



# Initial Results From the World's First Total-Body Positron Emission Tomograph

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<sup>3</sup> Siemens Healthineers

# Disclosures

Investigator:

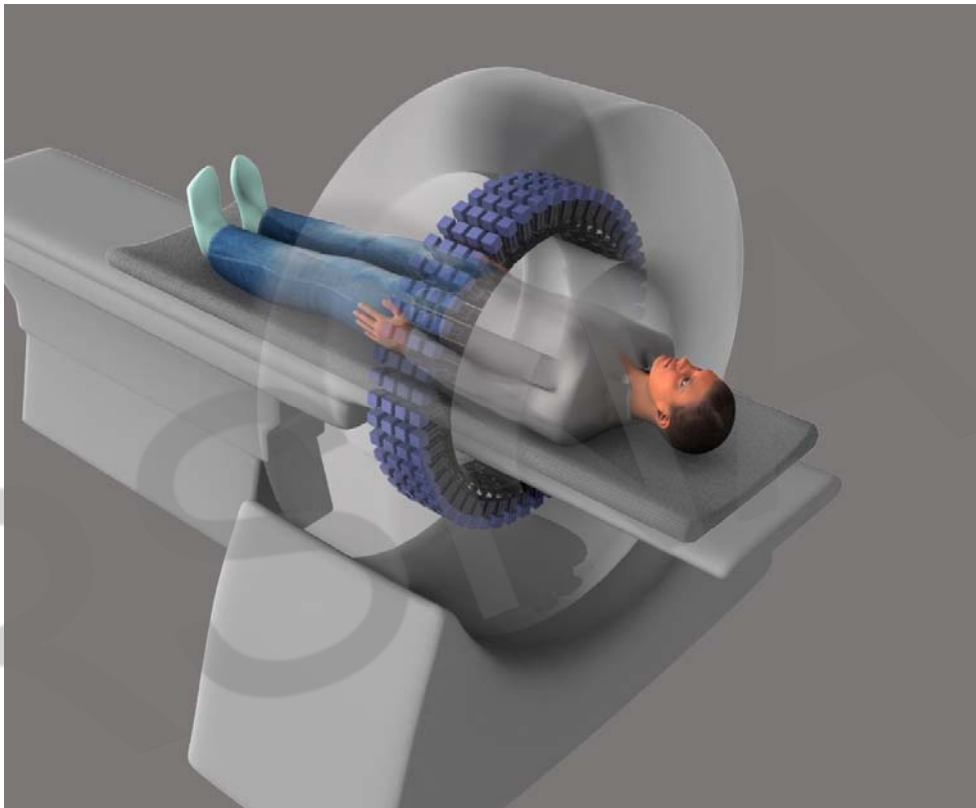
United Imaging Healthcare

UC Davis has a sales-based gift agreement with United Imaging Healthcare

FDA status:

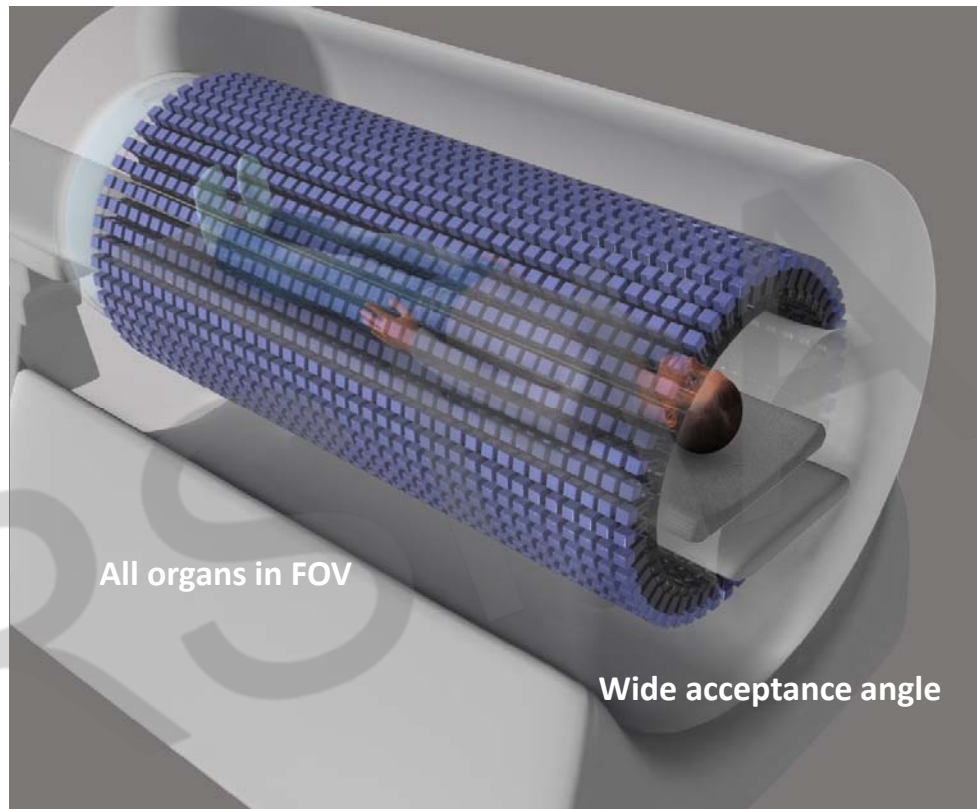
Total Body PET scanner is not FDA approved

# Problem: most PET signal is wasted



- All PET scans today are limited by low numbers of detected photons, high dose, or both.

# Solution: Scanner covers the entire patient



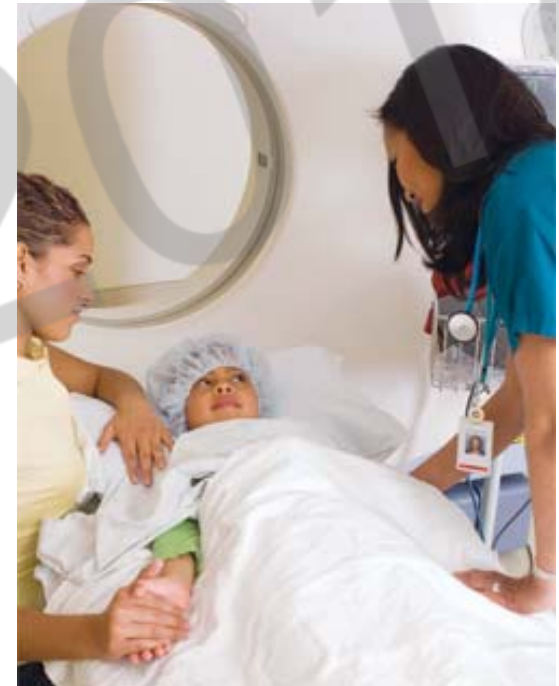
- Image better  
~6-fold gain in SNR
- Image faster  
- up to  $1/40^{\text{th}}$  time
- Image longer/late  
~ 5 more half-lives
- Image with low dose  
- up to  $1/40^{\text{th}}$  dose
- Total body coverage

# Research applications

Application	Advantage from EXPLORER
Developmental neuro-psychiatric disorders	Low dose
Imaging <i>in utero</i>	Low dose
Mechanisms and cures for arthritis	Low dose => multiple scans on same subject
Obesity; metabolic syndrome	Low dose => multiple scans on same subject
Diabetes; exercise physiology	Low dose => multiple scans on same subject
Drug development: multi-organ pharmacokinetics, dosimetry	Total-body imaging; late time-point imaging
Multi-system disease: Parkinson's; brain-gut interactions	Total-body imaging

# Clinical applications

- Ultra-fast pediatric scans – less anesthesia
- Improved scanning for morbidly obese patients
- Single breath-hold PET
- Any search for small cancer deposits
- High-throughput scanning in urban centers
- Follow-up scanning in pediatric oncology
- Immunotherapy planning and dosimetry
- Total-body imaging:
  - Tumor glycolysis
  - Tumor perfusion
  - Thrombosis/PE
  - Peripheral vascular disease



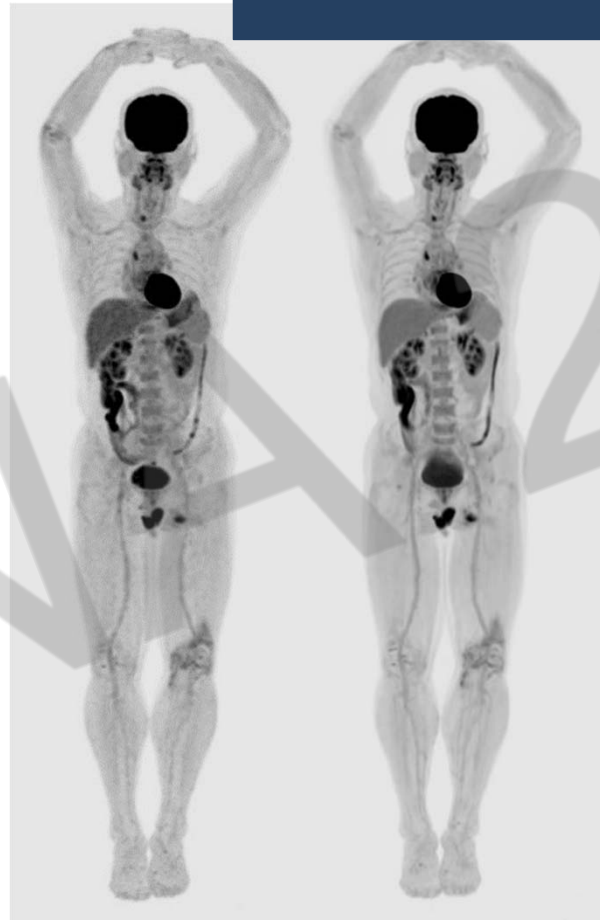
(UCLA health system)

# EXPLORER scanner

- Axial FOV: 194 cm
- Transaxial FOV: 68.6 cm
- Bore diameter: 76 cm
- 564,480 crystals
- 80 row CT



## EXPLORER: First human images



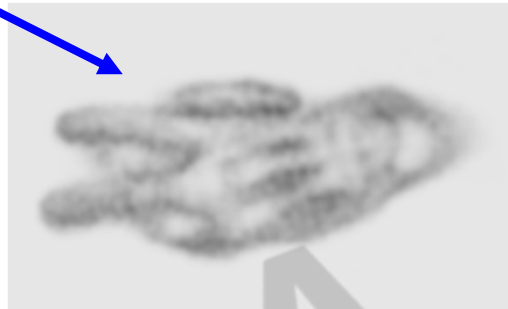
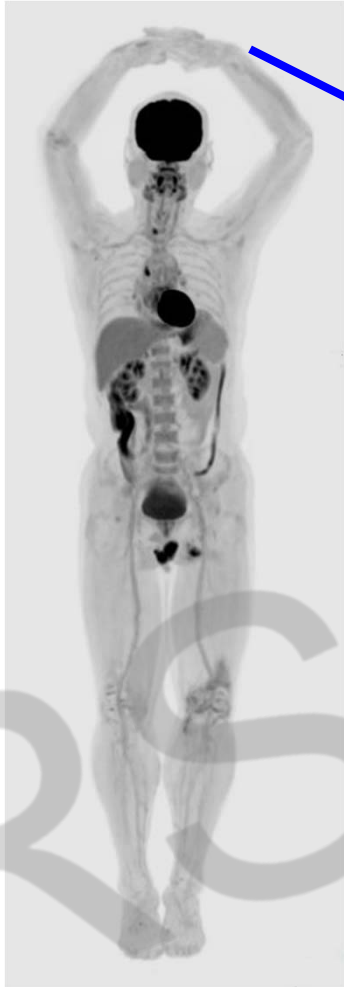
1 min scan  
81 min p.i.

20 min scan  
82 min p.i.

61-yo male, 65 kg; 164 cm; 7.8 mCi. Credit: Zhongshan Hospital; Shanghai



## EXPLORER: First human images



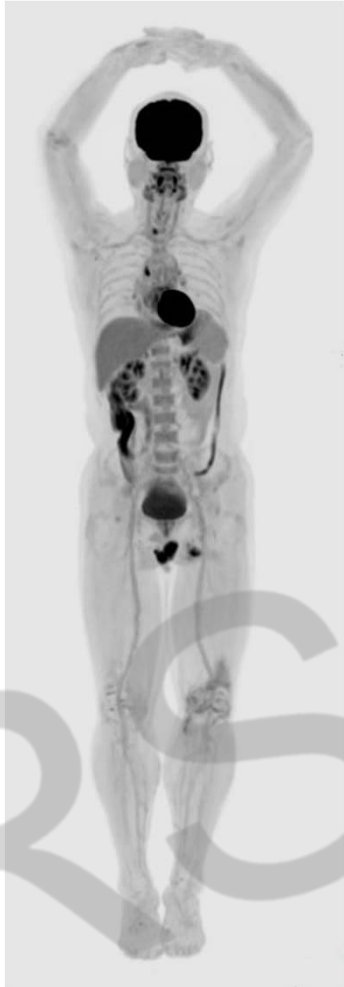
61-yo male, 65 kg; 164 cm; 7.8 mCi; 82 min p.i.; 20 min acq. Credit: Zhongshan Hospital; Shanghai

## EXPLORER: First human images



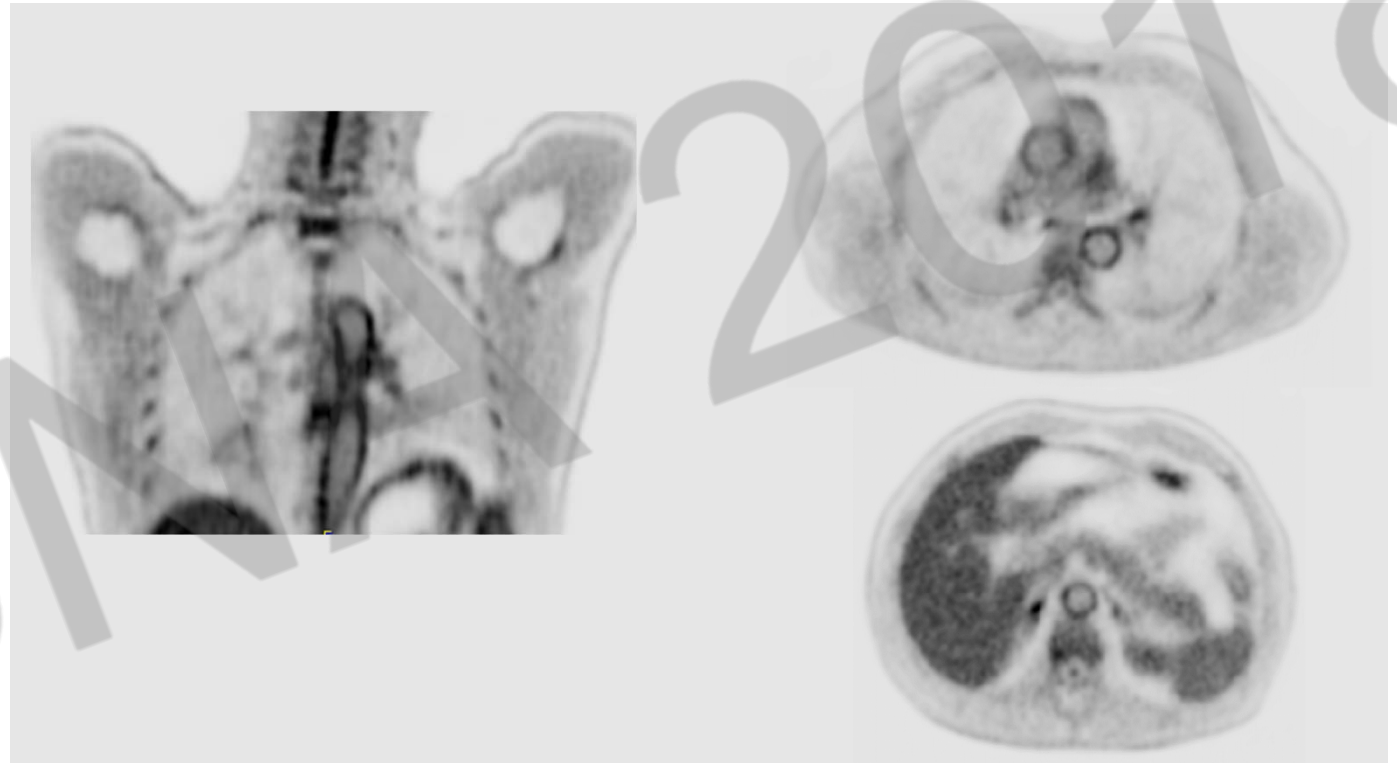
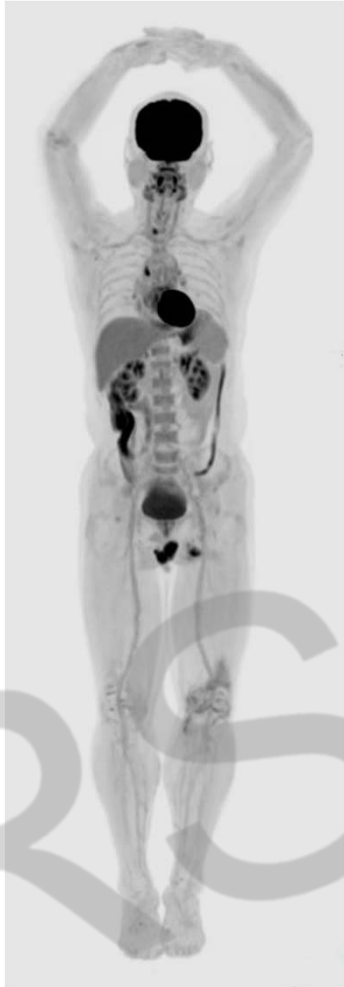
Patient: 63 yo female , 55kg; 2.183mCi (80 MBq); 25 min p.i.; 25mins  
Reconstruction: TOF-PSF-OSEM; 10 itrs / 20subs; 1.17mm x 1.17 mm x 1.42 mm voxels  
Credit: Zhongshan Hospital; Shanghai

## EXPLORER: First human images



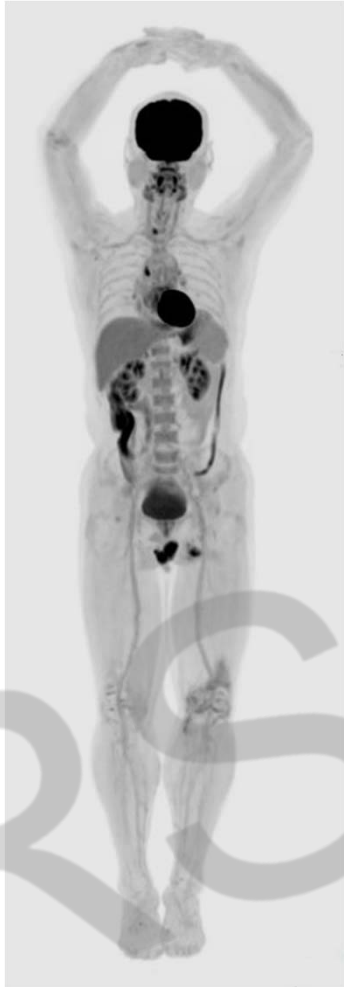
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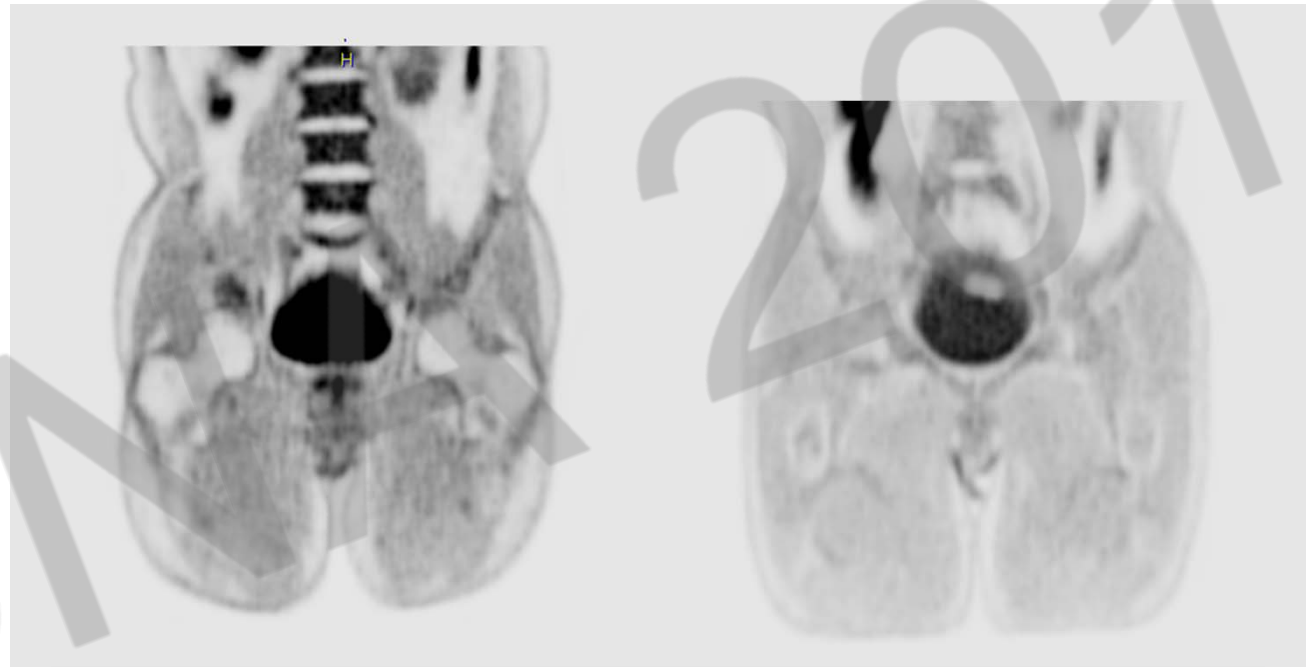
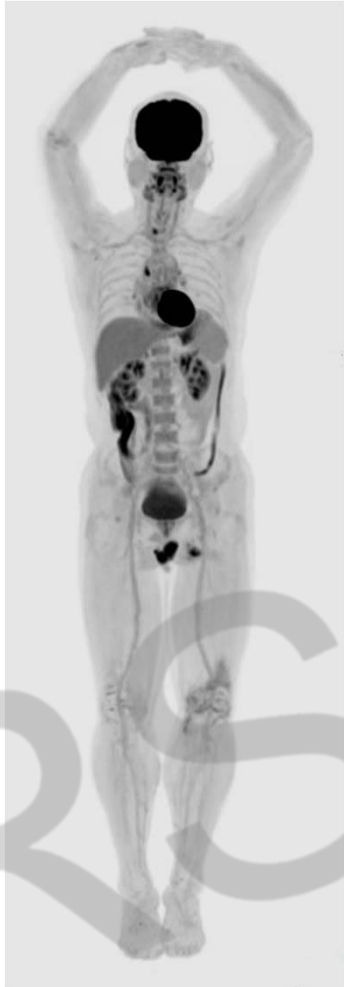
61-yo male, 65 kg; 164 cm; 7.8 mCi; 82 min p.i.; 20 min acq. Credit: Zhongshan Hospital; Shanghai

## EXPLORER: First human images



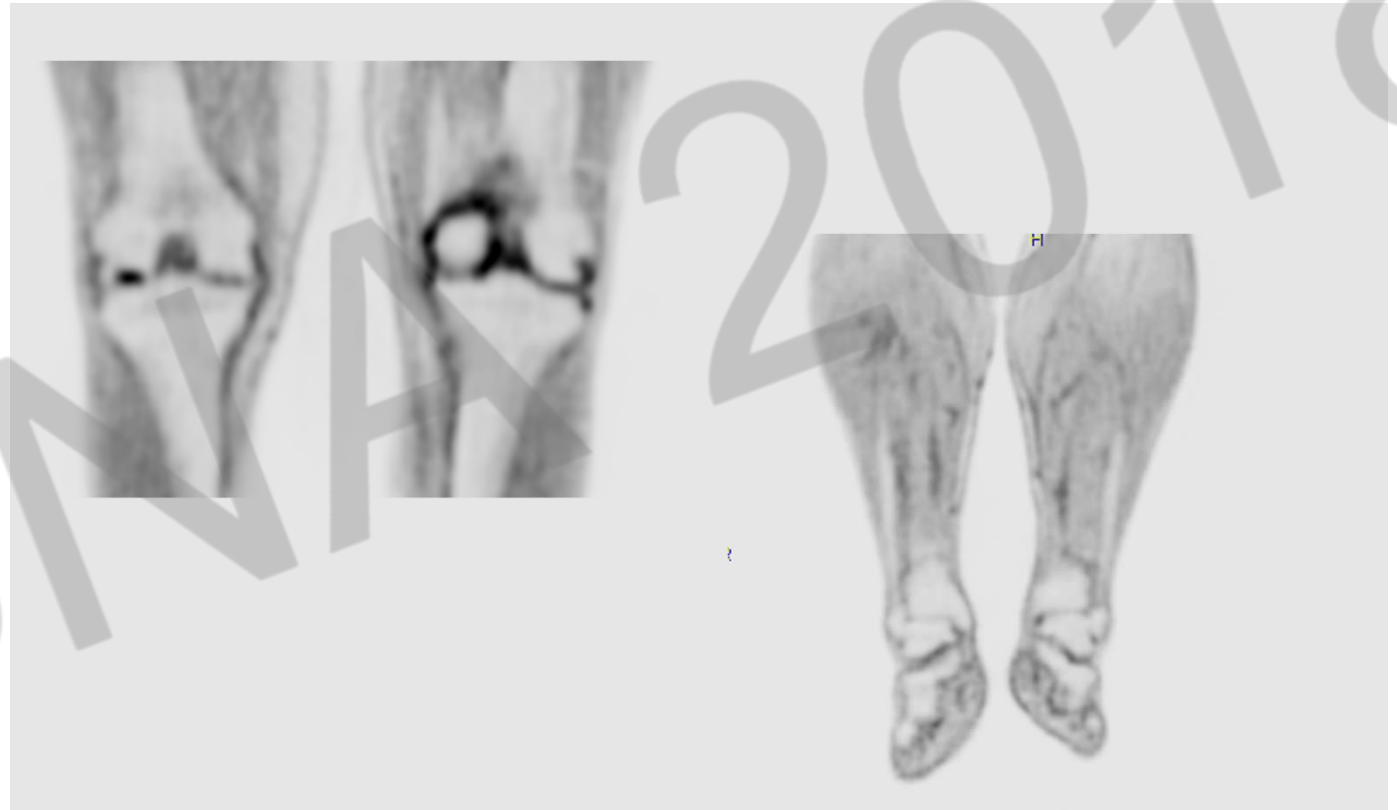
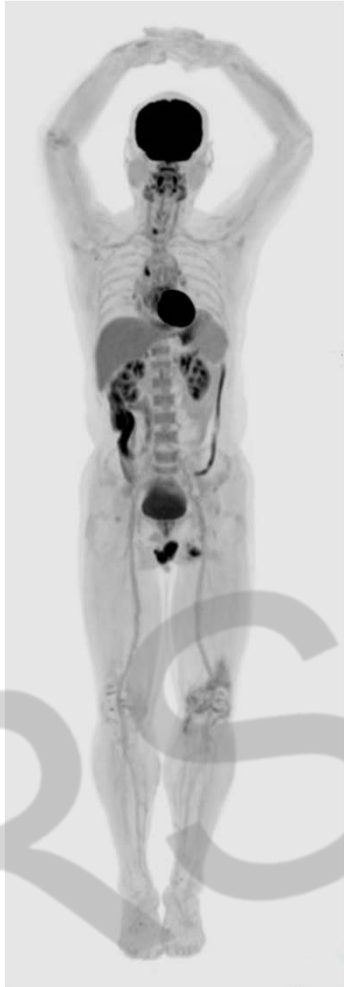
61-yo male, 65 kg; 164 cm; 7.8 mCi; 82 min p.i.; 20 min acq. Credit: Zhongshan Hospital; Shanghai

## EXPLORER: First human images



61-yo male, 65 kg; 164 cm; 7.8 mCi; 82 min p.i.; 20 min acq. Credit: Zhongshan Hospital; Shanghai

## EXPLORER: First human images



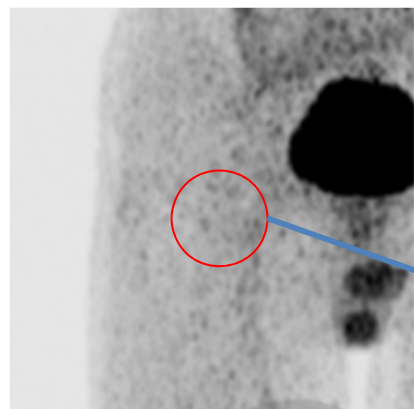
61-yo male, 65 kg; 164 cm; 7.8 mCi; 82 min p.i.; 20 min acq. Credit: Zhongshan Hospital; Shanghai

# EXPLORER Claims

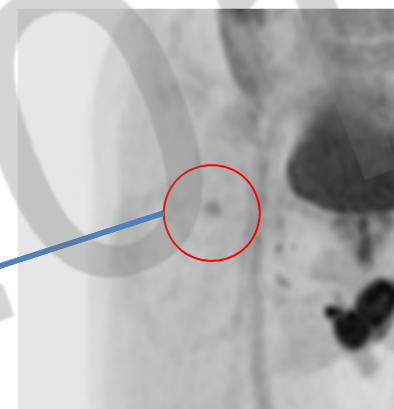
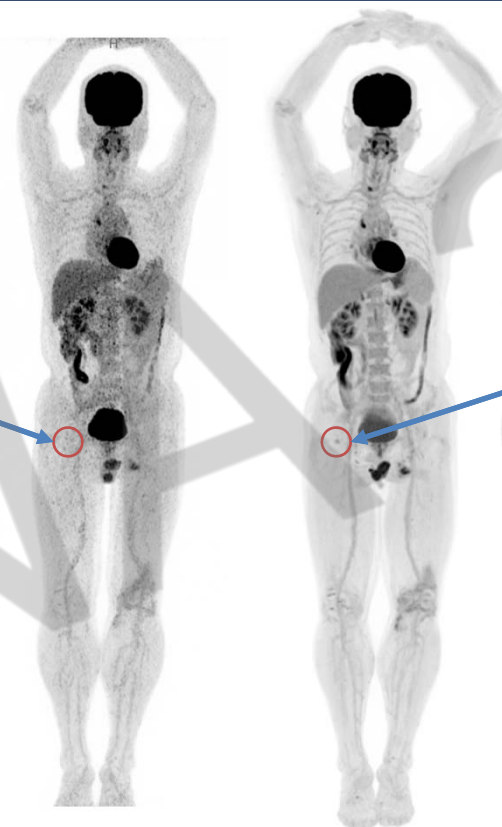




# EXPLORER Claim: Image Better



**Conventional PET  
(uMI 780)**  
8 beds, 2mins/bed,  
50 min p.i.

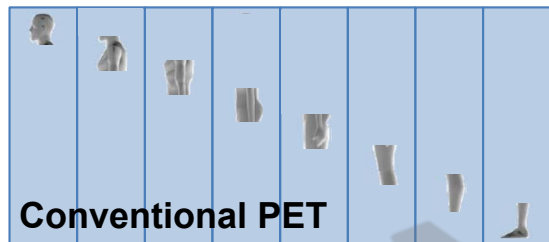


**EXPLORER**

20 min scan, 1 bed  
82 min p.i.

# EXPLORER Claim: Image Faster

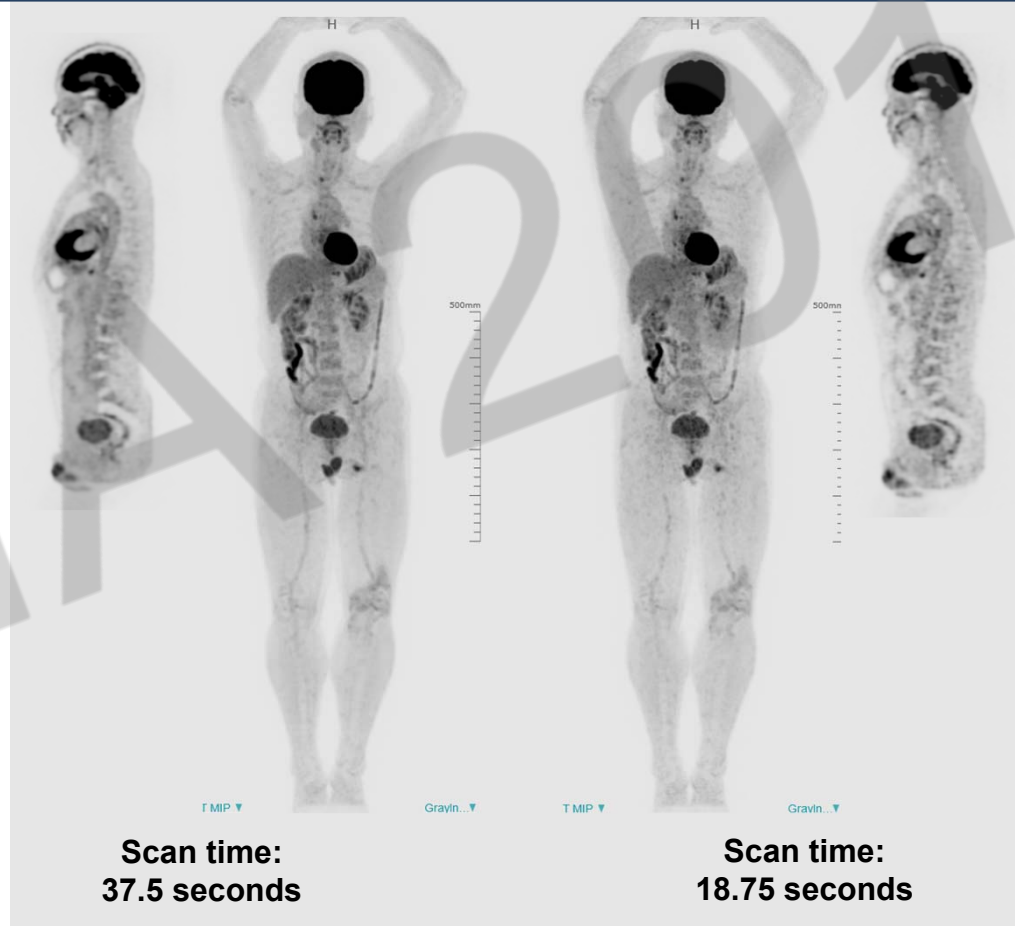
- Total-body PET in ~30 seconds



10-20 mins



EXPLORER



# EXPLORER Claim: Image Longer/Later

- Major increase in dynamic range

can image for 5 more half lives

- $^{11}\text{C}$

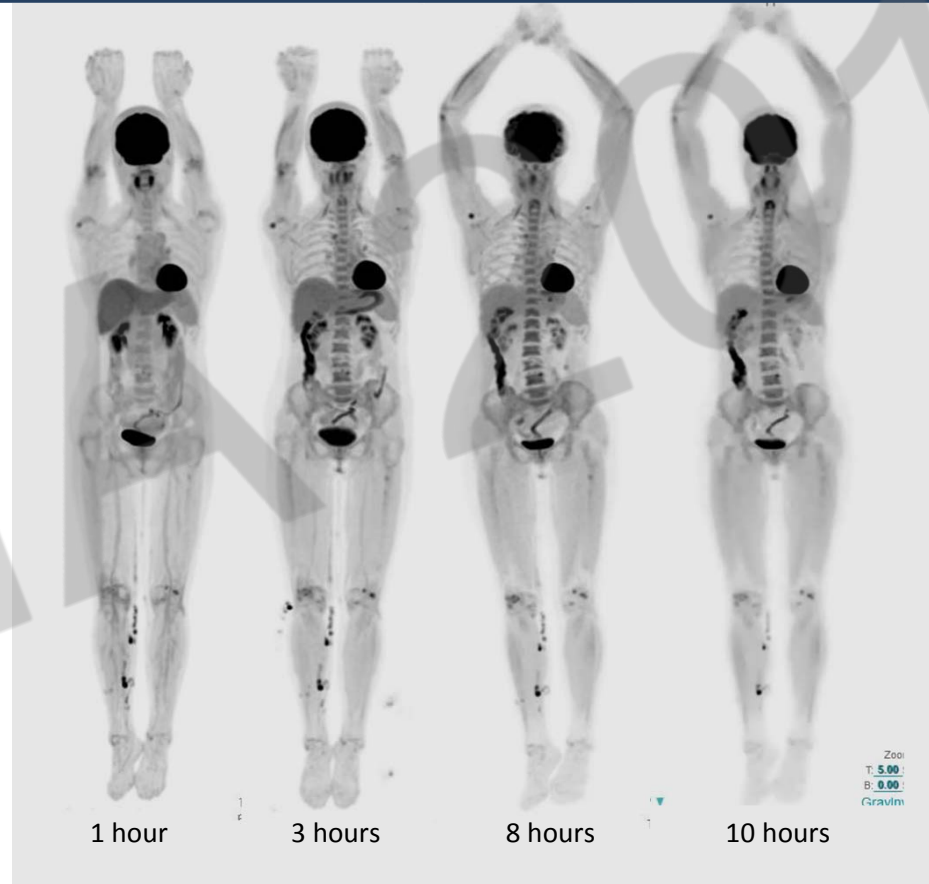
➤ 3 hours

- $^{18}\text{F}$

> 16 hours

- $^{89}\text{Zr}$

> 30 days



56 kg female; 6.7 mCi (248 MBq) injected activity; 14 min acquisition

# EXPLORER Claim: Image with Low Dose

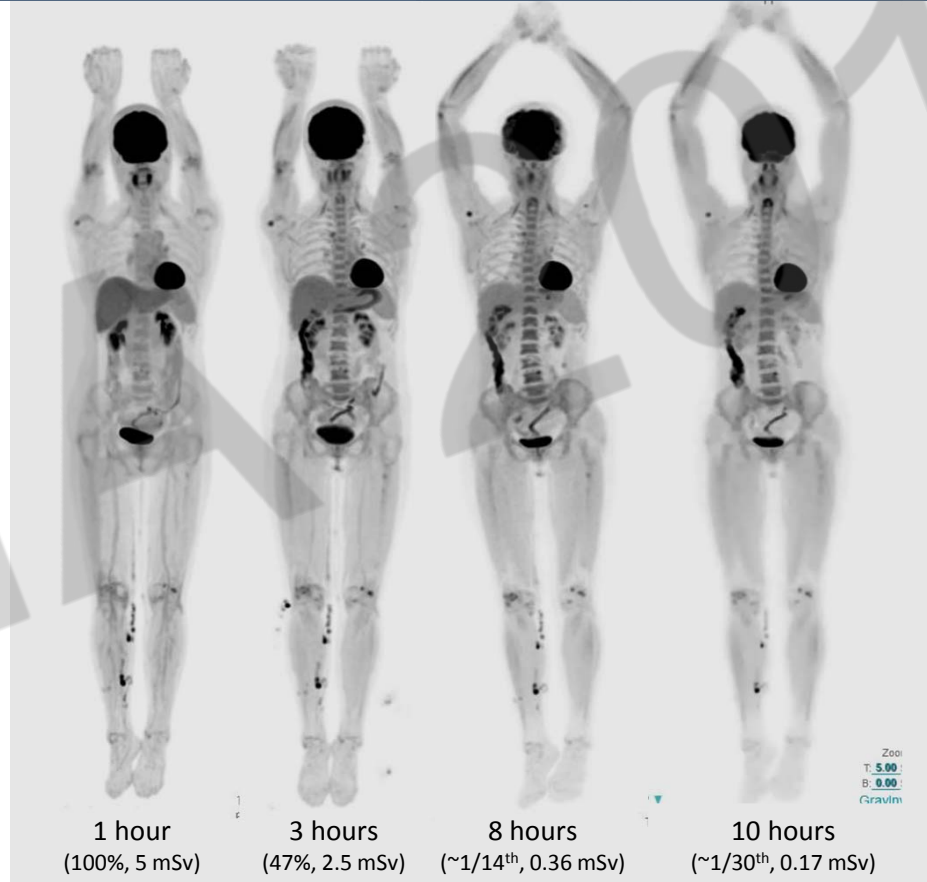
- 40-fold reduction in dose
  - Whole-body PET at ~0.15 mSv



Conventional PET



EXPLORER



56 kg female; 6.7 mCi (248 MBq) injected activity; 14 min acquisition

## EXPLORER Claim: Image with Low Dose

- **40-fold reduction in dose**
  - Whole-body PET at ~0.15 mSv



Conventional PET



EXPLORER



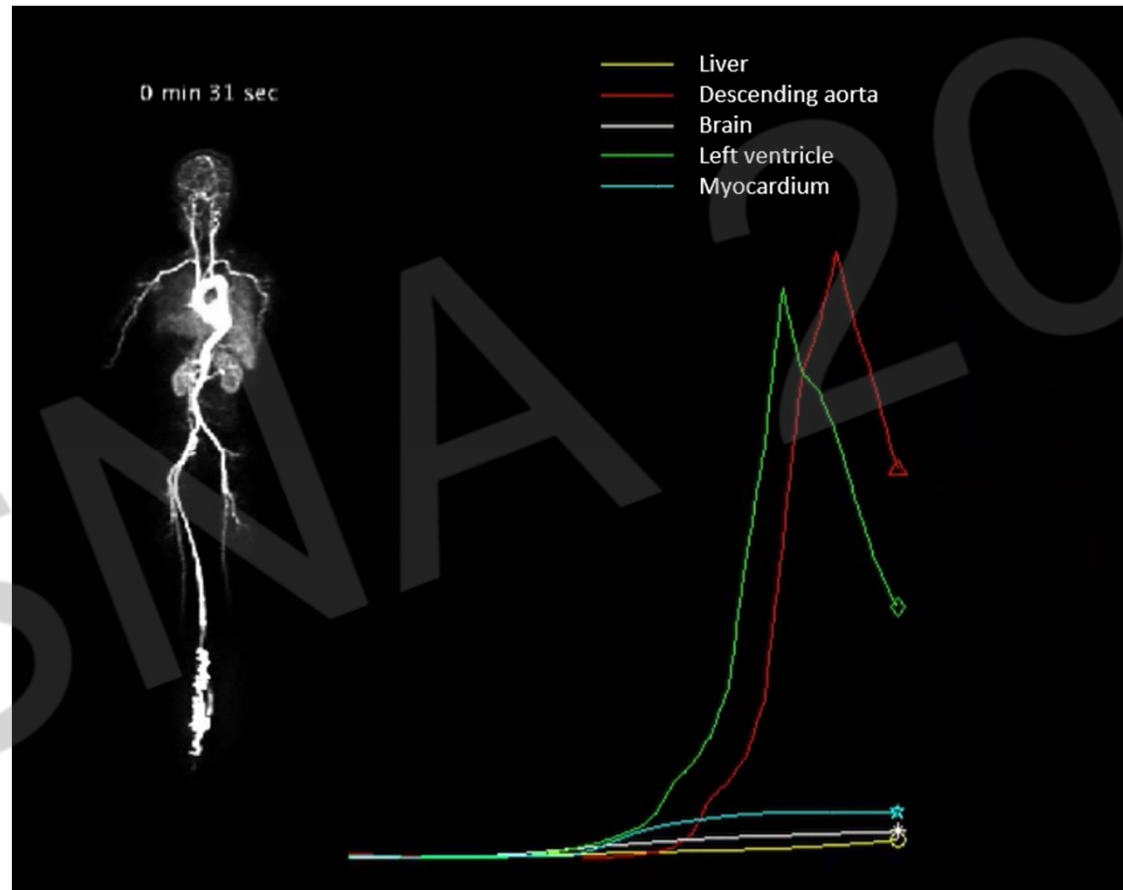
45 yo female, 43.5 kg

0.68 mCi (25 MBq)  
injected activity

10 min acquisition

50 min post injection

# EXPLORER Claim: Total-body Dynamic Imaging



# EXPLORER Program 2005 – 2018 Acknowledgements



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Qiyu Peng



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## Industrial collaborators:

United Imaging  
Siemens  
SensL  
Philips  
KAGE Medical

## Industry Advisory Panel:

Hongdi Li (United Imaging)  
Michael Casey (Siemens)  
Matthias Schmand (Siemens)  
Chi-Hua Tung (Philips)  
Chuck Stearns (GE)  
Gerd Muehllehner (KAGE)

## United Imaging engineering team:



## Funding:

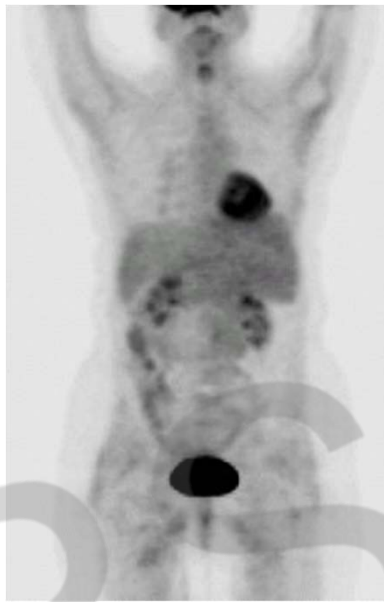
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R01 CA206187  
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R35 CA197608

UC Davis and U Penn

## Medical Advisory Team

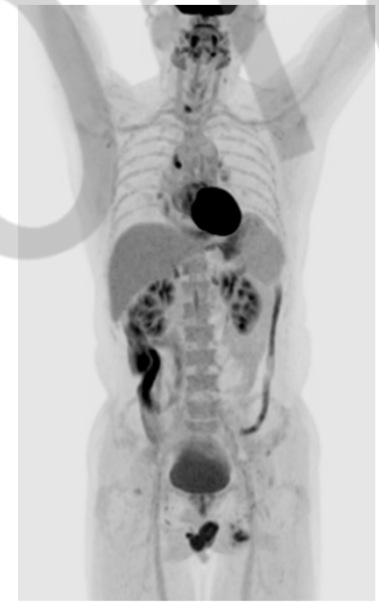
Richard Wahl (Washington Univ.)  
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Michael Graham (Univ. of Iowa)  
William Jagust (LBNL)  
Pat Price (Imperial College)  
Roger Gunn (Imanova)  
Ilan Rabiner (Imanova)

## Progress and future clinical applications



Whole-body PET,  
HR+, 2001

- Ultra-fast pediatric scans – less anesthesia
- Low-dose follow-up scanning in pediatric oncology
- Improved scanning for morbidly obese patients
- Single breath-hold PET
- Any search for small cancer deposits
- High-throughput scanning in urban centers
- Immunotherapy planning and dosimetry
- Total-body tumor perfusion
- Peripheral vascular disease



Total-body PET,  
EXPLORER, 2018