NUAGE, ION CLOUD TRACKER

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Abstract: NUAGE is a data parallel Matlab code which simulates the ion cloud effect in electron storage rings. The ion cloud is tracked in the ring taking into account the transverse and longitudinal effect of the beam-ion interaction, tracking in magnetic elements, usage of electrodes and gaps as clearing means. This program has been used to compute ionised ion equilibrium state and its neutralisation factor. The NUAGE code is presented, the model, analysis method and performances are discussed.

Beam-Ion Model

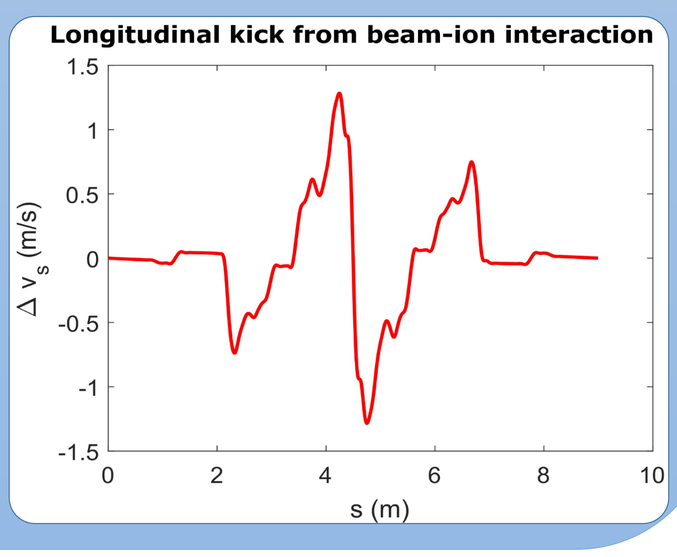
- Model based on beam-beam interaction under the "strong-weak" approximation
- The transverse ion kicks Δv_x and Δv_y are given by the Bassetti-Erskine formula:

$$i\Delta v_x + \Delta v_y = -\frac{NK\sqrt{\pi}}{\sqrt{2(\sigma_x^2-\sigma_y^2)}}\left(w\left[\frac{x+iy}{\sqrt{2(\sigma_x^2-\sigma_y^2)}}\right] - \exp\left[-\left(\frac{x^2}{2\sigma_x^2}+\frac{y^2}{2\sigma_y^2}\right)^2\right] w\left[\frac{x\frac{\sigma_y}{\sigma_x}+iy\frac{\sigma_x}{\sigma_y}}{\sqrt{2(\sigma_x^2-\sigma_y^2)}}\right]\right)$$

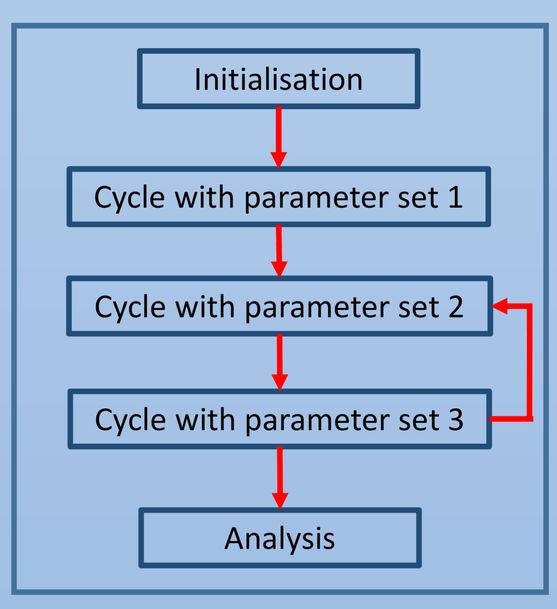
- The longitudinal ion kick is given by Sagan formula:

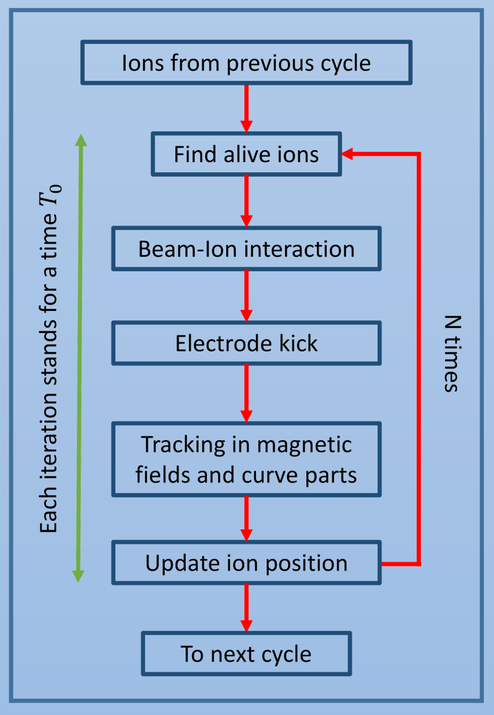
$$\Delta v_s = [-\alpha_x\epsilon_x + \eta\eta'\sigma_\epsilon^2]\frac{\partial \Delta v_x}{\partial x} - \alpha_y\epsilon_y\frac{\partial \Delta v_y}{\partial y}$$

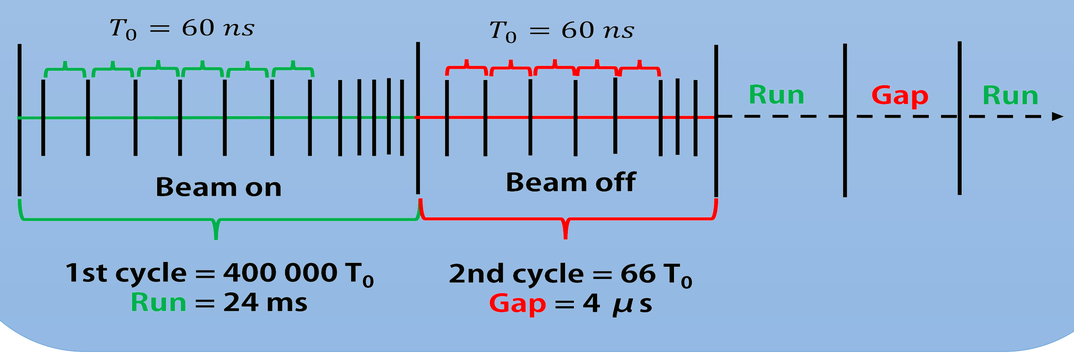
- The Twiss parameters and the lattice design completely determine the ions motion in the accelerator



NUAGE

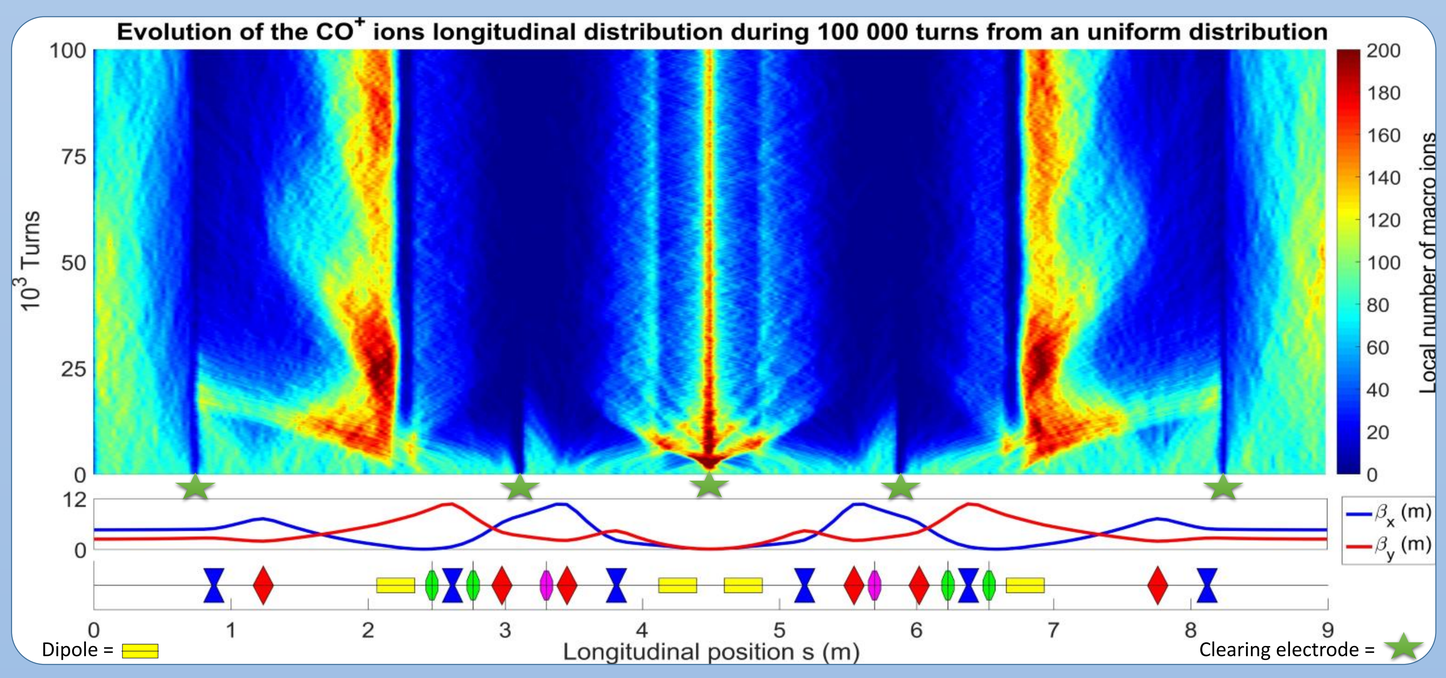


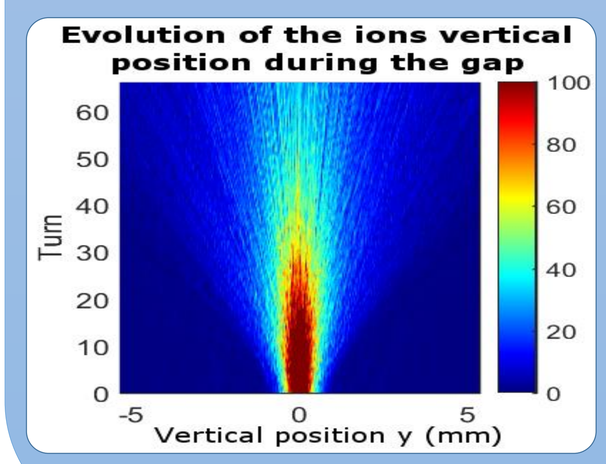


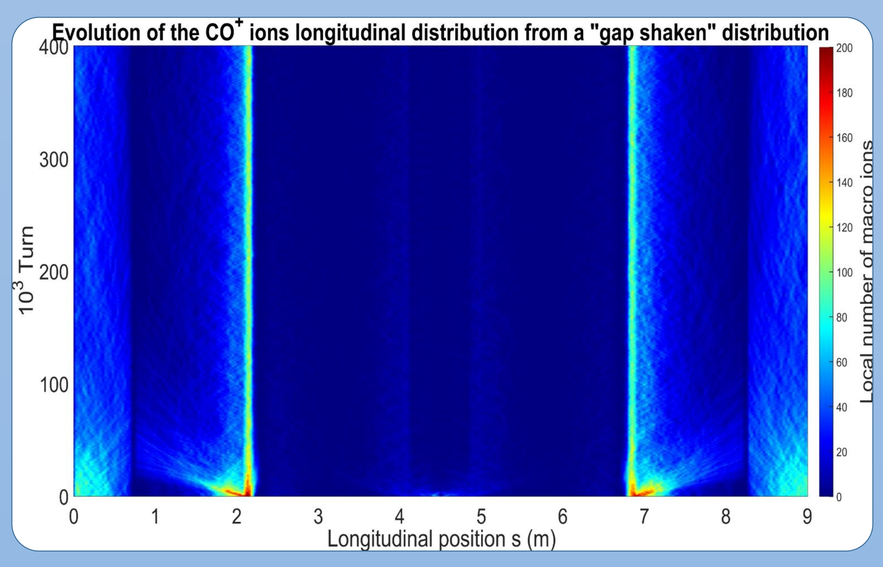


Result in the case of ThomX storage ring

- In NUAGE, all the ions are considered created at the start of the simulation and initialised with a Gaussian distribution in transverse and an uniform distribution along the ring in longitudinal.







- The average neutralisation factor gives an indication on how much the electron beam dynamics is perturbed by the ion cloud:

$$\eta = \frac{Total\ charge\ of\ the\ ion\ cloud}{Total\ charge\ of\ the\ electron\ beam}$$