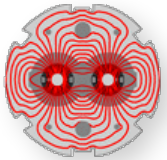
Ideas for extended interaction region magnet slicing



Tracking through IR using field descriptions (tilted solenoid + fringe + quad overlap)

implemented in direct tracking FieldStep, MDISim-GEANT4

and applied to FCC-ee,

as previously presented

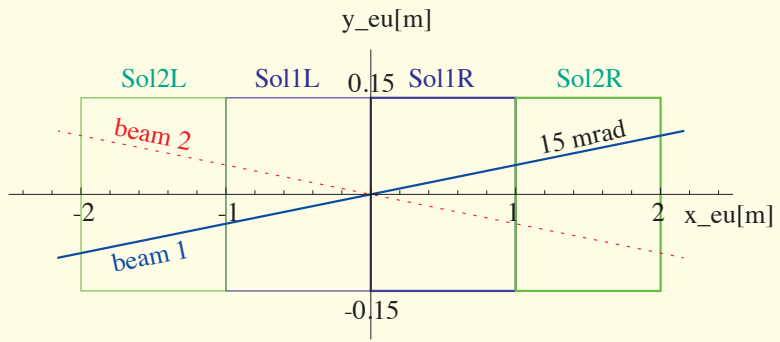
FCC-ee optics meetings

#95 05/04/2019 Comparison of tracking and maps for tilted solenoid with fringe fields

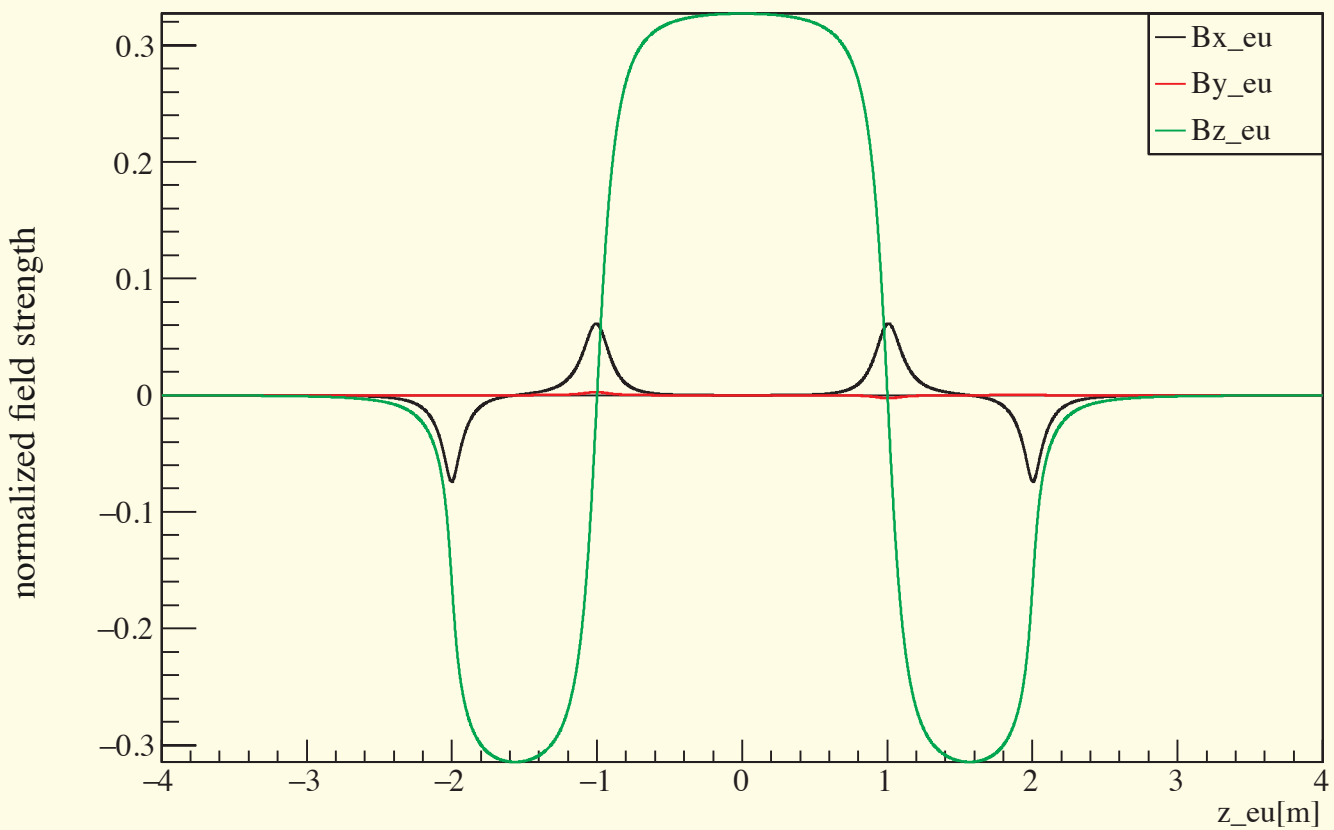
#96 03/05/2019 Tracking through solenoid with overlapping fields in quadrupole using Geant4

#105 11/10/2019 Radiation generated at the IP ~ 40 kW solenoid + ~ 400 kW beamstrahlung at FCC-ee Z hitting the beam pipe 49 - 55 m from IP

Illustration of geometry and fields - used as example close to FCC-ee geom.

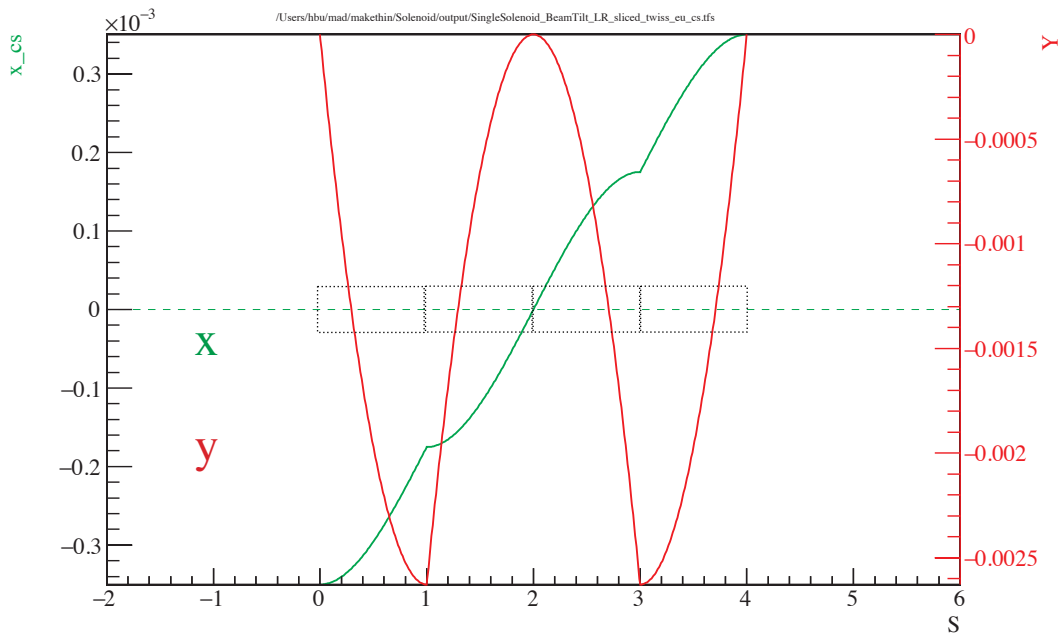


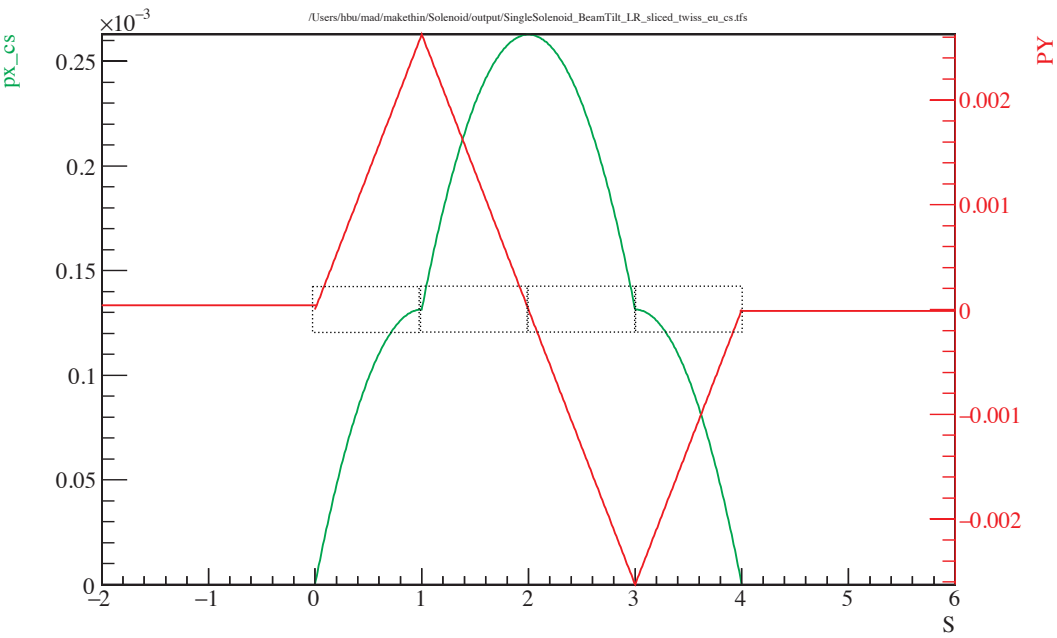
four 1m solenoid anti-solenoid pieces

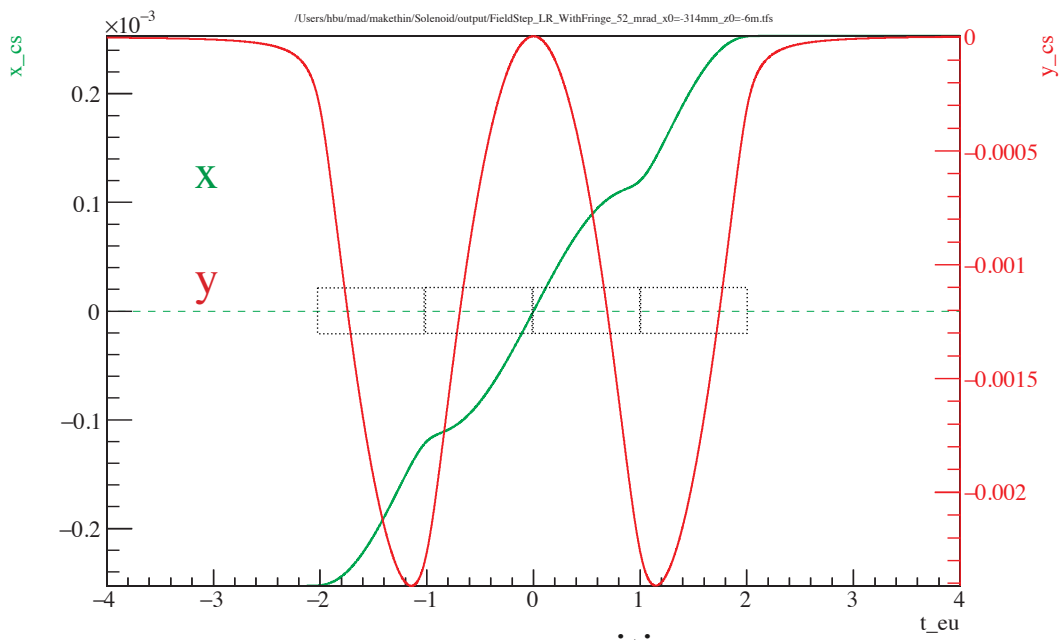


Comparison

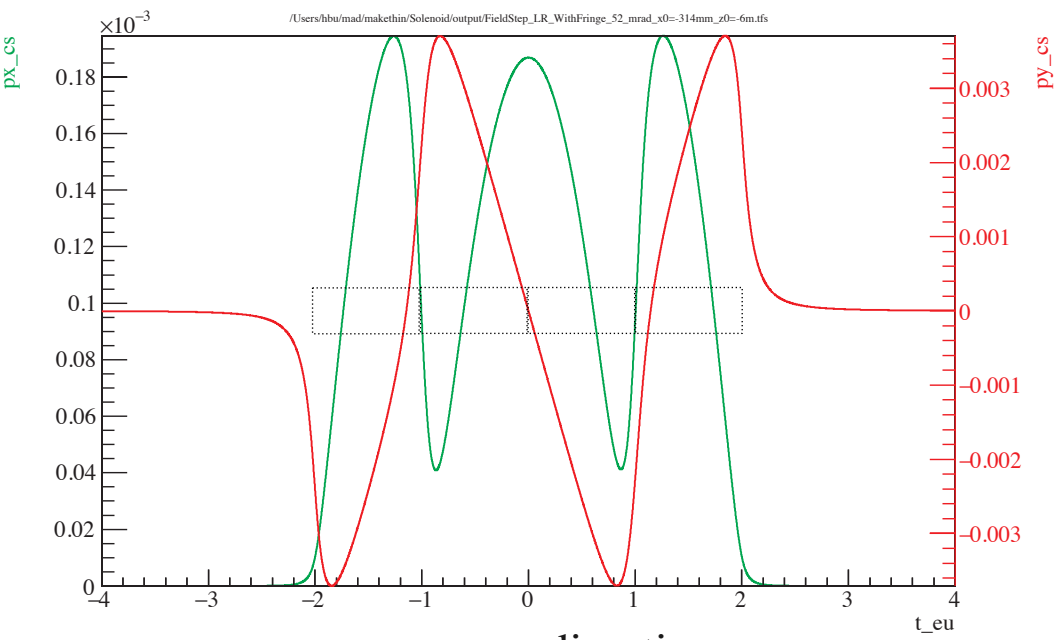
±15 mrad crossing angle, 2 T, 45.6 GeV





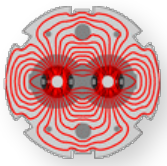


position

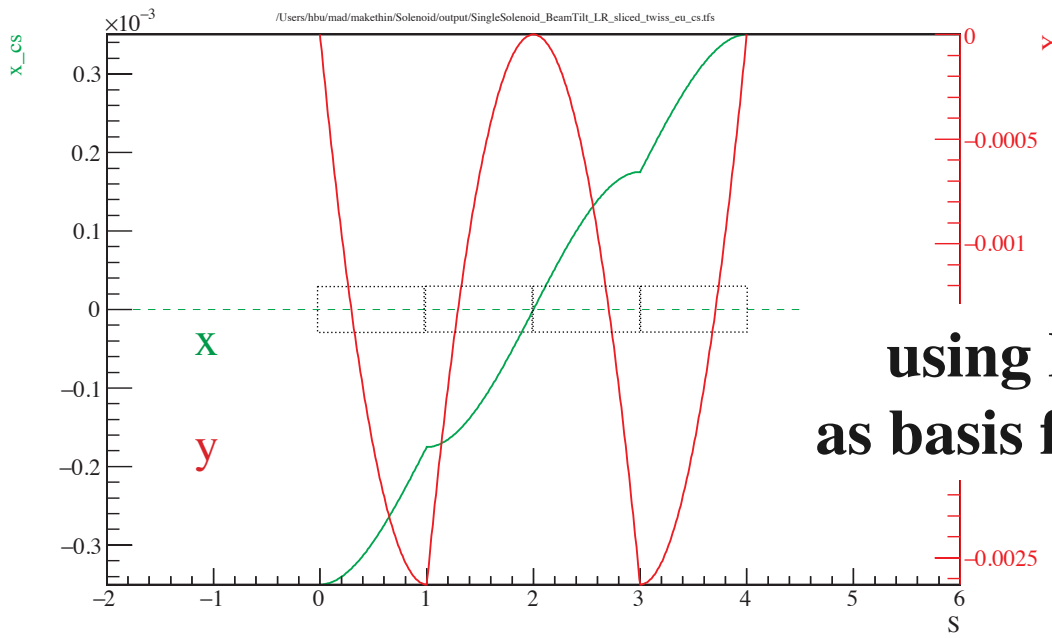


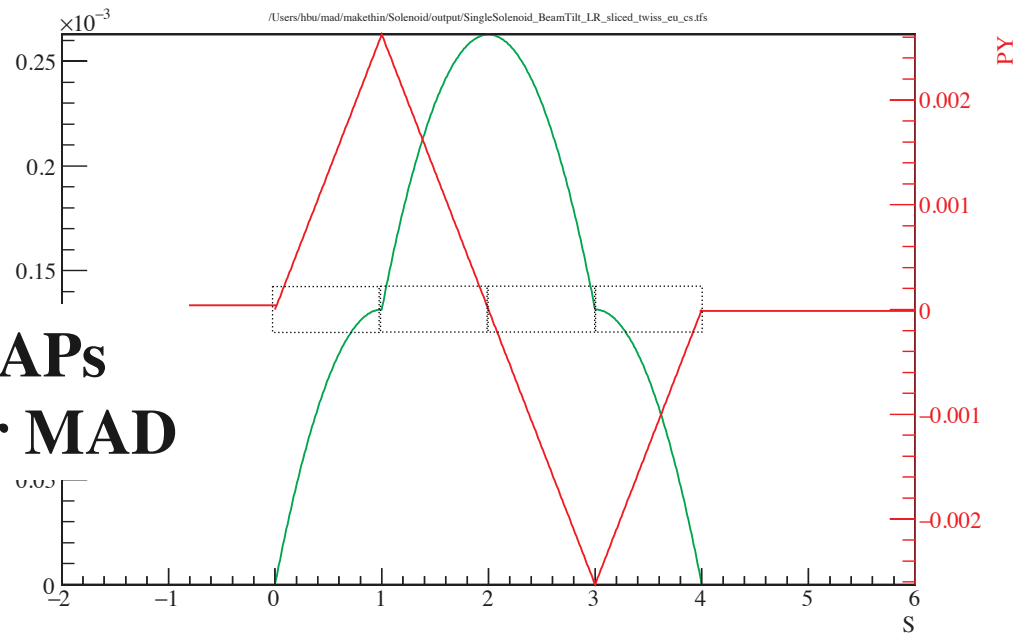
direction

Comparison

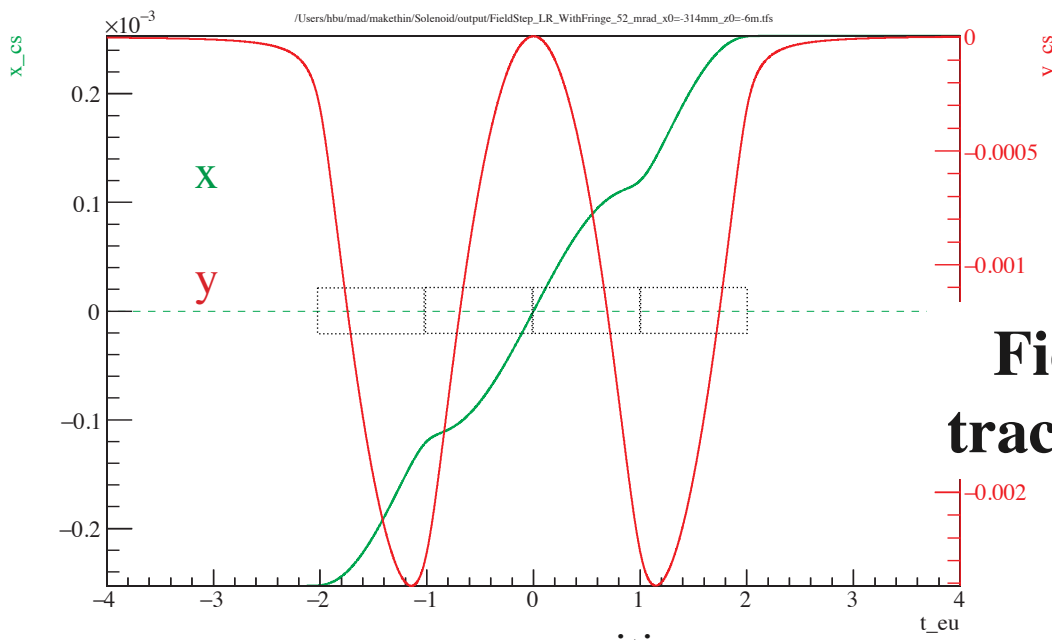


±15 mrad crossing angle, 2 T, 45.6 GeV



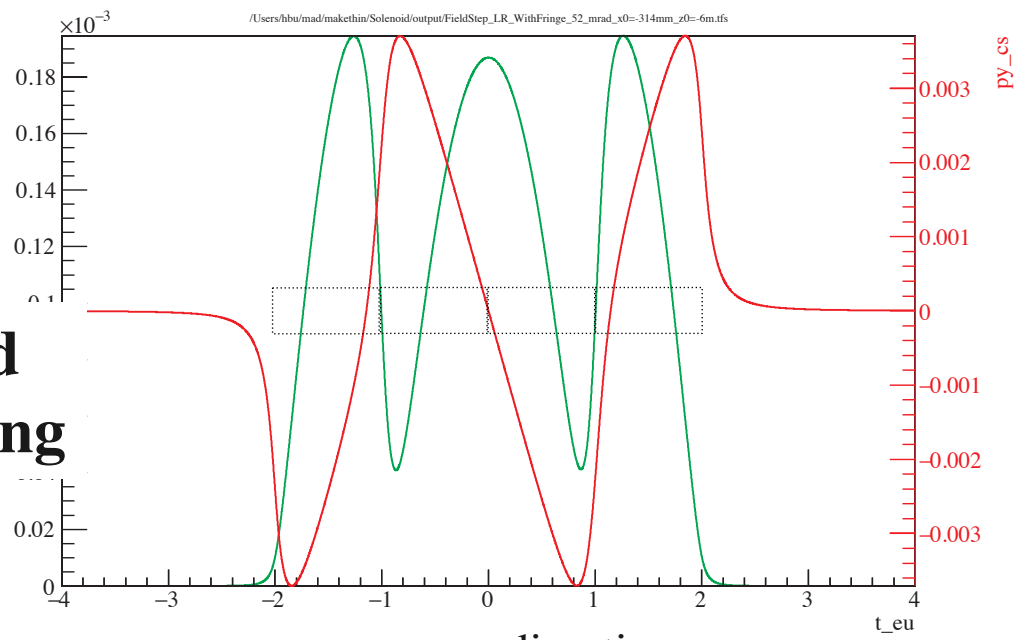


using MAPs as basis for MAD



position

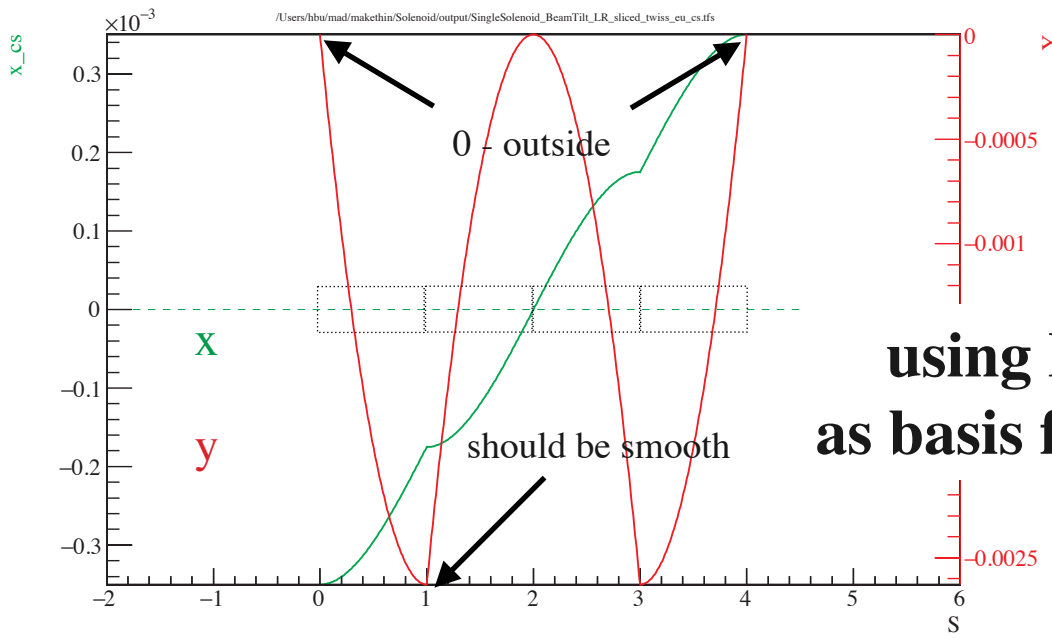
Field tracking



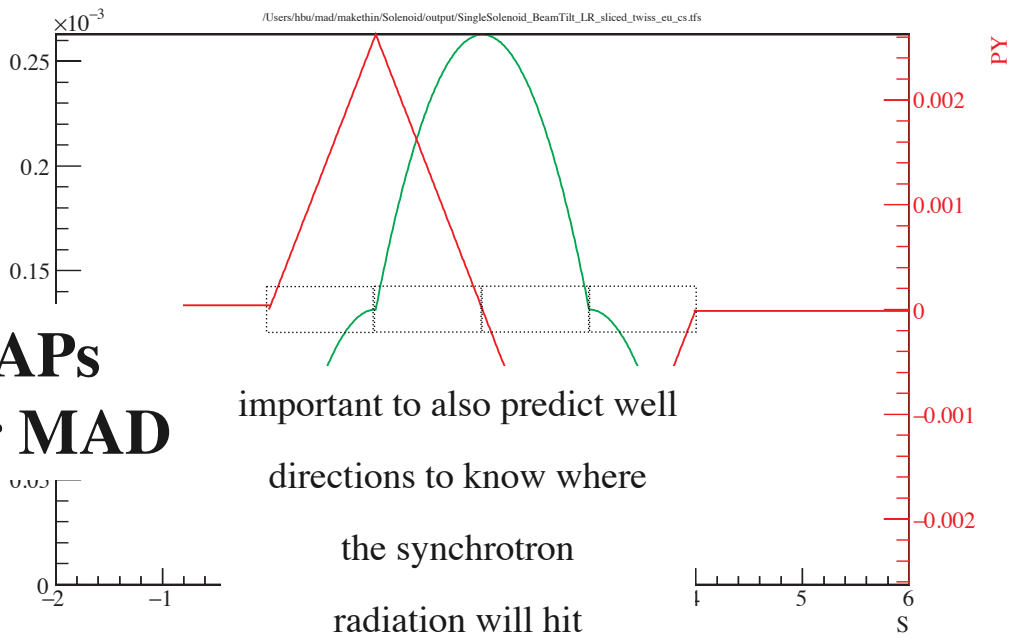
direction

Comparison

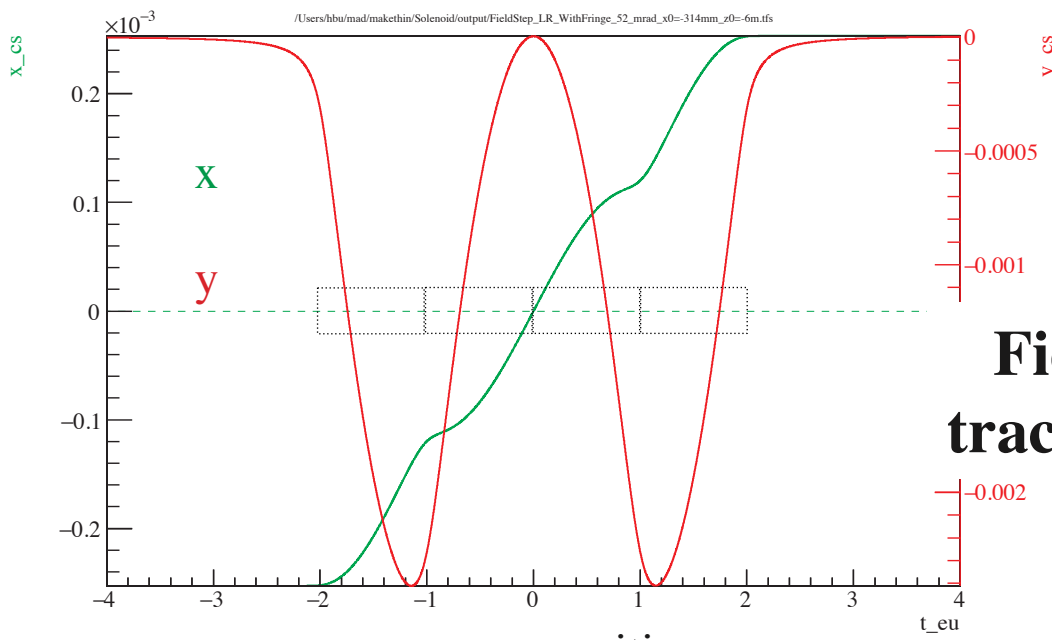
±15 mrad crossing angle, 2 T, 45.6 GeV



using MAPs as basis for MAD

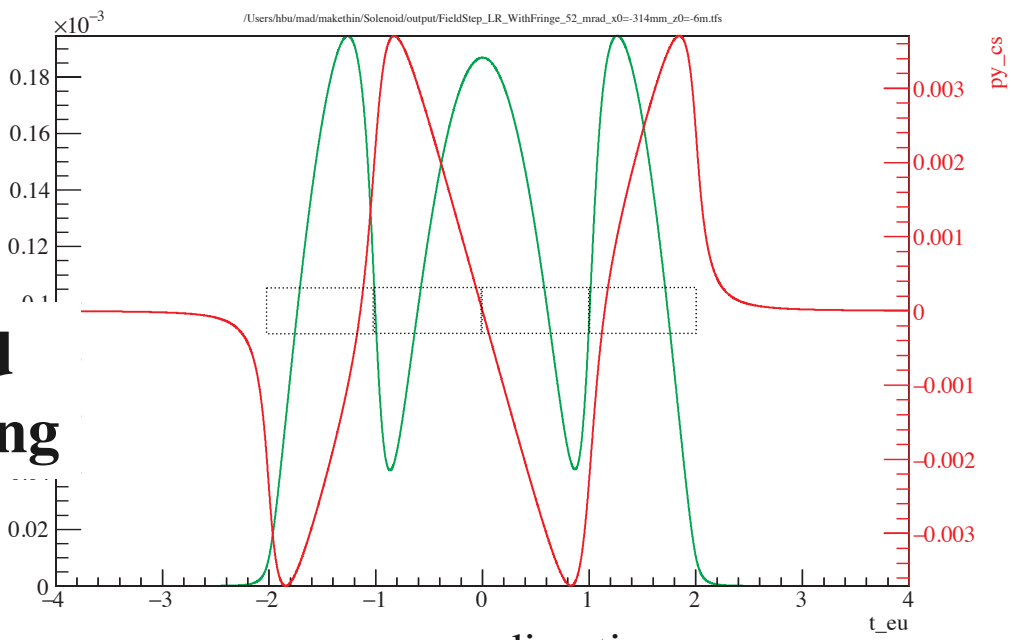


important to also predict well directions to know where the synchrotron radiation will hit



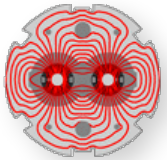
position

Field tracking



direction

Conclusions as presented in 4/2019 meeting



Sector Maps : derived from Hamiltonian by A. Dragt, G. Ripken et al.

provide transformation by element — **as seen from outside**

very powerful for optics design

slicing (module MAKETHIN) designed to well approximate the element transformation

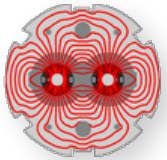
to reproduce twiss parameters as relevant (far) outside the element

but usually giving a **good approximation** for tracking through standard elements like bending magnets

Not adequate for solenoids with crossing angle (tilted solenoids in beam coordinates)

with major fringe and overlapping fields as required **for the FCC-ee IP fields**

How to deal with complicated IP fields ?



Determine the particle trajectories by direct tracking

using an analytic field description or field maps

Direct tracking allows to integrate synchrotron radiation (including beamstrahlung)

in a natural way (FCC-ee optics #105 presentation)

Use this as a basis in complicated cases (IP fields) to obtain all required information

As in a real machine, beta functions, dispersion .. can be measured based on orbit/trajectory information

On a more abstract level direct tracking can be considered as

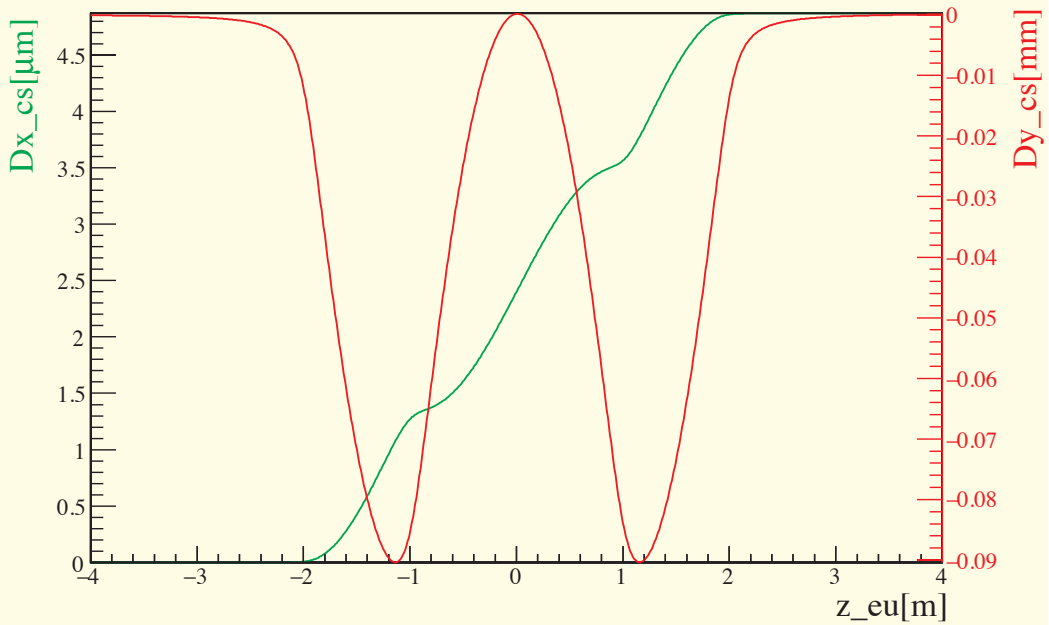
- **numerically solving** (stepwise integrating) **the equations of motions**
- **can be approximated by a sequence of kicks, provided by thin multipoles**

(symplectic kick-drift-kick integration)

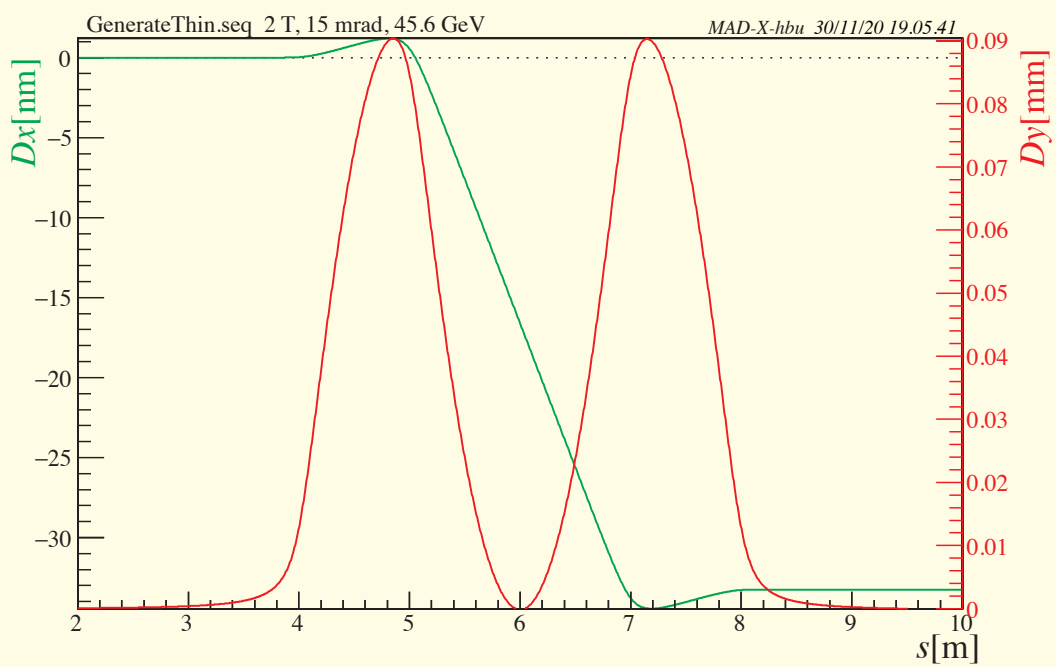
Construct a new "GenerateThin" module to describe the whole IP region as a sequence of thin multipoles, that can be plugged in the machine lattice description (sequence file) **readable by MAD-X**

Exploratory test

dispersion from tracking with deltap=10^{-6}



GeneratedThin.seq read by MAD-X



Using multipoles slices,
kick strength fitted to fields
evaluated (in the first iteration)
for a straight line tilted by
15 mrad horizontally through IP