Vernier Analysis Update

Run 12

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UC Riverside

Outline

Analysis Overview

Analysis Overview

Data Extraction	Correlation and Calculation	Systematic Corrections	Cleaning Data
PRDF ➢ GL1P Scalers ➢ Bunch Numbers ➢ Scaler Events ➢ Trigger Scalers ➢ Time Stamp ➢ ATP Number **WCM/DCCT** ➢ Individual bunch populations, blue and yellow beams ➢ Total beam ion population (bunched + not bunched) ➢ Time stamp **BPM** ➢ Beam position (x,y) for blue and yellow beams at sector 7 and 8	**PRDF** ➢ Calculate scaler rates ➢ Correct scaler rates for live-time fluctuation (use clock-scaler if available, scaler-events if not) ➢ Calculate systematic, statistical errors associated with constant-beam-position scaler rates ➢ Correlate beam displacement & rates, fit distribution for beam width **WCM/DCCT** ➢ Calculate corrected beam populations using WCM/DCCT **BPM** ➢ Use BPM data to identify absolute time for constant-beam-position-steps	**Simulation** ➢ Hourglass effect / Crossing Angle **PRDF** ➢ Use time synchronization to correct for rate losses due to ion loss in real time ➢ BBC Efficiency (trigger acceptance + vertex correction) **WCM/DCCT** ➢ Rate correction (overall correction done, but correlation is better) **BPM** ➢ Use average RMS of fluctuation of beam position about each step average to assign systematic ➢ Additional systematics from magnet current ➢ Discussion with Angelika – is BPM data even viable, or should we use programmed step values? (Try both, compare results)	**PRDF** ➢ Synchronize network time stamps from ATPs ➢ Separate data into bunches, and bunch integrate ➢ Sum scalers down to single time stamps **WCM/DCCT** ➢ Data is ready to use, ensure synchronization to PRDF time stamp **BPM** ➢ Data is ready to use, ensure synchronization to time stamps

Remaining Work

- **Simulations**
  - Find bug related to other half-scans
  - Extract final values for $\beta^*, \theta_{xing}, N_{MC}$
- **Beam Width**
  - Use N_{MC} to correct rates, re-fit beam width
- **Put pieces together to calculate σ_{BBC} and $\mathcal{L}_{RHIC}$**
- **Finish analysis note**

Timeline, Schedule, Book-Keeping

- **Hard Deadlines**
  - Thesis Defense: July 18
  - Moving: July 25
  - New Job: August 1
  - Time left: 8 weeks to first draft thesis, 12 weeks to graduation.
- **Schedule**
  - Thesis writing - 80% time
  - Finalizing vernier analysis - 20% time
  - Goal: weekly PWG updates.
  - Stretch Goal: Finish thesis early, concentrate rest of time on analysis
  - 20% of thesis complete
- **Work Estimates**
  - Finalizing simulations: within 1-2 weeks
  - Finalizing beam width w/corrections: within 2-4 weeks
  - Finalizing analysis note: in parallel w/thesis

From Last Time

From Last Time

- Discussed, solved issue with normalization
- Showed latest simulations with corrected normalization
- Link to last talk: Last Talk or direct URL: https://www.phenix.bnl.gov/cdsagenda/askArchive.php?base=agenda&categ=a1613&id=a1613s1t71/moreinfo

From Last Time

Homework: Investigate remaining issues with other half-scans
Progress:

Simulation Progress

Discussion

Conclusion

Conclusion

Backup

From Last Time

- Explored various parametеterizations of the beam z-profile
- Fits show same results as data driven method, but they are wrong
- Simple gaussian model produces different results when used in Amaresh's framework vs my framework
- Machinery in place for rootfinding, minimization of differences between simulation and data.

From Last Time

Homework:

I was tasked to figure out why the simple gaussian model looks wrong - there should be a symmetric ZDC z-profile gaussian, centered at z = 0, if model is implimented correctly.

Progress:

I found the problem in the code - the difference between my method, and Amaresh's method was how we handled normalization. As we know, gaussians have normalization dependant on the width of the distriubtion, but this width gains additional z-dependance when considering the β^* squeeze effect. I implimented this, and now distributions match very closely.

New: Last time, I mentioned that multiple-collisions do not effect the resultant distributions. I was wrong - so this parameter has been added back into the simulation.

Parameter Space

- Since I have not done the multiple collisions correction myself, I use the Run 15 numbers, and create a graph of scan-step vs multiple collisions rate, from which I interpolate the rate. To account for luminosity shifts, I allow the parameter to vary by a factor of 50%.
- Care should be taken, as Run 15 had a higher average luminosity by a factor of 2, with respect to Run 12.
- Because distributions are generated randomly, there is some fluctuation in the final spectra. Therefore, we not halt the simualtion after 10 iterations, Which corresponds to the binary search step reaching a size of less than 1% of the value of the original seed parameter.

Discussion

Simulations are in good agreement with data for available scanning steps, with the following caveats:

- **Caveat:** The vernier scan can be broken down into four half-scans - portions where the beam starts maximally displaced, and ends maxmially overlapped (or the reverse).
- **Caveat:** We therefore can configure the simulation to handle one half-scan, but then require that we transpose this code properly to each other half scan.
- **Caveat:** Currently, we have simulated the first half of the horizontal scan.
- **Caveat:** Other scans were simulated also, but the results should not be trusted, because further adjustments are needed.
- **Caveat:** Therefore, the first half scan, horizontal scans for Run 359711 have been simulated, along with the other three,

Run 359711, Scan Step 0

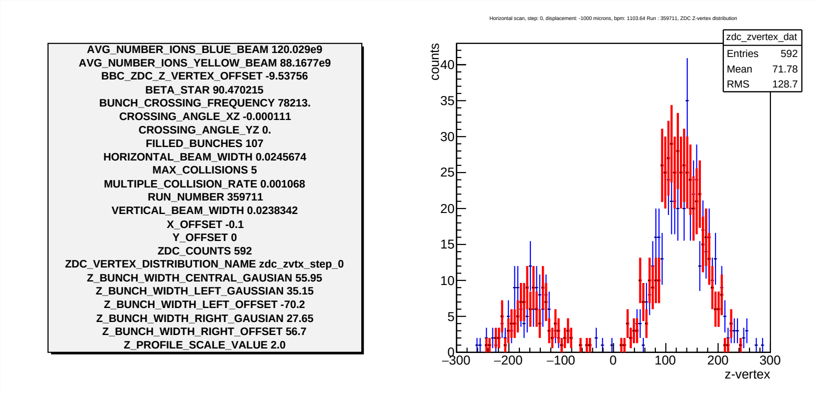

Figure 1: Excellent matching between simulation and data, watch θ_{XZ} - it does not change much.

Run 359711, Scan Step 1

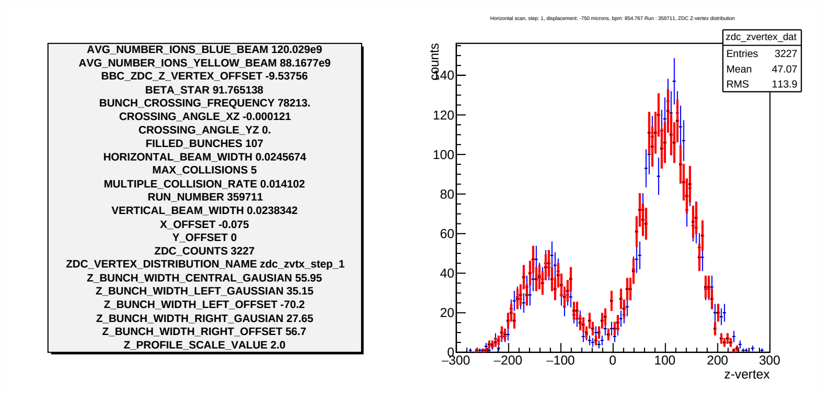

Figure 2: Excellent matching between simulation and data, watch θ_{XZ} - it does not change much.

Run 359711, Scan Step 2

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 85.987794
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ -0.000136
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.013646
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET -0.06
Y_OFFSET 0
ZDC_COUNTS 7641
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_2
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

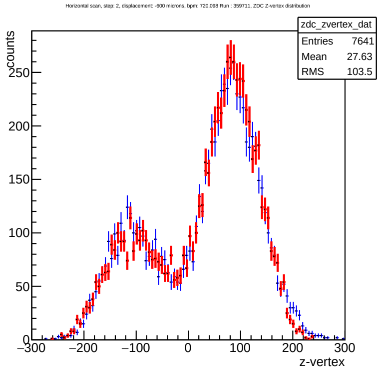

Figure 3: Excellent matching between simulation and data, watch θ_{XZ} - it does not change much.

Run 359711, Scan Step 3

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 92.263185
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ -0.000115
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.096849
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET -0.045
Y_OFFSET 0
ZDC_COUNTS 21998
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_3
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

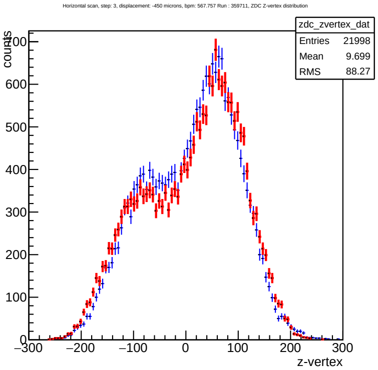

Figure 4: Excellent matching between simulation and data, watch θ_{XZ} - it does not change much.

Run 359711, Scan Step 4

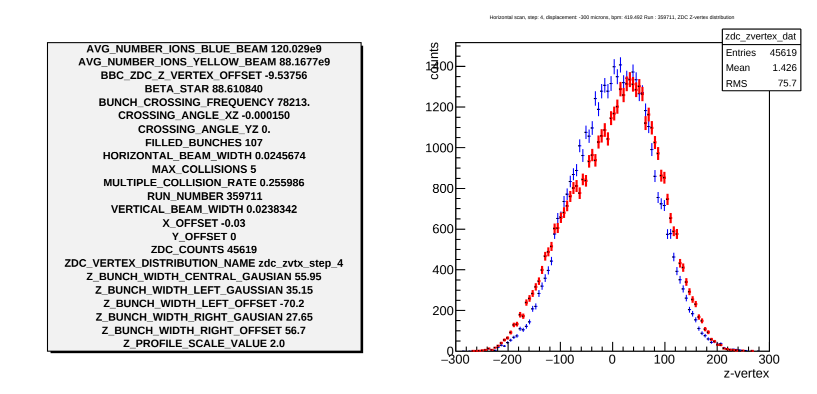

Figure 5: Less stable of the "good" distributions. Due to the obvious differences between simlation and data. Note that with the different shape, the β^* and θ_{XZ} do not match the other distributions as well.

Run 359711, Scan Step 5

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 92.296388
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ -0.000277
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.249448
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET -0.015
Y_OFFSET 0
ZDC_COUNTS 66813
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_5
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

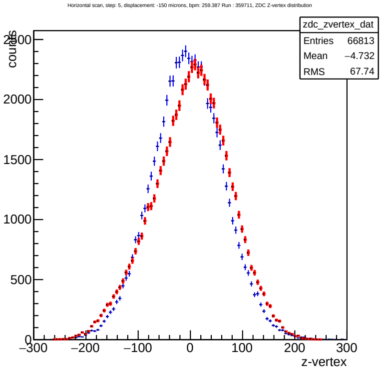

Figure 6: Less stable of the "good" distributions. Due to the obvious differences between simlation and data. Note that with the different shape, the β^* and θ_{XZ} do not match the other distributions as well.

Run 359711, Scan Step 6

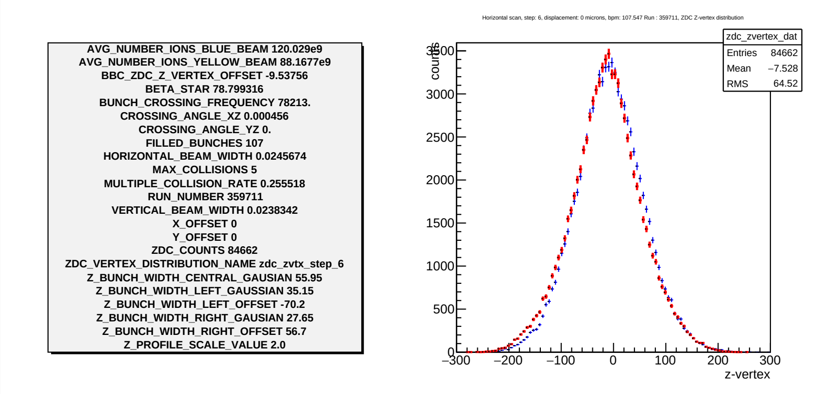

Figure 7: Note that we see the crossing angle change sign here.

Summary Data

Step	β^*	θ_{XZ}	θ_{YZ}	N_{MC}
0	90.470215	-0.000111	0.	0.001068
1	91.765138	-0.000121	0.	0.014102
2	85.987794	-0.000136	0.	0.013646
3	92.263185	-0.000115	0.	0.096849
4	88.610840	-0.000150	0.	0.255986
5	92.296388	-0.000277	0.	0.249448
6	78.799316	0.000456	0.	0.255518
7	87.830567	0.000330	0.	0.517198
8	93.226075	0.000085	0.	0.320010
9	90.536622	0.000046	0.	0.109506
10	93.192871	0.000051	0.	0.018549
11	92.063965	0.000065	0.	0.012652
12	79.496583	0.000070	0.	0.000809
13	83.563965	-0.08e-3	-0.000078	0.000953
14	80.077638	-0.08e-3	-0.000078	0.007320
15	83.563965	-0.08e-3	-0.000078	0.033369
16	92.080567	-0.08e-3	-0.000078	0.136202
17	92.130371	-0.08e-3	-0.000078	0.114620
18	92.196777	-0.08e-3	-0.000078	0.437010
19	88.395019	0.000437	0.	0.621702
20	85.390138	0.000002	0.	0.223648
21	92.761231	0.000002	0.	0.207431
22	88.693848	0.000002	0.	0.101992
23	92.379395	0.000002	0.	0.028989
24	79.015138	0.000002	0.	0.016319
25	83.613769	0.000002	0.	0.000809

- **Ready:**
    - **Horizontal Scan Part 1:** Steps 0 through 6 are working properly
- **Needs More Work:**
    - **Horizontal Scan Part 2:** Steps 6 - 12
    - **Vertical Scan Part 1:** Steps 13 - 19
    - **Vertical Scan Part 2:** Steps 20 - 25
- Probably a small bug in the code resulting from imporper translation between scans.

Run 359711, Scan Step 7

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 87.830567
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ 0.000330
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.517198
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0.015
Y_OFFSET 0
ZDC_COUNTS 84924
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_7
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

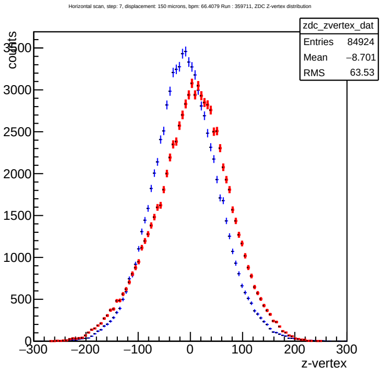

Figure 8:

Run 359711, Scan Step 8

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 93.226075
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ 0.000085
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.320010
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0.03
Y_OFFSET 0
ZDC_COUNTS 76225
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_8
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

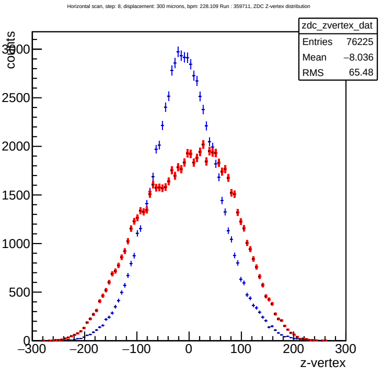

Figure 9:

Run 359711, Scan Step 9

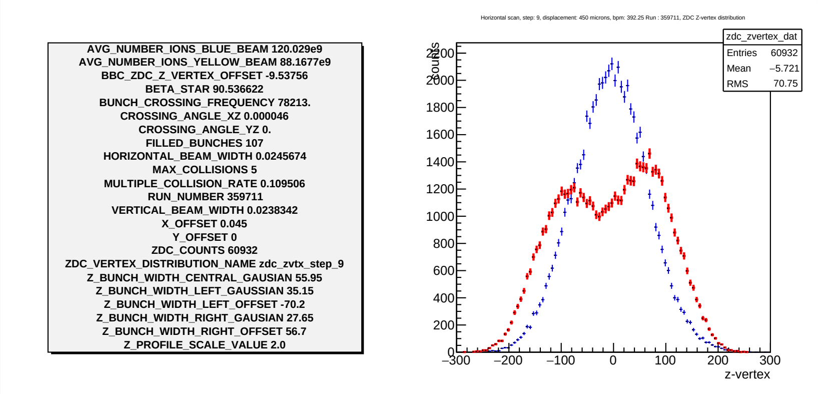

Figure 10:

Run 359711, Scan Step 10

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 93.192871
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ 0.000051
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.018549
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0.06
Y_OFFSET 0
ZDC_COUNTS 38126
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_10
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

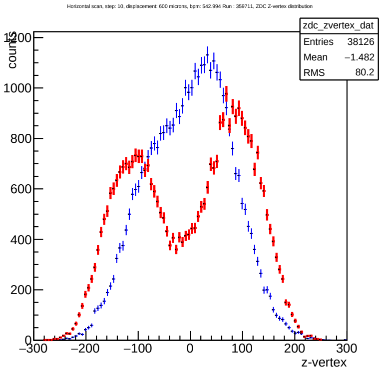

Figure 11:

Run 359711, Scan Step 11

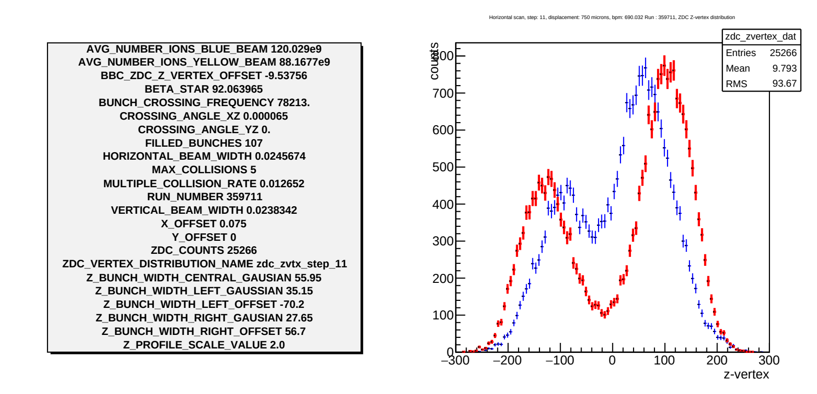

Figure 12:

Run 359711, Scan Step 12

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 79.496583
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ 0.000070
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.000809
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0.1
Y_OFFSET 0
ZDC_COUNTS 2786
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_12
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

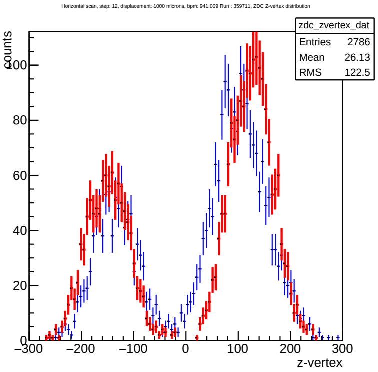

Figure 13:

Run 359711, Scan Step 13

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 83.563965
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ -0.08e-3
CROSSING_ANGLE_YZ -0.000078
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.000953
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0
Y_OFFSET -0.1
ZDC_COUNTS 891
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_13
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

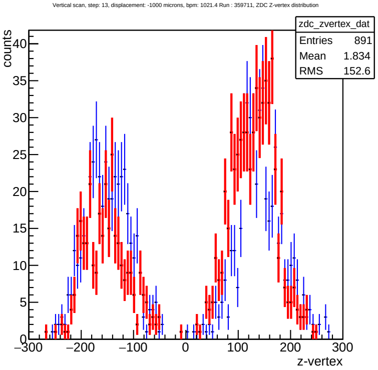

Figure 14:

Run 359711, Scan Step 14

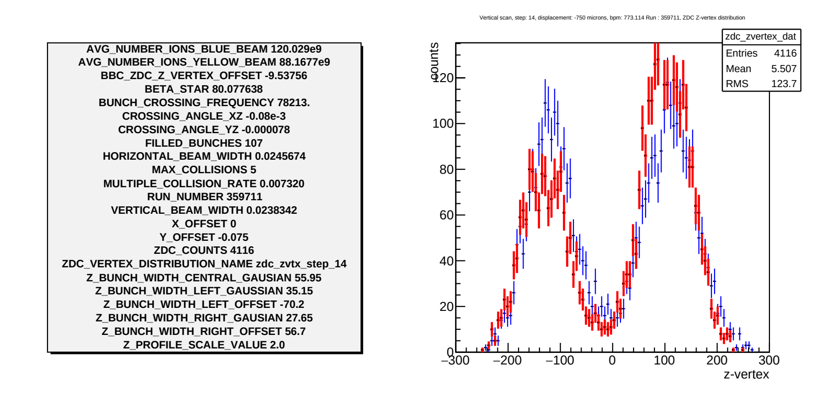

Figure 15:

Run 359711, Scan Step 15

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 83.563965
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ -0.08e-3
CROSSING_ANGLE_YZ -0.000078
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.033369
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0
Y_OFFSET -0.06
ZDC_COUNTS 11658
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_15
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

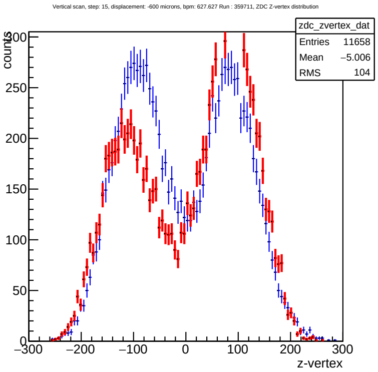

Figure 16:

Run 359711, Scan Step 16

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 92.080567
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ -0.08e-3
CROSSING_ANGLE_YZ -0.000078
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.136202
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0
Y_OFFSET -0.045
ZDC_COUNTS 28561
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_16
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

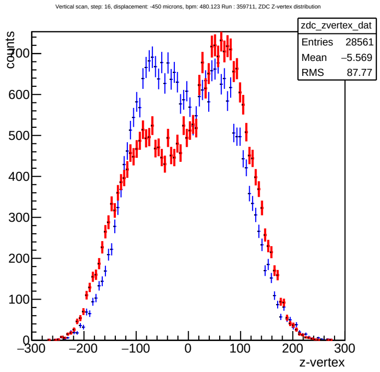

Figure 17:

Run 359711, Scan Step 17

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 92.130371
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ -0.08e-3
CROSSING_ANGLE_YZ -0.000078
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.114620
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0
Y_OFFSET -0.03
ZDC_COUNTS 52700
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_17
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

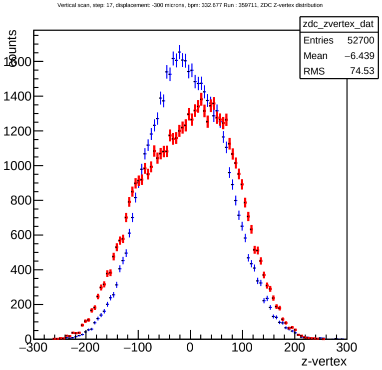

Figure 18:

Run 359711, Scan Step 18

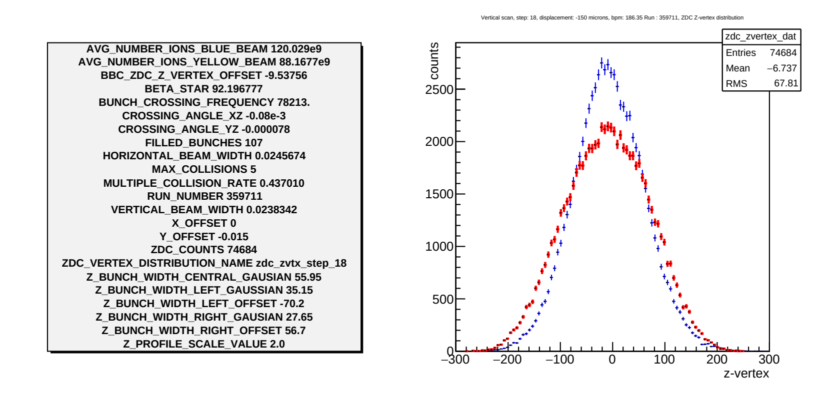

Figure 19:

Run 359711, Scan Step 19

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 88.395019
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ 0.000437
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.621702
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0
Y_OFFSET 0
ZDC_COUNTS 82560
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_19
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

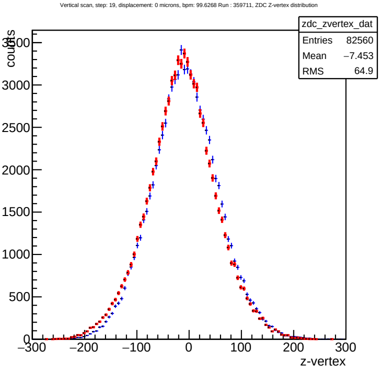

Figure 20:

Run 359711, Scan Step 20

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 85.390138
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ 0.000002
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.223648
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0
Y_OFFSET 0.015
ZDC_COUNTS 77749
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_20
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

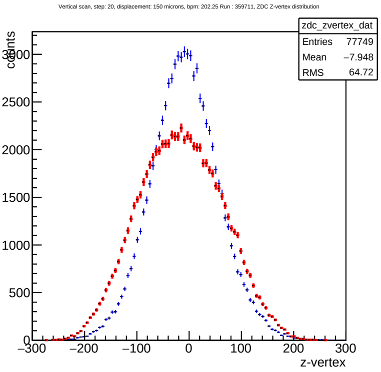

Figure 21:

Run 359711, Scan Step 21

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 92.761231
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ 0.000002
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.207431
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0
Y_OFFSET 0.03
ZDC_COUNTS 69294
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_21
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

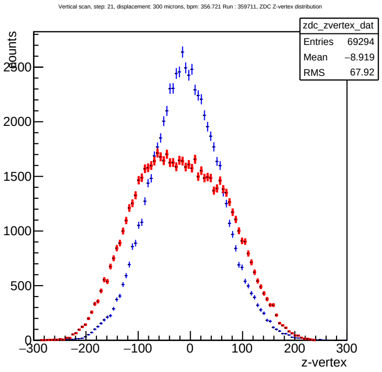

Figure 22:

Run 359711, Scan Step 22

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 88.693848
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ 0.000002
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.101992
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0
Y_OFFSET 0.045
ZDC_COUNTS 46910
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_22
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

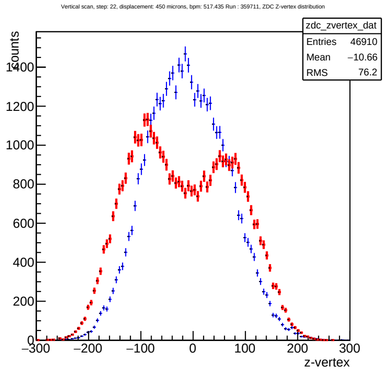

Figure 23:

Run 359711, Scan Step 23

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 92.379395
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ 0.000002
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.028989
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0
Y_OFFSET 0.06
ZDC_COUNTS 24398
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_23
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

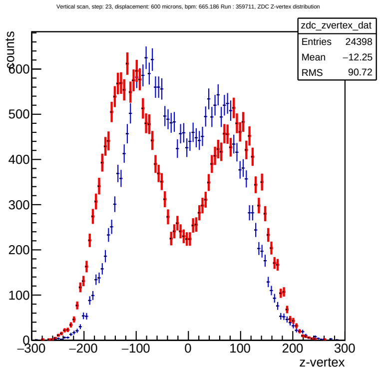

Figure 24:

Run 359711, Scan Step 24

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 79.015138
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ 0.000002
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.016319
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0
Y_OFFSET 0.075
ZDC_COUNTS 15156
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_24
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

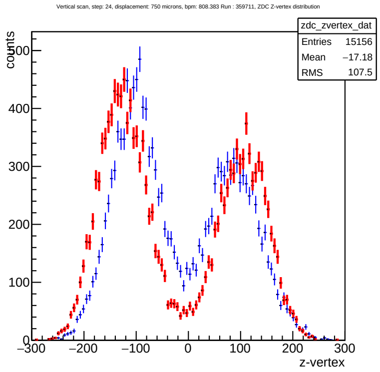

Figure 25:

Run 359711, Scan Step 25

AVG_NUMBER_IONS_BLUE_BEAM 120.029e9
AVG_NUMBER_IONS_YELLOW_BEAM 88.1677e9
BBC_ZDC_Z_VERTEX_OFFSET -9.53756
BETA_STAR 83.613769
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ 0.000002
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.0245674
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.000809
RUN_NUMBER 359711
VERTICAL_BEAM_WIDTH 0.0238342
X_OFFSET 0
Y_OFFSET 0.1
ZDC_COUNTS 838
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_25
Z_BUNCH_WIDTH_CENTRAL_GAUSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0

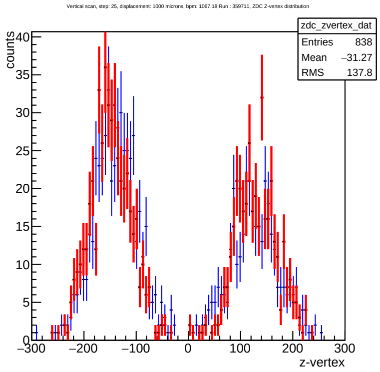

Figure 26: