



XFM – transition to iCMR

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Structural Heart Interventions

XRF

US

EM nav

CT

MRI

IMAGE CO-REGISTRATION

Improve success & safety

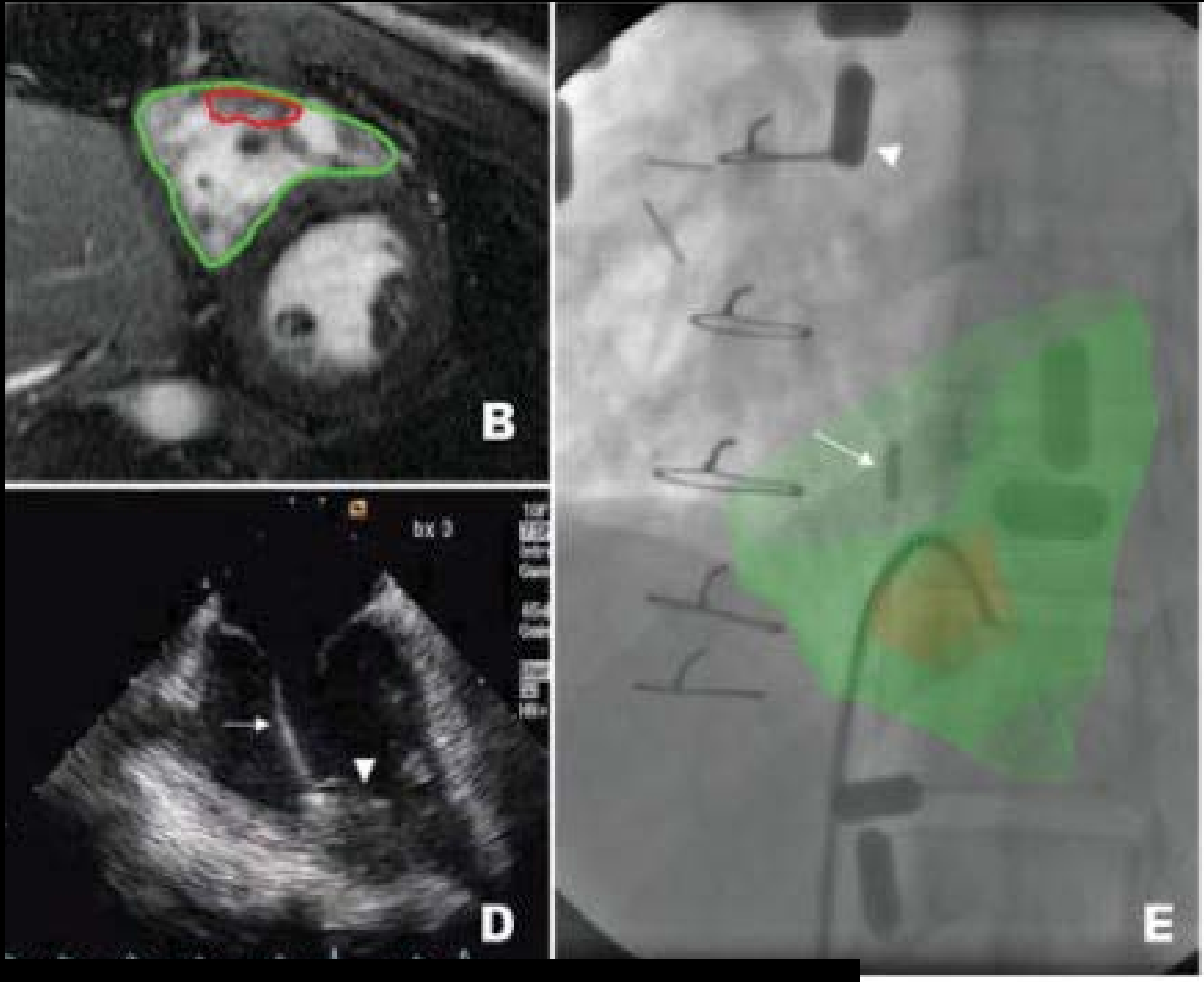
Improve efficiency

More minimally invasive options

Transition to iCMRI

XFM: Surface Fiducials

Application: Endomyocardial Tumor Biopsy



Gutierrez, de Silva, Raval, Lederman 2007 CCI

XFM: Surface Fiducials

- MRI immediately prior to XRF
- Fiducial markers may interfere with intra-op imaging
- Skin and organs are not rigidly fixed

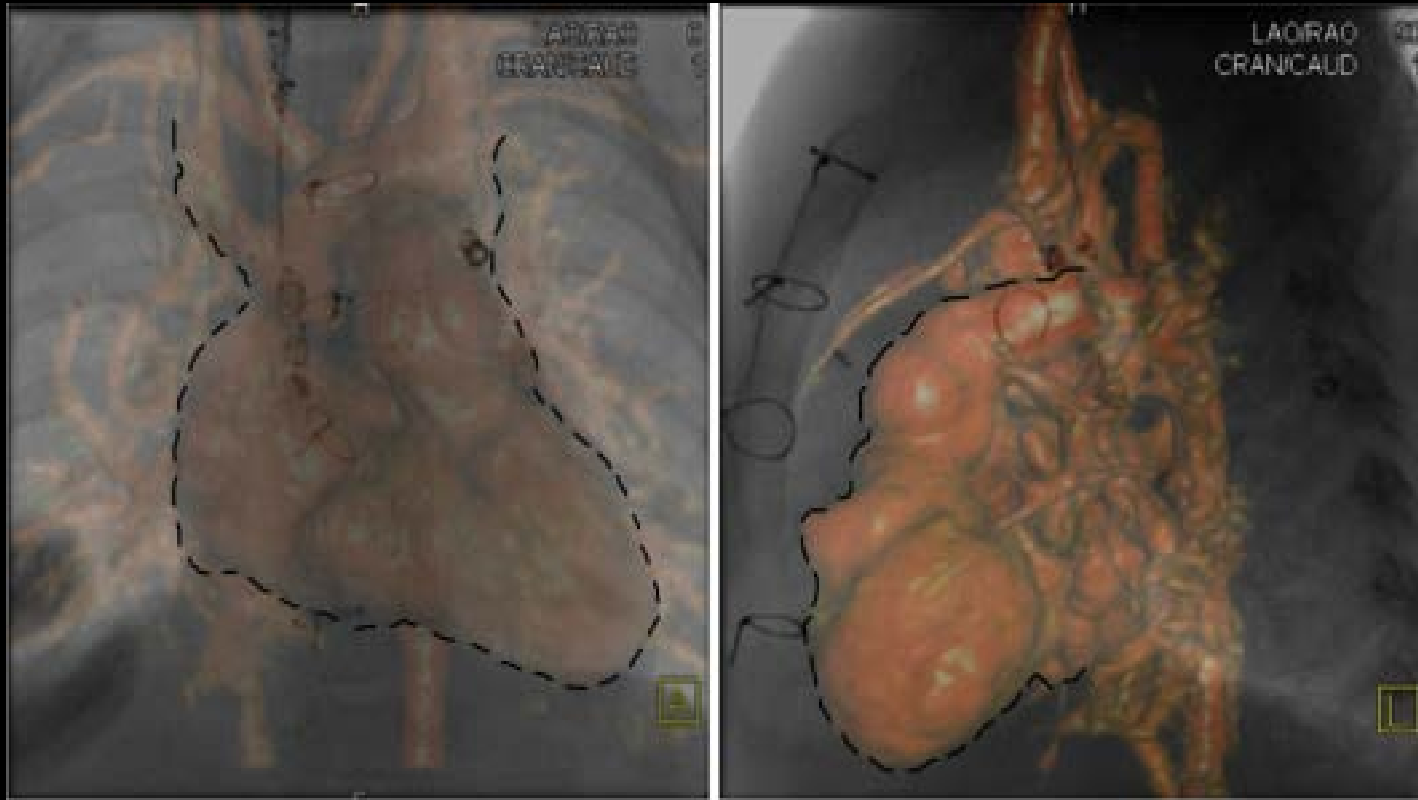
Iliac artery intervention



Gutierrez, de Silva, Raval, Lederman 2007 CCI

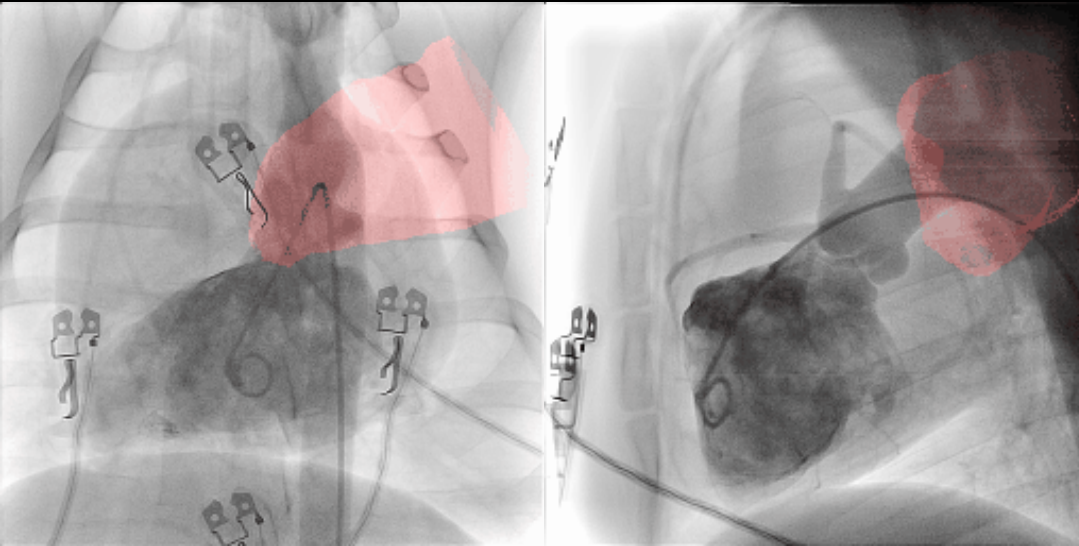
XFM: Internal “Marker” Alignment

“Syngo InSpace 3D/3D fusion, iPilot dynamic, register to patient”

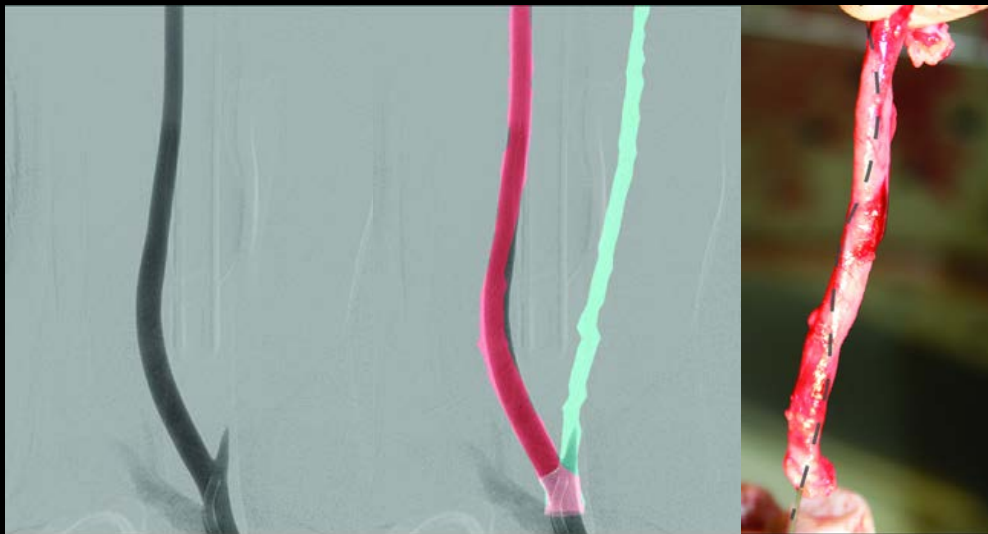


SIEMENS

XFM: “Anatomy of Interest” Alignment



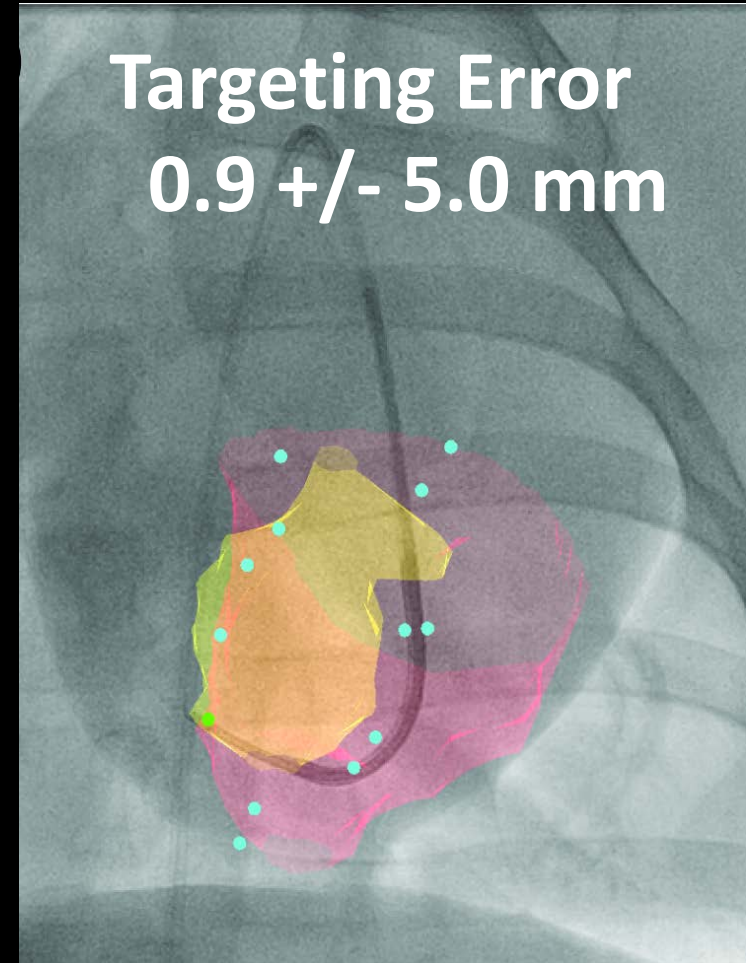
Tomkowiak, Raval 2011 CCI



Klein, Raval 2012 CCI

Transendocardial
Injection

Targeting Error
 0.9 ± 5.0 mm



Schmuck, Raval 2015 JCardTransRes

Mis-registration

**Lack of
RT 3D Device
Tracking**

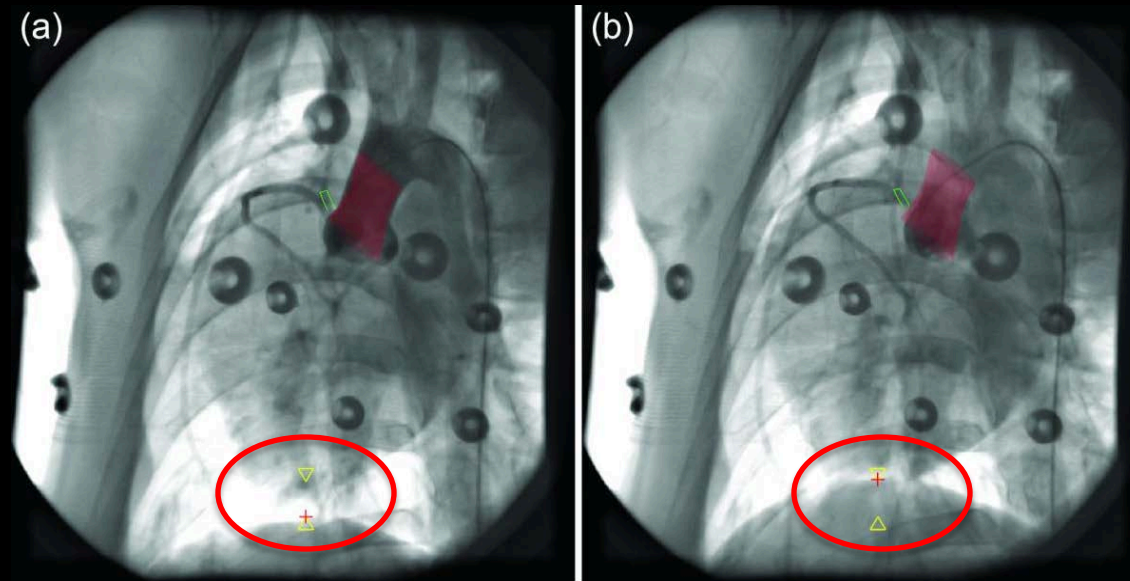
**Why isn't
XFM
routinely
adopted?**

**Workflow
Inefficiencies**

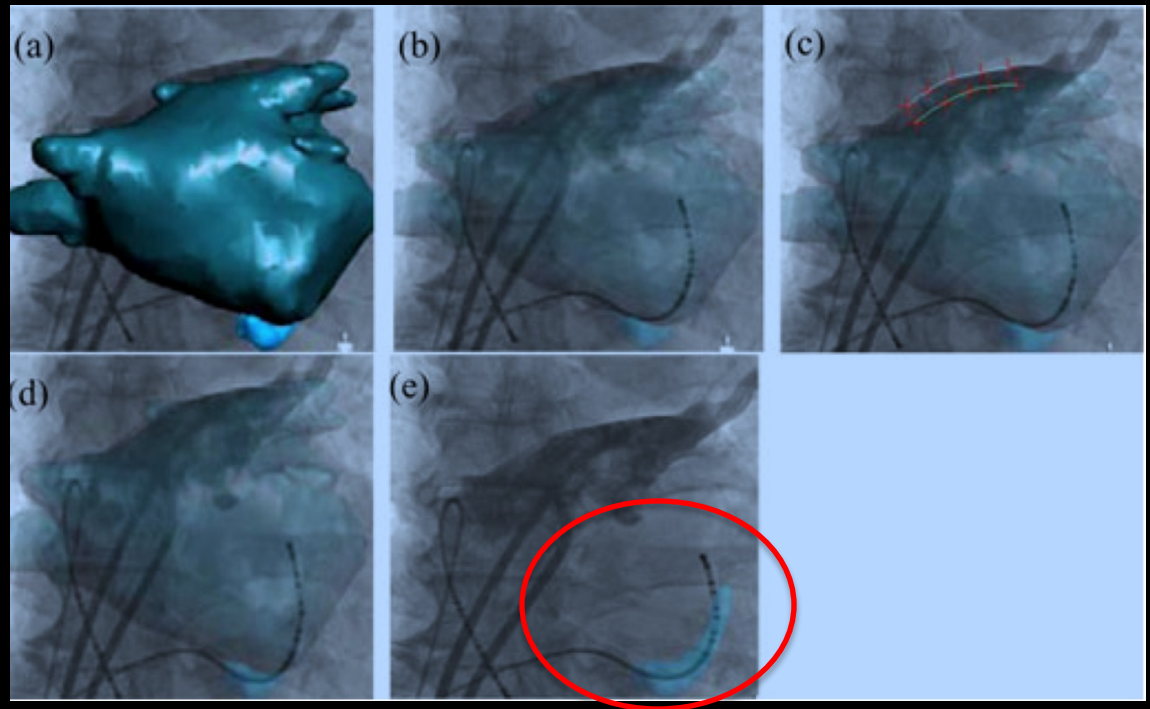
**Lack of Infrastructure
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XRF Based Respiratory Motion Correction

Faranesh 2013 Med Phys

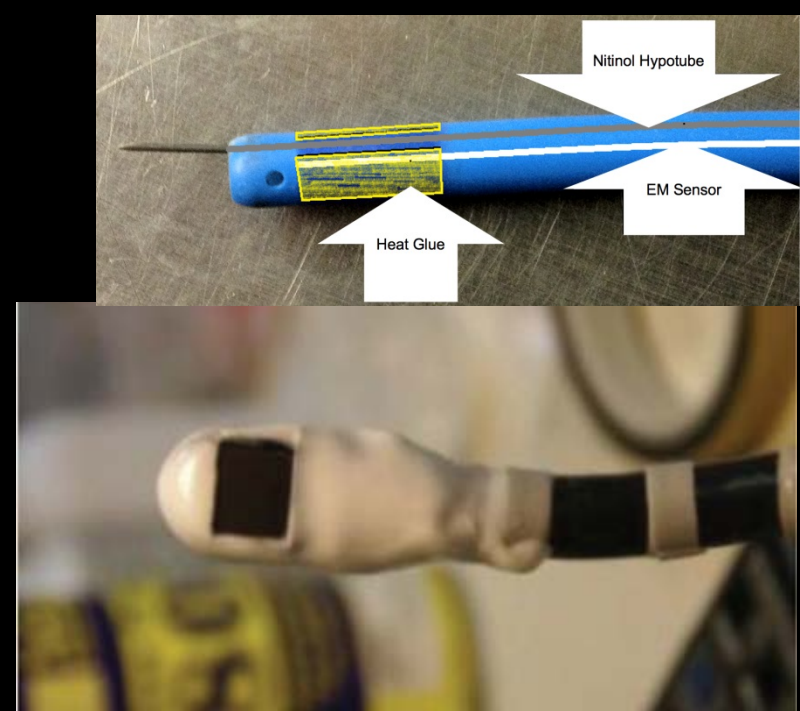


Ma, Rhode 2012 IEEE-BME

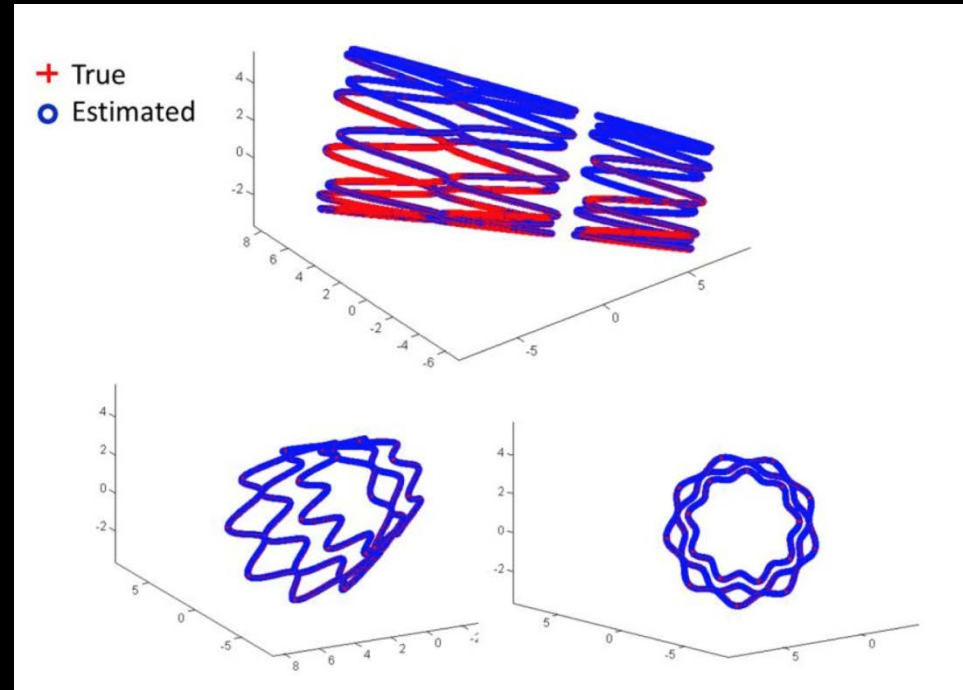
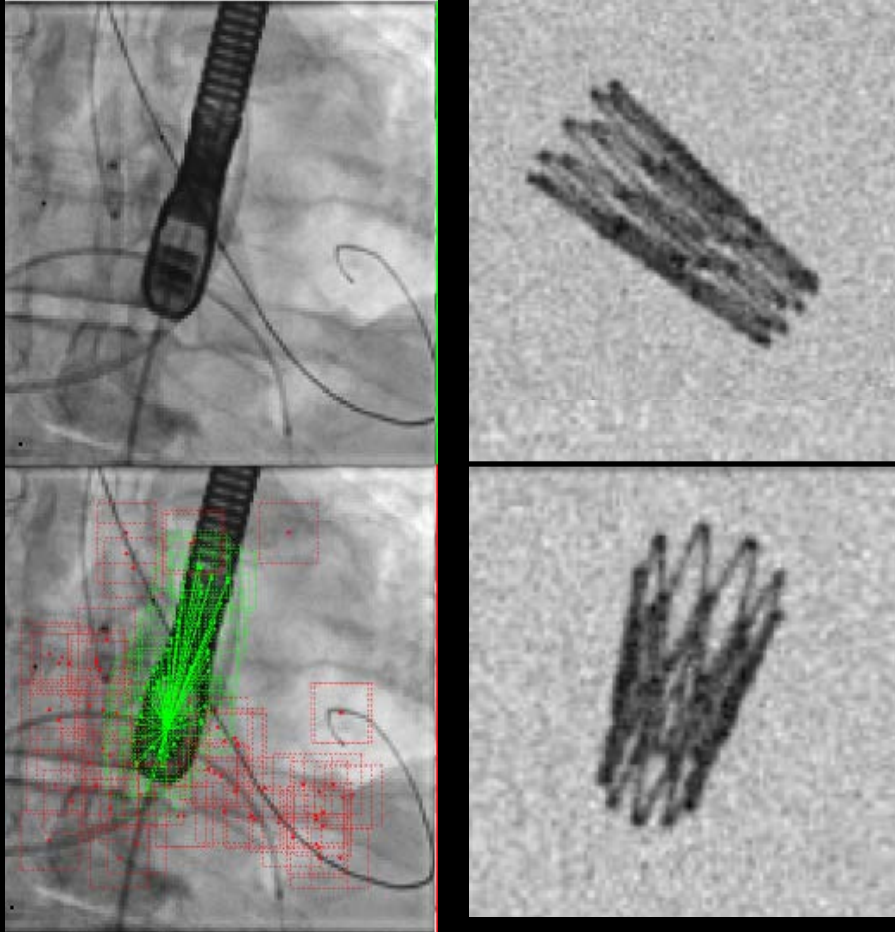


MRI to EM to 3DUS to XRF Motion Compensation

Application: Transendocardial
Stem Cell Delivery



RT 3D Tracking of Devices for TAVR – biplane XRF



Hatt CR, Raval AN. *Efficient Feature-based 2D/3D Registration of TEE to XRF for Cardiac Interventions*. SPIE 2014

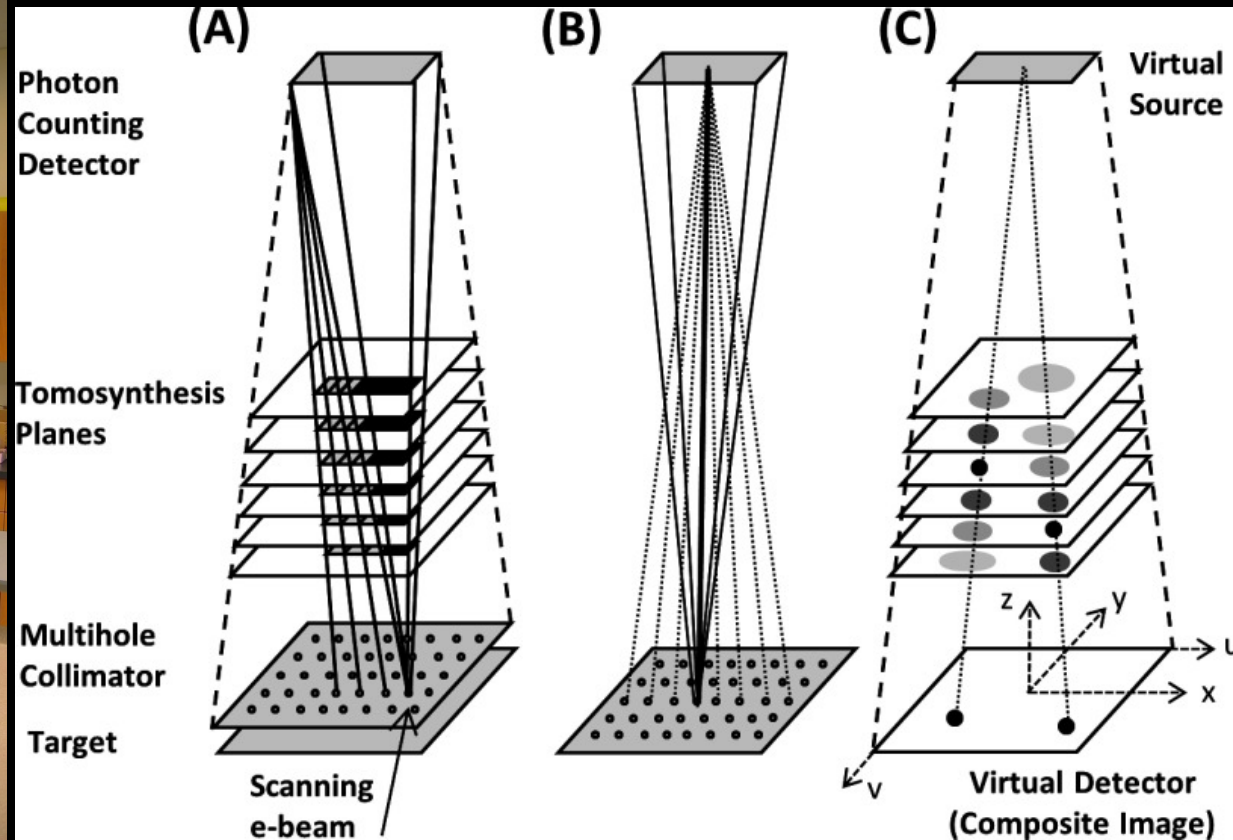
Hatt CR, Raval AN. *Robust 5DOF trans-esophageal echo probe tracking at 50 fps*. MICCAI 2015

Hatt, Raval. *Hough Forests for Real-Time, Automatic Device Localization in Fluoroscopic Images: Application to TAVR* MICCAI 2015

Hatt CR, Raval AN, Spiedel M. *Dynamic tracking of prosthetic valve motion and deformation from bi-plane x-ray views: feasibility study* - 2016 in press

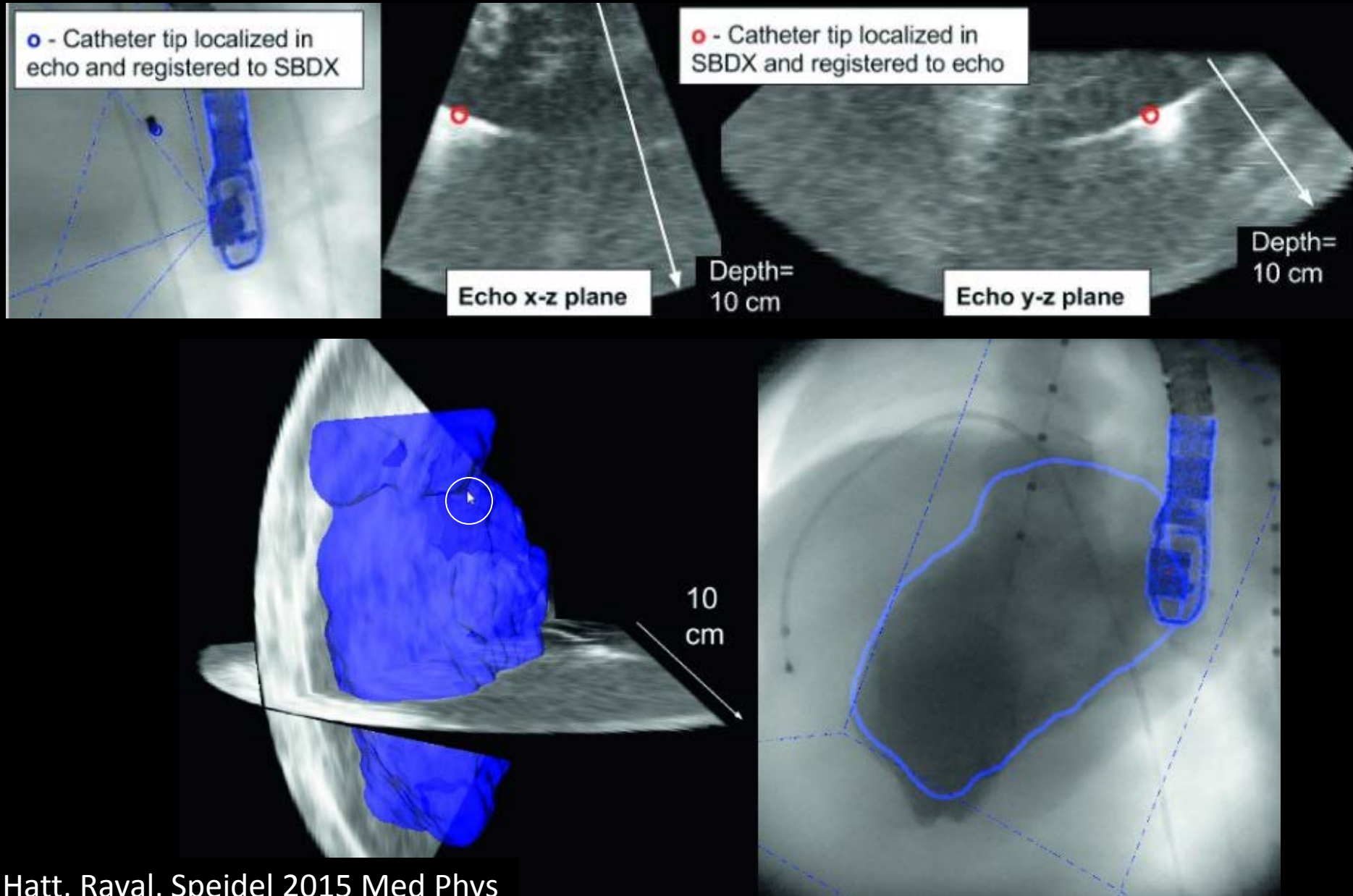
Low Dose, Single XRF Gantry, rt3D Device Tracking

Scanning Beam Digital X-ray (SBDX)

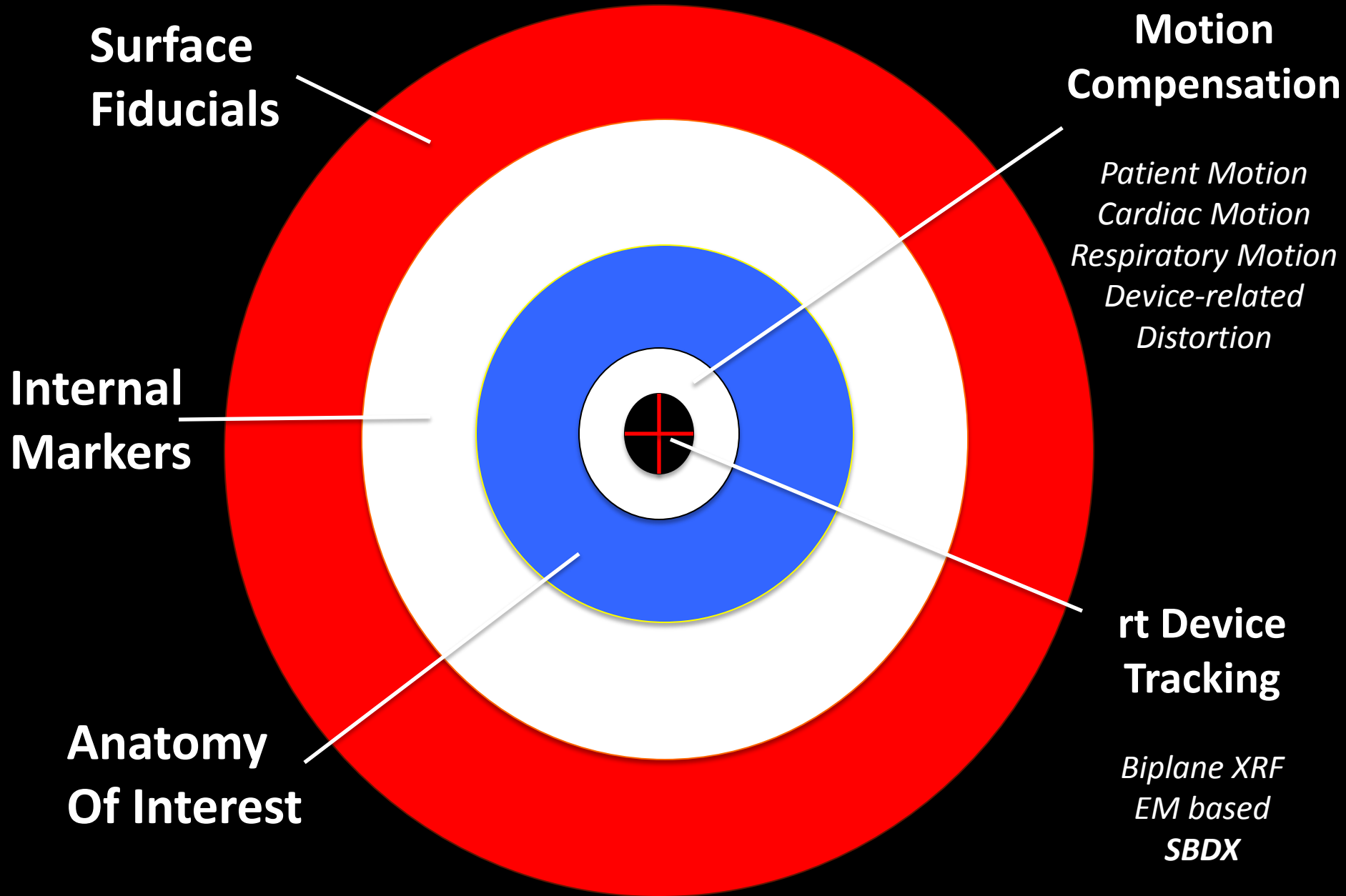


510K Approved, Novaray & Triple Ring Technologies

3D US to XRF using Single Gantry, low Dose SBDX



Interventional Image Co-Registration – Zeroing in...





Madison, WI

Thank you for your attention!