

Transcranial Doppler Non-Imaging Technique

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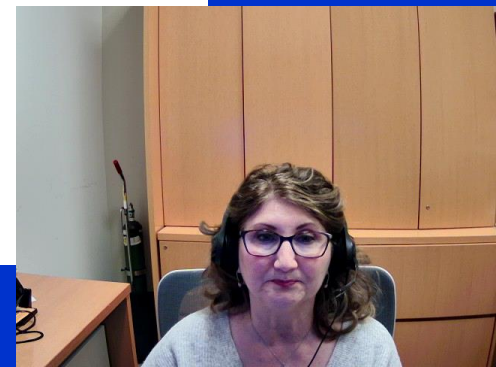
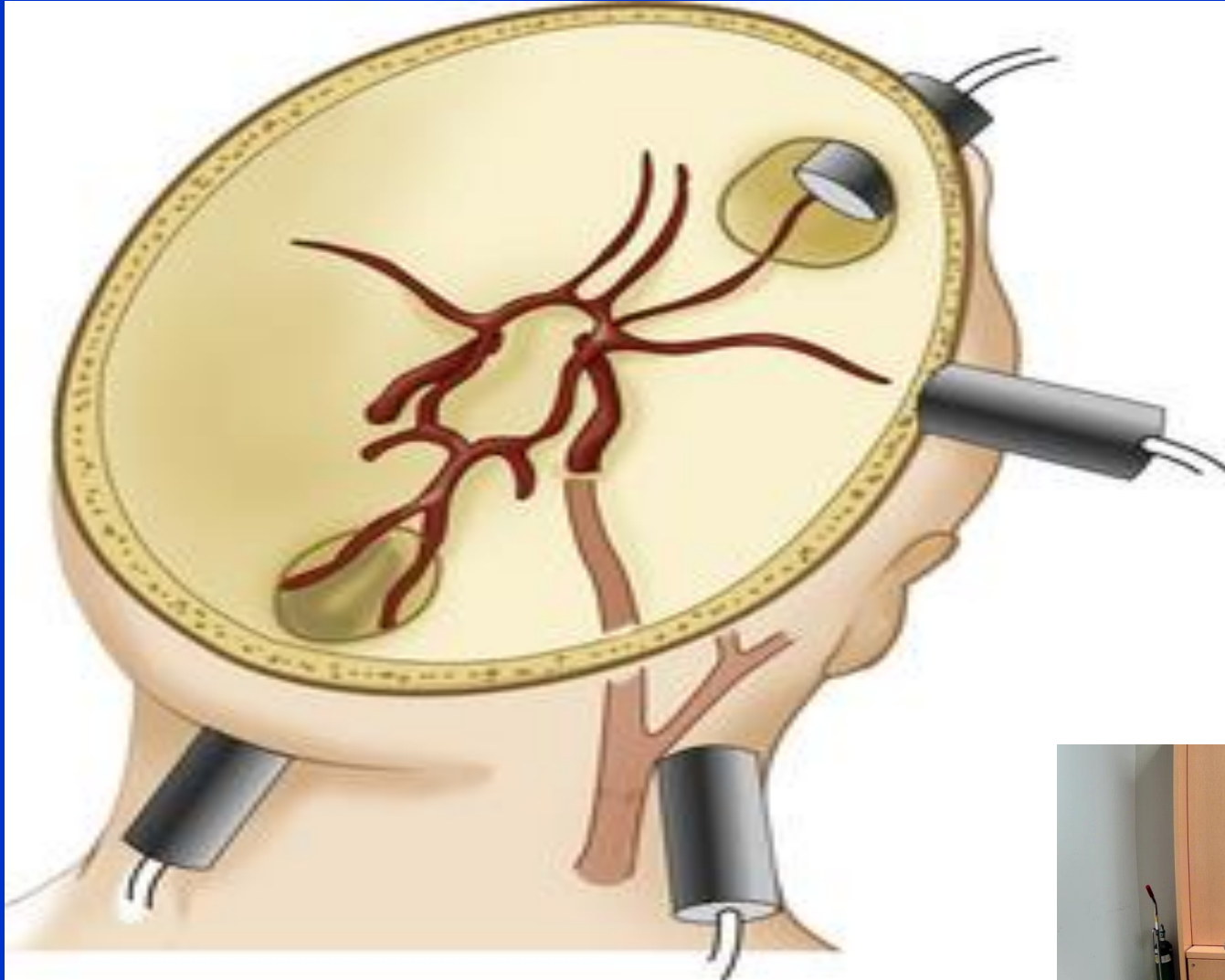
Vessel Identification

No Visual Map - Audio

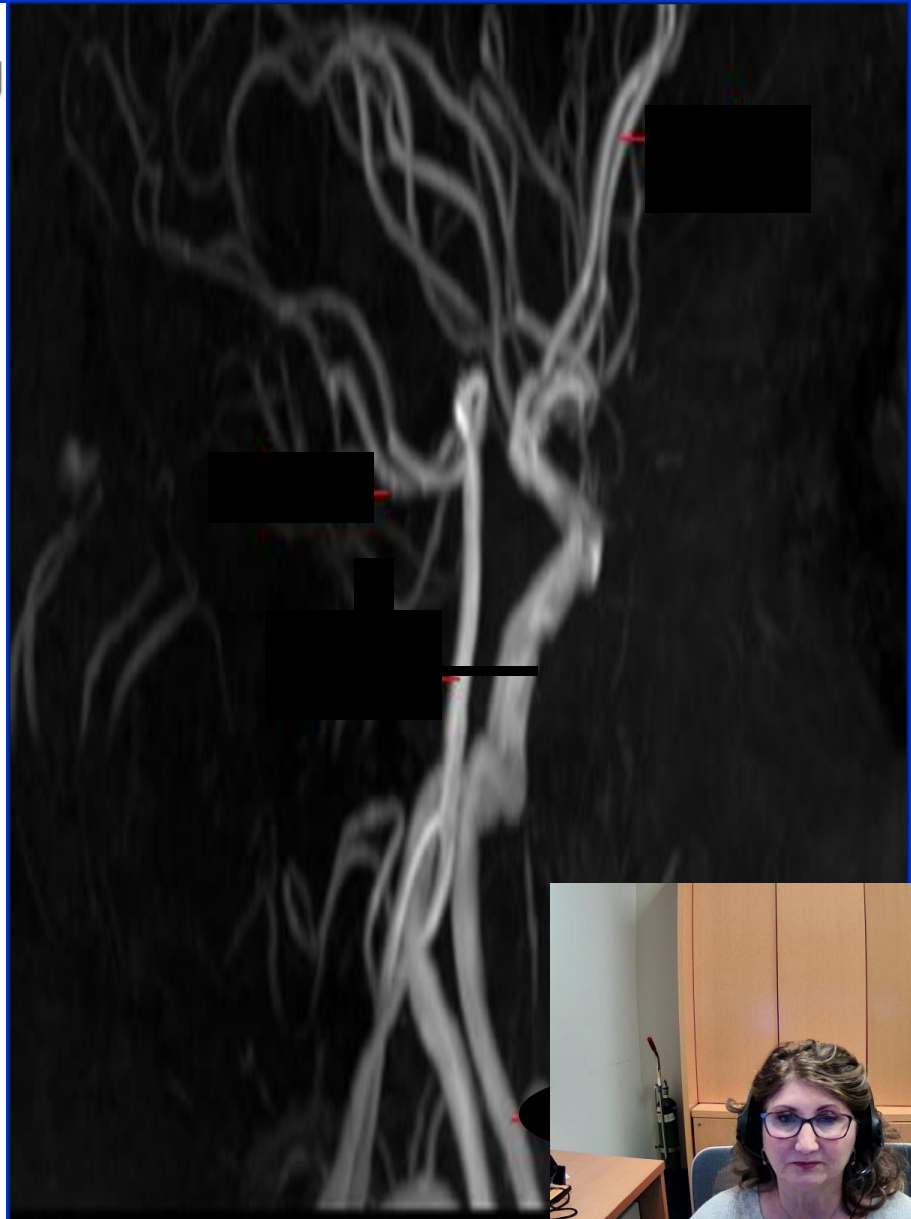
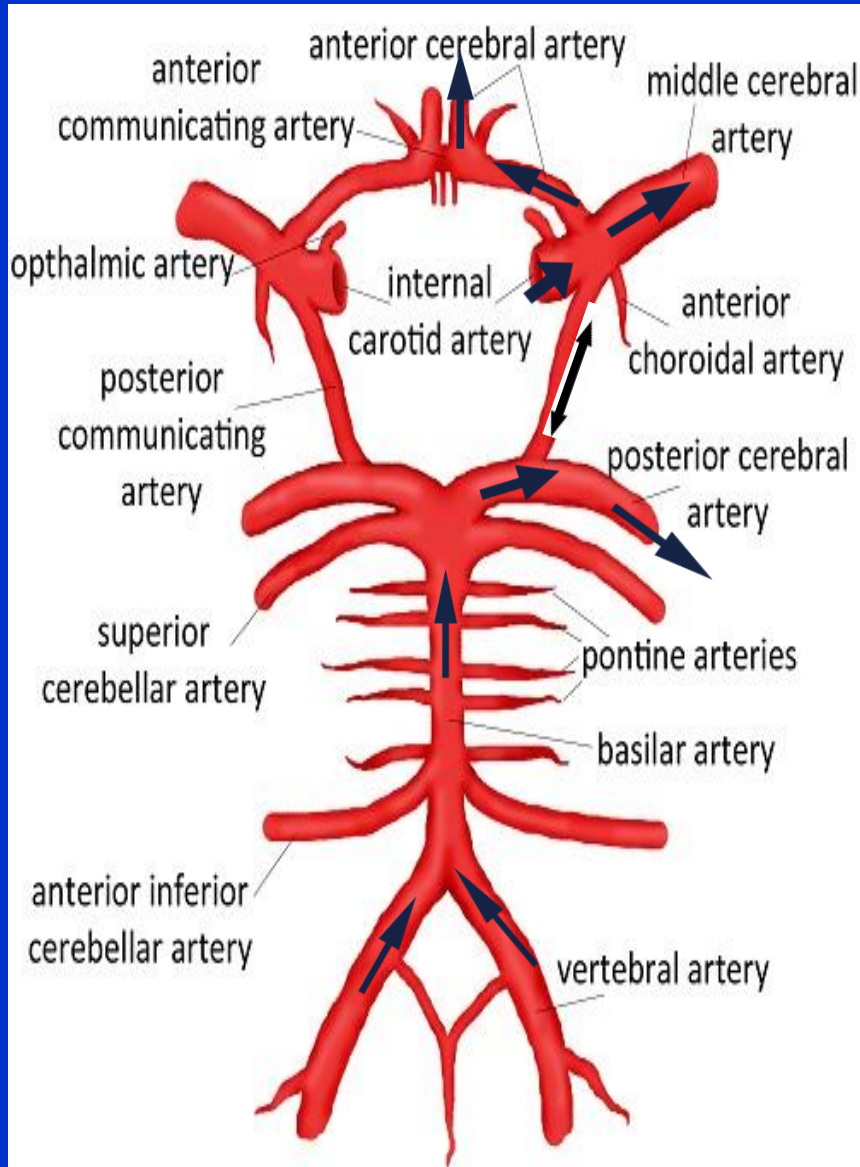
1. Find the best window (signal intensity and pitch)
2. Follow the anatomical landmarks and adjust depths for age and head size: Infant, Child, Adult
3. Determine Flow Direction
4. Spatial relationship with other vessels:
Anterior to Posterior circulation
Develop a mental 3-D image



Acoustic Approaches



Navigating through the Circle of Willis

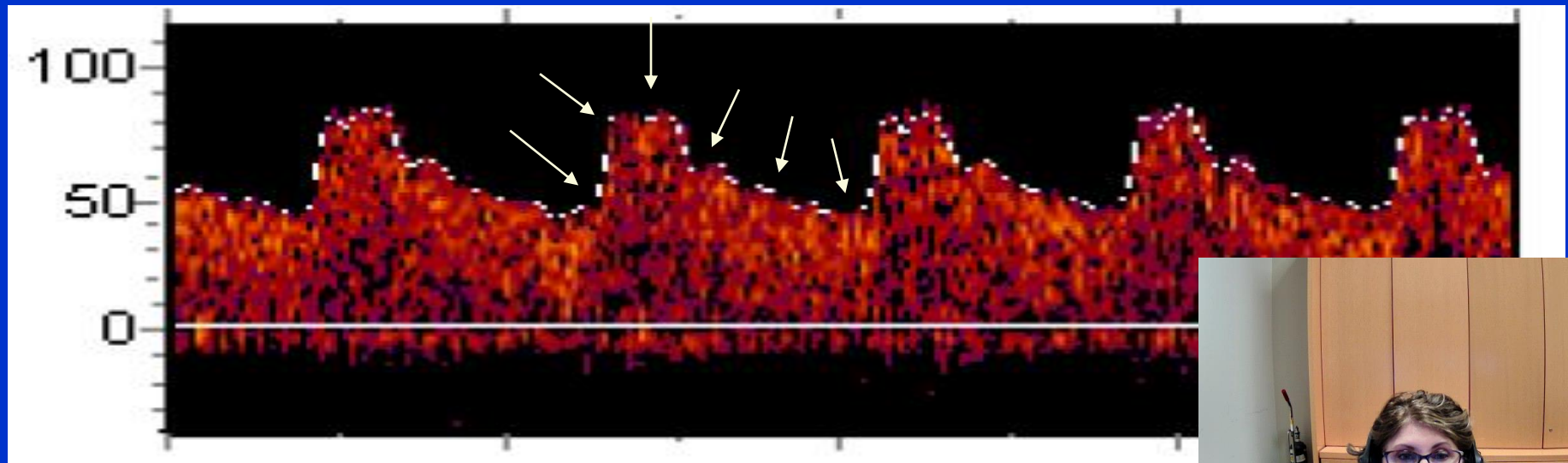


Velocity

All Peaks Velocities are Averaged Within A Single Cardiac Cycle

Time -Averaged Mean Velocities (TAMV)

“Envelope Fit”



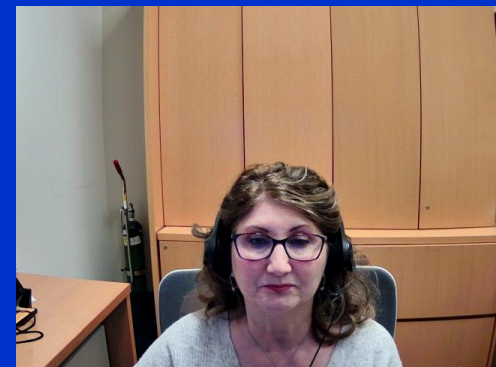
Vessel Velocity Hierarchy

Anterior Circulation:

- MCA
- ACA
- PCA

Posterior Circulation:

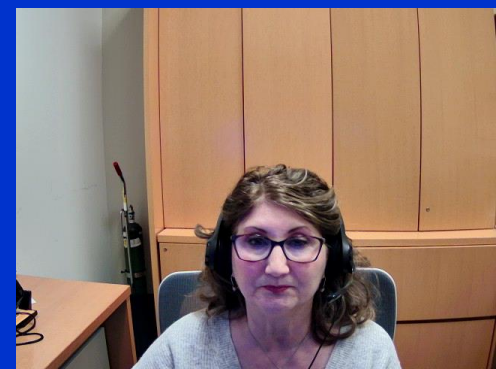
- Basilar
- Vertebral



Normal Values

Artery	Window	Depth (mm)	Direction	Mean Flow Velocity
MCA	Temporal	30 to 60	Toward probe	55 ± 12 cm/s
ACA	Temporal	60 to 85	Away	50 ± 11 cm/s
PCA	Temporal	60 to 70	Bidirectional	40 ± 10 cm/s
TICA	Temporal	55 to 65	Toward	39 ± 09 cm/s
ICA (siphon)	Orbital	60 to 80	Bidirectional	45 ± 15 cm/s
OA	Orbital	40 to 60	Toward	20 ± 10 cm/s
VA	Occipital	60 to 80	Away	38 ± 10 cm/s
BA	Occipital	80 to 110	Away	41 ± 10 cm/s

TCD, transcranial Doppler; MCA, middle cerebral artery; ACA, anterior cerebral artery; PCA, posterior cerebral artery; TICA, terminal internal carotid artery; ICA, internal carotid artery; OA, ophthalmic artery; VR, vertebral artery; BA, basilar artery.



Pulsatility Index Calculation

Vessel Flow Resistance

$$\text{PI} = \frac{\text{PSV} - \text{EDV}}{\text{Mean Velocity}}$$

Below Normal = < .6

Normal = .6 to 1.1

Above Normal = 1.2 to 1.5

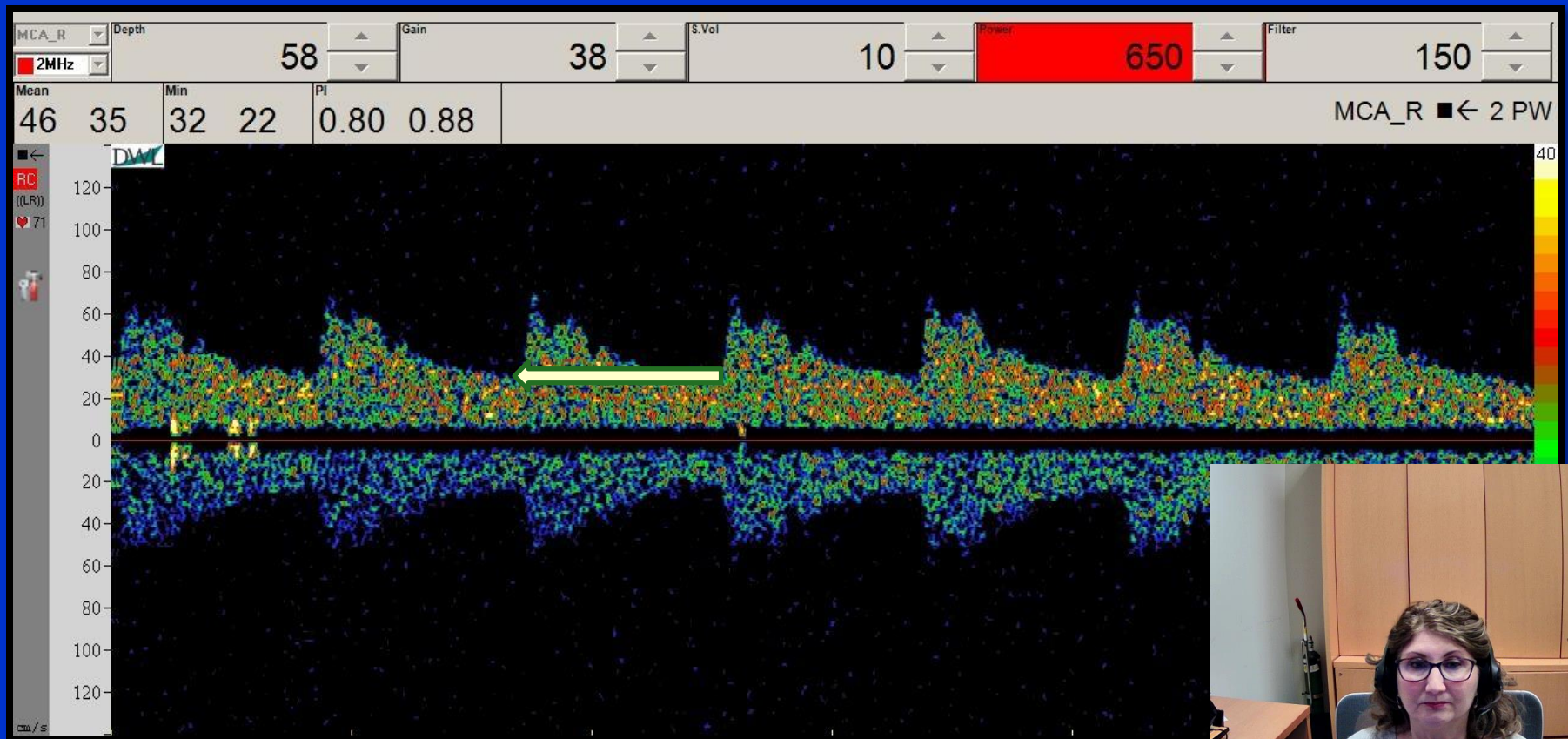
Abnormal = > 1.5



Visual Measure of Resistance

Normal Resistance:

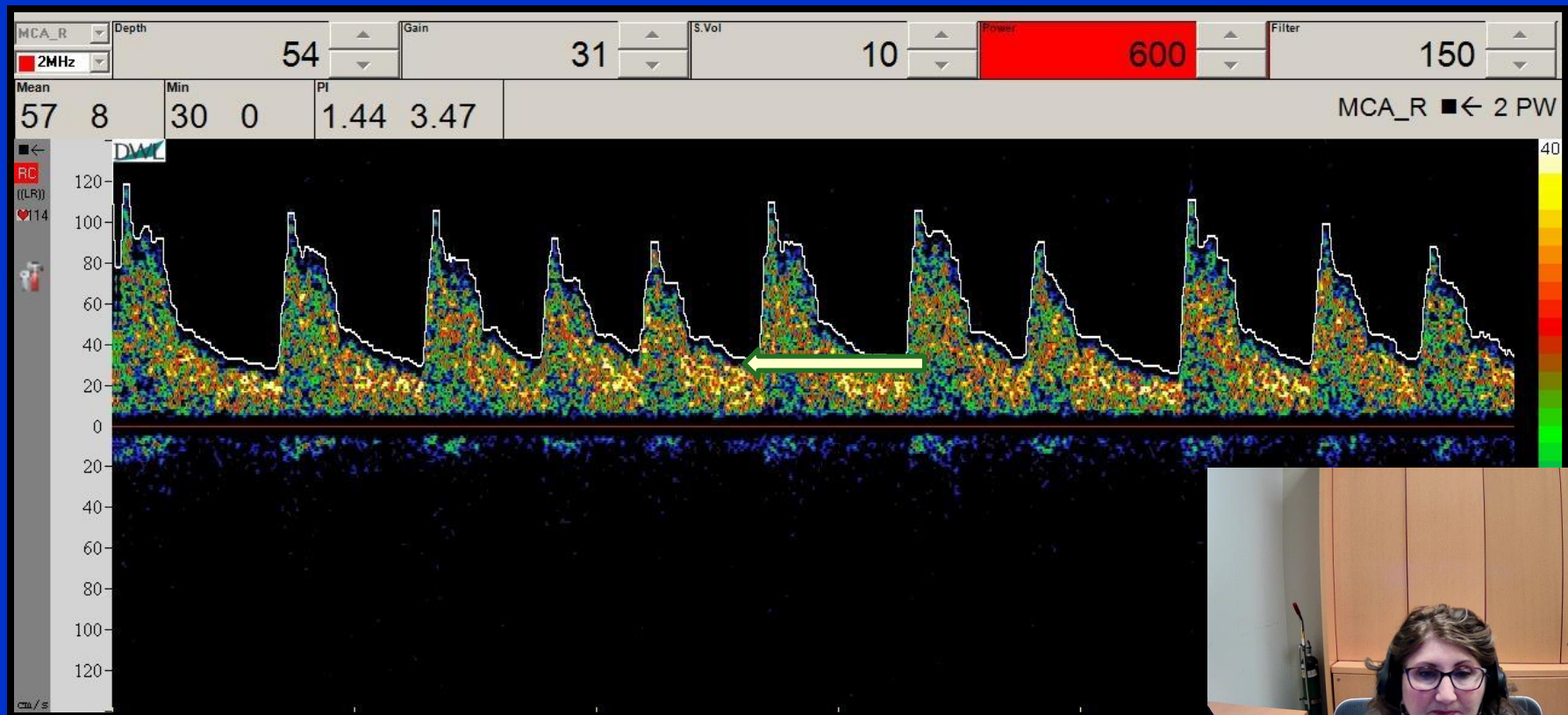
End Diastole Reaches to $\frac{1}{2}$ of The Total Height of The Waveform



Visual Measure of Resistance

High Resistance:

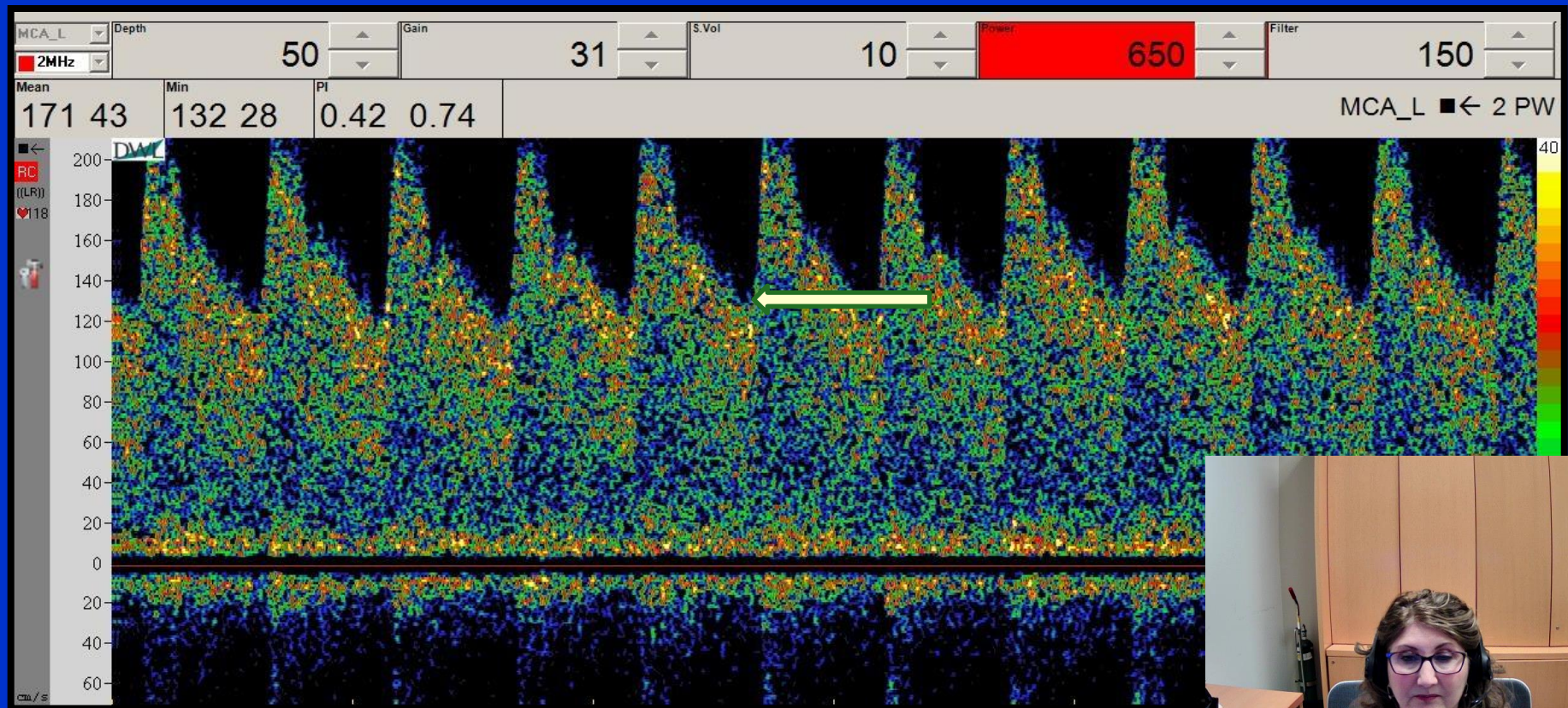
End Diastole Reaches Only 1/3 of The Total Height of The Waveform



Visual Measure of Resistance

Low Resistance:

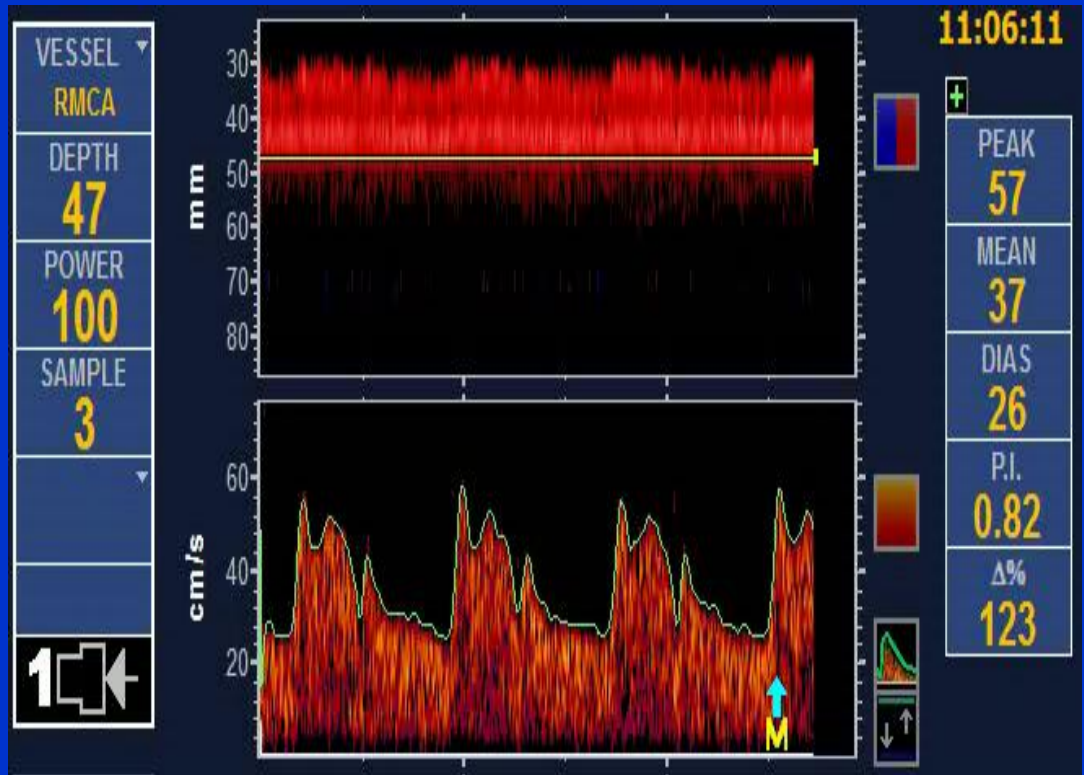
End Diastole Reaches Up To 2/3 The Total Height of The Waveform



Normal Waveform

How To Identify:

1. Normal velocity
2. Normal P.I.
3. Straight Upstroke
4. No significant bruit



The Importance of Angle: Highest Pitch = Highest Velocity

Test 00000000000000000000

Routine Main Screen

VIASONIX

Intracranial

Summary

New

Load

Menu

Exit

Vessel	Depth	Mean	Peak	Diast	PI
► R MCA	63				
R MCA/ACA					
R T-ICA					
R ACA					
R PCA P1					
R EX-ICA	50				
L MCA	45				
L MCA/ACA					
L T-ICA					
L ACA					
L PCA P1					
L EX-ICA	50				
R Ophthalmic	50				
R Siphon	70				
L Ophthalmic	50				
L Siphon	70				
R Vertebral	50				
L Vertebral					

Add

Delete



Next Vessel

Redo

Save

Replay

Waveform Label

Cursors Off

Envelope: Upper

Invert

Multi Depth

Auto Depth: Off



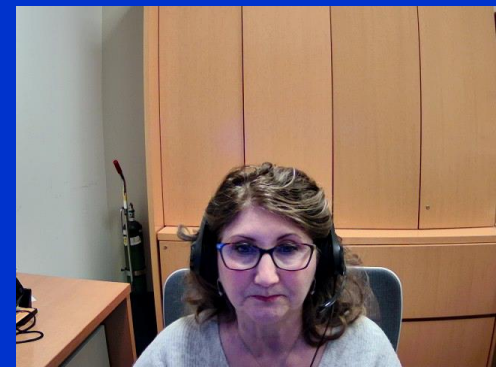
Transducer Technique

3 Ways to Improve the Doppler Signal:

1. **Angulation:** Tipping the probe on its edge
2. **Push- Pull:** Pushing or pulling against the skin without an angle change
3. **Sliding:** Sliding the probe over the skin to a different location

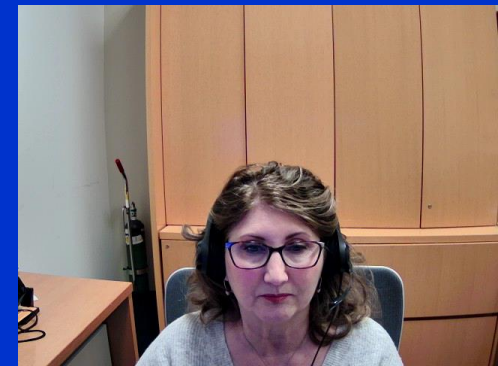


Transducer Technique: Overhand

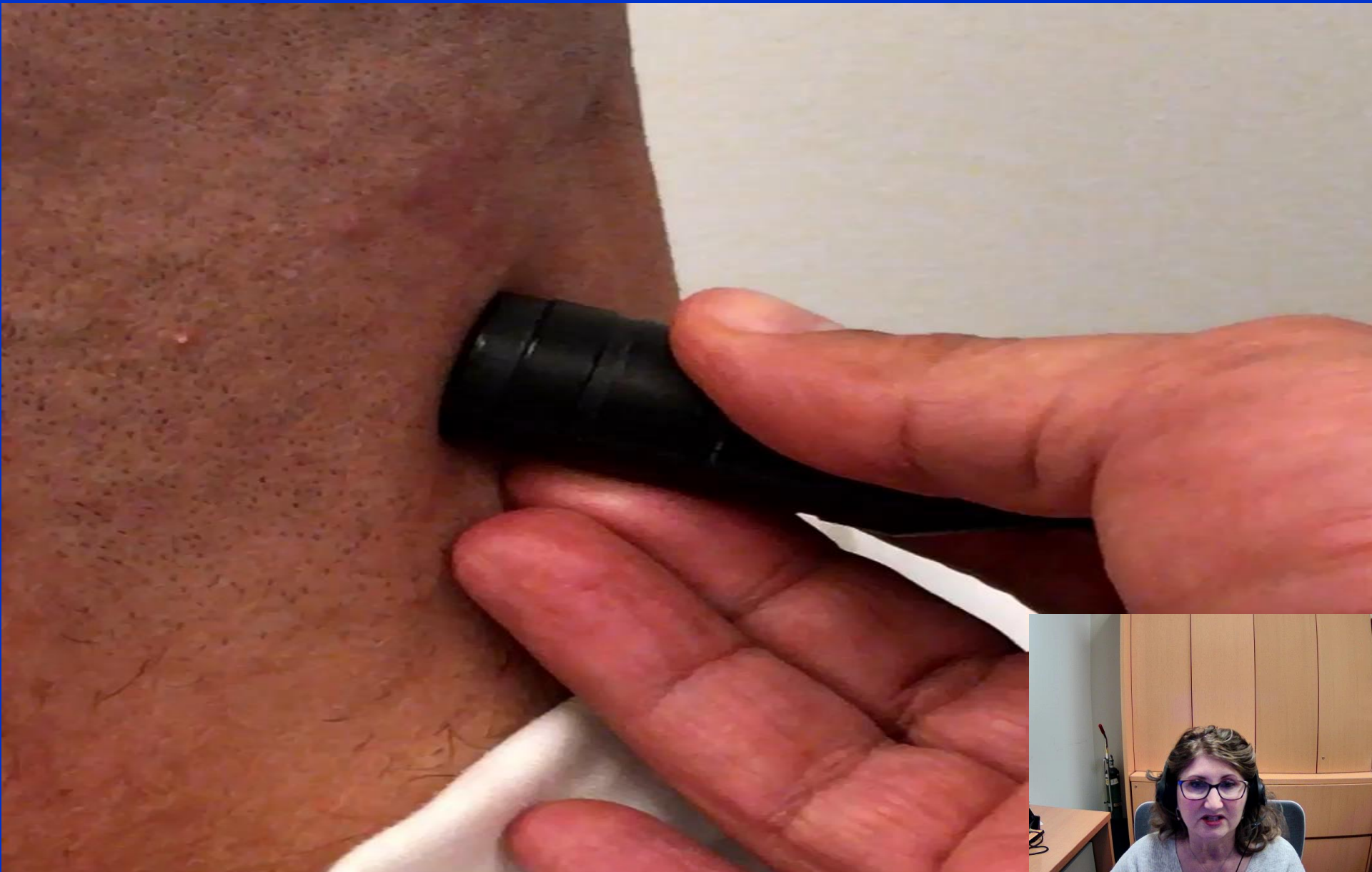


General all-purpose hand-hold

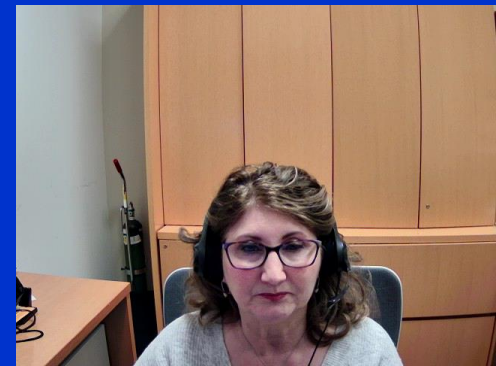
Transducer Technique: Underhand



Transforaminal Approach



Transducer Technique: Backhand

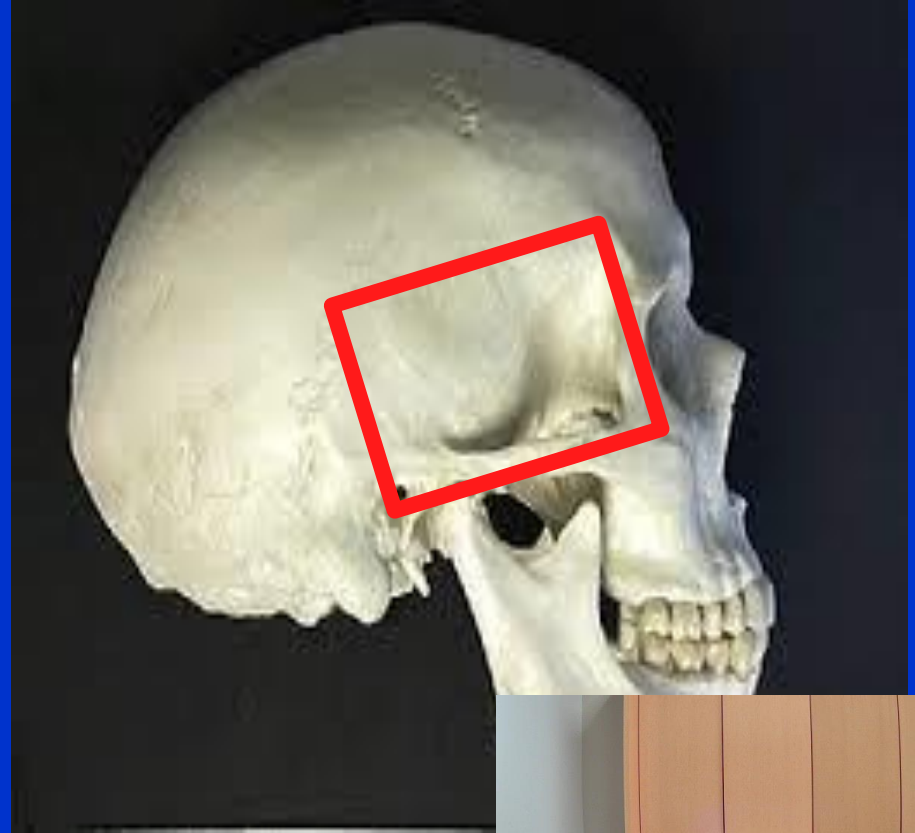


Where Do I Begin?

The Transtemporal Approach

- Above the Zygomatic Arch
- Behind the Orbital Ridge

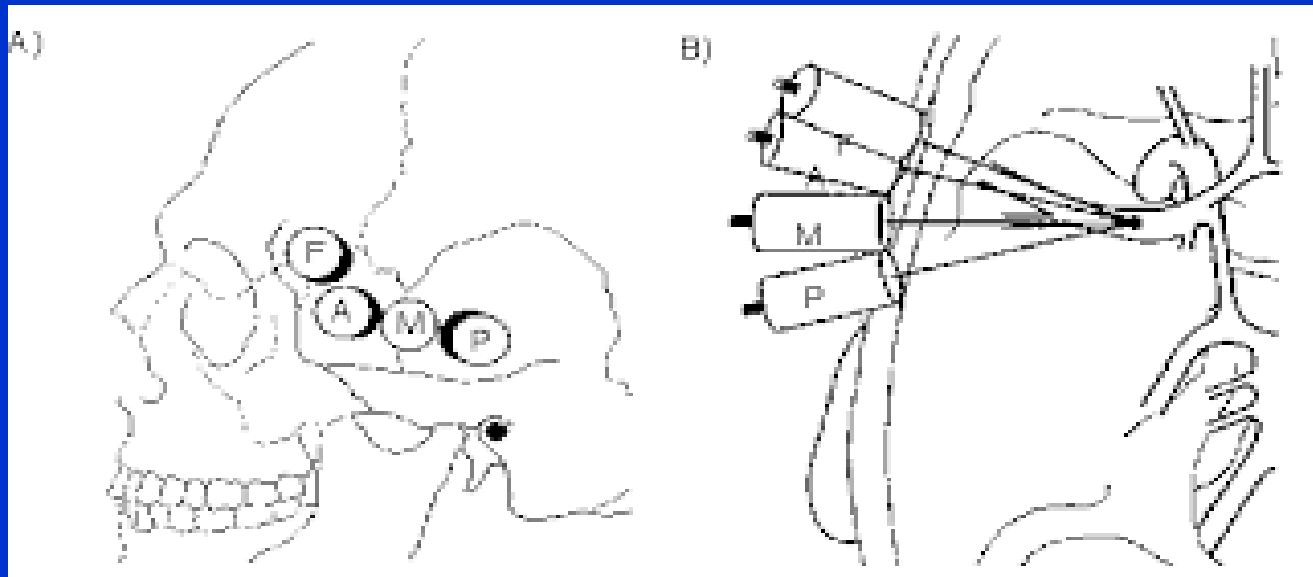
Anterior Circulation



The Temporal Window

CSMC Neurovascular Laboratory

- Anterior
- Middle
- Posterior
- Frontal

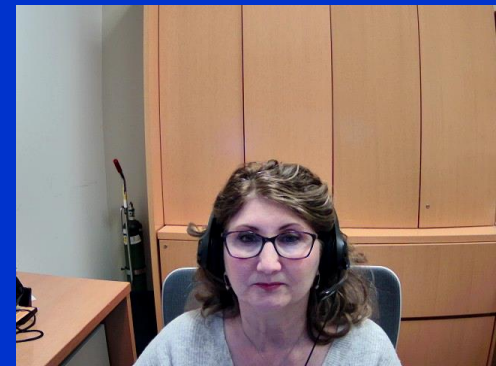


How do I Angle the Transducer?

-MCA-



- Temporal Bone
- Angle **Superiorly**
- Depth: 40-65mm
- Flow Direction: **Toward**



MCA (40-60mm)

Angle: Superior and Anterior

ddddd test

Routine Main Screen

VIASONIX

Summary

New

Load

Menu

Exit

Vessel	Depth	Mean	Peak	Diast	PI
✓ R MCA	45	56.1	78.9	37.9	0.73
✓ R MCA	50	57.0	79.0	39.3	0.70
✓ R MCA	55	53.0	74.7	36.8	0.72
✓ R T-ICA	60	50.4	70.7	34.3	0.72
✓ R ACA	62	-55.9	-80.2	-37.3	0.77
✓ R ACA	70	-40.8	-58.2	-27.1	0.76
✓ R PCA P1	65	19.4	33.6	4.7	1.49
✓ R MCA	50				
▶ R MCA	50	60.6	82.6	40.4	0.70
✓ R MCA/ACA	60	-45.5	-69.0	-29.2	0.87
✓ R T-ICA	60	31.2	44.3	20.8	0.75
✓ R ACA	60	-46.2	-69.0	-29.4	0.86
✓ R PCA P1	65	36.9	53.5	23.8	0.81
✓ R EX-ICA	50	-31.5	-51.1	-19.9	0.99
✓ R EX-ICA	50	-33.8	-52.6	-20.9	0.94
✓ R Vertebral	70	-48.5	-69.5	-32.5	0.76
✓ Basilar	80	-46.3	-66.7	-30.4	0.78

Add

Delete

DEPTH
50

SWEEP
6 s

SAMPLE
12 mm

POWER
70%

SCALE
192 cm/s

GAIN
1

FILTER
100 Hz

VOLUME
100%

PROBE
2 PW

Save

Replay

Waveform Label

Cursors Off

Envelope:
Upper

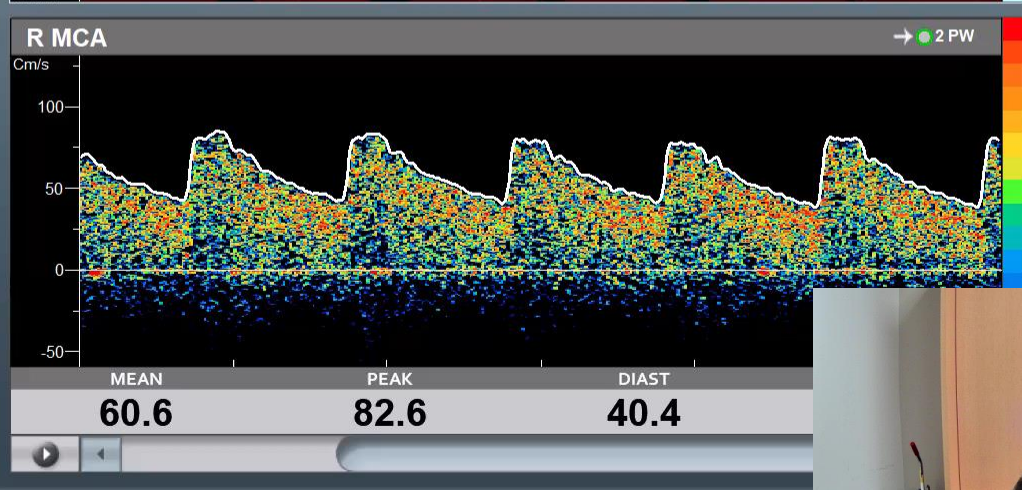
Invert

Auto Depth: Off

Recalculate
Parameters

Online

Resume Examination



TIC: 1.58

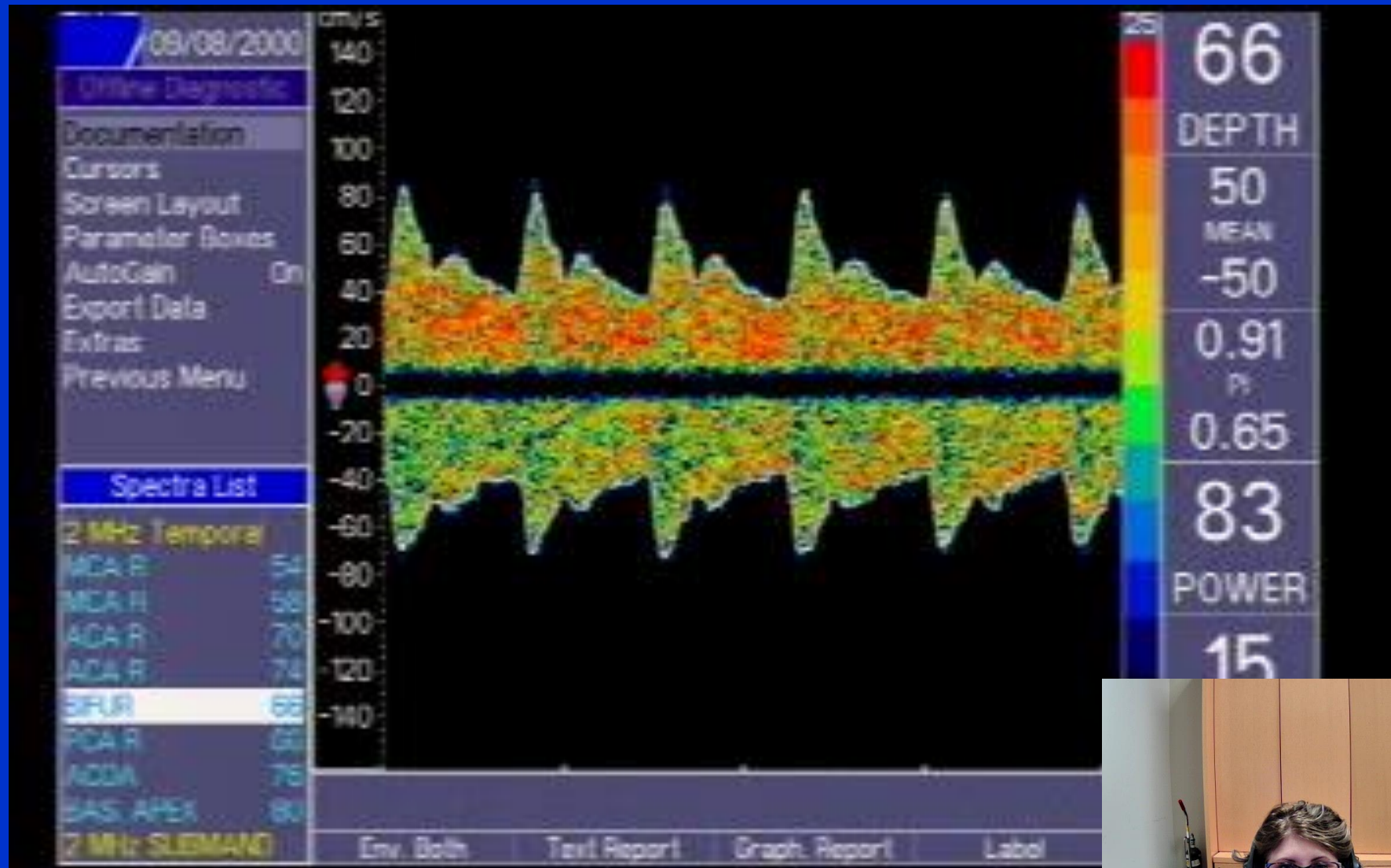
II

↶

🖨

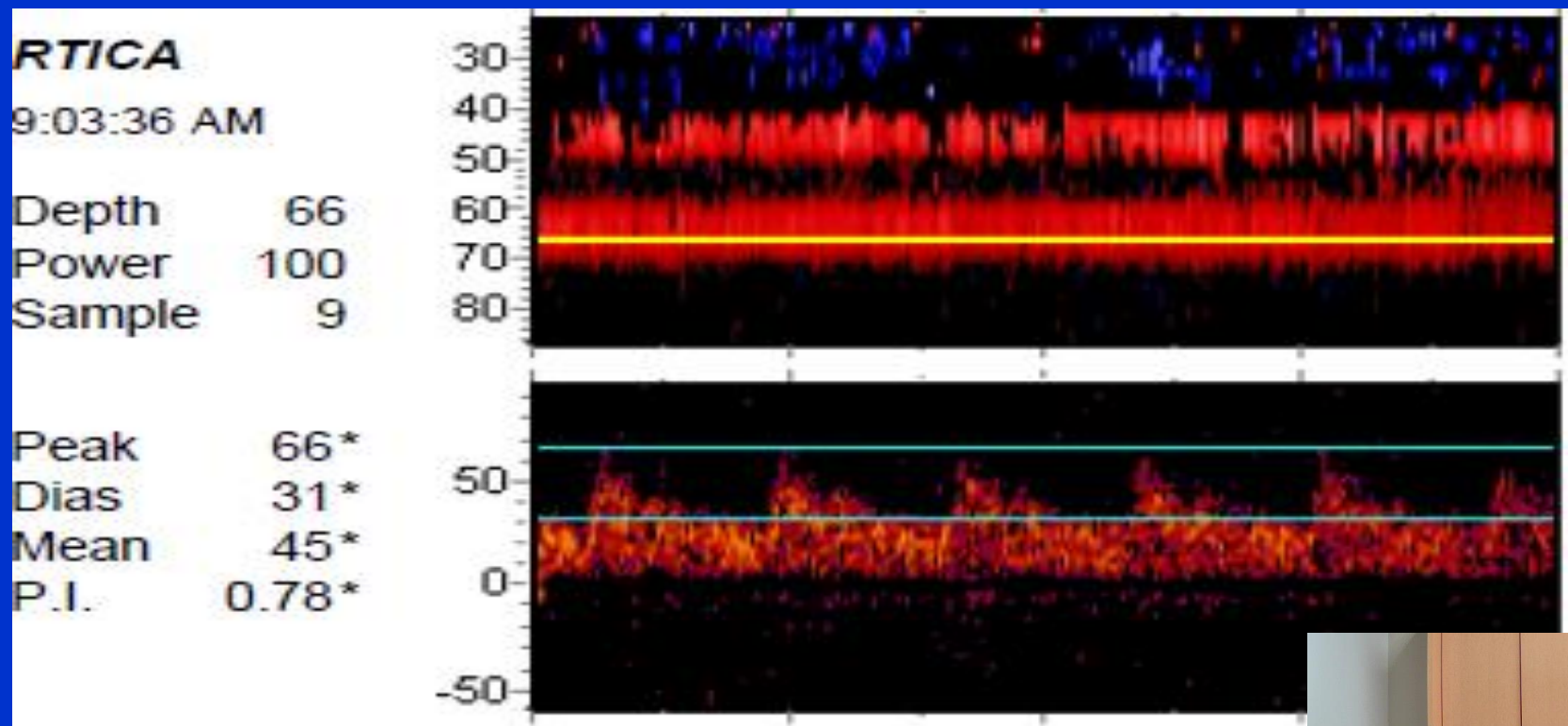
⚙

MCA/ACA Bifurcation (60-70mm)



TICA (Terminal ICA)

Find the Bifurcation - Then Angle Toward the Feet



How Do I Angle the Transducer?

-ACA-



- Temporal Bone
- Angle **Anteriorly**
- Depth: 60-75mm
- Flow Direction: **Away**



ACA (60-75mm)

Angle: Anterior

dddd test

Routine Main Screen

VIASONIX

Summary

New

Load

Menu

Exit

Vessel	Depth	Mean	Peak	Diast	PI
✓ R MCA	45	56.1	78.9	37.9	0.73
✓ R MCA	50	57.0	79.0	39.3	0.70
✓ R MCA	55	53.0	74.7	36.8	0.72
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▶ R ACA	62	-55.9	-80.2	-37.3	0.77
✓ R ACA	70	-40.8	-58.2	-27.1	0.76
✓ R PCA P1	65	19.4	33.6	4.7	1.49
✓ R MCA	50				
✓ R MCA	50	60.6	82.6	40.4	0.70
✓ R MCA/ACA	60	-45.5	-69.0	-29.2	0.87
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✓ R ACA	60	-46.2	-69.0	-29.4	0.86
✓ R PCA P1	65	36.9	53.5	23.8	0.81
✓ R EX-ICA	50	-31.5	-51.1	-19.9	0.99
✓ R EX-ICA	50	-33.8	-52.6	-20.9	0.94
✓ R Vertebral	70	-48.5	-69.5	-32.5	0.76
✓ Basilar	80	-46.3	-66.7	-30.4	0.78

Add

Delete

DEPTH
62

SWEEP
6 s

SAMPLE
12 mm

POWER
64 s

SCALE
231 cm/s

GAIN
6

FILTER
100 Hz

VOLUME
100%

PROBE
2 PW

Save

Replay

Waveform Label

Cursors Off

Envelope:
Lower

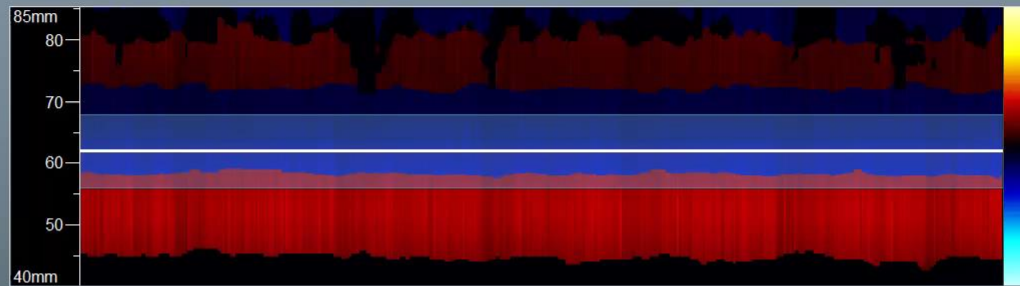
Invert

Auto Depth: Off

Recalculate
Parameters

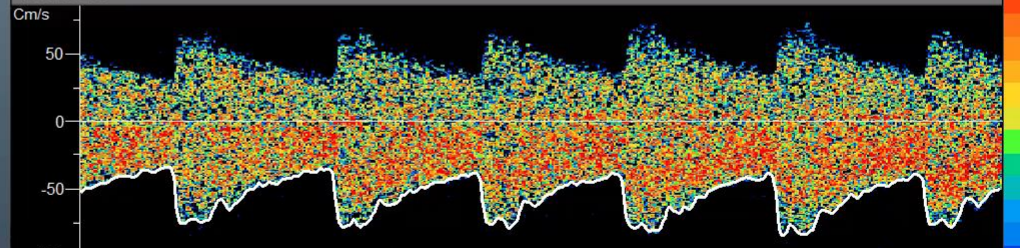
Online

Resume Examination



R ACA

→ 2 PW



MEAN

-55.9

PEAK

-80.2

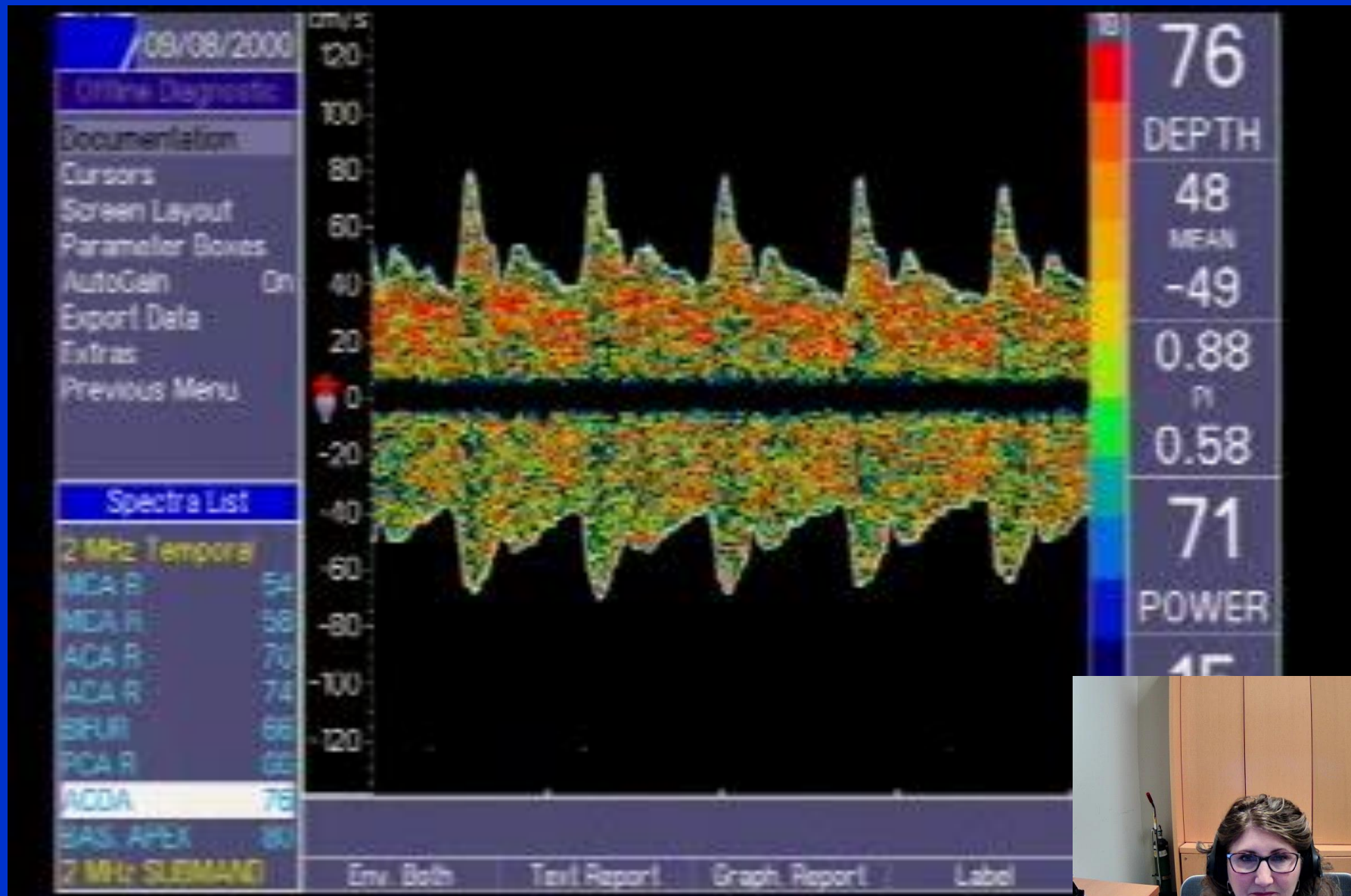
DIAST

-37.3

TIC: 1.45



ACoM (75-80mm)



How Do I Angle the Transducer?

-PCA-



- Temporal Bone
- Angle **Posterior and Inferior**
- Depth: 55-79mm
- Flow Direction: **Toward**



PCA (55-75mm)

Angle: Posterior and Inferior

ddddd test

Routine Main Screen

VIASONIX

Summary

New

Load

Menu

Exit

Vessel	Depth	Mean	Peak	Diast	PI
✓ R MCA	45	56.1	78.9	37.9	0.73
✓ R MCA	50	57.0	79.0	39.3	0.70
✓ R MCA	55	53.0	74.7	36.8	0.72
✓ R T-ICA	60	50.4	70.7	34.3	0.72
✓ R ACA	62	-55.9	-80.2	-37.3	0.77
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✓ R MCA	50				
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✓ R MCA/ACA	60	-45.5	-69.0	-29.2	0.87
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✓ R ACA	60	-46.2	-69.0	-29.4	0.86
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✓ R EX-ICA	50	-31.5	-51.1	-19.9	0.99
✓ R EX-ICA	50	-33.8	-52.6	-20.9	0.94
✓ R Vertebral	70	-48.5	-69.5	-32.5	0.76
✓ Basilar	80	-46.3	-66.7	-30.4	0.78

Add

Delete

DEPTH
65

SWEEP
6_s

SAMPLE
12_{mm}

POWER
53%

SCALE
192_{Cm/s}

GAIN
7

FILTER
100_{Hz}

VOLUME
100%

PROBE
2 PW

Save

Replay

Waveform Label

Cursors Off

Envelope:
Upper

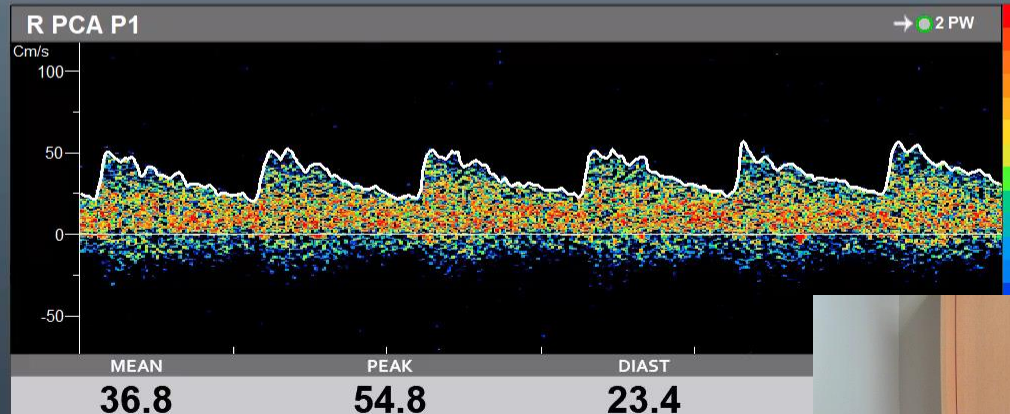
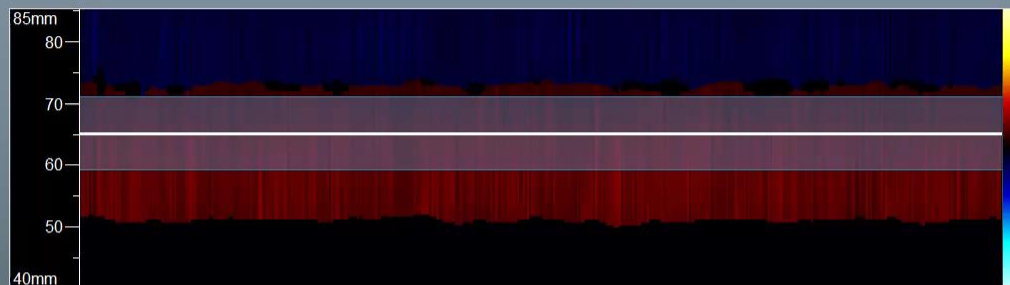
Invert

Auto Depth: Off

Recalculate
Parameters

Online

Resume Examination

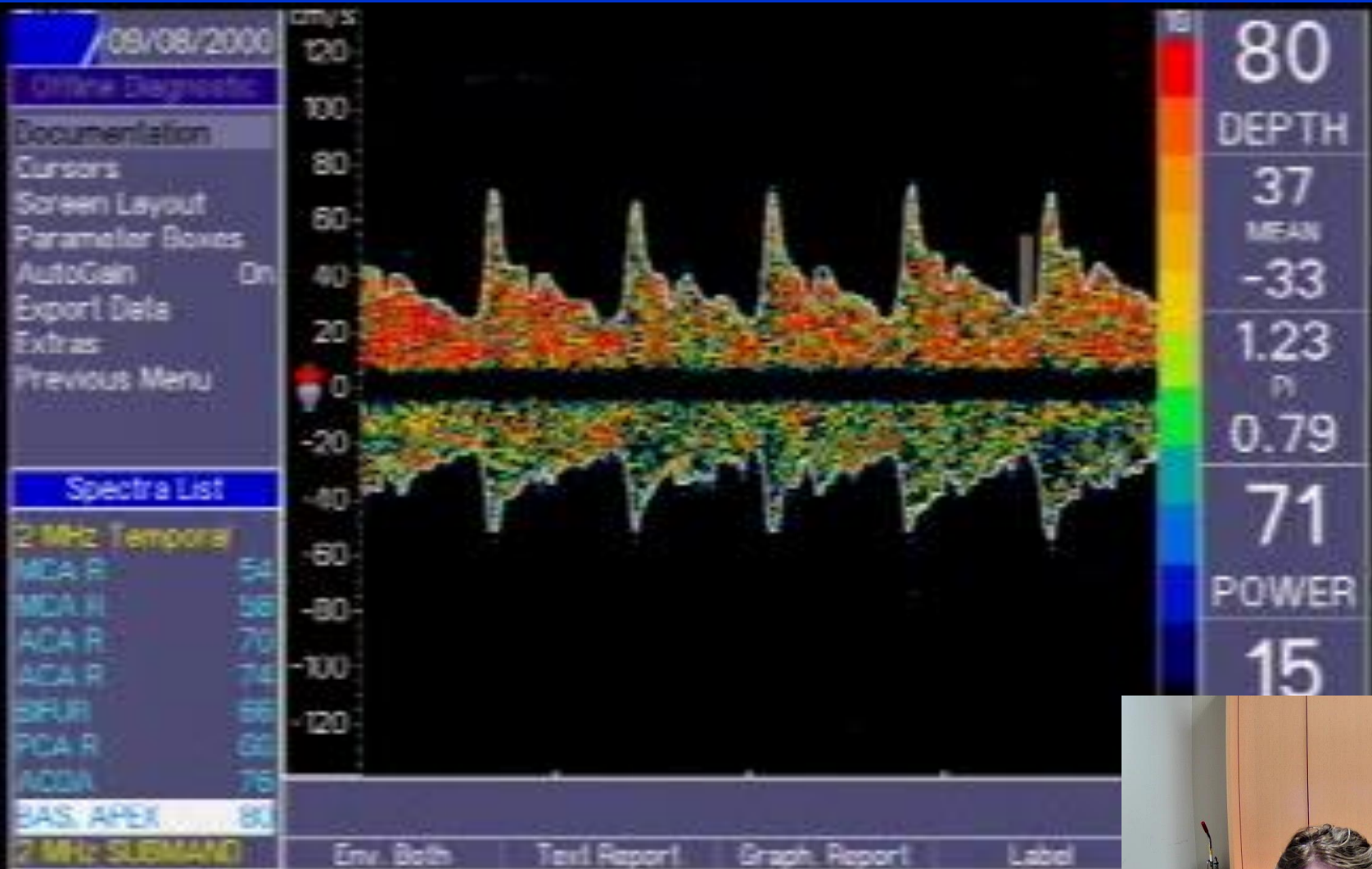


TIC: 1.21



Top of Basilar (STOP Protocol)

Locate the P1, then increase the depth to midline



How Do I Angle the Transducer?

Extracranial ICA (ICAec)



- Under the Ramus of the mandible (submandibular)
- Angle **Superior and Medial**
- Depth: 50mm
- Flow Direction: **Away**

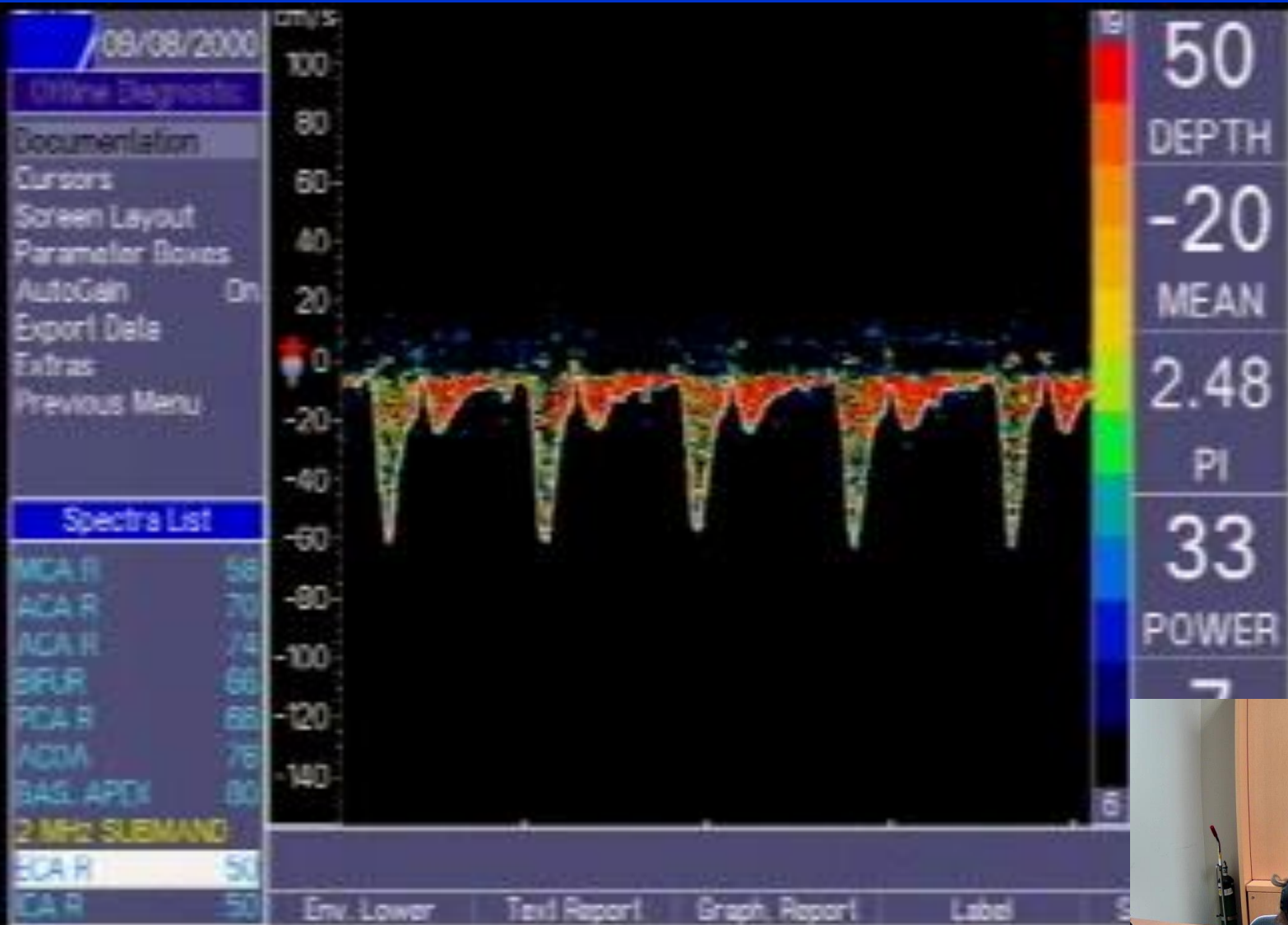


ICAec (50mm)

Angle: Superior and Medial



ECA- High Resistance



Ophthalmic and Siphon

- **Decrease Power to $\leq 10\%$**
- Close the eyelid and use light pressure!
- Should Not Scan: prosthetic eye, recent eye surgery, hard contact lenses
- Siphon: Sliding lateral toward the outer edge of eyelid
- The Contralateral ACA: 80mm- Medial Superior angle



How Do I Angle the Transducer?

Transorbital

Ophthalmic Artery-

- Angle: **Medial and Inferior**
- Depth: 50mm
- Flow Direction: **Toward**

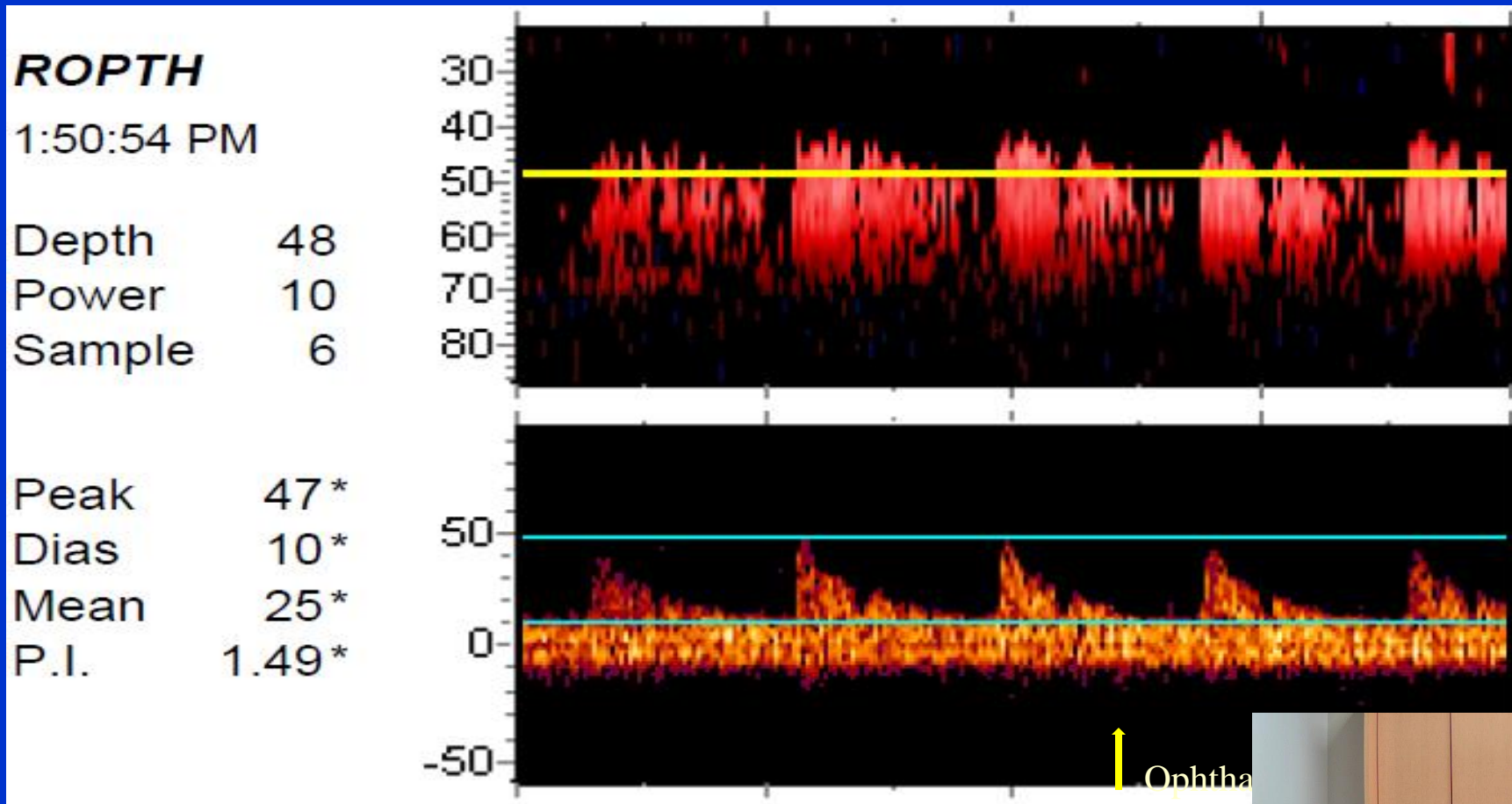
➤ Siphon-

- Angle: **Medial – angle varies**
- Depth: 60-70mm
- Flow Direction: **Away or Toward**



Ophthalmic Artery (50mm)

Angle: Inferior and Medial



Siphon (60-70mm)

test test

LSIPHN

05/18/2017 09:22 AM

52/-25
Mean

69/-47
Max

41/-18
Min

0.55/1.18
PI

10%
Power

90 -

60 -

30 -

0

base

-30 -

-60 -

cm/s

8 sec

80 -

70

Depth

60 -

50 -

40 -

30 -

mm

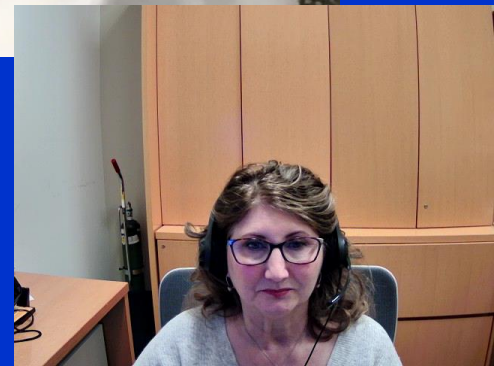
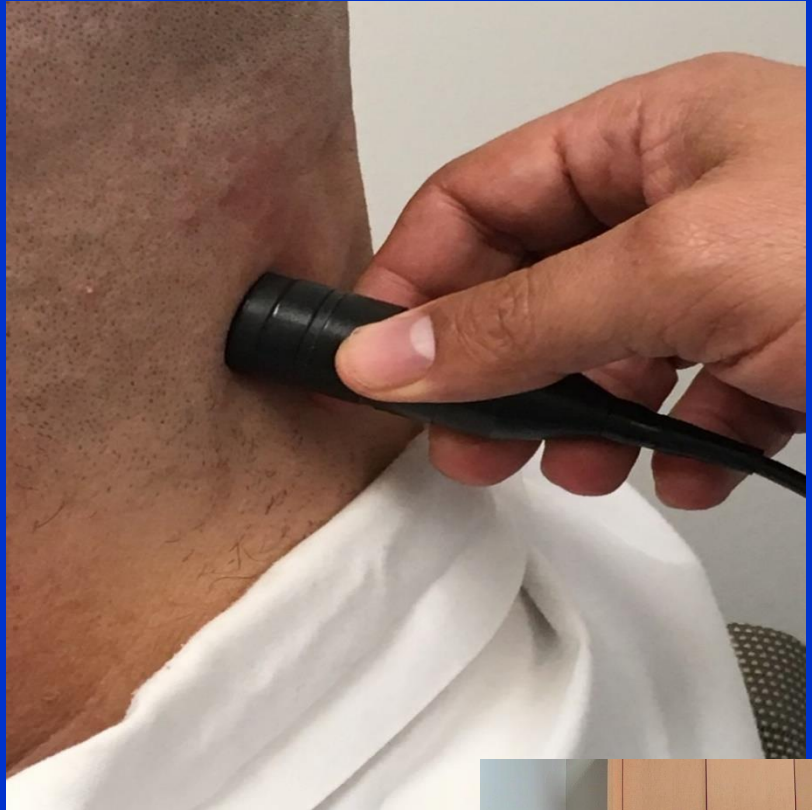


How Do I Angle the Transducer?

-Subforaminal/ Vertebrobasilar

- **Vertebral: 50-80mm**
 - Direction : **Away**
 - Place probe under Mastoid
 - **Flat, medial angle:** Shallow
 - **Superior, Medial:** Deep
- **Basilar: 80-110mm**
 - Direction: **Away**
 - Move Probe toward the foramen
 - Push and scoop wrist motion

Posterior Circulation



Vertebral Artery (60-80mm)

Angle: Superior and Medial

LVERT

8:33:25 AM

Depth 63

Power 100

Sample 9

Peak -41

Dias -21

Mean -29

P.I. 0.69

30

40

50

60

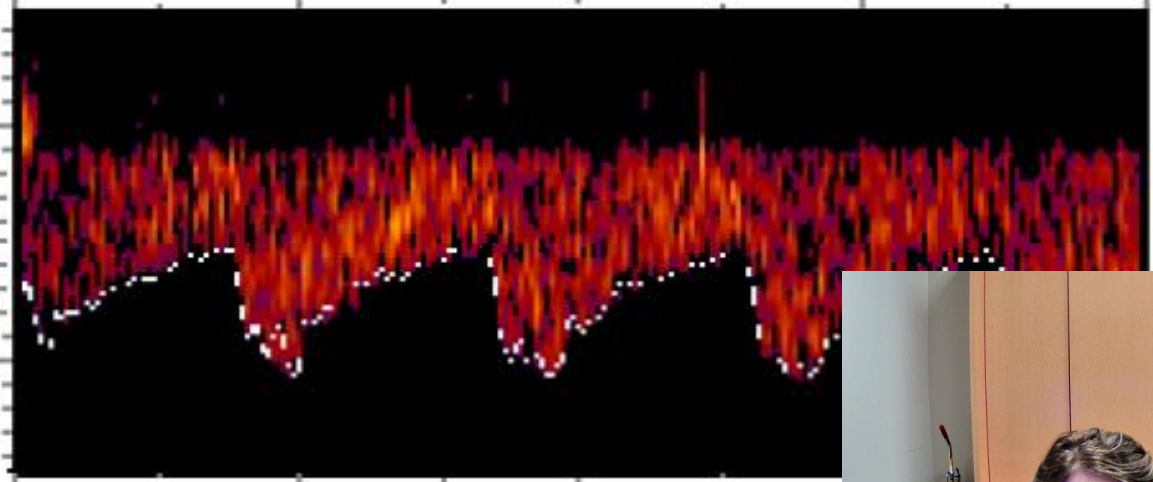
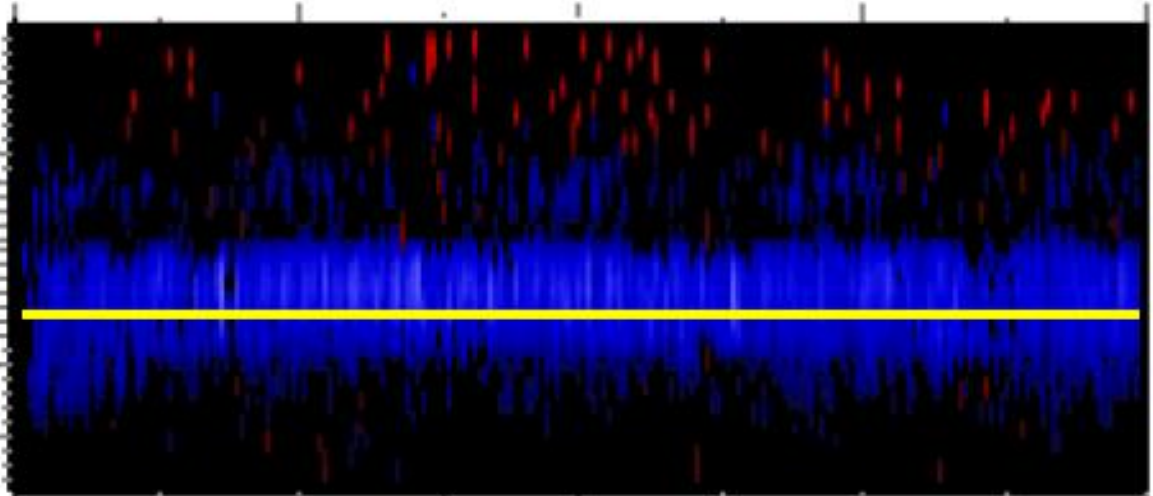
70

80

0

-20

-40



Basilar Artery (85-115mm)

Angle: Superior- Can Be Tortuous

dddd test

Routine Main Screen

VIASONIX

Summary

New

Load

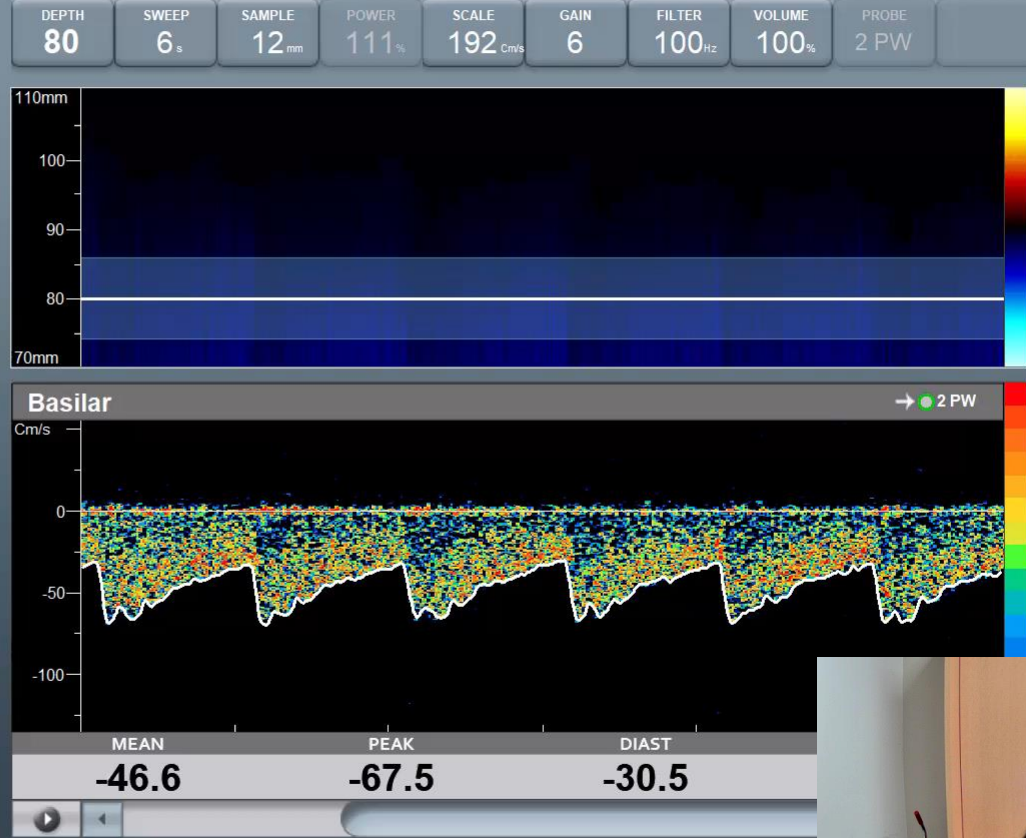
Menu

Exit

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✓ R T-ICA	60	31.2	44.3	20.8	0.75
✓ R ACA	60	-46.2	-69.0	-29.4	0.86
✓ R PCA P1	65	36.8	54.8	23.4	0.85
✓ R EX-ICA	50	-31.5	-51.1	-19.9	0.99
✓ R EX-ICA	50	-33.8	-52.6	-20.9	0.94
✓ R Vertebral	70	-48.5	-69.5	-32.5	0.76
▶ Basilar	80	-46.3	-66.7	-30.4	0.78

Add

Delete



Save

Replay

Waveform Label

Cursors Off

Envelope:
Lower

Invert

Auto Depth: Off

Recalculate
Parameters

Online

Resume Examination

TIC: 2.52 TIS: 1.1 TIB: 4.62

M-Mode

1. Bands of color (**red** & **blue**): representing **flow direction** across the Anterior or Posterior circulations
2. Easier to comprehend: Provides an overview of where the flow can be found: and what depth
3. M-mode **does not**:
 - represent velocity or pulsatility
 - describe a disease process
 - provide a thorough/complete TCD examination
4. M-Mode represents **reflected power (intensity)**



LMCA

2:17:34 PM

Depth 54

Power 100

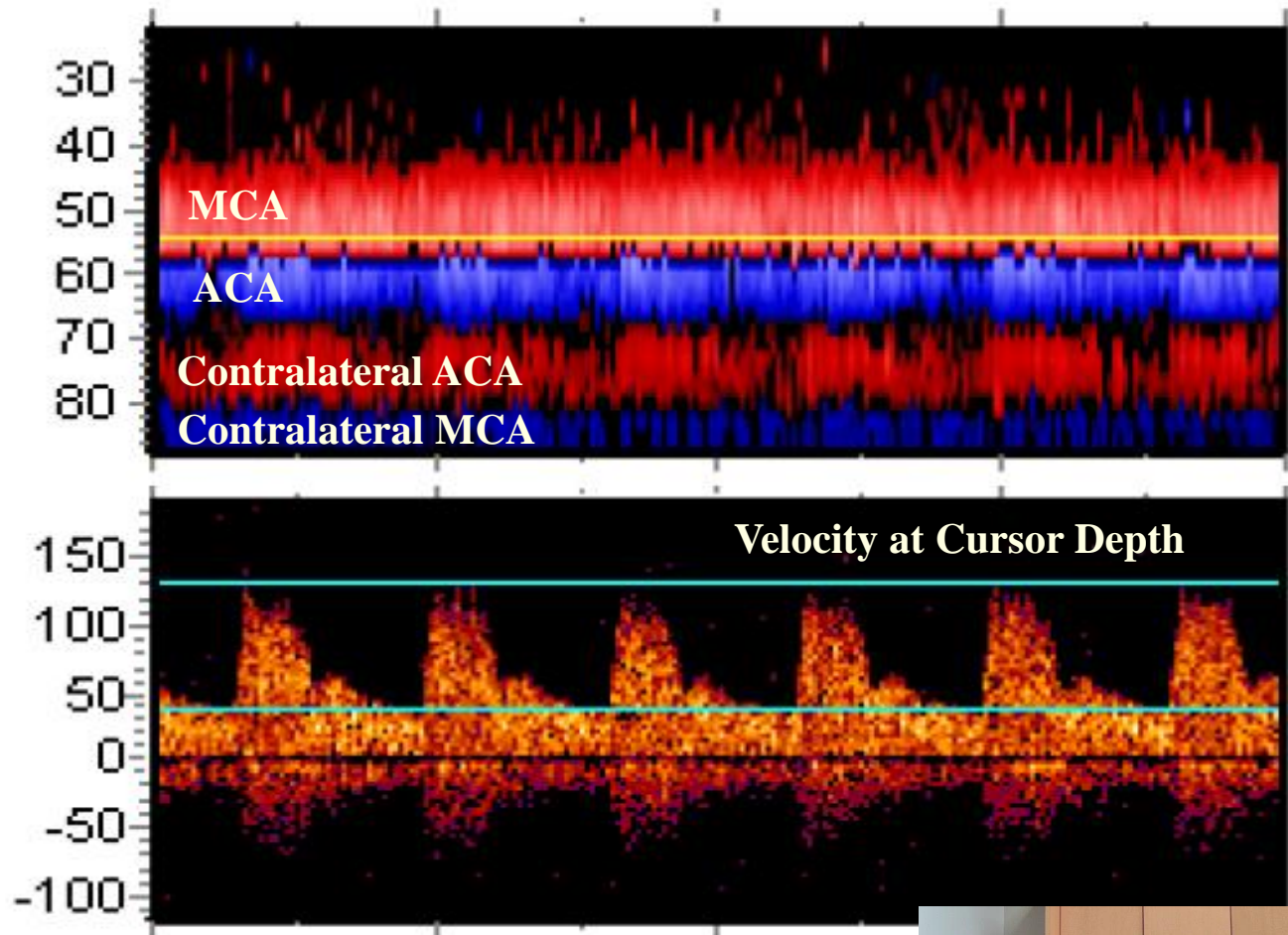
Sample 6

Peak 131*

Dias 36*

Mean 74*

P.I. 1.28*



Red, Blue, Red, Blue

Signature M-Mode Presentation of the Anterior

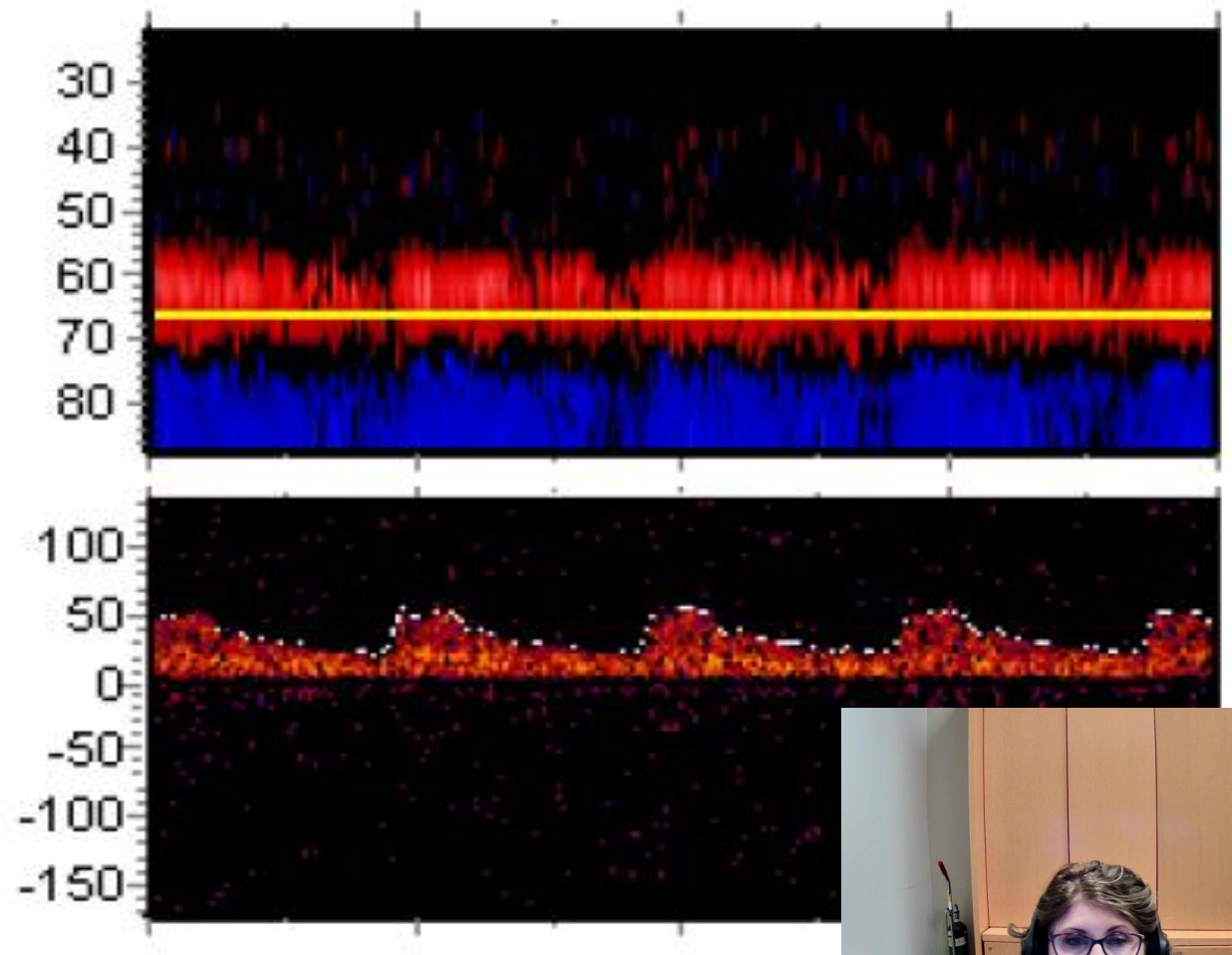


MCA vs. PCA

P1 Portion of PCA is shallow, it ends at 54-55mm of Depth – “RED”

Top of Basilar (TOB) at Bifur. – “BLACK”

Deeper than Bifur. is the Contralateral P1 PCA – “BLUE”



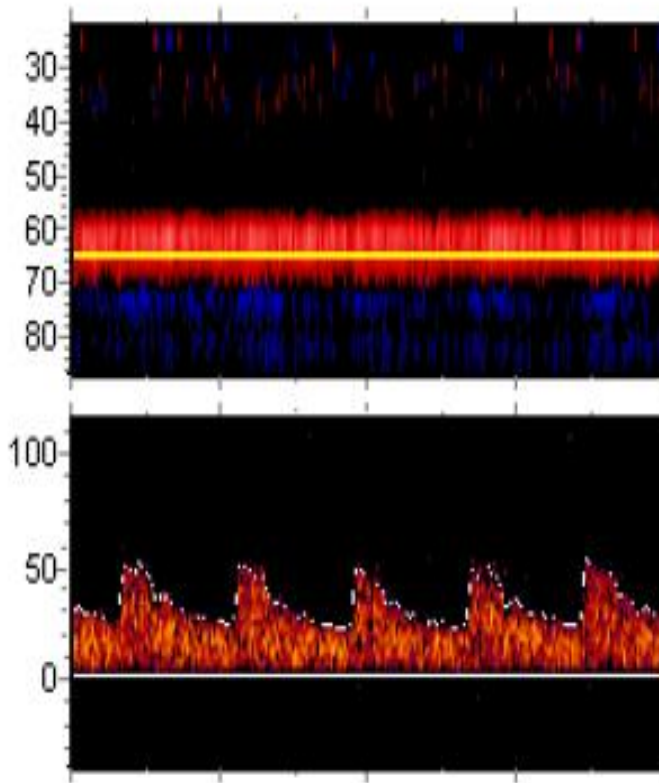
PCA- Light Reactivity

eyes closed

RPCA

10:40:25 AM

Depth 65
Power 100
Sample 6



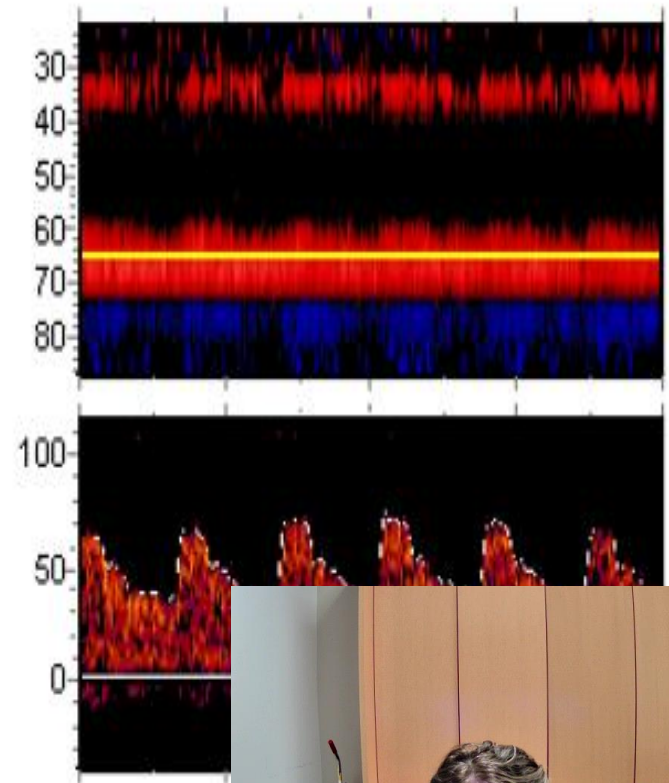
Peak 51
Dias 24
Mean 34
P.I. 0.79

eyes open

RPCA

10:39:30 AM

Depth 65
Power 100
Sample 6



Peak 70
Dias 36
Mean 50
P.I. 0.68

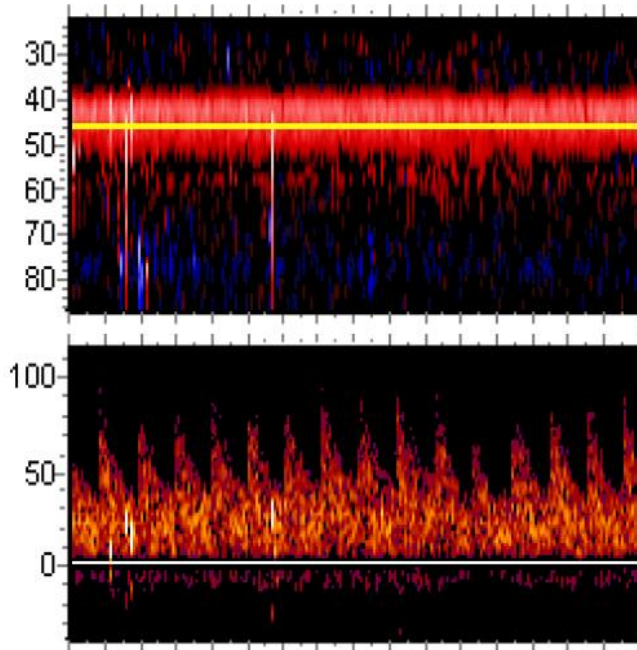


Advantage of Dual Monitoring: Identifies Asymmetry, Emboli and Bubbles

RMCA

12:34:26 PM

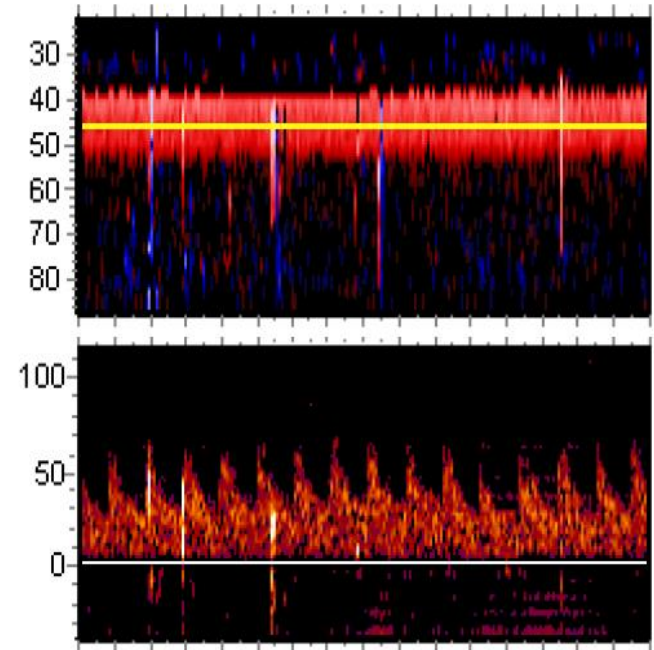
Depth 45
Power 50
Sample 3



LMCA

12:34:26 PM

Depth 45
Power 50
Sample 3



14:05:06

VESSEL
LMCA

DEPTH
50

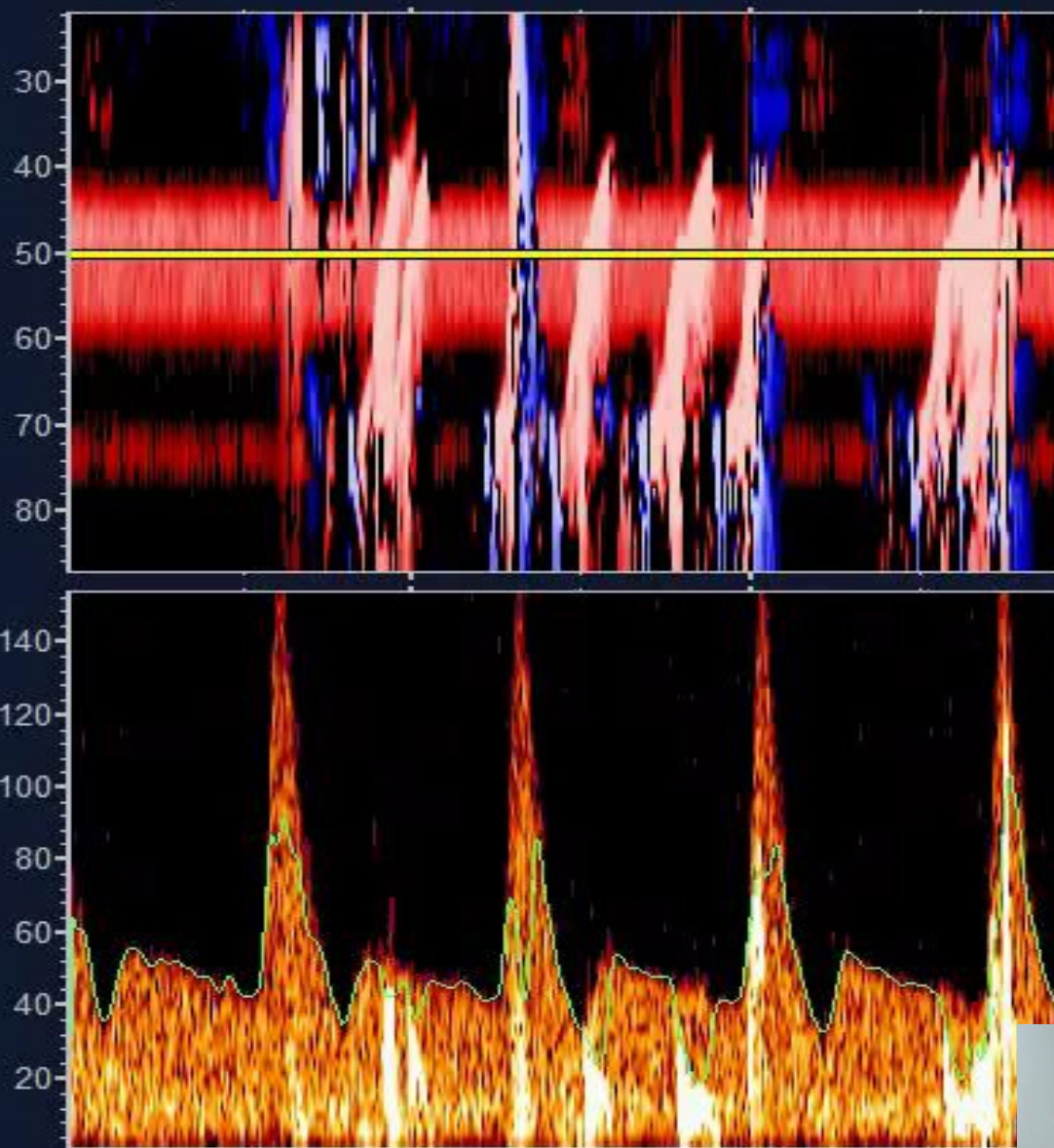
POWER
50

SAMPLE
3

1

mm

cm/s



+

PEAK

93

MEAN

51

DIAS

32

P.I.

1.18

$\Delta\%$

250



Technical Difficulties

- **80%** of the Population: Incomplete Circle of Willis
- **5-10%** of the Population have acoustically insufficient Temporal windows due to increased bone density
- Missing or Hypoplastic vessels: ACA, P1 PCA, ACoM
- Persistent Fetal Circulation: Change in PCA normal flow direction
* **Best identified with imaging**
- “Narrow” windows, or finding the “best” window



Thank You for Your Kind Attention!