Effect of replacing the ATF2 QF1 by a perfect one

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KEK/ATF2

- The recent earthquake has delayed the plans concerning ATF2 experiments.
- Before end 2013 is planned to get 37nm vertical spot size.
- After 2013 Ultra-low beta proposal will be implemented.

ATF2

Table: ATF2 parameters ($E = 1.3$GeV)

Project	**Status**	β_y^* (mm)	L^* (m)	ξ_y
ATF2 Nominal	Design	0.1	1.0	19000
ATF2 Ultra Low	Proposed	0.025	1.0	76000

ATF2 Final Focus System

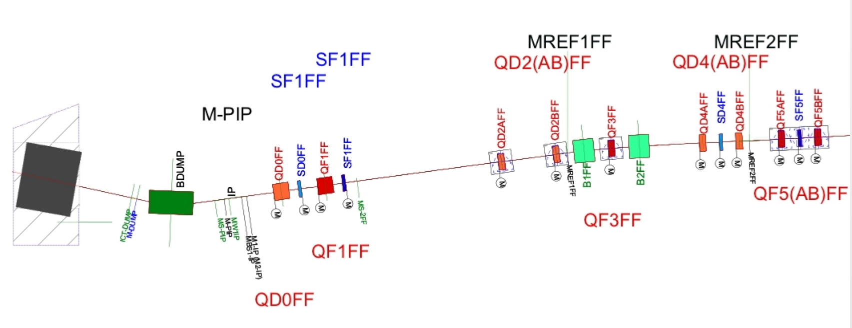


Figure: ATF2 Final Magnets of the FF

ATF2 QF1

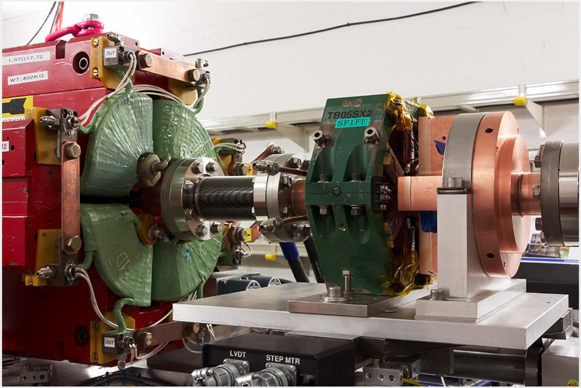


Figure: ATF2 QF1 and SF1FF magnets

New CERN QF1

- The installation and operation is planned for the beginning of 2013.
- The main parameters of the magnet must be fixed in next months.
- A second magnet could be proposed for QD0.

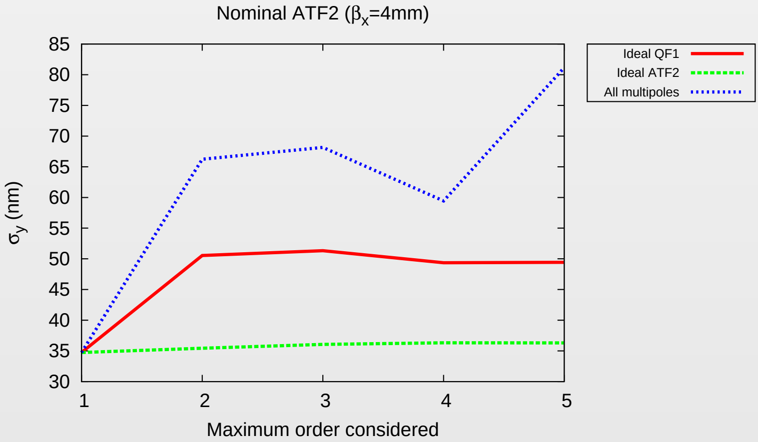
Limit with the CERN QF1

- We assume an ideal QF1 magnet, i.e. null terms different from quadrupolar in the multipolar expansion.
- With this assumption we can determine the conceptual beam size limit we can get assuming a perfect CERN magnet design.
- All the measured beam sizes are rms beam sizes. Shintake monitors can give a lower measurement.

Nominal design

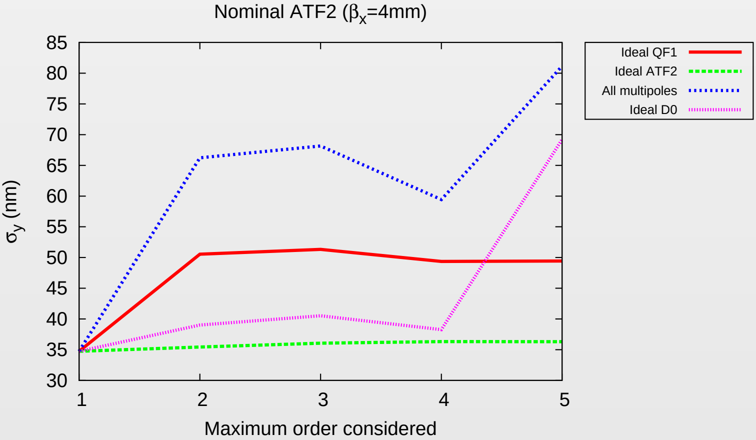
$\beta_x^* = 4\text{mm}, \beta_y^* = 0.1\text{mm}$

Nominal proposal



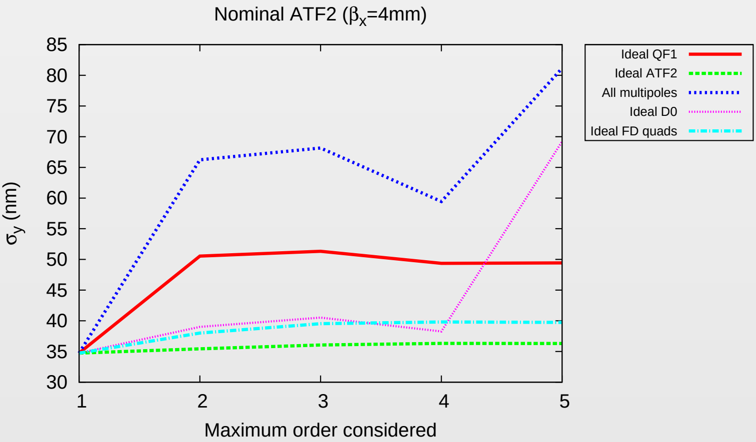
- The effect of the QF1 multipoles is important but maybe not enough. $\sigma_y \sim 50nm$

Nominal proposal



- Replacing QD0 only, the high order contributions from QF1 dominate but "it works for lower orders".

Nominal proposal



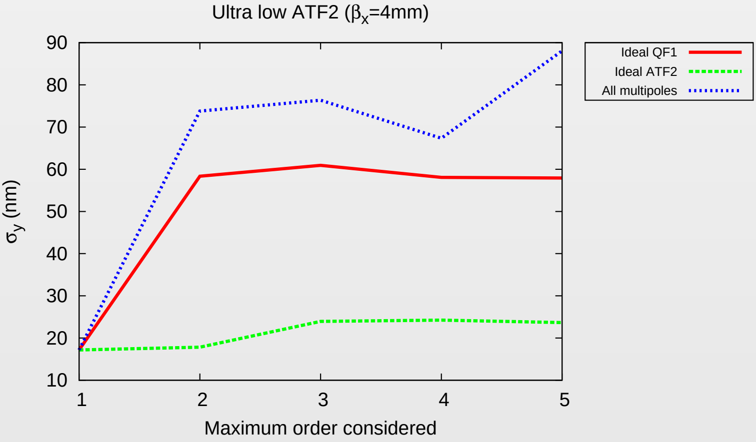
- Replacing both, we can reach a beam size $\sim$ 40nm.

Ultra low betas

$$\beta_x^* = 4\text{mm}, \beta_y^* = 25\mu\text{m}$$

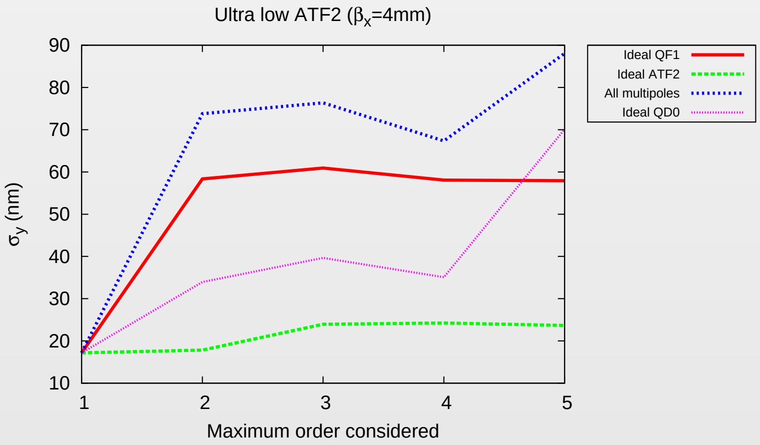
- Designed to achieve the 20nm vertical IP beam size without considering the multipolar components of the Final Doublet magnets

Ultra low beta proposal $\beta_x^* = 4\text{mm}$



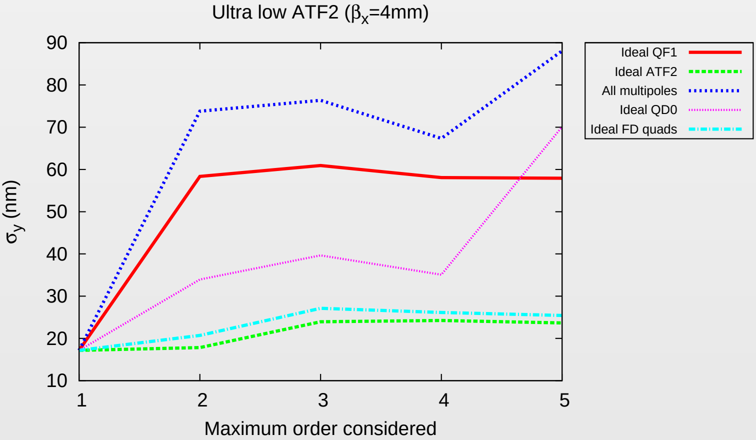
- The contribution of QF1 is not so important but it avoids high order effects.

Ultra low beta proposal $\beta_x^* = 4\text{mm}$



- Replacing QD0 we still have the high order contributions from QF1, but "is not a bad solution for lower orders".

Ultra low beta proposal $\beta_x^* = 4\text{mm}$



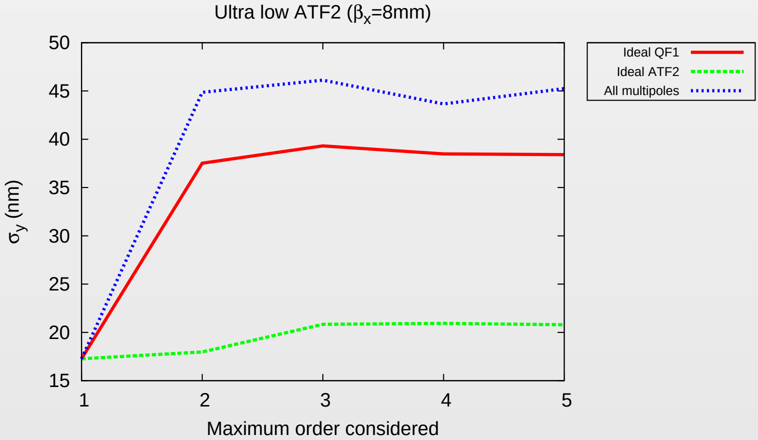
- Replacing both we can reach a 27nm vertical beam size, a good number for UL proposal.

Ultra low betas

$\beta_x^* = 8\text{mm}, \beta_y^* = 25\mu\text{m}$

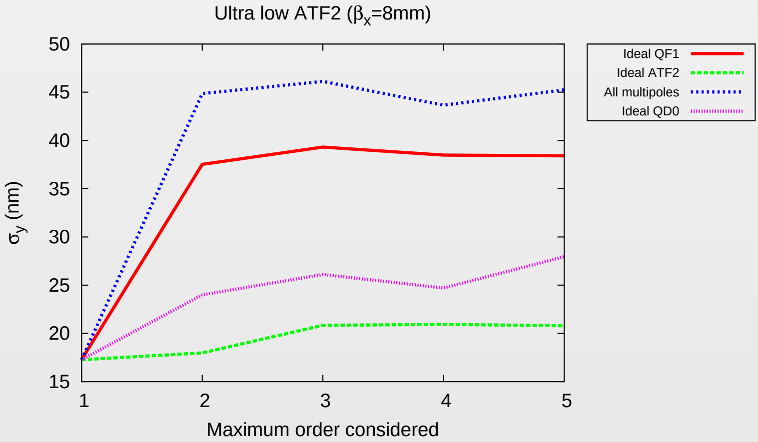
(ATF2 is now operating at $\beta_x^* = 8\text{mm}$)

Ultra low beta proposal $\beta_x^* = 8\text{mm}$



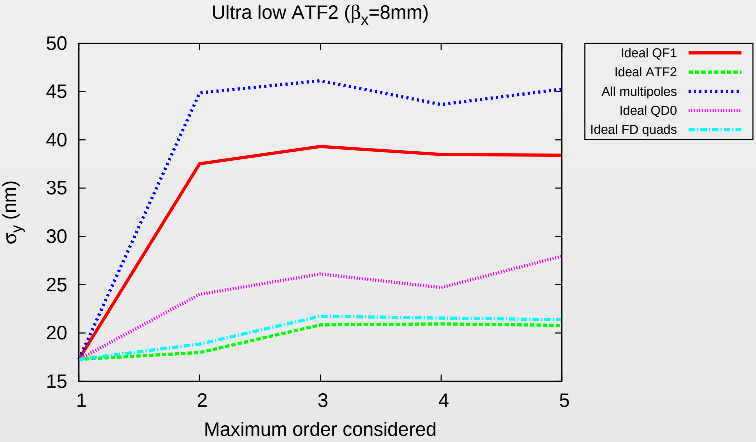
- The effect of the ideal QF1 is not so important. Replace only QF1 is not a good option.

Ultra low beta proposal $\beta_x^* = 8\text{mm}$



- Replace QD0 instead of QF1 is a better solution. $\sigma_y \sim 28\text{nm}$.

Ultra low beta proposal $\beta_x^* = 8\text{mm}$



- But the best option seems to be replace both. $\sigma_y \sim 22\text{nm}$.

Conclusions/Options

Design	Replacement	Beam size
Nominal ($\beta_x^* = 4$mm)	QF1 QD0	40nm
Nominal ($\beta_x^* = 4$mm)	QF1	49nm
Nominal ($\beta_x^* = 4$mm)	QD0	69nm
Ultra low ($\beta_x^* = 4$mm)	QF1 QD0	27nm
Ultra low ($\beta_x^* = 4$mm)	QF1	58nm
Ultra low ($\beta_x^* = 4$mm)	QD0	70nm
Ultra low ($\beta_x^* = 8$mm)	QF1 QD0	22nm
Ultra low ($\beta_x^* = 8$mm)	QF1	38nm
Ultra low ($\beta_x^* = 8$mm)	QD0	28nm

- **For the nominal proposals, it is necessary replace both magnets.**
- **For the UL ($\beta_x^* = 8$mm) replace only QD0 is not a bad option.**