Simulations on beam beam compensation with wire

T. Rijoff, F. Zimmermann

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Wire
Compensation

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Zimmermann

BaseTest

Wire
Compensation

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Zimmermann

AddTest

For reference, simulations with only head on on IP1 and IP5
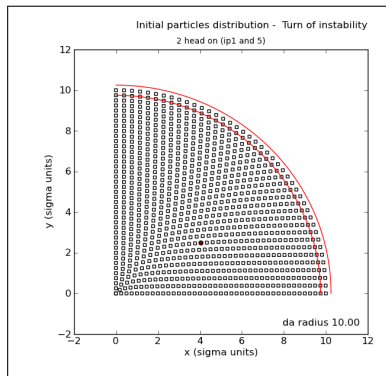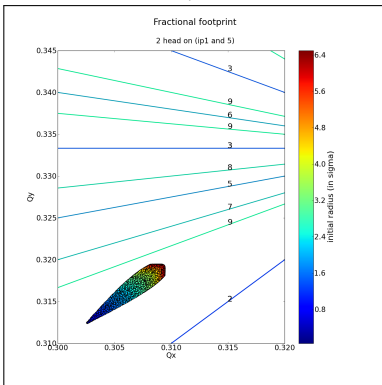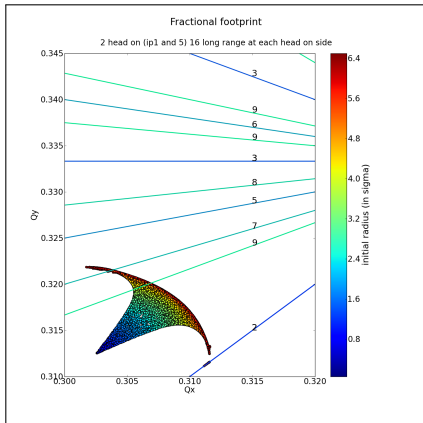
footprint values

- $Q_x \in [0.3014, 0.3116]$
- $Q_y \in [0.3111, 0.3219]$

line	part	$< 4\sigma$
2	4	0
7	2	0
9	14	5

Dynamical Aperture
Radius 8.50 σ

30.7% unstable particles
of which 19.0% over the
stability radius

Added two wires at the nominal positions (104.93m after IP)
at 9.5 σ with current 176.76 A

s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
104.93	104.93	0.00000	−0.00888	1738.14	1734.78
13434.22	104.93	−0.00888	0.00000	1738.14	1734.78

Fractional footprint
head on ip1 and ip5 + 16 long range at each ho
+ wire 105 m after ip at 9.5 sigma 176.76 A

footprint values

- $Q_x \in [0.3026, 0.3096]$
- $Q_y \in [0.3124, 0.3196]$

Tune footprint doesn't
cross any resonance line
with order smaller than 10

Dynamical Aperture

Radius 8.50 σ

19.8% unstable particles
(14.0% over the stability
radius)

Wire
Compensation

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Zimmermann

Head On

Head On +
Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod
9.5 σ 177A
11 σ 177A
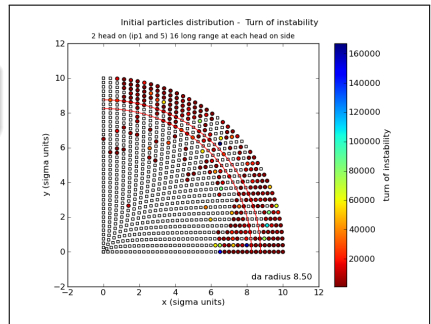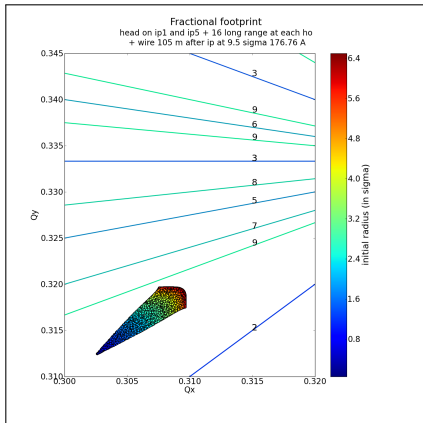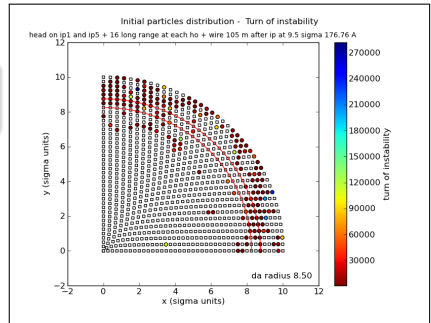11 σ 237A

Wire at TCT
mod 2
9.5 σ 177A
11 σ 177A
11 σ 237A

Square wire

Simulated a square wire with 1mm side with 4 point-like wires .
For example for the wire at the nominal positions at 9.5 σ

IP1

x pos	y pos
m	m
0.00000	−0.00888

$\Rightarrow$

(−0.0005 , −0.00888)	(0.0005 , −0.00888)
(−0.0005 , −0.00988)	(0.0005 , −0.00988)

IP5

x pos	y pos
m	m
−0.00888	0.00000

$\Rightarrow$

(−0.00988, 0.0005)	(−0.00888, 0.0005)
(−0.00988, −0.0005)	(−0.00888, −0.0005)

Fractional footprint
head on ip1 and ip5 + 16 long range at each ho
+ square wire 105 m after ip at 9.5 sigma 176.76 A

footprint values

- $Q_x \in [0.3026, 0.3101]$
- $Q_y \in [0.3125, 0.3200]$

line	part	< 4σ
9	4	1

Dynamical Aperture

Radius 9.00 σ

16.41% unstable particles
(6.54% over the stability
radius)

Initial particles distribution - Turn of instability
head on ip1 and ip5 + 16 long range at each ho
+ square wire 105 m after ip at 9.5 sigma 176.76 A

Wires moved at 11 σ with current 176.76 A

9.5 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
104.93	104.93	0.00000	−0.00888	1738.14	1734.78
13434.22	104.93	−0.00888	0.00000	1738.14	1734.78

11 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
104.93	104.93	0.00000	−0.01028	1738.14	1734.78
13434.22	104.93	−0.01028	0.00000	1738.14	1734.78

Wire
Compensation

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Zimmermann

Head On

Head On +
Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A
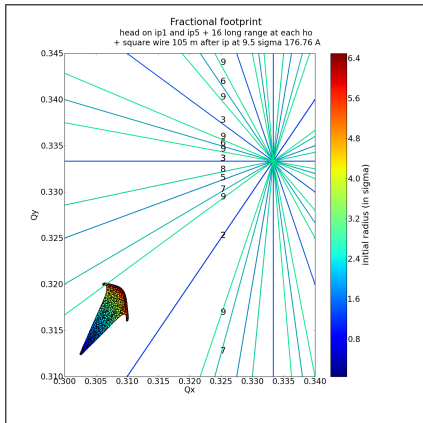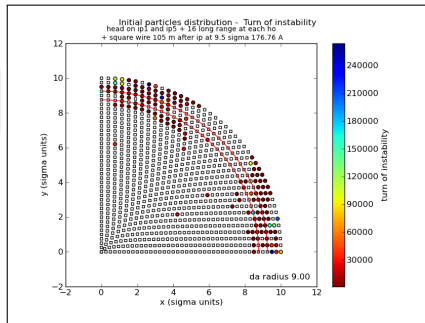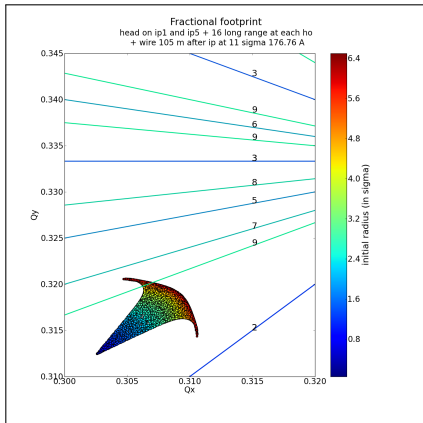
Wire at TCT
mod
9.5 σ 177A
11 σ 177A
11 σ 237 A

Wire at TCT
mod 2
9.5 σ 177A
11 σ 177A
11 σ 237 A

Fractional footprint
head on ip1 and ip5 + 16 long range at each ho
+ wire 105 m after ip at 11 sigma 176.76 A

footprint values

- $Q_x \in [0.3026, 0.3105]$
- $Q_y \in [0.3125, 0.3205]$

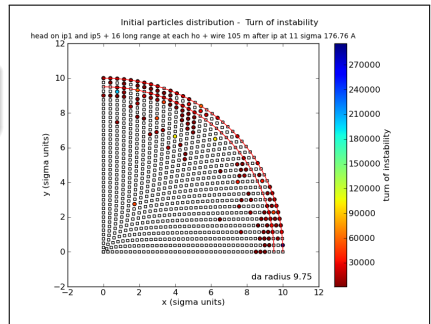| line	part	$< 4\sigma$
9	8	1

Dynamical Aperture

Radius 9.75 σ

14.7% unstable particles
of which 11.9% over the
stability radius

Wire Compensation

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Head On

Head On + Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT mod
9.5 σ 177A
11 σ 177A
11 σ 237 A

Wire at TCT mod 2
9.5 σ 177A
11 σ 177A
11 σ 237 A

Wire at 105m, d = 11 σ , I = 176.8 A - Square Wire

Fractional footprint
head on ip1 and ip5 + 16 long range at each ho
+ square wire 105 m after ip at 11 sigma 176.76 A
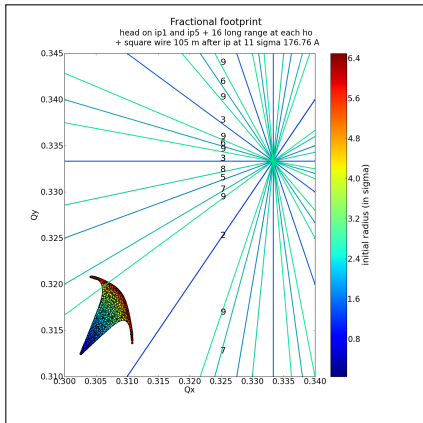
footprint values

- $Q_x \in [0.3026, 0.30916]$
- $Q_y \in [0.31246, 0.31916]$

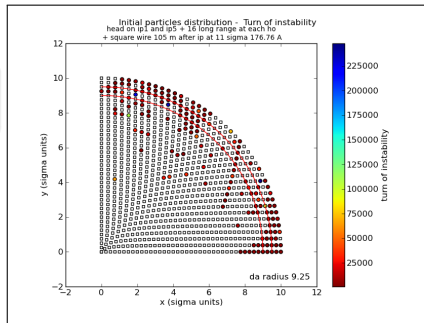| line	part	$< 4\sigma$
9	1	1

Wire at 105m, d = 11 σ , I = 176.8 A - Square Wire

Dynamical Aperture

Radius 9.25 σ

18.40% unstable particles (9.65% over the stability radius)

Initial particles distribution - Turn of instability
head on ip1 and ip5 + 16 long range at each ho
+ square wire 105 m after ip at 11 sigma 176.76 A

Wires at 11 σ with current 236.98 A
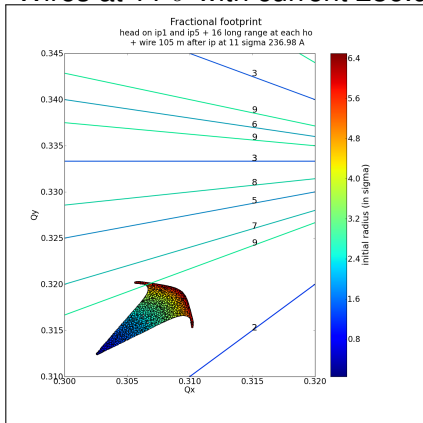
footprint values

- $Q_x \in [0.3026, 0.3102]$
- $Q_y \in [0.3125, 0.3202]$

line	part	$< 4\sigma$
9	5	4

Dynamical Aperture

Radius 8.25 σ

34.4% unstable particles,
25.8% over the stability
radius

Initial particles distribution - Turn of instability

Wire Compensation

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Head On

Head On + Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT mod
9.5 σ 177A
11 σ 177A
11 σ 237 A

Wire at TCT mod 2
9.5 σ 177A
11 σ 177A
11 σ 237 A

Wire at 105m, d = 11 σ , I = 237.0 A - Square Wire

Fractional footprint
head on ip1 and ip5 + 16 long range at each ho
+ square wire 105 m after ip at 11 sigma 176.76 A

footprint values

- $Q_x \in [0.3026, 0.30916]$
- $Q_y \in [0.31246, 0.31916]$

line	part	$< 4\sigma$
9	1	1

Dynamical Aperture
Radius 9.50 σ

14.86% unstable particles (9.53% over the stability radius)

Two wires at the TCT location at 9.5 σ with current 176.76 A

9.5 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
26513.04	−145.84	0.00000	−0.00537	1581.02	635.83
13181.77	−147.52	−0.00845	0.00000	1574.90	602.24

Wire
Compensation

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Zimmermann

Head On

Head On +
Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod
9.5 σ 177A
11 σ 177A
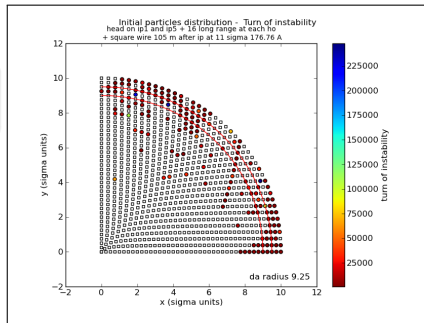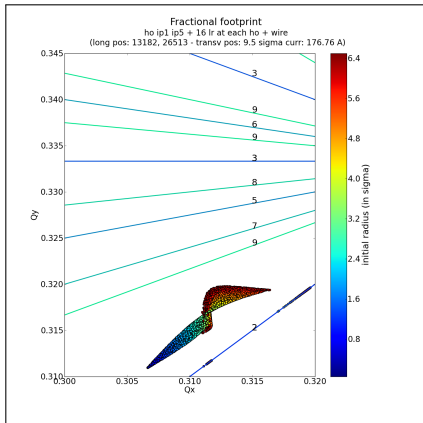11 σ 237A

Wire at TCT
mod 2
9.5 σ 177A
11 σ 177A
11 σ 237 A

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13182, 26513 - transv pos: 9.5 sigma curr: 176.76 A)

footprint values

- $Q_x \in [0.3066, 0.3196]$
- $Q_y \in [0.3110, 0.3198]$

line	part	$< 4\sigma$
2	194	92

Tune footprint *twists!*

Dynamical Aperture

Radius 8.25 σ

30.8 % unstable particles,
22.0 % over the stability
radius

Central tune moved back to the original value

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13182, 26513 - transv pos: 9.5 sigma curr: 176.76 A)
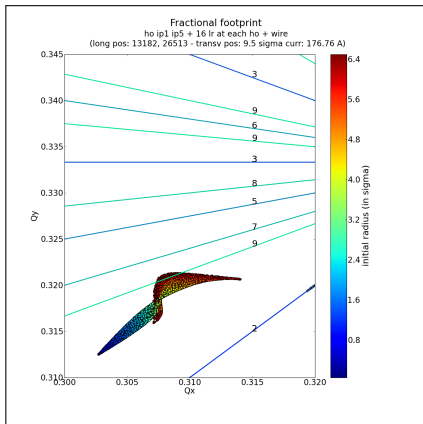
footprint values

- $Q_x \in [0.3027, 0.3200]$
- $Q_y \in [0.3125, 0.3213]$

line	part	$< 4\sigma$
2	6	3
9	21	5

Tune footprint *twists!*

Central tune moved back to the original value

Dynamical Aperture

Radius 7.75 σ

33.8 % unstable particles, 27.5 % over the stability radius

Wires moved at 11 σ with current 176.76 A

9.5 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
26513.04 m	−145.84	0.00000	−0.00537	1581.02	635.83
13181.77 m	−147.52	−0.00845	0.00000	1574.90	602.24

11 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
26513.04	−145.84	0.00000	−0.00622	1581.02	635.83
13181.77	−147.52	−0.00979	0.00000	1574.90	602.24

Wire
Compensation

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Head On

Head On +
Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod
9.5 σ 177A
11 σ 177A
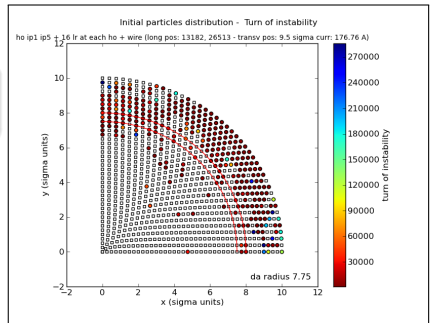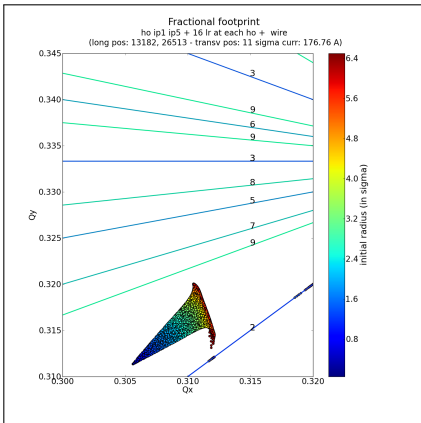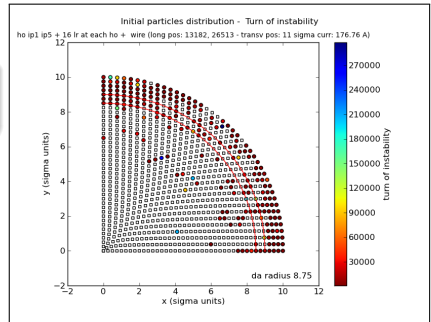11 σ 237 A

Wire at TCT
mod 2
9.5 σ 177A
11 σ 177A
11 σ 237 A

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13182, 26513 - transv pos: 11 sigma curr: 176.76 A)

footprint values

- $Q_x \in [0.3056, 0.3200]$
- $Q_y \in [0.3114, 0.3200]$

line	part	$< 4\sigma$
2	6	0

Dynamical Aperture

Radius 8.75 σ

24.6 % unstable particles
(16.2 % over the stability
radius)

Initial particles distribution - Turn of instability

Wire
Compensation

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Zimmermann

Head On

Head On +
Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
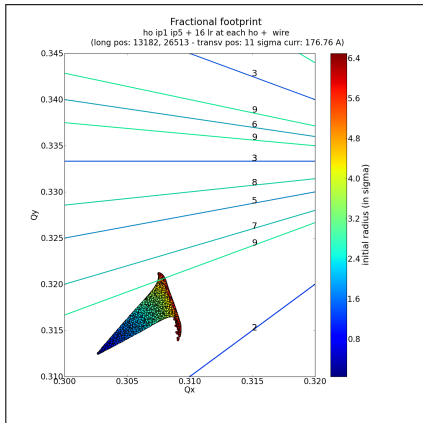9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod 2
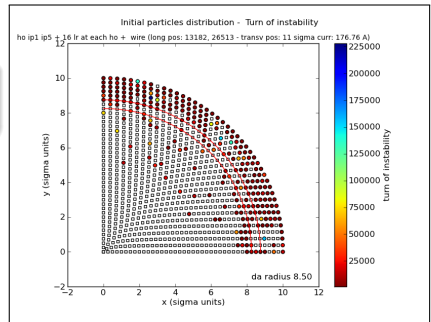9.5 σ 177A
11 σ 177A
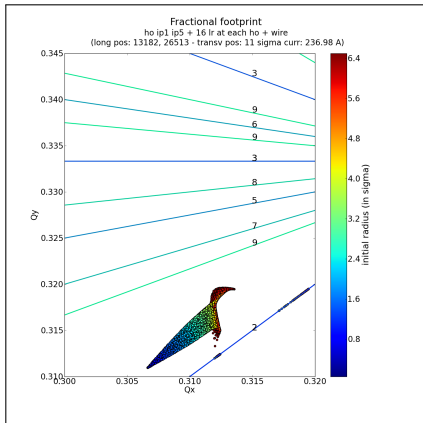11 σ 237A

Central tune moved back to the original value

footprint values

- $Q_x \in [0.3027, 0.3092]$
- $Q_y \in [0.3125, 0.3212]$

line	part	$< 4\sigma$
9	10	6

Central tune moved back to the original value

Dynamical Aperture
Radius 8.50 σ

28.4 % unstable particles
(20.6 % over the stability
radius)

Initial particles distribution - Turn of instability

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13182, 26513 - transv pos: 11 sigma curr: 236.98 A)

footprint values

- $Q_x \in [0.3066, 0.3195]$
- $Q_y \in [0.3110, 0.3196]$

line	part	$< 4\sigma$
2	34	8

Tune footprint *twists!*

Dynamical Aperture

Radius 8.50 σ

26.5 % unstable particles
of which 18.8 % over the
stability radius

Wire
Compensation

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Zimmermann

Head On

Head On +
Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod
9.5 σ 177A
11 σ 177A
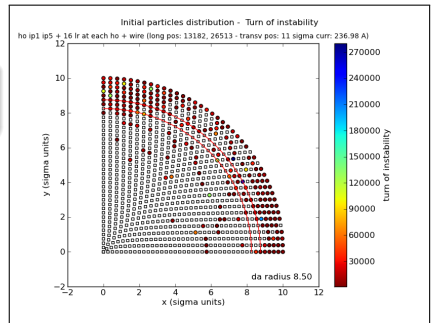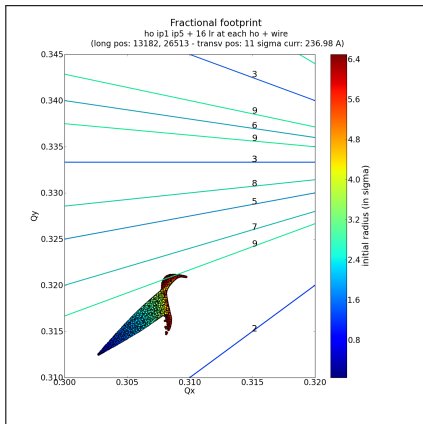11 σ 237A
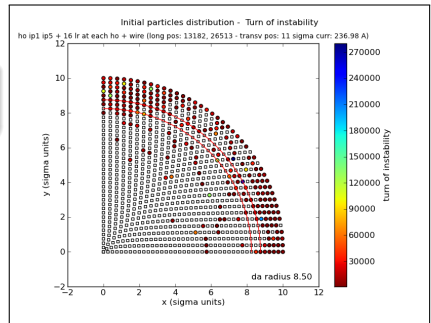
Wire at TCT
mod 2
9.5 σ 177A
11 σ 177A
11 σ 237A

Central tune moved back to the original value

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13182, 26513 - transv pos: 11 sigma curr: 236.98 A)

footprint values

- $Q_x \in [0.3027, 0.3097]$
- $Q_y \in [0.3125, 0.3211]$

line	part	$< 4\sigma$
9	19	5

Tune footprint *twists!*

Central tune moved back to the original value

Dynamical Aperture

Radius 8.50 σ

28.2 % unstable particles
of which 20.3 % over the
stability radius

Wire at TCT β : problem!

Wire
Compensation

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Zimmermann

Head On

Head On +
Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod 2
9.5 σ 177A
11 σ 177A
11 σ 237 A

Wire at nominal position			
s	**IP dist**	β_x	β_y
104.93	104.93	1738.14	1734.77
13434.22	104.93	1738.14	1734.78

Wire at nominal position			
s	**IP dist**	β_x	β_y
104.93	104.93	1738.14	1734.77
13434.22	104.93	1738.14	1734.78

Wire at TCT			
s	**IP dist**	β_x	β_y
26513.04	-145.84	1581.02	635.83
13181.77	-147.52	1574.90	602.24

Wire at TCT β : problem!

Wire at nominal position			
s	**IP dist**	β_x	β_y
104.93	104.93	1738.14	1734.77
13434.22	104.93	1738.14	1734.78

Wire at TCT			
s	**IP dist**	β_x	β_y
26513.04	-145.84	1581.02	635.83
13181.77	-147.52	1574.90	602.24

Try: Move the wire at TCTH.4L5 to a different location!

Wire at TCT β : problem!

Wire at nominal position			
s	**IP dist**	β_x	β_y
104.93	104.93	1738.14	1734.77
13434.22	104.93	1738.14	1734.78

Wire at TCT			
s	**IP dist**	β_x	β_y
26513.04	-145.84	1581.02	635.83
13181.77	-147.52	1574.90	602.24

Try: Move the wire at TCTH.4L5 to a different location!

Wire at TCT modified			
s	**IP dist**	β_x	β_y
26513.04	-145.84	1581.02	635.83
13478.824	149.53	563.15	1567.60

Wire at TCTVA.4L1.B1 + Wire moved for best beta.
Horizontal location at 9.5 σ, curr 176.76 A

9.5 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
26513.04	−145.84	0.00000	−0.00537	1581.02	635.83
13478.82	149.53	−0.00505	0.00000	1574.90	602.24

Wire Compensation

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Head On

Head On + Long Range

Wire at BBC
9.5 σ 177A
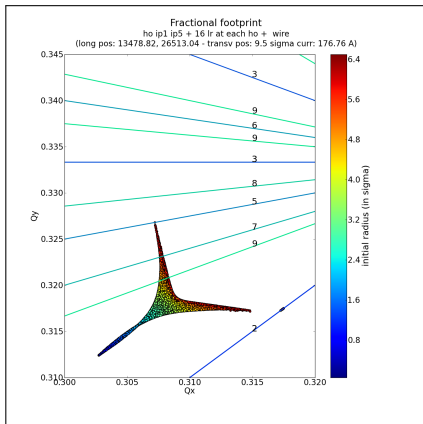11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A
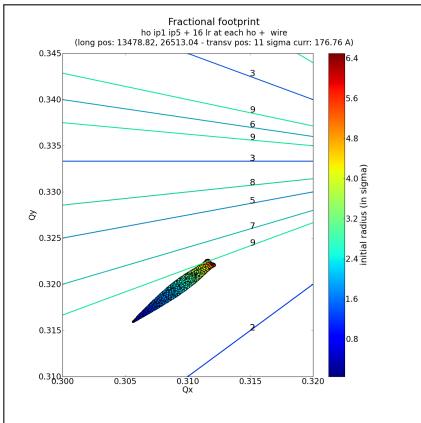
Wire at TCT mod
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT mod 2
9.5 σ 177A
11 σ 177A
11 σ 237A

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13478.82, 26513.04 - transv pos: 9.5 sigma curr: 176.76 A)

footprint values

- $Q_x \in [0.3067, 0.3193]$
- $Q_y \in [0.3172, 0.3322]$

line	part	$< 4\sigma$
5	18	7
7	72	23
8	3	0
9	246	91

Dynamical Aperture

Radius 7.00 σ

43.1 % unstable particles
(37.5 % over the stability
radius
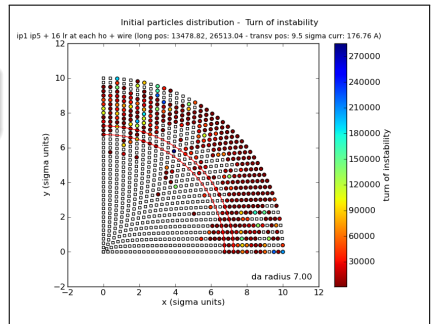
Initial particles distribution - Turn of instability
ip1 ip5 + 16 lr at each ho + wire (long pos: 13478.82, 26513.04 - transv pos: 9.5 sigma curr: 176.76 A)

Wire
Compensation

T. Rijoff, F.
Zimmermann

Head On

Head On +
Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod
9.5 σ 177A
11 σ 177A
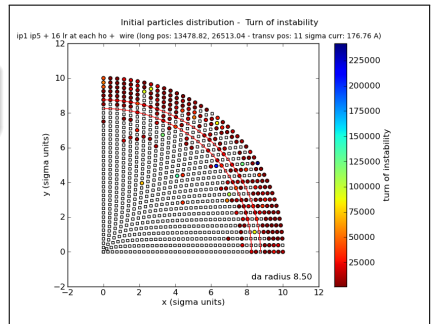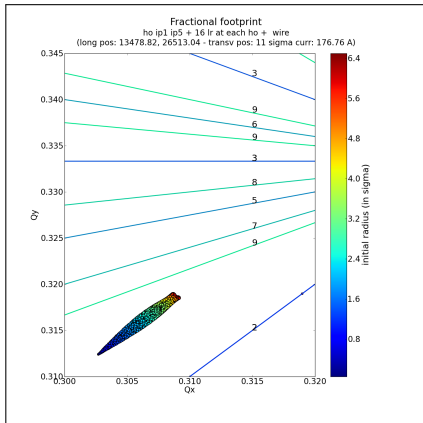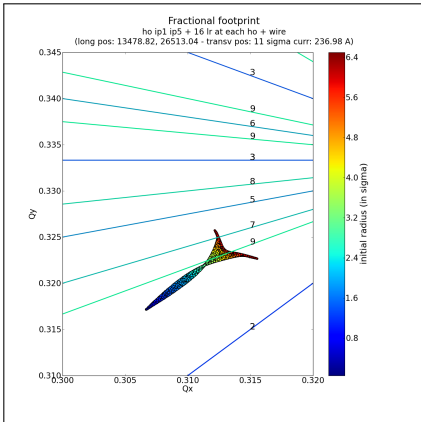11 σ 237A

Wire at TCT
mod 2
9.5 σ 177A
11 σ 177A
11 σ 237A

Central tune moved back to the original value

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13478.82, 26513.04 - transv pos: 9.5 sigma curr: 176.76 A)

footprint values

- $Q_x \in [0.3027, 0.3175]$
- $Q_y \in [0.3124, 0.3268]$

line	part	$< 4\sigma$
2	4	0
7	3	1
9	5	1

Wires moved at 11 σ with curr 176.76 A

9.5 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
26513.04	−145.84	0.00000	−0.00537	1581.02	635.83
13478.82	149.53	−0.00505	0.00000	1574.90	602.24

11 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
26513.04	−145.84	0.00000	−0.00622	1581.02	635.83
13478.82	149.53	−0.00585	0.00000	1574.90	602.24

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13478.82, 26513.04 - transv pos: 11 sigma curr: 176.76 A)

footprint values

- $Q_x \in [0.3056, 0.3121]$
- $Q_y \in [0.3159, 0.3226]$

line	part	$< 4\sigma$
9	39	6

Dynamical Aperture

Radius 8.50 σ

27.9 % unstable particles
(20.6 % over the stability
radius)

Initial particles distribution - Turn of instability

Wire Compensation

T. Rijoff, F. Zimmermann

Head On

Head On + Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT mod
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT mod 2
9.5 σ 177A
11 σ 177A
11 σ 237A

Central tune moved back to the original value

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13478.82, 26513.04 - transv pos: 11 sigma curr: 176.76 A)

footprint values

- $Q_x \in [0.3027, 0.3190]$
- $Q_y \in [0.3124, 0.3190]$

Tune footprint doesn't cross any resonance line with order smaller than 10

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13478.82, 26513.04 - transv pos: 11 sigma curr: 236.98 A)

footprint values

- $Q_x \in [0.3067, 0.3155]$
- $Q_y \in [0.3172, 0.3257]$

line	part	$< 4\sigma$
7	16	5
9	41	14

Wire at TCT + mod, dist: 11 σ , curr: 237.0 A

Wire
Compensation

T. Rijoff, F.
Zimmermann

Head On

Head On +
Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A
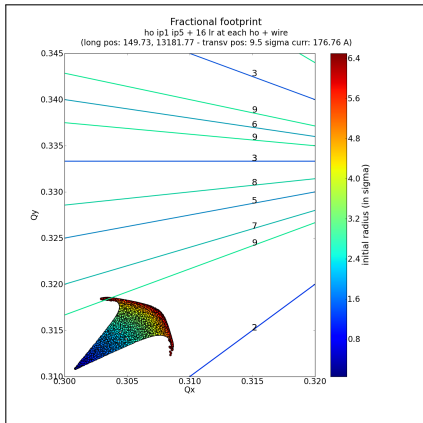
Wire at TCT
mod
9.5 σ 177A
11 σ 177A
11 σ 237 A

Wire at TCT
mod 2
9.5 σ 177A
11 σ 177A
11 σ 237 A

Dynamical Aperture

Radius 8.50 σ

30.5 % unstable particles
(22.1 % over the stability
radius)

Wire
Compensation

T. Rijoff, F.
Zimmermann

Head On

Head On +
Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod
9.5 σ 177A
11 σ 177A
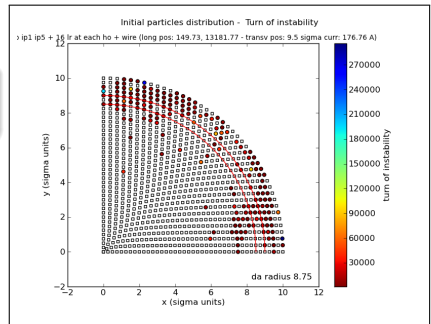11 σ 237 A

Wire at TCT
mod 2
9.5 σ 177A
11 σ 177A
11 σ 237 A

Central tune moved back to the original value

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13478.82, 26513.04 - transv pos: 11 sigma curr: 236.98 A)
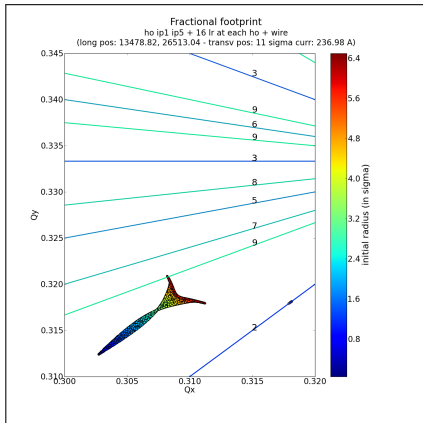
footprint values

- $Q_x \in [0.3027, 0.3181]$
- $Q_y \in [0.3124, 0.3209]$

line	part	$< 4\sigma$
9	3	0

Wire at nominal position			
s	**IP dist**	β_x	β_y
104.93	104.93	1738.14	1734.77
13434.22	104.93	1738.14	1734.78

Wire at nominal position			
s	**IP dist**	β_x	β_y
104.93	104.93	1738.14	1734.77
13434.22	104.93	1738.14	1734.78

Wire at TCT			
s	**IP dist**	β_x	β_y
26513.04	-145.84	1581.02	635.83
13181.77	-147.52	1574.90	602.24

Wire at TCT β, problem: 2 solution

Wire at nominal position			
s	**IP dist**	β_x	β_y
104.93	104.93	1738.14	1734.77
13434.22	104.93	1738.14	1734.78

Wire at TCT			
s	**IP dist**	β_x	β_y
26513.04	-145.84	1581.02	635.83
13181.77	-147.52	1574.90	602.24

Try: Move the wire at TCTH.4L5 to a different location!

Wire at TCT β, problem: 2 solution

Wire at nominal position			
s	**IP dist**	β_x	β_y
104.93	104.93	1738.14	1734.77
13434.22	104.93	1738.14	1734.78

Wire at TCT			
s	**IP dist**	β_x	β_y
26513.04	-145.84	1581.02	635.83
13181.77	-147.52	1574.90	602.24

Try: Move the wire at TCTH.4L5 to a different location!

Wire at TCT modified			
s	**IP dist**	β_x	β_y
149.73	149.73	559.44	1566.89
13181.77	-147.52	1574.90	602.24

Wire at TCTH.4L5 + Wire moved for best beta.
Horizontal location at 9.5 σ, curr 176.76 A

9.5 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
149.73	−145.84	0.00000	−0.00843	559.44	1566.89
13181.77	−147.52	−0.00845	0.00000	1574.90	602.24

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 149.73, 13181.77 - transv pos: 9.5 sigma curr: 176.76 A)

footprint values

- $Q_x \in [0.3009, 0.3086]$
- $Q_y \in [0.3109, 0.3185]$

line	part	$< 4\sigma$
9	3	0

Dynamical Aperture

Radius 8.75 σ

20.3 % unstable particles
(13.2 % over the stability
radius

Wires moved at 11 σ with curr 176.76 A

9.5 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
149.73	−145.84	0.00000	−0.00843	559.44	1566.89
13181.77	−147.52	−0.00845	0.00000	1574.90	602.24

11 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
149.73	−145.84	0.00000	−0.00976	559.44	1566.89
13181.77	−147.52	−0.00979	0.00000	1574.90	602.24

Wire
Compensation

T. Rijoff, F.
Zimmermann

Head On

Head On +
Long Range

Wire at BBC
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at TCT
mod 2
9.5 σ 177A
11 σ 177A
11 σ 237A

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 149.73, 13181.77 - transv pos: 11 sigma curr: 176.76 A)
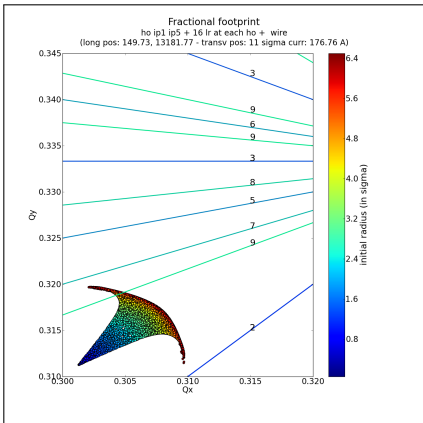
footprint values

- $Q_x \in [0.3013, 0.3097]$
- $Q_y \in [0.3113, 0.3197]$

line	part	$< 4\sigma$
9	5	1

Dynamical Aperture

Radius 9.00 σ

23.4 % unstable particles
(12.5 % over the stability
radius)
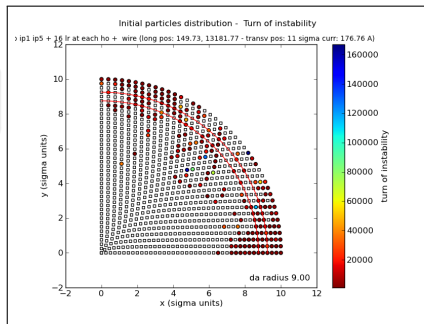
Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 149.73, 13181.77 - transv pos: 11 sigma curr: 236.98 A)
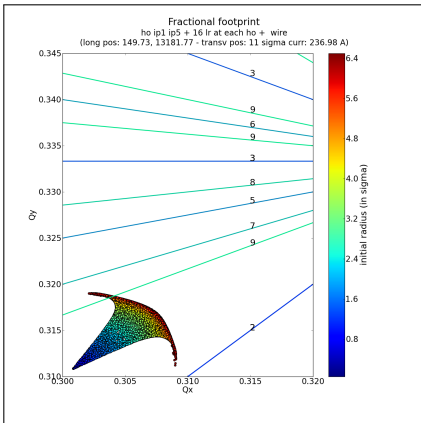
footprint values

- $Q_x \in [0.3009, 0.3091]$
- $Q_y \in [0.3109, 0.3190]$

line	part	$< 4\sigma$
9	6	2

Dynamical Aperture
Radius 8.75 σ

22.3 % unstable particles
(13.2 % over the stability
radius)
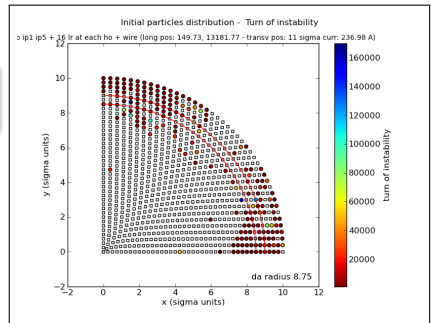
Two wires at the Q5 location at 9.5 σ with current 176.76 A

9.5 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
198.89	198.89	0.00000	−0.00478	105.92	503.04
13528.18	198.89	−0.00219	0.00000	105.92	503.04

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 198.89, 13528.18 - transv pos: 9.5 sigma curr: 176.76 A)

footprint values

- $Q_x \in [0.3005, 0.3097]$
- $Q_y \in [0.322, 0.3443]$

line	part	$< 4\sigma$
5	28	10
6	1	0
7	9	3
8	3	0

Dynamical Aperture

Radius 5.75 σ

52.5 % unstable particles,
48.4 % over the stability
radius
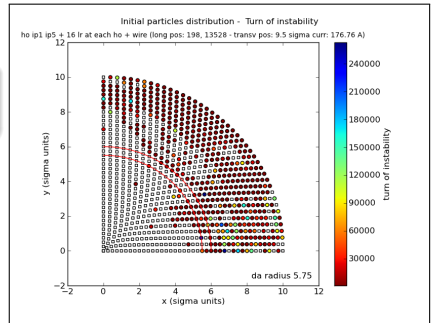
Central tune moved back to the original value

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 198.89, 13528.18 - transv pos: 9.5 sigma curr: 176.76 A)
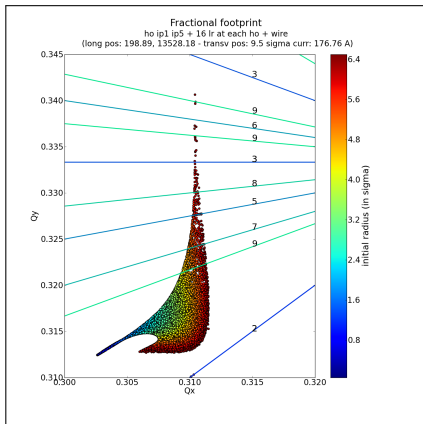
footprint values

- $Q_x \in [0.3026, 0.3115]$
- $Q_y \in [0.3101, 0.3406]$

line	part	$< 4\sigma$
5	9	1
7	10	3
8	1	0
9	20	5

Central tune moved back to the original value

Dynamical Aperture

Radius 7.00 σ

43.5 % unstable particles,
38.5 % over the stability
radius

Wires moved at 11 σ with current 176.76 A

9.5 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
198.89	198.89	0.00000	−0.00478	105.92	503.04
13528.18	198.89	−0.00219	0.00000	105.92	503.04

11 σ					
s	from IP	x pos	y pos	β_x	β_y
m	m	m	m	m	m
198.89	198.89	0.00000	−0.00553	105.92	503.04
13528.18	198.89	−0.00254	0.00000	105.92	503.04

Wire at Q5, distance: 11 σ , current: 176.8 A
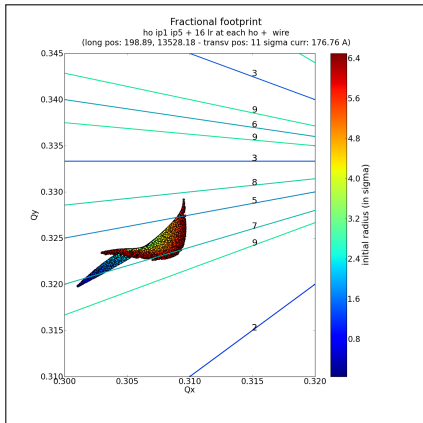
footprint values

- $Q_x \in [0.3011, 0.3096]$
- $Q_y \in [0.3198, 0.3292]$

line	part	$< 4\sigma$
5	6	1
7	28	12

Tune footprint *twists!*

Dynamical Aperture

Radius 7.50 σ

35.9 % unstable particles,
30.8 % over the stability
radius
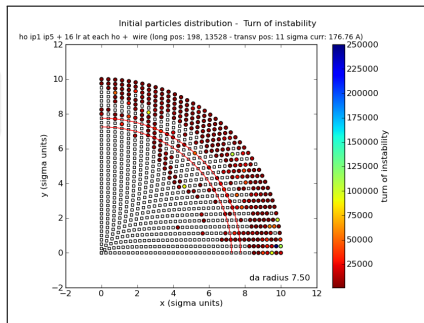
Central tune moved back to the original value

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 198.89, 13528.18 - transv pos: 11 sigma curr: 176.76 A)
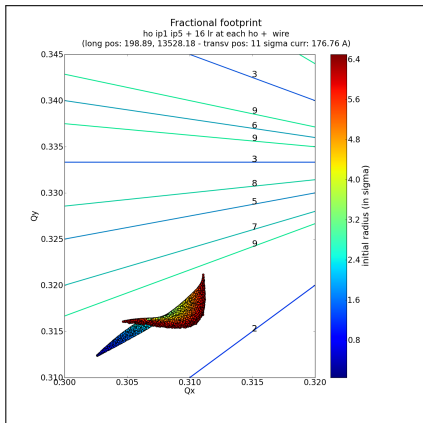
footprint values

- $Q_x \in [0.3026, 0.3112]$
- $Q_y \in [0.3124, 0.3211]$

Footprint *twists!*

Central tune moved back to the original value

Dynamical Aperture

Radius 8.25 σ

30.0 % unstable particles, 24.3 % over the stability radius
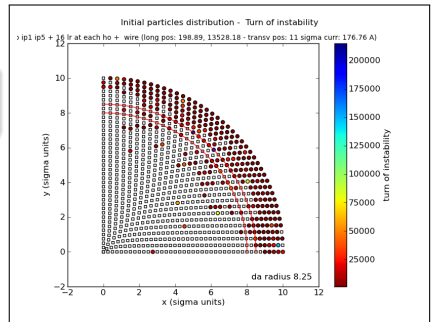
Wire
Compensation

T. Rijoff, F.
Zimmermann

Wire at Q5
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at BBC
Crossing 2 / 3
6.33σ 177A
7.33σ 177A
7.33σ 237A

Wire at TCT
Crossing 2 / 3
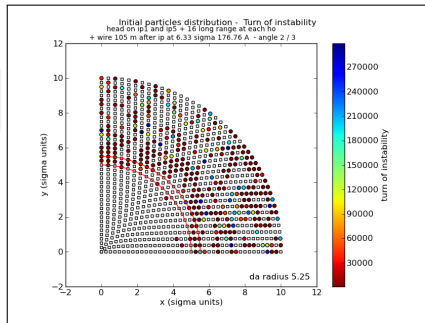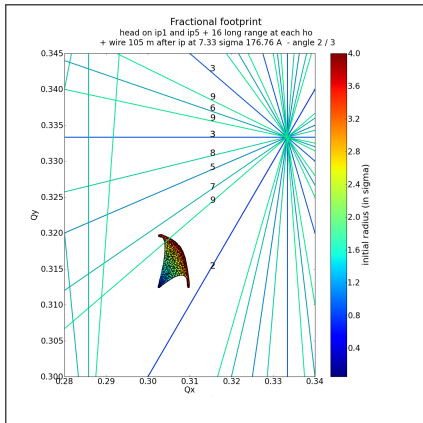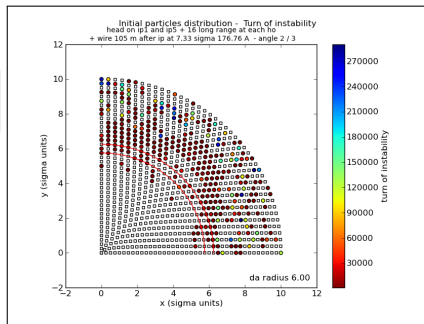6.33σ 177A
7.33σ 177A
7.33σ 237A

Wire at TCT
mod2
Crossing 2 / 3
6.33σ 177A
7.33σ 177A
7.33σ 237A

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 198.89, 13528.18 - transv pos: 11 sigma curr: 236.98 A)
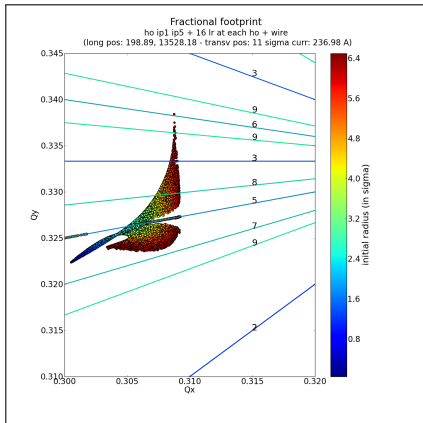
footprint values

- $Q_x \in [0.3000, 0.3093]$
- $Q_y \in [0.3224, 0.3384]$

line	part	$< 4\sigma$
3	7	0
5	31	17
8	4	0

Wire at Q5 , distance: 11 σ , current: 237.0 A

Dynamical Aperture

Radius 7.00 σ

45.6 % unstable particles,
38.7 % over the stability
radius
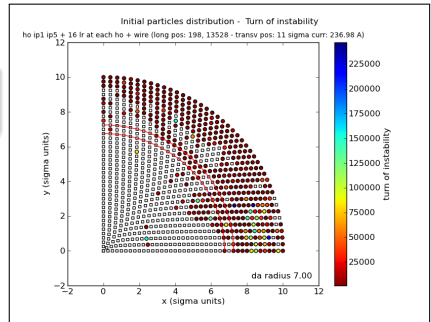
Central tune moved back to the original value

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 198.89, 13528.18 - transv pos: 11 sigma curr: 236.98 A)
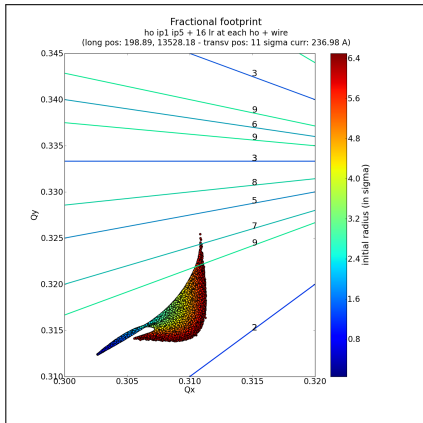
footprint values

- $Q_x \in [0.3026, 0.3113]$
- $Q_y \in [0.3124, 0.3254]$

line	part	$< 4\sigma$
7	5	1
9	18	1

Central tune moved back to the original value

Dynamical Aperture

Radius 7.75 σ

37.9 % unstable particles, 31.2 % over the stability radius
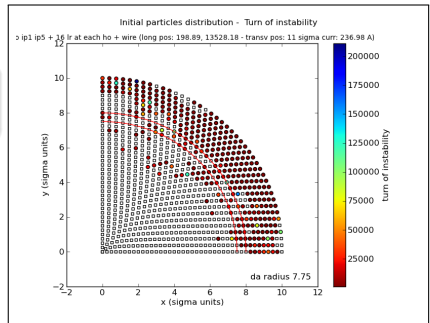
Initial particles distribution - Turn of instability

Wire Compensation

T. Rijoff, F. Zimmermann

Wire at Q5
9.5 σ 177A
11 σ 177A
11 σ 237A

Wire at BBC
Crossing 2 / 3
6.33σ 177A
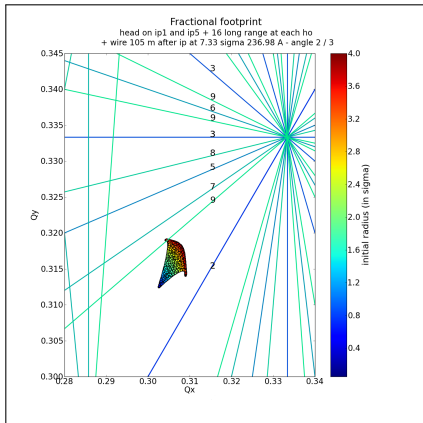7.33 σ 177A
7.33σ 237A

Wire at TCT
Crossing 2 / 3
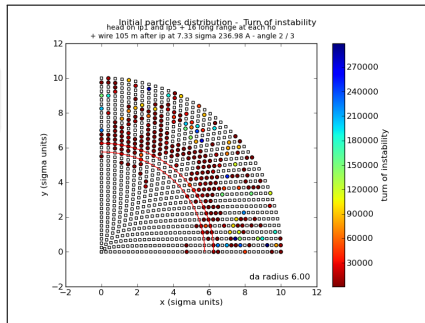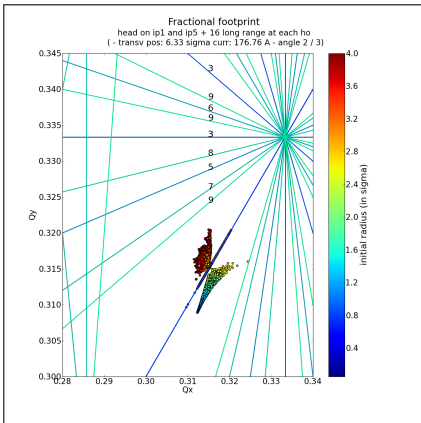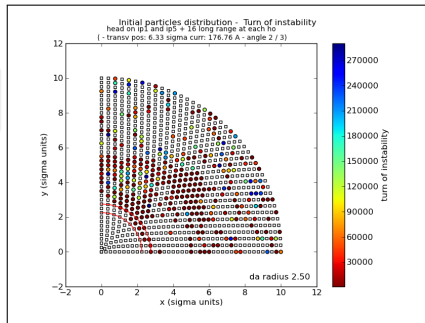6.33σ 177A
7.33 σ 177A
7.33σ 237A

Wire at TCT mod2
Crossing 2 / 3
6.33σ 177A
7.33 σ 177A
7.33σ 237A

Fractional footprint
head on ip1 and ip5 + 16 long range at each ho
+ wire 105 m after ip at 6.33 sigma 176.76 A - angle 2 / 3
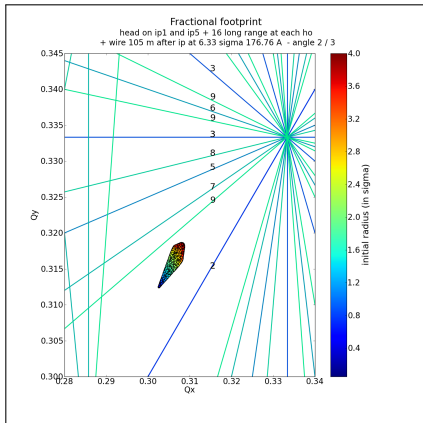
footprint values

- $Q_x \in [0.3026, 0.3086]$
- $Q_y \in [0.3125, 0.3186]$

Tune footprint doesn't cross any resonance line with order smaller than 10

Dynamical Aperture

Radius 5.25 σ

35.03% unstable particles
(2.00% over the stability
radius)

Initial particles distribution - Turn of instability
head on ip1 and ip5 + 16 long range at each ho
+ wire 105 m after ip at 6.33 sigma 176.76 A - angle 2 / 3

Fractional footprint
head on ip1 and ip5 + 16 long range at each ho
+ wire 105 m after ip at 7.33 sigma 176.76 A - angle 2 / 3

footprint values

- $Q_x \in [0.3026, 0.3097]$
- $Q_y \in [0.3125, 0.3197]$

line	part	$< 4\sigma$
9	3	3

Dynamical Aperture

Radius 6.00 σ

35.70% unstable particles (3.55% over the stability radius)

Initial particles distribution - Turn of instability
head on ip1 and ip5 + 16 long range at each h
+ wire 105 m after ip at 7.33 sigma 176.76 A - angle 2 / 3

Fractional footprint
head on ip1 and ip5 + 16 long range at each ho
+ wire 105 m after ip at 7.33 sigma 236.98 A - angle 2 / 3

footprint values

- $Q_x \in [0.3026, 0.3091]$
- $Q_y \in [0.3125, 0.3191]$

line	part	$< 4\sigma$
9	9	9

Dynamical Aperture

Radius 6.00 σ

30.16% unstable particles
(2.88% over the stability
radius)

Fractional footprint
head on ip1 and ip5 + 16 long range at each ho
(- transv pos: 6.33 sigma curr: 176.76 A - angle 2 / 3)

footprint values

- $Q_x \in [0.3097, 0.3244]$
- $Q_y \in [0.3089, 0.3205]$

line	part	$< 4\sigma$
2	1680	1680

Dynamical Aperture

Radius 2.50 σ

37.92% unstable particles (0.55% over the stability radius)

Initial particles distribution - Turn of instability
head on ip1 and ip5 + 16 long range at each ho
(- transv pos: 6.33 sigma curr: 176.76 A - angle 2 / 3)

Central tune moved back to the original value

Fractional footprint
head on ip1 + ip5 + 16 long range at each ho
(- transv pos: 6.33 sigma curr: 176.76 A - angle 2 / 3 with rot)

footprint values

- $Q_x \in [0.3006, 0.3224]$
- $Q_y \in [0.3027, 0.3235]$

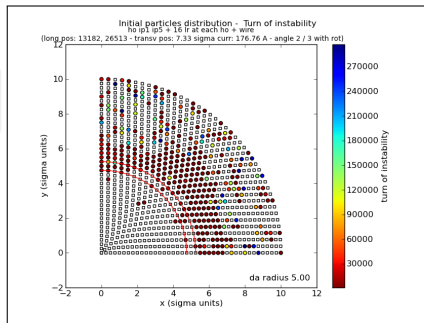| line	part	$< 4\sigma$
2	14	14
7	6	6
9	6	6

Central tune moved back to the original value

Dynamical Aperture

Radius 4.00 σ

33.92% unstable particles
(1.66% over the stability
radius)

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13182, 26513 - transv pos: 7.33 sigma curr: 176.76 A - angle 2 / 3)

footprint values

- $Q_x \in [0.3099, 0.3193]$
- $Q_y \in [0.3099, 0.3193]$

line	part	$< 4\sigma$
2	1376	1376

Dynamical Aperture

Radius 4.75 σ

38.69% unstable particles
(3.55% over the stability
radius)
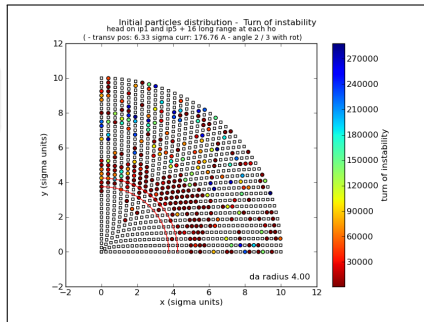
Wire at TCT , d = 7.33 σ , I = 176.8 A - Crossing Angle 2 / 3

Central tune moved back to the original value

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13182, 26513 - transv pos: 7.33 sigma curr: 176.76 A - angle 2 / 3 with rot)
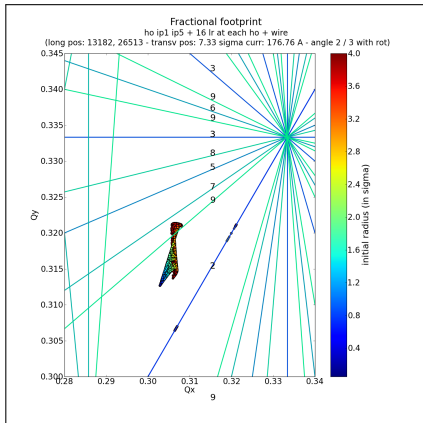
footprint values

- $Q_x \in [0.3029, 0.3212]$
- $Q_y \in [0.3064, 0.3214]$

line	part	$< 4\sigma$
2	14	14
9	3	3

Central tune moved back to the original value

Dynamical Aperture

Radius 5.00 σ

38.69% unstable particles
(2.00% over the stability
radius)

Initial particles distribution - Turn of instability
ho ip1 ip5 + 16 lr at each ho + wire
(long.pos: 13182, 26513 - transv pos: 7.33 sigma curr: 176.76 A - angle 2 / 3 with rot)

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13182, 26513 - transv pos: 7.33 sigma curr: 236.98 A - angle 2 / 3)

footprint values

- $Q_x \in [0.3101, 0.3199]$
- $Q_y \in [0.3089, 0.3199]$

line	part	$< 4\sigma$
2	1986	1986

Dynamical Aperture

Radius 3.00 σ

46.45% unstable particles
(0.78% over the stability
radius)
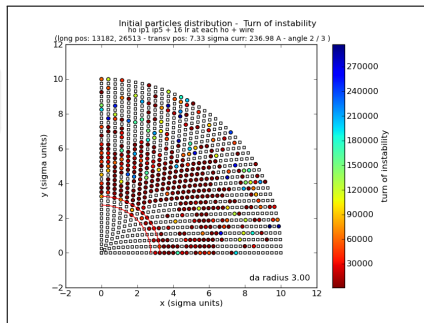
Central tune moved back to the original value

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13182, 26513 - transv pos: 7.33 sigma curr: 236.98 A - angle 2 / 3 with rot)
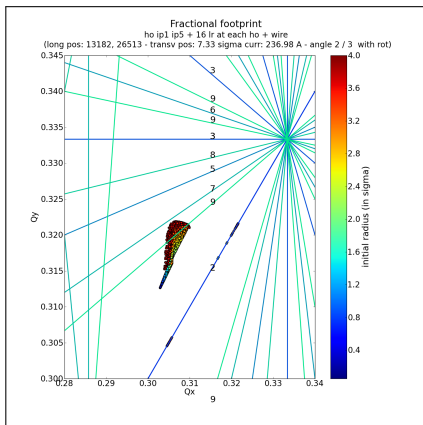
footprint values

- $Q_x \in [0.3029, 0.3216]$
- $Q_y \in [0.3045, 0.3219]$

line	part	$< 4\sigma$
2	60	60
9	10	10

Central tune moved back to the original value

Dynamical Aperture

Radius 4.75 σ

36.03% unstable particles
(3.22% over the stability
radius)

Initial particles distribution - Turn of instability
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 13182, 26513 - transv pos: 7.33 sigma curr: 236.98 A - angle 2 / 3 with rot)

footprint values

- $Q_x \in [0.2982, 0.3056]$
- $Q_y \in [0.3039, 0.3155]$

Tune footprint doesn't cross any resonance line with order smaller than 10

Dynamical Aperture

Radius 5.50 σ

31.37% unstable particles
(3.22% over the stability
radius)

Central tune moved back to the original value

Dynamical Aperture

Radius 5.50 σ

31.37% unstable particles (3.22% over the stability radius)

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 149.73, 13181.77 - transv pos: 7.33 sigma curr: 176.76 A)

footprint values

- $Q_x \in [0.2972, 0.3075]$
- $Q_y \in [0.3066, 0.3176]$

line	part	$< 4\sigma$
9	2	2

Dynamical Aperture

Radius 5.50 σ

41.46% unstable particles
(3.88% over the stability
radius)

Fractional footprint
ho ip1 ip5 + 16 lr at each ho + wire
(long pos: 149.73, 13181.77 - transv pos: 7.33 sigma curr: 236.98 A)

footprint values

- $Q_x \in [0.2970, 0.3062]$
- $Q_y \in [0.3041, 0.3162]$

line	part	$< 4\sigma$
9	1	1

Dynamical Aperture

Radius 5.75 σ

36.14% unstable particles (3.88% over the stability radius)

Initial particles distribution – Turn of instability
ho ip1 ip5 + 16 Ir at each ho + wire
(long pos: 149.73, 13181.77 - transv pos: 7.33 sigma cur: 236.98 A)