

CYCLOTRON PRODUCTION OF RADIOSOTOPES AND RADIOPHARMACEUTICALS IN SINR

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The SINR facility was initially installed in 1964, a 1.2m classical fixed energy cyclotron (proton MeV, deuteron 16 MeV, Alpha 32 MeV) and modified 1985 into 1.38 isochronous, multiparticle with variable energy: proton up to 16 MeV, 20 μ A external beam intensity; deuteron up to 16 MeV, 30 μ A and alpha up to 32 MeV, 18 μ A.¹

Cyclotron production of radiosotopes and radiopharmaceuticals program has been preferentially undertaken hardly since the establishment of cyclotron by the grants of Academia Sinica and National Nature Science Foundation Commission.

The radiosotopes have been produced in connection with some strong points:

1. for supplying its neighbourhood with a wide spectrum of short-lived radioisotopes when it is not available.
2. in some particular circumstances the cyclotron-produced radioisotopes are used exclusively
3. to meet the needs of nuclear medicine for special radioisotopes of ideal nuclear characteristics and usefulness (Table I).²⁻³

The pertinent characteristics of cyclotron-produced radioisotopes towards nuclear medicine have made it most expedient for radiopharmaceutical production. Consequently, both inorganic⁴⁻¹¹ and organic¹²⁻¹⁸ radiopharmaceutical preparations have been forwarded (Tables II, III). And through their production the establishment of irradiation facility, targetry, fast radiochemistry, quality control as well as radiopharmacology have been carried out. Some of these radiopharmaceutical preparations, after passing the critical pharmacological examinations, have been supplied to hospitals for clinical uses.⁹⁻²⁰

Table I Radioisotopes Produced at SINR Cyclotron

Nuclide	T _{1/2}	Nuclear reaction used	Projectile energy (MeV)	Production rate (mCi/mAh)	Applications*
² Be	53.3d	⁷ Li(p,n) ⁷ Be	8	80	Biomed. Agr.
¹¹ C	20.3m	¹¹ B(p,n) ¹¹ C	8	5000	Org. Rph.
²² Na	2.6a	²⁴ Mg(d, α) ²² Na	13.4	2	PAT
²⁴ Na	15.0h	²³ Na(d,p) ²⁴ Na	13.4	80	Biomed.
⁴² K	12.4h	⁴¹ K(d,p) ⁴² K	13.4	60	Biomed.
⁵⁴ Mn	313d	⁵⁶ Fe(d, α) ⁵⁴ Mn	16	5	Nucl. Phys.
⁵⁶ Co	77.3d	⁵⁶ Fe(d,n) ⁵⁶ Co	13.4	10	Envir.
⁵⁷ Co	270d	⁵⁶ Fe(d,n) ⁵⁷ Co	7.5	3	NM, MB
⁶¹ Cu	3.4h	⁶⁰ Ni(d,n) ⁶¹ Cu	16	600	Nucl. Phys.
⁶¹ Cu	3.4h	⁵⁹ Co(α ,2n) ⁶¹ Cu	32	4000	Nucl. Phys.
⁶⁷ Ga	78h	Zn(d,xn) ⁶⁷ Ga	16	320	NM imag.
⁶⁸ Ga	68.3m	⁶⁸ Ge e.c. ⁶⁸ Ga			NM. Gener.
⁶⁸ Ge	287d	⁶⁶ Zn(α ,2n) ⁶⁸ Ge	32	3	
⁷⁴ As	17.8h	Ge(d,xn) ⁷⁴ As	13.4	80	Agr. pharm.
⁷⁷ Br	57h	⁷⁵ As(α ,2n) ⁷⁷ Br	32	90	NM. Org. Rph.
⁸⁵ Sr	64d	⁸⁵ Rb(d,2n) ⁸⁵ Sr	13.4	15	Biomed. Tox.
¹¹¹ In	67.2h	¹⁰⁹ Ag(α ,2n) ¹¹¹ In	32	200	NM. imag.
¹²³ I	13.3h	¹²¹ Sb(α ,2n) ¹²³ I	32	300	NM. imag.

Table I (cont'd)

Nuclide T1/2	Nuclear reaction used	Projectile energy (MeV)	Production rate (mCi/mAh)	Applications*
^{197m} Hg 24h	¹⁹⁷ Au(d,2n) ^{197m} Hg	16	100	NM
²⁰¹ Tl 74h	²⁰³ Tl(p,3n) ²⁰¹ Pb	28	390	NM imag.
		e.c. ²⁰¹ Tl		
²⁰³ Pb 52.1h	²⁰³ Tl(p,n) ²⁰³ Pb	28	2400	NM imag.
²⁰³ Pb 52.1h	²⁰³ Tl(d,2n) ²⁰³ Pb	15	180	Biomed. Tox.

* Org. Rph. - organic radiopharmaceutical
 Nucl. phys. - nuclear physics
 NM - nuclear medicine
 pharm - pharmaceutical
 Envir. - environment protection
 Gener. - radioisotope generator
 PAT - positron annihilation technology
 NM imag. - nuclear medical imaging

TABLE II - Inorganic Radiopharmaceuticals

Nuclide	Radiopharmaceutical Preparation	Application
²⁴ Na	Sodium chloride injection	Sodium metabolism
⁷⁷ Br	Sodium bromide injection	Extracellular fluid volume
⁶⁷ Ga	Gallium citrate, isotonic injection	Tumor localization
⁸⁵ Sr	Strontium chloride injection	Bone scan
¹¹¹ In	Indium chloride injection	Bone marrow scan
	Indium bleomycin injection	Tumor scan
	DTPA-conjugated monoclonal antibody of hFbg	Thrombosis localization
¹²³ I	Sodium iodide, isotonic injection	Thyroid scan
²⁰¹ Tl	Thallium chloride injection	Myocardium scan

TABLE III - Organic Radiopharmaceuticals

Nuclide	Radiopharmaceutical	Application
¹¹ C	Amino-cyclopentane-carboxylic acid	Pancreas and tumor scan
¹¹ C	Valine	Pancreas scan
¹¹ C	Leucine	Pancreas scan
¹¹ C	Benzoic acid	Renal scan
¹¹ C	Propionic acid	Myocardium scan
¹¹ C	Glucose	Sugar metabolism
		Brain function
⁷⁷ Br	DOPA	Dopamine receptor scan
⁷⁷ Br	Tetraacetyl-3-deoxy-glucose	Brain function

^{123}I
 ^{123}I
 ^{123}I

O-Hippuran
Iodohexadecanoic acid
Human fibrinogen

Renal function scan
Heart scan
Thrombosis scan

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