S-3

PET/CT 원리와 장점

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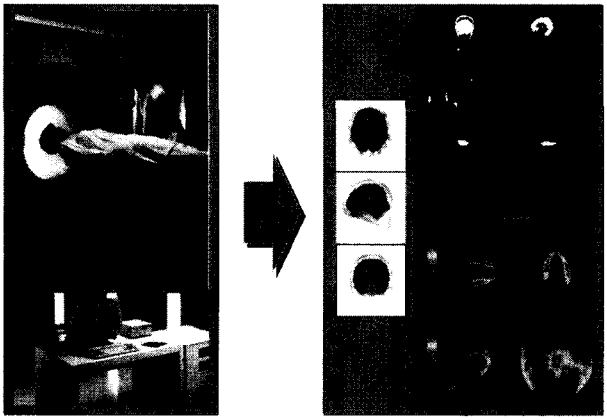
최 용

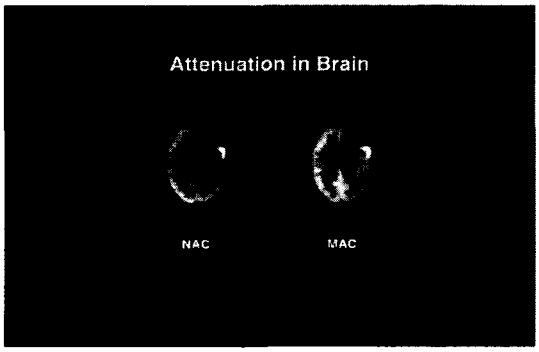
PET (양전자방출단층촬영기)

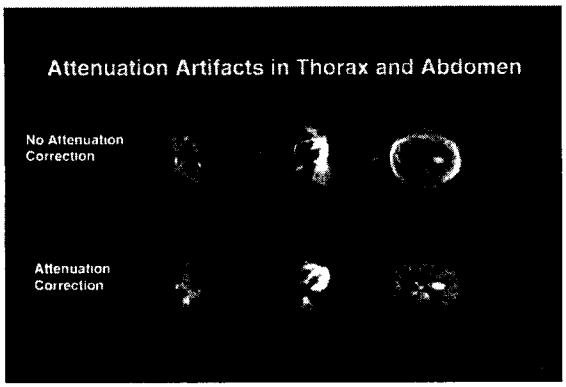
- 생물학적 기능영상 (cf. MRI, CT)
- PET 기기:높은 민감도
  감쇠, 산란 등 물리적 영상저하 요인
  최소화
- PET 방사성의약품: O-15, N-13, C-11, F-18
  짧은 반감기
  높은 비방사능



PET/CT 스케너 개발 동기

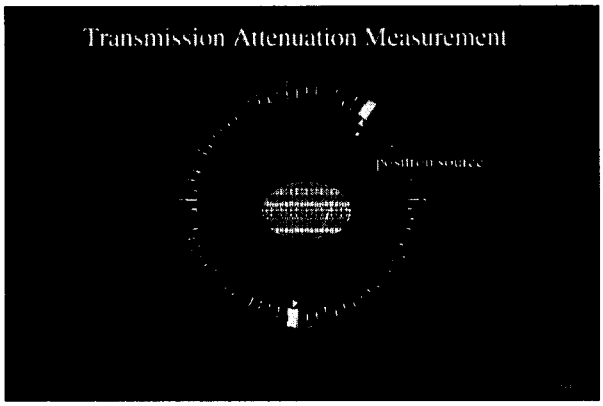
- 고 성능 감쇠 보정 방법 개발 필요
- 고 분해능 형태 영상과 비교 판독 필요

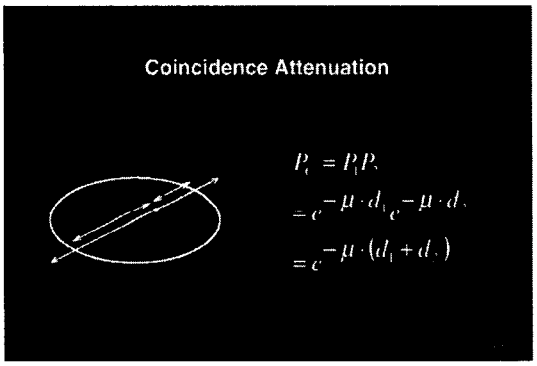


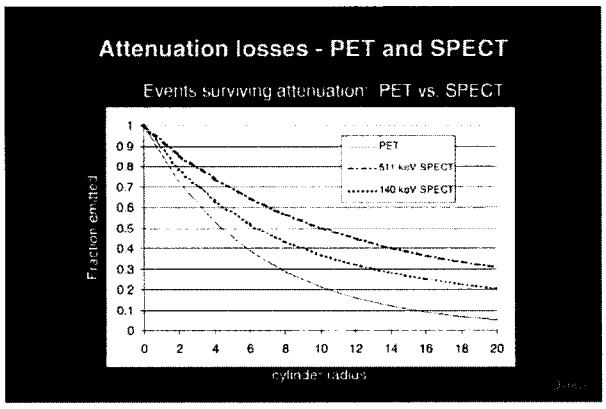


감쇠 보정 방법

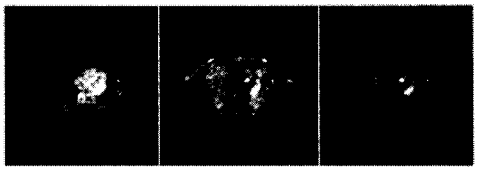
- Transmission scan (MAC)
  - Smoothing options
  - T+E correction
  - Segmented attenuation correction (SAC)
- Operator-specified ellipse (CAC)
- Edge-finding in sinogram (autoCAC)
  Operator-specified convex polygon
- CT based attenuation correction





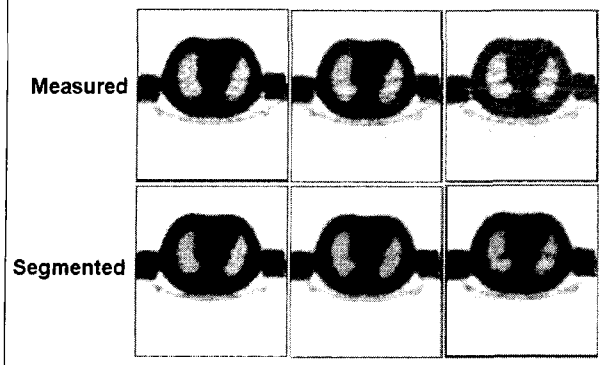


감쇠 보정 효과

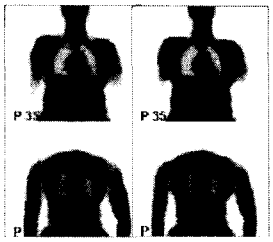


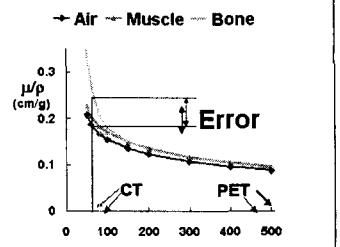
	Measured	No corr	Bad contour
Myo/Lung	9	2	2
Myo/Tissue	4	5	8

Segmented Attenuation Correction



CT-based attenuation correction (low noise)



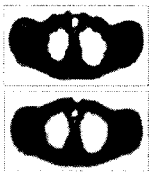


Rod sources Segmented

Transmission source strength

Standard PET: 0.1-1 GBq

CT-based: 2 10^6 GBq



CT: 70 keV

Scaled: 511 keV

CT Based Attenuation Correction

- Scaling, Segmentation (soft tissue, bone, lung (density varies 30%)), Hybrid
- Procedure
  - Reduce CT image to 128 x 128 matrix
  - Transform CT pixel values to 511 keV linear attenuation coefficient
  - Forward project the attenuation image
  - Smooth the sinogram with 8 mm Gaussian filter
  - Apply to emission data

CT Based Attenuation Correction

- Scaling:

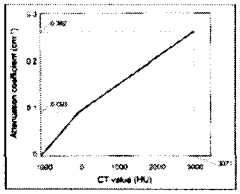


TABLE 1. Mass attenuation coefficients (linear attenuation coefficient/density) in cm^2/g. Data are from Hubbell (ref. 9)

	80 keV			500 keV			Ratio of totals
Material	Photoelec.	Compton	Total	Photoelec.	Compton	Total	80 keV:500 keV
Air	0.006	0.161	0.167	<0.001	0.087	0.087	1.92
Water	0.008	0.176	0.184	<0.001	0.097	0.097	1.90
Muscle	0.008	0.176	0.182	<0.001	0.096	0.096	1.90
Bone	0.034	0.175	0.209	<0.001	0.093	0.093	2.26
Teflon	---	---	0.188	-----	---	0.087	1.93

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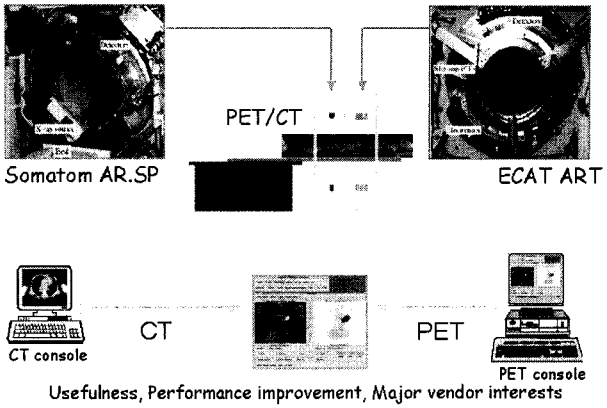
기능영상-해부영상 융합 소프트웨어 방법

- Works well for rigid organ: brain
- Two image sets contain little correlative information
- Differences between two scans: patient movement, patient positioning
- Uncontrollable differences: internal organ movement
- Non-linear image warping: labor intensive

기능영상-해부영상 융합 하드웨어 방법

- Lang TF, et al. Description of a prototype emission-transmission computed tomography imaging system. JNM 1992
- Blankespoor SC, et al. Attenuation correction of SPECT using X-ray CT on an emission-transmission CT system. IEEE TNS 1996
- Beyer T, et al. A combined PET/CT scanner for clinical oncology. JNM 2000

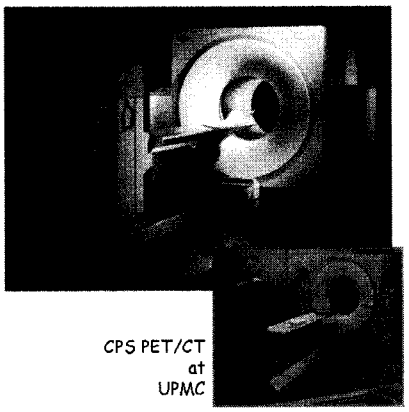
The hardware approach (1998)



Usefulness, Performance improvement, Major vendor interests

CPS PET/CT (Biograph)

- 3D ECAT HR+
  - 70 cm port
  - no septa, no rods
- Somatom Emotion
  - 0.8 s spiral CT
  - 50 cm FOV
- Software
  - *syngo* platform
  - CT and PET
  - fusion viewer
- PHS
  - 145 cm co-scan
  - floor-mounted rails
  - flat pallet for RTP



CPS PET/CT at UPMC

Discovery LS

Highest Performance. . .

PET

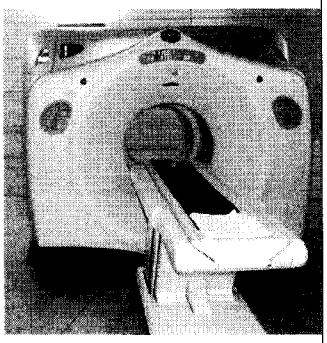
Advance NXi

Highest Sensitivity
Best Resolution
Lowest Scatter Fraction
Fastest *Quality* Imaging

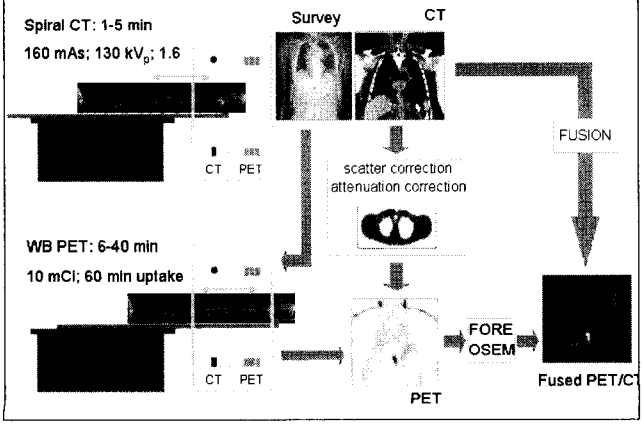
CT

LightSpeed Plus

4-Slice Helical CT
17 seconds Whole Body
0.625 mm slices



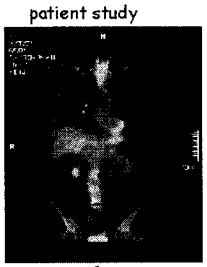
PET/CT scan protocol University of Pittsburgh PET/CT scanner



CPS PET/CT

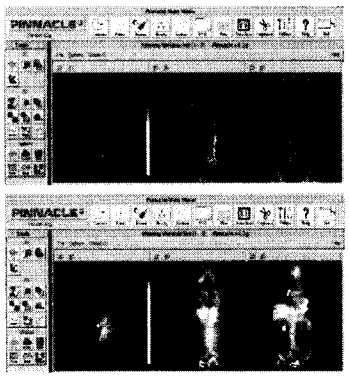
ADAC Pinnacle

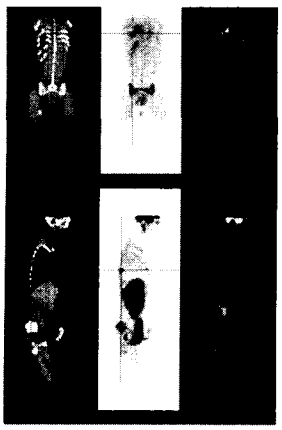
CPS PET/CT scanner: patient study



syngo fusion viewer

68 year-old male
Nodules in right lung





Lung Cancer

DISCOVERY LS

Bringing You....

A WHOLE NEW WORLD

of PET/CT

Challenges in Clinical Imaging

- Arm position: raised or down
- Transverse FOV: CT - 50 cm, PET – 60 cm
  - Truncation of CT -> accuracy of attenuation correction
- Respiratory motion
  - CT: inhalation, PET: normal breathing
  - CT, PET: shallow breathing

Future Design

- Cohesive system integration: avoid duplication of data acquisition and image reconstruction systems
- Disease management approach
- High sensitivity panel detector: whole-body scan time < 10 min