



Echo Overlay On Fluoroscopy

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Colorado

Echo Overlay On Fluoroscopy

- No Disclosures

Echo Overlay on Fluoroscopy

- Exponential growth in novel percutaneous interventions in congenital / structural heart disease
- Echo guidance
 - TTE, TEE, ICE, Real Time 3D TEE
- Fusion Imaging – developed in 2012

Echo Overlay on Fluoroscopy

- Learning Objectives:
 - Use of fusion imaging in pediatrics
 - Advantages
 - Disadvantages
 - Radiation
 - 5 cases



Echocardiography

- Small field of view
- Excellent visualization of soft tissue
- Provides physiologic information (color Doppler)
- Limited views of catheters and devices
- Advent of 3D echo



Balzer , *Euro J Echocardiogr.* 2009;10:341-9
Perk, *J Am Soc Echocardiogr.* 2009;22:865-82
Quiafe, *Curr Cardiol Reports.* 2014; 16: 452
Thaden, *J Am Soc Echocardiogr.* 2016;29:503-12

Fluoroscopy

- **Wide field of view**
- **Excellent visualization of bony structures, catheters, and devices**
- **Limited cardiac structural anatomy and adjacent tissues**



Echo & Fluoroscopy

- **Echo and Fluoroscopy displayed in different orientation**
 - **Hinders rapid image interpretation**
 - **Misunderstand anatomy**
 - **Contribute to procedural complexity**



Echocardiographic Guidance

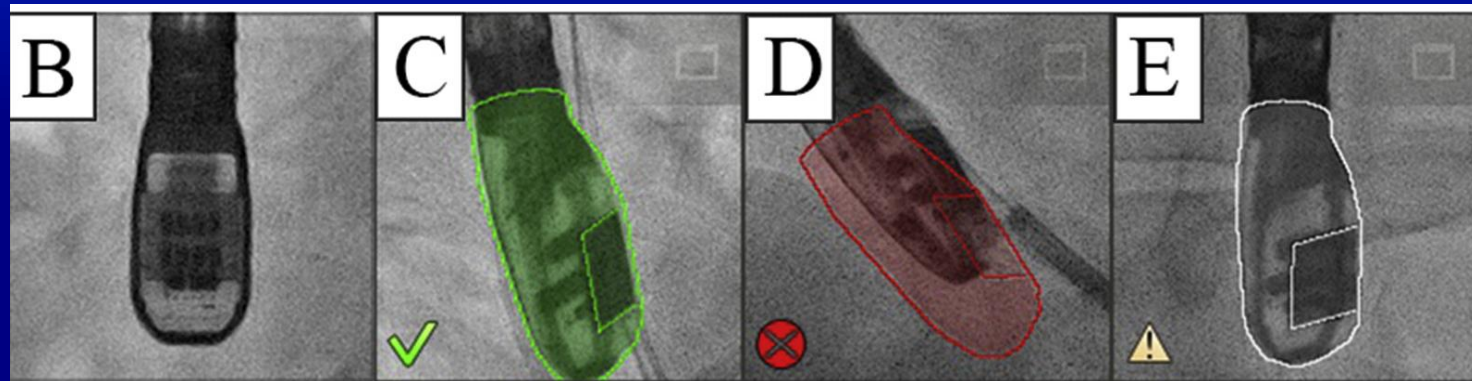
- Focused images
 - Visualize equipment and lesions
 - Assess immediate results and potential complications
- Modality selection (2D or 3D)
 - Optimize hand-eye coordination of interventionalist
 - Align a device and target anatomy
- Real-time with instantaneous use and interpretation in dynamic environment

Fusion Imaging = EchoNavigator

- Integrate ultrasound better into interventional procedures
- Useful clinically for fluoroscopy and 3D TEE images to be *displayed in a similar visual perspective*
- Placement of *labels and markers on both the ultrasound and x-ray images* facilitate catheter navigation, device placement, and evaluation of the result

Fusion Imaging = EchoNavigator

- **Registration**



- **Targets**

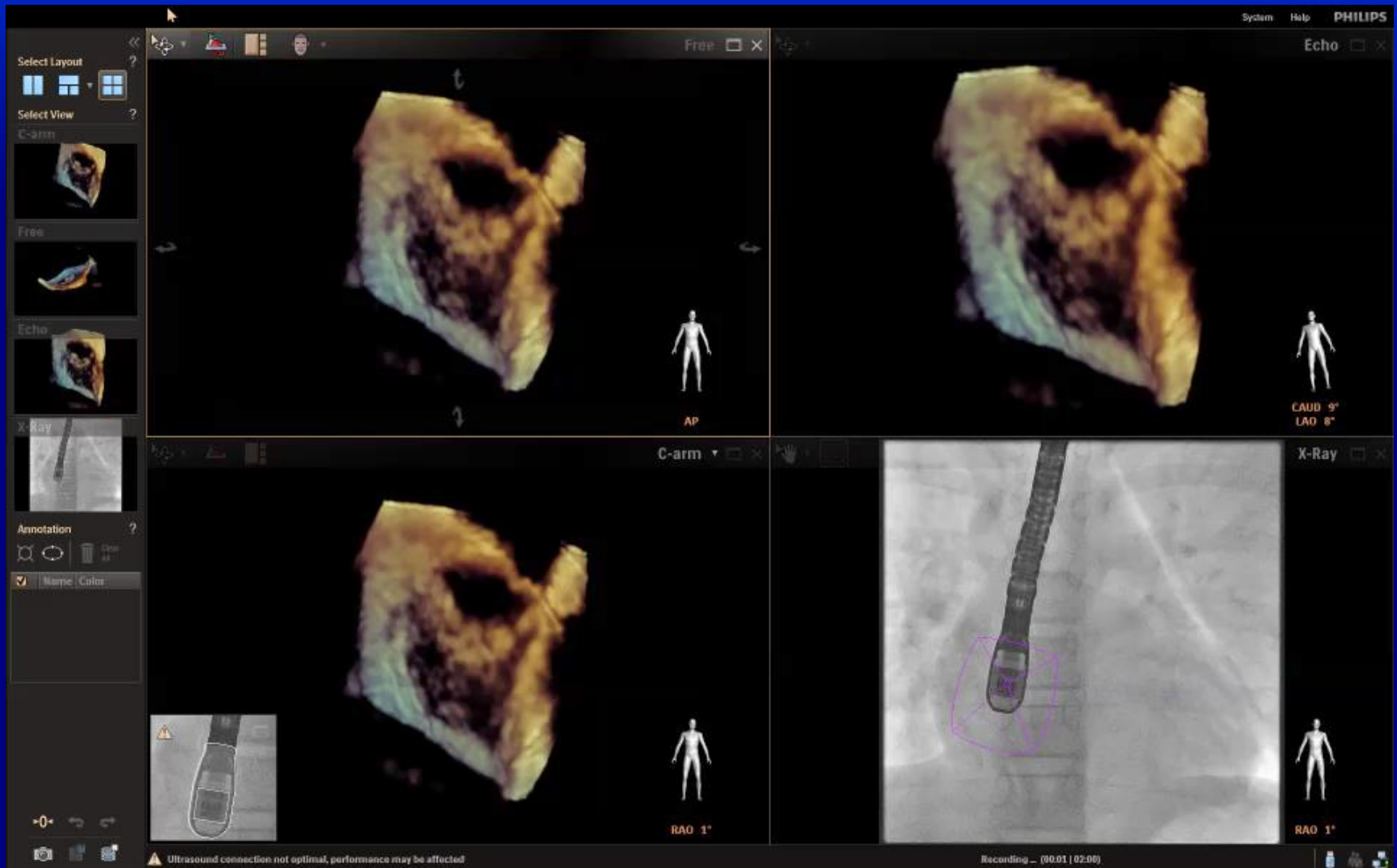
- Placed on important structures on echo and automatically displayed on fluoroscopy

- **Overlay**

- Soft tissues overlay on fluoroscopy

EchoNavigator – ASD Device Closure

Integration of 3D TEE with Fluoroscopy



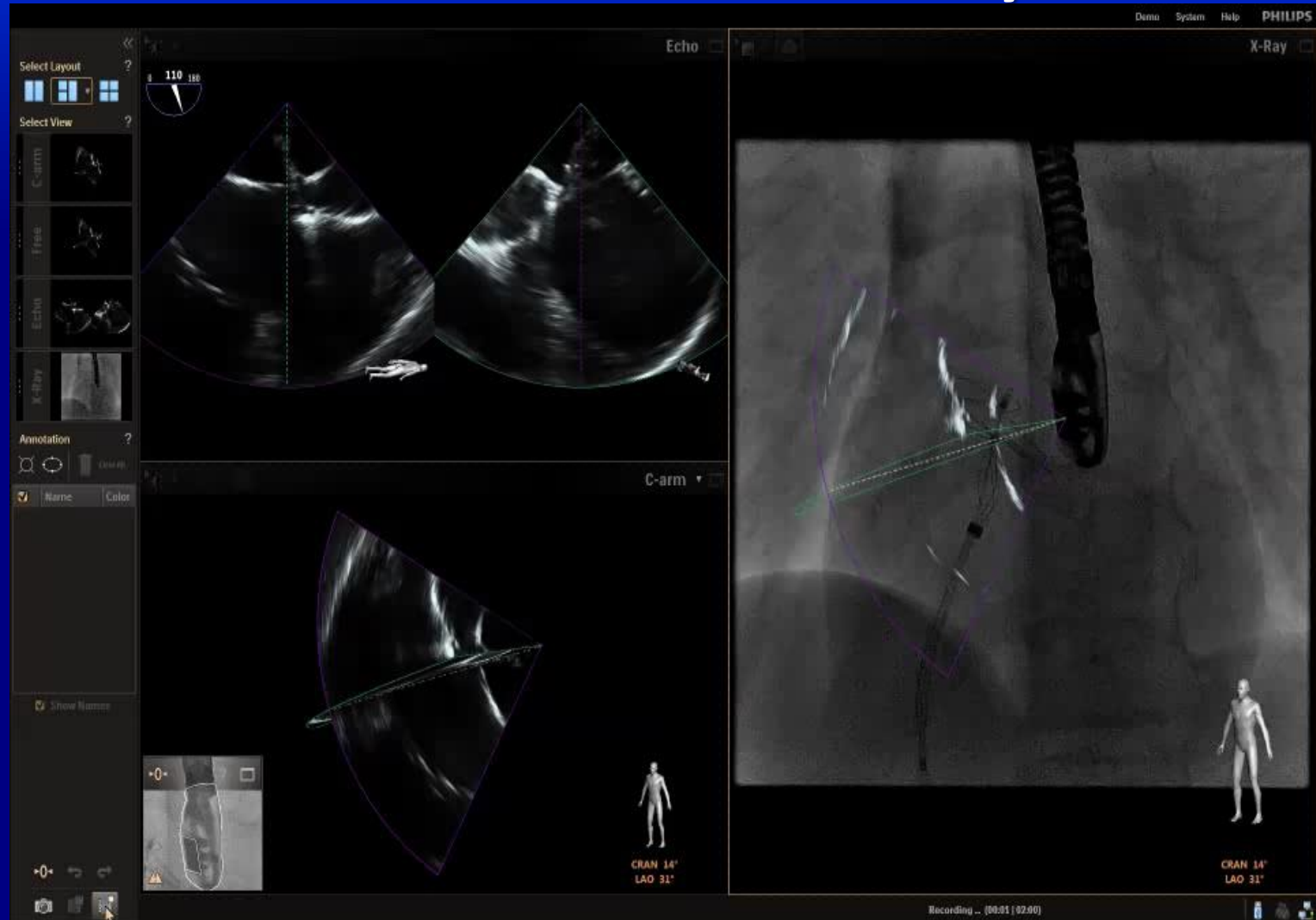
EchoNavigator

Integration of 3D TEE with Fluoroscopy - Target

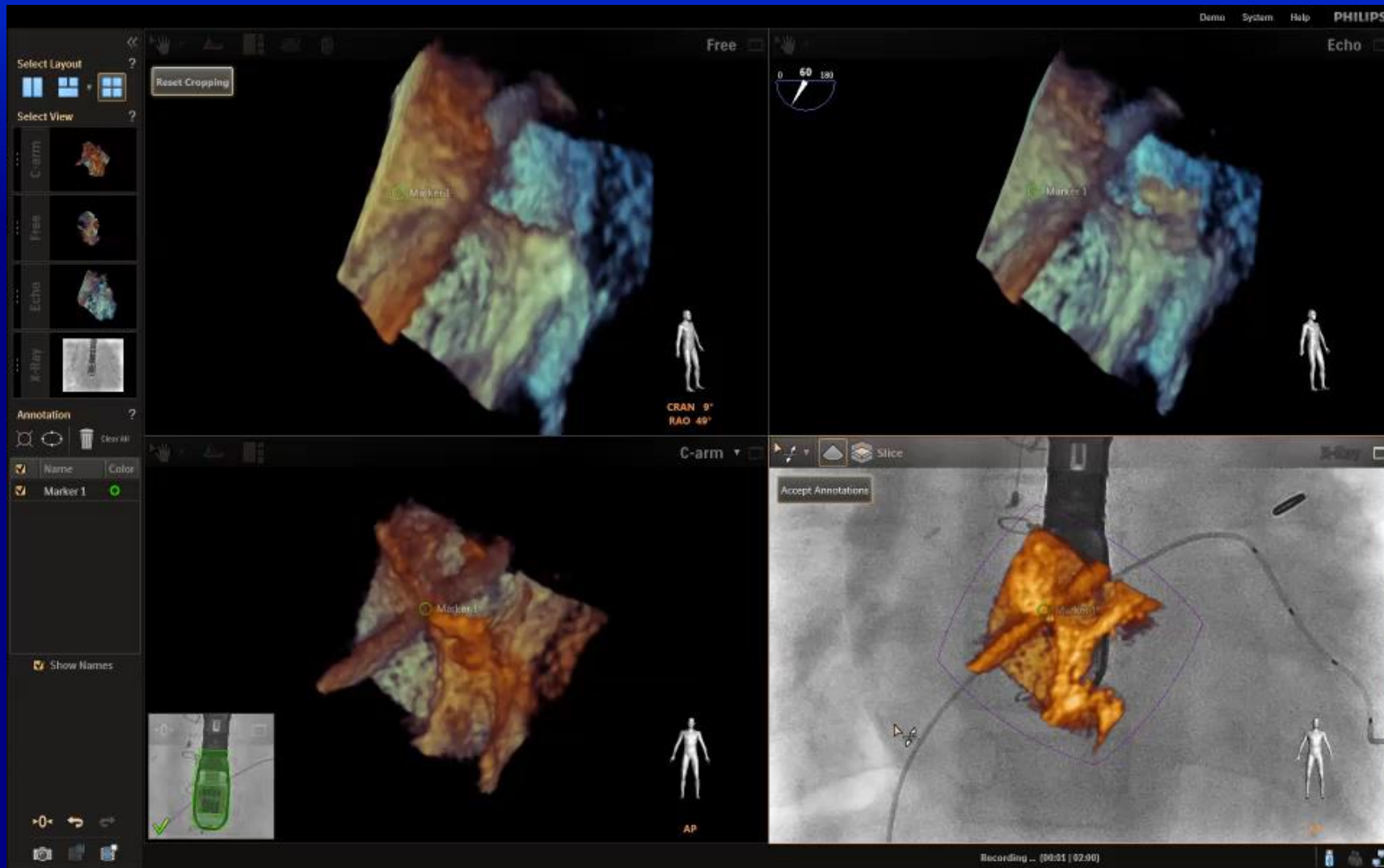


EchoNavigator

Live X-Plane TEE Overlay



EchoNavigator – 3D Overlay



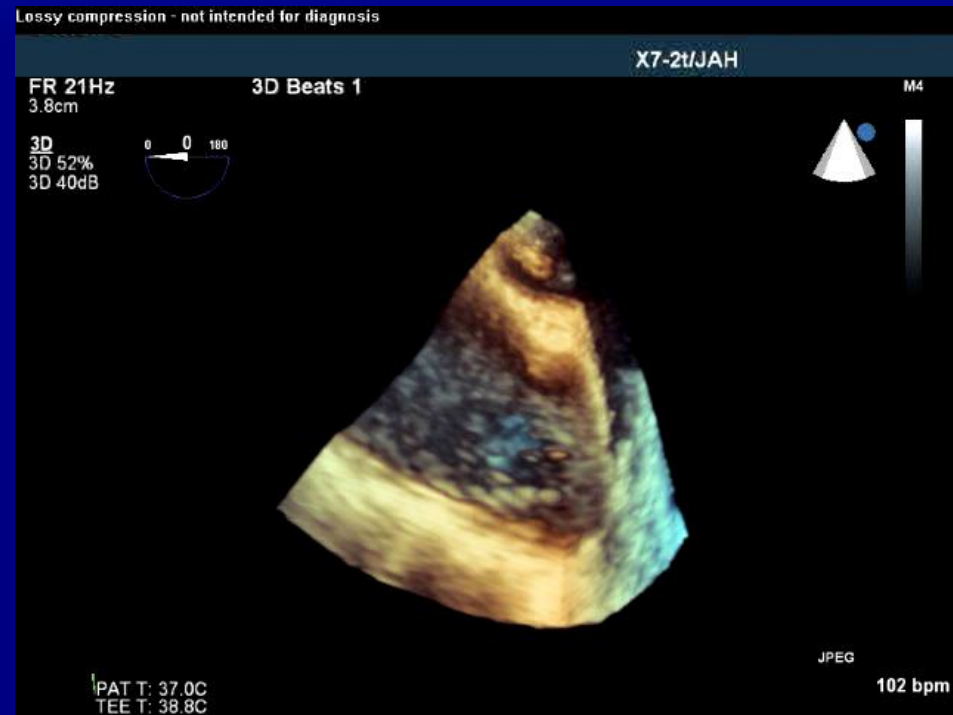
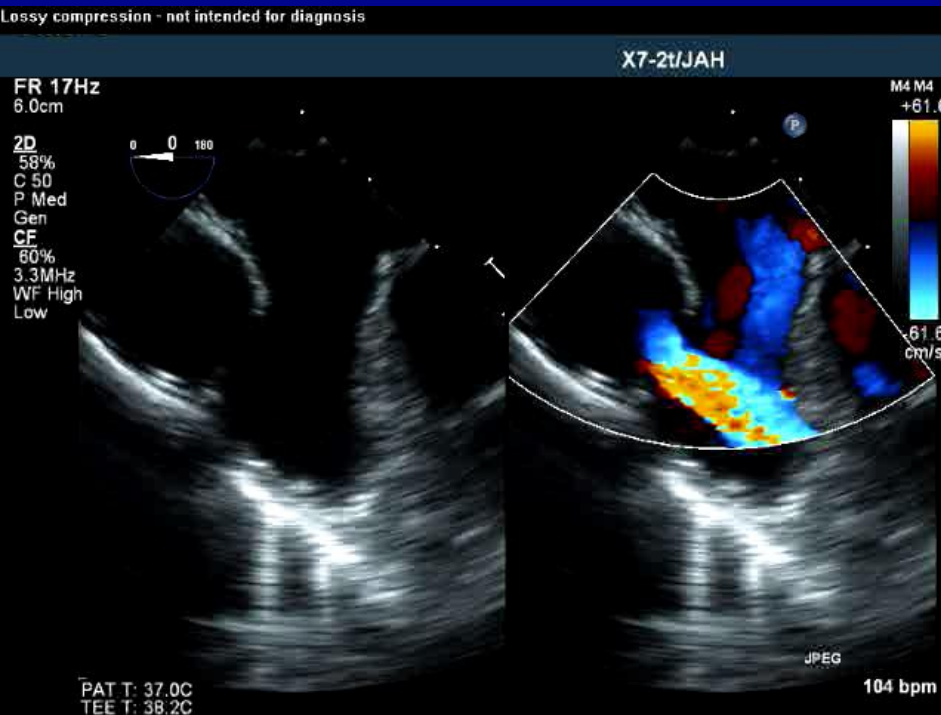
EchoNavigator - 3D Overlay



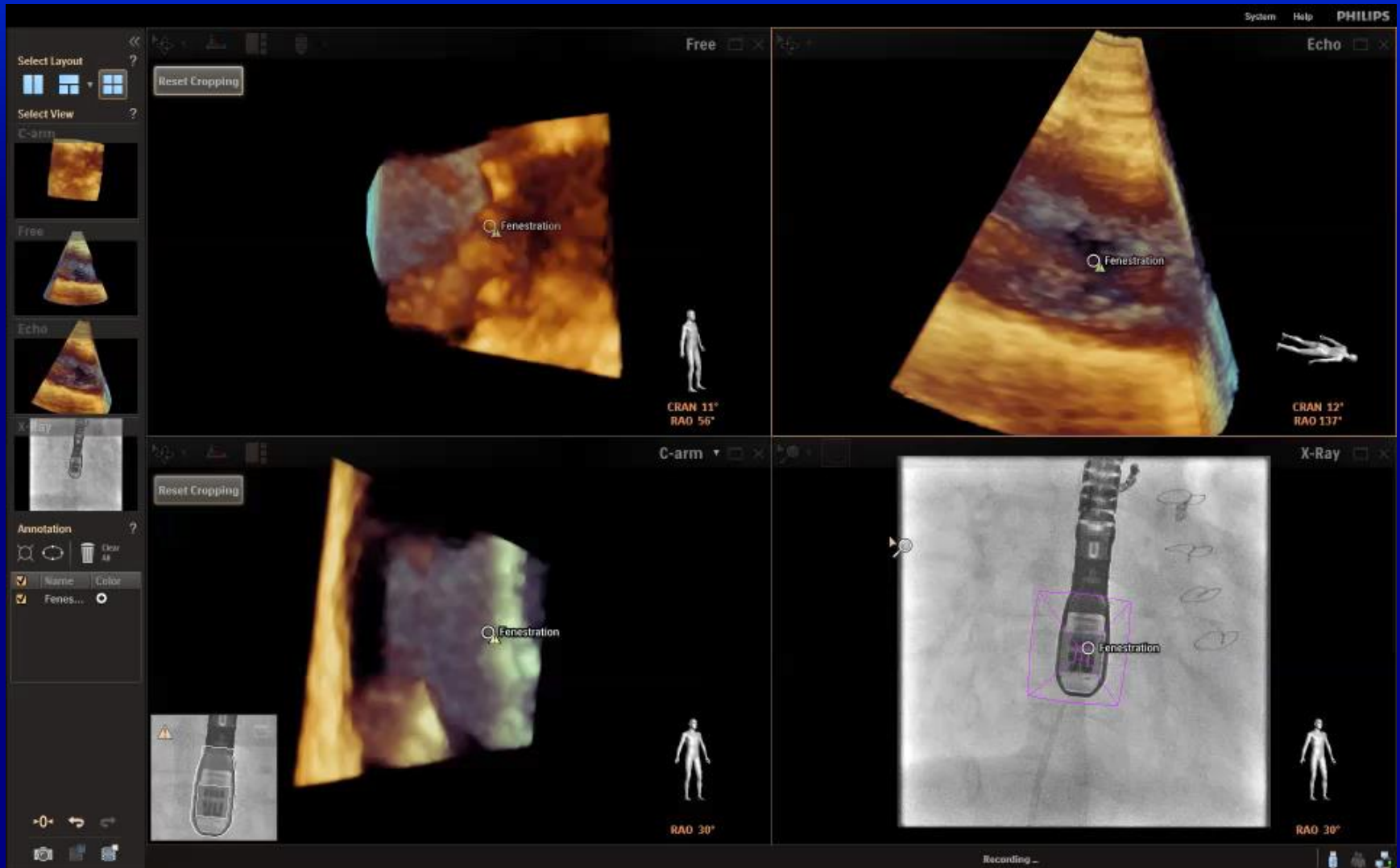
Fontan Fenestration Closure

2D TEE of Fontan Fenestration

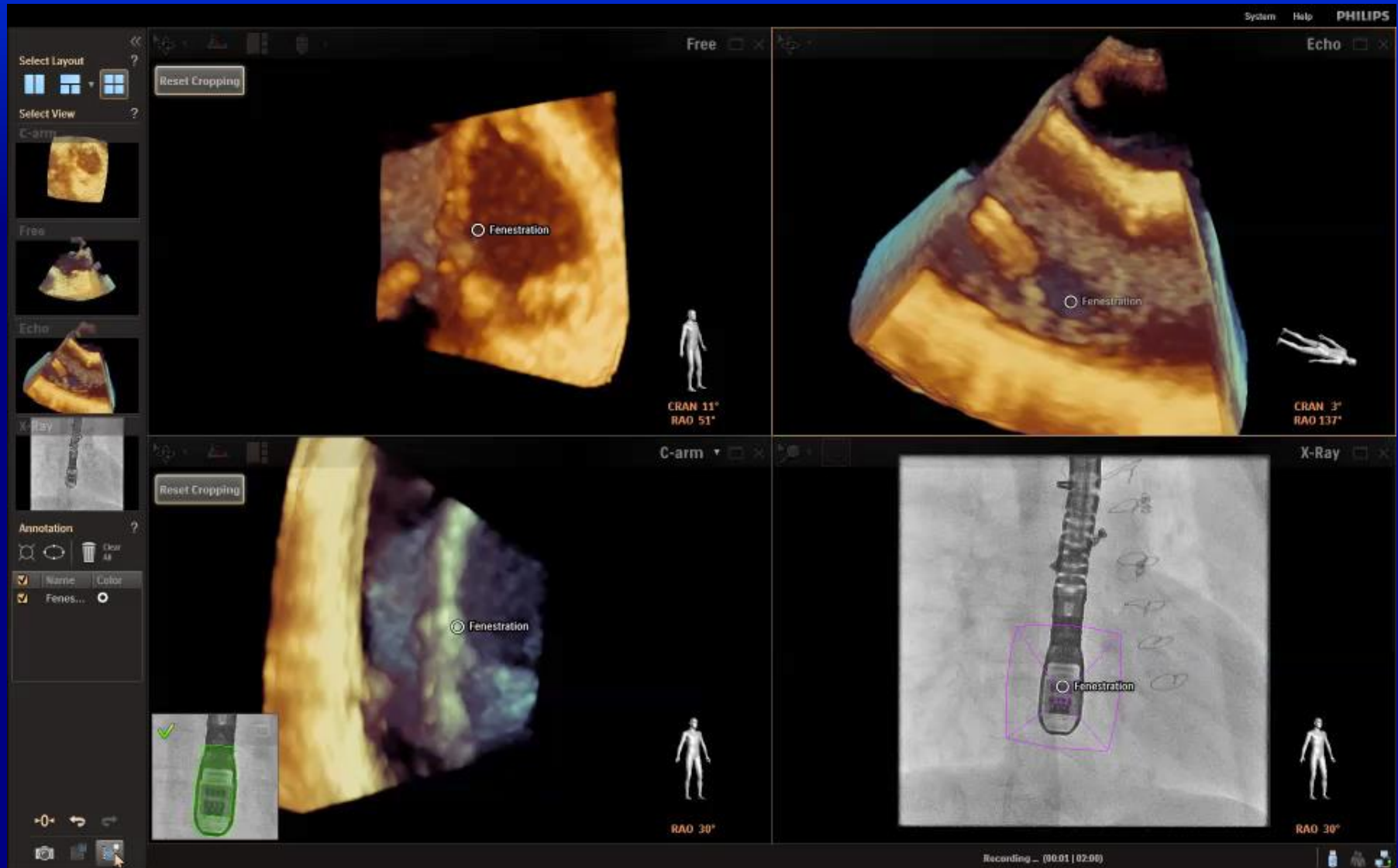
3D TEE of Fontan Fenestration



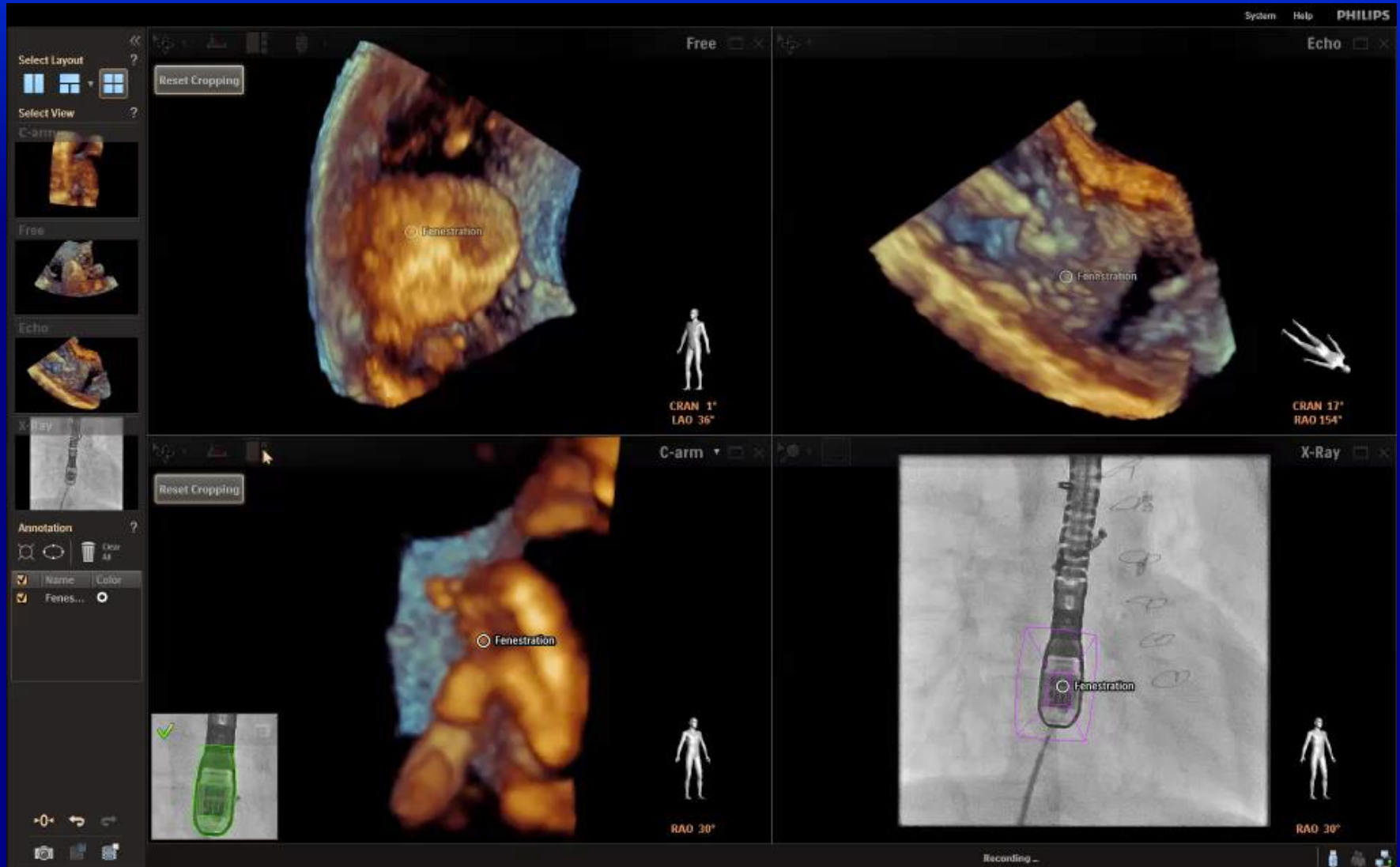
EchoNavigator – Target Placement



EchoNavigator - Crossing



EchoNavigator – Fenestration Closure



EchoNavigator – Fenestration Closure

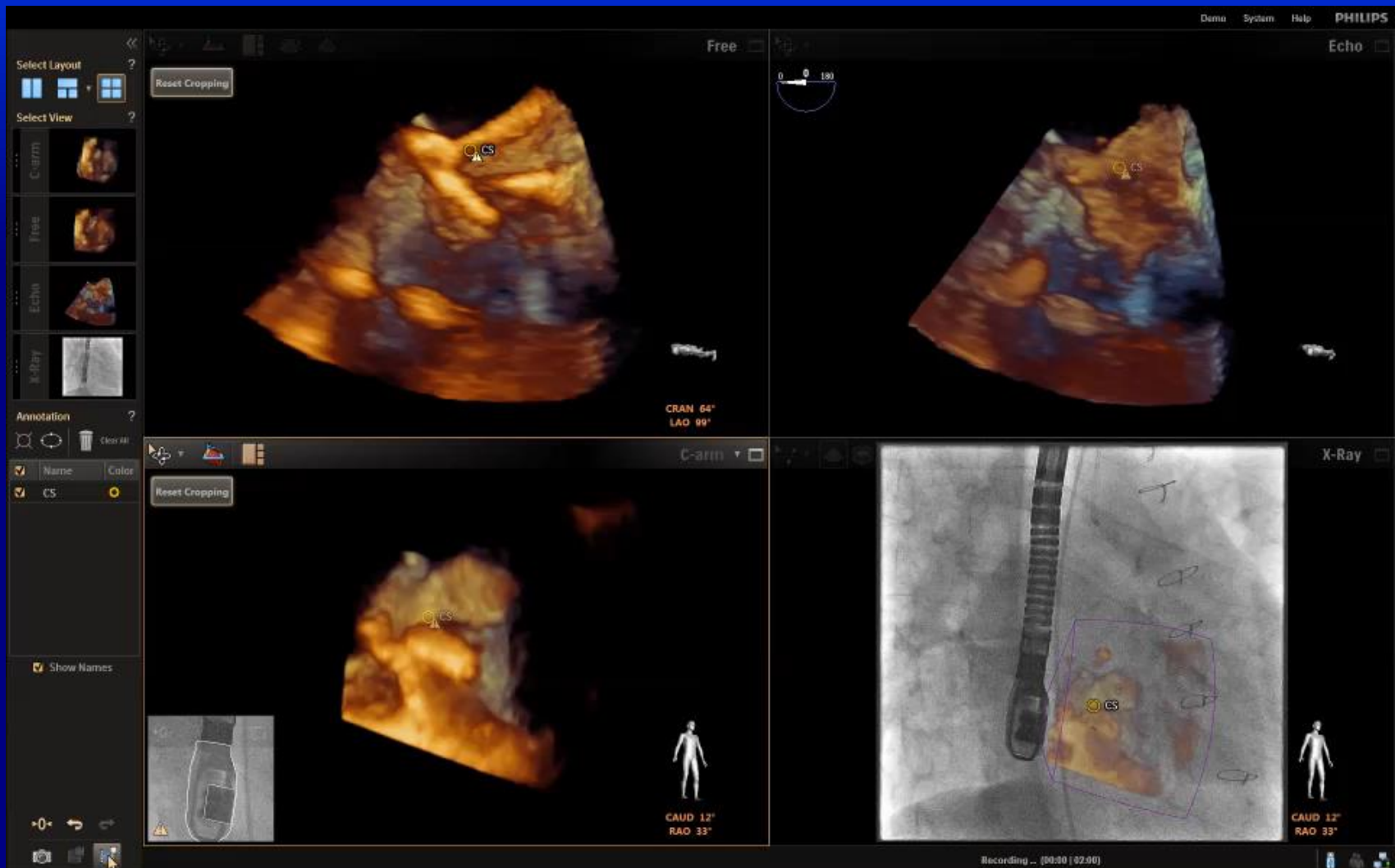


Transcatheter Tricuspid Valve Implant



Ebstein's s/p 25mm Metronic porcine valve with severe regurgitation – crossing of valve using 3D overlay

Transcatheter Tricuspid Valve Implant



Metronic Bioprosthesis valve placed above the coronary sinus.

Transcatheter Tricuspid Valve Implant



Positioning of 22mm Melody Valve

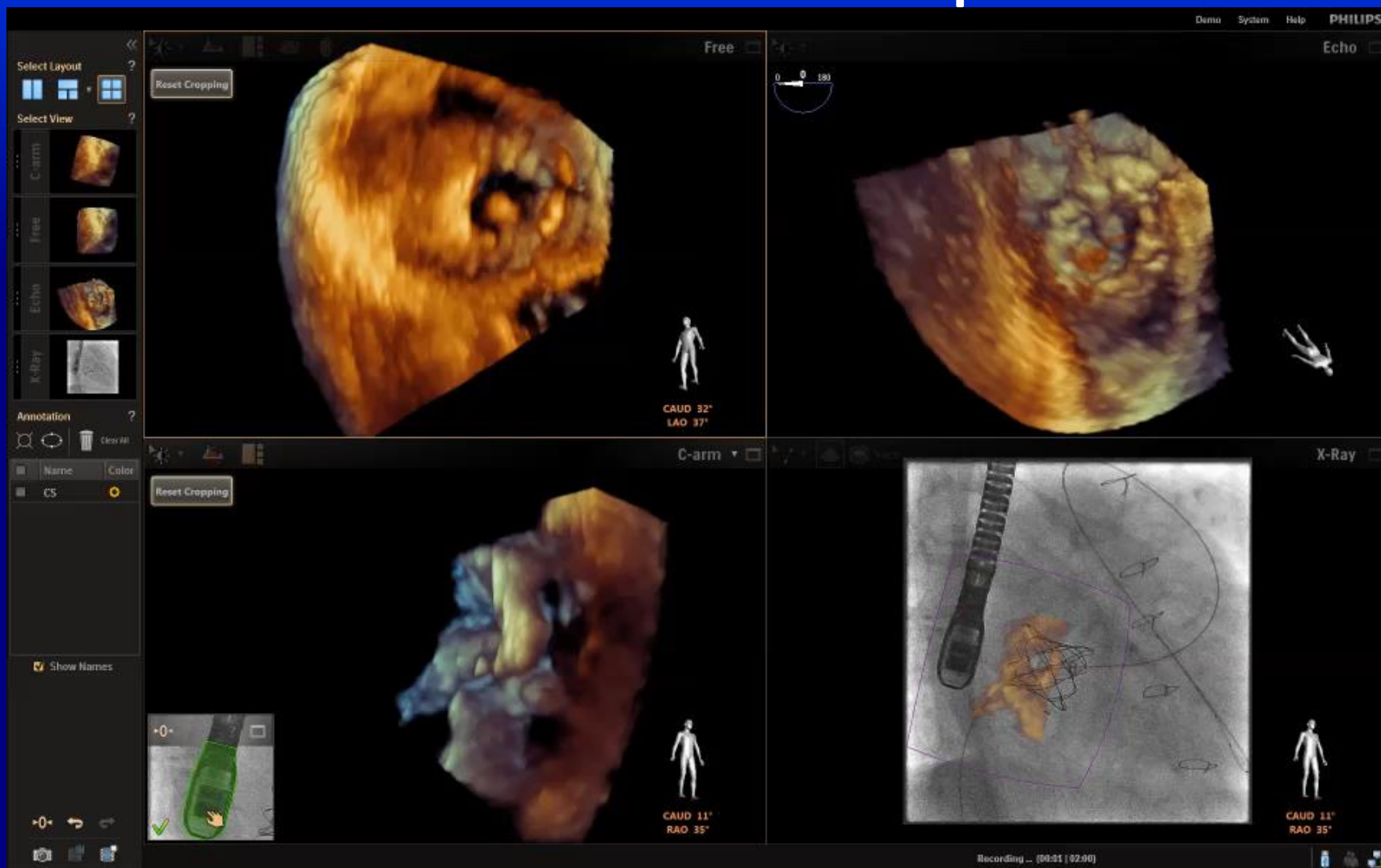
Transcatheter Tricuspid Valve Implant



Deploying the 22mm Melody valve

Transcatheter Tricuspid Valve Implant

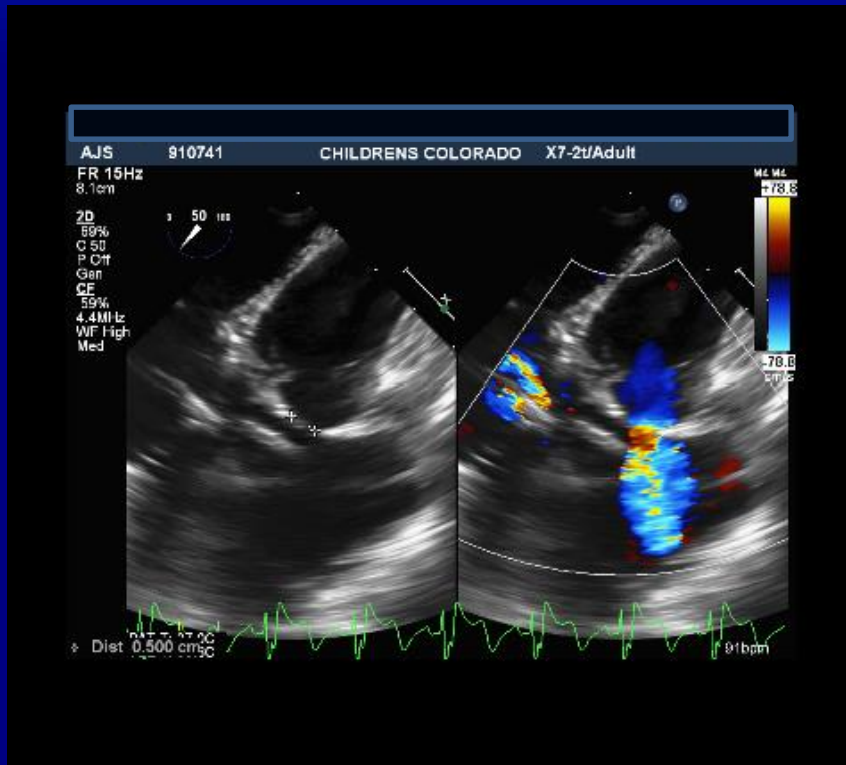
Evaluation of Device in Multiple Views



22mm Melody Valve deployed with no obstruction to CS

VSD Device Placement

2D TEE VSD Measurement

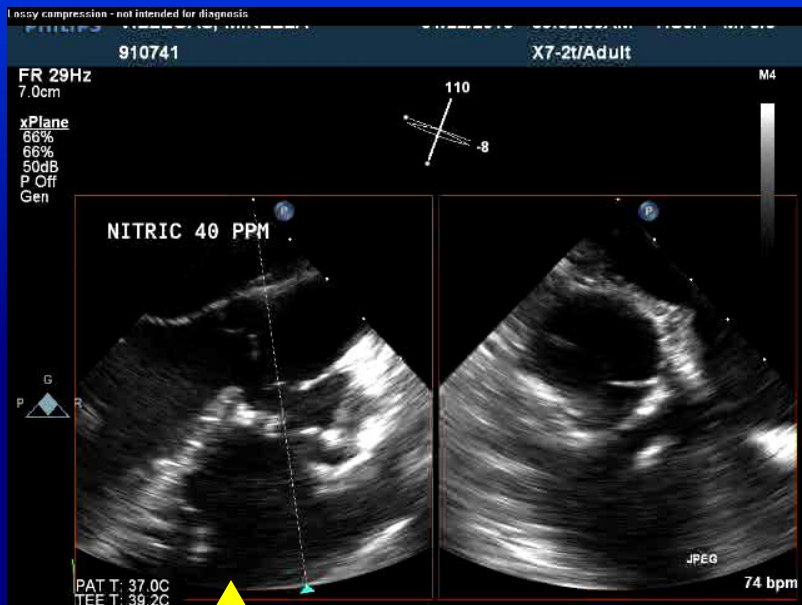


2D TEE Residual VSD



Measurements were also made from VSD to the aortic valve

VSD Device Placement



X-plane of VSD



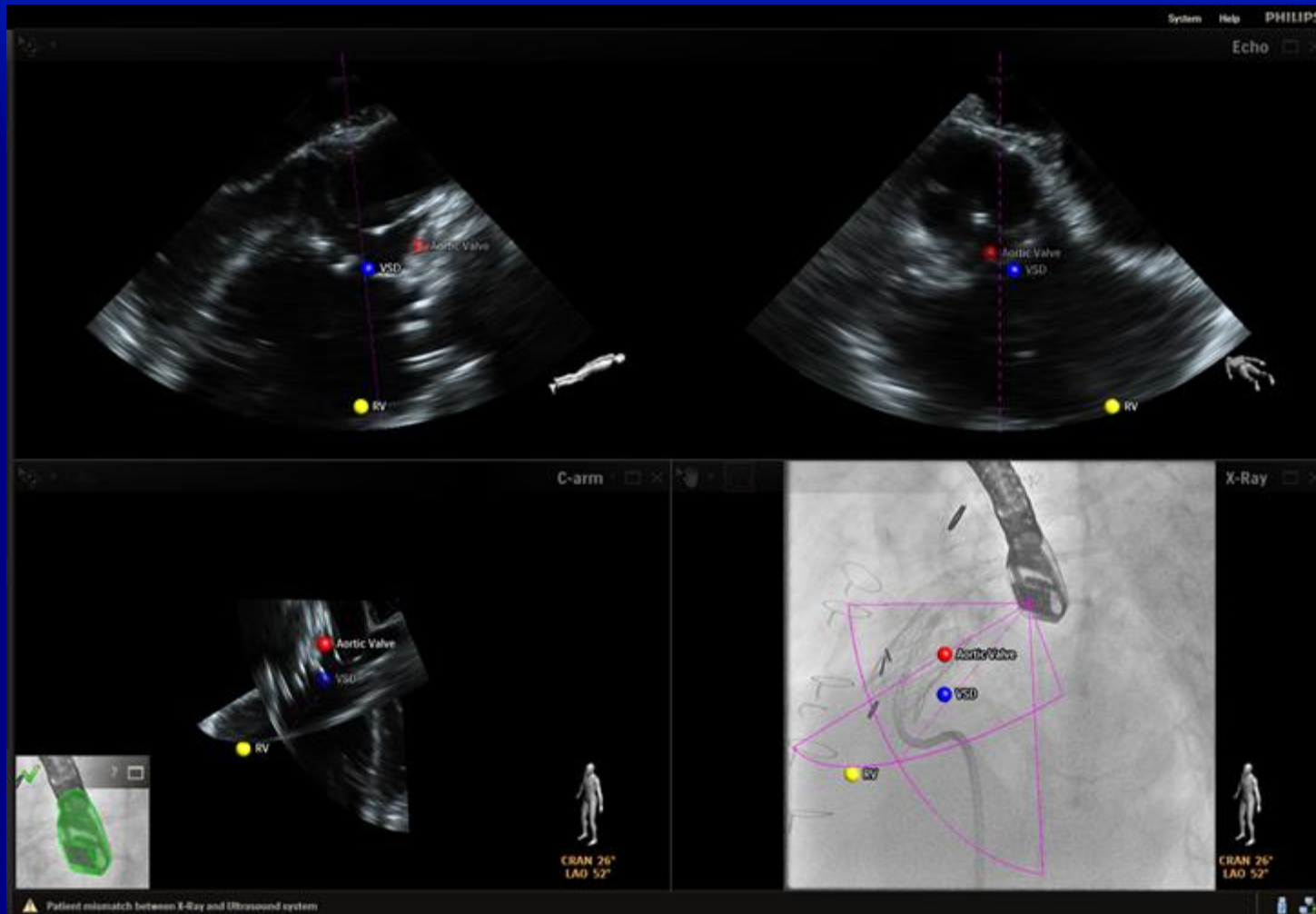
3D TEE of residual VSD



3D TEE of residual VSD in color

EchoNavigator – VSD Device

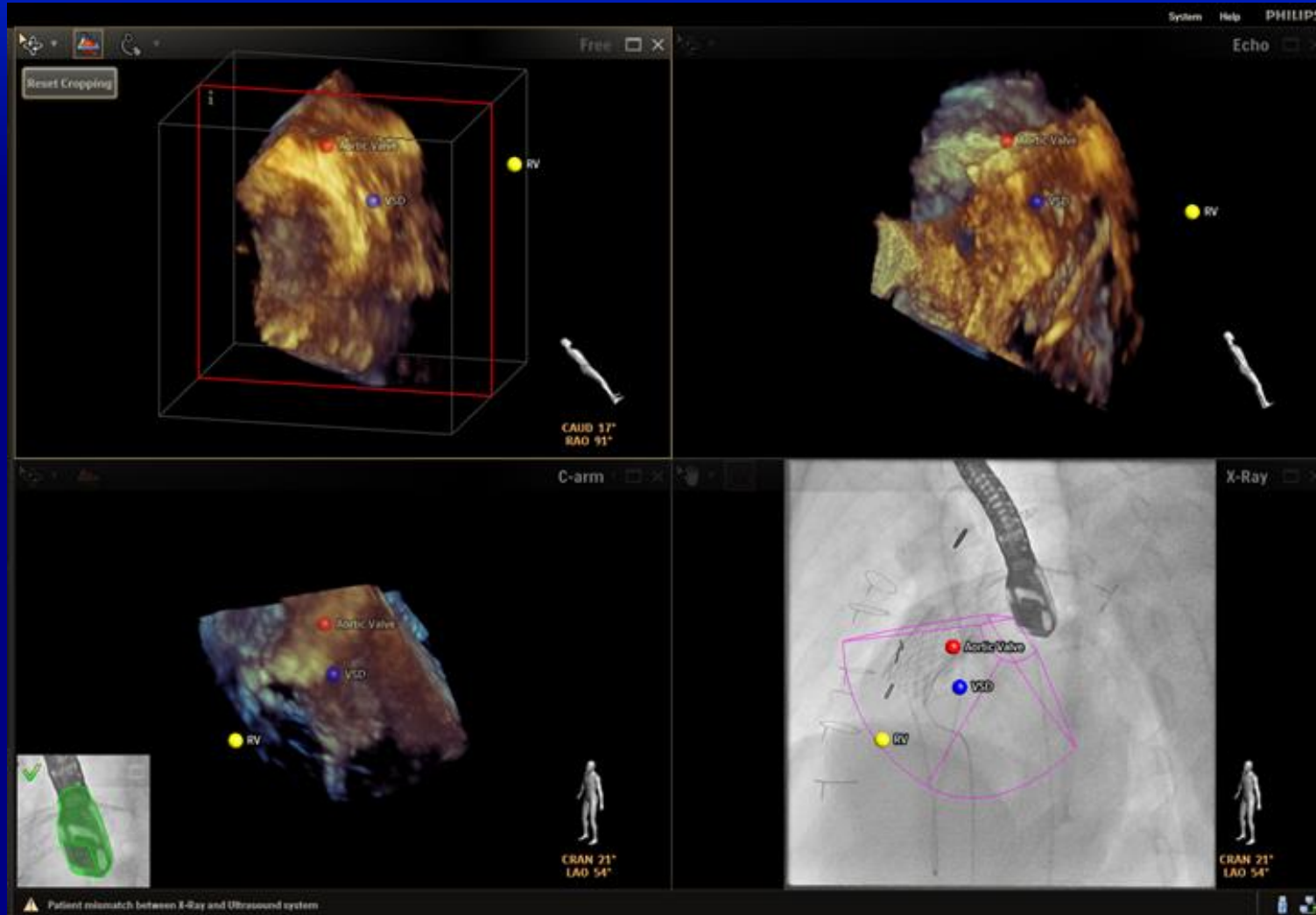
Creating Optimal Views for Navigation



1. Placing multiple markers to define soft tissue planar targets for device placement

EchoNavigator – VSD Device

Creating Optimal Views for Navigation



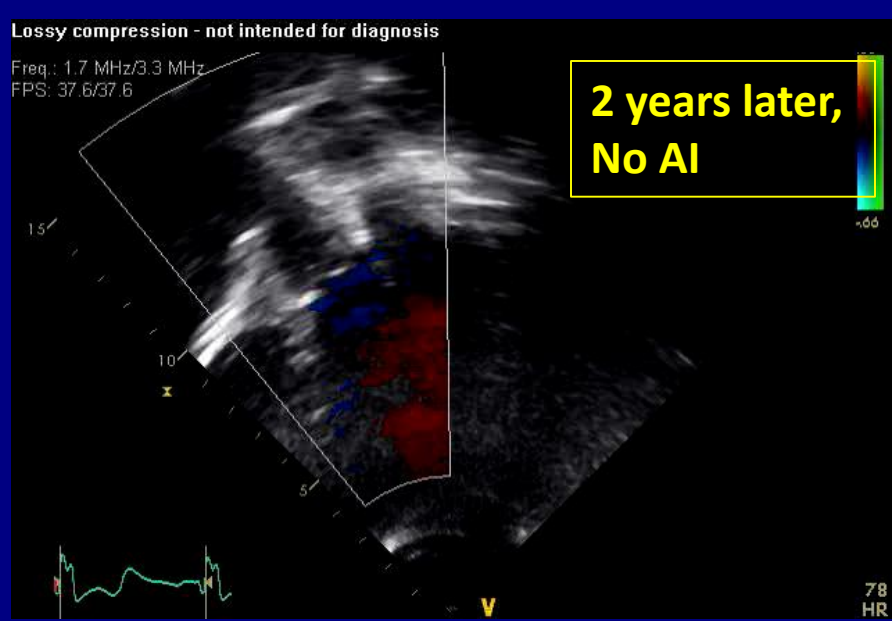
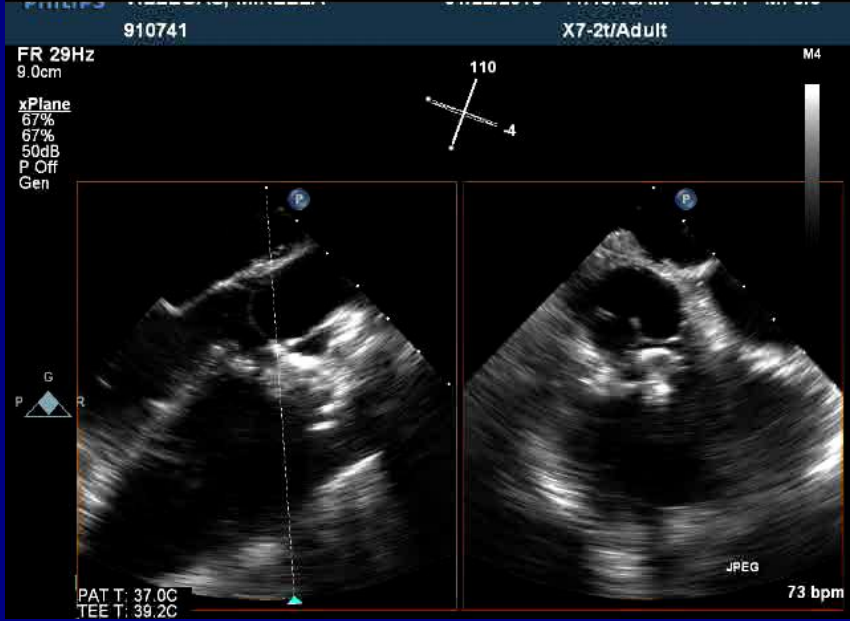
2. Markers appear on live fluoro images during device deployment

VSD Device Placement

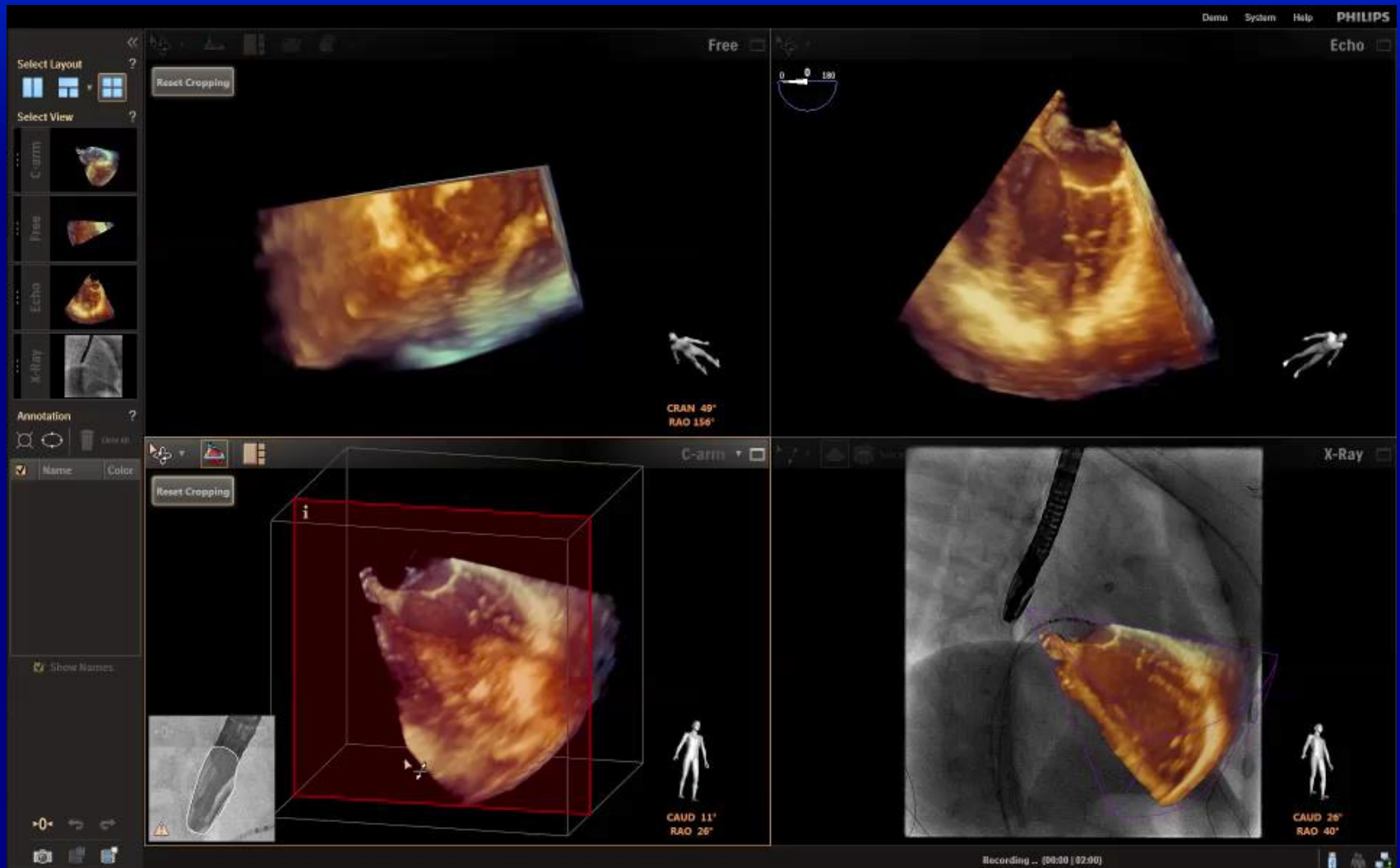
Catheter Crossing in 3D



VSD Device Placement



Cryoablation - EchoNavigator 3D Overlay



EchoNavigator – CHCO Experience

Procedures (n)	Age (yrs)	Weight (kg)	Anatomic Definition			Procedure Guidance		
			E	G	P	S	NA	I
ASD closure (10)	7.5 (5-18)	28.4 (18.1-49.1)	7	3	-	7	3	-
Font Fen closure (3)	5.3 (5-5.8)	31.1 (17.4-34)	3	-	-	3	-	-
TViV (3)	11 (9-16)	40 (29-54.2)	3	-	-	3	-	-
VSD closure (1)	9	22.0	1	-	-	1	-	-
LPA balloon angioplasty (Font Fen creation) (1)	7	21	1	-	-	1	-	-
LPA stent (Font Fen creation) (1)	10	29.5	-	1	-	-	1	-
Blade/balloon angioplasty of Eustachian valve (1)	22	77	-	1	-	-	1	-
Font Fen occlusion; RPA stent (1)	7	22.8	1	-	-	1	-	-
Diagnostic/PHTN (ASD dilation) (1)	26	59	1	-	-	1	-	-
Descending aorta stent dilation (Font Fen creation) (1)	7	24.9	-	1	-	1	-	-
BAV; TS puncture (1)	10	38.2	1	-	-	1	-	-
Diagnostic (Senning baffle leak closure) (1)	3	16	1	-	-	1	-	-
Font Fen Creation (1)	9	20.7	1	-	-	1	-	-

E = Excellent; G = Good; P = Poor; S = Superior; NA = No Added Benefit; I = Inferior

EchoNavigator – ASD closures

	Mean	95% CI		p-value
		Lower	Upper	
Fluoro time (min)				
Control	18.62	15.69	21.55	0.0005
Case	12.61	10.98	14.24	
Procedure time (min)				
Control	94.52	85.09	103.94	0.1145
Case	107.3	92.49	122.11	
Radiation dose (mGy.cm2)				
Control	12114.73	7358.91	16870.56	0.0291
Case	6916.4	4920.07	8912.73	

Adult LAA Occlusion

Table 2. Procedural data.

	Total (n = 34)	EN+ (n = 17)	EN- (n = 17)	p-value
Radiation dose (Gy/cm ²), mean ± SD	70.5±54	48.5±30.7	93.9±64.4	0.01
Fluoroscopy time (min), mean ± SD	20.3±10	16.7±7	24.0±11.4	0.035
Contrast media amount (ml), mean ± SD	184.9±110.6	172.3±92.7	197.5±127.8	0.53
Procedure time (min), mean ± SD	89.9±29	89.6±28.8	90.1±30.2	0.96
Device sizes (mm), mean ± SD	25±2	25±3	26±2	0.2
Lobe diameter (mm): 22/24/26/28/30, n	6/9/11/6/1	5/3/5/3/0	1/6/6/3/1	
Major complications				
Serious pericardial effusion	-	-	-	
Systemic embolism	-	-	-	
Ischemic stroke	-	-	-	
Hemorrhagic stroke	-	-	-	
Minor complications				
Pericardial effusion, without tamponade	-	-	-	
Femoral hematoma, n (%)	2 (5.9)	1 (5.9)	1 (5.9)	
Others	-	-	-	

Fusion Imaging

- Helpful
 - ASD, VSD, fenestration, and baffle closures
 - ASD and fenestration creations
 - Transcatheter tricuspid valve implants
- Not helpful
 - Descending aorta stent
 - LPA stents
- Unknown
 - Melody valve in the pulmonary position

3D TEE and Fusion Imaging

3D TEE

- Clear soft tissue anatomy
- Can see catheters
- Fast image generation
 - Anatomy can be seen in different planes simultaneously (X-plane)

Fusion Imaging

- Clear 3D visualization of anatomy facilitated cath manipulation/guidance (3 windows simultaneously)
- Target placement
- Table side control of 3D dataset
- Fluoroscopic image projection
- 3D overlay of soft tissue anatomy

Conclusions

- **Echo Overlay on Fluoroscopy (EchoNavigator) developed**
 - Harmonize echo and fluoro images
 - Ability to place labels and landmarks in 3D space
- **Better understanding of anatomy and the 3D relationship of deployed device and defect**
- **More efficient navigation by having multiple and optimal views**
- **Enhance team communication and assist visual guidance**
- **Reduce overall radiation exposure and fluoro time**

Thank you!

Acknowledgments:

Tom Fagan, MD

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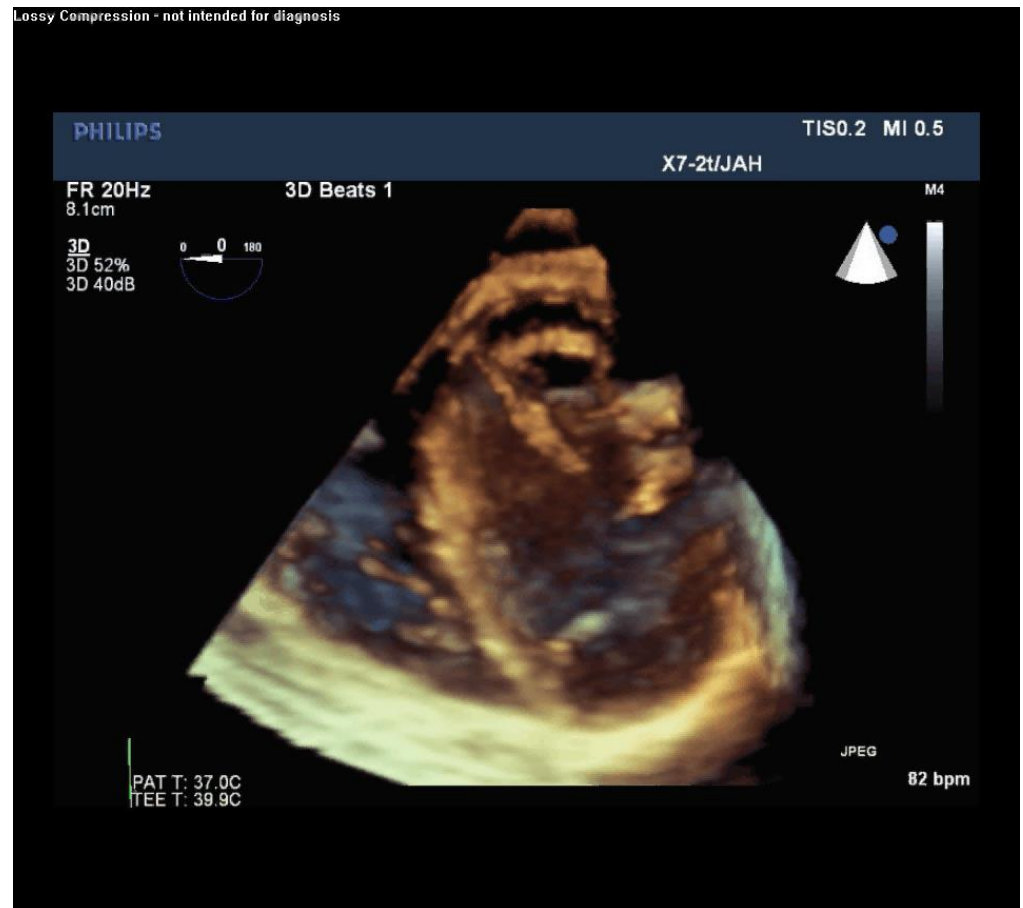
Dunbar Ivy, MD

Carlie Breman, RDCS

Philips Healthcare



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EchoNavigator – CHCO Experience

1/2013 – 2/2015

(n=26)

Advantages	n	Disadvantages	n
Clear 3D visualization of anatomy facilitated cath manipulation/guidance (3 windows simultaneously)	18	Need smaller probe; improve near field visualization.	5
Use of targets facilitated cath manipulation	9	A higher 3D TEE frame rate may give better definition of the defect.	2
Improved definition of device/cardiac relationships	6	Presence of ASA obfuscated clear atrial septal visualization	1
Use of 2D/3D overlay facilitated catheter guidance and device positioning	5	Left bronchus was interposed between probe and LPA obscuring area of distal LPA stenosis.	1
Used extensively to assess leaflet function pre- and post- valve placement.	3	Metallic artifact/reverberations made it difficult to visualize deployed blade catheter adequately.	1
Manual registration allowed transgastric views for optimal image guidance	1	RPA post Fontan could not be visualized well by TEE for stent placement	1
		Overlay visualization of ASD sizing balloon inadequate with low density of contrast	1
		RV-to-PA conduit too far in the far field for adequate visualization	2