# Advanced Imaging: Techniques and Tricks

A Basic Review of Radiation Safety

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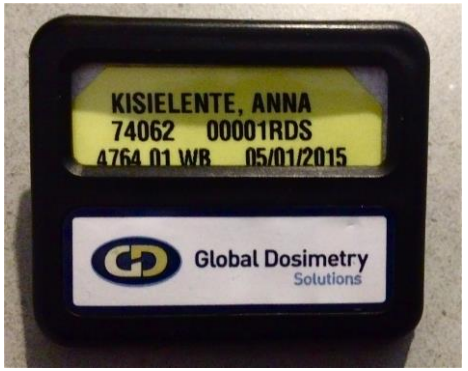
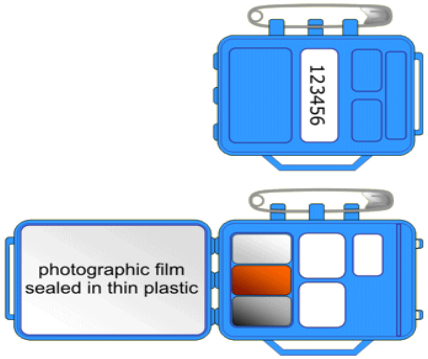
# Occupational Dose Measurement


- The International unit for human exposure is measured in the Sievert (**Sv**).
- Factors the relative biological effectiveness (RBE) of ionizing radiation (x-rays, gamma rays, and neutrons) and exposed tissues.
- Represents the stochastic (cancer causing) health effects of ionizing radiation.
- Radiation exposure in the U.S. is measured in **rem** (radiation equivalent man).
- 1 rem= 10 mSv

# How is radiation dose monitored?

- Dosimeter- external radiation monitoring device.
- Used to detect gamma and x-rays.
- Film badges- comprised of film with emulsion and a casing (plastic or metal) to protect the film.
- Total Effective Dose: Dosimeter placed at the level of the thyroid.
- Deep Effective Dose: Dosimeter placed at the level of the hip.

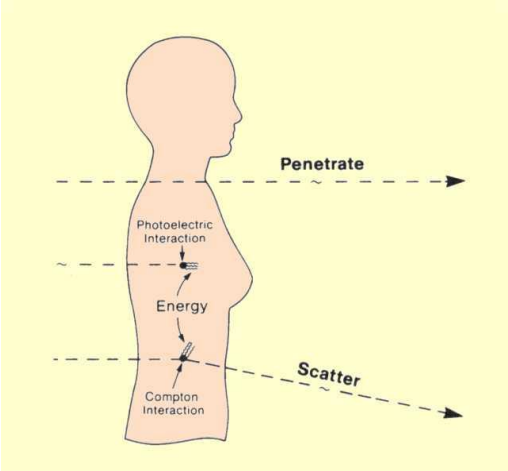


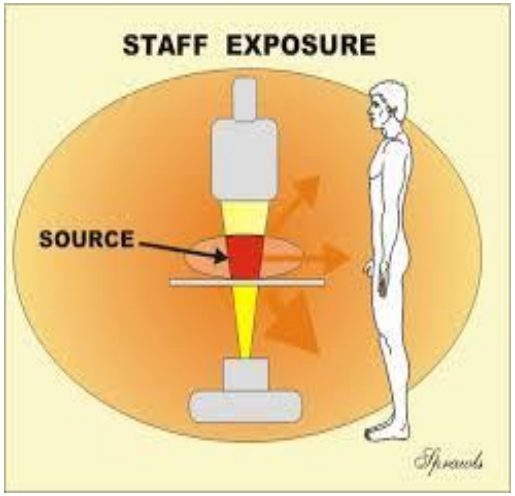



# US Occupational Dose Limits

- Joint Committee on Administration Rules Section 340.210
- Annual Limits set to ensure proper health and safety of occupational radiation workers.
- Total Effective Dose equivalent of 0.05 Sv (5 rem).
- Deep Dose equivalent and the committed dose equivalent to any individual organ or tissue equal to 0.05 Sv (50 rem).
- Lens Dose equivalent of 0.15 Sv (15 rem).
- Shallow Dose (skin or extremities) equivalent of 0.5 Sv (50 rem).
- Dosimeter readings are given in mrem (1/1000 rem).

# Scatter Radiation




- Considered a type of secondary radiation.
- Radiation that has passed through a substance (patient), then has changed direction.
- X-ray photons engage in Compton interactions and produce scatter radiation.
- Scatter radiation is the primary source of occupational exposure.

# Angiographic Radiation Protection

WEAR A LEAD GARMENT

WEAR LEAD GOGGLES

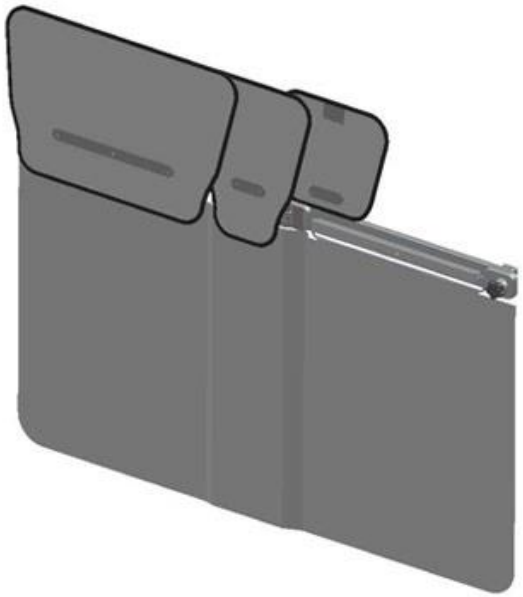
# Operator Protection

## UPPER BODY PROTECTION

- Hanging ceiling mounted lead shielding provides protection for the torso and eyes.

## LOWER BODY PROTECTION

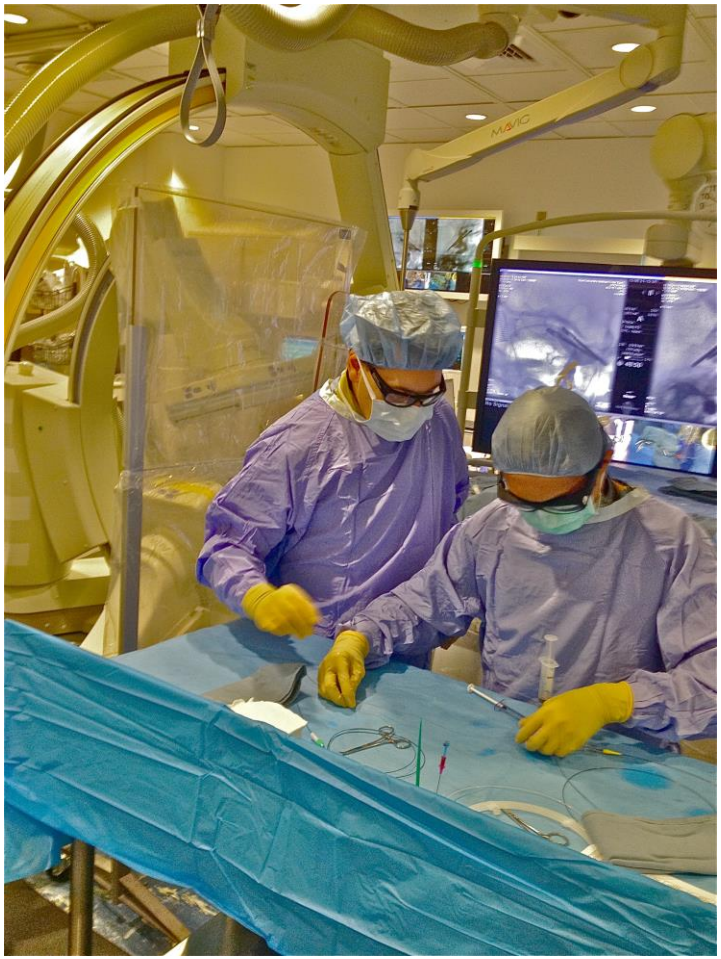
- Side rail shielding, attached to the angiographic table provides lower body protection.



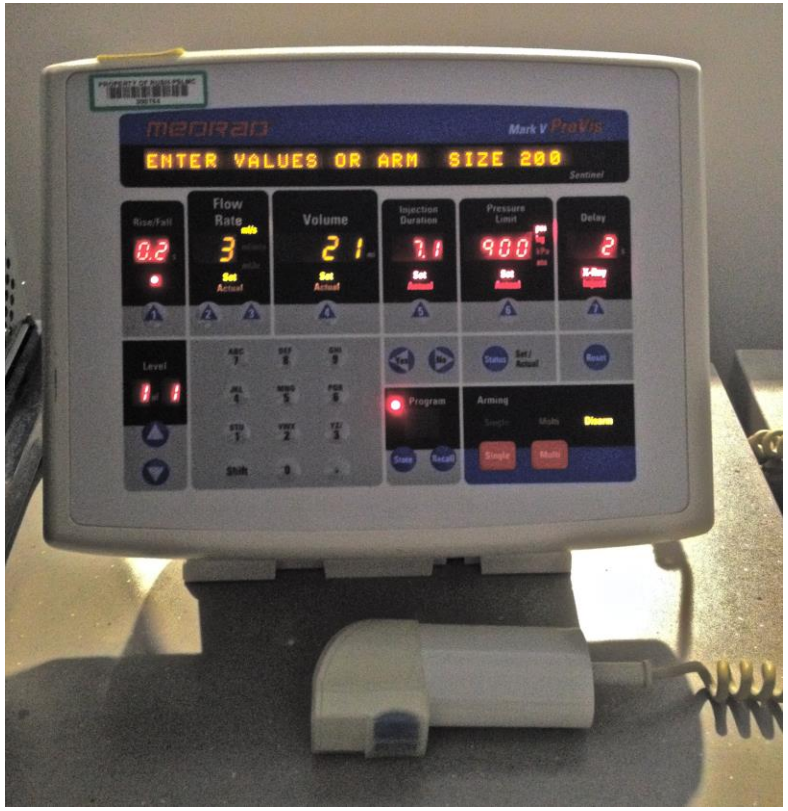
The combination of upper and lower body radiation shielding provides a 99% reduction in scatter radiation exposure to the operator.

# Incorporate Additional Lead Shielding

- Mobile “rolling lead” lead may be used to provide additional radiation scatter protection to the operator.
- Sterilely prepare the lead shield with fluoroscopic covers to ensure the mobility of unit during surgery.
- The mobile unit should be situated next to the detector of the second x-ray plane.
- Provides additional upper and lower body scatter radiation protection.



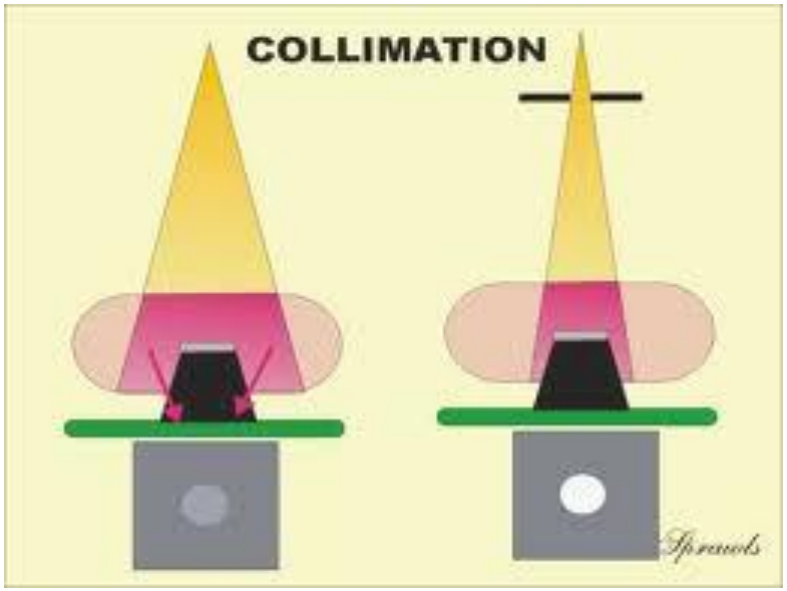
# Pressure Injector




- Reduces occupational radiation exposure.
- Situated in the control room of angiographic suite.
- Allows for angiographic imaging without occupational exposure to radiation.
- Allows for better control of contrast injection verses “hand-runs”.
- Especially useful in 3D, 4D, DSA, and high-speed DSA acquisitions.

# Beam Collimation

- Collimate the x-ray beam to the tightest possible window.
- Avoid irradiating unnecessary tissue located outside of the region of interest.
- Reduces scatter radiation and image noise.



# Image Detector Placement

## RAISED DETECTOR


- Non-lowered image detector height contributes to increased patient exposure.

## LOWERED DETECTOR


- Lowering the image detector directly reduces patient dose rate.
- A reduction of 0.25 mGy/s was observed in phantom testing.

Research provided by Mark Supanich, Ph.D. Diagnostic Medical Physicist
Rush University Medical Center

# Procedure Table Placement

## TUBE CLOSE TO PATIENT


- Directly related to increased patient dose.

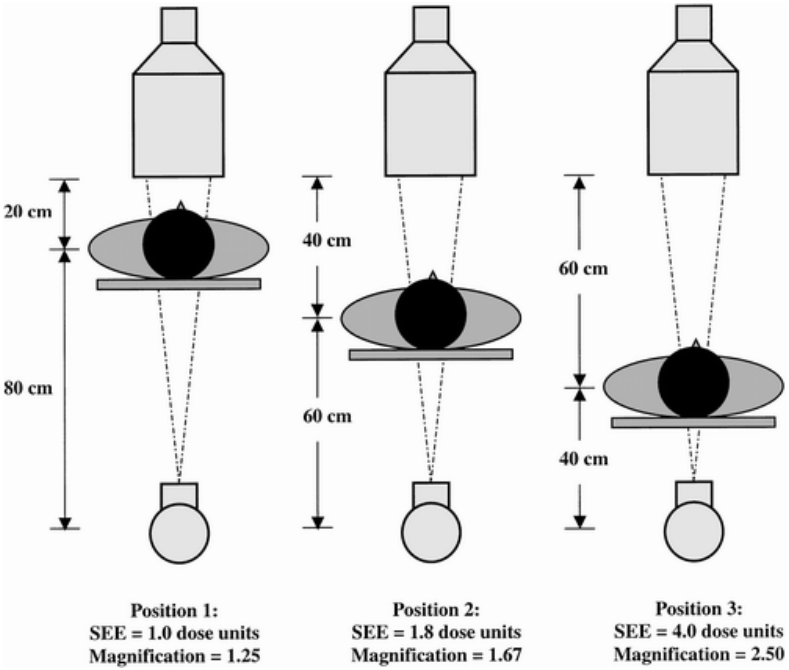
## TUBE FAR FROM PATIENT


- Move the patient as far from the tube as possible.

Research provided by Mark Supanich, Ph.D. Diagnostic Medical Physicist
Rush University Medical Center

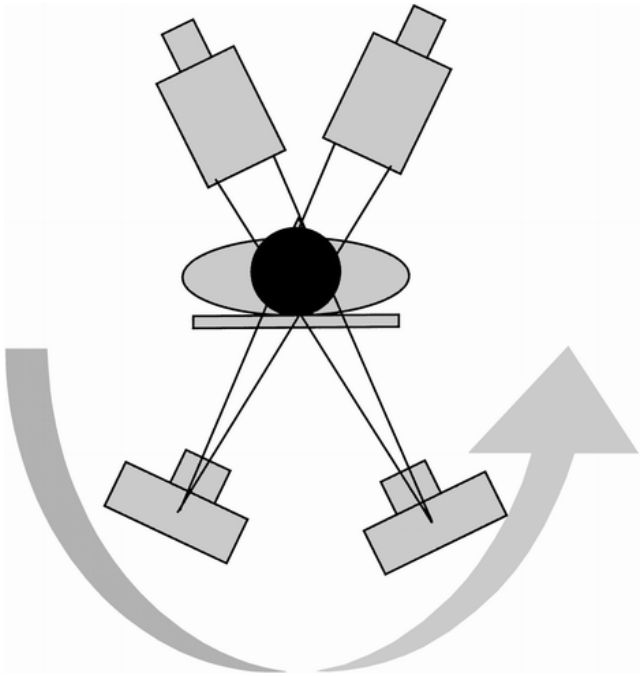
## TABLE HEIGHT

- Raise the table as close to the image detector as possible.



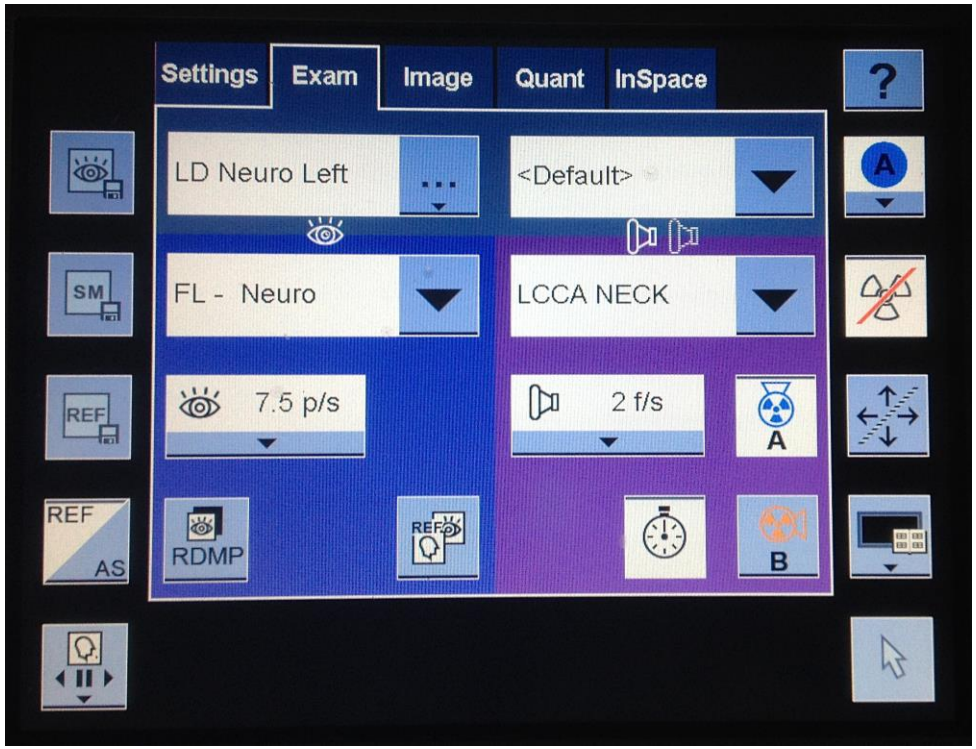

## ROTATE TUBE

- Dose spreading.



Images located on ASRT website.

# Adjustable Fluro Rates




- Standard and Low-Dose Protocols.
- Low acquisition rates.
- Increasing pulse rate, increases patient and operator exposure.

Techniques and Tricks

# Advanced Imaging Updates

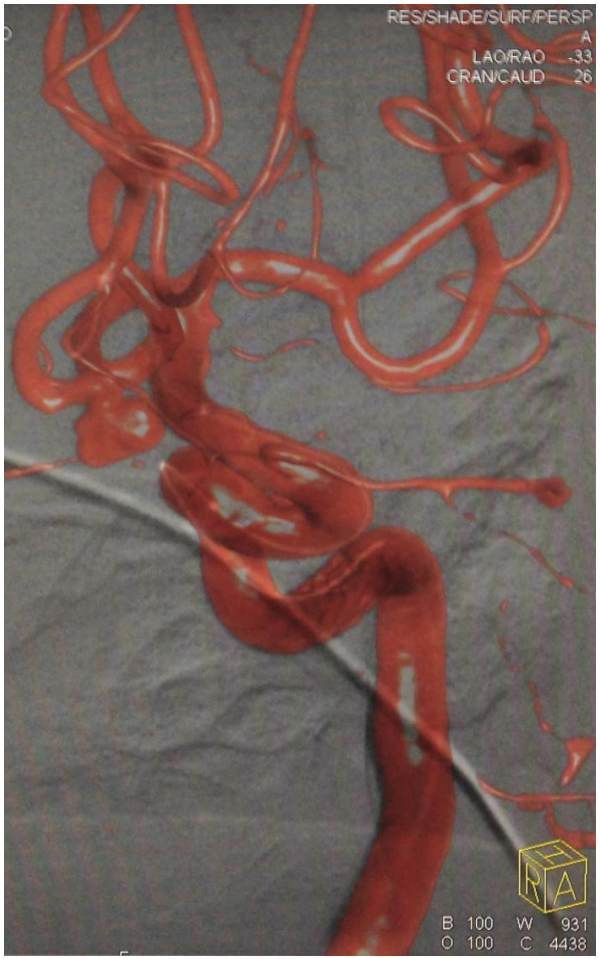
# Siemens Syngo Inspace 3D


- High-contrast 3D angiography.
- 5sDSA acquisition.
- 3 mL/s for 21mL, 2 second XR delay.
- Volume Rendered Technique (VRT).
- Maximum Intensity Projections (MIP).

# Post-Processing of 3D Acquisitions

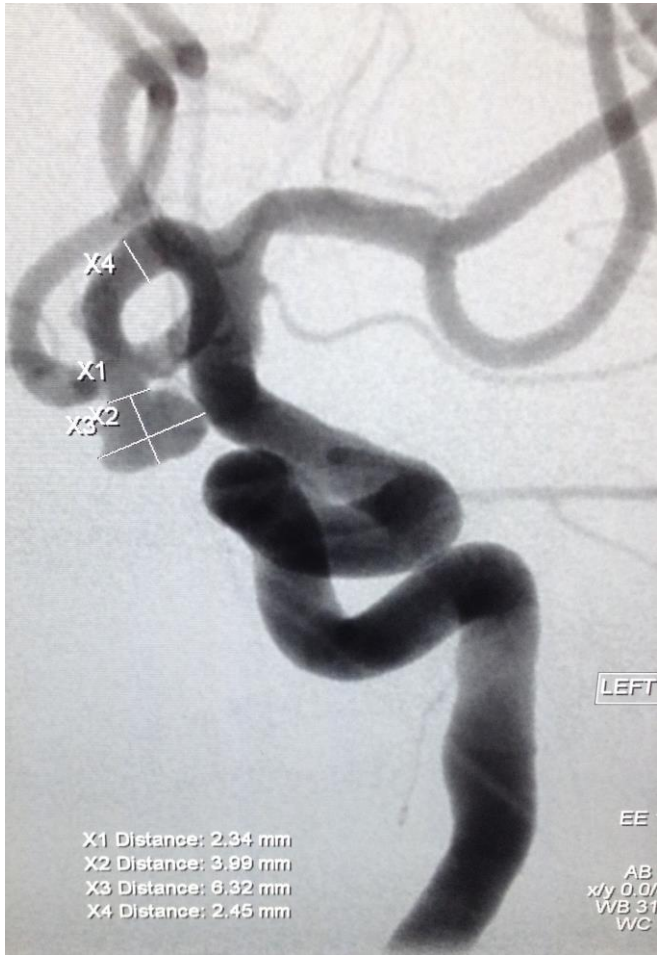
- Post reconstruction: Inspace reconstruction of initial acquisition (image).
- **Parameters:** Medium VOI, 512x512 matrix size, Kernel: HU, Image Characteristics: Sharp, Reconstruction Mode: Natural Mask.
- Press reconstruction icon (large box with calculator).
- Display VRT onto monitor for visualization.

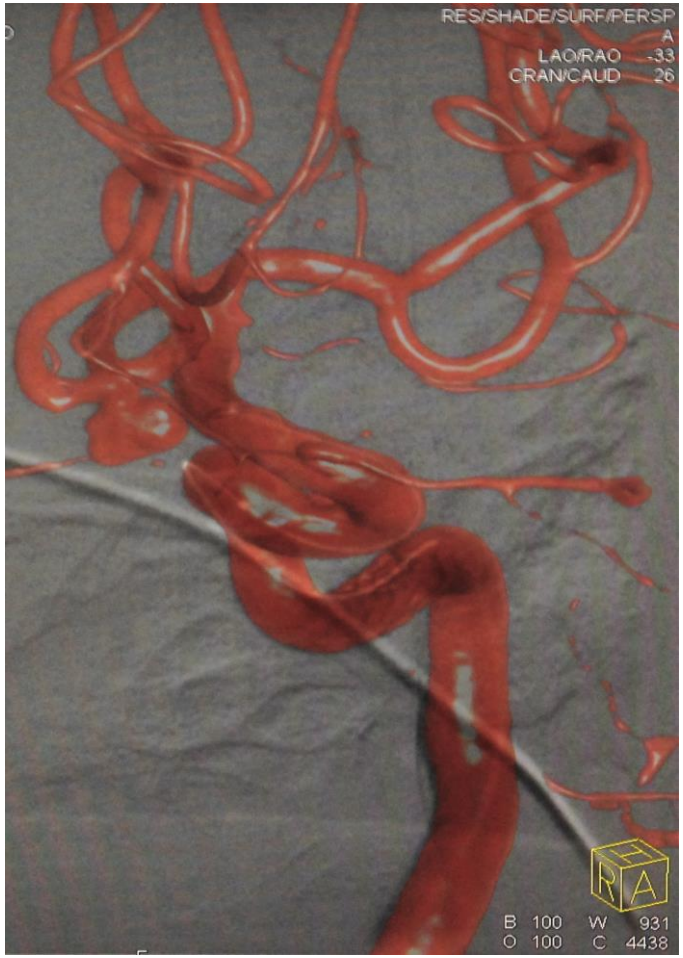
# Siemens Syngo iPilot



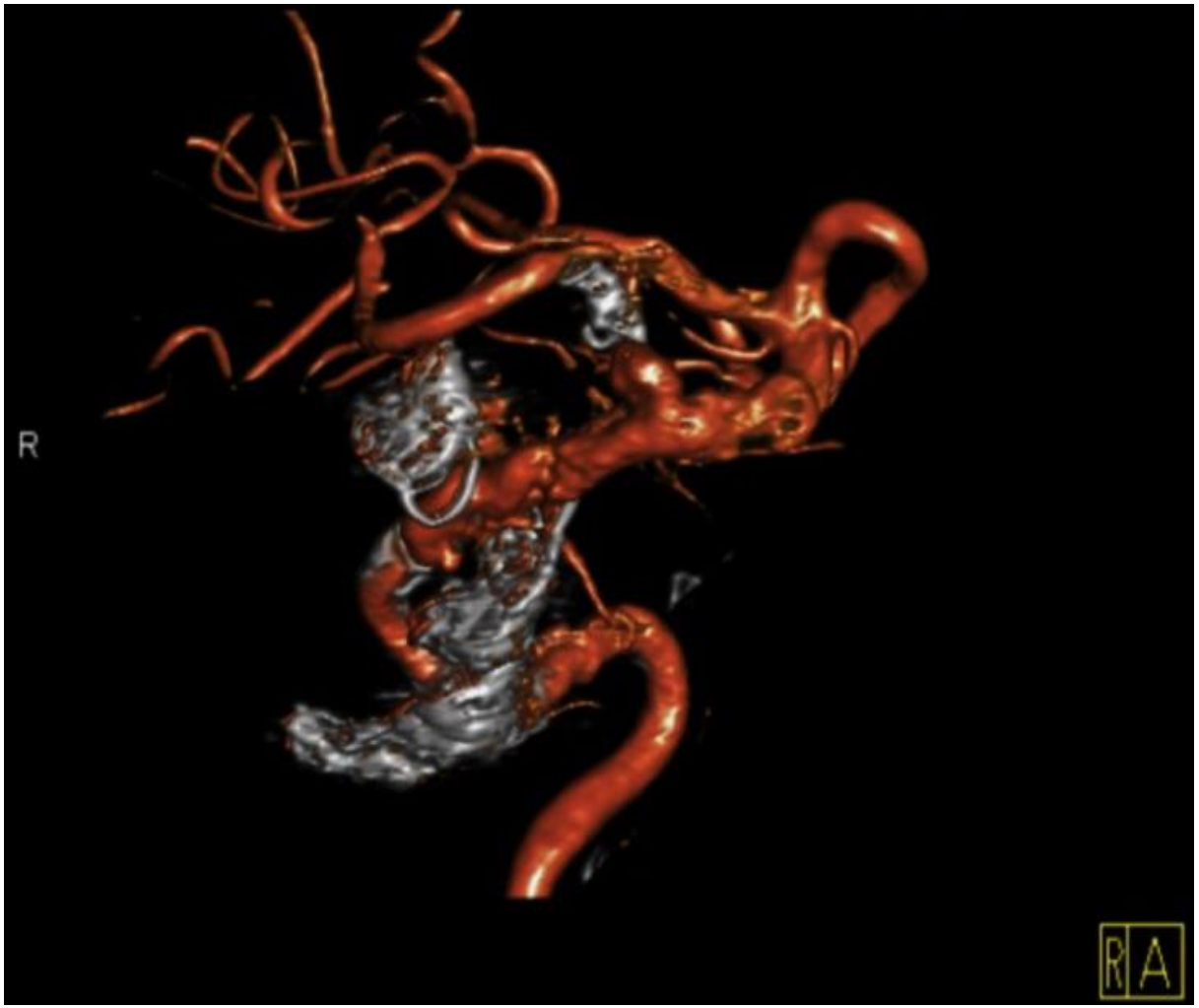

- 3D dynamic overlay.
- Adjustable vessel contrast windowing.
- Allows for visualization of microcatheters, coils, wires, and stents.
- Potential decrease in patient dose, contrast, and examination length.

# 2D Vs. 3D Roadmap



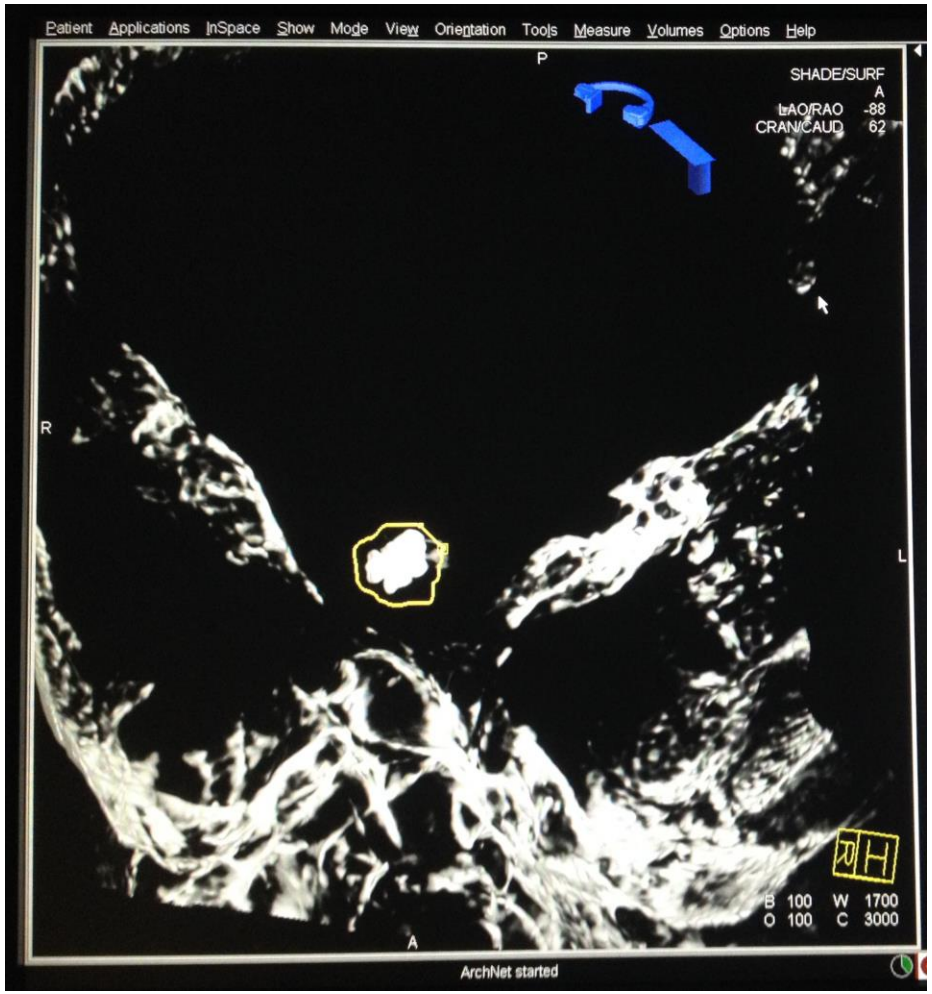



# Dual Volume




- 3D visualization of metallic implants and vasculature.
- 5sDSA Dual Volume acquisition.
- 3 mL/s for 21 mL, 2s XR delay.
- Requires additional post-processing.

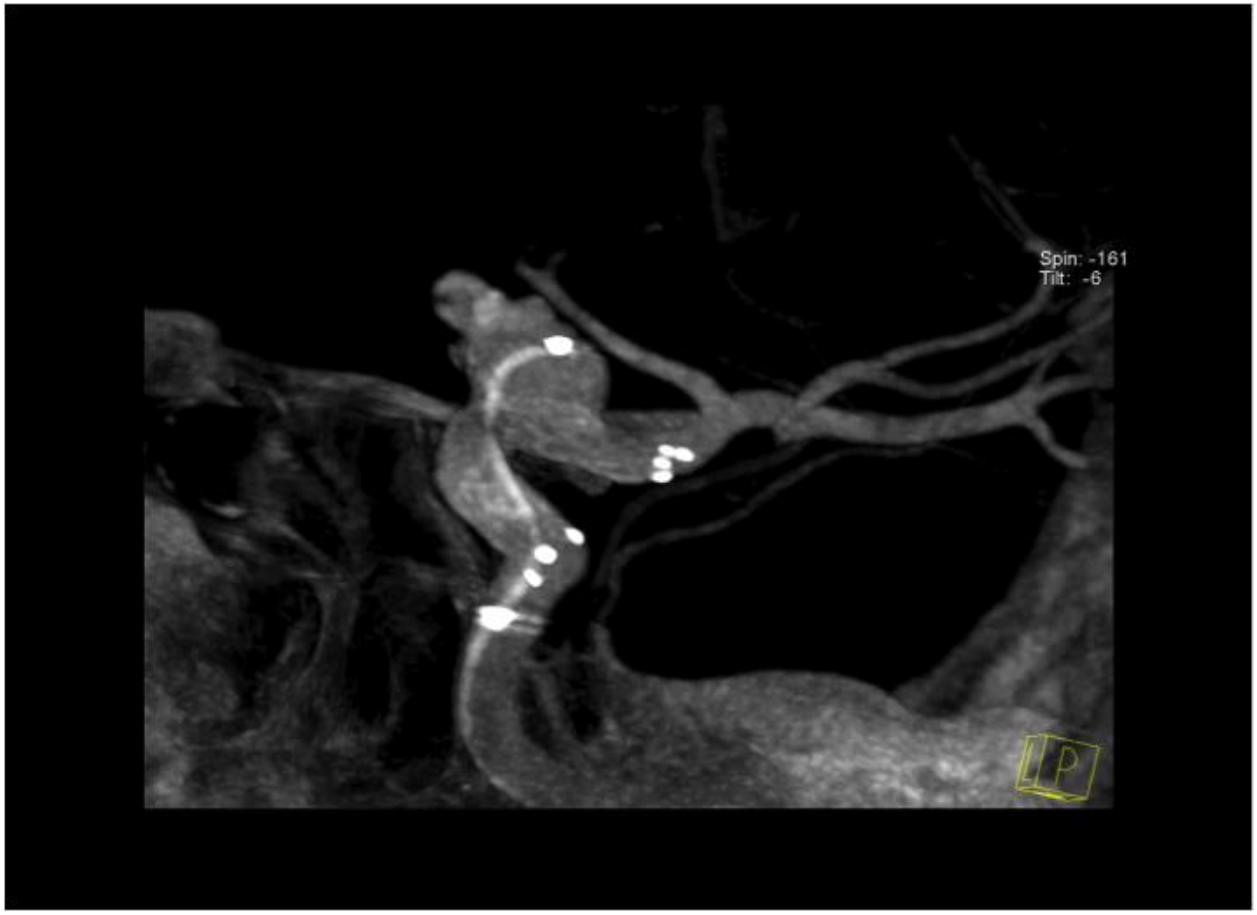
# Dual Volume Post Processing




- **Parameters:** Medium VOI, 512x512 matrix size, Kernel: EE, Image Characteristics: Auto/Smooth, Reconstruction Mode: Sub with MoCo.
- Press reconstruction icon (large box with calculator).
- Close reconstruction, open patient browser, drag and drop in both volumes into Inspace (Sub with Moco and Nat Mask).
- Load merged, change preset to AX AX AutoDualVolume.

# Dual Volume Syngo iPilot Dynamic Overlay

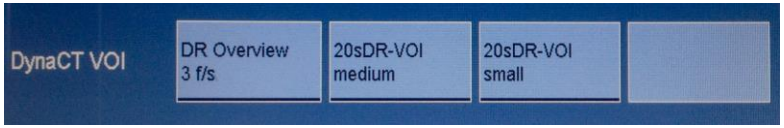
# Dyna CT- Intrastent



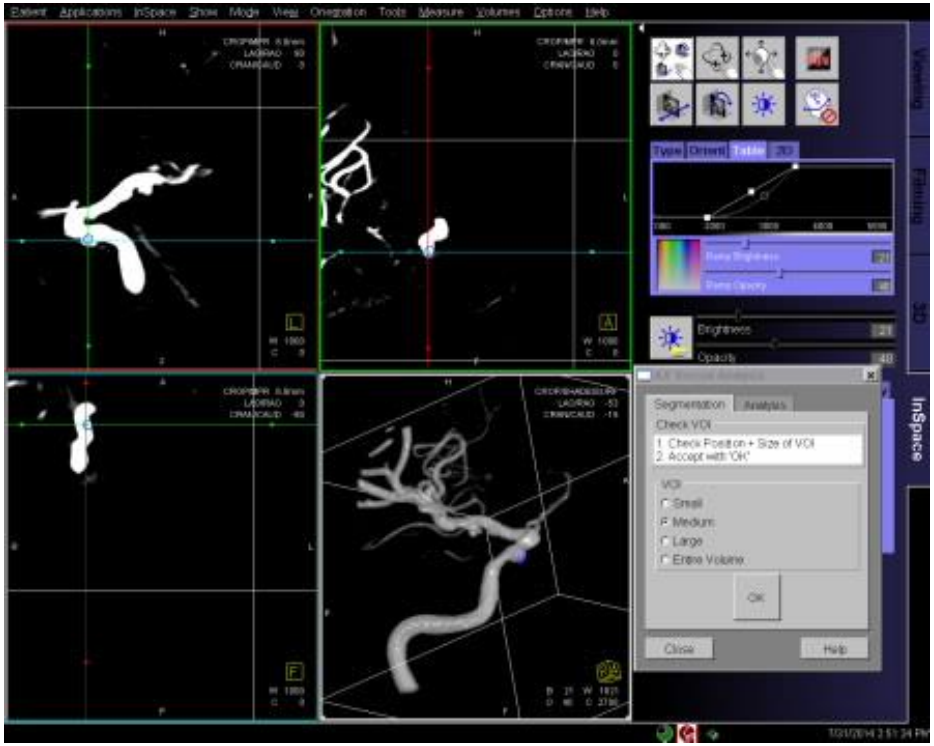

- 20s DR- small or medium VOI.
- Low-contrast injection- 20% dilution.
- 2mL/s for 40mL, 2s XR delay.
- Post processing: thin MIP’s.

# DynaCT- iPilot Overlay

- Non-contrast DynaCT.
- 20 second DR with a small VOI.
- Performed post-stent deployment.
- After post processing, image is overlaid onto live fluro.

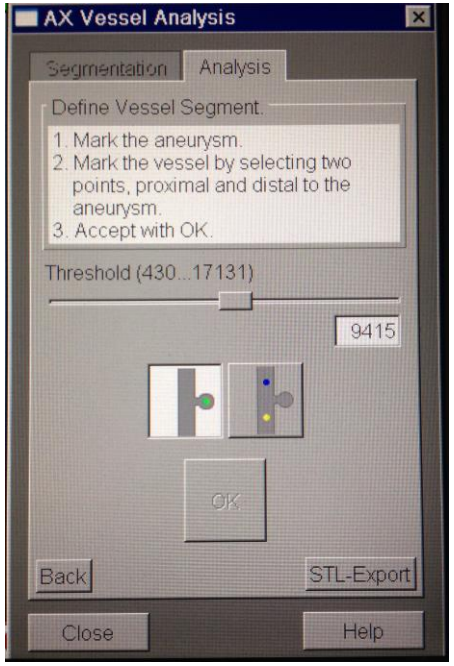


# Siemens Vessel Analysis



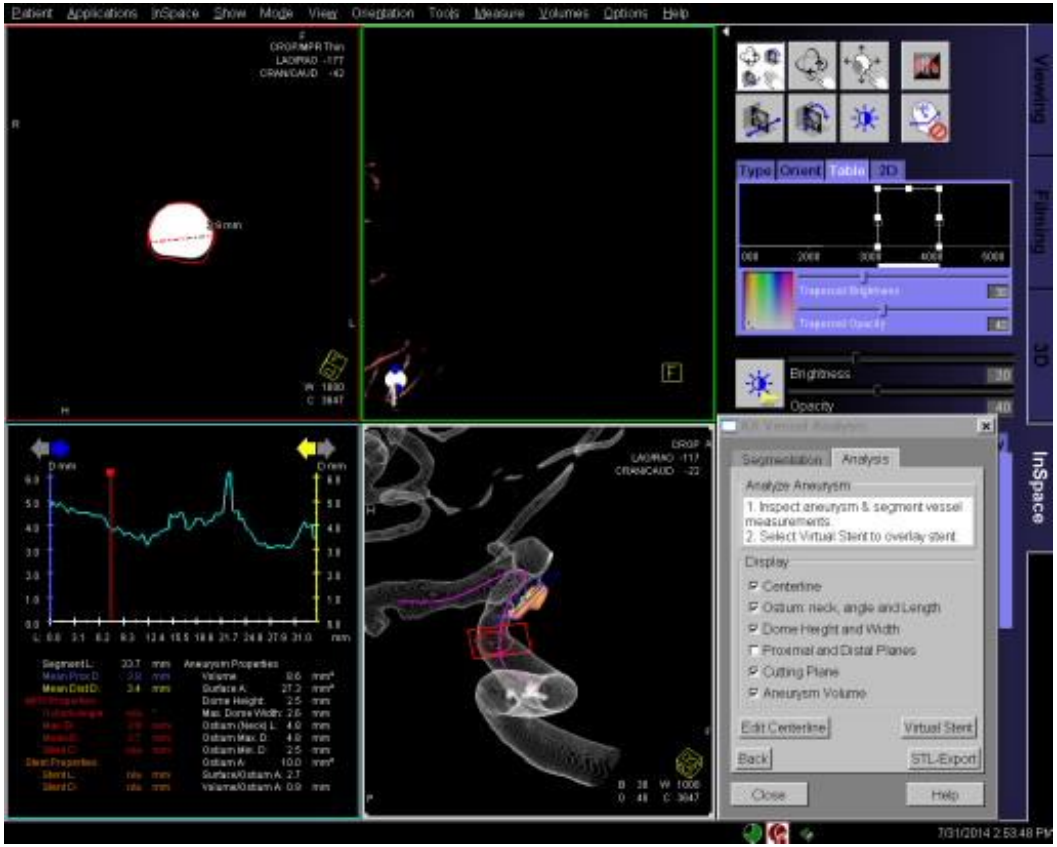

- Load 3D DSA into Inspace.
- Select AX Vessel Analysis (Measure tab).
- Asses stent sizes, vessel diameter, aneurysm neck and length.
- Position for seed point placement.
- Select VOI.
- Select OK.

# Seed Point Placement




- Enable stenosis analysis.
- The workstation automatically segments the vessel after selecting the proper seed points.

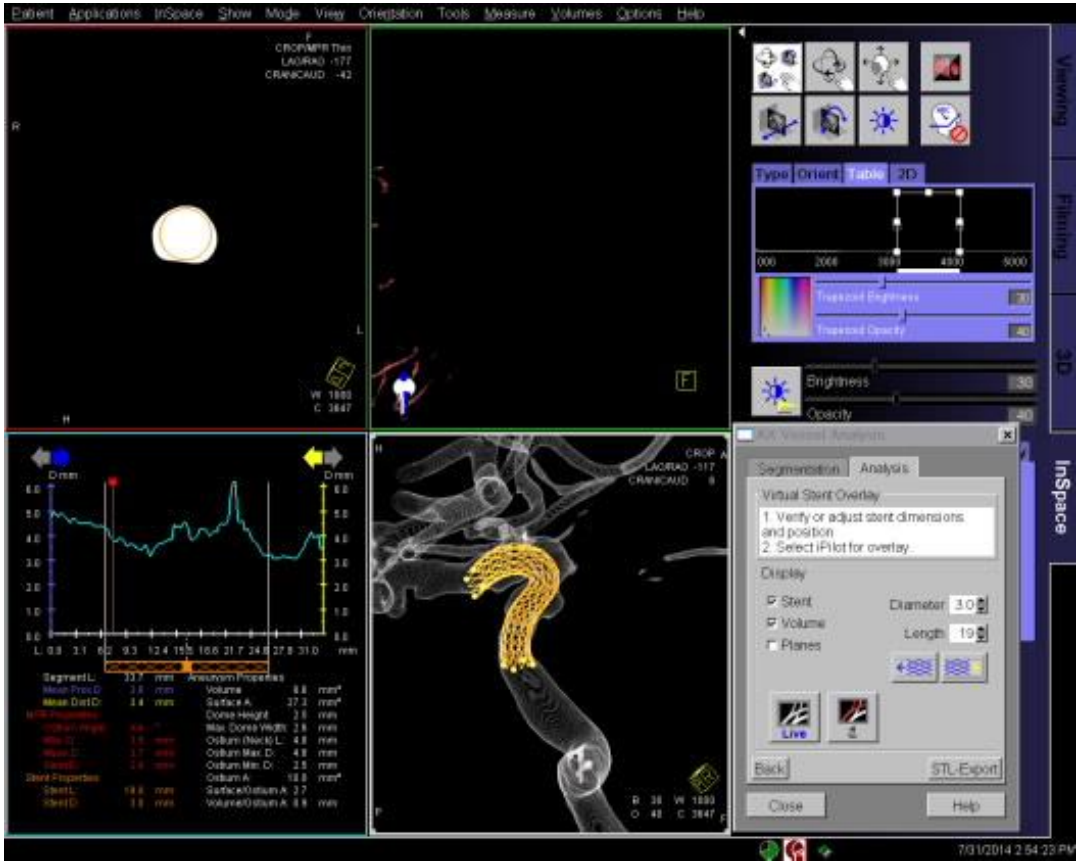
# Layout of Vessel Analysis Tool

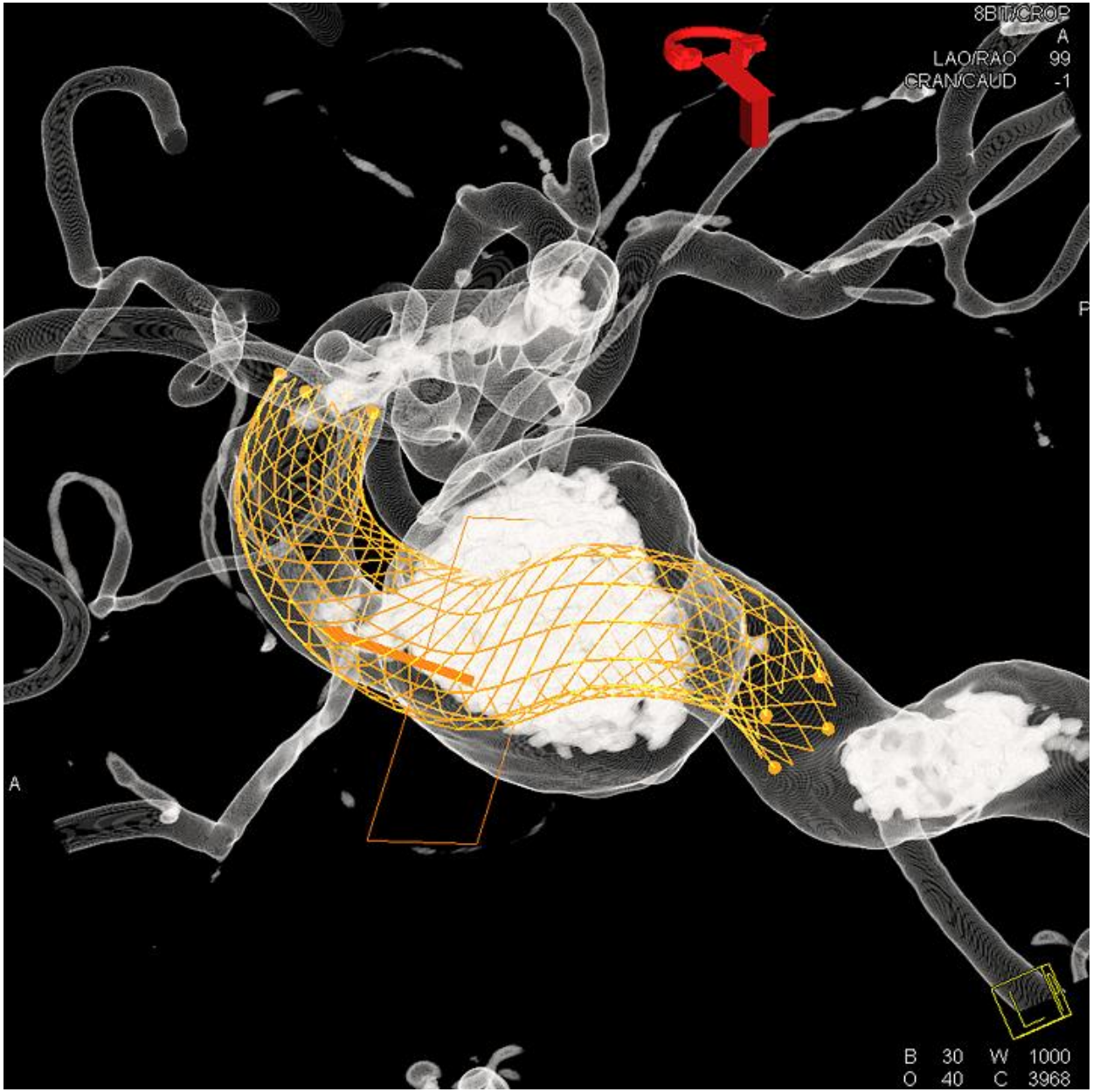



- Top Left: In-plane vessel dimensions (red plane).
- Top Right: Volume rendered endoluminal view (red plane).
- Bottom Left: Vessel and aneurysm dimensions. The red line indicates the position along centerline.
- Bottom Right: Volume rendered vessel, centerline, and aneurysm volume.

# Virtual Stent

- Top Left: In-plane position of stent (red plane).
- Top Right: Volume rendered endoluminal view (red plane).
- Bottom Left: Vessel and aneurysm dimension along the centerline between points.
- Bottom Right: Volume rendered virtual stent.

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# 3D/3D Fusion- iPilot Overlay

- Load CT, MRI, or previous DynaCt (3D volume). Clip around the area on interest- then bookmark.
- Perform 5sDR or 5sDR-LD with patient on the table. Unload 5sDR reconstruction from workstation.
- Load CT, MR, Dyna CT volume into Inspace tab, then open additional volume (5sDR).
- Select 3D/3D fusion (tools tab), align datasets, click on Auto, then pre-aligned, select register (image). Save registration, close all windows.
- Load original study (CT, MR, Dyna CT) and apply bookmark.
- Select iPilot Dynamic to overlay fusion onto workstation.