

Epicardio AVRT Tutorial

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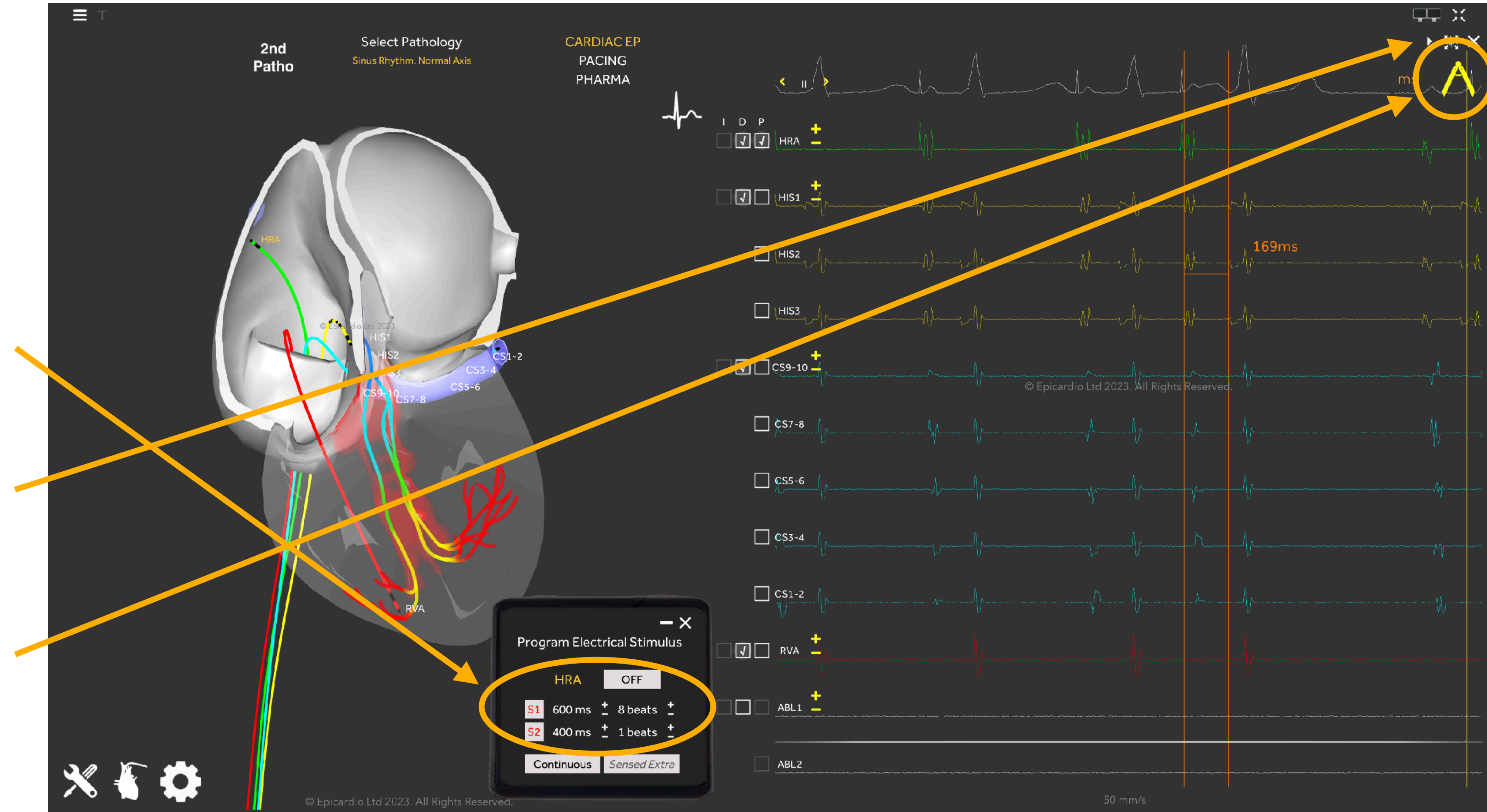
Let's do some pacing manoeuvres.

Clinical relevance: We will start with an anterograde curve to assess the AVN function.

Action 1: Select S1 and S2 in the pacing module. They should both be red. Set S1 to 600ms, 8 beats. Set S2 to 400ms, 1 beat. Turn the stimulator ON.

Action 2: Pause the simulation after the final paced beat.

Action 3: Click on the 'ECG caliper' icon and measure the A-H interval. This measurement is taken from the earliest atrial activity on the HIS catheter to the earliest His signal on the HIS catheter. Use whichever of the 3 HIS bipoles has the earliest signal.



Action 1: Now, reduce the S2 time to 360ms. Turn the stimulator ON, and pause after the last paced beat.

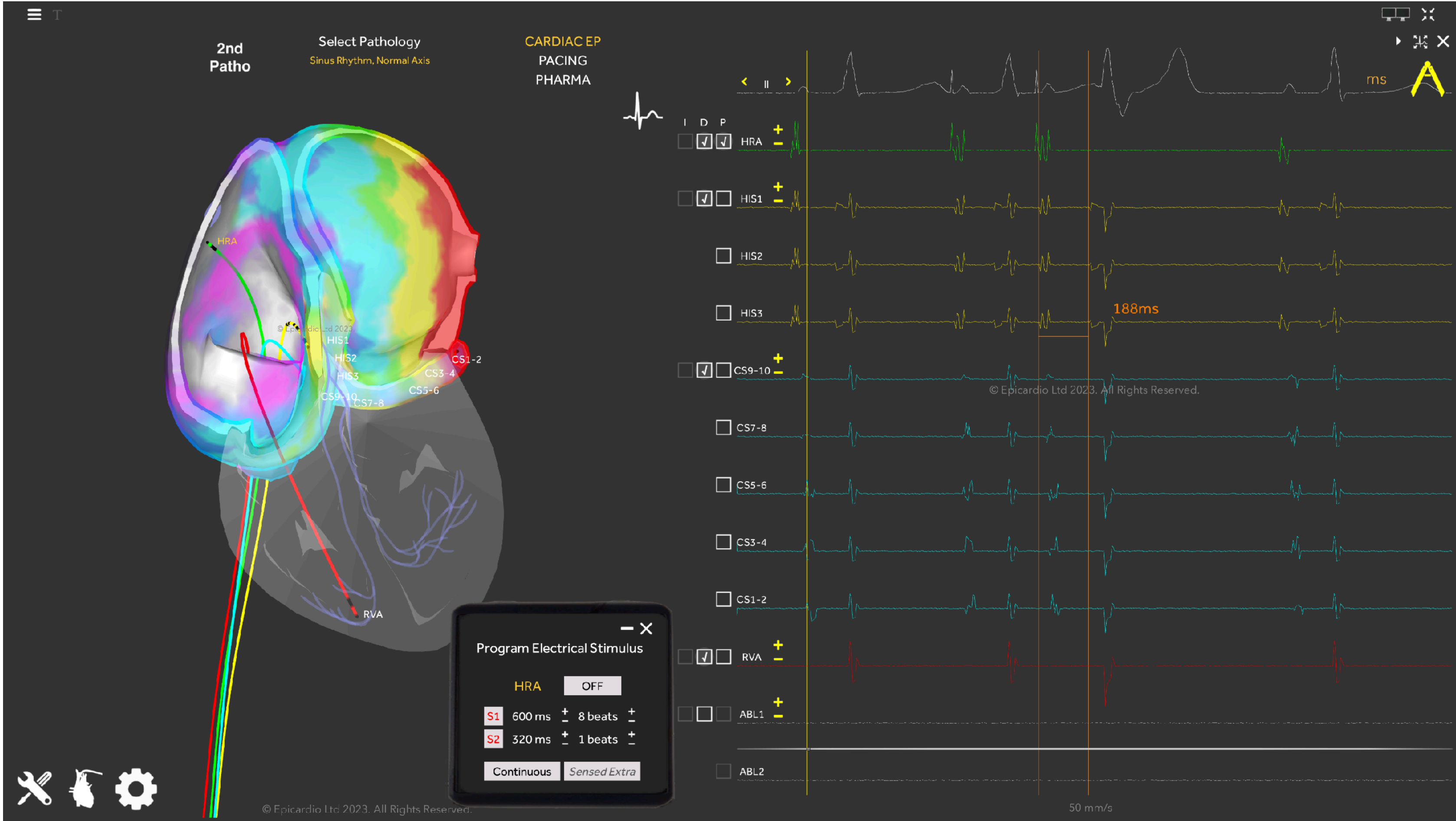
Action 2: Re-measure the A-H interval. Has it got longer?

The screenshot displays the Epicardio software interface. On the left, a 3D anatomical model of the heart shows catheters in the HRA, HIS1-3, CS1-2, CS3-4, CS5-6, CS7-8, CS9-10, and RVA. The '2nd Patho' window is active, showing 'Sinus Rhythm, Normal Axis'. The 'Program Electrical Stimulus' window is open, showing S1 at 600ms (8 beats) and S2 at 360ms (1 beat). The ECG display on the right shows multiple channels: I, D, P, HRA, HIS1, HIS2, HIS3, CS9-10, CS7-8, CS5-6, CS3-4, CS1-2, RVA, ABL1, and ABL2. A 176ms interval is marked on the HIS1 trace. The top right shows 'CARDIAC EP PACING PHARMA' and a small ECG trace with a yellow 'A' marker.

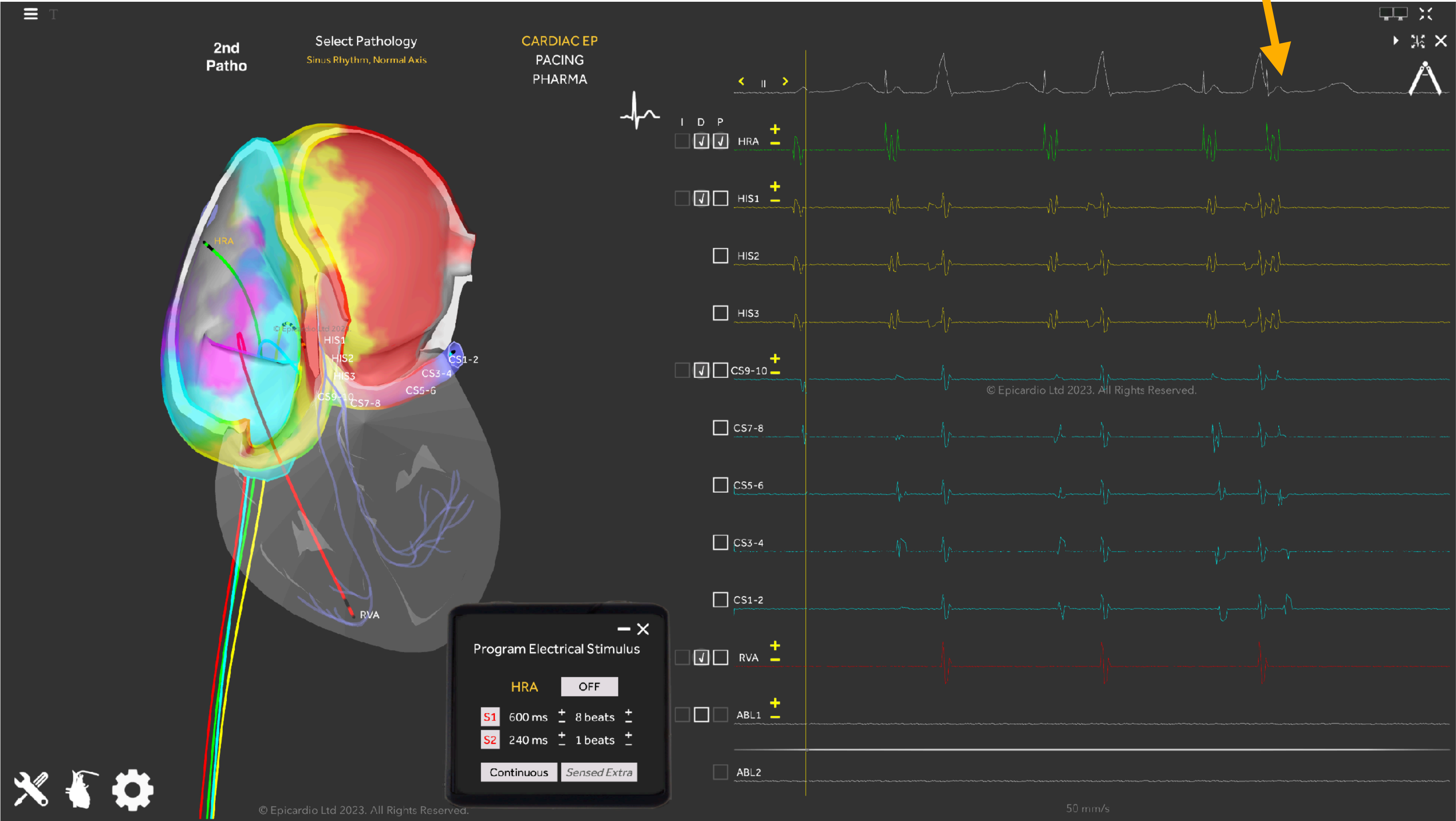
Action 1: Now, reduce the S2 time to 320ms. Turn the stimulator ON, and pause after the last paced beat.

Action 2: Re-measure the A-H interval. Note further lengthening.

Action 3: Repeat this process noting the lengthening of the A-H interval until you encounter AVN block, also called AVN refractory point.



Observation: Note AVN block. The block has occurred between the HIS catheter and the Bundle of His. The structure here is the compact AVN. The refractory point of the AVN is the shortest S2 interval after which block occurs. By reducing S2 sequentially by 10ms you can get a very accurate measurement.



Let's add in an accessory pathway.

Action: In ECG/EGM Tools menu, click on 'ACC PATH' (accessory pathway) to insert a pathway. Change the location of the pathway to 'Left Lateral'. Change 'Conduction Direction' to 'Concealed'.

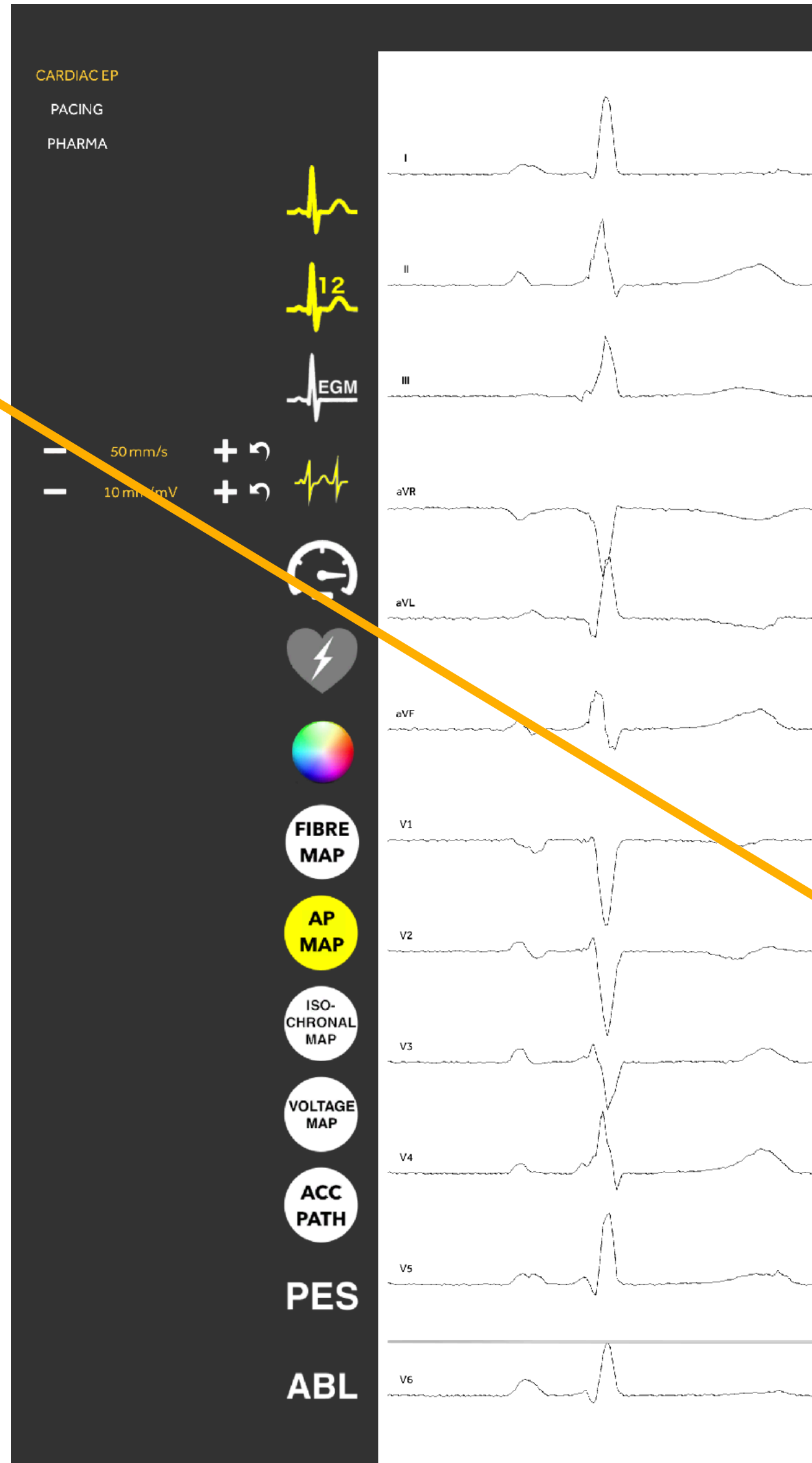
With concealed conduction, the accessory pathway only conducts in the retrograde direction.

Observation: Note no change on the 12 lead ECG morphology when the pathway is concealed.

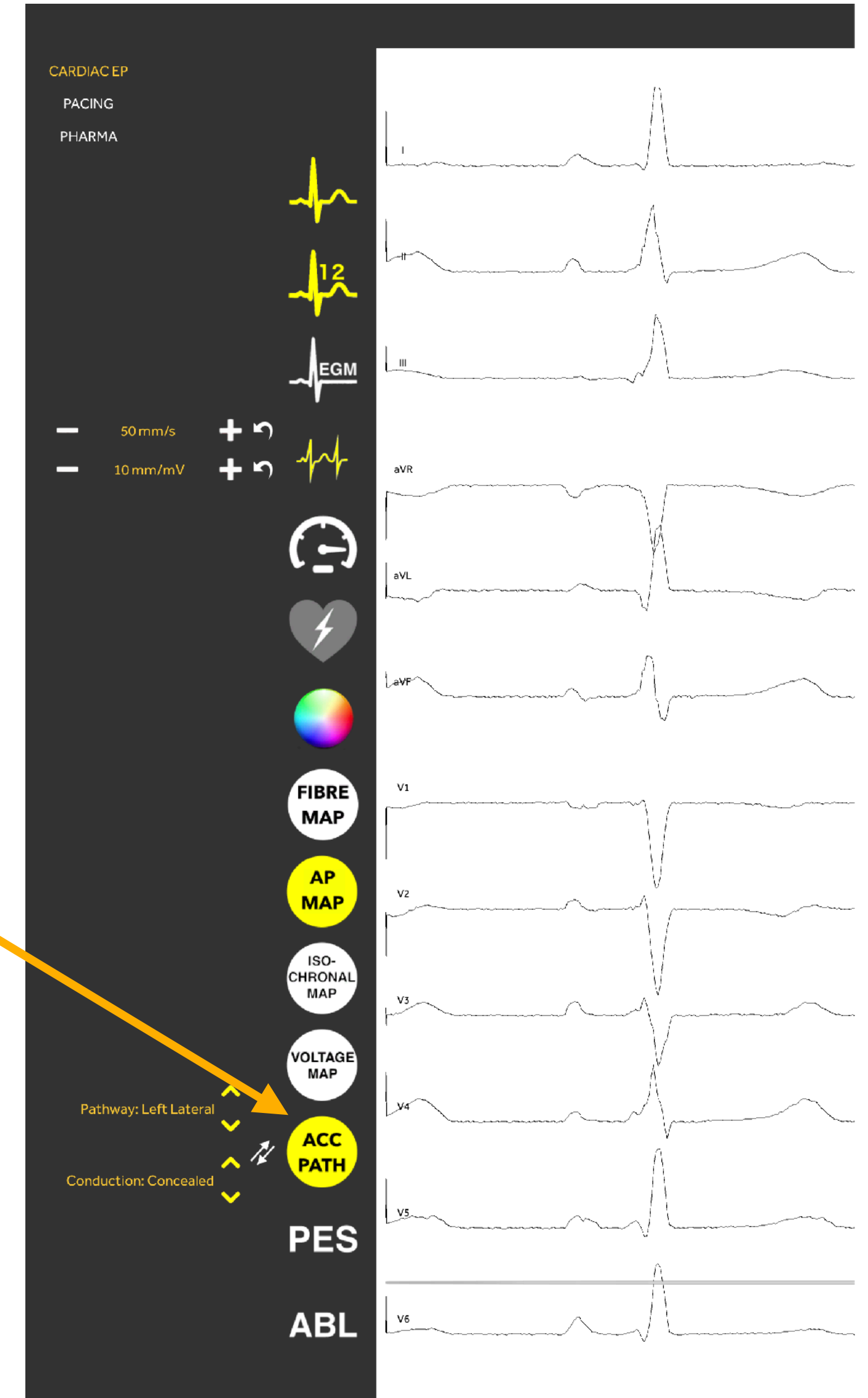
As is often the case with Left Lateral Accessory Pathways, conduction is concealed as the pathway is far from the AV Node. Conduction to the ventricles occurs via the AV Node before the action potential reaches the Left Lateral Pathway.

By the time the action potential arrives at the left lateral pathway, the ventricular tissue at the insertion of the accessory pathway has become refractory from anterograde conduction via the His-Purkinje network.

No Accessory Pathway



LL Accessory Pathway with Concealed Conduction



In the following pages we will perform manoeuvres to simulate an EP study performed in the EP lab.

Clinical relevance: This will enable us to diagnose the arrhythmia, localise the accessory pathway (in this instance) and direct ablation therapy treatment.

The first pacing manoeuvre is a 'retrograde conduction test'. It allows us to determine the presence or absence of a retrogradely conducting accessory pathway.

Action 1: Select 'P' on the RVA channel.

Action 2: Set the S1 rate in ms to a rate that is faster than the intrinsic rate. Turn on 'Continuous' pacing. Pause the recording once you have screen of paced beats.

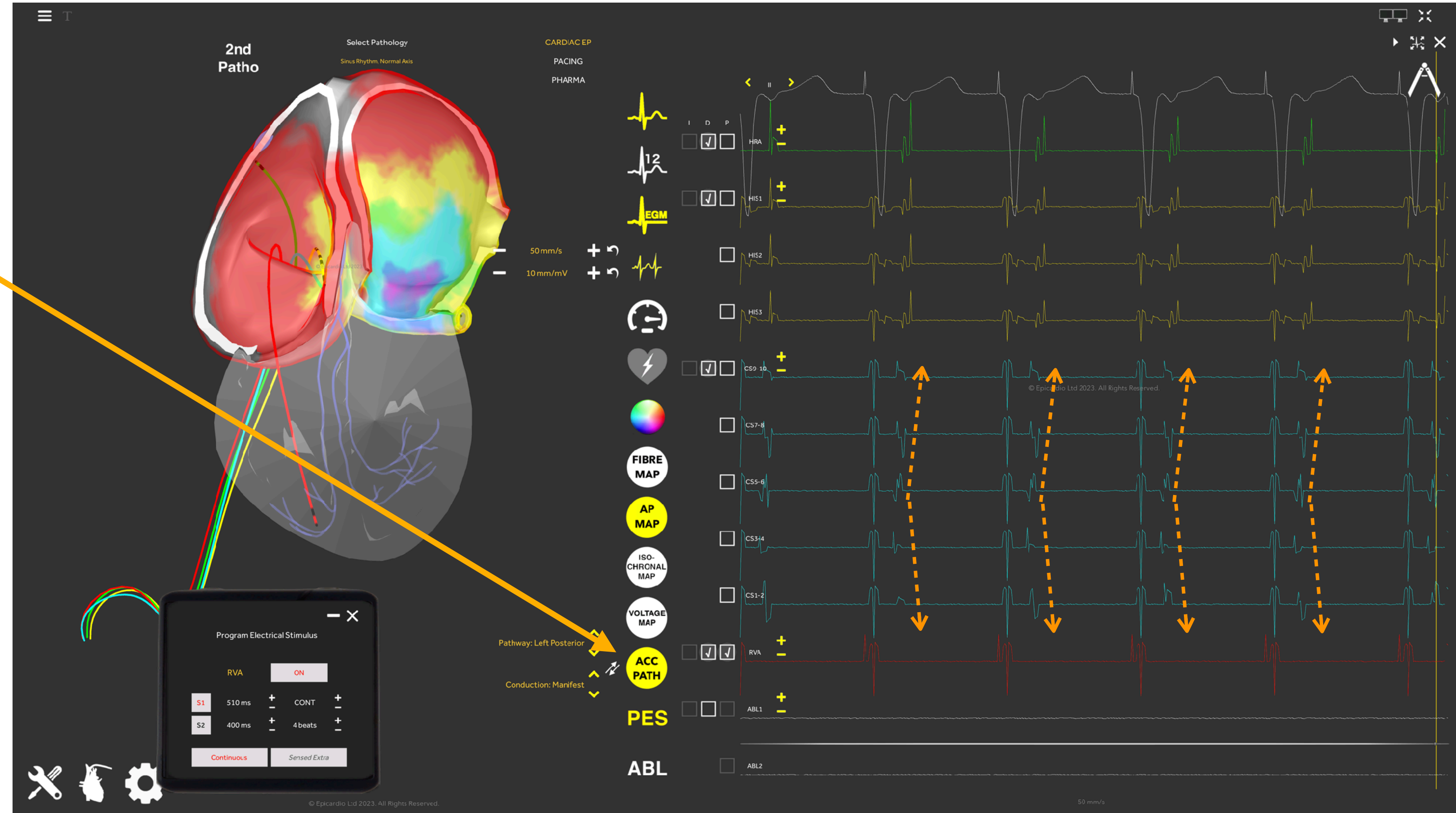


Another eccentric pattern to appreciate occurs in the presence of a Left Posterior accessory pathway.

Action: Change the location of the accessory pathway to Left Posterior and repeat continuous pacing from the RV Apex, at a rate faster than the intrinsic rate.

Observation: Note the earliest atrial signal is now CS5-6 - CS7-8, getting later proximally and distally (orange arrows).

Clinical relevance: This helps to “bracket” the accessory pathway so we know exactly where on the annulus to guide the ablation catheter to deliver ablation therapy.



Let's add in an arrhythmia.

Action 1: Use the "Select Pathology" menu to select "AV Reentrant Tachycardia". Note an arrhythmia has started.

Action 2: In ECG/EGM Tools menu, change the ACC PATH (accessory pathway) location to Right Lateral.

Observation: Note the concentric activation sequence on the CS catheter with CS9-10 leading (see dashed orange arrows), with electrograms getting later sequentially as we move towards CS1-2.

The screenshot displays the Epicardio software interface. On the left, a 3D heart model shows the AVN and accessory pathways. A yellow arrow points to the "Select Pathology" menu, which is set to "AV Reentrant Tachycardia". Another yellow arrow points to the "2nd Patho" label. A third yellow arrow points to the "ACC PATH" menu, which is set to "Right Lateral". Below the heart model is a "Program Electrical Stimulus" window with the following settings:

Channel	Duration	Rate
S1	600 ms	8 beats
S2	400 ms	4 beats

The right side of the interface shows ECG/EGM traces for various catheters: I, D, P, HRA, HIS1, HIS2, HIS3, CS9-10, CS7-8, CS5-6, CS3-4, CS1-2, RVA, ABL1, and ABL2. The CS9-10 trace shows a concentric activation sequence, with dashed orange arrows indicating the timing of the electrograms. The ACC PATH is highlighted in yellow. The bottom right corner shows a scale of 50 mm/s.

The first manoeuvre to perform is entrainment from the RV Apex.

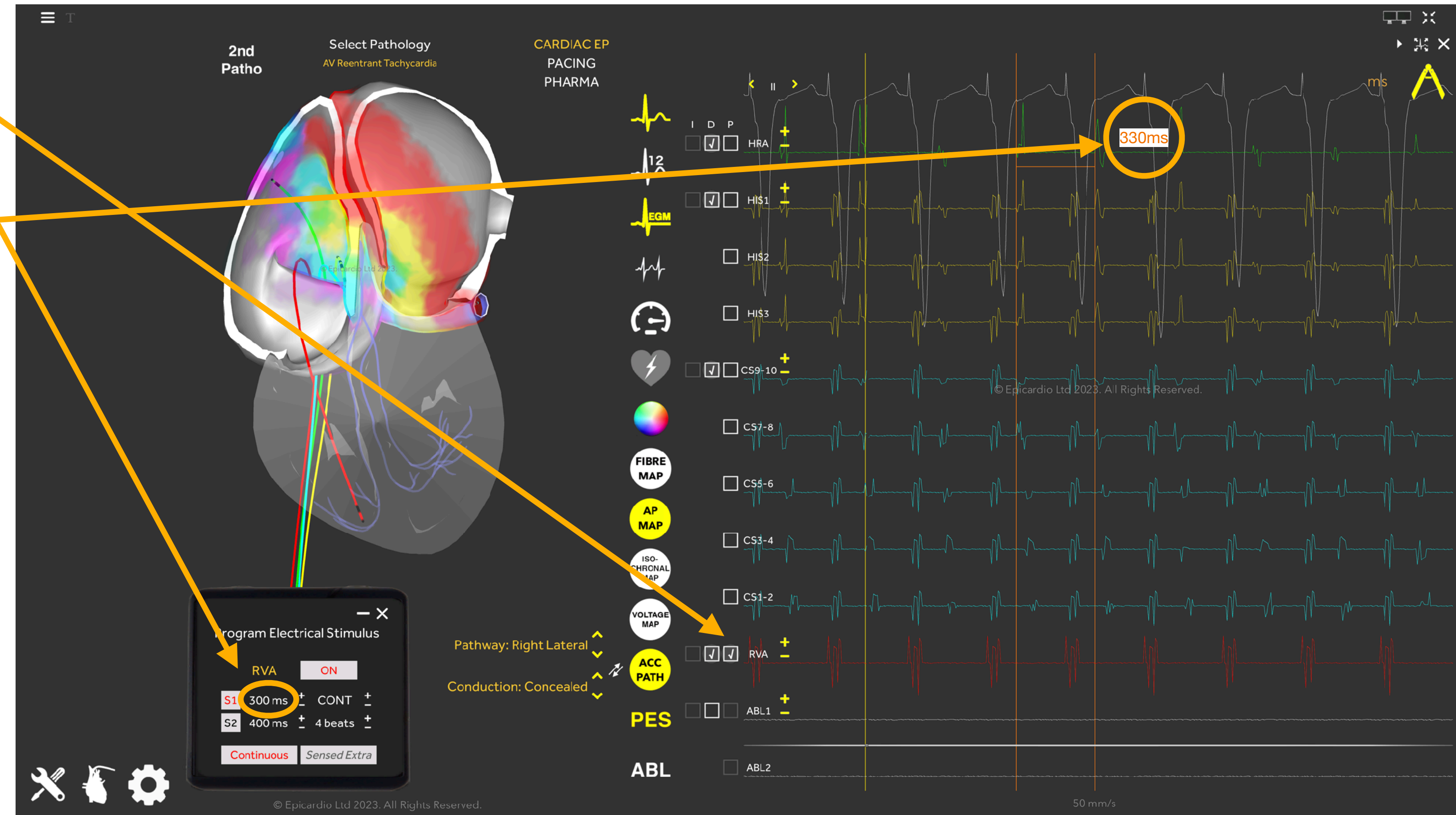
Action 1: Select 'P' on the RVA channel.

Action 2: The Tachycardia Cycle Length (TCL) is 330ms. Thus, set the RVA S1 pacing rate to 300ms and click on 'Continuous'. This will initiate pacing. Ensure both 'Continuous' and 'ON' are both red.

Action 3: Pause the simulation once you see a continuously paced ECG morphology and a 1:1 relationship between the RVA and the Atrium.

Action 4: Is the Atrium entrained by RV Apex pacing? Measure the A-A interval on the HRA channel. Is it the same as the pacing rate? If so, the Atrium is entrained by RV Apex pacing.

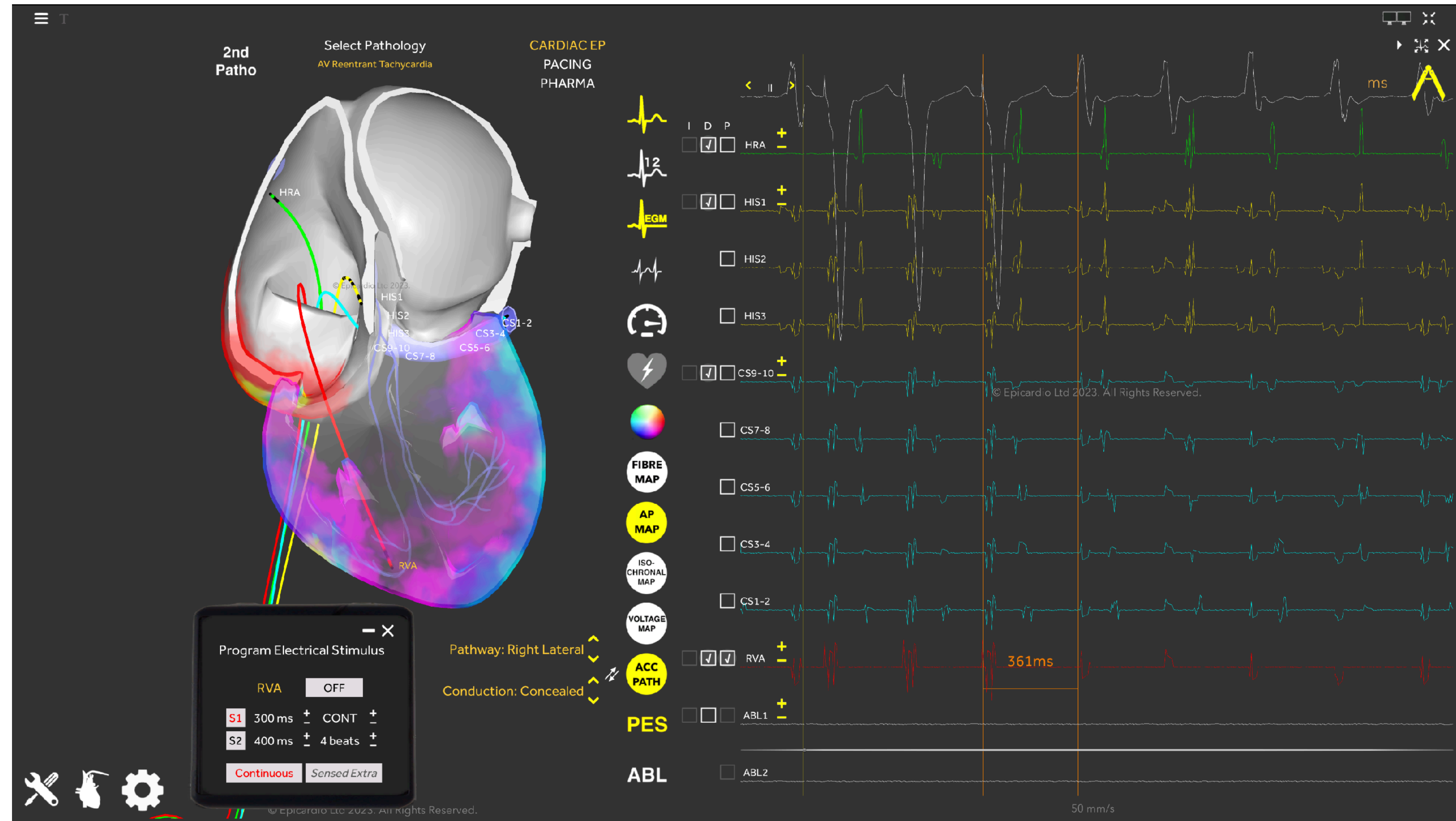
Clinical relevance: Entrainment is a fundamental concept in cardiac electrophysiology, allowing us to test differential diagnosis hypotheses.



Action: Resume the simulation, turn off pacing and pause the simulation again once you can see a page with a few paced beats followed by a few non-paced beats.

Observation: Look closely at the EGMs immediately following the final paced beat. The response to RVA entrainment here follows an A-H-V pattern.

Clinical relevance: This observation allows us to quickly rule out Atrial Tachycardia from this EP study. Remember, in the EP lab we can't control which Arrhythmia we are investigating!



Action: Now measure the interval between the last paced beat and the first return signal on the RVA bipole. This interval is called the Post-Pacing Interval (PPI).

Subtract the TCL from this interval. Is the result less than **40ms**?

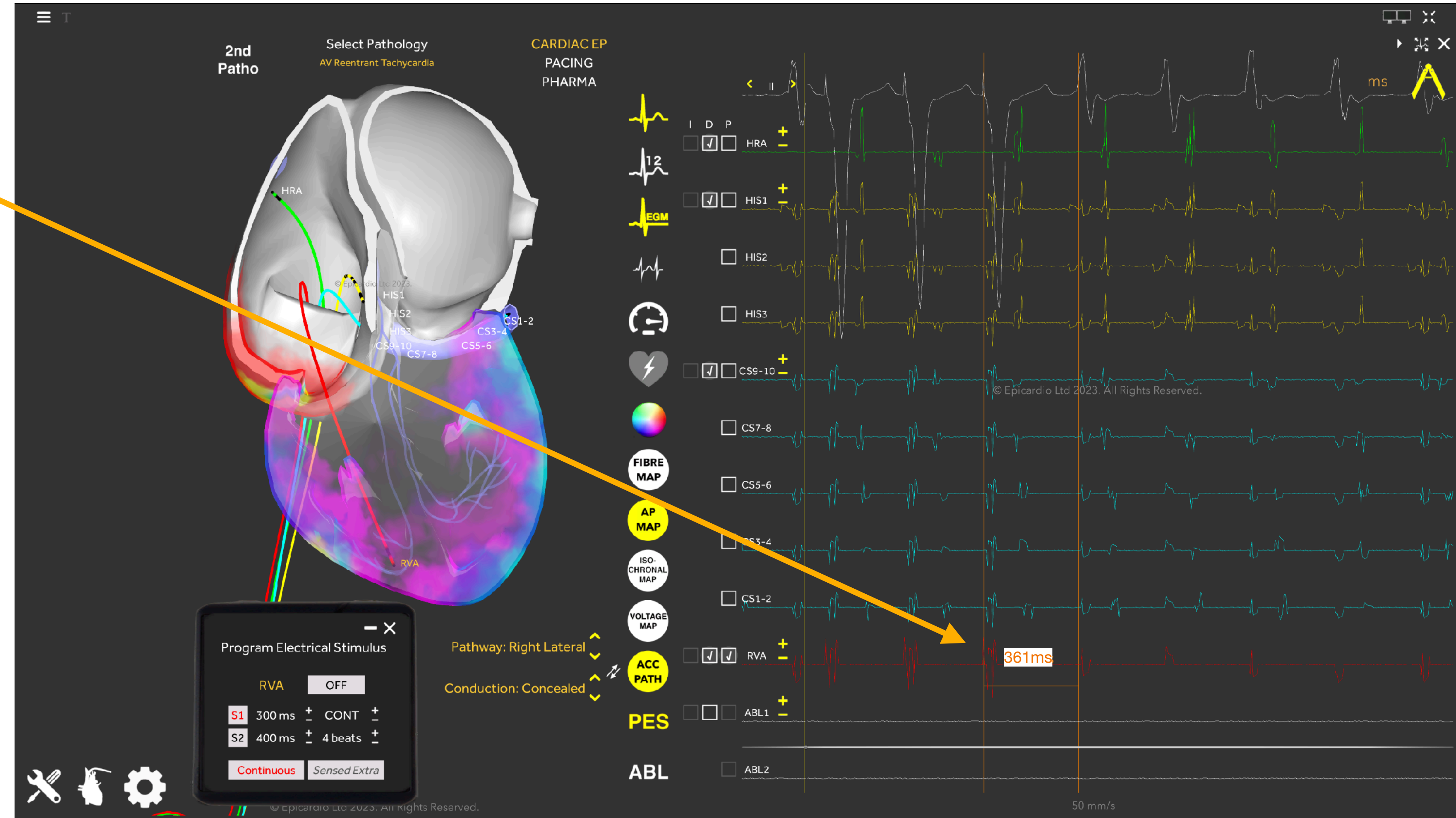
Clinical relevance: If the PPI-TCL is <40ms, the site of pacing is within the tachycardia circuit.

Entrainment of Right Lateral AVRT from the RV Apex:

TCL = 330ms

PPI = 361ms

PPI - TCL = **31ms**



Let's repeat with a Left Lateral pathway location.

Action: Select 'Left Lateral' from the 'ACC PATH' icon.

Observation: Note the switch in activation sequence on the CS catheter. Now CS1-2 is leading (note orange caliper on 4th CS1-2 electrogram), with bipoles getting later sequentially as we move towards CS9-10.

The AP colour also shows conduction moving eccentrically from left to right across the atria (blue arrow).

The screenshot displays the Epicardio software interface. On the left, a 3D heart model shows the atria with a color-coded activation sequence. A blue arrow points to the 'ACC PATH' icon in the software interface. The '2nd Patho' is 'AV Reentrant Tachycardia'. The 'ACC PATH' is set to 'Left Lateral' and 'Conduction: Concealed'. The 'Program Electrical Stimulus' window shows settings for S1 (330 ms, CONT) and S2 (400 ms, 4 beats). The electrogram shows a sequence of activation from CS1-2 to CS9-10, with orange arrows indicating the activation sequence. A blue arrow points to the 'ACC PATH' icon in the software interface.

Observation: TCL has now slowed to 365ms.

Action 1: Thus, to entrain, set the RVA S1 pacing rate to 335ms.

Action 2: Turn on pacing and again pause and measure to check that the Atria have been entrained by RV Apex pacing.

The screenshot displays the Epicardio software interface. On the left, a 3D heart model shows the '2nd Patho' (AV Reentrant Tachycardia) with a color-coded map. The 'Program Electrical Stimulus' window is open, showing the following settings:

Channel	Rate	Mode	Beats
RVA	335 ms	CONT	4 beats
S1	330 ms	CONT	
S2	400 ms	CONT	

The ECG display on the right shows multiple leads. A yellow arrow points to a 365ms interval on the RVA trace, indicating the tachycardia cycle length. The 'Program Electrical Stimulus' window is highlighted with orange arrows from the text on the left. The ECG traces are color-coded: I, D, P (green), HRA (red), HIS1 (yellow), HIS2 (orange), HIS3 (light green), CS9-10 (cyan), CS7-8 (blue), CS5-6 (purple), CS3-4 (magenta), CS1-2 (dark blue), RVA (red), ABL1 (grey), and ABL2 (grey). The scale bar at the bottom right indicates 50 mm/s.

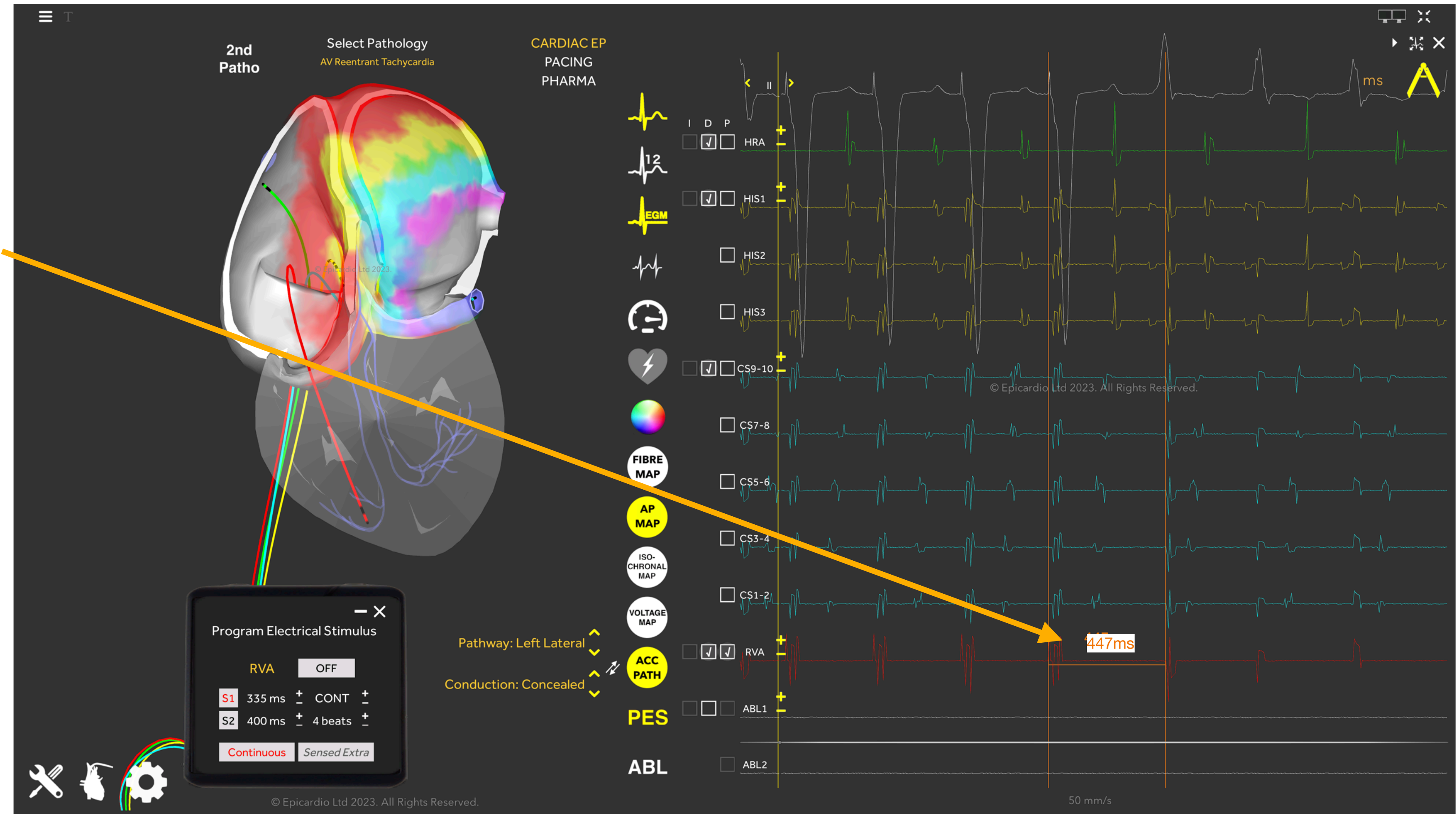
Action 1: Now turn off pacing, pause and measure the PPI.

Action 2: The PPI is now 447 ms. Subtract the TCL from this PPI interval. Is the result less than 40 ms?

Clinical relevance: If the PPI-TCL is >40ms, the site of pacing is far from the tachycardia circuit.

Entrainment of Left Lateral AVRT from the RV Apex:

TCL = 365ms
PPI = 447ms
PPI - TCL = **82ms**



Action 1: Now change the pacing site to CS1-2 and repeat the entrainment manoeuvre.

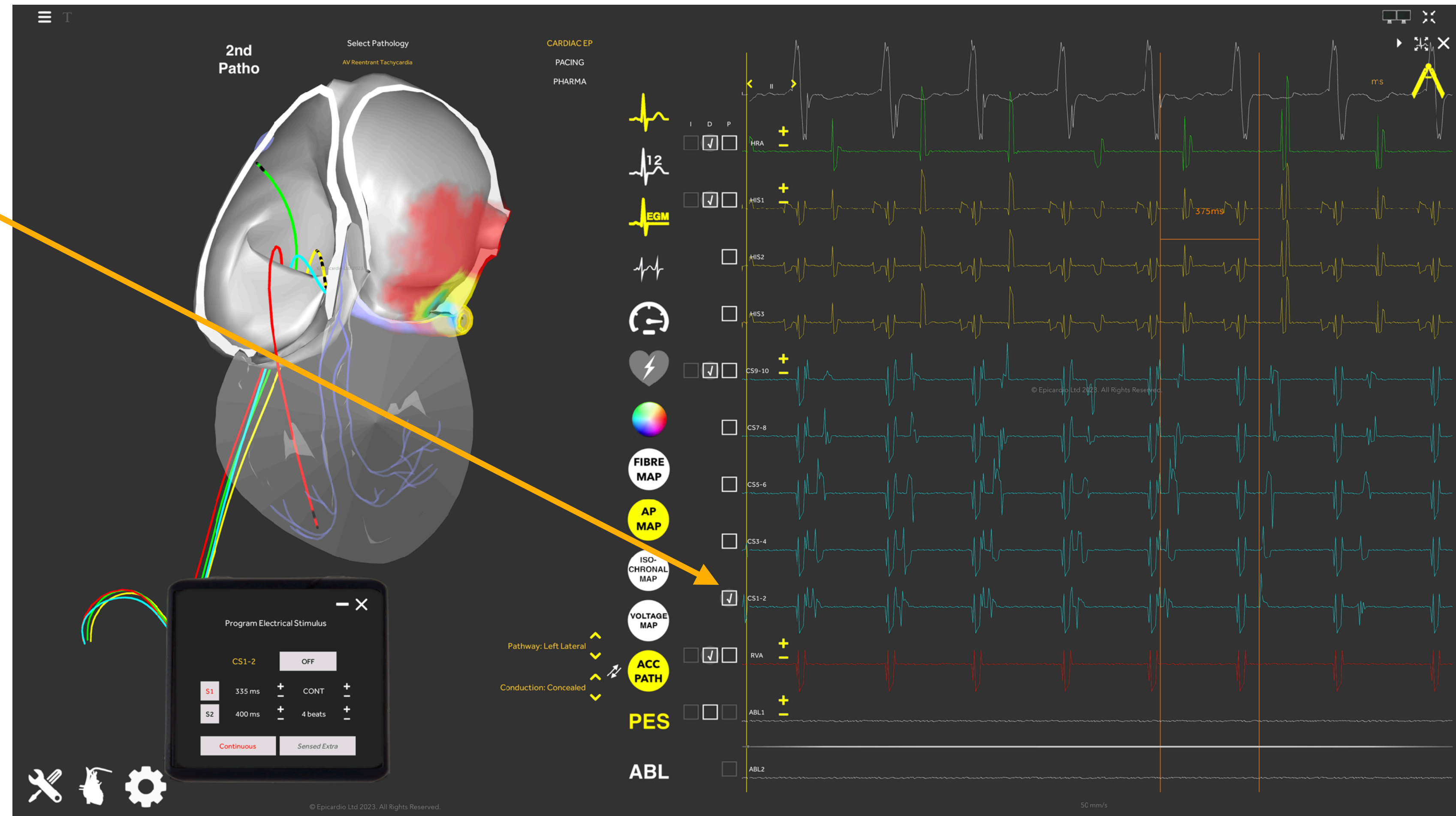
Entrainment of Left Lateral AVRT from CS1-2:

TCL = 365ms

PPI = 375ms

PPI - TCL = **10ms**

Clinical Relevance: The shorter the PPI-TCL, the more confident one can be that the pacing site is in the tachycardia circuit.

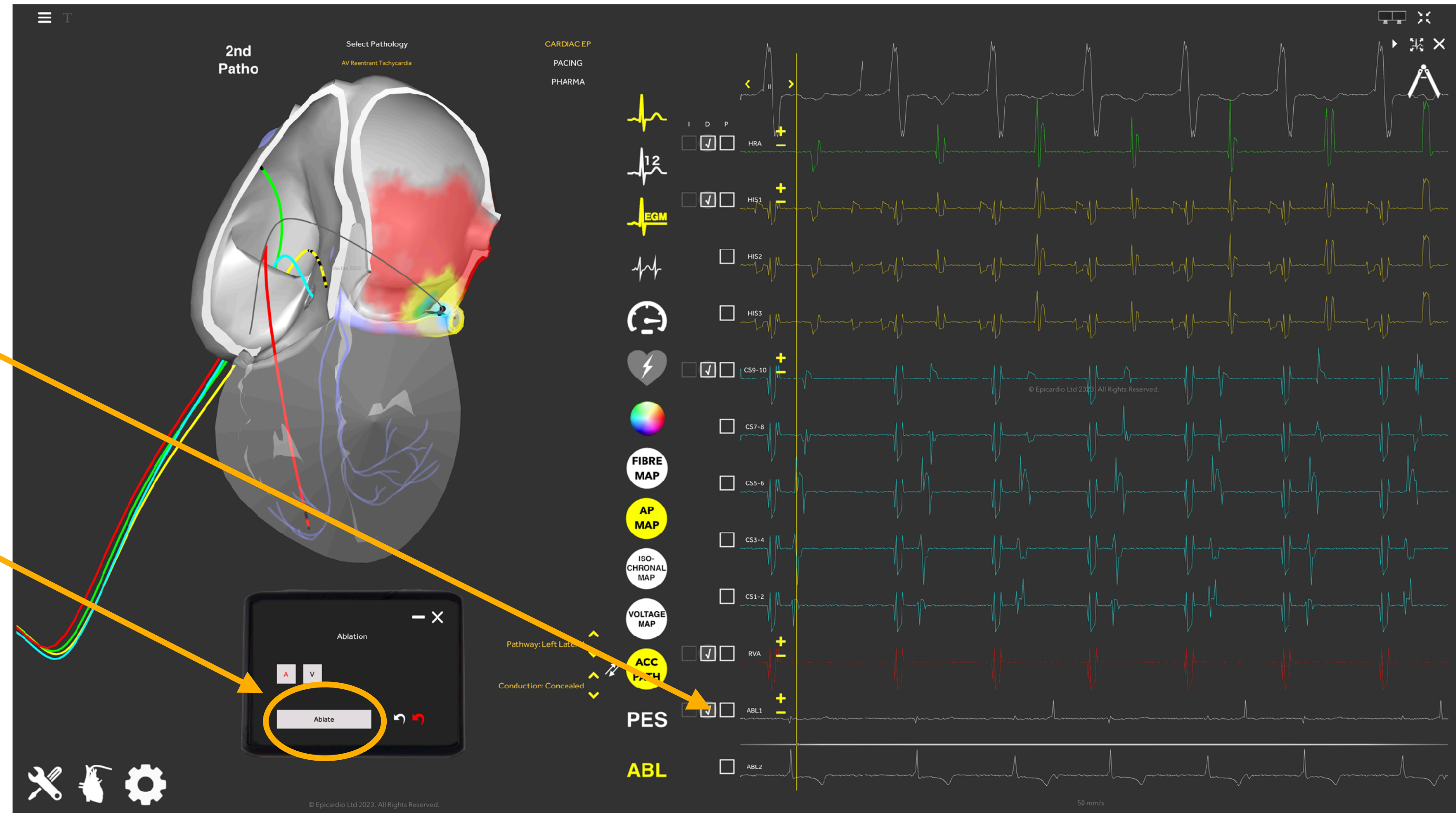


Now we have located the accessory pathway to the lateral wall of the left atrium, we can progress with ablation of the region around the accessory pathway.

Action 1: Check 'D' on the ablation (ABL) channel to insert the ablation catheter to its default initial position. Drag the catheter to the earliest site of activation at CS1-2. You may pick-drag-drop the catheter tip (black point).

Action 2: Click on Ablate on the Ablation toolbar to begin RF delivery. Drag and drop the ablation catheter during ablation to deliver a new lesion (red spheres).

Tip: Navigation of the ablation catheter is easiest if you grab the very tip of the catheter.



The tachycardia will terminate once sufficient lesions have been delivered to destroy the accessory pathway tissue (see red spheres).

Observation: Note Sinus Rhythm resuming once tachycardia has been terminated.

