NHS
University Hospitals of Liverpool
Group

Doppler Techniques in Liver Imaging

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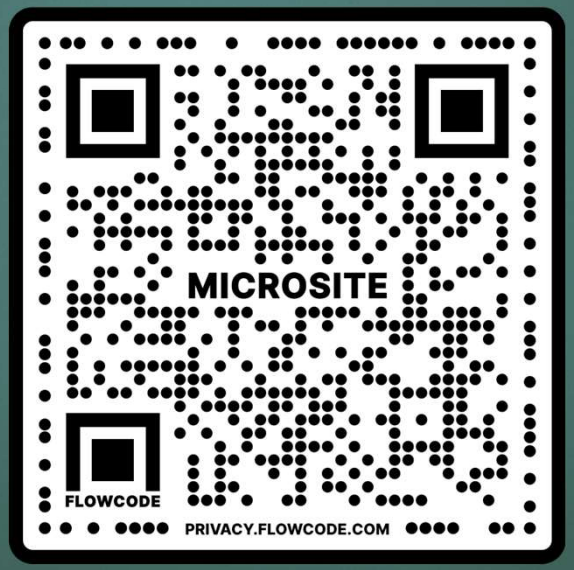
& CLINICAL LEAD FOR ULTRASOUND

BMUS General Medical Study Day
Friday 26th June, 2026

General Medical Ultrasound Study Day 2026

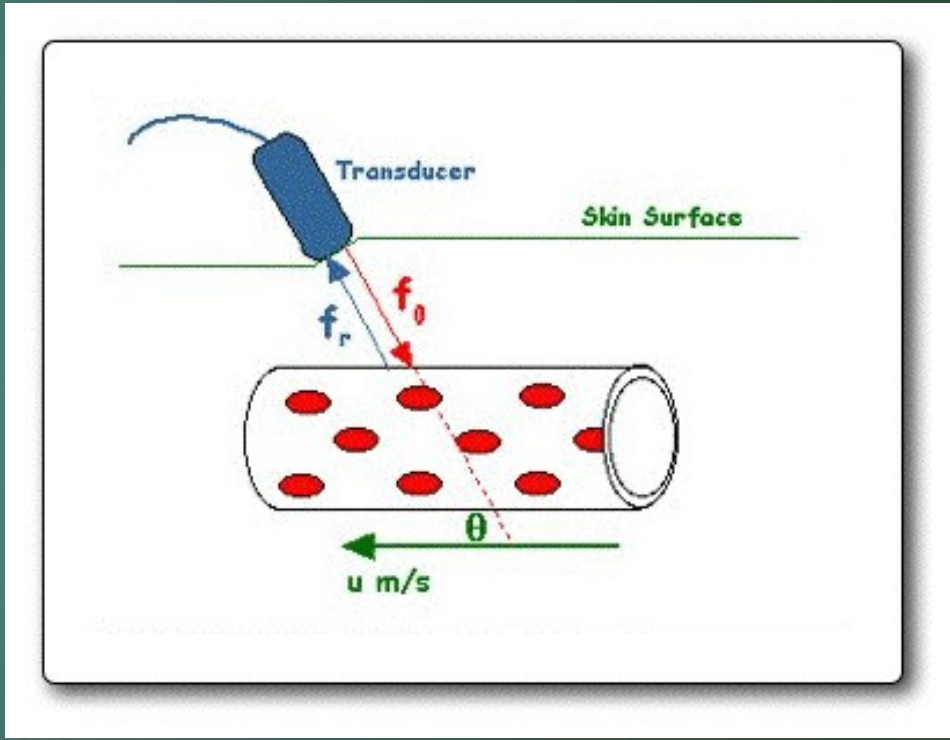
SCAN THE QR CODE TO ACCESS PROGRAMME, SURVEY & FUTURE EVENTS



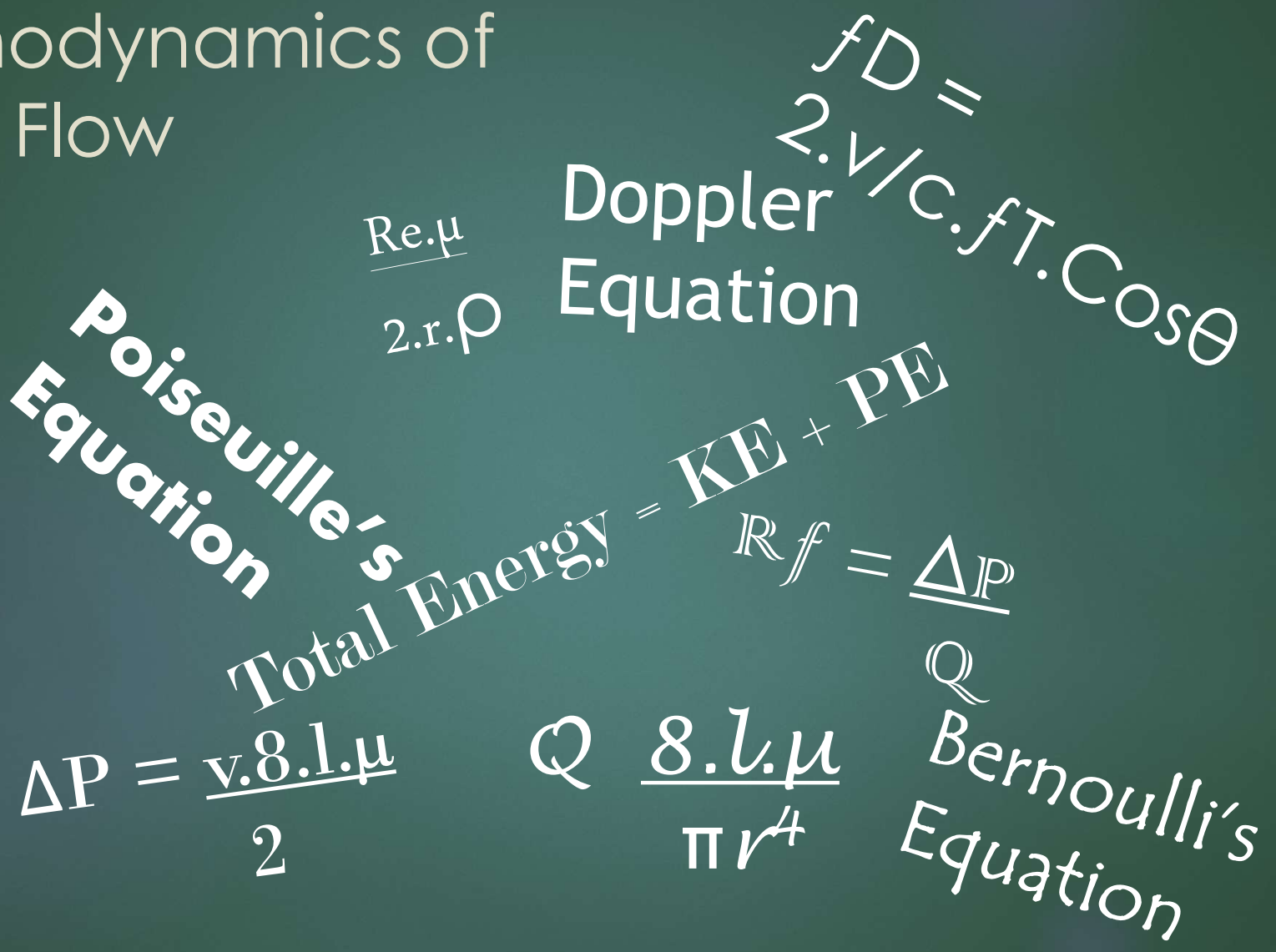
Doppler Equation

- $\mathit{f}D = \frac{2.v.\text{Cos}\theta.\mathit{f}T}{c}$

- $\mathit{f}D$ - Doppler shift frequency
- v – velocity
- c - speed of sound
- Cosθ - Cos of angle of insonation
- $\mathit{f}T$ - Transducer frequency



Haemodynamics of Blood Flow



Blood

- Complex fluid
- Newtonian fluid

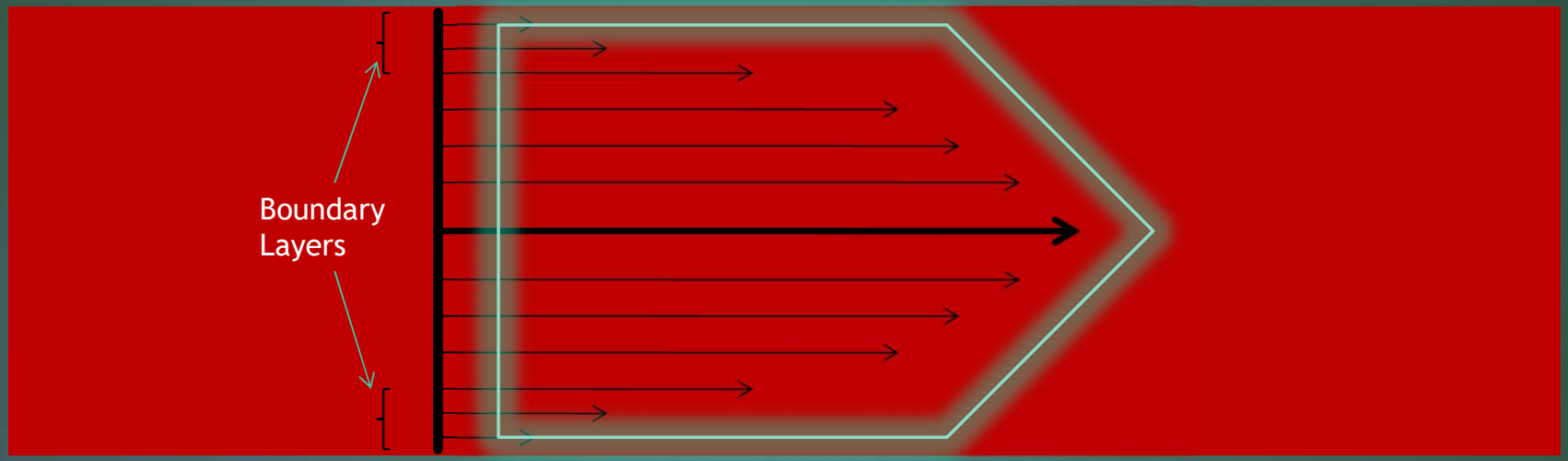
- Viscosity
  - μ
  - $kgm^{-1}s^{-1}$ or Pascal seconds (Pa s)
  - NOT CONSTANT
  - Changes with increased temp or haematocrit
  - decreases when velocity increases

Blood Flow

- Volume flow (ml per minute)
- Frictional losses

Blood Flow 2

- Laminar Flow

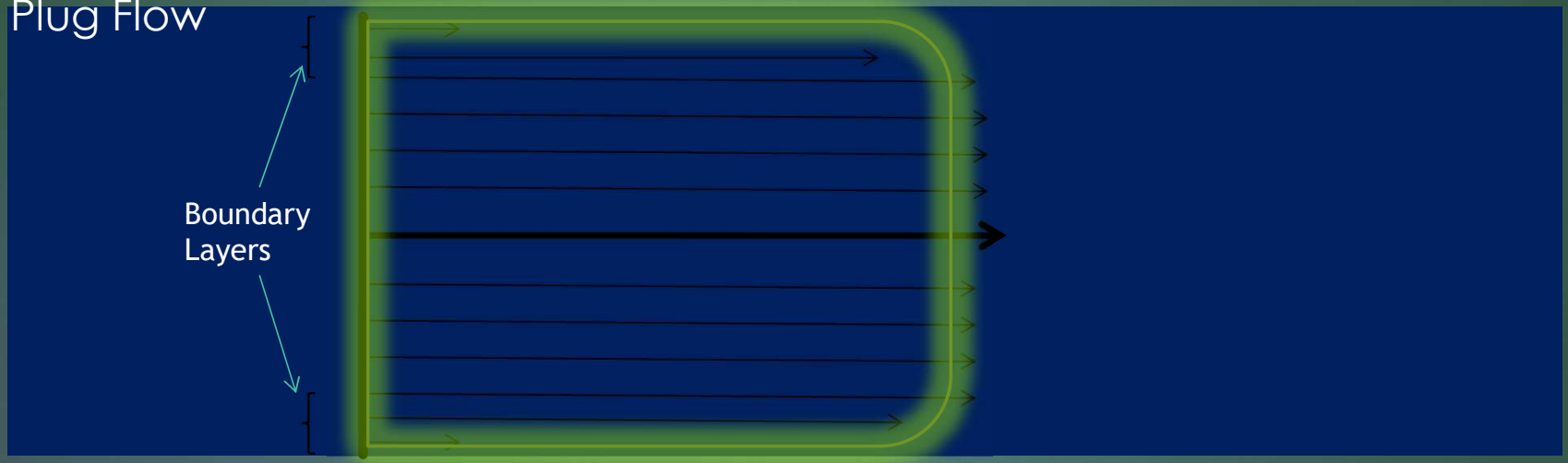


(Arterial Flow)

Important to use small Doppler gate in centre of the vessel for accurate velocity readings

Blood Flow 3

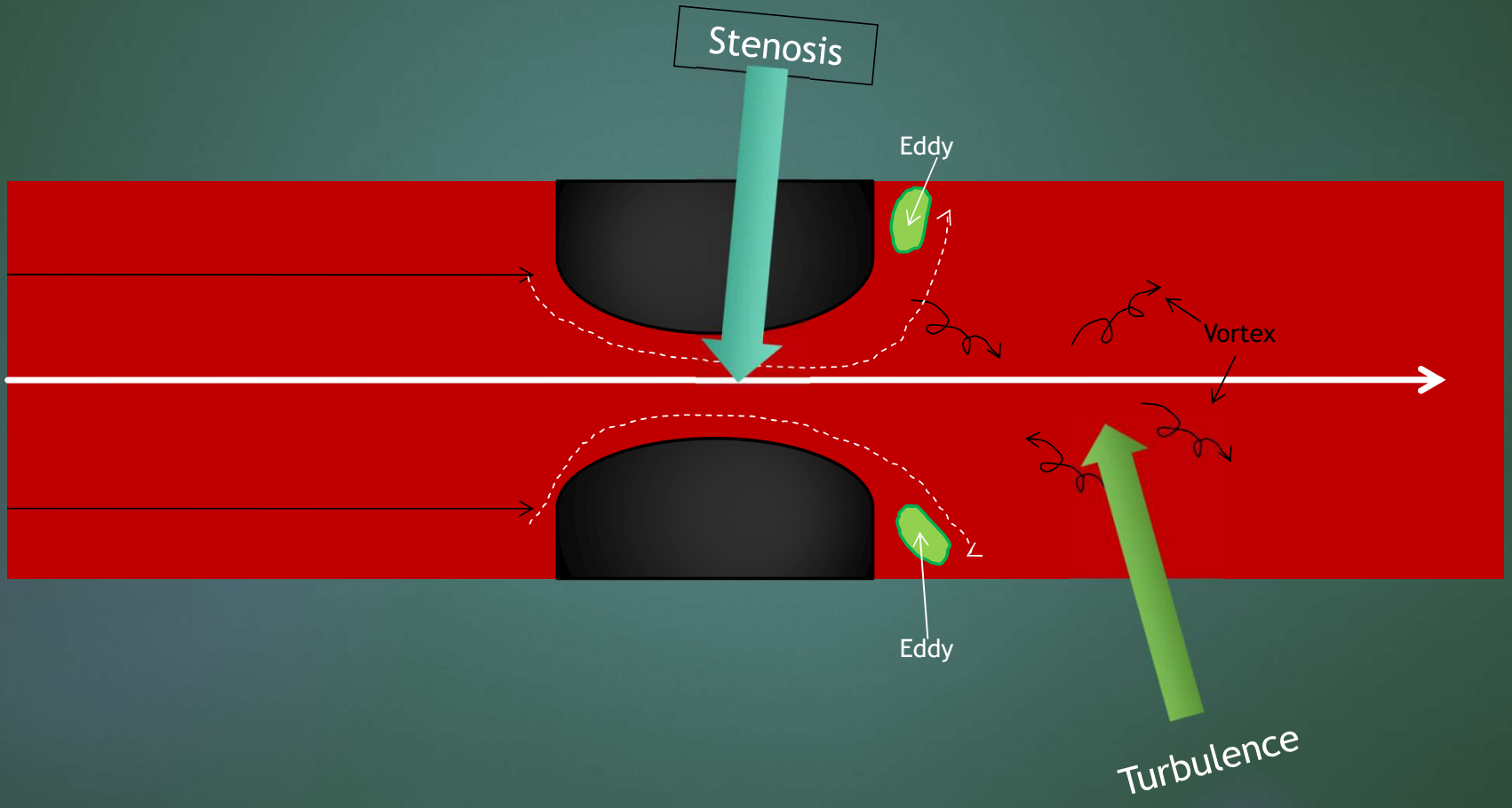
- Plug Flow



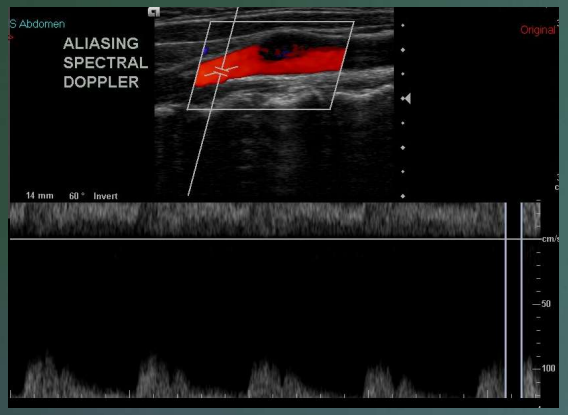
(Venous Flow)

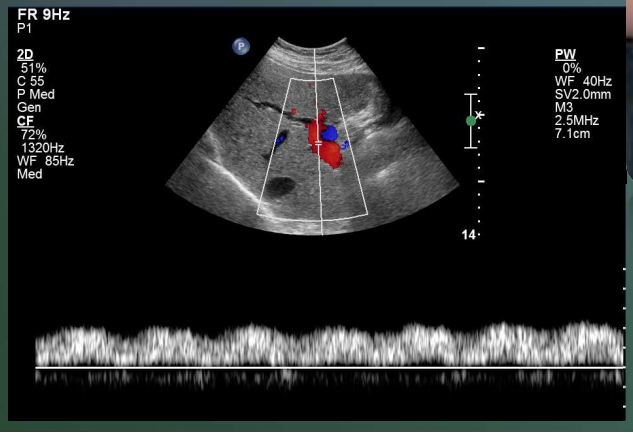
Important to use large Doppler gate to encompass the vessel for accurate flow information

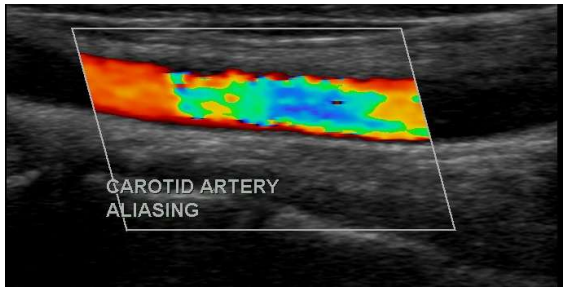
Haemodynamics of a Stenosis



Doppler







Colour

- Flow at one site
- Poor temporal resolution – low frame rate at depth
- Subject to aliasing
- Angle dependent
- Overall view of flow within a region

Power

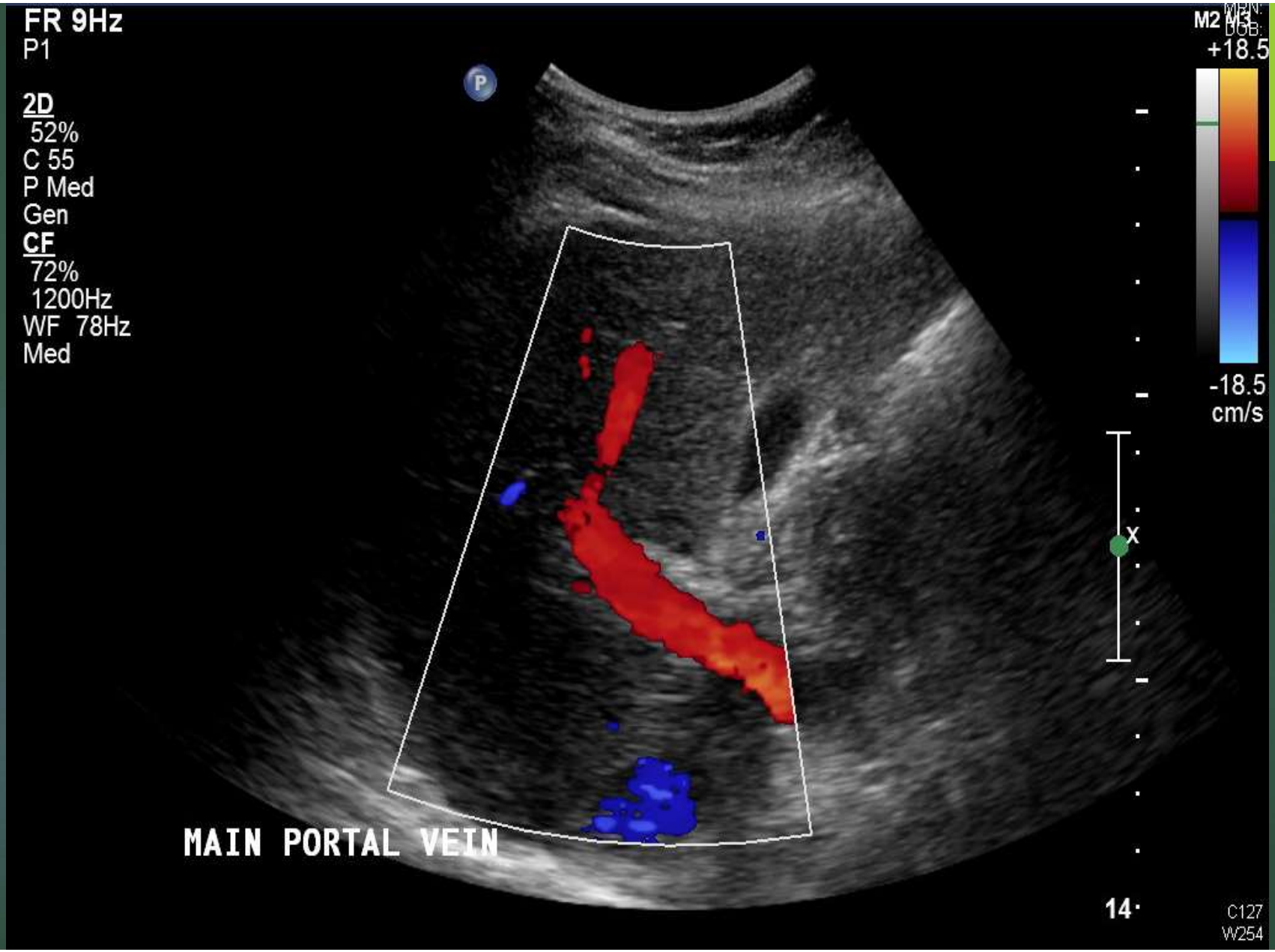
- Sensitive to low flow
- No directional Info
- Poor temporal resolution – susceptible to tx movement
- Not angle dependent

Spectral

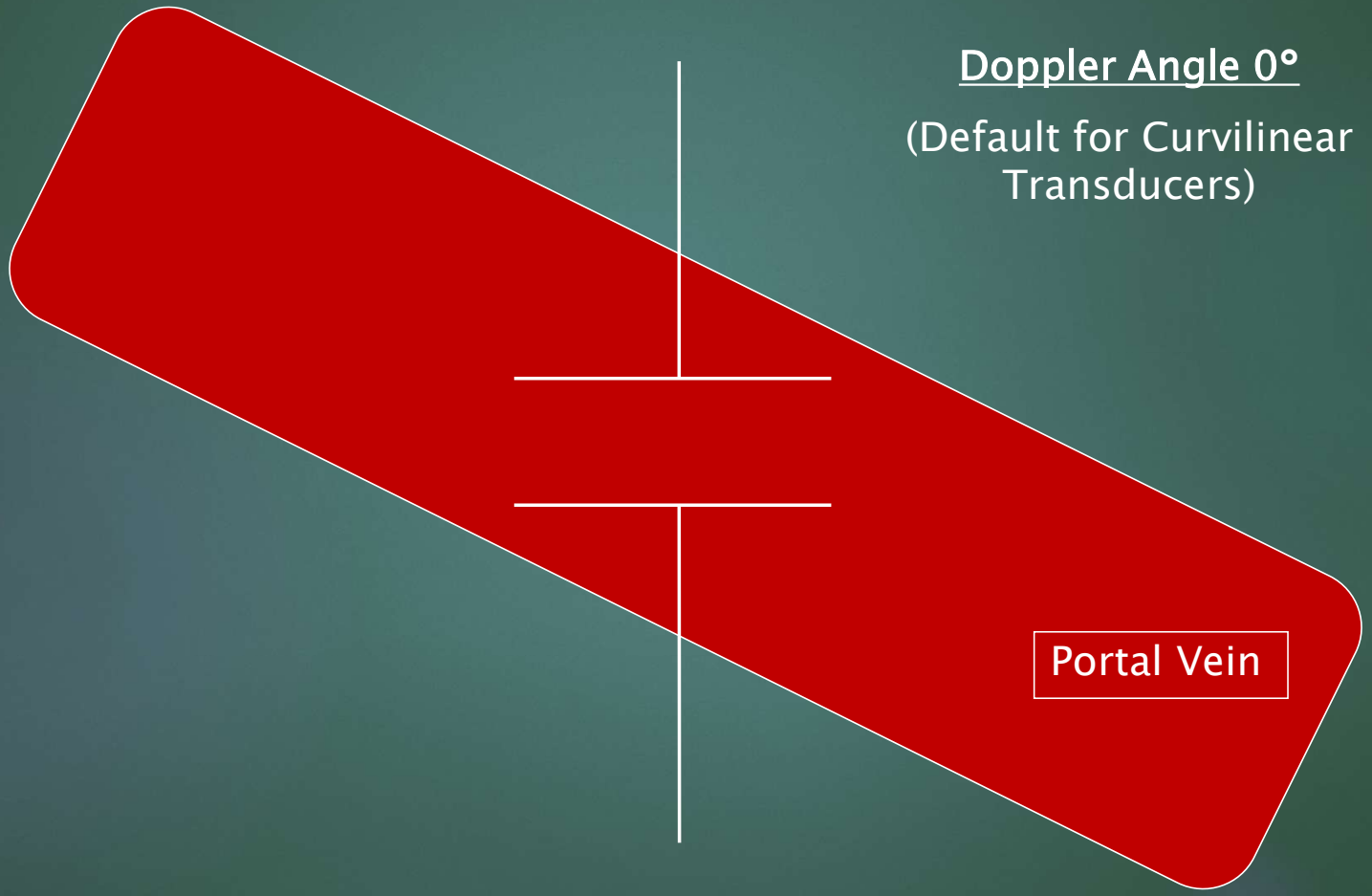
- Flow at one site
- Good temporal resolution – detailed analysis of blood flow
- Subject to aliasing
- Angle dependent
- Limit on max. velocity measured (PRF related)

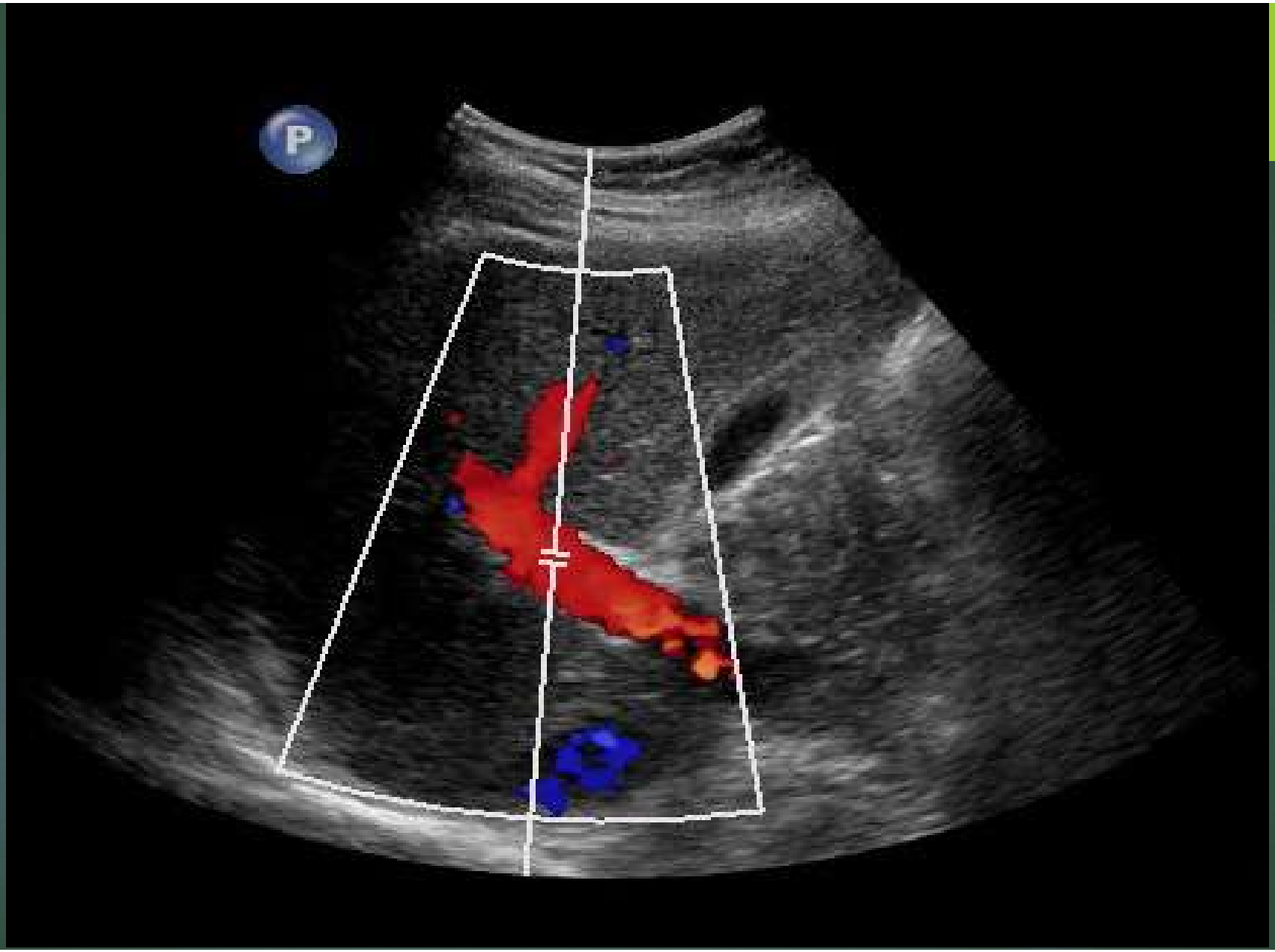
Anatomy of the PV

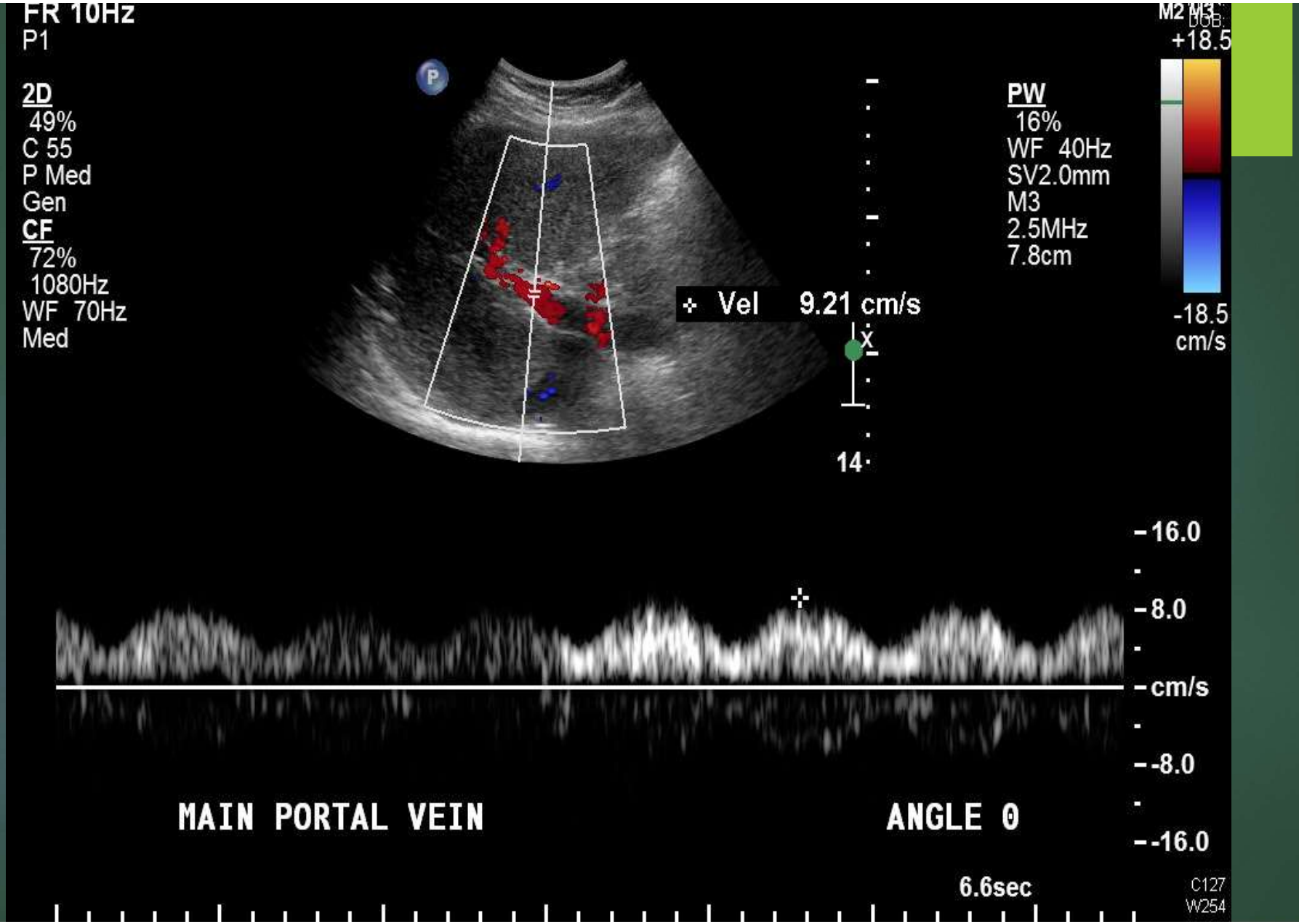
- Normal US appearances
  - Bright, thicker, hyperechoic fibro-fatty wall
  - Bifurcates into right and left branches
  - 10mm diameter (up to a max of 16mm)
  - Increases in size post-prandially; with deep inspiration; with posture changes
  - Monophasic waveform with gentle undulations due to respiratory modulation
  - Velocity >12cm/s
  - Same directional flow as Hepatic Artery


FR 9Hz
P1
2D
52%
C 55
P Med
Gen
CF
72%
1200Hz
WF 78Hz
Med
M2 V3
+18.5
-18.5
cm/s
MAIN PORTAL VEIN
14
C127
W254

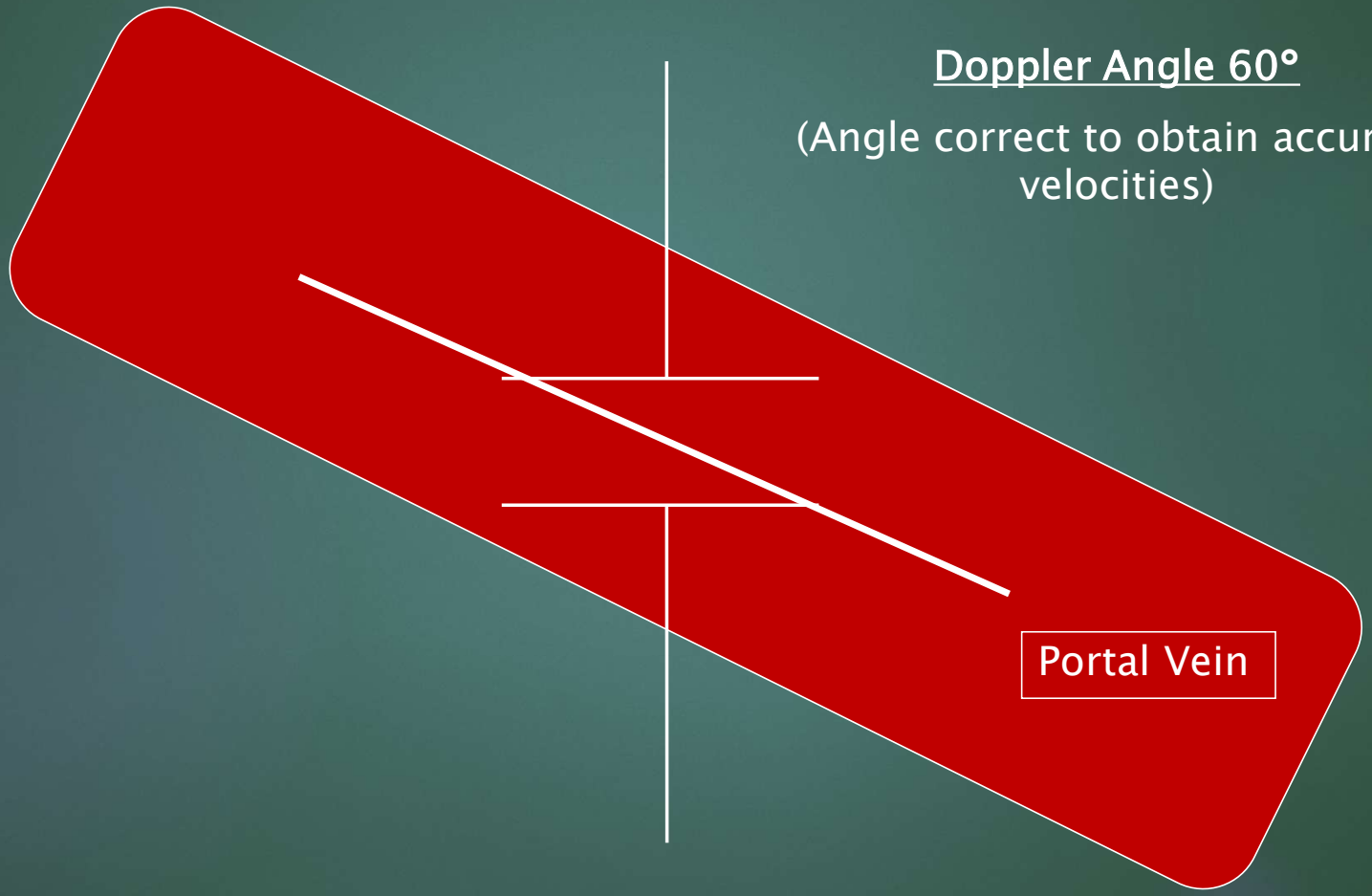
Physics & Haemodynamics 2




P

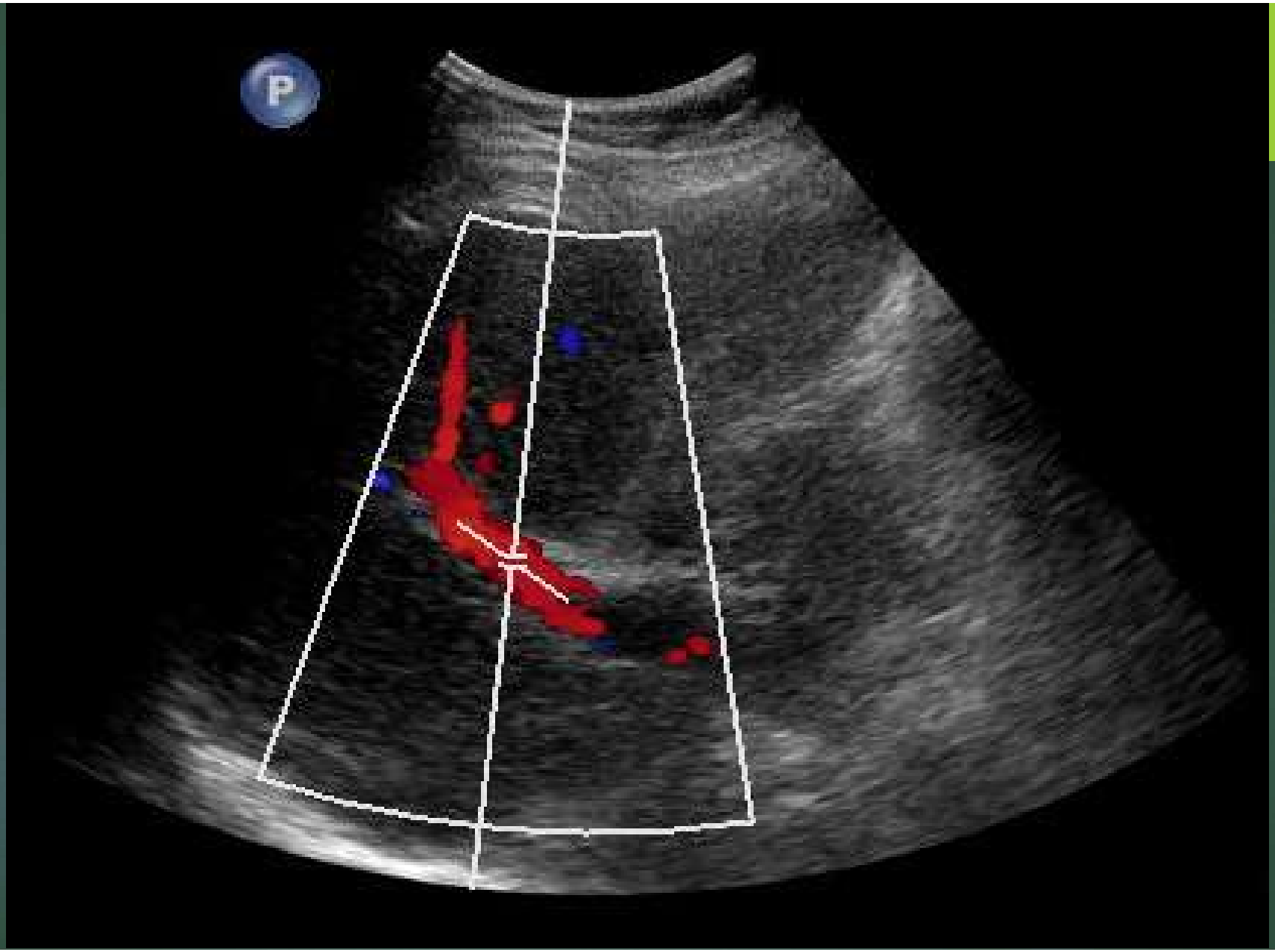

FR 10Hz
P1
2D
49%
C 55
P Med
Gen
CF
72%
1080Hz
WF 70Hz
Med
PW
16%
WF 40Hz
SV2.0mm
M3
2.5MHz
7.8cm
+18.5
-18.5
cm/s
Vel 9.21 cm/s
14
-16.0
-8.0
cm/s
-8.0
-16.0
MAIN PORTAL VEIN
ANGLE 0
6.6sec
C127
W254

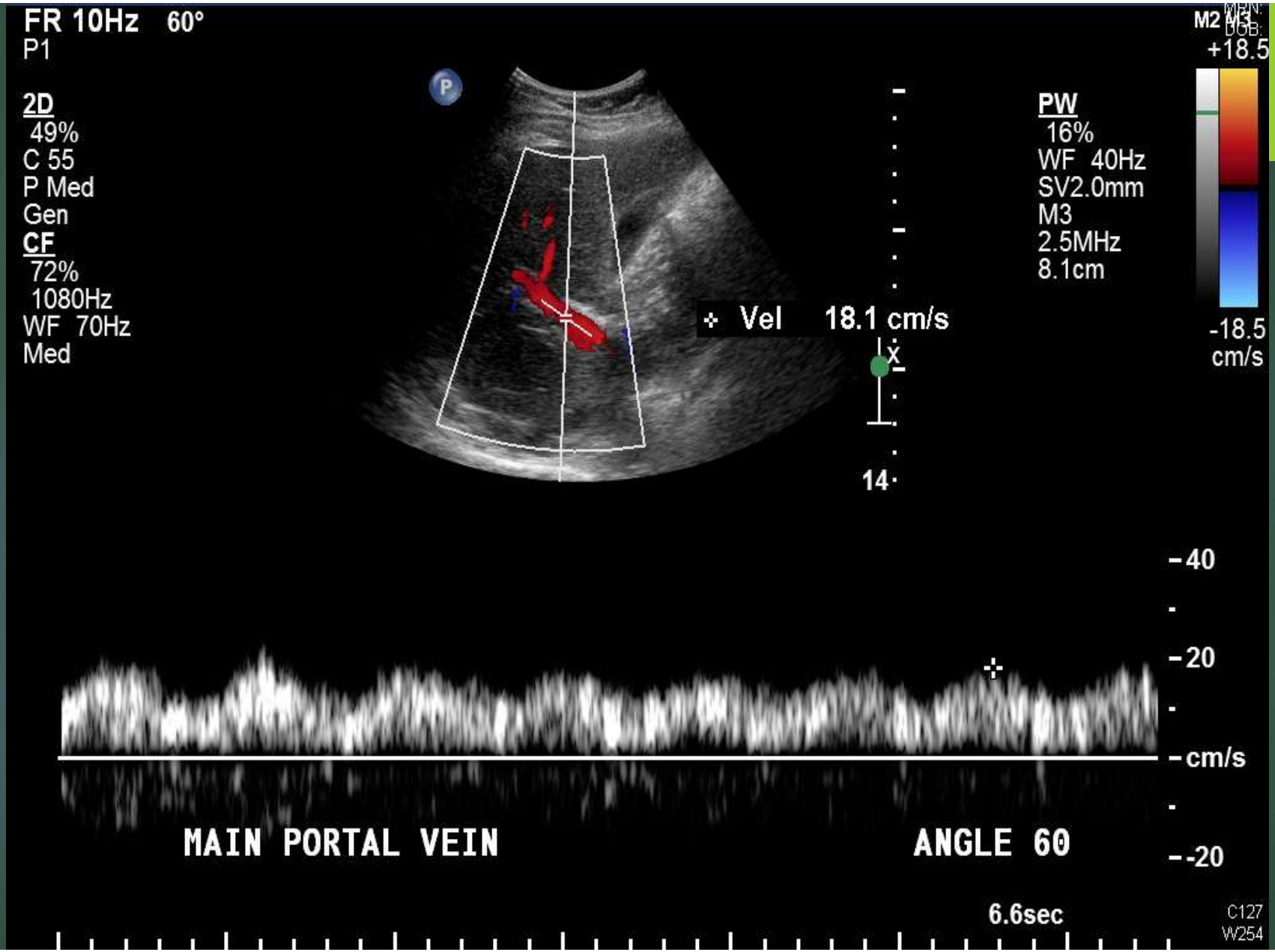
Physics & Haemodynamics 3



Doppler Angle 60°

(Angle correct to obtain accurate velocities)




FR 10Hz 60°
P1
2D
49%
C 55
P Med
Gen
CF
72%
1080Hz
WF 70Hz
Med
Vel 18.1 cm/s
14
PW
16%
WF 40Hz
SV2.0mm
M3
2.5MHz
8.1cm
+18.5
-18.5
cm/s
40
20
cm/s
-20
MAIN PORTAL VEIN
ANGLE 60
6.6sec
C127
W254

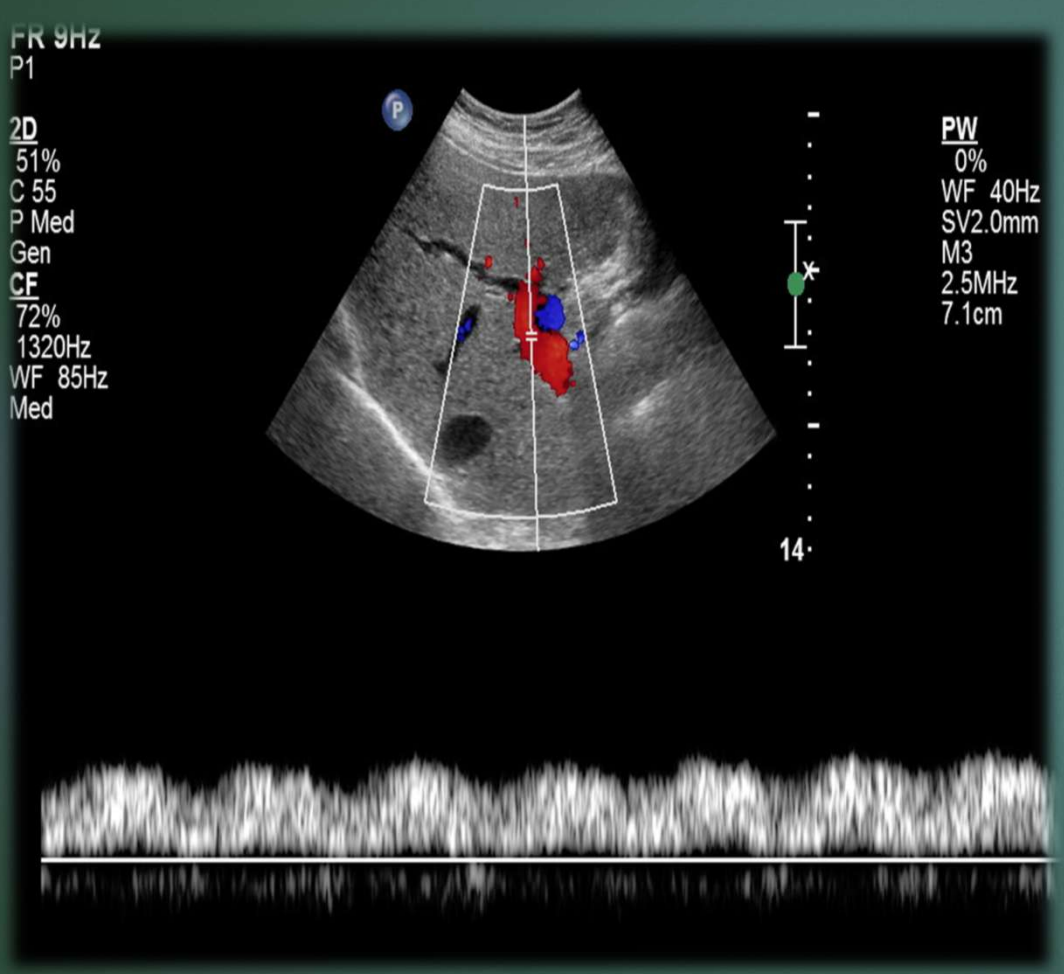
Portal Venous Flow

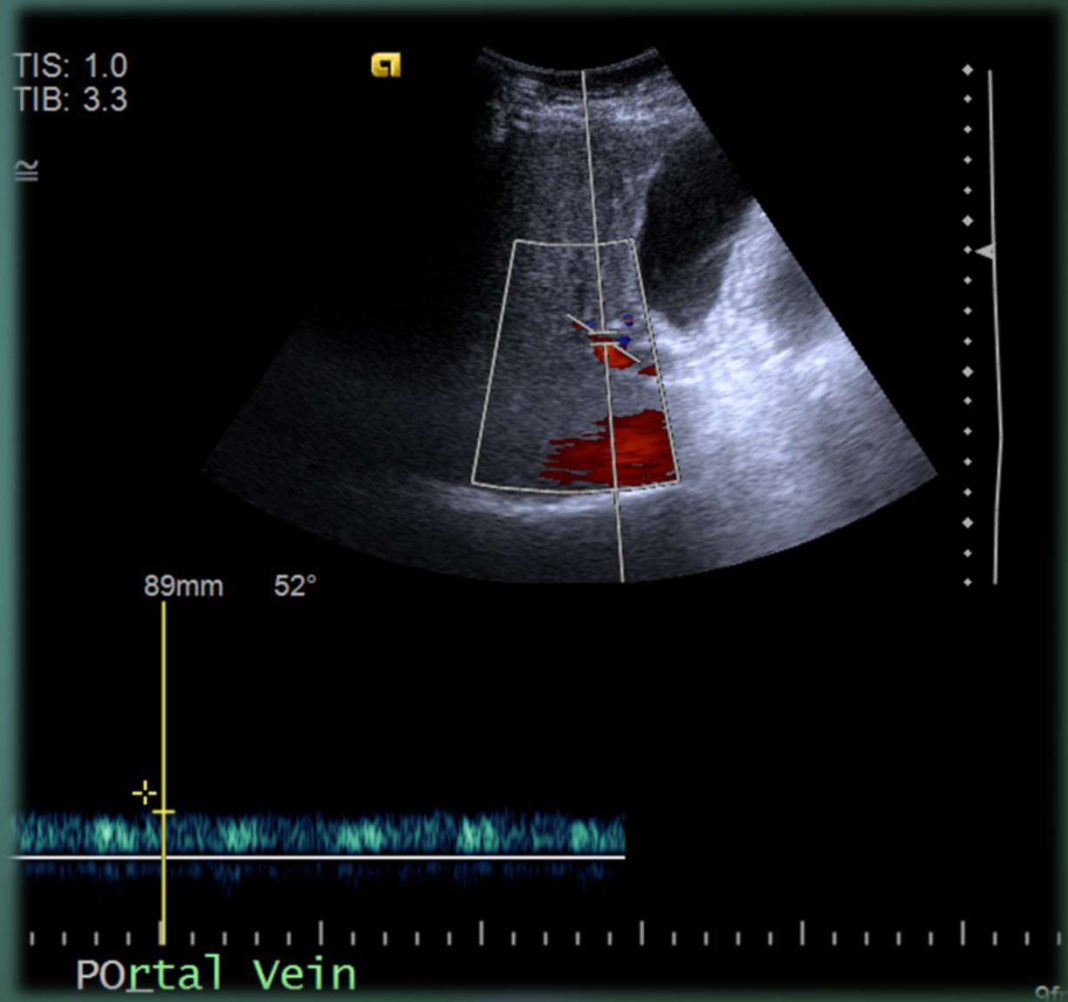
- Normal
  - Hepatopetal
  - Velocity (>12cm/s)
  - Modulates with respiration
  - Dependant on:
    - prandial state
    - Deep/shallow respiration

How to be sure??

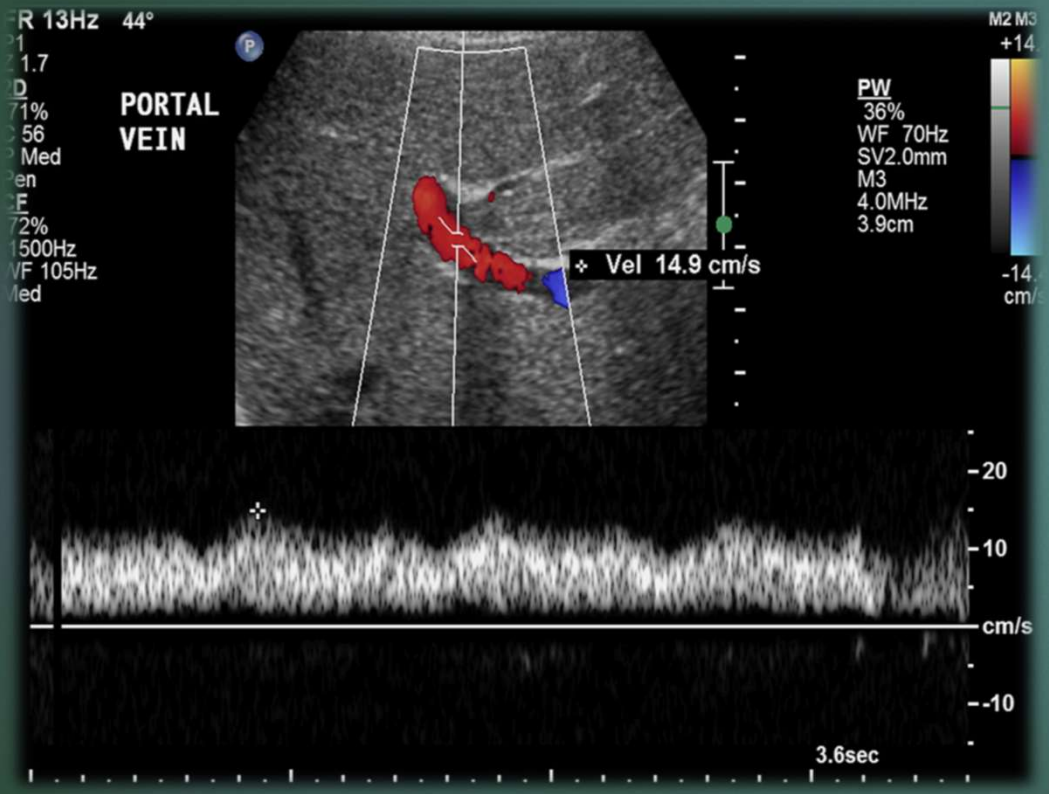
- Hepatofugal flow
  - Check hepatic artery flow direction
  - Set spectral Doppler gate to pick up both vessels
- PV thrombosis
  - Angle of insonation
  - PRF & gain
  - Power Doppler
  - US contrast

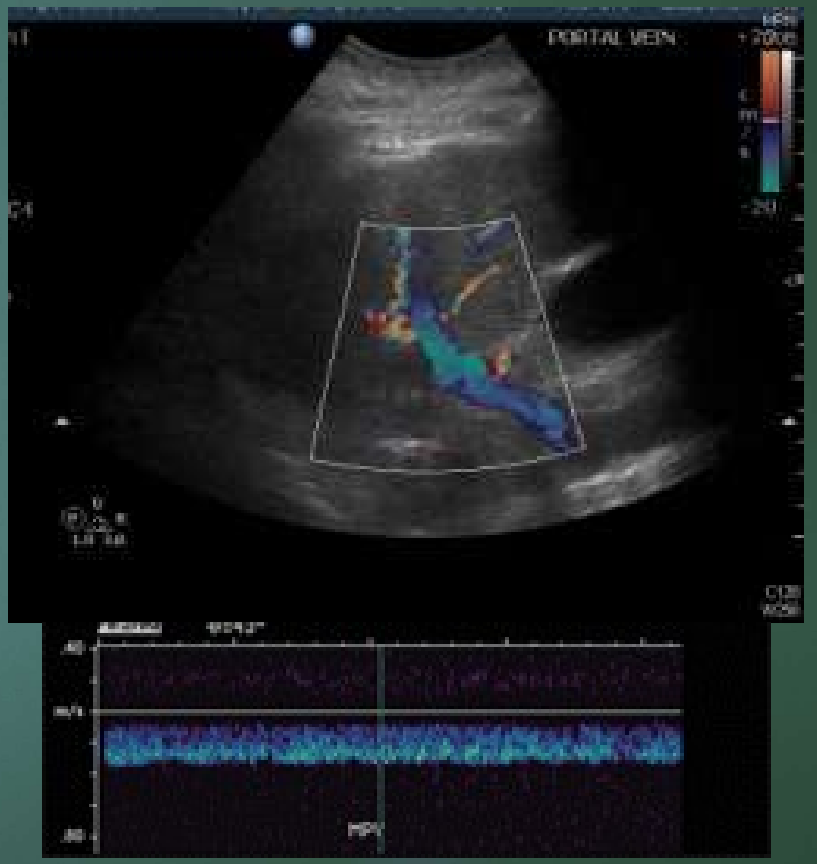
Changes to PV spectral Doppler





Hepatopetal / Hepatofugal



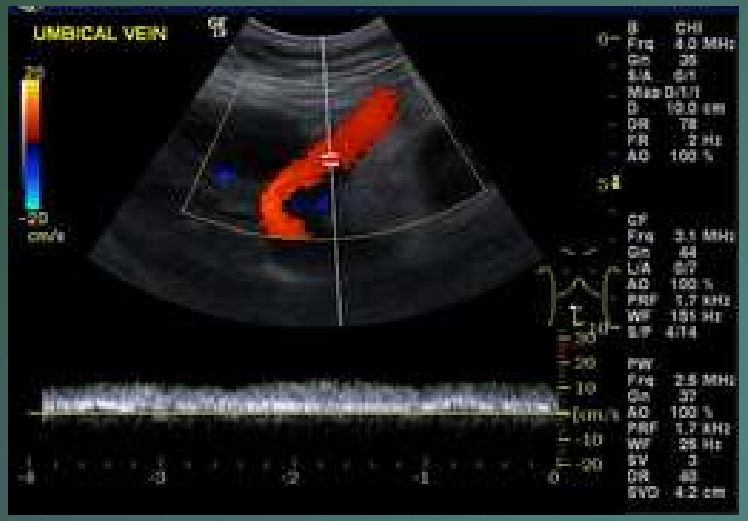


Thrombosis

Common Causes:

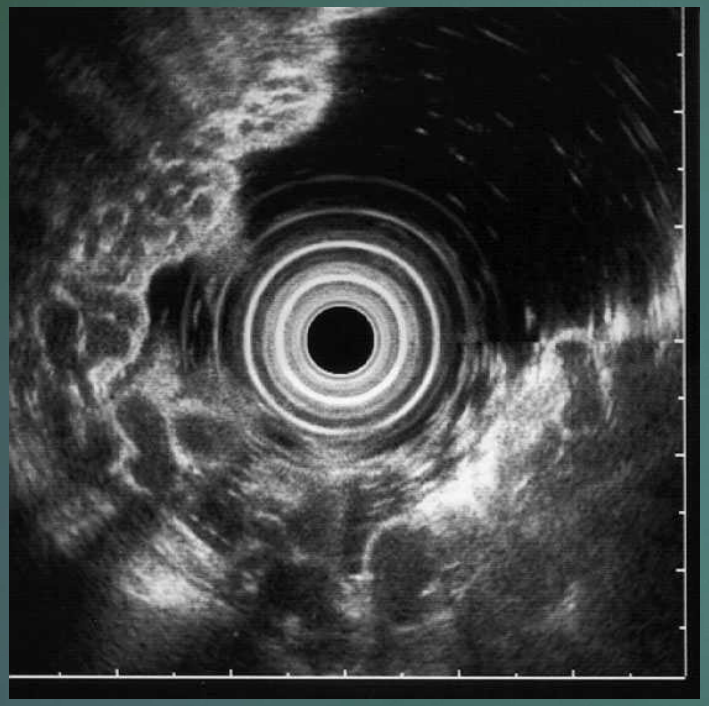
- Splenectomy
- Pancreatitis
- Diverticulitis
- Cirrhosis

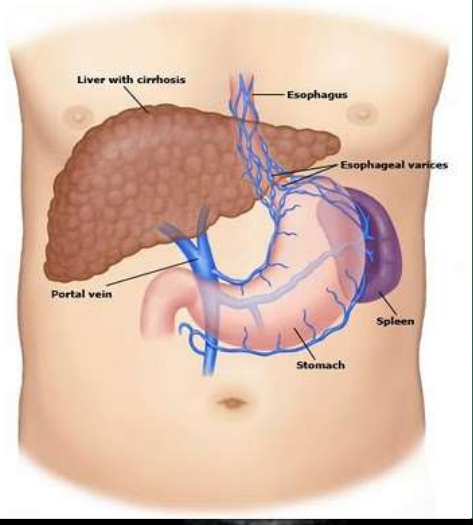
Umbilical Vein Recanalisation

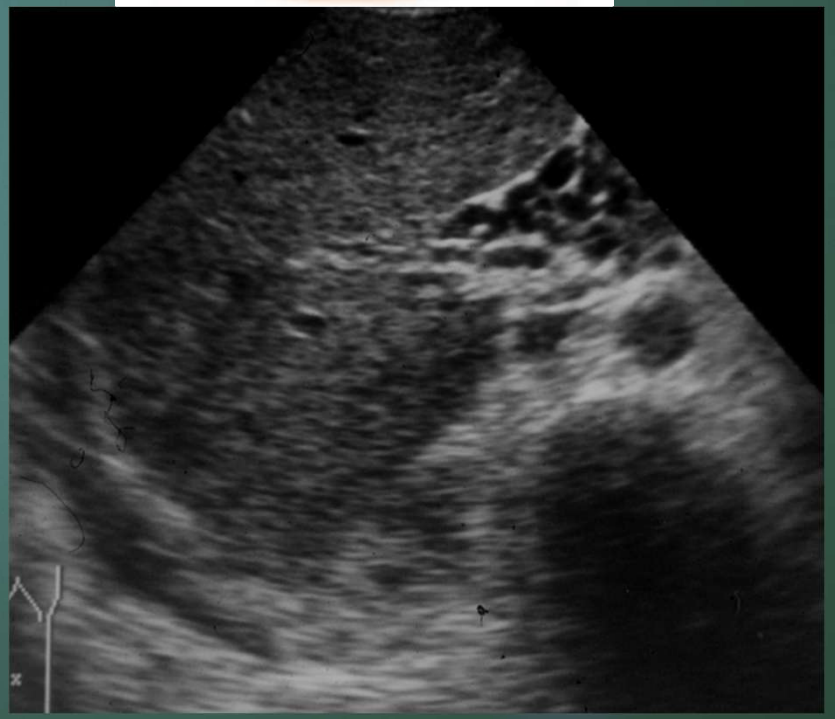


Pressure builds up due to scar tissue in and around the liver which can cause the closed round ligament to reopen

Varicies

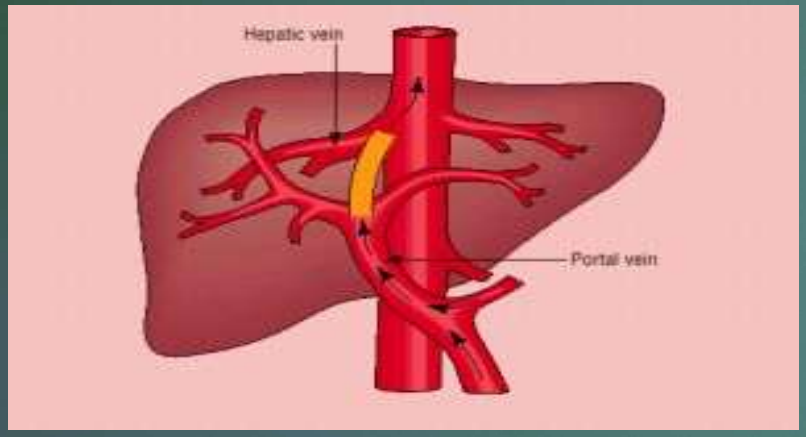



Liver with cirrhosis
Esophagus
Esophageal varices
Portal vein
Spleen
Stomach

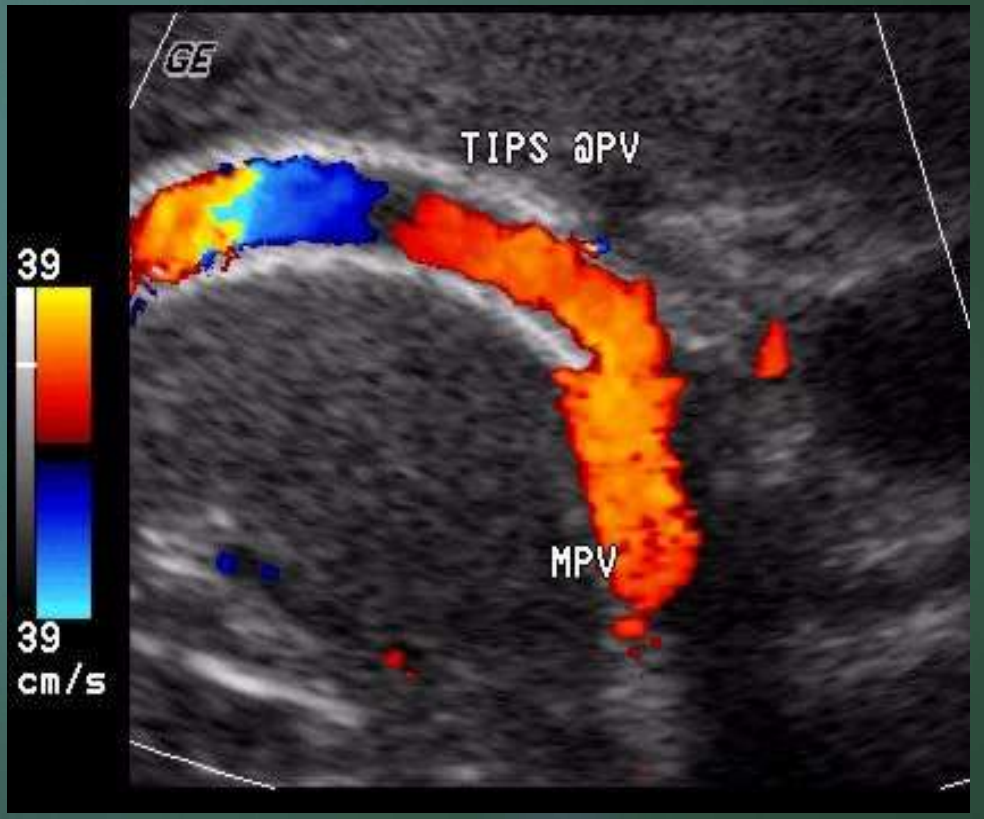


Management of Portal Hypertension

TIPS (transjugular intrahepatic portosystemic shunt)



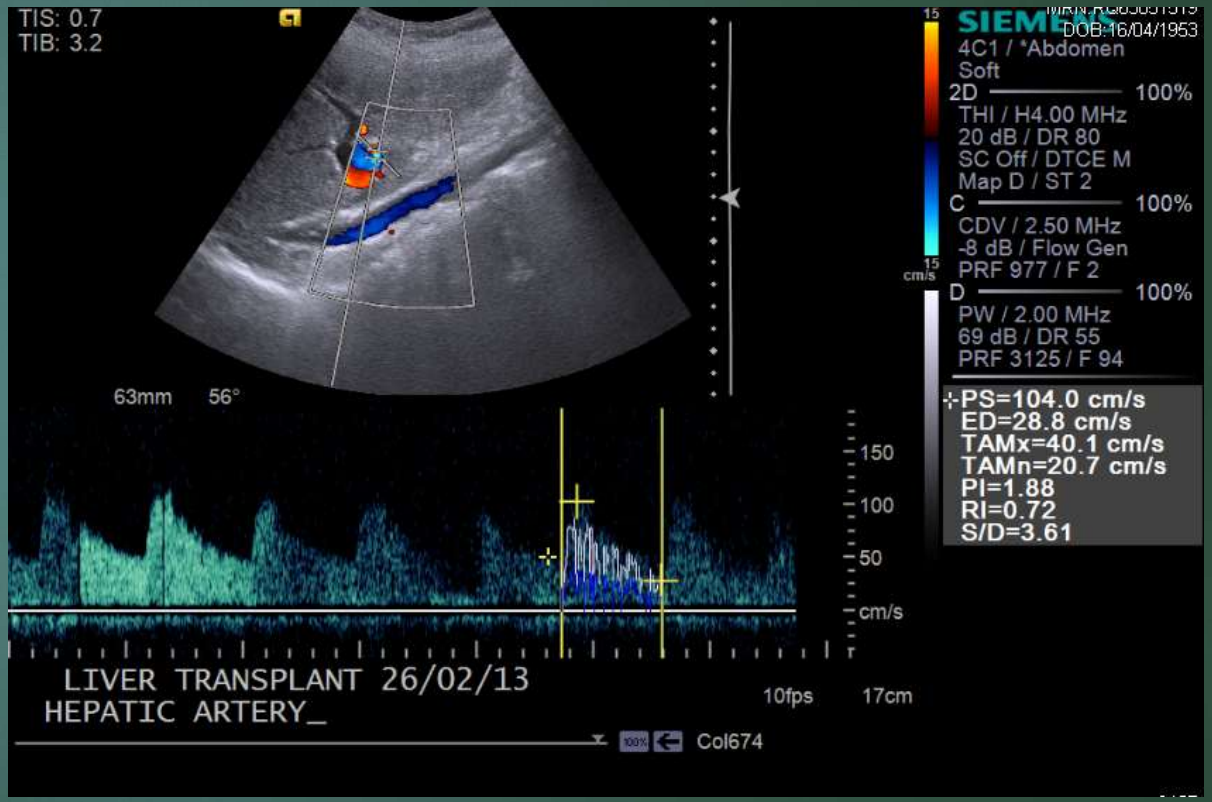
- Check Patency
  - 90-190cm/s
- Check flow direction



Hepatic Artery

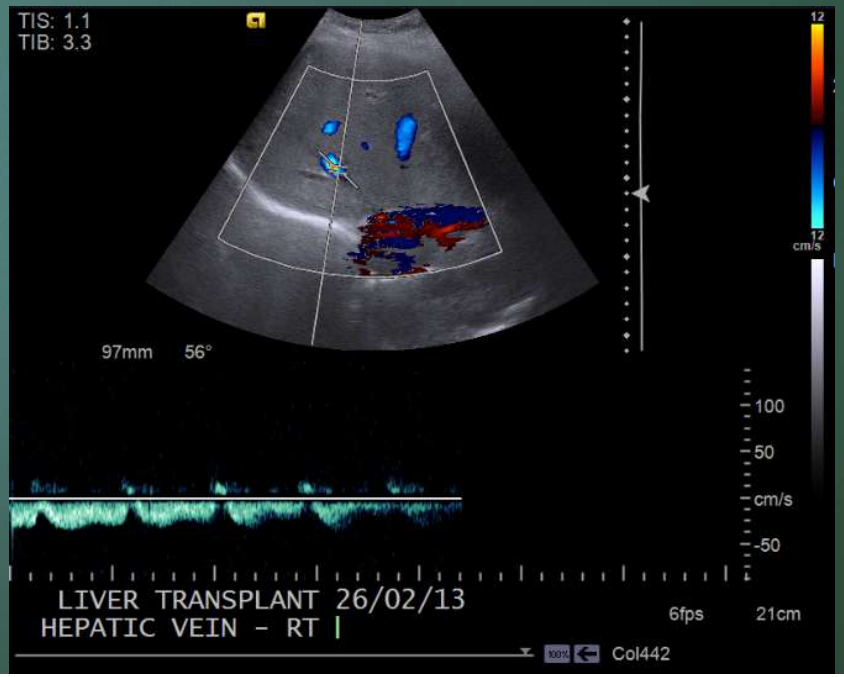
- Arises from the coeliac axis
- Supplies GB (via cystic artery) and liver
- 30% of blood flow into liver
- 90% of oxygenated blood

- It supplies the disease process



Hepatic Veins

- Left, middle, right branches
- Assess patency in most cases
- Waveforms can show non-liver related issues:
  - AF; cardiac dysfunction; mechanical respiration)
- Budd-Chiari syndrome
- US most sensitive test



Thanks for Listening

Any Questions?