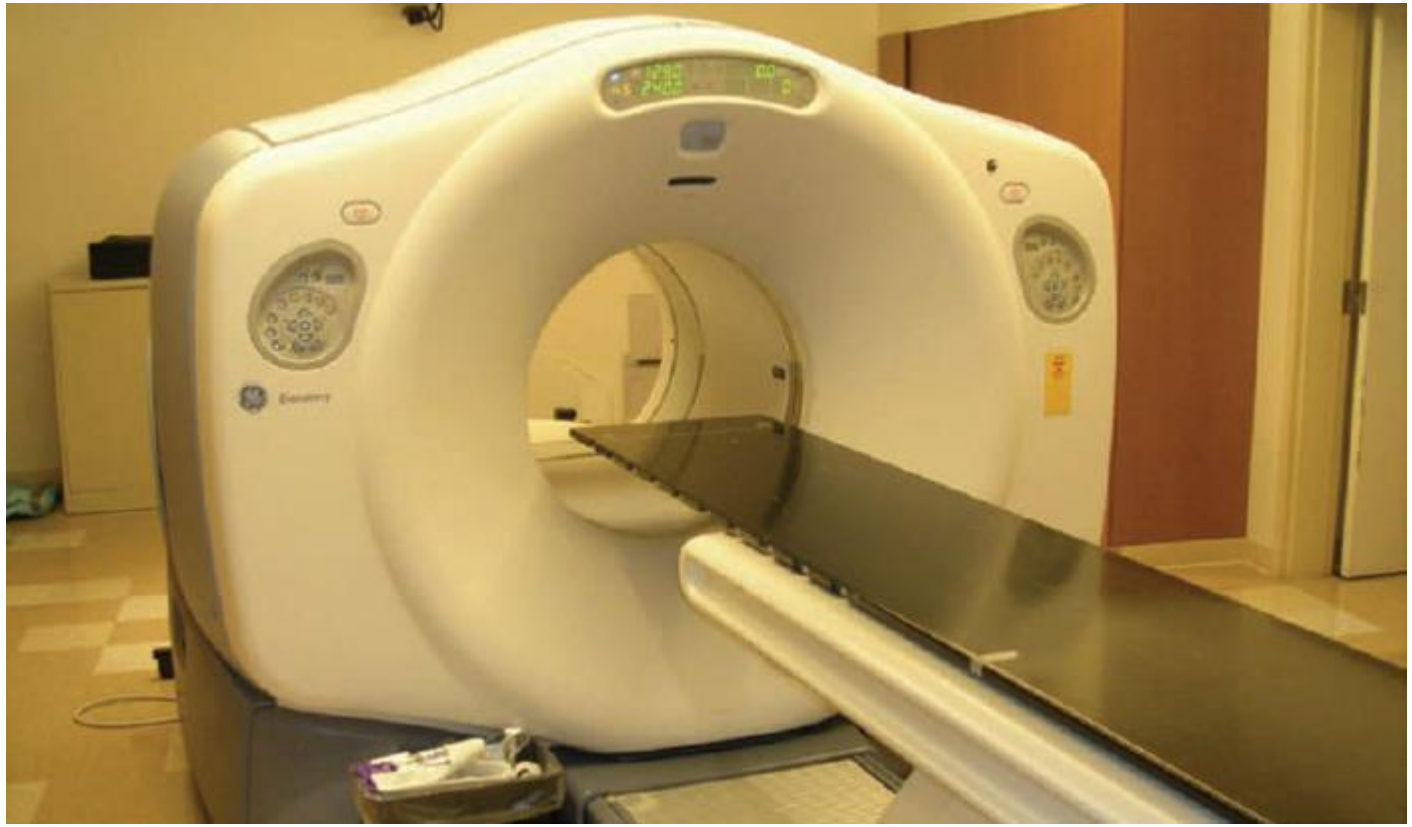
# NeuroMapping:

## PET (Positron Emission Tomography)

**(Alteration of Neurochemicals/Neuroligands)**

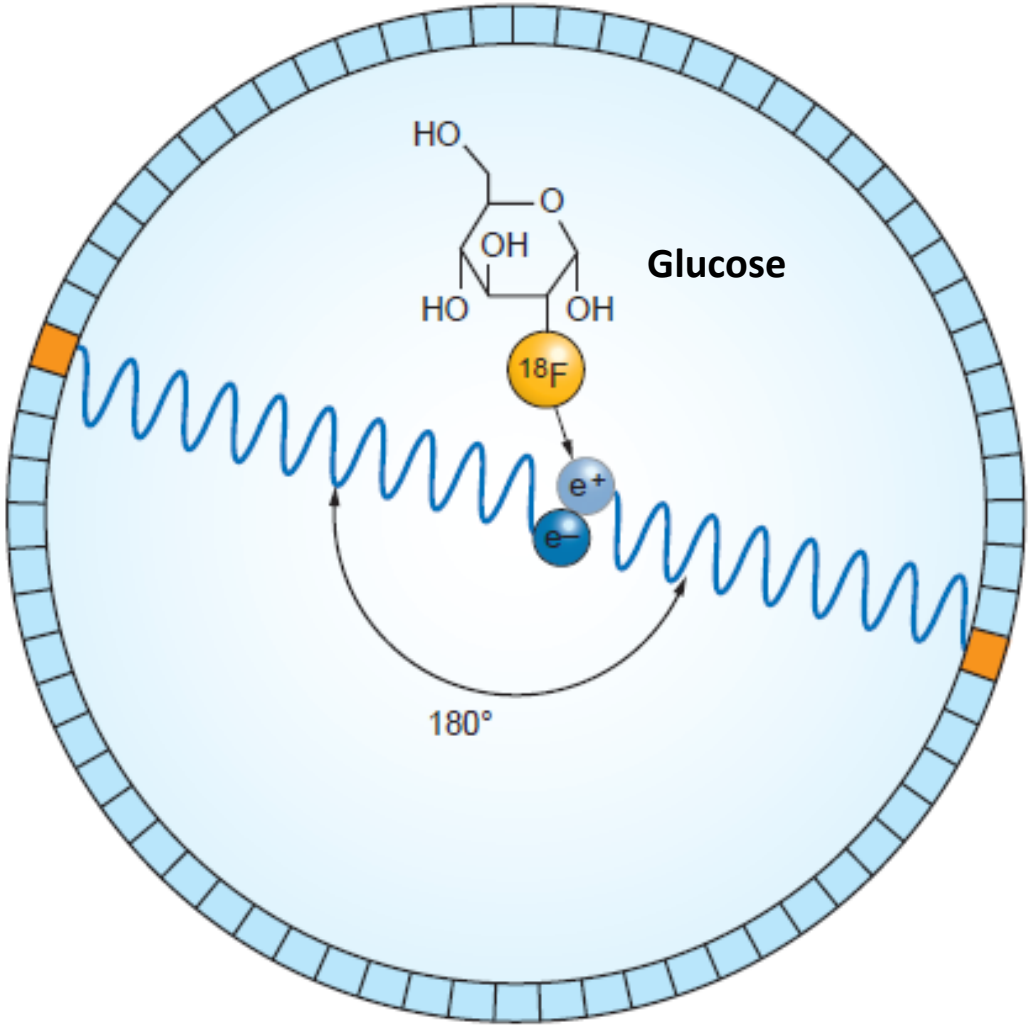
# Combined PET – CT Fusion scanner

(To see Anatomical location of Physiological abnormality)



# Principle of PET:

## Positron Emission Tomography



| Radiotracer | Label | Half-life (hours) | Application |
|---|---|---|---|
| Choline | $^{11}C$ | 0.34 | Choline metabolism |
| Acetate | $^{11}C$ | 0.34 | Fatty acid/sterol metabolism |
| Tyrosine | $^{11}C$ | 0.34 | Amino acid metabolism |
| Methionine | $^{11}C$ | 0.34 | Amino acid metabolism |
| Ammonia | $^{13}N$ | 0.17 | Vascular perfusion |
| Water | $^{15}O$ | 0.03 | Vascular perfusion |
| FDG | $^{18}F$ | 1.83 | Glucose metabolism |
| FLT | $^{18}F$ | 1.83 | Cellular proliferation |
| FHBG | $^{18}F$ | 1.83 | Gene expression |
| FIAU | $^{18}F$ | 1.83 | Gene expression |
| Galacto-RGD | $^{18}F$ | 1.83 | Angiogenesis |
| Dimeric-RGD | $^{18}F$ | 1.83 | Angiogenesis |
| FMISO | $^{18}F$ | 1.83 | Hypoxia |
| FAZA | $^{18}F$ | 1.83 | Hypoxia |
| EF5 | $^{18}F$ | 1.83 | Hypoxia |
| Cu-ATSM | $^{64}Cu$ | 12.70 | Hypoxia |
| Cu-PTSM | $^{64}Cu$ | 12.70 | Vascular perfusion |

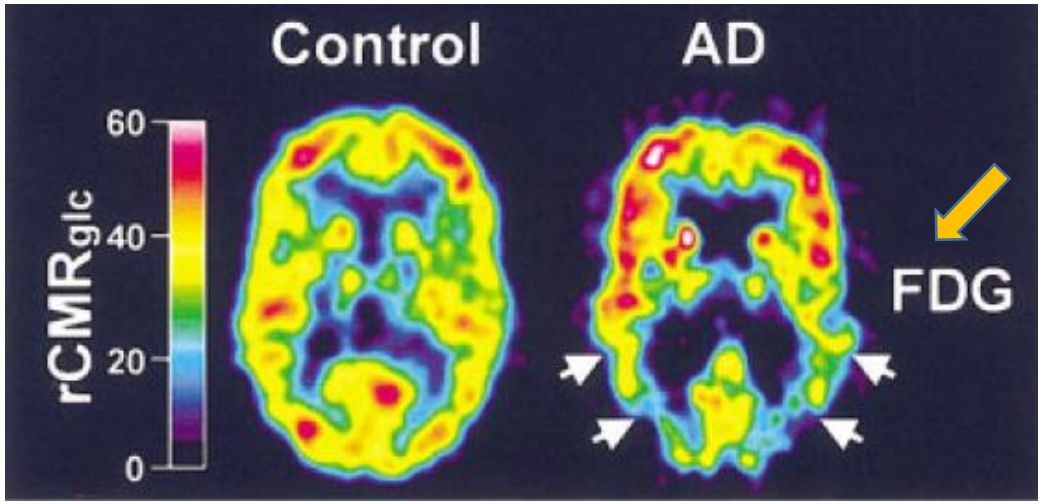
FDG, [$^{18}$F]fluoro-2-deoxyglucose; FLT, [$^{18}$F]fluorothymidine; FHBG, $^{18}$F-9-[4-fluoro-3-(hydroxymethyl)butyl]guanine; FIAU, $^{131}$I-2′-fluoro-2′-deoxy-1-ß-D-arabinofuranosyl-5-iodouracil ; RGD, arginine-glycine-aspartic acid; FMISO, [$^{18}$F]fluoromisonidazole; FAZA, [$^{18}$F]fluoroazomycin-arabinoside; EF5, 2-(2-nitro-1*H*-imidazol-1-yl)-N-(2,2,3,3,3-[$^{18}$F] pentafluoropropyl)-acetamide; Cu-ATSM: Cu(II)-diacetyl-bis(N(4)-methylthiosemicarbazone); Cu-PTSM: Cu(II)-

**P.E.T.**

**Radiotracers**

**SPECT Imaging can <u>not</u> show much difference between brains of:**
**Normal Person & Alzheimer's Disease (Memory Disorder).**

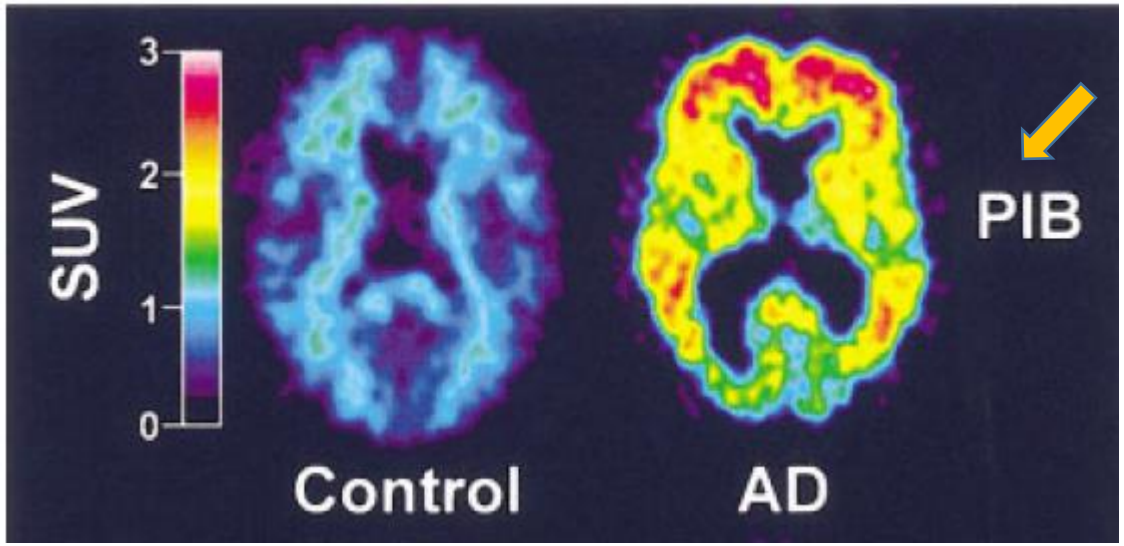
**However, PET imaging <u>can</u> show much difference [15,000/-]**




← **<u>SPECT Image [500/-]</u>**

(Single Photon Emission Computed Tomography - Cheaper)

**<u>PET Image</u>**



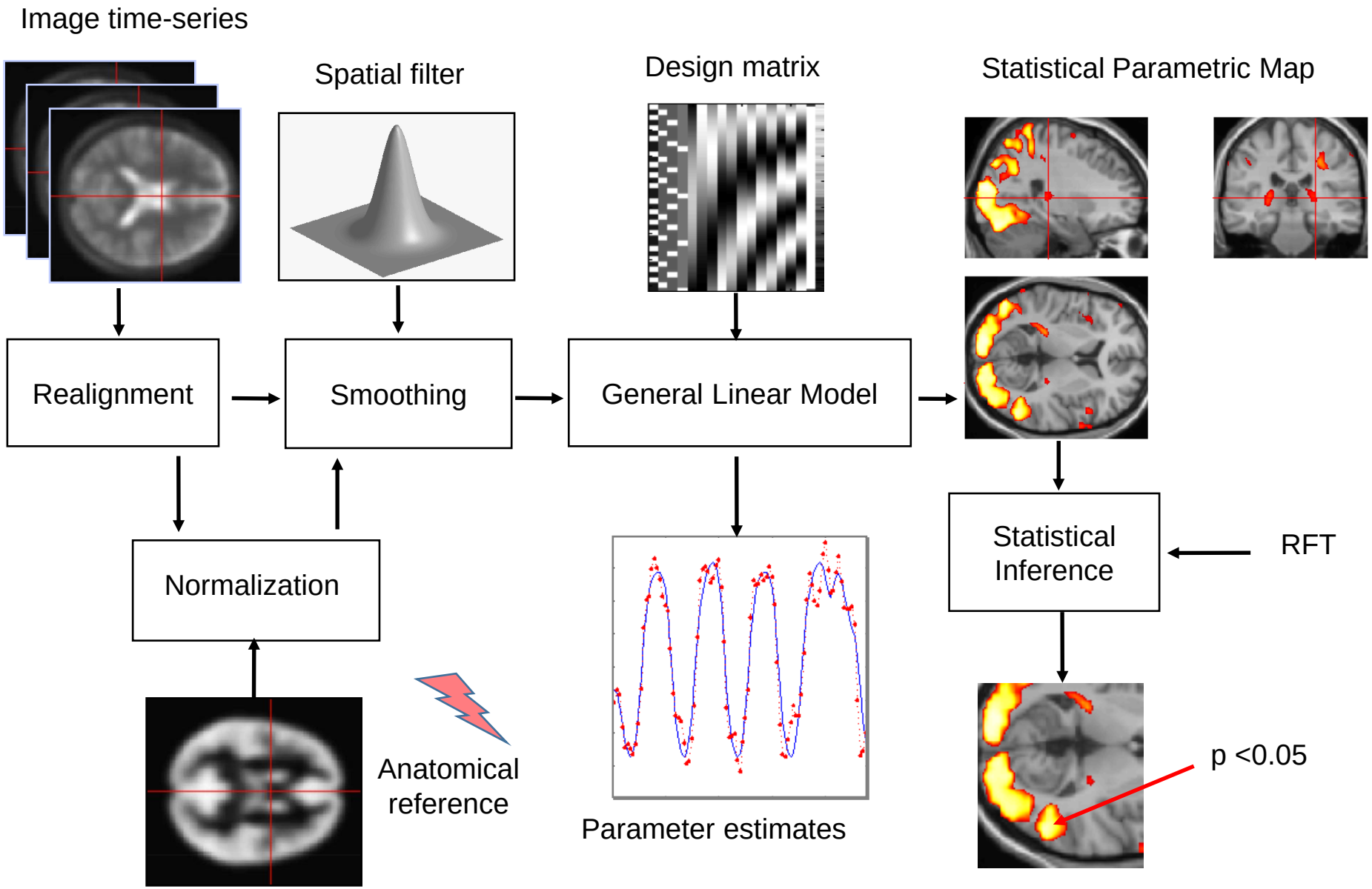

FDG = Fluor-deoxy-glucose--Radioactive biochemical (SPECT)

rCMR = regional Cerebral metabolic rate (glucose)

PiB = Pittsburg Compound – B (benzo-thiazole. Tags amyloid) (PET)

SUV = Standard Uptake Value

# Steps of PET Image Processing: Statistical Parametric Mapping (SPM)



## Method Adapted from Joshi's paper:

# A Semiautomated Method for Quantification of F 18 Florbetapir PET Images

Abhinay D. Joshi, Michael J. Pontecorvo, Ming Lu, Daniel M. Skovronsky, Mark A. Mintun, and Michael D. Devous, Sr.

*Avid Radiopharmaceuticals, Inc., Philadelphia, Pennsylvania*

JNM The Journal of NUCLEAR MEDICINE

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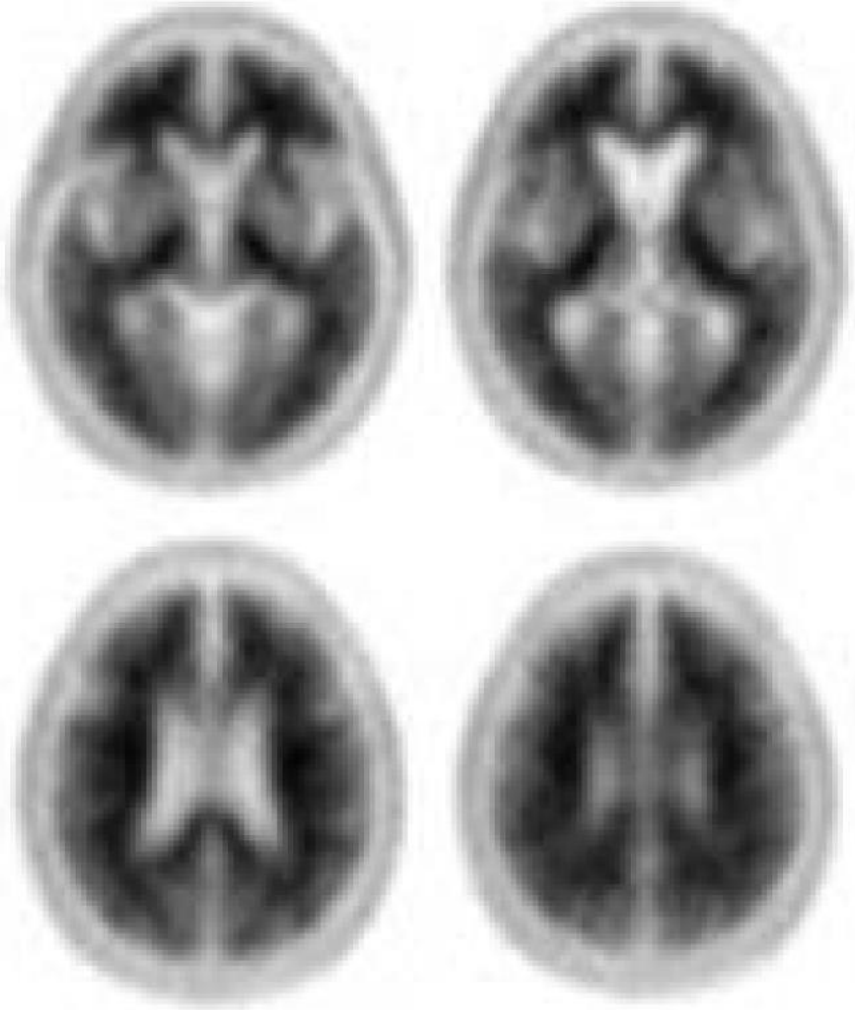
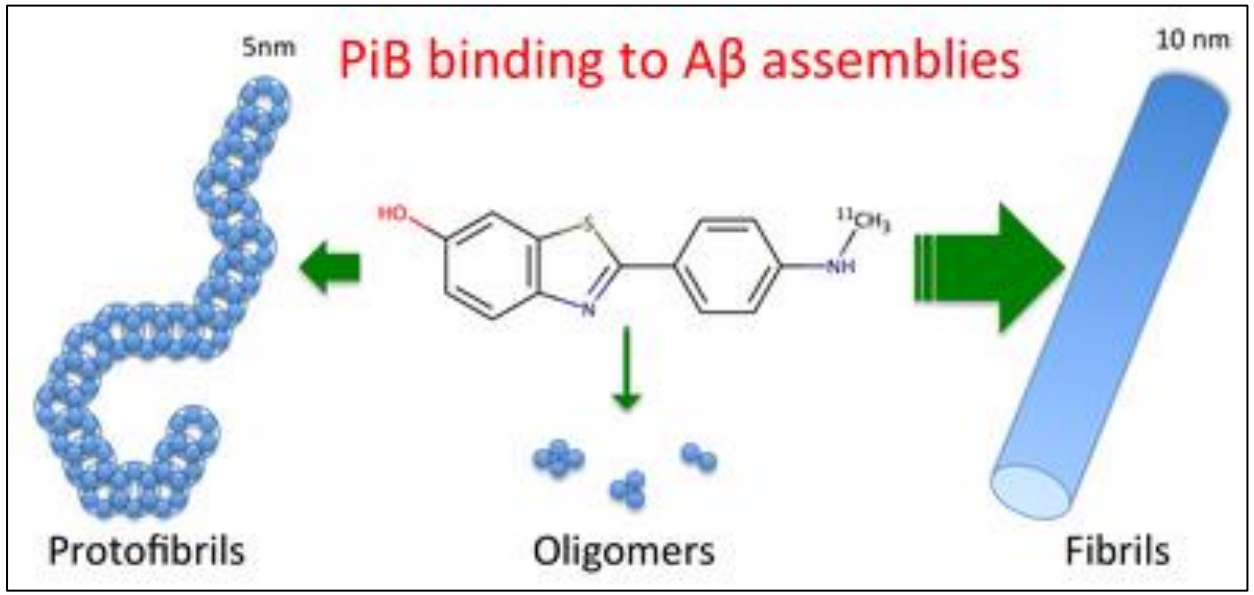
Published online: September 3, 2015.
Doi: 10.2967/jnumed.114.153494

**Florbetapir PET template in MNI brain atlas space created by averaging PET images of:**

**Alzheimer's patients (*n* = 11)**
**&**
**Normal Subjects (*n* = 15)**



**Benzo-Thiazole**



# PET – MRI

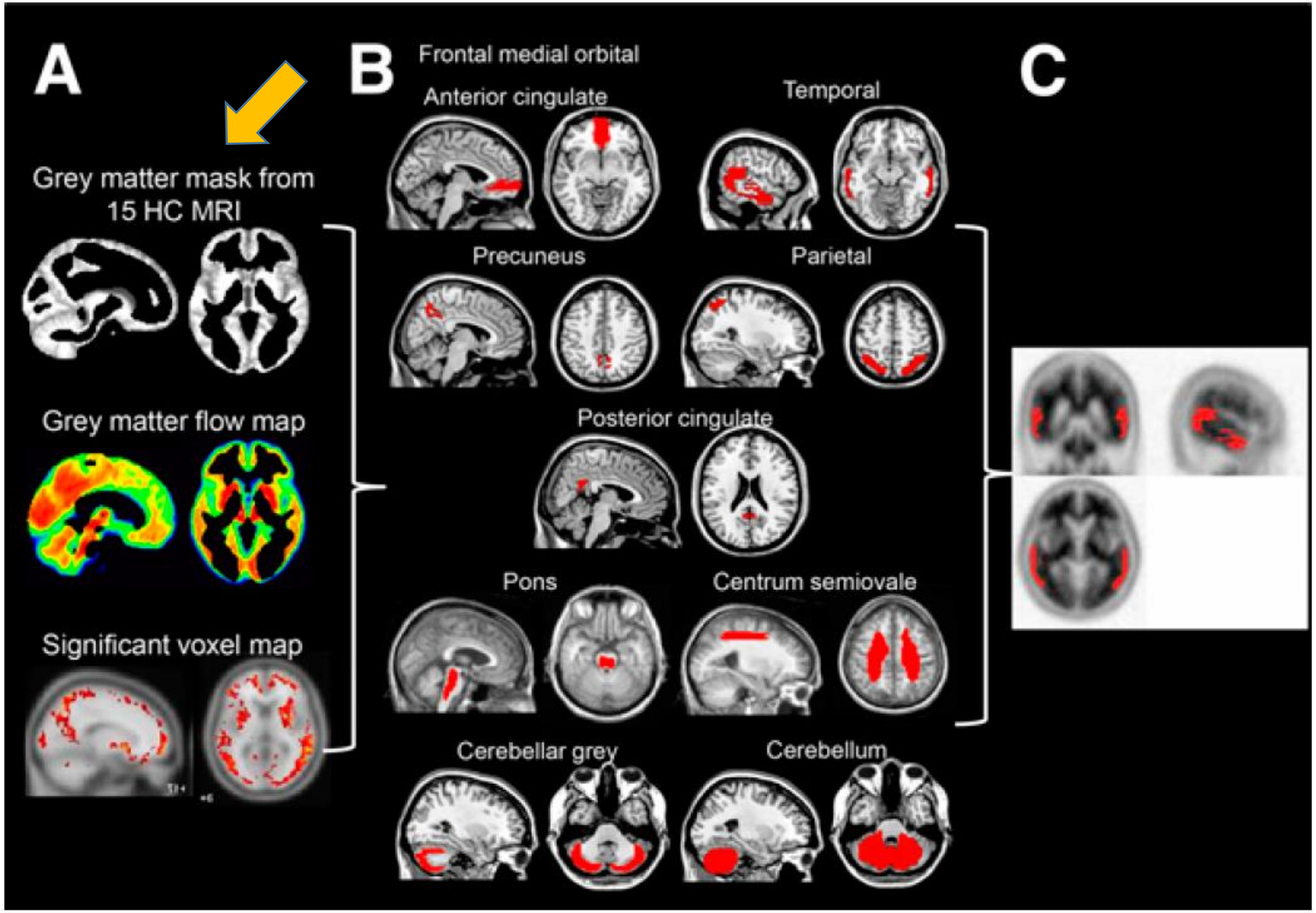
## Method for obtaining PET mapping of biochemical's uptake

**(A) Data used to create VOIs: (Voxels of Interest).**

**(A) VOIs (red) for 6 cortical regions & 4 reference regions overlaid on MR template images in MNI space.**

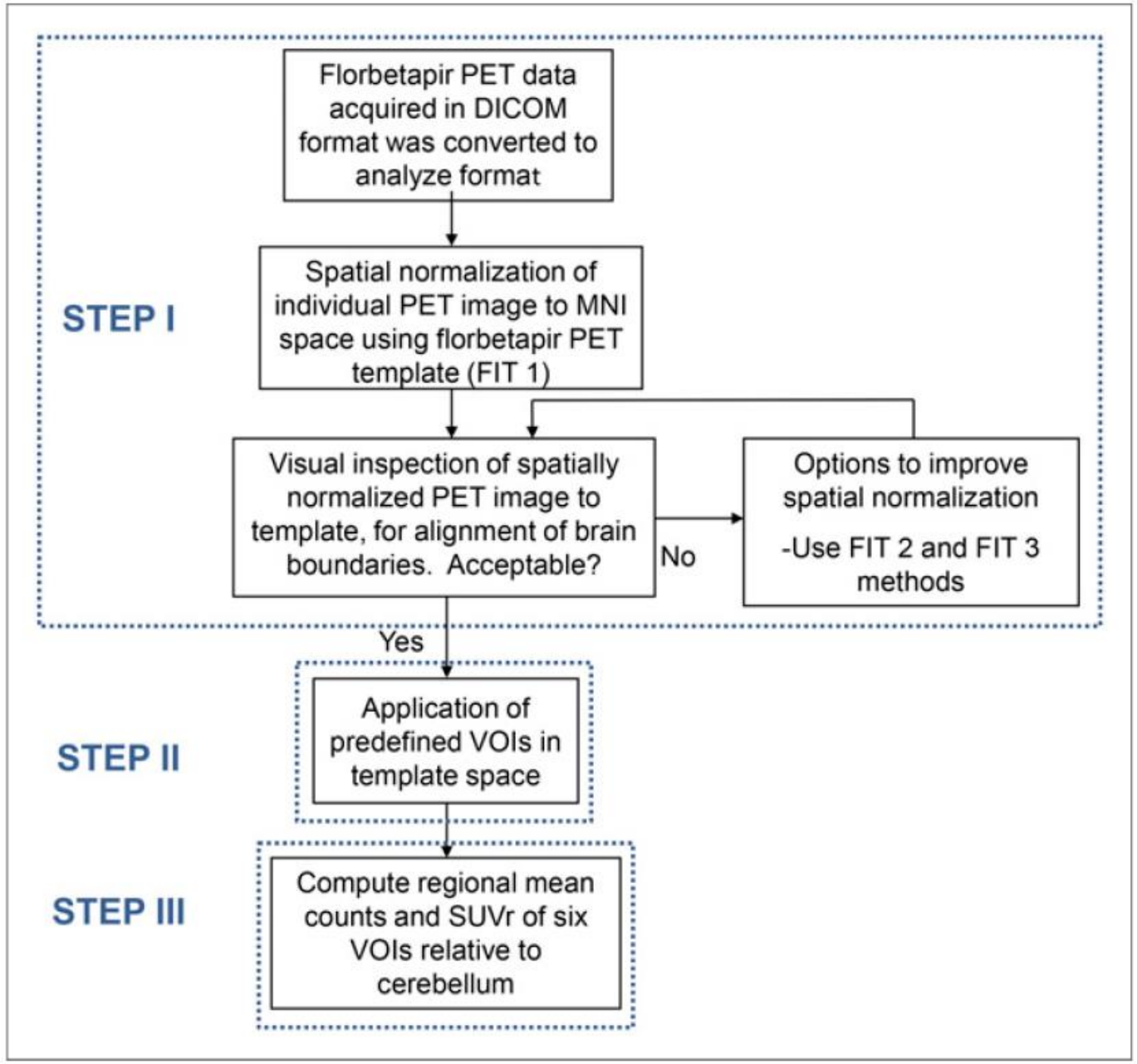
**(First image in top row shows overlay of frontal medial orbital and anterior cingulate regions; only 1 region is seen because of overlap in 2 VOIs.**

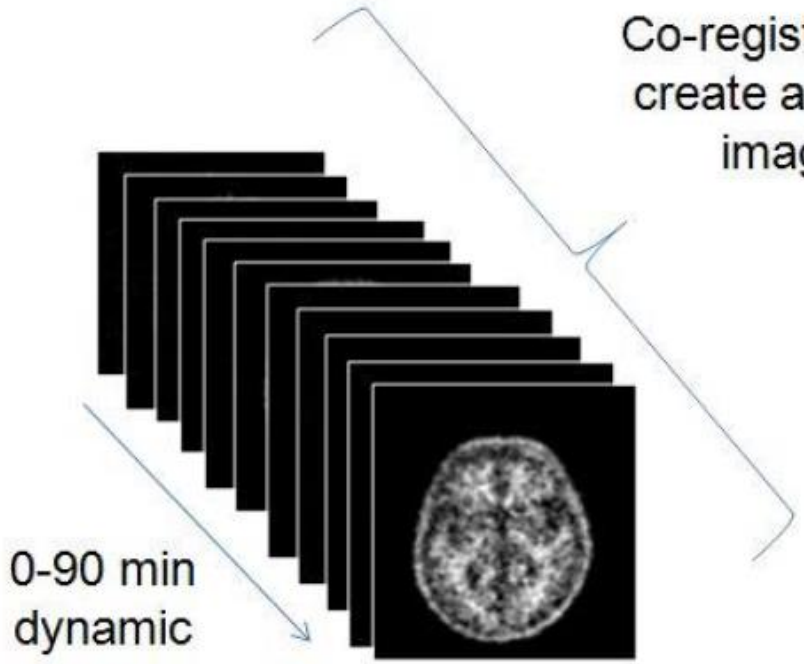
**(C) Example of temporal VOI overlaid on F 18 Florbetapir PET template.**



# Flowchart of mapping Amyloid toxic protein in Alzheimer's patient's brain

## ($F^{18}$ Fluor-beta-pir PET scan)



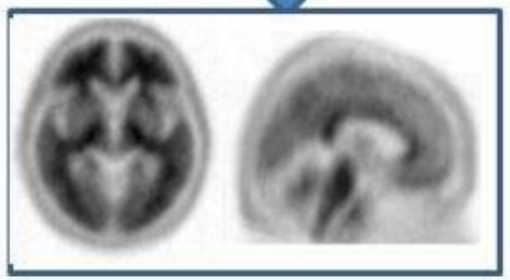



Co-register and create a mean image

Spatially normalize mean image to MNI space

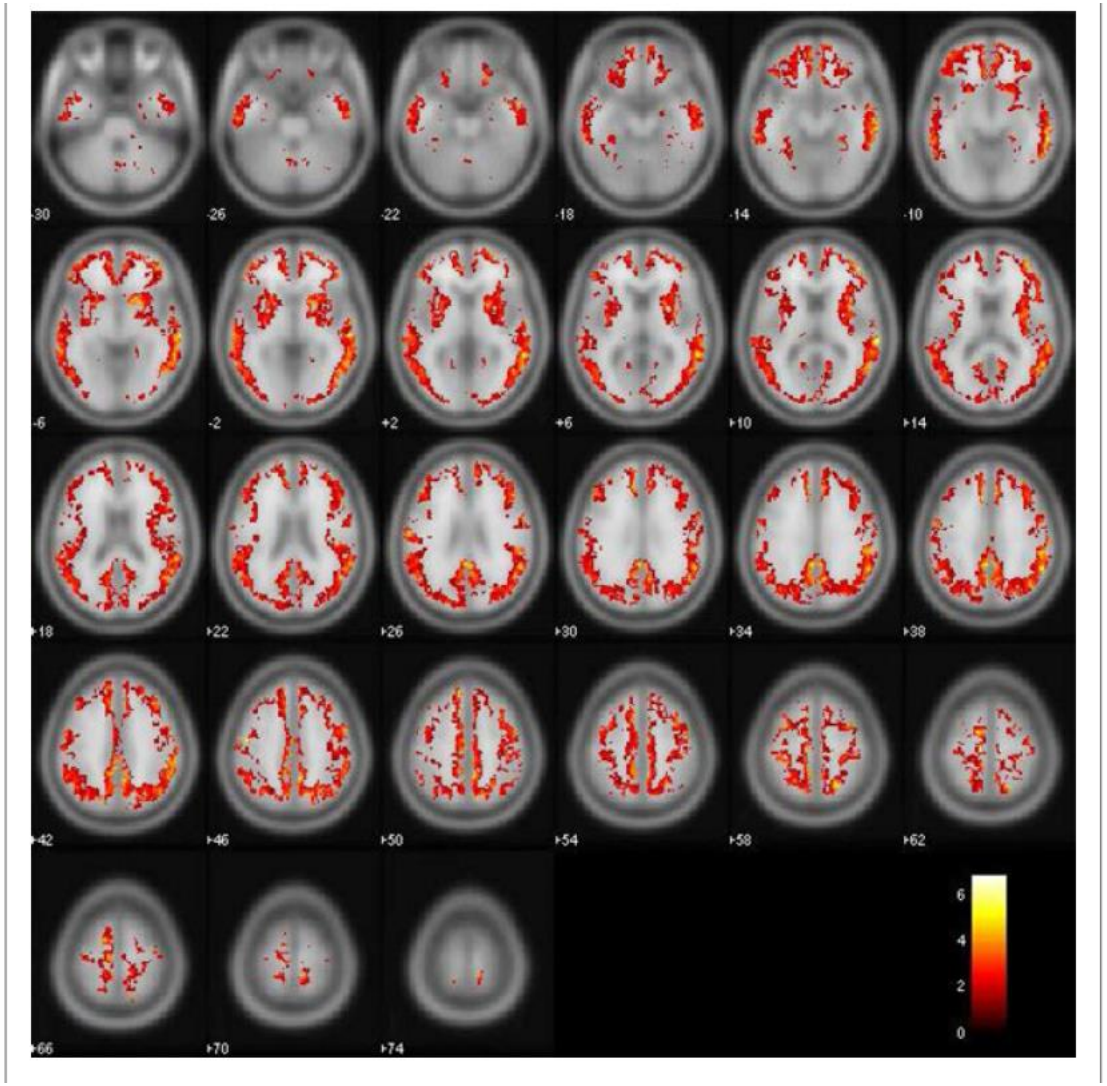
Apply transformation to co-registered dynamic frame data from 0-90 min

Use a 10 min image from 50-60 min. Average the spatially normalized 50-60 min image across 11 AD and 15 HC



**Creation of standard florbetapir PET template in MNI (Montreal standard) space:**

**One uses the 10-min image at 50 min after injection from 15 Normal Subjects and 11 Alzheimer's Patients**




## Significant voxels where Florbetapir retention in Alzheimer patients exceeds Normal subjects

($p$ < 5%)

# Cerebellum's PET Amyloid Uptake accurately distinguishes Alz. Patients from Normal Subjects

**Note:**

YCN = Young Control Normal;
AD = Alz. Disease;
ODD = Other Dementia disorders;
HC = Healthy Controls;
MCI = Mild Cognitive Impairment (pre-AD)