Abdomen Vascular Doppler exam

ALPINION MEDICAL SYSTEMS

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1) Abdominal Aorta
2) Iliac and Femoral Artery
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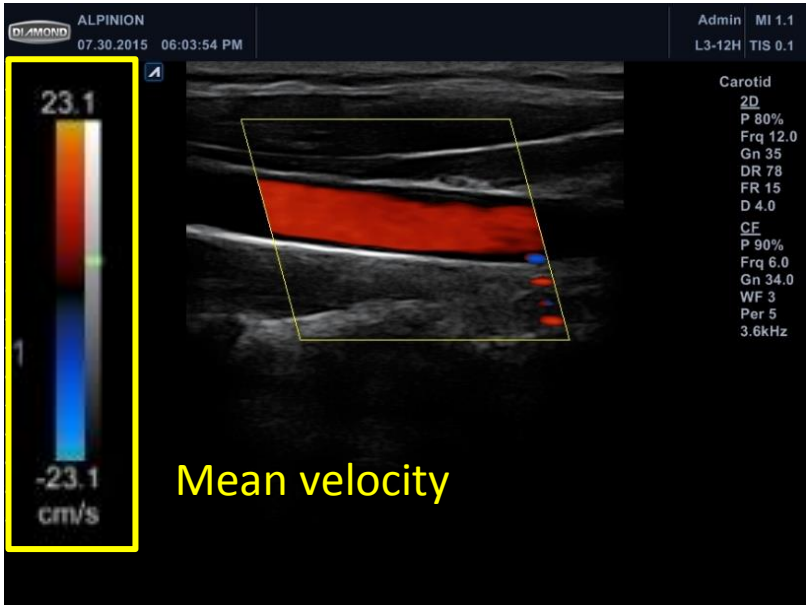
Goals for performing vascular exams

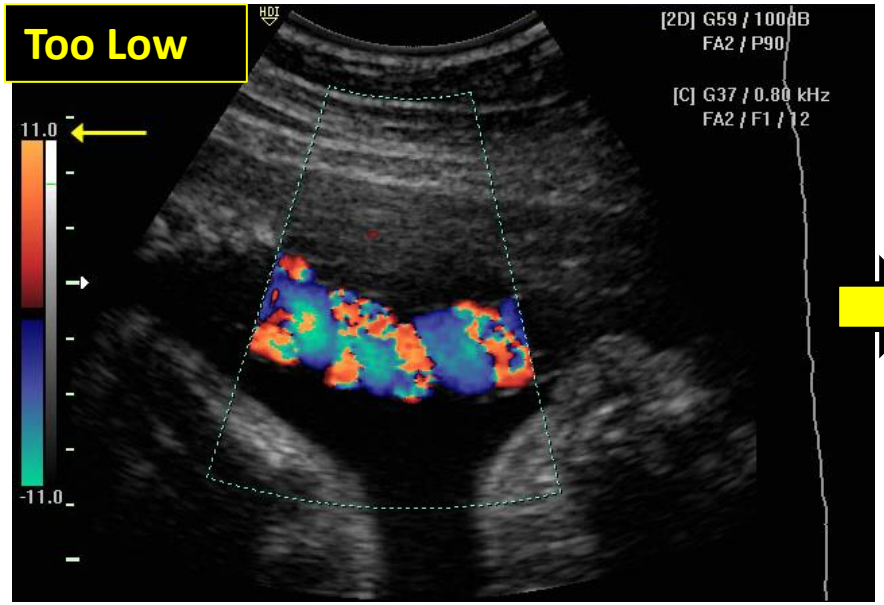
- The presence of blockages to blood flow or narrowing of vessels (i.g. arterial stenosis or venous thrombosis)
- Less than normal or absent blood flow to various organs
- Greater than normal blood flow in infections
- The presence of increased vascular resistance
- Identification of abdominal artery aneurysm and documentation of size and location

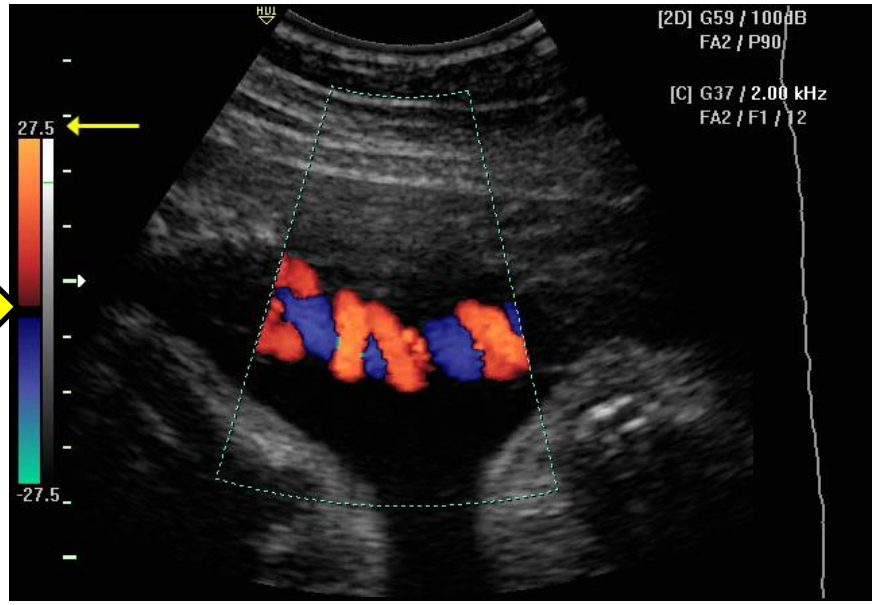
Color Flow vs. Spectral Doppler

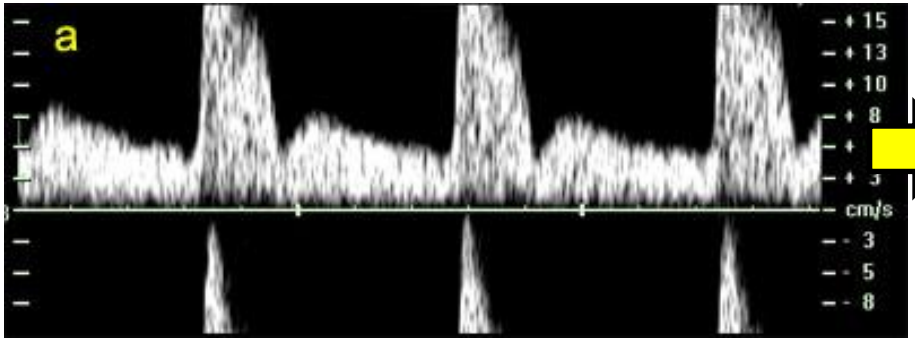
Color Flow	Spectral Doppler
• Overall view of flow • Direction information • Mean velocity • Turbulent flow	• Examine flow at one site • Detail flow information • Peak velocity • various index (RI, PI, AT..)

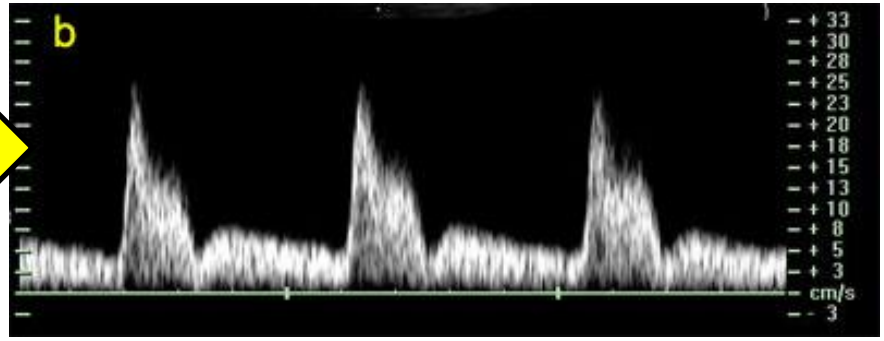


Aliasing artifact

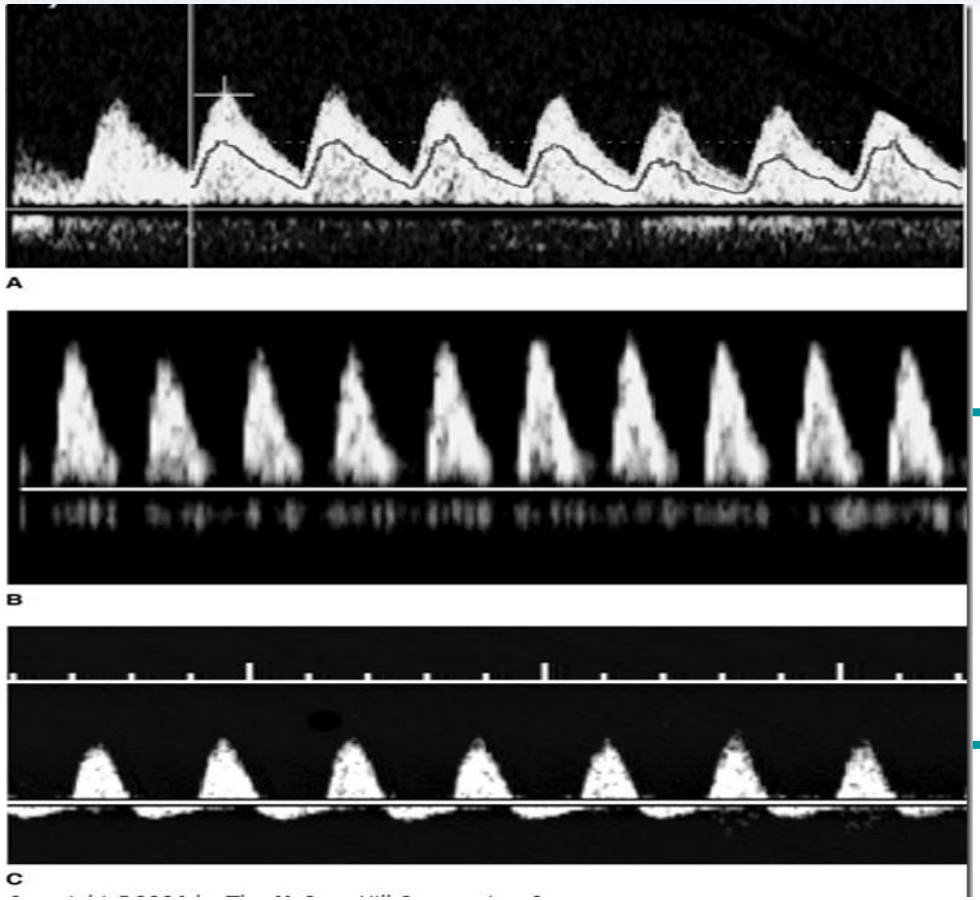








Low vs. High Resistance spectrum



Low Resistance waveform
- Good Diastolic flow

High Resistance waveform
- Poor Diastolic flow
- Flow Reversal in end-diastolic

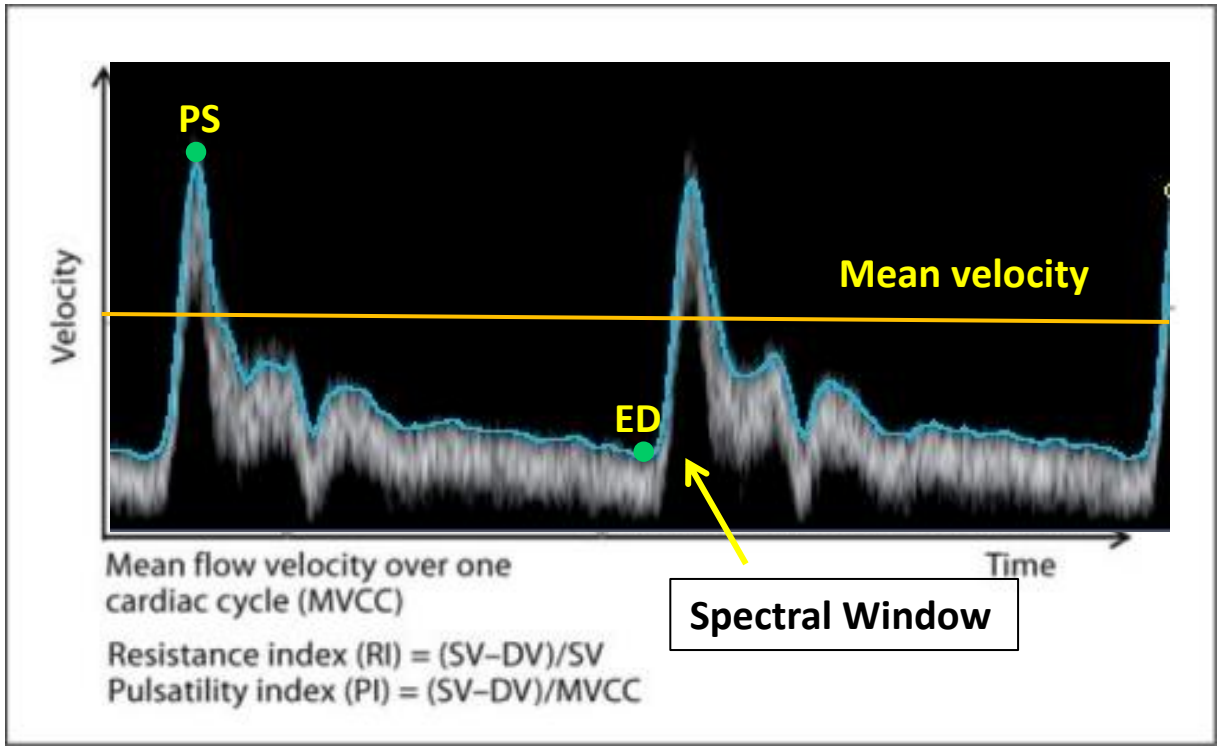
A. **Normal diastolic flow**

B. **Absence of end-diastolic flow**

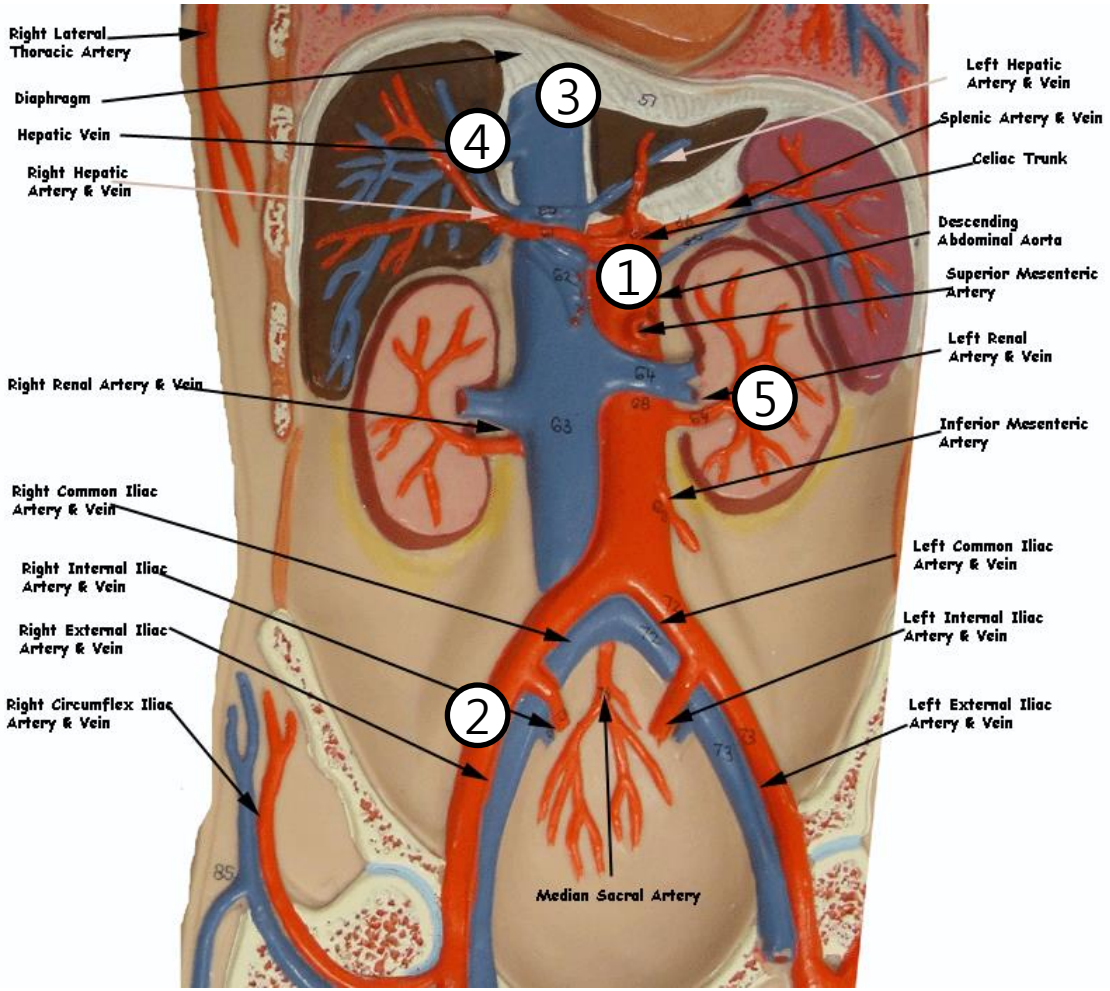
C. **Reversed end-diastolic flow**

Indices of Measurement

- PSV: Peak systolic Velocity
- EDV: End diastolic Velocity
- RI (Resistive Index) = (PS-ED)/PS
- PI (Pulsatility Index) = (PS-EC)/MV

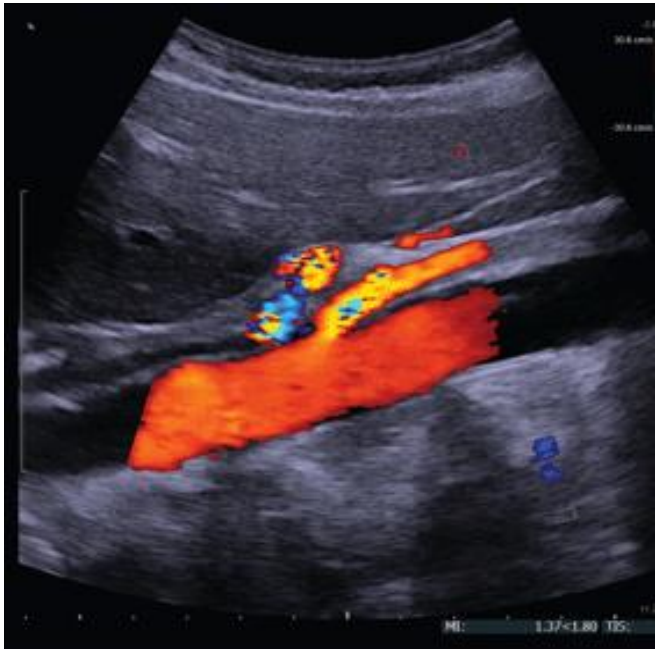


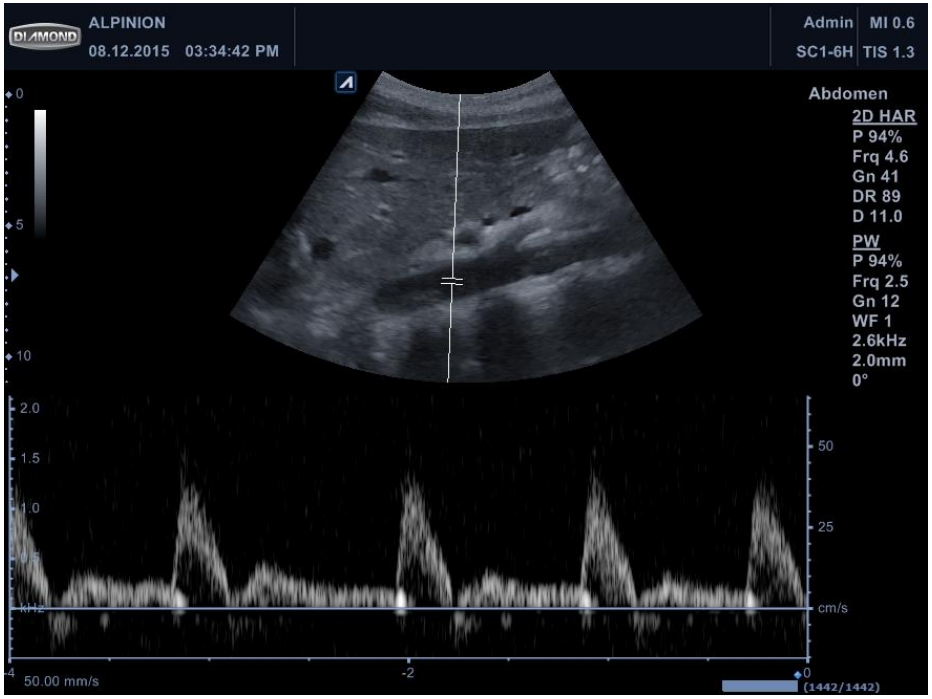
Doppler Study



1. Abdominal Aorta
2. Iliac & Femoral Artery
3. IVC/Hepatic Veins
4. Portal Veins
5. Renal parenchymal study

1) Abdominal Aorta



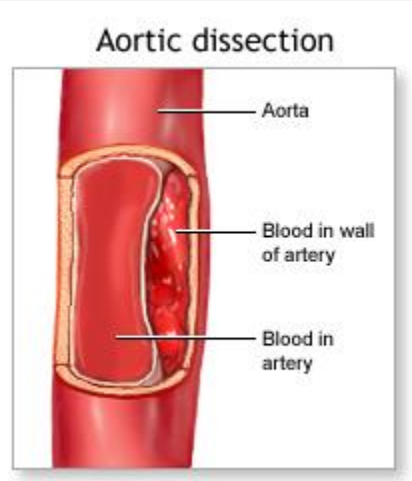


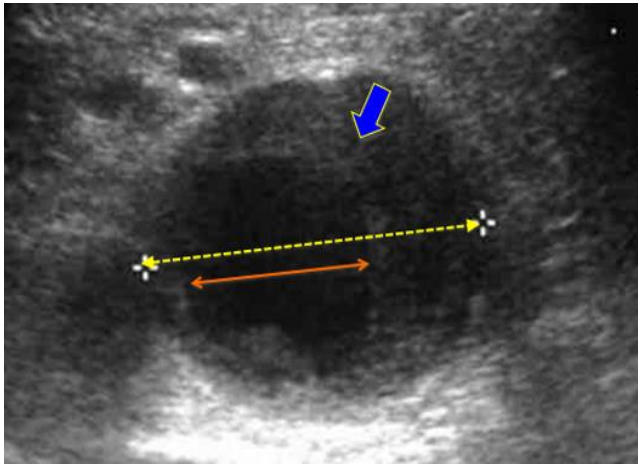
- **Clean spectral window**
- **Different waveform : Proximal AA / Distal AA**
- **Occlusive disease may change resistance and waveform**

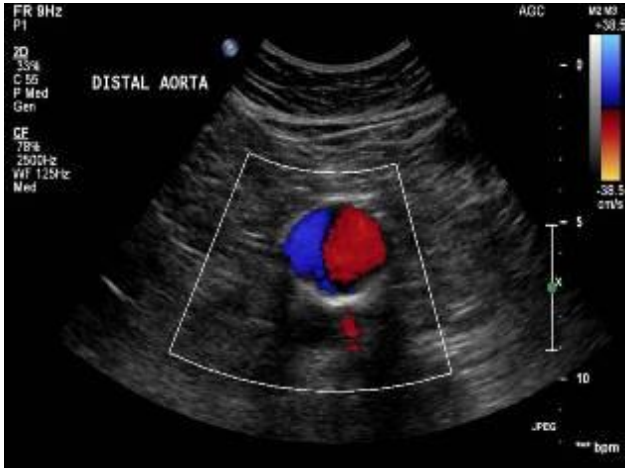
Proximal AA	Distal AA
• Above Renal Artery • Biphasic • Low resistance to organs	• Below Renal Artery • Triphasic • Supply lower extremities (High resistance)

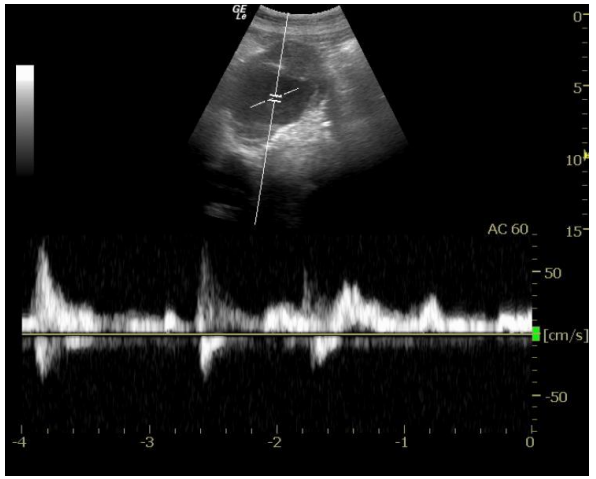
1) Abdominal Aorta – Aneurysm

- Enlarged vessel > 3cm
- Thrombus accumulation causes increased echogenicity in the lumen
- Measure true vessel size, outer – outer
- Turbulence flow seen in Color
- Both direction during systolic in PW Doppler



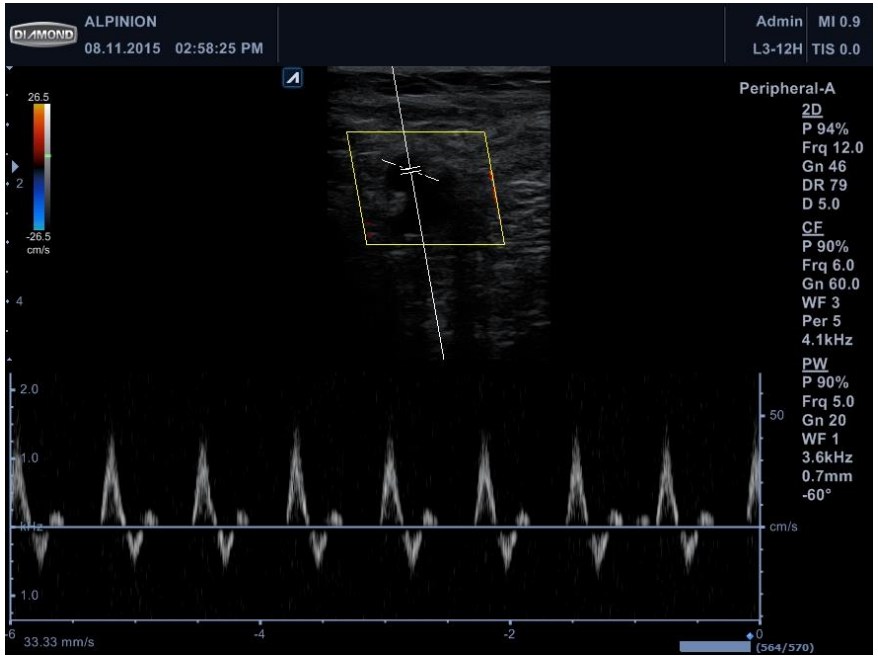






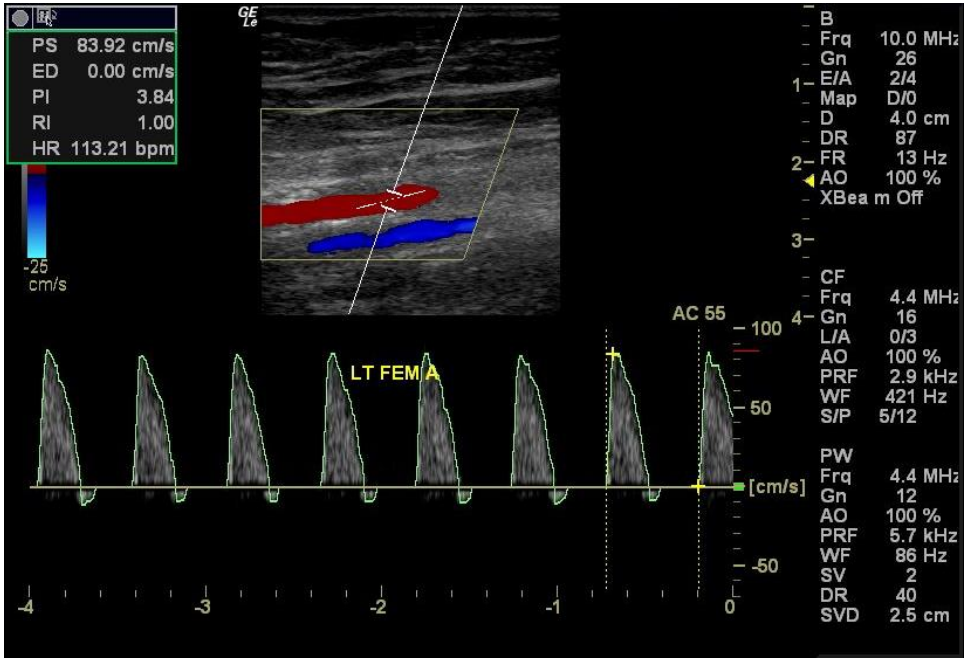
2) Iliac and Femoral Artery

Normal Doppler



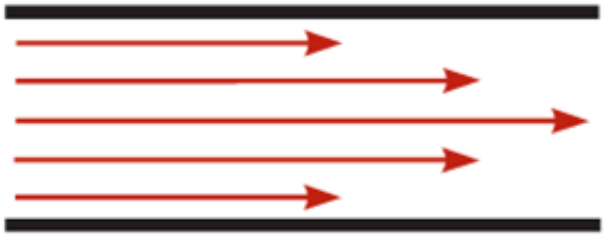
- Clean spectral window
- High resistance waveform with a reverse diastolic flow
- Occlusive disease may change resistance and waveform

Femoral Artery Stenosis



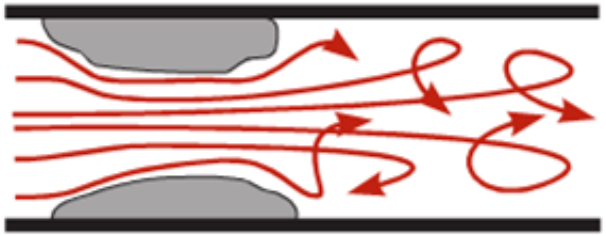
- Turbulent flow
- Spectral Broadening
- High peak velocity

Spectral Broadening

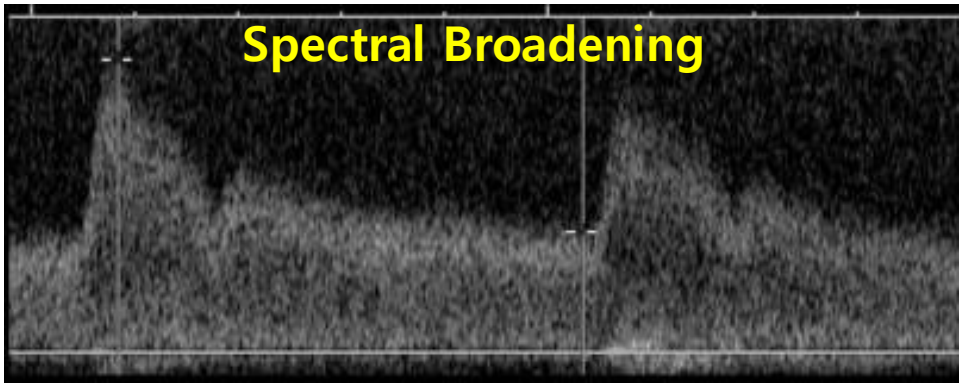


Laminar Flow

- Immediately after stenosis

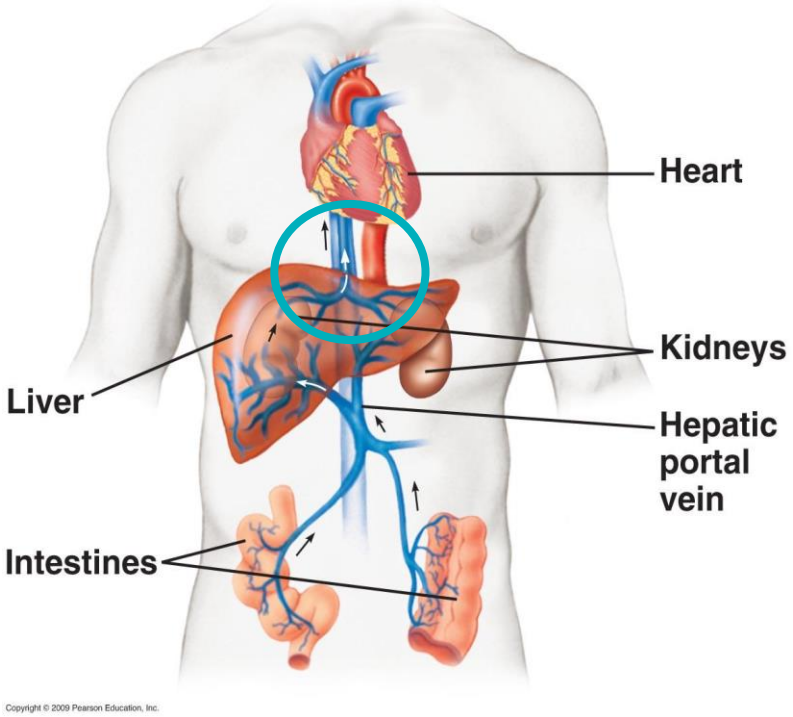


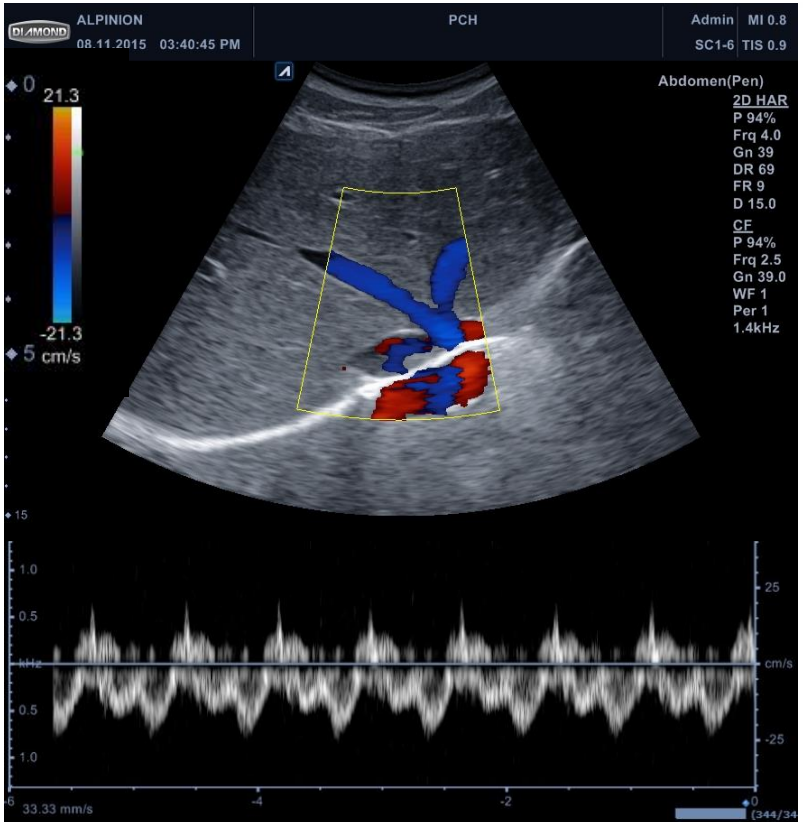
Turbulent Flow



- Fill – in of the spectral window
- Wide range of velocities
- Normal in small vessels (Renal artery, hepatic artery …)
- Other factors can cause the pseudo-spectral broadening.

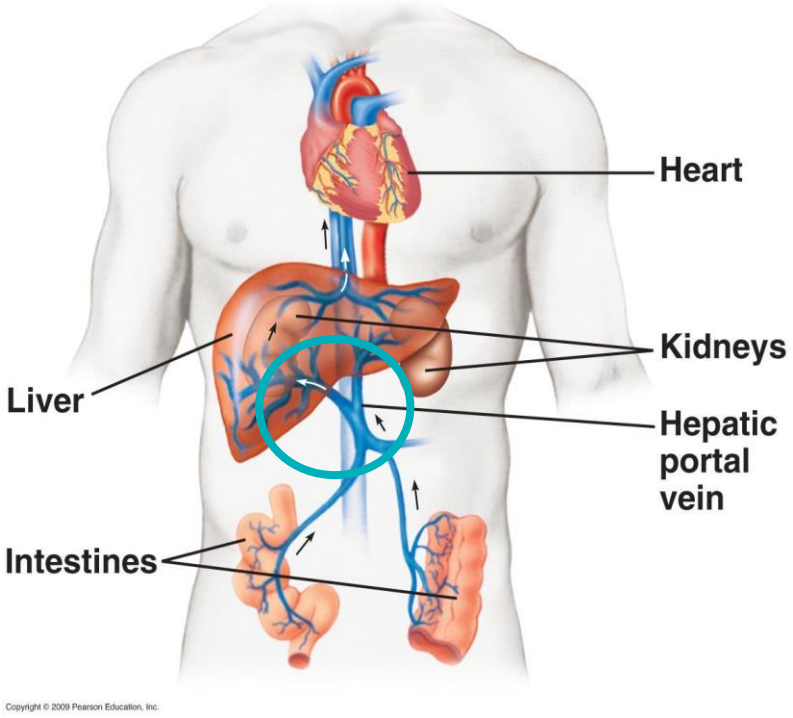
3) IVC / Hepatic Veins

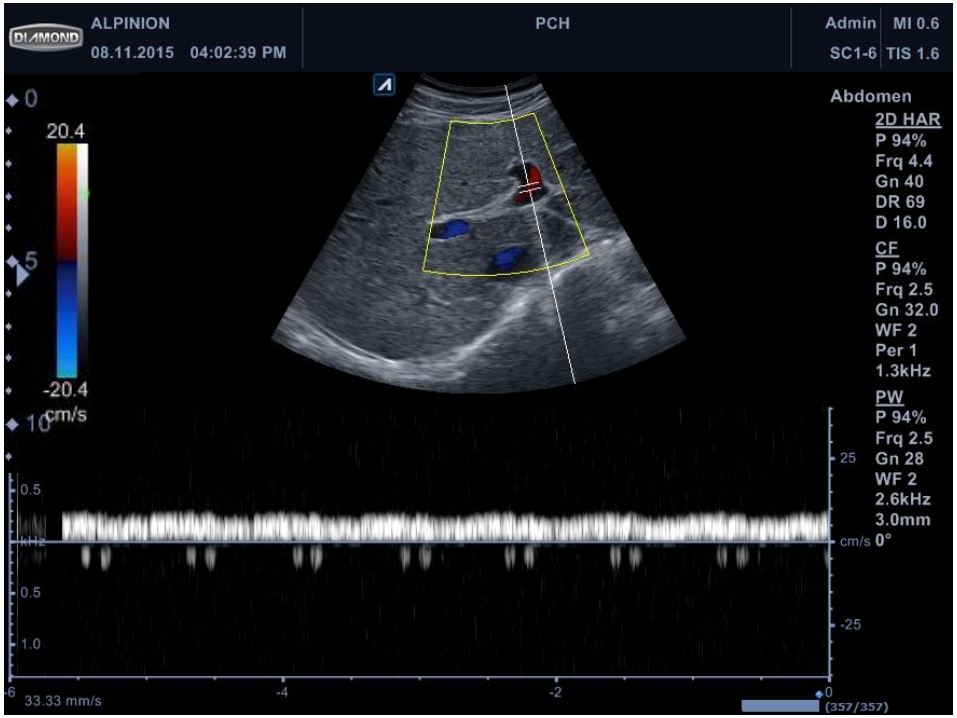




- **Hepatic veins flow toward IVC and heart**
- **Away from transducer – normally, Blue**
- **Characteristic pulsatile flow (12~25cm/s)**
- **Two antegrade flow toward the heart**
- **One retrograde flow toward the liver**

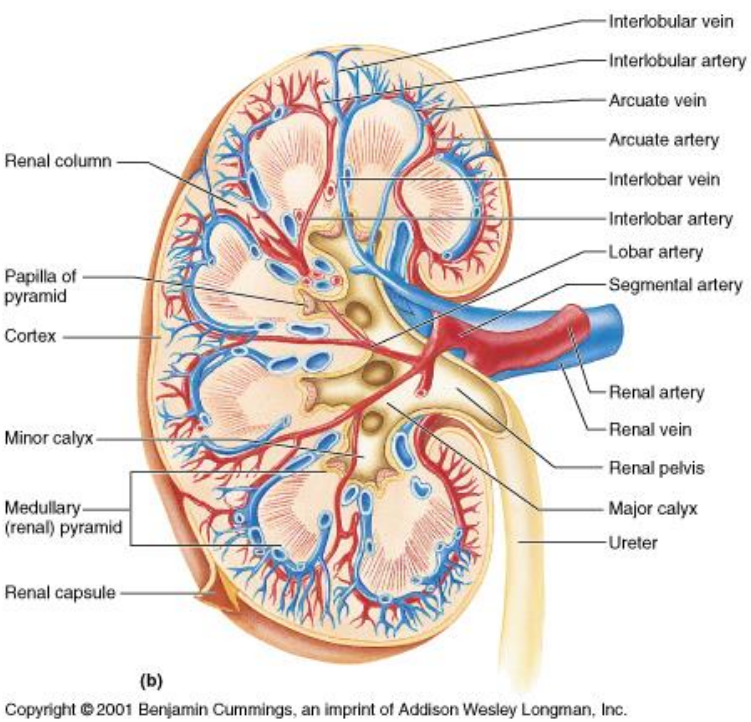
4) Portal Veins

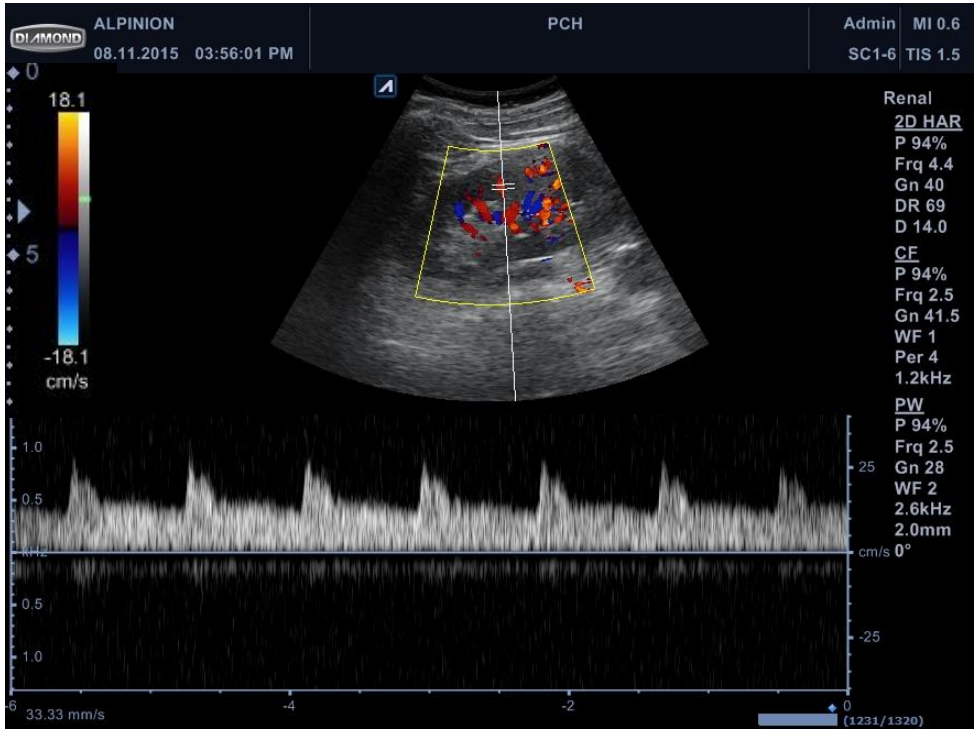




- Continuous flow toward the liver
- Toward the transducer – normally, Red
- Low velocity (20~28cm/s)
- Reflect Respiratory or Cardiac variation

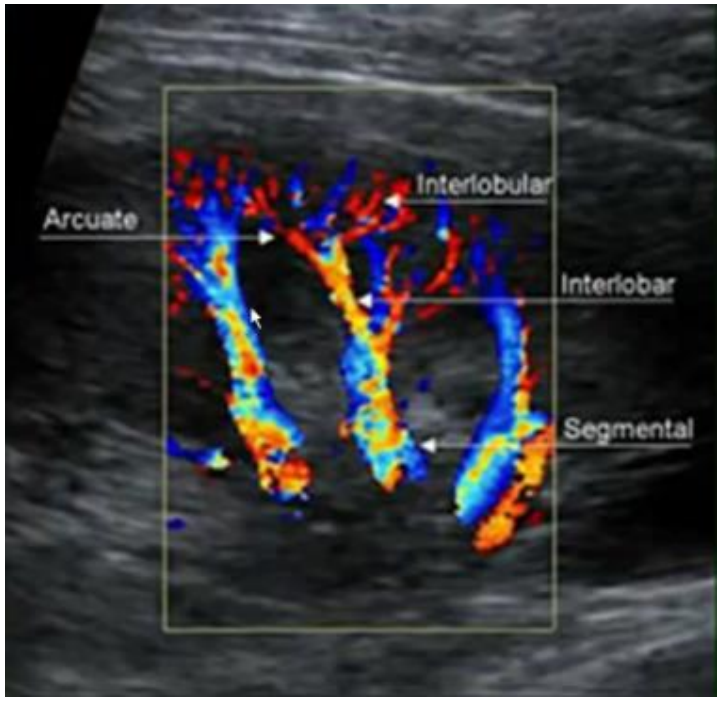
5) Renal Parenchymal Doppler





- **Color Doppler – the perfusion to the edge of the renal cortex**
- **Low velocities (14~18cm/s)**
- **Normal Spectral broadening & low resistance waveform**
- **Resistive index – measured at the interlobar / interlobular arteries**

Color Doppler vs. Power Doppler



Color Doppler	Power Doppler
Presence & Direction	Presence of blood flow
Less sensitivity	More sensitivity

Directional Power Doppler

- Power Doppler + Direction information
- More sensitive than CF mode image
- Change the Color map to number 8, 9

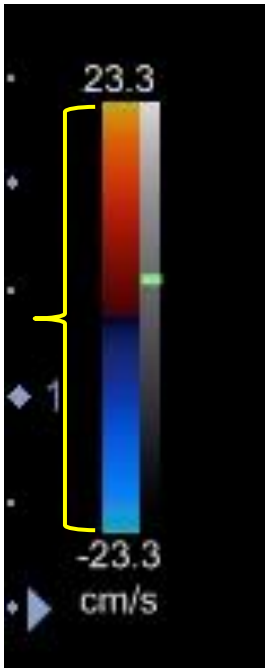
Guidelines for optimal Doppler examination

- Adjust gain & filter
- Adjust velocity scale
- Doppler angle < 60 by angle steering & probe position
- Color box as small & superficial as possible
- Sample volume size: 2/3 of vessel width in the center

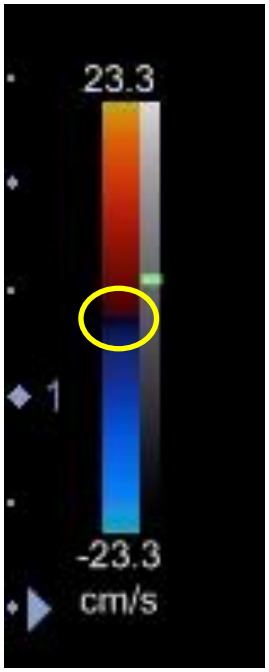
Color Doppler Parameter

Parameter	Image effect
Scale (kHz)	= PRF • For detection of **higher** flow velocities, increase the scale velocity • For detection of **slower** flow velocities, decrease the scale velocity
Threshold	= Balance Threshold assigns the grayscale level where color information stops Lowering the threshold displays more grayscale and less color
Color box size	Wider color box reduces the frame rate
Angle Steer	To obtain a good CF image, color box angle should be steered
Ensemble	= sensitivity Higher ensemble helps to detect the color signal more rapidly and sensitively
Smooth	Lower smooth level makes the pixel size smaller
Persist	The time for displaying color lasts with higher persist
WF (Wall Filter)	Filter out clutter signals caused from vessel movement

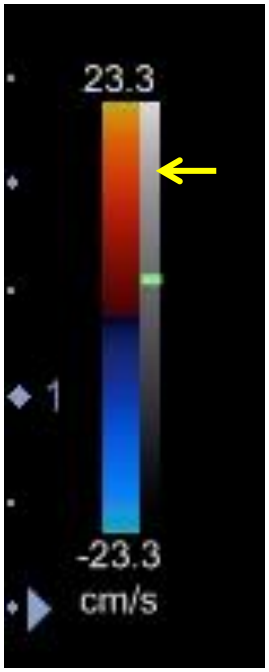
Color map



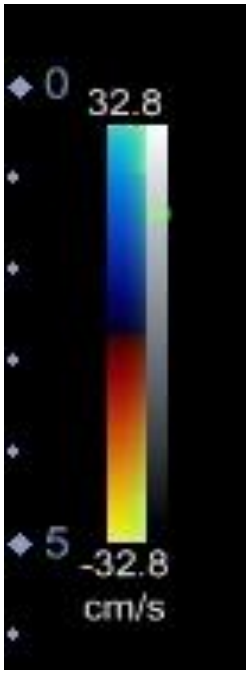
Mean Velocity range (cm/sec)



Baseline Wall filter



Threshold = Color write priority

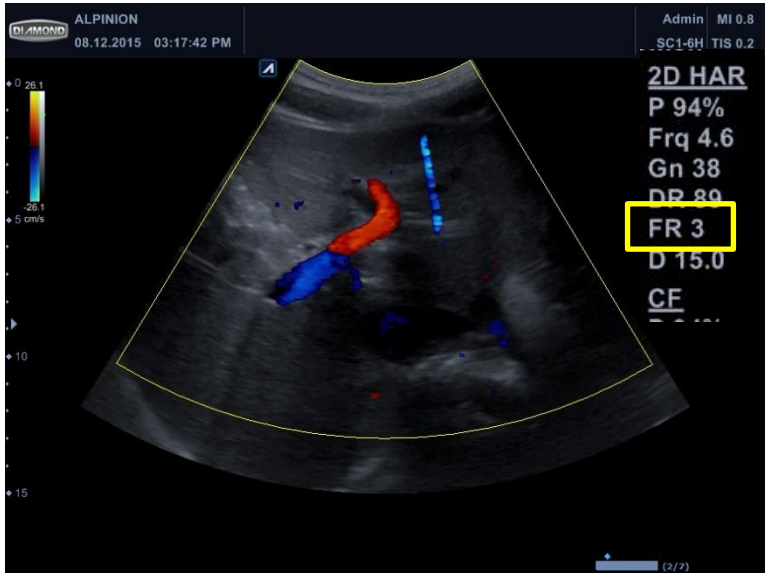


Inversion Color map

Color Parameter - Box Size & Angle Steer

1) Color box size

Oversized color box
Frame rate↑, Resolution↓

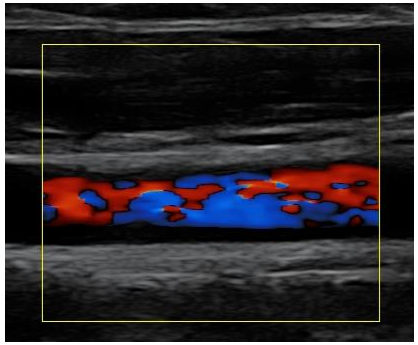


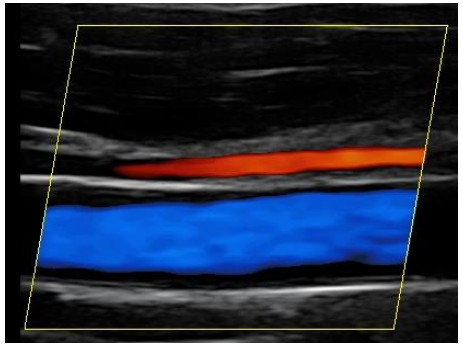
Color box should be as small & superficial as possible

2) Color box steering

Perpendicular
Poor image

Angle steer
Direction of flow
Good image

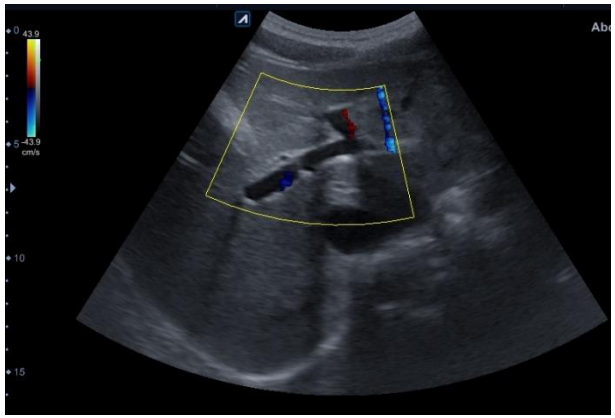


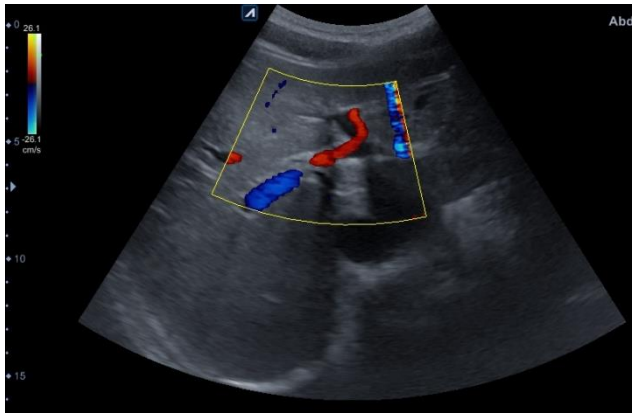


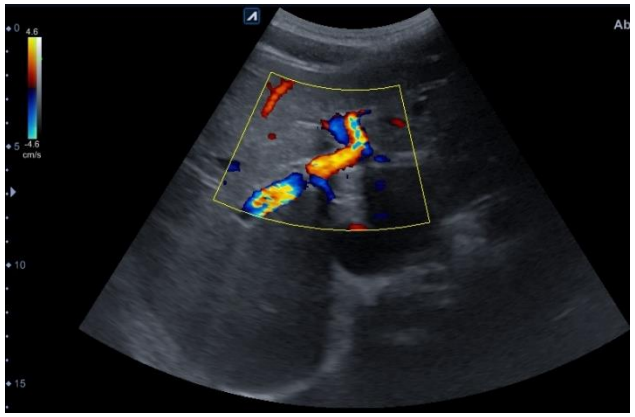
Steer the color box to obtain a good Doppler angle

Color Parameter - Scale (PRF)

3) Color Scale (PRF)







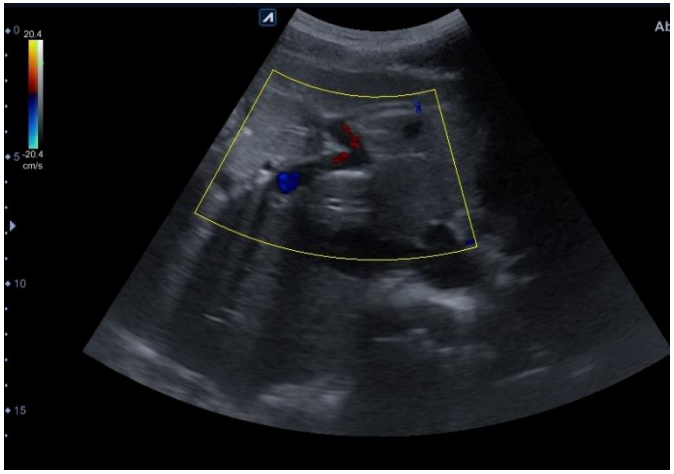
High color velocity scale
(43cm/sec)
Apparent absence of flow in PV

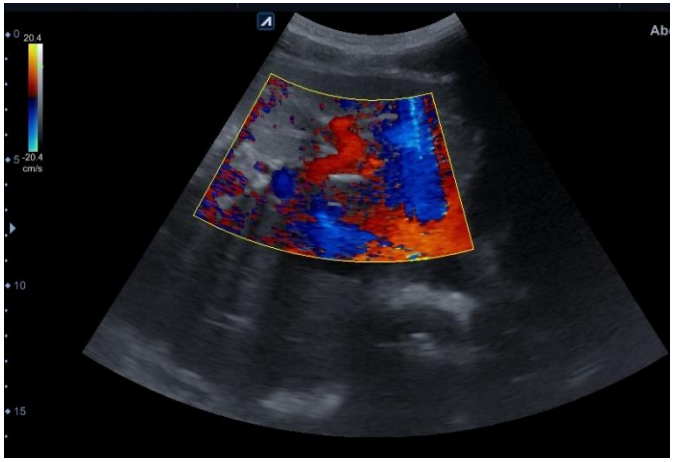
Proper Color velocity scale
28cm/sec
Normal flow in PV

Low color velocity scale
(4cm/sec)
Color aliasing in PV & its branches

Color Parameter - Gain & Threshold

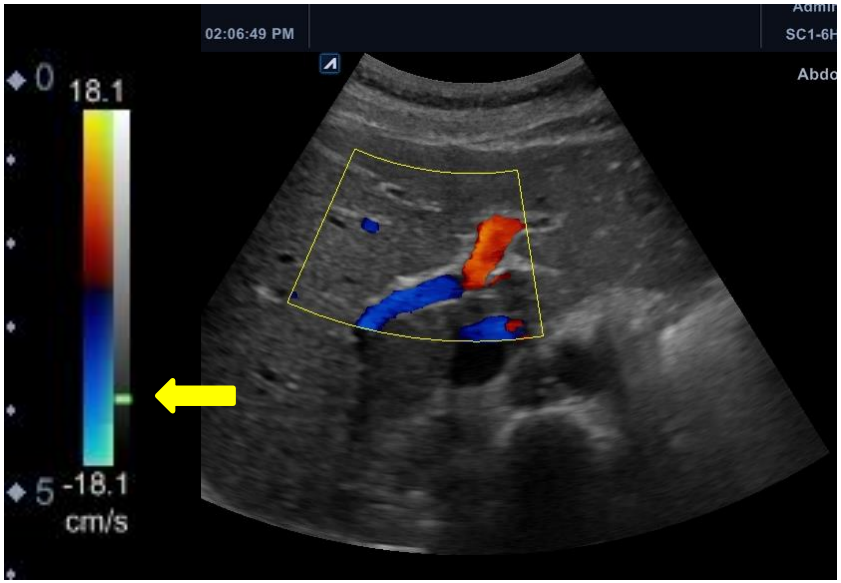
4) Color Gain





Gain should be set as high as possible
Without displaying random color speckles

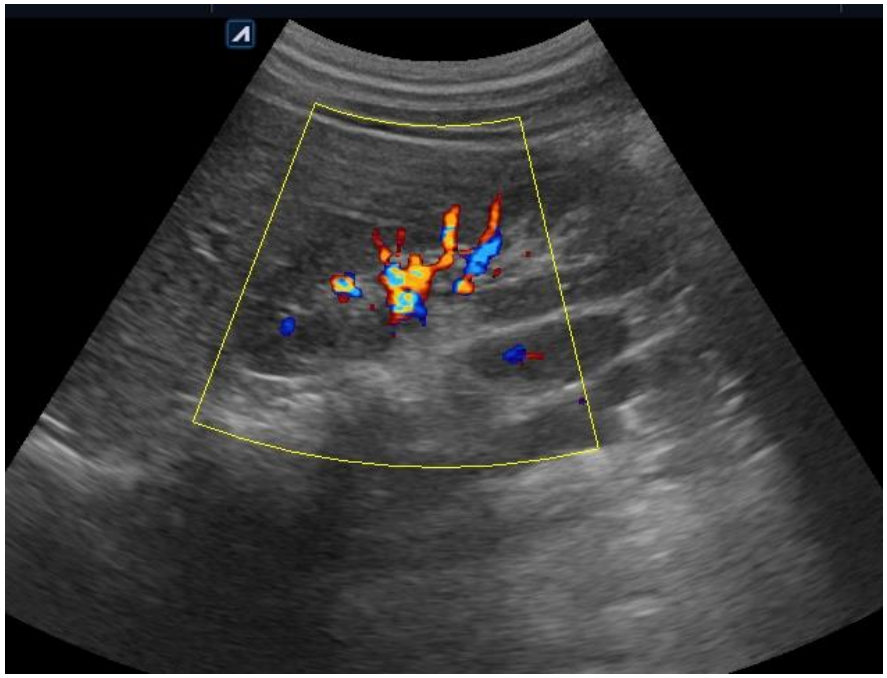
5) Threshold (=Balance)



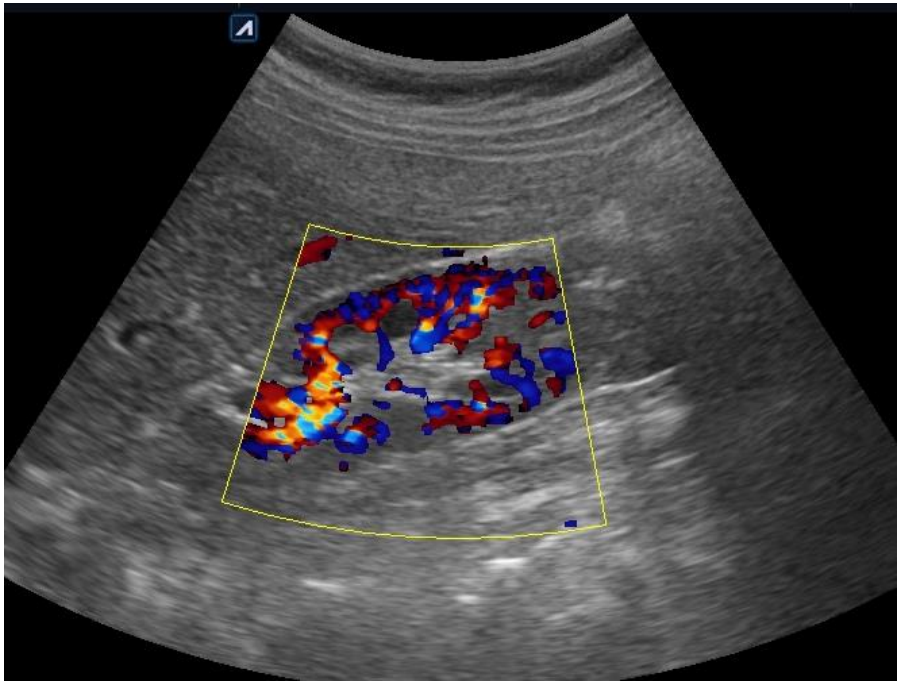
Threshold = Color-Grayscale Priority
If high threshold causes overwriting of color on tissue, the threshold can be lowered

Color Parameter – Ensemble

6) Ensemble (=Sensitivity)



Ensemble 4

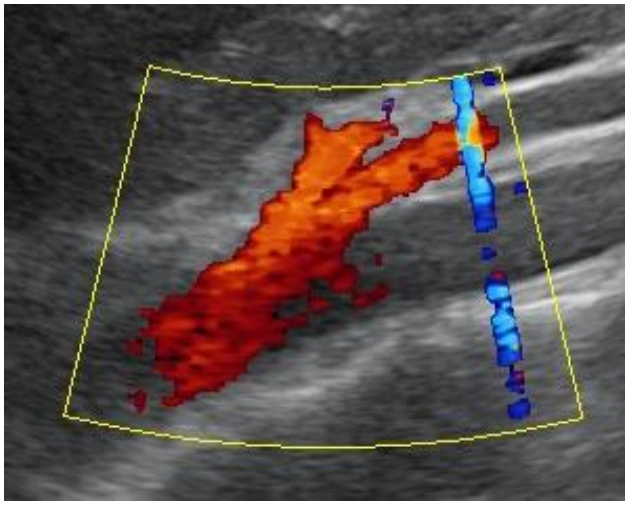


Ensemble 16

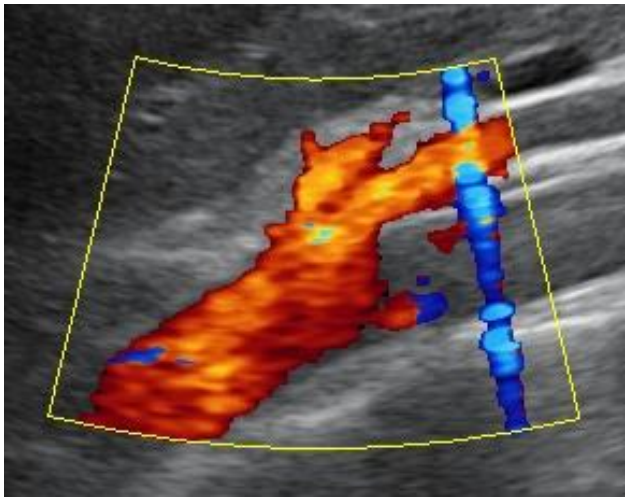
Increasing the ensemble will send more pulse to increase the sensitivity
It is good to detect the micro-vessels, but decrease the frame rate.

Color Parameter – Smooth

6) Smooth filter



Low Smooth
- Small cell size



High Smooth
- Big cell size

Increasing the Smooth filter can make color image smoother,
But the size of color cell gets bigger.

Imaging Tips – Color Flow mode

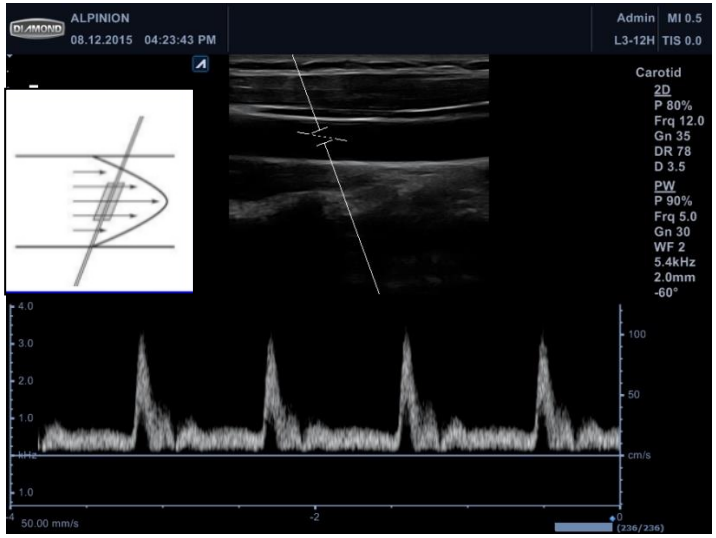
Goal	Possible Action
Eliminate aliasing	• Increase the velocity scale • Adjust the color baseline
Increase sensitivity	• Decrease the velocity scale • Increase color gain • Decrease 2D gain • Decrease color wall filter
Decrease flash artifact	• Decrease color gain • Increase color wall filter • Increase the velocity scale
Increase color smoothing	• Increase color gain • Increase frame averaging • Decrease Smooth
Increase color filling	• Increase color gain • Decrease the velocity scale
Increase frame rate	• Decrease the color box size • Decrease color line density to low • Decrease depth

PW Doppler Parameter

Parameter	Image effect
SV (Sample Volume)	Small sample volume is desirable for better resolution.
Scale (kHz)	= PRF When aliasing artifact occurs, scale(PRF) should be increased
Baseline	To prevent aliasing, the baseline should be adjusted.
Angle Correct	Around 45°~60° angle to the direction flow is ideal
Sweep	The displayed time interval. • Fast sweep speed (shorter interval) is useful for detail. • Slow sweep speed (longer interval) is useful to see the rate and rhythm of blood flow
Auto angle	Automatic angle correction, Select among -60°, 0°, 60°
Invert	Invert the spectrum Positive velocities display below the baseline

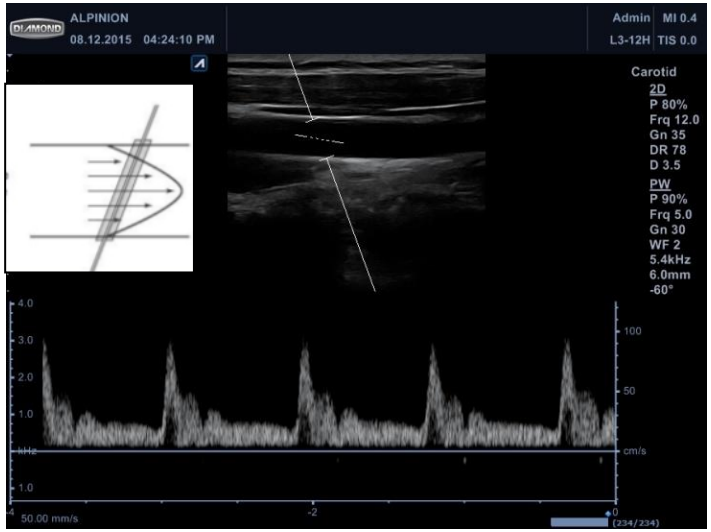
Sample Volume

1) Sample Volume



- **Small SV (2mm)**

- 2/3 of vessel width in the center
- Locate the SV at the center of vessel

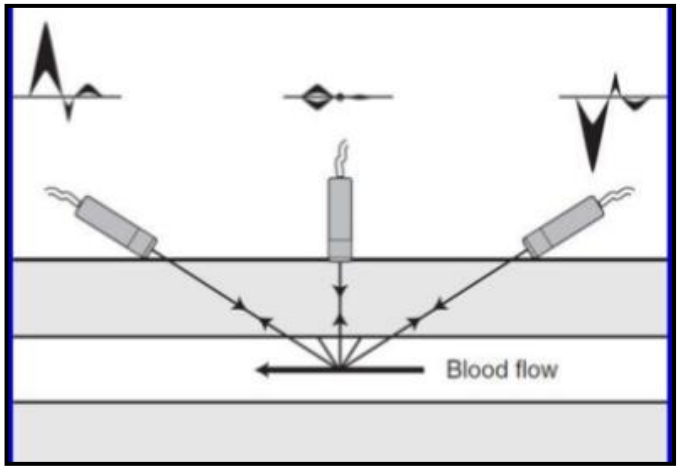


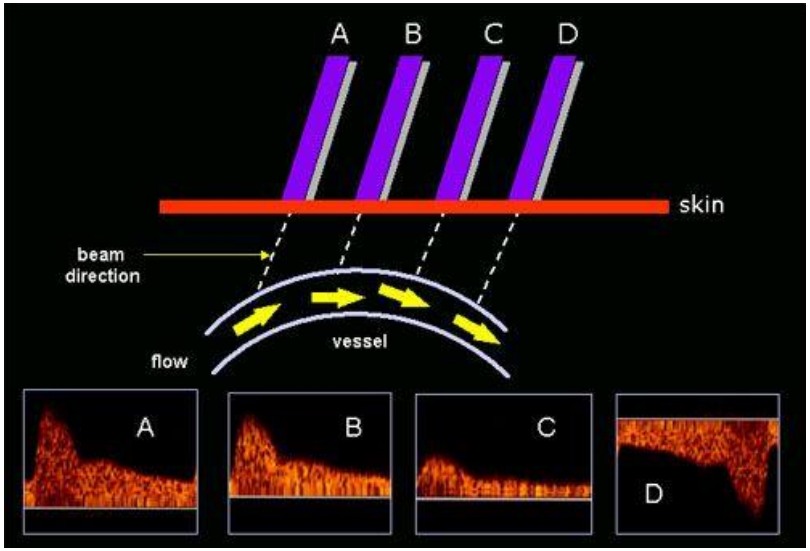
- **Large SV (6mm)**

- Wide range of velocities in laminar flow
- Pseudo-spectral broadening

Spectrum location

2) Spectrum Invert





A. Blood flow toward the transducer

→ Positive Doppler shifts

→ Above the baseline

B. Blood flow perpendicular to the beam

→ No signals

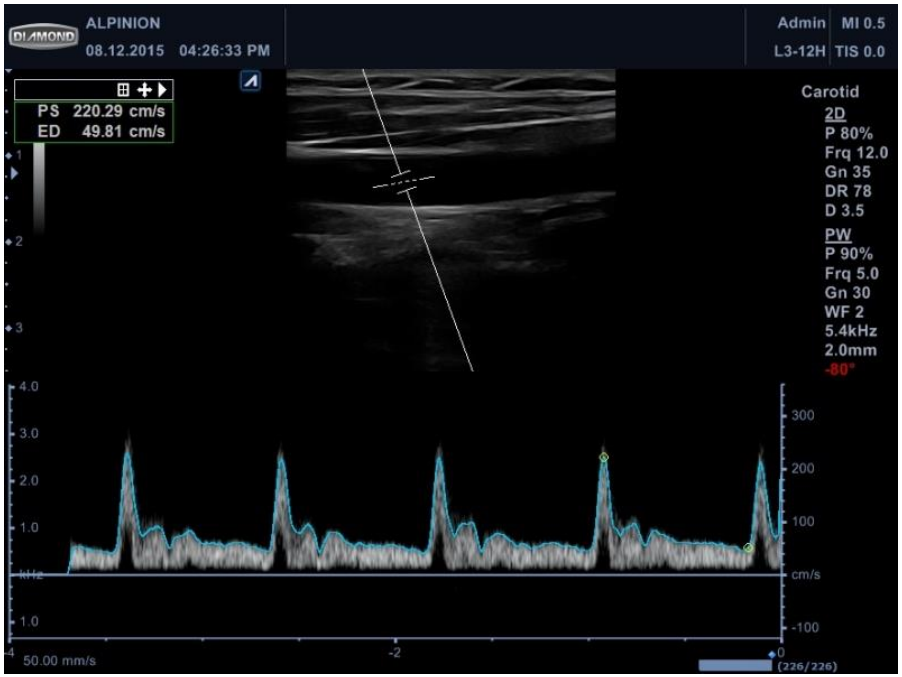
C. Blood flow away from the transducer

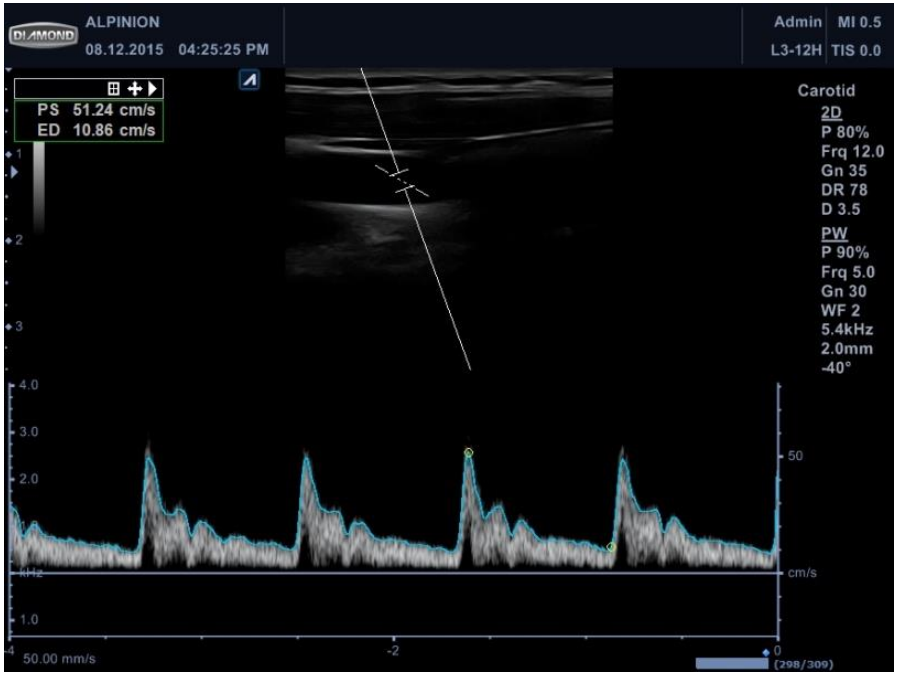
→ Negative Doppler shifts

→ Below the baseline

Doppler Angle Correction

3) Angle Correction





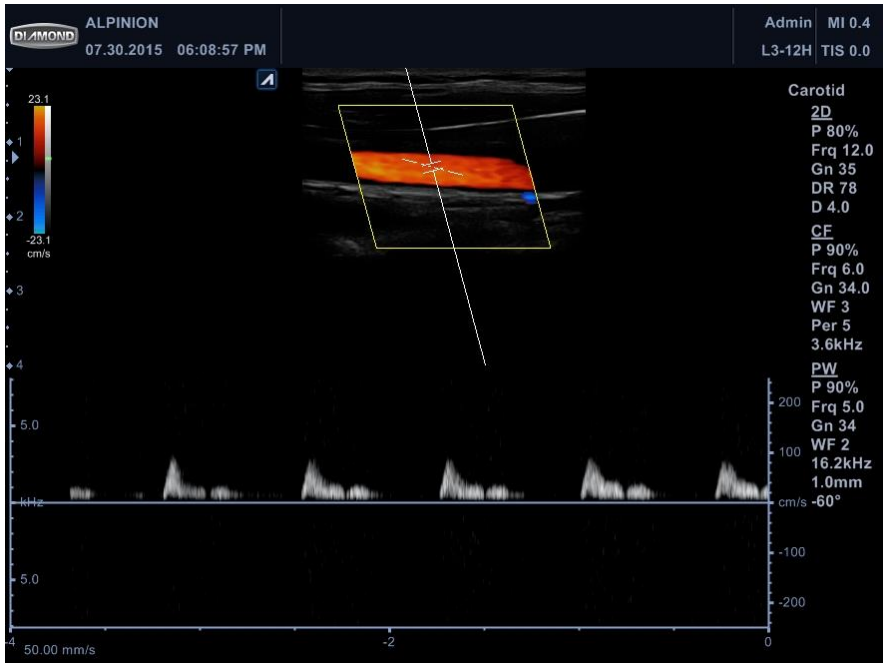
PW angle: 80°
PS: 220cm/s
ED: 50cm/s

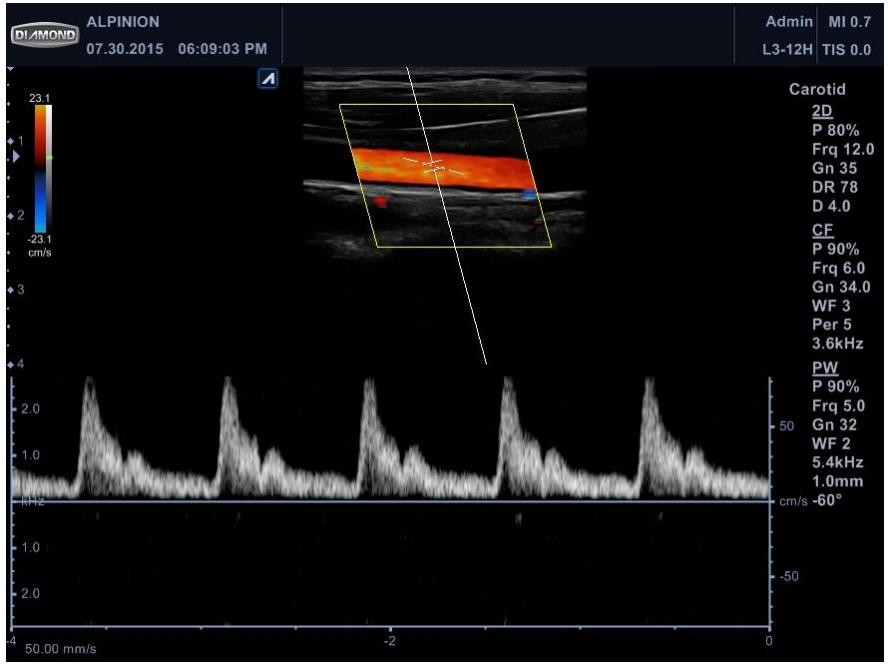
PW Angle: 40°
PS: 52cm/s
ED: 11cm/s

Use angle correction (≤ 60 degrees), if an accurate velocity is important

Velocity Scale (PRF)

4) Spectral Scale





High Spectral scale : 16.2kHz

Adjust the Spectral scale : 5.4kHz

If the PRF is too high, the waveform on the display will be very small
If the PRF is too small, aliasing will occur

Imaging Tips – PW mode

Goal	Possible Action
Increase sensitivity	• Adjust Doppler angle to flow • Decrease SV(sample volume size) • Decrease PRF
Noise reduction	• Decrease Doppler gain • Increase wall filter • Decrease SV(sample volume size)
Eliminate aliasing	• Increase the velocity scale • Adjust the baseline • Adjust Doppler angle to flow • Turn on Xpeed™
Display low-velocity spectrum	• Decrease the velocity scale • Decrease wall filter

The range of velocities – Abdominal vessels

Abdominal Vessels	Velocity range (cm/s)
Aorta	90±10
Hepatic Artery	31±13
Splenic Artery	34±9
Superior Mesenteric Artery	27±7
Renal Artery	30±10
Inferior Vena Cava	19±8
Portal Vein	26.5±5.5
Renal Vein	18±4

Thank You

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MEDICAL SYSTEMS