Accelerator activities 2012

RCNP accelerator group operates the cyclotron cascade system to provide high quality beams for various experiments in nuclear and fundamental physics and applications. The cyclotron upgrade project is on going to give intense proton beam more than 10 μA with little beam loss on the way from the AVF cyclotron to a target. A 2.45 GHz proton source is under development to provide high brightness proton beams. Improvements of accelerator components have been continued as well. Here is a summary of achievements in 2012.

Operation:

In 2012, cyclotrons were stopped after July, because the AVF cyclotron building was reformed for anti-earth quake. The operating statistics is given in Table 1. Table 2 and 3 show accelerated ion species and the beam on target for different beam lines.

Table 1. Operating statistics in 2012

Beam time for experiments	2450^{h} 08^{m}
Tuning of beam for experiments	402^{h} 44^{m}
Developments	1131^{h} 26^{m}
Total	3984^{h} 18^{m}
Scheduled maintenance and set up for experiments	1739^{h} 24^{m}
Unscheduled shutdown	100^{h} 18^{m}
Scheduled shutdown & Holidays	2960^{h} 00^{m}
Total	4799^{h} 42^{m}

Table 2. Accelerated ion species.

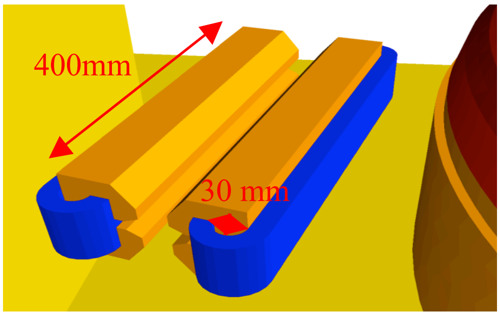
Proton	1445^{h} 44^{m}
3-He	174^{h} 37^{m}
Alpha	536^{h} 17^{m}
6-Li	211^{h} 57^{m}
12-C	80^{h} 31^{m}
16-O	25^{h} 00^{m}
18-O	94^{h} 27^{m}
20-Ne	31^{h} 04^{m}
22-Ne	36^{h} 03^{m}
132Xe	203^{h} 50^{m}
POL-P	1144^{h} 48^{m}
Total	3984^{h} 18^{m}

Table 3. Beam on target for different beam lines.

D	0^{h} 16^{m}
G	60^{h} 43^{m}
K	171^{h} 30^{m}
J	41^{h} 02^{m}
WS	1389^{h} 02^{m}
WSS	91^{h} 08^{m}
WN	314^{h} 50^{m}
N0	66^{h} 41^{m}
EN	158^{h} 28^{m}
ES	91^{h} 25^{m}
ENN	65^{h} 03^{m}
Total	2450^{h} 08^{m}

Developments:

In the extraction region of the AVF cyclotron, mismatching of the extracted beam trajectories to the medium energy beam transport (MEBT) system and insufficient beam focusing in the extraction region caused beam loss and activation of the extraction components. A horizontal beam spread caused by a steep fall of a cyclotron field is compensated by a field gradient corrector before extraction. The new gradient corrector has a set of quadrupoles similar to a normal quadrupole lens. The pole face of the corrector doesn't have an exact hyperbolic shape due to the non-linear external field distribution in the extraction region. In order to generate transversally-reversed field gradient, pole pieces are separated into right and left parts and upper and lower poles are combined by an iron return yoke on each side. An active of a sixteen-turn hollow conductor is mounted on each return yoke. Two coils are independently excited. Field gradient was measured to satisfy matching conditions for 839 MeV ^{129}Xe with the largest rigidity of 1.64 Tm [1]. Figure 1 shows the three dimensional model and a photograph of the assembled gradient corrector. Performance test will be done in 2013.



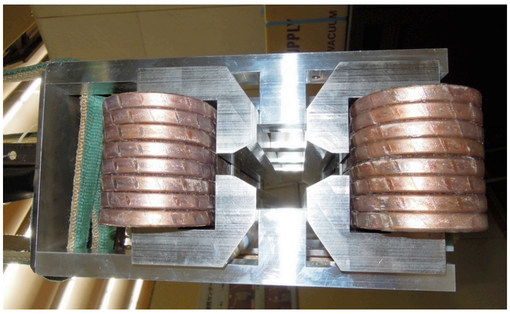


Figure1: Three dimensional model (left) and the photograph of the assembled gradient corrector (right).

A 2.45 GHz ECR source was built to increase proton currents High intensity is strongly requested for UCN and muon production. Figure 2 shows a photograph of the source. Three ring permanent magnets generate magnetic field which does not have a mirror shape. The maximum RF power is 2 kW. BN plates are put both ends of the plasma chamber. 0.8 mA proton was observed at the extraction voltage of 15 kV. Developments are ongoing to achieve higher intensity than 1 mA [2].

Figure 2: A 2.45 GHz proton source.

[1] M. Fukuda et al., Proceedings of CYC2013, TUPSH006.

[2] T. Yorita et al., Proceedings of CYC2013, TUPPT016.