

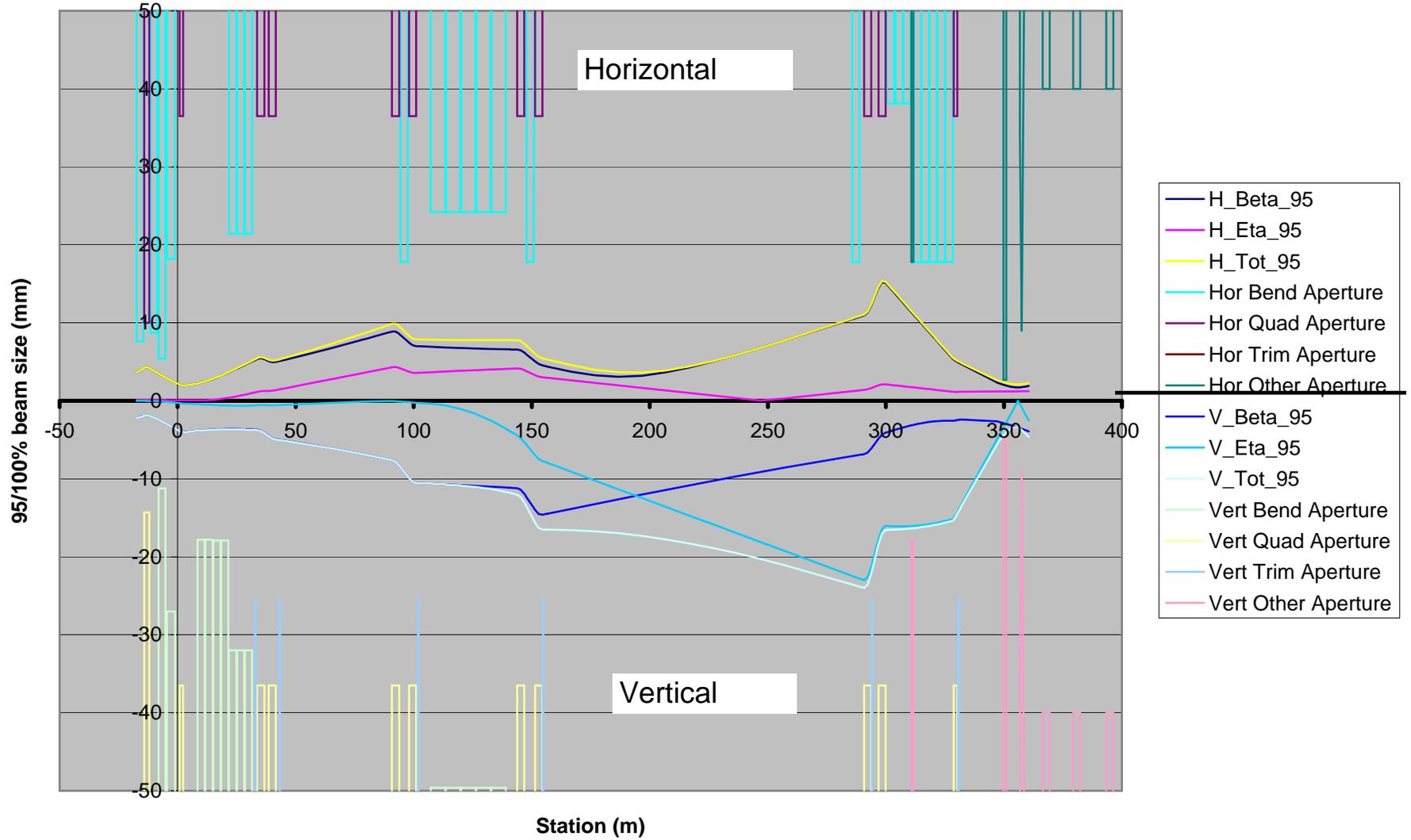
## Case of no new magnets

11 constraints on transport and targeting

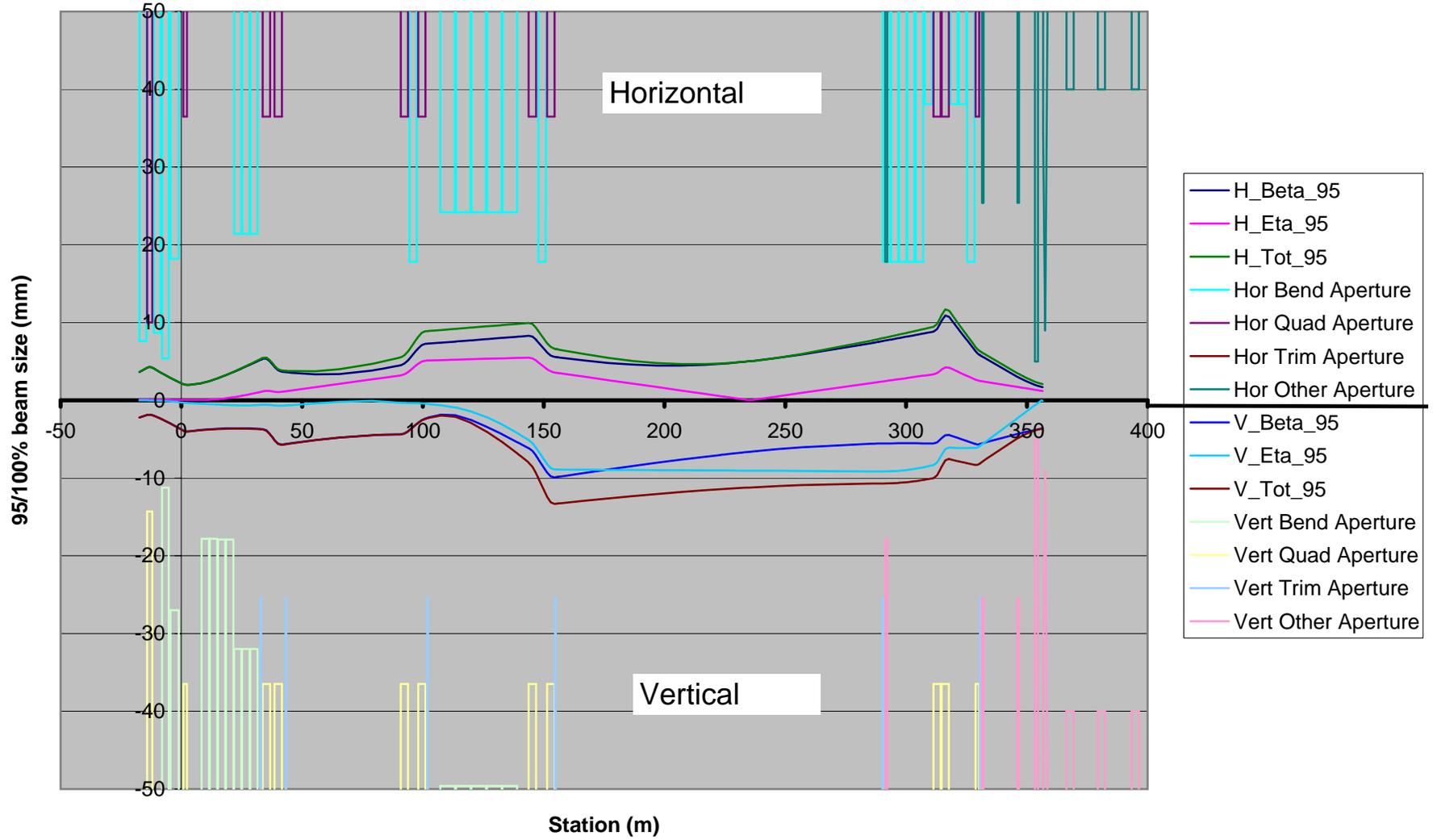
Constraint condition	Tolerance	Location	Fitted value
$\beta_x = 0$	200	Q105	161.3
$\beta_y = 0$	200	Q107	306.2
$\beta_x = 0$	250	carrier pipe	71.6
$\beta_y = 0$	250	carrier pipe	155.2
$\eta_x = 0$	5	carrier pipe	-.4
$\eta_y = 0$	2.5	carrier pipe	7.5
$\beta_x = 9.39$	6	target	9.1
$\beta_y = 37.57$	10	target	42.1
$\eta_y = 0$	.3	target	-.1
$\alpha_x = 0$	3	target	.3
$\alpha_y = 0$	1	target	.7

9 variables in the fit, gradients of quads 102-110

# 95/100% Beam Sizes and Apertures



# 95/100% Beam Sizes and Apertures



## Case of new magnets included

### Upstream fit

6 constraints on transport

Constraint condition	Tolerance	Location	Fitted value
$\beta_x = 0$	200	Q105	54.4
$\beta_y = 0$	200	Q107	72.3
$\beta_x = 0$	250	carrier pipe	79.0
$\beta_y = 0$	250	carrier pipe	65.4
$\eta_x = 0$	5	carrier pipe	-.1
$\eta_y = 0$	2.5	carrier pipe	.04

6 variables in the fit, gradients of quads 102-107

### Downstream fit

8 constraints on transport and targeting

Constraint condition	Tolerance	Location	Fitted value
$\beta_y = 0$	200	carrier pipe	245.5
$\beta_x = 0$	200	Q109	268.7
$\eta_x = 0$	2.5	Q109	2.4
$\beta_x = 9.39$	6	target	13.8
$\beta_y = 37.57$	10	target	38.1
$\eta_y = 0$	.3	target	-.01
$\alpha_x = 0$	3	target	.38
$\alpha_y = 0$	1	target	-.03

7 variables in the fit, station of first new quad, station of second new quad, gradients of two new quads plus quads 108-110

## Quads 108, 109 and 110, position by hand

- Get best results when quads 108 and 109 are separated minimally
- Insert the pair successively before each bending magnet in pretarget
- Select best location by minimized betas in transport
- This chooses location between sixth and seventh of nine dipoles
- Insert quad 110 successively before each bending magnet downstream of Q108-Q109 pair, again minimizing betas in transport
- This chooses location between eighth and ninth dipoles
- At the best fit value, quads 109 and 110 run higher than 90 amps
  - Replace 10' Q109 by 10' plus 5', in series
  - Replace 5' Q110 by 10'
- Results for quad gradients/currents:

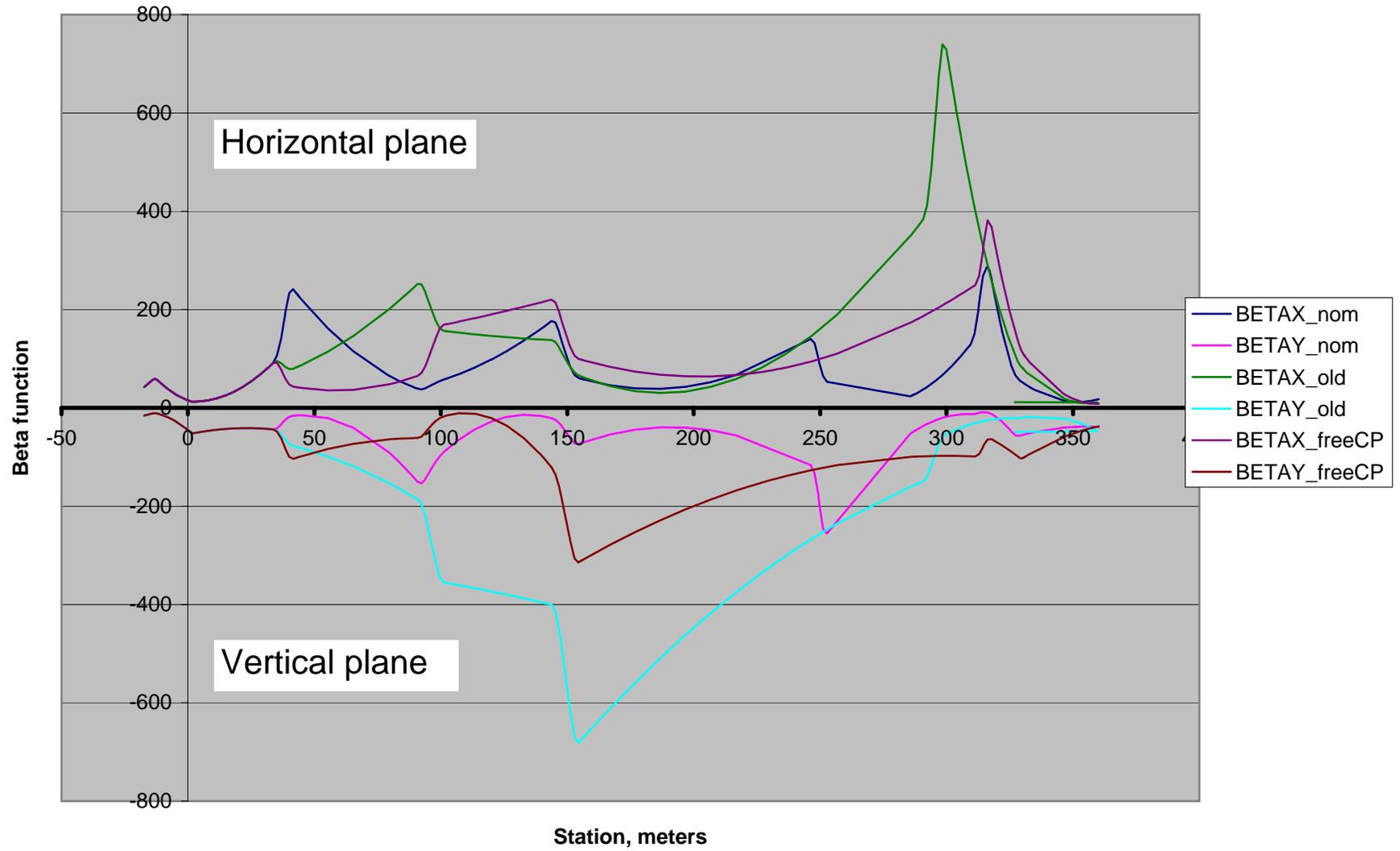
Magnet	Gradient (kg/m)	Current (amp)
101	-144.74	-70.40
102	-119.22	-57.99
103	123.27	59.96
104	-67.30	-32.74
105	17.69	8.60
106	89.28	43.43
107	-100.49	-48.88
107a	163.98	79.76
107b	-158.89	-77.29
108	-131.11	-63.77
109	129.79	63.13
110	-99.56	48.43

- Location of largest beam size in pretarget region has changed
  - Move three large aperture dipoles to coincide with largest size beam
  - This selects sixth thru eighth of nine dipoles

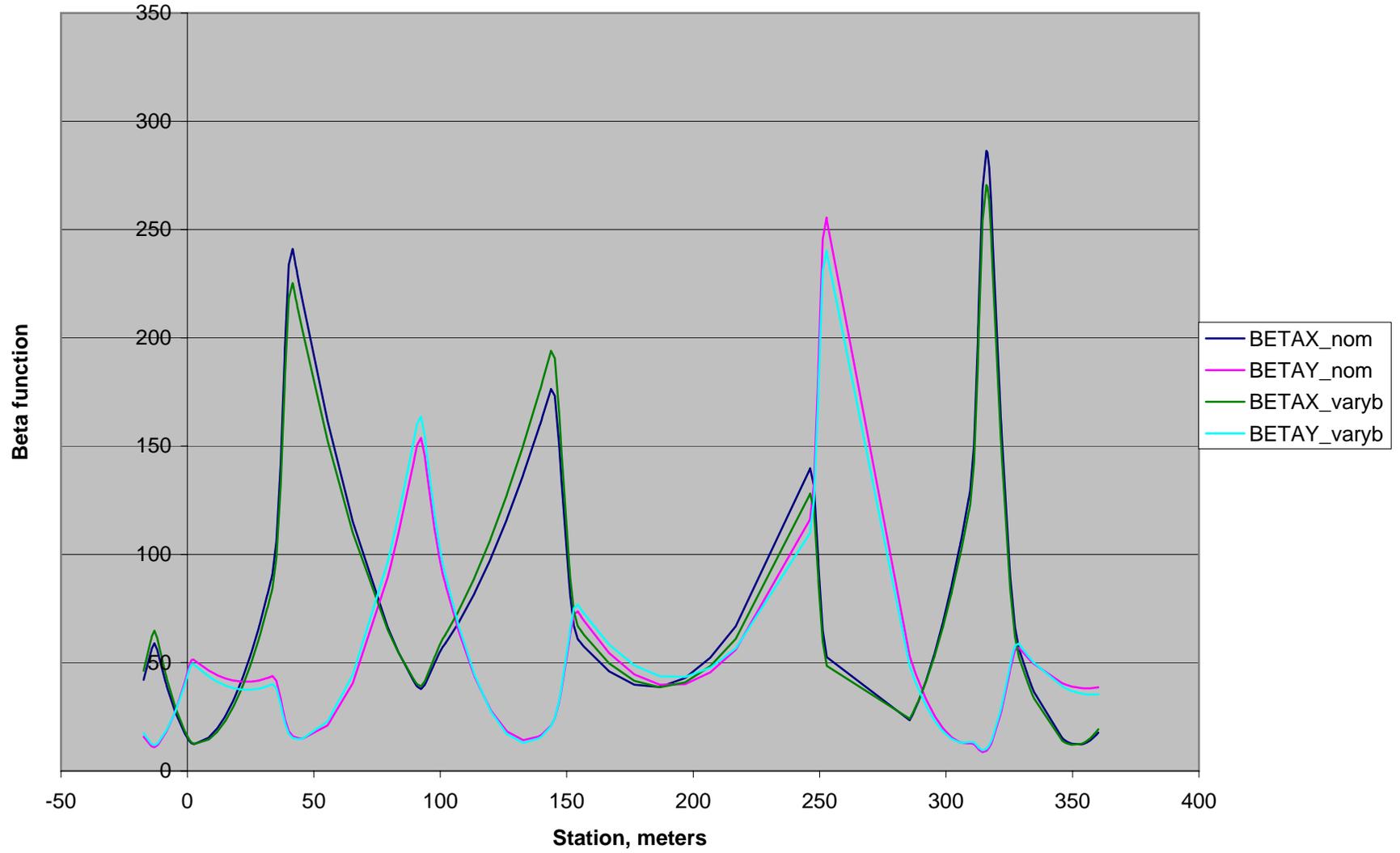
## Changes in quad and dipole positions in pretarget hall change bend centers and resulting downstream trajectory

- In practice cannot change transverse position of target, buried in shielding
- Similarly cannot change targeting angle, which is set by location of far detector
- Turn two knobs - fields of EPB (V110) and 6-3-120 (V109) strings
  - (Note that these two strings have run at identical fields thus far)
  - Fit these two values to produce desired position and angle at target
  - Result is unfortunate - runs 6-3-120 string far into saturation
- Solution is a compromise:
  - Change the angle into pretarget by varying V105 string in stub, goes from -17.82 kgauss to -18.05 kgauss
  - This lowers elevation of beam by 2.3" at start of carrier tunnel and 11.2" at its end
  - Replace the ninth pretarget EPB dipole with a 6-3-120
  - V110 EPB string drops from 14.25 kgauss to 13.72 kgauss and V109 6-3-120 string goes to 15.50 kgauss, 1025 amps

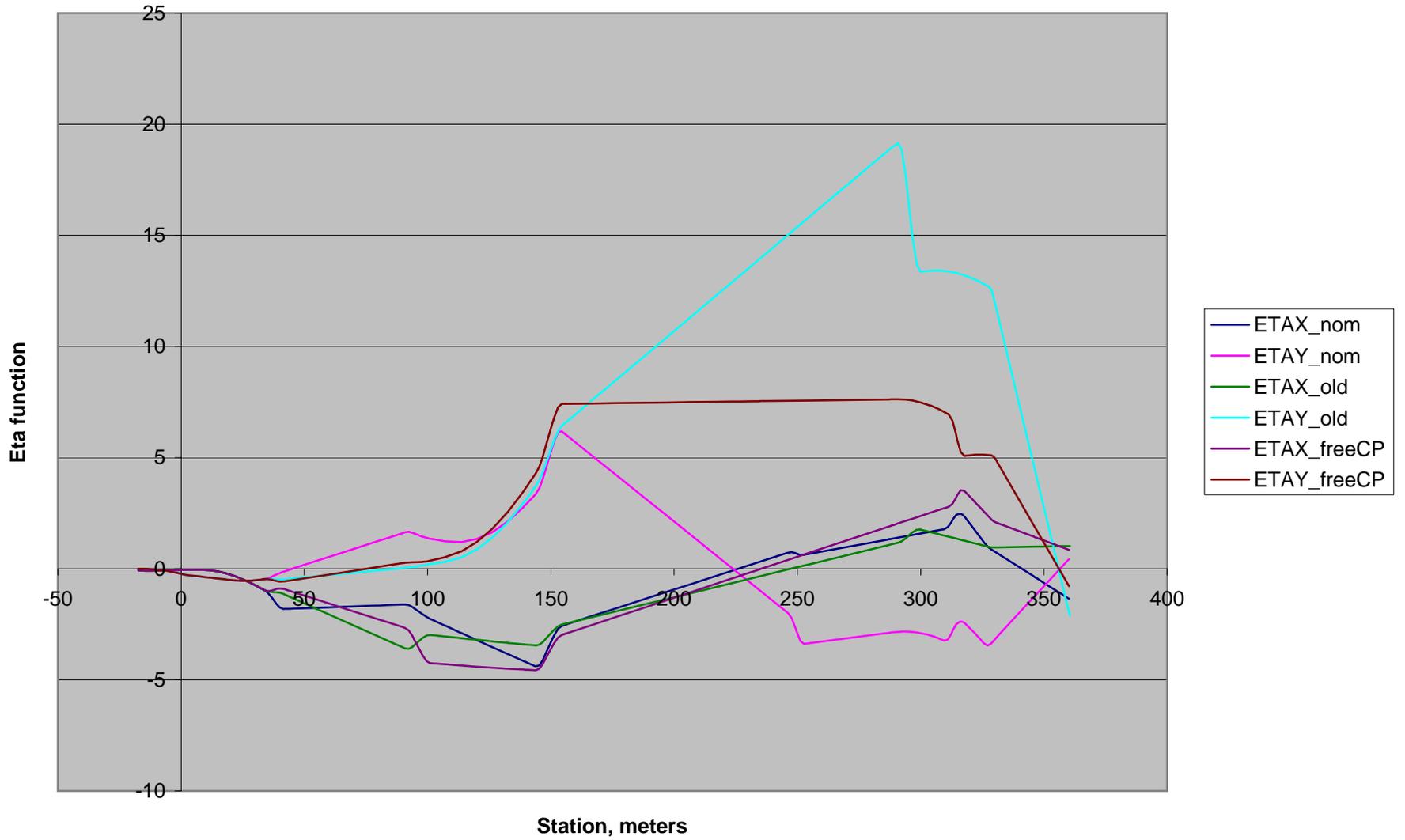
### Three Generations of Beta Functions



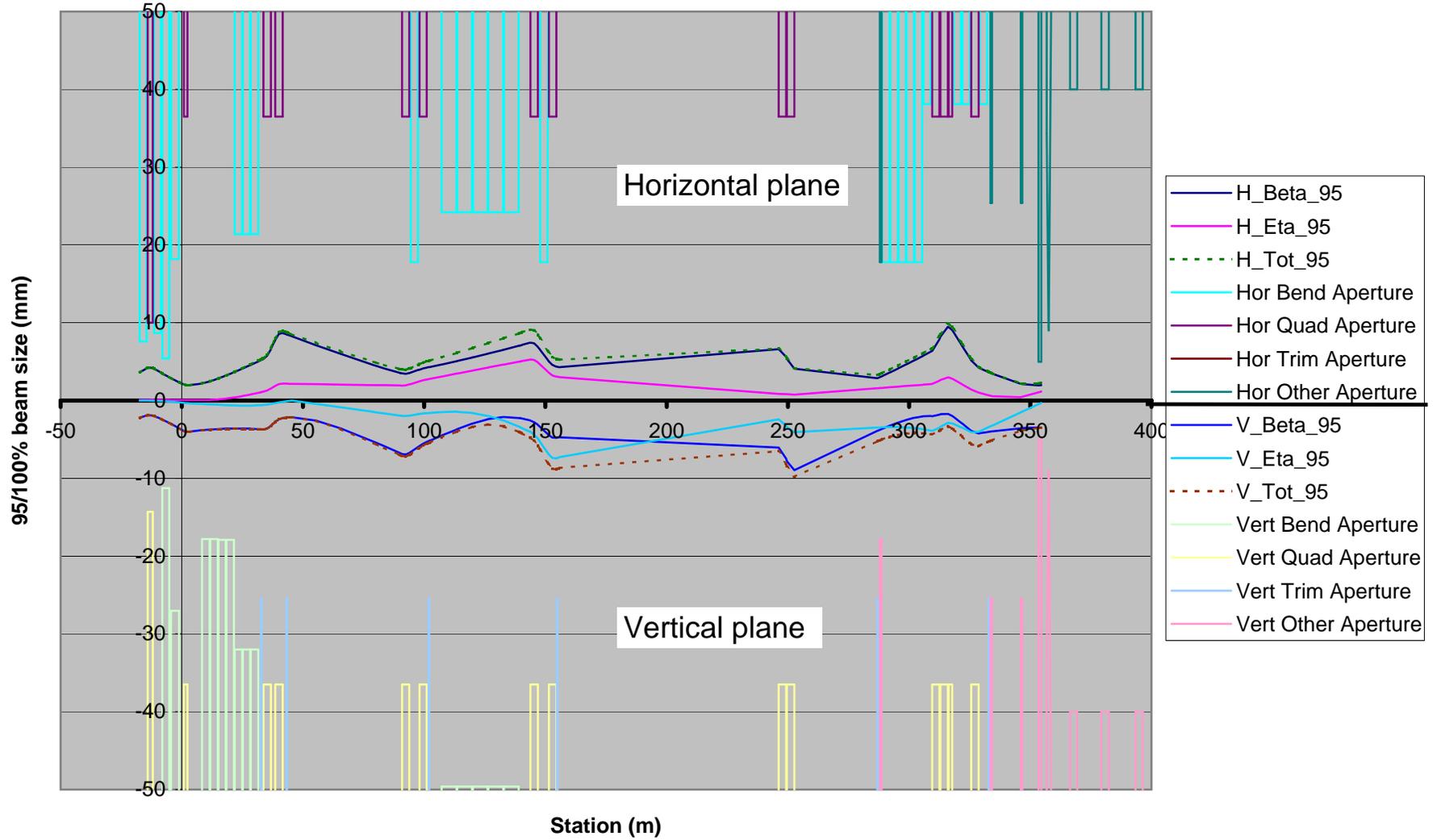
**Beta Dependence on Initial Values**



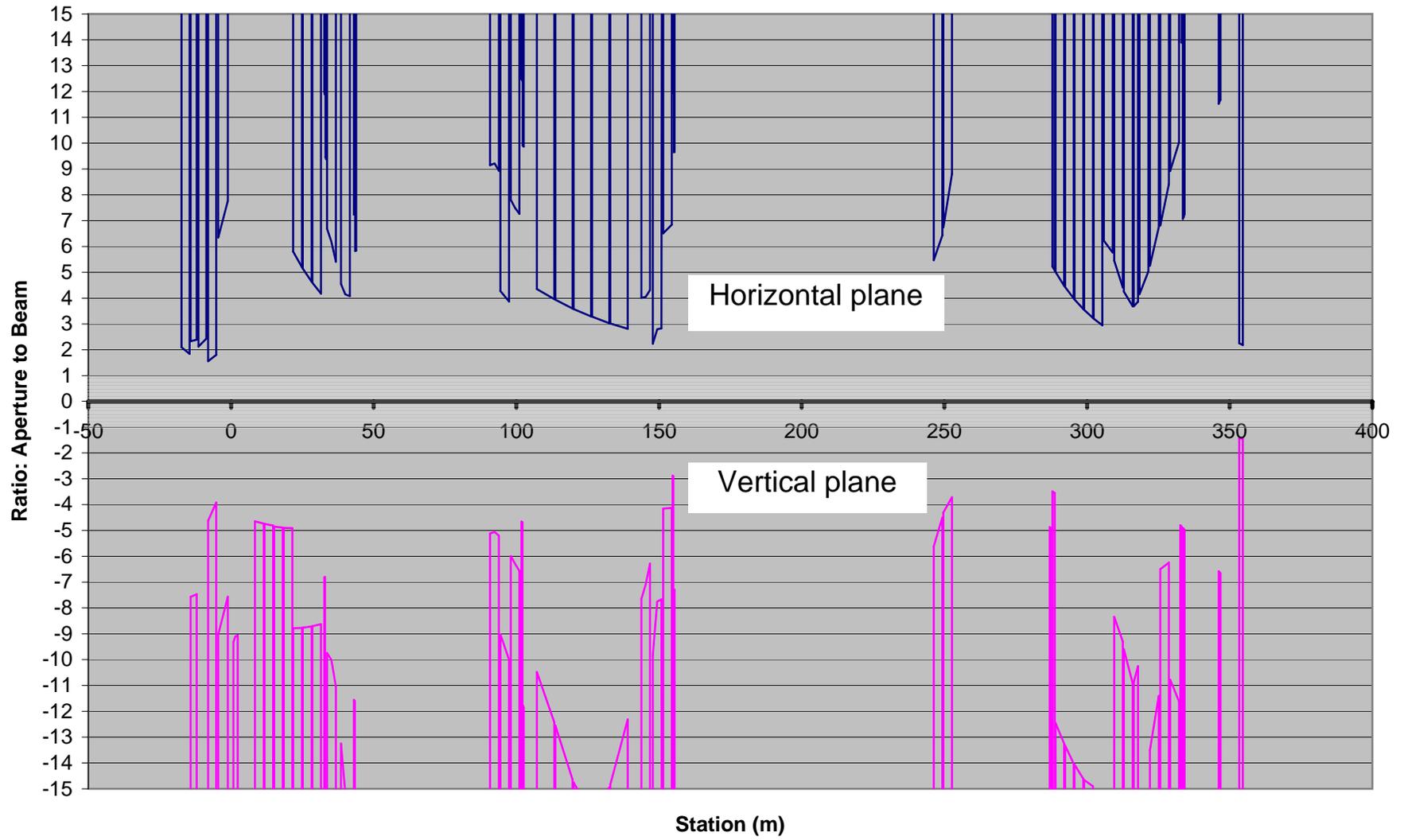
### Three Generations of Eta Functions



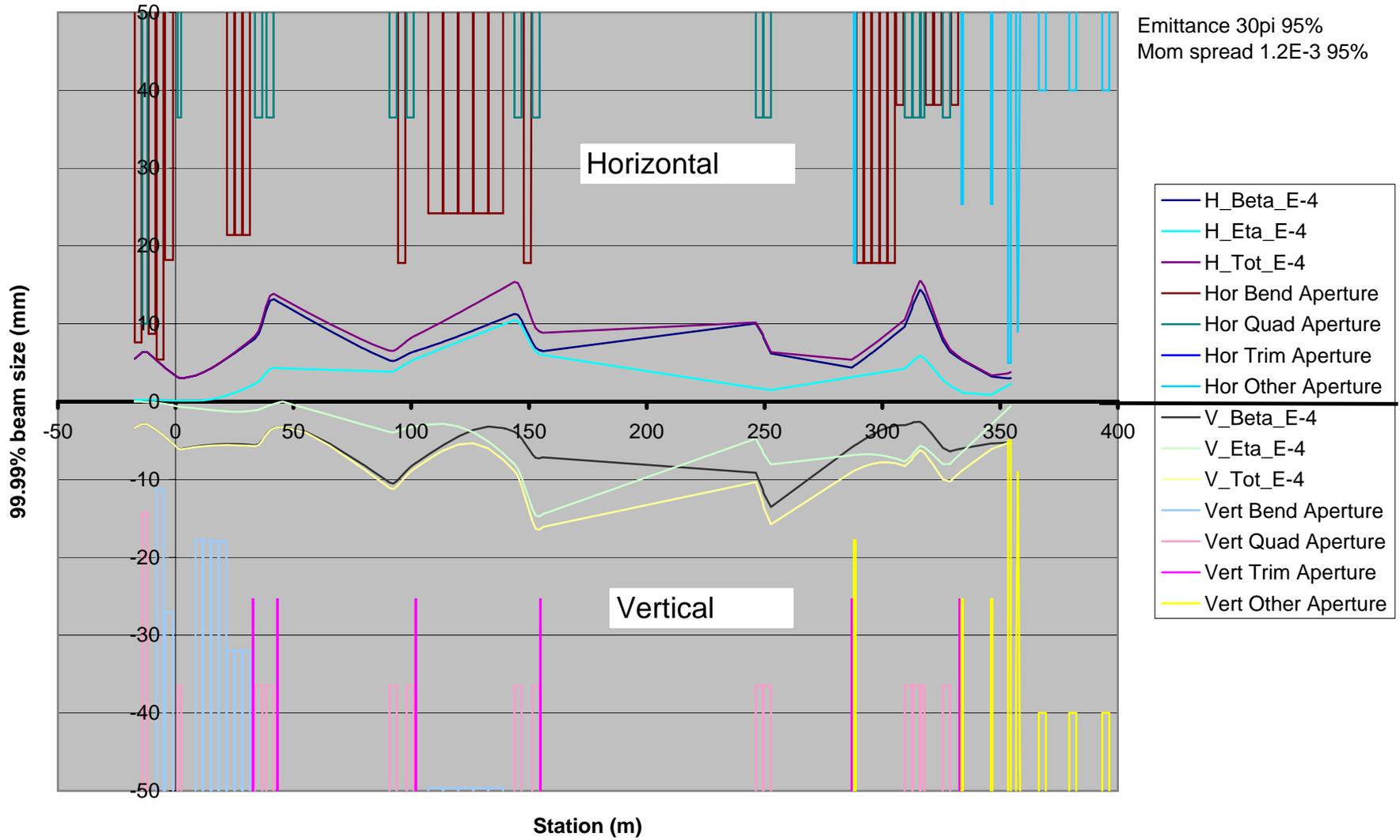
# 95/100% Beam Sizes and Apertures



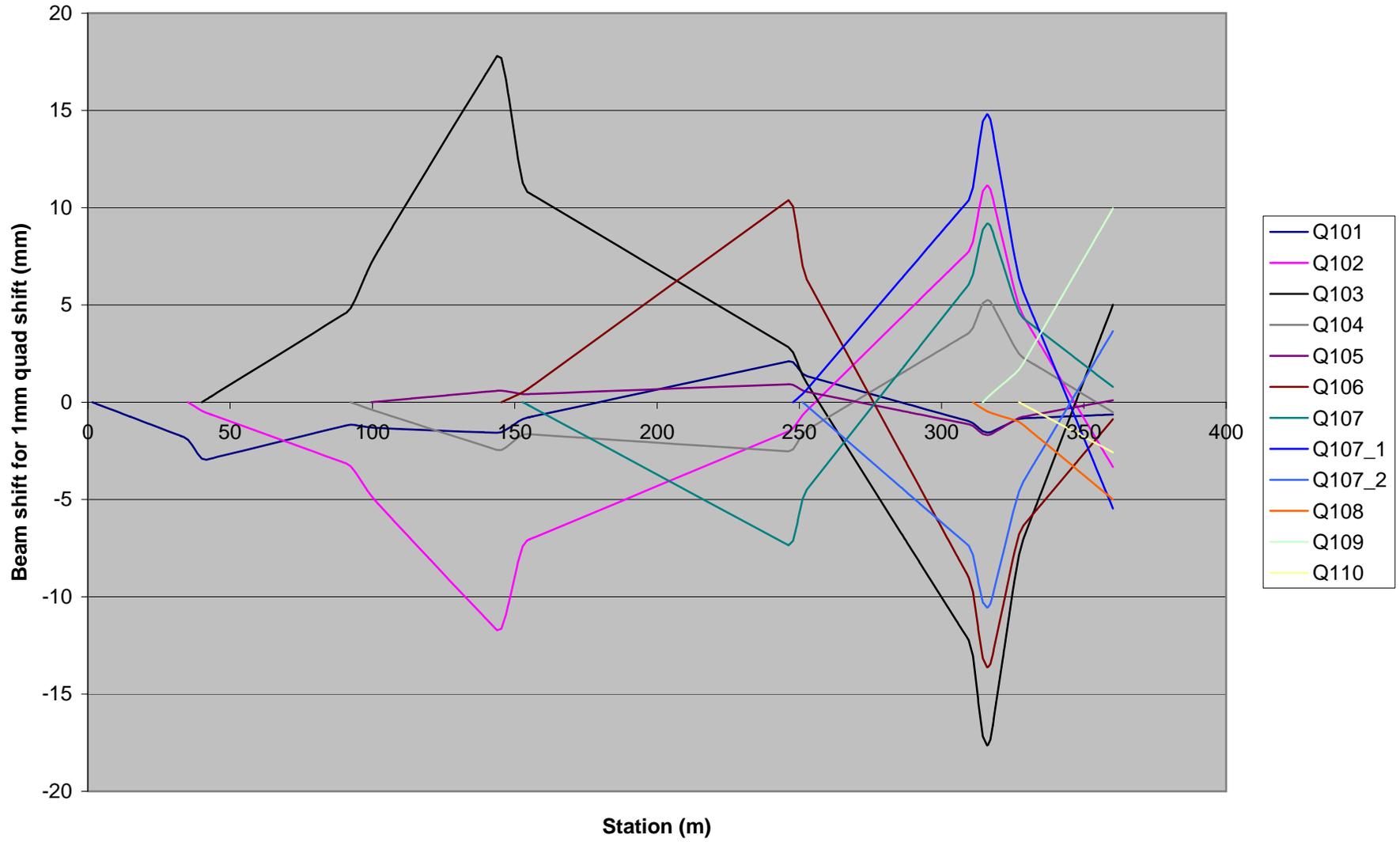
# Ratio Plot



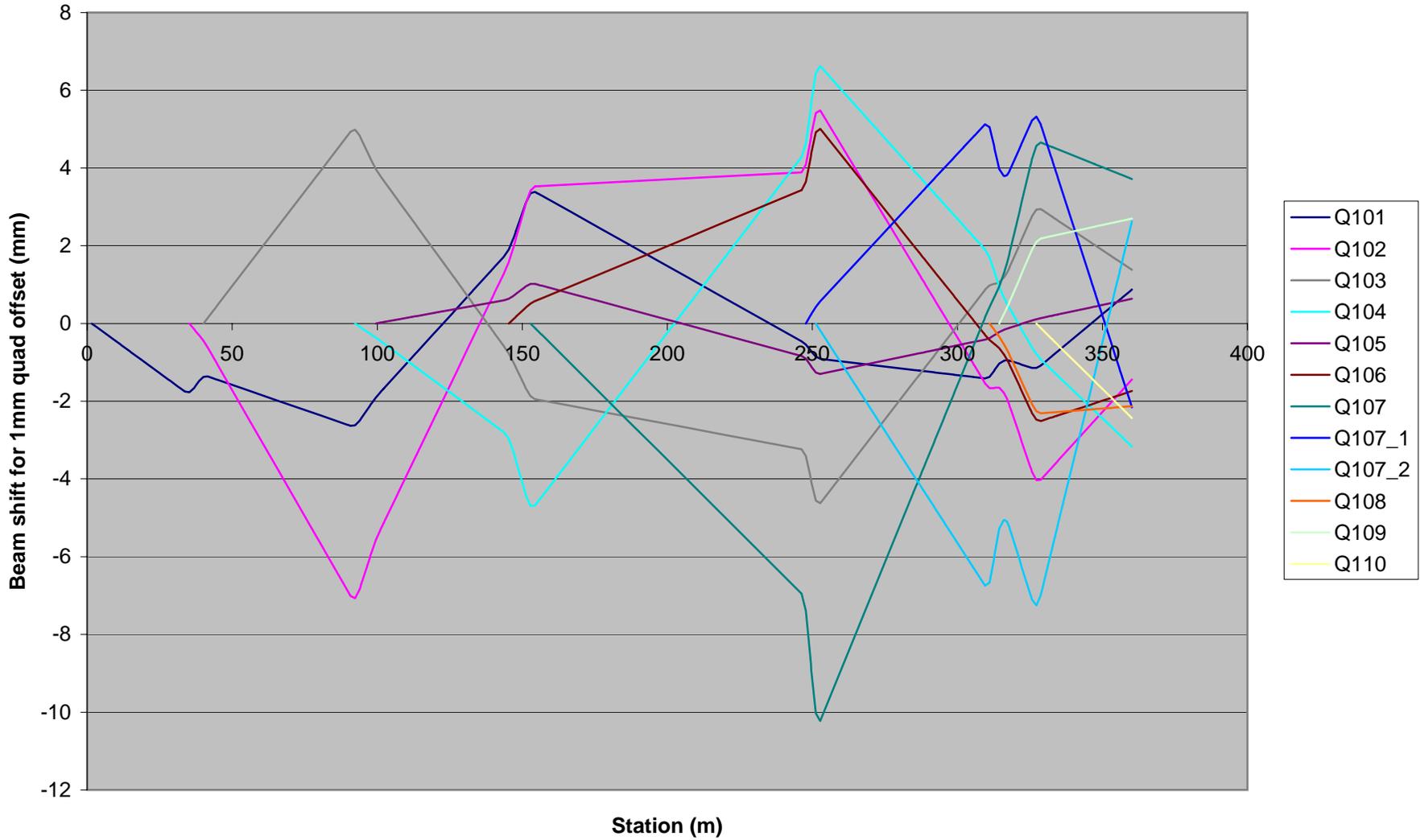
# 1.0E-4 Tails Beam Sizes and Apertures



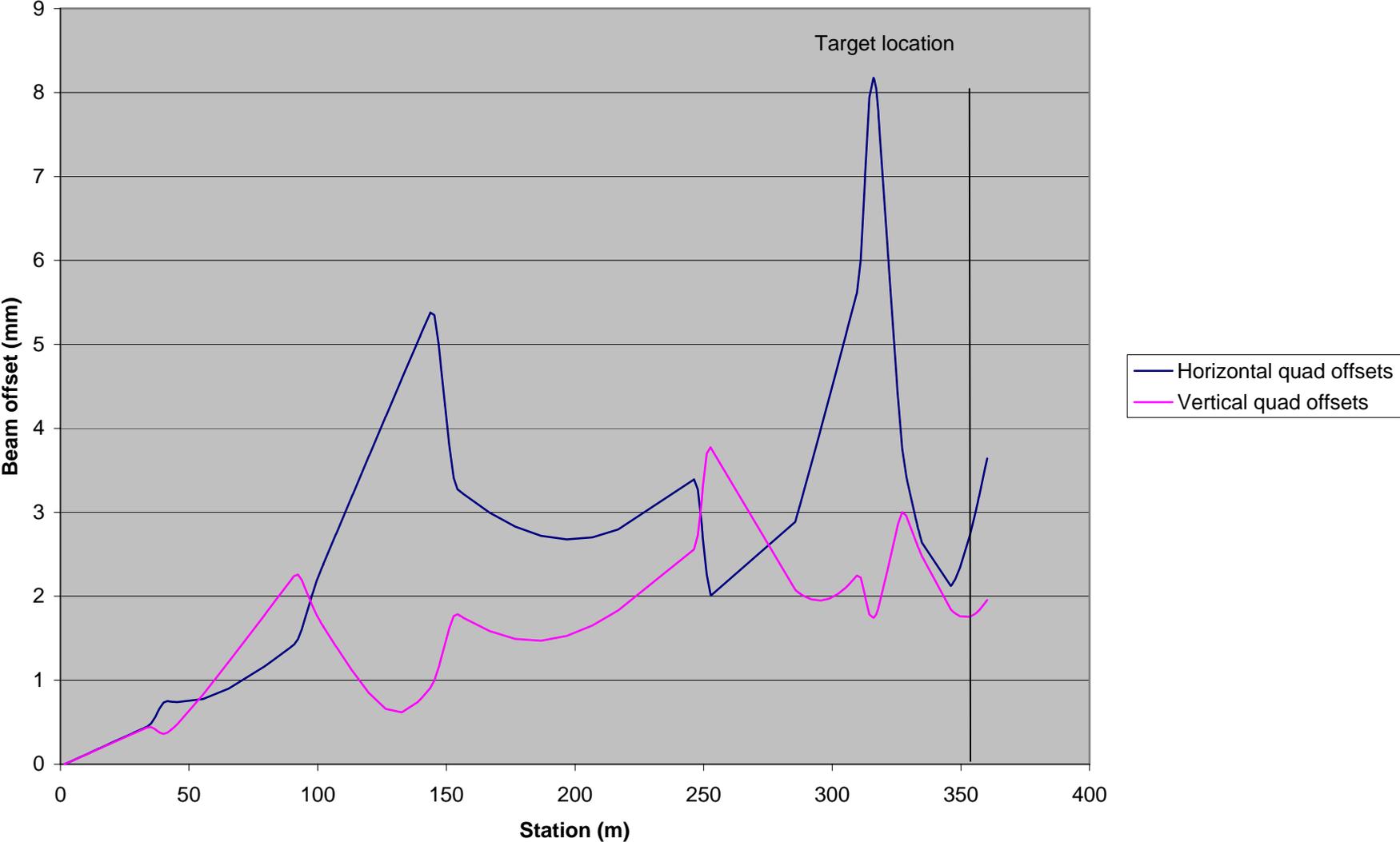
### Effects of Horizontal Quad Displacements



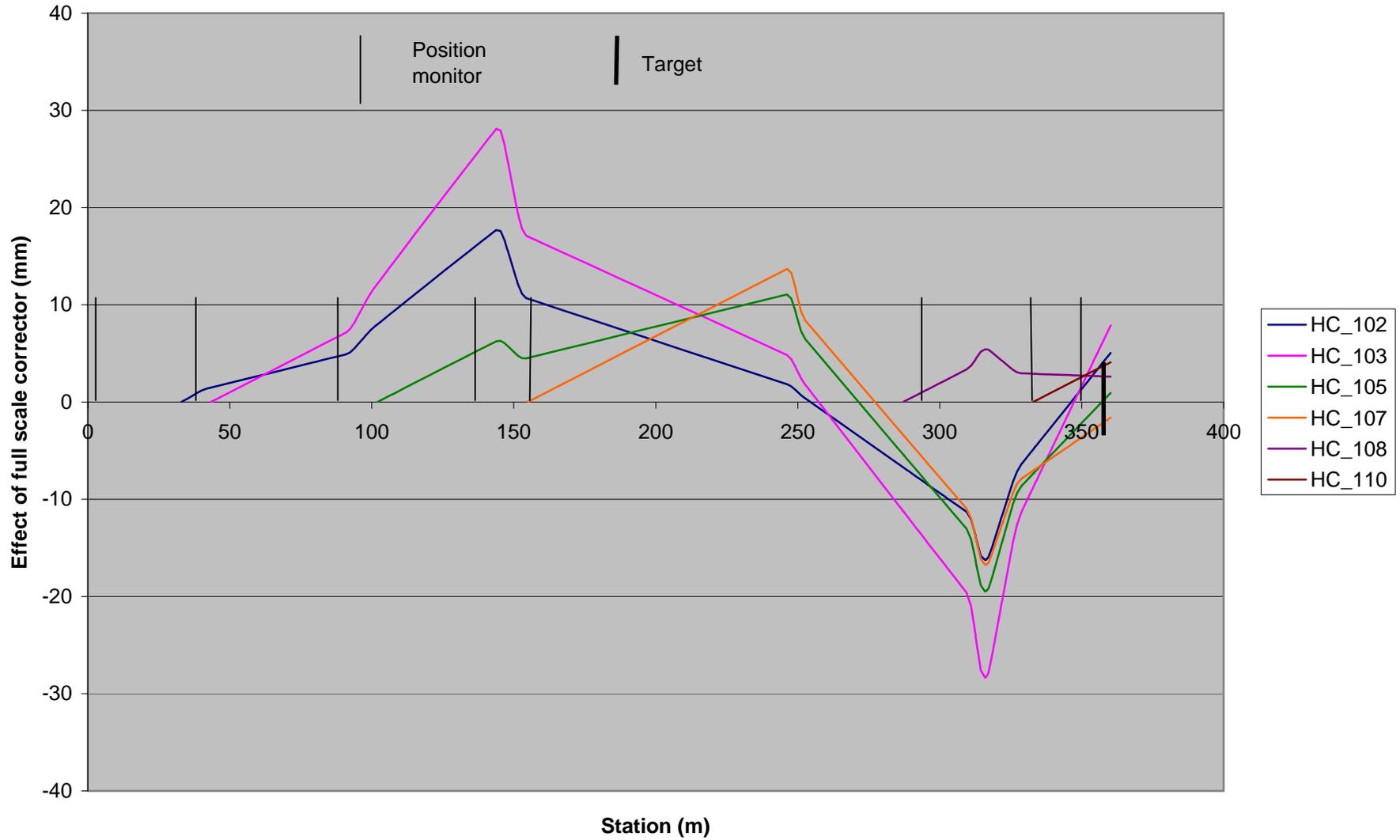
### Beam Shifts from Vertical Quad Offsets



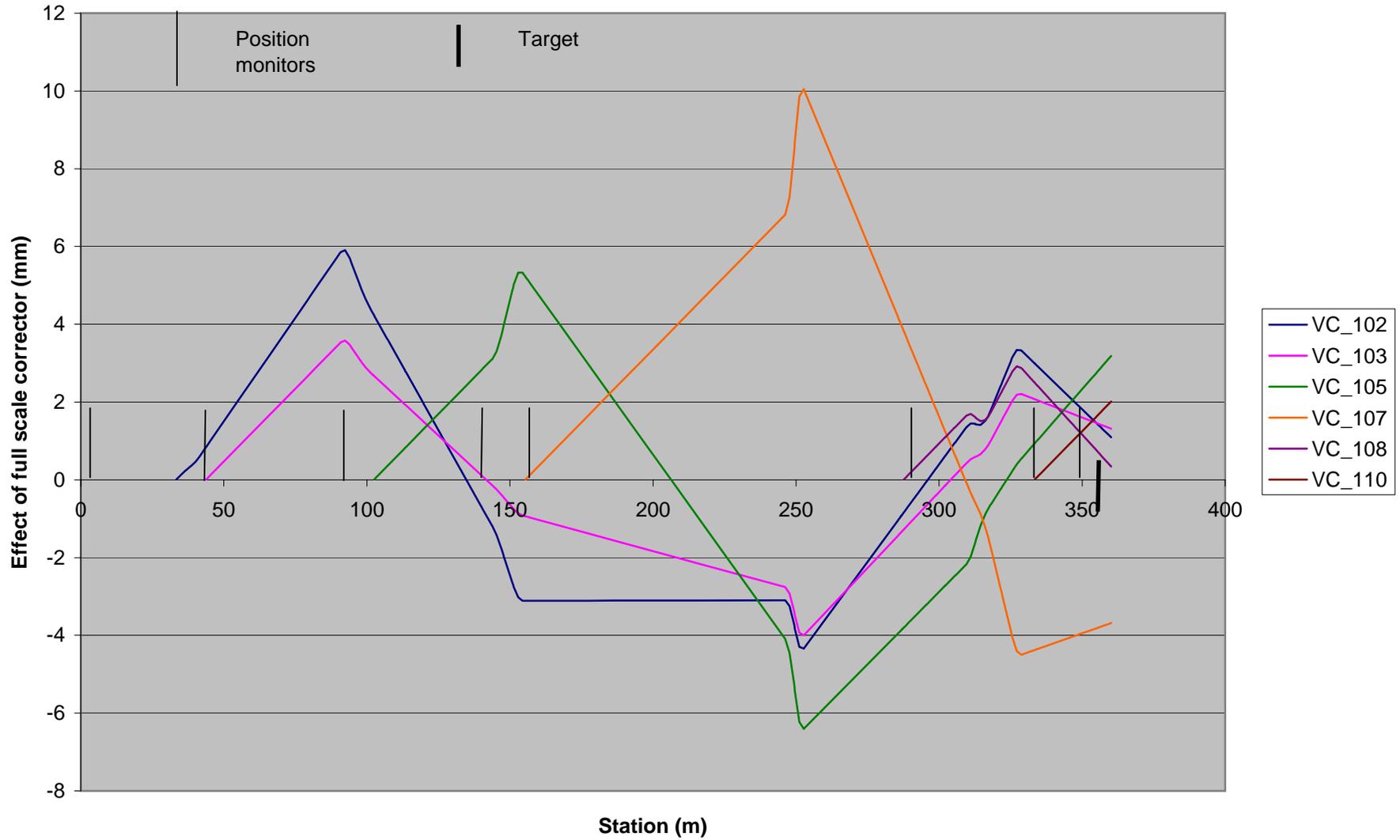
### Combined Effect of .25mm Quad Offsets



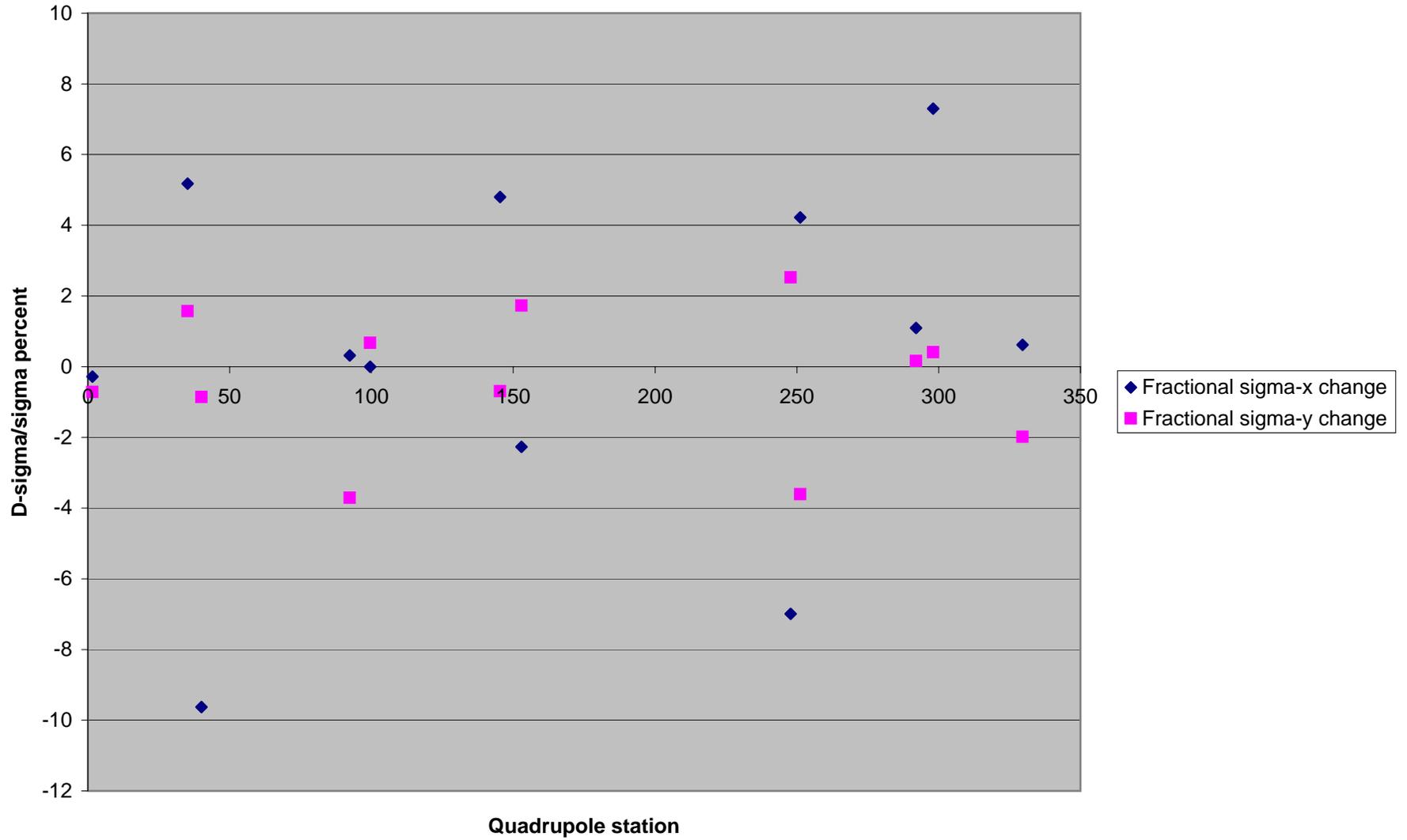
# Horizontal Corrector Ranges



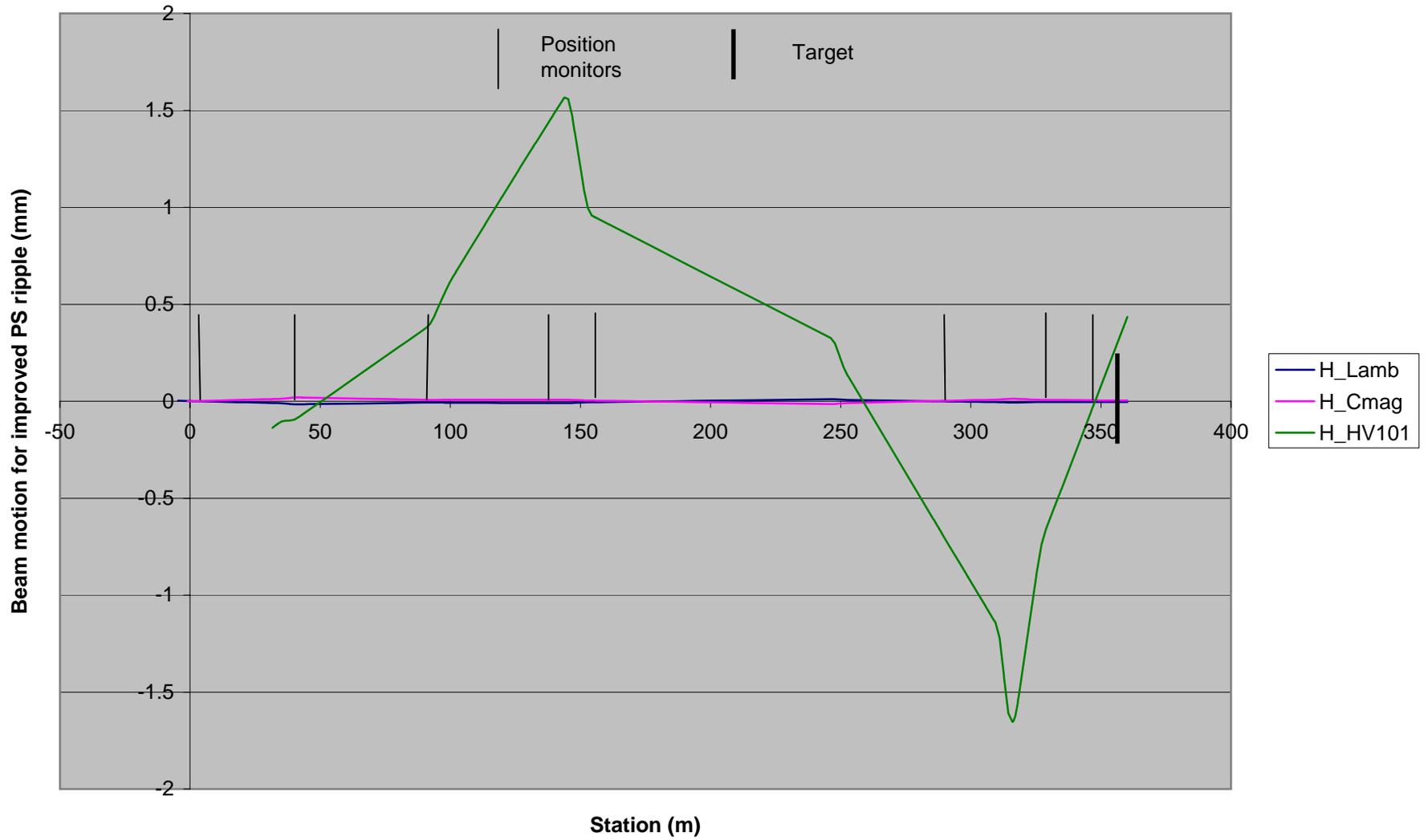
# Vertical Corrector Ranges



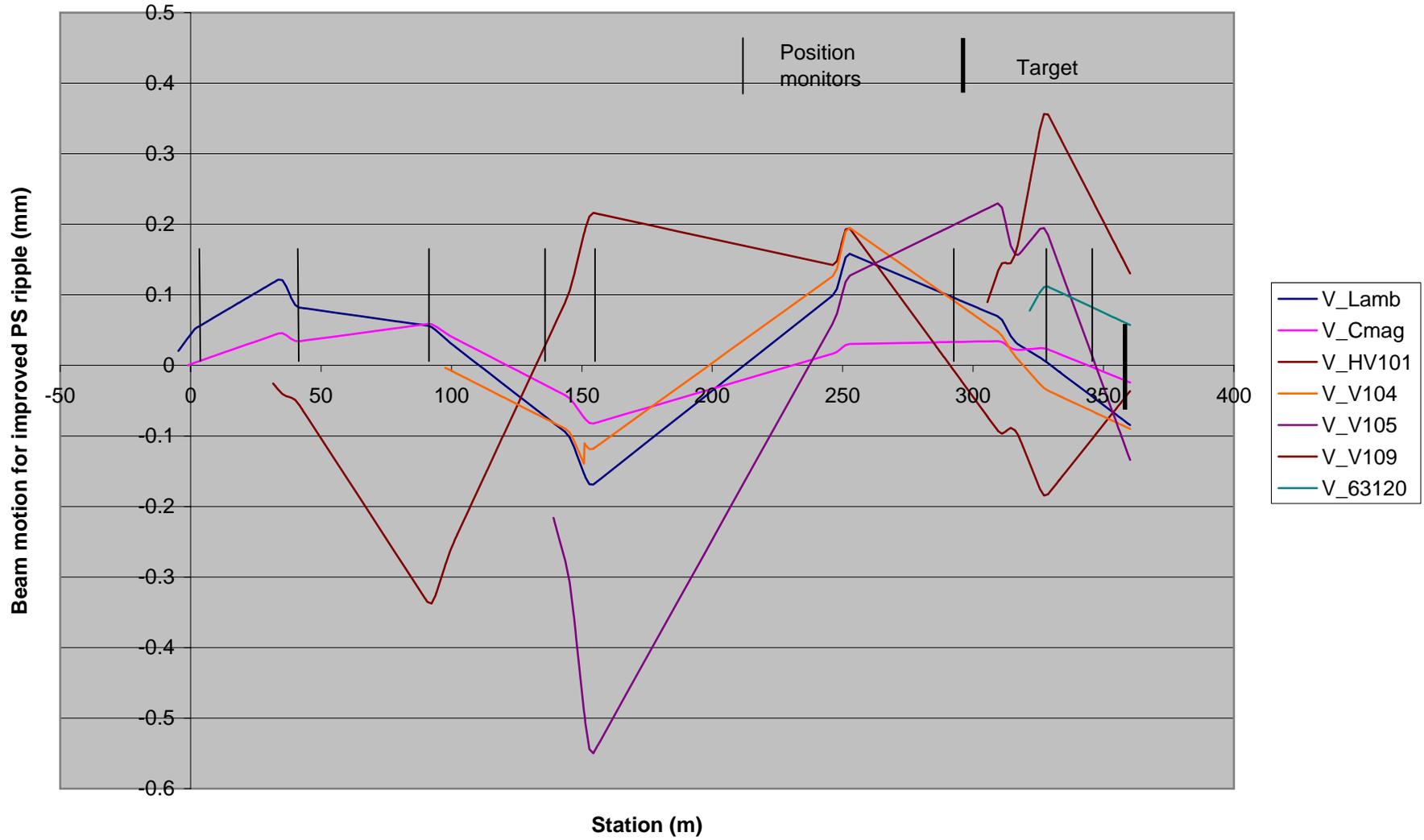
Fractional beam size change at target for 1% gradient change



### Sensitivities to PS in Horizontal



### Sensitivities to Power Supplies Vertical



## Summary of changes

- Add three new 3Q120 quadrupoles on two circuits
  - Plus power, water, vacuum
- Almost all quadrupoles run at increased current
  - Ramifications on sensitivity
- Replace one EPB dipole with a 6-3-120.
  - This probably requires one additional power supply
- Change magnet stands (not yet built), minimally in stub region, more significantly in pretarget
- Carrier pipe no longer parallel to carrier tunnel
- Free drift space between targeting BPM pairs cut by 2.1 meters out of 15 meters