

# Expansion Tube Theory

*Principal Investigator: Dr. Ronald K. Hanson*

*Research Associates: Dr. Jay Jeffries; Dr. David Davidson*

## Overview

An expansion tube is an impulse flow device used to generate short-duration, high-velocity gas flows. The device generally consists of three sections of tubing aligned in tandem. Thin plastic or metal diaphragms are used to isolate the sections from each other. As in a conventional shock tube, the driver section is initially filled to high pressure with a light gas. The driven section is filled to a lower pressure with the test gas of interest. The third section of tubing, named the expansion section, contains a light gas at very low pressure.

When the driver/driven diaphragm is broken, the driver gas expands into the driven section. A shock wave is formed which propagates into the test gas, inducing an increase in temperature and pressure behind it. The shock travels down the tube, breaks the driven/expansion diaphragm, and accelerates upon entering the expansion section. The shocked test gas is then cooled and accelerated by an unsteady, constant area expansion from the driven section into the lower-pressure expansion section.

This is in contrast to a reflected-type shock tunnel, in which the stagnant gas near the end wall is accelerated through a steady flow, variable area expansion. Since an expansion tube can accelerate mixtures to similar high velocities (as a reflected shock tunnel), but without exposing the gases to the same high temperatures and pressures, it is well suited for use with reactive mixtures.

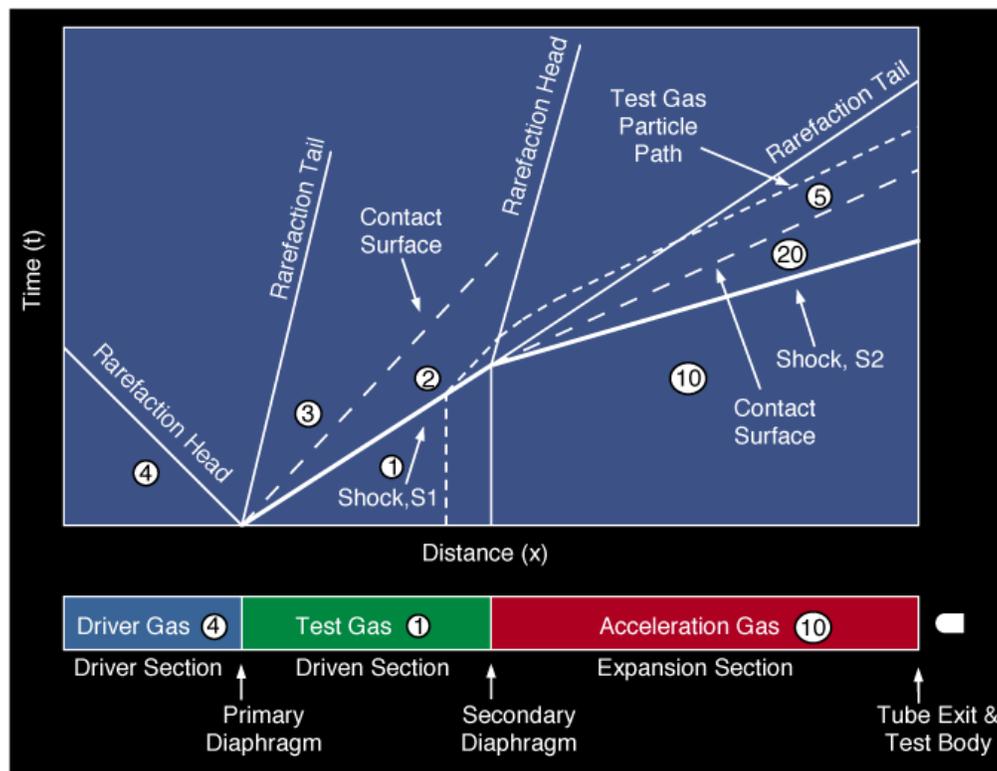


Figure 1: X-t diagram of expansion tube

Above is an x-t wave diagram and schematic of an expansion tube. Gas states are summarized as follows: 1 = initial condition of test gas in driven section, 4 = initial condition of driver gas, 3 = expanded driver gas, 2 = post-shock condition of the test gas, 5 = expanded test gas, 10 = initial condition of acceleration gas in expansion section, 20 = post-shock condition of acceleration gas in expansion section. Below is a sketch of an expansion tube with optical diagnostics.

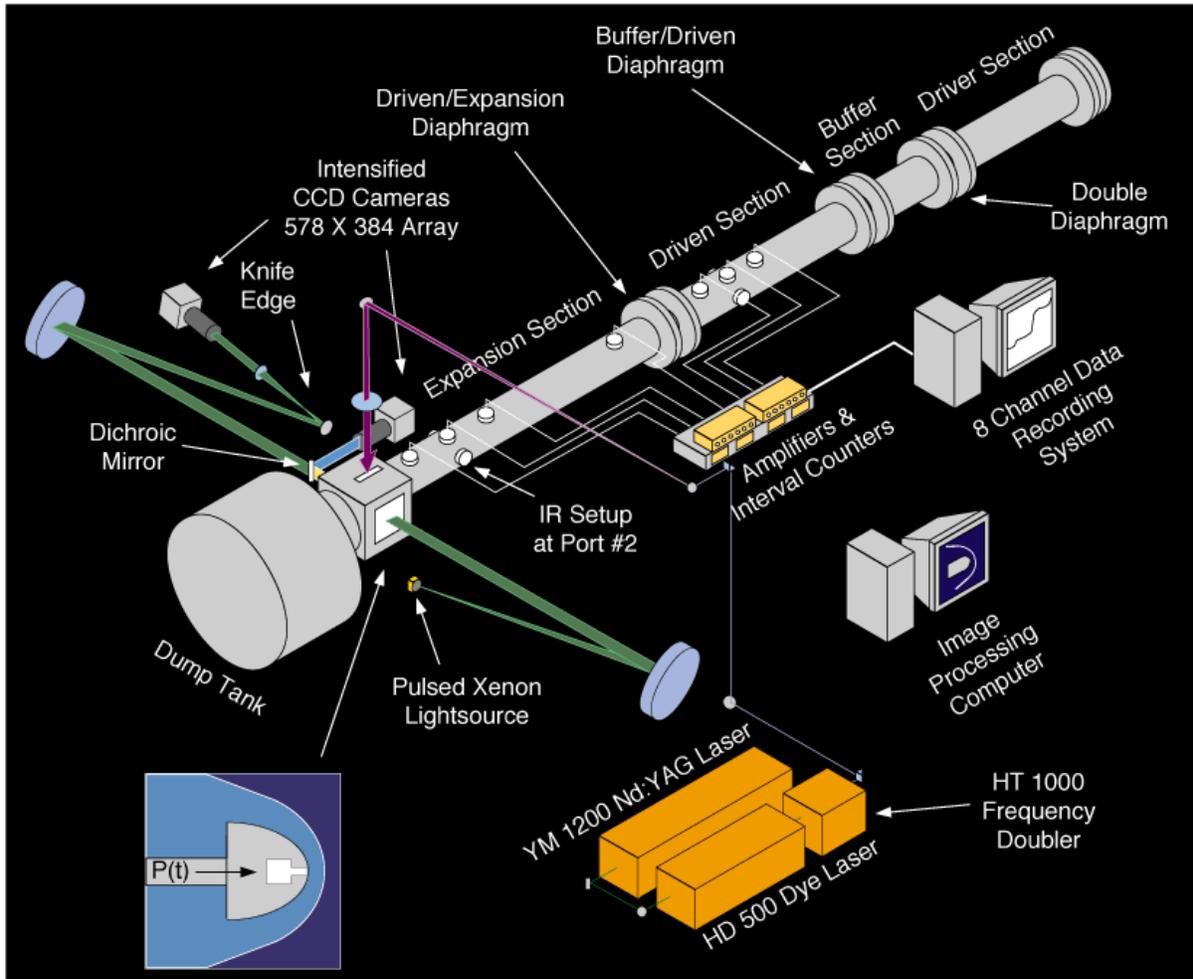


Figure 2: Schematic of expansion tube setup