

## AN INCREASED $^{18}\text{F}$ RADIONUCLIDE PRODUCTION.

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In the  $^{18}\text{F}$  daily preparation a diminished yield of radioisotopic production is often found. This fact, most times, is connected to the altered internal surface of the PEE and teflon lines for the  $^{18}\text{F}$  transferring to the hot cells because of radiations. This anomaly is due to an  $\text{H}_2^{18}\text{O}$  insufficient filling into the target. Infact a target foils bombardment causing the release of radioactive  $\text{Ag}^+$  ions sets in. These ions passing through the transferring line damage it.

This problem has been solved by an increased  $\text{H}_2^{18}\text{O}$  filling, from 0.7 to 1.3 mL. A further steady increasing in the  $^{18}\text{F}$  production is due to the features of the new target:

1. back plane: integrated in the silver flange; 2. water cooling surface: enlarged with fins; 3. target connections: high pressure fittings.

In conclusion a careful filling of the new target has increased the fluorine-18 average daily production from 7.4 GBq to 18.5 GBq, using recovered water (time: thirty minutes; beam: 15mA) and allows to replace teflon lines every year instead of every three months.

### 1 Introduction

The cyclotron is an accelerator of particles, which, already used for many years in the scope of fundamental research has in more recent times been employed in applied research mostly in the biomedical field.

At the Institute Pascale, a Scanditronix MC-17 cyclotron was installed in 1991, for on site production of  $\text{B}^+$  emitting short half life isotopes, i.e.  $^{15}\text{O}$ ,  $^{11}\text{C}$ ,  $^{13}\text{N}$ ,  $^{18}\text{F}$ .

The first clinical studies of radiopharmaceuticals with positron emitting nuclides were performed in our Institute in 1984, when a brain dedicated mod. NEUROECAT "PET" apparatus of CTI, equipped with one BGO crystal ring of detectors with geometric octagonals was installed.

Studies were done in the blood-brain barrier with  $^{68}\text{Ga}$ -EDTA, using a Germanium-Gallium generator. Presently the radioisotopes produced by our cyclotron are used as precursors of radiotracers for new Siemens PET EXCAT 47, installed in our institute in September 1994.

The entire system is situated under the ground floor of the Nuclear Medicine Department at the Institute. This level contains the screening room of the cyclotron, storage systems for radioactive waste, a control room, the electronic panels and a cooling system, the office, spare parts deposit

and reagents. On the same floor there is the radiochemical laboratory, where the hot cells are installed.

On the ground floor there is located the PET room, plus all the connection systems for transport of radioactive gases and radiopharmaceuticals.

The cyclotron MC-17 is the synchronised fixed energy type, it produces proton beams of 17.2 MeV and deuteron beams of 8.6 MeV, and it is equipped with targets for  $^{20}\text{Ne}(\text{d},\text{a})^{18}\text{F}$ ,  $^{18}\text{O}(\text{p},\text{n})^{18}\text{F}$ ,  $^{14}\text{N}(\text{p},\text{a})^{11}\text{C}$ ,  $^{16}\text{O}(\text{p},\text{a})^{13}\text{N}$ ,  $^{14}\text{N}(\text{d},\text{n})^{15}\text{O}$ .

### 2 Problems connected to the $^{18}\text{F}$ production.

The fluorine-18 production starting from  $^{18}\text{O}$  enriched water has showed several problems. In particular the most frequent one has been the fragmentation of the liquid column inside the transferring tube which made it difficult to collect the bombardment product because of the high resistance. At first it was ascribed to the high pressure of the transferring helium, set at 60 psi. But the tests performed at a growing pressure have put in evidence that this parameter affects only the yield of the fluorine production. The real problem was the damaging of the teflon and PEE lines internal surface, which convey the fluorine produced to the radiochemistry laboratory.

The fact that the target wasn't filled completely (0.7 mL of enriched water) caused the titanium and silver foils bombardment with the subsequent releasing of metallic ions. These ions damaged the transferring lines to the hot

cells when the irradiated liquid passed. This problem has been solved by increasing the  $H_2^{18}O$  volume up to 1.3 mL, though the nominal capacity was 0.7 mL.

Another cause of the reduction in the fluorine production depended on the release of silicone into the target, identified through GC and HPLC, due to the use of sterile disposable syringes. This problem has been solved by using Hamilton syringes for the filling of the target.

### 3 Changes of the target for an increased $^{18}F$ production.

The target formerly used for fluorine-18 production had two foils which put on the opposite surfaces of silver flange constituted the bombardment chamber. The 0.5mm silver back foil was cooled by deionized water while the 0.025 mm titanium front foil was cooled by helium current. This target caused many problems,; a difficult maintenance , a long radioactive exposure for the operator, a frequent gas and water leaks, and an insufficient cooling (fig. 1).

All these inconveniences have been solved by using a new target (fig. 2) which has one titanium foil placed before the bombardment chamber which is integrated in the silver flange. In fact the titanium foil is cooled by helium gas, while because of the increased surface of the back chamber water cooling has been improved. Besides the presence of the high pressure fittings has made it possible to remove the problems due to gas leaks. The replacing of the only foil is easy and allows a nominal exposure for the operator .

During the weekly production the transferring lines and the target are cleaned using ethanol and water. Then they are dried using helium current for fifty minutes. This is to prevent the  $H_2^{18}O$  enriched water dilution. In addition to this  $^{18}F$  collecting vials are flamed with a bunsen becco to avoid the  $^{18}F$  excessive adsorbment on the eventual microscratching of the internal surface of the vials.

- |                          |                  |
|--------------------------|------------------|
|                          | "Old"            |
| 1. Back plane            | Silver foil      |
| 2. Water cooling surface | Plane            |
| 3. Target connections    | Flanged fittings |

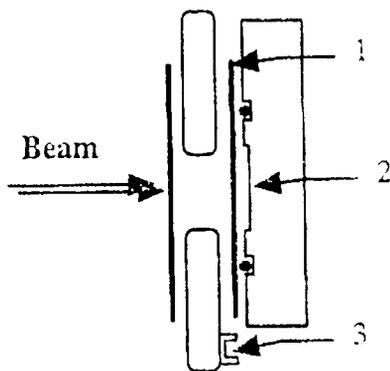


Fig. 1

- |                          |                                 |
|--------------------------|---------------------------------|
|                          | "New"                           |
| 1. Back plane            | Integrated in the silver flange |
| 2. Water cooling surface | Enlarged with fins              |
| 3. Target connections    | High pressure                   |

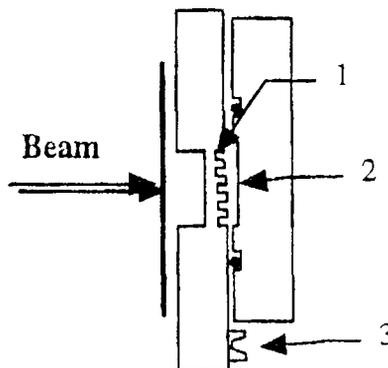


Fig. 2

### 4 Conclusion

A careful filling of the new target (.3 mL) with the use of the Hamilton syringes, by keeping the transferring lines perfectly cleaned, thus avoiding the production of metallic ions and silicone particles, has provided an increased fluorine-18 production (18.5 GBq) for the FDG synthesis.

The weekly maintenance of the target and the transferring lines has avoided the risks of a reduced production due to dilution of enriched water and  $^{18}F$  adsorbment.

This results in a reduced bombardment time, as only 30 minutes of irradiation are required to get a  $^{18}F$  quantity sufficient to provide 200 mCi of [ $^{18}F$ ] FDG.

### 5 References

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