Hybrid waveform

PN + NR

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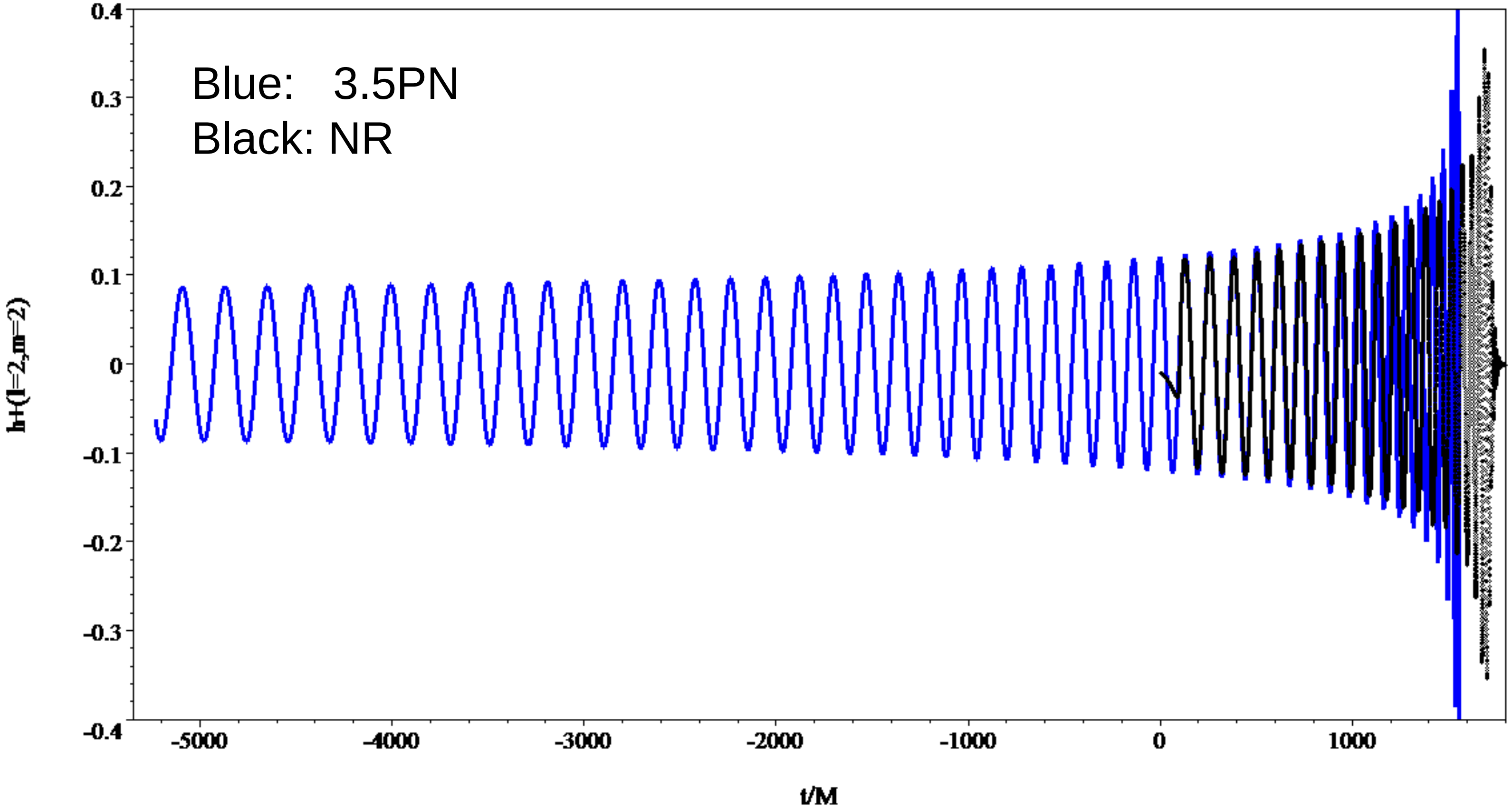
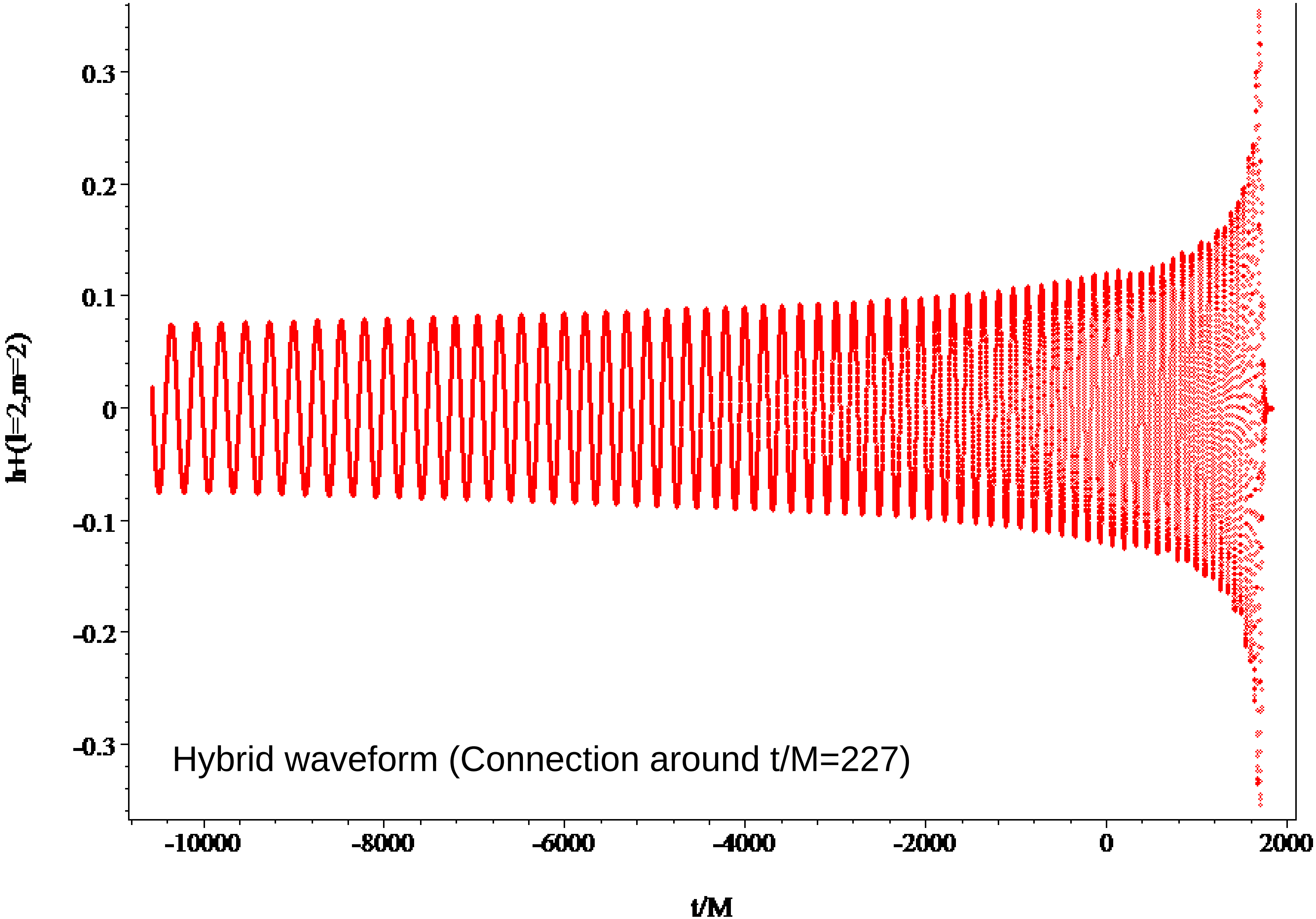


To obtain the smooth connection between the PN and NR waveforms, first we use

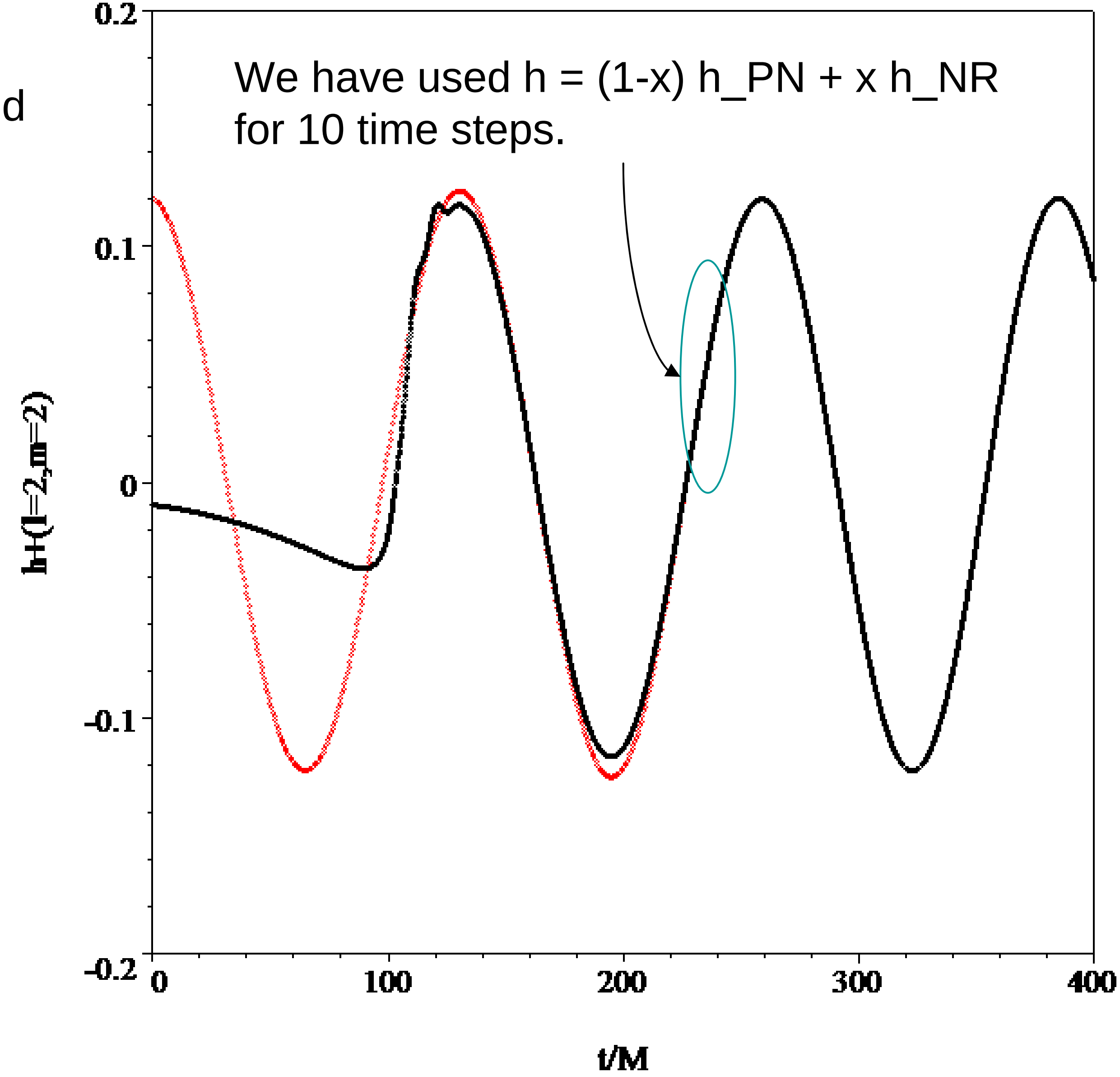
$$h = (1-x)\, h_{PN} + x\, h_{NR}$$

This is a simple version of
P. Ajith et al., Class. Quant. Grav. 24, S689 (2007) [arXiv:0704.3764 [gr-qc]].
(We have ignored the amplitude modification.)

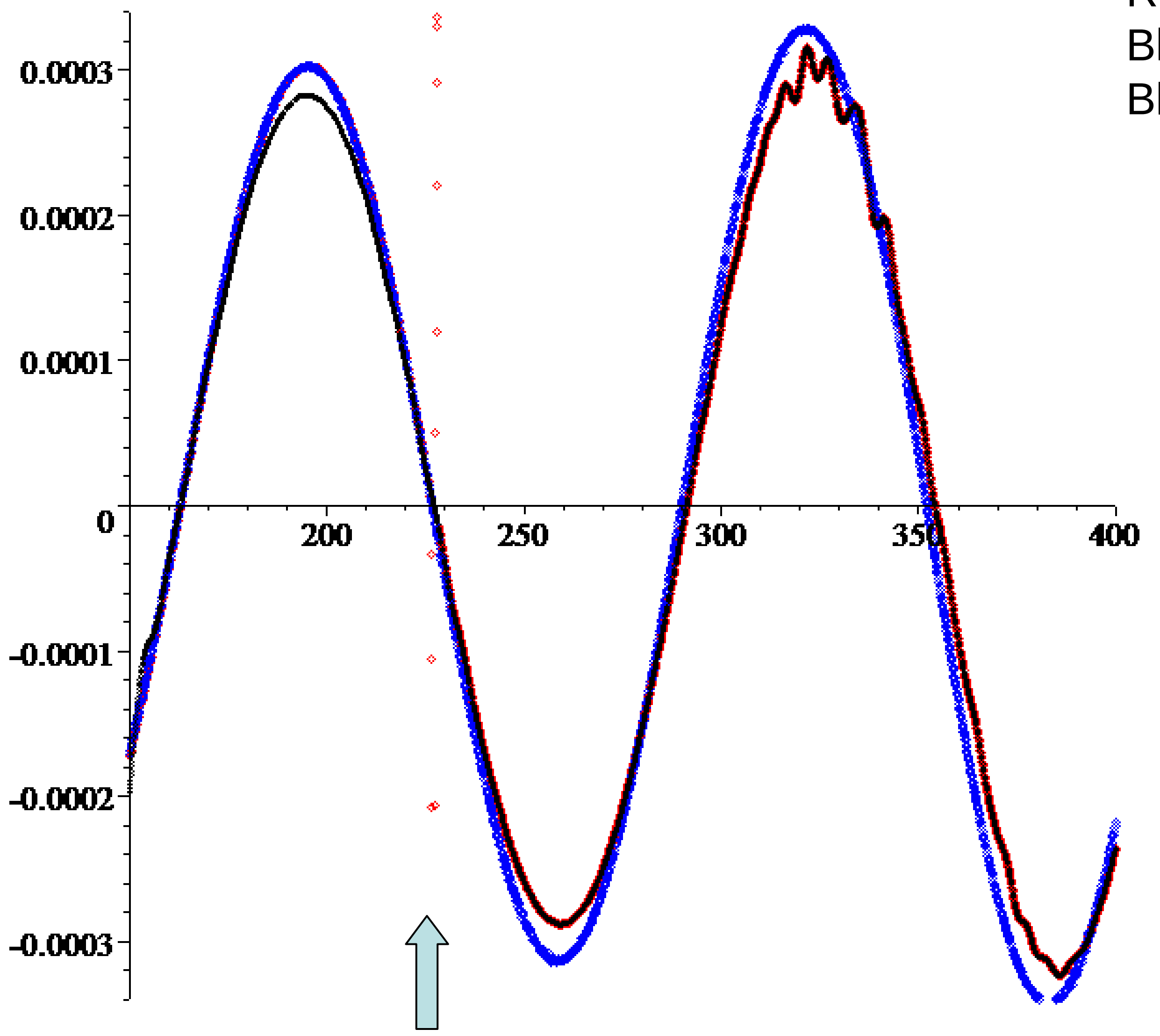
Matching at around t/M=227



Red: Hybrid
Black: NR



psi4



There is a bad behavior.

Smoothing out

When we use $h = (1-x) h_{PN} + x h_{NR}$, this guarantees only C^0 of the hybrid waveforms.

We can find that there is a jump in psi4.

Therefore, to obtain at least C^2 hybrid waveforms, we need to consider

$$h = (1-F(x)) h_{PN} + F(x) h_{NR}$$

where, for example, we use a simple polynomial,

$$F(x) = x^3(6x^2-15x+10)$$

This guarantees the C^2 behavior at $F(x)=0$ and 1.

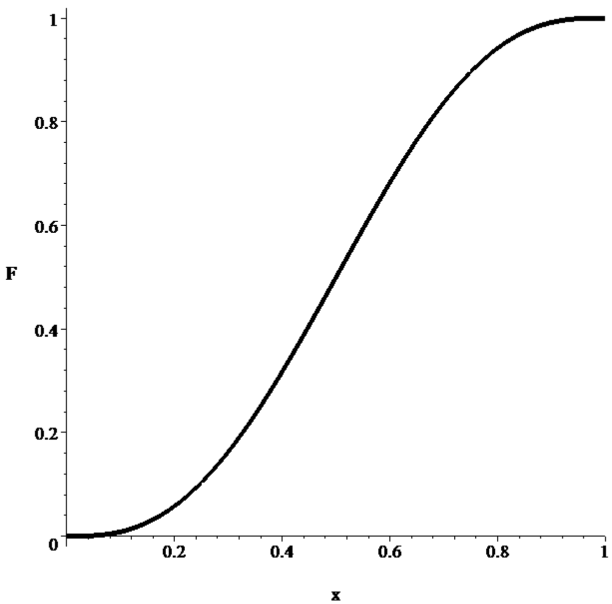
A better matching

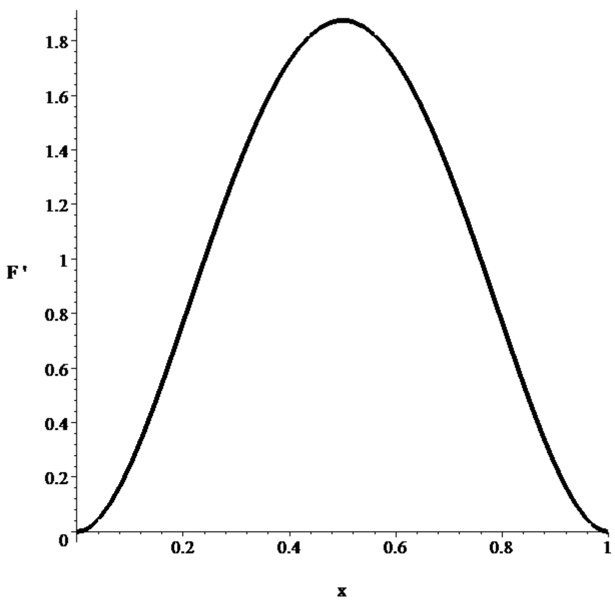
As a weight function, we consider

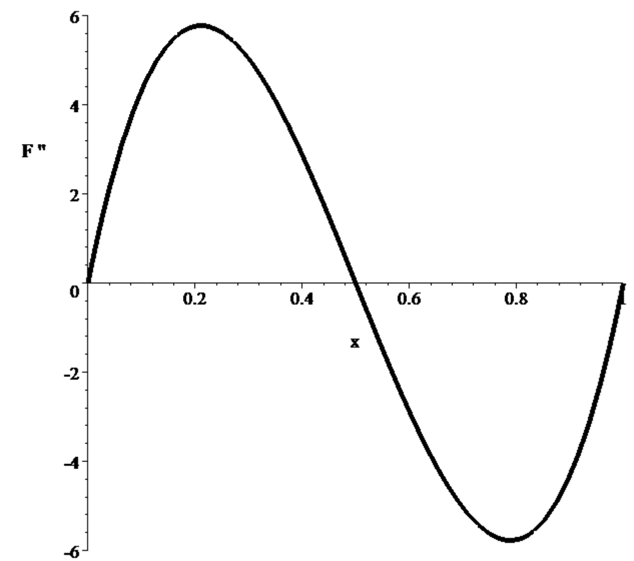
$h = (1-F(x))\, h_{PN} + F(x)\, h_{NR}$; $F(x) = x^3*(6*x^2-15*x+10)$

This guarantees the C^2 behavior of hybrid waveforms
at $F(x)=0$ ($x=0$) and 1 ($x=1$).

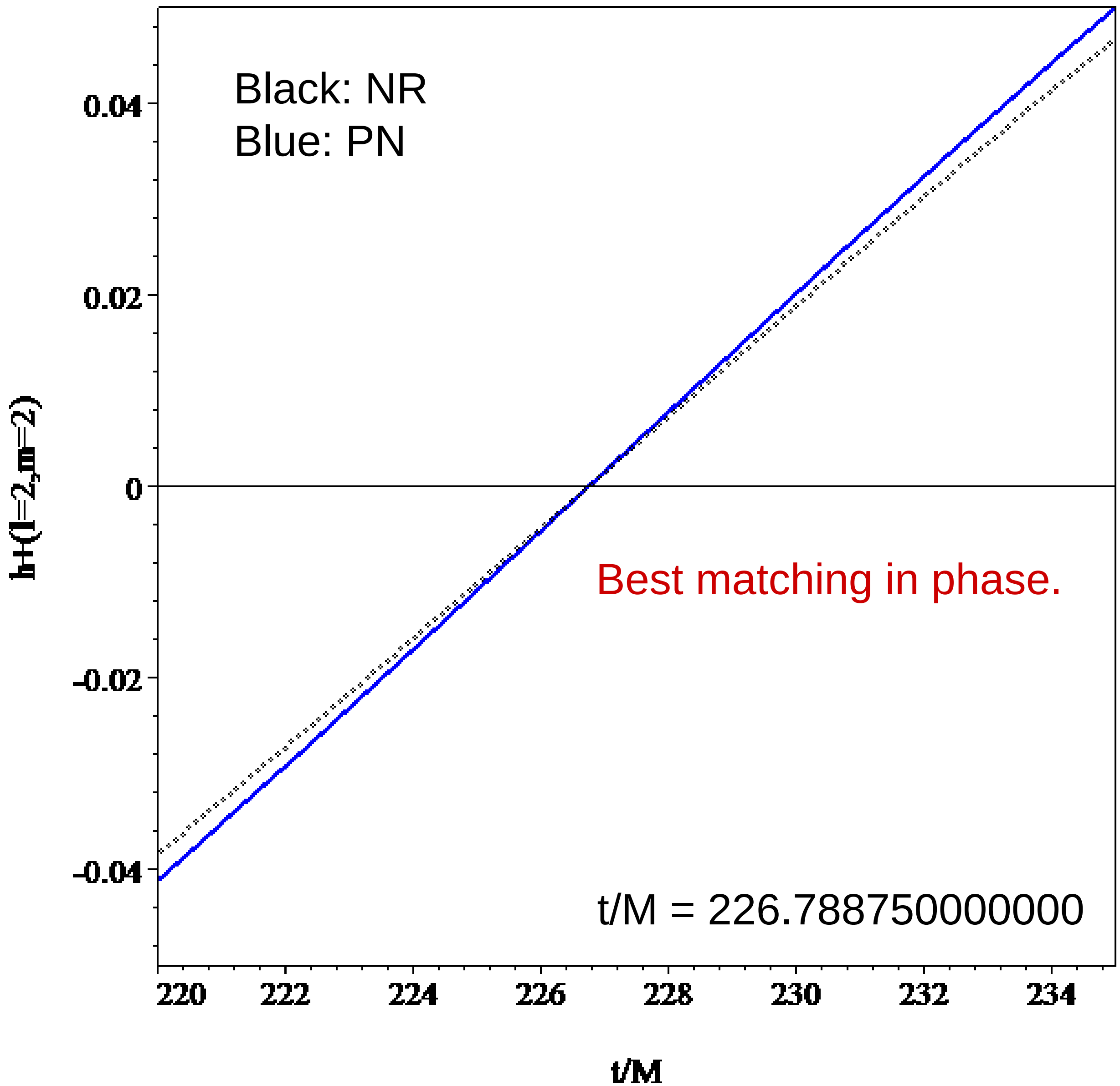
$F(x) = 10*x^3 + O(x^4)$ around $x=0$
$F(x) = 1+10*(x-1)^3+O((x-1)^4)$ around $x=1$





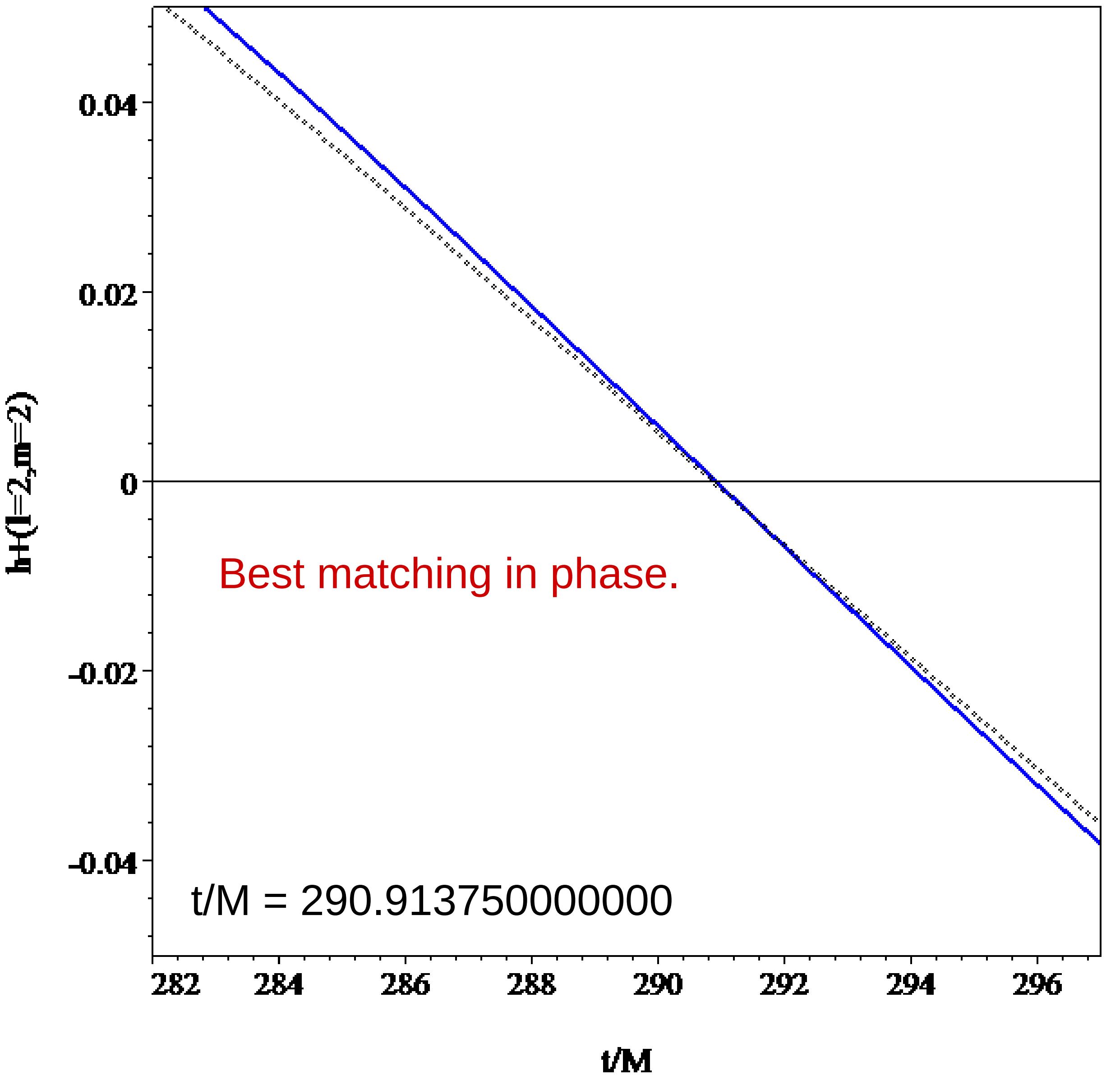


delT - DT = -112.646250000000 (DT := .106875000000000, one time step)



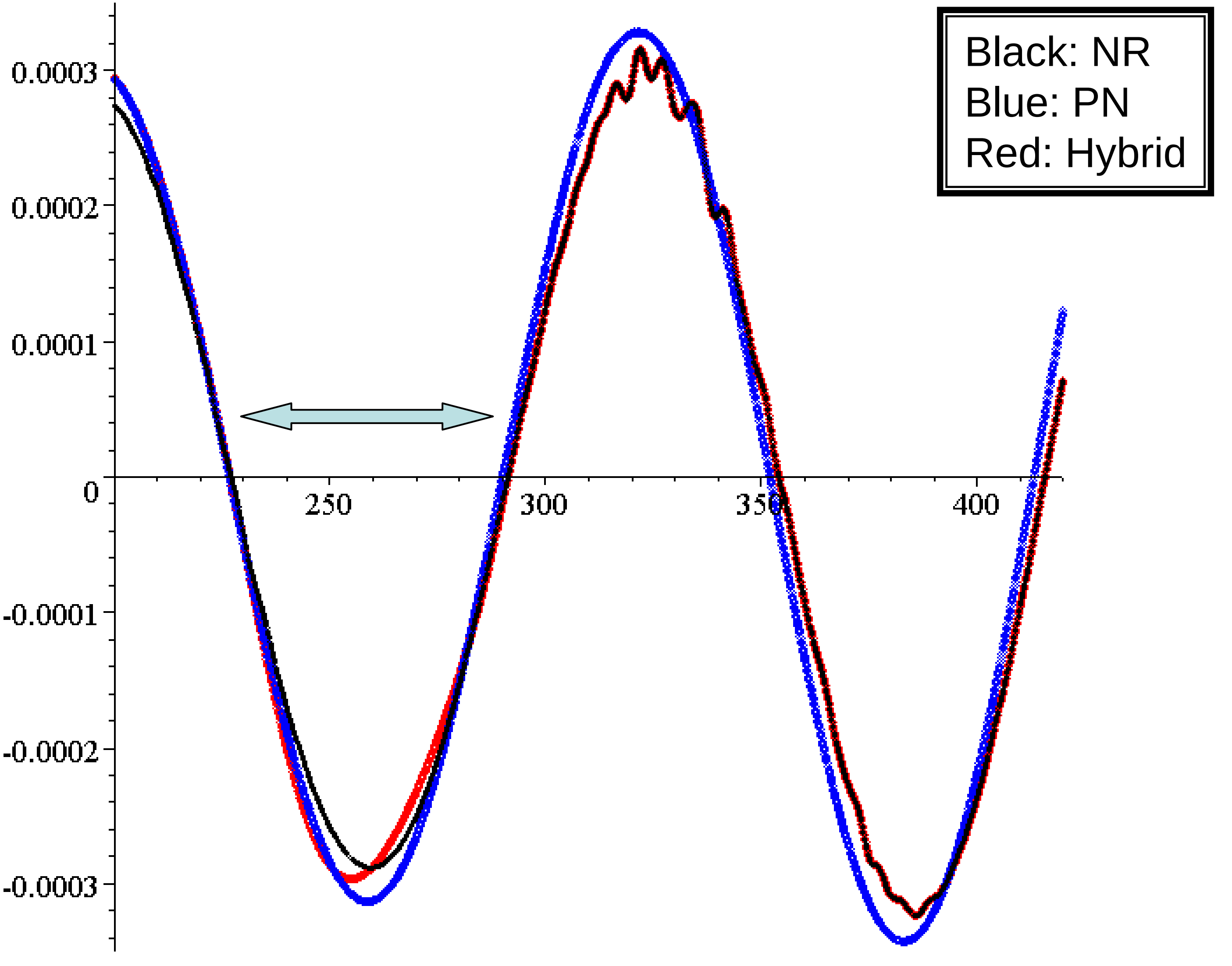
Setting this phase at the starting point of the matching.

delT - 11*DT = -113.715000000000 (DT := .106875000000000, one time step)



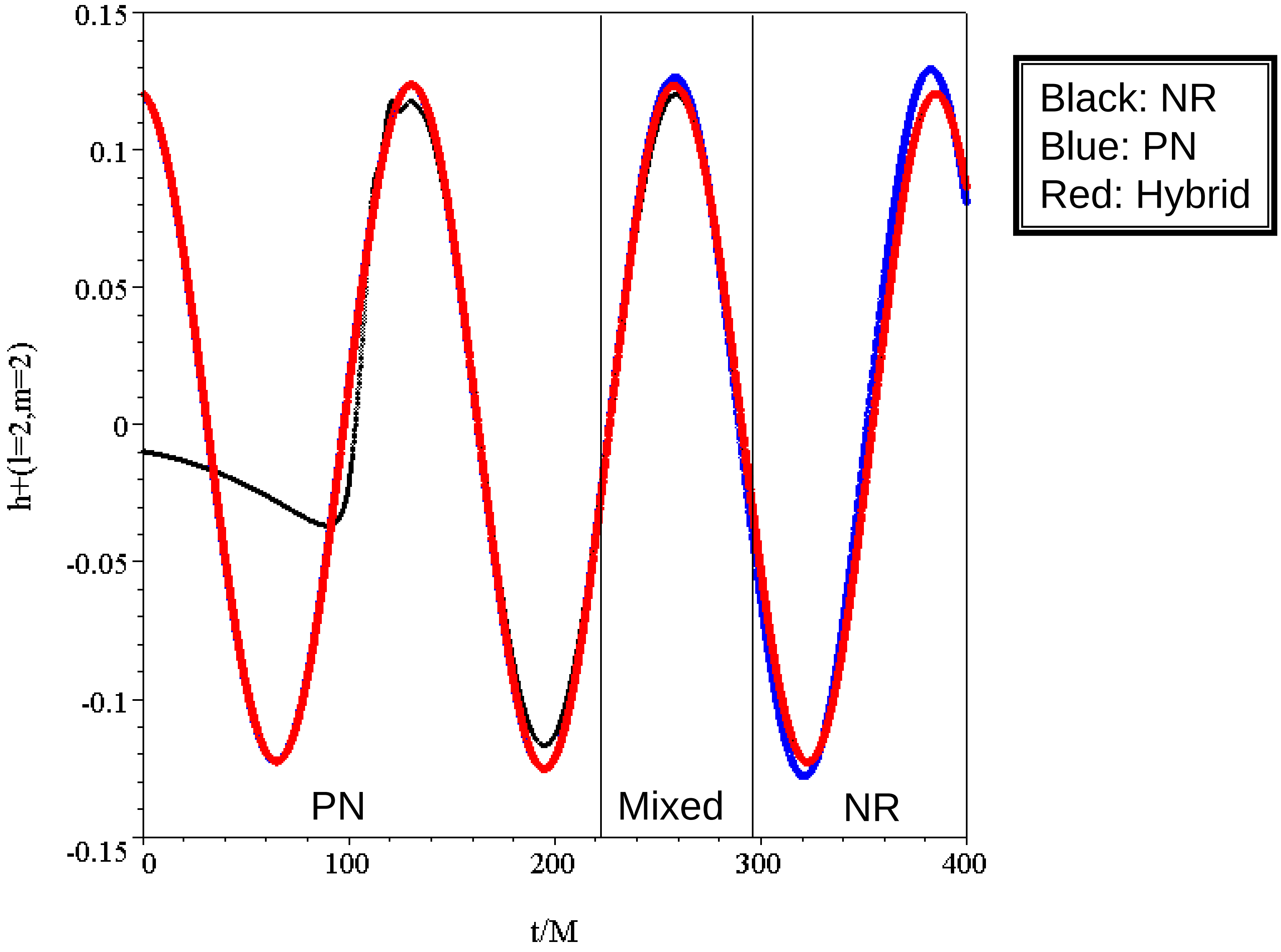
Around this phase, the hybrid waveform becomes totally the NR.

600 time steps (from t/M = 227 to 291)
A half wavelength has been used for the matching.



\psi_4 (Connection from t/M = 227)

Waveforms around the matching region



Hybrid waveform at late times