**Motivation**

$$H_d = -\vec{d}_e \cdot \vec{E}$$

Permanent EDMs violate $T$ symmetry.

Many theories beyond the Standard Model predict $T$ violation and EDMs at current experimental precision.

**ACME II Apparatus**

1. **Buffer Gas Beam Source**
2. **Rotational Cooling**
3. **EDM State Preparation**
4. **Precission**
5. **State Readout**
6. **Magnetic Field Coils**
7. **Electric Field Plates**
8. **Detection**

**Solid angle enhancement**

$$d_e = h C_{accep} \tau$$

$C =$ measurement contrast
$\tau =$ coherence time
$$C_{accep} = \text{effective electric field}$$
$\eta =$ molecule flux
$\tau =$ integration time

Large $C_{accep}$ inside ThO molecule

**State Preparation**

Preparation of spin precession state performed via optical pumping with $\approx$ 6% efficiency.

Cohesive state preparation via STIRAP has $\approx 75\%$ demonstrated efficiency.

STIRAP gives $\approx 12 \times$ gain in state preparation.

See poster “Twelve-fold increase in the number of usable ThO molecules for the ACME electron electric-dipole measurement through STIRAP.” Panda et al.

**Refinement and readout beam control**

Monitor and feedback on preparation and readout beams to suppress anticipated Stark interference phase offset, and relative Doppler shift between two readout beams.

Also monitor and correct ellipticity in preparation and readout beams to suppress anticipated phase offset.

**Detection wavelength**

PMTs detect 512 nm with $\approx 75\%$ efficiency.

**Improve electric field plates**

High-power laser beams

**Thermal induced stress**

**Breakdown fields**

**Elipticity gradiences**

**Symmetry error**

**Summary of upgrades**

**Feature**

Anticipated systematic error improvement

**Beamline geometry**

$\approx 10 \times$

Suppressed STIRAP polarization fluctuations, AC Stark shifts, AC Stark interference.

**Fluorescence collection**

$\approx 2.5 \times$

Reduced field plates birefringence

**STIRAP state preparation**

$\approx 12 \times$

Suppress ellipticity gradients

**Detection wavelength**

$\approx 2.5 \times$

Monitor and feedback to reduce Stark interference.

**Total projected statistical improvement**

$\approx 380 \times$

Measure non-reversing magnetic field near spin precession region to suppress AC Stark shift phases.

**Thermochemical Beam Source**

Thermochemical target ($Th + ThO$)

**Equilibrium partial pressure of ThO**

$\approx 10^{-10}$

**Light collection**

Optimized collection optics using light pipes instead of fiber bundles with $\approx 50\%$ packing fraction increases detection by $\approx 2.5 \times$

**References**

More information: [www.electronedm.info](http://www.electronedm.info)

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5. “Ablation yield and pulse shapes.” Equilibrium partial pressure of ThO.