生醫實驗期中報告
Magnetocardiography

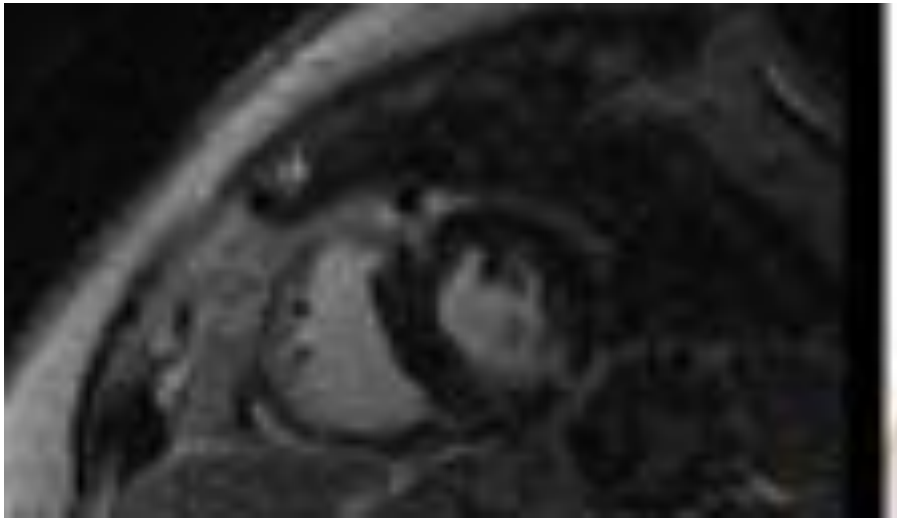
Group8
B98901005　林　震
B98901033　郭家維
B98901052　陳河穆

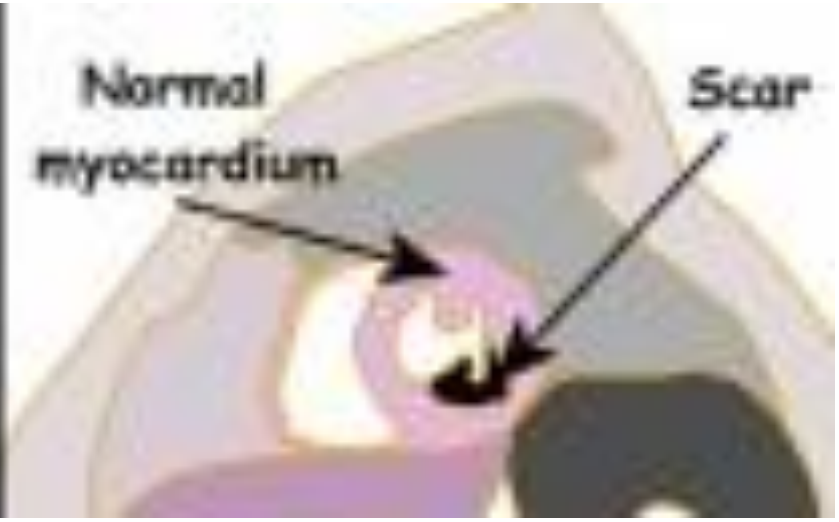
Outline

- Experiment
  - myocardial scar detection
- MCG
  - What's MCG?
  - MCG vs. ECG
  - SQUID
  - With MRI

Myocardial scar

- 當心肌細胞因物理或疾病因素受傷後，新生的纖維組織形成疤痕





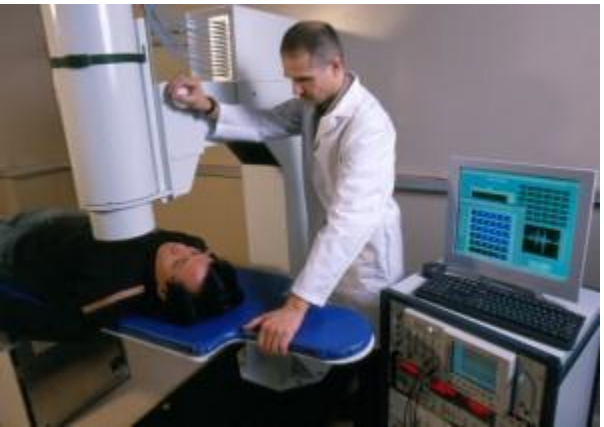
結疤會怎樣嗎？

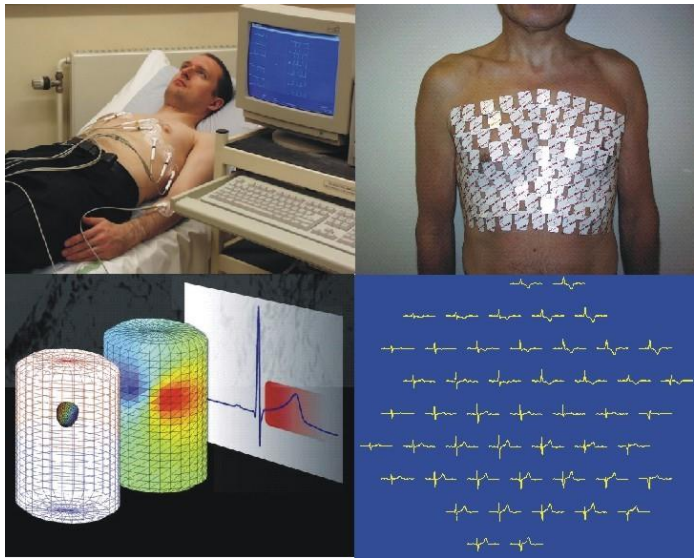
- 導致心肌缺氧
- 阻礙心電傳導
- 心室自發去極化

所以我們要檢測

- 心電圖ECG
- —extended electorcardiography(BSPM)
- 100 electrodes, not practical

- MCG：magnetocardiography





Experiment

- MCG 於心肌疤痕檢測是否有效

Table 1. Characteristics of the 10 patients.

Patient number	RCA	LCX	LAD	Segment number	Transity (%)	EF (%)	NYHA class	Age/sex
1			X	13,14,15,16,17	100	38	I - II	69/m
			X	1,7,8,9	50			
2			X	13,14,16,17	50	23	III	57/m
3		X		3,9	70	58	I - II	70/m
4		X		3,	70	50	II	69/m
			X	7,12,	30			
5			X	7,12	25	47	II	59/m
6			X	13,14,15,16,	100	31	III	67/m
	X			17	30			
	X			5,6,	50			
				11,12				
7			X	13,16,	80	37	II	71/m
		X		3,9,	50			
	X			10,11,12	50			
8			X	8,9	40	58	I	58/m
			X	13,14,15,	100			
	X			11,12	40			
9			X	1,6,7,	80	38	II	59/f
			X	12,13,14	60			
10			X	2,8	50	45	II	81/f
		X		3,9	50			

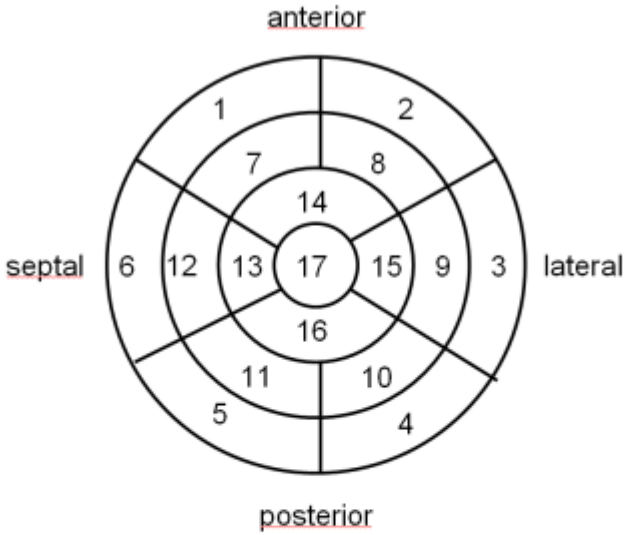


Figure 1. Modified 17-segment model of the heart according to [15]. 1: basal anteroseptal; 2: basal anterolateral; 3: basal lateral; 4: basal posterolateral; 5: basal posteroseptal; 6: septal; 7: mid anteroseptal; 8: mid anterolateral; 9: mid lateral; 10: mid posterolateral; 11: mid posteroseptal; 12: mid septal; 13: apical septal; 14: apical anterior; 15: apical lateral; 16: apical posterior; 17: apex.

MCG?

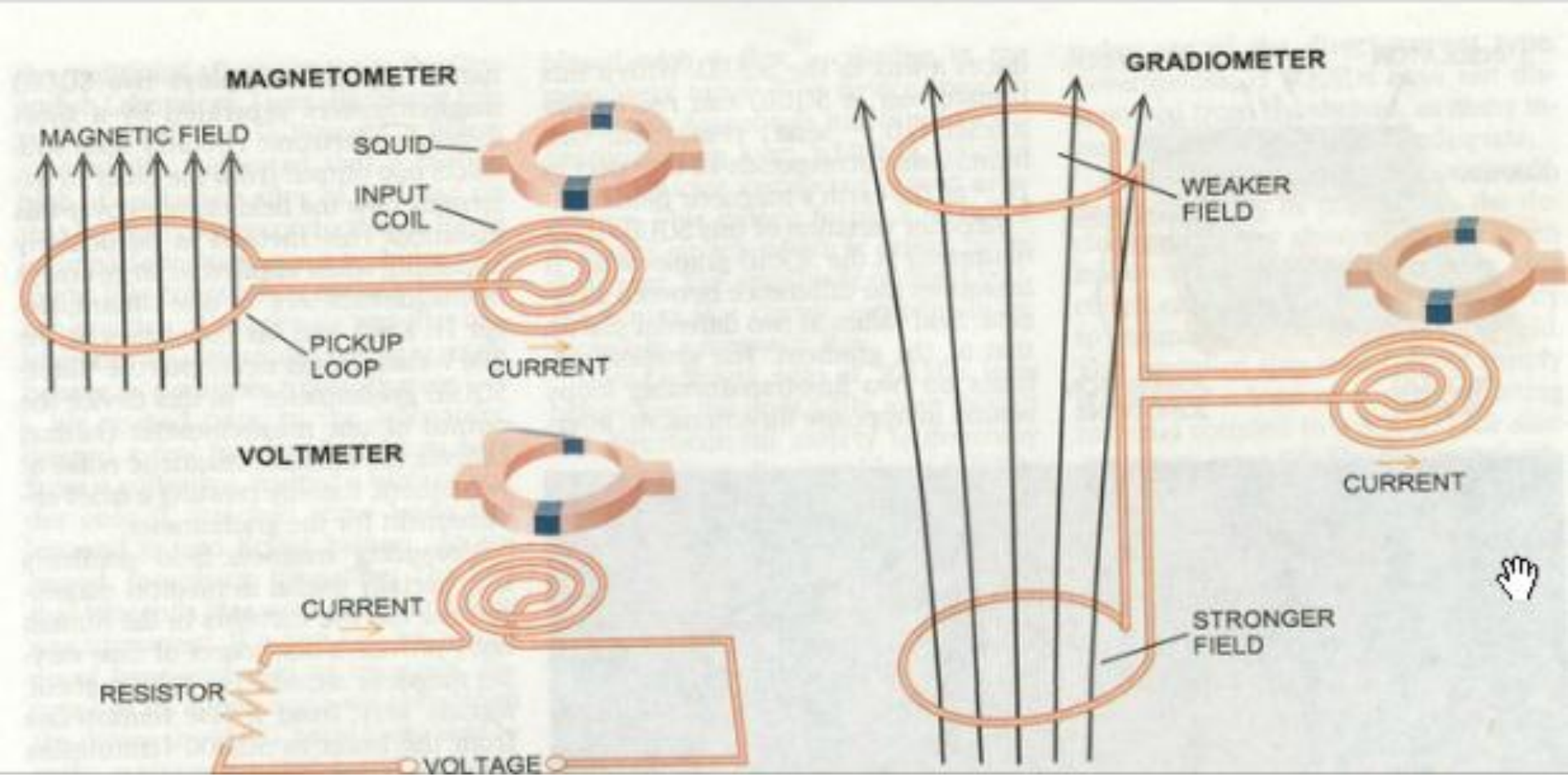
- Magnetocardiogram
- Detection of biomagnetic signal
- MCG vs. ECG
  - No distortion (by resistance between source and electrodes)
  - No contact needed (different view of heart due to misplaced electrodes)
  - Can see those cardiac currents invisible to the ECG.
- However, biomagnetic signal is too weak to detect. **→SQUID**

SQUID

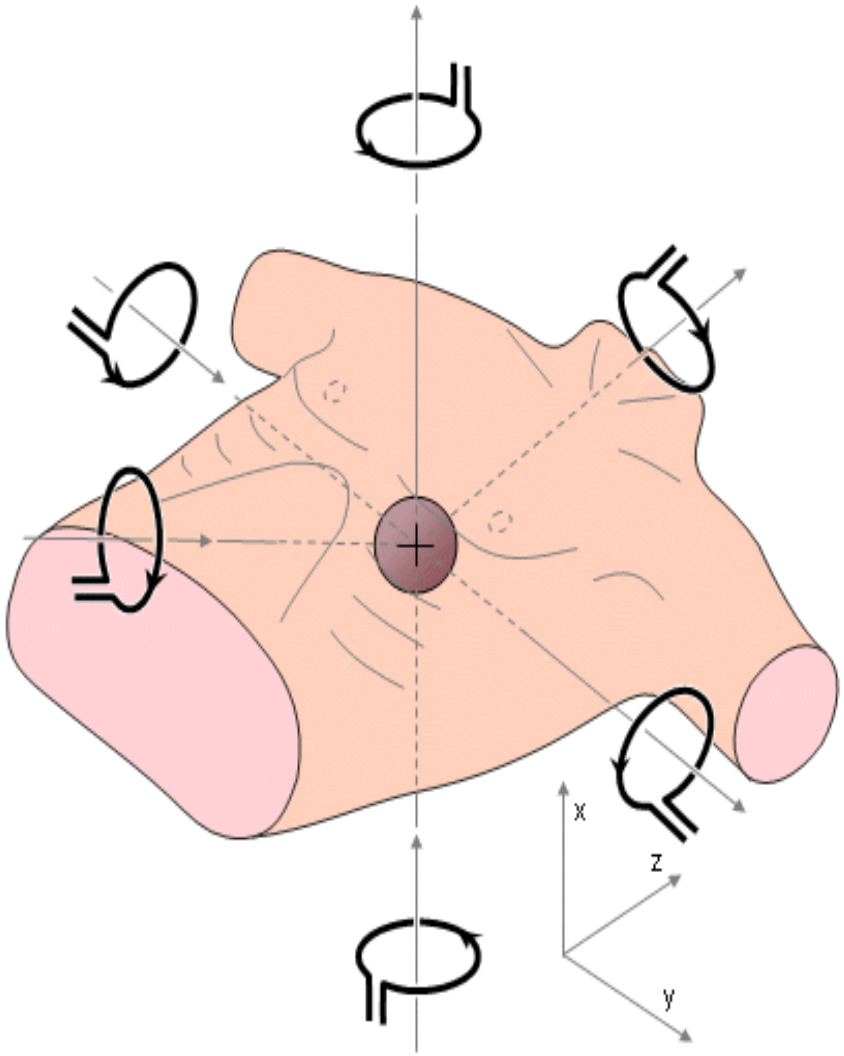
- Superconducting quantum interference devices
- The SQUID is an extremely sensitive magnetic field detector.
- Can detect fields on the order of 10e-15 T
  - Earth's magnetic field: 10e-4 T
  - Heart's magnetic field: 10e-11 T
  - Brain's magnetic field: 10e-15 T

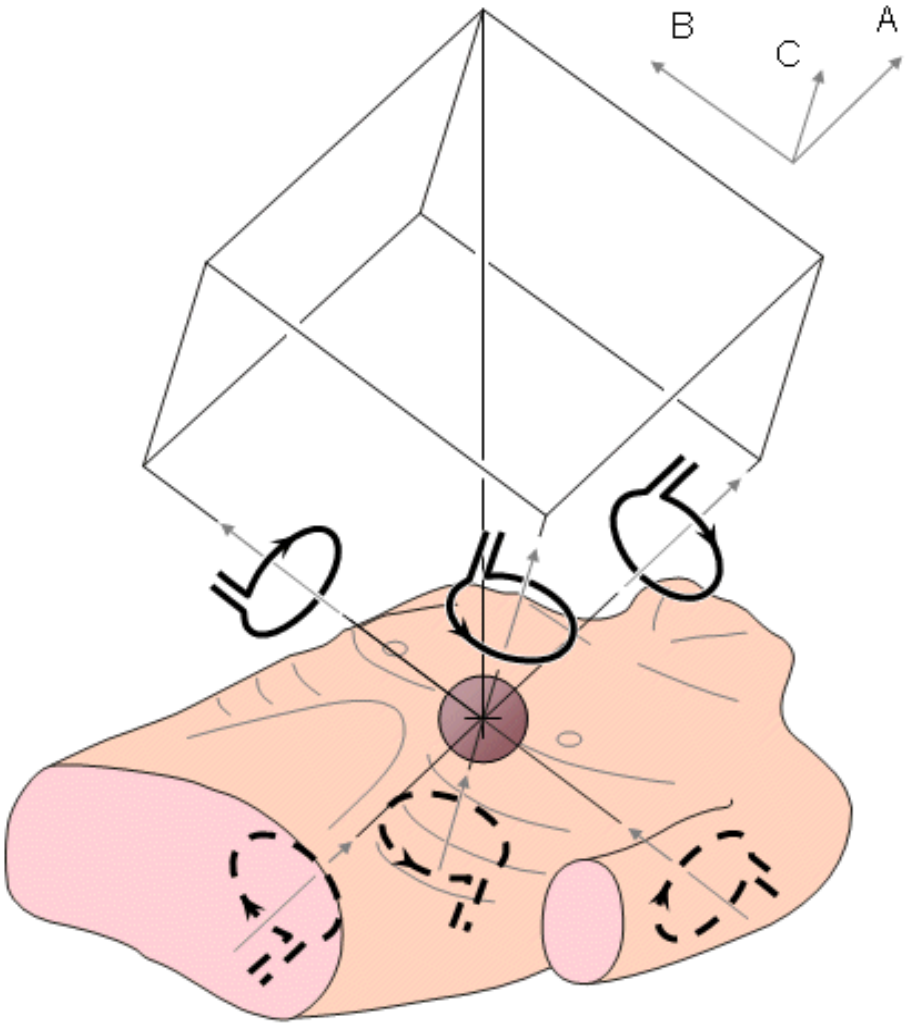
Aiding Detection

- Gradiometer, Magnetometer, Voltometer



Lead system





MCGs registering

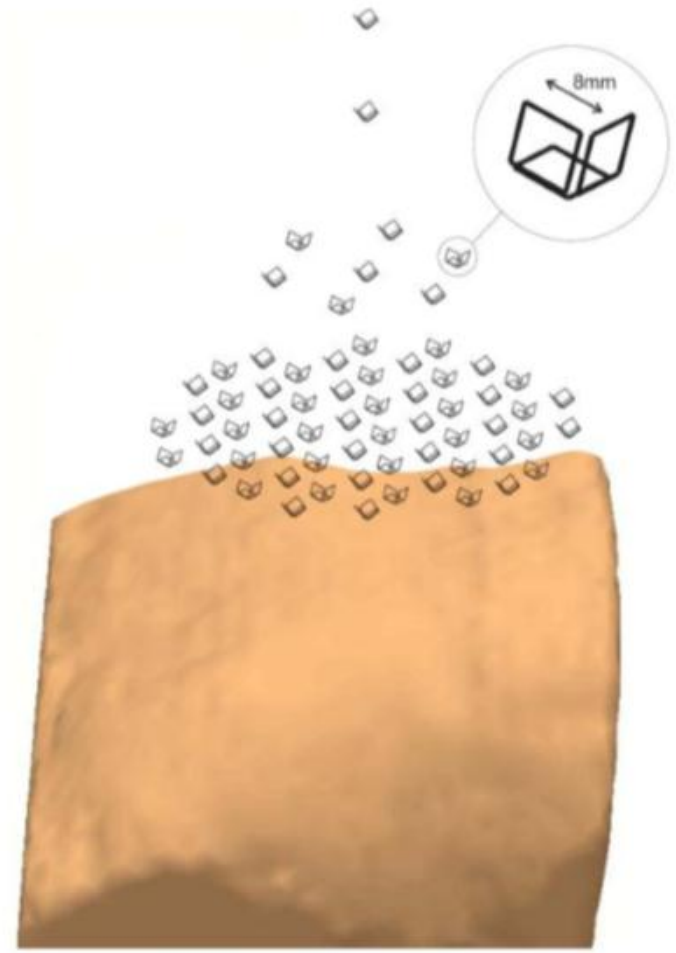


Figure 2. SQUID sensor array of the ARGOS 200 system (195 magnetometers with orthogonal sensor triplets in four levels above the torso) [16].

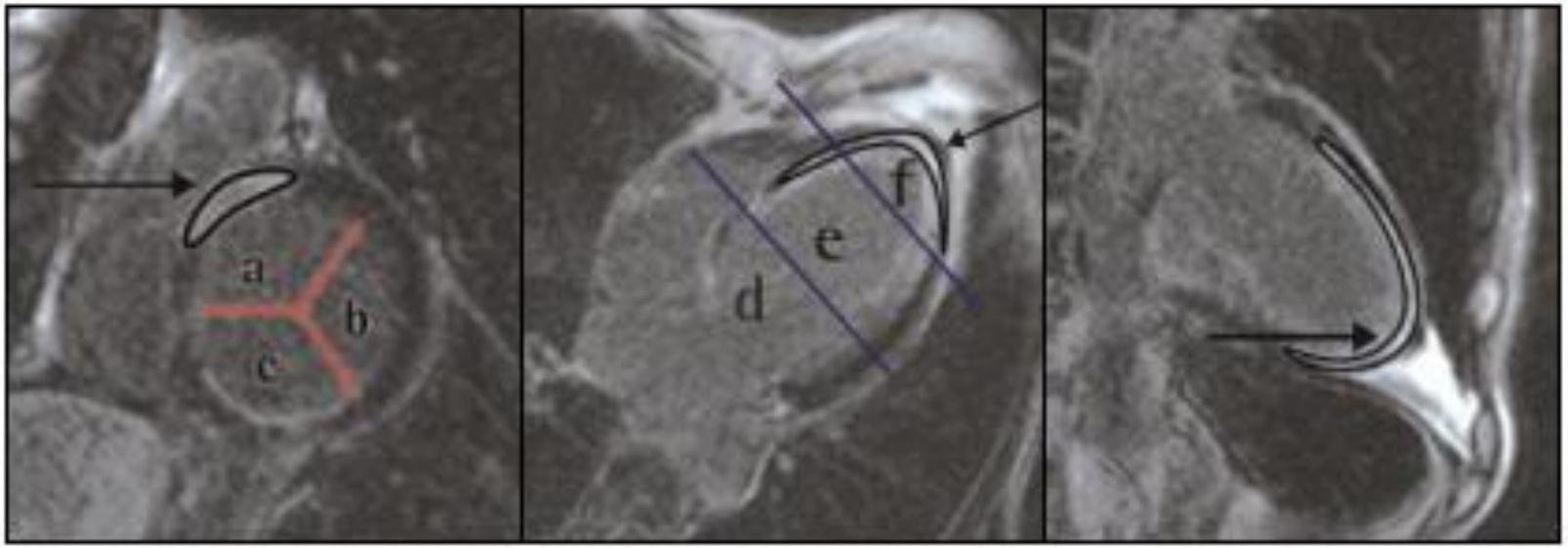
MCG registering

等磁場圖

圖七：磁場分布圖

Model by MRI

- 外型
- 表皮厚度
- 自行假設的導電度



Current density distribution

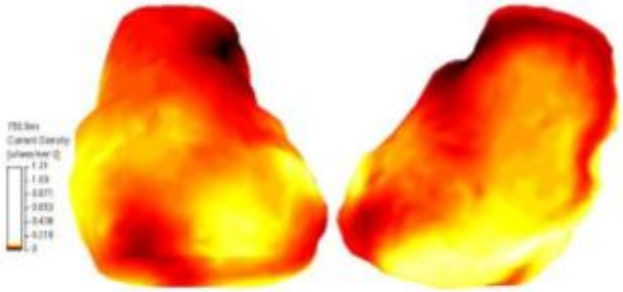


Figure 4. Current density distribution at the T wave maximum of a healthy control with left ventricle (right) and right ventricle (left) views.

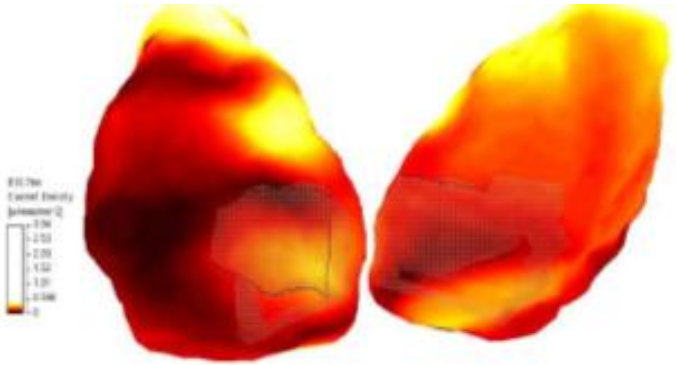


Figure 5. Current density distribution at the T wave maximum of patient 4 with left ventricle (right) and right ventricle (left) views. Gray grid = scar on surface; gray grid within black lines = septal scar; 1 = circular/semi-circular edge phenomenon; 2 = lingual-shaped ridge; 3 = low current density in the infarct area.

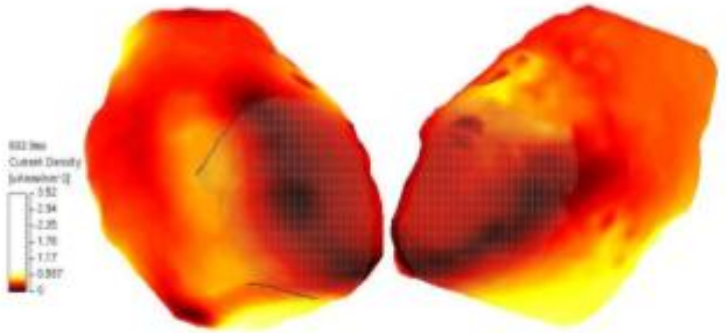


Figure 6. Current density distribution at the T wave maximum of patient 1 with left ventricle (right) and right ventricle (left) views. Gray grid = scar on surface; gray grid within black lines = septal scar; 1 = circular/semi-circular edge phenomenon; 2 = lingual-shaped ridge; 3 = low current density in the infarct area.

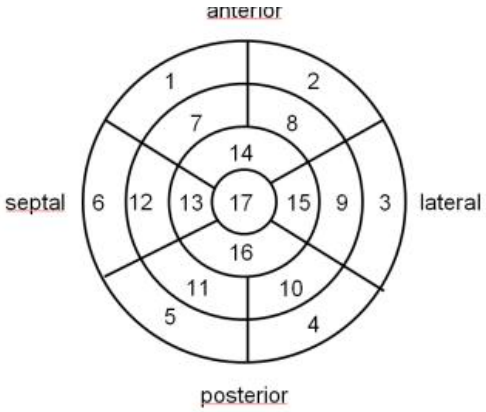
Current density distribution

- Viable myocardium area --> high current density
- Scared myocardium area --> low current density

- Offer the possibility of distinguishing those two condition

Correlation coefficient

$$r_{xy} = CC_{patient} = \frac{cov(x,y)}{\sqrt{var(x)} \cdot \sqrt{var(y)}}$$



Character x = variability of current density of the heart

Character y = the infarct status

Resulte CC = 0.81 (high correlation coefficient)