

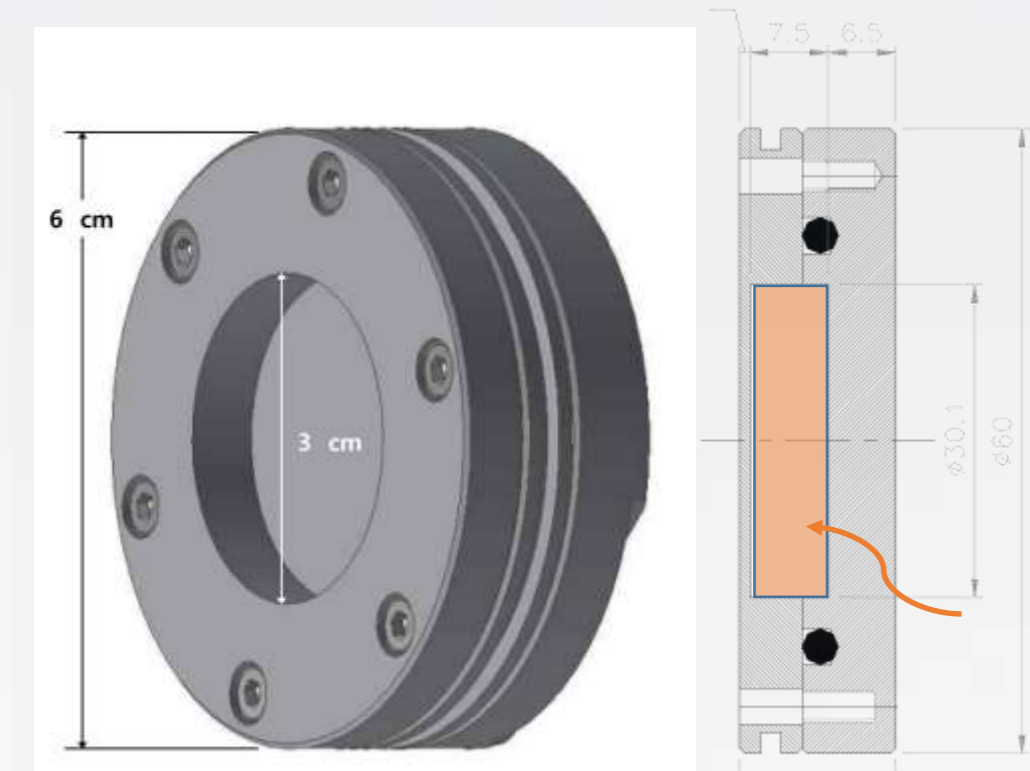
Fabrication and Operation Test of Beam Wobbler Using Halbach Dipole Magnets for KOMAC RI Production Beamline



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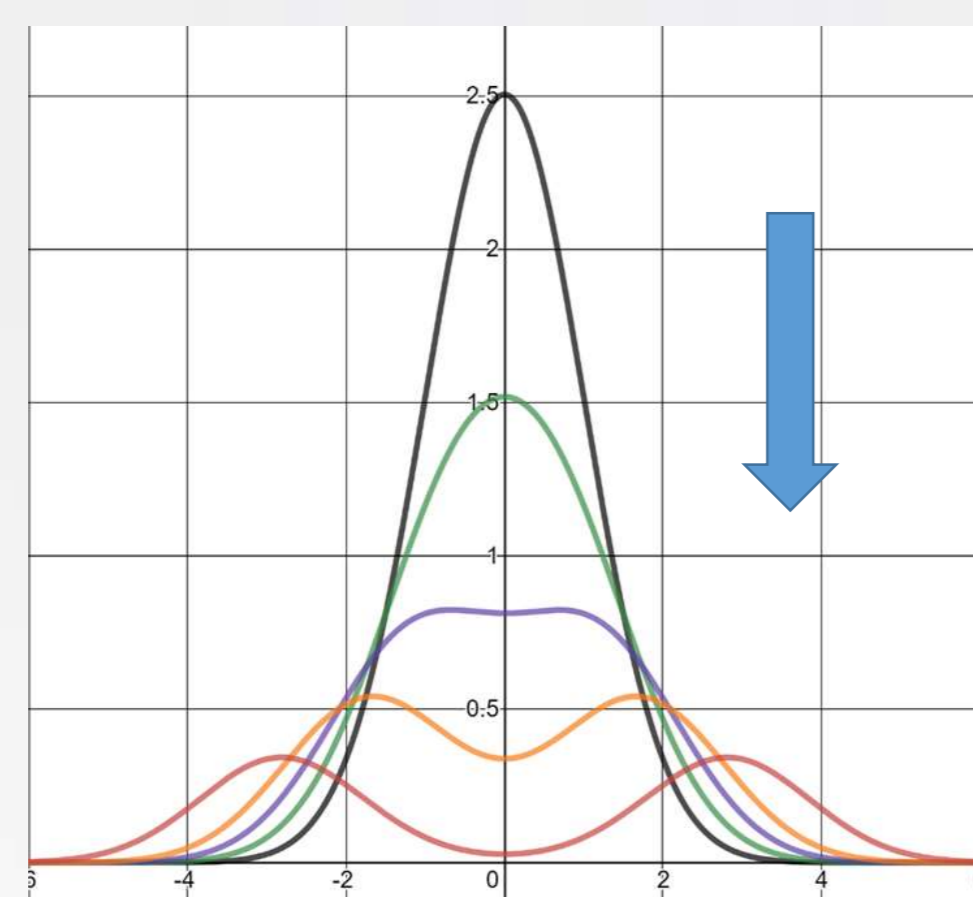
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Beam Wobbler using Halbach Dipole Magnets for RI Production Beamline @ KOMAC

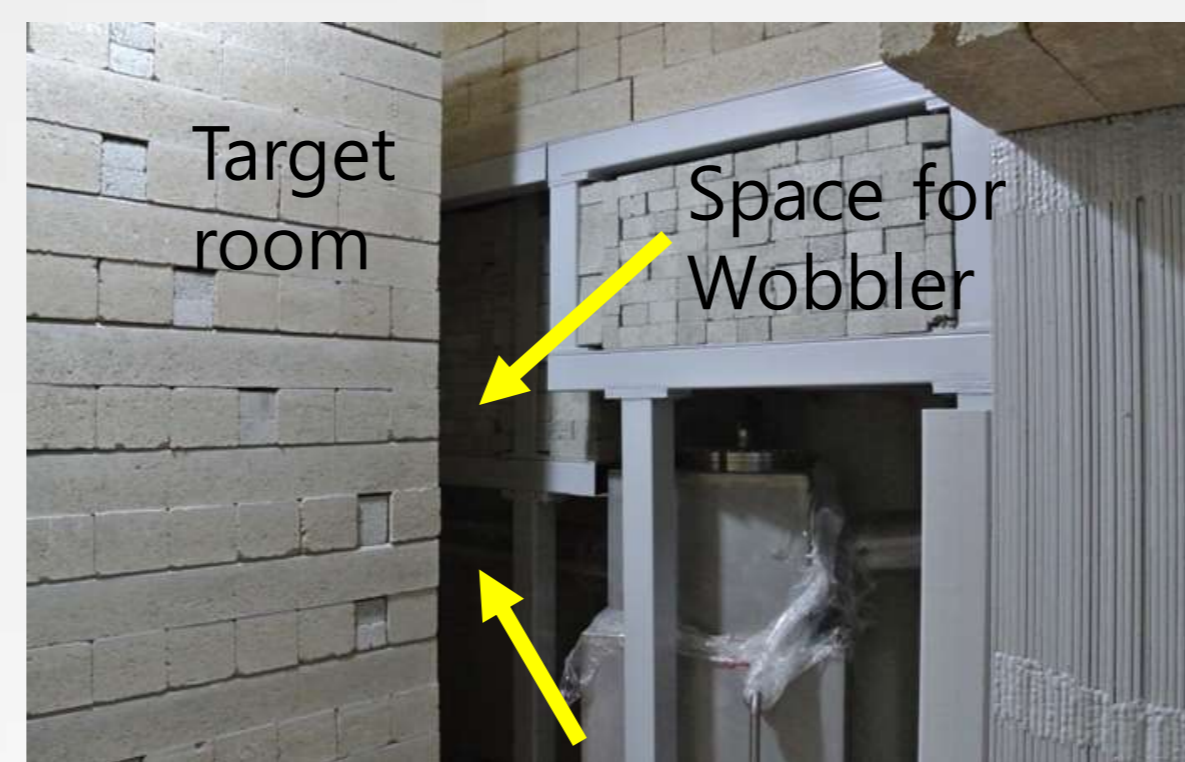


RI production target
(1.5 cm radius)

Preventing target damage by high power proton beam and improving utilization of target are important.



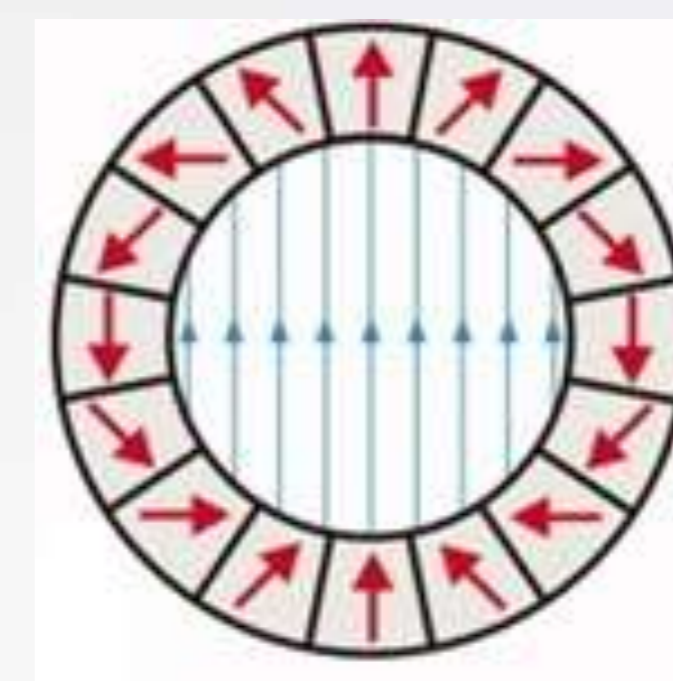
Using wobbler,
- Reduce peak power
- Improve uniformity
- Minimize beam loss



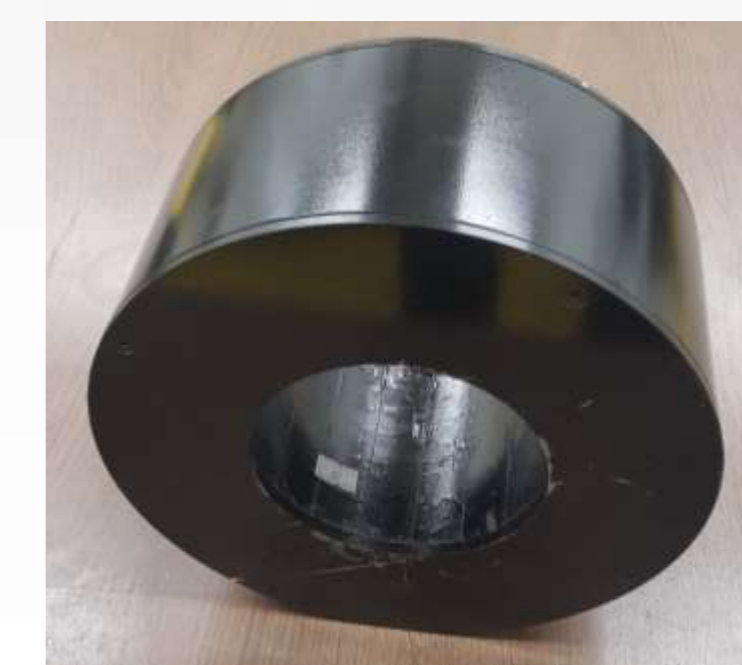
Only <100 cm long, <50 cm wide wobbler is accessible

Absolutely out of space
⇒ Wobbler should be installed in target room
⇒ Electromagnet wobbler is impossible

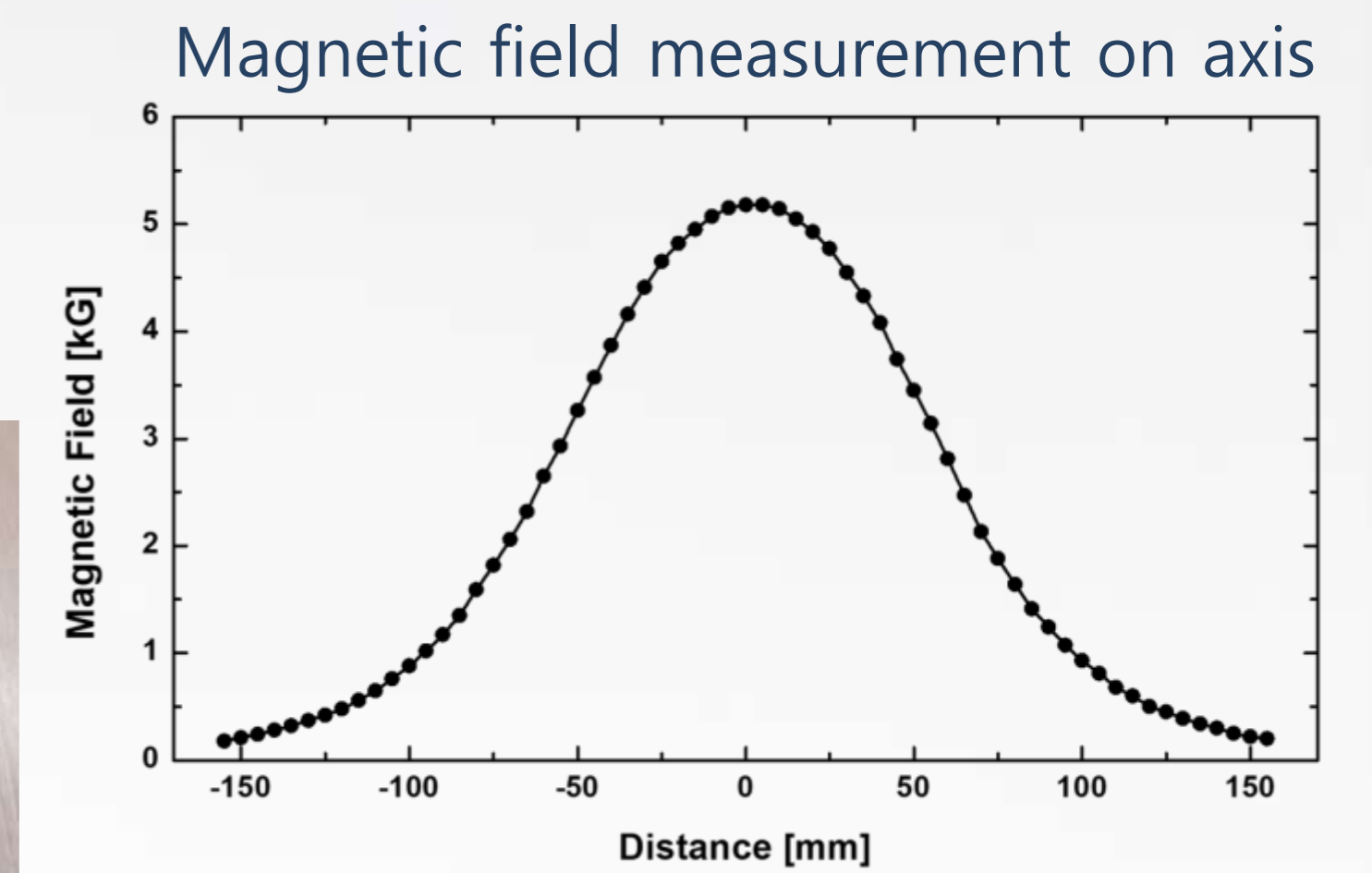
∴ Need a wobbler with rotating permanent magnets
And as simple as possible considering installation, radiation environment, and maintenance



Halbach Dipole Magnet :
consisting of small permanent magnets,
outer magnetic field is almost zero.

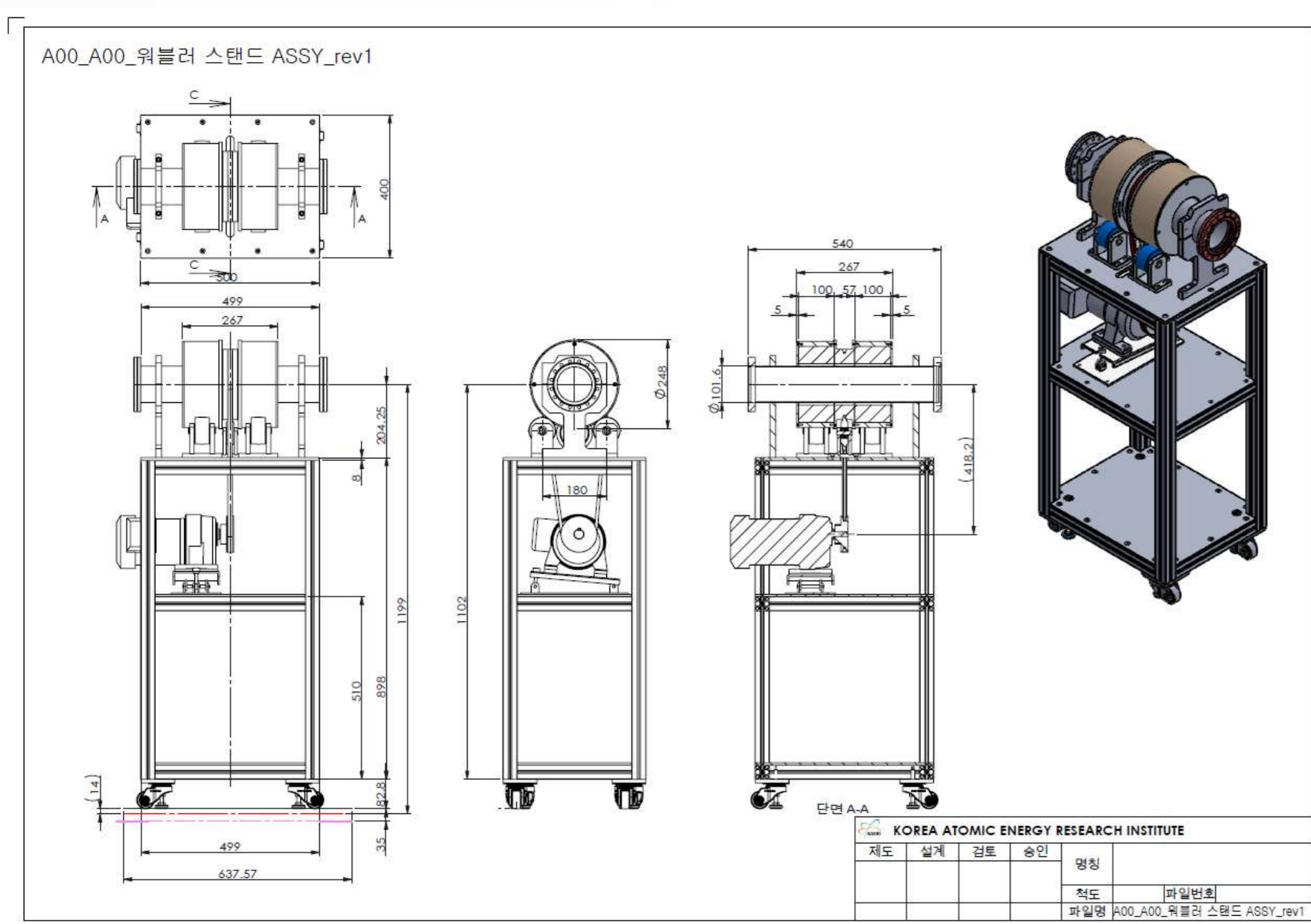


Halbach Dipole Magnet
to be used

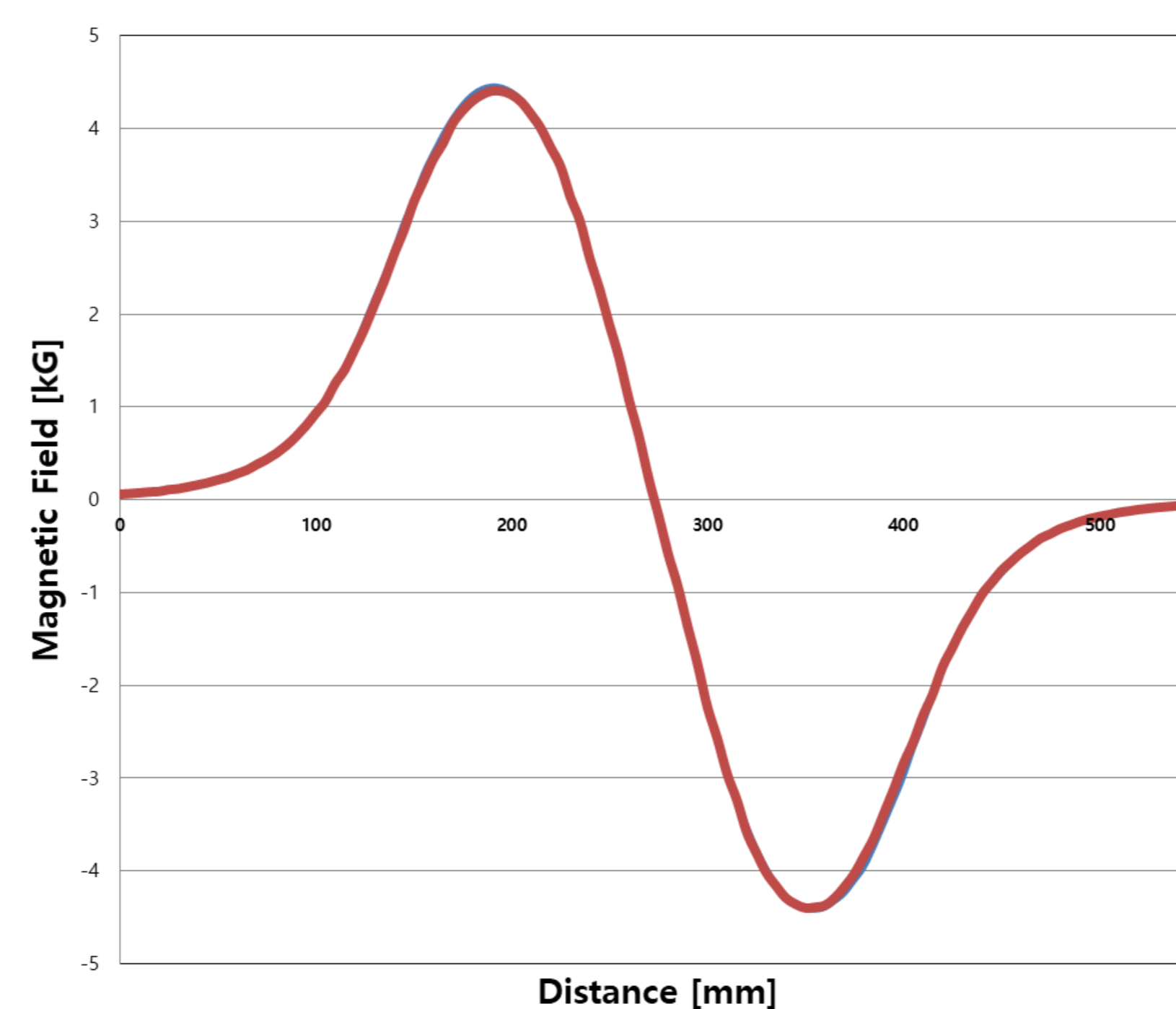


$B \cdot L = 0.0689 \text{ T}\cdot\text{m}$
⇒ 2.7° bending for 100-MeV proton
⇒ If proton moves forward 150 mm,
it moves 7 mm in transverse.

Fabrication of Beam Wobbler



Fabrication drawing



Measured magnetic field of wobbler magnets
@ central axis

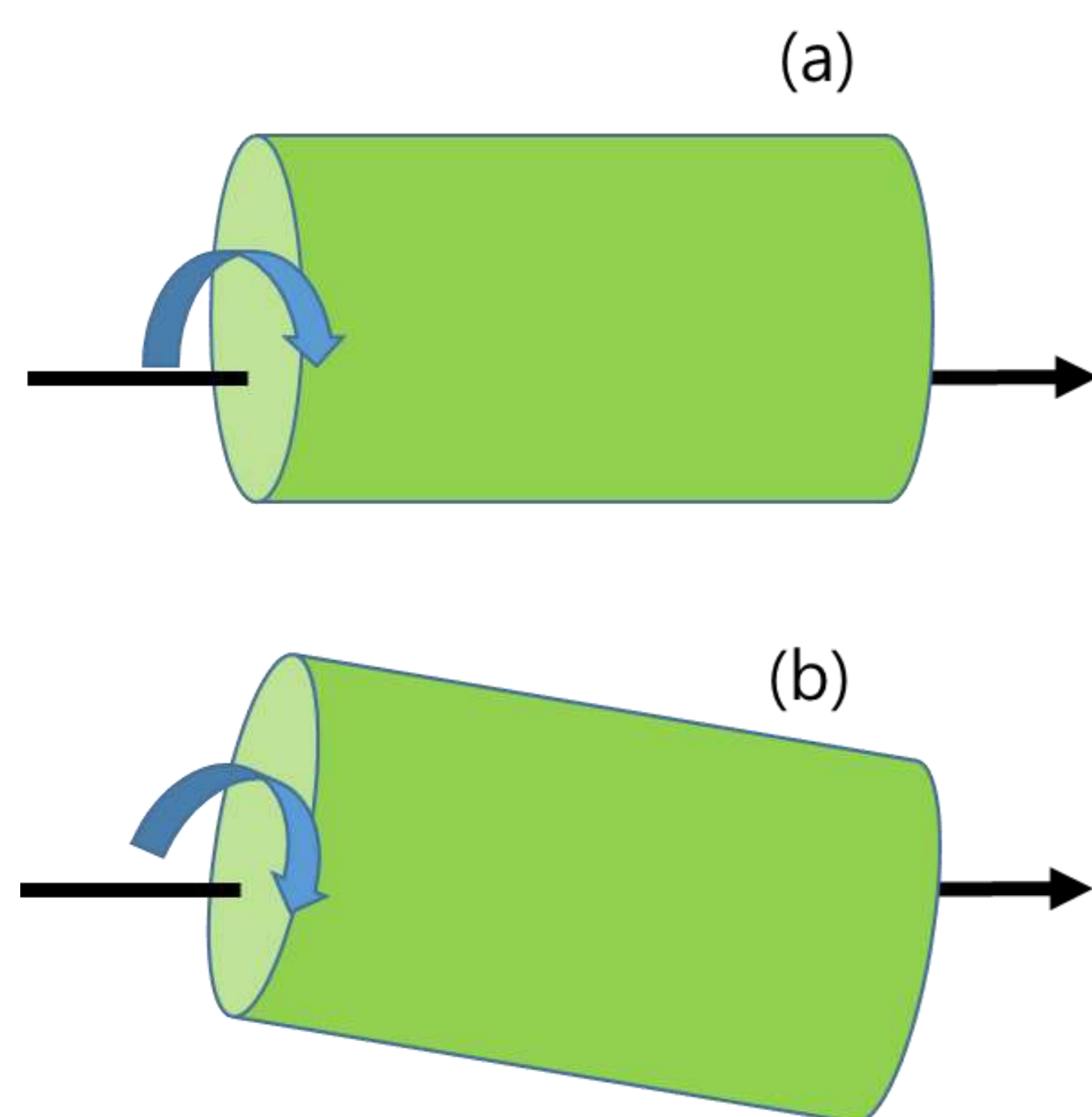


Wobbler under factory test

1 hour operation test @180 rpm
- no big problem overall
- slight temperature increase of beam pipe due to eddy current : No problem
- vibrations of less than 1 mm amplitude : analysis required

Analysis of Vibration Effect

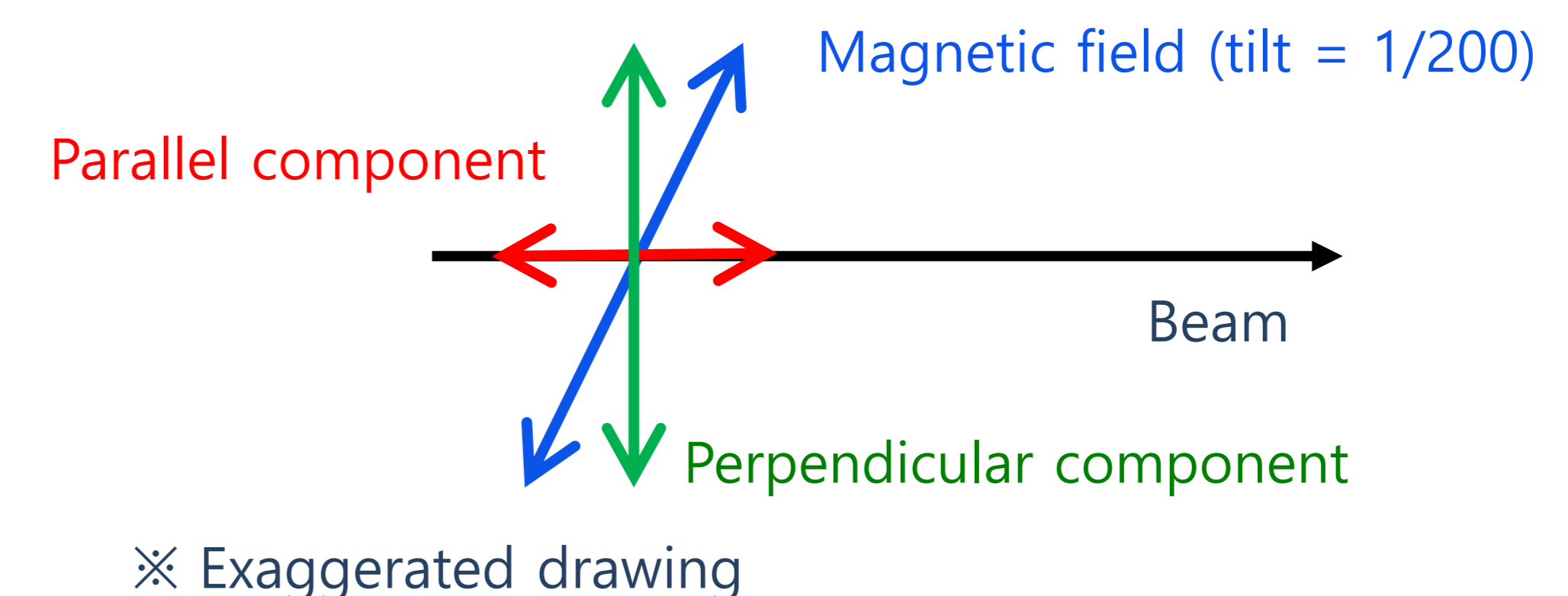
Vibration modes of wobbler magnet



(a) Oscillating globally around center axis :
no effect on beam because magnetic field located 1 mm away from axis differs little from central magnetic field

(b) Oscillating center of left and right sides with a 180 degree phase difference :
magnetic field component perpendicular to beam decreases due to the magnetic field tilted in the beam direction, and instead magnetic field parallel to beam is generated

- Parallel magnetic field does not affect beam
- Decrease in perpendicular magnetic field is about 0.5% (= 1/200, assuming that the length of the wobbler magnet is 400 mm)
- It is small enough to be negligible given that the distance from the wobbler to the target is within 1 m.



Status and Future Plan



Beam wobbler waiting installation

- Wobbler required to reduce peak power and improve uniformity on RI targets
- Due to space limitations, Halbach magnets wobbler to be installed in the target room
- According to design, wobbler fabrication completed
- Off-line test operation completed and performance verified
- Vibration of wobbler magnet was found during the test, but it is expected that there will be no problems as a result of the analysis.
- Beam wobbler waiting for installation at target room shielding door
- Plan to install wobbler for future experiments irradiating high power beams to targets