IMPROVING VASCULAR IMAGING IN THE PRESENCE OF METALLIC STENTS USING SPECTRAL PHOTON COUNTING COMPUTED TOMOGRAPHY AND K-EDGE IMAGING

INITIAL EXPERIENCE

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SPCCT
IMAGING ALL THE PHOTONS

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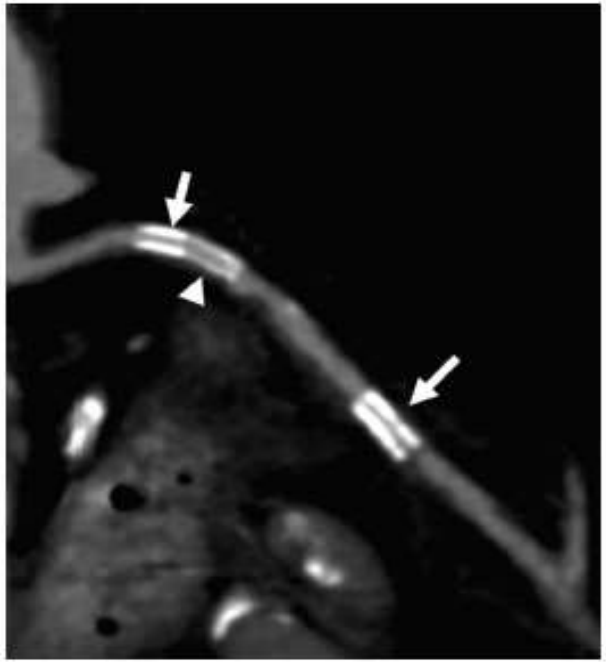
BACKGROUND

- Treatment of coronary atherosclerosis involves **metallic stent** placement
- Metal related **blooming artifacts** impair diagnosis of **in-stent restenosis**

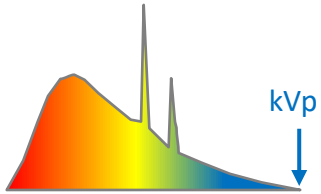


OBJECTIVE

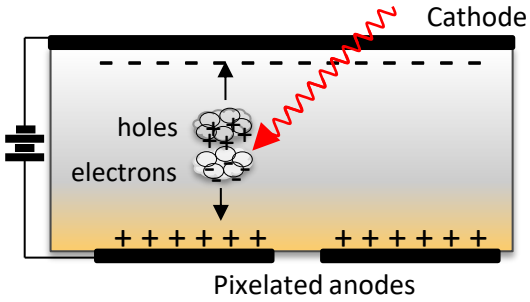
To assess the capability of a preclinical Spectral Photon Counting CT scanner to improve vascular imaging in the presence of stents in comparison with standard CT

MATERIALS AND METHODS SPCCT

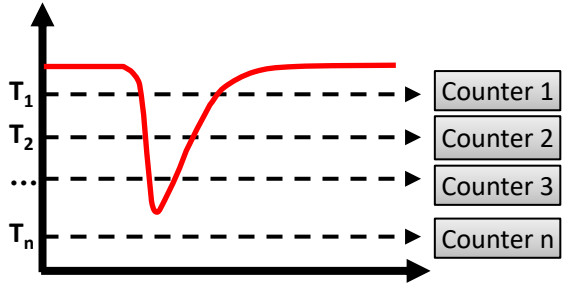
1. X-ray spectrum



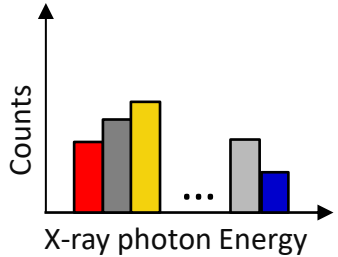
2. Direct conversion detector



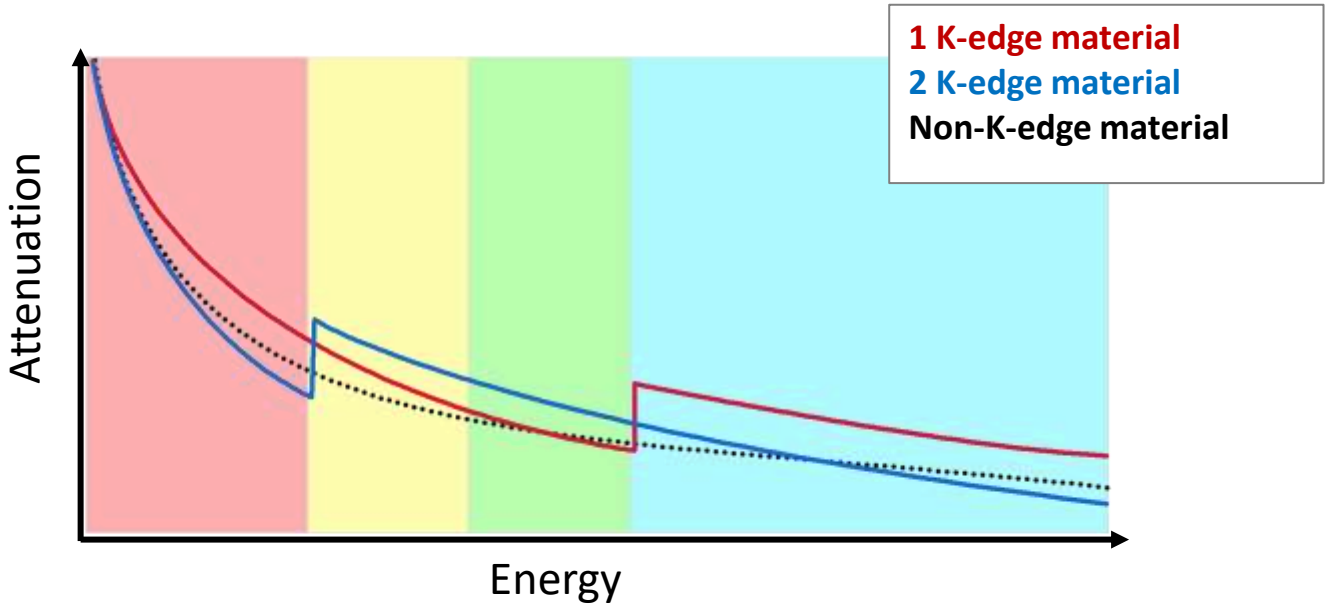
3. Photon Counting



4. Energy spectrum



MATERIALS AND METHODS K-EDGE



MATERIALS AND METHODS

IN VITRO AND IN VIVO – NZW RABBIT STENTS IMAGING

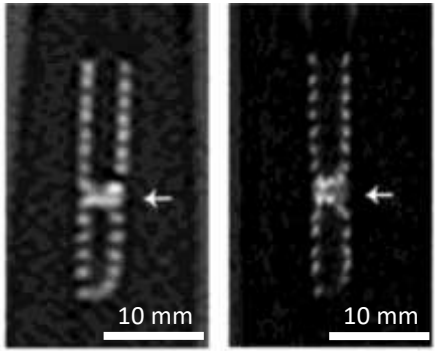
- **Coronary stents (3.5mm)**:
  - Co-Cr (60 µm strut width)
  - **Pt**-Cr (81 µm strut width)
  - Stainless steel (80 µm strut width)
  - = Simulated calcifications, In-vitro
- **Contrast agents, for angiography**:
  - **Iodine (**Iomeron, Bracco)
  - **Gadolinum** (Multihance, Bracco)
- **Similar imaging protocols for SPCCT and B64:**
  - tube voltage of 120 kVp
  - tube current of 100 mAs
  - Voxel size **0.2x0.2x0.25 mm^3** - SPCCT
  - Voxel size **0.2x0.2x0.33 mm^3** - B64
- **SPCCT specific reconstructions**:
  - **Iodine** material decomposition
  - **Gadolinium** and **Platinum** specific k-edge
- Qualitative and quantitative analysis for strut and lumen size.

SPCCT
IMAGE ME ALL THE PHOTONS

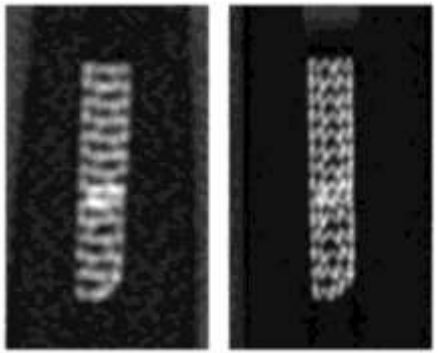
RESULTS IN VITRO SPATIAL RESOLUTION

Cobalt – chromium

B64 SPCCT



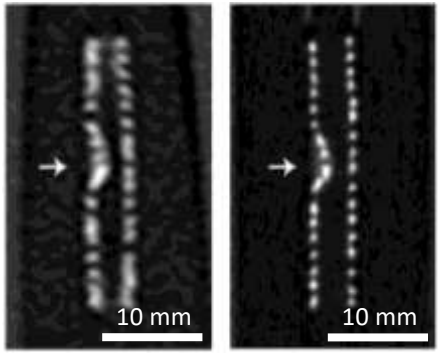
0.2 mm thick slice (in water)



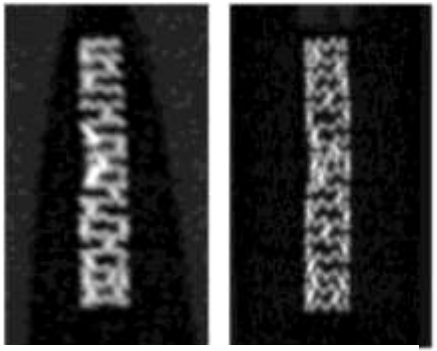
2mm thick MIP

Platinum – chromium

B64 SPCCT



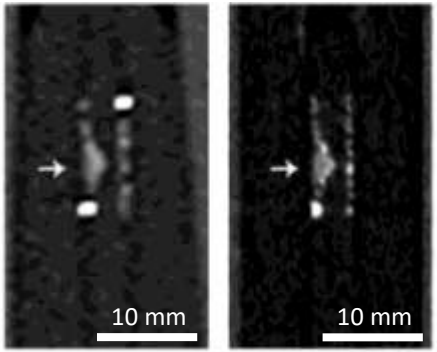
0.2 mm thick slice (in water)



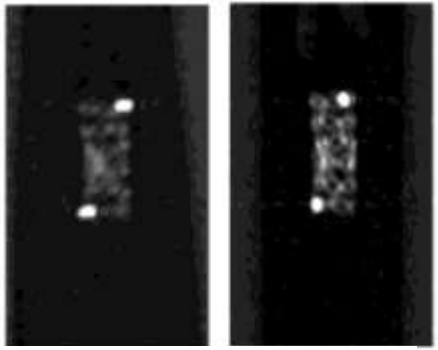
2mm thick MIP

Stainless steel

B64 SPCCT



0.2 mm thick slice (in water)



2mm thick MIP

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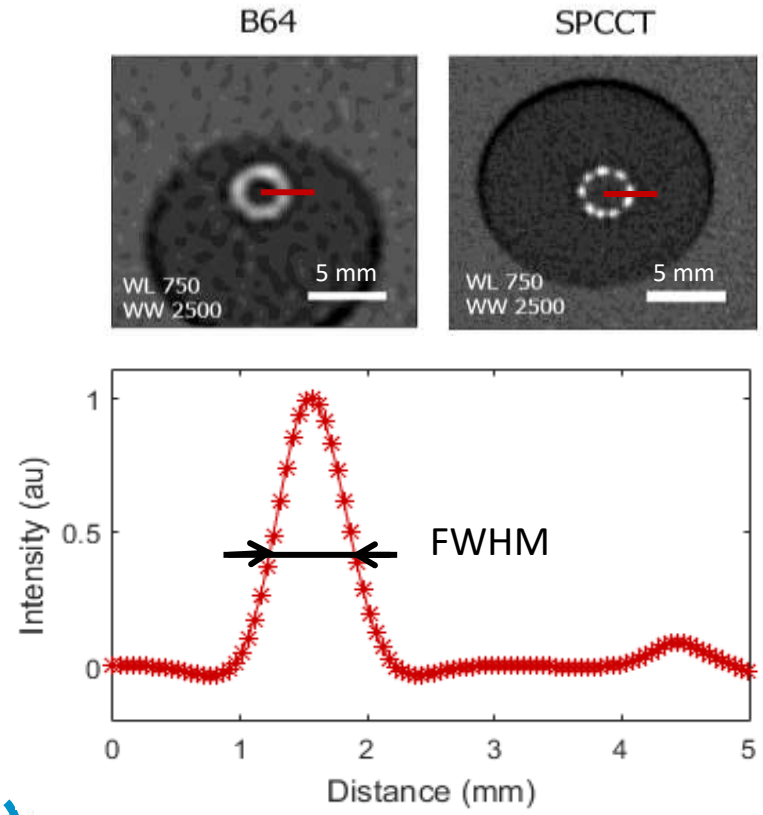
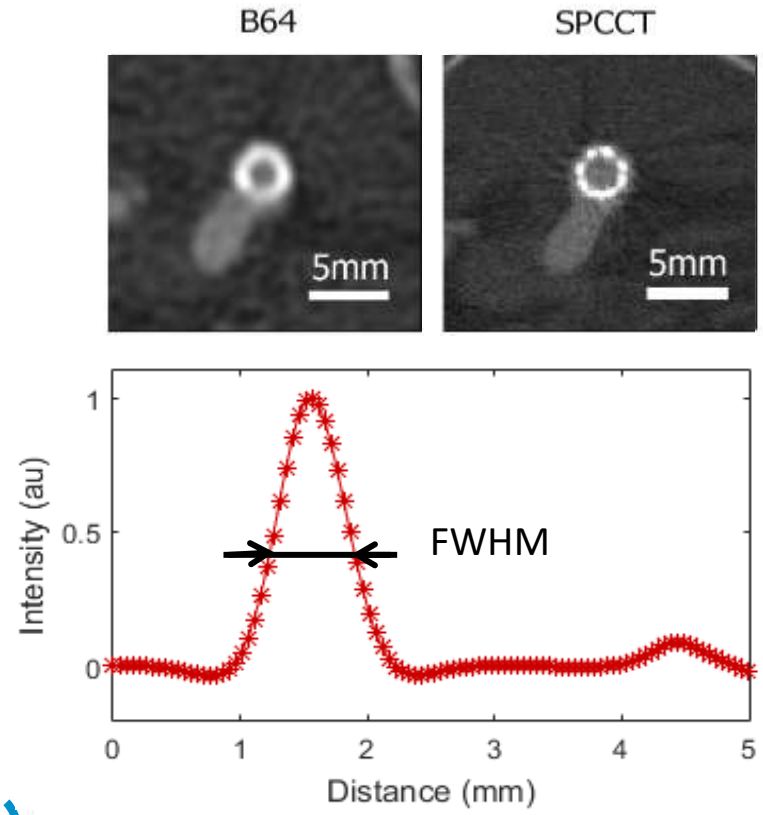
RESULTS IN VITRO SPATIAL RESOLUTION



	B64	SPCCT
	Measured strut thickness (mm) ~80 µm	
Coroflex Blue Neo (Co-Cr)	1.03 ± 0.004	0.70 ± 0.002 *
Promus Premier (Pt-Cr)	1.00 ± 0.003	0.71 ± 0.002 * Pt: 0.71 ± 0.007*
Tsunami Gold (Stainles steel)	1.04 ± 0.009	0.69 ± 0.004 *
	Measured lumen diameter (mm) ~3.3mm	
Coroflex Blue Neo (Co-Cr)	1.96 ± 0.006	2.44 ± 0.01 *
Promus Premier (Pt-Cr)	1.9 ± 0.003	2.28 ± 0.01 *
Tsunami Gold (Stainles steel)	2.18 ± 0.04	2.71 ± 0.04 *

* - $p < 0.05$, Mean ± SEM

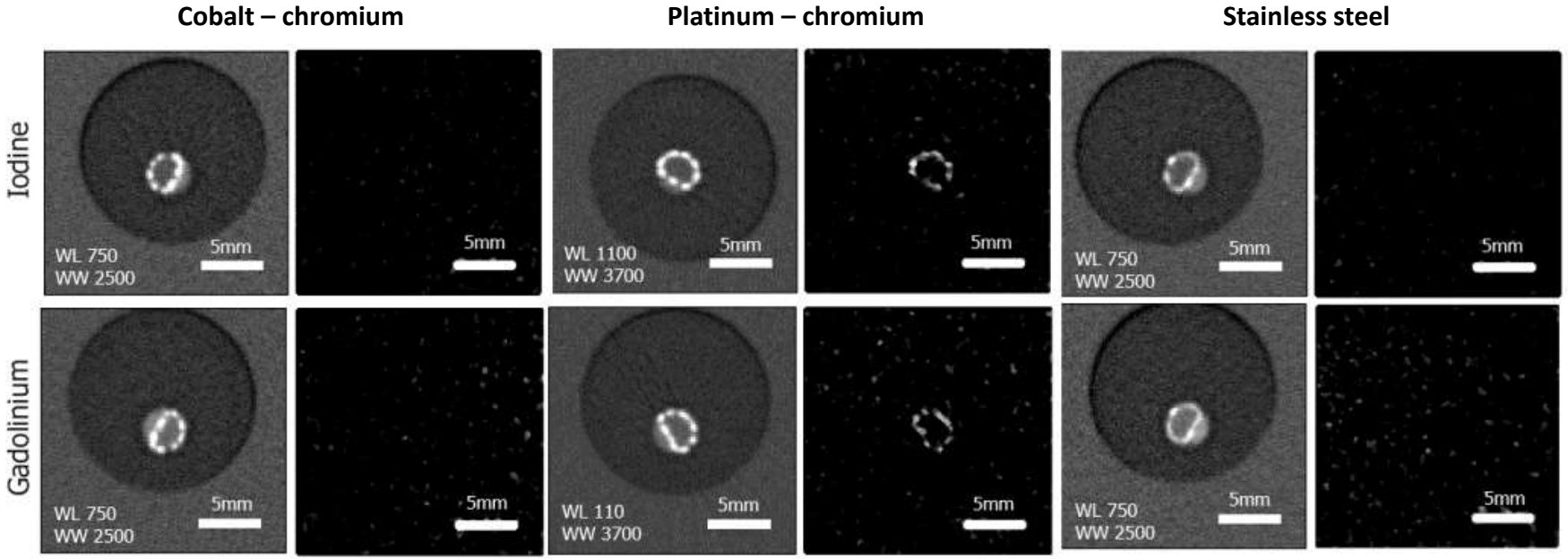
RESULTS IN VIVO SPATIAL RESOLUTION



	B64	SPCCT
	Measured strut thickness (mm) ~80 µm	
Coroflex Blue Neo (Co-Cr)	1.13 ± 0.009	0.79 ± 0.006 *
Promus Premier (Pt-Cr)	1.11 ± 0.005	0.74 ± 0.003 * Pt: 0.70 ± 0.012*
Tsunami Gold (Stainles steel)	1.06 ± 0.008	0.75 ± 0.004 *
	Measured lumen diameter (mm)	
Coroflex Blue Neo (Co-Cr)	1.73 ± 0.008	2.06 ± 0.006 *
Promus Premier (Pt-Cr)	1.60 ± 0.004	1.85 ± 0.004 *
Tsunami Gold (Stainles steel)	1.50 ± 0.008	1.81 ± 0.003 *

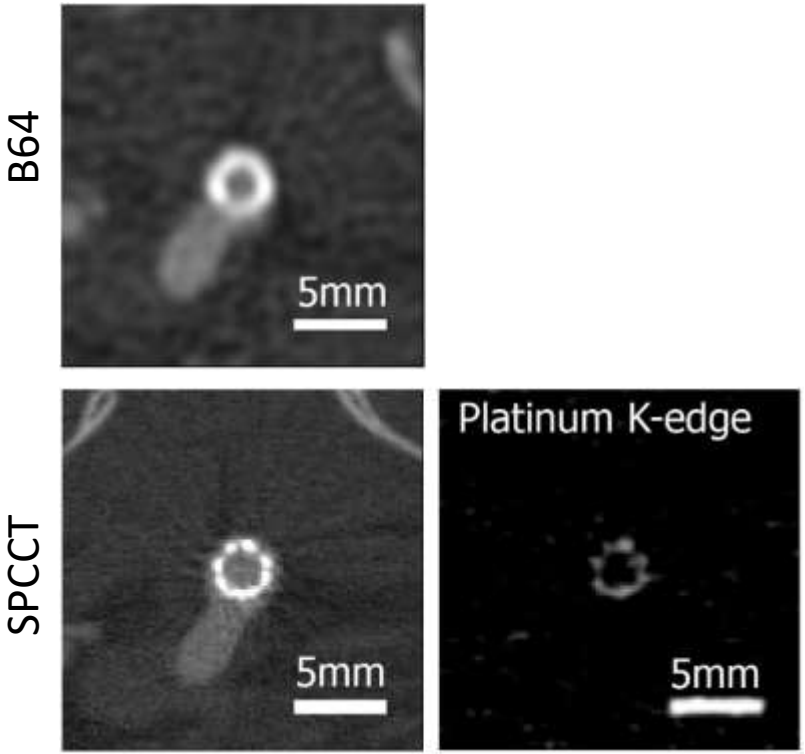
* - $p < 0.05$, Mean ± SEM

RESULTS IN VITRO STENT SPECIFIC IMAGING



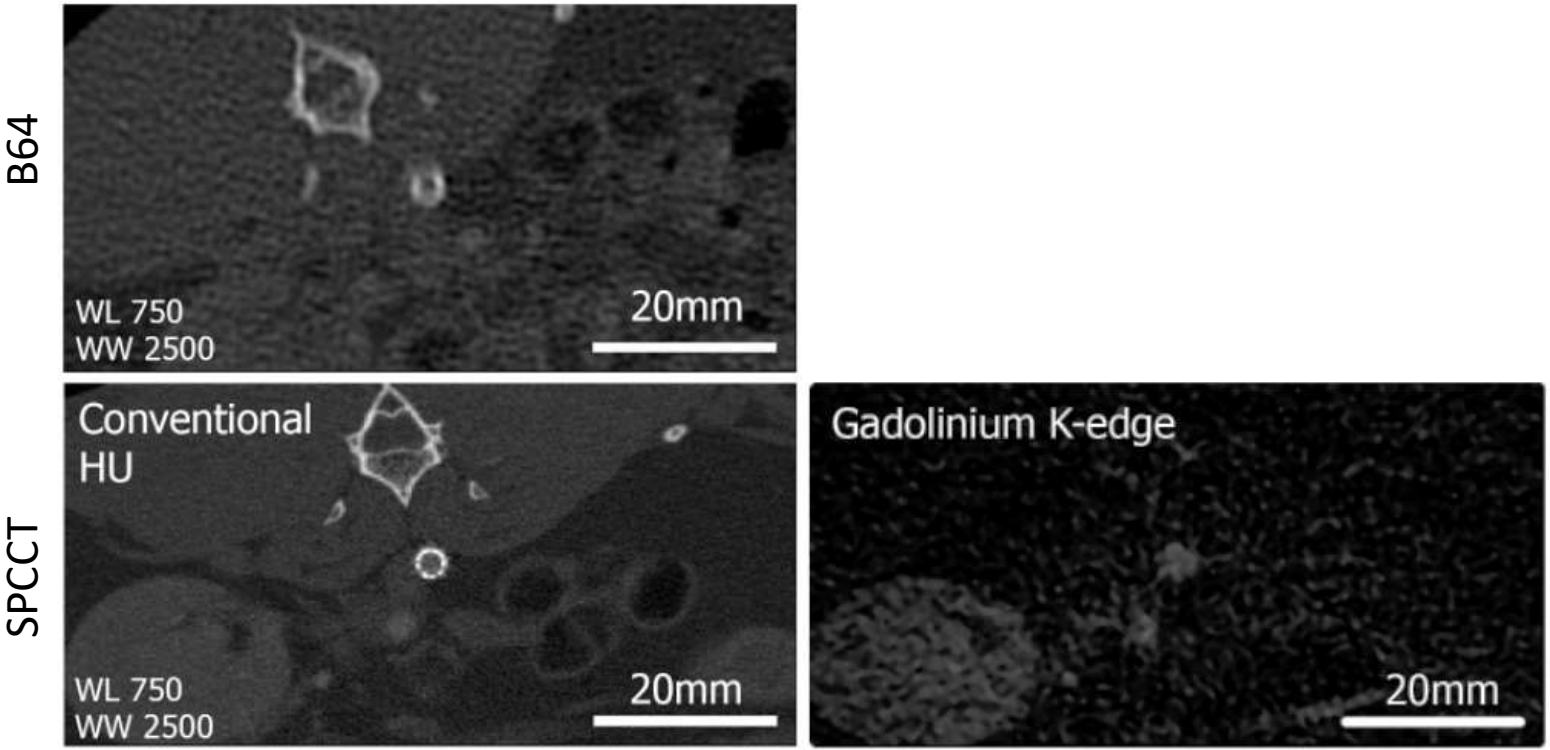
Conventional HU | Pt-specific k-edge (1pix gaussian filter) | Conventional HU | Pt-specific k-edge (1pix gaussian filter) | Conventional HU | Pt-specific k-edge (1pix gaussian filter)

RESULTS IN VIVO IMAGING WITH IODINE



(1pix gaussian filter)

RESULTS IN VIVO IMAGING WITH GADOLINIUM



(1pix gaussian blur)

CONCLUSIONS:

- SPCCT demonstrates **significant reduction of blooming artifacts** compared to conventional CT
  - Improved visualization of stent metallic mesh
  - Improved lumen delineation

- The capability of SPCCT to provide **element specific K-edge images** allowed **specific visualization of the platinum containing stent**
  - Potential for validation of correct **deployment** of Pt containing stents in humans

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