Overview

- Introduction
- Light & Endoscopy
- X-Rays
- Nuclear imaging
- Magnetic Resonance Imaging
- Ultrasound imaging

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- X-Rays
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Ultrasound Imaging

- An ultrasound is a High Frequency sound (mechanical wave).
- Ultrasound imaging uses the same technology as bats or submarine sonars

Ultrasound Imaging

Short History:

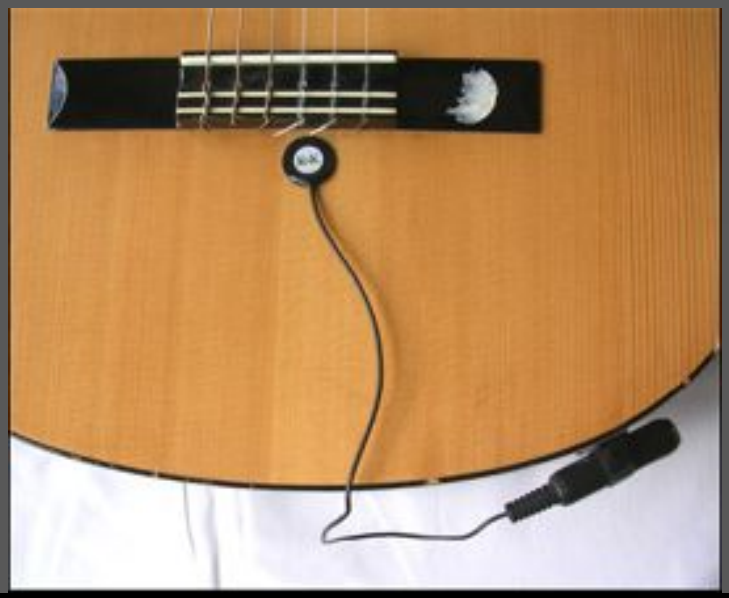
- 1794 : Spallanzani discovers ultrasound observing bats

They can move without using their eyes.

Ultrasound Imaging

Short History:

- 1794 : Spallanzani discovers ultrasound observing bats
- 1880 : Discovery of the piezoelectric effect (Pierre & Jacques Curie)



Ultrasound Imaging

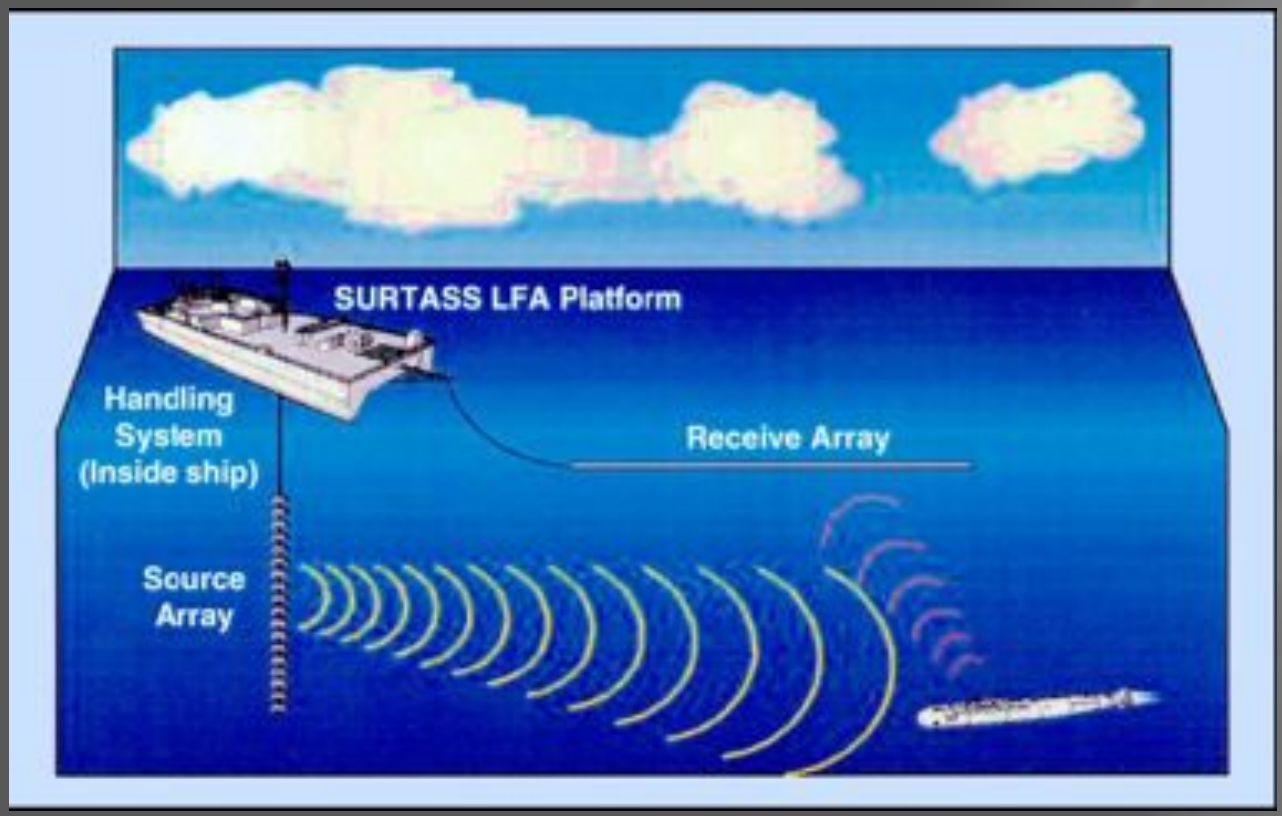
Short History:

- 1794 : Spallanzani discovers ultrasound observing bats
- 1880 : Discovery of the piezoelectric effect (Pierre & Jacques Curie)
- 1883 : Galton builds an ultrasound whistle

Ultrasound Imaging

Short History:

- 1915 : first SONAR (SOund NAvigation and Ranging)





Ultrasound Imaging

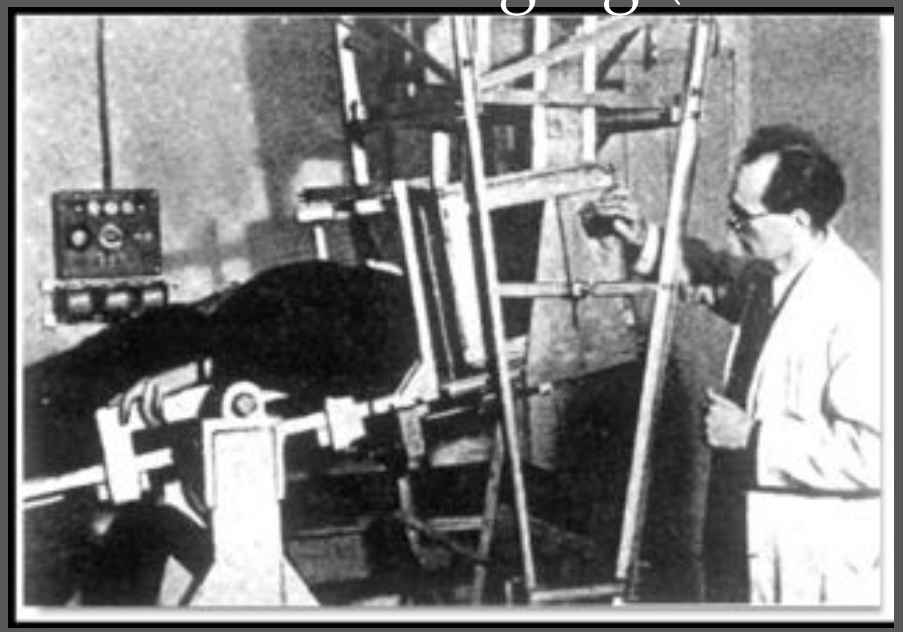
Short History:

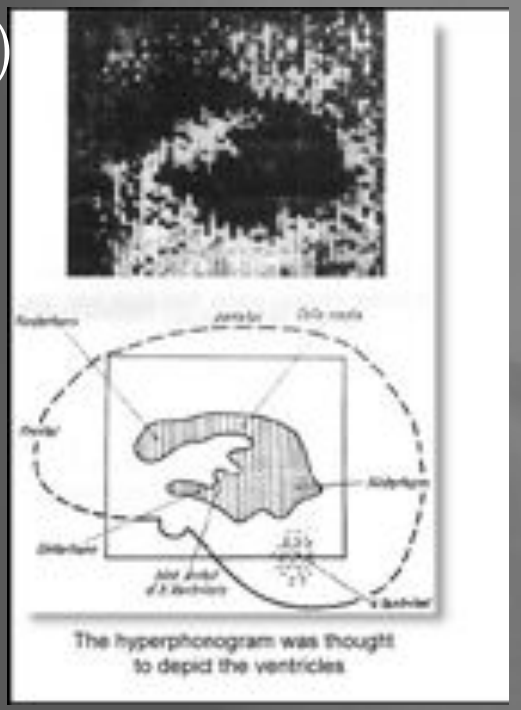
- 1915 : first medical application of the SONAR

Ultrasound Imaging

Short History:

- 1915 : first medical application of the SONAR
- 1947 Visualization of the first brain tumor by ultrasound imaging (Dussik brothers)







Ultrasound Imaging

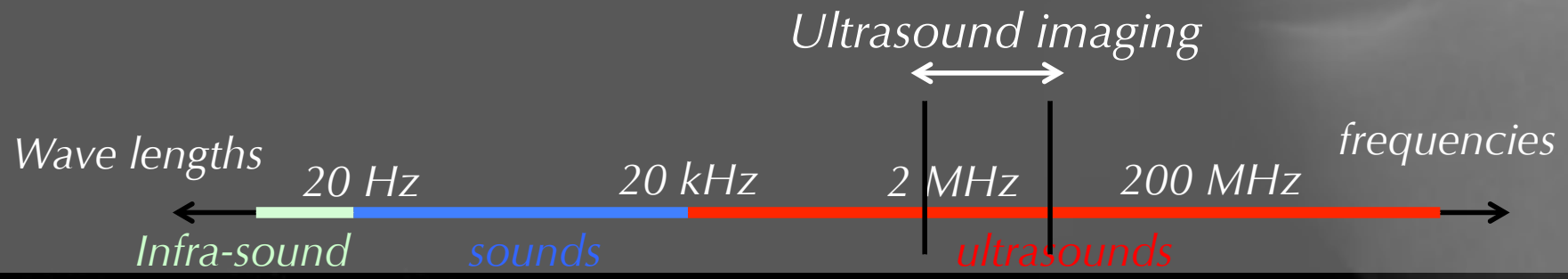
Short History:

- 1957 First swiping ultrasound imager

Ultrasound Waves

- Propagate within matter through
  - Compressions,
  - Relaxations.
- Do not propagate in vacuum

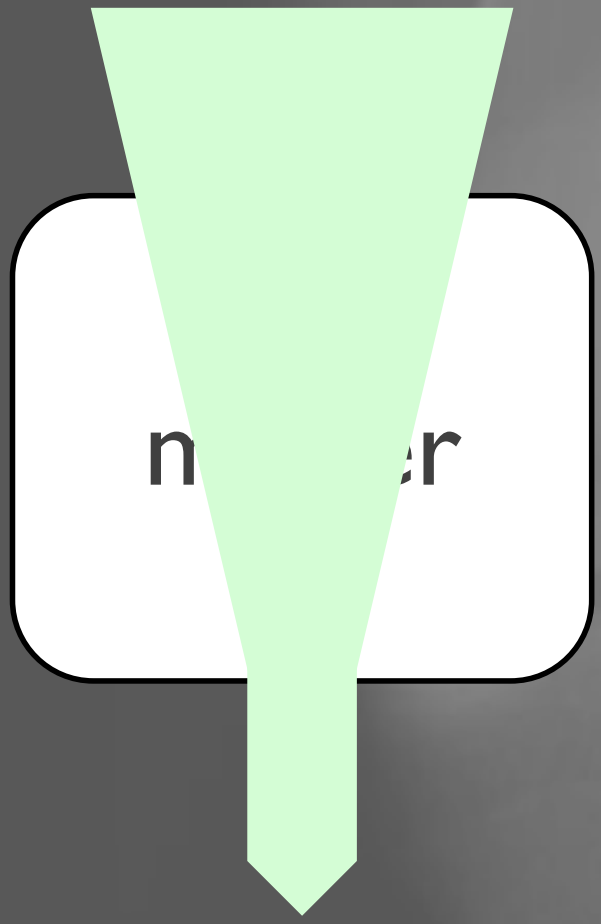
Field	Propagation Speed (m/s)
Air	333
Water	1480
Fat	1446
Muscle	1542–1626
Blood	1566
Bone	2070–5350



Ultrasound and Matter Interactions

- Absorption :

Attenuation	Matx Depth
2,5-3,5 MHz	> 15cm
5 MHz	10cm
7,5 MHz	5-6cm
10 MHz	2-3cm



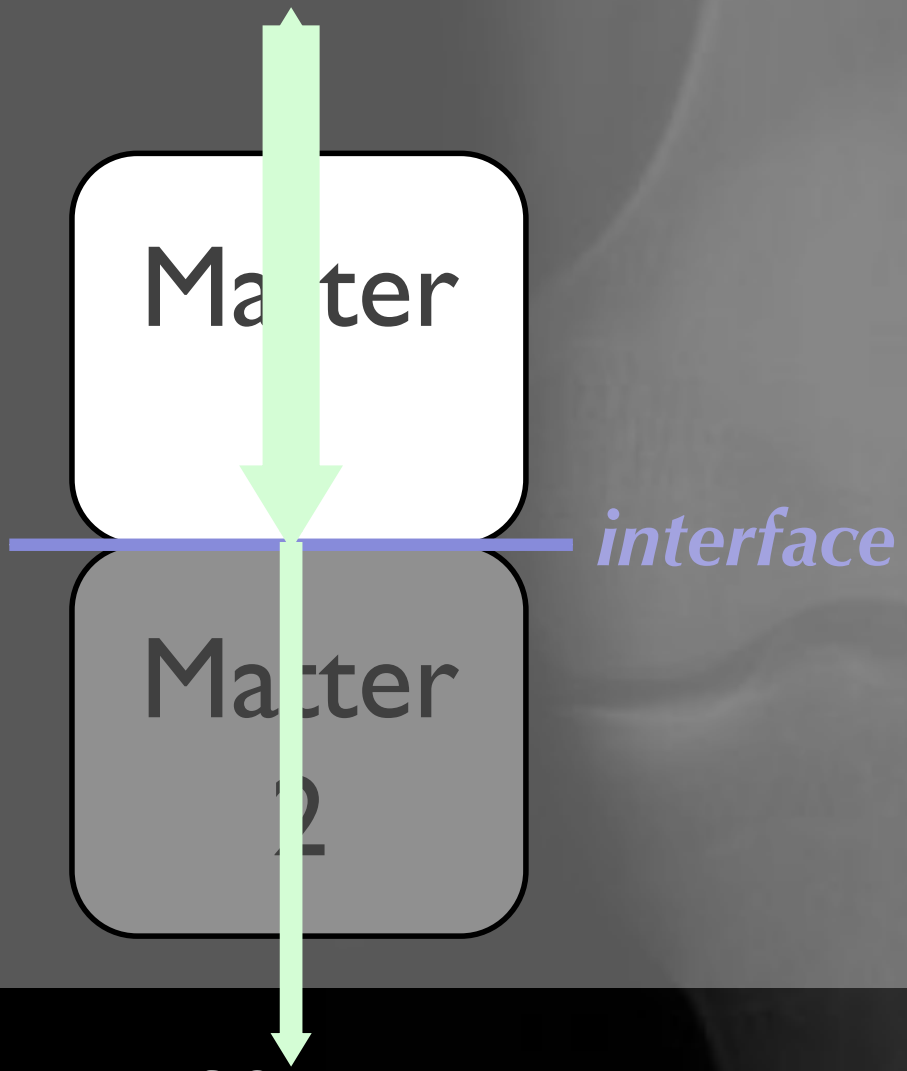
Ultrasound and Matter Interactions

Material	Att. coefficient (dB/cm MHz)
Water	0.002
Fat	0.66
Soft Tissue	0.9
Muscle	2.0
Air	12.0
Bone	20.0
Lung	40.0

- Water, Fat, Soft Tissues, Muscles
  - ➢ Good Ultrasound Transfer Materials
- Air, Bones, Lungs:
  - ➢ Stop Ultrasounds

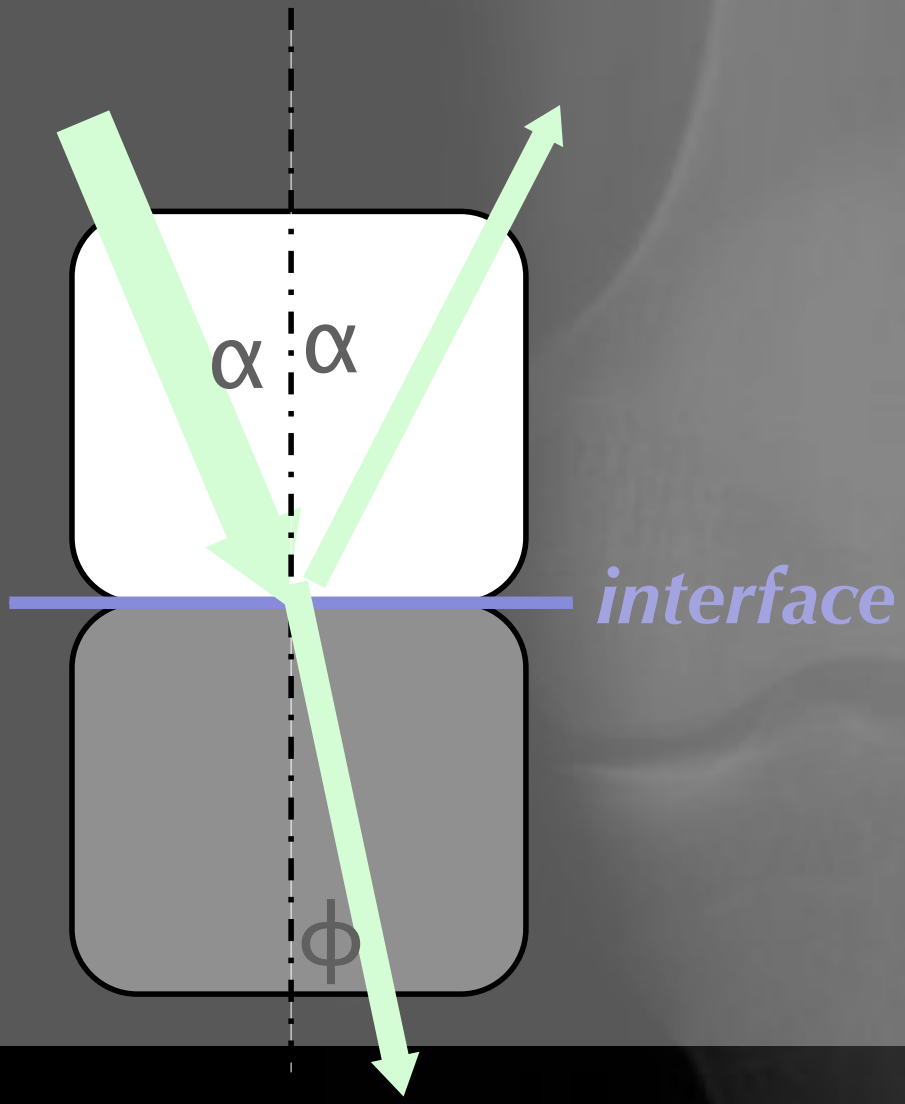
Ultrasound and Matter Interactions

- Absorption
- Reflection (echo)



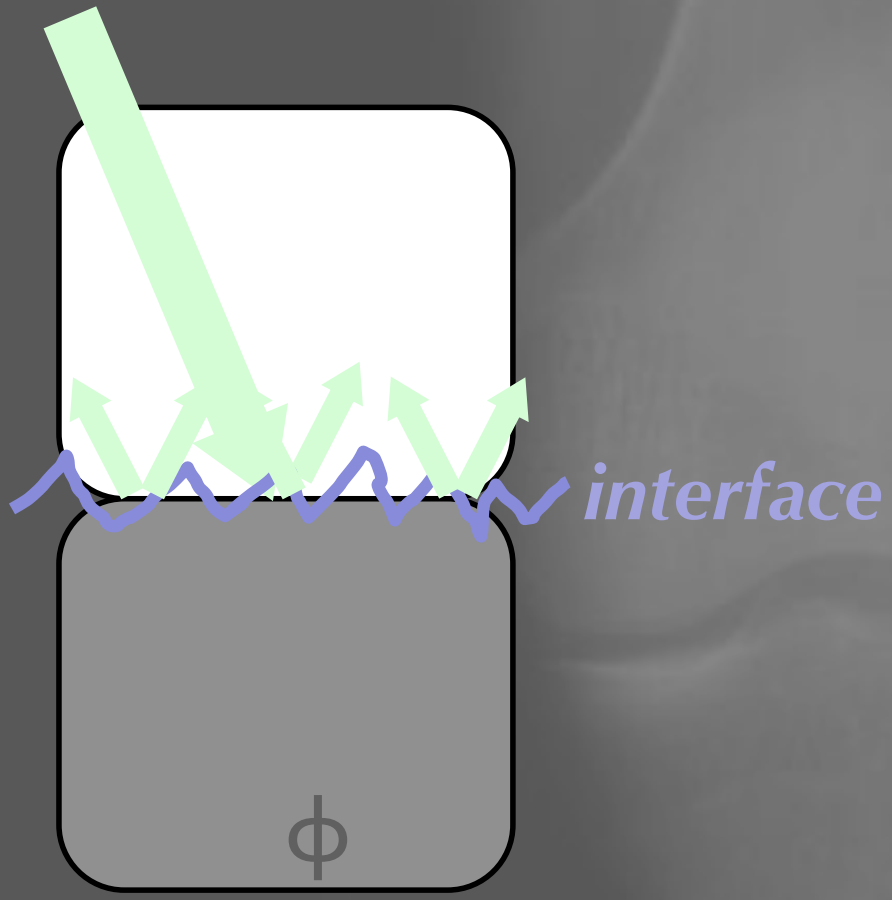
Ultrasound and Matter Interactions

- Absorption
- Reflection (echo)
- Refraction



Ultrasound and Matter Interactions

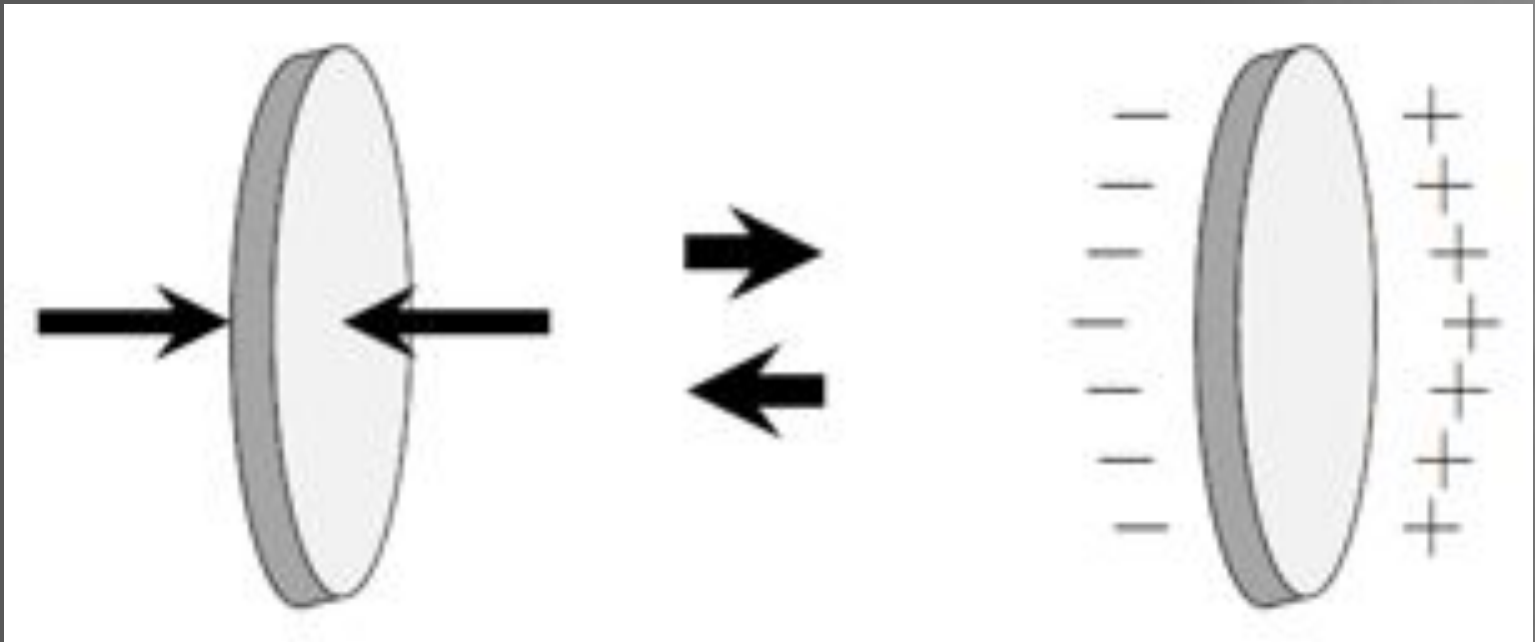
- Absorption
- Reflection (echo)
- Refraction
- Scattering



Ultrasound Imaging Principle

- Piezoelectric effect:

  Electric curent ⇔ Mechanical waves



Ultrasound Imaging Principle

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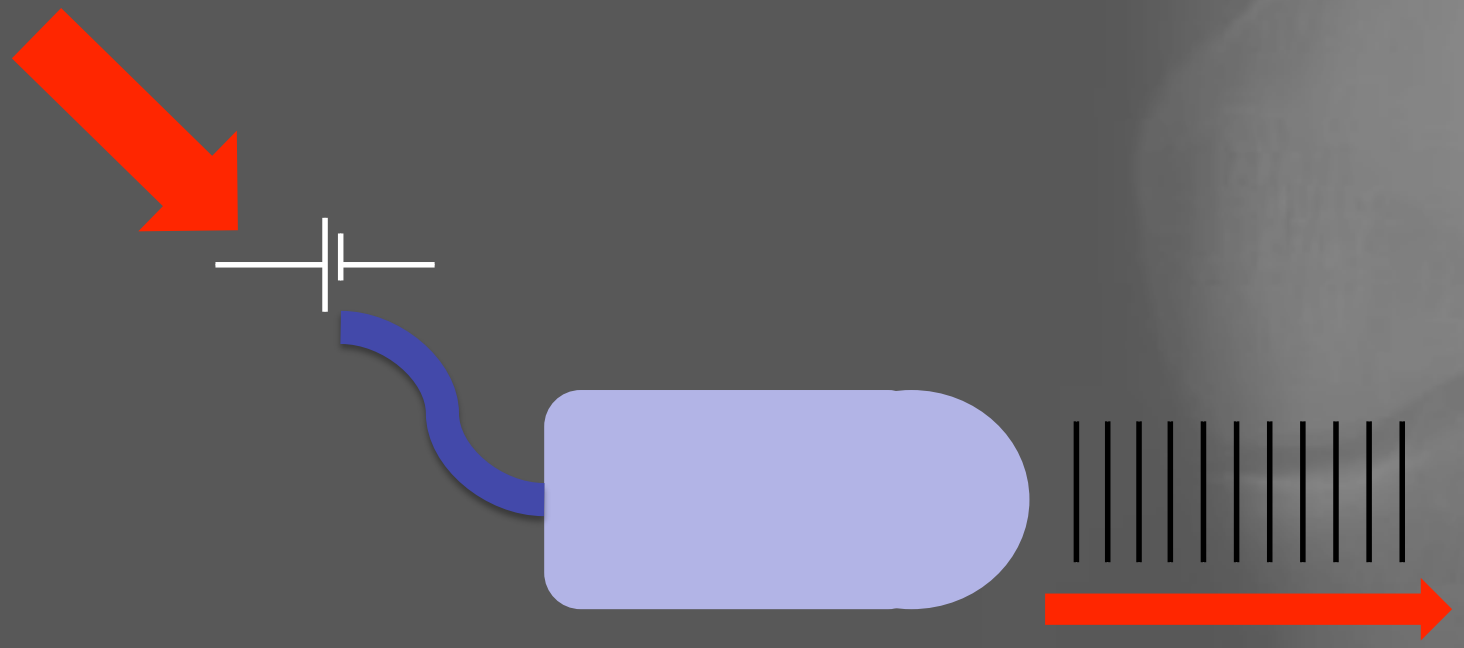
Ultrasound Imaging Principle

- Piezoelectric effect:

  Electric curent => Mechanical waves



Ultrasound Imaging Principle

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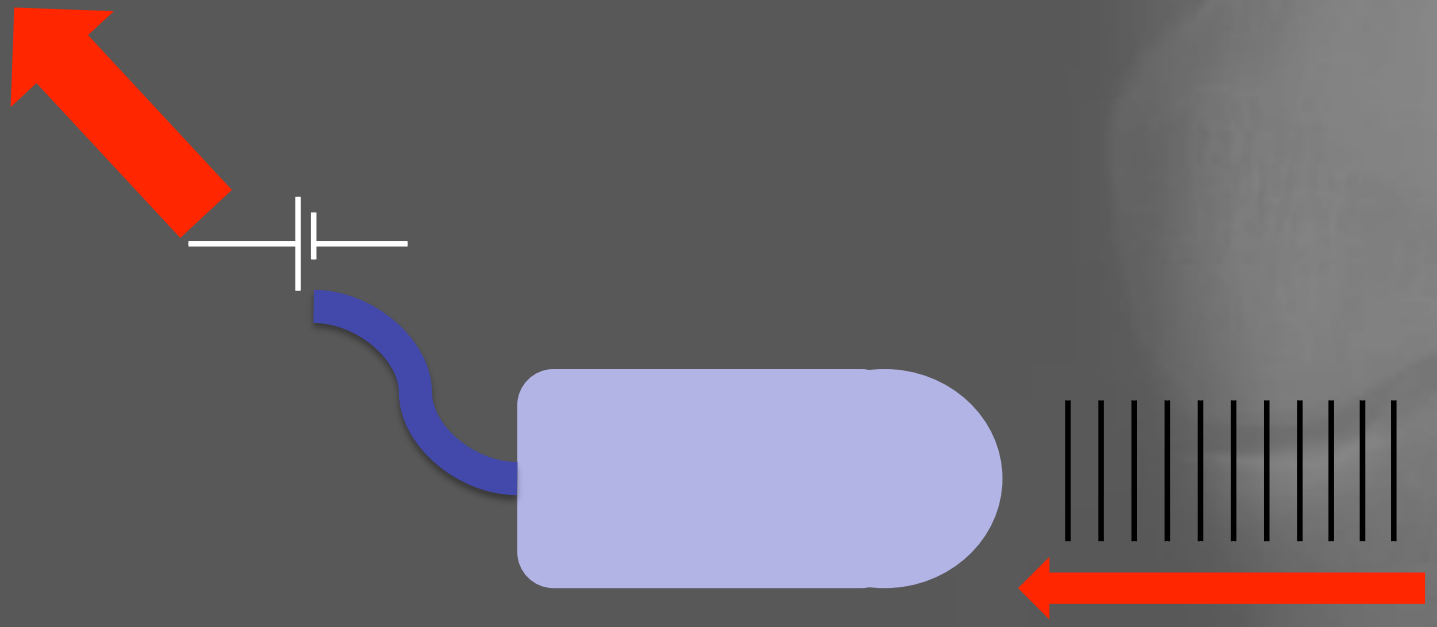
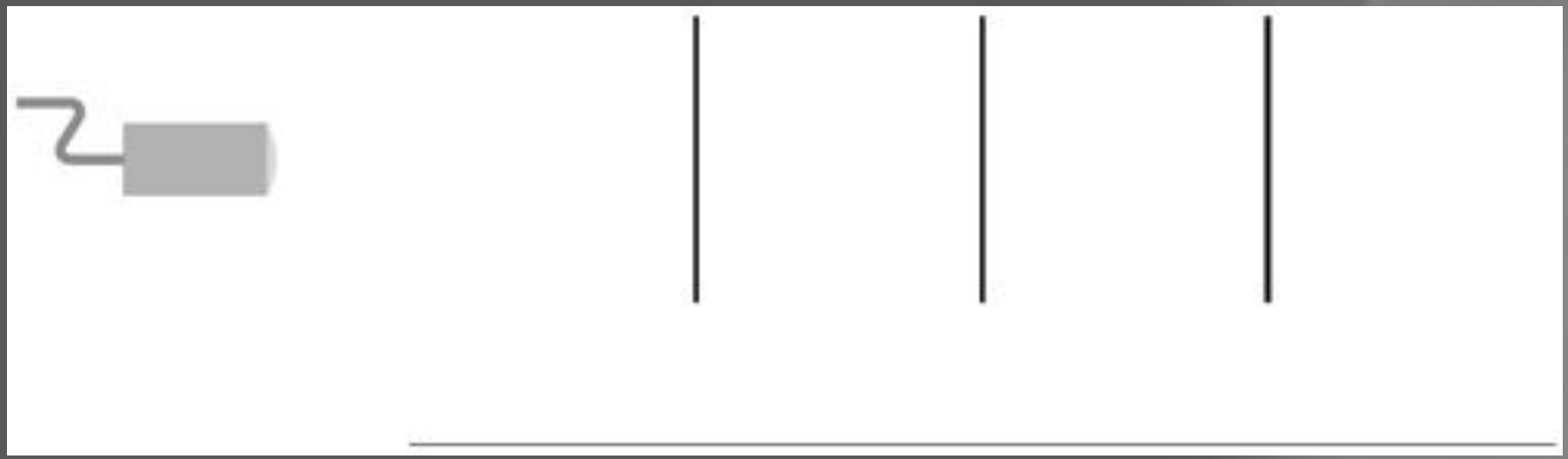
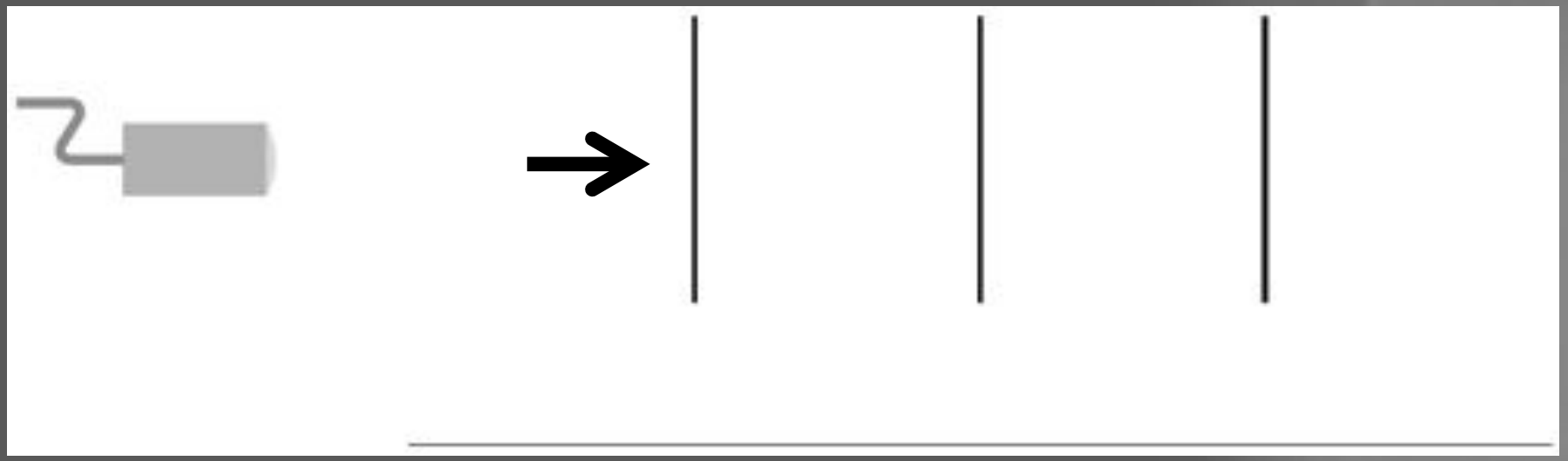


Ultrasound Imaging Device

- Ultrasound Probe
- Computation Unit
- Puls controler (controls frequency, length and amplitude of current emission)
- Screen/keyboard/etc.



- Formation d'une image 1D :



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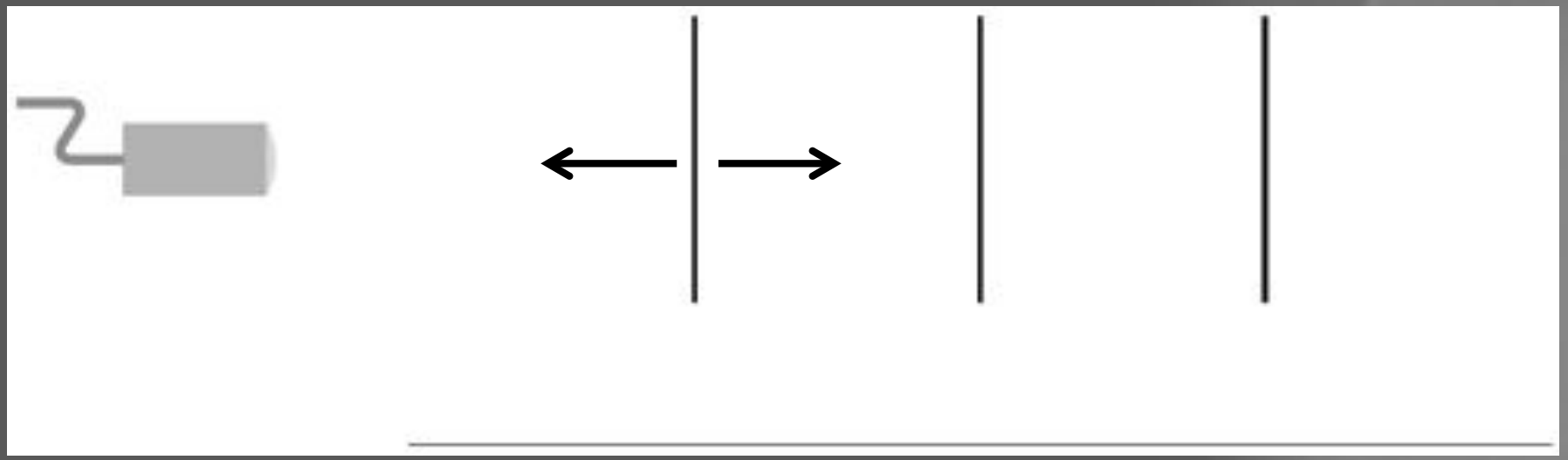

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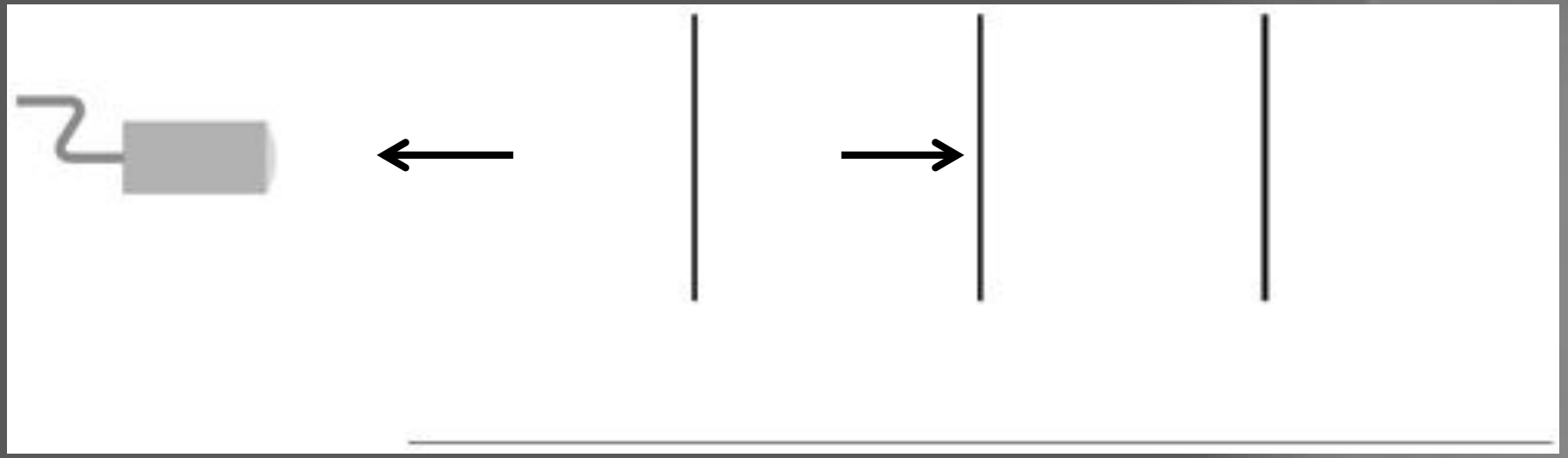

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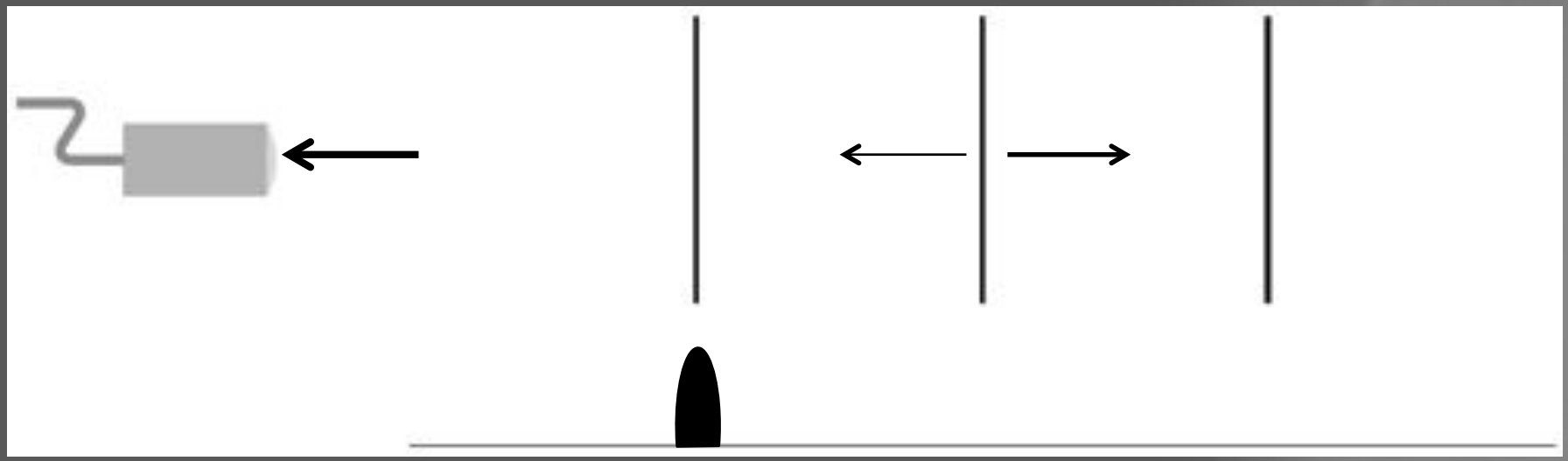

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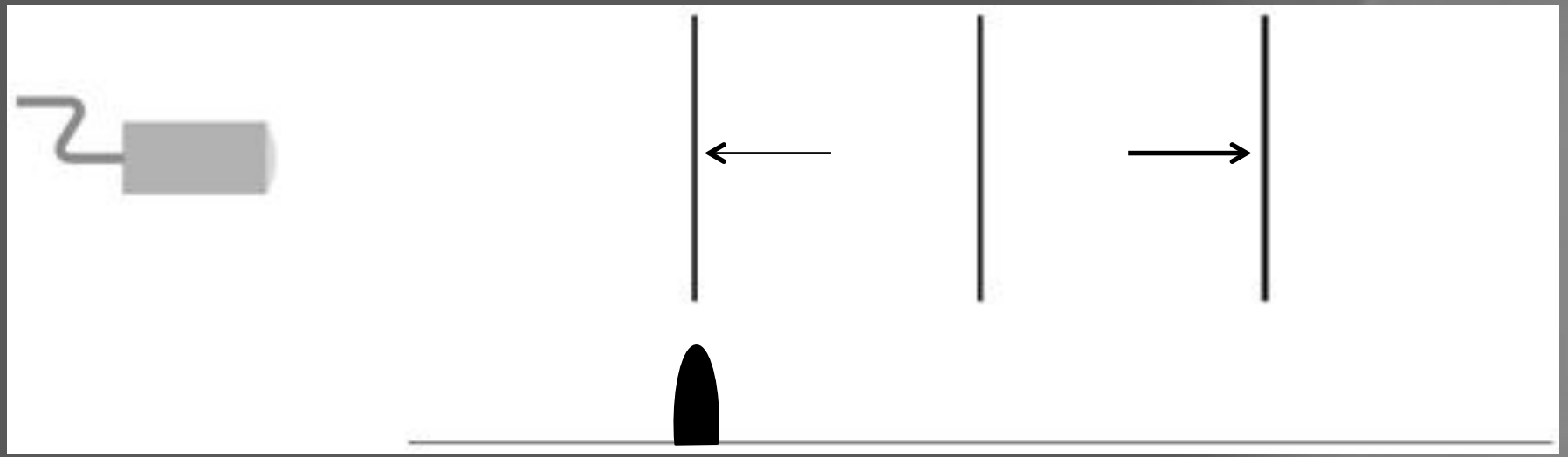

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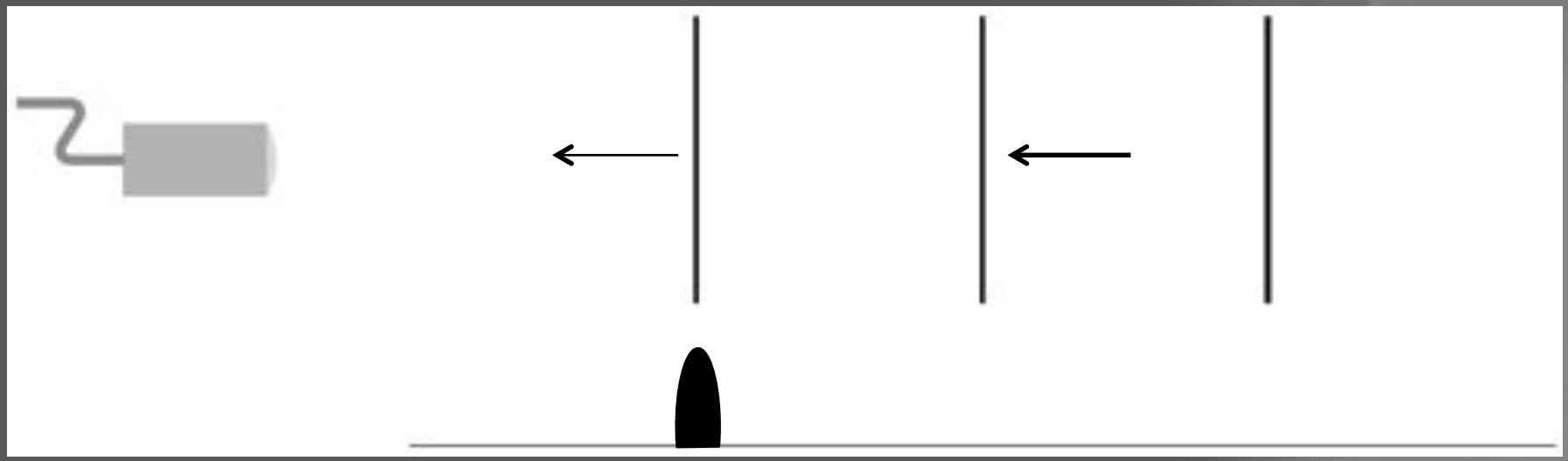

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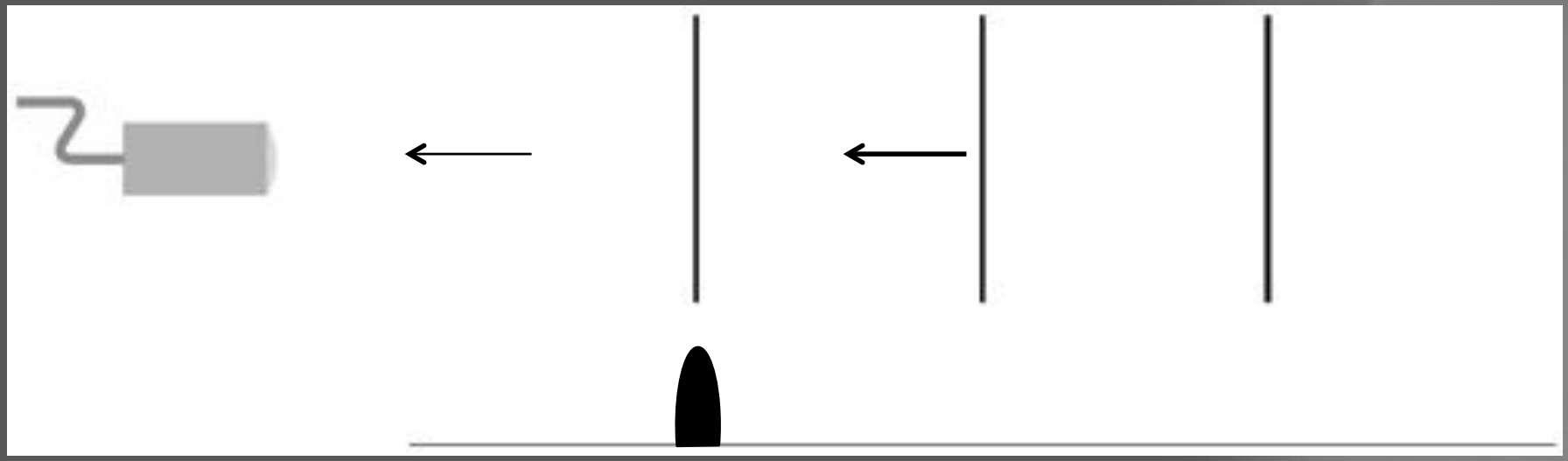

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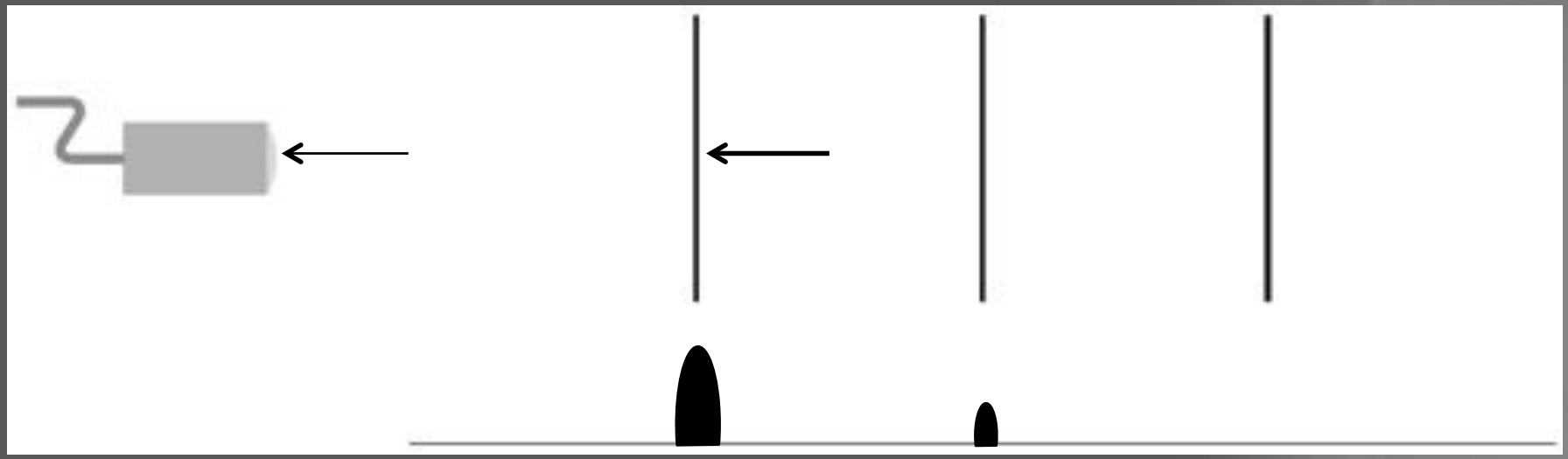

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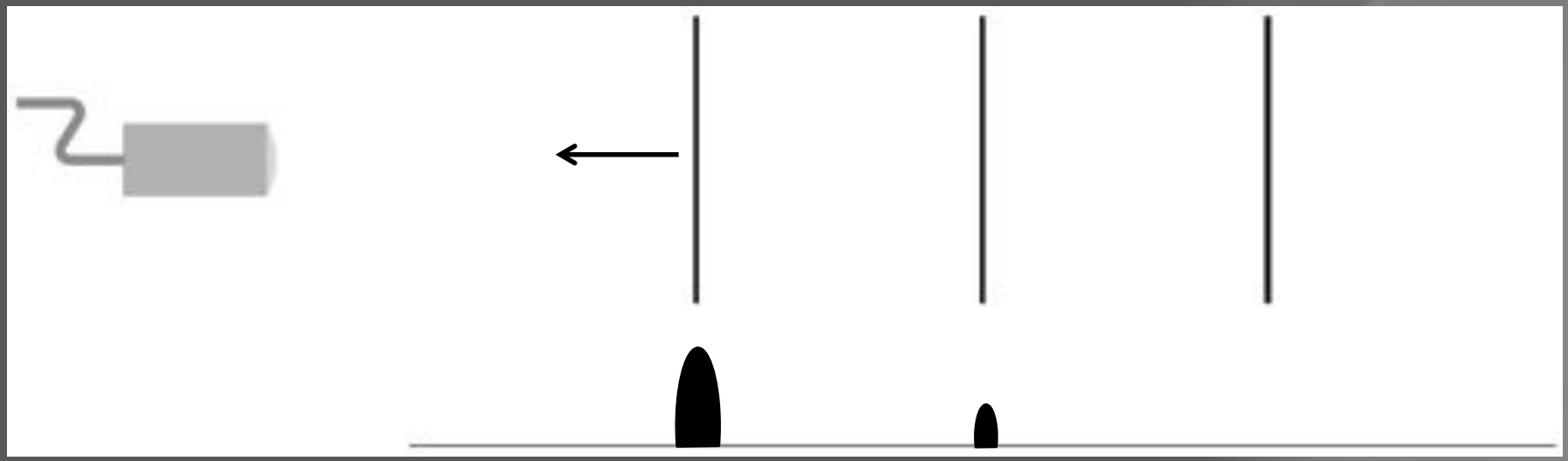

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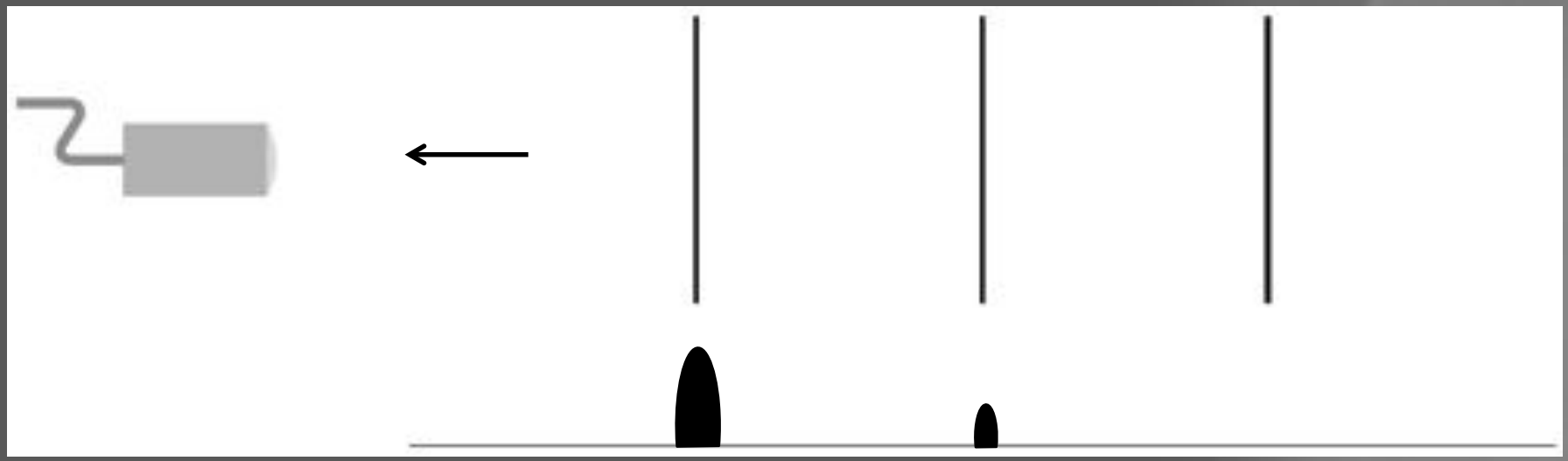

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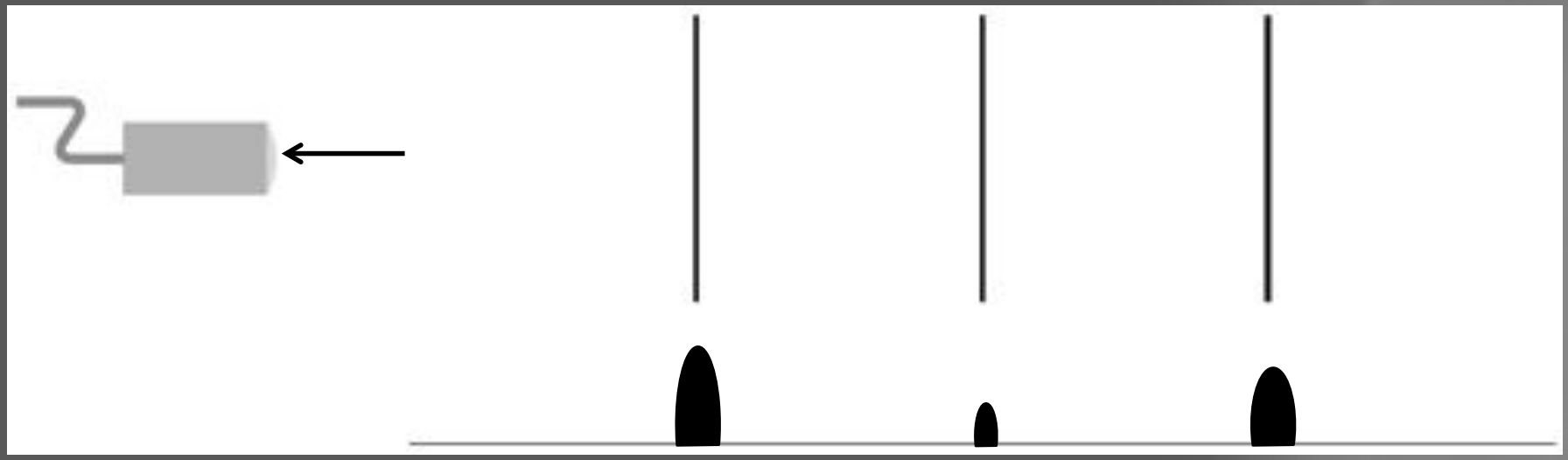

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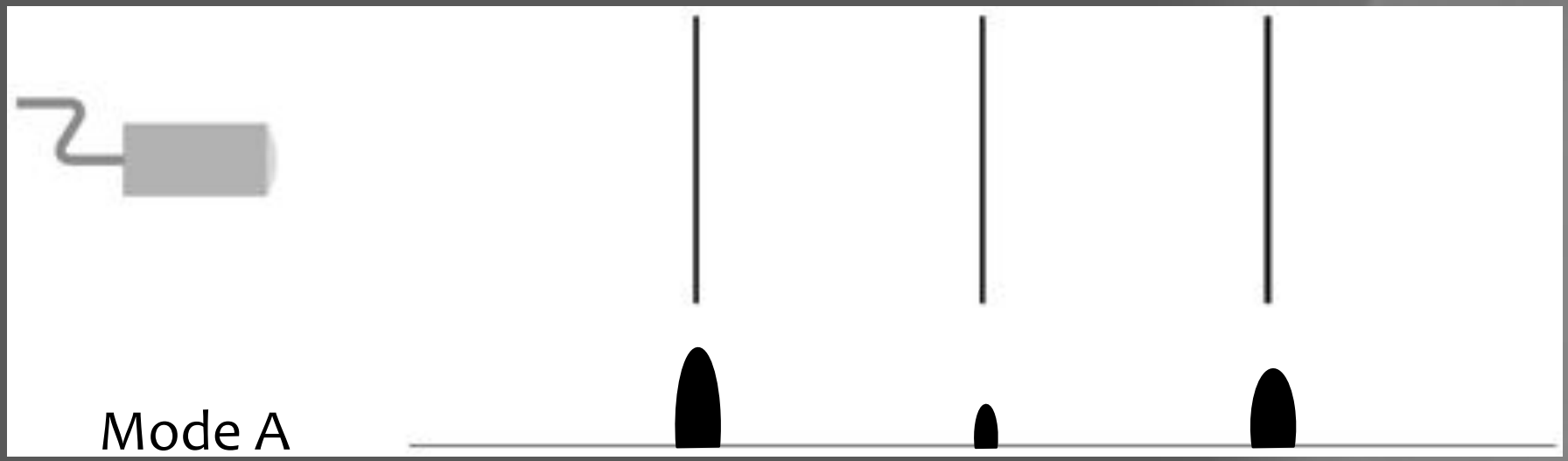

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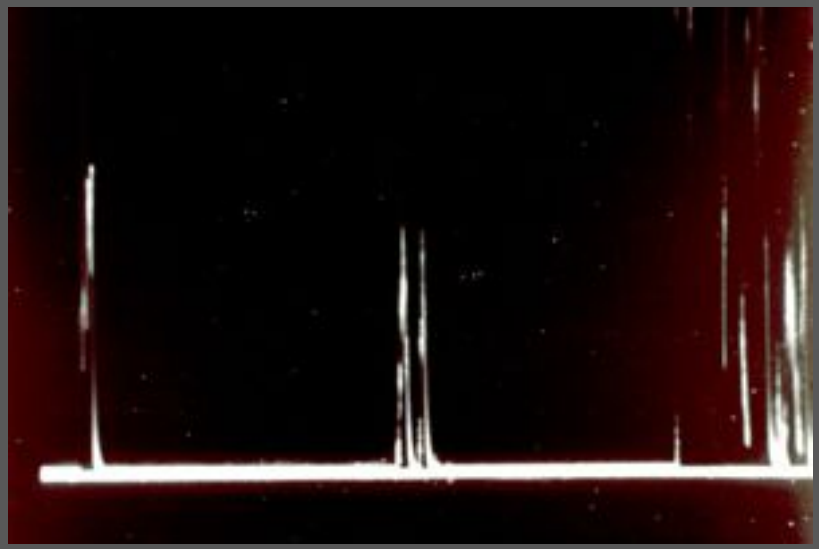

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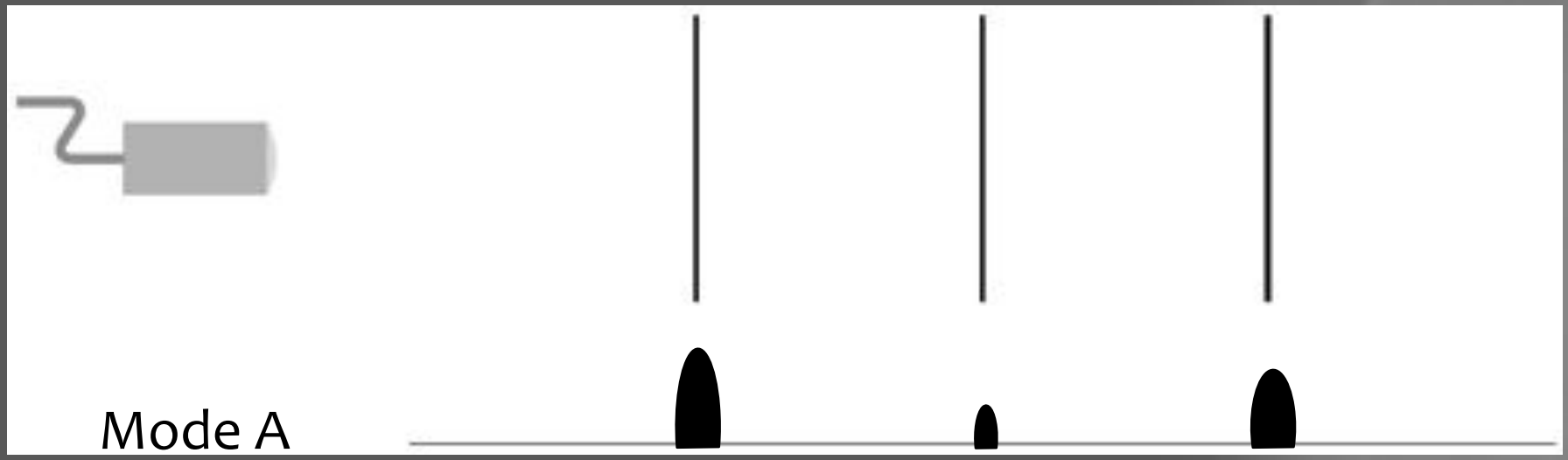

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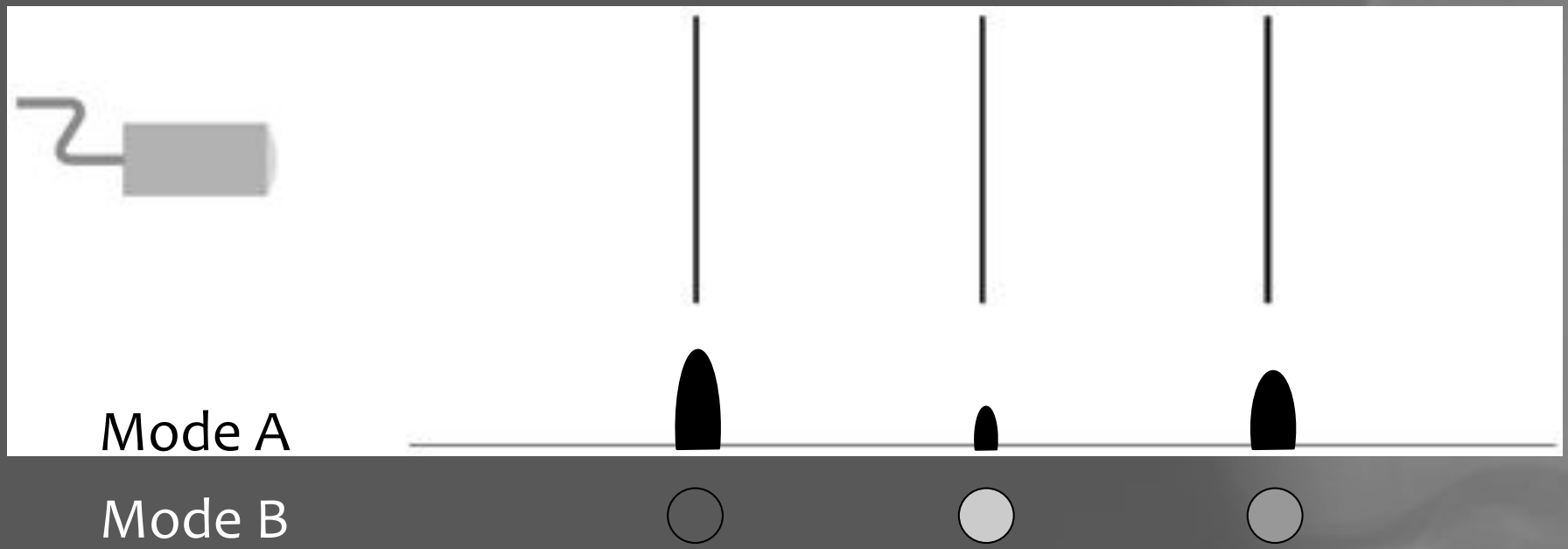

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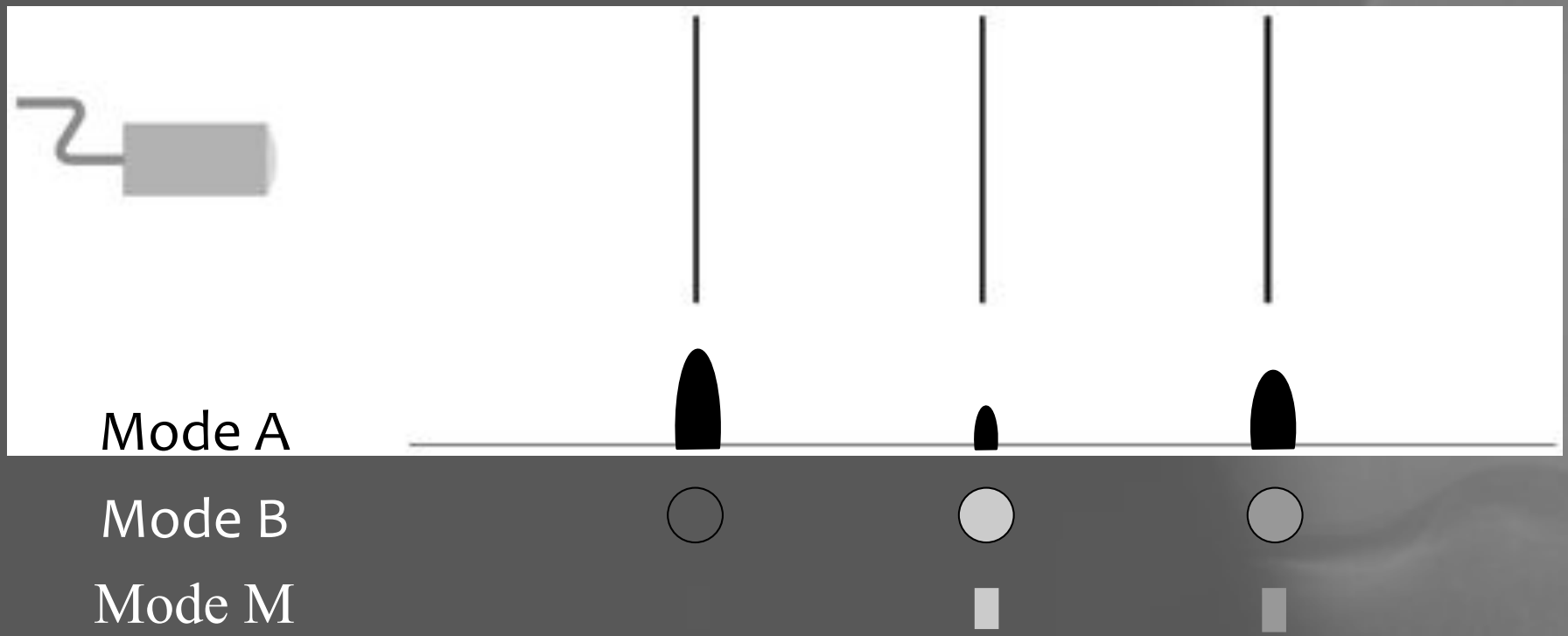

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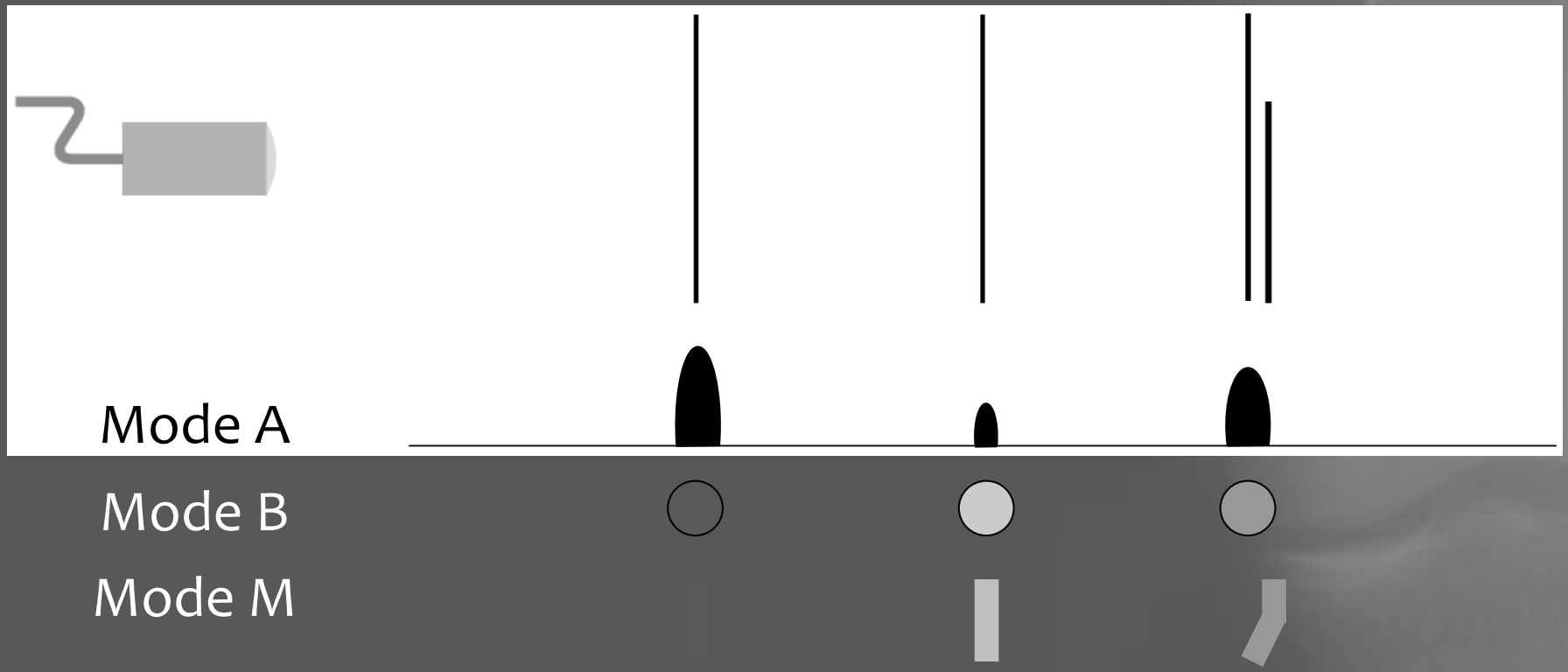

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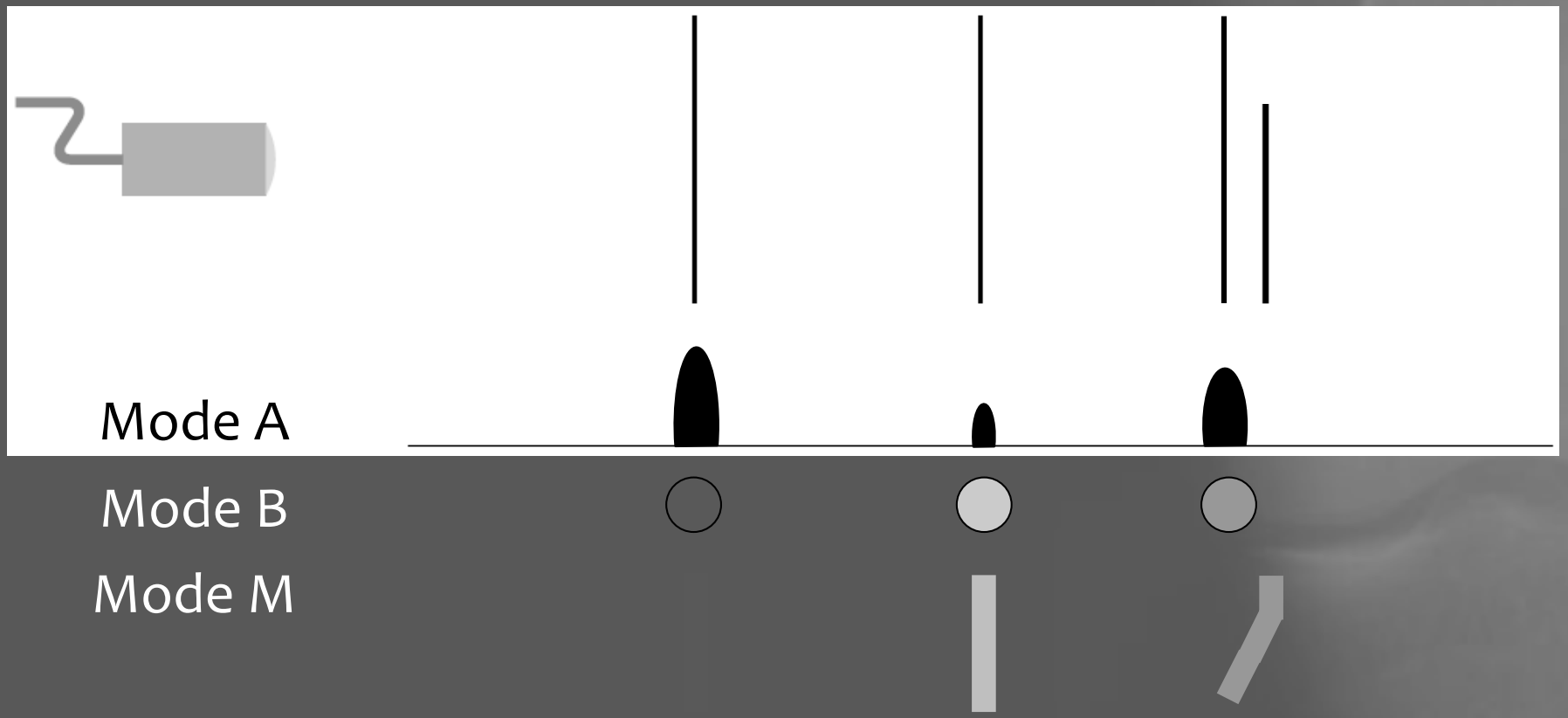

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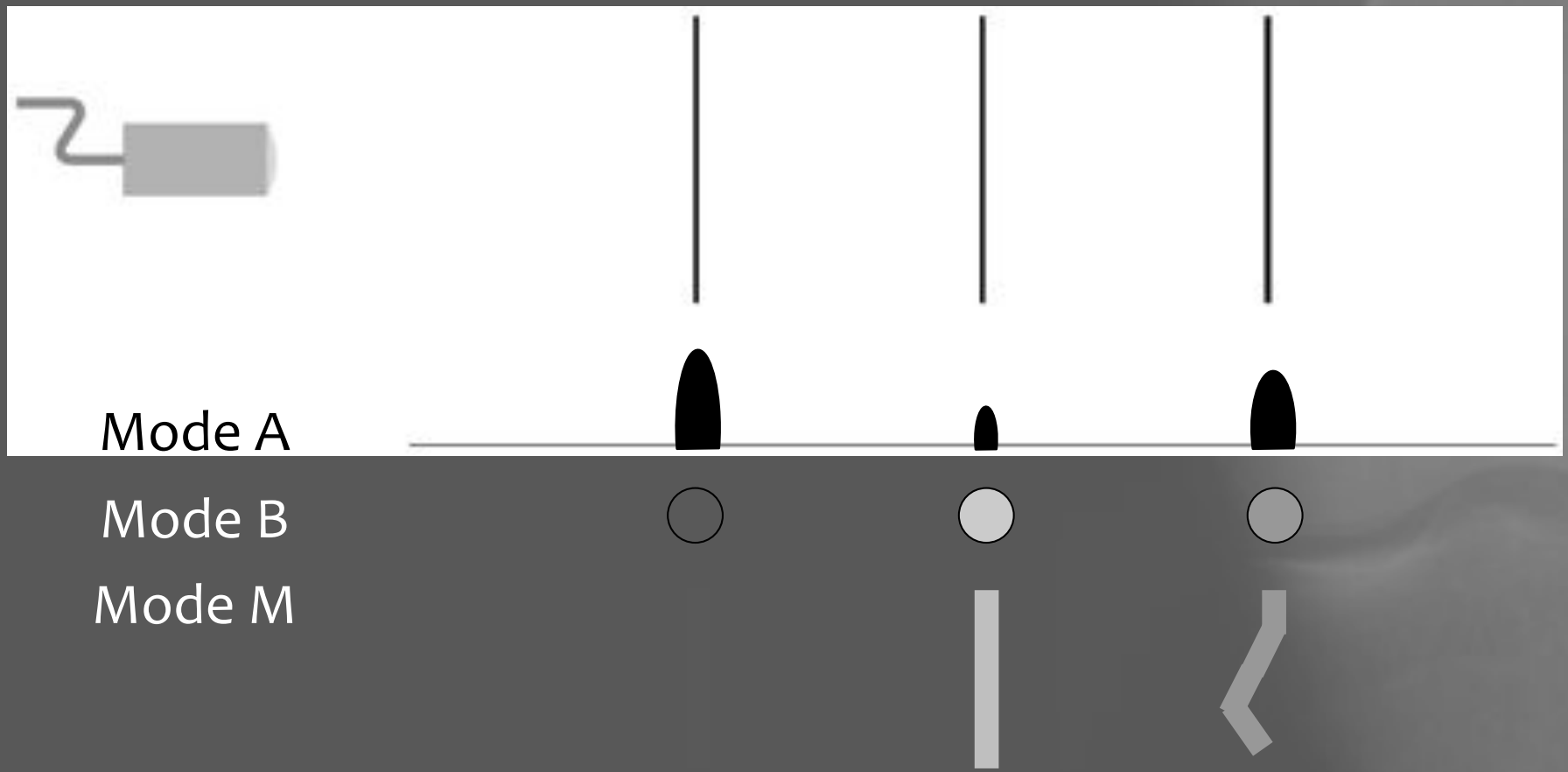

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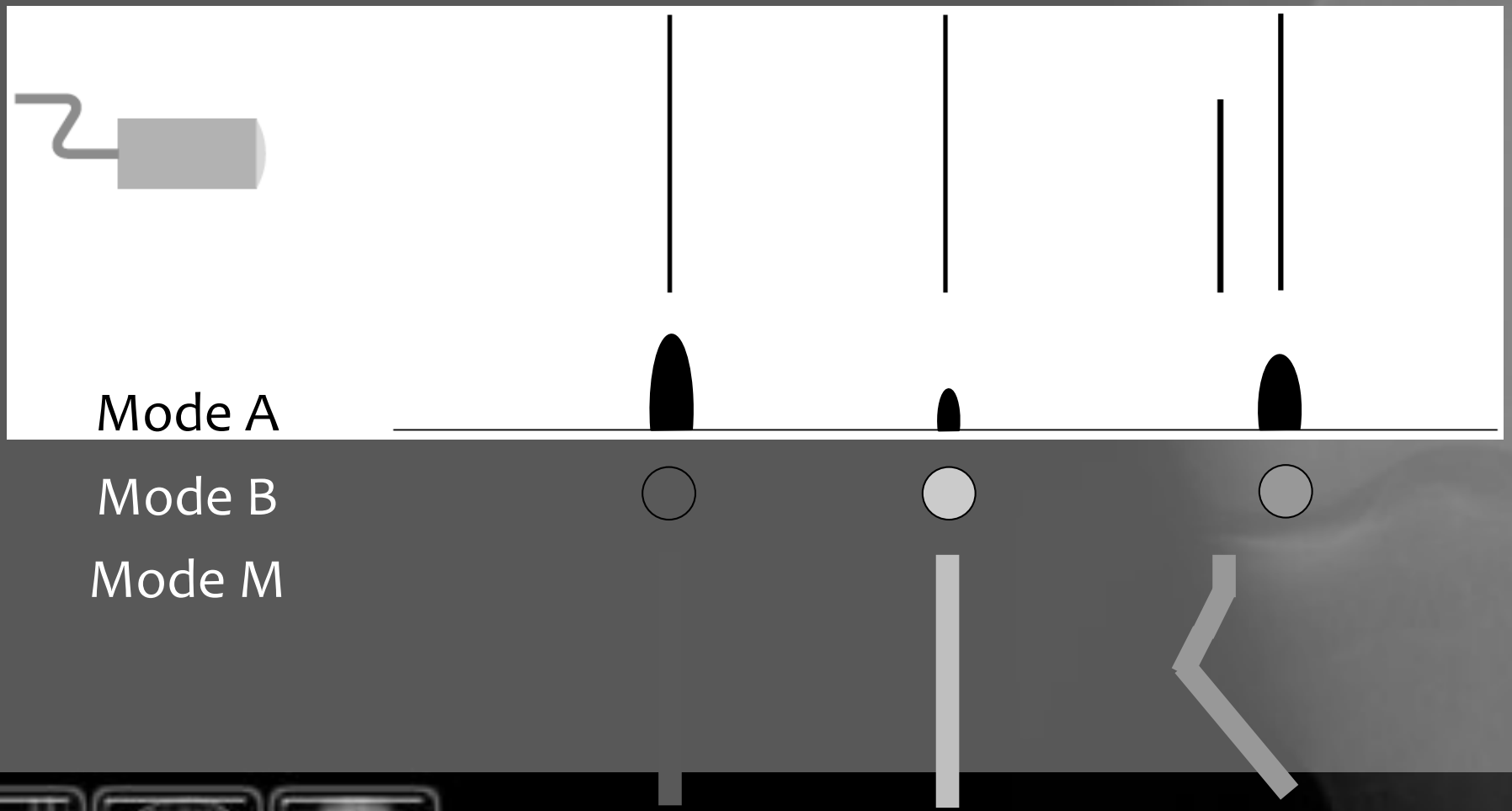

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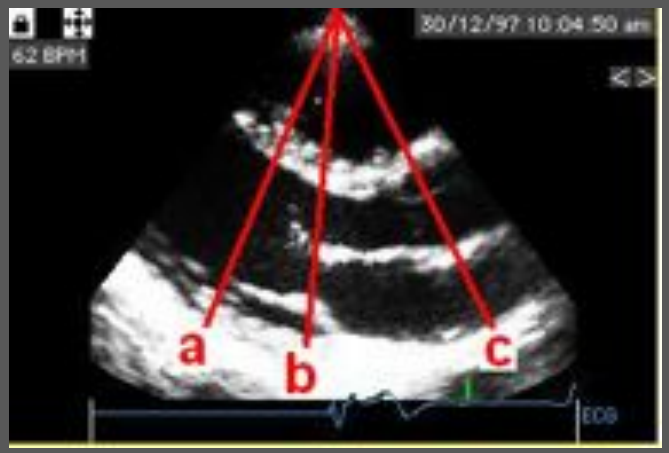
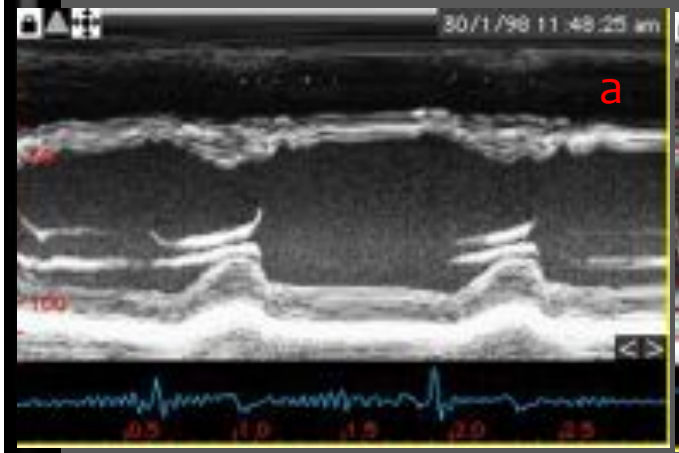
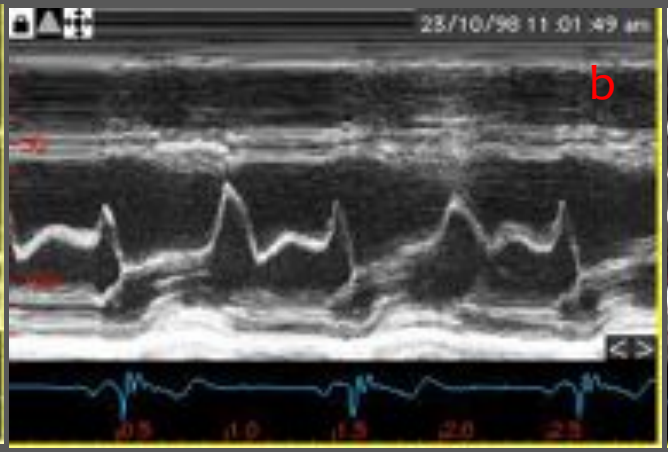


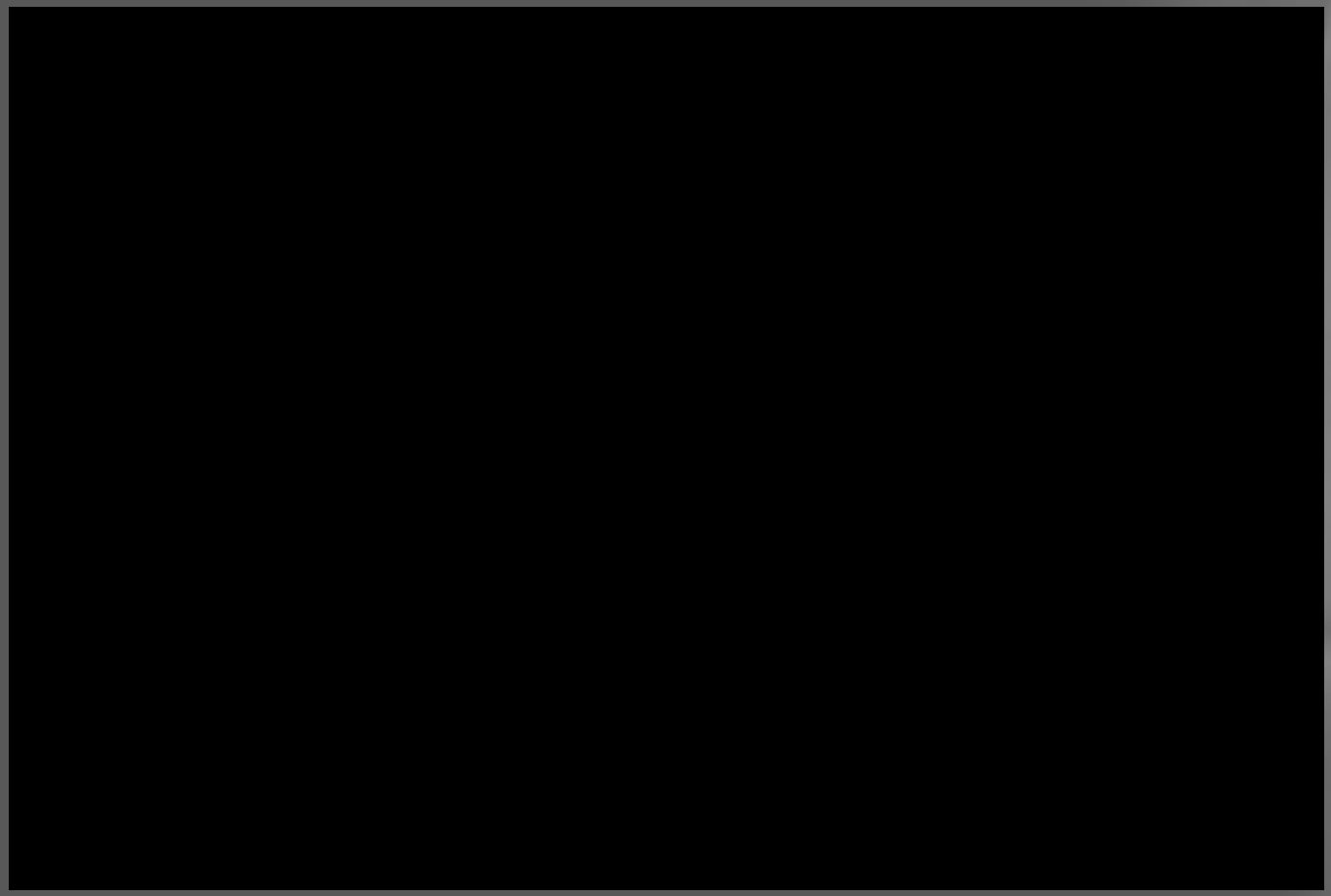




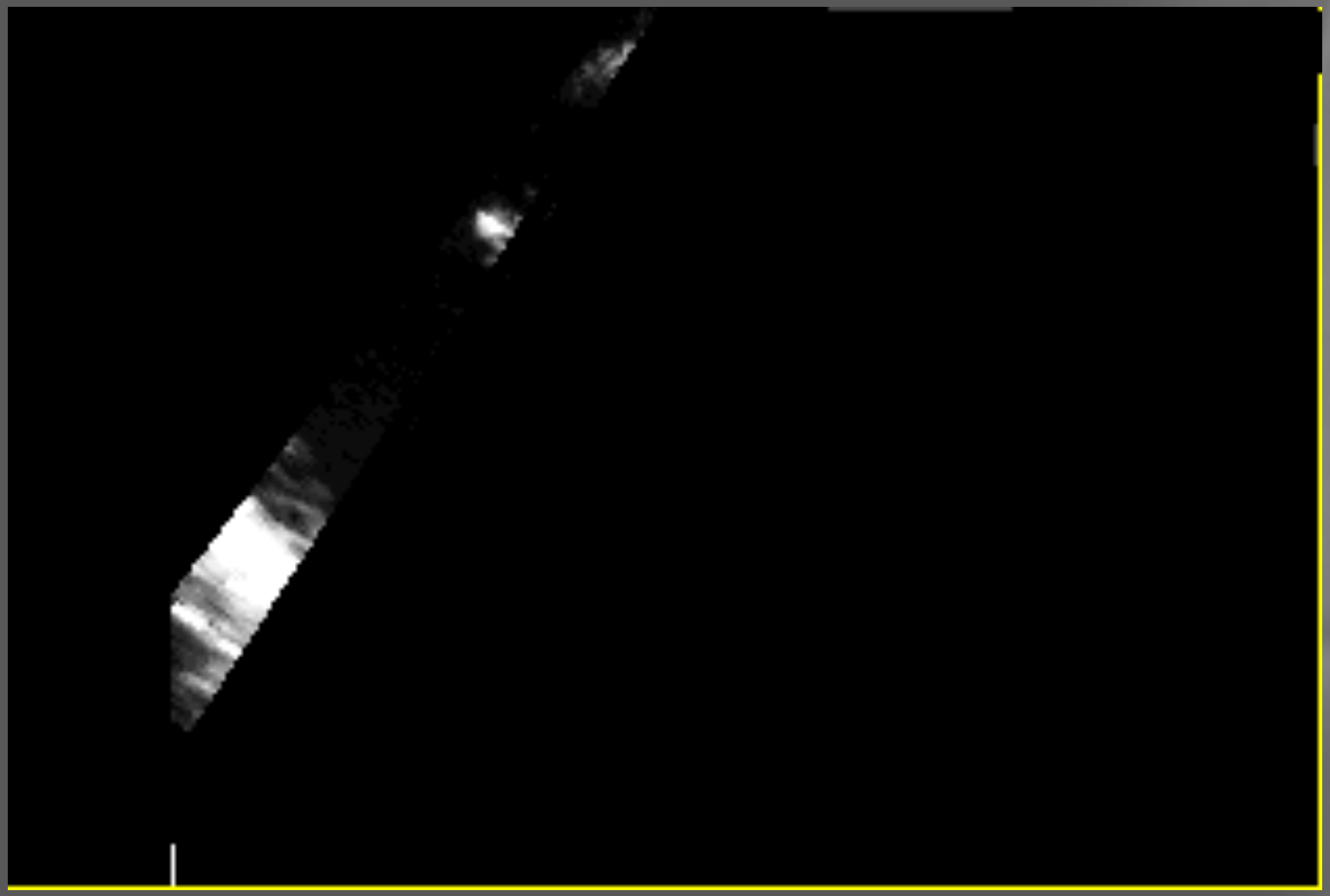
M-mode

http://folk.ntnu.no/stoylen/strainrate/Ultrasound

- 2D Ultrasound Imaging



- Formation d'une image 2D :



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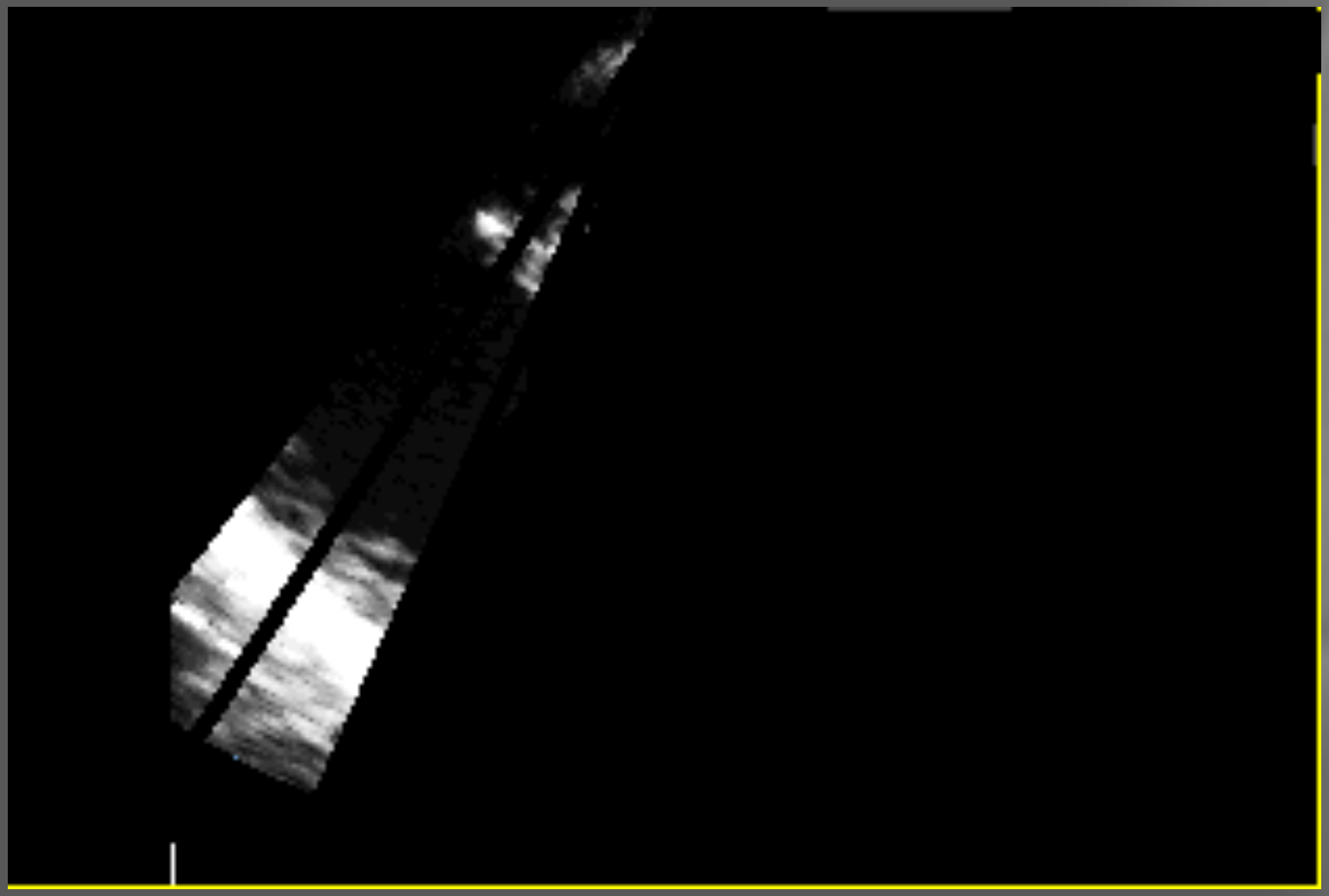

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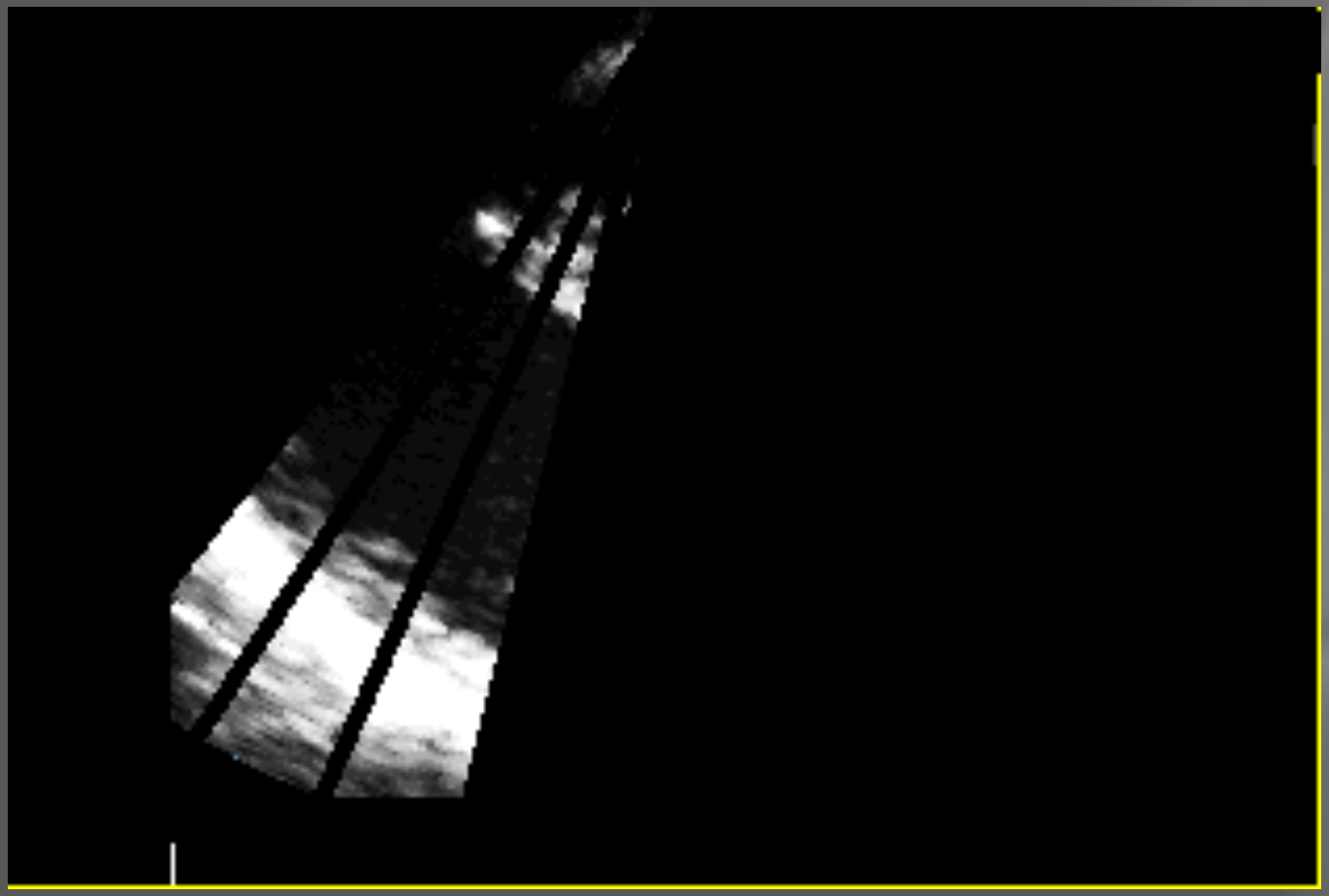

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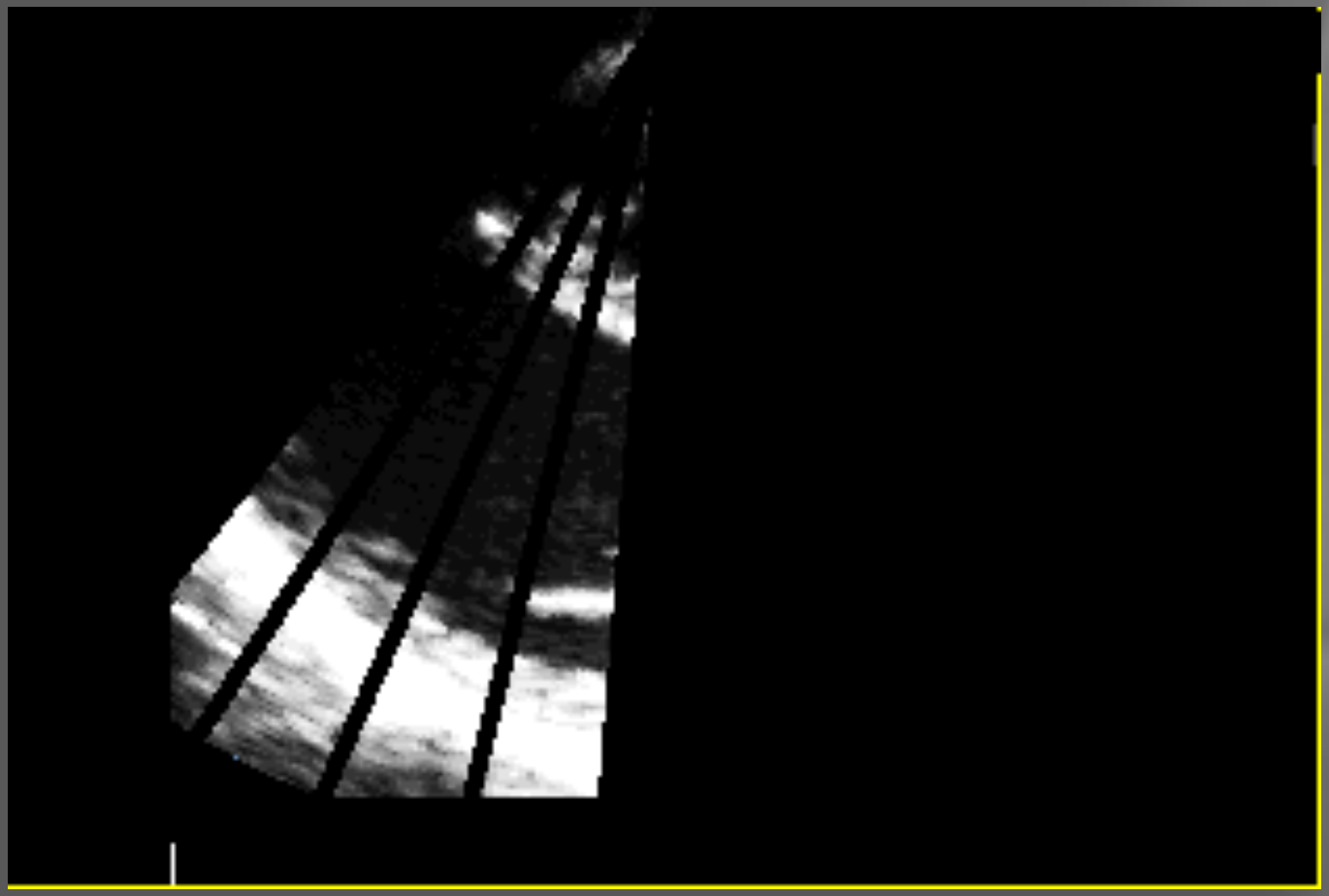

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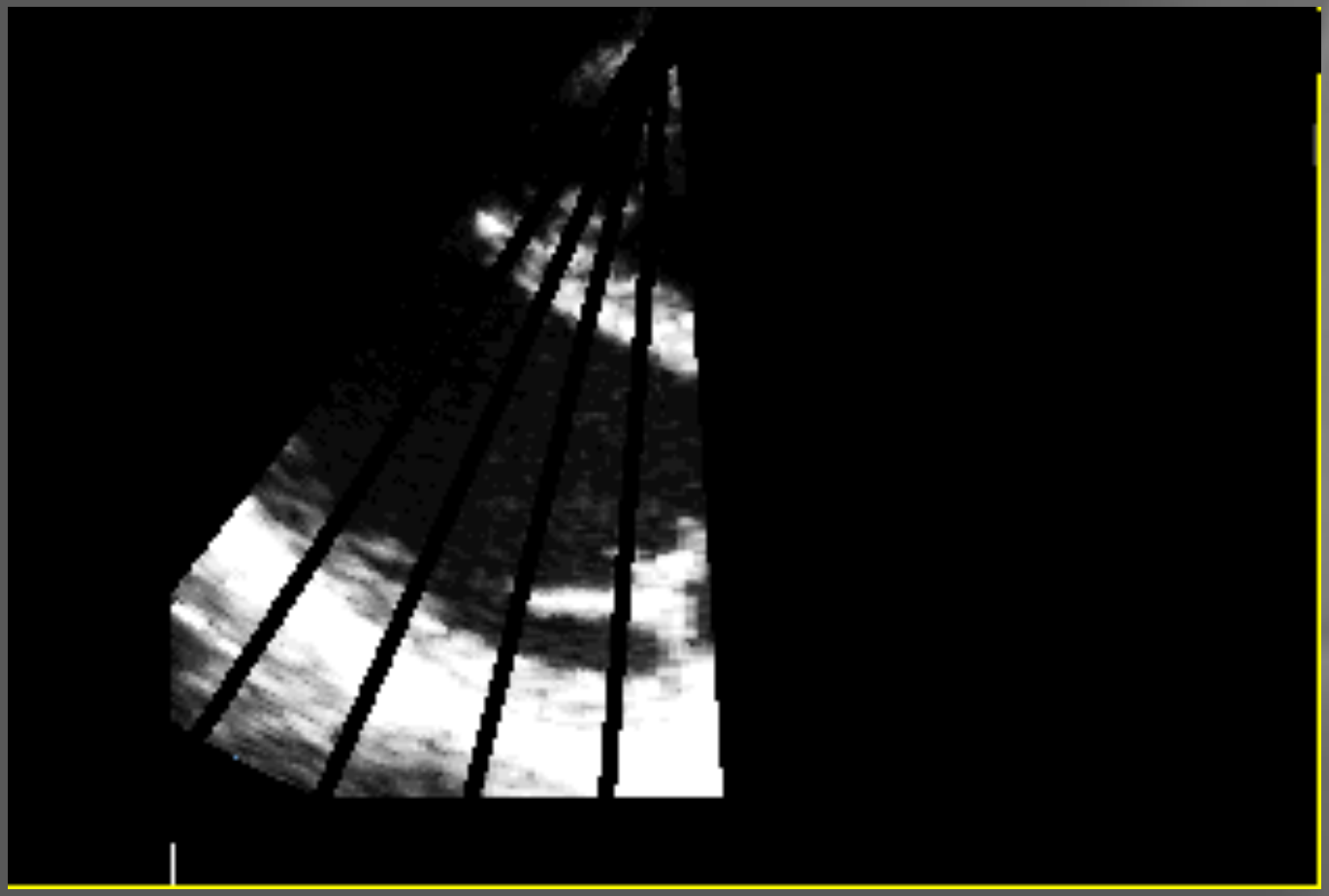

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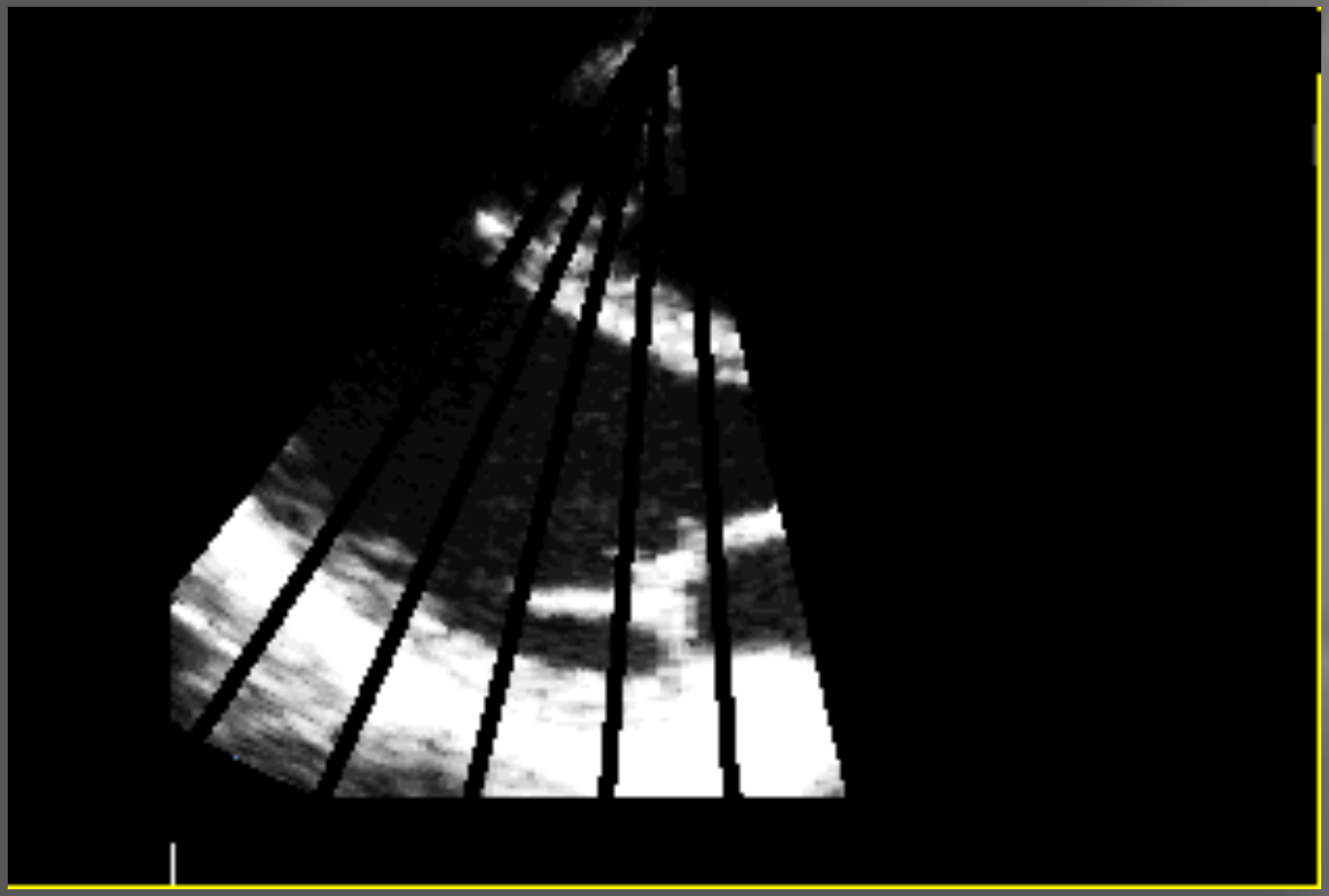

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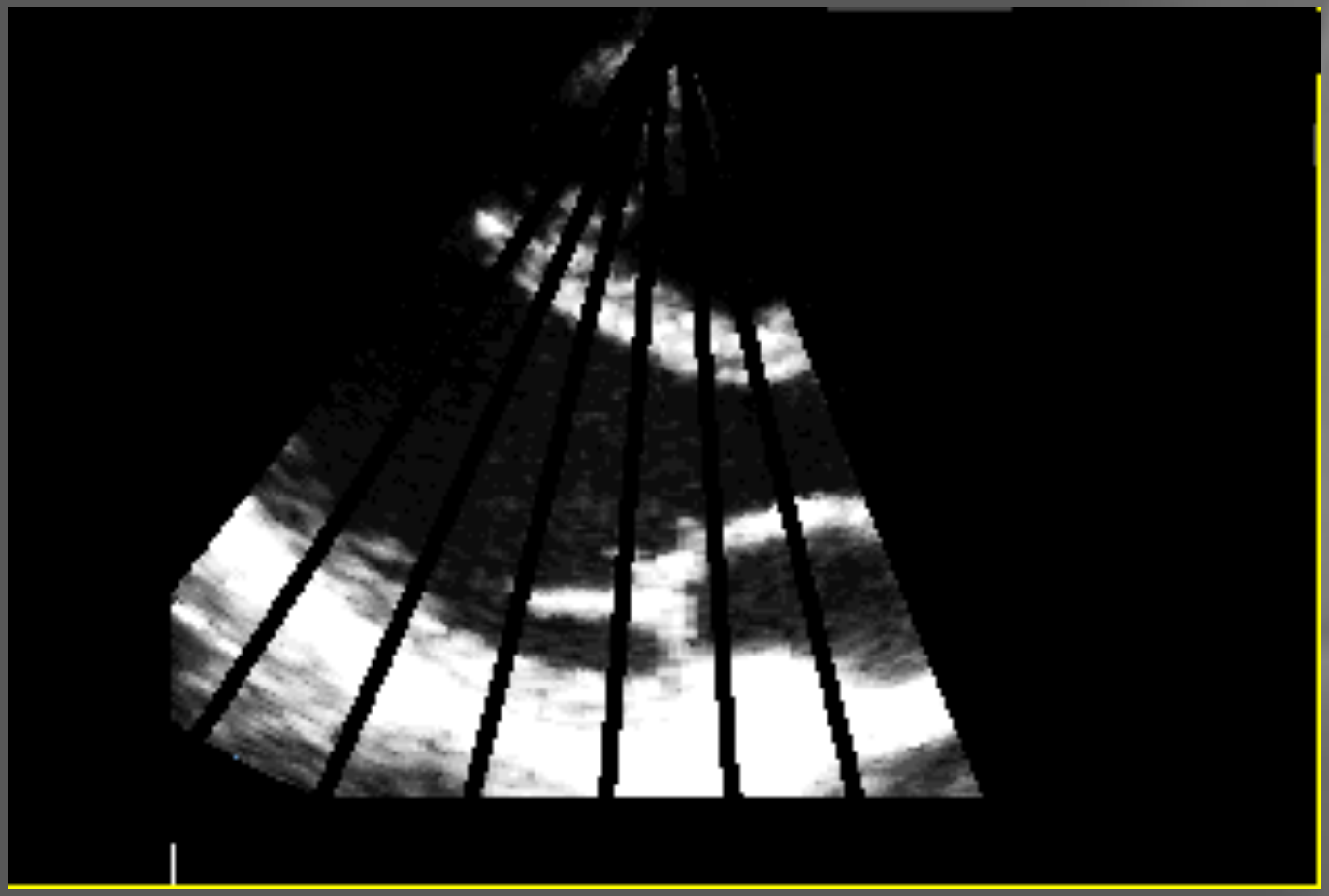

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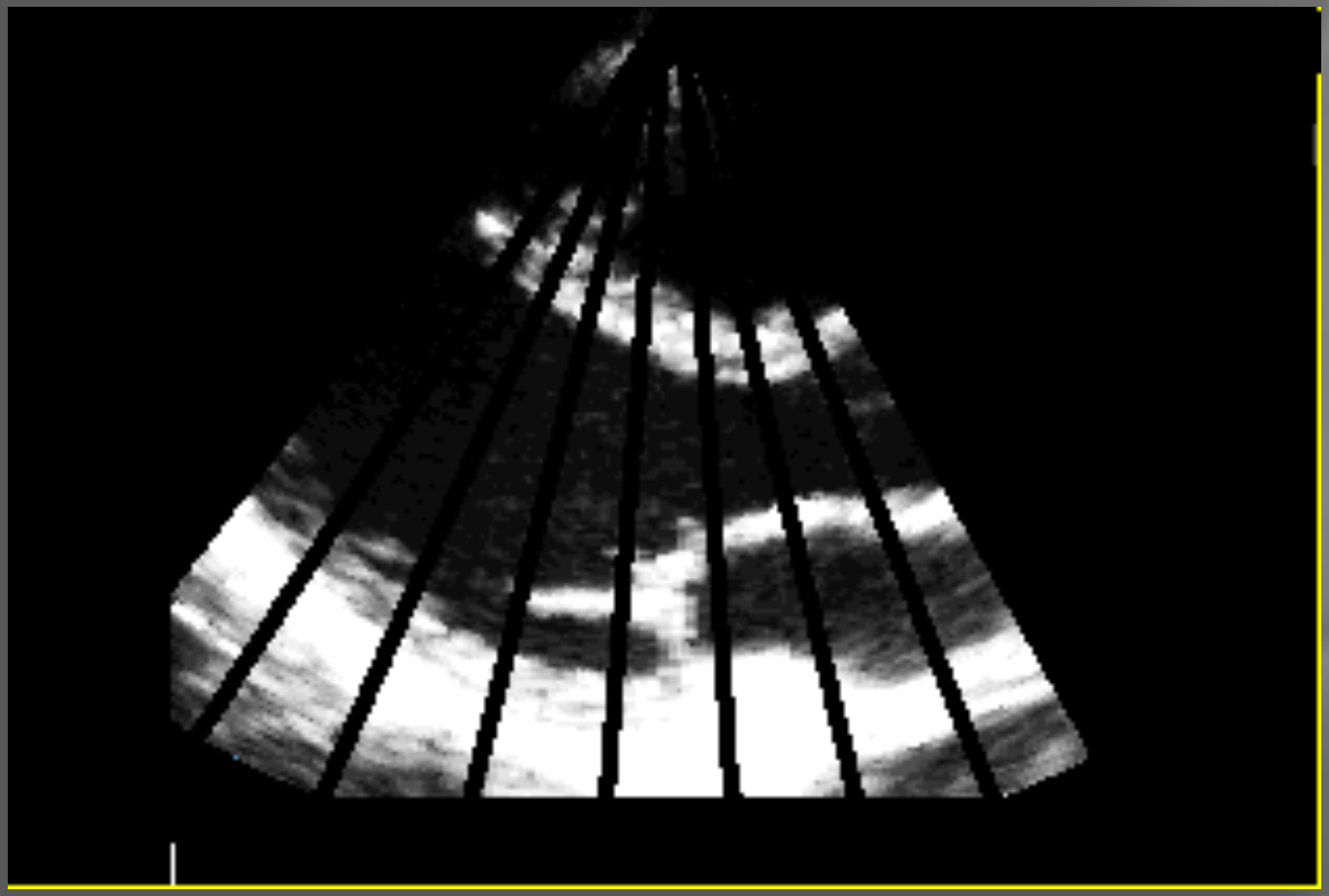

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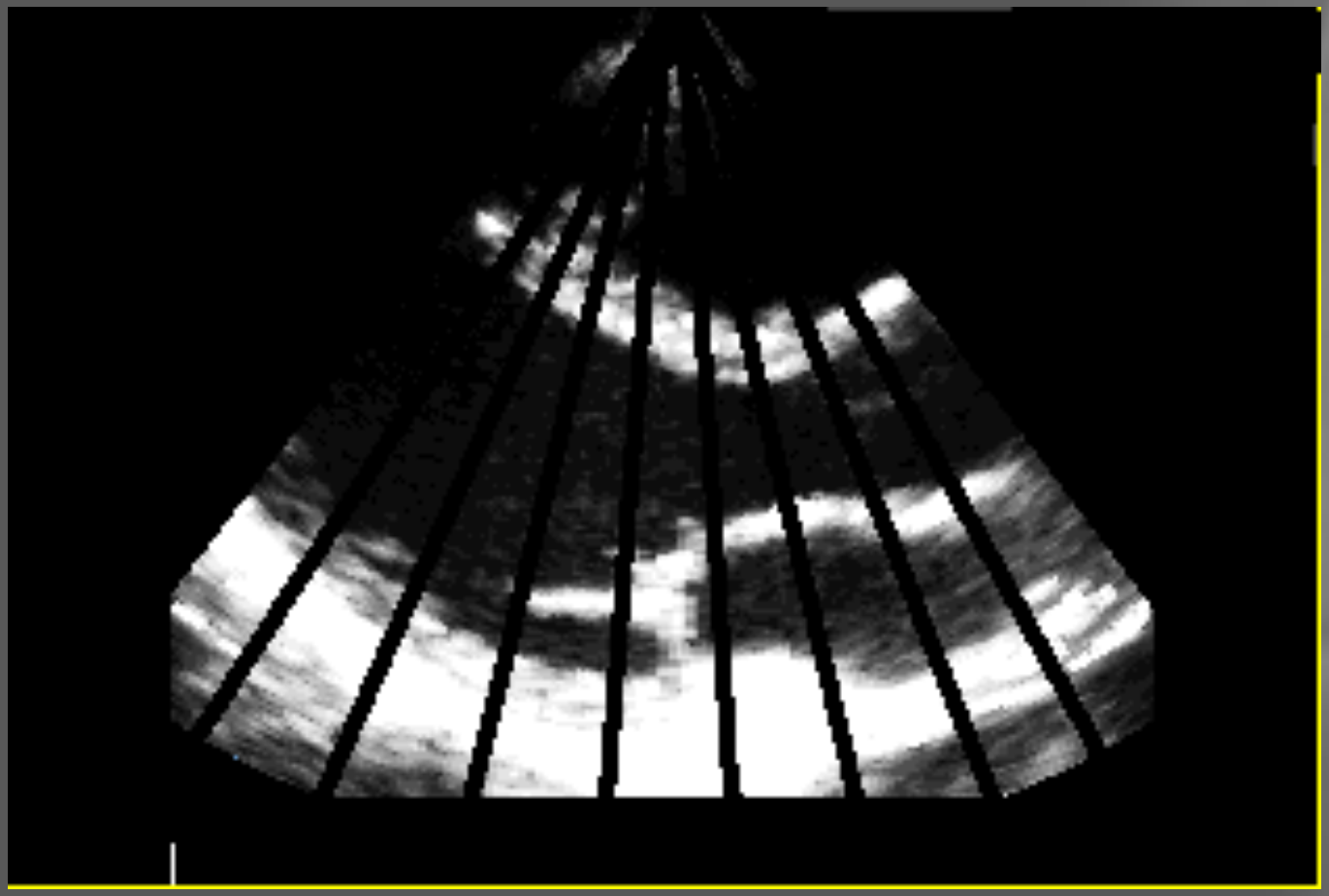


- Formation d'une image 2D :

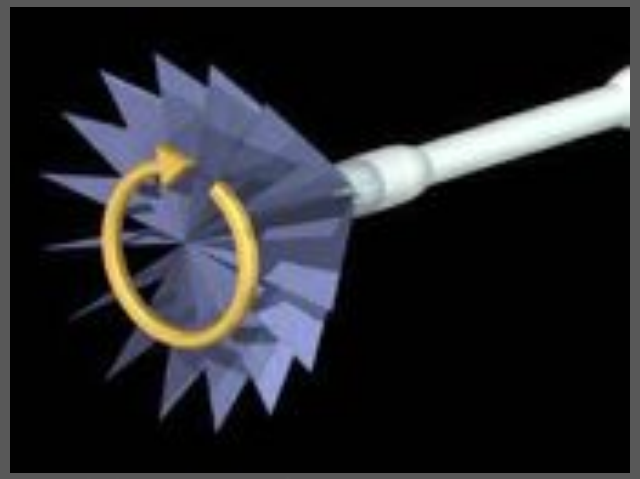
http://folk.ntnu.no/stoylen/strainrate/Ultrasound/#2D

- Image 2D + temps :

http://www-sante.ujf-grenoble.fr/sante/CardioCD/cardio/video.htm

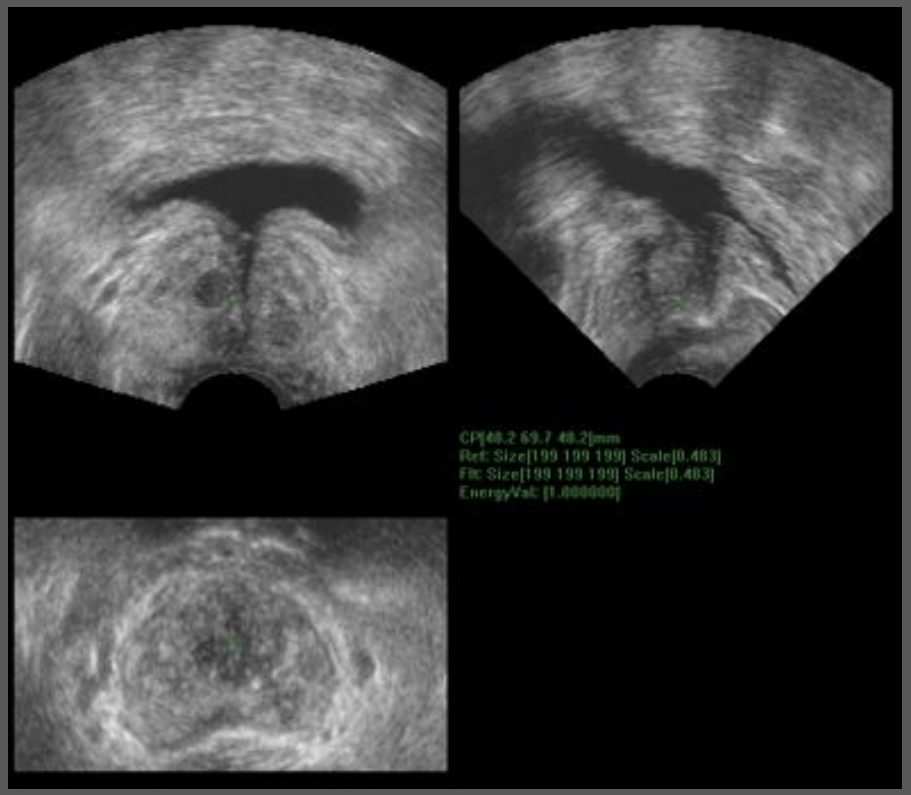


- 3D Ultrasound Imaging



(image 3D + temps = image 4D)

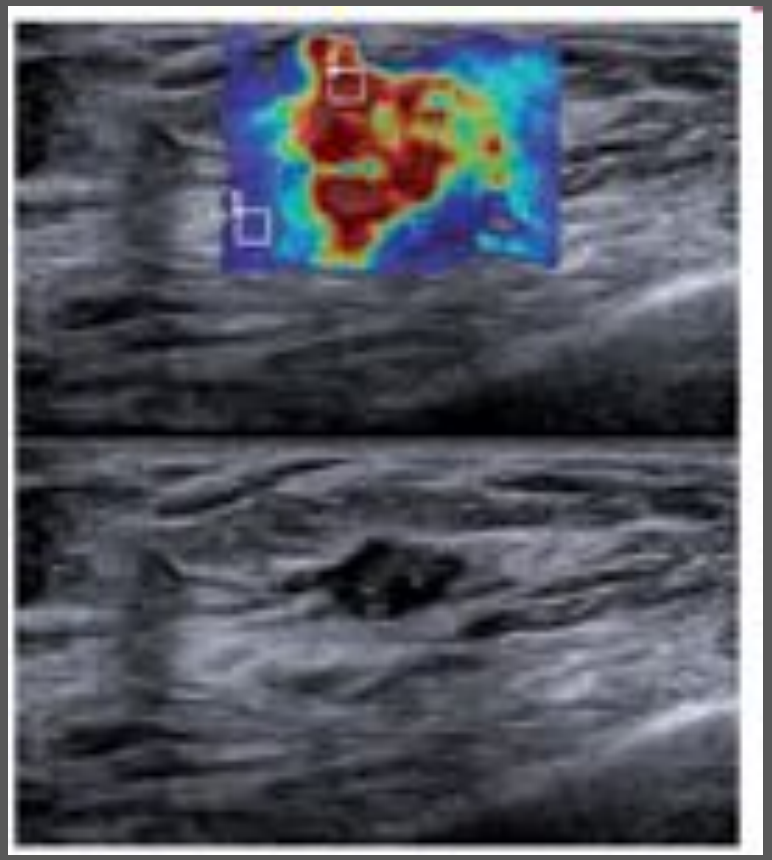
- Visualisation de l'image 3D :



Vessie + prostate

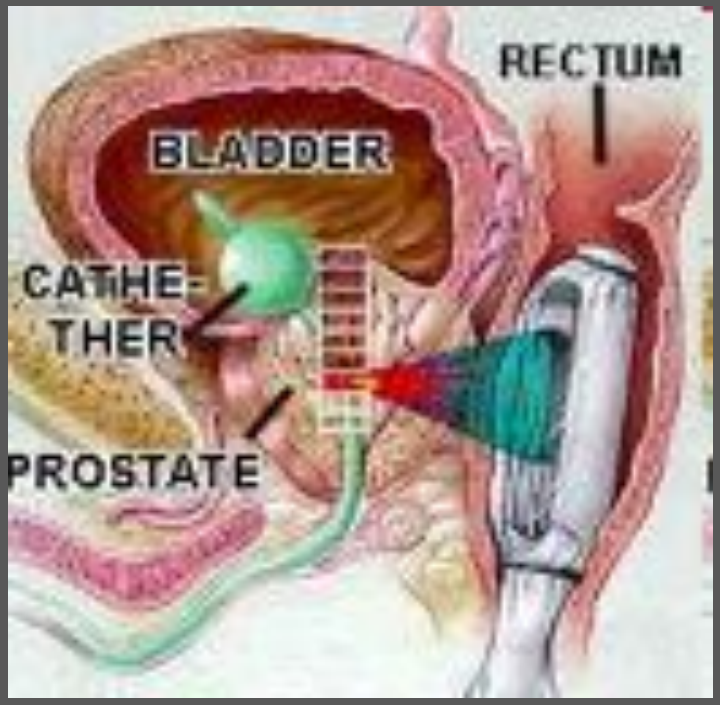
- Doppler Ultrasound

- Élastographie (diagnostic) :



détection de tumeurs en se basant sur l'observation q'une tumeur est moins élastique que les tissus sains avoisinant

- HIFU : High Intensity Focused Ultrasound



Ablation thermique d'une tumeur

Intensité 10.000 fois plus élevée que l'imagerie par Ultrasons

Faisceaux convergents
→ échauffement brutal des tissus et destruction