

The CYCLONE - 3D

I.B.A. presents an alternative to
the $^{82}\text{Sr} \rightarrow ^{82}\text{Rb}$ generator :

INTRODUCTION

A number of today's P.E.T. centers operate without direct connection to a cyclotron. The recent concept of positron emitters distribution centers and their implementations is likely to increase the number of such "stand alone" cameras.

For those P.E.T. centers, the only possible agent for the measurement of flow is the $^{82}\text{Sr} \rightarrow ^{82}\text{Rb}$ generators. However, the use of the ^{82}Rb suffers from several well known disadvantages :

- the high positron energy decreases the imaging resolution ;
- the availability of the generators has been irregular and, considering the sources of ^{82}Sr , is unlikely to improve ;
- the cost is relatively high ;
- the ^{82}Rb does not form endogenic compounds as does the oxygen, thus raising questions in the interpretation of data.

I.B.A. has designed what is probably the world's smallest commercial cyclotron. This cyclotron is essentially a one function/one button ^{15}O generator. It uses the $^{14}\text{N}(d,n) \rightarrow ^{15}\text{O}$ reaction on natural nitrogen at 3.2 MeV deuteron energy.

Enclosed in the base of the cyclotron, a simple chemistry unit dispenses the ^{15}O in the classical forms : $^{15}\text{O}_2$, C^{15}O , C^{15}O_2 , H_2^{15}O .

GENERAL DESIGN FEATURES

The relatively modest beam specifications of such a cyclotron : 3.2 MeV deuteron, up to 50 μA of extrated beam on target, allows I.B.A. to reach the ultimate in cyclotron design simplicity.

The CYCLONE-3D is a classic, flat pole, weak focusing cyclotron using positive ion acceleration and classic electrostatic deflector extraction. However, due to the low energy of the deuteron beam and the careful choice of construction materials, practically no activity is generated in other elements than the target itself. The magnet is square (1m x 1m x 0.7m), with a vertical acceleration plane, allowing to locate the target at ground level and to use the cyclotron structure as self shielding.

The CYCLONE-3D opens like a book to allow an easy access to all interior parts : 90° dees operating in H=1 mode, ion source, deflector, targets. A relatively powerful oil diffusion pump, backed by a mechanical pump allows the cyclotron to reach the operating vacuum in less than 15 minutes after venting to the atmosphere.

The R.F. oscillator, the deflector power supply and various subsystems are located on top of the magnet. The power supplies all fit in a single 19-inch cabinet. The cooling is ensured by a simple, small size unit, that can be located either outside the building or on its roof.

CONTROL

The CYCLONE-3D is NOT computer controlled. Actually, the machine is so simple that an ON/OFF button and a switch for selecting the appropriate chemical form of the ^{15}O is all that is required.

This cyclotron is probably smaller and simpler to use than your average soft-drink vending machine.

COST

Investing in a CYCLONE-3D is no greater than a two years supply of ^{82}Sr - ^{82}Rb generators (if they were available every month).

Economy of operation is, as with other I.B.A. accelerators, a prime feature of the Cyclone-3D. The power consumption is minimal, as the accelerator needs only to be operated for a few minutes each time a dose of ^{15}O is required.

There are no special building requirements. The Cyclone-3D can be moved on wheels, taken through a door, and being self-shielded, installed in any existing room. Operating the Cyclone-3D is a matter of switching it on and collecting the radio-isotope. Maintenance is minimal.

TYPICAL PRODUCTION BATCHES:

- * 250 mCi ^{15}O labeled CO_2 , CO , O_2
- * 100 mCi ^{15}O labeled H_2O

Cyclone-3D Parameters

Beam

Type of ions extracted	D ⁺	
Type of ions accelerated	D ⁺	
Energy	3.2	MeV
Maximum intensity		
- (guaranteed)	50	μA
- (expected)	75	μA

Power consumption

Stand-by conditions	<4	kW
At full beam power	<30	kW

Magnetic structure

(classical circular pole magnet)

Field	1.6	Tesla
D.C. power in the coils	9.6	kW
Iron weight	4.0	tons
Copper weight	0.5	tons

R.F. system

Number of dees	2	
Dee angle (effective)	90	degrees
Harmonic mode	1	
Frequency (fixed)	12.2	MHz
Dee voltage (nominal)	30.0	kV
Dissipated R.F. power		
- per dee	3.5	kW
- beam acceleration	0.3	kW

Injection

Type of source (internal)	P.I.G.	
Filament power	0.5	kW
Filament lifetime	> 200	hours
Arc power	0.5	kW
H ₂ flow	5 ... 10	St.cc/min

Production target

Nuclear reaction	$^{14}\text{N}(d,n) \rightarrow ^{15}\text{O}$
Yield at 3 MeV	6 mCi/mA (sat.)

Size

Height	1.60	m
Width	1	m
Depth	1.2	m
	+ one 19 in. cabinet	

