Advances in mapping methods and technology

George Van Hare MD
Division Chief, Pediatric Cardiology
Co-Director, Heart Center

Presenter disclosures

- Financial (Relationships with industry)
  - None
- Off-label, experimental or investigational use of drugs or devices:
  - Historical only

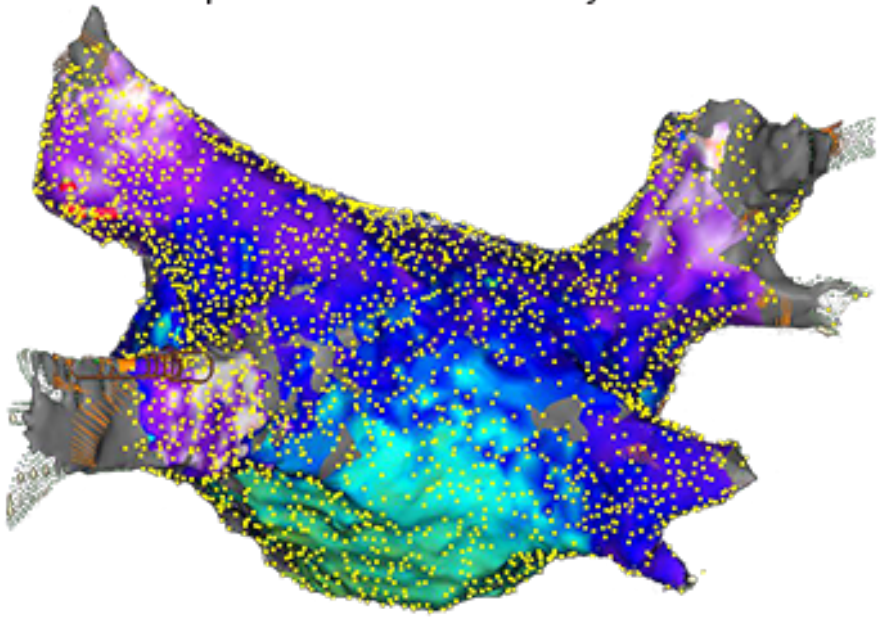
Topics

- Latest CARTO and NavX systems
- Voltage mapping in AVNRT
- ECG imaging → CardioInsight
- Place of entrainment

EnSite Precision

- Incorporates contact force data
- Includes magnetic and impedence localization data that are integrated
  - Impedance localization less accurate
  - Magnetic localization requires sensors
- Automated and rapid creation of anatomy using any catheter in the heart
- Automatic rejection of catheter-induced ectopy

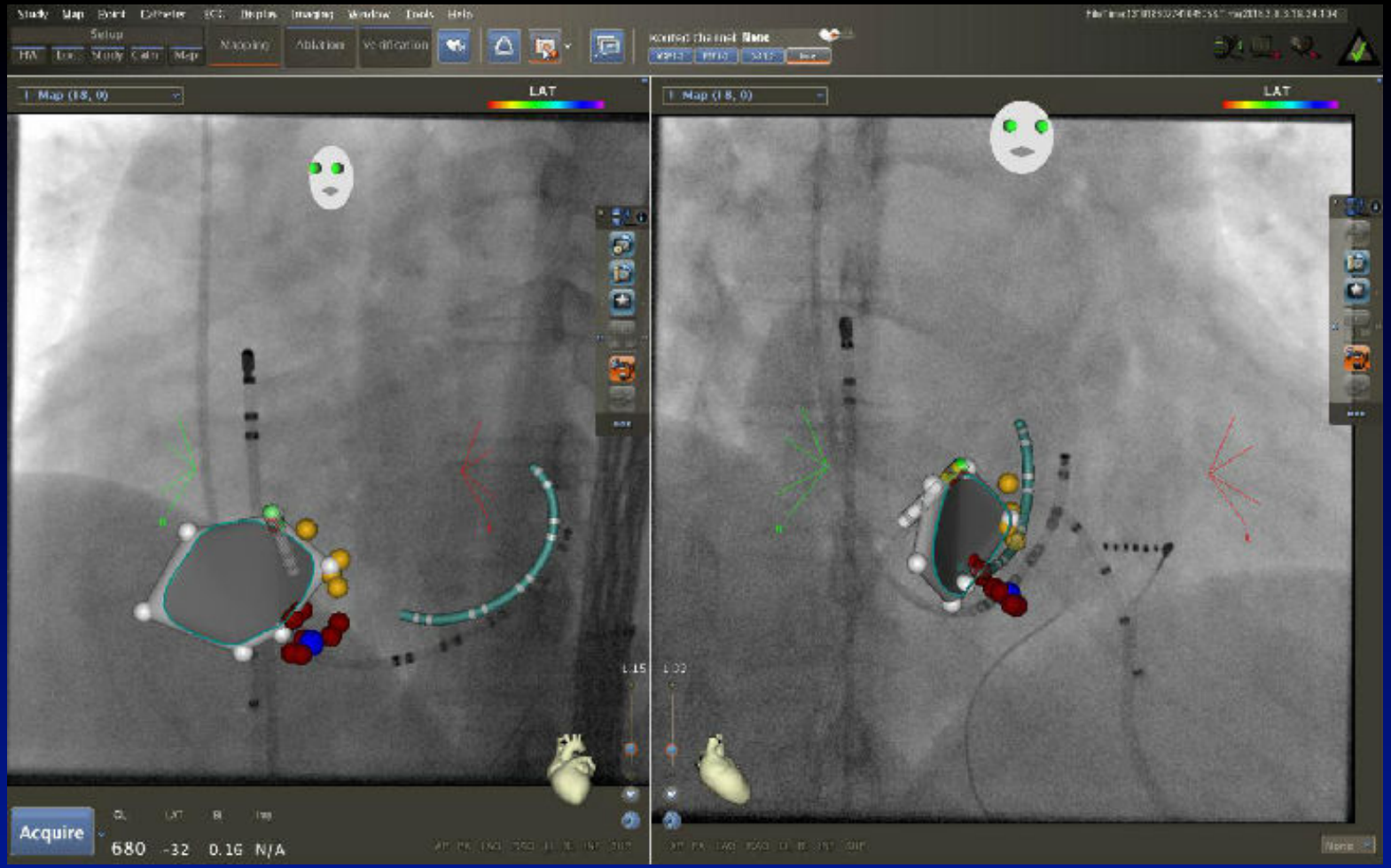
Impedance-Field Flexibility



Magnetic-Field Precision

CARTO 3

- Magnetic localization using proprietary catheters
- Incorporates intracardiac echo images
  - Soundstar catheter/CartoSound module
- Incorporates static fluoro image to minimize need for active fluoroscopy
  - CartoUNIVU



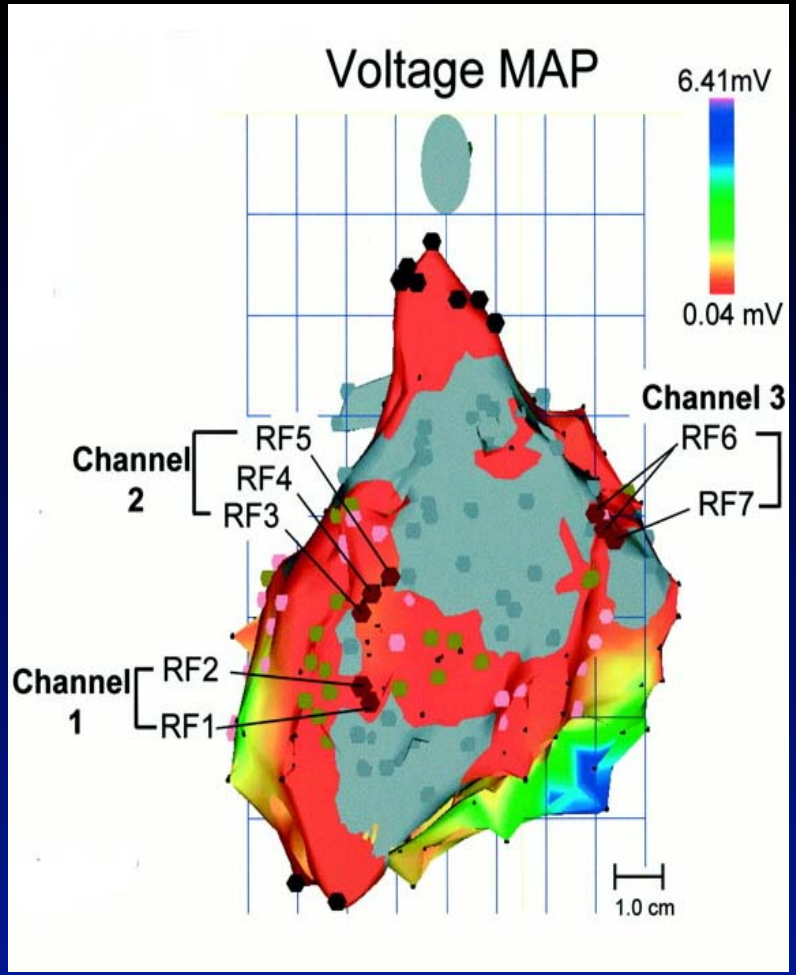
West China Hospital, Sichuan University

Other systems, optimized for atrial fibrillation

- Rhythmia (Boston Scientific)
  - Uses 64-electode basket catheter, impedance and magnetic localization, faster mapping
- CardioNXT (in development)
- Topera Rotor Mapping (Abbott)
  - Focal Impulse and Rotor Modulation (FIRM)
  - FIRMap Basket catheter

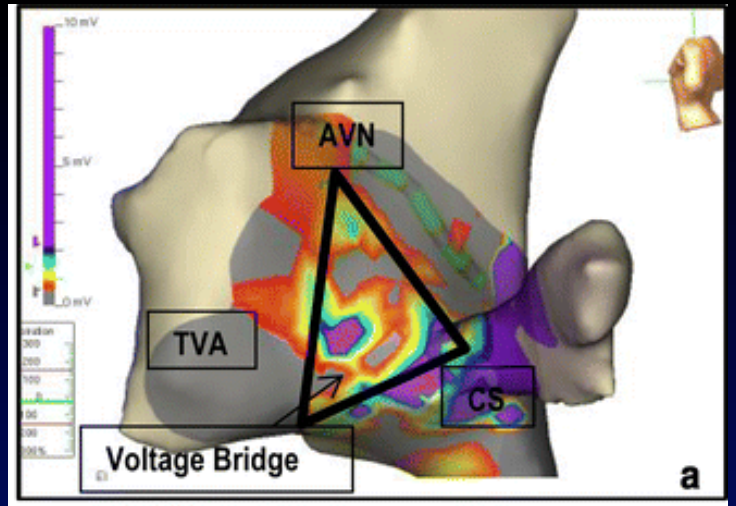
Nakagawa et al. Fontan voltage map

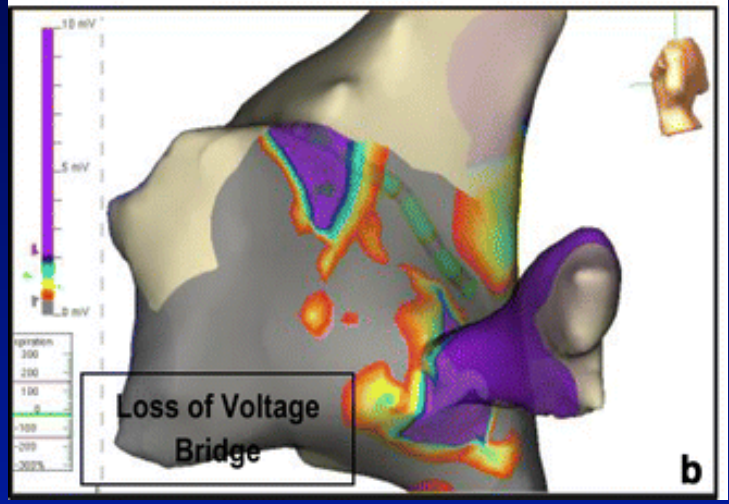
- Signals > 0.03 mV included
- Signals <0.03 mV defined as scar



Nakagawa et al. Circulation 103:699, 2001

Voltage mapping in AVNRT



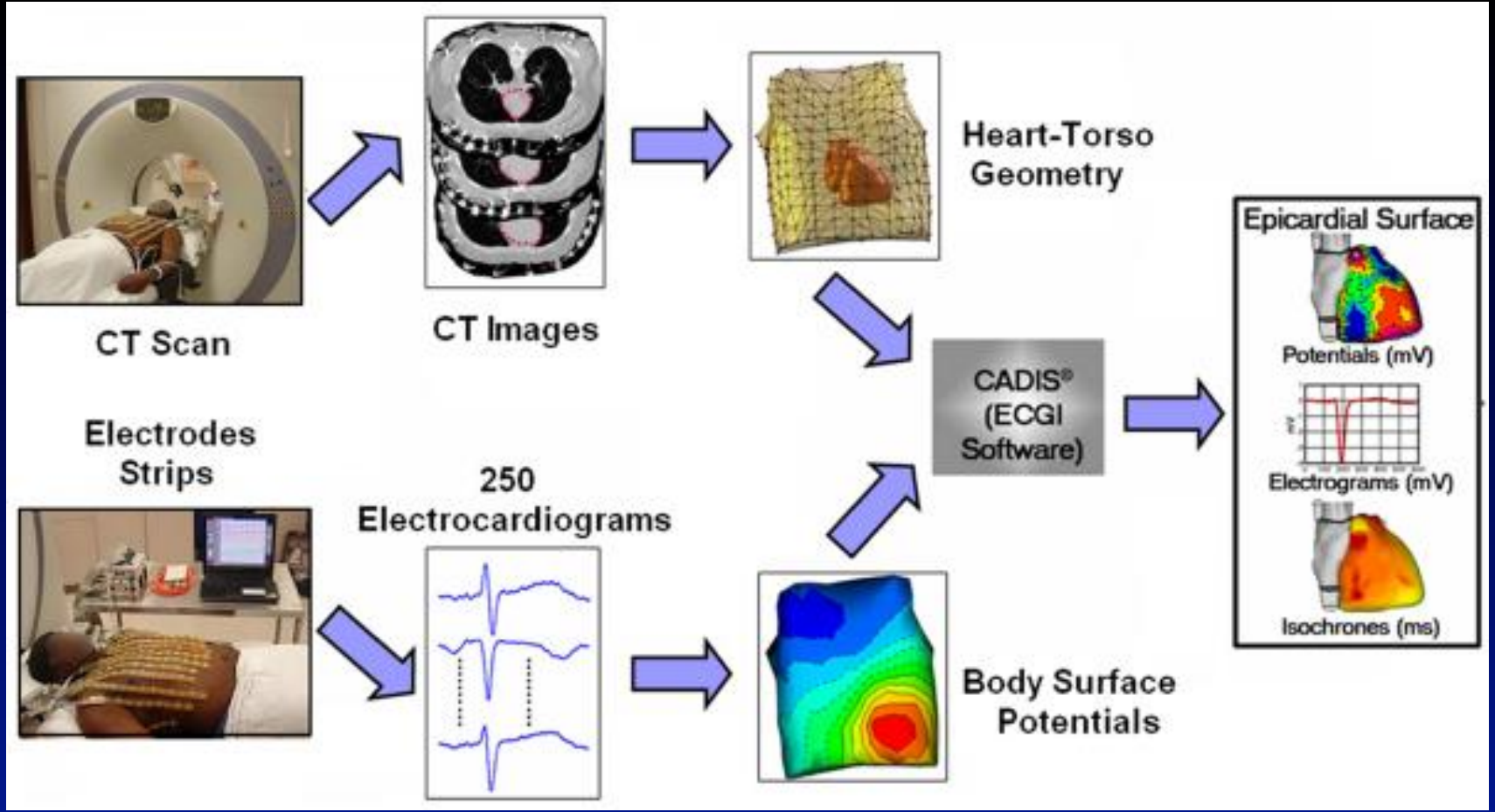


- Low voltage "bridge" in slow pathway region
- Thought to represent actual slow pathway
- Successful ablation associated with loss of voltage

Malloy et al Ped Cardiol 2014

Electrocardiographic Imaging (ECGI)

Medtronic CardioInsight mapping system

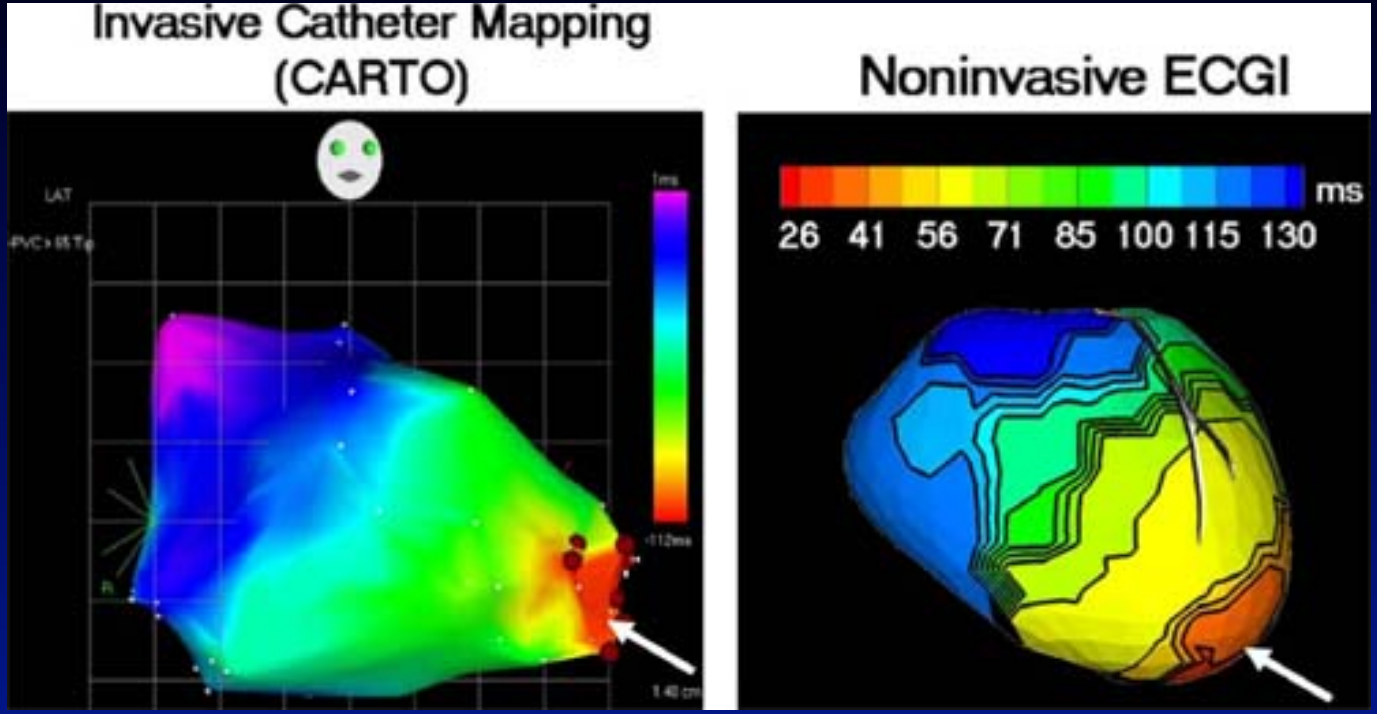


Ramanathan et al. Nature Medicine 2004

Forward and Inverse Problems in Electrocardiography

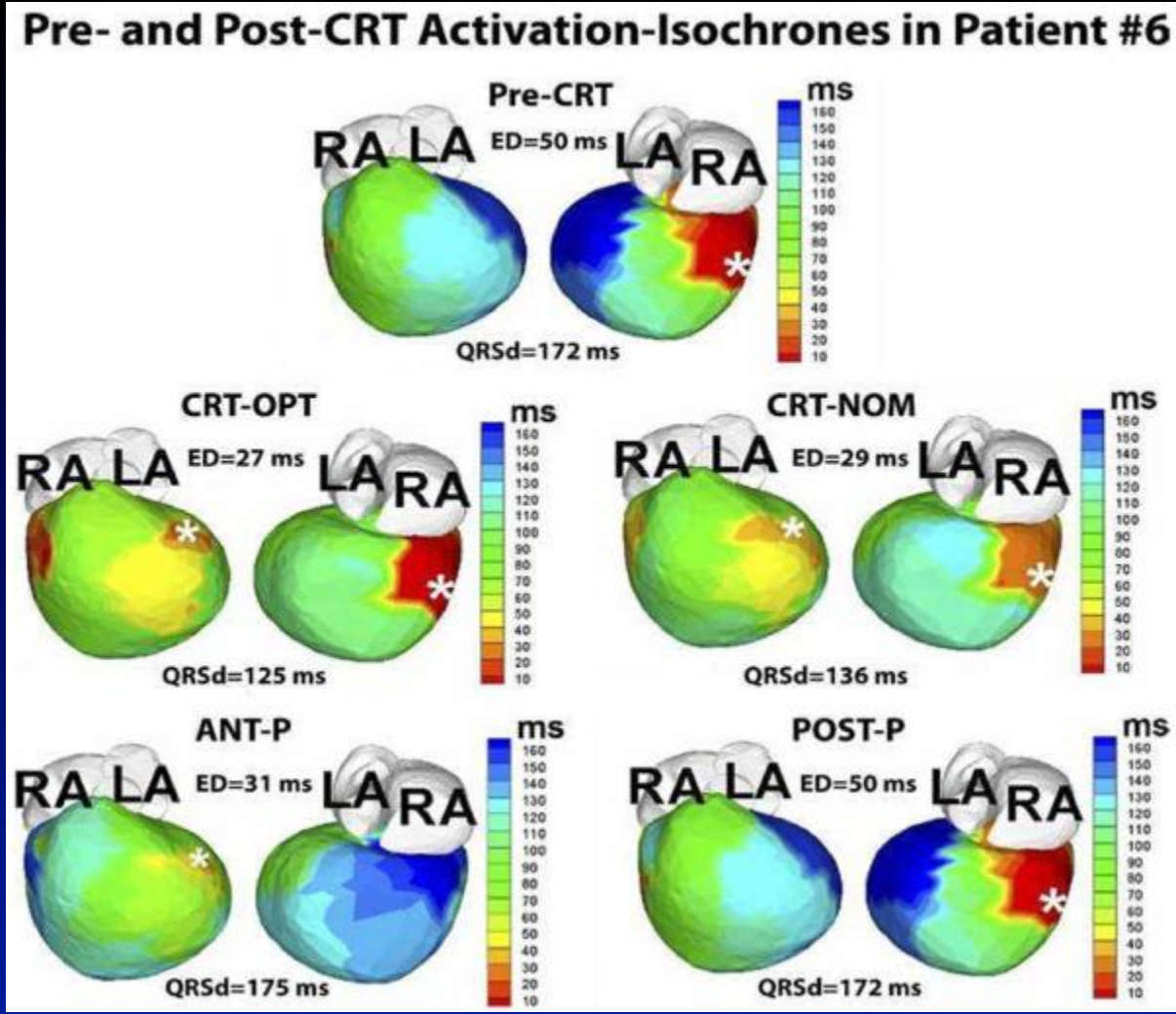
- *Forward Problem*: Calculation of body surface (ECG) potentials from known epicardial potentials
- *Inverse Problem:* Reconstruction of epicardial potentials from body surface potentials

Focal VT from LV apex

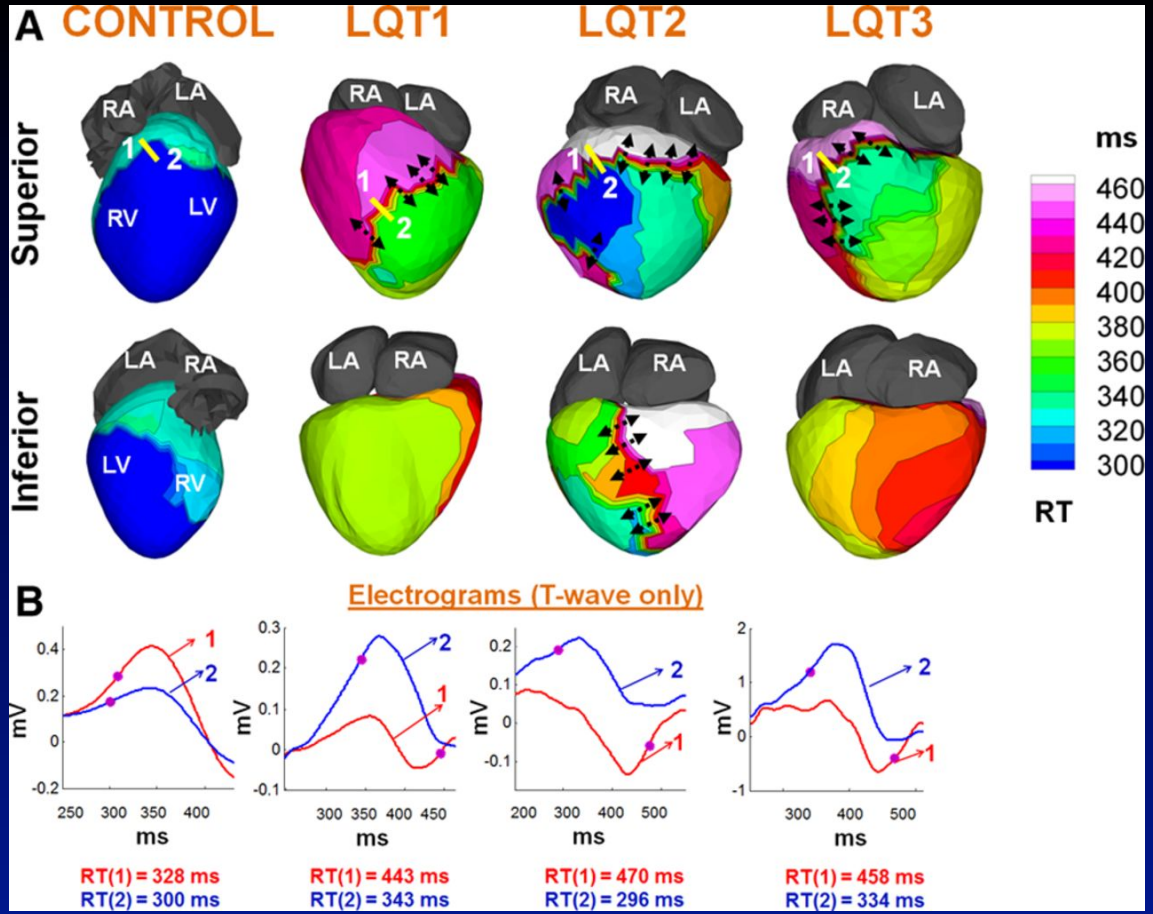


Charulatha Ramanathan

Use in CRT: choosing a place for the LV lead



Epicardial recovery time maps in LQTS



Vijayakumar et al. Circulation. 2014

ECG imaging of VT + stereotactic radiotherapy = completely noninvasive ablation

- Philip Cuculich MD (Cardiology) and Clifford Robinson MD (Radiation Therapy), Washington University
- 3 patients treated: failed VT ablation, multiple ICD shocks
- No recurrence after 1 year follow-up

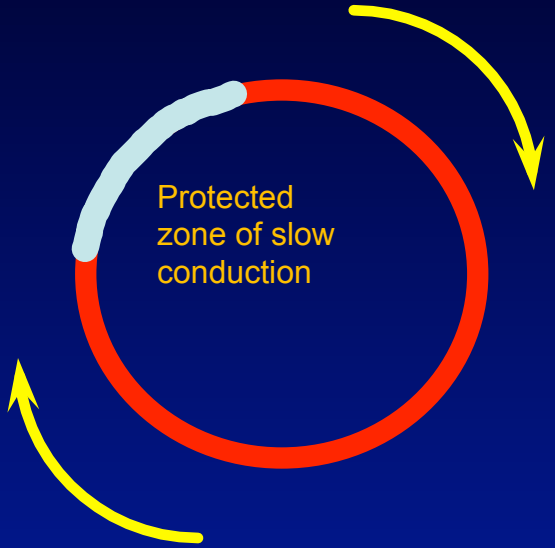
Possible future pediatric uses of ECGI

- Ablation planning, esp focal tachyarrhythmias
  - ? RVOT vs aortic cusp
- Choosing optimal pacing site for CRT
  - Can be acquired in cath lab
- Identifying scars in tetralogy patients with VT
- Risk stratification for LQTS

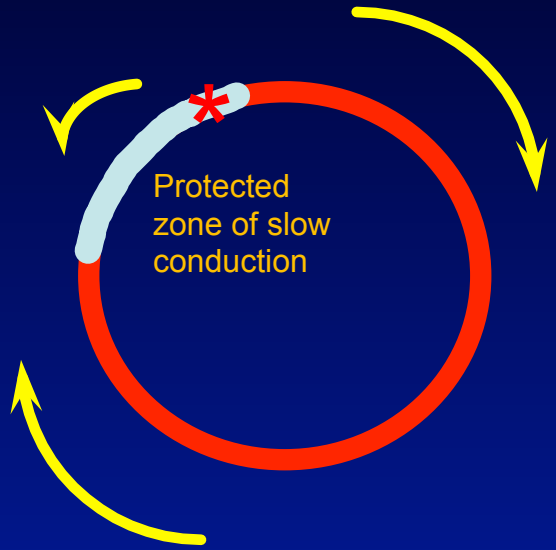
Question: What is the role of entrainment mapping in the age of ubiquitous 3-dimensional mapping?

Consider two atrial arrhythmias…

in a patient following atrial surgery



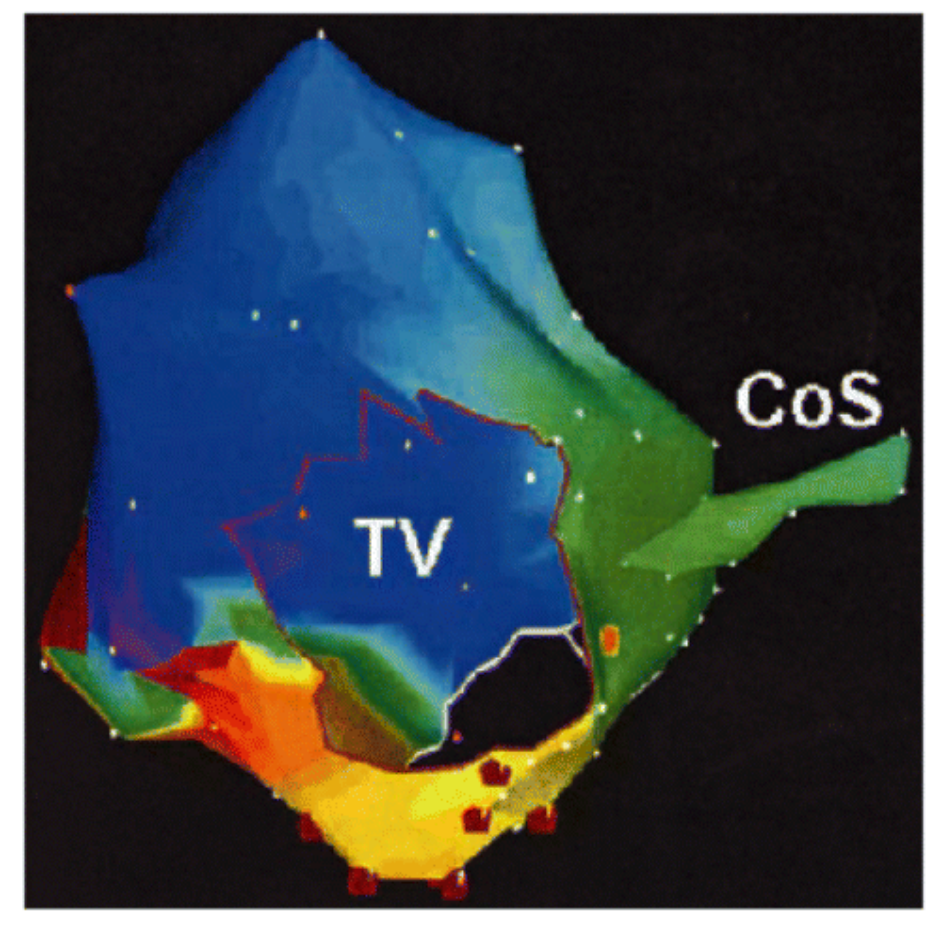
Macro-reentrant



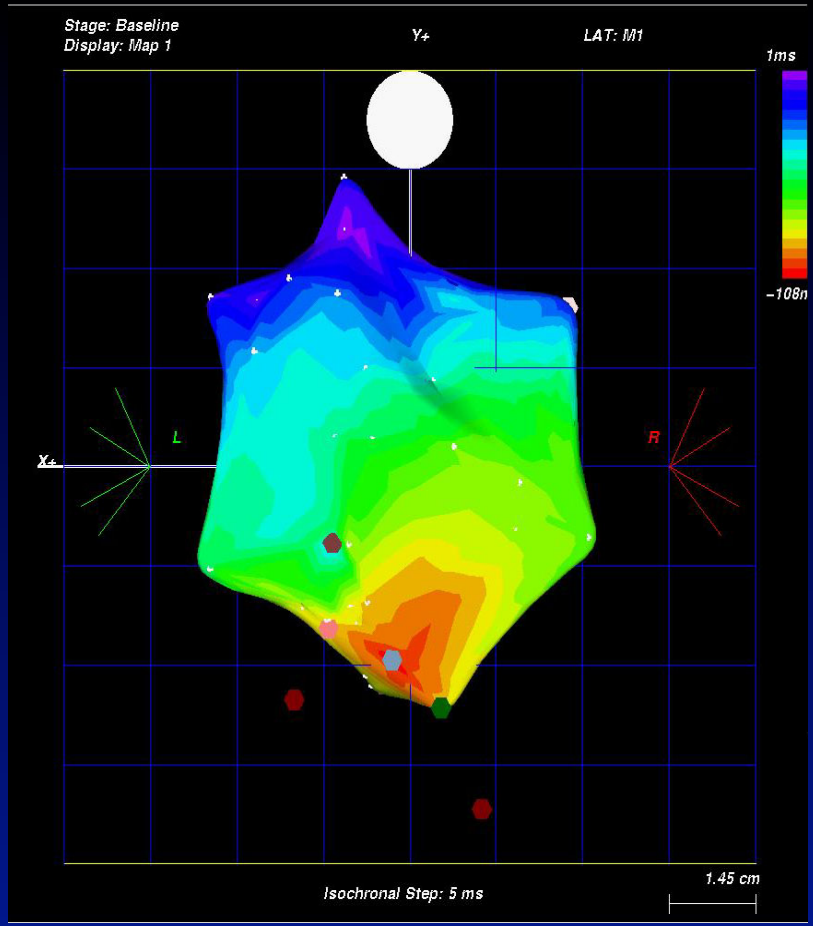
Automatic focus

Pitfalls with 3-dimensional mapping: *Anatomy is not the only issue*

- Isochronal maps may not clearly differentiate macroreentry, microreentry and automatic focus tachycardia
  - Conduction of focal or microreentry through rest of atrium will be constrained, just as it is with macroreentry, and may even occupy entire interval, and so appear to be reentrant
  - Conduction into bystander areas from reentrant zone can appear to be from a single site, and so can appear focal



Mandapati, et al. JCE 2003

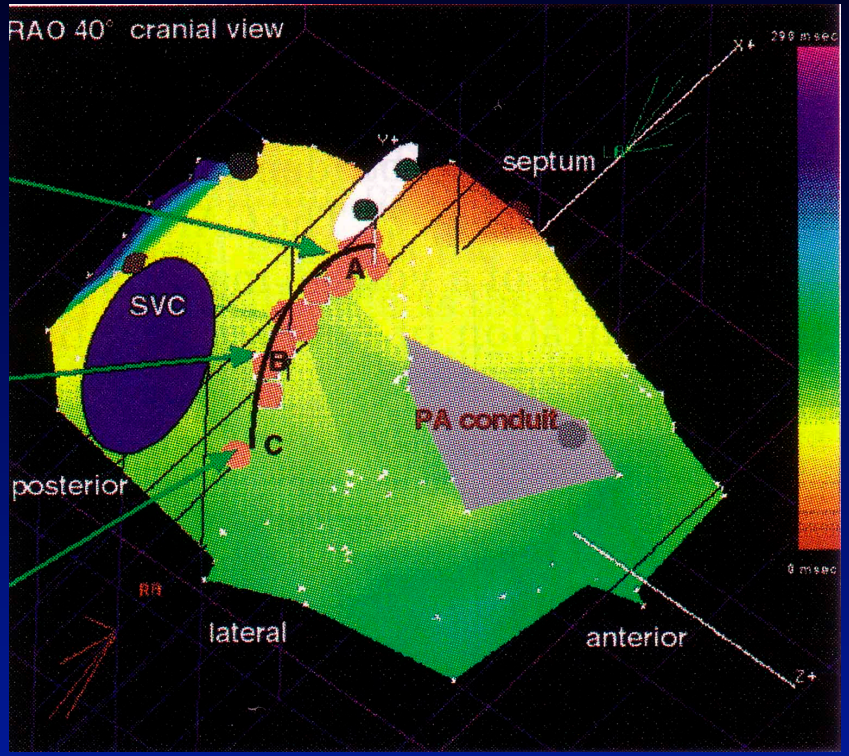


Senning patient, SVA activation

Anatomy is not the only issue

- Short version:
  - Macroreentry, microreentry, and focal tachycardias can LOOK THE SAME by electroanatomic mapping
- Entrainment pacing from multiple sites is necessary to *make a diagnosis*

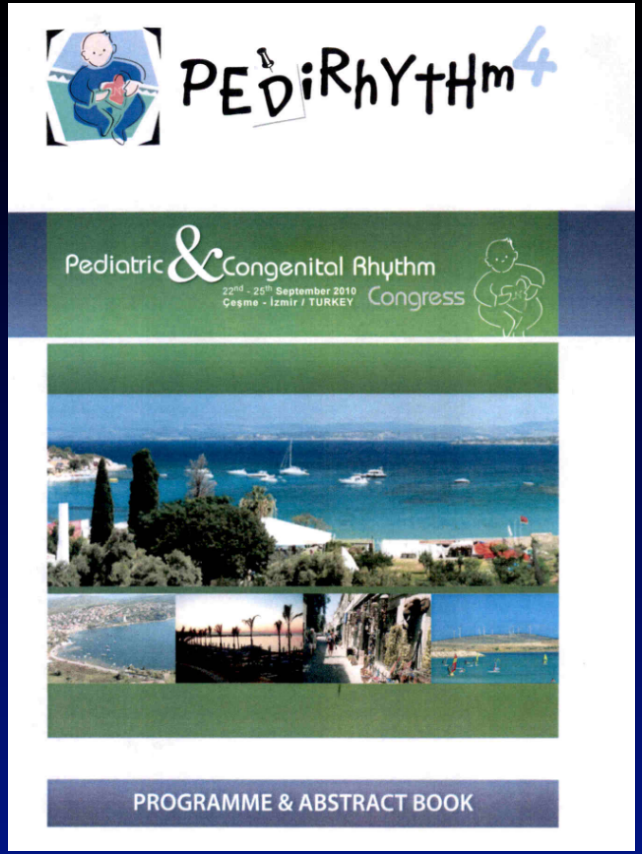
Pitfalls with 3-dimensional mapping:
The problem of double potentials



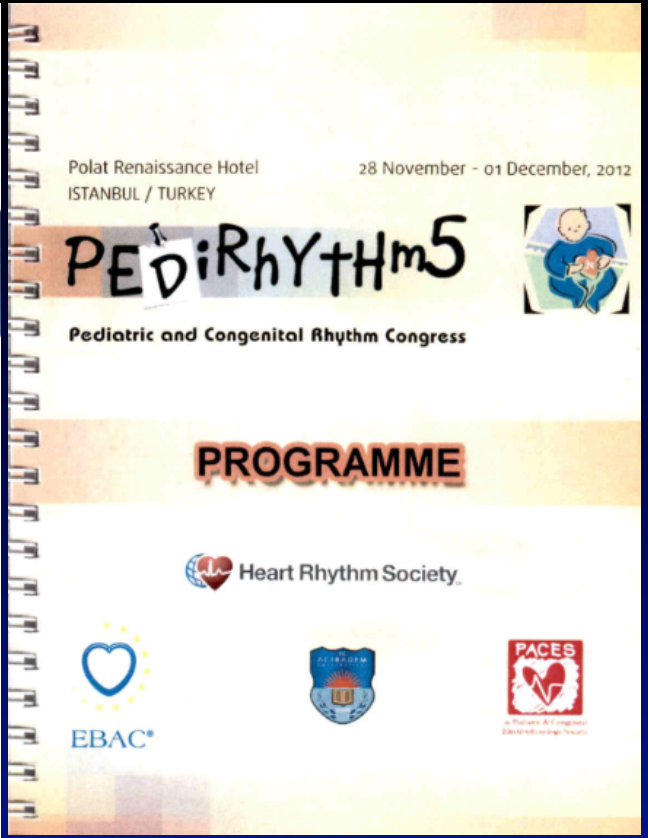
- Double potentials represent conduction on either side of a barrier
- Mapping systems must acceptone or the other component
- Because of interpolation, different timing on either side of line of block may not be recognized

Final thoughts

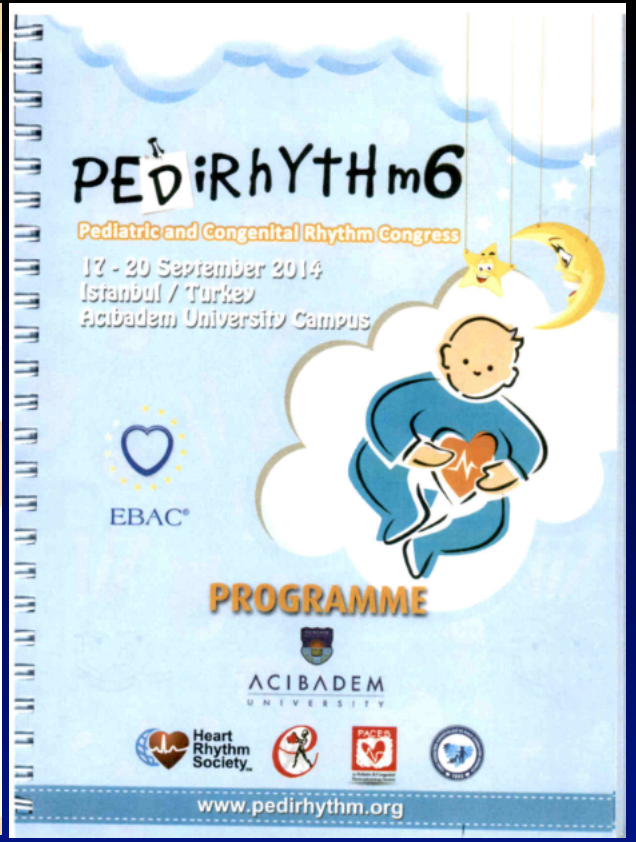
- Modern advances in mapping systems are driven by the needs of the adult population
- However, we can subvert this to our own purposes
- Don’t forget to be an electrophysiologist



Çeşme-Izmir
2010



Istanbul
2012



Istanbul – Asian side
2014