Plots Peter uses for analysis of an FEL accelerator

Peter Williams 04/05/2016 (Star Wars Day)

1. Plots derived from the particle phase space at a particular machine location (typically a screen)
   1. Raw phase space
      1. **Horizontal phase space** (x vs px) (A, E, GPT)
      2. **Vertical phase space** (y vs py) (A, E, GPT)
      3. **Screen image** (x vs y) (A, E, GPT)
      4. Divergence at screen (px vs py) (A, E, GPT)
      5. **Longitudinal phase space** (dz or dt vs dp) (A, E, GPT)
      6. Longitudinal – transverse position correlations (dz or dt vs x or y)
      7. Longitudinal – divergence correlations (dz or dt vs px or py)
      8. Energy deviation – transverse position correlations (dp vs x or y)
      9. Energy deviation – divergence correlations (dp vs px or py)
   2. Statistically analysed phase space (sliceAnalysis
      1. Binned in dz or dt (user selected bin size) vs **current** per bin (i.e. scaled to Amps) (Ele, Astra)
      2. Binned in dz or dt (user selected bin size) vs **centre of mass** in x or y (or px or py or dp)
      3. Binned in dz or dt (user selected bin size) vs betax or betay per bin
      4. Binned in dz or dt (user selected bin size) vs **normalised emittance** in x or y per bin
      5. Binned in dz or dt (user selected bin size) vs **std. dev of dp** per bin (eg figure out <p>(s) of slice, then <|p-p(slice)|>) simply slice by longitudinal coord. Most important in core of bunch where I is high.
      6. Binned in dz or dt (user selected bin size) vs gain length calculated from Ming Xie formula per bin (Elegant only)
2. Plots comparing particle phase spaces at multiple machine locations
   1. Raw phase space
      1. Longitudinal phase spaces absolute (dz or dt vs dp in keV)
      2. **Longitudinal phase spaces relative** (dz or dt vs dp/(mean p at each location) in %)
3. Plots showing evolution of parameters along the machine (all have s = path length on x-axis)
   1. **Centroids**
      1. (centre of mass of bunch in each coordinate, (clara-cen-page1.vsh5) Cx Cy, etc
      2. deviation from central momentum due to radiative losses….) – aka first order moments (Cdelta from clara-cen-page1.vsh5) but Cdelta means little in ASTRA
   2. **Mean momentum (pCentral from clara-cen-page1 (and sig and …) or pAverage Astra**
   3. Second order moments (s1 (=sqrt(<x\*x>) , s12, …, s66) (all the stuff in sig s11, s12 E, A)
   4. **Sizes in each dimension calculated from second order moments** (standard deviations of bunch in each coordinate, e.g. beam sizes (=sqrt((x-<x>)^2) etc), divergences, etc) (So Sx, Sxp, Sy, Syp, Ss St Sdelta dataset in sig????)
   5. **Optical functions** –
      1. betax, betay, alphax, alphay, (see .twi file) (betax, alpha E&A
      2. phase advances, (.twi file nux nuy (Elegant only)
      3. mismatch parameters (ma datasets????) check with Peter (sig file, Eonly)
   6. **Cumulative transport matrix elements** (e.g. R11, R12, …., R56, R65,….)
      * 1. **R56 R12 R34 R16 R36**
   7. **Normalised emittances** (with and **without** dispersive contributions)
      1. **Sig file enx eny (corrected are ecnx ecny)**
   8. Geometric emittances
      1. Sig file ecx ecy, ex, ey
   9. **Bunch length**
      1. **Sig file St (Sz)**
   10. **Relative energy spread**
       1. **Sig file Sdelta**
   11. Allowed aperture of transport
       1. .twi xAperture, yAperture in (together with Sx, Sy and multiples of Sx, Sx (transform operator)) (Elegant only? ASK PETER IF WANTS THIS FROM ASTRA)
   12. Lost particles (Check if Elegant and ASTRA leave them where they die)
       1. Histogram vs s.
       2. Use particle ID to map back to original phase space. (phase space x,y,z)
          1. Get file(s) from Frank.
4. 3D phase spaces coloured by initial position.
5. Movie of (3D, or xy, or longitudinal phase space down machine)
6. Lost particles (as part of initial phase space, coloured by s position lost)

Future colliders.

CSRtrack – I/O formats?/???

Microbunching parameters.