Improved Magnetic Field Control for Experiments with Sodium Bose-Einstein Condensates

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What is a Bose-Einstein Condensate, and why?

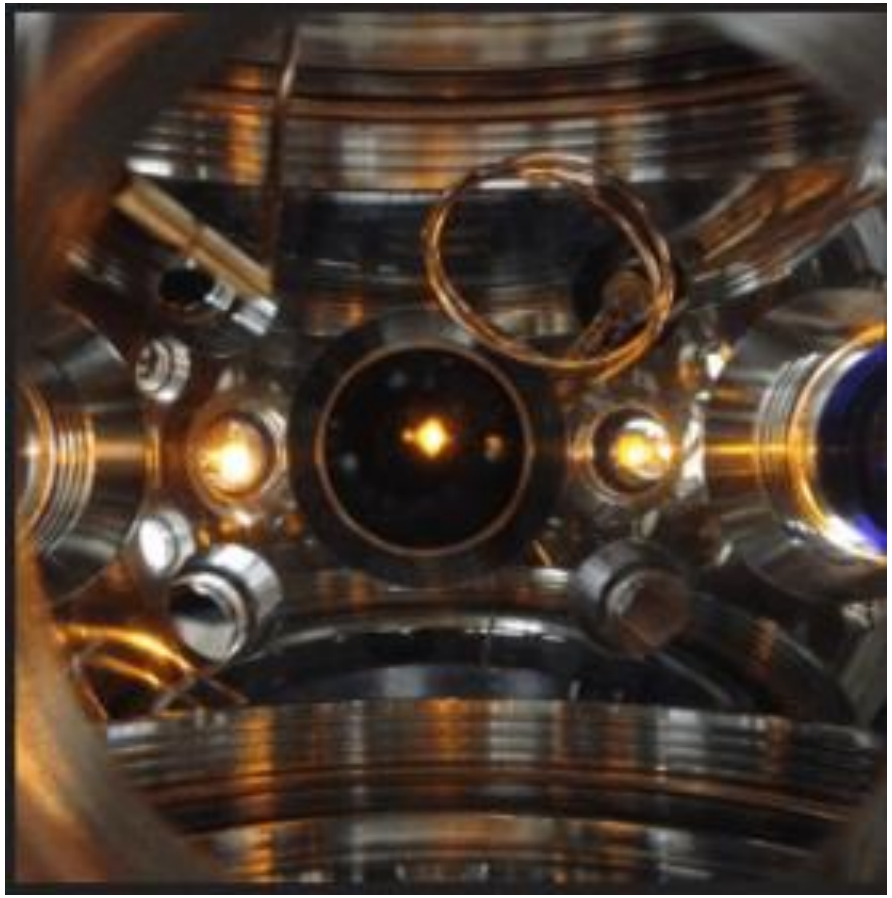


Image Credit: Schwettmann Group

- Cool sodium vapor to a few nano-Kelvin
- Atomic wavepackets begin to overlap
- Spin interaction becomes macroscopic and easily observable
- Useful for interferometry

Principles of laser cooling

- Resonance gap undergoes a Doppler shift based on movement
- Slightly off resonant light (redshifted) will be absorbed and emitted
- Absorption causes directed change in momentum
  - Emission is isotropic
- Overall, gas is cooled to some minimum

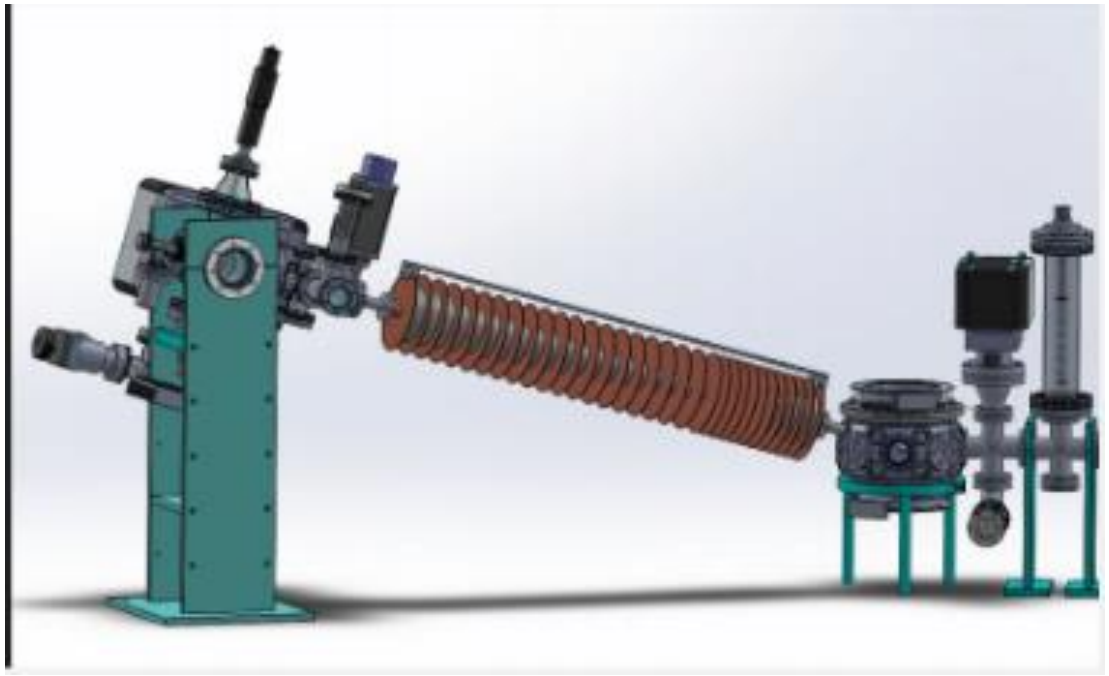
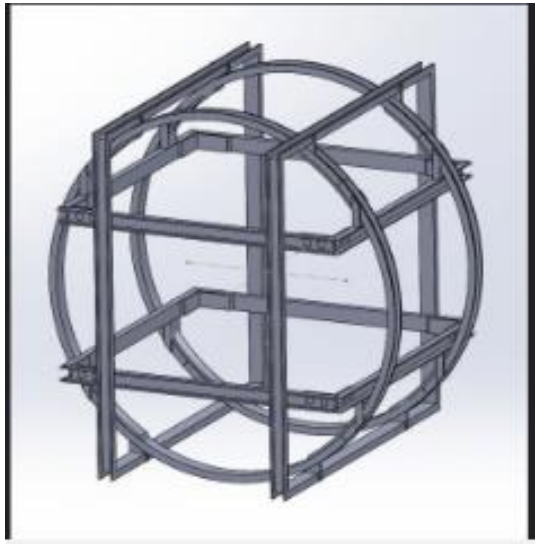


Image Credit: Schwettmann Group

From laser cooling to the magneto-optical trap

- Zeeman shift
  - Resonance gap changes based on magnetic field gradient
- Must be controlled in two places
  - Initial slowing
  - Ensure uniform field inside trap



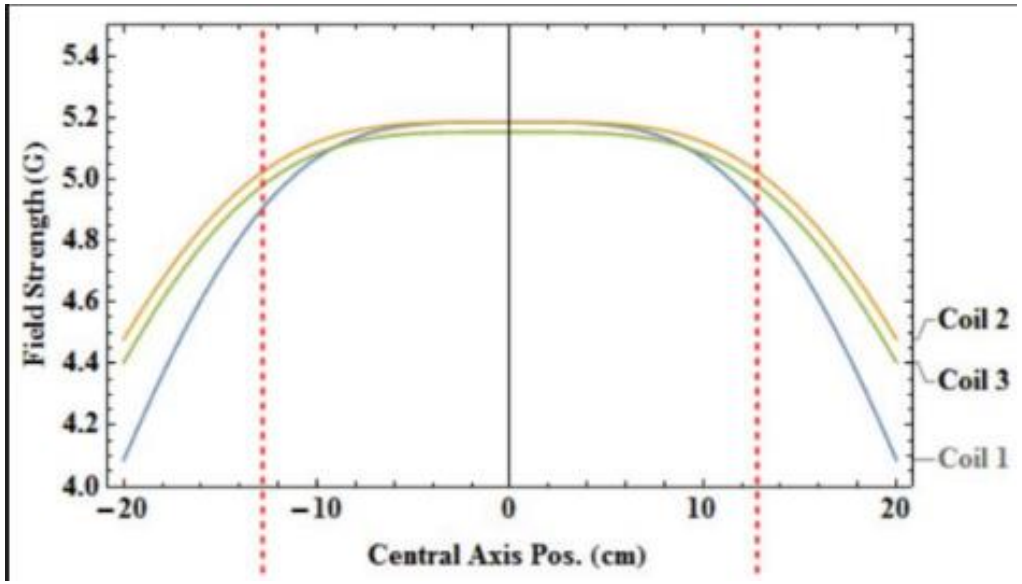


Image Credit: Schwettmann Group

My contribution

- Current solution for controls three pairs of coils
  - Slow response
  - Noise from controller
- Design and manufacture a current controller that allows
  - Individual control over all six coils
  - Fast current switching as needed for future experiments
  - Stable current once setpoint is chosen
  - Capable of handling output of ±5 A