Target Field Direction Measurement

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Overview

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Background

- Horizontal compass measures the angle made by the horizontal magnetic field with respect to electron beam direction in Hall C.
- It was built in University of Kentucky and used in at least two experiments :
  - "Measurement of the Neutron Electric Form Factor at High Q^2" (E02-013).
  - "Measurement of Single Target-Spin Asymmetry in Semi-Inclusive Reaction on a Transversely Polarized ^{3}He Target" (E06-010).
- All of its missing parts have been rebuilt and a compass fixture has been built in the machine shop at University of Kentucky for its use in experiments (E12-06-110 and E12-06-121).

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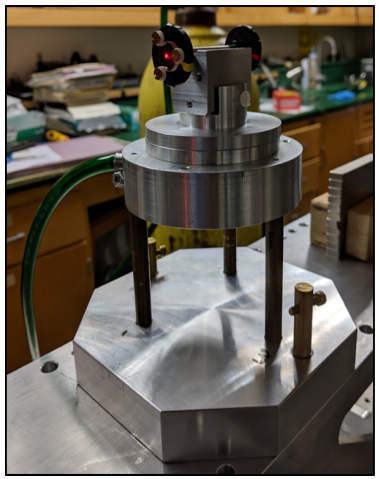
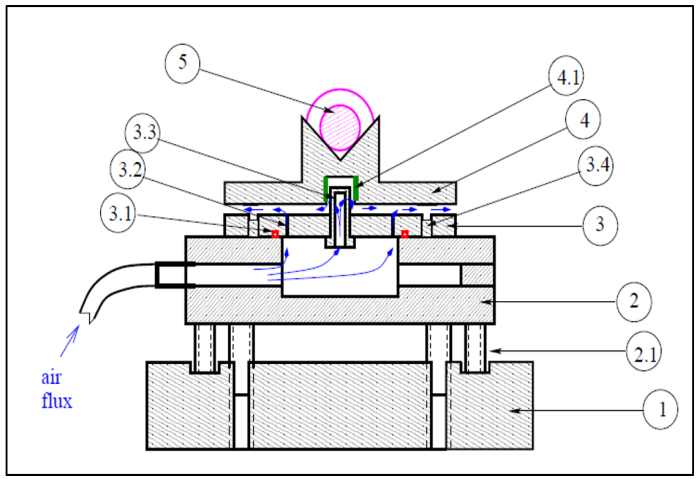
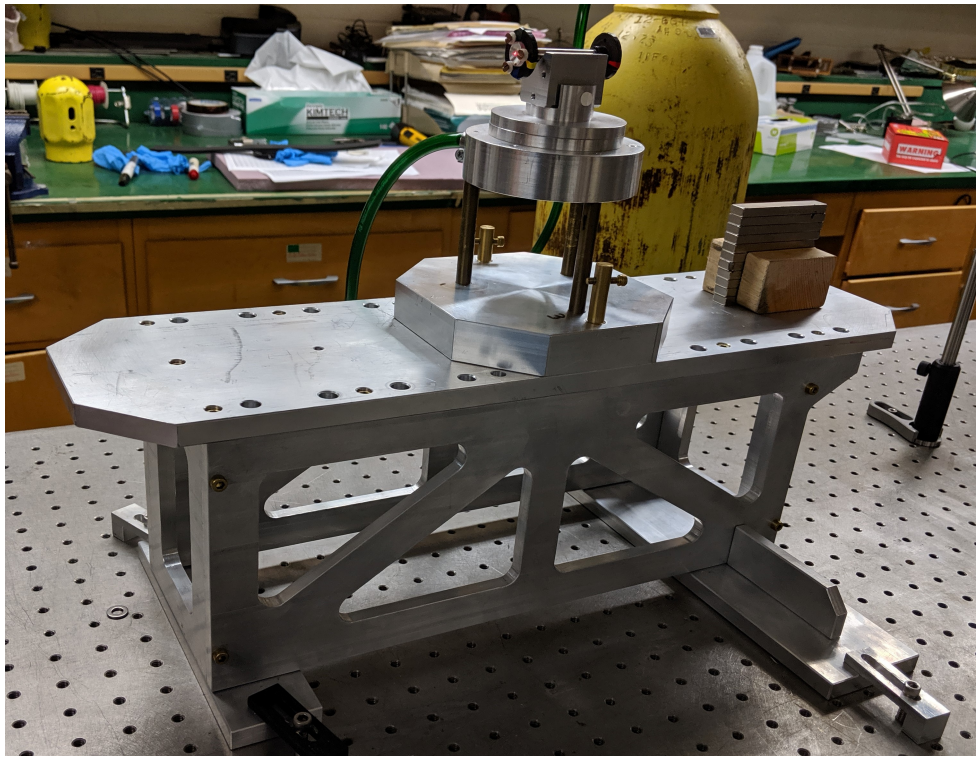
Design Details





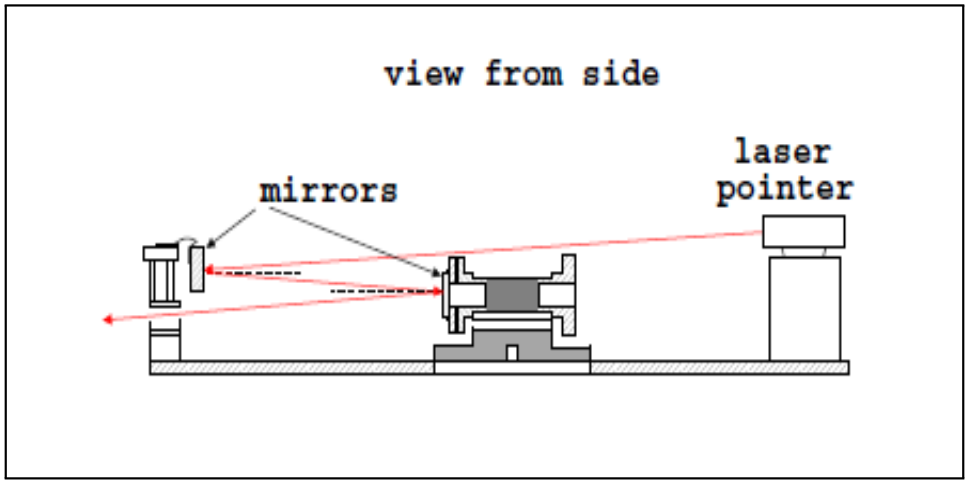
- Air floated device.
- Cylindrical magnet with mirror and circular scale attached.
- Three screws and a spring is used to align the mirror.
- Three adjustable legs.

Design Details



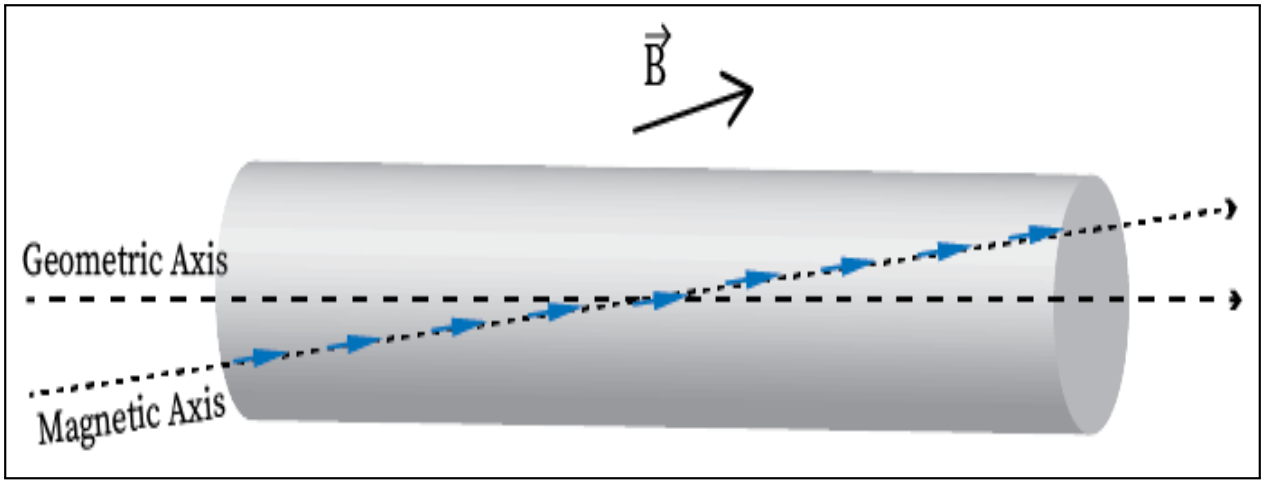
- Compass fixture with 11 equidistant holes.
- Target field direction will be scanned in 11 positions along the target length.

How Does it Work?



- The magnetic axis of the cylindrical magnet points to the direction of the target field while floating.
- The magnetic field direction is measured by determining the direction of the surface normal of the mirror.
- The surface normal of the mirror is given by the angular bisector of the incident and reflected laser beams.

How Does it Work?



- The geometric and magnetic axes of the cylindrical magnet do not coincide.
- The compass mirror is aligned parallel to the magnetic axis of the compass magnet to minimize the horizontal error.

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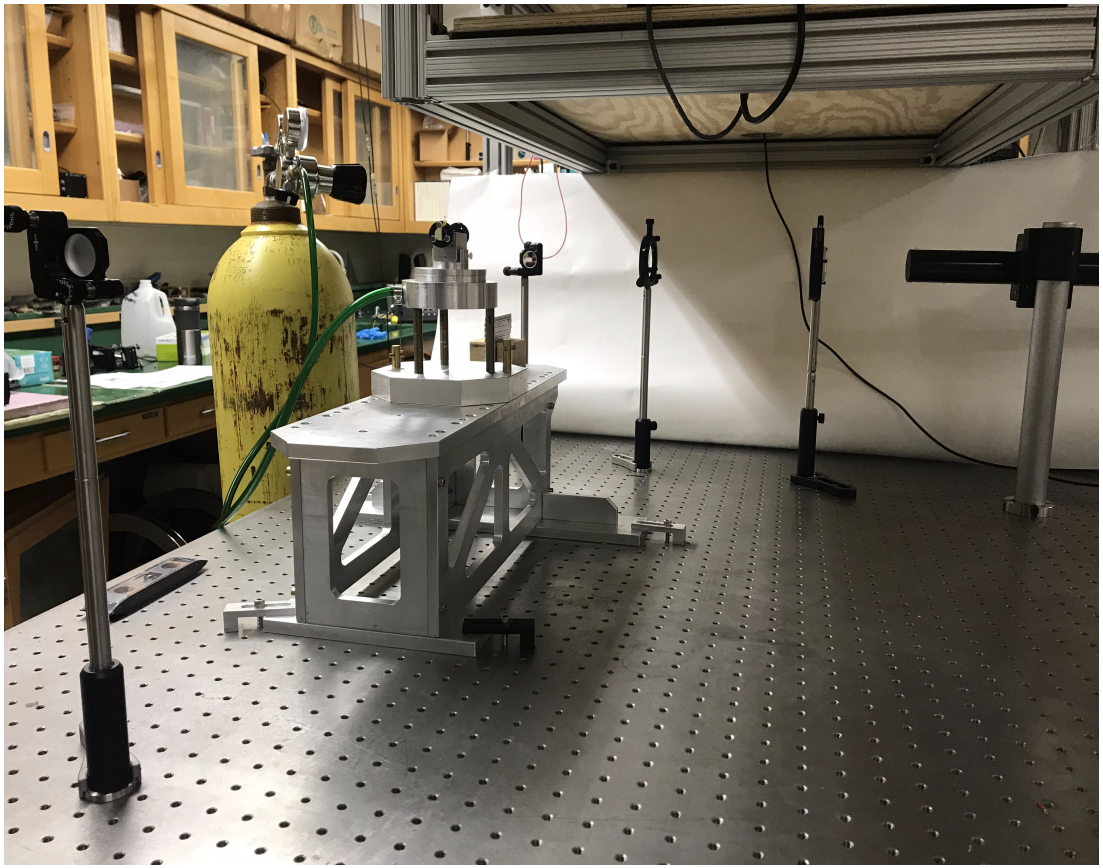
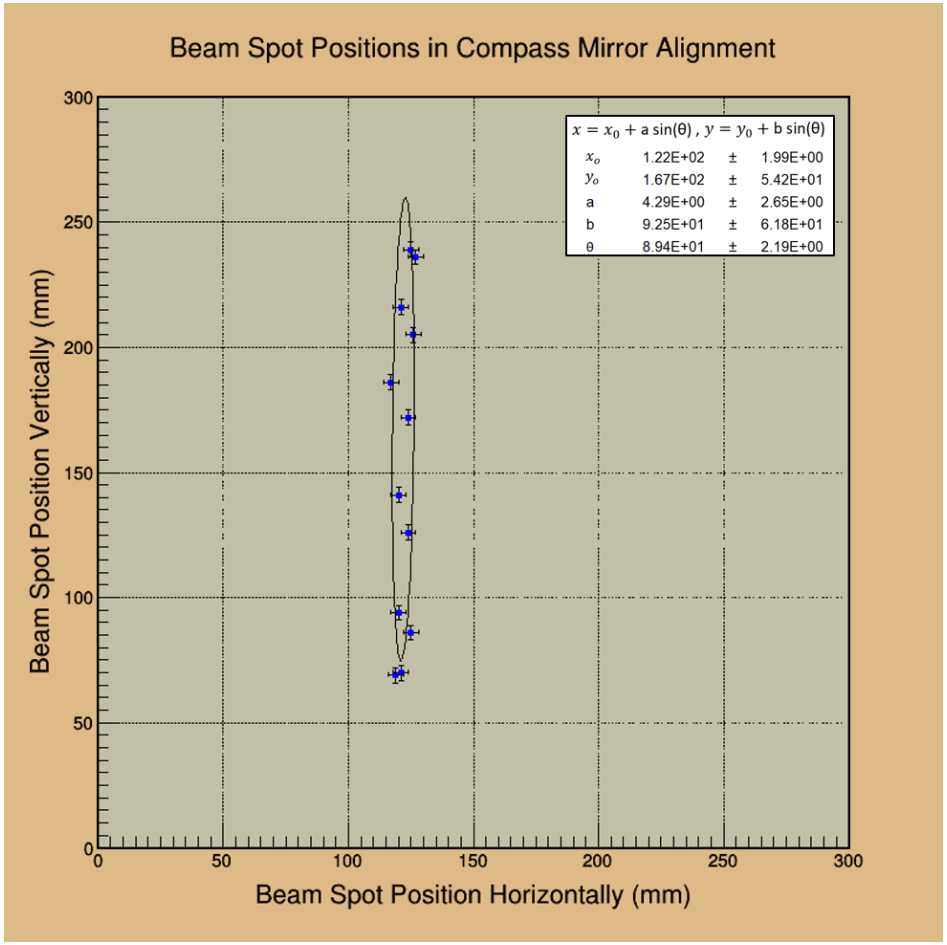
Test Setup



- Two convex lenses were used to collimate the laser beam.
- The reflected beam spot was monitored on a screen 2 meter away from the compass.
- A permanent magnet was used to generate 15 Gauss magnetic field.

Result



- The ellipse is a result of 360° scan of the cylindrical magnet.
- The semi minor axis of the fitted ellipse determines the horizontal error in the field direction measurement.
- Total Horizontal Error : $\pm\mathbf{0.1}^\circ$
  Where,
  Statistical error:$\pm 0.09^\circ \pm 0.05^\circ$
  Systematic error:$\pm 0.03^\circ$

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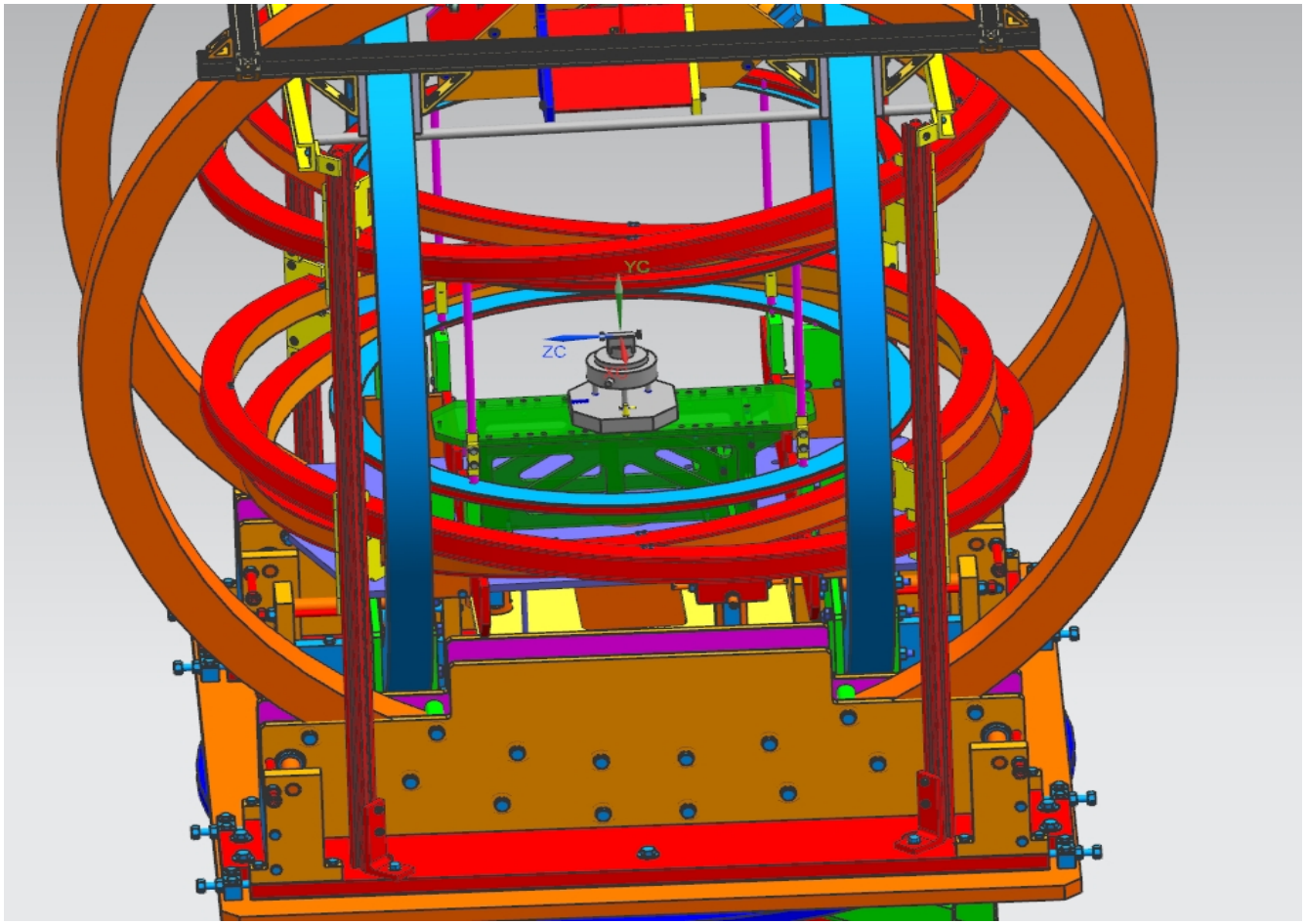
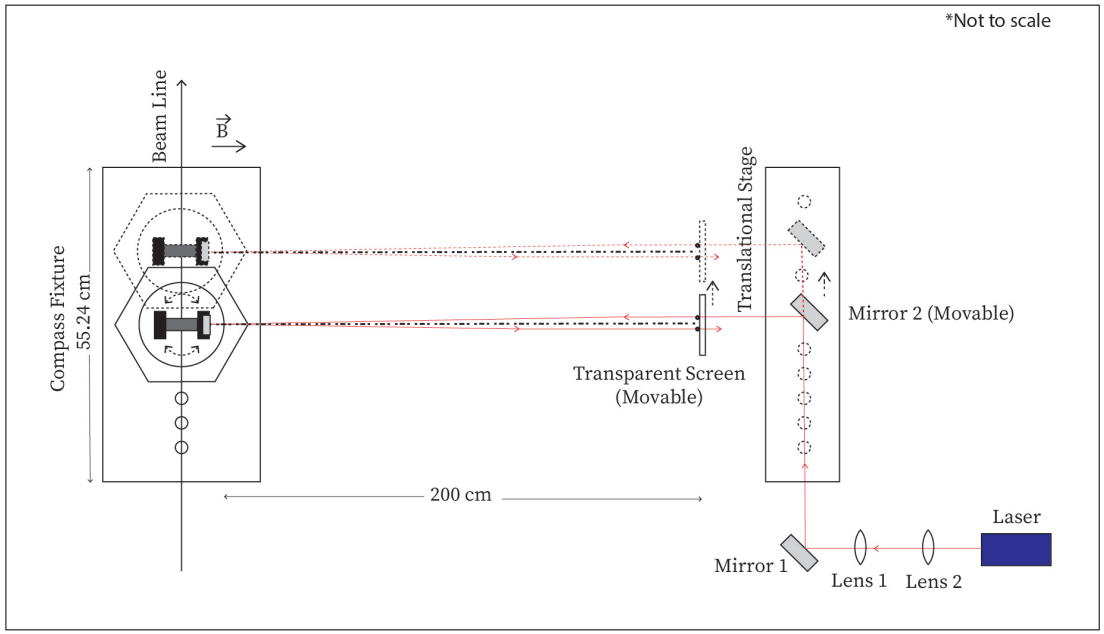
Compass Fixture

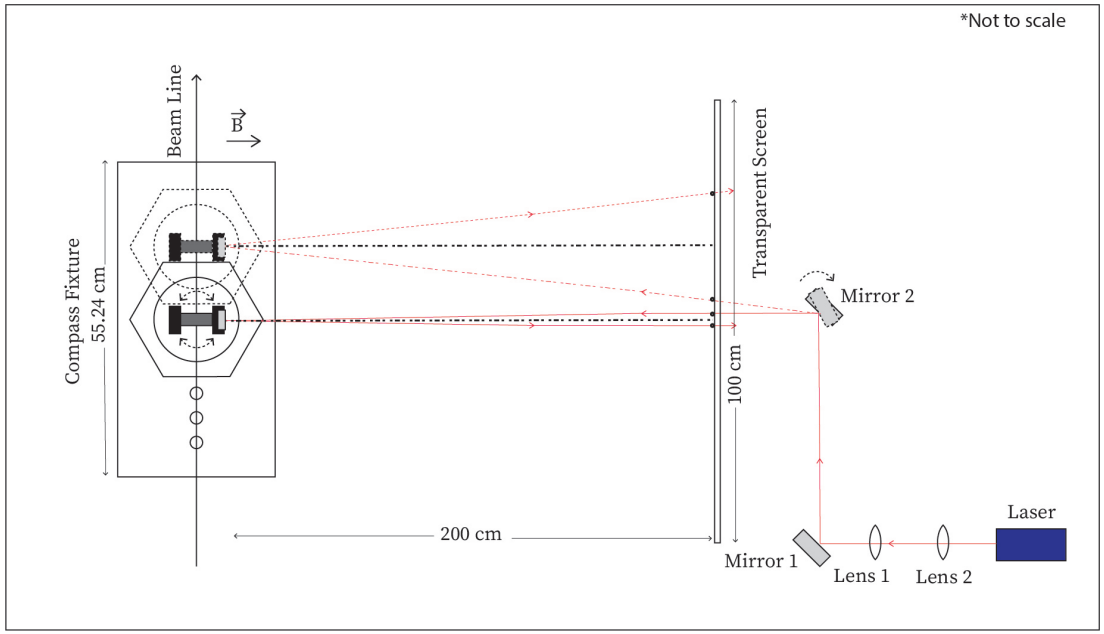


Compass Measurement (Installation Plan 1)



- Requires one movable mirror, one fixed mirror and a movable transparent screen (approx. 15 cm $\times$ 15 cm).
- Requires survey of three points for each position of the horizontal compass.

Compass Measurement (Installation Plan 2)



- Requires a big transparent screen (approx. 100 cm $\times$ 100 cm), both the mirrors are fixed in place.
- Requires survey of three points for each position of the horizontal compass.

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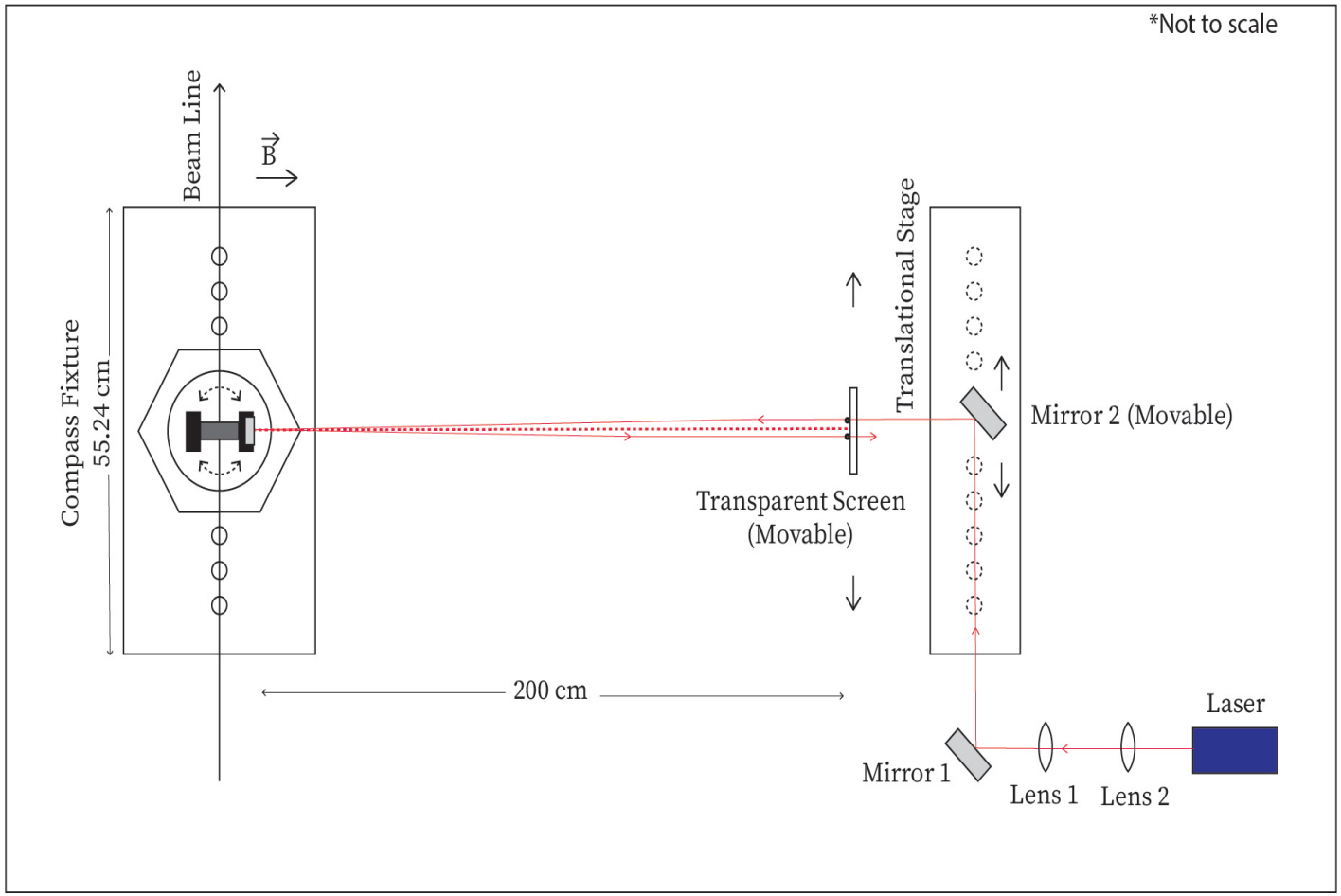
Summary

- The testing of the compass has been completed and it is ready for the upcoming experiment.
- An optics table will be required in Hall C to set up the laser and the mirrors for the horizontal compass measurements.
- The alignment group will be required during each compass measurement.

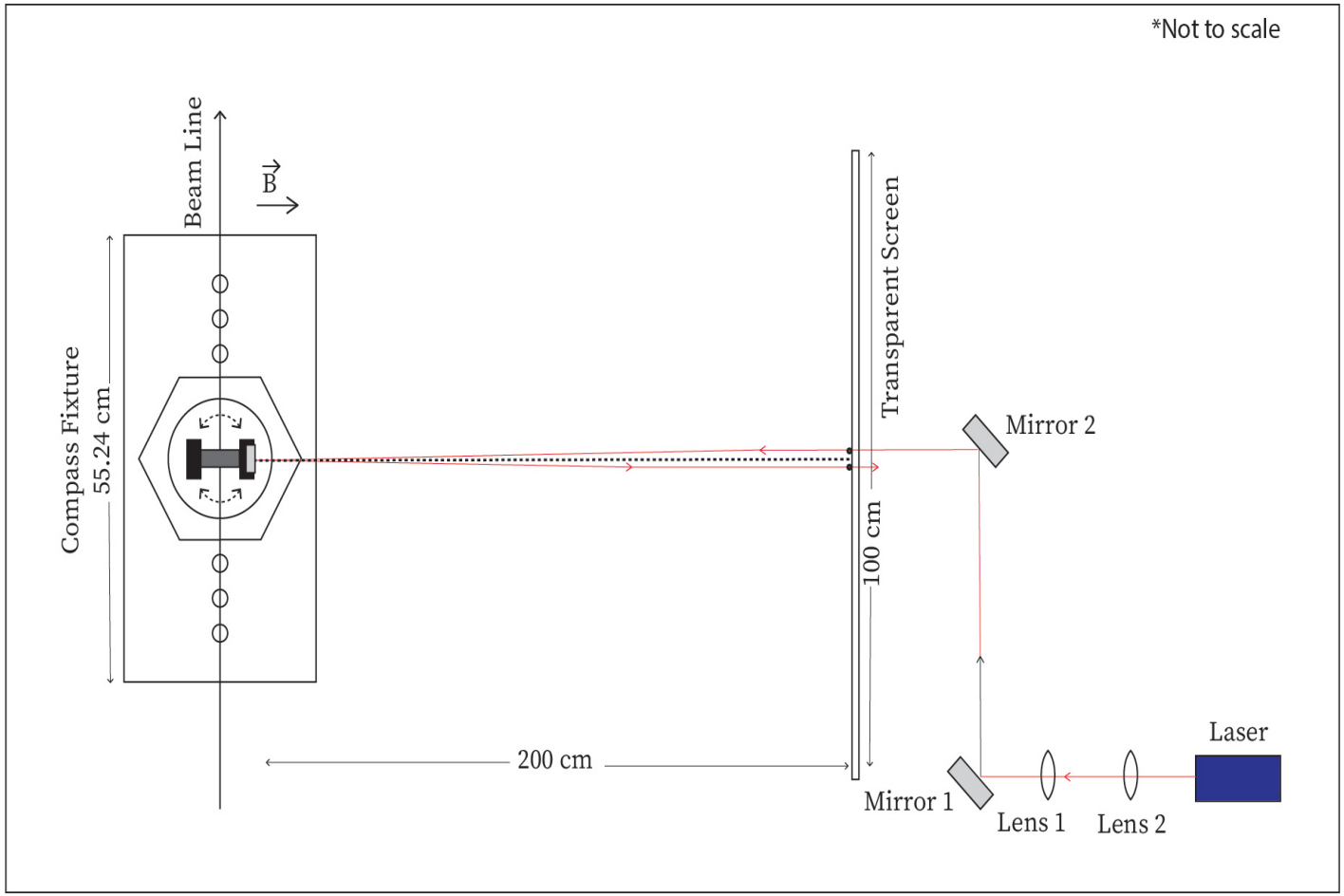
Thank you!

Backup Slides

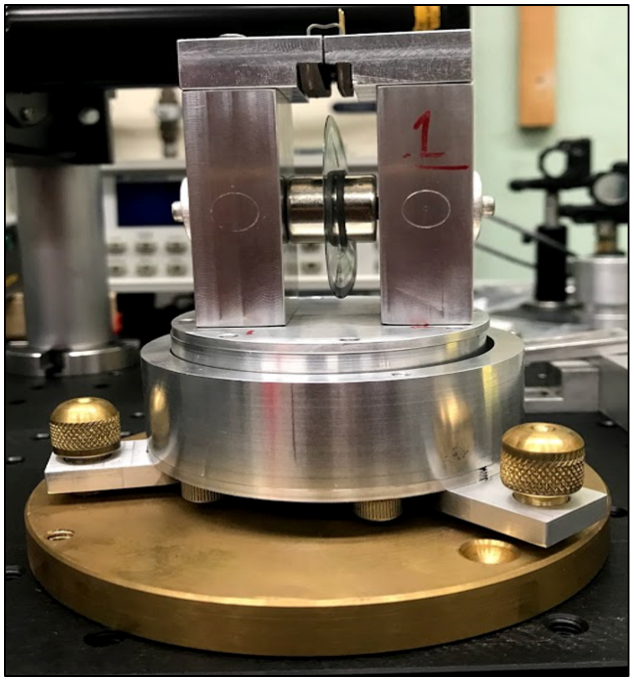
Compass Measurement (Installation Plan 1)

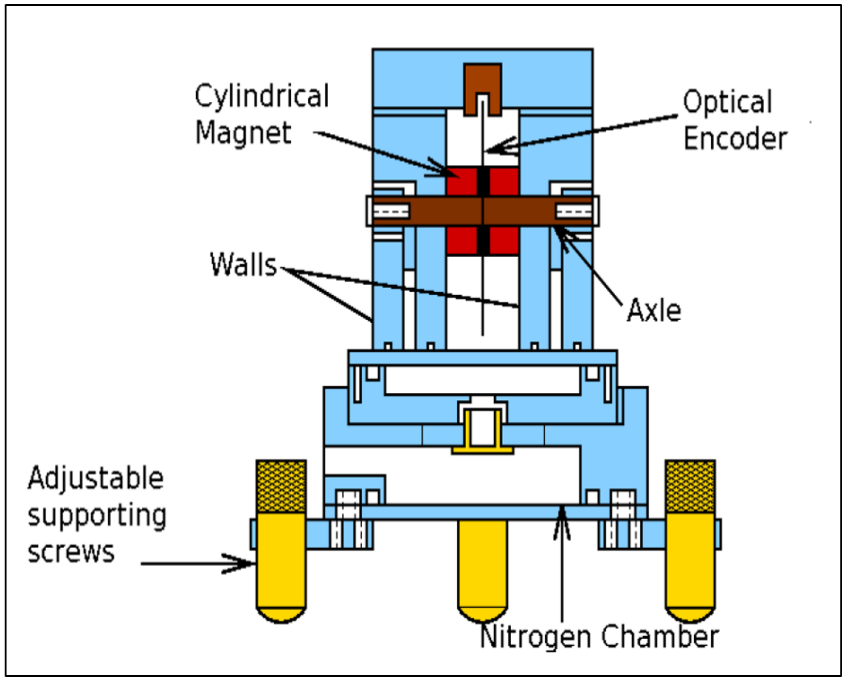


Compass Measurement (Installation Plan 2)



Vertical Compass





Measures the angle made by the vertical magnetic field with respect to the horizontal plane in Hall C.

Vertical Compass

- Angle made by vertical magnetic field with respect to horizontal plane :

$$\theta = 90^\circ - (N_1 - N_2) \times \frac{0.09}{2}$$

N_1: encoder reading after turning on vertical magnetic field
N_2 : encoder reading after 180° rotation of floating disk.

- Calibration of the device will be done in a horizontal magnetic field.