# The "Recomputed Emittances" and "Intensities and Efficiencies" Summary Tables
# Beams-doc-1872
# Version 1.0

Timofei Bolshakov, Vaia Papadimitriou

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## Abstract

This document describes the tables that summarize the proton and pbar emittances and intensities throughout the acceleration chain as well as the efficiencies for every step of the process. This information is provided concisely on a store by store basis and gets automatically inserted into the Shot ScrapBook.

# 1. Introduction

This work got initiated with the purpose of providing a concise summary of proton and pbar emittances, intensities as well as transfer efficiencies throughout the acceleration chain on a store by store basis. The information in these tables is based on the same Classes/Methods as for the calculation of similar quantities in the Supertable (see Ref [1]). Most of the emittances are "recomputed" on the basis of the most up-to-date information which is not necessarily available at the Front End (eg. lattice functions, dispersion, etc). The format of the "Recomputed Emittances" and "Intensities and efficiencies" summary tables is similar. The "Recomputed Emittances" tables were completed and commissioned approximately a year ago but were recently updated to include Recycler information. The "Intensities and efficiencies" tables were completed and commissioned recently.

# 2. The "Emittances" summary tables

## 2.1 Links and general structure

1) The WEB link for the "Recomputed Emittances" summary tables is: http://www-bd.fnal.gov/SDA_Viewer/shot_emittances_catalog.jsp . These tables can be found in the "Summary Information/Tables" section of the SDA home page ( http://www-bd.fnal.gov/sda/ ), under *Emittances*.

2) At the link listed above one can find the summary tables on a store by store basis starting from store 2658 (June 6, 2003). One has also the option to "Build" or "Rebuild" the tables for any store at will by typing the store number inside the box at the top of the http://www-bd.fnal.gov/SDA_Viewer/shot_emittances_catalog.jsp link.

3) For each store there are nine links available as described in the WEB page; the three most used ones are "W " (Whole), "WS" (Whole Structure) and "I" (Incomplete). For example, for store 4097 we have:
http://www-bd.fnal.gov/javaapplications/html_write/ShotSummary/4097.html and
http://www-bd.fnal.gov/javaapplications/html_write/ShotSummary/4097_struct.html and
http://www-bd.fnal.gov/javaapplications/html_write/ShotSummary/incompleted_4097.html .
The first link points to the content of the table, eg. emittance values (see Fig. 1), the second link points to the code used for the calculation of those numbers, and the third to the content of the table in the beginning of HEP. This last version of the table is the one sent by default to the "Shot Scrapbook".

## 2.2 Content and format of the summary tables

1) The data source of the "Recomputed Emittances" summary tables are classes MIEmittVarious and TeVEmittVarious of the osdaphysics package which can be found in:
http://www-bd.fnal.gov/cgi-acc/cvsweb.cgi/gov/fnal/controls/applications/osdaphysics/ . For the Accumulator core emittances we do not use any recomputation. We get the values directly from the

devices A:EMT3VN (vertical) and A:EMT3HN (horizontal). For the Recycler extracted emittances we do not use any recomputation either. We get the values directly from the devices R:EMVANM (vertical) and R:EMHANM (horizontal).

2) The tables are organized in having six columns and sixteen rows of data. The first three columns contain the vertical, horizontal and longitudinal emittances for protons and the last three the corrsesponding emittances for pbars. The rows represent the stages during the acceleration stage and correspond to emittances for a) Accumulator core, b) Recycler extracted, c) Main Injector at 8 GeV, d) Main Injector at 150 GeV, after coalescing, e) Proton Injection, f) Pbar Injection porch, g) Pbar Injection h) Before Ramp, i) Flattop, j) Squeeze, k) Initiate Collisions, l) Remove Halo, m) Begin of HEP, n) End of HEP, o) Effective emittance and p) Initial luminosity.

On the header we report the store number, the date of the store as well as the initial pbar stack and stash sizes. For the *Remove Halo* and *End of HEP* cases we report emittances based on both Flying Wire measurements as well as Sync Lite measurements. For the *Effective Emittance* we report again two values; one based on measured proton and pbar emittances from Flying Wires and the other based on the average of the measured CDF and D0 luminosities. In the 16$^{th}$ row we report separately the Initial luminosities of CDF and D0.

# 3. The "Intensities and Efficiencies" summary tables

## 3.1 Links and general structure

1) The WEB link for the "Intensities and Efficiencies" summary tables is: http://www-bd.fnal.gov/SDA_Viewer/shot_intensities_catalog.jsp . These tables can be found in the "Summary Information/Tables" section of the SDA home page ( http://www-bd.fnal.gov/sda/ ), under *Intensities and Efficiencies*.

2) At the link listed above, one can find the summary tables on a store by store basis starting from store 3554 (June 2, 2004). One has also the option to "Build" or "Rebuild" the tables for any store at will by typing the store number inside the box at the top of the http://www-bd.fnal.gov/SDA_Viewer/shot_intensities_catalog.jsp link.

3) For each store there are two links available: "W " (Whole) and "WS" (Whole Structure). For example for store 4148 we have: http://www-bd.fnal.gov/javaapplications/html_write/RecomputedIntensities/intensity_4148.html and http://www-bd.fnal.gov/javaapplications/html_write/RecomputedIntensities/intensity_4148_struct.html. The first link points to the content of the table, eg. intensity and efficiency values (see Fig. 2 and 3), while the second link points to the code used for the calculation of those numbers.

## 3.2 Content and format of the summary tables

1) The data source of the "Intensities and Efficiencies" summary tables is basically device values sampled at the appropriate time and stored in the SDA database. In addition, there is some recomputation involved when we try to assign fractions of the pbar intensities coming from the

Accumulator vs the Recycler and when we compute the efficiencies.

2) The tables have two parts: the FBI-based table and the SBD-based table. The FBI-based table is the default, and there the intensities are based on the FBI devices. In the SBD-based table, the Tevatron intensities are based on the SBD devices (the SBD devices are not ready yet for use for the Main Injector intensities). The tables are organized in having six columns and seventeen (ten) rows of data for the FBI (SBD) tables respectively. The first three columns contain the intensity, step efficiency and cumulative efficiency for protons and the last three the corresponding quantities for pbars. The rows represent the stages during the acceleration stage and correspond to intensities/efficiencies for a) Booster, b) Amount of pbars unstacked, c) Main Injector at 8 GeV, d) Main Injector at 150 GeV, e) Main Injector at 150 GeV, after coalescing, f) Proton Injection, g) Pbar Injection porch, h) Pbar Injection i) Before Ramp, j) Flattop, k) Squeeze, l) Initiate Collisions, m) Remove Halo, n) Begin of HEP, o) End of HEP, p) Initial luminosity and q) Shot setup time. For the SBD-based table the first data row corresponds to Proton Injection.

On the header of the table we report the store number, the date of the store as well as the initial pbar stack and stash sizes. In the 16$^{th}$ row of the FBI-based table we report separately the Initial luminosities of CDF and D0 and in the 17$^{th}$ row the Shot Setup time for the shot. For the cumulative efficiency columns, the normalization is being performed with respect to Booster intensity for the protons and with respect to amount of pbars unstacked/unstashed for the pbars. In the pbar columns, the numbers in blue (left) and green (right) indicate the intensities/efficiencies for the Accumulator and Recycler. We distinguish between pbars from Accumulator and Recycler by checking the value of V:NPBSRC (1 for Accumulator and 2 for Recycler). The number in bold in the center of the column indicates the total pbar efficiency. For the *Inject Protons* case we report intensities as the sum of all 36 bunches, the values taken right after injection from devices C:FBIPNG or T:SBDPIS right after Injection. For the *Inject Pbars* case, the intensity we report in the FBI-based table is the sum over all 9 transfers of the difference between C:FBIANG (after injection) and C:ANGSUM or C:FBIANG[0] (before injection). For the SBD-based table, and for store numbers greater or equal to 3954, the same intensity is the sum over all 9 transfers of the difference between T:SBDAIS (after injection) and T:SBASUM or T:SBDAIS[0] (before injection). Since device T:SBASUM was introduced only in store 3954, for stores that took place earlier the intensity is simply the sum over all 9 transfers of T:SBDAIS.

# 4. The Beam2(A/B) Intensity Tables for the Main Injector

## 4.1 Links and general structure

1) The WEB link for the "Beam2-based Intensities" tables is: http://www-bd.fnal.gov/SDA_Viewer/beam2_intensities_catalog.jsp . These tables can be found in the "Summary Information/Tables" section of the SDA home page ( http://www-bd.fnal.gov/sda/ ), under *Some more SDA and D44 based tables* and then under *"Beam2" Intensity Tables*.

2) At the link listed above, one can find the tables on a store by store basis starting from store 3674 (July 25, 2004). One has also the option to "Build" or "Rebuild" the tables for any store at will by typing the store number inside the box at the top of the

http://www-bd.fnal.gov/SDA_Viewer/beam2_intensities_catalog.jsp link.

3) For each store there are two links available: "W " (Whole) and "WS" (Whole Structure). For example for store 4148 we have:
http://www-bd.fnal.gov/javaapplications/html_write/Beam2Intensities/beam2_intensity_4148.html and
http://www-bd.fnal.gov/javaapplications/html_write/Beam2Intensities/beam2_intensity_4148_struct.html. The first link points to the content of the table, eg. intensity values (see Fig. 4), while the second link points to the code used for the calculation of those numbers.

## 4.2 Content and format of the tables

1) The data source of the "Beam2" Main Injector Intensity tables is basically device values sampled at the appropriate time and stored in the SDA database. In addition, there is some recomputation involved when we try to assign fractions of the pbar intensities coming from the Accumulator vs the Recycler.

2) The tables have two parts: the Proton table and the Pbar table. In the Proton table the intensities are based on the I:BEAM2B devices while in the Pbar table the intensities come from the I:BEAM2A devices. The Proton table is organized in having thirty eight columns and four rows of data. The first column corresponds to the sum of intensities of all thirty six proton transfers and the second column to the average intensity and the deviation (in parenthesis) of the thirty six transfers. The following thirty six columns correspond to the individual intensities of the thirty six proton transfers. The four rows correspond to: a) MI: Injection, 8 GeV (I:BEAM2B[0], b) MI: Start of Ramp, ~9 GeV (I:BEAM2B[1]), c) MI: Start of Flattop, 150 GeV (I:BEAM2B[2]) and d) MI: Extraction to TeV, 150 GeV (I:BEAM2B[5]). The Pbar table is organized in having fifteen columns and four rows of data. The first column corresponds to the sum of intensities of all nine proton transfers and the second column to the average intensity and the deviation (in parenthesis) of the nine transfers. The third column corresponds to the sum of intensities of the Accumulator transfers and the fourth column to the average intensity and the deviation (in parenthesis) of the Accumulator transfers. The fifth column corresponds to the sum of intensities of the Recycler transfers and the sixth column to the average intensity and the deviation (in parenthesis) of the Recycler transfers. The following nine columns correspond to the individual intensities of the nine pbar transfers. Accumulator columns are indicated in blue and Recycler columns in green. The four rows correspond to: a) MI: Injection, 8 GeV (I:BEAM2A[0], b) MI: Start of Ramp, ~9 GeV (I:BEAM2A[1]), c) MI: Start of Flattop, 150 GeV (I:BEAM2A[2]) and d) MI: Extraction to TeV, 150 GeV (I:BEAM2A[5]).

3) We have noticed that occasionally there are some negative intensity numbers for some of the pbar transfers, eg.:
(http://www-bd.fnal.gov/javaapplications/html_write/Beam2Intensities/beam2_intensity_4176.html). It turns out that this is related to the mixed 8 GeV energy operation. When the $2A ramp clock event is sent out, the I2 ramp profile generator sets event $22 to the start of ramp. In this case I2 sees the start of ramp at 1.2s which is the mini ramp from Recycler energy to Accumulator energy. The real start of ramp is at 4.5s. This timer has to be reset by hand every time the $2A ramp profile is sent from I2. These tables can be used as a diagnostic in that respect. When negative intensities appear in

the pbar transfers, the timer can be reset.

## 5. Sending the summary tables to the Shot Scrapbook

The “I” versions of the “Emittances” and “Intensities and Efficiencies” summary tables are being computed at case 14 (HEP). They are being stored on the WEB Server and sent automatically to the Shot Scrapbook, ( http://www-bd.fnal.gov/cgi-mach/machlog.pl?nb=scrap03&load=no ). The “W” versions of the summary tables are being computed at case 15 (Pause HEP) or at case 29 (Abort) and are stored on the WEB Server. In case there was an Abort before the case HEP was reached into a store, then the “W” versions of the summary tables are being stored on the WEB Server and also sent into the Shot Scrapbook. For the “Intensities and Efficiencies” table the “W” version overwrites the “I” version on the WEB Server. The area where the tables are actually stored is: "http://www-ad.fnal.gov/javaapplications/html_write/" on the WEB or "/export/users/html_write" for DAE cluster machines where all the servlets and DAE and JSPs are run or "\\daesrv\java_users\html_write" for Windows Users who have permission to map these directories. In reality the Users do not have to check these areas since all these tables are referenced from the http://www-bd.fnal.gov/SDA_Viewer/ *catalog.jsp's mentioned in the previous sections.

## 6. Summary

As a summary we should mention that in the SDA home page we store summary tables which contain concise information of emittances, intensities and efficiencies for protons and pbars throughout the acceleration chain. Some of these tables get sent automatically in the Collider Shot Scrapbook.

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http://www-bd.fnal.gov/javaapplications/html_write/ShotSummary/4

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# Recomputed Emittances Table

Shot Summary 4097 04/13/2005 02:13:39 Initial Stack size: 143.1 E10 Initial Stash size: 26.09 E10

| Store # 4097 | Proton Vertical pi-mm-mr | Proton Horizontal pi-mm-mr | Proton Longitudinal eV-sec | Pbar Vertical pi-mm-mr | Pbar Horizontal pi-mm-mr | Pbar Longitudinal eV-sec |
|---|---|---|---|---|---|---|
| Accumulator | . | . | . | 2.0 | 5.6 | 2.1 |
| Recycler | . | . | . | 2.1 | 2.0 | 15.7 |
| MI 8 GeV | 12.7 | 13.5 | . | 5.2 | 5.4 | 1.3 |
| MI 150 GeV | 11.9 | 13.0 | . | 5.5 | 6.2 | 2.6 |
| Proton Injection | 16.5 | 14.0 | 3.4 | . | . | . |
| Pbar Injection Porch | 16.6 | 14.5 | 3.4 | . | . | . |
| Pbar Injection | 17.5 | 15.7 | 3.3 | 8.3 | 10.0 | 3.5 |
| Before Ramp | 17.8 | 17.9 | 3.3 | 8.6 | 9.8 | 3.5 |
| Flattop | 19.3 | 26.7 | 3.7 | 9.0 | 15.7 | 3.8 |
| Squeeze | 14.7 | 21.6 | 3.8 | 8.1 | 14.0 | 3.8 |
| Initiate Collisions | 14.2 | 21.2 | 3.8 | 7.7 | 14.7 | 3.8 |
| Remove Halo - FW [Sync lite] | 14.3 [ 17.5 ] | 22.0 [ 16.2 ] | 3.8 | 8.6 [ 46.8 ] | 15.5 [ 40.0 ] | 3.8 |
| Begin of HEP - Sync lite | 17.5 | 16.1 | . | 38.0 | 67.0 | . |
| End of HEP - FW [Sync lite] | 27.1 [ 31.3 ] | 39.0 [ 27.7 ] | 7.2 | 25.3 [ 26.0 ] | 30.0 [ 38.2 ] | 5.5 |
| Eff. Emittance from Luminosities (from emittancies) | 12.8 ( 14.7 ) | 12.8 ( 14.7 ) | . | . | . | . |
| Initial Lumosity | 81.71 | E30, CDF | 74.9 | E30, DZero | . | . |

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**Fig. 1:** Emittance summary table for store 4097.

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http://www-bd.fnal.gov/javaapplications/html_write/RecomputedIntensities/intensity_4148.html

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Shot Summary 4148 05/16/2005 21:14:42 Initial Stack size: 154.63 E10 Initial Stash size: 56.04 E10

## FBI-based table (Main)

| Tevatron Shot Stage | Proton Intensity [E9] | Step Efficiency [%] | Cumulative Efficiency [%] | Pbar Intensity [E9] All Acc Rec | Step Efficiency [%] All Acc Rec | Cumulative Efficiency [%] All Acc Rec |
|---|---|---|---|---|---|---|
| Booster | 12418 | . | . | . | . | . |
| Amount unstacked | . | . | . | **1908** 1390 518 | . | . |
| MI 8GeV | 12268 | 98.8 | 98.8 | **1957** 1440 517 | **102.6** 103.6 99.9 | **102.6** 103.6 99.9 |
| MI 150 GeV | 11565 | 94.3 | 93.1 | **1896** 1383 513 | **96.9** 96.1 99.2 | **99.4** 99.5 99.1 |
| MI Coalescing | 9837 | 85.1 | 79.2 | **1642** 1213 429 | **86.6** 87.7 83.6 | **86.0** 87.3 82.8 |
| Inject Protons | 9937 | 101.0 | 80.0 | . | . | . |
| Pbar Injection porch | 9811 | 98.7 | 79.0 | . | . | . |
| Inject Pbars | 9610 | 98.0 | 77.4 | **1565** 1153 412 | **95.4** 95.0 96.2 | **82.0** 82.9 79.7 |
| Before Ramp | 9593 | 99.8 | 77.3 | **1536** 1122 414 | **98.1** 97.3 100.4 | **80.5** 80.7 80.0 |
| Flattop | 9188 | 95.8 | 74.0 | **1464** 1058 405 | **95.3** 94.3 97.9 | **76.7** 76.1 78.3 |
| Squeeze | 9050 | 98.5 | 72.9 | **1411** 1011 400 | **96.4** 95.5 98.7 | **74.0** 72.7 77.3 |
| Initiate Collisions | 9037 | 99.9 | 72.8 | **1405** 1005 400 | **99.5** 99.4 99.9 | **73.6** 72.3 77.3 |
| Remove Halo | 8769 | 97.0 | 70.6 | **1378** 983 395 | **98.1** 97.9 98.8 | **72.2** 70.7 76.3 |
| Begin HEP | 8764 | 99.9 | 70.6 | **1377** 982 395 | **99.9** 99.8 100.0 | **72.2** 70.6 76.3 |
| [illegible] | [illegible] | [illegible] | [illegible] | **636** | **46.2** | **33.3** |

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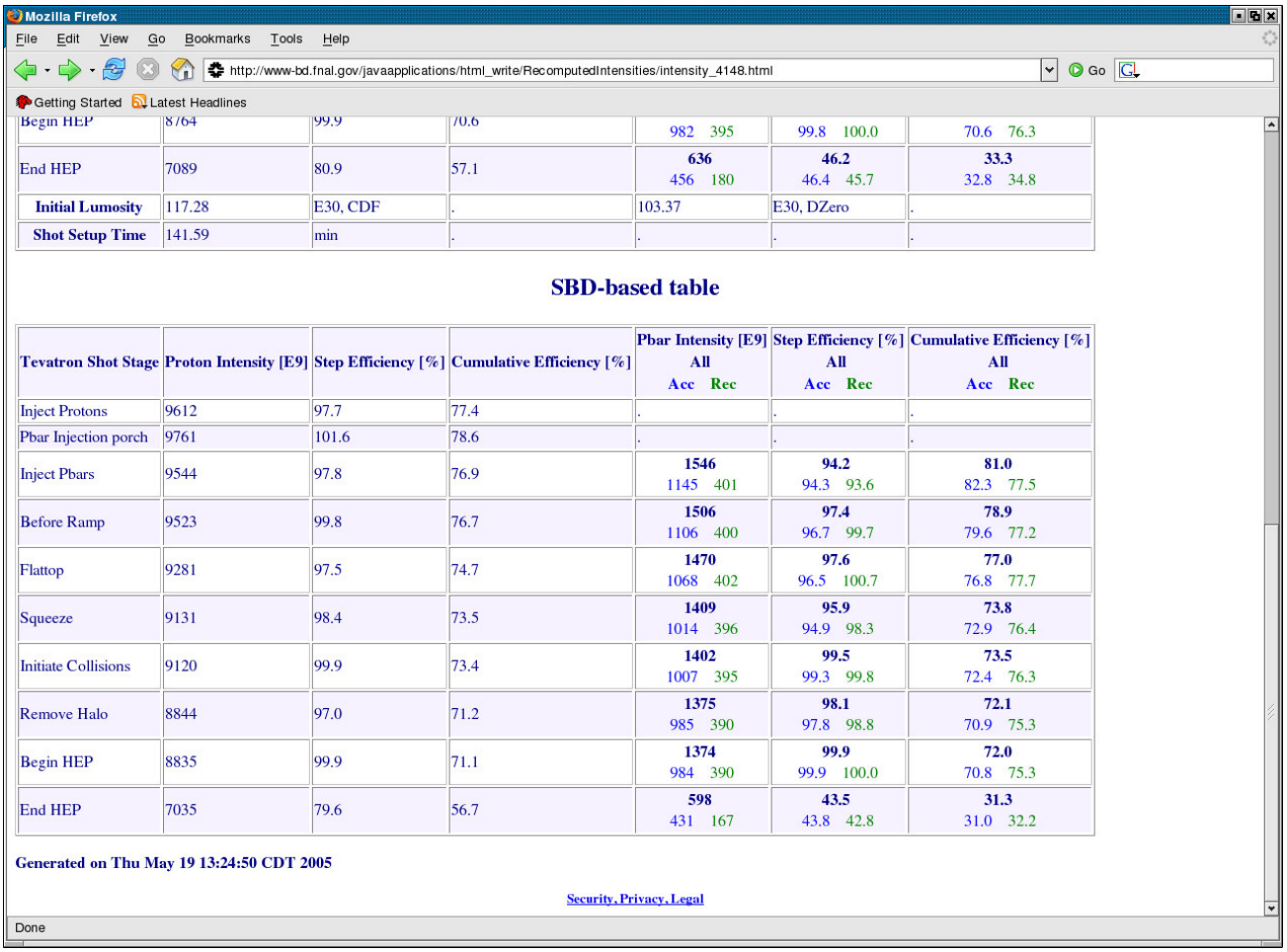
**Fig. 2:** Intensity/Efficiency summary table (Part 1) for store 4148. Here all intensities are based on the FBI devices.



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http://www-bd.fnal.gov/javaapplications/html_write/RecomputedIntensities/intensity_4148.html

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| | | | | | | |
|---|---|---|---|---|---|---|
| Begin HEP | 8764 | 99.9 | 70.6 | 982 395 | 99.8 100.0 | 70.6 76.3 |
| End HEP | 7089 | 80.9 | 57.1 | **636**<br>456 180 | **46.2**<br>46.4 45.7 | **33.3**<br>32.8 34.8 |
| **Initial Lumosity** | 117.28 | E30, CDF | . | 103.37 | E30, DZero | . |
| **Shot Setup Time** | 141.59 | min | . | . | . | . |

**SBD-based table**

| Tevatron Shot Stage | Proton Intensity [E9] | Step Efficiency [%] | Cumulative Efficiency [%] | Pbar Intensity [E9] All Acc Rec | Step Efficiency [%] All Acc Rec | Cumulative Efficiency [%] All Acc Rec |
|---|---|---|---|---|---|---|
| Inject Protons | 9612 | 97.7 | 77.4 | . | . | . |
| Pbar Injection porch | 9761 | 101.6 | 78.6 | . | . | . |
| Inject Pbars | 9544 | 97.8 | 76.9 | **1546**<br>1145 401 | **94.2**<br>94.3 93.6 | **81.0**<br>82.3 77.5 |
| Before Ramp | 9523 | 99.8 | 76.7 | **1506**<br>1106 400 | **97.4**<br>96.7 99.7 | **78.9**<br>79.6 77.2 |
| Flattop | 9281 | 97.5 | 74.7 | **1470**<br>1068 402 | **97.6**<br>96.5 100.7 | **77.0**<br>76.8 77.7 |
| Squeeze | 9131 | 98.4 | 73.5 | **1409**<br>1014 396 | **95.9**<br>94.9 98.3 | **73.8**<br>72.9 76.4 |
| Initiate Collisions | 9120 | 99.9 | 73.4 | **1402**<br>1007 395 | **99.5**<br>99.3 99.8 | **73.5**<br>72.4 76.3 |
| Remove Halo | 8844 | 97.0 | 71.2 | **1375**<br>985 390 | **98.1**<br>97.8 98.8 | **72.1**<br>70.9 75.3 |
| Begin HEP | 8835 | 99.9 | 71.1 | **1374**<br>984 390 | **99.9**<br>99.9 100.0 | **72.0**<br>70.8 75.3 |
| End HEP | 7035 | 79.6 | 56.7 | **598**<br>431 167 | **43.5**<br>43.8 42.8 | **31.3**<br>31.0 32.2 |

**Generated on Thu May 19 13:24:50 CDT 2005**

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**Fig. 3:** Intensity/Efficiency summary table (Part 2) for store 4148. Here all intensities are based on the SBD devices.

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http://www-bd.fnal.gov/javaapplications/html_write/Beam2Intensities/beam2_intensity_4148.html

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**Proton Table**

| Device at the end of transfer | Sum for all transfers | Average (Dev.) | Transfer #1 | Transfer #2 | Transfer #3 | Transfer #4 | Transfer #5 | Transfer #6 | Transfer #7 | Transfer #8 | Transfer #9 | Transfer #10 | Transfer #11 | Transfer #12 | Transfer #13 | Transfer #14 | Transfer #15 | Tr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I:BEAM2B[0] MI:Injection, 8 GeV | 12211.954 | 339.221 ( 5.040 ) | 339.704 | 335.137 | 340.710 | 334.511 | 335.699 | 335.600 | 343.230 | 338.139 | 344.954 | 345.753 | 339.858 | 337.068 | 341.107 | 339.478 | 334.449 | 34 |
| I:BEAM2B[1] MI:Start of Ramp, ~9GeV | 12215.248 | 339.312 ( 5.126 ) | 339.562 | 335.187 | 338.684 | 334.386 | 338.382 | 338.096 | 343.479 | 337.910 | 342.349 | 345.670 | 339.954 | 336.643 | 341.210 | 341.450 | 334.959 | 34 |
| I:BEAM2B[2] MI:Start of Flattop, 150 GeV | 12167.609 | 337.989 ( 5.627 ) | 339.399 | 336.974 | 336.439 | 335.277 | 335.587 | 330.699 | 346.765 | 335.480 | 347.051 | 342.678 | 338.012 | 333.644 | 337.213 | 336.925 | 330.977 | 34 |
| I:BEAM2B[5] MI:Extraction to Tev, 150 GeV | 12139.239 | 337.201 ( 5.655 ) | 339.657 | 335.048 | 336.784 | 335.553 | 329.745 | 332.278 | 340.832 | 334.553 | 340.224 | 338.163 | 338.464 | 333.495 | 335.535 | 337.485 | 331.228 | 34 |

**Pbar Table**

| Device at the end of transfer | Sum for all transfers | Average (Dev.) | Sum for Acc transfers | Average (Dev.) | Sum for Rec transfers | Average (Dev.) | Transfer #1 from Acc. | Transfer #2 from Acc. | Transfer #3 from Rec. | Transfer #4 from Rec. | Transfer #5 from Acc. | Transfer #6 from Acc. | Transfer #7 from Rec. | Transfer #8 from Acc. | Transfer #9 from Acc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I:BEAM2A[0] MI:Injection, 8 GeV | 1134.063 | 126.007 ( 71.020 ) | 633.514 | 105.586 ( 78.584 ) | 500.549 | 166.850 ( 16.686 ) | -3.807 | -3.807 | 179.986 | 177.259 | 177.259 | 177.259 | 143.304 | 143.304 | 143.304 |
| I:BEAM2A[1] MI:Start of Ramp, ~9GeV | 530.606 | 58.956 ( 83.491 ) | .225 | .038 ( 3.511 ) | 530.380 | 176.793 ( 7.703 ) | 1.892 | -6.287 | 180.934 | 183.450 | 4.487 | 2.650 | 165.997 | -1.776 | -.741 |
| I:BEAM2A[2] MI:Start of Flattop, | 1949.656 | 216.628 ( 68.953 | 1423.389 | 237.231 ( 76.241 | 526.267 | 175.422 ( 9.549 ) | 290.311 | 344.918 | 179.081 | 184.851 | 271.601 | 221.692 | 162.335 | 185.591 | 109.276 |

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**Fig. 4:** Main Injector Intensity summary table for store 4148 with information for individual proton and pbar transfers. The intensities here are based on the I:BEAM2B and I:BEAM2A devices.