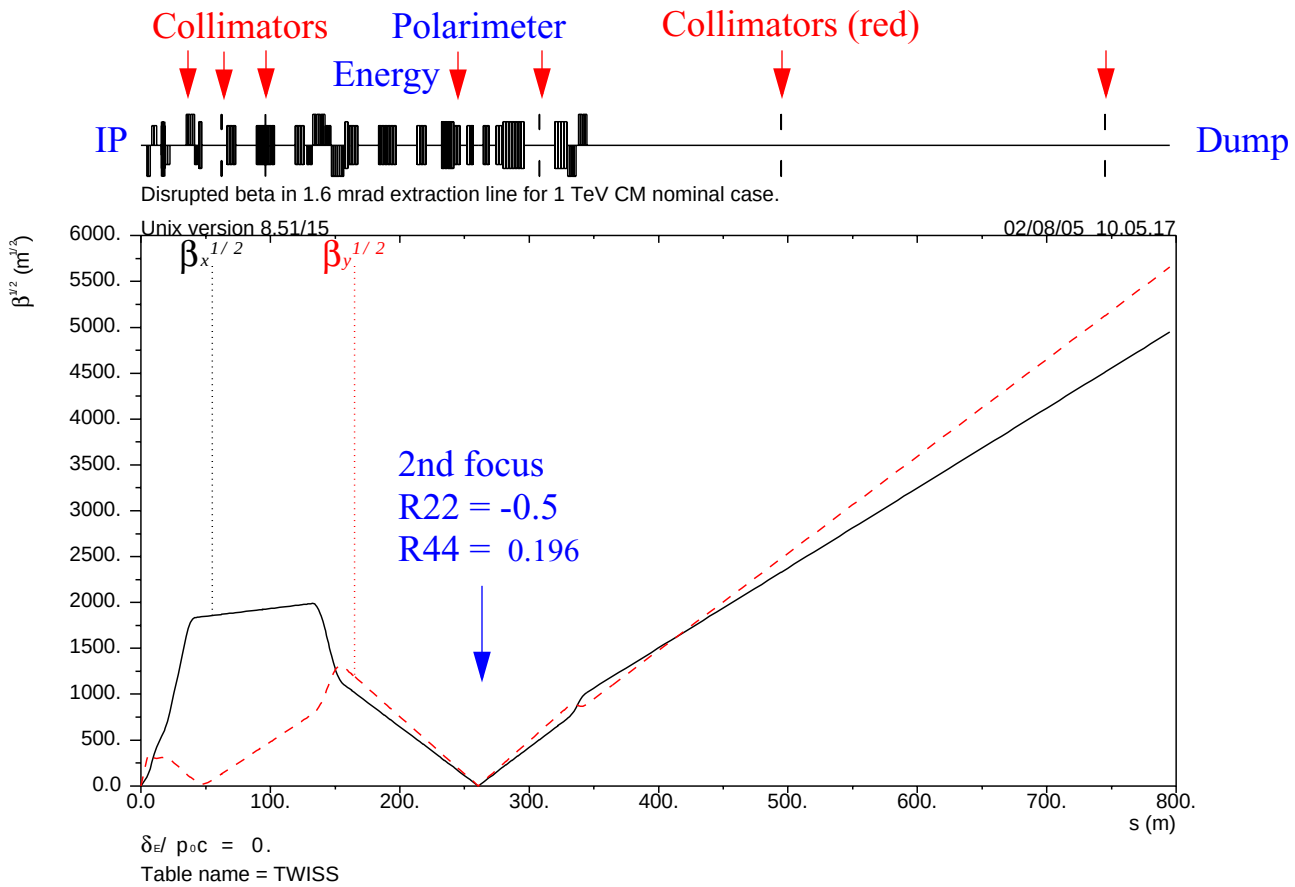
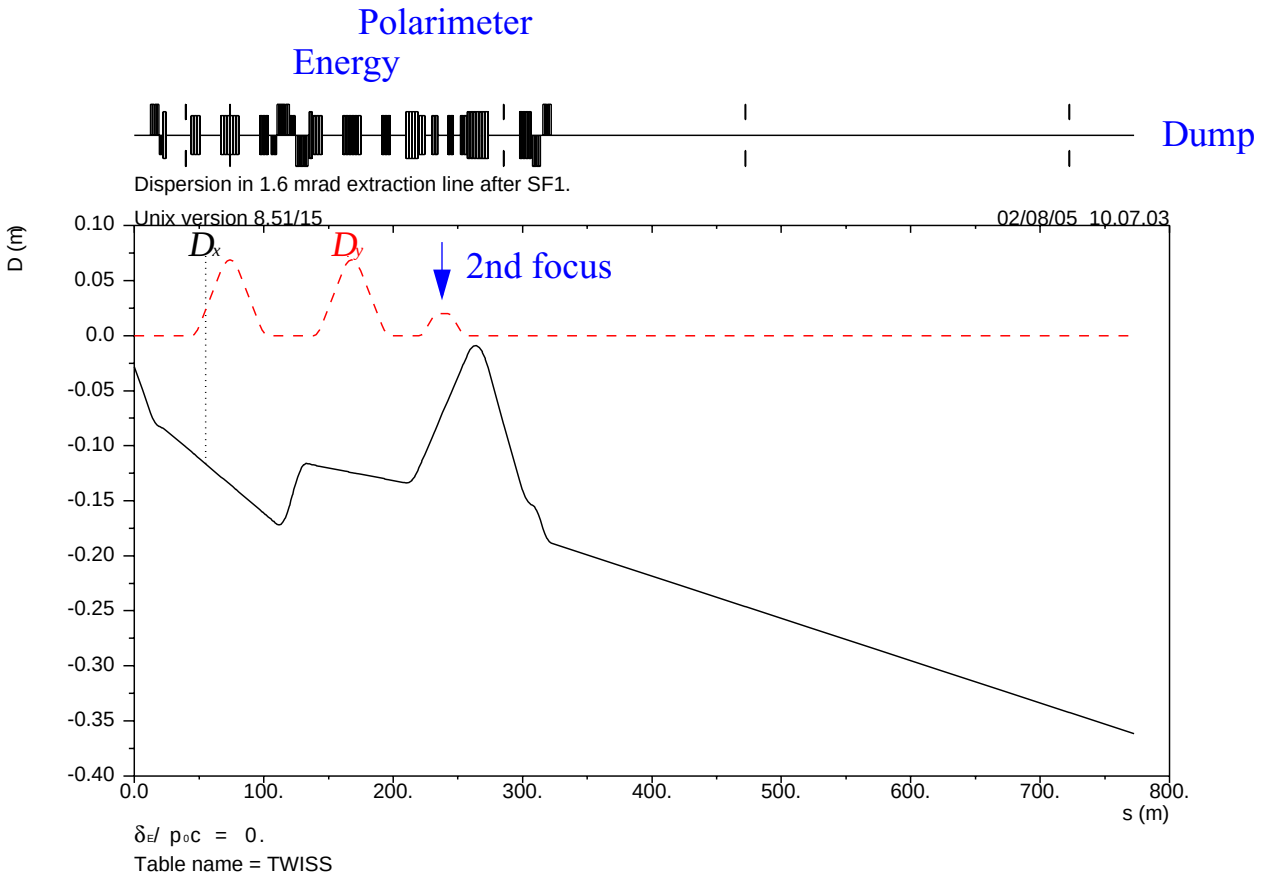
1.6 MRAD EXTRACTION LINE FOR 1 TEV CM

- New Final Doublet for 1 TeV CM
- 1.6 mrad crossing angle
- Extraction magnets for 1 TeV CM
- More collimators to remove low energy tail



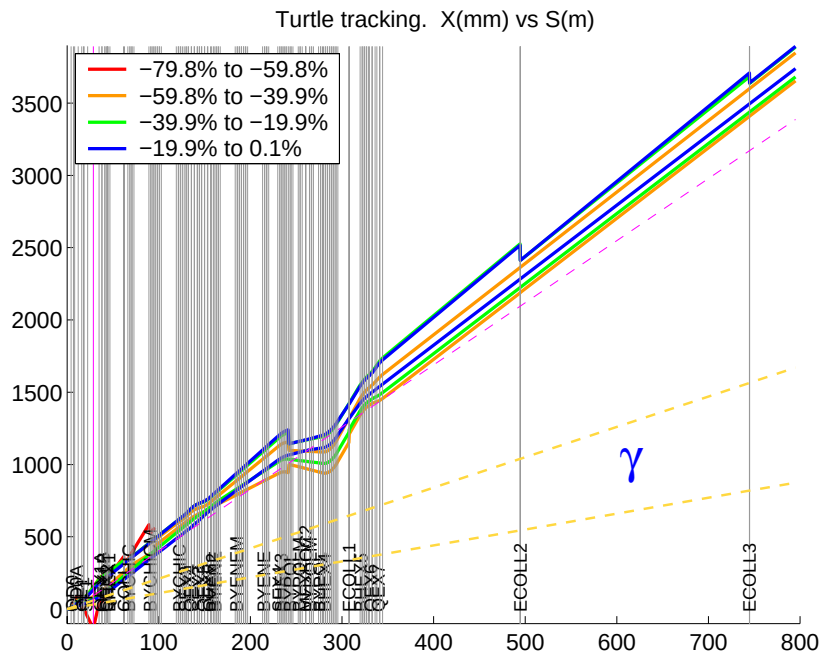
Linear dispersion

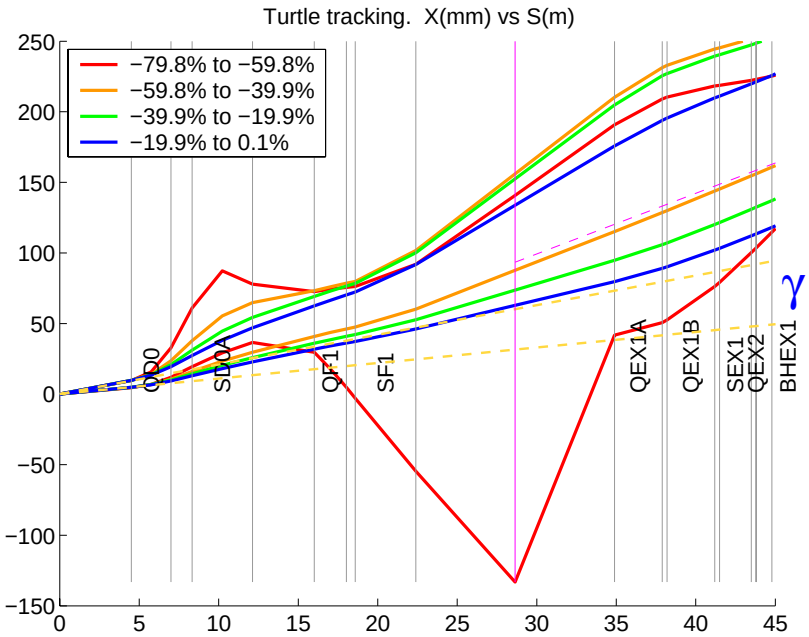
- At chicane collimator: $\eta_x = -13.5$ cm, $\eta_y = 6.9$ cm
- At center of energy chicane: $\eta_x = -12.4$ cm, $\eta_y = 6.9$ cm
- At the 2nd focus: $\eta_x = -7.0$ cm, $\eta_y = 2.0$ cm
- At dump: $\eta_x = -36.2$ cm, $\eta_y = 0$ cm

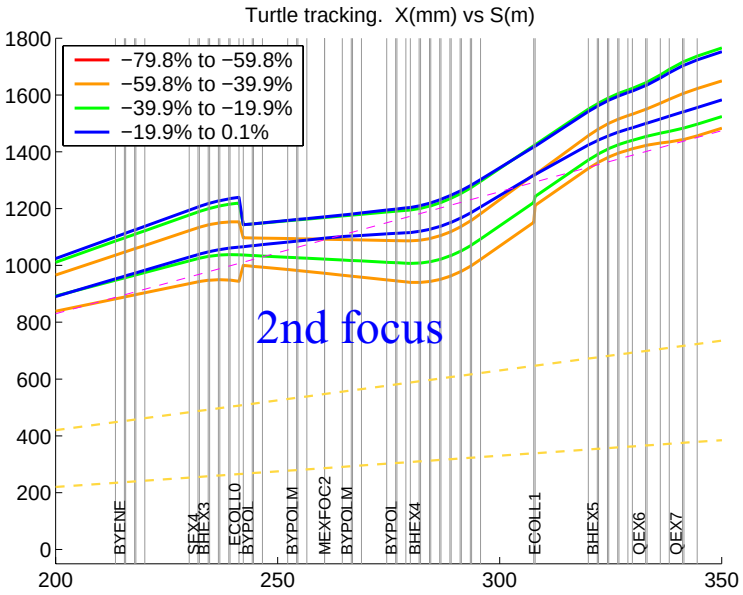


1 TeV CM disrupted beam for IP distribution: X'_{max}=550 μrad, Y'_{max}=600 μrad, E_{min}=20%*E_0

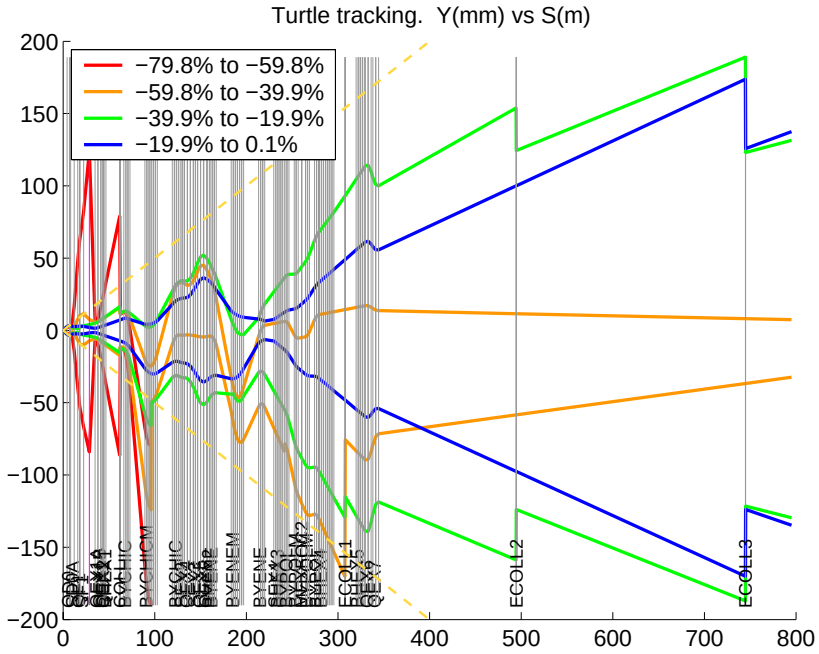
Horizontal beam envelope

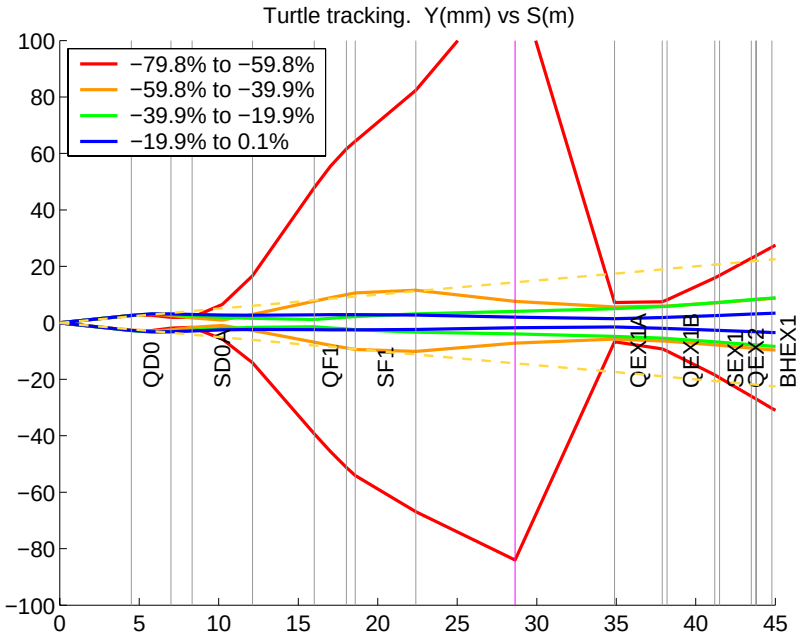


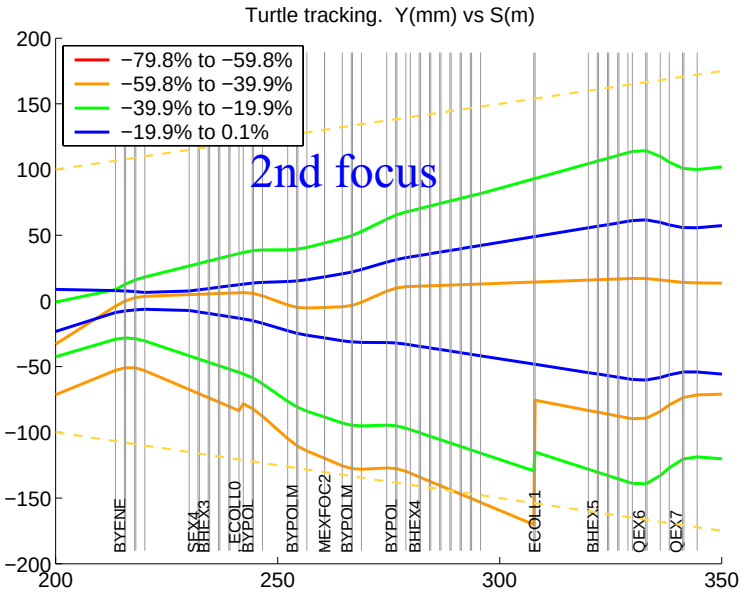




Vertical beam envelope



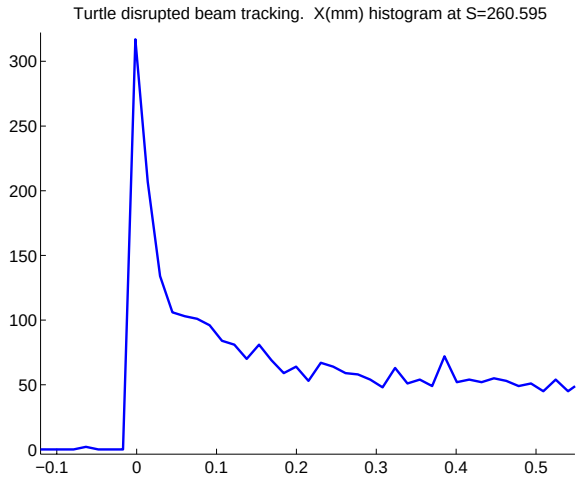




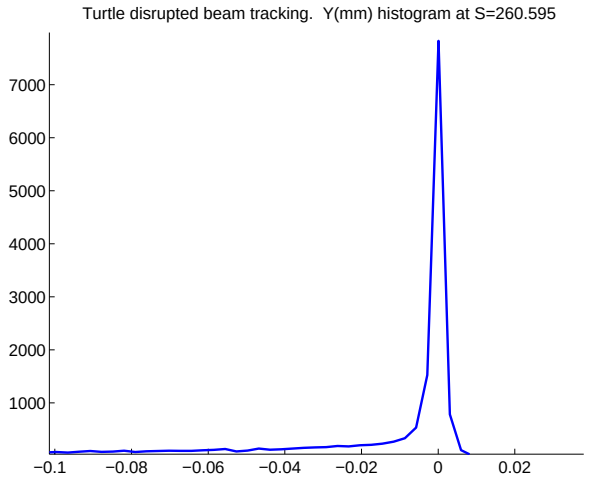
Disrupted X & Y distribution at the 2nd focus for 1 TeV CM

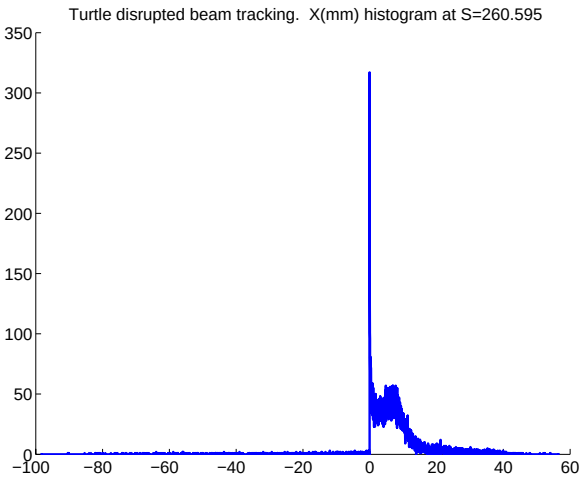
- Desired beam core sigma at 2nd IP: $\sigma < 100$ μm.
- Sextupole geometric aberrations increase the horizontal size.

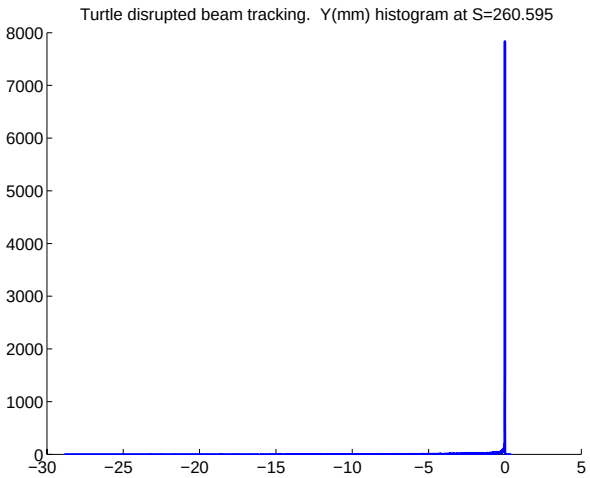
X



Y



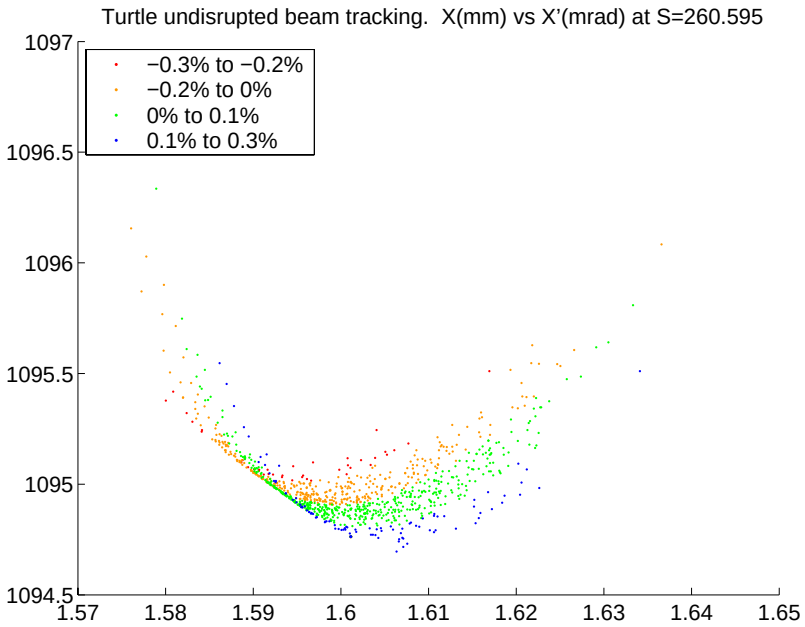




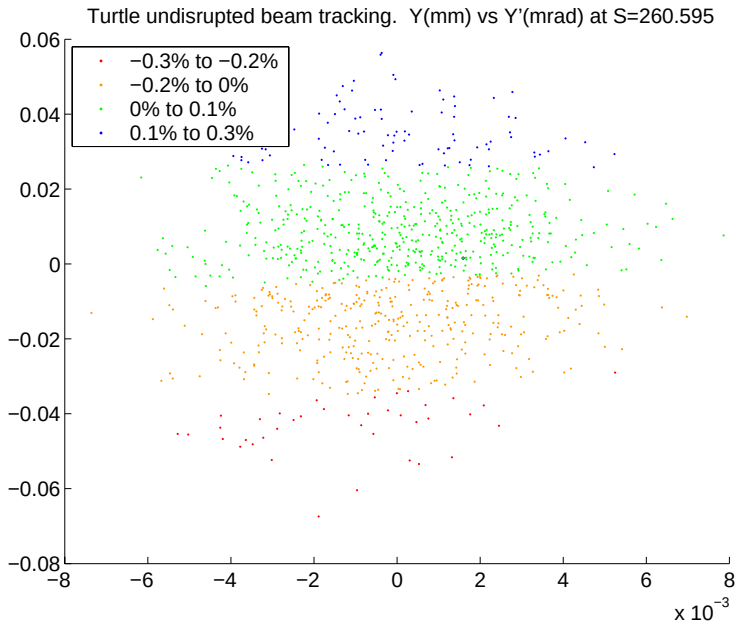
Undisrupted phase space at the 2nd focus for 1 TeV CM

- Quadratic X' vs. X due to sextupole geometric aberrations.
- More sextupole optimization is needed.

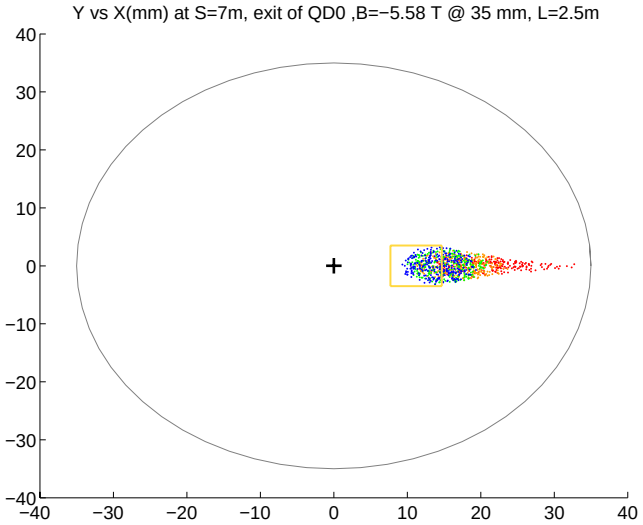
X' vs. X

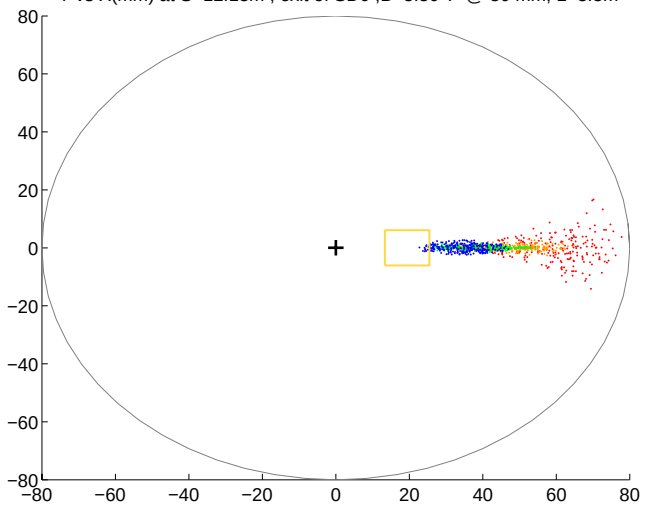


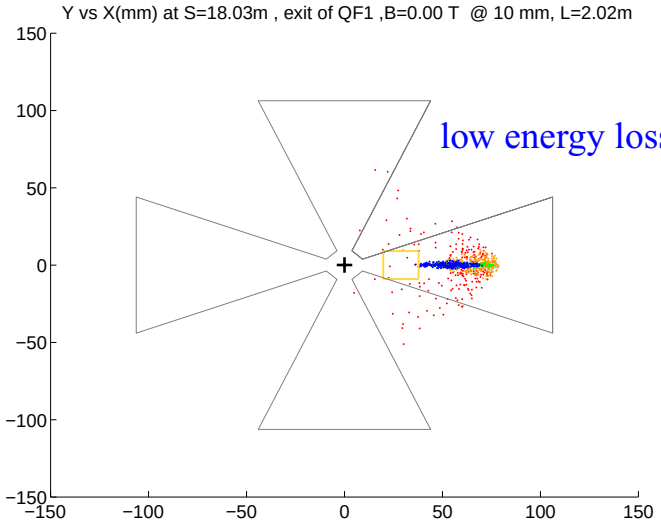
Y' vs. Y

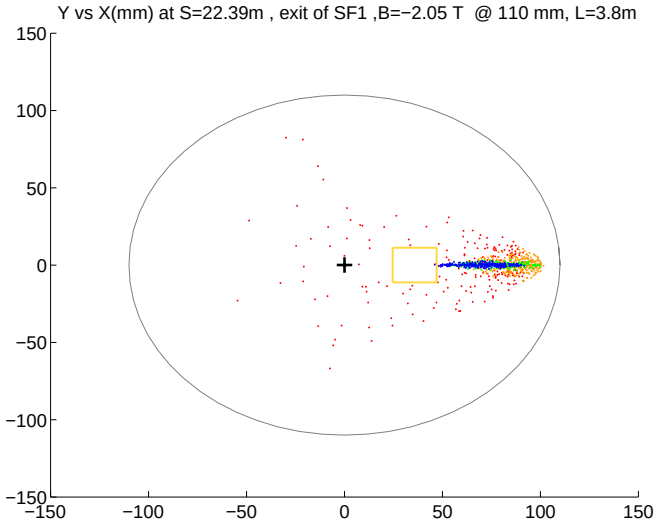


XY beam distribution at magnets for 1 TeV CM and initial IP distribution with X'_{max}=550 μrad, Y'_{max}=600 μrad, E_{min}=20%*E_0

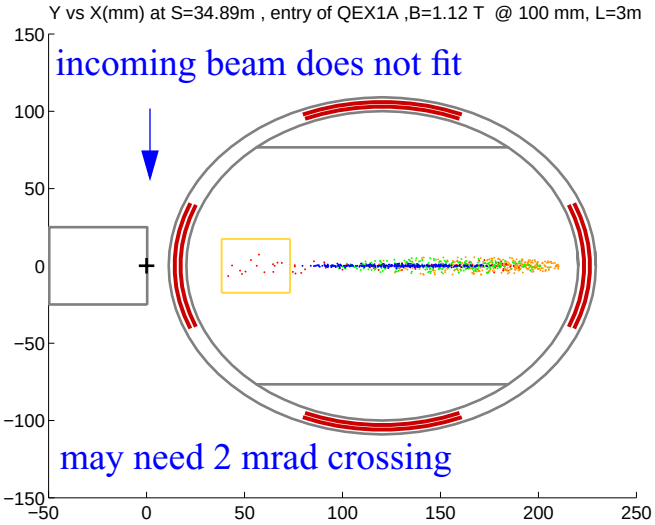


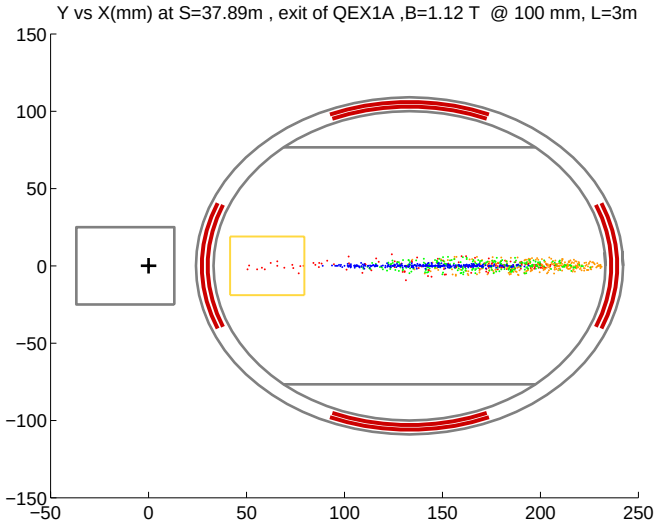


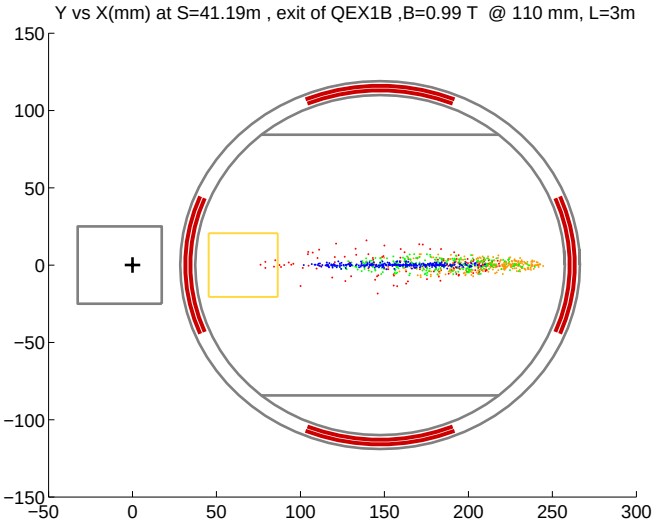


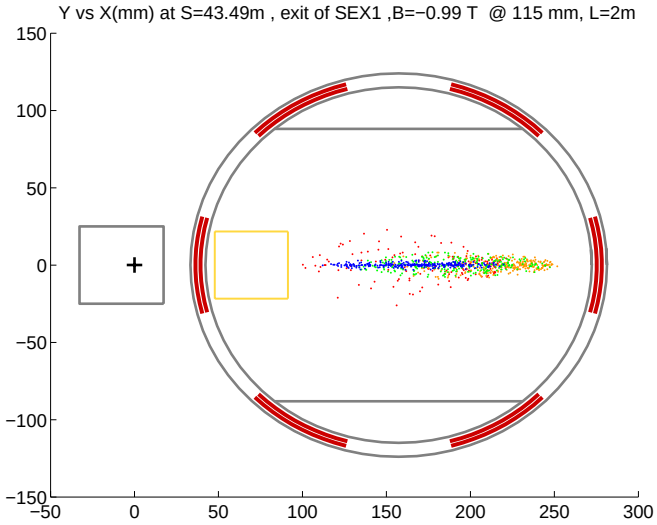


XY beam distribution at magnets for 1 TeV CM and initial IP distribution with X'_{max}=550 μrad, Y'_{max}=600 μrad, E_{min}=20%*E_0



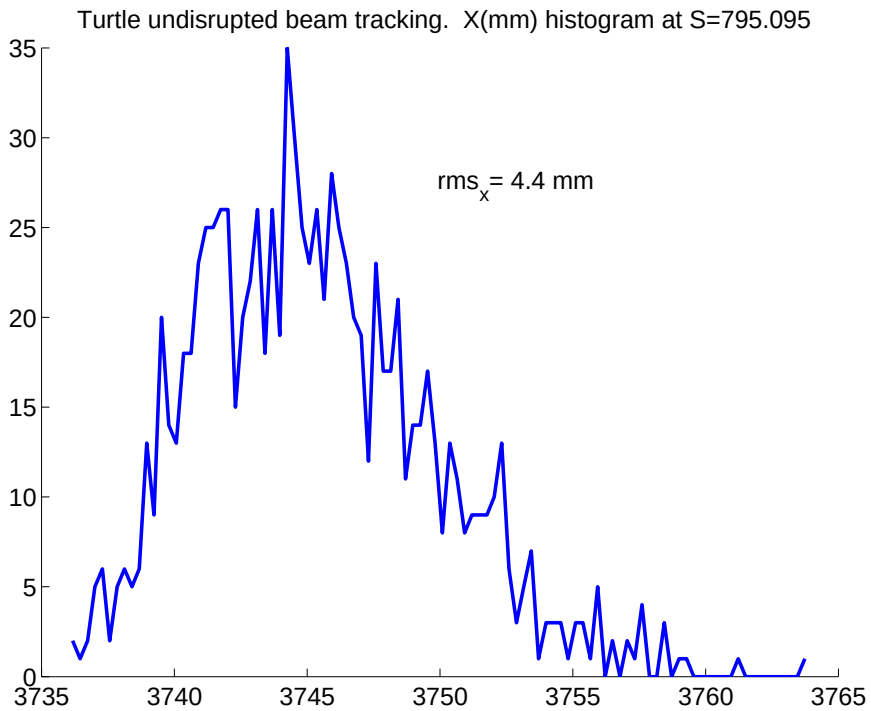


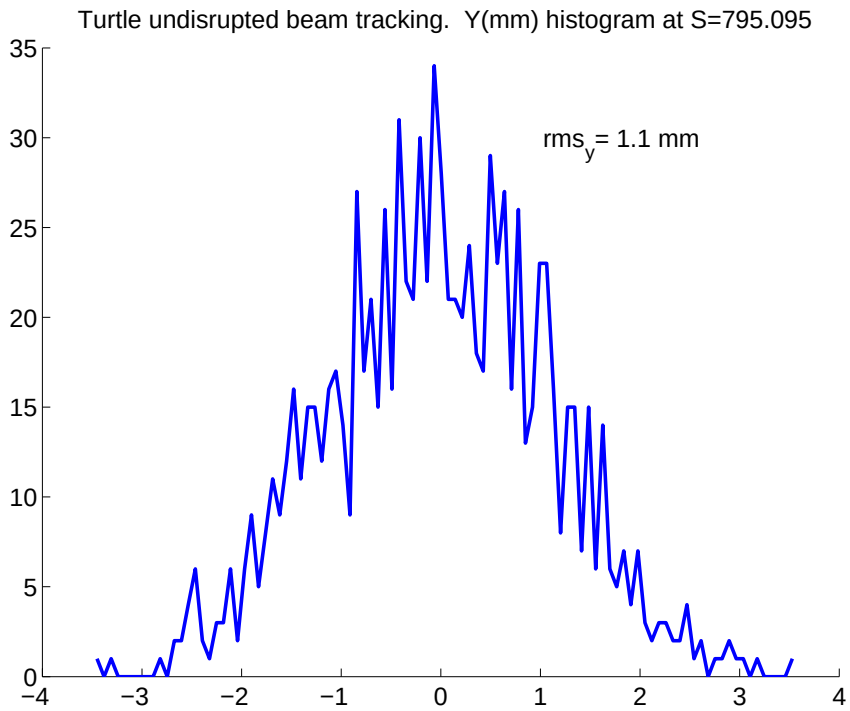




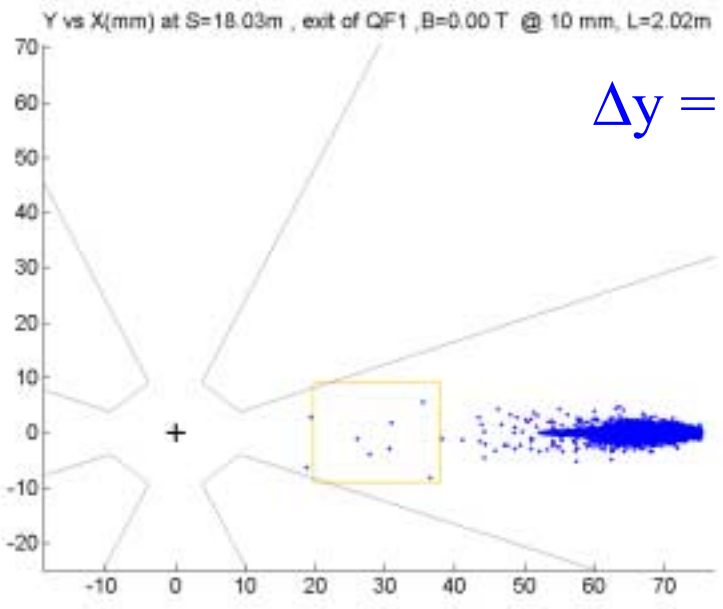
Undisrupted XY distribution at dump for 1 TeV CM

- This size should be acceptable for the dump.



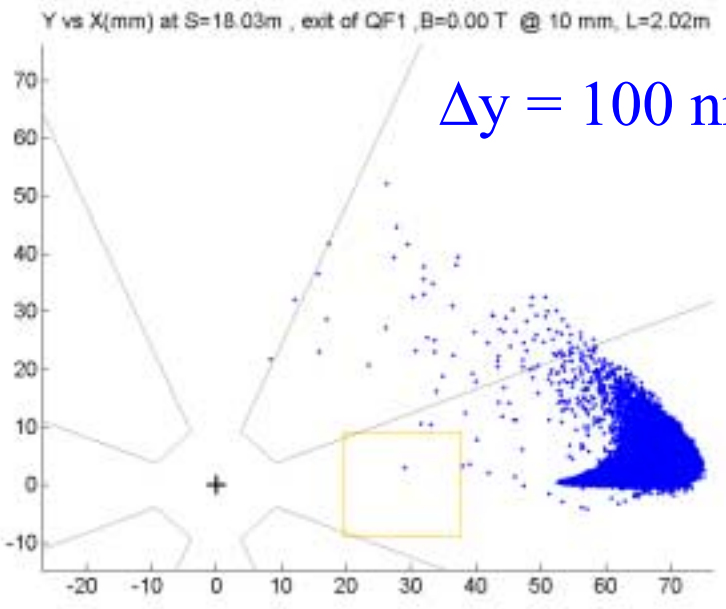


Realistic disrupted XY distribution at QF1 for 1 TeV CM nominal with and without offset at IP



$\Delta y = 0$

No loss

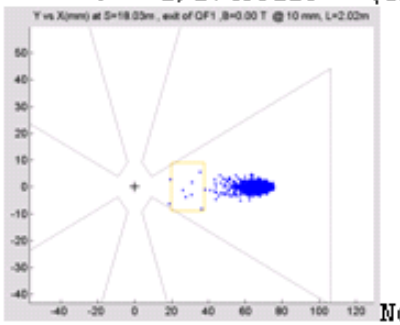


$\Delta y = 100$ nm

44 W loss

Beam power loss for 1 TeV CM nominal and Δy = 0

```
High statistics, head-on, 1TeV nominal,  N rays=   217095
     total N in the beam1=17453218 particles
     saved to taill_1t_0_65E0_or_gt_500urad.dat N=217095
     => * 1/17453218   (estimate Watts : *18000/2)
```



No loss on QF1

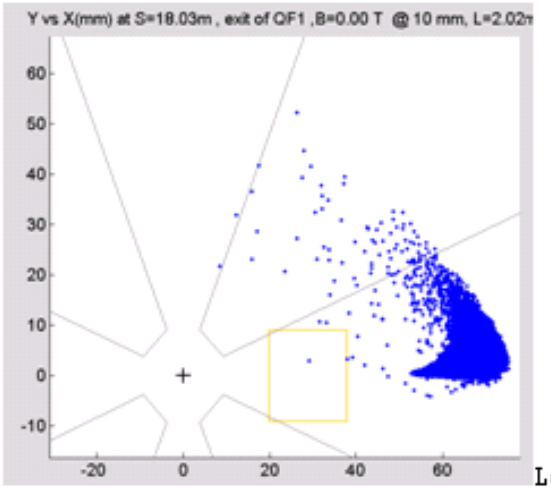
POSITION	LABEL	RAYS	RATIO	~KW
34.892 M	ECOLLA	29	1.6e-6	0.0150
34.892 M	QEX1A	2	1.1e-7	0.0010
61.792 M	HCOLL	47	2.6e-6	0.0242
62.092 M	VCOLL	7	4.0e-7	0.0036
89.392 M	BYCHIC	9	5.1e-7	0.0046
91.692 M	BYCHIC	3	1.7e-7	0.0015
93.992 M	BYCHIC	2	1.1e-7	0.0010
95.992 M	VCOLL2	85950	4.9e-3	44.3
307.695 M	ECOLL1	2065	1.1e-4	1.06
TOTAL		88114	5.0e-3	45.4

```
Low statistics, head-on, 1TeV nominal,  N rays=    34906
     => *1/34906
```

POSITION	LABEL	RAYS	RATIO	~KW
95.992 M	VCOLL2	182	5.2e-3	46.9
307.695 M	ECOLL1	1	2.8e-5	0.25
494.495 M	ECOLL2	9	2.5e-4	2.3
744.795 M	ECOLL3	104	2.9e-3	26.8
TOTAL		296	8.5e-3	76.5

Beam power loss for 1 TeV CM nominal and Δy = 100 nm

```
High statistics, dy=100nm, 1TeV nominal, Nrays= 300301
     total N in the beam1=10122901 particles
     saved to taill_lt_0_65E0_or_gt_500urad.dat N=300301
     => *1/10122901
```



Loss on QF1 ~50 rays

POSITION	LABEL	RAYS	RATIO	~KW
10.230 M	SDOA	1	9.8e-8	0.0009
18.000 M	QF1	50	4.9e-6	0.0445
34.892 M	ECOLLA	92	9.0e-6	0.0818
34.892 M	QEX1A	1	9.8e-8	0.0009
36.392 M	QEX1A	1	9.8e-8	0.0009
61.792 M	HCOLL	79	7.8e-6	0.0702
62.092 M	VCOLL	3978	3.9e-4	3.5367
89.392 M	BYCHIC	9	8.8e-7	0.0080
93.992 M	BYCHIC	1	9.8e-8	0.0009
95.992 M	VCOLL2	72807	7.1e-3	64.7308
241.292 M	ECOLL0	23308	2.3e-3	20.7225
276.895 M	BYPOL	222	2.1e-5	0.1974
307.695 M	ECOLL1	73358	7.2e-3	65.2206
TOTAL		173857	1.7e-2	154.5716

Magnet parameters at 1 TeV CM

Name	N	L (m)	dB_y/dx (T/m)	R (mm)
QD0	1	2.5	-159.37	35
QF1	1	2.0	67.21	10
QEX1A	1	3.0	11.25	100
QEX1B	1	3.0	8.97	110
QEX4	3	3.0	5.84	~100
QEX5	3	3.0	-7.14	~100
QEX6	2	3.0	-5.69	~150
QEX7	2	3.0	5.15	~150

Name	N	L (m)	d^2B_y/dx^2 (T/m^2)	R (mm)
SD0	1	3.8	1032.19	80
SF1		3.8	-339.09	110
SEX1	1	2.0	-150.10	115
SEX2	2	2.0	-150.10	~100
SEX3	2	2.0	83.39	~100

Name	N	L (m)	B (T)	Θ (mrad)
BHEX1	1	2.0	-0.375	-0.45
BHEX2	1	2.0	0.153	0.184
BHEX3	4	2.0	0.618	0.741
BHEX4	7	2.0	-0.831	-0.997
BHEX5	4	2.0	0.774	0.929
BYCHIC	6	2.0	0.834	1.0
BYCHICM	6	2.0	-0.834	-1.0
BYENE	6	2.0	0.834	1.0
BYENEM	6	2.0	-0.834	-1.0
BYPOL	4	2.0	0.834	1.0
BYPOLM	4	2.0	-0.834	-1.0

* Some apertures need to be defined more accurately based on beam loss calculations.