

Modernization program of Cyclone®18 at CRC, ULg

IBA RadioPharma Solutions & IBA Customer Service, Louvain-la-Neuve, Belgium (www.iba-group.com)
Cyclotron Research Center, University of Liège, Belgium (<http://www.cyclotron.ulg.ac.be>)

The Cyclone® 18/9 at CRC

The IBA Cyclone® 18/9 was installed at the Research Center in 1999 and was integrated into a pharmaceutical facility that originally produced FDG, and which currently produces novel radio-pharmaceuticals for clinical trials in phases 1 to 3.

In Dec 2012, the modernization program of the cyclotron was ordered to upgrade to the latest equipment generation and to extend the lifetime of the equipment.



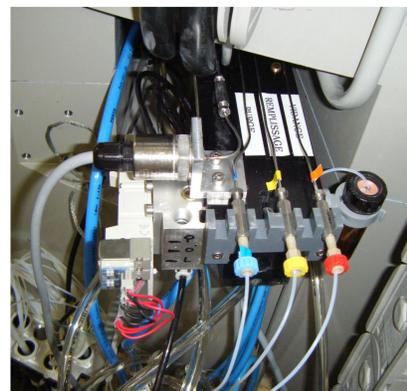
Before upgrade
outside & inside

Modernization, refurbishment and upgrade

Since the Cyclone® 18/9 was to be used in proton beam mode only it was decided to remove the deuteron source and upgrade to **Cyclone® 18/18 TWIN** proton sources.

The other sub-systems were replaced by modern equipment without changing the overall beam delivered by the cyclotron (~80 µA extracted).

The Siemens S5 PLC control system is now obsolete and no longer supported and is replaced by the S7 generation. The overall software interface was updated, but not to the full automatic mode available from IBA.



CRC's own development of Rheodyne pneumatic control was interfaced (right) with the control system and the ¹⁸O-filling & ¹⁶O-rinsing systems were fully updated with pneumatic rotating filling valves and a new distribution/switching system for ¹⁸F delivery to the labs.

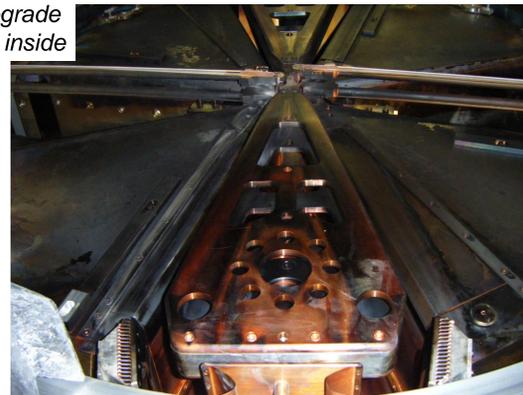
Electric cavity tuning

The new electric cavity tuning has an electric motor driven by the LLRF (low level RF rack) to tune the resonant frequency of the cavities of the Cyclone®18, this replacing the hydraulic system. This reduces maintenance and provides a better stability and tuning of the RF resonant frequency.

PLC control system S5 to S7

Since the existing S5 PLC was unsupported anymore by Siemens and in view of such large modernization program with additional capabilities in ¹⁸F target filling, rinsing and switching, the PLC control was updated to the modern S7. A new Dell server with better performance and reliability (dual hard disk mirror) is now running the InTouch User Interface, providing more feedback to the user and allowing remote connectivity and multiple control stations. Four control stations are installed within the CRC facility.

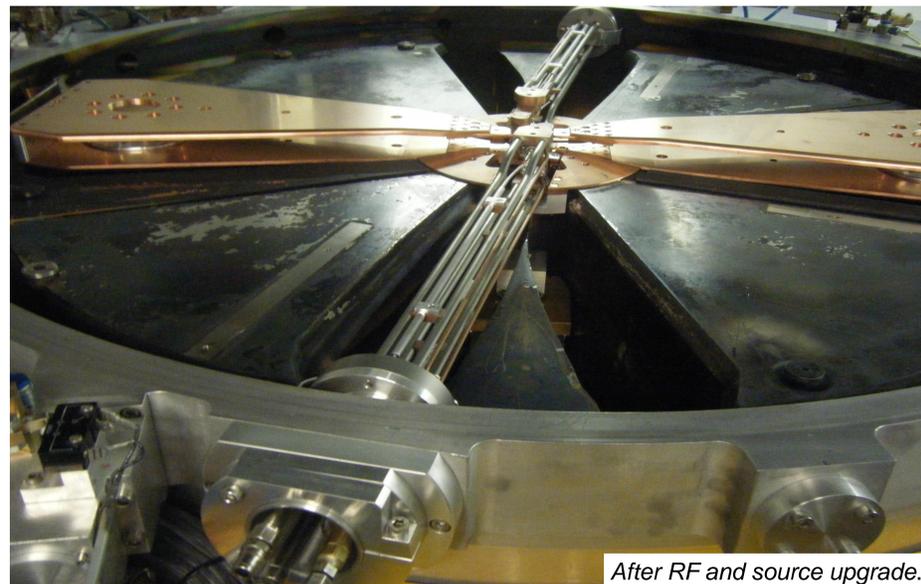
New central region, Dees' and TWIN proton sources



The cyclotron central region, dees & counter-dees were upgraded to house two proton sources (IBA 18/18 TWIN – patented) with the latest generation of ion source body in stainless steel.

The duplication of sources is an advantage in operation and helps reduce maintenance tasks.

The new source body has improved cathode holders, lower gas leakage under vacuum and has a centering pin for easier tuning.



After RF and source upgrade.

New Radio Frequency (RF) amplifiers & LLRF



New control PLC & server + LLRF+ driver cabinet.

A modern solid state (transistor) pre-driver and a new Low Level RF control unit (LLRF) were installed together in the PLC cabinet (left picture).

The RF final amplifier (tube based, filament driven) with improved stability, reliability and tuning was installed together with a new Heliac™ cable to supply the cyclotron.

A double kapton insulation in the final amplifier is less prone to damage and reduces maintenance.

The overall RF chain is now more stable and reliable, with better tuning and feedback to the supervision system. It is identical to the current out-of-factory cyclotrons, fully supported by IBA.

Helium cooling system & valves

The Helium valve manifold was replaced by the latest helium valves installed at the immediate exit of the target. The blue plastic tubing is replaced by stainless steel distribution loops (seen in lower part of picture), with flow and return connections at each target (grey lines with the helium isolation valves also shown), less prone to leakage and providing higher helium flow to the targets.



The Helium compressor is the latest KNF model at high flow with double-head and water-cooling.

New target manifold; Helium valves & connectors

Conclusions

This major refurbishment program was conducted in two phases, in **close collaboration with the CRC team and IBA team** to respect the program schedule and work in an efficient and safe way. Dual beam operation is improved with the automatic compensation coil system (IBA-patent) and the new helium cooling.

The new machine was back on-line in January 2014, after one month of work, providing the expected level of performance since then.

The Cyclone® 18/18 is now ready for the future, its useful lifetime has been extended for at least another 20 years without costly decommissioning of major parts (e.g. magnet yoke).

Through the modernization and the 3 additional targets, production reliability and **personnel radiation protection** are increased as well.



Cyclone® 18/18 after modernization

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*contacts: françois.marchal@iba-group.com; Christian.Lemaire@ulg.ac.be