Study of the ATF injector and Linac

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ATF group mtg.
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Improved Injector Oct '98

SHB1(357MHz) vs. SHB2(357MHz)

LO (3m Acc. Structure) vs.2 10/10/98
Energy spread at injector
Pulsewidth and energy spread at injector as a function of buncher phase

![Graph showing bunchlength FWHM (ps) and ΔI/I as a function of buncher phase.]
Beam loss as a function of buncher phase
GUN HV studies
(beam loss through injector)
Emittance measurements at 80 MeV and 1.3 GeV
Emittance fits using SAD
SUMMARY OF EMITTANCE MEASUREMENTS

<table>
<thead>
<tr>
<th></th>
<th>Gun current (10E10)</th>
<th>EMIT X norm (m rad)</th>
<th>EMIT Y norm (m rad)</th>
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<tr>
<td>L0 normal curr.</td>
<td>3.3</td>
<td>2.98E-5</td>
<td>6.27E-5</td>
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<td>Linac normal curr</td>
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<td>1.68E-5</td>
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<td>Linac. v-kick 1 mm</td>
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<td>Linac high curr.</td>
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<td>L0 13/11/98</td>
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<tr>
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<td>1.7E-4</td>
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<td>ATF-REP-97-29 LINAC</td>
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<td>1.5E-4</td>
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</table>
SCREENS ALONG LINAC

M5L

M10L

M6L

M13L

M7L

M14L

M8L

M15L

M9L

-MATCHING PROBLEM? (BEAM LOST)
(TRYING TO MATCH)
WAKEFIELD STUDIES
Calculation of expected wakefield contribution to Linac emittance

Chao et al. model: (assuming no energy spread) betatron oscillation gives:

\[ y = \hat{y} \cdot e^{i k L} \frac{1}{n! (2n)!} \left( \frac{\eta}{2i} \right)^n \]

\[ \eta = \frac{e N < W_x > \beta_0}{E_0} f(E_0, E_f) \]

\[ \beta \sim E^{1/2} \]

\[ f = \frac{\sqrt{\frac{E_f}{E_0}} - 1}{\sqrt{\frac{E_0}{E_f}} - 1} \]

\[ E_0 = 80 \text{MeV}, \; E_f = 1.3 \text{GeV}, \; L = 80 \text{m} \]

\[ N = 2.5 \times 10^{10}, \; \beta_0 = 6 \text{m}, \; \sigma_x = 2.3 \text{mm} \]

\[ L_s = 48 \text{m structure length} \]

\[ < W_x > = 1.38 \times 10^{15} \frac{V}{C m^2} \left( \frac{L_s}{L} \right) = 0.83 \times 10^{15} \frac{V}{C m^2} \]

\[ f = 0.4 \]

\[ \eta = 8.0 \]

Expect 2x increase of vertical beam size at 1.3 GeV for 1 sigma size kick at injector i.e.,

16x increase in emittance
BNS damping required to damp beam breakup

\[ \beta \sim E^{1/2} : \]

\[ \frac{\Delta E}{E} \approx \frac{eN}{4} < W_x > \frac{\beta_0^2}{E} = 0.37 \]

Could possibly get damping 1/2 of that energy spread. Still too large.

Tested asymmetry of BNS damping phasing the linac +10 deg. Observed tails on screen at 1.3 GeV at +10 GeV that disappeared at -10 deg. Unfortunately no emittance measurement was done.
Beam position stability at Injector and Linac
CHECK Riz's agm

predicted orbit response (by lars):

ZH4L

ZH3L

ZH2L

ZH1L
summary

- Linac emittance as good as before injector changes and better than design emittance.

- Linac emittance 3-4 times worse than injector.

- Wakefields MAYBE the answer: have seen tails and intensity jitter on screens and position jitter on BPMs. Also some agreement with quick wakefield calculation.

- Injector energy spread problem for transmission through to first accelerator structure. Possibly an acceptance problem of the analysis section before L1 or a lattice problem? Operating point compromises bunchlength for the sake of small energy spread (5%) Not able to do better with normal tuning.

- Beam loss throughout the linac still a problem and possibly affecting emittance measurement.

- Remaining checks: (concentrate on beam loss, emittance in Linac is O.K.)
  - Residual field on analyzer section using corrector. May improve orbit.
  - SHB or buncher phase drifts.
  - Phasing tools (multiknob). (L1 and L2 tied to same klystron).