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)
      2. **Vertical phase space** (y vs py)
      3. **Screen image** (x vs y)
      4. Divergence at screen (px vs py)
      5. **Longitudinal phase space** (dz or dt vs dp)
      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
      1. Binned in dz or dt (user selected bin size) vs **current** per bin (i.e. scaled to Amps)
      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
      6. Binned in dz or dt (user selected bin size) vs gain length calculated from Ming Xie formula per bin
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** (centre of mass of bunch in each coordinate, deviation from central momentum due to radiative losses….) – aka first order moments
   2. **Mean momentum**
   3. Second order moments (s1 (=sqrt(<x\*x>) , s12, …, s66)
   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)
   5. **Optical functions** – betax, betay, alphax, alphay, phase advances, mismatch parameters
   6. **Cumulative transport matrix elements** (e.g. R11, R12, …., R56, R65,….)
   7. **Normalised emittances** (with and **without** dispersive contributions)
   8. Geometric emittances
   9. **Bunch length**
   10. **Relative energy spread**
   11. Allowed aperture of transport
   12. Lost particles