

Vernier Analysis Update

Run 12

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July 5, 2016

UC Riverside

From Last Time

Progress

Results From Tuning - Horizontal Scan

Results From Tuning - Vertical Scan

Conclusion

From Last Time

From Last Time

- Discussed potential issues with beam-offset not being well simulated. Use BPM or use planned steps? (Using BPM data)
- Statistical Noise may be responsible for poor convergence
- Links to all previous recent talks:
https://github.com/Jollyhrothgar/analysis_presentations

Action Items

- Increased simulated events by factor of 1000
- Applied smoothing to simulated z-vertex profile (6 iterations)
- Investigating independent MC correction, to increase simulation precision for β^* and θ_{xing} .

Progress

Root Finding And Simulation Convergence

- **Requirements:**

- Well-behaved search domain
- Clear global minimum in convergence test

- **Realizations:**

- With χ^2 test and residual test, there are many local minima, not one strong global minima
- Beam displacement measurement has unaccounted for uncertainty
- BBC Rate differences caused by beam displacement, not luminosity loss, which was shown to be on order of 1% previously.
- Allow beam displacement to vary within uncertainty, obtain better results.

BBC Rate, Run 360879

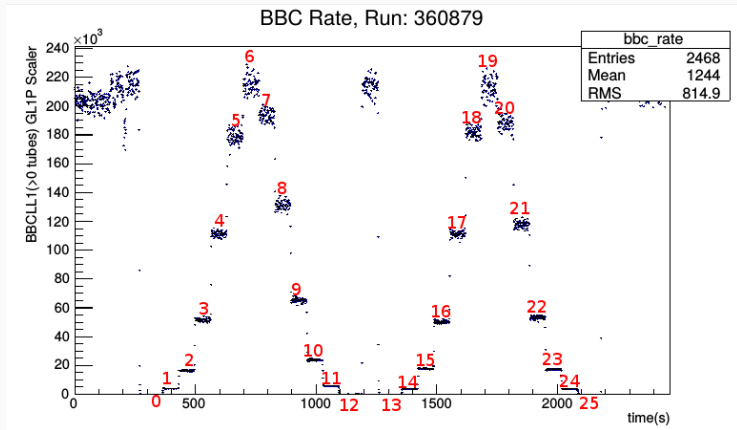
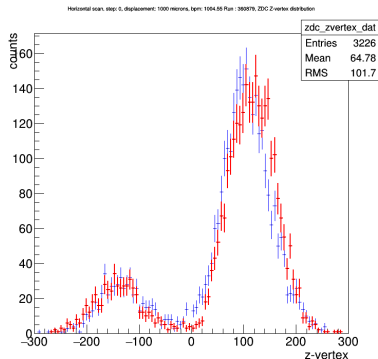


Figure 1: Rates hint that beam displacement is not consistent. See difference between step 5 and 7. Small deviations in displacement have a large effect on the observed z-vertex profile.

Results From Tuning - Horizontal Scan

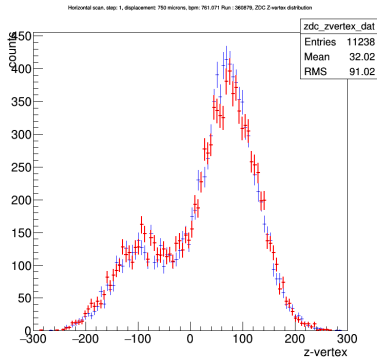
Step 0

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 83.198731
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.000163
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.000613
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET -0.100455
  Y_OFFSET 0
ZDC_COUNTS 3226
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_0
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



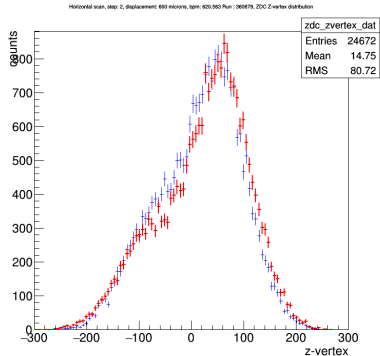
Step 1

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 85.688965
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.000150
  CROSSING_ANGLE_YZ 0.
    FILLED_BUNCHES 107
  HORIZONTAL_BEAM_WIDTH 0.027369
    MAX_COLLISIONS 5
  MULTIPLE_COLLISION_RATE 0.012142
    RUN_NUMBER 360879
  VERTICAL_BEAM_WIDTH 0.0265107
    X_OFFSET -0.06
    Y_OFFSET 0
    ZDC_COUNTS 11238
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_1
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



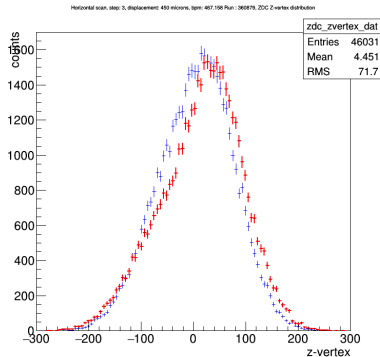
Step 2

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 85
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.000195
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.028605
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET -0.045
  Y_OFFSET 0
  ZDC_COUNTS 24672
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_2
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



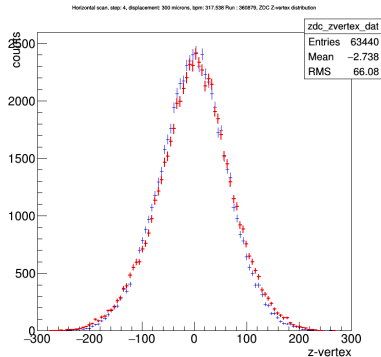
Step 3

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 85
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.00024
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.103220
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET -0.032
  Y_OFFSET 0
  ZDC_COUNTS 46031
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_3
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



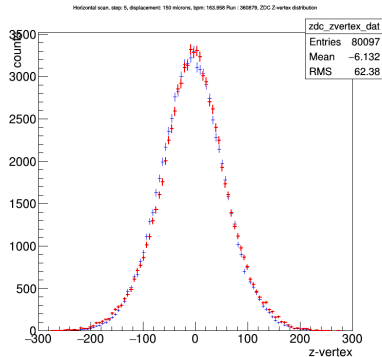
Step 4

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 85
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.0004
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.193673
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET -0.01
  Y_OFFSET 0
  ZDC_COUNTS 63440
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_4
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



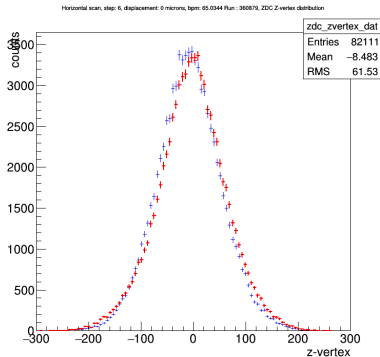
Step 5

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 89
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.0005
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.414231
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET -0.005
  Y_OFFSET 0
  ZDC_COUNTS 80097
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_5
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



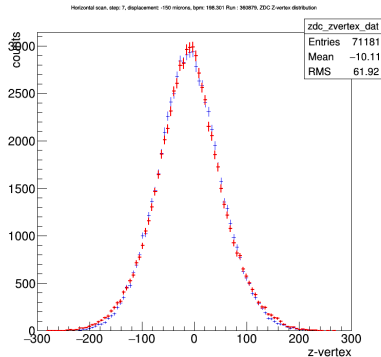
Step 6

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 82.169434
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.000505
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.545801
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0.006503
  Y_OFFSET 0
  ZDC_COUNTS 82111
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_6
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



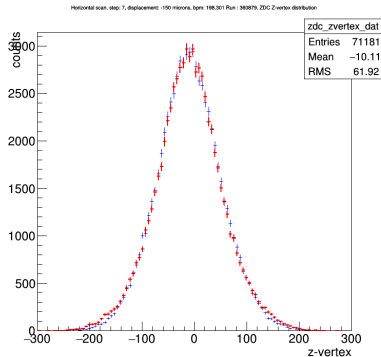
Step 7

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 85
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.0005
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.201315
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0.00
  Y_OFFSET 0
  ZDC_COUNTS 71181
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_7
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



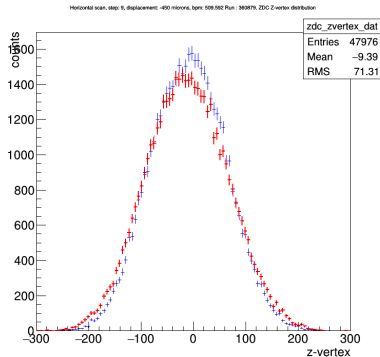
Step 8

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 85
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.0005
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.201315
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0.00
  Y_OFFSET 0
  ZDC_COUNTS 71181
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_7
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



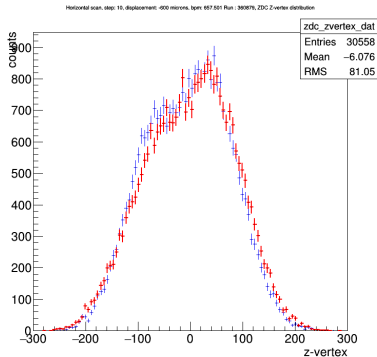
Step 9

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 89
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.00009
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.092678
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0.01
  Y_OFFSET 0
  ZDC_COUNTS 47976
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_9
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



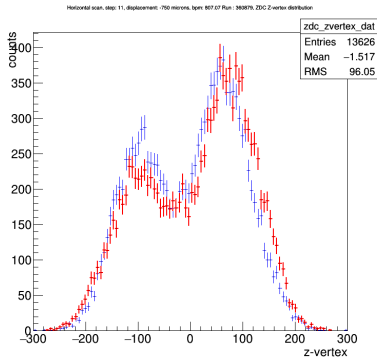
Step 10

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 85
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.00007
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.019254
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0.033
  Y_OFFSET 0
  ZDC_COUNTS 30558
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_10
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



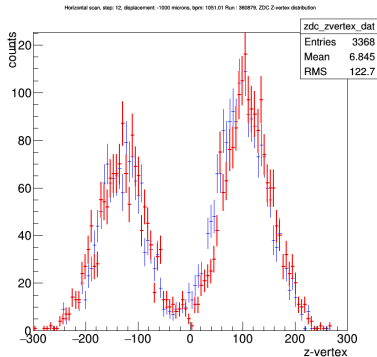
Step 11

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 87.830567
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.00007
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.012922
  RUN_NUMBER 360879
  VERTICAL_BEAM_WIDTH 0.0265107
    X_OFFSET 0.06
    Y_OFFSET 0
    ZDC_COUNTS 13626
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_11
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



Step 12

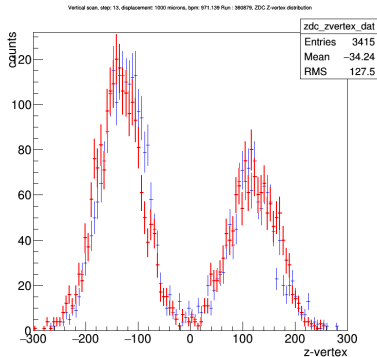
```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 77.819825
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.000036
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.000681
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0.09
  Y_OFFSET 0
  ZDC_COUNTS 3368
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_12
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



Results From Tuning - Vertical Scan

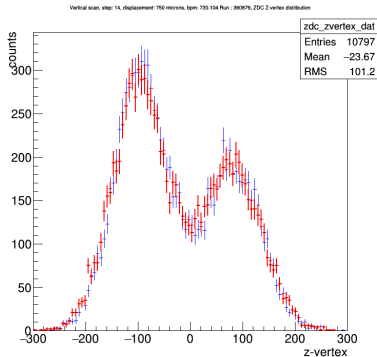
Step 13

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 76.657714
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.000046
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.001298
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET -0.097114
  ZDC_COUNTS 3415
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_13
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



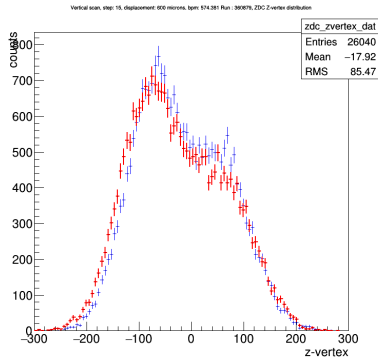
Step 14

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 84.576660
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.00005
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.016914
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET -0.06
  ZDC_COUNTS 10797
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_14
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



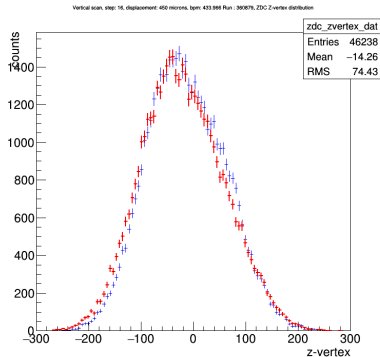
Step 15

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 87.448732
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.00009
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.036174
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET -0.044
  ZDC_COUNTS 26040
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_15
  Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
  Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
  Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
  Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
  Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
  Z_PROFILE_SCALE_VALUE 2.0
```



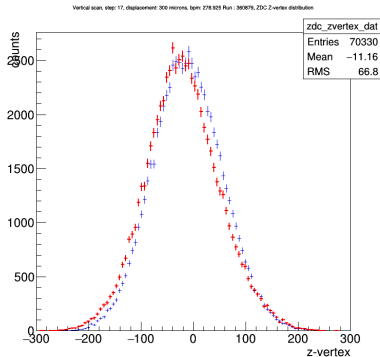
Step 16

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 91.184083
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.00015
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.070320
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET -0.02
  ZDC_COUNTS 46238
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_16
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



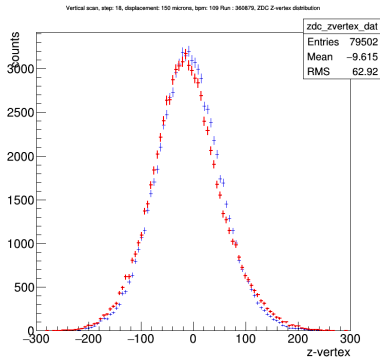
Step 17

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 89.
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.00035
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.334313
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET -0.01
  ZDC_COUNTS 70330
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_17
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



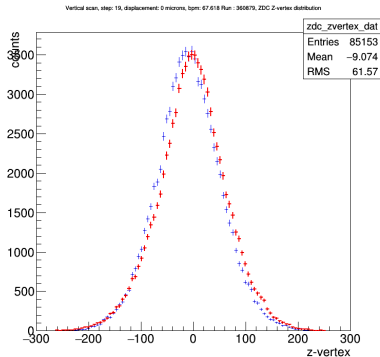
Step 18

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET 0.
BETA_STAR 86.319824
BUNCH_CROSSING_FREQUENCY 78213.
CROSSING_ANGLE_XZ -0.00045
CROSSING_ANGLE_YZ 0.
FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.419094
RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
_X_OFFSET 0
_Y_OFFSET -0.010900
ZDC_COUNTS 79502
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_18
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



Step 19

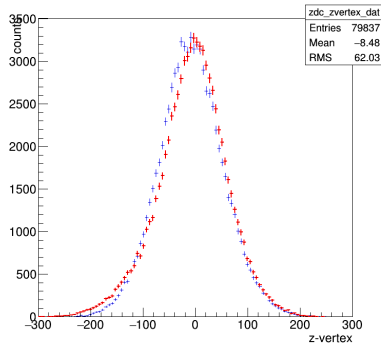
```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 88.046388
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.000475
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.261758
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET 0.006762
  ZDC_COUNTS 85153
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_19
  Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
  Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
  Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
  Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
  Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
  Z_PROFILE_SCALE_VALUE 2.0
```



Step 20

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -30.7391
  BETA_STAR 85
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ 0.00045
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.264361
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET 0.02
  ZDC_COUNTS 79837
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_20
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```

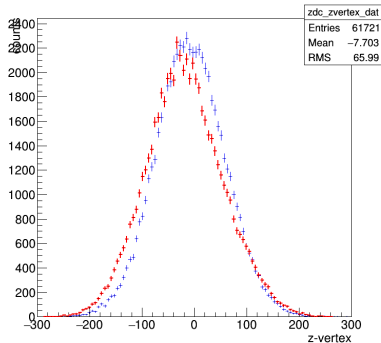
Vertical scan, step 20, displacement: -150 microns, tpcr 223.068 Run : 360879, ZDC Z-vertex distribution



Step 21

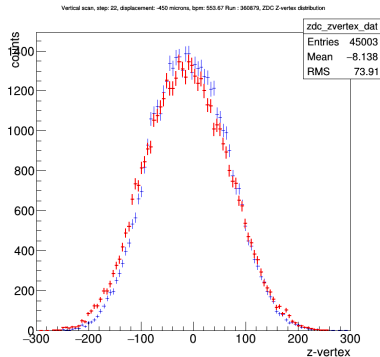
```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 80
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.0003
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.179534
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET 0.01
  ZDC_COUNTS 61721
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_21
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```

Vertical scan, step: 21, displacement: -300 microns, bpm: 355.68 Run: 360879, ZDC Z-vertex distribution



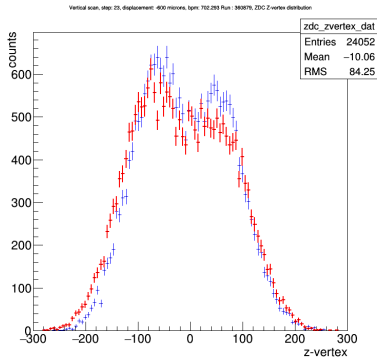
Step 22

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 85
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.00005
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.042497
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET 0.015
  ZDC_COUNTS 45003
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_22
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



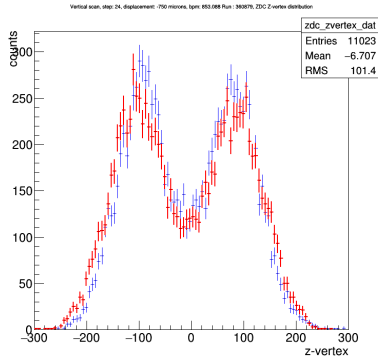
Step 23

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 95.
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.00003
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.011786
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET 0.044
  ZDC_COUNTS 24052
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_23
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



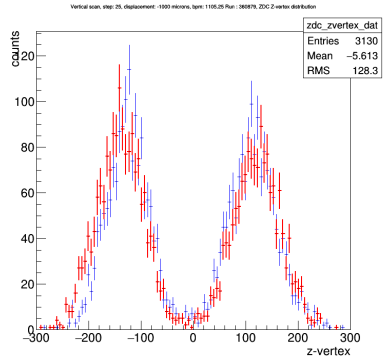
Step 24

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 85.622558
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.00001
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.006142
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET 0.063
  ZDC_COUNTS 11023
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_24
  Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
  Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
  Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
  Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
  Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
  Z_PROFILE_SCALE_VALUE 2.0
```



Step 25

```
AVG_NUMBER_IONS_BLUE_BEAM 119.837e9
AVG_NUMBER_IONS_YELLOW_BEAM 119.243e9
BBC_ZDC_Z_VERTEX_OFFSET -10.7391
  BETA_STAR 78.185058
BUNCH_CROSSING_FREQUENCY 78213.
  CROSSING_ANGLE_XZ -0.000008
  CROSSING_ANGLE_YZ 0.
  FILLED_BUNCHES 107
HORIZONTAL_BEAM_WIDTH 0.027369
  MAX_COLLISIONS 5
MULTIPLE_COLLISION_RATE 0.000639
  RUN_NUMBER 360879
VERTICAL_BEAM_WIDTH 0.0265107
  X_OFFSET 0
  Y_OFFSET 0.1
  ZDC_COUNTS 3130
ZDC_VERTEX_DISTRIBUTION_NAME zdc_zvtx_step_25
Z_BUNCH_WIDTH_CENTRAL_GAUSSIAN 55.95
Z_BUNCH_WIDTH_LEFT_GAUSSIAN 35.15
Z_BUNCH_WIDTH_LEFT_OFFSET -70.2
Z_BUNCH_WIDTH_RIGHT_GAUSSIAN 27.65
Z_BUNCH_WIDTH_RIGHT_OFFSET 56.7
Z_PROFILE_SCALE_VALUE 2.0
```



Conclusion

- With tuning, we find that β^* is within a reasonable range compared to the advertised value of 85, varying between 75 - 89.
- With tuning, we find that θ_{xing} varied within its acceptable range of ± 2 milli-radians, ranging generally from -0.4 milli-radians to 0.4 milli-radians.
- Next up: a 500 GeV run for comparison.