MEC6602E: Transonic Aerodynamics

HOMEWORK 2

Prepared by:
Kamal Jemmali 2019339
Hugo Javourez 2420717

Submitted to :
M.Frédéric Plante. Ph.D, CPI

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The main goal is to simulate a shock tube, 2 nozzles case, the first one is the supersonic input and output, and the second one is the supersonic input and subsonic output. In this report, we will show the density, rho, and mack number over x. .Futhermore, we will show error L2 in fonction of the numbers of iterations. We will also do the simulation at differents CFL. Please refer is

1 Macmormack Simulations

Before any analysis, We will show the results we got at differents parameters.

1.1 Shock Tube

1.1.1 results

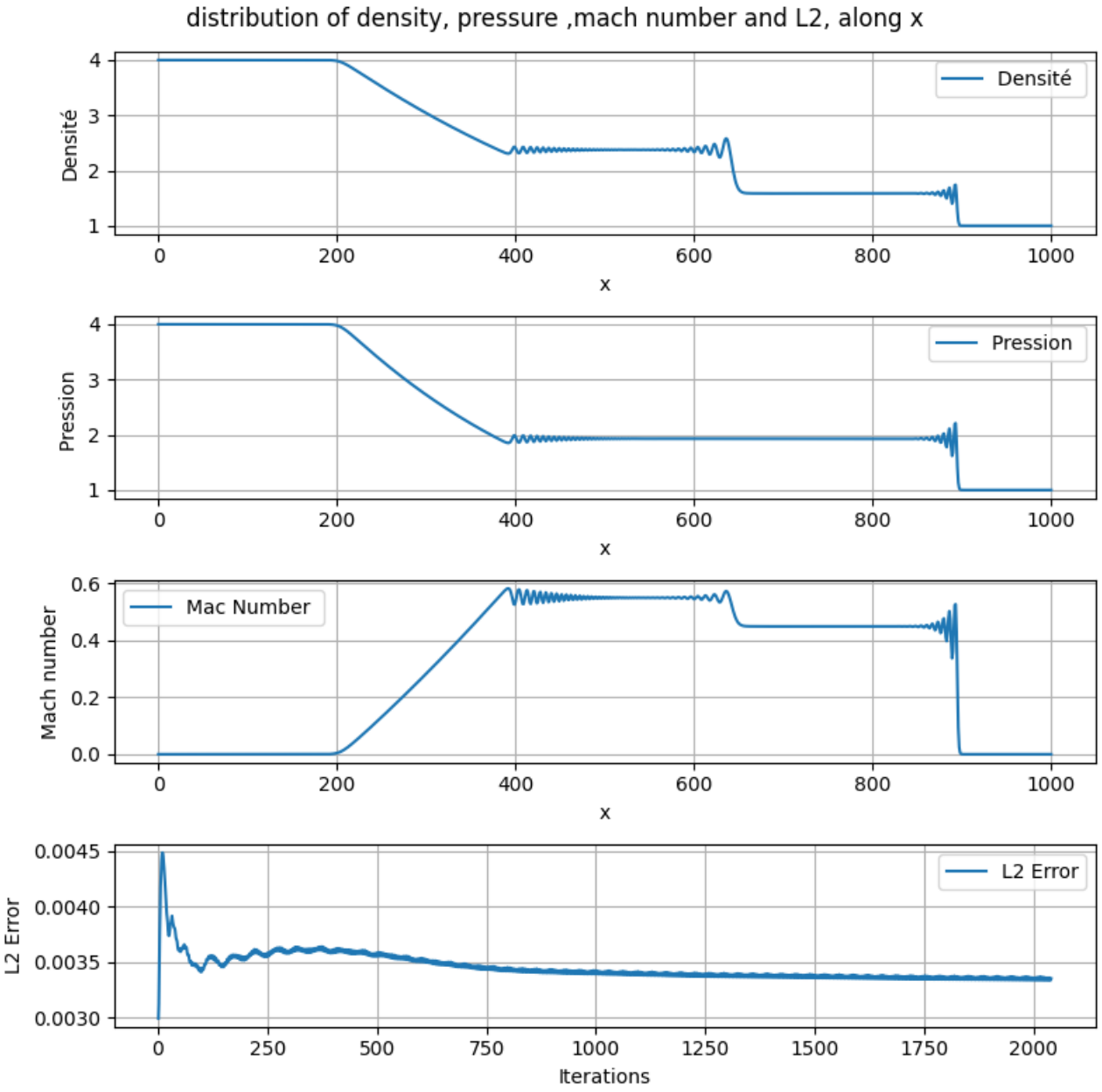

Figure 1: Tube Maccormack simulation at CFL 0.25

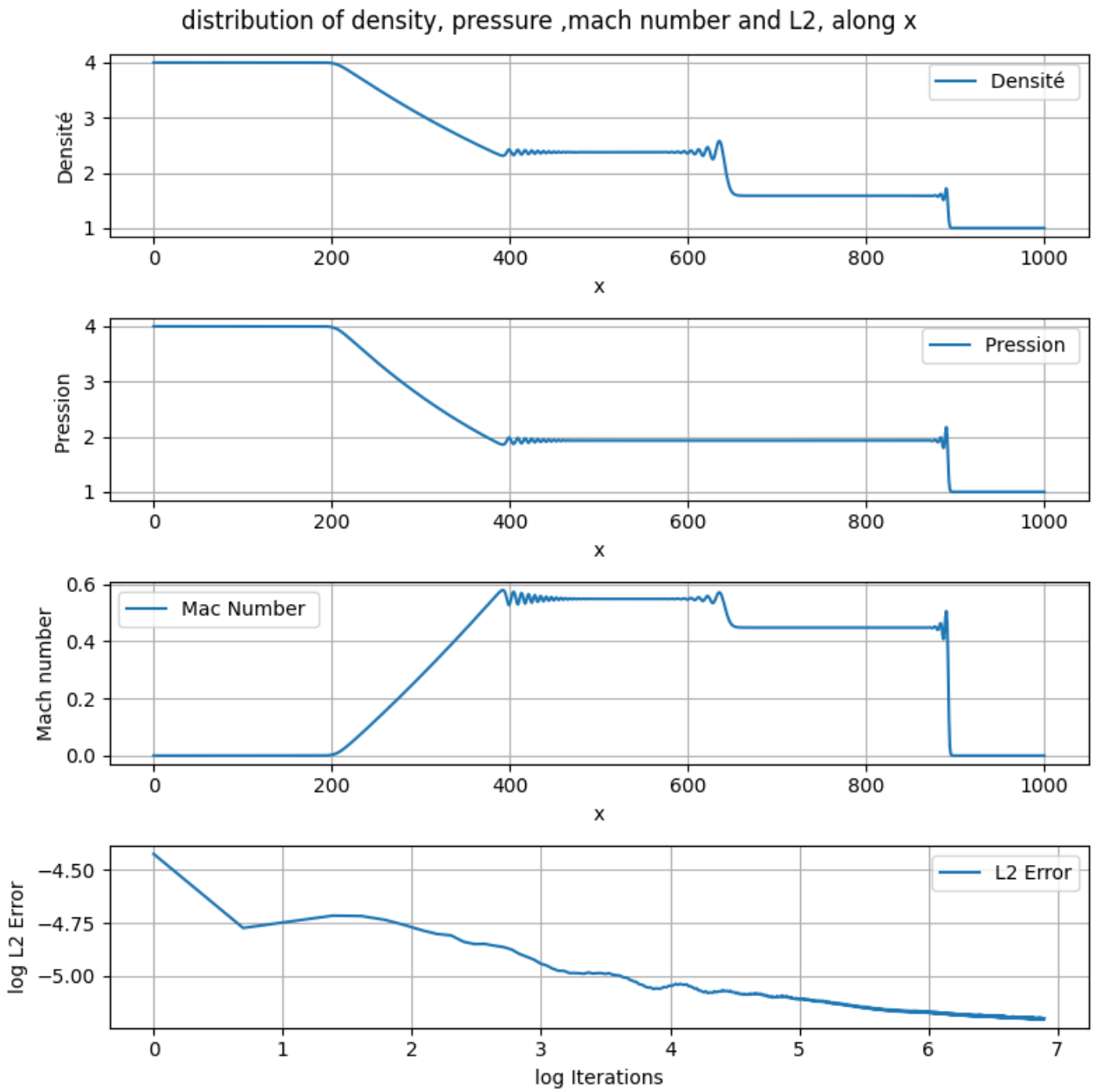

Figure 2: Tube Maccormack simulation at CFL 0.50

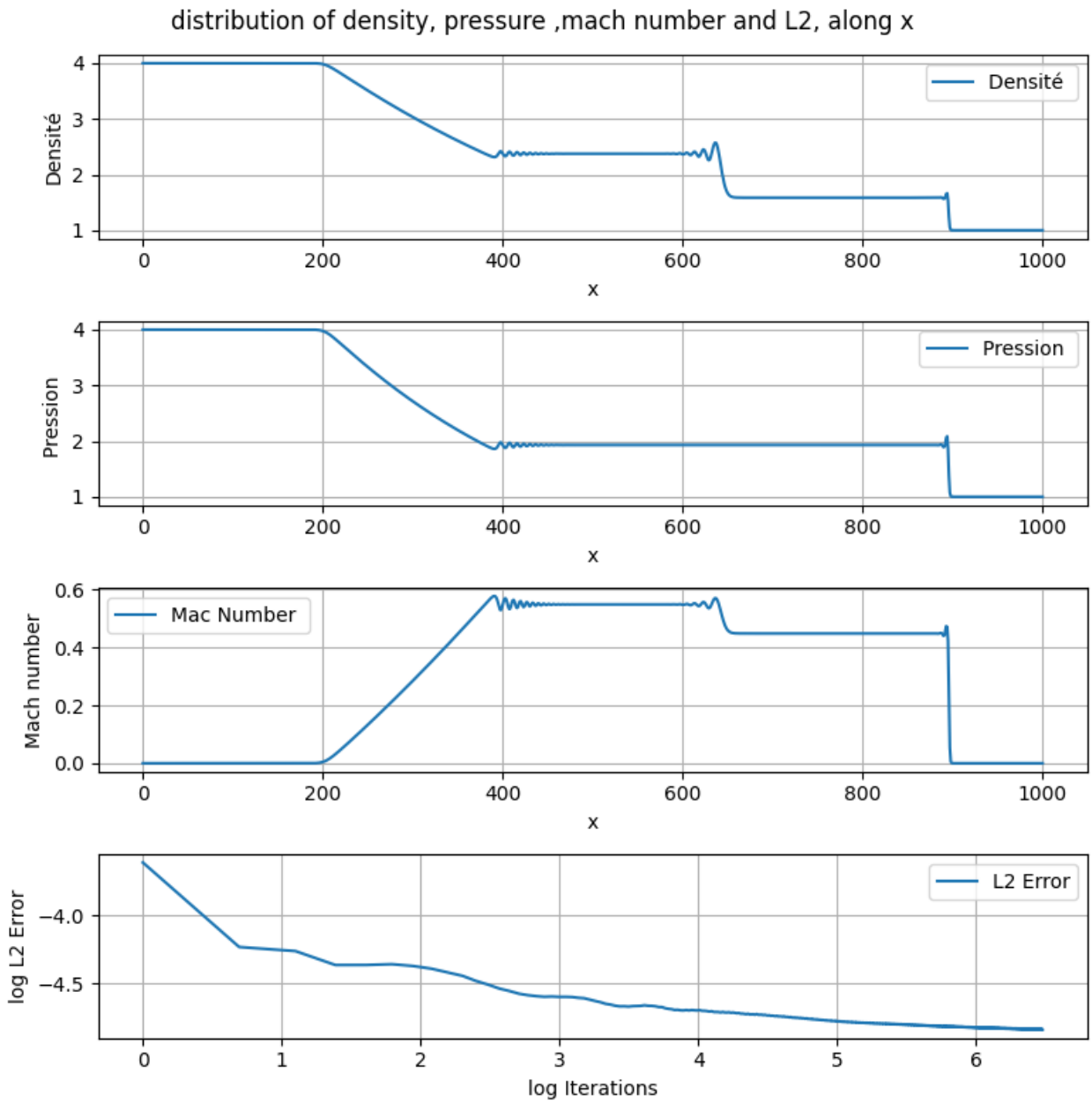

Figure 3: Tube Maccormack simulation at CFL 0.75

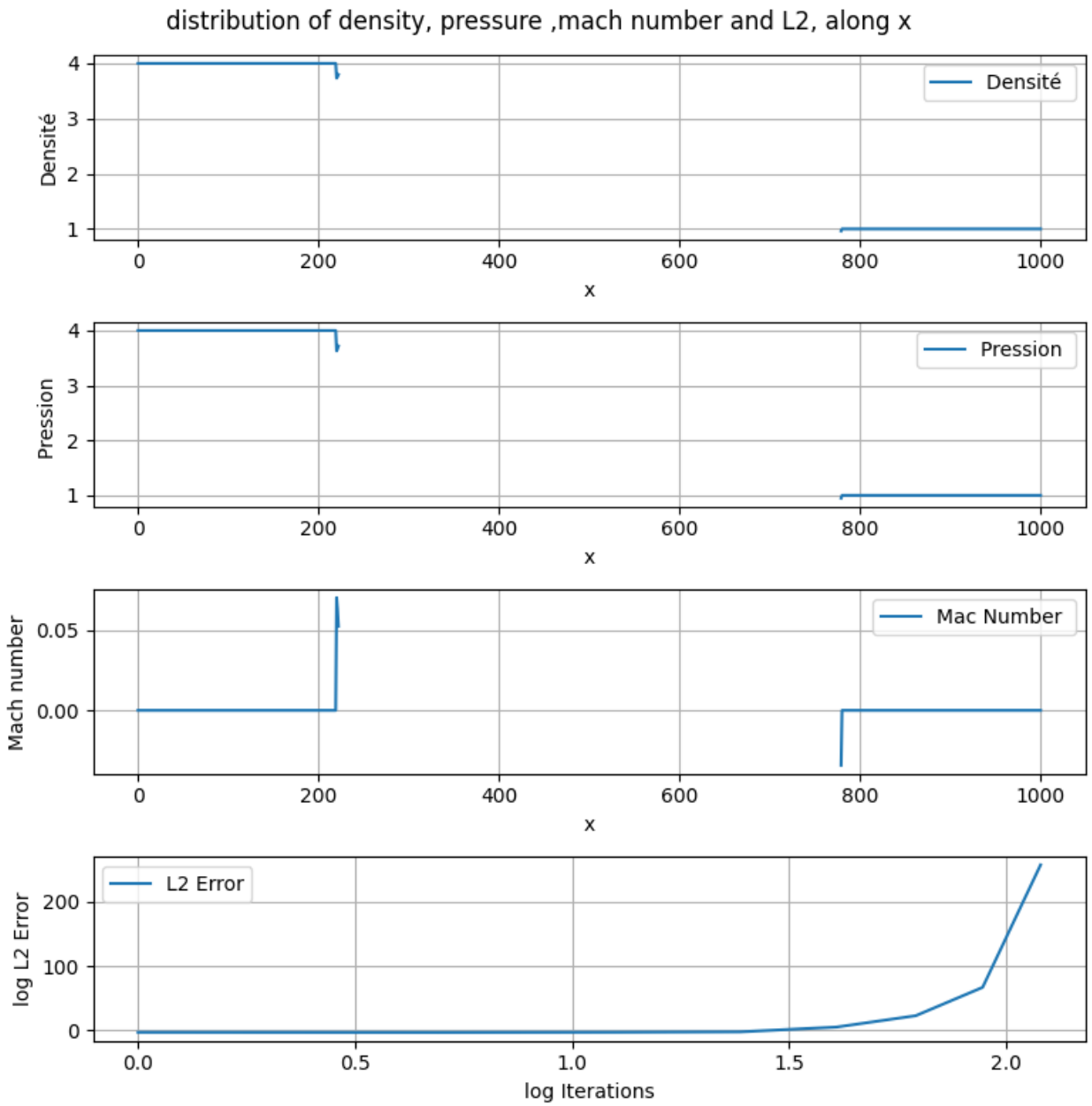

Figure 4: Tube Maccormack simulation at CFL 1.1

1.1.2 Analysis

As we can see, for $0 < CFL < 1$, The scheme converge to a certain solutions that is the solution given is the .dat file .We can also see that the scheme is stable because the L2 gets lowers when there is more iterations. As exepected, thios does not happen when the $CFL > 1$ Because this is an explicit scheme

1.2 SuperSonic - Supersonic Nozzle

1.2.1 results

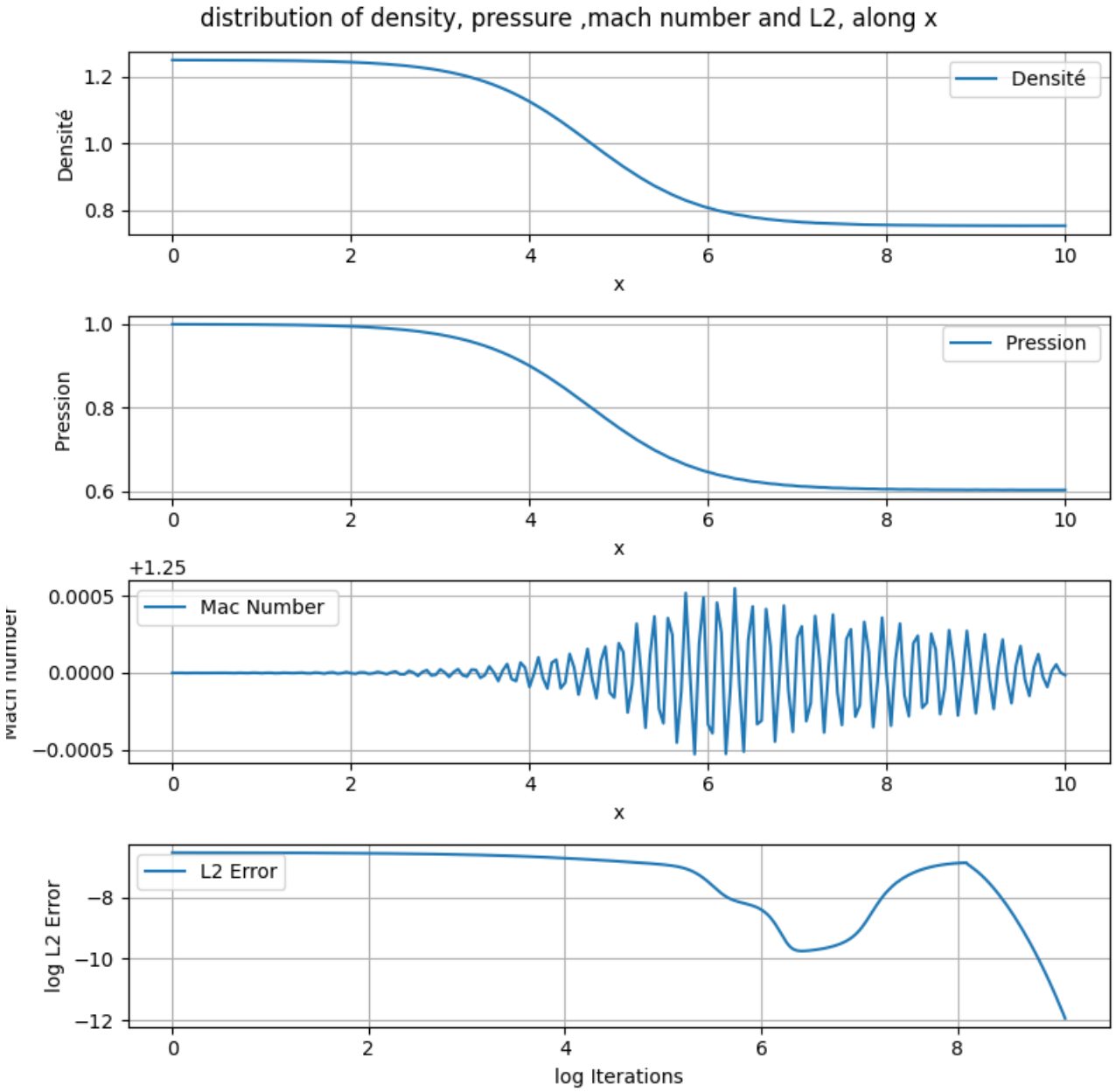

Figure 5: Tuyère supersonic-supersonic at CFL = 0.5

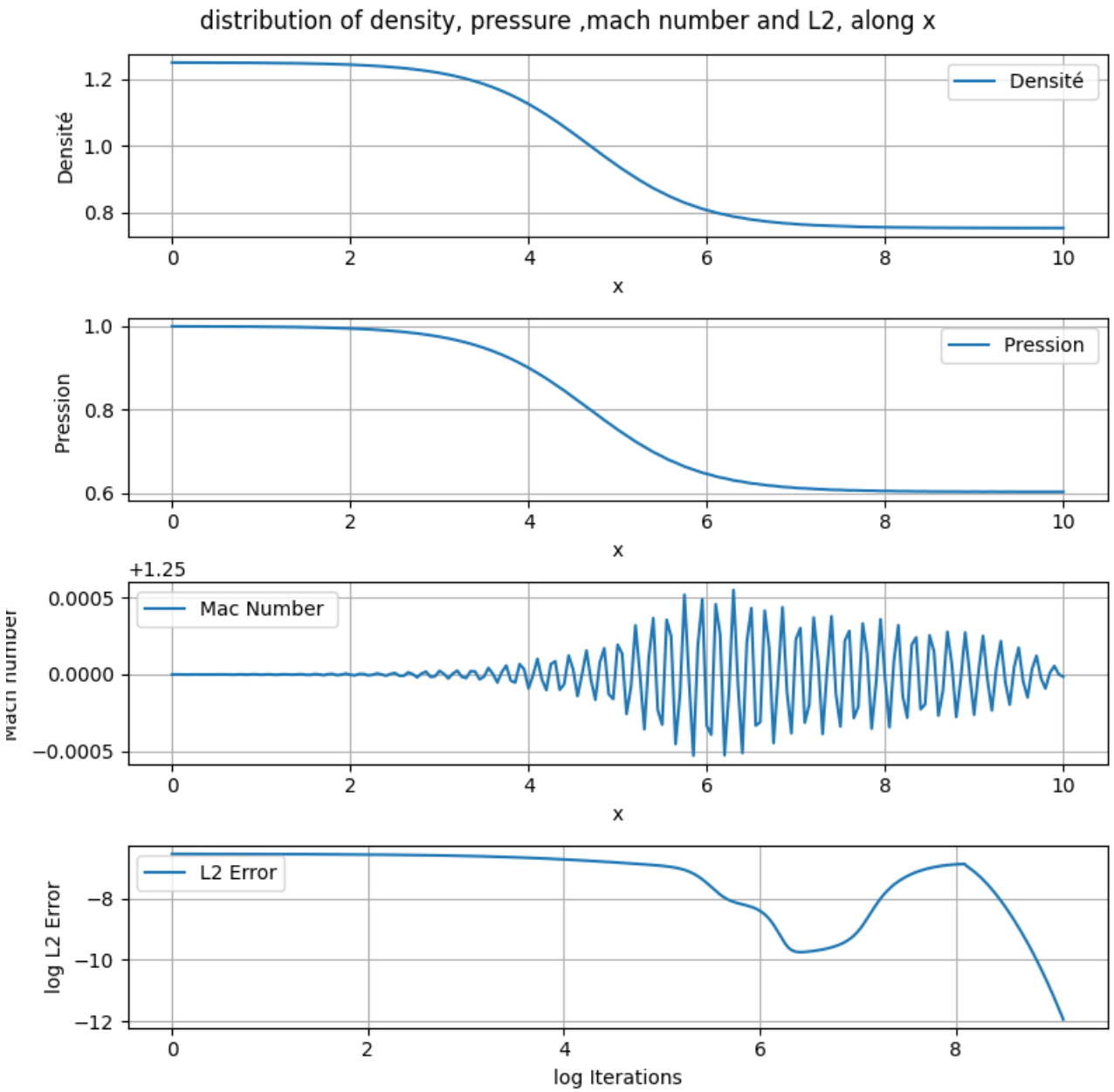

Figure 6: Tuyère supersonic-supersonic at CFL = 0.5

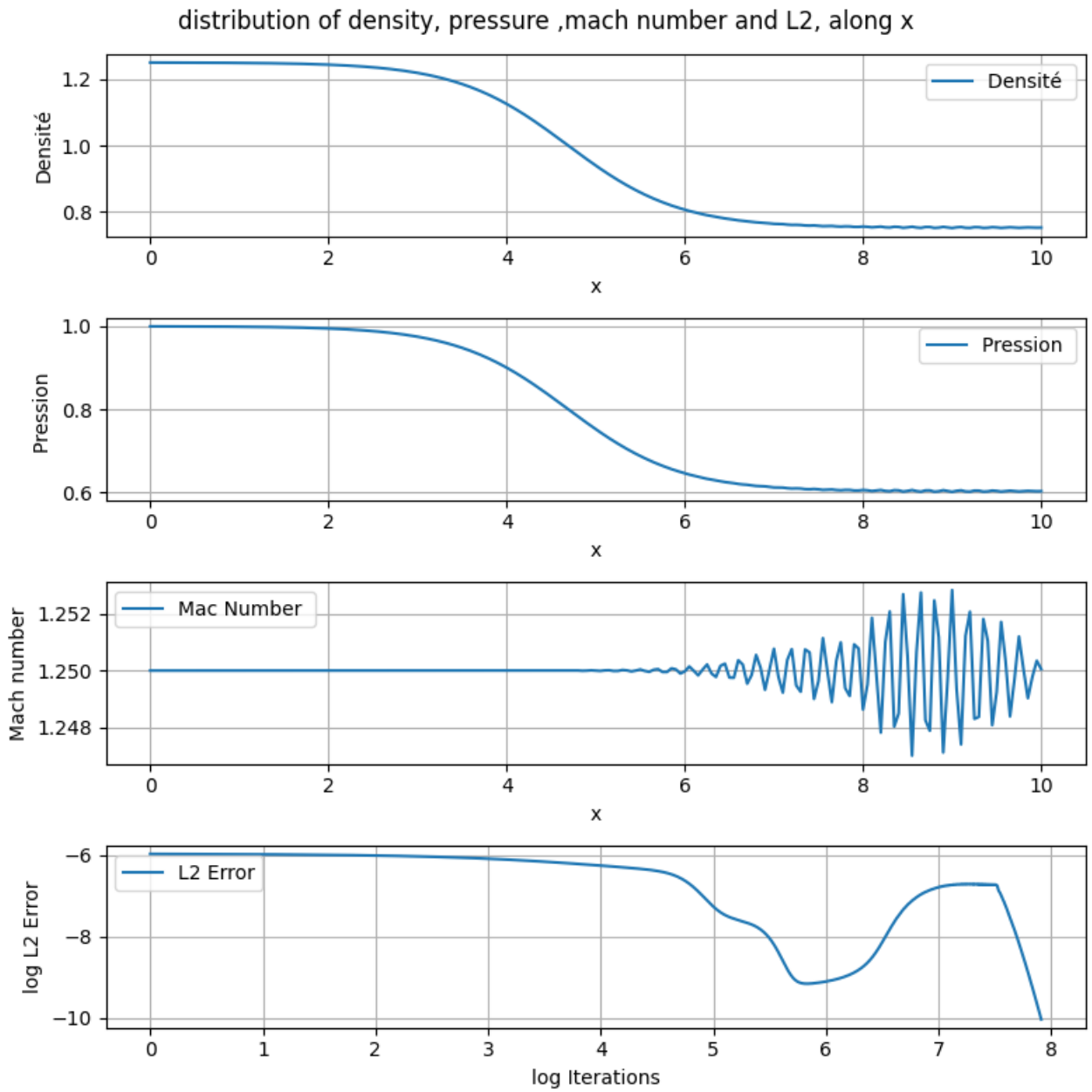

Figure 7: Tuyère supersonic-supersonic at CFL = 0.90

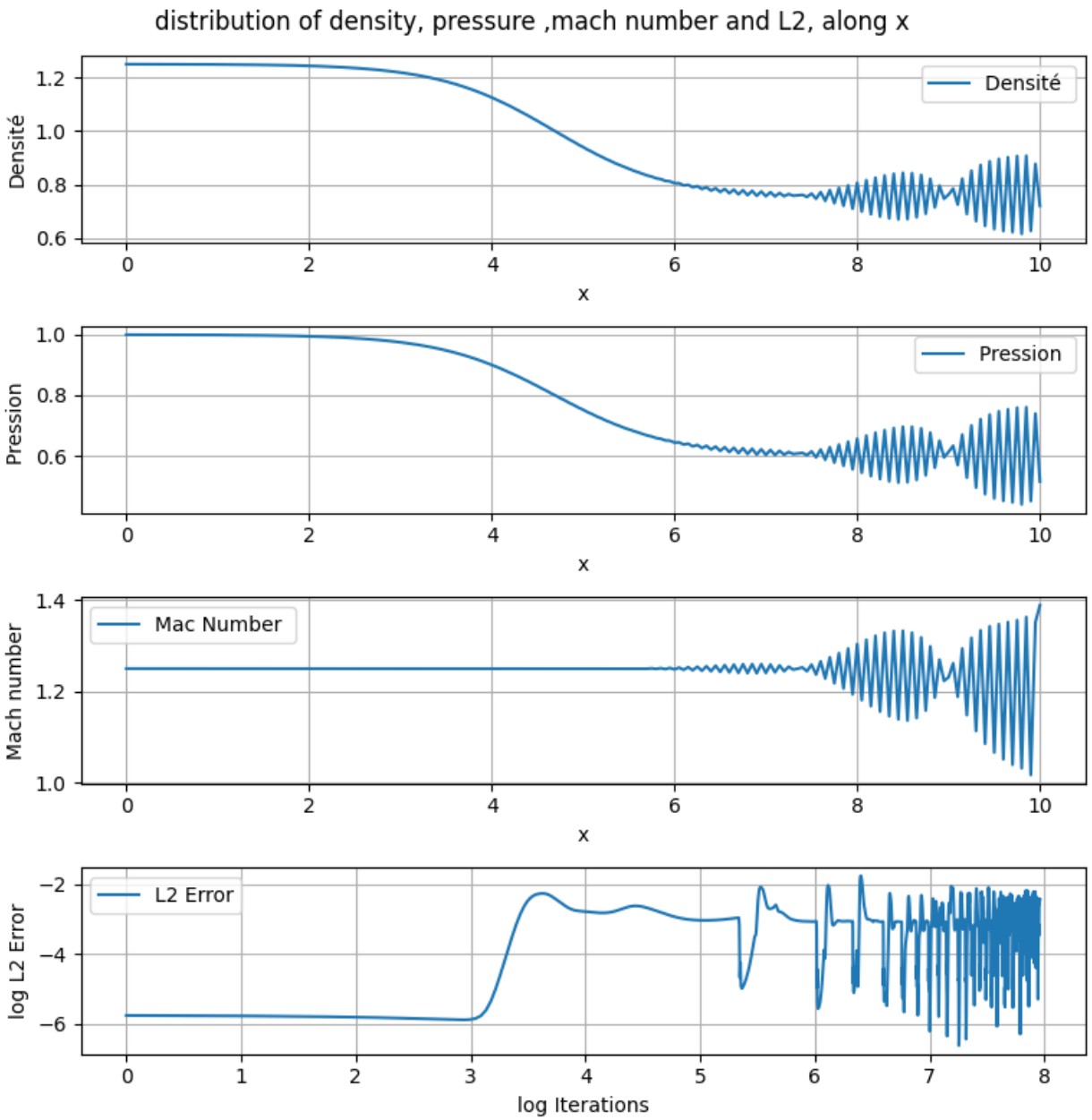

Figure 8: Tuyère supersonic-supersonic at CFL = 1.10

1.2.2 Analysis

This is what we were expection, a drop in density and pressure when it stabilise and the mach number becoming 1.25 everywhere. Careful, the mach number seems to be instable at the outlet, but please pay attention to the y-axis, you will see that its quite stable. As expected, the CFL number has an influence here. Its should not be higher than 1.

1.3 SuperSonic - Subsonic Nozzle

1.3.1 results

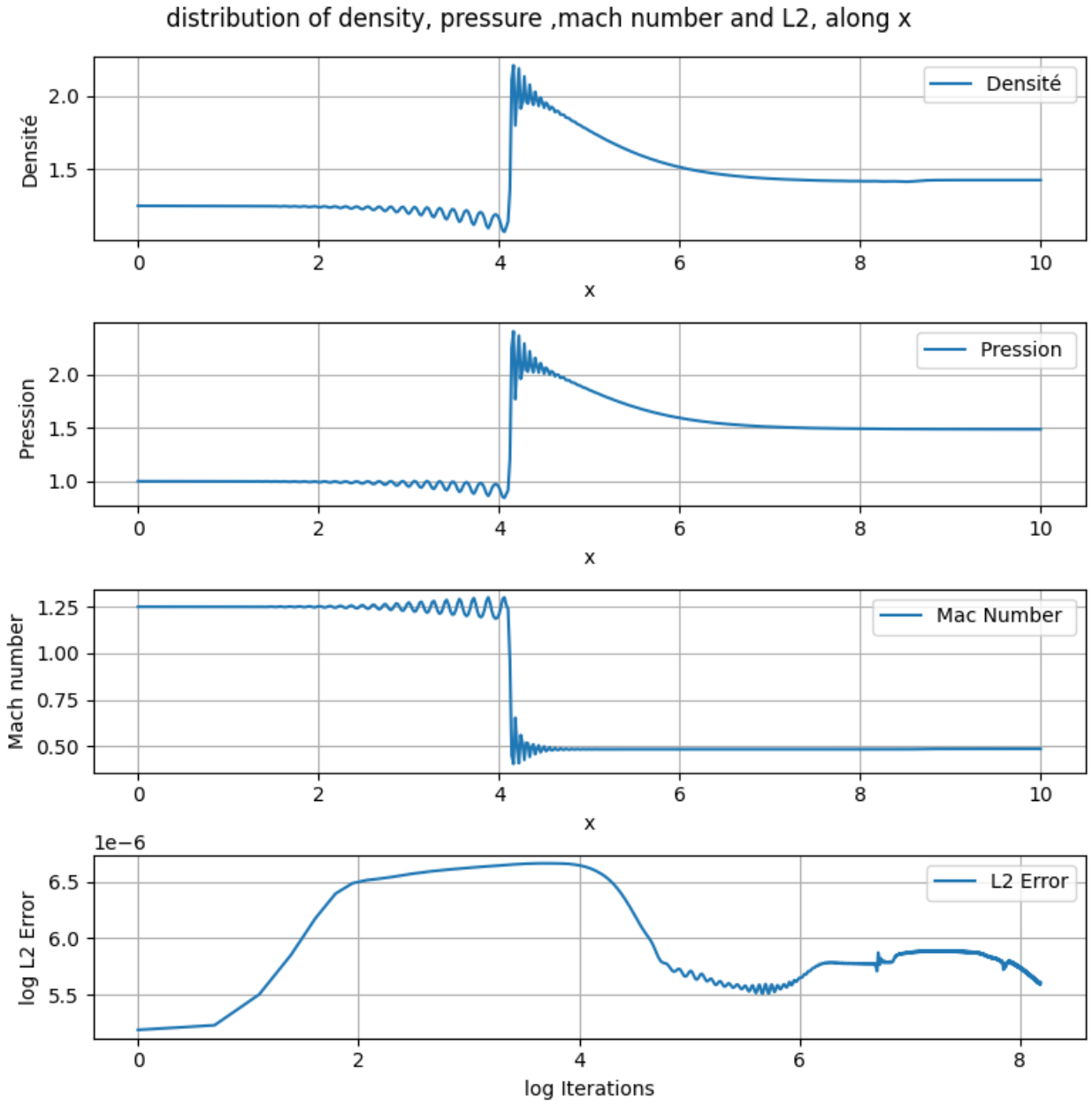

Figure 9: Tuyère supersonic-subsonic at CFL = 0.6

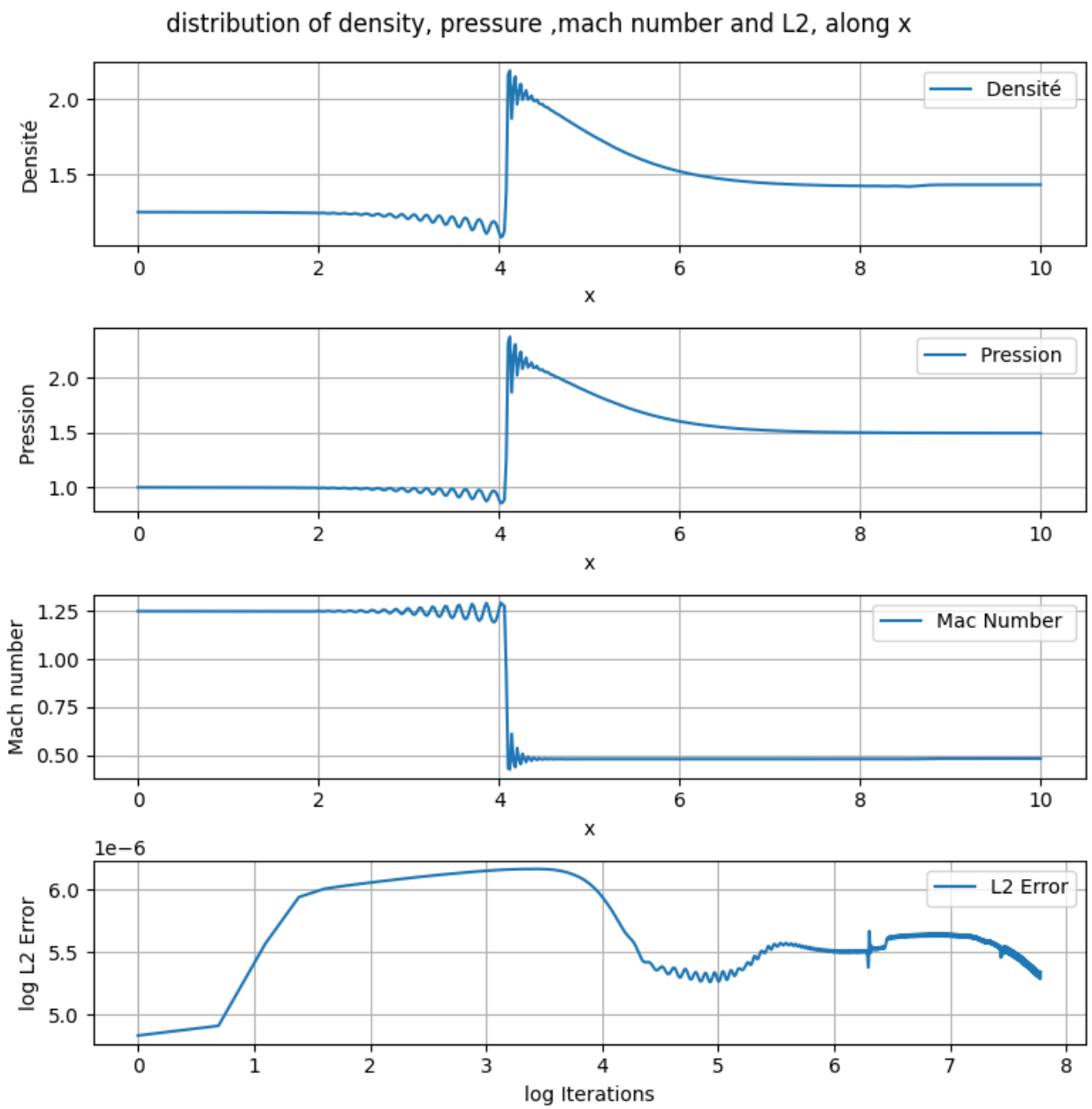

Figure 10: Tuyère supersonic-subsonic at CFL = 0.9

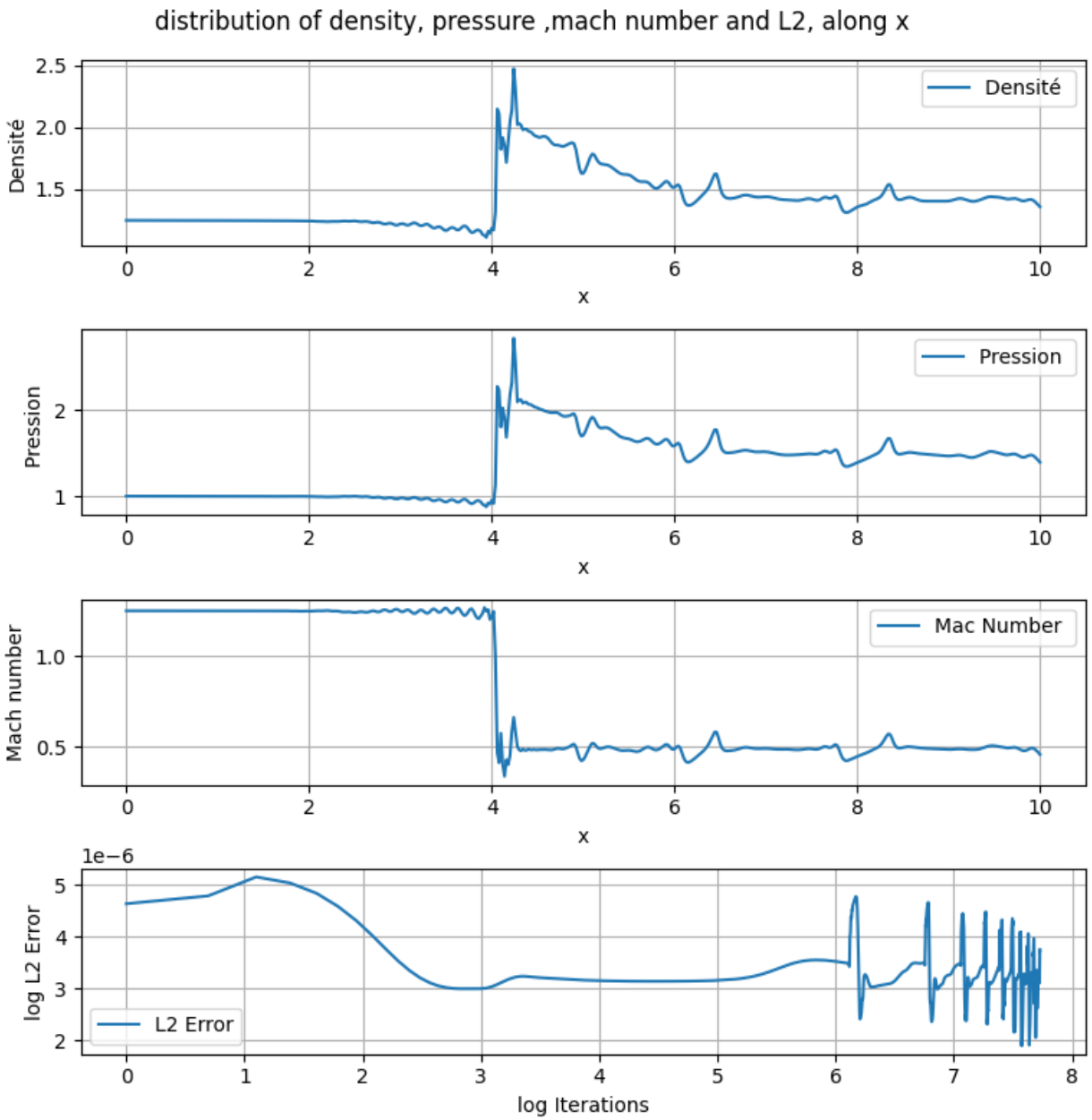

Figure 11: Tuyère supersonic-subsonic at CFL = 1.1

1.3.2 analysis

As we can see here, those result are the same results given at the manual, we were expecting a big drop on speed, while the pressure and density explode at the end which is something quite logical. Here, When the $cfl > 1$ we get something quite right with alot of instability, but it never diverges.

2 ANNEXE 2: GITHUB LINK

Click for Github Acces