



Université  
de Lille



# FROM VESALIUS TO POURCELOT VIA HARVEY & PULSED COLOR DOPPLER

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PROF. DR. RAFFAELE PISANO, H.D.R.

PROF. DR. JEAN-MICHEL CORREAS, M.D., A.I.H.P., P.U.-P.H.





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M.D., A.I.H.P., HY F.A.C.R., HY P.U.-P.H.**



**HONORARY PROFESSOR AND  
CHAIRMAN OF RADIOLOGY & MEDICAL  
IMAGING DEPARTMENT AT THE HOSPITAL  
NECKER OF PARIS**

**PIONEER IN MEDICAL ULTRASOUND**



# PROF. DR. RAFFAELE PISANO, H.D.R.

- PROFESSOR OF HISTORY & EPISTEMOLOGY OF SCIENCES AND TECHNOLOGIES AT THE UNIVERSITY OF LILLE (FRANCE)
- PRESIDENT OF THE IDTC-INTER-DIVISIONAL TEACHING COMMISSION (DLMPST/IUHPST/DHST/IHPST)
- [HTTP://WWW.IDTC-IUHPS.COM/](http://www.idtc-iuhps.com/)
- PAST PRESIDENT OFFICER OF THE EUROPEAN SOCIETY FOR THE HISTORY OF SCIENCES



- CURRENT POSITION IN THE LECTURE:
- **RAFFAELE PISANO HAS FED THE HISTORICAL AND THE EPISTEMOLOGICAL CONTENTS OF THE LECTURE**



# PROF. DR. JEAN-MICHEL CORREAS, M.D., A.I.H.P., P.U.-P.H.

- JEAN-MICHEL CORREAS IS PROFESSOR OF RADIOLOGY AND MEDICAL IMAGING AT THE HOSPITAL NECKER-ADULTS OF PARIS CHAIRED BY PROF. DR. OLIVIER HÉLÉNON.
- HE IS THE HEAD OF THE ULTRASOUND SECTION
- INTERNATIONAL EXPERT-CONSULTANT AND LECTURER
- CURRENT POSITION IN THE LECTURE:
- **JEAN-MICHEL CORREAS HAS PARTICIPATED IN THE CLINICAL AND TECHNICAL CONTENT OF THE LECTURE.**
- **HE SUPPLIED THE WHOLE ULTRASONOGRAPHIC ICONOGRAPHY**



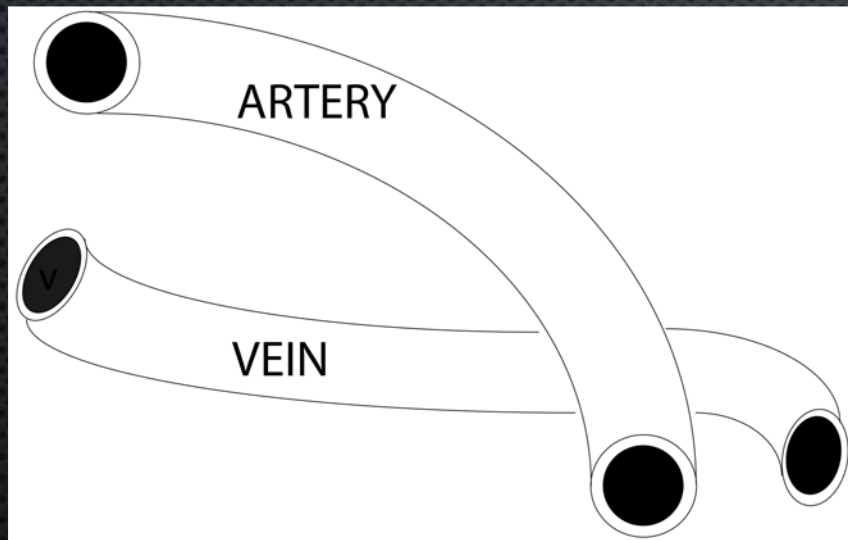
Jean-Michel Corr  as



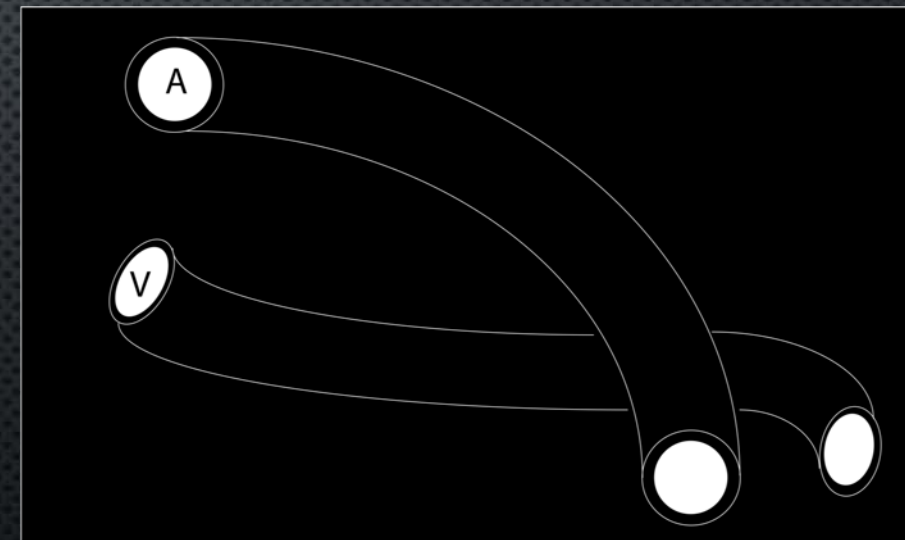
# VESSELS ACCORDING TO THE BOARD

These aren't noodles...

## WHITEBOARD

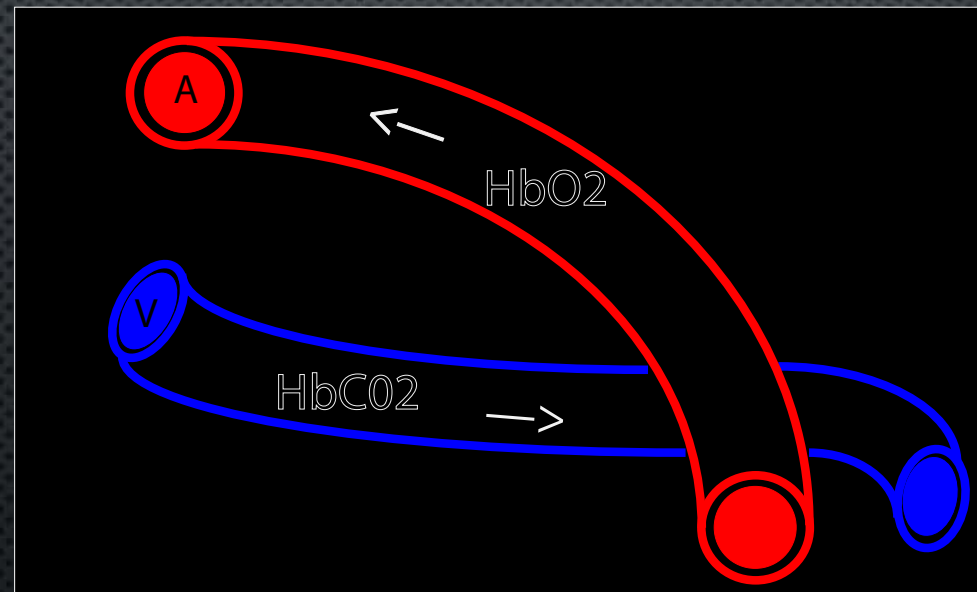


## BLACKBOARD





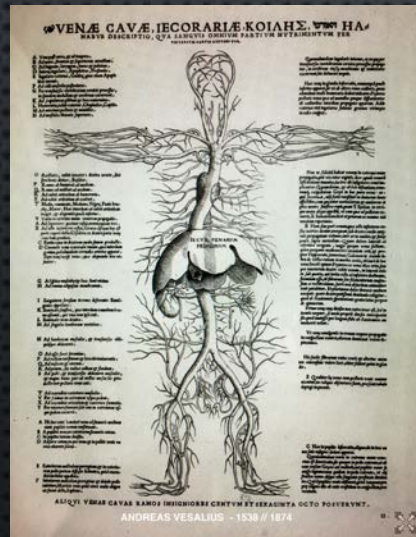
# COLORED VESSELS ON A BLACKBOARD



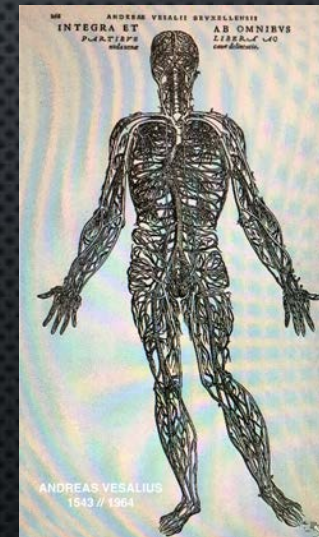


# ANDREAS VESALIUS (1514 – 1564)

## VENOUS VESSELS



## ARTERIAL VESSELS

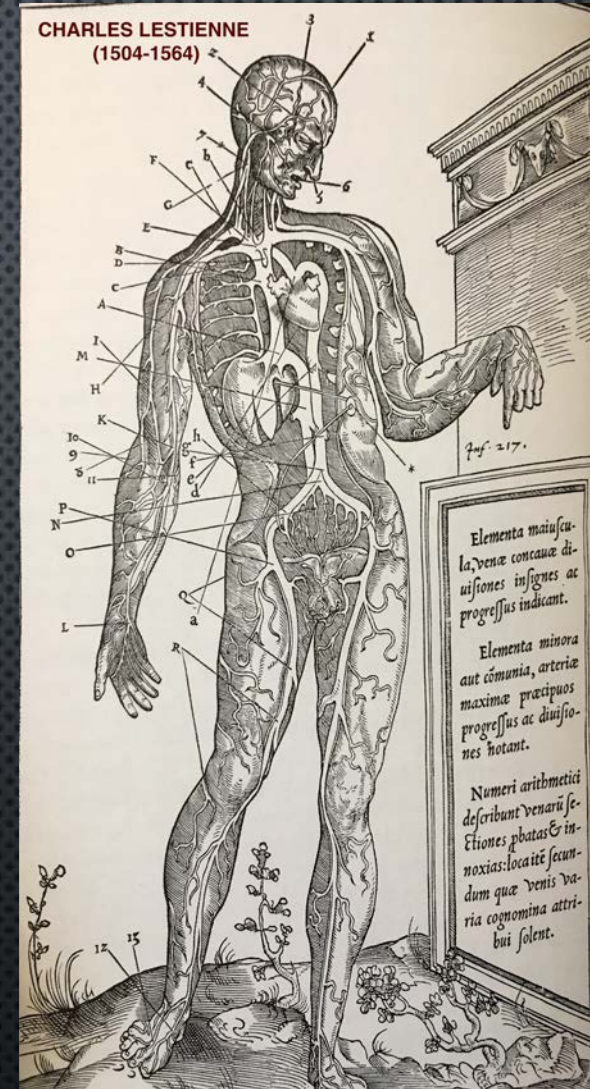


Wood engraving



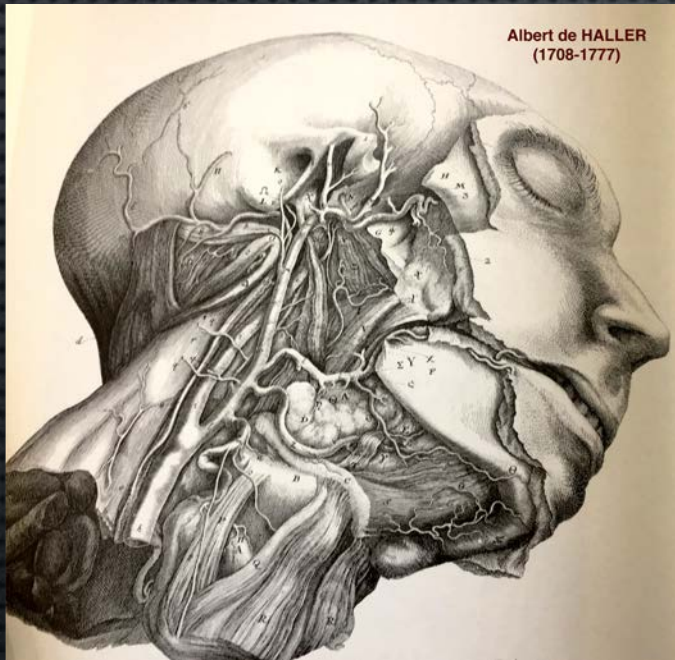
# CHARLES ESTIENNE 1504 - 1564

## VESSELS

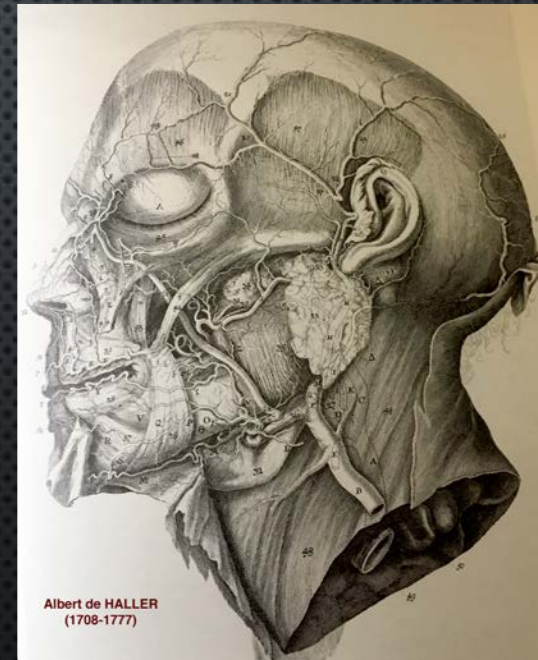




# ALBERT DE HALLER (1708-1777)



Copper  
engraving





## WILLIAM HARVEY (1578-1657)

1609: PHYSICIAN AT THE ST  
BARTHOLOMEW'S HOSPITAL IN LONDON

1628: EXERCITATIO ANATOMICA DE  
MOTU CORDIS ET SANGUINIS IN  
ANIMALIBUS





# WILLIAM HARVEY : 1628

- "IT HAS BEEN SHOWN BY REASON AND EXPERIMENT THAT BLOOD BY THE BEAT OF THE VENTRICLES FLOWS THROUGH THE LUNGS AND HEART AND IS PUMPED TO THE WHOLE BODY",



# MARCELLO MALPIGHI

## 1628-1694

1667; MALPIGHI WAS APPOINTED AT THE UNIVERSITY OF BOLOGNE WHERE HE DEVELOPED MICROSCOPIC STUDIES IN BIOLOGY.

DE VISCERUM STRUCTURA EXERCITATIO

**Evidence of distal arteriovenous shunts**  
**Artery in red, vein in blue**





# J.D. MOLLON THE ORIGINS OF THE MODERN COLOR SCIENCE

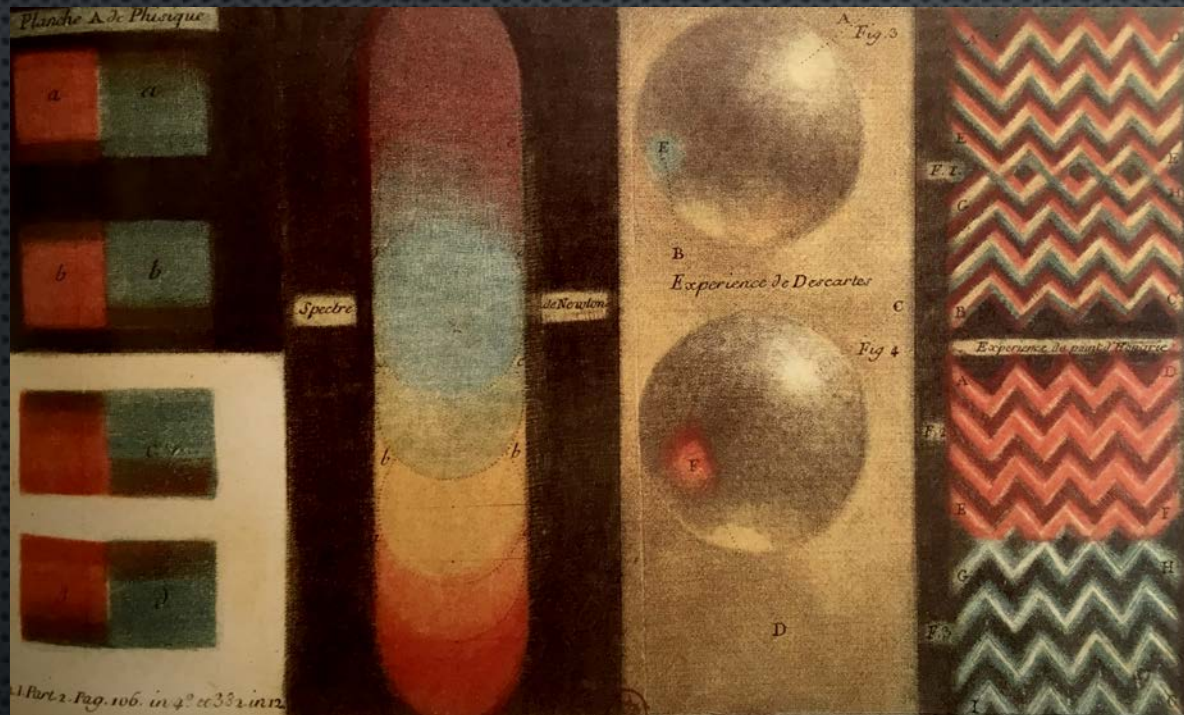
IN: S.K. SHEVELL ED. THE SCIENCE  
COLOR. 2<sup>ND</sup> ED. OSA ELSEVIER, 2003,  
PP 2-32

- 1. NEWTON'S THEORY



# NEWTON'S SPECTRUM

COLORED PICTURE BY GAUTIER D'AGOTY





J.D. MOLLON  
THE ORIGINS OF THE  
MODERN COLOR  
SCIENCE

IN: S.K. SHEVELL ED. THE SCIENCE  
COLOR. 2<sup>ND</sup> ED. OSA ELSEVIER, 2003,  
PP 2-32

- 2. TRICHROMACY BY JACQUES-CHRISTOPHE LE BLON  
AND JAN L'ADMIRAL.



# JACQUES-CHRISTOPHE LE BLON

FIRST EXPERIMENT OF ETCHING IN  
TRICHROMACY (RGB)





# THE HEART BY JAN L'ADMIRAL (1699–1773)

## TRICHROMY



## SYNTHESIS





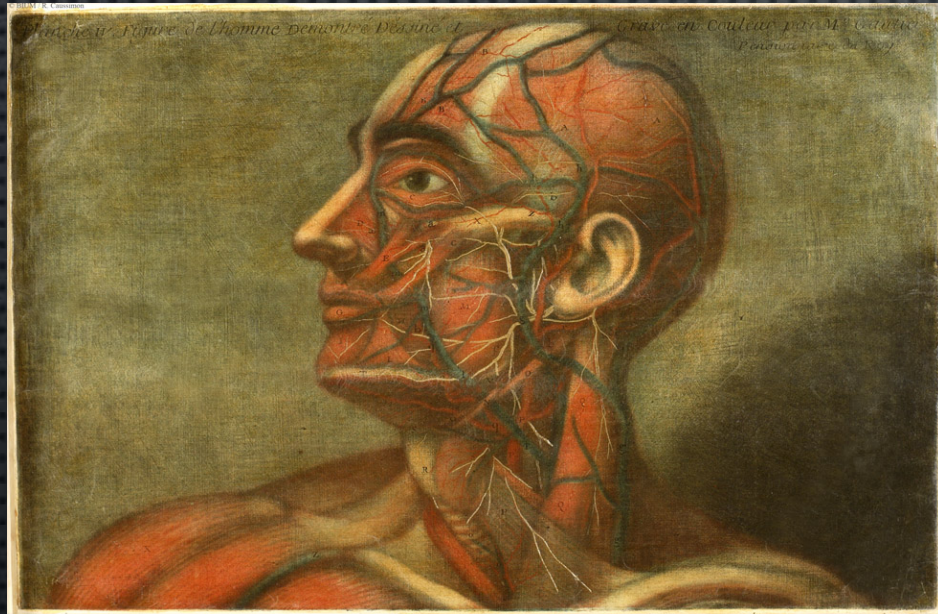
J.D. MOLLON  
THE ORIGINS OF THE  
MODERN COLOR  
SCIENCE

IN: S.K. SHEVELL ED. THE SCIENCE  
COLOR. 2<sup>ND</sup> ED. OSA ELSEVIER, 2003,  
PP 2-32

- 3. TRICHROMACY BY GAUTIER D'AGOTY



# JACQUES FABIEN GAUTIER D'AGOTY (1716-1785)





# LITHOGRAPHY ON LIMESTONE

- 1792: **LITHOGRAPHY** BY **ALOYS SENEFELDER** (1771-1834)
- 1815: **CHARLES PHILIBERT DE LASTEYRIE DU SAILLANT** (1759-1849) LITHOGRAPHY IN PARIS
- 1836 : **GODEFROY ENGELMANN** (1788-1839): CHROMOLITHOGRAPHY IN QUADRICHRMACY (CYAN, MAGENTA, YELLOW, BLACK)
- CONVENTIONAL COLORS
  - RED = LEFT HEART AND AORTA
  - BLUE = RIGHT HEART AND PULMONARY ARTERY AND CAVAL VEINS
  - YELLOW OR WHITE OR BLACK = NERVES
  - PURPLE OR YELLOW OR WHITE = LYMPHATIC VESSELS

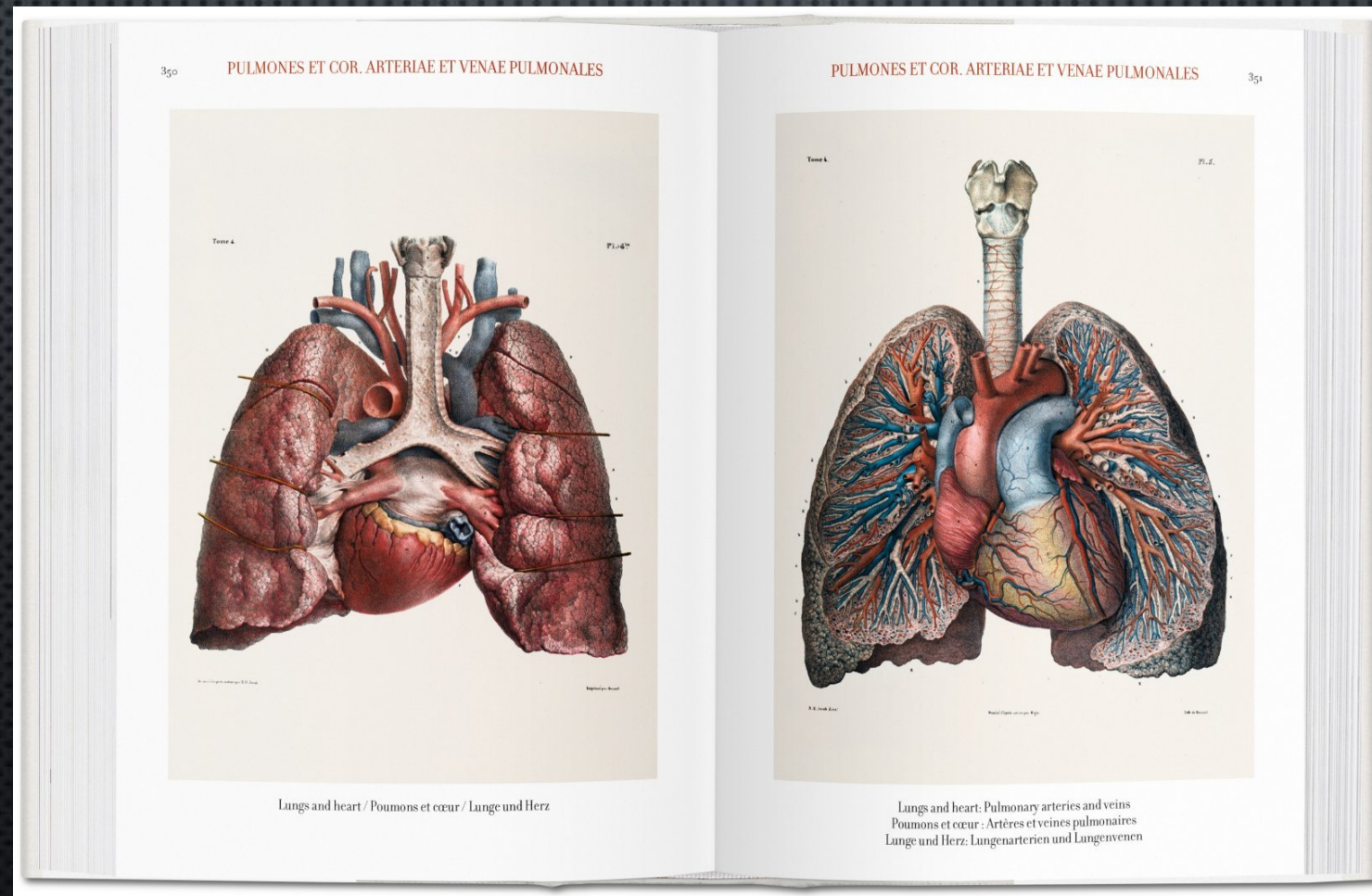


# JEAN-BAPTISTE BOURGERY (1797-1849) AND NH JACOB





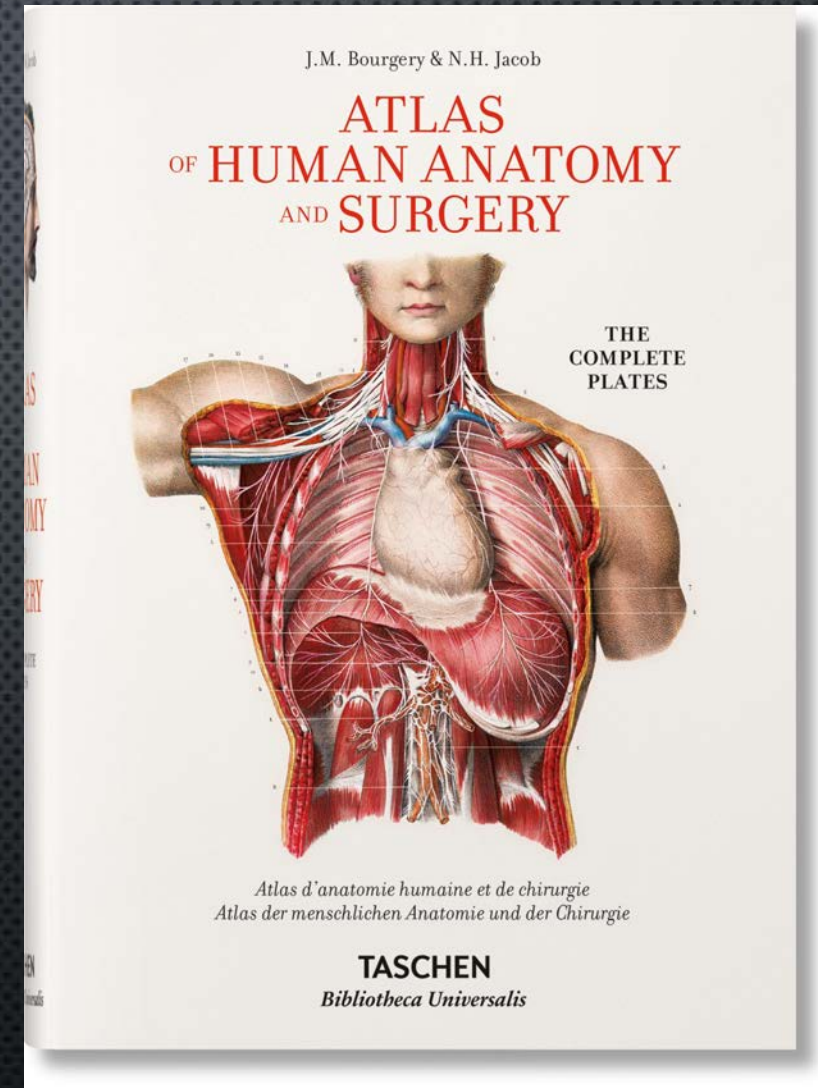
# JEAN-BAPTISTE BOURGERY





JEAN-BAPTISTE MARC  
BOURGERY  
(1797-1849)

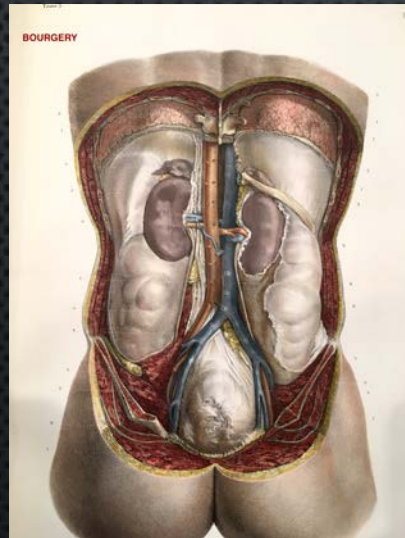
NICOLAS-HENRI JACOB (1782-1871)



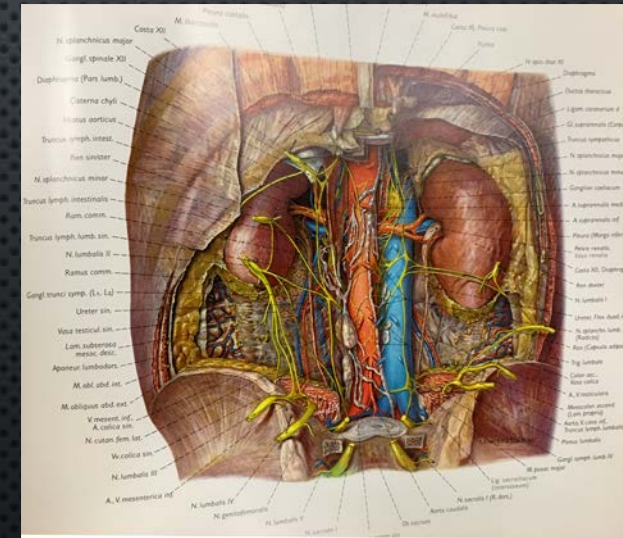


# RETROPERITONEAL SPACE

BOURGERY:  
CHROMOLITHOGRAPHY



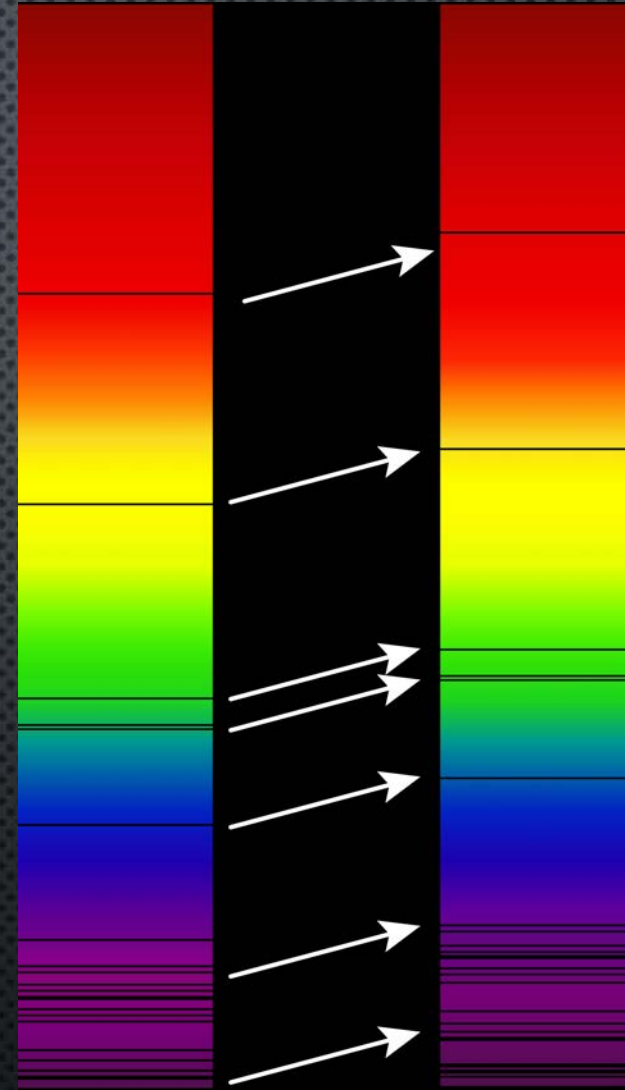
PERNKOPF (1980): OFFSET





CRISTIAN DOPPLER  
(1803-1853)  
THE RED SHIFT

THE CHANGE IN FREQUENCY OR  
WAVELENGTH OF A WAVE IN RELATION TO  
AN OBSERVER WHO IS MOVING RELATIVE  
TO THE WAVE SOURCE





# ULTRASONOGRAPHY

CRISTIAN DOPPLER (1803-1853)

THE RED SHIFT

- 1 PAUL LANGEVIN (1872-1946)
- 2 ERNEST RUTHERFORD (1871-1937)
- 3 IAN DONALD (1910-1987)
- 4 LEANDRE POURCELOT (1940-)



# LEANDRE POURCELOT, MD, DR SCI. UNIVERSITY FRANÇOIS RABELAIS TOURS

- POURCELOT L. DESCOTES J., « EFFET DOPPLER ET MESURE DU DÉBIT SANGUIN », *C R ACAD SC. PARIS*, N<sup>O</sup> 261, 1965, P. 253-6.
- L POURCELOT, J M POTTIER, P ARBEILLE, ET AL. « ÉTUDE DE LA FONCTION CARDIOVASCULAIRE CHEZ LES ASTRONAUTES (MISSION STG 51 G — JUIN 1985) [CARDIOVASCULAR FUNCTION IN ASTRONAUTS (MISSION STG 51 G--JUNE 1985)] », *BULLETIN DE L'ACADÉMIE NATIONALE DE MÉDECINE*, VOL. 170, N<sup>OS</sup> 3-4, MARS 1986, P. 341-344



# LÉANDRE POURCELOT

## BY JOSEPH SK WOO

POURCELOT DEVELOPED THE FIRST EUROPEAN ULTRASONIC DOPPLER VELOCIMETER IN 1964. IN 1974 HE DESCRIBED THE "RESISTANCE INDEX" OR THE "POURCELOT INDEX" USED IN THE ASSESSMENT OF DOPPLER VELOCITY WAVEFORMS. IN 1977 HE DESCRIBED PIONEERING WORK ON COLOR-CODED DOPPLER IMAGES. FOR THE PAST 40 YEARS HE HAS CONTINUOUSLY WORKED AT INVENTING AND PERFECTING DOPPLER DEVICES AT TOURS. IN 1972 POURCELOT AND HIS RESEARCH GROUP DEVELOPED ONE OF THE FIRST REAL-TIME ULTRASOUND IMAGING SYSTEMS BASED ON THE ELECTRONIC SCANNING OF A LINEAR ARRAY.

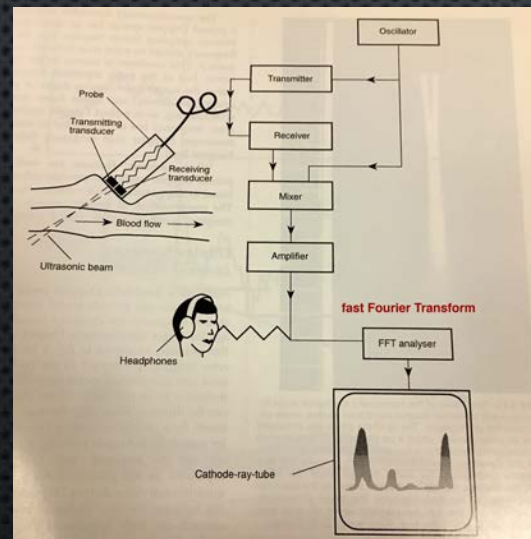


Leandre Pourcelot

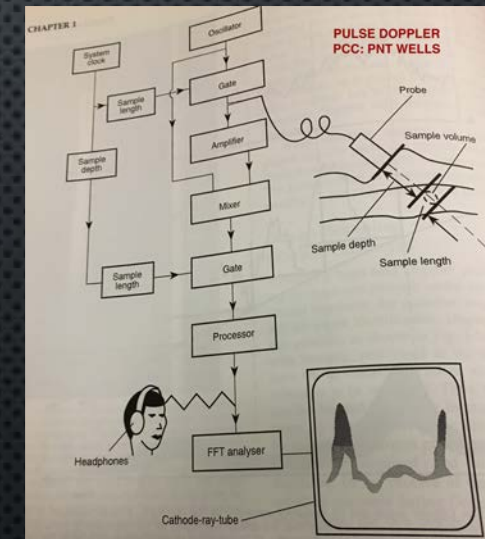


# VASCULAR DOPPLER BY PNT WELLS

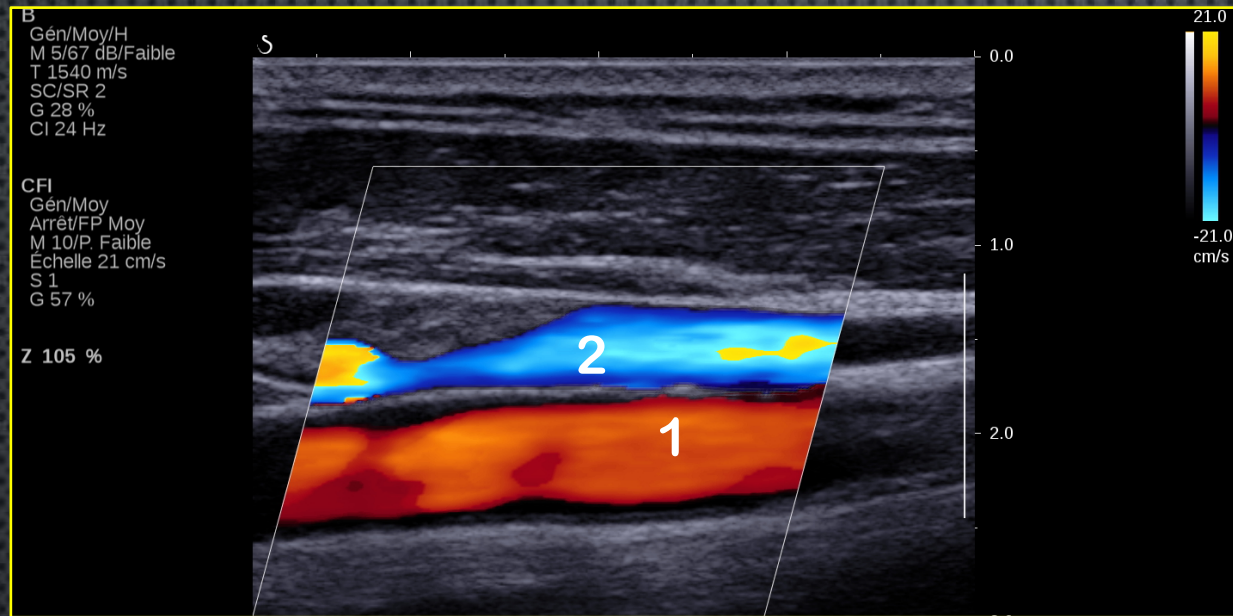
## SIMPLE DOPPLER



## PULSED WAVE DOPPLER

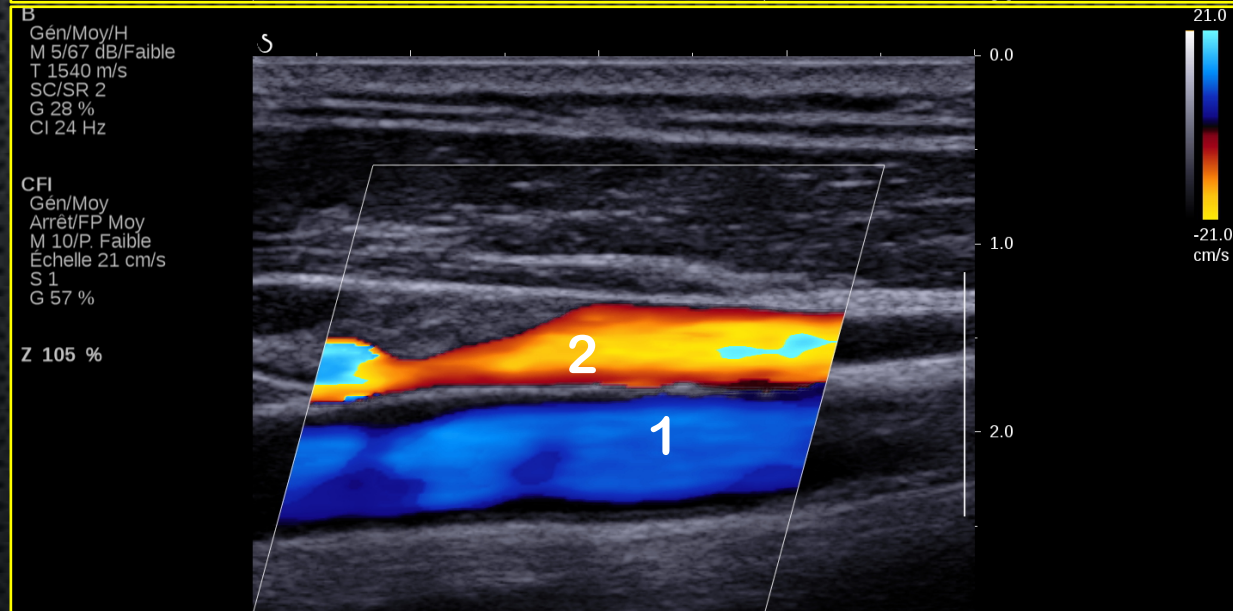






Carotide artery (1) and jugular vein (2)

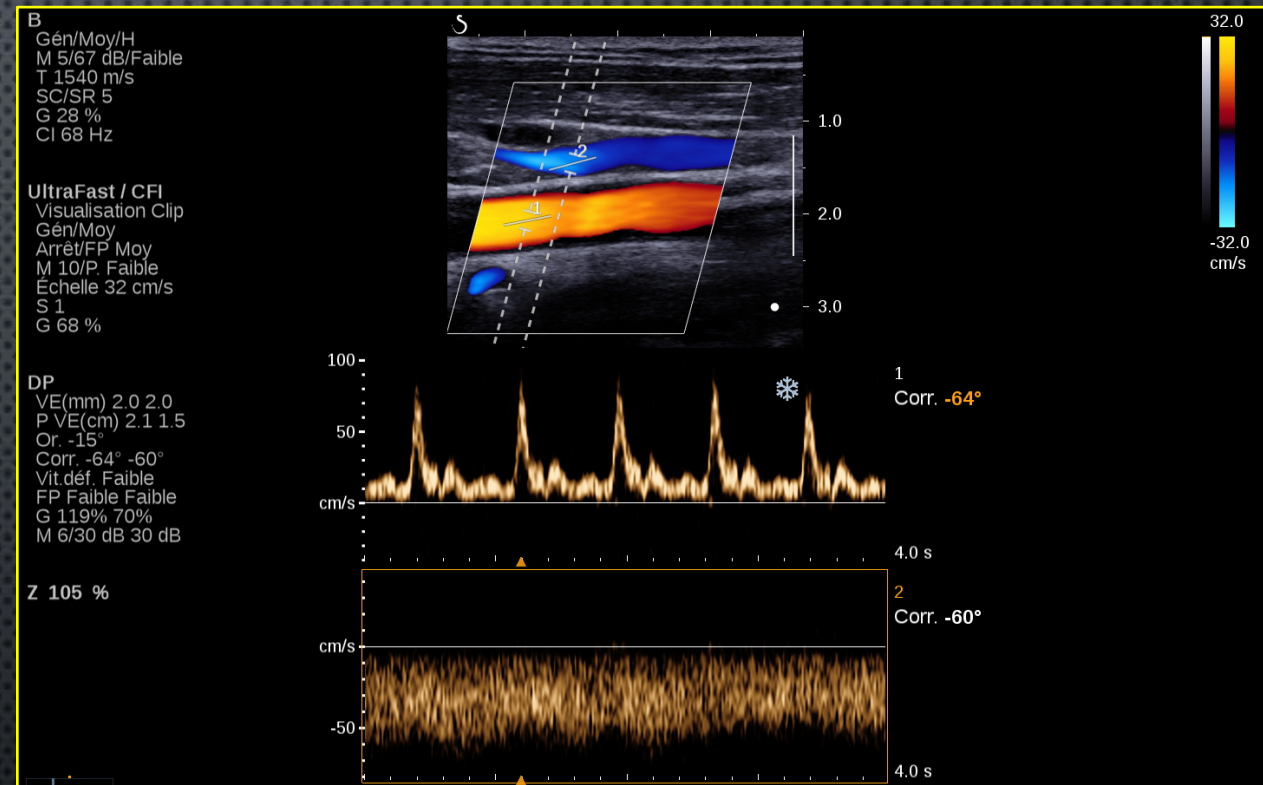
Similar acquisition but reversal of the direction of the encoding of the blood flow.





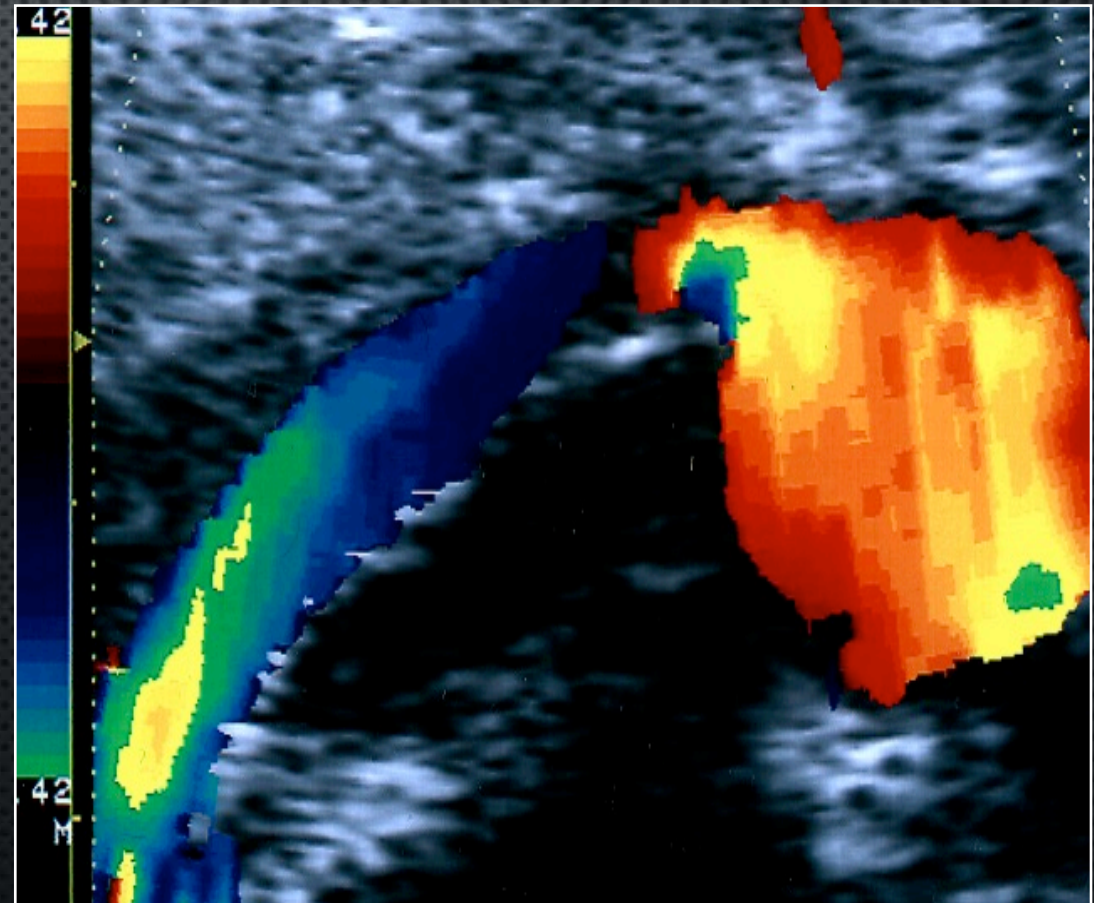
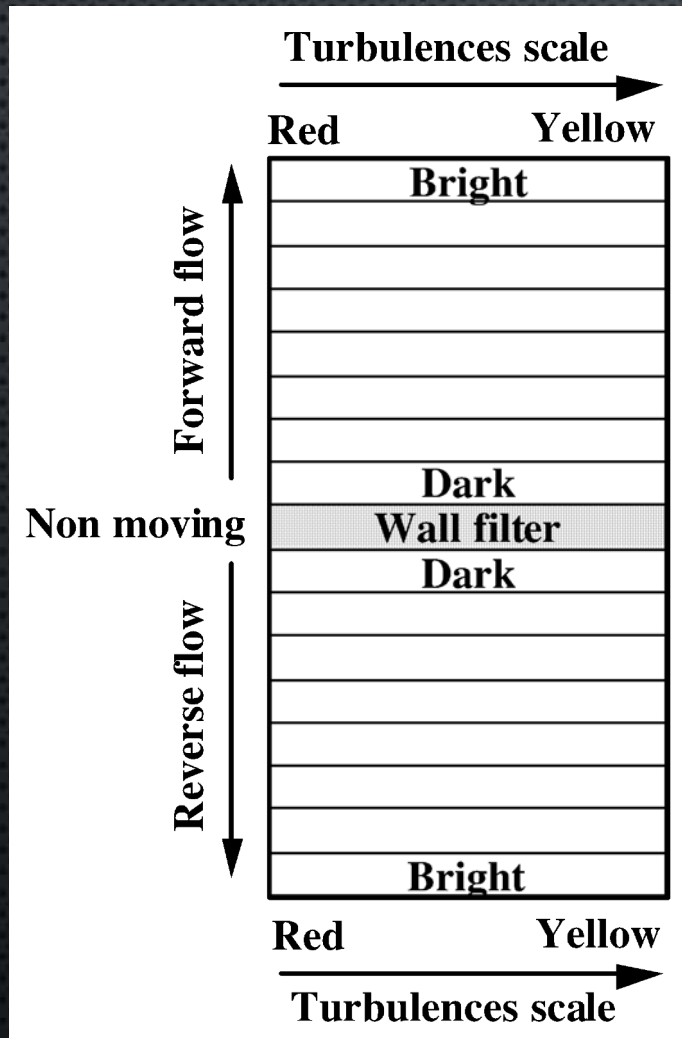
# ULTRAFAST DOPPLER

SIMULTANEOUS IDENTIFICATION OF THE CAROTID ARTERY (1) AND THE JUGULAR VEIN (2) BY ASSOCIATED SPECTRAL ANALYSIS





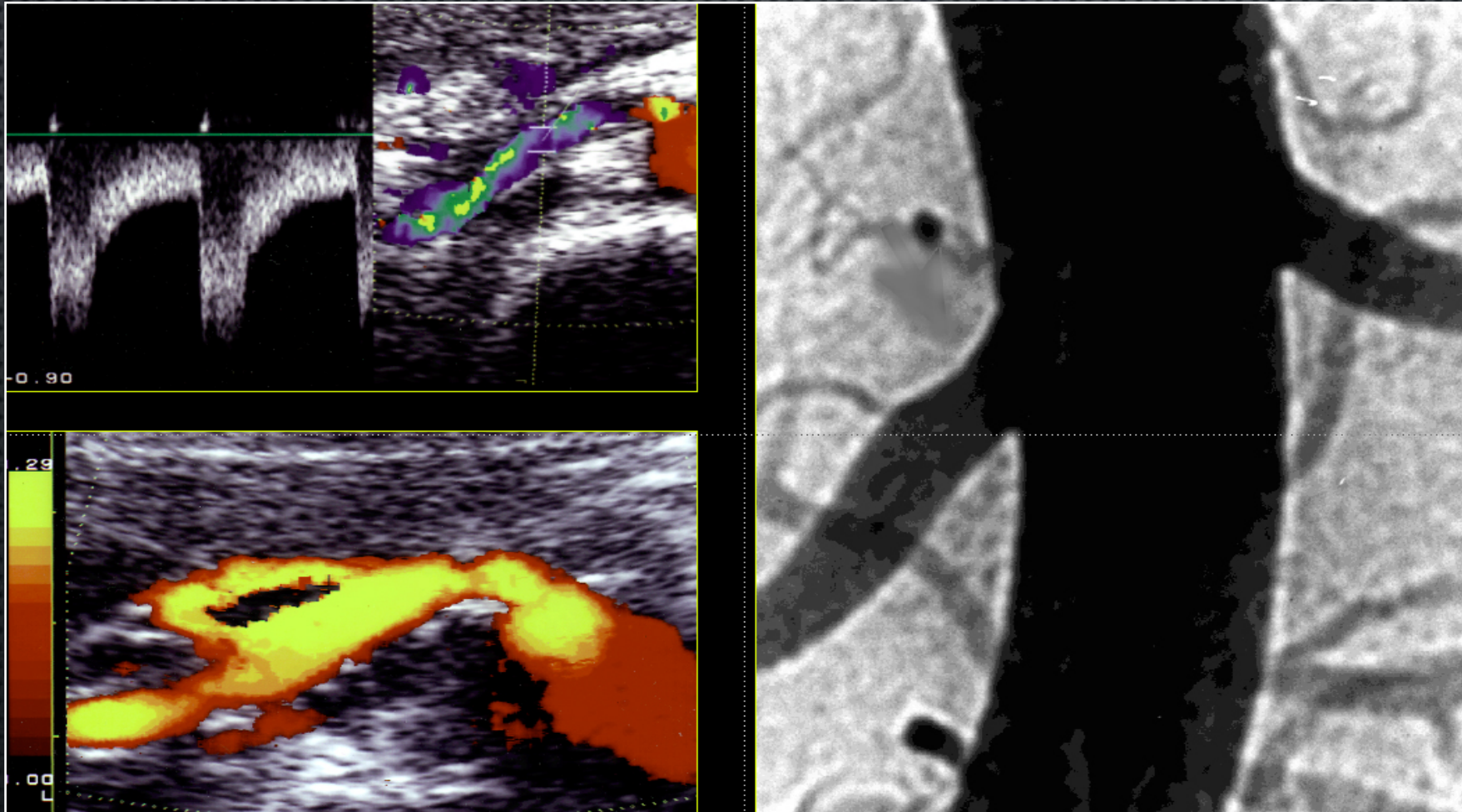
# THE NORMAL RENAL ARTERY: THE DOPPLER COLOR ENCODING





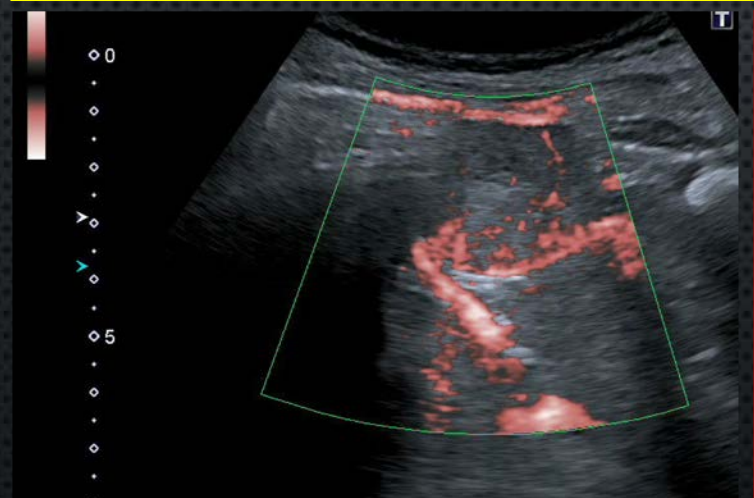
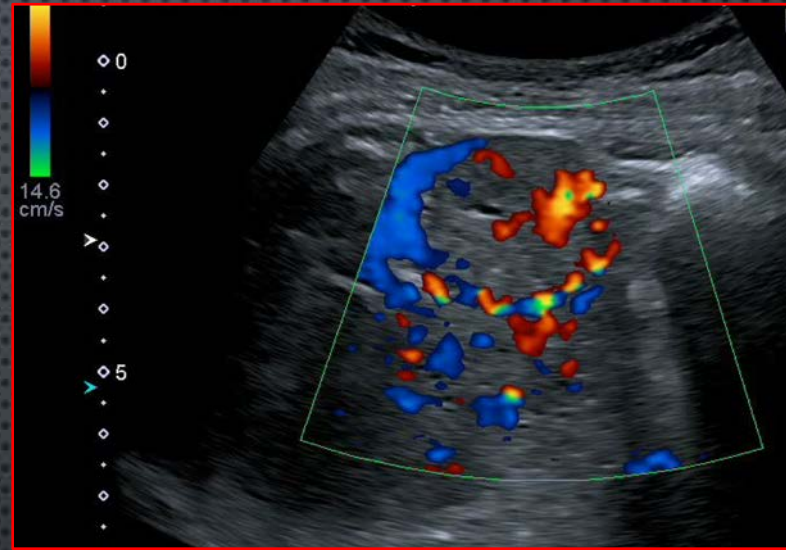
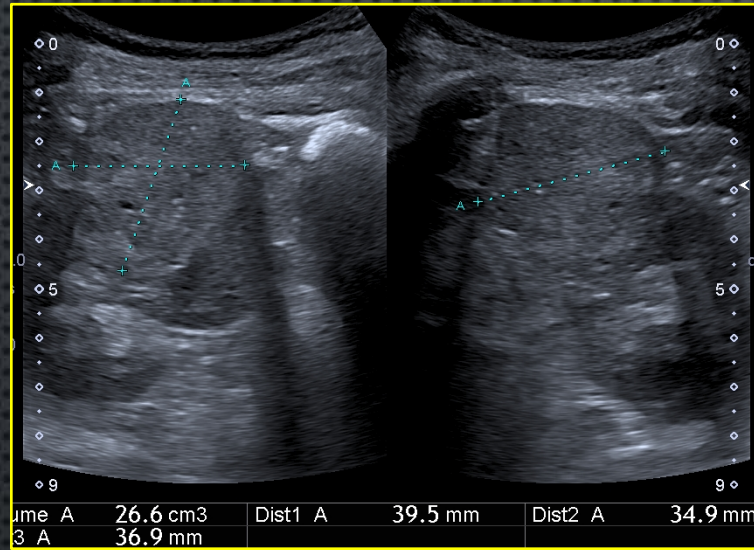
# Power Doppler US Imaging

## Atheromatous stenosis of the renal artery

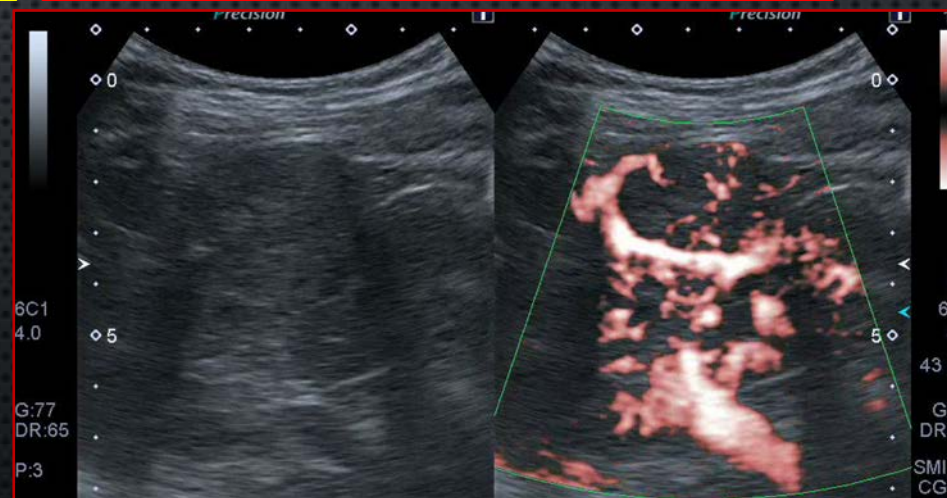




# ONCOCYTOMA OF THE UPPER POLE OF THE LEFT KIDNEY



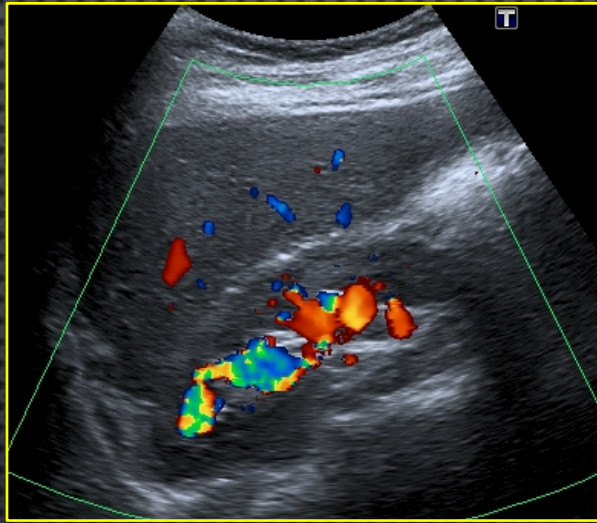
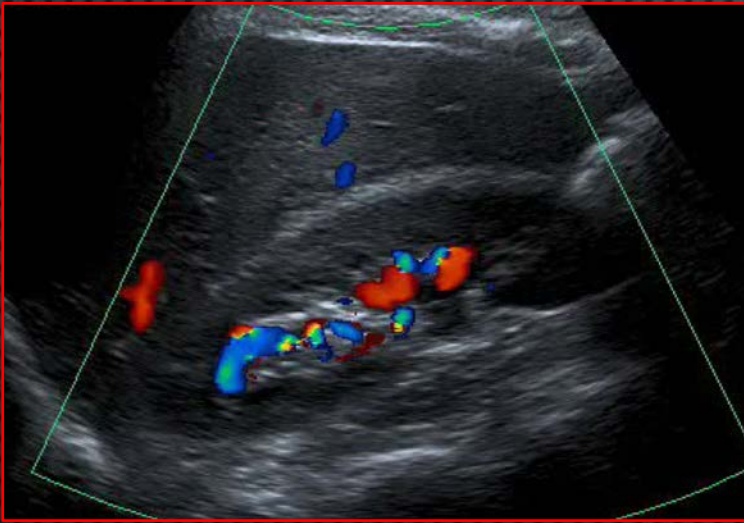
**Micro Doppler (SMI)**



**Contrast-enhanced Micro Doppler (SMI)  
(Sonovue)**

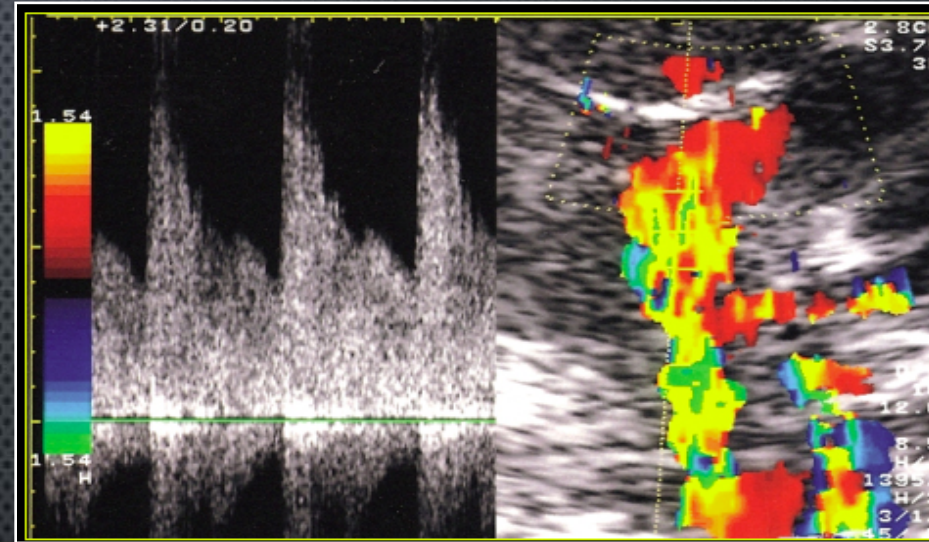


# ARTERIAL ANEURYSM OF THE RIGHT KIDNEY





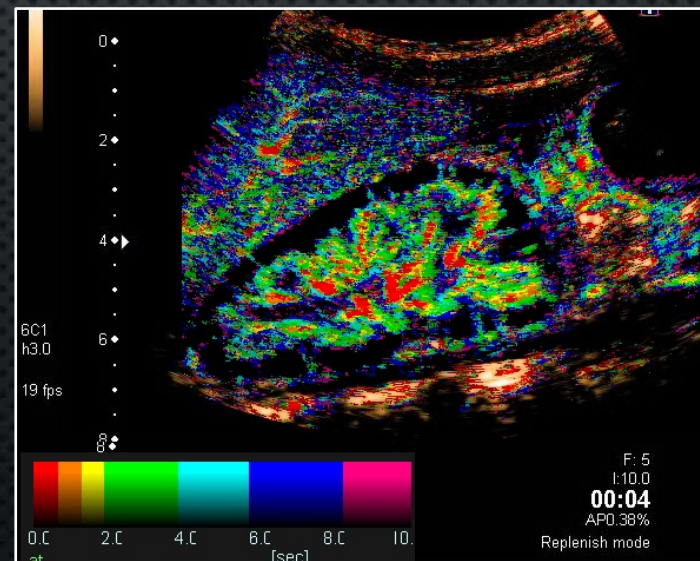
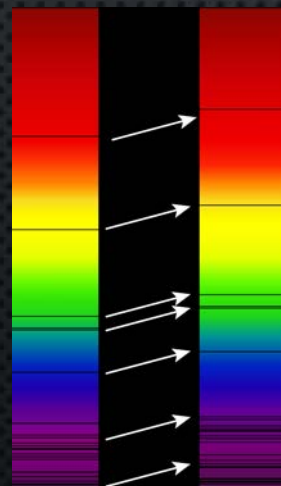
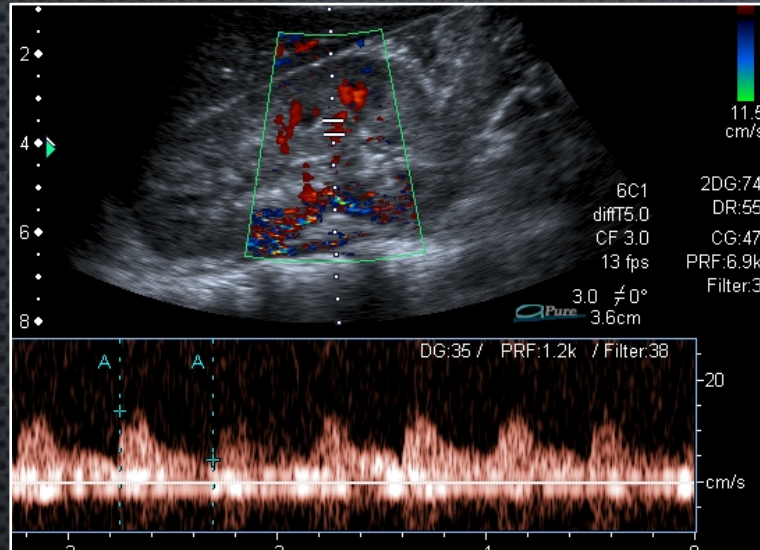
# PHENOMENON OF ALIASING



- When the backscattered frequency is higher than half of the PRF, the highest velocities (ie frequencies) are reversed and superimposed to the Doppler spectrum
- This effect can be corrected by moving the baseline toward the lower velocities and/or using the “high PRF” mode (that introduces a spatial ambiguity as two spectral windows are created)



# ACUTE RENAL CORTICAL NECROSIS





**CONCLUSION: DOPPLERISTS ONLY UNDERSTAND  
COLOR DUPLEX DOPPLER.**

**COLOR IS NOT COSMETIC IN CDD. IT IS AN ONTOLOGICAL VISUALISATION OF AN ACOUSTIC  
PHENOMENON CREATED BY THE DEVICE GENERATING THE SYMPTOMATOLOGY**