MINItrace™ Qilin $^{18}F^-$ production system

Data sheet

Overview

The GE Healthcare MINItrace Qilin positron emitting isotope production system is a compact, self-shielded, highly automated cyclotron. It enables fast, easy and efficient production of PET tracers. The design makes it an affordable platform based on the well-proven PETtrace cyclotron.

The MINItrace Qilin can produce the commonly used PET isotopes for clinical routine procedures and research. It also has the capacity to support local distribution demands.

The MINItrace Qilin combined with GE automated chemistry systems, such as the FASTlab™ 2 Synthesizer (sold separately), can produce pharmaceutical grade PET precursors and tracers with consistently high yields.

Primary benefits

Compact installation

The MINItrace Qilin is a compact and easy-to-install PET tracer production system. The vertical cyclotron orientation, high efficiency radiation shielding and integrated support systems minimize the room requirements to 5.5 × 4.5 m / 18 × 15 ft (25 m^2 / 270 ft^2) and minimal floor modifications.

Reliability and production capacity

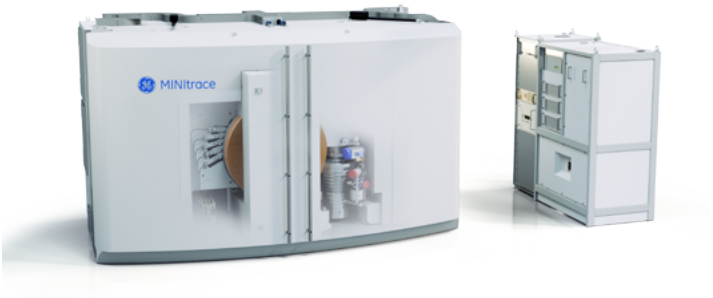
The MINItrace Qilin system is designed for high reliability and meeting clinical demands, which, combined with a GE chemistry system, provides tracers for 3 to 4 PET/CT scanners. Several productions may be run consecutively with high reliability.

Lower dose to personnel

The innovative vertical cyclotron mid-plane design and quick-release components have made it possible to lower the radiation dose exposure to maintenance personnel.

Versatility

The MINItrace Qilin can be configured in a number of different ways to meet your needs. You can select different options including numerous target systems and chemistry modules for production of tracers beyond oncology programs, such as neurology and cardiology programs.



MINItrace Qilin cyclotron

Fully automated

The entire sequence of producing the PET isotopes and tracers is fully automated. The operator only needs to select the tracer, the amount of activity required, and initiate the sequence. The control system automatically prepares the cyclotron and the targets, tunes the beam, and manages the target irradiation. This significantly contributes to the ease of use in operating the cyclotron and tracer production in comparison to conventional tracer production facility set up. Routine operation can be performed by a trained hospital technican.

Full upgradeability

The MINItrace Qilin cyclotrons have a continuous upgrade path built-in to ensure that each cyclotron has access to the latest technology and advancements.

Configuration

The MINItrace Qilin is a system for ^{18}F-fluoride production.

A number of different options can be added to produce additional isotopes and tracers. For more details, refer to the *MINItrace Qilin target and process options* data sheet.

The basic MINItrace Qilin system includes the ^{18}F-fluoride target system.

- **S9120ST, MINItrace Qilin cyclotron**
  2700 mCi / 92.5 GBq ^{18}F-fluoride after 2 h of irradiation
  radiation shield

More than 2 hours of irradiation will further increase the yield of ^{18}F-fluoride. The amount specified for 2 hours is sufficient for production of 25 to 30 doses of FDG, supplying 2 to 3 PET/CT scanners in an average clinical patient load day.

System components

Magnet

The design of the MINItrace Qilin cyclotron magnet offers simple and robust operation. The coils are made of hollow-core, water-cooled copper conductors that are fiberglass insulated and cast in epoxy. This design feature contributes to reliable and stable tracer production.

Radio frequency (RF) system

The RF system consists of two resonators and an RF Power Generator (RFPG) applying RF power to the two resonators within the vacuum chamber, that accelerate the particles. Operation is automatically regulated by the cyclotron control system, optimizing the production output.

Ion source

The ion source for the MINItrace Qilin cyclotron is mounted internally in a fixed position. The design is of the Penning Ion Gauge (PIG) discharge type with cathodes heated by the discharge.

An alignment tool for online performance optimization of the ion source is included. As the tool allows ion source adjustment without breaking the vacuum, the down-time of the cyclotron is reduced.

Beam extraction

The MINItrace Qilin has a beam extraction efficiency above 99.9%. A thin carbon foil is used to extract the beam, the control system sets the foils in an appropriate position and automatically fine-adjusts the position to optimize beam transmission to the target.

Beam diagnostics

The beam characteristics are computer controlled, allowing optimal tuning. Continuous monitoring of the extraction foil, collimators, and targets is provided to allow a fully automated start-up, tuning, and operation.

Vacuum system

The MINItrace Qilin vacuum system consists of one high-vacuum oil diffusion pump and one mechanical roughing pump. A dedicated vacuum system controller performs pressure monitoring, vacuum pump sequencing and system operation.

Control system

The MINItrace Qilin control system is equipped with a cyclotron control unit and a PC workstation. The control unit carries out all the automated closed-loop and logical control tasks, while the workstation is used for operator inputs and database handling. A complete software package for fully automated cyclotron and process system operation is provided.

Control system functions include:

- System start-up, including warm-up periods (<5 min from a cold start) and component monitoring.
- Initiation of production parameters, including selection of irradiation, duration of irradiation and beam current.
- Data logging with hard copy print out possibility
- Beam tuning capability to optimize system operation and efficiency.
- Continuous monitoring of system operating parameters, with appropriate protection interlocks and warnings.

MINItrace Qilin ion source

Target mounting and support

Five fixed target ports are located along the side of the cyclotron vacuum chamber.

The bayonet mechanism ensures rapid and simple installation and removal of the targets. Target media and cooling water are delivered to the target through quick connections.

Integrated shielding

The MINItrace Qilin self-shield consists of borated concrete with additional re-enforcement of polyethylene and lead. The shielding capacity is sufficient to allow personnel to enter and work in the cyclotron room during production.

S9120ST, MINItrace Qilin basic configuration

P5120JA, MINItrace Qilin basic cyclotron

The MINItrace Qilin is an automated, fixed energy (9.6 MeV protons), negative ion accelerator designed for fast, easy, efficient and reliable production of PET tracers.

P5120JP, MINItrace Qilin pre-installation kit

The installation kit includes the material and detailed instructions to perform the pre-installation work for a MINItrace Qilin system.

P5120JS, MINItrace Qilin self-shield

The MINItrace Qilin radiation shielding provides radiation shielding for the cyclotron system.

P5260MR, MINItrace Qilin $^{18}F^-$ Nb 25 target system

The target system includes a target with a niobium chamber and a filling volume of 2.5 ml, a Liquid Target Filler (LTF), collimators, valves, tubing, product panel, and an acceptance test kit. The target performance is verified against a beam current of 50 µA. This target has a maintenance interval of 15 mAh, representing 150 two hour productions. No helium cooling is needed, improving reliability and maintenance requirements.

P5260MS, MINItrace Qilin $^{18}F^-$ Nb 25spare target

A complete target body with a Niobium chamber and a filling volume of 2.5 ml. The target performance is verified against a beam current of 50 µA.

P5260QL, Cyclotron Client Station 2.0 (optional)

An additional workstation that allows the user to operate and monitor the cyclotron system from an alternate location.

System performance

MINItrace Qilin isotope production summary

Isotope	Nuclear reaction
Fluorine-18	$^{18}O(p,n)^{18}F$

MINItrace Qilin $^{18}F^-$ performance

Chemical form	Yield (EOB)	Irradiation time
$^{18}F^-$Fluoride	1600 mCi / 59.2 GBq	60 min
$^{18}F^-$Fluoride	2700 mCi / 100 GBq	120 min

Tracer production yields and specifications

Please refer to the *MINItrace Qilin target and process system options* data sheet.

Site planning requirements

GE Healthcare will assist the customer in site planning and give suggestions how to design the facility.

For detailed site preparation requirements, refer to *MINItrace Qilin Site Planning Guide (dir. 2232993-100).*

System dimensions

Cyclotron including self-shield	
Length	2100 mm (83 in)
Width	3600 mm (142 in)
Height	2100 mm (83 in)
Weight	50 350 kg (111 000 lbs)

Radio Frequency Power Generator, RFPG	
Width	1180 mm (47 in)
Depth	800 mm (32 in)
Height	1800 mm (71 in)
Weight	750 kg (1640 lbs)

Control cabinet, CCAB	
Width	600 mm (24 in)
Depth	800 mm (32 in)
Height	1800 mm (71 in)
Weight	300 kg (661 lbs)

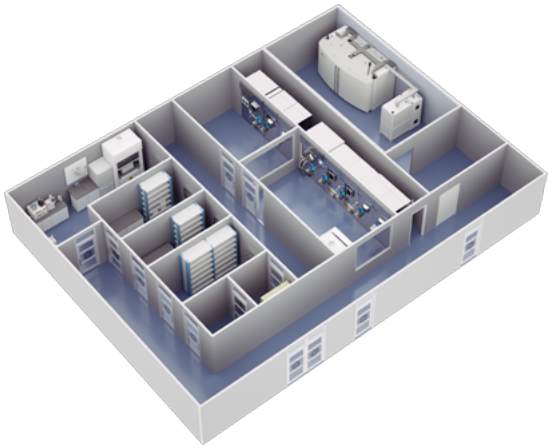
Cooling water system*	
Width	800 mm (31 in)
Depth	250 mm (10 in)
Height	2050 mm (81 in)

* The secondary cooling system is an integral part of the self-shield and is included in the overall dimensions given for the self-shield.

System requirements

Cyclotron cooling system	
Cooling capacity	40 kW
Flow	50-70 l/min (13-18 US Gallon/min)
Inlet temperature to secondary cooling unit	maximum 13 °C (55 °F)
Max system pressure	0.6 Mpa
Differential pressure (heat exchanger)	~ 0.05 Mpa

Total power consumption	
Operation mode (max)	35 kW
Standby mode	3.5 kW



Example of facility layout

Imagination at work

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