Limitations in modelling tools

L. Farvacque

A . Ropert

Motivation

- Designing a new tool for optimising SR lattices
- Summarise what is presently available in different tools
  - 1st order / Non-linear
  - Analytical / Tracking
  - Collective effects
  - Lifetime
- Flexible enough
- Powerful optimisation engine

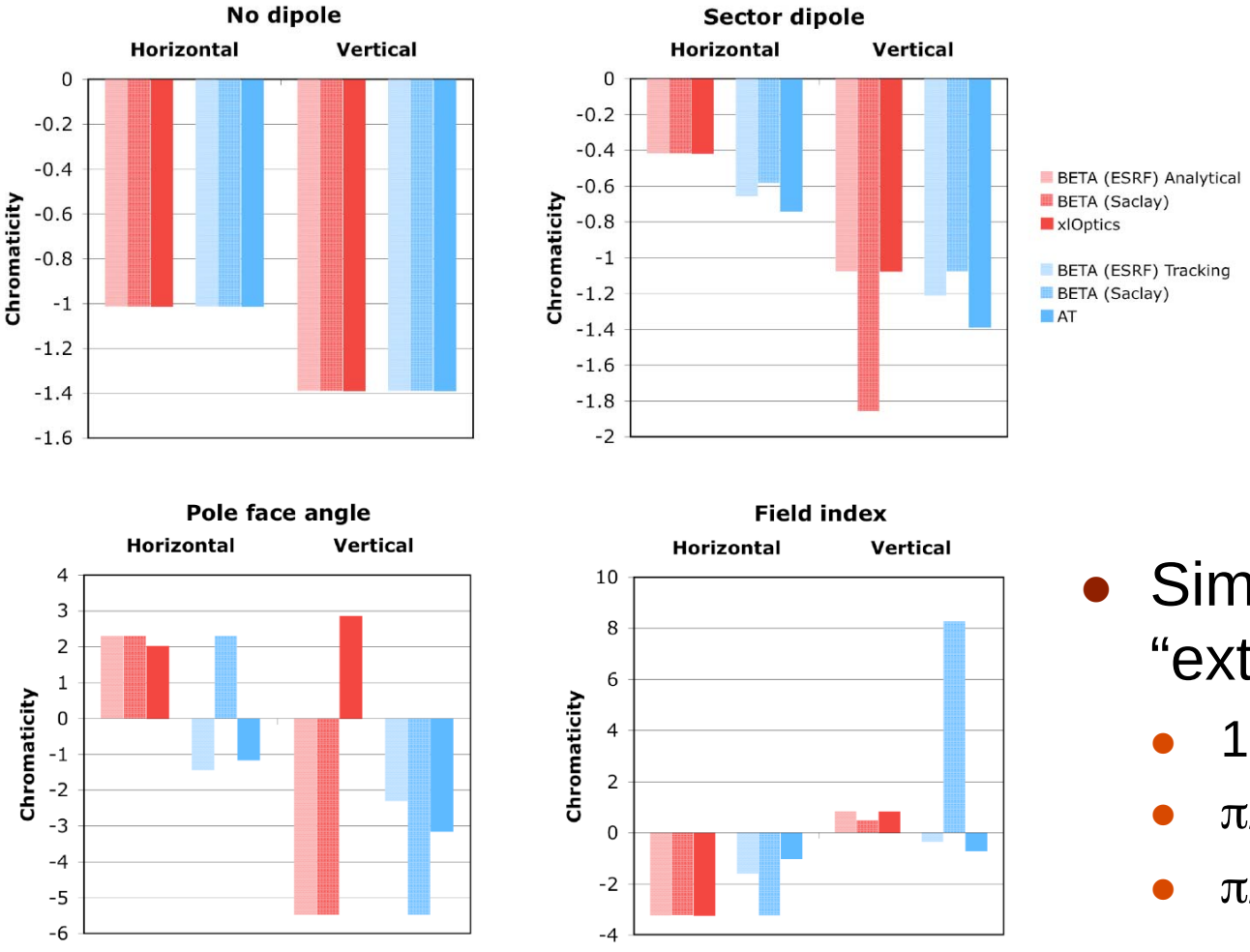
Non-linear features

- Criteria for non-linear optimisation
  - Ideally: lifetime !
  - Dynamic aperture
  - Tune shifts with
    - Momentum
    - Amplitude
  - Driving terms…
    - Fourier transformation: single resonance driving terms
    - Global

Chromaticity issues

- Analytical
  - Different formulae
    - *Bassetti, CERN, 1984*
    - *Takao et al., SPring8, 2004*
    - …
  - No question for quadrupole and sextupole contributions
  - Various results for dipole contribution
    - Pole face angle
    - Field index
    - Usually considered as a small contribution in large machines
- Tracking
  - Off-momentum treatment of dipole and edges

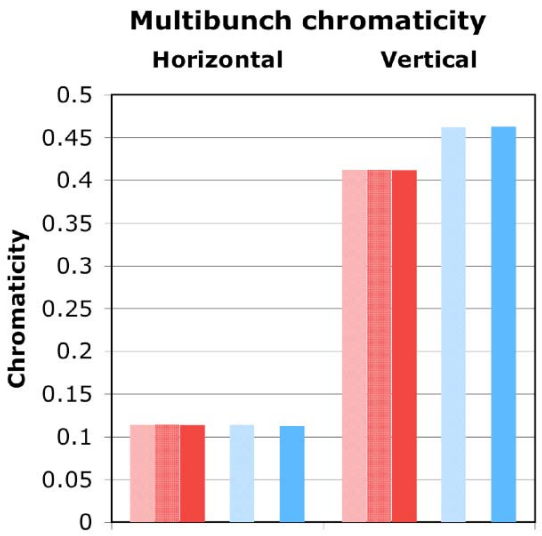
A few examples



- Simulation in “extreme” conditions:
  - 10 m dipole radius
  - $\pi/2$ bending angle
  - $\pi/4$ pole face angle

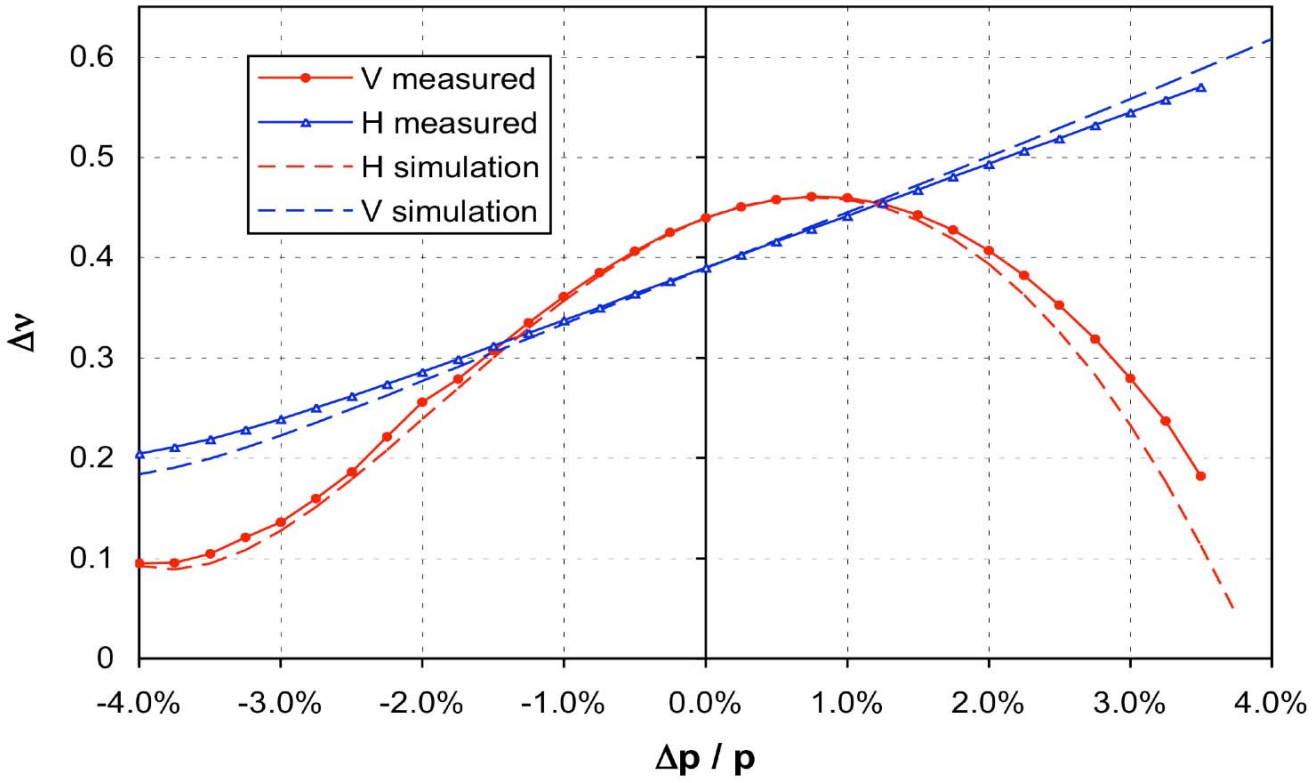
A few examples

- ESRF lattice: still significant difference in the vertical plane



Comparison with experiment

- Except for the vertical offset, the agreement with experiment is fairly good



Other issues

- Dipole fringe field
  - Vertical focusing: well known
  - Vertical chromaticity

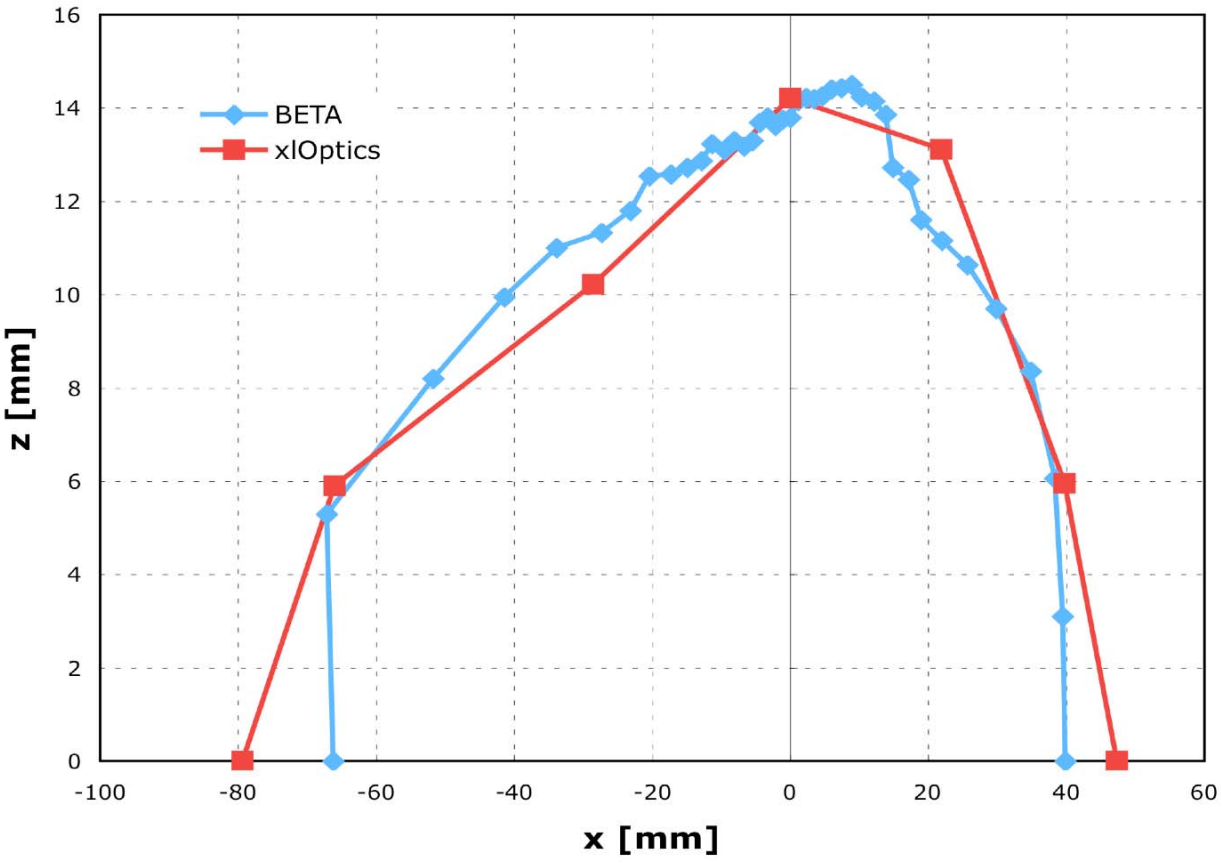
- Quadrupole fringe field
  - tune shift with amplitude
    - Can be taken into account analytically
    - Not included in tracking

ESRF development

- Excel spreadsheet
  - Well suited for analytical expressions
  - User interface and graphics for “free”
  - Automation possibilities with VBA
- Tracking
  - Accelerator Toolbox (*A Terebilo*) modules interfaced through VBA
  - NAFF (*J Laskar*) for frequency analysis

Sample

- Good agreement with BETA



- ESRF lattice
- No errors
- 250 turns

xlOptics

- Advantages
  - Everything is visible
    - All formulae can be checked and modified easily
  - The solver can fit virtually anything
    - “unlimited” variables and constraints
  - Fully interactive
  - Spreadsheet interface
  - Easy to customize
    - Add plots…
- Drawbacks
  - Excel needed ! ⇒ Windows or MacOS
  - Unworkable above a certain number of lattice elements (2000-3000)
    - Corresponds to ESRF with errors
  - It is easy to “break” the spreadsheet