

Deep learning for sparse spectral ptychographic x-ray computed tomography (Spect-PXCT)

**Redhouane Boudjehem^{1,2*}, Anico Kulow^{1,2}, Florent Magaud^{1,2}, Jean-Louis Hazemann^{1,2},
Samy Ould-Chikh³, Javier Perez⁴ and Julio César da Silva^{1,2}**

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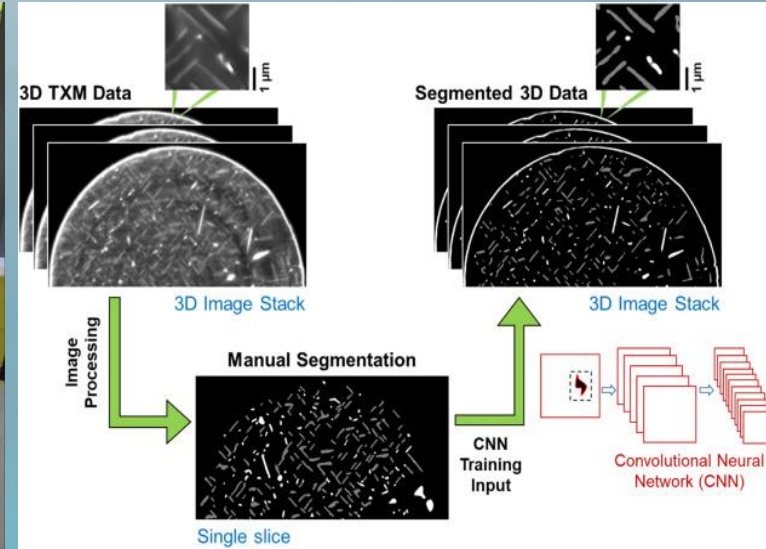
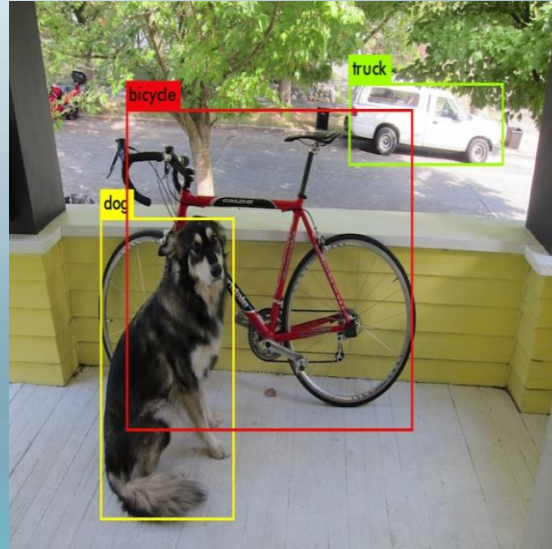
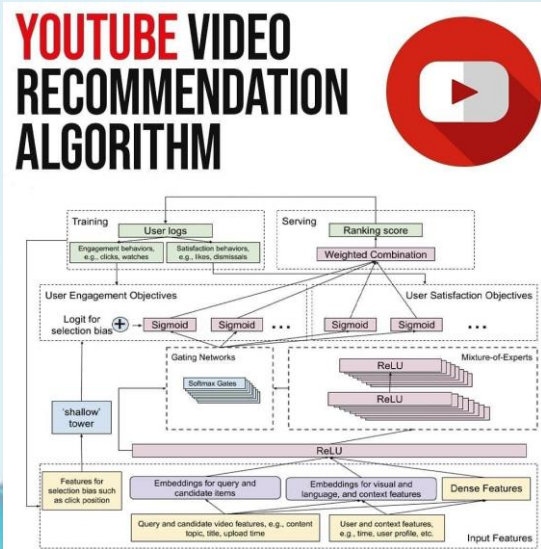
¹Univ. Grenoble Alpes, CNRS, Grenoble INP, Institut Néel, Grenoble, France

²CRG beamlines, ESRF, Grenoble, France

³KAUST Catalysis Center, Thuwal, Saudi-Arabia

⁴Soleil synchrotron, Saint-Aubin, France





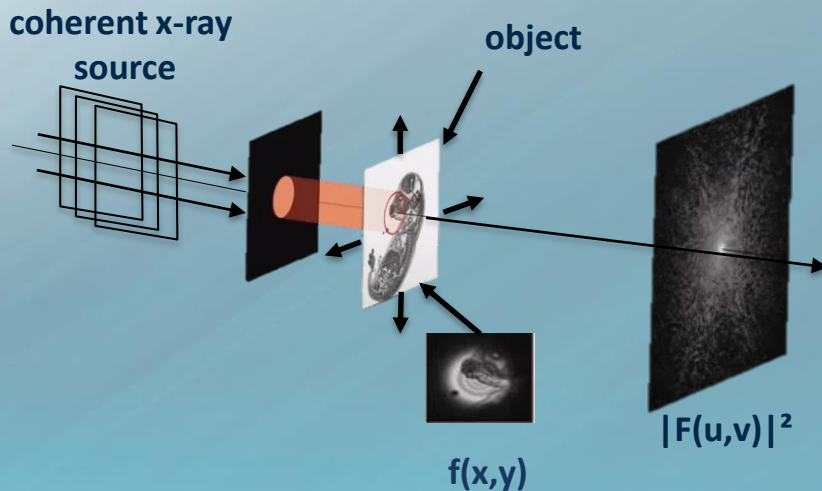
Zhao et al.,
 “Recommending What Video to Watch Next”

Redmon et al.,
 “You Only Look Once”

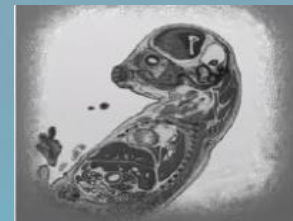
Shashank Kaira et al.,
 “Automated Correlative Segmentation of Large Transmission X-Ray Microscopy Tomograms Using Deep Learning”



- ❑ Lensless microscopy technique
- ❑ Provide images with high resolution
- ❑ Can be combined with tomography



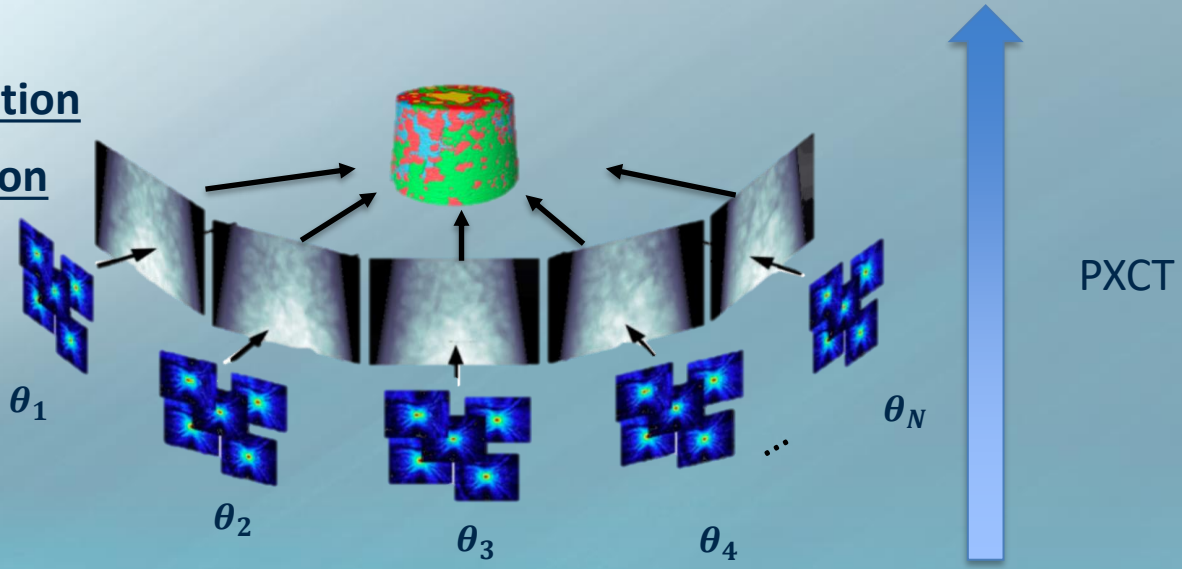
scan positions



reconstructed image



Tomographic reconstruction
 ↑
Projections reconstruction
 ↑
Scans acquisition



Dierolf et al., « Ptychographic X-Ray Computed Tomography at the Nanoscale » PXCT: Ptychographic X-ray computed tomography

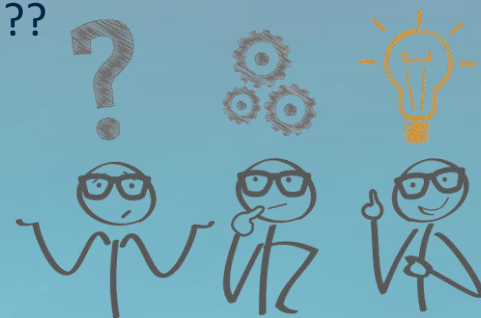


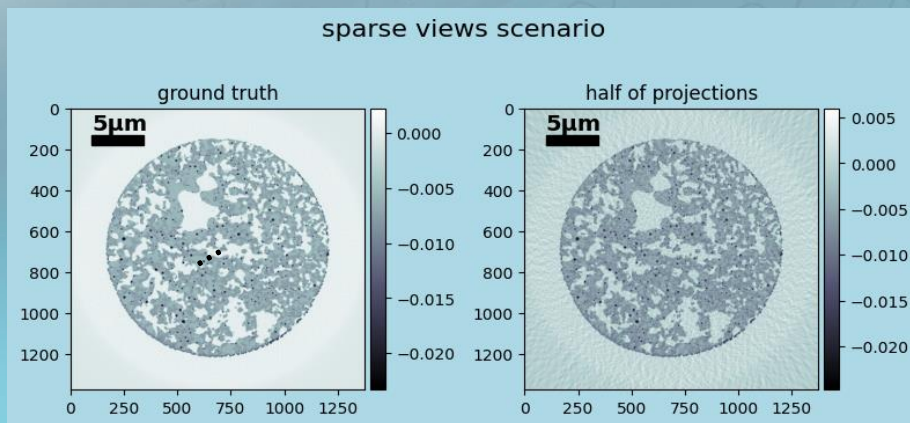
Acquisition of 1 tomogram can take half day or more

“Not practical in the case of spectral tomography”



Acquire less projections or reduce exposure time ??





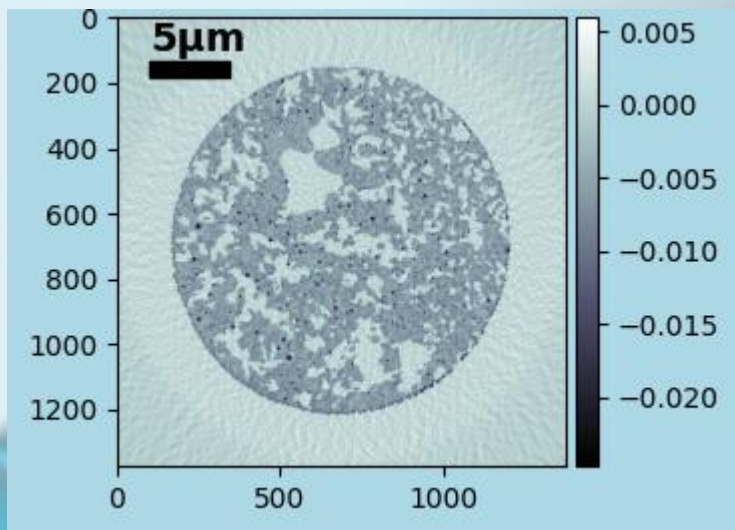
Less projections :

❑ Noisy image

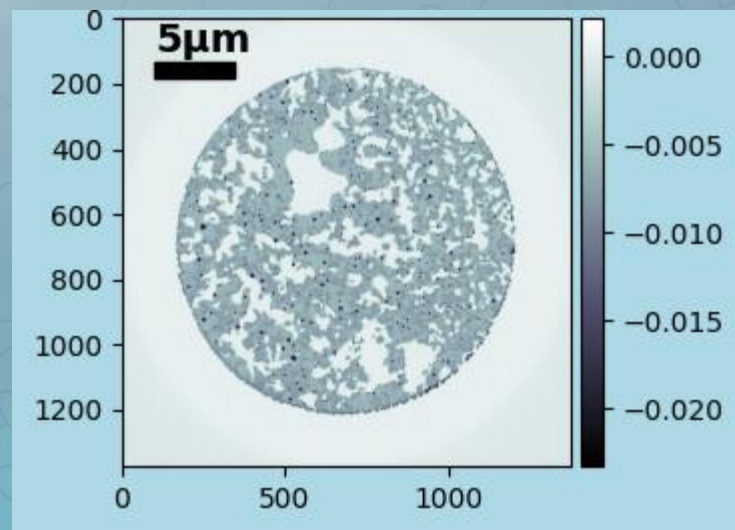
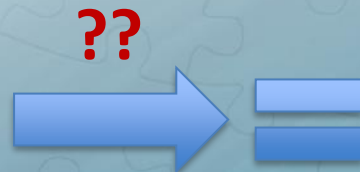
❑ Less time



Less projections scenario:



Initial reconstruction

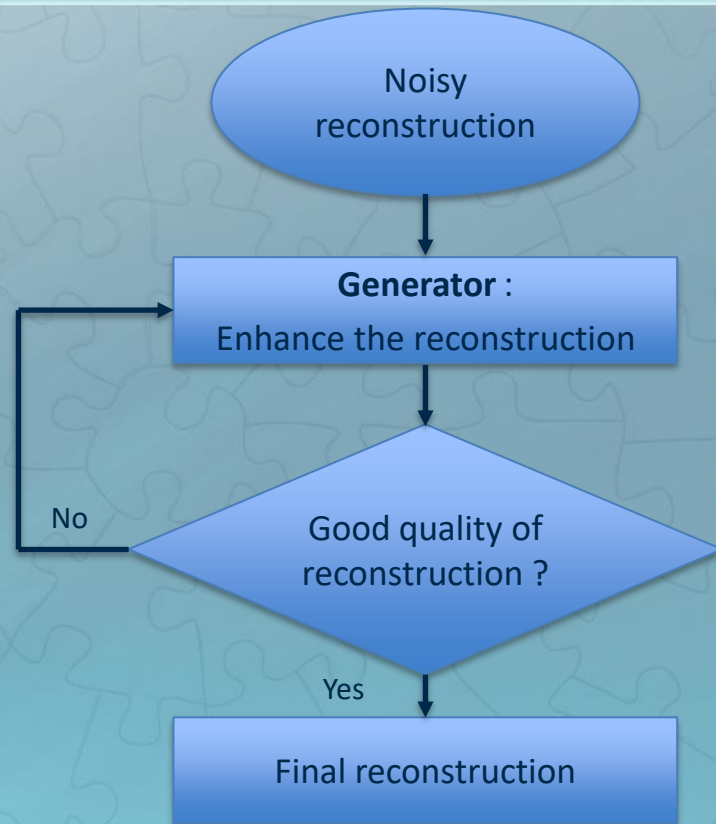


Enhanced reconstruction



TomoGAN:

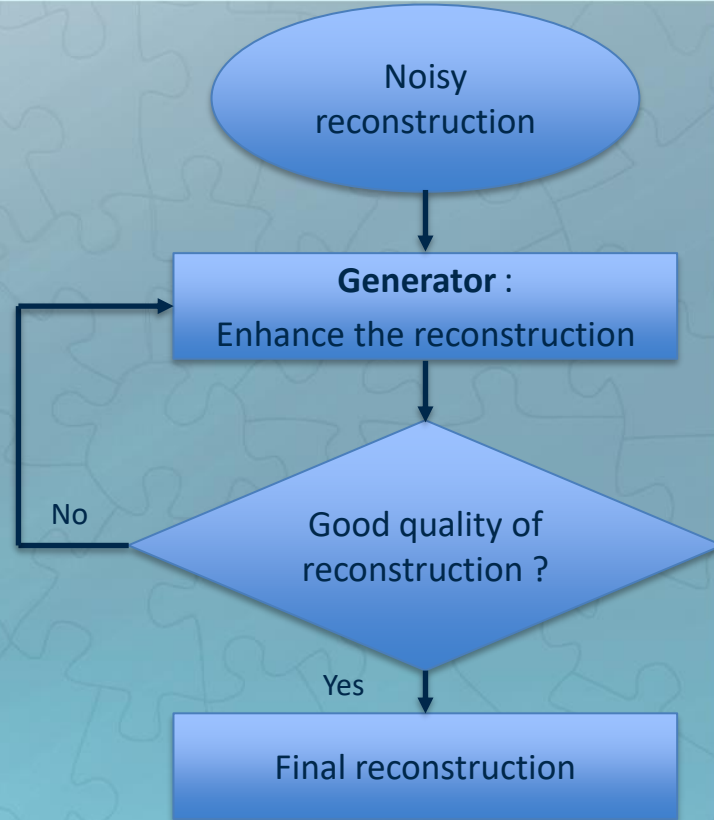
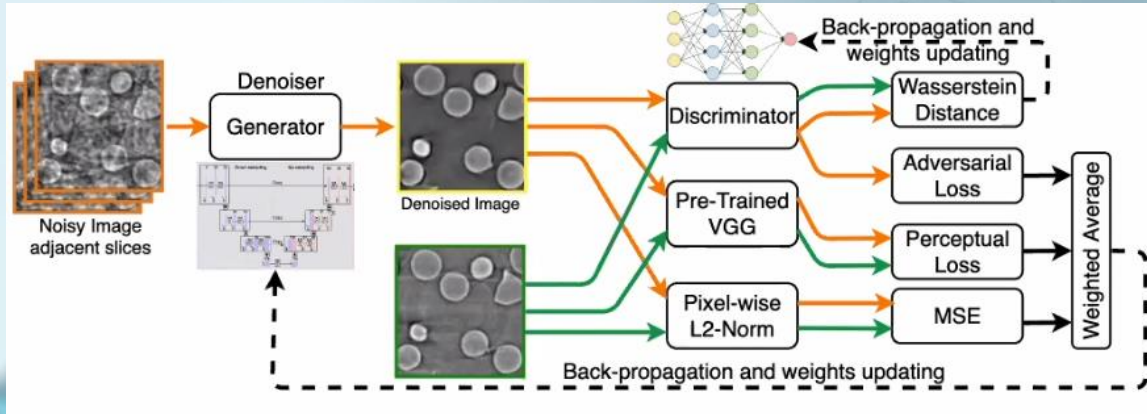
- ❑ Can be trained with limited data
- ❑ Supervised learning
- ❑ Generates greatly improved reconstruction of low dose, and noisy data
- ❑ Can be applied to a variety of experimental datasets from different instruments



Liu et al., « TomoGAN »



TomoGAN:



Liu et al., « TomoGAN »



Datasets:

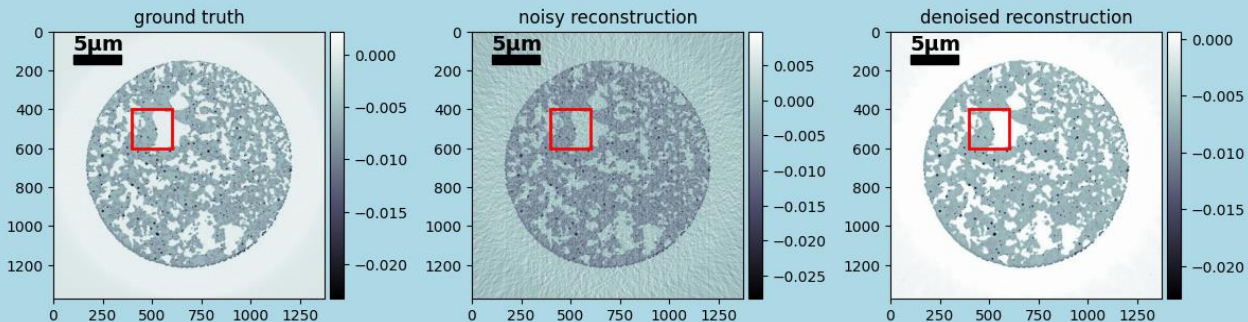
- Same sample acquired at 2 different energies (8337,8344) eV
- 984 projections
- Train : 384 slices (320 for training,64 for test) from tomogram acquired at 8337 eV.
- Prediction : noisy slices from 2nd tomogram acquired at 8344

Sparse cases:

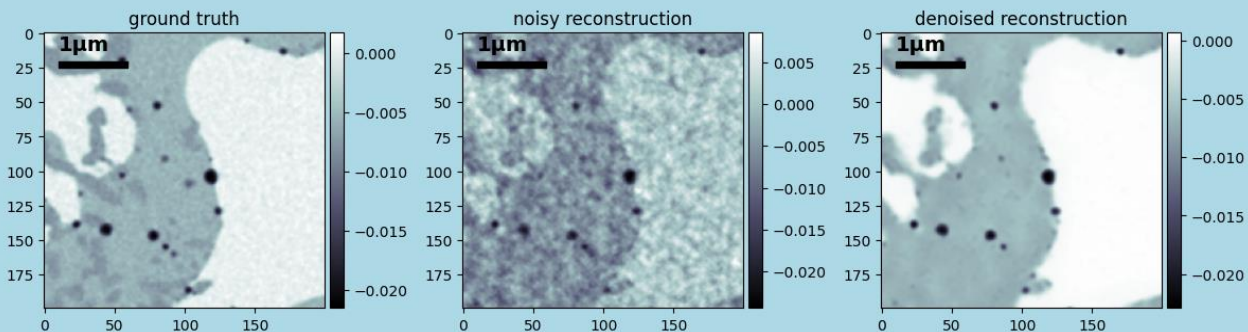
- Subsample the original projections of 2nd tomogram to 1/2 and 1/8 for experiments



TomoGAN for 1/8 of projections



TomoGAN for 1/8 of projections

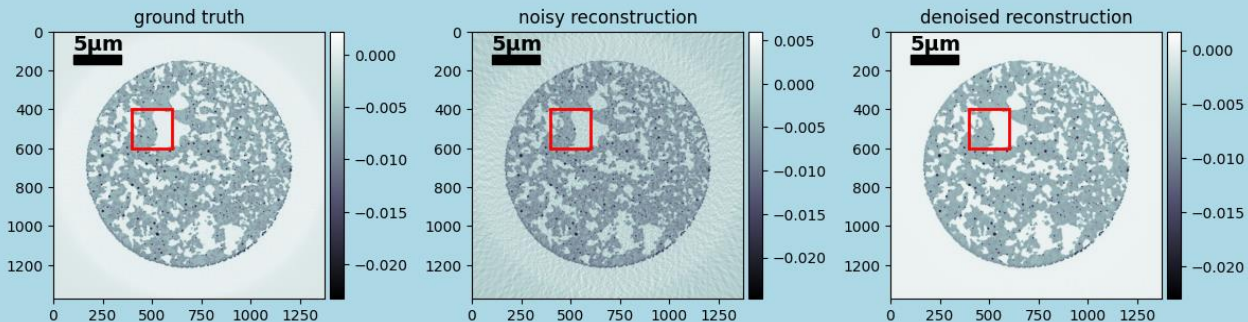


ROI*	SSIM* (%)	Mean SSIM (%)	Sd* SSIM (%)
Noisy reconstruction	31	40	3
Denoised reconstruction	68	69	1

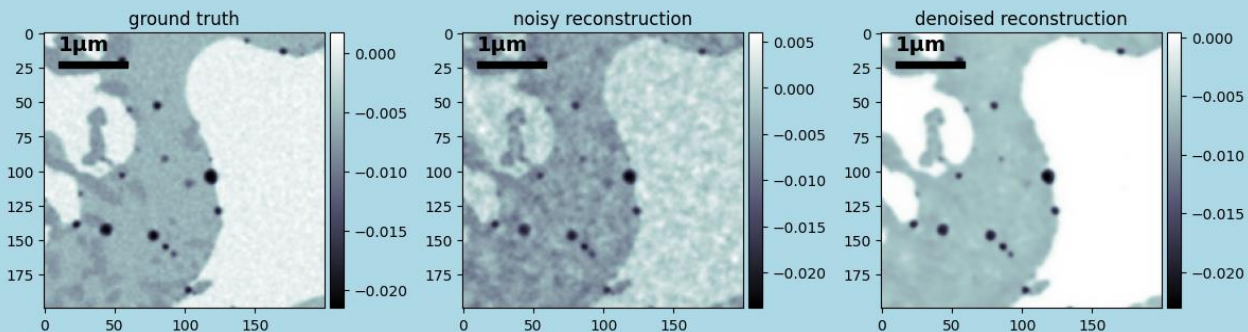
ROI: region of interest
 SSIM: Structural SIMilarity
 Sd: standard deviation



TomoGAN for 1/2 of projections



TomoGAN for 1/2 of projections



ROI*	SSIM* (%)	Mean SSIM (%)	Sd* SSIM (%)
Noisy reconstruction	51	59	4
Denoised reconstruction	75	76	1

ROI: region of interest
 SSIM: Structural SIMilarity
 sd: standard deviation



- ❑ By training TomoGAN on 1 complete high-resolution tomographic dataset at a given energy, we are capable to retrieve images from tomographic dataset at another energy with much fewer projections
- ❑ TomoGAN with some adjustment can be exploited for the spectral tomography taking advantage of the similarity of the tomograms



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Julio César da Silva
Jean-Louis Hazemann
Anico Kulow
Florent Magaud (poster)

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SWING

Javier Perez

Thank **You** for your attention!

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