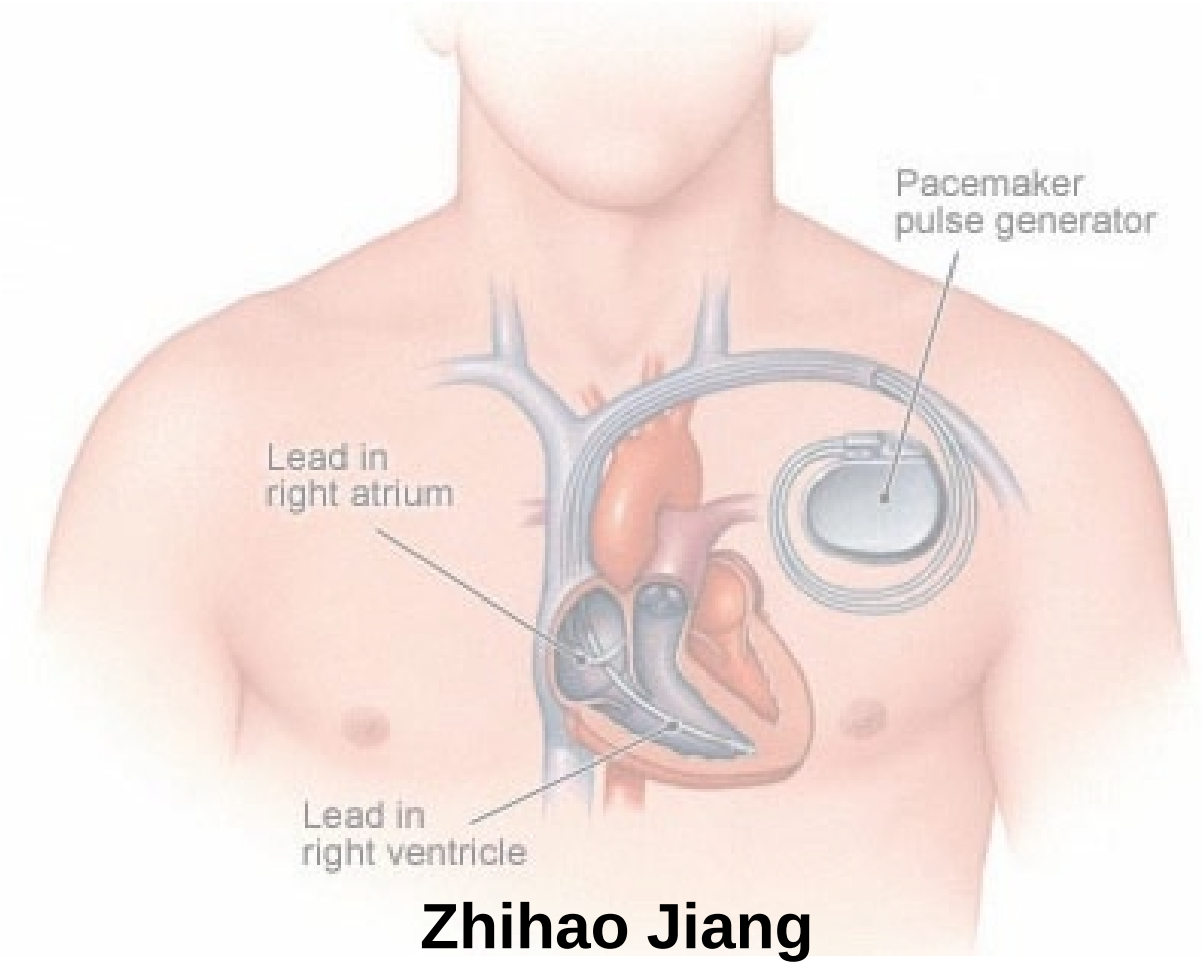
Heart & Pacemaker Basics



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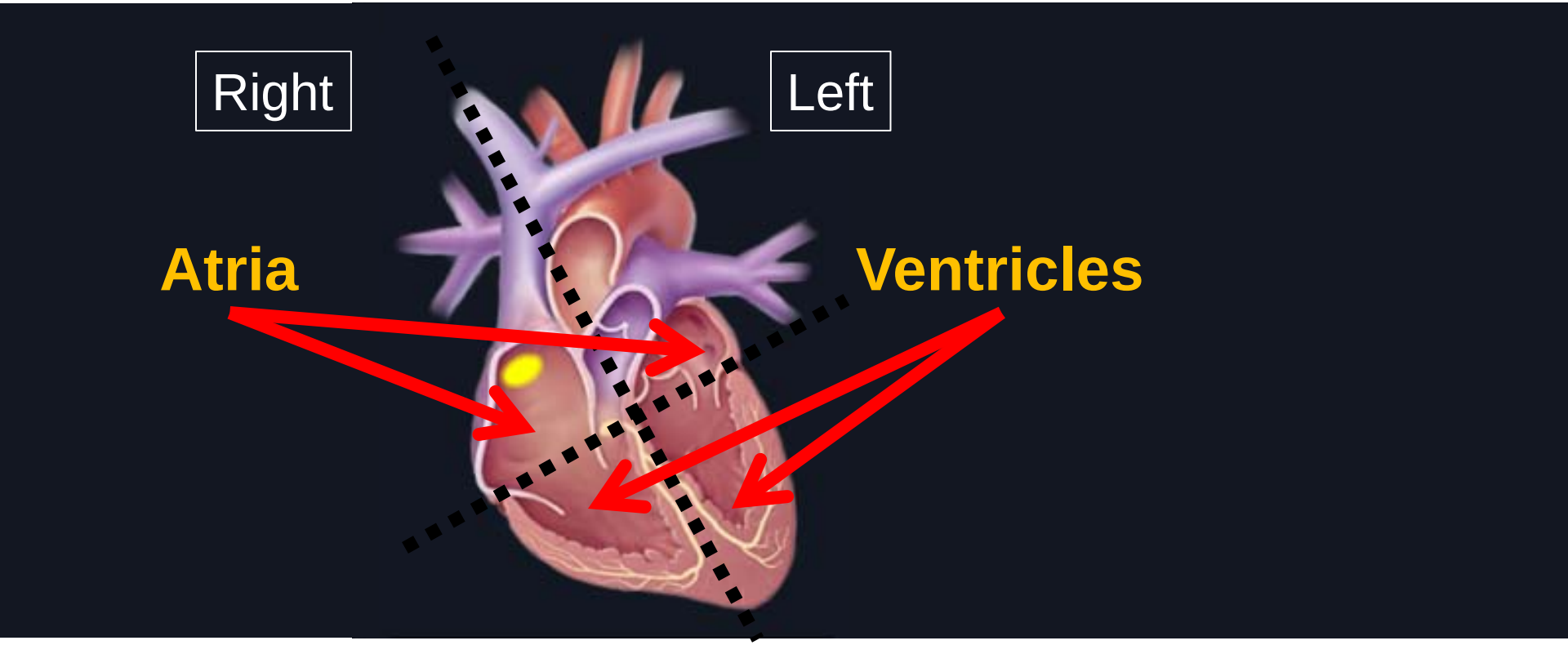
Heart Anatomy

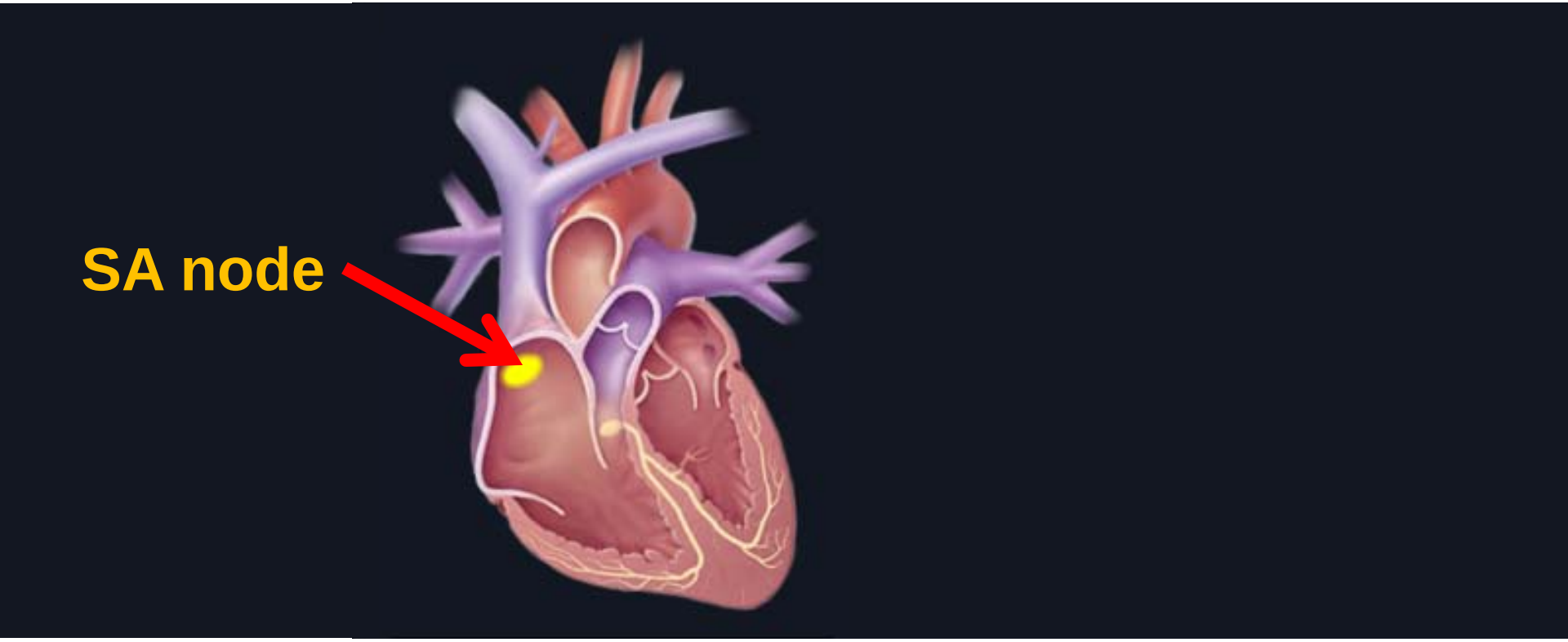
- 4 heart chambers



Courtesy of Medtronic

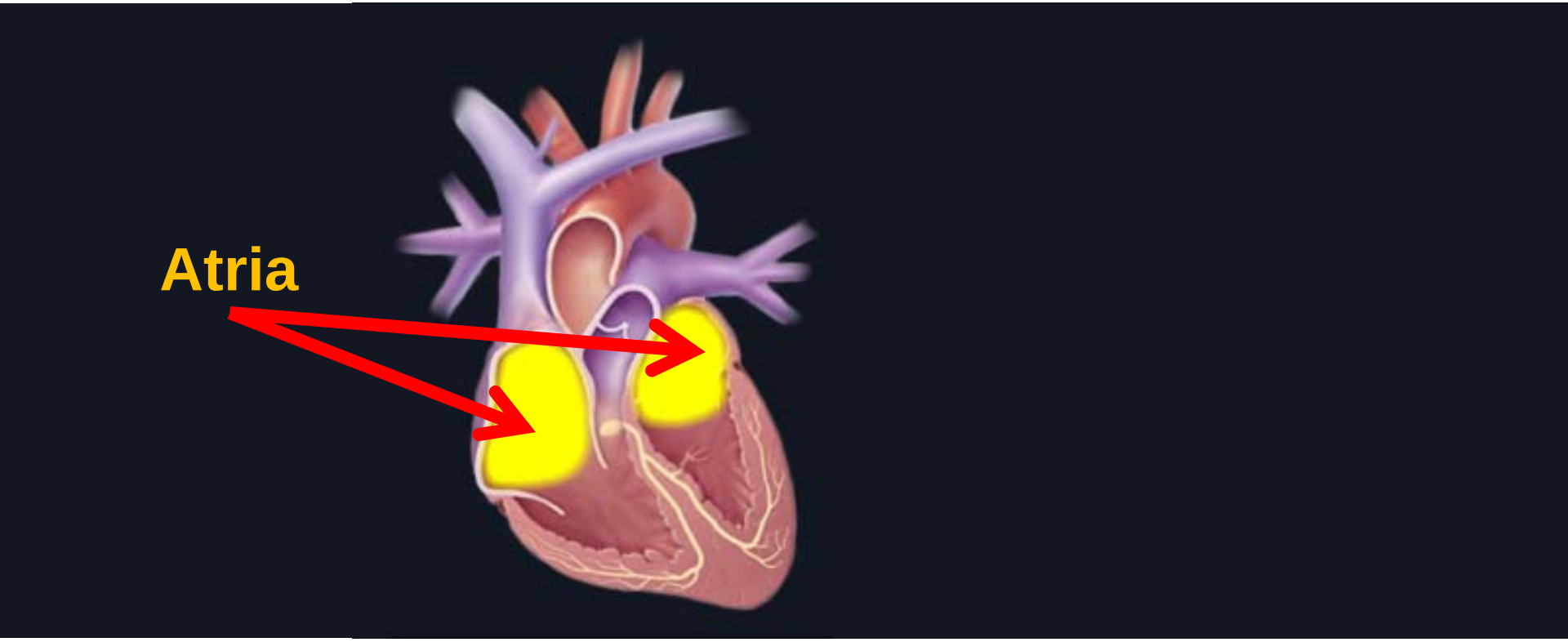
Impulse Formation

- Natural pacemaker: Periodic electrical impulses



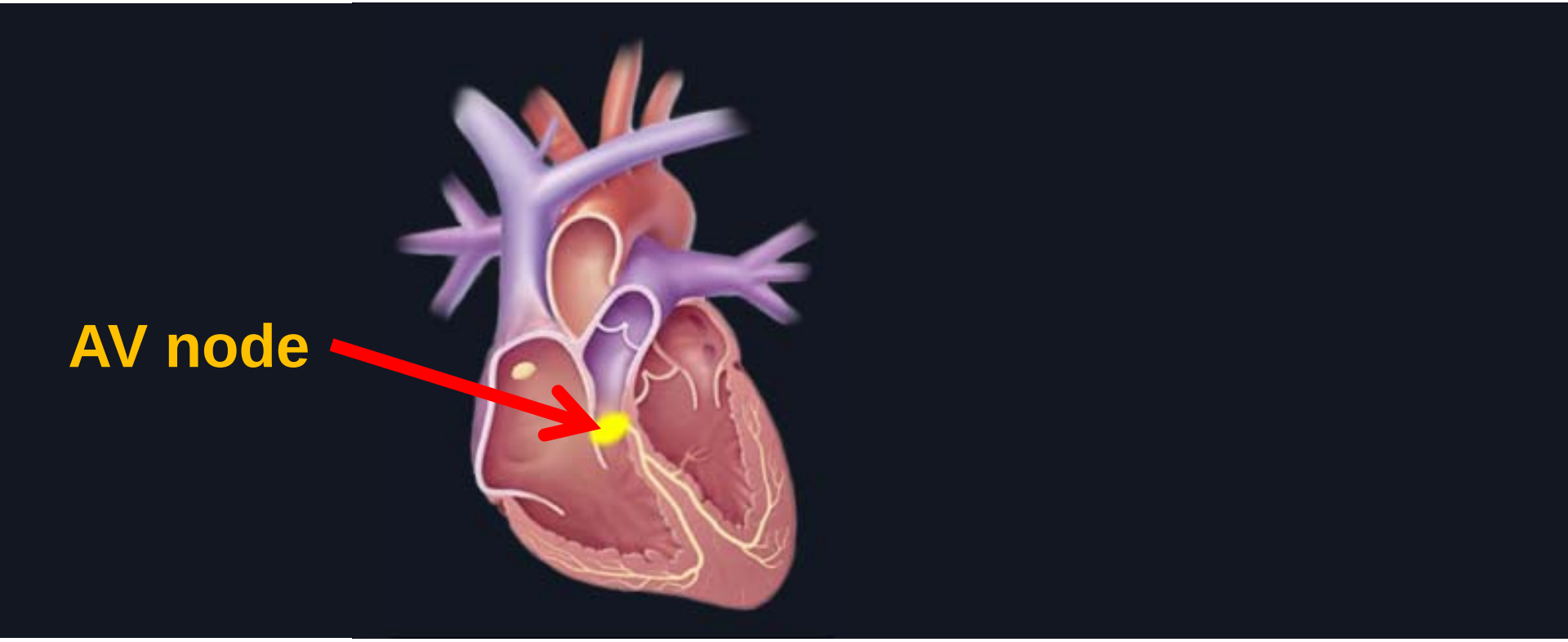
Atrial Contraction

- Activation → Muscle contraction



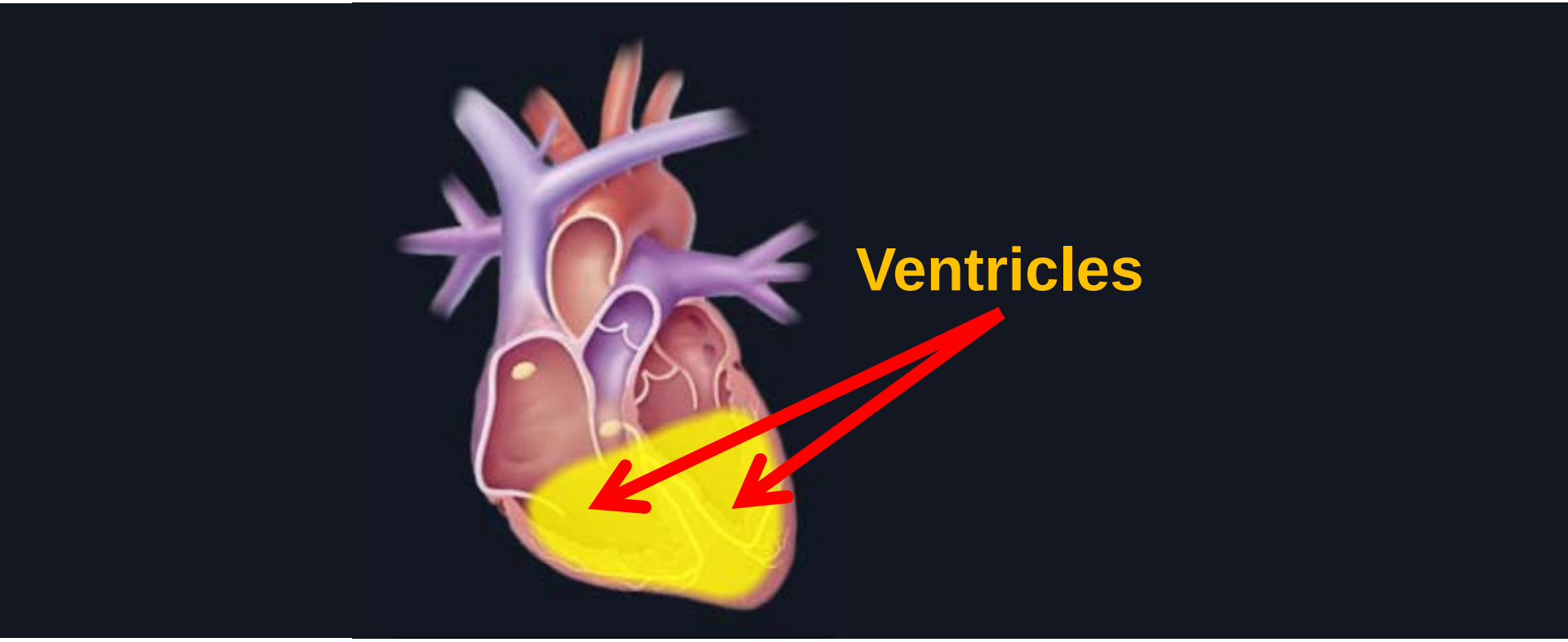
Delay At AV Node

- Allows the ventricles to fill fully



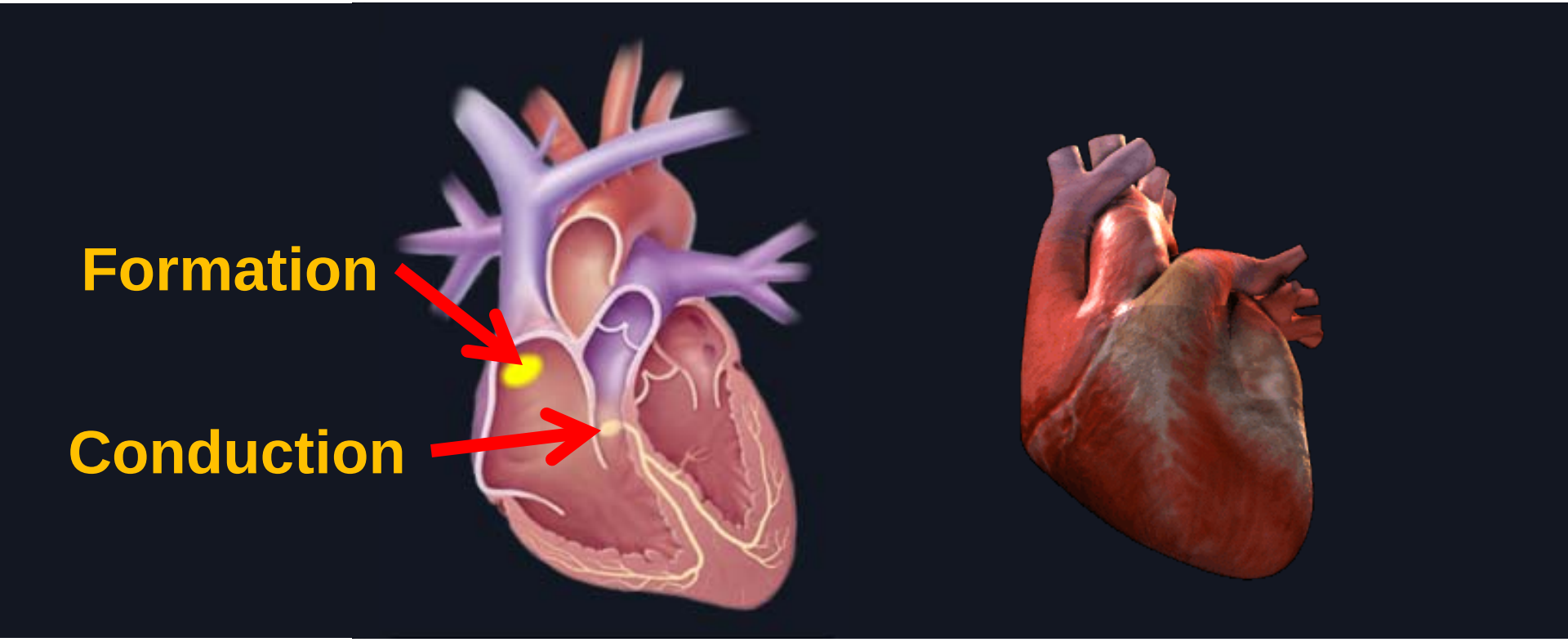
Ventricular Contraction

- Pump blood out of the heart



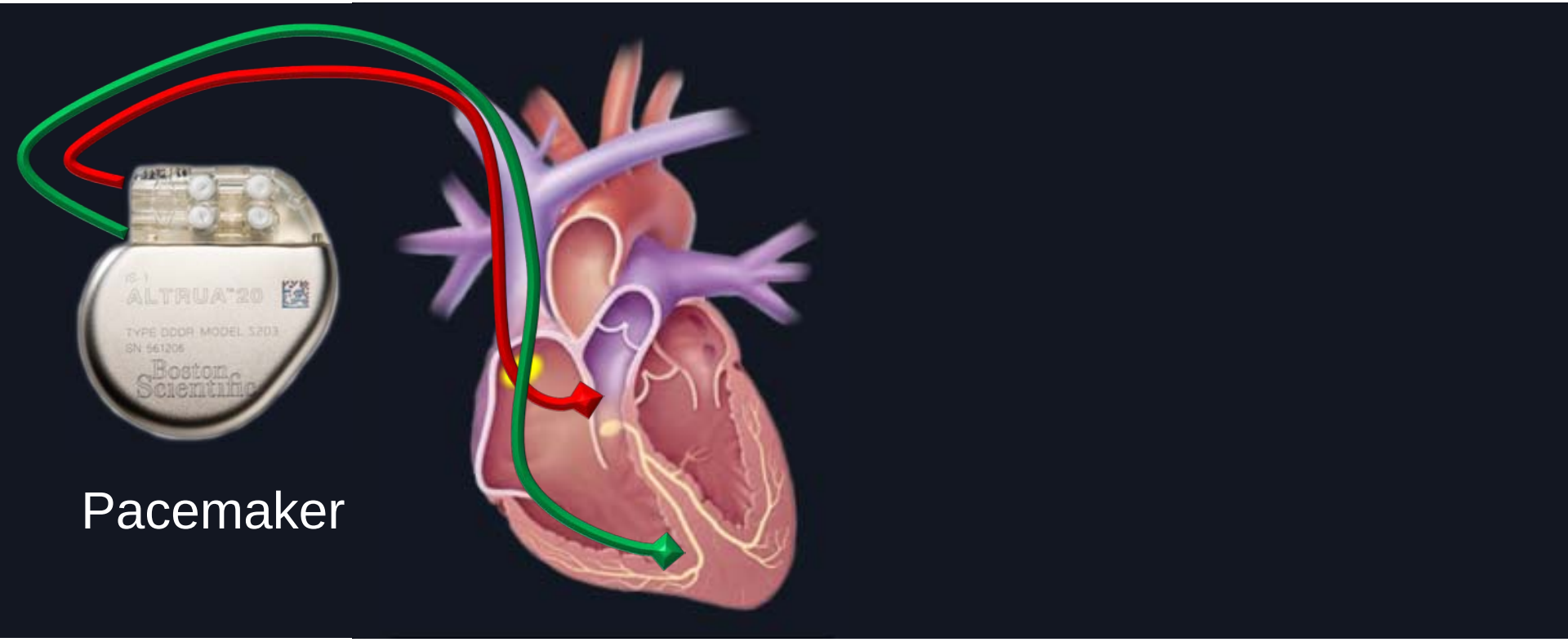
Bradycardia

- Slow heart rate



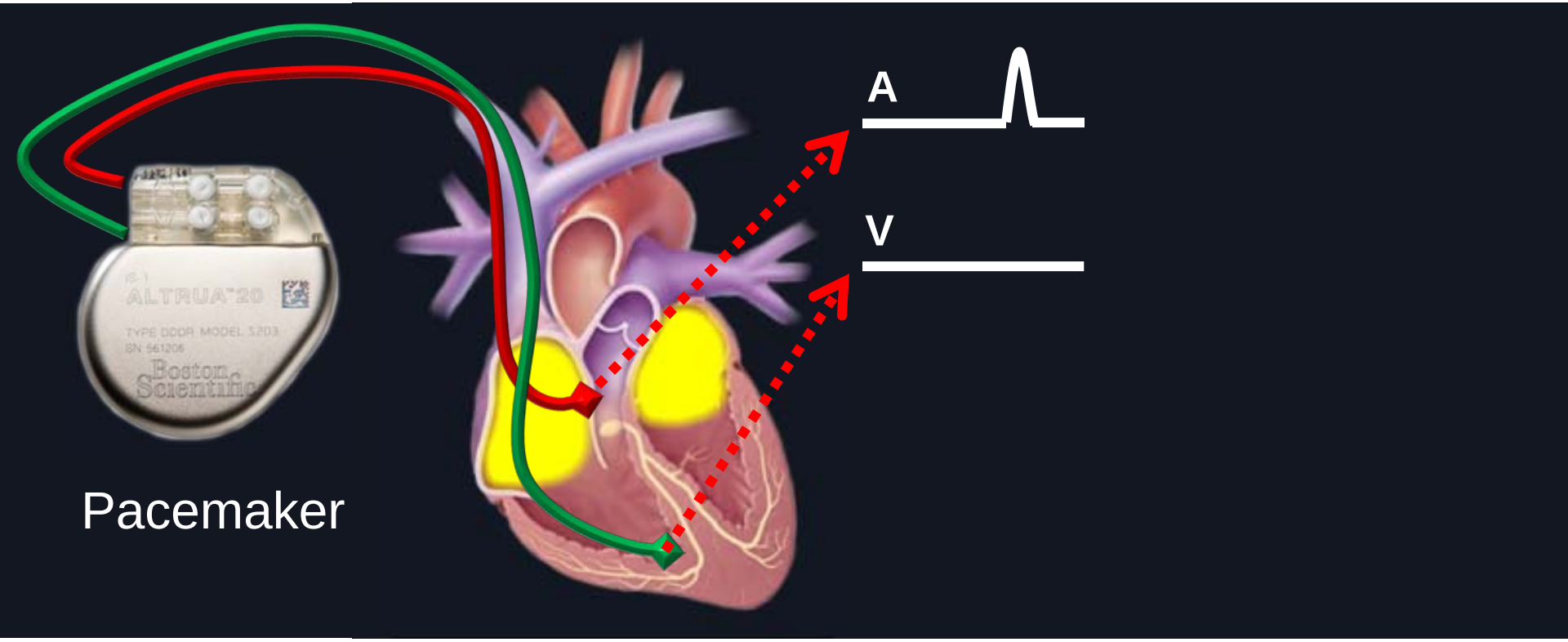
Dual Chamber Pacemaker

- Two leads implanted in right atrium and ventricle



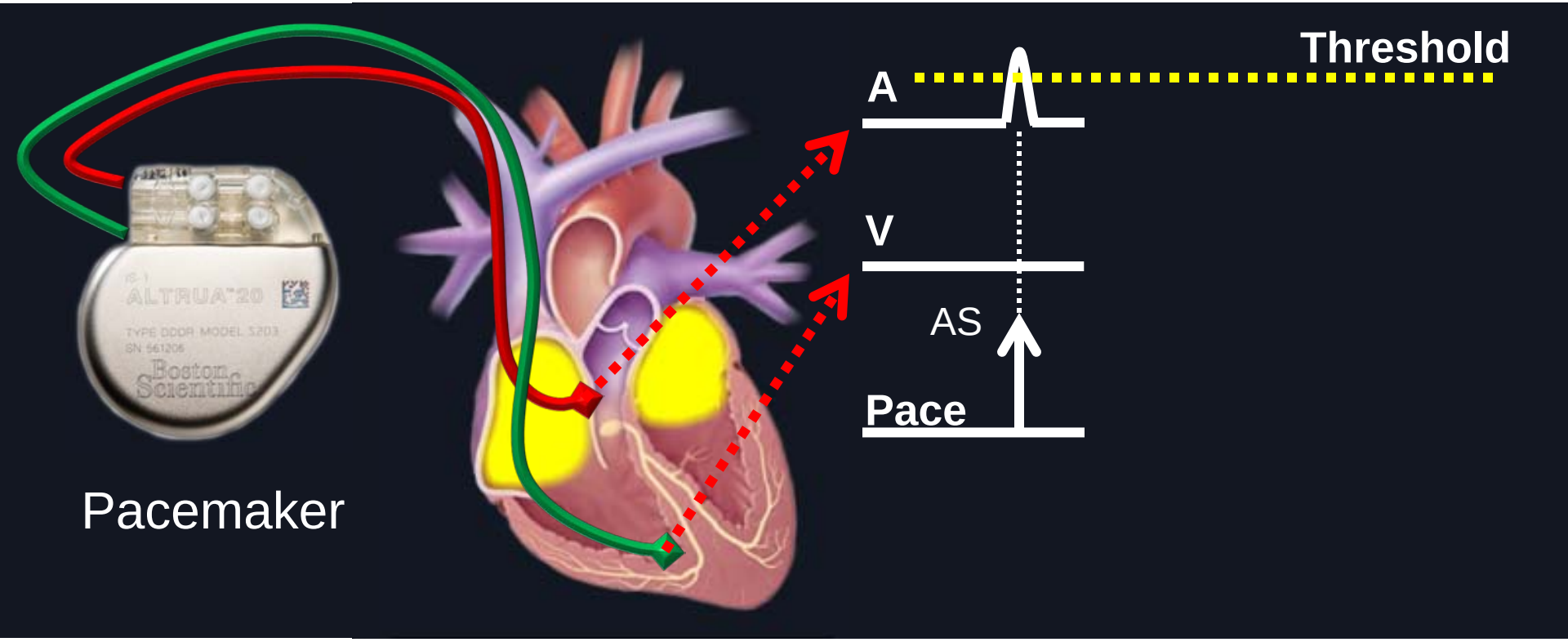
Electrogram (EGM) signals

- Voltage change due to activation



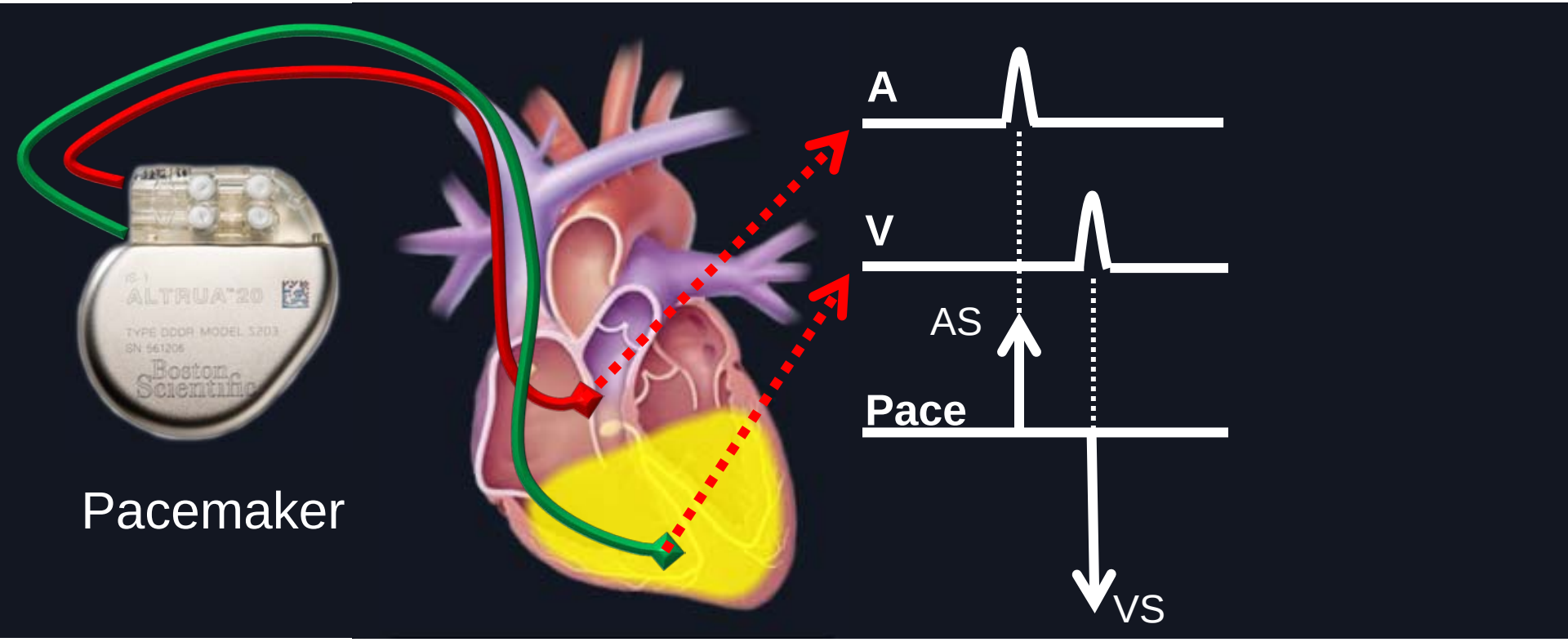
Atrial Sensing (AS)

- Generate sensed event when signal above threshold



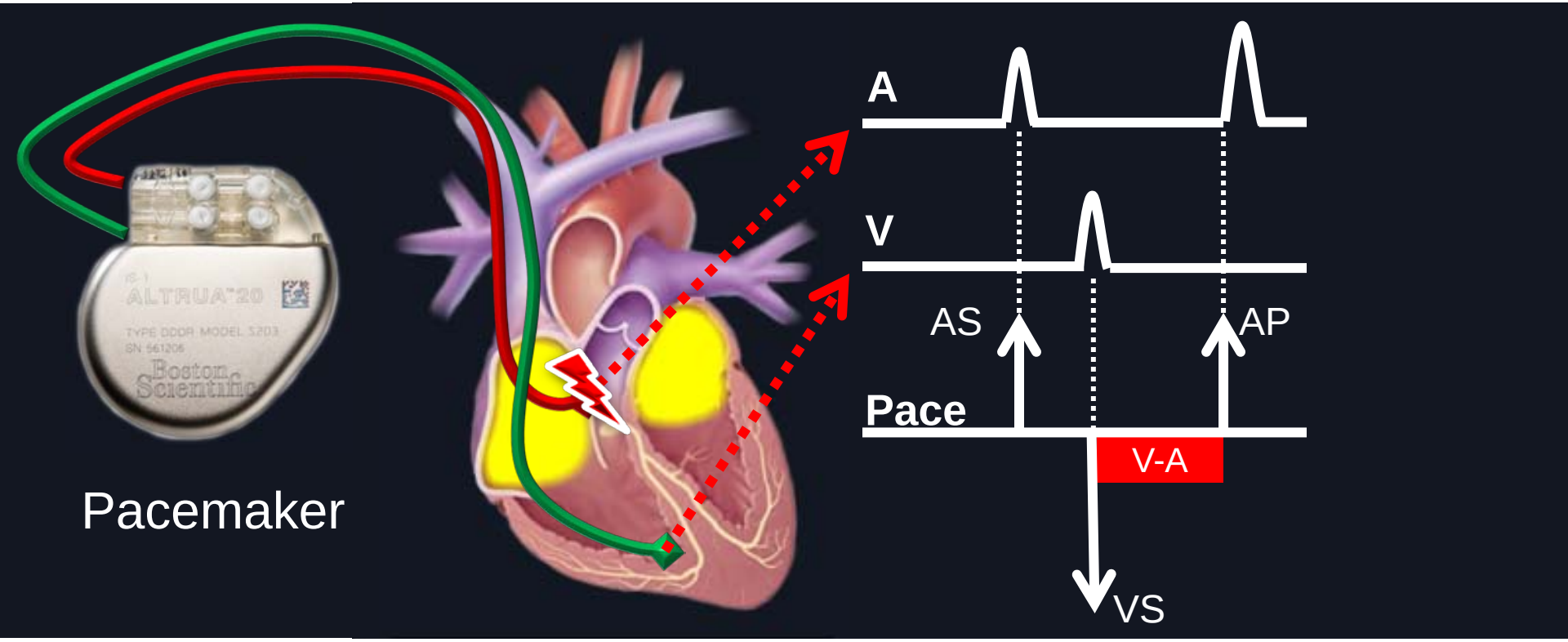
Ventricular Sense (VS)

- Same for ventricular channel



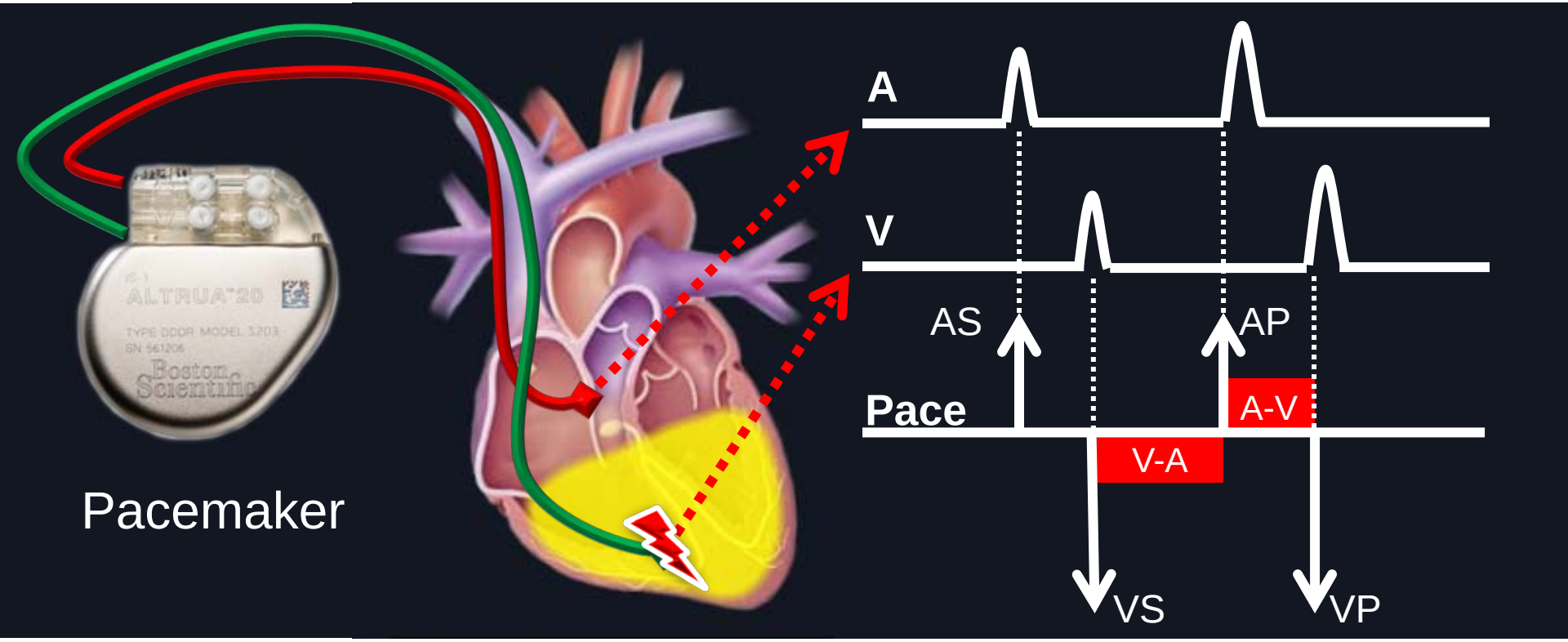
V-A deadline & Atrial Pacing (AP)

- Pace atrium when no AS within deadline



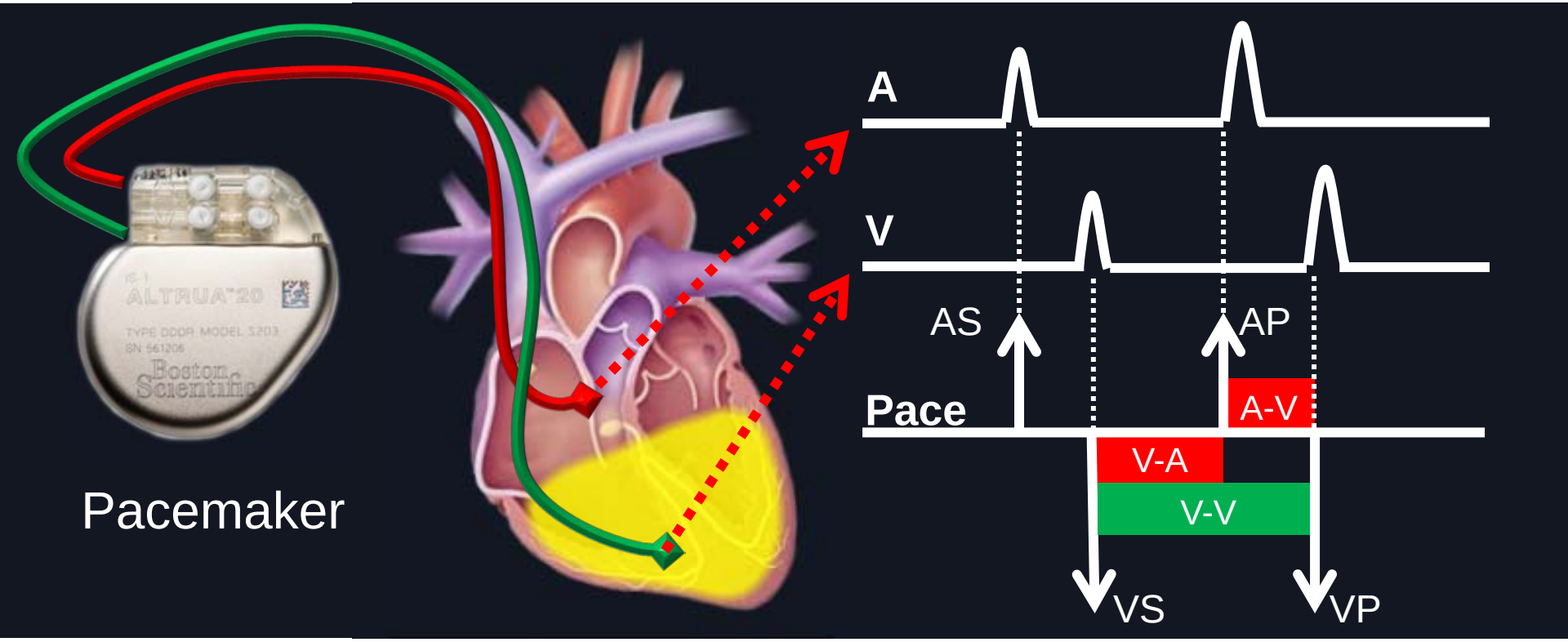
A-V deadline and Ventricular Pacing (VP)

- Pace ventricle if no VS happen within deadline



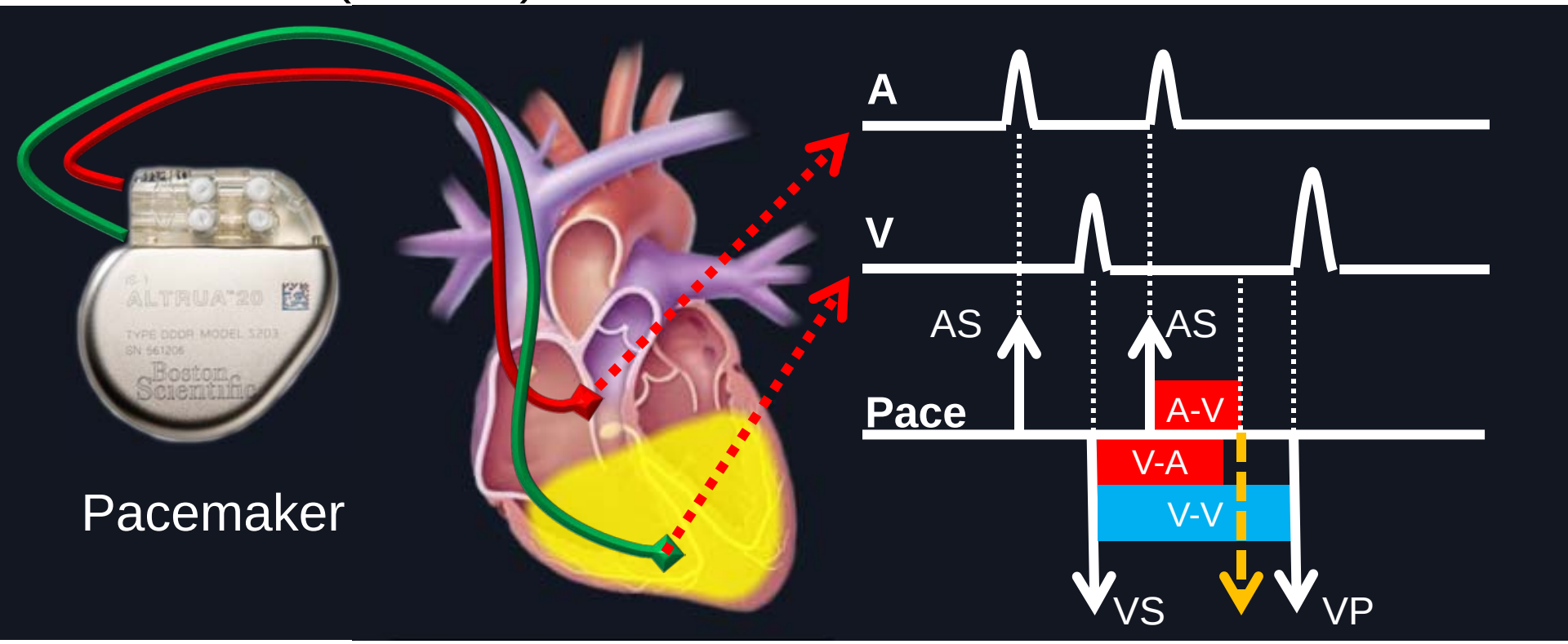
V-V deadline

- Minimum ventricular rate allowed



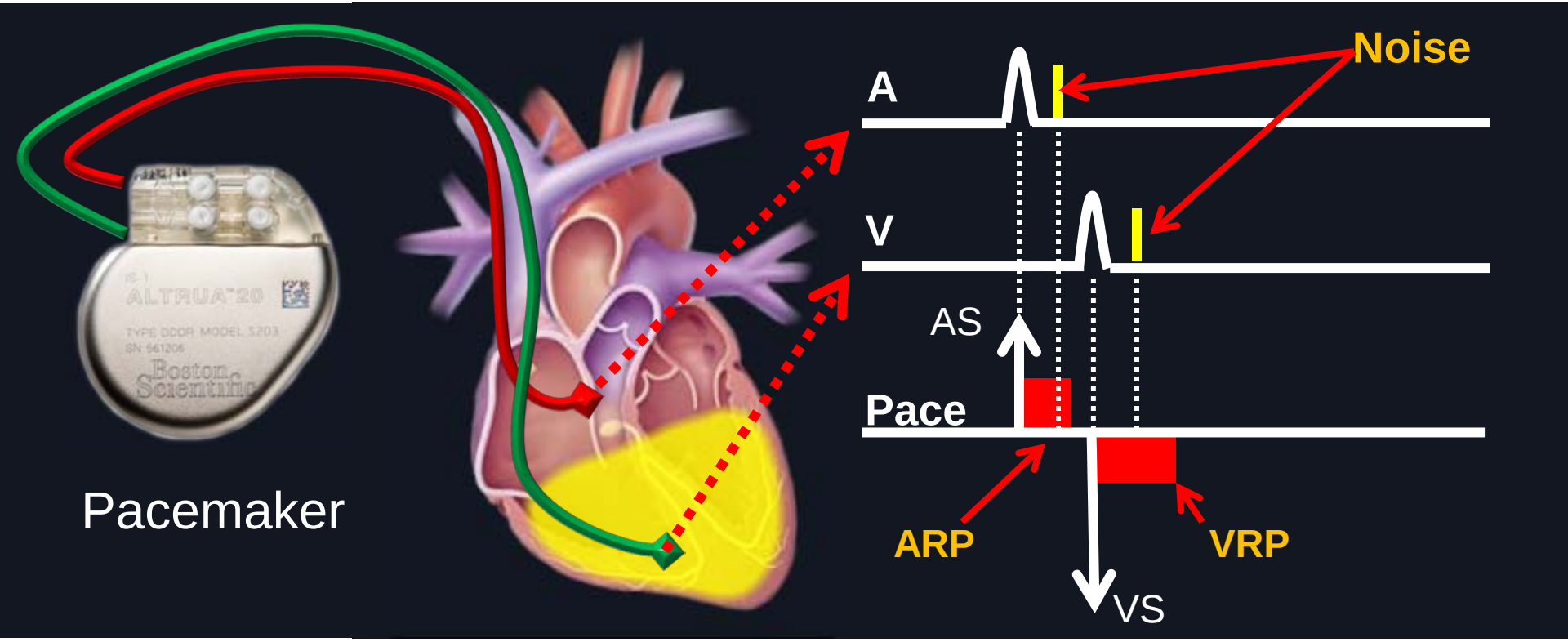
Minimum Ventricular Pacing Interval

- Scheduled VP delayed if time since last ventricular event (VS, VP) is less than threshold



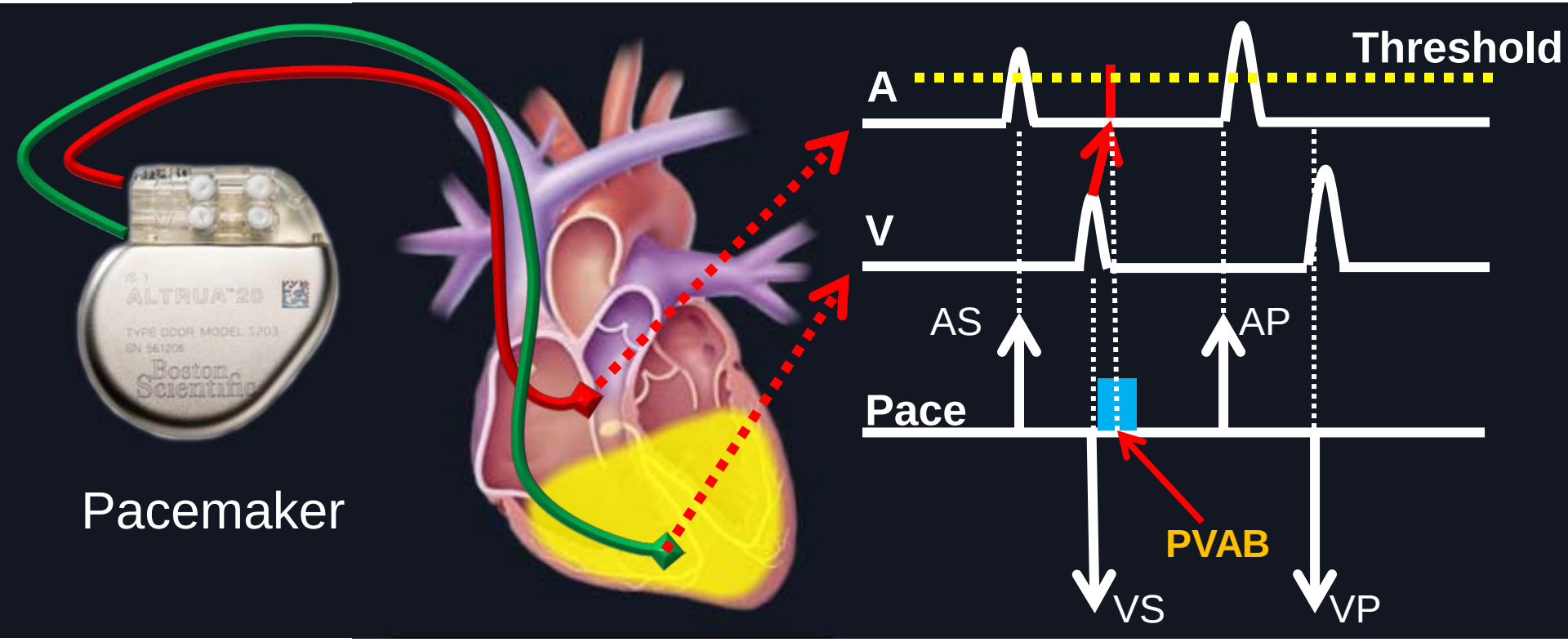
Minimum interval between Sensed events

- Mimic **refractory** property of heart tissue



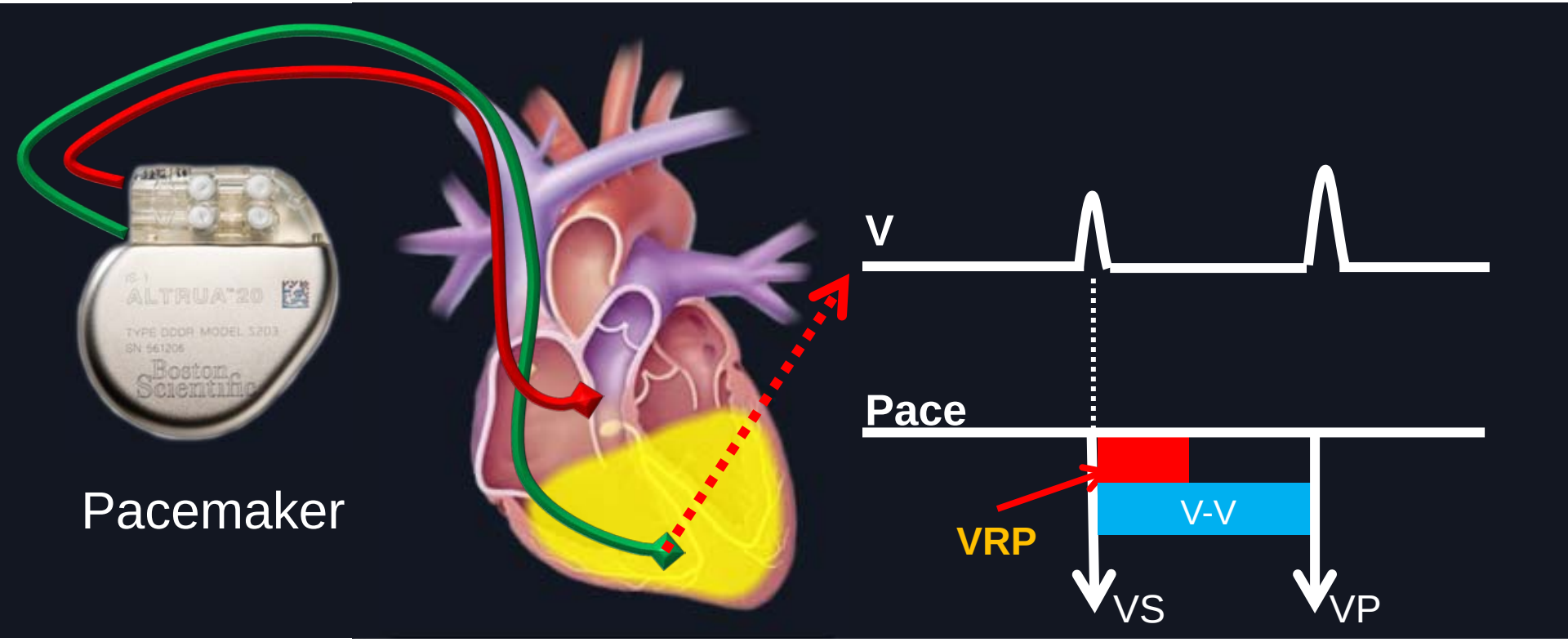
Post-Ventricular Atrial Blocking period (PVAB)

- Preventing **crosstalk** between A and V channels



Single Chamber Mode

- Maintain ventricular rate

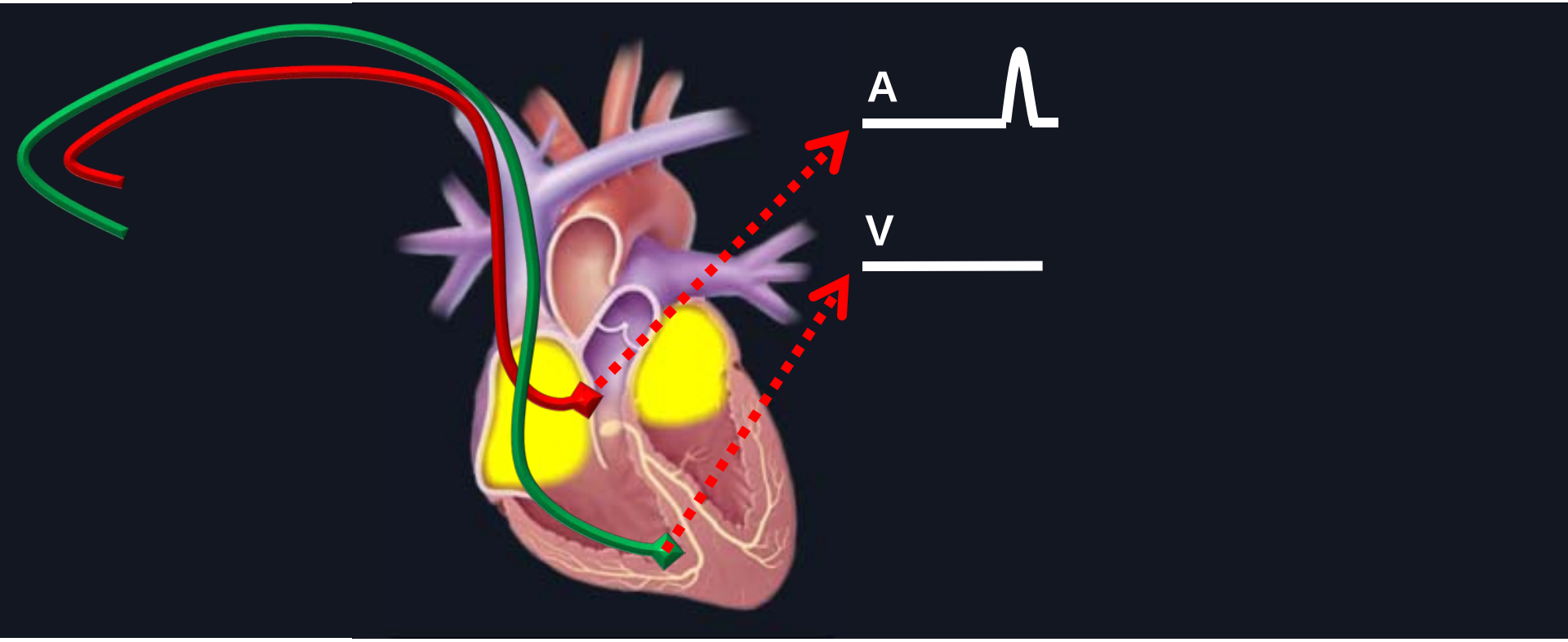


Pacemaker Mediated Tachycardia (PMT)

- Pacemaker inappropriately increases ventricular rate
  - Normal ventricular rate without pacemaker
  - Ventricular Tachycardia with pacemaker
- Two cases
  - Atrial Tachycardia Response
  - Endless Loop Tachycardia (ELT)

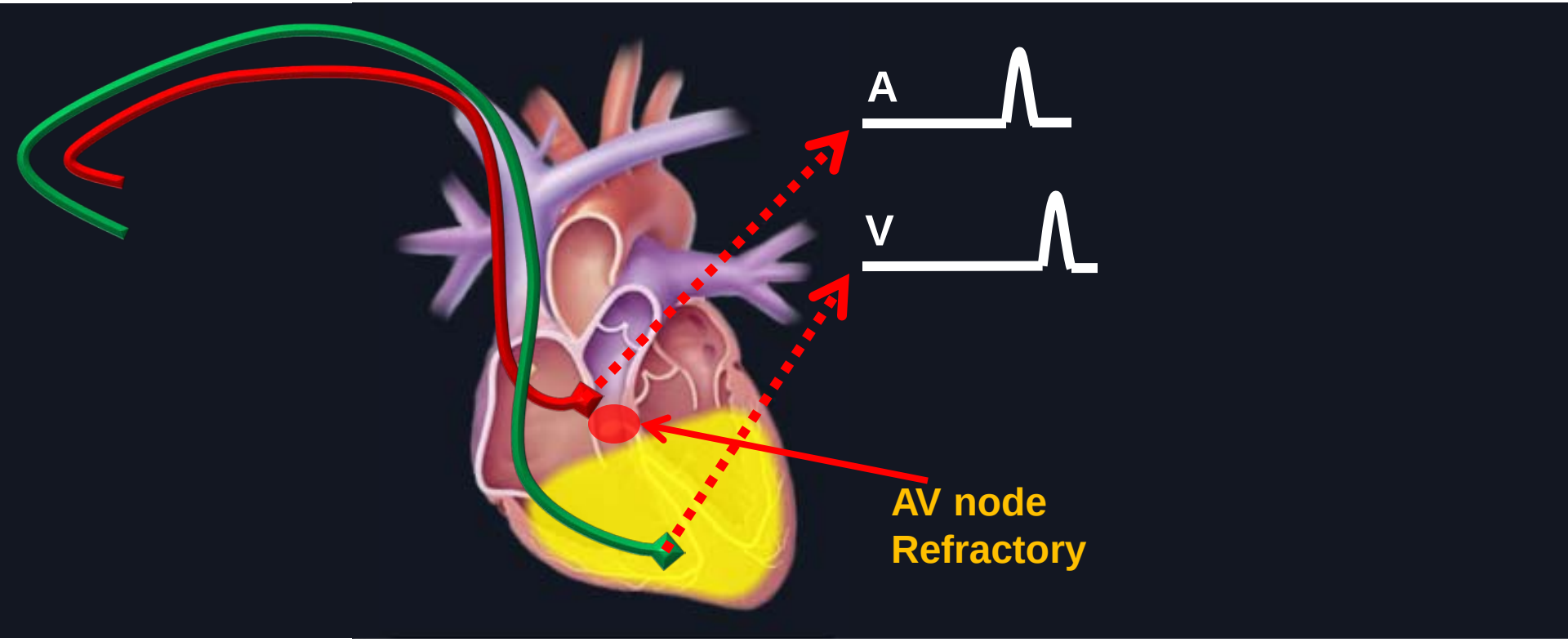
Atrial Tachycardia Response: Open-loop

- Atrial Tachycardia: Abnormally fast atrial rate



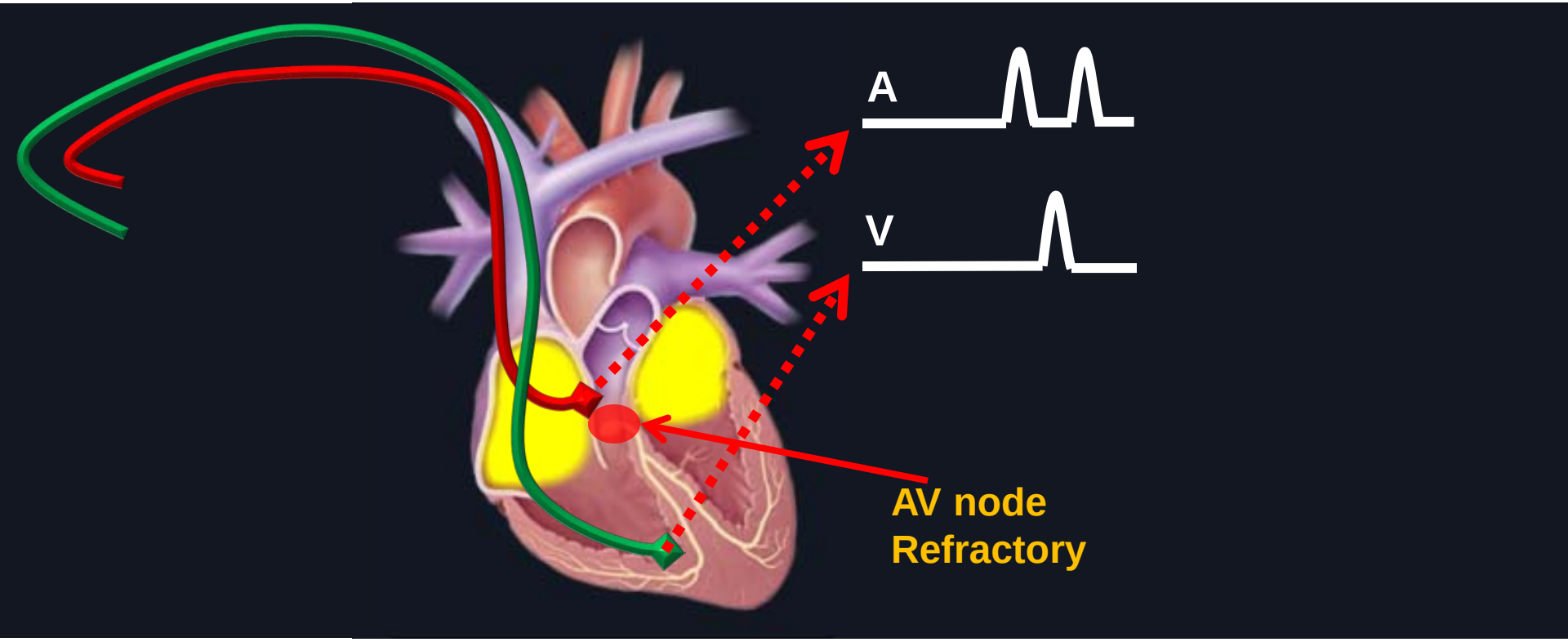
Atrial Tachycardia Response: Open-loop

- AV node enters Refractory period



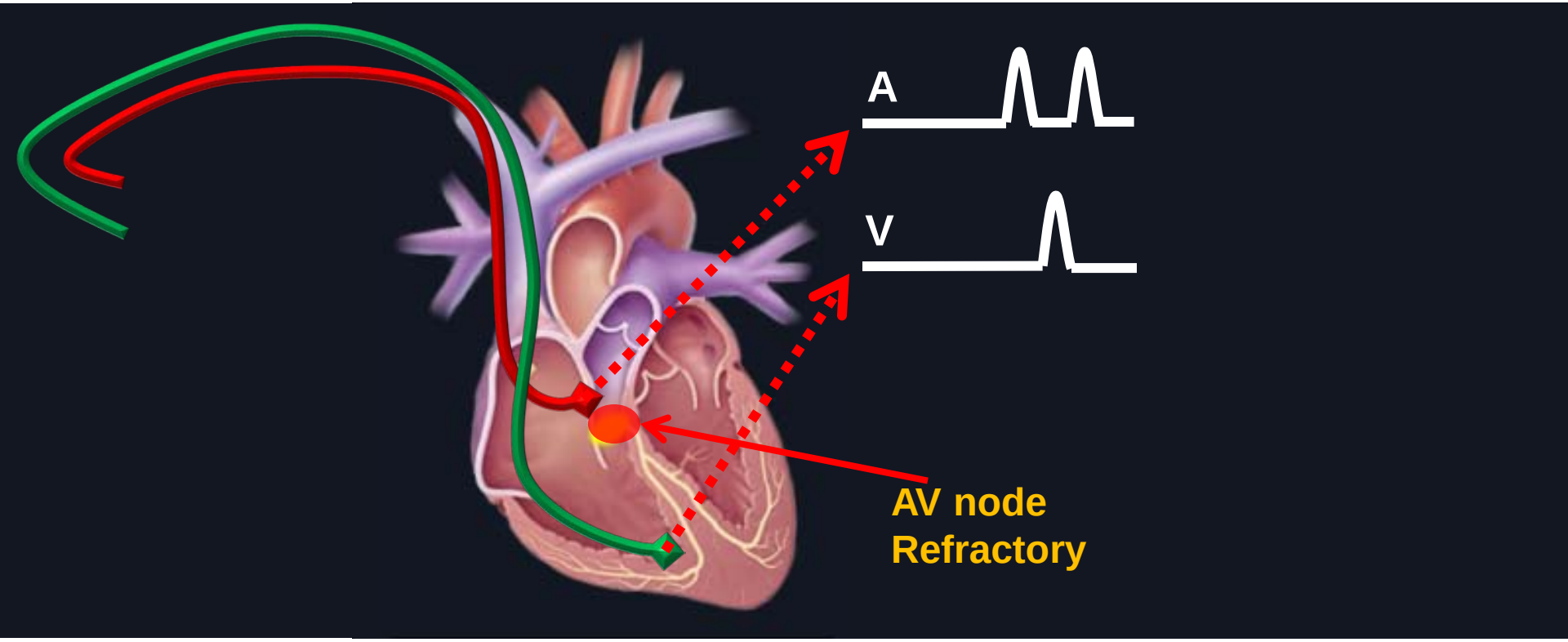
Atrial Tachycardia Response: Open-loop

- Another early atrial contraction



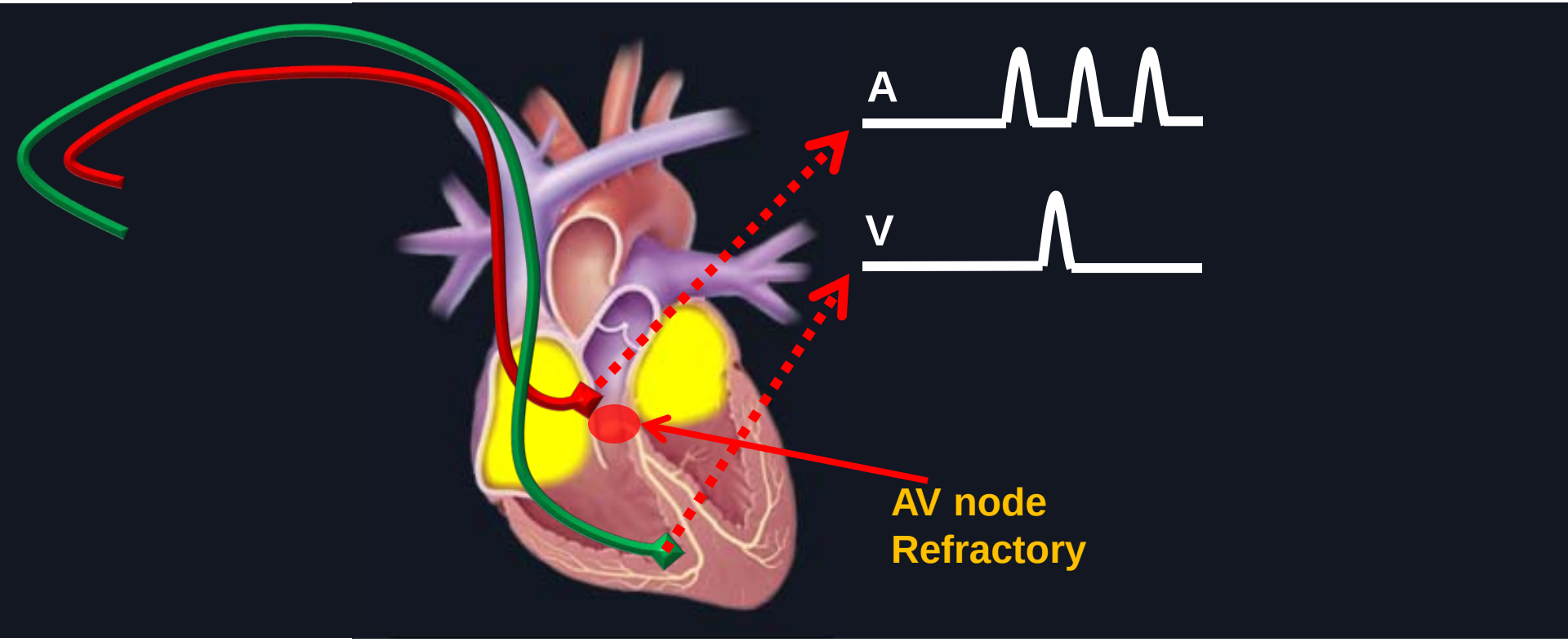
Atrial Tachycardia Response: Open-loop

- Blocked by AV node during refractory



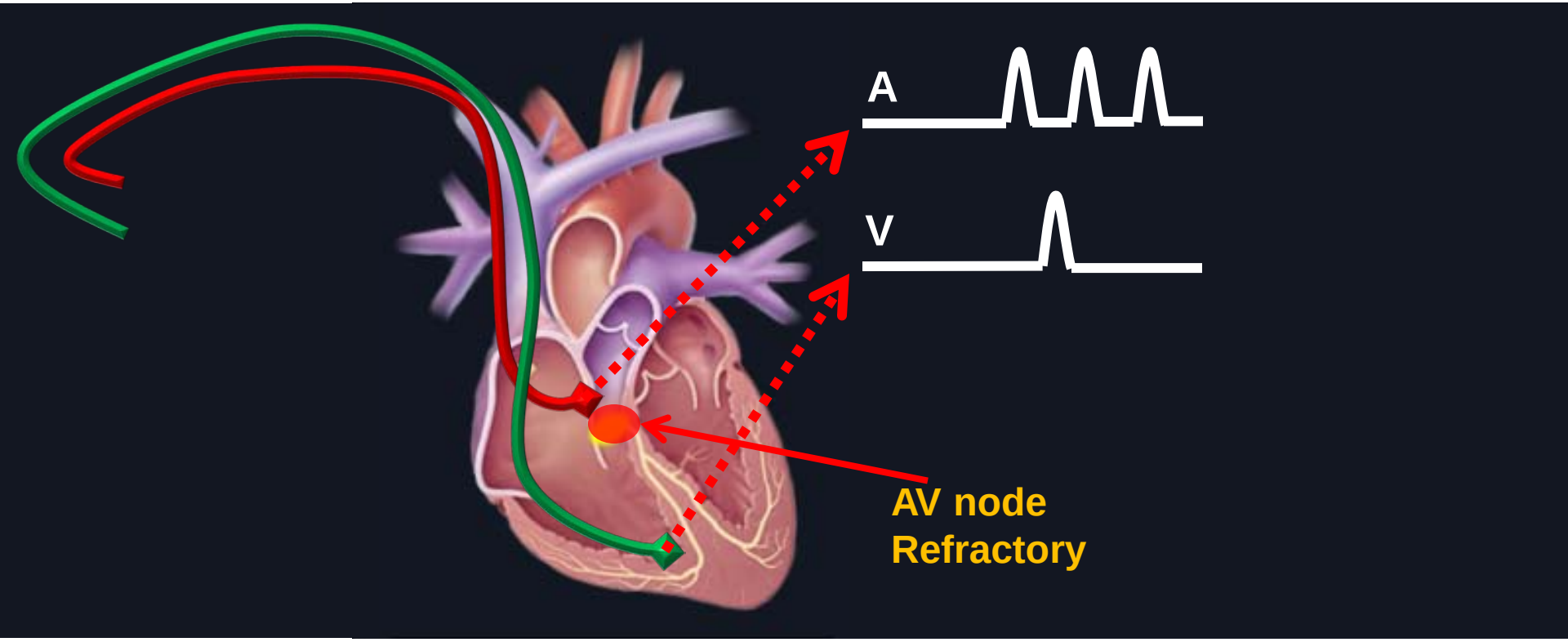
Atrial Tachycardia Response: Open-loop

- Third atrial contraction



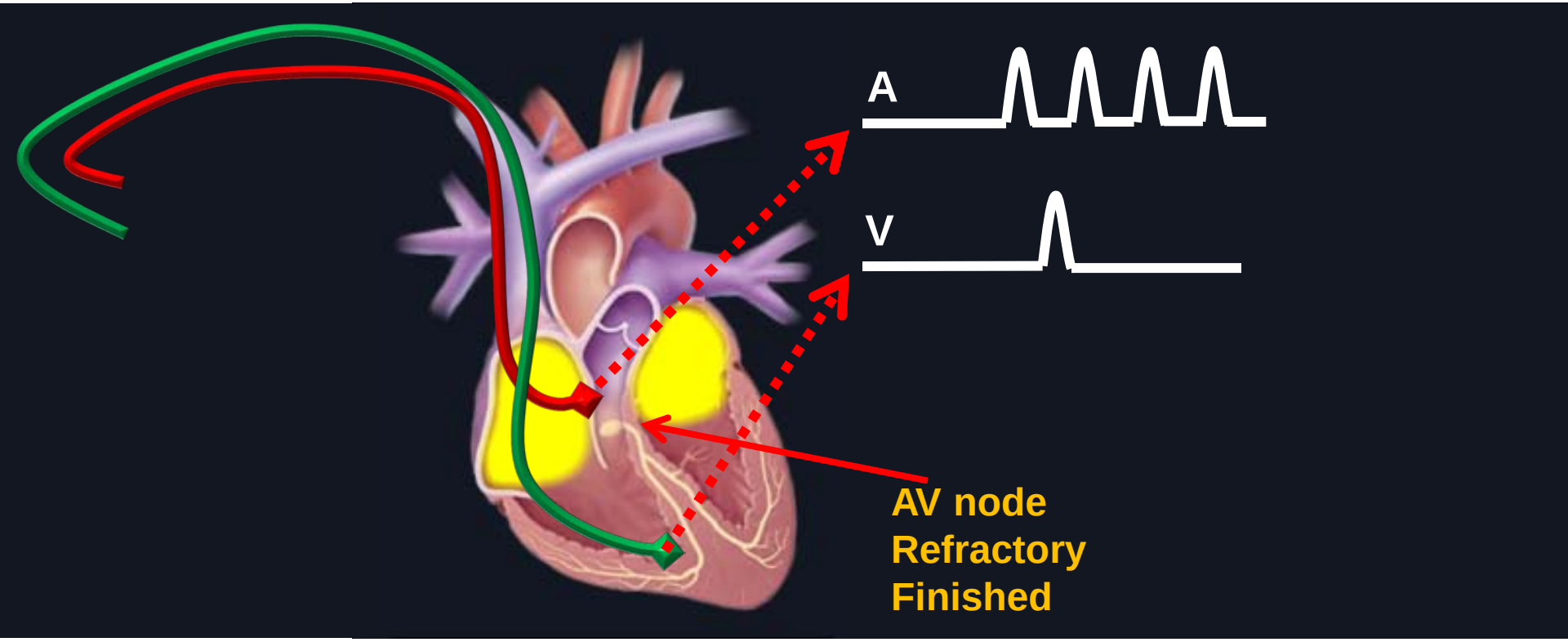
Atrial Tachycardia Response: Open-loop

- Blocked by AV node again



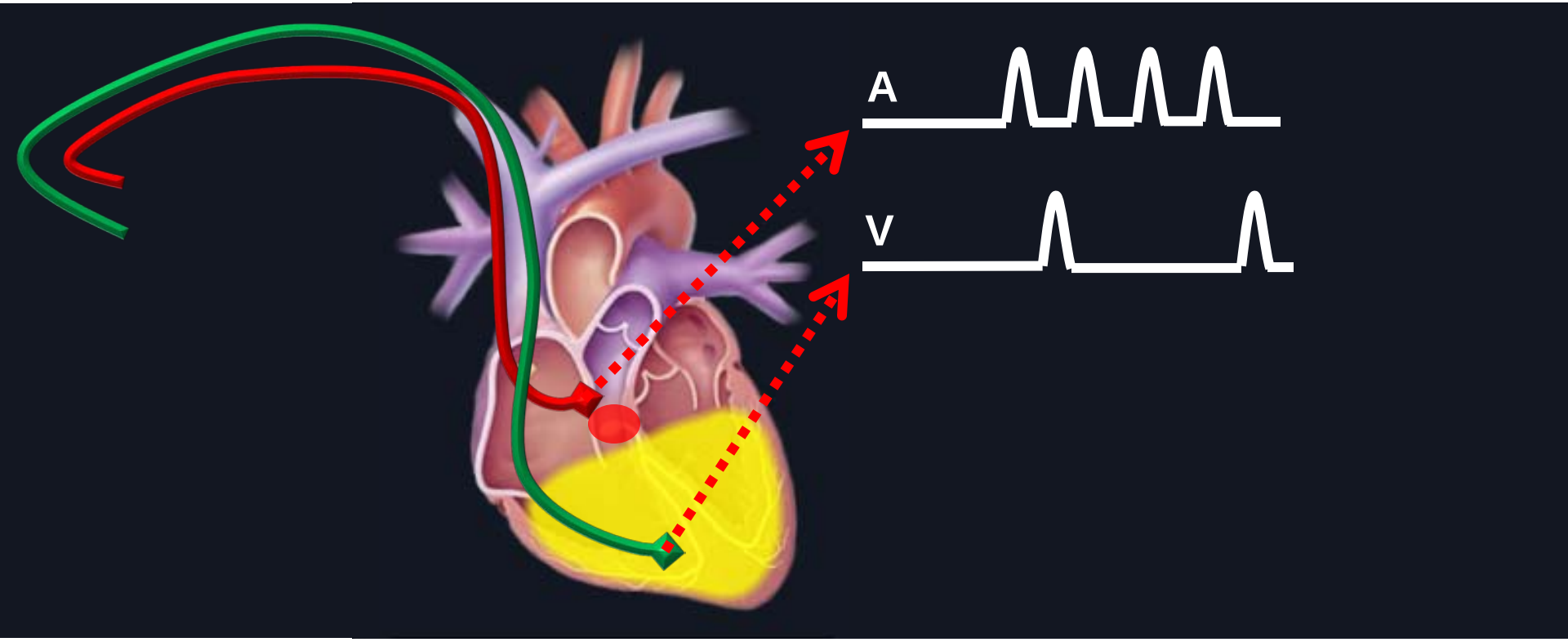
Atrial Tachycardia Response: Open-loop

- AV node refractory finished



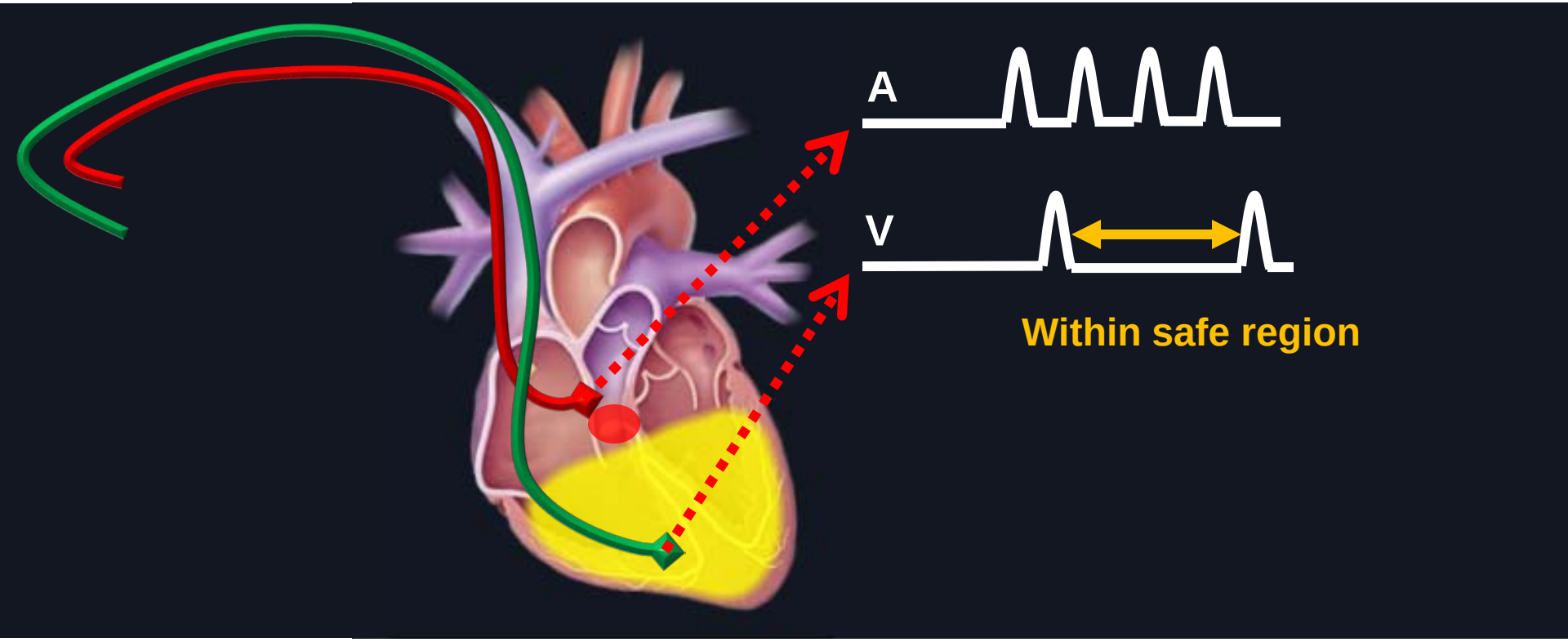
Atrial Tachycardia Response: Open-loop

- 3:1 A-V conduction



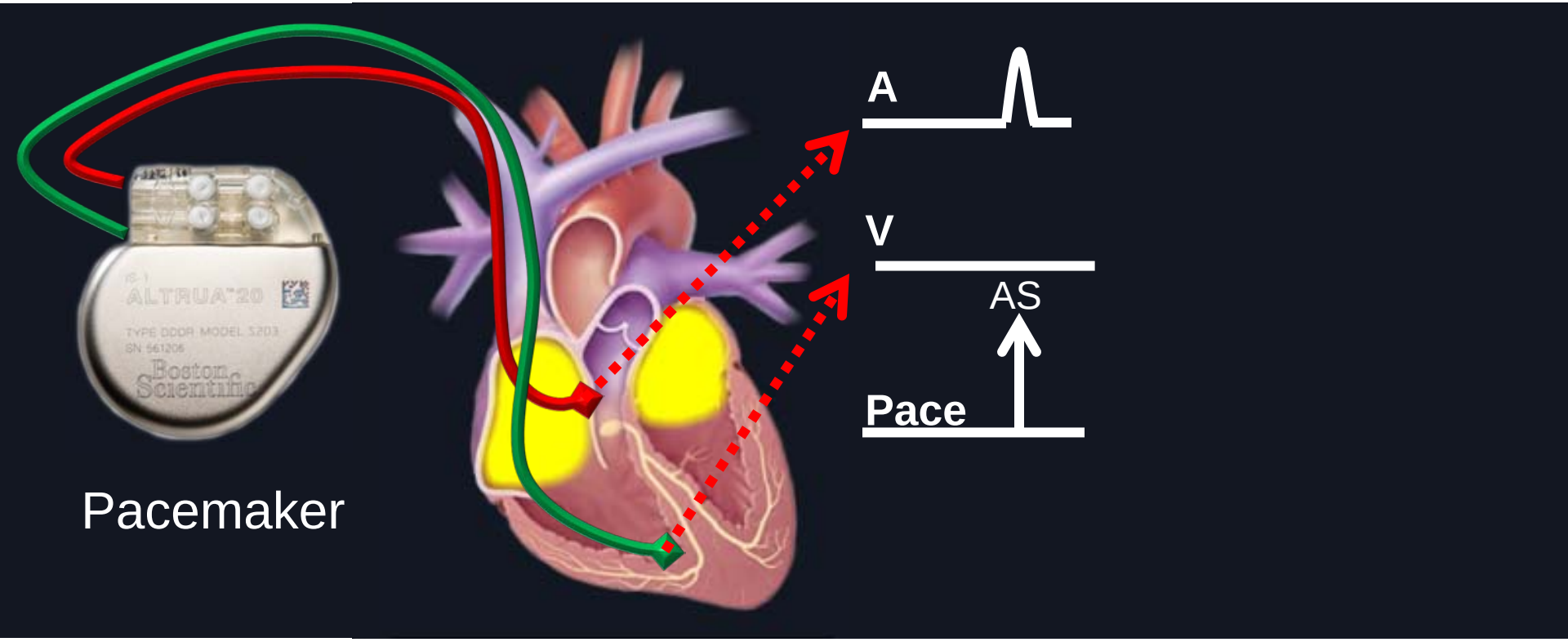
Atrial Tachycardia Response: Open-loop

- Normal Ventricular rate in contrast to fast atrial rate



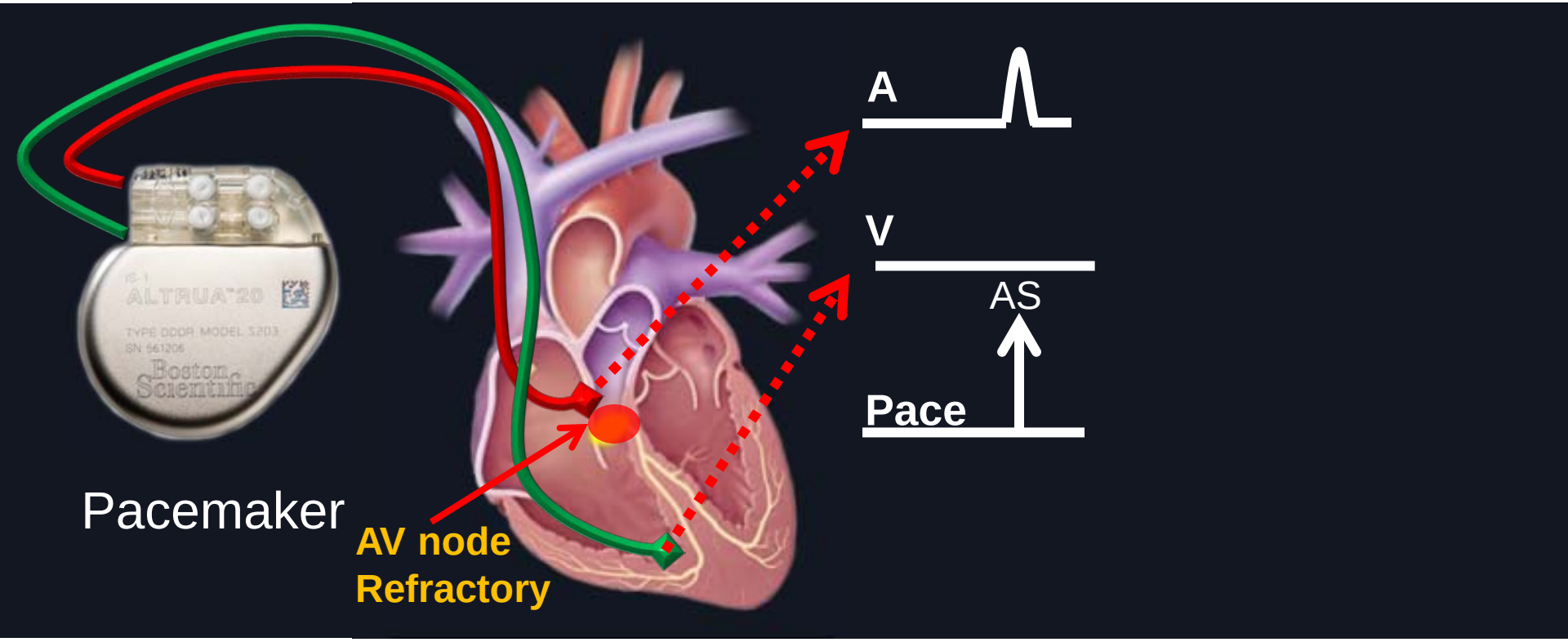
Atrial Tachycardia Response: Closed-loop

- Inappropriately increase ventricular rate



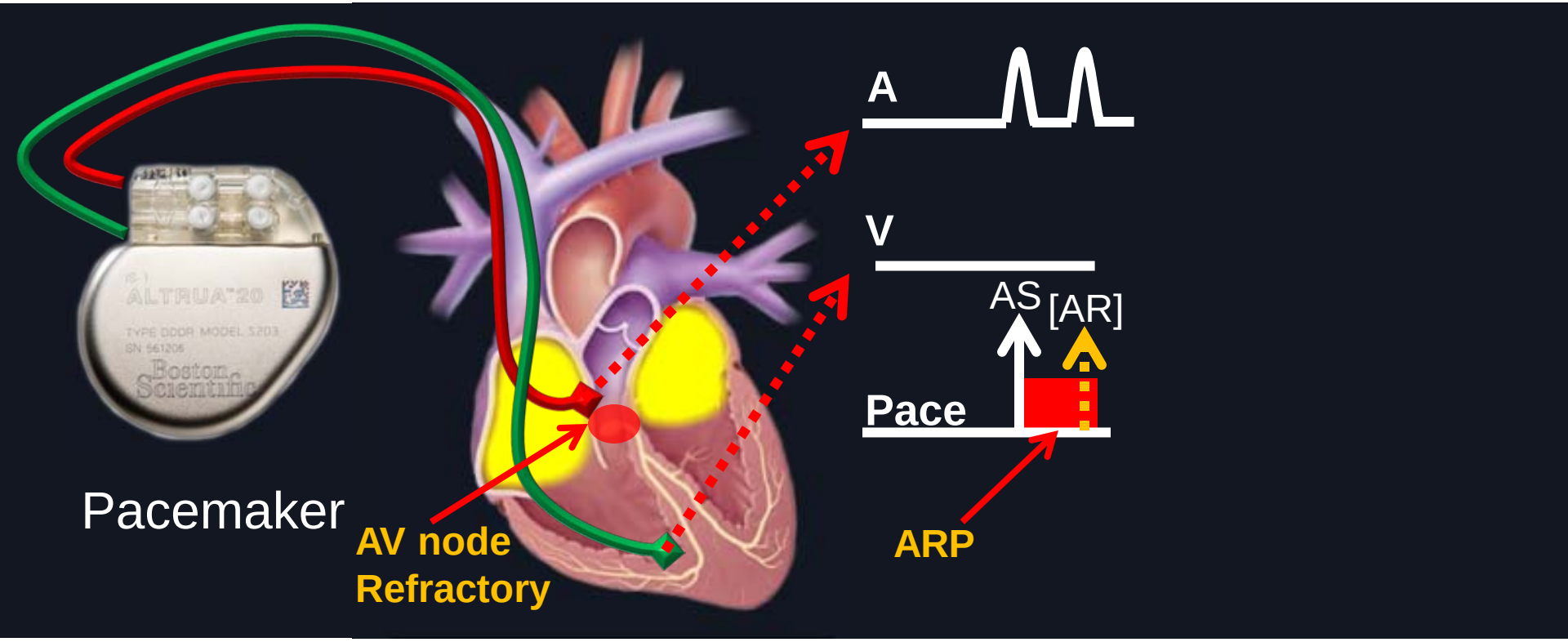
Atrial Tachycardia Response: Closed-loop

- Mimic **refractory** property of heart tissue



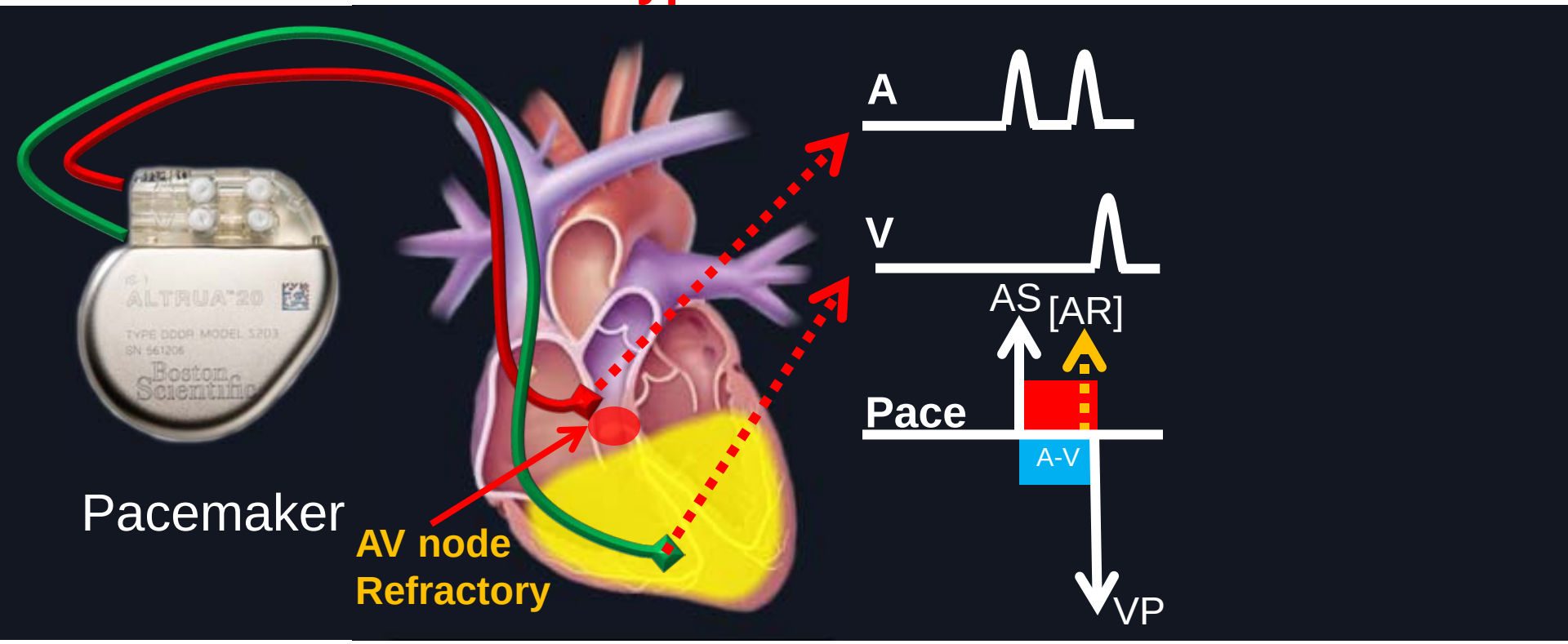
Atrial Tachycardia Response: Closed-loop

- Some of the fast atrial events are filtered



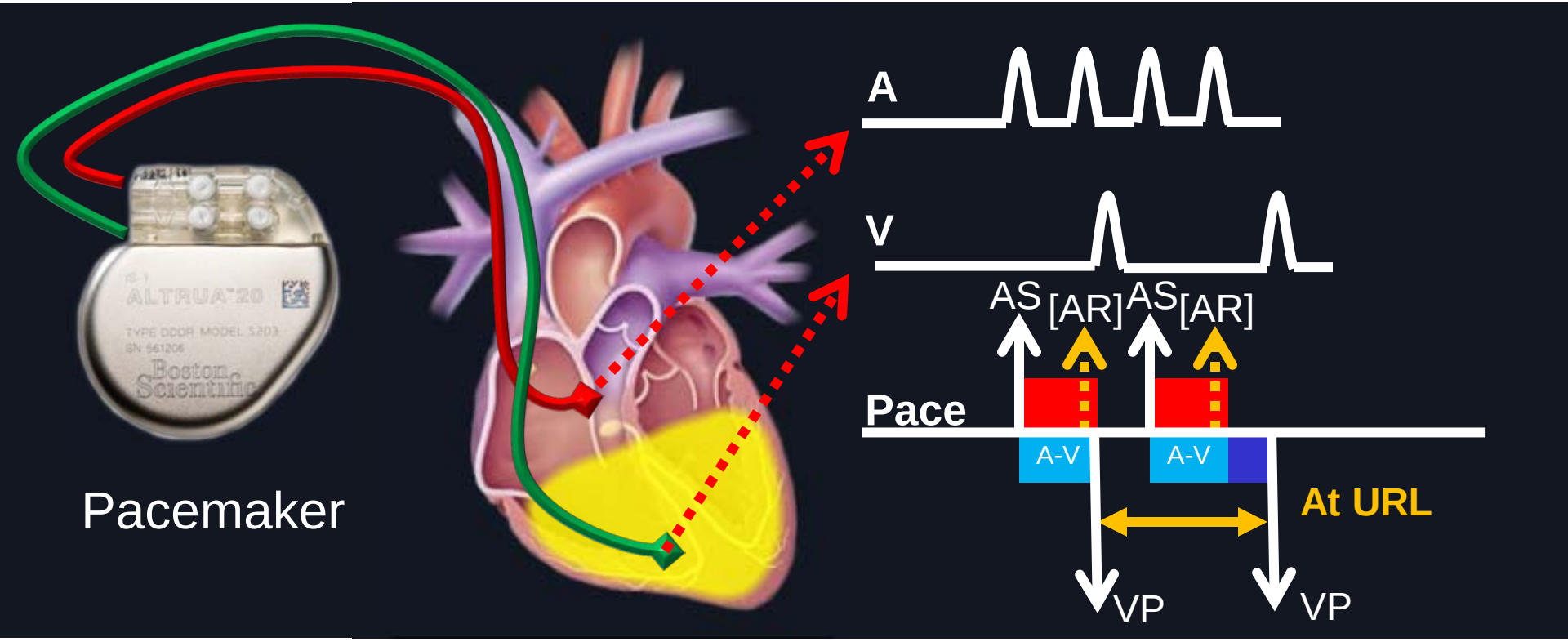
Atrial Tachycardia Response: Closed-loop

- VP when AV node in Refractory
- AV node function **bypassed**



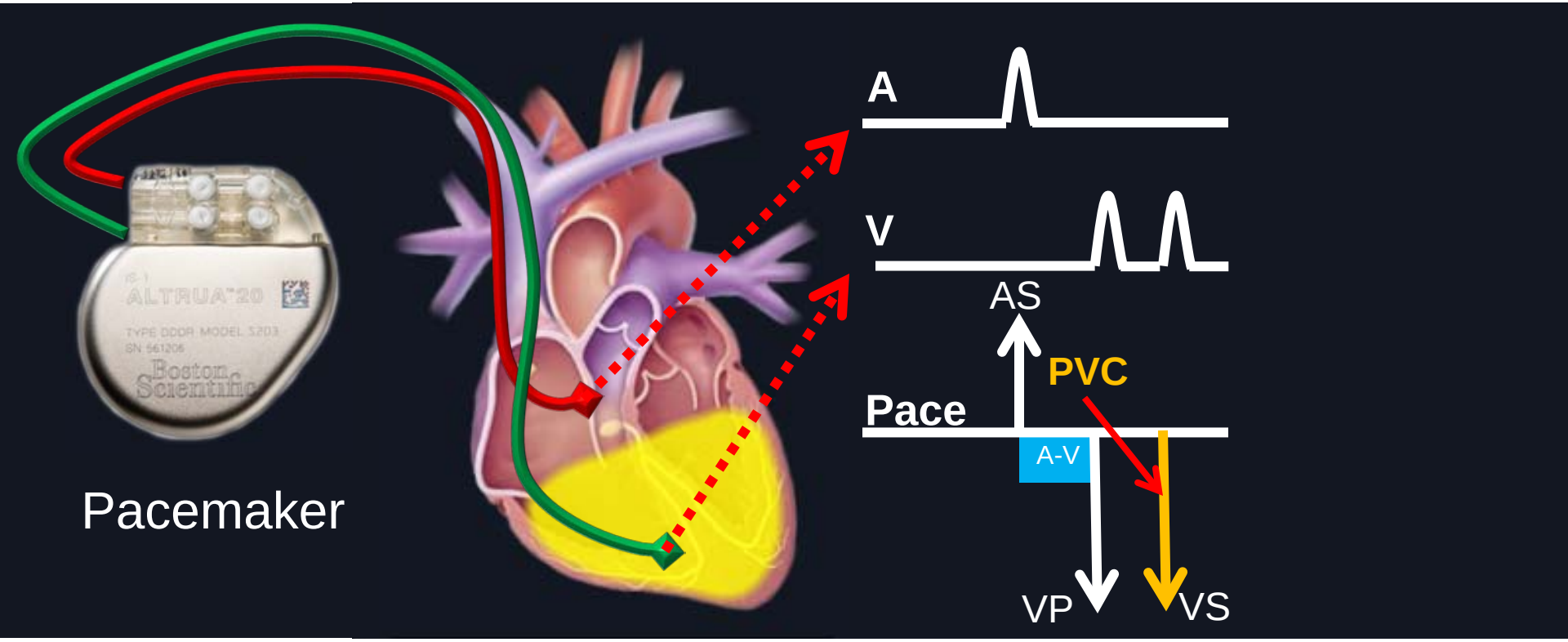
Atrial Tachycardia Response: Closed-loop

- Ventricular rate at Upper Rate Limit



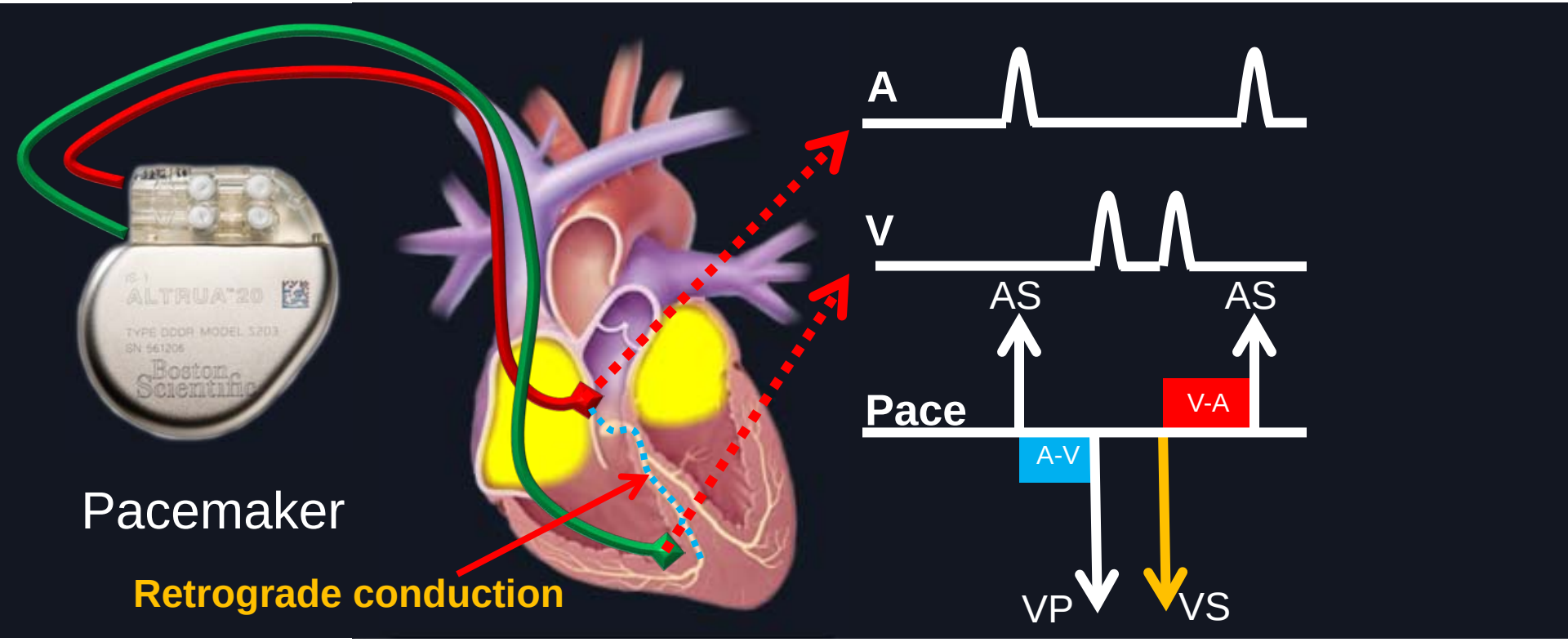
Endless Loop Tachycardia (ELT): Closed-loop

- Pre-mature Ventricular Contraction (PVC)



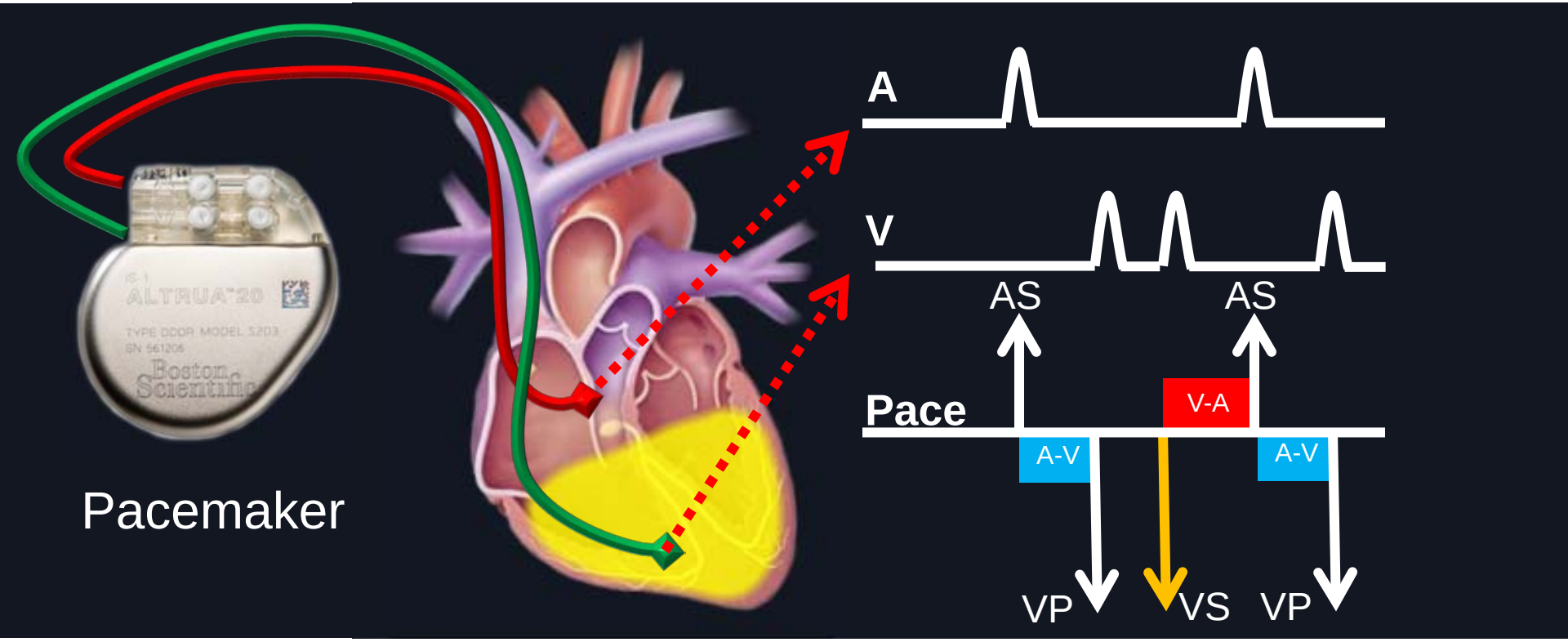
Endless Loop Tachycardia (ELT): Closed-loop

- Retrograde conduction causing atrial contraction



Endless Loop Tachycardia (ELT): Closed-loop

- VP after A-V deadline



Endless Loop Tachycardia (ELT): Closed-loop

- The VP-AS-VP pattern persists, causing ELT