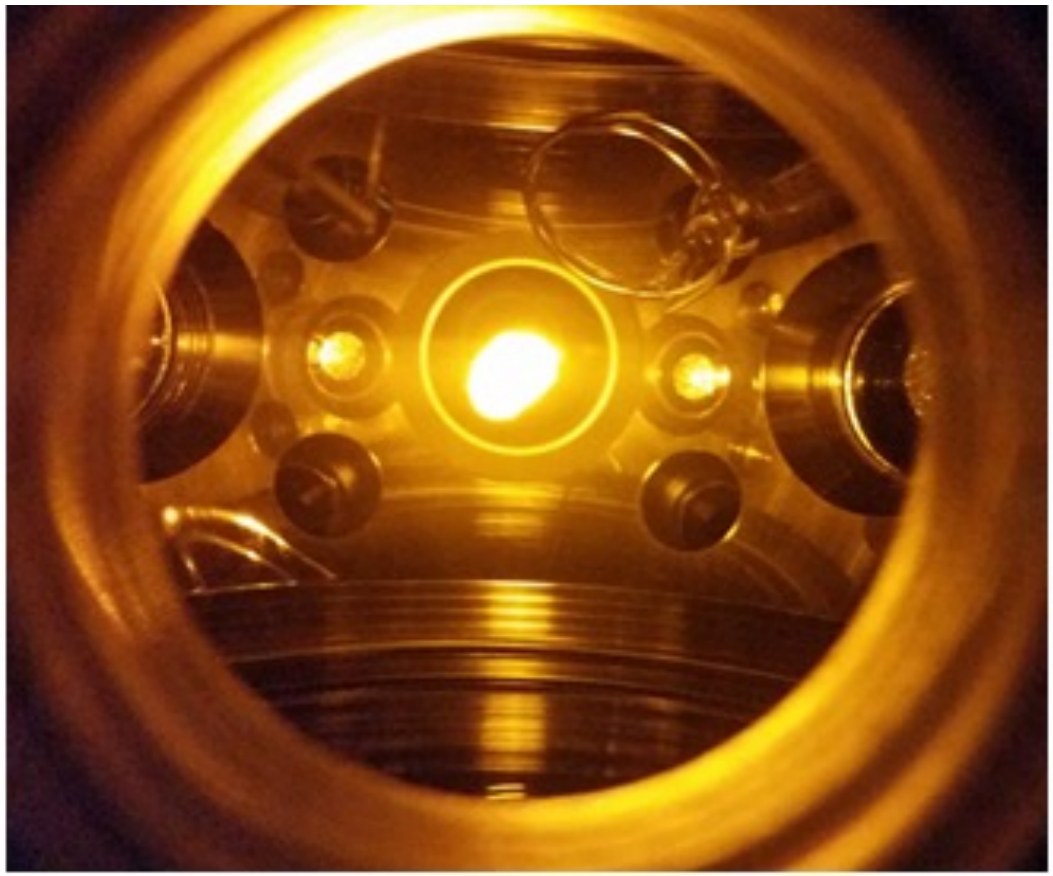
Control of External Fields in a Spinor Bose-Einstein Condensate



Jason Gordon

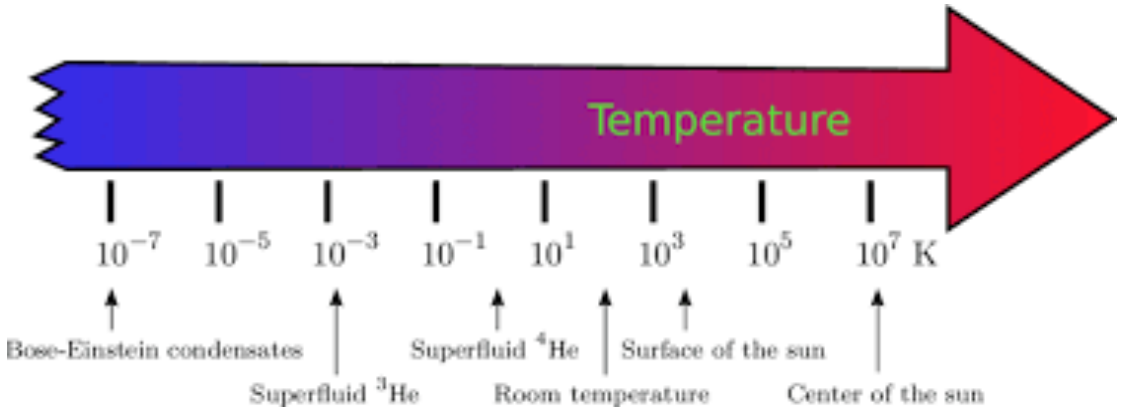
2022 REU Project

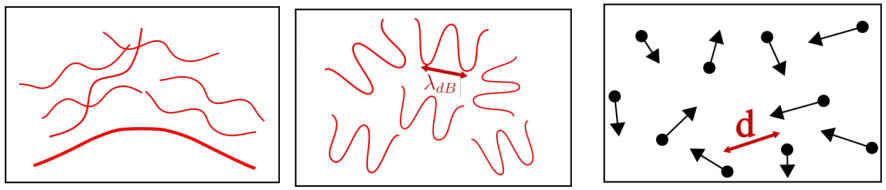
Advisor: Arne Schwettmann

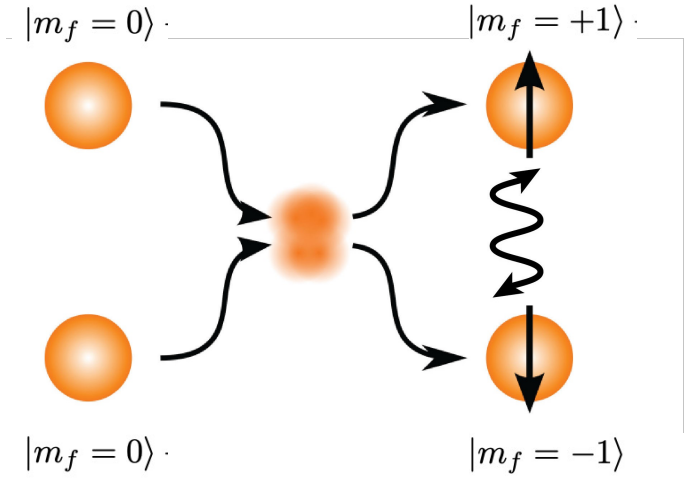
Graduate Students: Hio Giap Ooi, Shan Zhong

Spinor Bose-Einstein Condensate

- Ultra-cold Gas
- Forms only at Nano-Kelvin Temperatures
- Overlapping Wavefunctions Act as One Wavefunction
- Study Spin Structure and Dynamics
- Quantum Enhanced Sensing

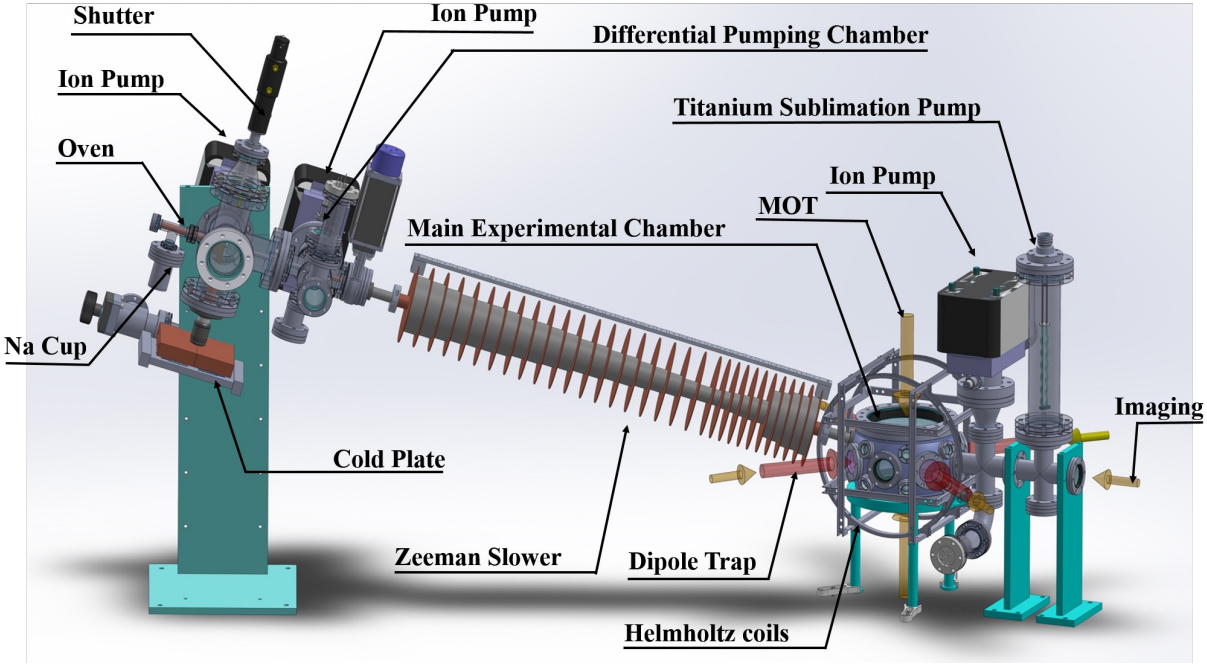


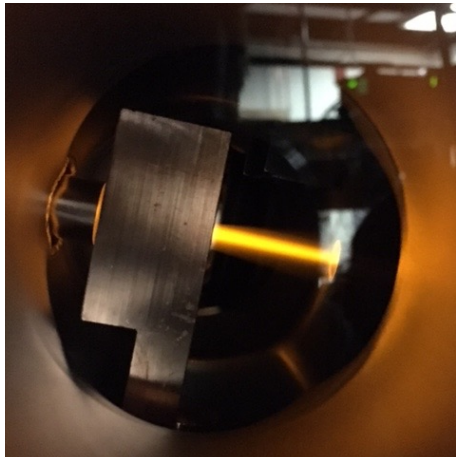


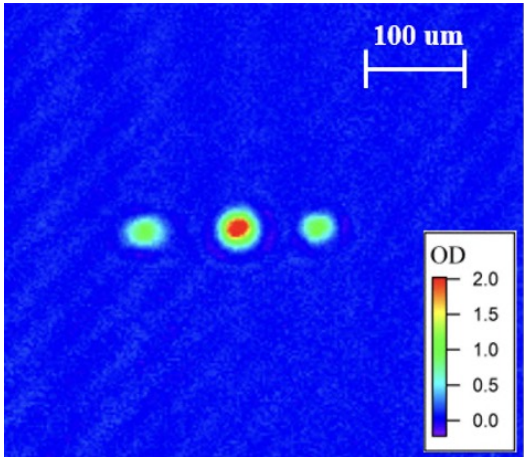


Spinor BEC Setup

- Na Heated in Oven
- Atomic Beam Formed
- Slowed by Zeeman Slower
- Laser-Cooled and Trapped in a Magneto Optical Trap (10^{-5} k)
- Evaporatively Cooled into a BEC (10^{-7} k)
- Separated into Spin States (Helmholtz Coils)
- Shadow Imaged

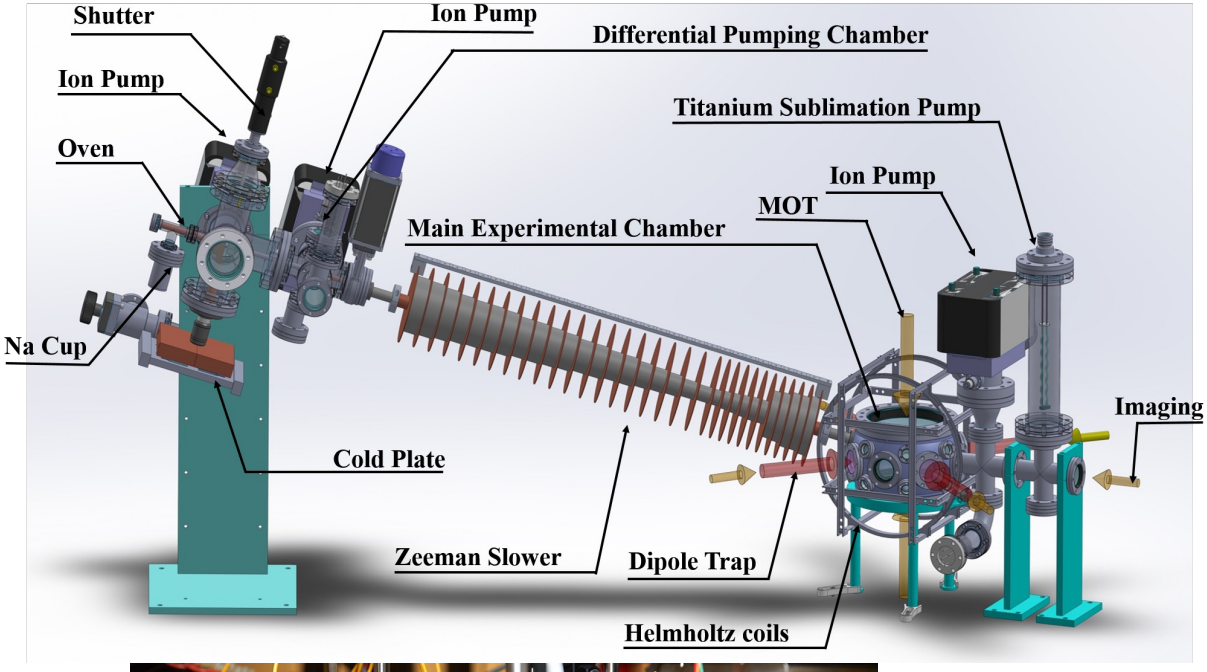


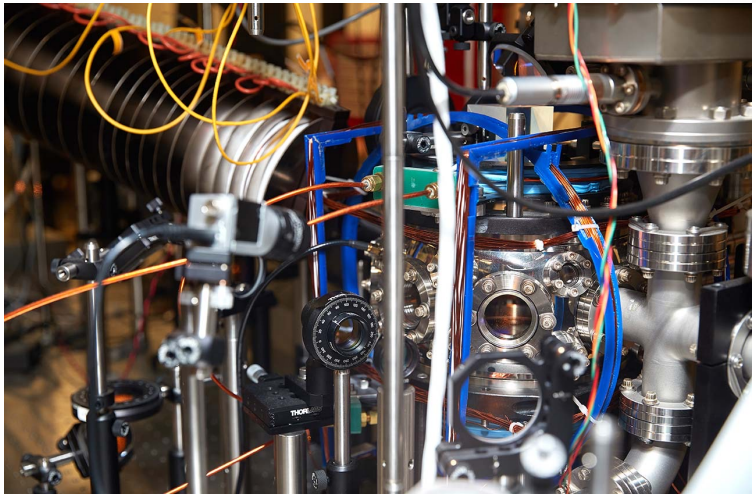




Spinor BEC Setup

- Na Heated in Oven
- Atomic Beam Formed
- Slowed by Zeeman Slower
- Laser-Cooled and Trapped in a Magneto Optical Trap (10^{-5} k)
- Evaporatively Cooled into a BEC (10^{-7} k)
- Separated into Spin States (Helmholtz Coils)
- Shadow Imaged



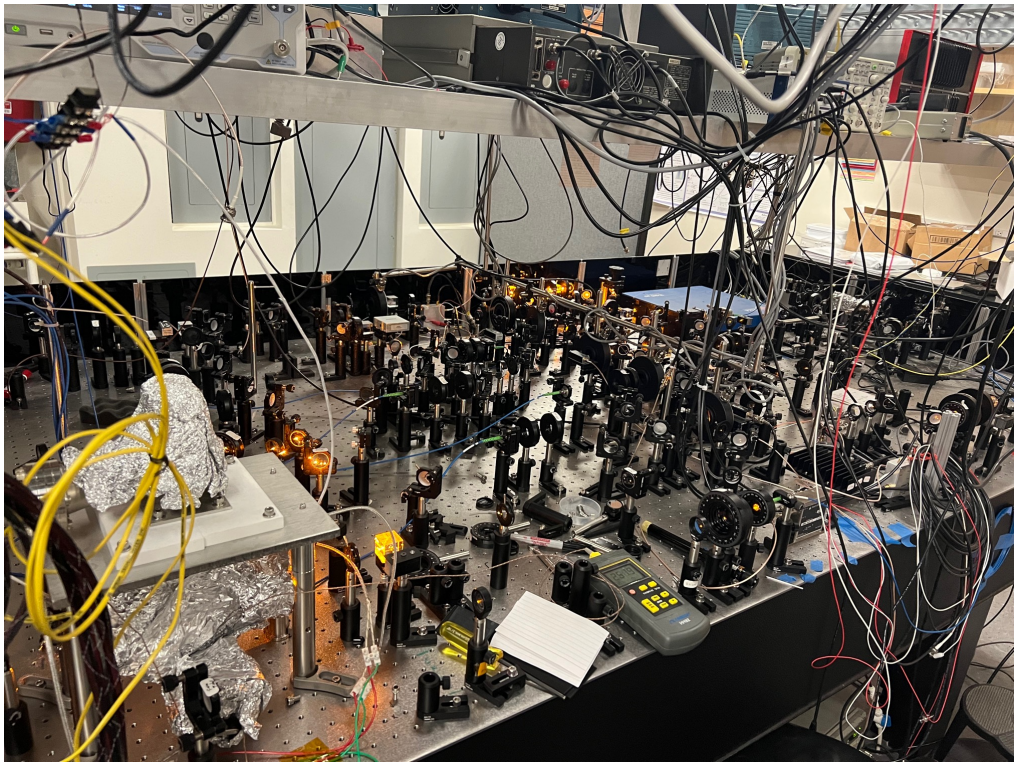


Magnetic Field Sensor

- Designed by John Wrench and Cameron Cinnamon
- Control Box and Sensor Head
- Detects μ-Gauss Fluctuations
- Used for External B-Field Stabilization
- Reset Circuit to Demagnetize Sensor
- Adjustable Offsets

My Role

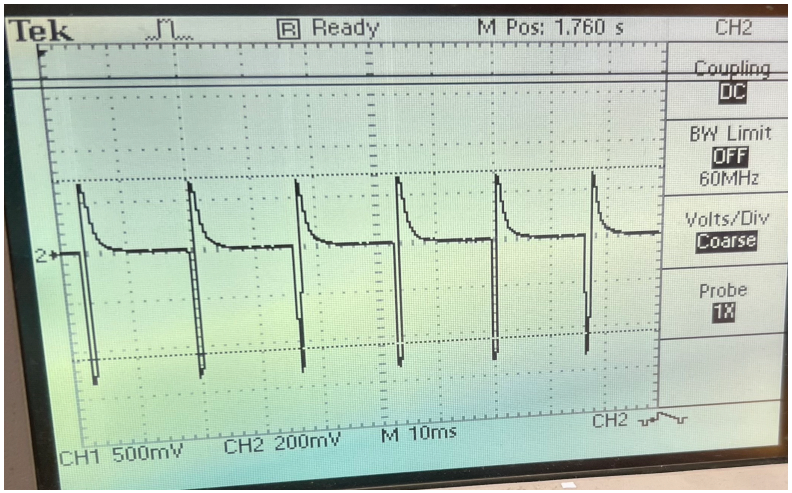
- Understand and Test the Magnetic Field Sensor
- Background Readings and Literature Research
- Map each Optics Table for the move
- Help Hio with Four Wave Mixing Experiment
    - Aligned Laser to Fiber and Apertures



Conclusion and Outlook

CQRT
Center for Quantum Research and Technology

- Reading and Learning
- Test Magnetic Field Sensor
  - With Magnets
  - On the Optical Table
- 3-D Rendering of Table



Preliminary Results: