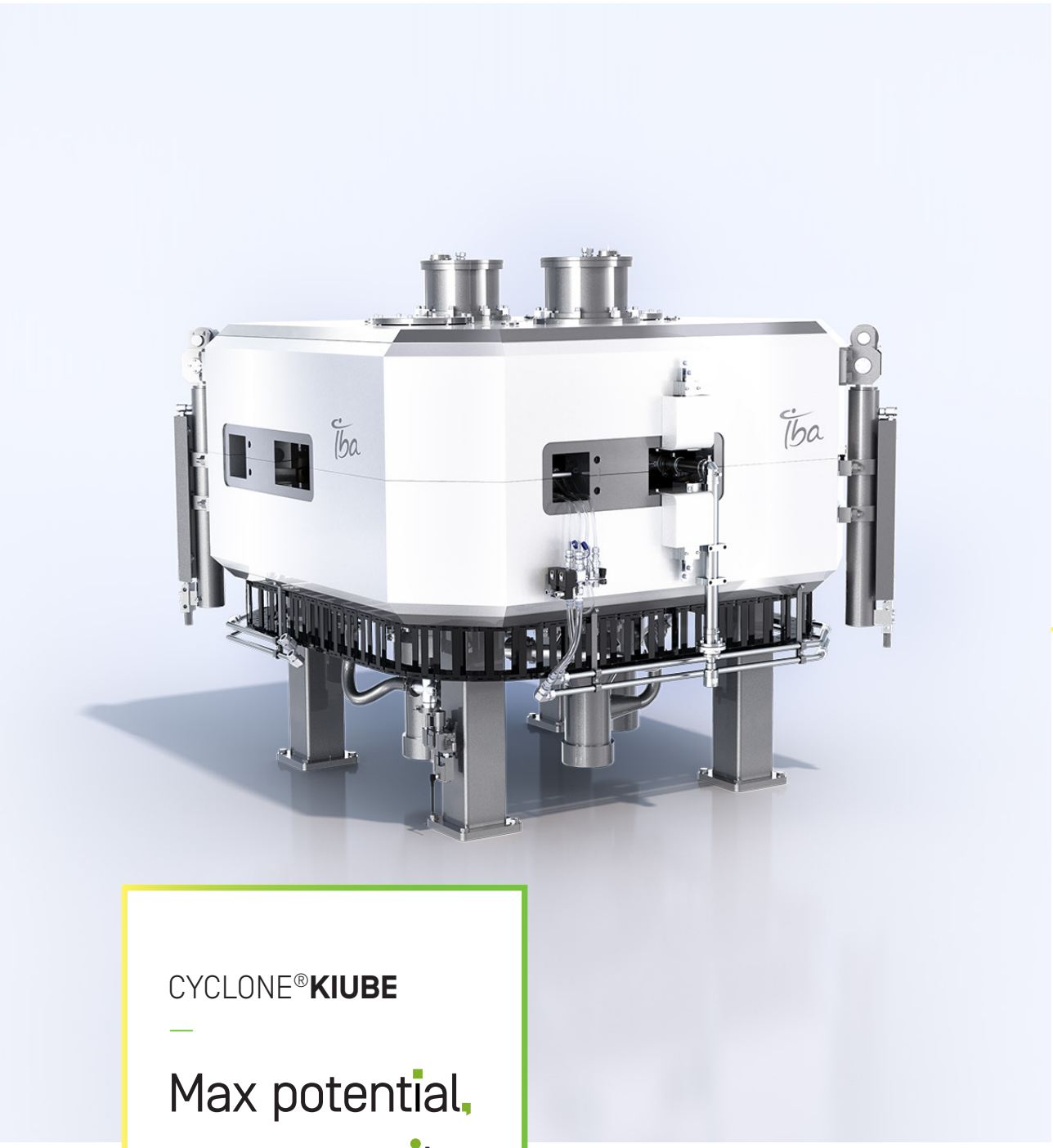
Life.
Science.



CYCLONE®**KIUBE**

—

Max potential. max capacity.

RADIO
PHARMA
SOLUTIONS

35 years of experience concentrated in one innovation.

— 30 years of innovation and expertise concentrated in the CYCLONE®**KIUBE**

The first world reference

In 1986, IBA launched the first compact cyclotron for industrial production of radioisotopes. This revolutionary new design increased the production efficiency by a factor 15 and created a world reference.

30 years later, IBA once again makes history with the launch of its new 18 MeV cyclotron. CYCLONE®**KIUBE** is more compact and the most powerful mid energy PET cyclotron. It has been developed with three keywords in mind: **Reliability, High Performance and Flexibility**. These keywords were defined in collaboration with our Users.

Expertise benefiting to a large installed base

With IBA as partner, you have the assurance to remain at the forefront of innovation and to benefit of every novel feature for tracer production.

More than 300 cyclotrons installed over 5 continents demonstrate this expertise and customer satisfaction.

Support over the lifetime of your system

IBA provides continuous support over the lifetime of your project, expanding your skills and applications, boosting your uptime and maximizing the return on your investment with all the latest innovations, services and training.

In addition, the system is built so that future upgrades can be easily implemented to keep your cyclotron state-of-the-art.

150
IBA PATENTS ON PARTICLE ACCELERATORS

35
YEARS OF EXPERTISE

— A story of Cyclotron Innovations

1985
DEEP VALLEY CYCLOTRON
5 X MORE OUTPUT,
3 X LESS ENERGY
EP022786

1990
VECTIO® BEAM
TRANSPORT LINE
FOR R&D

2000
NIOBIUM NIRTA® FLUOR
TARGET FOR BETTER
ISOTOPE QUALITY
EP1716576

2002
NIRTA® SOLID TARGET
TO GIVE ACCESS TO
NEW ISOTOPES
IP: EP1570493

2003
DUAL BEAM REGULATION
FOR DOUBLED PRODUCTION
EP1566082

2005
HIGH CURRENT
MACHINE 150µA
FOR INCREASED
PRODUCTION CAPACITY

2006
TARGET SHIELDS FOR
EASY DECOMMISIONING
EP2033199

2008
TWIN PROTON
SOURCES
TO MAXIMIZE UPTIME
EP2196073

2011
NIRTA® FLUOR CONICAL
TARGET FOR REDUCED
ENRICHED WATER USE
WO 2012/055970

2012
ZEPHIROS® CONTROL
SYSTEM FOR EASE OF USE
EP2581914

2015
GA-68 PRODUCTION
USING A
LIQUID TARGET
EP15170854

2016
CYCLONE KIUBE
EP16169489, EP16169490
EP16169494, EP16169497
EP16171282

2018
CUSTOM ENERGY
CYCLONE® KIUBE
EP3503693

2021
EXTRACTION SYSTEM WITH
4 STRIPPERS

Designed for Ever.

— CYCLONE®**KIUBE** will evolve with you, for you

Upgradable like no other

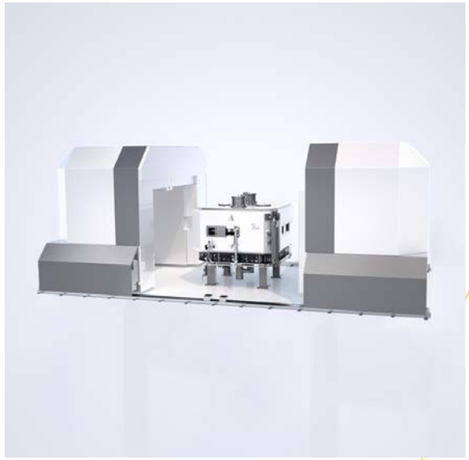
CYCLONE®**KIUBE** is upgradable like no other cyclotron, so you can increase your production capacity; from 100 µA to 150µA, 180 µA or even up to 300µA on target.
With a lower initial investment, you can start with the CYCLONE®**KIUBE** 100 while maintaining the ability to increase your PET Center's capacity over time with an on-site upgrade.

Infinite flexibility

With eight independent exit ports, CYCLONE®**KIUBE** is the most flexible system, producing the widest range of PET radioisotopes.
A full range of Nirta® targets are available giving you access to **^{18}F, ^{13}N, ^{15}O, ^{11}C** (CO_2 & CH_4), **$^{18}F_2$, ^{68}Ga, ...**
In addition, IBA provides Nirta® Solid target technology for the production of radioisotopes such as **^{64}Cu, ^{89}Zr, ^{124}I, ...**

Custom Energy.

The IBA-patented custom energy CYCLONE®KIUBE allows users to irradiate the target directly at a fixed energy level of 13, 14 or 15 MeV, without using a degrader.



This is our typical production schedule thanks to the IBA 8-exit ports cyclotron :

Time	Radionuclide	Radio pharmaceutical
4.30-6.00	^{18}F	FDG
6.30-8.00	^{18}F	F-other
8.15-8.45	^{11}C	CHOLINE
10.00-12.00	^{18}F	MK9470
12.30-13.00	^{11}C	Raclopride
13.30-13.40	^{13}N	NH3
14.00-16.00	^{15}O	10*H_2O
16.30-17.00	^{11}C	PDE10A

Prof. Dr Guy Bormans
Head of radiopharmacy
KATHOLIEK UNIVERSITEIT LEUVEN, BELGIUM

CYCLONE® KIUBE WITH SELF-SHIELDING OPTION*

10Ci **370 GBq** 100 µA → **16Ci** **592 GBq** 150 µA

UPGRADABLE

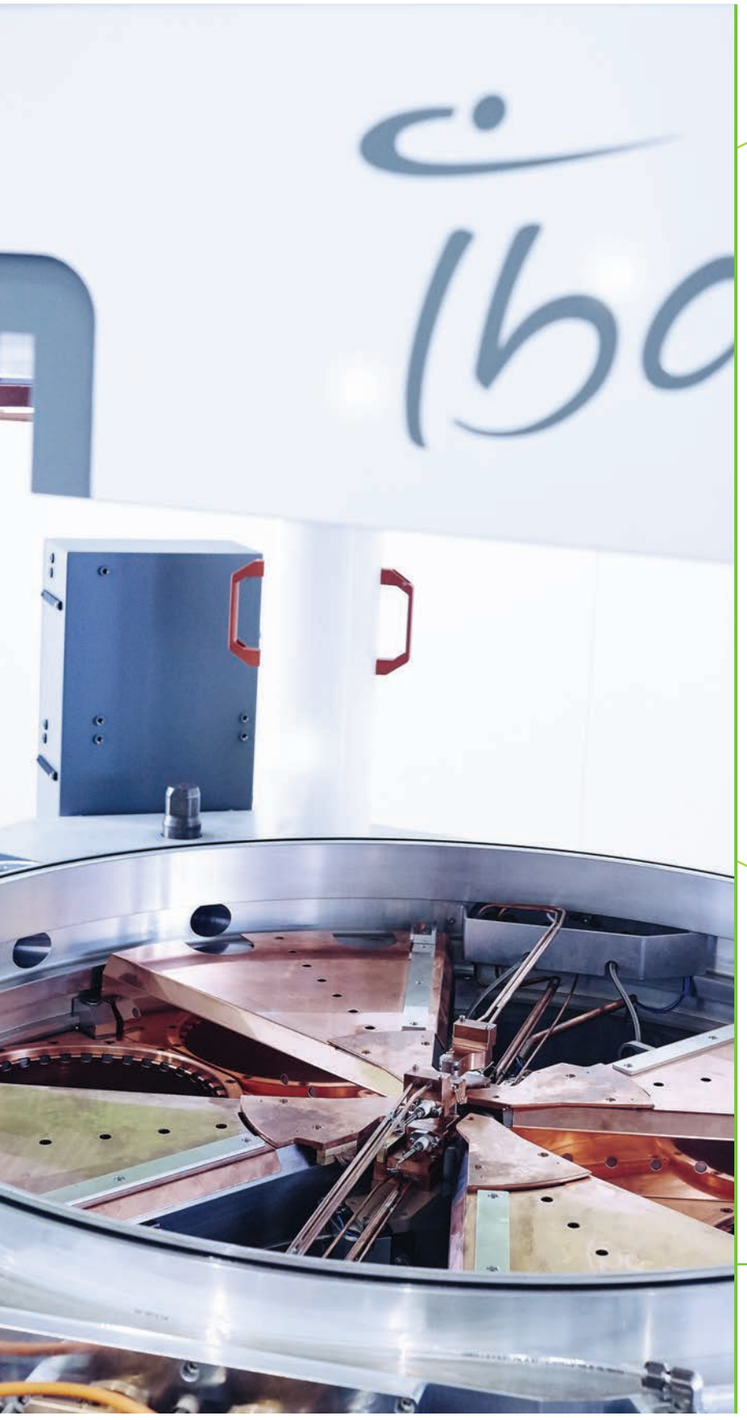
CYCLONE® KIUBE VAULTED*

10Ci **370 GBq** 100 µA → **16Ci** **592 GBq** 150 µA → **20Ci** **740 GBq** 180 µA → **30Ci** **1110 GBq** 300 µA

UPGRADABLE

**Production in Curies of ^{18}F- in 2 hours run*

Designed to Deliver.



After 10 years of excellent experiences with Cyclone® 18/9,

*we have now added the new CYCLONE®**KIUBE**. Outstanding! All well thought engineering details made the operation unprecedentedly easy, reliable and maintenance fast and safer, lowering dose exposure.*

Francisco Alves
Chief physicist & head of Cyclotron
ICNAS-UNIV. COIMBRA - PORTUGAL

300 [µA]
MAX CURRENT OF
THE CYCLONE®KIUBE

— CYCLONE®**KIUBE** delivers outstanding performances

The most cost-effective

It has been demonstrated that 18 MeV is the optimal proton energy for the highest production yield of most of PET radioisotopes. Your production capacity is optimized so as your revenue; your center footprint is kept to a reasonable size so as your investment. This means that 18 MeV is the most cost-effective solution for your PET isotopes production.

The growing demand for radioisotopes means a greater need for efficiency. CYCLONE®**KIUBE** saves enriched water and has the lowest power consumption per Curie produced, yet is the most powerful of the market.

The most performant cyclotron

CYCLONE®**KIUBE** offers unmatched production capacity for an internal source PET cyclotron. A 2-hour dual beam run could generate up to 30 Ci of ^{18}F-; hence, an incredible batch of FDG synthesized on your Synthera®+ modules.

Maximum reliability

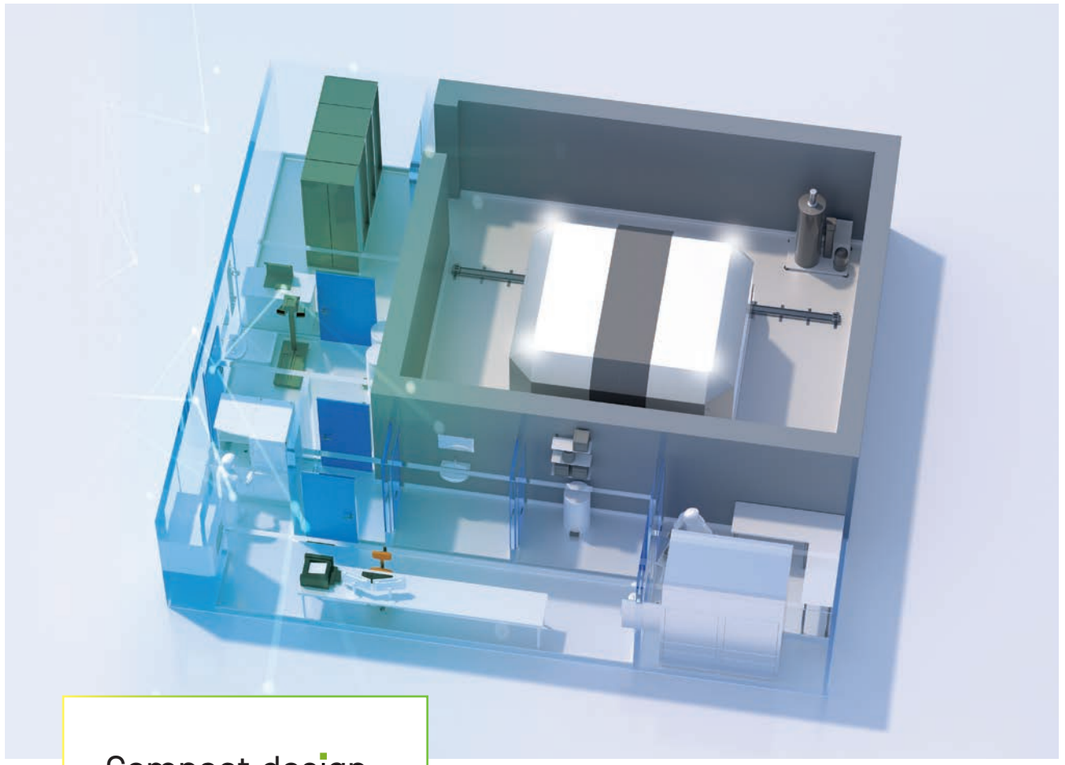
Its unique twin-proton sources give maximum reliability, as switching to the second source during operation is simple, fast and completely automated, translating into more than 99% source uptime. Moreover, the production is optimized in real time thanks to the automatic tuning of the ion source, stripper and magnetic field.

HIGHEST PRODUCTION CAPACITY

µA	^{18}F- capacity/run	FDG doses/run[*]
CYCLONE®**KIUBE** 100	2 hours : 10 Ci / 370 GBq	60 - 100
CYCLONE®**KIUBE** 150	2 hours : 16 Ci / 592 GBq	96 - 160
CYCLONE®**KIUBE** 180	2 hours : 20 Ci / 740 GBq	120 - 200
CYCLONE®**KIUBE** 300	2 hours : 30 Ci / 1110 GBq	180 - 300

(*) using Synthera® FDG chemistry (12h shelf life - stability).
May vary according to local conditions, transport time and patients schedule.

Designed for you.



Compact design

Its compact design can fit into any existing cyclotron vault.

Cyclone®KIUBE is also available with a self-shielding option.

IntegraLab® ONE

IBA experts designed the **world's most optimized** (c)GMP PET center with a footprint of less than 100m² (1,070 square feet) including a 18 MeV self-shielded cyclotron, while allowing a very high production capacity of ^{18}F for FDG and ^{68}Ga.

IntegraLab®ONE is a real ready-to-run integrated Radiopharmacy, designed to ensure a fast, smooth and risk-free set up of your (c) GMP radiopharmacy.

IntegraLab® PLUS

IntegraLab® PLUS is a **fully integrated** solution, combining the equipment and services required to establish a Radiopharmaceutical (c)GMP Production Center tailored to your precise needs.

Our approach is **truly comprehensive**, taking your project from building design to production, with full regulatory compliance, and with the selection, integration, installation and qualification of the equipment needed to meet your radioisotope production goals.

< 100 M²

1,070 FT² PET CENTER AREA

— A self-monitoring cyclotron that maximizes your uptime

Unmatched reliability

CYCLONE®**KIUBE** has an unmatched reliability. Its compact design includes redundancy for the main systems (ion sources, strippers, targets, vacuum pumps,...).

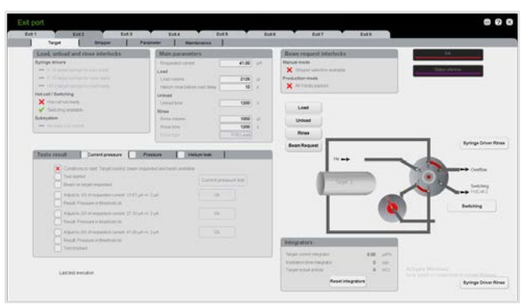
The software self-tests prior to production and automatically self-audits after maintenance, leading to maximized uptime.

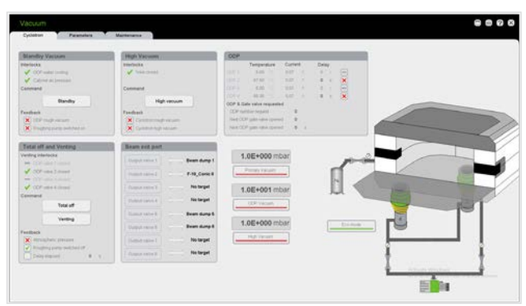
The choice of low activation material combined with the optimization of the maintenance tasks ensure the lowest radiation exposure for your staff.

User-friendly Software

The software is very user-friendly, meaning it is easier to train and rotate the staff that operates the system. It provides an easy and guided control of the system with a simple production mode for an automatic set up to maximise your ^{18}F production and the manual mode gives you full flexibility.

The 24/7 helpdesk provides you with peace of mind, with IBA experts analyzing cyclotron data in order to diagnose and solve 95% of problems remotely.





Nirta® target technology

Complete target range for your extended needs

— ^{18}F- conical liquid target

High power with low enriched water consumption

- Efficient design to achieve 4Ci/ml in 2 hour-run
- Lowest enriched water consumption on the market
- Wide range of volumes available: your production capacity will always match your needs
- Quick and low dose maintenance: less pieces and o-rings
- Easier disassembling, assembling and manipulation.

— Liquid targets

Unique solution for ^{68}Ga production

The unique and patented (US10600528B2 and EP3101660B1) solution for production of ^{68}Ga-radiopharmaceuticals for human use has many advantages :

- Seamless automation of the whole process with the Synthera® platform
- No risk of long-lived ^{68}Ge (271 days) in the final product
- Production every hour depending on patient schedule
- Simple & cost effective GMP production process for in-house use or for distribution production similar to the ^{18}F process

— Solid targets

Enlarge your cyclotron possibilities.

The Vectio® beam line extension can be installed for high power solid target work and for research with proton beam.

Solid target technology for the production of novel radioisotopes

- Routine production and research programs
- Full packages available including dissolution and purification modules
- Possibility to have a pneumatic transport system between the cyclotron vault and the radiochemistry laboratory.
- The Nirta® Plus solid target can be installed inside the self-shielding

	Nirta® solid target	Nirta® Plus solid target	Nirta® High Power[1,2] solid target
Target current	20-40 µA	40-75µA	up to 300µA[3]
Target angle	90°	35°	customizable capsule (from 10°-90°)
Automated transfer	1 way in option	1 way in option	2 ways

[1] EP18187472.6.
[2] Vectio beam line required
[3] Energy degrader on capsule will reduce beam current capacity to 150 µA

TYPICAL PRODUCTION WITH SOLID TARGETS – PET/SPECT ISOTOPES

	^{64}Cu[1]	^{89}Zr[1]	^{124}I[1]	^{123}I[1]	^{66}Ga	^{67}Ga	^{111}In	^{86}Y
Half-life	12.7h	78h	4.18d	13.27h	9.49h	78h	67h	14.7h
Target reaction	^{64}Ni(p,n)^{64}Cu	^{89}Y(p,n)^{89}Zr	^{124}Te(p,n)^{124}I	^{123}Te(p,n)^{123}I	^{66}Zn(p,n)^{66}Ga	^{67}Zn(p,n)^{67}Ga		^{86}Sr(p,n)^{86}Y
Target Material	^{64}Ni	^{89}Y	^{124}Te	^{123}Te	^{66}Zn	^{67}Zn	^{111}Cd	^{86}Sr
Energy (on target) (MeV)	14	15	15	16	16	16	16	18
Yield (mCi/µAh) [2]	1.34-8.5[3]	0.34	0.45	2.34	-	-	-	-

[1] commercial package available
[2] The production rate is given by yield x target current x irradiation time.
The maximum target current depends on the irradiation station (Nirta® Solid, Nirta® Solid Plus, Nirta® High power solid)
[3] depending on target material thickness. 0.073 mCi/µAh/mg of Ni-64

^{18}F

	Conical 5	Conical 8	Conical 12	Conical 16
Chemical form		[^{18}F-]		
Target reaction		^{18}O(p,n)^{18}F		
Target material		$H_2{}^{18}O$		
Window material		Havar®		
Insert material		Niobium		
Enriched water volume (ml)	1.8 - 2.0	2.3 - 2.5	2.7 - 3.0	3.5 - 4.3
Irradiation time (min)	120	120	120	120
Recovered activity EOB (Ci) / (GBq)	5 / 185	8 / 296	12 / 444	16 / 592

Thanks to the combination of the CYCLONE®KIUBE and the Nirta® ^{18}F$^-$ targets,

we have a cost-effective solution for large production of ^{18}F; high activity in a short run with low enriched water consumption. We are happy with the reliability and performance and we are proud to produce 60 Ci ^{18}F a day to deliver to hospitals for patient diagnosis.

Volkan Çam
Technical Manager
NUKLEON, TURKEY

	^{68}Ga	^{13}N	^{64}Cu[1]
Chemical form	[^{68}Ga]$GaCl_3$	[^{13}N]NH_3	[^{64}Cu]$CuCl_2$
Target reaction	^{68}Zn(p,n)^{68}Ga	^{16}O(p,α)^{13}N	^{68}Ni(p,n)^{68}Cu
Target material	Enriched ^{68}Zn salt	H_2O (natural) + 5mMol Ethanol	enriched ^{64}Ni solution
Window material	Niobium	Havar®	Niobium
Insert material	Niobium	Niobium	Niobium
Energy degrador	na	Graphite	na
Beam energy	18 MeV	16 MeV	18 MeV
Target yield (mCi/µA sat)	-[2]	38	-[2]
irradiation time (min)	60	20	300
Insert volume (ml)	3.7	3.7	5
Recovered activity EOB (mCi) / (GBq)	200 / 7.4	1000 / 37	50/1.85

[1] not commercially available
[2] depending on target solution concentration and other parameters

— Gas targets

	^{15}O	^{11}C – CO_2	^{11}C – CH_4
Chemical form	[^{15}O]O_2	[^{11}C]CO_2	[^{11}C]CH_4
Target reaction	^{15}N(p,n)^{15}O	^{14}N(p, α)^{11}C	^{14}N(p, α)^{11}C
Target material	$^{15}N_2$ + 0.5-1% O_2	N_2 + 0.5-1% O_2	N_2 + 5% H_2
Window material	Aluminum	Aluminum	Aluminum
Insert material	Aluminum	Aluminum	Aluminum
Energy degrador	Graphite	na	na
Beam energy	13 MeV	18 MeV	18 MeV
Insert volume (ml)	4 – 5/min (cont. flow)	55	40
Target yield(mCi/µA sat)	30	150	60
irradiation time (min)	online	30	30

Technical features.

	Cyclone® KIUBE 100	Cyclone® KIUBE 150	Cyclone® KIUBE 180	Cyclone® KIUBE 300
HIGH CAPACITY PROTON BEAM				
Energy	18 MeV			
Beam current on target	100 µA	150 µA	180 µA	300 µA
TARGET FLEXIBILITY				
Number of target ports	8			
Simultaneous extracted beams	2			
Vectio® Beam Transport Line	short, medium, long			
LOW POWER CONSUMPTION				
Stand-by mode	< 3 kW			
Beam-on mode	< 45 kW	< 55 kW	< 60 kW	< 65 kW
COMPACT DESIGN				
Cyclotron weight	18 Tons			
Cyclotron overall dimensions [m]	1.9 x 1.9 x 1.8 [l x w x h]			
Internal room dimensions [m]	3.8 x 3.8 x 2.5 - Recommended : 4 x 4 x 2.5 [l x w x h]			
Internal room dimensions with self-shielding [m]	6 x 7 x 3 [l x w x h]		-	-
Self-shielding overall dimensions/piece [m]	4.645 x 2.770 x 2.575 [l x w x h]		-	-

www.iba-radiopharmasolutions.com

Life.
Science.

ABOUT IBA (Ion Beam Applications S.A)

IBA is a cancer diagnostics and treatment company and the worldwide technology leader in the field of proton therapy. The company's expertise lies in the development of next-generation proton therapy technologies and radiopharmaceuticals that provide oncology care providers with premium quality services and equipment, including IBA's leading fully-integrated IntegraLab® system.

ABOUT IBA RADIOPHARMA SOLUTIONS

Based on long-standing expertise, IBA RadioPharma Solutions supports hospitals and radiopharmaceutical distribution centers with their in-house radioisotope production by providing them with global solutions, from project design to the operation of the facility. In addition to high-quality technology production equipment, IBA has developed in-depth experience in setting up GMP radiopharmaceuticals production centers.

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Certified B Corporation