Helium leak detection response of the LIGO beamtube using a finite element diffusion model

R. Weiss June 19, 2013

The finite element diffusion program btleakfind5.for was used to estimate the response of the Helium pressure in the beamtube after Helium has covered a leak in the beamtube. The figures below show the results for a 1.0e-5 torr liter/sec leak placed at 2000m covered with 1 atmosphere of helium beginning at 0 seconds. The tube is pumped by 150 liters/sec at 0 meters and 1000 liters/sec at 4000m.

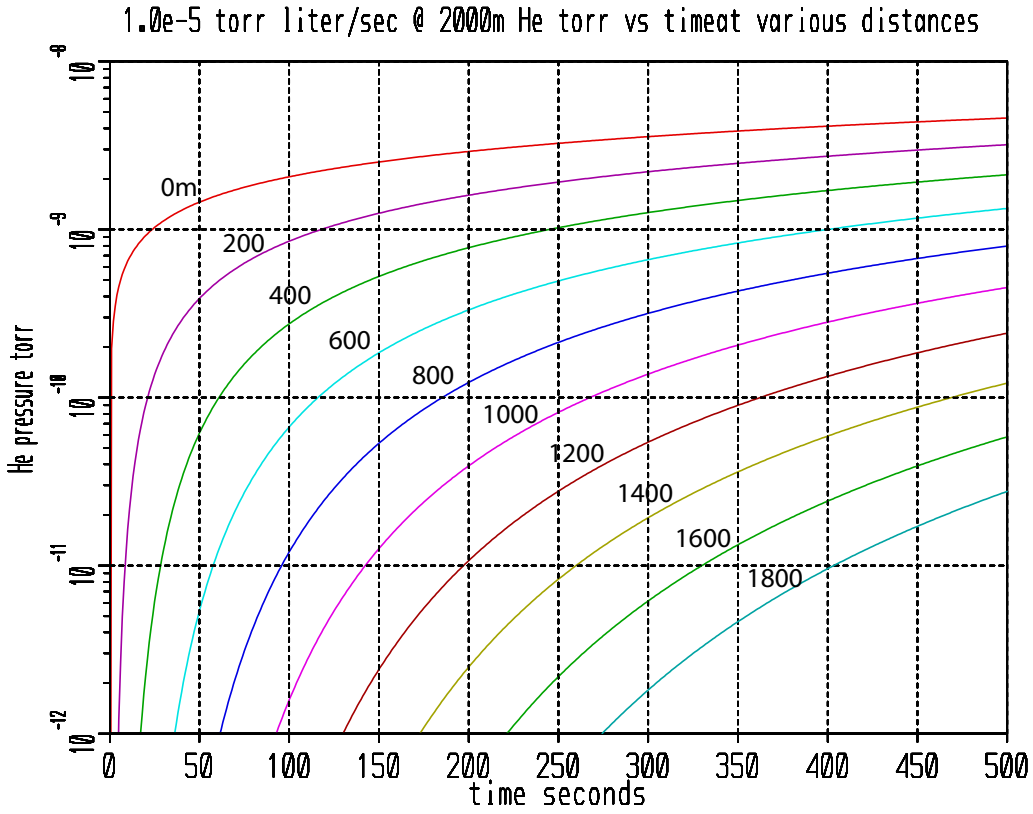

Figure 1: The Helium pressure vs time for a variety of distances from the leak in meters. The leak is covered with 1 atmosphere of Helium at 0 seconds. The Helium pressure is then maintained.

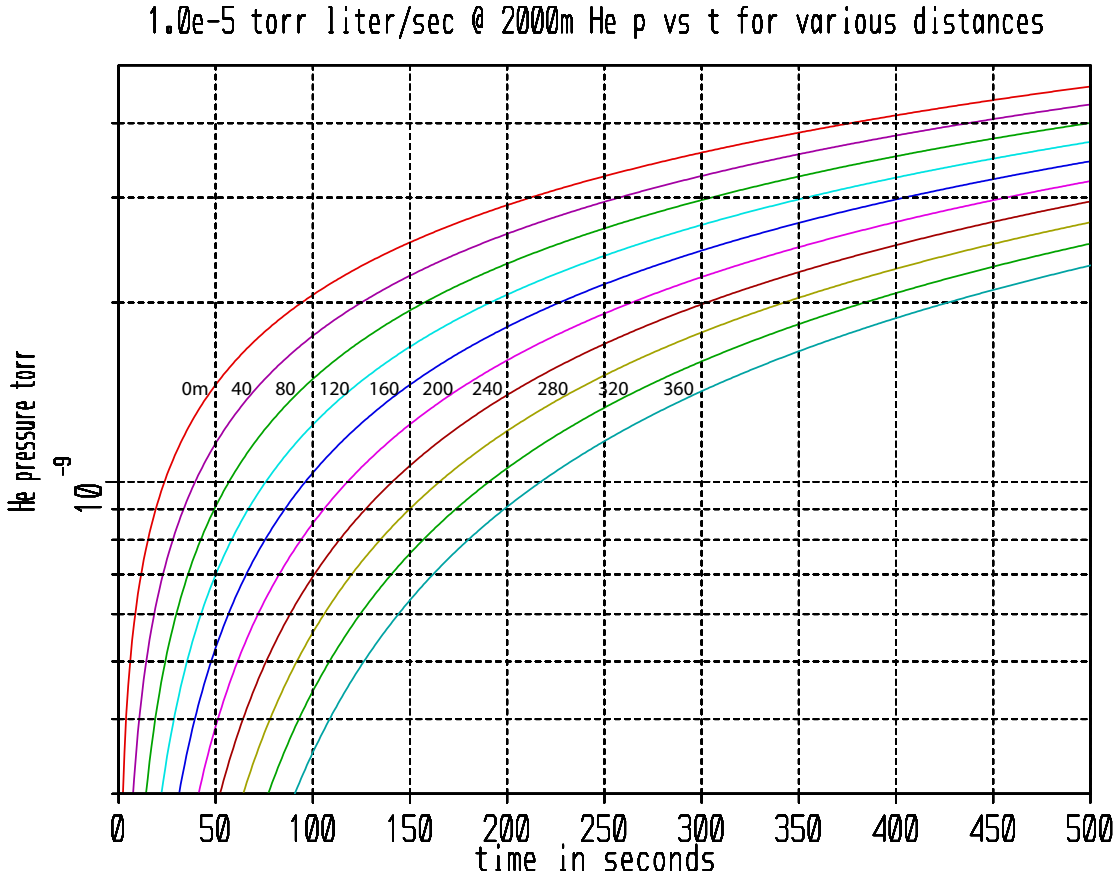

Figure 2: Same as Figure 1 but with a smaller set of separations.

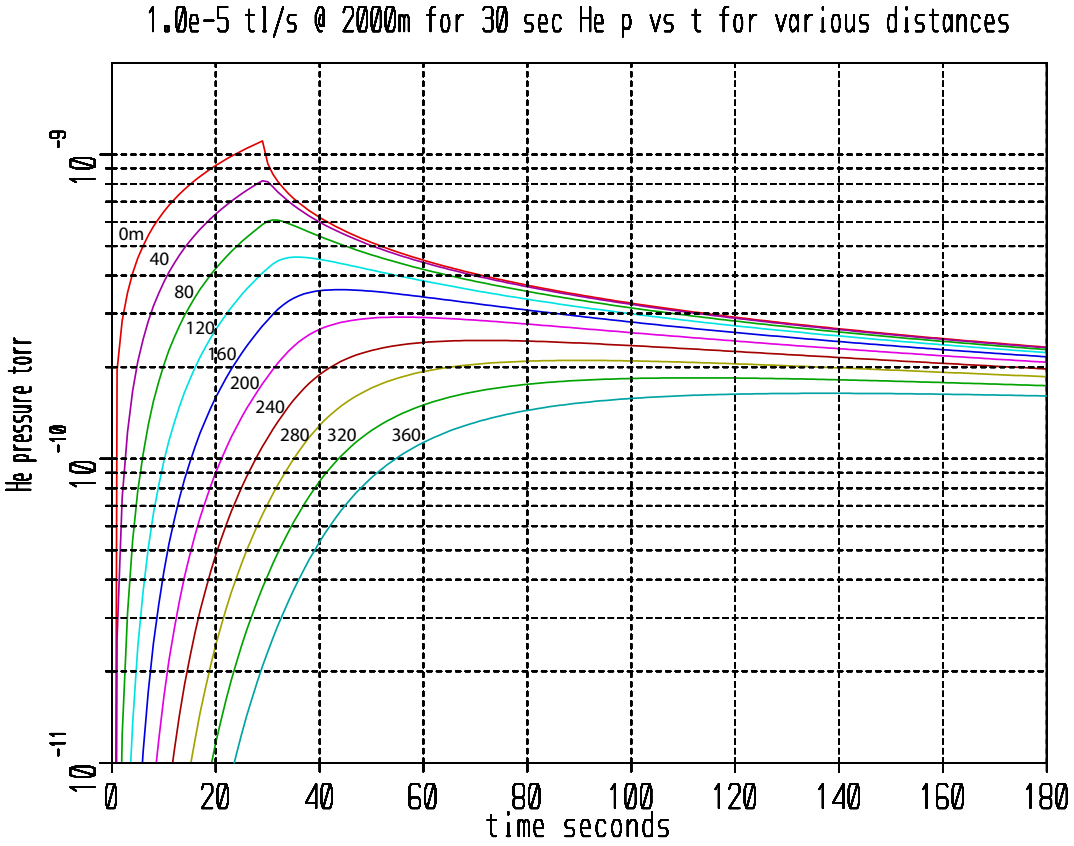

Figure 3: The helium pressure is maintained at the leak for 30 seconds. The same modeling as is done by Zucker in T1300553 . The two estimation methods agree. There is a factor of 5 to 10 penalty paid for placing the leak detector a distance of 240 meters from the leak. The modeling also shows that one would have to use an RGA in multiplier mode to to be useful in leak detection on the beamtube for leaks less than 10^{-5} torr liters/sec.