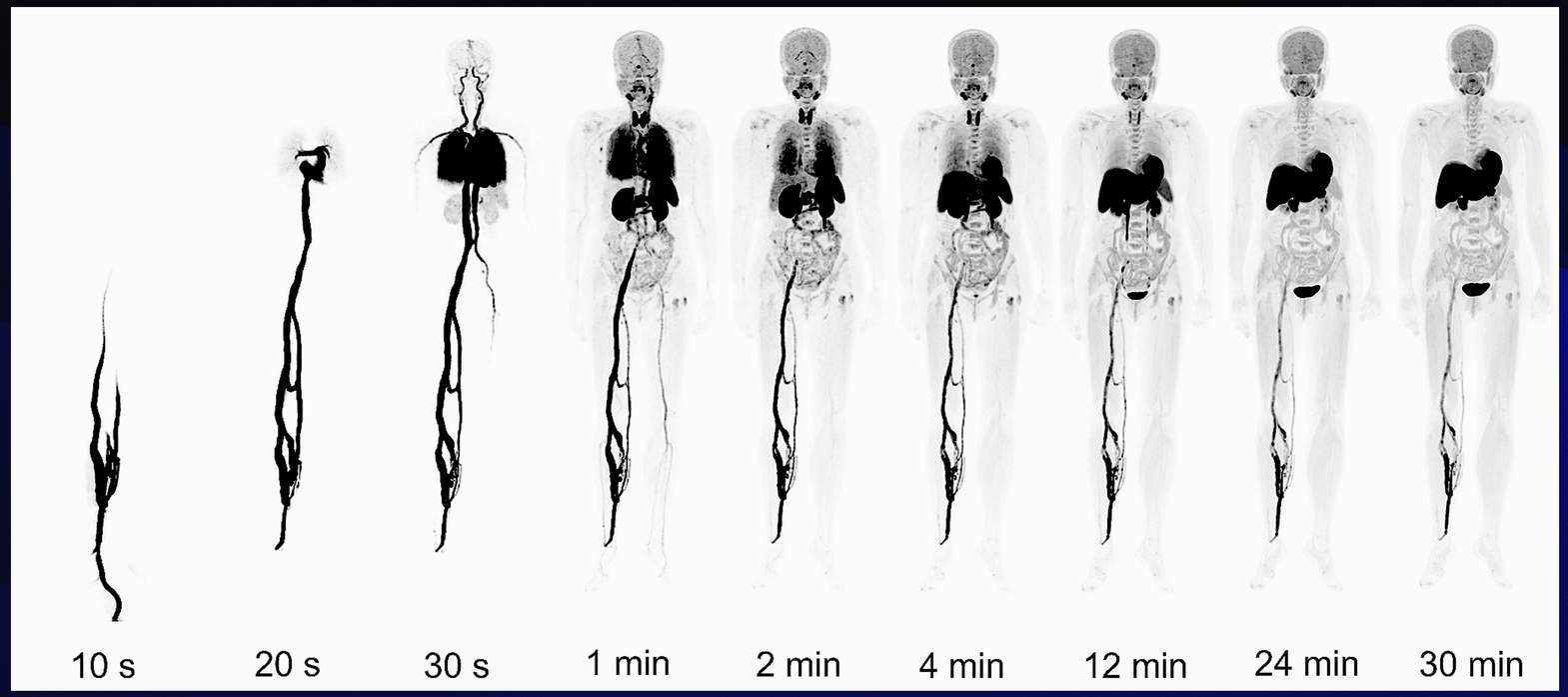
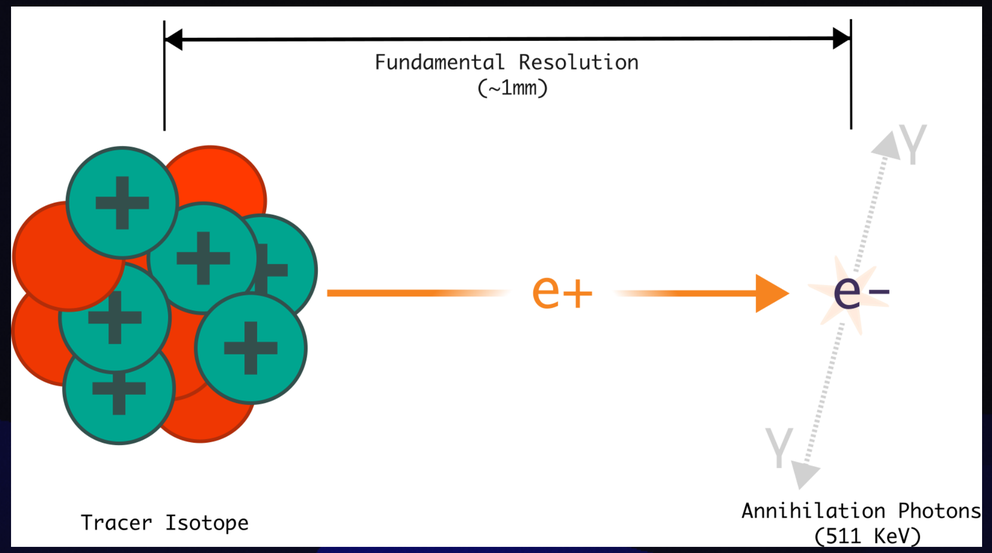
Photon Reconstruction for Full Body PET

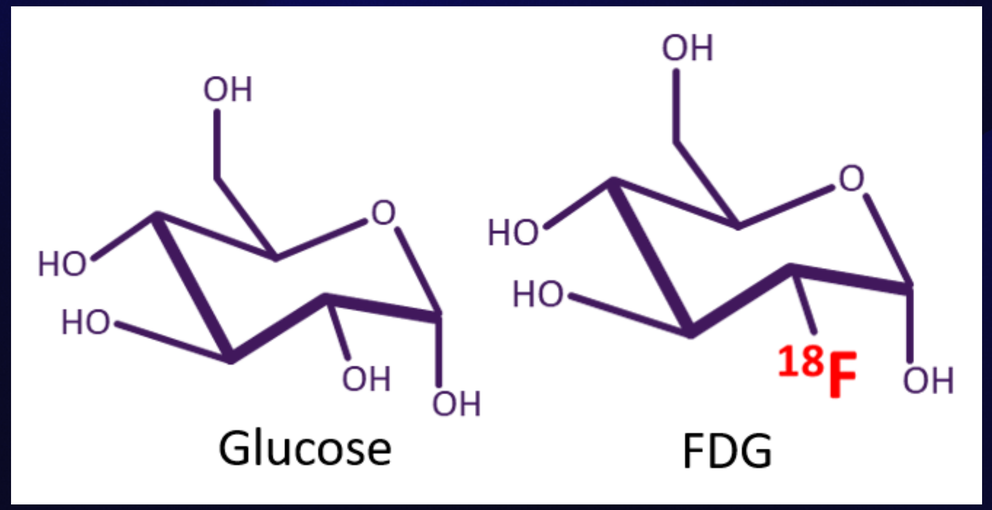
To improve image quality and patient comfort.

Project by Finn Onori
Supervised by Ben Wynne

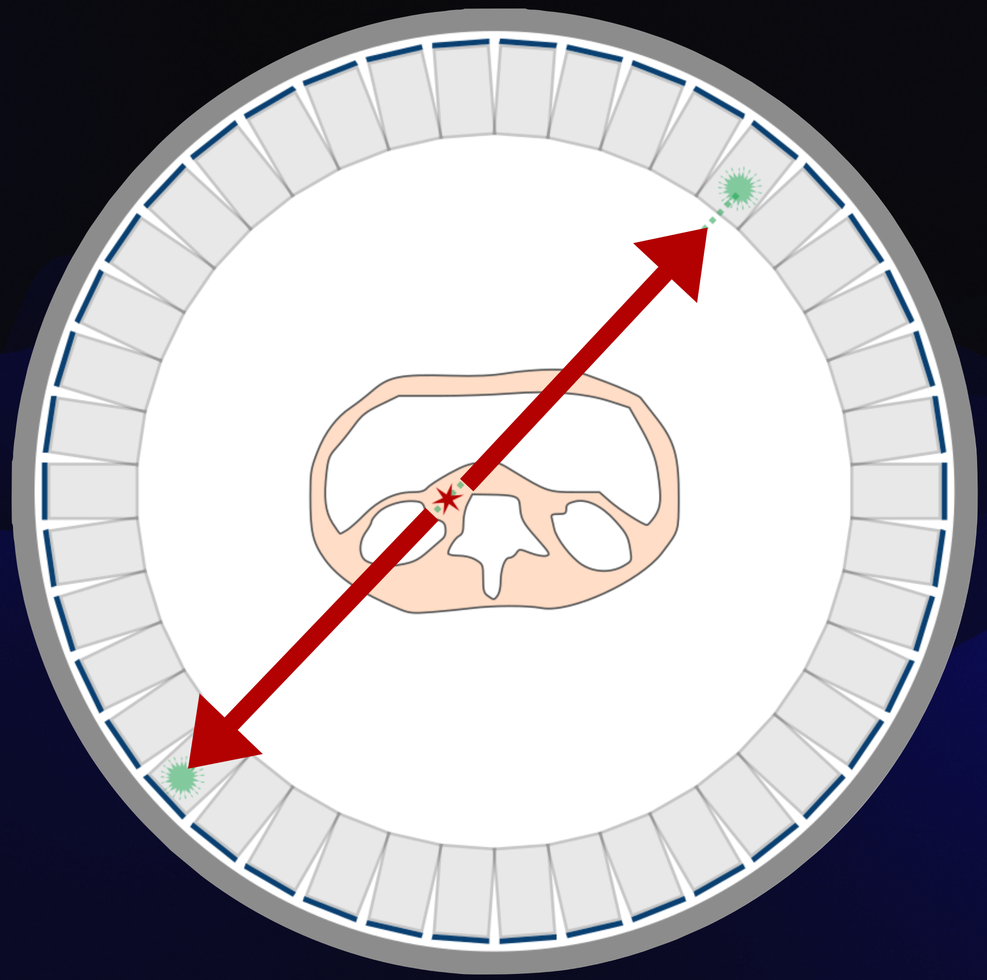


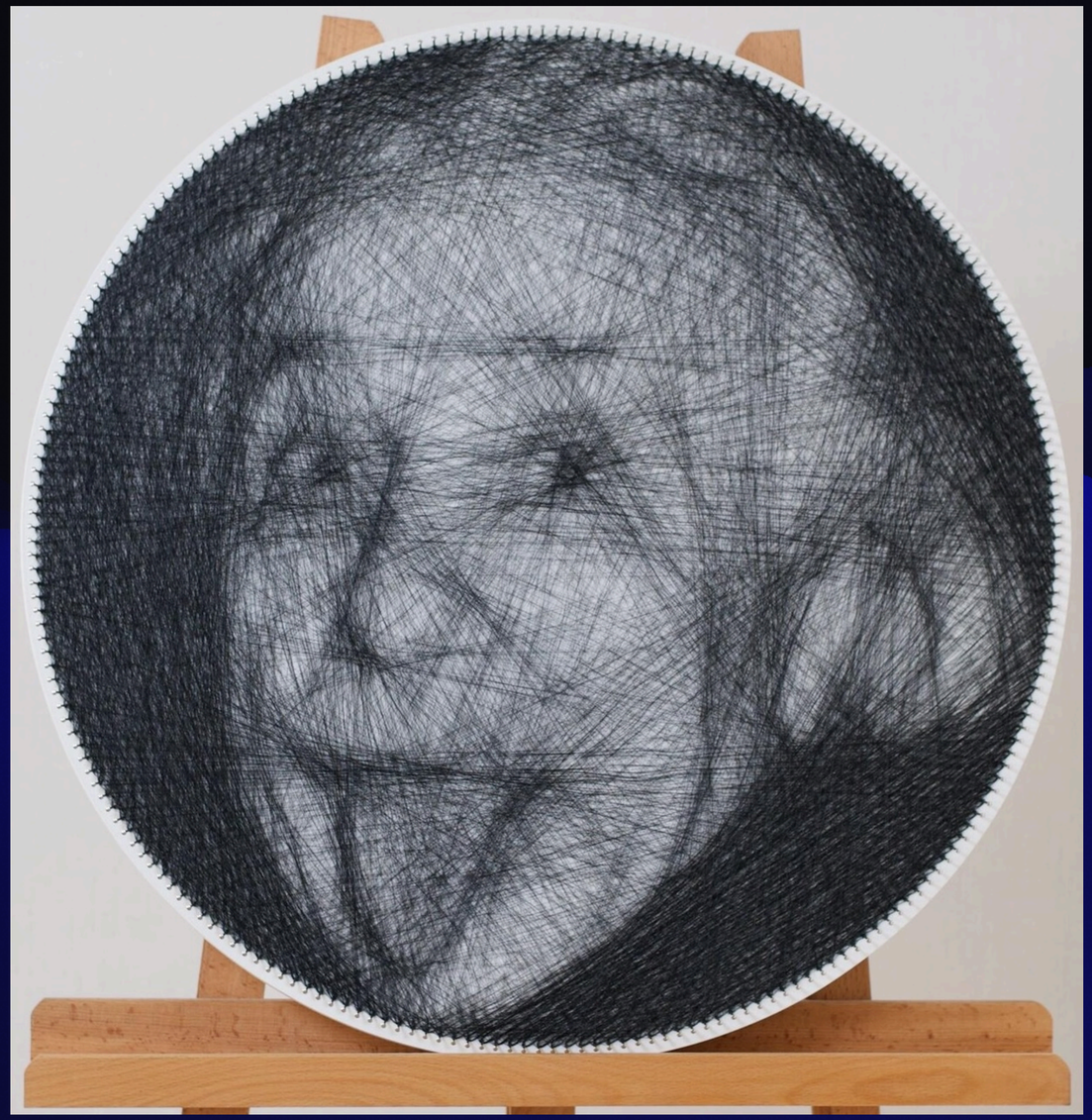

10 s
20 s
30 s
1 min
2 min
4 min
12 min
24 min
30 min

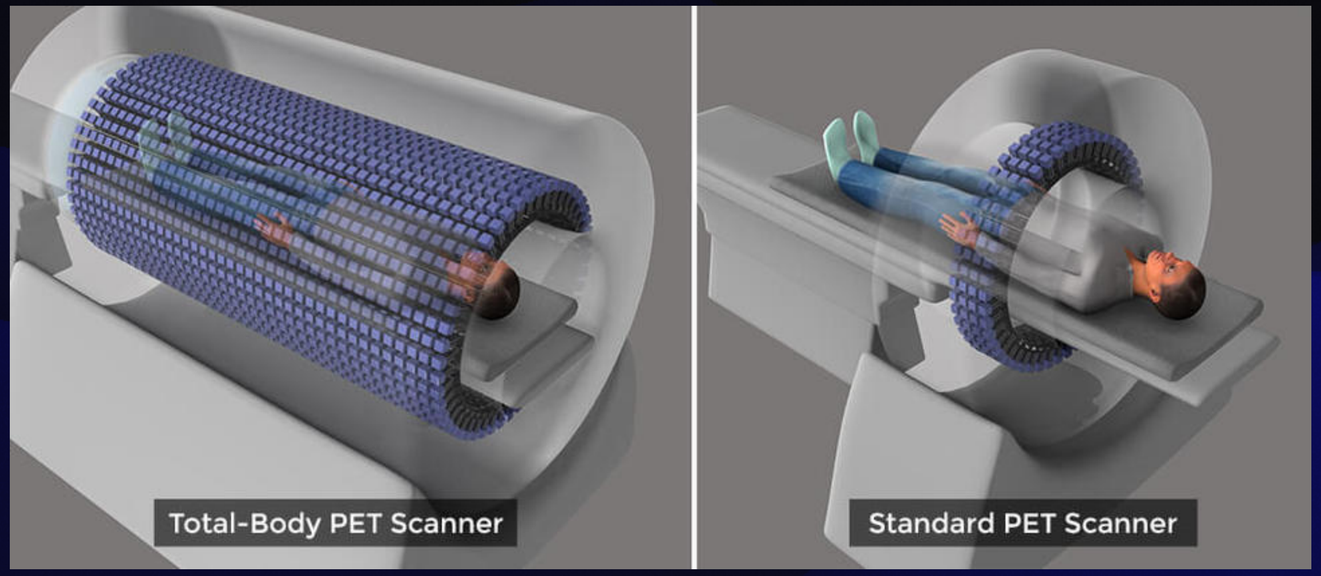


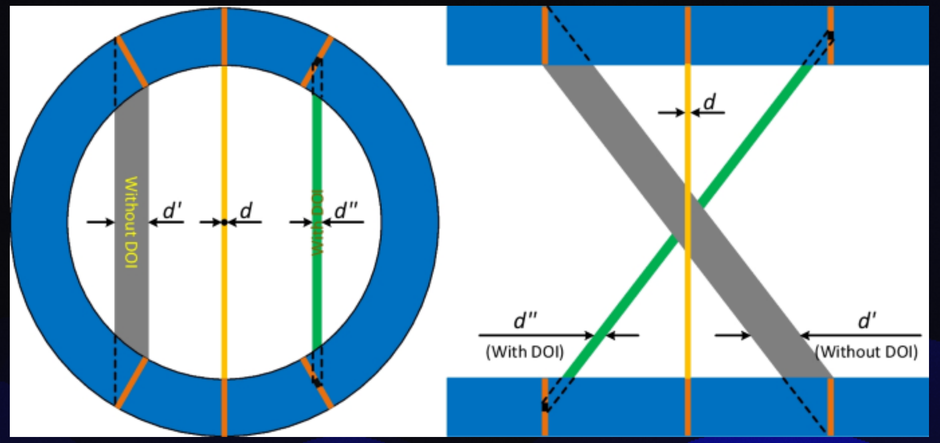


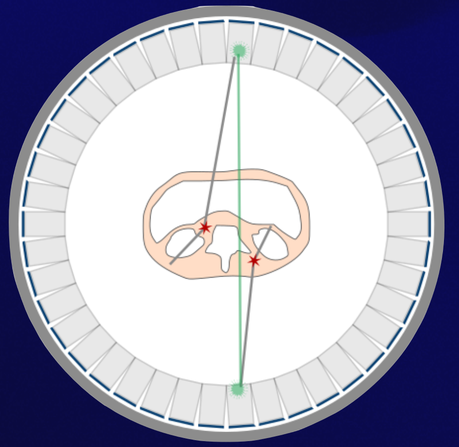
Tracer	Isotope	half-life (mins)	Process	Application
Ammonia	N-13	9.8	Blood perfusion	Brain activation
Water	O-15	2.04	Blood perfusion	Cardiology
Methionine	C-11	20.3	Protein synthesis	Oncology
FDG	F-18	109.8	Glucose metabolism	Oncology Cardiology
FACBC	F-18	109.8	Amino Acid Transport	Oncology

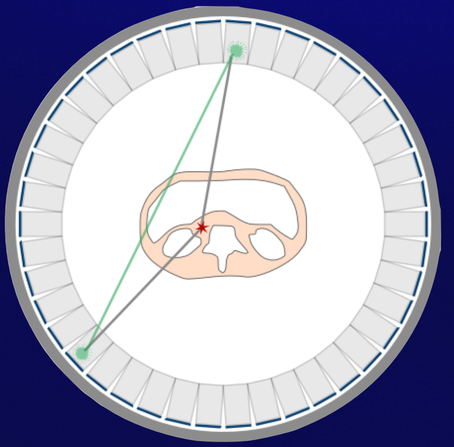


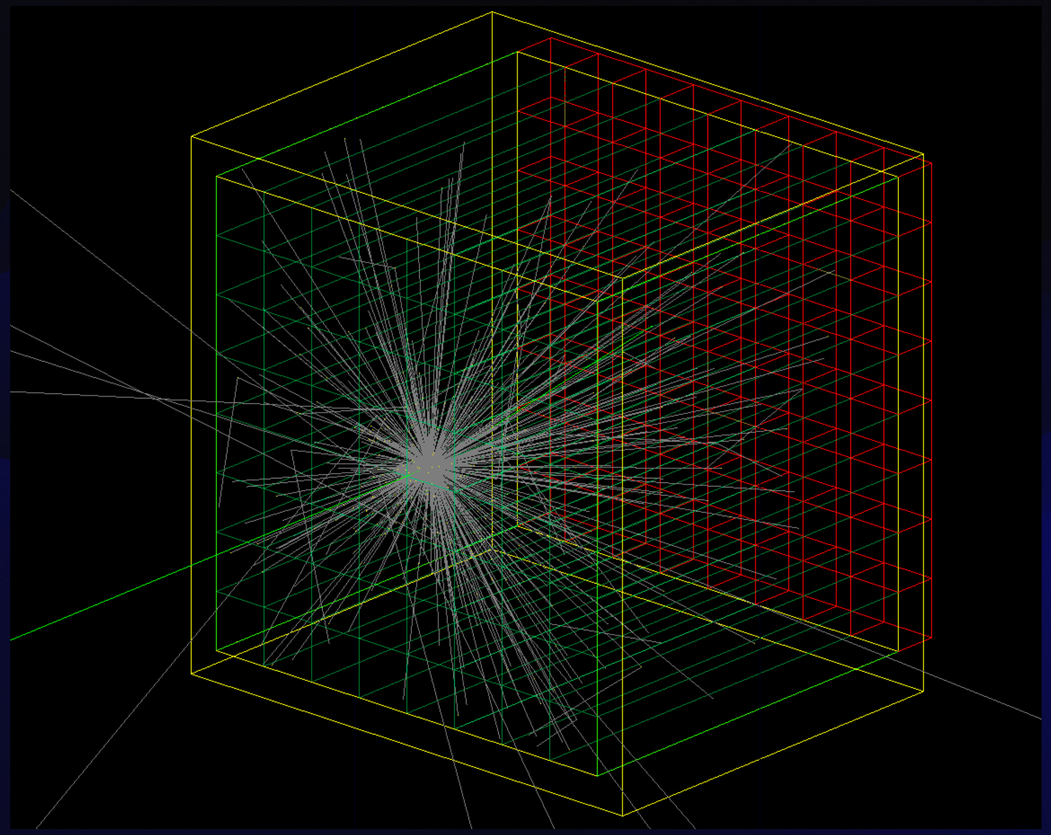


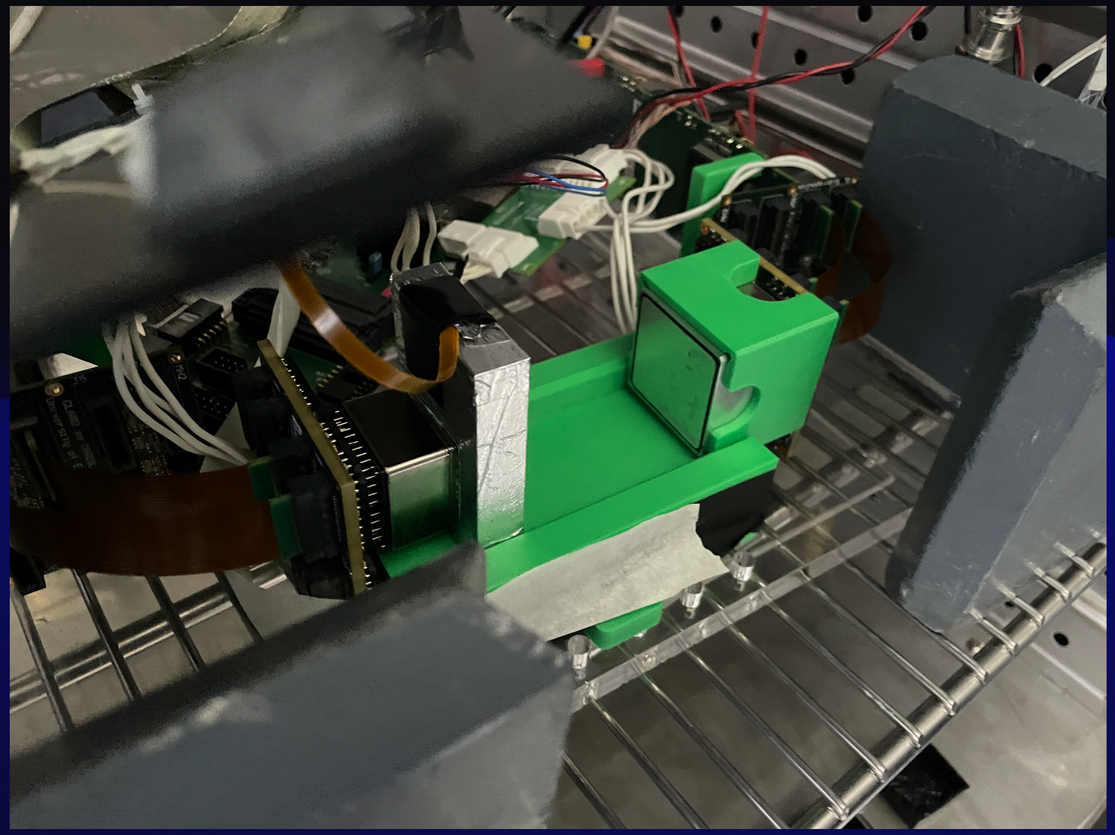

Total-Body PET Scanner
Standard PET Scanner

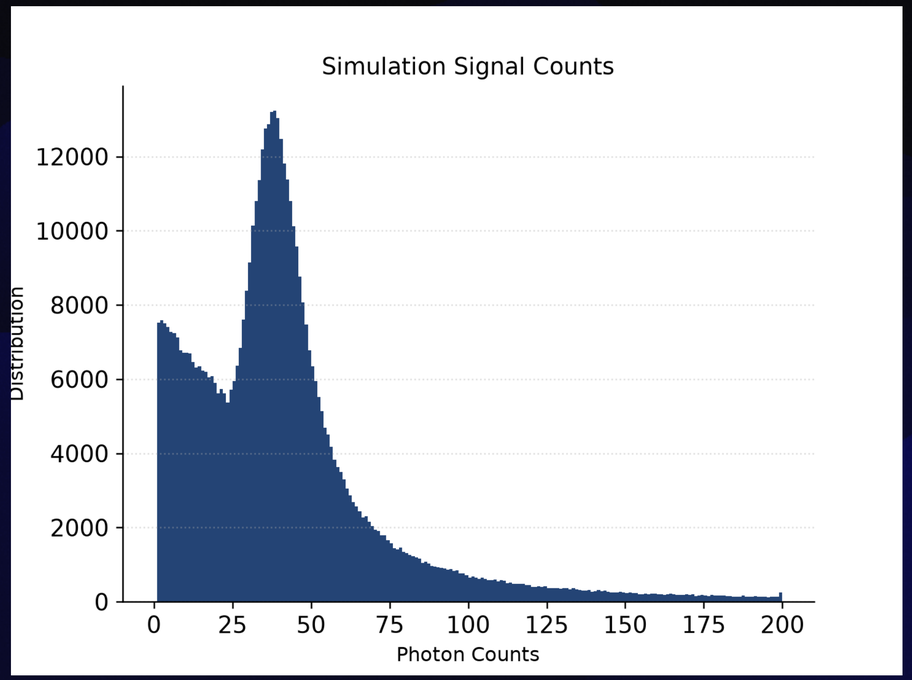

Without DOI
With DOI
d'
d
d''
d
d''
(With DOI)
d'
(Without DOI)

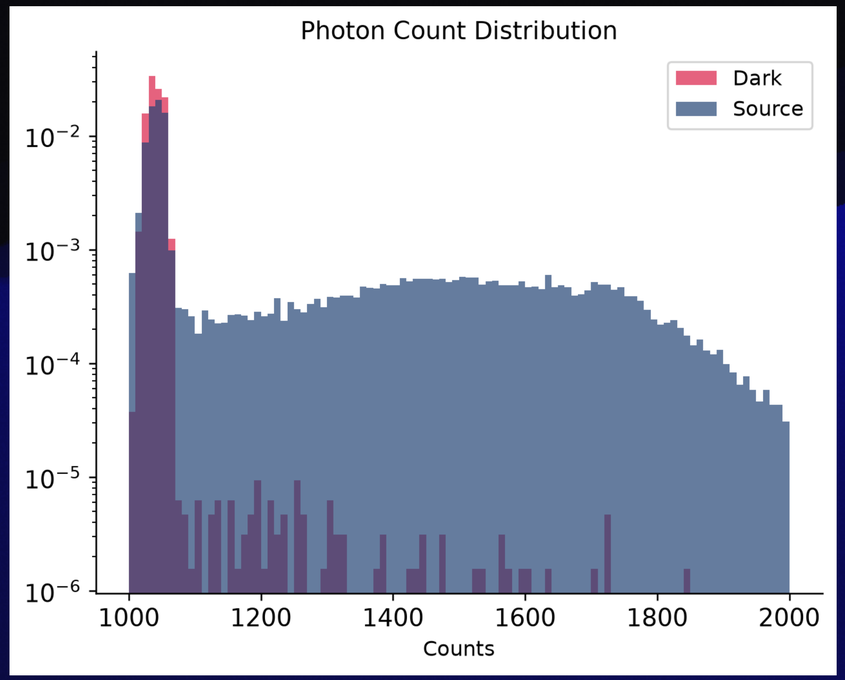


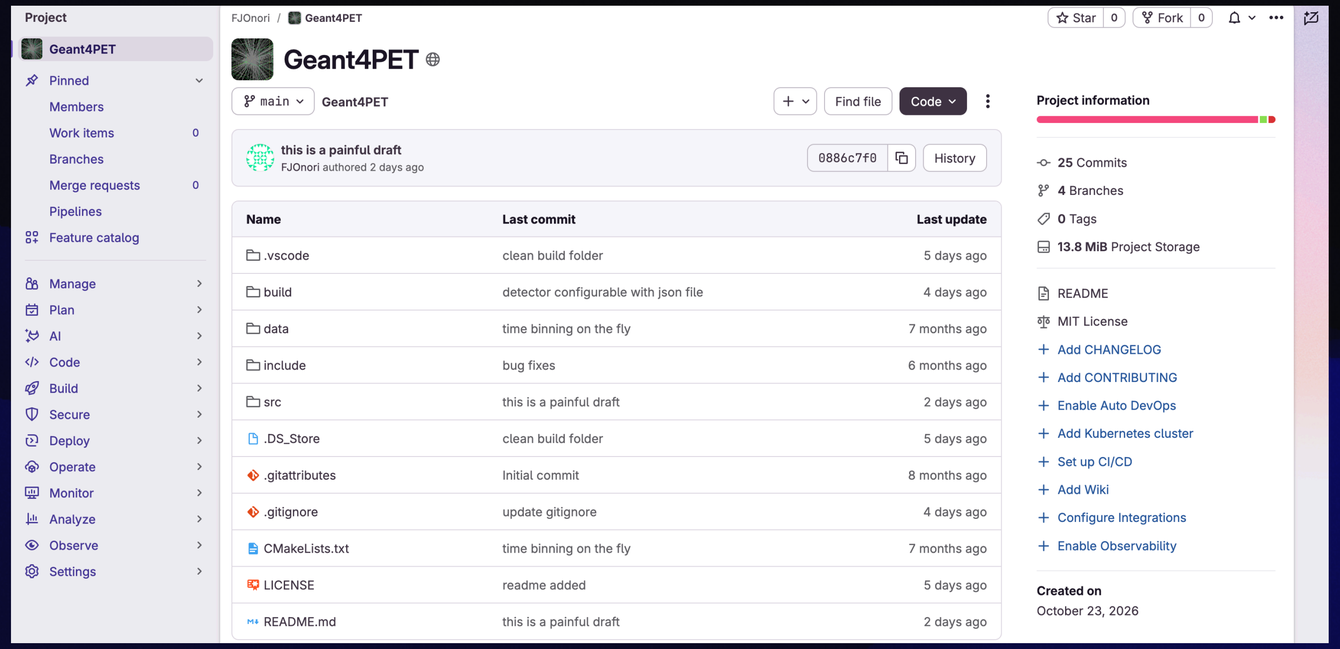






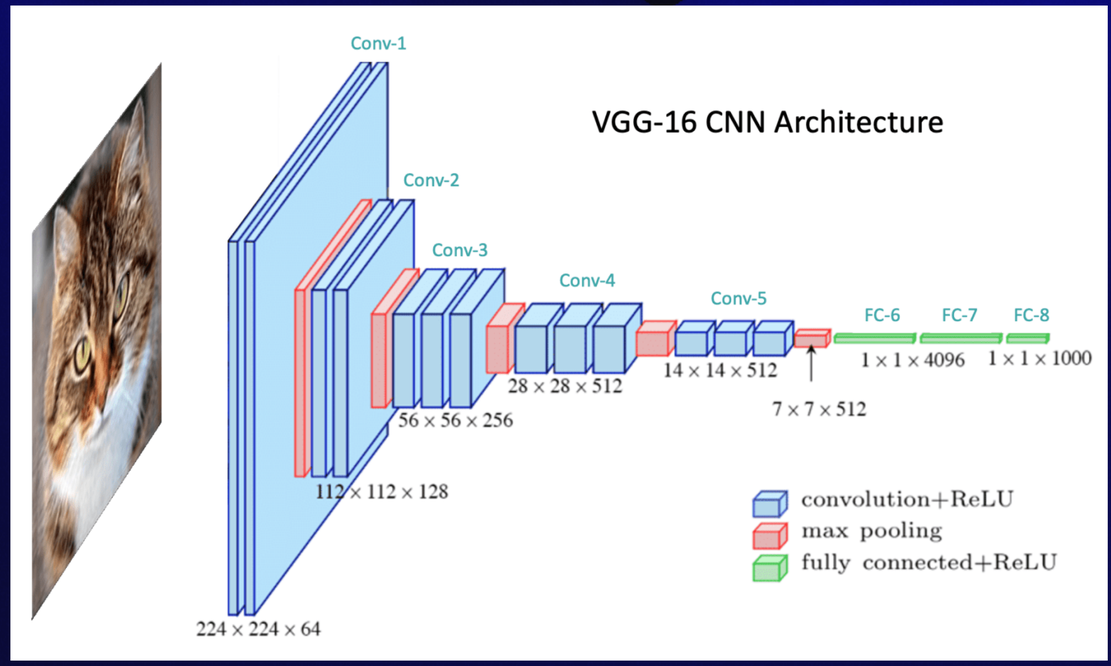

Simulation Signal Counts
Distribution
12000
10000
8000
6000
4000
2000
0
0
25
50
75
100
125
150
175
200
Photon Counts

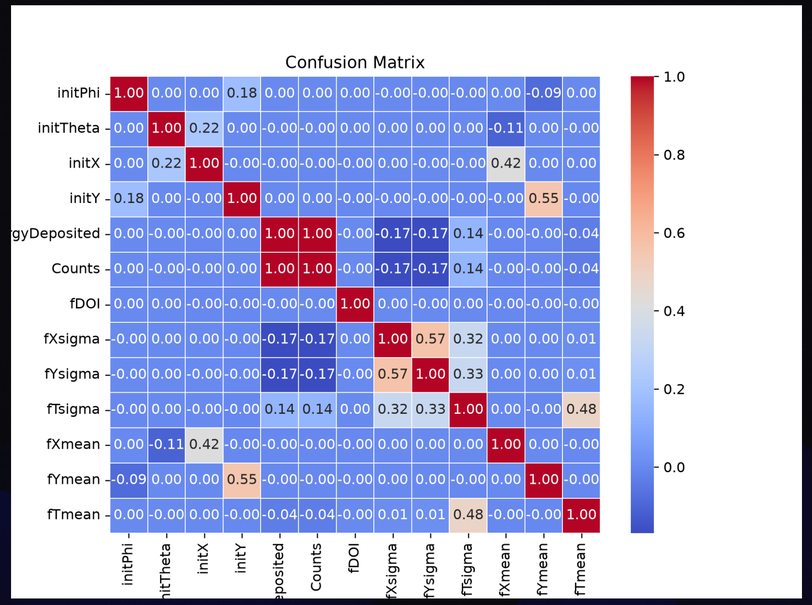

Photon Count Distribution
Dark
Source
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
1000
1200
1400
1600
1800
2000
Counts

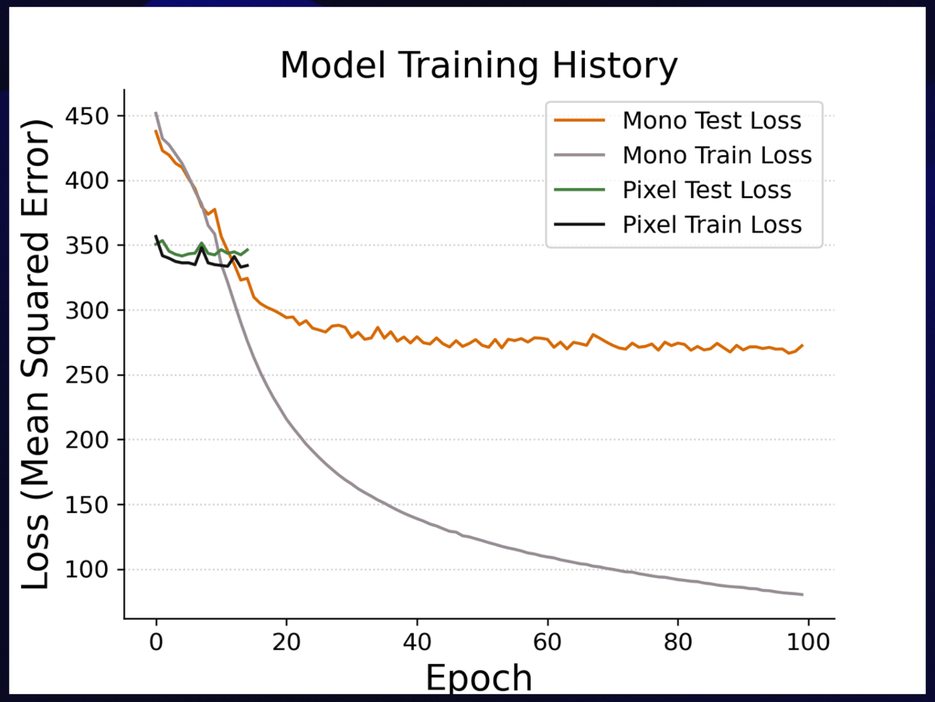


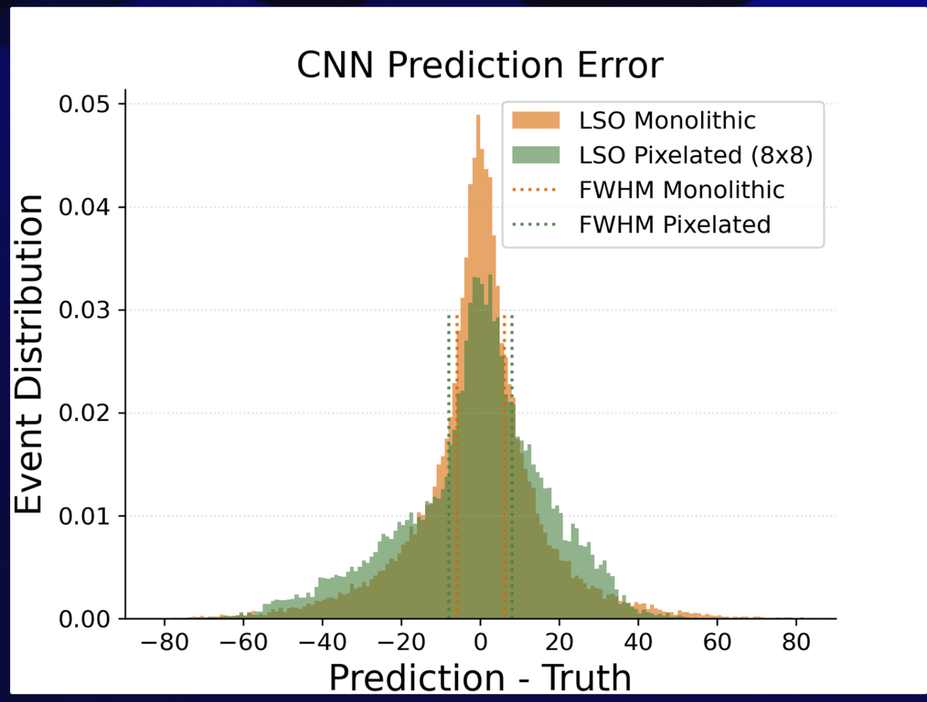
https://gitlab.com/s1960329/Geant4PET.git

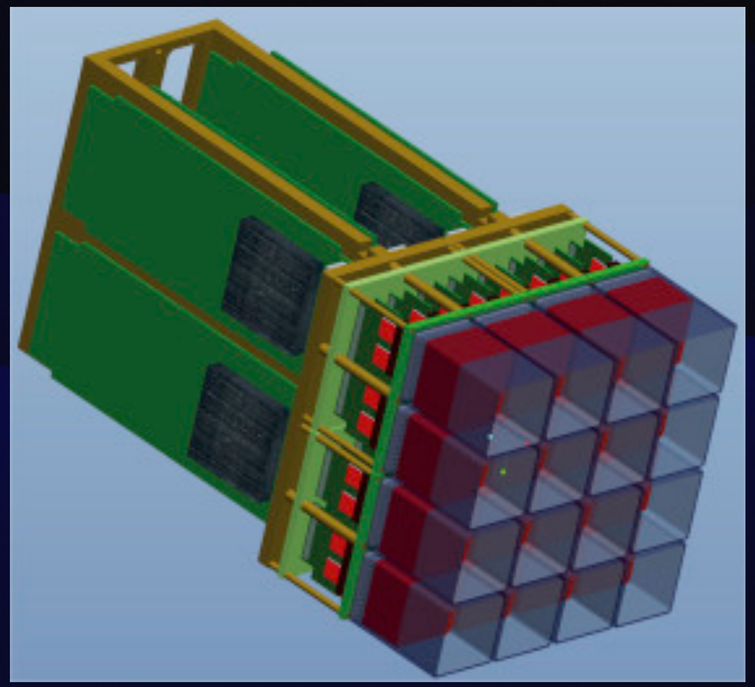
Layer	Input Shape	Output Shape	Param #
Cov 3D	(10, 8, 8, 1)	(8, 6, 6, 16)	448
Max Pooling	(8, 6, 6, 16)	(4, 3, 3, 16)	0
Cov 3D	(4, 3, 3, 16)	(2, 1, 1, 16)	6,928
Dense	(,32)	(, 1280)	42,240
Dense	(,1280)	(, 1280)	1,639,680
Dense	(,1280)	(,640)	819,840
Dense	(,640)	(,1)	641

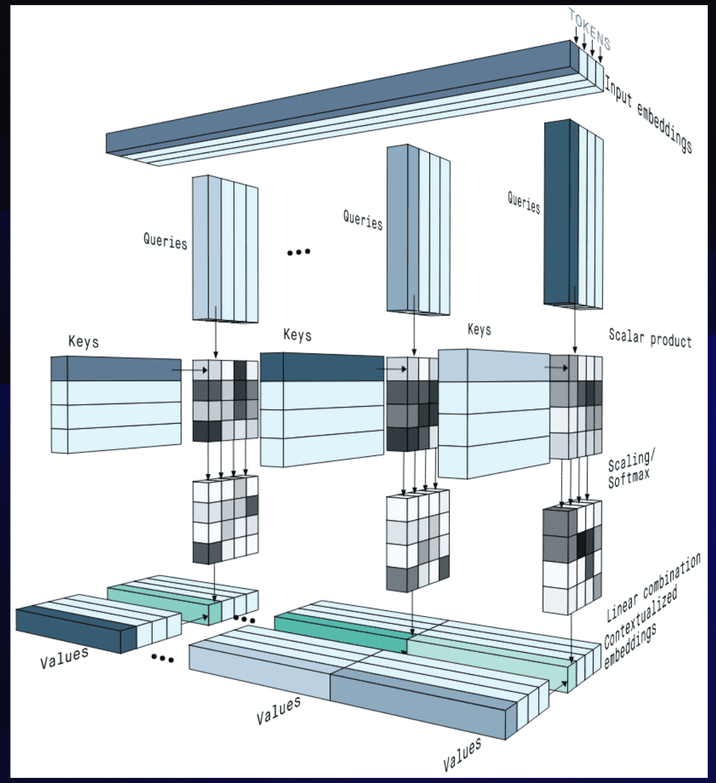


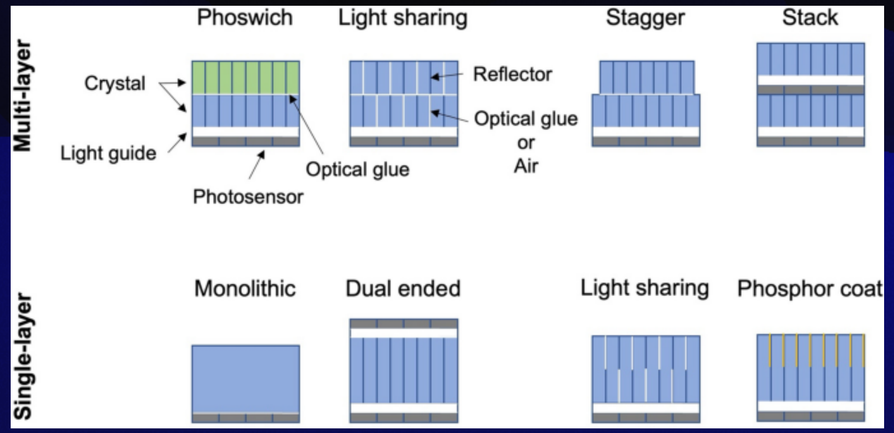

Confusion Matrix
initPhi
initTheta
initX
initY
gyDeposited
Counts
fDOI
fXsigma
fYsigma
fTsigma
fXmean
fYmean
fTmean
1.0
0.8
0.6
0.4
0.2
0.0


Model Training History
Mono Test Loss
Mono Train Loss
Pixel Test Loss
Pixel Train Loss
Loss (Mean Squared Error)
Epoch
450
400
350
300
250
200
150
100
0
20
40
60
80
100


CNN Prediction Error
LSO Monolithic
LSO Pixelated (8x8)
FWHM Monolithic
FWHM Pixelated
Event Distribution
Prediction - Truth
0.05
0.04
0.03
0.02
0.01
0.00
−80
−60
−40
−20
0
20
40
60
80




TOKENS
Input embeddings
Queries
Queries
Queries
Keys
Keys
Keys
Scalar product
Scaling/
Softmax
Values
Values
Values
Linear combination
Contextualized
embeddings


Multi-layer
Phoswich
Light sharing
Stagger
Stack
Crystal
Light guide
Photosensor
Optical glue
Reflector
Optical glue
or
Air
Single-layer
Monolithic
Dual ended
Light sharing
Phosphor coat

Questions