MOP031

Design of High Sensitive Magnet and Beam dynamics for AMS cyclotron

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Abstract

To produce a Carbon 14 for Accelerator Mass Spectrometry (AMS), AMS Cyclotron magnet was designed. For AMS system, Cyclotron magnet has been required high mass resolution. In order to realize high mass resolution, the phase error is designed within ±10 and the mass resolution was 5000. Cyclotron electromagnet was designed with a mass resolution of 5000, a harmonic number of 10, a center magnetic field of 0.5332 T, a maximum energy of 200 keV, a minimum turn separation of 1.2 mm. and a size of 1580 mm x 800mm. We used CST particle studio and Cyclone for beam dynamics simulation of this cyclotron magnet. This paper describes AMS cyclotron magnet and beam dynamics design.

AMS Cyclotron structure

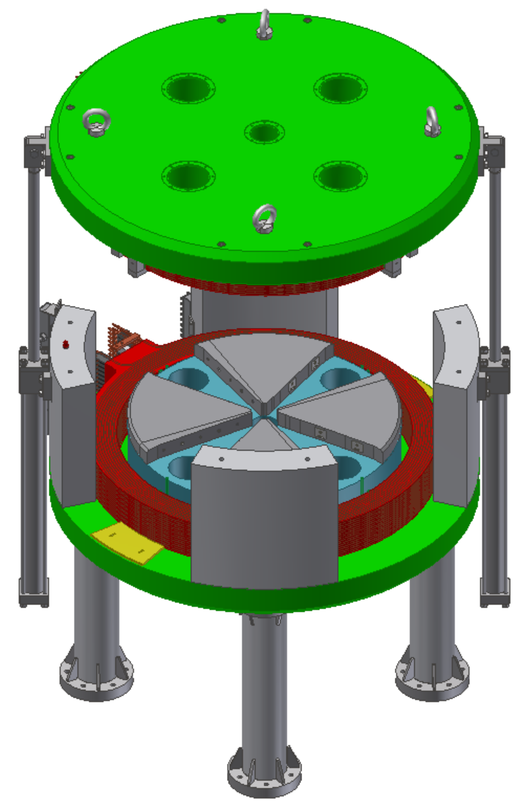

Fig 1. 3-D drawing of AMS cyclotron

Table 1. AMS cyclotron magnet specification

Parameters	Values
Maximum energy	200 keV
Beam species	Carbon-14 negative
Ion source	Cs sputtering
Number of sectors	4
Hill angle	60°
Valley angle	40°
Pole radius	0.510 m
Extraction radius	0.453 m
Hill / Valley gap	0.25
Harmonic number	10
Radio frequency	5.8 MHz
Radial tune	~ 1.01
Vertical tune	0.4
B-field (min., max.)	0.137, 0.687 T

Design and system description

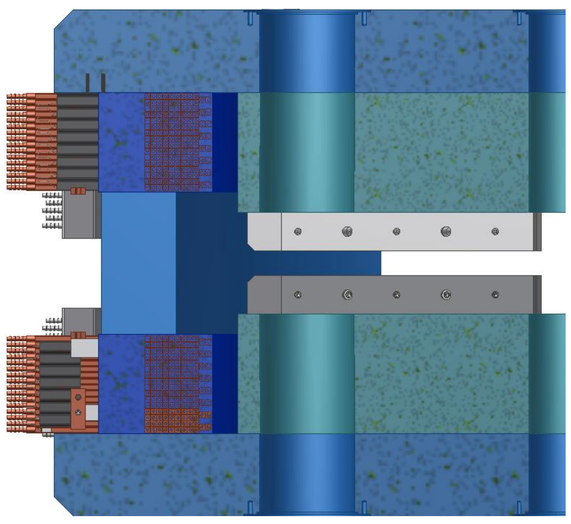

Fig 2. AMS magnet side view

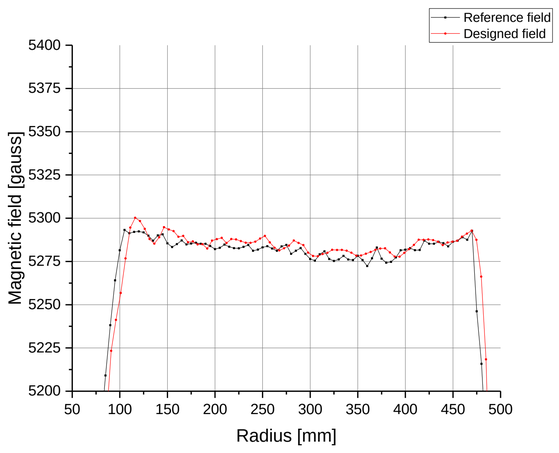

Fig 3. AMS Cyclotron magnetic field

- The 3-D drawing of AMS cyclotron magnet is shown as fig. 2. This magnet has been adopted to design of low valley which can reduce the power consumption of magnet.
- The magnetic field was modified by magnetic field error calculation. The magnetic field error between reference field and designed field should be less than 10 Gauss for get high quality of carbon-14 beam

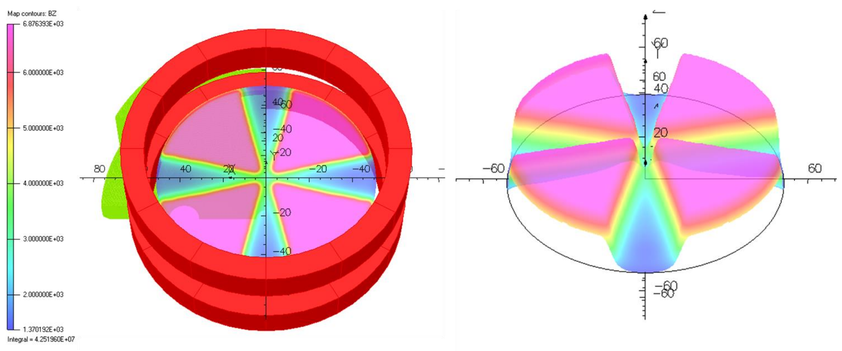

Fig 4. Magnetic field simulation

The magnetic field design is based on basic design parameter and calculated by TOSCA Opera 3-D.

Results and discussion

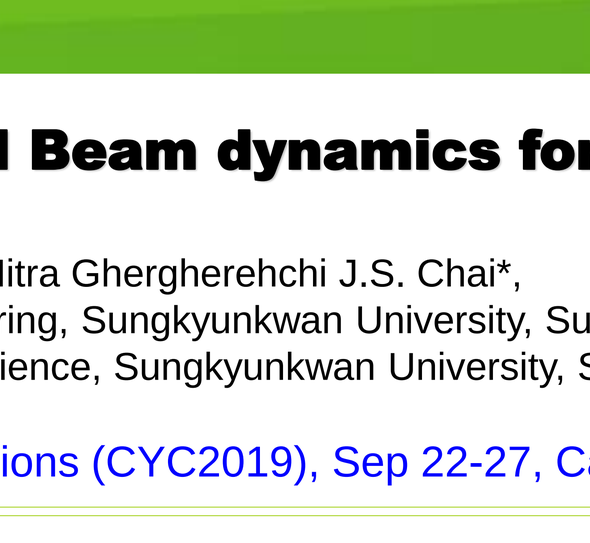

Fig 4. Cyclone beam simulation

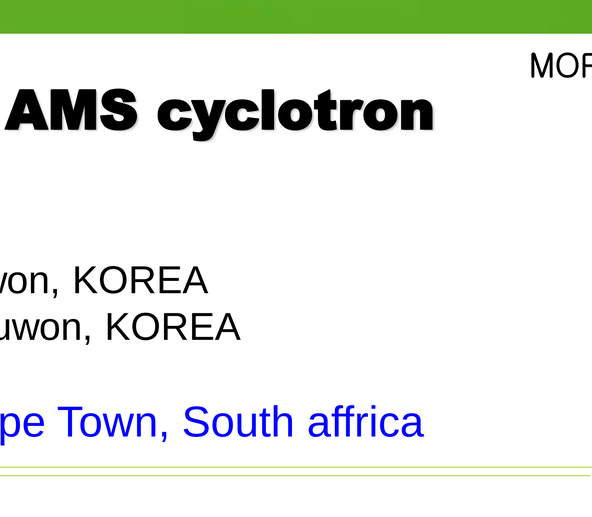

Fig 5. CST particle studio beam simulation

- The Carbon-14 beam is accelerated form 20keV to 200 keV
- Fig 4. shows a single particle trajectory simulation using CYCLONE code
- Fig 5. shows a multi particle trajectory simulation using CST particle studio.

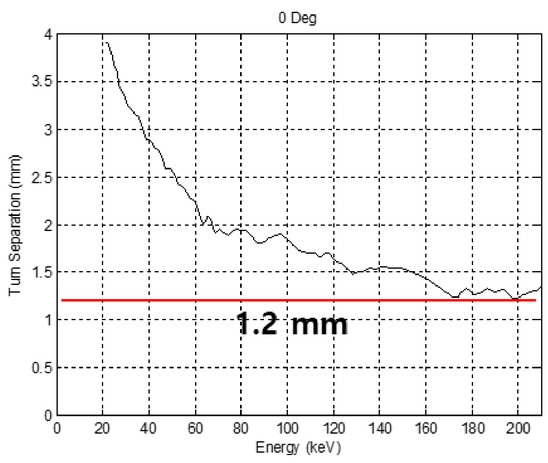

Fig 6. Minimum turn separation of carbon-14

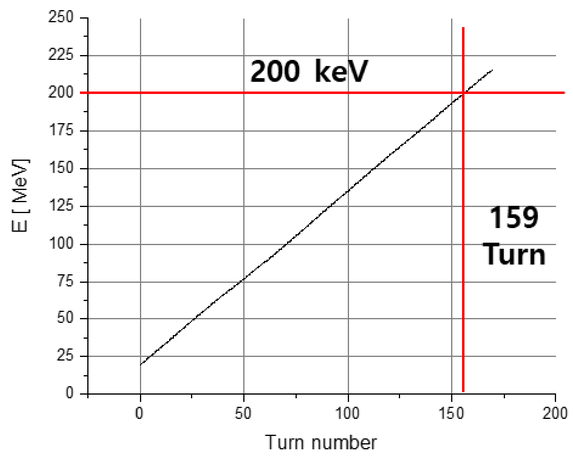

Fig 7. Energy increasement of carbon-14

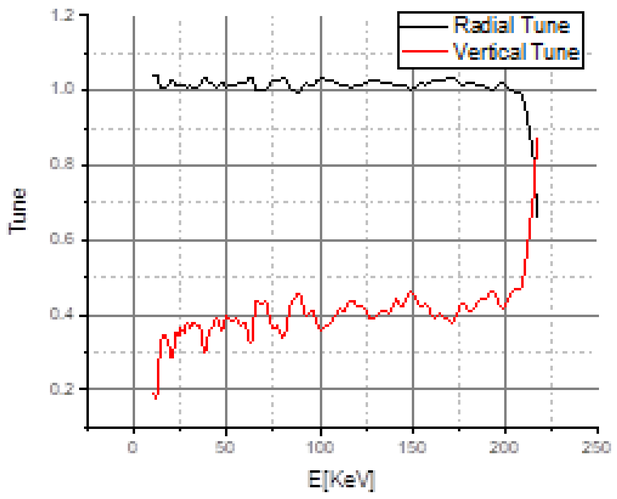

Fig 8. Radial and vertical tune of AMS cyclotron

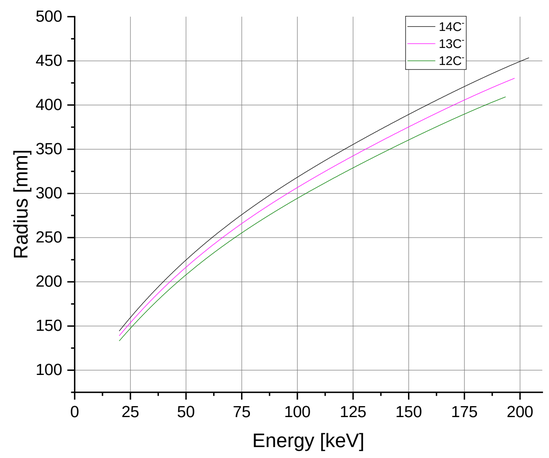

Fig 9. Acceleration graph of various particles

- Carbon-14 is accelerated to over than 200 keV, carbon-13, 12 is cannot accelerate to 200 keV.

Conclusion

In this study, Magnetic field measurement instrument for compact cyclotron has been developed. Magnetic field measurement system measures the field in the range of 5 mm for radial direction and 1 degree for angular direction. The range is adjustable in the program code. Magnetic field measurement system can monitor the field intensity synchronously. This magnetic field measurement instrument was adopted simple structure and magnetic field measurement error was less than 0.1 Gauss. It is utilized for full field mapping of electromagnet with high accuracy.

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