Cyclone® 30 : high current and multi-particle status

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INTRODUCTION

To extend customer choice in the high energy range, IBA has developped the Cyclone® 30 High Current (1.2 mA H- called HC) and the Cyclone® 30 Multi-particle (H-/D-/He++ called XP). Those 2 cyclotrons are based on the well known Cyclone® 30 with the same yoke dimensions and main functionalities.

C30HC : from 800µA to 1.2mA

The well known IBA C30 cyclotron have been upgraded to a new high current version (C30HC). For this purpose a new ion source, a new injection line and a new central region have been designed and tested. A new final amplifier will provide 100 kW of RF power for beam acceleration.

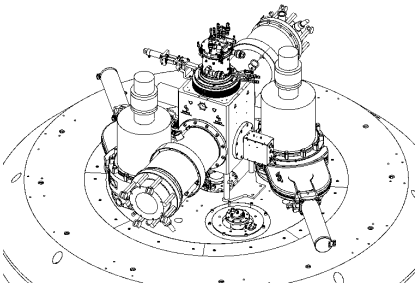

Figure 1: C30 HC - New injection line- general overview

On the top of the accelerator, the ion source is mounted on top of the vacuum box containing an Einzell lens, a buncher and a Faraday cup. The axial bore of the cyclotron contains a X-Y steerer, a solenoid and two small quadrupoles (whose position can be adjusted in rotation to match the emittance from source to central region).

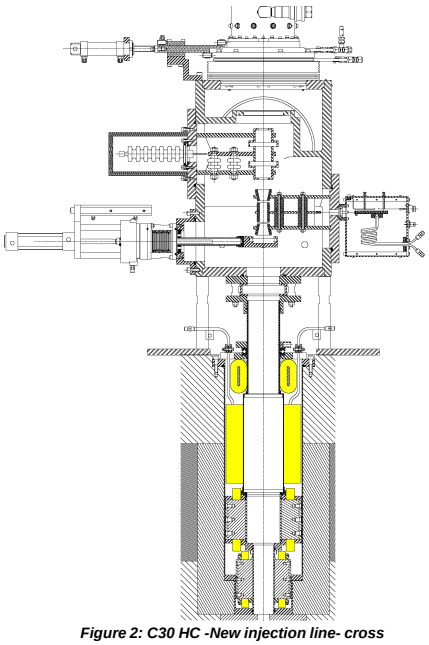

Figure 2: C30 HC -New injection line- cross section

The vacuum system has been improved by using two turbomolecular pumps. This improvement will reduce vacuum stripping in the injection line during beam handling from source to central region.

The fully assembled cyclotron passed the factory tests in 2010. In order to avoid machine activation, beam test went no further than the ion source system and central region. The results were good and demonstrated beam currents up to 2 mA on pop up probe (at 1 MeV in the machine).

The installation took place in 2011 in Turkey (Taek - Ankara).
During the last months, the high current version successfully completed all site acceptance tests, and especially those regarding the upgrade, namely 1.2 mA accelerated on one extraction port and a dual beam production at 2*500µA.
Furthermore, the machine has shown good behavior up to 1.5 mA extracted current.
The cyclotron shows an exemplary stability during commissioning and acceptance tests, such that the handover by the customer has been done early in March.

C30XP : He++ beam at 30MeV

The IBA C30xp cyclotron is an upgrade of the famous IBA C30 cyclotron that will accelerate two families of ions.
• q/m = 1/2 : α accelerated to 30 MeV and D- ions in the 7.5-15 MeV range.
• q/m = 1/1 : H- ions in the 15-30 MeV range.
The adjustment of the magnetic field is achieved by altering the q/m=1/2 magnetic field using movable magnetic inserts in two opposite valleys.

The injection system is based on the design of the Cyclone® 70 installed in Nantes. This ion source bench is composed on one side of a H-/D- ion source and on the other side by a He++ ion source (Supernanogan® from Pantechnik). At ion source exit, beams are first focused glazer lenses, then bent by a central magnet and focused by a quadrupole triplet. Like in the C30HC version, the injection line also contains a buncher, einzel lenz and faraday cup installed in a vacuum box located just underneath the cyclotron yoke.

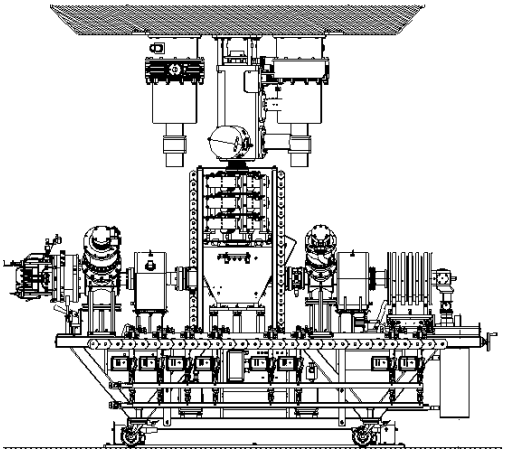

Figure 3: C30 XP -3 particles injection system

The axial bore of the cyclotron houses the last elements of the injection line a XY-steerer. A focusing solenoid and two small quadrupoles (position adjustable in rotation to match the emittance from source to central region) and an

The acceleration will be provided by using a specific dual frequency amplifier and set of cavities [3]. Indeed, the q/m = 1/1 and the q/m =1/2 particles will all be accelerated on the fourth harmonic, hence at about 68 Mhz and about 34 Mhz, respectively.

Two methods of extraction for positive or negative accelerated ions will be used:
• negative ions H^- and D^- will be extracted by stripping, allowing to extract at various energies (from 15-30MeV). The stripping extraction systems will be installed on two opposite sides of the cyclotron, permitting dual beam mode production.
• positive α particles will be extracted using an electrostatic deflector installed on one cyclotron side.

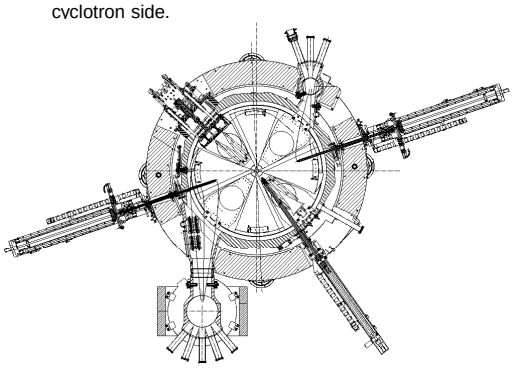

Figure 4: C30 XP – Median plane view

The multi-particle version ended up its factory acceptance tests (e.g. mechanical integration, tests of functionalities) at Louvain-La-Neuve (Belgium).
The rigging have been done at Jülich and the installation will start within 4-6 weeks. The beam acceleration and full power tests will be validated on site but most of the risks have been mitigated during the factory tests.

REFERENCES

[1] ECPM 2009- IBA C30 Cyclotron Beam Intensity Upgrade
W. Kleeven, S. Zaremba, M. Abs and B. Nactergal

[2] ECPM 2009 - Design of IBA C30xp Cyclotron magnet E. Forton, S. Zaremba, W. Kleeven, M. Abs

[3] ECPM 2012 - New dual frequency RF system for Cyclone 30XP M. Abs, B. Nactergal, T. Lamon, T. Vanderlinden

Slide 1

efo3 Il faut mettre plus de détails sur ces références => conférence ECPM, conférence cyclo etc...
Eric Forton, 5/3/2012