

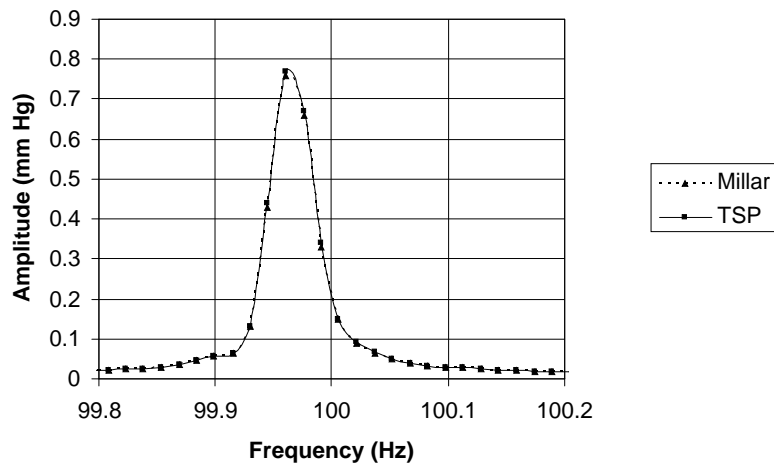
# Validation Test Results – Scisense Pressure Sensor (February 2006)

The purpose of this document is to validate the Scisense pressure sensor against the accepted standard 1.4 F sensor from Millar Instruments and, in some cases, compared to a third, high-precision, industrial, pressure sensor. The test covers the areas of frequency response, steady state drift, temperature drift and linearity. In-vivo comparisons are also shown for purposes of comparing the physiological responses of both sensors.

## Sensor Frequency Response

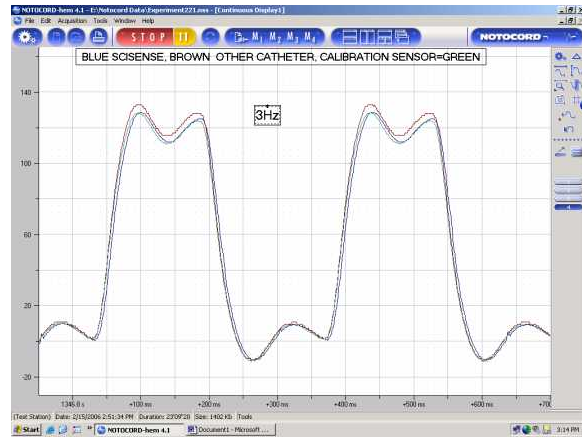
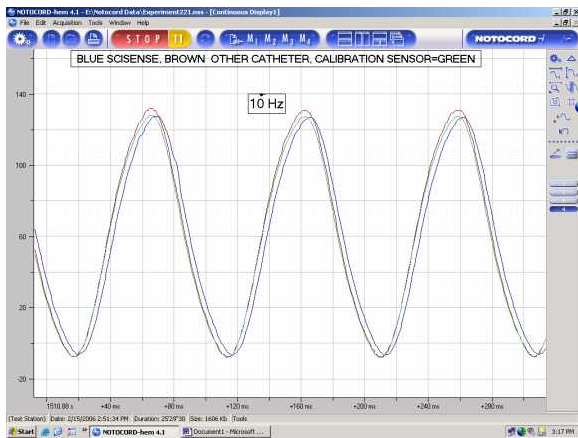
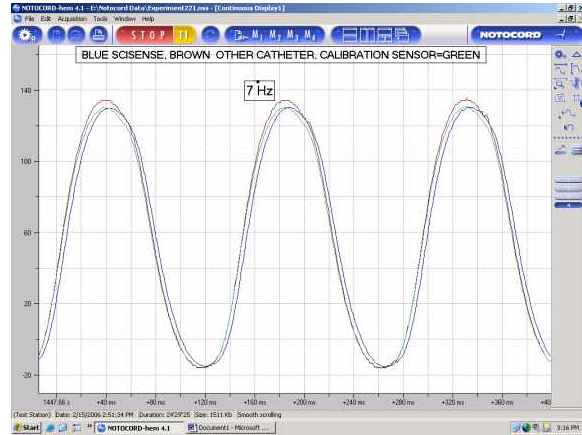
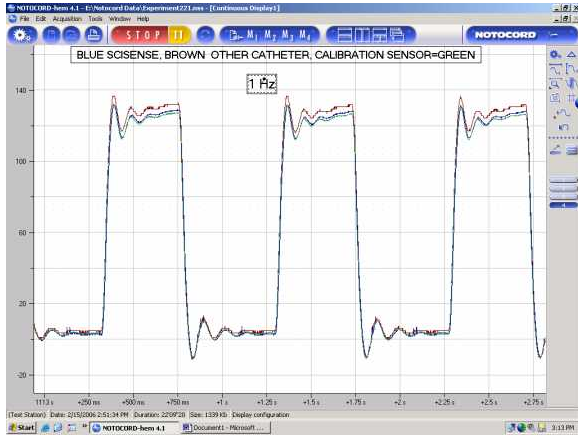
As a first step to test the frequency response and accuracy of the Scisense pressure sensor, a Frequency Response chamber was built to house both the Scisense and the Millar sensors simultaneously. This allowed for a direct comparison under identical conditions. The chamber consisted of a 12-inch audio speaker in a one-inch thick Plexiglas cylinder. The speaker creates sound waves at a know frequencies.

The signal in the chamber was cycled starting at a frequency of 10 Hz and increased in steps up to 100Hz. This would represent 10 times the heart rate of a mouse. **Figure 1** below shows a good correlation of the two sensors at 100 Hz.



**Figure 1.** FFT of Millar and Scisense sensors at 100 Hz, showing good correlation at 100 Hz.

A direct observation from 1Hz to 10Hz was also made to compare sensor outputs at more realistic amplitudes. The graphs below show the results of this comparison.



**Figure 2:** Scisense and Millar frequency response fundamentals

The above graphs show a good correlation of the two sensors as the frequency is increased. Some of the lower fundamentals show a higher frequency component that shows the two catheters as they swing from low to high frequency events.

## Steady State Drift Results

It is important that the pressure baseline should not shift during an experiment. The allowed specification is 6mmHg over a 12-hour period. In order to validate the Scisense sensor, it was placed into a closed chamber where pressure and temperature were maintained as a constant. Once again, a Millar sensor was also present for comparison purposes. The results are shown in **Figure 3** below.

It should be noted that both sensors drift less than the accepted 6mmHg over the 12-hour period. Both sensors demonstrate reasonable warm-up periods for initial drift.



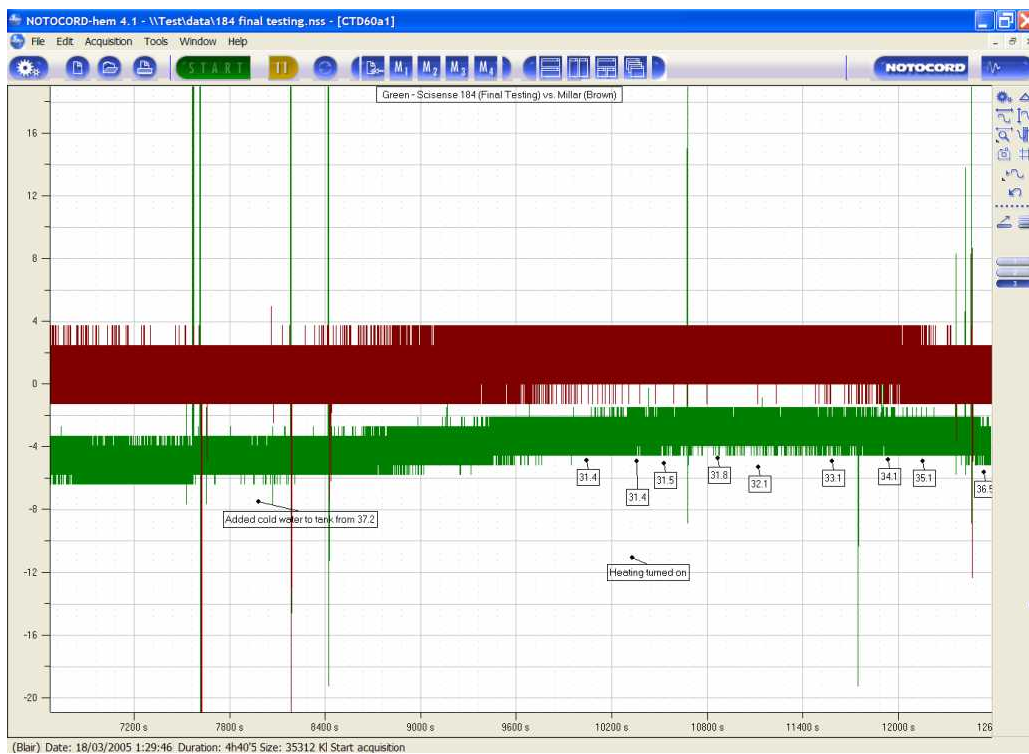
**Figure 3:** The plots show 12-hour drift rates of less than 5mmHg for both the Scisense and the Millar sensors.

## Temperature Induced Drift

Piezo-resistive sensors are very sensitive to temperature changes and consequently must be compensated to avoid temperature related drift. The accepted standard in this case is 2 mmHg over a 10 degree Celsius range.

For this test, the same chamber was used as per the steady state drift test; only in this case the temperature was changed while the pressure was held constant. Both the Scisense and the Millar sensor had drift curves of less than 2mmHg for the ten-degree span as shown in Figure 4, below.

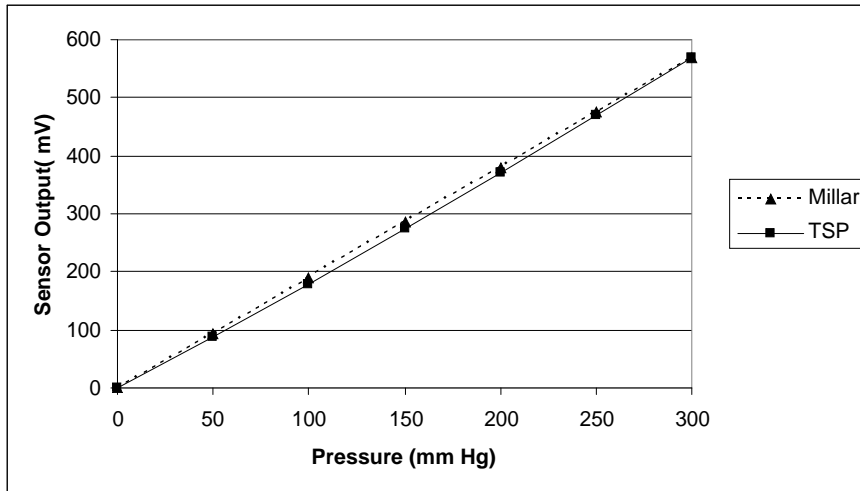
It should be noted that the small variation in the more precise Scisense signal is within the overall noise band of the Millar signal.



**Figure 4:** Millar (top) versus Scisense (Lower): Both sensors show similar drift characteristics over a ten-degree span, although the Millar signal shows a higher level of baseline noise.

## Linearity Testing

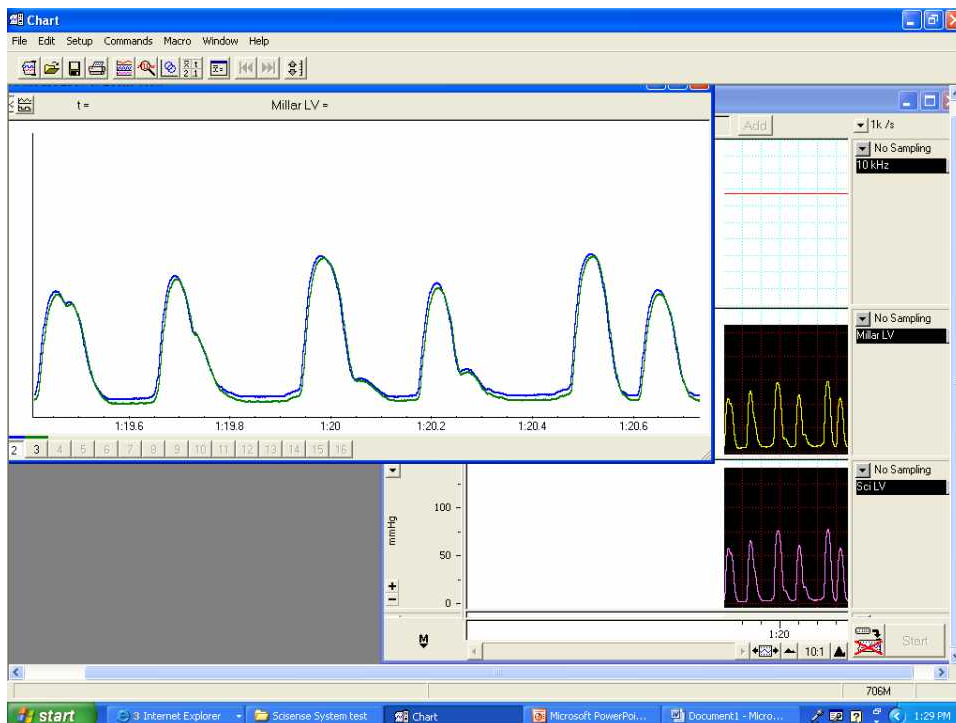
Linearity was compared to the Millar by changing the pressure in the test tank while holding temperature at a fixed point. The pressure in the tank was increased from 0 to 300 mmHg in 50 mmHg increments. The pressures were observed with a mercury column. The results show that the linearity of the two sensors matches within  $\pm 1$  mmHg.



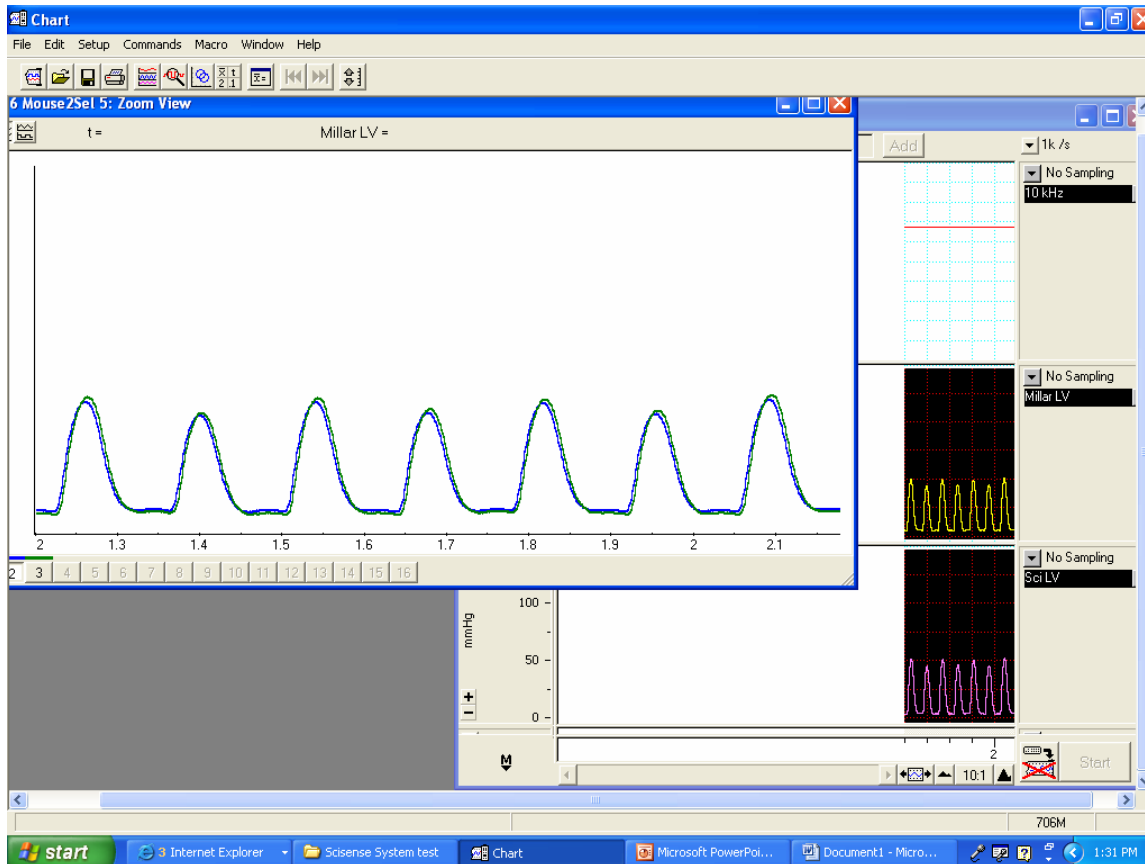
**Figure 4** Linearity of the Scisense and Millar sensors as observed *in vitro* inside a pressure vessel.

## In-Vivo Testing

Pressure sensing catheters from Scisense and Millar Instruments were placed in the LV of an anesthetized mouse by an independent lab and data collected simultaneously for comparison purposes. Test results show comparable results between the two systems.



Note: Traces offset to facilitate comparison



## CONCLUSION

The Scisense pressure sensor meets the highest standards for frequency response and other critical conditions. In addition, its optimal 1.2 French size and flexing characteristics provide it with a number of physiological advantages over its competition, leading to superior data collection and results.