107° CONGRESSO NAZIONALE
della SOCIETÀ ITALIANA DI FISICA

SEZIONE V
Biofisica e fisica medica

14th September 2021

Evaluation of the radiomic feature robustness with heterogeneous insert simulating CT lung lesions

Istituto Nazionale di Fisica Nucleare

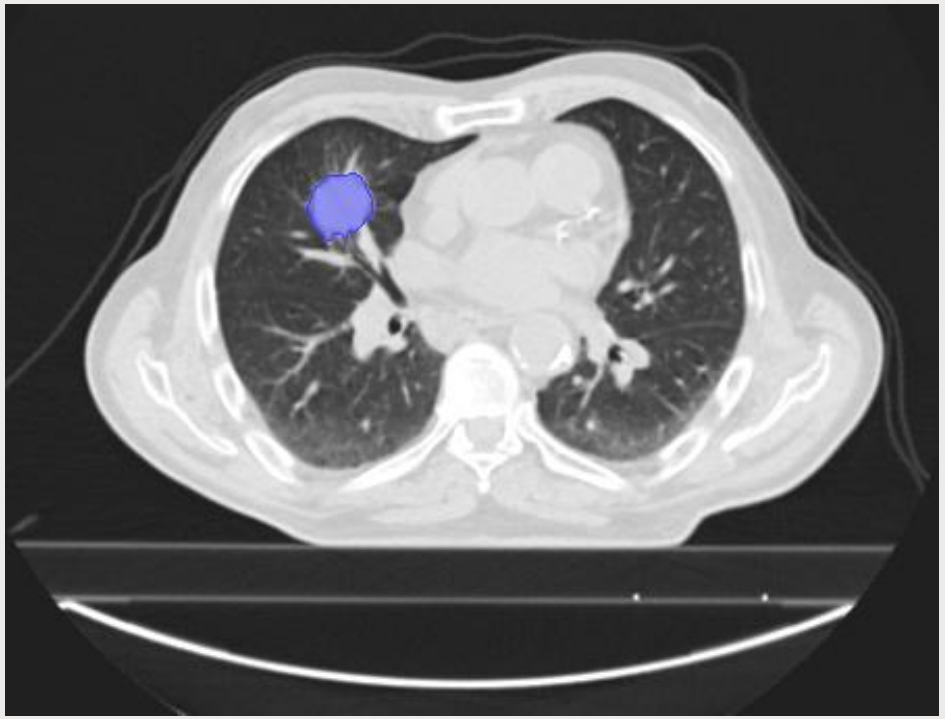
IEO Istituto Europeo di Oncologia

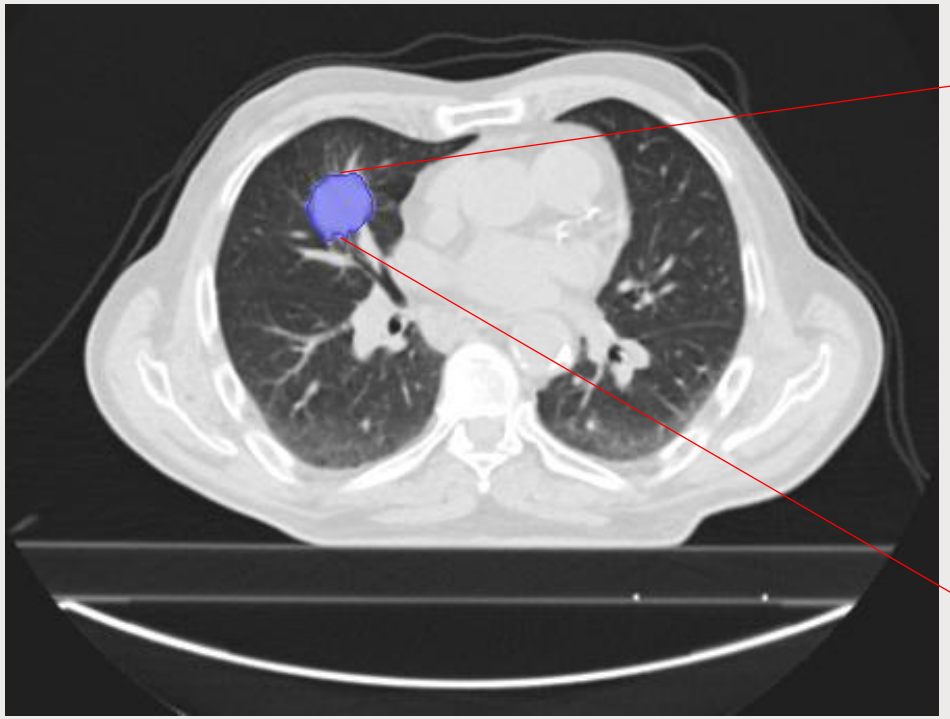
UNIVERISTÀ DEGLI STUDI DI PAVIA

Lisa Rinaldi

Physics Ph.D. Student

- What is Radiomics?
- Why robustness? How to investigate it?
- The project outline
- Results and the future





-510	-110	-321	-189	-133	22	-420	-703
-200	1	15	53	3	15	21	-6
12	50	100	80	62	35	5	-66
-40	44	77	87	75	83	-12	-297
-85	35	41	90	58	55	34	-100
-798	16	50	59	62	60	-44	-4
-204	-90	-7	39	38	26	-5	-202
-406	-355	-100	-37	-155	-8	-210	-520

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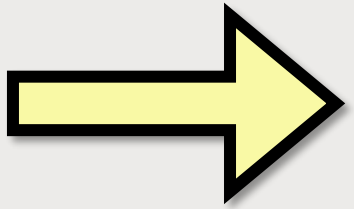

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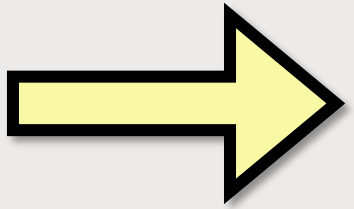
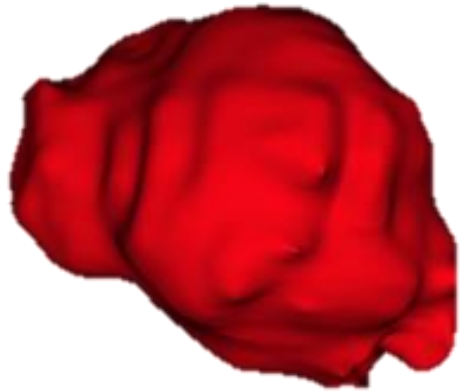


SHAPE



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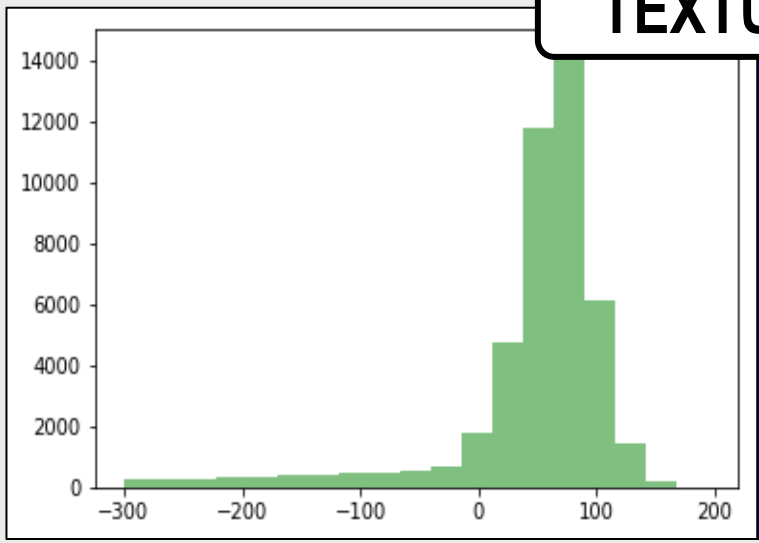

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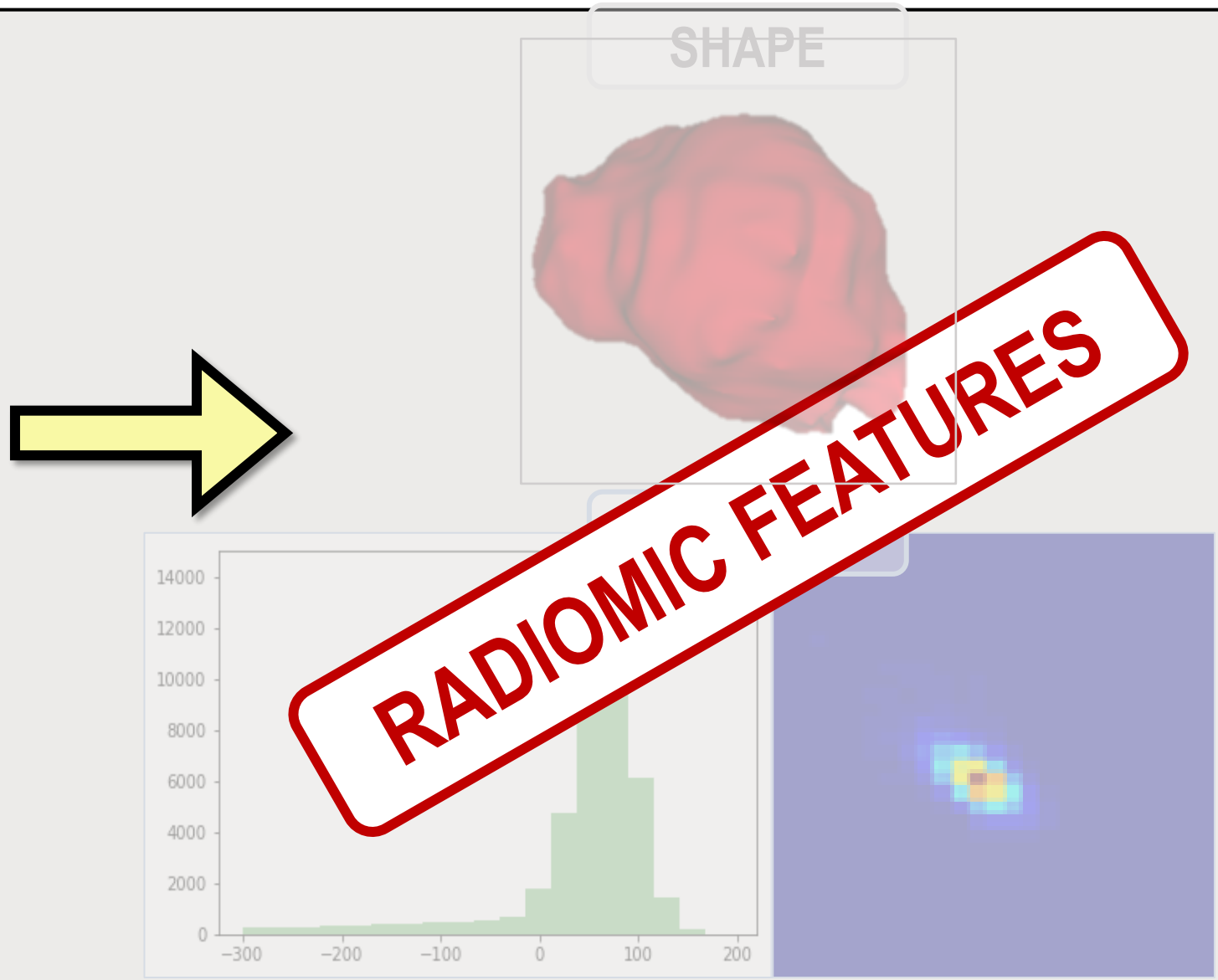
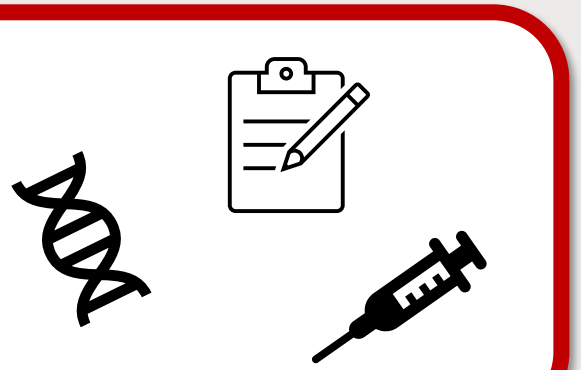


RADIOMIC FEATURES



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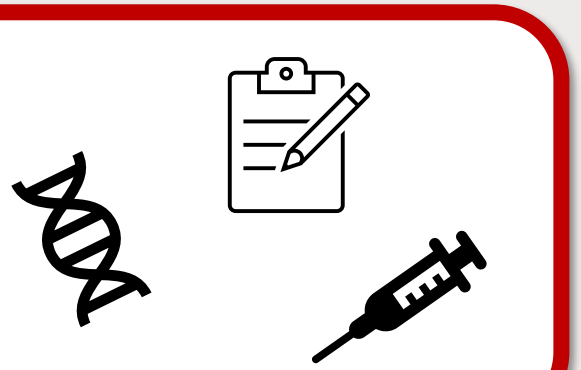


PREDICTIVE MODEL

- What is Radiomics?
- Why robustness? How to investigate it?
- The project outline
- Results and the future

REPEATABILITY

a measurement repeated multiple times on the same object by the same operator with the same procedure and the same experimental apparatus in a short time

RIPRODUCIBILITY

measurement and/or the investigated object change between a repetition and the other

FEATURE ROBUSTNESS

PHANTOMS

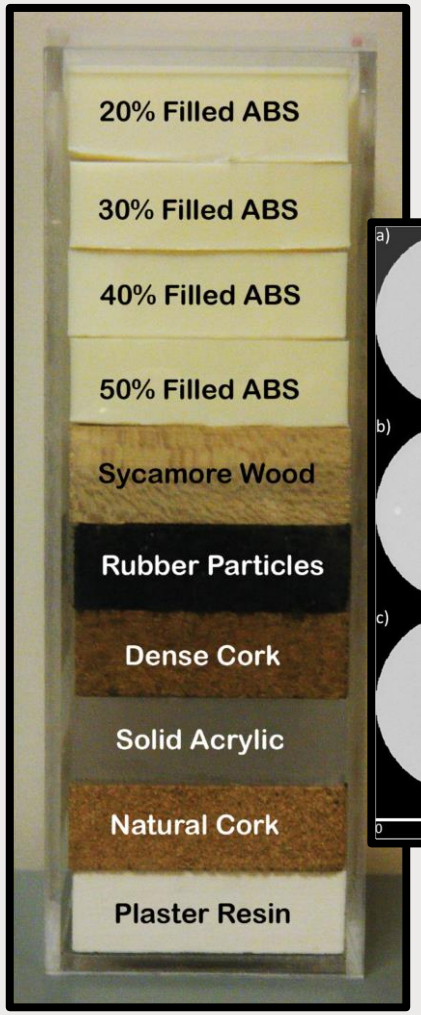
PROS

- limitless repeated acquisition
- inter-scanner variability
- acquisition parameters varied in a controlled way
- no movement effect
- no privacy issues

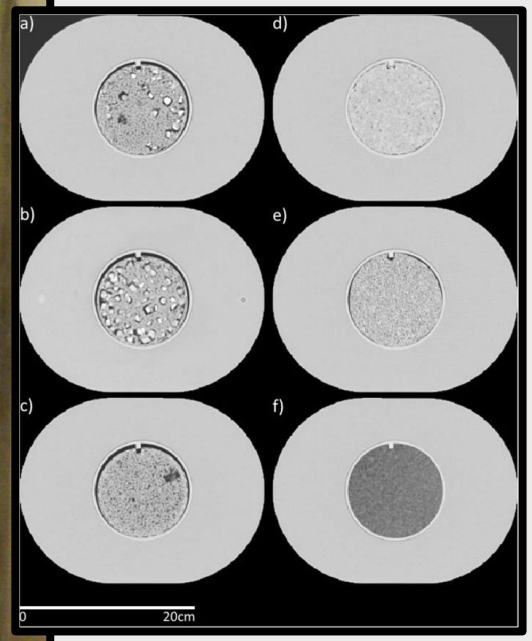
- no tissue heterogeneity
- no patient variability

CONS

Mackin et al., PLOS One. 2017, 12(9)

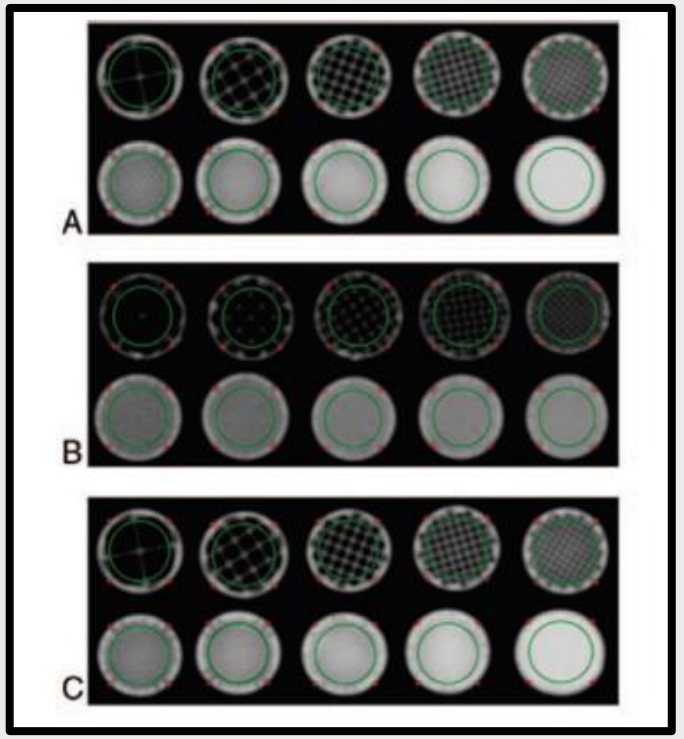


Ger et al., Sci Rep. 2018, 8, 13047



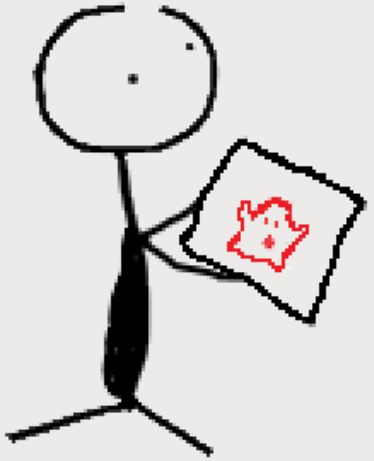
Samei et al., J Med Imaging. 2019, 6(2)

Dayeong et al., Medicine. 2020, 99(1)



PHANTOMS IN RADIOMICS

- What is Radiomics?
- Why robustness? How to investigate it?
- The project outline
- Results and the future



2 prototypes of lung inserts

1

Polyethylene Terephthalate (PET-G)

3D printed

2

Powdered sodium polyacrylate

+ iodinated contrast

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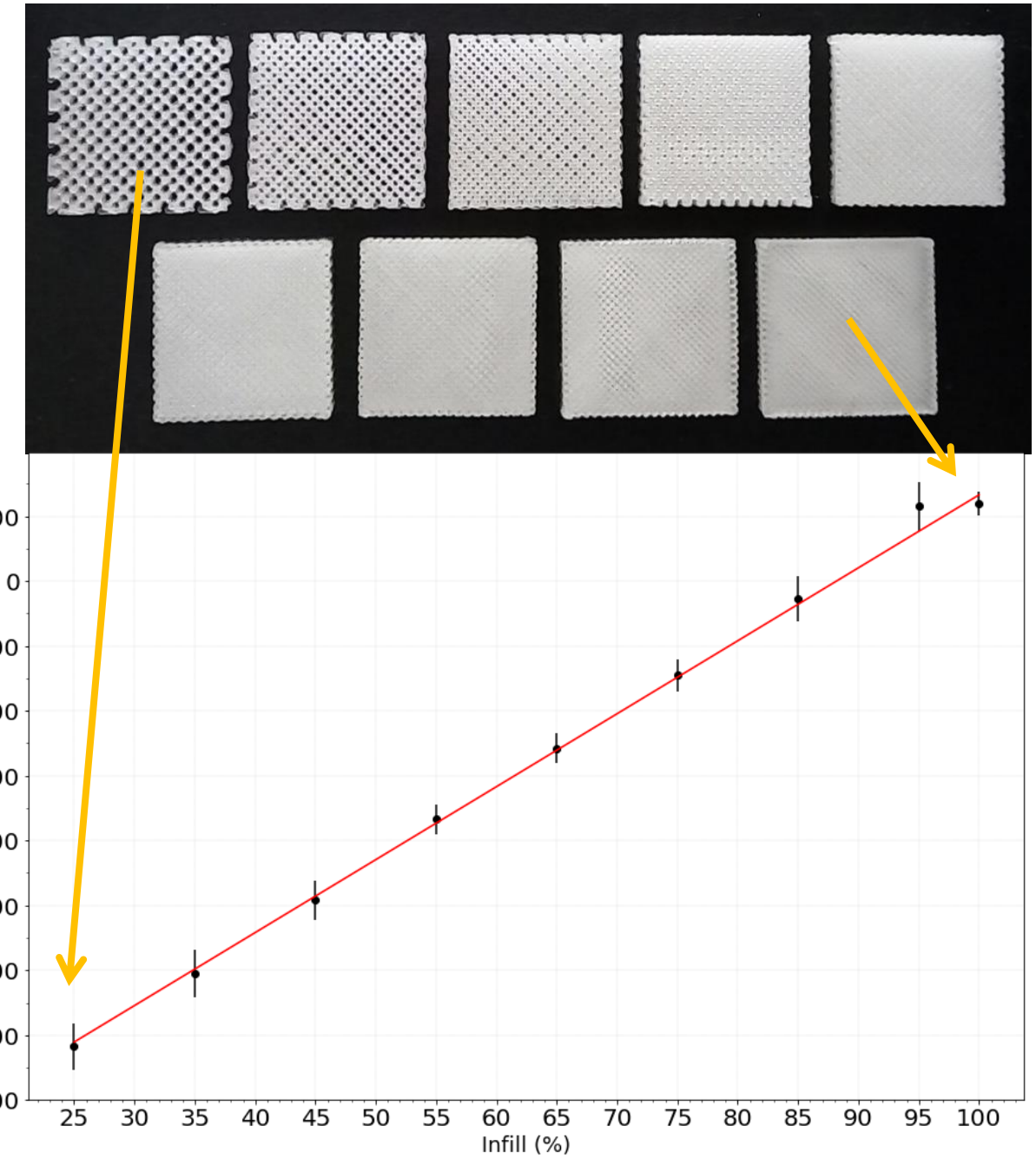
29 NSCLC patients and Catphan® for comparison

62 ± 22 HU

PET-G

Characterisation

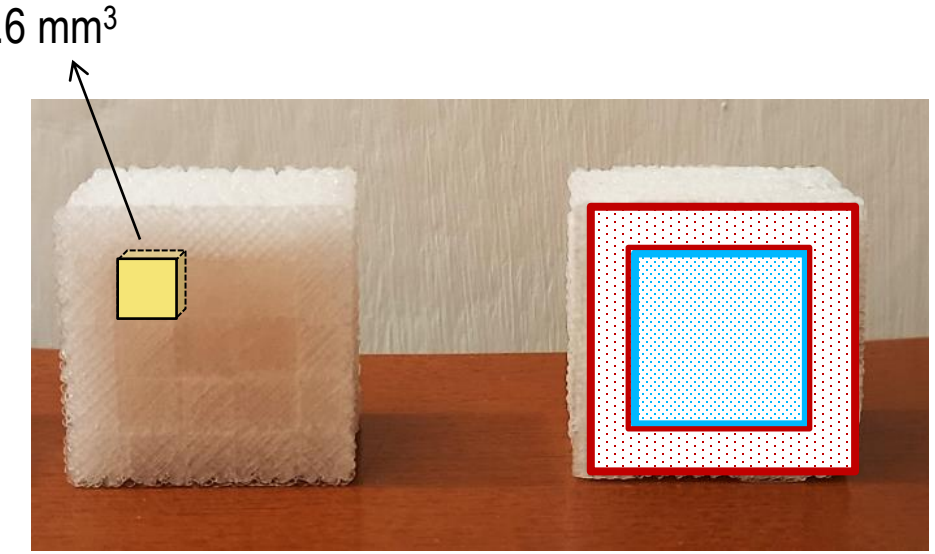
- 3D printed (FFF)
- Range infill: 25-100 %

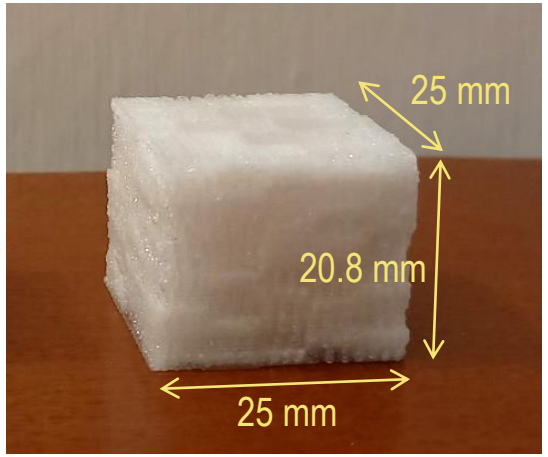


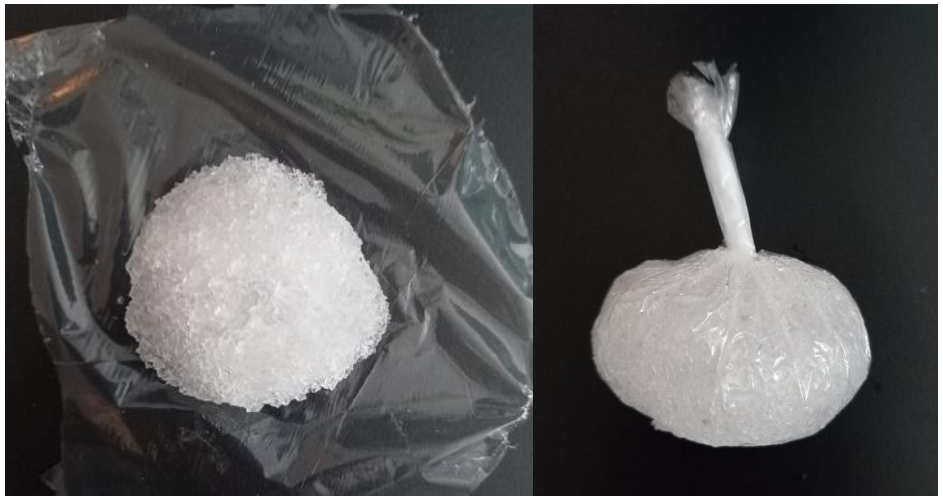
PET-G

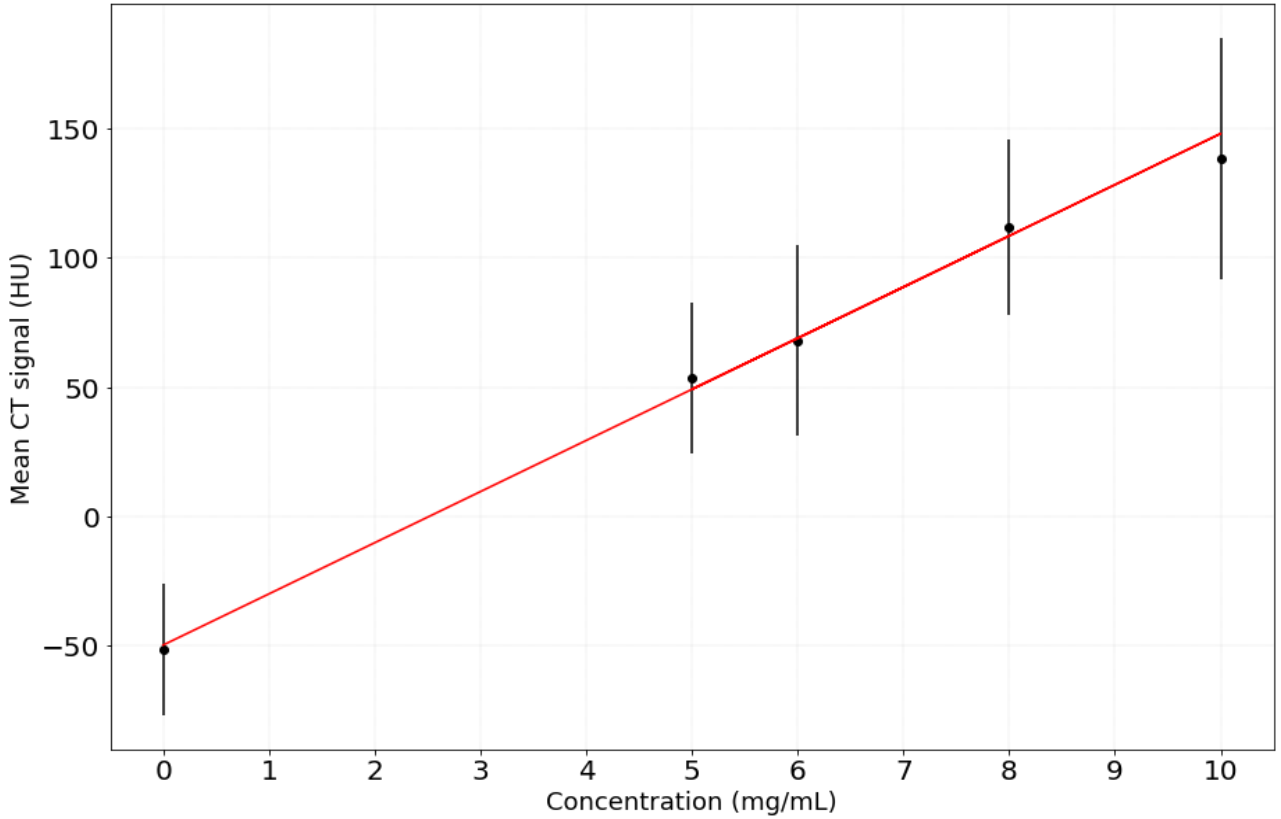
- 3D printed (FFF)

- Range infill
  - CORE: 75-100%
  - BORDER: 50-75%









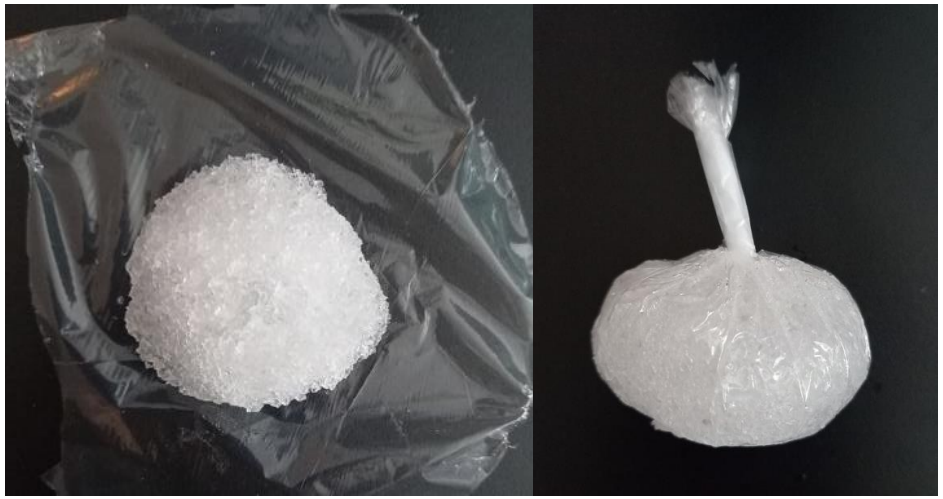
Sodium polyacrylate

Characterisation

+ Water

+ Iodinated contrast medium

different contrast concentration



Sodium polyacrylate

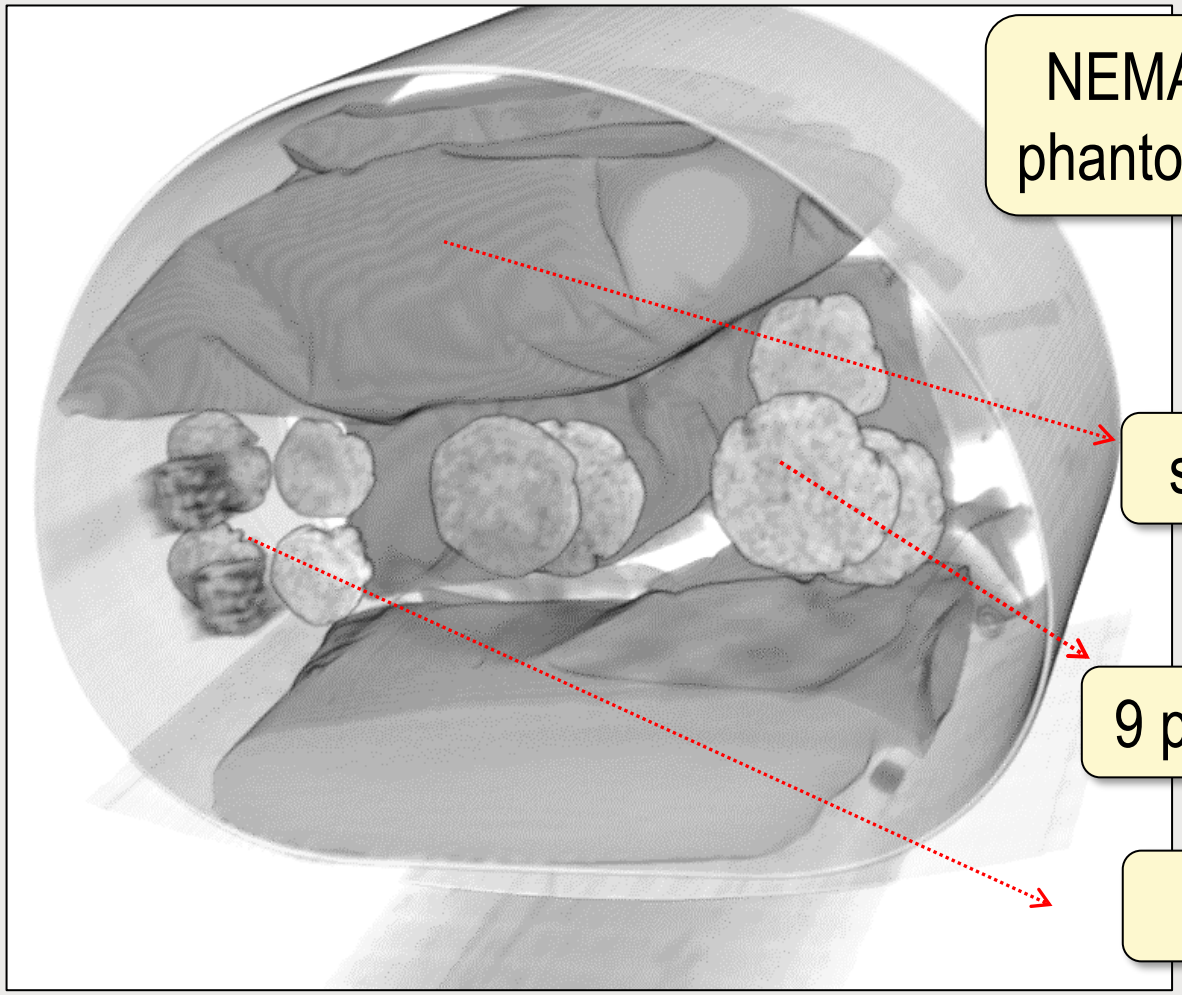
9 inserts:

5 mg/mL
6 mg/mL
8 mg/mL
0 mg/mL + 5 mg/mL + 10 mg/mL
0 mg/mL + 7 mg/mL + 10 mg/mL
0 mg/mL + 5 mg/mL + 8 mg/mL
0 mg/mL + 8 mg/mL + 10 mg/mL
6 mg/mL + 2mL water
0 mg/mL + 4.5 mg/mL + 7 mg/mL

Characterisation

+ Water
+ Iodinated contrast medium

different contrast concentration



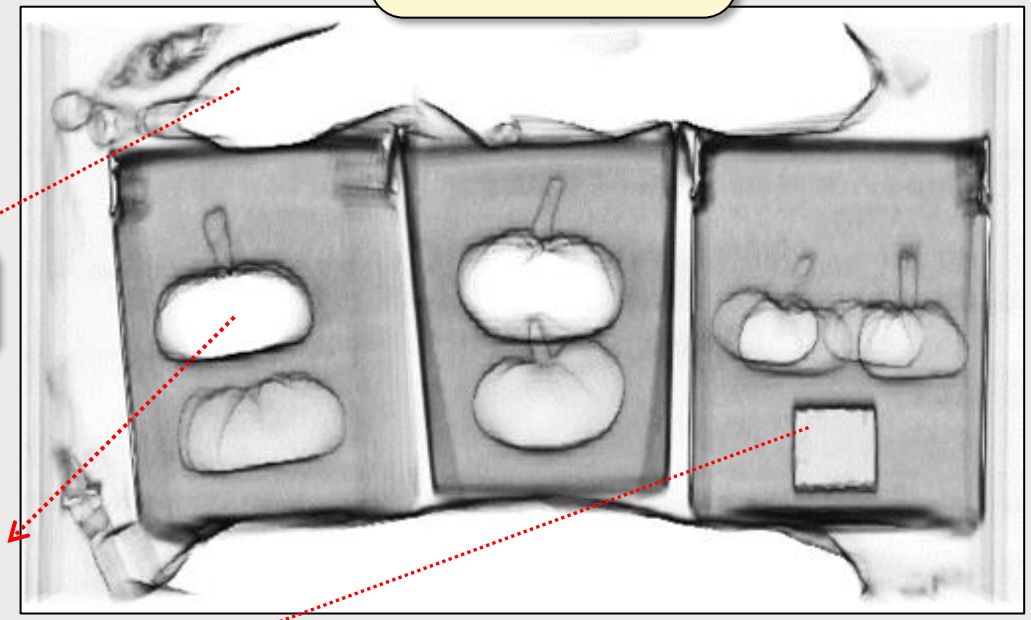
NEMA phantom

saline bags

9 polyacrylate

2 PET

3 containers with cork



10 repeated CT acquisitions

3D VOI for each insert

Pyradiomics software: 153 features

Similarity with real lesions

$$range_{i,pts} = [10^{th}percentile, 90^{th}percentile]_{i,pts}$$

$$P_{ij} = \begin{cases} 1, & feature_{ij} \in range_{i,pts} \\ 0, & otherwise \end{cases}$$

Repeatability

$$CV_{ij} = \left| \frac{\text{standard deviation}_{ij}}{\text{mean}_{ij}} \right|_{10rep}$$

CV ≤ 0.10 for repeatability

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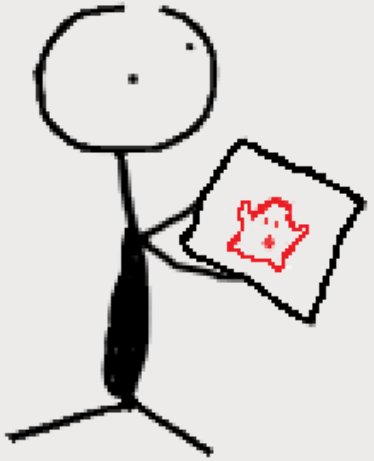
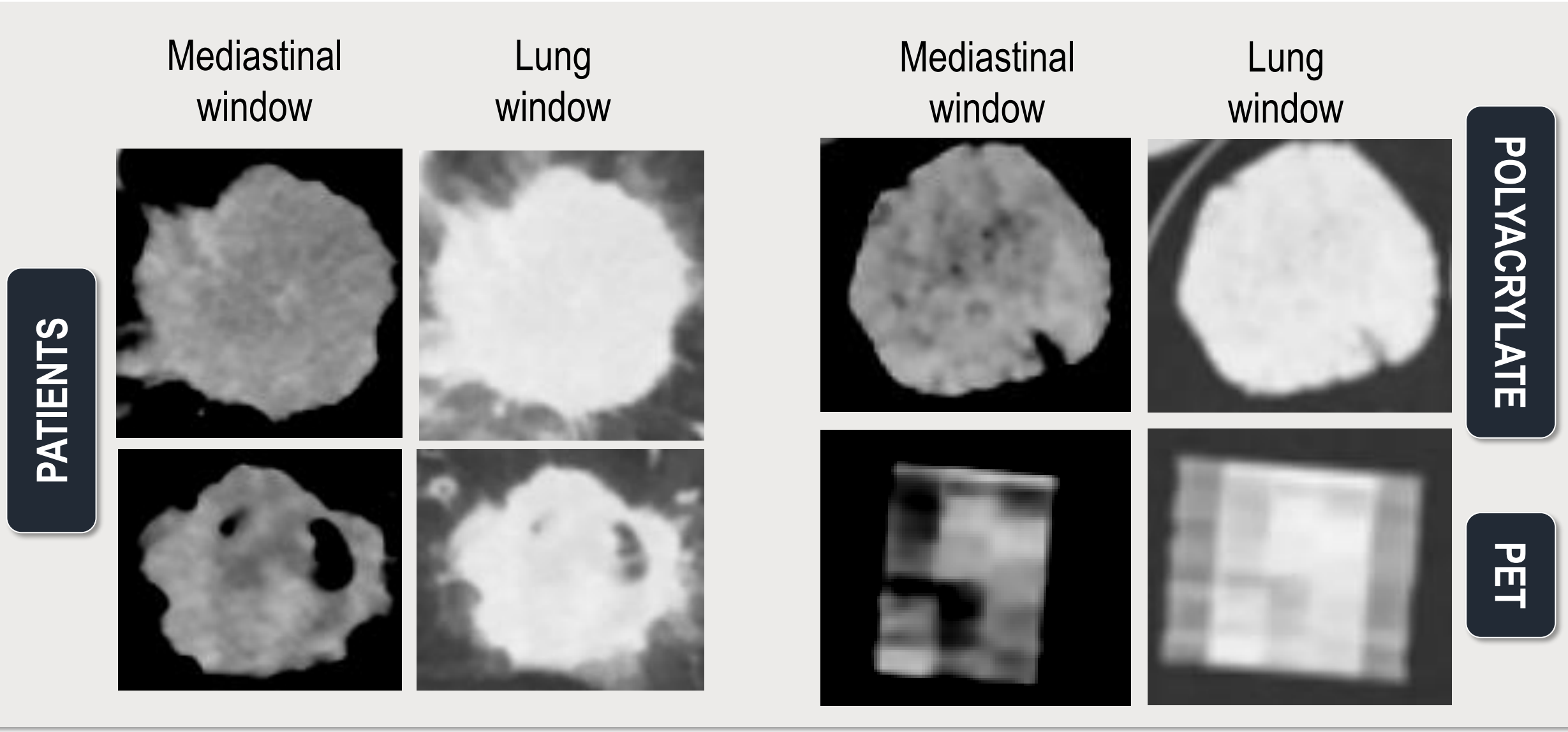
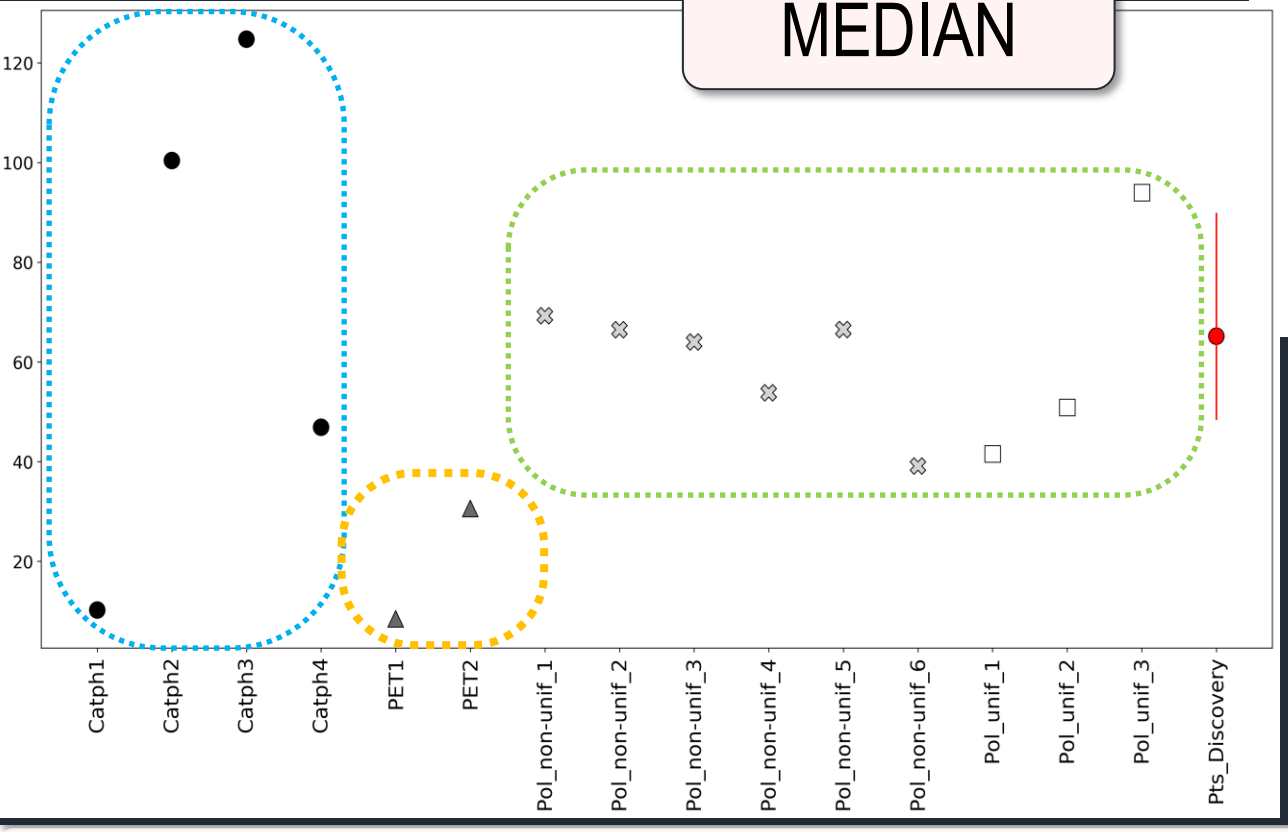


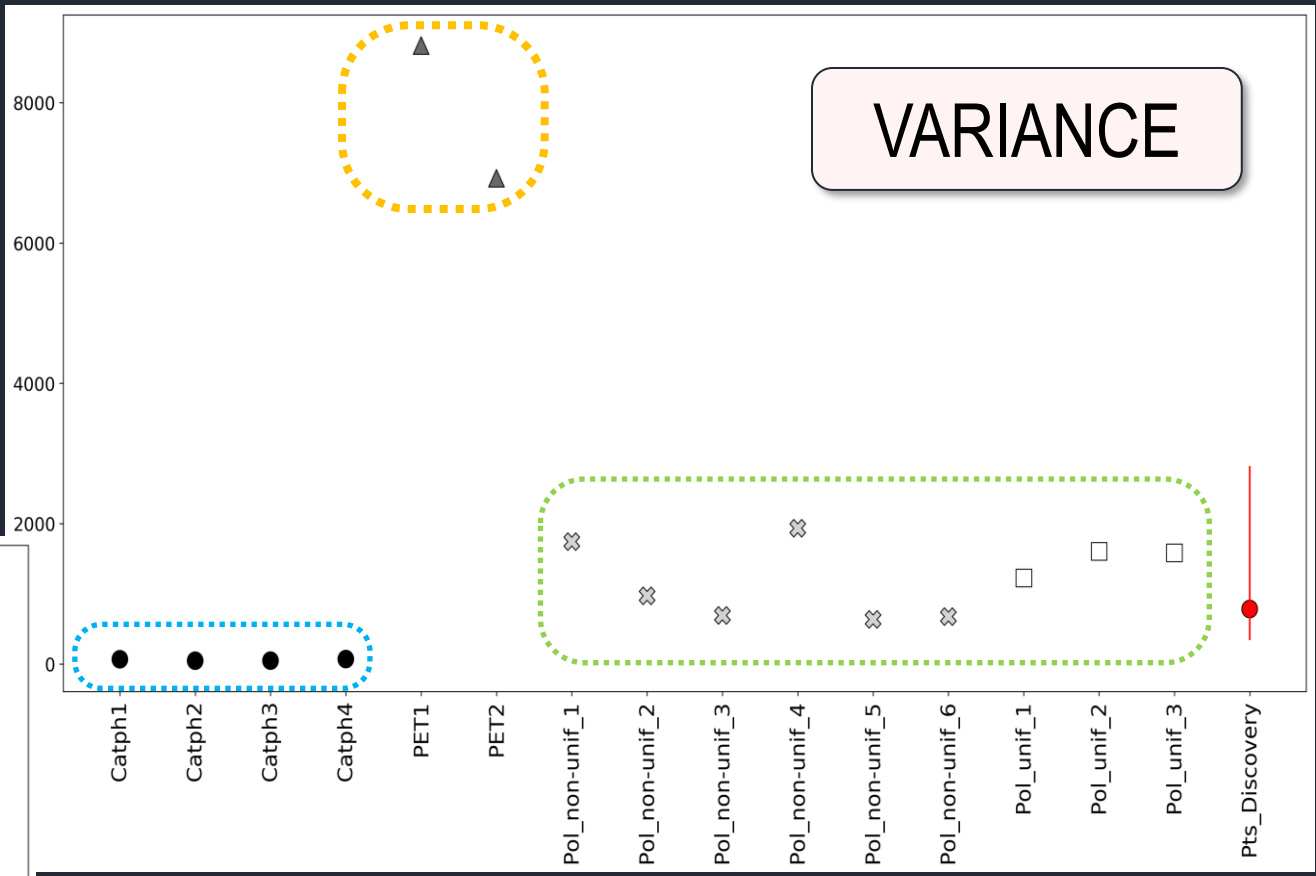

Mediastinal window
Lung window
Mediastinal window
Lung window
PATIENTS
POLYACRYLATE
PET

Basic CT properties

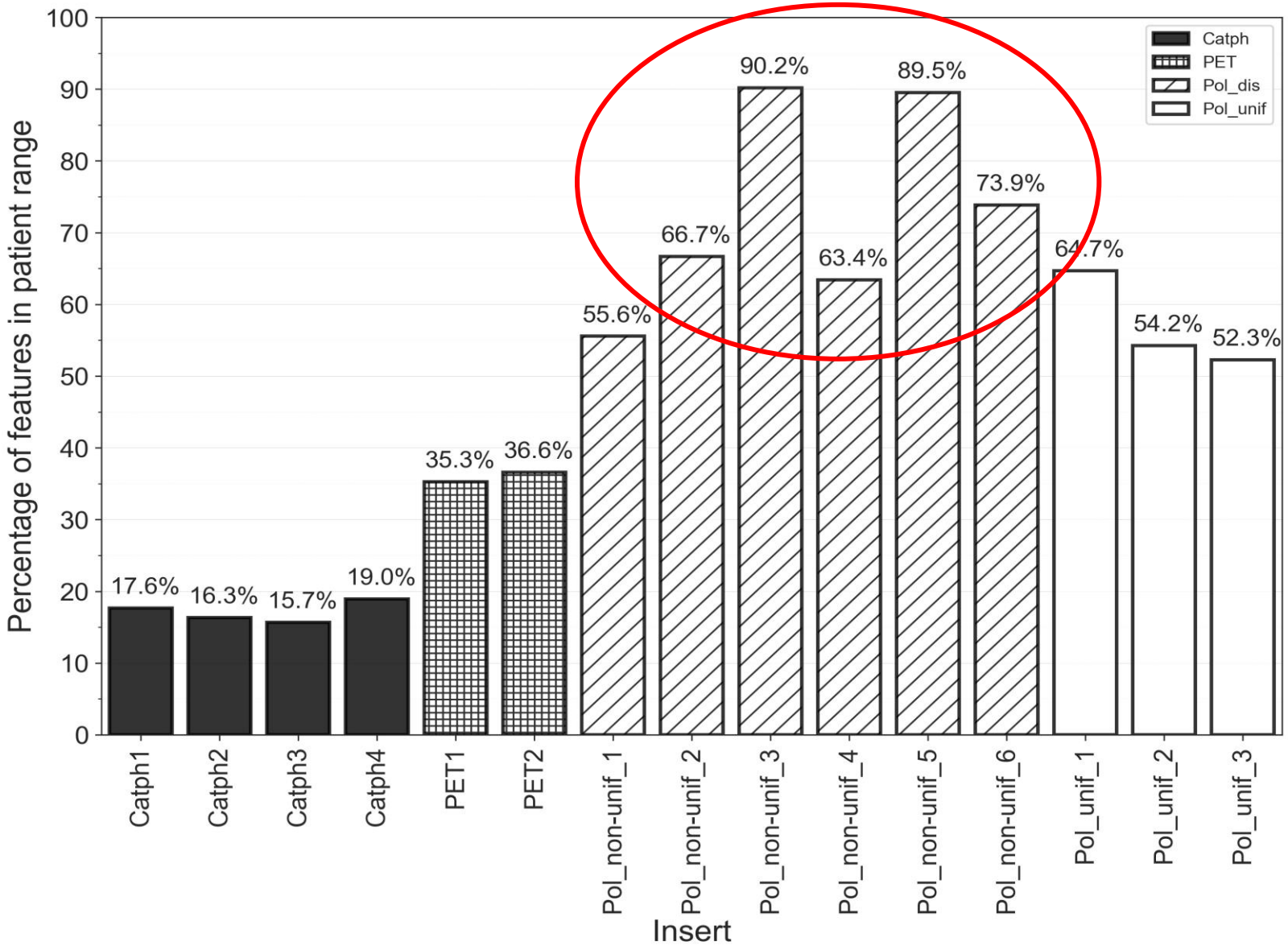
MEDIAN



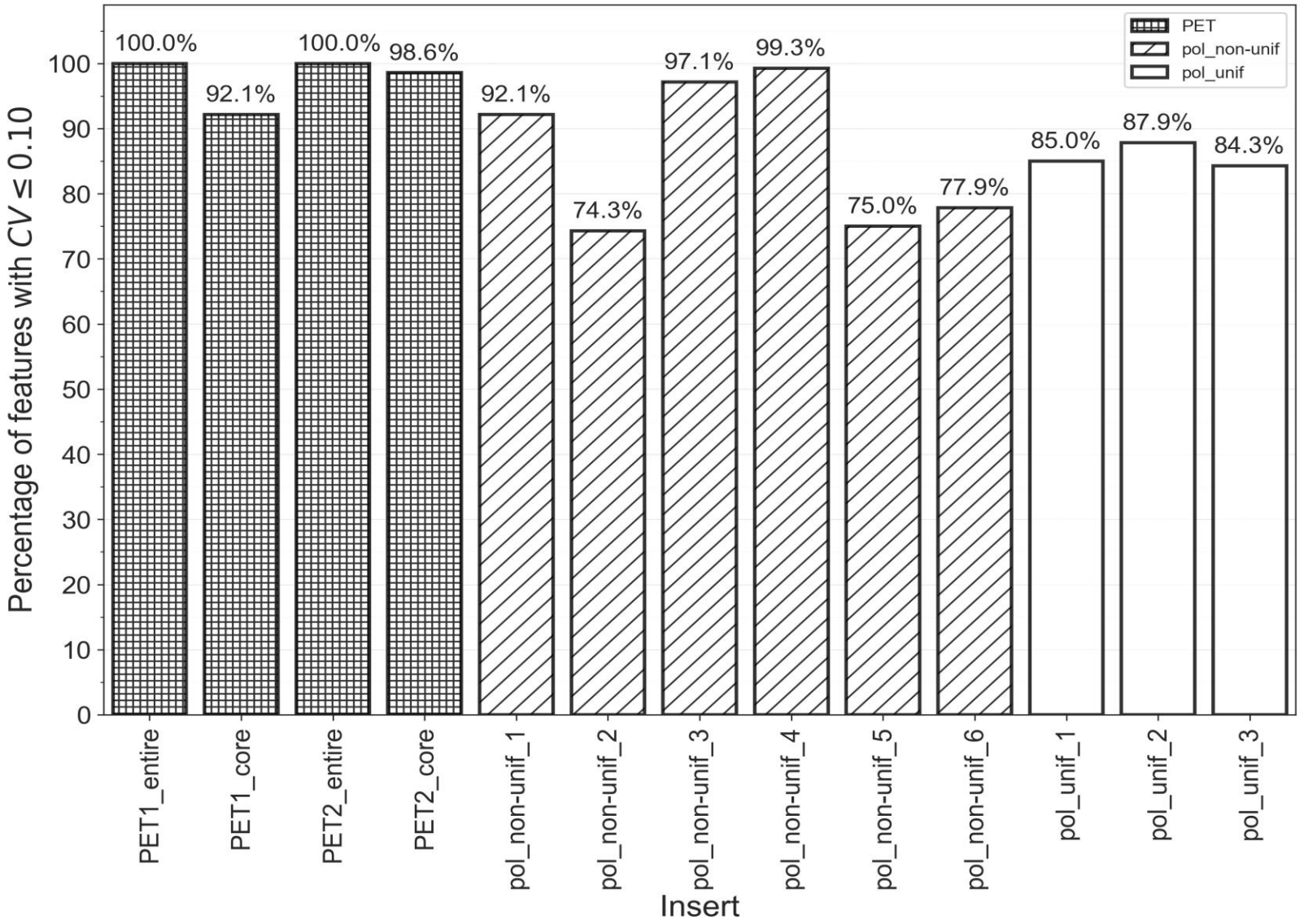
VARIANCE



Similarity with real lesions



Repeatability



FUTURE

- Compare different scanners and acquisition parameters
- New PET inserts more similar to real tumours

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