Team Activity Report – 2021 (Period: 01.01 - 31.12)

Deadline: February 14th, 2021

Unit	U1288
Team	Laboratory of Translational Imaging in Oncology (LITO)
Team leader	Irène Buvat
Title (Pr or Dr)	DR1 CNRS
Label (ex: Ligue, Labex, ATIP-Avenir,…)	n/a
Researcher unique identifier(s) (such as ORCID, Research ID, etc.)	ORCID: 0000-0002-7053-6471
SCIENTIFIC PRODUCTION	
List of Publications indicating *-Impact factor (IF) if known* *-DOI*	1. **Seban RD**, Richard C, Nascimento-Leite C, Ghidaglia J, **Provost C**, Gonin J, Le Tourneau C, Romano E, Deleval N, **Champion L**. Absolute lymphocyte count after COVID-19 vaccination is associated with vaccine-induced hypermetabolic lymph nodes on ^{18}F-FDG PET/CT: a focus in breast cancer care. J Nucl Med. 2021 sous presse. DOI: 10.2967/jnumed.121.263082. IF=10.057 2. Loap P, **De Marzi L**, Almeida CE, Barcellini A, Bradley J, de Santis MC, Dendale R, Jimenez R, Orlandi E, Kirova Y. Hadrontherapy techniques for breast cancer. Crit Rev Oncol Hematol. 169:103574, 2021. DOI: 10.1016/j.critrevonc.2021.103574. IF=6.312 3. Ortiz R, **De Marzi L**, Prezado Y. Proton Minibeam Radiation Therapy and Arc Therapy: Proof of Concept of a Winning Alliance. Cancers (Basel). 14(1):116, 2021. DOI: 10.3390/cancers14010116. IF=6.639 4. Cavallone M, Prezado Y, **De Marzi L**. Converging Proton Minibeams with Magnetic Fields for Optimized Radiation Therapy: A Proof of Concept. Cancers (Basel). 14(1):26, 2021. DOI: 10.3390/cancers14010026. IF=6.639 5. **Beddok A,** Cottu P, Fourquet A, Kirova Y. Combination of modern radiotherapy and new targeted treatments for breast cancer management. Cancers 13(24):6358, 2021. DOI: 10.3390/cancers13246358. IF=6.639 6. Chegraoui H, Philippe C, Dangouloff-Ros V, Grigis A, Calmon R, Boddaert N, **Frouin F,** Grill J, Frouin V. Object detection improves tumour segmentation in MR images of rare brain tumours. Cancers 13(23): 6113, 2021. DOI: https://doi.org/10.3390/cancers13236113 IF=6.639 7. Loap P, Vischioni B, Bonora M, Ingargiola R, Ronchi S, Vitolo V, Barcellini A, Goanta L, **De Marzi L**, Dendale R, Pacelli R, Locati L, Calugaru V, **Mammar H**, Cavalieri S, Kirova Y, Orlandi E. Biological Rationale and Clinical Evidence of Carbon Ion Radiation Therapy for Adenoid Cystic Carcinoma: A Narrative Review. Front Oncol. 11:789079, 2021. DOI: 10.3389/fonc.2021.789079. IF=6.244 8. El Beheiry M, Gaillard T, Girard N, Darrigues L, Osdoit M, Feron JG, Sabaila A, Laas E, Fourchotte V, Laki F, Lecuru F, Couturaud B, Binder JP, Masson JB, Reyal F, **Malhaire C**. Breast Magnetic Resonance Image Analysis for Surgeons Using Virtual Reality: A Comparative Study. JCO Clin Cancer Inform. 5:1127-1133, 2021. DOI: 10.1200/CCI.21.00048. No IF 9. Loap P, Vitolo V, Barcellini A, **De Marzi L**, Mirandola A, Fiore MR, Vischioni B, Jereczek-Fossa BA, Girard N, Kirova Y, Orlandi E. Hadrontherapy for

Thymic Epithelial Tumors: Implementation in Clinical Practice. Front Oncol. 11:738320, 2021. DOI: 10.3389/fonc.2021.738320. IF=6.244

10. Maia Leite A, **Ronga MG**, Giorgi M, Ristic Y, Perrot Y, Trompier F, Prezado Y, Créhange G, **De Marzi L**. Secondary neutron dose contribution from pencil beam scanning, scattered and spatially fractionated proton therapy. Phys Med Biol, in press, 2021. DOI: https://doi.org/10.1088/1361-6560/ac3209 IF=3.609
11. Hahn C, Ödén J, Dasu A, Vestergaard A, Fuglsang Jensen M, Sokol O, Pardi C, Bourhaleb F, Leite A, **de Marzi L**, Smith E, Aitkenhead A, Rose C, Merchant M, Kirkby K, Grzanka L, Pawelke J, Lühr A. Towards harmonizing clinical linear energy transfer (LET) reporting in proton radiotherapy: a European multi-centric study. Acta oncologica, 1–9, 2021. DOI: https://doi.org/10.1080/0284186X.2021.1992007 IF=4.089
12. **Créhange G**, Goudjil F, Krhili SL, Minsat M, **de Marzi L**, Dendale R. The role of proton therapy in esophageal cancer. Cancer radiotherapie, S1278-3218(21)00248-1, 2021. DOI: https://doi.org/10.1016/j.canrad.2021.08.015 IF=1.018
13. **Ronga MG**, Cavallone M, Patriarca A, Leite AM, Loap P, Favaudon V, **Créhange G**, **De Marzi L**. Back to the Future: Very High-Energy Electrons (VHEEs) and Their Potential Application in Radiation Therapy. Cancers. 13:4942, 2021. DOI: https://doi.org/10.3390/cancers13194942 IF=6.639
14. Bertho A, Ortiz R, Juchaux M, Gilbert C, Lamirault C, **Pouzoulet F,** Polledo L, Liens A, Warfving N, Sebrie C, Jourdain L, Patriarca A, **de Marzi L**, Prezado Y. First Evaluation of Temporal and Spatial Fractionation in Proton Minibeam Radiation Therapy of Glioma-Bearing Rats. Cancers. 13(19):4865, 2021. DOI: https://doi.org/10.3390/cancers13194865 IF=6.639
15. Loap P, Vitolo V, Barcellini A, **De Marzi L**, Mirandola A, Fiore MR, Vischioni B, Jereczek-Fossa BA, Girard N, Kirova YM, Orlandi E. Hadrontherapy for thymic epithelial tumors: implementation in clinical practice. Front. Oncol. 11:738320, 2021. DOI: https://doi.org/10.3389/fonc.2021.738320 IF=6.244
16. Bradshaw TJ, Boellaard R, Dutta J, Jha AK, Jacobs P, Li Q, Liu C, Sitek A, Saboury B, Scott PJH, Slomka PJ, Sunderland JJ, Wahl RL, Yousefirizi F, Zuehlsdorff S, Rahmim A, **Buvat I**. Nuclear Medicine and Artificial Intelligence: Best Practices for Algorithm Development. J Nucl Med. in press, 2021. IF=10.057
17. Wimberley C, **Buvat I**, Boutin H. Imaging translocator protein expression with Positron Emission Tomography. Eur J Nucl Med Mol Imaging. 49:74-75, 2021. DOI: 10.1007/s00259-021-05601-y IF=9.236
18. Kolinger GD, García DV, Kramer GM, Frings V, Zwezerijnen GJC, Smit EF, De Langen AJ, **Buvat I**, Boellaard R. Effects of tracer uptake time in non-small cell lung cancer ^{18}F-FDG PET radiomics. J Nucl Med. in press, 2021. DOI: 10.2967/jnumed.121.262660 IF=10.057
19. Sabra D, Intzandt B, Desjardins-Crépeau L, Langeard A, Steele CJ, **Frouin F**, Hoge RD, Bherer L, Gauthier C. Sex moderates the relationship between aortic stiffness, cognition, and cerebrovascular reactivity in healthy older adults. PLoS One. 16(9):e0257815, 2021. DOI: 10.1371/journal.pone.0257815 IF=3.240
20. Peters N, Wohlfahrt P, Dahlgren CV, **de Marzi L**, Ellerbrock M, Fracchiolla F, Freeh J, Gomà C, Góra J, Jensen MF, Kajdrowicz T, Mackay R, Molinelli S, Rinaldi I, Rompokos V, Siewert D, van der Tol P, Vermeren X, Nyström H, Lomax A, Richter C. Experimental assessment of inter-centre variation in stopping-power and range prediction in particle therapy. Radiother Oncol. 163:7-13, 2021. DOI: https://doi.org/10.1016/j.radonc.2021.07.019 IF=6.280

21. Loap P, Mirandola A, **De Marzi L**, Dendale R, Iannalfi A, Vitolo V, Barcellini A, Filippi AR, Jereczek-Fossa BA, Kirova Y, Orlandi E. Current Situation of Proton Therapy for Hodgkin Lymphoma: from Expectations to Evidence. Cancers 13: 3746, 2021. DOI: https://doi.org/10.3390/cancers13153746 IF=6.639
22. Loap P, **De Marzi L**, Mirandola A, Dendale R, Iannalfi A, Vitolo V, Barcellini A, Filippi AR, Jereczek-Fossa BA, Kirova Y, Orlandi E. Development and Implementation of Proton Therapy for Hodgkin Lymphoma: Challenges and Perspectives. Cancers, 13:3744, 2021. DOI: https://doi.org/10.3390/cancers13153744 IF=6.639
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25. Soussain C, **Malaise D**, Cassoux N. Primary vitreoretinal lymphoma: A diagnostic and management challenge. Blood. 2021 May 25:blood.2020008235. DOI: 10.1182/blood.2020008235. IF=22.113
26. **Orlhac F,** Eertink JJ, **Cottereau AS,** Zijlstra JM, Thieblemont C, Meignan M, Boellaard R, **Buvat I.** A guide to ComBat harmonization of imaging biomarkers in multi center studies. J Nucl Med. in press, 2021. DOI: https://doi.org/10.2967/jnumed.121.262464 IF=10.057
27. **Jehan-Besson S**, Clouard R, Boddaert N, Grill J, **Frouin F.** Optimization of a Shape Metric Based on Information Theory Applied to Segmentation Fusion and Evaluation in Multimodal MRI for DIPG Tumor Analysis. Proceedings of 5th International Conference GSI 2021: 772-780. No IF
28. **Cottereau AS**, Meignan M, **Nioche C**, Clerc J, Chartier L, Vercellino L, Casasnovas O, Thieblemont C, **Buvat I**. New approaches in characterisation of lesions dissemination in DLBCL patients on baseline PET/CT. Cancers. 13:3998, 2021. DOI: https://doi.org/10.3390/cancers13163998 IF=6.639
29. **Seban RD**, Donnadieu A, Journo G, Bidard FC, Richard C, Rouzier R, **Champion L.** ^{18}F-FDG PET/CT in Relapsed Endometrial Cancer Treated with Preoperative PD-1 Inhibitor Dostarlimab**.** Diagnostics. 11:1353, 2021. DOI: https://doi.org/10.3390/diagnostics11081353 IF=3.706
30. **Seban RD**, Synn S, Muneer I, **Champion L**, Schwartz LH, Dercle L. Don't overlook spleen glucose metabolism on [18F]-FDG PET/CT for cancer drug discovery and development. Curr Cancer Drug Targets. 21:944-952, 2021. DOI: 10.2174/1568009621666210720143826. IF=3.428
31. **Seban RD**, Assié JB, Giroux-Leprieur E, Massiani MA, Bonardel G, Chouaid C, Deleval N, Richard C, Mezquita L, Girard N, **Champion L**. Prognostic value of inflammatory response biomarkers using peripheral blood and [18F]-FDG PET/CT in advanced NSCLC patients treated with first-line chemo- or immunotherapy. Lung Cancer. 159: 45-55, 2021. DOI: https://doi.org/10.1016/j.lungcan.2021.06.024 IF=5.705
32. **Wallis D, Soussan M**, Lacroix M, Akl P, Duboucher C, **Buvat I**. An FDG-PET/CT deep learning method for fully automated detection of pathological mediastinal lymph nodes in lung cancer patients. Eur J Nucl Med Mol

Imaging. in press, 2021. DOI: https://doi.org/10.1007/s00259-021-05513-x IF=9.236

33. **Orlhac F, Nioche C**, Klyuzhin I, Rahmim A, **Buvat I**. Radiomics in PET imaging - A practical guide for newcomers. PET Clin. 16(4):597-612, 2021. DOI: 10.1016/j.cpet.2021.06.007 No IF
34. **Seban RD**, **Champion L**, Yeh R, Schwartz LH, Dercle L. Assessing immune response upon systemic RNA vaccination on [18F]-FDG PET/CT for COVID-19 vaccine and then for immune-oncology? (letter to the Editor). Eur J Nucl Med Mol Imaging. 48:3351-3352, 2021. DOI: 10.1007/s00259-021-05468-z IF=9.236
35. Dumas JL, Dal R, Zefkili S, Robilliard M, Losa S, Birba I, Vu-Bezin J, Beddok A, Calugaru V, Dutertre G, **De Marzi L**. Addressing the dosimetric impact of bone cement and vertebroplasty in stereotactic body radiation therapy. Phys Med. 202185:42-49. DOI: 10.1016/j.ejmp.2021.04.023. IF=2.685
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37. **Orlhac F, Buvat I.** Comment on Ibrahim, A. et al. The Effects of In-Plane Spatial Resolution on CT-Based Radiomic Features' Stability with and without ComBat Harmonization. Cancers. 13(12): 3037, 2021. DOI: https://doi.org/10.3390/cancers13123037 IF=6.639
38. **Seban RD**, Vermersch C, **Champion L**, Bonsang B, Roger A, Ghidaglia J. Immune-Related Erythema Nodosum Mimicking in Transit Melanoma Metastasis on [18F]-FDG PET/CT. Diagnostics. 11: 747, 2021. DOI: https://doi.org/10.3390/diagnostics11050747 IF=3.706
39. Aide N, Lasnon C, Kesner A, Levin C, **Buvat I**, Iagaru A, Hermann K, Badawi RD, Cherry SR, Bradley KM, McGowan DR. New PET technologies: embracing progress and pushing the limits. Eur J Nucl Med Mol Imaging. 48: 2711–2726, 2021. DOI: https://doi.org/10.1007/s00259-021-05390-4 IF=9.236
40. Beyer T, Bailey DL, Birk UJ, **Buvat I**, Catana C, Cheng Z, Fang Q, Giove F, Kuntner C, Laistler E, Moscato F, Nekolla SG, Rausch I, Ronen I, van Elmpt W, Saarakkala S, Thielemans K, Moser E. Medical Physics and Imaging – A timely perspective. Frontiers in Physics. 9:634693, 2021. DOI: https://doi.org/10.3389/fphy.2021.634693 IF=3.560
41. **Seban RD, Champion L,** Deleval N, Richard C, **Provost C.** Immune Response Visualized In Vivo by [18F]-FDG PET/CT after COVID-19 Vaccine. Diagnostics. 11: 676, 2021. DOI: https://doi.org/10.3390/diagnostics11040676 IF=3.706
42. **Seban RD**, Rouzier R, Latouche A, Deleval N, Guinebretiere JM, **Buvat I**, Bidard FC, **Champion L.** Total metabolic tumor volume and spleen metabolism on baseline [18F]-FDG PET/CT as independent prognostic biomarkers of recurrence in resected breast cancer. Eur J Nucl Med Mol Imaging. 48: 3560-3570, 2021. DOI: https://doi.org/10.1007/s00259-021-05322-2 IF=9.236
43. Schneider T, **De Marzi L**, Patriarca A and Prezado Y. Monte Carlo Comparison of Proton and Helium-ion Minibeam Generation Techniques. Front. Phys. 9:595721, 2021. DOI: https://doi.org/10.3389/fphy.2021.595721 IF=3.560
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clinical proton beam using a scCVD diamond membrane microdosimeter. Sensors (Basel). 21:1314, 2021. DOI: https://www.mdpi.com/1424-8220/21/4/1314 IF=3.576

45. Leduc A, Chaouni S, **Pouzoulet F**, **De Marzi L**, Megnin-Chanet F, E Corre, Stefan D, Habrand JL, Sichel F, Laurent C. Differential normal skin transcriptomic response in total body irradiated mice exposed to scattered versus scanned proton beams. Sci Rep 11, 5876, 2021. DOI: https://doi.org/10.1038/s41598-021-85394-0 IF=4.379
46. **Buvat I**, **Orlhac F**. The T.R.U.E. checklist for identifying impactful AI-based findings in nuclear medicine: is it True? Is it Reproducible? Is it Useful? Is it Explainable? J Nucl Med. 62: 752-754, 2021. DOI: https://doi.org/10.2967/jnumed.120.261586 IF=10.057
47. Prezado Y, Hirayama R, Matsufuji N, Inaniwa T, Martínez-Rovira I, Seksek O, Bertho A, Koike S, Labiod D, **Pouzoulet F**, Polledo L, Warfving N, Liens A, Bergs J, Shimokawa T. A potential renewed use of very heavy ions for therapy: Neon minibeam radiation therapy. Cancers. 13:1356, 2021. DOI: 10.3390/cancers13061356 IF=6.639
48. Weber M, Kersting D, Umutlu L, Schäfers M, Rischpler C, Fendler WP, **Buvat I**, Herrmann K, Seifert R. Just another 'Clever Hans'? Neural Networks and FDG PET-CT to predict the Outcome of Patients with Breast Cancer. Eur J Nucl Med Mol Imaging. 48: 3141-3150, 2021. DOI: 10.1007/s00259-021-05270-x IF=9.236
49. **Seban RD**, **Champion L**, Schwartz LH, Dercle L. Spleen glucose metabolism on [F-18]-FDG PET/CT: a dynamic double-edged biomarker predicting outcome in cancer patients (letter to the Editor). Eur J Nucl Med Mol Imaging. 48: 2309-2311, 2021. DOI: 10.1007/s00259-020-05126-w IF=9.236
50. **Saint Martin MJ**, **Orlhac F**, **Akl P, Khalid F**, **Nioche C**, **Buvat I**, **Malhaire C**, **Frouin F**. A radiomics pipeline dedicated to Breast MRI: validation on a multi-scanner phantom study. MAGMA. 34: 355-366, 2021. DOI: 10.1007/s10334-020-00892-y IF=2.310
51. **Cottereau AS**, Meignan M, **Nioche C**, Capobianco N, Clerc J, Chartier L, Vercellino L, Casasnovas O, Thieblemont C, **Buvat I**. Risk stratification in diffuse large B cell lymphoma using lesion dissemination and metabolic tumor burden calculated from baseline PET/CT. Ann Oncol. 32: 404-411, 2021. DOI: 10.1016/j.annonc.2020.11.019 IF=32.976
52. Perret P, Slimani L, Barone-Rochette G, Vollaire J, Briat A, Ahmadi M, Henri M, Desruet MD, Clerc R, Broisat A, Riou L, Boucher F, **Frouin F,** Djaileb L, Calizzano A, Vanzetto G, Fagret D, Ghezzi, C. Preclinical and clinical evaluation of a new method to assess cardiac insulin resistance using nuclear imaging. J Nucl Cardiol. 2021 DOI: 10.1007/s12350-020-02520-7 IF=5.952
53. Sundar LKS , Muzik O, **Buvat I**, Bidaut L, Beyer T. Potentials and caveats of artificial intelligence in hybrid imaging. Methods. 188: 4-19, 2021. DOI: 10.1016/j.ymeth.2020.10.004 IF=3.608
54. **Orlhac F**, Lecler A, Savatovski J, **Goya-Outi J**, **Nioche C**, Charbonneau F, Ayache N, **Frouin F**, Duron L, **Buvat I**. How can we combat multicenter variability in MR radiomics? Validation of a correction procedure. Eur Rad. 31: 2272-2280, 2021. DOI: 10.1007/s00330-020-07284-9 IF=5.315
55. Capobianco N, Meignan M, **Cottereau AS**, Vercellino L, Sibille L, Spottiswoode B, Zuehlsdorff S, Casasnovas O, Thieblemont C, **Buvat I**. Deep learning FDG uptake classification enables total metabolic tumor volume estimation in diffuse large B-cell lymphoma. J Nucl Med. 62: 30-36, 2021. DOI: 10.2967/jnumed.120.242412 IF=10.057

H factor for team leader and average citation index, indicating source (Webscience, etc.)	Irène Buvat H-index Web of Science Core Collection = 42 Average citation index (articles only, abstracts excluded) Web of science = 52.88 H-index google scholar = 48 Total number of citations google scholar = 14436, Web of Science = 9205
List of Patents *-Title* *-Reference N°* *-Date* *-List of people involved*	Method for assisting with prognosis 17/611,997 (USA) 17/11/2021 **Irène Buvat, Anne Ségolène Cottereau**, Michel Meignan, **Christophe Nioche**
List of scientific highlights in 2021 (Publication or other) - 5 max.	1. Validation of an artificial intelligence algorithm for automated identification of metabolically active tumor sites throughout the body using whole-body PET images. Capobianco N, Meignan M, Cottereau AS, Vercellino L, Sibille L, Spottiswoode B, Zuehlsdorff S, Casasnovas O, Thieblemont C, Buvat I. Deep learning FDG uptake classification enables total metabolic tumor volume estimation in diffuse large B-cell lymphoma. J Nucl Med. 62: 30-36, 2021. **Highly cited paper (top 1%).** 2. Publication in **Annals of Oncology (IF=32.976)** of our **new patented predictive PET imaging biomarker** to characterize the dissemination of the disease in lymphoma patients, that we have validated on over 400 patients. Other teams have now confirmed and published the prognostic value of this imaging biomarker in different lymphoma subtypes. 3. Production of new versions of the **LIFEx** software (latest is v7.1) that we freely distribute to the community, with **now > 5000 users**. The Cancer Research paper published in 2018 to describe the software has already been cited more than 300 times (WoS) and is a "highly cited paper" (top 1%). 4. **Funding of the CASSIOPEIA project**, "Targeting Cancer Associated Fibroblast to tackle metastases and resistance to treatment in Triple Negative Breast Cancer" as part of the 5th national RHU call (9966 M€ funding). LITO is highly involved in the project, leading WP2 and participating in WP4, WP5, WP7, WP8 and WP9. 5. 560 k€ **funding** (Sesame + ITMO Cancer equipment) **for the purchase of a microPET/CT** which will equip the RadExp platform for the development of translational research in in vivo molecular imaging.
Other written productions of the team (e.g.: book chapter, etc.) - 5 max.	1. Contribution to a series of guidelines regarding the development and validation of artificial intelligence in nuclear medicine, with 2 papers already accepted: - Bradshaw TJ, Boellaard R, Dutta J, Jha AK, Jacobs P, Li Q, Liu C, Sitek A, Saboury B, Scott PJH, Slomka PJ, Sunderland JJ, Wahl RL, Yousefirizi F, Zuehlsdorff S, Rahmim A, **Buvat I**. Nuclear Medicine and Artificial Intelligence: Best Practices for Algorithm Development. J Nucl Med. in press, 2021. IF=10.057 - Jha AK, Bradshaw TJ, **Buvat I**, Hatt M, Prabhat KC, Liu C, Obuchowski NF, Saboury B, Slomka PJ, Sunderland JJ, Wahl RL, Yu Z, Zuehlsdorff S, Rahmim A, Boellaard R. Nuclear Medicine and Artificial Intelligence: Best Practices for Evaluation (the RELAINCE guidelines). J Nucl Med. in press, 2022. IF=10.057 2. Book chapter: « Apport et potentiel de l'Intelligence Artificielle en imagerie médicale pour la cancérologie » Fanny Orlhac et Irène Buvat, Ouvrage IA & Santé, CNRS Edition, in press.

List of software developed *-Name* *-Version* *-Release date*	LIFEx https://lifexsoft.org/index.php/product/overview-of-versions Two official releases in 2021: may 2021 (LIFEx 7.0) and september 2021 (LIFEx 7.1)
List of startup *-Name* *-Date of creation* *-Team members*	n/a
ORGANIZATION OF SCIENTIFIC MEETINGS - INSTITUTIONAL RESPONSABILITIES	
List of invitations to meetings and seminars (in France or international) *-Meeting title* *-Date* *-Place* *-Presentation title* *-Authors*	1. Seminar at the Institute of Neuroscience in Grenoble, February 2021, Virtual. "Harmonisation des données d'imagerie", Fanny Orlhac. 2. Invited Seminar at Institut Jules Bordet, 12 March 2021, Virtual. "How can AI help us decipher the molecular imaging radiome for enhanced precision medicine in oncology", Irène Buvat. 3. Australian and New Zealand Society of Nuclear Medicine annual scientific meeting, May 2021, Virtual. "Radiomics in Nuclear Medicine: where do we stand?", Irène Buvat. 4. CoViD19 workshop: Inflammation and Molecular Imaging Advanced Molecular Imaging Systems and Their Potential Role in Diagnosis and Treatment of the Infection and Inflammation in the CoViD19, May 2021, Virtual. "The role of dynamic PET imaging", Irène Buvat. 5. Virtual Society of Nuclear Medicine and Molecular Imaging meeting, June 2021. Hal Anger lectureship: "The transformative power of Artificial Intelligence in the practice of Nuclear Medicine", Irène Buvat. 6. Virtual Society of Nuclear Medicine and Molecular Imaging meeting, June 2021. "Summary Session Data Analysis and Management: latest developments presented at the SNMMI annual meeting", Irène Buvat. 7. EAMBES Fellows meeting, June 2021, Virtual. "The transformative power of AI in medical imaging", Irène Buvat. 8. European Molecular Imaging Meeting, August 2021, Goëttingen. "Principles of Radiomics and Machine Learning", Irène Buvat. 9. Société Française de Médecine Nucléaire (SFMN) 7th annual meeting, September 2021. Montrouge. "IA pour les nuls: les fondamentaux nécessaires pour les applications en imagerie médicales", Irène Buvat. 10. 8th international workshop on PET in lymphoma and myeloma (PILM 2021), September 2021, Virtual. "What will AI change regarding MTV measurement and risk identification ?", Irène Buvat. 11. 8th international workshop on PET in lymphoma and myeloma (PILM 2021), September 2021, Virtual. "Measuring the total metabolic tumor volume from whole body PET: state of the art, including contributions of AI", Irène Buvat. 12. 8th international workshop on PET in lymphoma and myeloma (PILM 2021), September 2021, Virtual. "Harmonizing the cut-off values : presentation of the ComBat method", Fanny Orlhac. 13. 4th course on Computational Systems Biology of Cancer, October 2021, Online. "Multi-omics and Machine Learning Approaches: Radiomics and machine learning in oncology", Irène Buvat. 14. IFAMP Webinar, October 2021, Online. "R-AI-diomics in nuclear medicine : the good, the bad and the ugly", Irène Buvat. 15. CHILI4: Conference in Hybrid Imaging live, European Society of Hybrid, Molecular and Translational Imaging, October 2021, Vienna. "Artificial Intelligence in multimodality hybrid imaging", Irène Buvat.

	16. EPSM, Engineering and Physical Sciences in Medicine Conference 2021, November 2021, Brisbane, Australia. "The 3 main ways AI is transforming nuclear medicine and molecular imaging", Irène Buvat. 17. EPSM, Engineering and Physical Sciences in Medicine Conference 2021, November 2021, Brisbane, Australia. "Radiomics for tumor characterization in nuclear medicine : the good, the bad and the ugly", Irène Buvat. 18. Virtual conference on applied radiation oncology, November 2021, Virtual. "Measurement challenges in nuclear medicine", Irène Buvat. 19. Les 10 ans de la plateforme RadeXp, December 2021, Orsay. « L'imagerie moléculaire in vivo préclinique : vers une anatomopathologie virtuelle », Irène Buvat. 20. Groupe de travail bi-académique « Intelligence artificielle et santé » de l'Académie de Médecine, December 2021, Paris. « Les trois pouvoirs de l'intelligence artificielle en imagerie médicale », Irène Buvat.
List of organized meetings, workshops, seminars (indicate if at Curie, in France or international) *-Meeting title* *-Date* *-Place* *-Presentation title* *-Authors*	1. International: 2nd Virtual Training School "Radiomics and AI for Molecular Medicine", 11-13 October 2021, Virtual, organized by Thomas Beyer (MUW), Fanny Orlhac (LITO), and Irène Buvat (LITO). 2 talks given + 3 hand-on sessions. With the participation of 2 PhD students from LITO: Nicolas Captier and Louis Rebaud. 2. International: Society of Nuclear Medicine meeting 2021, June 2021, Virtual. Organization of the "Physics, Instrumentation & Data Sciences" session building. Irène Buvat. 3. International: European Congress of Radiology, March 2021, On-line only. Irène Buvat, member of the organization committee. 4. Curie: Webinar LITO, January 2021, "Radiomic and anthropometric analyses in multimodal imaging for the exploration of predictive and prognostic factors in oncology". Pierre Decazes. 5. Curie: Webinar LITO, February 2021, "Analysis of histological images in the preclinical study of neurodegenerative diseases." Thierry Delzescaux & Huaqian Wu. 6. Curie: Webinar LITO, March 2021, "Development and clinical applications of new biomarkers in 18F-FDG PET imaging in lymphomas". Anne-Ségolène Cottereau. 7. Curie: Webinar LITO, April 2021, "Radiomics and Genomics in breast MRI". Katja Pinker. 8. Curie: Webinar LITO, May 2021, "Clustering of longitudinal shape data sets into mixtures of independent or branching trajectories". Stéphanie Allassonnière. 9. Curie: Webinar LITO, July 2021, "Non-invasive PET quantification: Extracting an image derived input function using factor analysis". Catriona Wimberley. 10. Curie: Webinar LITO, September 2021, "Chronnectome derived from fMRI". Christophe Habas. 11. Curie: Webinar LITO, October 2021, "Segmentation of axillary lymph nodes in PET/CT scans in the context of breast cancer using a hybrid method with hierarchical models and convolutional neural networks". Diana Farfan Cabrera.
Public outreach (TV, radio, press…), specify if PI or Team members name: *-Topic* *-Audience (eg. Researchers, general public)*	1. Regular contribution to "L'essential", the Curie journal, Irène Buvat. 2. Short Video Ruban Rose for the "Prix Avenir", Web. Irène Buvat, October 2021. 3. BSmart. "IA: Du dépistage au traitement du cancer". General Public. TV. November 2021.

-Media *-Date*	
Expertise: commissions of trust (ERC panel, CNRS & Inserm Committees, advisory boards, etc.) *-Name* *-Elected or nominated member* *-Period of mandate (start & end if known)*	1. Irène Buvat, member of the Artificial Intelligence Task Force of the Society of Nuclear Medicine and Molecular Imaging, USA (nominated), 2019-now. 2. Irène Buvat, Christophe Nioche, Fanny Orlhac, members of the International Biomarker Standardization Initiative (IBSI), 2018-now 3. Irène Buvat, ITMO Cancer expert (nominated), 2014-2022. 4. Irène Buvat, IBISA, member of the scientific committee (nominated), 2020-2021. 5. Irène Buvat, Institut Pascal, Université Paris Saclay, member if the scientific committee (nominated), 2016-now. 6. Irène Buvat, member of the "Commission Institutionnelle d'Ethique" of Institut Curie, 2021-now. 7. Fanny Orlhac, member of Artificial Intelligence working group of Unicancer, 2019-now 8. Frédérique Frouin, Inserm, Scientific Advisory Board, member (elected), 2017-2021 9. Frédérique Frouin, Labex PRIMES, Scientific Advisory Board, member (nominated) 2019-now
Board memberships (e.g.: journal editor, etc.)	1. Associate editor of the "Journal of Nuclear Medicine" (IF=10.057): management of ~ 60 manuscripts every year, since 2020. Irène Buvat 2. Associate editor of "Molecular Imaging and Biology" (IF=3.488): management of ~ 4 manuscripts every year, since 2020. Irène Buvat 3. Board member of "European Journal of Nuclear Medicine and Molecular Imaging" (IF=9.236): management of ~ 5 manuscripts every year and 1 special issue / year, since 2019. Irène Buvat 4. Board member of "European Journal of Nuclear Medicine and Molecular Imaging Research" (IF=3.138): management of ~ 5 manuscripts every year. Irène Buvat 5. Board member of "Physics in Medicine and Biology" (IF=3.609): management of ~ 5 manuscripts every year. Frédérique Frouin.
Memberships of Scientific Societies	1. Member of the Society of Nuclear Medicine and Molecular Imaging, Irène Buvat, Fanny Orlhac 2. Member of the European Alliance of Medical and Biological Engineering and Science (EAMBES), Irène Buvat 3. Member of the European Association of Nuclear Medicine, Irène Buvat, Fanny Orlhac 4. Member of the Société Française de Photobiologie, Carole Thomas 5. Member of the IEEE Engineering in Medicine and Biology Society, Frédérique Frouin
Others expertises (reviewer for scientific journals, expert for national and international funding bodies, e.g. ANR, ERC, etc)	1. Regular reviewers (>2 papers per year) for Journal of Nuclear Medicine (I Buvat, F Orlhac, F Frouin), Physics in Medicine and Biology (I Buvat, F Frouin), Medical Physics (I Buvat, F Frouin), IEEE Transactions on Medical Imaging (I Buvat, F Frouin), European Journal of Nuclear Medicine and Molecular Imaging (I Buvat), European Journal of Nuclear Medicine and Molecular Imaging Research (I Buvat), European Journal of Nuclear Medicine and Molecular Imaging Physics (I Buvat, F Orlhac), Journal of the American College of Cardiology (I Buvat), Medical Image Analysis (F Frouin, F Orlhac), Eur Radiology (F Orlhac), Sci Rep (F Orlhac), IEEE ISBI (F Frouin), IEEE EMBC (F Frouin), IEEE BHI (F Frouin), Am J Nanaotechnology and nanomedicine (C Thomas), Cancers (C Thomas), Cancer management and research (C Thomas), International Journal of Molecular sciences (C Thomas), International Journal of Radiation Oncology Biology and Physics (C Thomas), Investigative Ophthalmology and visual science (C Thomas), J

	Material chemistry B (C Thomas), J Porphyrin Phthalocyanines (C Thomas), Marine drugs (C Thomas), Nanoscale (C Thomas), Photochemical and Photobiological Sciences (C Thomas), Sci Pharm (C Thomas), Cancer management and research (C Thomas), PhotoDiagnosis and Photodynamic Therapy (C Thomas). 2. Expertise for international funding bodies: • Institut Jules Bordet, Belgium (I Buvat) • MUI-START Program, Medical University of Innsbruck, Austria (F Orlhac) • University of California Los Angeles, Yale University, Johns Hopkins School of Medicine (I Buvat) (Tenure tracks and promotions) 3. Expertise for national funding bodies: • ANR (I Buvat, F Frouin, F Orlhac) • ANRT CIFRE grants (I Buvat) • Cancéropole Ile de France (I Buvat) • Cancéropôle Provence Alpes Côte d'Azur (F Frouin) • INCA (I Buvat) • Région Ile de France: Challenge IA for Health (F Orlhac) • Région Nouvelle Acquitaine (F Frouin) 4. Reviews for international meetings for national funding bodies: • Society of Nuclear Medicine and Molecular Imaging annual meeting (I Buvat, F Orlhac) • European Association of Nuclear Medicine annual meeting (I Buvat, F Orlhac) • MICCAI (Medical Image Computing and computer Assisted Intervention) Challenges (F Orlhac) • European Congress of Radiology (I Buvat) • European Society of Molecular Imaging (ESMI) meeting (I Buvat) 5. PhD thesis committees: • David Wallis, "A Study of Machine Learning and Deep Learning Methods and Their Application to Medical Imaging", Université Paris Saclay, I Buvat, PhD supervisor. • Constance de Margerie-Mellon, « Imagerie quantitative pour la construction de modèles prédictifs : applications au nodule pulmonaire et à la maladie hépatique chronique avancée » , Université de Paris, 2021, I Buvat, Reviewer. • Timothée Zaragori, « Intégration des analyses dynamique optimisée et radiomique en TEP à la 18F-FDOPA pour la caractérisation des gliomes en routine Clinique », Université de Lorraine, 2021, I Buvat, Reviewer. • David Bourhis, « Evaluation quantitative de l'indice d'obstruction vasculaire en tomoscintigraphie pulmonaire », Université de Bretagne Occidentale, 2021, I Buvat, Reviewer. • Amel Raboudi, « Gestion du cycle de vie des études multimodales de recherche biomédicale préclinique pour le partage et la réutilisation des données hétérogènes », Université Technologique de Compiègne, 2021, I Buvat, Committee member. • Diana Farfan Cabrera "Segmentation of axillary lymph nodes in PET/CT scans in the context of breast cancer using hierarchical models and Deep Learning", Université de Reims Champagne-Ardennes 2021, F Frouin, Reviewer.
CLINICAL ACTIVITIES	

Link with Curie Hospital or other *-Person* *-Project* *-Funding*	1. Curie: Hervé Brisse / Caroline Malhaire (Medical Imaging department) : Neotex, Radiomics in breast MRI to predict response to neoadjuvant chemotherapy, « Temps Médical Protégé ». Participation in the EORTC BCG 1984 trial. 2. Curie: François Clément Bidard (Medical Oncology) / Olivier Madar (Dpt of radiopharmacology) / Fatima Mechta Grigoriou (Research center): Ga68-FAPI synthesis for clinical imaging of Fibroblast Activation Protein activation, PMS Sein funding 3. Curie: Laurence Champion / Romain-David Seban (Dpt of Nuclear Medicine, Saint Cloud): Prediction of **A**xillary lymph node involvement and **M**etastasis occurrence in **BRE**ast cancer PET imaging using **A**rtificial **I**ntelligence, CIFRE grant supported by Dosisoft 4. Curie: Nicolas Girard (Dpt of Thoracic Oncology), Alain Livartowski (Direction of Data), Nina Jehanno and Marie Luporsi (Dpt of Nuclear Medicine, Paris), Hervé Brisse (Dpt of Radiology, Paris): Radiomic approaches for lung cancer precision medicine, RALUCA (LITO funding), PANACEE project (Janseen Horizon funding), TIPIT project (Fondation Arc funding), Precision Predict project (BPI and Health Data Hub funding) 5. Curie: Gilles Créhange, Valentin Calugaru, Arnaud Beddok (Dpt of Oncology – Radiotherapy): Radiomics for the characterization of tissue damages induced by radiation therapy and optimization of re-irradiation treatment plans, supervision of PhD thesis of Arnaud Beddok 6. Curie: Nathalie Cassoux (Dpt of Onco-ophtalmology), François Doz (Dpt of Onco-pediatry), PhotoDynamicTherapy project for retinoblastoma treatment, Retinostop (PSL and Fondation l'Occitane fundings) 7. Other: Jacques Darcourt, Olivier Humbert, Anne-Capucine Rollet (Dpt of Nuclear Medicine, Centre Antoine Lacassagne, Nice): Distinction between radionecrosis and progression based on 18F-FDOPA PET images for glioma patients (3IA Côte d'Azur and LITO funding) 8. Other: Anne-Ségolène Cottereau (Dpt of Nuclear Medicine, Cochin Hospital, Paris), Design and validation of PET imaging prognostic biomarkers for lymphoma patients, supervision of PhD thesis of Anne-Ségolène Cottereau 9. Other: Pierre-Yves Brillet (Dpt of Radiology, Avicenne Hospital, Bobigny), IRMomics in lung cancer patients (LITO funding)
DISTINCTIONS	
List of Awards for **PI** *-Title* *-Date* *-Country*	1. Hal Anger Lectureship Award by the Society of Nuclear Medicine and Molecular Imaging (USA) on "The transformative power of Artificial Intelligence in the Practice of Nuclear Medicine". June 2021. 2. Fellow of "the European Alliance for Medical and Biological Engineering Sciences". June 2021. 3. "Ruban Rose Avenir" award, for the project entitled "In vivo characterization of tumor heterogeneity using PET imaging in metastatic triple negative breast cancer" by the Ruban Rose association (France). October 2021.
List of Awards for **Team Members** *-Title* *-Date* *-Country*	
List of Promotions (CR1, DR1, etc.) for **PI & Team members**	Frédérique Frouin : CRCN Inserm → CRHC Inserm, effective 1st January 2022.

Only for CNRS, Inserm, Universities members *- Name* *-Date* *-Grade*	
List of Recruitments (new permanent CNRS, Inserm, Univ.) for **Team members** Only for CNRS, Inserm, Universities members *-Name* *-Date* *-If Inserm, CNRS, Universities*	n/a.
List of Researchers **HDR** for **PI & Team members**	1. Hervé Brisse, PH Curie 2. Irène Buvat, DR1 CNRS 3. Frédérique Frouin, CRHC Inserm 4. Michaël Soussan, PUPH Paris 13 5. Carole Thomas, CRCN Inserm
ON-GOING FUNDED PROJECTS & COLLABORATIONS	
NATIONAL - Individual projects Project Title **Translational or not** Funding source Managed by Curie, CNRS… Total Amount - k€ Period **(start-end)** Publications or Patents *Indicate the number in your list*	**PANACEE**, translational, PI: Fanny Orlhac, funded by Janssen Horizon, managed by Curie, 150 k€, 2020-2023. Publications: not yet
INTERNATIONAL - Individual projects Project Title **Translational or not** Funding source Managed by Curie, CNRS… Total Amount - k€ Period **(start-end)** Publications or Patents *Indicate the number in your list*	
INDUSTRIAL - Individual projects Project Title **Translational or not** Funding source Managed by Curie, CNRS… Total Amount - k€ Period **(start-end)** Publications or Patents *Indicate the number in your list*	1. **CIFRE grant** of Thibault Escobar **funded by Dosisoft**: Development of radiomic models for treatment planning and patient monitoring in PET/CT/MRI. Contract managed by Curie, 60 k€ for Curie + 118 k€ for the PhD salary directly supported by Dosisoft, 2020-2023. Publication: Escobar T, Vauclin S, Orlhac F, Nioche C, Pineau P, Champion L, Brisse H, Buvat I. Voxel-Wise Supervised Analysis of Tumors with Multimodal Engineered Features to Highlight Interpretable Biological Patterns. Med Phys, **submitted**. 2. **CIFRE grant** of Louis Rebaud **funded by Siemens Healthineers**: Whole-body and total-body biomarkers in PET/CT imaging. Contract managed by Curie, 73 k€ for Curie + 118 k€ for the PhD salary directly supported by Siemens, 2021-2024.

	Publication: Not yet. 3. **CIFRE grant** of Maria Grazia Ronga **funded by Thales**: Study of very high energy electron radiation therapy (VHEE). Contract managed by Curie, 79 k€ for Curie + 118 k€ for the PhD salary directly supported by Thales, 2021-2024. Publications: Number 10 and number 13.
NATIONAL - Collaborative projects Project Title **Translational or not** PI role: PI Role: *Coord. or Part.* Funding source Managed by Curie, CNRS… Total Amount - k€ Period **(start-end)** Publications or Patents *Indicate the number in your list*	**1. Precision-Predict**, translational, PI : Nicolas Girard, Co-PI in LITO : Irène Buvat and Fanny Orlhac (partners), funded by BPI France and Health Data Hub, managed by Curie, 300 k€ for Curie, 2020-2022. No publication yet. **2. TIPIT,** translational, PI : Emmanuel Barillot, PI in LITO : Irène Buvat and Fanny Orlhac (partners), funded by Fondation Arc, managed by Curie, 600 k€ (~180 k€ for LITO), 2020-2023. No publication yet. 3. **AgeMed 2.0,** translational, From aged cells to medical applications, PI : Eric Gilson, PI Curie : Irène Buvat (partner), managed by Inserm, 61.5 k€, 2020-2024. No publication yet. 4. **BIOMEDE-IA,** translational, Artificial Intelligence tools for DIPG characterization PI : Frédérique Frouin, funded by Gustave-Roussy, managed by Inserm, 120 k€, 2020-2023. Publications: number 6 and number 27. 5. **VOCALE:** Detection of recurrent nerve palsy using echography, PHRC-I PI C Trésallet, coPI Frédérique Frouin, managed by Inserm, 110 k€, 2019-2022. No publication yet. 6. **EXOGLYC:** Cardiac vectoring of extracellular vesicles by modification of their glycosylation, PI : Philippe Menasché, PI Curie : Claire Provost, ANR funding managed by Curie (24 k€ for LITO), 2021-2023. No publication yet. 7. **Retinoblastoma**, translational Inter- and intratumoral heterogeneity of retinoblastomas, funded by Projet Ligue contre le cancer, PI F Radavanyi, coPI Irène Buvat, Hervé Brisse, managed by Curie, 25 k€, 2021-2024. No publication yet.
INTERNATIONAL - Collaborative projects Project Title **Translational or not** PI role: PI Role: *Coord. or Part.* Funding source Managed by Curie, CNRS… Total Amount - k€ Period **(start-end)** Publications or Patents *Indicate the number in your list*	**1. HYBRID**, translational, PI in France: Irène Buvat (partner), funded by ITN (H2020-MSCA-ITN-2017), managed by Curie, 70 k€, 2020-2021. Publications: number 32, and DOI: 10.1016/j.media.2022.102368, just accepted in 2022. **2. HOLY2020,** translational, PI in France: Irène Buvat (partner), funded by EraCoSysMed3rd joined transnational call (ANR-19-SYME-0005-03 contract), managed by Curie, 237 k€, 2020-2023. Publication: Girum KB, Rebaud L, Cottereau AS, Meignan M, Clerc J, Vercellino L, Casasnovas O, Morschhauser F, Thieblemont C, Buvat I. 18F-FDG PET maximum intensity projections and artificial intelligence: a win-win combination to easily measure prognostic biomarkers in DLBCL patients. **Submitted**.
INDUSTRIAL - Collaborative projects Project Title **Translational or not** PI role: PI Role: *Coord. or Part.* Funding source Managed by Curie, CNRS… Total Amount - k€ Period **(start-end)** Publications or Patents *Indicate the number in your list*	**1. AI.DReAM,** translational, PI : Baptiste Perrin GE Healthcare, PI Curie : Irène Buvat (partner), funded by BPI France, managed by Curie, 710 k€, 2020-2025. Publications: not yet. 2. **PDT to treat retinoblastoma,** translational, PI Curie : Carole Thomas collaboration with the Laboratoires Synth-Innove, funded by PSL pré-maturation 70K€ (2018-2022), Fondation l'Occitane 20k€ (2019-2021). Publications: not yet. 3. **RHU CASSIOPEIA,** translational, PI : Fatima Mechta-Grigoriou Institut Curie, funded by ANR, managed by Curie, 9966 k€, 2022-2027. Publications: not yet.

Other collaborations	
Other Highlight for the year	
Comments	