Status and needs of dynamic aperture calculations

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Thanks to: E. Todesco

Outline

- MadX to SixTrack: makethin
- SixTrack flags and Sixdesk Environment
- Example with current lattice
- DA studies requirements & outlook
  - Working point at injection
  - Impact of arc dipole's field quality
  - Impact of sextupoles and inner triplet field quality on dynamic apertures (WP2/WP3?)

MadX to SixTrack

- makethin.madx script converts the thick integrated lattice in thin optics, taking into account:
  - phase advances of each arc cell
  - phase advances of insertions
  - each element (dipole, quadrupole, sextupole) of the lattice is sliced with 2 slices except the inner triplet with 4 slices (…first evaluation…)

- it is included in the repository: http://fccr.web.cern.ch/FCCr/hh/LATTICE_V4/Baseline

- it is integrated in the most recent version of the python tool (see A. Chancé)

N.B. strongly based on the naming convention of the lattice elements and markers placed in the lattice.

SixTrack flags and Sixdeskenv

Sixtrack flag

- bignblz option is needed for FCC (BIG!) lattice:
  - in sixdeskenv add: *export BIGNBLZ="yes please"*

  $\Rightarrow$ N. B. *set_env BIGNBLZ runs must be made using the platform LSF!!!*

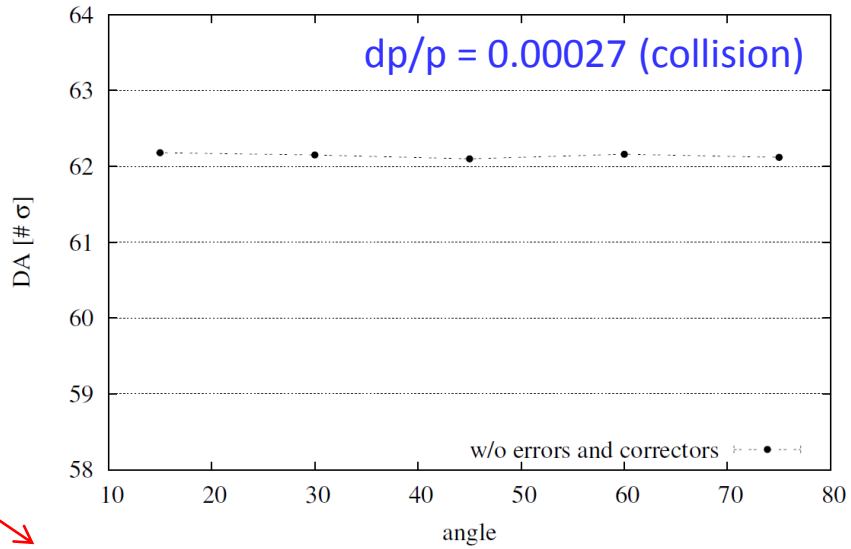
Sixdeskenv

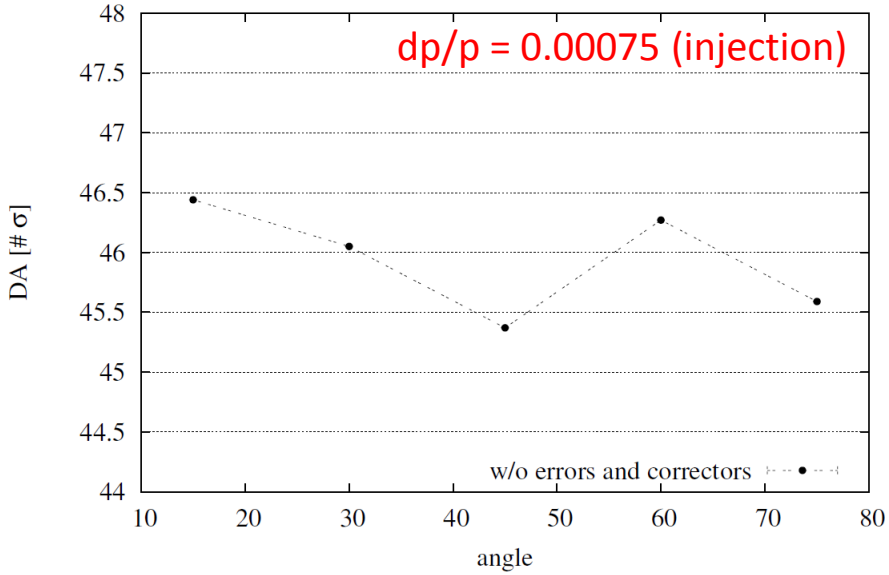
- to have 3 digits for the integer part of the tune, changed:
  - *run_six*
  - *run_awk*
  - *run_post*
  - *run_join10*
  - *dot_profile*
  - *fix_taskids*

Examples: no errors

Inputs long-term DA study:

- 60 seeds
- # of particle pairs 30
- Emit 2.2e-6 m.rad
- E_0 = 50 TeV
- dp/p = **0.00027**, **0.00075**
- dp/p max = 0.002
- tunex=107.93, tuney=106.34
  (…present tune… not proposing it)
- sigma step = 2, 5 angles □ [0,90°]





Computational time:

- ./run_mad6t ⇒ 4 min **(up to 15 min if errors and matching are included)**
- ./run_six ⇒ 2 h
- ./run_join10 ⇒ 4 min
- ./run_post ⇒ 15 min
- ./run_awk ⇒ < sec

N.B. more seeds ,angles, etc… increase the time …

Arc dipole's field quality

- First table for dipole's multipole errors provided (*E. Todesco FCC-hh design meeting 28/05/2015*)

- Needs:
  - full integration of insertion optics and trims for total tune ?
  - will assume LHC collision tune, which seems a good point for beam-beam (*X. Buffat FCC-hh design meeting 28/05/2015*)
  - what about quadrupole field quality ?

- provide first estimate of impact of dipole's errors for September
  ⇒ no magnets mis-alignment and no multipole correction considered
  (? see next slide)

Average

			Uncertainty		Random	
Normal	Injection	High Field	Injection	High Field	Injection	High Field
2	0.000	0.000	0.484	0.484	0.484	0.484
3	-5.000	20.000	0.781	0.781	0.781	0.781
4	0.000	0.000	0.065	0.065	0.065	0.065
5	-1.000	-1.500	0.074	0.074	0.074	0.074
6	0.000	0.000	0.009	0.009	0.009	0.009
7	-0.500	1.300	0.016	0.016	0.016	0.016
8	0.000	0.000	0.001	0.001	0.001	0.001
9	-0.100	0.050	0.002	0.002	0.002	0.002
10	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000
Skew						
2	0.000	0.000	1.108	1.108	1.108	1.108
3	0.000	0.000	0.256	0.256	0.256	0.256
4	0.000	0.000	0.252	0.252	0.252	0.252
5	0.000	0.000	0.050	0.050	0.050	0.050
6	0.000	0.000	0.040	0.040	0.040	0.040
7	0.000	0.000	0.007	0.007	0.007	0.007
8	0.000	0.000	0.007	0.007	0.007	0.007
9	0.000	0.000	0.002	0.002	0.002	0.002
10	0.000	0.000	0.001	0.001	0.001	0.001
11	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000

Field quality at collision

- adapted *macro_errors.madx* and *Efcomp_MBAXD.madx* by S. Fartoukh
- radius of reference = 0.017 m

90% of seed matched (tunes & chromaticity) but:

⇓

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**********************
** ALL PARTICLE LOST    **
**   PROGRAM STOPS      **
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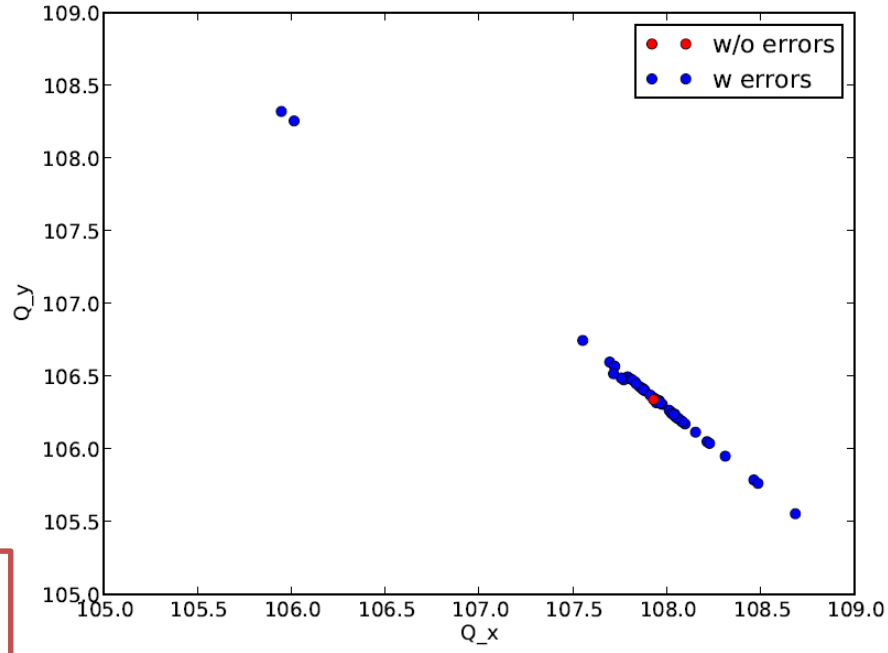
⇓

- Needs to compensate b3…
- Explore nominal LHC tunes…
- Maybe also quadrupole components a bit high… ?



Impact of IR field quality

To be coordinated with **WP3**

- Definition of lattices to be studied: nominal, ultimate, flat, injection…
- Integration of the different lattices
- Study the impact of interaction region magnets w or w/o arcs errors ?

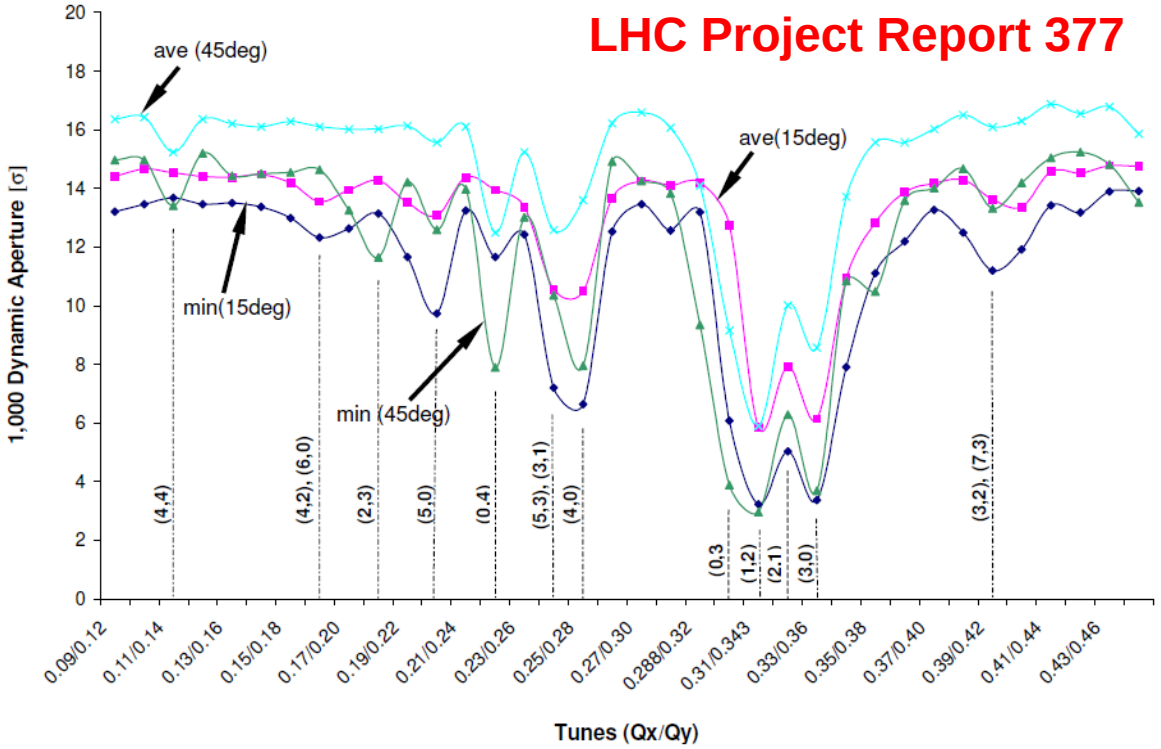
- What about inner triplet fringe fields ?

Working point at injection

High order multipoles in the arcs are more important at injection, due to larger emittance and larger dp/p ⇒ need to determine best working point at injection

@ LHC tune scan performed at three different distances (Q_x-Q_y=-0.01, Qx-Qy= -0.03, Q_x-Q_y=-0.05)

- for Q_x-Q_y=-0.01 no improvement
- for Q_x-Q_y=-0.05 more resonance play a role



@ FCC

- same tune distances ?
- tune split ?
- need injection optics

Conclusion

- Tools for FCC-hh Dynamics Aperture calculation have been developed (makethin.madx) and adapted starting from the (HL-)LHC ones.

- Further development and optimization possible and needed…

- Needs:
  - Optics for the different specific studies (injection, ….)
  - Trims for tune scan
  - Local correctors for b3
  - …