

Centre de recherche, Centre hospitalier universitaire de Sherbrooke

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Completed by: Dr. Brigitte Guérin, Centre d'imagerie moléculaire de Sherbrooke

1. Cyclotron Facility – Contact info

Institute (name/address):	Centre de recherche of the CHUS (CR CHUS)/CIUSSS-CHUS
Institution URL:	Cr.chus.qc.ca
Person in charge (name/ph#/email):	Lyne Caouette/819-346-1110 ext 11860 lyne.caouette@usherbrooke.ca
Position/title:	Operation Manager
Cyclotron manager/engineer (name/ph#/email)	Éric Berthelette/819-346-1110 ext 16662 eberthelette.chus@ssss.gouv.qc.ca
QA manager (name/ph#/email)	Philippe Martineau/819-346-1110 ext 16662 philippe.martineau@usherbrooke.ca
QC manager	Sébastien De Breyne Gagnon/819-346-1110 ext 16662 sebastien.de.breyne-Gagnon@USherbrooke.ca
Other senior staff (titles/name/ph#/email):	Head of Radiochemistry, Tracer development Prof. Brigitte Guérin/1-819-346 1110 ext 15285 brigitte.guerin2@sherbrooke.ca

2. Cyclotron characteristics

Cyclotron manufacturer/model	Advanced Cyclotron Systems (EBCO) TR-19 and TR-24
Cyclotron installation date (Year):	TR-19: 1998, TR-24: 2012
Dual beam?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes
Any upgrades?	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes, Describe: Ion source on TR-19 (2016)
Particles:	<input checked="" type="checkbox"/> ^1H <input type="checkbox"/> ^2H <input type="checkbox"/> ^3He <input type="checkbox"/> ^4He

Particle energy, or range (MeV):	TR24: 16 to 24 MeV TR19: 13-19 MeV
Max particle current (μA):	TR24: 500 μA TR19: 150 μA
Typical particle current (μA):	75-90 μA for ^{18}F production

3. Cyclotron Operation Prefer not to answer

Planned operating days per week:	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7
Number of planned maintenance days/month:	3 days
Number of planned shutdown weeks per year:	1 week
Total operating hours (h)/week:	
h/week for radionuclide production:	25 h
h/week for research:	15 h
h/week for maintenance:	6 h
h/week for applications:	

4. Is the cyclotron used to produce Prefer not to answer

Calibration sources? (specify which & quantity)	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes FDG 40 μCi
Mossbauer sources? (specify which & quantity)	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes
X-ray sources? (specify which & quantity)	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes
Intense neutron beam? (specify average $E_n = ?$)	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes

5. Application questions Prefer not to answer

Are pre-clinical studies using cyclotron radiopharmaceuticals carried out on-site?	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes (if available, types of radiotracers and name(s) and email(s) of PIs): ^{11}C -Méthionine, ^{11}C -palmitate, ^{11}C -acetate, ^{11}C -acetoacetate, ^{18}F -4FMFES, ^{18}F -FAZA, ^{18}F -FET, ^{11}C -carvedilol, ^{64}Cu -peptides (Bombesin, PACE4, kinine, NPY, octreotate, enkephaline...), ^{89}Zr antibodies
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	For radiosynthesis: Prof. Brigitte Guérin, PhD; brigitte.guerin2@sherbrooke.ca
Are clinical studies using cyclotron radiopharmaceuticals carried out on-site?	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes (if available, types of radiotracers and name(s) and email(s) of PIs): Na ¹⁸ F, ¹⁸ F-FLT, ¹⁸ F-FTHA, ¹⁸ F-FES, ¹⁸ F-4FMFES, ¹¹ -acetate, ¹¹ C-acetoacetate, ¹¹ C-PIB, ^{99m} Tc-pertechnetate For radiosynthesis: Prof. Brigitte Guérin, PhD; brigitte.guerin2@sherbrooke.ca For clinical studies: Prof. Éric Turcotte, MD; Eric.E.Turcotte@USherbrooke.ca
Are cyclotron radionuclides/labelled compounds used or planned to be used for agricultural applications such as plant biochemistry/research?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes (if available, types of radiotracers and name(s) and email(s) of PIs):
Is the cyclotron used for nuclear reaction cross-section measurements?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):
Is the cyclotron used for targetry development?	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes (if available, types of isotopes, and name(s) and email(s) of PIs): ⁶⁴ Cu and ⁸⁹ Zr, ^{99m} Tc
Is the cyclotron used for materials science?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):
Is the cyclotron used for radiography?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):
Is the cyclotron used for radiobiology?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):
Is the cyclotron used for physics research?	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes (if available, name(s) and email(s) of PIs): Prof. Brigitte Guérin & Roger Lecomte
Is the cyclotron used for activation analysis?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):
Is the cyclotron used for proton therapy?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):

Is the cyclotron used for neutron therapy?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):
Other (specify)	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):

6. Types of imaging equipment N/A, Prefer not to answer

Single photon (specify if gamma camera, SPECT, or SPECT-CT):	
Number of clinical scanners:	1 SPECT and 6 SPECT/CT (2 site,s Fleurimont & Hotel-Dieu)
Number of pre-clinical scanners:	1
Number of plant biochemistry scanners:	
PET (specify if PET, PET/CT, or PET/MR):	PET/CT
Number of clinical scanners:	2 PET/CT
Number of pre-clinical scanners:	1 PET/SPECT/CT, 1 PET/CT (mouse), 1 PET
Number of plant biochemistry scanners:	

7. Do you supply radionuclide(s), radiotracer(s), or radiopharmaceutical(s) to other institutions? (No/ Yes/ Prefer not to answer). If yes, and if available, please provide the name of product, institution, and supply frequency:

Product	Institution	Frequency
[¹⁸ F] FDG	Isologic	3-5 days/week
⁶⁴ Cu	Diverse	On demand
⁸⁹ Zr	Diverse	On demand

8. Cyclotron/radionuclide/radiochemistry/radiopharmacy training

Is the cyclotron used for education and training in nuclear sciences, health physics, etc?	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes (if available, name(s) and email(s) of PIs): Training MSc, PhD students & PDF; Program of in <i>Sciences des radiation et imagerie biomédicale</i> at the FMSS, Université de Sherbrooke
Does your institute participate in trainee exchange (for production):	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):
Does your institute participate in trainee exchange (for research):	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):
Does your institute accept IAEA research fellows for training/experience:	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):
Other training opportunities (specify):	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes (if available, name(s) and email(s) of PIs):

9. Radionuclide production – $^{18}\text{F}(\text{F}^-)$ N/A, Prefer not to answer

Reaction	<input checked="" type="checkbox"/> $^{18}\text{O}(\text{p},\text{n})^{18}\text{F}$; <input type="checkbox"/> $^{16}\text{O}(^3\text{He},\text{p})^{18}\text{F}$; <input type="checkbox"/> $^{20}\text{Ne}(\text{d},\gamma)^{18}\text{F}$; <input type="checkbox"/> $^{16}\text{O}(\alpha,\text{d})^{18}\text{F}$
Typical current (μA):	75 μA – 90 μA
Typical energy (MeV):	18 MeV
Typical yield (GBq):	300 GBq – 450 GBq
Typical target pressure (psi):	60-100 PSI
Is target He cooled?	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes
Typical beam time (min):	120 min
Typical Y_{sat} if known (GBq/ μA)	8 GBq/ μA
% Isotopic enrichment ^{18}O	98%
^{18}O supplier(s)	Huayi Isotopes
Target volume [^{18}O]H ₂ O (mL)	TR-24: 4 mL, TR-19: 2.5 mL
Usage per year [^{18}O]H ₂ O (mL)	2000 ml
Do you recycle [^{18}O]H ₂ O?	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes (if “yes”, <input type="checkbox"/> in-house <input checked="" type="checkbox"/> return to supplier)

10. Radionuclide production – ^{11}C ($[^{11}\text{C}]\text{CH}_4$) N/A, Prefer not to answer

Typical current (μA):	
Typical energy (MeV):	
Typical yield (GBq):	
Typical target pressure (psi):	
Typical beam time (min):	
Typical Y_{sat} if known (GBq/ μA):	
Gas mixture:	
Target volume:	
$[^{11}\text{C}]\text{CH}_3\text{I}$ production ASU model:	
Typical yield (GBq):	
Typical yield (% d.c.):	

11. Radionuclide production – ^{11}C ($[^{11}\text{C}]\text{CO}_2$) N/A, Prefer not to answer

Typical current (μA):	30 μA
Typical energy (MeV):	18 MeV
Typical yield (GBq):	
Typical target pressure (psi):	600 PSI
Typical beam time (min):	20 min
Typical Y_{sat} if known (GBq/ μA):	
Gas mixture:	N_2/O_2 (0.5%)
Target volume:	
$[^{11}\text{C}]\text{CH}_3\text{I}$ production ASU model:	Home made
Typical yield (GBq):	
Typical yield (% d.c.):	

12. Other radionuclides produced N/A, Prefer not to answer

Product	Yield on batch (GBq)	Irradiation parameters (MeV/ μ A/min)	Typical target mass/material	Extraction method	Used on site?	Distribution/sales?
^{13}N	6.23	17.8 MeV, 15 μ A, 25min.	0.05M EtOH/H ₂ O		<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes
^{15}O	In start				<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes
$^{18}\text{F-F}_2$					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
^{44}Sc					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
^{64}Cu	3.7GBq	15.5 MeV, 40 μ A, 120 min	40mg, enriched ^{64}Ni	McCarthy <i>et al.</i> Nucl Med Biol 1997; 24(1):35	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes
^{67}Ga					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
^{86}Y					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
^{89}Zr	0.282	9.5 à 12.0 MeV 10 μ A, 110 min.	^{89}Y		<input checked="" type="checkbox"/> No <input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes
$^{94\text{m}}\text{Tc}$					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
$^{99\text{m}}\text{Tc}$		24 MeV, 400 μ A, 360 min			<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes
^{103}Pd					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
^{111}In					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
^{123}I					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
^{124}I					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
^{201}Tl					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
^{211}At					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
Other:					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes

					<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
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13. Radiopharmaceutical production – ¹⁸F(FDG) N/A, Prefer not to answer

Production frequency (batches/week)	8
Used on site	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes
Distribution/sales	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes
ASU model	GE TracerLab
Typical yield (GBq):	160 GBq
Typical yield (% , decay corrected):	65% <input checked="" type="checkbox"/> pre/post dose-cal; or <input type="checkbox"/> indirectly via ASU
ASU model	<input type="checkbox"/> N/A GE Fast lab
Typical yield (GBq):	In start
Typical yield (% , decay corrected):	_____ <input type="checkbox"/> pre/post dose-cal; or <input type="checkbox"/> indirectly via ASU
ASU model	<input checked="" type="checkbox"/> N/A
Typical yield (GBq):	
Typical yield (% , decay corrected):	_____ <input type="checkbox"/> pre/post dose-cal; or <input type="checkbox"/> indirectly via ASU

14. Radiopharmaceutical production – Other Products (please copy table for as many products as desired) N/A, Prefer not to answer

Product:	
Production frequency (batches/week)	
Stage:	<input type="checkbox"/> R&D <input type="checkbox"/> Pre-clinical <input type="checkbox"/> Clinical
Used on site	<input type="checkbox"/> No <input type="checkbox"/> Yes
Distribution/sales	<input type="checkbox"/> No <input type="checkbox"/> Yes
ASU model	
Typical yield (GBq):	
Typical yield (% , decay corrected):	_____ <input type="checkbox"/> pre/post dose-cal; or <input type="checkbox"/> indirectly via ASU
ASU model	<input type="checkbox"/> N/A

Typical yield (GBq):	
Typical yield (% , decay corrected):	_____ <input type="checkbox"/> pre/post dose-cal; or <input type="checkbox"/> indirectly via ASU

15. Radionuclides and radiopharmaceuticals planned to be produced in the next 1-3 years (specify)

N/A, Prefer not to answer

Product:	Application:

16. Additional comments: N/A