Crystal Collimation in the Recycler Ring *

A.I. Drozhdin
Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510

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1 Recycler Ring Lattice

The choices to install the crystal in the Recycler Ring would be between straight section MI52 and MI62. The prefered location currently would be MI62. The reason that MI52 looked good was because that is where there would be a Lambertson magnet to try to attempt to extract beam using VR. However, MI52 has many more elements there and it may be hard to get it installed. (from Dean Still)

Protvino crystal:
consists of 8 strips,
each strip length=2mm,
R=10m,
bend=-0.2mrad, (channeling at one strip)
RPmis= 0.00mrad,
strip thickness = 0.3mm
volume reflection - +0.0068*8=+0.054mrad
Impact at the crystal at first interaction is 8μm
Secondary collimators are at 5 sigma + 0.5mm
Simulation during 50 turns

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14	0.00000	0.33083E-01	0.0000E+00	MP610BN
2	0.00000	0.54000E-04	0.0000E+00	MP610BS
15	0.00000	-0.47400E-03	0.0000E+00	MP610BS
14	0.00000	-0.99249E-01	0.0000E+00	MP610BS
19	1.54940	0.22538E-01	0.1330E+01	G610B
15	0.00000	-0.43383E-04	0.0000E+00	G610B
19	1.54940	0.22538E-01	0.1330E+01	G610B
14	0.00000	0.33083E-01	0.0000E+00	MP610BN
2	0.00000	0.54000E-04	0.0000E+00	MP610BS
15	0.00000	-0.47400E-03	0.0000E+00	MP610BS
14	0.00000	-0.99249E-01	0.0000E+00	MP610BS

14	0.00000	-0.16414E+00	0.0000E+00	MP333BN
3	0.00000	0.14000E-03	0.0000E+00	MP333BS
15	0.00000	-0.14220E-02	0.0000E+00	MP333BS
14	0.00000	0.11833E+00	0.0000E+00	MP333BS
3	0.00000	0.50472E-03	0.0000E+00	MPS333BU
15	0.00000	0.38914E-01	0.0000E+00	MPS333BU
14	0.00000	0.21377E+00	0.0000E+00	MPS333BU
17	2.24790	0.10920E-01	0.1375E+01	G333B
15	0.00000	-0.11008E+00	0.0000E+00	G333B
17	2.24790	0.10920E-01	0.1375E+01	G333B
2	0.00000	0.13743E-04	0.0000E+00	MPS333BD
15	0.00000	0.11960E-02	0.0000E+00	MPS333BD
14	0.00000	0.13742E+00	0.0000E+00	MPS333BD
14	0.00000	-0.16414E+00	0.0000E+00	MP333BN
3	0.00000	0.14000E-03	0.0000E+00	MP333BS
15	0.00000	-0.14220E-02	0.0000E+00	MP333BS
14	0.00000	0.11833E+00	0.0000E+00	MP333BS

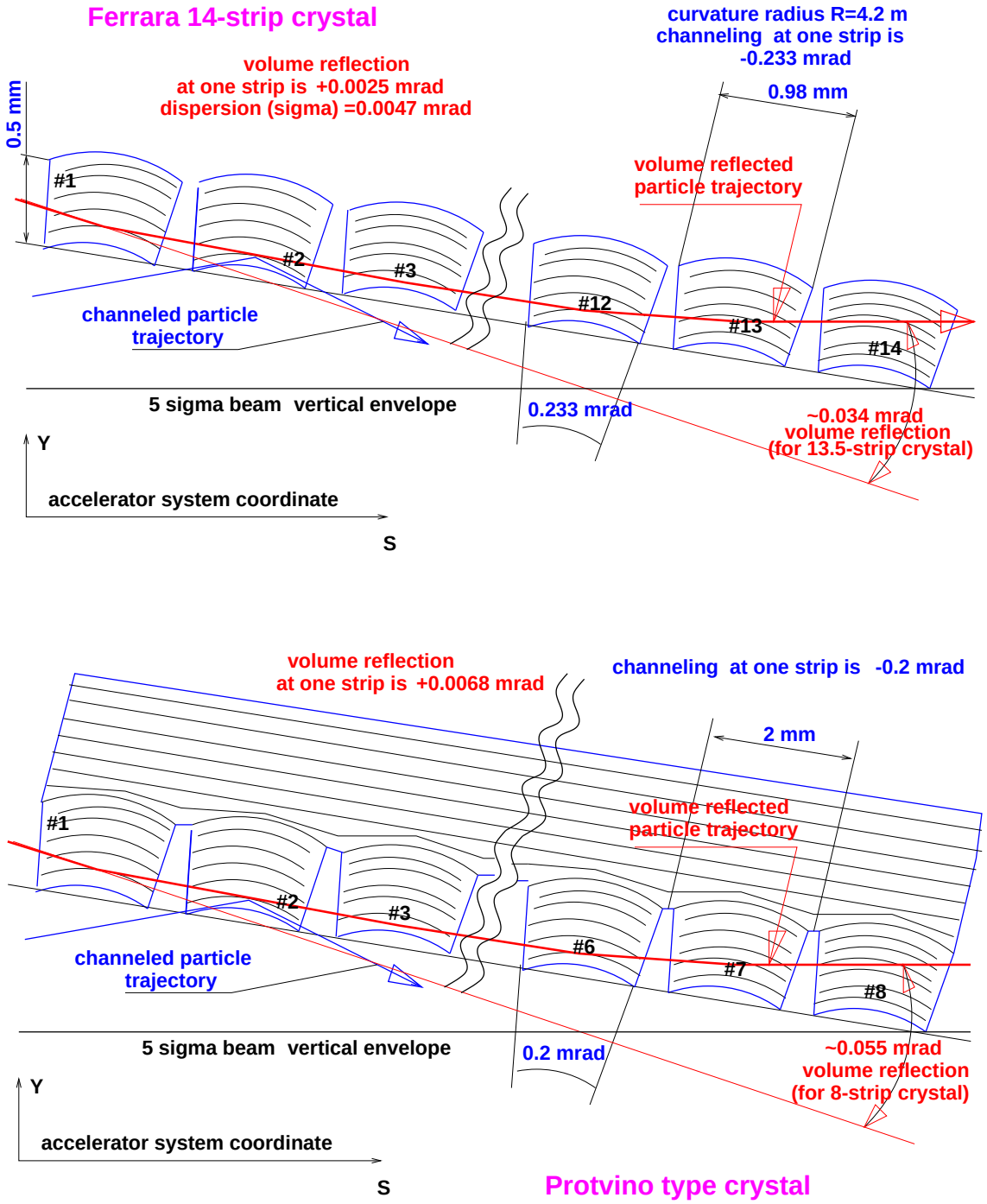

Figure 1: 14-strip Ferrara (top) and 8-strip Protvino (bottom) vertical crystal located in the Tevatron E0 section in 3.15 m upstream of E0 horizontal crystal. Each strip of crystal is bended down by +0.233 mrad in Ferrara crystal set, and down by 0.2 mrad in Protvino crystal set. There is no rotation of the next crystal with respect to the previous one in both crystal sets. Accumulation of volume reflection from all crystal strips happens automatically because of large bending angle of each individual strip. Channeling is possible only by one strip of the set, because the acceptance of channeling is much less compared to bending angle of one strip.

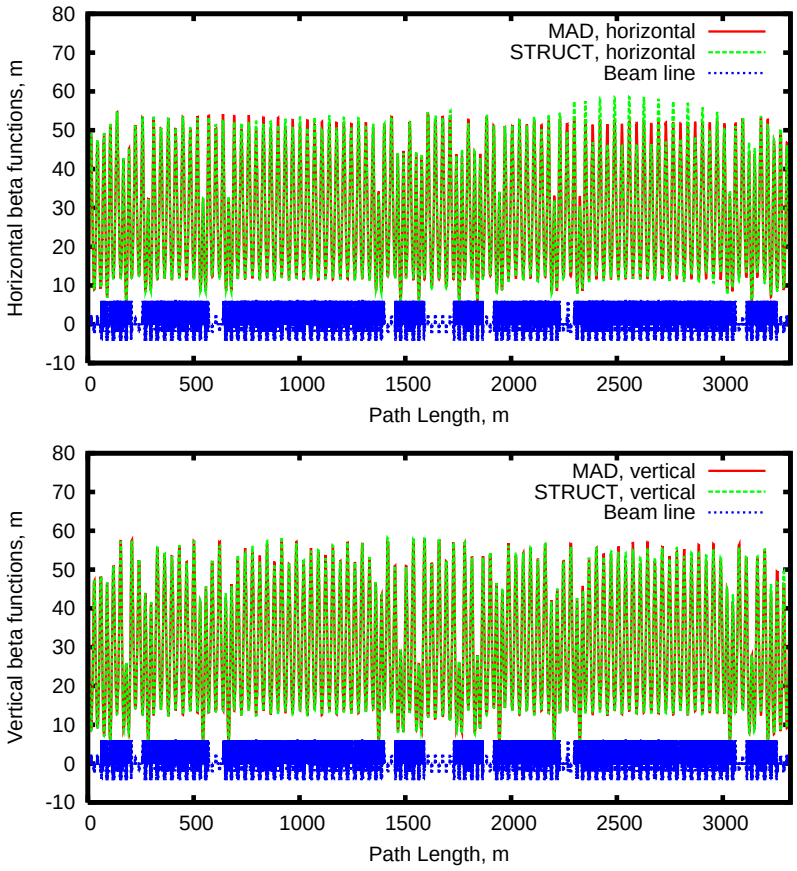

Figure 2: Horizontal (top) and vertical (bottom) beta-functions in the Recycler Ring.

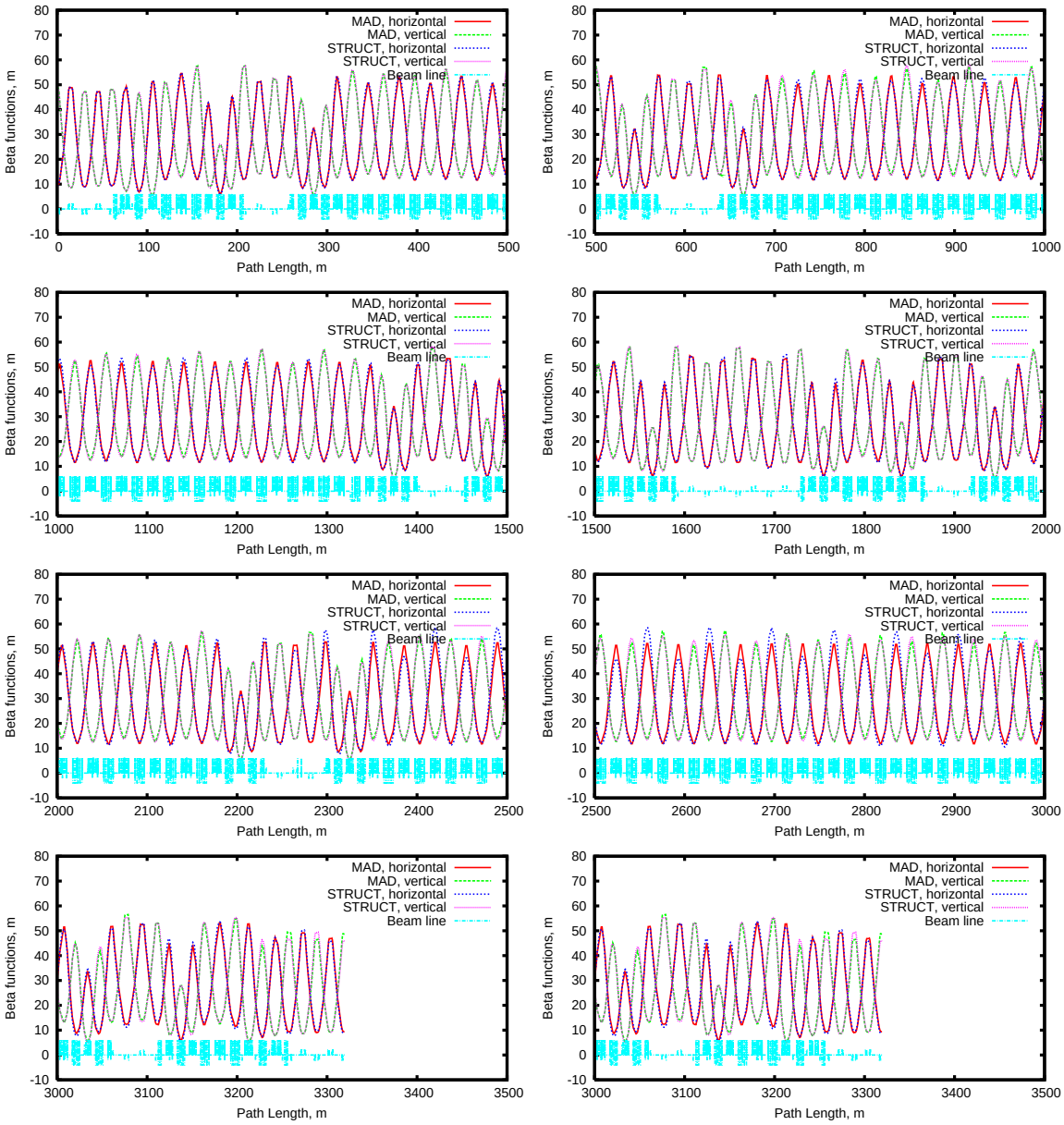

Figure 3: Beta-functions along the Recycler Ring.

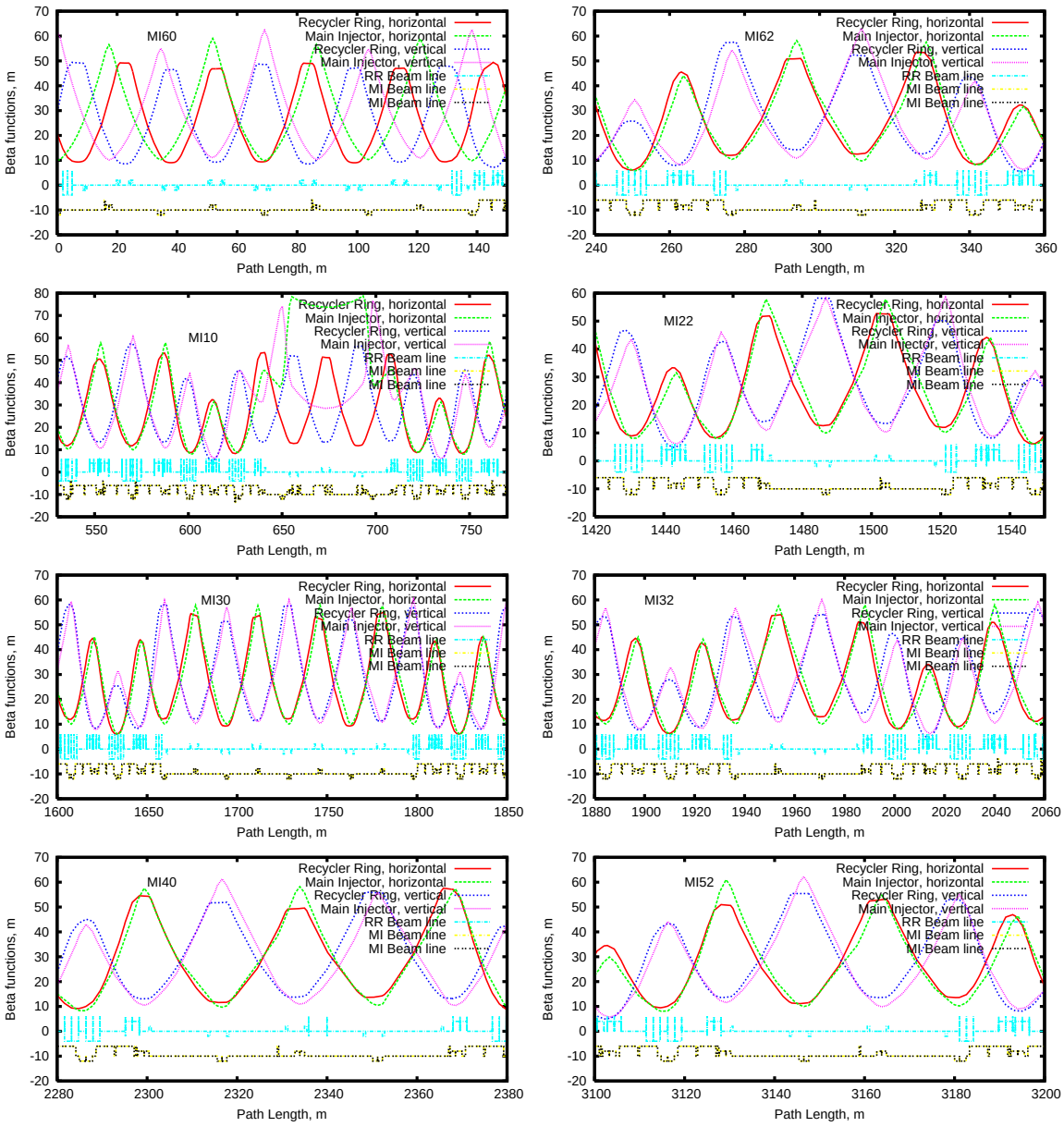

Figure 4: Comparison of beta-functions in the straight sections of the Main Injector and Recycler Ring.

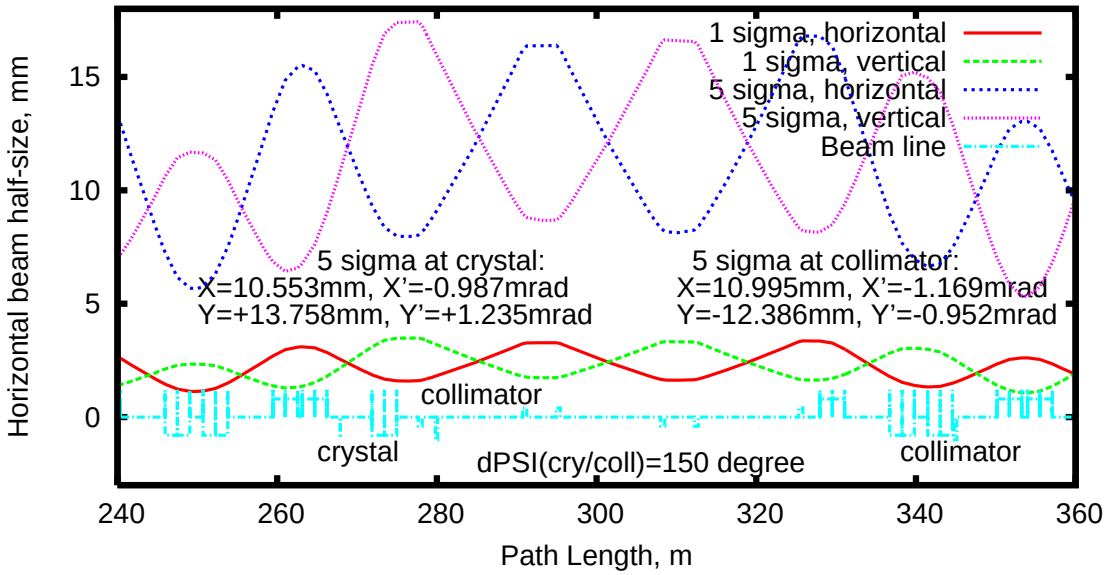

Figure 5: Beam size in the MI62 cristal and collimator of the Recycler Ring.

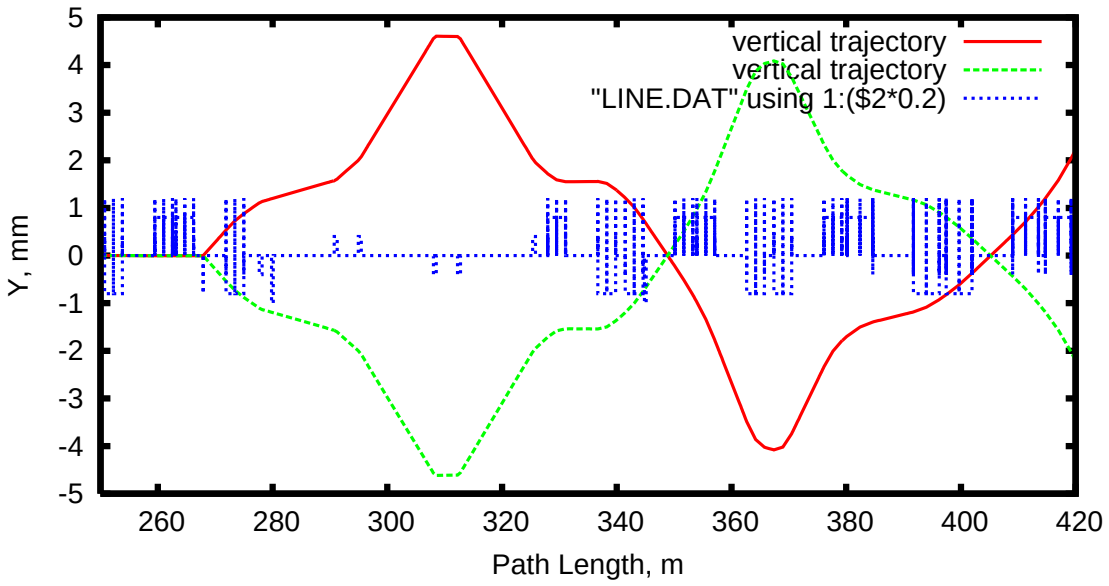

Figure 6: Vertical trajectory in the MI62 section from the kick at the crystal.

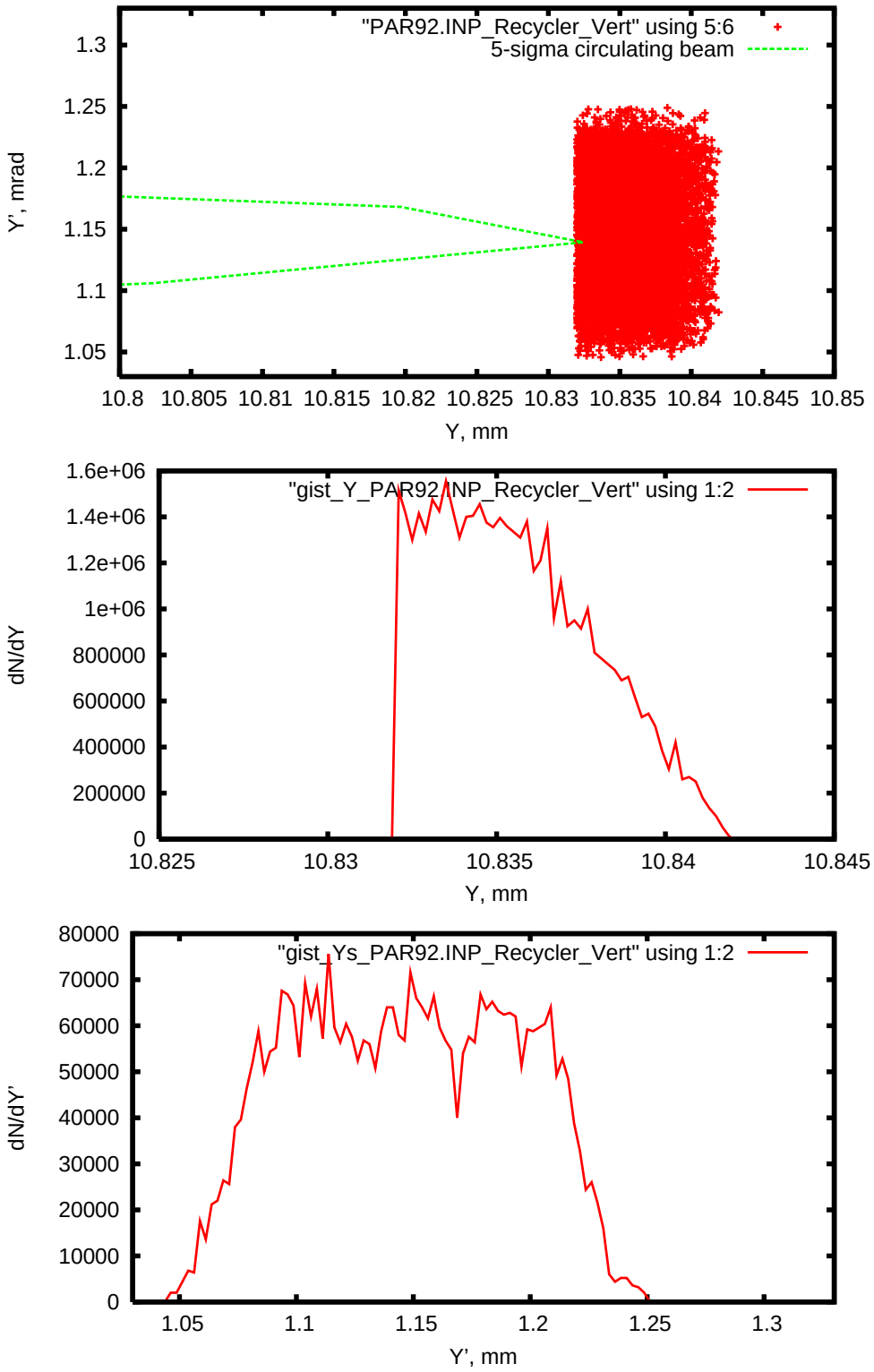

Figure 7: Initial particles population (top) and distributions (middle and bottom) in a phase plane at crystal entrance.

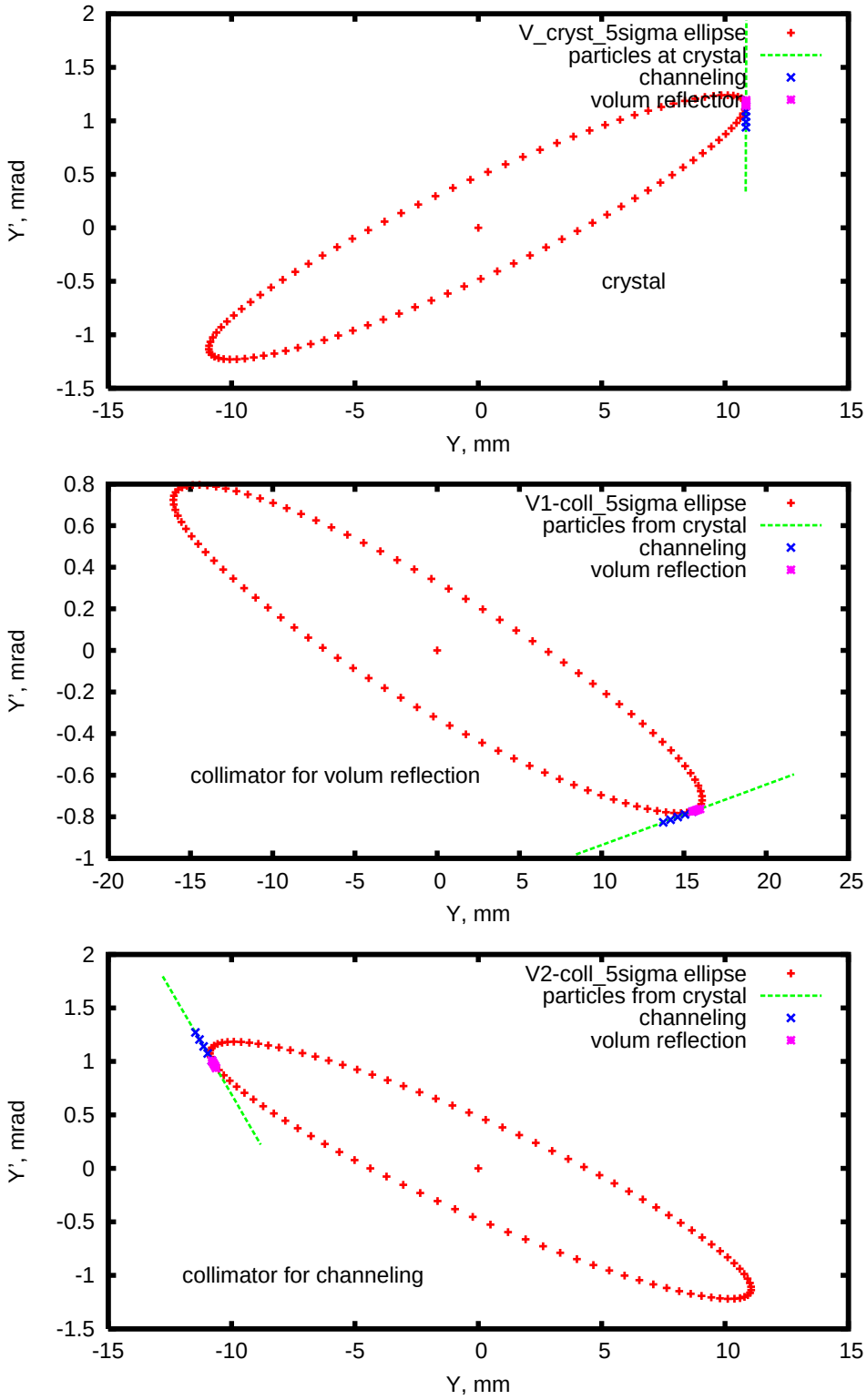

Figure 8: Position of particles at crystal entrance (top) and collimators V1-coll and V2-coll entrance (middle and bottom) in a phase plane during the first turn after interaction with crystal.

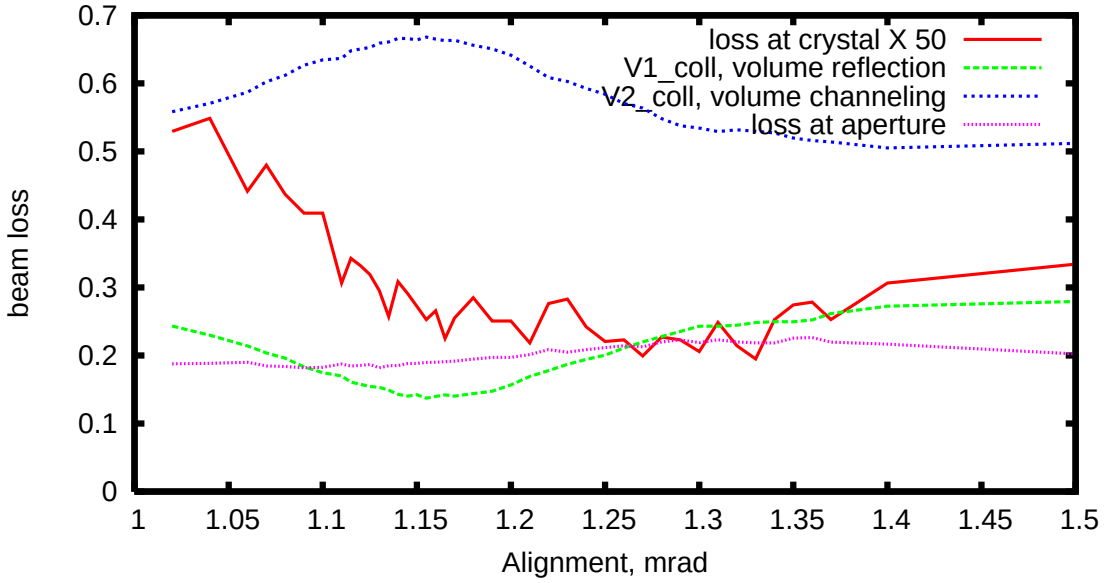

Figure 9: Beam loss at crystal, collimators and the Recycler ring aperture at collymation.

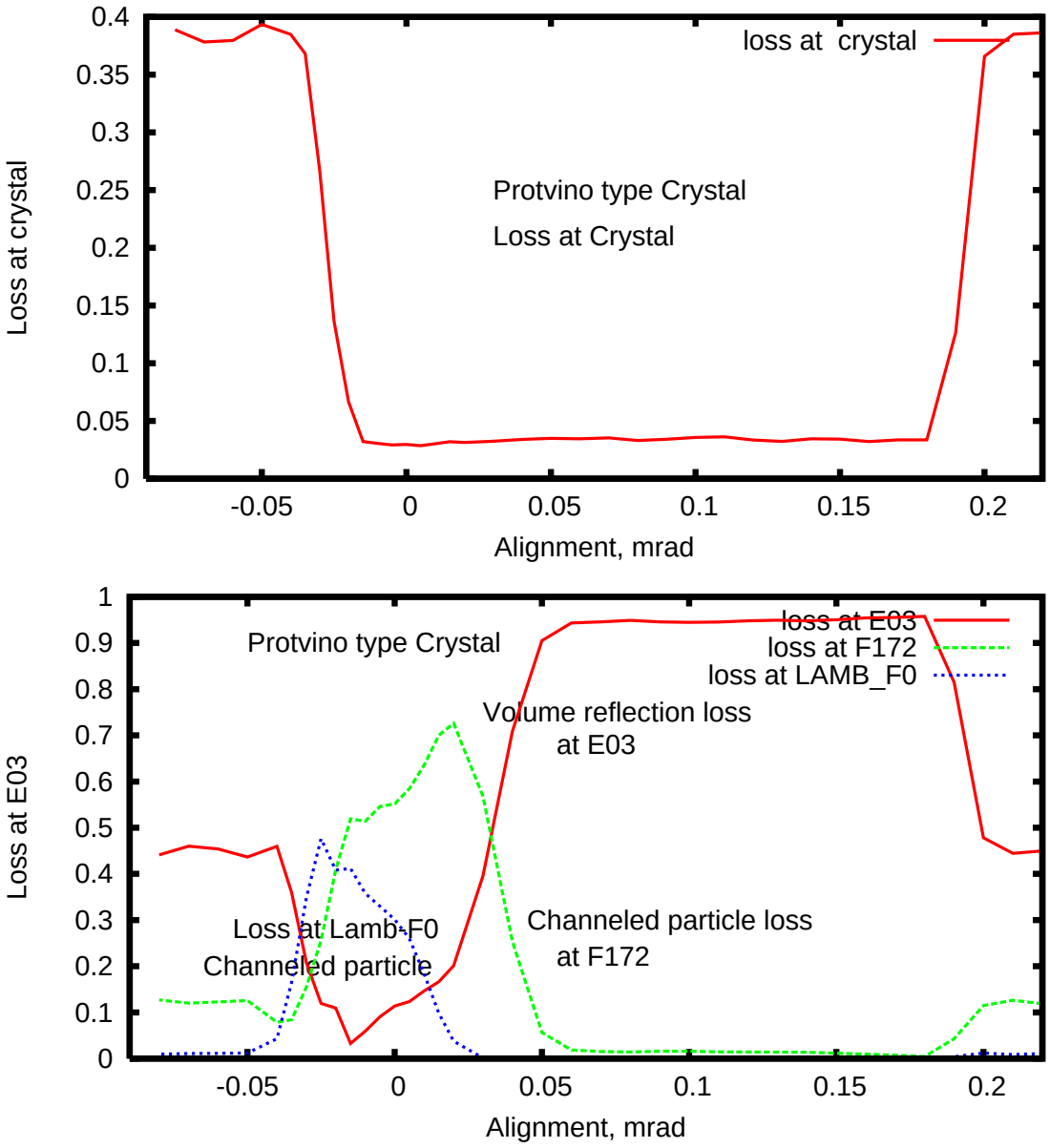

Figure 10: Calculations are done during 20 turns. Particle impact parameter at crystal in simulations is 10μm. Secondary collimators are at 6σ. Particle loss at crystal (top), at F172 collimator and Lambertson F0 (channeling particles), and at E03 collimator (volume reflected particles). Here we multiplied particle loss by the ratio of total number of particles in the simulation to number of particle lost during simulation time, assuming that in a real machine all halo particles are lost during collimation.

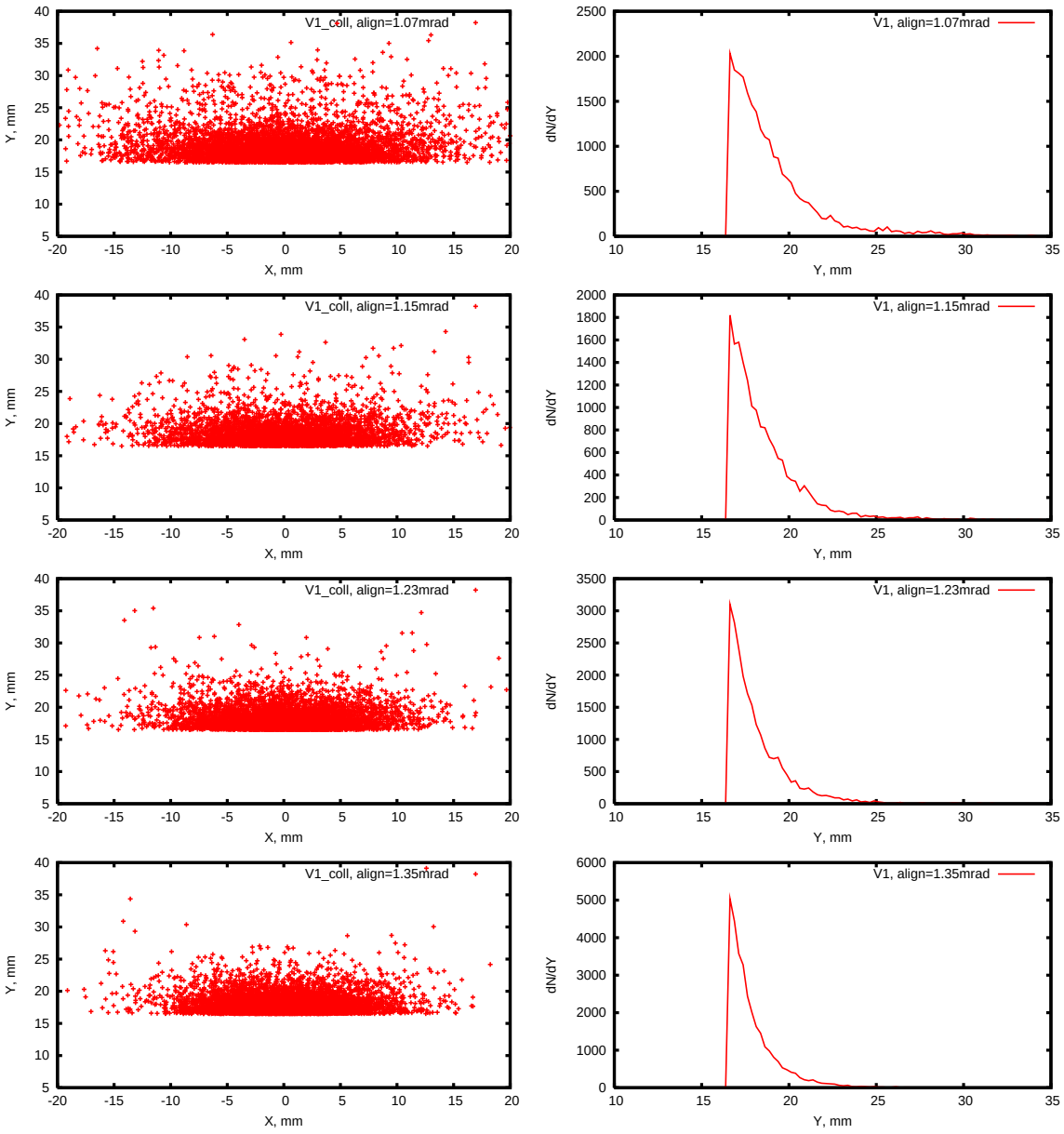

Figure 11: Population (left) and distribution (right) of particle lost in the collimator V1-coll (volume reflection) at crystal entrance alignment of 1.07, 1.15, 1.23 and 1.35 mrad .

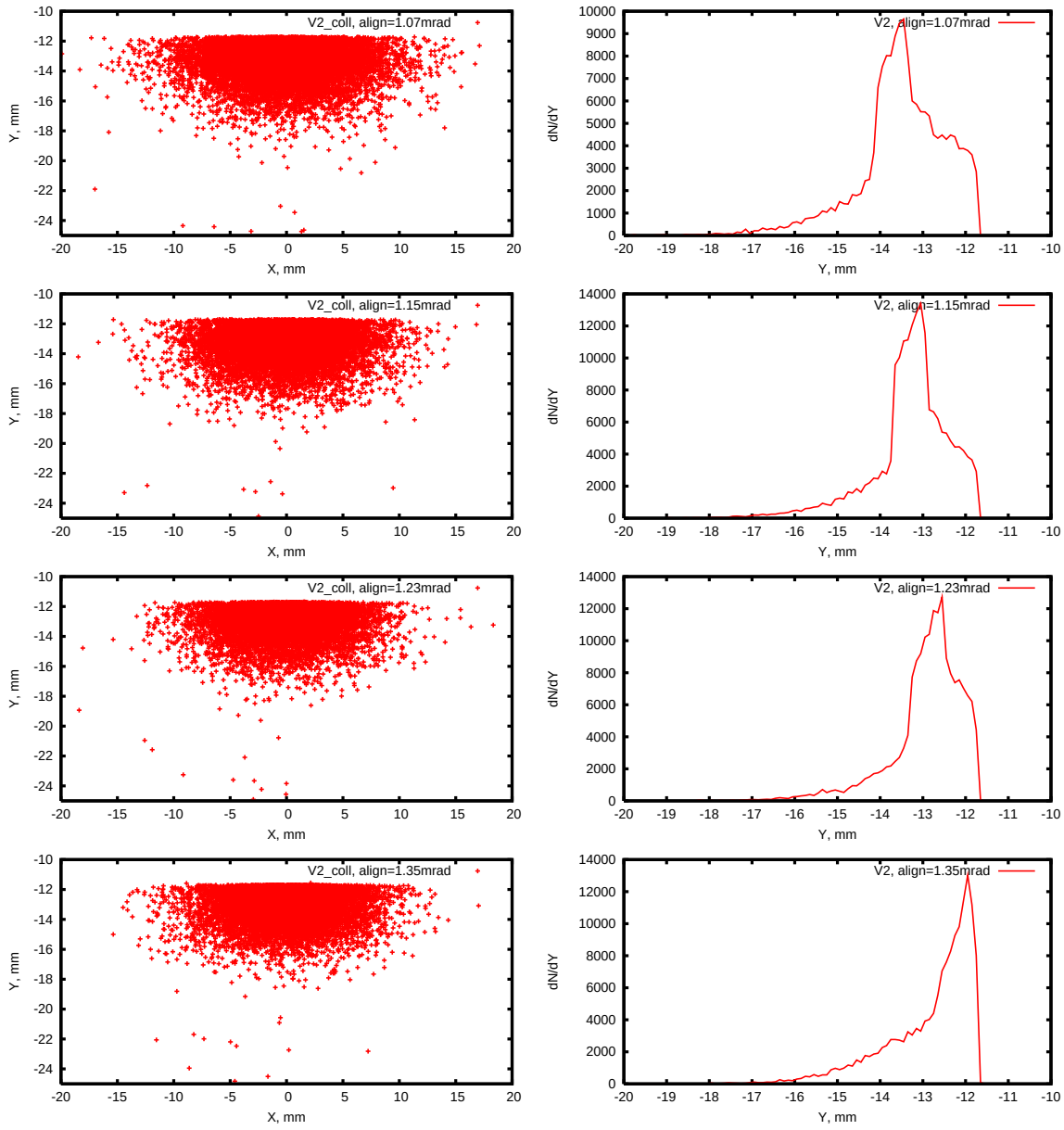

Figure 12: Population (left) and distribution (right) of particle lost in the collimator V2-coll (channeling) at crystal entrance alignment of 1.07, 1.15, 1.23 and 1.35 mrad .