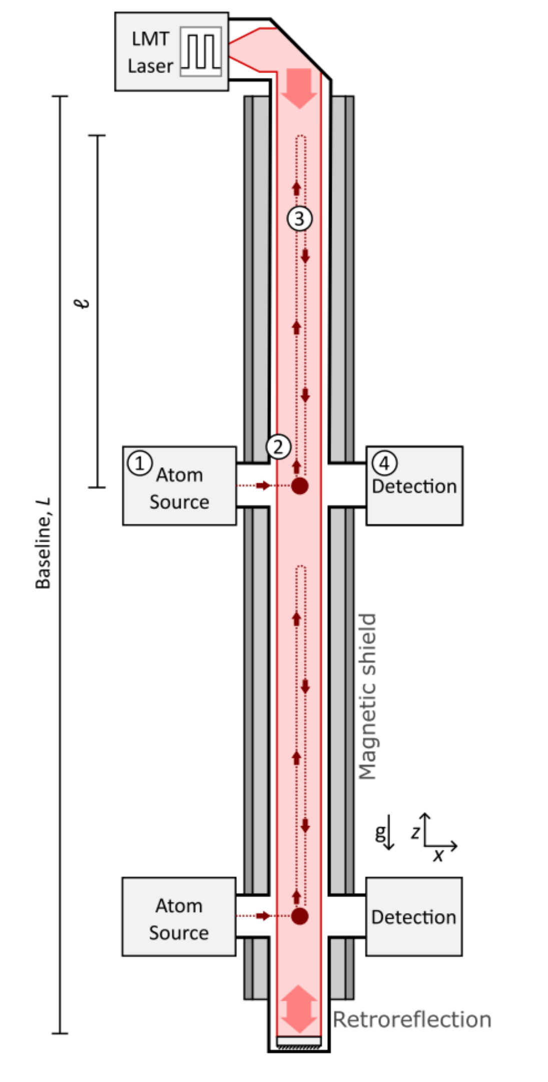
Strontium atoms in a MOT

“Sidearm” or “Atom source”

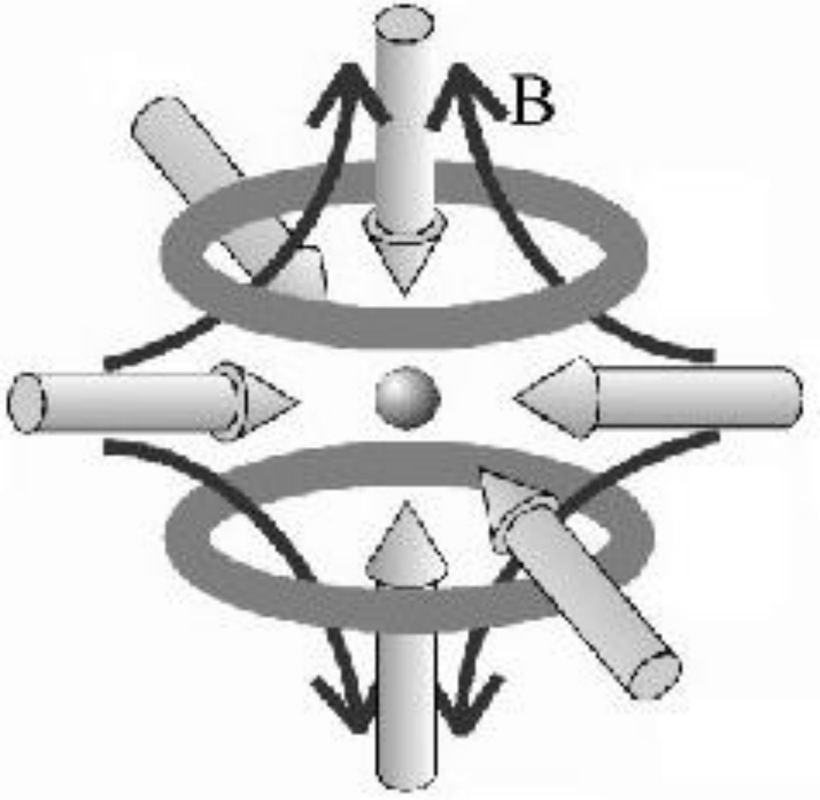
We need to cool each cloud of atoms to $T \lesssim \mathrm{nK}$

→ Cloud expansion $\lesssim$ mm/s

Image: Sr atoms in an optical lattice clock at NPL, UK
W. Bowden et al. Scientific Reports 9, 11704 (2019)



B field requirements



In an external DC field, the atoms in the MOT move by:

$$\Delta z = B_{offset} \times 1/\frac{dB}{dz}$$

We have $\frac{dB}{dz} \approx 10\ mT/m$ (for red MOT)

We need $\Delta z \lesssim 10\ \mu m$ (for MOT to match dipole trap)

→ Target maximum B field deviations (integrated ~ uHz to 10 kHz:

$$\boldsymbol{B_{offset} < 100\ nT}$$

Suggested B field measurement

Suitable 3-axis Hall probe, e.g. : https://www.bartington.com/products/precision-magnetometers/mag-13-three-axis/

Use a few low-noise Hall probes at different locations in the shaft to measure B in the most relevant bandwidth:

DC - a few kHz

Split into two datasets

- Noise spectrum: mHz - 3 kHz
- Long-term field: 1 Sa/s for a few weeks

Take measurements, then decide mitigation approach

Other concerns

A couple of potentially concerning features pointed out in Daniel's EM noise slides:

1. UPS switching currents (8, 16, 25 kHz) find their return paths through all interconnected structures
   - What does this mean? Cold atom technology includes sensitive analog circuits for e.g. lasers and coils
   - Possible mitigation: fancy UPS to supply all the cold atom equipment
2. Low frequency magnetic field
   - E.g. 50 Hz + harmonics can be difficult to compensate or shield – could be a showstopper if these are too large. Another reason to measure with Hall probe…