Electrophilic fluoride-18 from an 11 MeV proton cyclotron for radiolabeling of presynaptic dopaminergic PET tracers

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The reliable production of ($\sp{18}$F) F$\sb2$ from an 11 MeV proton cyclotron has been achieved through the implementation of two accelerator targets built to exploit the copious $\sp{18}$O(p,n)$\sp{18}$F cross-section. Yields of electrophilic ($\sp{18}$F) F$\sb2$ from the targets reached deciCurie levels with specific activities approaching 3 Ci/mmole with 75 minute irradiations at 10 μA. Higher specific activities are expected with longer bombardments and increased beam current.

The targets, one nickel, the other with a gold-plated target chamber, have been tested for ($\sp{18}$F) F$\sb2$ production efficiency under two bombardment protocols. An economic two-step protocol cryogenically reclaims the precious enriched $\rm\sp{18}O\sb{2}$ target material following $\sp{18}$F production, followed by a second ($\sp{18}$F) F$\sb2$ recovery irradiation of Kr + F$\sb2$. Studies of target performance using this protocol under variable irradiation conditions suggest a five compartment model governing the in-target kinetics. Similarly, the ($\sp{18}$F) F$\sb2$ yields have been tested using a single irradiation protocol consisting of bombardment of $\rm\sp{18}O\sb{2}$ + F$\sb2$. Theoretical descriptions of beam induced phenomena in the irradiated target are also presented.

The behavior of these targets cannot be judged solely on the amount of reactive $\sp{18}$F which elutes from the target; successful radiochemical synthesis utilizing this $\sp{18}$F activity in a model reaction is the true test. Synthesis of 6- ($\sp{18}$F) fluoro-L-DOPA (6-FD) by the fluoro-demercuration method of Luxen served this purpose, testing the eletrophilic ($\sp{18}$F) F$\sb2$ gas from the two targets and two irradiation protocols. Elution of Kr + ($\sp{18}$F) F$\sb2$ from the two-step method achieved the expected 12% radiochemical yields from ($\sp{18}$F) F$\sb2,$ while experience with $\sp{18}$F activity eluted with oxygen from the single irradiation protocol suffered lower yields.

Solutions to problems associated with 6-FD studies for Positron Emission Tomography (PET) are addressed. A physiological compartmental model describing dopaminergic kinetics has been constructed to investigate PET's sensitivity to 6-FD metabolite formation. A high count rate, high efficiency plastic scintillator based automated blood sampler needed for input function collection is also reported. By resolution of these technical hurdles, pre-clinical PET imaging trials of 6-($\sp{18}$F) fluoro-L-DOPA in normal subjects have been initiated at Wisconsin.