UE9020400 | DOPPLER SONOGRAPHY

EXPERIMENT PROCEDURE

- Doppler sonographic examinations of a human model arm.
- Measurement of the flow velocity of blood.
- Diagnosis of stenosis (vascular stricture) in an arm.
- Recording of Doppler spectra and pulse curves.

OBJECTIVE

Investigating a model arm

SUMMARY

The goal of the experiment is to learn how blood flow measurements are made with Doppler ultrasound. A realistic arm model is used to show the differences between continuously (venous) and pulsatile (arterial) flow and between normal blood flow and a stenosis.

REQUIRED APPARATUS

Quantity	Description	Item Number
1	Ultrasonic Doppler Apparatus	1022330
1	Arm Phantom Set	1022331
1	Centrifugal Pump	1002575
1	Ultrasonic Coupling Gel	1008575

BASIC PRINCIPLE

Doppler sonography uses the Doppler Effect to assess whether structures (usually blood) are moving towards or away from the ultrasonic probe, and its relative velocity. By calculating the frequency shift of a particular sample volume, for example a jet of blood flow over a heart valve, speed and direction of this sample volume can be determined and visualized. Doppler frequency shift is the difference in ultrasonic frequency between transmitted and received echoes, i.e. the echo frequency minus the transmitted frequency. The Doppler frequency is proportional to the blood flow velocity.

Doppler sonography is particularly useful in cardiovascular studies (sonography of the vasculature system and heart) and essential in many areas such as determining reverse blood flow in the liver vasculature in portal hypertension. The Doppler information is displayed graphically using spectral Doppler or as an image using color Doppler.
For the experiment a pump is switched on and the speed is adjusted in a middle range (approx. 4000 min^{-1}). The mode is GK (continuously, venous). With the Doppler probe and coupling gel the arm model is scanned for a vessel with a significant audio signal.
The flow in the spectral image is analyzed for negative and positive components. The probe direction is then switched by 180°. Then the vessel is scanned for changes in the spectral image (stenosis) and the differences between the images of the “healthy” vessel and the stenosis will be characterized.
Lastly the pump is switched to P_1 and P_2 mode (pulsatil) the images are analyzed and the pulse rate is determined.

EVALUATION

Figure 1 shows a continuously (venous) flow with a mean Doppler shift of approx. -700Hz. The minus in the Doppler shift means a flow away from the probe.
Figure 2 is the spectral distribution with rotated probe. Flow towards the probe (the same Doppler shift, but positive).
Figure 3 is the Doppler spectral figure of a stenosis. The differences to a normal (healthy) figure like shown in figure 1 are:

1. A local increase of the maximum Doppler shift (maximum flow velocity).
2. A decrease of mean frequency and a broadening of the spectra.
3. An increase of reflux phenomenon (negative and positive parts of the spectra).

Figure 4 shows the pulsatile flow of P_1 with a pulse rate of ca. 90min^{-1}.

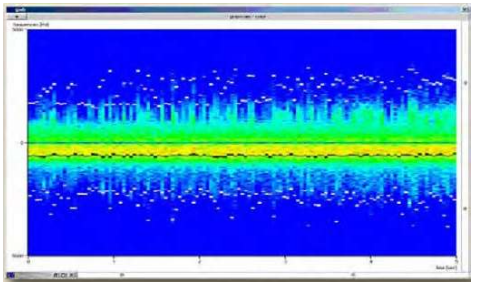

Fig. 1: Doppler spectrum of blood flow in veins

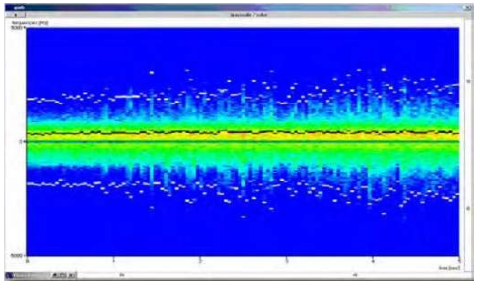

Fig. 2: Spectral distribution with rotated probe

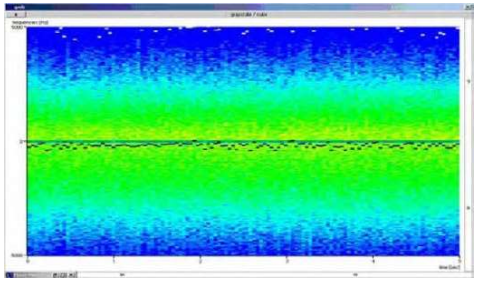

Fig. 3: Doppler spectrum of a stenosis

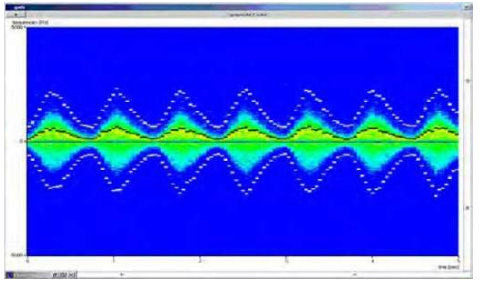

Fig. 4: Pulsatile flow