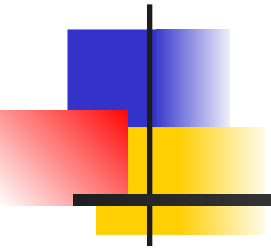
Entrainment – Basic Principles



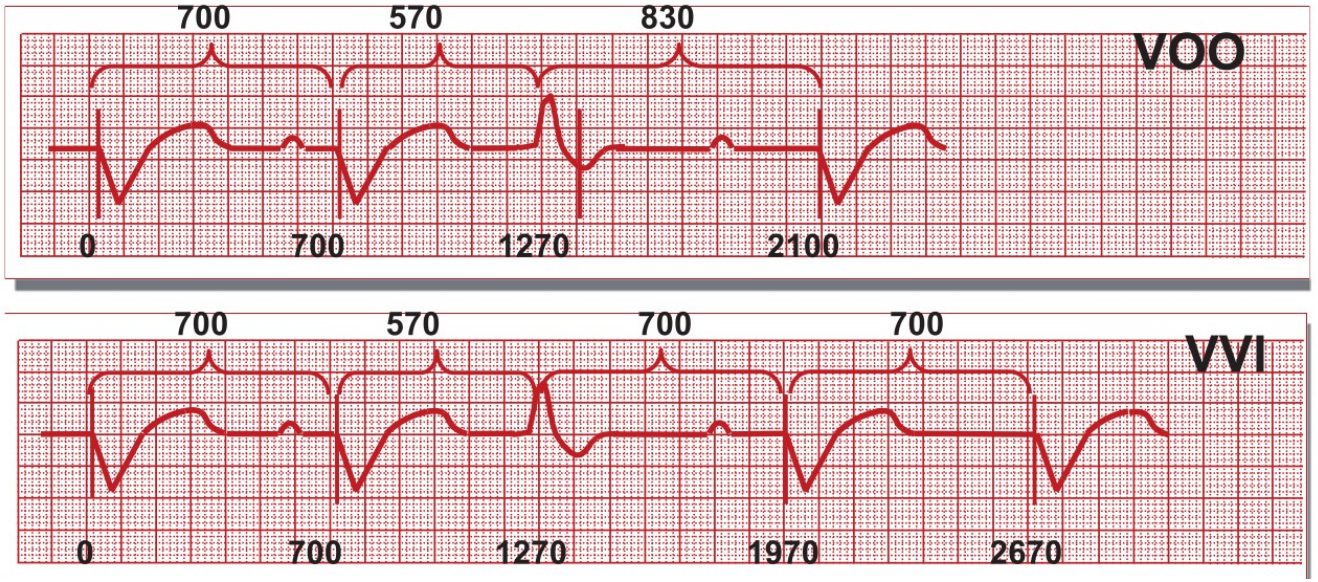
Raja Selvaraj

JIPMER

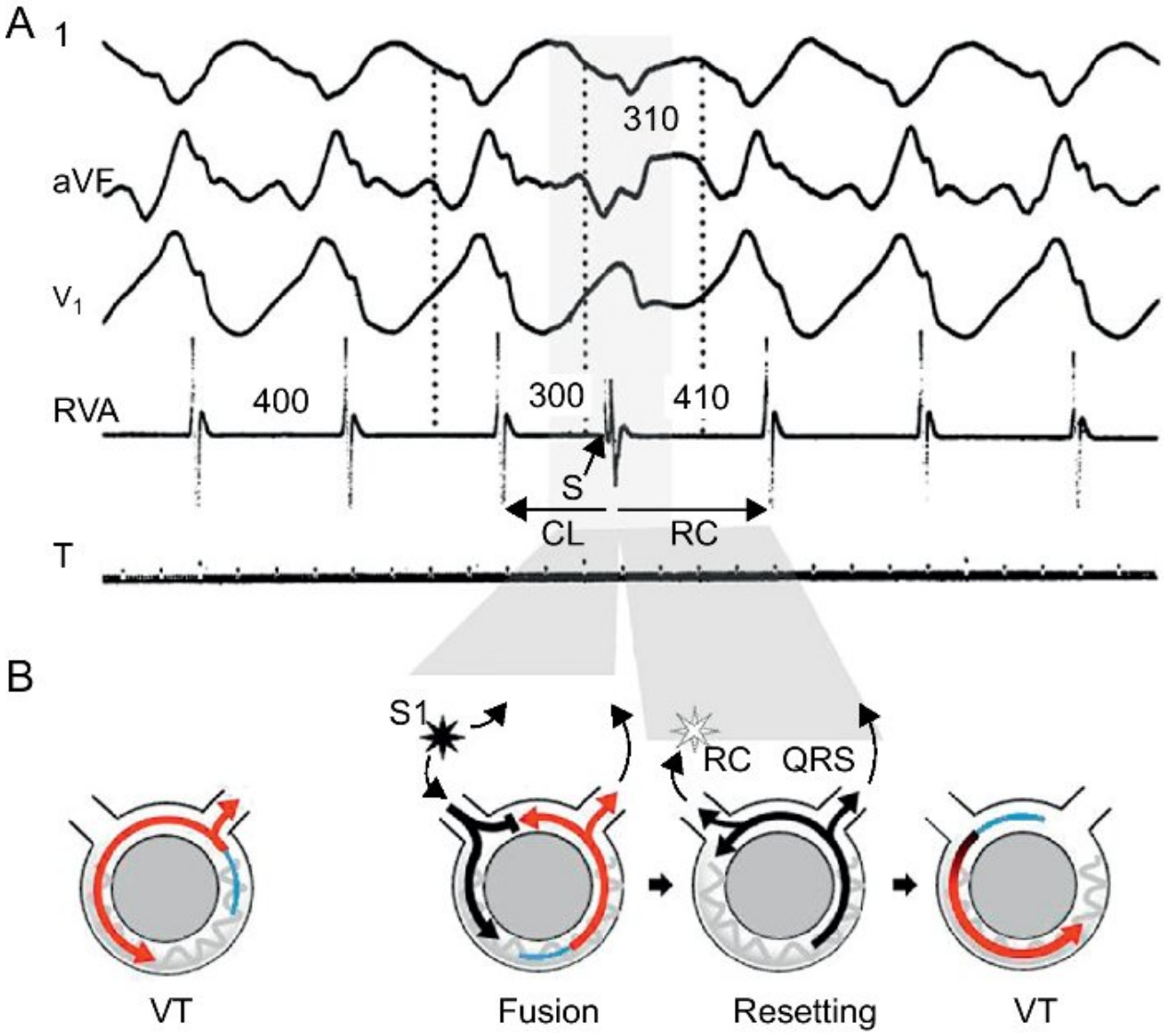
What is entrainment?

Reset

- Setting a clock back to starting point
- Premature beat with “non-compensatory pause”



Reset in the context of reentry



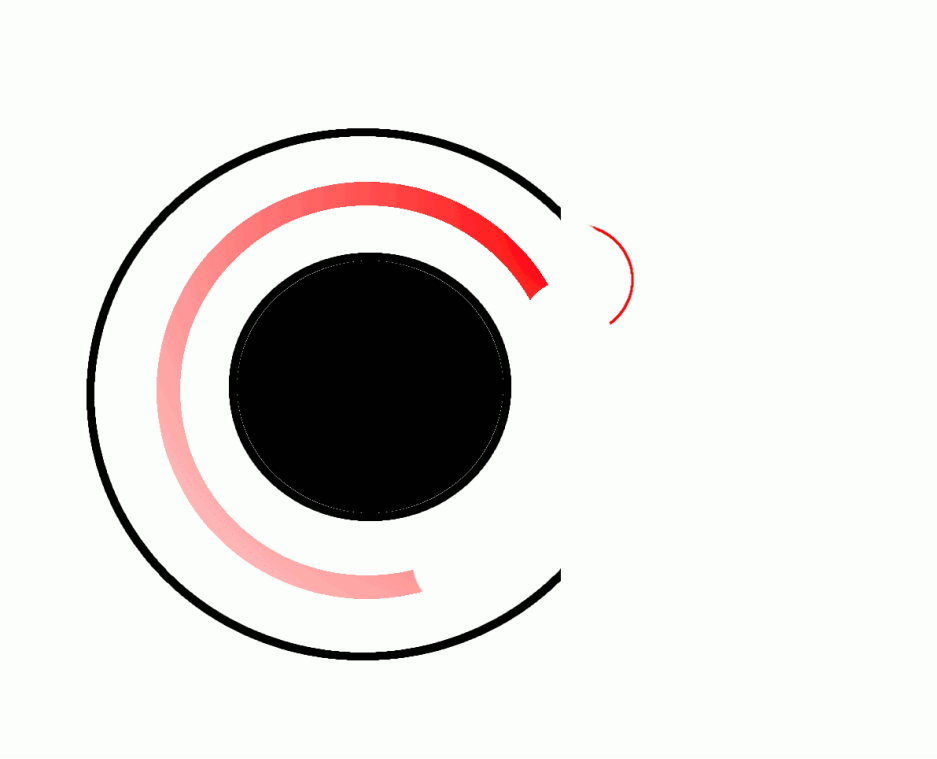
Entrainment

Entrainment is continuous resetting

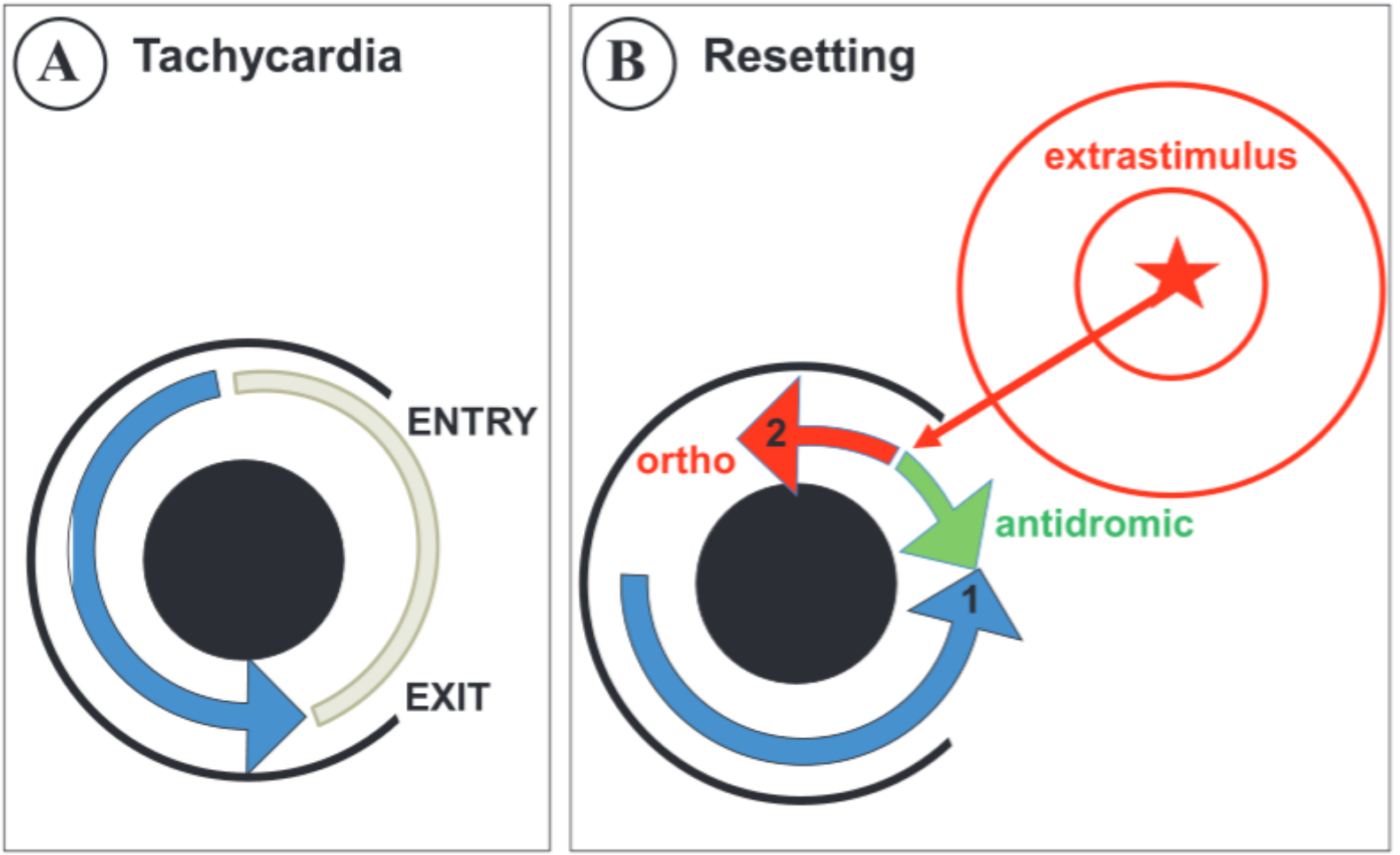
Reentrant circuit

Excitable gap

No entrance block

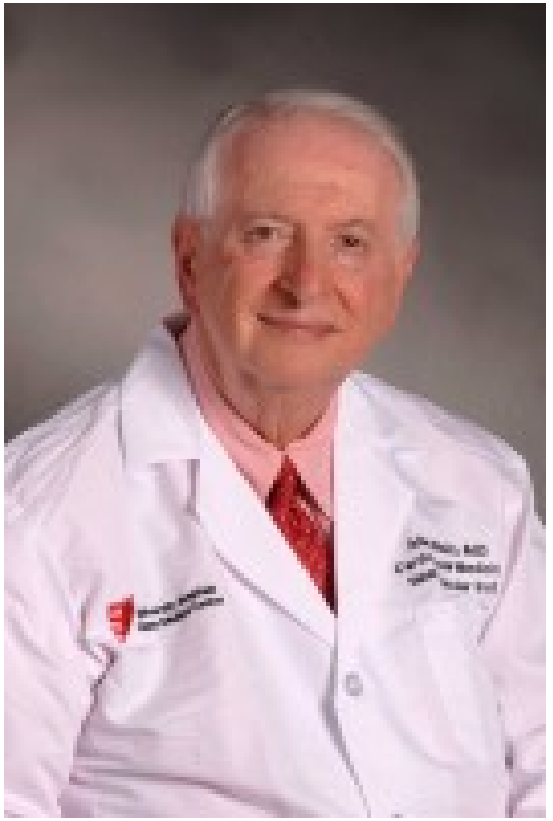


Mechanism of reset



Identifying entrainment

- Continuation of tachycardia after cessation of pacing doesnt always mean entrainment
- Overdrive suppression of automatic focus
- Termination and reinitiation of reentry
- Waldo proposed two criteria, two more added later

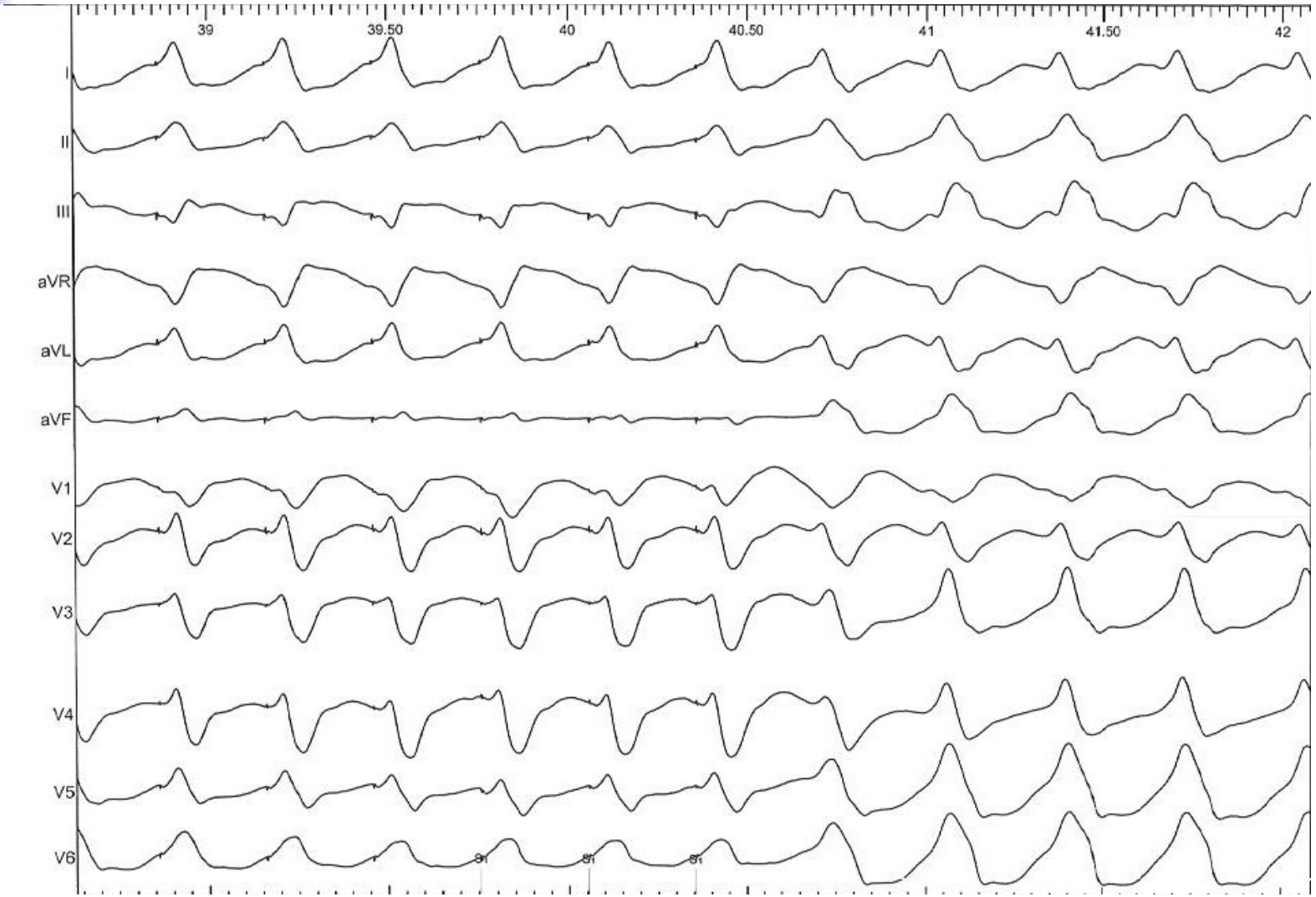



EXIT

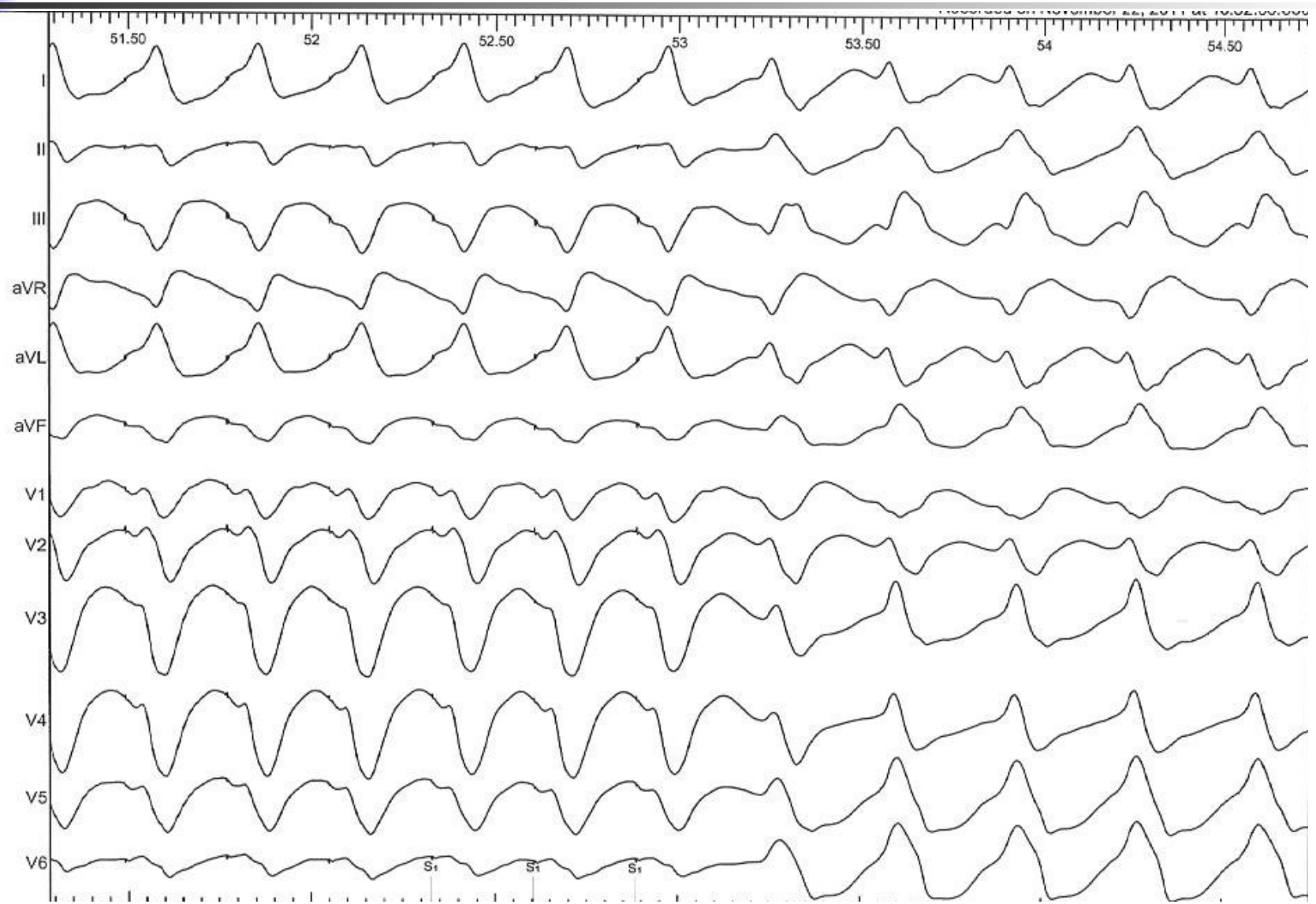
Four criteria

- Constant fusion
- Progressive fusion
- Localised conduction block with termination
- Intracardiac equivalent of progressive fusion

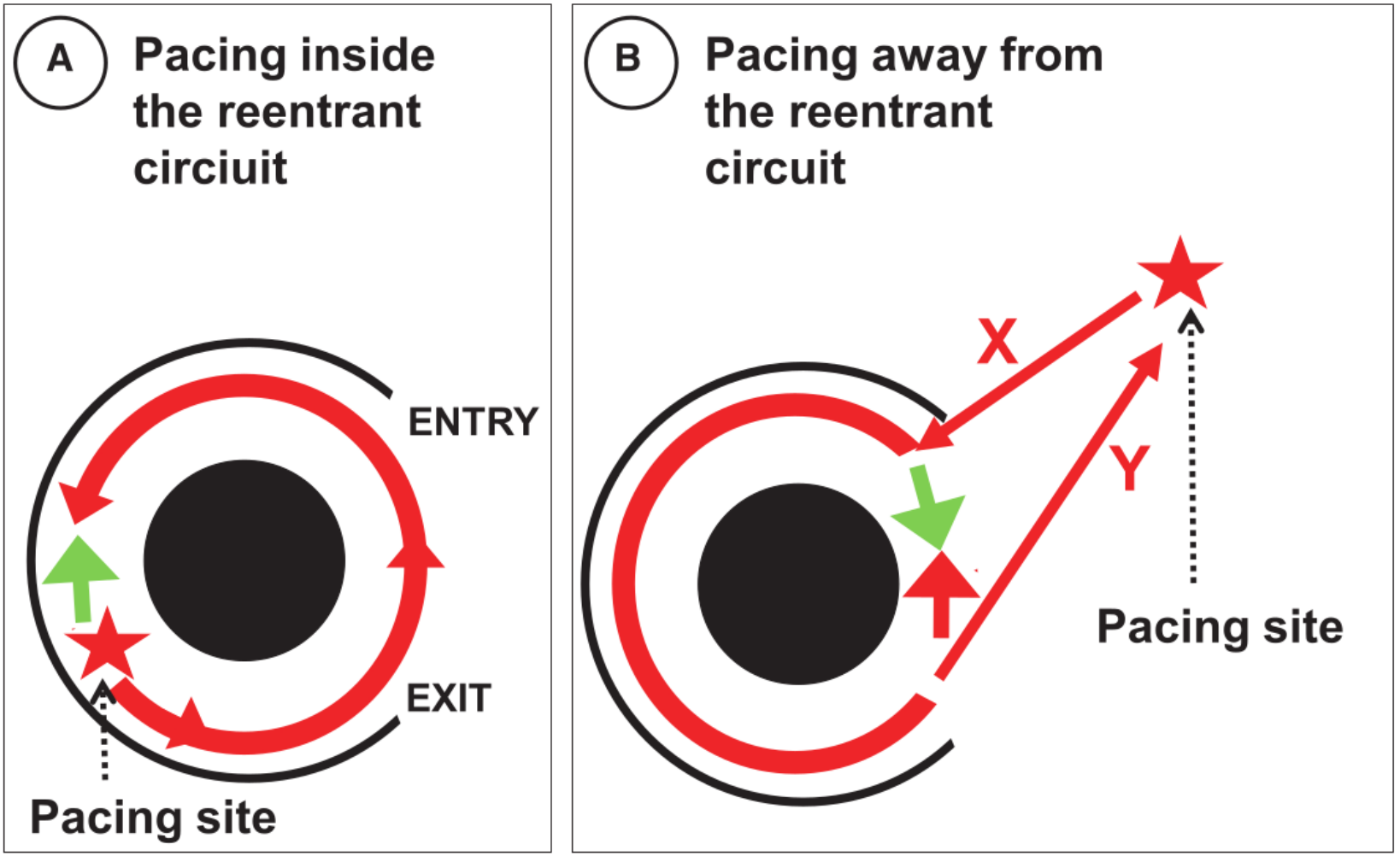
Fusion is the hallmark of entrainment - Constant fusion



Progressive fusion



Post pacing interval



How to do – General tips

Pacing CL

- Confirm tachycardia CL is stable
- Pace 20-30 ms shorter than tachycardia CL
- Faster – decrement in circuit
- Slower – measurement error

Synchronize ?

- Always pace in synchronous mode
- Learn to set up
- Usually signal from pacing site itself
- Choose another signal if required

Unipolar or bipolar ?

- More precise localization with unipolar pacing
- Unipolar more likely to saturate, makes measurement difficult

Scenario 1 – Atrial flutter

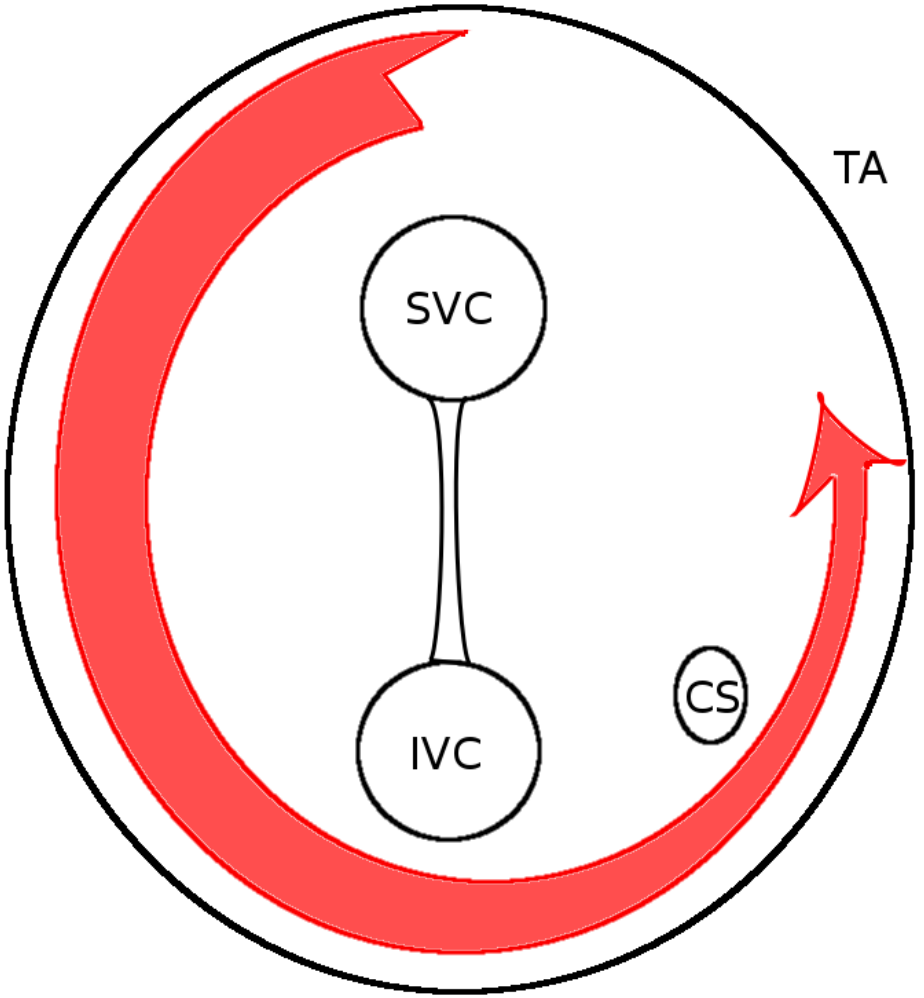
Atrial flutter

- Identify mechanism
- Identify chamber
- Identify isthmus

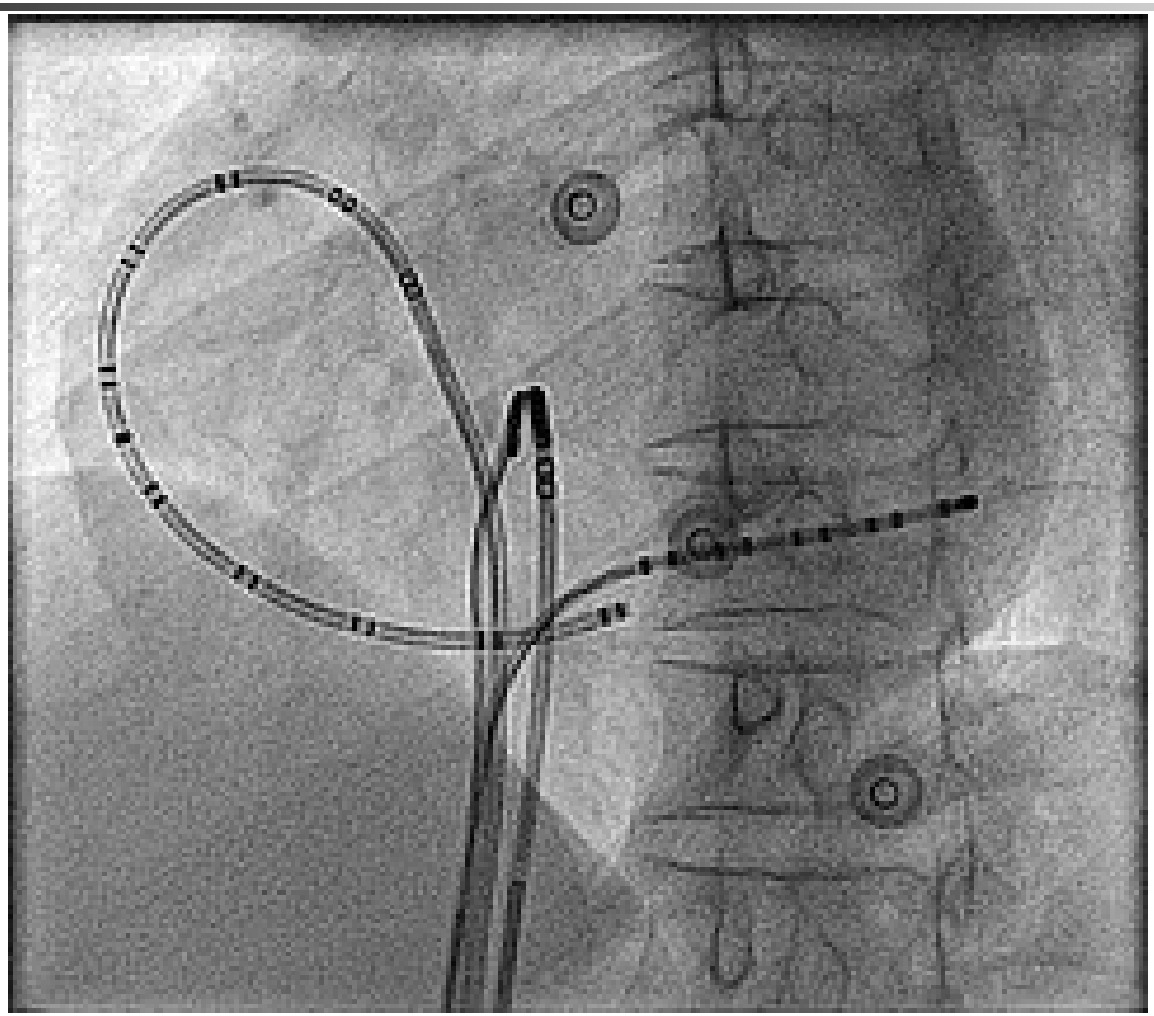
Identify chamber of origin

- Entrainment from multiple sites, usually
  - High right atrium
  - Proximal CS
  - Distal CS

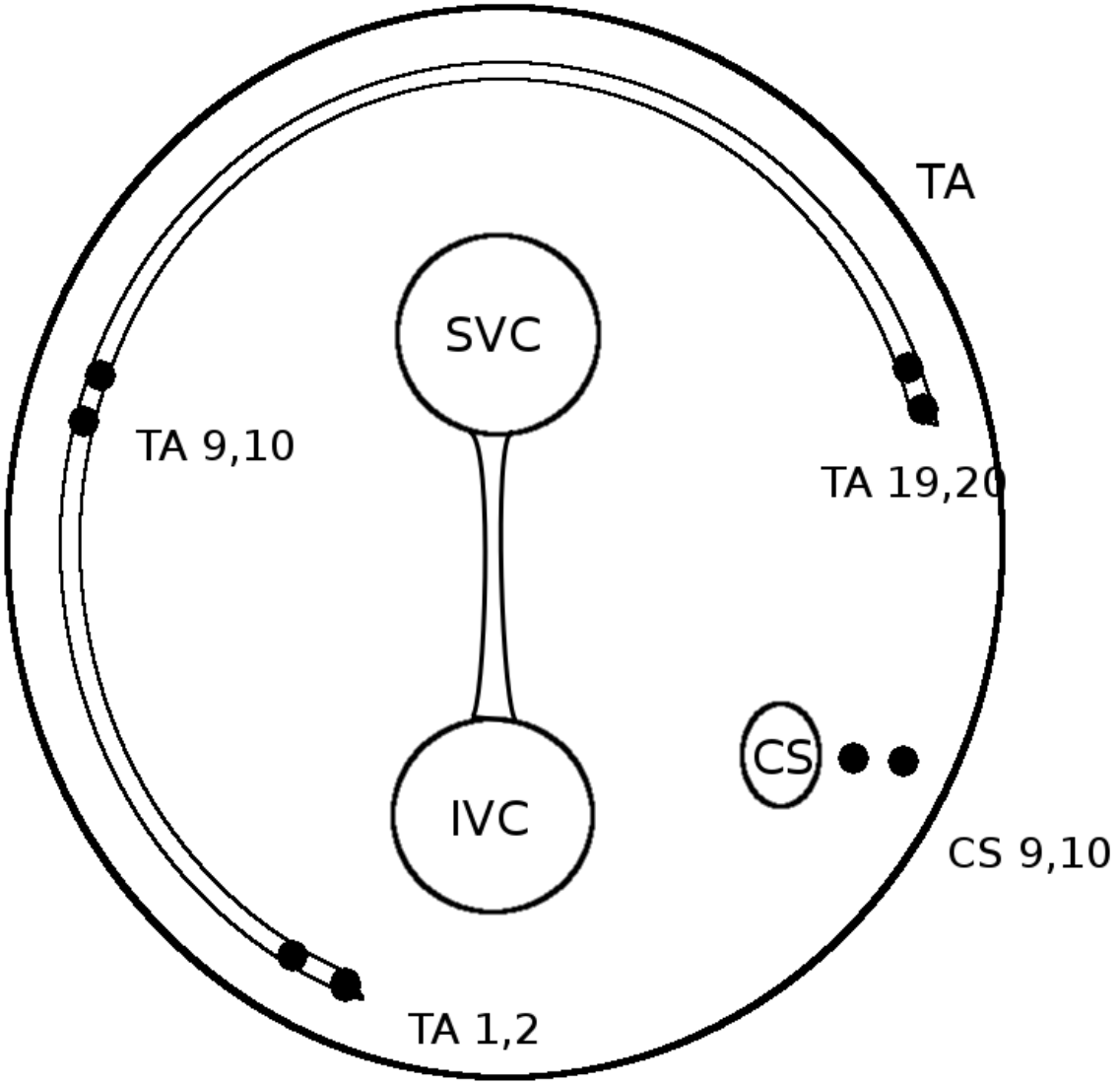
Typical Atrial flutter



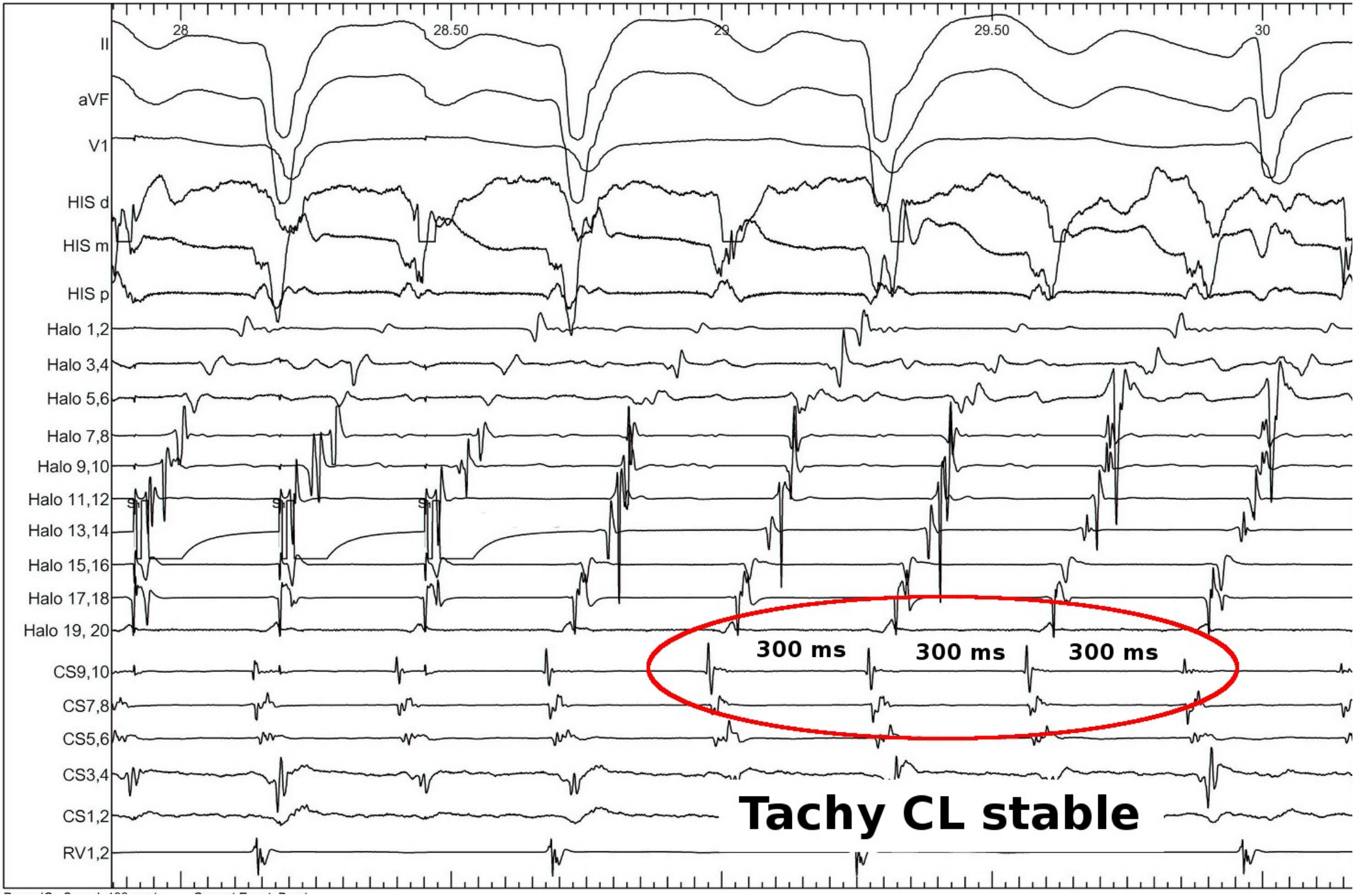
Catheters

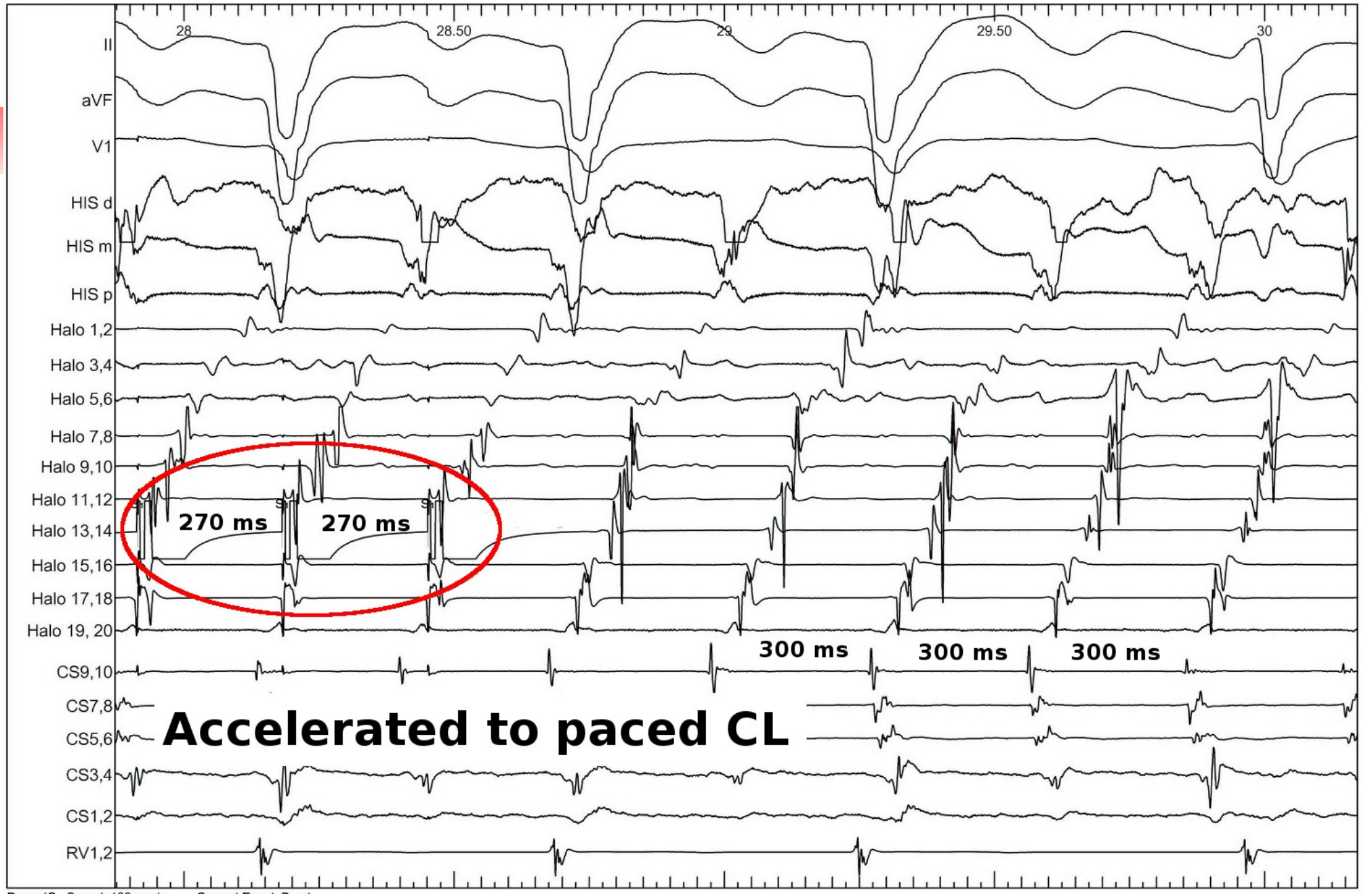


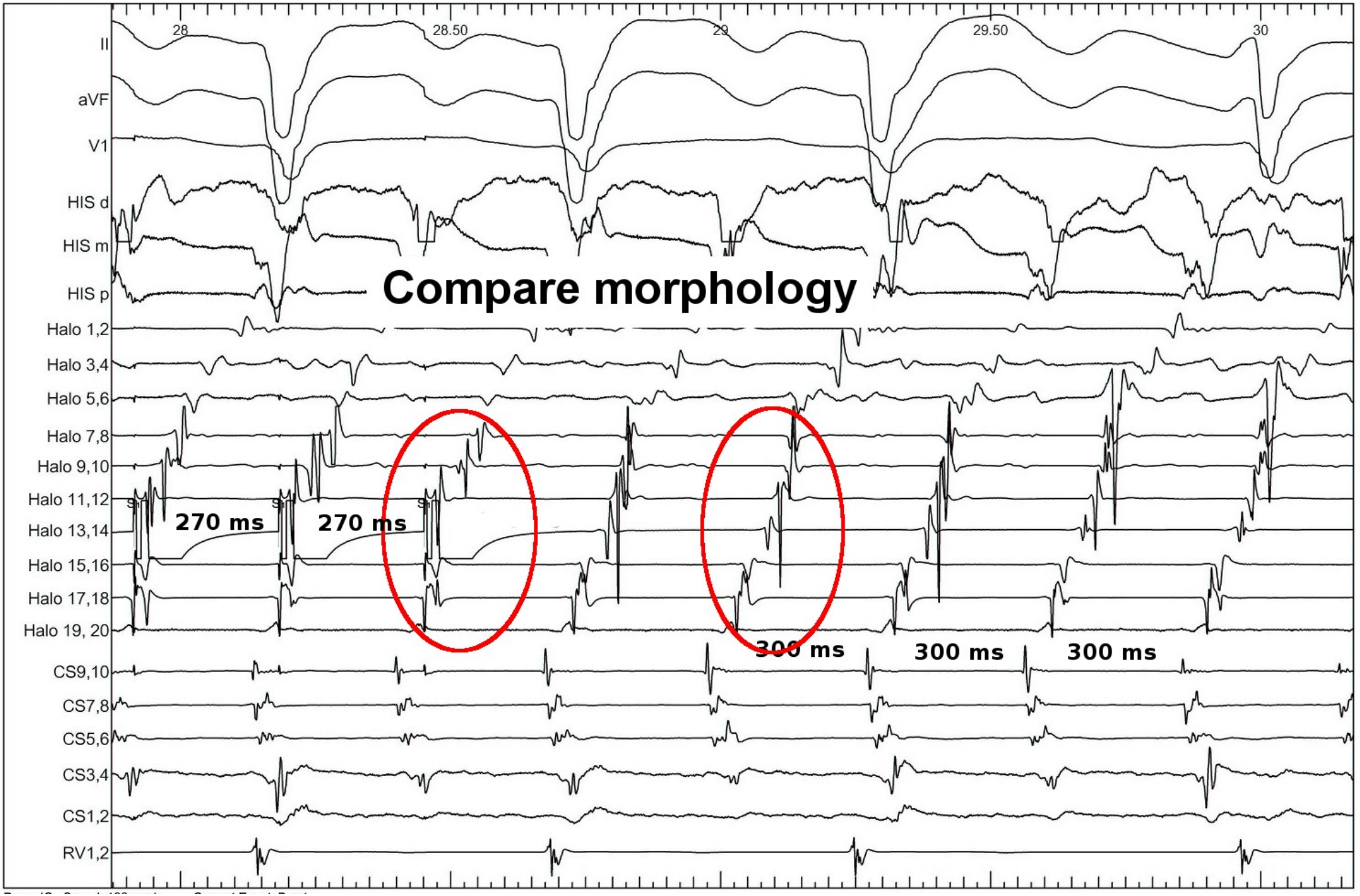
Catheters

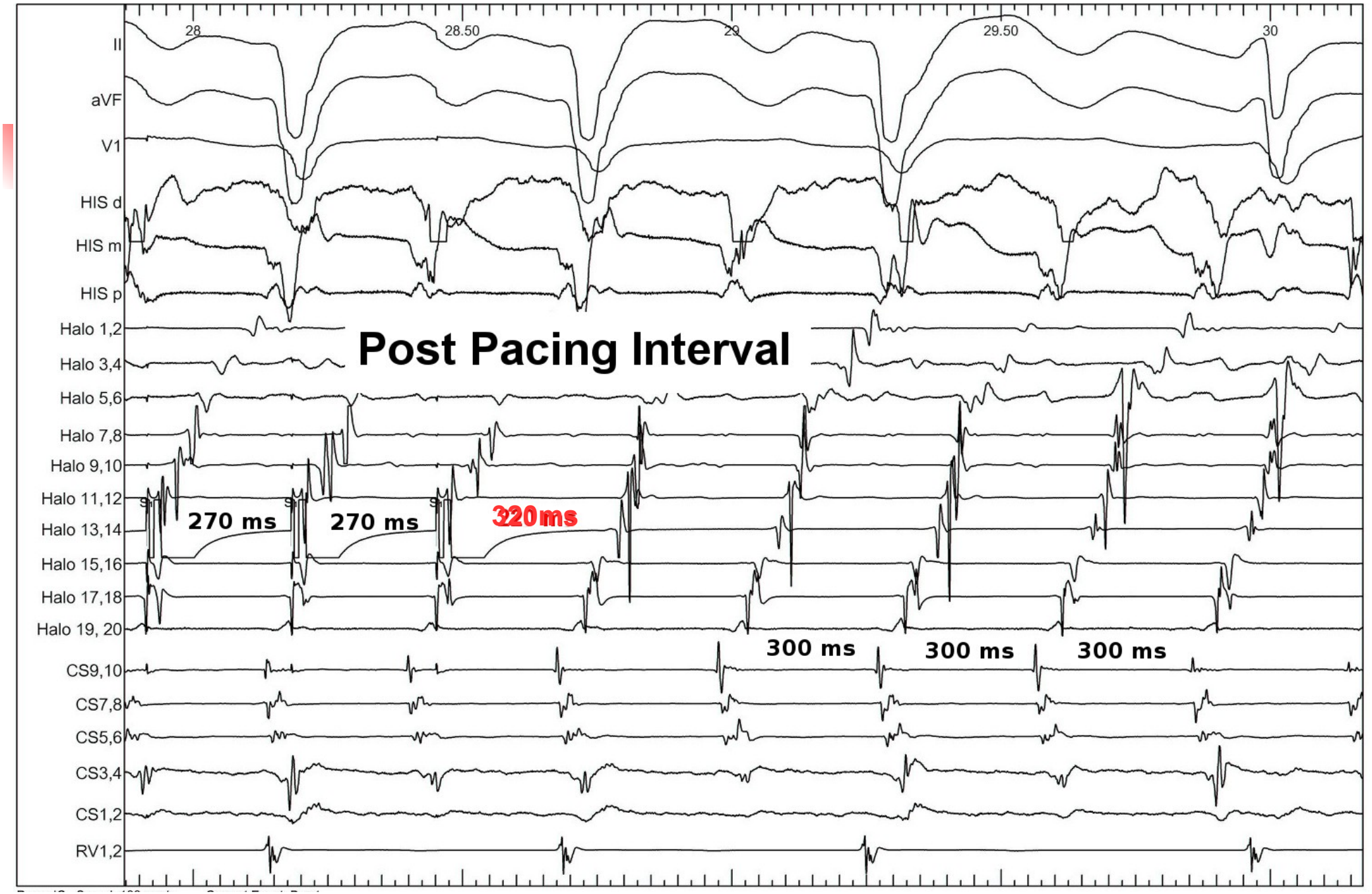


Atrial flutter – Pacing from lateral RA


28
28.50
29
29.50
30
II
aVF
V1
HIS d
HIS m
HIS p
Halo 1,2
Halo 3,4
Halo 5,6
Halo 7,8
Halo 9,10
Halo 11,12
Halo 13,14
Halo 15,16
Halo 17,18
Halo 19, 20
CS9,10
CS7,8
CS5,6
CS3,4
CS1,2
RV1,2
300 ms
300 ms
300 ms
Tachy CL stable


28
28.50
29
29.50
30
II
aVF
V1
HIS d
HIS m
HIS p
Halo 1,2
Halo 3,4
Halo 5,6
Halo 7,8
Halo 9,10
Halo 11,12
Halo 13,14
Halo 15,16
Halo 17,18
Halo 19, 20
CS9,10
CS7,8
CS5,6
CS3,4
CS1,2
RV1,2
270 ms
270 ms
300 ms
300 ms
300 ms
Accelerated to paced CL

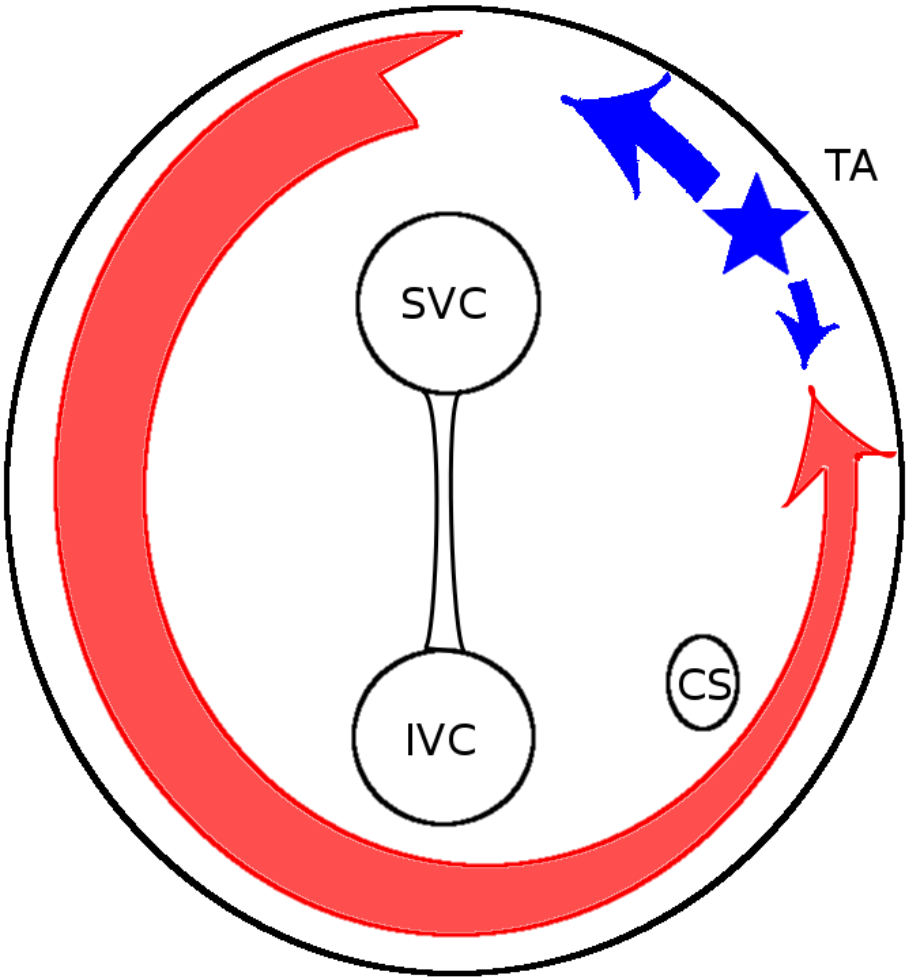

28
28.50
29
29.50
30
II
aVF
V1
HIS d
HIS m
HIS p
Compare morphology
Halo 1,2
Halo 3,4
Halo 5,6
Halo 7,8
Halo 9,10
Halo 11,12
Halo 13,14
Halo 15,16
Halo 17,18
Halo 19, 20
270 ms
270 ms
300 ms
300 ms
300 ms
CS9,10
CS7,8
CS5,6
CS3,4
CS1,2
RV1,2


28
28.50
29
29.50
30
II
aVF
V1
HIS d
HIS m
HIS p
Halo 1,2
Halo 3,4
Halo 5,6
Halo 7,8
Halo 9,10
Halo 11,12
Halo 13,14
Halo 15,16
Halo 17,18
Halo 19, 20
CS9,10
CS7,8
CS5,6
CS3,4
CS1,2
RV1,2
Post Pacing Interval
270 ms
270 ms
320 ms
300 ms
300 ms
300 ms

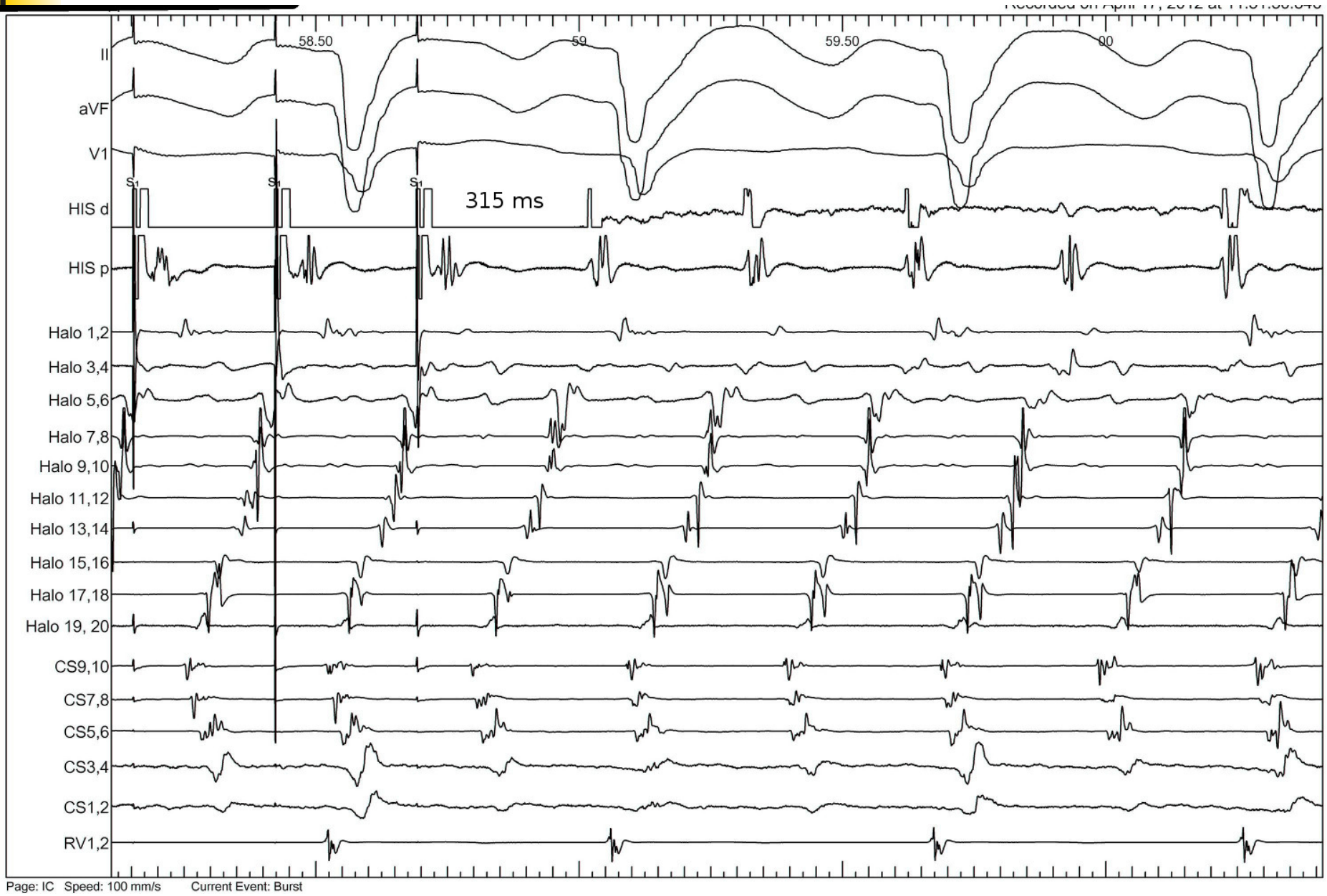
Interpretation

- Entrainable – Reentry
- PPI – TCL < 30 ms – In the circuit
- Manifest fusion – Not in slow area

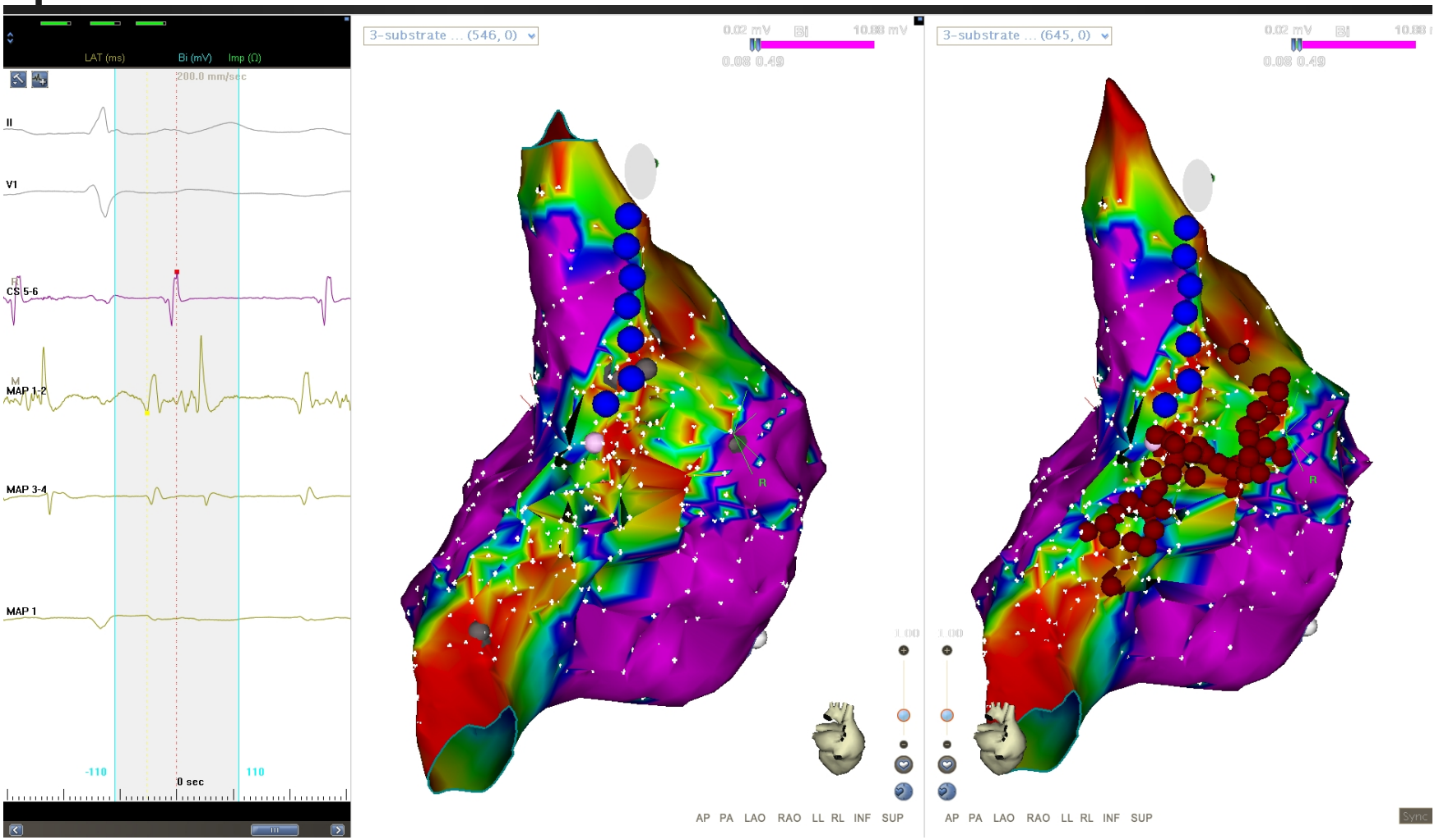
Fusion



Pacing from isthmus



Atypical flutter

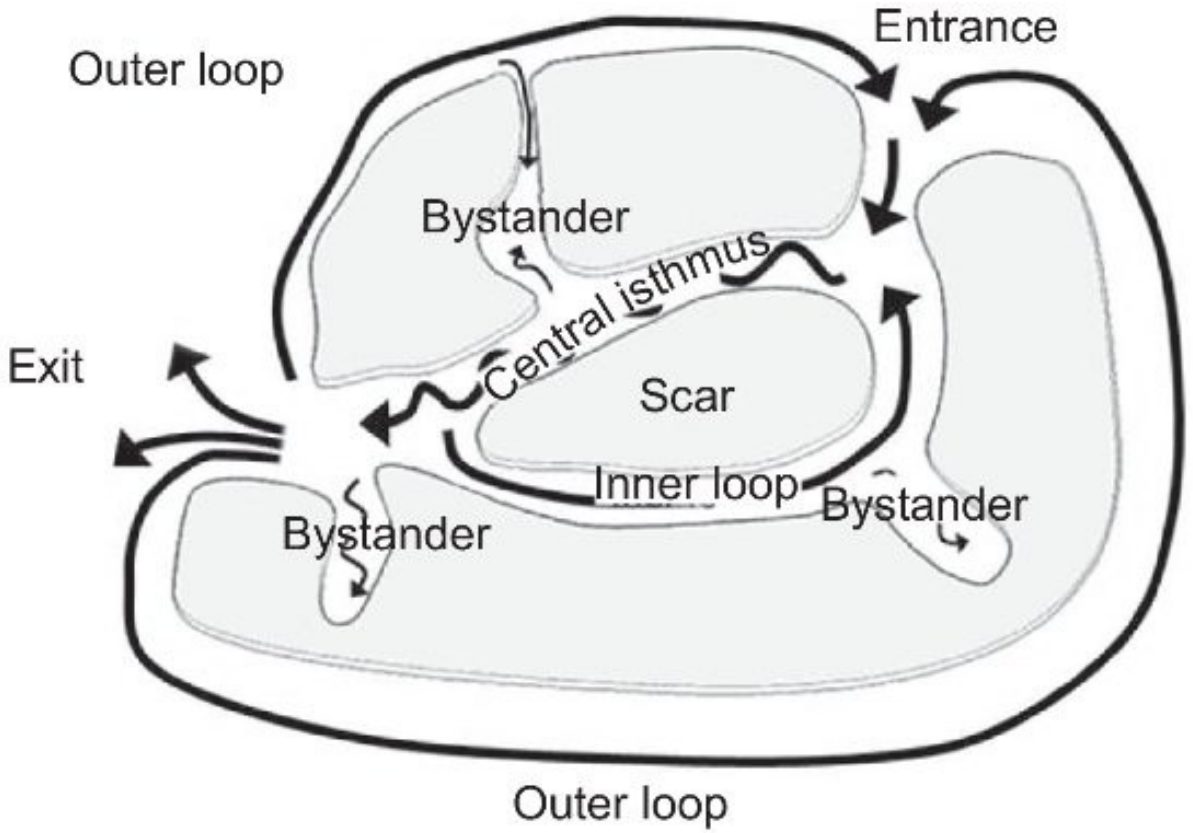


Scenario 2 – Ventricular Tachycardia

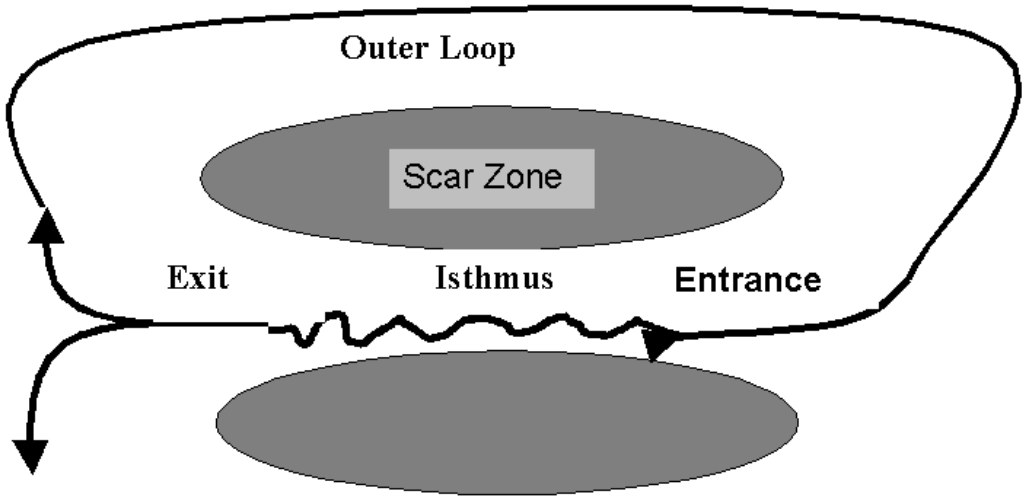
Identifying isthmus

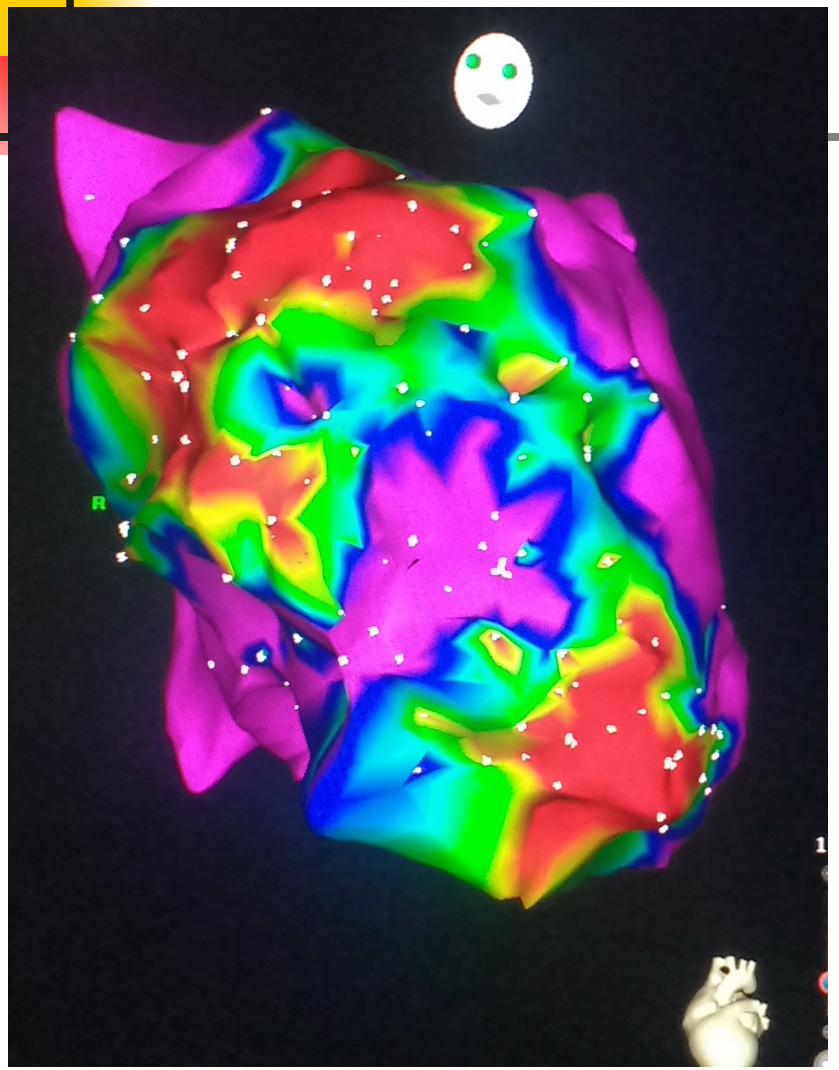
- Fusion with PPI > TCL – outside the circuit
- Fusion with PPI=TCL – in circuit
- No fusion with PPI=TCL – in isthmus
- No fusion, PPI>TCL – bystander

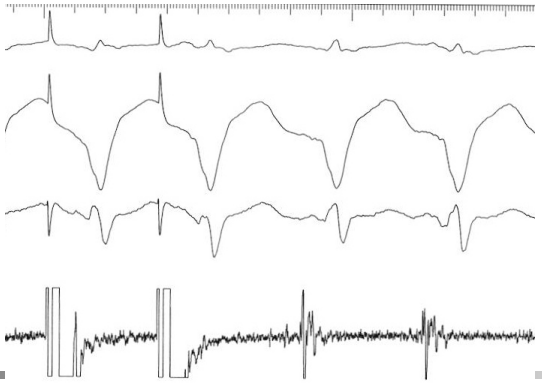
- Stim to QRS indicates location in isthmus
- S to QRS – EGM to QRS

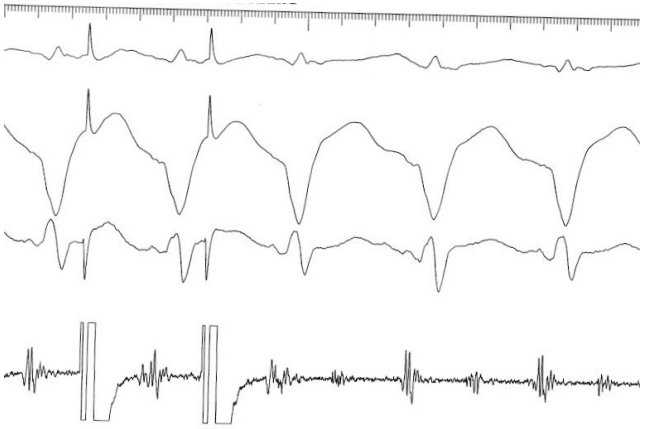

Entrance
Outer loop
Bystander
Central isthmus
Exit
Scar
Inner loop
Bystander
Bystander
Outer loop

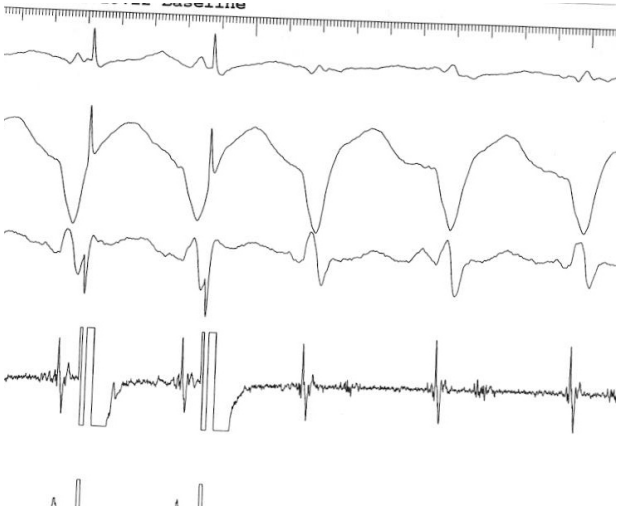
Simplified model

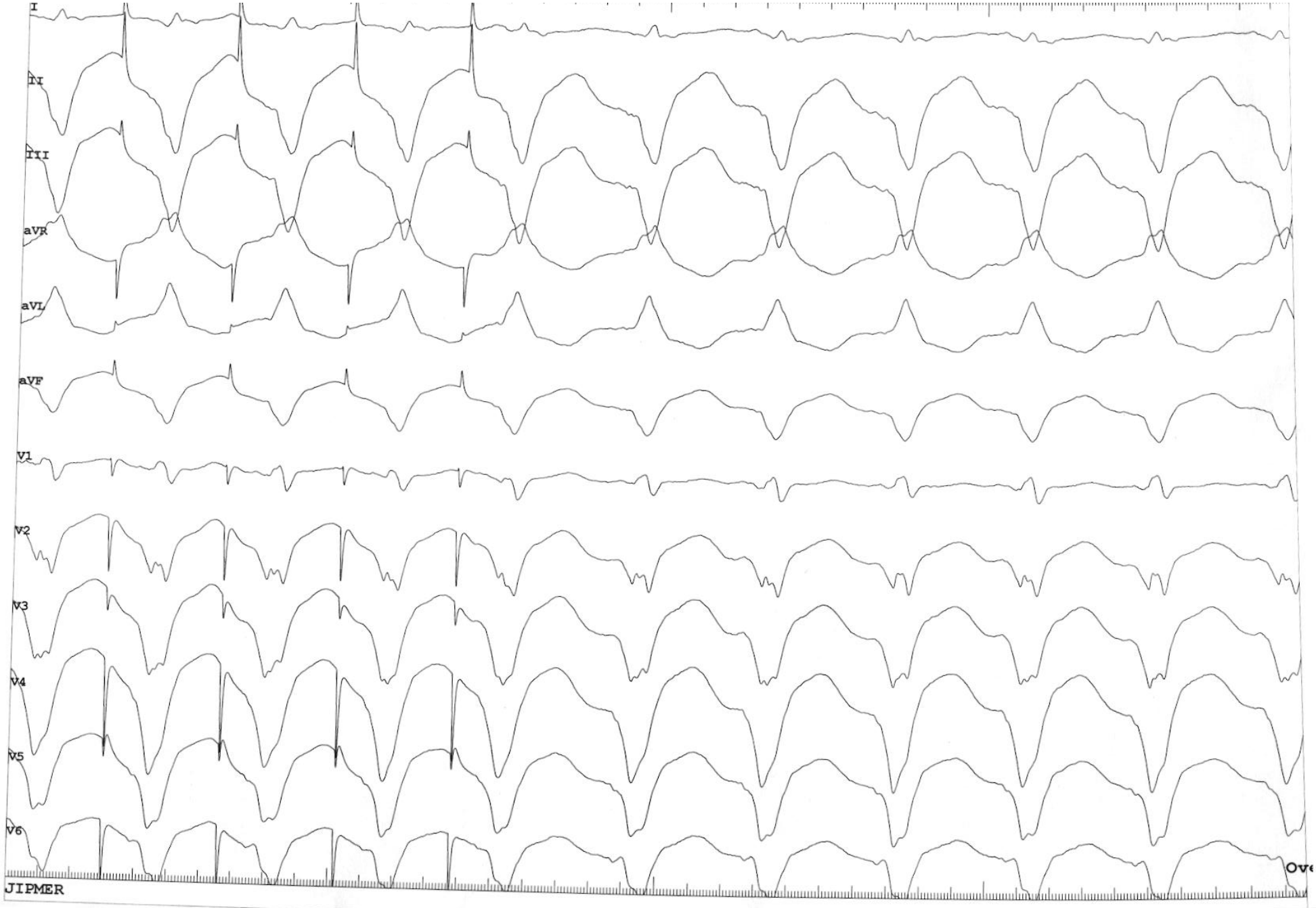


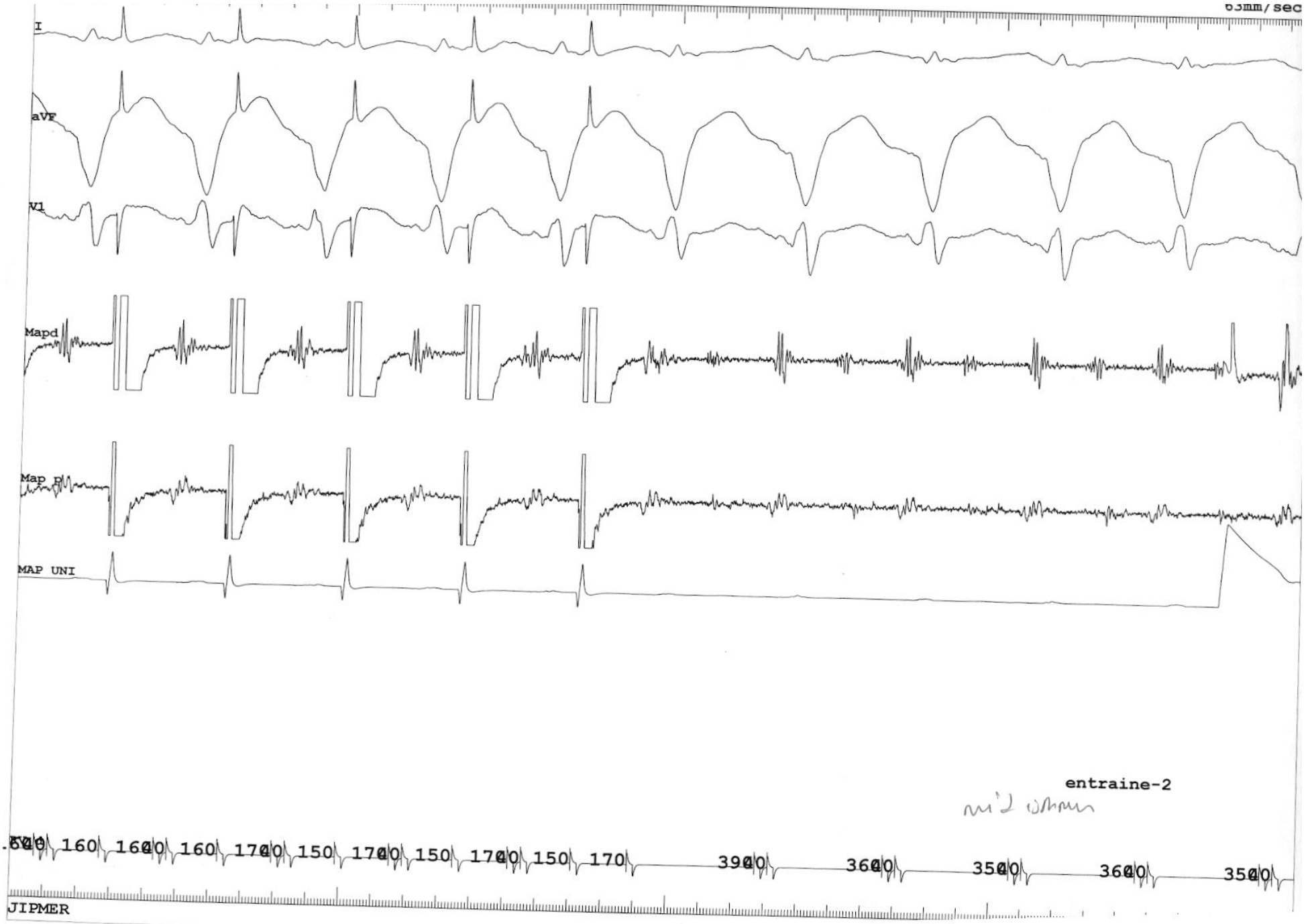

R








I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
JIPMER

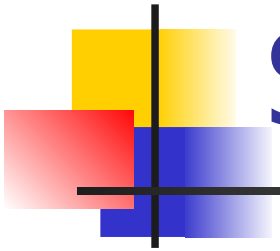

25mm/sec
I
aVF
V1
Mapd
Map p
MAP UNI
entraine-2
160 160 160 170 150 170 150 170 150 170 390 360 350 360 350
JIPMER

Miscellaneous uses

- Entrainment of SVT
  - PPI – TCL
  - Entrainment with fusion
- Bundle branch reentry

Tips and tricks

- Decrement – pace as close to TCL as possible
- Measure to local signal, not far field
- When the return signal is not well seen
  - Signal from adjacent catheter
  - N+1 method



Summary

- Entrainment is often intimidating in the beginning
- But once concepts are understood, it is much easier
- Utility in diverse areas