

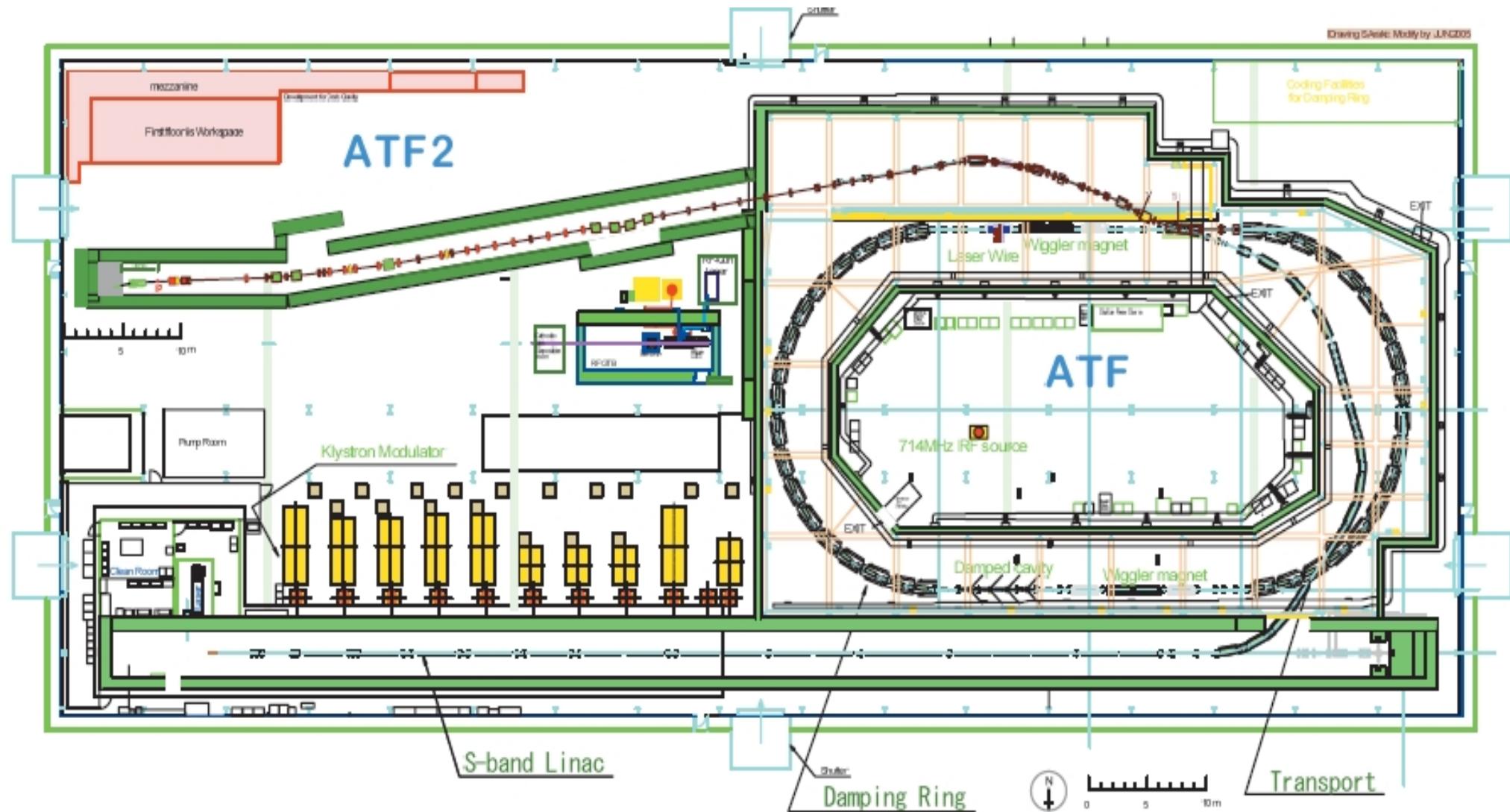
Study of time-dependent corrections in the ATF2 beam-line

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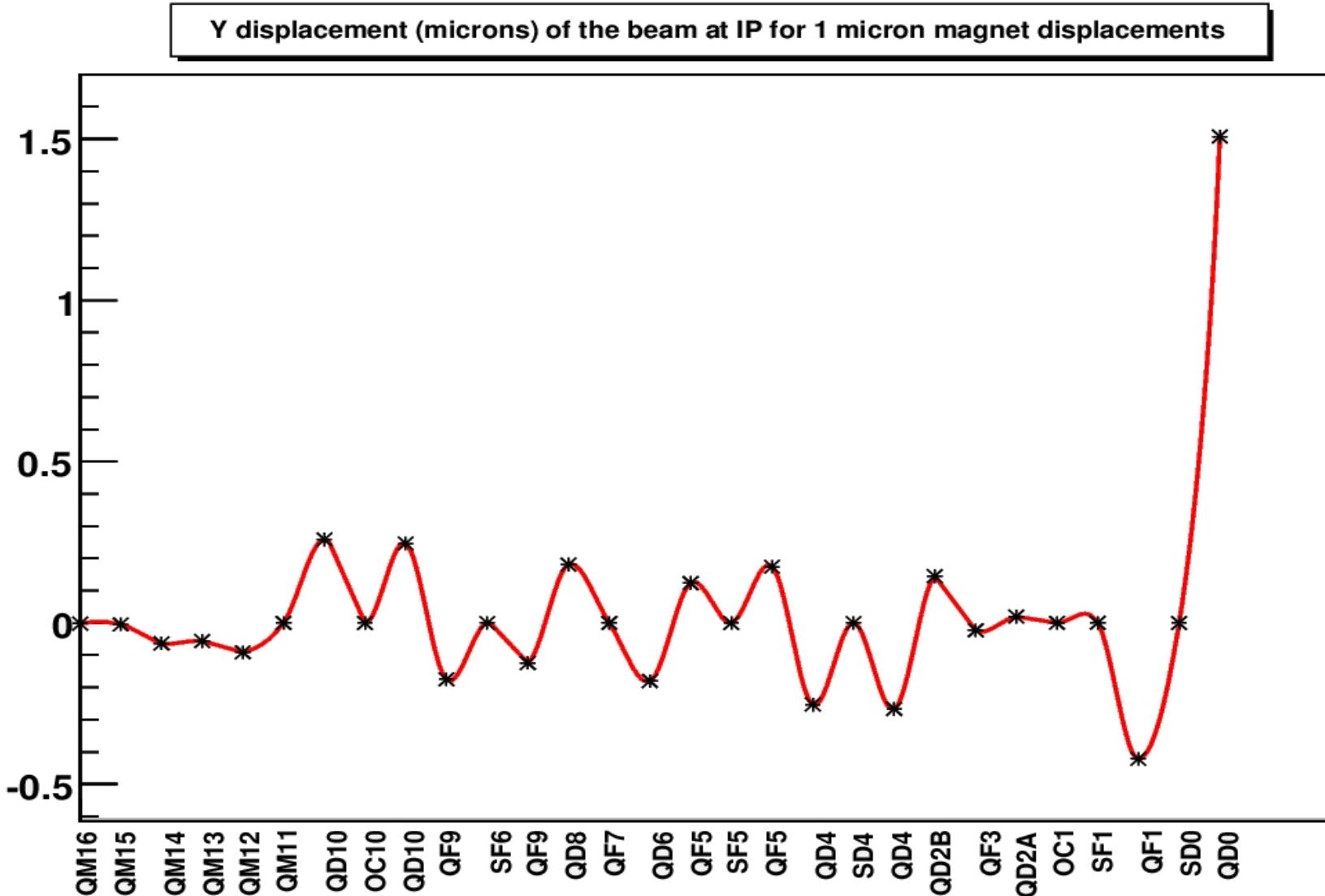
Layout of ATF2



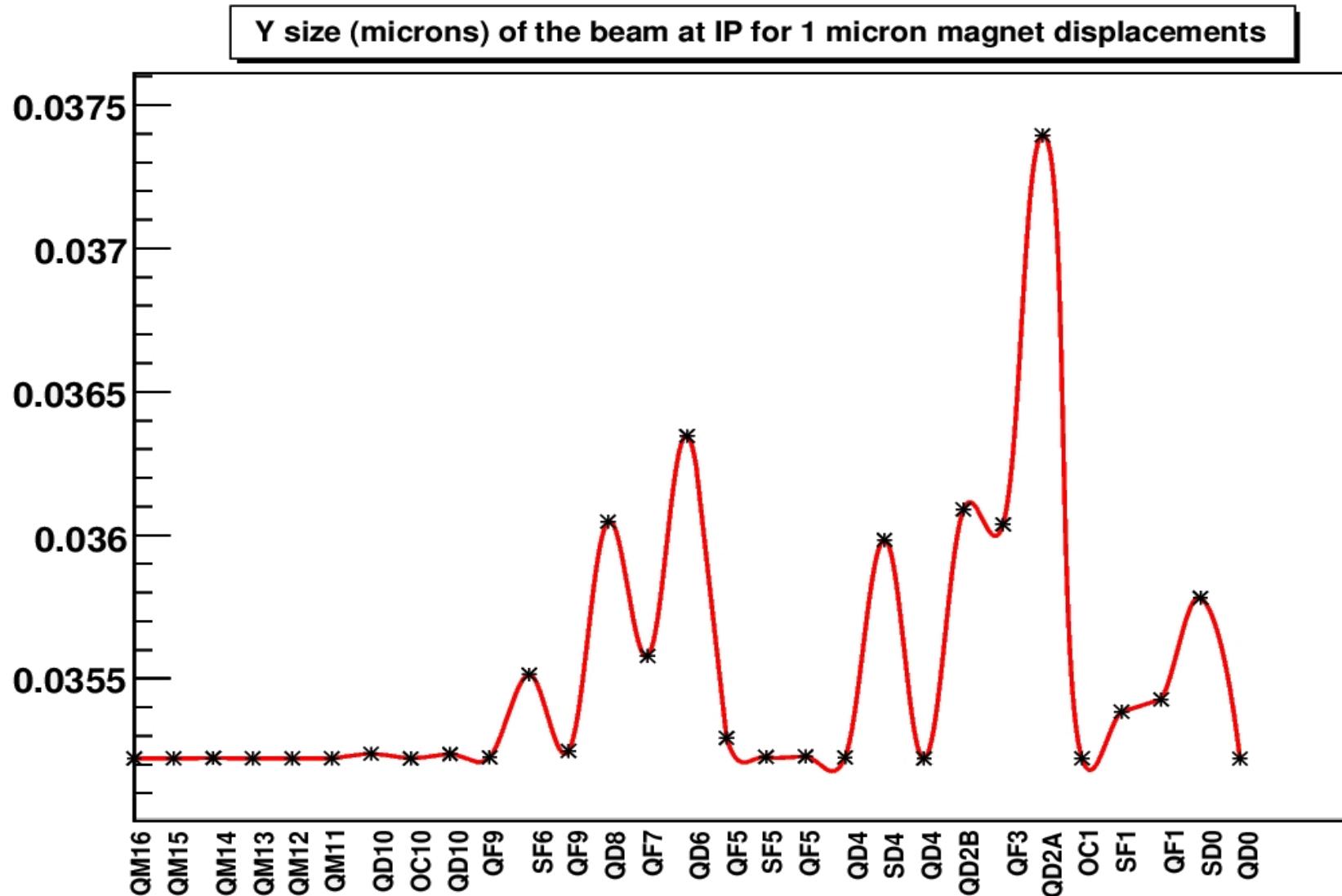
ATF2 IP parameters

Beam Energy [GeV]	1.3
L* [m]	1
emit_x (norm)[m-rad]	3. E-6
emit_y (norm)[m-rad]	3. E-8
beta_x [mm]	4.0
beta_y [mm]	0.1
eta_x' [rad]	0.14
dE/E	~0.1

Position sensitivity to magnets displacement



Size sensitivity to magnets displacement



Analysis of displacements' influence

- 1) Vertical beam size is 37 nm. To achieve this beam size (Goal A) we must :
 - Reduce rms fluctuations at IP to 1/3 sigma.
 - Control beam position relative to all sextupoles.
- 2) Displacements of FD magnets (the most powerful) produce largest effects on position of beam at IP.

$$Y_{ip} = Y'_{magnet} * F = dY_{magnet} * k * l * F \quad \text{with - } F : \text{focal distance}$$
$$= dY_{magnet} \quad \begin{aligned} & - dY_{magnet} : \text{displacement of magnet} \\ & - k : \text{quadrupole strength} \\ & - l : \text{length of quadrupole} \end{aligned}$$

- 3) Increase of size is due to displacements in sextupoles.

Quadrupole term added : $dk = 2 * m * dY_{magnet}$ with - m : sextupole strength

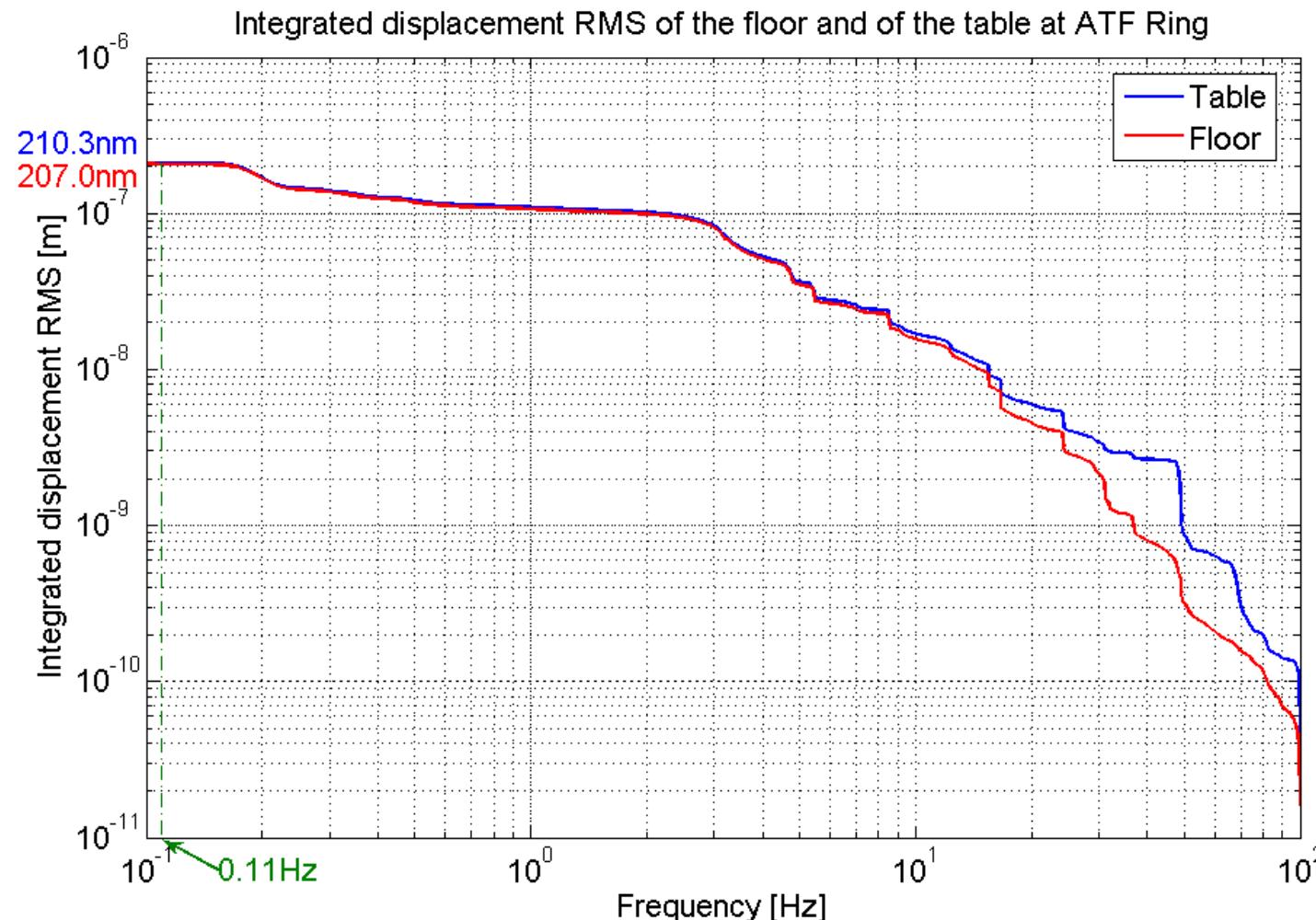
Size variation : $dS/S = dF/F = dk/k_0 = 2 * m / k_0 * dY_{magnet}$

Measurement of ground motion at ATF site

$$\text{Fourier transform } X(f) = \int_{-T/2}^{T/2} x(t) e^{-2\pi i f t} dt$$

$$\text{power spectral density } S_x(f) = 2 \lim_{T \rightarrow \infty} \frac{1}{T} [X(f)]^2$$

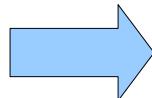
$$\text{Integrated rms displacement } z_{rms}(f_1, f_2) = \sqrt{\int_{f_1}^{f_2} S_x(f) df}$$



B. Bolzon
R. Sugahara

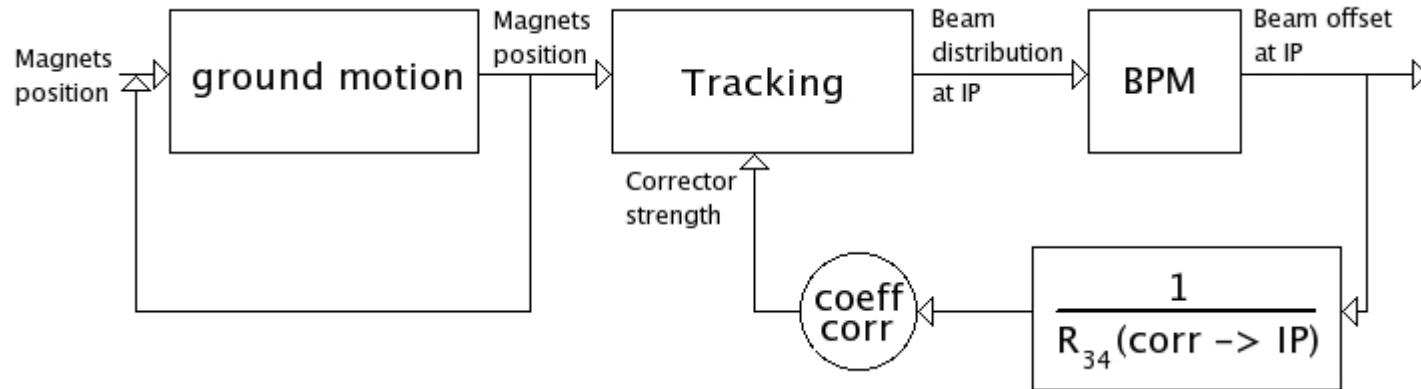
Feedback necessity

- Sampling of beam at 1 Hz make possible feedback corrections up to 0.1 Hz.
- RMS ground motion amplitude is about 0.2 micron at 0.1 Hz.
- 0.2 micron displacement in FD (resp. others magnets) result in about 0.2 (resp. 0.04) micron beam displacement at IP.
- So, after correction, we can expect 0.2 micron at IP if FD movement is independent from IP and 0.04 if good coherence is limited to FD.
- To achieve the 0.01 micron IP displacement aim (goal A), we must rely on coherence at some level beyond the FD.



Realistic simulations of ground motion followed by beam corrections are required for quantitative study.

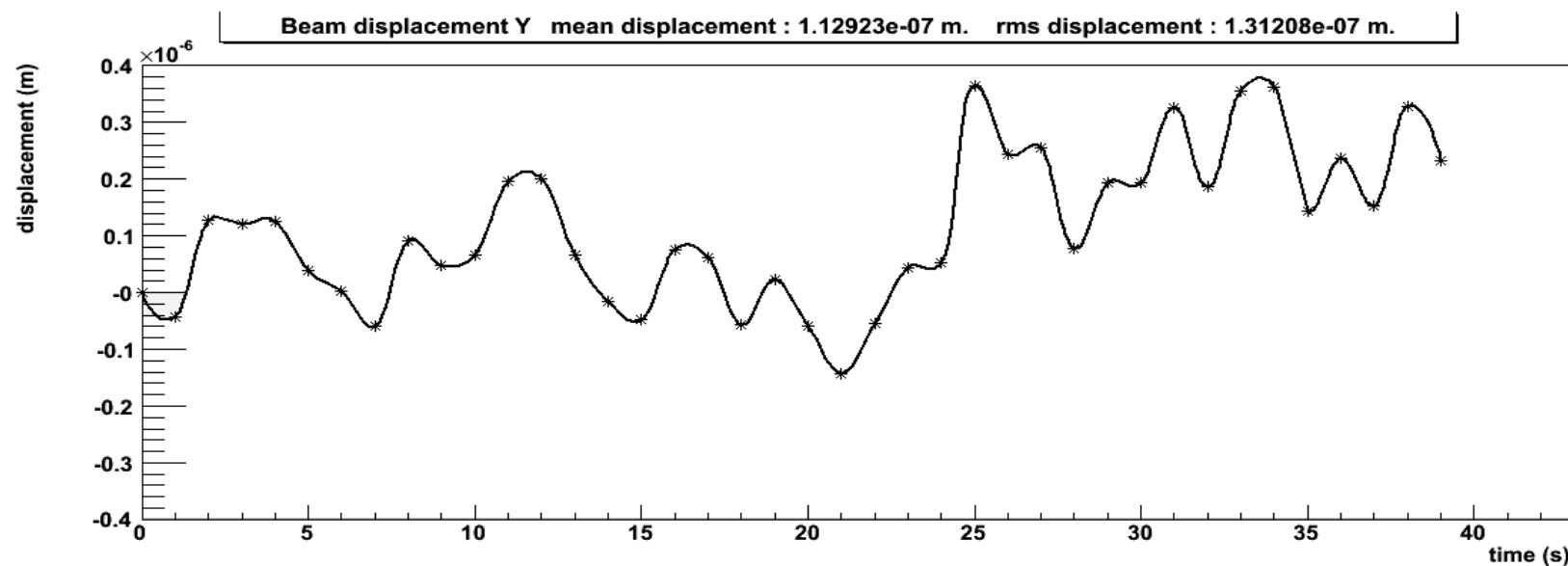
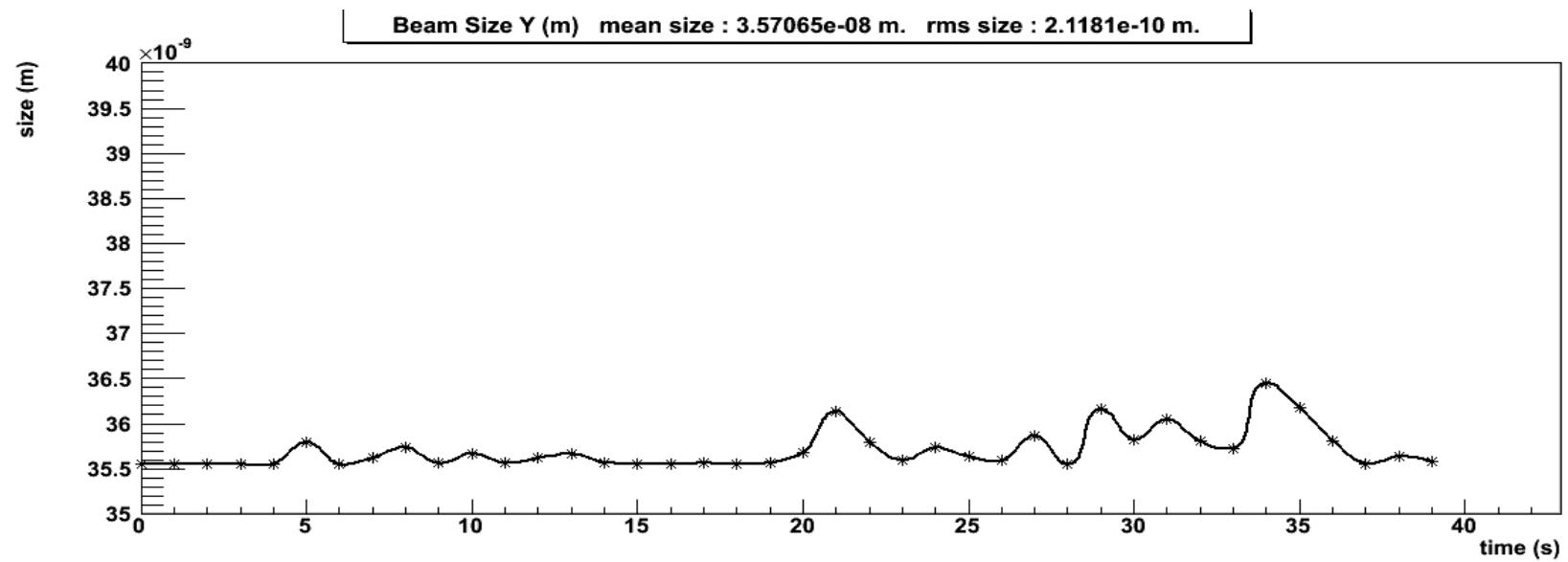
Feedback simulation



Scheme of the feedback simulation realized with Placet.

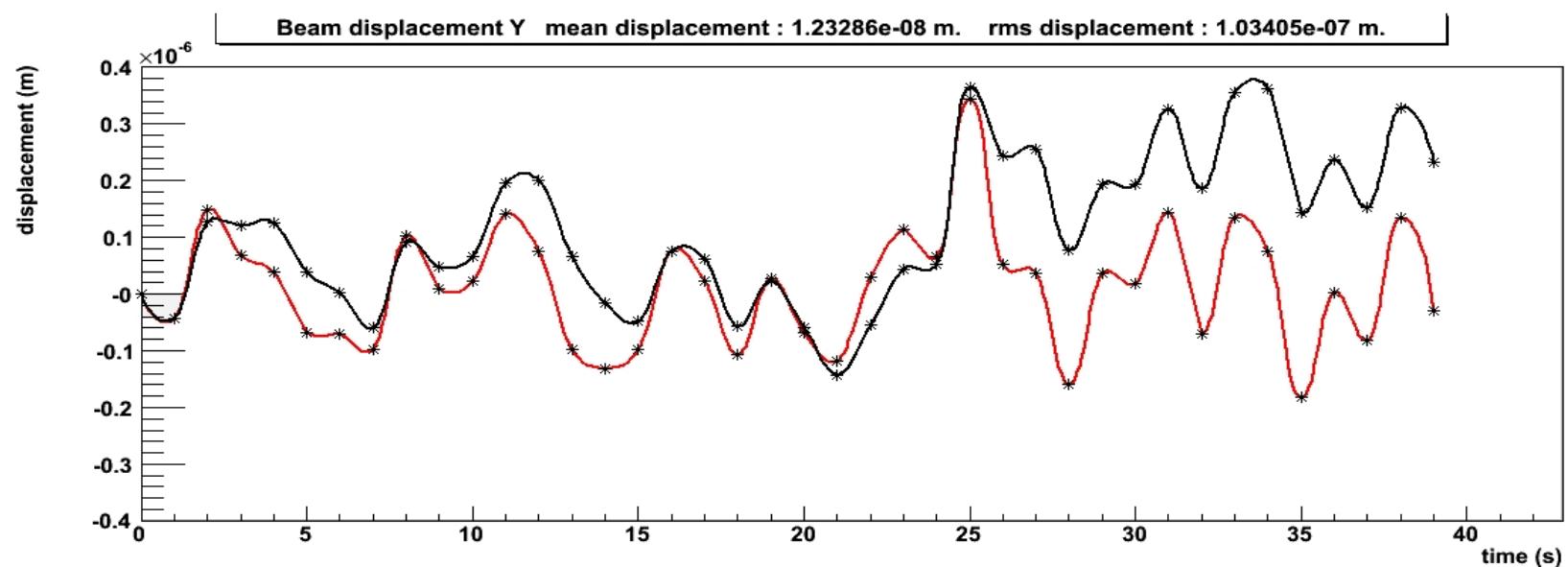
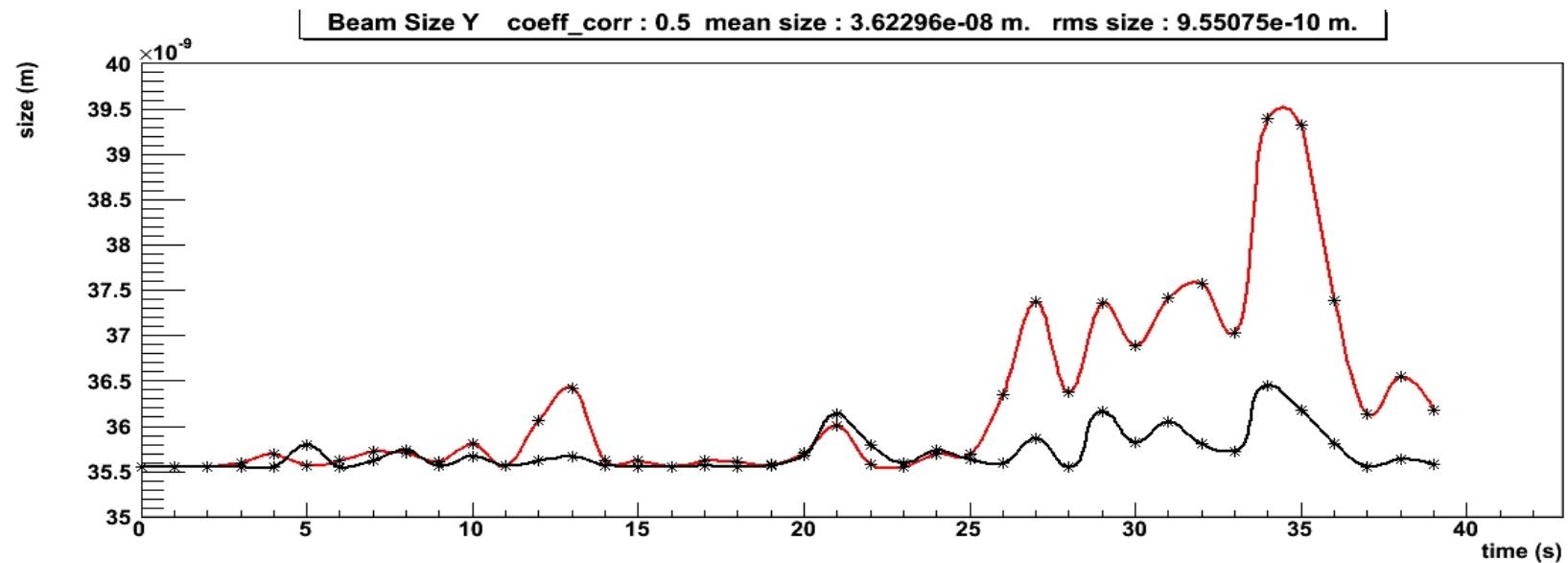
- 1) Proportional controller
- 2) Proportional Integrator controller

Simulation of ground motion



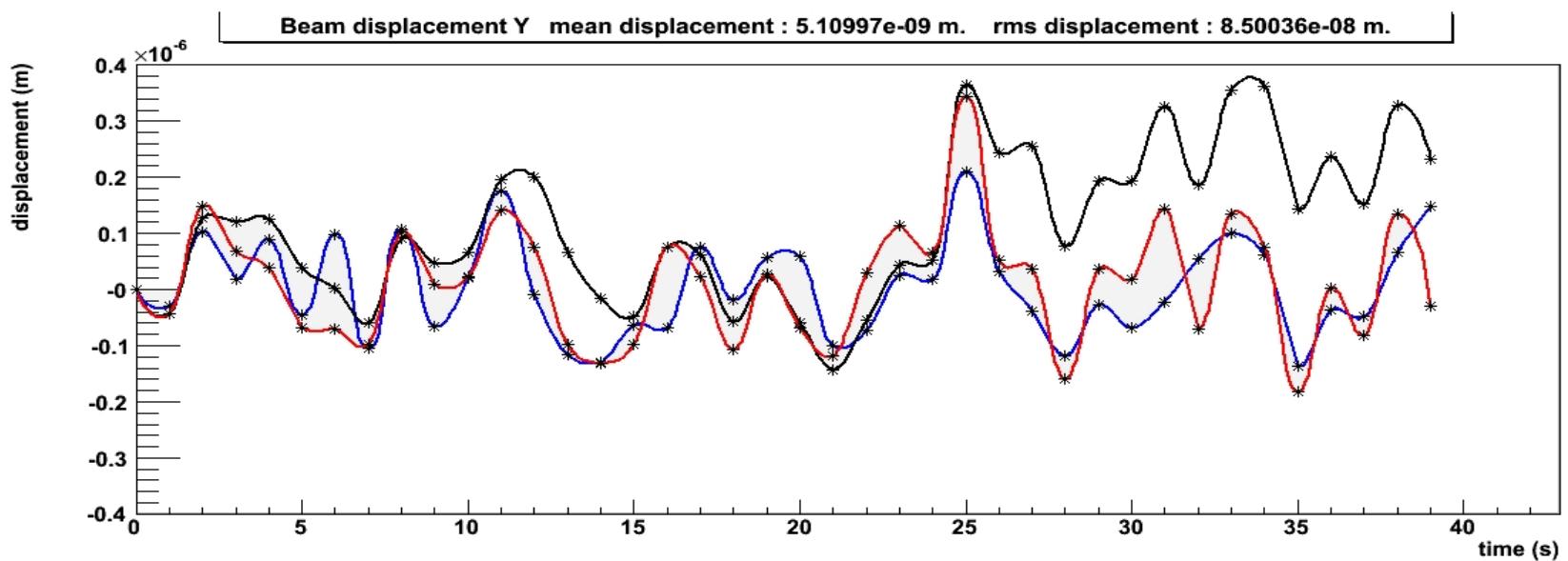
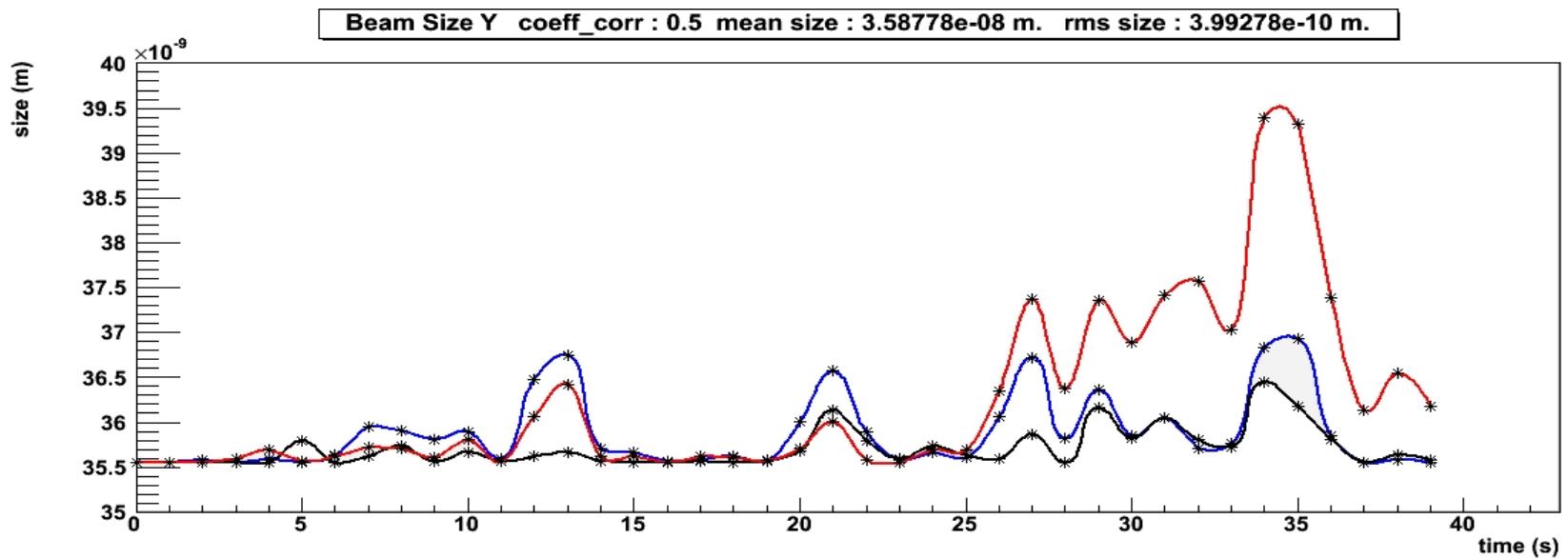
Beam size and displacement at IP as function of time

Feedback simulation with FD vibration



Beam size and displacement at IP as function of time

Feedback simulation without FD vibration (coherence FD - IP = 1)



Beam size and displacement at IP as function of time

Conclusion and prospects

- 1) Improvement shown with P and PI single corrector feedback control.
- 2) Need to understand simulation of ground motion coherence properties in Placet.
- 3) At least, a second corrector is needed at beginning of FF.