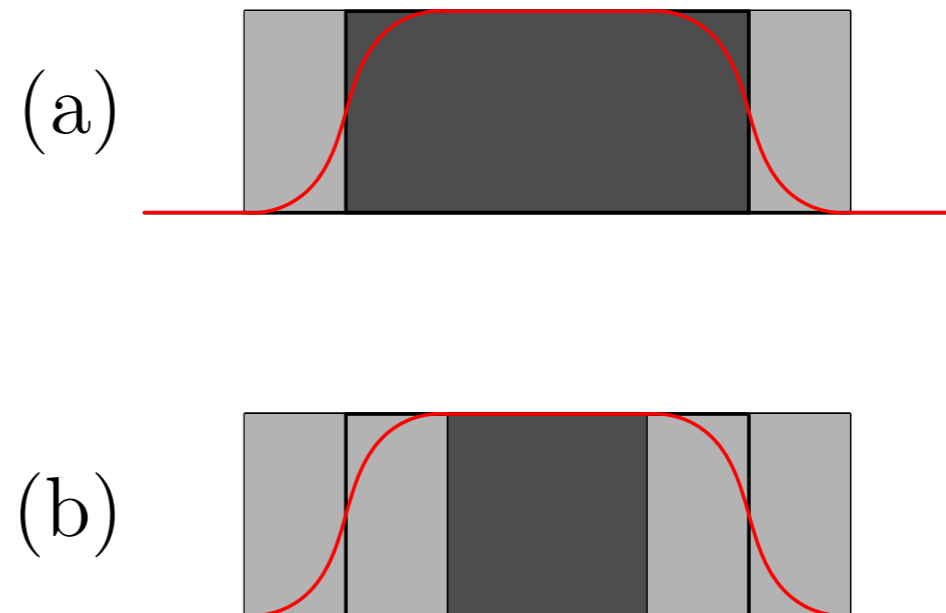# Fringe field implementation

Dave Brett, University of Manchester

Choice of model

- Choose (a) as conserves original hard edge model and doesn't interfere with error tables.

- Integrator/ Taylor map if of part of magnet symplecticity broken ending mid magnet.

  - If full magnet integrated need ~200 steps per magnet. 24 magnets per turn. 4800 steps per turn.

  - Experience with crabs, numerical integrator 840 steps per turn -> 1 week to do 70,000 turns.

(a)

(b)

Leading order model

Total magnetic field

Hard edge position — Contribution from $A_x[xy^2]$ and $A_y[x^2y]$ components

- Leading order model calculates Bz kick based upon quadrupole field going to a step function.

- Bz field dominated by components of leading order model.

At x=30mm, normalised to MQXC.1R1

$$k_0^{[\text{effective}]} = k_0$$

$$H = \frac{q}{p_0}\hat{B}\frac{1}{1+\delta}\left[\frac{b_1}{12}\left(3x^2yp_y - 3y^2xp_x + y^3p_y - x^3p_x\right) + \boxed{\frac{a_1}{6}\left(x^3p_y + y^3p_x\right)}\right]$$

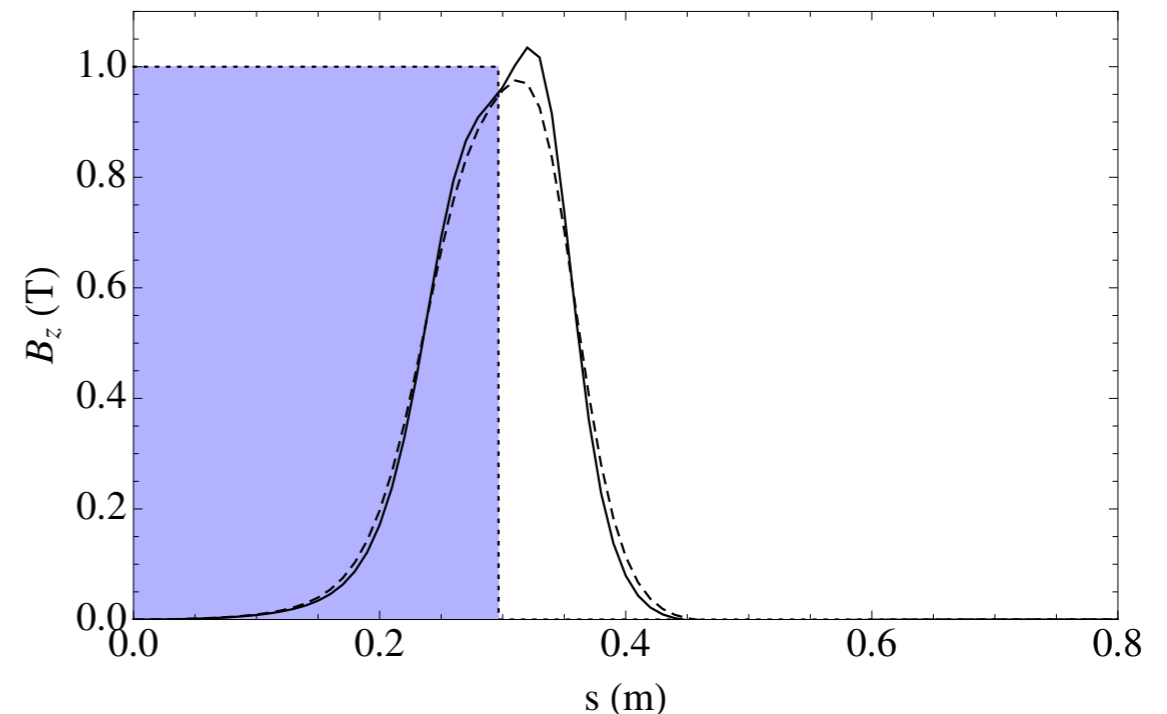$$k_0 = \frac{q\hat{B}}{p_0}b_1$$

$$k_0^{[\text{effective}]} = 4\frac{q}{p_0}\int_0^L A_x[xy^2](s)\,ds$$

Only skew quadrupole component solvable.
Higher order terms not solvable.
Rotate beam -45°, transfer map, reverse rotation

3

Leading order model

- Comparing Forest-Wu integrator through fitted Ax, Ay components of field with leading order model.

- Agreement begins to fail after ~30 mm particularly in py dependence of y.

- Effect overall very small compared with magnitude of kicks from Az.

- Az kicks wrapped up in error table.

- Preliminary implementation in SixTrack.
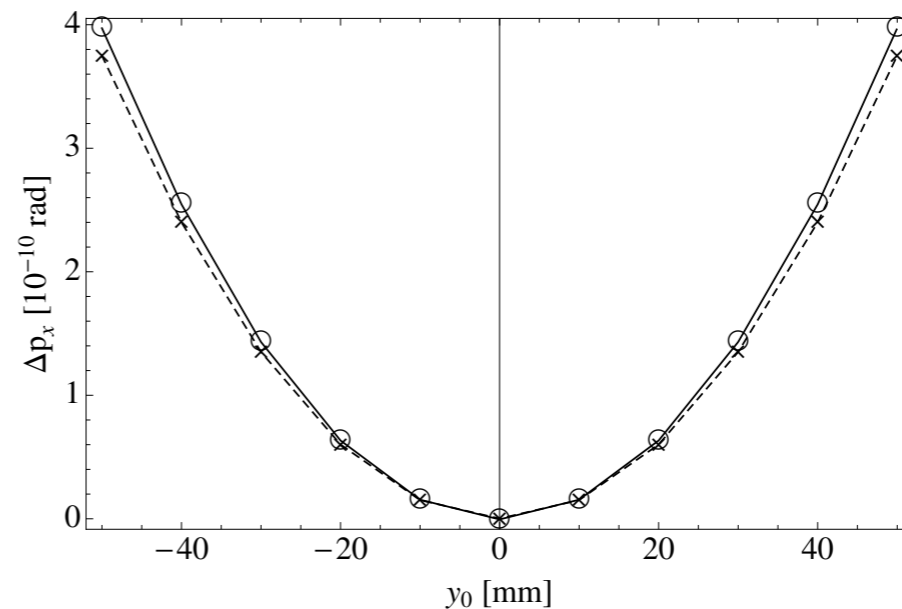

-*- Leading order thin lens model -⊕- Numerical integration of $A_{x,y}$

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4
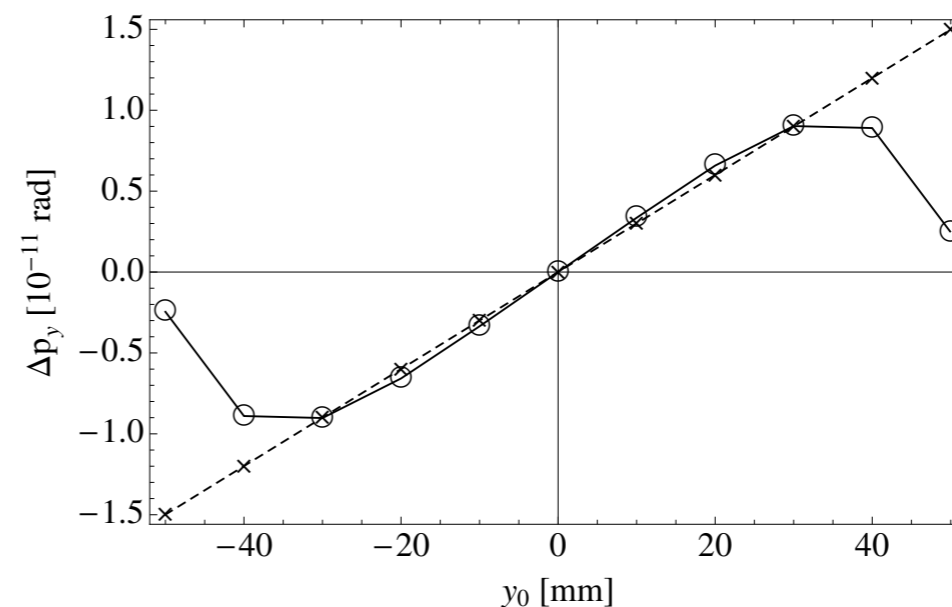
SixTrack result

- Implemented in FOX and numerical tracking.

- Strength needs to be passed from MADX (this is not implemented yet).

- Current implementation involved manual insertion on fort.2 files (Like Taylor maps).

- Study run with SLHC v3.1b optics, IT v6.6 errors, WISE arc errors, 60 seeds, no crab cavities, no beam-beam. Fringe fields applied to IT magnets in IR1 and IR5 only.

IT Model
--- Hard edge --- Leading order
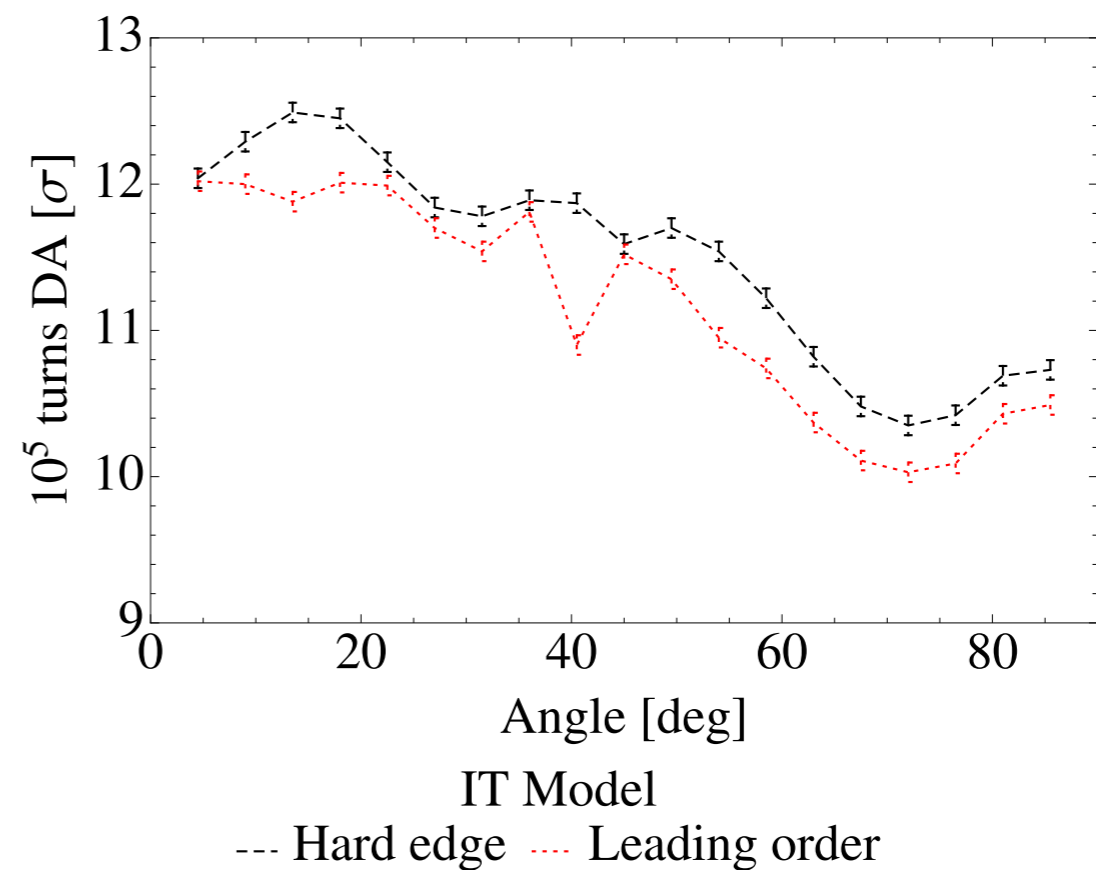
Conclusion

- Fringe field leading order model seems suitable and shows that it has some effect on the DA.

- Input into MADX needed to allow inclusion in mask file.

- Suggestion:

  - New special marker type which can have element type and strength values passed to SixTrack from MADX.