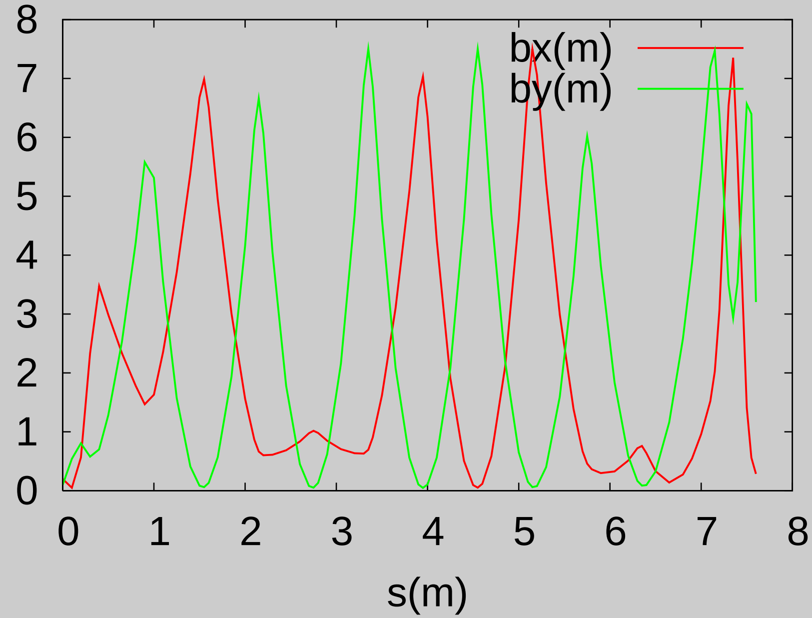
Broad Band Chopper for ACD2

Small voltage available: $\boldsymbol{\Delta V} \simeq$ 600 V (Sergei)

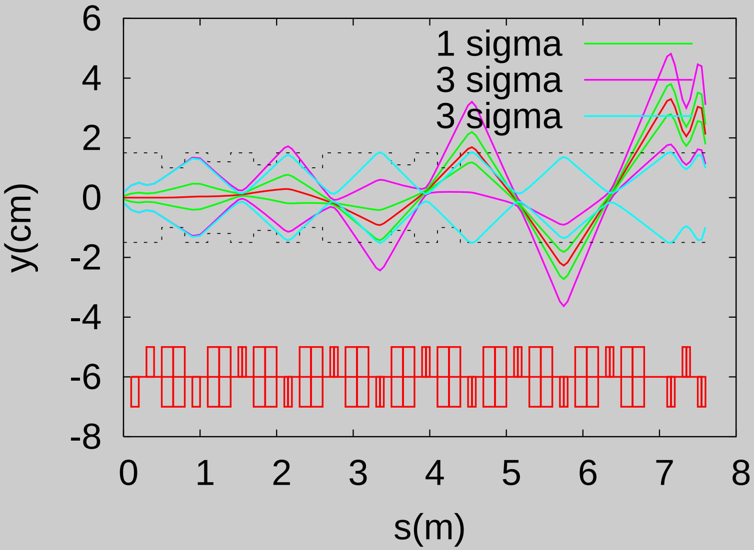
Chopping at 2.5 MeV, right after RFQ, $\boldsymbol{\epsilon_x}=\boldsymbol{\epsilon_y}=$3.4 mm mrad, $\boldsymbol{\epsilon_z}=$70 KeV deg

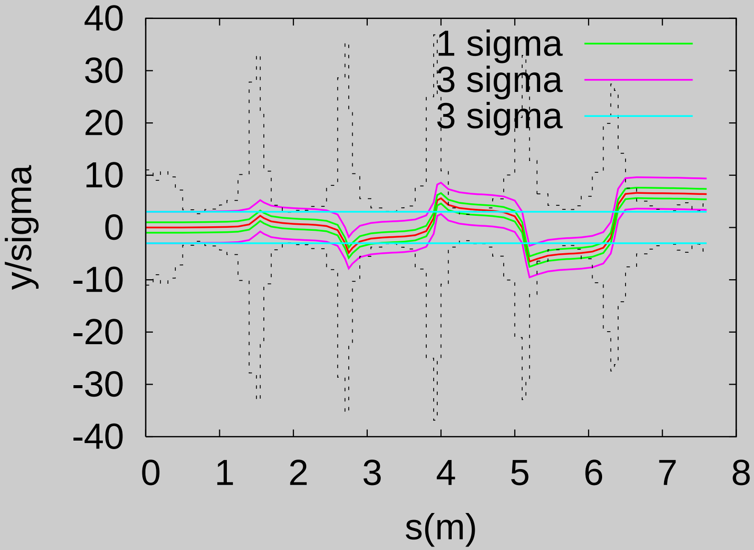
One possible scheme uses 6 vertical kickers, each 30 cm long, interleaved with quadrupoles and provides room for a RF buncher.

MAD-X



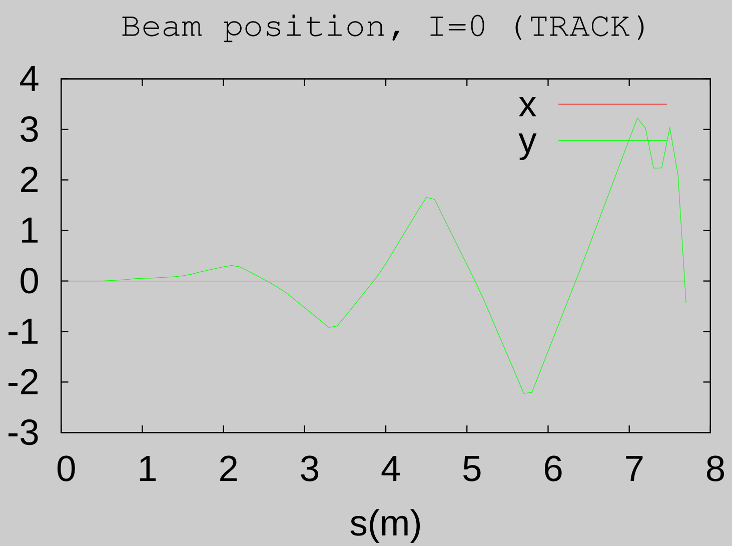
Variable gap height (between 2 and 2.4 cm), depending on beam size, for maximum field. No losses for the un-kicked beam without space charge.

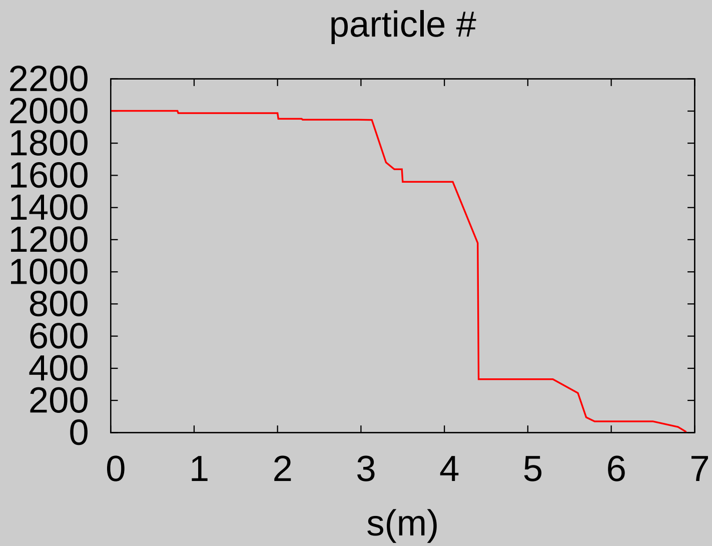




11 kickers shown, but only 1th to 4th and 6th and 7th powered.

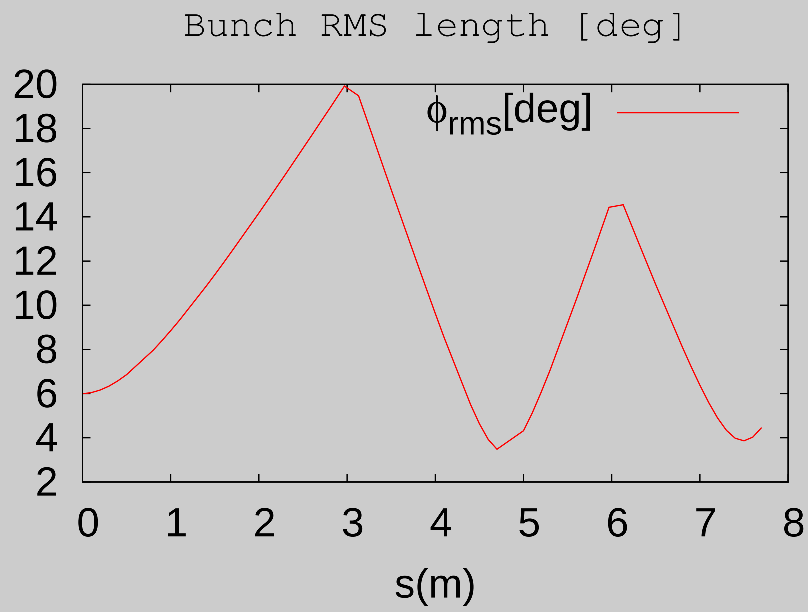
TRACK, with I=0 mA and no cavities, gives same Twiss functions and trajectory as MAD-X. All particles are kicked out, although they are lost not just at the end of the line. The half-aperture is everywhere 1.5 cm. Only kickers have smaller gaps (between 1.0 and 1.2 cm).



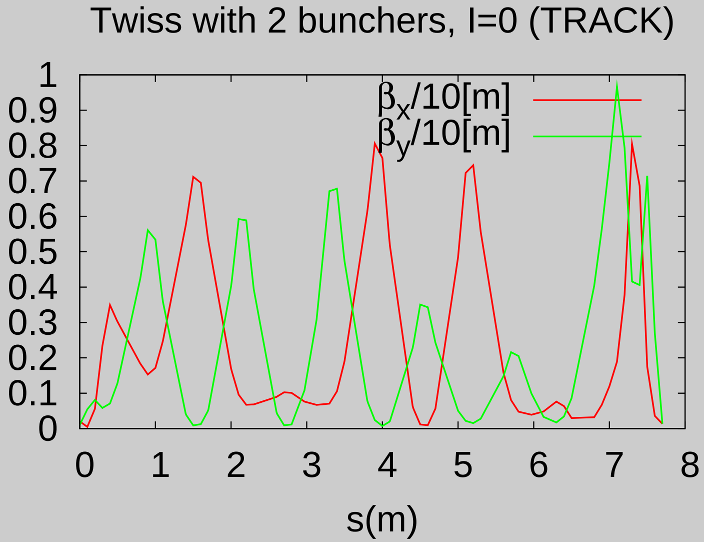


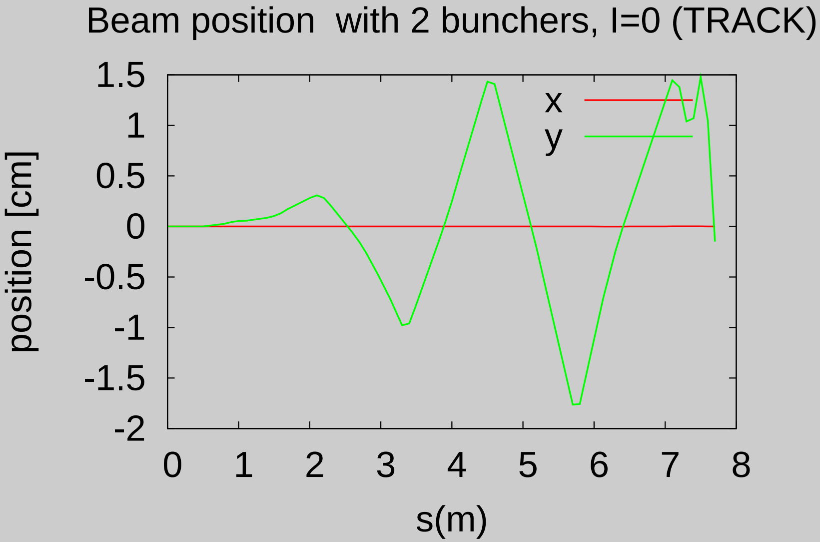
Two bunchers at 3 m and 6 m (field map from ICD1) . Frequency: 162.5 MHz

TRACK

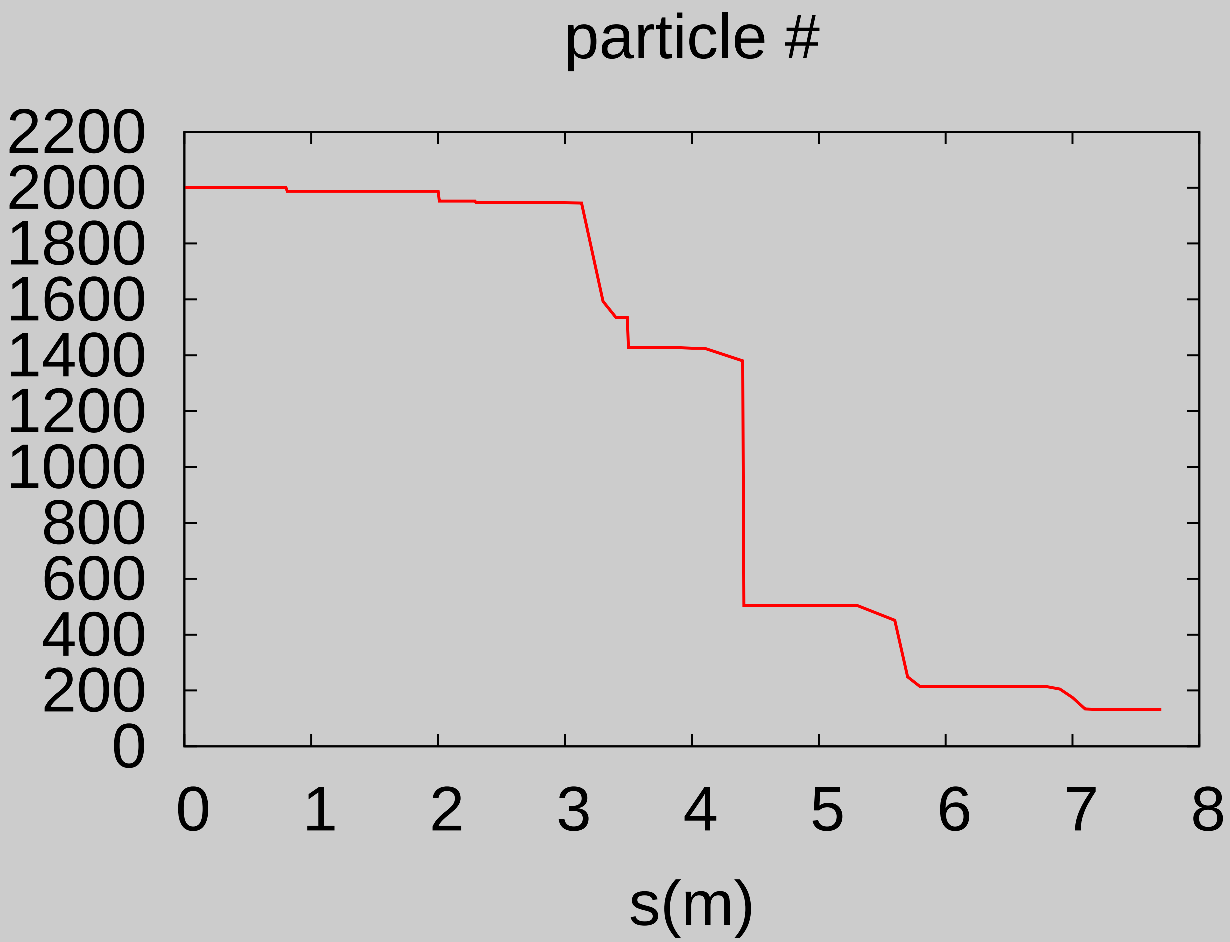


When the bunchers are inserted as cavities (map file edited to increase aperture to 1.5 cm) the optics is perturbed, 2.9% of the un-kicked beam is lost.

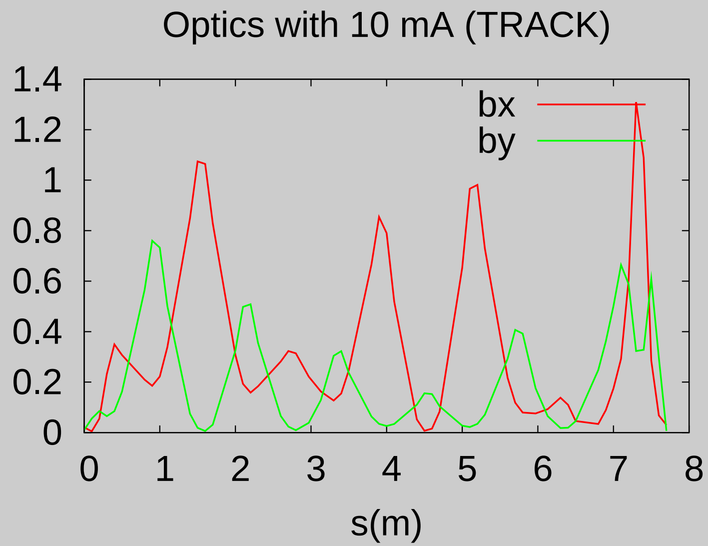


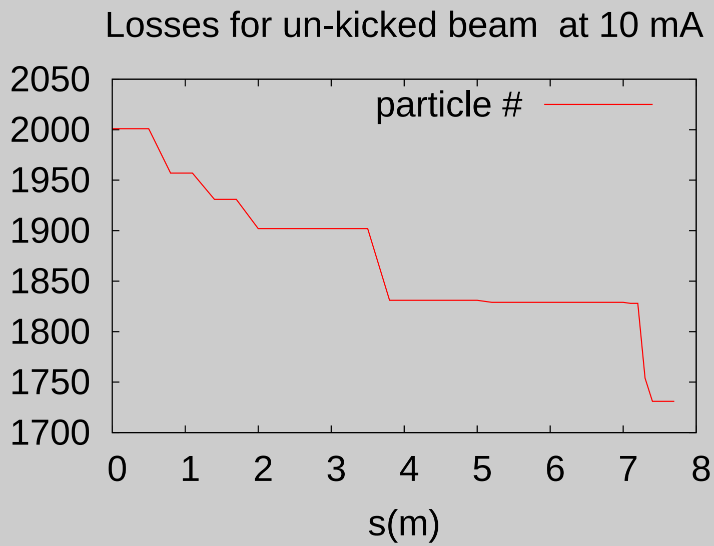


Not all particles are kicked out when the kickers are on.



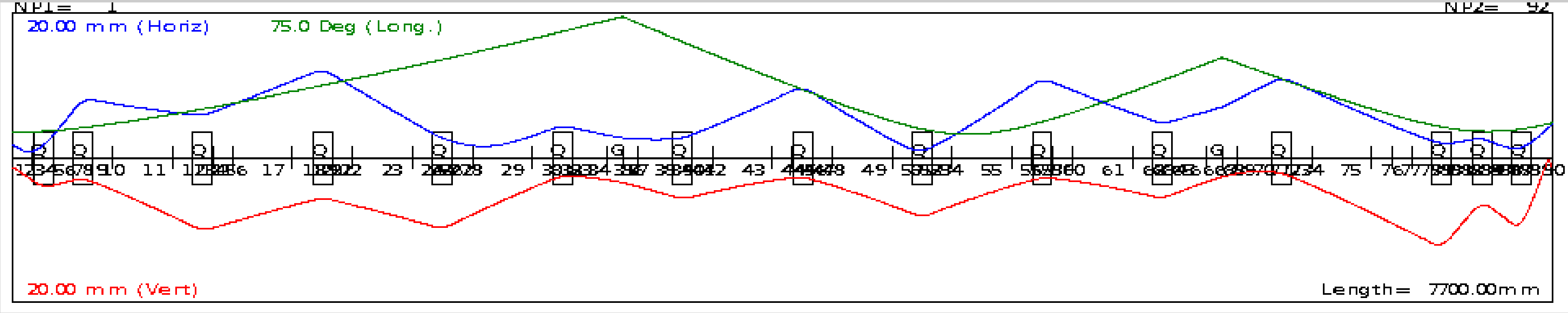
I=10 mA at 162.5 MHz: large losses (14%) also for the un-kicked beam!

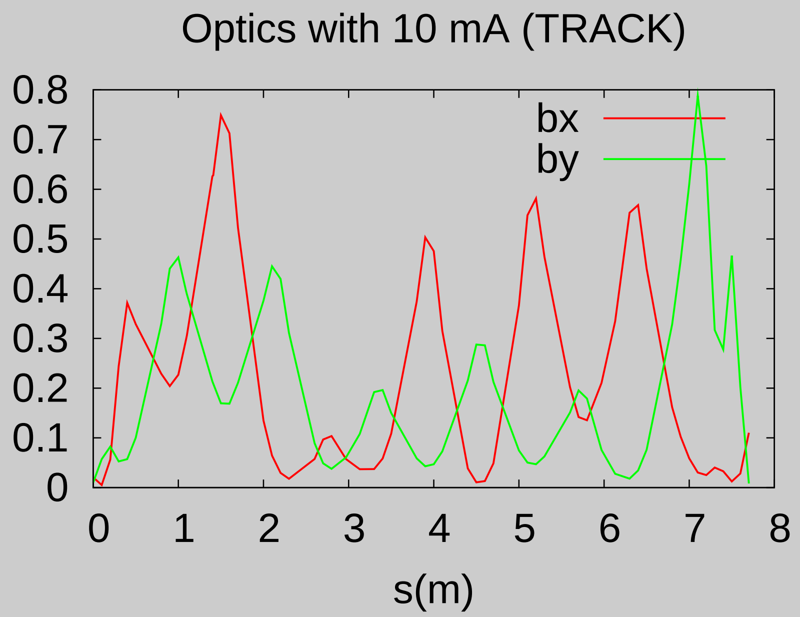




The kickers are simulated in TRACK by electrostatic 3D quads and have round aperture while our kickers should have r_x larger than r_y (large vertical kick without limiting the horizontal aperture). A short drift (r_x and r_y may be different) with the kicker aperture was introduced up/downstream each kicker, while the kicker radius itself was increased. This reduced the losses to about 9%. Optics would need to be re-matched.

Optics re-matching with trace3D, after adjusting buncher voltage, did not help (no enough flexibility). Moreover there is no way of checking what is going on with the trajectory. Empirical adjustments lead to an acceptable solution for the un-kicked beam (no losses).

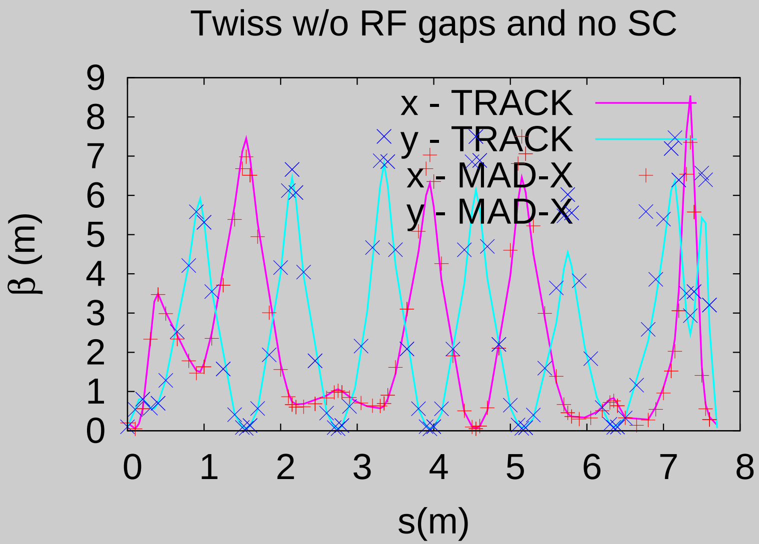


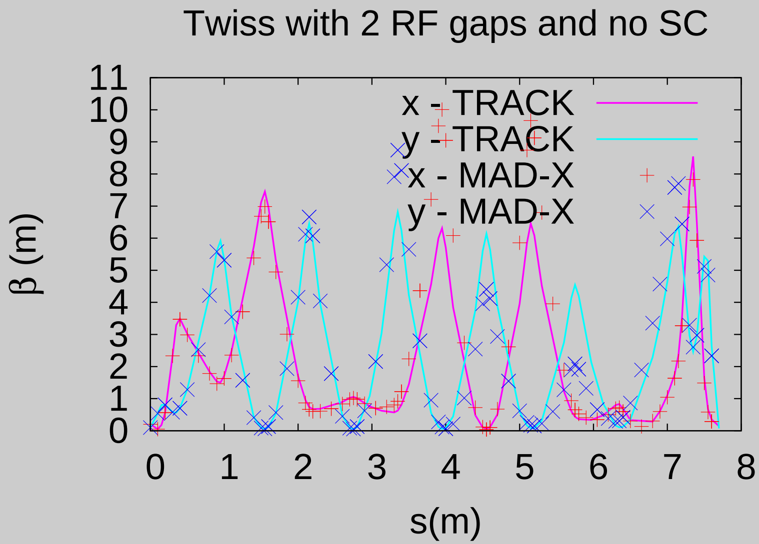


But, the trajectory produced by the kickers was completely screwed up....

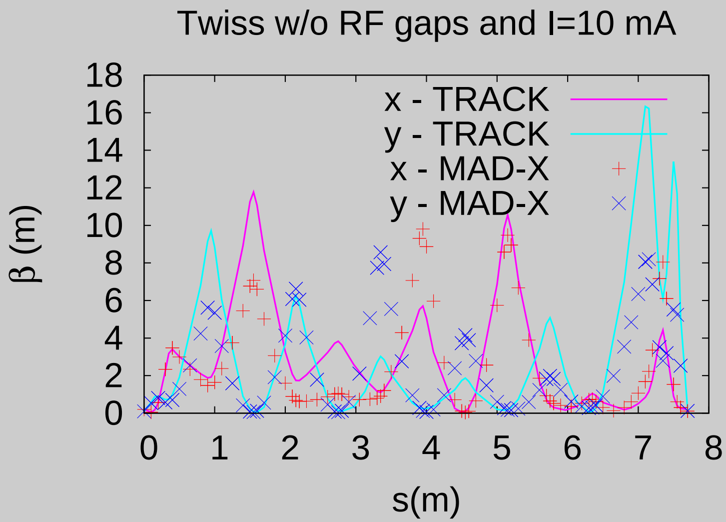
MAD-X has the needed flexibility but it has no space charge computation.

The RF gaps can be introduced into MAD-X (or 8) by specifying the transfer matrix elements; the agreement with trace3D is excellent, decent with TRACK.





Space charge has been introduced in MAD-X by inserting a BB lens at each quadrupole and assigning a charge to each of them proportional to the distance (see Alexahin et al., PAC07, THPAN105).



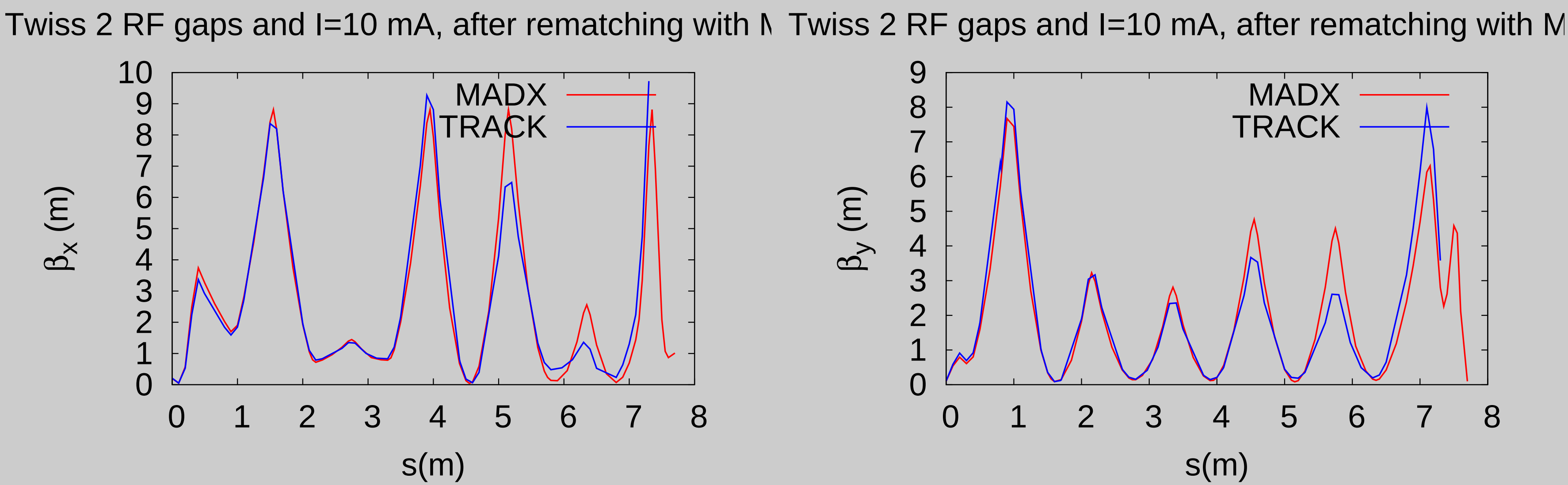
Agreement is not very good. Thus the lens charges have been optimized so to fit TRACK Twiss functions; this makes sense if the new values are *not* depending on the optics (for instance if the starting values were not correctly evaluated).

Once the charges have been found, MAD-X has been used to:

- fit to unperturbed Twiss; this did not lead to the unperturbed trajectory...
- fit trajectory directly

It is worth noting that the size of the BB lens, which changes when the optics changes, has been *recomputed* during the fit procedure (self-consistency).

The resulting quadrupole strength have been introduced into TRACK. The agreement is decent.



I did not succeed decreasing β to the unperturbed values and therefore there is still a 5% of the unkicked beam which is lost. Impossble to say what happens to the kicked beam: at 4.4 m only 200 particles (from the starting 1000) survives and TRACK stops.

A different approach:

TRACK used for computing the objective function inside a minimization code (using a NAGLIB routine). It works, in principle. But

- TRACK stops when too many particles are lost during the optimization procedure
- the trick of increasing the aperture results in a cell size change and the space charge effect is quite different!

Impasse(?): how to compute the trajectory of the kicked beam if it is not possible to increase the aperture? Likely the s.c. does not effect the trajectory (unless boundary conditions taken into account). To be checked.

Work slowed down by

- issues with the MAD-X version for MAC in presence of BB lenses (!)
- no more NAGLIB license for the linux
- no MAC version of TRACK