Photodetachment of H^- at the GBAR Experiment

Lance Lampert

22-6-23

Mentors

Dr. Pauline Comini

Dr. Laszlo Liszkay

Motivation for GBAR Experiment

Our understanding of gravity is incomplete.

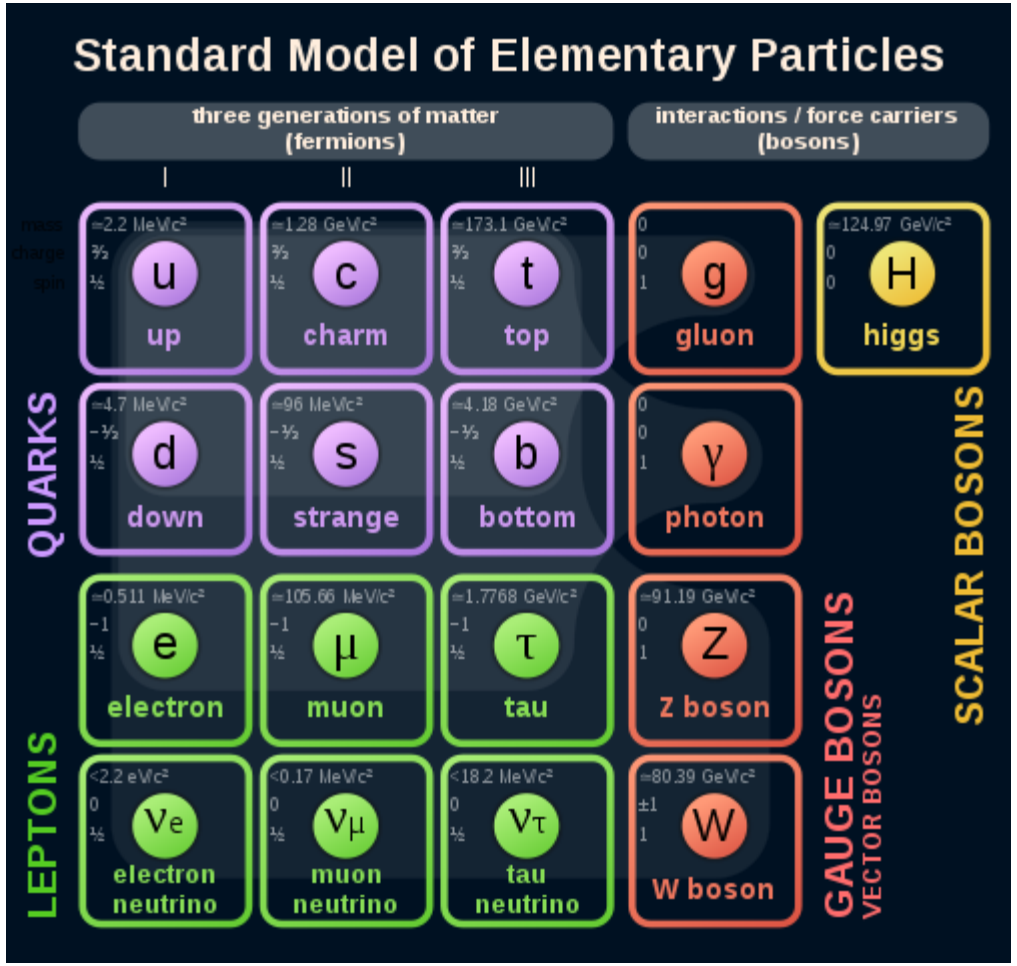
- **Quantum Field Theory says nothing about gravity**
- **Dark Energy and Dark Matter linger**

Test the Weak Equivalence Principle with antimatter.

- **No (meaningful) direct measurement of the interaction of gravity on antimatter exists.**
  - Best and only direct result from free fall: $-65g < \bar{g} < 110g$ from ALPHA

Require a stable, neutral particle for freefall.

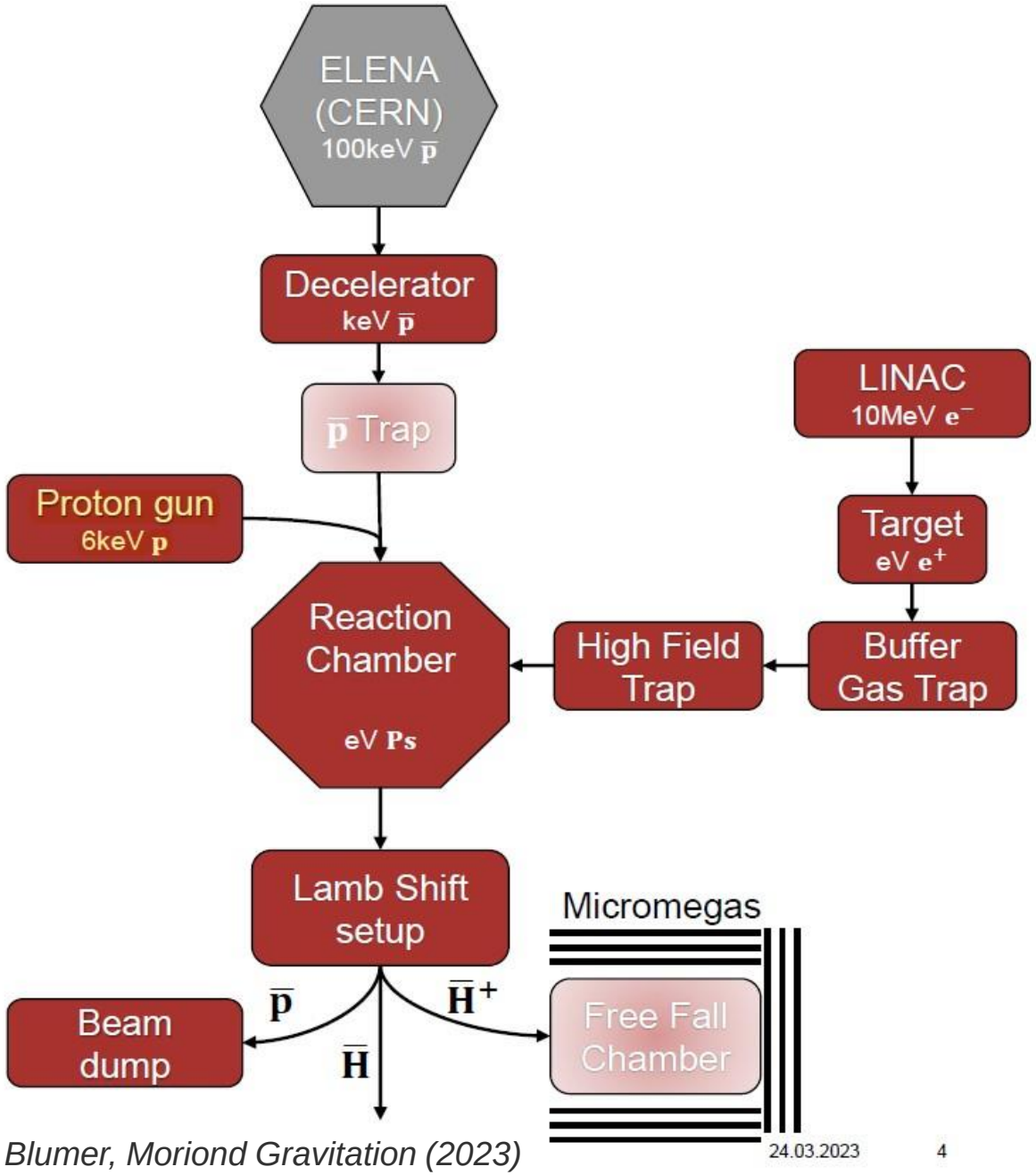
- **Cannot use antineutrons, positronium…**
- **Next simplest particle: antihydrogen!**



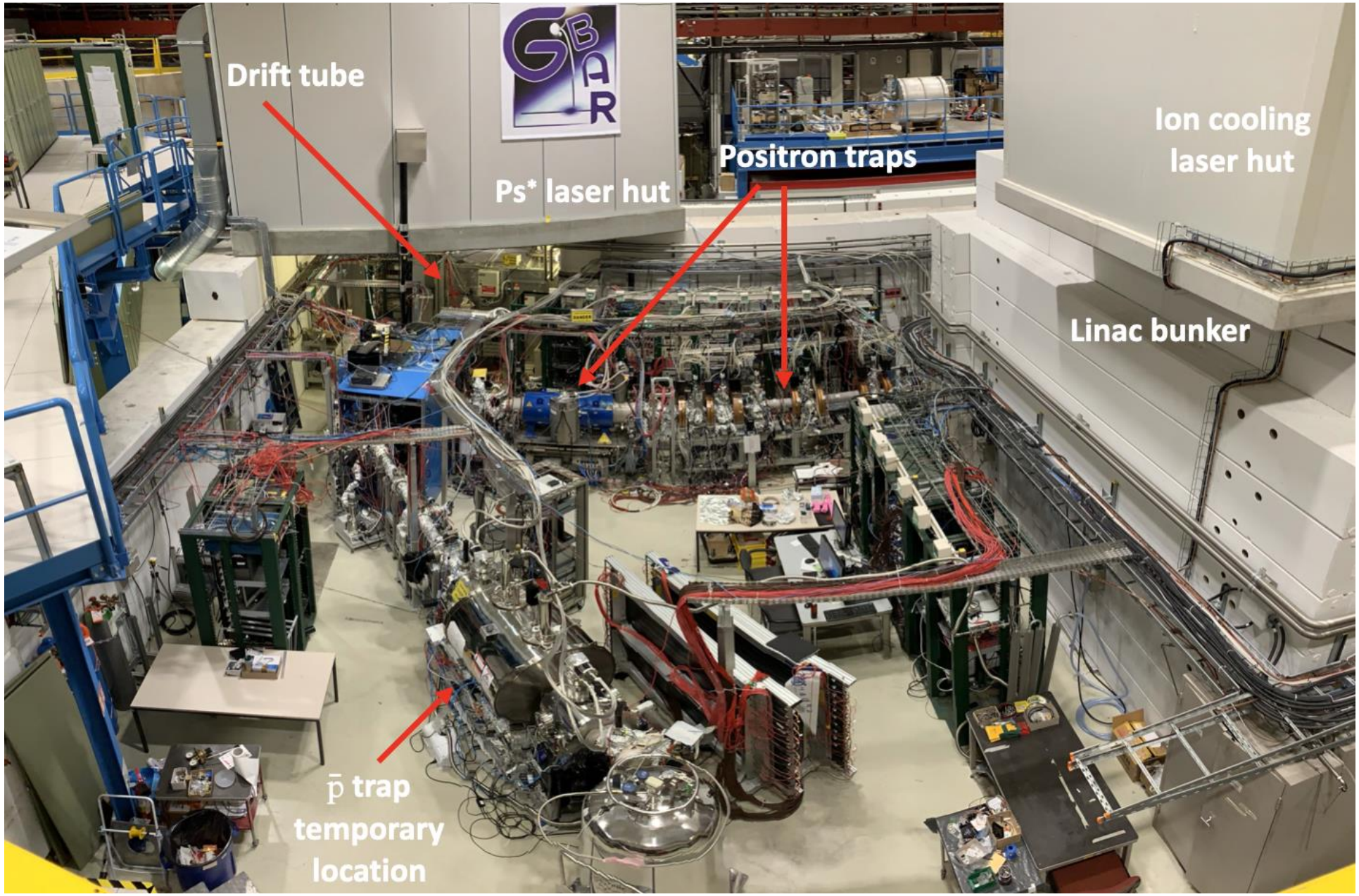
Wikipedia

GBAR Experiment Overview

- **Excited positronium reacts with slow antiprotons**
- **Several particles are produced and are directed based on their charge**
- **Antihydrogen ions directed to free fall chamber**
  - Cooled, then photodetached, and finally, free-fall.



Philip Blumer, Moriond Gravitation (2023)



GBAR Collaboration, CERN-SPSC-2023-008

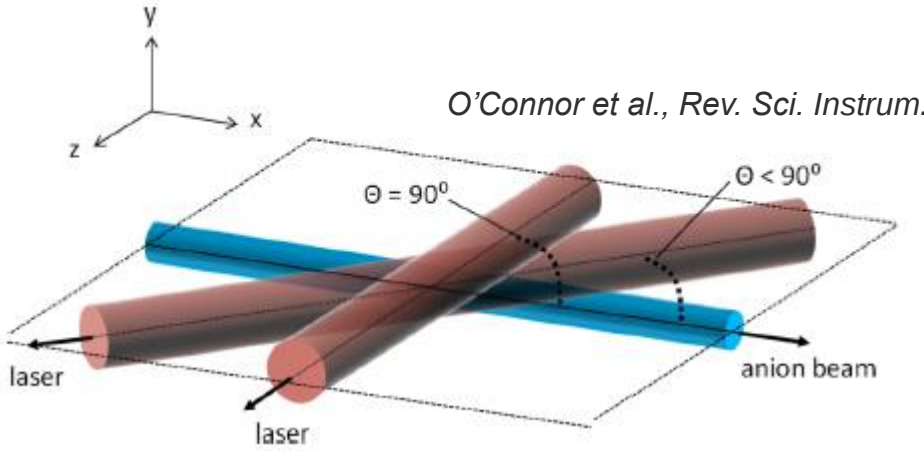
Photodetachment of H^-

Benchmark: Cross-section measurement of $\overline{H} + Ps \rightarrow \overline{H}^+ + e^-$.

- **Can use hydrogen as a proxy for antihydrogen: $H + Ps \rightarrow H^- + e^+$**

Have access to H^- beam from ELENA

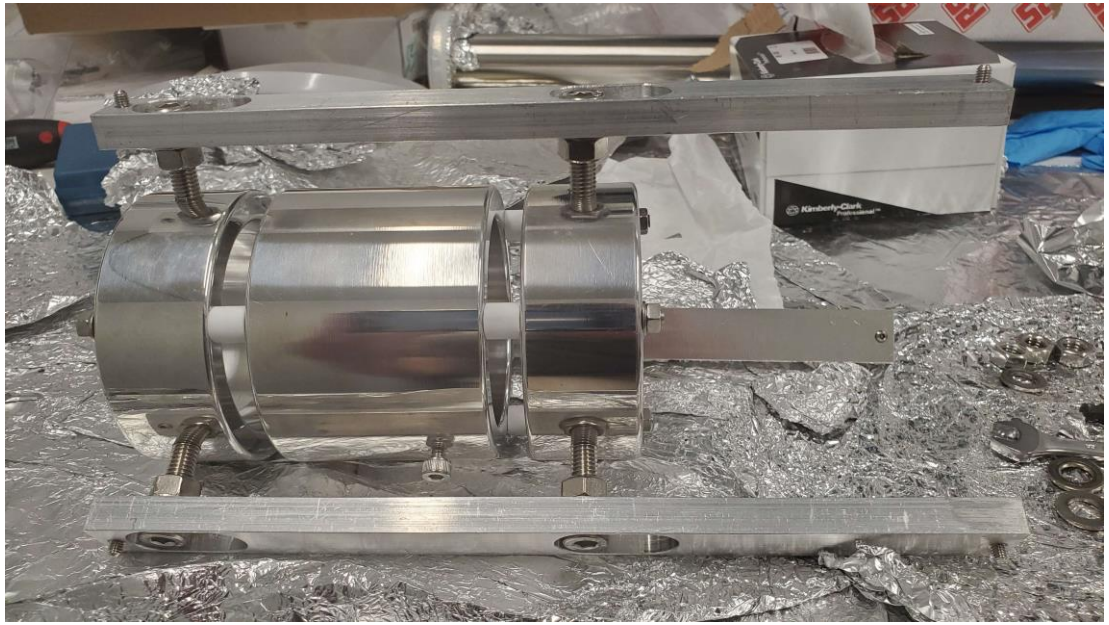
- **Photodetach H^- upon entering RC.**



O'Connor et al., Rev. Sci. Instrum. (2015)

Progress so far & tasks ahead:

- **Installing new optics for $\overline{p}$ / H^- line.**
- **Aligning optics for pulsed Photodetachment laser.**
- **Calculating photodetachment probabilities based on experimental parameters.**




BAR