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# Advanced Imaging for Interventional Neurosurgery

Jason Cotham, RT(R)
Rush University Medical Center
Chicago, IL

# Outline

1. Introduction to neurovascular treatment indications
2. Scan and injection protocols for 3D DSA and DynaCT
3. Reconstruction parameter and secondary reconstruction
4. Tools in *syngo* InSpace and the 3D card for advanced postprocessing
5. Introduction to *syngo* iFlow and *syngo* Virtual Stent

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# Neurovascular Treatment Indications

1. Arterial Venus Malformations (AVM)
2. Subarachnoid Hemorrhage (SAH)
3. Stroke
4. Carotid Stenosis
5. Stent assisted aneurysm coiling

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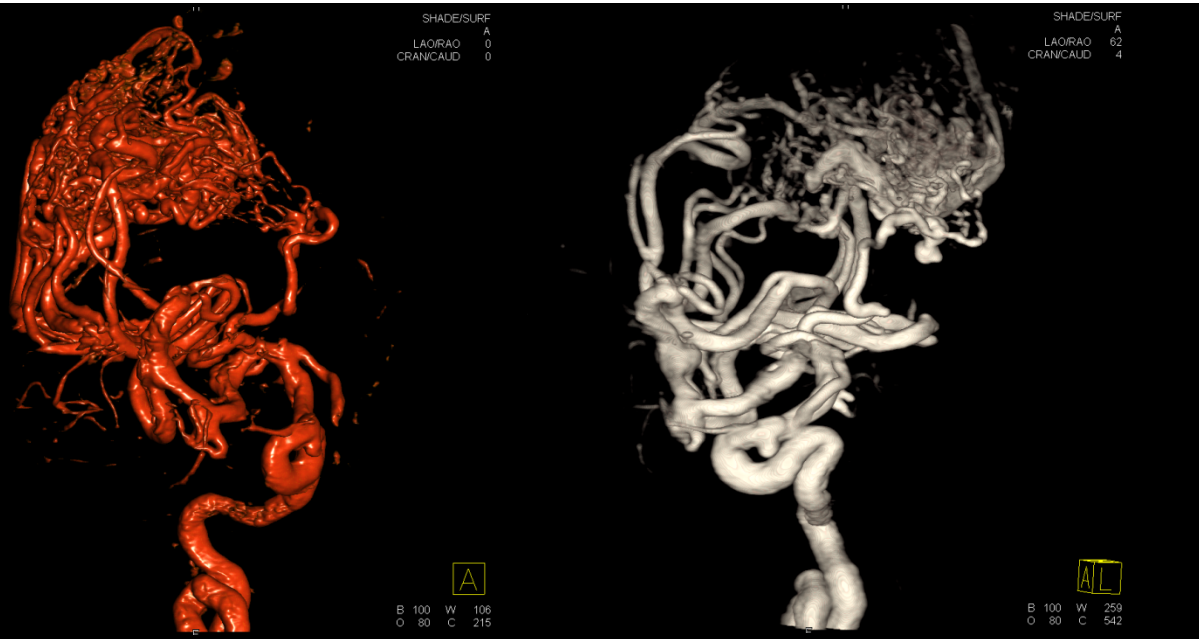
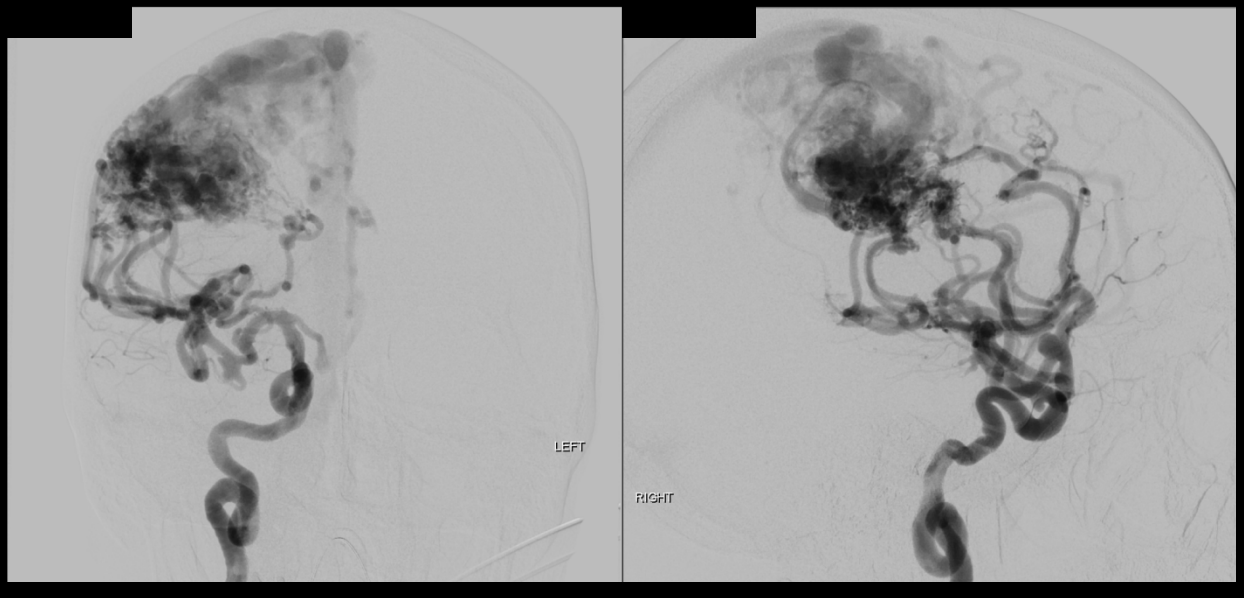
# Arterial Venus Malformations (AVM)

AP and lateral VRT reconstruction showing massive right AVM

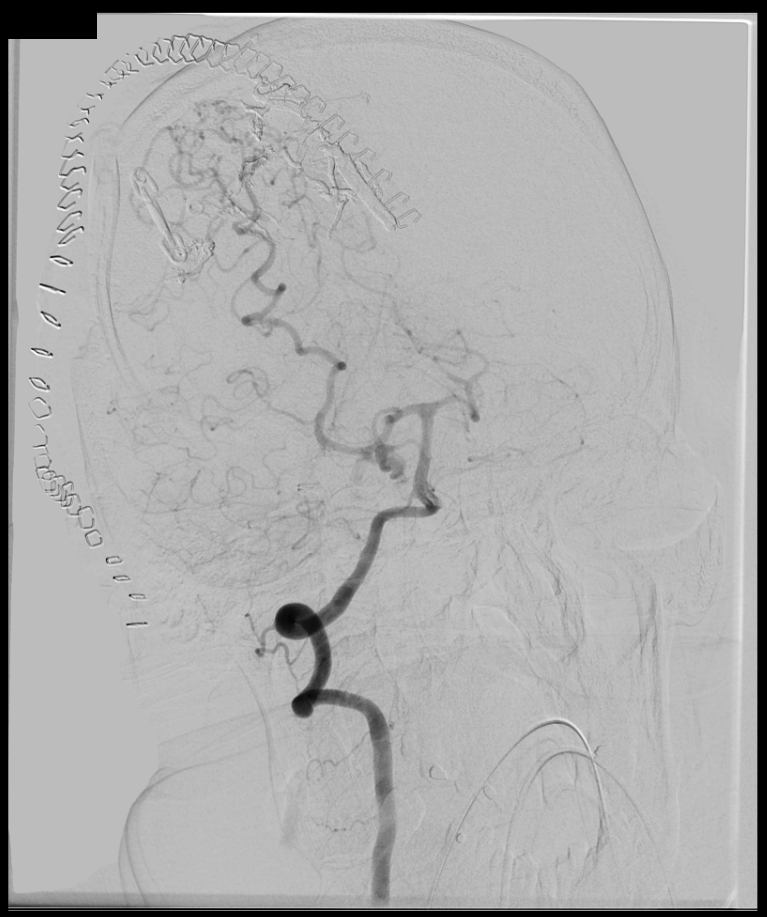



2D DSA AP and lat of massive right AVM



# Arterial Venus Malformations (AVM)

Status after endovascular Onyx embolization
and surgical removal of AVM

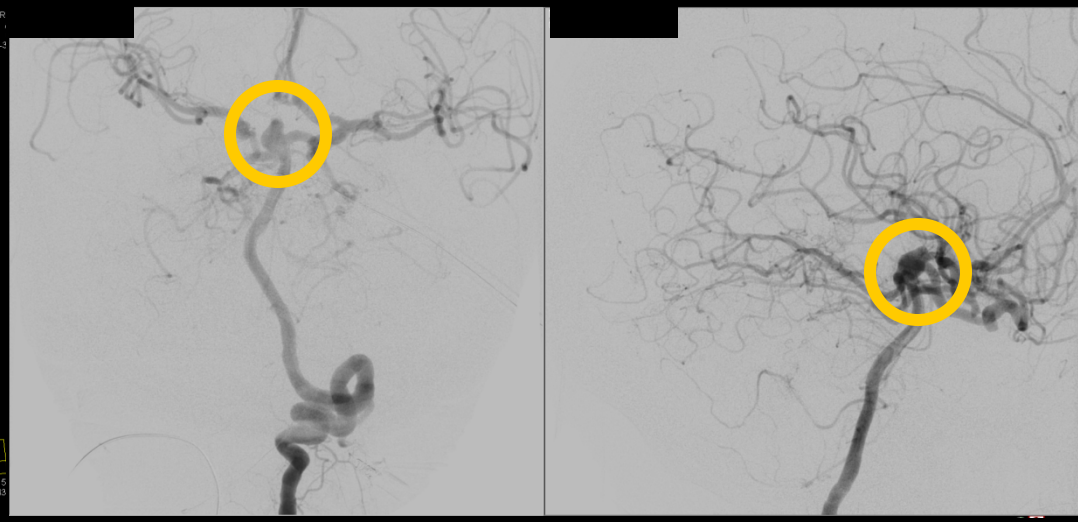


# Subarachnoid Hemorrhage (SAH)

nCT demonstrating SAH

3D DSA showing basilar tip aneurysm

2D DSA before aneurysm coiling

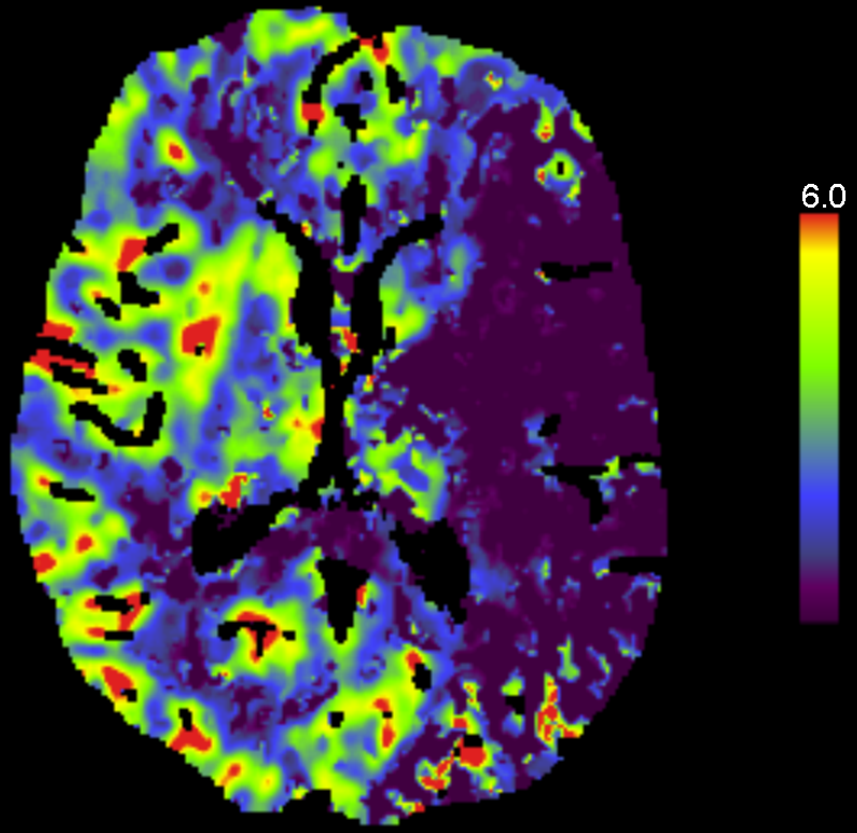


# Subarachnoid Hemorrhage (SAH)

AP and lateral 2D DSA view of coiled basilar tip aneurysm

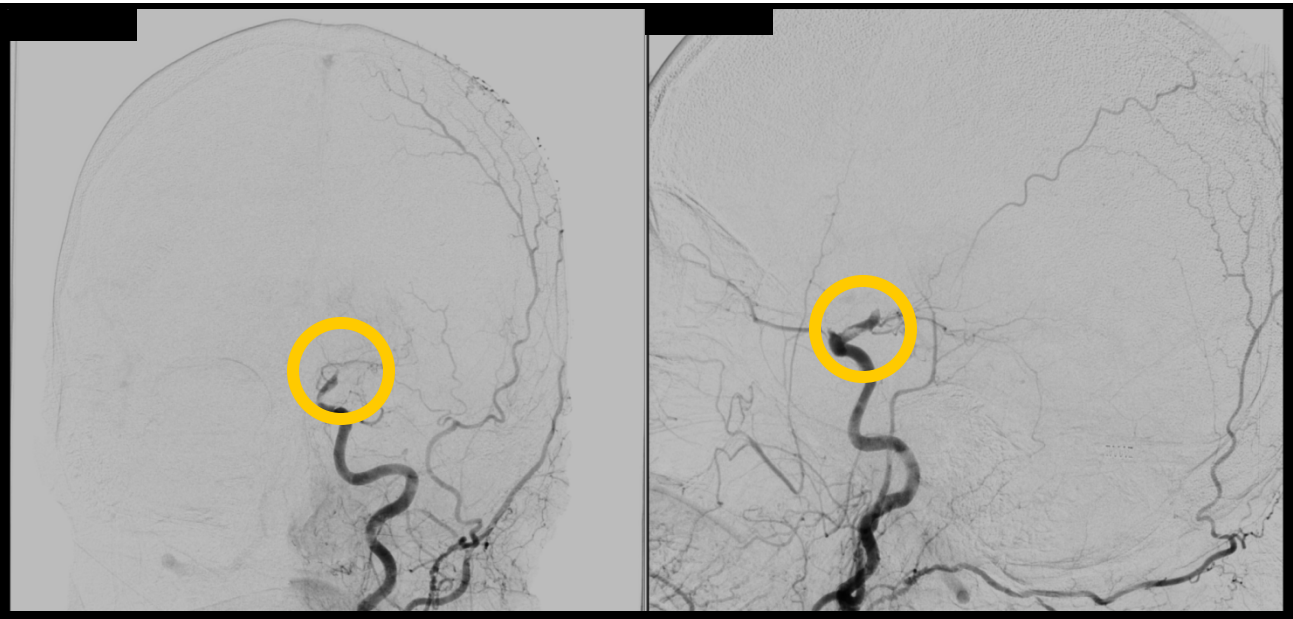

# Stroke

CT Perfusion (CBV) demonstrating left MCA artifact

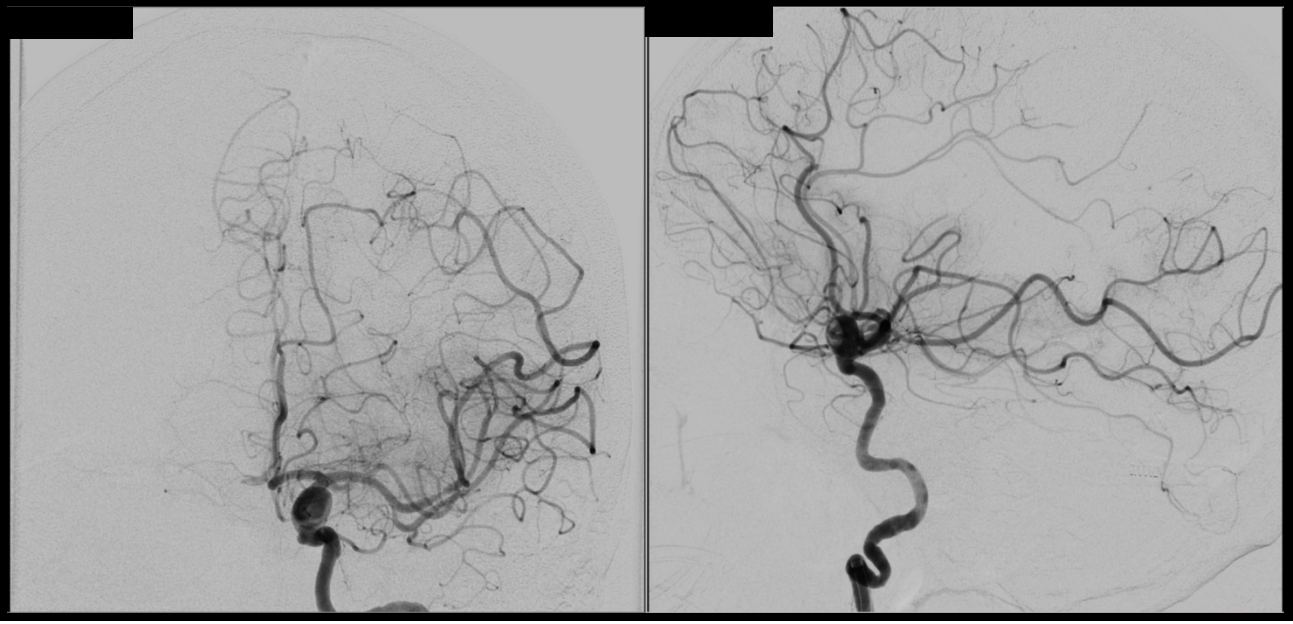


# Stroke

Biplane DSA showing occlusion of left MCA



After mechanical thrombolysis treatment showing left ICA aneurysm



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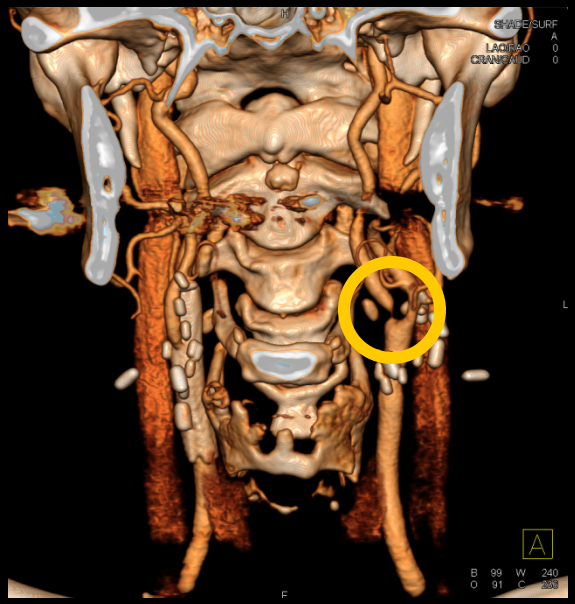
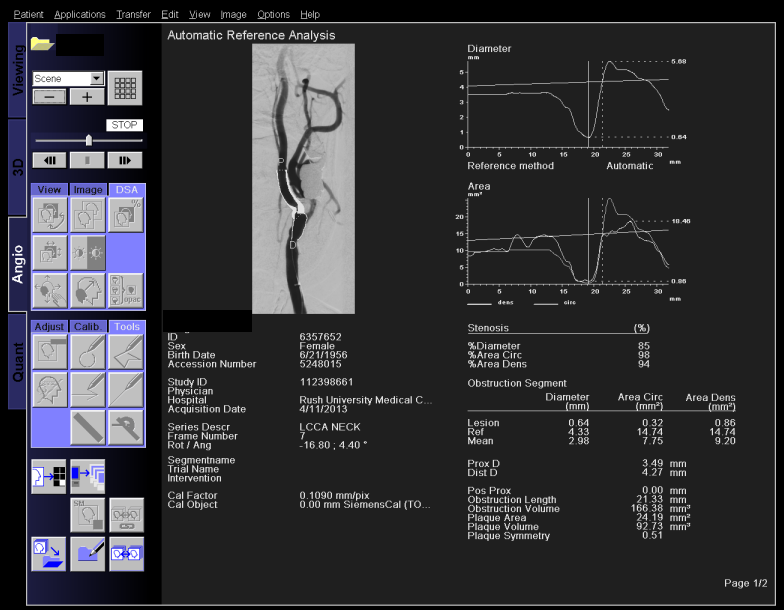
# Carotid Stenosis

Pre-CTA of left internal carotid artery stenosis



DSA run prior to stent placement

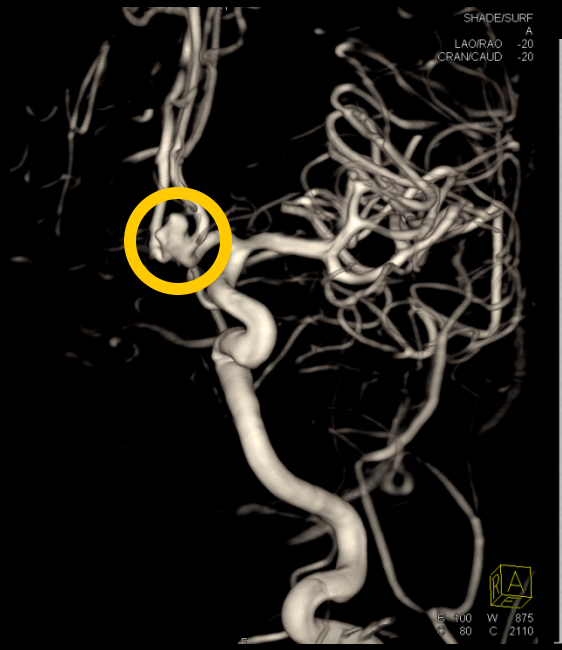
Evaluation of stenosis using Quant




DSA run post stent

# Stent/ Coiling of Aneurysm

3D DSA showing left ACA* aneurysm




Post stent placement


Post stent placement and aneurysm coiling

* ACA: anterior communicating artery

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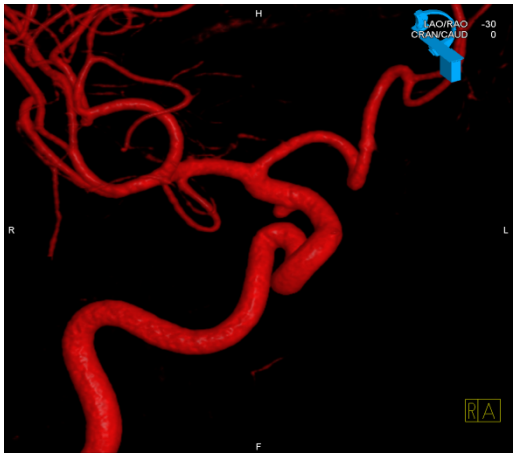
# Scan and injection protocols for 3D DSA

3D DSA protocols and indication

- 5sDSA: aneurysm, intracranial stenosis
- 10sDSA: AVM, tumor




Injection Protocol for 5sDSA:

- Flow rate: 3cc/ sec.
- Total volume: 21cc
- X-ray delay: 2 sec
- Contrast dilution: Full strength


Injection protocol for 10sDSA:

- Flow rate: 3cc/ sec.
- Total volume: 36cc
- X-ray delay: 2 sec
- Contrast dilution: Full strength

**Total volume: Flow rate x (run time + X-ray delay)**

# Scan and injection protocols for DynaCT

Used DynaCT protocols and indication

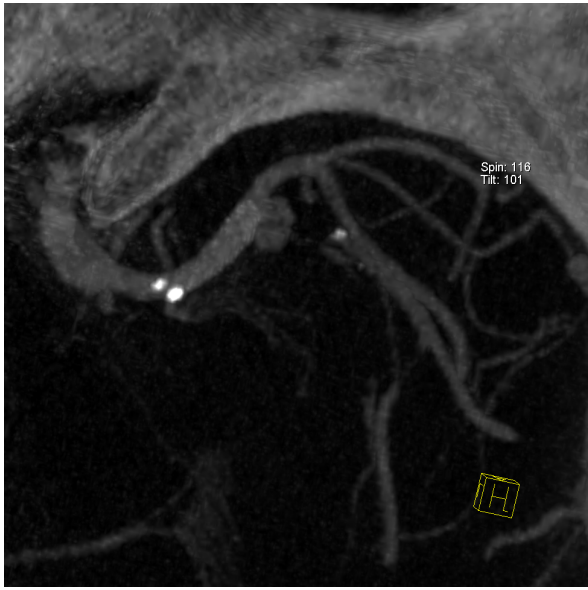
- 20sDR (70kV): bleed
- 20sDR (109kV, reduces metal artifacts): stent follow-up

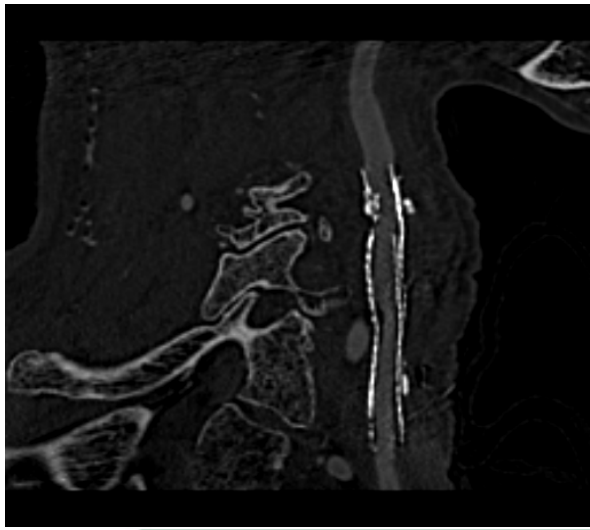
Injection Protocol for 20sDR Intrastent:

- Flow rate: 2cc/sec
- Total volume: 40cc
- X-ray delay: 2sec
- Contrast dilution: 20% (20cc contrast, 80cc saline)

Injection protocol for ivDynaCT:

- Flow rate: 4cc/sec
- Total volume: 80cc
- X-ray delay: 13sec
- Contrast dilution: full strength



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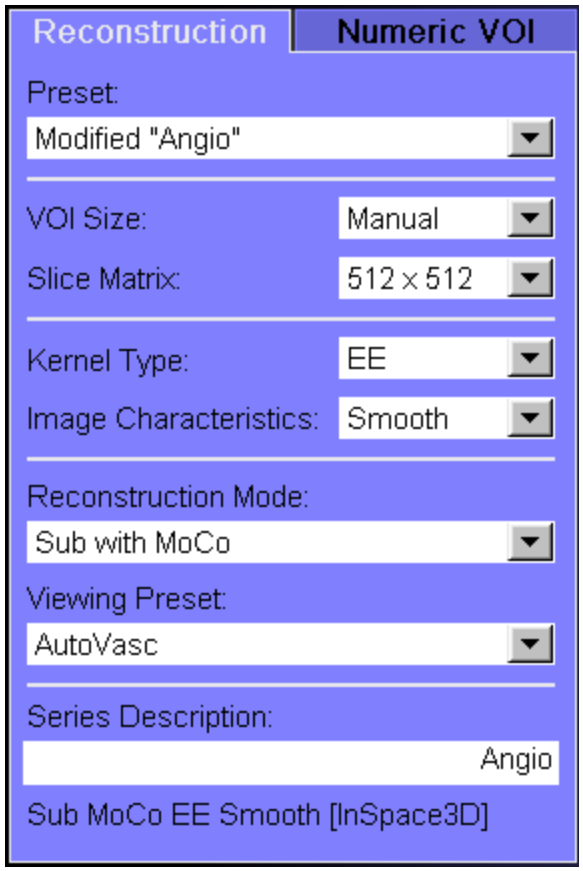
# Reconstruction parameter I




Preset:

- Defines all following parameters, specific for one application, e.g. DynaCT Head

VOI Size:

- Defines the size of the reconstruction
- Options: Small, medium, full

Slice Matrix:

- Should always be 512x512 for best resolution

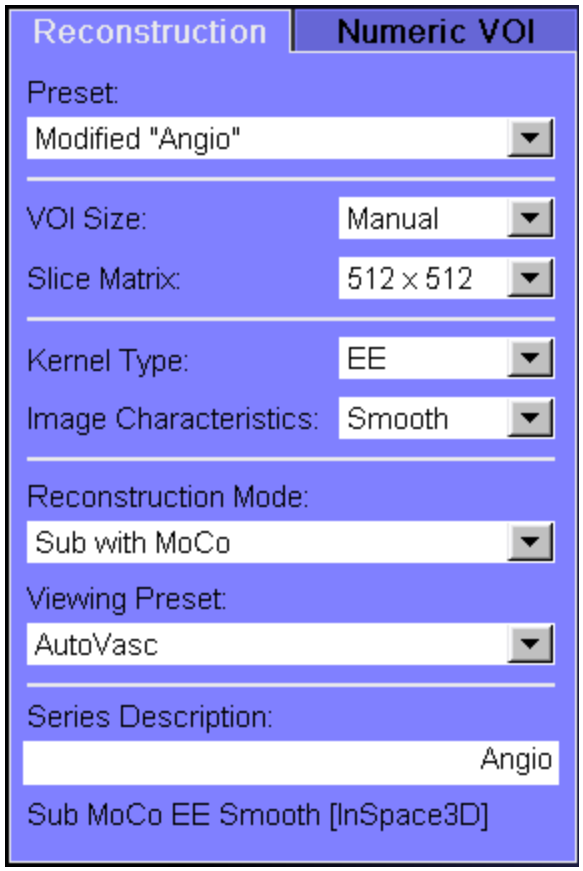
Kernel Type:

- EE: Edge Enhancement, for 3D DSA only
- HU: Hounsfield Unit, for DynaCT's

Image Characteristics:

- Similar to kernel in CT
- Options: very smooth, smooth, normal, sharp, auto
- If 3D DSA images are very noisy, use *smooth*
- For DynaCT use *normal*
- For stent visualization use *sharp*
- *Auto* often defaults on sharp

# Reconstruction parameter II




Reconstruction mode:

- Options: Sub, NatFill, NatMask, Sub with MoCo, Dual Volume, Dual Volume with MoCo
- *Sub (with MoCo):* Use for all 3D DSA
- *Dual Volume (with MoCo):* Use for 3D DSA with metal implants, e.g. coils, clips to visualize metal in a different color
- *NatMask:* Use for 3D DSA to reconstruct only the non-contrast mask run
- *NatFill:* Use for 3D DSA to reconstruct CT like images

Viewing Preset:

- Defines how the reconstruction will be shown in InSpace, e.g. Golden for 3D DSA

Series Description:

- Gives the reconstruction a name to be easily identified in the Patient Browser

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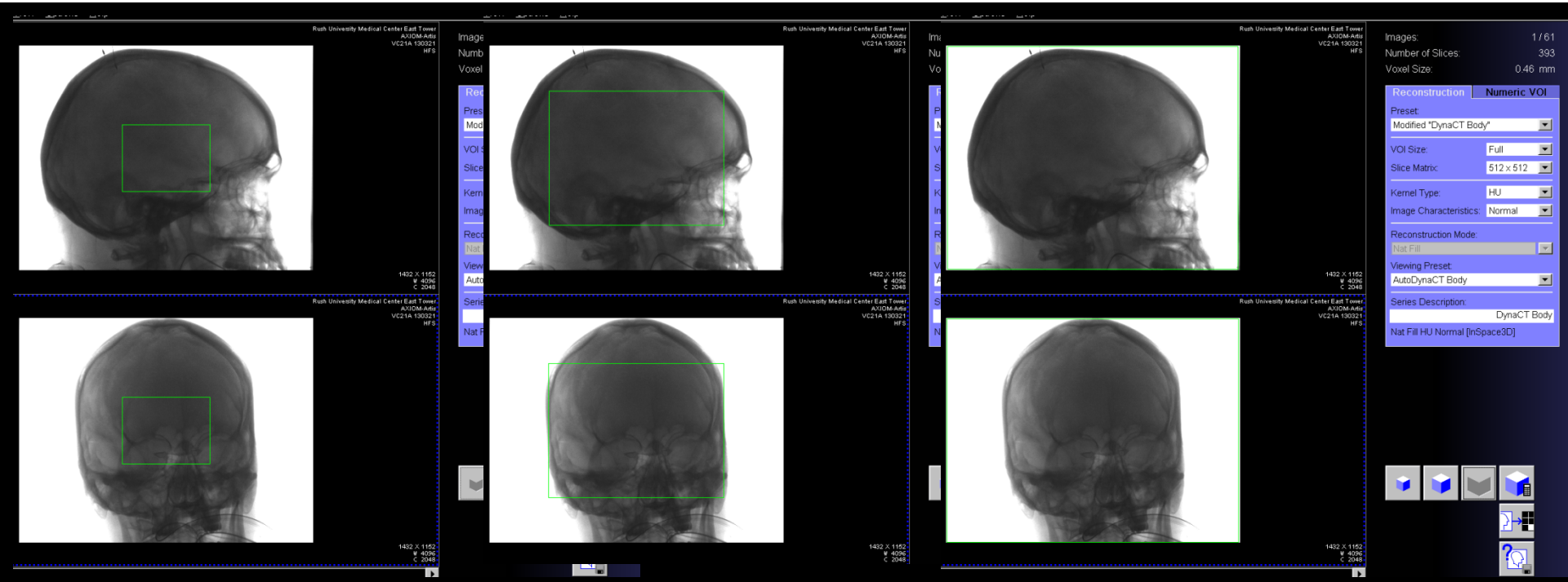
# VOI Sizes




Small VOI

Medium VOI

Large VOI

Small VOI: For best resolution, e.g. stent, small vessels, bony structures
Medium VOI: Standard for 3D DSA
Large VOI: To include the entire scan field, e.g. AVM's or DynaCT's for registration purposes

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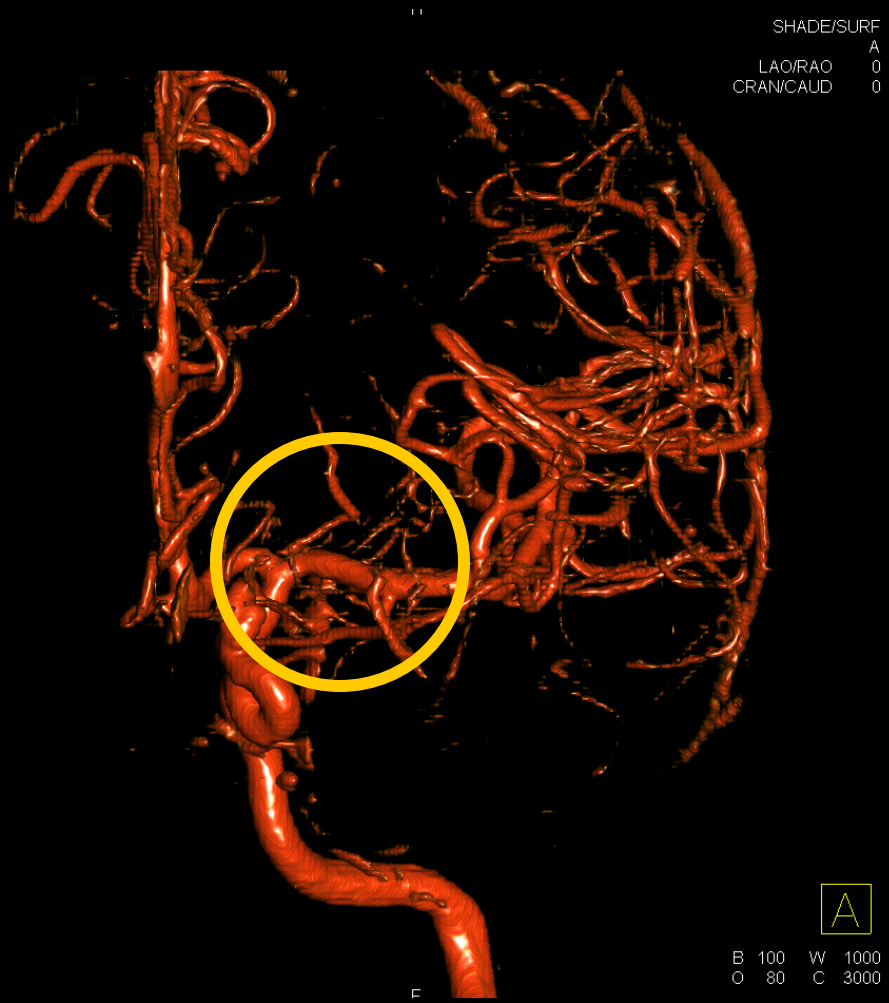
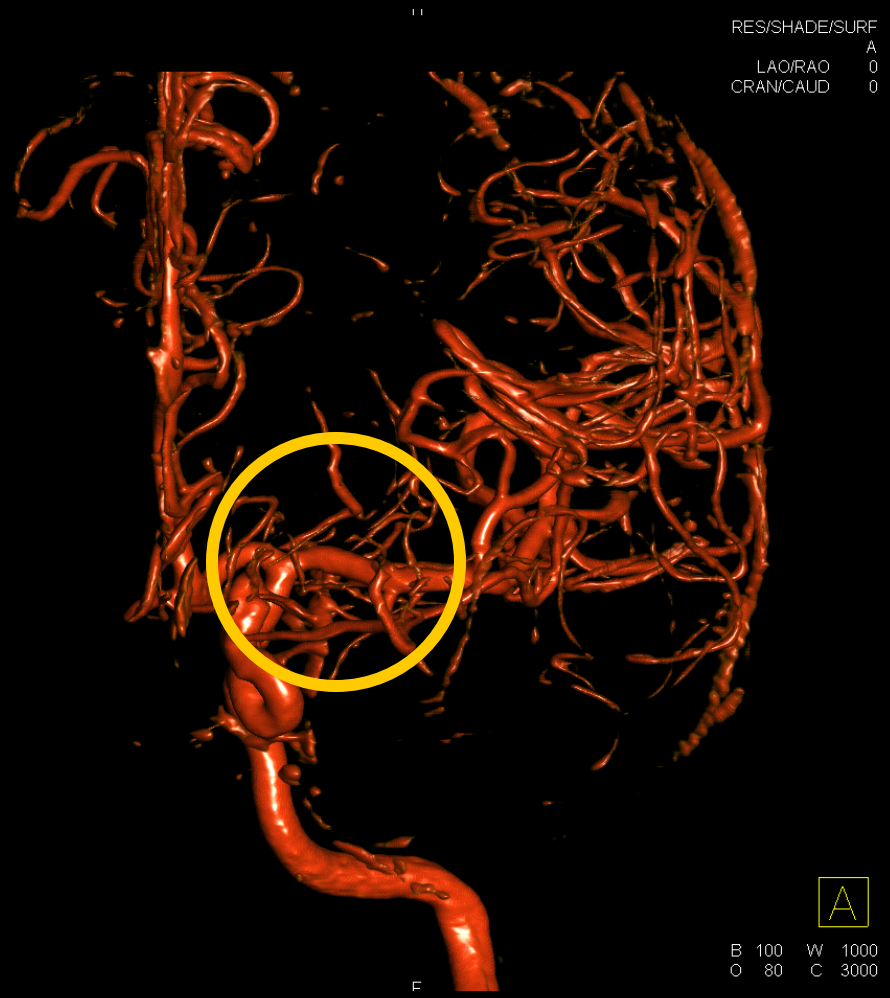
# Slice Matrix

256 slice matrix

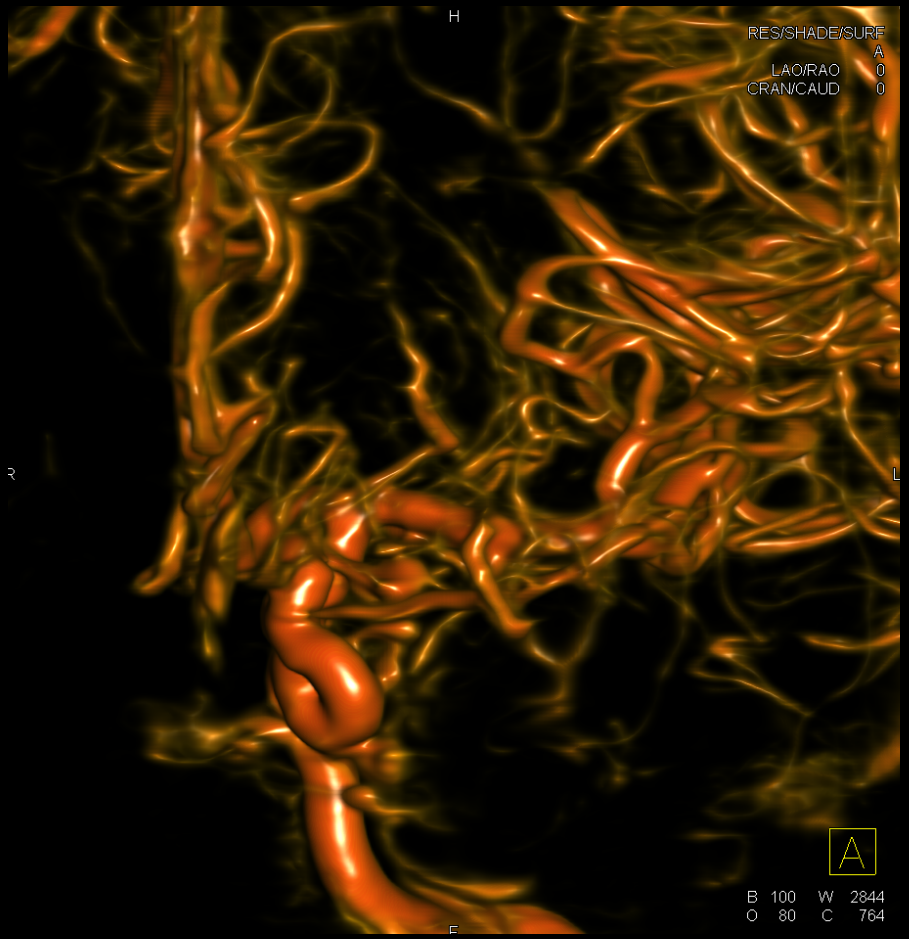



512 slice matrix

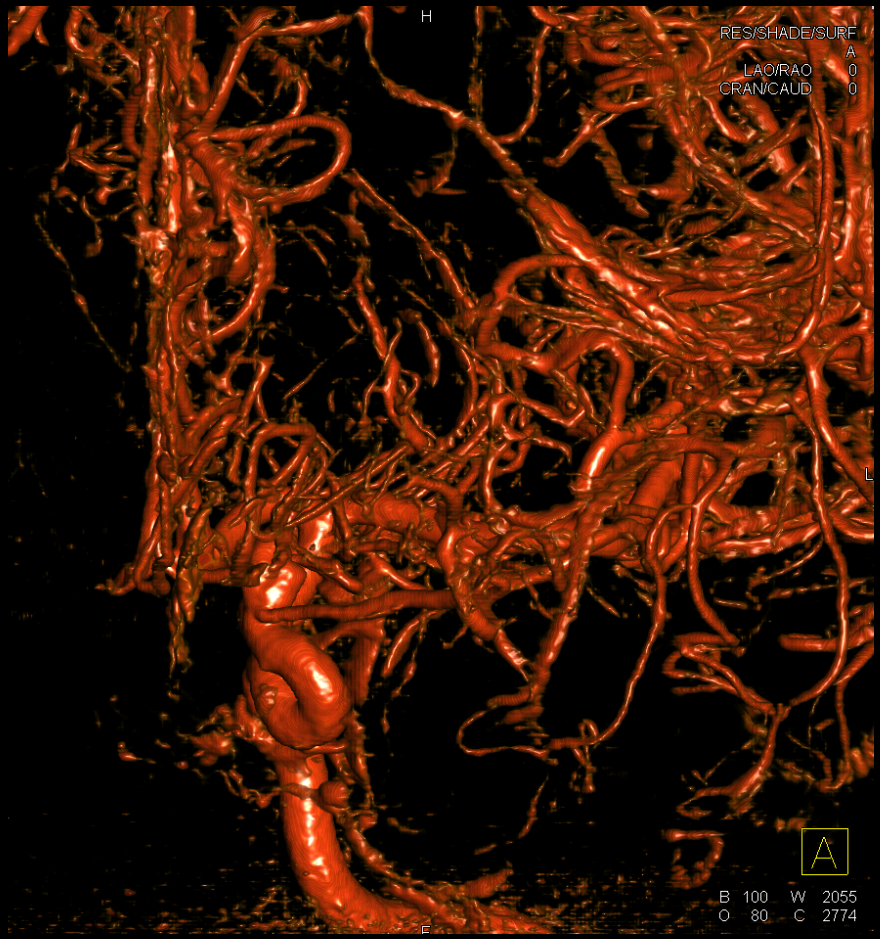


# Image Characteristics

## Smooth




## Sharp



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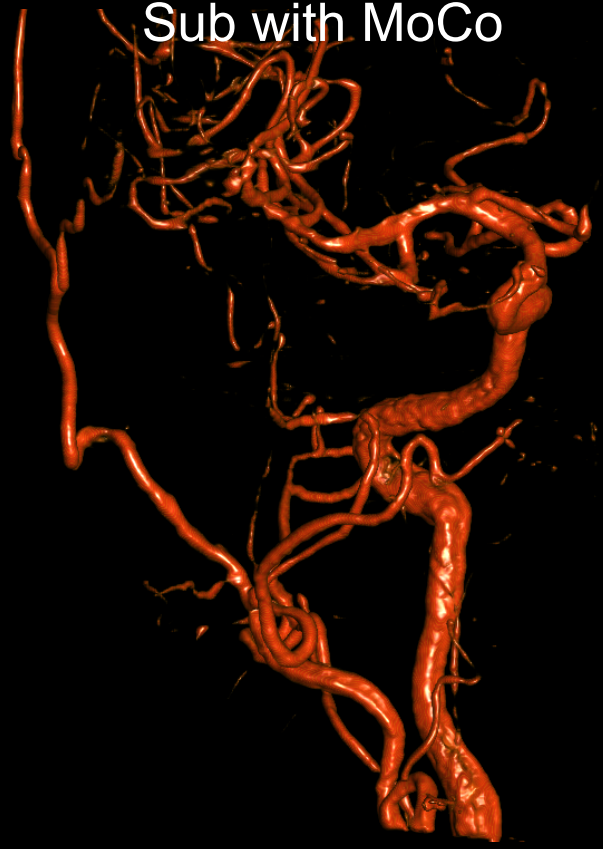
# 3D DSA with Motion Correction


How to get there:

1. Load e.g. 5sDSA into InSpace Reconstruction (*Patient* -> *Send to 3D*)
2. Under *Reconstruction Mode* select "*Sub with MoCo*"
3. Start reconstruction

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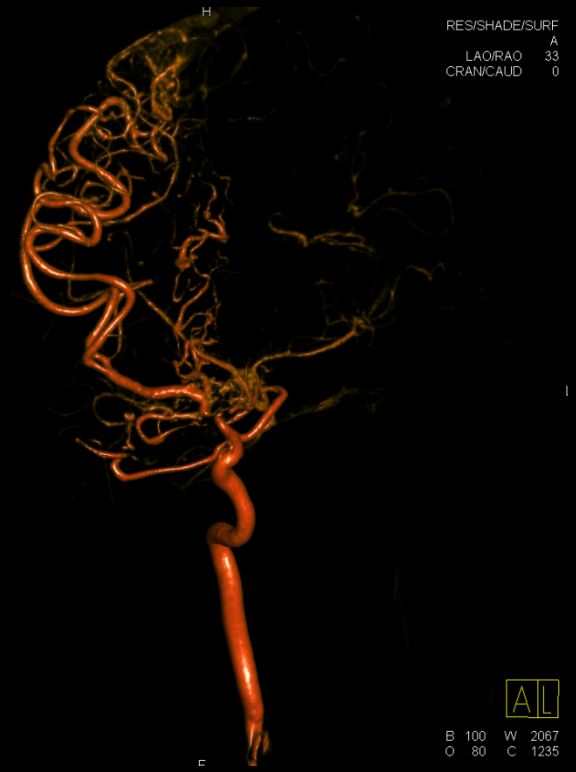
# NatFill recon of 3D DSA

Primary Reconstruction




Secondary Reconstruction

How to get there

1. Load e.g. 10sDSA into InSpace Reconstruction (*Patient* -> *Send to 3D*)
2. Under *Reconstruction Mode* select "*NatFill*"
3. Start reconstruction

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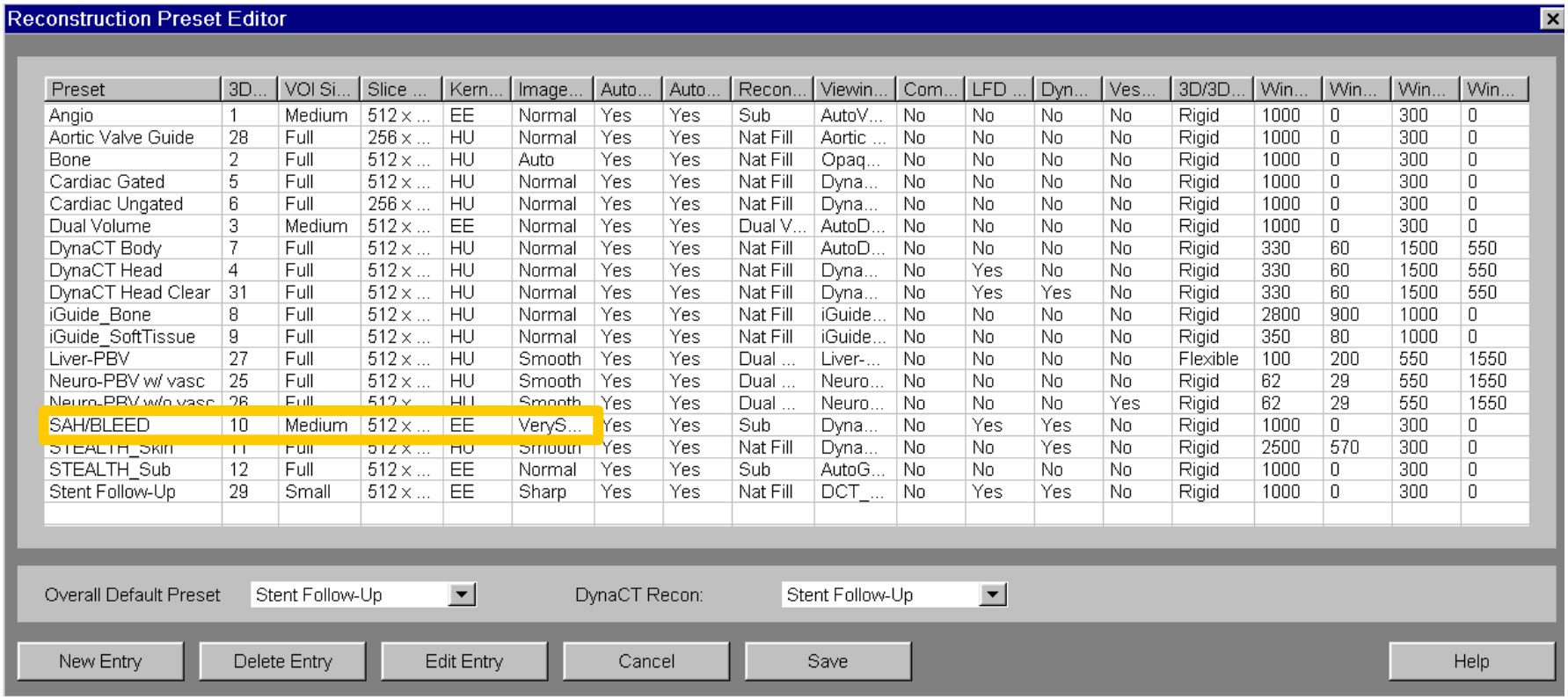
# Reconstruction Preset Editor




| Preset | 3D... | VOI Si... | Slice ... | Kern... | Image... | Auto... | Auto... | Recon... | Viewin... | Com... | LFD ... | Dyn... | Ves... | 3D/3D... | Win... | Win... | Win... | Win... |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Angio | 1 | Medium | 512 x ... | EE | Normal | Yes | Yes | Sub | AutoV... | No | No | No | No | Rigid | 1000 | 0 | 300 | 0 |
| Aortic Valve Guide | 28 | Full | 256 x ... | HU | Normal | Yes | Yes | Nat Fill | Aortic ... | No | No | No | No | Rigid | 1000 | 0 | 300 | 0 |
| Bone | 2 | Full | 512 x ... | HU | Auto | Yes | Yes | Nat Fill | Opaq... | No | No | No | No | Rigid | 1000 | 0 | 300 | 0 |
| Cardiac Gated | 5 | Full | 512 x ... | HU | Normal | Yes | Yes | Nat Fill | Dyna... | No | No | No | No | Rigid | 1000 | 0 | 300 | 0 |
| Cardiac Ungated | 6 | Full | 256 x ... | HU | Normal | Yes | Yes | Nat Fill | Dyna... | No | No | No | No | Rigid | 1000 | 0 | 300 | 0 |
| Dual Volume | 3 | Medium | 512 x ... | EE | Normal | Yes | Yes | Dual V... | AutoD... | No | No | No | No | Rigid | 1000 | 0 | 300 | 0 |
| DynaCT Body | 7 | Full | 512 x ... | HU | Normal | Yes | Yes | Nat Fill | AutoD... | No | No | No | No | Rigid | 330 | 60 | 1500 | 550 |
| DynaCT Head | 4 | Full | 512 x ... | HU | Normal | Yes | Yes | Nat Fill | Dyna... | No | Yes | No | No | Rigid | 330 | 60 | 1500 | 550 |
| DynaCT Head Clear | 31 | Full | 512 x ... | HU | Normal | Yes | Yes | Nat Fill | Dyna... | No | Yes | Yes | No | Rigid | 330 | 60 | 1500 | 550 |
| iGuide_Bone | 8 | Full | 512 x ... | HU | Normal | Yes | Yes | Nat Fill | iGuide... | No | No | No | No | Rigid | 2800 | 900 | 1000 | 0 |
| iGuide_SoftTissue | 9 | Full | 512 x ... | HU | Normal | Yes | Yes | Nat Fill | iGuide... | No | No | No | No | Rigid | 350 | 80 | 1000 | 0 |
| Liver-PBV | 27 | Full | 512 x ... | HU | Smooth | Yes | Yes | Dual ... | Liver-... | No | No | No | No | Flexible | 100 | 200 | 550 | 1550 |
| Neuro-PBV w/ vasc | 25 | Full | 512 x ... | HU | Smooth | Yes | Yes | Dual ... | Neuro... | No | No | No | No | Rigid | 62 | 29 | 550 | 1550 |
| Neuro-PBV w/o vasc | 26 | Full | 512 x ... | HU | Smooth | Yes | Yes | Dual ... | Neuro... | No | No | No | Yes | Rigid | 62 | 29 | 550 | 1550 |
| SAH/BLEED | 10 | Medium | 512 x ... | EE | VeryS... | Yes | Yes | Sub | Dyna... | No | Yes | Yes | No | Rigid | 1000 | 0 | 300 | 0 |
| STEALTH_Skin | 11 | Full | 512 x ... | HU | Smooth | Yes | Yes | Nat Fill | Dyna... | No | No | Yes | No | Rigid | 2500 | 570 | 300 | 0 |
| STEALTH_Sub | 12 | Full | 512 x ... | EE | Normal | Yes | Yes | Sub | AutoG... | No | No | No | No | Rigid | 1000 | 0 | 300 | 0 |
| Stent Follow-Up | 29 | Small | 512 x ... | EE | Sharp | Yes | Yes | Nat Fill | DCT_... | No | Yes | Yes | No | Rigid | 1000 | 0 | 300 | 0 |

- Each preset is linked to a protocol on the Artis
- Stores all reconstruction parameters specific to each protocol
- Create custom secondary reconstructions (e.g. SAH/BLEED using a VerySmooth image characteristic)

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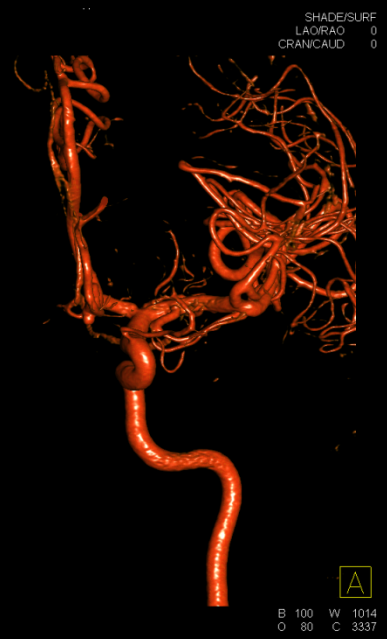
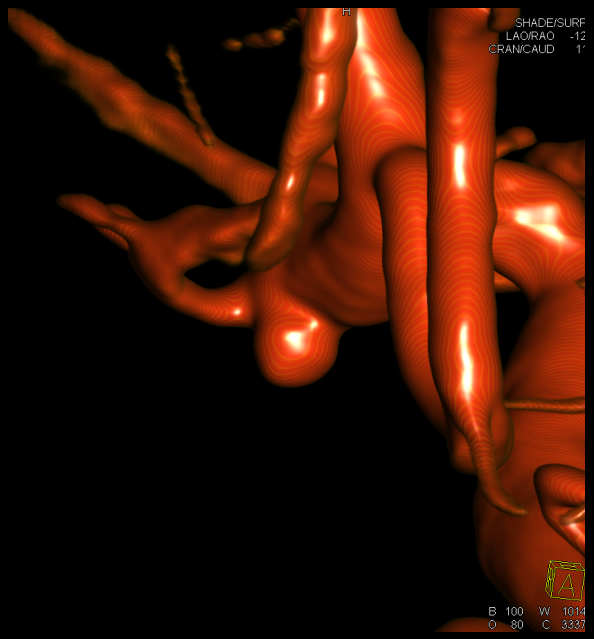
# Post processing for 3D DSA (diagnostic)

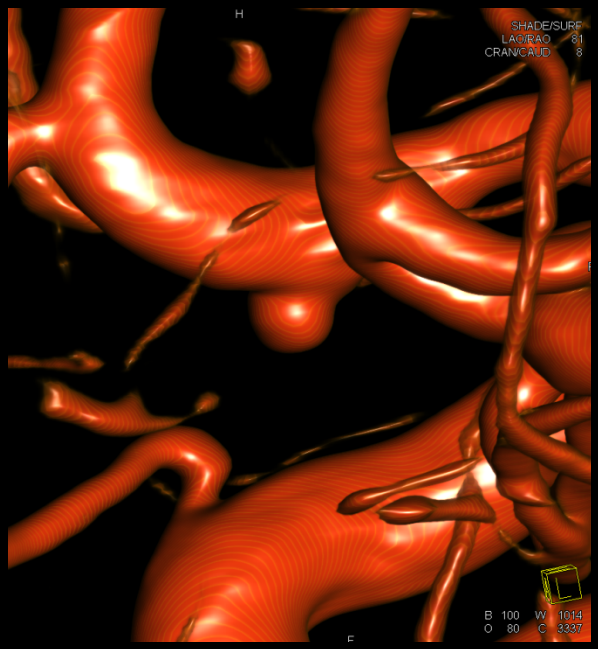
Default AP view




Anterior oblique view




Left oblique view



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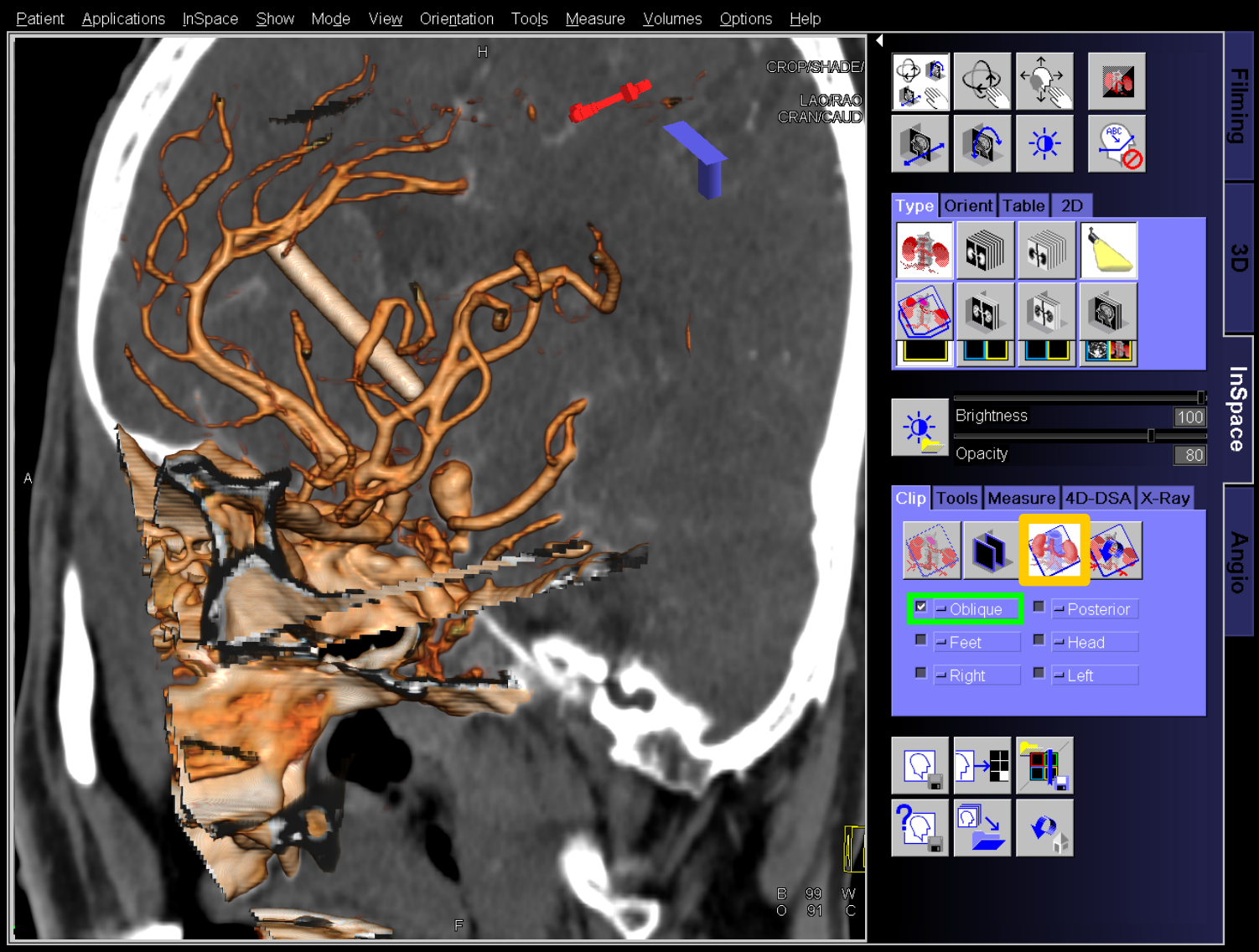
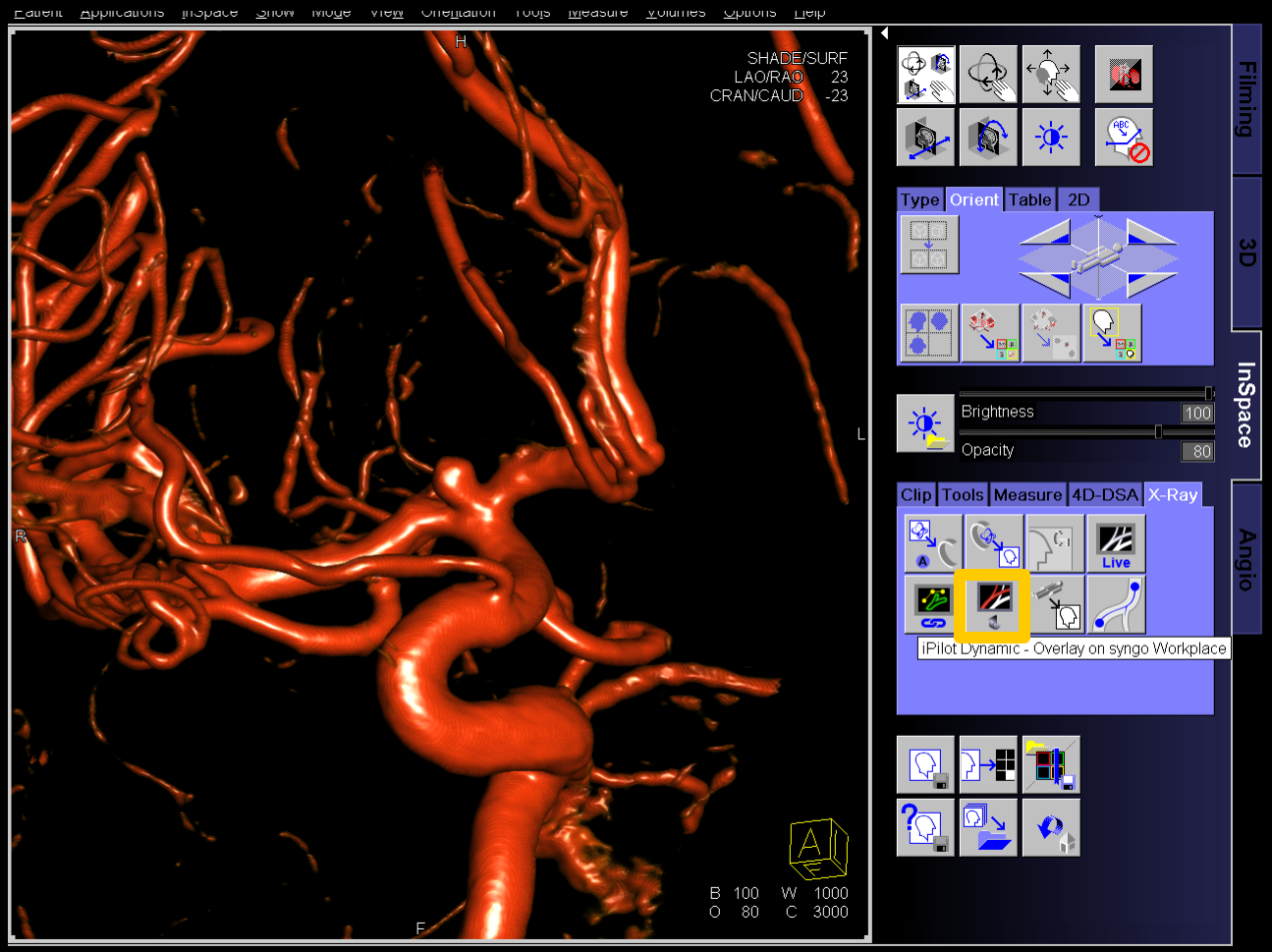
# Embedded MPR in ruptured aneurysms



# 3D Roadmap

- Optimal treatment projection of ICA bifurcation aneurysm
- Click on *iPilot Dynamic* to overlay this view to live fluoro on the workstation monitor



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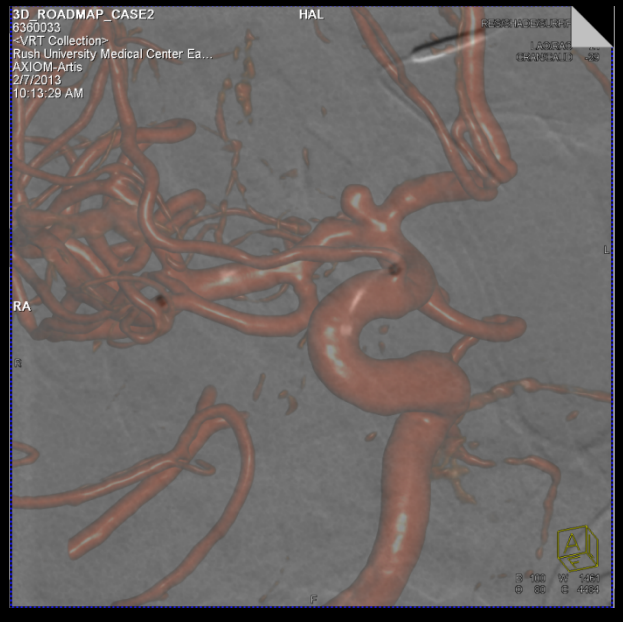
# 3D Roadmap

Guidewire

Stent microcatheter




Coiled aneurysm

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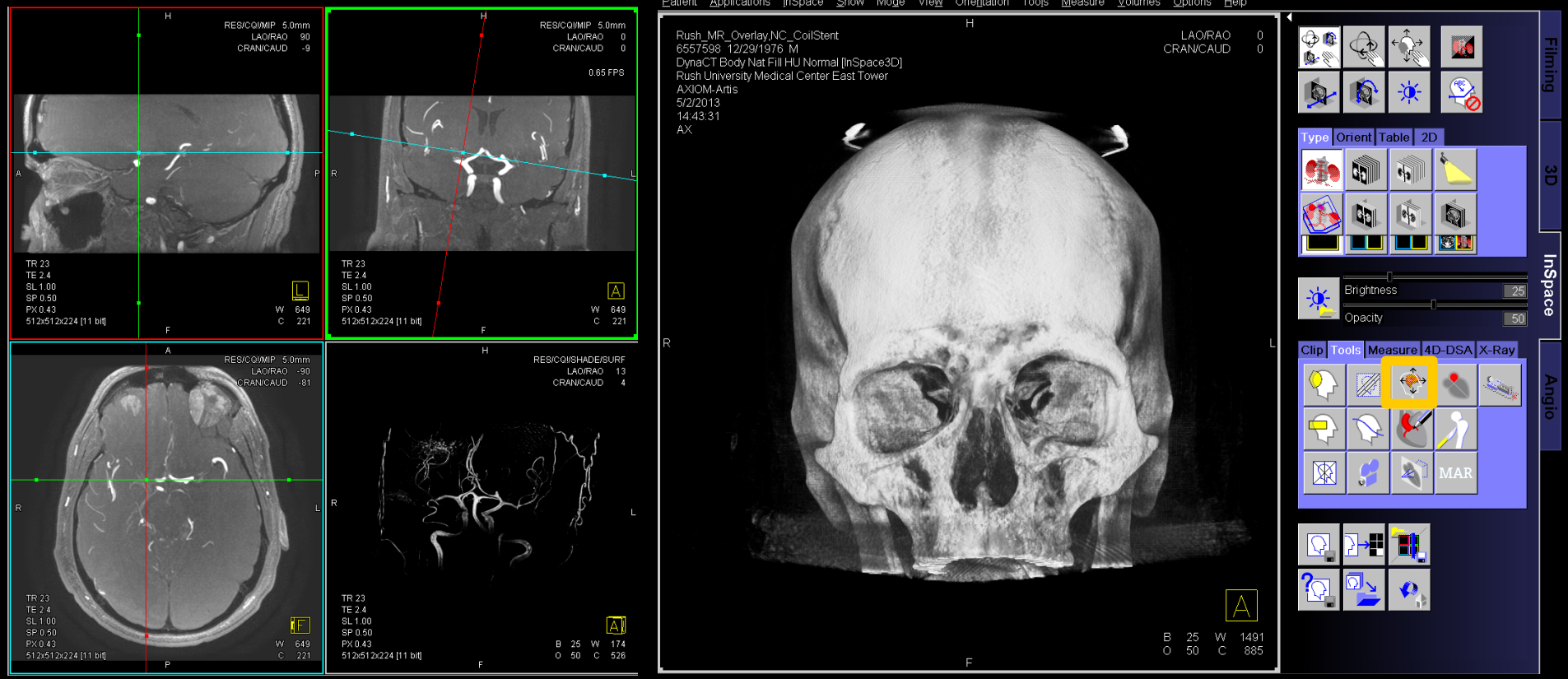
# 3D/3D Registration with MRA/ DynaCT

- MRA (3D TOF*) to visualize the aneurysm
- 5sDR non-contrast for registration
- Load both to InSpace, click on *Fusion*




* TOF: Time of Flight

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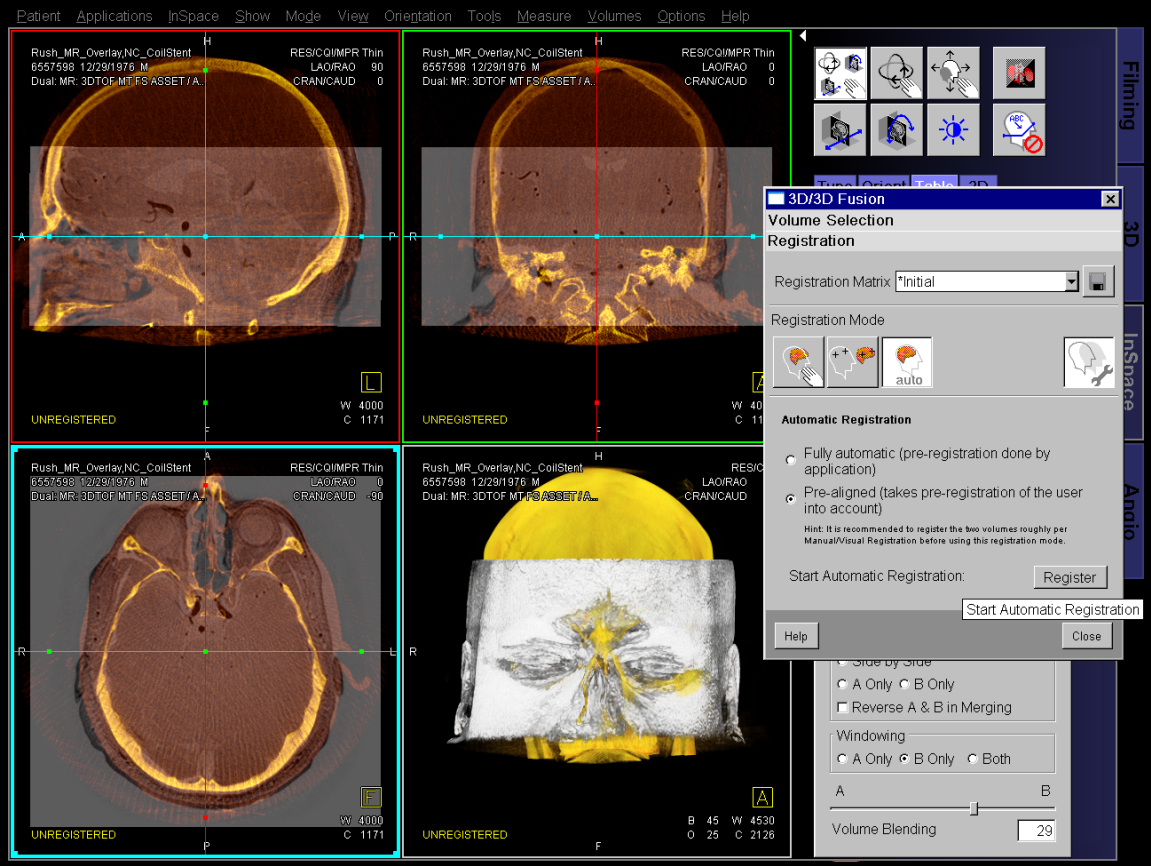
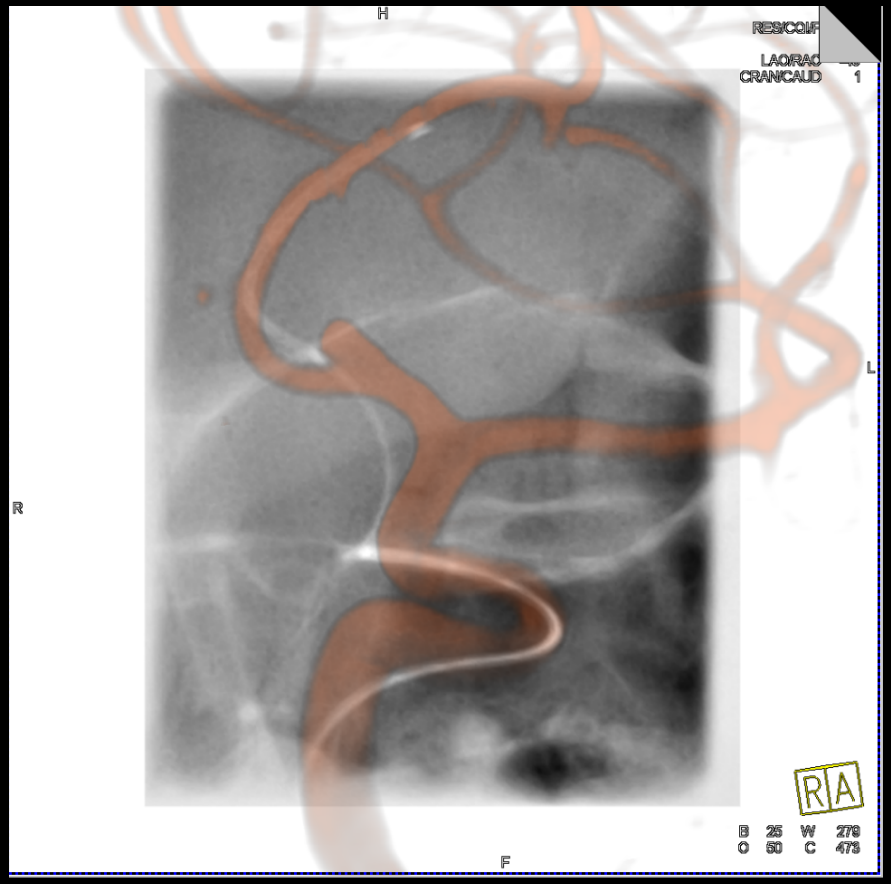
# 3D/3D Registration with MRA/ DynaCT

- Align both datasets, click on *auto*, *Pre-aligned, Register*
- Check registration, then save Registration Matrix
- Close patient data and load only the MR dataset in InSpace
- Click on iPilot Dynamic to overlay



# 3D/3D Registration with MRA/ DynaCT

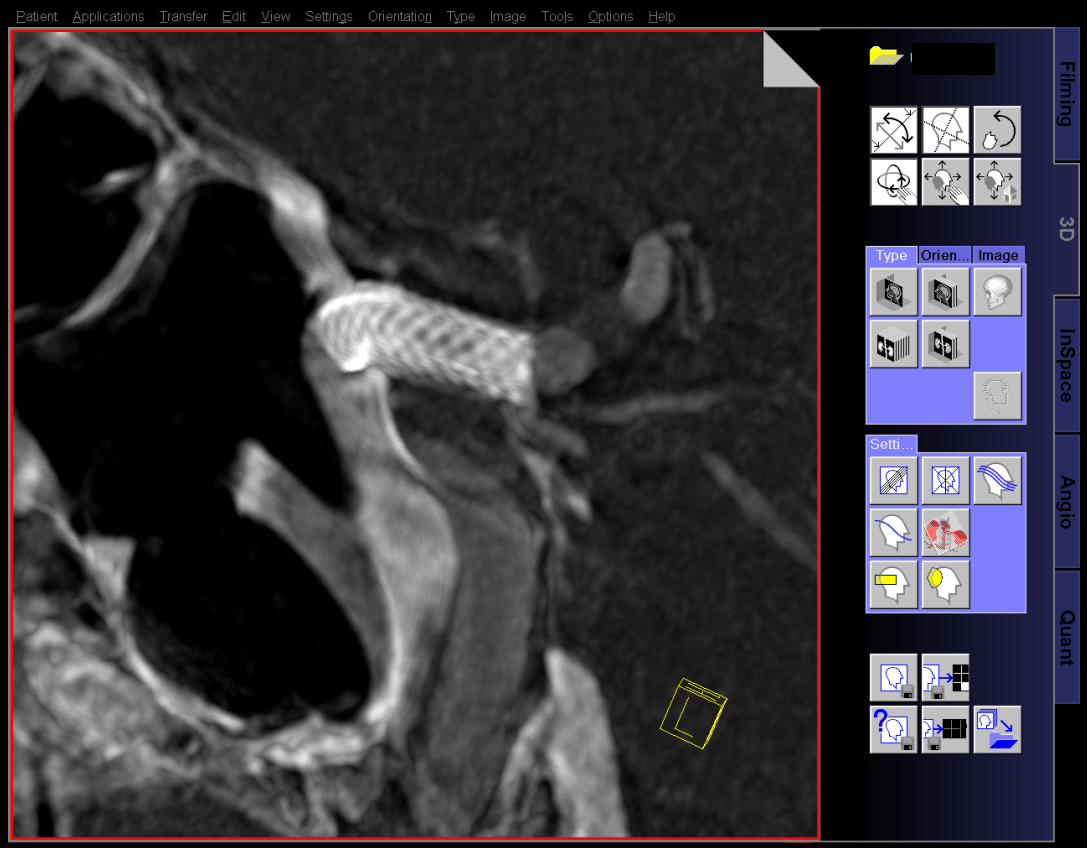
- MRA (3D TOF) to visualize the aneurysm
- 5sDR non-contrast for registration


Optional: In the *iPilot Dynamic* window select *Invert Gray Scale* and change the MR preset

# Post processing for DynaCT in 3D card

- Perform 2nd reconstruction with small VOI, centered on the area of interest (e.g. stent, flow diverter)
- Create individual images to best visualize the device and its relation to bone or other vessels



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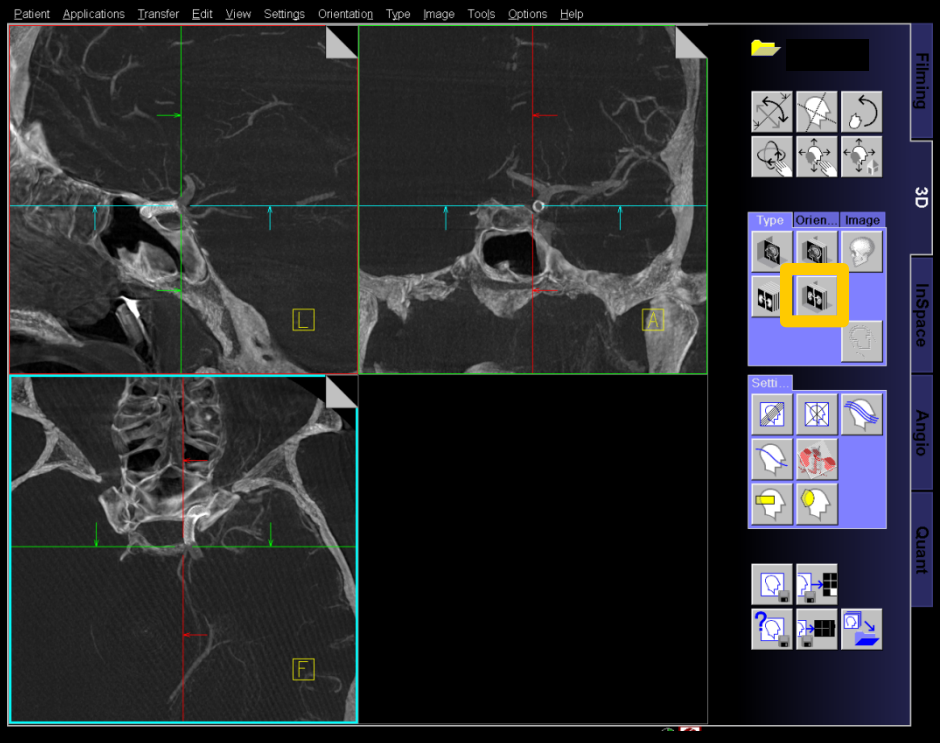
# Curved MRP/ MIP

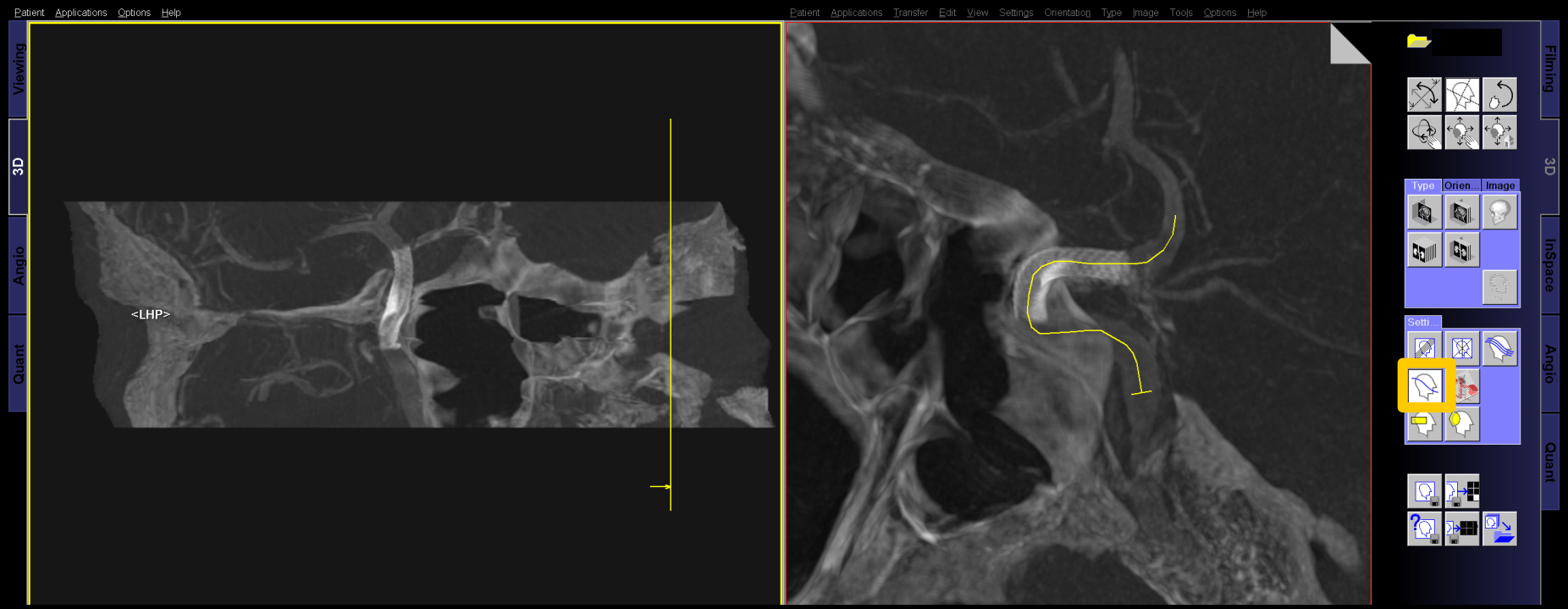
Load dataset to 3D card and change to thin MIP and adjust window settings




Rotate until area of interest is in profile

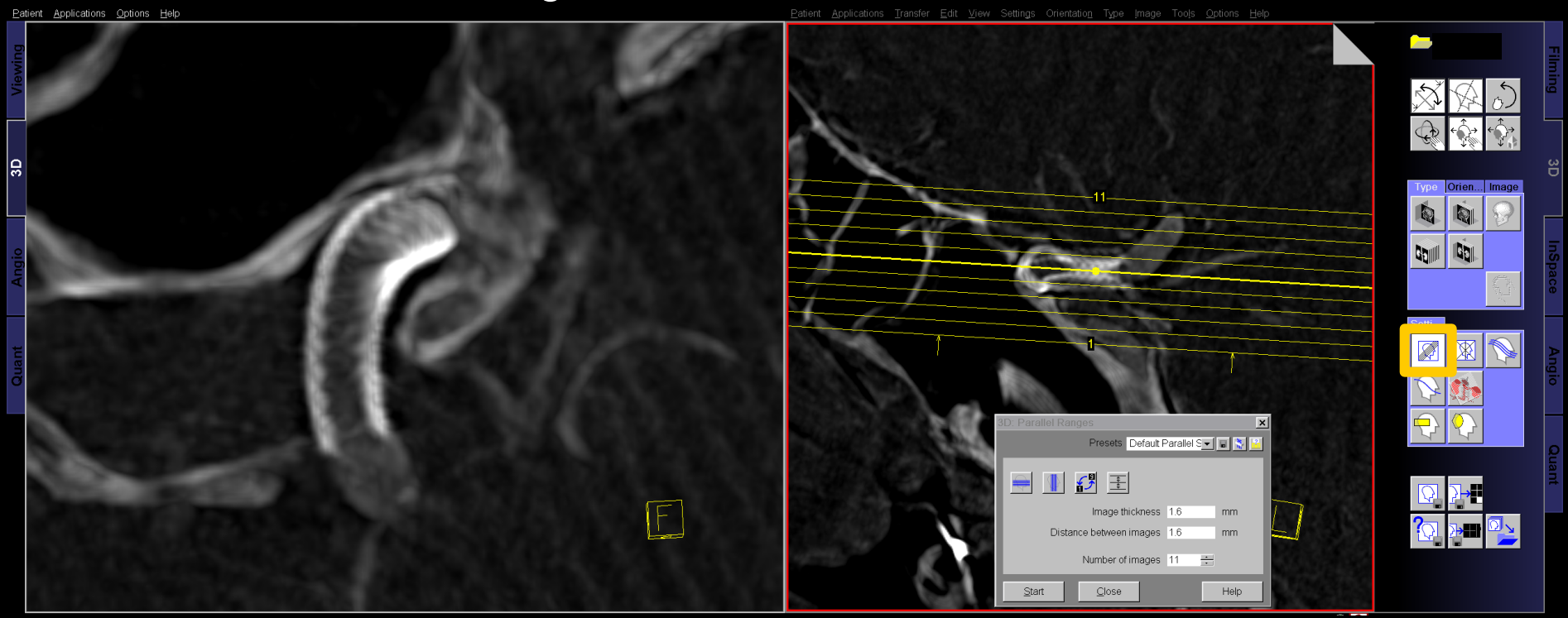
# Curved MRP/ MIP

Select the *Curved Mode* icon and draw a line, following the course of the vessel, end with a double click, the result will be shown on the 2nd monitor



# Parallel MRP/ MIP ranges

- Select *Parallel Ranges* icon, position the centerline on the stent and tilt the ranges to follow the vessel
- Adjust parameter so that *Image thickness* = *Distance between slices*
- Deselect *Keep number of images constant* and adjust the range to cover the area of interest
- Start and save the range after reconstruction



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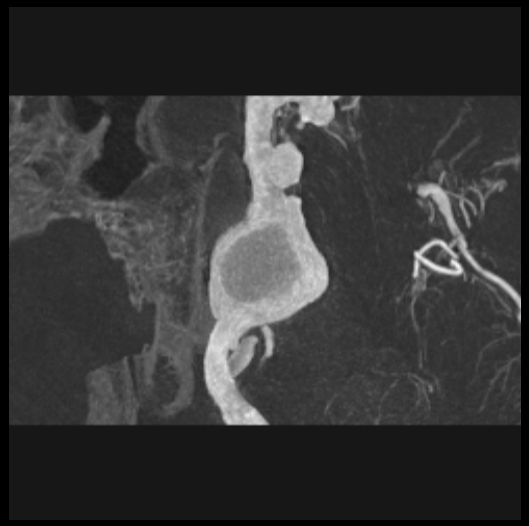
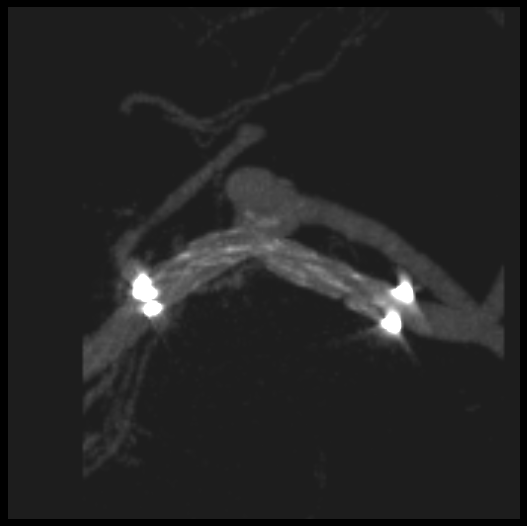
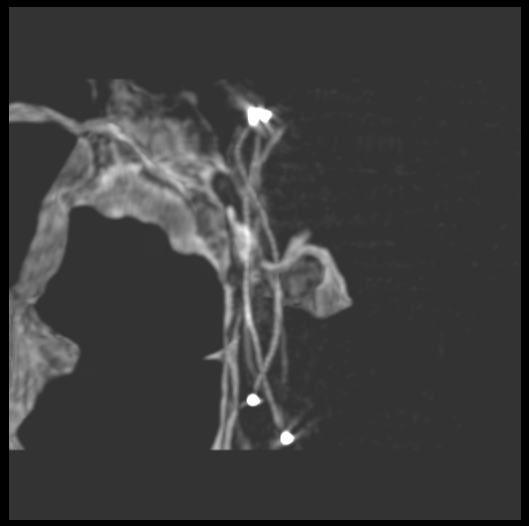
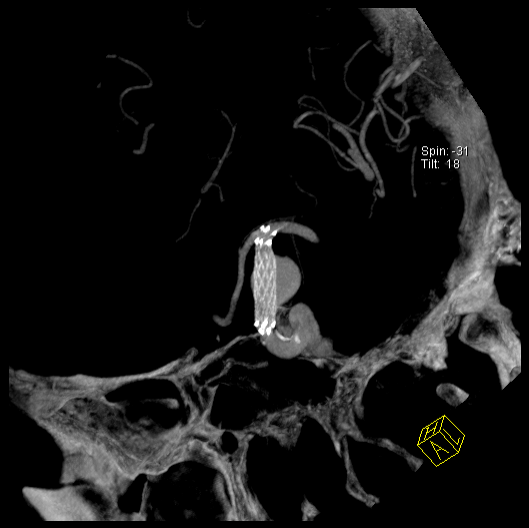
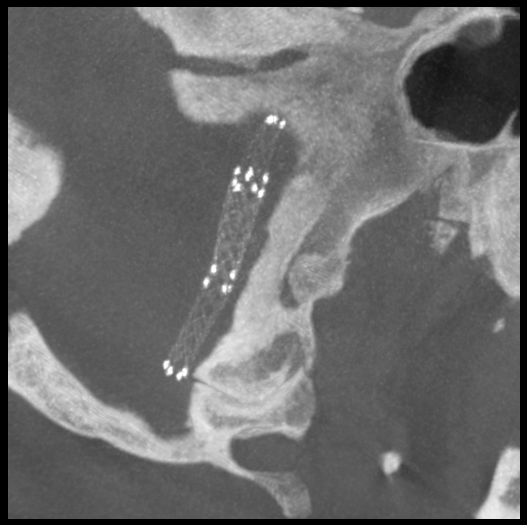
# Results of 3D post processing









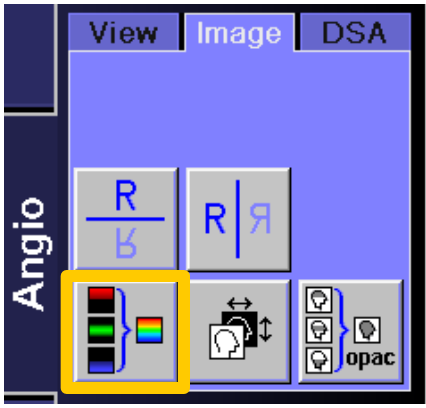



# Outline

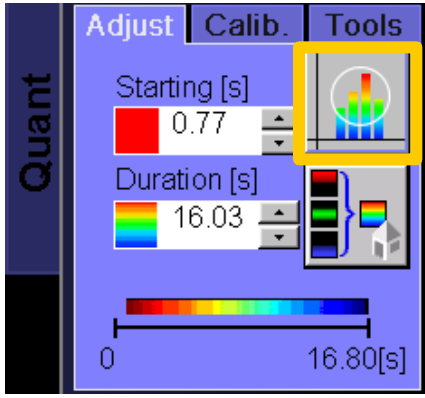
1. Introduction to neurovascular treatment indications
2. Scan and injection protocols for 3D DSA and DynaCT
3. Reconstruction parameter and secondary reconstruction
4. Tools in *syngo* InSpace and the 3D card for advanced postprocessing
5. **Introduction to *syngo* iFlow and *syngo* Virtual Stent**

# *syngo* iFlow – Intro & Workflow

- Provides a single composite image that shows the history of the contrast medium movement through the vessel in time in a colored image
- Required images: 2D DSA acquisitions with positive contrast (iodine)




- Load 2D DSA images in *Angio* taskcard
- Select *iFlow* icon on *Image* tab card
- To compare 2 runs, e.g. pre and post flow diverter placement, make sure that *Starting* time and *Duration* is the same for both runs
- Place the cursor over the image to see the time of maximum contrast, click to set a marker
- To make ROI measurements click on *Total Contrast ROI selection* icon and place a circular, rectangular or freehand ROI



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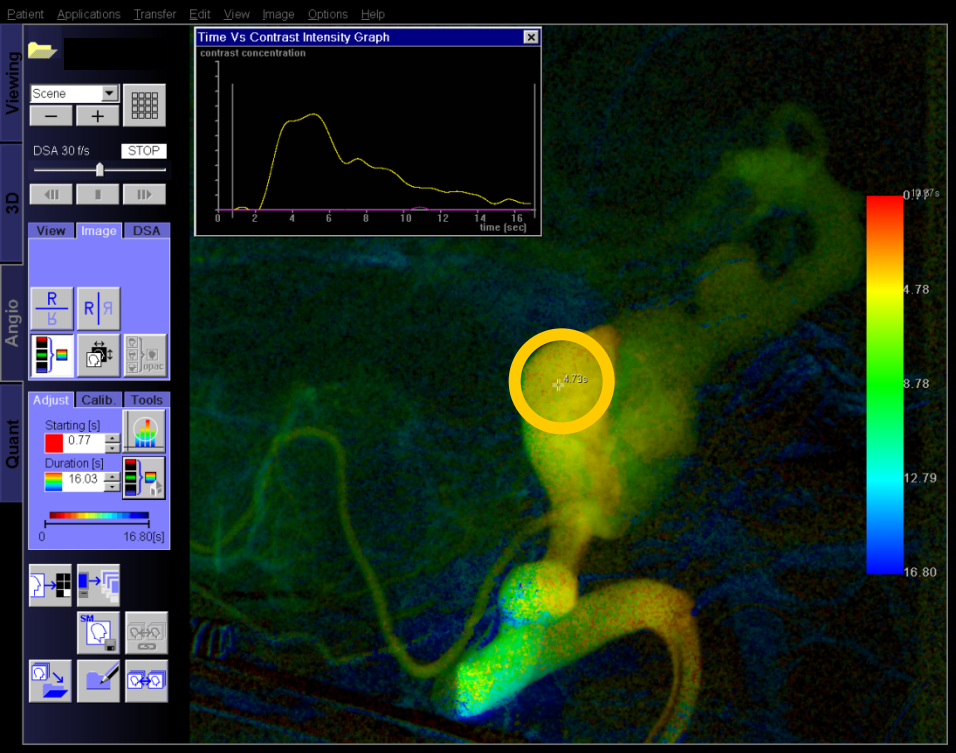
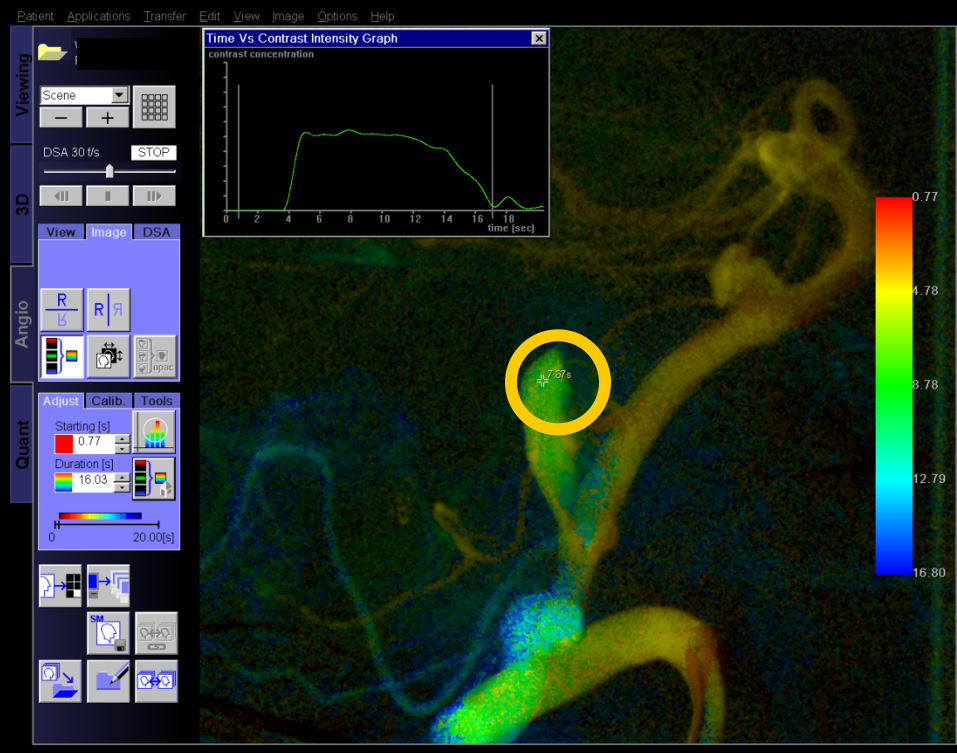
# *syngo* iFlow – pre/ post flow diverter

## Giant aneurysm in left ICA

### Pre flow diverter placement



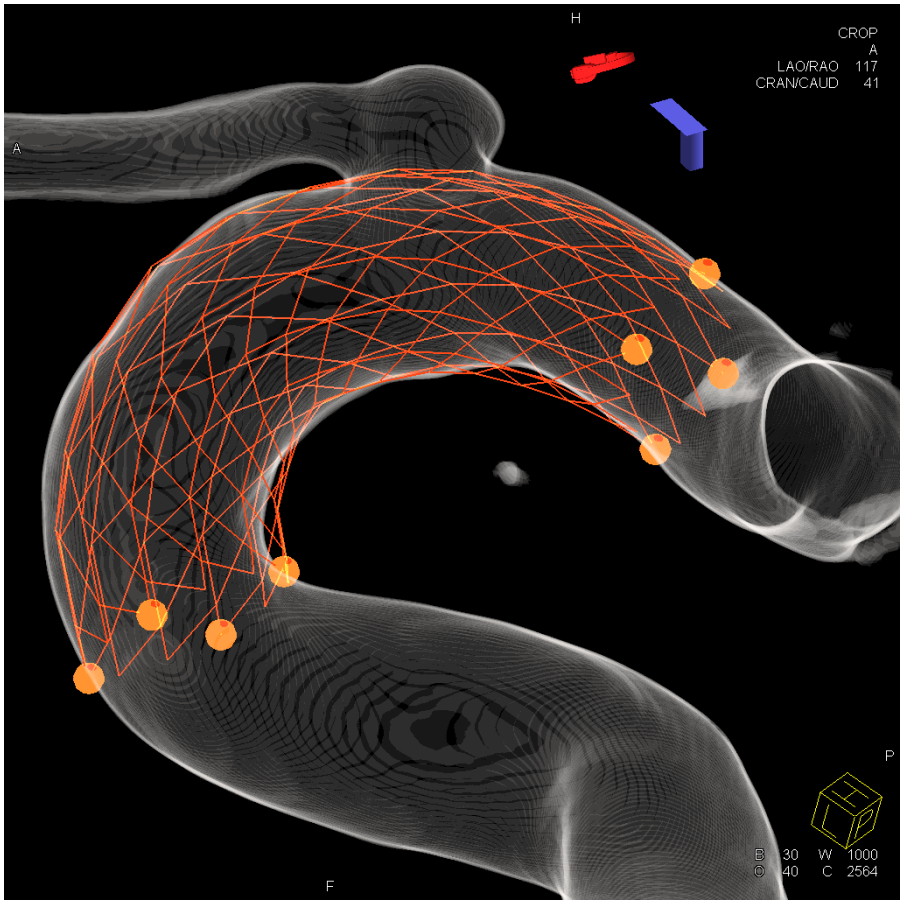

### Post flow diverter placement




Contrast enhancement in aneurysm is clearly delayed after FD placement

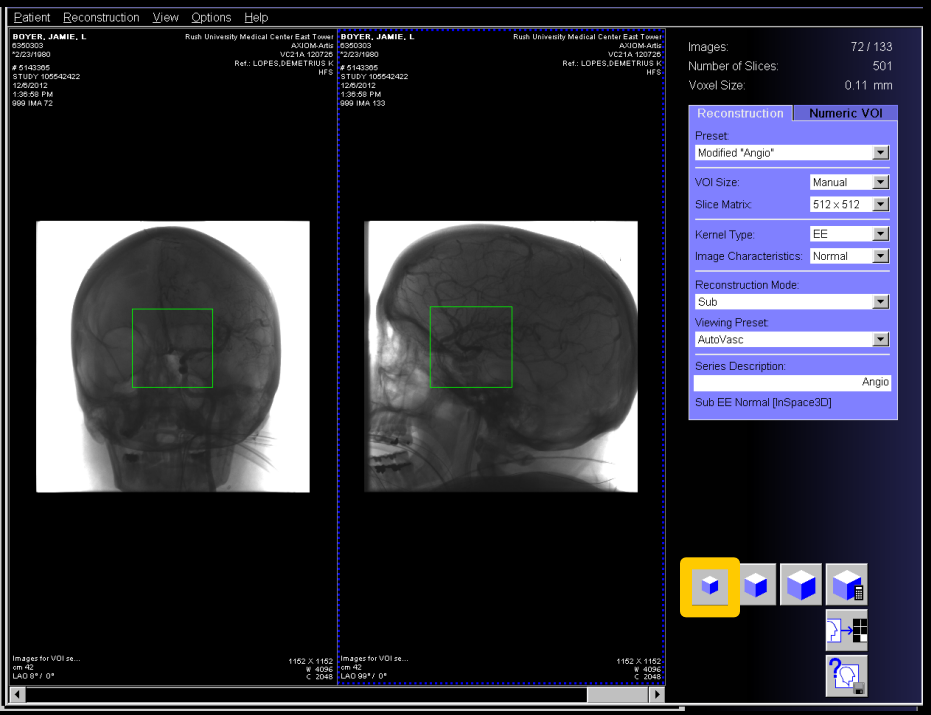
# *syngo* Virtual Stent – Intro & Workflow

- Allows precise stent planning in complex cases
- Results can be overlaid to live fluoro for guidance during stent deployment

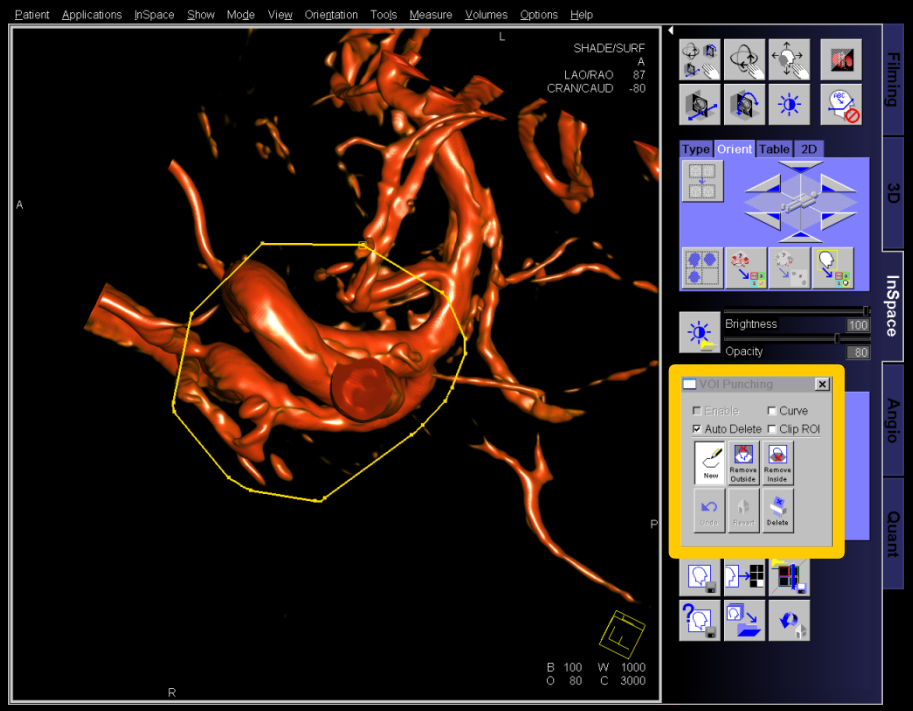


# *syngo* Virtual Stent – Step 1 & 2

Perform 2nd recon with small VOI for best image quality

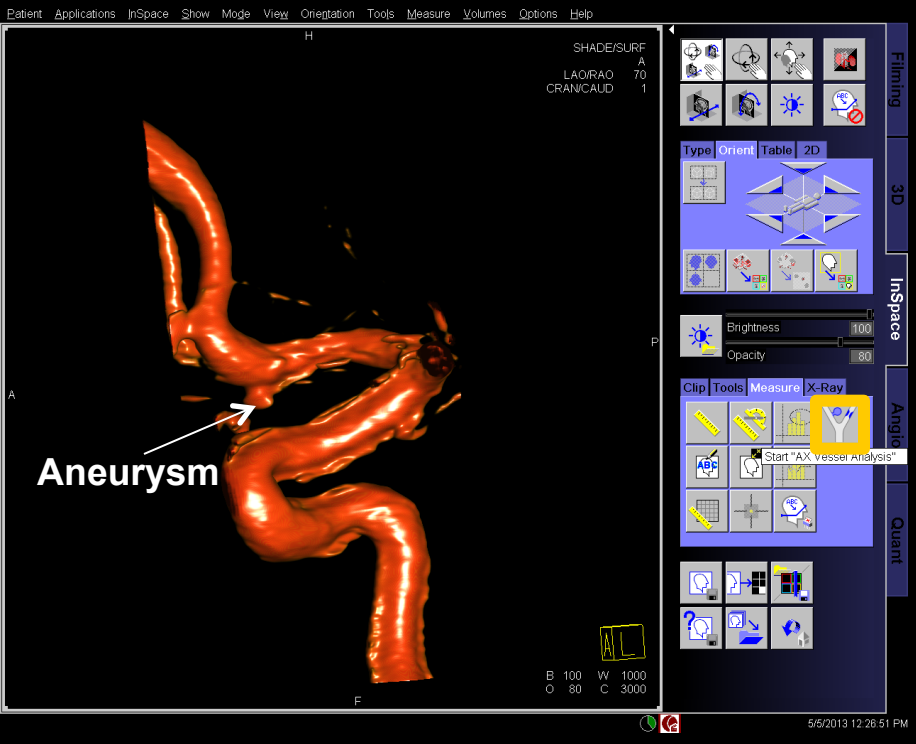



VOI Punching to delete all vessel around the area of interest

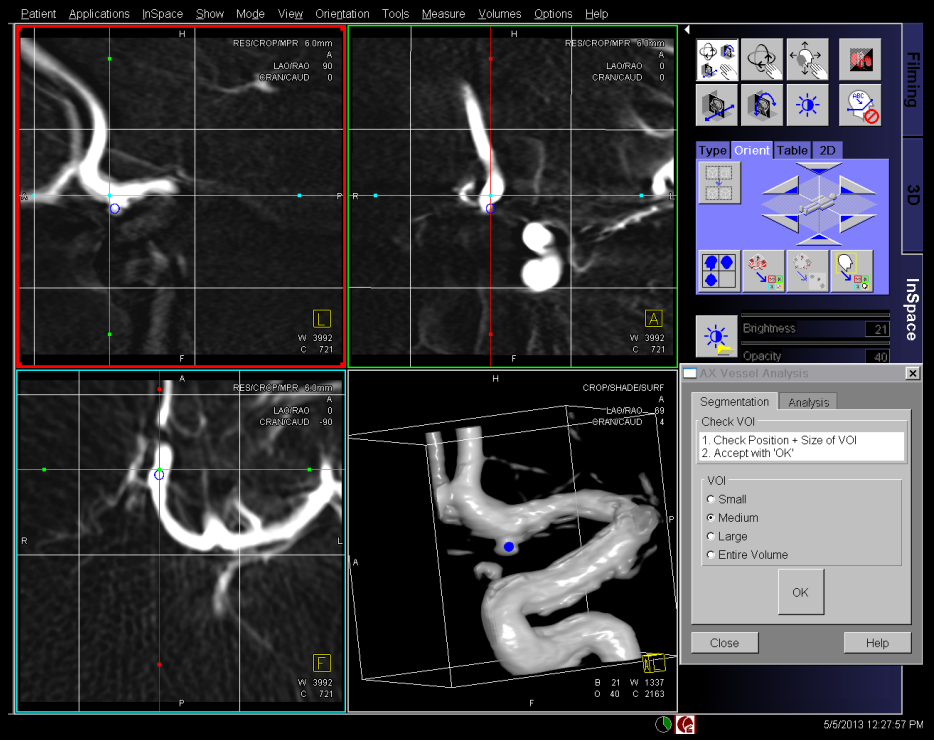


# *syngo* Virtual Stent – Step 3 & 4

Select *AX Vessel Analysis* icon on *Measure* tab card

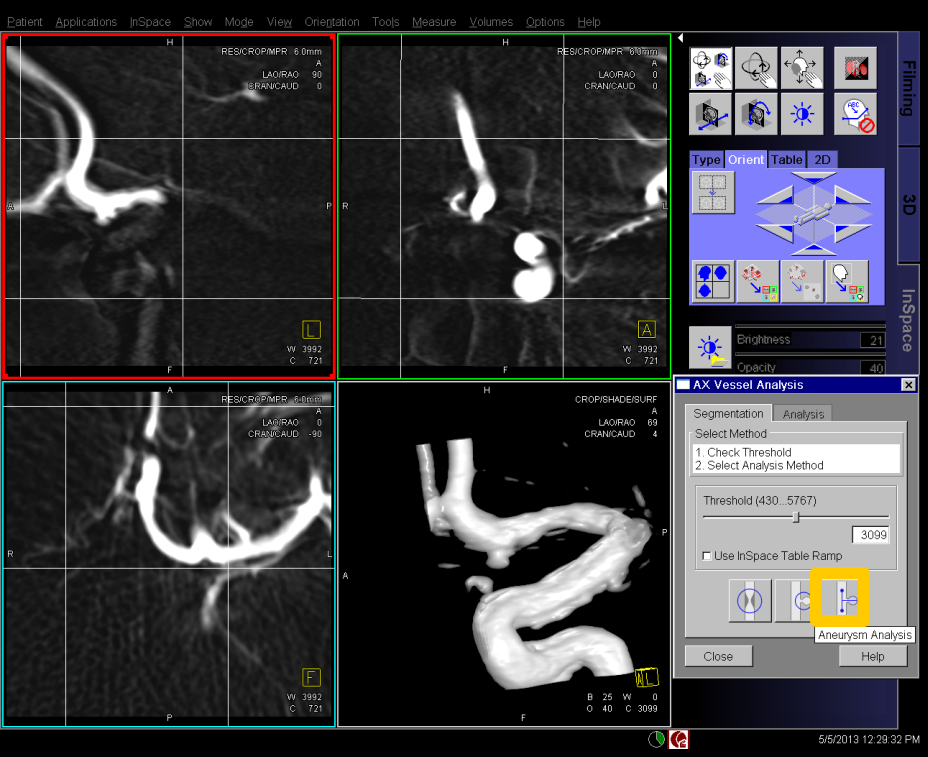



Make sure that VOI is centered on aneurysm (blue dot) and click *OK*

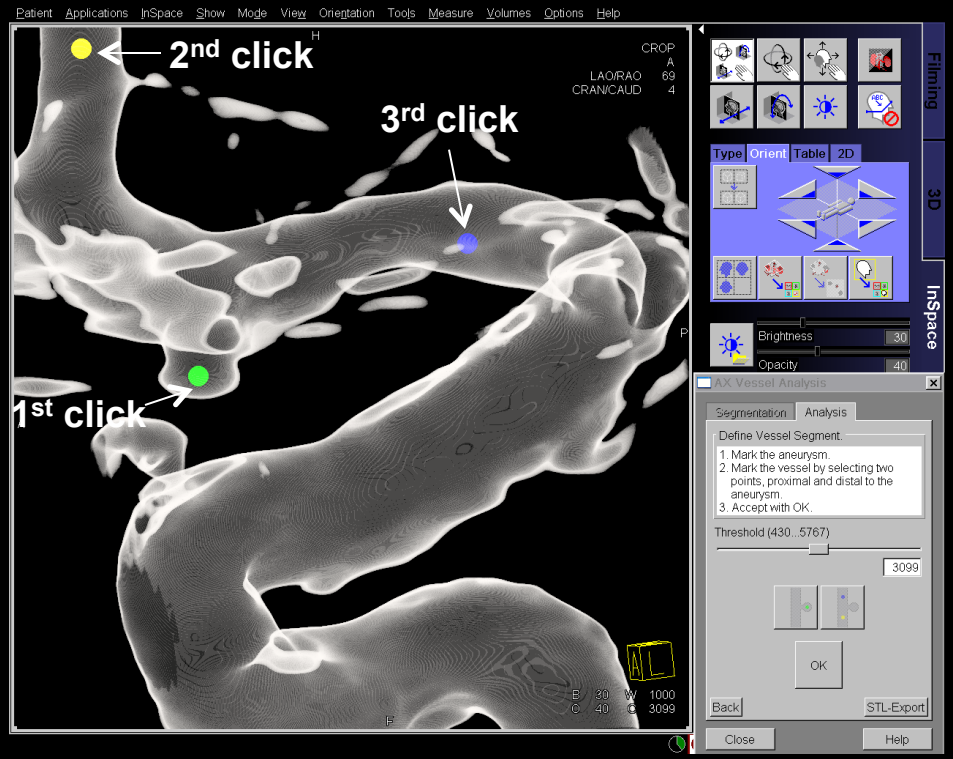


# *syngo* Virtual Stent – Step 5 & 6

Click on *Aneurysm Analysis*




Click inside the aneurysm, than proximal and distal, click *OK*



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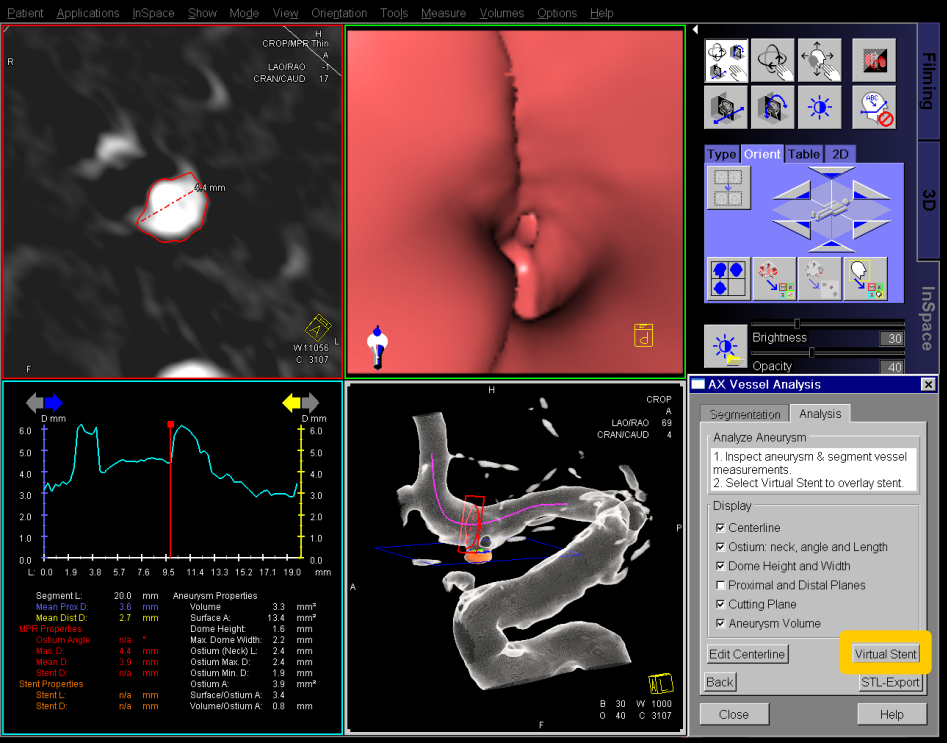
# *syngo* Virtual Stent – Step 7 & 8

Check centerline + aneurysm measurement, click on *Virtual Stent*




Change stent length and position, click on iPilot to overlay to fluoro