

## Some Notes on Using PIP with Proton Beam (1998)

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Technical Note

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## 1 PUE Signals

- PIP requires SUM and DIFF(ERENCE) signals from a PUE (PickUp Electrode) in the Booster Ring. These signals are piped to MCR Console 4 (MCR-4) and are currently available for Horizontal PUE D2 on the labeled spigots at MCR-4. (Vertical PUE D1 is currently out of service.)
- To set the PUE gain, go to Spreadsheet page "Booster/Injection/Ltb". For device "BMD.BPM GAIN1.BC", set the number in the "Setpt" column to "21" and select "X50" in the "C2" column. (The entry in the "C1" column should be "NOR".)
- Disable the Booster RF to obtain "clean" PUE signals.

## 2 Chopper Setup

The chopper needs to be set up so that only a single half-turn of beam is injected into the booster. Since we are currently running with harmonic  $h = 1$  in Booster, this amounts to injecting a single bunch with a width of 180 degrees. To set up the chopper, do the following in the Chopper Program:

1. Click on "Setup" near the top of the program window and select "Parameters". (A "Physics Parameters" Pop-up should appear.)
2. Set "Inj. Turns" equal to 1.

3. Set "Bunch Width(Deg)" equal to 180, and click on "OK" in the Pop-up.
4. Click on "Make Live" (near the top right-hand corner of the program window) to implement the half-turn mode of operation.

### 3 Scope Setup

Do the Following:

1. Connect the Pue SUM signal to CHANNEL 1 of the Scope.
2. Connect the Pue DIFF signal to CHANNEL 2.
3. Set scope sweep to 5 microseconds per division.
4. Select XBAR Trigger Start "B.PEAKER.GU".
5. Select XBAR Delay Clock "BGN.MEGA.HZ.BPKR.CK" and set 2450 microsecond delay. Then adjust delay so that the first pass of beam through the Pue is seen 2 to 5 microseconds after the trigger. The full sweep should then show 35 to 40 passes through the Pue.
6. Adjust the gain and offset of Channels 1 and 2 so that the SUM and DIFF signals are fully contained and centered vertically on the scope screen.
7. Store a full sweep of the SUM and DIFF signals (i.e. capture a full sweep and then stop the trigger so that the sweep image is frozen on the scope screen).

### 4 Running PIP

Click on the background screen at the MCR-4 SUN Workstation—this will bring up a menu of items. Select "LABView" and then "Pip". Two windows will appear—one called "Pip" and the other called "Get Waveform Pip.vi". In the "Get Waveform Pip.vi" window, do the following:

1. Click on the “Run” arrow near the upper left-hand corner of the window. (The word “Run” appears when you move the cursor onto the arrow.)
2. Click on the “ACQUIRE DATA” Button. (This, of course, should be done only after you have stored a sweep of the sum and difference signals on a scope as described above.) You should then see the captured data appear on the “SUM” and “DIFF” graphs in the window.

Now, in the “Pip” window, a menu of PUE choices will have popped up and other menus will pop up as you proceed. Do the following:

1. Select a PUE (e.g. BOOSTER PUEHD2). A menu of parameters will then pop up; don’t change anything here—just click on “OK”. A menu of Injection choices will then appear.
2. Select the INJection point (e.g. BOOSTER C5 FOIL). A menu of parameters will again pop up—just click on “OK” as before.
3. Now click on the words “Do Pip” near the top of the window. The following options will appear:
  - Standard Analysis
  - Coupled Analysis
  - Display Fitted Parameters
  - Plot Pos vs Turn
  - Plot Sum vs Turn
  - Plot Sum/Diff
  - Plot Tune Spectrum
  - Print Analysis Results
4. Select “Standard Analysis” (or “Coupled Analysis” if you happen to be investigating the effects of coupling). After a short delay, a plot of position-versus-turn data points and a fitted curve should appear.
5. Select “Display Fitted Parameters” to see the fitted parameters. (Note that the fitted parameters are stored in a file called “result.dat” in /operations/app\_store/Pip/data).

6. Select "Print Analysis Results" to print the fitted parameters. (The output should appear on laser printer mcr1w1 in the MCR.)

The other "Do Pip" options may be used as follows:

- Select "Plot Sum/Diff" if you wish to see the SUM and DIFF signals that were acquired from the scope.
- Select "Plot Pos vs Turn" if you wish to re-display the position-versus-turn data points and fitted curve.
- Select "Plot Sum vs Turn" if you wish to see the calculated Sum signal. (This is actually the integral of the sum signal for each pass of beam through the PUE.)
- Select "Plot Tune Spectrum" if you wish to see the Discrete Fourier Transform of the position-versus-turn data.

## 5 Typical Results

Figures 1 and 2 show scope traces of the SUM and DIFF signals obtained from PUE D2. Note that the lower trace in Figure 1 is the signal from the XF100 current transformer in the LTB (Linac To Booster) line—it shows that just a single bunch is being injected into the Booster.

Figure 3 shows the SUM and DIFF signals read from the scope by the PIP program.

Figure 4 shows the corresponding plots of position-versus-turn data and fitted curve obtained by the PIP program. Figure 5 shows the fitted parameters.

Figure 6 shows the Discrete Fourier Transform (Tune Spectrum) of the position-versus-turn data.

Figure 7 shows the integral of the sum signal for each pass through the PUE.

Figure 1

21-Aug-98  
10:25:30

PUE D2 SUM Signal

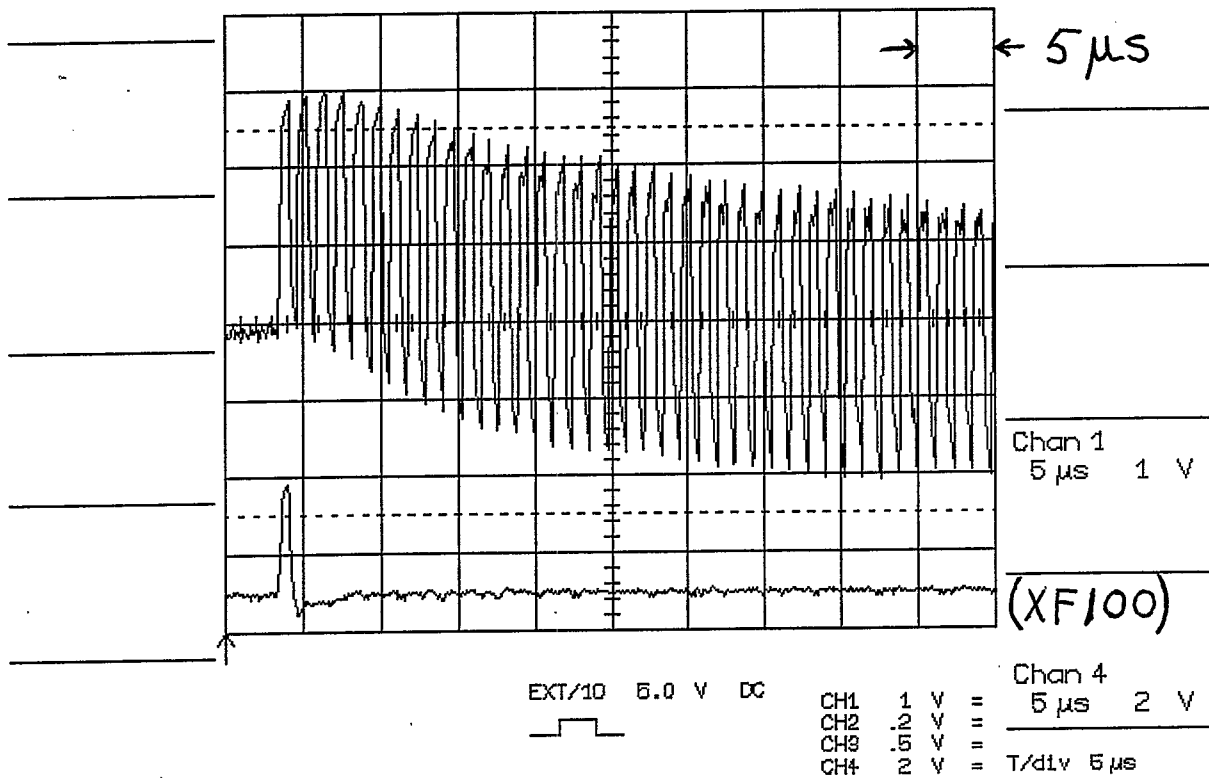


Figure 2

21-Aug-98  
10:23:52

PUE D2 DIFF Signal

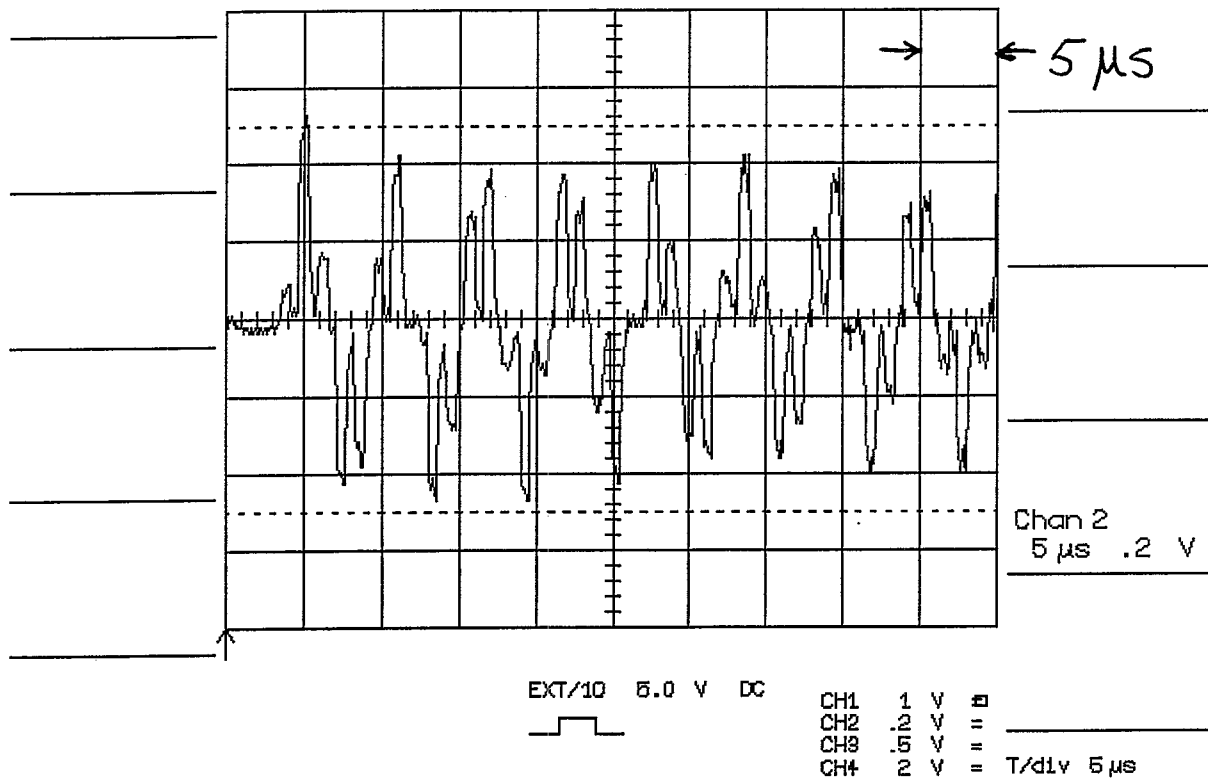
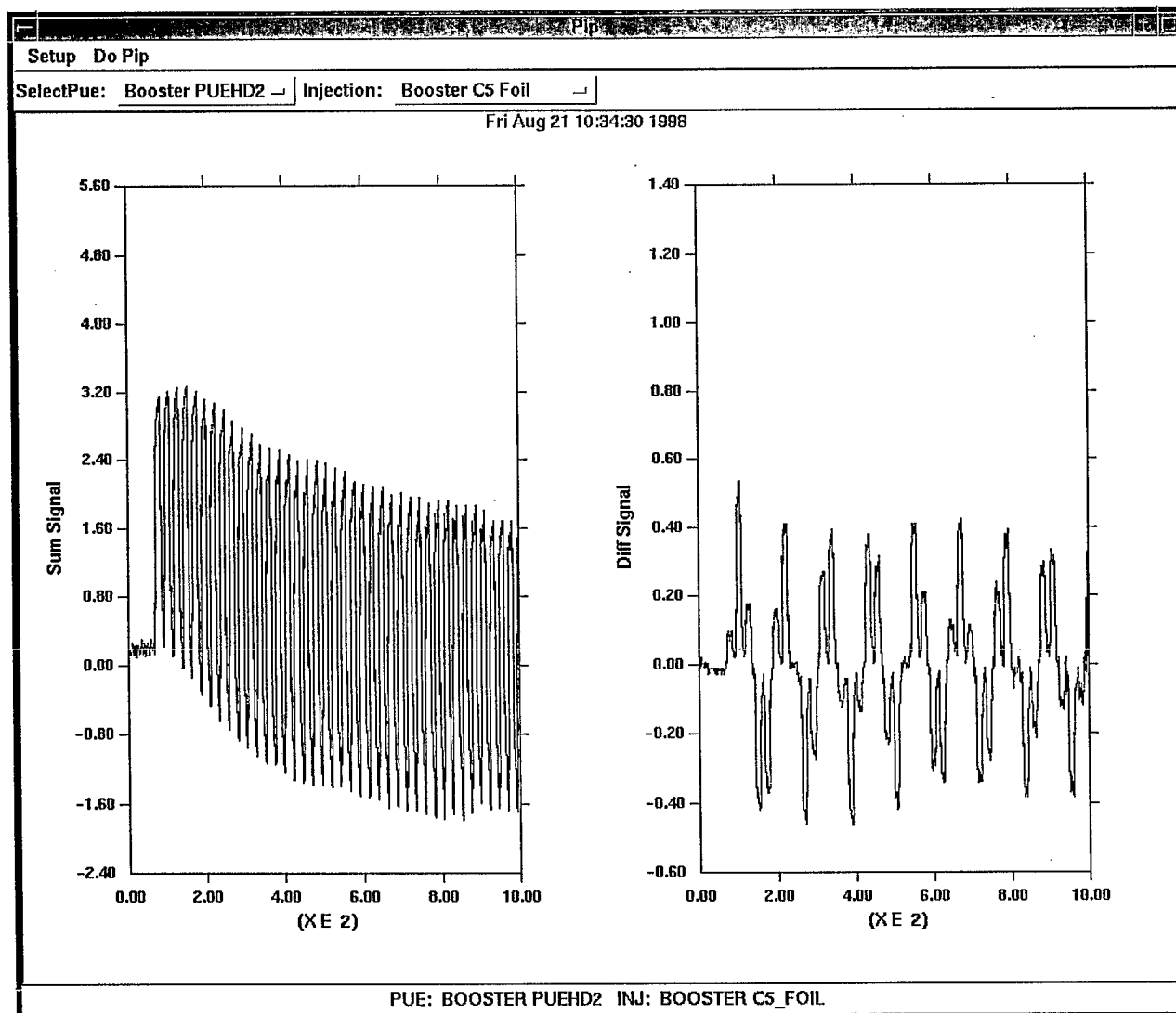
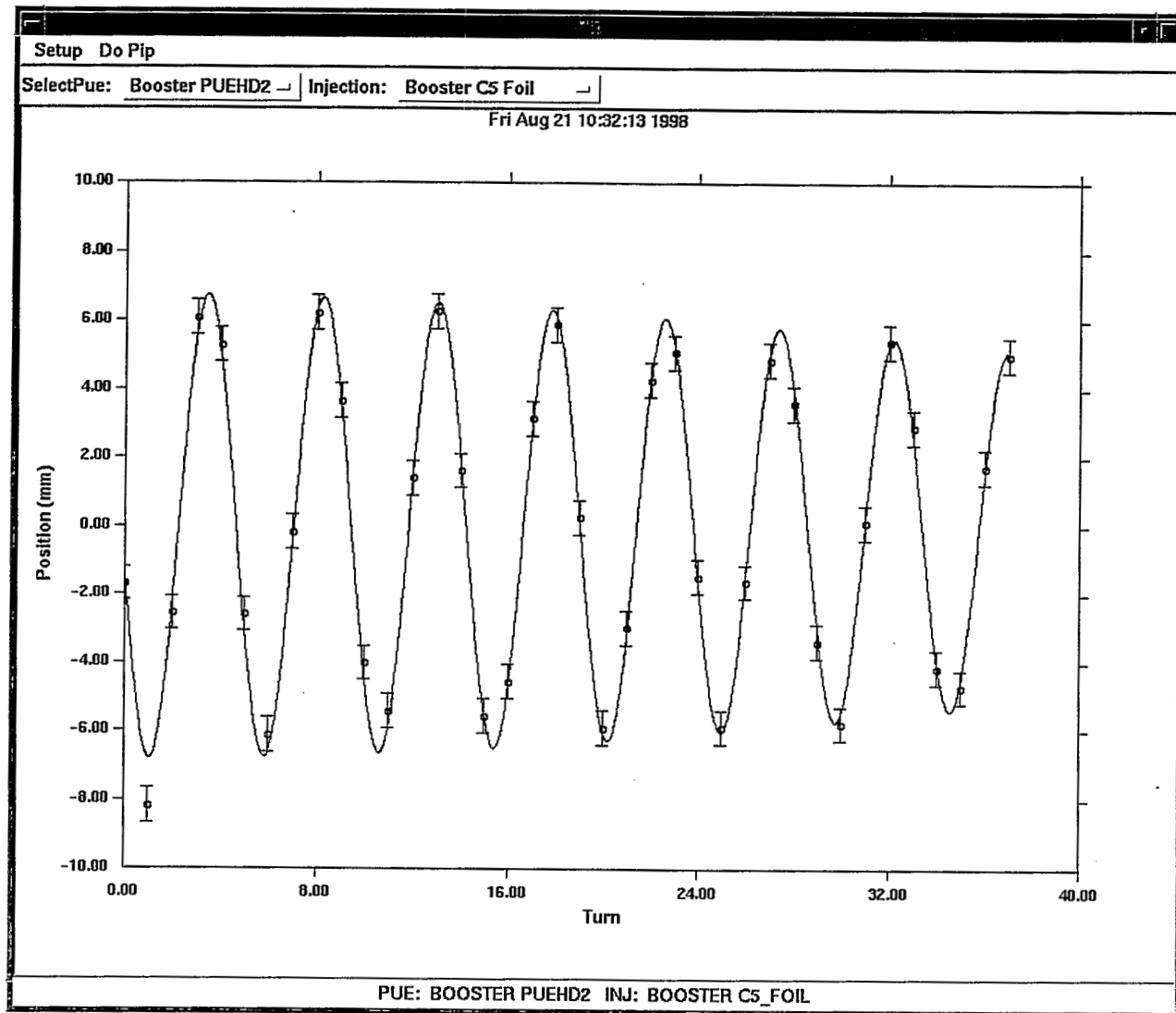


Figure 3



# Figure 4



# Figure 5

TRIGGER\_TIME :Date = AUG 21, 1998, Time = 10:19:24.11

Fitted Parameters: Chisq/dof = 0.585302, Number of Turns = 38

A1 = 0.208658 +/- 0.001021	A3 = 0.000006 +/- 0.000028
A2 = 0.281081 +/- 0.007553	A4 = 0.003178 +/- 0.000366
A6 = -0.020462 +/- 0.160876	A5 = 6.779452 +/- 0.179103
A7 = -0.001473 +/- 0.007516	

Period = 23.710564 samples = 1.185528e-06 seconds

----- Derived Parameters -----

Tune = 4.7913 +/- 0.0010

Tune shift/turn = -1.208e-05 +/- 5.672e-05

Tune spread (fw) = 6.356e-03 +/- 7.313e-04

Amplitude(mm) = 6.78 +/- 0.18

Courant-Snyder Invariant(mm mrad) = 3.720933 +/- 0.196603

Position of eo at PUE(mm) = -0.02 +/- 0.16

PUE: BOOSTER PUEHD2 INJ: BOOSTER C5\_FOIL

Position wrt eo at PUE(mm) = -1.32 +/- 0.32

Angle wrt eo at PUE(mrad) = 0.358 +/- 0.049

Position wrt eo at INJ(mm) = -2.17 +/- 0.30

Angle wrt eo at INJ(mrad) = -0.847 +/- 0.102

Figure 6

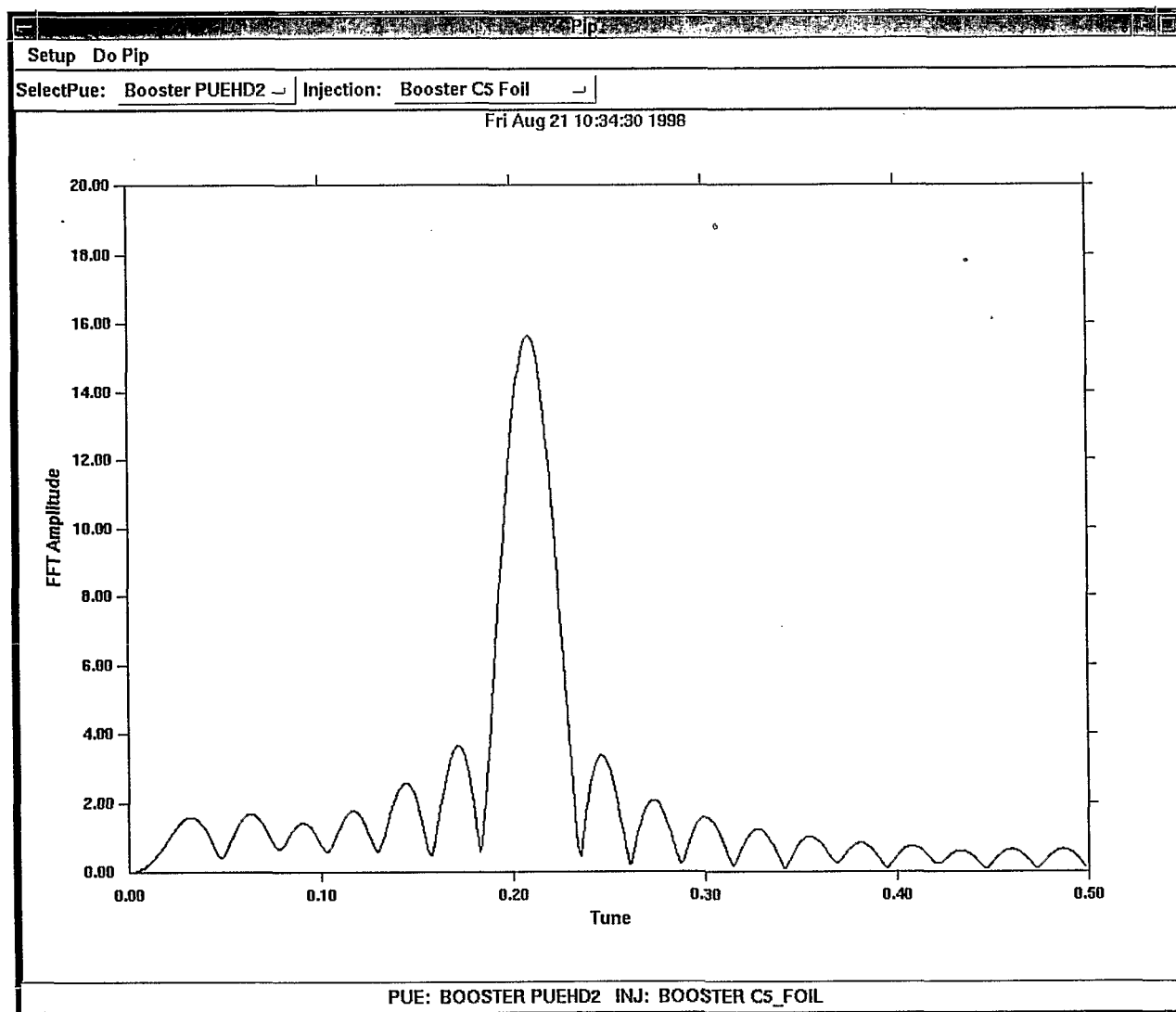


Figure 7

