Safety and control improvements in fluorine-18 production at CV-28 cyclotron

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This report presents a centralized network of radiation monitors installed in the CV-28 cyclotron's facility at this Institute [1] in order to improve both safety and control processes related to the production of fluorine-18 (^{18}F), a radioisotope used in Positron Emission Tomography (PET). To minimize radiation exposure of operating personnel, a pressurized capillary tube transfers the irradiated ^{18}F solution from the beam target inside the CV-28 accelerator chamber to a processing room and into a heavily shielded cell where the radiopharmaceutical fluorodeoxyglucose (FDG) is synthesized. The capillary tube is several meters long so any failure in the nitrogen gas pumping system that controls the transfer would take minutes to be noticed. To increase control of the transfer process, two radiation monitors have been placed along the tube. The monitors were designed and manufactured by the authors and encompass an internal Geiger-Müller tube for gamma radiation detection and a microprocessor which is responsible for all monitor's processing tasks: high voltage sensing and control, detector saturation sensing, pulse shaping and counting, radiation dose rate calculations and alarm threshold setting. Additionally, the monitors contain an Ethernet interface allowing them to send sensitive information - including radiation dose rate measurements - to a supervisory computer located in the cyclotron's control room. The first monitor was positioned next to the wall bordering the cyclotron chamber and the processing room. Sensing a sudden increment in gamma activity indicates the fluorine left the accelerator chamber and entered the processing room. This event is signaled to the supervisory computer, which promptly indicates it on screen for operator's acknowledgment. Another monitor was placed inside the FDG cell. For safety purposes, this second monitor also incorporates visual and audible alarms. Moreover, whenever gamma radiation is high in the cell, this monitor energizes the door's magnetic lock and senses a mechanical switch indicating the door is properly shut. Otherwise audible and visible alarms are triggered, both locally and at the control room. Figure 1 shows a photograph of the FDG cell with the second monitor located next to the capillary tube and above the processing station for FDG synthesis.

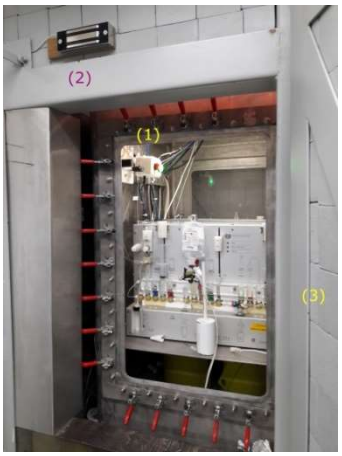

Figure 1. FDG cell: radiation monitor (1), magnetic door lock (2) and cell door (3)

Measurements from both radiation monitors as well as status from both the door lock and the door sensor are all presented to the operator at a computer screen in the cyclotron's control room as shown in Figure 2. Also, this supervisory interface allows remote adjustment of each monitor's alarm threshold independently. Thus, the presence of radiation monitors remotely connected to a supervisory computer in the control room along with automated door lock and alarms stand as further safety and control measures for production of ^{18}F at CV-28.

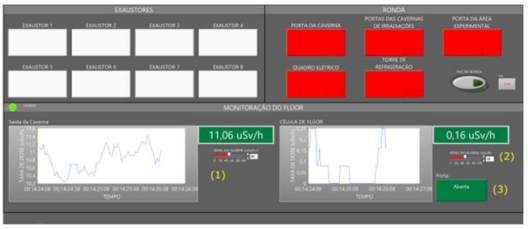

Figure 2. Supervisory computer screen with status of: first monitor (1), second monitor (2) and FDG cell door (3)

References

[1] DE LACERDA, F.; FARIAS, M.S.; NUNES, R.C.E.; SUITA, J.C.; DE SANT'ANNA, C.R. Safety and control improvements in fluorine-18 production at CV-28 cyclotron, Proceedings of the INAC 2019, ABEN.