Towards Horn Optimization for FFAG beamline

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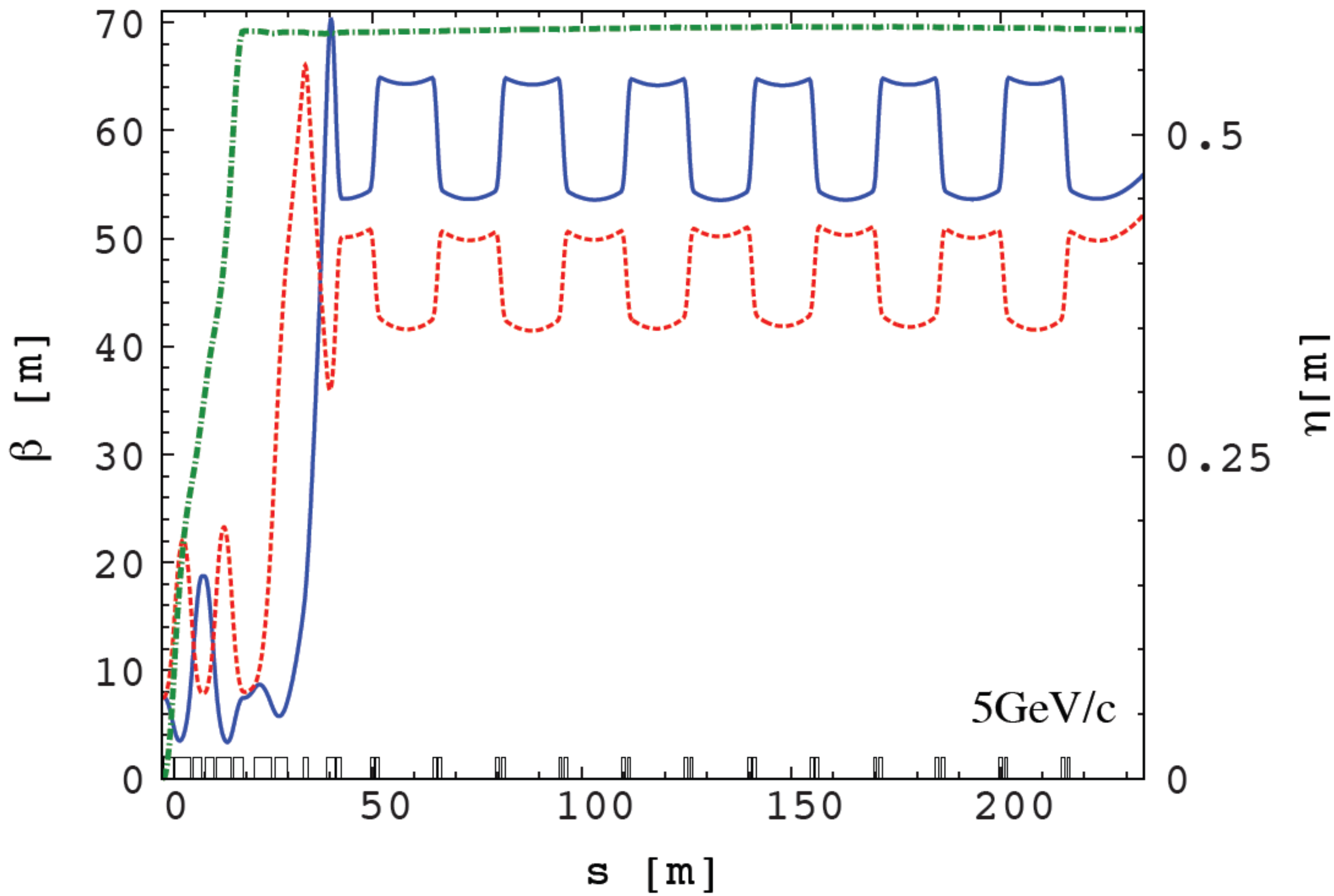
Introduction

- In below I assume we can fulfil the scaling promise:
  - Optics is independent of momentum
- Facts:
  - In circular scaling FFAG
    β~R -> d β/ β=dR/R

    for us -> R~386m, dR~0.5m -> β ~const -> Betatron function should be approximately independent of momentum
  - In straight FFAG β=const -> Betatron function is independent of momentum

Our Solution



Idea for horn optimization

- Maximise number of particles after the horn inside FFAG acceptance:
  - Maximise number of particles which obey: $\gamma(p)r^2 + 2\alpha(p)\, r\, p_T / p_Z + \beta(p)(p_T / p_Z)^2 < \varepsilon F(p)$,

    where ε is total unnormalized acceptance at the reference momentum (2Pi.mm.rad in our case)

    and F(p) includes limitations coming from dispersion

Idea for horn optimization (ideal case)

- Maximise number of particles after the horn inside FFAG acceptance:
  - Maximise number of particles which obey: $\gamma r^2 + 2\alpha\, r\, p_T / p_Z + \beta (p_T / p_Z)^2 < \varepsilon F(p)$,

    where ε is total unnormalized acceptance at the reference momentum (2Pi.mm.rad in our case)

    and F(p) includes limitations coming from dispersion and Twiss functions are now independent of momentum

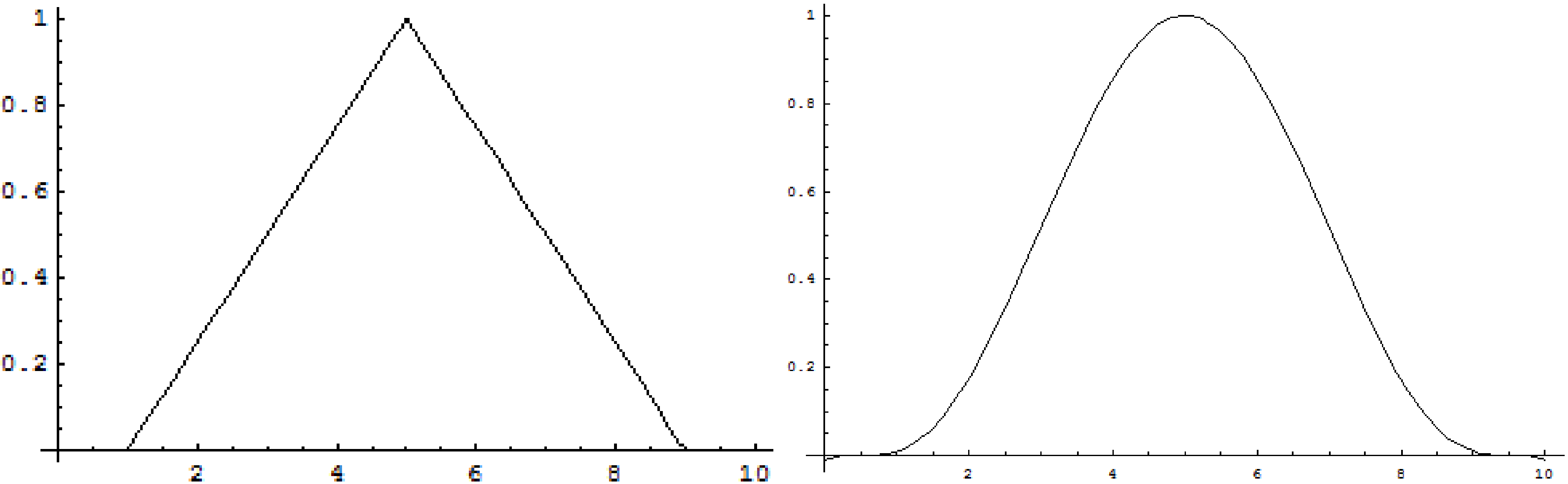
F(p) function for ideal case

F(p)= (US[5-p]*US[p-1]*(p-1)/4+US[9-p]*US[p-(5+ϵ)]*(9-p)/4)

- F(p)is triangle function with 1 at 5 GeV/c and zero outside (1,9) GeV/c interval -> now needs to be updated
- US[x] is the unit step which is zero for x<0 and 1 for x=1 or above.
- p is in GeV/c
- ϵ is an infinitesimal small number. It depends on machine precision used, but may be 10^-11 for example.
  This is just to avoid overshoot at 5 to the value of 2. You may argue it is irrelevant.
- You may also replace it by similar differentiable function like:
  $F(p)=-(531441/64)^{-1}(p-0.5)^{3}(p-9.5)^{3}$

F(p) function for ideal case -2

F(p)



P [GeV/c]

…however

- It seems the phase advance may not be constant as a function of momentum
- We may proceed in parallel along:
  – Re-introducing nontrivial β(p), α(p), γ(p) and F(p)
  – Trying to re-establish constant phase advance by correcting the lattice.