



---

# **Extraction Method for Blood Vessels, Based on the Velocity Profile Measured by Phase Shift Method**

**Y KATO   R HIMENO**

**Computer and Information Division  
The Institute of Physical and Chemical Research**

---

# Computational Model

-What is the most important?-

The Model is...

Reflecting the characteristics of the object

Constructed quantitatively.

Material Property

Geometry

# Characteristics of Sequences

## -What does the signal mean ?-

To observe the blood vessel, PS and TOF are usually used:

### **PS**

The phase shows the velocity.  
(Velocity =  $VENC \cdot \text{Phase} / \pi$ )

### **TOF**

The intensity is proportional to the velocity.  
(Relative Velocity)



## Purpose

---

- Investigate the accuracy of velocity measurement.
- Propose the extraction method of the blood vessel, based on the velocity.

The model is made, whose accuracy is known.

# Accuracy of the Velocity Measurement (PS Method) -Method-

## Influences •••Relaxation Time, TR, TE, VENC

---

T1 [msec]	$5.6 \times 10^2 - 2.5 \times 10^3$
TR [msec]	50,100
TE [msec]	10,16
VENC [cm/s]	Integer nearest to the Maximum Velocity

---

Reynolds number	300
Resolution	1mm/pixel
Diameter of Vessel	8mm

---

**All the measurements was done by 1.5 T EXCELART MR System (TOSHIBA Corporation, JAPAN).**

## Result

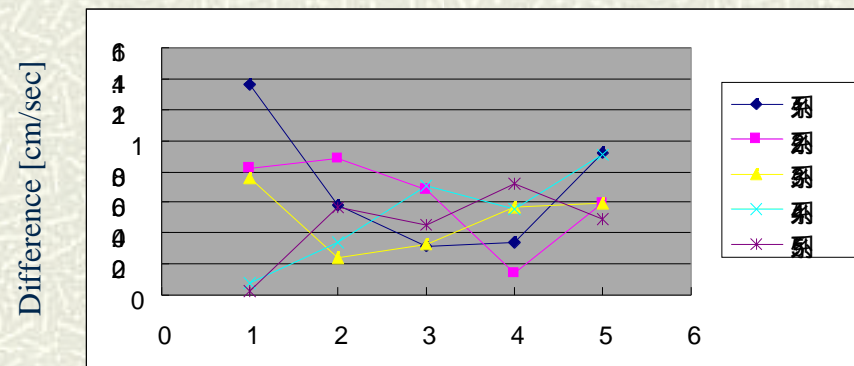
TR •••• no influence in the range

T1, VENC••••• no influence in the range of  $1.7 \times 10^3 - 5.6 \times 10^2$  msec

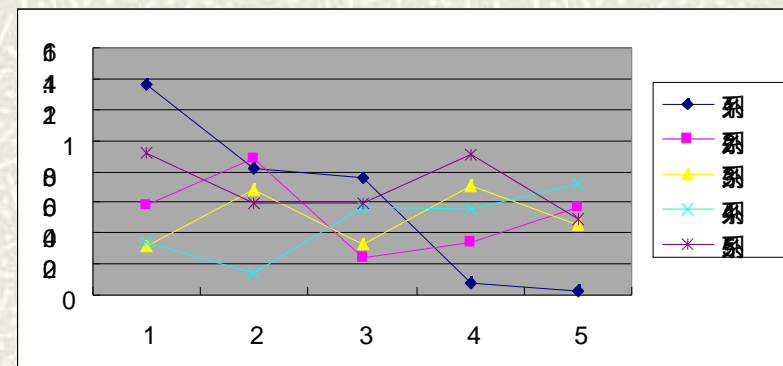
TE ••••• no influence, except T1 =  $1.7 \times 10^3$  (not the maximum error)

**The maximum error was less than 10 %.**

# Dephasing Effect



Longitudinal Direction



Transverse Direction



## Discussion

Considering T1 of Blood is 700 - 1500 msec:  
The value was not influenced by these parameters.  
Maximum error < 10 %



**Measurements in PS images are reliable.**

# Extraction Method

## -PS Images-

---

### **The characteristics of this method:**

Using the continuity of the blood vessel  
The data in the boundary is known.

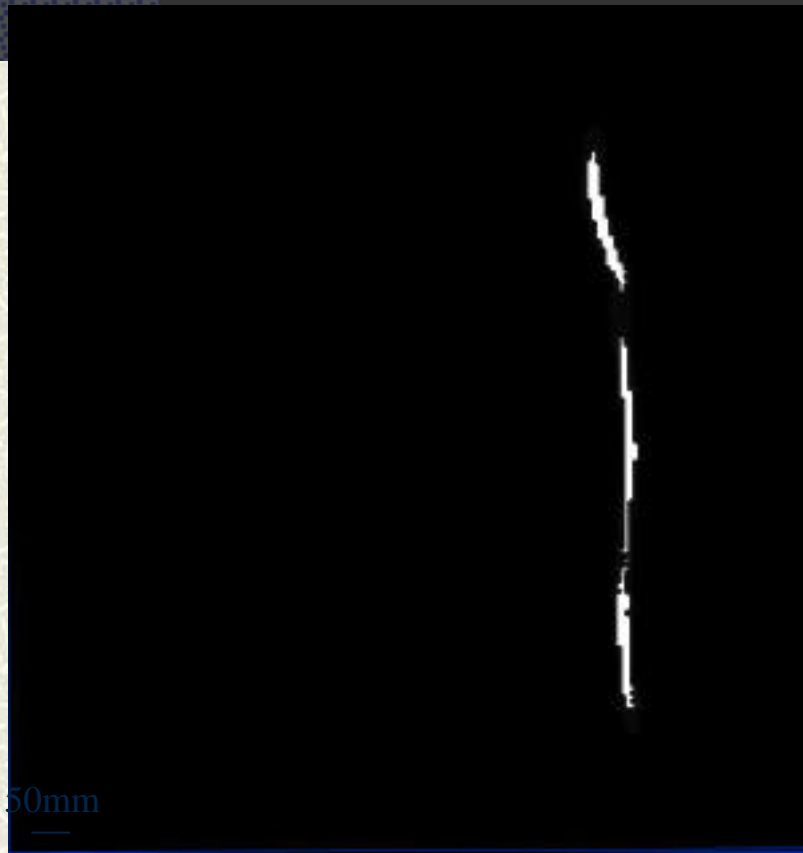
### **What the operator have to do:**

Set the starting point  
Set the minimum velocity in the blood vessel.

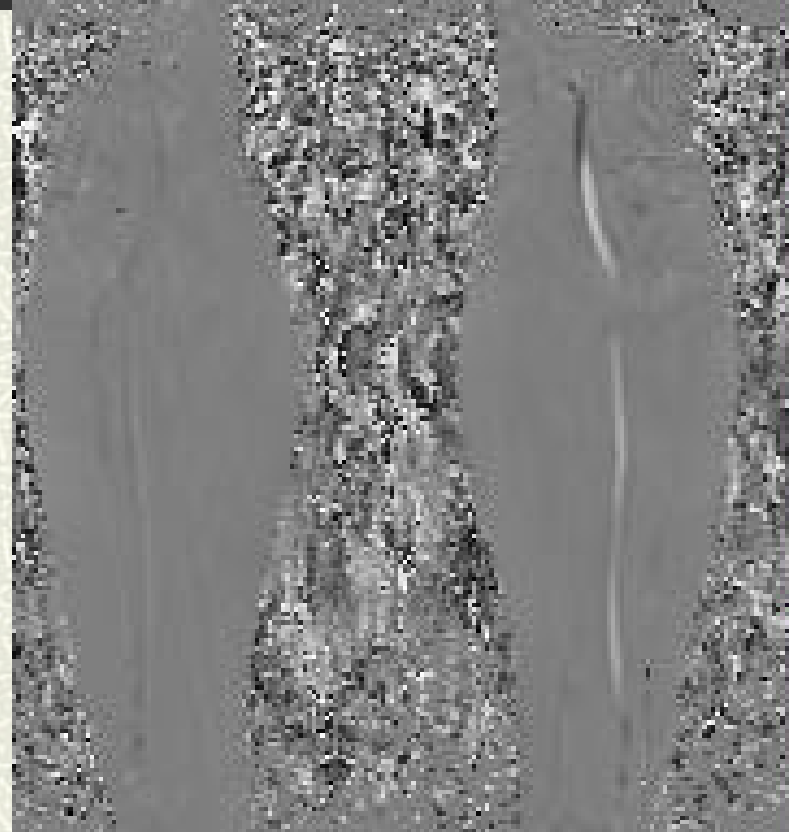
## Example (Femoral Artery)



## Example (Femoral Artery)



Binarized Image



Original Image

## Example (Cerebral Artery)



## **Extraction Method -TOF Images-**

---

**The Starting point and the threshold value  
are decided automatically.**

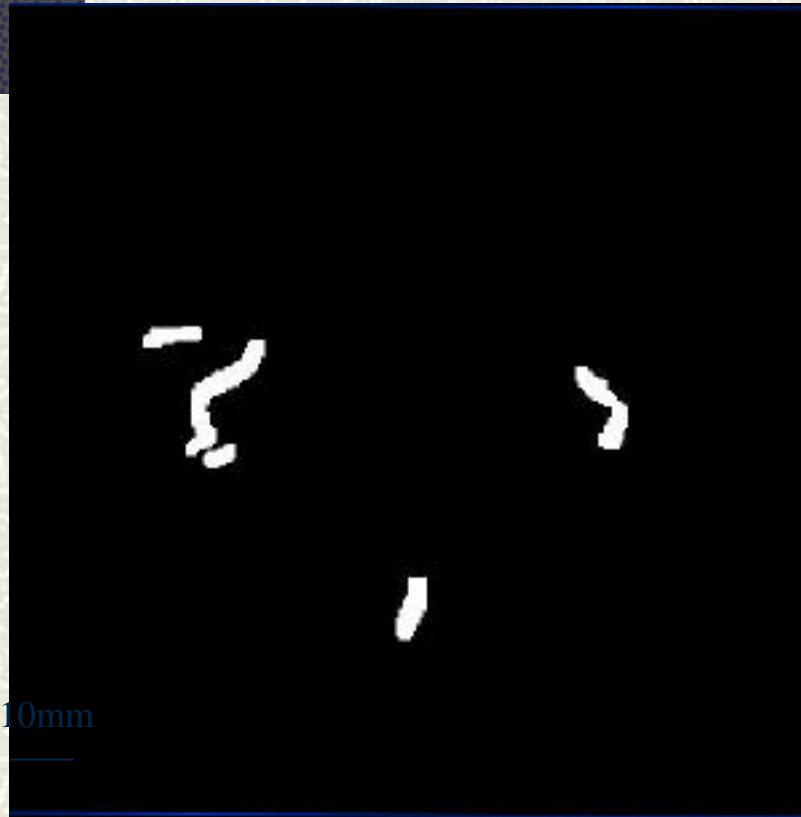
Starting Point ●●● 1- 100 points in the highest intensity  
Threshold Value ●●● the frequency is 10 times higher at  
the value.

## Example (TOF)

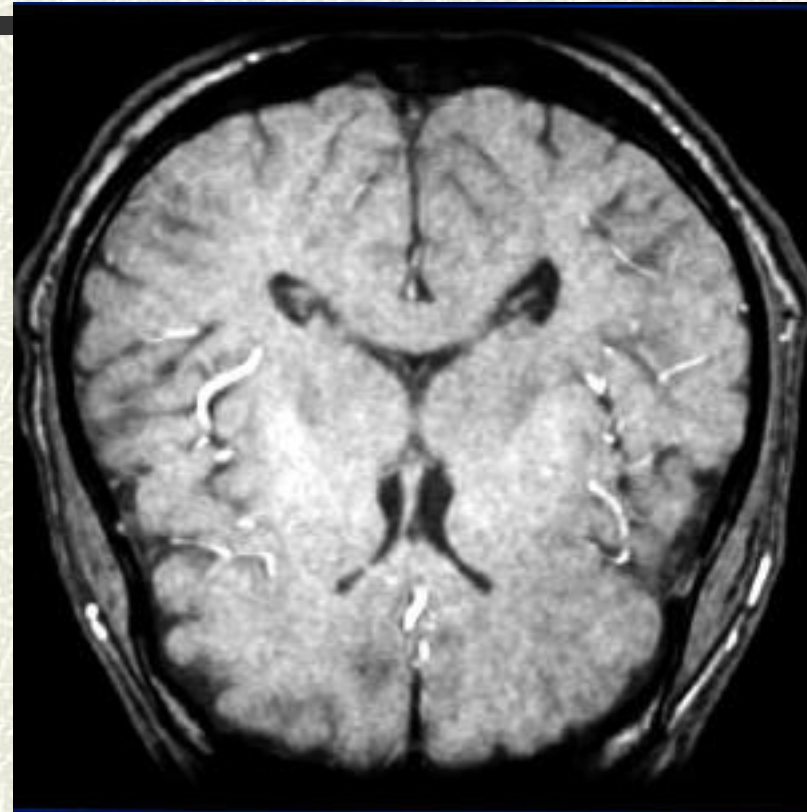


Computer and Information Division  
The Institute of Physical and Chemical Research

## Example (TOF)



Binarized Image



Original Image



## Conclusion

---

- PS method has enough accuracy to measure the blood flow.
- The automatic extraction method was proposed, which could be evaluated quantitatively.
- This extraction method could apply to PS and TOF images.

Evaluate the geometrical data quantitatively and automatically

- Decide the centerline based on the reasonable assumption



Diameter, shear stress, .....