Routine DE Acquisitions in an Oncological Center

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Routine DE Acquisitions in an Oncological Center: Structure

- Introduction on CT in oncology
- Technical choices in routine acquisitions
- Clinical DE applications selection
  - VNC - iodine map use in current exams
    - Body CT examples in oncology
  - Perfusion imaging and quantification in routine pulmonary CT angiography
- Bonus (SE) Abdominal perfusion application
  - Hepatic perfusion with arteriography extraction in radioembolization planning

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Intro - CT-scans Specificities in Oncology

- Screening & FU are the most usual indications
- > 80% CECT
- > 50% multiple regions CT (all body, thorax + H&N…)
- Many CT as part of clinical studies

➔ We need standardized techniques

Intro – Patients Specificities in Oncology

- Frequent examinations resulting in high cumulative radiation dose
- Longer life expectancy
- At high risk of pulmonary embolism
- Increased prevalence of renal failure

➔ Limit iodine and radiation doses

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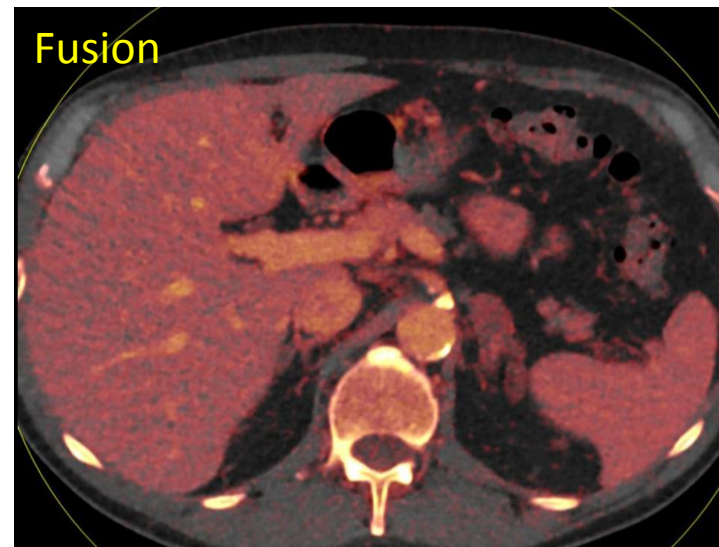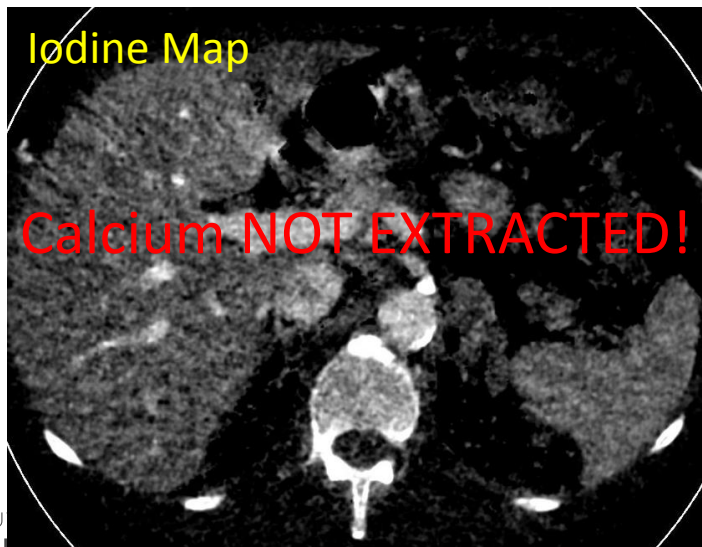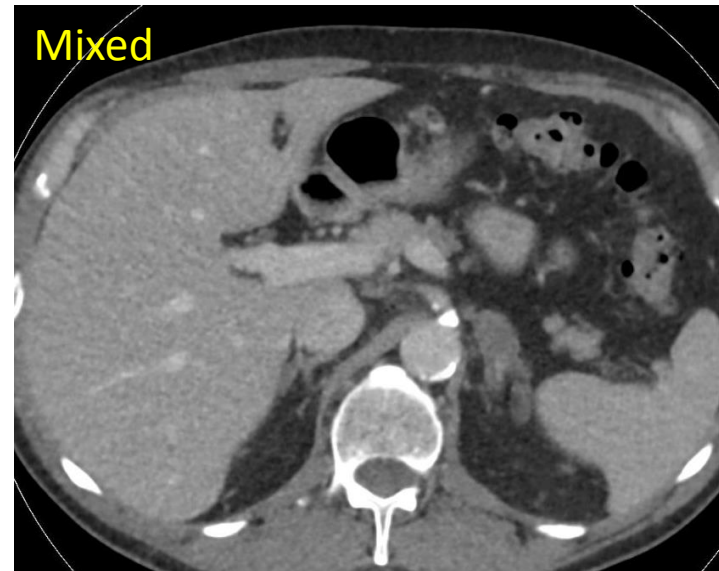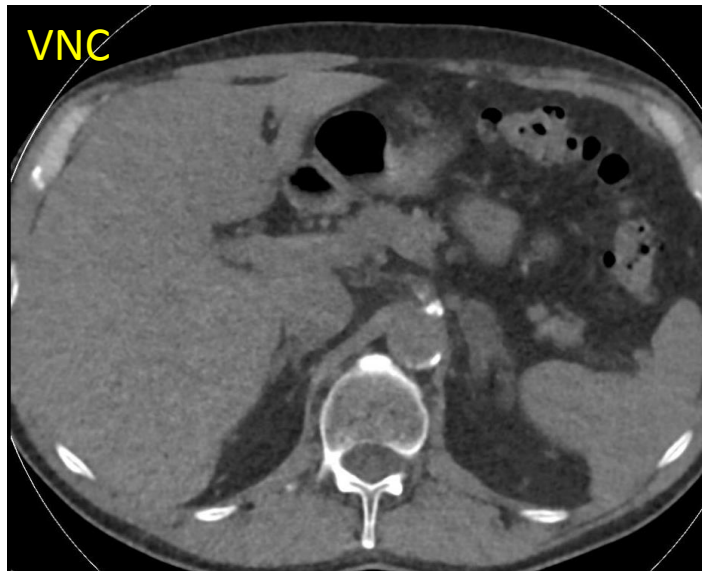INSTITUUT

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In House Routine Technical Choices

- Somatom Force® - **All CECT in dual energy**
- Common use of VNC & iodine map
- **No more non-enhanced CT before a CECT**
- Maximal use of IR algorithms and dose reduction
- Very low dose CT for pulmonary screening (DLP 20 mGy.cm)
- Reduced iodine quantity for pulmonary angiography (40ml, 16g)
- Abdominal CT: iodine volume/flow related to the patient's weight

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Abdominal CT : iomeprol 400 mg/ml
Best portal phase

< 56 kg	75 ml	2.5 ml/s
56-65 kg	90 ml	3 ml/s
66-85 kg	105 ml	3.5 ml/s
86-95 kg	120 ml	4 ml/s
>95 kg	130 ml	4.5 ml/s

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VNC-Iodine Map in Current Exams

VNC

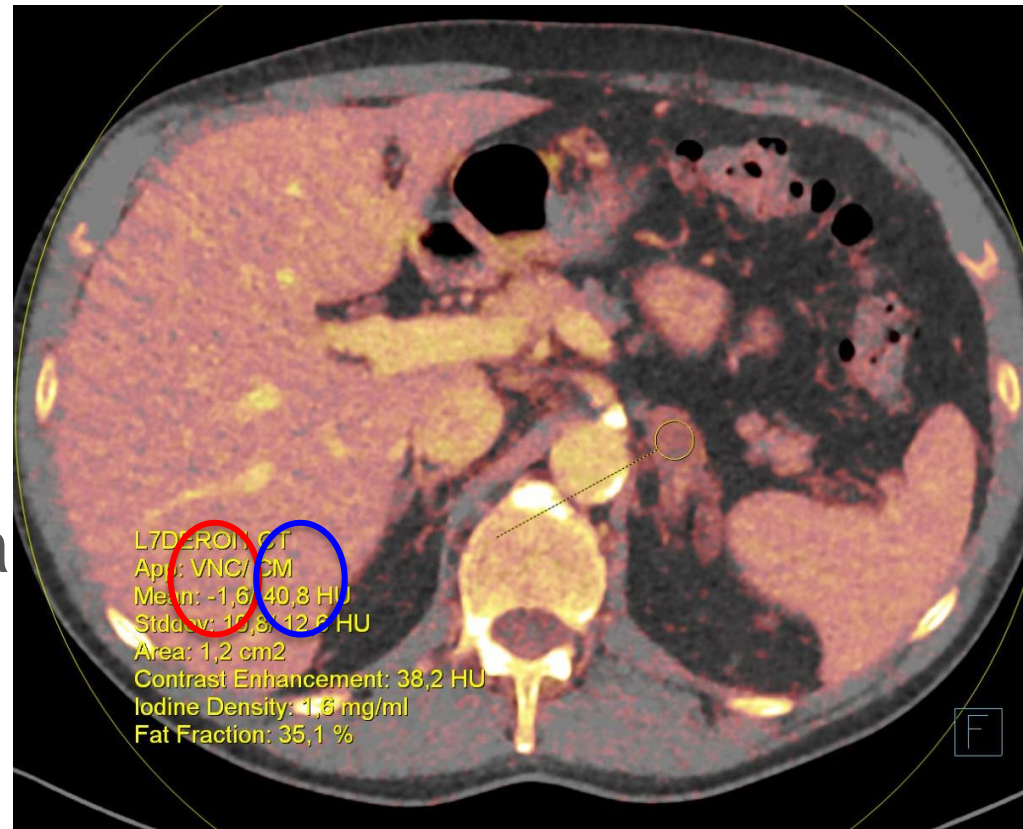Mixed

Iodine Map

Calcium NOT EXTRACTED!

Fusion

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Density ROI on VNC-Iodine Map Fusion Various Clinical Applications

- Know the spontaneous density of adrenal lesion

- Be sure an hepatic lesion is enhancing

- Differentiate hematoma and enhancement

- Estimate enhancement

- …

L7D ROI CT
App: VNC/CM
Mean: -1,6 40,8 HU
Stddev: 10,8 12,6 HU
Area: 1,2 cm2
Contrast Enhancement: 38,2 HU
Iodine Density: 1,6 mg/ml
Fat Fraction: 35,1 %

Calculated VNC density $\sim$ 10 HU lower than measured density!

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Density ROI and Iodine fraction
Potential functionnal studies

- Follow an hypervascular lesion
  - Chemotherapy ongoing
  - Mid-term RT
  - → early response evaluation
- Predict tumor response to anti angiogenic
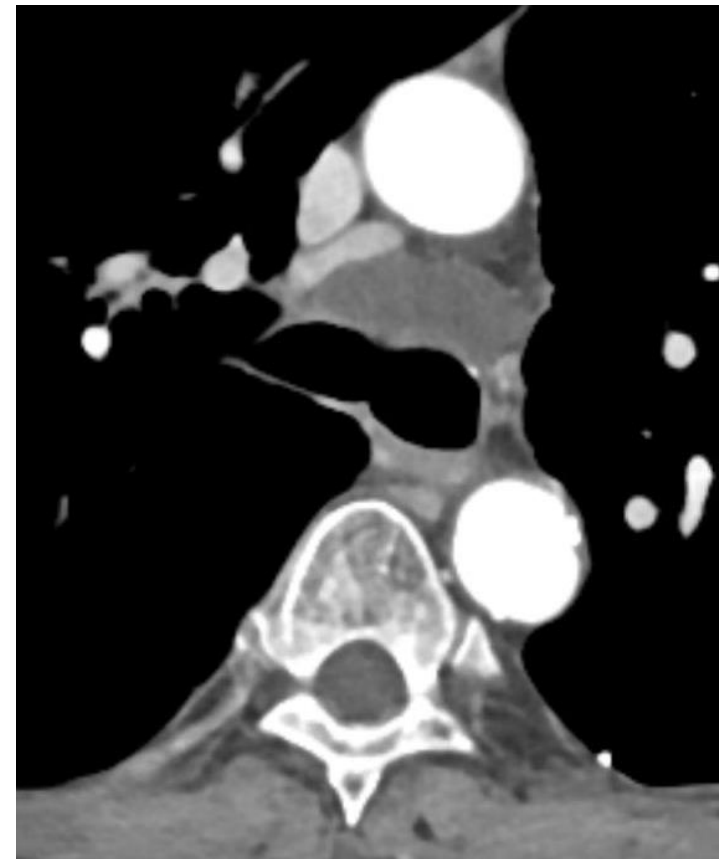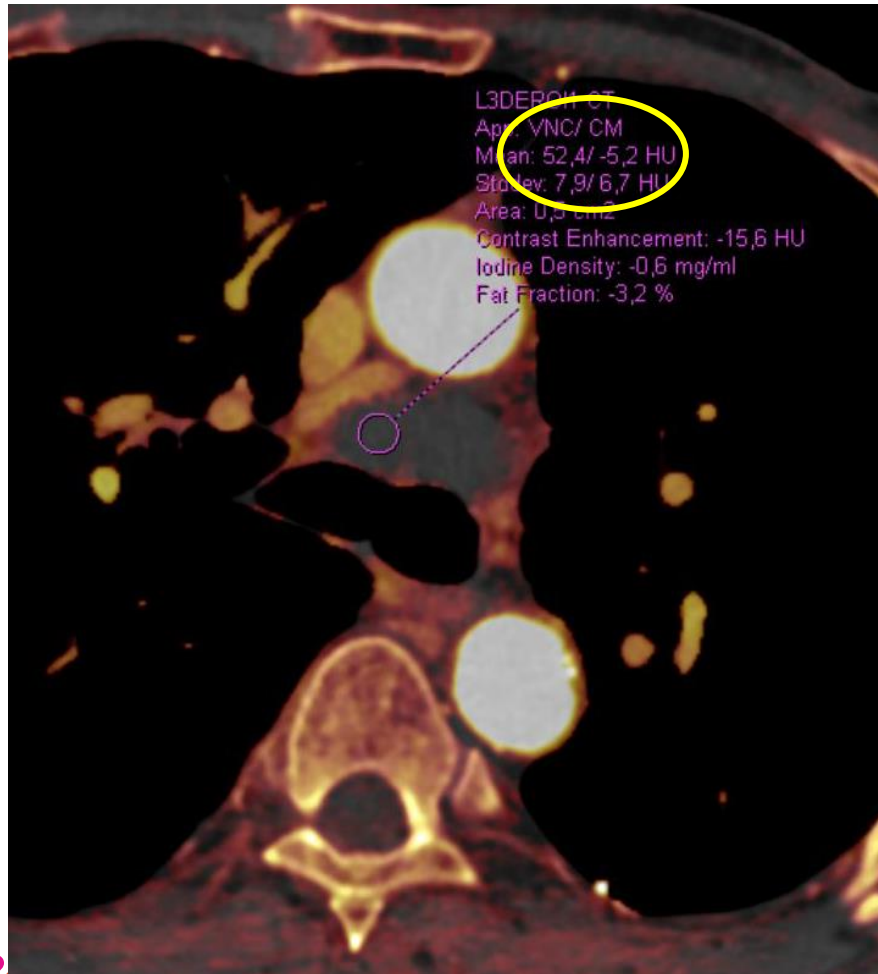- Differentiate infiltrated small nodes (5-15 mm)
- …

Density ROI oncological examples
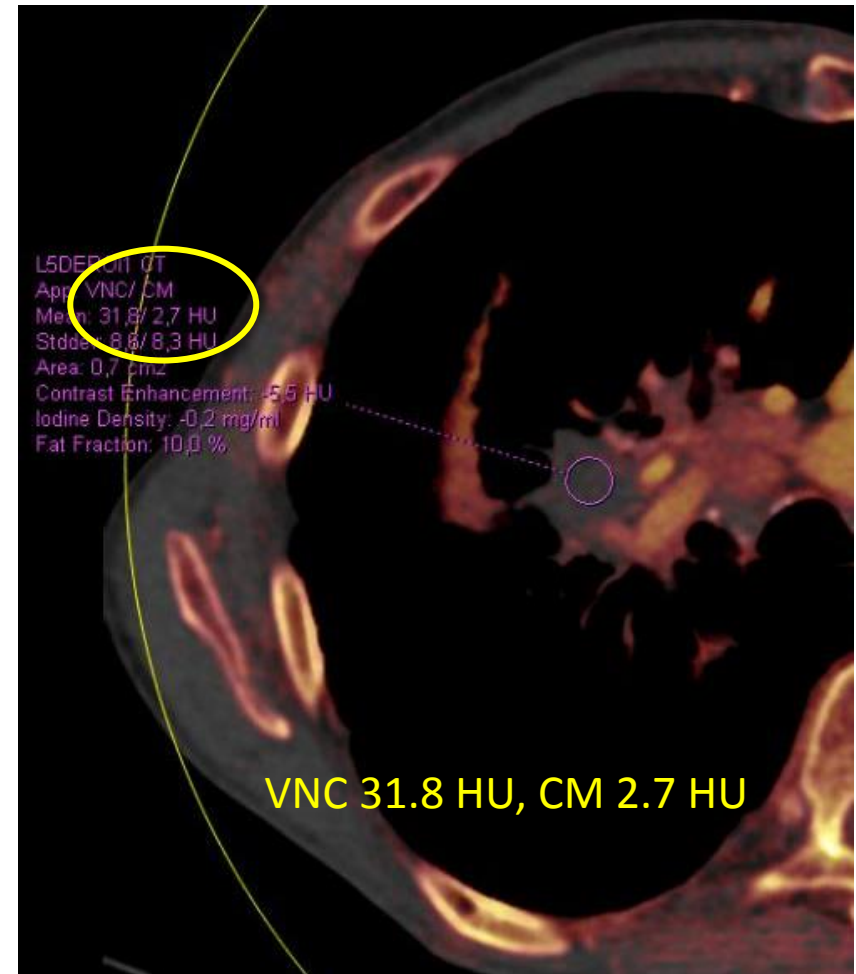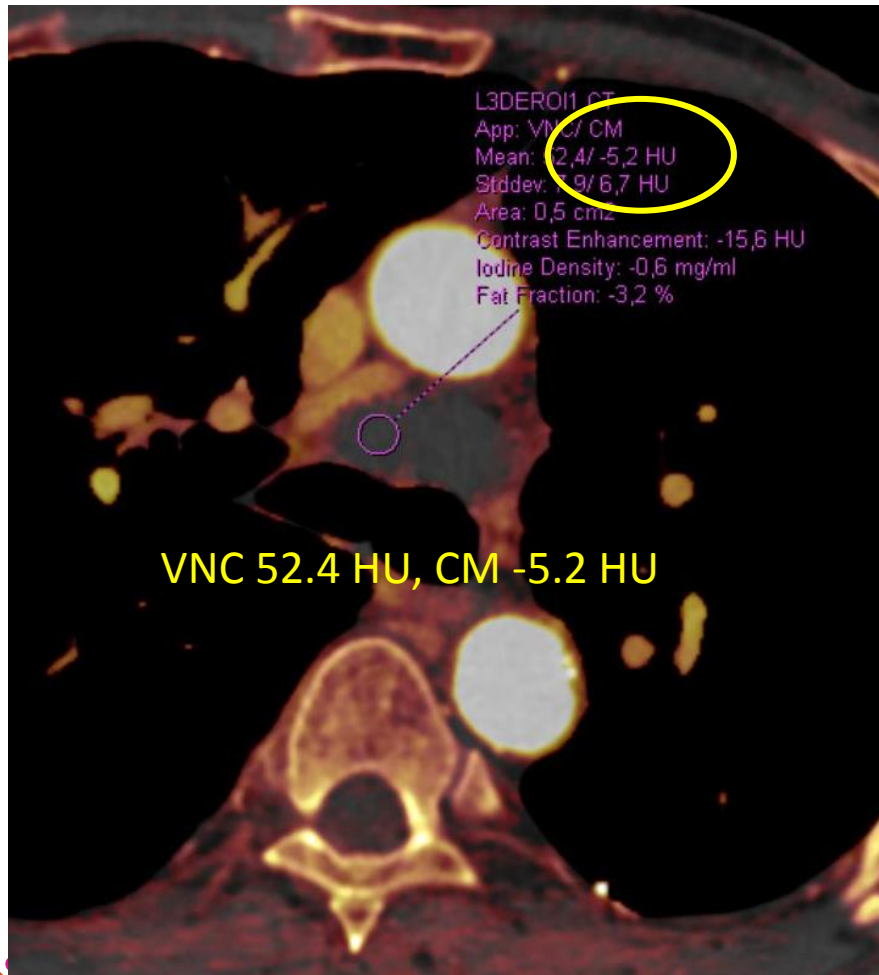## Case1 : FU Lung cancer post RT

Density ROI
Case1 : FU Lung cancer post RT

L3DEROI CT
App: VNC/ CM
Mean: 52,4/ -5,2 HU
StdDev: 7,9/ 6,7 HU
Area: 0,5 cm2
Contrast Enhancement: -15,6 HU
Iodine Density: -0,6 mg/ml
Fat Fraction: -3,2 %

VNC 52.4 HU, CM -5.2 HU

Density ROI
Case1 : FU Lung cancer post RT

VNC 52.4 HU, CM -5.2 HU

VNC 31.8 HU, CM 2.7 HU

Density ROI
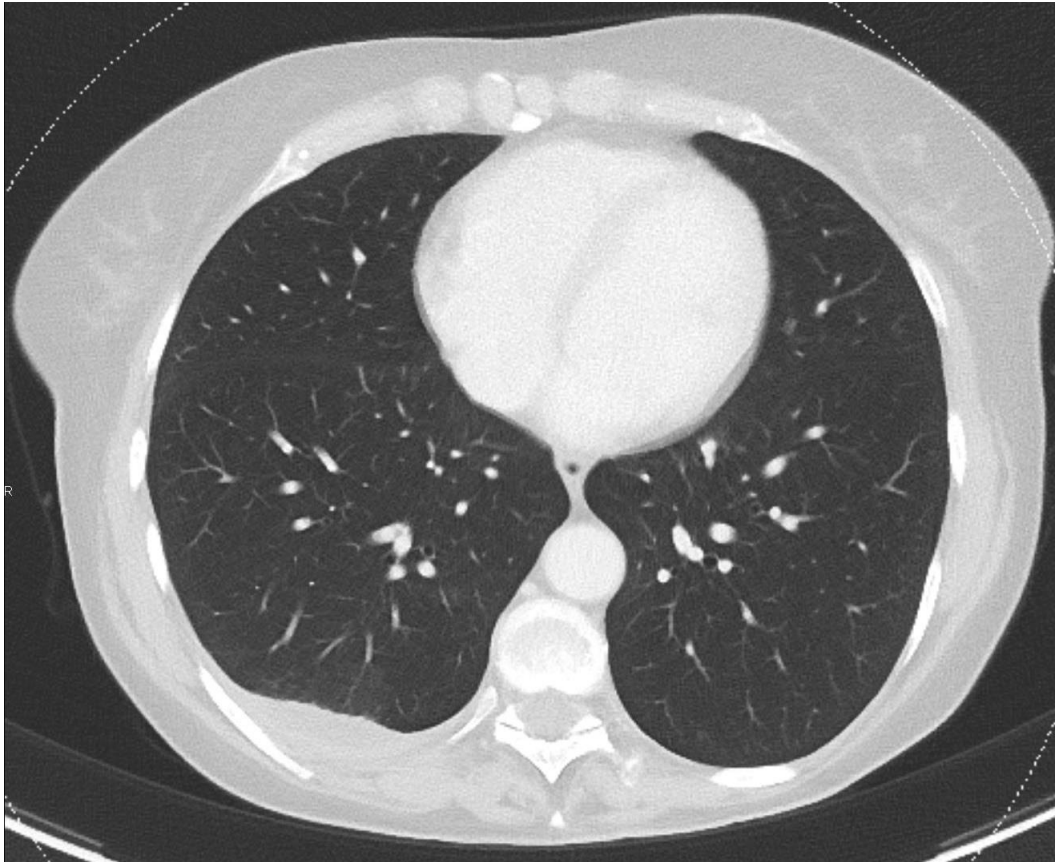# Case1 : FU Lung cancer post RT
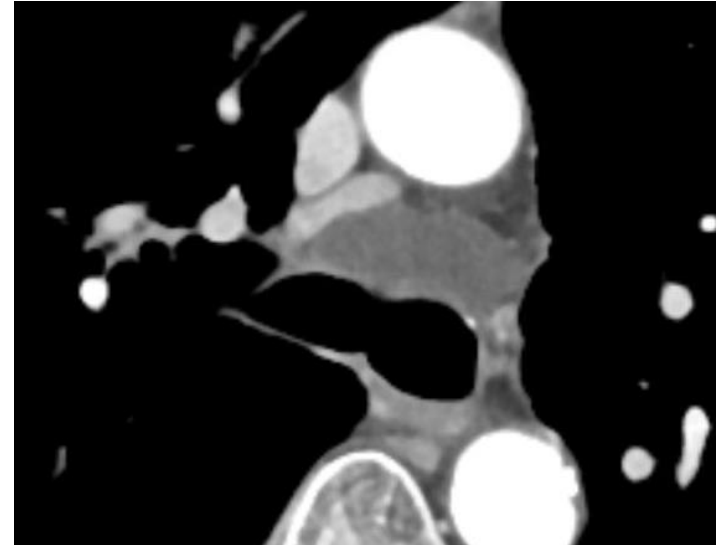
- Conclusions:
  - Post-radiation fibrosis
  - Phantom node

Density ROI
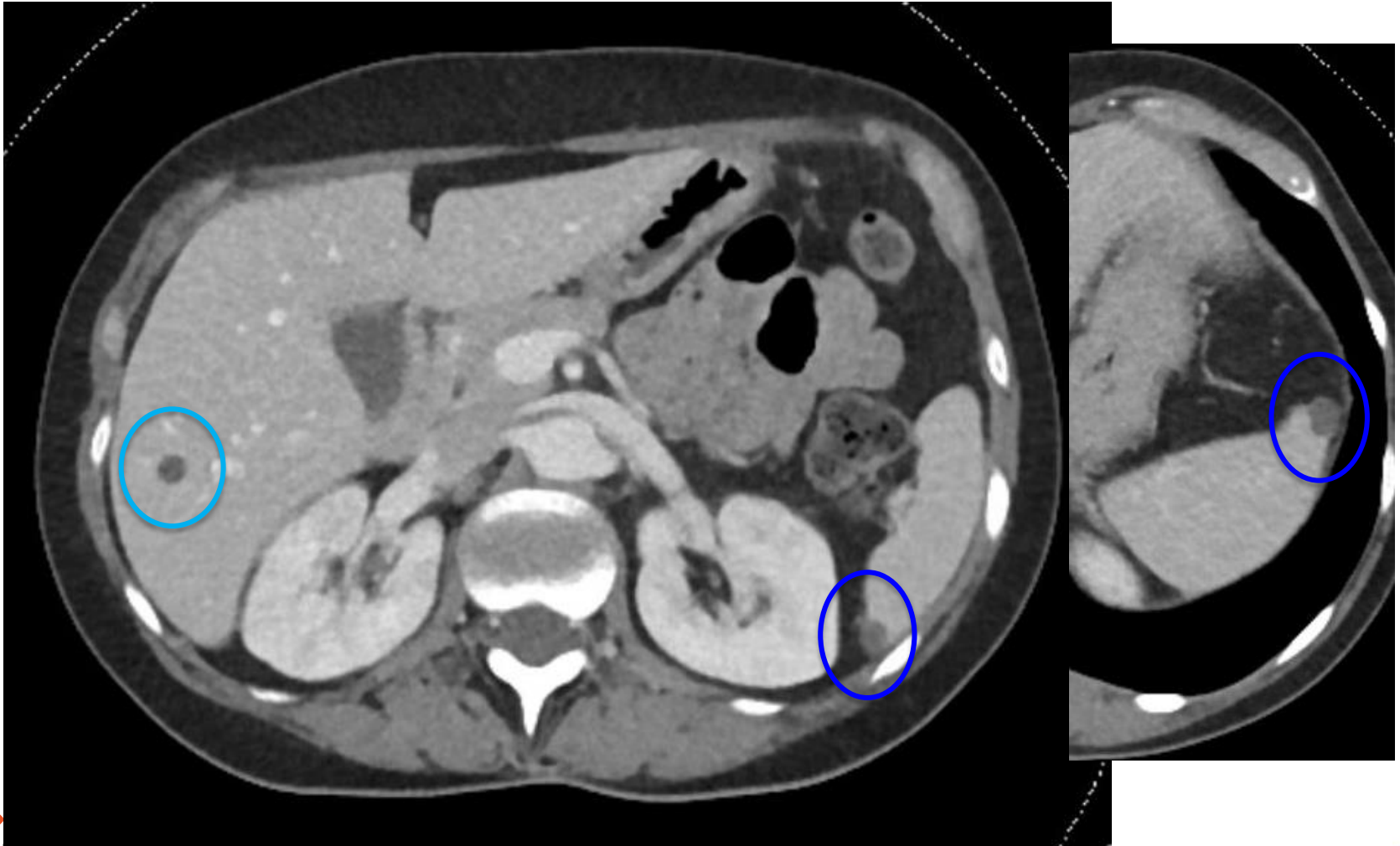## Case 2 : FU Melanoma
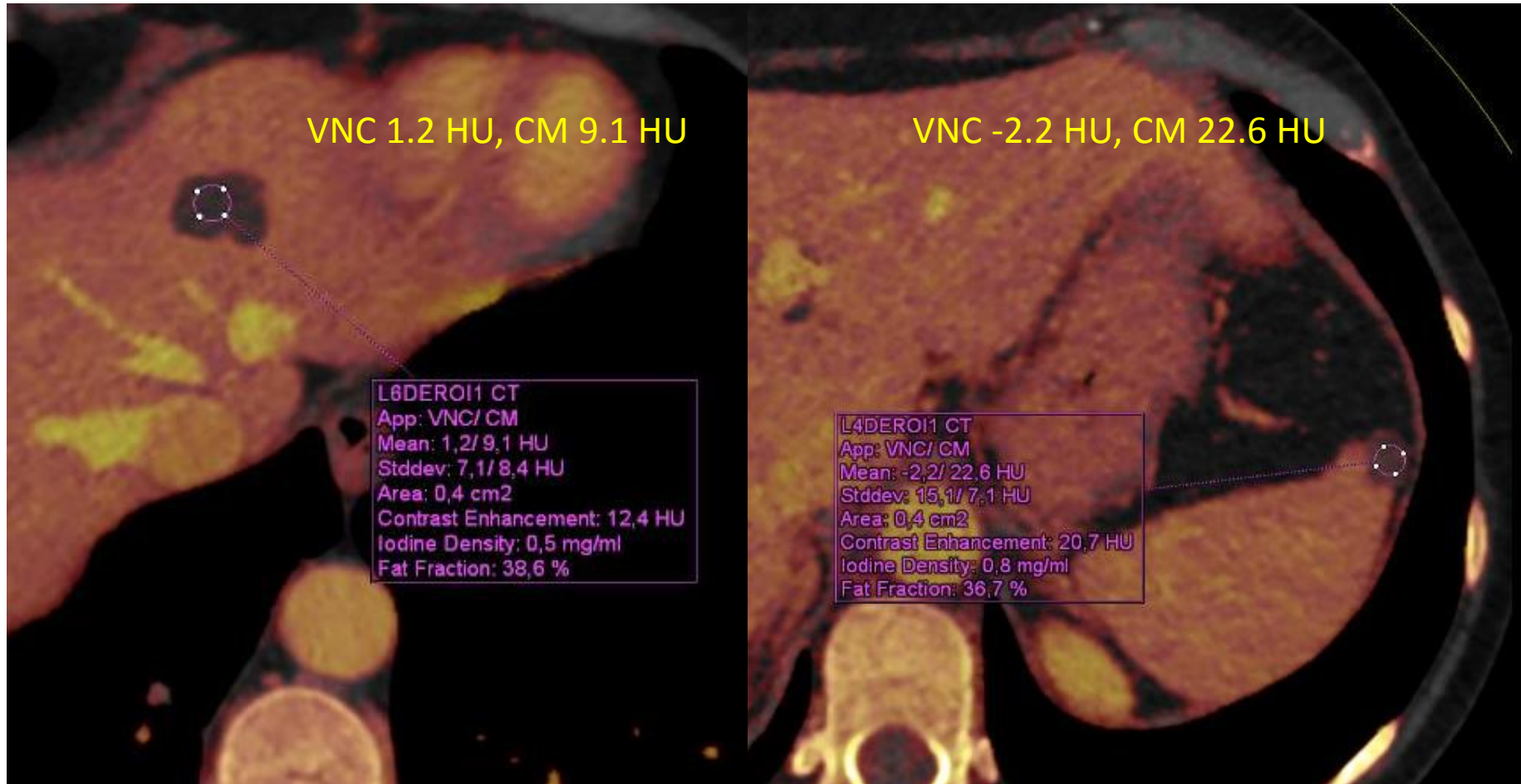

- Pleural met surgery scar
- Complete remission

Density ROI
Case 2 : FU Melanoma

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Density ROI
Case 2 : FU Melanoma

VNC 1.2 HU, CM 9.1 HU

VNC -2.2 HU, CM 22.6 HU

L6DEROI1 CT
App: VNC/ CM
Mean: 1,2/ 9,1 HU
Stddev: 7,1/ 8,4 HU
Area: 0,4 cm2
Contrast Enhancement: 12,4 HU
Iodine Density: 0,5 mg/ml
Fat Fraction: 38,6 %

L4DEROI1 CT
App: VNC/ CM
Mean: -2,2/ 22,6 HU
Stddev: 15,1/ 7,1 HU
Area: 0,4 cm2
Contrast Enhancement: 20,7 HU
Iodine Density: 0,8 mg/ml
Fat Fraction: 36,7 %

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Density ROI
Case 2 : FU Melanoma : 4 and 8m before

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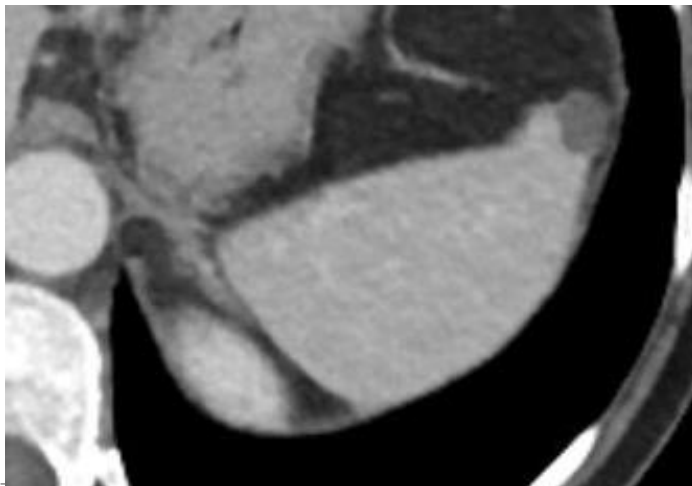iris
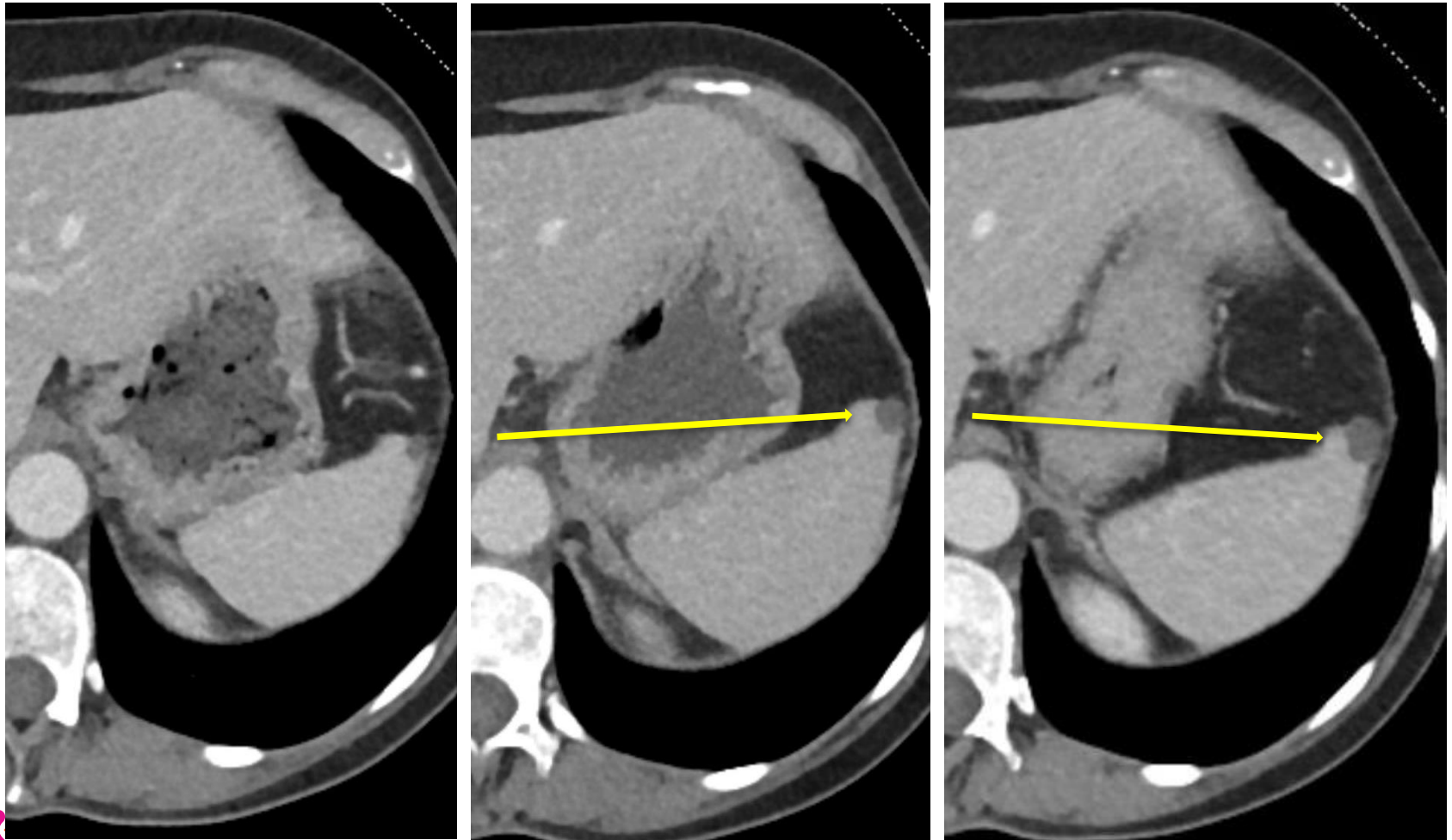
Density ROI
Case 2 : FU Melanoma

- Liver
  - Low density
  - Non-enhancing
  - → Benign cyst

- Spleen
  - Low density
  - Weakly enhancing
  - Increasing size
  - → Melanoma met
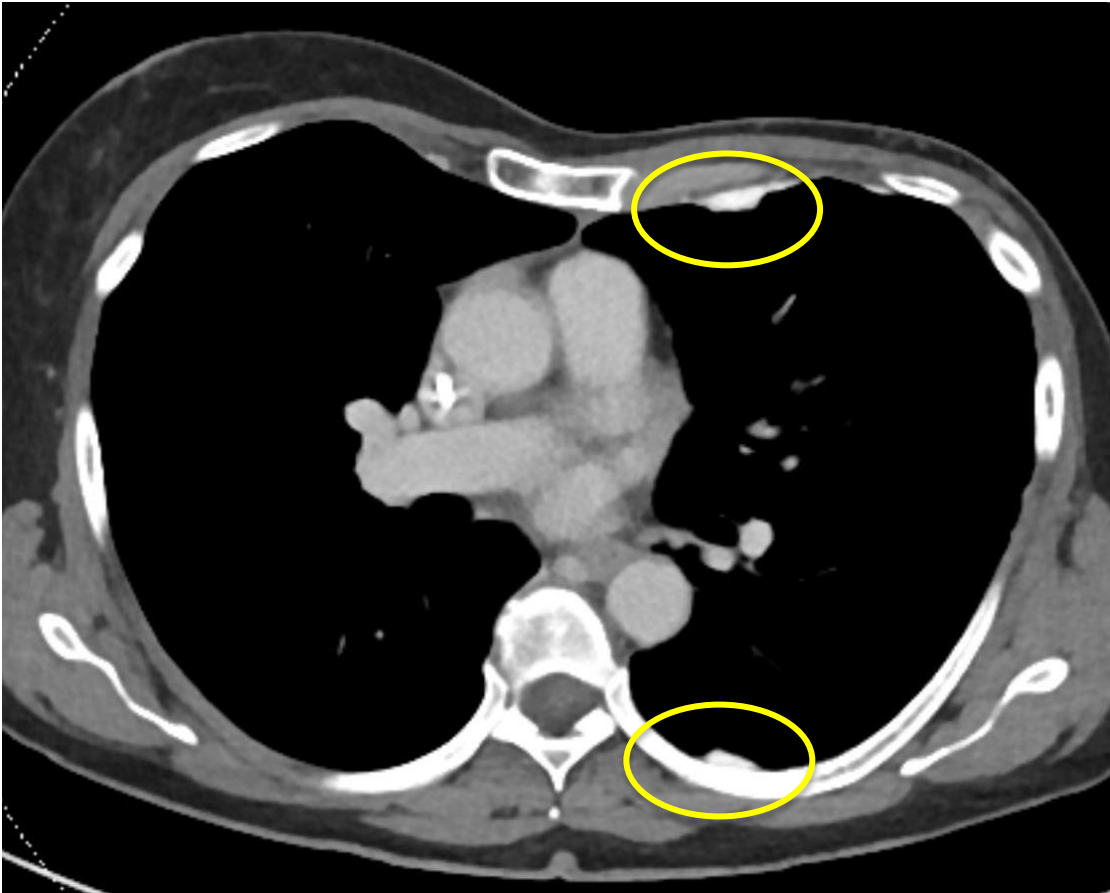
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Density ROI
Case 3 : FU breast cancer

- Bone, hepatic and pleural mets
- Herceptine - trastuzumab
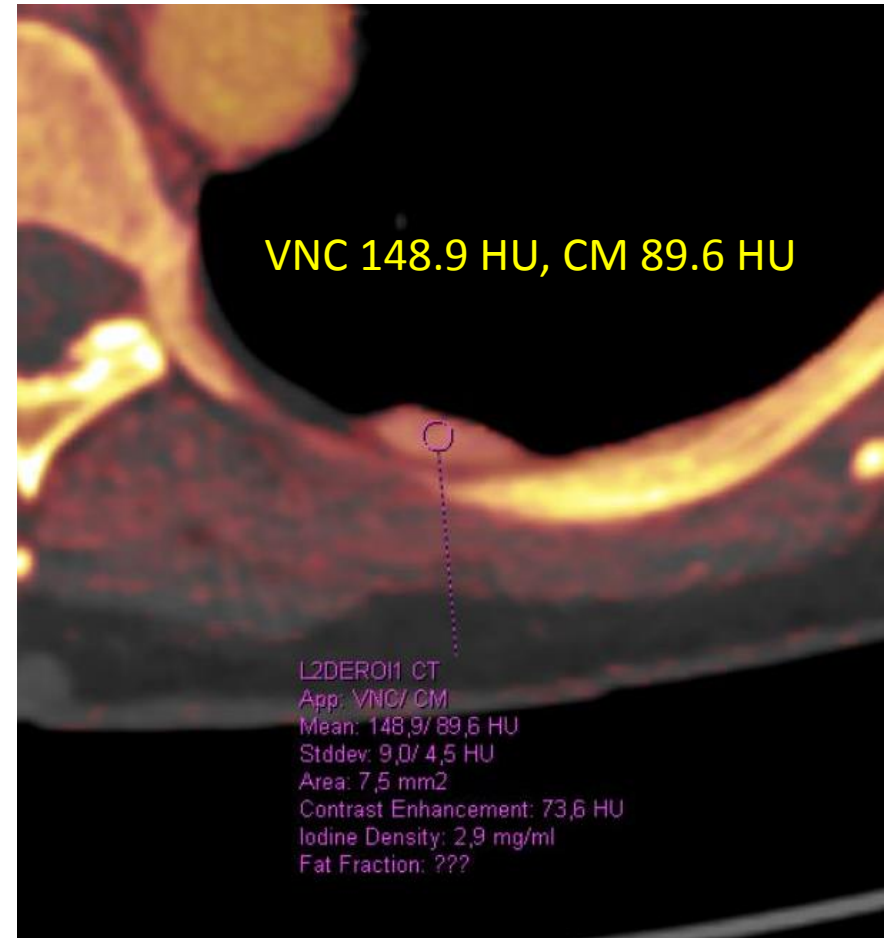- Complete remission

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Density ROI
Case 3 : FU breast cancer

- Pleural lesions
- High density on mixed image
- Diagnosis?
  - Pleural plate
  - Met scare
  - Active met

Density ROI
Case 3 : FU breast cancer

L1DEROI1 CT
App: VNC/ CM
Mean: 177,0/ 83,8 HU
Stddev: 8,1/ 6,4 HU
Area: 8,1 mm2
Contrast Enhancement: 85,0 HU
Iodine Density: 3,4 mg/ml
Fat Fraction: ???

VNC 177.0 HU, CM 83.8 HU

VNC 148.9 HU, CM 89.6 HU

L2DEROI1 CT
App: VNC/ CM
Mean: 148,9/ 89,6 HU
Stddev: 9,0/ 4,5 HU
Area: 7,5 mm2
Contrast Enhancement: 73,6 HU
Iodine Density: 2,9 mg/ml
Fat Fraction: ???

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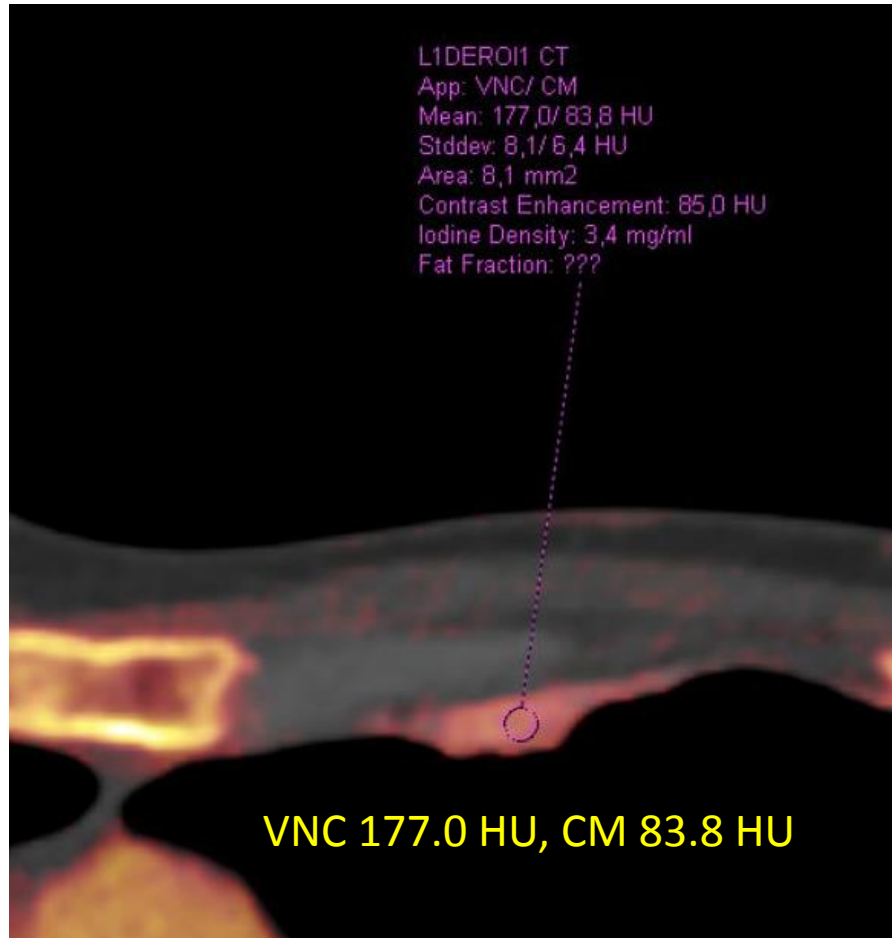
Density ROI
Case 3 : FU breast cancer

VNC 177.0 HU, CM 83.8 HU
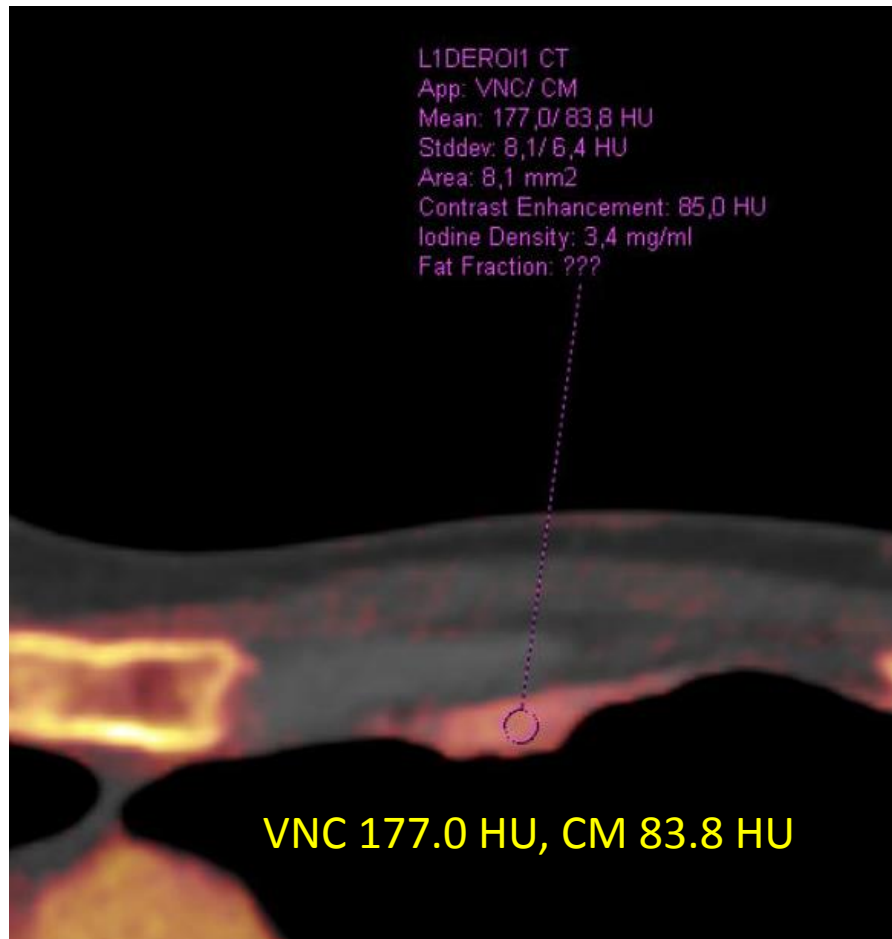
- ◆ Very high density on VNC
  - → diffusely calcified

- ◆ Substantial enhancement
  - → vascularized

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Density ROI
Case 3 : FU breast cancer 3y before

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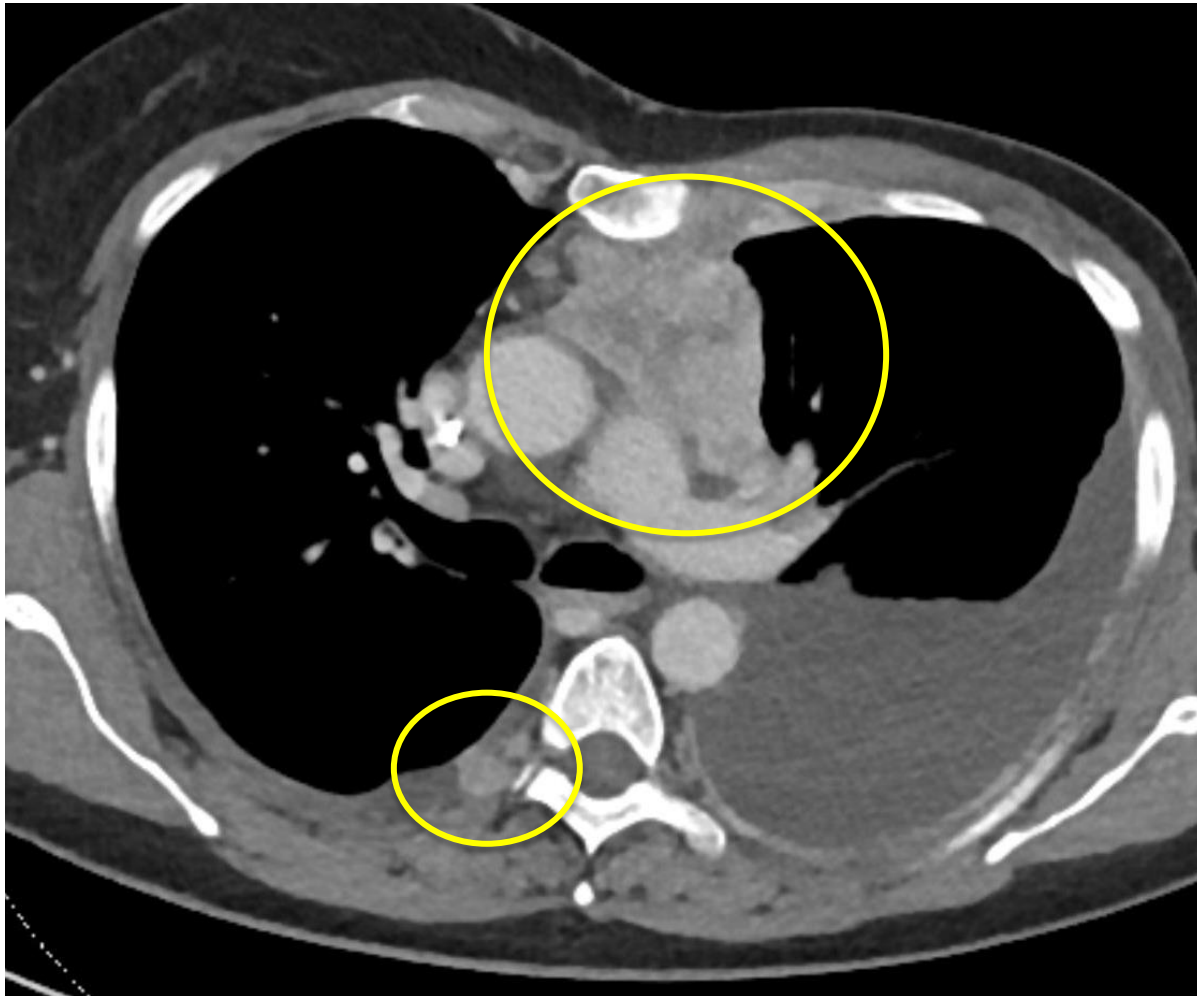
Density ROI
Case 3 : FU breast cancer
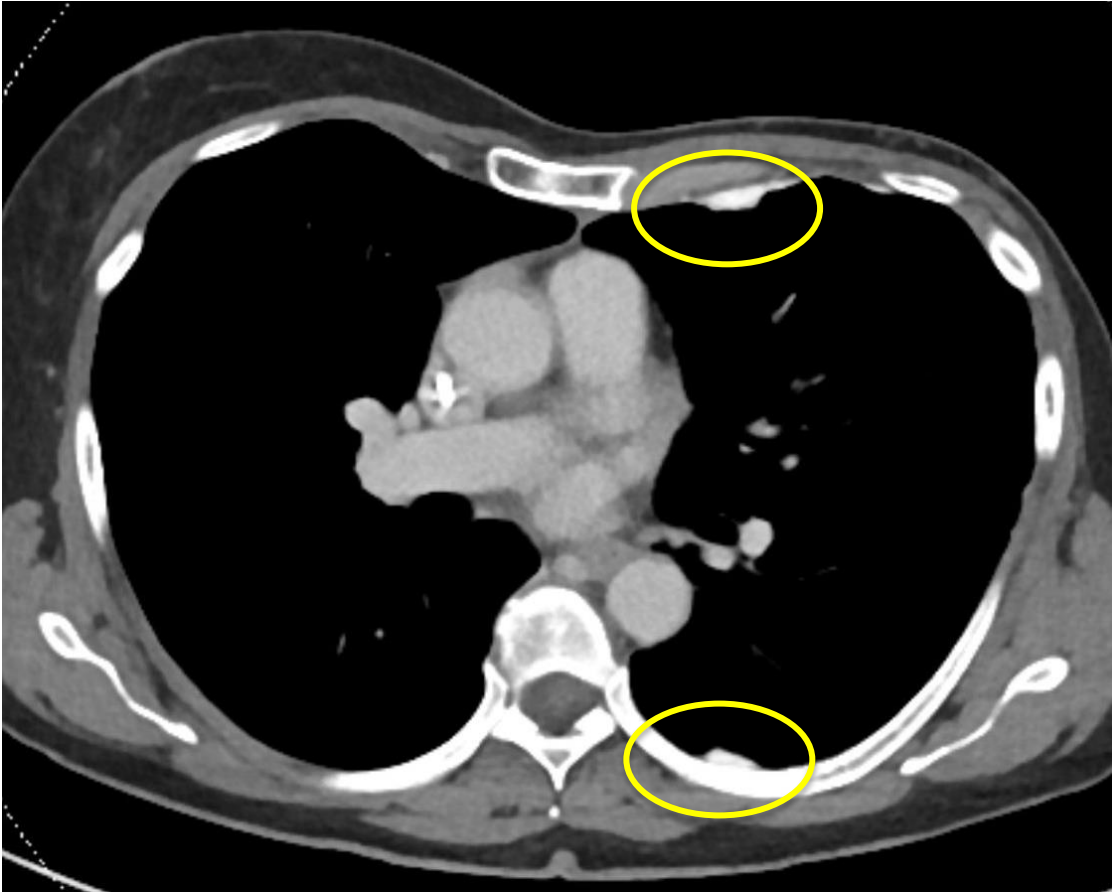
- Conclusions
  - Residual pleural metastases
  - Diffusely calcified
  - Latent / non-evolutive

Pulmonary CT Angiography

- DE acquisition - Systematic perfusion imaging

- DLP: 120 mGy.cm, Iodine CA: 16g

- Reduced procedure duration:
    - Exam <10 min
    - Acquisition <5 s
    - Reconstructions < 3 min

- Multiple informations obtained
    - Chest morphological CT scan
    - Angiography
    - Perfusion imaging
    - Volumes and perfusion quantification

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Pulmonary CT Angiography
1 Anatomical mixed images

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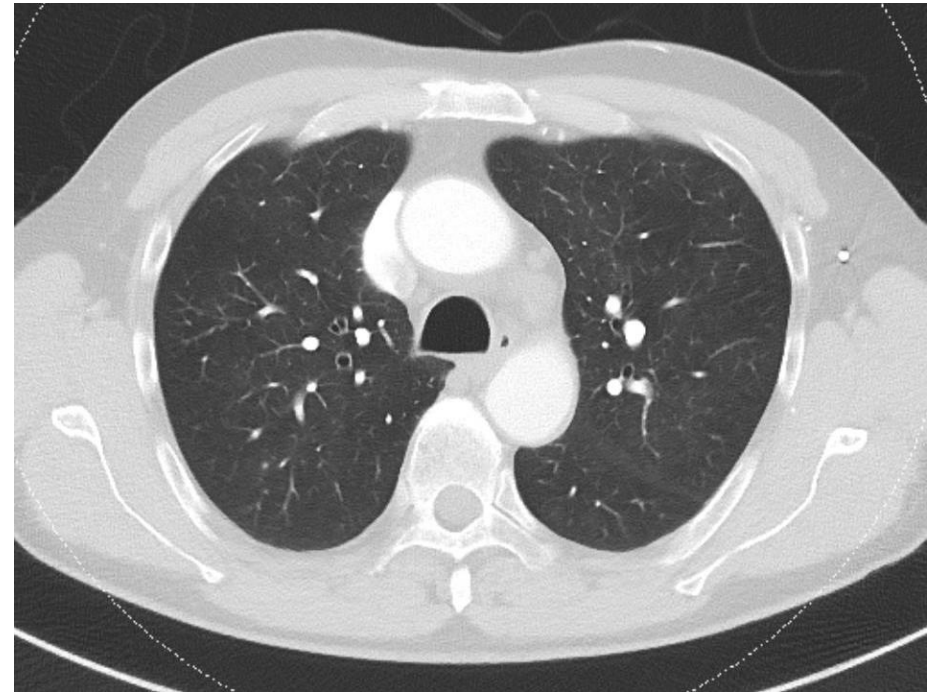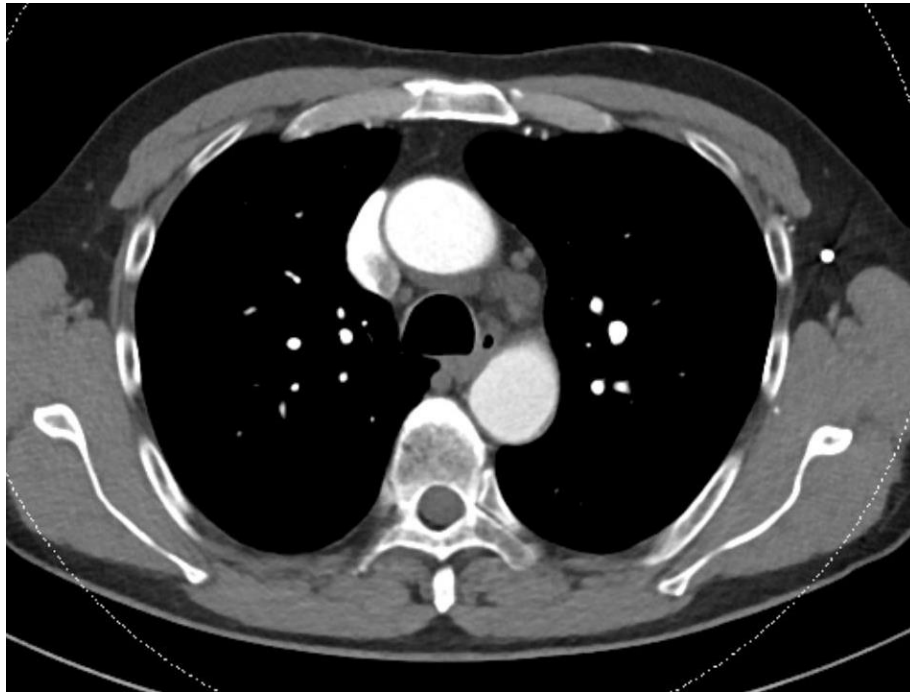
Pulmonary CT Angiography
2 Angiography (low KV tube)

Pulmonary embolism

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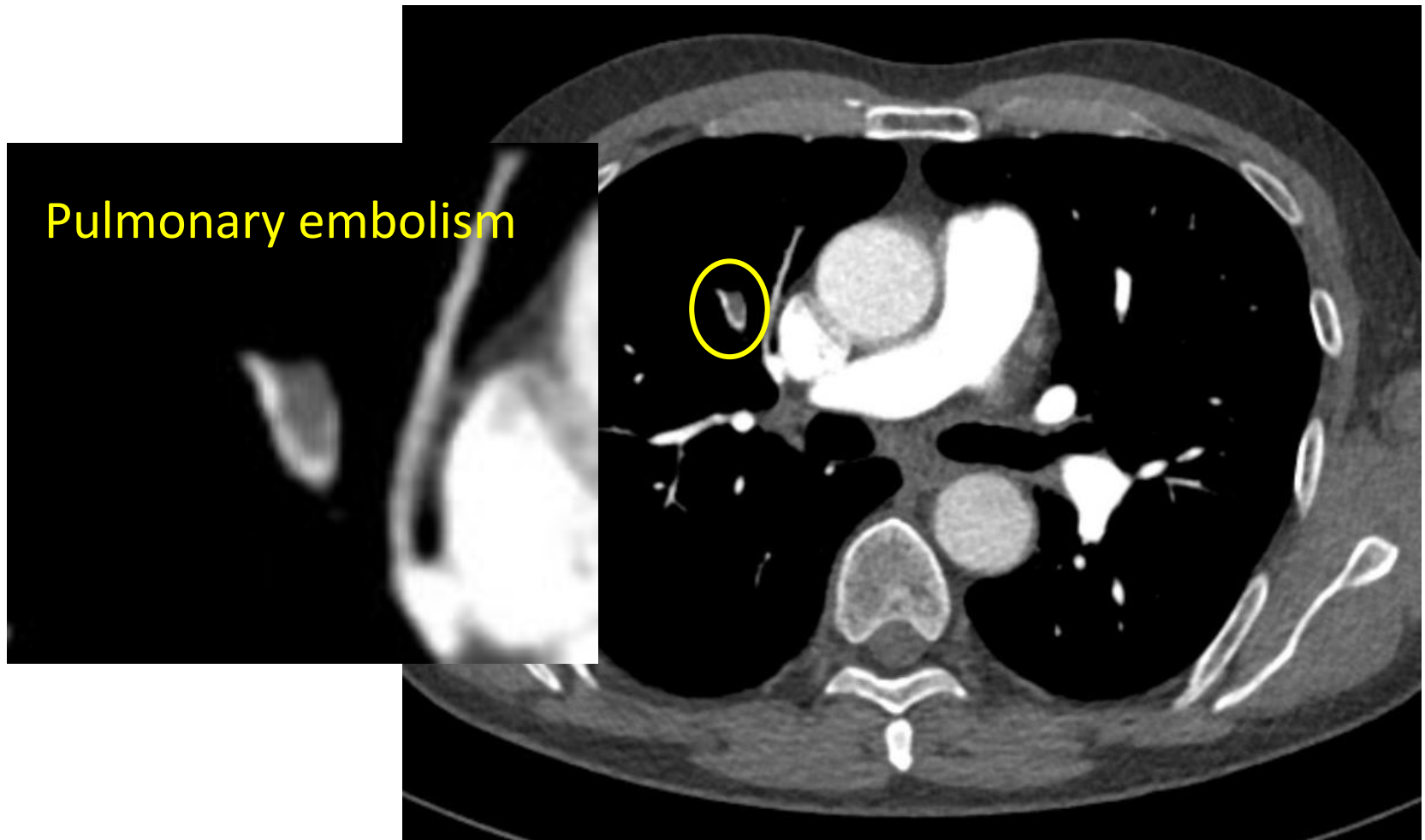
Pulmonary CT Angiography
3 2D perfusion fusion images

Perfusion defect

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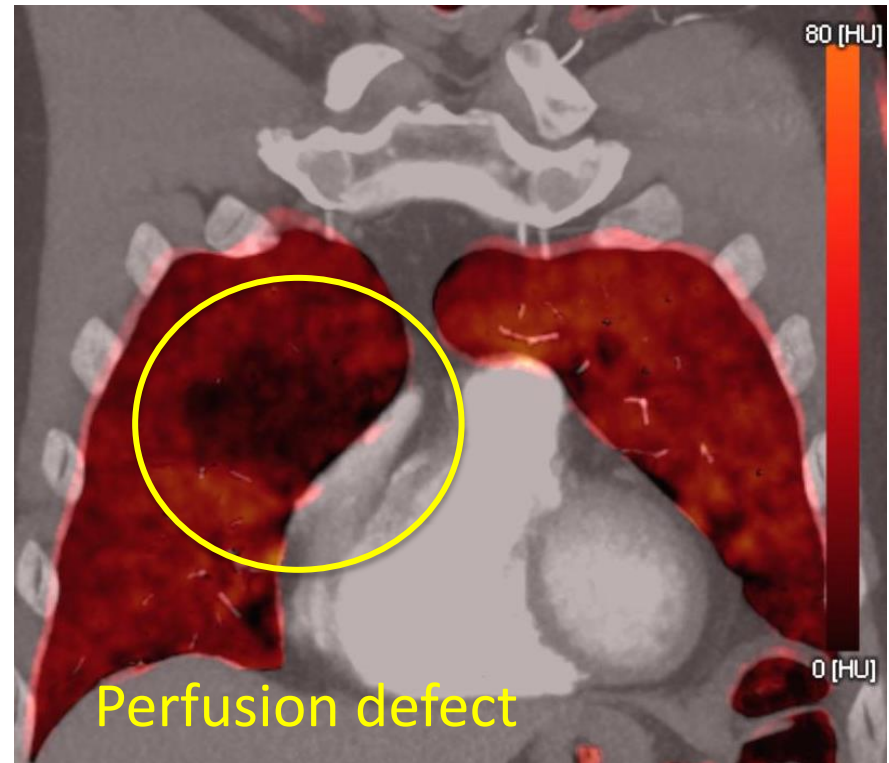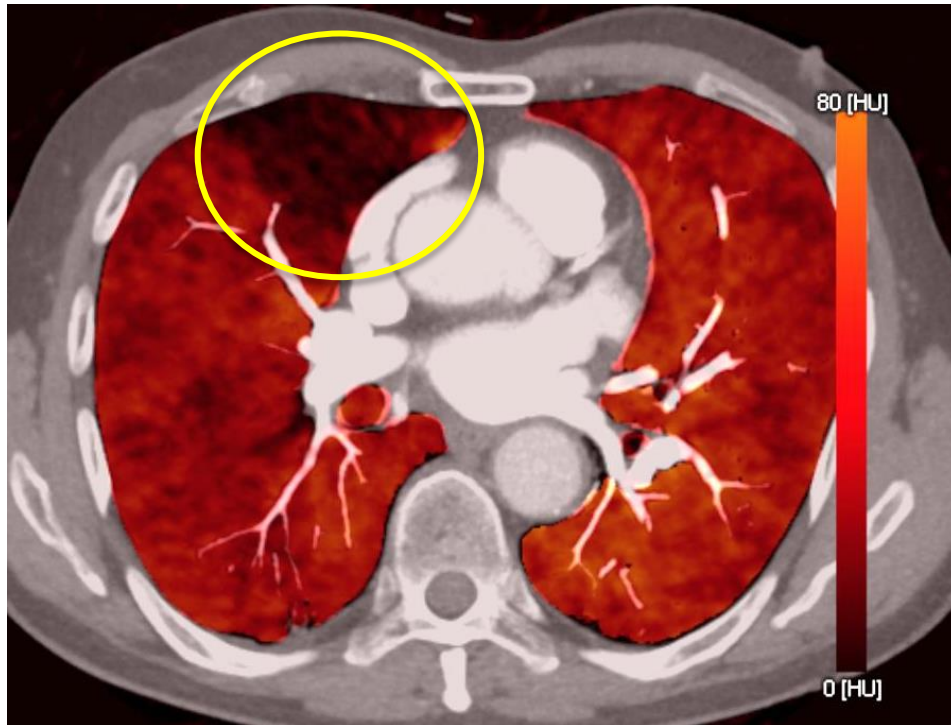
Pulmonary CT Angiography
3D perfusion images
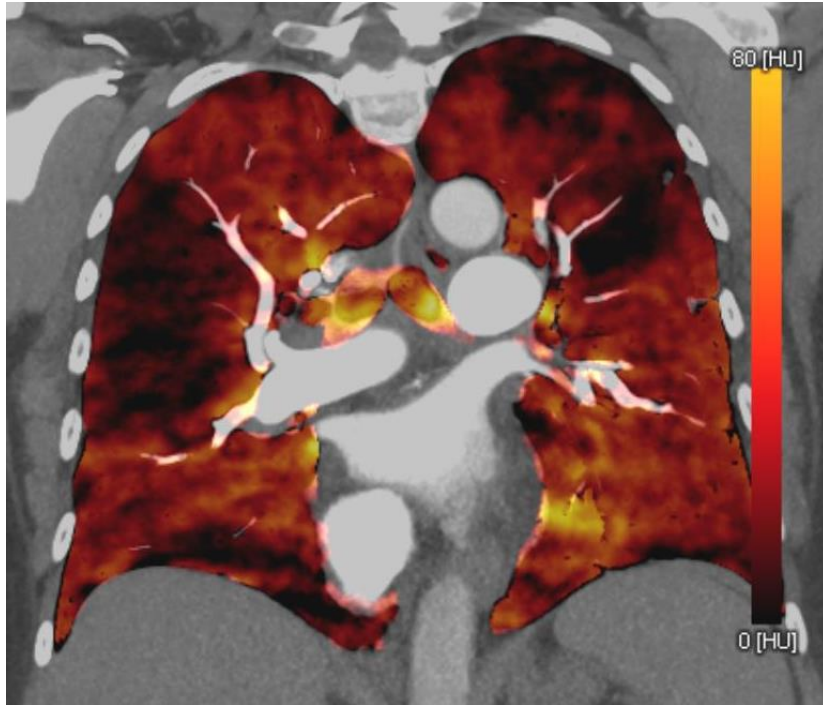
Numerous perfusion defects
< peripheral PE

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Pulmonary CT Angiography
4. lung volumes & perfusion quantification

	Volume [cm3]	Full Volume [cm3]	Below Min [% of Voxels]	Above Max [% of Voxels]	Enhancement [HU]
Total	3742	3742	0	8	45+/-18
Left and Right Lung					
Right	2088	2088	0	8	42+/-15
Left	1654	1654	0	9	49+/-21
Parts of Right Lung					
Right - Upper	702	702	0	5	40+/-12
Right - Middle	691	691	0	7	37+/-16
Right - Lower	696	696	0	12	49+/-15
Parts of Left Lung					
Left - Upper	556	556	0	5	49+/-28
Left - Middle	551	551	0	8	46+/-13
Left - Lower	547	547	0	14	53+/-17

- ◆ Automatic lung segmentation & perfusion info
- ◆ Perf corresponds to average enhancement

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Pulmonary CT Angiography

	A	B	C	D	E	F	G
1	**Quantification des volumes et de la perfusion pulmonaire**						
2							
3	Volume du poumon droit :	2088	ml	55,8%			
4	Volume du poumon gauche :	1654	ml	44,2%			
5	Volume pulmonaire total :	3742	ml	100%			
6							
7	Répartition perfusionnelle du poumon droit						
8	1/3 supérieur :	40	UH	31,7%	du poumon D	17,7%	du total
9	1/3 moyen :	37	UH	29,4%	du poumon D	16,4%	du total
10	1/3 inférieur :	49	UH	38,9%	du poumon D	21,7%	du total
11	Poumon D			100%	du poumon D	55,8%	du total
12							
13	Répartition perfusionnelle du poumon gauche						
14	1/3 supérieur :	49	UH	33,1%	du poumon G	14,6%	du total
15	1/3 moyen :	46	UH	31,1%	du poumon G	13,7%	du total
16	1/3 inférieur :	53	UH	35,8%	du poumon G	15,8%	du total
17	Poumon G			100%	du poumon G	44,2%	du total
18							
19	Poumons D+G					100%	du total

- Introduce in a table to calculate perf % of each 1/3 lung

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Hepatic Perfusion CT – Arteriography Extraction

- Use in locoregional hepatic transarterial therapies
  - **Radioembolization**
  - Chemoembolization
  - Hepatic arterial infusion
- Radioembolization proceeds in 3 steps
  - **Perfusion CT with arteriography extraction**
  - Embolization simulation
  - Treatment

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Hepatic Perfusion CT – Arteriography Extraction

- 1st step before invasive procedures

- Objectives:
  - Appreciate arterial part of tumoral perfusion
  - Predict the response to treatment
  - Obtain a CT hepatic arteriography to plan the selective arteriography

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Hepatic Perfusion CT – Arteriography Extraction Clinical Case

- CRC with exclusive hepatic bilobar mets

- Progressive after 2 chemotherapy runs

- FDG-PET + lesions

- Full liver radioembolization decision

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Hepatic Perfusion: Post Processing
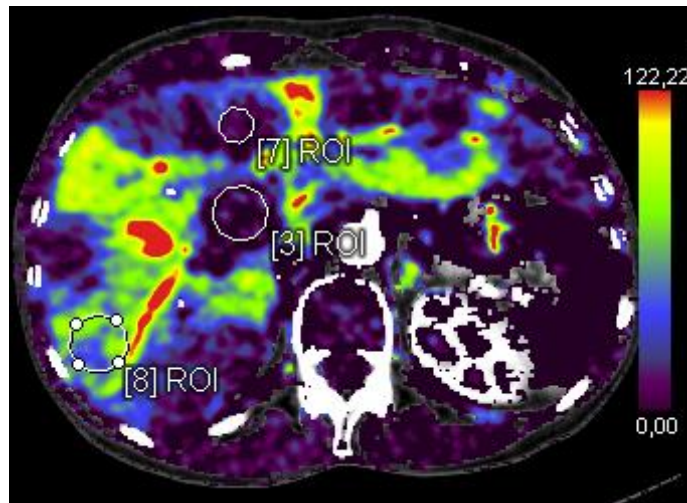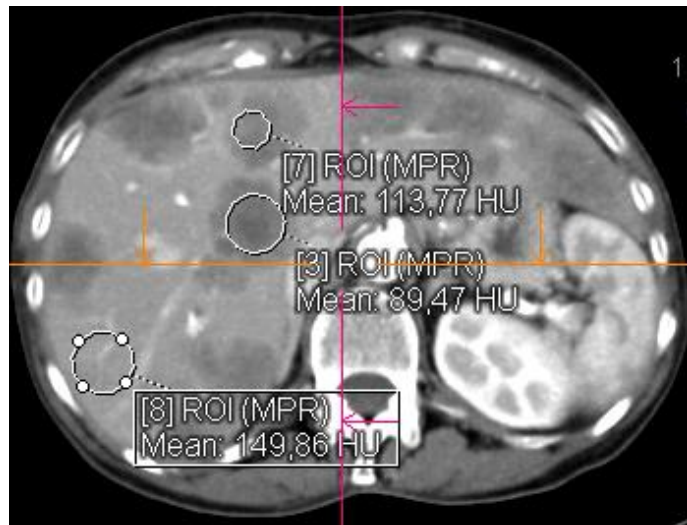
- ◆ HPI
  - ◆ Lesions 1 86%
  - ◆ Lesion 2 80%
  - ◆ Normal tissue 36%
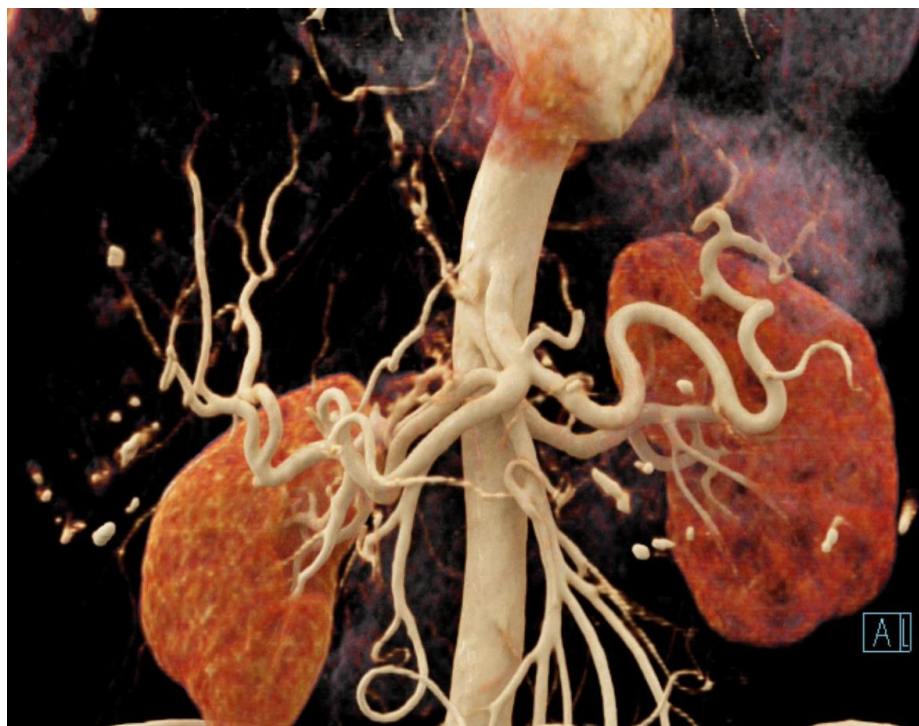
- ◆ →Vascularisation
  - ◆ Lesions 80% arterial
  - ◆ Normal T 1/3 arterial
  - ◆ Good candidate for radioembolization

Hepatic Perfusion: Post Processing Arteriography Extraction

- Best arterial time point selected

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Hepatic Perfusion: Post Processing Arteriography Reconstructions

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Conclusions

- Technical standardization prime in oncology
- Iodine and radiation doses have to be restricted for these very exposed patients
- We recommand a systematic use of dual energy acquisitions for CECT
- We recommand to execute all the body scans on the same scanner
- VNC/Iodine Map use is often helpfull

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Conclusions

- A pulmonary dual energy CT angiography offers simultaneousely
  - An anatomical chest imaging
  - An angiography
  - A perfusion lung imaging
  - Perfusion & volumes quantification

Conclusions

- Hepatic perfusion CT in locoregional transarterial therapies planning allows

    - To appreciate the arterial part of tumoral perfusion
    - To extract a high contrast arteriography

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Thank you for your attention