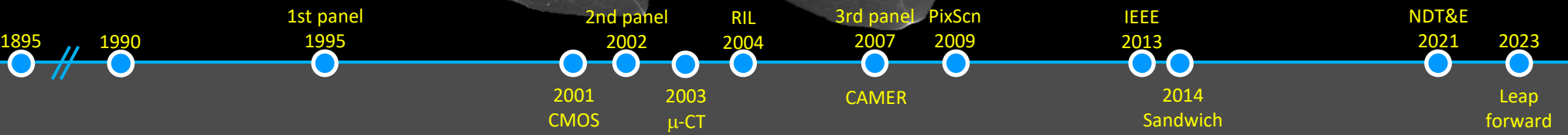
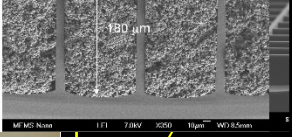
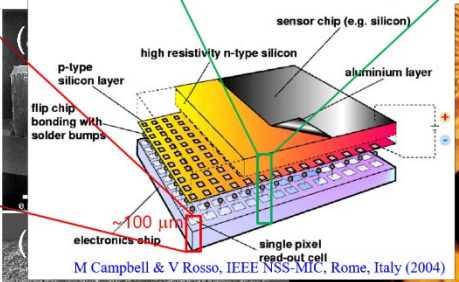
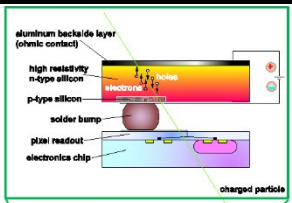
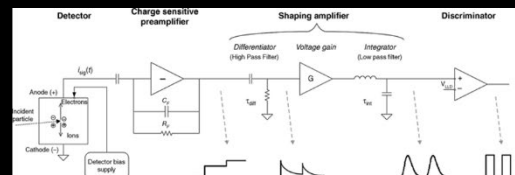


# Radiation Imaging Laboratory

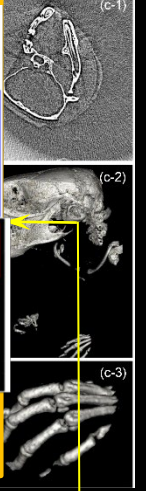
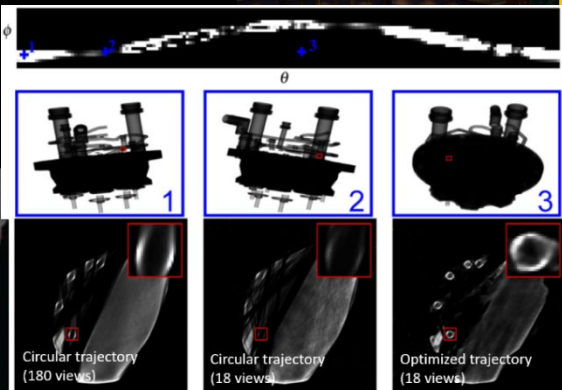
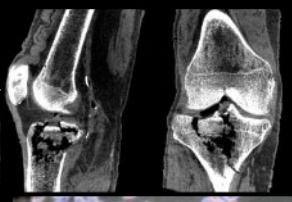
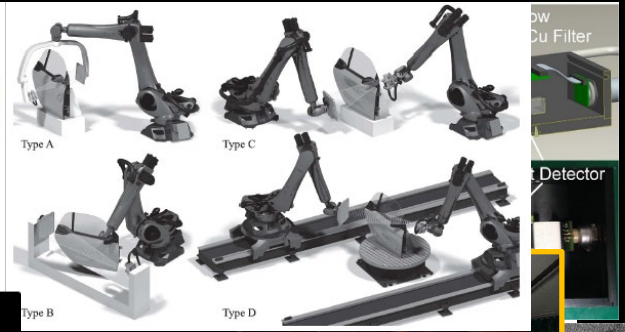
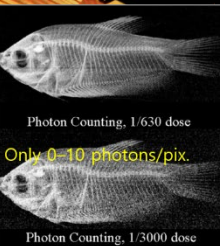
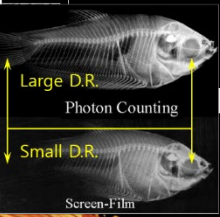
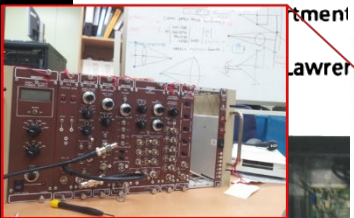


Ho Kyung Kim  
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School of Mechanical Engineering  
Center for Advanced Medical Engineering Research  
Pusan National University



Xerox Palo Alto Research Center (1990)



1895

1990

1st panel  
1995

2nd panel  
2002

RIL  
2004

3rd panel  
2007

PixScn  
2009

IEEE  
2013

2014  
Sandwich

NDT&E  
2021

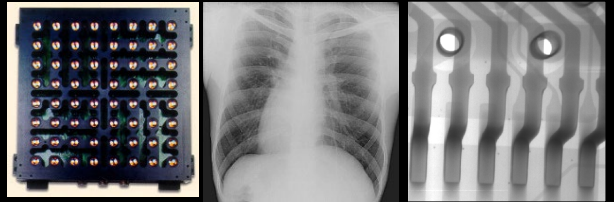
2023

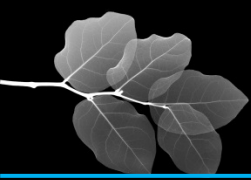
2001  
CMOS

2003  
μ-CT

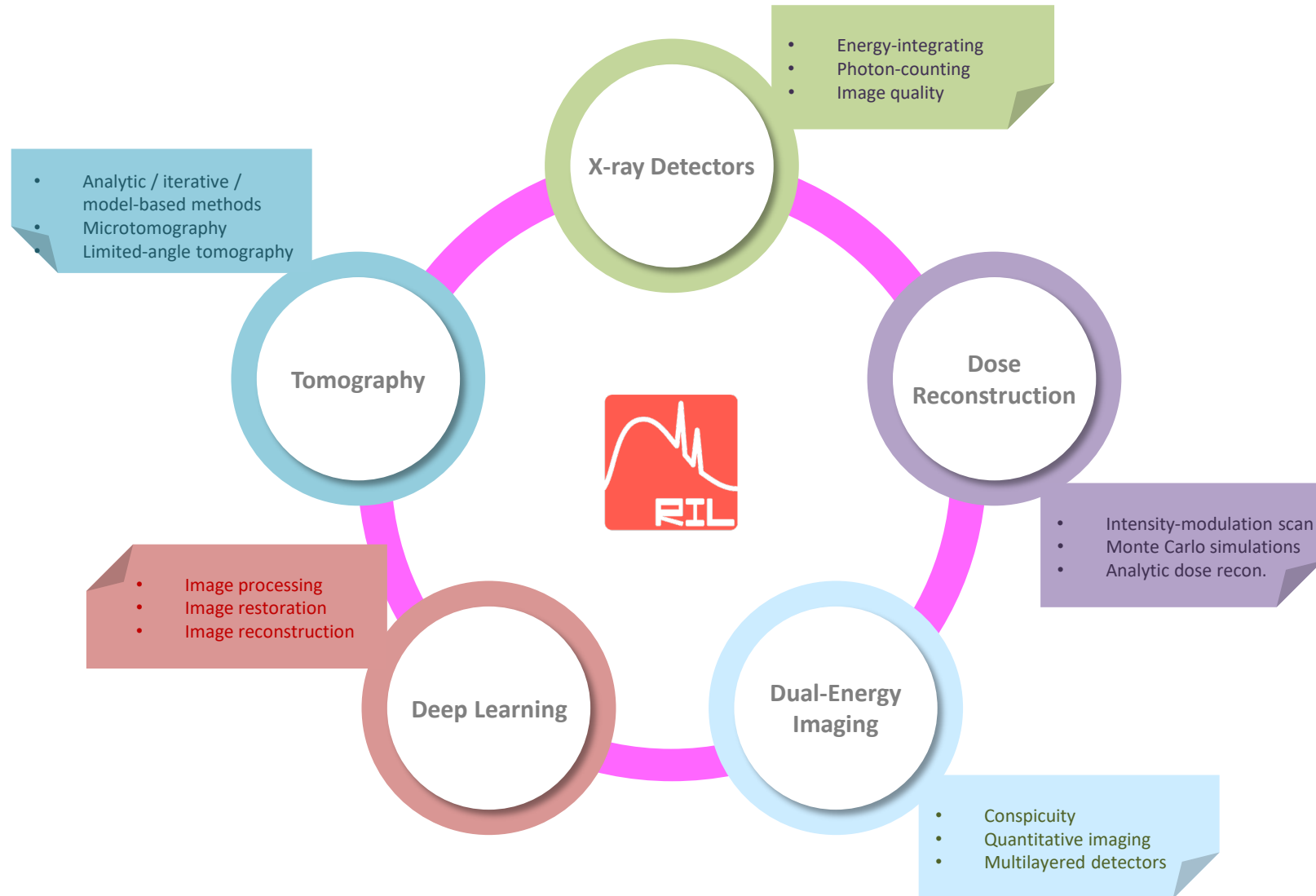
CAMER

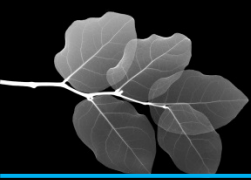
Leap forward





# Eigenvectors

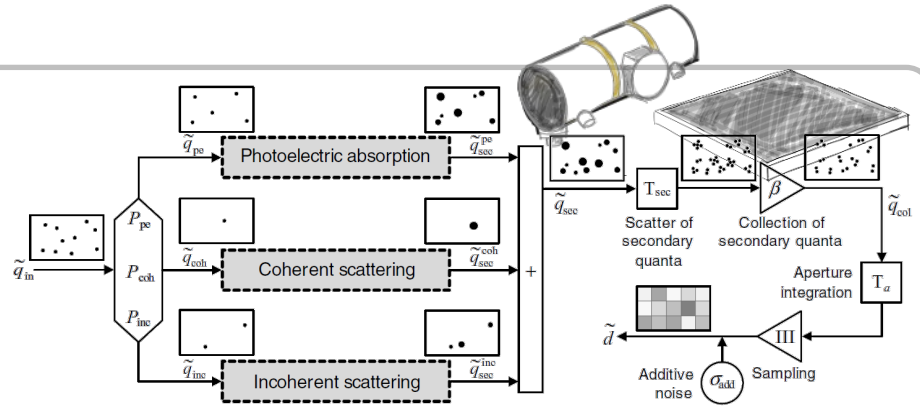




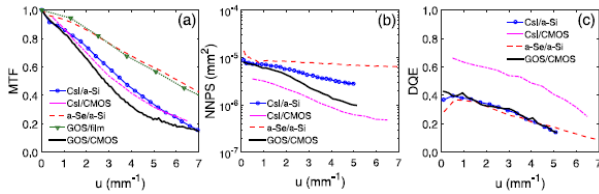
# X-ray Detectors



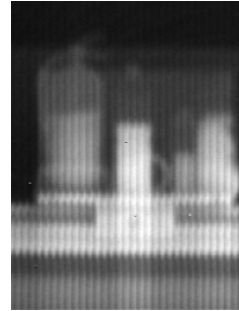
- DQE, cascaded-systems modeling & analysis
- Precise measurements of image quality
- Backscatter imaging
- Bio/clinical & industrial imaging
- Photon-counting detectors



## MTF, NPS, DQE



## BX reconstruction



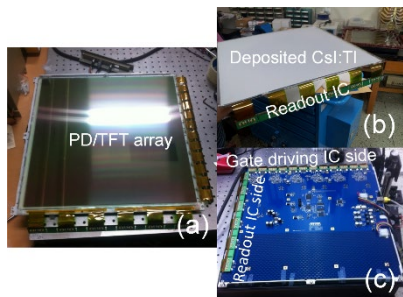
## PDF-transfer relationship (PCD)

Table III. Summary of PDF transfer relationships through elementary gain and selection processes (Ref. 42 and 43).

Process	PDF-transfer relationship	PDF transfer
General gain or selection		
		$p_{N_i}(N_i) = \int p_{N_{i-1}}(N_{i-1}) p_{N_i}(N_i) dN_{i-1}$ (81)
Quantum selection (Ref. 43)	Conditional PDF for quantum processes	Conditional PDF
		$p_{N_i}(N_i N_{i-1}) = \sum_j \binom{N_{i-1}}{j} \alpha^j (1-\alpha)^{N_{i-1}-j} \delta(N_i - j)$ (82)
Input-labeled quantum selection I: one set of parameters $b$ for all input quanta (Ref. 42)		$p_{N_i}(N_i N_{i-1}) = \sum_j \binom{N_{i-1}}{j} (\alpha^j (1-\alpha)^{N_{i-1}-j})^b \delta(N_i - j)$ (83)
Input-labeled quantum selection II: one set of parameters $b$ for each input quantum (Ref. 42)		$p_{N_i}(N_i N_{i-1}) = \sum_j \binom{N_{i-1}}{j} (\alpha^j (1-\alpha)^{N_{i-1}-j})^{b_j} \delta(N_i - j)$ (84)
Quantum gain (Ref. 43)		$p_{N_i}(N_i N_{i-1}) = \sum_j (p_{r_i} \alpha^{N_{i-1}-j} p_{r_i}) \delta(N_i - j)$ (85)
Input-labeled quantum gain I: one set of parameters $b$ for all input quanta (Ref. 42)		$p_{N_i}(N_i N_{i-1}) = \sum_j (p_{r_i} \alpha^{N_{i-1}-j} p_{r_i})^b \delta(N_i - j)$ (86)
Input-labeled quantum gain II: one set input parameters $b$ for each input quantum (Ref. 42)		$p_{N_i}(N_i N_{i-1}) = \sum_j ((p_{r_i} \alpha^{N_{i-1}-j} p_{r_i})^{b_j}) \delta(N_i - j)$ (87)

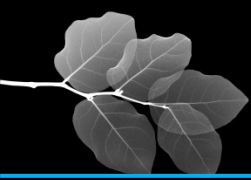
Medical Physics, Vol. 42, No. 1, January 2015

## Flat-panel detector



## MV scanner

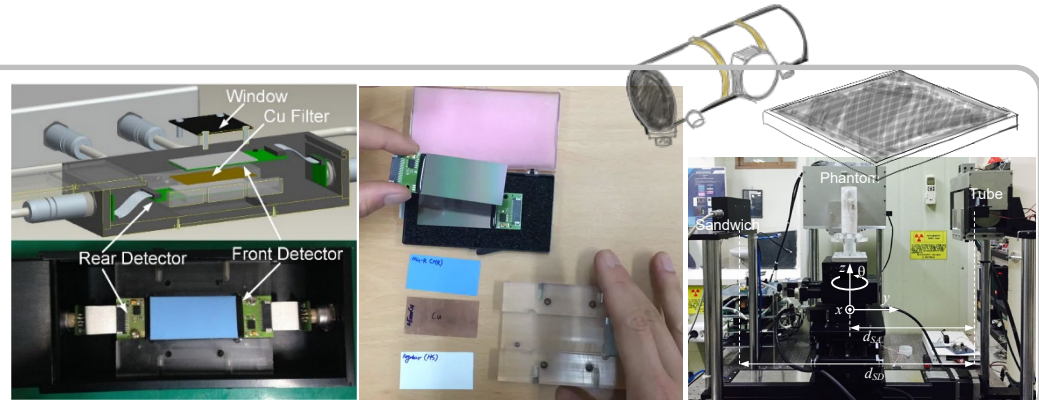




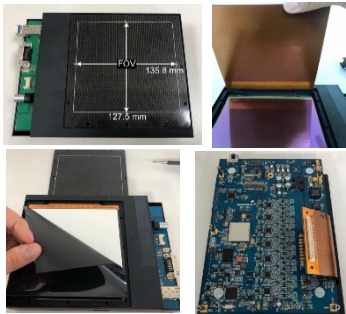
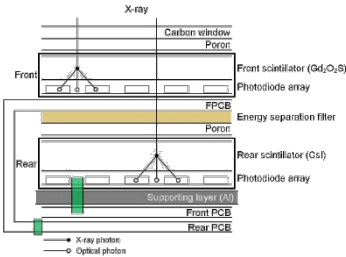
# Multi-Energy Imaging



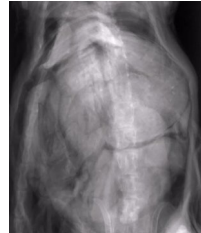
- Optimizing operation & system parameters
- Multilayered (sandwich) concept
- DE reconstructions
  - Linear combination
  - Basis material decomposition
- Photon-counting detector-based DEI



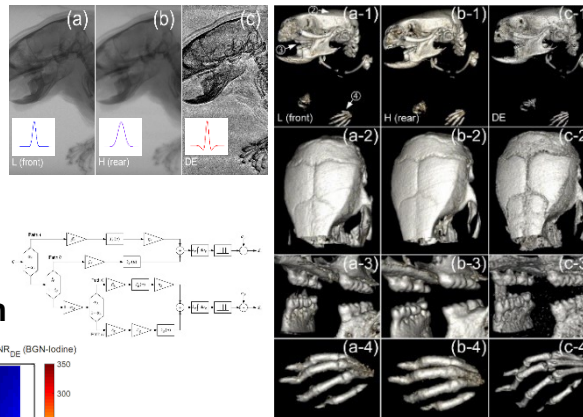
## Sandwich detector



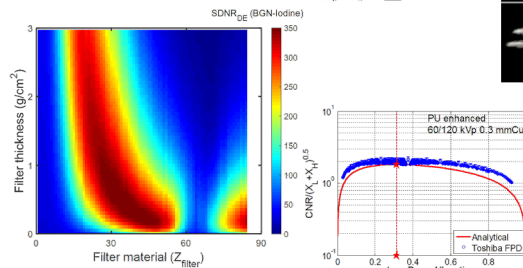
## Registration



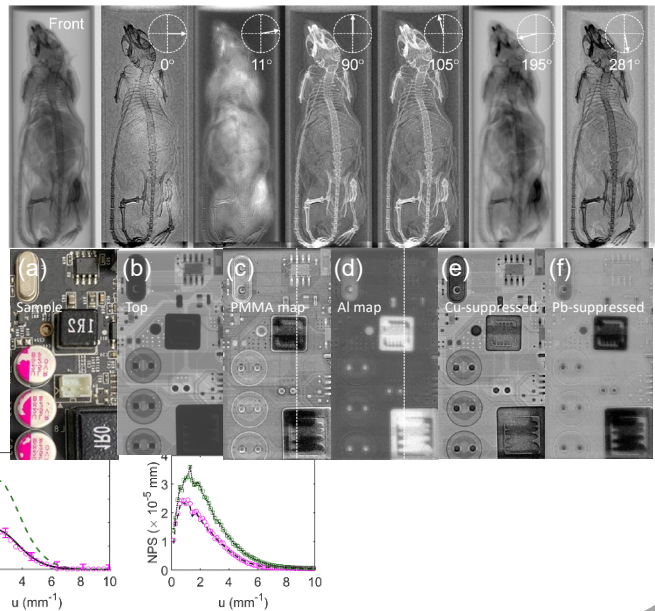
## Linear combination

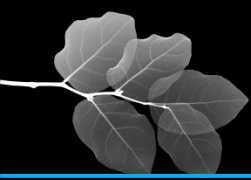


## Optimization



## Vector images

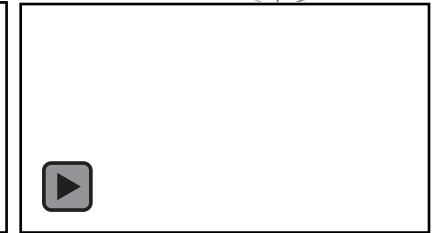
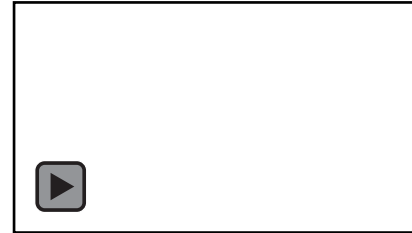
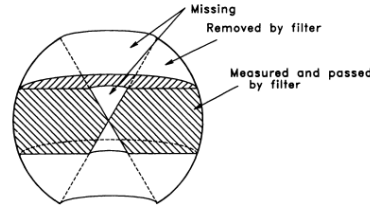
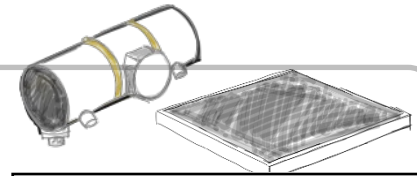




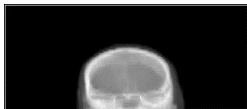
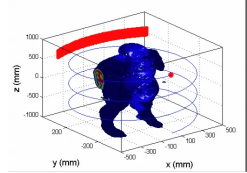
# Tomography



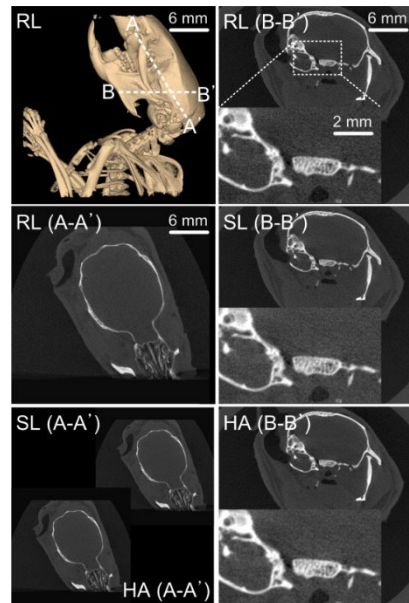
- Cascaded-systems modeling & analysis, 3D characterization
- Imaging simulations
- Algorithms
  - Analytic, iterative, model-based
  - Deep learning
- Microtomography
- Limited-angle tomography



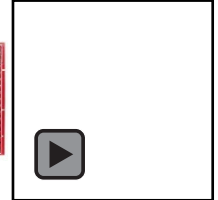
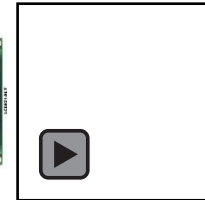
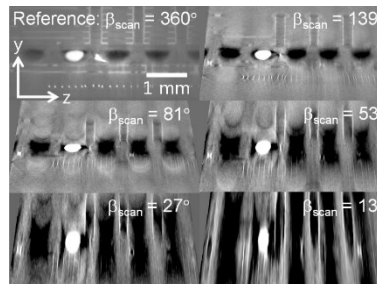
## Simulations



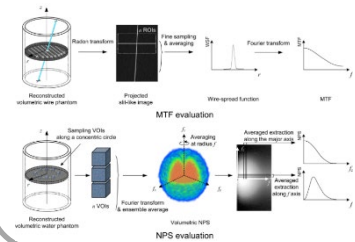
## Microtomography



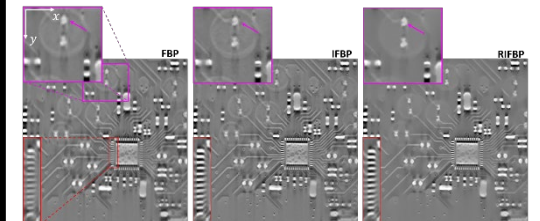
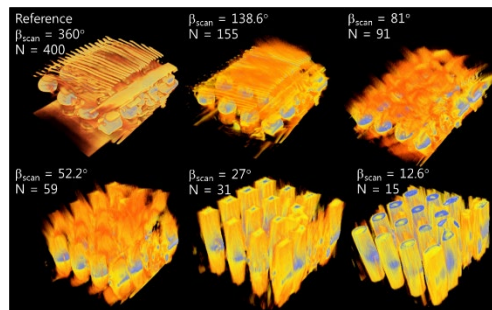
## Limited-angle tomography

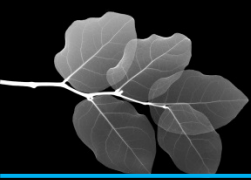


## Characterization



## Algorithms

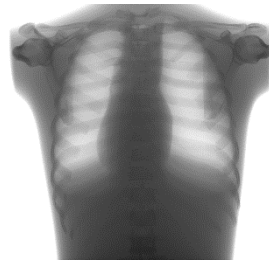




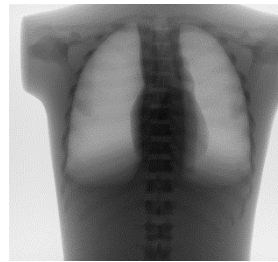
# Dose Reconstruction



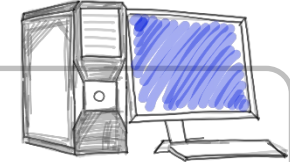
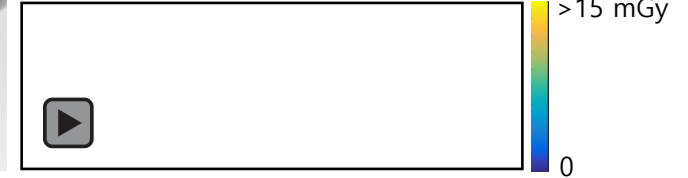
- Monte Carlo simulations
- Patient-specific dose estimation
- Intensity-modulated CT scans
- Fast dose estimation algorithms



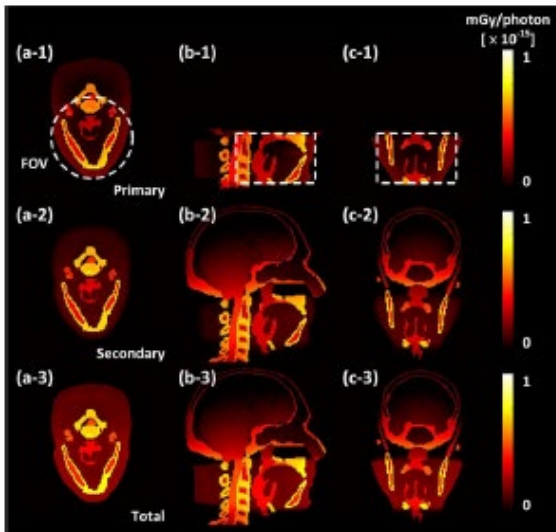
Measurement



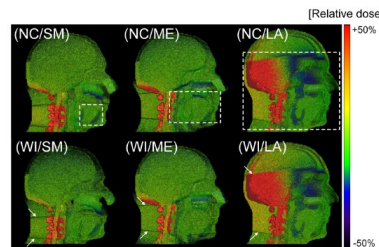
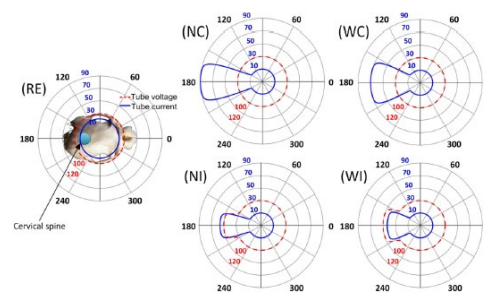
Virtual image



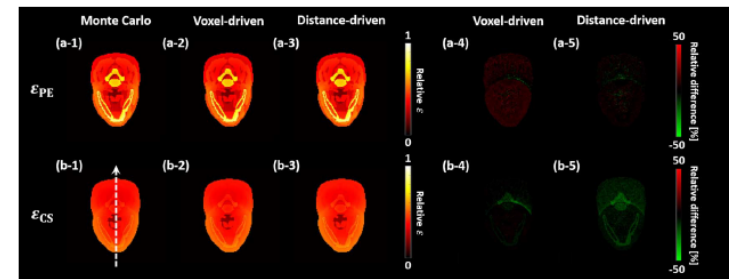
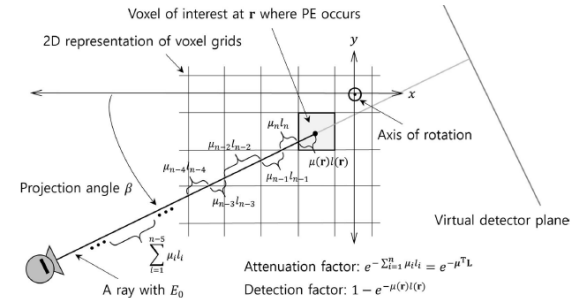
## MC simulations

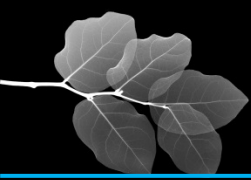


## Intensity-modulated scan scenarios



## Voxel-driven approach for dose estimation

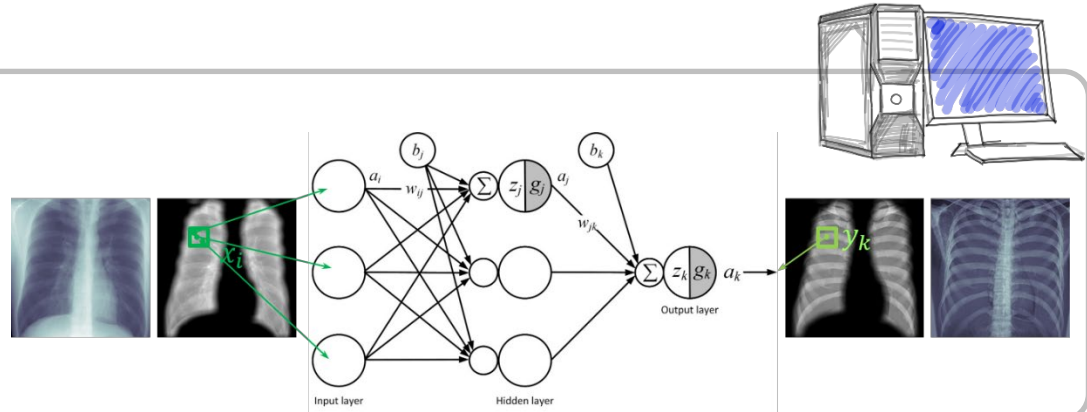




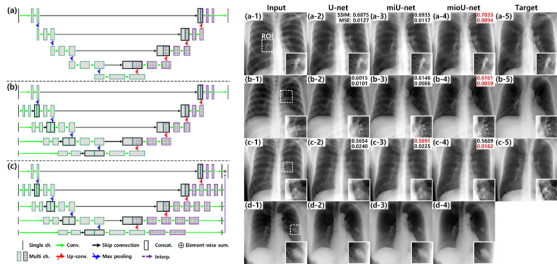
# Deep Learning



- Digital image processing
- Dual-energy imaging
- Image restoration (super resolution)
- Network design & optimization
- Image reconstruction

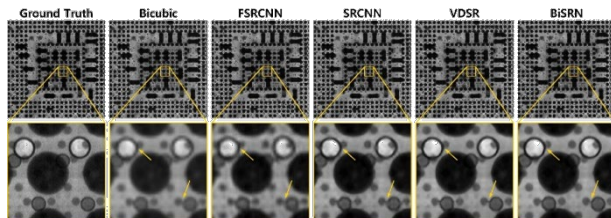


## DE imaging

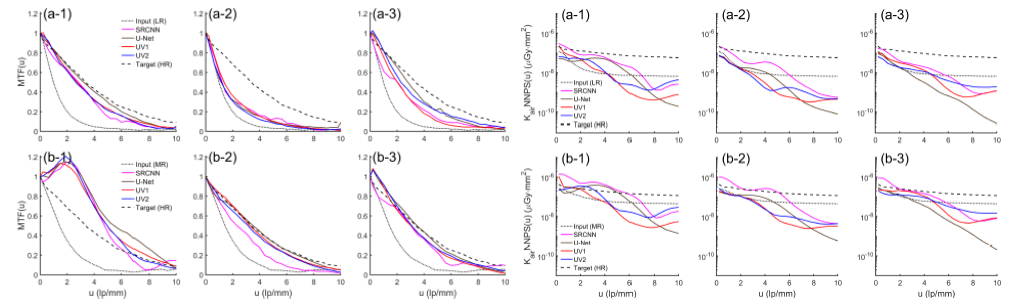
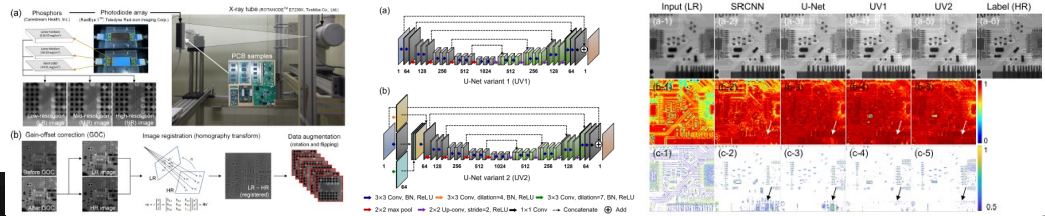


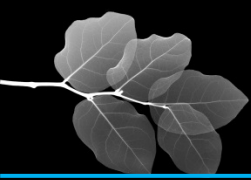
Zoom image (checkerboard artifacts)

## Super resolution

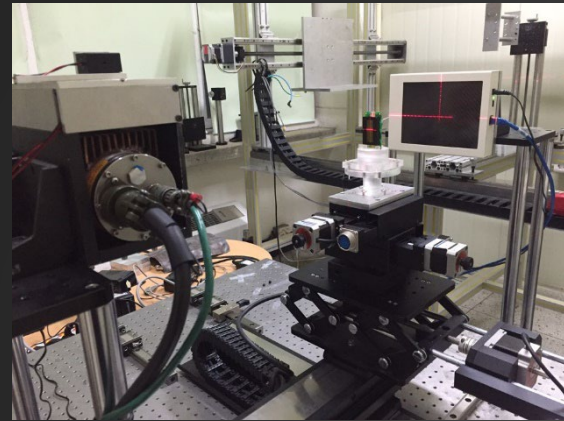


## Fourier analysis of multi-scale networks for super resolution



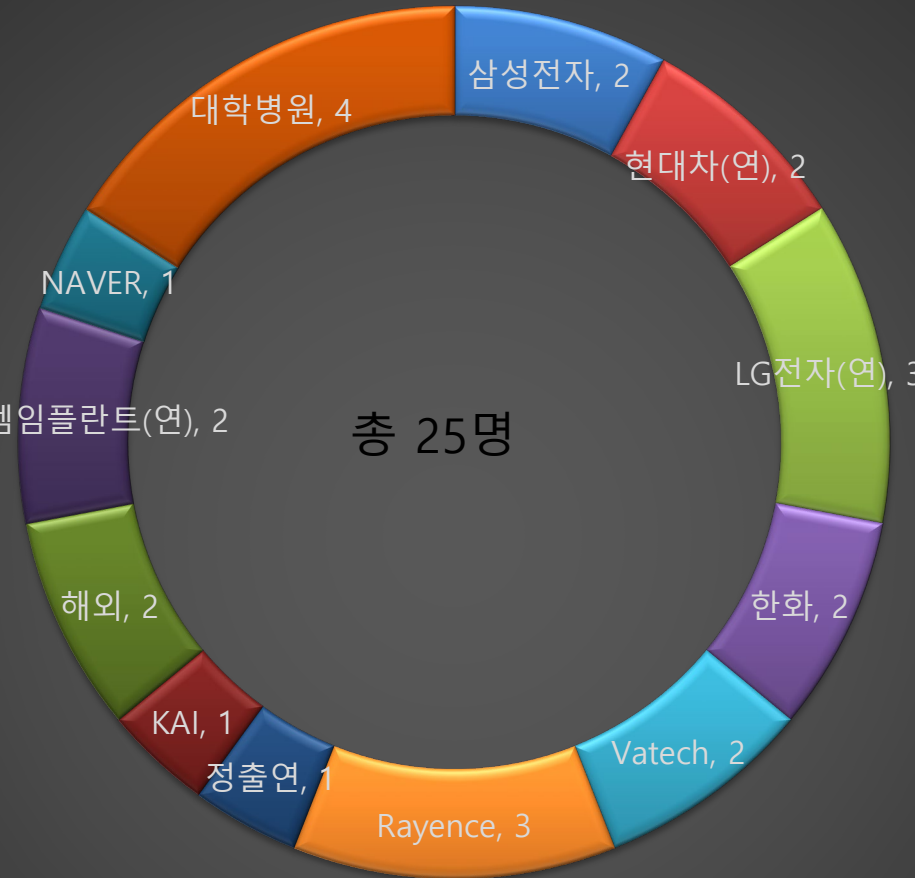


# The Largest Eigenvalue = *Students!*



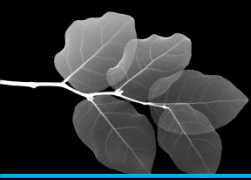
3214-1 for measurements

오스템임플란트(연), 2

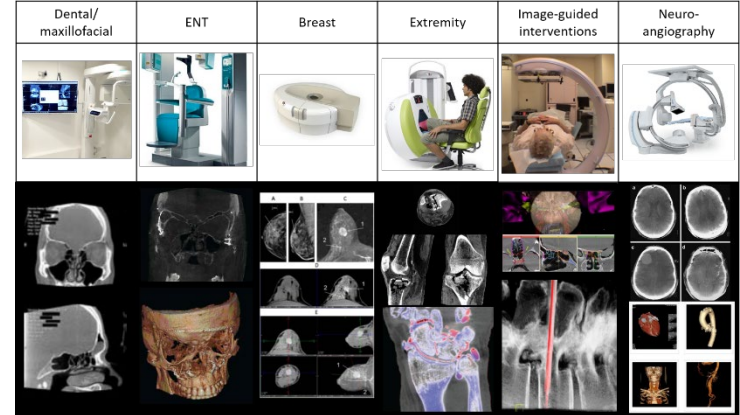
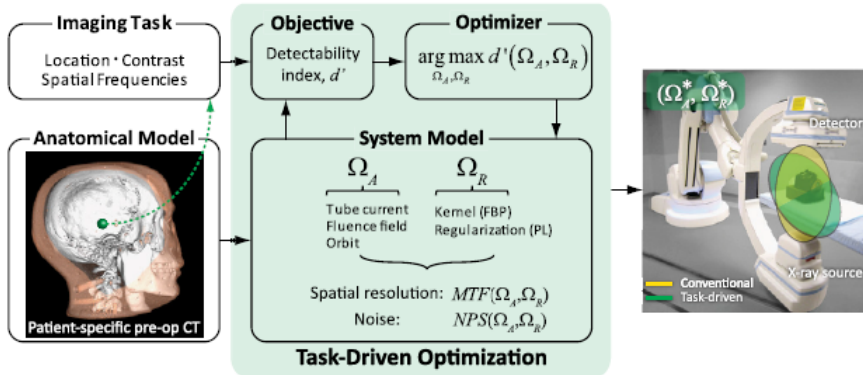


M120 for computation

- ▶ 삼성전자
- ▶ 현대차(연)
- ▶ LG전자(연)
- ▶ 한화
- ▶ Vatech
- ▶ Rayence
- ▶ 정출연
- ▶ KAI
- ▶ 해외
- ▶ 오스템임플란트(연)
- ▶ NAVER
- ▶ 대학병원



# An Eigenvalue ... Forward



$$SNR_I^2 = G^2 \int_{-u_N}^{+u_N} \int_{-v_N}^{+v_N} \frac{|\Delta S(u, v)|^2 MTF^2(u, v)}{NPS(u, v)} dudv \equiv d'_{SKE}^2$$

