LANDAU DAMPING BY OCTUPOLES AND SPACE CHARGE

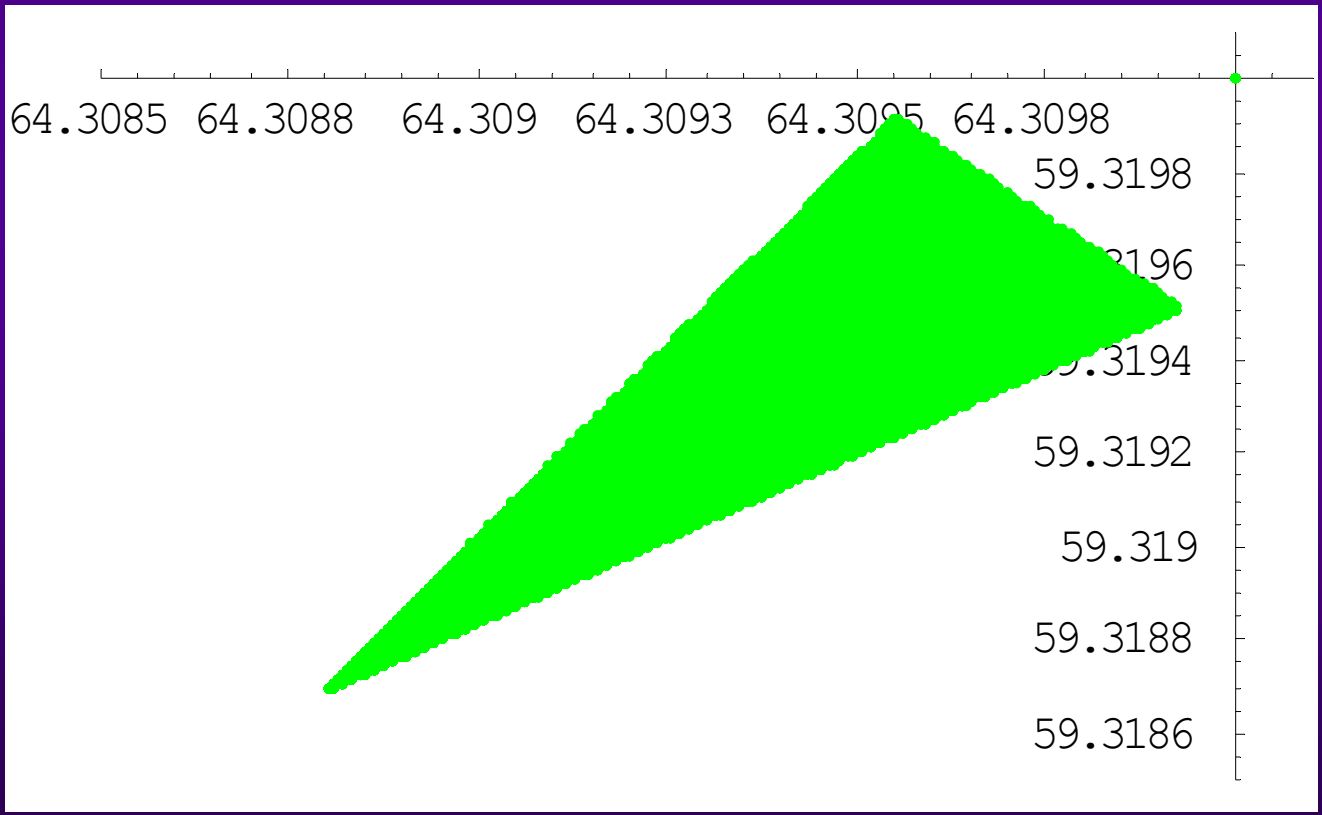
E. Metral

- **New analytical formula to draw the stability diagram**
  $\Rightarrow$ Application to the LHC at injection
- **Some examples**
- **Conclusion**

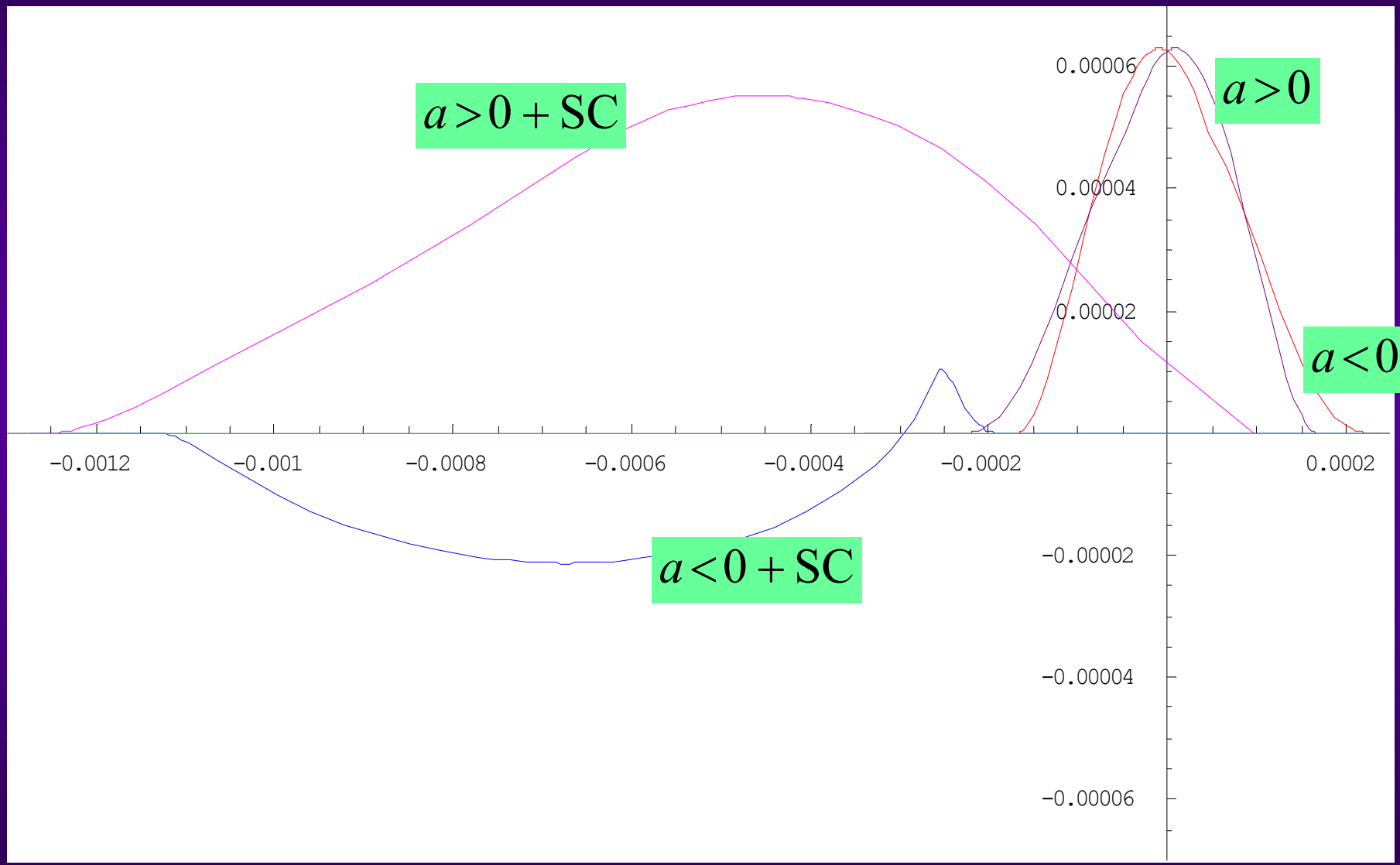
STABILITY DIAGRAMS FOR THE LHC AT INJECTION (1/2)

- Quasi-parabolic distribution of Ruggiero-Berg
- The SC tune shift used in these computations is for a bunch of elliptical cross-section and parabolic density, using the same limit as for the quasi-parabolic distribution

$$J_x + J_y \leq 5\,\varepsilon$$



STABILITY DIAGRAMS FOR THE LHC AT INJECTION (2/2)

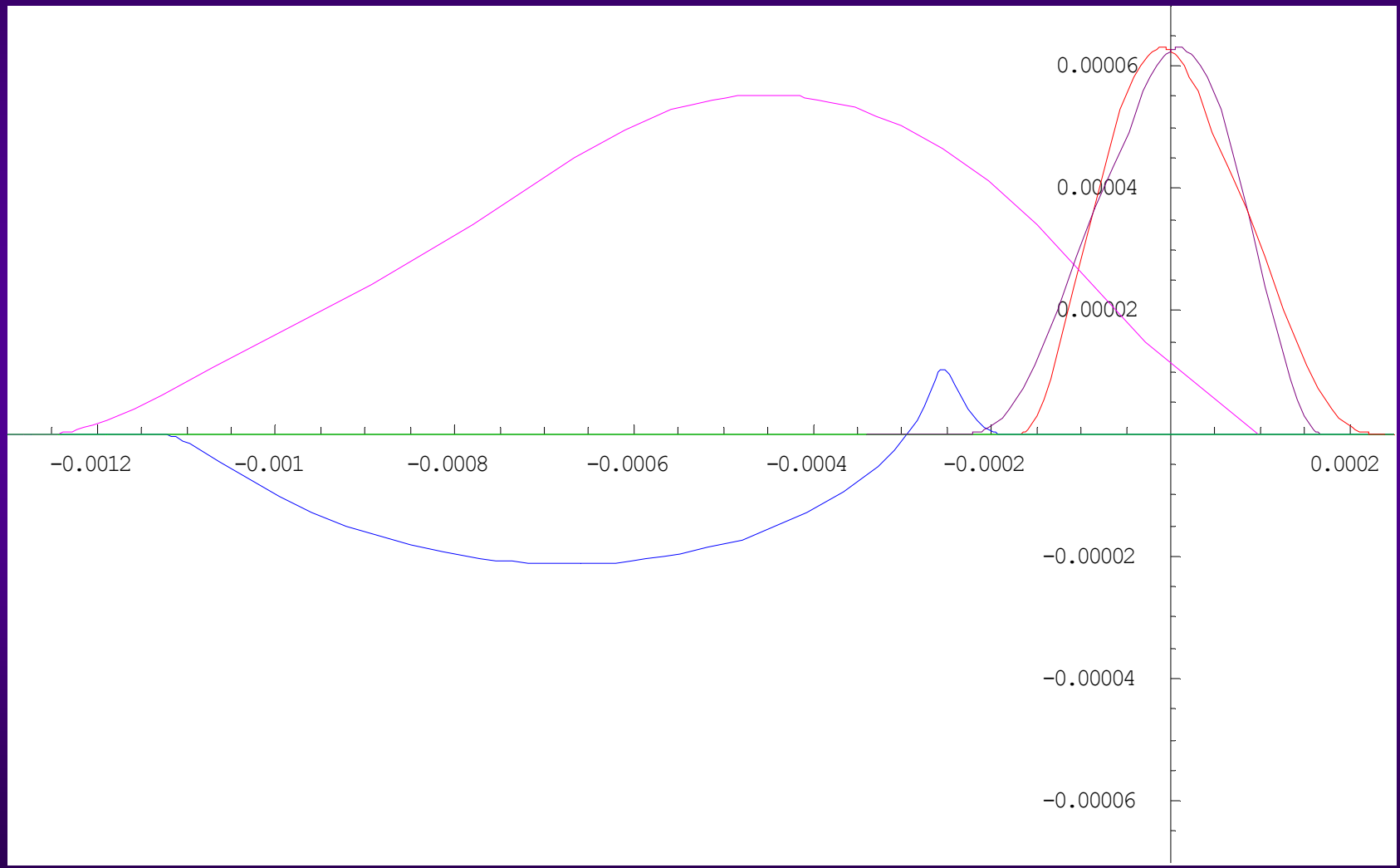


SOME EXAMPLES (1/12)

LHC beam at injection

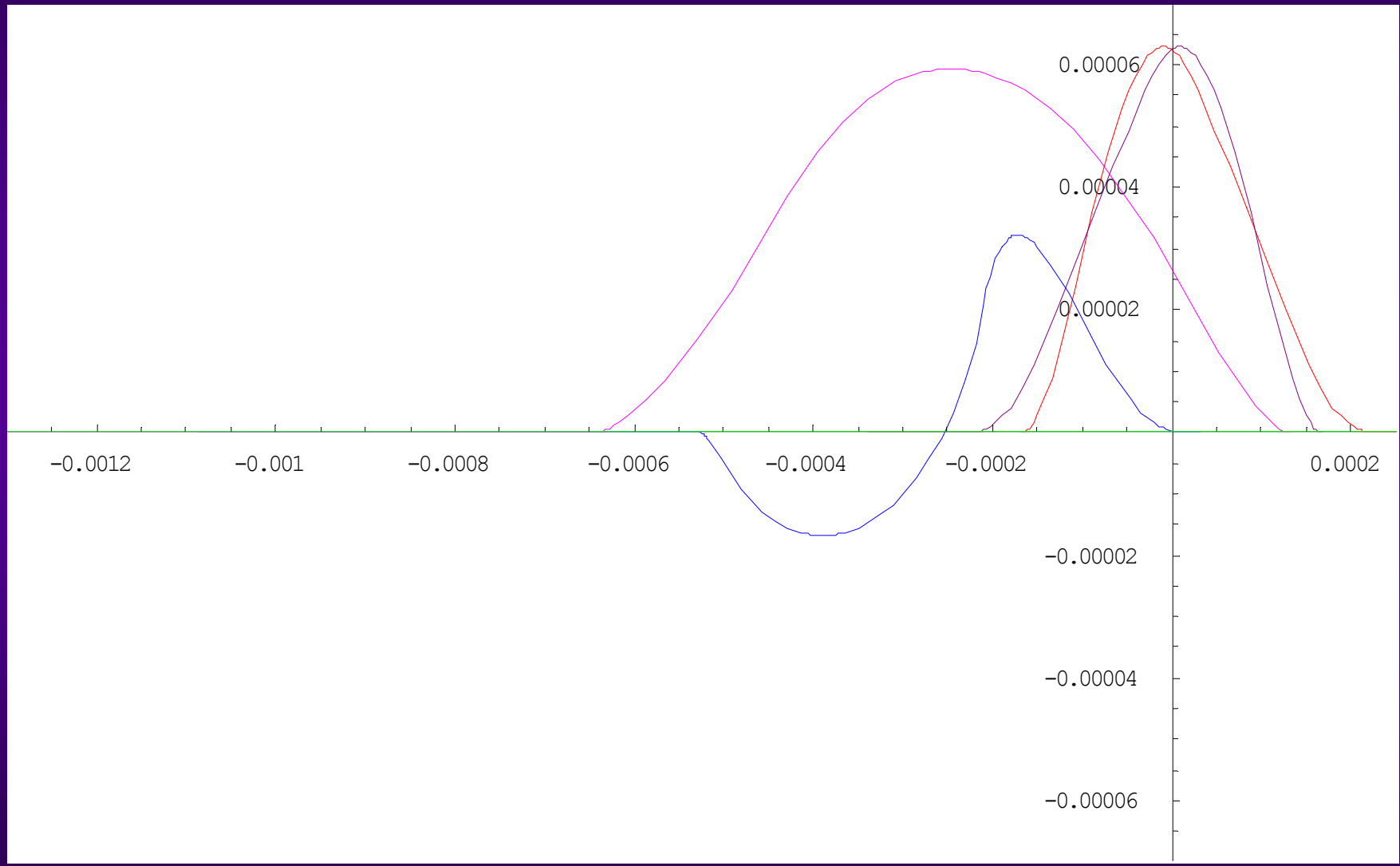
$N_b = 1.1 \times 10^{11}$ p/b

$\Delta Q^{oct}_{\mathrm{rms,max}} = 0.56 \times 10^{-4}$



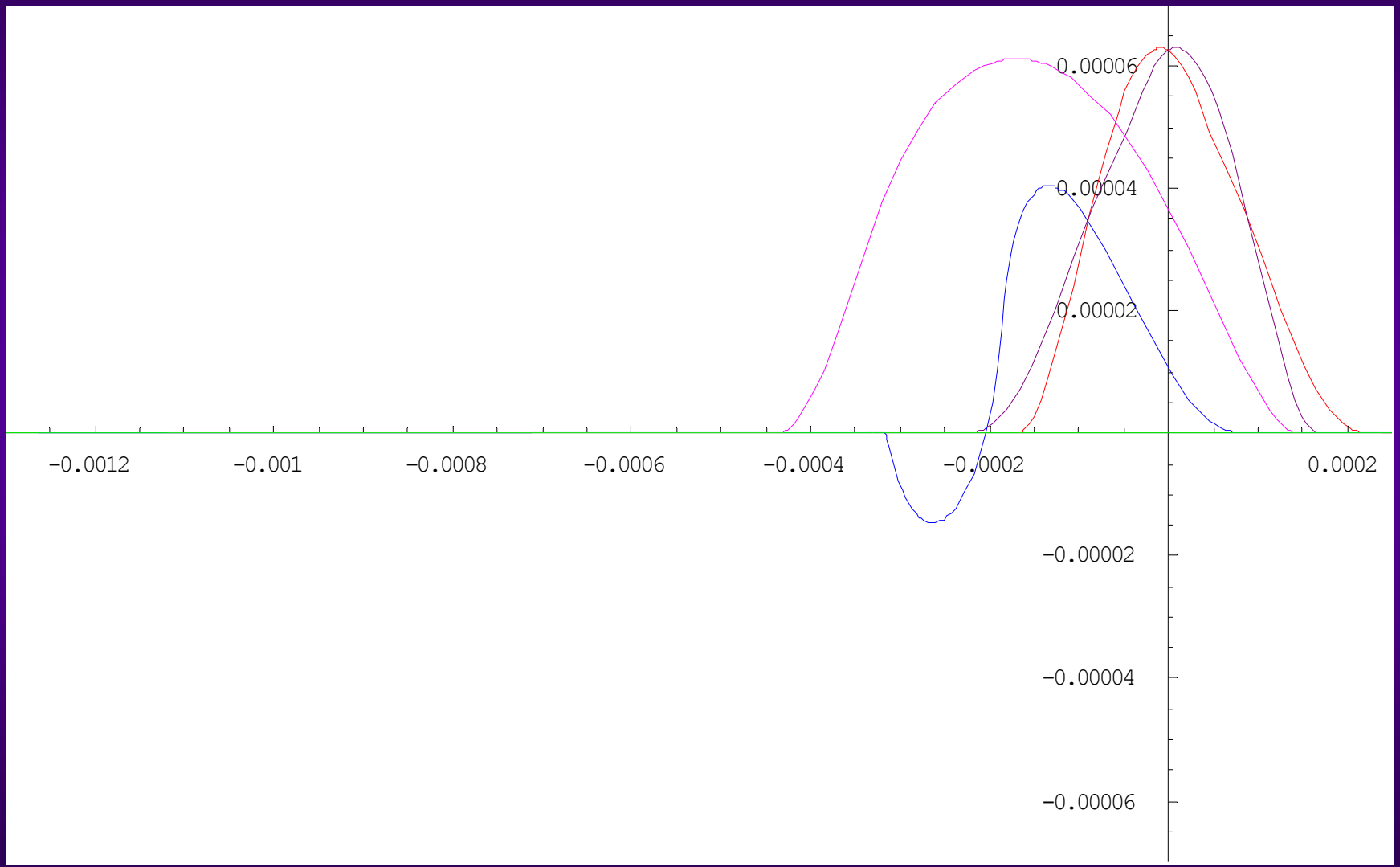
SOME EXAMPLES (2/12)

$N_b/2$



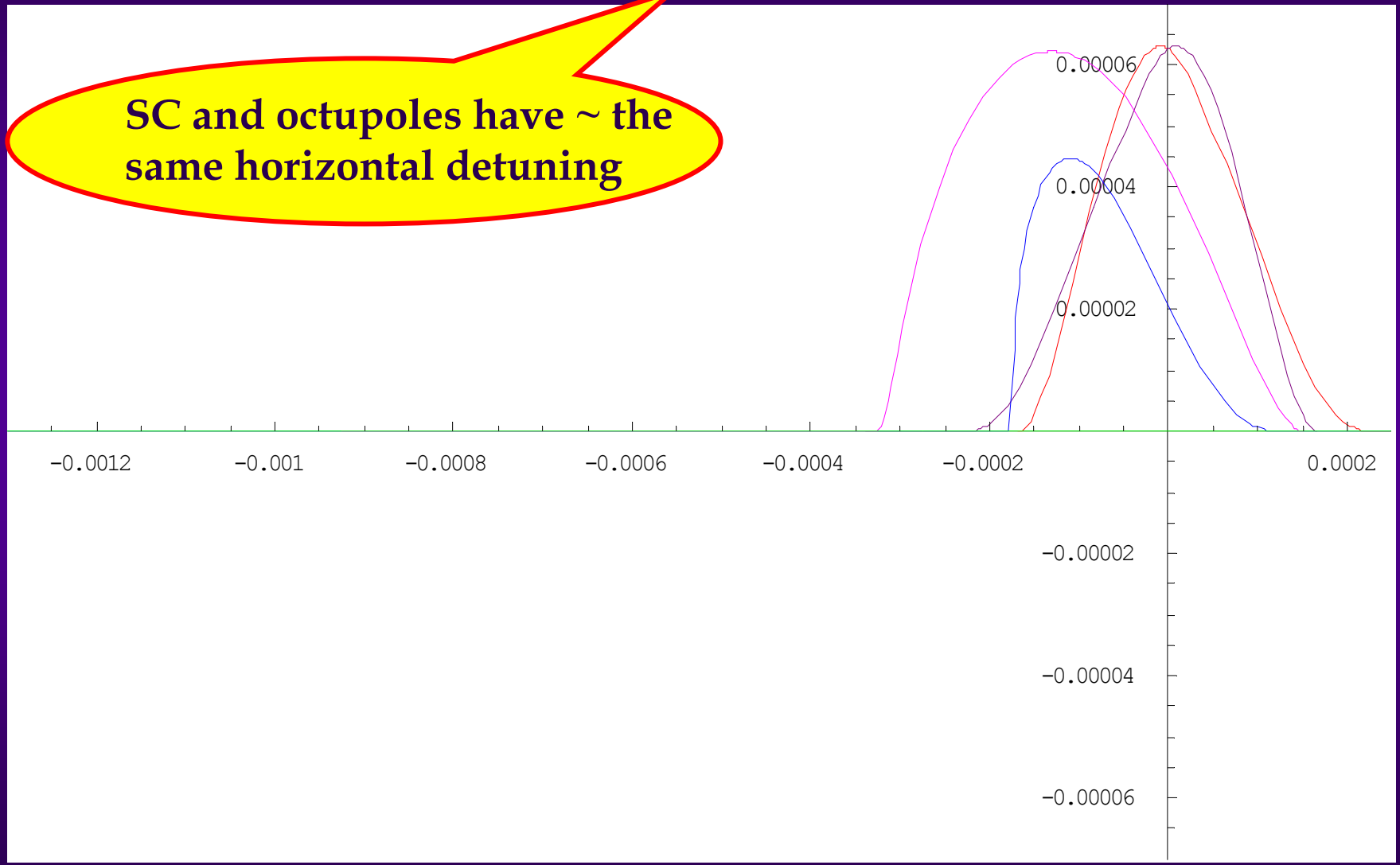
SOME EXAMPLES (3/12)

$N_b/3$



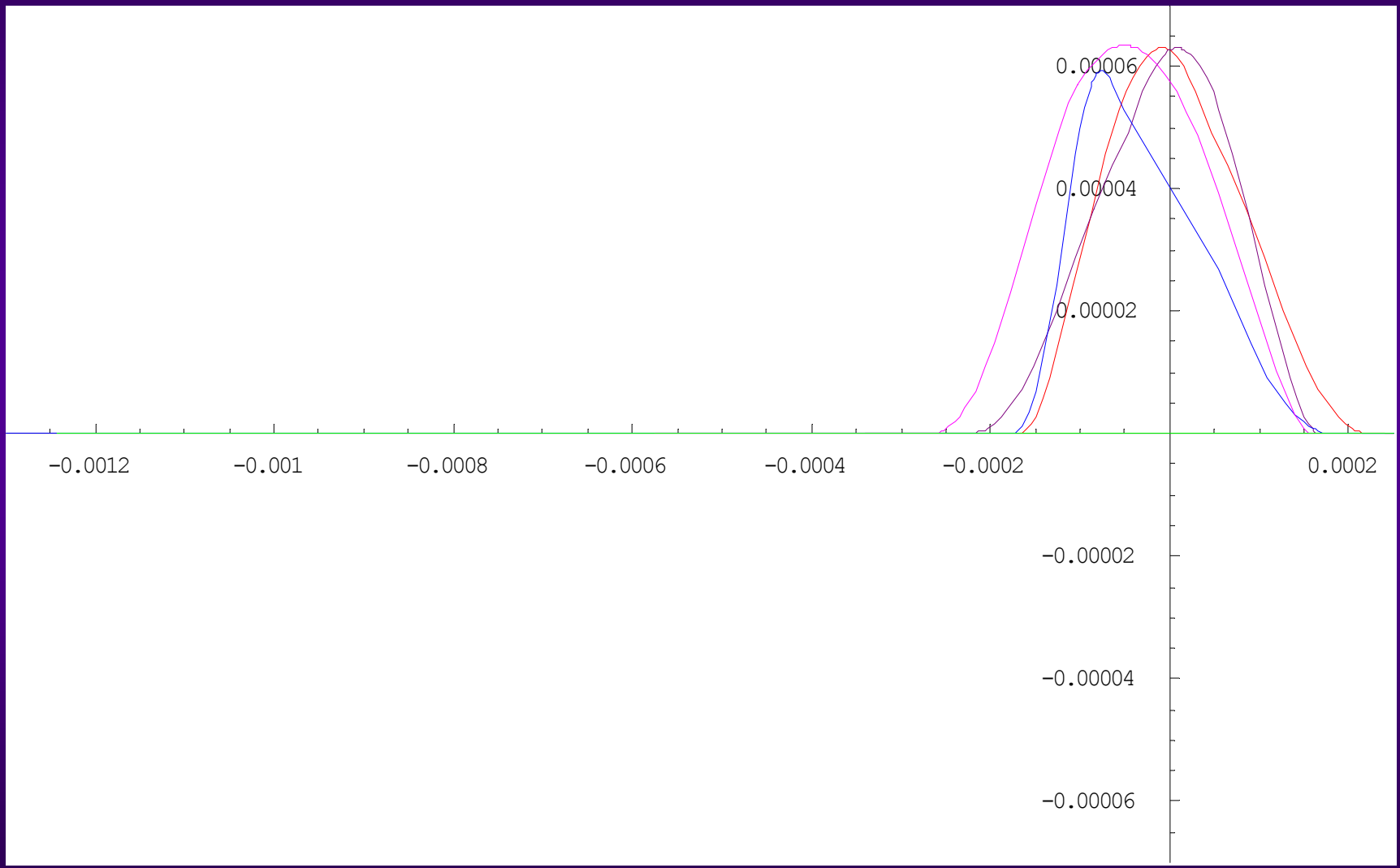
SOME EXAMPLES (4/12)

$N_b/4$



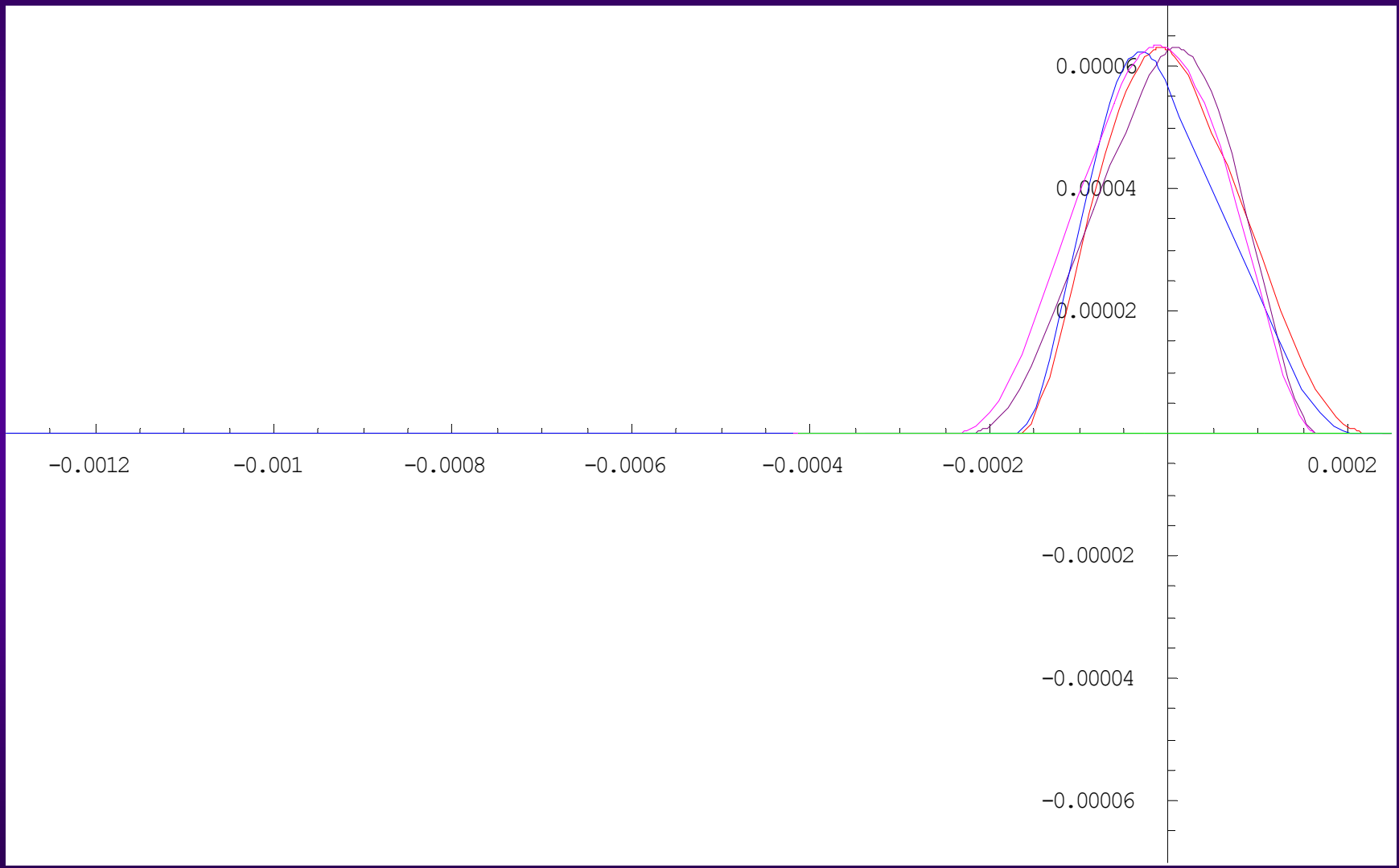
SOME EXAMPLES (5/12)

$N_b/10$



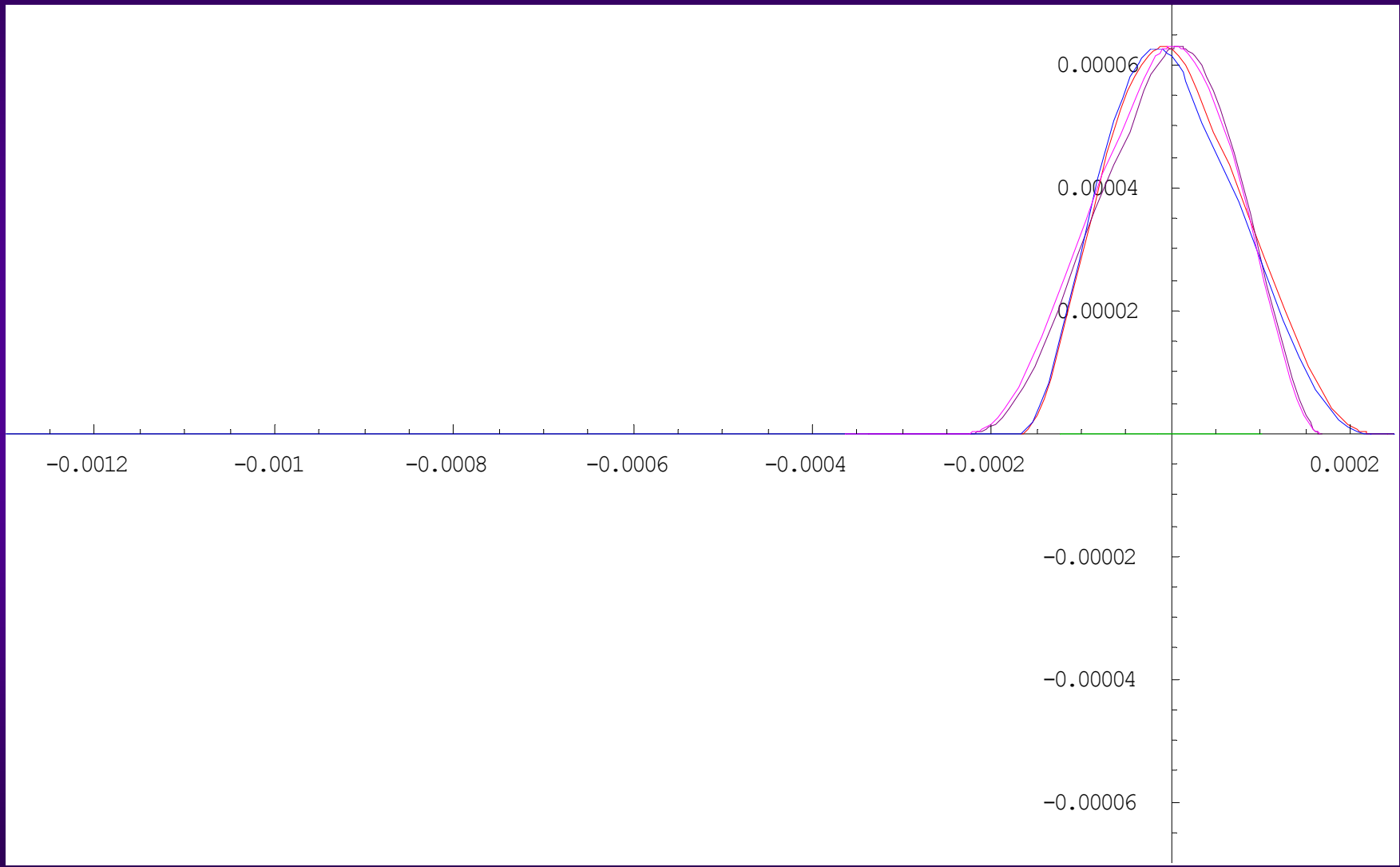
SOME EXAMPLES (6/12)

$N_b/30$



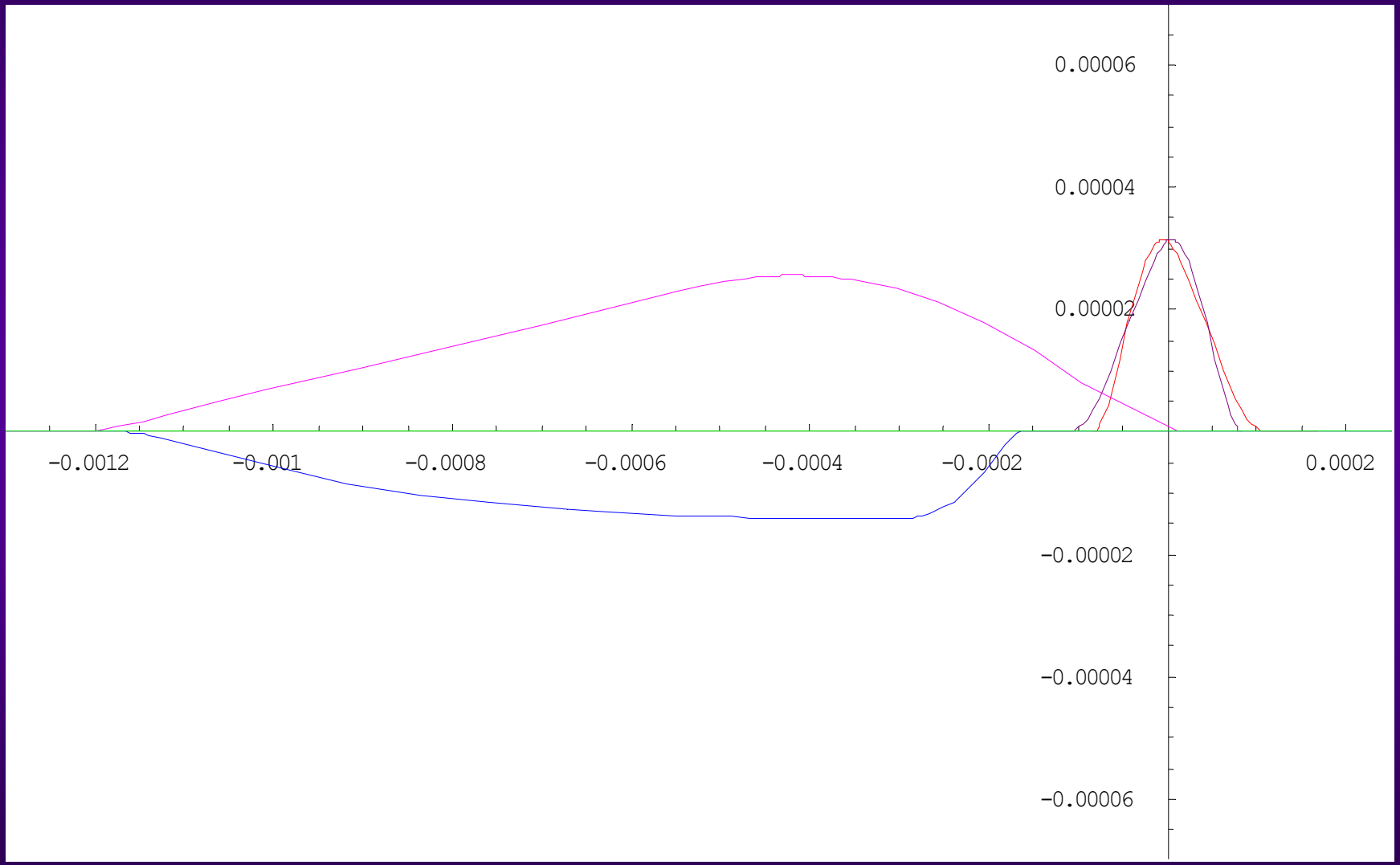
SOME EXAMPLES (7/12)

$N_b/100$



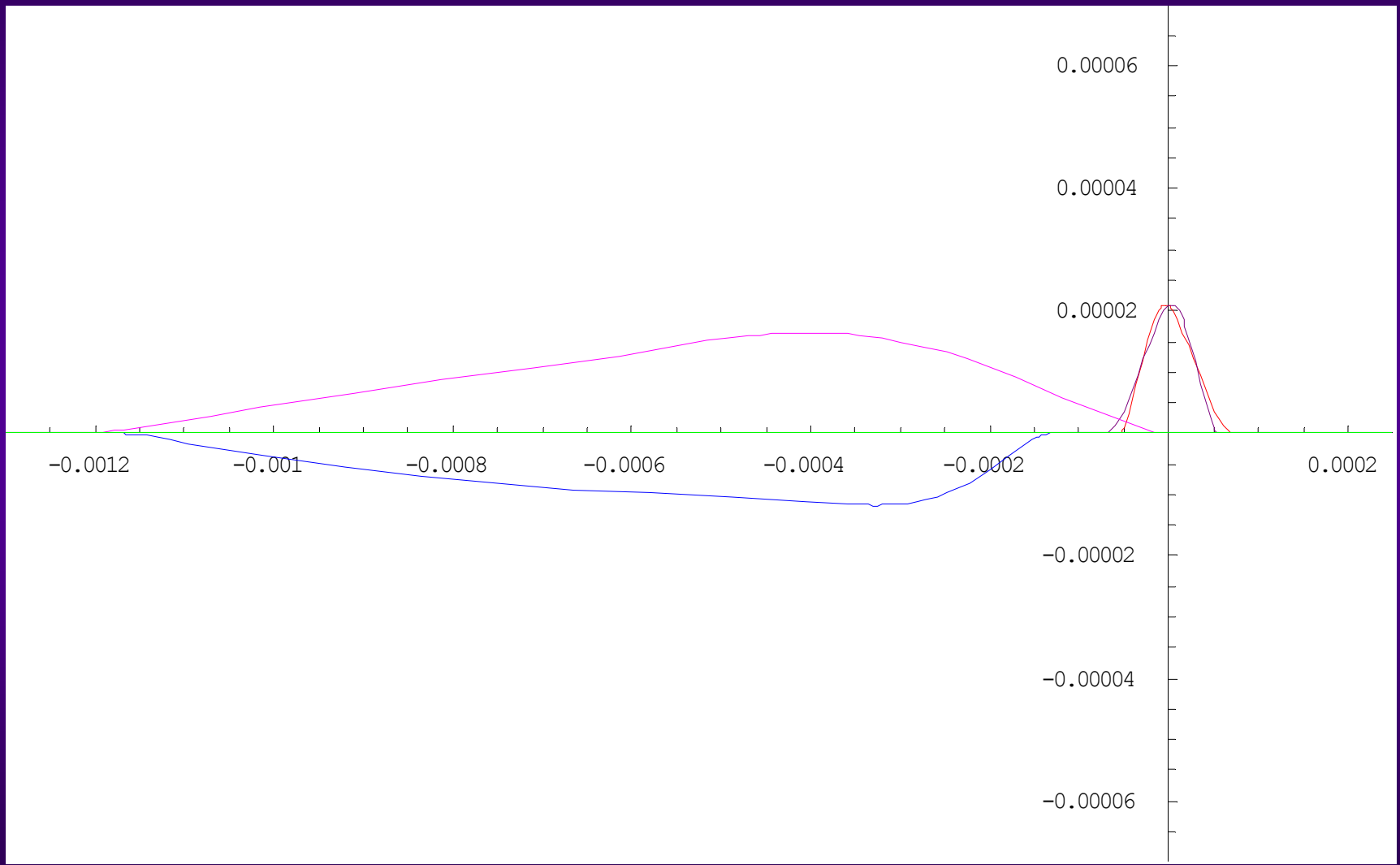
SOME EXAMPLES (8/12)

$$\Delta Q^{oct}_{\mathrm{rms,max}} / 2$$



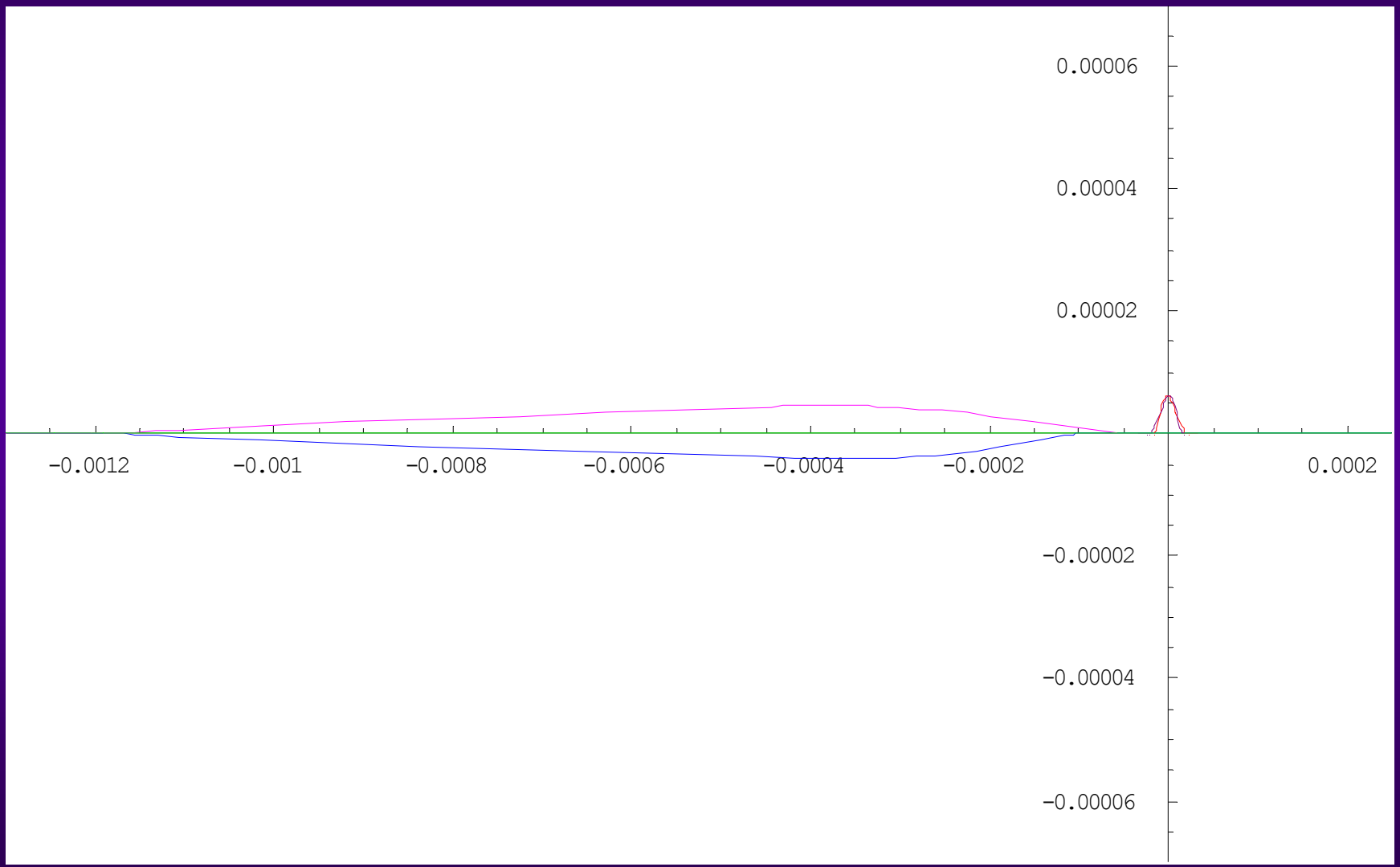
SOME EXAMPLES (9/12)

$$\Delta Q^{oct}_{\mathrm{rms,max}} / 3$$



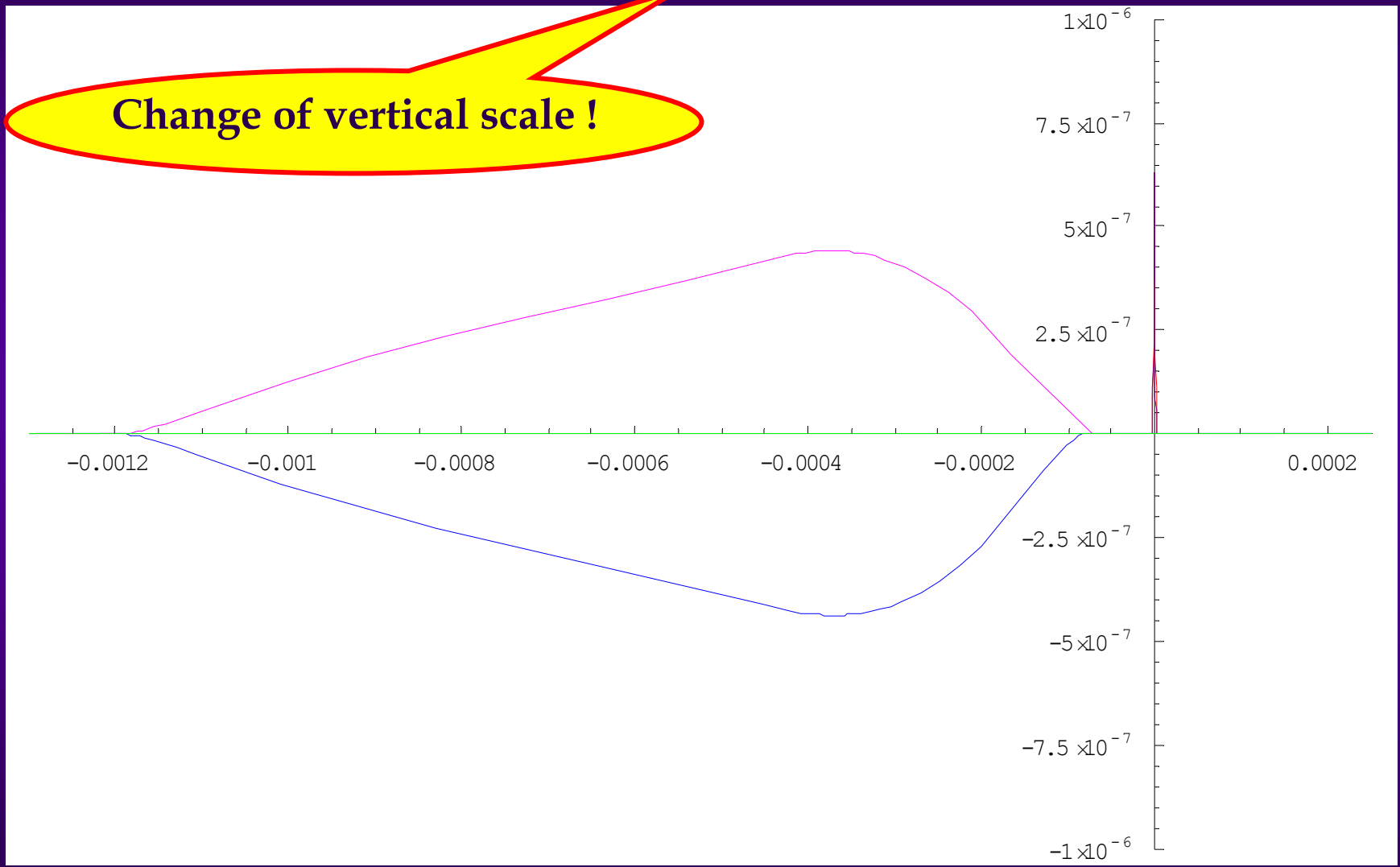
SOME EXAMPLES (10/12)

$$\Delta Q^{oct}_{\mathrm{rms,max}} / 10$$



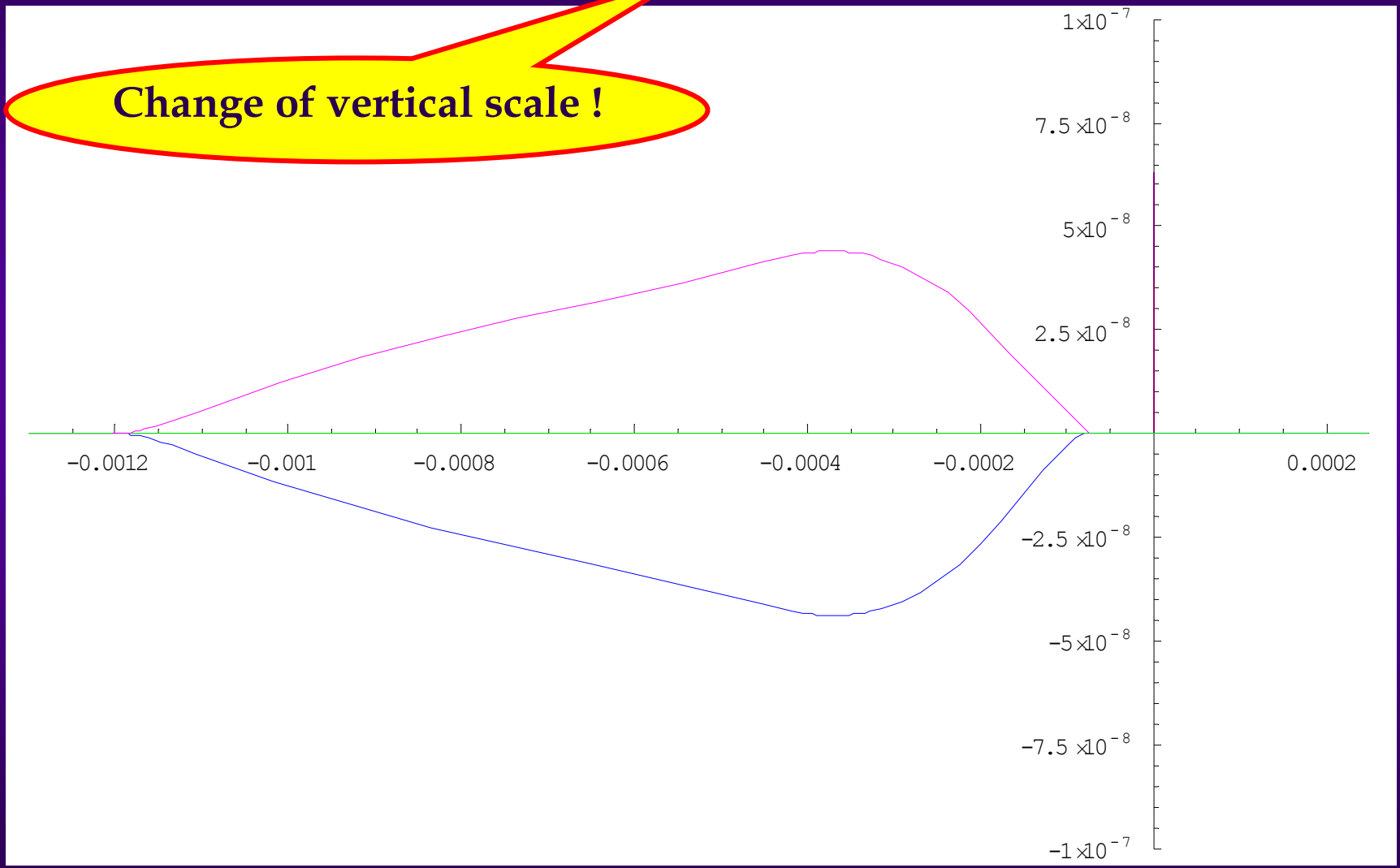
SOME EXAMPLES (11/12)

$$\Delta Q^{oct}_{\mathrm{rms,max}} / 100$$

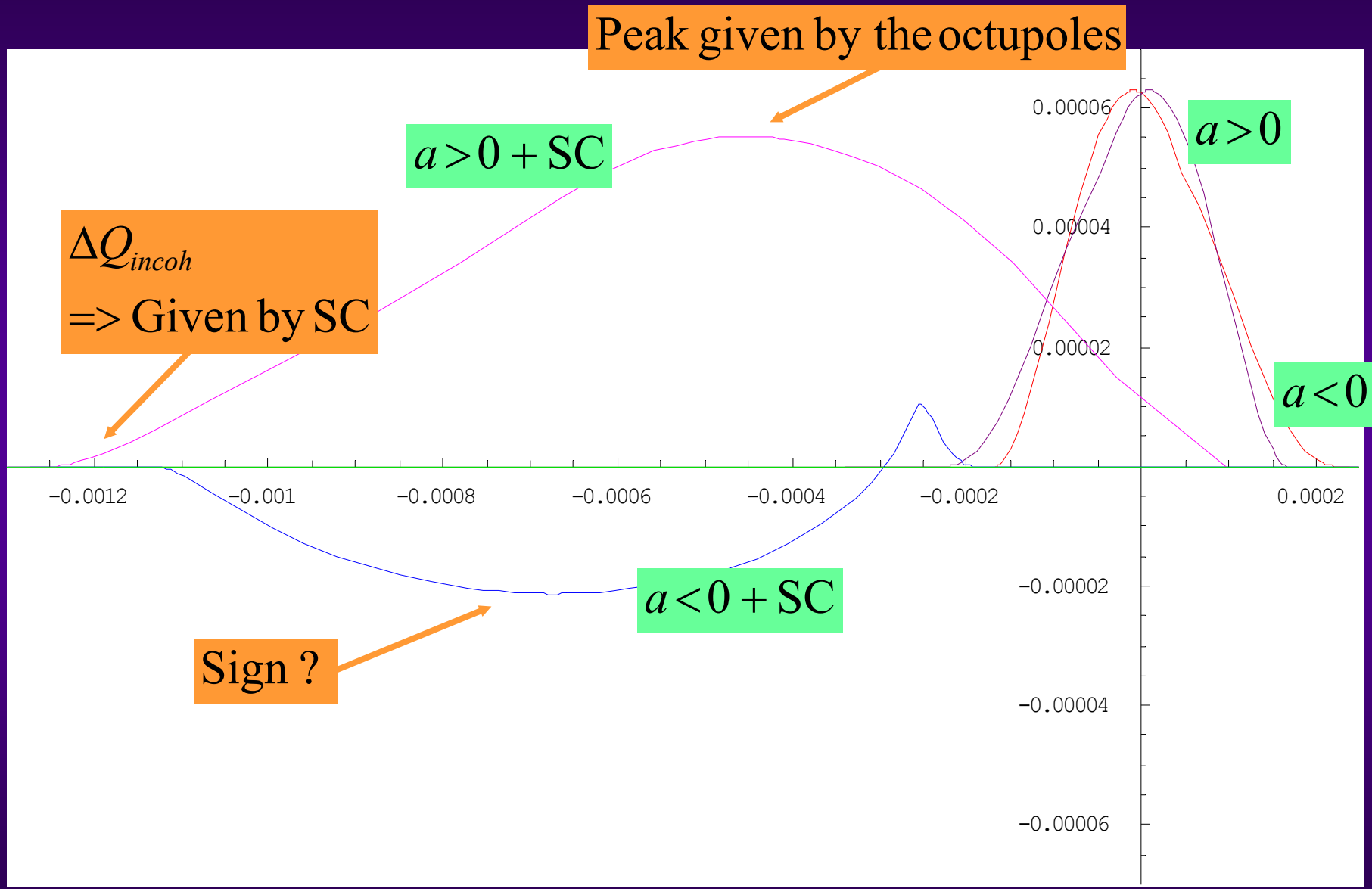


SOME EXAMPLES (12/12)

$$\Delta Q^{oct}_{\mathrm{rms,max}} / 1000$$



CONCLUSION (1/2)



CONCLUSION (2/2)

- The new formula should be a good approximation (according to me… $\Rightarrow$ To be checked)
- Results obtained with this formula
  - No SC $\Rightarrow$ Stability diagrams of Ruggiero-Berg
  - No octupoles $\Rightarrow$ No stability diagram : result of Mohl-Schonauer
  - SC "helps" for the good sign of the octupoles (positive detuning) : result of Mohl-Schonauer
  - SC "degrades the situation" for the bad sign of the octupoles (negative detuning) : result of Mohl-Schonauer
  - The spread to damp the real part of the coherent tune shift is given by the SC + octupoles
  - The spread to damp the imaginary part of the coherent tune shift is given by the octupoles : result of Mohl-Schonauer
- Other known effects to be checked with this formula ?