F. Méot, Dec. 2016

Effect of snakes on tunes and chromas, at injection

Contents

• **RHIC 4-module snakes are simulated using Ramesh's two 3D OPERA maps of respectively right-handed and left-handed modules.**

• **Tunes and chromas, snakes off or on, $G\gamma = 45.5$.**

Note : inkection optics should be used, collision is, instead, for now (optical functions plots in slied # 5). Snakes change the focusing in IR regions, this may have substantial effect on tune. This has to be updated with proper optics.

SNAKES OFF

```
 Reference, before change of frame (part #     1)  :
  0.  -3.46581390E-06  -1.18678295E-05   0.   0.   3.83384557E+05   1.27982715E+01

              TWISS  parameters,  periodicity  of   1  is  assumed
                              -  COUPLED  -

      Beam  matrix  (beta/-alpha/-alpha/gamma) and  periodic  dispersion  (MKSA units)
          1.949062     0.058889     0.000000     0.000000     0.000000     0.001580
          0.058889     0.514847     0.000000     0.000000     0.000000     0.002030
          0.000000     0.000000     2.059936    -0.027239     0.000000     0.000000
          0.000000     0.000000    -0.027239     0.485812     0.000000     0.000000
          0.000000     0.000000     0.000000     0.000000     0.000000     0.000000
          0.000000     0.000000     0.000000     0.000000     0.000000     0.000000

                          Betatron  tunes  (Q1 Q2 modes)

                 NU_Y =  0.68499553         NU_Z =  0.67299602

                                  ----------------------------------------
                                  -  EDWARDS AND TENG'S PARAMETRIZATION  -
                                  ----------------------------------------

                                                                          MODE 1              MODE 2

     FRACTIONAL PART OF THE BETATRON TUNES IN THE DECOUPLED FRAME:        0.68499553          0.67299602

     EDWARDS-TENG'S PARAMETERS:
                              - ALPHA:                                   -0.05888897          0.02723900
                              - BETA:                                     1.94906212          2.05993600
                              - GAMMA:                                    0.51484655          0.48581216

     HAMILTONIAN PERTURBATION PARAMETERS:

                           - DISTANCE FROM THE NEAREST DIFFERENCE LINEAR RESONANCE:     0.00000000
                           - COUPLING STRENGTH OF THE DIFFERENCE LINEAR RESONANCE:      0.00000000

                           - DISTANCE FROM THE NEAREST SUM LINEAR RESONANCE:            0.00000000
                           - UNPERTURBED HORIZONTAL TUNE:                              0.68499553
                           - UNPERTURBED VERTICAL TUNE:                                0.67299602

                                  Momentum compaction :

                                dL/L / dp/p =  1.78866203E-03
 (dp =  1.000000E-04      L(0)   =    3.83385E+05 cm,  L(0)-L(-dp) =    6.85822E-02 cm,  L(0)-L(+dp) =   -6.85669E-02 cm)

                                  Transition gamma  =  2.36448115E+01

                                  Chromaticities :

                                dNu_y / dp/p =  2.00068579E+00
                                dNu_z / dp/p =  1.99970750E+00
```

SNAKES ON

```
 Reference, before change of frame (part #     1)  :
  0.  -4.56024376E-06   6.31737633E-06  -1.55944093E-06   3.37854334E-05   3.83384968E+05   1.27982854E+01

              TWISS  parameters,  periodicity  of   1  is  assumed
                              -  COUPLED  -

      Beam  matrix  (beta/-alpha/-alpha/gamma) and  periodic  dispersion  (MKSA units)
          1.936703     0.050666     0.000000     0.000000     0.000000     0.000149
          0.050666     0.517667     0.000000     0.000000     0.000000     0.001667
          0.000000     0.000000     2.007300    -0.332127     0.000000    -0.000119
          0.000000     0.000000    -0.332127     0.553135     0.000000    -0.001162
          0.000000     0.000000     0.000000     0.000000     0.000000     0.000000
          0.000000     0.000000     0.000000     0.000000     0.000000     0.000000

                          Betatron  tunes  (Q1 Q2 modes)

                 NU_Y =  0.68194766         NU_Z =  0.73614756

                                  ----------------------------------------
                                  -  EDWARDS AND TENG'S PARAMETRIZATION  -
                                  ----------------------------------------

                                                                          MODE 1              MODE 2

     FRACTIONAL PART OF THE BETATRON TUNES IN THE DECOUPLED FRAME:        0.68194766          0.73614756

     EDWARDS-TENG'S PARAMETERS:
                              - ALPHA:                                   -0.05066621          0.33212699
                              - BETA:                                     1.93670259          2.00729961
                              - GAMMA:                                    0.51766702          0.55313533

     HAMILTONIAN PERTURBATION PARAMETERS:

                           - DISTANCE FROM THE NEAREST DIFFERENCE LINEAR RESONANCE:    -0.05405238
                           - COUPLING STRENGTH OF THE DIFFERENCE LINEAR RESONANCE:      0.00399628

                           - DISTANCE FROM THE NEAREST SUM LINEAR RESONANCE:            0.41809522
                           - UNPERTURBED HORIZONTAL TUNE:                              0.68202142
                           - UNPERTURBED VERTICAL TUNE:                                0.73607380

                                  Momentum compaction :

                                dL/L / dp/p =  1.78676165E-03
 (dp =  1.000000E-04      L(0)   =    3.83385E+05 cm,  L(0)-L(-dp) =    6.85099E-02 cm,  L(0)-L(+dp) =   -6.84936E-02 cm)

                                  Transition gamma  =  2.36573823E+01

                                  Chromaticities :

                                dNu_y / dp/p =  3.82686455E+00
                                dNu_z / dp/p =  3.96685338E+00
```

• **From left to right, tunes change from**

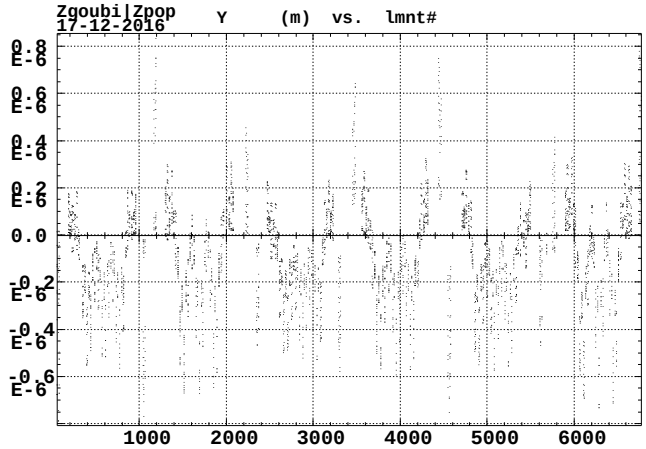
uncoupled, NU_Y = 0.68499553 NU_Z = 0.67299602 to, weakly coupled, Q1 = 0.68194766 Q2 = 0.73614756

and chromas increase by 1.9 unit, from 2 to 3.9.

- **Just to show that residual orbits in these simulations are negligible :**

- **SNAKES OFF**

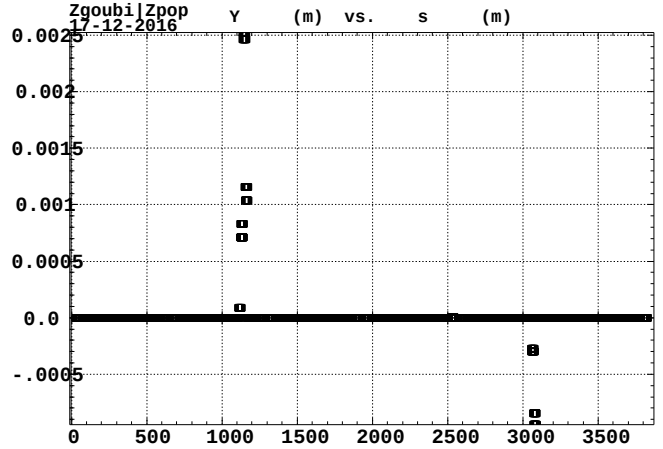
HORIZONTAL :



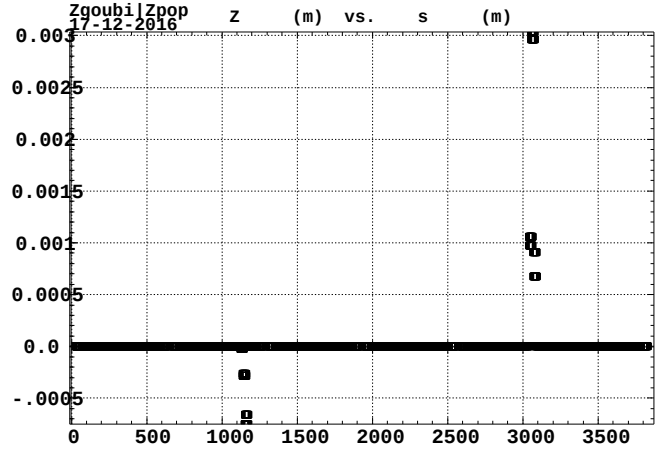
Initial vertical conditions zero remain zero.

- **SNAKES ON**

HORIZONTAL :

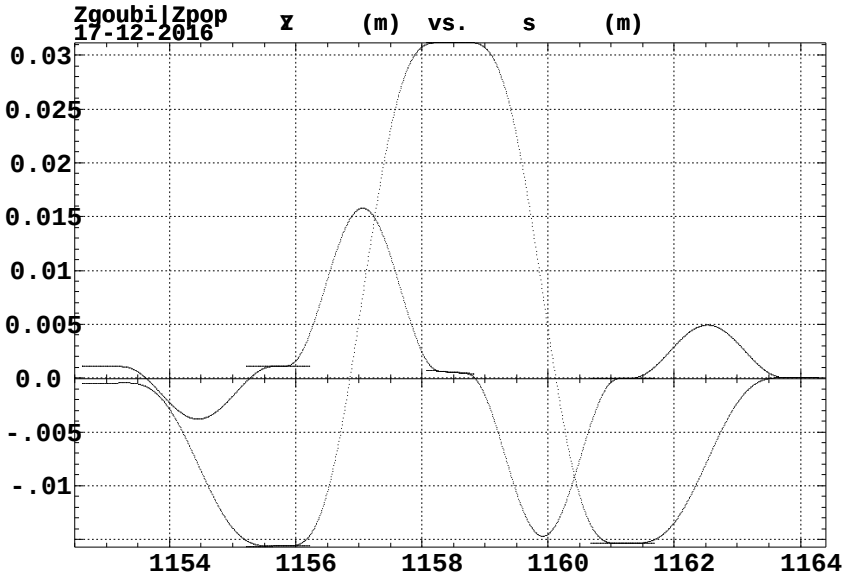


VERTICAL :

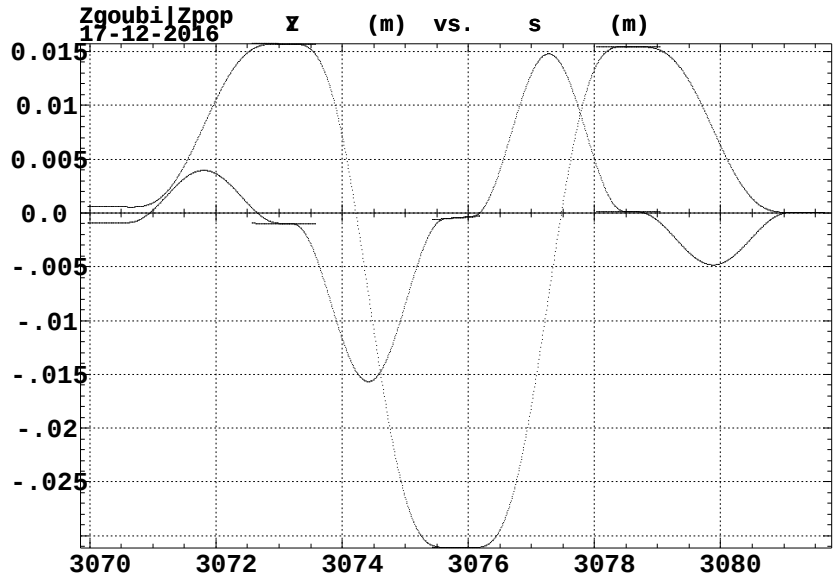


- **Shows Y and Z orbit excursions in the two snakes :**

SNAKE 1 :

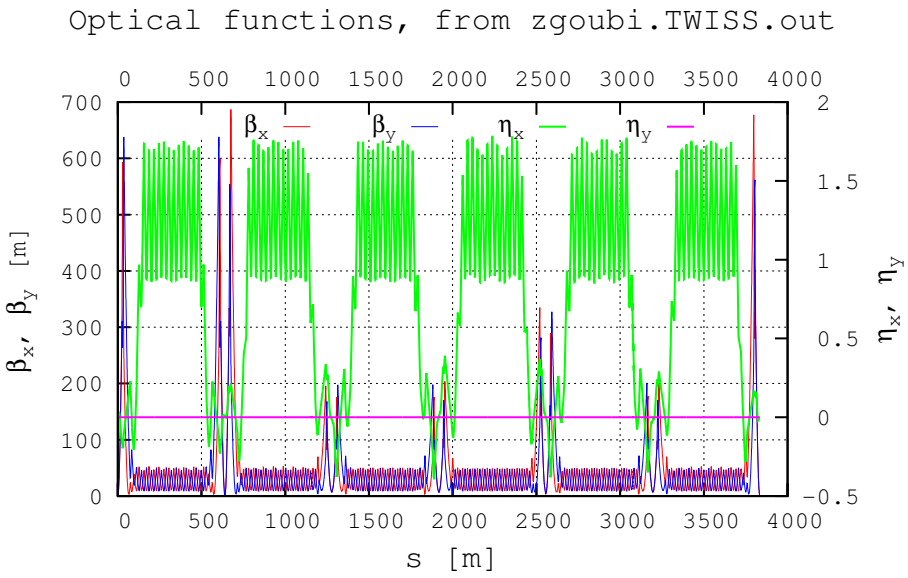


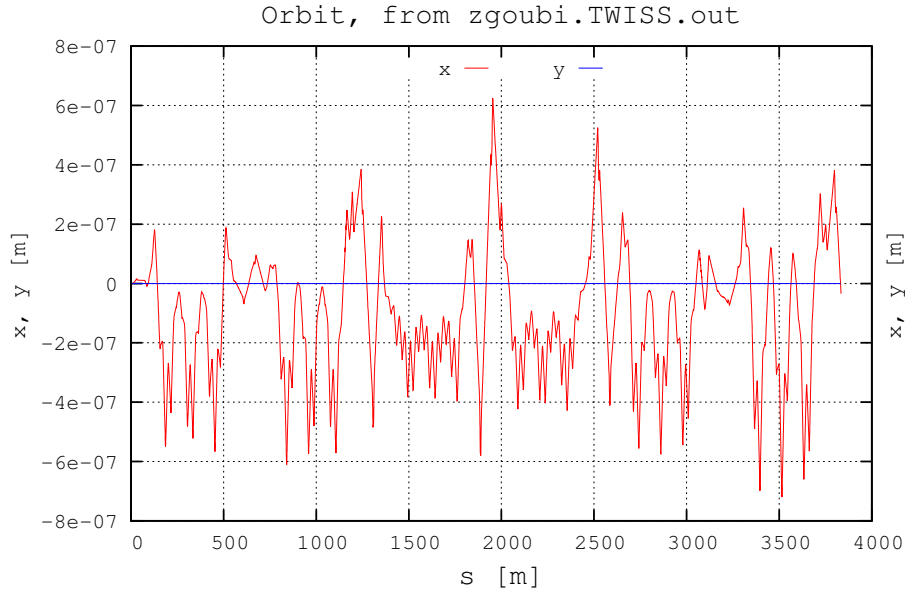
SNAKE 2 :



• **Optical functions ($G.gamma = 45.5$ - with collision optics (!)) :**

• **SNAKES OFF**





• **SNAKES ON**