

## INSTALLATION AND COMMISSIONING OF THE Cyclone®70P: Zevacor PROJECT

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### Abstract

In October 2013, IBA sold its first Cyclone®70p, extracted 70 MeV proton machine to Zevacor Pharma, Indianapolis, IN, USA.

This brand new machine combine the advantages of the design of the Cyclone®30 HC (1,5mA extracted beam) and the Cyclone®70 XP (multi-particle). Moreover, this high energy cyclotron has been optimized for  $H^-$  ions acceleration, activation reduction and long term beam production.

The installation will be used for high power and long term irradiations of rubidium Rb targets to produce strontium  $^{82}\text{Sr}$  generator applied in the field of cardiac imaging.

From cyclotron to beam lines and up to the target station, all subsystems have been reviewed to reach highest level of quality, reduce the activation (by the use of low activation material and reduction of beam losses) and finally optimized the maintenance.

For that delivery, the machine will be equipped with 6 beam transport lines and 2 solid target station units.

In June 2015, about 21 months after contract signature, the IBA Factory Acceptance Tests have been successfully performed in Belgium and the machine was shipped to Indianapolis, IN, USA to be installed in Customer factory cyclotron vault.

### RIGGING AND INSTALLATION

In September 2015, the Cyclone® 70P and auxiliary equipment have been successfully rigged (inserted) into the various vaults (see Figs. 1-3).

This 140 tons cyclotron and its surrounding equipment reached their final position in a few days allowing the installation start up.

The installation has been started according to ambitious schedule (3 months in advance of the contractual planning) thanks to a very good collaboration with the Customer during the whole building construction.

### COMMISSIONING

The Cyclone® 70P for Zevacor Pharma (Figs. 4-6) is delivering 70 MeV proton beam to up to 6 target vaults.

All those vaults (cyclotron and targets) have typically 4m concrete walls to shield it.

The beam is extracted thanks to stripper shaft (variable energy from 30 to 70 MeV) through 2 switching magnets located on each side of the cyclotron to the beam lines.

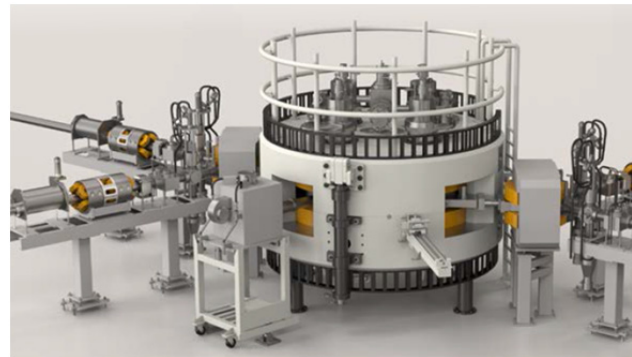


Figure 1: Cyclone® 70P general overview.



Figure 2: Cyclone® 70P rigging in Indianapolis.



Figure 3: Cyclone® 70P in vault in Indianapolis.

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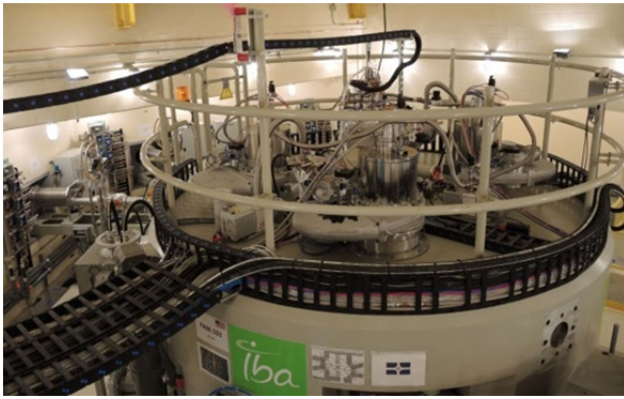


Figure 4: Cyclone® 70P : ion source.

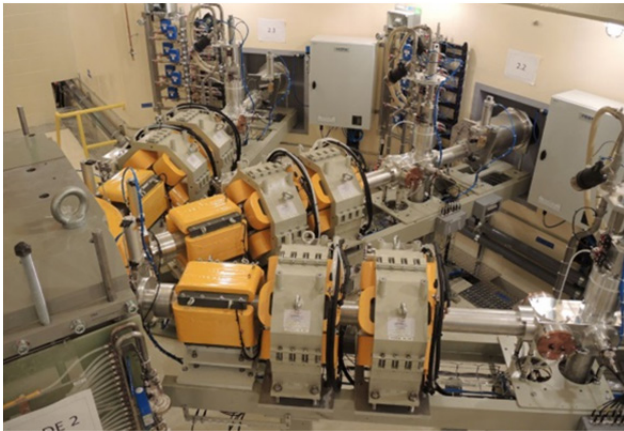


Figure 5: Cyclone® 70P: 3 beam lines on one side.



Figure 6: Cyclone® 70P: cyclotron beam transport line and the solid target station

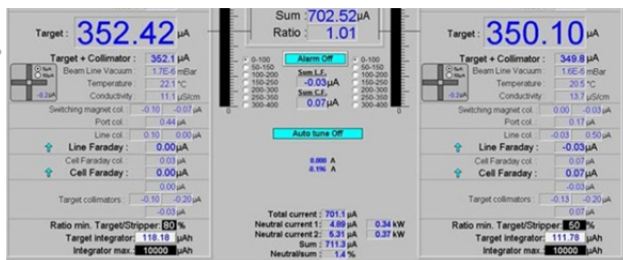


Figure 7: Cyclone® 70P: first full beam extraction (dual beam mode).

In March 2015, the beam was optimized and then was extracted at 70 MeV out of the cyclotron and injected into several beam transport lines.

The beam was transported during the first week in the single beam and then in the dual beam mode.

About 8 weeks later, full beam (700  $\mu\text{A}$  in dual beam mode) was successfully extracted on specific beam stops (beam dumps). See Figure 7.

The machine commissioning started with the RF system in November 2015 up to the internal beam production in December 2015.

By end of January 2015, the whole equipment installation (i.e., cyclotron, beam lines, targets and ancillaries) have been done, piped, wired, etc. The whole system was ready for beam extraction.

The internal beam losses (i.e., magnetic and vacuum stripping losses) at full beam current represent only about 1% of total beam current thanks to the choice of the RF mode (harmonic 4) and the optimization of vacuum pumping system.

From June to end of July, site acceptance tests and training have been performed on the machine. By the end of July 2016, the full system was accepted by Customer and the hand-over has been done.

## CONCLUSIONS

IBA successfully designed a 70 MeV proton-only accelerator. This brand new machine has been designed, assembled, installed and validated in less than 32 months (i.e. about 5 months ahead of contractual schedule).

This world record planning was reached thanks to the close collaboration with Customer on building construction and commissioning.

*“The collaboration with IBA on this project has been great from the start, said Zevacor Molecular Executive Vice President and Chief Operating Officer, John Zehner.*

*IBA worked closely with our management team to provide the timely information needed to complete this complicated project ahead of schedule by several months.*

*Our expectations have been exceeded in both the technical support and equipment specifications. We definitely recommend IBA for the supply of high energy cyclotrons.”*