$^{18}F^-$ saturation yield in Large Volume cylindrical IBA target

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Introduction

In last decade increasing demand for clinical F-18 Fludeoxyglucose requires a greater F-18 fluoride production. From the other side increasing price of enriched O-18 water compel us to find the most effective way of F-18 activity production. One of the possible way, how to optimize and increase yield of F-18, is to increasing target current with retaining the same or less volume of enriched water. Optimization of F-18 production on IBA **L**arge **V**olume cylindrical target is presented.

Methods and Results

Irradiations of [18O]H_2O by 18 MeV proton beams with intensities 40-55 μA were performed on CYCLON 18/9, IBA cyclotron and on **LV** cylindrical IBA target:

Table of Main parameters of LV cylindrical target.

Target current	40-55 μA
Target volume Filling volume	2.5 ml 2.0 ml
Target pressure	30-35 bar
Standard yield declare by IBA	5Ci/2h EOB
Window Burst Pressure	>50 bar

Irradiated enriched water was transported to the hot cell using RDS (Radioactive Delivery System) system and was measured in Curriementor 4 Isotope Calibrator made by PTW.
At the beginning it was necessary to satisfy several requirements:

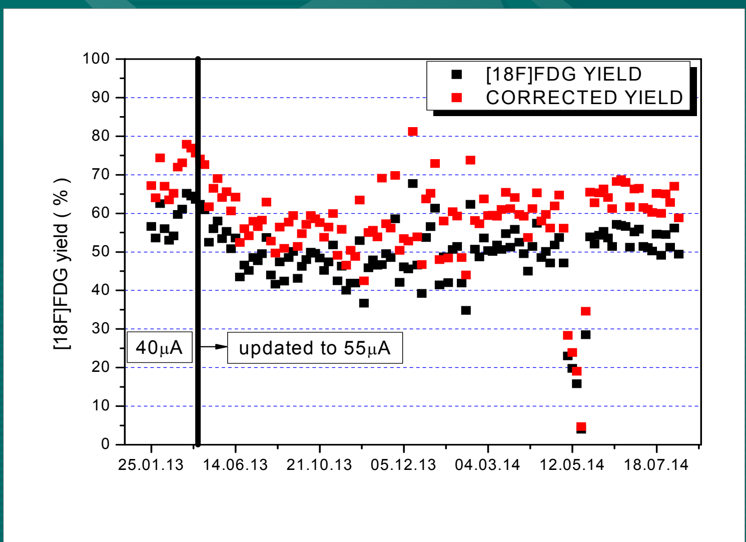
- **target and water cooling**.

Using a simple two dimensional equation we can roughly estimate the equilibrium temperature inside the target:

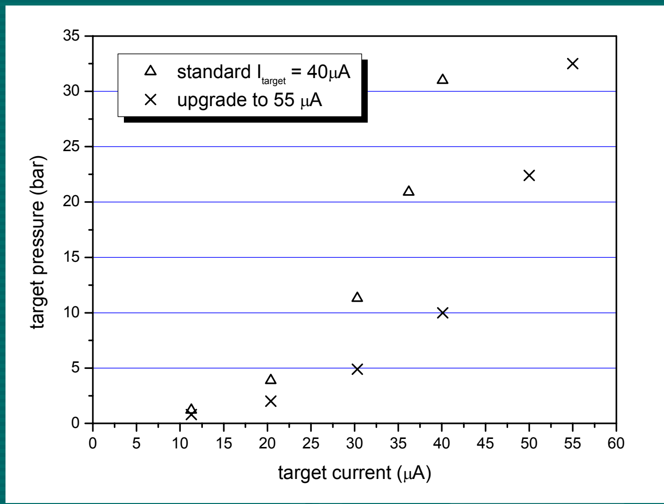
$$\Delta t = HT / Ak$$

where:
Δt= the temperature rise in the target chamber over cooling water temperature
H = is the heat load
T = thickness of target metal wall
A = area of metal in contact with target water
k = thermal conductivity
In our case with heat load 720 W= 40 μA * 18 MeV – Δt = 78 °C. From the curve of boiling point of water as a function of pressure, we can observe t = 212°C at 20 bar or 243°C at 35_bar respectively, which correspond max. heat load up to 90-95 μA of target current.

FDG synthesis yields.



Target Pressure as a Function of Beam Current



- **pressure and filling water volume.**

Filling water volume was from 2 to 2.15 ml to guarantee stop all beam in water. Also during experiments for safety reasons the operating pressure was limited to 35 bar as the window rupture pressure is >50 bar for used 0.05 mm Havar foil. In this case increasing target volume with increasing current was provided with longer tube.
The saturated yields of F-18 for 40 μA to 55 μA target currents are given in Table below. No systematic decrease in yields with increasing target current was observed and yields were in line with the 230±10 mCi/μA measured at acceptance test of target.

Activities in the target at EOB

Target current (μA)	*Satur. yield* (mCi/μA)		*Activity* ^{EOB} *1h* (GBq)
40	231	8.55	108
45.5	232	8.6	116
50	229	8.46	132.5
55	232	8.6	150

The [18F]FDG yields from productions using the TRACERlab-Mx module are shown in left Figure. All presented productions of F-18 were prepared with LV target with 55 μA. No decrease in the yield was observed with increasing beam current. The lower yields in May 2014 were due to problems with inpurity of enreached water [18O]H_2O.

Conclusion

It has been demonstrated that it is possible to produce routinely 250 GBq / 2 hr (6.8 Ci / 2 hr) of F-18 Fluoride using LV cylindrical target (operating conditions: 55 μA, 18 MeV, 98% enriched water). As the next step we want to test dual beam – 2 x 55 μA with two LV targets and expected activity about 500 GBq of F-18 Fluoride in 2 hours is expected.