Tevatron Orbit Smoothing Procedure

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(After B0 horizontal bumping to reduce losses)

This memo describes the details of the Tevatron orbit smoothing procedure.
The history of establishing the reference orbits is given in Appendix A.

The orbit smoothing should be done by with **T39 file 5 as the reference orbit file.**
The reference orbit file is marked as **the T39 reference file** in this document.

Steps in the Tevatron orbit smoothing procedure.

1) **Save the DFGs before smoothing.**
   Save the DFGs in C50 file ____.

2) **Inject uncoalesced beam.**
   No need to do Proton Injection tune up.
   Use normal sequencer aggregate.
   Turn off separators
   (Use page I15.)
   Make sure that the BPMs are in PROTON and BATCH mode
   (Use the command BPM_MODES PROTON BATCH from near the end of the Proton Pilot Aggregate in the sequencer.)
   Set the BPM threshold to Thrsh2 = 2.84E9
   (Use the command BPM_MODES COLL_THRESH 2.84 from near the end of the Proton Pilot Aggregate in the sequencer.)

3) **Test BPMs.**
   Use program T41 BPM Beam Diagnostics. (Run script *send_to_martens.*
   This can be done with the REPLAY T41 send_to_martens near the end of the Proton Pilot Aggregate in the sequencer.)
   If many BPMs are faulty, try to reboot the houses.
   Make note of the bad BPMs.
   (Note: Presently the HPE11 and VPA14 BPMs are out of service.)

4) **Save snapshot of orbit.**
   Collect a front porch BPM snapshot and save in T39 file ____.

5) **Ramp to 980 GeV flattop.**
Ramp to flattop, but do not go to low beta.
(This is with uncoalesced beam and separators off.)

6) **Save the ramp BPM profiles.**
Save the ramp BPM profiles in T39 file ____. (Save all 10 profile frames.)
Collect a flattop snapshot BPM profile and save in T39 file ____.

7) **Make BPM difference file.**
Plot the just saved T39 file of ramp profile with **the T39 reference file** subtracted.
Save the ramp profile differences on the ramp in T39 file ____.
(Look for obviously flaky BPM data.)

8) **Calculate the corrections on the ramp.**
Run TOP while still at the 980 GeV flattop but before the LB squeeze.
Smooth the horizontal and then vertical planes.

I. For both HORZ and VERT the setups should be:

a)	Table:	ACCELERATE
b)	Slot Range:	Use slot range 3-12
c)	Plane:	HORZ or VERT
d)	DFG source:	DFG
e)	BPM source:	T39 file
f)	BPM frame:	0
g)	BPM file:	File # from step 7 above.
h)	Desired orbit:	Desired Pos (Select file 1)
i)	Selected Lattice:	AUTO
j)	Algorithm:	SVD
k)	Stepcut:	100

II. For the desired position table select file 1.
Then mask out additional BPMs that failed the T41 test.

III. Run the smooth sequence.

IV. Plot DFG difference using CORRECTOR COMPARE.

a) Plot DFG differences on a scale of +/- 0.02 mrad
b) Look for DFG changes greater than +/-0.02 mrad cutoff.
c) If any DFG change is greater than the cutoff, then mask out this DFG in the desired positions table and redo the smooth.

V. Send the DFG settings to hardware.

9) **Save DFG settings.**
Save the DFGs in C50 file ____.

10) **Verify the smoothing was successful (at least at flattop.)**
Take a snapshot of the flattop orbit.
Save snapshot in T39 file _____.
Plot this file with **the T39 reference file**, frame 9 subtracted.
This shows how well the orbit was smoothed.

11) **Do the low beta squeeze.**
For this squeeze the DFG settings at flattop will be the newest settings, but the DFGs in the squeeze tables (the h-tables) are still the previous settings.

12) **Save the low beta squeeze BPM profiles**.
Save the low beta profile frames in T39 files.
Frames 0-34 in T39 file _____.

13) **Make BPM difference files**.
Plot the just saved T39 files squeeze BPM profiles with **the T39 reference file** subtracted.
Save the squeeze BPM differences orbits in T39 files.

Frames 0-34: File from above ____ - **the T39 reference file** = T39 file ____.

14) **Calculate correction for the low beta squeeze.**
Run TOP while still at low beta, but before aborting the beam.
Smooth the horizontal and vertical planes.
Each plane requires three separate smooth calculations.

I. For both HORZ and VERT the setups should be

a) Table: SQUEEZE
b) Slot Range: Use slot range (3-26)
c) Plane: HORZ or VERT

d) DFG source: DFG
e) BPM source: T39 file
f) BPM file: Use three file from step 13 above
g) BPM frame: 11
h) Desired orbit: Desired Pos (Select file 2)
i) Selected Lattice: AUTO
j) Algorithm: SVD
k) Stepcut: 100

II. For the desired position table select file 2.
Then mask out additional BPMs that failed the T41 test.

III. Run the smooth sequence.

IV. Plot DFG difference using CORRECTOR COMPARE

a) Plot DFG differences on a scale of +/- 0.02 mrad.
b) Look for DFG changes greater than +/-0.02 mrad.
c) If any DFG change is greater than the cutoff, then mask out this DFG in the desired positions table and redo the smooth.

V. Send the DFG settings to hardware.

15) **Save the DFG settings.**
Save the DFGs in C50 file ___.

16) **Verify the smoothing was successful (at least at low beta.**)
Take a snapshot of the low beta orbit.
Save snapshot in T39 file _____.
Plot this file with **the T39 reference file**, frame 34 subtracted.
This shows how well the orbit was smoothed

17) **Collect orbits on proton only store**.
Get rid of beam and do another proton only store.
The store should be with uncoalesced beam and with the separators off.
Save the BPM profiles in T39 files.
Frames 0-34 in T39 file _____.

18) **Verify the smoothing was successful.**
Compare the orbits taken in step 17 to the reference orbits,
Frames 0-34 in **the T39 reference file**.

Appendix A: History of Establishing Reference Orbits

After the fall 2003 shutdown changes were made to the Tevatron BPM offsets and the changes documented on the beams document database server at http://beamdocs.fnal.gov/cgi-bin/public/DocDB/ShowDocument?docid=924

Starting point:

On 11/19/03 the Tevatron orbits were smoothed the goal of establishing a set of reference orbits.

As a general strategy, the orbits in the straight sections (near A0, B0, C0, D0, E0 and F0) were kept at locations from before the fall 2003 shutdown were smoothed toward a zero reading on the BPM. During this smooth the BPM offsets is T39 had been updated based on measurements of the electrical offsets and a review of the mechanical offsets. The attempt was to make all of the orbits the same as the 150 GeV orbit (which is saved in C50 reference file 2) except near F0 where a F0HPOS horizontal position bump of +2.5 mm was put in at 980 GeV and gradually reduced to 0 mm at 700 GeV in order to make a smooth transition to the 150 GeV orbit. **After this smooth, the profile frames were store in T39 file 339.**

Other changes to the orbits followed in the next few days:

On 11/21/03 a –50 urad F0HANG horizontal angle bump was put in at F0 in all energy slots from 150 GeV up to 980 GeV. The orbit profiles were then saved in T39 file 425. As an approximation, this bump moved the beam radial outwards at HPE48 and HPE49 by about 2.5 mm and radial inward at HPF11 by about 0.5 mm. Unfortunately, the rest of the orbit had wandered compared to T39 file 399 so file 425 is not a good reference file.

More orbit work was done on 11/21/03. A +1.5 mm F0VPOS bump was put in at 150 GeV and gradually removed by 500 GeV, and a +1.0 mm T:HE83:3 3-bump was put in at 150 GeV. Then we copied the HE48:3 bump to 500 GeV. The bump is only +1.0 mm at 200 and 300 GeV, and reduced to +0.5 mm at 400 and 500 GeV, and out at 600 GeV.

Things get somewhat confusing at this point in the log book. What orbits in T39 correspond to what settings is not clear. There was also considerable confusion about the state of the bumps at this time.

On 11/22/03 we did a +2mm bump at T:HPB26 from 150 GeV up to 500 GeV.

On 11/25/03 we made a correction to the BPM offsets for T39. As a result of these, the amount of apparent orbit change is -1.42 mm for VPB11, -0.78 mm for VPC11, -0.3 mm for VPB49, +0.3 mm for HPB49, +0.79 mm for HPC11, and +1.41 mm for HPB11.

During all of this time T:VPC49 was broken and therefore we do not have a good measurement for the beam position at this location.

Combining all of this info the Tev reference orbit consists of:

Start with the positions in T39 file 339.
This is the starting point.

Use the positions in T39 file 425 for the positions near F0.
This is after the -50 urad F0HANG bump was added at all ramp slots. The BPMs included are T:HPE46, T:HPE48, T:HPE49, T:HPF11, T:HPF13, T:HPF0LU, T:HPF0LD, T:VPE47, T:VPE49, T:VPF11, T:VPF12, T :VPF0LU, and T:VPF0LD.

Add additional +1.0 mm T:HE48:3 bump at 150 GeV to 300 GeV and +0.5 mm T:HE48:3 bump at 400 and 500 GeV. This gives us more room at E48 on the proton helix.

Add +2.0 mm T:HBE26:3 bump from 150 GeV to 500 GeV. To reduce losses at this location.

Add -1.42 mm for VPB11
Add -0.78 mm for VPC11
Add -0.30 mm for VPB49
Add +0.30 mm for HPB49
Add +0.79 mm for HPC11
Add +1.41 mm for HPB11.
These are to compensate for the changes in the BPM offsets.

Added +2mm V0FPOS bump to include changes to vertical position at F0.

Resulting Reference File (T39 file 2)

The result of all of this is T39 file 2 "Reference Prof Nov startup MAM".

Big Vertical Drift

On December 2, 2003 a vertical oscillation of +/- 5mm in the orbit was found and corrected. The largest change was to T:VA49 which changed by about -0.04 mrad at all energy and low beta slots. The source of the orbit distortion was not identified.

At this time it was recognized the T39 reference file 2 did not have the correct orbit to reduce the size of the orbit bump at F0 at higher energies.

Quench at F32

On December 2, 2003 we quenched at F32 during a shot setup acceleration. The orbit was moved horizontally outward at F32 by +2.0 mm (using a HPF32:3 bump) and horizontally outward at F44 by +1.5 mm (using a HPF44:3 bump) in order to reduce beam losses at these locations. The changes were made at all energy slots from 150 Gev to 980 Gev.

Resulting Reference File (T39 file 1)

The orbits in T39 reference file 2 were combined with the F0 bumps and HF32 and HF44 bumps mentioned above.

The result of this was T39 file 1, "Reference Prof (F0 bumps) MAM"

Here are some notes on the DFG strengths near this same time.
These notes are from the DFG settings on December 2, 2003.

T:VF47 is running at 36.4 Amps at flattop.

C:HA48 has 36.75 Amp max current in the squeeze.
T:HA48 has 38.88 Amp max current in the squeeze.
T:HA49 has 44.59 Amp max current in the squeeze.
T:VF47 has 36.41 Amp max current in the squeeze.
T:VB12 has 41.81 Amp max current in the squeeze.

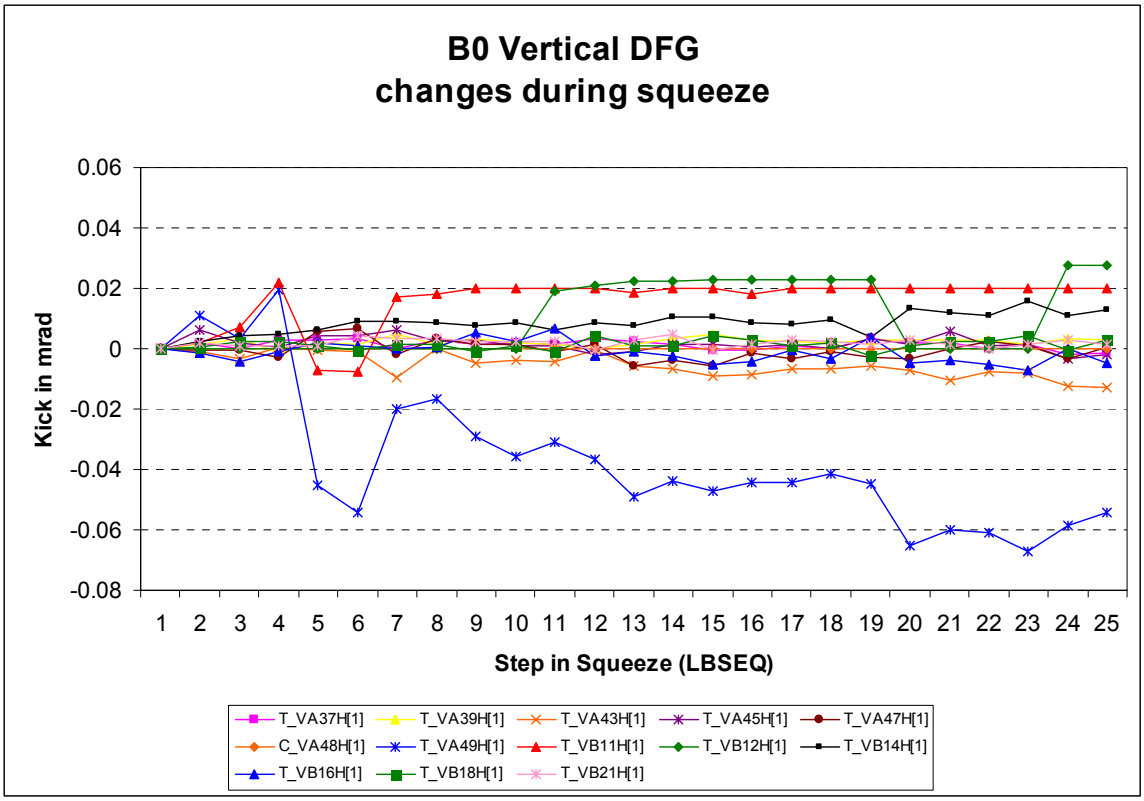
DFGS WITH ANGLE LARGER THAN 0.10 MRAD ON THE RAMP

NAME	150	200	300	400	500	600	700	800	900	980
T:HE48	0.114	0.107	0.107	0.093	0.093	0.079	0.079	0.079	0.079	0.079
T:HF13	0.102	0.104	0.101	0.102	0.101	0.104	0.098	0.092	0.087	0.086

DFGS WITH ANGLE LARGER THAN 0.10 MRAD IN THE SQUEEZE

T:HA48 0.10 is max angle
T:HA49 0.12 is max angle
T:VB12 0.11 is max angle

Note that T:VA49 changes by a large amount during the low beta squeeze.



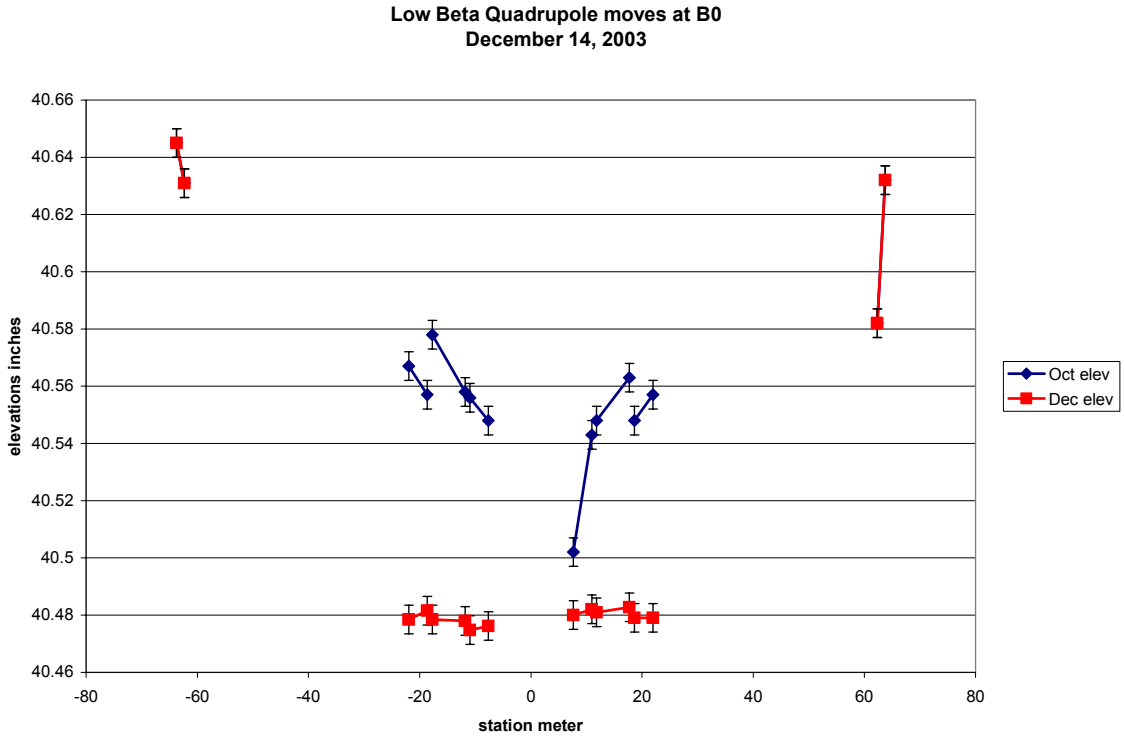
B0 Low Beta Quadrupole Moves.

On December 5, 2003 the Tevatron had a 16 house quench as the result of a pot being inserted into the beam. A ~1 week long shutdown resulted and during this time some of the magnets in the C1 house were re-aligned (unrolled) and the low beta quadrupoles at B0 were moved to align them with each other, and also lowered in order to lower the vertical position of the interactions in the CDF detector.

The moves of the quadrupoles are shown in the figure and table below.

	STATION	ELEV 10-03	DELTA	NEW IDEAL	DEC 132 SET ELEVATIONS
	METERS	INCH	INCH	INCH	INCH
AQ5U	-63.708	40.645	0.000	40.645	40.645
AQ5D	-62.307	40.631	0.000	40.631	40.631
AQ2U	-21.974	40.567	-0.088	40.479	40.479
AQ2U	-18.621	40.557	-0.078	40.479	40.482
AQ3U	-17.745	40.578	-0.099	40.479	40.479
AQ3D	-11.852	40.558	-0.079	40.479	40.478

AQ4U	-10.976	40.556	-0.077	40.479	40.475
AQ4D	-7.623	40.548	-0.069	40.479	40.476
BQ4U	7.623	40.502	-0.023	40.479	40.480
BQ4D	10.976	40.543	-0.064	40.479	40.482
BQ3U	11.852	40.548	-0.069	40.479	40.481
BQ3D	17.745	40.563	-0.084	40.479	40.483
BQ2U	18.621	40.548	-0.069	40.479	40.479
BQ2D	21.974	40.557	-0.078	40.479	40.479
Q5U	62.308	40.582	0.000	40.582	40.582
Q5D	63.710	40.632	0.000	40.632	40.632



In addition to these low beta quad moves, several DFG correctors were used to keep the orbit bumps local. The change to the DFG are predicted to be

Corrector	Change at flattop	Change at collisions
C:VA48	-0.027 mrad	-0.027 mrad
T:VB11	-0.095 mrad	-0.120 mrad
T:VB12	-0.075 mrad	-0.075 mrad

and the changes to the orbit positions are predicted to be

BPM location	Changes at flattop	Changes at collisions
T:VPA49	-0.81 mm	-0.67 mm
T:VPB0U	-0.04 mm	-0.04 mm
T:VPB0D	-4.53 mm	-4.84 mm
T:VPB11	-2.45 mm	-2.39 mm

where these predicted BPM position changes include the re-alignment of the IR BPMs which are attached to the low beta quadrupoles.

Given these changes, the T39 reference file 1 was modified by adding the predicted changes to the collision orbit to the BPM readings in T39 file 1. Since the flattop and collision orbit changes are similar, the predicted change at collisions was add to all energy and low beta slots. The new file was saved in T39 file 3.

Resulting Reference File (T39 file 3)

The orbits in T39 reference file 1 were combined with predicted orbit changes from the low beta quadrupole moves.

The result of this was T39 file 3, "Referenc Prof (B0 IR move) MAM"

Startup After 16 House Quench and B0 Low Beta Moves.

On December 15th, after the shutdown, we re-started the Tevatron.

After the startup the all of the corrector elements in the D49 spool piece were found open. Thus we are running without T:HD49 and T:VD49. Before the shutdown T:HD49 was running at about +0.025 mrad and T:VD49 was running at about -0.035 mrad.
These correctors were set to zero by making a vertical 3-bump at VD39 of about -2.5 mm and a horizontal 3-bump at HD49 of about -0.5 mm. The horizontal bump was using HD48, HD49 and HE11, The vertical bump was the standard 3-bump. (See Tev E-log for more details.)

The bumps made around E0 to compensate for the D49 spool failure correctors were:

Energy	T:VD49:3(mm)	T:HD49:3(mm)
150	-2.0	-.5
200	-2.5	-.5
300	-2.5	-.5
400	-2.5	-.5
500	-3.0	-.5
600	-2.5	-.5
700	-2.5	-.5

800	-3.0	-.5
900	-3.0	-.5
980	-2.5	-.5

After these changes the orbit was smoothed to T39 reference file 3, but with T:HD49 and T:VD49 disabled. This was done on Dec 15th, 2003. The resulting orbit up the ramp and through the squeeze is saved in T39 file 503. The changes in the horizontal orbit are lost in the noise. Vertically the position at VPD47 changed by about +1.5 mm and the position at VPD49 changed by about -1.1 mm.

Wednesday Dec 17th, 2003. To help reduce losses when aborting beam, we did a -1 mm A0VPOS bump at flattop to allow for more margin in the abort of P25 into the dump. A save has been made on C50 into file 92. According to aperture scans performed on December 3rd, we should have 7.6 mm of available aperture in the negative direction for coalesced beam.

New Luminosity Record!!

From Dec 18th, 2003 MCR E-log

15:10:27- Store 3103 is in
CDF Lum 51.5E
D0 Lum 48.35E30
Avg Lum 49.92E30
NEW RECORD - ollie

Resulting Reference File (T39 file 4)

T39 reference file 4 was created by starting with T39 reference file 3. Then the BPM positions at HPD48 and HPD49 were copied from T39 file 503 (after the smooth without the D49 spool.) The reference file also put in the estimated changes for the -1mm A0VPOS bump at flattop. The bump was only put in at flattop, but the T39 reference file phased in the bump starting at 700 Gev.

The result of this was T39 file 4, "Refernc Prof (A0 bmp, D49) MAM"

New Desired Position Tables

The desired position tables in files 23 and 24 were copied to files 1 and 2. These are marked as "standard".

B14 spool piece replacement

On Dec 27th, 2003 the Tevatron started up after a replacement of the B14 spool piece.

During the shutdown C49 was modified to move DFGs around A0 from the Arc Corrector Groups into their own DFG groups. These A0 groups are configured just like the B0 and D0 corrector groups. The major difference is that the A0 correctors now have H-tables. That will be useful for controlling the orbit through SQA0. Specifically,

* T:HF44, T:HF46, T:HF48, T:HF49, T:HA11, T:HA13, T:HA15 are now in the "A0 Horz Correctors" group.

* T:VF45, T:VF47, T:VF49, T:VA11, T:VA12, T:VA14, T:VA16 are now in the "A0 Vert Correctors" group.

During the shutdown a number of dipole and quadrupole magnets in the B1 and B2 houses were unrolled. Before the startup, J. Annala changed all energy slots of the following correction elements by the amount shown below. I show the before and after for the 150 GeV slots.

		Angle (mrad)	
Corrector	Change	Before	After
VB21	-.025	.012	-.013
VB23	-.048	.041	-.006
VB25	-.065	.086	.021
VB27	-.014	-.015	-.028
VB29	-.002	.038	.036

Smoothing After B14 Spool Piece Replacement

After the startup the orbit could not be smoothed to the T39 file 4 reference orbit because HA49 would be running too hard during the squeeze. To compensate some 3-bumps were done at flattop to reduce the current in HA49 and HB11.

From JA note: To get this I did a +2mm standard 3 bump at HA46. I did a -.4 mm 3 bump at A49 using the A46, A49 and B11 corrector. I did a -.6mm bump at HB13 using HB11, HB13 and HB15 in order to get the current in HB11 down. The result of all of this was the flattop top orbit saved in T39 file 535.

Smoothing in the squeeze to T39 file 4 also predicted too large currents in the correctors. Therefore, the desired position table modified and did not use HA48, HA49, HB11 or HB12. The squeeze was smoothed to T39 file4 with the modified desired position table.

Some confusion about the RF frequency. Vladimir noticed that the RF frequency is off by 15 Hz again (see horz diff orbit above). Looks like the new RF frequency calculation never was put in the download file, and a reboot must have put us back where we were

before November. Looks like we reverted to the old RF frequency on Dec 16 at the last reboot. The stores we did just before Christmas were done with the old RF frequency.

T39 file 540 contains the profiles with the separators off and the RF frequency was set to the correct value.

Report on DFG settings as found on Jan 5th, 2003

```
Values of DFG during the ramp and the squeeze
Getting Live DFG data
Today's date
05-JAN-2004 15:38:12
T_STORE =  3127


DFGS WITH CURRENT LARGER THAN 35.00 AMPS ON THE RAMP


NAME      150    200    300    400    500    600   700     800    900    980
C:VA48  -5.71  -7.61 -11.42 -15.22 -19.03 -22.83 -26.64 -30.44 -34.25 -37.29
T:VC23   4.76   6.73  10.73  14.65  17.63  21.68  25.15  28.74  32.34  35.63


DFGS WITH CURRENT LARGER THAN 35.00 AMPS IN THE SQUEEZE

C:HA48  44.28 is max current
T:HA48  43.51 is max current
T:HA49  36.45 is max current
T:HB11 -40.42 is max current
C:VA48 -37.29 is max current
T:VA49 -36.17 is max current
T:VC23  35.63 is max current


DFGS WITH ANGLE LARGER THAN 0.10 MRAD ON THE RAMP

NAME      150    200    300    400    500    600   700     800    900    980
T:HE48  0.114  0.107  0.107  0.093  0.093  0.079  0.079  0.079  0.079  0.079
T:HF13  0.100  0.102  0.099  0.099  0.099  0.102  0.095  0.091  0.086  0.085


DFGS WITH ANGLE LARGER THAN 0.10 MRAD IN THE SQUEEZE

C:HA48   0.11  is max angle
T:HA48   0.11  is max angle
T:HB11  -0.10  is max angle


AVERAGE HORZ DFGS CORRECTION UP THE RAMP.
Ramp slot  0 has average horz angle of  -0.977 urad
Ramp slot  1 has average horz angle of  -0.828 urad
Ramp slot  2 has average horz angle of  -0.966 urad
Ramp slot  3 has average horz angle of  -0.889 urad
Ramp slot  4 has average horz angle of  -0.790 urad
Ramp slot  5 has average horz angle of  -0.529 urad
Ramp slot  6 has average horz angle of  -0.602 urad
Ramp slot  7 has average horz angle of  -0.775 urad
Ramp slot  8 has average horz angle of  -0.407 urad
Ramp slot  9 has average horz angle of  -0.964 urad
```

Orbit Smoothing Jan 9th, 2004

The orbits had drifted by about 1-1.5 mm from the reference orbit and were smoothed on January 9th, 2004. The horizontal orbit near B0 continued to be a problem and I could not smooth the orbit to the reference orbit in T39 file 4. This was similar to the experience that Jerry observed when smoothing after the B14 spool piece replacement.

I did change the desired position table for the ramp part of the smooth in order to compensate for the failed dipole corrector at D49. This was done by enabling the T:HD48 corrector. The resulting desired position tables are shown below.

```
....   == 'Desired Positions,Skip,Bad Corrector,Bad BPM,Pos Freeze'

  HORZ   |  FILE READ   |  SAVE FILE   |  RESTORE   |  LOCK   |  DELETE   |  RETURN
         |      A       |      B       |      C     |      D      |      E      |      F
T: 0U     0     . *.     0     . *.                    0     . *.                                  0U
T: 0D     0     . *.     0     . *.                    0     . *.                                  0D
T: 0LU                                                                                 0     . *.   0LU
T: 0LD                                                                                 0     . *.   0LD
T: 11     0     ....     0     .*..     0     ....     0     .*..     0     ....     0     ....   11
C: 12                      .*                                 .*
T: 12                    0     . *.                    0     . *.                                  12
T: 13     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   13
T: 15     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   15
T: 17     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   17
T: 19     0     ....     0     ....     0     ....     0     ....     0     ..*.     0     ....   19
T: 22     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   22
T: 24     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   24
T: 26     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   26
T: 28     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   28
T: 32     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   32
T: 34     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   34
T: 36     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   36
T: 38     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   38
T: 42     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   42
T: 44     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   44
T: 46     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   46
C: 48               .*                         .*                                                 48
T: 48     0     .**.     0     .**.     0     .**.     0     ..*.     0     .**.     0     .**.   48
T: 49     0     ....     0     ....     0     ....     0     .*..     0     ....     0     ....   49


  VERT   |  FILE READ   |  SAVE FILE   |  RESTORE   |  LOCK   |  DELETE   |  RETURN
         |      A       |      B       |      C     |      D      |      E      |      F
T: 0U     0     * *.     0     * *.                    0     * *.                                  0U
T: 0D     0     * *.     0     * *.                    0     * *.                                  0D
T: 0LU                                                                                 0     * *.   0LU
T: 0LD                                                                                 0     * *.   0LD
T: 11     0     ....     0     .*..     0     ....     0     .*..     0     ....     0     ....   11
T: 12     0     .**.     0     .**.     0     .**.     0     .**.     0     .**.     0     .**.   12
T: 14     0     ..*.     0     ....     0     ....     0     ....     0     ....     0     ....   14
T: 16     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   16
T: 18     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   18
T: 21     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   21
T: 23     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   23
T: 25     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   25
T: 27     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   27
T: 29     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   29
T: 33     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   33
T: 35     0     ....     0     ....     0     ....     0     .*..     0     ....     0     ....   35
T: 37     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   37
T: 39     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   39
T: 43     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   43
T: 45     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   45
T: 47     0     ....     0     ....     0     ....     0     ....     0     ....     0     ....   47
C: 48               .*                         .*                                                 48
T: 48     0     . *.                     0     . *.                                               48
T: 49     0     ....     0     ....     0     ..*.     0     .*..     0     ....     0     ....   49
```

After the smoothing was finished, a proton only store with the separators off was done and the profiles saved in T39 file 590.

Comparing file 590 (after the smooth) to the reference file (T39f4) does not show much difference vertically. One exception is that T:VPF32 differs by about -1mm in frames 10 through 34. This is odd since the correctors do not change between frame 9 and 10. Likely this is a flaky BPM T:VPF32. Also, T:VPC49 is about -0.6 mm lower than the reference after the smooth. This BPM is masked out of the desired position table.

Comparing file 590 (after the smooth) to the reference file (T39f4) does show some differences horizontally, particularly around B0. For frame 9 and 10, T:HPA46 is about +1.5 mm as compared to the reference file. Near B0, the HPA49, HPB11, and HPB12 orbits are about -0.5 to -1.0 mm more to the radial inside as compared to the reference file.

Bumps made between Jan 9th and Jan 14th, 2004

Made a -0.5 mm HPA46:3 bump at flattop. (To reduce losses at T:LMA4Q1)

Made a +2 mm HE48:3 bump at 150 Gev and 200 Gev.

Made a +2.0 mm HA49:3 bump at 150 and 200 Gev.
Made a +1.5 mm HA49:3 bump at 300 Gev.
Made a +1.0 mm HA49:3 bump at 400 Gev.

After this a report of the DFGs gives:

```
Values of DFG during the ramp and the squeeze
Getting Live DFG data
Today's date
15-JAN-2004 18:21:14
T_STORE =  3172

DFGS WITH CURRENT LARGER THAN 35.00 AMPS ON THE RAMP

NAME      150    200    300    400    500    600   700     800    900    980

T:HA49   9.54  13.00  18.97  21.29  19.70  22.86  28.10  33.19  37.05  21.70
T:VE29  -5.35  -7.23 -10.44 -13.85 -18.32 -21.39 -23.99 -28.08 -32.09 -35.13
T:VE45  -5.47  -6.73 -10.80 -14.84 -17.12 -21.34 -25.76 -28.62 -32.37 -35.44
C:VA48  -5.71  -7.61 -11.42 -15.22 -19.03 -22.83 -26.64 -30.44 -34.25 -37.29


DFGS WITH CURRENT LARGER THAN 35.00 AMPS IN THE SQUEEZE

C:HA48  44.24 is max current
T:HA48  43.51 is max current
T:HA49  49.19 is max current
T:HB11 -40.42 is max current
T:VE29 -35.13 is max current
T:VE45 -35.44 is max current
C:VA48 -37.29 is max current
T:VA49 -41.16 is max current
```

```
DFGS WITH ANGLE LARGER THAN 0.10 MRAD ON THE RAMP

NAME      150    200    300    400    500    600   700     800    900    980

T:HE48  0.186  0.179  0.107  0.093  0.093  0.079  0.079  0.079  0.079  0.079
T:HF13  0.098  0.103  0.101  0.097  0.097  0.101  0.098  0.090  0.089  0.085
T:HA49  0.161  0.165  0.161  0.135  0.100  0.097  0.102  0.105  0.105  0.056
T:HC11 -0.102 -0.065 -0.052 -0.048 -0.053 -0.047 -0.045 -0.036 -0.023 -0.006


DFGS WITH ANGLE LARGER THAN 0.10 MRAD IN THE SQUEEZE

C:HA48   0.11  is max angle
T:HA48   0.11  is max angle
T:HA49   0.13  is max angle
T:HB11  -0.10  is max angle
T:VA49  -0.11  is max angle


AVERAGE HORZ DFGS CORRECTION UP THE RAMP.
Ramp slot  0 has average horz angle of   0.300 urad
Ramp slot  1 has average horz angle of   0.983 urad
Ramp slot  2 has average horz angle of   0.304 urad
Ramp slot  3 has average horz angle of   0.059 urad
Ramp slot  4 has average horz angle of  -0.862 urad
Ramp slot  5 has average horz angle of  -0.495 urad
Ramp slot  6 has average horz angle of  -0.641 urad
Ramp slot  7 has average horz angle of  -0.894 urad
Ramp slot  8 has average horz angle of  -0.634 urad
Ramp slot  9 has average horz angle of  -1.309 urad
```

Updated Reference File (T39 file 4)

Starting with T39 file 4, the reference orbit was updated by making the following changes to the orbit positions.

-0.5 mm at HPA46, flattop => squeeze
(For the bump at HPA46 to reduce losses.

-0.5 mm at HPA49, all slots
-1.1 mm at HPB0U, all slots
-0.7 mm at HPB0D, all slots
-0.6 mm at HPB11, all slots
-1.1 mm at HPB12, all slots
(Related to problems keeping the correctors below their limits.)

-0.5 mm at VPA49, all slots
(This BPM is not used in the smooth and may have wandered.)

	HPA48	HPA49	HPB0U	HPB0D
150 Gev	+1.2	+1.6	-1.0	-2.0
200 Gev	+1.2	+1.6	-1.0	-2.0
300 Gev	+0.9	+1.2	-0.7	-1.5
400 Gev	+0.6	+0.8	-0.5	-1.0

(For the bumps that Bruce put in to reduce losses.)

+2.0 mm at HPA46, flattop and 0^{th} step in the squeeze.
(As a kludge due to confusion in the horizontal orbit at flattop.)

The result of this was T39 file 5, "Ref Prof (B0 Horz bumping) MAM"