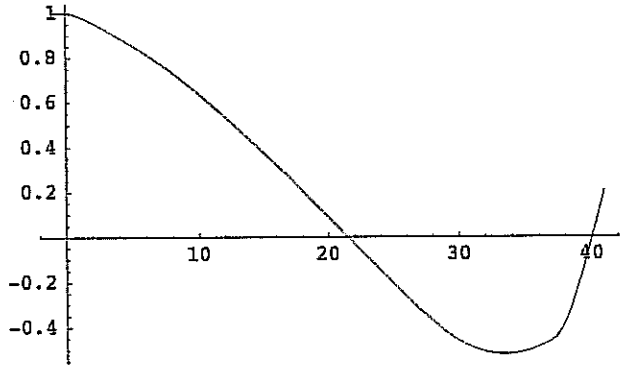
Out[817]= 1.

Out[818]= 0.

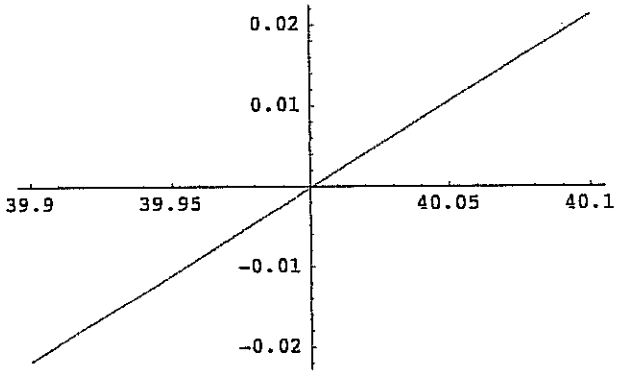
Out[819]= 0

Out[820]= -1

Out[821]= 41



X (7)

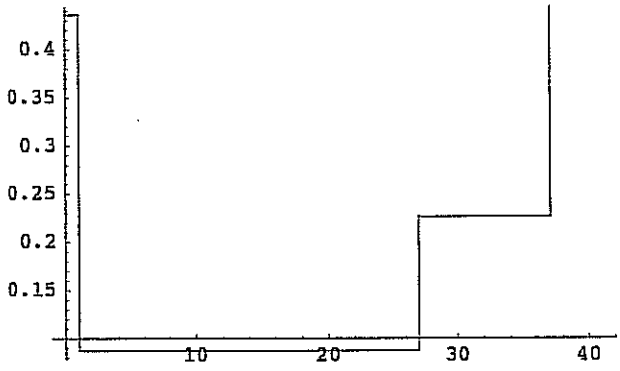


240 MeV (10)

Out[848]= 0.0870315

Out[849]= 0.226282

Out[850]= 0.754273



Out[853]= 1.

Out[854]= 0.

Out[855]= 0

Out[856]= -1

Out[857]= 41

X(z)