Estimating the effects from non-linearities in the ATF extraction line

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IFIC - LAL - CERN

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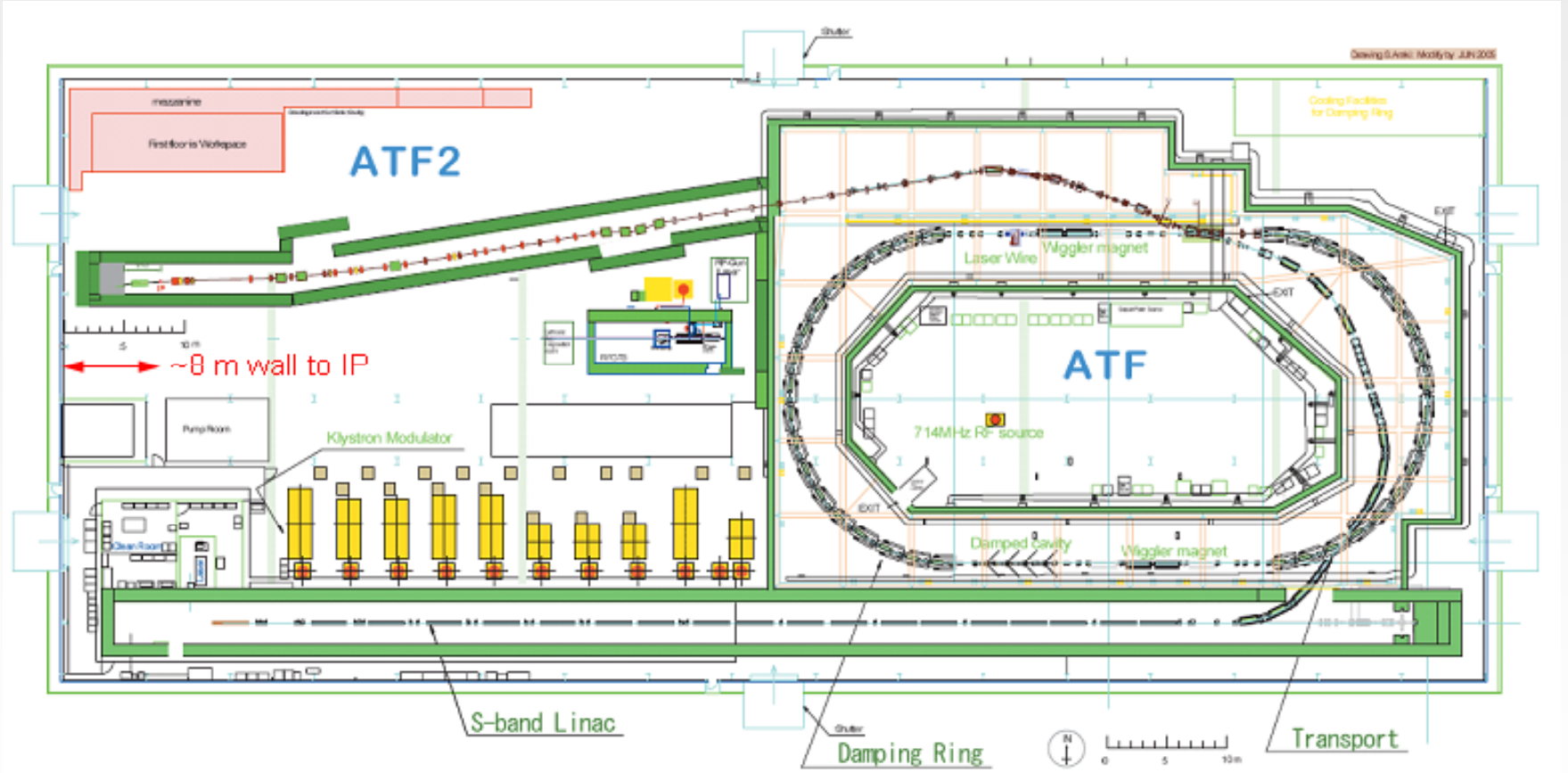
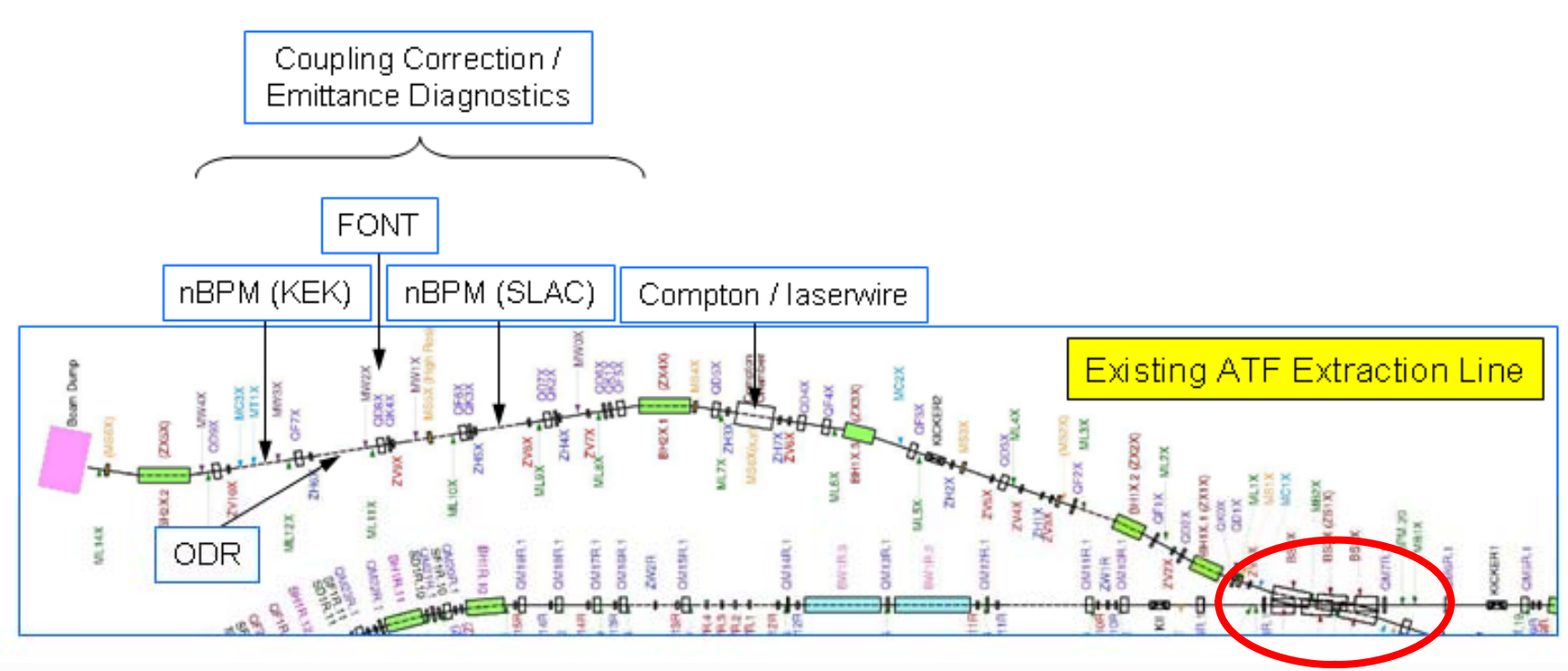
Layout of ATF2



ATF Extraction Line (EXT)

Problem:

Measured vertical emittances are higher than expected

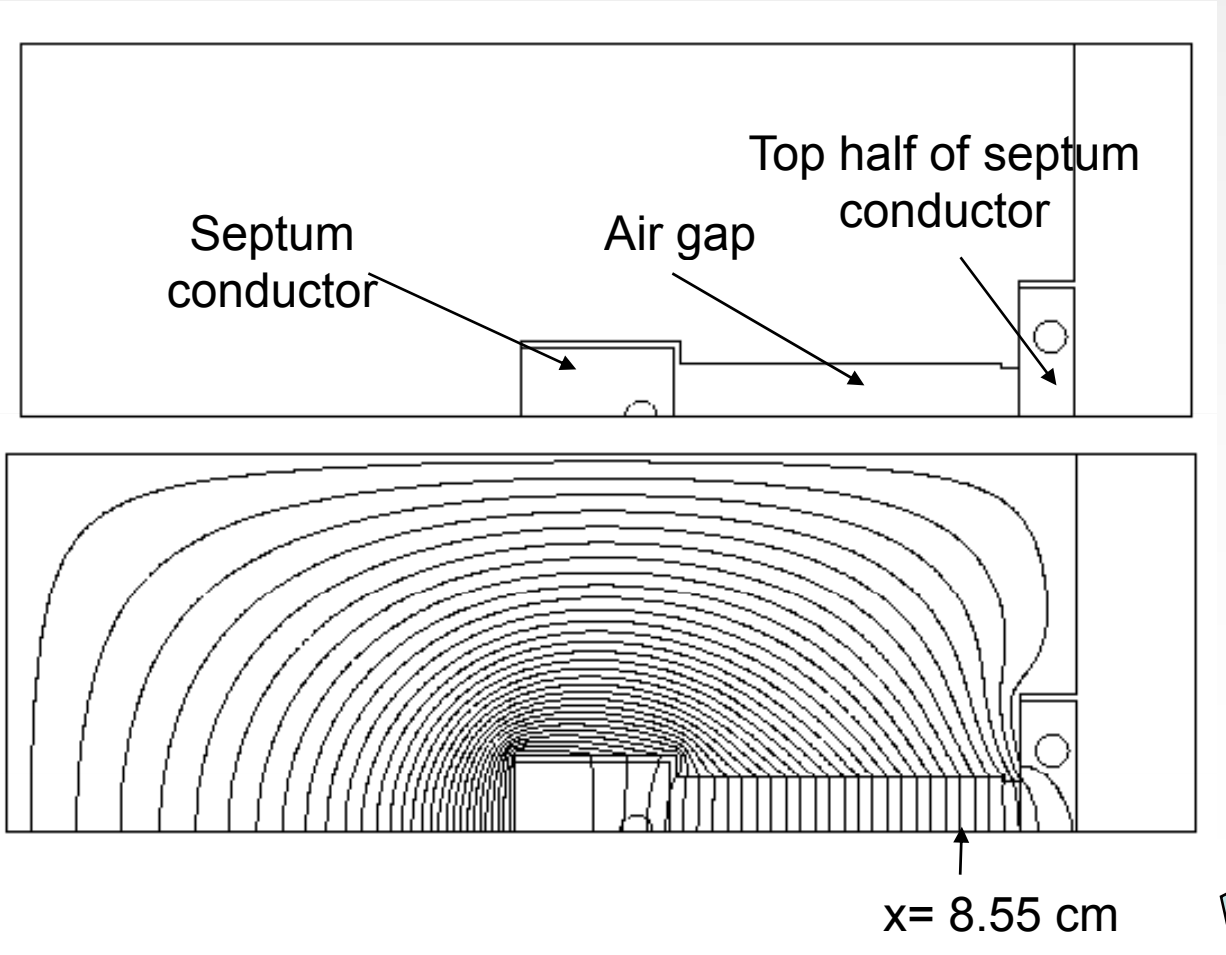


Septum magnets + Q7 and Q6 quadrupoles

Study the effect of the non-linearities of the magnets shared with the DR on the vertical emittance

Shared magnets

The beam passes off-axis through the QM6X and QM7X quadrupoles and the BS1X, BS2X and BS3X septum manets.



The beam passes off-axis through the septum

On-going work

Tracking studies in the ATF Extraction Line:

- Introducing multipole components for the septum magnets and the QM7 and QM6 quadrupoles (from C. Spencer)

-For different beam offsets

to estimate the impact on the emittance of the beam.

On-going work

Particles created with PLACET at the entrance of EXT (50000 particles):

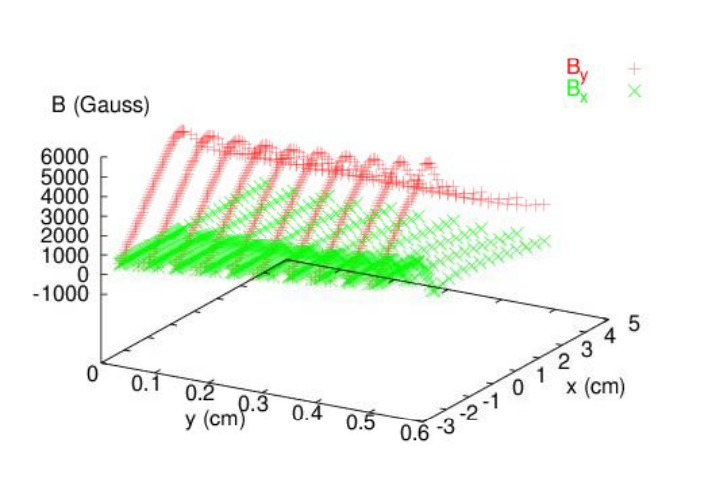
normalized emittances

E_0 (GeV)	1.3
$\gamma\varepsilon_x$ (m rad)	3.0×10^{-6}
$\gamma\varepsilon_y$ (m rad)	3.0×10^{-8}
σ_ε (%)	0.1
σ_z (mm)	8.0
$ß_{x\,(m)}$	7.212
$ß_{y\,(m)}$	2.903
$\alpha_{x\,(m)}$	1.151
$\alpha_{y\,(m)}$	-1.721

Tracking studies with MAD8
Introducing QM7 multipoles ⇒ Which multipoles?

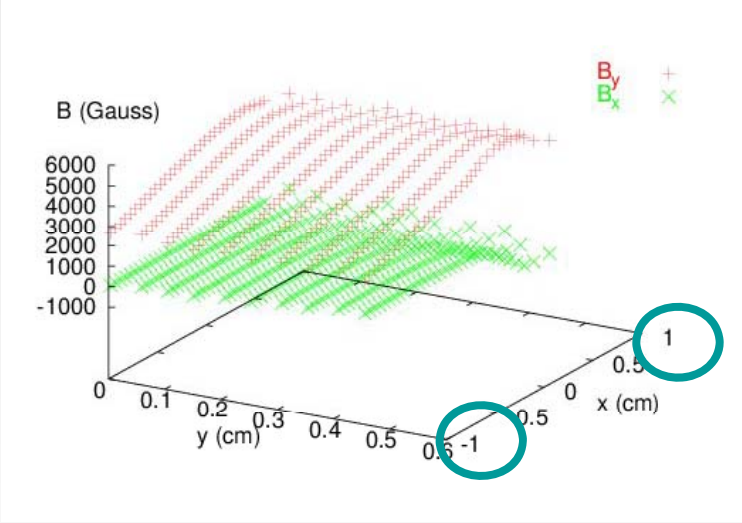
Quadrupole QM7 (multipole decomposition)

Field map of a Q7-like quadrupole
(from C. Spencer)

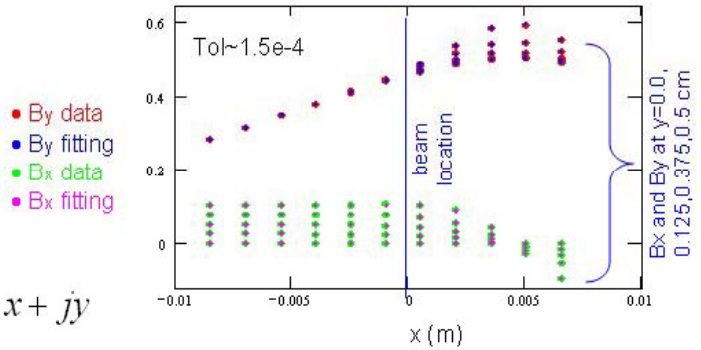


x-2.25 cm

cut in x



Fit presented by F. Zhou



$z = x + jy$

$$B_y + jB_x = 0.461 + 17.557z - 959.345z^2 - 1.426\cdot10^5 z^3 - 9.898\cdot10^6 z^4$$
$$+ 4.93\cdot10^8 z^5 + 1.551\cdot10^{11} z^6 + 6.512\cdot10^{12} z^7 - 9.81\cdot10^{14} z^8$$
$$- 9.424\cdot10^{16} z^9 + 2.051\cdot10^{18} z^{10} + 4.082\cdot10^{20} z^{11} - 6.191\cdot10^{21} z^{12} - 1.281\cdot10^{24} z^{13}$$

Multipoles presented by S. Kuroda

(for L=6 cm)

$$K(N-1)L = \frac{a_N}{B\rho}((N-1)!)L$$

N	KN	MAD notation
1	0.00638	K0L
2	0.2429	K1L
3	-26.6	K2L
4	-1.18e4	K3L
5	-3.29e6	K4L
6	8.19e8	K5L

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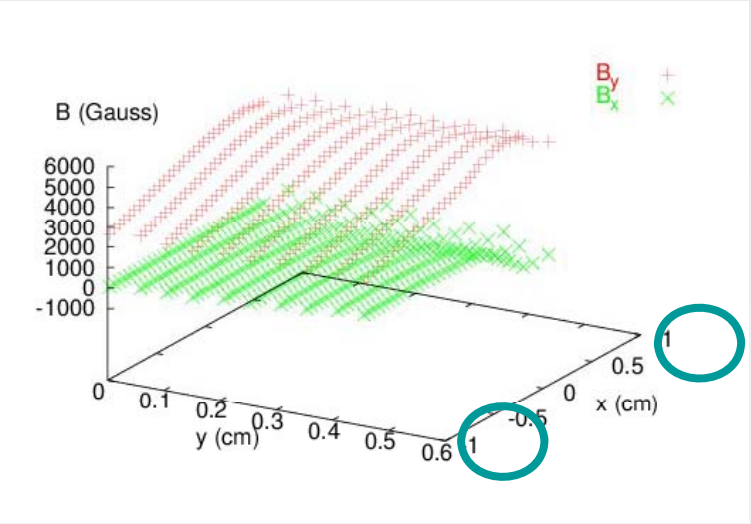

y=0 cm

(Bx=0)

Fit:

$$By = 0.461227 + 17.5409\,x - 975.611\,x^2 - 164998.\,x^3 - 1.83452\times10^{7}\,x^4 + 1.22734\times10^{9}\,x^5 + 1.03418\times10^{12}\,x^6 + 8.1599\times10^{13}\,x^7 - 3.15181\times10^{16}\,x^8 - 6.10052\times10^{18}\,x^9 + 6.81761\times10^{18}\,x^{10} + 8.79816\times10^{22}\,x^{11} + 8.10734\times10^{24}\,x^{12} + 2.33606\times10^{26}\,x^{13}$$

y=0 cm

(Bx=0)

(for L=6 cm)

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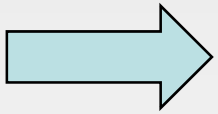

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But this is not the exact length of the magnet*.
Recalculating with the real length: L=7.89 cm

N	KN	MAD notation
1	0.00839	K0L
2	0.3192	K1L
3	-35.507	K2L
4	-1.80e4	K3L
5	-8.01e6	K4L
6	2.68e9	K5L

(from EXT.mad)

N	KN	MAD notation
1	-0.00894	K0L
2	0.39808	K1L

dipole

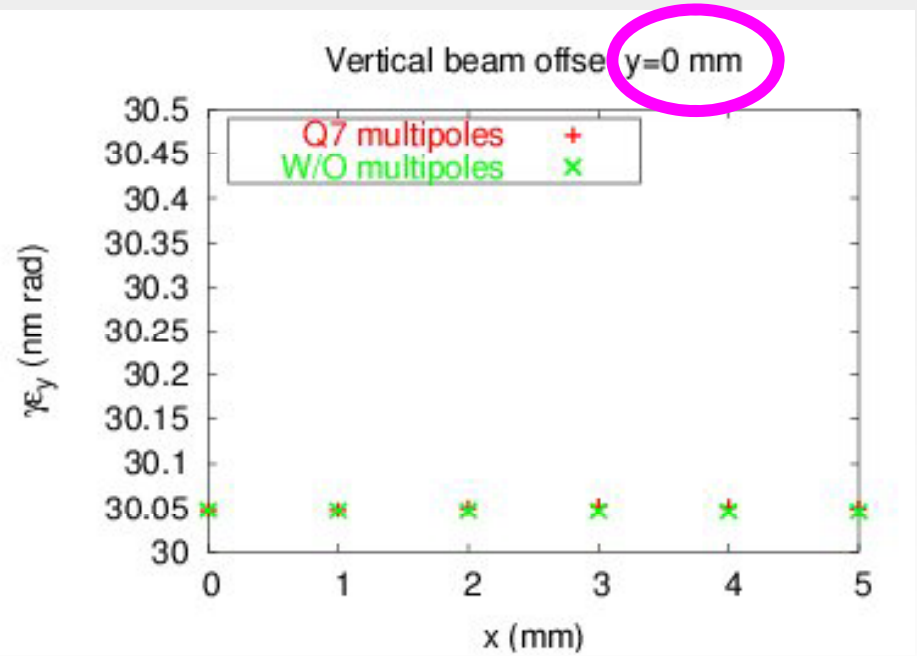
quadrupole

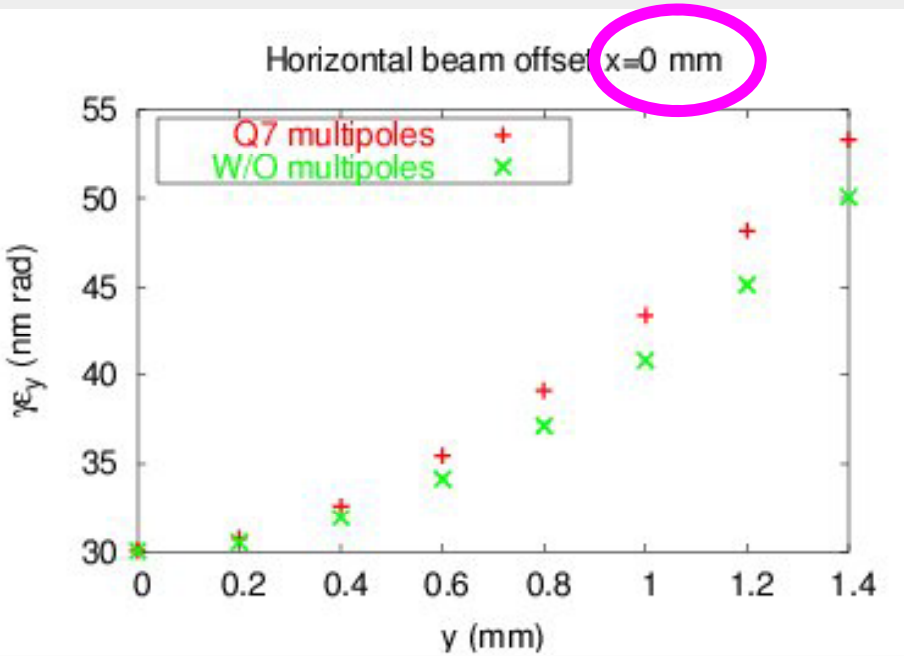
20% of difference

*L=6 cm corresponds to an old deck of ATF DR

Tracking studies with multipole field for QM7

Vertical emittance with x or y beam offsets





x

y

Tracking studies with multipole field for QM7

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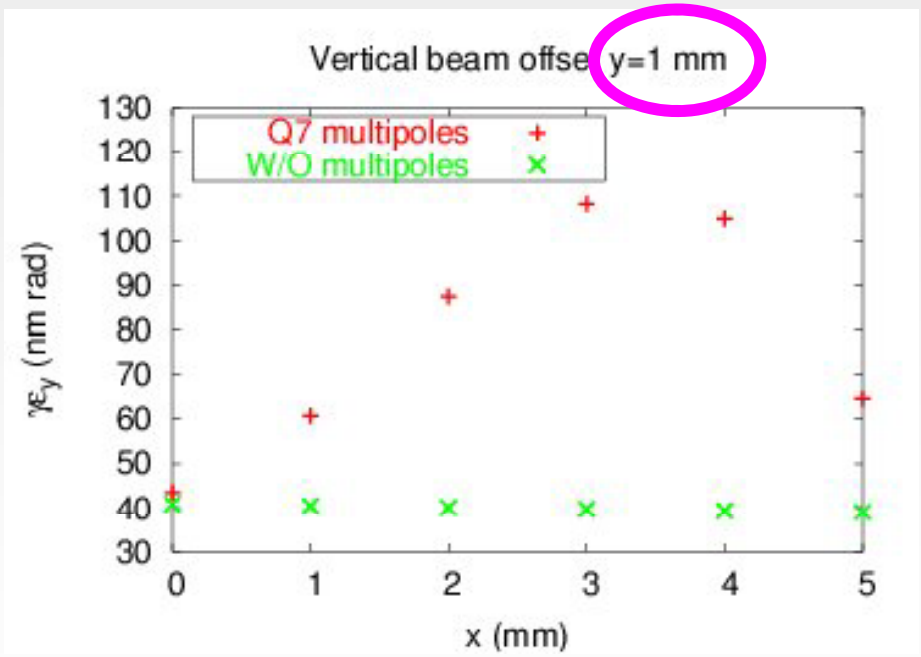

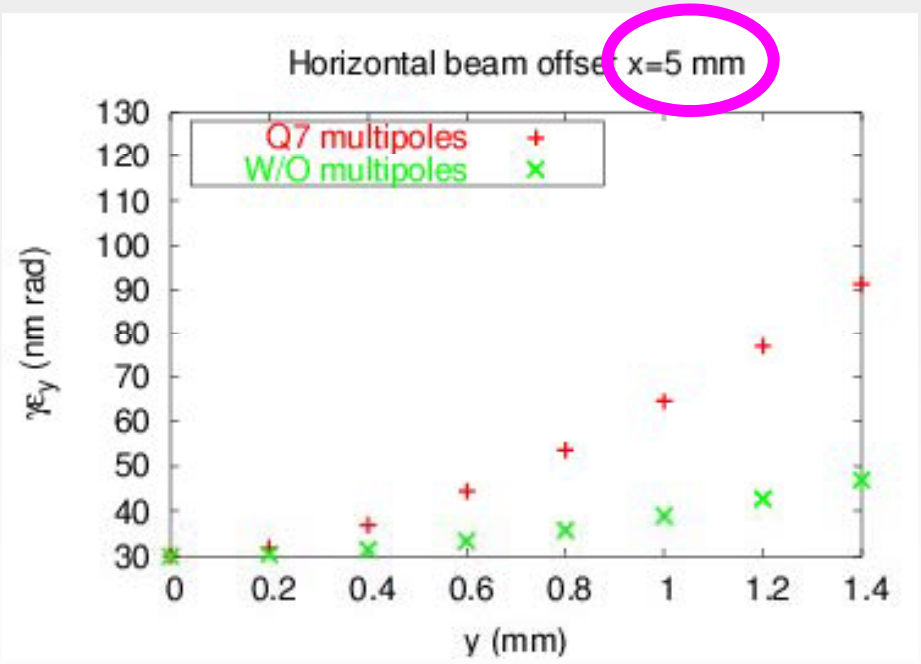

x

y